ESCAPE Training Manual

FOREWORD

This manual explains components, system operations and functions for the ESCAPE.

For proper repair and maintenance, a thorough familiarization with this manual is important, and it should always be kept in a handy place for quick and easy reference.

All the contents of this manual, including drawings and specifications, are the latest available at the time of printing. As modifications affecting repair or maintenance occur, relevant information supplementary to this volume will be made available at Ford dealers. This manual should be kept up-to-date.

Ford Motor Company reserves the right to alter the specifications and contents of this manual without obligation or advance notice.

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APPLICATION:
This manual is applicable to vehicles beginning with the Vehicle Identification Numbers (VIN), and related materials shown on the following page.

CONTENTS

VEHICLE IDENTIFICATION NUMBERS (VIN)

LFA CKZTNX✻2 000001—
LFA CLZTNX✻2 000001—
LFA CMZTVX✻2 000001—
LFA CNZTVX✻2 000001—
LFA YKZTNX✻2 000001—
LFA YLZTNX✻2 000001—
LFA YMZTVX✻2 000001—
LFA YNZTVX✻2 000001—

RELATED MATERIALS

ESCAPE Repair Manual F1A3-10-06C
ESCAPE Overhaul Manual F1A3-30-06C
ESCAPE Bodyshop Manual F342-20-06C
ESCAPE Wiring Diagrams F1A3-20-06C

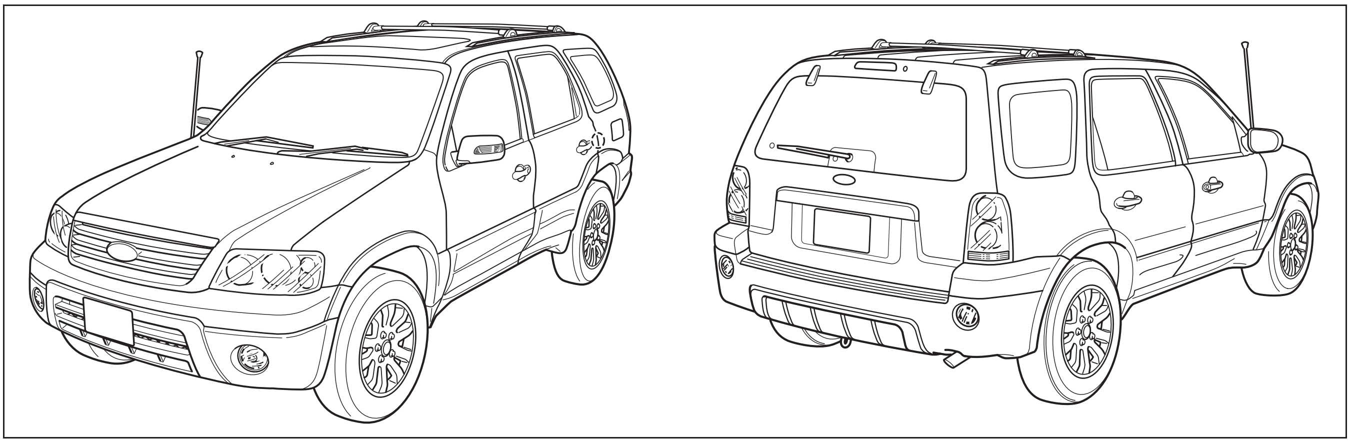
GENERAL INFORMATION

00-00 GENERAL INFORMATION

AIM OF DEVELOPMENT

id000000100100

External View



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Vehicle Outline
Engine
L3

- Mechanical
  - — L3 (2.3 L) 4-cylinder engines have been adopted.
  - — The lightweight, aluminum alloy cylinder block and lower block provide superior vibration resistance. Superior crank support stiffness combined with lightweight pistons and connecting rods have been adopted for a comfortable, liner drive feel.
  - — Low-tension piston rings, and shimless tappets have been adopted, minimizing friction losses and improving fuel economy.
  - — With the adoption of the variable valve timing mechanism, optimum valve timing corresponding to the engine operation condition is achieved.
  - — An auto-tensioner that automatically adjusts the belt to compensate for stretching has been adopted to minimize maintenance requirements.
- Intake and exhaust controls
  - — With the adoption of the variable intake air system, high torque is obtained from the lower-medium to high engine speed ranges.
  - — The variable tumble system has been adopted to promote the atomization of the air-fuel mixture and to improve emission gas purification efficiency.
  - — With the adoption of the variable valve timing system that controls intake valve timing in accordance with driving conditions to attain highly efficient air charging, maximum torque is achieved at all engine speeds.
  - — An exhaust gas recirculation (EGR) system has been adopted for all models resulting in cleaner exhaust emissions and reduced fuel consumption.

AJ (3.0L Duratec)

- Mechanical
  - — An aluminum-alloy cylinder head and cylinder block have been adopted.
- Intake and exhaust controls
  - — An exhaust gas recirculation (EGR) system has been adopted for all models resulting in cleaner exhaust emissions and reduced fuel consumption.

Suspension and steering

- Front suspension
  - — A strut suspension has been adopted.
- Rear suspension
  - — A multi-link suspension has been adopted.
- Power steering
  - — With the adoption of an engine speed sensing power steering mechanism, handling stability has been improved.

Brakes

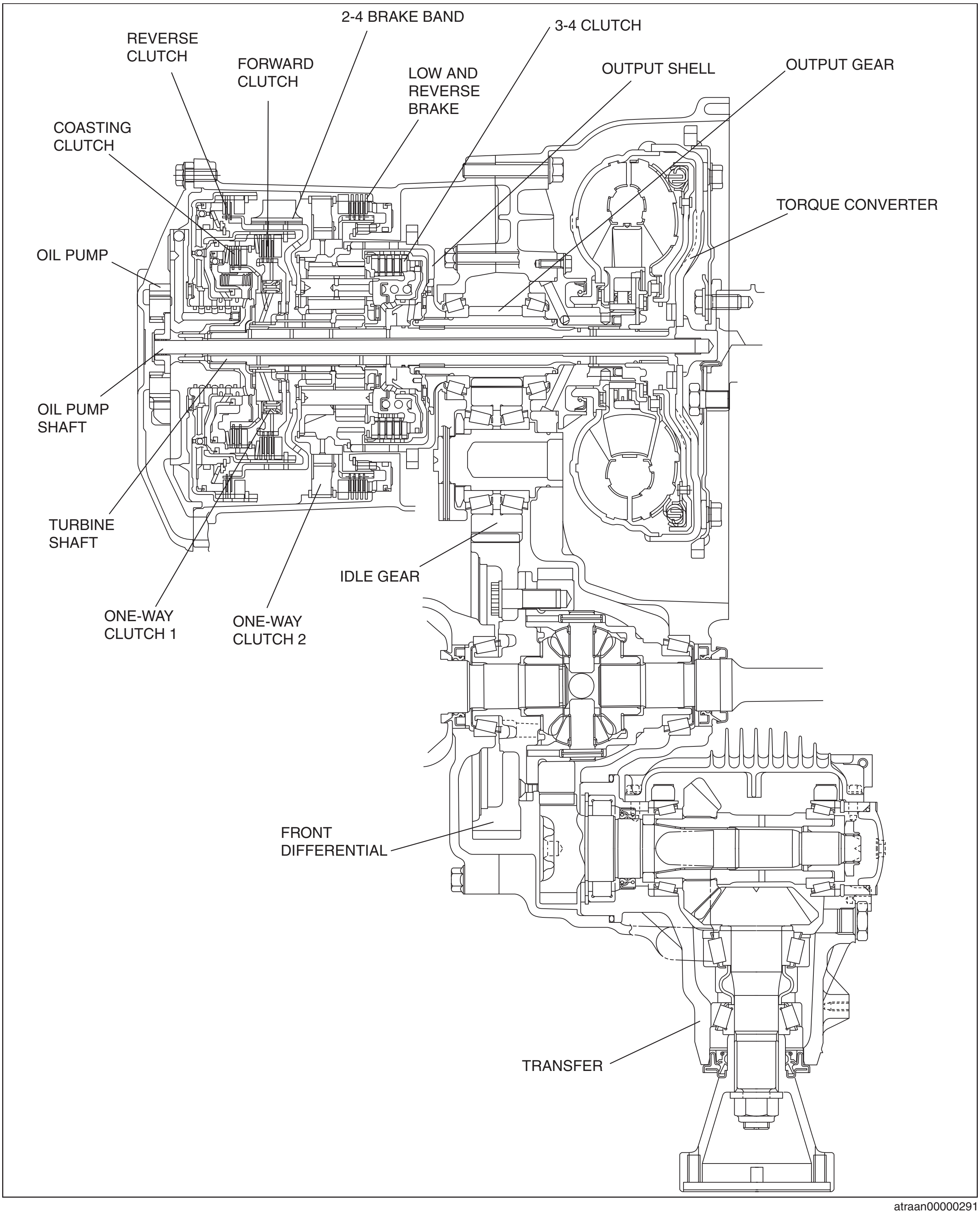
- A tandem-type master cylinder has been adopted, improving braking force.
- A large diameter, tandem diaphragm power brake unit has been adopted, improving braking force.
- A large diameter, ventilated disc-type front brake has been adopted, improving braking force.
- A large diameter, solid disc-type rear brake has been adopted, improving braking force.

ABS

- The ABS HU/CM, integrating both the hydraulic unit (HU) and control module (CM), has been adopted, resulting in size and weight reduction.

Transaxle/Transmission
Automatic transaxle [GF4AX-EL]

- GF4AX-EL automatic transaxles have been adopted for L3 engine vehicles.
  - — Duty cycle solenoid valves have been adopted to provide optimal hydraulic pressure control according to driving conditions.
  - — A 3-2 timing solenoid valve has been adopted to provide engagement timing control of the 2-4 brake band and 3-4 clutch to soften shift shock.
  - — A variable displacement, trochoid gear oil pump has been adopted to provide quiet and high-efficiency oil discharge.



atraan00000291

Automatic transaxle [LA4AX-EL (CD4E)]

- LA4AX-EL automatic transaxles have been adopted for AJ (3.0L Duratec) engine vehicles.
- The automatic transaxle is a four-speed, front wheel drive automatic transaxle with electronic controls for:
  - — Electronic pressure control for shift quality
  - — Shift scheduling
  - — 3-2 shift timing
  - — Engine braking using coast clutch
  - — TCC control
- The transaxle features a four element torque converter with a TCC and a geartrain that includes:
  - — Compound planetary gear set
  - — Chain drive
  - — Planetary gear set final drive
  - — Pinion and side gear differential
- The hydraulic control system of the transaxle has five solenoids that control:
  - — Shift feel, through line pressure control
  - — Shift scheduling, through shift valve positioning control
  - — Modulated application of the TCC
  - — Timing of 3-2 shifts
  - — Engine braking using coast clutch

Safety

- An immobilizer system has been adopted. This anti-theft device prevents the engine from being started unless the encrypted identification code, transmitted from a special electronic chip embedded in the key, corresponds with the identification code registered in the vehicle.
- Side air bags that effectively protect the chest area have been adopted for the seats.

VEHICLE IDENTIFICATION NUMBER (VIN) CODE

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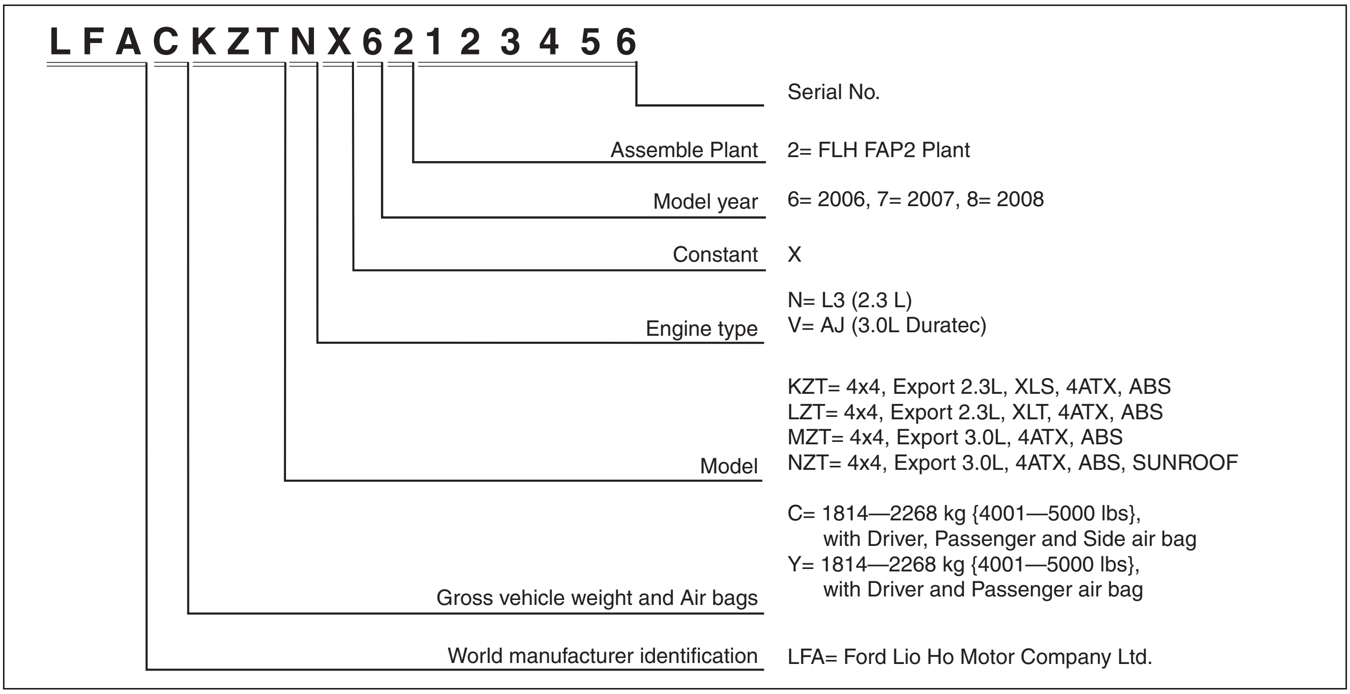

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VEHICLE IDENTIFICATION NUMBER (VIN)

id000000100300

LFA CKZTNX*2 000001—
LFA CLZTNX*2 000001—
LFA CMZTVX*2 000001—
LFA CNZTVX*2 000001—
LFA YKZTNX*2 000001—
LFA YLZTNX*2 000001—
LFA YMZTVX*2 000001—
LFA YNZTVX*2 000001—

UNITS

id000000100400

Electrical current	A (ampere)
Electric power	W (watt)
Electric resistance	ohm
Electric voltage	V (volt)
Length	mm (millimeter)
	in (inch)
Negative pressure	kPa (kilo pascal)
	mmHg (millimeters of mercury)
	inHg (inches of mercury)
Positive pressure	kPa (kilo pascal)
	kgf/cm^2 (kilogram force per square centimeter)
	psi (pounds per square inch)
Torque	N·m (Newton meter)
	kgf·m (kilogram force meter)
	kgf·cm (kilogram force centimeter)
	ft·lbf (foot pound force)
	in·lbf (inch pound force)
Volume	L (liter)
	US qt (U.S. quart)
	Imp qt (Imperial quart)
	ml (milliliter)
	cc (cubic centimeter)
	cu in (cubic inch)
	fl oz (fluid ounce)
Weight	g (gram)
	oz (ounce)

Conversion to SI Units (Système International d'Unités)

- All numerical values in this manual are based on SI units. Numbers shown in conventional units are converted from these values.

Rounding Off

- Converted values are rounded off to the same number of places as the SI unit value. For example, if the SI unit value is 17.2 and the value after conversion is 37.84, the converted value will be rounded off to 37.8.

Upper and Lower Limits

- When the data indicates upper and lower limits, the converted values are rounded down if the SI unit value is an upper limit and rounded up if the SI unit value is a lower limit. Therefore, converted values for the same SI unit value may differ after conversion. For example, consider 2.7 kgf/cm^2 in the following specifications:

210—260 kPa {2.1—2.7 kgf/cm^2, 30—38 psi}
270—310 kPa {2.7—3.2 kgf/cm^2, 39—45 psi}

- The actual converted values for 2.7 kgf/cm^2 are 265 kPa and 38.4 psi. In the first specification, 2.7 is used as an upper limit, so the converted values are rounded down to 260 and 38. In the second specification, 2.7 is used as a lower limit, so the converted values are rounded up to 270 and 39.

NEW STANDARDS

id000000801400

- Following is a comparison of the previous standard and the new standard.

New Standard		Previous Standard		Remark
Abbreviation	Name	Abbreviation	Name	
AP	Accelerator Pedal	—	Accelerator Pedal	
APP	Accelerator Pedal Position	—	Accelerator Pedal Position	
ACL	Air Cleaner	—	Air Cleaner	

New Standard		Previous Standard		Remark
Abbreviation	Name	Abbreviation	Name	
A/C	Air Conditioning	—	Air Conditioning	
BARO	Barometric Pressure	—	Atmospheric Pressure	
B+	Battery Positive Voltage	V_B	Battery Voltage	
—	Brake Switch	—	Stoplight Switch	
—	Calibration Resistor	—	Corrected Resistance	#6
CMP sensor	Camshaft Position Sensor	—	Crank Angle Sensor	
LOAD	Calculated Load Voltage	—	—	
CAC	Charge Air Cooler	—	Intercooler	
CLS	Closed Loop System	—	Feedback System	
CTP	Closed Throttle Position	—	Fully Closed	
CPP	Clutch Pedal Position	—	Clutch Position	
CIS	Continuous Fuel Injection System	EGI	Electronic Gasoline Injection System	
CS sensor	Control Sleeve Sensor	CSP sensor	Control Sleeve Position Sensor	#6
CKP sensor	Crankshaft Position Sensor	—	Crank Angle Sensor 2	
DLC	Data Link Connector	—	Diagnosis Connector	
DTM	Diagnostic Test Mode	—	Test Mode	#1
DTC	Diagnostic Trouble Code(s)	—	Service Code(s)	
DI	Distributor Ignition	—	Spark Ignition	
DLI	Distributorless Ignition	—	Direct Ignition	
EI	Electronic Ignition	—	Electronic Spark Ignition	#2
ECT	Engine Coolant Temperature	—	Water Thermo	
EM	Engine Modification	—	Engine Modification	
—	Engine Speed Input Signal	—	Engine RPM Signal	
EVAP	Evaporative Emission	—	Evaporative Emission	
EGR	Exhaust Gas Recirculation	—	Exhaust Gas Recirculation	
FC	Fan Control	—	Fan Control	
FF	Flexible Fuel	—	Flexible Fuel	
4GR	Fourth Gear	—	Overdrive	
—	Fuel Pump Relay	—	Circuit Opening Relay	#3
FSO solenoid	Fuel Shut Off Solenoid	FCV	Fuel Cut Valve	#6
GEN	Generator	—	Alternator	
GND	Ground	—	Ground/Earth	
HO2S	Heated Oxygen Sensor	—	Oxygen Sensor	With heater
IAC	Idle Air Control	—	Idle Speed Control	
—	IDM Relay	—	Spill Valve Relay	#6
—	Incorrect Gear Ratio	—	—	
—	Injection Pump	FIP	Fuel Injection Pump	#6
—	Input/Turbine Speed Sensor	—	Pulse Generator	
IAT	Intake Air Temperature	—	Intake Air Thermo	
KS	Knock Sensor	—	Knock Sensor	
MIL	Malfunction Indicator Lamp	—	Malfunction Indicator Light	
MAP	Manifold Absolute Pressure	—	Intake Air Pressure	
MAF	Mass Air Flow	—	Mass Air Flow	
MAF sensor	Mass Air Flow Sensor	—	Airflow Sensor	
MFL	Multiport Fuel Injection	—	Multiport Fuel Injection	
OBD	On-Board Diagnostic	—	Diagnosis/Self Diagnosis	
OL	Open Loop	—	Open Loop	
—	Output Speed Sensor	—	Vehicle Speed Sensor 1	
OC	Oxidation Catalytic Converter	—	Catalytic Converter	
O2S	Oxygen Sensor	—	Oxygen Sensor	
PNP	Park/Neutral Position	—	Park/Neutral Range	
PID	Parameter Identification	—	Parameter Identification	

New Standard		Previous Standard		Remark
Abbrevi-ation	Name	Abbrevi-ation	Name	
—	PCM Control Relay	—	Main Relay	#6
PSP	Power Steering Pressure	—	Power Steering Pressure	
PCM	Powertrain Control Module	ECU	Engine Control Unit	#4
—	Pressure Control Solenoid	—	Line Pressure Solenoid Valve	
PAIR	Pulsed Secondary Air Injection	—	Secondary Air Injection System	Pulsed injection
—	Pump Speed Sensor	—	NE Sensor	#6
RAM	Random Access Memory	—	—	
AIR	Secondary Air Injection	—	Secondary Air Injection System	Injection with air pump
SAPV	Secondary Air Pulse Valve	—	Reed Valve	
SFI	Sequential Multipoint Fuel Injection	—	Sequential Fuel Injection	
—	Shift Solenoid A	—	1–2 Shift Solenoid Valve	
		—	Shift A Solenoid Valve	
—	Shift Solenoid B	—	2–3 Shift Solenoid Valve	
		—	Shift B Solenoid Valve	
—	Shift Solenoid C	—	3–4 Shift Solenoid Valve	
3GR	Third Gear	—	3rd Gear	
TWC	Three Way Catalytic Converter	—	Catalytic Converter	
TB	Throttle Body	—	Throttle Body	
TP	Throttle Position	—	—	
TP sensor	Throttle Position Sensor	—	Throttle Sensor	
TCV	Timer Control Valve	TCV	Timing Control Valve	#6
TCC	Torque Converter Clutch	—	Lockup Position	
TCM	Transmission (Transaxle) Control Module	—	EC-AT Control Unit	
—	Transmission (Transaxle) Fluid Temperature Sensor	—	ATF Thermosensor	
TR	Transmission (Transaxle) Range	—	Inhibitor Position	
TC	Turbocharger	—	Turbocharger	
VSS	Vehicle Speed Sensor	—	Vehicle Speed Sensor	
VR	Voltage Regulator	—	IC Regulator	
VAF sensor	Volume Air Flow Sensor	—	Air Flow Sensor	
WUTWC	Warm Up Three Way Catalytic Converter	—	Catalytic Converter	#5
WOT	Wide Open Throttle	—	Fully Open	

#1: Diagnostic trouble codes depend on the diagnostic test mode
#2: Controlled by the PCM
#3: In some models, there is a fuel pump relay that controls pump speed. That relay is now called the fuel pump relay (speed).
#4: Device that controls engine and powertrain
#5: Directly connected to exhaust manifold
#6: Part name of diesel engine

ENGINE

01 SECTION

01

01-00A OUTLINE [L3]

ENGINE ABBREVIATIONS[L3]

id0100a1100100

ABDC	After Bottom Dead Center
ABS	Antilock Brake System
ATDC	After Top Dead Center
ATF	Automatic Transaxle Fluid
BBDC	Before Bottom Dead Center
BDC	Bottom Dead Center
BTDC	Before Top Dead Center
CAN	Controller Area Network
CCM	Comprehensive Component Monitor
CM	Control Module
DC	Drive Cycle
DOHC	Double Overhead Camshaft
EBD	Electronic Brakeforce Distribution
EX	Exhaust
FFD	Freeze Frame Data
HU	Hydraulic Unit
IN	Intake
KOEO	Key On Engine Off
KOER	Key On Engine Running
M	Motor
LF	Left Front
LR	Left Rear
OCV	Oil Control Valve
PCV	Positive Crankcase Ventilation
RF	Right Front
RR	Right Rear
SEI	Single Electronic Ignition
SST	Special Service Tool
TDC	Top Dead Center

ENGINE FEATURES[L3]

id0100a1100200

On-board Diagnostic

To meet the EOBD regulations	• Diagnostic test modes adopted
Improved serviceability	• DTCs adopted • KOEO/KOER self-test function adopted • PID/DATA monitor function adopted • Simulation test function adopted

Mechanical

Improved engine performance	• Variable valve timing mechanism adopted
Weight reduction	• Aluminum-alloy adopted for mainframe parts (cylinder head and block)
Reduced vibration and noise	• Aluminum-alloy cylinder head adopted • Crankshaft pulley with torsional damper adopted • Silent timing chain adopted • Deep skirt-type cylinder block adopted, composed of an integrated main bearing cap together with a ladder frame structure • Pendulum-type engine mounts adopted
Improved serviceability	• Serpentine type drive belt adopted • Drive belt auto tensioner adopted • Timing chain adopted • Engine front cover with service holes adopted

Lubrication

Reduced noise	• Aluminum alloy oil pan adopted
Reduced weight	• Plastic oil strainer adopted
Improved lubricity	• Trochoid gear type oil pump adopted • Oil jet valves adopted

Cooling System

Improved reliability	• Degassing type coolant reserve tank adopted
Reduced weight	• Cross flow type radiator with aluminum core and plastic tank adopted • Stainless steel thermostat with plastic thermostat cover adopted
Miniaturization	• Built-in type water pump adopted
Reduced engine noise and vibration	• Electric cooling fans adopted
Improved serviceability	• Longer-life new engine coolant (type FL22) adopted

Intake-air System

Improved engine torque	• Variable intake air system adopted
Improved noise reduction	• Resonance chamber adopted
Improved emission gas purification	• Variable tumble system adopted

Fuel System

Improved serviceability	• Nylon tubes adopted for fuel hoses in engine compartment and around fuel tank; Quick release connectors adopted for joints
Reduction of evaporative gas	• Returnless fuel system adopted

Emission System

Improved emission gas purification	• Exhaust gas recirculation (EGR) system adopted • Catalytic converter system adopted

Charging System

Miniaturization	• Non-regulator type generator with built-in power transistor adopted
Reduced operation noise	• Generator with two delta connection type stator coils adopted

Ignition System

Improved reliability	• Independent ignition control system with distributorless ignition coils adopted
Improved durability	• Spark plugs with an iridium alloy center electrode and platinum tip ground electrode adopted

Starting System

Improved startability	• Reduction type starter adopted

Control System

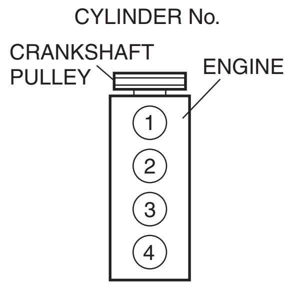
Improved engine torque and output	• Variable intake air control adopted
Improved emission performance	• Variable tumble control adopted • EGR system adopted
Wiring harness simplification	• CAN adopted

ENGINE SPECIFICATION[L3]

id0100a1100300

Specification

Item				Specification
MECHANICAL				
Type				Gasoline, 4-cycle
Cylinder arrangement and number				In-line, 4-cylinder
Combustion chamber				Pentroof
Valve system				DOHC, timing chain driven, 16 valves
Displacement			(ml {cc, cu in})	2,261 {2,261, 137.9}
Bore × stroke			(mm {in})	87.5 × 94.0 {3.44 × 3.70}
Compression ratio				10:1
Compression pressure			(kPa {kgf/cm^2, psi} [rpm])	1,430 {14.5819, 207.404} [290]
Valve timing	IN	Open	BTDC (°)	0—30
		Close	ABDC (°)	62—32
	EX	Open	BBDC (°)	42
		Close	ATDC (°)	5
Valve clearance	(mm {in})	IN		0.22—0.28 {0.0087—0.011} [Engine cold]
		EX		0.27—0.33 {0.0106—0.012} [Engine cold]
LUBRICATION SYSTEM				
Type				Force-fed type
Oil pressure (reference value) [oil temperature: 100°C {212°F}]			(kPa {kgf/cm^2, psi} [rpm])	337—591 {3.44—6.03, 49.0—85.8} [3,000]
Oil pump	Type			Trochoid gear type
	Relief valve opening pressure (reference value)		(kPa {kgf/cm^2, psi})	420—520 {4.28—5.30, 60.9—75.4}
Oil filter	Type			Full-flow, paper element
	Bypass pressure		(kPa {kgf/cm^2, psi})	80—120 {0.82—1.22, 11.6—17.4}
Oil capacity (approx. quantity)	Total (dry engine)		(L {US qt, Imp qt})	5.1 {5.4, 4.5}
	Oil replacement		(L {US qt, Imp qt})	4.0 {4.2, 3.5}
	Oil and oil filter replacement		(L {US qt, Imp qt})	4.4 {4.6, 3.9}
COOLING SYSTEM				
Type				Water-cooled, Electromotive
Coolant capacity (approx. quantity)			(L {US qt, Imp qt})	7.5 {7.9, 6.6}
Water pump	Type			Centrifugal, V-ribbed belt-driven
Thermostat	Type			Wax, bottom-bypass
	Opening temperature		(°C {°F})	80—84 {176—183}
	Full-open temperature		(°C {°F})	97 {207}
	Full-open lift		(mm {in})	8.0 {0.31} or more
Radiator	Type			Corrugated fin
Cooling system cap	Cap valve opening pressure		(kPa {kgf/cm^2, psi})	93.2—122.6 {0.95—1.25, 13.5—17.8}

Item			Specification
Cooling fan	Type		Electric
Cooling fan	Number of blades		No.1: 5 No.2: 7
Cooling fan	Outer diameter	(mm {in})	300 {11.8}
Cooling fan	Fan motor output	(W)	No.1: 70 No.2: 120
FUEL SYSTEM			
Injector		Type	Multiple hole type
Injector		Type of fuel delivery	Top-feed
Injector		Type of drive	Electronic
Pressure regulator control pressure (within the fuel tank)		(kPa {kgf/cm^2, psi})	Approx. 390 {3.98, 56.6}
Fuel pump		Type	Electric
Fuel tank	Capacity	(L {US gal, Imp gal})	61.0 {16.1, 13.4}
Fuel	Type		Regular unleaded fuel (Research octane number is 90 or above)
EMISSION SYSTEM			
EGR		Type	Stepping motor
Catalyst		Type	WU-TWC (monolith) TWC (monolith)
EVAP control system		Type	Charcoal canister type
PCV system		Type	Closed type
CHARGING SYSTEM			
Battery	Voltage	(V)	12
Battery	Type and capacity (5-hour rate)	(A·h)	55D23L (48)
Generator	Output	(V-A)	12-110
Generator	Regulated voltage	(V)	13—15 (Controlled by PCM)
Generator	Diagnosis function		On-board diagnostic system (Controlled by PCM)
IGNITION SYSTEM			
Ignition system	Type		SEI (Single Electronic Ignition)
Ignition system	Spark advance		Electronic
Ignition system	Firing order		1—3—4—2 (all cylinders independent firing) 
Spark plug	Type		LFG1 18 110 (ILTR5A-13G), L3Y2 18 110
STARTING SYSTEM			
Starter	Type		Coaxial reduction
Starter	Output	(kW)	1.4
CONTROL SYSTEM			
PSP switch		Type	ON/OFF
ECT sensor		Type	Thermistor
IAT sensor (Inside MAF sensor)		Type	Thermistor
TP sensor		Type	Hall element
APP sensor		Type	Hall element
MAF sensor		Type	Hot-wire
HO2S (front)		Type	Zirconia element (All range air/fuel ratio sensor)
HO2S (rear)		Type	Zirconia element (Stoichiometric air/fuel ratio sensor)

Item		Specification
KS	Type	Piezoelectric element
MAP sensor	Type	Piezoelectric element
CKP sensor	Type	Hall element
CMP sensor	Type	Hall element

Recommended engine oil

Item	Specification
Grade	API SG/SH/SJ/SL or ILSAC GF–2/GF–3
Viscosity (SAE)	40, 30, 20, 20W–20, 10W–30, 10W–40, 10W–50, 20W–40, 15W–40, 20W–50, 15W–50, 5W–20, 5W–30

01-00B OUTLINE [AJ (3.0L Duratec)]

ENGINE ABBREVIATIONS[AJ (3.0L Duratec)]

id0100a2100100

ABDC	After Bottom Dead Center
ABS	Antilock Brake System
ATDC	After Top Dead Center
ATF	Automatic Transaxle Fluid
ATX	Automatic Transaxle
BBDC	Before Bottom Dead Center
BDC	Bottom Dead Center
BTDC	Before Top Dead Center
CAN	Controller Area Network
CCM	Comprehensive Component Monitor
DC	Drive Cycle
D.P.F.	Differential Pressure Feedback
EX	Exhaust
HLA	Hydraulic Lash Adjuster
IG	Ignition
IN	Intake
KOEO	Key On Engine Off
KOER	Key On Engine Running
LH	Left Hand
M	Motor
O/D	Overdrive
OFF	Switch Off
ON	Switch On
OSS	Output Shaft Speed
P/S	Power Steering
RH	Right Hand
SST	Special Service Tool
TDC	Top Dead Center
TFT	Transaxle Fluid Temperature
TSS	Turbine Shaft Speed

ENGINE FEATURES[AJ (3.0L Duratec)]

id0100a2100200

Mechanical

Reduced weight	• Aluminum alloy oil pan adopted • Aluminum alloy engine mount bracket adopted
Reduced engine noise and vibration	• Silent timing chain adopted • Crankshaft pulley with torsional damper adopted
Improved serviceability	• Drive belt auto tensioner adopted • Timing chain adopted • Engine front cover with service holes adopted

Lubrication

Reduced noise	• Aluminum alloy oil pan adopted
Improved lubricity	• Trochoid gear type oil pump adopted • Water-cooled type oil cooler adopted

Cooling System

Improved reliability	• Degassing type coolant reserve tank adopted
Reduced weight	• Cross flow type radiator with aluminum core and plastic tank adopted
Reduced engine noise and vibration	• Electric cooling fans adopted
Improved serviceability	• Longer-life new engine coolant (type FL22) adopted

Intake-air System

Improved noise reduction	• Resonance chamber adopted

Fuel System

Improved serviceability	• Nylon tubing for fuel hoses in the engine compartment and around the fuel tank, and quick release connectors on the connecting parts adopted
Evaporative gas reduction	• Returnless fuel system adopted

Emission System

Improved emission gas purification	• EGR system adopted • Catalytic converter system (three-way catalyst) adopted

Charging System

Improved reliability	• Generator with built-in power transistor adopted

Ignition System

Improved reliability	• Independent ignition control system with distributorless ignition coils adopted

Starting System

Improved startability	• Reduction type starter adopted

Control System

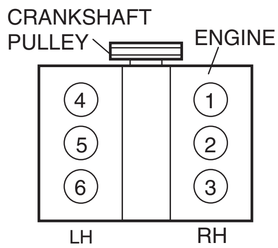
Improved emission gas purification	• EGR control adopted

ENGINE SPECIFICATION[AJ (3.0L Duratec)]

id0100a2100300

Specification

Item			Specification
MECHANICAL			
Type			Gasoline, 4-cycle
Cylinder arrangement and number			60 ° V configuration, 6-cylinder
Combustion chamber			Pentroof
Valve system			DOHC, timing chain driven, 24 valves
Displacement		(ml {cc, cu in})	2,967 {2,967, 181.0}
Bore × stroke		(mm {in})	89.0 × 79.5 {3.50 × 3.13}
Compression ratio			10.0 : 1
Compression pressure		(kPa {kgf/cm^2, psi} [rpm])	1,480 {15.10,215} [210]
Valve timing	IN	Open BTDC (°)	4
		Close ABDC (°)	48
	EX	Open BBDC (°)	56
		Close ATDC (°)	12
Valve clearance (Engine cold)	IN	(mm {in})	0 {0} Maintenance-free
	EX		
LUBRICATION SYSTEM			
Type			Force-fed type
Oil pressure (reference value) [oil temperature: 100°C {212°F}]		(kPa {kgf/cm^2, psi} [rpm])	103 {1.1, 15} min [1,500]
Oil pump	Type		Trochoid gear type
	Relief valve opening pressure (reference value)	(kPa {kgf/cm^2, psi})	485 {4.95, 70.3}
Oil cooler	Type		Water-cooled
Oil filter	Type		Full-flow, paper element
	Bypass pressure	(kPa {kgf/cm^2, psi})	125—151 {1.3—1.5, 18—22}
Oil capacity (approx. quantity)	Total (dry engine)	(L {US qt, Imp qt})	6.2 {6.6, 5.5}
	Oil replacement	(L {US qt, Imp qt})	5.2 {5.5, 4.6}
	Oil and oil filter replacement	(L {US qt, Imp qt})	5.7 {6.0, 5.0}
COOLING SYSTEM			
Type			Water-cooled, Electromotive
Coolant capacity (approx. quantity)		(L {US qt, Imp qt})	10.0 {10.6, 8.80}
Water pump	Type		Centrifugal, V-ribbed belt-driven
Thermostat	Type		Wax, bottom-bypass
	Opening temperature	(°C {°F})	84—88 {184—190}
	Full-open temperature	(°C {°F})	99 {210}
	Full-open lift	(mm {in})	7.3 {0.29} or more
Radiator	Type		Corrugated fin
Cooling system cap	Cap valve opening pressure	(kPa {kgf/cm^2, psi})	93.2—122.6 {0.95—1.25, 13.5—17.8}
Cooling fan	Type		Electric
	Number of blades		No.1: 5 No.2: 6
	Outer diameter	(mm {in})	No.1, No.2: 320
	Fan motor output	(W)	No.1, No.2: 220
INTAKE-AIR SYSTEM			
Air cleaner element	Type		Paper element (dry type)

Item		Specification
FUEL SYSTEM		
Injector	Type	Multiple hole type
	Fuel supply type	Top-feed
	Drive types	Electronic
Pressure regulator control pressure	(kPa {kgf/cm^2, psi})	Approx. 450 {4.59, 65.3}
Fuel pump type		Electric
Fuel tank	Capacity (L {US gal, Imp gal})	61.0 {16.1, 13.4}
Fuel type		Unleaded (RON 90 or above)
EMISSION SYSTEM		
EGR type		Vacuum control
Catalyst type		WU-TWC
Evaporative emission (EVAP) control system		Canister type
Positive crankcase ventilation (PCV) system		Closed type
CHARGING SYSTEM		
Battery	Voltage (V)	12
	Type and capacity (5-hour rate) (A·h)	80D26L (55)
Generator	Output (V-A)	13.5-110
	Regulated voltage (V)	13—15
	Self diagnosis function	Equipped
IGNITION SYSTEM		
Ignition system	Type	SEI (Single Electronic Ignition)
	Spark advance	Electronic
	Firing order	1—4—2—5—3—6 CYLINDER No. 
Spark plug	Type	AJ11 18 110 (AGSF-32N)
STARTING SYSTEM		
Starter	Type	Coaxial reduction
	Output (kW)	1.4
CONTROL SYSTEM		
ECT sensor		Thermistor
IAT sensor (Inside MAF)		Thermistor
TP sensor		Potentiometer type
MAF sensor		Hot wire
HO2S		Zirconia element (Stoichiometric air/fuel ratio sensor)
CKP sensor		Pickup type
CMP sensor		Pickup type
D.P.F. EGR sensor		Piezoelectric element type

Recommended engine oil

Item	Specification
Grade	API SM or ILSAC GF–4
Viscosity (SAE)	5W–30

01-02A ON-BOARD DIAGNOSTIC [L3]

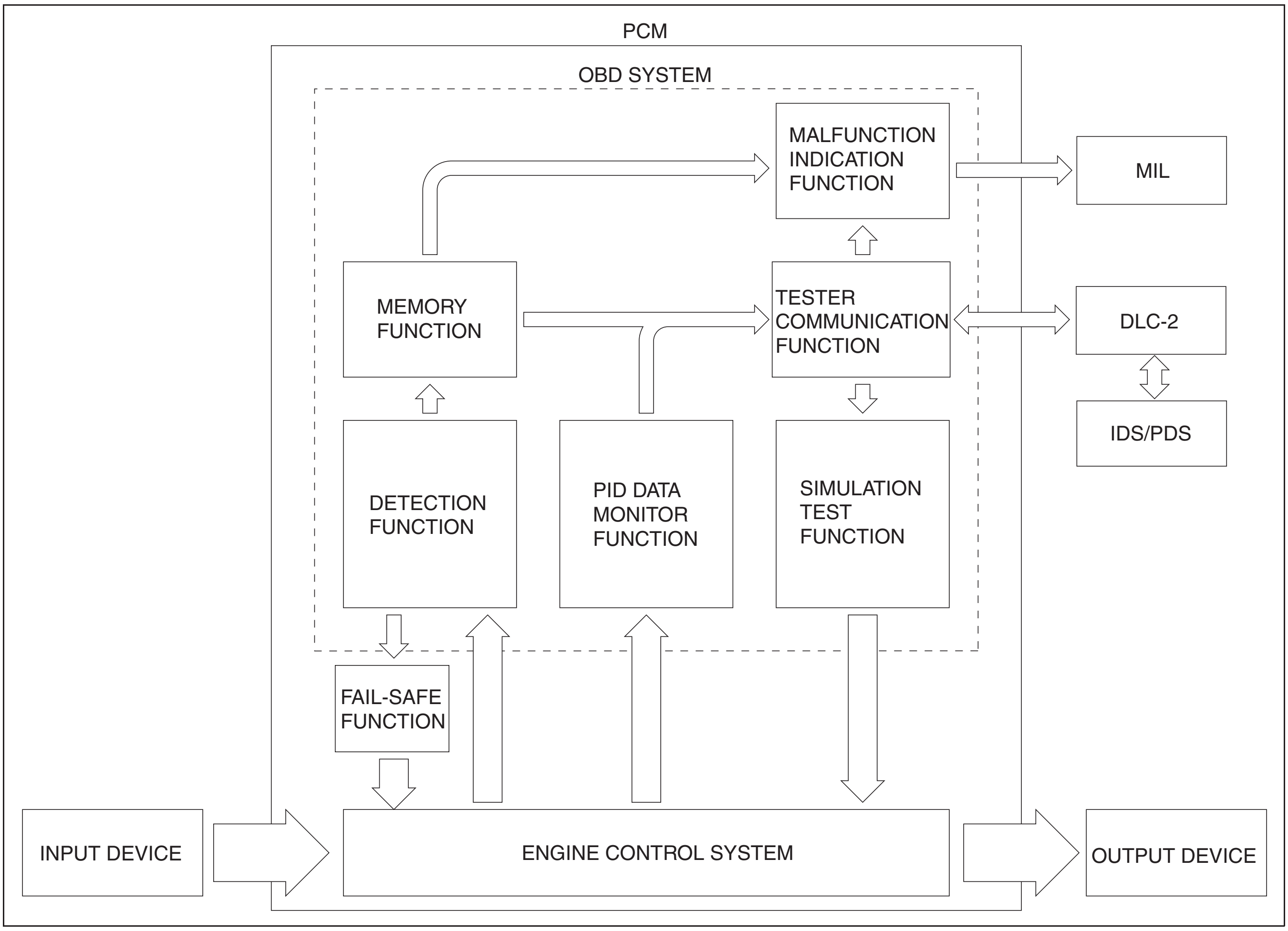
ON-BOARD DIAGNOSTIC OUTLINE[L3]

id0102a2100100

Features

To meet the EOBD regulations	• Diagnostic test modes adopted
Improved serviceability	• DTCs adopted • KOEO/KOER self-test function adopted • PID/DATA monitor function adopted • Simulation test function adopted

Block Diagram



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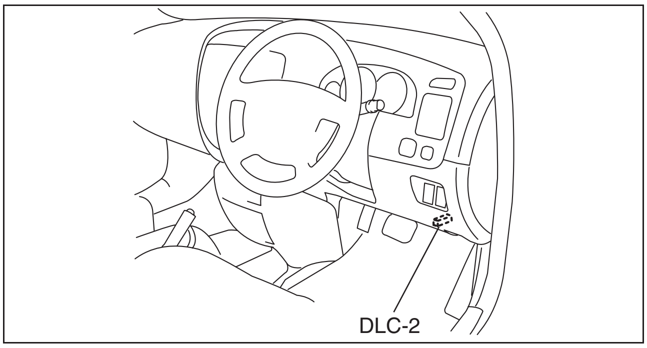
ON-BOARD DIAGNOSTIC SYSTEM EXTERNAL DIAGNOSTIC UNIT COMMUNICATION FUNCTION[L3]

id0102a2141800

Features

- The data link connector 2 (DLC-2) conforming to International Organization for Standardization (ISO) standards has been added.



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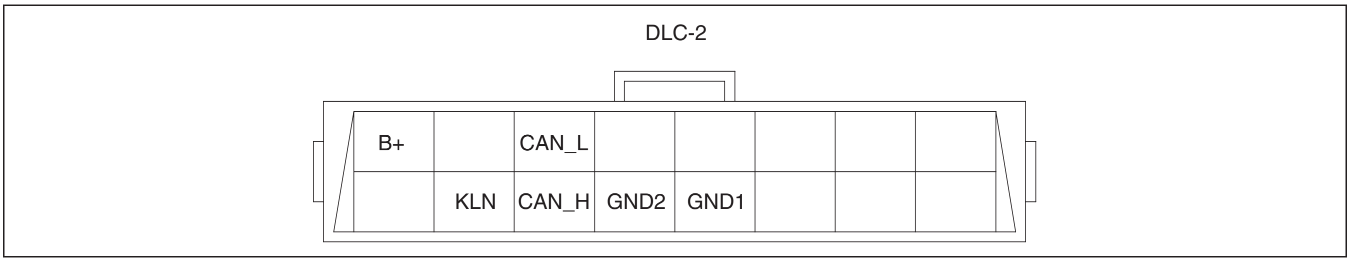
DLC-2

- A connector (DLC-2) conforming to International Organization for Standardization (ISO) standards has been added.
- Shape and terminal arrangement as stipulated by the ISO 15031-3 (SAE J1962) international standard has been adopted for this connector. The connector has a 16-pin construction that includes the CAN_H, CAN_L, KLN, GND1, GND2 and B+ terminals.



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Terminal	Function
KLN	Serial communication terminal (Malfunction diagnosis use)
CAN_L	Serial communication terminal (LO)
CAN_H	Serial communication terminal (HI)
GND1	Body GND terminal
GND2	Serial communication GND terminal
B+	Battery power supply terminal

DIAGNOSTIC TEST MODE[L3]

id0102a2100200

- To match the OBD regulations, the following diagnostic test modes have been supported.

Diagnostic test mode	Item
Mode 01	Sending diagnostic data (PID data monitor/On-board system readiness test)
Mode 02	Sending freeze frame data
Mode 03	Sending emission-related malfunction code (Diagnostic trouble code: DTC)
Mode 04	Clearing/resetting emission-related malfunction information
Mode 05	Sending oxygen sensor monitor test results
Mode 07	Sending continuous monitoring system test results (pending code)

- The diagnostic test modes are as shown below.

Sending Diagnostic Data (Mode 01)

PID data monitor

- The PID monitoring items are shown in the table.

PID data monitor table

Full names	Condition/unit	
Diagnostic trouble code counter	–	
Malfunction indicator	ON/OFF	
Fuel system loop status	Refer to table below.	
Engine load calculated value	%	
Engine coolant temperature	°C	°F
Short fuel trim	%	
Long fuel trim	%	
Intake manifold absolute pressure	%	kPa
Engine speed	rpm	
Vehicle speed	km/h	mph
Spark advance	BTDC	
Intake air temperature	°C	°F
Mass air flow	g/s	
Throttle position	%	
Oxygen sensor location	–	
Front heated oxygen sensor	V	
Rear heated oxygen sensor	V	
OBD requirement to which vehicle designed	–	
Distance travelled while MI is activated	km	miles

Meaning of FUEL SYS1

Display	Meaning
-NA-	Not applicable
OPEN	Feedback stops: Engine coolant temperature is lower than the determined feedback zone.
CLOSE	Feedback operating: HO2S being used for feedback is okay.
OP DRV	Feedback stops: Open loop due to driving condition.
OP SYS	Feedback stops: Open loop due to detected system fault.
CL O2S	Feedback operating: Malfunction occurred in HO2S (rear) system.

On-board system readiness test

- The items supported by the on-board system readiness test are shown below.

  Continuous monitoring system

  — Misfire monitoring

  — Fuel system monitoring

  — Comprehensive component monitoring (CCM)

  Intermittent monitoring system

  — Catalyst monitoring

  — HO2S monitoring

  — HO2S heater monitoring

Sending Freeze Frame Data (FFD) (Mode 02)

- The FFDs are shown in the table.

FFD monitor table

Full names	Condition/unit	
DTC that caused required FFD storage	–	
Fuel system loop status	OPEN: NON-F/B, CLOSE: F/B	
Engine load calculated value	%	
Engine coolant temperature	°C	°F
Short fuel trim	%	
Long fuel trim	%	
Intake manifold absolute pressure	%	kPa
Engine speed	rpm	
Vehicle speed	km/h	mph
Spark advance	BTDC	
Intake air temperature	°C	°F
Mass air flow	g/s	
Throttle position	%	

Sending Emission-related Malfunction code (DTC) (Mode 03)

- The DTCs are shown in the table.

DTC table

×: Applicable
—: Not applicable

DTC No.	Condition	MIL	DC	Monitor item	Self-test type*1	Memory function
B1342	PCM malfunction	OFF	—	Other	C, O	—
P0011	CMP timing over-advanced	ON	1	CCM	C, R	×
P0012	CMP timing over-retarded	ON	2	CCM	C, R	×
P0030	Front HO2S heater control circuit problem	ON	2	HO2S heater	C, O, R	×
P0031	Front HO2S heater circuit low input	ON	2	HO2S heater	C, O, R	×
P0032	Front HO2S heater circuit high input	ON	2	HO2S heater	C, O, R	×
P0037	Rear HO2S heater circuit low input	ON	2	HO2S heater	C, O, R	×
P0038	Rear HO2S heater circuit high input	ON	2	HO2S heater	C, O, R	×
P0069	Manifold absolute pressure/atmospheric pressure correlation	ON	2	CCM	C	×
P0101	MAF sensor circuit range/performance problem	ON	2	CCM	C	×
P0102	MAF sensor circuit low input	ON	1	CCM	C, O, R	×
P0103	MAF sensor circuit high input	ON	1	CCM	C, O, R	×
P0107	MAP sensor circuit low input	ON	1	CCM	C, O, R	×
P0108	MAP sensor circuit high input	ON	1	CCM	C, O, R	×
P0111	IAT sensor circuit range/performance problem	ON	2	CCM	C	×
P0112	IAT sensor circuit low input	ON	1	CCM	C, O, R	×
P0113	IAT sensor circuit high input	ON	1	CCM	C, O, R	×
P0117	ECT sensor circuit low input	ON	1	Engine cooling system	C, O, R	×
P0118	ECT sensor circuit high input	ON	1	Engine cooling system	C, O, R	×
P0122	TP sensor No.1 circuit low input	ON	1	CCM	C, O, R	×
P0123	TP sensor No.1 circuit high input	ON	1	CCM	C, O, R	×
P0125	Excessive time to enter closed loop fuel control	ON	2	Engine cooling system	C	×
P0131	Front HO2S circuit low input	ON	2	HO2S	C, O, R	×
P0132	Front HO2S circuit high input	ON	2	HO2S	C, O, R	×
P0133	Front HO2S circuit problem	ON	2	HO2S	C	×
P0134	Front HO2S no activity detected	ON	2	HO2S	C, R	×
P0138	Rear HO2S circuit high input	ON	2	HO2S	C, O, R	×
P0140	Rear HO2S no activity detected	ON	2	HO2S	C, R	×

DTC No.	Condition	MIL	DC	Monitor item	Self-test type*1	Memory function
P0222	TP sensor No.2 circuit low input	ON	1	CCM	C, O, R	×
P0223	TP sensor No.2 circuit high input	ON	1	CCM	C, O, R	×
P0300	Random misfire detected	Flash/ ON	1 or 2	Misfire	C, R	×
P0301	Cylinder No.1 misfire detected	Flash/ ON	1 or 2	Misfire	C, R	×
P0302	Cylinder No.2 misfire detected	Flash/ ON	1 or 2	Misfire	C, R	×
P0303	Cylinder No.3 misfire detected	Flash/ ON	1 or 2	Misfire	C, R	×
P0304	Cylinder No.4 misfire detected	Flash/ ON	1 or 2	Misfire	C, R	×
P0327	KS circuit low input	ON	1	CCM	C, O, R	×
P0328	KS circuit high input	ON	1	CCM	C, O, R	×
P0335	CKP sensor circuit problem	ON	1	CCM	C	×
P0340	CMP sensor circuit problem	ON	1	CCM	C	×
P0403	EGR valve (stepper motor) circuit problem	ON	2	CCM	C, O, R	×
P0421	Warm up catalyst system efficiency below threshold	ON	2	Catalyst	C	×
P0443	Purge solenoid valve circuit problem	ON	2	CCM	C, O, R	×
P0480	Cooling fan relay No.1 control circuit malfunction	OFF	1	Other	C, O, R	×
P0481	Cooling fan relay No.2 and No.3 control circuit malfunction	OFF	1	Other	C, O, R	×
P0482	Cooling fan relay No.4 control circuit malfunction	OFF	1	Other	C, O, R	×
P0500	VSS circuit problem	ON	2	CCM	C	×
P0505	IAC system problem	OFF	—	Other	R	—
P0506	Idle control system RPM lower than expected	ON	2	CCM	C	×
P0507	Idle control system RPM higher than expected	ON	2	CCM	C	×
P0550	PSP switch circuit malfunction	ON	2	Other	C	×
P0564	Cruise control switch circuit malfunction	OFF	1	Other	C	×
P0571	Brake switch circuit problem	OFF	1	Other	C	×
P0601	PCM memory check sum error	ON	1	CCM	C, O, R	×
P0602	PCM programming error	ON	1	CCM	C, O, R	×
P0604	PCM RAM error	ON	1	CCM	C, O, R	×
P0606	ECM/PCM processor	ON	1	CCM	C, O, R	×
P0607	PCM performance problem	OFF	1	Other	C, O, R	×
P0610	PCM vehicle options error	ON	1	CCM	C, O, R	×
P0638	Throttle actuator control circuit range/performance problem	ON	1	CCM	C	×
P0661	Variable intake-air solenoid valve circuit low input	OFF	1	Other	C, O, R	×
P0662	Variable intake-air solenoid valve circuit high input	OFF	1	Other	C, O, R	×
P0703	Brake switch input circuit problem	ON	2	CCM	C	×
P2006	Variable tumble shutter valve stuck closed	ON	2	CCM	C, R	×
P2009	Variable tumble solenoid valve circuit low input	ON	2	CCM	C, O, R	×
P2010	Variable tumble solenoid valve circuit high input	ON	2	CCM	C, O, R	×
P2088	Oil control valve (OCV) circuit low	ON	1	CCM	C, O, R	×
P2089	Oil control valve (OCV) circuit high	ON	1	CCM	C, O, R	×
P2096	Target A/F feedback system too lean	ON	2	Fuel system	C	×
P2097	Target A/F feedback system too rich	ON	2	Fuel system	C	×
P2100	Throttle actuator circuit open	ON	1	CCM	C, O, R	×
P2101	Throttle actuator circuit range/performance	ON	1	CCM	C, R	×
P2102	Throttle actuator circuit low input	ON	1	CCM	C, O, R	×
P2103	Throttle actuator circuit high input	ON	1	CCM	C, O, R	×
P2107	Throttle actuator control module processor error	ON	1	CCM	C, R	×
P2108	Throttle actuator control module performance error	ON	1	CCM	C, R	×

DTC No.	Condition	MIL	DC	Monitor item	Self-test type*[1]	Memory function
P2119	Throttle actuator control throttle body range/performance problem	ON	1	CCM	C, R	×
P2122	APP sensor No.1 circuit low input	ON	1	CCM	C, O, R	×
P2123	APP sensor No.1 circuit high input	ON	1	CCM	C, O, R	×
P2127	APP sensor No.2 circuit low input	ON	1	CCM	C, O, R	×
P2128	APP sensor No.2 circuit high input	ON	1	CCM	C, O, R	×
P2135	TP sensor No.1/No.2 voltage correlation problem	ON	1	CCM	C, O, R	×
P2138	APP sensor No.1/No.2 voltage correlation problem	ON	1	CCM	C, O, R	×
P2177	Fuel system too lean at off idle	ON	2	Fuel system	C, R	×
P2178	Fuel system too rich at off idle	ON	2	Fuel system	C, R	×
P2187	Fuel system too lean at idle	ON	2	Fuel system	C, R	×
P2188	Fuel system too rich at idle	ON	2	Fuel system	C, R	×
P2195	Front HO2S signal stuck lean	ON	2	HO2S	C	×
P2196	Front HO2S signal stuck rich	ON	2	HO2S	C	×
P2228	BARO sensor circuit low input	ON	1	CCM	C, O, R	×
P2229	BARO sensor circuit high input	ON	1	CCM	C, O, R	×
P2237	Front HO2S positive current control circuit open	ON	2	HO2S	C, O, R	×
P2251	Front HO2S negative current control circuit open	ON	2	HO2S	C, O, R	×
P2502	Charging system voltage problem	OFF	1	Other	C, R	×
P2503	Charging system voltage low	OFF	1	Other	C, R	×
P2504	Charging system voltage high	OFF	1	Other	C, R	×
P2507	PCM B+ voltage low	ON	1	CCM	C, O, R	×

*[1] : C: CMDTC self-test, O: KOEO self-test, R: KOER self-test

Sending Continuous Monitoring System Test Results (pending code) (Mode 07)

- These appear when a problem is detected in a monitored system.

1 drive cycle type

- If any problems are detected in the first drive cycle, pending codes will be stored in the PCM memory, as well as DTCs.
- After pending codes are stored, if the PCM judges that the system is normal in any future drive cycle, the PCM deletes the pending codes.

2 drive cycle type

- The code for a failed system is stored in the PCM memory in the first drive cycle. If the problem is not found in the second drive cycle, the PCM judges that the system returned to normal or the problem was mistakenly detected, and deletes the pending code. If the problem is found in the second drive cycle too, the PCM judges that the system has failed, and stores the pending codes, and the DTCs.
- After pending codes are stored, if the PCM judges that the system is normal in any future drive cycle, the PCM deletes the pending codes.

KOEO/KOER SELF-TEST[L3]

id0102a2100400

- The self-test function consists of the KOEO (Key On, Engine Off) self-test, performed when the ignition switch is at ON, and the KOER (Key On, Engine Running) self-test, performed when idling. If an abnormality is detected as either self-test is executed, a is displayed on the IDS/PDS. Using the self-test function, the present malfunction or a successful repair is readily confirmed. Refer to the self-test function table for the corresponding DTCs.

  KOEO (Key ON, Engine Off) self-test

  — The KOEO self-test is a power train control system self-diagnosis, performed when the ignition switch is at ON and the engine is stopped. A KOEO self-test begins when the connected IDS/PDS sends an execute command to the PCM.

  — As the KOEO self-test is performed, the PCM performs inspection for the set DTCs and if a malfunction is detected the DTC is displayed on the IDS/PDS.

  KOER (Key ON, Engine Running) self-test

  — The KOER self-test is a power train control system self-diagnosis, performed when the ignition switch is at ON and the engine is idling. A KOER self-test begins when the connected IDS/PDS sends an execute command to the PCM.

  — As the KOER self-test is performed, the PCM performs inspection for the set DTCs and if a malfunction is detected the DTC is displayed on the IDS/PDS.

KOEO/KOER self-test function table

×: Applicable
—: Not applicable

DTC No.	Condition	KOEO	KOER
B1342	PCM malfunction	×	—
P0011	CMP timing over-advanced	—	×
P0012	CMP timing over-retarded	—	×
P0030	Front HO2S heater control circuit problem	×	×
P0031	Front HO2S heater circuit low input	×	×
P0032	Front HO2S heater circuit high input	×	×
P0037	Rear HO2S heater circuit low input	×	×
P0038	Rear HO2S heater circuit high input	×	×
P0069	Manifold absolute pressure/atmospheric pressure correlation	—	—
P0101	MAF sensor circuit range/performance problem	—	—
P0102	MAF sensor circuit low input	×	×
P0103	MAF sensor circuit high input	×	×
P0107	MAP sensor circuit low input	×	×
P0108	MAP sensor circuit high input	×	×
P0111	IAT sensor circuit range/performance problem	—	—
P0112	IAT sensor circuit low input	×	×
P0113	IAT sensor circuit high input	×	×
P0117	ECT sensor circuit low input	×	×
P0118	ECT sensor circuit high input	×	×
P0122	TP sensor No.1 circuit low input	×	×
P0123	TP sensor No.1 circuit high input	×	×
P0125	Excessive time to enter closed loop fuel control	—	—
P0131	Front HO2S circuit low input	×	×
P0132	Front HO2S circuit high input	×	×
P0133	Front HO2S circuit problem	—	—
P0134	Front HO2S no activity detected	—	×
P0138	Rear HO2S circuit high input	×	×
P0140	Rear HO2S no activity detected	—	×
P0222	TP sensor No.2 circuit low input	×	×
P0223	TP sensor No.2 circuit high input	×	×
P0300	Random misfire detected	—	×
P0301	Cylinder No.1 misfire detected	—	×
P0302	Cylinder No.2 misfire detected	—	×
P0303	Cylinder No.3 misfire detected	—	×
P0304	Cylinder No.4 misfire detected	—	×
P0327	KS circuit low input	×	×
P0328	KS circuit high input	×	×
P0335	CKP sensor circuit problem	—	—
P0340	CMP sensor circuit problem	—	—
P0403	EGR valve (stepper motor) circuit problem	×	×
P0421	Warm up catalyst system efficiency below threshold	—	—
P0443	Purge solenoid valve circuit problem	×	×
P0480	Cooling fan relay No.1 control circuit malfunction	×	×
P0481	Cooling fan relay No.2 and No.3 control circuit malfunction	×	×
P0482	Cooling fan relay No.4 control circuit malfunction	×	×
P0500	VSS circuit problem	—	—
P0505	IAC system problem	—	×
P0506	Idle control system RPM lower than expected	—	—
P0507	Idle control system RPM higher than expected	—	—
P0550	PSP switch circuit malfunction	—	—
P0564	Cruise control switch circuit malfunction	—	—
P0571	Brake switch circuit problem	—	—

DTC No.	Condition	KOEO	KOER
P0601	PCM memory check sum error	×	×
P0602	PCM programming error	×	×
P0604	PCM RAM error	×	×
P0606	ECM/PCM processor	×	×
P0607	PCM performance problem	×	×
P0610	PCM vehicle options error	×	×
P0638	Throttle actuator control circuit range/performance problem	—	—
P0661	Variable intake-air solenoid valve circuit low input	×	×
P0662	Variable intake-air solenoid valve circuit high input	×	×
P0703	Brake switch input circuit problem	—	—
P2006	Variable tumble shutter valve stuck closed	—	×
P2009	Variable tumble solenoid valve circuit low input	×	×
P2010	Variable tumble solenoid valve circuit high input	×	×
P2088	Oil control valve (OCV) circuit low	×	×
P2089	Oil control valve (OCV) circuit high	×	×
P2096	Target A/F feedback system too lean	—	—
P2097	Target A/F feedback system too rich	—	—
P2100	Throttle actuator circuit open	×	×
P2101	Throttle actuator circuit range/performance	—	×
P2102	Throttle actuator circuit low input	×	×
P2103	Throttle actuator circuit high input	×	×
P2107	Throttle actuator control module processor error	—	×
P2108	Throttle actuator control module performance error	—	×
P2119	Throttle actuator control throttle body range/performance problem	—	×
P2122	APP sensor No.1 circuit low input	×	×
P2123	APP sensor No.1 circuit high input	×	×
P2127	APP sensor No.2 circuit low input	×	×
P2128	APP sensor No.2 circuit high input	×	×
P2135	TP sensor No.1/No.2 voltage correlation problem	×	×
P2138	APP sensor No.1/No.2 voltage correlation problem	×	×
P2177	Fuel system too lean at off idle	—	×
P2178	Fuel system too rich at off idle	—	×
P2187	Fuel system too lean at idle	—	×
P2188	Fuel system too rich at idle	—	×
P2195	Front HO2S signal stuck lean	—	—
P2196	Front HO2S signal stuck rich	—	—
P2228	BARO sensor circuit low input	×	×
P2229	BARO sensor circuit high input	×	×
P2237	Front HO2S positive current control circuit open	×	×
P2251	Front HO2S negative current control circuit open	×	×
P2502	Charging system voltage problem	—	×
P2503	Charging system voltage low	—	×
P2504	Charging system voltage high	—	×
P2507	PCM B+ voltage low	×	×

PID/DATA MONITOR AND RECORD[L3]

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- The PID/DATA monitoring items for the fuel and emission control systems are as shown in the table below.

Monitor item table

Monitor item	Definition	Unit/Condition	PCM terminal
AC_REQ	A/C request signal	ON/OFF	1AP
ACCS	A/C relay	ON/OFF	1AN
AFR	Air/fuel ratio	—	2Z 2AC 2AD
AFR_ACT	Actual air/fuel ratio	—	2Z 2AC 2AD
ALTF	Generator field coil control duty value	%	2AQ
ALTT V	Generator output voltage	V	2AM
APP	Accelerator pedal position	%	1Y 1AG
APP1	APP sensor 1	% V	1Y
APP2	APP sensor 2	% V	1AG
ARPMDES	Target engine speed	RPM	—
BOO	Brake switch	ON/OFF	1AU
BPA	Brake pressure applied switch	ON/OFF	—
CATT11_DSD	Desired catalyst temperature bank one, sensor one	°C	—
CHRGLP	Generator warning light	ON/OFF	—
COLP	Refrigerant pressure switch (middle)	ON/OFF	1R
DTCCNT	Number of DTC detected	—	—
ECT	Engine coolant temperature	°C / °F V	2AK
EQ_RAT11	Equivalence ratio (lambda)	—	2Z 2AC 2AD
EQ_RAT11_DSD	Desired equivalence ratio (lambda)	—	—
ETC_ACT	Electronic throttle control actual	°	2A 2B
ETC_DSD	Electronic throttle control desired	% °	—
EVAPCP	Purge solenoid valve duty value	%	2AN
FAN1	Cooling fan control	ON/OFF	1D
FAN2	Cooling fan control	ON/OFF	1W
FP	Fuel pump relay	ON/OFF	1AR*1 1AQ*2
FUELPW	Fuel injector duration	ms	2AZ 2BB 2BC 2BD
FUELSYS	Fuel system status	OL/CL/OL-Drive/OL-Fault/CL-Fault	—
GENVDSD	Generator voltage desired	V	—
HTR11	HO2S heater (front)	ON/OFF	2G
HTR12	HO2S heater (rear)	ON/OFF	2C
IAT	Intake air temperature	°C / °F V	1AH
IMRC	Variable tumble solenoid valve	ON/OFF	2AI
IMTV	Variable Intake air control solenoid valve	ON/OFF	2AJ
INGEAR	Load/no load condition	ON/OFF	—
IVS	CTP condition	IDLE/ OFF IDLE	2M 2I

Monitor item	Definition	Unit/Condition	PCM terminal
KNOCKR	Knocking retard	°	2Q 2R
LOAD	Engine load	%	—
LONGFT1	Long term fuel trim	%	—
MAF	Mass airflow	g/s V	1AC
MAP	Manifold absolute pressure	kPa, inHg V	2AL
MIL	Malfunction indicator lamp	ON/OFF	—
MIL_DIS	Travelled distance since the MIL illuminated	km, mile	—
NUMKEYS	Number of keys stored in module	—	—
O2S11	Front HO2S	A	2Z 2AC 2AD
O2S12	Rear HO2S	V	2AH
PSP	Power steering pressure switch	Low/High	2S
RO2FT1	Rear oxygen sensor fuel trim	—	—
RPM (Engine speed)	Engine speed	rpm	2U
SCCS (Speed control command switch)	Speed control command switch	—	—
SEGRP (EGR valve (stepping motor) position)	EGR valve (stepping motor) position	—	2AU 2AR 2AY 2AV
SEGRP DSD (Desired SEGRP valve position)	Desired SEGRP valve position	%	—
SELTESTDTC (Diagnostic trouble codes)	Diagnostic trouble codes	—	—
SHRTFT1 (Short term fuel trim)	Short term fuel trim	%	—
SHRTFT12 (Short term fuel trim bank 1 sensor 2)	Short term fuel trim bank 1 sensor 2	%	—
SPARKADV (Ignition timing)	Ignition timing	°	2BE 2BF 2BG 2BH
test (Test mode)	Test mode	ON/OFF	—
TIRESIZE (Tire Size (rev / mile))	Tire Size (rev / mile)	rev/mile	—
TP REL (Relative throttle position)	Relative throttle position	%	—
TP 1 (TP sensor 1)	TP	% V	2M
TP 2 (TP sensor 2)	TP	% V	2I
TPCT (TP sensor voltage at CTP)	TP sensor voltage at CTP	V	2I 2M
VPWR ()	Battery positive voltage	V	1BA
VSS (Vehicle speed)	Vehicle speed	kph, mph	—

Monitor item	Definition	Unit/Condition	PCM terminal
VT ACT1 (Actual valve timing)	Actual valve timing	°	2AF
VT DIFF1 (Difference between target and actual valve timing)	Difference between target and actual valve timing	°	2AF
VT DUTY1 (Oil control valve duty value)	Oil control valve duty value	%	2AF

*1 : With immobilizer system
*2 : Without immobilizer system

SIMULATION TEST[L3]

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- The simulation test items for the fuel and emission control systems are as shown in the table below.

Simulation item table

×: Applied
—: Not applied

Simulation item	Applicable component	Operation	Test condition		PCM terminal
			IG ON	Idle	
ACCS	A/C relay	ON or OFF	×	×	1AN
ALTF	Generator field coil control duty value	ON or OFF	—	×	2AQ
ARPMDES	Engine speed desired	For idle speed: Actuated by any value	×	×	—
EVAPCP	Purge solenoid valve	For purge solenoid valve: Actuated by any duty value (0—100%)	×	×	2AN
FAN1	Fan1 control signal	ON or OFF	×	×	1D
FAN2	Fan2 control signal	ON or OFF	×	×	1W
FP	Fuel pump relay	ON or OFF	×	×	1AR*1 1AQ*2
FUELPW1	Fuel injection duration	Actuated +50%— -50% fuel injection time	—	×	2AZ 2BB 2BC 2BD
GENVDSD	Generator voltage desired	Actuated by any voltage of the of the generator	—	×	—
HTR11	Front heated exhaust gas oxygen sensor heater	ON or OFF	×	×	2G
HTR12	Rear heated exhaust gas oxygen sensor heater	ON or OFF	×	×	2C
IMRC	Variable tumble control solenoid control signal in PCM	ON or OFF	×	×	2AI
IMTV	Variable intake air system control solenoid control signal in PCM	ON or OFF	×	×	2AJ
INJ#1	Fuel injector (Cylinder No.1)	ON or OFF	—	×	2BB
INJ#2	Fuel injector (Cylinder No.2)	ON or OFF	—	×	2BC
INJ#3	Fuel injector (Cylinder No.3)	ON or OFF	—	×	2BD
INJ#4	Fuel injector (Cylinder No.4)	ON or OFF	—	×	2AZ
SEGRP	EGR valve (stepping motor)	Actuated by any stepping value (0—60 steps)	×	×	2AU 2AR 2AY 2AV
TEST	—	ON or OFF	×	×	—
VT DUTY1 Wt	Oil control valve	For oil control valve: Actuated by any duty value (0—100%)	×	×	2AF

*1 : With immobilizer system
*2 : Without immobilizer system

DTC[L3]

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- Detection logics and conditions are as shown below.

CMP Timing

CMP timing over-advanced (P0011)

- The actual valve timing is over-advanced by 15 ° from the target valve timing for specified period when the oil control valve (OCV) is controlled in the maximum valve timing retard condition.
  - — Engine speed is below 4,000 rpm
  - — Engine coolant temperature is 70—110 °C {158—230 °F}

CMP timing over-retarded (P0012)

- Actual valve timing is over-retarded by 10 ° from the target valve timing for specified period when the oil control valve (OCV) system control is within the feedback range.
  - — Engine speed is below 4,000 rpm
  - — Engine coolant temperature is 70—110 °C {158—230 °F}

Oxygen Sensor Heater

Front HO2S heater control circuit problem (P0030)

- OBD system monitors the output signal voltage from oxygen sensor which is proportion to the element impedance of oxygen sensor.
- If the output signal voltage isn't between 0.75 V and 1.5 V after specified time from engine start, heater performance considered failed.
  - — Battery voltage: 10—18 V
  - — Time from engine start is 20 s or more

Front HO2S heater circuit low input (P0031)

- The PCM monitors the front HO2S heater output voltage. if the PCM turns the front HO2S heater off or on but the front HO2S heater circuit remains low voltage, the PCM determines that the front HO2S heater circuit has a malfunction.

Front HO2S heater circuit high input (P0032)

- The PCM monitors the front HO2S heater output voltage. if the PCM turns the front HO2S heater off or on but the front HO2S heater circuit remains high voltage, the PCM determines that the front HO2S heater circuit has a malfunction.

Rear HO2S heater circuit low input (P0037)

- The PCM monitors the rear HO2S heater output voltage. if the PCM turns the rear HO2S heater off or on but the rear HO2S heater circuit remains low voltage, the PCM determines that the rear HO2S heater circuit has a malfunction.

Rear HO2S heater circuit high input (P0038)

- The PCM monitors the rear HO2S heater output voltage. if the PCM turns the rear HO2S heater off or on but the rear HO2S heater circuit remains high voltage, the PCM determines that the rear HO2S heater circuit has a malfunction.

MAF Sensor

MAF circuit range/performance problem (P0101)

- PCM monitors mass intake air flow amount when the engine is running.
  - — If the mass intake air flow amount is above 50 l/s for 5 s and the engine speed is below 2,000 rpm with the engine running, the PCM determines that the detected mass intake air flow amount is too high.
  - — If the mass intake air flow amount is below 1—57.8 l/s (The value depends on engine speed.) for 5 s and the engine speed is above 1,000 rpm with the engine running and the throttle opening angle above 50 %, the PCM determines that detected the mass intake air flow amount is too low.

MAF sensor circuit low input (P0102)

- The PCM monitors input voltage from the MAF sensor when the engine running. If the input voltage is below 0.21 V, the PCM determines that the MAF circuit has a malfunction.

MAF sensor circuit high input (P0103)

- The PCM monitors the input voltage from the MAF sensor when the engine running. If the input voltage is above 4.9 V, the PCM determines that the MAF circuit has a malfunction.

MAP Sensor
Manifold absolute pressure/atmospheric pressure correlation (P0069)
- PCM monitors differences between intake manifold vacuum and atmospheric pressure. If the difference is below -12 kPa {-90 mmHg, -3.5 inHg} or above 12 kPa {90 mmHg, 3.5 inHg} when the following conditions are met, the PCM determines that there is a MAP sensor performance problem.
  — 12—16 s from when ignition switch is turned off.
  — Intake air temperature is above -10°C {14°F}.
  — Engine coolant temperature is above 70°C {158°F}.

MAP sensor circuit low input (P0107)
- The PCM monitors the input voltage from the MAP sensor when intake air temperature is above –10 °C {14 °F}. If the input voltage is below 0.1 V, the PCM determines that the MAP sensor circuit has a malfunction.

MAP sensor circuit high input (P0108)
- The PCM monitors the input voltage from the MAP sensor when intake air temperature is above –10 °C {14 °F}. If input the voltage is above 4.9 V, the PCM determines that the MAP sensor circuit has a malfunction.
  — Calculated load: 13—32 %

Intake Air Temperature (IAT) Sensor
IAT circuit range/performance problem (P0111)
- If the intake air temperature is higher than the engine coolant temperature by 40 °C {72 °F} for 60 s with key on, the PCM determines that there is a IAT sensor performance problem.

IAT sensor circuit low input (P0112)
- The PCM monitors the IAT sensor signal. If the PCM detects that the IAT sensor voltage is below 0.16 V, the PCM determines that the IAT sensor circuit has a malfunction.

IAT sensor circuit high input (P0113)
- The PCM monitors the IAT sensor signal. If the PCM detects that the IAT sensor voltage is above 4.8 V, the PCM determines that IAT sensor circuit has a malfunction.

Engine Coolant Temperature (ECT) Sensor
ECT sensor circuit low input (P0117)
- The PCM monitors the ECT sensor signal. If the PCM detects that the ECT sensor voltage is below 0.2 V, the PCM determines that the ECT sensor circuit has a malfunction.

ECT sensor circuit high input (P0118)
- The PCM monitors the ECT sensor signal. If the PCM detects that the ECT sensor voltage is above 4.6 V, the PCM determines that the ECT sensor circuit has a malfunction.

Excessive time to enter closed loop fuel control (P0125)
- The PCM monitors the ECT sensor signal after engine is started while the engine is cold. If the engine coolant temperature does not reach the expected temperature for a specified period, the PCM determines that it has taken an excessive amount of time for the engine coolant temperature to reach the temperature necessary to start closed-loop fuel control.

Throttle Position (TP) Sensor
TP sensor No.1 circuit low input (P0122)
- If the PCM detects that the TP sensor voltage is below 0.2 V while the engine is running, the PCM determines that the TP circuit has a malfunction.

TP sensor No.1 circuit high input (P0123)
- If the PCM detects the TP sensor No.1 voltage is to be above 4.85 V after ignition switch to the ON position, PCM determines that TP circuit has a malfunction.

TP sensor No.2 circuit low input (P0222)
- If PCM detects TP sensor No.2 voltage is to be below 0.2 V after the ignition switch to the ON position, the PCM determines that TP circuit has a malfunction.

TP sensor No.2 circuit high input (P0223)
- If the PCM detects the TP sensor No.2 voltage is to be above 4.85 V after the ignition switch to the ON position, the PCM determines that the TP circuit has a malfunction.

TP sensor No.1/No.2 voltage correlation problem (P2135)

- The PCM compares the input voltage from TP sensor No.1 with the input voltage from TP sensor No.2 when the engine is running. If the difference is more than the specification, the PCM determines that there is a TP sensor No.1/No.2 voltage correlation problem.

Front Heated Oxygen Sensor (HO2S)
Front HO2S circuit low input (P0131)

- The PCM monitors the input voltage from the front HO2S while the engine is running. If the input voltage is above 1.0 V for 2 s, the PCM determines that the front HO2S circuit voltage is low.

Front HO2S circuit high input (P0132)

- The PCM monitors the input voltage from the front HO2S when the engine is running. If the input voltage is less than 1.0 V for 2 s, the PCM determines that the front HO2S circuit voltage is high.

Front HO2S circuit problem (P0133)

- Oxygen sensor malfunction is detected by measuring of the average frequency of oxygen sensor signal, time required to pass from rich to lean, time required to pass from lean to rich.
- The average frequency of oxygen sensor signal is more than the threshold value.
  — HO2S heater, HO2S, and TWC Repair Verification Drive Mode
  — Following conditions are met:
    - Front HO2S heater monitor is completed.
    - Fuel system loop status is closed loop fuel control.
  — ECT sensor and front HO2S heater and normal.
  — Engine speed: 1,000—3,200 rpm
  — Charging efficiency: 20—62.5 %
  — Engine coolant temperature above 70 °C {158 °F}

Front HO2S no activity detected (P0134)

- The PCM monitors the input voltage from front HO2S when the following conditions are met. Under the following monitoring conditions, the input voltage more than 3.22 V, the PCM determines that the front HO2S is not activated.
  — HO2S, HO2S heater and TWC Repair Verification Drive Mode
  — Following conditions are met
    - Front HO2S heater is turned on for more than 30 s.
    - Battery voltage: 10 —18 V

Front HO2S signal stuck lean (P2195)

- The PCM monitors the front HO2S output current when the following conditions are met. If the average output current is more than 1.2 A for 25 s, the PCM determines that the front HO2S signal remains lean.
  — ECT: more than 70 °C {158 °F}
  — Engine speed: 1,000—3,200 rpm
  — Charging efficiency: 20—62.5 %
  — Output voltage from the front HO2S: more than 0.2 V

Front HO2S signal stuck rich (2196)

- The PCM monitors the front HO2S output current when the following conditions are met. If the average output current is less than 0.85 A for 25 s, the PCM determines that the front HO2S signal remains rich.
  MONITORING CONDITION
  — ECT: more than 70 °C {158 °F}
  — Engine speed: 1,000—3,200 rpm
  — Charging efficiency: 20—62.5 %
  — Output voltage from the front HO2S: less than 0.8 V

Front HO2S positive current control circuit open (P2237)

- The PCM monitors front HO2S positive current control circuit voltage. If the voltage is not changed against the PCM control value while the engine running, the PCM determines that the front HO2S positive current control circuit is open.

Front HO2S negative current control circuit open (P2251)

- The PCM monitors front HO2S negative current control circuit voltage. If the voltage is not changed against the PCM control value while the engine running, the PCM determines that the front HO2S negative current control circuit is open.

Rear Heated Oxygen Sensor (HO2S)
Rear HO2S circuit high input (P0138)
- The PCM monitors input voltage from rear HO2S. If the input voltage from the rear HO2S is above 1.2 V for 0.8 s, the PCM determines that circuit input is high.

Rear HO2S no activity detected (P0140)
- The PCM monitors the input voltage from the rear HO2S when the following conditions are met. Under the following monitoring conditions, if the input voltage from the rear HO2S does not even exceed 0.55 V though the short term fuel trim is controlled up to 20.5 % for 9.6 s, the PCM determines that sensor circuit is not activated.
  — HO2S, HO2S heater and TWC repair verification drive mode
  — Following conditions are met for above 20.8 s
    - Engine speed is above 1,500 rpm.
    - Engine coolant temperature is above 70 °C {158 °F}.

Misfire Monitor
Random misfire detected (P0300), Cylinder misfire detection (P0301, P0302, P0303, P0304)
- The PCM monitors CKP sensor input signal interval time. The PCM calculates the change of interval time for each cylinder. If the change of interval time exceeds the preprogrammed criteria, the PCM detects a misfire in the corresponding cylinder. While the engine is running, the PCM counts the number of misfires that occurred at 200 crankshaft revolutions and 1,000 crankshaft revolutions and calculates the misfire ratio for each crankshaft revolution. If the ratio exceeds the preprogrammed criteria, the PCM determines that a misfire, which can damage the catalytic converter or affect emission performance, has occurred.

Knock Sensor
KS circuit low input (P0327)
- The PCM monitors input signal from the KS when the engine is running. If the input voltage is below 0.06 V the PCM determines that the KS circuit has a malfunction.

KS circuit high input (P0328)
- The PCM monitors the input signal from the KS when the engine is running. If the input voltage is above 4.9 V the PCM determines that KS circuit has a malfunction.

Crankshaft Position (CKP) Sensor
CKP sensor circuit malfunction (P0335)
- If the PCM does not receive the input voltage from the CKP sensor for 4.2 s while the MAF is 1.95 g/s {0.25 lb/min.} or above, the PCM determines that the CKP sensor circuit has a malfunction.

Camshaft Position (CMP) Sensor
Camshaft position (CMP) sensor circuit malfunction (P0340)
- The PCM monitors the input voltage from the CMP sensor when the engine is running. If the PCM does not receive the input voltage from the CMP sensor while the PCM receives the input signal from the CKP sensor, the PCM determines that the CMP circuit has a malfunction.

EGR Valve
EGR valve (stepper motor) circuit problem (P0403)
- The PCM monitors the input voltage from EGR valve. If the voltage remain low or high, the PCM determines that the EGR valve circuit has a malfunction.

Catalyst System
Warm up catalyst system efficiency below threshold (P0421)
- PCM compares number of front HO2S sensor and rear HO2S inversions for a predetermined time. PCM monitors number of inversions rear sides performs while front side inverts for specified number of times when the following monitoring conditions are met. detects inversion ratio is below threshold, PCM determines that catalyst system has deteriorated.
  — Calculated TWC temperature: more than 400 °C {752 °F}
  — Engine speed: 1,500—3,000 rpm
  — LOAD:16—50 % (at engine speed 2,000 rpm)

Purge Solenoid Valve
Purge solenoid valve circuit problem (P0443)
- The PCM monitors the input voltages from the purge solenoid valve. If the voltage remains low or high, the PCM determines that the purge solenoid valve circuit has a malfunction.

Fan Control System
Fan relay No.1 control circuit malfunction (P0480)
- PCM monitors cooling fan relay No.1 control signal. If voltage remains low or high, PCM determines that fan relay No.1 circuit has a malfunction.

Fan relay No.2 and No.3 control circuit malfunction (P0481)
- PCM monitors cooling fan relay No.2 and No.3 control signal. If voltage remains low or high, PCM determines that fan relay No.2 and No.3 circuit has a malfunction.

Fan relay No.4 control circuit malfunction (P0482)
- PCM monitors cooling fan relay No.4 control signal. If voltage remains low or high, PCM determines that fan relay circuit has a malfunction.

Vehicle Speed Sensor (VSS)
VSS circuit problem (P0500)
- If an error in the wheel speed signal from the ABS HU/CM is detected by CAN, the PCM detects a malfunction in the vehicle speed signal.

Idle Air Control (IAC) Valve
IAC system problem (P0505)
- The PCM cannot control idle speed toward target idle speed while KOER self test.

Idle control system RPM lower than expected (P0506)
- Actual idle speed is lower than expected by 100 rpm for 14 s, when brake pedal is depressed (brake switch is on) and steering wheel is held straight ahead (power steering pressure (PSP) switch is off).

Note
- If intake air temperature is below –10 °C {14 °F}, the PCM cancels diagnosis of P0506.

Idle control system RPM higher than expected (P0507)
- Actual idle speed is higher than expected by 200 rpm for 14 s, when the brake pedal is depressed (brake switch is on) and steering wheel is held straight ahead (power steering pressure (PSP) switch is off).

Note
- If intake air temperature is below –10 °C {14 °F}, the PCM cancels diagnosis of P0507.

Power Steering Pressure (PSP) Switch
PSP switch circuit malfunction (P0550)
- The PCM monitors PSP switch signal. If input voltage is low voltage (switch stays on) for 1 min. when the VSS is above 60 km/h {37 mph} and ECT is above 60 °C {140 °F}, the PCM determines that PSP switch circuit has a malfunction.

Cruise Control Switch
Cruise control switch circuit malfunction (P0564)
- The PCM monitors the cruise control switch signal. If the PCM detects that any one of following switches (Main, CANCEL, SET/COAST, RESUME/ACCEL) remains on for 2 min, the PCM determines that the cruise control switch circuit has a malfunction.

PCM
PCM memory check sum error (P0601)
- PCM internal memory check sum error

PCM programming error (P0602)
- No configuration data in the PCM

Note
- If the “PCM CONFIGURATION” is successful, the PCM stores DTC P0602 and illuminates the MIL (system is normal). Clear DTC P0602 using the IDS/PDS after the “PCM CONFIGURATION”.
- The MIL goes out after three drive cycles with no failure (DTCs remain in PCM).

PCM RAM error (P0604)
- PCM internal RAM malfunction.

ECM/PCM processor (P0606)
- The PCM internal CPU malfunction

PCM performance problem (P0607)
- PCM internal malfunction.

PCM vehicle options error (P0610)
- PCM data configuration error

PCM B+ voltage low (P2507)
- The PCM monitors the voltage of back-up battery positive terminal. If the PCM detects battery positive terminal voltage below 2.5 V for 2 s, the PCM determines that the backup voltage circuit has a malfunction.

Throttle Actuator
Throttle actuator control circuit range/performance problem (P0638)
- The PCM compares the actual TP with the target TP when the engine is running. If the difference is more than the specification, the PCM determines that there is a throttle actuator control circuit range/performance problem.

Throttle actuator circuit open (P2100)
- The PCM monitors the electronic throttle valve motor current. If the PCM detects that the electronic throttle valve motor current is below the threshold current, the PCM determines that the electronic throttle valve motor circuit has a malfunction.

Throttle actuator circuit range/performance (P2101)
- If any of the following conditions continue for a specified period of time or more the PCM detects a malfunction in the throttle actuator.
  — The voltage of the throttle actuator power supply is 4 V or less while the drive-by-wire relay is on
  — There is a system error in the drive-by-wire system of the PCM
  — The temperature of the drive-by-wire system in the PCM is 180 °C {356 °F} or more

Throttle actuator circuit low input (P2102)
- PCM monitors the throttle actuator circuit current. If the PCM detects that the throttle actuator circuit current is excessively low, the PCM determines that the throttle actuator circuit was a malfunction.

Throttle actuator circuit high input (P2103)
- PCM monitors the throttle actuator circuit current. If the PCM detects that the throttle actuator circuit current is excessively high, the PCM determines that the electronic throttle actuator circuit has a malfunction.

Throttle actuator control module processor error (P2107)
- Throttle actuator control module internal processor error

Throttle actuator control module performance error (P2108)
- If the PCM detects either of the following conditions, the PCM determines that throttle actuator control system has a malfunction.
  — TP sensor power supply voltage below 4.4 V
  — TP sensor No.1 output voltage below 0.20 V or above 4.85 V (DTC P0122 or P0123)
  — TP sensor No.2 output voltage below 0.20 V or above 4.85 V (DTC P0222 or P0223)
  — PCM internal circuit for TP sensor No.1 input circuit malfunction.

Throttle actuator control throttle body range/performance problem (P2119)
- The PCM compares the TP with the default TP when the ignition switch is off. If the TP is higher than the default TP, the PCM determines that there is a throttle actuator control throttle body range/performance problem.

Variable Intake air System Control Solenoid Valve
Variable intake air solenoid valve circuit low input (P0661)
- The PCM monitors the variable intake air solenoid valve control signal. If the PCM turns variable intake air solenoid valve off but voltage still remains low, the PCM determines that variable intake air solenoid valve circuit has a malfunction.

Variable intake air solenoid valve circuit high input (P0662)
- The PCM monitors the variable intake air solenoid valve control signal. If the PCM turns variable intake air solenoid valve on but voltage still remains high, the PCM determines that the variable intake air solenoid valve circuit has a malfunction.

Brake Switch

Brake switch circuit problem (P0571)

- The PCM monitors changes in input voltage for brake switch No.1 and No.2 (signal from instrument cluster). If the PCM detects that both brake switches No.1 and No.2 remain on or off for 15 s, it determines that the brake switch circuit has a malfunction.

Brake switch input circuit problem (P0703)

- The PCM monitors changes in input voltage from the brake switch No.1. If the PCM does not the voltage changes while alternately accelerating and decelerating 8 times, the PCM determines that the brake switch No.1 circuit has a malfunction.

Variable Tumble Control System

Variable tumble shutter valve stuck closed (P2006)

- PCM monitors the mass variable tumble shutter valve position using the variable swirl shutter valve switch. If PCM turns the variable tumble solenoid valve off but the variable swirl position still remains closed, the PCM determines that the variable tumble shutter valve is stuck closed.

Variable tumble solenoid valve circuit low input (P2009)

- The PCM monitors variable tumble solenoid valve control signal. If the PCM turns variable tumble solenoid valve off but voltage still remains low, the PCM determines that variable tumble solenoid valve circuit has a malfunction.

Variable tumble solenoid valve circuit high input (P2010)

- The PCM monitors the variable tumble solenoid valve control signal. If the PCM turns variable tumble solenoid valve on but the voltage still remains high, the PCM determines that the variable tumble solenoid valve circuit has a malfunction.

Oil Control Valve

Oil control valve (OCV) circuit low (P2088)

- The PCM monitors the OCV voltage. If the PCM detects the OCV control voltage (calculated from the OCV) is below the threshold voltage (calculated from the battery positive voltage), the PCM determines that the OCV circuit has a malfunction.

Oil control valve (OCV) circuit high (P2089)

- The PCM monitors the OCV voltage. If the PCM detects that the OCV control voltage (calculated from the OCV) is above the threshold voltage (calculated from battery positive voltage), the PCM determines that the OCV circuit has a malfunction.

Fuel System

Target A/F feedback system too lean (P2096)

- The PCM monitors the target A/F fuel trim when under the target A/F feedback control. If the fuel trim is more than the specification, the PCM determines that the target A/F feedback system is too lean.

Target A/F feedback system too rich (P2097)

- The PCM monitors the target A/F fuel trim when under the target A/F feedback control. If the fuel trim is less than specification, the PCM determines that the target A/F feedback system is too rich.

Fuel system too lean at off idle (P2177)

- PCM monitors short term fuel trim (SHRTFT), long term fuel trim (LONGFT) during closed loop fuel control at off-idle. If the LONGFT and the sum total of these fuel trims exceed preprogrammed criteria, the PCM determines that fuel system is too lean at off-idle.

Fuel system too rich at off idle (P2178)

- PCM monitors short term fuel trim (SHRTFT), long term fuel trim (LONGFT) during closed loop fuel control at off-idle. If the LONGFT and the sum total of these fuel trims exceed the preprogrammed criteria, the PCM determines that fuel system is too rich at off-idle.

Fuel system too lean at idle (P2187)

- The PCM monitors short term fuel trim (SHRTFT) and long term fuel trim (LONGFT) during closed loop fuel control at idle. If the LONGFT and the sum total of these fuel trims exceed the preprogrammed criteria, the PCM determines that fuel system is too lean at idle.

Fuel system too rich at idle (P2188)

- PCM monitors short term fuel trim (SHRTFT), long term fuel trim (LONGFT) during closed loop fuel control at idle. If the LONGFT and the sum total of these fuel trims exceed preprogrammed criteria, the PCM determines that fuel system is too rich at idle.

Accelerator Pedal Position Sensor

Accelerator pedal position (APP) sensor No.1 circuit low input (P2122)

- The PCM monitors the input voltage from APP sensor No.1 when the engine is running. If the input voltage is less than 0.2 V, the PCM determines that the APP sensor No.1 circuit input voltage is low.

Accelerator pedal position (APP) sensor No.1 circuit high input (P2123)

- The PCM monitors the input voltage from APP sensor No.1 when the engine is running. If the input voltage is above 4.5 V, the PCM determines that the APP sensor No.1 circuit input voltage is high.

APP sensor No.2 circuit low input (P2127)

- The PCM monitors the input voltage from APP sensor No.2 when the engine is running. If the input voltage is less than 0.2 V, the PCM determines that the APP sensor No.2 circuit has a malfunction.

APP sensor No.2 circuit high input (P2128)

- The PCM monitors the input voltage from APP sensor No.2 when the engine is running. If the input voltage is more than 4.5 V, the PCM determines that the APP sensor No.2 circuit has a malfunction.

APP sensor No.1/No.2 voltage correlation problem (P2138)

- The PCM compares the input voltage from APP sensor No.1 with the input voltage from APP sensor No.2 when the engine is running. If the difference is more than the specification, the PCM determines that there is an APP sensor No.1/No.2 angle correlation problem.

BARO sensor

BARO sensor circuit low input (P2228)

- PCM monitors the input voltage from the BARO sensor. If the input voltage at the PCM is below 1.95 V, the PCM determines that the BARO sensor circuit has a malfunction.

BARO sensor circuit high input (P2229)

- PCM monitors the input voltage from the BARO sensor. If the input voltage at the PCM is above 4.45 V, the PCM determines that the BARO sensor circuit has a malfunction.

Generator

Charging system voltage problem (P2502)

- The PCM determines that the generator output voltage is above 17 V or battery voltage is below 11 V while the engine is running.

Charging system voltage low (P2503)

- The PCM needs more than 20 A from the generator, and determines that the generator output voltage is be below 8.5 V while the engine running.

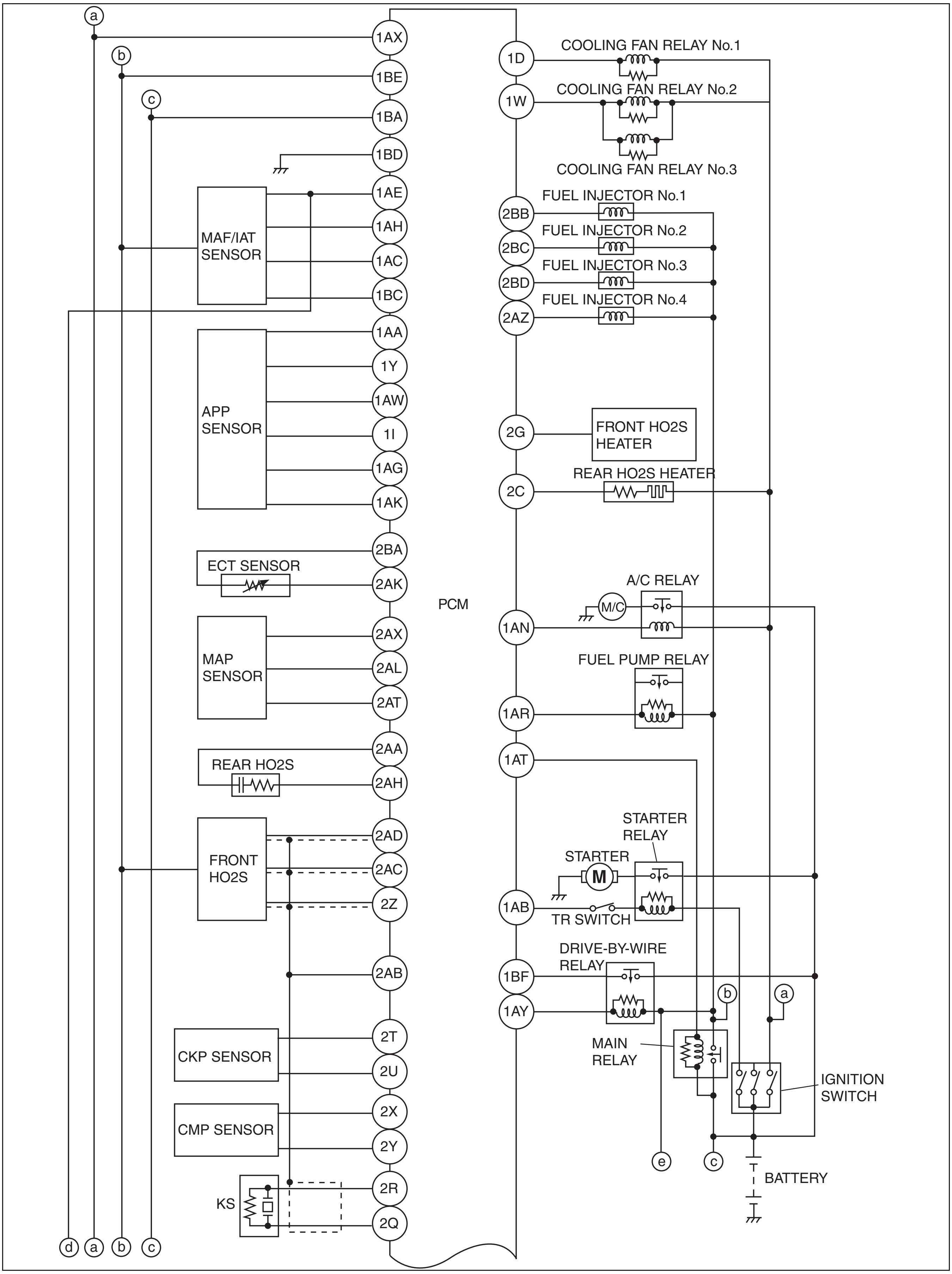
Charging system voltage high (P2504)

- The PCM determines that the generator output voltage is above 18.5 V or battery voltage is above 16.0 V while the engine running.

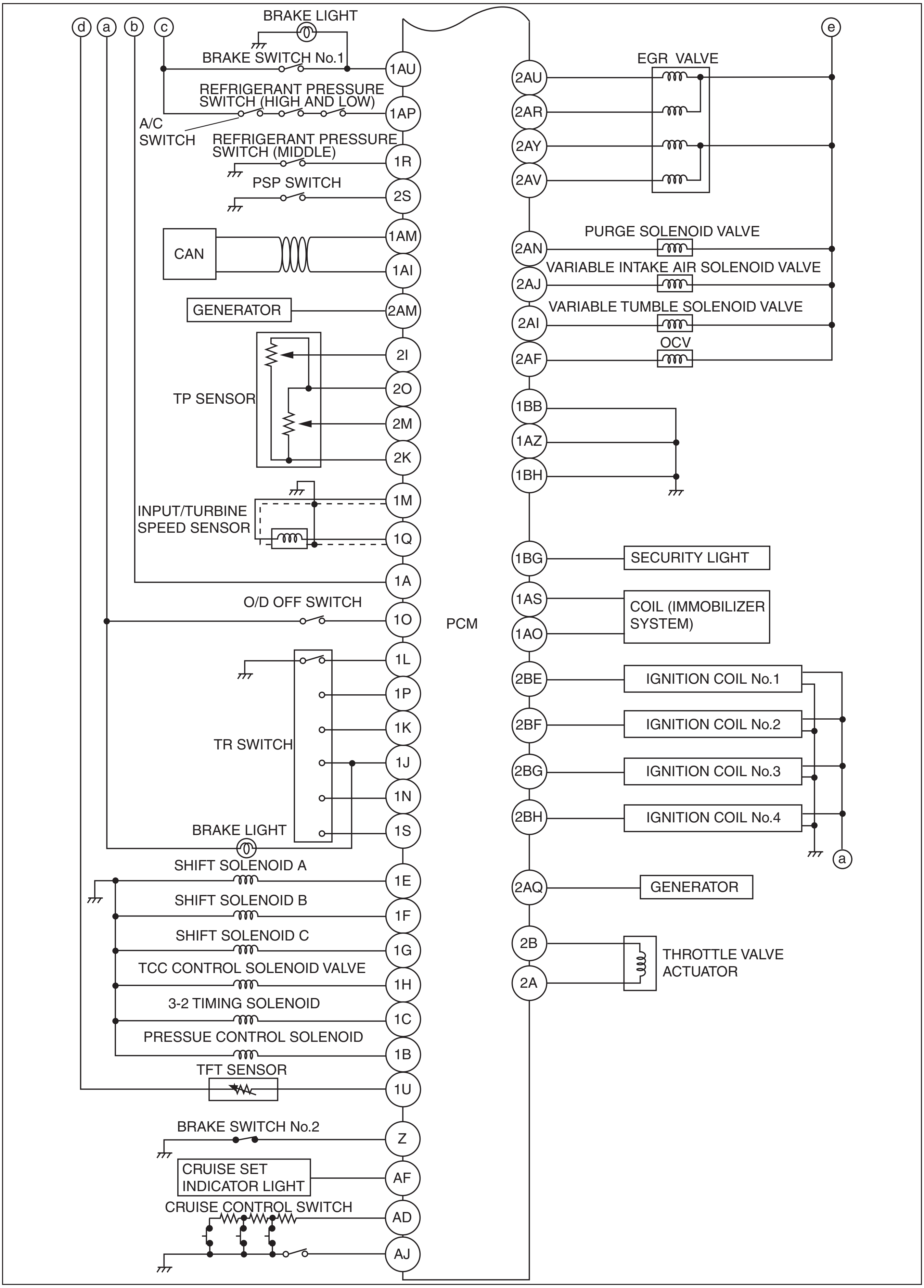
ON-BOARD DIAGNOSTIC WIRING DIAGRAM[L3]

id0102a2800100

With Immobilizer System

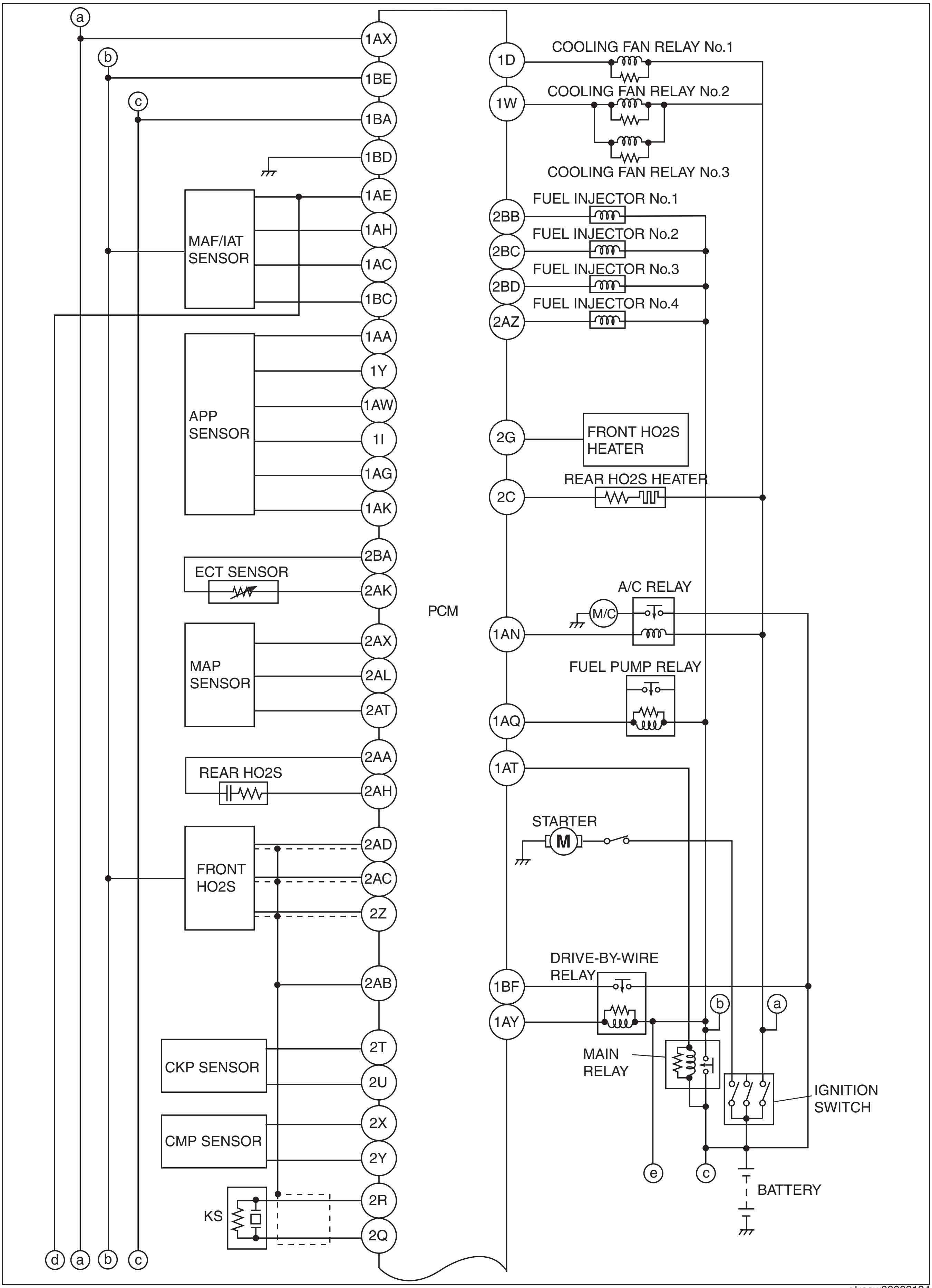


atraaw00002133



aesffn00000103

Without Immobilizer System



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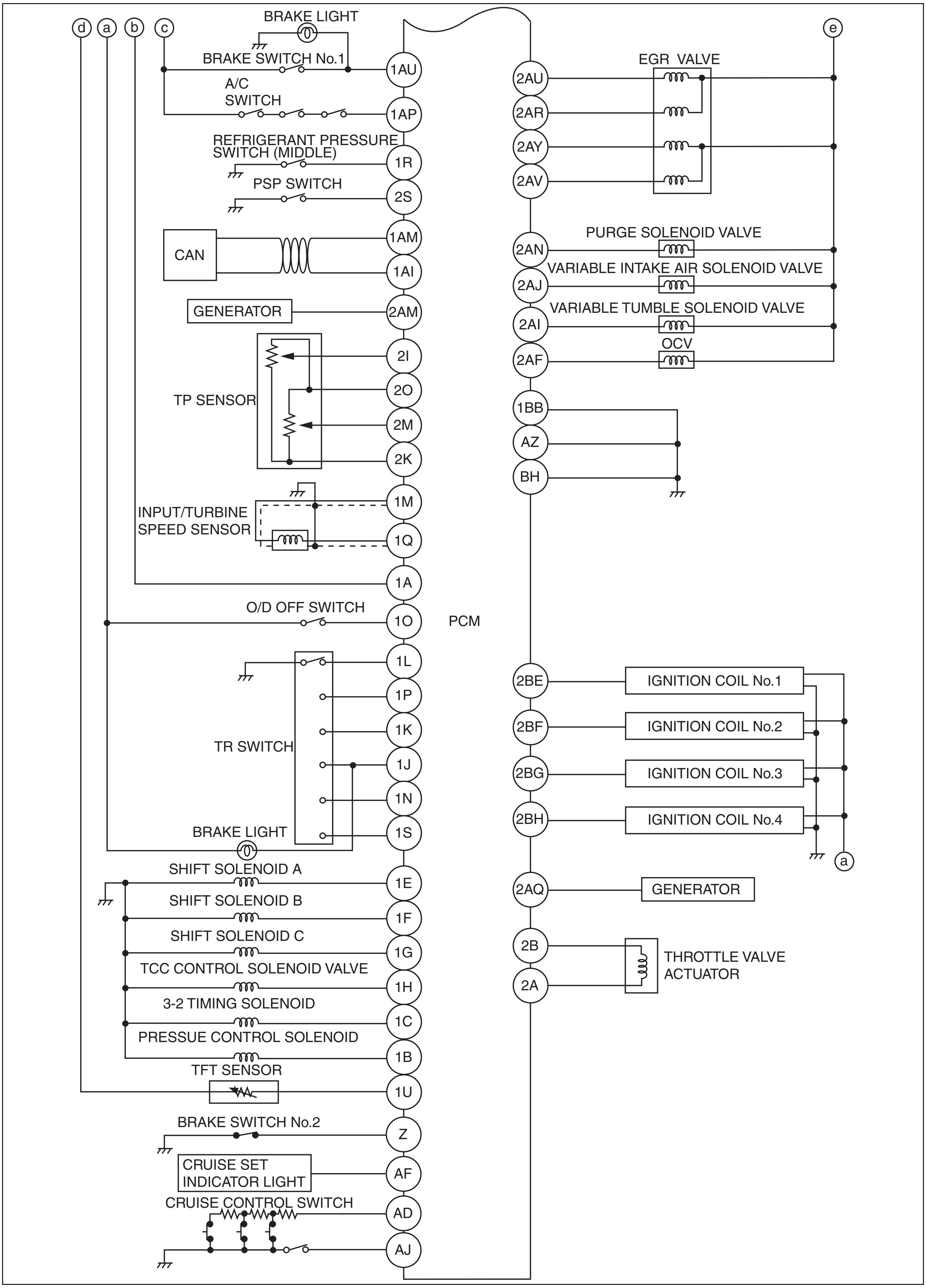


aesffn00000104

01-02B ON-BOARD DIAGNOSTIC [AJ (3.0L Duratec)]

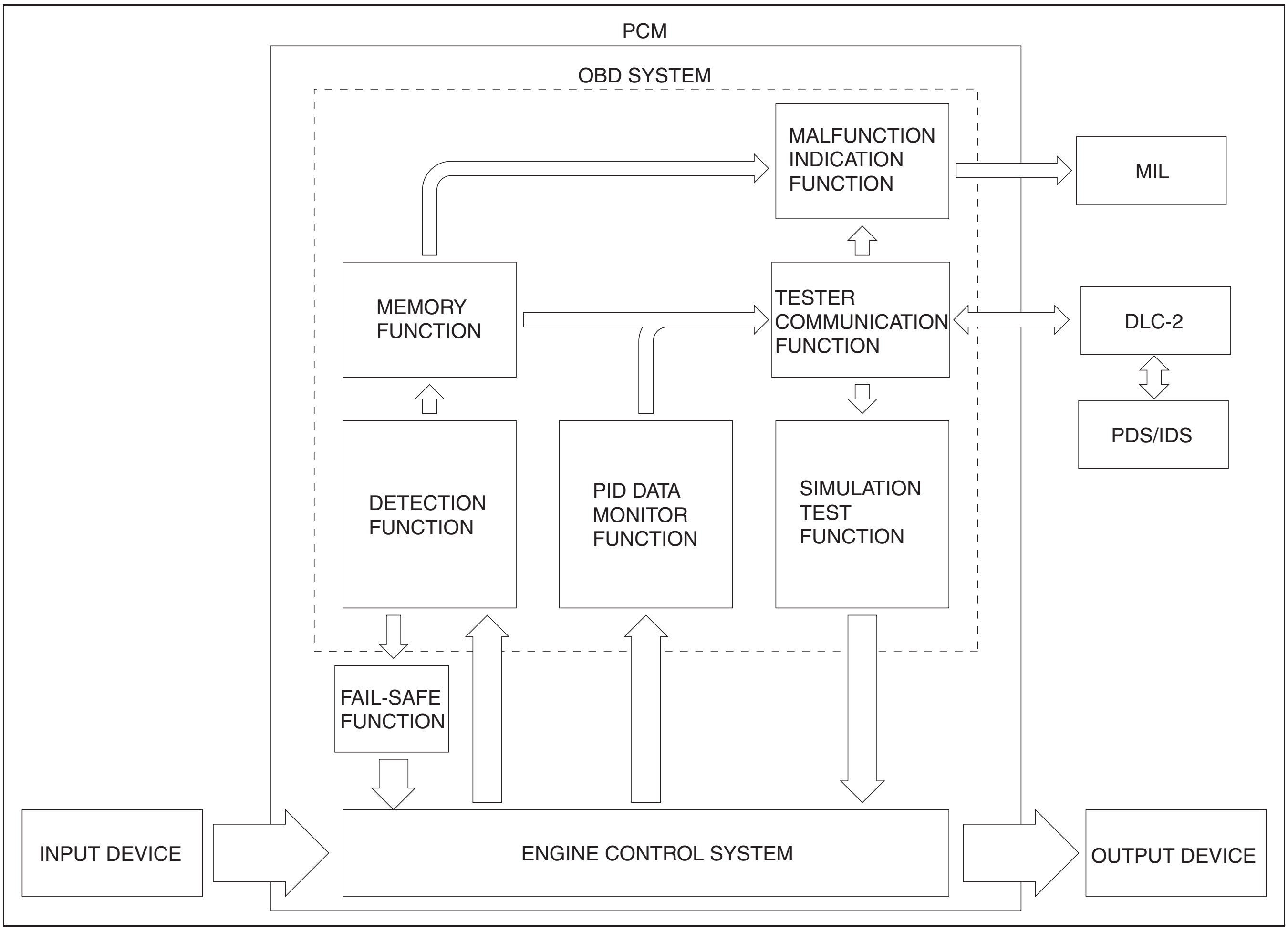
ON-BOARD DIAGNOSTIC OUTLINE[AJ (3.0L Duratec)]

id0102a4100100

Features

Satisfies emission regulation	• An on-board diagnostic (OBD) system consisting of the following functions has been adopted: — Malfunction detection function — PID/data monitor function — Simulation function — External diagnostic unit communication function — Malfunction display function — Diagnostic data memory function • Malfunction indicator lamp (MIL) adopted • Data link connector-2 (DLC-2) adopted

Block Diagram



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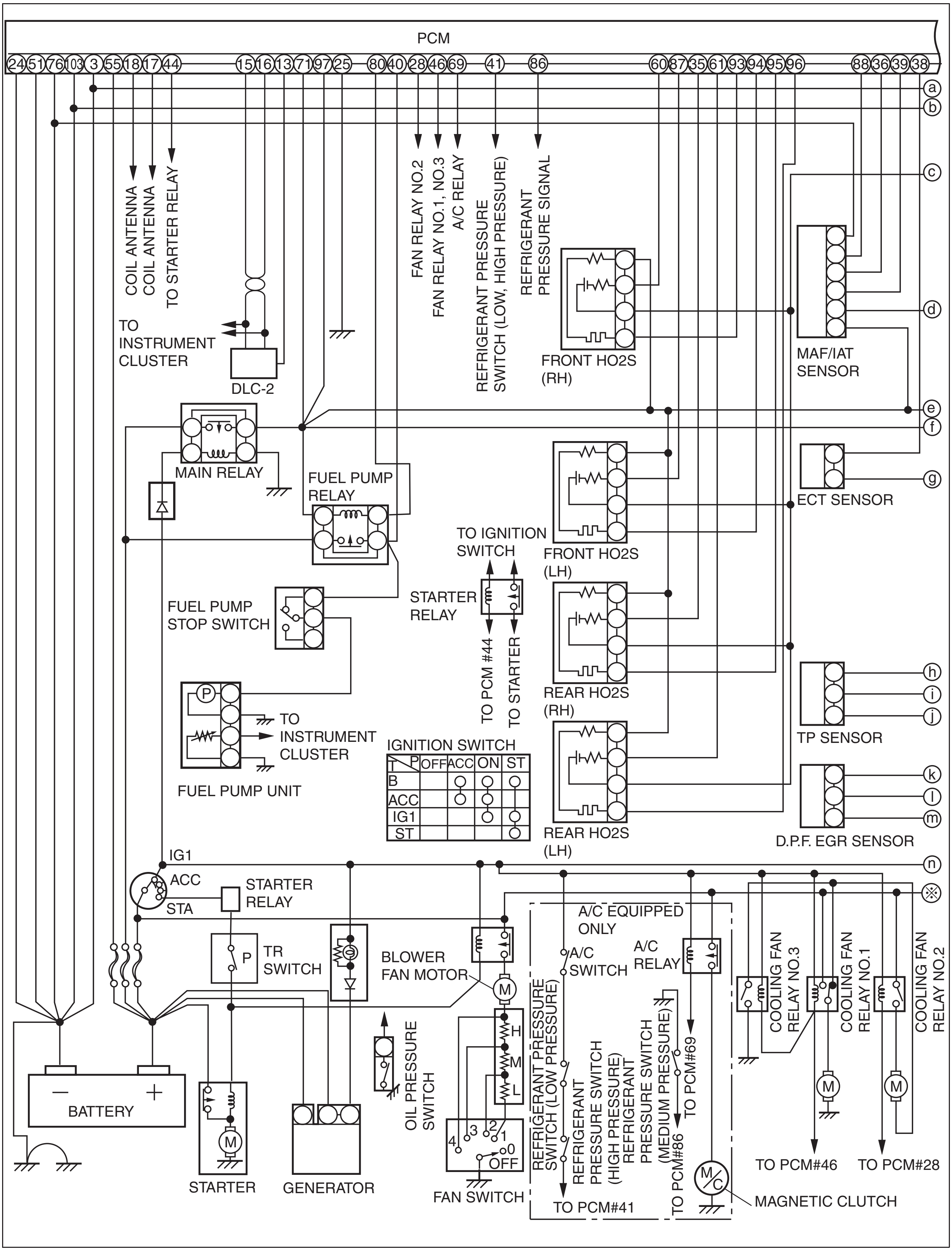
DIAGNOSTIC SYSTEM WIRING DIAGRAM[AJ (3.0L Duratec)]

id0102a4142400



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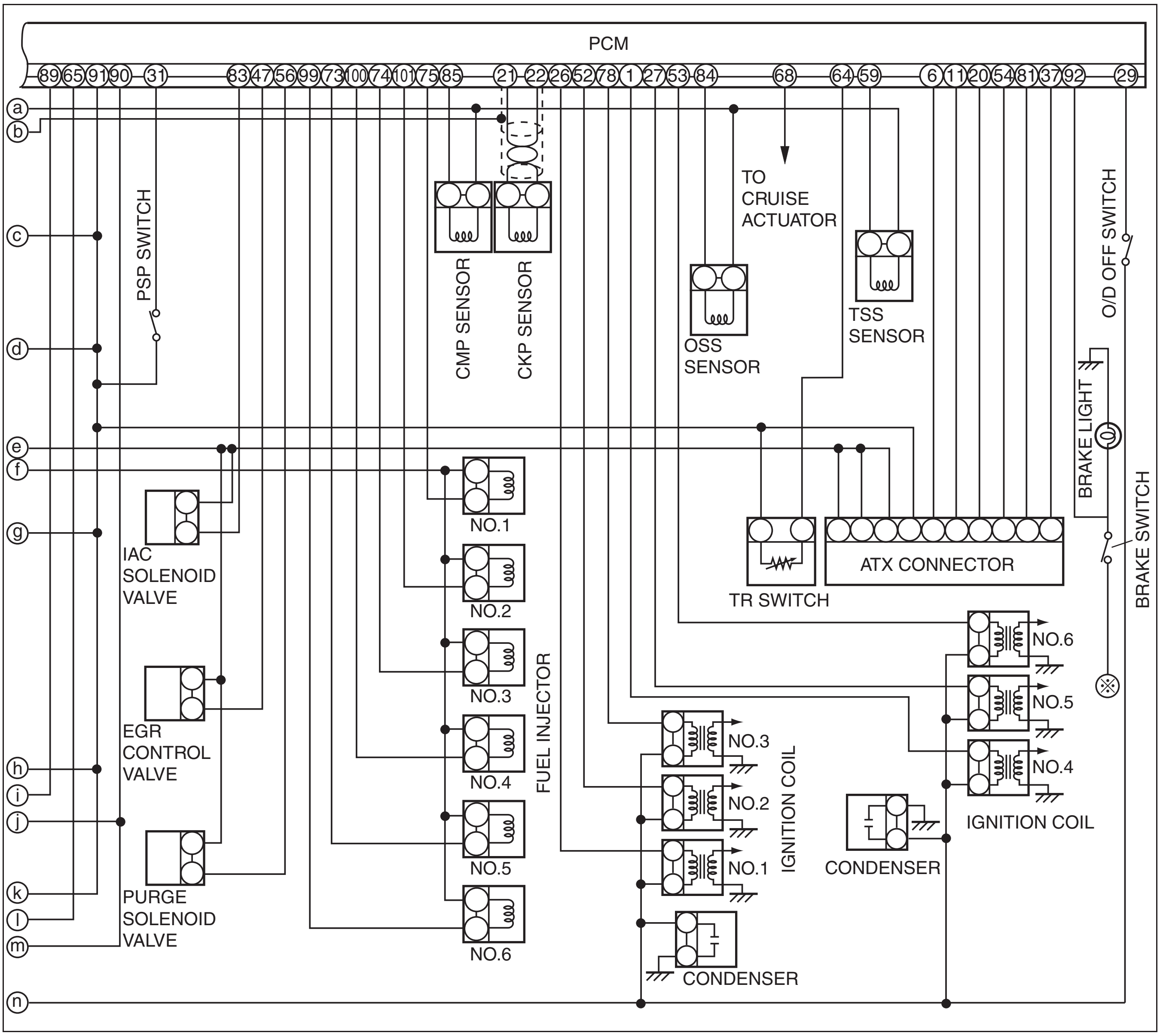


aesffn00000097

ON-BOARD DIAGNOSTIC SYSTEM MALFUNCTION DETECTION FUNCTION[AJ (3.0L Duratec)]

id0102a4141900

Features

- If any malfunction develops in the engine control system, the PCM stores that malfunction as a DTC. Stored DTCs can be read-out using the PDS/IDS.
- The malfunction detection function includes malfunction diagnosis and self-test functions.

Malfunction Diagnosis Function

- This function detects malfunctions that develop in the engine control system.
- When the malfunction conditions are consistent with the malfunction determination conditions preset in the PCM, the PCM determines that an engine control system malfunction has occurred and stores the corresponding DTC(s).

DTC Table

DTC	Description
P0053	Front HO2S (RH) heater resistance
P0054	Rear HO2S (RH) heater resistance
P0059	Front HO2S (LH) heater resistance
P0060	Rear HO2S (LH) heater resistance
P0102	MAF circuit low input
P0103	MAF circuit high input

DTC	Description
P0112	IAT circuit low input
P0113	IAT circuit high input
P0116	ECT circuit range/performance problem
P0117	ECT circuit low input
P0118	ECT circuit high input
P0122	TP circuit low input
P0123	TP circuit high input
P0125	Insufficient coolant temperature for closed loop fuel control
P0131	Front HO2S (RH) sensor circuit out of range low voltage
P0132	Front HO2S (RH) sensor circuit out of range high voltage
P0133	Front HO2S (RH) sensor circuit slow response
P0135	Front HO2S (RH) heater circuit malfunction
P0136	Rear HO2S (RH) sensor circuit malfunction
P0138	Rear HO2S (RH) sensor circuit out of range high voltage
P0141	Rear HO2S (RH) heater circuit malfunction
P0151	Front HO2S (LH) sensor circuit out of range low voltage
P0152	Front HO2S (LH) sensor circuit out of range high voltage
P0153	Front HO2S (LH) sensor circuit slow response
P0155	Front HO2S (LH) heater circuit malfunction
P0156	Rear HO2S (LH) sensor circuit malfunction
P0158	Rear HO2S (LH) sensor circuit out of range high voltage
P0161	Rear HO2S (LH) heater circuit malfunction
P0171	System to lean (Right bank)
P0172	System to rich (Right bank)
P0174	System to lean (Left bank)
P0175	System to rich (Left bank)
P0201	Injector circuit/Open - Cylinder 1
P0202	Injector circuit/Open - Cylinder 2
P0203	Injector circuit/Open - Cylinder 3
P0204	Injector circuit/Open - Cylinder 4
P0205	Injector circuit/Open - Cylinder 5
P0206	Injector circuit/Open - Cylinder 6
P0230	FP primary circuit malfunction
P0231	FP secondary circuit low
P0232	FP secondary circuit high
P0300	Random misfire
P0301	Cylinder No.1 misfire detection
P0302	Cylinder No.4 misfire detection
P0303	Cylinder No.2 misfire detection
P0304	Cylinder No.5 misfire detection
P0305	Cylinder No.3 misfire detection
P0306	Cylinder No.6 misfire detection
P0320	Ignition engine speed input circuit
P0340	Camshaft position (CMP) sensor circuit malfunction
P0401	EGR flow insufficient detected
P0402	EGR flow excessive detected
P0420	Right bank catalyst system efficiency below threshold
P0430	Left bank catalyst system efficiency below threshold
P0603	Internal control module KAM error
P0605	Internal control module ROM error
P1000	OBD system readness test not complete
P1100	MAF sensor intermittent
P1112	IAT circuit performance problem
P1117	ECT circuit performance problem
P1120	TP sensor out of range low (Ratch to low)

DTC	Description
P1121	TP sensor inconsistent with MAF sensor
P1125	TP sensor intermittent
P1130	Lack of front HO2S (RH) switch, fuel trim at limit
P1131	Lack of front HO2S (RH) switch, sensor indicates lean
P1132	Lack of front HO2S (RH) switch, sensor indicates rich
P1137	Lack of rear HO2S (RH) switch, sensor indicates lean
P1138	Lack of rear HO2S (RH) switch, sensor indicates rich
P1150	Lack of front HO2S (LH) switch, fuel trim at limit
P1151	Lack of front HO2S (LH) switch, sensor indicates lean
P1152	Lack of front HO2S (LH) switch, sensor indicates rich
P1157	Lack of rear HO2S (LH) switch, sensor indicates lean
P1158	Lack of rear HO2S (LH) switch, sensor indicates rich
P1309	MIsfire monitor disabled
P1400	Differential Pressure Feedback (D.P.F.) EGR sensor circuit low voltage detected
P1401	Differential Pressure Feedback (D.P.F.) EGR sensor high voltage detected
P1405	Differential Pressure Feedback (D.P.F.) EGR sensor upstream hose off or plugged
P1406	Differential Pressure Feedback (D.P.F.) EGR sensor down steam hose off or plugged
P1408	EGR flow out of self test range
P1460	Wide open throttle A/C cutout primary circuit malfunction
P1474	Cooling fan relay No.2 primary circuit failure
P1479	Cooling fan relay No.1 and No.3 primary circuit failure
P1501	Vehicle Speed Sensor (VSS) out of Self Test Range
P1504	IAC solenoid valve circuit
P1506	IAC overspeed error
P1507	IAC underspeed error
P1633	Keep alive voltage too low
P1635	Tire/axle ratio out of acceptable range
P1639	PCM Vehicle ID block corrupted or not programmed
P1650	PSP switch circuit malfunction
P1703	Brake switch out of self-test range
P2195	Lack of front HO2S (RH) switch, sensor indicates lean
P2196	Lack of front HO2S (RH) switch, sensor indicates rich
P2197	Lack of front HO2S (LH) switch, sensor indicates lean
P2198	Lack of front HO2S (LH) switch, sensor indicates rich
P2270	Lack of rear HO2S (RH) switch, sensor indicates lean
P2271	Lack of rear HO2S (RH) switch, sensor indicates rich
P2272	Lack of rear HO2S (LH) switch, sensor indicates lean
P2273	Lack of rear HO2S (LH) switch, sensor indicates rich

Comprehensive Component Monitor

- The Comprehensive Component Monitor (CCM) monitors for malfunctions in any powertrain electronic component or circuit that provides input or output signals to the PCM that can effect emissions and is not monitored by another system monitor. Inputs and outputs are, at a minimum, monitored for circuit continuity or specified range of values. Where feasible, inputs are also inspected for rationality, and outputs are inspected for proper functionality.
- CCM covers many components and circuits, and tests them in various ways depending on the hardware, function, and type of signal. For example, analog inputs such as throttle position or engine coolant temperature are typically inspected continuously for opens, shorts, and unspecified values. Some digital inputs such as vehicle speed or crankshaft position rely on rationality inspections; inspecting if the input value makes sense at the current engine operating conditions. These types of tests require monitoring several components and can only be performed under appropriate test conditions.
- Outputs such as the IAC solenoid valve are inspected for opens and shorts by monitoring an inspection circuit or “dedicated IC chip” associated with the output. Other outputs, such as relays, require an additional inspection circuit to monitor the secondary side of the relay. Some outputs are also monitored for proper function by observing the reaction of emission-related components to a given change in the output command. An IAC solenoid valve can be functionally inspected by monitoring actual idle speed relative to the target engine speed. Some tests can only be performed under appropriate test conditions.
- The following is an example of some of the input and output components monitored by the CCM for OBD. The monitored components belong to a PCM supported subsystem.

Inputs

— Includes: MAF sensor, IAT sensor, ECT sensor, TP sensor, CMP sensor, refrigerant pressure switch (medium pressure)

Outputs

— Includes: Fuel pump, A/C relay, IAC solenoid valve, purge solenoid valve

- The CCM is activated after the engine is started and is operating. A DTC is stored in the PCM memory and the MIL is illuminated if a malfunction is detected for two consecutive drive cycles. Many of the CCM monitor items are also performed during self-test.

EGR System Monitor

- The differential pressure feedback EGR system monitor is an on-board diagnostic function designed to test the integrity and flow characteristics of the EGR system. The monitor is activated after certain base engine conditions are satisfied and during EGR system operation. Signals from the following components are required for EGR monitor operation.
  — ECT sensor, IAT sensor, TP sensor, CKP sensor
- The differential pressure feedback EGR sensor and circuit are continuously monitored for opens and shorts. The monitor inspects for input voltage from the differential pressure feedback EGR sensor that exceeds the maximum or minimum allowable limits. DTCs P1400 and P1401 are associated with this test.
- The EGR control valve and circuit are continuously monitored for opens and shorts. The monitor inspects if EGR control valve circuit voltage is inconsistent with the EGR control valve circuit control status. DTC P1409 is associated with this test.
- The test for a stuck open EGR valve or EGR flow at idle is continuously performed whenever at idle (TP sensor indicates closed throttle). The monitor compares the differential pressure feedback EGR circuit voltage at idle to the circuit voltage stored during key on engine off to determine if EGR flow is present at idle. DTC P0402 is associated with this test.
- The differential pressure feedback EGR sensor upstream hose is tested once per drive cycle for disconnection and plugging. The test is performed during acceleration with the EGR valve closed. The PCM momentarily commands the EGR valve closed. The monitor inspects if the differential pressure feedback EGR sensor voltage during diagnosis is inconsistent with voltage when there is no EGR flow. A voltage increase or decrease during acceleration while the EGR valve is closed may indicate a malfunction in the inspection hose during this test. DTC P1405 is associated with this test.
- The EGR flow rate test is performed when EGR control is in its most stable state (engine load and speed are moderate). The monitor compares the actual differential pressure feedback EGR sensor voltage to the ideal sensor voltage for that state to determine if EGR flow rate is acceptable or insufficient. This is a system test and may result in DTC P0401 (for any EGR system malfunction) to be stored. DTC P1408 is similar to P0401 but is detected during the KOER self-test.
- The MIL is illuminated if a malfunction is detected during two consecutive drive cycles.

Fuel System Monitor

- The fuel system monitor is an on-board function designed to monitor correction values for fuel injection control. The fuel control system uses fuel injection learning correction values stored in the PCM to compensate for deviations in fuel system components due to normal wear and aging. During fuel system feedback control, fuel injection control learns the corrections required to correct a “biased” rich or lean fuel system. These corrections are stored as fuel feedback correction coefficients. Fuel injection control has two correction methods: Long term and short term fuel corrections. Long term fuel correction uses the learning correction coefficient and short term fuel correction uses the fuel feedback correction coefficient. Inputs from the ECT, IAT, and MAF sensors are required to activate fuel injection control and perform fuel system monitor. Once activated, the fuel system monitor inspects if the fuel feedback and fuel learning correction coefficients exceed a specified limit. When a malfunction is detected as described below, the fuel system monitor stores a corresponding DTC.
  — The HO2S detects the presence of oxygen in the exhaust gas and provides the PCM with feedback indicating the air/fuel ratio.
  — A correction factor is added to the fuel injector pulse width calculation according to the long and short term fuel corrections as needed to compensate for deviations in the fuel system.
  — As the deviation from the stoichiometric air/fuel ratio becomes larger, air/fuel ratio control suffers and uncombusted gas in the exhaust increase. If the stoichiometric air/fuel ratio exceeds the specified limit and the fuel correction coefficient approaches the specified limit, the fuel system monitor stores DTCs as follows:
    - DTCs P0171 and P0174: Detection of a lean shift in fuel system operation
    - DTCs P0172 and P0175: Detection of a rich shift in fuel system operation
- The MIL is illuminated if a malfunction is detected during two consecutive drive cycles.

HO2S Monitor

- The HO2S monitor is an on-board diagnostic function designed to monitor the HO2S sensor for malfunctions or deterioration that can affect emissions. The HO2S used for fuel injector control is monitored for proper output voltage. Inputs from the ECT, IAT, MAF and CKP sensors are required for HO2S monitor operation. The fuel system and misfire detection monitors must also have been performed successfully before the HO2S monitor is activated.
  — The HO2S detects the oxygen content in the exhaust gas and outputs voltage between 0—1.0 V. If the air fuel ratio is leaner than the stoichiometric air/fuel ratio (14.7: 1), the HO2S generates 0—0.45 V. If the air fuel ratio is richer than the stoichiometric air/fuel ratio (14.7: 1), the HO2S generates 0.45—1.0 V. The HO2S monitor evaluates the HO2S for proper operation.
  — Once the HO2S monitor is activated, it monitors the HO2S output voltage and response frequency. Excessive voltage is determined by comparing HO2S output voltage with a specified maximum voltage. When the monitor conditions are satisfied, fuel injection control for HO2S monitor is executed and the HO2S output voltage and output response frequency are observed. At this time, the HO2S output voltage is evaluated to determine if the sensor is capable of switching (activated). An HO2S heater circuit malfunction is determined by turning the heater on/off and monitoring for corresponding voltage variation at the PCM terminal, and by measuring voltage flow through the heater circuit. DTCs associated with the HO2S monitor are divided in the following manner:
    - P1130, P1131, P1132, P1150, P1151, P1152: Property failure
    - P0133, P0153: Slow response rate
    - P0135, P0155: Heater circuit malfunction
- The MIL is illuminated if a malfunction is detected during two consecutive drive cycles.

Misfire Detection Monitor

- The misfire detection monitor is an on-board diagnostic function designed to detect engine misfire and identify in which cylinder the misfire has occurred. Misfire is defined as lack of combustion in a cylinder due to absence of spark, poor fuel metering, poor compression, or any other cause. The misfire detection monitor will only be enable when certain base engine conditions are first satisfied. Inputs from the ECT, MAF and CKP sensors are required for the monitor to be performed. The misfire detection monitor is also activated during the self-test.
  — The PCM synchronizes the ignition timing with crankshaft rotation signal from the CKP sensor. The crankshaft rotation signal is also the main signal used for determining which cylinder misfires.
  — The crankshaft rotation signal generated by the CKP sensor is derived from by sensing the passage of teeth on the crankshaft position wheel mounted on the end of the crankshaft.
  — This signal is input to the PCM and then used to calculate the time between crankshaft rotation signals, and also crankshaft rotation speed and acceleration. The power loss of each cylinder is determined by comparing the accelerations of each cylinder. When the power loss of a particular cylinder exceeds a specified value and other conditions are met, then that cylinder is determined to have misfired.
  Misfire type A
    - Upon detection of a serious misfire that could cause catalyst damage, the MIL flashes once per second during the misfire and a DTC is stored.
  Misfire type B
    - Upon detection of a misfire that could exceed the emission limits or cause the vehicle to fail an inspection and maintenance tailpipe emissions test, the MIL illuminates and a DTC is stored. DTC P0300 is stored in the case of a multiple cylinder misfire.
  — DTCs P0301, P0302, P0303, P0304, P0305, and P0306 are stored in case of an individual type A or type B single cylinder misfire.

Freeze Frame Data

- When the PCM detects an engine control system malfunction. it stores the vehicle and engine operation status at that moment. This data stored in the PCM is freeze frame data.
- Freeze frame data is stored at the same time that the MIL illuminates and any previous DTC data is overwritten.
- Items stored as freeze frame data are shown below.

Freeze Frame Data Table

PID	Unit
Fuel feedback control status (RH,LH)	—
Charging efficiency (For engine control)	%
ECT	°C
Fuel feedback correction amount (RH, LH)	%
Fuel learning correction amount (RH, LH)	%
Intake air pressure	kPa
Engine speed	rpm
Vehicle speed	km/h

On-board Diagnostic System (OBD) Readiness Test

- Allows verification of whether or not the OBD items (monitor items) set in the PCM have been successfully completed.
- Fuel injection control, and CCM and non-CCM components, are constantly monitored since their status is constantly diagnosed.
- The status of intermittently monitored diagnostic items can be initiated by activating the initialization function for diagnostic data.

Self-test Function

- The self-test function consists of the KOEO (Key On, Engine Off) self-test, performed when the ignition switch is turned to the ON position and the engine is stopped, and the KOER (Key On, Engine Running) self-test, performed when idling.
- When the self-test is activated, the PCM performs engine control system diagnosis. If any malfunction is detected as a result of the diagnosis, the applicable DTC is stored. Stored DTCs can be read-out using the PDS/IDS.
- Using the self-test function, the present malfunction or a successful repair is readily confirmed. Refer to the self-test table for the corresponding DTCs.

KOEO (Key ON, Engine Off) Self-test

- The KOEO self-test, performed when the ignition switch is turned to the ON position and the engine is stopped, is designed to diagnose malfunctions related to DTCs applicable to this self-test function. A KOEO self-test begins when the connected the PDS/IDS sends an execute command to the PCM.

KOER (Key ON, Engine Running) Self-test

- The KOER, self-test performed when the ignition switch is turned to the ON position, the vehicle is stopped and the engine is idling, is designed to diagnose malfunctions related to DTCs applicable to this self-test function. A KOER self-test begins when the connected the PDS/IDS an execute command to the PCM.

Self-test Table

x: Applicable
—: Not applicable

DTC	System Malfunction Location	KOEO self-test	KOER self-test
P0053	Front HO2S (RH) heater resistance	x	x
P0054	Rear HO2S (RH) heater resistance	x	x
P0059	Front HO2S (LH) heater resistance	x	x
P0060	Rear HO2S (LH) heater resistance	x	x
P0102	MAF circuit low input	x	x
P0103	MAF circuit high input	x	x
P0112	IAT circuit low input	x	x
P0113	IAT circuit high input	x	x
P0116	ECT circuit range/performance problem	x	x
P0117	ECT circuit low input	x	x
P0118	ECT circuit high input	x	x
P0122	TP circuit low input	x	x
P0123	TP circuit high input	x	x
P0125	Insufficient coolant temperature for closed loop fuel control	x	x
P0131	Front HO2S (RH) sensor circuit out of range low voltage	x	x
P0132	Front HO2S (RH) sensor circuit out of range high voltage	x	x
P0133	Front HO2S (RH) sensor circuit slow response	x	x
P0135	Front HO2S (RH) heater circuit malfunction	x	x
P0136	Rear HO2S (RH) sensor circuit malfunction	x	x
P0138	Rear HO2S (RH) sensor circuit out of range high voltage	x	x
P0141	Rear HO2S (RH) heater circuit malfunction	x	x
P0151	Front HO2S (LH) sensor circuit out of range low voltage	x	x
P0152	Front HO2S (LH) sensor circuit out of range high voltage	x	x
P0153	Front HO2S (LH) sensor circuit slow response	x	x
P0155	Front HO2S (LH) heater circuit malfunction	x	x
P0156	Rear HO2S (LH) sensor circuit malfunction	x	x
P0158	Rear HO2S (LH) sensor circuit out of range high voltage	x	x

DTC	System Malfunction Location	KOEO self-test	KOER self-test
P0161	Rear HO2S (LH) heater circuit malfunction	x	x
P0171	System to lean (Right bank)	x	x
P0172	System to rich (Right bank)	x	x
P0174	System to lean (Left bank)	x	x
P0175	System to rich (Left bank)	x	x
P0201	Injector circuit/Open - Cylinder 1	x	x
P0202	Injector circuit/Open - Cylinder 2	x	x
P0203	Injector circuit/Open - Cylinder 3	x	x
P0204	Injector circuit/Open - Cylinder 4	x	x
P0205	Injector circuit/Open - Cylinder 5	x	x
P0206	Injector circuit/Open - Cylinder 6	x	x
P0230	FP primary circuit malfunction	x	x
P0231	FP secondary circuit low	x	x
P0232	FP secondary circuit high	x	x
P0300	Random misfire	—	—
P0301	Cylinder No.1 misfire detection	—	—
P0302	Cylinder No.4 misfire detection	—	—
P0303	Cylinder No.2 misfire detection	—	—
P0304	Cylinder No.5 misfire detection	—	—
P0305	Cylinder No.3 misfire detection	—	—
P0306	Cylinder No.6 misfire detection	—	—
P0320	Ignition engine speed input circuit	—	—
P0340	Camshaft position (CMP) sensor circuit malfunction	x	x
P0401	EGR flow insufficient detected	—	x
P0402	EGR flow excessive detected	—	x
P0420	Right bank catalyst system efficiency below threshold	—	—
P0430	Left bank catalyst system efficiency below threshold	—	—
P0443	Purge solenoid valve control circuit malfunction	x	x
P0460	Fuel level sensor circuit malfunction	x	x
P0603	Internal control module KAM error	x	—
P0605	Internal control module ROM error	x	x
P1000	OBD system readness test not complete	x	x
P1100	MAF sensor intermittent	x	x
P1112	IAT circuit performance problem	—	—
P1117	ECT circuit performance problem	—	—
P1120	TP sensor out of range low (Ratch to low)	x	x
P1121	TP sensor inconsistent with MAF sensor	—	x
P1125	TP sensor intermittent	—	—
P1130	Lack of front HO2S (RH) switch, fuel trim at limit	—	—
P1131	Lack of front HO2S (RH) switch, sensor indicates lean	—	x
P1132	Lack of front HO2S (RH) switch, sensor indicates rich	x	x
P1137	Lack of rear HO2S (RH) switch, sensor indicates lean	—	x
P1138	Lack of rear HO2S (RH) switch, sensor indicates rich	—	x
P1150	Lack of front HO2S (LH) switch, fuel trim at limit	—	—
P1151	Lack of front HO2S (LH) switch, sensor indicates lean	—	x
P1152	Lack of front HO2S (LH) switch, sensor indicates rich	x	x
P1157	Lack of rear HO2S (LH) switch, sensor indicates lean	—	x
P1158	Lack of rear HO2S (LH) switch, sensor indicates rich	—	x
P1309	MIsfire monitor disabled	—	—
P1400	Differential Pressure Feedback (D.P.F.) EGR sensor circuit low voltage detected	x	x
P1401	Differential Pressure Feedback (D.P.F.) EGR sensor high voltage detected	x	x
P1405	Differential Pressure Feedback (D.P.F.) EGR sensor upstream hose off or plugged	—	x

DTC	System Malfunction Location	KOEO self-test	KOER self-test
P1406	Differential Pressure Feedback (D.P.F.) EGR sensor down steam hose off or plugged	x	x
P1408	EGR flow out of self test range	—	x
P1460	Wide open throttle A/C cutout primary circuit malfunction	x	x
P1474	Cooling fan relay No.2 primary circuit failure	x	x
P1479	Cooling fan relay No.1 and No.3 primary circuit failure	x	x
P1501	Vehicle Speed Sensor (VSS) out of Self Test Range	x	x
P1504	IAC solenoid valve circuit	x	x
P1506	IAC overspeed error	x	x
P1507	IAC underspeed error	x	x
P1633	Keep alive voltage too low	x	x
P1635	Tire/axle ratio out of acceptable range	—	—
P1639	PCM Vehicle ID block corrupted or not programmed	x	x
P1650	PSP switch circuit malfunction	x	x
P1703	Brake switch out of self-test range	x	x
P2195	Lack of front HO2S (RH) switch, sensor indicates lean	—	x
P2196	Lack of front HO2S (RH) switch, sensor indicates rich	x	x
P2197	Lack of front HO2S (LH) switch, sensor indicates lean	—	x
P2198	Lack of front HO2S (LH) switch, sensor indicates rich	x	x
P2270	Lack of rear HO2S (RH) switch, sensor indicates lean	—	x
P2271	Lack of rear HO2S (RH) switch, sensor indicates rich	—	x
P2272	Lack of rear HO2S (LH) switch, sensor indicates lean	—	x
P2273	Lack of rear HO2S (LH) switch, sensor indicates rich	—	x

ON-BOARD DIAGNOSTIC SYSTEM PID/DATA MONITOR FUNCTION[AJ (3.0L Duratec)]

id0102a4142100

Features

- PIDs that satisfy emission regulations are included.

Function

- Allows for monitoring emission-related data, such as input/output signals, PCM calculated values and system status.
- Items that can be monitored are shown below.

PID/Data Monitor Table

External diagnostic unit

PID	Unit
Fuel feedback control status (LH, RH)	—
Charging efficiency (For engine control)	%
ECT	°C
Fuel feedback correction (LH, RH)	%
Fuel learning correction (LH, RH)	%
Engine speed	rpm
Vehicle speed	km/h
Ignition timing	°
Intake air temperature	°C
Intake airflow rate	g/s
Throttle position (Absolute value)	%
HO2S (LH, RH) output voltage	V
Target air/fuel ratio feedback correction (LH, RH)	%
OBD requirement to which vehicle is designed	—

PDS/IDS

PID name	Data contents	Unit/Operation
ACCS	A/C relay	ON/OFF
ACP	Refrigerant pressure switch (medium pressure)	OPEN/CLOSED
ANTISCAN	Anti-scan function	Off/Active
AST	Time since start	s
AXLE	Axle ratio	—
B+	Battery positive voltage	V
BARO	Barometric pressure	kPa, in Hg
		Hz
	Barometric pressure (vacuum)	kPa, in Hg
BOO	Brake switch	ON/OFF
CANVENT	Canister venting status	Yes Falt/No Falt
CAT_EVAL	Catalyst monitor evaluated	YES/NO
CAT_TEST	Catalyst system test ready	Not Ready/ Ready
CMPFM	CMP sensor status	Yes Falt/No Falt
DPFEGR	D.P.F. EGR sensor	V
DRIVECNT	Valid drive counter	—
DTCCNT	Stored DTC count	—
ECT	Engine coolant temperature	V
		Norm/Hot/Cold
		°C, °F
ECT_F	ECT sensor malfunction	Yes Fault/ No Fault
EGR_EVAL	EGR system evaluated	YES/NO
EGR_F	EGR status	Yes Fault/ No Fault
EGR_TEST	EGR system test ready	Not Ready/ Ready
EGRVR	EGR control valve control signal	%
EGRVR_F	EGR control valve malfunction	No Fault/Open/ Short/ Yes Fault
EVAP_EVAL	Evaporative system monitor evaluated	YES/NO
EVAP_TEST	Evaporative emission system test ready	Not Ready/ Ready
EVAP020C	EVAP monitor 0.020 leak check complete	NO/YES
EVAP020D	EVAP monitor not allowed until refuel leak check	Allow/Not Allow
EVAP020R	EVAP monitor 0.020 leak check ready	Not Ready/ Ready
EVAPCV	Evaporative emission canister vent valve	Off/Varying/On
		%
EVAPCV_F	Evaporative emission canister purge fault	Yes Fault/ No Fault
EVAPSOAK	EVAP monitor soak time conditions met	NO/YES
EVAPSTA	Evaporative emission monitor	0-Vac Pulldown/ 1-Vac Stable/2-Vac Hold/3-Vac Release/4-Vapor Gen/5-Vent to Atm/6-Monitor Compl/Not Running
EVAPVM	Evaporative emission vapor management valve	Off/Varying/On
		%
EVAPVM_F	Evaporative emission vapor management fault	Yes Fault/ No Fault
EVAPVMA	Evaporative purge control	V
FAN	Fan control signal	Off/Low/High

PID name	Data contents	Unit/Operation
FAN_F	Fan control malfunction	No Fault/LFC Fault/HFC Fault/ Yes Fault
FAN1	Cooling fan relay No.1 control signal	ON/OFF
FAN2	Cooling fan relay No.2 control signal	ON/OFF
FCIL	Fuel cap off indicator lamp	ON/OFF
FCIL_F	Fuel cap off indicator lamp fault	Yes Fault/ No Fault
FLI	Fuel level	%
FLI_F	Fuel level input FMEM flag	Yes Fault/ No Fault
FP	Fuel pump control signal	ON/OFF
FP_F	Fuel pump control malfunction	Yes Fault/ No Fault
FPM	Fuel pump operation status	ON/OFF
FTP	Fuel tank pressure transducer	V
		kPa, in Hg
FTP_F	Fuel tank pressure transducer status	Yes Fault/ No Fault
FTP_H2O	Fuel tank pressure as inches of water	—
FUELPW1	Fuel injection control signal (Right bank)	ms
FUELPW2	Fuel injection control signal (Left bank)	ms
FUELSYS	Fuel system control status	Open Loop/ Closed Loop/ OL-Drive/ OL-Fault/ CL-Fault
HFC	High-speed fan control relay control	ON/OFF
HFC_F	High-speed fan control relay control malfunction	Yes Fault/ No Fault
HTR11	Front HO2S heater (right bank) control signal	ON/OFF
HTR11F	Front HO2S heater (right bank) control signal malfunction	Yes Fault/ No Fault
HTR12	Rear HO2S heater (right bank) control signal	ON/OFF
HTR21	Front HO2S heater (left bank) control signal	ON/OFF
HTR22	Rear HO2S heater (left bank) control signal	ON/OFF
HTRCM11	Front HO2S heater (right bank) control current value	mA
HTRCM12	Rear HO2S heater (right bank) control current value	mA
HTRCM21	Front HO2S heater (left bank) control current value	mA
HTRCM22	Rear HO2S heater (left bank) control current value	mA
IAC	Idle speed control signal	mA
		%
IAC_F	Idle speed control malfunction	No Fault / Open / Short / Yes Fault
IAC_MODE	Idle speed control status	DASHPOT / PREPOSITION / CTRL LEARN / CTRL NO LRN
IAT	Intake air temperature	V
		°C, °F
IAT_F	Intake air temperature signal error	Yes Fault/ No Fault
INJ_F	Fuel injector control malfunction	No Fault / #1 Fault / #2 Fault / #3 Fault /#4 Fault / #5 Fault / #7 Fault / Yes Fault
INJ1_F	Fuel injector No. 1 control malfunction	Yes Fault/ No Fault

PID name	Data contents	Unit/Operation
INJ2_F	Fuel injector No. 2 control malfunction	Yes Fault/ No Fault
INJ3_F	Fuel injector No. 2 control malfunction	Yes Fault/ No Fault
INJ4_F	Fuel injector No. 4 control malfunction	Yes Fault/ No Fault
INJ5_F	Fuel injector No. 5 control malfunction	Yes Fault/ No Fault
INJ6_F	Fuel injector No. 6 control malfunction	Yes Fault/ No Fault
KAM fuse	Keep alive memory power	FAULT / OK
KNOCK 1	KS	—
LFC	Low-speed fan control relay control	ON/OFF
LFC_F	Low-speed fan control relay control malfunction	Yes Fault/ No Fault
LOAD	Engine load	%
LONGFT1	Fuel system learning correction (Right bank)	%
LONGFT2	Fuel system learning correction (Left bank)	%
MAF	Mass air flow	—
		V
MAF_F	Mass Air Flow Status	Yes Fault/ No Fault
MAN VAC	Manifold air pressure	kPa, in Hg
MFF_EGR	D.P.F. EGR sensor input at time of misfire	V
MFF_IAT	Intake air temperature at time of misfire	°C, °F
MFF_LOAD	Engine lad at time of misfire	%
MFF_PNP	Park/neutral position at time of misfire	Drive/Neutral
MFF_RNTM	Engine running time at time of misfire	ms
MFF_RPM	Engine RPM at time of misfire	RPM
MFF_SOAK	Engine off soak time prior to misfire	ms
MFF_TP	Throttle position at time of misfire	V
MFF_TRIP	Number of trips since the time of misfire	—
MFF_VSS	Vehicle speed at time of misfire	km/h
MIL	MIL illumination status	ON/OFF
MIL_F	MIL driver fault	Yes Fault/ No Fault
MIN_KEY	Minimum required number of programmed keys	—
MISFIRE	Misfire malfunction detected	NO / YES
MP_LRN	Learned misfire correction profile	NO / YES
N_KEYCODE	Number of keys programmed in module	—
NM	Total number of misfires	—
O2S_EVAL	Oxygen sensor monitor evaluated	YES / NO
O2S_TEST	Heated exhaust oxygen sensor system test ready	Not Ready / Ready
O2S11	HO2S (right bank) output signal	Lean / Rich
		V
O2S11_F	Front HO2S (right bank) output signal malfunction	Yes Fault/ No Fault
O2S12	Rear HO2S (right bank) output signal	V
O2S21	Front HO2S (Left bank) output signal	Lean / Rich
		V
O2S21_F	Front HO2S (Left bank) output signal malfunction	Yes Fault/ No Fault
O2S22	Rear HO2S (Left bank) output signal	V
O2SHTR_EVAL	Heated exhaust oxygen sensor heater system evaluated	YES / NO
OTMSTATE	Output test mode	ON/OFF

PID name	Data contents	Unit/Operation
PATS_TYPE	Security access method	Timed/Coded
PATSENABL	Engine starting permission status	Enabled/ Disabled
PIP	Profile ignition pick-up	ON/OFF
PSP	PSP signal	HIGH/LOW
RPM	Engine speed	RPM
RPMDSD	Desired idle speed RPM	RPM
SERV_MOD	PATS service module status	YES / NO
SHRTFT1	Fuel system feedback correction (Right bank)	%
SHRTFT2	Fuel system feedback correction (Left bank)	%
SPAREKEY	Spare key programming status	Enabled/ Disabled
SPARKADV	Ignition timing	BTDC °
THEFT_LMP	Anti-theft indicator lamp control	ON/OFF
TIRESIZE	Tire size (rev/mile)	RPM
TORQUE	Net engine torque	—
TP	Throttle position	V
		PT / WOT / CT
TP RATE	Throttle valve angle variation per given unit of time	—
TP_F	TP sensor status	Yes Fault/ No Fault
TPCT	Lowest closed throttle voltage	V
TQ_CNTRL	Torque fuel/spark limiting status	None / TRANS PRESS / TRAC CTRL /SPEED LIMIT / RPM LIMIT / TIP IN / DECEL /TRANS SHIFT / OIL TEMP / DSD RPM REQ /ANTI STALL / ETC FAULT / ANTI THEFT /SPEED CTRL
TRANSMIT	Anti-theft RF enable and transmit command	ON/OFF
TRIP	On-board diagnostic trip completed	YES / NO
TRIP CNT	Number of on-board diagnostic trips completed	—
UNL_KEY	Unlimited key mode	Enabled/ Disabled
VPWR	Module supply voltage	V
VSS	Vehicle speed	km/h, mph
VSS_FM	Vehicle speed sensor signal status	Yes Fault/ No Fault
WAC/ACCR	Air conditioning clutch	ON/OFF
WAC_F	A/C relay control malfunction at fully-open accelerator	Yes Fault/ No Fault

ON-BOARD DIAGNOSTIC SYSTEM SIMULATION FUNCTION[AJ (3.0L Duratec)]

id0102a4142200

Features

- Simulation items for output components are supported.

Function

- Output parts preset in the PCM can be operated regardless of PCM control status.
- The items that can be operated are as shown below.

Active command mode table

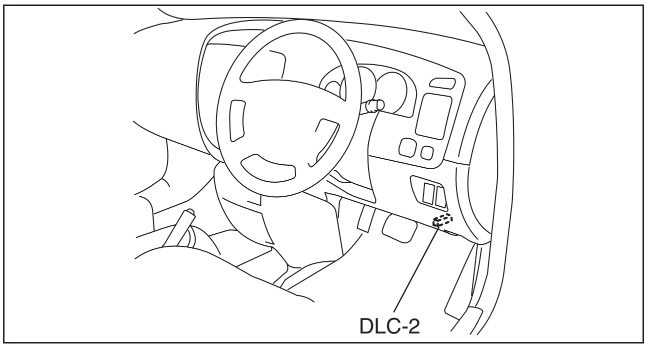
Item	Part operated	Unit/Operation
EGRVR	EGR valve duty cycle	%
EVAPCV	Evaporative emission canister vent valve	Off / Varying / On
EVAPCV	Evaporative emission canister vent valve	%
EVAPVM	Evaporative emission vapor management valve	Off / Varying / On
		%
FP	Fuel pump relay	ON/OFF
HFC	fan control High speed	ON/OFF
LFC	fan control Low speed	ON/OFF
SPARKADV	Ignition timing	BTDC°
THEFT_LMP	Anti-theft indicator lamp control	ON/OFF
TRANSMIT	Anti-theft RF enable and transmit command	ON/OFF

ON-BOARD DIAGNOSTIC SYSTEM EXTERNAL DIAGNOSTIC UNIT COMMUNICATION FUNCTION[AJ (3.0L Duratec)]

id0102a4141800

Features

- The data link connector 2 (DLC-2) conforming to International Organization for Standardization (ISO) standards has been added.



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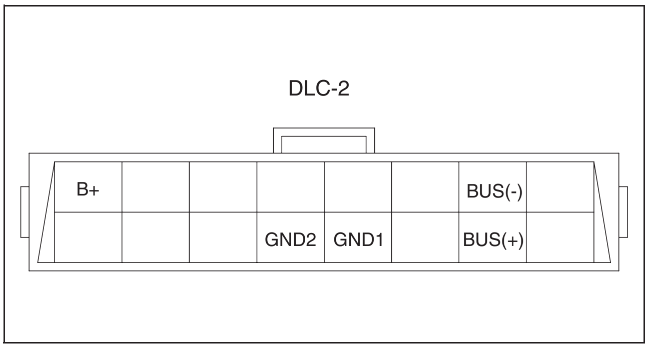
DLC-2

- Shape and terminal arrangement as stipulated by the ISO 15031-3 (SAE J1962) international standard has been adopted. A 16-pin terminal structure is used.

Terminal	Function
B+	Battery power supply terminal
BUS(-)	Serial communication LO terminal
BUS(+)	Serial communication HI terminal
GND1	Body GND terminal
GND2	Serial communication GND terminal



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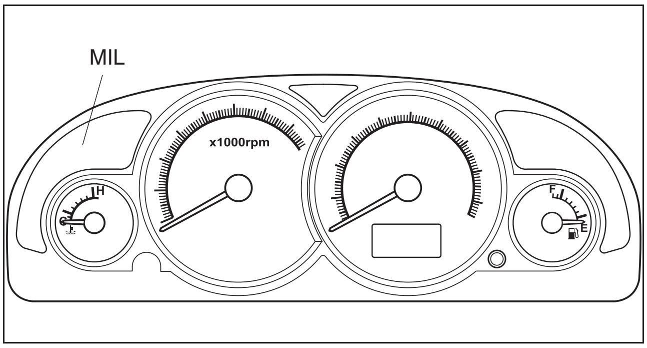
ON-BOARD DIAGNOSTIC SYSTEM MALFUNCTION DISPLAY FUNCTION[AJ (3.0L Duratec)]

id0102a4142000

Features

- The MIL has been adopted to alert the driver when a malfunction occurs in the engine control system.
- The MIL is built into the instrument cluster.



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Function

- When an engine control system malfunction occurs, a DTC is stored in the PCM at the same time the MIL illuminates.

ON-BOARD DIAGNOSTIC SYSTEM DIAGNOSTIC DATA MEMORY FUNCTION[AJ (3.0L Duratec)]

id0102a4141700

Features

- A diagnostic data memory function has been adopted for storing/clearing engine control system diagnostic data.

Memory Function

- The following diagnostic data can be stored in the PCM using the memory function:
  — DTC count
  — DTCs
  — Freeze frame data
  — On-board diagnostic system status
- A DTC is stored in the PCM when an engine control system malfunction occurs. This stored DTC can then be read-out using the PDS/IDS and is displayed as a five character code (PXXXX).
- The DTC is stored in or cleared from the PCM according to the drive cycle count setting.

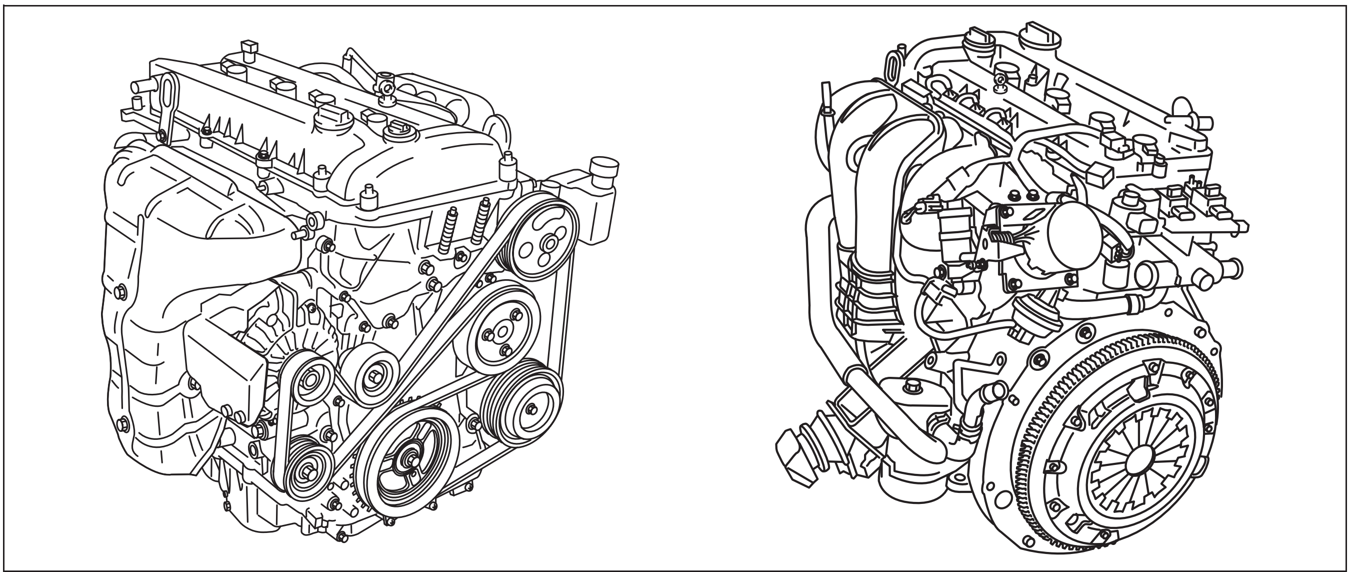
Initialization Function

- Diagnostic data stored in the PCM can be cleared using the initialization function.

01-10A MECHANICAL [L3]

ENGINE STRUCTURAL VIEW[L3]

id0110a4119200



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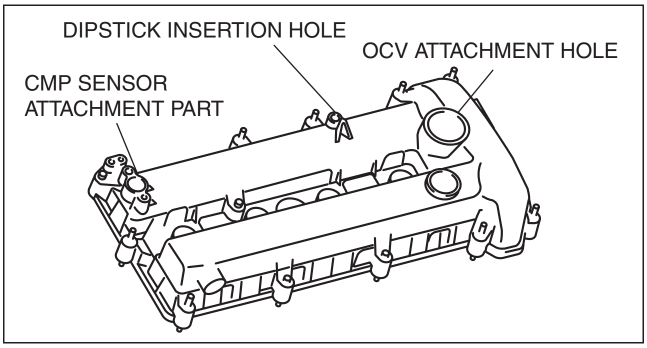
CYLINDER HEAD COVER CONSTRUCTION[L3]

id0110a4100200

- The cylinder head cover is made of integrated plastic, which is lightweight and sound absorbent.
- The oil filler cap is a bayonet type. The boss for installing the camshaft position (CMP) sensor is provided at the rear of the cylinder head cover.
- A dipstick insertion hole has been equipped to the cylinder head cover.



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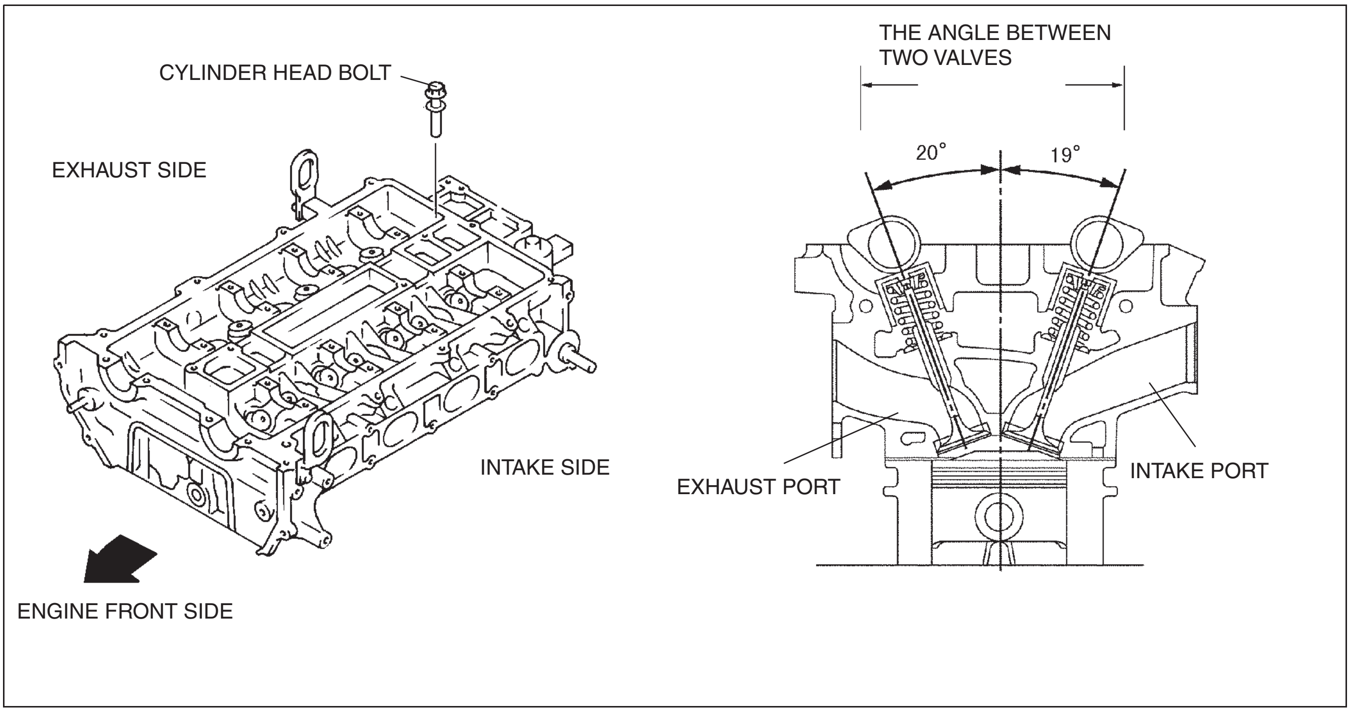
CYLINDER HEAD CONSTRUCTION[L3]

id0110a4100300

- The cylinder head is made of a high heat conductive, lightweight aluminum alloy, which is quenched.
- Compact, pentroof-type combustion chambers have been adopted. The spark plugs are mounted at the top of the combustion chambers to improve combustion efficiency.
- The intake/exhaust port layout is a cross flow type, (the angle between two valves is 39°, the two intake valves and the two exhaust valves per cylinder) which improves air intake/exhaust efficiency.
- The cylinder head bolts are plastic region tightening bolts to be tightened in five motions to insure tightening stability.



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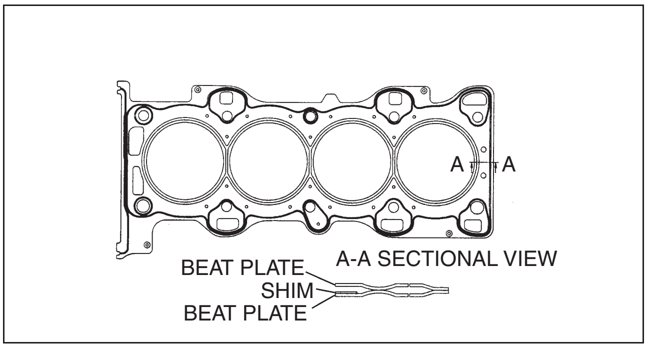
CYLINDER HEAD GASKET CONSTRUCTION[L3]

id0110a4100400

- Cylinder head gaskets are 2 layer-metal gaskets.



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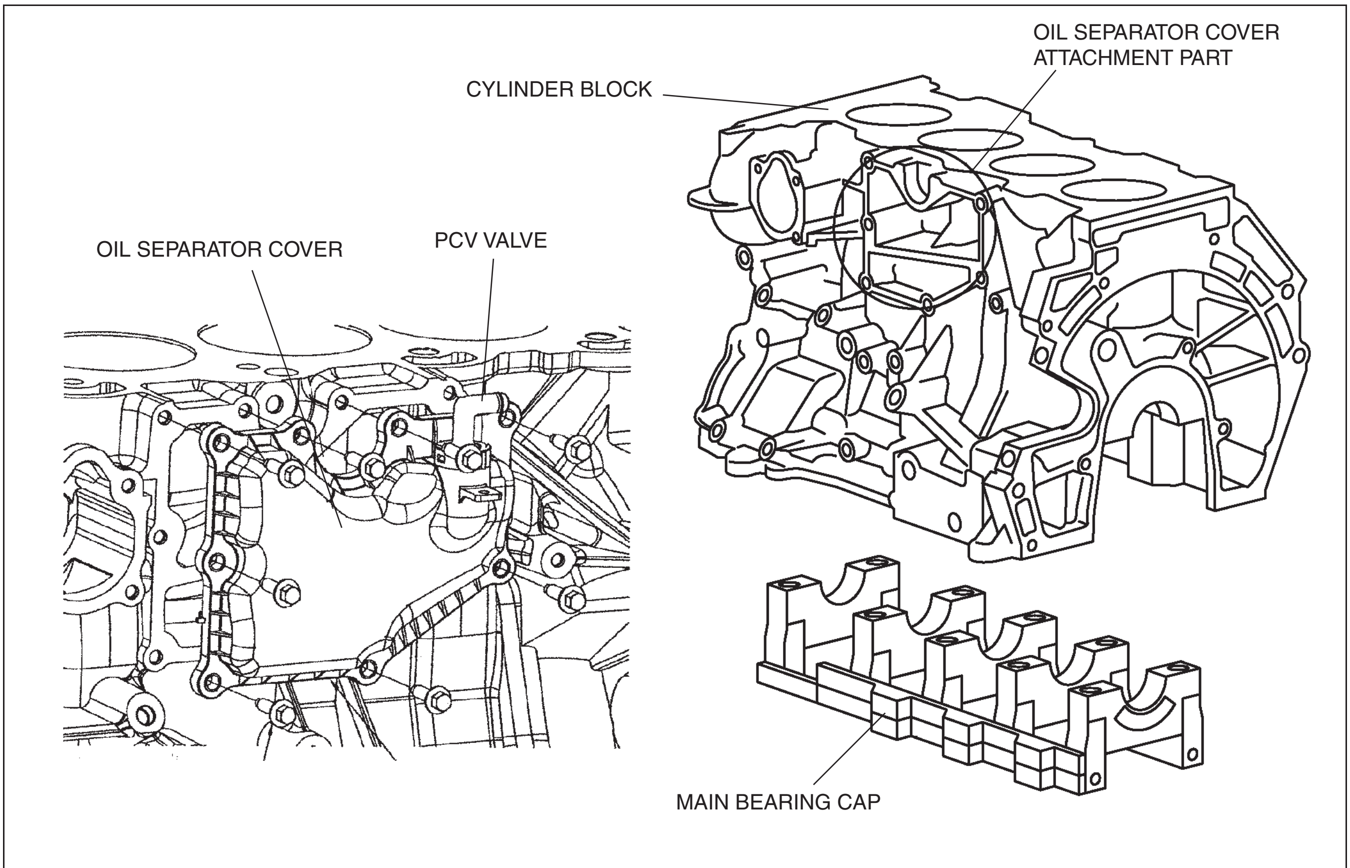
CYLINDER BLOCK CONSTRUCTION[L3]

id0110a4100500

- The cylinder block is made of aluminum alloy, which is cast with the cast iron liner, improving heat radiation and decreasing weight.
- The cylinder block is a deep skirt type and forms the ladder frame structure with the integrated main bearing cap. The water jacket of the cylinder block is a closed deck type. Its higher rigidity reduces vibration and noise.
- The cylinder block has the oil separator cover on the opposite side of the fresh air intake, the PCV (positive crankcase ventilation) valve and the oil separator function with an part for installing the PCV valve, to improve blow-by gas ventilation efficiency.
- There is no positioning tab where the upper and lower main bearings are installed.
- The main bearing cap bolts are elastic region tightening bolts.



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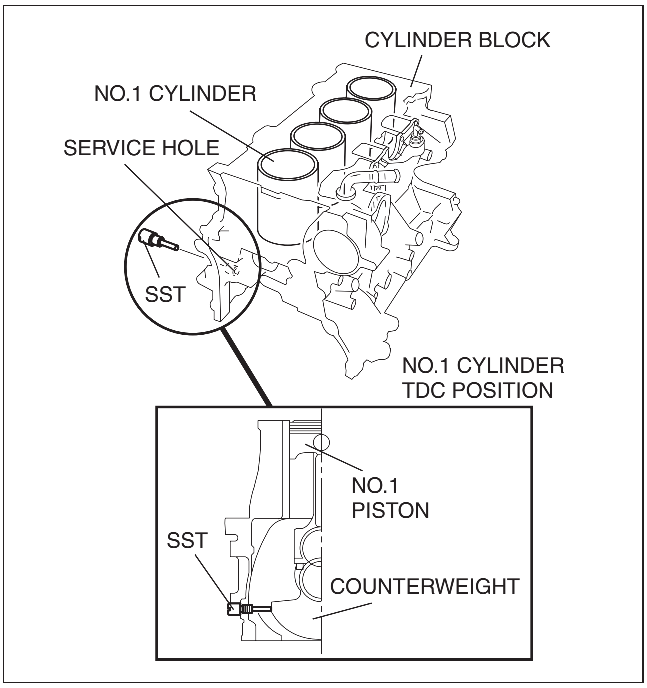
- The service hole for installing the **SST**, which is used for detecting the No.1 cylinder TDC position, is located at the right side of the cylinder block. The TDC position can be detected when the **SST** edge touches the cutting surface of the No.1 counterweight.



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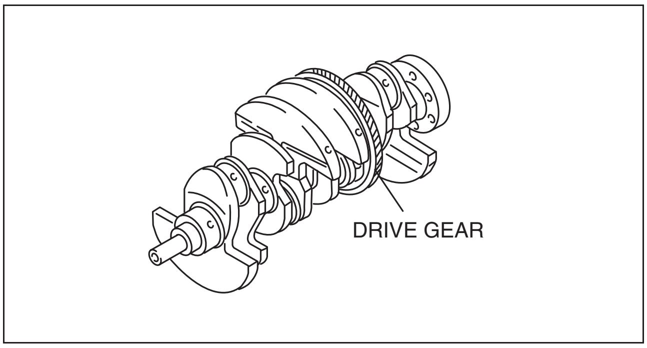
CRANKSHAFT, MAIN BEARING CONSTRUCTION[L3]

id0110a4100800

- A five axle-hole, 8 counter weight cast iron crankshaft has been adopted. The shrinkage fitted drive gear is attached to the crankshaft and the crankshaft drives the balance shaft.
- There is no positioning key where the crankshaft sprocket and crankshaft pulley are installed. The crankshaft sprocket must be installed using the **SST** with the No.1 cylinder aligned with TDC position. Tightening pressure on the tightening bolt is used to secure the crankshaft sprocket and crankshaft pulley.
- An oil line for supplying oil to each journal is provided in the crankshaft. Crank pins and fillets on both sides of the journal are rolled to bear heavy loads.



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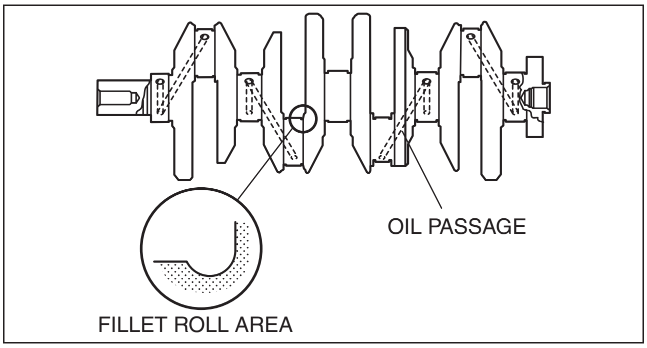
- Upper and lower main bearings are made of aluminum alloy and the upper side No.3 journal bearing is integrated with the thrust bearing. The upper main bearing has oil grooves and oil holes.
- There is no upper and lower bearings′ positioning tab for installing the main journal.



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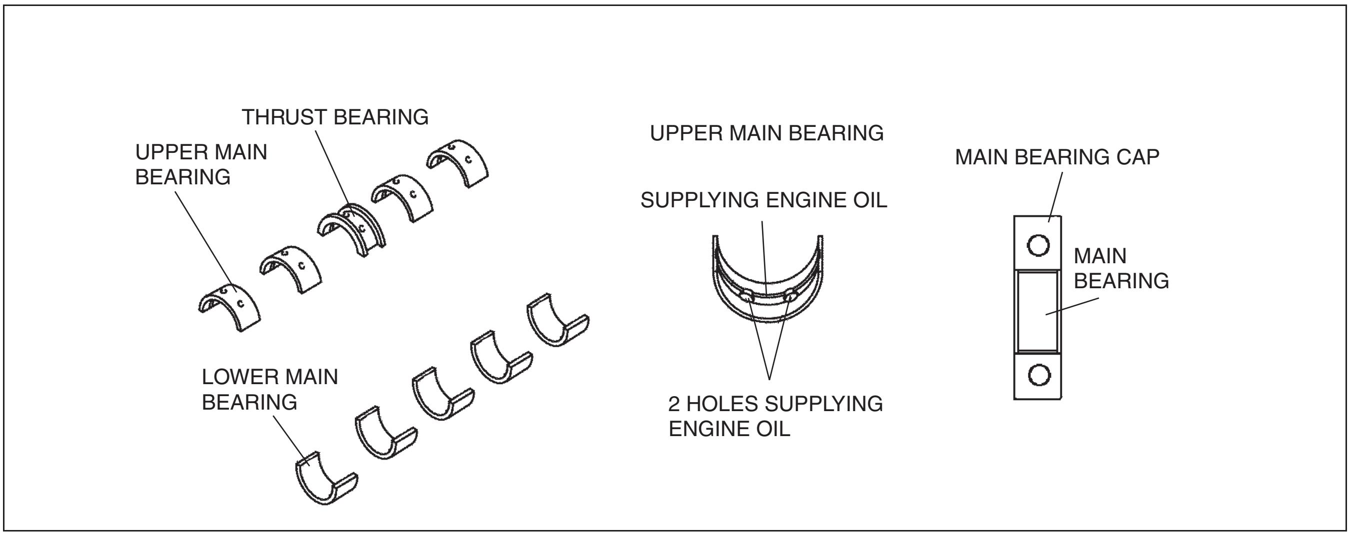
- Measure and attach the main bearings (upper and lower) so that they are positioned at the center the main bearing cap.



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- The main bearing can be selected from three types including STD, 0.25 OS, and 0.50 OS.

CRANKSHAFT SPROCKET CONSTRUCTION[L3]

id0110a4120400

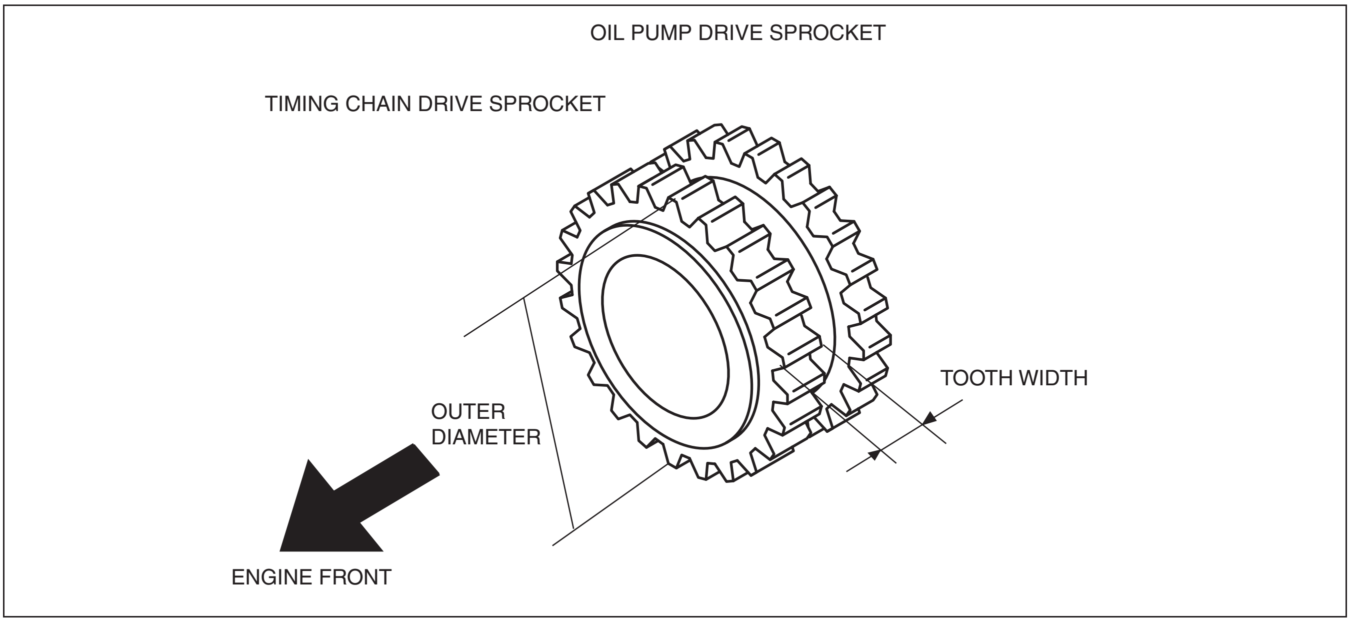
- High-strength chromium steel has been adopted for the crankshaft sprocket. Due to carburizing protection, abrasion resistance at all chain contact points is increased.
- The crankshaft sprocket consists of the timing chain sprocket and oil pump sprocket, which are integrated into a single unit.
- The keyway on the crankshaft sprocket, used to position the crankshaft during installation, has been eliminated.

Timing Drive Sprocket Specification.

ITEM	
Outer diameter (mm {in})	About 48.495 {1.9093}
Tooth width (mm {in})	About 8.03 {0.316}

Oil Pump Drive Sprocket Specification.

ITEM	
Outer diameter (mm {in})	About 48.495 {1.9093}
Tooth width (mm {in})	About 5.93 {0.242}



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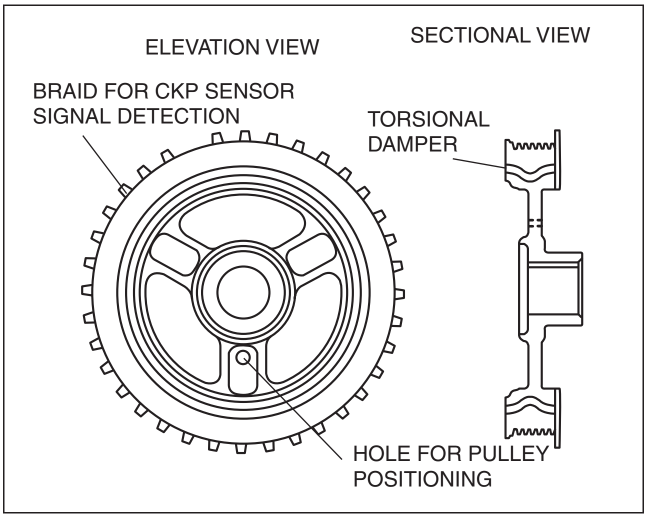
CRANKSHAFT PULLEY CONSTRUCTION[L3]

id0110a4101800

- The crankshaft position (CKP) signal detecting blade has been adopted for the crankshaft pulley. The torsional damper, which prevents the crankshaft from wobbling, has also been adopted for the crankshaft.
- There is no positioning key slot on the crankshaft pulley. Instead, the positioning hole on the crankshaft pulley and the engine front cover are used for aligning the crankshaft pulley with the crankshaft.
- Crankshaft pulley rock bolt is plastic region tightening bolt to be tightened in two steps to insure crankshaft pulley tightening stability.



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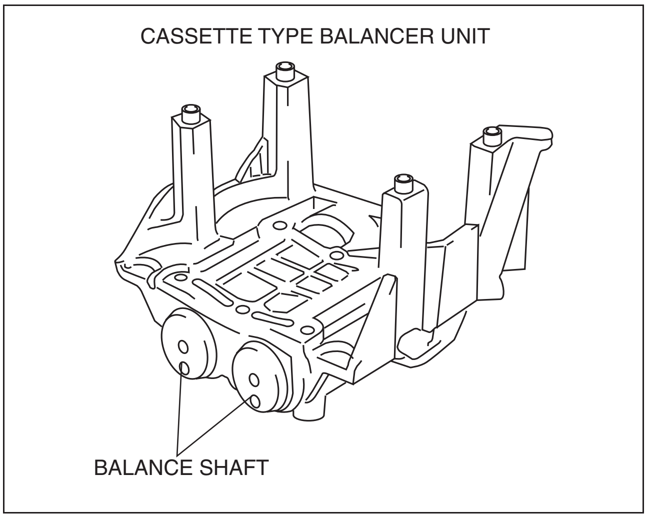
BALANCER UNIT OUTLINE[L3]

id0110a4101600

- The cassette type balancer, which is separated from the engine, has been adopted for the L3 engine models to reduce vibration from the engine.



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BALANCER UNIT CONSTRUCTION/OPERATION[L3]

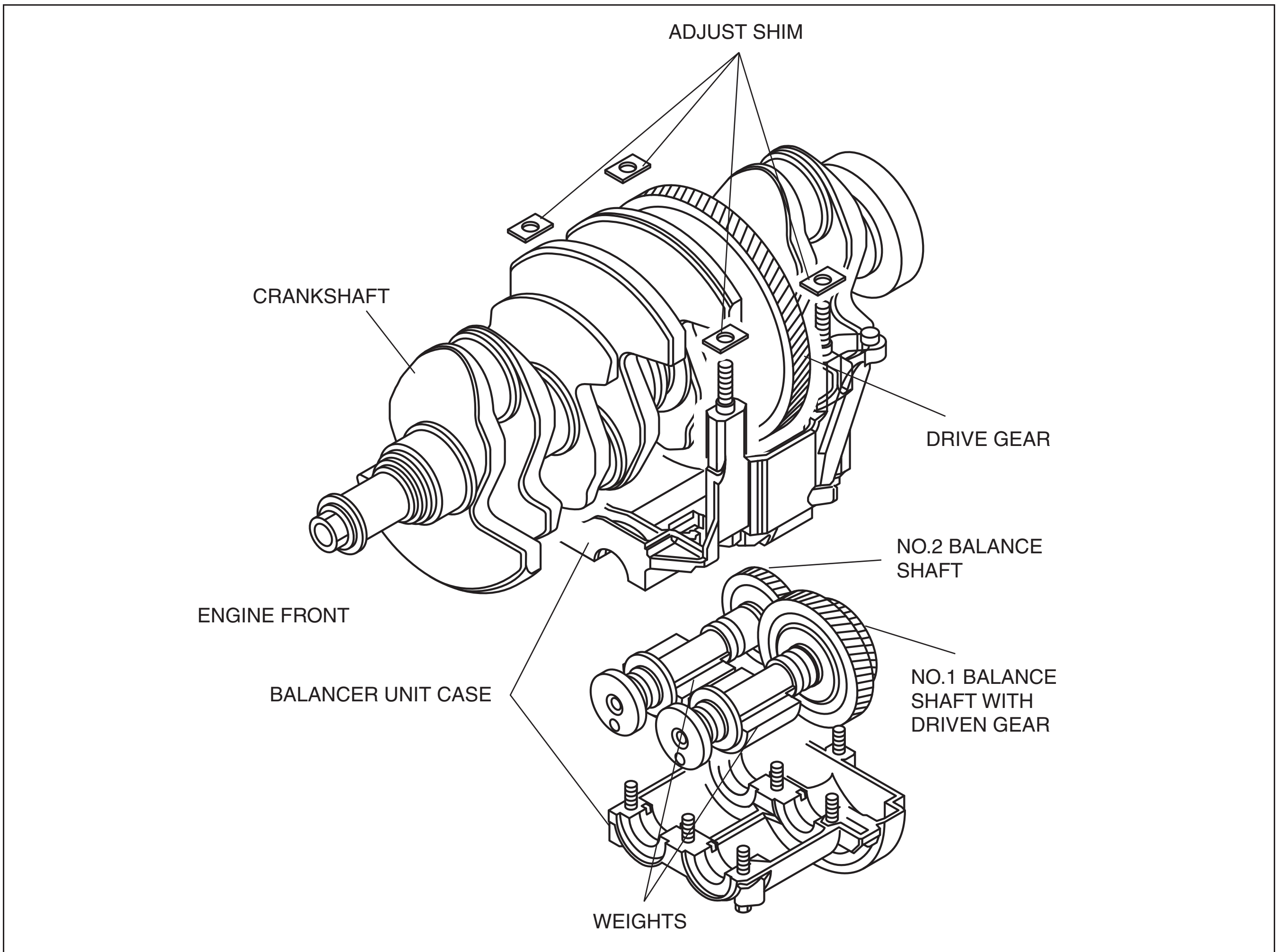
id0110a4101700

Construction

- The balancer unit consists of two balancer shafts (No.1 and No.2) with weights, the balancer unit case and the adjust shim which adjusts the amount of backlash in the crankshaft.
- The two balancer shafts (No.1 and No.2) are driven by the drive gear which is attached to the crankshaft.
- The balancer unit cannot be disassembled because it is a precision unit.

Operation

- The rotary motion is transmitted from the drive gear, which is between the back of the No.3 cylinder and No.4 main journal, directly to the No.1 balance shaft with driven gear. Then the balance unit transmits the rotation motion to the No.2 balance shaft. The ratio of gears, which are attached to the No.1 and No. 2 balancer shafts, has been set so that the gear rotates at twice the velocity of the crankshaft. The rotation velocity of the balancer shaft counterbalances (generates force in the opposite direction) the rotation inertial force (secondary inertial rotation force) from the crankshaft.



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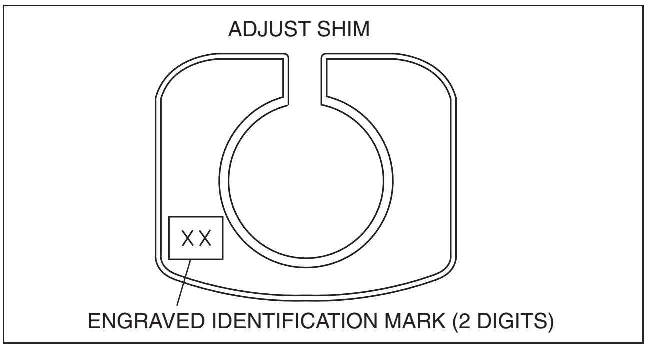
- Replace the adjust shim to adjust backlash. There are 40 kinds of adjuster shim depending on the thickness. The adjuster shim can be determined by checking the engraved identification mark (2 digits) on it.



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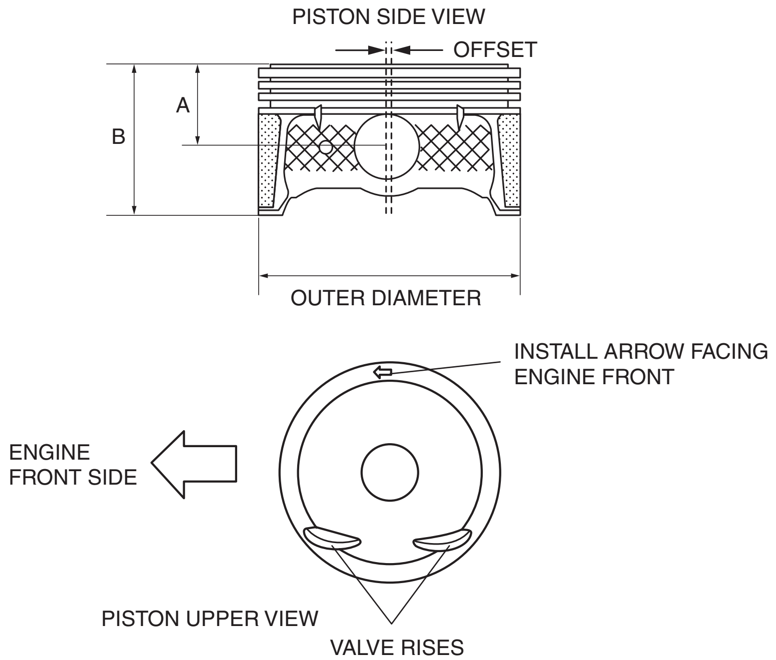
PISTON, PISTON RING, PISTON PIN CONSTRUCTION[L3]

id0110a4100600

- The pistons are made of aluminium alloy, which withstands heat and is highly conductive.
- The piston skirt is coated with graphite to reduce friction.
- The offset pistons are used to reduce piston-slapping noise.
- To prevent the piston from being reassembled in the wrong direction, the front mark (←) is on the piston.
- Pistons and connecting rods cannot be disassembled because they are shrinkage fit.

Piston Specification.

ITEM		
Outer diameter	mm {in}	87.465—87.495 {3.4436—3.4436}
Offset quantity	mm {in}	0.8 {0.031}
Compression height: A	mm {in}	28.5 {1.12}
Piston height: B	mm {in}	51.0 {2.01}



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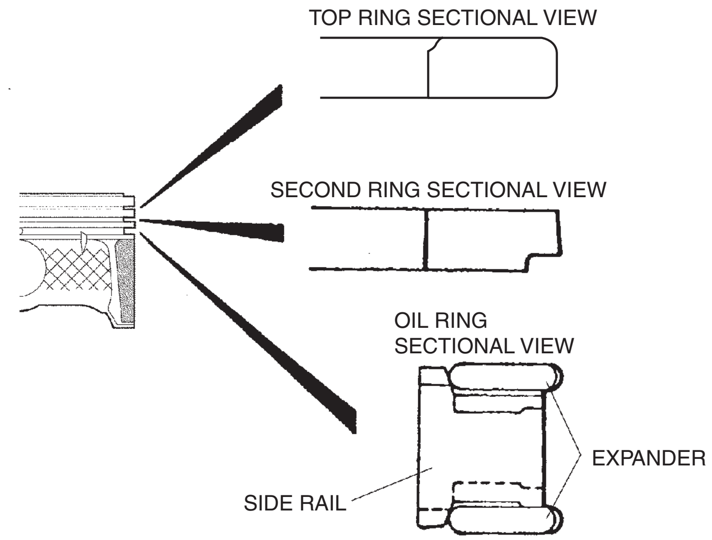
- The following piston rings have been adopted: Barrel face ring for top ring, taper under cut ring for second ring, two scuff rings and an expander for oil ring.
- The piston pin is made of chrome steel alloy, which has superior rigidity.
- The connecting rod and the piston pin are shrinkage fit, so that it cannot be disassembled.



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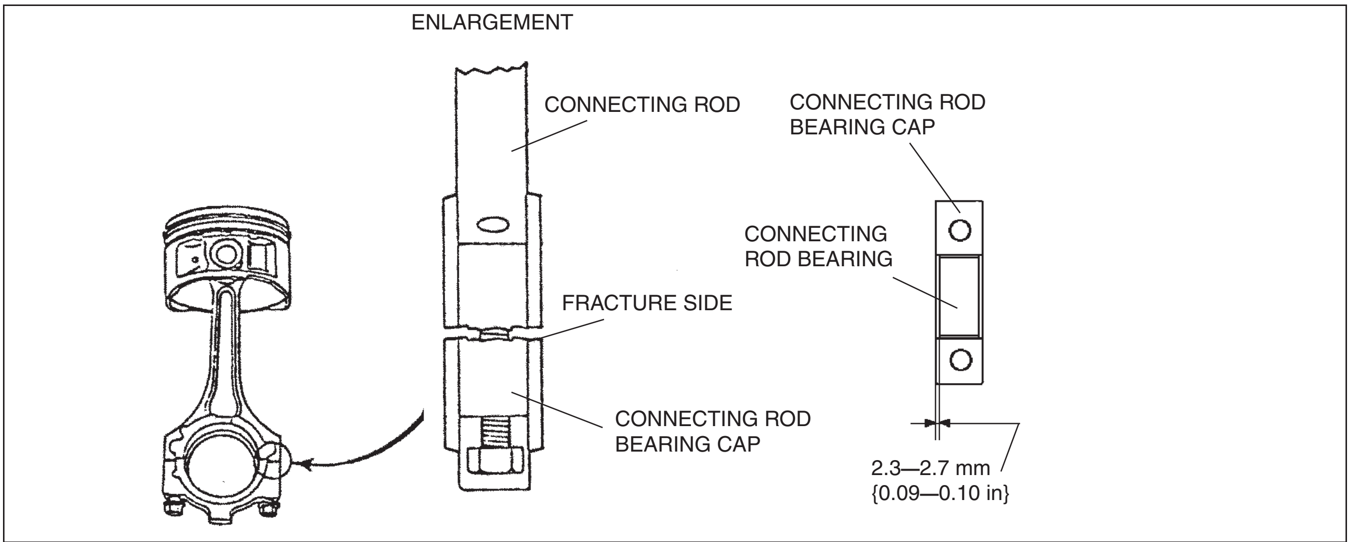
CONNECTING ROD, CONNECTING ROD BEARING CONSTRUCTION[L3]

id0110a4100700

- Connecting rod is made of structural sintered alloy to improve rigidity.
- The connecting rod, the piston, and the piston pin are shrinkage fit, so that they cannot be disassembled.
- The connecting rod bolts are plastic region tightening bolts to be tightened in two steps to insure tightening stability.
- There shall be no positioning tab for the connecting rod bearing. When installing the bearing, measure the position of the bearing so that the position gets to the center of the connecting rod and the bearing cap, and install it.
- The big end of the connecting rod and the connecting rod cap were originally formed as a single unit and then it was cut into the connecting rod and the cap. The form of the cutting surface is used for the alignment mark for the connecting rod and the cap.



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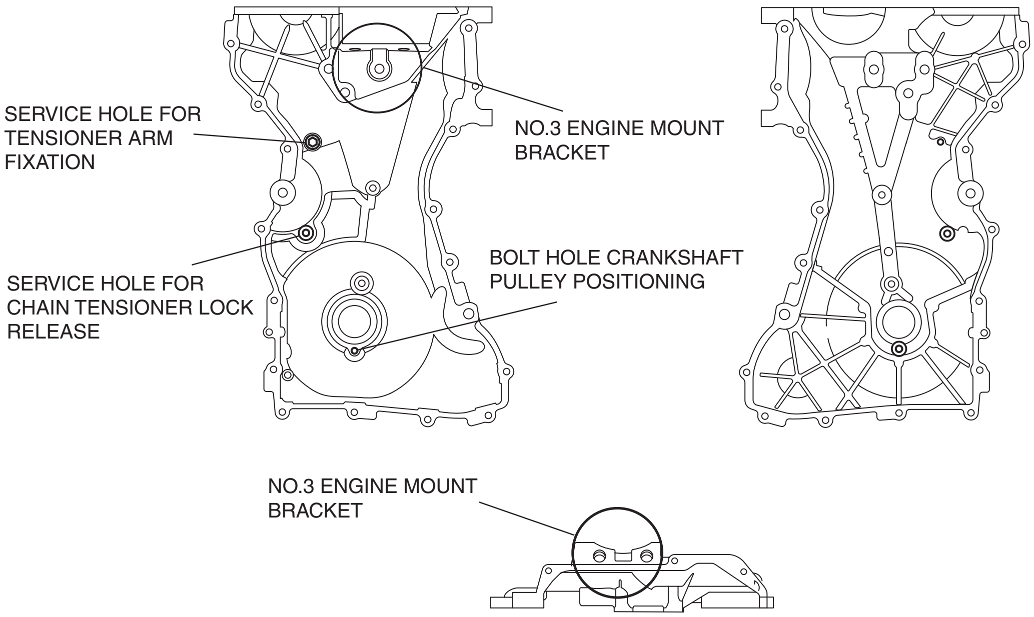
- The upper lower bearing of the connecting rod bearing is made of aluminum alloy.
- There are three kinds of connecting rod bearings depending on the oil clearance.

Bearing size	Bearing thickness (mm {in})
	L3
Standard	1.496—1.502 {0.0589—0.0591}
0.25OS	1.621—1.627 {0.0639—0.0640}
0.50OS	1.746—1.752 {0.0688—0.0689}

ENGINE FRONT COVER CONSTRUCTION[L3]

id0110a4119100

- The engine front cover is made of aluminum alloy, and is integrated with the No.3 engine-mounting bracket, to improve noise absorption and weight reduction.
- The bolt hole for crankshaft pulley positioning, the service hole for unlocking the chain adjuster ratchet, and the service hole for securing the tensioner arm when loosening the timing chain, are on the engine front cover.



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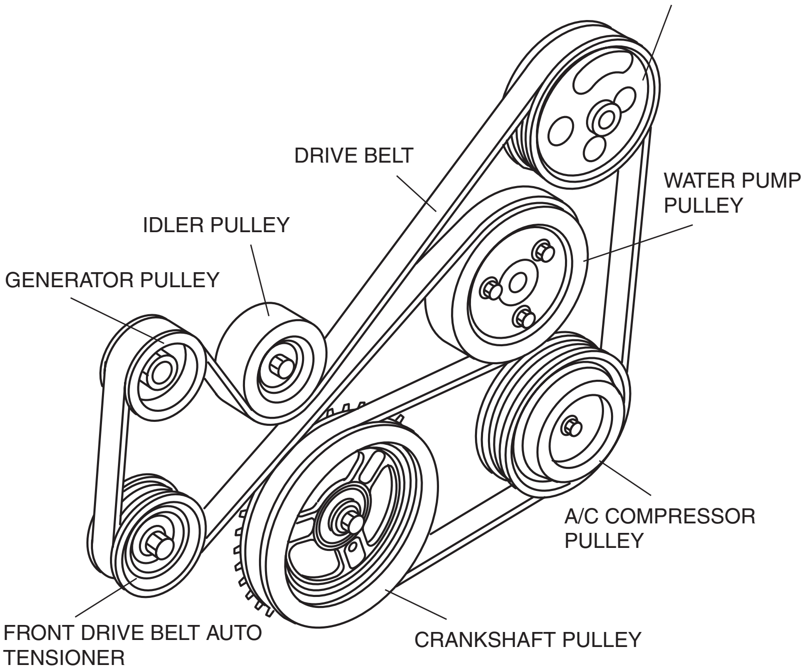
DRIVE BELT CONSTRUCTION[L3]

id0110a4102500

- A serpentine type drive belt with a V-ribbed belt to drive the supplemental units has been adopted. This shortens the engine length and improves serviceability.
- A front drive belt auto tensioner with an embedded coil spring has been adopted to automatically maintain the optimal drive belt tension.

Drive Belt Specification.

ITEM		
Belt length size	mm {in}	About 2,310 {90.94}
Belt width size	mm {in}	About 20.5 {0.81}



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CAMSHAFT CONSTRUCTION[L3]

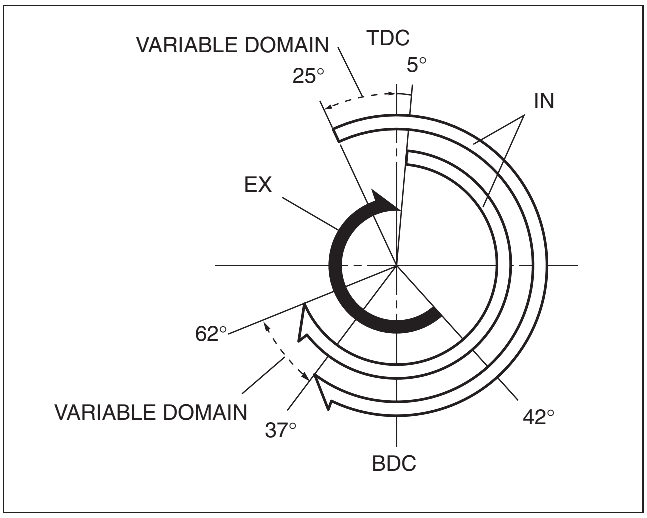
id0110a4101300

- The cast iron 5 axis-hole, which has great rigidity, has been adopted for the camshaft to insure higher reliability.
- The endplay of the camshaft is regulated at the rear of the No. 1 journal.
- The lubricating oil is supplied through the oil supply hole at each journal. Additionally the cam nose part is chill casted to improve the abrasion resistance and the width of cam hill part is shortened to reduce the weight.
- There shall be no positioning pin or key slot for the camshaft sprocket at the edge of the camshaft. The lubrication process has been adopted for the camshaft sprocket tightening bolt to prevent instability in the axis during tightening.
- There is an oil line, by which the oil is supplied to the variable valve timing actuator, located at the L3 engine model intake port side camshaft (front of camshaft).

Camshaft Specification.

ITEM			
		IN	EX
LIFT	(mm {in})	9.1 {0.35}	7.8 {0.31}
Overlap	(°)	0—30	

- The detection unit (trigger plate) for the camshaft position (CMP) sensor is at the intake port side camshaft.
- The groove for securing the No.1 cylinder TDC for the camshaft, is provided at the rear of the intake and exhaust camshaft.



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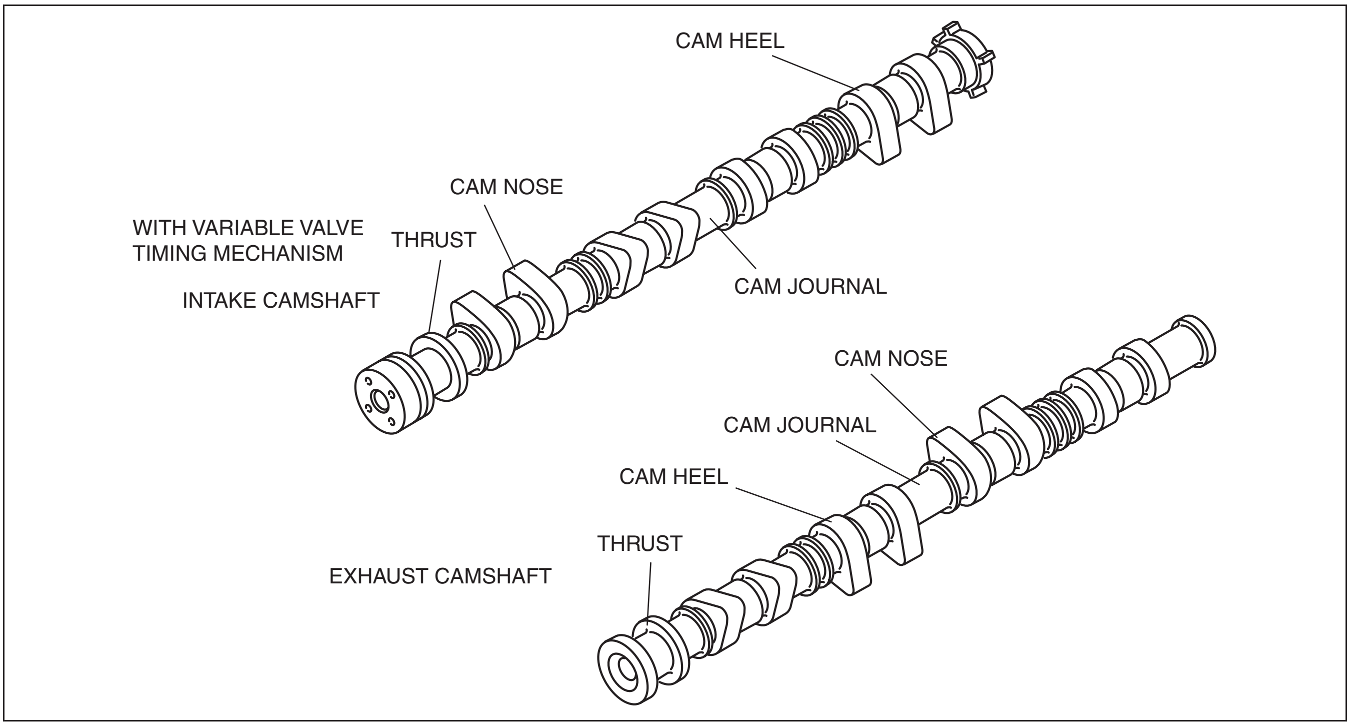

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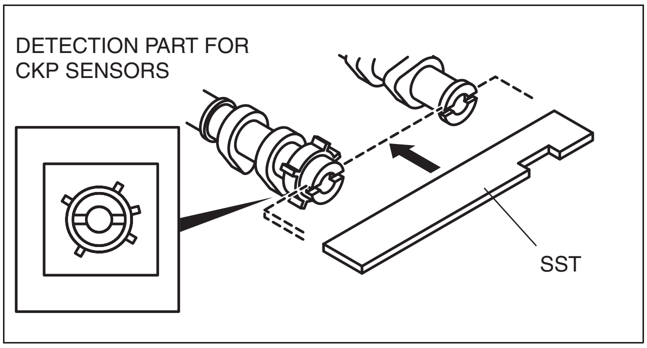

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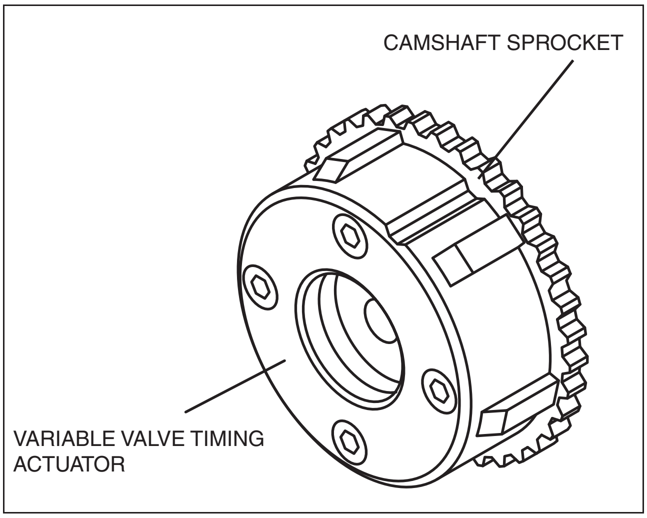
CAMSHAFT SPROCKET CONSTRUCTION[L3]

id0110a4102100

- The sintered alloy, which has high rigidity, has been adopted for the camshaft sprocket and is quenched to improve the abrasion resistance at the contact point with the timing chain.
- L3 engine model intake port side camshaft sprocket is integrated (cannot be disassembled) with the variable valve timing actuator.



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VALVE MECHANISM OUTLINE[L3]

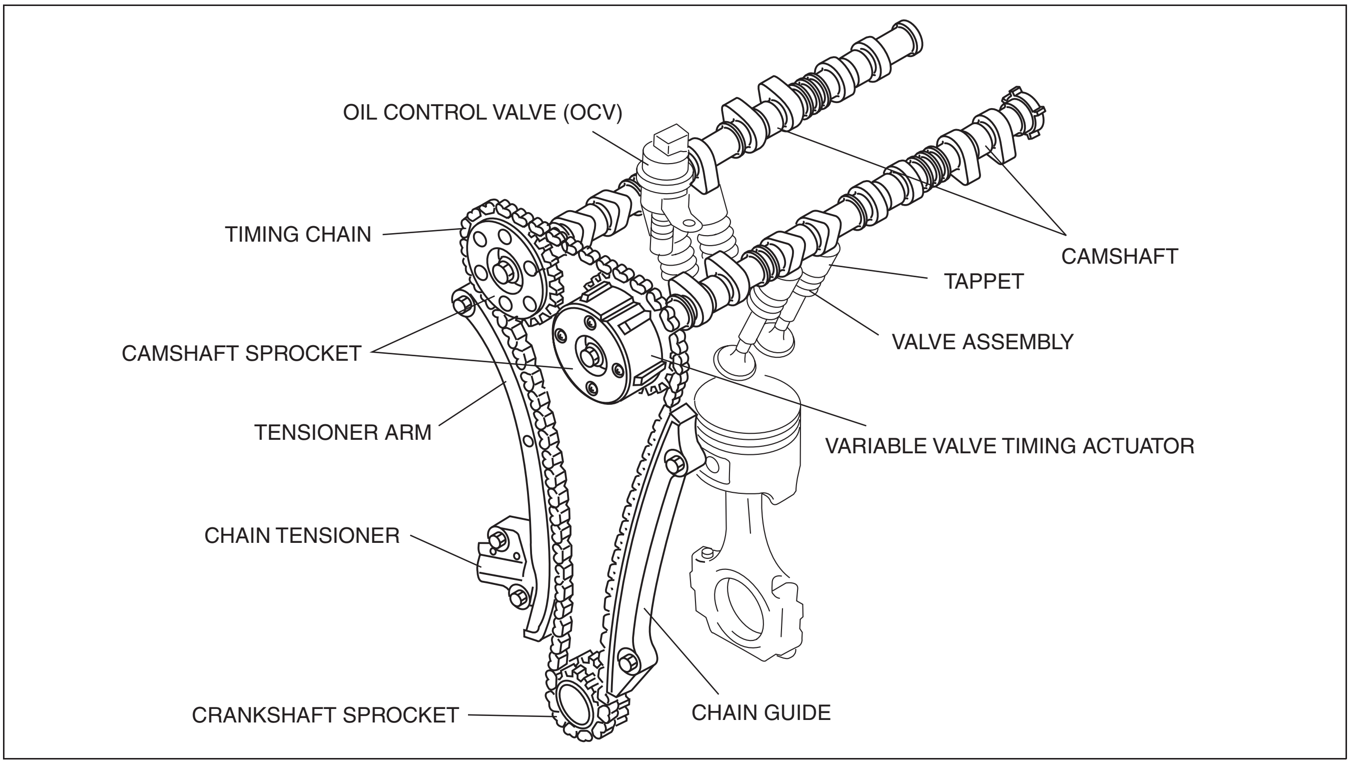
id0110a4120000

- There are two intake ports and two exhaust ports each cylinder. Totally 16 valves are directly driven by two camshafts.
- The variable valve timing mechanism, which insures the best valve timing depending on the drive condition by constantly changing the phase of the intake port side camshaft, has been adopted.

VALVE MECHANISM STRUCTUAL VIEW[L3]

id0110a4120100

Structural view



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VALVE, VALVE SPRING, VALVE SEAL, VALVE GUIDE CONSTRUCTION[L3]

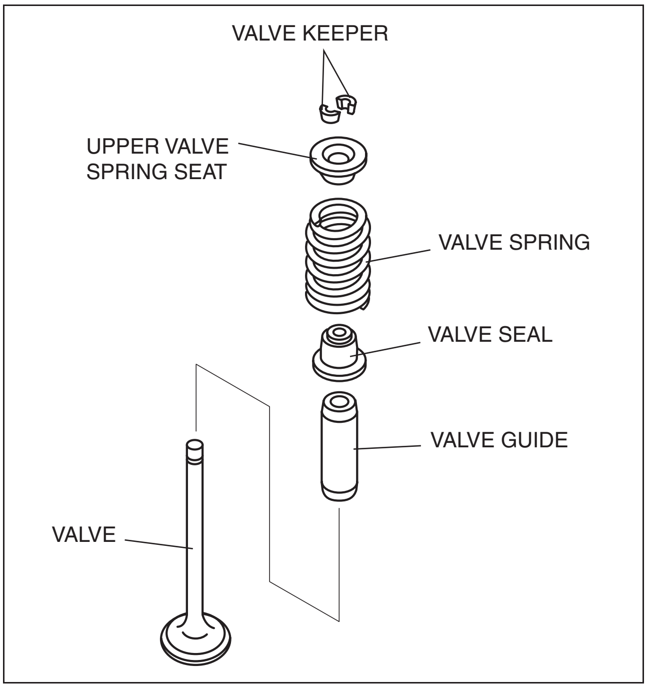
id0110a4101100

- The valves are heat-resistant steel. There are two intake valves, two exhaust valves per cylinder.

Valve specification

ITEM		
valve full length	(mm {in})	Intake valve: About 101.6 {4.000} Exhaust valve: About102.6 {4.039}
Intake valve umbrella diameter	(mm {in})	About 32.5 {1.28}
Exhaust valve umbrella diameter	(mm {in})	About 28 {1.10}
Stem diameter	(mm {in})	Intake valve: About 5.5 {0.22} Exhaust valve: About 5.5 {0.22}

- The intake valve and the exhaust valve are treated with the tufftride process to improve abrasion resistance.
- The valve spring is an uneven outer dimension type. It has been improved by reducing the size of the upper seat.
- The valve guide is made of the sintered alloy to improve abrasion resistance.
- The valve seat is integrated with the lower valve spring seat to simplify the unit and improve its serviceability.



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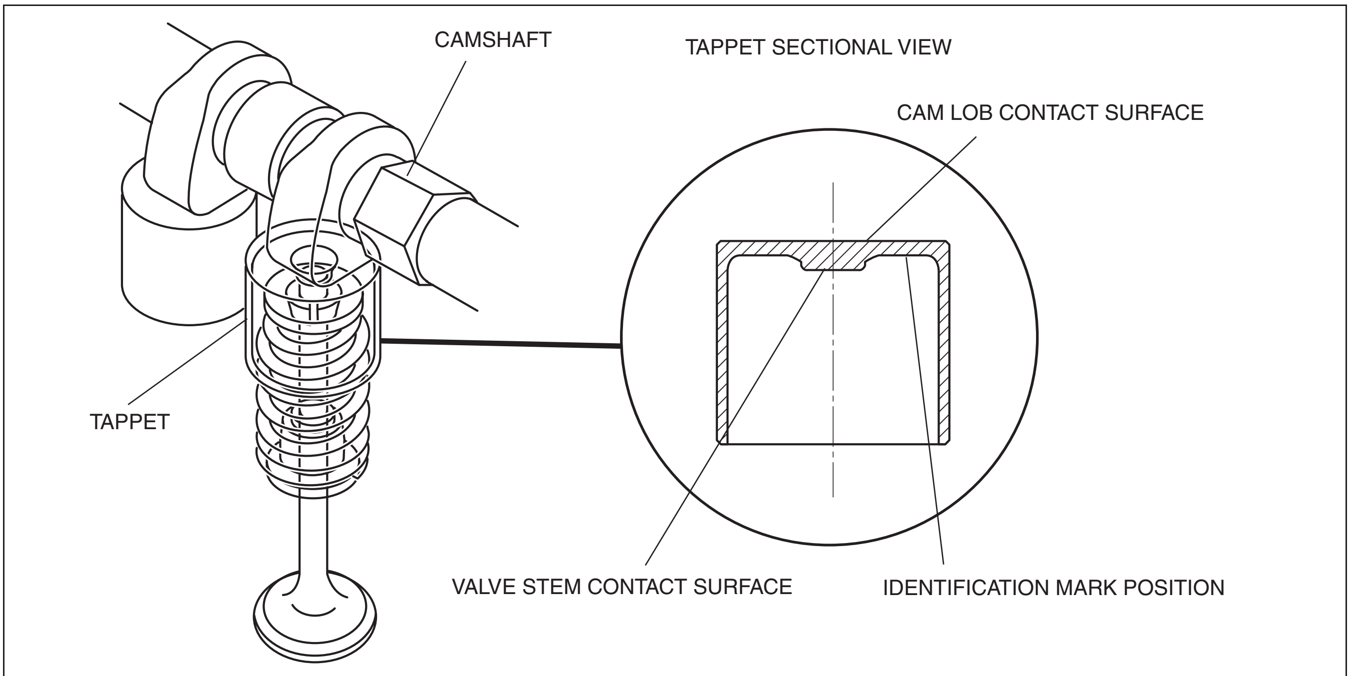
TAPPET CONSTRUCTION[L3]

id0110a4102200

- The tappet is a shimless tappet which is integrated with the shim.
- The tappet surface is phosphate-coated to smooth the attaching surface to the cam and improve abrasion resistance.
- The valve clearance can be adjusted by replacing the tappet. There are 35 kinds of tappets depending on the thickness. The tappet kind can be determined by the engraved identification mark (3 digits).

Tappet Specification.

Discernment mark	Tappet thickness (mm {in})	The number of jumps (mm {in})
725—625	3.725—3.625 {0.1467—0.1427}	0.025 {0.00098}
602—122	3.602—3.122 {0.1418—0.1229}	0.02 {0.00078}
100—000	3.100—3.000 {0.1220—0.1181}	0.025 {0.00098}



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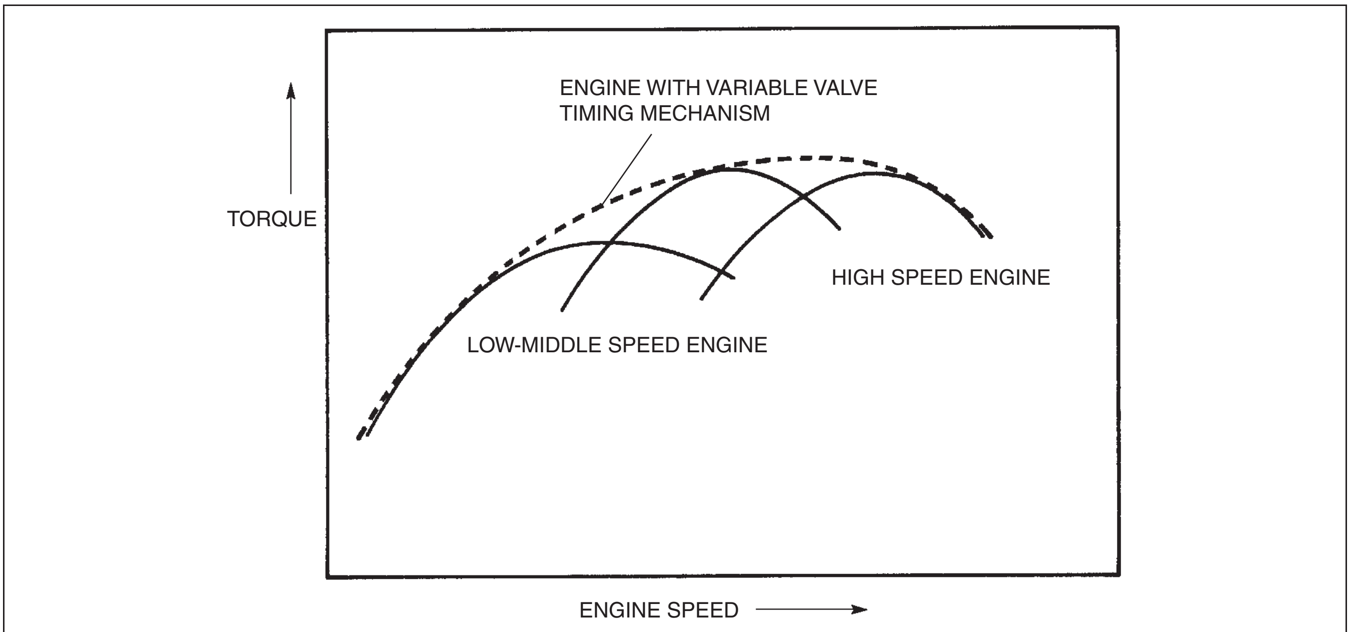
VARIABLE VALVE TIMING MECHANISM OUTLINE[L3]

id0110a4101900

- A variable timing mechanism, which realizes optimum valve timing according to engine operation conditions by continuously modifying the phases of the intake camshaft and crankshaft, has been adopted.



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Variable Valve Timing Mechanism
Function

- The variable valve timing mechanism continuously modifies the phases of the variable valve timing actuator and the intake camshaft using hydraulic pressure controlled by the oil control valve (OCV) so that optimal valve timing is obtained according to engine operation conditions.
- The OCV operation is based on signals from the PCM according to engine operation conditions and it controls hydraulic pressure to the variable valve timing actuator.

Operation and purpose according to driving condition
Idling range, light load range

- Due to a reduction in the amount of overlap, less combusted gas is returned to the intake port. This stabilizes idle speed in the idling range, improving fuel economy, and also ensures engine stability in the light load range.

Medium load range

- Overlap amount has been increased and the EGR ratio inside the cylinder is higher. This reduces engine friction loss (pumping loss), lowering the combustion temperature and reducing the amount of NOx the in exhaust gas. The amount of hydrocarbon emission has also been reduced through reignition of non-combusted gas.

Heavy load, low-middle speed range

- The intake valve is closed early, and high volumetric efficiency is obtained to improve low-middle speed torque.

Heavy load, high speed range

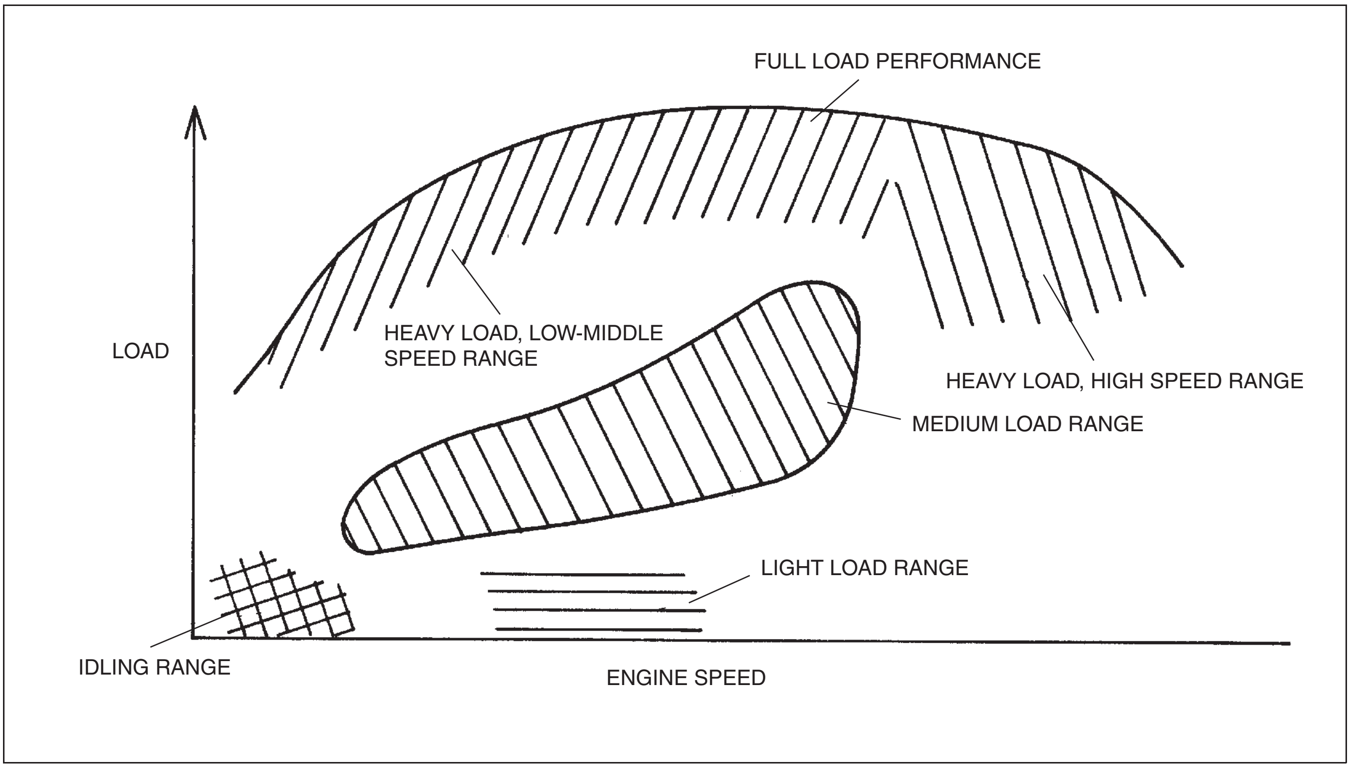
- Timing for intake valve closure is delayed and high volumetric efficiency is obtained to improve maximum output.

When temperature is low

- The overlap amount has been minimized to prevent combusted gas from returning to the intake port and to reduce the additional fuel injection amount. This improves fuel economy and stabilizes fast idle speed.

When engine is started or stopped

- Startability has been improved because the overlap amount has been minimized to prevent combusted gas from returning to the intake port.



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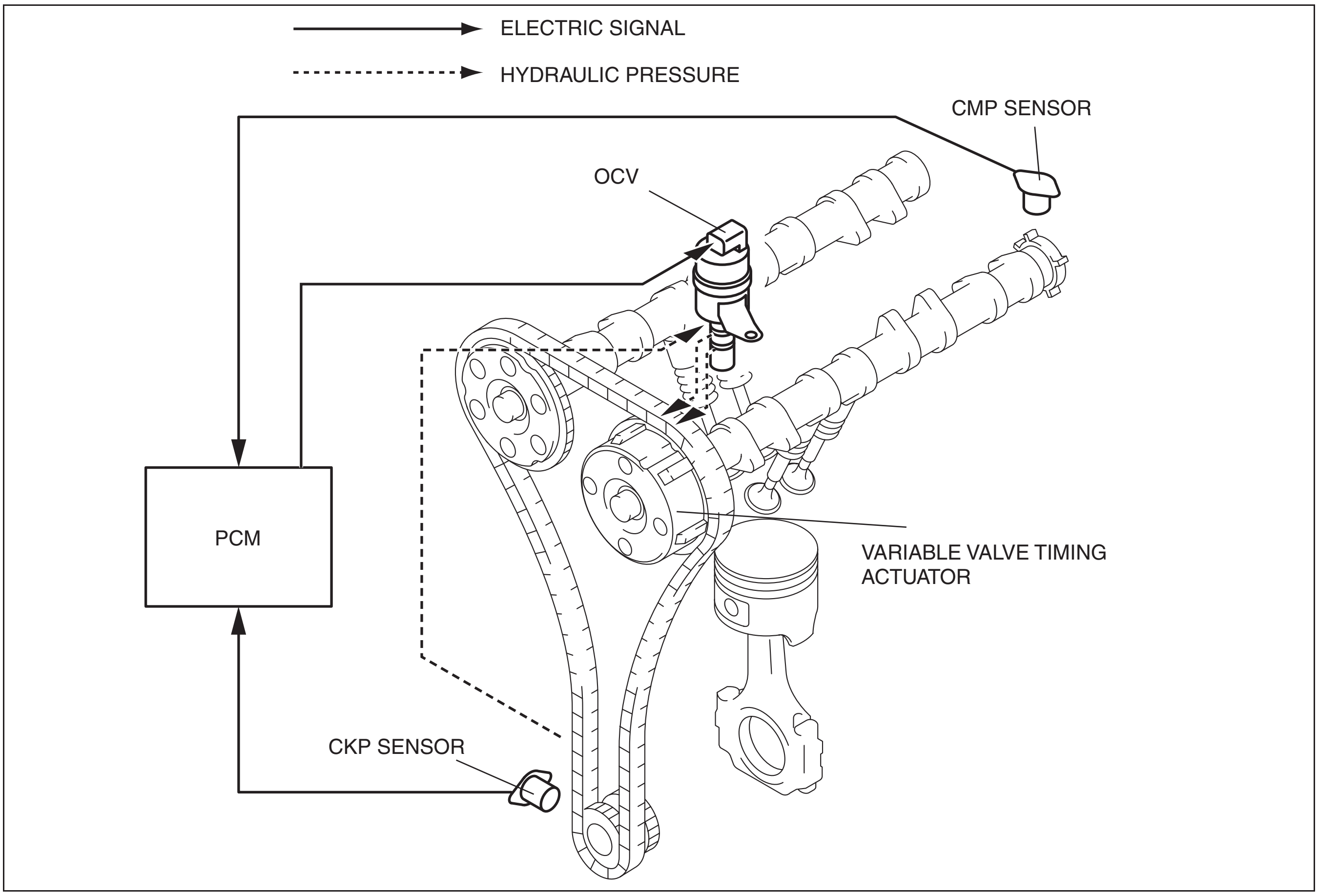
Construction

- The variable valve timing mechanism consists of a variable valve timing actuator, oil control valve (OCV), CKP sensor, CMP sensor, and the PCM.



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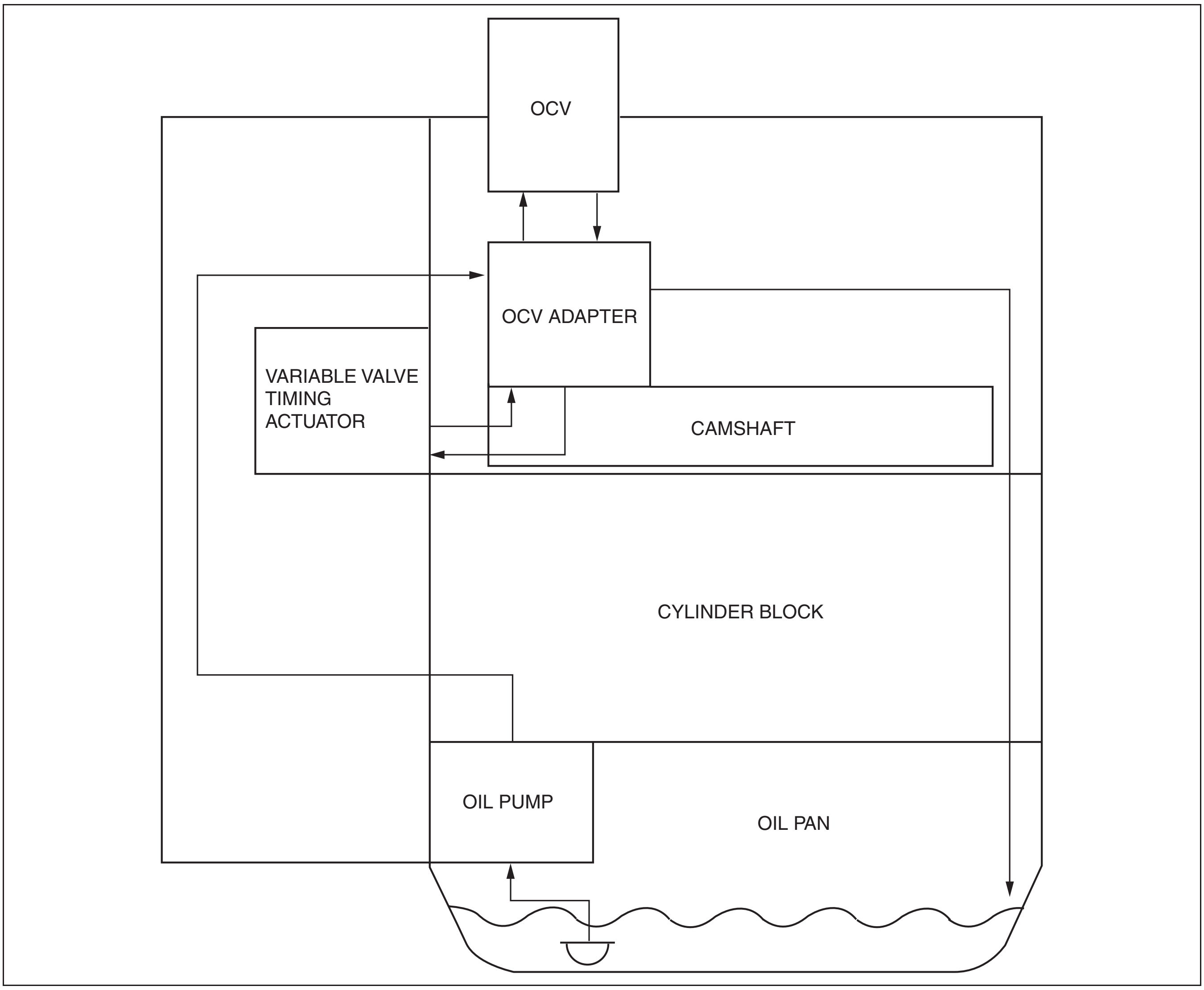
Hydraulic Pressure Flow Diagram



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VARIABLE VALVE TIMING MECHANISM CONSTRUCTION/OPERATION[L3]

id0110a4102000

Component and function

Variable valve timing actuator	• Continuously modifies the phases of the intake camshaft and crankshaft at the forward end of the intake camshaft using hydraulic pressure from the oil control valve (OCV).
OCV	• Operated by current (duty signal) from the PCM. Switches the hydraulic oil passages to the variable valve timing actuator.
CKP sensor	• Inputs engine revolution signal to the PCM.
CMP sensor	• Inputs cylinder identification signal to the PCM.
PCM	• Controls the OCV so that optimum valve timing is obtained according to engine operation conditions.

Operation outline

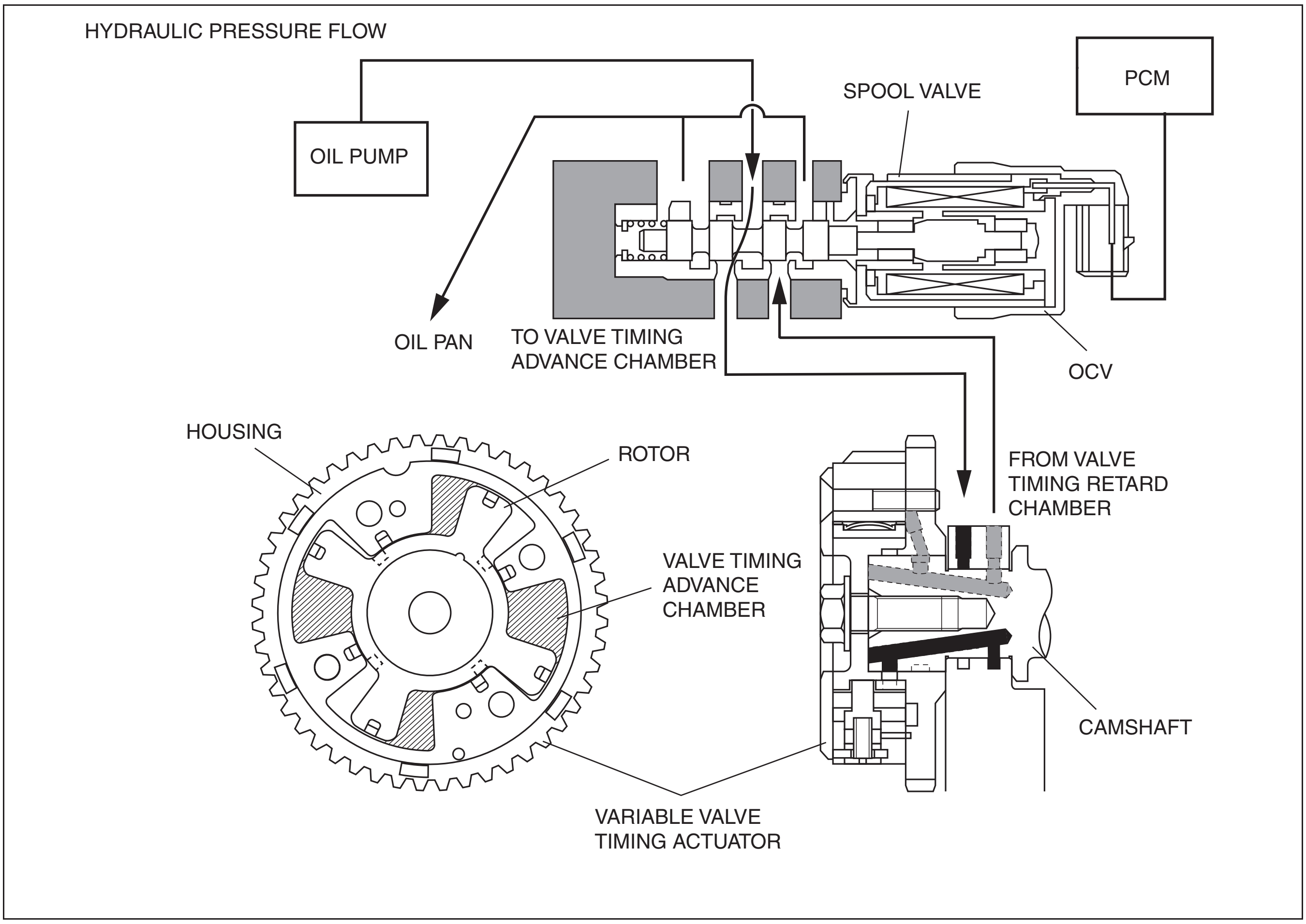
- The variable valve timing actuator has two hydraulic chambers: a valve timing advance chamber and a valve timing retard chamber. They are located between the integrated housing of the camshaft sprocket and the camshaft integrated rotor. The oil pump supplies engine oil. to each chamber. Hydraulic pressure applied to each chamber is controlled by the OCV and the relative phases of the camshaft sprocket and the camshaft are modified to obtain optimum valve timing according to engine operation conditions.

At engine start

- When the stopper pin in the variable valve timing actuator engages with the rotor, which is at the position of maximum valve timing retard due to spring force, the camshaft sprocket and the camshaft rotate as one unit. When the oil pump pressure rises and the stopper pin is disengaged, it becomes possible to modify the relative angles of the camshaft sprocket and the camshaft.

Advancing valve timing

- When the spool valve in the OCV moves to the left according to the PCM signal, hydraulic pressure, from the oil pump, feeds into the valve timing advance passage and finally to the valve timing advance chamber in the variable valve timing actuator. Then, the rotor integrated with the camshaft rotates in the valve timing advance direction, against the housing driven by the crankshaft, and the valve timing is advanced.



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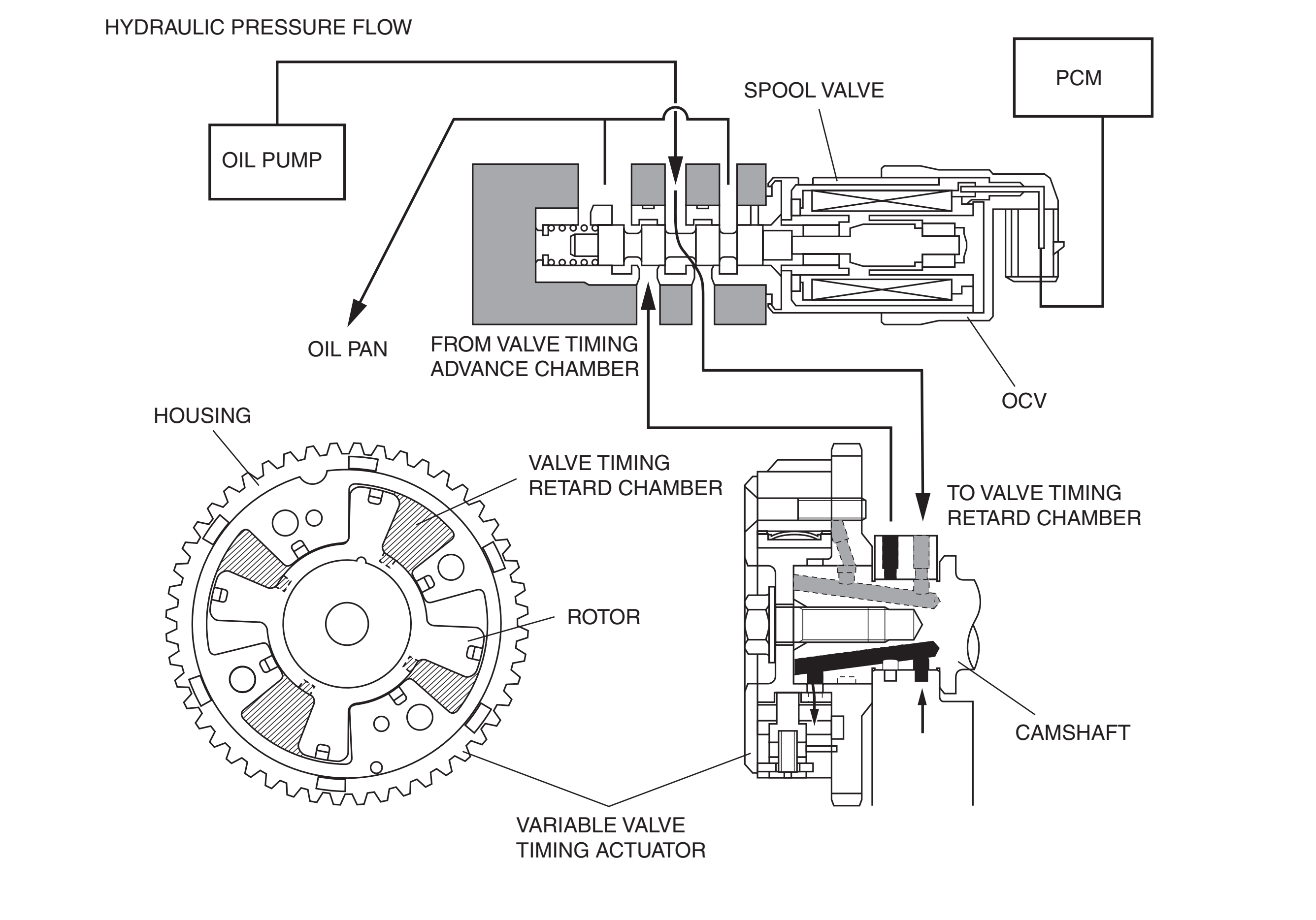
Retarding valve timing

- When the spool valve in the OCV moves to the right according to the PCM signal, hydraulic pressure, from the oil pump, feeds into the valve timing retard passage and finally to the valve timing retard chamber in the variable valve timing actuator. Then, the rotor integrated with the camshaft rotates in the valve timing retard direction, against the housing driven by the crankshaft, and valve timing is retarded.



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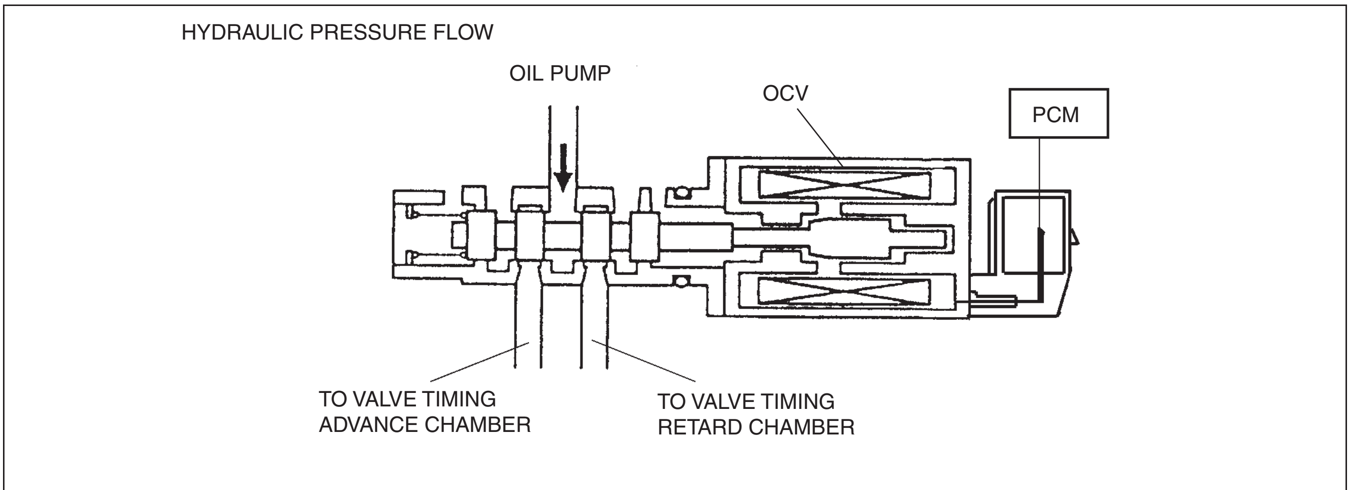
Maintaining intermediate valve timing

- The spool valve in the OCV is located near the middle of the valve timing advance and retard positions. Because of this, hydraulic pressures are maintained in both valve timing advance and retard chambers of the variable valve timing actuator. At the same time, relative angles of the rotor and the housing are fixed and maintained, resulting in fixed valve timing.



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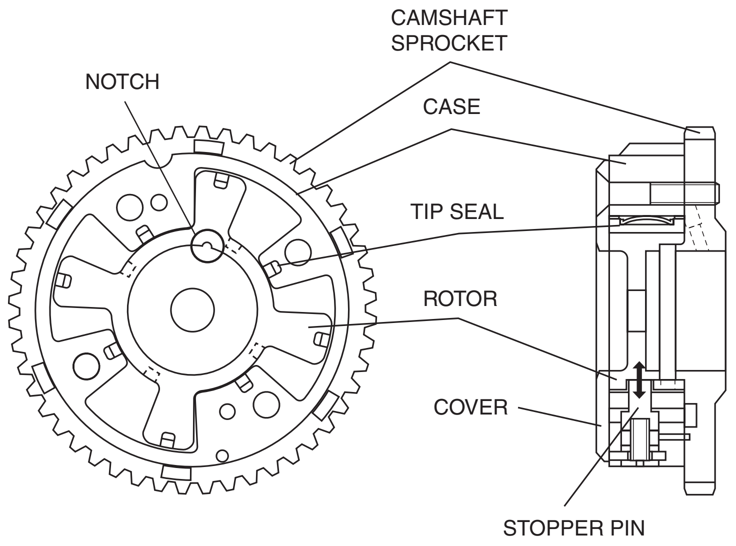
VARIABLE VALVE TIMING ACTUATOR CONSTRUCTION[L3]

id0110a4102300

- The variable valve timing actuator consists of the following: a housing case integrated to the camshaft sprocket, a cover, a camshaft integrated rotor, and a stopper pin that retains the rotor and case when the engine stops. Also, the rotor has a chip seal that seals the valve timing advance chamber and the valve timing retard chamber.
- The cover and rotor of the variable valve timing actuator are notched, and are used as alignment marks when inspecting the variable valve timing actuator.



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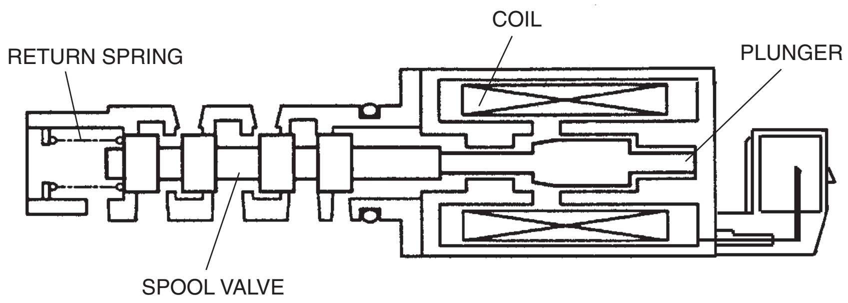
OIL CONTROL VALVE (OCV) CONSTRUCTION[L3]

id0110a4102400

- The oil control valve (OCV) consists of a spool valve that switches the passages for engine oil, a coil that moves the spool valve, a plunger, and a return spring.



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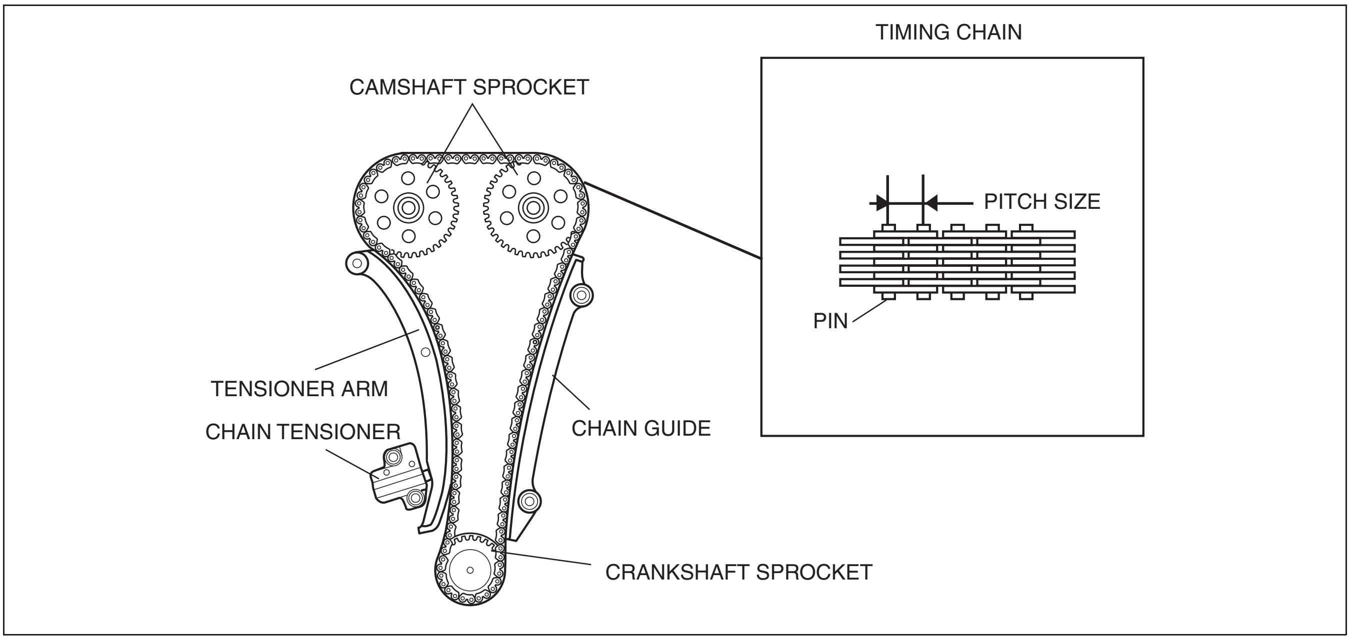
TIMING CHAIN, CHAIN TENSIONER CONSTRUCTION[L3]

id0110a4101200

- A silent chain (link grounding type) type has been adopted for the timing chain to reduce tapping noise caused by matching each sprocket.
- Engine oil inside the engine front cover lubricates the timing chain and each sprocket. The pin part of the timing chain is nitrite-treated to improve abrasion resistance.

Timing Chain Specification.

ITEM	L3
Pitch size (mm {in})	6.35 {0.25}



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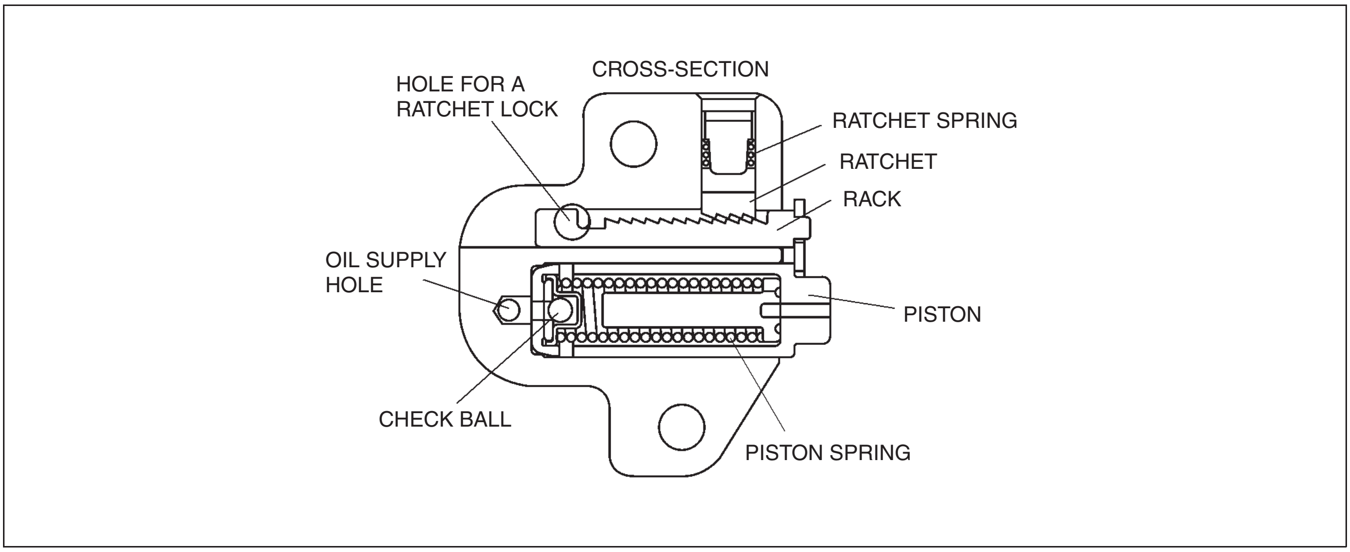
- Oil pressure type chain tensioner has been adopted for the timing chain tensioner. The tension of the timing chain is maintained constant, using the oil pressure and the spring force in the chain tensioner.
- The oil pressure type chain tensioner consists of the following parts: Piston spring, which depresses the tensioner arm, check ball which maintains pressure to the tensioner arm.



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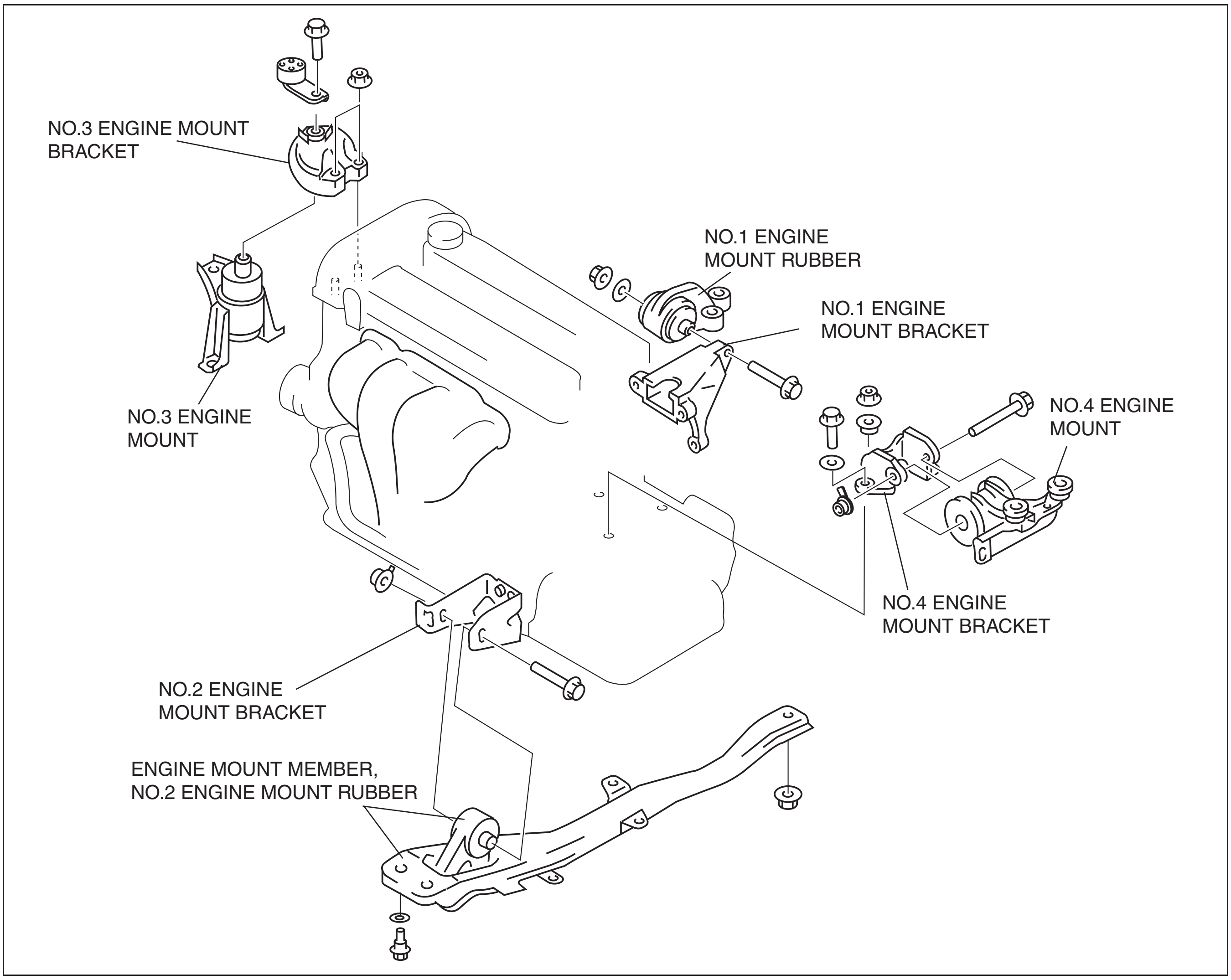
ENGINE MOUNT OUTLINE[L3]

id0110a4101400

- The engine is supported at four points and simplification of engine mount composition has been attained.
- An oil-filled No.3 engine mount rubber has been adopted to reduce noise and vibration in the cabin.



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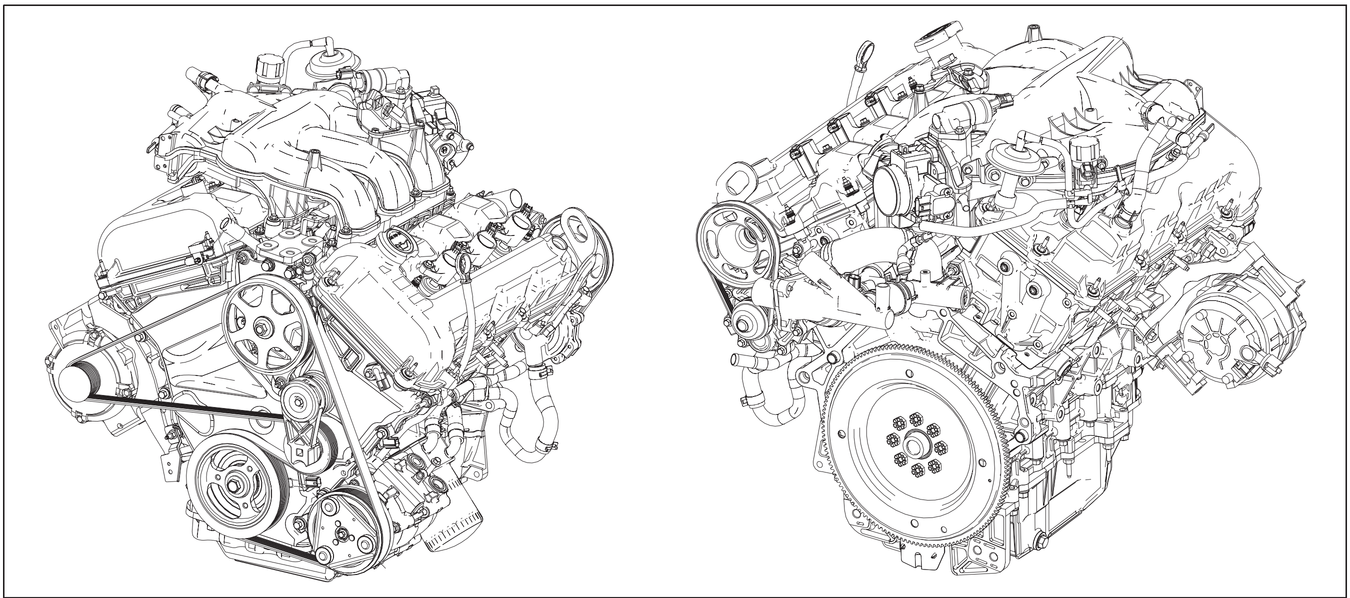
01-10B MECHANICAL [AJ (3.0L Duratec)]

01

ENGINE STRUCTURAL VIEW[AJ (3.0L Duratec)]

id0110a3119200



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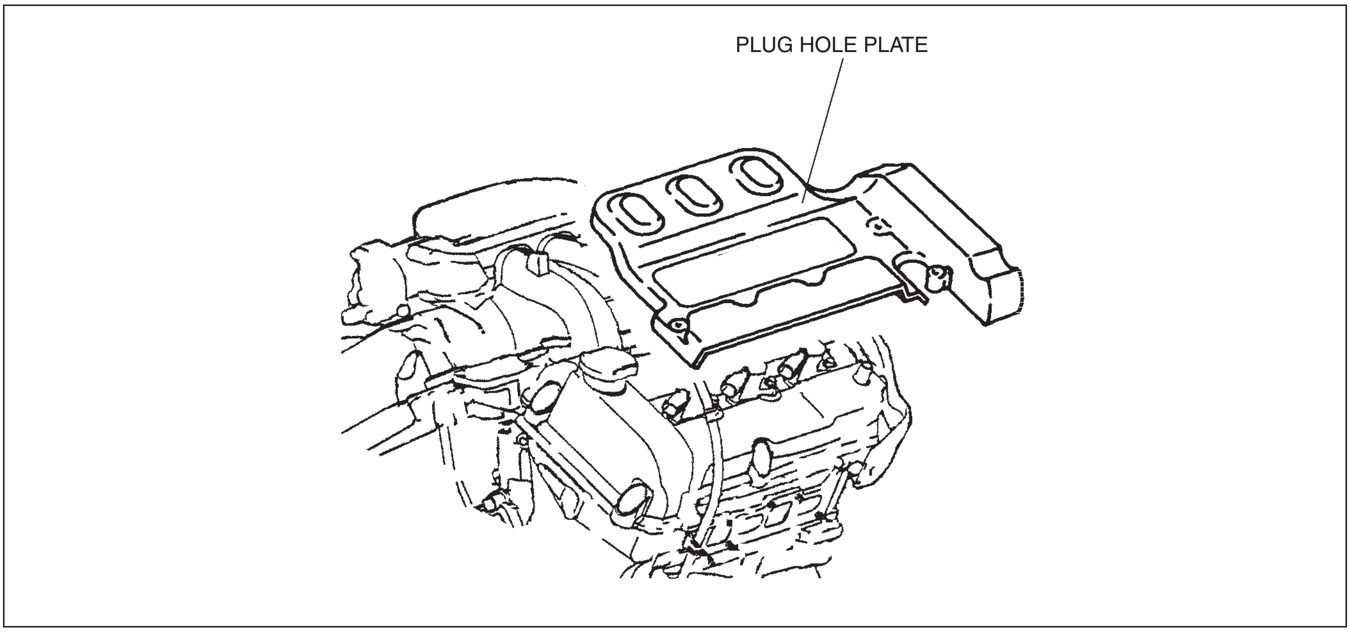
PLUG HOLE PLATE CONSTRUCTION[AJ (3.0L Duratec)]

id0110a3119300

- A plug hole plate with an integrated water pump drive belt cover has been adopted to improve appearance.



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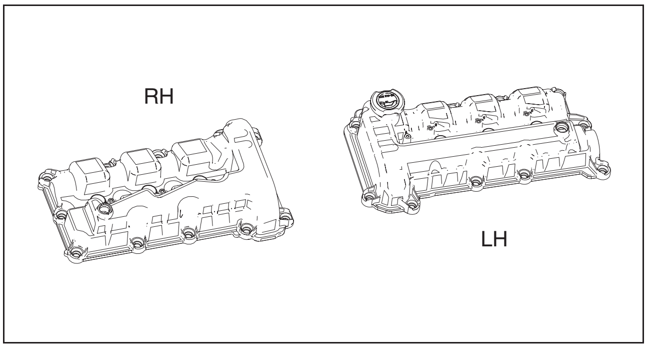
CYLINDER HEAD COVER CONSTRUCTION[AJ (3.0L Duratec)]

id0110a3100200

- The cylinder head cover is made of integrated aluminum alloy, which is lightweight and sound absorbent.



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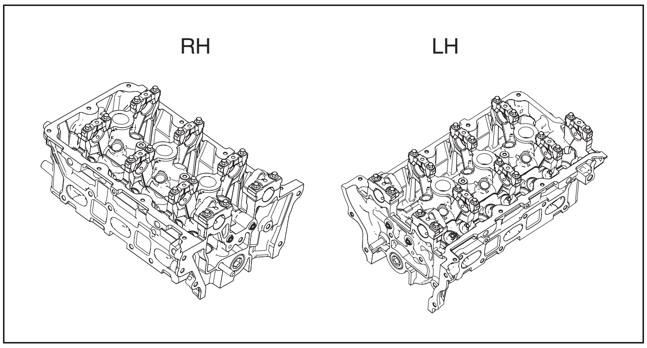
CYLINDER HEAD CONSTRUCTION[AJ (3.0L Duratec)]

id0110a3100300

- A high heat conductive, lightweight aluminum alloy cylinder head has been adopted.
- Compact, pentroof-type combustion chambers have been adopted, and the spark plugs are mounted at the top of the combustion chamber to improve combustion efficiency.
- The intake/exhaust port layout is a cross flow type with four valves per cylinder (two intake valves and two exhaust valves) which improves air intake/exhaust efficiency.
- Torque-to-yield cylinder head bolts have been adopted for the cylinder head bolts.



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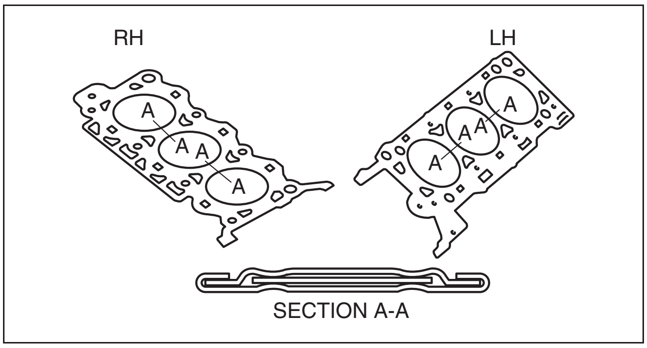
CYLINDER HEAD GASKET CONSTRUCTION[AJ (3.0L Duratec)]

id0110a3100400

- Steel laminated cylinder head gaskets have been adopted.



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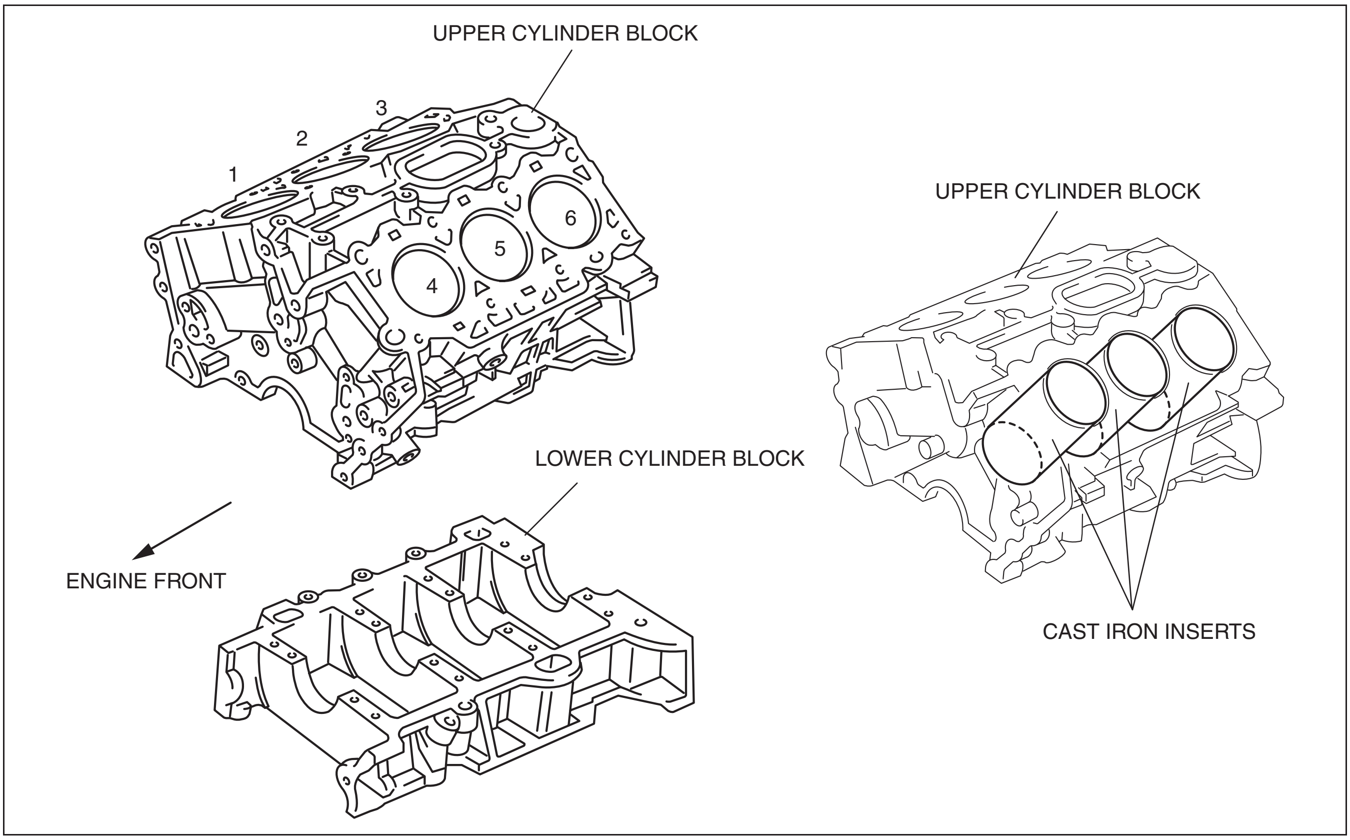
CYLINDER BLOCK CONSTRUCTION[AJ (3.0L Duratec)]

id0110a3100500

- Aluminum alloy has been adopted on the cylinder block, and it consists of upper and lower cylinder blocks.
- Each cylinder is lined with a steel liner. Liner cutting and replacement is not possible.
- The cylinders are numbered 1, 2, 3 from the front along the right bank and 4, 5, 6 from the front along the left bank.



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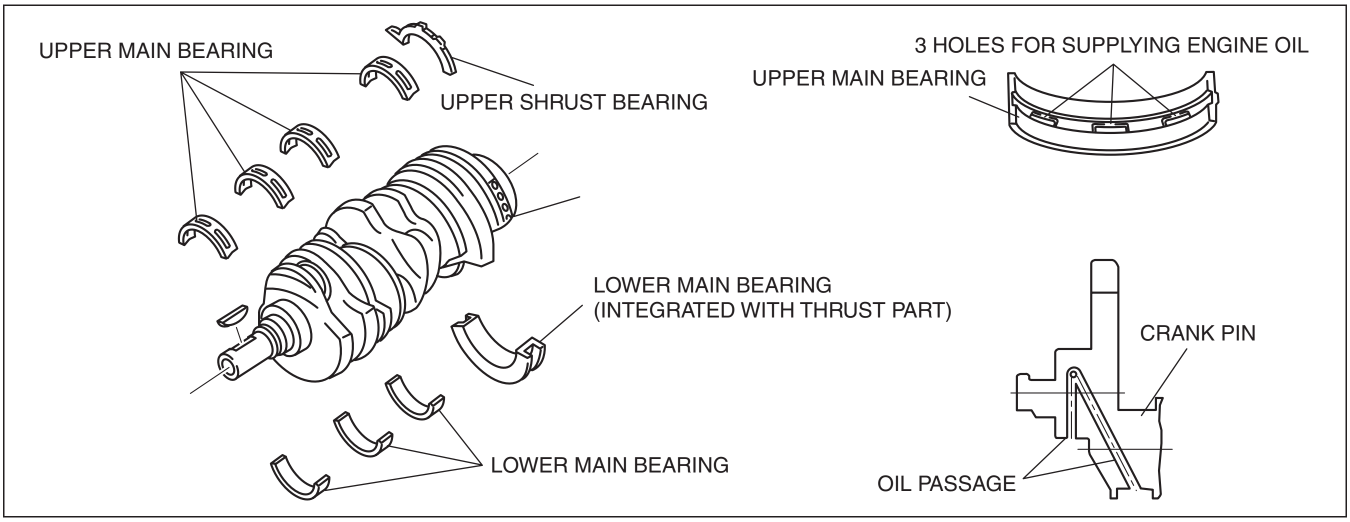
CRANKSHAFT, MAIN BEARING CONSTRUCTION[AJ (3.0L Duratec)]

id0110a3100800

- Cast iron has been adopted on the crankshaft.
- The crankshaft has internal oil passages for supplying oil to each journal.
- The internal surface of the upper main bearing has oil grooves and holes for oil lubrication.
- An integrated thrust bearing has been adopted on the lower main bearing.



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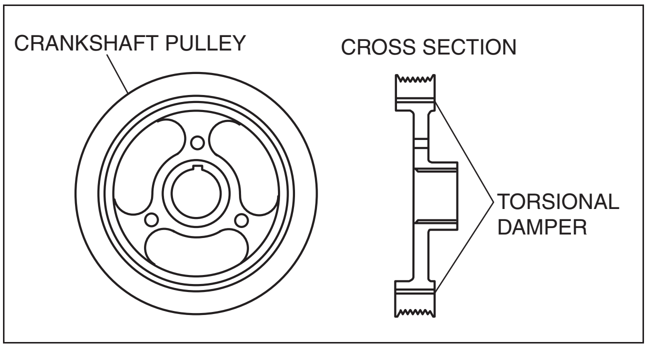
CRANKSHAFT PULLEY CONSTRUCTION[AJ (3.0L Duratec)]

id0110a3101800

- A torsional damper pulley is used for the crankshaft pulley to reduce noise and torsional vibration.



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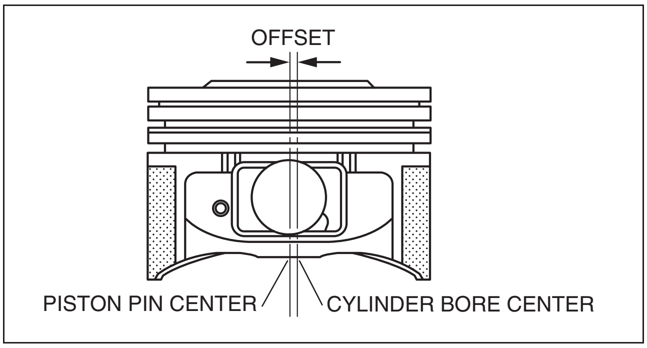
PISTON CONSTRUCTION[AJ (3.0L Duratec)]

id0110a3119600

Construction

- High-heat strengthened aluminum alloy has been adopted on the pistons for excellent thermal conductivity.
- The piston skirt is coated with molybdenum to improve durability.
- Offset pistons have been adopted to reduce piston slapping noise.
- Front mark has been adopted on the upper surface of the piston to prevent mis-assembly of the front/back.
- A full-floating type connection has been adopted on the piston and connecting rod connection.



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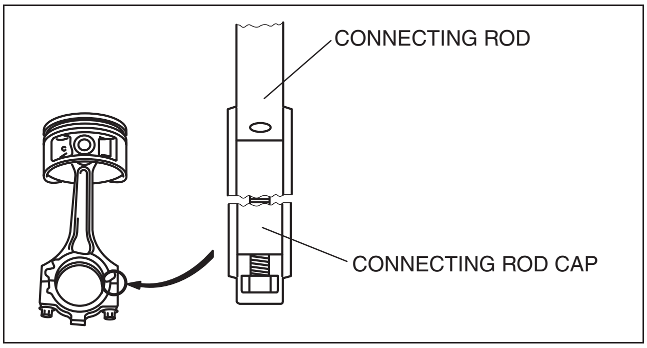
CONNECTING ROD CONSTRUCTION[AJ (3.0L Duratec)]

id0110a3119700

- The large end of the connecting rod and its cap are integrated and then sheared off during production. This sheared surface shape is used as the alignment mark for the connecting rod and cap.
- Torque-to-yield bolts have been adopted for the connecting rod bolts.



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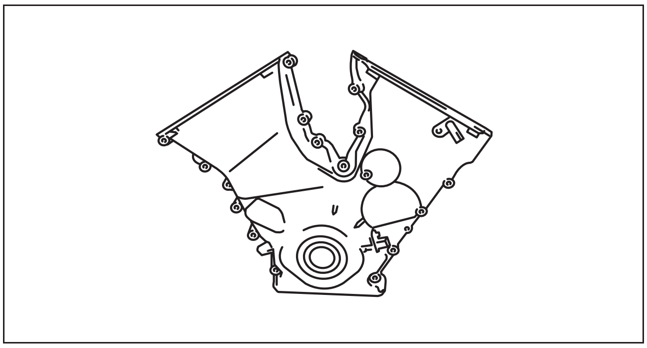
ENGINE FRONT COVER CONSTRUCTION[AJ (3.0L Duratec)]

id0110a3119100

- Aluminum alloy has been adopted on the engine front cover to improve noise absorption and weight reduction.



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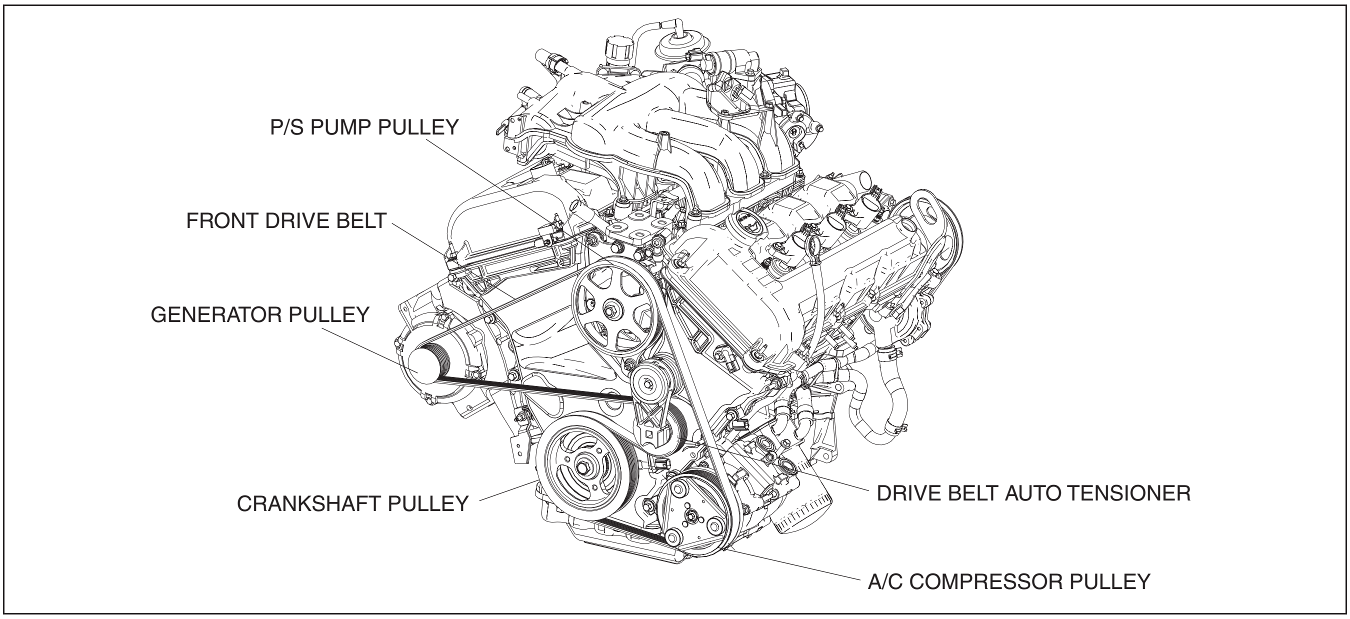
DRIVE BELT CONSTRUCTION[AJ (3.0L Duratec)]

id0110a3102500

Front Drive Belt

- A single V-ribbed belt (serpentine type) has been adopted on the front drive belt which drives the generator, P/S oil pump and the A/C compressor. A drive belt auto tensioner inside the coil spring has been adopted which is automatically adjusted so that the appropriate tension from the tensioner pulley is maintained.
- The front drive belt tension is automatically adjusted so that appropriate tension from the auto tensioner for the front drive belt is maintained.



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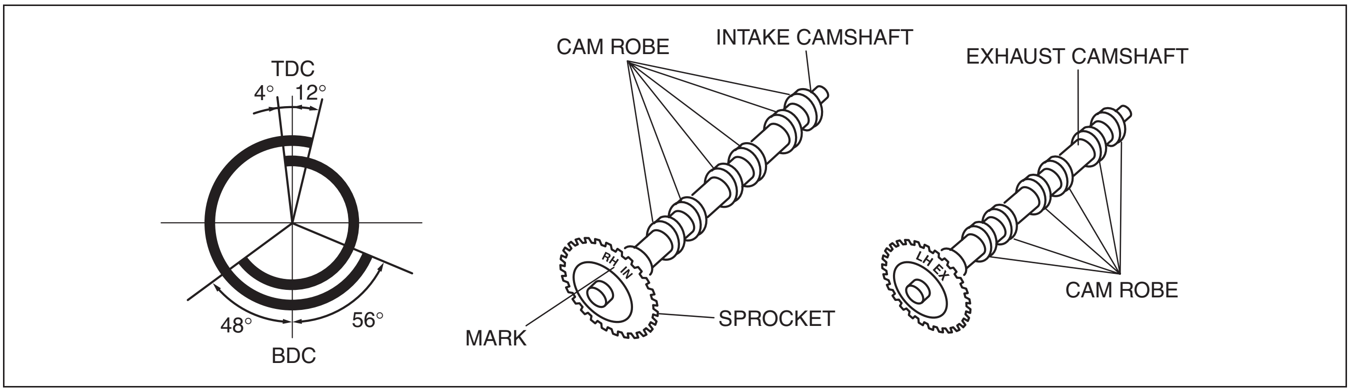
CAMSHAFT CONSTRUCTION[AJ (3.0L Duratec)]

id0110a3101300

- A steel camshaft has been adopted.
- A hollow assembly type camshaft with a press fit cam lobe has been adopted to improve weight reduction.
- The front of the camshaft sprockets have been separately marked RH, LH, IN and EX to prevent mis-assembly.
- The rear end of the of the exhaust camshaft (LH) is engaged with the water pump pulley.

Valve timing

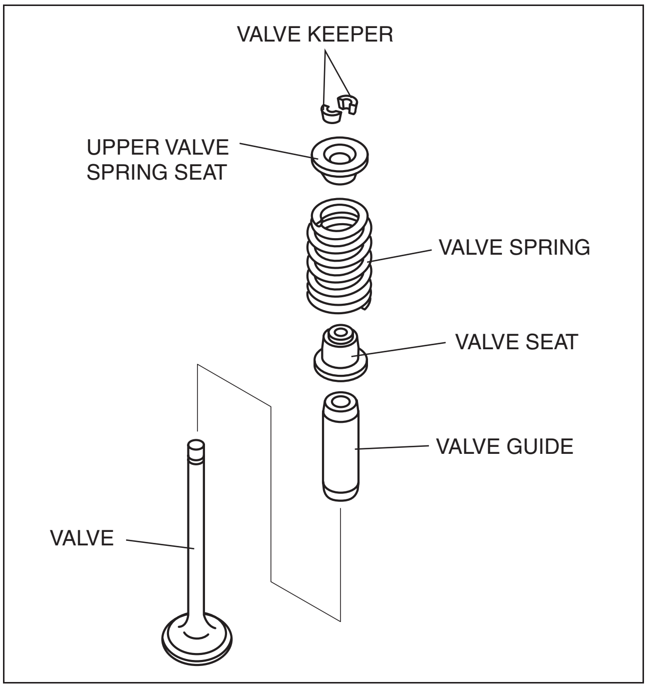


atraan00000076

VALVE, VALVE SPRING, VALVE SEAL GUIDE CONSTRUCTION[AJ (3.0L Duratec)]

id0110a3120200

- Heat-resistant steel rods have been adopted on the four valves, with two intake valves and two exhaust valves per cylinder.
- A valve seal integrated into the lower valve spring seat has been adopted for simplification and improved serviceability.

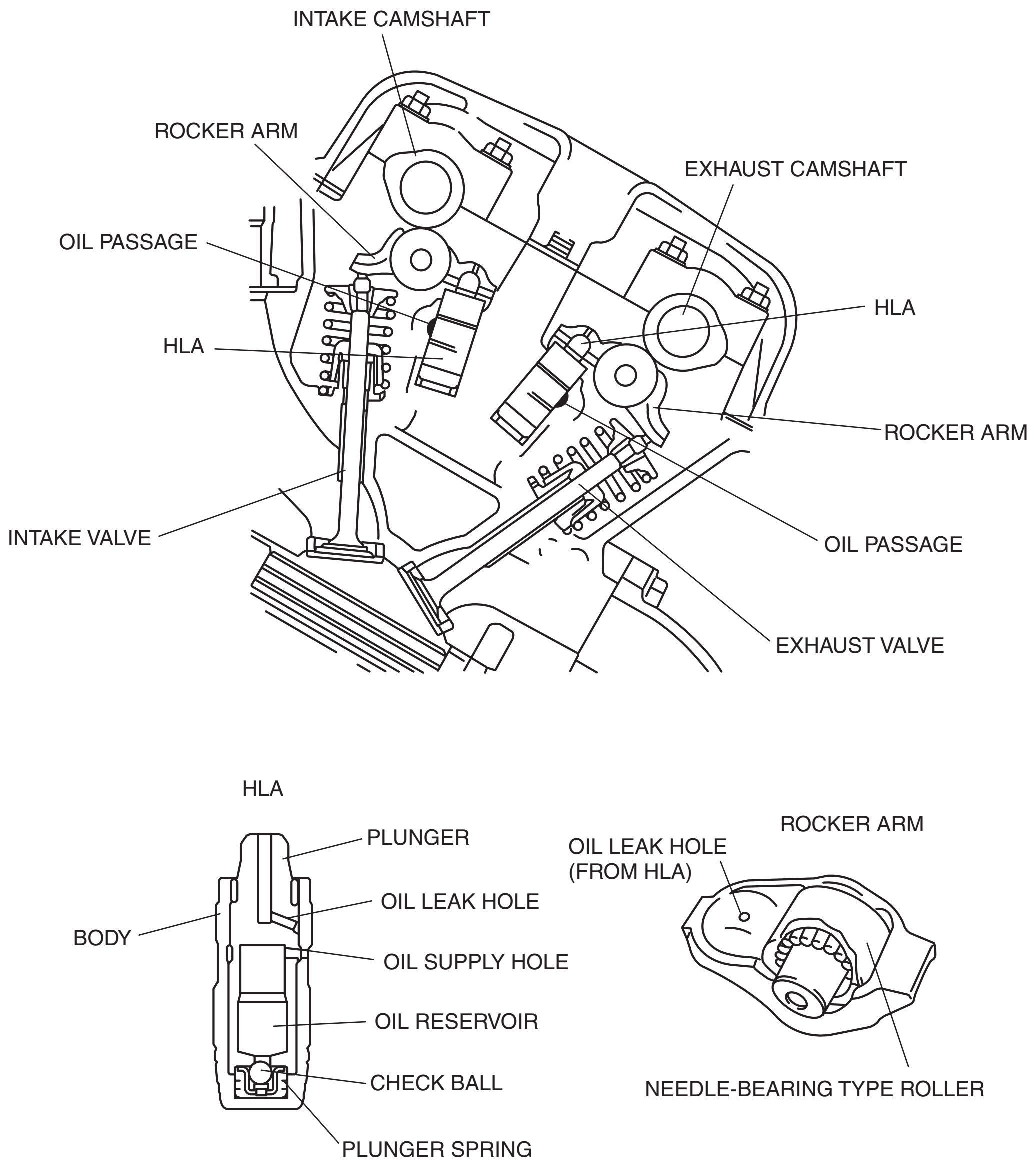


atraan00000079

HYDRAULIC LASH ADJUSTER (HLA) CONSTRUCTION[AJ (3.0L Duratec)]

id0110a3119900

- An HLA has been adopted to keep the valve clearance at 0 mm {0 in}.
- The HLA consists of the body, plunger, plunger spring and check ball.
- The rocker arm has adopted a needle-bearing type roller.



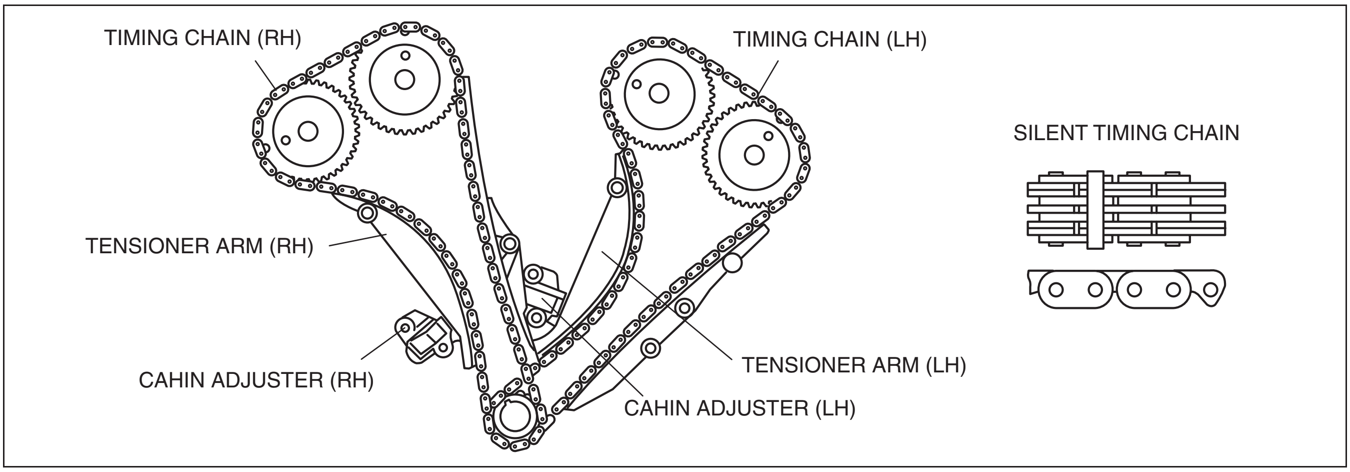
atraan00000080

TIMING CHAIN, CHAIN ADJUSTER CONSTRUCTION[AJ (3.0L Duratec)]

id0110a3120300

Timing Chain

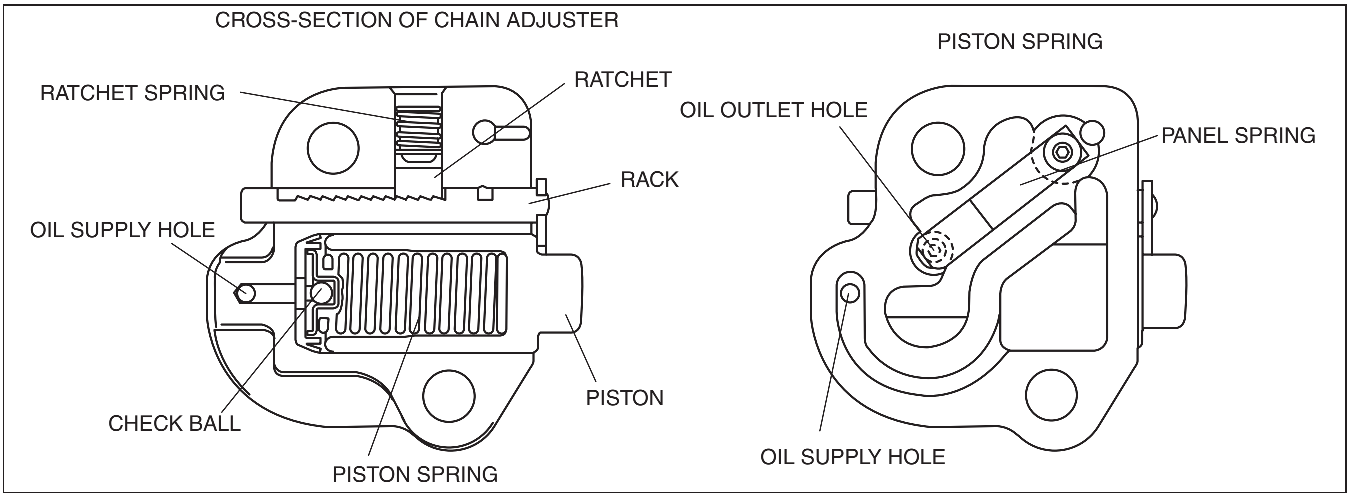
- A silent timing chain has been adopted to reduce chain operating noise caused by the engagement of each sprocket.
- The timing chain tension is maintained constantly at all times by a chain adjuster.



atraan00000092

Chain Adjuster

- An oil pressure type chain adjuster has been adopted.
- The chain adjuster consists of a ratchet and rack that fixes the piston movement, a piston and spring that pushes the tensioner arm, and a check ball that maintains pressure on the tensioner arm.
- Panel springs on the back of the check ball and adjuster prevent oil in the adjuster from draining. Thus the chain adjuster can maintain the force that pushes the piston against the tensioner arm, even if the engine is not operated for a long period of time.

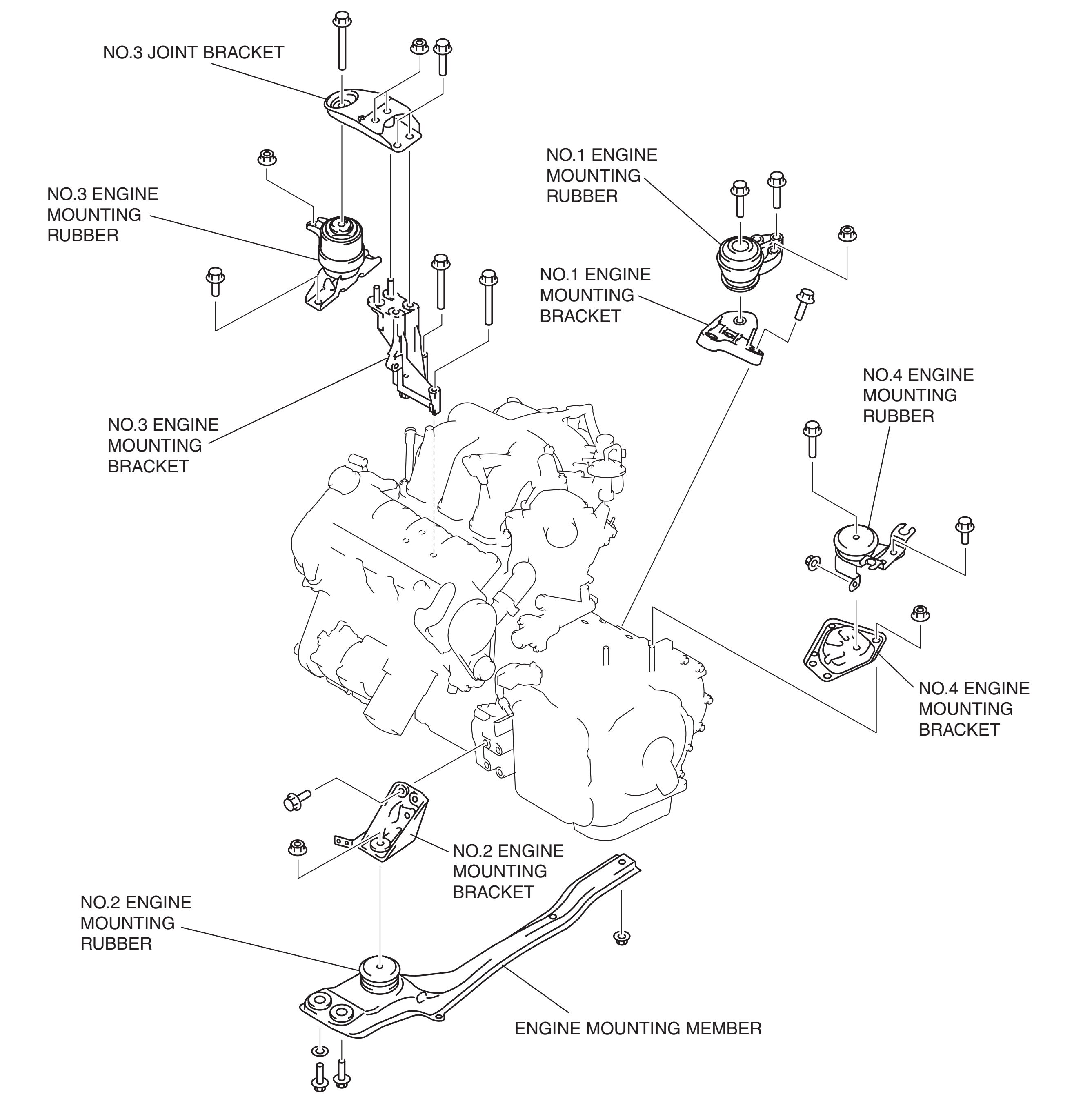


atraan00000093

ENGINE MOUNT OUTLINE[AJ (3.0L Duratec)]

id0110a3101400

- The engine is supported by four engine mount.
- An oil-filled No.3 engine mount rubber has been adopted to reduce noise in the cabin.



atraan00000273

01-11A LUBRICATION [L3]

LUBRICATION SYSTEM OUTLINE[L3]

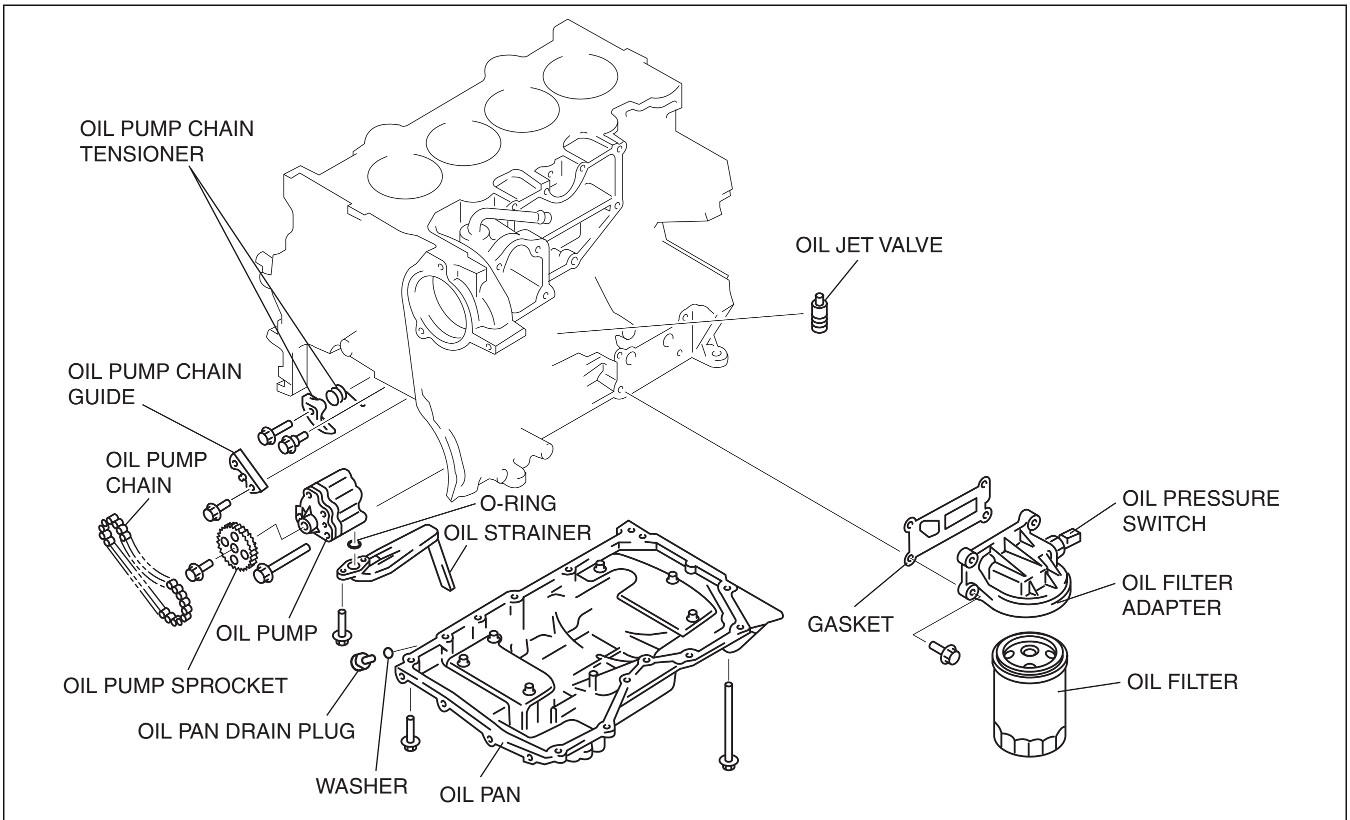
id0111a1100100

Features

Reduced noise	• Aluminum alloy oil pan adopted
Reduced weight	• Plastic oil strainer adopted
Improved lubricity	• Trochoid gear type oil pump adopted • Oil jet valves adopted

LUBRICATION SYSTEM STRUCTURAL VIEW[L3]

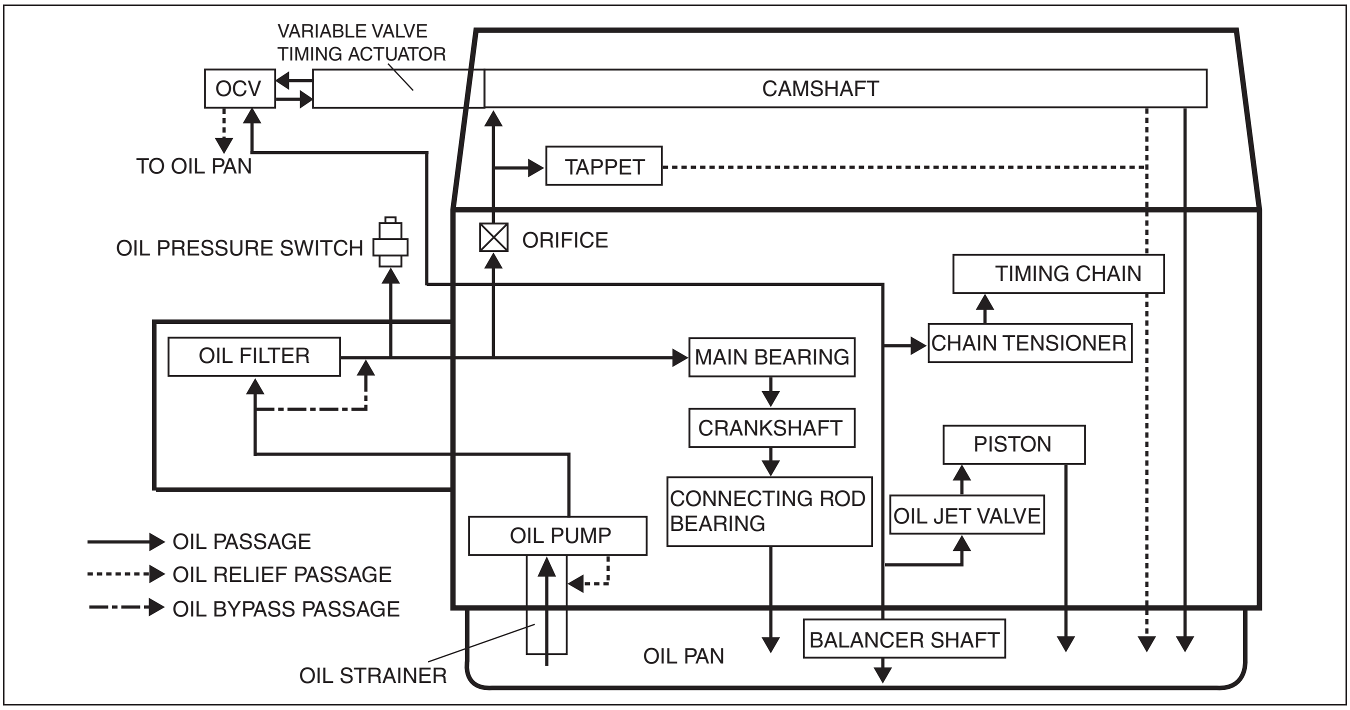
id0111a1100200



atraan00000051

LUBRICATION SYSTEM FLOW DIAGRAM[L3]

id0111a1100300

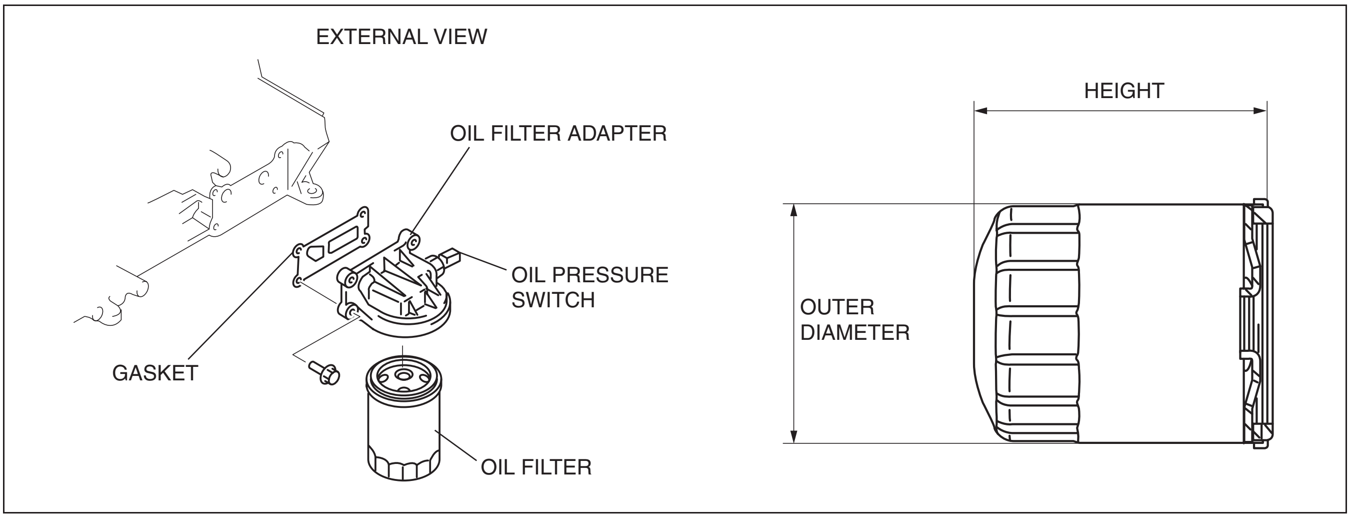


atraan00000097

OIL FILTER CONSTRUCTION[L3]

id0111a1100800

- The oil filter component is installed on the left surface (vehicle front) of the cylinder block.
- An aluminum oil filter adapter has been adopted for weight reduction. The oil pressure switch is installed on the oil filter adapter.
- The oil filter is a full-flow paper element type with an outer diameter of 76.2 mm {3.00 in} and height of 94.0 mm {3.70 in}.

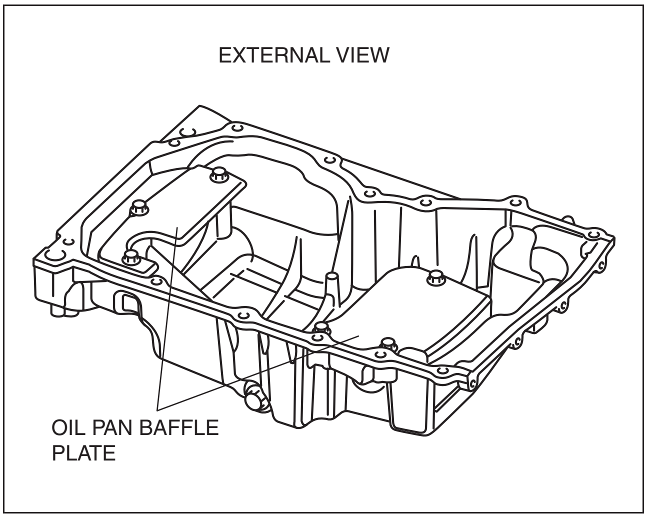


atraan00000136

OIL PAN CONSTRUCTION[L3]

id0111a1100400

- An aluminum alloy oil pan has been adopted for noise reduction.
- An oil pan baffle plate has been adopted inside the oil pan to stabilize engine oil diffusion by crankshaft rotation and oil level when the vehicle rolls.
- A silicon sealant with excellent sealing qualities has been adopted.

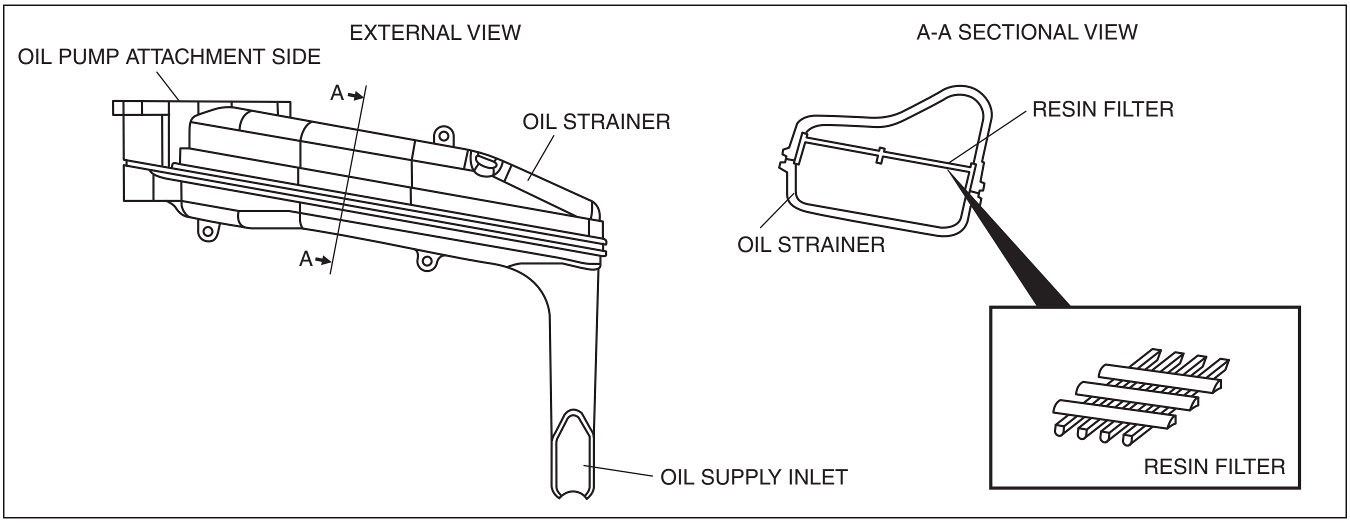


atraan00000098

OIL STRAINER CONSTRUCTION[L3]

id0111a1100700

- A plastic oil strainer with a resin filter in the middle of the strainer has been adopted for weight reduction.

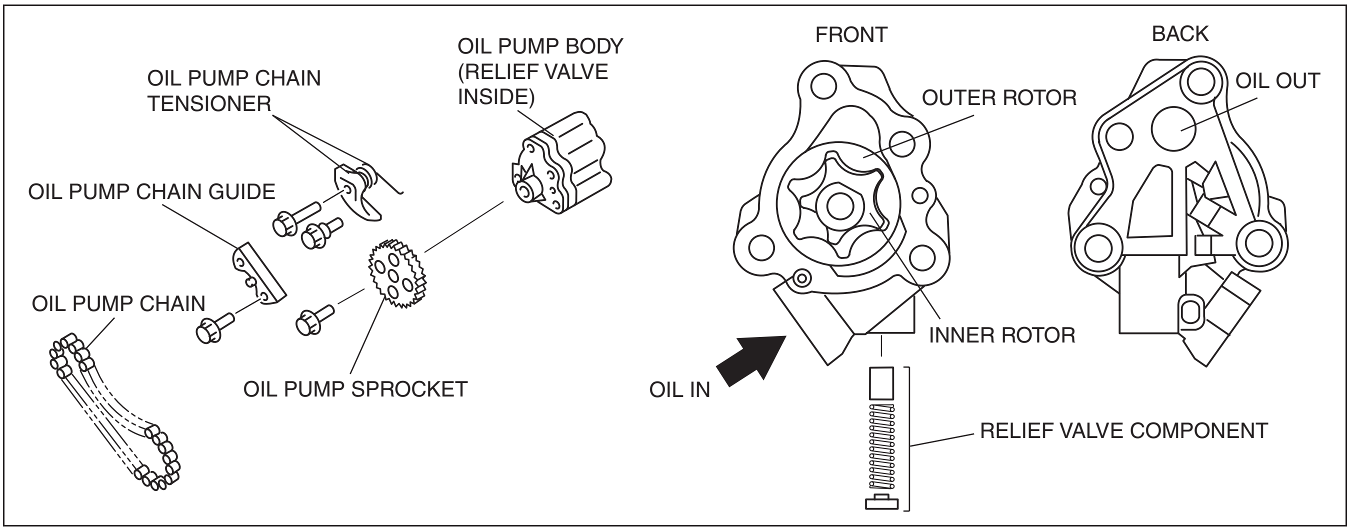


atraan00000103

OIL PUMP CONSTRUCTION[L3]

id0111a1100600

- The oil pump is installed inside the engine front cover. The crankshaft drives the inner rotor through the oil pump chain and oil pump sprocket.
- The oil pump component consists of the oil pump body, oil pump sprocket, oil pump chain, oil pump chain guide, and oil pump chain tensioner.
- A trochoid gear has been adopted on the oil pump.
- The oil pump consists of the inner and outer rotors, relief valve, and oil pump body.
- The oil pump cannot be disassembled. If there is an oil pump malfunction, replace it as a single unit.

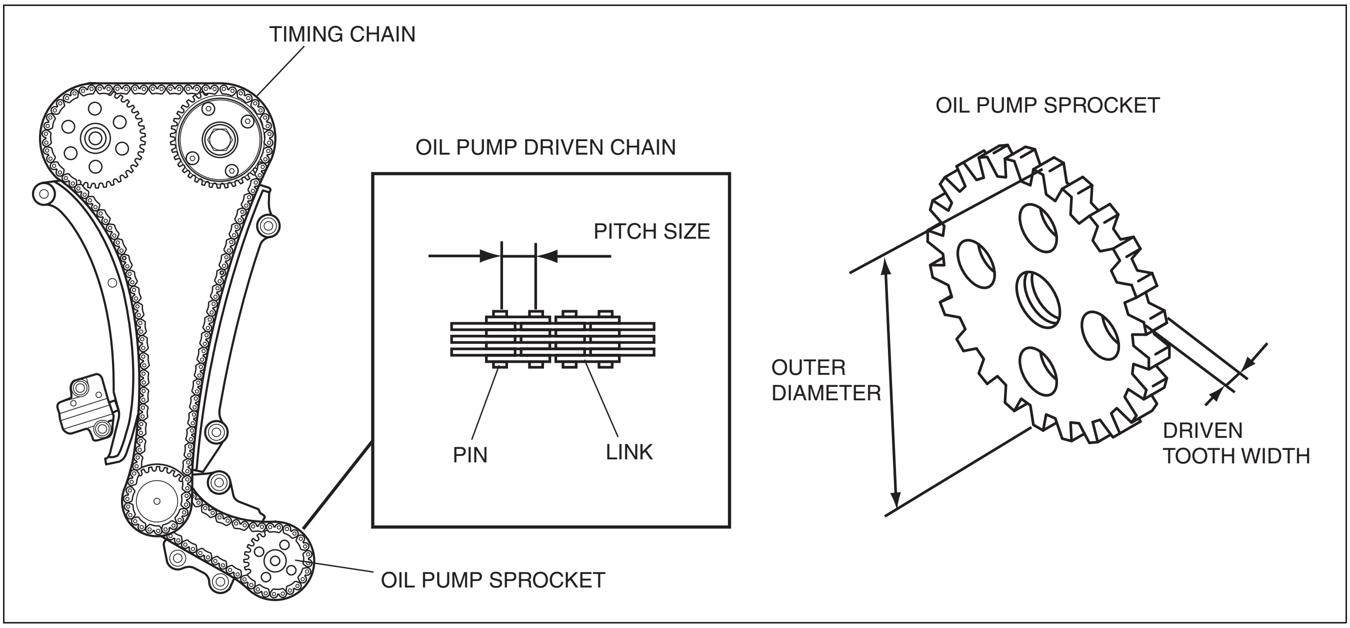


atraan00000101

Oil pump specification

Item	Engine speed [rpm]	Specification (kPa {kgf/cm^2, psi})
Oil discharge pressure (reference value) [Oil temperature: 100 °C {212 °F}]	1,500	180— 387 {1.84—3.95, 26.2—56.1}
	3,000	337—591 {3.44—6.03, 49.0—85.8}
Relief valve opening pressure (reference value)		420—520 {4.28—5.30, 60.9—75.4}

- A silent chain (link connecting type) has been adopted to the oil pump chain to reduce chain operation noise when the chain and the sprocket engage.
- The engine oil in the engine front cover lubricates the oil pump chain. Wear resistance has been improved using nitriding processing of the pins constructing the oil pump chain.
- The sintered material in the oil pump sprocket has been furnace hardened to improve durability.



atraan00000102

Oil pump driven chain, oil pump sprocket specification

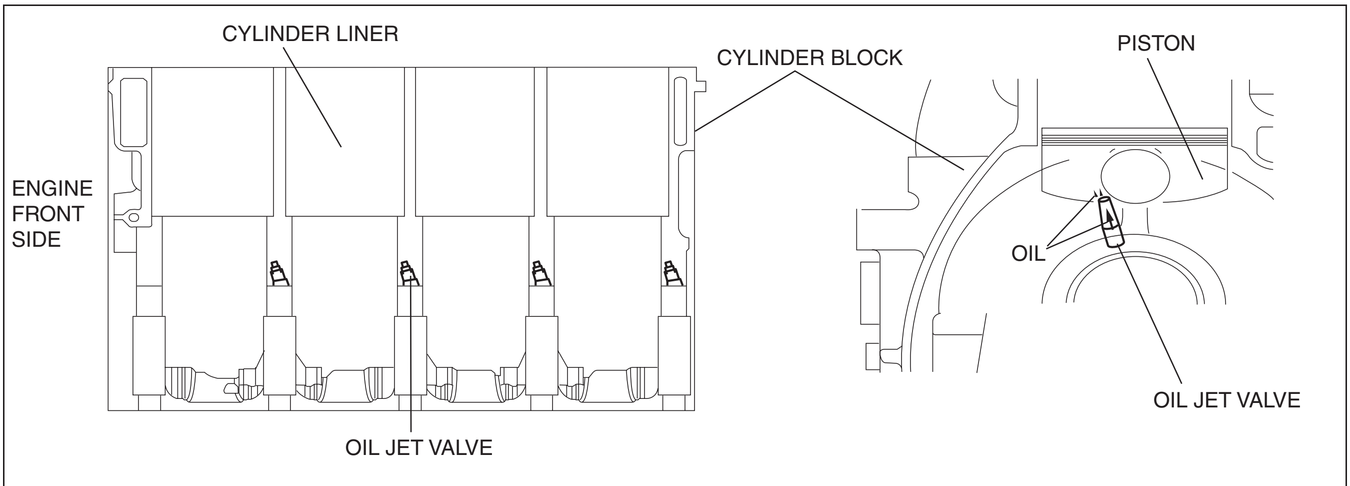
Item		Specification (mm {in})
Oil pump driven chain	Pitch size	6.35 {0.25}
Oil pump sprocket	Outer diameter	46.46 {1.829}
	Driven tooth width	5.7 {0.23}

OIL JET VALVE CONSTRUCTION/OPERATION[L3]

id0111a1100500

Construction

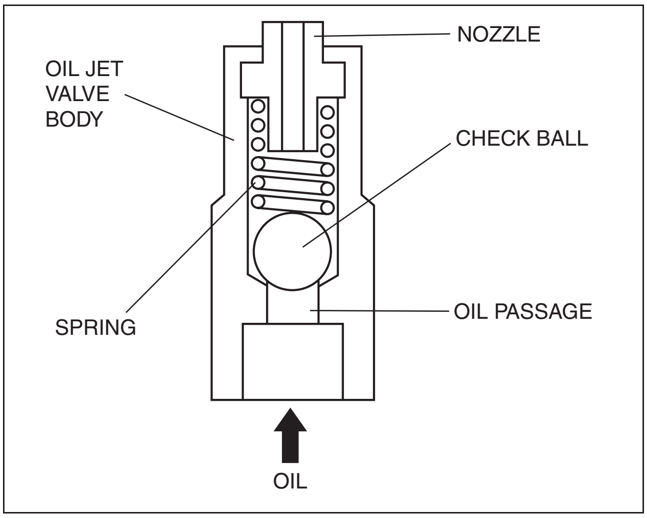
- The oil jet valves are installed in the cylinder block (in the main journal). The oil jet valve nozzles are installed pointed toward the back surface of each piston.
- The oil jet valves are designed to maintain optimum oil pressure in the engine by controlling the oil injection according to the oil pressure applied to the check ball in the oil jet valves.



atraan00000099

Operation

- Oil pressure applied to the check-ball in the oil jet valve opens and closes the oil passage-way to the nozzle and controls oil injection starting and stopping.
- Oil pressure greater than the specified value applied to the check-ball in the oil jet valve opens the oil passage to the spring-pressed nozzle, starting injection. Conversely, oil pressure less than the specified value applied to the check-ball blocks the oil passage by spring force, stopping injection.



atraan00000100

01-11B LUBRICATION [AJ (3.0L Duratec)]

LUBRICATION SYSTEM OUTLINE[AJ (3.0L Duratec)]

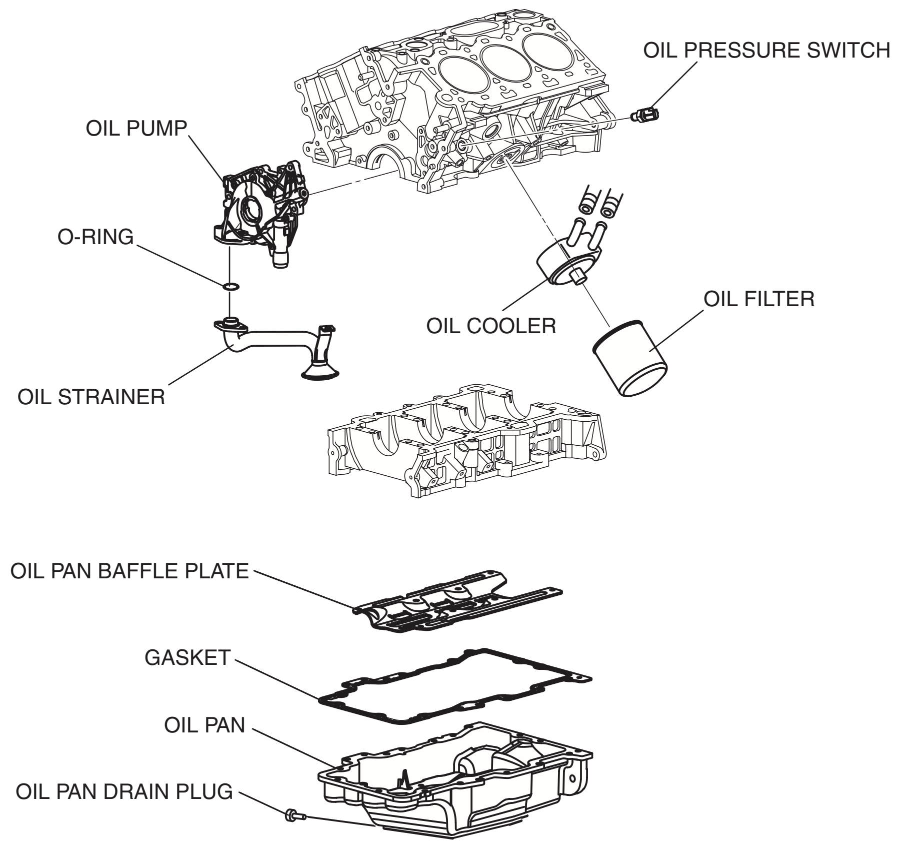
id0111a2100100

Features

Reduced noise	• Aluminum alloy oil pan adopted
Improved lubricity	• Trochoid gear type oil pump adopted • Water-cooled type oil cooler adopted

LUBRICATION SYSTEM STRUCTURAL VIEW[AJ (3.0L Duratec)]

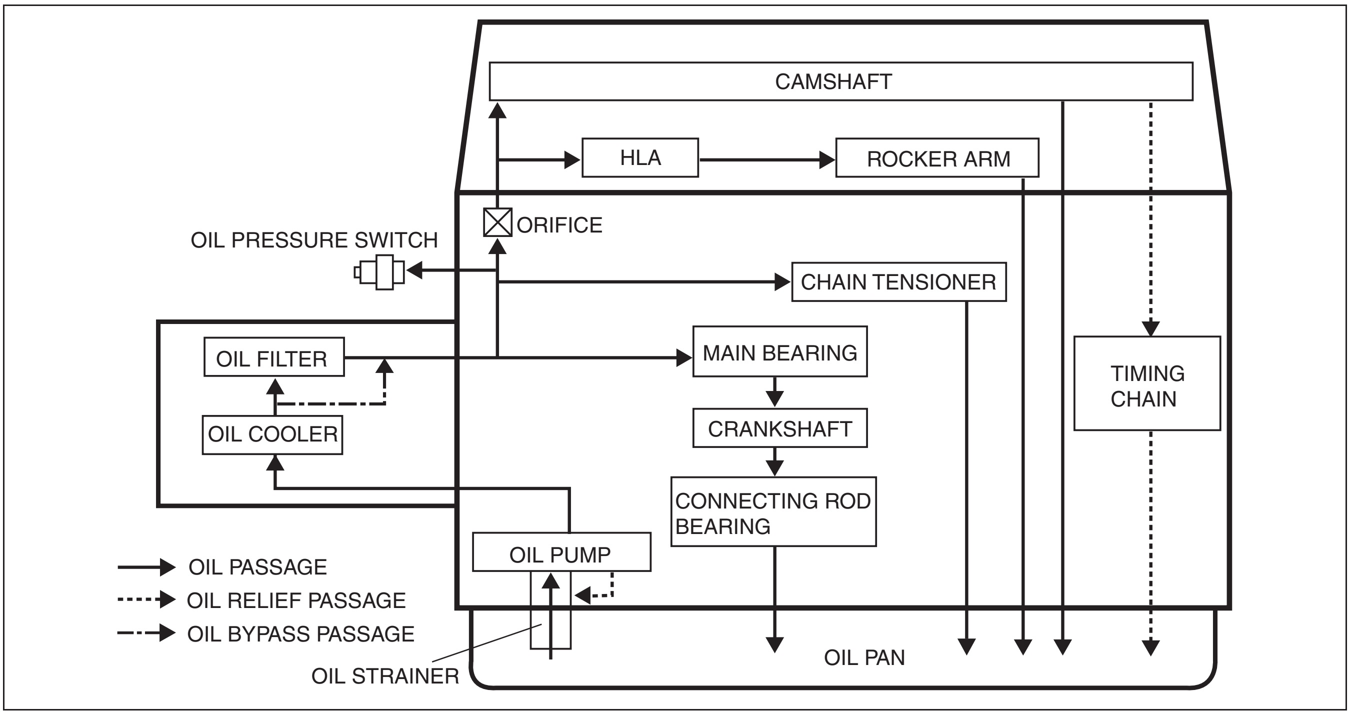
id0111a2100200



atraan00000054

LUBRICATION SYSTEM FLOW DIAGRAM[AJ (3.0L Duratec)]

id0111a2100300

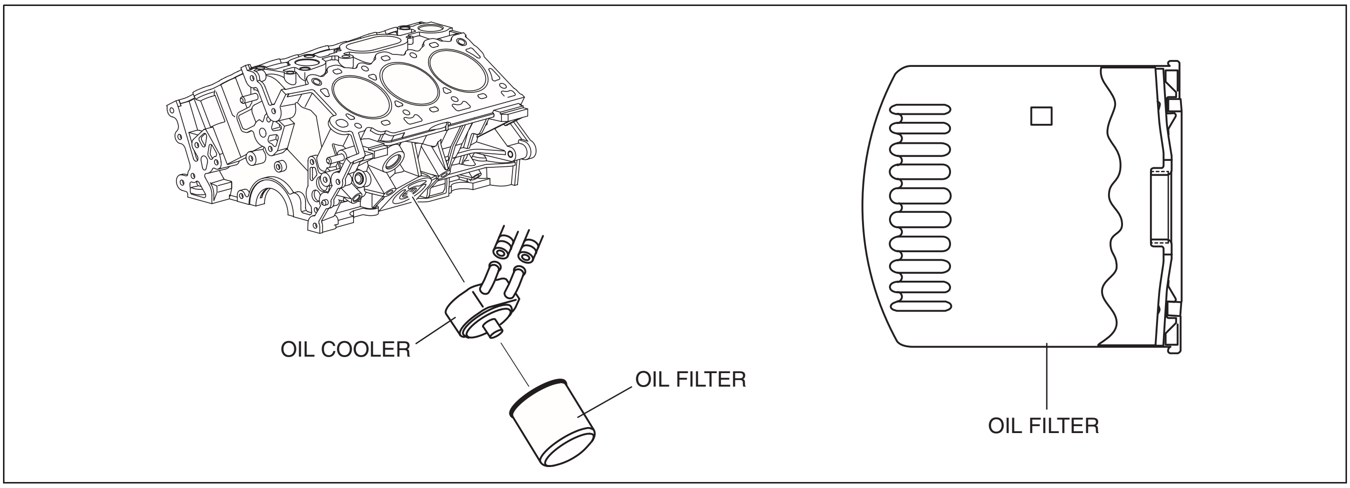


atraan00000104

OIL FILTER, OIL COOLER CONSTRUCTION[AJ (3.0L Duratec)]

id0111a2118100

- A full-flow paper element type oil filter has been adopted.
- A water-cooled type oil cooler has been adapted to reduce the engine oil degradation.

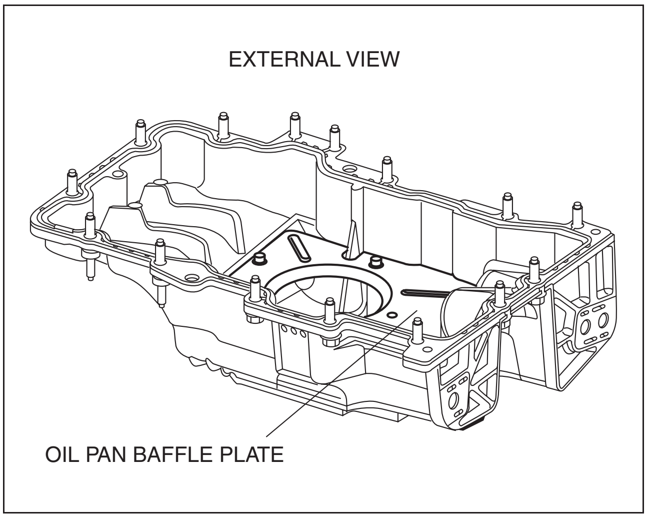


atraan00000107

OIL PAN CONSTRUCTION[AJ (3.0L Duratec)]

id0111a2100400

- An aluminum alloy oil pan has been adopted for noise reduction.
- An oil pan baffle plate has been adopted inside the oil pan to stabilize engine oil diffusion by crankshaft rotation and oil level when the vehicle rolls.

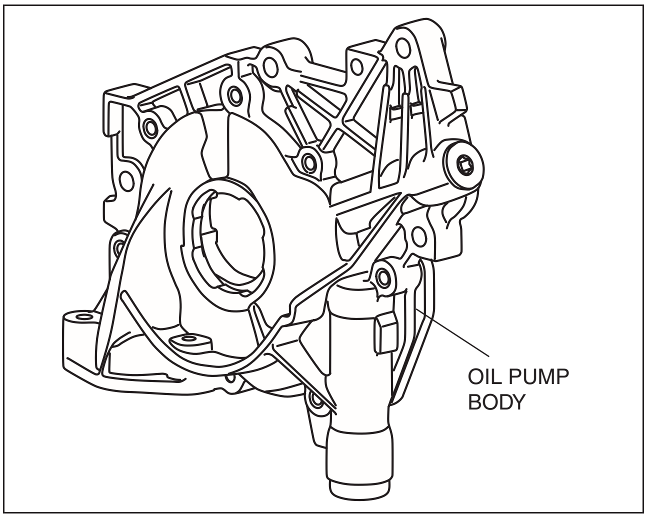


atraan00000105

OIL PUMP CONSTRUCTION[AJ (3.0L Duratec)]

id0111a2100600

- The oil pump is directly driven by the crankshaft to reduce engine noise.
- A trochoid gear type oil pump has been adopted to ensure stable discharge function.
- The oil pump cannot be disassembled. If there is an oil pump malfunction, replace it as a single unit.
- The oil pump regulator, which adjusts the oil pressure, is built into the oil pump body.



atraan00000106

01-12A COOLING SYSTEM [L3]

COOLING SYSTEM OUTLINE[L3]

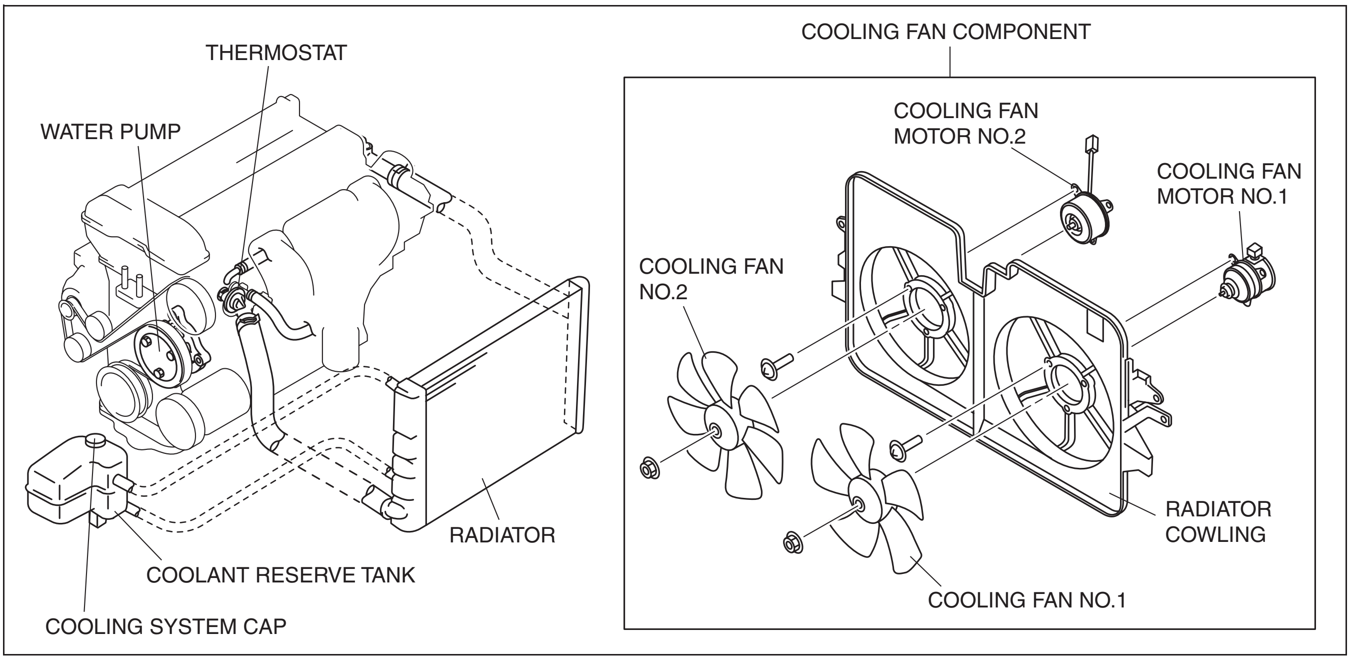
id0112a1100100

Features

Improved reliability	• Degassing type coolant reserve tank adopted
Reduced weight	• Cross flow type radiator with aluminum core and plastic tank adopted • Stainless steel thermostat with plastic thermostat cover adopted
Miniaturization	• Built-in type water pump adopted
Reduced engine noise and vibration	• Electric cooling fans adopted
Improved serviceability	• Longer-life new engine coolant (type FL22) adopted

COOLING SYSTEM STRUCTURAL VIEW[L3]

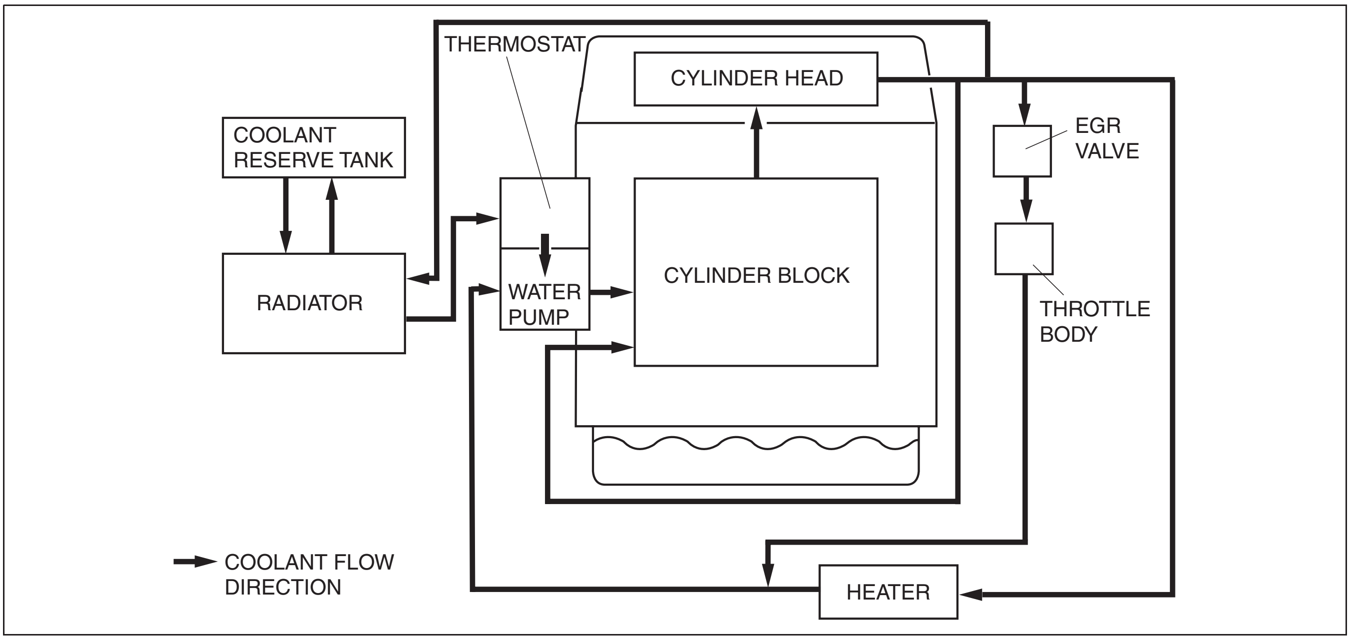
id0112a1100200



atraan00000108

COOLING SYSTEM FLOW DIAGRAM[L3]

id0112a1100300

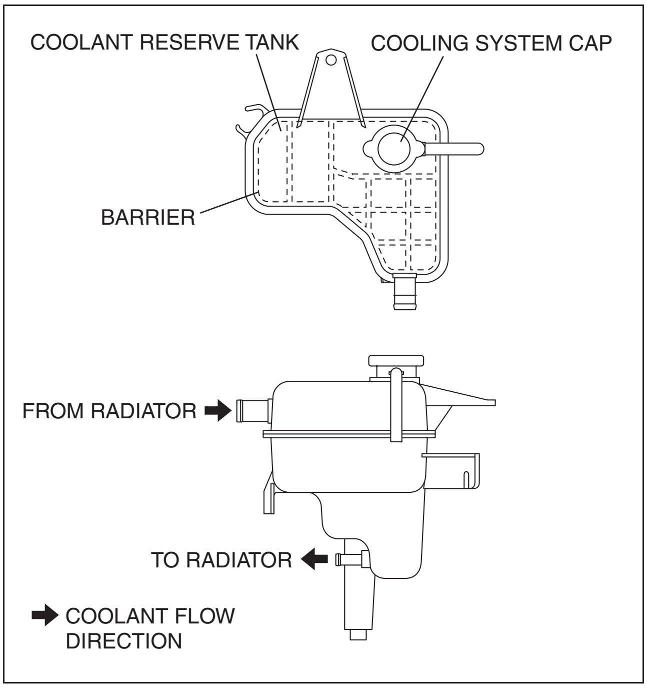


atraan00000109

COOLING SYSTEM CAP, COOLANT RESERVE TANK CONSTRUCTION[L3]

id0112a1142100

- A low-pressure type cap has been adopted for the cooling system. It is installed on the coolant reserve tank to improve serviceability when adding engine coolant and bleeding air.
- A degassing type coolant reserve tank has been adopted, to integrate the simple airtight sub-tank and the air/water separating tank, improving the air/water separating function. The integrated and large-size degassing tank consists of a labyrinth structure with internal barriers to lengthen the distance to the outlet and reduce the flow speed to lengthen the time the engine coolant has to accumulate, improving the air/water separation function.

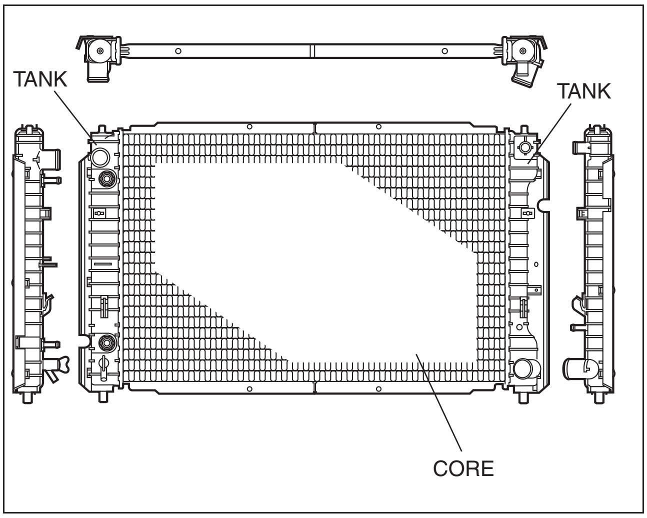


atraan00000113

RADIATOR CONSTRUCTION[L3]

id0112a1142000

- A cross-flow radiator with corrugated fins is used to improve cooling performance.
- The radiator tanks are made of plastic and the core is made of aluminum for weight reduction.
- Four mounting rubbers are utilized to decrease vibration.
- The radiator has an ATF oil cooler in the left side radiator tank.



atraan00000112

THERMOSTAT CONSTRUCTION/OPERATION[L3]

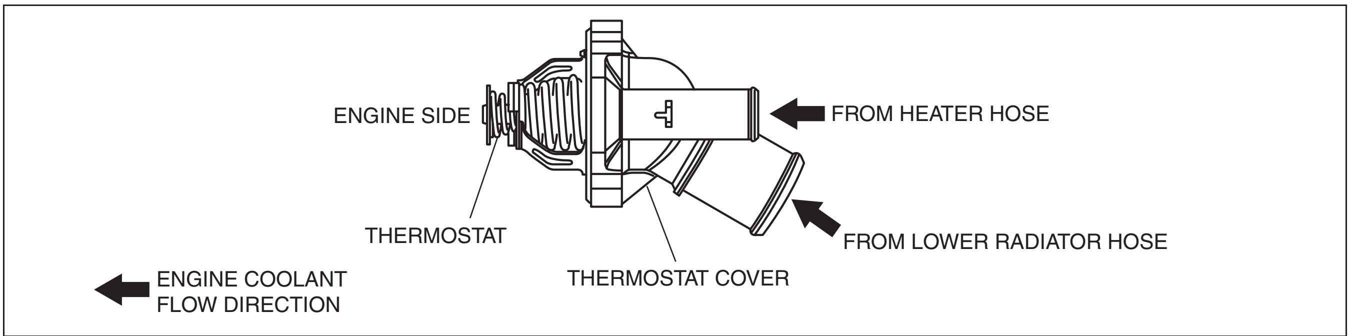
id0112a1100700

Construction

- A wax-type thermostat with a jiggle-valve has been adopted.

Operation

- When the engine coolant temperature reaches 80—84 °C {176—183 °F}, the valve starts opening to allow engine coolant to flow from the radiator stabilizing the engine coolant temperature. When the engine coolant temperature decreases to approx. 75 °C {167 °F}, the valve closes to stop the engine coolant flow from the radiator.



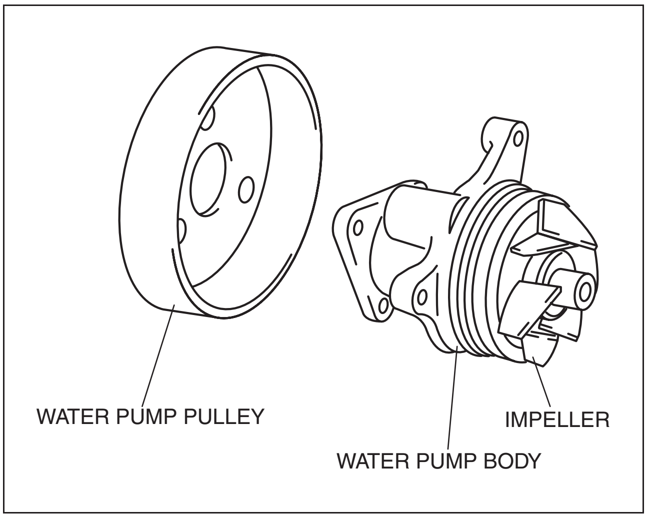
atraan00000110

WATER PUMP CONSTRUCTION/OPERATION[L3]

id0112a1100400

Construction

- The aluminum alloy water pump with the impeller built into the cylinder block has been adopted for size reduction.
- The water pump is not serviceable and must be replaced as a single unit if it has a malfunction.



atraan00000369

Operation

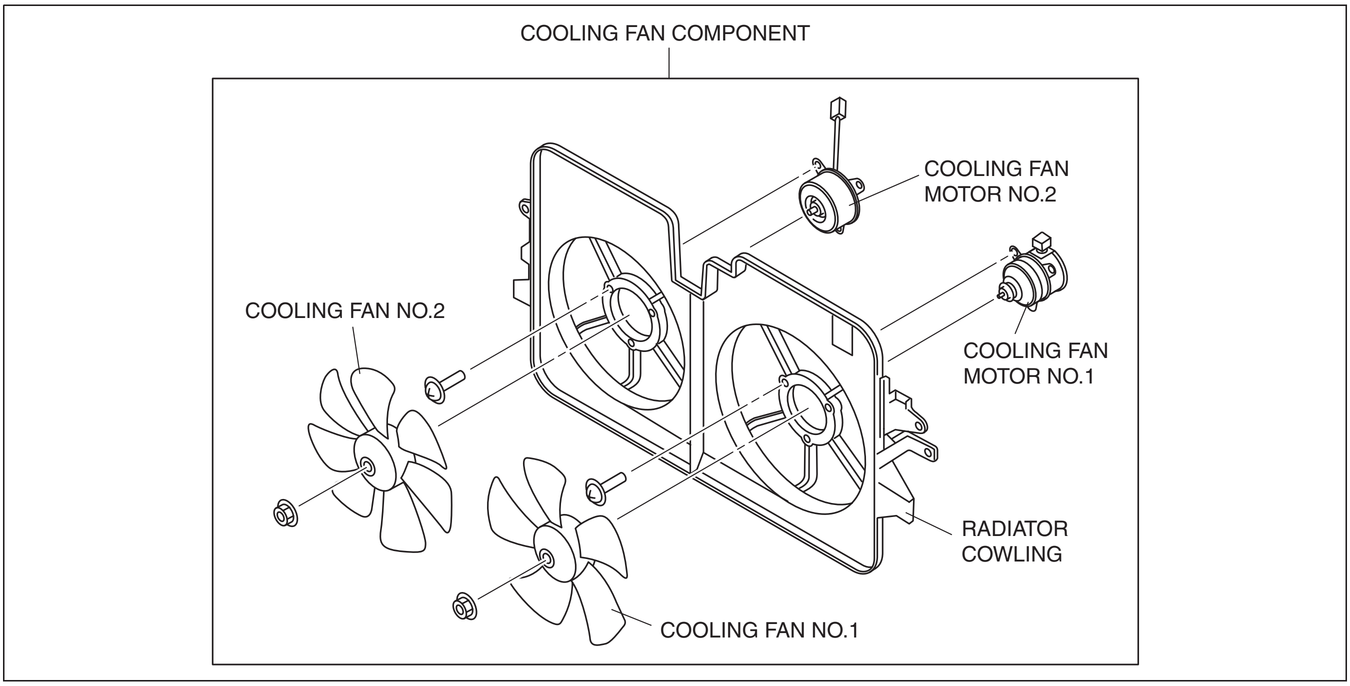
- The water pump is driven by the drive belt.

COOLING FAN COMPONENT CONSTRUCTION/OPERATION[L3]

id0112a1141900

Construction

- The cooling fan component consists of the radiator cowling, cooling fans, and cooling fan motors.
- Electric cooling fans No.1 and No.2, which operate according to the fan control signal from the PCM, have been adopted. Due to this, engine noise has been reduced and rapid engine warming-up is possible.
- The radiator cowling and cooling fans are made of plastic for weight reduction.



atraan00000111

Cooling fan, cooling fan motor specification

Item		Specification	
		No.1	No.2
Cooling fan	Number of blades	5	7
	Outer diameter (mm {in})	300 {11.8}	
Cooling fan motor output (W)		70	120

Operation

- Cooling fans No.1 and No.2 operate according to the engine coolant temperature and whether the A/C is on or off. (See 01-40A-37 ELECTRICAL FAN CONTROL OPERATION[L3].)

01-12B COOLING SYSTEM [AJ (3.0L Duratec)]

01

COOLING SYSTEM OUTLINE[AJ (3.0L Duratec)]

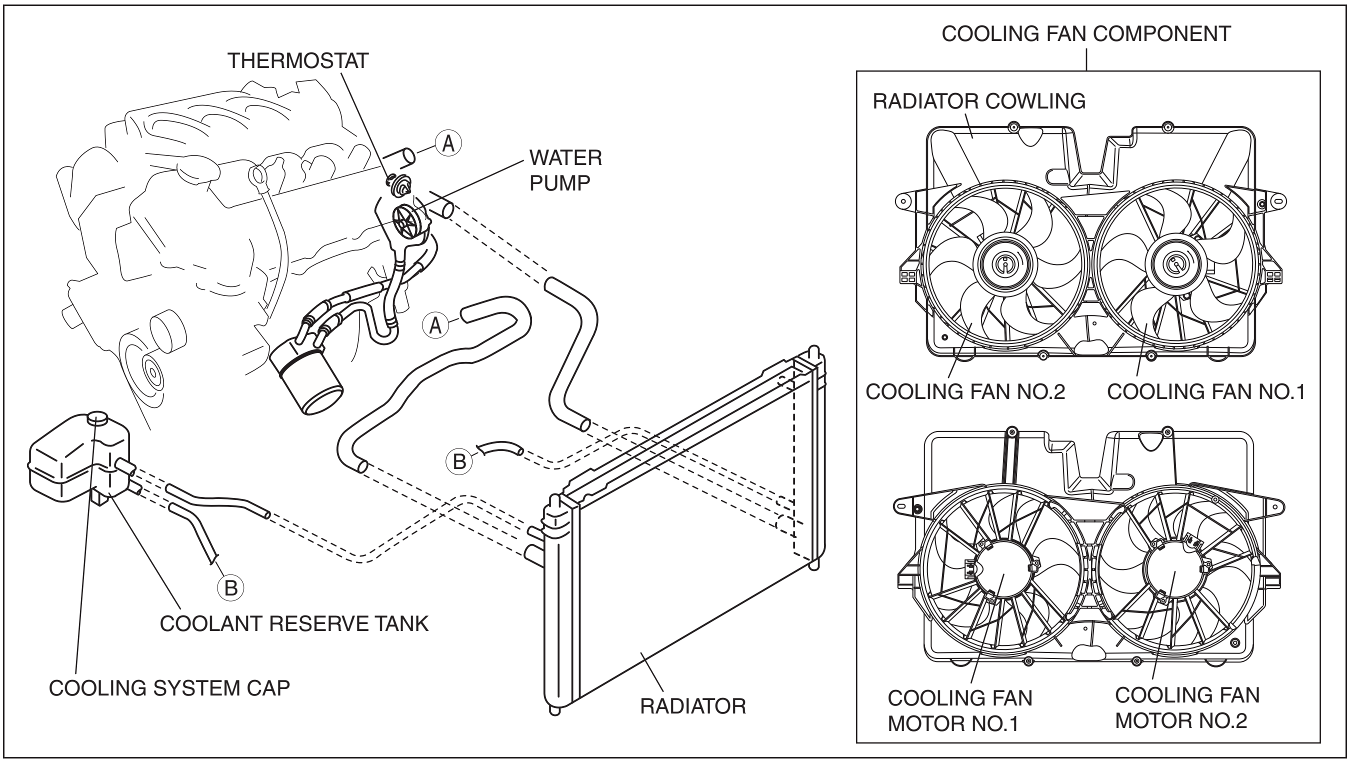
id0112a2100100

Features

Improved reliability	• Degassing type coolant reserve tank adopted
Reduced weight	• Cross flow type radiator with aluminum core and plastic tank adopted
Reduced engine noise and vibration	• Electric cooling fans adopted
Improved serviceability	• Longer-life new engine coolant (type FL22) adopted

COOLING SYSTEM STRUCTURAL VIEW[AJ (3.0L Duratec)]

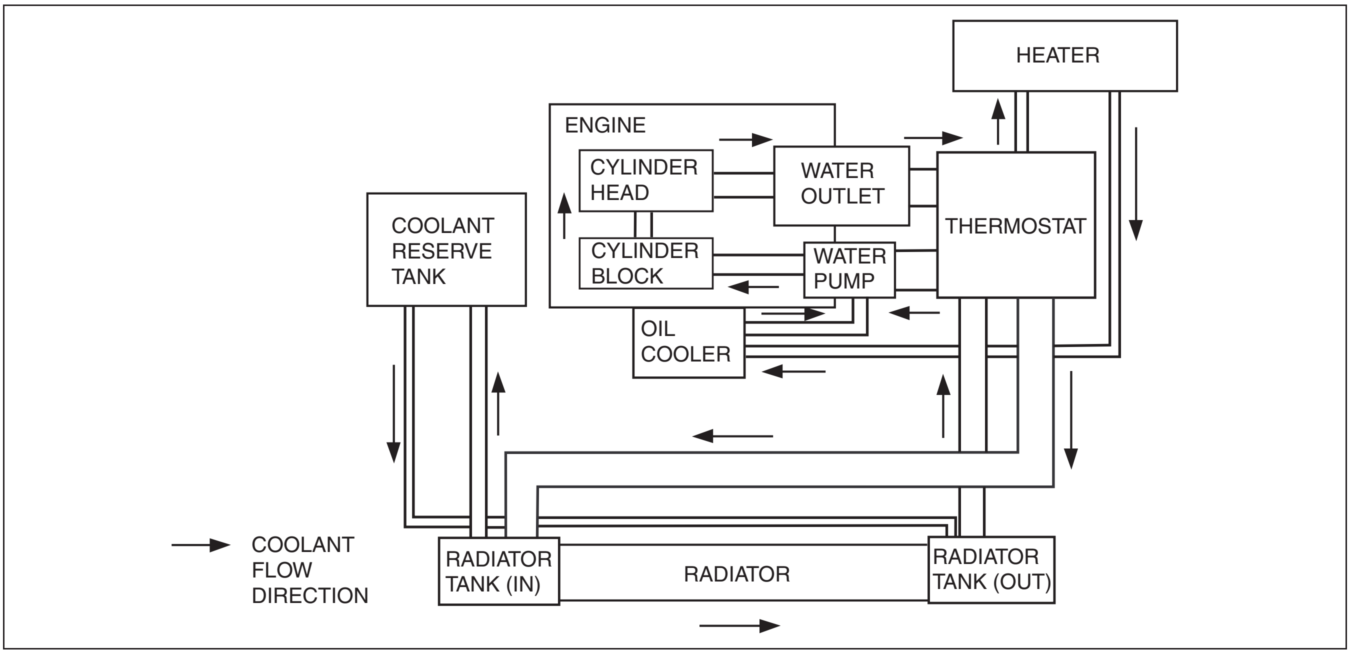
id0112a2100200



atraan00000114

COOLING SYSTEM FLOW DIAGRAM[AJ (3.0L Duratec)]

id0112a2100300

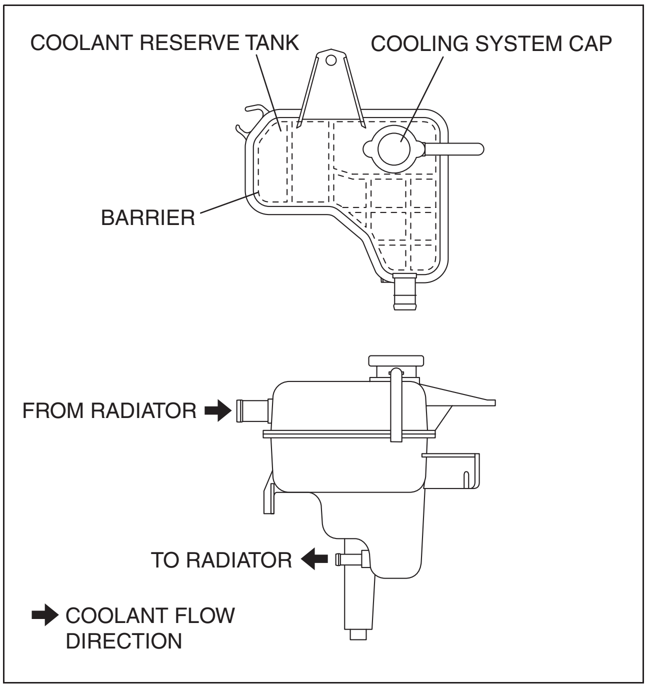


atraan00000115

COOLING SYSTEM CAP, COOLANT RESERVE TANK CONSTRUCTION[AJ (3.0L Duratec)]

id0112a2142100

- A low-pressure type cap has been adopted for the cooling system. It is installed on the coolant reserve tank to improve serviceability when adding engine coolant and bleeding air.
- A degassing type coolant reserve tank has been adopted, to integrate the simple airtight sub-tank and the air/water separating tank, improving the air/water separating function. The integrated and large-size degassing tank consists of a labyrinth structure with internal barriers to lengthen the distance to the outlet and reduce the flow speed to lengthen the time the engine coolant has to accumulate, improving the air/water separation function.

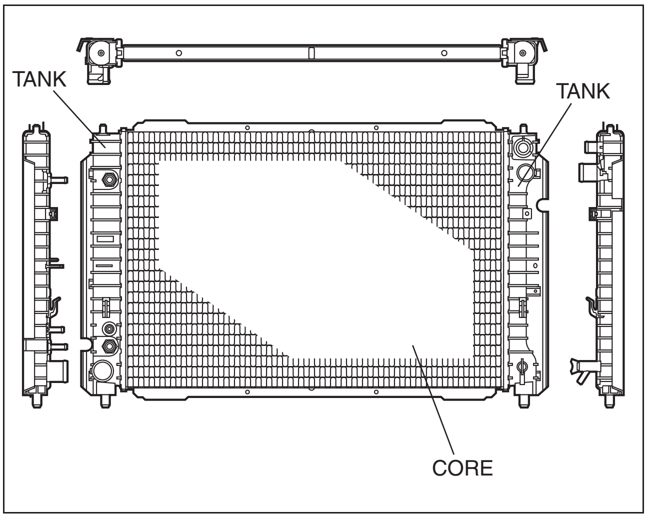


atraan00000120

RADIATOR CONSTRUCTION[AJ (3.0L Duratec)]

id0112a2142000

- A cross-flow radiator with corrugated fins is used to improve cooling performance.
- The radiator tanks are made of plastic and the core is made of aluminum for weight reduction.
- Four mounting rubbers are utilized to decrease vibration.
- The radiator has an ATF oil cooler in the left side radiator tank.



atraan00000119

THERMOSTAT CONSTRUCTION/OPERATION[AJ (3.0L Duratec)]

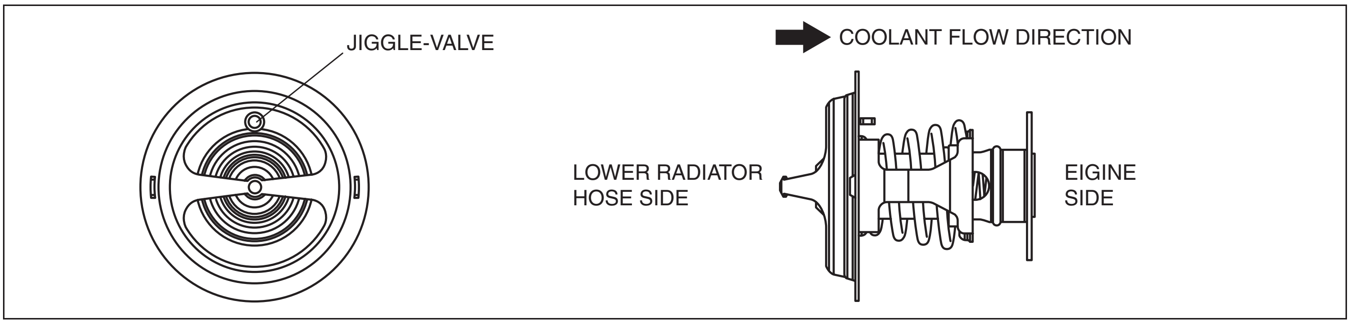
id0112a2100700

Construction

- A wax-type thermostat with a jiggle-valve has been adopted.
- Stainless steel has been adopted on the thermostat body for excellent corrosion resistance.

Operation

- When the engine coolant temperature reaches 84—88 °C {184—190 °F}, the valve starts opening to allow engine coolant to flow from the radiator stabilizing the engine coolant temperature. When the engine coolant temperature decreases to approx. 83 °C {181 °F}, the valve closes to stop the engine coolant flow from the radiator.



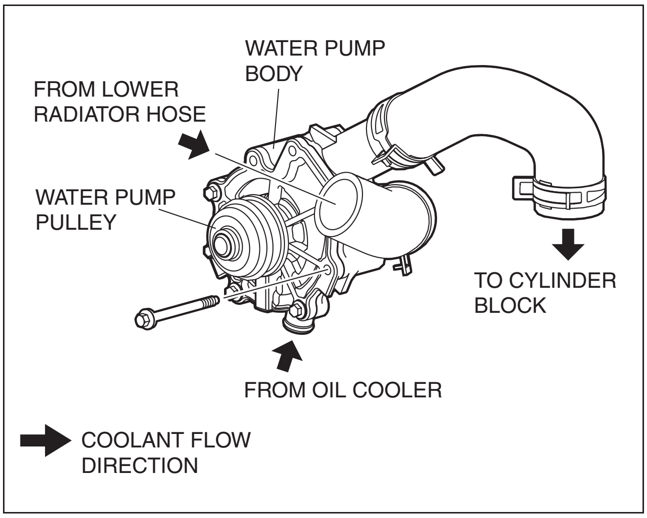
atraan00000117

WATER PUMP CONSTRUCTION/OPERATION[AJ (3.0L Duratec)]

id0112a2100400

Construction

- The water pump body is made of aluminum alloy and installed to the rear of the LH cylinder head.
- A stretch belt has been adopted to the rear drive belt which operates the water pump.



atraan00000116

Operation

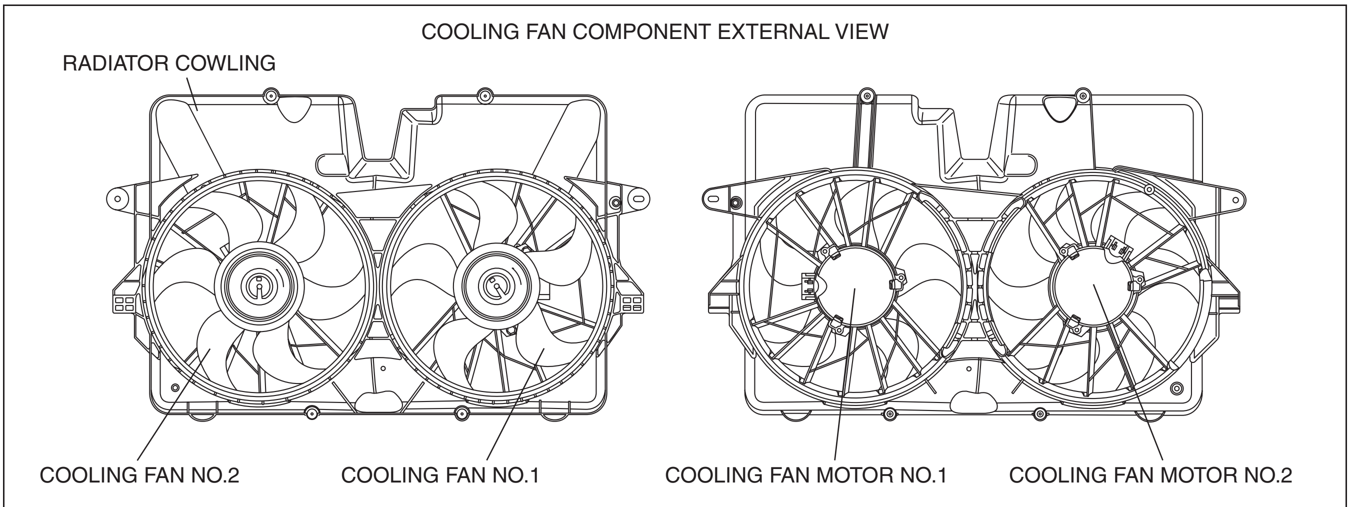
- The water pump is driven by a V-ribbed belt off the pulley on the rear end of the exhaust camshaft in the LH cylinder head.

COOLING FAN COMPONENT CONSTRUCTION/OPERATION[AJ (3.0L Duratec)]

id0112a2141900

Construction

- The cooling fan component consists of the radiator cowling, cooling fans, and cooling fan motors.
- Electric cooling fans No.1 and No.2, which operate according to the fan control signal from the PCM, have been adopted. Due to this, engine noise has been reduced and rapid engine warming-up is possible.
- The radiator cowling and cooling fans are made of plastic for weight reduction.
- The cooling fan component cannot be disassembled.



atraan00000118

Cooling fan, cooling fan motor specification

Item		Specification	
		No.1	No.2
Cooling fan	Number of blades	5	6
	Outer diameter (mm {in})	320	
Cooling fan motor output (W)		220	

Operation

- Cooling fans No.1 and No.2 operate according to the engine coolant temperature and whether the A/C is on or off.

01-13A INTAKE-AIR SYSTEM [L3]

INTAKE-AIR SYSTEM OUTLINE[L3]

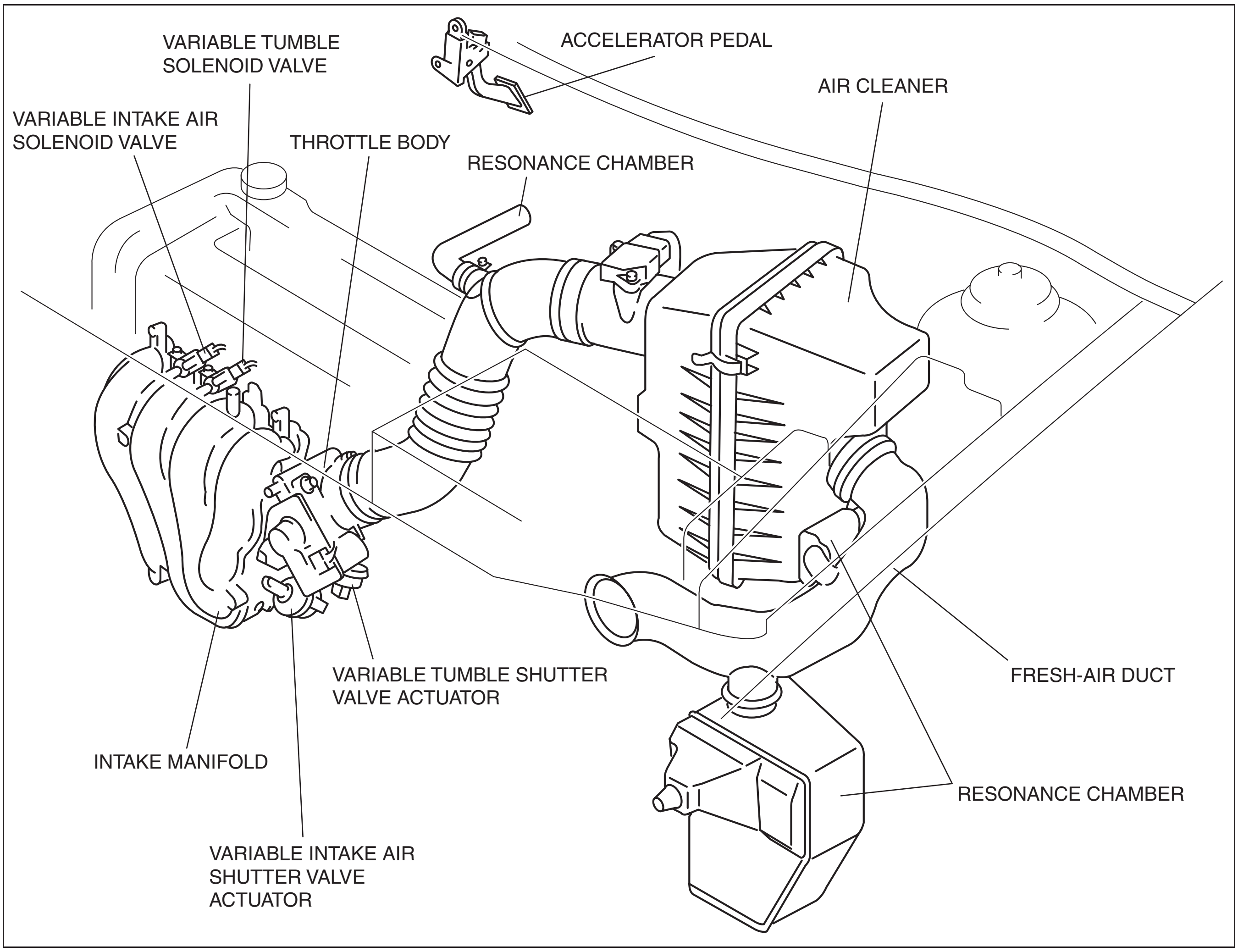
id0113a2100100

Features

Improved engine torque	• Variable intake air system adopted
Improved noise reduction	• Resonance chamber adopted
Improved emission gas purification	• Variable tumble system adopted

INTAKE-AIR SYSTEM STRUCTURAL VIEW[L3]

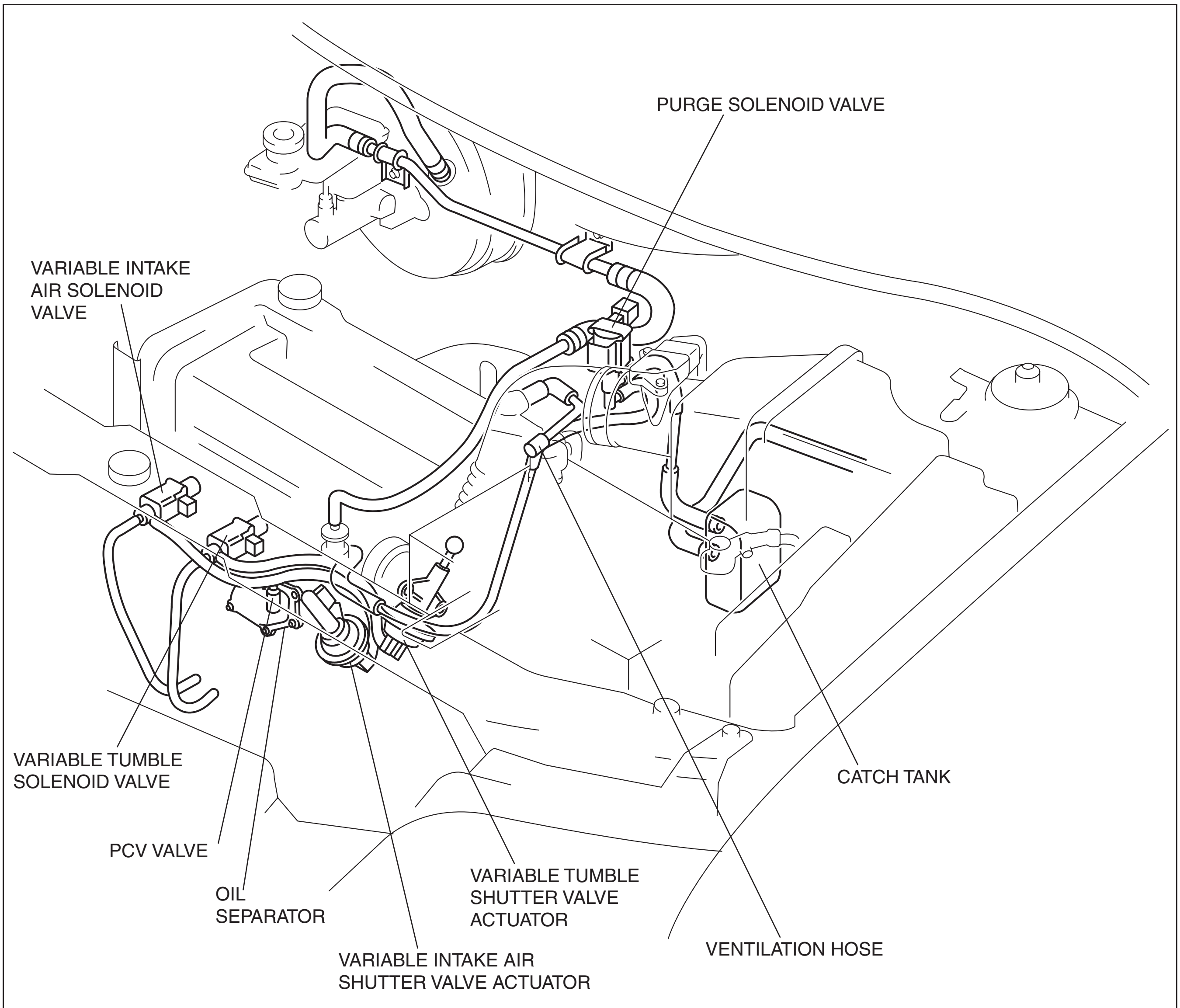
id0113a2100200



atraan00000194

INTAKE-AIR SYSTEM HOSE ROUTING DIAGRAM[L3]

id0113a2100400



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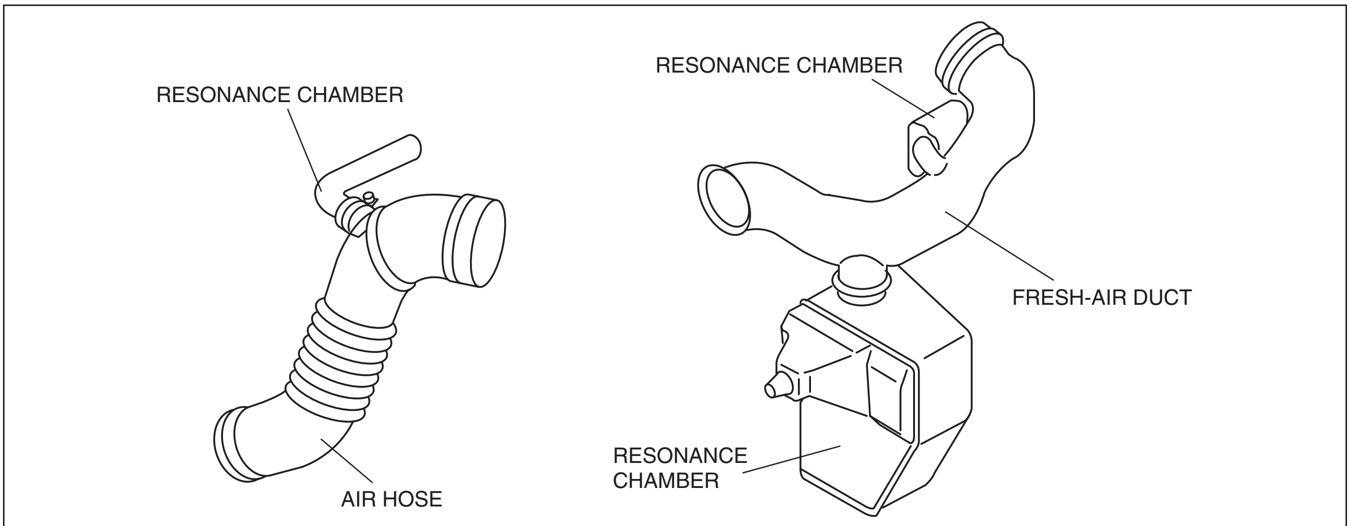
RESONANCE CHAMBER OUTLINE[L3]

id0113a2147600

- Installed on the fresh-air duct to reduce intake air noise.

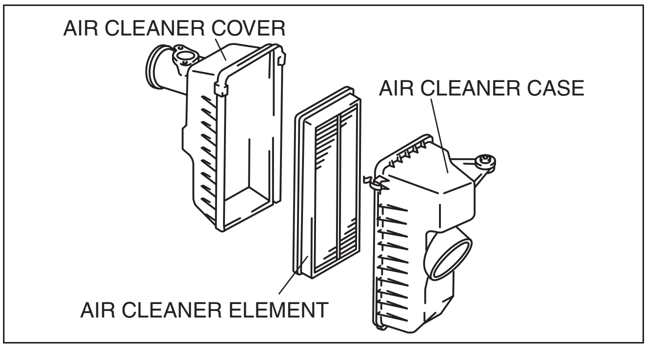


atraan00000058

AIR CLEANER CONSTRUCTION[L3]

id0113a2101400

- The air cleaner is composed of the air cleaner case, air cleaner cover, and air cleaner element.
- Non-woven fabric (dry type) has been adopted for the air cleaner element.



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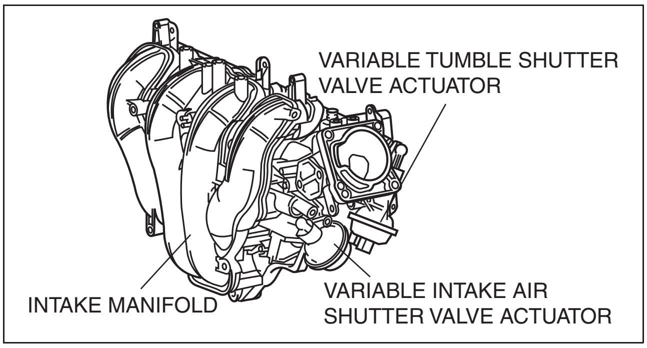
INTAKE MANIFOLD CONSTRUCTION[L3]

id0113a2100800

- The intake manifold is made of hard plastic for weight reduction.
- The intake manifold is composed of the variable intake air shutter valve actuator and variable tumble shutter valve actuator.



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THROTTLE BODY FUNCTION[L3]

id0113a2101500

- A throttle body with a single, electronic-control, motor-operated valve has been adopted in place of the previous cable-controlled throttle valve type.
- Since IAC control during idling is performed by the throttle valve, there is no IAC valve.
- The PCM determines the throttle valve opening angle based on driving conditions, and operates the motor accordingly.
- The throttle valve opening angle is feedback to the PCM by the TP sensor.

THROTTLE BODY CONSTRUCTION[L3]

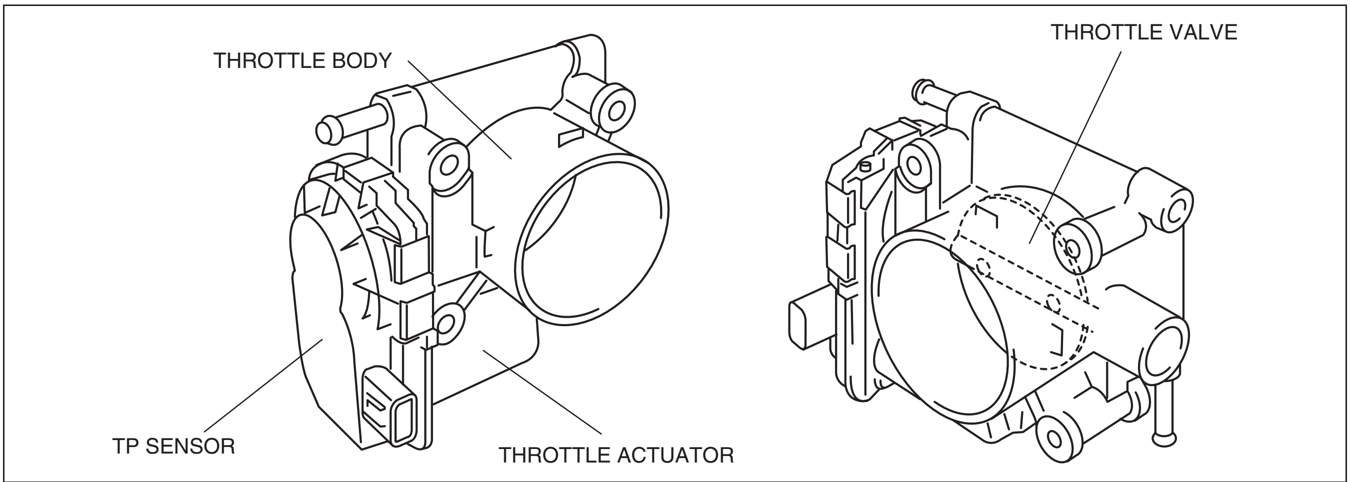
id0113a2147700

- The throttle body mainly consists of the throttle valve, TP sensor, and throttle actuator.
- A low-energy consuming DC motor has been adopted for the throttle actuator to improve response performance.
- To keep moisture from freezing inside the throttle body, and thus prevent the throttle valve from getting stuck, engine coolant is circulated through the throttle body.
- To prevent the possible loss of PCM data and throttle body settings, the throttle body cannot be disassembled.

THROTTLE BODY OPERATION[L3]

id0113a2147800

- When the throttle actuator is not energized, the throttle valve is maintained slightly open due to force of the return spring.

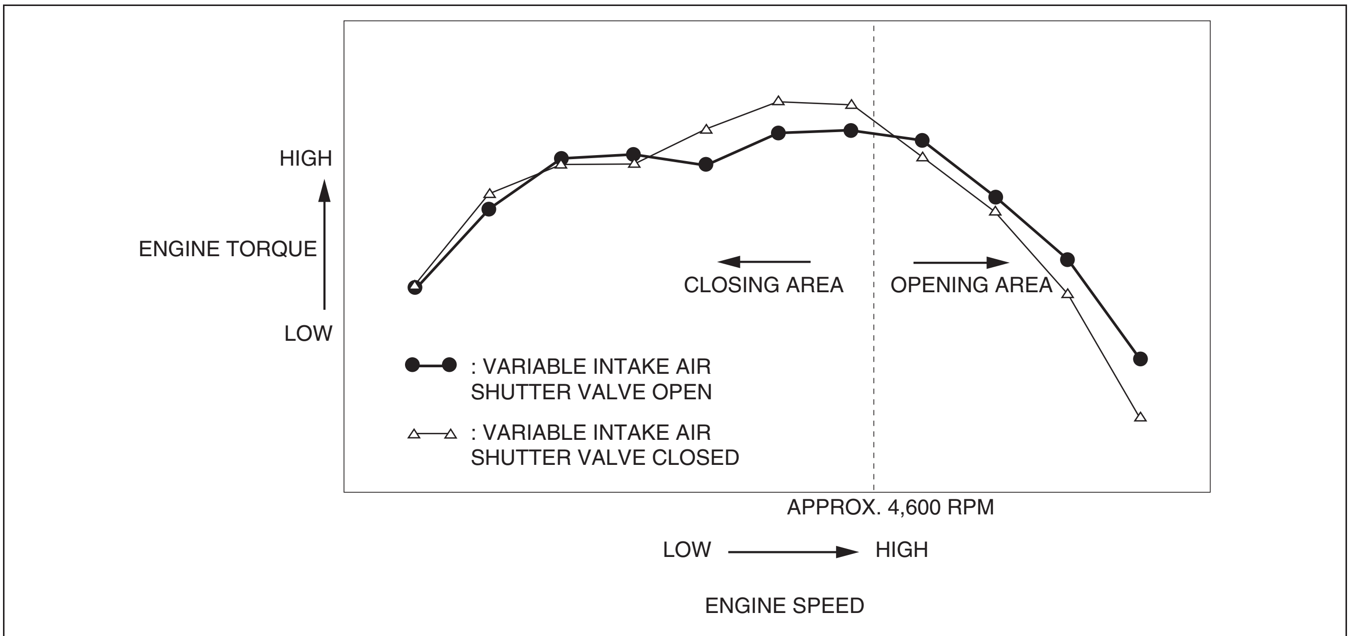


atraan00000062

VARIABLE INTAKE AIR SYSTEM FUNCTION[L3]

id0113a2147000

- The variable intake air system maintains high torque from the low to high engine speed ranges.
- Changes the effective intake manifold length when the engine speed borders on **4,600 rpm** to enhance the inertia charging effect. As a result, higher torque is obtained in all ranges.
- For the variable intake air control, refer to CONTROL SYSTEM, Variable Intake Air Control (See 01-40A-17 VARIABLE INTAKE AIR CONTROL OUTLINE[L3].)



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Inertia charging effect

— Airflow in the intake air pipe pulsates according to the opening and closing of the intake valve. When the intake valve closes, intake air is compressed near the intake valve due to inertia force. The resulting pressure wave is reflected to the throttle valve side by the intake valve and the wave is then reflected back to the intake valve side when it reaches the dynamic chamber. The effective intake manifold length is controlled so that the pressure wave returns to the intake valve at the intake stroke. Due to this, air intake volume increases, resulting in higher torque.

Effective intake manifold length

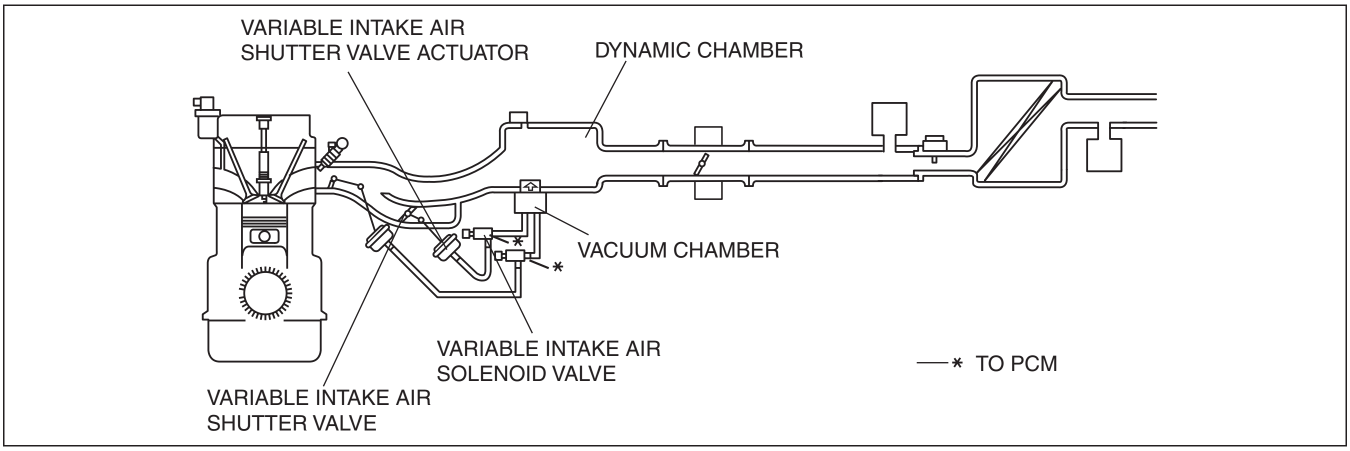
— The effective intake manifold length is the length from the intake valve to the dynamic chamber.

— The effective intake manifold length changes according to the positioning of the reflected pressure wave transmitted through the intake air pipe by the opening and closing of the variable intake air shutter valve in the intake manifold.

VARIABLE INTAKE AIR SYSTEM STRUCTURE[L3]

id0113a2147200

- Mainly consists of the variable intake air solenoid valve, variable intake air shutter valve, variable intake air shutter valve actuator and vacuum chamber.



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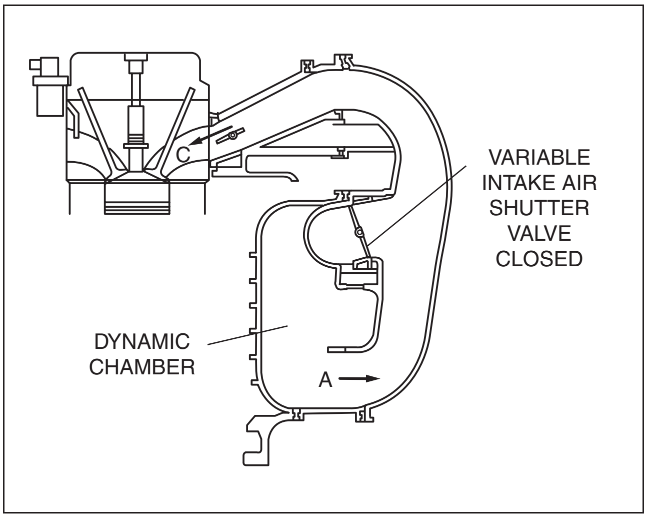
VARIABLE INTAKE AIR SYSTEM OPERATION[L3]

id0113a2147100

At engine speed less than 4,600 rpm (variable intake air shutter valve is closed)

- Intake manifold vacuum is applied to the variable intake air shutter valve by the operation of the variable intake air solenoid valve, closing the variable intake air shutter valve.
- Under this condition, the effective intake manifold length is from the intake valve to the dynamic chamber (A—C). An inertia charging effect is obtained due to this elongated intake manifold length, air intake volume increases, and higher torque is obtained at low to medium engine speeds.



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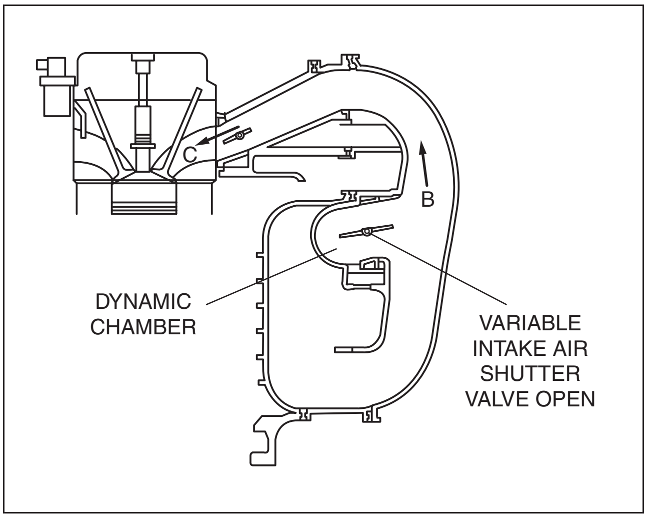
At engine speed of 4,600 rpm or more (variable intake air shutter valve is open)

- The variable intake air shutter valve is open.
- Under this condition, the effective intake manifold length is from the intake valve to the chamber (B—C). The intake air inertia effect is obtained at high engine speeds due to this shortened intake air pipe, increasing intake airflow amount in the cylinder, and higher torque at high engine speeds is obtained.



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VARIABLE TUMBLE SYSTEM FUNCTION[L3]

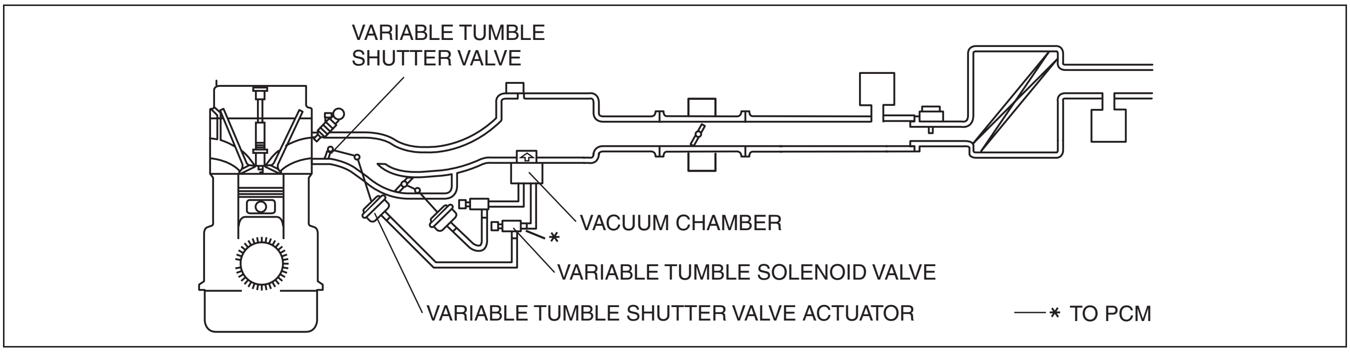
id0113a2147300

- The variable tumble system functions to lower emissions at cold-engine start.
- At cold-engine start, the variable tumble system increases intake airflow speed by closing the shutter valve and narrowing the intake passage. As a result, the air-fuel mixture quality from the injector is improved. Additionally, the creation of a powerful air tumble in the combustion chamber promotes the atomization of the air-fuel mixture. Due to this, exhaust emission efficiency is improved.
- For the variable tumble control, refer to CONTROL SYSTEM, Variable Tumble Control. (See01-40A-18 VARIABLE TUMBLE CONTROL OUTLINE[L3].)

VARIABLE TUMBLE SYSTEM STRUCTURE[L3]

id0113a2147500

- Mainly consists of the variable tumble solenoid valve, variable tumble shutter valve, variable tumble shutter valve actuator, and vacuum chamber.



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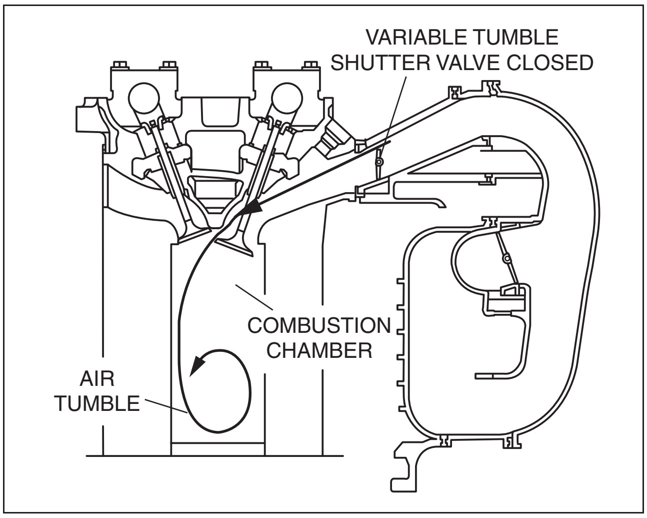
VARIABLE TUMBLE SYSTEM OPERATION[L3]

id0113a2147400

Engine speed approx. 3,750 rpm or more and engine coolant temperature approx. 63°C {145 °F} or more (variable tumble shutter valve is closed)

- Intake manifold vacuum is applied to the variable tumble shutter valve actuator by the operation of the variable tumble solenoid valve, closing the variable tumble shutter valve. At this time, the intake passage is narrower than normal, increasing intake airflow speed and also creating a powerful air tumble in the combustion chamber.



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VARIABLE INTAKE AIR SOLENOID VALVE FUNCTION[L3]

id0113a2148000

- Switches the intake manifold vacuum passage between the intake manifold and the actuator.

VARIABLE INTAKE AIR SOLENOID VALVE CONSTRUCTION/OPERATION[L3]

id0113a2147900

Construction

- The variable intake air solenoid valve mainly consists of the solenoid coil, spring, and plunger.

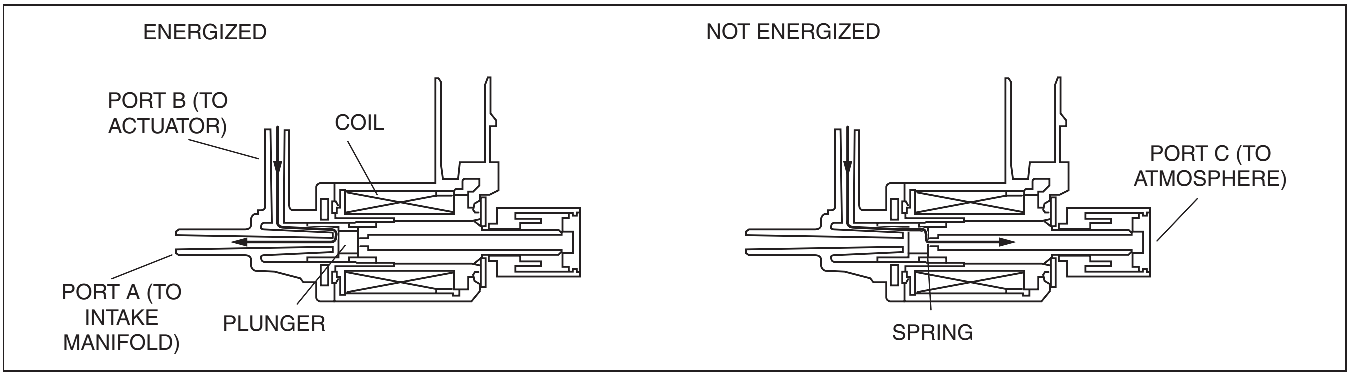
Operation

Energized

- The solenoid coil magnetizes, pulling the plunger. The passage between A and B ports opens due to the plunger being pulled, and intake manifold vacuum is applied to the actuator.

De-energized

- The intake manifold vacuum passage is blocked, and the passage between ports B and C opens, depressurizing the actuator.



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VARIABLE TUMBLE SOLENOID VALVE FUNCTION[L3]

id0113a2148200

- Switches the intake manifold vacuum passage between the intake manifold and the actuator.

VARIABLE TUMBLE SOLENOID VALVE CONSTRUCTION/OPERATION[L3]

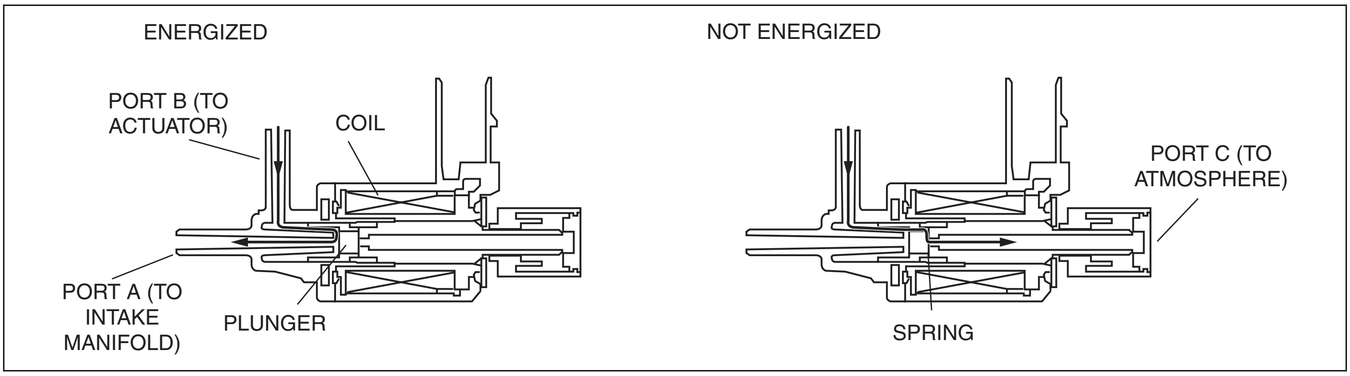
id0113a2148100

Construction

- The variable tumble solenoid valve mainly consists of the solenoid coil, spring, and plunger.

Operation
Energized
- The solenoid coil magnetizes, pulling the plunger. The passage between A and B ports opens due to the plunger being pulled, and intake manifold vacuum is applied to the actuator.

Not energized
- The intake manifold vacuum passage is blocked, and the passage between ports B and C opens, depressurizing the actuator.



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VARIABLE INTAKE AIR SHUTTER VALVE ACTUATOR FUNCTION[L3]

id0113a2148400

- Opens and closes the shutter valve.

VARIABLE INTAKE AIR SHUTTER VALVE ACTUATOR CONSTRUCTION[L3]

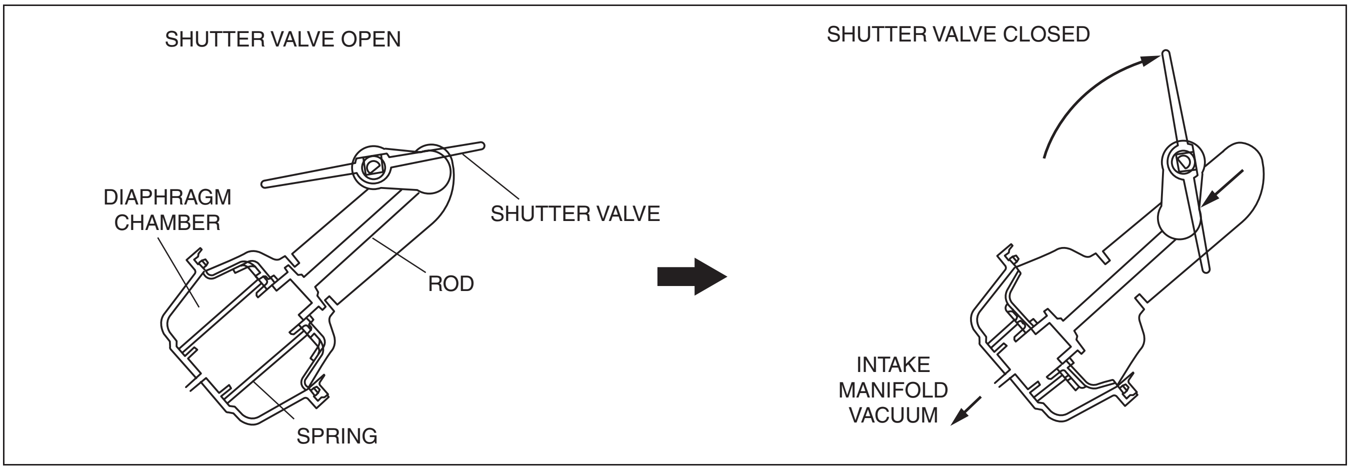
id0113a2148300

- The variable intake air shutter valve actuator is mainly consists of the body, rod and diaphragm chamber spring.

VARIABLE INTAKE AIR SHUTTER VALVE ACTUATOR OPERATION[L3]

id0113a2148500

- Normally, the spring force presses against the rod, keeping the shutter valve open. When vacuum is applied to the diaphragm chamber from the intake manifold, the rod is pulled, closing the shutter valve.



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VARIABLE TUMBLE SHUTTER VALVE ACTUATOR FUNCTION[L3]

id0113a2148700

- Opens and closes the shutter valve.

VARIABLE TUMBLE SHUTTER VALVE ACTUATOR CONSTRUCTION[L3]

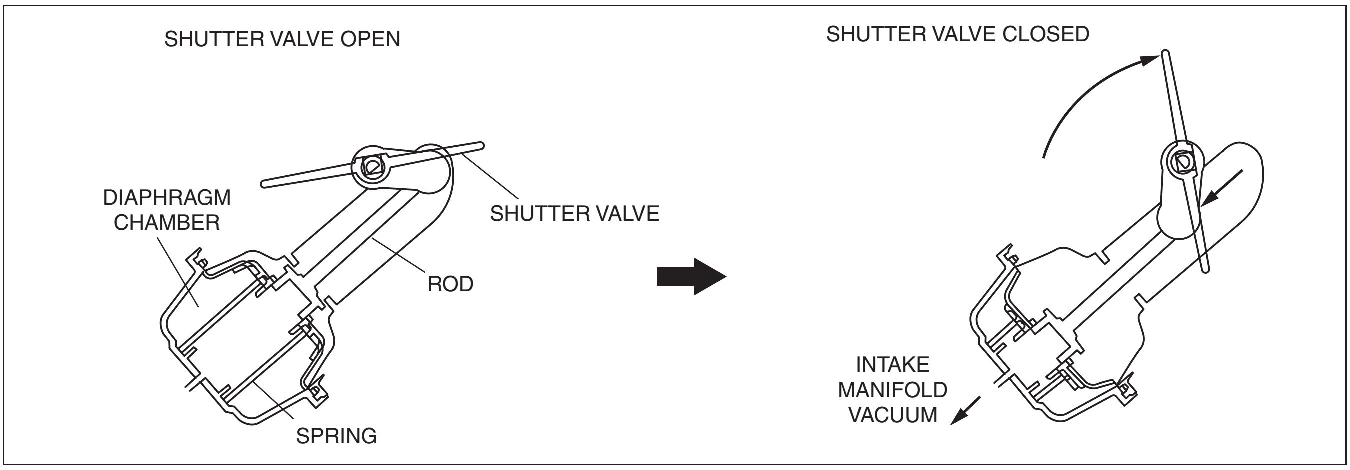
id0113a2148600

- The variable tumble shutter valve actuator is mainly consists of the body, rod and diaphragm chamber spring.

VARIABLE TUMBLE SHUTTER VALVE ACTUATOR OPERATION[L3]

id0113a2148800

- Normally, the spring force presses against the rod, keeping the shutter valve open. When vacuum is applied to the diaphragm chamber from the intake manifold, the rod is pulled, closing the shutter valve.



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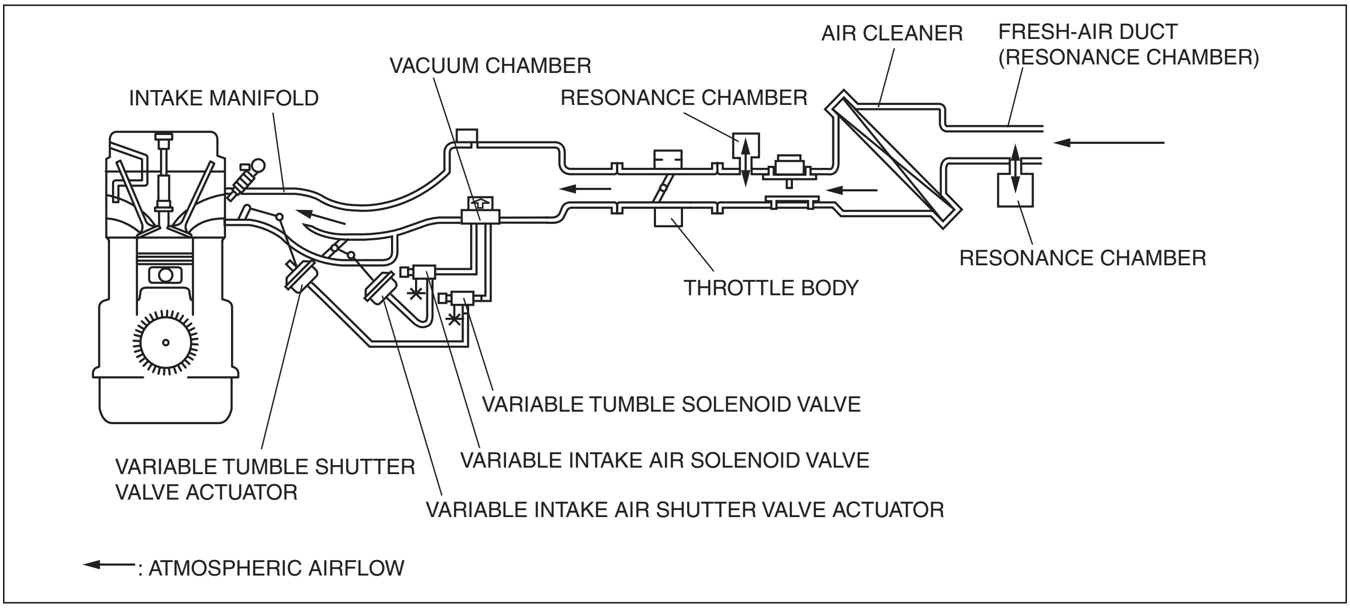
INTAKE-AIR SYSTEM DIAGRAM[L3]

id0113a2801600



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01-13 INTAKE-AIR SYSTEM [AJ (3.0L Duratec)]

01

INTAKE-AIR SYSTEM OUTLINE[AJ (3.0L Duratec)]

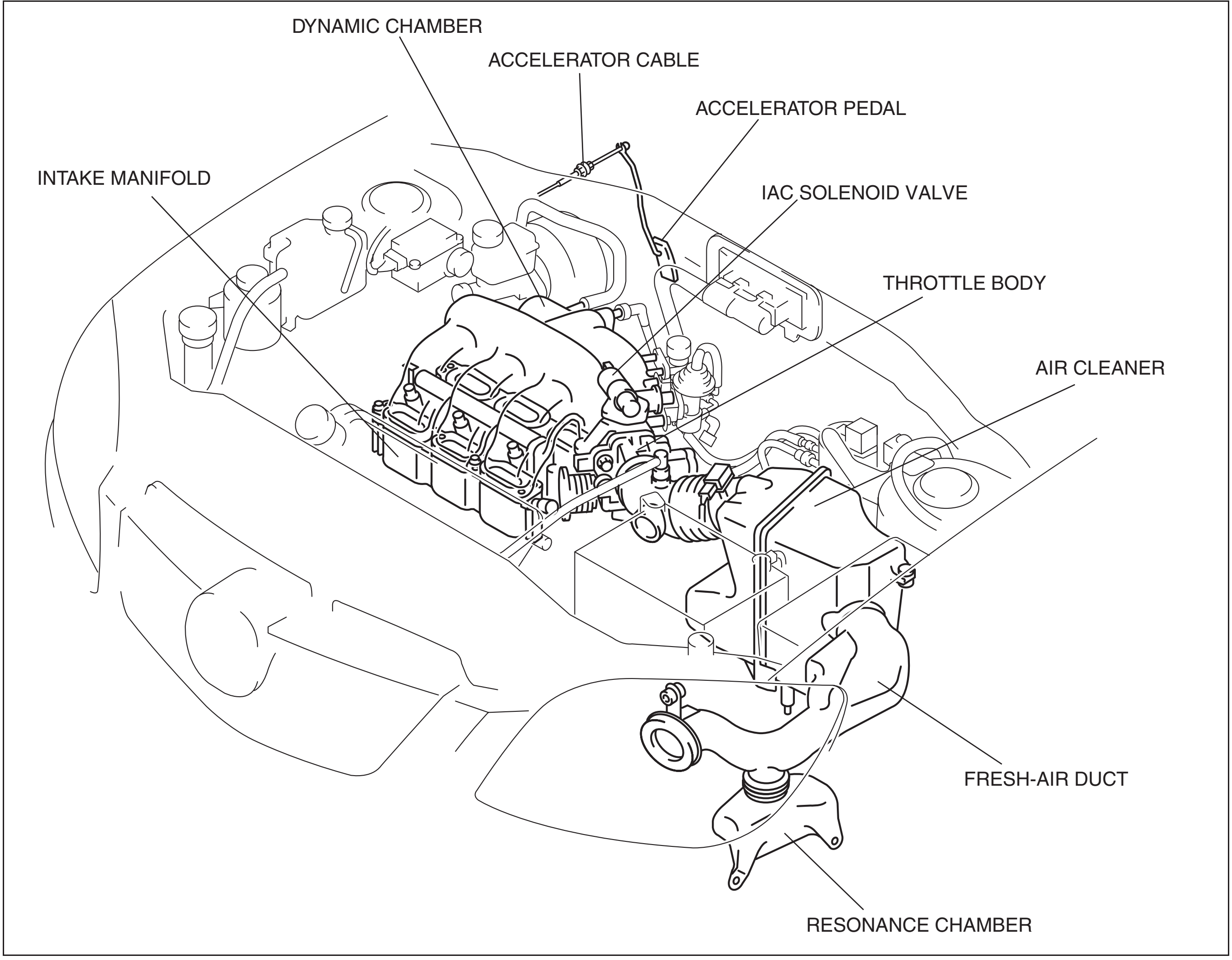
id0113a1100100

Features

Improved noise reduction	• Resonance chamber adopted

INTAKE-AIR SYSTEM STRUCTURAL VIEW[AJ (3.0L Duratec)]

id0113a1100200



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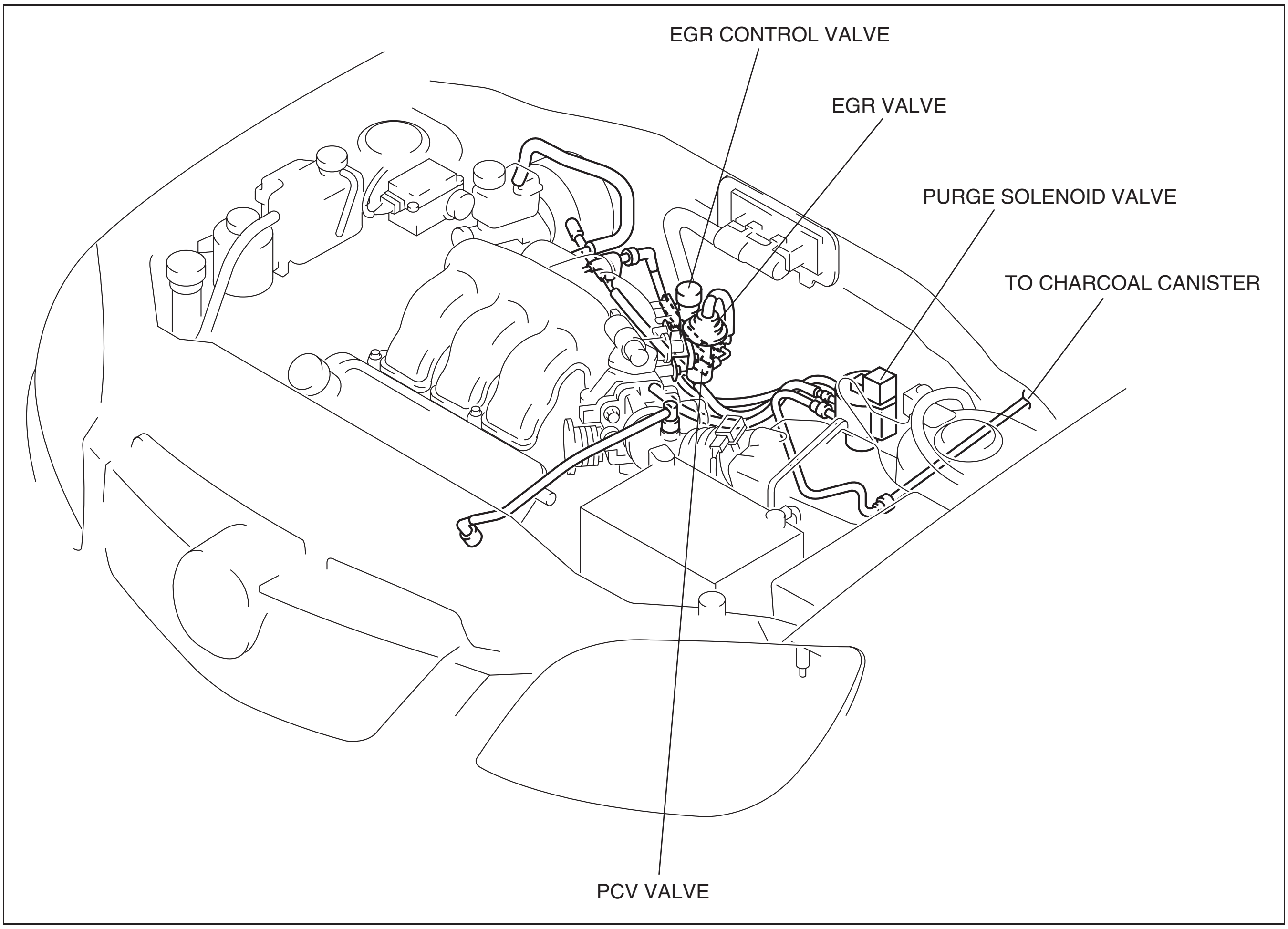
INTAKE-AIR SYSTEM HOSE ROUTING DIAGRAM[AJ (3.0L Duratec)]

id0113a1100400



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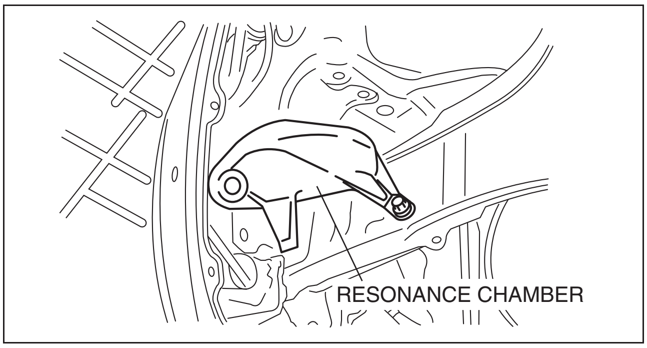
RESONANCE CHAMBER OUTLINE[AJ (3.0L Duratec)]

id0113a1147600

- Installed to the air cleaner to reduce intake air noise.



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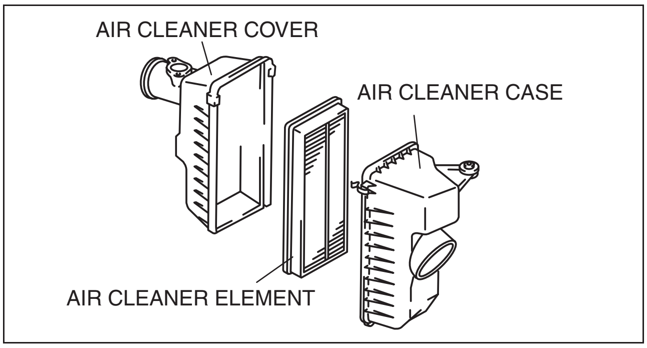
AIR CLEANER CONSTRUCTION[AJ (3.0L Duratec)]

id0113a1101400

Construction

- Consists of the air cleaner case, air cleaner cover, and air cleaner element.
- Non-woven fabric (dry type) has been adopted for the air cleaner element.



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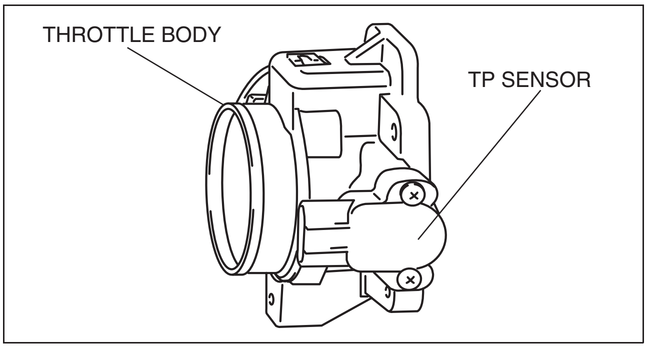
THROTTLE BODY CONSTRUCTION[AJ (3.0L Duratec)]

id0113a1147700

Construction

- Consists of the throttle position (TP) sensor, throttle valve, and throttle body.



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IDLE AIR CONTROL (IAC) SOLENOID VALVE OUTLINE[AJ (3.0L Duratec)]

id0113a1149000

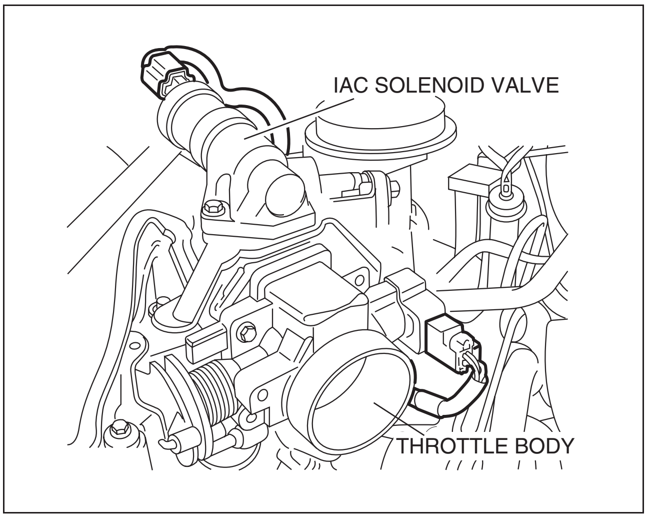
- Electrically adjusts the amount of air that bypasses the throttle valve.

IDLE AIR CONTROL (IAC) SOLENOID VALVE CONSTRUCTION/OPERATION[AJ (3.0L Duratec)]

id0113a1148900

Construction

- Installed near the throttle body installation area of the intake manifold.
- Consists of the housing, plunger, and coil.



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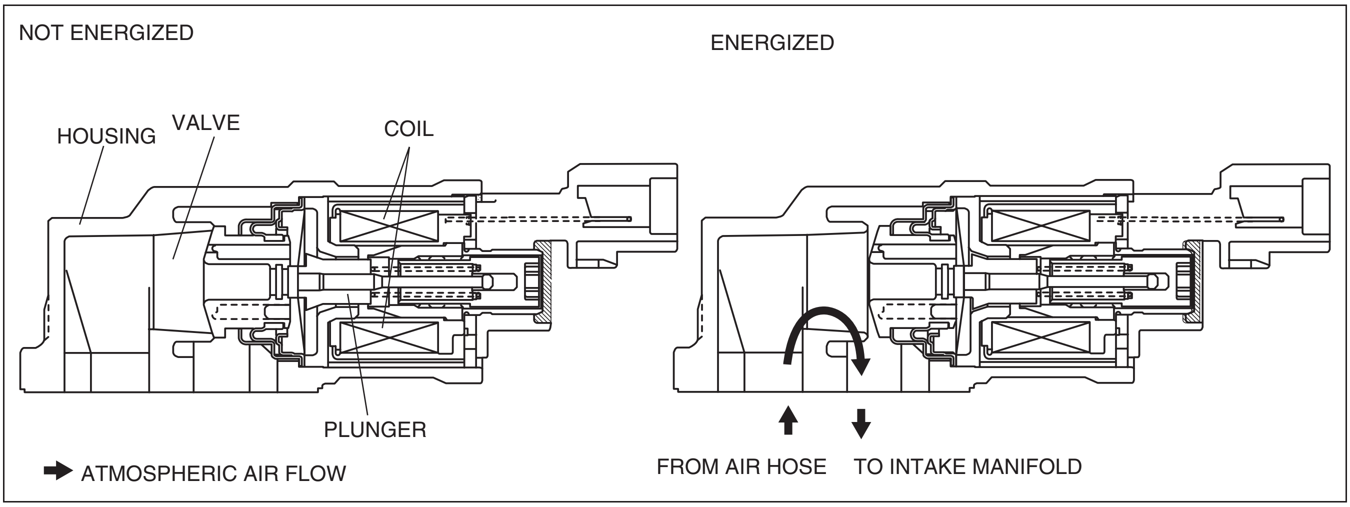
Operation

- Air that bypasses the throttle valve passes from the air hose upstream of the throttle valve, through the IAC solenoid valve and is suctioned towards the intake manifold downstream of the throttle valve.
- The plunger moves according to a duty signal from the PCM and the size of the bypass passage opening varies accordingly.
- The amount of air that bypasses the throttle valve varies according to the size of the bypass opening; the larger the opening, the more air that is bypassed.



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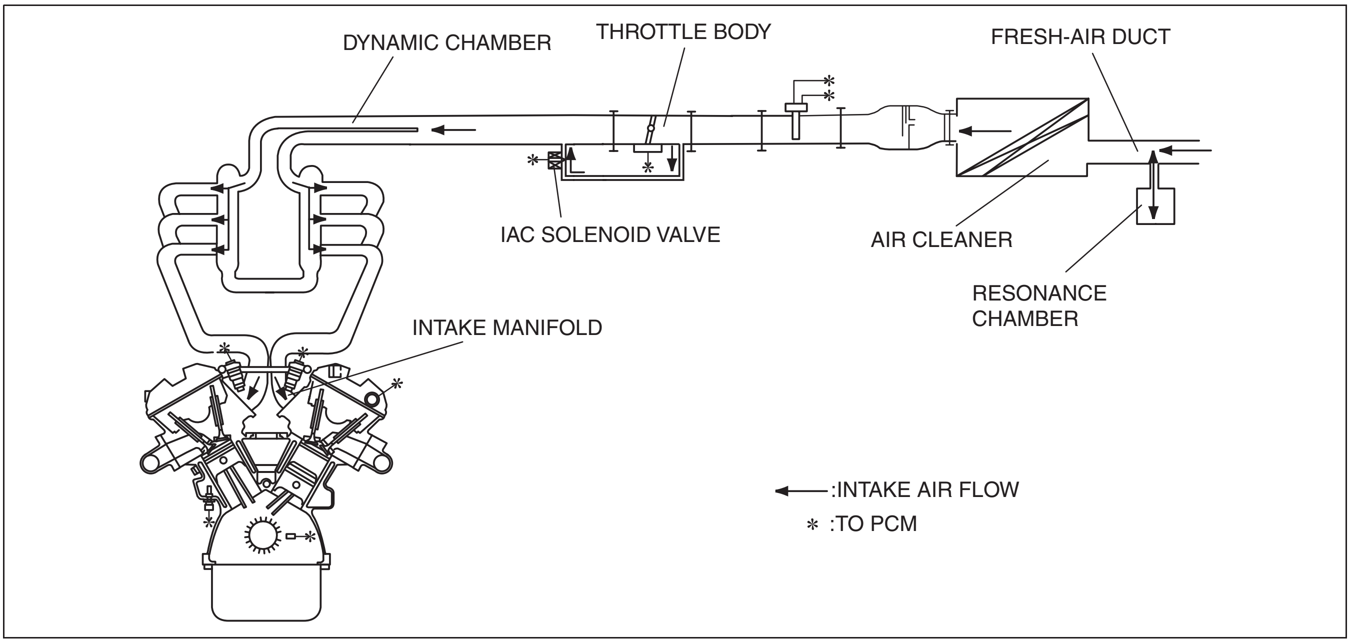
INTAKE-AIR SYSTEM DIAGRAM[AJ (3.0L Duratec)]

id0113a1801600



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01-14A FUEL SYSTEM [L3]

01

FUEL SYSTEM OUTLINE[L3]

id0114a2100100

Features

Improved serviceability	• Nylon tubes adopted for fuel hoses in engine compartment and around fuel tank; Quick release connectors adopted for joints
Reduction of evaporative gas	• Returnless fuel system adopted

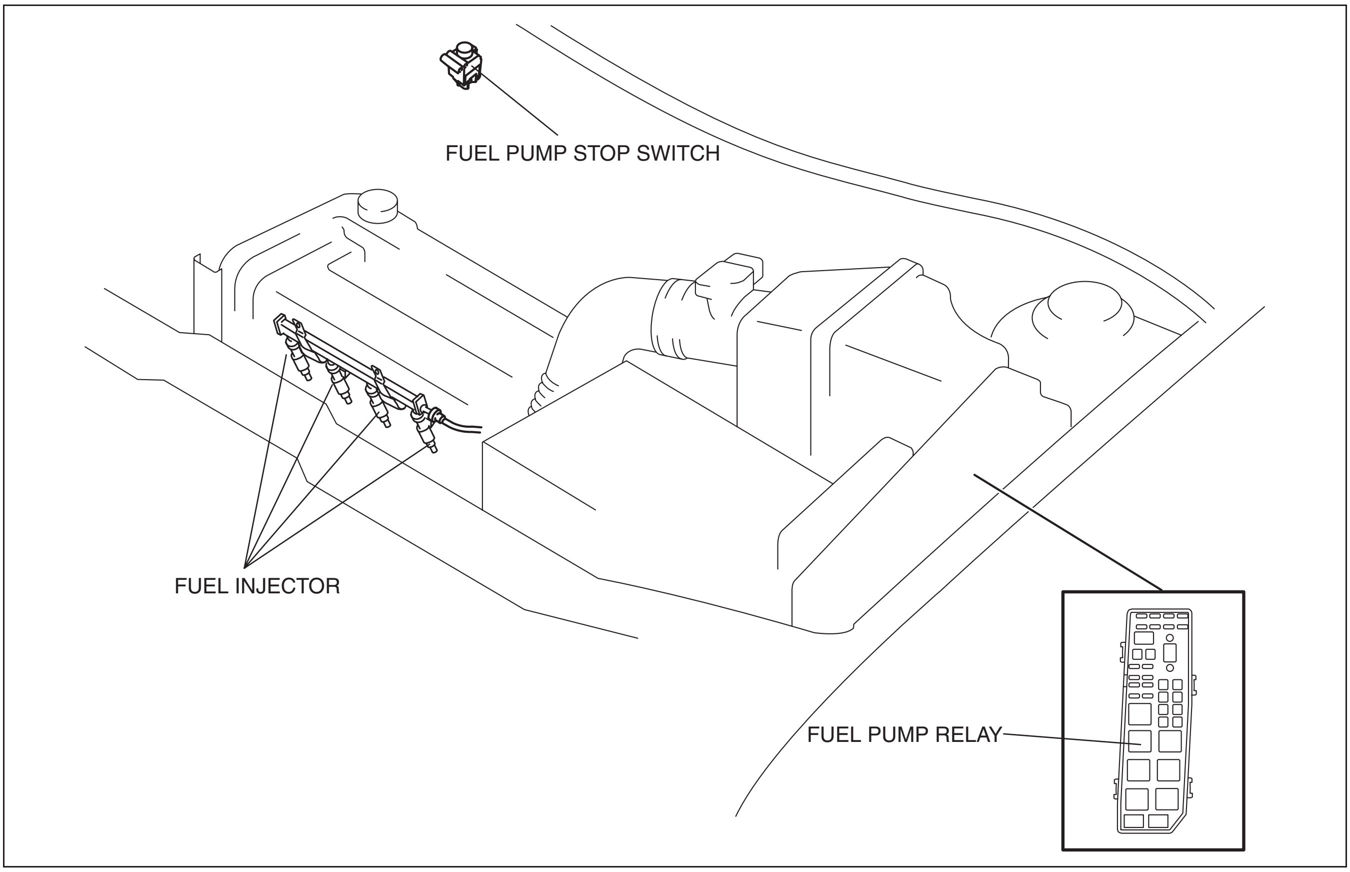
Specification

Item			Specification
Injector	Type		Multiple hole type
	Fuel supply method		Top-feed
	Drive types		Electronic
Pressure regulator control pressure		(kPa {kgf/cm^2, psi})	Approx. 390 {3.98, 56.6}
Fuel pump type			Electric
Fuel tank capacity		(L {US gal, Imp gal})	61.0 {16.1, 13.4}
Fuel type			Regular unleaded fuel (Research octane number is 90 or above)

FUEL SYSTEM STRUCTURAL VIEW[L3]

id0114a2100200

Engine compartment side



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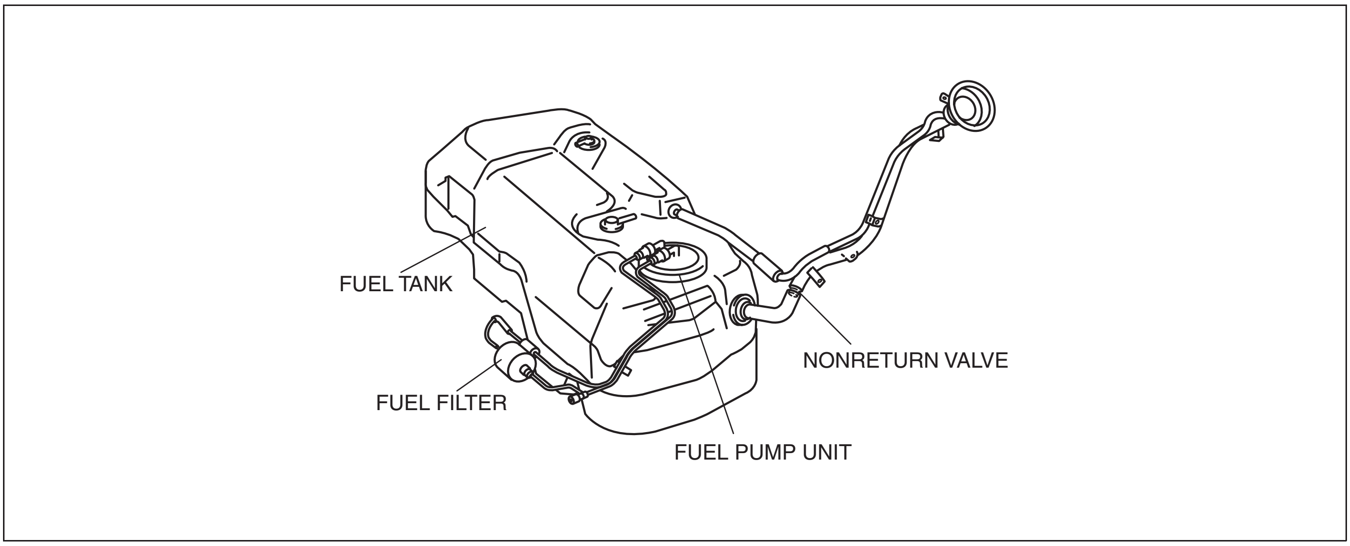
Fuel tank side



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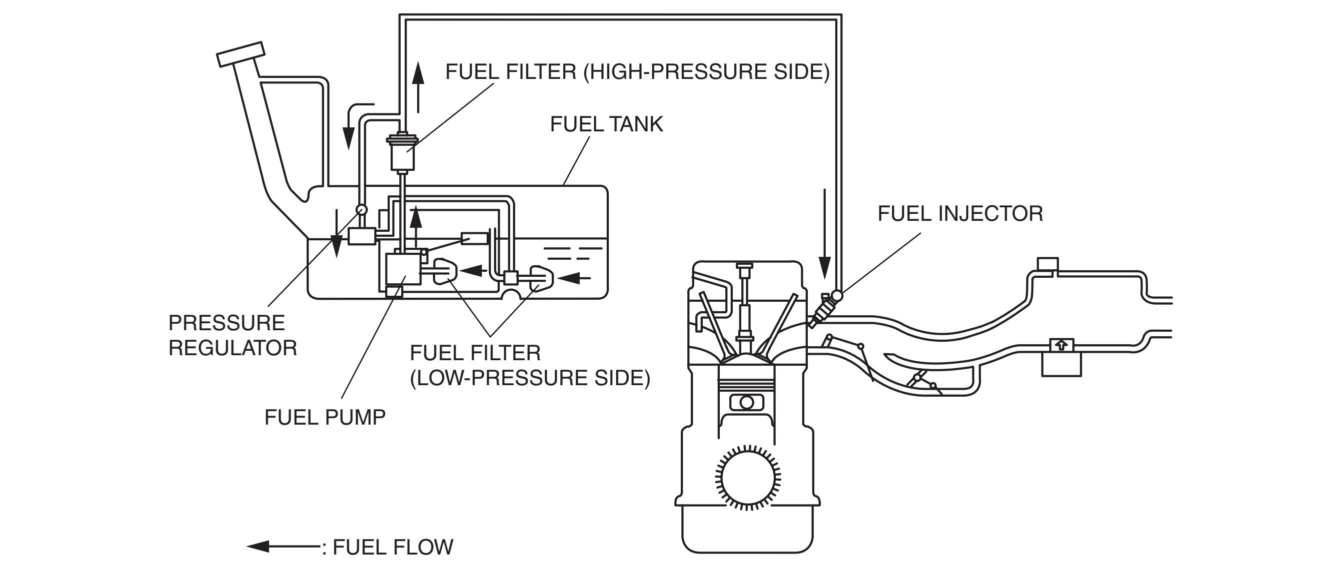
FUEL SYSTEM FLOW DIAGRAM[L3]

id0114a2100300

Fuel flow



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RETURNLESS FUEL SYSTEM OUTLINE[L3]

id0114a2101000

- The returnless fuel system reduces fuel evaporation in the fuel tank by suppressing fuel temperature increase.
- The pressure regulator located in the fuel tank prevents fuel return from the engine compartment side, thereby maintaining a low temperature in the fuel tank. Due to this, formation of evaporative gas produced by rising fuel temperature is suppressed.
- The pressure regulator is built into the fuel pump unit in the fuel tank.

RETURNLESS FUEL SYSTEM OPERATION[L3]

id0114a2101100

- Fuel in the fuel tank is pumped out through the fuel filter (low-pressure) by the fuel pump, filtered by the fuel filter (high-pressure), and then regulated to a specified pressure by the pressure regulator.
- The pressure regulated fuel is sent to the fuel injectors.
- After pressure regulation, unnecessary fuel is returned from the pressure regulator to inside the fuel pump unit.

FUEL TANK CONSTRUCTION[L3]

id0114a2101900

- Capacity is **61.0 L {16.1 US gal, 13.4 Imp gal}**.
- Two rollover valves that include check valves (two-way) are built-in. For the rollover valve, refer to the emission system. (See 01-16A-7 ROLLOVER VALVE FUNCTION[L3].)
- Made of hard plastic for weight reduction.

NONRETURN VALVE FUNCTION[L3]

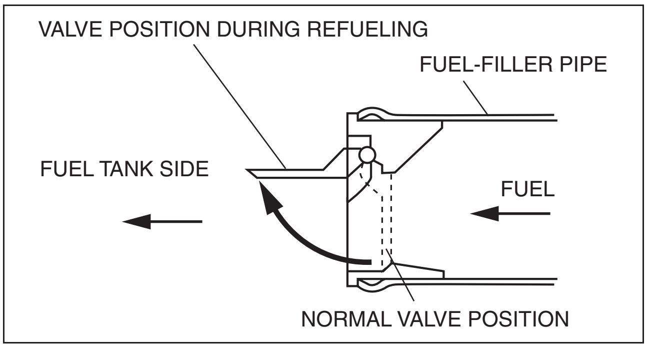
id0114a2102000

- Prevents fuel from spouting out due to evaporative gas pressure in the fuel tank when removing the fuel-filler cap.

NONRETURN VALVE CONSTRUCTION/OPERATION[L3]

id0114a2102100

- A single valve type has been adopted.
- Installed on the fuel tank side of the fuel-filler pipe.
- Under normal conditions, this valve is closed as shown by the dotted line. When refueling, it opens to the position shown by the solid line due to fuel flow. When refueling is finished, the valve returns to the normal valve position due to spring force.



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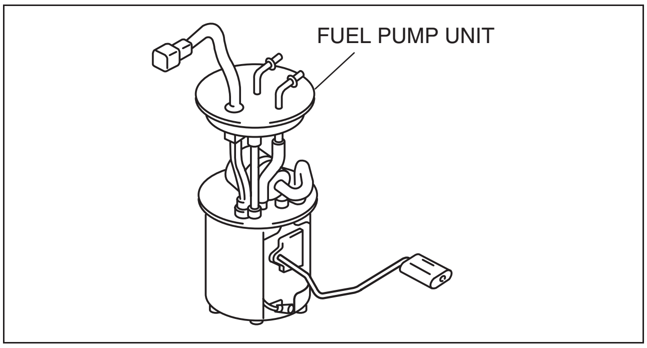
FUEL PUMP UNIT FUNCTION[L3]

id0114a2101400

- The fuel pump suctions fuel from the fuel tank and pumps it to the fuel distributor.

FUEL PUMP UNIT CONSTRUCTION/OPERATION[L3]

id0114a2101500



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Fuel Pump Unit

- The fuel pump unit mainly consists of a pressure regulator, fuel pump, fuel reserve cup, and fuel filter (low-pressure).
- A pressure regulator is built-in due to the adoption of a returnless fuel system.
- A hard-plastic fuel pump unit, with an integrated pressure regulator and fuel pump, has been adopted to simplify the fuel line.
- The fuel pump unit cannot be disassembled.
- Fuel in the fuel reserve cup is suctioned out through the fuel filter (low-pressure) by the fuel pump, and pumped to the fuel filter (high-pressure). Pressure regulated return fuel is sent back to the fuel reserve cup or the fuel tank through the pressure regulator.
- If return fuel pressure exceeds the given value, the relief valve discharges return fuel into the fuel pump unit without passing it through the venturi. Due to this, return fuel pressure is maintained below the given value.

Pressure Regulator

- The pressure regulator is mainly consists of a spring, release valve, and diaphragm.
- Built into the fuel pump unit due to adoption of a returnless fuel system.
- Cannot be removed because it is integrated with the fuel pump unit.
- Pressure regulates fuel discharged by the fuel pump to **approx. 390 kPa {3.98 kgf/cm^2, 56.6 psi}** using the spring, diaphragm, and release valve, and then pumps it to the fuel distributor.
- If fuel pressure exceeds **approx. 390 kPa {3.98 kgf/cm^2, 56.6 psi}** the release valve opens to discharge unnecessary fuel pressure (fuel).

QUICK RELEASE CONNECTOR FUNCTION[L3]

id0114a2102200

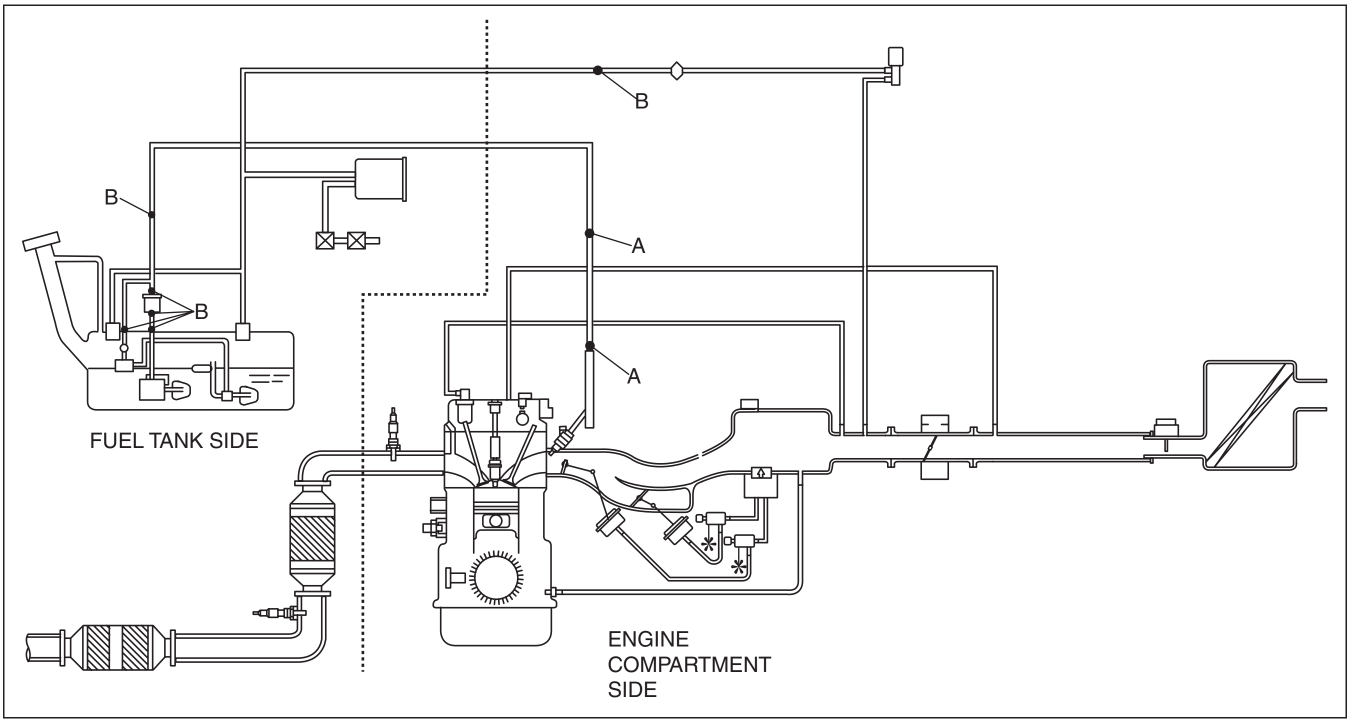
- Quick release connectors that can be easily connected/disconnected have been adopted to improve serviceability.

QUICK RELEASE CONNECTOR CONSTRUCTION/OPERATION[L3]

id0114a2102300

- There are two types of quick release connectors.

Quick release connector locations



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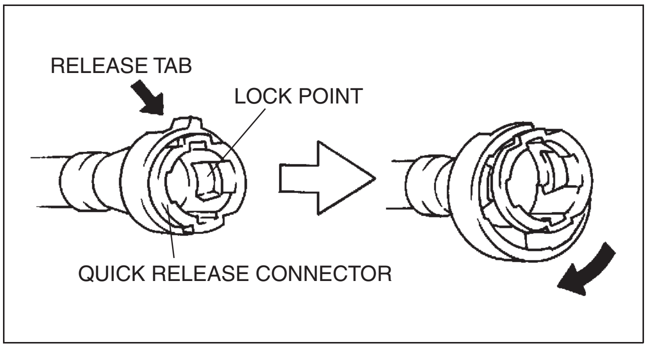
Type A

- Used in the engine compartment.
- An **SST** is not used with this type.
- Mainly consists of a retainer and O-ring. The quick release connector is integrated with the fuel hose and therefore cannot be disassembled.
- When the quick release connector is connected, the fuel pipe projection is locked at the clamp lock point. By pushing the clamp release tab to expand the clamp, the lock point is released allowing the fuel pipe to be disconnected.
- To connect the quick release connector properly, push it into the fuel pipe until a locking click sound is heard.



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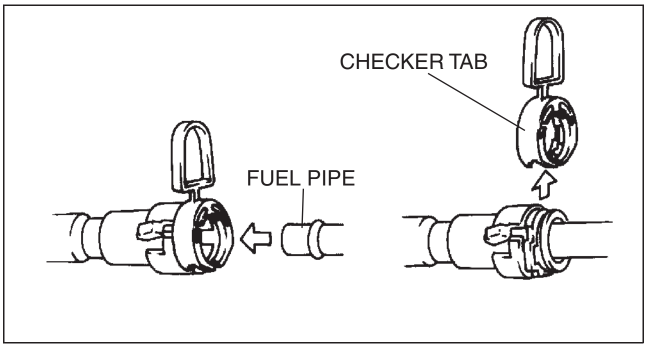
- New quick release connectors are fitted with a checker tab that prevents improper fit. This checker tab cannot normally be removed. When the quick release connector is properly connected to the fuel pipe, the lock is released and the checker tab comes off. Due to this, it can be verified that the quick release connector is completely connected.



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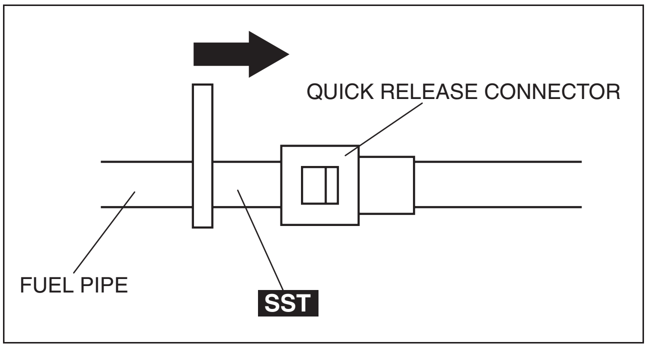
Type B

- When removing the quick connector, either of the 2 types of SSTs can be used.



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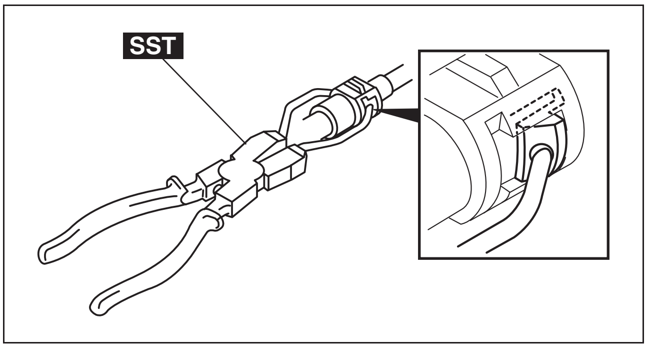
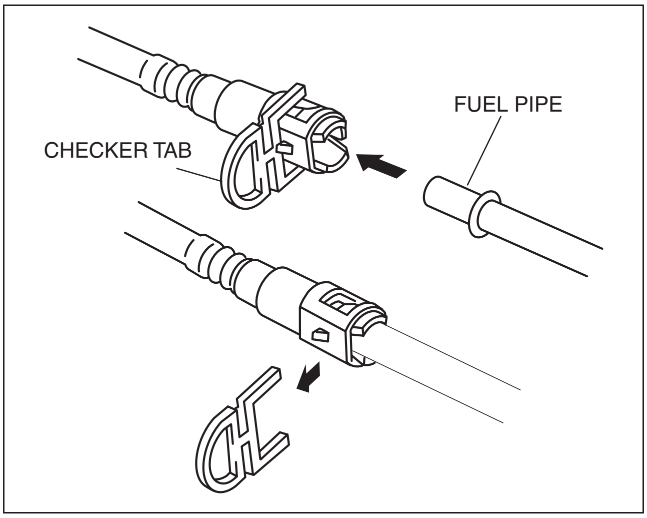
- The connector can be disconnected by pinching the retainer tab with the SST and pulling the connector.
- To connect the quick release connector properly, push it into the fuel pipe until a locking click sound is heard.



atraan00000084

- New quick release connectors are fitted with a checker tab that prevents improper fit. This checker tab cannot normally be removed. When the quick release connector is properly connected to the fuel pipe, the lock is released and the checker tab comes off. Due to this, it can be verified that the quick release connector is completely connected.



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FUEL INJECTOR FUNCTION[L3]

id0114a2101200

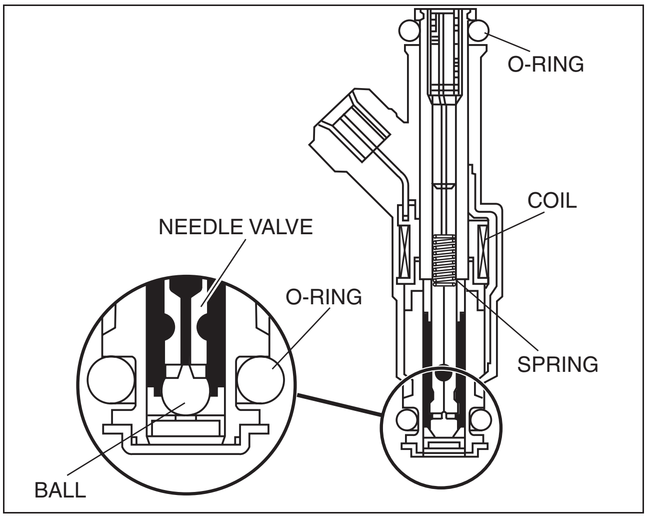
- Injects fuel according to fuel injector control signals from the PCM.

FUEL INJECTOR CONSTRUCTION/OPERATION[L3]

id0114a2101300

- The fuel injector mainly consists of a coil, spring, needle valve, and ball.
- Installed on the cylinder head.
- A signal is sent from the PCM causing excitation current to pass through the coil and thereby pull in the needle valve. A signal is sent from the PCM causing exciting current passes through the coil and thereby pulling in the needle valve. Since the ball that opens and closes the injection opening is integrated with the needle valve, it is pulled together with the needle valve and fuel is injected.

- The amount of injection is determined by the open time of the needle valve (equal to the energization time of the coil).



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FUEL FILTER (HIGH PRESSURE) FUNCTION[L3]

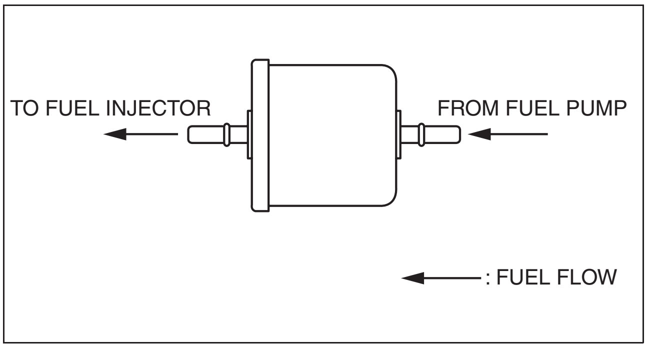
id0114a2153000

- Filters the minute foreign material filtered out the fuel filter. (Low pressure side)

FUEL FILTER (HIGH PRESSURE) CONSTRUCTION/OPERATION[L3]

id0114a2153100

- It is installed to front of the fuel tank.



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FUEL PUMP RELAY FUNCTION[L3]

id0114a2100700

- Controls the fuel pump on/off according to control signals from the PCM.

FUEL PUMP STOP SWITCH FUNCTION[L3]

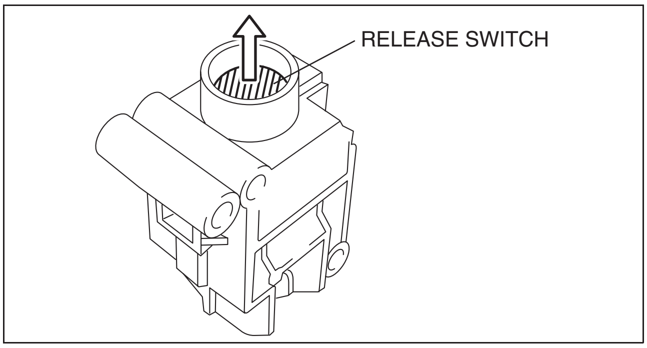
id0114a2151000

- If the fuel pump is subject to a large impact while operating, such as that from a collision, fuel may leak from the fuel line. To prevent this, fuel pump operation is stopped when a large impact is detected.

FUEL PUMP STOP SWITCH CONSTRUCTION/OPERATION[L3]

id0114a2150900

- Installed under the driver-side A-pillar lower trim.
- The release switch moves upward when subject to a large impact. Due to this, current to the fuel pump is cut off and fuel pump operation is stopped.
- Current to the fuel pump can be resumed by pressing the release switch down again.



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01-14B FUEL SYSTEM [AJ (3.0L Duratec)]

01

FUEL SYSTEM OUTLINE[AJ (3.0L Duratec)]

id0114a1100100

Features

Improved serviceability	• Nylon tubing for fuel hoses in the engine compartment and around the fuel tank, and quick release connectors on the connecting parts adopted.
Evaporative gas reduction	• Returnless fuel system adopted

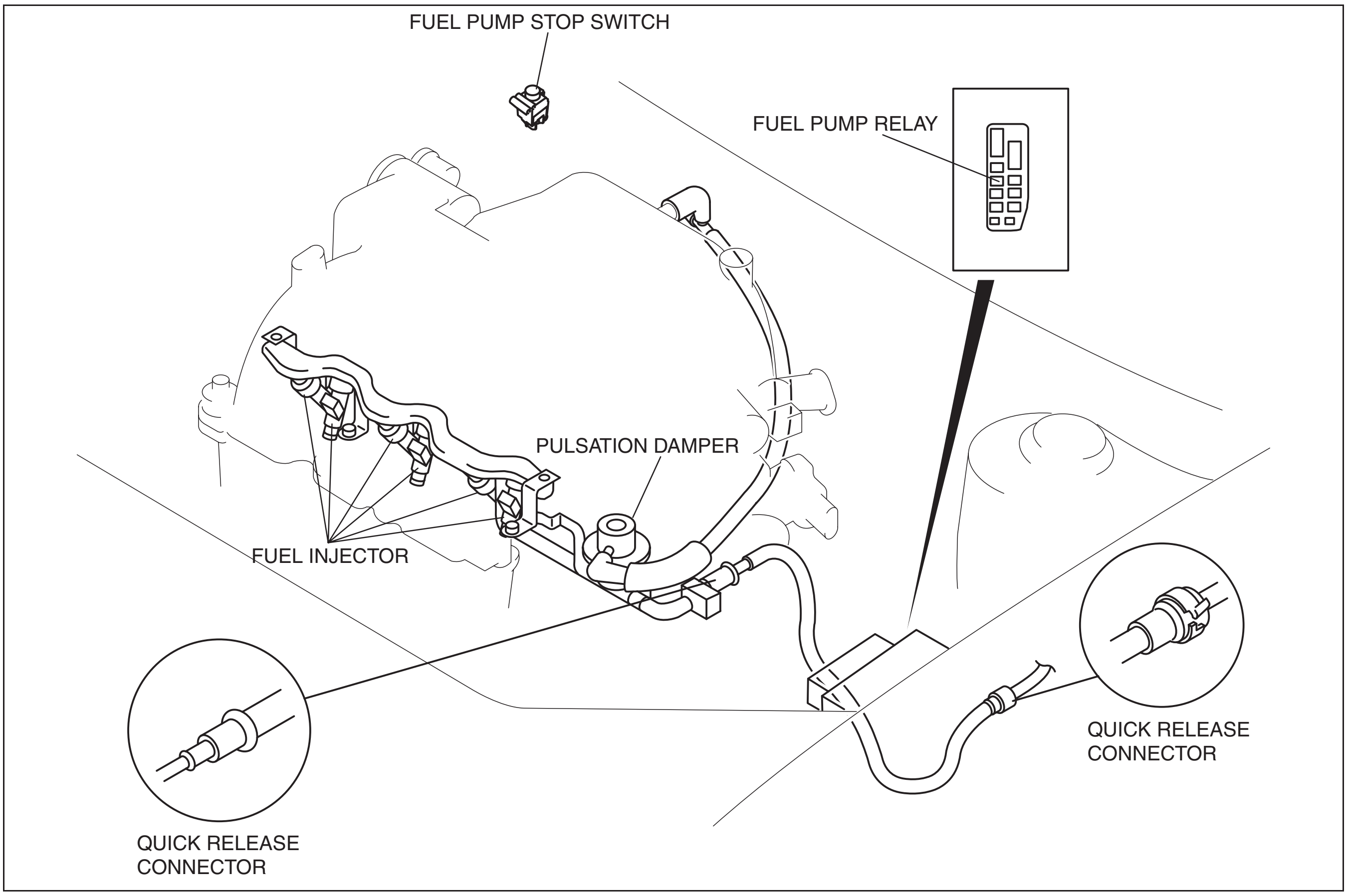
Specification

Item			Specification
Injector	Type		Multiple hole type
	Fuel supply type		Top-feed
	Drive types		Electronic
Pressure regulator control pressure		(kPa {kgf/cm^2, psi})	Approx. 450 {4.59, 65.3}
Fuel pump type			Electric
Fuel tank capacity		(L {US gal, Imp gal})	61.0 {16.1, 13.4}
Fuel type			Unleaded (RON 90 or above)

FUEL SYSTEM STRUCTURAL VIEW[AJ (3.0L Duratec)]

id0114a1100200

Engine Compartment Side



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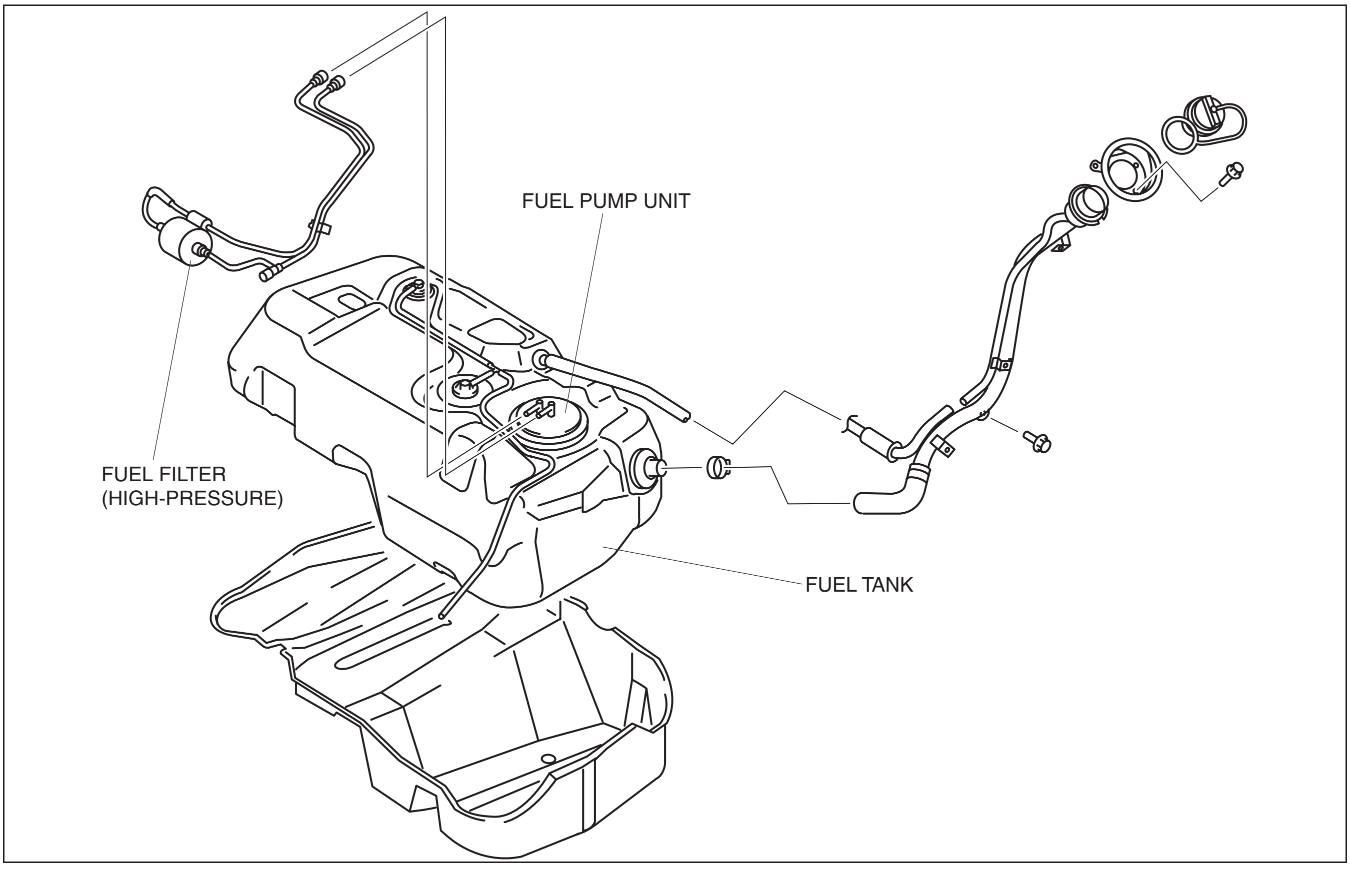
Fuel Tank Side



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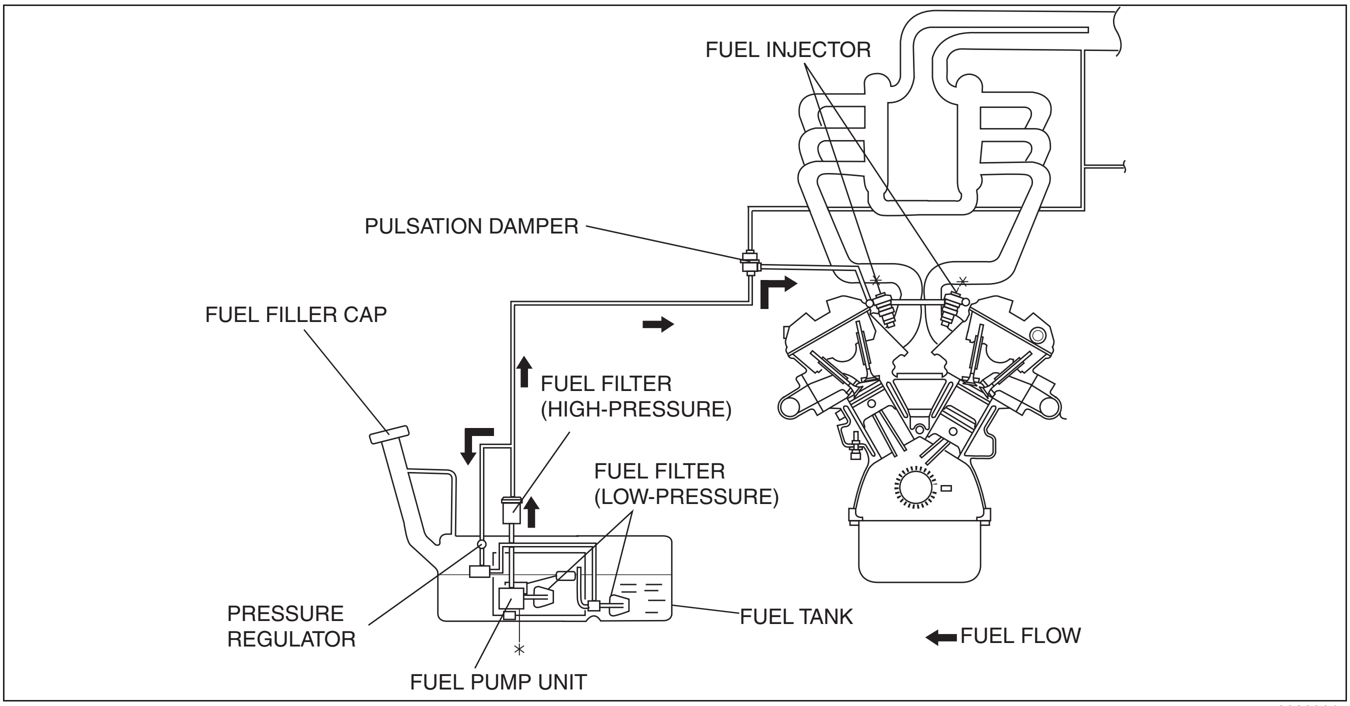
FUEL SYSTEM FLOW DIAGRAM[AJ (3.0L Duratec)]

id0114a1100300



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RETURNLESS FUEL SYSTEM OUTLINE[AJ (3.0L Duratec)]

id0114a1101000

Features

- The returnless fuel system controls rises in fuel temperature and surpresses the release of evaporative gas.
- The pressure regulator located in the fuel tank prevents fuel return from the engine compartment side, thereby maintaining a low temperature in the fuel tank. As a result, the generation of evaporative gas from a rise in fuel temperature is surpressed.
- The pressure regulator is built into the fuel pump unit in the fuel tank.

RETURNLESS FUEL SYSTEM OPERATION[AJ (3.0L Duratec)]

id0114a1101100

- Fuel in the fuel tank is pumped out through the fuel filter (low-pressure) by the fuel pump, filtered by the fuel filter (high-pressure), and then regulated to a specified pressure by the pressure regulator.
- Pressure adjusted fuel is sent to the fuel injectors.
- After the pressure is adjusted, unused fuel is returned to the fuel pump unit from the pressure regulator.

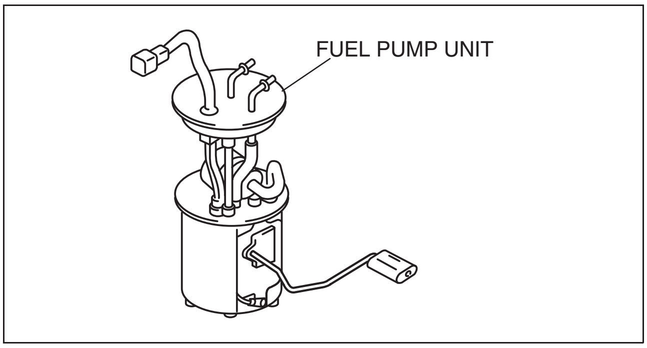
FUEL PUMP UNIT FUNCTION[AJ (3.0L Duratec)]

id0114a1101400

- The fuel pump suctions fuel from the fuel tank and pumps it to the fuel distributor.

FUEL PUMP UNIT CONSTRUCTION/OPERATION[AJ (3.0L Duratec)]

id0114a1101500



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Fuel Pump Unit

- Consists of a pressure regulator, fuel pump, fuel reserve cup, and fuel filter (low-pressure).
- A pressure regulator is built-in due to the adoption of a returnless fuel system.
- The fuel pump unit cannot be disassembled.
- If the return pressure exceeds a given value, the relief valve activates to discharge fuel into the fuel pump unit. As a result, return pressure is maintained at the specified value or less.

Pressure Regulator

- Built into the fuel pump unit due to adoption of a returnless fuel system.
- Cannot be removed because the pressure regulator and fuel pump unit are an integrated construction.
- Consists of a spring and diaphragm.

FUEL INJECTOR FUNCTION[AJ (3.0L Duratec)]

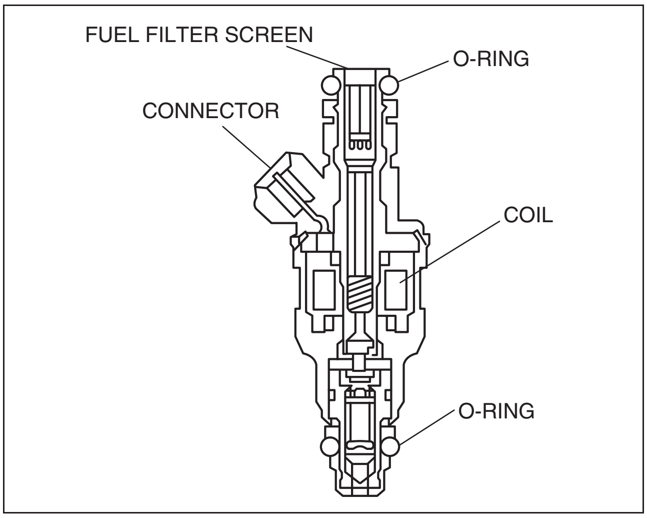
id0114a1101200

- Injects fuel according to fuel injector control signals from the PCM.

FUEL INJECTOR CONSTRUCTION/OPERATION[AJ (3.0L Duratec)]

id0114a1101300

- Installed on the intake manifold.
- The fuel injector is a solenoid-operated valve that meters fuel flow to the engine. The fuel injector is opened and closed a constant number of times per crankshaft revolution. The amount of fuel is controlled by the length of time the fuel injector is held open.
- The fuel injector is normally closed and is operated by 12 V from the main relay. The ground signal is controlled by the PCM.



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FUEL FILTER (HIGH PRESSURE) FUNCTION[AJ (3.0L Duratec)]

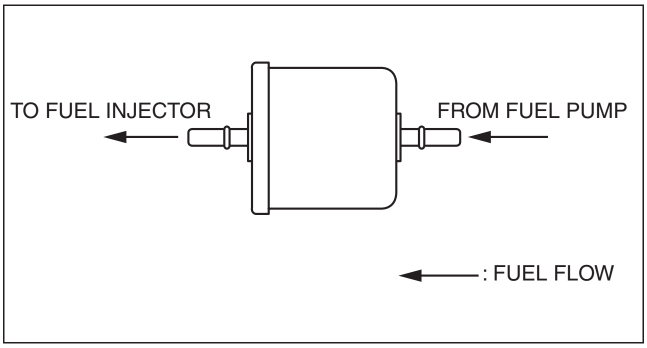
id0114a1153000

- Filters the fine foreign material which were filtered out the fuel filter (low-pressure).

FUEL FILTER (HIGH PRESSURE) CONSTRUCTION/OPERATION[AJ (3.0L Duratec)]

id0114a1153100

- It is installed to front of the fuel tank.



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FUEL PUMP RELAY FUNCTION[AJ (3.0L Duratec)]

id0114a1100700

- Controls the fuel pump on/off according to control signals from the PCM.

FUEL PUMP STOP SWITCH FUNCTION[AJ (3.0L Duratec)]

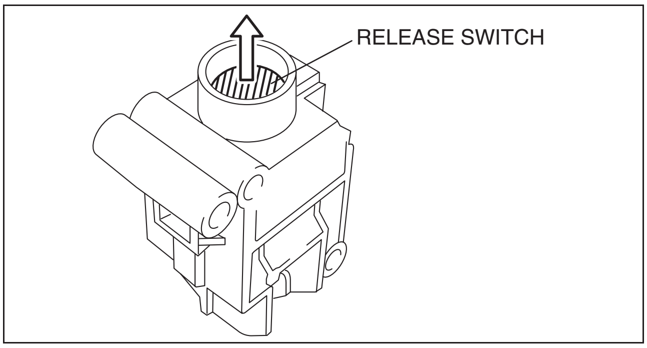
id0114a1151000

- If the fuel pump is subject to a large impact while operating, such as that from a collision, fuel may leak from the fuel line. To prevent this, fuel pump operation is stopped when a large impact is detected.

FUEL PUMP STOP SWITCH CONSTRUCTION/OPERATION[AJ (3.0L Duratec)]

id0114a1150900

- Installed under the driver-side A-pillar lower trim.
- The release switch moves upward when subject to a large impact. Due to this, current to the fuel pump is cut off and fuel pump operation is stopped.
- Current to the fuel pump can be resumed by pressing the release switch down again.



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01-15A EXHAUST SYSTEM [L3]

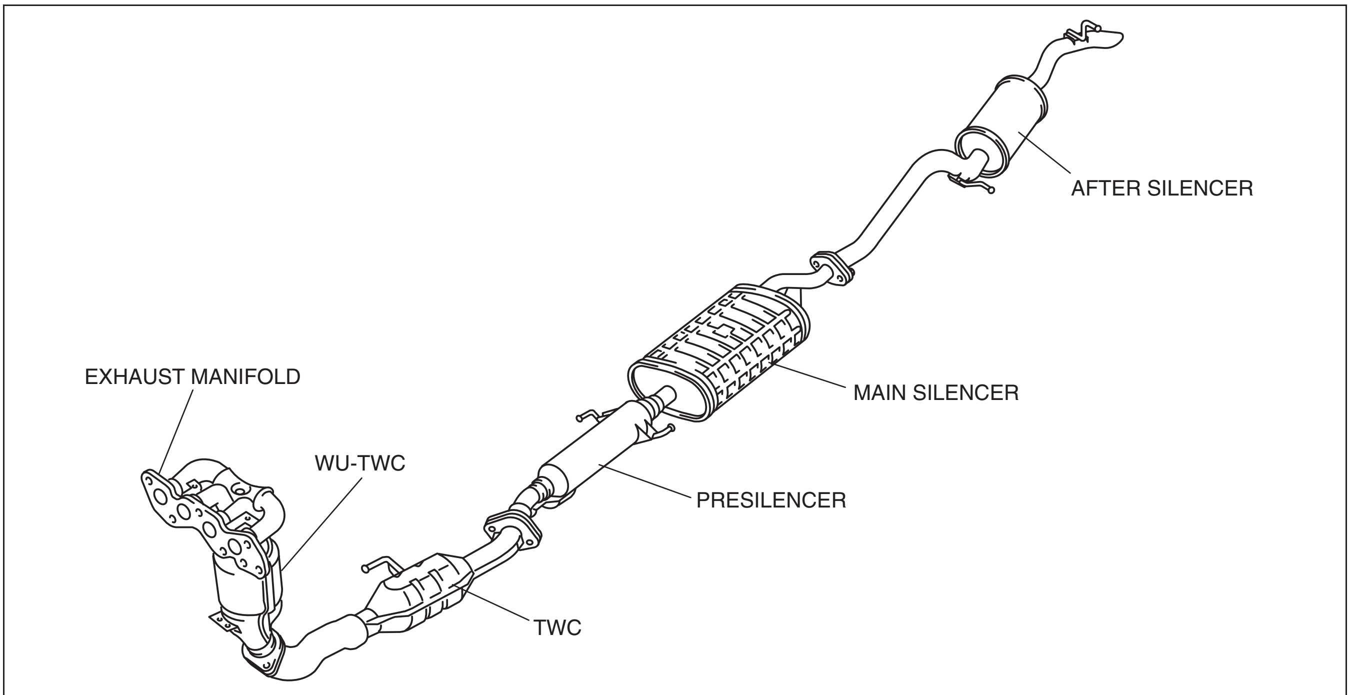
EXHAUST SYSTEM OUTLINE[L3]

id0115a2125600

- The exhaust piping is shorter due to the placement of the exhaust manifold at the rear of the engine for improved exhaust performance. Also, due to the shorter distance to the catalytic converter and the passage of hot emission gas through the catalytic converter, the catalyst function performs more efficiently.

EXHAUST SYSTEM STRUCTURAL VIEW[L3]

id0115a2100100



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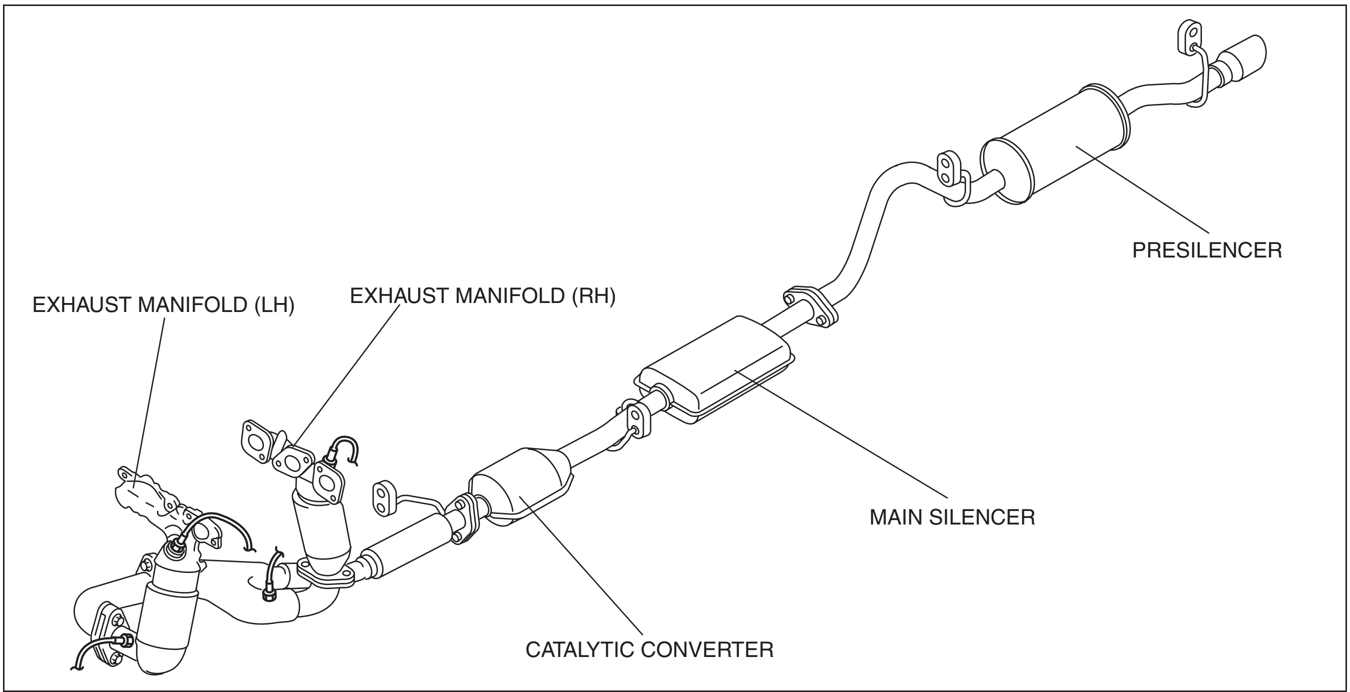
01-15B EXHAUST SYSTEM [AJ (3.0L Duratec)]

EXHAUST SYSTEM STRUCTURAL VIEW[AJ (3.0L Duratec)]

id0115a1100100



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01-16A EMISSION SYSTEM [L3]

EMISSION SYSTEM OUTLINE[L3]

id0116a2100100

Features

Improved emission gas purification	• Exhaust gas recirculation (EGR) system adopted • Catalytic converter system adopted

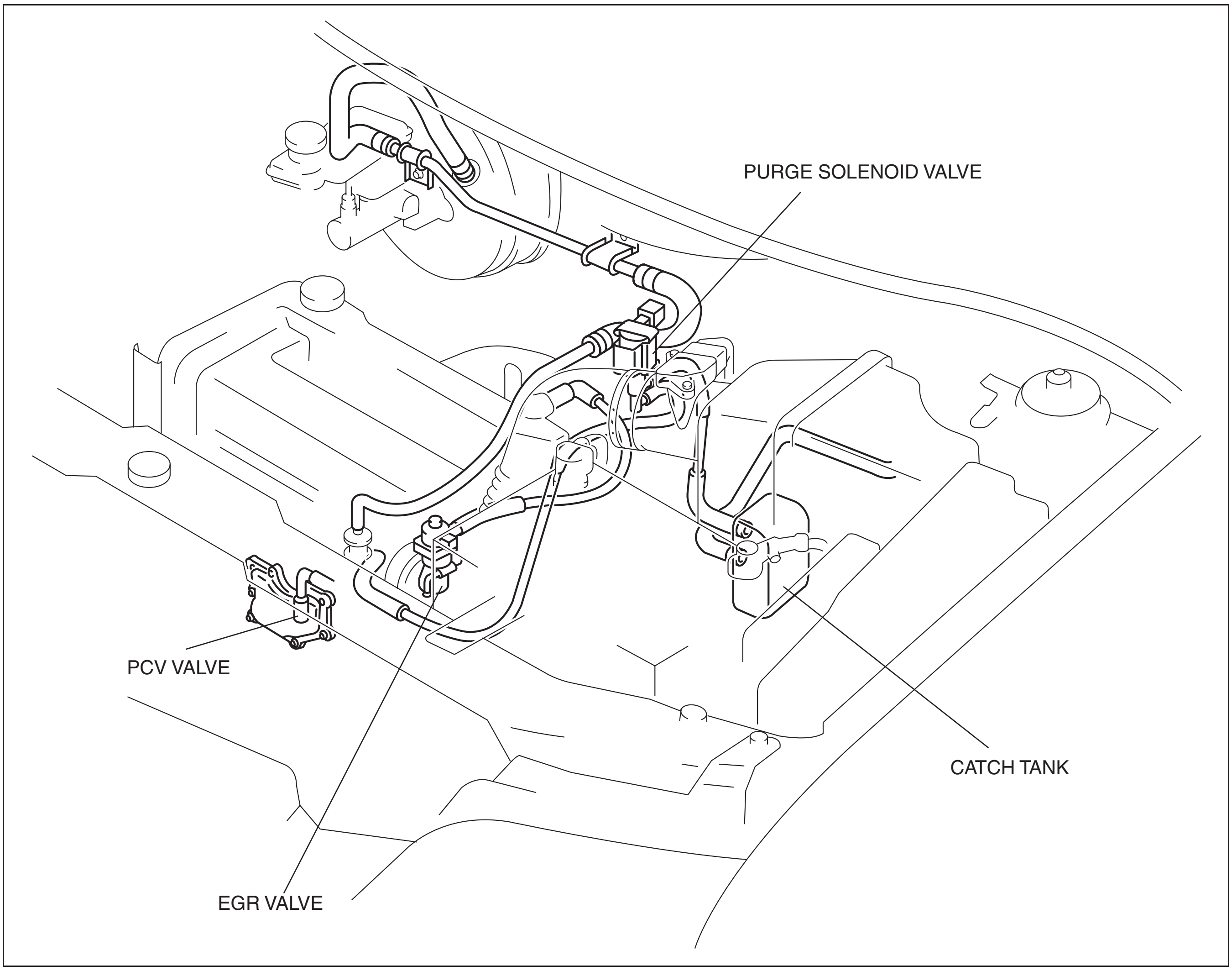
Specification

Item	Specification
EGR type	Stepping motor
Catalyst type	WU-TWC (monolith) TWC (monolith)
EVAP control system	Canister type
PCV system	Closed type

EMISSION SYSTEM STRUCTURAL VIEW[L3]

id0116a2100200

Engine compartment side



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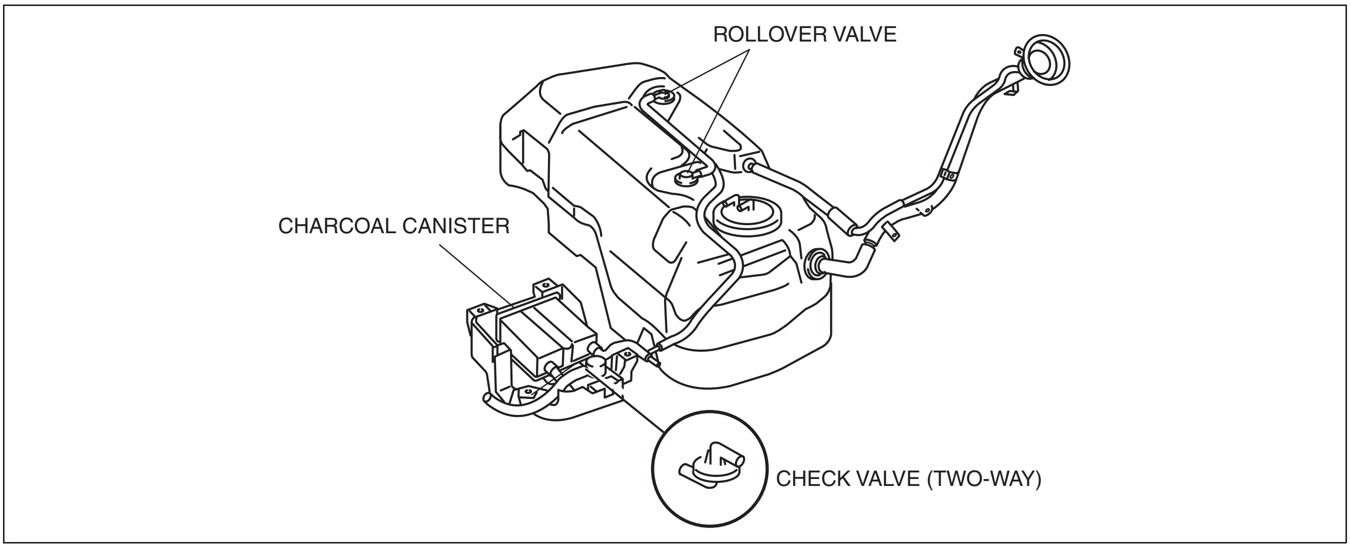
Fuel tank side



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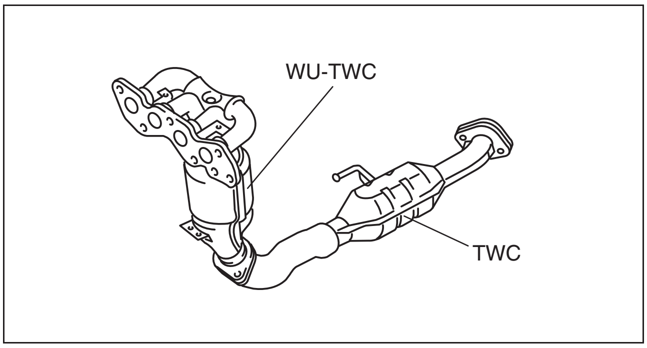
Exhaust System



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EXHAUST PURIFICATION SYSTEM OUTLINE[L3]

id0116a2100400

- The EGI system (fuel injection control, ignition control) burns fuel supplied to the engine at the theoretical air/fuel ratio for improved purification efficiency of the catalytic converter system.

CATALYTIC CONVERTER SYSTEM OUTLINE[L3]

id0116a2101400

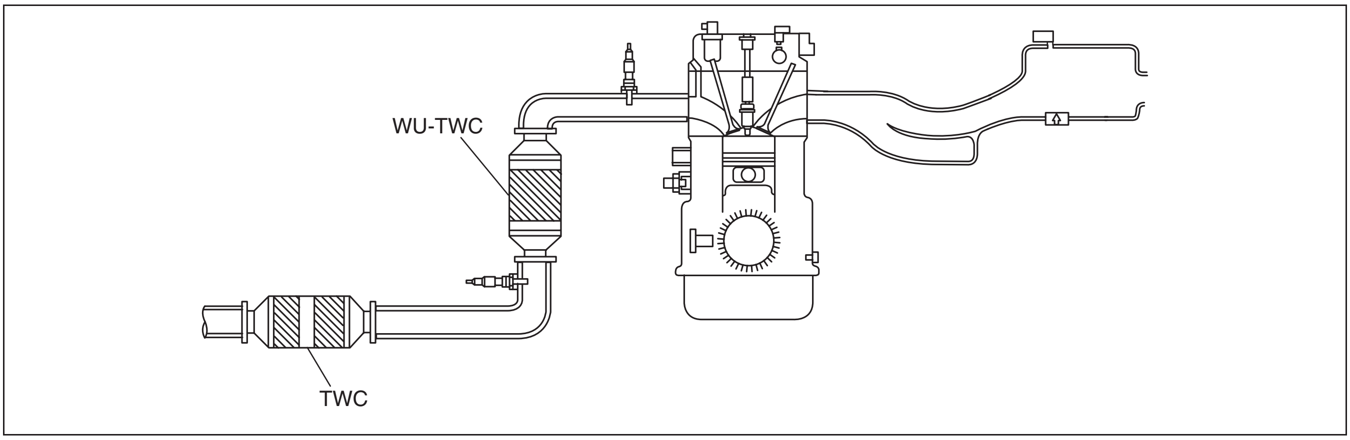
- Purifies contaminants in the exhaust gas by utilizing the chemical reactions of a three-way catalytic converter.

CATALYTIC CONVERTER SYSTEM STRUCTURE[L3]

id0116a2101500

- Consists of a three-way catalytic converter and insulator.
- A catalytic converter utilizing a platinum-palladium-rhodium system has been adopted.

System Diagram



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CATALYTIC CONVERTER SYSTEM OPERATION[L3]

id0116a2101600

- Contaminants in the exhaust gas (HC, CO, NO_x) are purified by oxidization and deoxidization while passing through the catalytic converter.
  — Oxidization process
    - Noxious HC (hydrocarbon) and CO (carbon monoxide) are bonded to oxygen which is converted to non-noxious carbon dioxide and water.
      $O_2 + HC + CO \rightarrow CO_2 + H_2O$
  — Deoxidization process
    - Noxious NO_x (nitrogen oxide) is converted to non-noxious nitrogen and oxygen.A part of the oxygen generated at this time is used in the oxidization process.
      $NO_x \rightarrow N_2 + O_2$

EVAPORATIVE EMISSION (EVAP) CONTROL SYSTEM OUTLINE[L3]

id0116a2100800

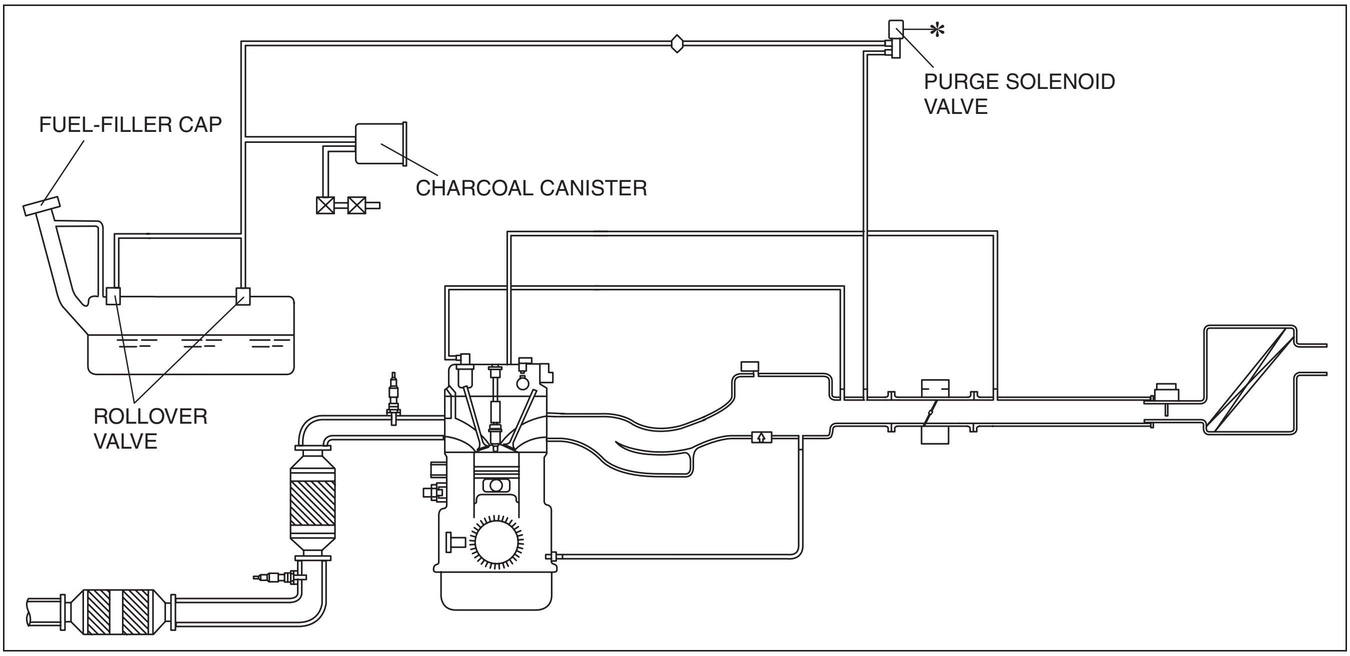
- With the adoption of the charcoal canister, release of evaporative gas into the atmosphere has been prevented.
- A duty solenoid valve (purge control valve) has been adopted for optimum control according to engine operation conditions.
- For control of evaporative purge, refer to evaporative purge control under system control. (See:01-40A-33 PURGE CONTROL OUTLINE[L3], 01-40A-33 PURGE CONTROL BLOCK DIAGRAM[L3], 01-40A-33 PURGE CONTROL OPERATION[L3])

EVAPORATIVE EMISSION (EVAP) CONTROL SYSTEM STRUCTURE[L3]

id0116a2100900

- Consists of a purge solenoid valve, charcoal canister, rollover valve, and fuel-filler cap.

System Diagram



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EVAPORATIVE EMISSION (EVAP) CONTROL SYSTEM OPERATION[L3]

id0116a2101000

- When the engine is stopped, evaporative gas in the fuel tank flows out when the pressure increases and is absorbed by the charcoal canister.
- Evaporative gas that was absorbed by the charcoal canister passes through the purge solenoid valve together with air introduced from the charcoal canister orifice when the engine is running, and is fed to the engine according to engine operation conditions.
- If the pressure in the fuel tank increases, air is introduced from the charcoal canister orifice through the rollover valve.If the charcoal canister orifice is clogged, the fuel-filler cap negative pressure valve opens and air is introduced to the fuel tank to prevent increased vacuum in the fuel tank, causing a load on the fuel tank.
- If there is a malfunction in the rollover valve, pressure in the fuel tank rises causing the fuel-filler cap positive pressure valve to open and evaporative gas is released into the atmosphere.

PURGE SOLENOID VALVE FUNCTION[L3]

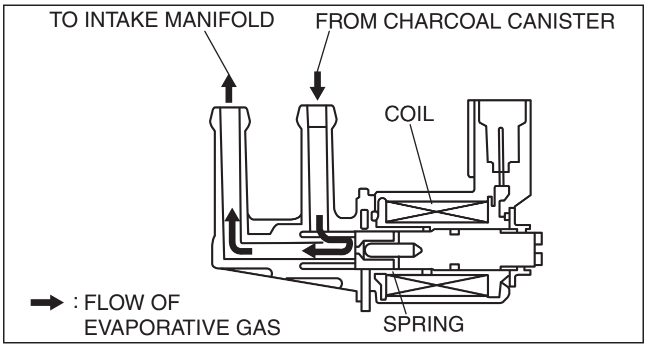
id0116a2102300

- Adjusts the amount of evaporative gas to be introduced to the intake air system.

PURGE SOLENOID VALVE CONSTRUCTION/OPERATION[L3]

id0116a2102400

- The purge solenoid valve is installed on the air hose.
- Mainly consists of a coil, spring, and plunger.
- Opens and closes the passage in the solenoid valve according to the purge solenoid valve control signal (duty signal) from the PCM to control the amount of evaporative gas to be introduced to the intake manifold according to engine operation conditions.
- The signal sent from the PCM energizes the coil and it becomes magnetized, pulling the plunger. The passage between the ports opens when the plunger is pulled, and evaporative gas is introduced to the intake air system due to the intake manifold vacuum.



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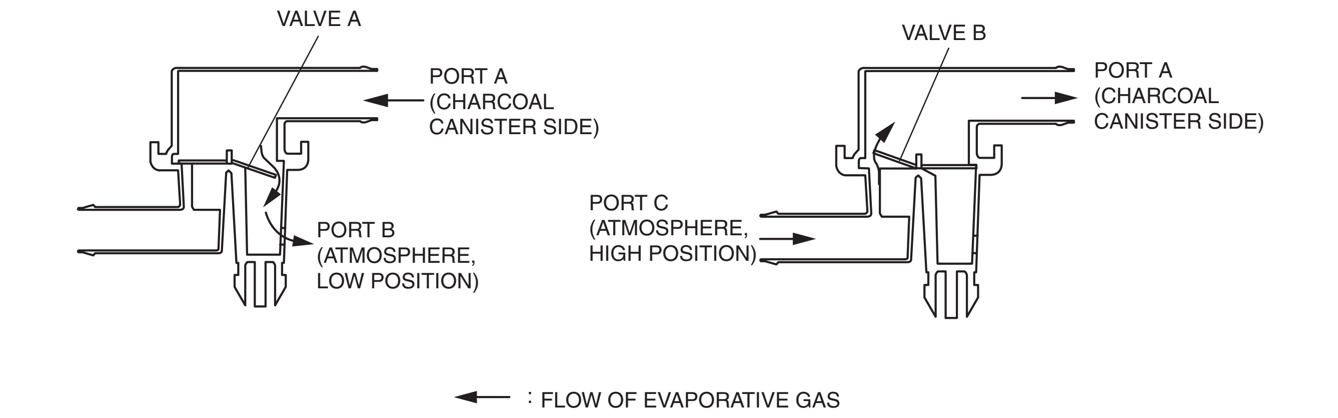
CHECK VALVE (TWO-WAY) CONSTRUCTION/OPERATION[L3]

id0116a2150500

- The check valve (two-way) is installed on the charcoal canister protector.
- Consists of valves and a body.
- When the charcoal canister discharges evaporative gas, valve A opens, and the gas is released to the atmosphere through port B.
- When the charcoal canister takes in atmospheric air, valve B opens and intake air enters through port C.
- If the check valve is flooded with water, valve A closes due to water pressure to prevent water from entering. The end of the hose connected to port C is located in a high position, and air intake occurs at this heightened position.



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CHECK VALVE (TWO-WAY) FUNCTION[L3]

id0116a2150600

- Controls the amount of evaporative gas discharged from the charcoal canister and the amount of atmospheric air intake.
- Prevents water from entering the evaporative gas line even if the check valve is flooded.

EGR SYSTEM OUTLINE[L3]

id0116a2100500

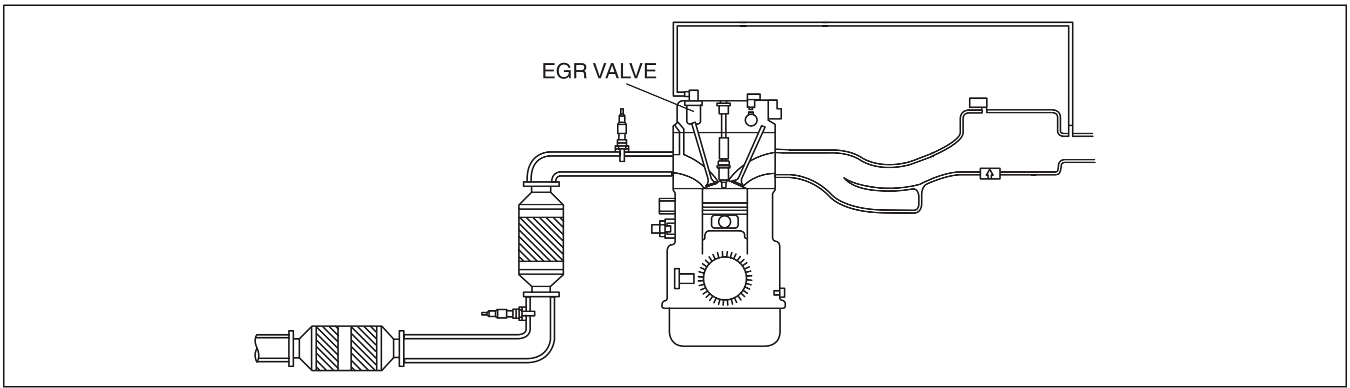
- An EGR valve with a stepping motor has been adopted for optimum control according to engine operation conditions.
- For control of EGR system, refer to EGR control under the control system. (See 01-40A-2 ENGINE CONTROL SYSTEM OUTLINE[L3].) (See 01-40A-9 ENGINE CONTROL SYSTEM BLOCK DIAGRAM[L3].)

EGR SYSTEM STRUCTURE[L3]

id0116a2100600

- Consists of an EGR valve and EGR pipe to conduct exhaust gas to the intake air system.

System Diagram



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EGR SYSTEM OPERATION[L3]

id0116a2100700

- The high occurrence of NO_x at high temperatures has been reduced by recirculating exhaust gas to the combustion chamber in order to lower the combustion temperature.
- The exhaust gas flows along the EGR passage in the cylinder head and into the EGR valve. Exhaust gas that has flowed past the EGR valve flows through the EGR passage and EGR pipe, and is conducted to the intake manifold.

POSITIVE CRANKCASE VENTILATION (PCV) SYSTEM OUTLINE[L3]

id0116a2101100

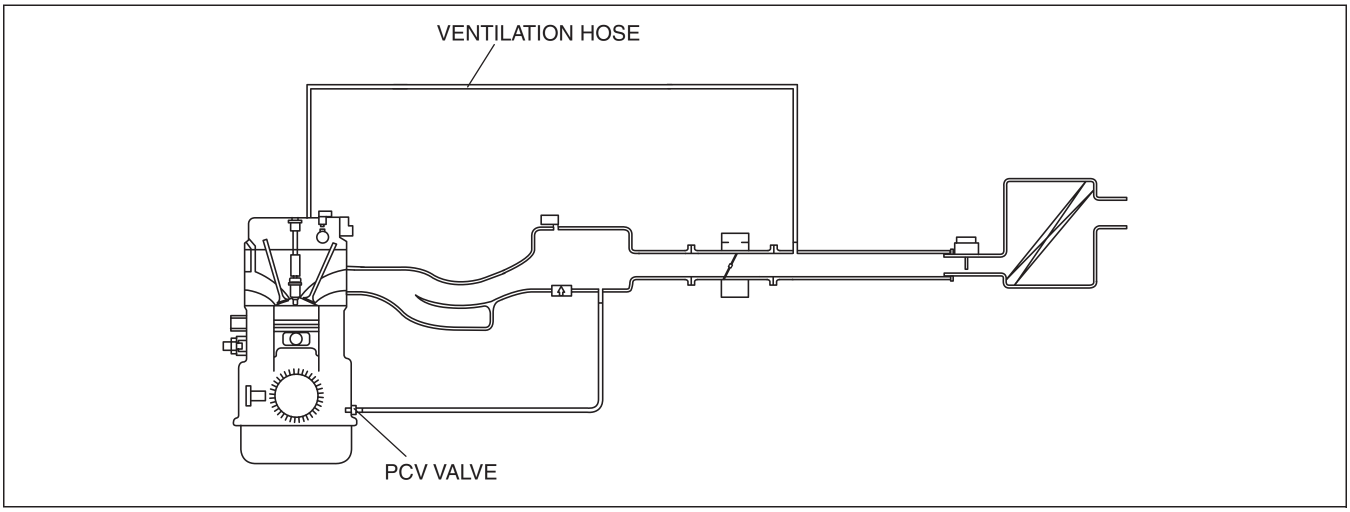
- A closed type has been adopted.

POSITIVE CRANKCASE VENTILATION (PCV) SYSTEM STRUCTURE[L3]

id0116a2101200

- Consists of a PCV valve and ventilation hose.
- The PCV valve is installed on the oil separator.

System Diagram



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POSITIVE CRANKCASE VENTILATION (PCV) SYSTEM OPERATION[L3]

id0116a2101300

- Blowby gas (unburnt gas), including carbon monoxide (CO) and hydrocarbons (HC) exhausted from the crankcase, is forced into the intake air system and burned in the combustion chamber to prevent its atmospheric release.

POSITIVE CRANKCASE VENTILATION (PCV) VALVE FUNCTION[L3]

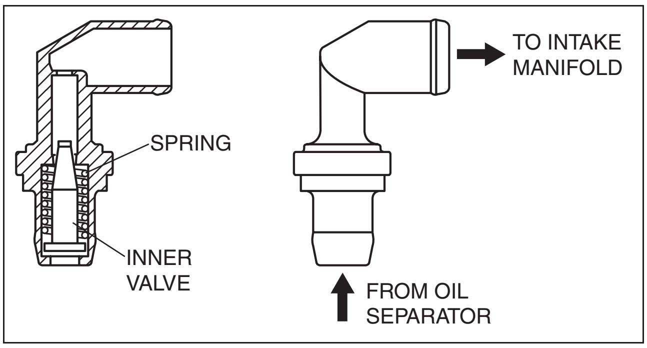
id0116a2101700

- Adjusts the amount of blowby gas conducted to the intake air system according to the intake manifold vacuum.
- Adjusts the air (including blowby gas) passing from the cylinder head cover to intake manifold during low load (when the intake manifold vacuum is high) to ensure an optimum air/fuel ratio.

POSITIVE CRANKCASE VENTILATION (PCV) VALVE CONSTRUCTION/OPERATION[L3]

id0116a2101800

- The PCV valve is mainly consists of a spring and valves.
- Ensures the passage of blowby gas by opening the valve according to the intake manifold vacuum, and adjusts the amount of gas by spring force.



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EGR VALVE FUNCTION[L3]

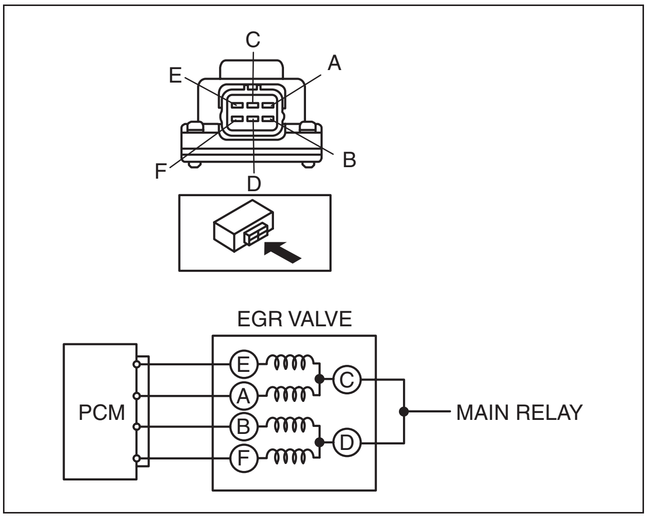
id0116a2102500

- Adjusts the amount of exhaust gas to be recirculated from the exhaust system to the combustion chamber based on the EGR control signal from the PCM.

EGR VALVE CONSTRUCTION/OPERATION[L3]

id0116a2102600

- The EGR valve is mainly consists of a rotor, coils, and a spring.
- Operates based on the signal from the PCM to drive the EGR valve stepping motor.
- The PCM determines the optimum EGR valve opening angle based on the engine speed and intake air amount when the engine is completely warmed up, and drives the EGR valve.



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FUEL-FILLER CAP FUNCTION[L3]

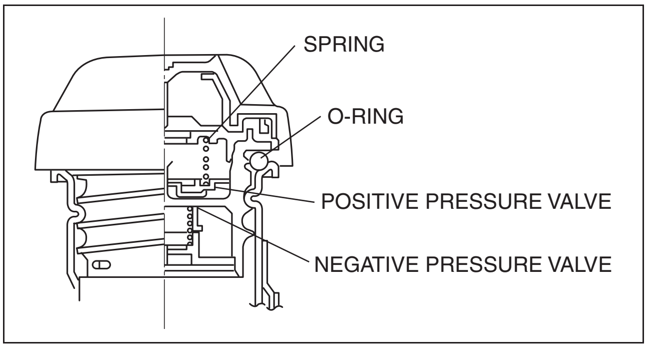
id0116a2102700

- If the evaporative gas passage is closed for some reason, the fuel filler cap prevents the generation of positive or negative pressure in the fuel tank, protecting it from deformation.

FUEL-FILLER CAP CONSTRUCTION/OPERATION[L3]

id0116a2102800

- Mainly consists of a positive pressure valve, negative pressure valve, spring, and O-ring.
- When there is positive pressure in the fuel tank due to evaporative gas, the evaporative gas is released into the atmosphere. When there is negative pressure, air is introduced to the fuel tank.
- The positive pressure valve and negative pressure valve opening pressures are higher than the check valve (two-way) built into the rollover valve, therefore the positive and negative pressure valves are normally not open.



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ROLLOVER VALVE FUNCTION[L3]

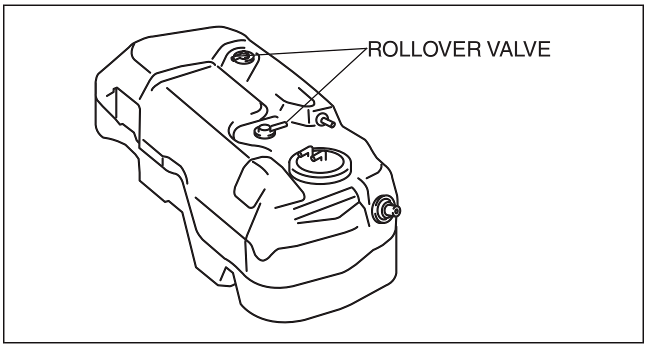
id0116a2102900

- The rollover valve prevents fuel flow into the evaporative gas passage during sudden cornering or vehicle rollover.
- The built-in check valve (two-way) maintains a constant pressure in the fuel tank.

ROLLOVER VALVE CONSTRUCTION/OPERATION[L3]

id0116a2103000

- The rollover valve is welded in two places along the evaporative gas passage on the upper surface of the fuel tank and cannot be removed.
- The rollover valve consists of a check valve (two-way), float, and spring.
- The rollover valve utilizes a combination of float weight, spring force, and buoyancy. When the float is immersed in the fuel, the float (valve) closes to block the sealing surface of the passage.



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CHARCOAL CANISTER FUNCTION[L3]

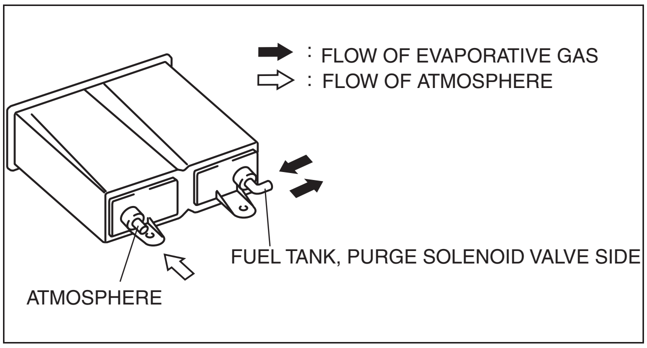
id0116a2101900

- The charcoal canister contains activated charcoal that temporarily absorbs evaporative gas.

CHARCOAL CANISTER CONSTRUCTION/OPERATION[L3]

id0116a2102000

- Installed on the rear of the fuel tank.
- During purge solenoid valve operation, atmospheric air enters the charcoal canister from the atmospheric orifice to entirely flood the activated charcoal and release the evaporative gas.



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01-16B EMISSION SYSTEM [AJ (3.0L Duratec)]

01

EMISSION SYSTEM OUTLINE[AJ (3.0L Duratec)]

id0116a1100100

Features

Improved emission gas purification	• EGR system adopted • Catalytic converter system (three-way catalyst) adopted

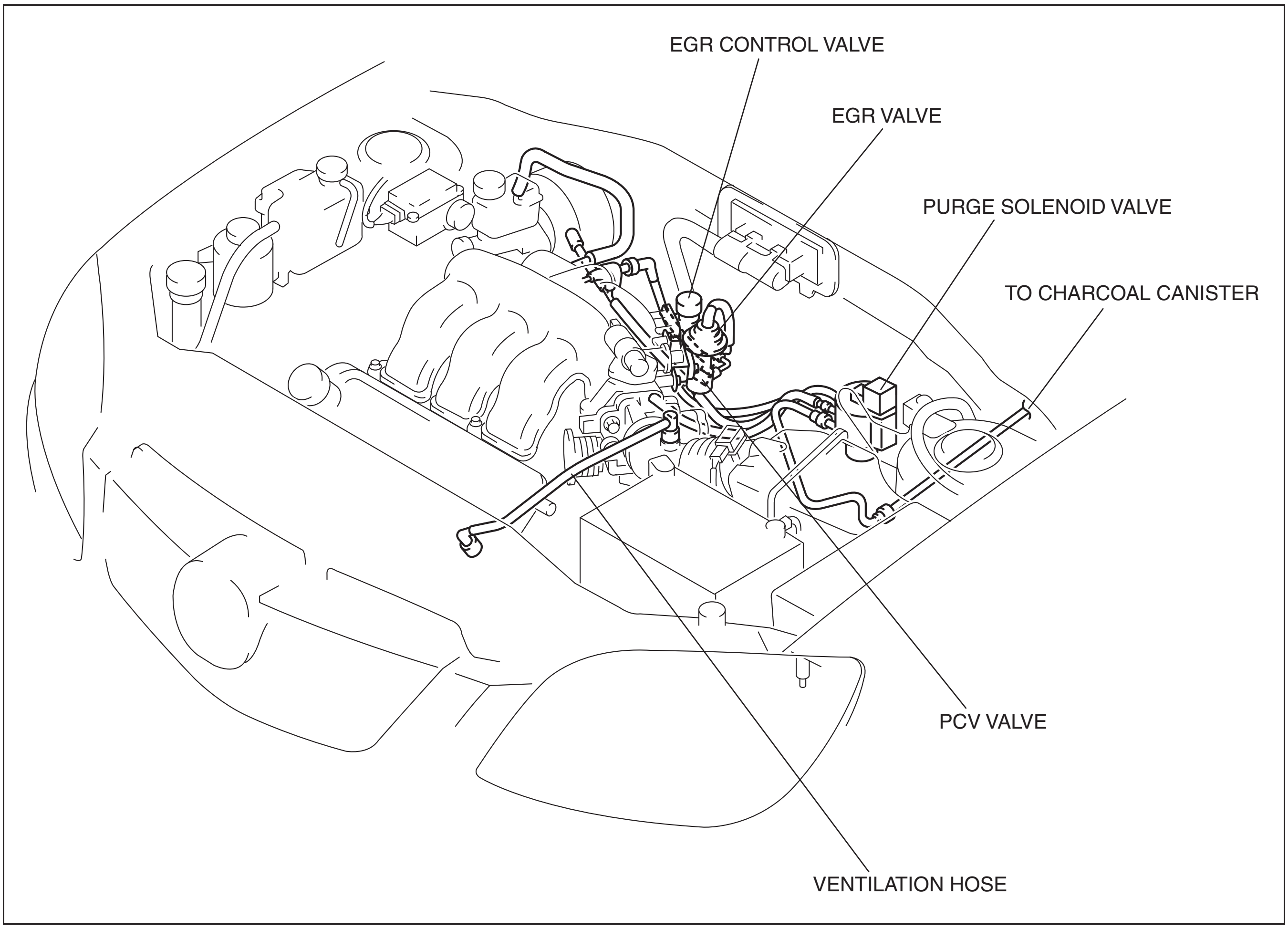
Specification

Item	Specification
EGR type	Vacuum control
Catalyst type	WU-TWC, TWC
Evaporative emission (EVAP) control system	Canister type
Positive crankcase ventilation (PCV) system	Closed type

EMISSION SYSTEM STRUCTURAL VIEW[AJ (3.0L Duratec)]

id0116a1100200

Engine Compartment Side



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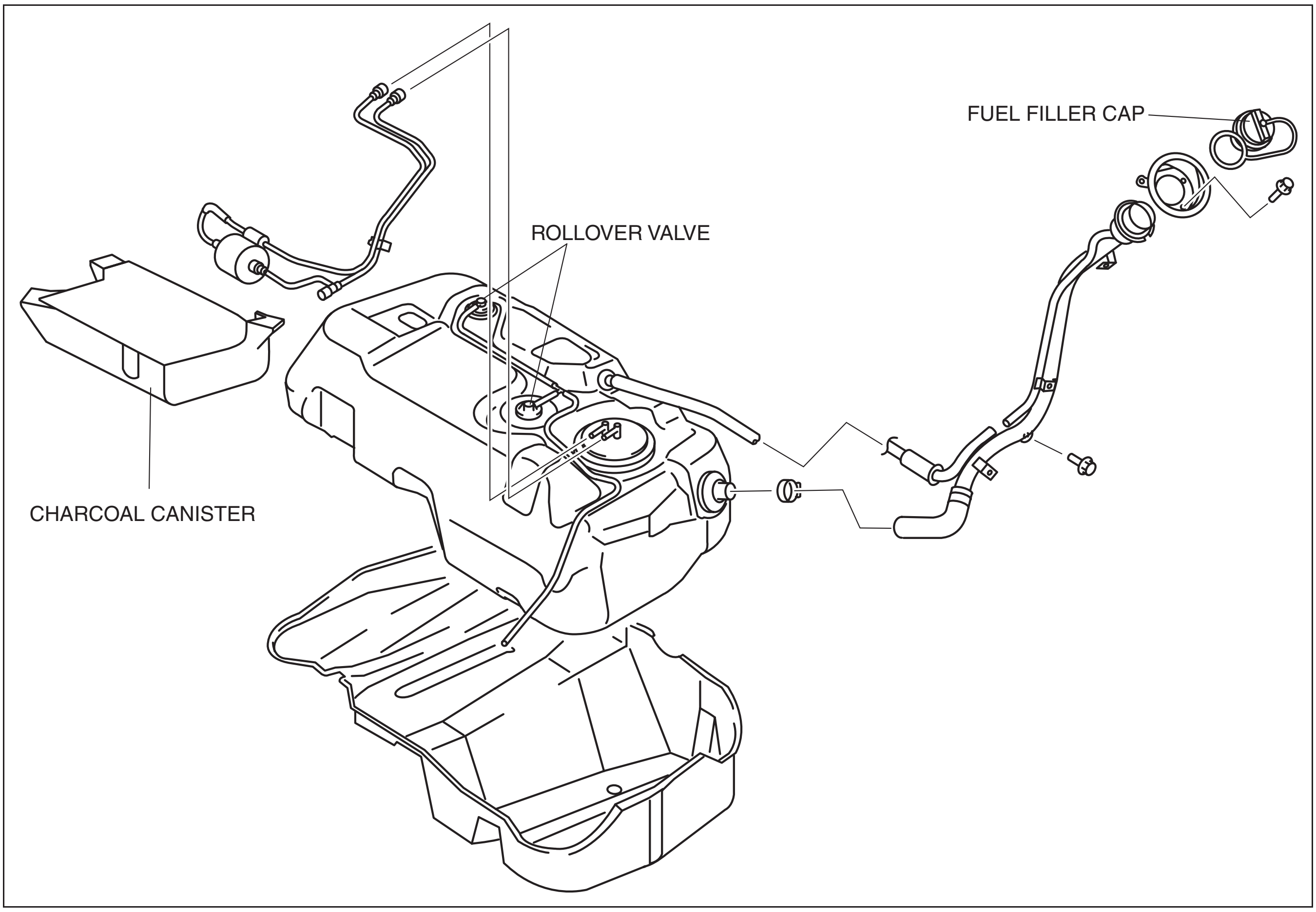
Fuel Tank Side



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CATALYTIC CONVERTER SYSTEM OUTLINE[AJ (3.0L Duratec)]

id0116a1101400

Feature

- Purifies contaminants in the exhaust gas by utilizing the chemical reactions of a three-way catalytic converter.

CATALYTIC CONVERTER SYSTEM CONSTRUCTION[AJ (3.0L Duratec)]

id0116a1150000

- Consists of a three-way catalytic converter and catalytic converter.

CATALYTIC CONVERTER SYSTEM OPERATION[AJ (3.0L Duratec)]

id0116a1101600

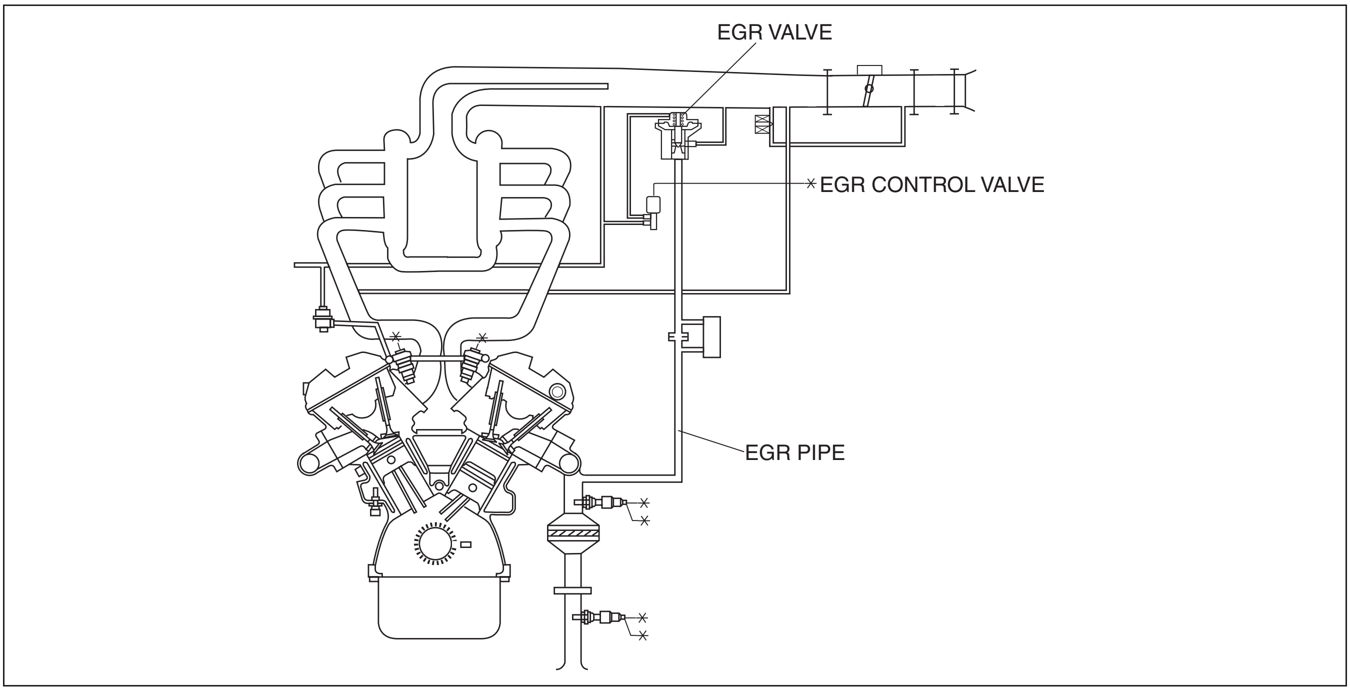
- Contaminants in the exhaust gas (HC, CO, NO_x) are purified by oxidization and deoxidization while passing through the catalytic converter.
  — Oxidization process
    - Noxious HC (hydrocarbon) and CO (carbon monoxide) are bonded to oxygen which is converted to non-noxious carbon dioxide and water.
      $O_2 + HC + CO \rightarrow CO_2 + H_2O$
  — Deoxidization process
    - Noxious NO_x (nitrogen oxide) is converted to non-noxious nitrogen and oxygen. A part of the oxygen generated at this time is used in the oxidization process.
      $NO_x \rightarrow N_2 + O_2$

EXHAUST GAS RECIRCULATION SYSTEM CONSTRUCTION[AJ (3.0L Duratec)]

id0116a1149100

- Consists of an EGR valve, EGR control valve, and EGR pipe.

System Diagram



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EXHAUST GAS RECIRCULATION SYSTEM OPERATION[AJ (3.0L Duratec)]

id0116a1149200

- The high occurrence of NO_x at high temperatures has been reduced by recirculating exhaust gas to the combustion chamber in order to lower the combustion temperature.
- Exhaust gas flows through the EGR pipe and into the EGR valve. The exhaust gas flow amount controlled by the EGR valve is conducted to the intake manifold.

EXHAUST GAS RECIRCULATION SYSTEM OUTLINE[AJ (3.0L Duratec)]

id0116a1149300

Feature

- A vacuum control type EGR valve has been adopted for optimum control according to engine operation conditions.

EVAPORATIVE EMISSION CONTROL SYSTEM OUTLINE[AJ (3.0L Duratec)]

id0116a1149600

Features

- With the adoption of the charcoal canister, release of evaporative gas into the atmosphere has been prevented.
- A duty solenoid (purge solenoid valve) has been adopted for optimum control according to engine operation conditions.

EVAPORATIVE EMISSION CONTROL SYSTEM OPERATION[AJ (3.0L Duratec)]

id0116a1149500

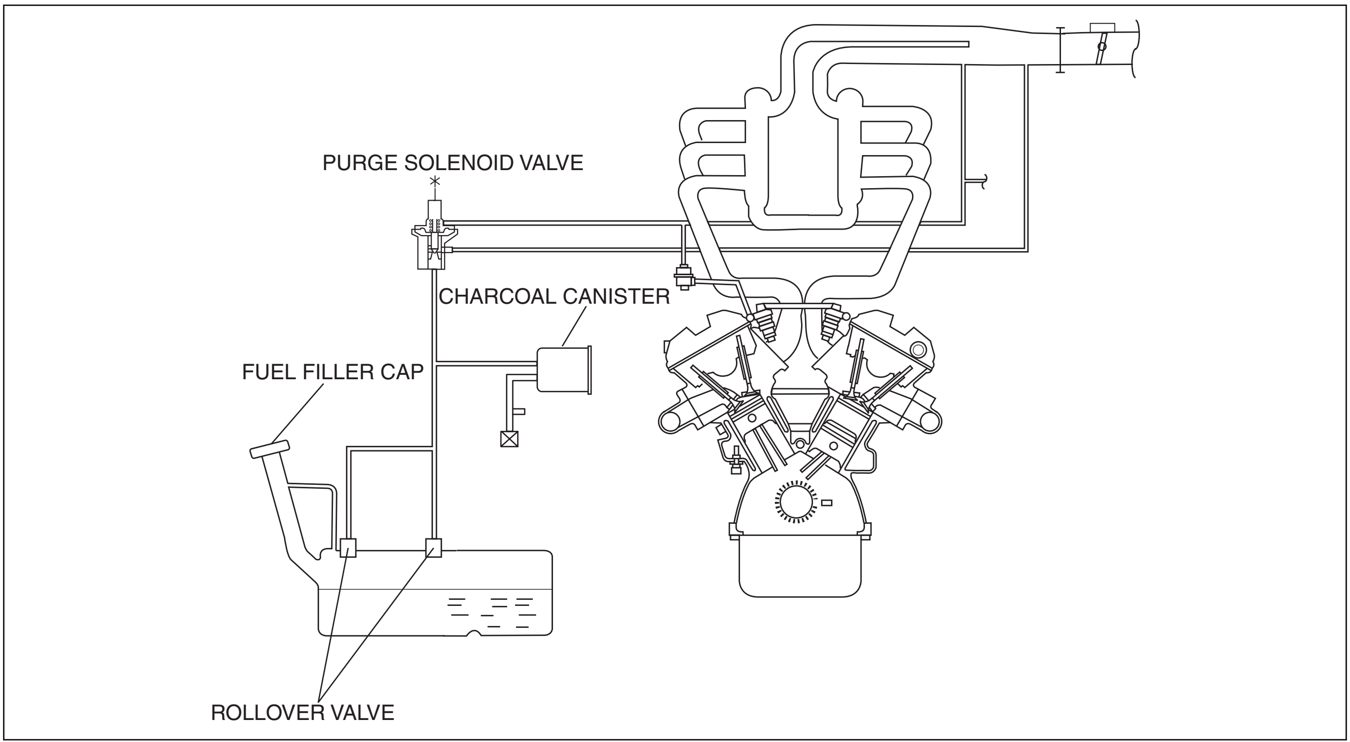
- When the engine is stopped, evaporative gas in the fuel tank flows out when the pressure increases and is absorbed by the charcoal canister.
- Evaporative gas that was absorbed by the charcoal canister passes through the purge solenoid valve together with air introduced from the charcoal canister orifice when the engine is running, and is fed to the engine according to engine operation conditions.
- If the pressure in the fuel tank increases, air is introduced from the charcoal canister orifice through the rollover valve. If the charcoal canister orifice is clogged, the fuel-filler cap negative pressure valve opens and air is introduced to the fuel tank to prevent increased vacuum in the fuel tank, causing a load on the fuel tank.
- If there is a malfunction in the rollover valve, pressure in the fuel tank rises causing the fuel-filler cap positive pressure valve to open and evaporative gas is released into the atmosphere.

EVAPORATIVE EMISSION CONTROL SYSTEM CONSTRUCTION[AJ (3.0L Duratec)]

id0116a1149400

- Consists of a purge solenoid valve, charcoal canister, rollover valve, and fuel-filler cap.

System Diagram



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POSITIVE CRANKCASE VENTILATION SYSTEM OUTLINE[AJ (3.0L Duratec)]

id0116a1149900

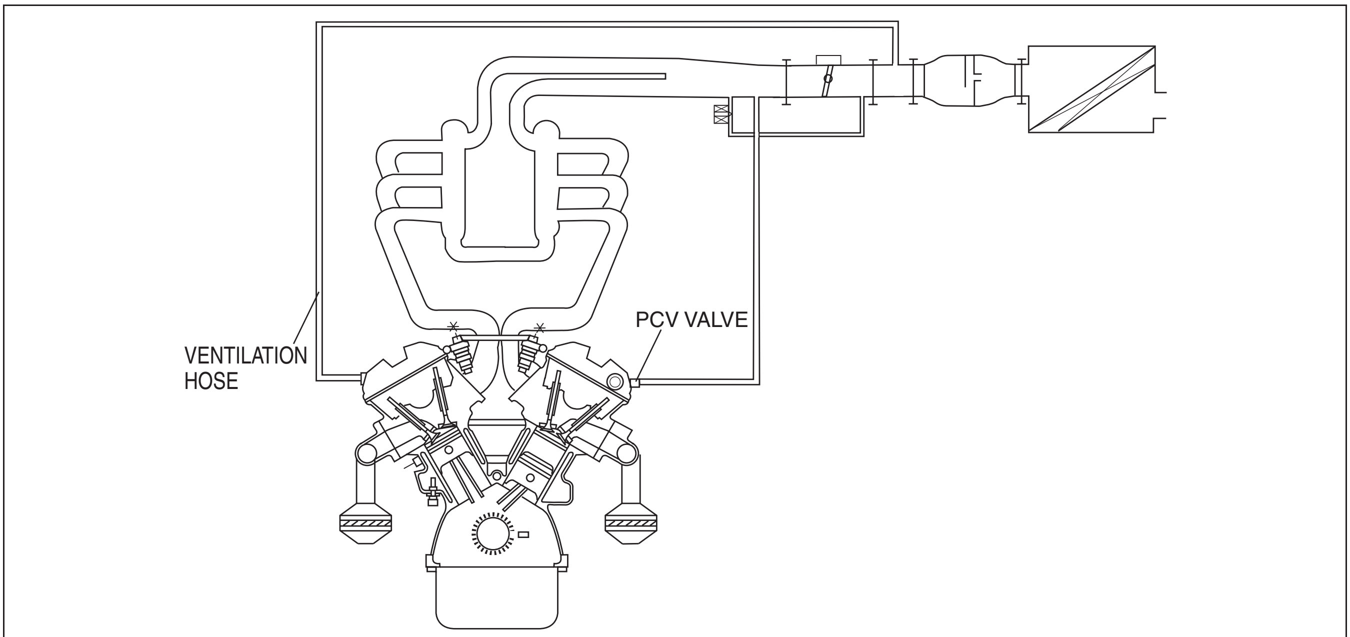
Feature

- A closed type system has been adopted.

POSITIVE CRANKCASE VENTILATION SYSTEM CONSTRUCTION[AJ (3.0L Duratec)]

id0116a1149700

- Consists of a PCV valve and ventilation hose.
- The PCV valve is installed on the oil separator.



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POSITIVE CRANKCASE VENTILATION SYSTEM OPERATION[AJ (3.0L Duratec)]

id0116a1149800

- Blowby gas (unburnt gas), including carbon monoxide (CO) and hydrocarbon (HC) exhausted from the crankcase, is forced into the intake air system and burned in the combustion chamber to prevent its atmospheric release.

PURGE SOLENOID VALVE FUNCTION[AJ (3.0L Duratec)]

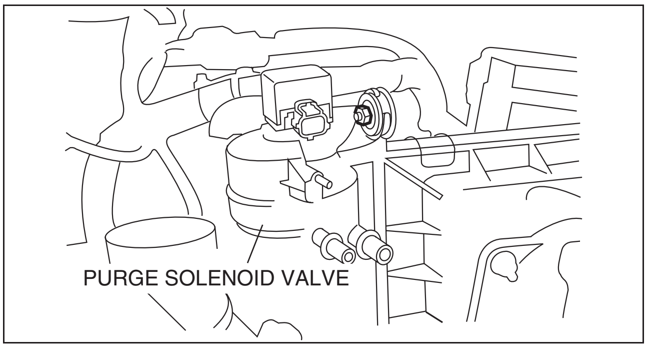
id0116a1102300

- Adjusts the amount of evaporative gas to be introduced to the intake air system.

PURGE SOLENOID VALVE CONSTRUCTION/OPERATION[AJ (3.0L Duratec)]

id0116a1102400

- Installed near the suspension tower in the engine compartment.
- Consists of a coil, spring and plunger.
- Opens and closes the passage in the solenoid valve according to the purge solenoid valve control signal (duty signal) from the PCM to control the amount of evaporative gas to be introduced to the intake manifold according to engine operation conditions.



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POSITIVE CRANKCASE VENTILATION VALVE CONSTRUCTION/OPERATION[AJ (3.0L Duratec)]

id0116a1150100

- Consists of a spring and valve.
- Ensures the passage of blowby gas by opening the valve according to the intake manifold vacuum, and adjusts the amount of gas by spring force.

POSITIVE CRANKCASE VENTILATION VALVE FUNCTION[AJ (3.0L Duratec)]

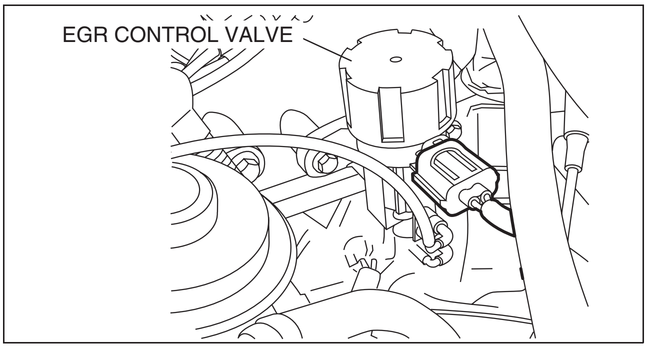
id0116a1150200

- Adjusts the amount of blowby gas conducted to the intake air system according to the intake manifold vacuum.
- Regulates the air (including blowby gas) passing from the cylinder head cover to the intake manifold during low load (when the intake manifold vacuum is high) to ensure an optimum air/fuel ratio.

EGR CONTROL VALVE CONSTRUCTION/OPERATION[AJ (3.0L Duratec)]

id0116a1150300

- Installed near the installation area of the intake manifold throttle body.
- Consists of a plunger, coils, and a spring.
- The EGR control valve moves the EGR control valve plunger according to the EGR control (duty) signal from the PCM to change the vacuum applied to the EGR valve.



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EGR CONTROL VALVE FUNCTION[AJ (3.0L Duratec)]

id0116a1150400

- Regulates the vacuum supplied to the EGR valve diaphragm based on the EGR control signal from the PCM.

EGR VALVE FUNCTION[AJ (3.0L Duratec)]

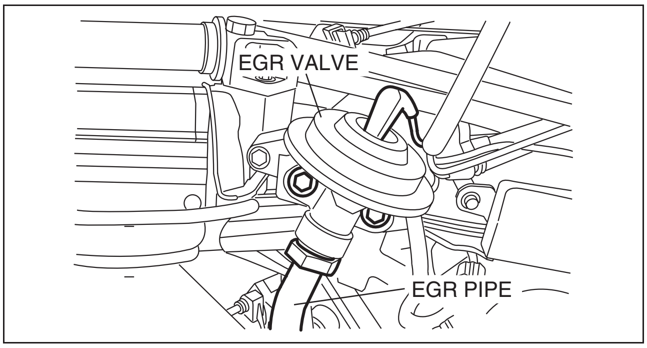
id0116a1102500

- Adjusts the amount of exhaust gas to be recirculated from the exhaust system to the combustion chamber based on the EGR control valve vacuum.

EGR VALVE CONSTRUCTION/OPERATION[AJ (3.0L Duratec)]

id0116a1102600

- Installed near the throttle body installation area of the intake manifold.
- Consists of a diaphragm, spring, and valve.
- The valve operates based on the driving of the diaphragm according to the control vacuum from the EGR control valve.



atraan00000187

CHARCOAL CANISTER FUNCTION[AJ (3.0L Duratec)]

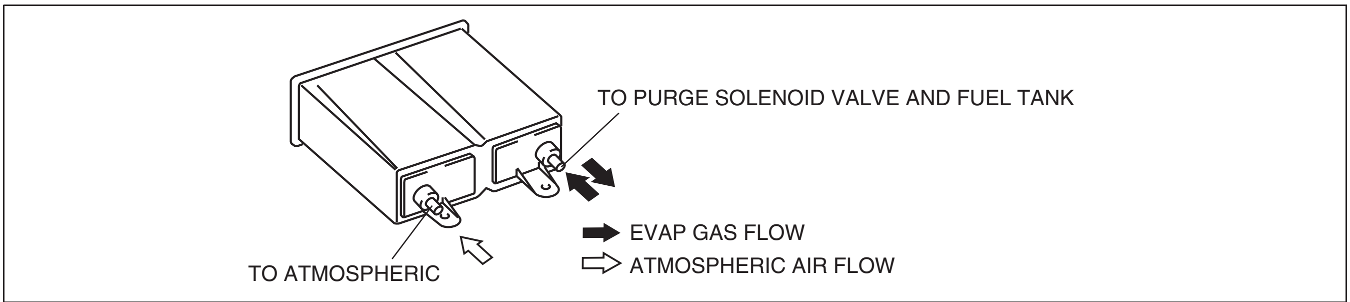
id0116a1101900

- The charcoal canister contains activated charcoal that temporarily absorbs evaporative gas.

CHARCOAL CANISTER CONSTRUCTION/OPERATION[AJ (3.0L Duratec)]

id0116a1102000

- Installed on the front of the fuel tank.
- During purge solenoid valve operation, atmospheric air enters the charcoal canister from the atmospheric orifice to entirely flood the activated charcoal and release the evaporative gas.



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01-17A CHARGING SYSTEM [L3]

CHARGING SYSTEM OUTLINE[L3]

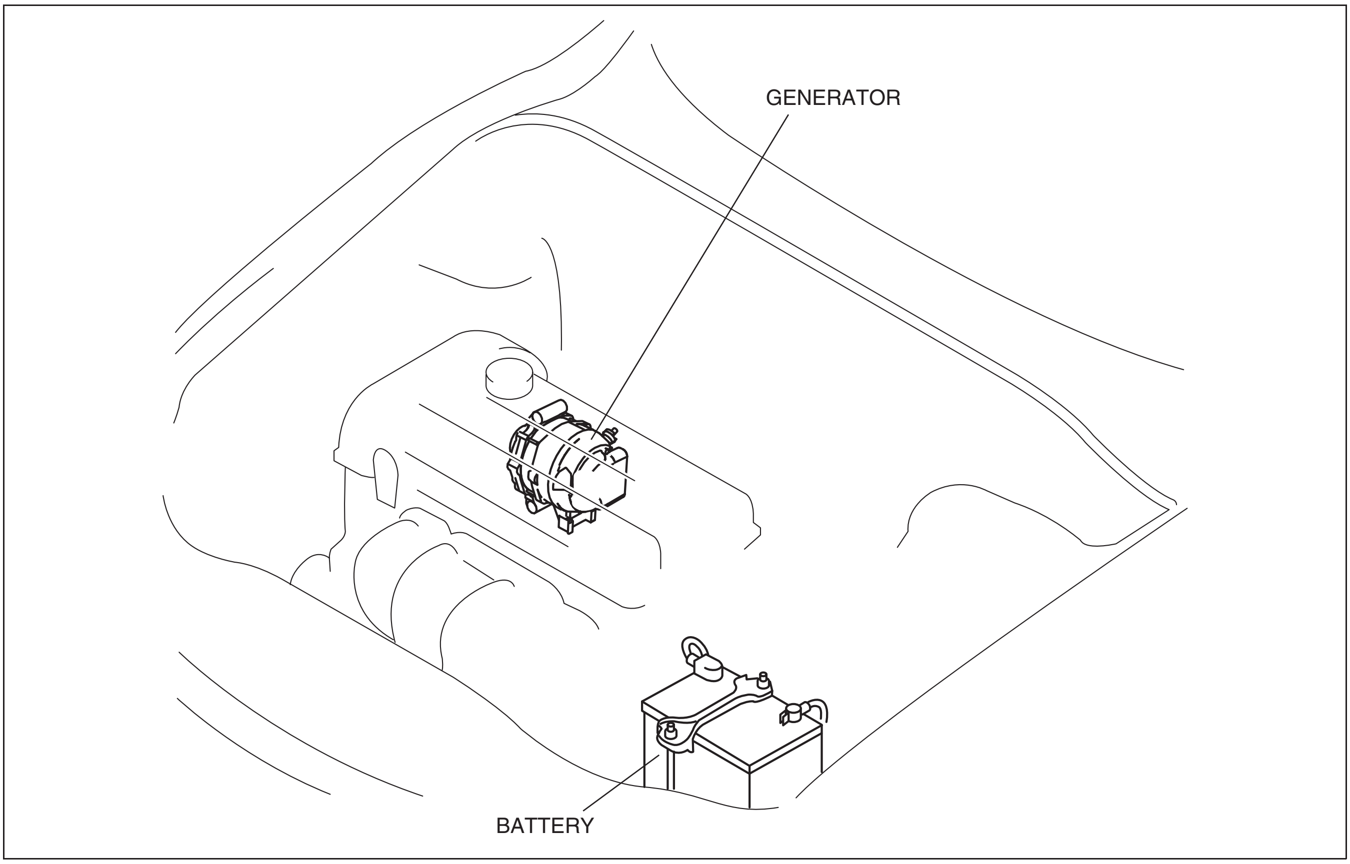
id0117a3102100

Features

Miniaturization	• Non-regulator type generator with built-in power transistor adopted
Reduced operation noise	• Generator with two delta connection type stator coils adopted

CHARGING SYSTEM STRUCTURAL VIEW[L3]

id0117a3102200



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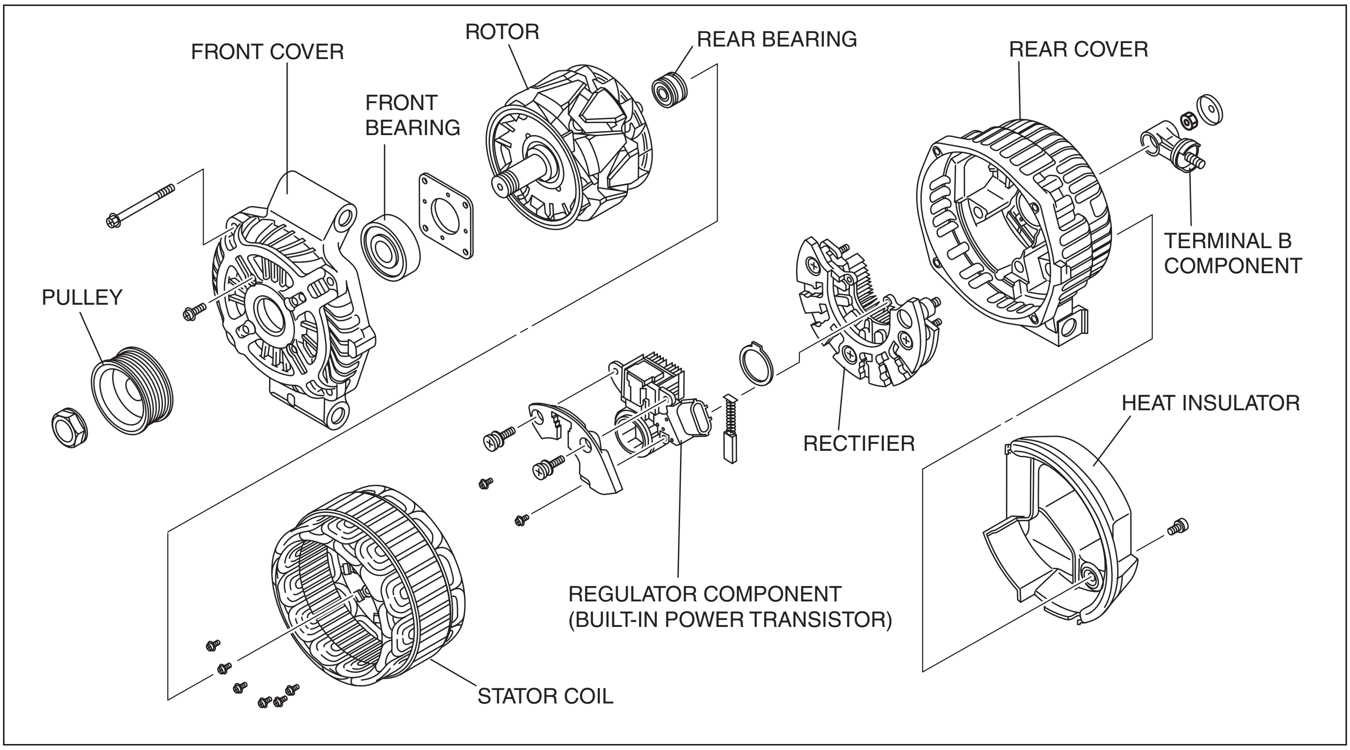
GENERATOR CONSTRUCTION[L3]

id0117a3102300

- With the elimination of the voltage regulator, generator control is carried out by the PCM. Excitation current in the field coil is increased or decreased by the duty signal from the PCM sent to the power transistor built into the generator. (See 01-40A-39 GENERATOR CONTROL OPERATION[L3].)
- Two delta connection type stator coils have been adopted.
- A generator duct and a generator heat insulator made of plastic have been adopted to protect the generator from the exhaust manifold heat.



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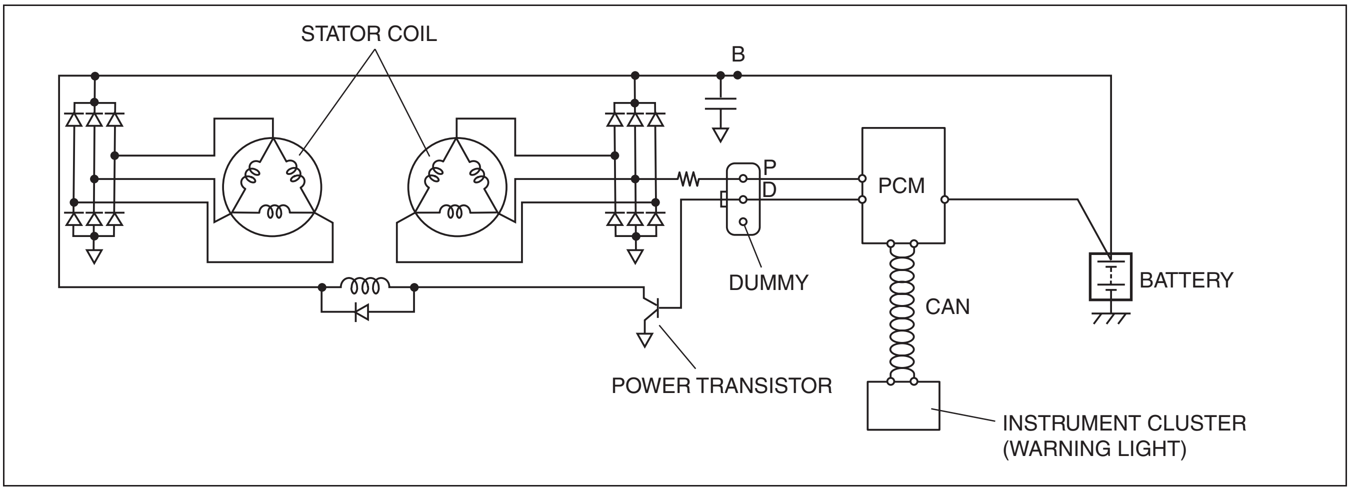

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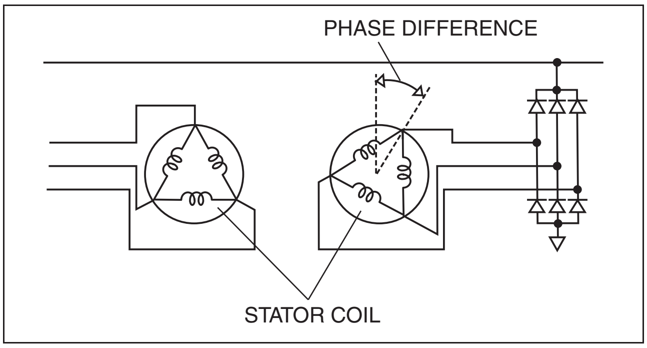
- The phase difference in the circuit of the two stator coils causes the electromagnetic pull between the rotor and the stator to be eliminated logically. Due to this, electromagnetic vibration and generator operation noise (electromagnetic noise) have been reduced.



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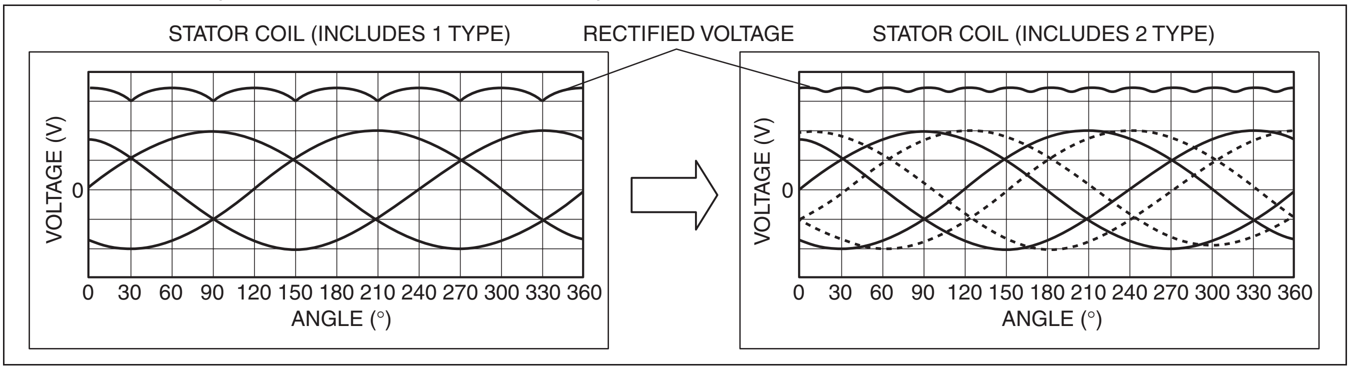
- The pulsation occurring through voltage rectifying is minimized, as a result, stable voltage output is supplied due to the adoption of two stator coils with the phase difference.



atraan00000127

- The generator warning light in the instrument cluster illuminates under the following conditions.
  — Charging system voltage problem
  — Charging system voltage low
  — Charging system voltage high
  — IAT sensor circuit low input
  — IAT sensor circuit high input

01-17B CHARGING SYSTEM [AJ (3.0L Duratec)]

CHARGING SYSTEM OUTLINE[AJ (3.0L Duratec)]

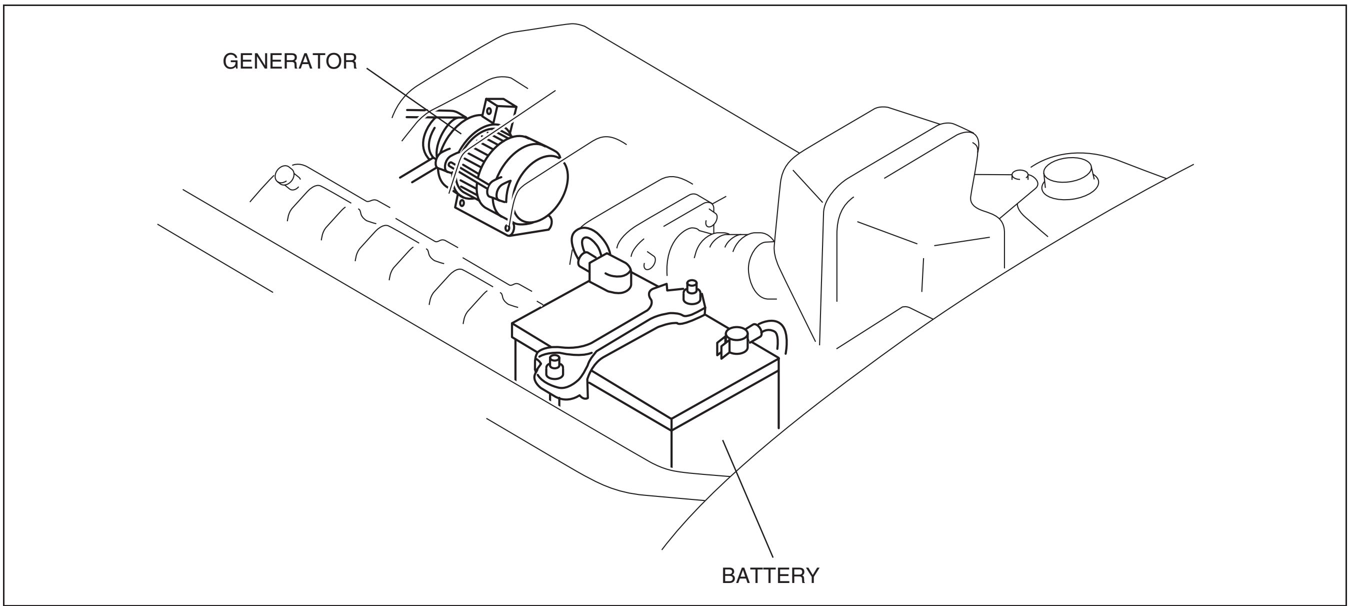
id0117a1102100

Features

Improved reliability	• Generator with built-in power transistor adopted

CHARGING SYSTEM STRUCTURAL VIEW[AJ (3.0L Duratec)]

id0117a1102200



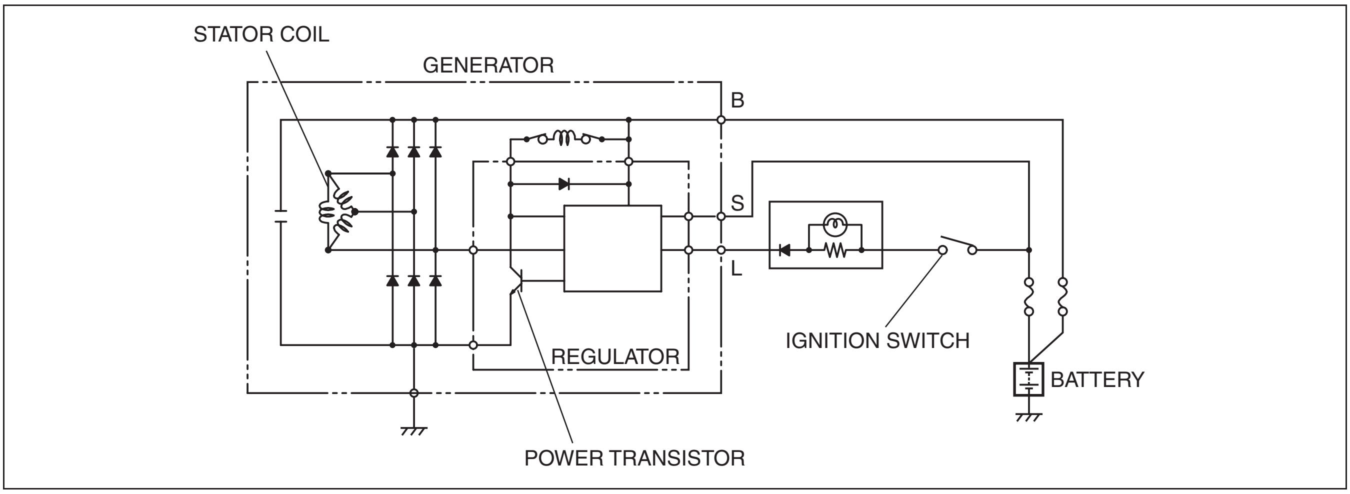
atraan00000121

GENERATOR CONSTRUCTION[AJ (3.0L Duratec)]

id0117a1102300

Generator

- When the ignition switch is turned to the ON position, voltage is supplied to the regulator from the terminal L circuit through the generator warning light in the instrument cluster. The regulator then operates and current flows to the generator field coil from the terminal S circuit. When the engine is started, the generator generates AC which is converted to DC internally. The current is then supplied to electronic devices through generator terminal B.
- When the generator begins generating electricity, voltage from the generator stator is fed back to the regulator. This feedback voltage (generally half the battery voltage) is used for illumination on/off of the warning lights.
- When the system is functioning normally, the generator output current is determined according to the voltage from the terminal S circuit. The regulator compares the voltage from the terminal S circuit and the set internal voltage, and adjusts the field current to control output correctly. The set voltage fluctuates according to temperature whereby, generally, the voltage is higher when the temperature is low and lower when the temperature is high. This keeps the battery charged in the winter and prevents overcharging in the summer.



atraan00000122

Terminal B circuit

- Generator output is supplied to the battery from terminal B, and to each electronic device.

Terminal L circuit

- Terminal L circuit is for supplying power to the regulator. When the ignition switch is turned to the ON position, this circuit supplies power. If there is a malfunction in the charging system, terminal L circuit is also used to illuminate the generator warning light.

Circuit terminal S

- Terminal S circuit is used to detect battery voltage. This voltage is used to determine generator output. This circuit is used to supply current to the rotor. The amount of current supplied to the rotor is determined by the generator output.

01-18A IGNITION SYSTEM [L3]

IGNITION SYSTEM OUTLINE[L3]

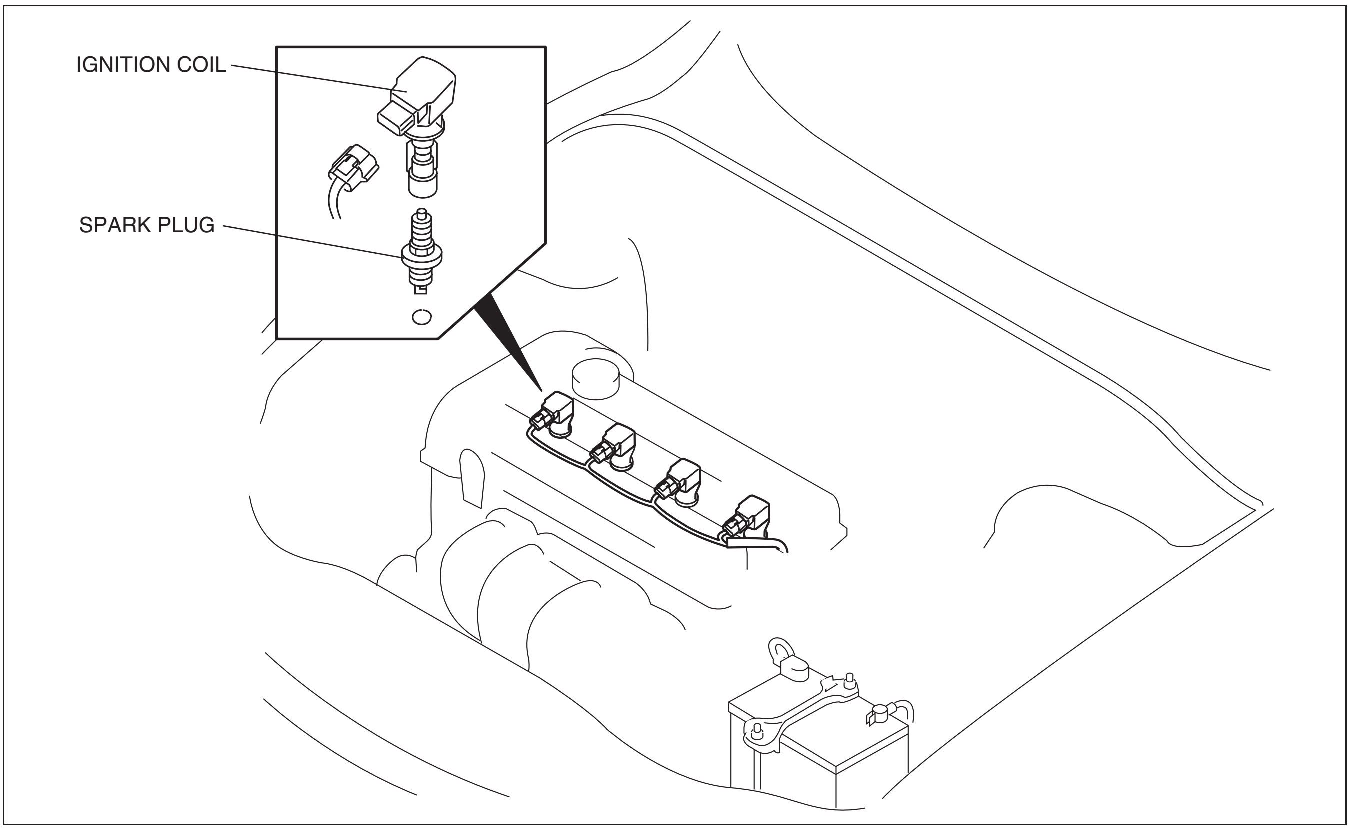
id0118a2100200

Features

Improved reliability	• Independent ignition control system with distributorless ignition coils adopted
Improved durability	• Spark plugs with an iridium alloy center electrode and platinum tip ground electrode adopted

IGNITION SYSTEM STRUCTURAL VIEW[L3]

id0118a2100100



atraan00000131

IGNITION COIL CONSTRUCTION/OPERATION[L3]

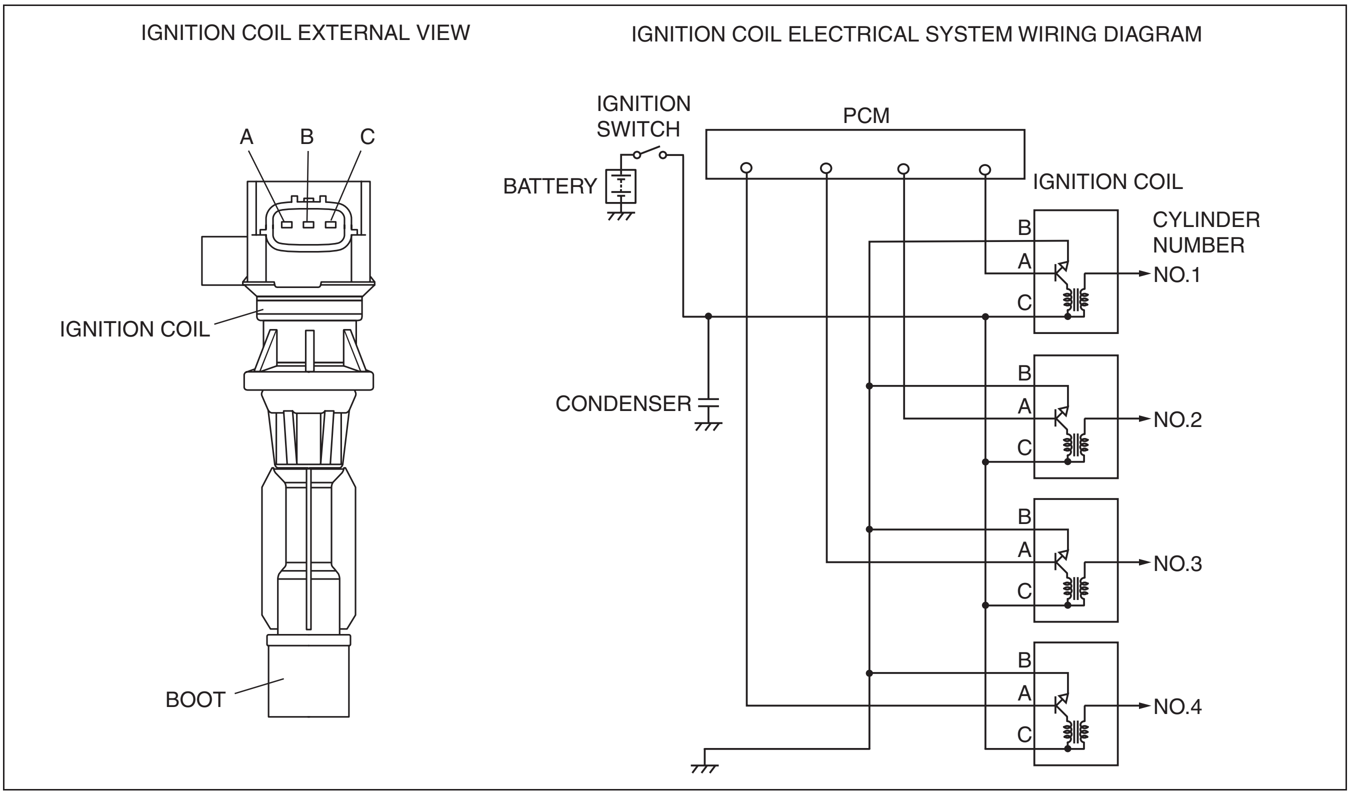
id0118a2100300

Construction

- Direct ignition coils installed directly to each spark plug have been adopted. By adopting direct ignition coils, high-tension leads have been eliminated in order to simplify the parts of the ignition system, preventing voltage reduction, and improving the firing efficiency.
- Independent firing control has been adopted to eliminate firing without spark, increasing firing energy.
- The direct ignition coil consists of an ignition coil, ignition coil connector, and boot area, which has the same function as the current high-tension lead.
- The igniter has been integrated into each ignition coil.

Operation

- The firing timing of the coil is controlled by the PCM for optimum ignition timing control.



atraan00000132

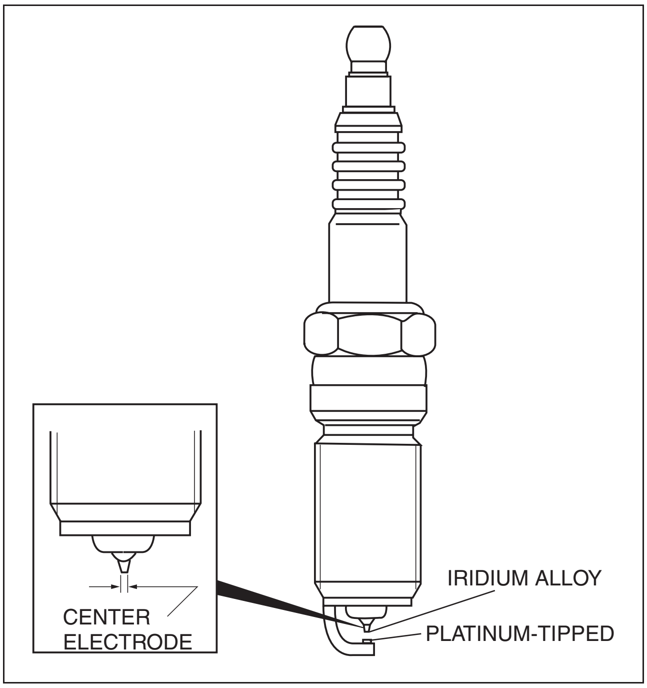
Terminal layout

Terminal		Signal
Three terminals	A	Ignition coil control signal
	B	Ground
	C	Power supply

SPARK PLUG CONSTRUCTION[L3]

id0118a2100400

- An iridium spark plug with excellent durability and firing performance has been adopted.
- The extremely thin, center electrode has a diameter of 0.6 mm {0.024 in} and is made of iridium alloy.
- Durability has been improved by the use of a platinum-tipped grounding electrode.
- Based on the thinner electrode (center electrode), electric discharge has been reduced and ignition has been improved, resulting in stable ignition performance under all driving conditions.



atraan00000133

01-18B IGNITION SYSTEM [AJ (3.0L Duratec)]

01

IGNITION SYSTEM OUTLINE[AJ (3.0L Duratec)]

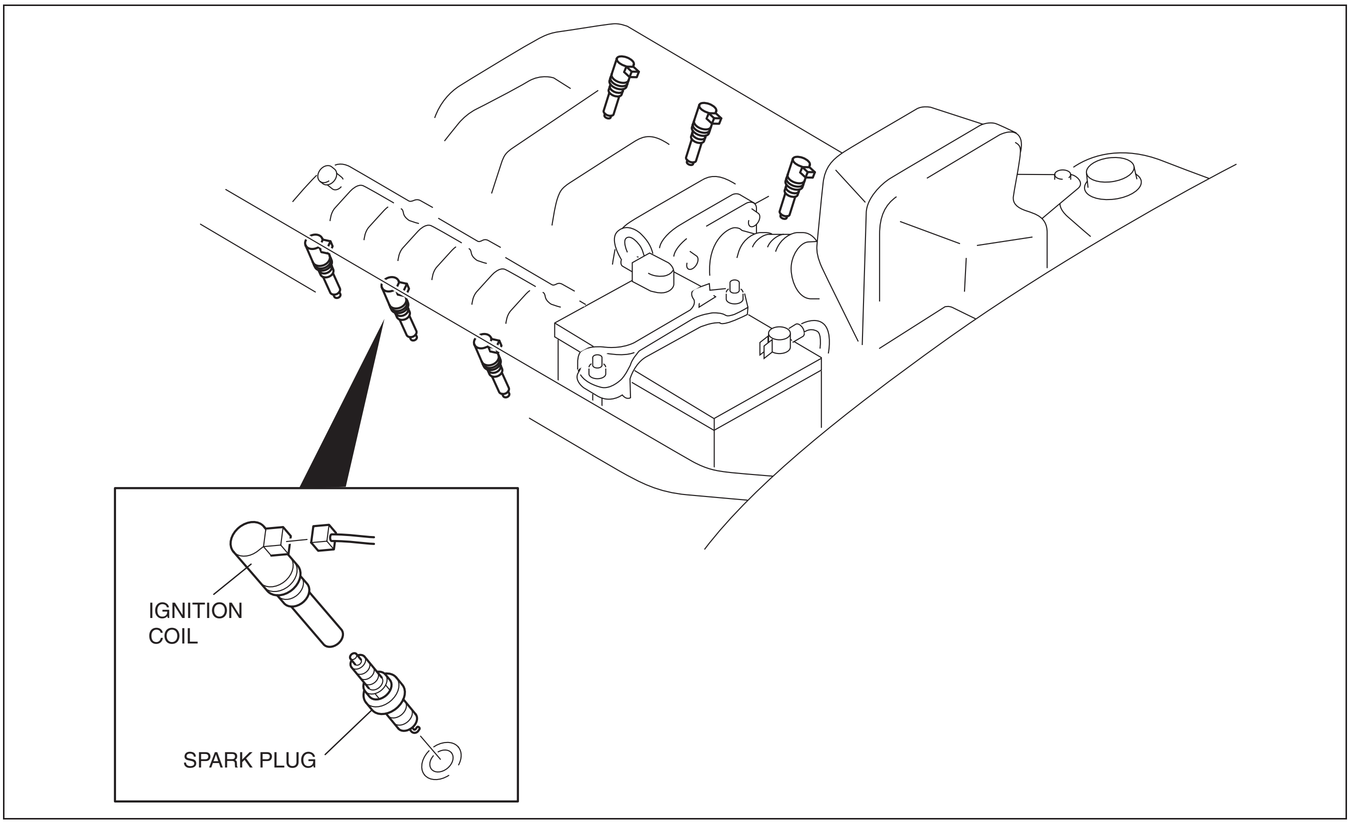
id0118a1100200

Features

Improved reliability	• Independent ignition control system with distributorless ignition coils adopted

IGNITION SYSTEM STRUCTURAL VIEW[AJ (3.0L Duratec)]

id0118a1100100



atraan00000128

IGNITION COIL CONSTRUCTION/OPERATION[AJ (3.0L Duratec)]

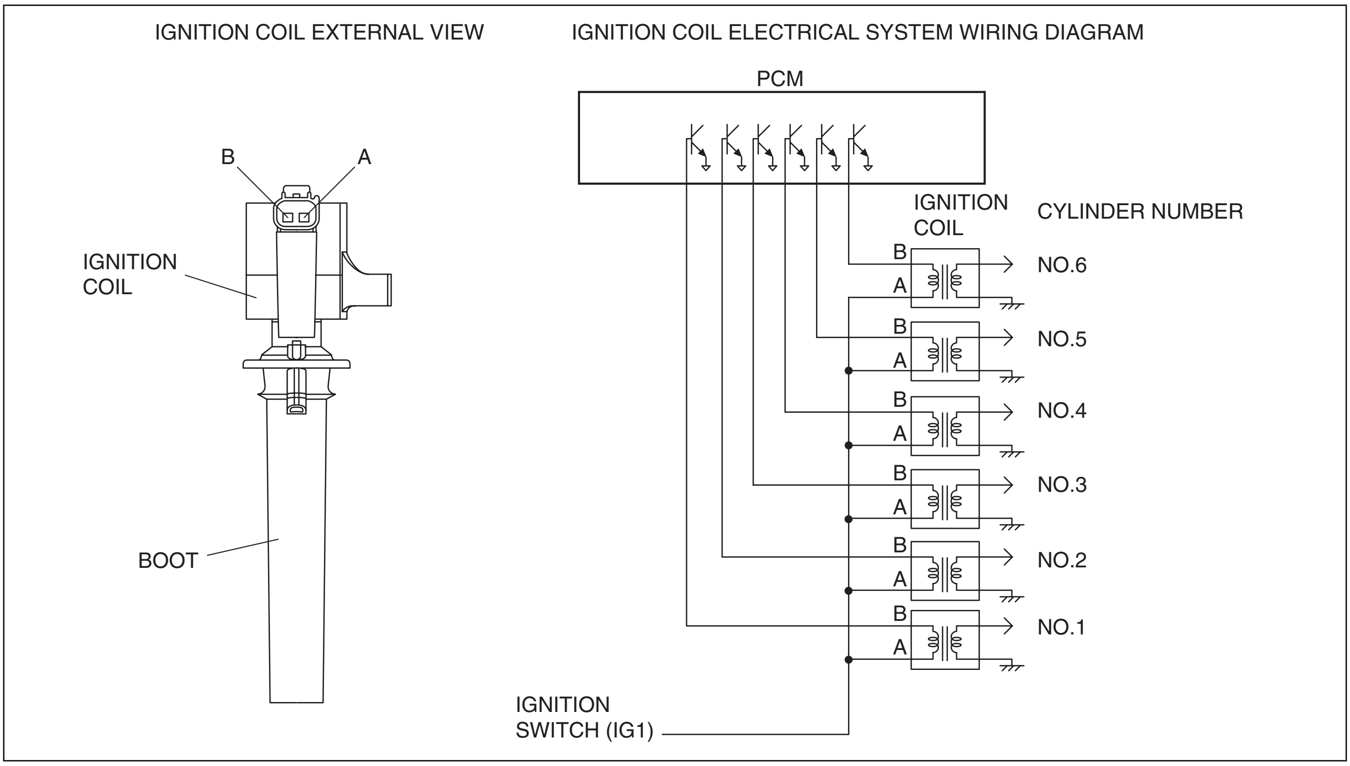
id0118a1100300

Construction

- Direct ignition coils installed directly to each spark plug have been adopted. By adopting direct ignition coils, high-tension leads have been eliminated in order to simplify the parts of the ignition system, preventing voltage reduction, and improving the firing efficiency.
- Independent firing control has been adopted to eliminate firing without spark, increasing firing energy.
- The direct ignition coil consists of an ignition coil, ignition coil connector, and boot area, which has the same function as the current high-tension lead.

Operation

- The firing timing of the coil is controlled by the PCM by means of a built-in igniter for optimum ignition timing control.



atraan00000129

Terminal layout

Terminal		Signal
Two terminals	A	Power supply
	B	Ignition coil control signal

01-19A STARTING SYSTEM [L3]

STARTING SYSTEM OUTLINE[L3]

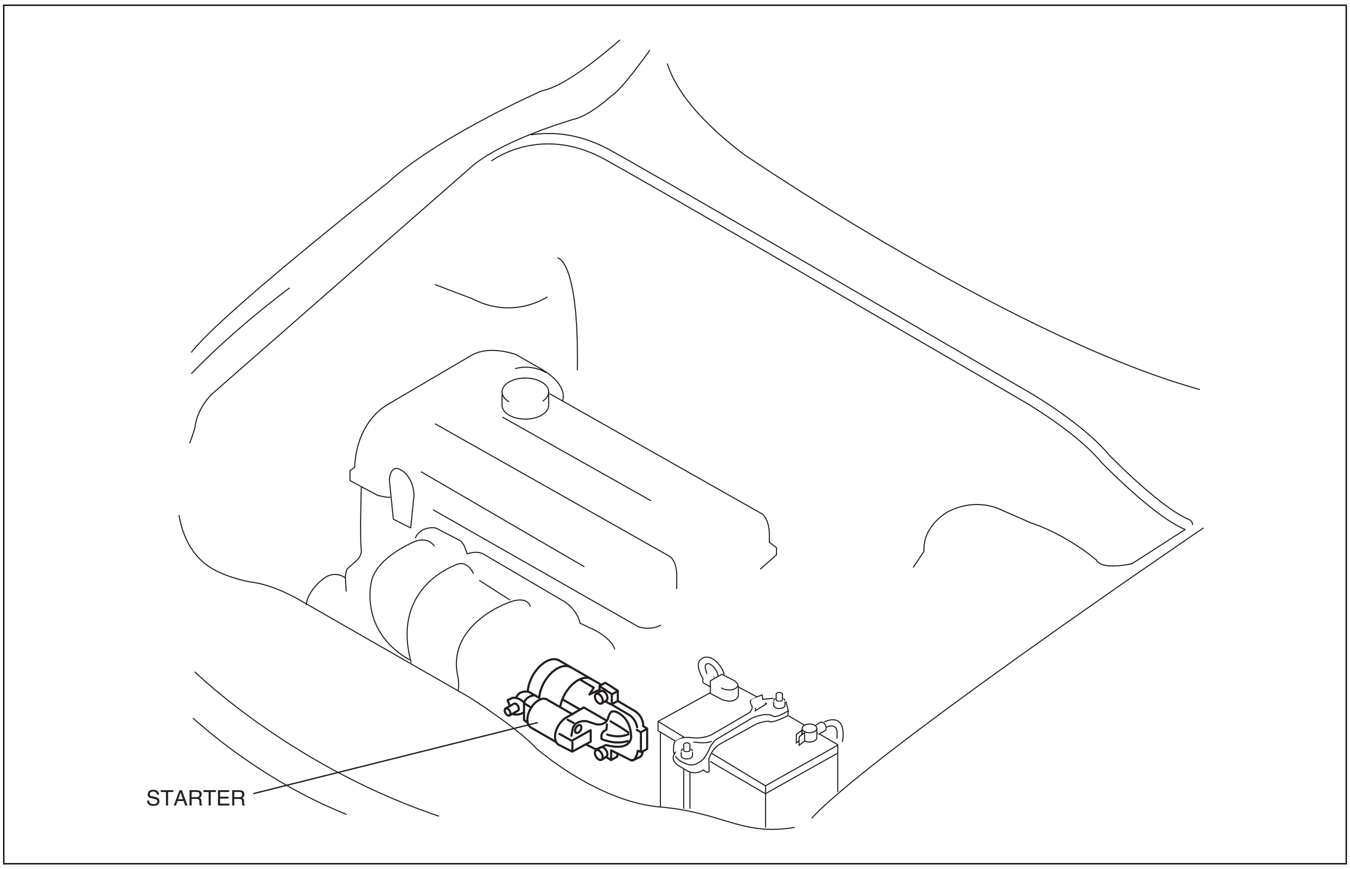
id0119a2100200

Features

Improved startability	• Reduction type starter adopted

STARTING SYSTEM STRUCTURAL VIEW[L3]

id0119a2100100



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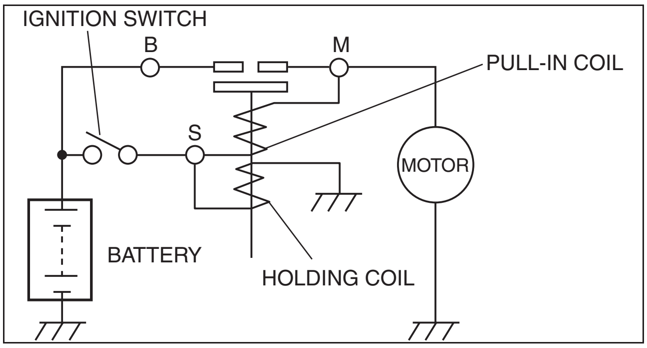
STARTER CONSTRUCTION[L3]

id0119a2100300

- A high torque coaxial reduction type starter has been adopted.



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01-19B STARTING SYSTEM [AJ (3.0L Duratec)]

STARTING SYSTEM OUTLINE[AJ (3.0L Duratec)]

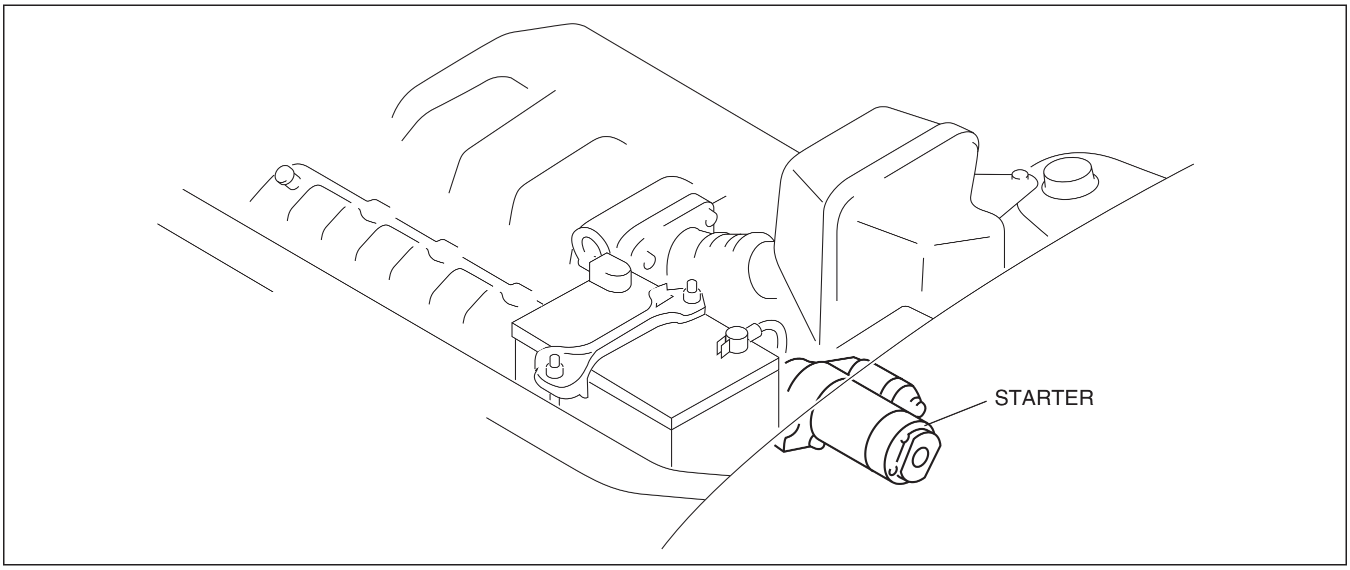
id0119a1100200

Features

Improved startability	• Reduction type starter adopted

STARTING SYSTEM STRUCTURAL VIEW[AJ (3.0L Duratec)]

id0119a1100100



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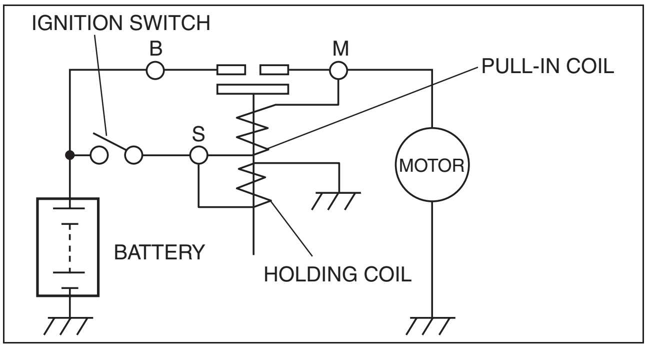
STARTER CONSTRUCTION[AJ (3.0L Duratec)]

id0119a1100300

- A high torque coaxial reduction type starter has been adopted.



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01-40A CONTROL SYSTEM [L3]

ENGINE CONTROL SYSTEM OUTLINE[L3]

id0140a7100100

Features

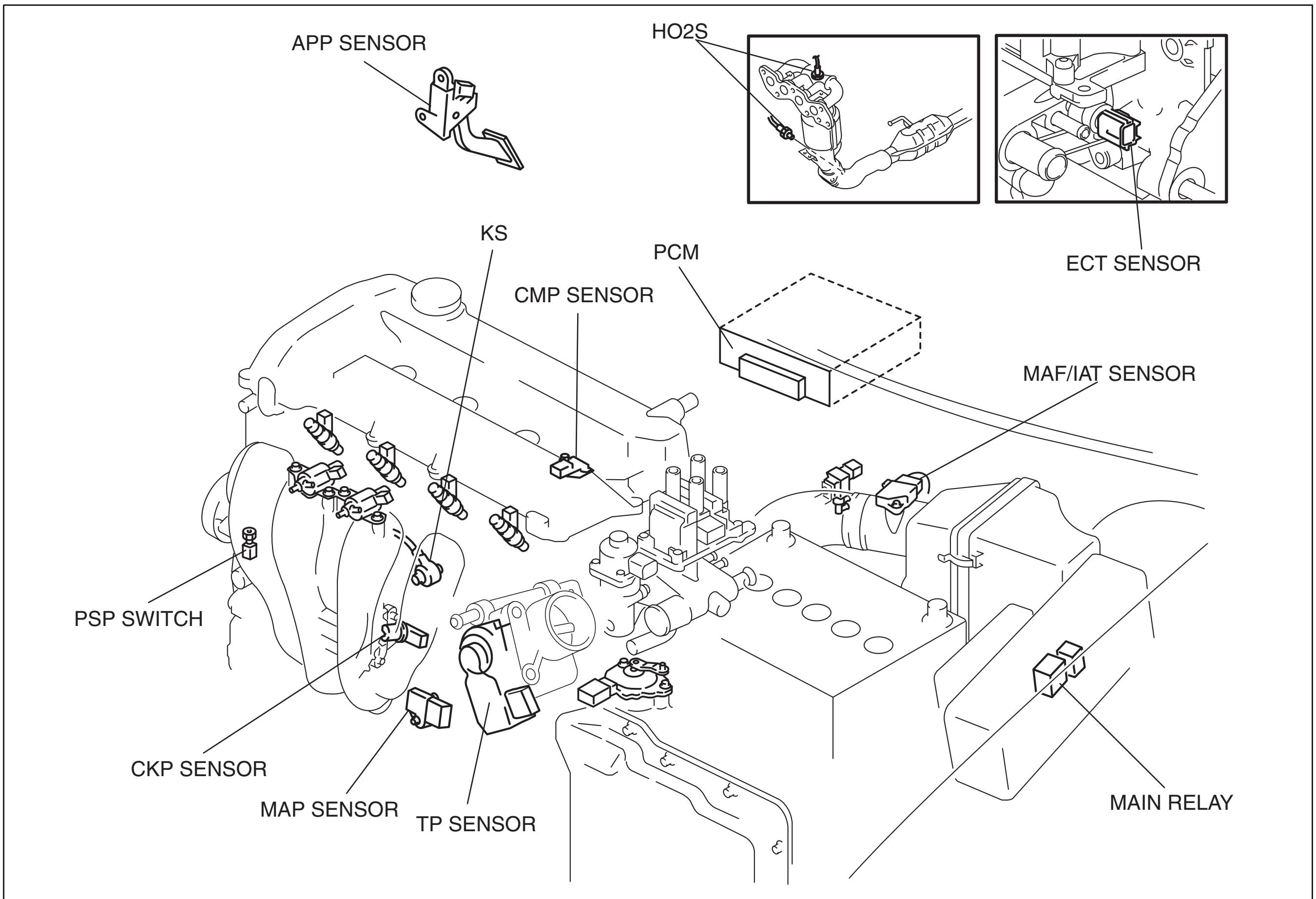
Improved engine torque and output	• Variable intake air control adopted
Improved emission performance	• Variable tumble control adopted • EGR system adopted
Wiring harness simplification	• CAN adopted

Specification

Item	Specification
ECT sensor	Thermistor
IAT sensor (Inside MAF sensor)	Thermistor
TP sensor	Hall element
APP sensor	Hall element
MAF sensor	Hot-wire
Front HO2S	Zirconia element (All range air/fuel ratio sensor)
Rear HO2S	Zirconia element (Stoichiometric air/fuel ratio sensor)
KS	Piezoelectric element
MAP sensor	Piezoelectric element
CKP sensor	Hall element
CMP sensor	Hall element
Brake switch	ON/OFF

ENGINE CONTROL SYSTEM STRUCTURAL VIEW[L3]

id0140a7100200



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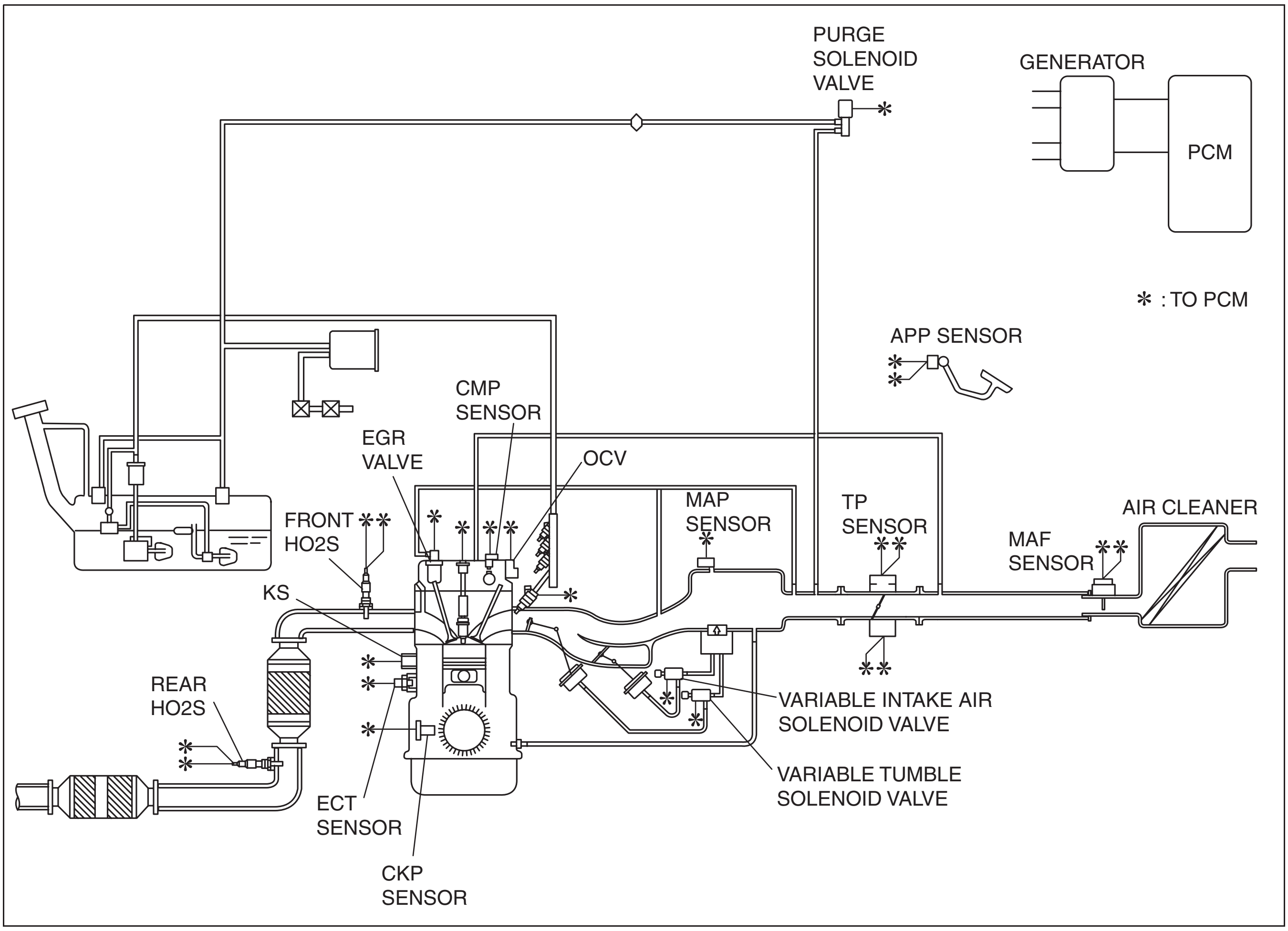
ENGINE CONTROL SYSTEM DIAGRAM[L3]

id0140a7100300



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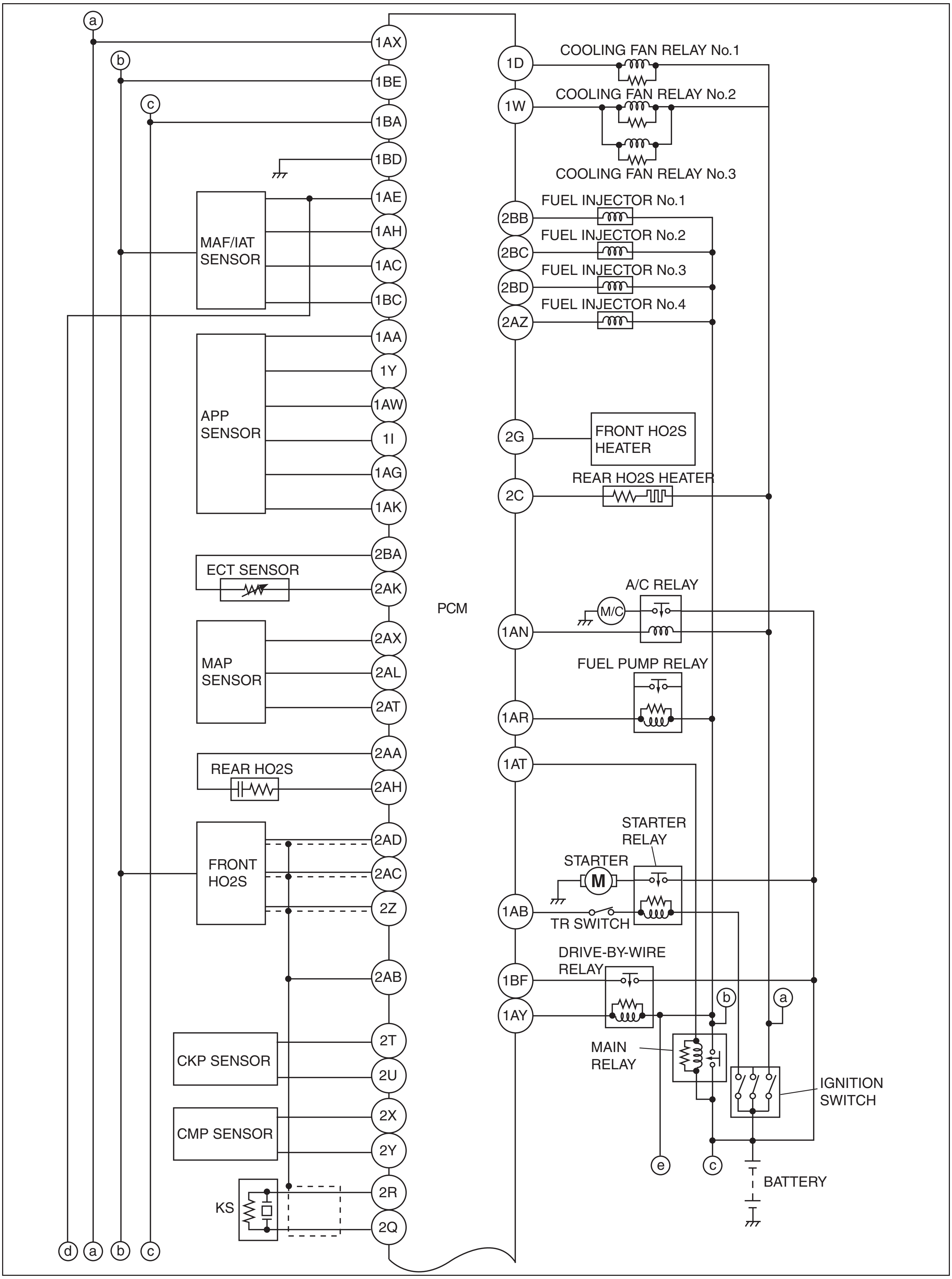
ENGINE CONTROL SYSTEM WIRING DIAGRAM[L3]

id0140a7100400

With Immobilizer System



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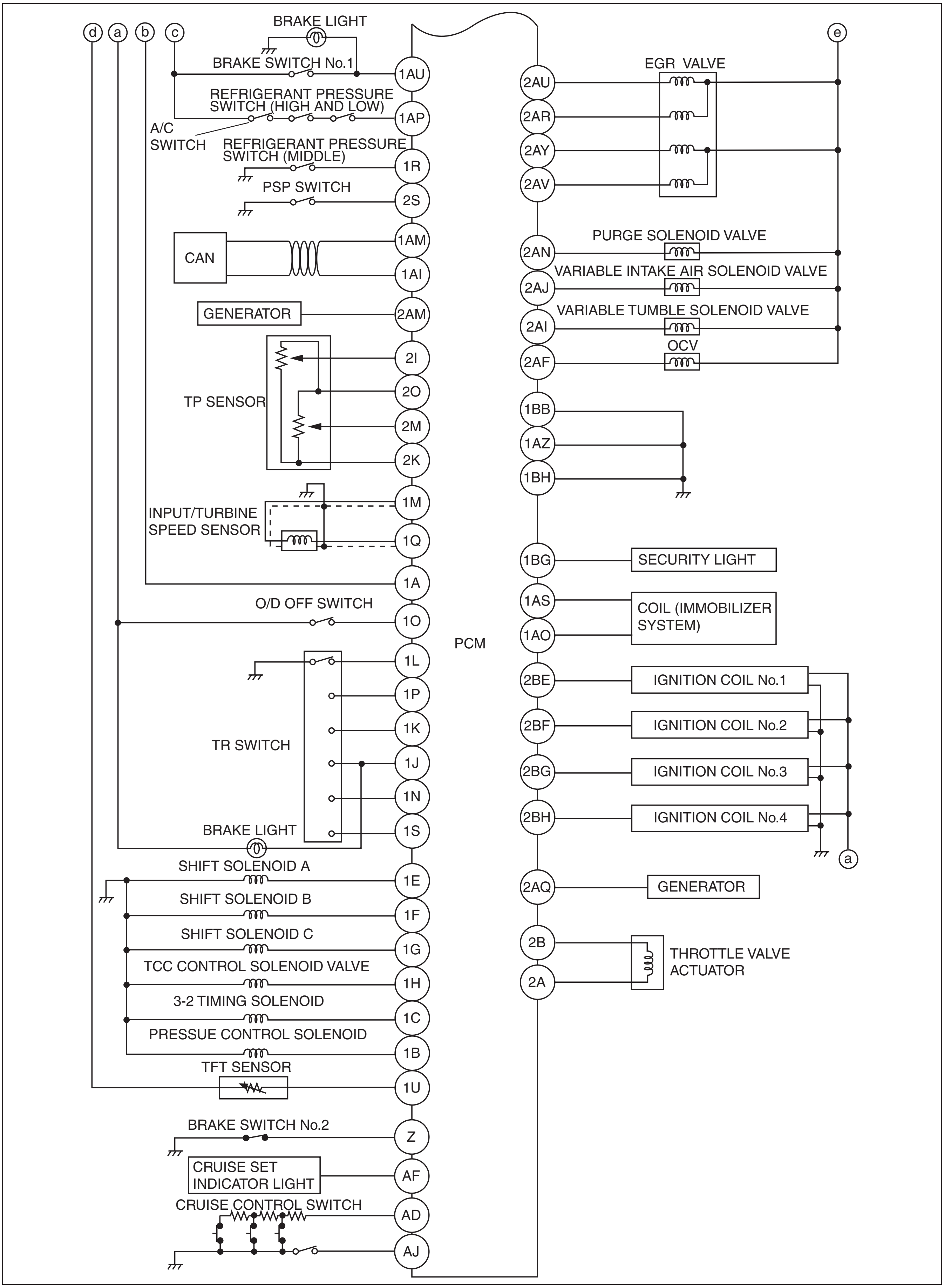

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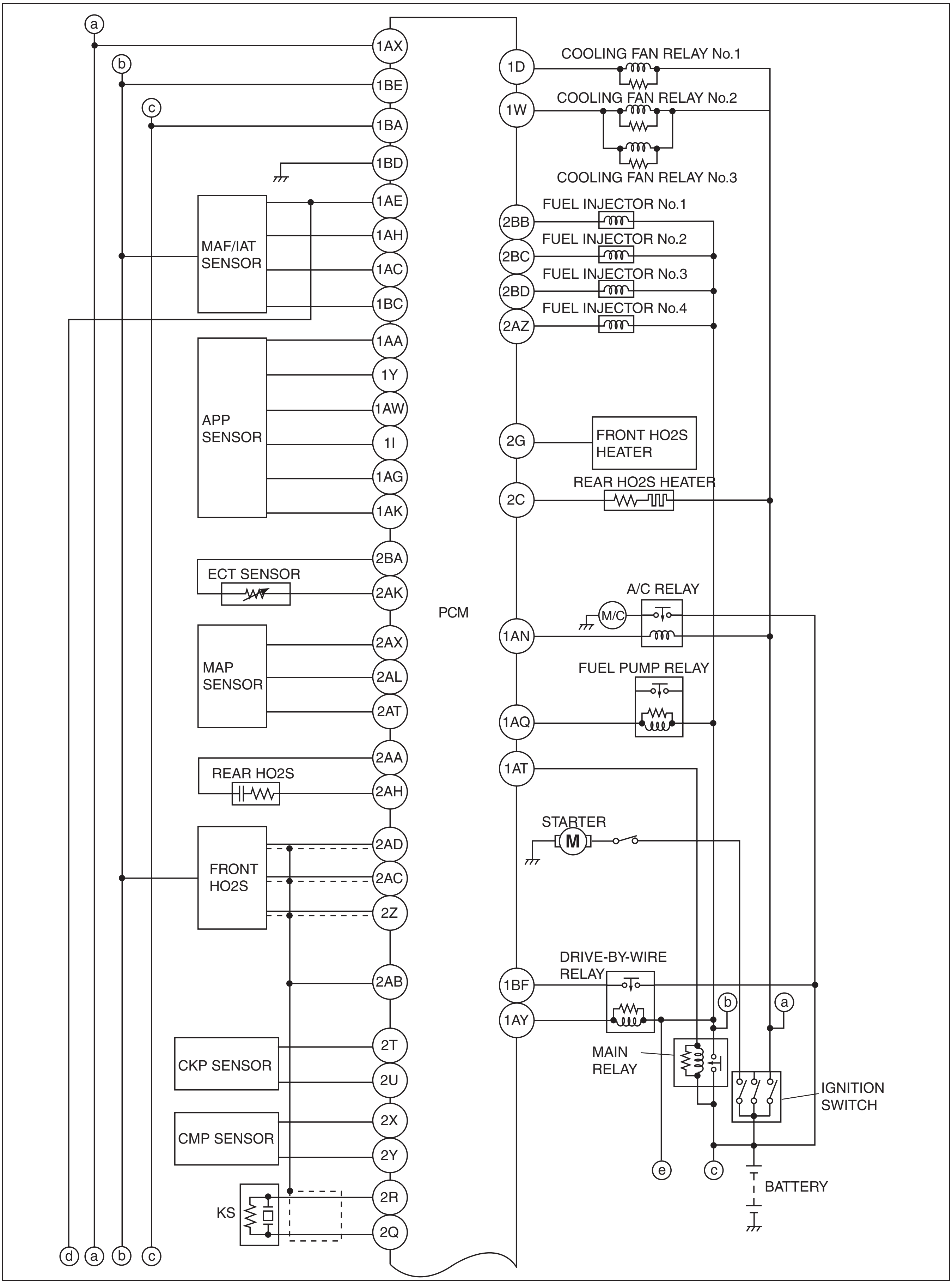
Without Immobilizer System



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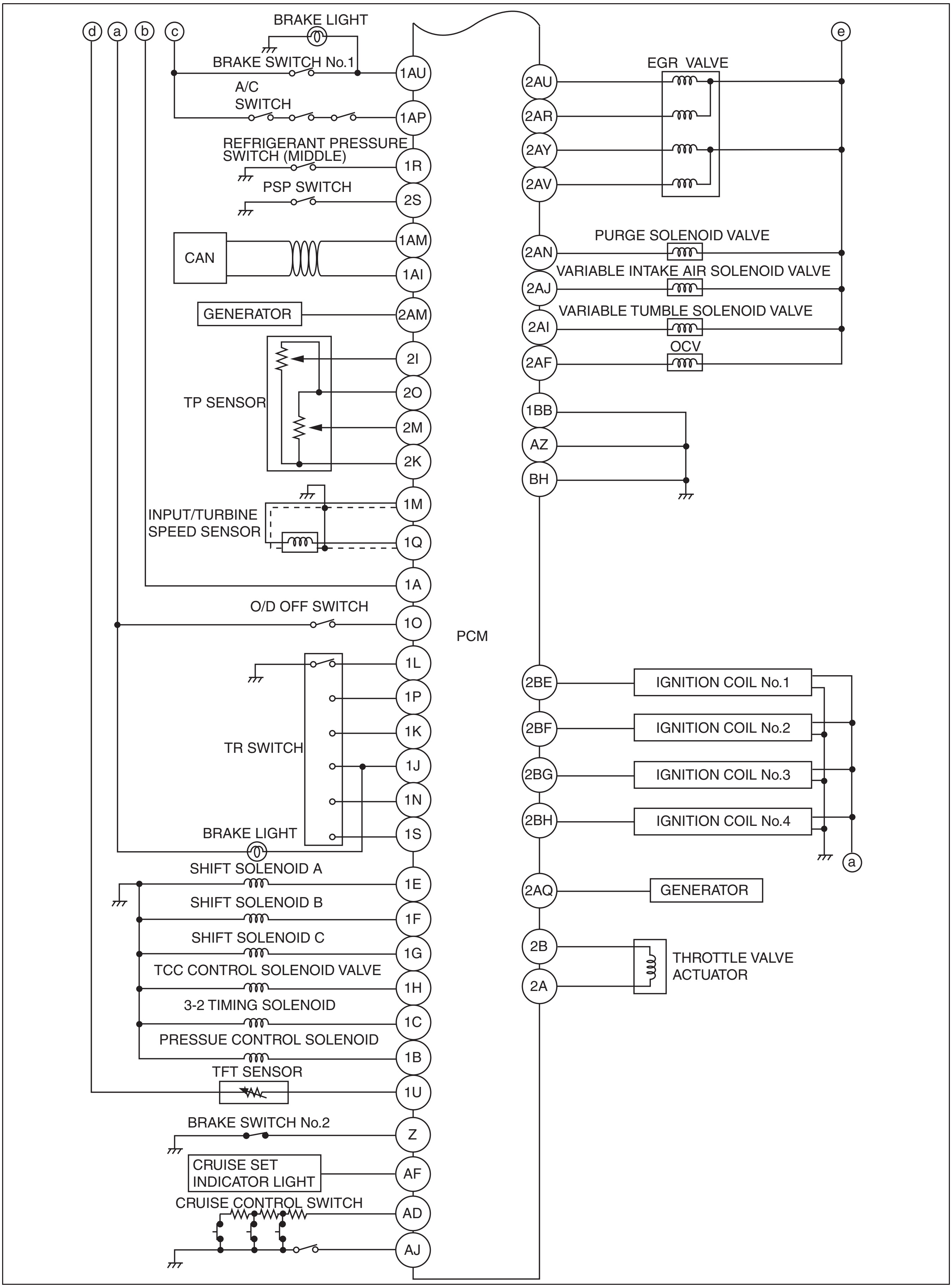
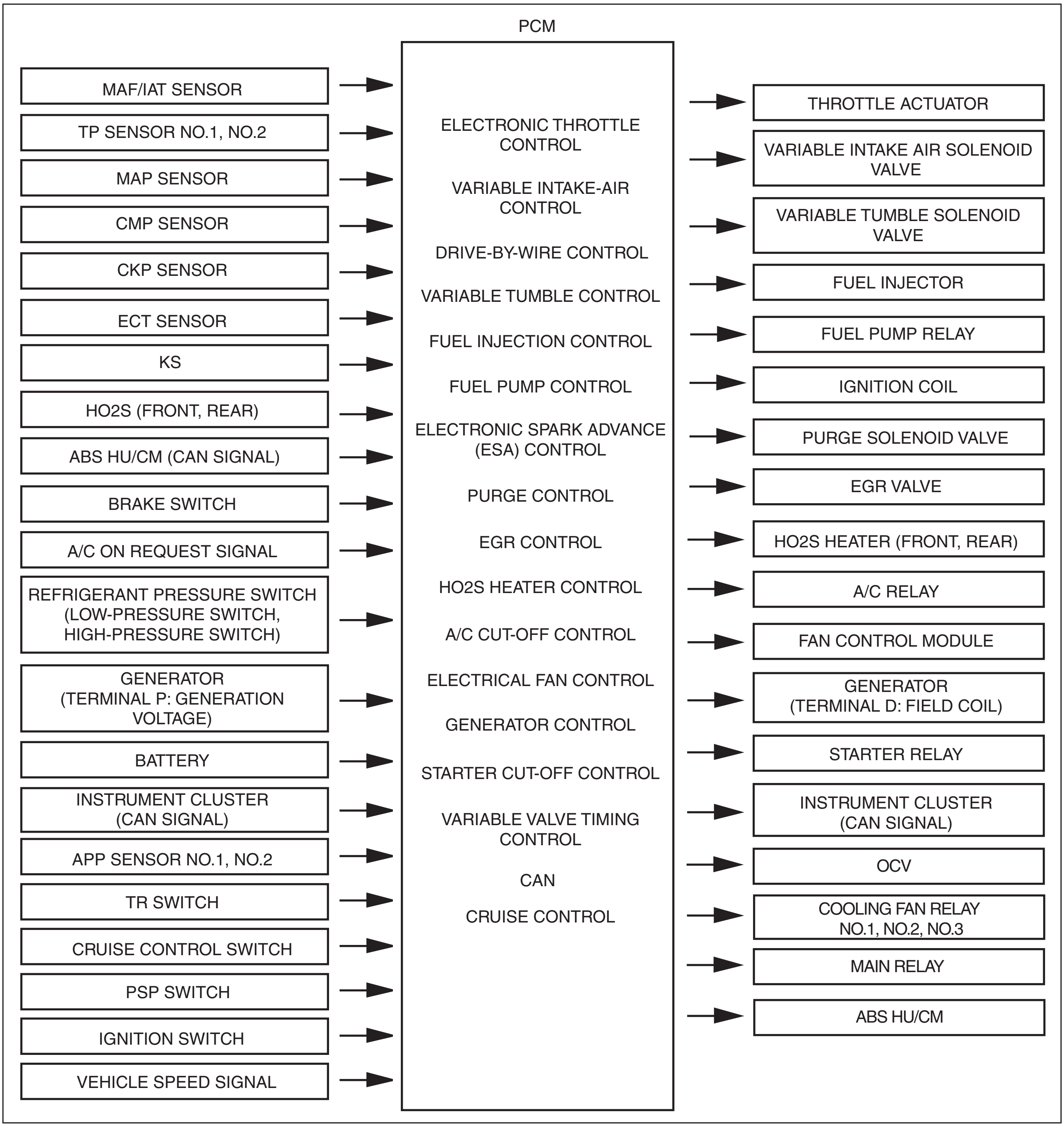

d
a
b
c
e
BRAKE LIGHT
BRAKE SWITCH No.1
A/C SWITCH
REFRIGERANT PRESSURE SWITCH (MIDDLE)
PSP SWITCH
CAN
GENERATOR
TP SENSOR
INPUT/TURBINE SPEED SENSOR
O/D OFF SWITCH
TR SWITCH
BRAKE LIGHT
SHIFT SOLENOID A
SHIFT SOLENOID B
SHIFT SOLENOID C
TCC CONTROL SOLENOID VALVE
3-2 TIMING SOLENOID
PRESSUE CONTROL SOLENOID
TFT SENSOR
BRAKE SWITCH No.2
CRUISE SET INDICATOR LIGHT
CRUISE CONTROL SWITCH
1AU
1AP
1R
2S
1AM
1AI
2AM
2I
2O
2M
2K
1M
1Q
1A
1O
1L
1P
1K
1J
1N
1S
1E
1F
1G
1H
1C
1B
1U
Z
AF
AD
AJ
PCM
2AU
2AR
2AY
2AV
2AN
2AJ
2AI
2AF
1BB
AZ
BH
2BE
2BF
2BG
2BH
2AQ
2B
2A
EGR VALVE
PURGE SOLENOID VALVE
VARIABLE INTAKE AIR SOLENOID VALVE
VARIABLE TUMBLE SOLENOID VALVE
OCV
IGNITION COIL No.1
IGNITION COIL No.2
IGNITION COIL No.3
IGNITION COIL No.4
GENERATOR
THROTTLE VALVE ACTUATOR
aesffn00000106

ENGINE CONTROL SYSTEM BLOCK DIAGRAM[L3]

id0140a7100500



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ENGINE CONTROL SYSTEM RELATION CHART[L3]

id0140a7100600

X: Applied

Item	MAIN RELAY	DRIVE-BY-WIRE CONTROL	VARIABLE INTAKE AIR CONTROL	VARIABLE TUMBLE CONTROL	VARIABLE VALVE TIMING CONTROL	FUEL INJECTION CONTROL	FUEL PUMP CONTROL	ESA CONTROL	EGR CONTROL	EVAPORATIVE PURGE CONTROL	HO2S HEATER CONTROL	A/C CUT-OFF CONTROL	STARTER CUT-OFF CONTROL	ELECTRICAL FAN CONTROL	GENERATOR CONTROL	CRUISE CONTROL	CAN
Input device																	
IAT sensor		X				X		X	X	X	X				X		
MAF sensor		X			X	X		X	X	X	X						
TP sensor No.1, No.2	X	X		X	X	X		X	X	X	X	X	X	X			
APP sensor No.1, No.2	X	X			X	X		X				X					
MAP sensor	X	X				X		X		X		X					
ECT sensor		X		X	X	X		X	X	X	X	X	X	X	X		
CMP sensor					X	X		X									
CKP sensor		X	X	X	X	X	X	X	X	X	X	X			X		
KS								X									
Front HO2S						X				X							
Rear HO2S						X				X							
TR switch		X				X		X	X	X		X					
Brake switch		X				X		X								X	
A/C on request signal		X				X		X				X	X	X			
Refrigerant pressure switch (low pressure switch, high pressure switch)		X				X		X				X	X				
Refrigerant pressure switch (medium pressure switch)		X											X				
Battery	X				X	X		X	X	X	X		X	X	X		
Generator (Terminal P: starter coil)		X				X		X					X		X		
Vehicle speed signal		X				X		X	X	X			X	X	X	X	X
Cruise control switch																X	
Instrument cluster (CAN signal)		X				X	X	X					X				X
PSP switch		X															
Ignition switch	X	X			X		X							X			X
Output device																	
Main relay	X																
Throttle actuator		X														X	
Variable intake air solenoid valve			X														
Variable tumble solenoid valve				X													
OCV					X												
Fuel injector						X											
Fuel pump relay							X										
Ignition coil								X									

Item	MAIN RELAY	DRIVE-BY-WIRE CONTROL	VARIABLE INTAKE AIR CONTROL	VARIABLE TUMBLE CONTROL	VARIABLE VALVE TIMING CONTROL	FUEL INJECTION CONTROL	FUEL PUMP CONTROL	ESA CONTROL	EGR CONTROL	EVAPORATIVE PURGE CONTROL	HO2S HEATER CONTROL	A/C CUT-OFF CONTROL	STARTER CUT-OFF CONTROL	ELECTRICAL FAN CONTROL	GENERATOR CONTROL	CRUISE CONTROL	CAN
EGR valve									X								
Purge solenoid valve										X							
Front HO2S heater											X						
Rear HO2S heater											X						
A/C relay												X					
Starter relay													X				
Cooling fan relays														X			
Generator (Terminal D: field coil)															X		
ABS HU/CM (CAN signal)																	X
Instrument cluster (CAN signal)																	X

MAIN RELAY CONTROL OUTLINE[L3]

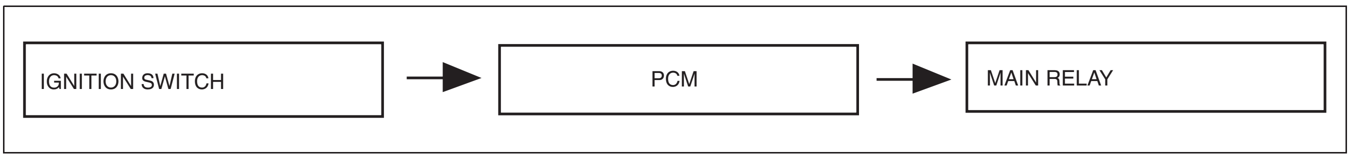
id0140a7170300

- When the ignition switch is turned to the ON position, the main relay turns on.
- When the ignition switch is turned from on to off, the main relay turns on for a few minutes to activate the fully-closed throttle learning function of the drive-by-wire control, the after-cooling function of the electrical fan control.

MAIN RELAY CONTROL BLOCK DIAGRAM[L3]

id0140a7170100

- The PCM controls the main relay on/off, based on commands from the ignition switch or the controls.



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MAIN RELAY CONTROL OPERATION[L3]

id0140a7170200

- When the ignition switch is turned to the ON position, the main relay turns on and power is supplied to sensors and devices.
- When the ignition switch is turned from on to off, a main relay on command signal is received the main relay turns on and the following actions take place:
  1. Throttle valve control: Fully closed throttle learning function (See 01-40A-14 DRIVE-BY-WIRE CONTROL OPERATION[L3].)
  2. After-cooling function of the electrical fan control (See 01-40A-37 ELECTRICAL FAN CONTROL OPERATION[L3].)
- When the on request signal from the controls stop, the main relay turns off.

DRIVE-BY-WIRE CONTROL OUTLINE[L3]

id0140a7170400

- The drive-by-wire control calculates the optimum target throttle valve opening angle at all ranges of engine speeds and controls the throttle valve actuator.
- The drive-by-wire control includes idle speed control, accelerator control, traction control, cruise control, and vehicle speed limiter.

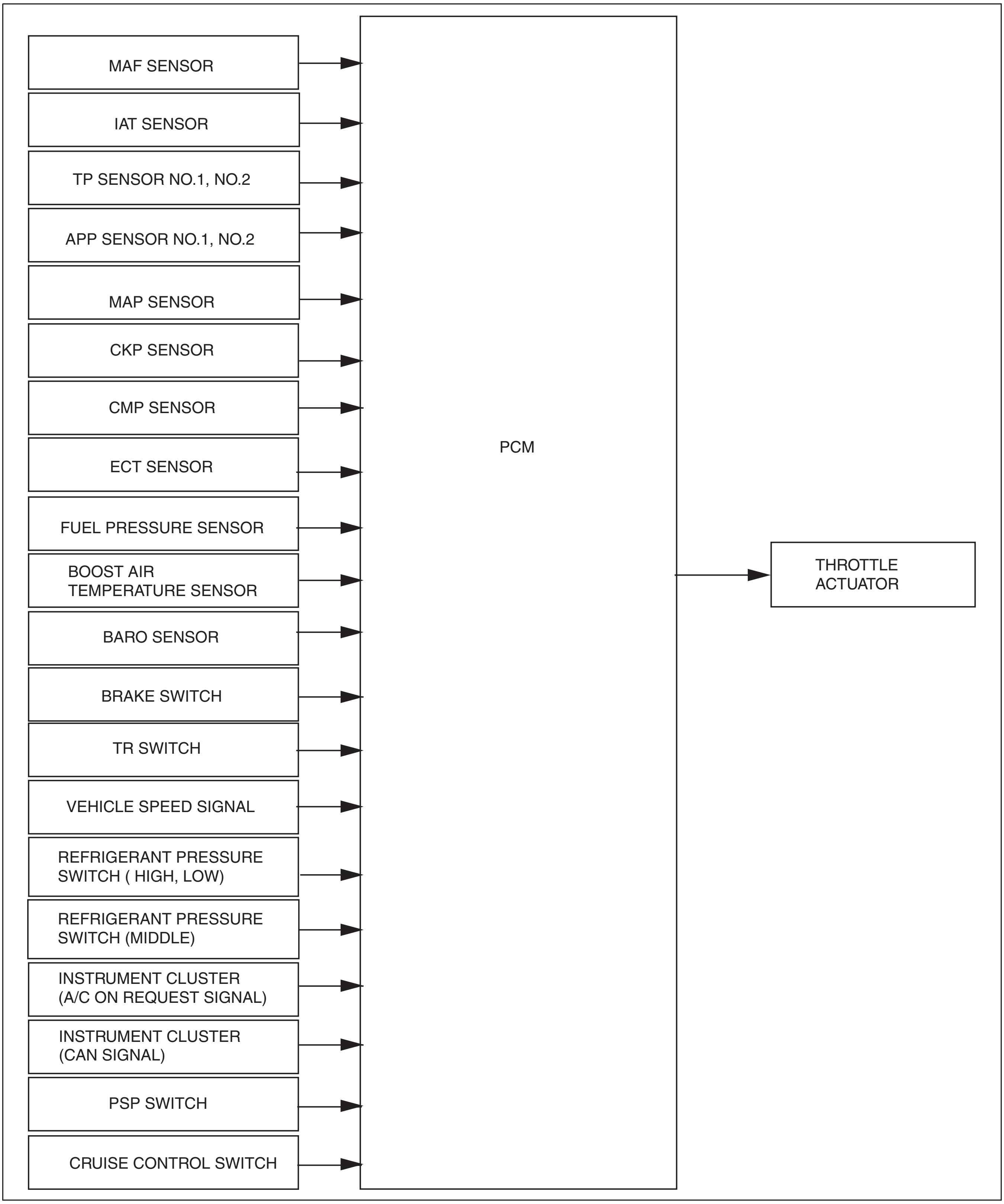
Control List

Control name	Control Outline
Idle speed control	• In order to ensure idling stability, the PCM controls the throttle valve and sets an optimal throttle valve opening angle based on the engine operating conditions.
Accelerator control	• The throttle actuator is controlled to the appropriate throttle opening angle according to the accelerator opening angle, gear position, and engine speed.
Traction control	• Controls the throttle valve opening angle by torque up/down request signals from the DSC HU/CM and TCM.
Cruise control	• Sets the vehicle speed by operation of the cruise control switch and controls the throttle valve opening angle so that it becomes close to the set vehicle speed.

DRIVE-BY-WIRE CONTROL BLOCK DIAGRAM[L3]

id0140a7170500

- The PCM calculates a throttle valve opening angle matching the engine operation conditions from the following input signals and sends a duty signal to the throttle valve actuator.



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DRIVE-BY-WIRE CONTROL OPERATION[L3]

id0140a7170600

Idle Speed Control

- In order to ensure idling stability, the PCM controls the throttle valve and sets an optimal throttle valve opening angle based on the engine operating conditions.

Target throttle valve opening angle determination

- The PCM calculates the intake airflow amount required to provide idling stability (IAC target airflow amount), and according to that, determines the target throttle valve opening angle.
- When the engine is cranking, the PCM sets the IAC target airflow amount according to the engine coolant temperature, and opens the throttle valve to that set value.

IAC target airflow amount

- The IAC target airflow amount is calculated by the PCM by subtracting the estimated value for the intake airflow amount which does not pass through the throttle valve from the calculated intake airflow amount required for idling stability (required volume weight).
  Required volumetric airflow amount
  — The required volumetric airflow amount is calculated from the target charging efficiency as corrected by the changes in intake airflow amount (due to the difference in vacuum pressure in the areas before and after the throttle valve) and in intake airflow density (which changes according to intake airflow temperature change).
  Target charging efficiency
  — The target charging efficiency is the charging efficiency* required to match engine operating conditions.
  — The target charging efficiency is calculated by adding all necessary corrections matching engine operating conditions to the basic charging efficiency as determined according to engine coolant temperature.

* : Charging efficiency is the ratio of the actual intake airflow amount over the maximum amount of airflow (mass) which can fill a cylinder. This figure grows larger in proportion to the increase in engine load.

Correction	Target	Conditions	Correction amount
A/C load correction	Prevents decrease in idle speed due to A/C operation.	A/C is operating.	A/C operation time→correction
P/S load correction	Prevents decrease in idle speed due to P/S operation.	P/S is operating.	P/S operation→correction
Electrical load correction	Prevents decrease in idle speed due to electrical load operation.	Idle speed during electrical load operation and under any condition during driving	High electrical load→large correction
D-range correction	Prevents decrease in idle speed due to shifting into D-range.	D-range signal is input.	P/S operation→correction
Dashpot correction	Prevents decrease in idle speed due to insufficient intake air amount during deceleration.	Decelerated	Low idle speed when shifted to D range→large correction
Correction at engine start	Prevents decrease in idle speed after engine start.	After cranking and engine start	Low ECT→large correction
Hot engine restart correction	Prevents decrease in idle speed from hot engine restart.	Just after cranking and engine start when the ECT is 60 °C {140 °F} or more the IAT is 40 °C {104 °F} or more	High intake airflow temperature→large correction
Feedback correction A	Sets idle speed to target engine speed.	Idle speed during idling (vehicle is stopped) is over or under the target engine speed (except during test mode).	Actual idle speed Target engine speed or less→volume increase correction Target engine speed or more→volume decrease correction
Feedback correction B	Sets to the target engine speed when the idle speed has decreased in the range not corrected by feedback correction A, and prevents a decrease in idle speed.	During deceleration at fully closed throttle, the engine speed is the target engine speed or more and when the feedback correction A is not performed (except during test mode).	Large difference between actual idle speed and target engine speed→large correction
Learning correction	Stores intake air volume changes based on differences between engines and changes due to aged deterioration, and feedback.	During feedback correction A when ECT is 85 °C {185 °F} or more.	During idling→average value of feedback correction A

Correction	Target	Conditions	Correction amount
Volume increase correction at vehicle start	Ensures driveability just after vehicle start.	When the accelerator pedal is depressed while the clutch pedal is kept depressing.	Large APP→large correction

Target idle speed
- The target idle speed for various engine operation conditions are as follows:

Standard

Load status	Idle speed (rpm) Neutral position
No load	650—750
Electrical loads on	650—750
P/S operating	650—750
A/C on	650—750

Accelerator Control
- Feedback control has been adopted to the throttle actuator and it is monitored by the TP sensor so that it reaches the target throttle opening angle.

Target throttle opening angle
- Throttle opening angle according to the engine speed and target charging efficiency table has been set.

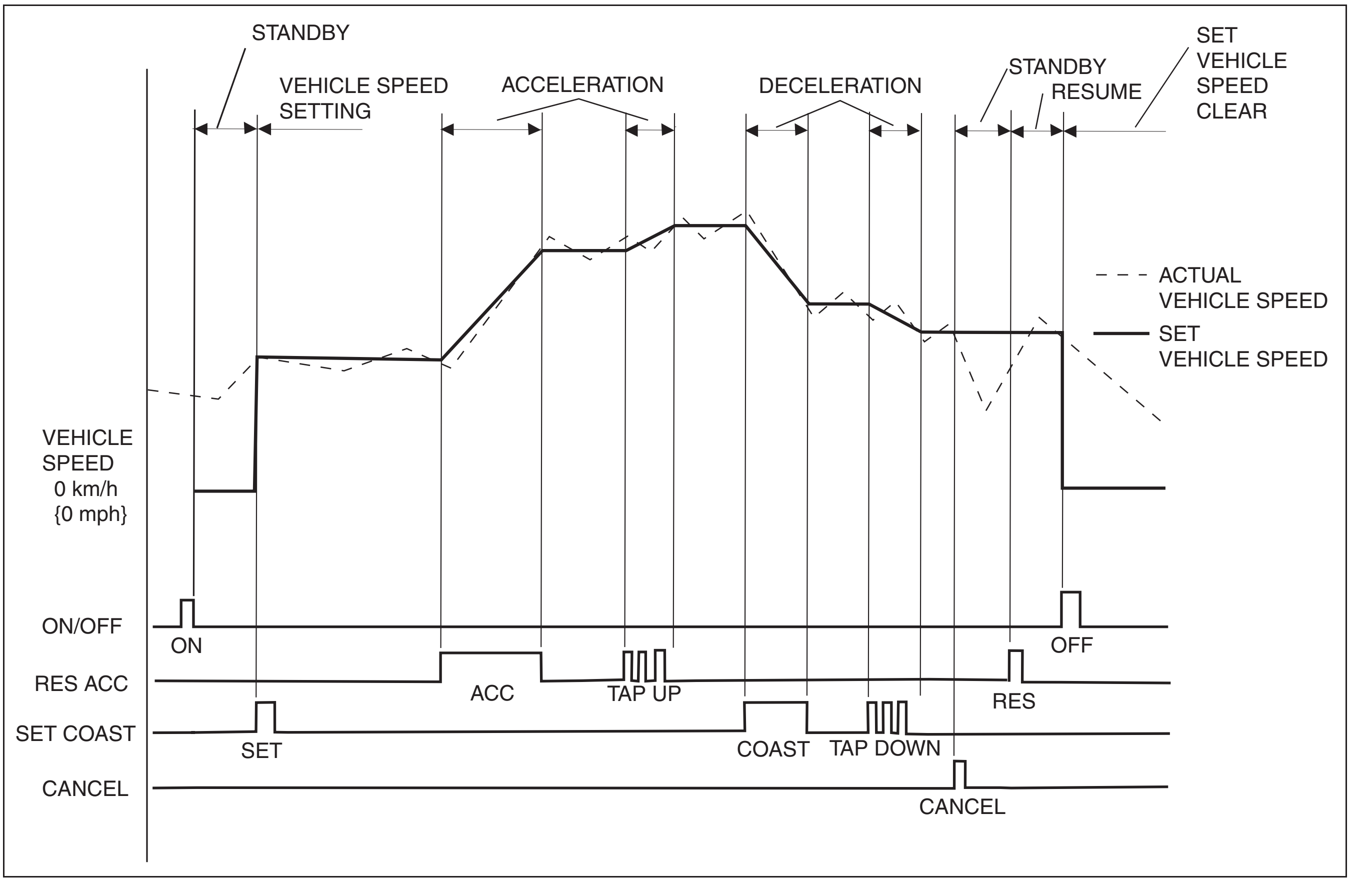
Target charging efficiency table
- This table has been created by assuming a target charging efficiency according to the engine speed and virtual accelerator opening angle.

Virtual accelerator opening angle
- The virtual accelerator opening angle has been set according to the gear position, vehicle speed, accelerator opening angle, and accelerator opening change rate to improve driveability.

Traction Control
- The PCM calculates the target throttle valve opening angle by the torque up/down request signal from the DSC HU/CM and TCM and the engine speed.

Cruise Control

- Calculates the throttle valve opening angle based on the deviation of the actual vehicle speed from the set vehicle speed which was set with the cruise control switch and sends a duty signal to the throttle valve actuator.
- The PCM controls the actual vehicle speed so that it is close to the set vehicle speed.



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- The cruise control includes the cruise control operation condition and the cruise control stop condition.

Cruise control operation condition

- When all of the following conditions are met, execution of the cruise control system is enabled (cruise control standby status).
  — Cruise control main switch: ON
  — Vehicle speed: Exceeds 30 km/h {18.6 mph}

Cruise control stop condition

- When any of the following conditions are met even while in cruise control, the PCM stops the cruise control and clears the set vehicle speed.
  — Ignition switch: OFF
  — Cruise control main switch: OFF
  — Cruise control related DTCs (P0564, P0571) detected
- When any of the following conditions are met even while in cruise control, the PCM stops the cruise control while storing the set vehicle speed.
  — Cancel switch: ON
  — TR switch: P/N position switch: ON
  — Vehicle speed: Less than 22.5 km/h {13.9 mph}
  — Brake switch: ON
  — The actual vehicle speed is 15 km/h {9.3 mph} or more lower than the set vehicle speed during cruise control (ascending).
  — Condition where actual vehicle speed is 15 km/h {9.3 mph} or more lower than the set vehicle speed continues for 60 s or more even when the RESUME/ACCEL switch is on.

Cruise control function

- The cruise control includes accelerating, coasting, resume, tap-down, tap-up and downshift functions.

Function List

Function	Contents
Accelerating	• When any of the following conditions are met while driving in cruise control and when the RESUME/ ACCEL switch is continuously pressed, the PCM gradually increases the set vehicle speed. — Except during resume operation — The RESUME/ACCEL switch is on one time or more during resume operation.
Coasting	• When the SET/COAST switch is continuously pressed, the PCM gradually decreases the set vehicle speed.
Resume	• When the RESUME/ACCEL switch signal is input to the PCM during regular driving (cruise control is stopped) and the previously set vehicle speed is stored in the PCM, the PCM sets the set vehicle speed to the previously set vehicle speed and begins control.
Tap down	• When all of the following conditions are met while driving in cruise control, the PCM decreases the set vehicle speed by 1.6 km/h {1 mph} and controls the throttle valve actuator. — During cruise control — RESUME/ACCEL switch off — The RESUME/ACCEL switch switches from off to on — When actual vehicle speed is lower (set vehicle speed −2 km/h {-1.2 mph})
Tap-up	• When all of the following conditions are met, the PCM increases the set vehicle speed by 1.6 km/h {1 mph} and controls the throttle valve actuator so that the vehicle speed is close to the set vehicle speed. — During cruise control — The RESUME/ACCEL switch switches from off to on
Downshift	• When the following conditions are met, a downshift signal is sent to the TCM via CAN. — RESUME/ACCEL switch on — Target vehicle acceleration is not reached

DRIVE-BY-WIRE RELAY CONTROL OUTLINE[L3]

id0140a7170700

- Supplies power to the drive-by-wire control.

DRIVE-BY-WIRE RELAY CONTROL OPERATION[L3]

id0140a7170800

- When the main relay is on, the drive-by-wire relay also turns on. (See 01-40A-11 MAIN RELAY CONTROL OUTLINE[L3].)

VARIABLE INTAKE AIR CONTROL OUTLINE[L3]

id0140a7176300

- Energizes the variable intake-air solenoid valve according to engine speed for enhanced inertia charging effect.

VARIABLE INTAKE AIR CONTROL BLOCK DIAGRAM[L3]

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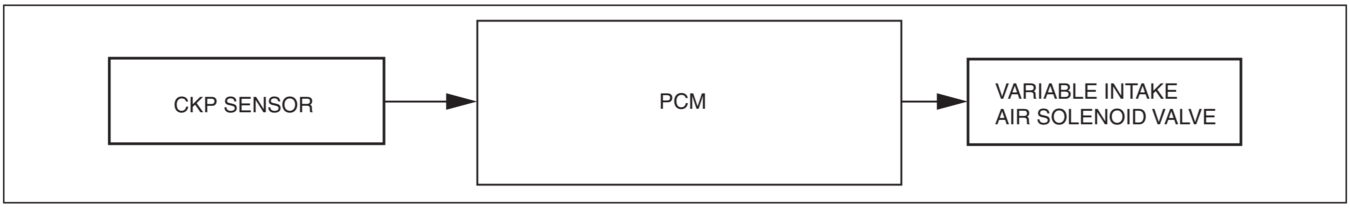

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VARIABLE INTAKE AIR CONTROL OPERATION[L3]

id0140a7176200

- The PCM energizes the variable intake air solenoid valve when the engine speed is less than 4,600 rpm, opening the variable intake air shutter valve to enhance the inertia charging effect at the low engine speed range.
- The PCM blocks energization to the variable intake-air solenoid valve when the engine speed is 4,600 rpm or more, closing the variable intake shutter valve to enhance the inertia charging effect at the high engine speed range.

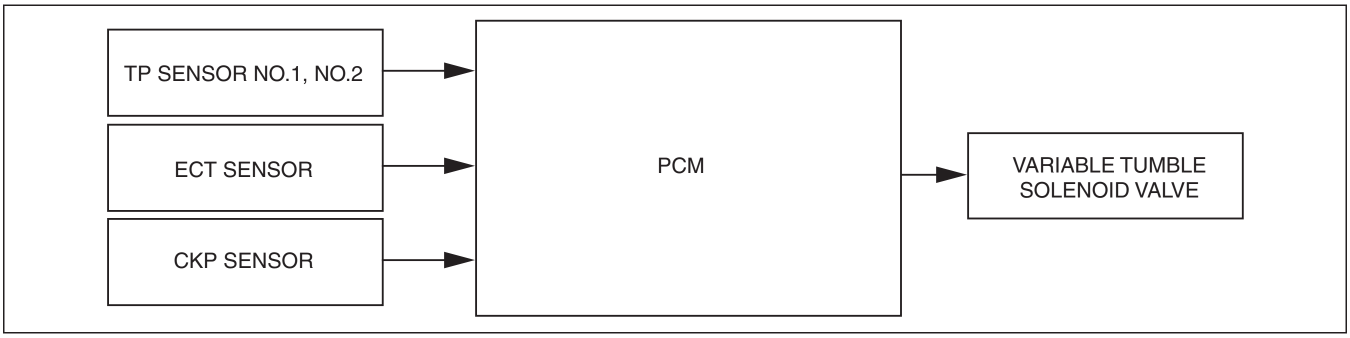
VARIABLE TUMBLE CONTROL OUTLINE[L3]

id0140a7176600

- At cold engine start, the following occur due to the closing of the variable tumble shutter valve for improved cold engine exhaust emission performance.
  — Improved intake airflow speed near injectors
  — Strong air tumble occurs in the combustion changer, promoting vaporization mixture of intake air and fuel

VARIABLE TUMBLE CONTROL BLOCK DIAGRAM[L3]

id0140a7176400



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VARIABLE TUMBLE CONTROL OPERATION[L3]

id0140a7176500

Operation conditions

- When all of the following conditions are met, the PCM energizes the coil of variable tumble solenoid valve. As a result, negative pressure is introduced to the diaphragm chamber of the variable tumble shutter valve actuator, pulling the actuator rod and closing the variable tumble shutter valve.
  — Engine speed less than 3,750 rpm
  — Engine coolant temperature less than 63 °C {145 °F}
  — Throttle valve opening angle is at the specified value or less (changes according to engine speed)

Inhibition conditions

- When a DTC for the engine coolant temperature sensor or throttle position sensor has been stored, the variable tumble control is inhibited and the variable tumble shutter valve is constantly open.

VARIABLE VALVE TIMING CONTROL OUTLINE[L3]

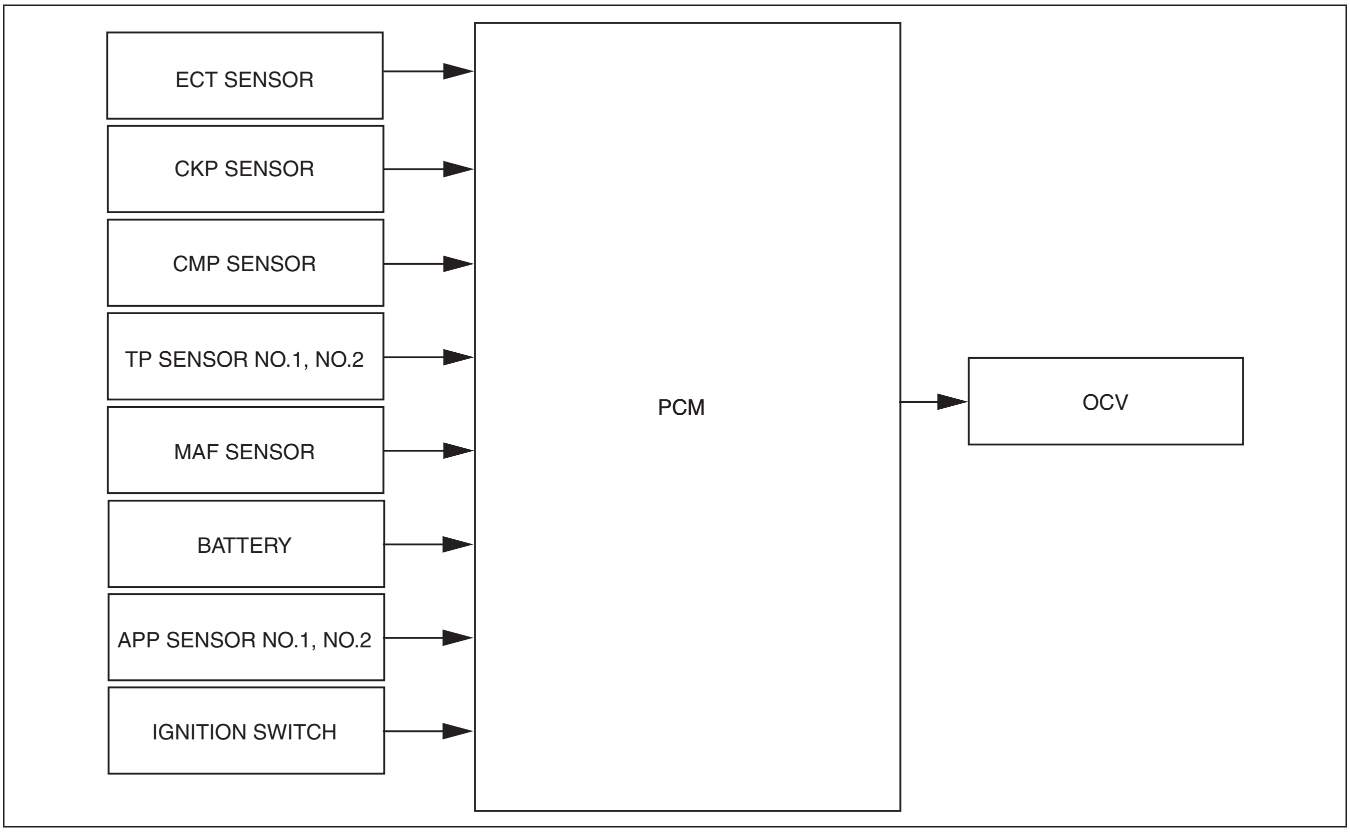
id0140a7171200

- Variable valve timing control changes the intake valve timing according to engine operation conditions to improve engine output, fuel economy, and exhaust emission performance.

VARIABLE VALVE TIMING CONTROL BLOCK DIAGRAM[L3]

id0140a7101600

- Based on the signals from the input sensors, the PCM determines the valve timing suitable for the engine operation conditions, drives the OCV, and switches the hydraulic passages of the variable valve timing actuator to provide appropriate valve timing.



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VARIABLE VALVE TIMING CONTROL OPERATION[L3]

id0140a7171300

- The PCM divides the oil control valve OCV drive range into four modes according to engine operation conditions. The OCV drive current is determined based on the target current calculated in each mode.

Cleaning Mode
Mode execution condition

- When the following condition is met:
  — IAC feedback execution condition

Purpose

- Cleaning mode is to remove foreign material in the OCV hydraulic passages.

Operation

- The target current in the cleaning mode is fixed at 100 mA or 1,000 mA. A current of 100 mA and 1,000 mA flows to the OCV alternately at certain intervals. When 100 mA current is supplied, the OCV opens the hydraulic passage for the retard chamber and hydraulic pressure from the oil pump is introduced to the retard chamber. When 1,000 mA current is supplied, the OCV opens the hydraulic passage for the advance chamber and hydraulic pressure is introduced from the oil pump to the advance chamber. After repeating this operation several times, foreign material mixed in the OCV is removed and the cleaning mode is completed.

Maximum Cam Retard Mode
Mode execution condition
- When any of the following conditions are met:
  — Cranking
  — Idling after completion of cleaning mode
  — DTC stored for the following devices:
    - ECT sensor, CKP sensor, CMP sensor, TP sensor, MAF sensor, OCV

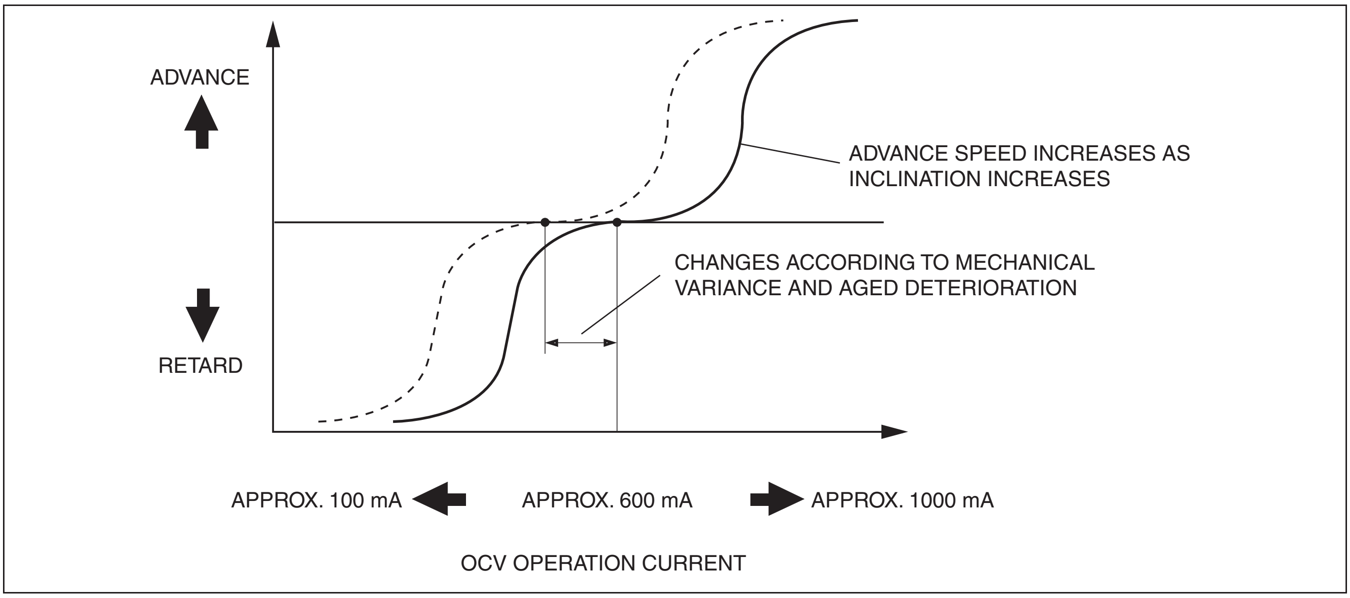
Purpose
- Maximum cam retard mode stabilizes engine speed by maximally retarding the valve timing when the engine speed is low during idling.

Operation
- When the target current in the maximum cam retard mode is fixed at 100 mA. When 100 mA current is supplied, the OCV opens the hydraulic passage for the retard chamber and hydraulic pressure from the oil pump is introduced to the retard chamber. Because of this, the variable valve timing actuator is fixed at the maximum retard position (minimum overlap).

Feedback Hold Mode
Mode execution condition
- Target valve timing and actual valve timing are almost the same.

Purpose
- The feedback hold mode holds the valve timing by returning the OCV spool valve to the neutral position when target valve timing suitable for the engine operation conditions is obtained.

Operation
- Though the target current in the feedback hold mode is basically around 600 mA, feedback operation is performed at all times so that the present OCV drive current approaches the target current. Because the hold current changes due to mechanical variation between engines and deterioration due to aging on OCV internal parts, the PCM continues to learn the changing current (hold current learning value) to maintain the spool valve in the neutral position.



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Feedback Mode
Mode execution condition
- Except during cleaning, maximum cam retard, or feedback hold modes.

Purpose
- Feedback mode obtains valve timing suitable for engine operation conditions by performing the feedback operation so that present OCV drive current is set closer to the target current determined by the PCM according to engine operation conditions.

Operation
- Based on engine operation conditions, the target current is set between 100 mA (maximum retard) and 1,000 mA (maximum advance), using the neutral point of approx. 600 mA as a reference. Actually, the target current is calculated by subtracting the current necessary for obtaining the target advance/retard amount, using a reference at the hold-current learning value calculated from the neutral position of the spool valve.

Advance spark speed correction
- If there is a large difference between the target valve timing and the actual valve timing, the target current correction is applied so that it is set closer to the target valve timing more quickly to raise the advance spark speed by advancing the spool valve initialization operation.
- The variable valve timing actuator advance spark speed increases as the hydraulic passage in the OCV widens and decreases as it narrows.

Valve timing determination
- The PCM controls current to the OCV to obtain optimum valve timing suitable for the engine operation conditions (target valve timing).
- The PCM compares target valve timing with actual valve timing, and feeds back the result to change valve timing smoothly.

Target valve timing
- Determined according to engine speed and charging efficiency.

Actual valve timing
- Means present valve timing. Actual valve timing is calculated by adding the maximum cam retard learning value for energization from the value detected by the CMP and CKP sensors.

Cam maximum retard learning value
- Though the intake camshaft valve timing (including maximum retard position) is detected based on the difference between the signal from the sensor and signal from the CKP sensor, the difference between the signals deviates due to the sensor installation condition. Because of this, the PCM stores the difference between the signal build-ups at the maximum OCV retard position to prevent deviation in valve timing detection.

FUEL INJECTION CONTROL OUTLINE[L3]

id0140a7101700

- Performs optimum fuel injection according to engine operation conditions.
- The PCM determines the engine operation conditions based on the signals from the following input devices and drives the injectors at the optimum fuel injection time (fuel injection amount) and the fuel injection timing to inject fuel. For the construction/operation of the fuel injector, refer to “FUEL SYSTEM, FUEL INJECTOR CONSTRUCTION/OPERATION”.

FUEL INJECTION CONTROL BLOCK DIAGRAM[L3]

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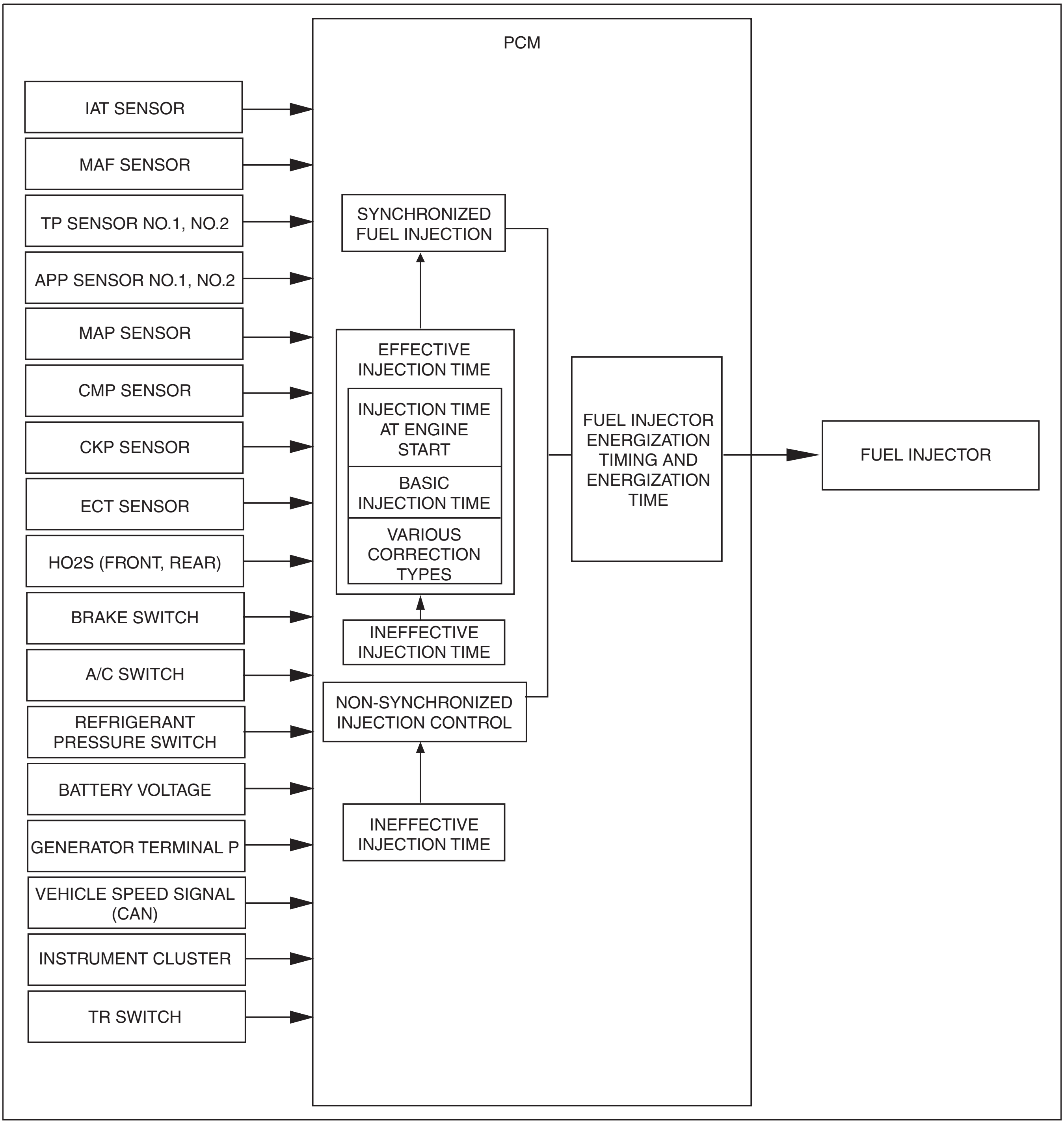

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FUEL INJECTION CONTROL OPERATION[L3]

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Operation

Injection timing

- There is synchronized fuel injection, which performs fuel injection by the setting of the crankshaft position, and non-synchronized fuel injection which performs fuel injection when the condition for fuel injection is met regardless of the crankshaft position.

Synchronized fuel injection

- The crankshaft rotation is synchronized by each intake and exhaust stroke of the cylinders, and fuel injection is performed by the fuel injection timing and the injection amount corresponding to the input signals of the following sensors.
  — CKP sensor, MAF sensor, ECT sensor, IAT sensor

Non-synchronized fuel injection

- The crankshaft rotation is not synchronized and fuel injection is performed by the injection timing and injection amount as triggered by the input signals of the following sensors.
  — TP sensor, MAF sensor, ECT sensor, IAT sensor

Relation between synchronized and non-synchronized fuel injection

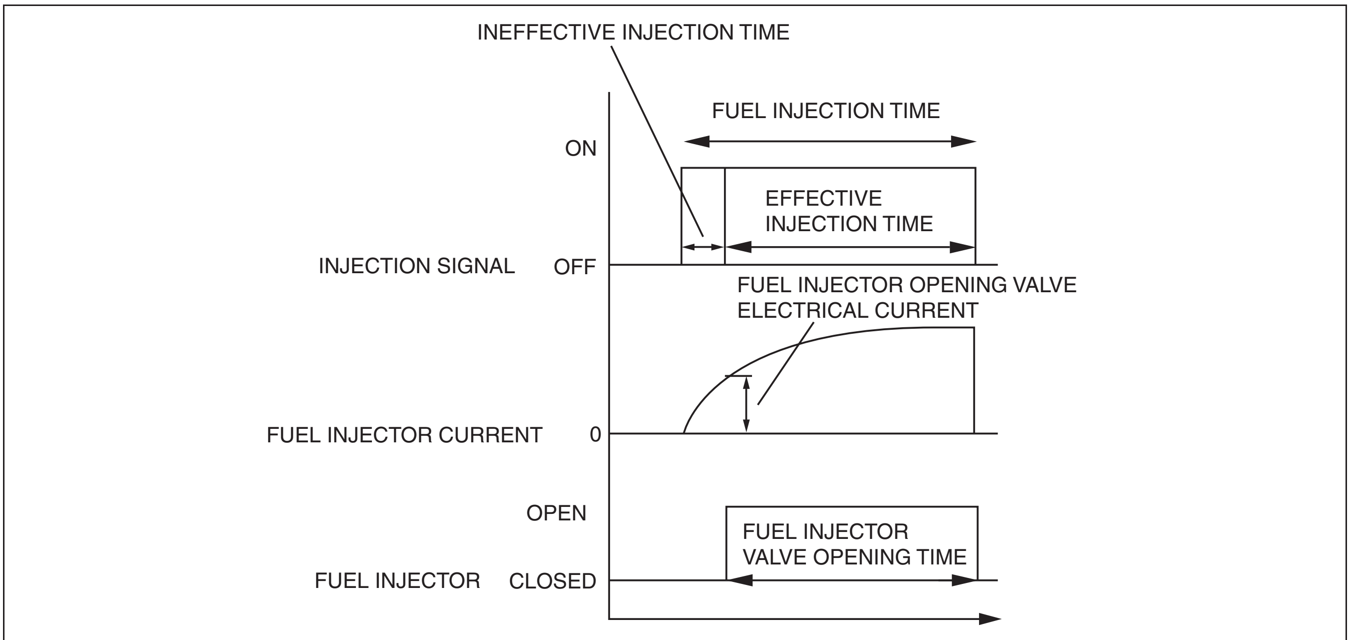
- If synchronized and non-synchronized fuel injection happen to occur together, fuel is injected by adding the fuel injection timing of both.

Injection time

- The PCM calculates the fuel injection amount according to the engine operation conditions as the fuel injection time and energizes the fuel injectors.

Fuel injector energization time and operation conditions

- The fuel injectors cause an operation delay with the start of energization from the PCM. The PCM calculates the fuel injection time by adding the non-injection time (ineffective injection time) with the actual injection time (effective injection time), and energizes the fuel injectors for this time.



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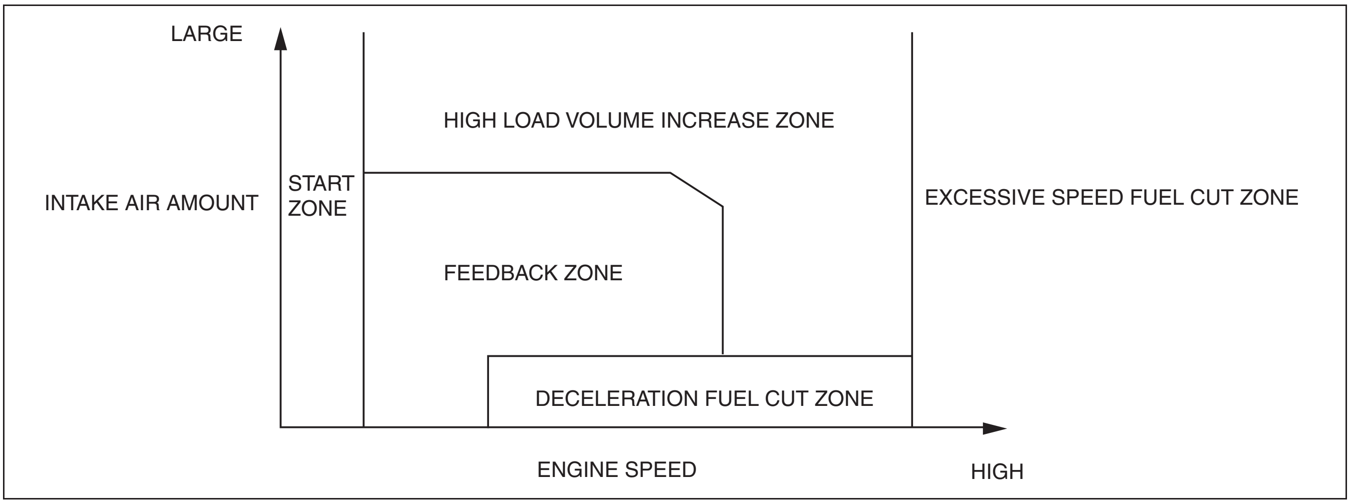
- The fuel injection time is based on the following formula:
  Fuel injection time = effective injection time + ineffective injection time
  Ineffective injection time
  — The fuel injectors cause a delay in operation due to a delay in the build-up of operation current from coil inductance with the start of energization, and by the mass of the needle valve and plunger, and spring resistance. This delay is the ineffective injection time.
  — The non-injection time is affected by the change in battery voltage. Accordingly, the PCM sets the non-injection time according to the battery voltage
  Effective injection time
  — The fuel injector opening valve time which is the actual fuel injection time is called the effective injection amount.

Determination of effective injection time
- The PCM divides the engine operation conditions into control zones according to engine speed and engine load and determines the effective injection time at each control zone to perform optimum air/fuel ratio control in all engine driving ranges.



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Start zone
Purpose
- Improved engine startability

Operation condition
- When engine speed is 500 rpm or less.

Determination of fuel injection time
- According to engine coolant temperature (ECT sensor) and engine speed (CKP sensor)

Feedback Zone
Purpose
- Improved fuel economy
- Improved exhaust gas purification

Control condition
- During engine operation other than high load volume increase zone and engine start zone.

Determination of fuel injection time
- During normal driving, the amounts of various correction types are added to the basic injection time to set to the theoretical air/fuel ratio.

High load volume increase zone
Purpose
- Improved driveability
- TWC protection

Control condition
- Either the charging efficiency or the throttle valve opening angle is a fixed value or more.

Determination of fuel injection time
- Corrections are added to the basic injection amount and the high load coefficient is calculated according to the engine speed, mass intake airflow amount and the throttle valve opening angle.

Excessive speed fuel cut zone
Purpose
- Engine protection

Control conditions
- When the engine speed is 6,800 rpm or more (WOT).
- When engine speed is 5,500 rpm or more and the engine coolant temperature is approx. -15 °C {5 °F} or less.
- All of the following conditions are met while the vehicle is stopped.
  — Engine speed of 1,500 rpm or more continues for 5 min.
  — Engine speed of 3,000 rpm or more continues for 2 min.
  — Engine speed of 6,000 rpm or more continues for 10 s.

Note
- The PCM determines that the driver continues to unintentionally depress the accelerator pedal

Determination of fuel injection time
- Fuel injection time is set to 0 (fuel cut).

Deceleration fuel cut zone
Purpose
- Improved fuel economy
- Prevents overheating of the catalytic converter

Control conditions
- When the engine conditions are as follows (10 s or longer after engine start):
  — Fully closed throttle valve
  — When the engine speed is at set value or more (differs depending on the ECT) (charging efficiency at fixed value or more, mass airflow sensor normal)

Determination of fuel injection time
- The fuel injection time is set to 0 (fuel cut).

Calculation method list for fuel injection time

A: Fuel injection time base, B: Correction for fuel injection time

Contents (Fuel injection time, calculation method, or determination method)		Control zone				
		Start	Feedback	High load volume increase	Excessive speed fuel cut	Deceleration fuel cut
Injection time at start	**Set value according to engine coolant temperature (low engine coolant temperature→long injection time)**	A				
Basic injection time	**Basic injection time = charging efficiency x fuel flow coefficient**		A	A		
Fuel cut	**Fuel injection time = 0**				A	A
Ineffective injection time	**Set time according to injector performance**	A	A	A		
Volume increase correction at engine start	Purpose: Maintains stability of engine speed just after engine start **Correction condition** • Specified time according to engine coolant temperature directly after engine start **Correction amount** • Low engine coolant temperature→large correction • Low intake air temperature→large correction	B	B			
Front HO2S feedback correction	Purpose: Controls air/fuel ratio to the theoretical air/fuel ratio **Correction condition** • When engine coolant temperature is at set value or more **Correction amount** • Front HO2S electromotive force is approx. 0.45 V or more→volume decrease correction • Front HO2S electromotive force is approx. 0.45 V or more→volume increase correction		B			
Rear HO2S feedback correction	Purpose: Corrects feedback amount according to deterioration of front HO2S and catalytic converter **Correction condition** • Engine coolant temperature is at set value or more • Engine speed is 500—4,250 rpm • Charging efficiency is 10—80% **Correction amount** • According to rear HO2S electromotive force→correction		B			
D-range correction (ATX)	Purpose: Ensures engine speed stability during D-range shifting **Correction condition** • Throttle valve fully-closed and shifted into D range **Correction amount** • Low engine coolant temperature→large correction		B			

High load volume increase correction	Purpose: Improved engine output, decrease of exhaust gas temperature **Correction condition** • According to engine speed when the throttle valve opening angle is the fixed value or more, otherwise, according to engine speed and charging efficiency **Correction amount** • High engine speed, high charging efficiency→large correction			B		
Warm-up volume increase correction	Purpose: When engine coolant temperature is low, maintains combustion stability **Correction condition** • While at set engine coolant temperature **Correction amount** • High charging efficiency, low engine coolant temperature→large correction		B	B		
A/C load increase correction	Purpose: Maintains engine speed stability during A/C operation **Correction condition** • A/C is operating **Correction amount** • Low engine coolant temperature→large correction		B	B		
Acceleration increase correction	Purpose: Corrects fuel injection delay during acceleration to ensure drive stability **Correction condition** • When acceleration amount (change in the amount of charging efficiency) is at set value or more **Correction amount** • Low engine coolant temperature→large correction • Large acceleration amount→large correction		B	B		
Deceleration volume increase correction	Purpose: Ensures engine speed stability after fuel cut recovery **Correction condition** • When recovery from fuel cut **Correction amount** • Low engine speed→large correction		B			
Learning correction	Purpose: Corrects deviation in air/fuel ratio from changes due to aged deterioration of mechanical devices **Correction condition** • Under any condition except purge control **Correction amount** • Learning value based on average of feedback correction value		B	B		
Intake air pressure correction	Purpose: Corrects ineffective charging time deviation from change in intake manifold vacuum **Correction condition** • Under any condition except start zone **Correction amount** • More intake manifold vacuum→large correction		B	B		

Fuel cut
- Includes fuel cut under the following conditions except fuel cut at excessive engine speed according to engine operation and deceleration fuel cut.

Sensor damage fuel cut
Purpose
- To prevent engine damage from abnormal ignition due to a malfunction input of a cylinder identification or the engine speed signal.

Control condition
- When damage to the crankshaft position sensor or camshaft position sensor is detected.

Dechoke control
Purpose
- To improve engine starting startability when spark plugs are flooded.

Control conditions
- When cranking close to fully-open throttle valve

Fuel cut during immobilizer system activation

Purpose

- To prevent vehicle theft

Execution conditions

- When an engine stop request signal is received from the immobilizer system, the PCM force-stops the fuel injectors. Therefore the engine stops.

FUEL PUMP CONTROL OUTLINE[L3]

id0140a7102000

- The fuel pump is operated when the ignition switch is turned to the ON position to improve startability. As a result, fuel pressure increases rapidly and stable fuel control is performed.

FUEL PUMP CONTROL BLOCK DIAGRAM[L3]

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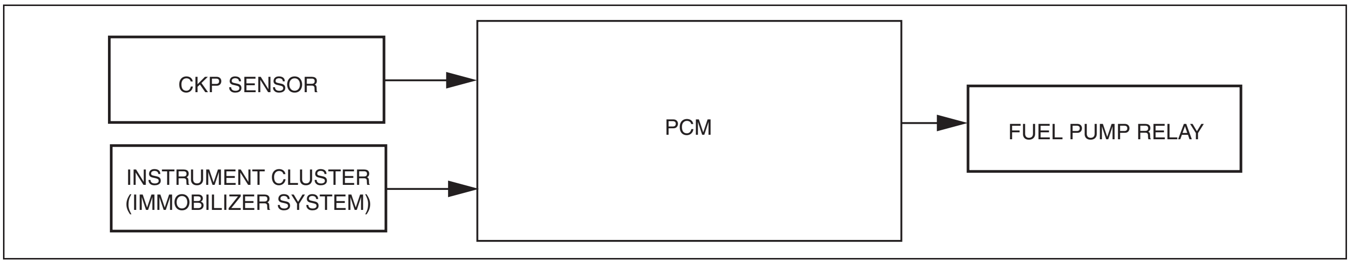

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FUEL PUMP CONTROL OPERATION[L3]

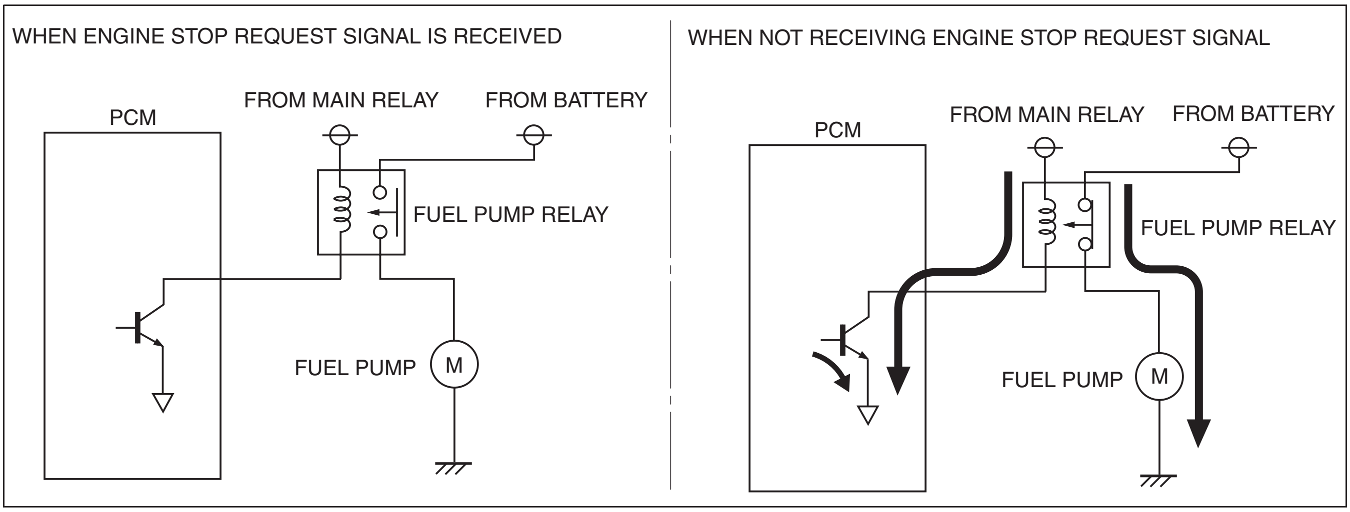
id0140a7102200

Operation Condition

- When the ignition switch is turned to the ON position, the PCM turns the fuel pump relay on for 1 s, then off.
- When it is detected that the NE signal rises during cranking, the fuel pump relay turns on.
- When the engine is stopped, the fuel pump relay turns off.

Operation Inhibition Condition

- When receiving an engine stop request signal from the immobilizer system, the PCM force-stops control of the fuel injectors. As a result, the engine does not start.



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ELECTRONIC SPARK ADVANCE OUTLINE[L3]

id0140a7175100

- Controls ignition to optimum timing according to engine operation conditions.
- Serviceability has been improved by eliminating the necessity of ignition timing.
- The PCM determines the engine operation conditions based on input signals from sensors, blocks current to the ignition coils by the calculated ignition timing, and discharges (ignition) the sparks plugs based on the effect of electromagnetic mutual induction.

ELECTRONIC SPARK ADVANCE BLOCK DIAGRAM[L3]

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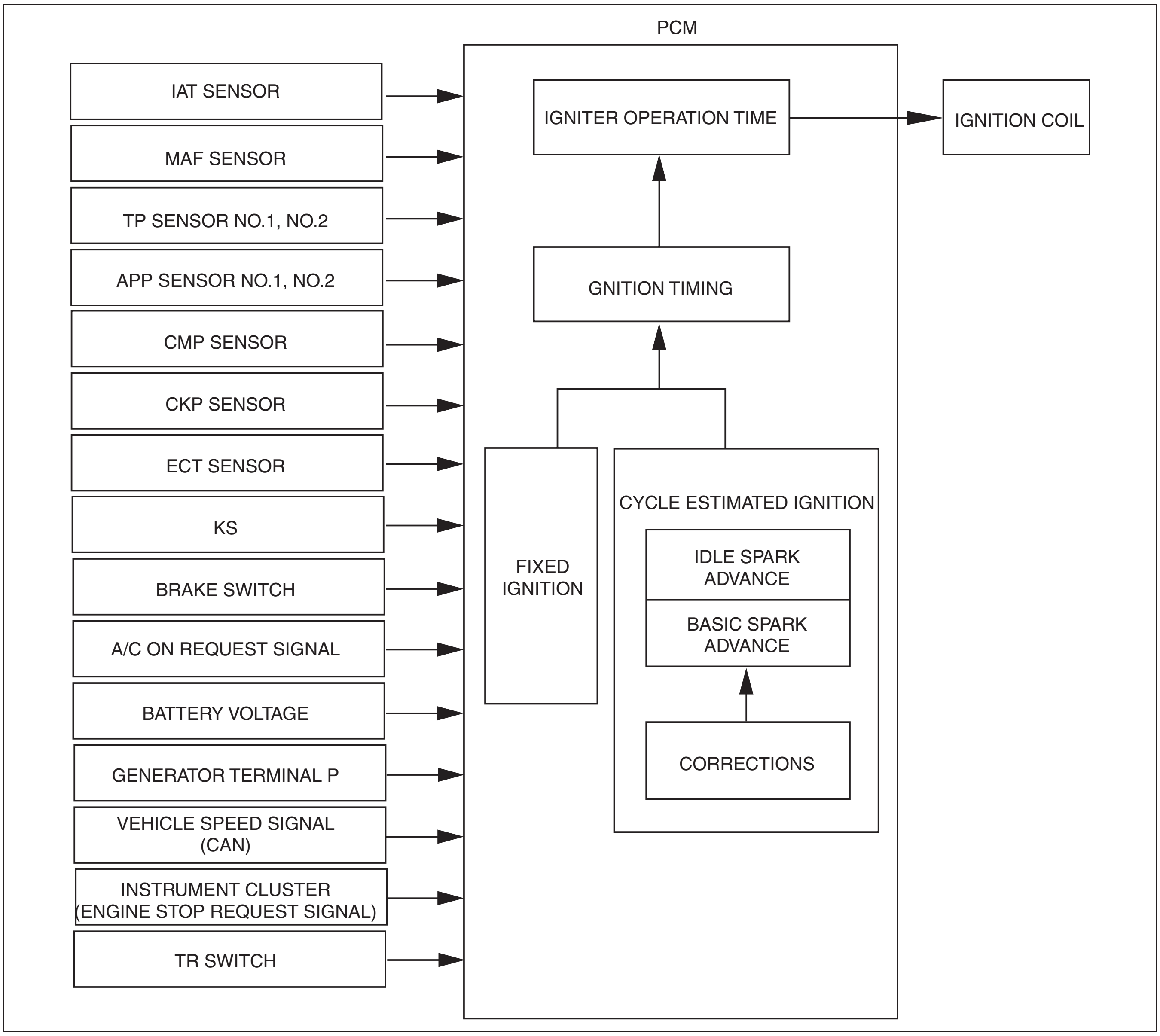

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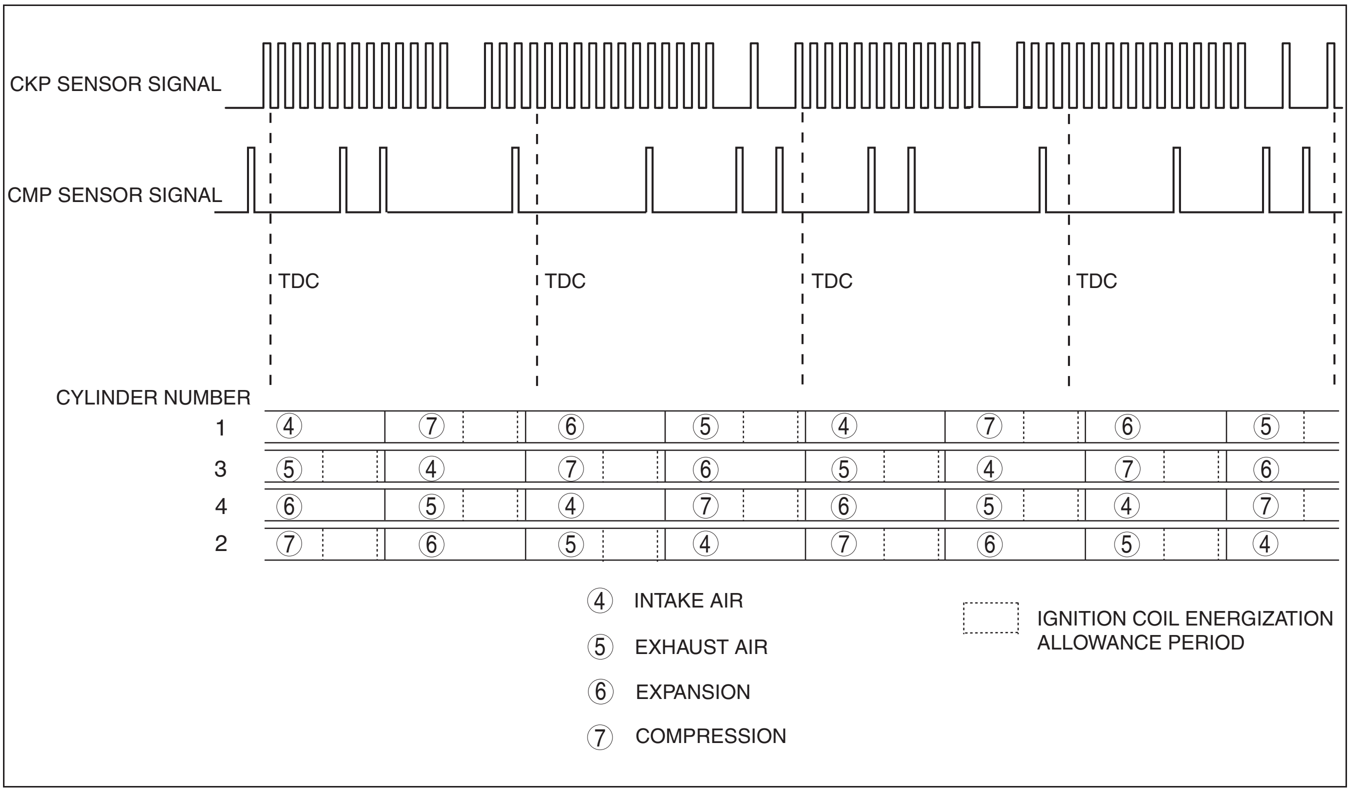
ELECTRONIC SPARK ADVANCE OPERATION[L3]

id0140a7175000

Ignition method

- The PCM excites the ignition coils employing either fixed ignition or cycle estimated ignition according to engine operation conditions.

Ignition method	Ignition timing	Ignition coil energization period
Fixed ignition	Fixed at BTDC 8°	Fixed period at BTDC 8° to end of energization
Cycle estimated ignition	Ignition at timing appropriate to engine operation conditions based on input signals	• Energization time (ignition coil energization time) to igniter is determined according to battery voltage • Cylinder independent ignition



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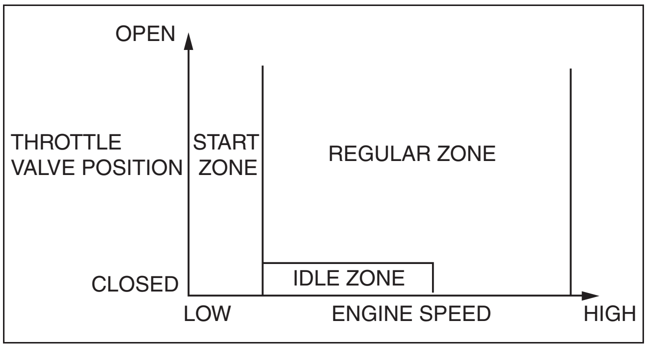
Determination of Ignition Timing

Division of control zones

- The PCM divides the engine control operations into each control zone according to the engine speed and throttle valve opening angle to determine the ignition timing by each of the control zones to perform optimum ignition control under all engine operation conditions.



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Control zone	Control condition	Ignition method
Start zone	Engine speed is 500 rpm or less. When mass airflow sensor is damaged.	Fixed ignition
Idle zone	Fully-closed throttle valve when engine speed is the target idle speed 1,750 rpm or less	Determines ignition timing adding each correction to the idle spark advance
Cycle estimated zone	Engine operation except start zone and idle zone	Determines ignition timing adding each correction to the basic spark advance

Ignition timing calculation method table

A: Ignition timing base, B: Correction for ignition timing

Contents		Calculation method or determination method for ignition timing, advance value and correction	Control zone: Start zone	Control zone: Idle zone	Control zone: Cycle estimated zone
Fixed ignition		Fixed at BTDC approx. 8° CA	A		
Cycle estimated ignition	**Idle spark advance**	Set value according to target speed and charging efficiency*		A	
	Basic spark advance	Set value according to engine speed and charging efficiency*			A
Correction	Engine coolant temperature advance correction	Purpose: Ensures combustion stability when engine coolant temperature is low **Except during idling** • High charging efficiency*, low engine coolant temperature→large correction		B	B
	Warm-up promotion spark retard correction	Purpose: Activates the catalytic converter earlier **Approx. 50 s after engine start** • According to engine coolant temperature→correction		B	
	Feedback correction	Purpose: Ensures idling stability **During idling (inhibited during test mode)** • Large difference between actual engine speed and target engine speed→large correction • Small difference between actual engine speed and target engine speed→small correction		B	
	EGR correction	Purpose: Prevents deviation of required ignition timing during EGR gas feed **When EGR valve position is the specified value or more except during EGR valve initialization** • According to engine speed and charging efficiency*→correction			B
	Deceleration fuel cut recovery retard correction	Purpose: Reduces shock after recovery from deceleration fuel cut and during re-acceleration while in deceleration fuel cut **Re-acceleration after recovery from deceleration fuel cut and while in deceleration fuel cut** • Low engine coolant temperature→large correction		B	B
	Acceleration spark retard correction	Purpose: Prevents knocking and shock during sudden acceleration **Acceleration when charging efficiency* volume increase (acceleration amount) is specified value or more** • High acceleration amount→high retard			B
	Standing start spark retard correction	Purpose: Prevents shock when vehicle accelerates from a standing start **When vehicle accelerates from a standing start** • According to engine speed, throttle valve opening angle, engine coolant temperature and intake air temperature→correction			B
	Knocking spark retard correction	Purpose: Knocking suppression **When knocking is detected while driving under high load** • Large amount of knocking→large correction			B

* : Charging efficiency is ratio of actual intake air amount to maximum air charging amount (mass volume) of cylinder. This value increases proportionately to the increase in engine load.

Ignition inhibition condition

- When receiving an engine stop request signal from the immobilizer system, the PCM force-stops control of ignition coils. As a result, the engine does not start.

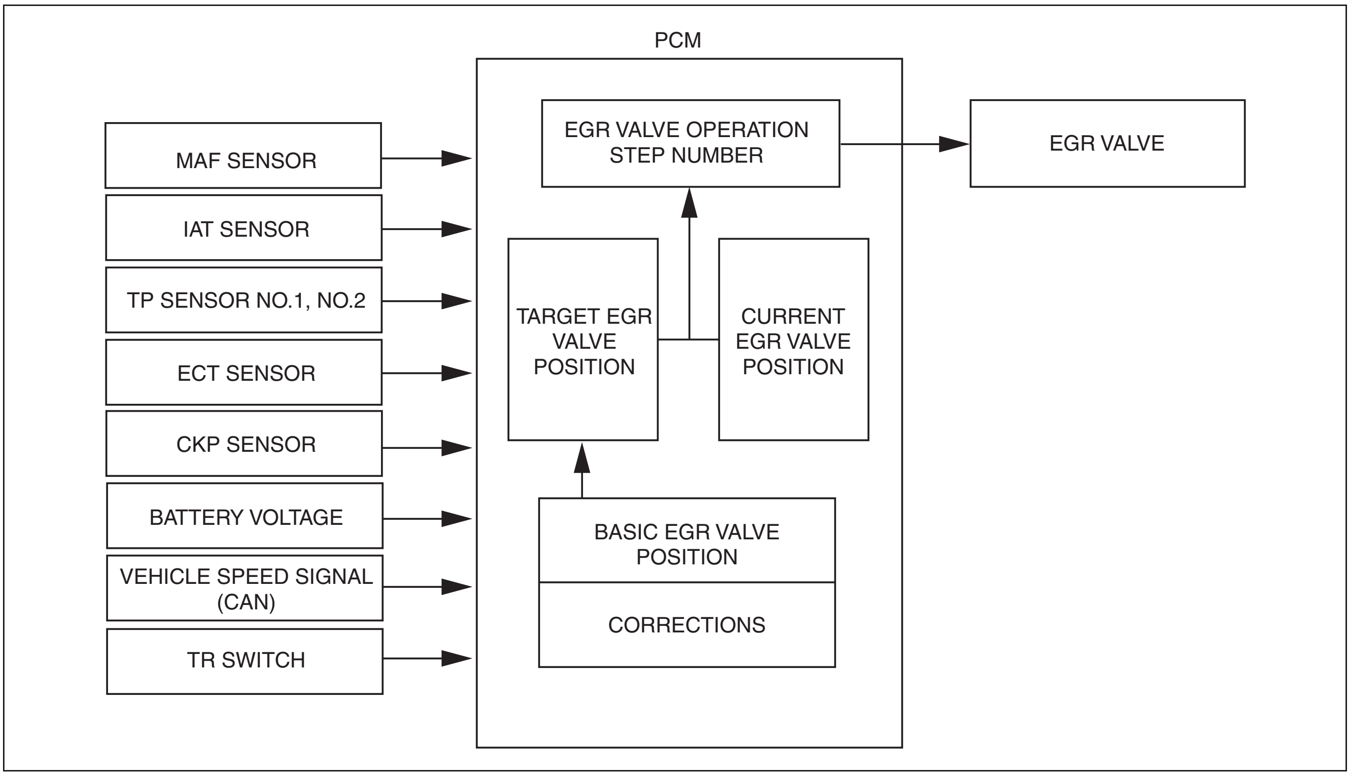
EGR CONTROL OUTLINE[L3]

id0140a7171400

- Adjusts the EGR valve to the optimum opening angle according to engine operation conditions.
- The valve in the EGR valve allows for more precise control by being driven by the stepping motor.

EGR CONTROL BLOCK DIAGRAM[L3]

id0140a7171500



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EGR CONTROL OPERATION[L3]

id0140a7171600

Stepping motor operation principles

- The PCM opens/closes the EGR valve by controlling the amount of stepping motor rotation (step number).
- The stepping motor operates by the combination of coils No.1—4, according to the stepping motor step number.

Energization condition for each coil

ON: Energization OFF Non-energization

When current step number divided by eight	0	1	2	3	4	5	6	7
Coil No.1 (PCM terminal 2AU)	ON	ON	ON	OFF	OFF	OFF	OFF	OFF
Coil No.2 (PCM terminal 2AR)	OFF	OFF	OFF	OFF	ON	ON	OFF	OFF
Coil No.3 (PCM terminal 2AY)	OFF	OFF	ON	ON	ON	OFF	OFF	OFF
Coil No.4 (PCM terminal 2AV)	ON	OFF	OFF	OFF	OFF	OFF	OFF	ON

Example of energization condition for each coil and step number

ON: Energization, OFF Non-energization

Step number	0	1	2	3	4	5	6	7	8	9	10	30	52
Coil No.1 (PCM terminal 2AU)	ON	ON	ON	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	OFF	OFF
Coil No.2 (PCM terminal 2AR)	OFF	OFF	OFF	OFF	ON	ON	ON	OFF	OFF	OFF	OFF	ON	ON
Coil No.3 (PCM terminal 2AY)	OFF	OFF	ON	ON	ON	OFF	OFF	OFF	OFF	OFF	ON	OFF	ON
Coil No.4 (PCM terminal 2AV)	ON	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	OFF	OFF	ON	OFF

- The energization condition of stepping motor coils No.1—4 can be verified by verifying the step number from “SEGRP” on the PID/data monitor function of the IDS/PDS.

Control outline

- The PCM constantly calculates the optimum target EGR valve position according to the engine operation conditions and controls the EGR stepping motor step number so that the current EGR valve position is close to the target.
- If the current EGR valve position is smaller than the target EGR position (deviation is a positive number), the PCM increases the stepping motor step number and opens the EGR valve. If larger (deviation is a negative number), the PCM decreases the stepping motor step number and closes the EGR valve. Step numbers are increased or decreased by one step at a time.

Target EGR valve position

- The PCM determines the value to increase or decrease the EGR valve opening angle according to the engine operation conditions. The PCM determines the target EGR valve position through each correction based on the basic EGR valve position that is set according to the engine speed and load.

Target EGR valve position determination table

Contents		Method for calculating or determining the EGR valve position and correction
Basic EGR valve position		Within steps 0—52 in the stepping motor determined as follows: • When the engine speed is 1,187—4,200 rpm and the charging efficiency[*1] is within 12.5—75%, the engine speed and charging efficiency are determined to be at basic position • When the EGR control inhibition conditions are met, step 0
Correction [*2]	Engine coolant temperature correction	Purpose: Improved driveability **Engine coolant temperature is 33—55 °C {122—131 °F}** • The step number is restricted to 50% of the basic EGR valve position (low engine coolant temperature—low step number) according to the engine coolant temperature. **Engine coolant temperature is 65 °C {131—149 °F} or more** • The step number is restricted to 100% of the basic EGR valve position (low engine coolant temperature→low step number) according to the engine coolant temperature.
	Intake air temperature correction	Purpose: Improved driveability **Intake air temperature is 50 °C {122 °F} or less** • Step number is restricted to 100% of the basic EGR valve position (basic EGR valve position = step number) **Intake air temperature is 50 °C {122 °F} or more** • Step number is restricted between 40—100% of basic EGR valve position (low intake air temperature→large step number)
	Acceleration/ deceleration correction	Purpose: Improved driveability **During acceleration/deceleration, when the throttle valve opening angle fluctuation rate is the set value or more** • During acceleration→step number is restricted to 20% of basic EGR valve position • During deceleration→step number is restricted to 0% of basic EGR valve position

[*1] : The charging efficiency is the ratio of the actual amount of intake air to the maximum air charging amount (mass volume) of the cylinder. This value increases proportionately to the increase in engine load.

[*2] : The correction is to restrict the basic EGR valve position value. Except for the above conditions and inhibition conditions, the correction value is 100%, and the target EGR valve position equals the EGR valve position value.

Inhibition conditions

- To improve driveability and ensure exhaust emission performance, the EGR valve closes when any of the following conditions are met. ( ) indicate input/output devices.
  — When throttle valve is fully closed (throttle position sensor)
  — When vehicle is stopped (speed sensor)
  — When the fuel injection control is in the high volume increase zone
  — The engine coolant temperature is 50 °C {122 °F} or less (engine coolant temperature sensor)
  — During deceleration (throttle position sensor)
  — Engine speed is less than 1,187 rpm or more than 4,200 rpm (crankshaft position sensor)
  — Charging efficiency is less than 12.5% or more than 75% (crankshaft position sensor, mass airflow sensor)
  — During traction control

PURGE CONTROL OUTLINE[L3]

id0140a7175700

- An appropriate amount of evaporative gas is fed into the dynamic chamber by the driving of the purge solenoid valve according to the engine operation conditions to ensure driveability and prevent release of evaporative gas into the atmosphere.
- The PCM determines the engine operation conditions based on the signals from the input devices indicated in the figure below to drive the purge solenoid valve. For the construction/operation of the purge solenoid valve, refer to “EMISSION SYSTEM, PURGE SOLENOID VALVE, CONSTRUCTION/OPERATION”.

PURGE CONTROL BLOCK DIAGRAM[L3]

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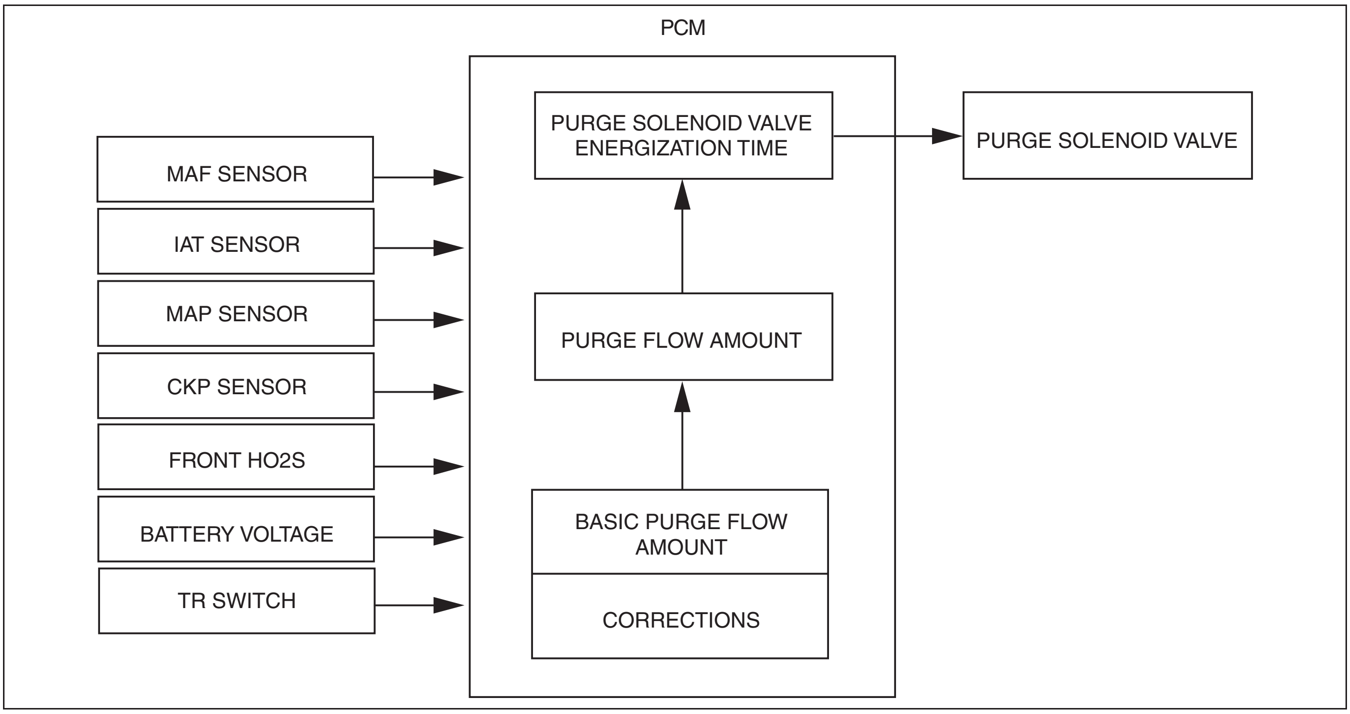

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PURGE CONTROL OPERATION[L3]

id0140a7175600

Determination of purge solenoid valve energization time

- The PCM determines the target purge flow amount according to engine operation conditions as the basic flow amount. The actual operation delays the build-up of operation current from coil inductance and corrects energization time according to fluctuation in battery voltage to cause operation delay based on the mass of the needle valve and plunger, and spring resistance. The lower the rate of battery positive voltage, the longer the energization time.

Calculation method for purge flow amount

- The PCM determines the purge flow amount through the addition of each correction to the basic purge flow amount.

Contents		Calculation or determination method of purge flow amount and correction
Basic purge flow amount		The basic purge flow amount is determined by multiplying the intake air temperature correction to the purge mass volume which is calculated by multiplying the base purge rate and the intake air mass volume, which differs according to engine conditions.
Correction	Purge startup correction	Purpose: Prevents a sudden change in air/fuel ratio during the startup of purge control. **During purge control startup** • When purge control operation conditions are met→correction
	Volume decrease correction	Purpose: Decreases the amount of purge flow and stabilize the air/fuel ratio. **When the fuel injection control feedback correction value is unstable** • According to the front HO2S feedback condition

Operation conditions

- For purge control during normal driving, the PCM sends a duty signal to the purge solenoid valve when all of the following conditions are met.
  — Fuel injection control is in the feedback zone or the high load volume increase zone.
  — Airflow passage damage related DTC is not stored.
  — Engine coolant temperature is 78 °C {172 °F} or more.

HO2S HEATER CONTROL OUTLINE[L3]

id0140a7103200

- Stabilized oxygen concentrations, even when the exhaust gas temperature is low, are detected by controlling of the HO2S, enabling feedback control of the fuel injection control even during cold-engine starting, improving emission performance when cold.
- When the exhaust gas temperature is high, the HO2S is protected from sharp rises in its temperature by stopping energization to the HO2S heater.
- Emission performance improvement and protection of the HO2S have both been achieved by the duty control of the front and rear HO2S according to the engine operation conditions (exhaust gas temperature).

HO2S HEATER CONTROL BLOCK DIAGRAM[L3]

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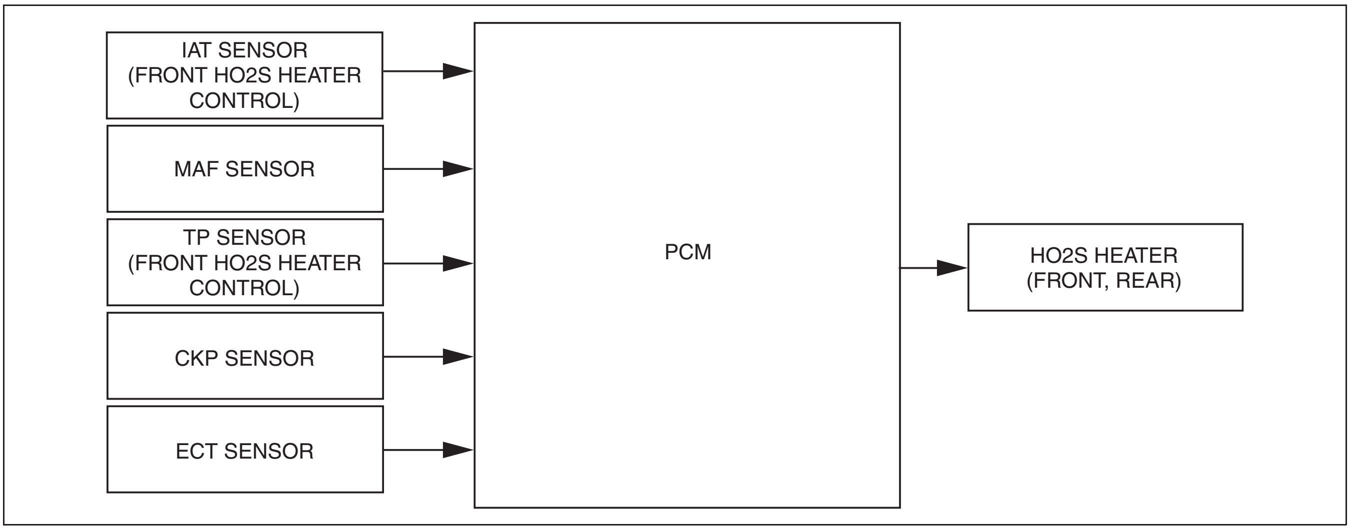

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HO2S HEATER CONTROL OPERATION[L3]

id0140a7103400

Front

Operation condition

- The PCM operates the front HO2S heater according to engine operation conditions as shown in the table below.

Drive duty ratio	Engine operation conditions
20 %	• Engine coolant temperature **5 °C {41 °F} or less**
35 %	• At engine start • During engine rotation except idling • When a DTC indicating a damaged engine coolant temperature sensor, throttle position sensor or intake air temperature sensor is detected.
100 %	• For a fixed period of time after engine start when the engine coolant temperature at engine start is **50 °C {122 °F} or less** than the engine coolant temperature when the engine is stopped from a previous operation (differs from engine coolant temperature at engine start [lower engine coolant temperature→longer time])

Inhibition conditions

- When all of the following conditions are met (for **6 s**):
  — During torque reduction execution
  — Engine speed is **5,000 rpm or more**.
- Engine speed **4,000 rpm or more**
- During high load
- When HO2S is damaged
- When ignition switch is turned to the ON position while engine is stopped

A/C CUT-OFF CONTROL OUTLINE[L3]

id0140a7103500

- Through energization and non-energization to the A/C relay (magnetic clutch) according to engine operation conditions, acceleration performance and engine reliability have been improved.

A/C CUT-OFF CONTROL BLOCK DIAGRAM[L3]

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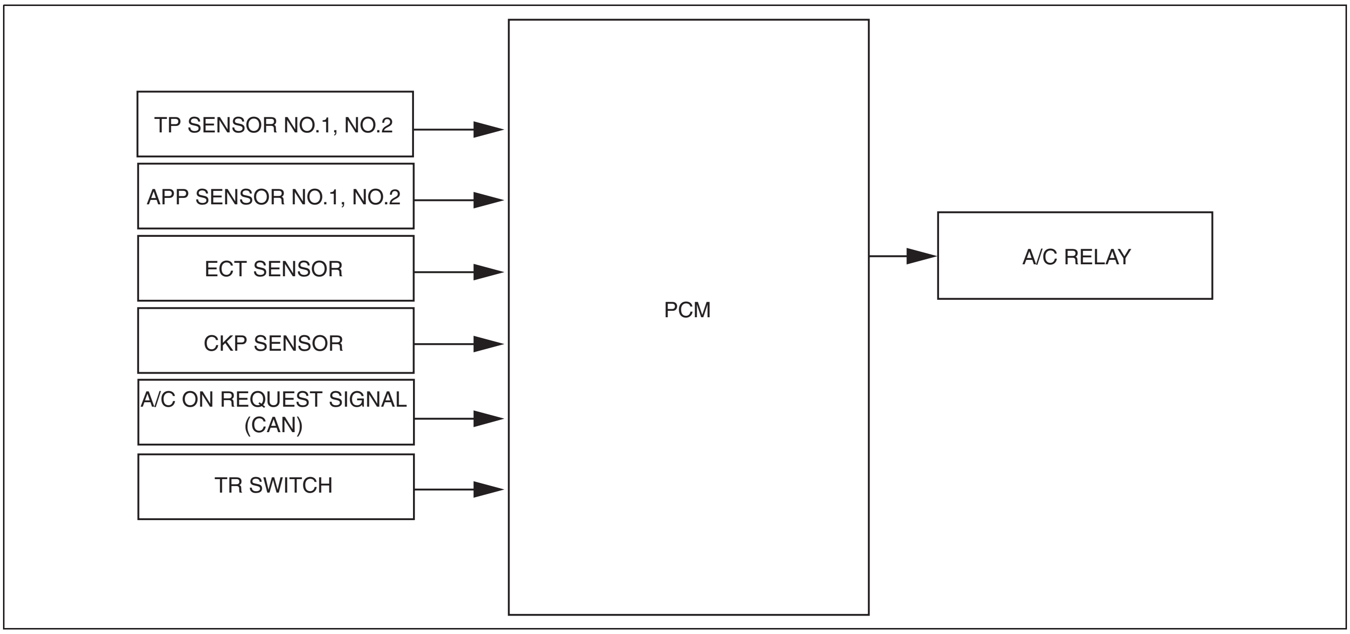

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A/C CUT-OFF CONTROL OPERATION[L3]

id0140a7103700

- The PCM stops energization to the A/C relay when any of the following conditions are met:

A/C cut-off control operation conditions

Operation condition	A/C relay non-energization period	Purpose
At engine start	Approx. 4 s	Improved startability
At drive-away	Approx. 3 s	Improved drive-away performance
During acceleration (throttle valve opening angle 50% or more)	Approx. 5 s	Improved acceleration performance
When the engine coolant temperature is 113 °C {235 °F}	Repeatedly turns on and off every 10 s until the engine coolant temperature is less than approx. 107 °C {225 °F}	Improved engine reliability
When the engine coolant temperature is 117 °C {242 °F} or more	Until the engine coolant temperature decreases to less than approx. 110 °C {230 °F}	Improved engine reliability
At high engine speed (engine speed 6,400 rpm or more)	Approx. 5 s	Improved engine speed stability

ELECTRICAL FAN CONTROL OUTLINE[L3]

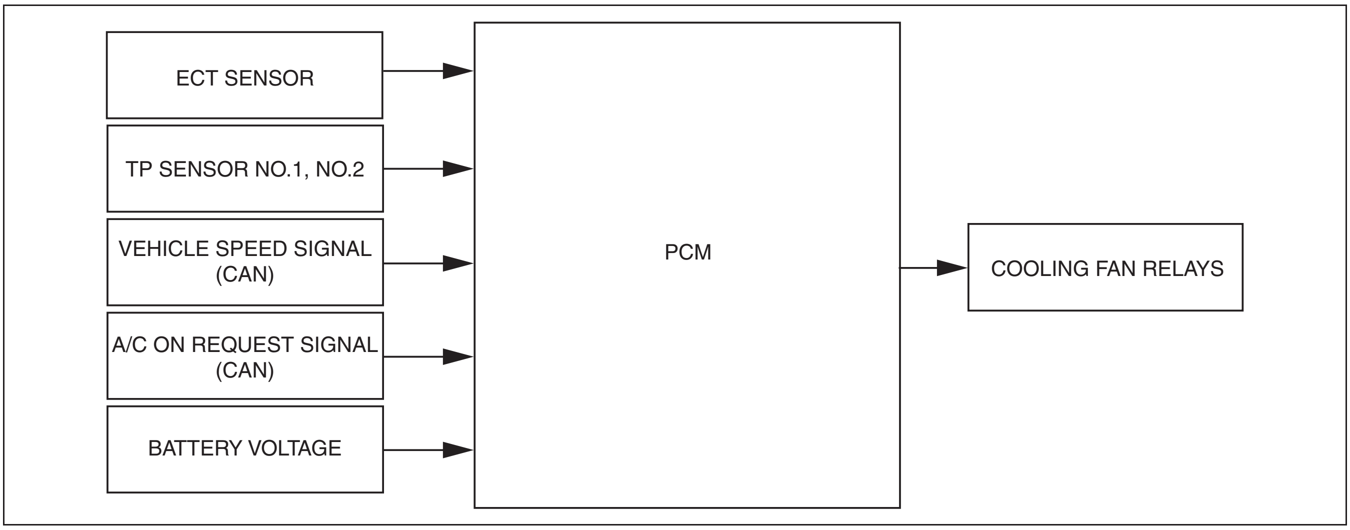
id0140a7103800

- Through cooling of the radiator and condenser by operation of the cooling fan according to vehicle conditions, engine reliability and cooling performance have been improved.

ELECTRICAL FAN CONTROL BLOCK DIAGRAM[L3]

id0140a7103900

- The PCM determines the engine operation conditions based on input signals from the sensors, calculating the optimum fan motor rotation speed as the fan motor drive duty ratio, and sends a signal to the cooling fan relays to control the cooling fan rotation speed.



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ELECTRICAL FAN CONTROL OPERATION[L3]

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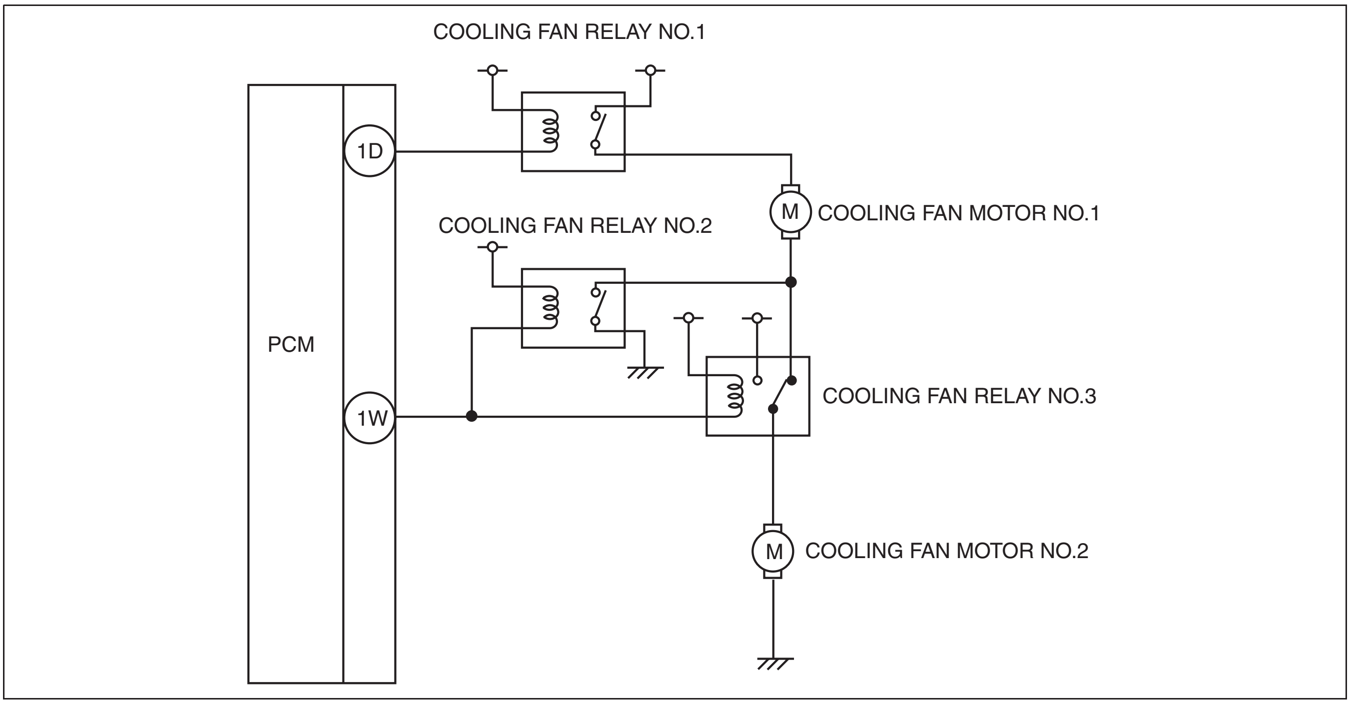
ON: Energized
OFF: De-energized

Condition		PCM terminal 1D	PCM terminal 1W	Operation condition
Cooling fan motor No. 1	Cooling fan motor No. 2			
Stopped	Stopped	OFF	OFF	A/C: OFF ECT: below 100 °C {212 °F}
Low speed	Low speed	ON	OFF	A/C: OFF ECT: 100—108 °C {212—226 °F}
High speed	High speed	ON	ON	A/C: OFF ECT: above 108 °C {226 °F}
Low speed	Low speed	ON	OFF	A/C: ON (middle switch OFF) ECT: below 108 °C {226 °F}
High speed	Middle speed/ High speed	ON	OFF	A/C: ON (middle switch ON) ECT: below 108 °C {226 °F}
High speed	High speed	ON	ON	A/C: ON ECT: above 108 °C {226 °F}



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STARTER CUT-OFF CONTROL OUTLINE[L3]

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- Theft deterrence has been improved by controlling energization to the starter relay according to an engine stop request signal from the immobilizer system.

STARTER CUT-OFF CONTROL BLOCK DIAGRAM[L3]

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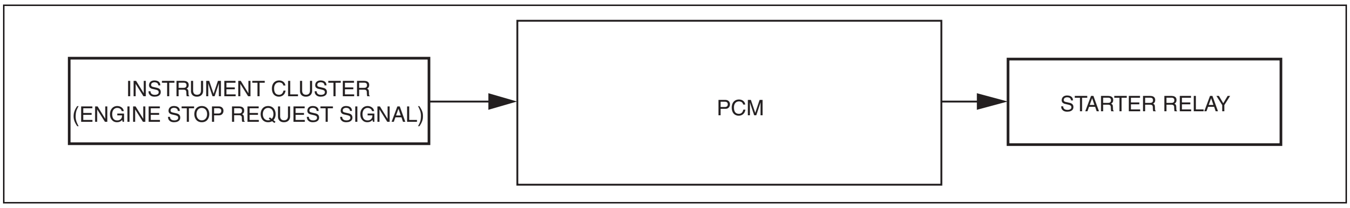

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STARTER CUT-OFF CONTROL OPERATION[L3]

id0140a7172200

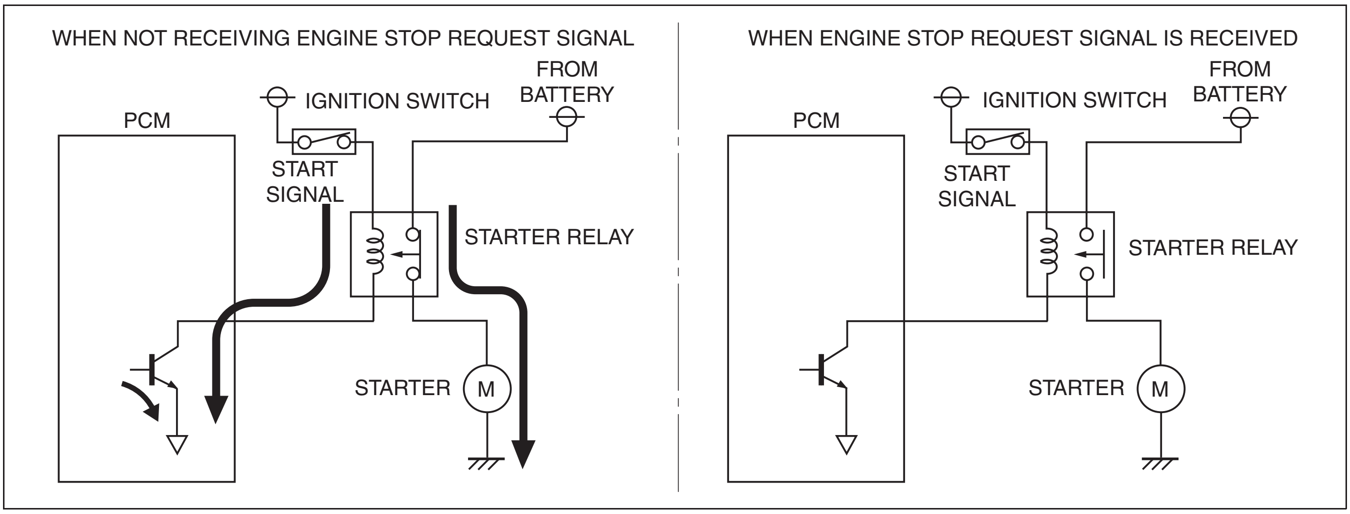
- The PCM stops energization of the starter relay according to an engine stop request from the immobilizer system.

  When receiving engine stop request signal

  — The PCM does not establish a ground to the starter circuit. Therefore, the starter motor does not rotate because there is no energization of the starter relay even if the ignition switch is turned to the START position, and the engine does not start.

  When not receiving engine stop request signal

  — The PCM establishes a ground to the starter circuit. Therefore, when the ignition switch is turned to the START position, the starter relay is energized and the starter motor rotates. As a result, the engine starts normally.



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GENERATOR CONTROL OUTLINE[L3]

id0140a7172300

- Idling stability and the corresponding load performance have been improved by optimum control of generator voltage according to engine operation and electrical load conditions.
- The PCM determines the engine operation and electrical load conditions based on the input signals from input devices shown in the figure below and controls the excitation time of the generator field coils.

GENERATOR CONTROL BLOCK DIAGRAM[L3]

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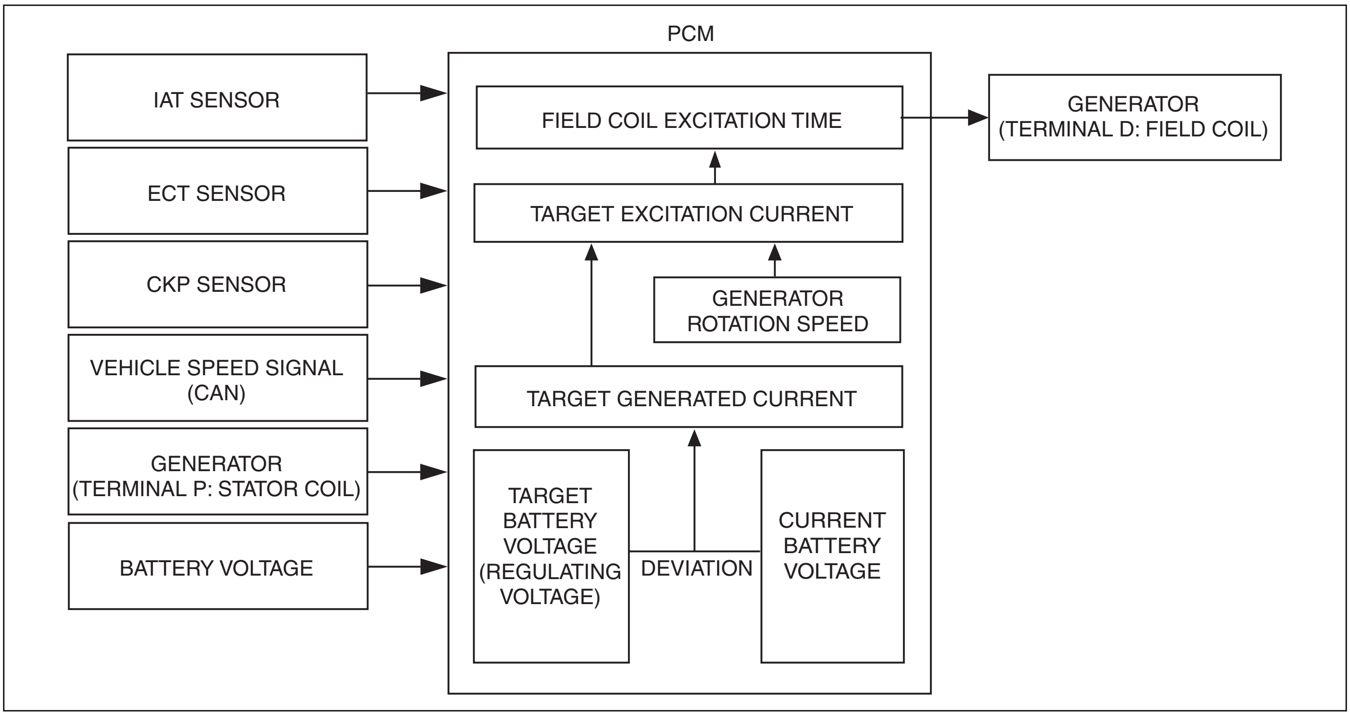

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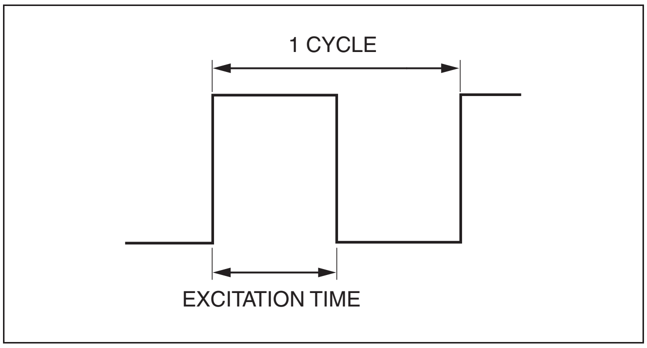
GENERATOR CONTROL OPERATION[L3]

id0140a7172500

Determination of field coil excitation time

- By sending a duty signal to the power transistor built into the generator, the PCM increases and decreases the field coil excitation current.
- The field coil excitation current changes according to changes in the power transistor excitation time by changing the duty signal duty ratio. For example, when the battery voltage is low, the duty signal duty ratio sent to power transistor is higher, and the excitation current to the field coils increases.



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Control

- To maintain optimum battery voltage, the PCM calculates the target excitation current based on the targeted generator current (target generated current) and the generator rotation speed at the time.
- The generator rotation speed is calculated from the generator pulley and crankshaft pulley ratios, and the engine speed.
- The PCM compares the target battery voltage (regulating voltage) calculated from the intake airflow temperature, engine speed and vehicle speed with the current battery voltage and, based on this difference, calculates the required generator current.
- When an electrical load is applied, the target rotation speed increases during idling because the battery voltage decreases due to the increased power consumption.

CONTROLLER AREA NETWORK (CAN) OUTLINE[L3]

id0140a7104100

- The PCM sends and receives data to and from other modules via the CAN system. Refer to Section 09 for a detailed explanation of the CAN. (See 09-40-2 MULTIPLEX COMMUNICATION SYSTEM CONSTRUCTION/ OPERATION[L3].)

Data sent

- Engine speed
- Vehicle speed
- ATX gear position/selector lever position
- Engine torque
- Throttle valve opening angle
- Brake pedal position
- Transaxle specifications
- TCC status
- Engine specification
- Immobilizer-related information
- AT warning light on request
- Engine coolant temperature
- Travelled distance
- Fuel injection amount
- MIL on request
- Generator warning light on request

Data received

- Brake system status
- Wheel speed (LF, RF, LR, RR)
- Fuel tank level
- Immobilizer-related information
- A/C on request
- Transaxle in reverse position

PCM FUNCTION[L3]

id0140a7105300

Function List

- The control descriptions are as shown below.

Function	Description
Main relay control	When the ignition switch is turned to the ON position, the main relay turns on.
Drive-by-wire control	The drive-by-wire control calculates the optimum target throttle valve opening angle at all ranges of engine speeds and controls the throttle valve actuator.
Drive-by-wire relay control	Supplies power to the drive-by-wire control.
Variable intake air control	Switches energization of the variable shutter valve actuator according to engine speed to enhance the inertia charging effect.
Variable tumble control	At cold engine start, the following effects occur due to the closing of the variable tumble control for improved cold engine emission performance. • Improved intake airflow speed near injectors • Strong air tumble occurs in the combustion changer, promoting vaporization mixture of intake air and fuel
Variable valve timing control	Changes the intake valve timing according to engine operation conditions to improve engine output, fuel economy and exhaust emission performance.
Fuel injection control	Performs optimum fuel injection according to engine operation conditions.
Fuel pump control	Performs energization of the fuel pump relay only when the engine is running (operates fuel pump) to improve stability and durability.
ESA control	Controls ignition to optimum timing according to engine operation conditions.
Evaporative purge control	An appropriate amount of evaporative gas is fed into the dynamic chamber by the driving of the purge solenoid valve according to the engine operation conditions to ensure driveability and prevent release of fuel vapor gas into the atmosphere.
EGR control	Adjusts the EGR to the optimum opening angle according to engine operation conditions.
HO2S heater control	Based on the control of the front and rear HO2S heater, a stabilized oxygen concentration is detected even at low exhaust gas temperature and feedback control of fuel injection even during cold engine start is made possible for improved cold temperature emission performance.
A/C cut-off control	The current application (energize/non-energize) to the A/C relay (magnetic clutch) is controlled according to the engine operation conditions to prevent deterioration of engine performance, damage to the engine, and deterioration of the A/C function.
Electrical fan control	Through cooling of the radiator and condenser by operation of the cooling fan according to vehicle conditions, engine reliability and cooling performance have been improved.
Starter cut-off control	Theft deterrence has been improved by controlling energization to the starter relay according to an engine stop request signal from the immobilizer system.
Generator control	Generator output is optimized according to the engine operation and electrical load conditions, ensuring idling stability and anti-load performance.
CAN	Used for communication with the EHPAS control module, ABS HU/CM, instrument cluster and DLC-2.

PCM CONSTRUCTION/OPERATION[L3]

id0140a7105400

Structure

- A 120-pin (two-block) PCM connector has been adopted.

ENGINE COOLANT TEMPERATURE (ECT) SENSOR FUNCTION[L3]

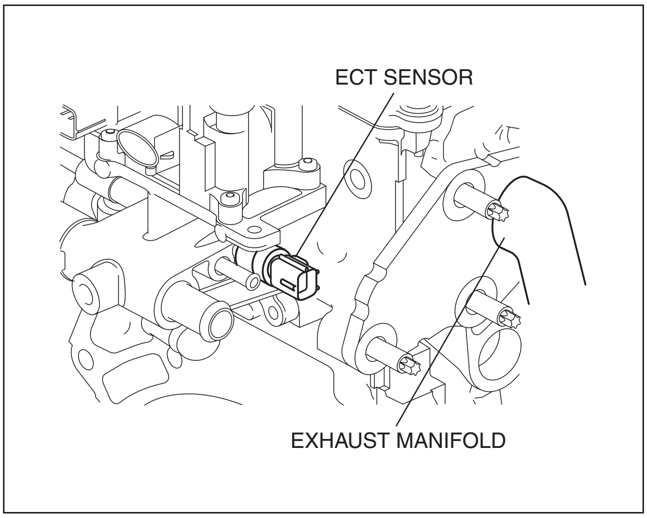
id0140a7173300

- Detects the engine coolant temperature.

ENGINE COOLANT TEMPERATURE (ECT) SENSOR CONSTRUCTION/OPERATION[L3]

id0140a7173400

- Installed on the water bypass tube (directly below the ignition coil).



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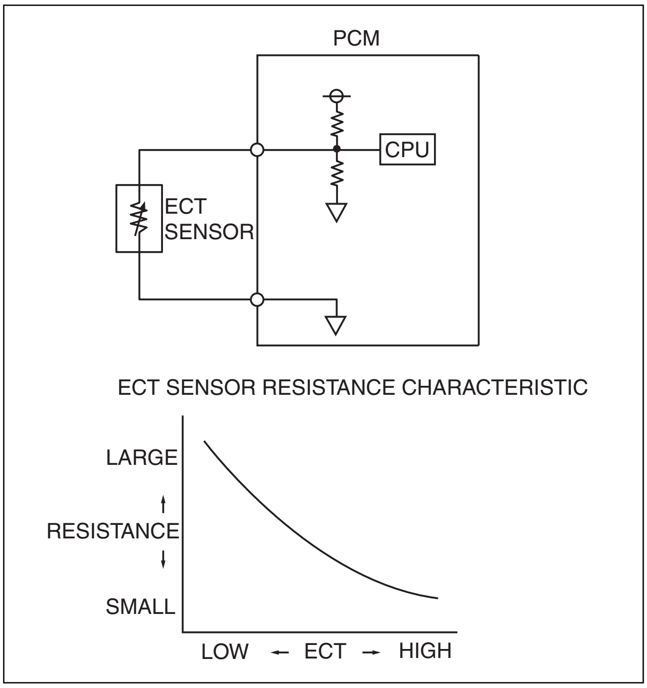
- The ECT is a thermistor type, the resistance changes according to the engine coolant temperature.
- The resistance decreases if the engine coolant temperature increases, and increases if the engine coolant temperature decreases.



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MASS AIR FLOW (MAF) SENSOR FUNCTION[L3]

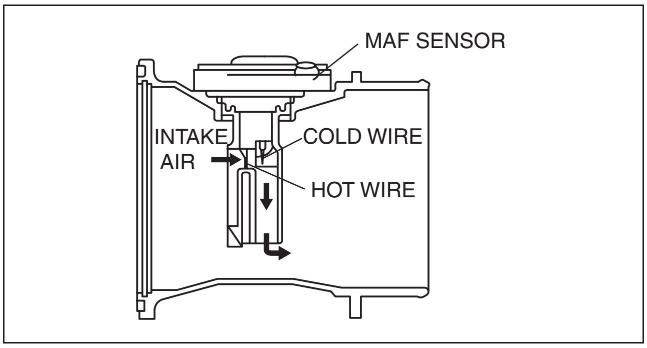
id0140a7172600

- Detects the air amount (mass airflow amount) inducted into the engine.

MASS AIR FLOW (MAF) SENSOR CONSTRUCTION/OPERATION[L3]

id0140a7172700

- Converts the mass intake airflow amount to voltage.
- When the temperature of the metal decreases, the resistance decreases. Using this characteristic, the hot wire captures heat from the flow of intake air and converts the intake airflow amount to voltage.
- The cold wire converts intake air density to voltage from the ambient temperature of the cold wire, using the characteristic of air whereby the intake air density decreases due to the increase in intake air temperature.



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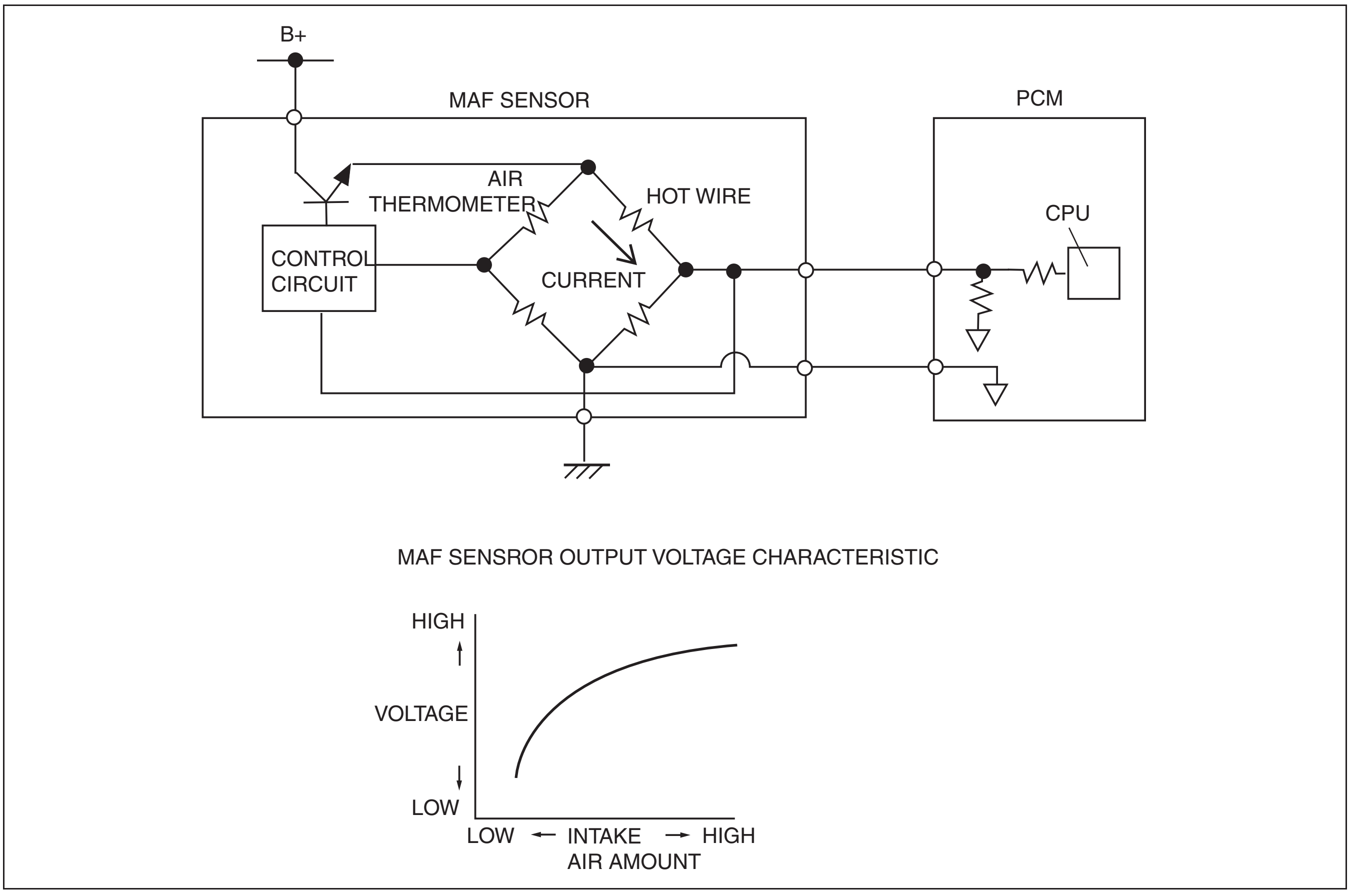
- The voltages obtained by the hot wire (intake airflow amount) and the cold wire are compared and the electric potential becomes stable by supplying the difference in voltage to the transistor. The voltage supplied to the hot wire is output as the mass intake airflow amount.



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INTAKE AIR TEMPERATURE (IAT) SENSOR FUNCTION[L3]

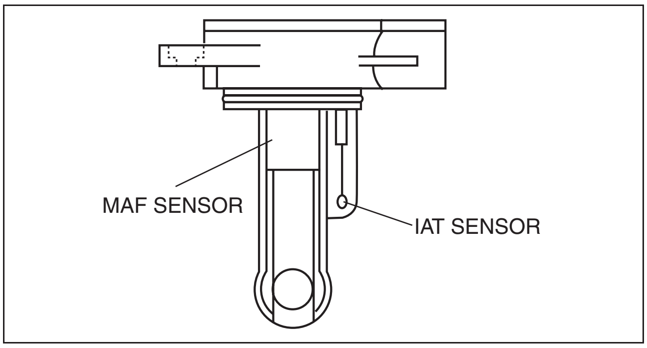
id0140a7173500

- Detects air temperature inducted in the engine.

INTAKE AIR TEMPERATURE (IAT) SENSOR CONSTRUCTION/OPERATION[L3]

id0140a7173600

- Built into the MAF sensor.



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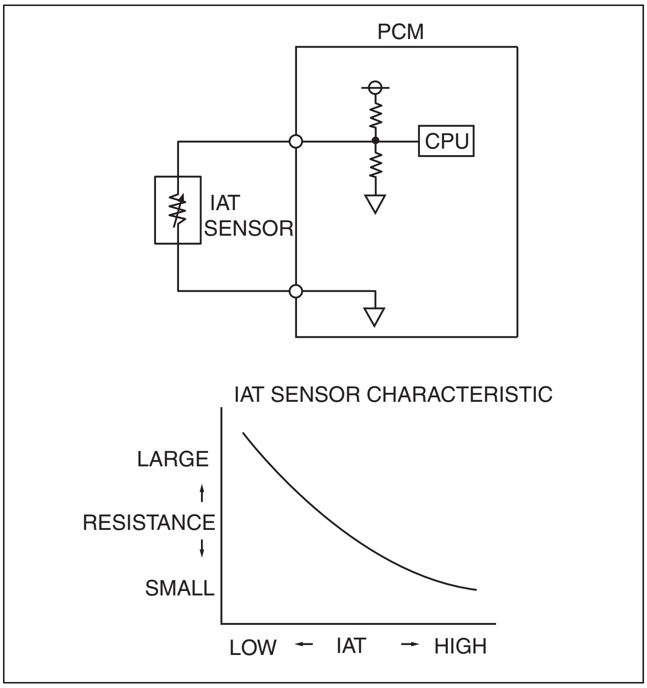
- The IAT sensor is a thermistor type, the resistance changes according to the intake air temperature.
- The resistance decreases if the intake air temperature increases and conversely increases if the intake air temperature decreases.



atraan00000166

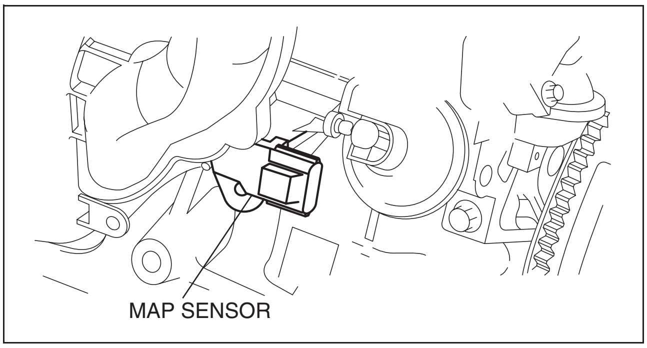
MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR FUNCTION[L3]

id0140a7173000

- Detects intake air pressure in the intake manifold.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CONSTRUCTION/OPERATION[L3]

id0140a7173100



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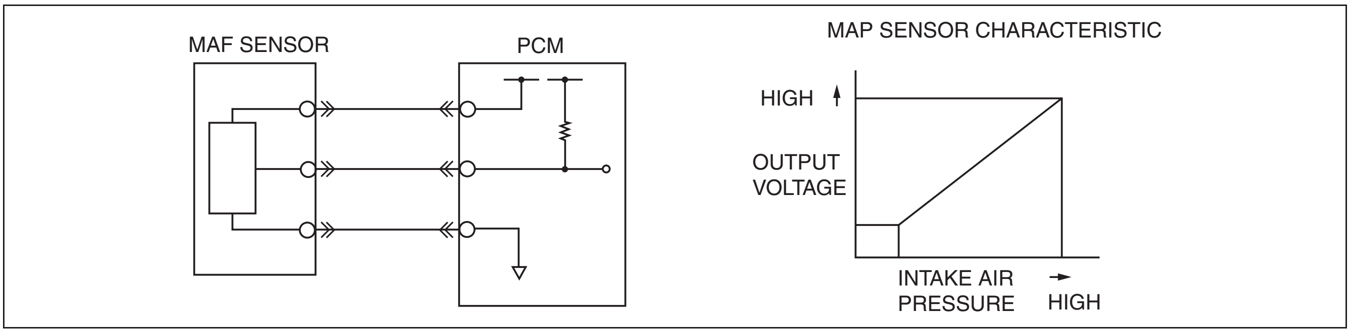
- When pressure is applied to the piezoelectric element in the sensor, an electric potential difference occurs. Output voltage increases as the intake air pressure increases.



atraan00000175

THROTTLE POSITION (TP) SENSOR FUNCTION[L3]

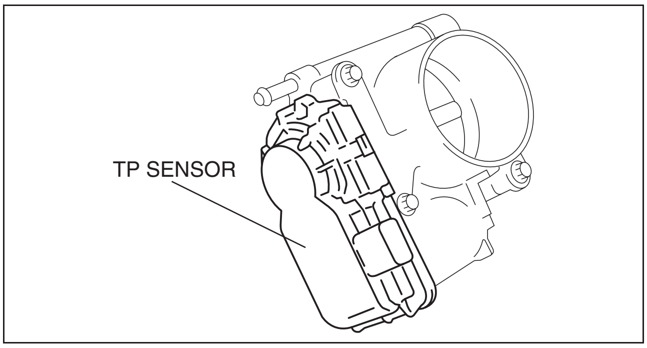
id0140a7173900

- Detects the throttle valve opening angle.

THROTTLE POSITION (TP) SENSOR CONSTRUCTION/OPERATION[L3]

id0140a7174000

- The sensor is built into the throttle body and detects the throttle valve opening angle.
- The Hall element design has been adopted for the sensor.
- A non contact type sensor has been adopted to improve durability.
- The TP sensor is composed of the main sensor and sub sensor, and detects the throttle valve opening angle with these two sensors (main and sub).
- Even if a malfunction occurs in either one of the sensors, the detection is performed with a normal sensor and drive-by-wire control is maintained.



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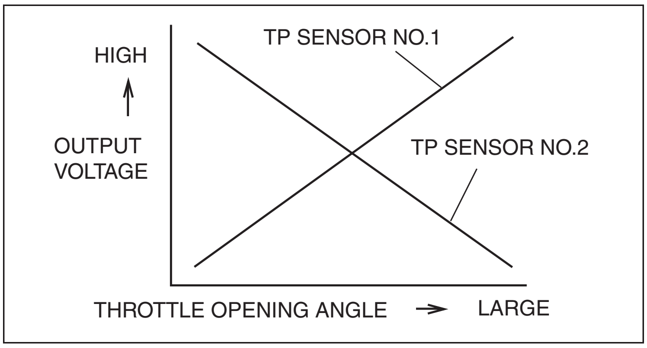
- If both the MAIN and SUB sensors for the TP sensor malfunction, signals necessary for the drive-by-wire control are not input to the PCM and the drive-by-wire control is disabled.
- However, even though the drive-by-wire control is disabled, the throttle valve opening angle necessary for minimum driving is maintained mechanically.

TP Sensor Voltage Characteristics



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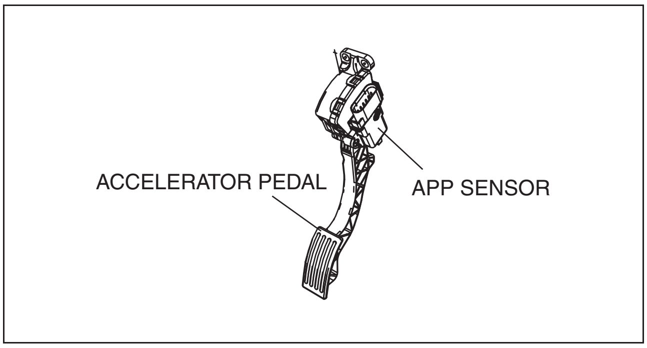
ACCELERATOR PEDAL POSITION (APP) SENSOR CONSTRUCTION/OPERATION[L3]

id0140a7174800

- The sensor is installed on the AP and detects how much the AP is depressed.
- The Hall element design has been adopted on the sensor.
- A non contact type sensor has been adopted to improve durability.
- The APP sensor is composed of the main sensor and sub sensor, and detects the accelerator opening angle with these two sensors (main and sub).
- The main sensor output a duty signal, and the sub sensor output a voltage signal.
- Even if a malfunction occurs in either one of the sensors, the detection is performed with a normal sensor drive-by-wire control is maintained.



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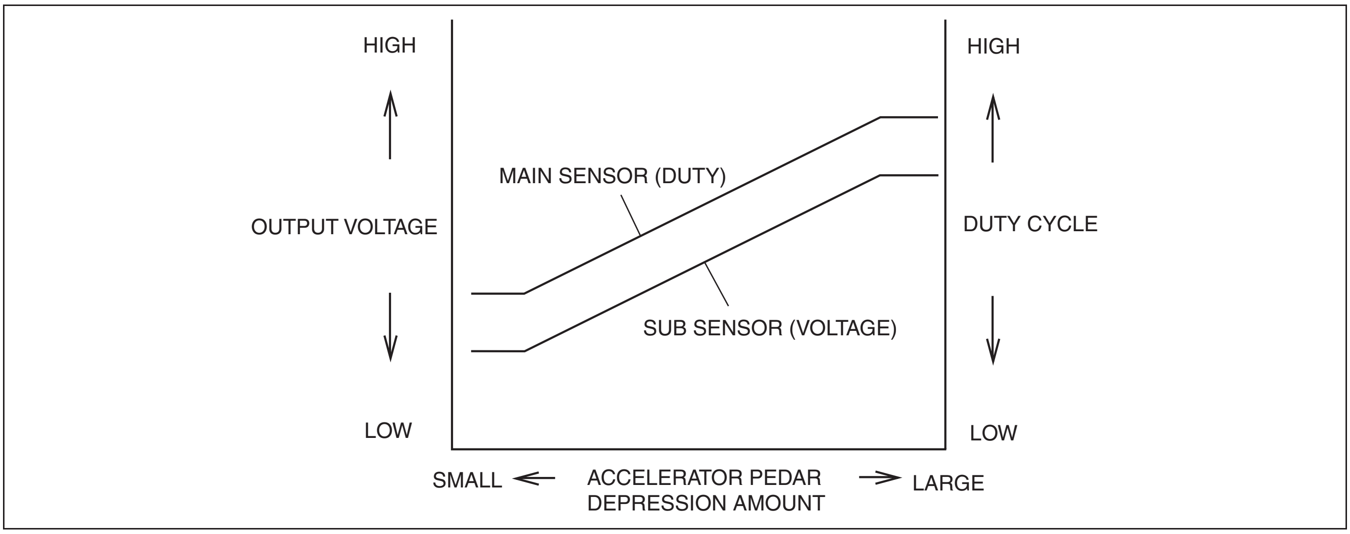
- If both the main and sub sensors for the APP sensor malfunction, signals necessary for the drive-by-wire control are not input to the PCM and the drive-by-wire control is disabled.

- However, even though the drive-by-wire control is disabled, the throttle valve opening angle necessary for minimum driving is maintained mechanically.



atraan00000182

ACCELERATOR PEDAL POSITION (APP) SENSOR FUNCTION[L3]

id0140a7174700

- Detects how much the AP is depressed.

HEATED OXYGEN SENSOR (HO2S) FUNCTION[L3]

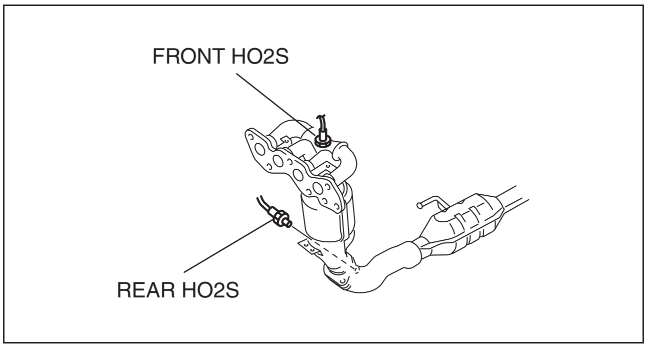
id0140a7173700

- Front HO2S: the wide-range air/fuel ratio sensor, which can linearly detect the oxygen concentration (air/fuel ratio of the air-fuel mixture) in the exhaust gas in all ranges, from lean to rich, is used on the front HO2S.
- Rear HO2S: detects the oxygen concentration in the exhaust gas.
- A heater has been adopted, allowing stable detection of the oxygen concentration even when the exhaust gas temperature is low.

HEATED OXYGEN SENSOR (HO2S) CONSTRUCTION/OPERATION[L3]

id0140a7173800

- Installed on the front and back of the WU-TWC.



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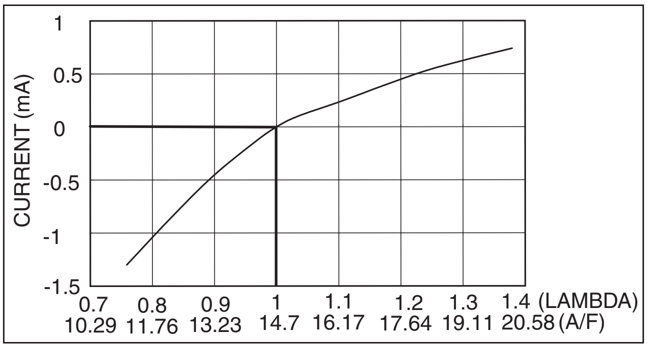
Front HO2S

- The wide-range air/fuel ratio sensor is a limited current type sensor, and can detect the oxygen concentration (air/fuel ratio of the air-fuel mixture) in the exhaust gas in all ranges, from lean to rich.
- A heater is built into the sensor to facilitate the activation of the HO2S at engine startup (when the exhaust gas temperature is low).
- The wide-range air/fuel ratio sensor converts the oxygen concentration in the exhaust gas into a current value, and sends the value to the PCM.
- The PCM calculates the λ (lambda) value of the air-fuel mixture based on the received current value.
- (λ (lambda)) = (actual air/fuel ratio)/14.7



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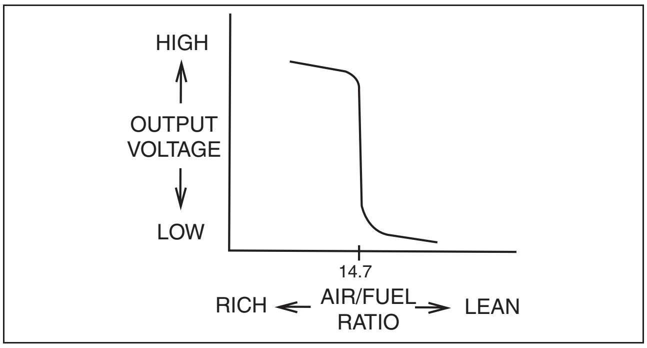
Rear HO2S

- A heater is built into the sensor to facilitate the activation of the HO2S at engine startup (when the exhaust gas temperature is low).
- A zirconium element is used on the sensor. When there is a difference between the oxygen concentration inside and outside the element, electromotive force is generated by the movement of oxygen ions (inside of the zirconium element: atmosphere, outside: exhaust gas). The electromotive force changes significantly at the boundary of the stoichiometric air/fuel ratio (A/F=14.7). The PCM receives the voltage generated from the HO2S directly, and increases or decreases the fuel injection amount by the fuel injection control so that it is close to the stoichiometric air/fuel ratio.
- When the temperature of the zirconium element is low, electromotive force is not generated. Therefore the HO2S is heated by a built-in heater, facilitating the oxygen sensor activation. Due to this, the sensor is efficiently activated even immediately after cold-engine startup, and a stable sensor output can be obtained.



atraan00000230

CRANKSHAFT POSITION (CKP) SENSOR FUNCTION[L3]

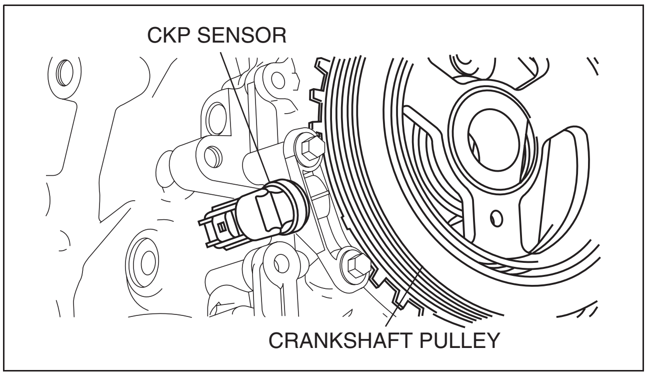
id0140a7104700

- Detects the pulse wheel rotation pulse as the engine crank angle signal.

CRANKSHAFT POSITION (CKP) SENSOR CONSTRUCTION/OPERATION[L3]

id0140a7104800

- Installed on the side surface of the cylinder block (driver’s side).
- The crankshaft position sensor pulse wheel has 30 projections with 10 ° of crank angle between the rising edge of each projection.
- The crankshaft position sensor consists of a hall element with a magnetic sensor, and a processing circuit that performs signal amplification and identification.



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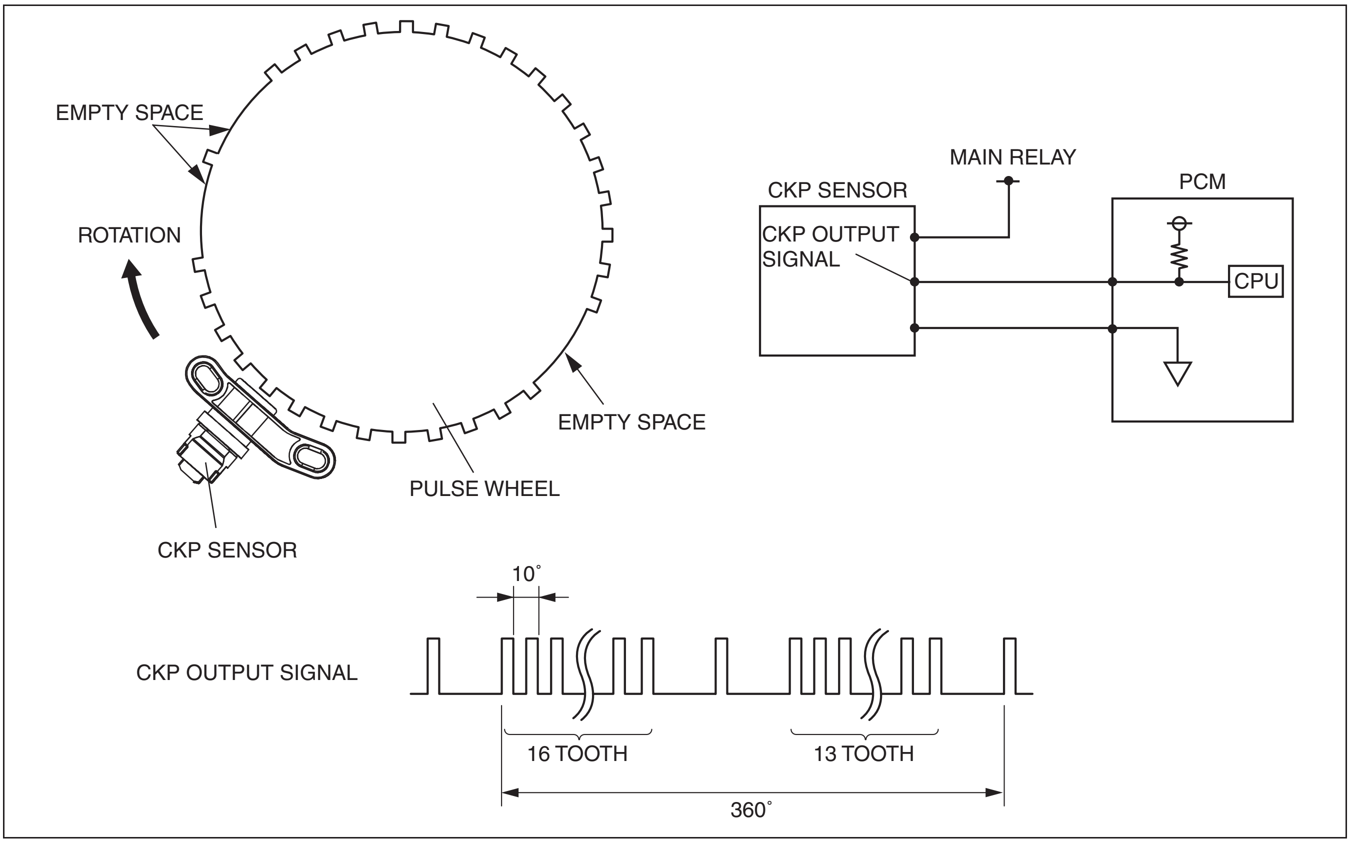
- The projections on the plate installed to the crankshaft pulley cause a change in the magnetic flux when they pass near the magnetic sensor of the CKP sensor by the rotation of the crankshaft. The CKP sensor converts the change in magnetic flux to a digital waveform (rectangular waves) by the processing circuit. The PCM detects the engine speed and crankshaft position based on the crankshaft position waveforms.



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CAMSHAFT POSITION (CMP) SENSOR FUNCTION[L3]

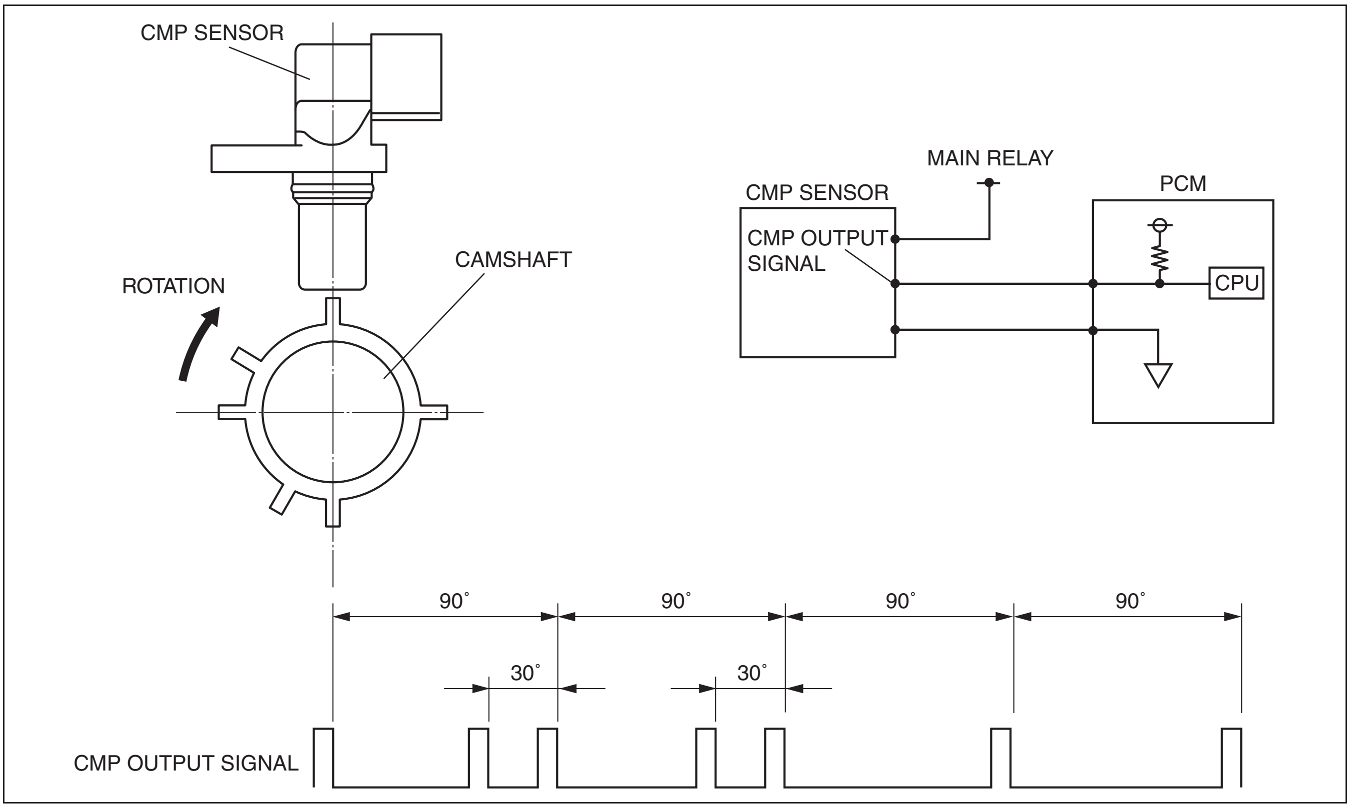
id0140a7104900

- The camshaft angle and TDC at each cylinder is detected.

CAMSHAFT POSITION (CMP) SENSOR CONSTRUCTION/OPERATION[L3]

id0140a7105000

- Installed on the engine head cover.
- Six pulses per one camshaft rotation are detected by a wide projection and a narrow projection installed on the intake air side camshaft.
- The camshaft position sensor consists of a hall element with a magnetic sensor, and a processing circuit that performs signal amplification and identification.
- The projections on the camshaft cause a change in the magnetic flux when they pass near the magnetic sensor of the CMP sensor by the rotation of the camshaft. The CMP sensor converts the change in magnetic flux to a digital waveform (rectangular waves) by the processing circuit. The PCM detects the engine speed and camshaft position based on the camshaft position waveforms.



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KNOCK SENSOR (KS) FUNCTION[L3]

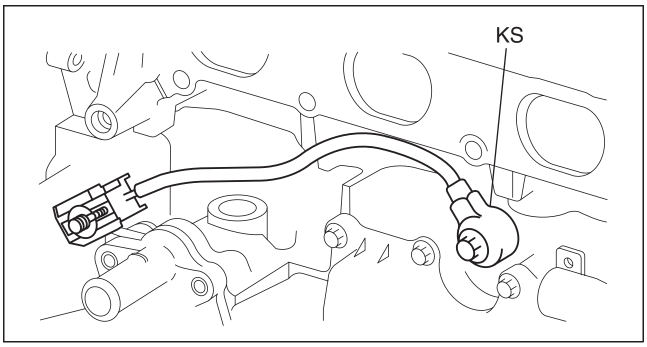
id0140a7174100

- Detects abnormal combustion in the engine.

KNOCK SENSOR (KS) CONSTRUCTION/OPERATION[L3]

id0140a7174200

- Installed on the front of the cylinder block (intake manifold side).
- Converts vibration from abnormal combustion in the engine to voltage using the piezoelectric effect in the semi-conductor and outputs it to the PCM.
- The piezoelectric effect is a phenomenon in which a difference in electric potential is produced on the surface of a piezoelectric element by the application of tensile load or pressure from a certain direction. Tensile load and pressure applied to the KS originates from engine vibration caused by abnormal combustion in the engine. The difference in electric potential, which results from the distortion by the vibration, is sent to the PCM as a knocking signal.



C3U0140S050

01-40B CONTROL SYSTEM [AJ (3.0L Duratec)]

01

ENGINE CONTROL SYSTEM OUTLINE[AJ (3.0L Duratec)]

id0140a1100100

Features

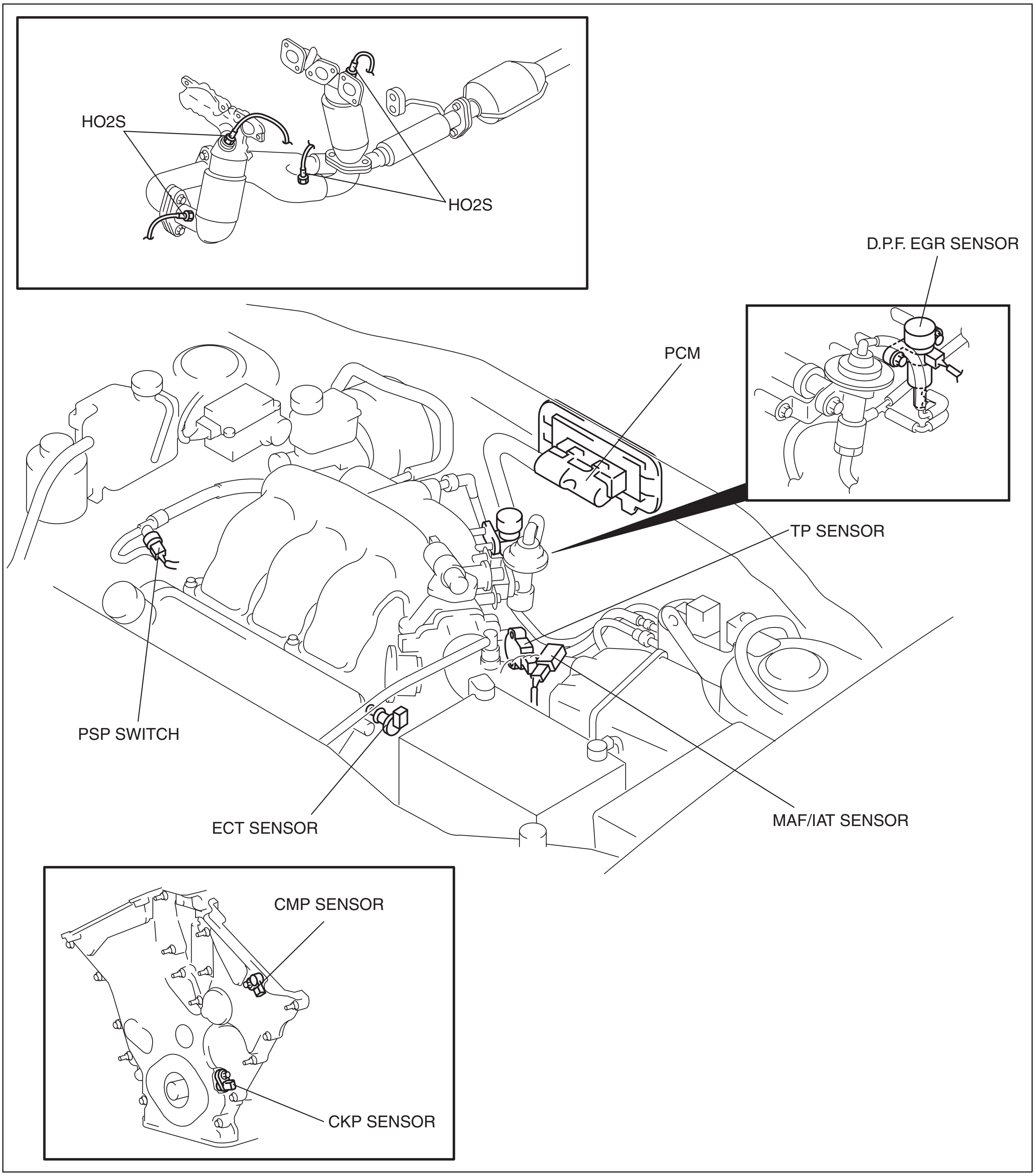
Improved emission gas purification	• EGR control adopted

Specification

Item	Specification
ECT sensor	Thermistor
IAT sensor (Inside MAF)	Thermistor
TP sensor	Potentiometer type
MAF sensor	Hot wire
HO2S	Zirconia element (Stoichiometric air/fuel ratio sensor)
CKP sensor	Pickup type
CMP sensor	Pickup type
D.P.F. EGR sensor	Piezoelectric element type

ENGINE CONTROL SYSTEM STRUCTURAL VIEW[AJ (3.0L Duratec)]

id0140a1100200



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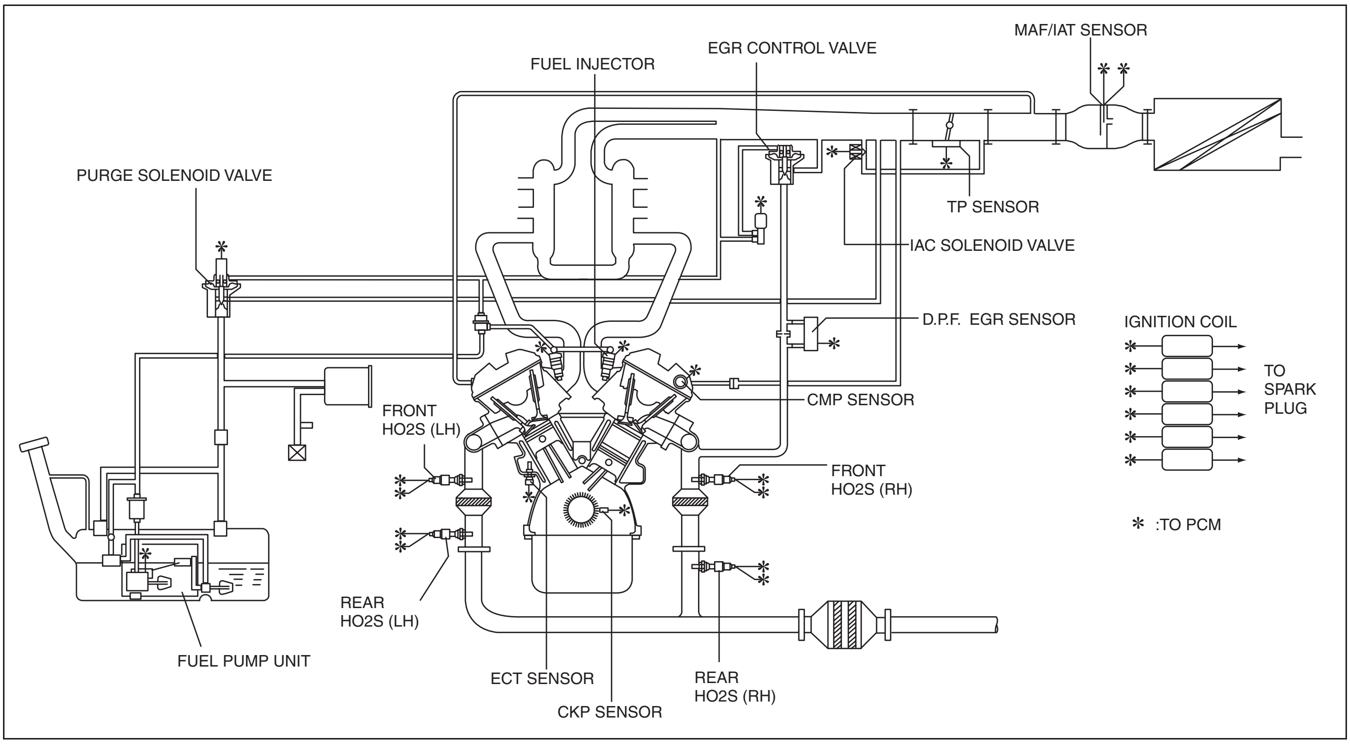
ENGINE CONTROL SYSTEM DIAGRAM[AJ (3.0L Duratec)]

id0140a1100300



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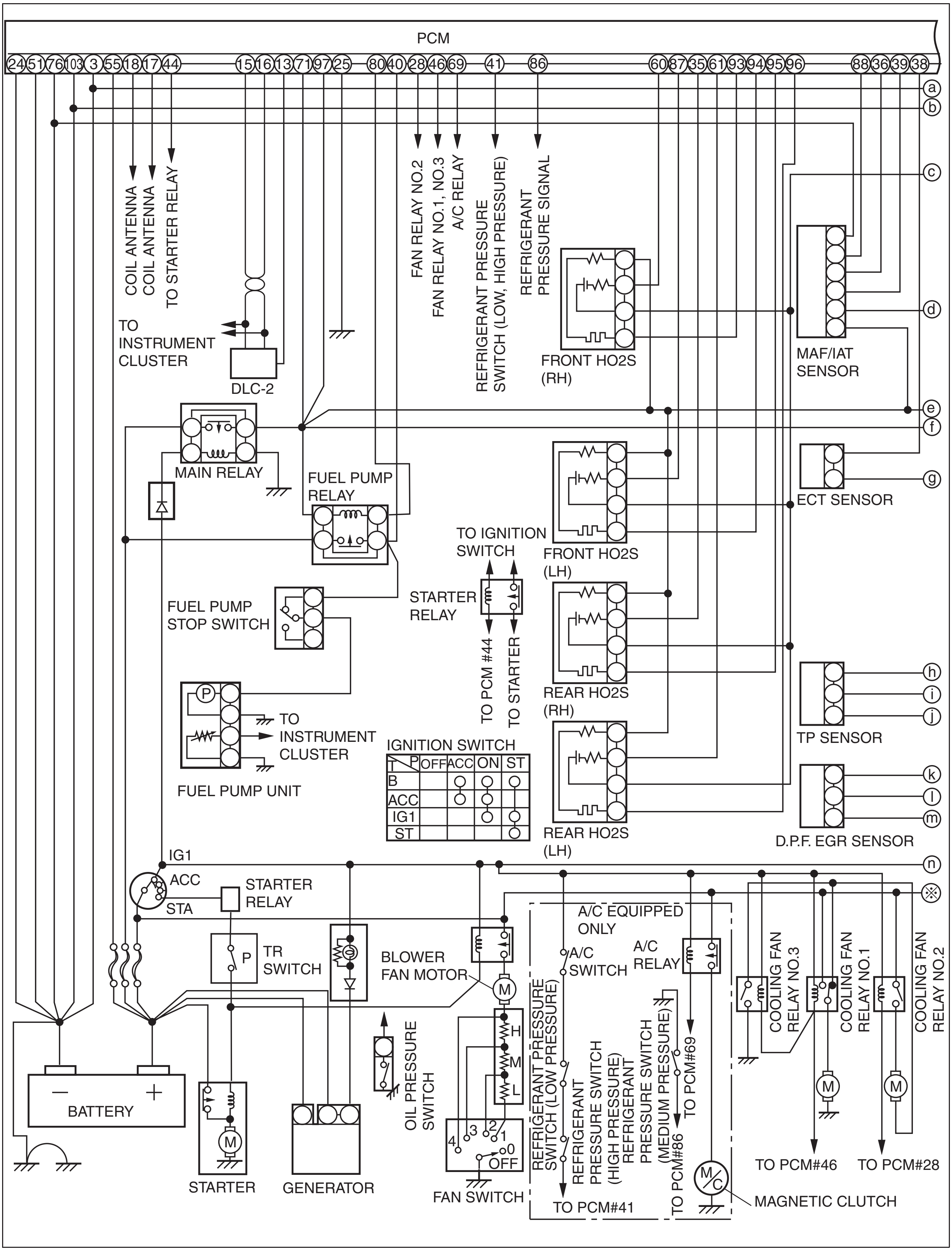
ENGINE CONTROL SYSTEM WIRING DIAGRAM[AJ (3.0L Duratec)]

id0140a1100400



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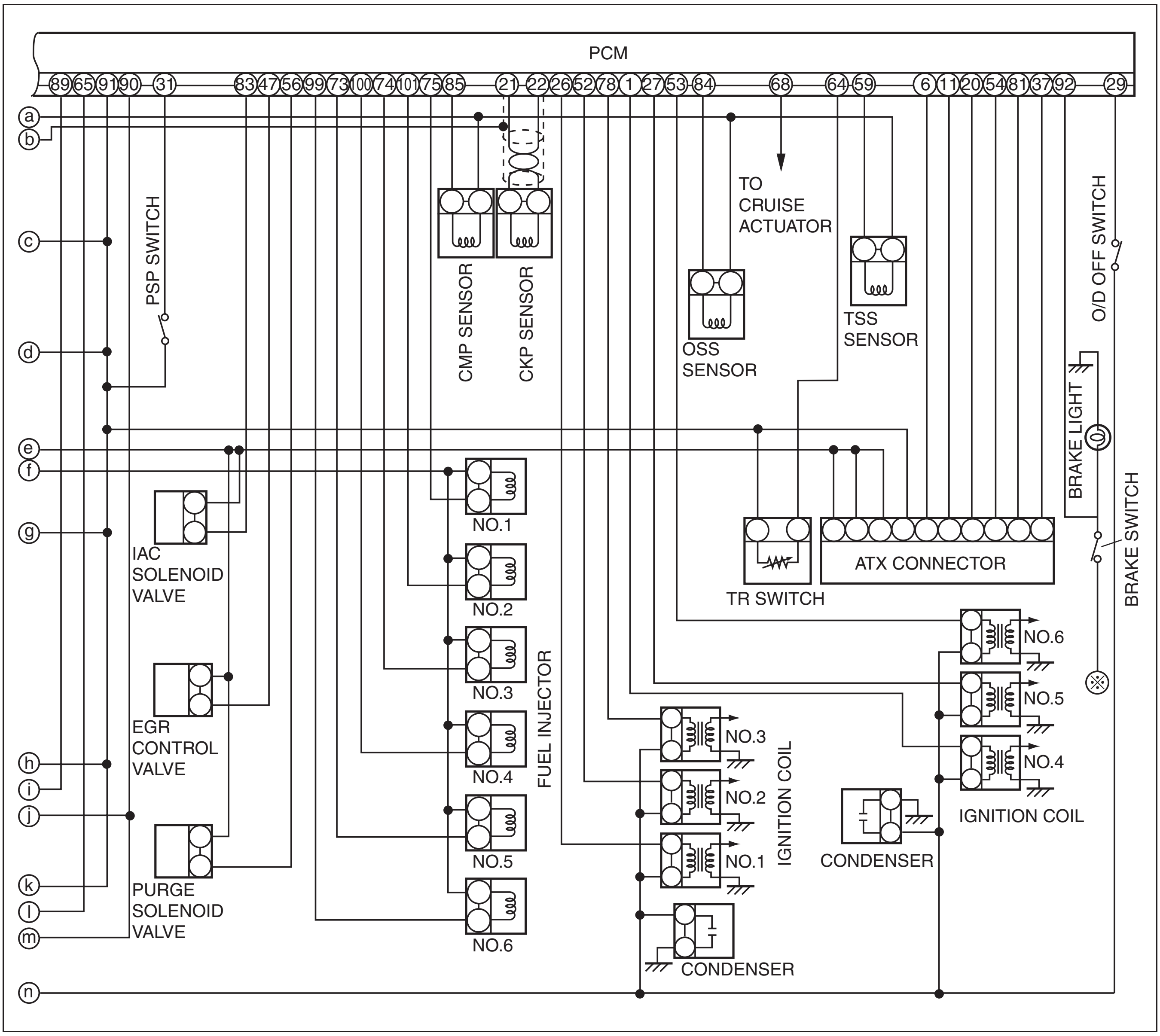

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PCM FUNCTION[AJ (3.0L Duratec)]

id0140a1105300

Function Table

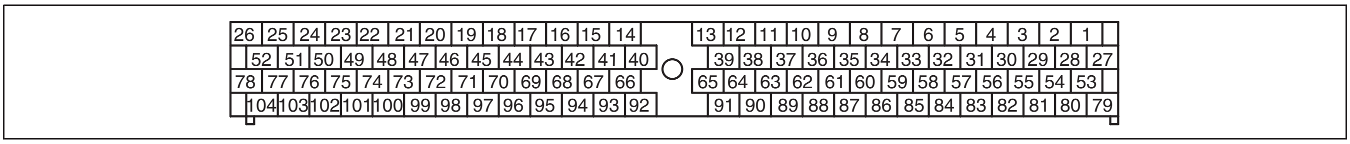
- The control descriptions are as shown below.

Function	Contents
IAC	The IAC solenoid valve ensures idling stability by the drive duty so that an optimum opening angle is obtained according to engine operation conditions.
Fuel injection control	Performs optimum fuel injection according to engine operation conditions.
Fuel pump control	Performs energization of the fuel pump relay (operates the fuel pump) only when the engine is running to improve safety and durability.
Ignition control	Controls ignition to optimum timing according to engine operation conditions.
Evaporative purge control	An appropriate amount of evaporative gas is fed into the dynamic chamber by the purge solenoid valve operation according to the engine operation conditions to ensure driveability and prevent release of evaporative gas into the atmosphere.
EGR control	Adjusts the EGR valve to the optimum opening angle according to engine operation conditions.
A/C cut-off control	Through energization and non-energization to the A/C relay (magnetic clutch) according to engine operation conditions, loss of engine performance, engine damage, and loss of A/C function are prevented.
Electrical fan control	Through cooling of the radiator and condenser by operation of the cooling fan according to vehicle conditions, engine reliability and cooling performance have been improved.

PCM CONSTRUCTION/OPERATION[AJ (3.0L Duratec)]

id0140a1105400

- The PCM uses a 104 pin (single block) connector.



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INTAKE AIR TEMPERATURE (IAT) SENSOR FUNCTION[AJ (3.0L Duratec)]

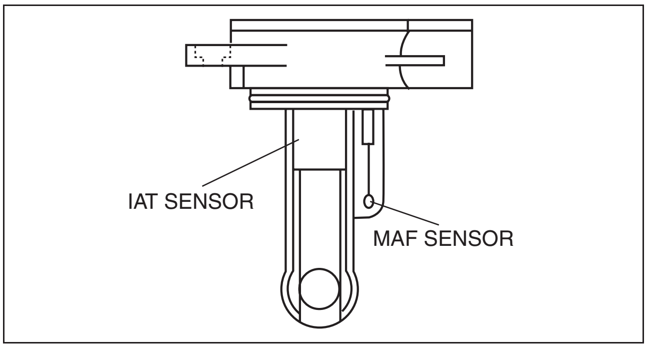
id0140a1178200

- Detects intake air temperature.

INTAKE AIR TEMPERATURE (IAT) SENSOR CONSTRUCTION/OPERATION[AJ (3.0L Duratec)]

id0140a1178100

- Built into the MAF sensor.
- The IAT sensor is a thermistor type in which the resistance changes according to the intake air temperature.



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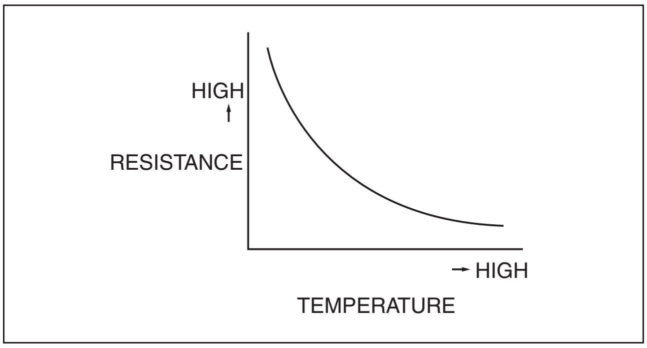
- As shown in the graph, the resistance decreases if the intake air temperature increases and conversely increases if the intake air temperature decreases.



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MASS AIR FLOW (MAF) SENSOR FUNCTION[AJ (3.0L Duratec)]

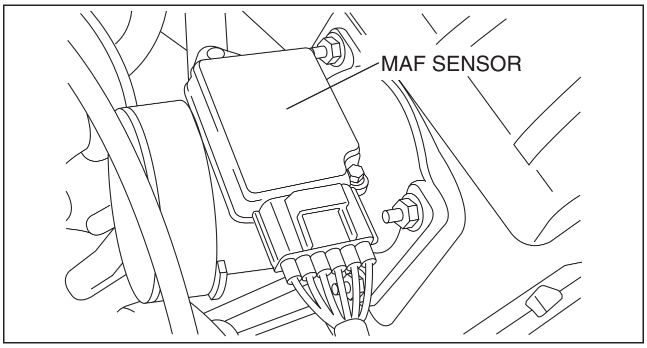
id0140a1176800

- Detects intake air amount (mass airflow amount).

MASS AIR FLOW (MAF) SENSOR CONSTRUCTION/OPERATION[AJ (3.0L Duratec)]

id0140a1176700

- Installed near the air cleaner outlet port.



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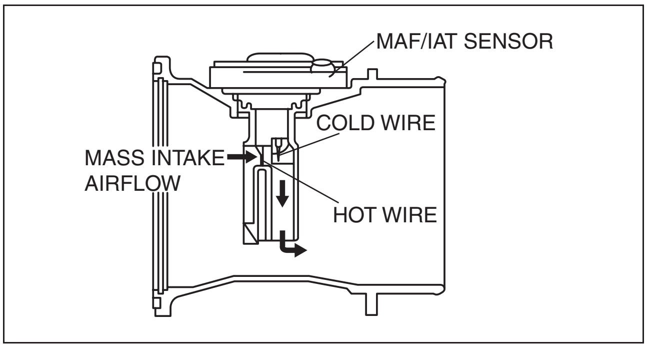
- Incorporates the intake air temperature sensor.
- When the temperature of the metal decreases, the resistance decreases. Using this characteristic, the hot wire captures heat from the flow of intake air and converts the intake airflow amount to voltage.
- The cold wire converts intake air density to voltage from the ambient temperature of the cold wire, using the characteristic of air whereby the intake air density decreases due to the increase in intake air temperature.
- The voltages obtained by the hot wire (intake airflow amount) and the cold wire (intake air correction value) are compared, and the electric potential is stabilized by supplying the voltage difference to the transistor. The voltage supplied to the hot wire is output as the mass intake airflow amount.



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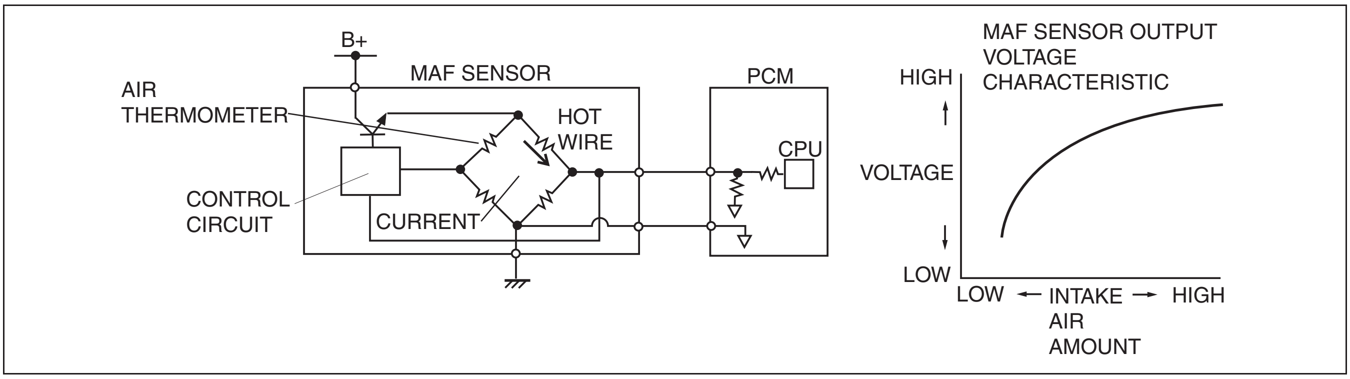

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CRANKSHAFT POSITION (CKP) SENSOR FUNCTION[AJ (3.0L Duratec)]

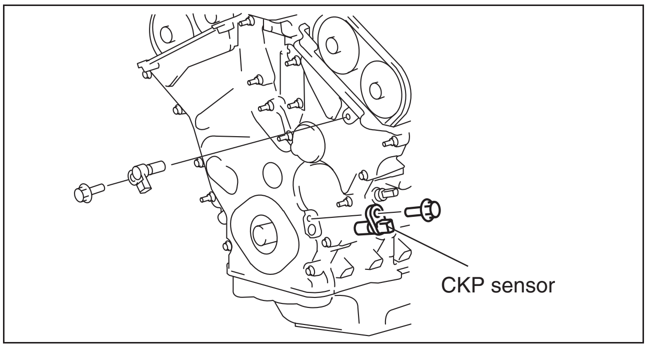
id0140a1177400

- Detects the pulse wheel rotation pulse as the engine crank angle signal.

CRANKSHAFT POSITION (CKP) SENSOR CONSTRUCTION/OPERATION[AJ (3.0L Duratec)]

id0140a1177300

- Installed on the lower part of the engine front cover.
- Detects the crankshaft rotation angle by monitoring the gear teeth and toothless gaps of the pulse wheel installed on the crankshaft pulley.
- The sensor is a pickup coil type.



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CAMSHAFT POSITION (CMP) SENSOR FUNCTION[AJ (3.0L Duratec)]

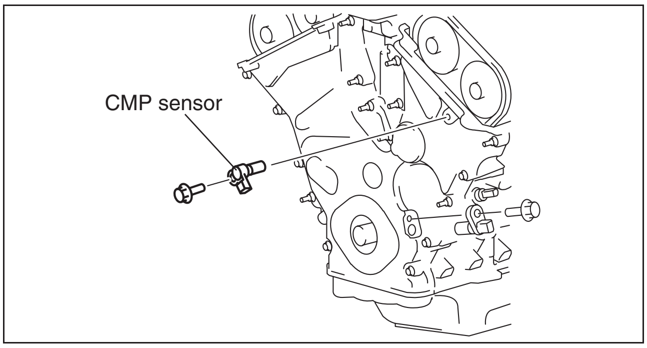
id0140a1177600

- Detects the rotation angle of the left bank exhaust side camshaft.

CAMSHAFT POSITION (CMP) SENSOR CONSTRUCTION/OPERATION[AJ (3.0L Duratec)]

id0140a1177500

- Installed on the upper part of the engine front cover.
- Detects camshaft rotation angle by monitoring the projection (detection part) located on the left bank exhaust side camshaft pulley.
- The sensor is a pickup coil type.



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ENGINE COOLANT TEMPERATURE (ECT) SENSOR FUNCTION[AJ (3.0L Duratec)]

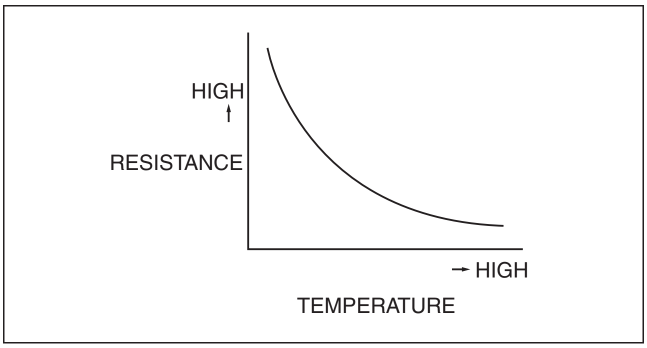
id0140a1178000

- Detects the engine coolant temperature.

ENGINE COOLANT TEMPERATURE (ECT) SENSOR CONSTRUCTION/OPERATION[AJ (3.0L Duratec)]

id0140a1177900

- Installed on the water bypass tube.
- The ECT is a thermistor type in which the resistance changes according to the engine coolant temperature.
- As shown in the graph, the resistance decreases if the engine coolant temperature increases, and conversely increases if the engine coolant temperature decreases.



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HEATED OXYGEN SENSOR (HO2S) FUNCTION[AJ (3.0L Duratec)]

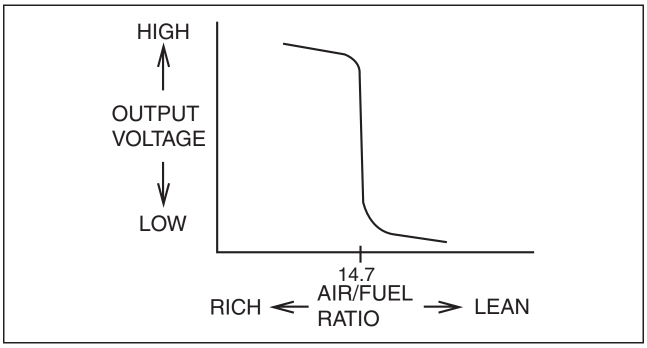
id0140a1178300

- Detects the oxygen concentration in the exhaust gas.
- A heater has been adopted to stabilize oxygen concentration detection even when exhaust gas temperature is low.

HEATED OXYGEN SENSOR (HO2S) CONSTRUCTION/OPERATION[AJ (3.0L Duratec)]

id0140a1178400

- Installed in front of the catalytic converter.
- The built-in heater promotes activation of the heated oxygen sensor at engine start (when exhaust gas is at low temperature).
- A zirconium element is used on the sensor. When there is a difference between the oxygen concentration on either side of the element, electromotive force is generated by the movement of oxygen ions (atmospheric air on the inner side of the zirconium element, exhaust gas on the outer side). The electromotive force changes significantly at the boundary of the stoichiometric air/fuel ratio (A/ F=14.7). The PCM inputs the voltage generated from the HO2S directly, and increases or decreases the fuel injection amount by the fuel injection control so that it is close to the stoichiometric air/fuel ratio.



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- When the temperature of the zirconium element is low, electromotive force is not generated so the element is heated by a built-in heater, promoting the oxygen sensor activation. Due to this, the sensor is efficiently activated even immediately after cold-engine start, and a stable sensor output can be obtained.

THROTTLE POSITION (TP) SENSOR FUNCTION[AJ (3.0L Duratec)]

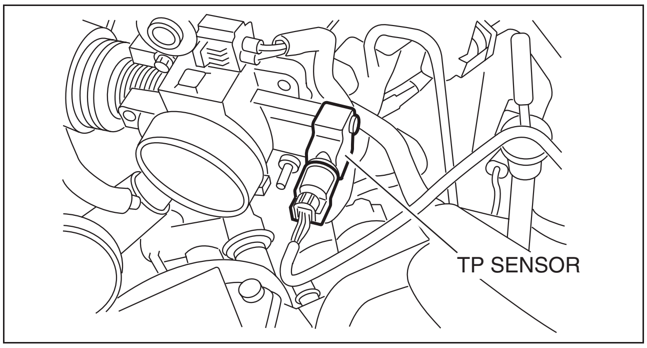
id0140a1178600

- Detects the throttle valve opening angle.

THROTTLE POSITION (TP) SENSOR CONSTRUCTION/OPERATION[AJ (3.0L Duratec)]

id0140a1178500

- Installed on the side of throttle body.
- A potentiometer type has been adopted.
- Detects the fluctuation in voltage (variable resistance) of the throttle valve opening angle and outputs it to the PCM. The voltage input to the PCM increases in proportion to the increase in throttle valve opening angle.



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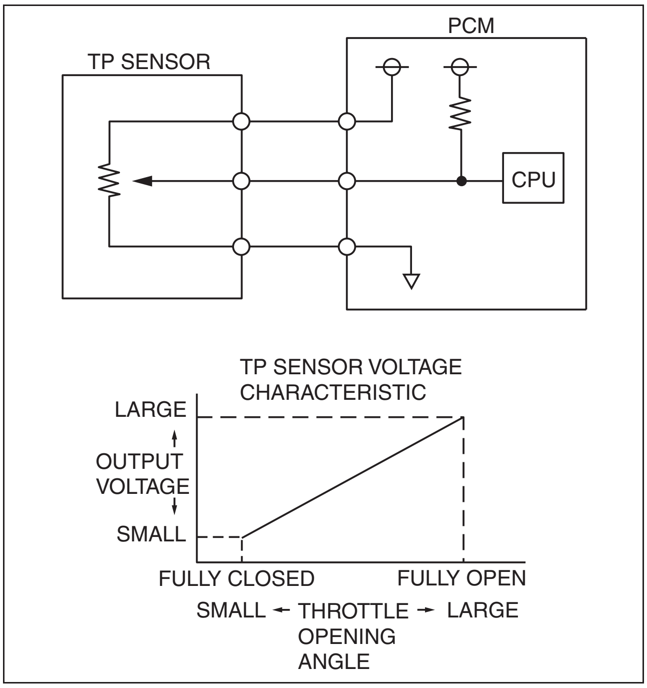
- Installed to the valve shaft so that it is linked to the opening and closing of the throttle valve.



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DIFFERENTIAL PRESSURE FEEDBACK (D. P. F.) EGR SENSOR FUNCTION[AJ (3.0L Duratec)]

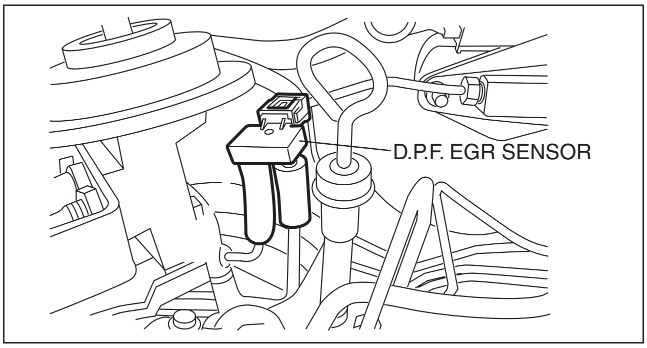
id0140a1190100

- Detects the difference between pressure formed downstream and upstream of the orifice in the middle of the EGR pipe as the EGR flow rate.

DIFFERENTIAL PRESSURE FEEDBACK (D. P. F.) EGR SENSOR CONSTRUCTION/OPERATION[AJ (3.0L Duratec)]

id0140a1190000

- Installed near the EGR valve.
- Induction pipes that go from downstream and upstream of the orifice in the middle of the EGR pipe are connected to the D.P.F. EGR sensor, and the sensor converts the difference in pressure formed downstream and upstream of the orifice into voltage.
- When the piezoelectric element in the sensor is strained due to differential pressure, an electric potential difference is created. The larger the strain, the higher the output voltage.



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SUSPENSION

02
SECTION

02-00 OUTLINE

SUSPENSION ABBREVIATIONS

id020000100100

4×4	4-wheel 4-drive

SUSPENSION FEATURES

id020000100200

Front Suspension

- The front suspension consist of the following parts:
  - — Shock absorber and coil spring
  - — Upper mount bracket
  - — Front lower arm
  - — Front lower arm ball joint
  - — Front stabilizer and bracket
  - — Stabilizer control link
  - — Front lower arm bushing
  - — Front crossmember
- The front shock absorber and coil spring can be disassembled and replaced. The left and right can also be replaced separately.
- Component parts of the stabilizer can be replaced separately.

Rear suspension

- The rear suspension consist of the following parts:
  - — Rear coil spring
  - — Rear shock absorber
  - — Lower arm
  - — Upper arm
  - — Bound stopper
  - — Rear crossmember
- The upper and lower arms, and the bushings can be replaced separately.
- Only the toe on the rear suspension can be adjusted.

SUSPENSION SPECIFICATIONS

id020000100300

Suspension

Item					Specification	
					Vehicle with 215/70R16 tires	Vehicle with 235/70R16 tires
Front suspension	Type				Strut type	
	Spring type				Coil spring	
	Shock absorber type				Cylindrical, double-acting (Low-pressure gas charged)	
	Stabilizer	Type			Torsion bar	
		Diameter		(mm {in})	21 {0.83}	
	Wheel alignment (Unloaded*)	Total toe-in	Tire [Tolerance ±4 {0.15}]	(mm {in})	L3: –1.0 {–0.04} AJ (3.0L Duratec): 3.0 {–0.12}	
				Degree	L3: –0°05′±0°14′ AJ (3.0L Duratec): 0°14′±0°14′	
		Maximum steering angle [Tolerance ±3°]		Inner	37°06′	35°18′
				Outer	30°54′	29°48′
		Caster angle (Reference) [Tolerance ±1°]			1°47′24″	
		Camber angle (Reference) [Tolerance ±1°]			L3: –0°28′48″ AJ (3.0L Duratec): –0°50′24″	
		Steering axis inclination (Reference)			L3: 11°06′ AJ (3.0L Duratec): 11°24′	
Rear suspension	Type				Multi-link	
	Spring type				Coil spring	
	Shock absorber type				Cylindrical, double-acting (Low-pressure gas charged)	
	Wheel alignment (Unloaded*)	Total toe-in	Tire [Tolerance ±4 {0.15}]	(mm {in})	L3: 1.0 {0.04} AJ (3.0L Duratec): 2.6 {0.10}	
				Degree	L3: 0°05′±0°07′ AJ (3.0L Duratec): 0°12′±0°07′	
		Camber angle [Tolerance ±1°]			0°02′24″	
		Thrust angle [Tolerance ±48′]			0°	

* : Unloaded: Fuel tank is full. Engine coolant and engine oil are at specified level. Spare tire, jack and tools are in designated position.

Wheels and Tires

Standard tire

Item			Specification	
Tire	Size		215/70R16 99H	235/70R16 105H
Wheel	Size		16 x 6.5J or 16 x 7.0J	16 x 7.0J
	Material		Steel, Aluminum alloy	Aluminum alloy
	Offset	(mm {in})	50 {2.0}	45 {1.8}
	Pitch circle diameter	(mm {in})	114.3 {4.50}	

Temporary spare tire

Item			Specification	
Tire	Size		T155/80R17 100M T155/90R17 100M	215/70R16 100M
Wheel	Size		17 x 4T	16 x 6.5J
	Material		Steel	
	Offset	(mm {in})	45 {1.8}	50 {2.0}
	Pitch circle diameter	(mm {in})	114.3 {4.50}	

02-11 WHEEL ALIGNMENT

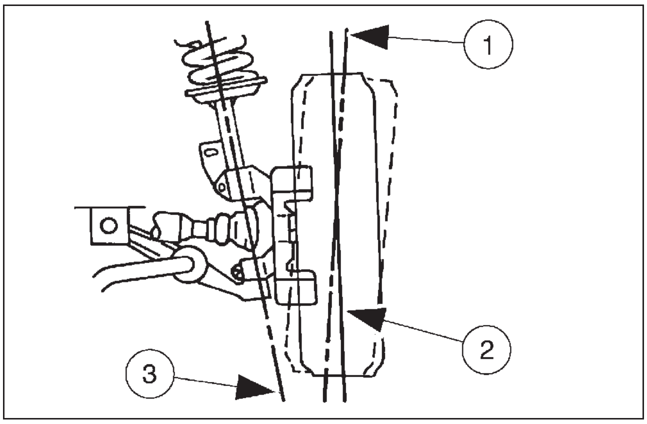
WHEEL ALIGNMENT OUTLINE

id021100100100

Camber

- Camber is the inward or outward tilting of the wheels at the top as viewed from the front of the vehicle.

Number	Item
1	Positive camber
2	True vertical
3	Steering axis



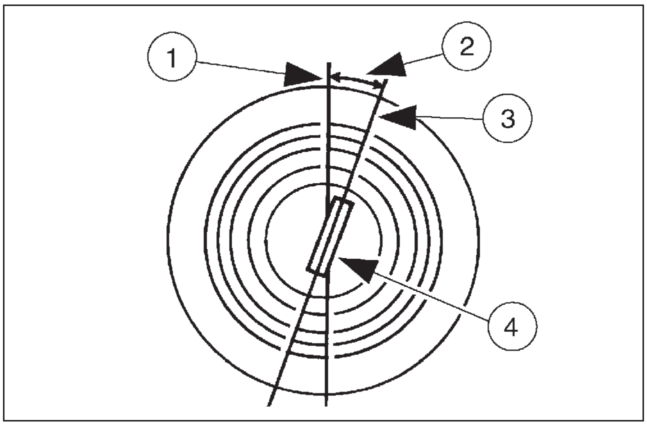
GF0166B

— When the wheels tilt out at the top, the camber is positive (+).
— When the wheels tilt in at the top, the camber is negative (–).

Caster

- Caster is the tilting of the steering axis either forward or backward from vertical.

Number	Item
1	True vertical
2	Positive caster
3	Strut ball joint centerline
4	Steering axis



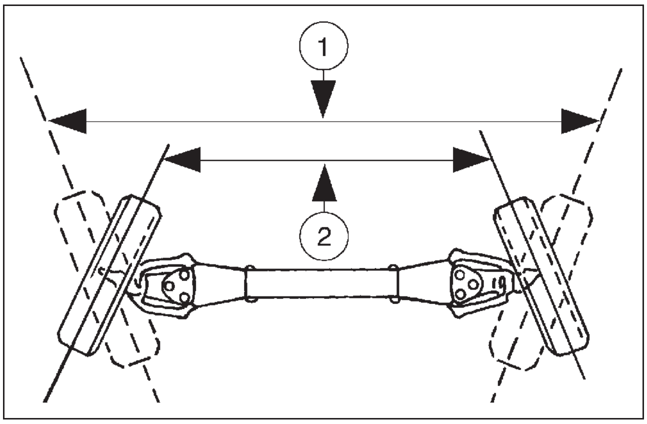
GF0167A

— A backward tilt is positive (+) caster and a forward tilt is negative (–) caster.
— Front caster adjustment is not a separate procedure on this vehicle. The front caster should fall within the specification when the front camber is adjusted.

Toe

- Toe is a measurement of how much the front of the wheels are turned in or out from the straight-ahead position.

Number	Item
1	Negative (–) toe (toe out)
2	Positive (+) toe (toe in)



GF0168A

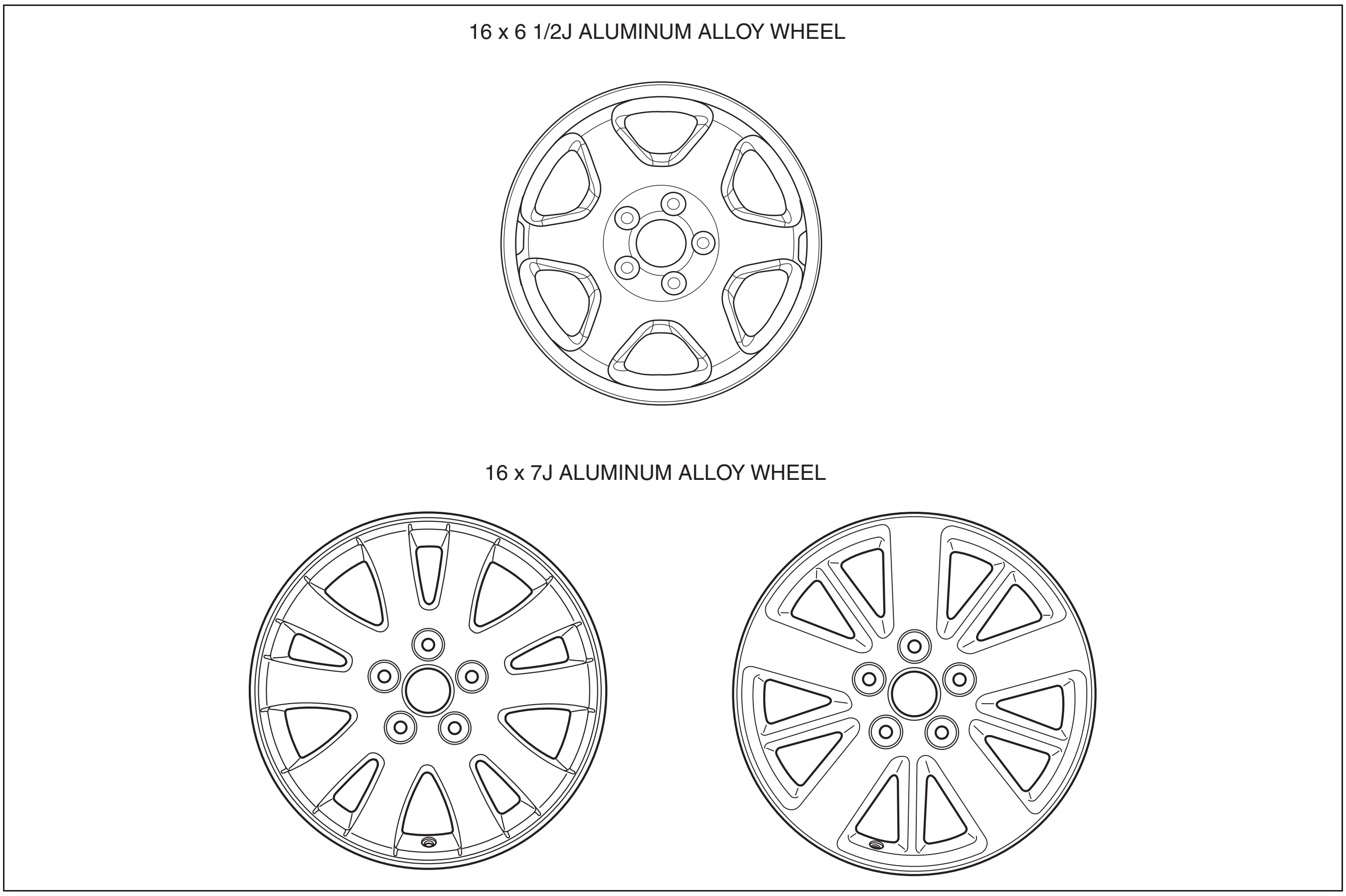
— When the wheels are turned in toward the front of the vehicle, toe is positive (+) (toe in). When the wheels are turned out from the front of the vehicle, toe is negative (–) (toe out).
— Toe is measured in degrees, from side to side, and totaled.

02

02-12 WHEEL AND TIRES

WHEELS AND TIRES STRUCTURAL VIEW

id021200100200



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02-13 FRONT SUSPENSION

FRONT SUSPENSION OUTLINE

id021300100100

- The front suspension consists of the following parts:
  — Front lower arm
  — Stabilizer bar
  — Stabilizer bushing
  — Stabilizer control link
  — Front shock absorber and coil spring
  — Front crossmember

FRONT CROSSMEMBER CONSTRUCTION

id021300100600

- The front crossmember is installed to the body with bolts and has the following feature:
  — The front crossmember has installation areas for the steering gear and linkage, front lower arm, engine mount member, transverse member and stabilizer bar.

02-14 REAR SUSPENSION

REAR SUSPENSION OUTLINE

id021400100100

- The rear suspension consists of the following parts:
  — Upper arm
  — Lower arm
  — Rear shock absorber
  — Coil spring
  — Rear crossmember

REAR CROSSMEMBER CONSTRUCTION

id021400100400

Construction

- The rear crossmember is installed to the body with bolts, and has the following feature.
  — The rear crossmember has installation areas for the upper arm, lower arm and rear exhaust hanger. The rear differential (4×4) is also installed to the rear crossmember.

DRIVELINE/AXLE

03 SECTION

03-00 OUTLINE

03

DRIVELINE/AXLE ABBREVIATIONS

id030000150300

RBC	Rotary Blade Coupling
4×2	4-wheel 2-drive
4×4	4-wheel 4-drive

DRIVELINE/AXLE SPECIFICATIONS

id030000100200

Item				Specification	
Engine type				L3	AJ (3.0 L Duratec)
Front axle	Wheel bearing type			Angular ball bearing	
Rear axle	Wheel bearing type			Angular ball bearing	
Front drive shaft	Joint type		Wheel side	Bell joint	
			Differential side	Tripod joint	
	Shaft diameter		(mm {in})	26.0 {1.02}	28.8 {1.13}
Rear drive shaft	Joint type		Wheel side	Bell joint	
			Differential side	Tripod joint	
	Shaft diameter		(mm {in})	23.0 {0.90}	
Joint shaft	Shaft diameter		(mm {in})	29.0 {1.14}	27.5 {1.08}
Rear differential	Fluid specification	Type		API Service GL-5 (SAE80W-90)	
		Capacity (approx. quantity)	(L {US qt, Imp qt})	1.4 {1.5, 1.2}	
Transfer oil		Grade		API service GL-5	API service GL-5
		Viscosity		SAE 80W-90	SAE 75W-140
		Capacity (Approx. quantity)	(L {US qt, Imp qt})	0.35 {0.37, 0.31}	0.35 {0.37, 0.31}

03-11 FRONT AXLE

FRONT AXLE CONSTRUCTION

id031100150500

- The front axle consists of the following parts:
  — Wheel bearing
  — Wheel hub
  — Hub bolt
  — Wheel knuckle

03-12 REAR AXLE

REAR AXLE CONSTRUCTION

id031200150600

- The rear axle consists of the following parts:
  — Wheel bearing
  — Wheel hub
  — Hub bolt
  — Wheel knuckle

03-13 DRIVE SHAFT

FRONT DRIVE SHAFT CONSTRUCTION

id031300151300

- The front drive shaft consists of the following parts:
  — Drive shaft
  — Boot clamp
  — Boot
  — Constant velocity joint
  — Clip

REAR DRIVE SHAFT CONSTRUCTION

id031300151400

03

- The rear drive shaft consists of the following parts:
  — Drive shaft
  — Boot clamp
  — Boot
  — Constant velocity joint
  — Clip

JOINT SHAFT CONSTRUCTION

id031300151500

- The joint shaft consists of the following parts:
  — Constant velocity joint
  — Joint shaft
  — Bracket
- A bearing and a dust cover are press fitted into the bracket and can be replaced if necessary. (For AJ (3.0 L Duratec)) models, replace the joint shaft component)

03-14 DIFFERENTIAL

REAR DIFFERENTIAL CONSTRUCTION

id031400129600

- The rear differential has the following features:
  — Integral-type housing hypoid gear design has the centerline of the pinion set below the centerline of the ring gear.
  — Hypoid ring gear and pinion consists of a ring gear and an overhung drive pinion which is supported by two opposed tapered roller bearings.
  — Pinion bearing preload is maintained by a drive pinion collapsible spacer on the pinion shaft and adjusted by the pinion nut.
  — Rear axle housing component consists of a cast aluminum center section and a stamped-steel rear differential housing cover.
  — Differential housing cover that uses a silicone sealant rather than a gasket.
  — Aluminum rear axle housing must be spread in order to remove the differential case.
  — Differential case is a one-piece design. It has two openings to allow for assembly of internal components and lubricant flow.
  — Differential pinion shaft is retained by a threaded differential pinion shaft lock bolt assembled to the differential case.
  — Differential case is mounted in the rear axle housing between two opposed differential bearings.
  — Differential bearings are retained in the rear axle housing by removable bearing caps.
- Differential bearing preload and ring gear backlash are adjusted by differential bearing shims located between the differential bearing cup and the rear axle housing.
- The use of a pinion depth gauge is required for correct differential ring gear and pinion adjustment.
- The drive shafts are held in the differential case by a drive shaft bearing retainer circlip. When each drive shaft is installed, the drive shaft bearing retainer circlip engages a step in the differential side gear.
- The rear drive axle operates as follows:
  — The rear axle drive pinion receives power from the engine through the transmission, transfer case, drive shaft and rotary blade coupling (when engaged).
  — The pinion gear rotates the differential case, which is bolted to the differential case outer flange.
  — Inside the differential case, two differential pinion gears are mounted on a differential pinion shaft which is pinned to the differential case.
  — These differential pinion gears are engaged with the differential side gears to which the drive shafts are splined.
  — As the differential case turns, it rotates the drive shafts and rear wheels.
  — When it is necessary for one wheel and drive shaft to rotate faster than the other, the faster turning differential side gear causes the differential pinion gears to roll on the slower turning differential side gear. This allows differential action between the two drive shafts.
- The rotary blade coupling cannot be disassembled. Replace it as a component.

03

03-15 PROPELLER SHAFT

PROPELLER SHAFT OUTLINE

id031500131200

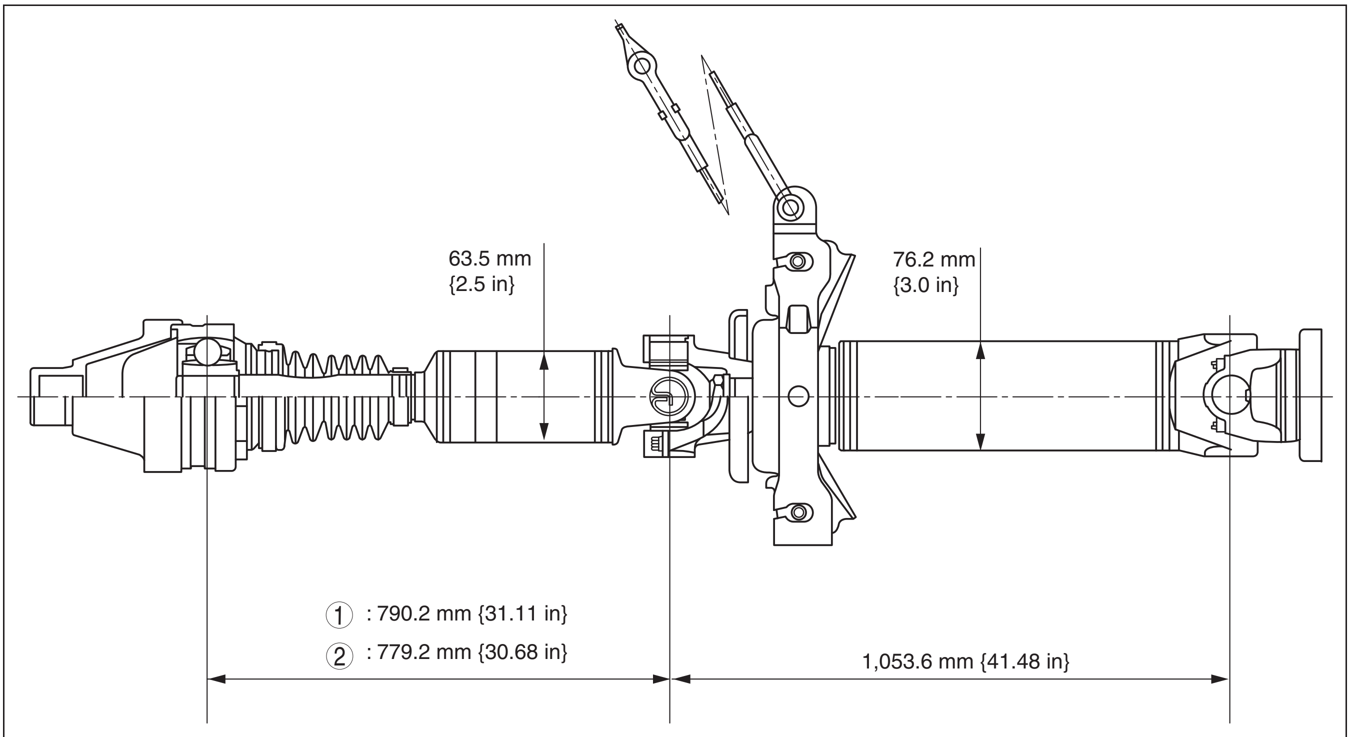
Features

- The propeller shaft consists of front and rear shafts.
- The propeller shaft has balance weights attached (spot-weld).

Caution

- **All propeller shaft component are balanced. If undercoating the vehicle, protect the propeller shaft to prevent overspray of any undercoating material.**

Structure



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1	GF4AX-EL	2	LA4AX-EL

UNIVERSAL JOINT CONSTRUCTION

id031500131300

- The single center joint has the following features:
  - — A lubed-for-life design that requires no periodic lubrication.
  - — Equipped with nylon thrust washers, located at the base of each bearing cup, which control end play, position the needle bearings and improve grease movement.

03-16A TRANSFER [GF4AX-EL]

TRANSFER FUNCTION[GF4AX-EL]

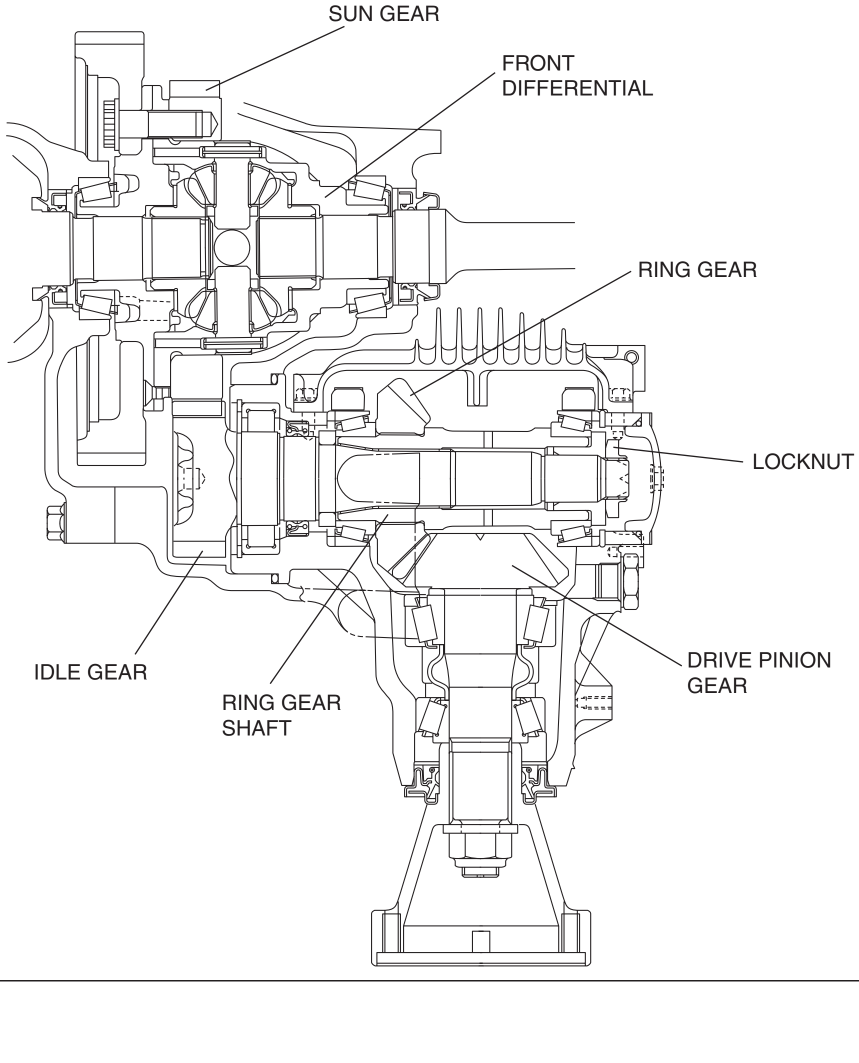
id0316a1136600

- A separated transfer with aluminum alloy carrier has been adopted for the size and weight reduction.
- The transfer consists of the idling gear, ring gear, and drive pinion. It changes the direction of the drive force from the front differential and transmits it to the propeller shaft.

TRANSFER CONSTRUCTION/OPERATION[GF4AX-EL]

id0316a1136500

- The idle gear is engaged with the front differential sun gear. The idle gear is spline engaged with the ring gear shaft and the ring gear is spline engaged with the ring gear shaft, so that when the front differential rotates, the idle and ring gears rotate as a single unit.
- Since the ring gear is engaged to the drive pinion, when the ring gear rotates, the force direction is changed to 90 ° to transmit it to the drive pinion, and then to the rear tires via the propeller shaft and rear differential.



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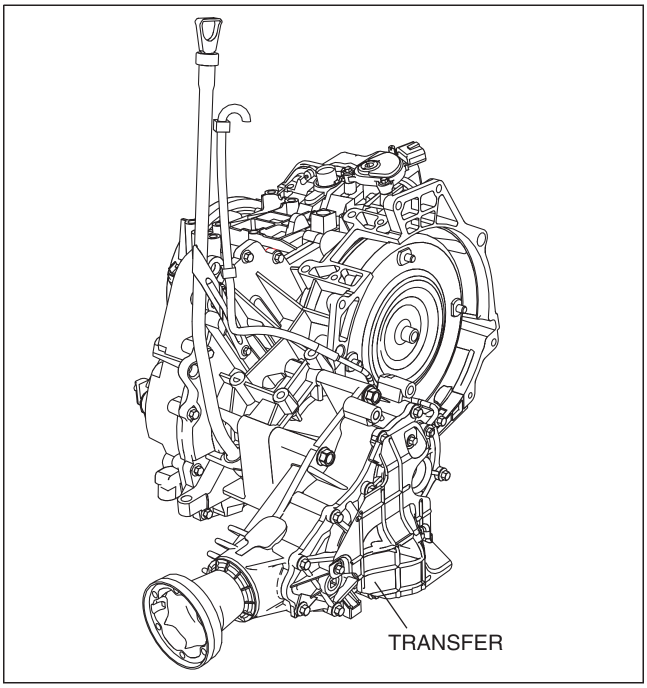
03-16B TRANSFER [LA4AX-EL (CD4E)]

TRANSFER CASE CONSTRUCTION[LA4AX-EL (CD4E)]

id0316a2136400

- The transfer case transmits the engine torque to the rear axle and rear propeller shaft through the front drive shaft and propeller shaft.
- The transfer case system consists of a power transfer unit, rear propeller shaft, coupling device, and rear axle.
- The power transfer unit is a gearbox that attaches to a transaxle.
- The drive shaft (RH) passes through the transfer case and engages the differential side gear.
- The transfer case provides power to the rear propeller shaft through a helical gear spline coupled to the transaxle differential case, a helical gear drop (idler gear) and hypoid/helical ring gear component and pinion set.

Note
- Repair of the transfer case is limited to seals, gaskets and output flange. If any of the geared components, tapered roller bearings, case cover or internal shafts malfunction, a new transfer case must be installed.



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- The transfer case is sealed from the transaxle and has its own oil sump.
- The transfer case uses API service GL-5 (oil grade), SAE 75W-140 (oil viscosity) and holds 0.35 L {0.37 US qt, 0.31 Imp qt}.
- The transfer case filler plug is located on the housing cover.

03-18 4-WHEEL DRIVE

4x4 SYSTEM CONSTRUCTION

id031800163000

- The 4×4 system consists of the following parts:
  - — 4×4 lock switch
  - — Transfer case
  - — Propeller shaft
  - — RBC (Rotary blade coupling)

4x4 SYSTEM OPERATION

id031800163100

- On front drive transaxle vehicles, a transfer case unit has been equipped to transmit power to the rotary blade coupling (RBC) installed to the rear differential through the drive shaft and universal joint.
- There are two 4×4 mode, AUTO and 4×4 ON. In the AUTO position, the vehicle travels in 4×2 unless the front wheels slip. If the front wheels slip, a difference in rotation speed between the front and rear axels occurs, and the rotary blade in the silicone fluid rotates. Rotation of the rotary blade produces pressure in the silicone fluid. Based on this pressure, the piston is pressed, the RBC clutch plate engages, and torque is transmitted to the rear wheels. The amount of torque supplied to the rear axel is based on the difference in vehicle wheel rotation speed between the front and rear wheels. At the point where there is no front wheel slip, the drive system returns to 4×2.
- The 4×4 ON mode locks the RBC using the built-in magnetic clutch to transmit power to the rear wheels from the rotating drive shaft. In 4×4 ON mode the vehicle travels in 4×4 unless the 4×4 lock switch is operated.

BRAKES

04 SECTION

04-00 OUTLINE

BRAKE ABBREVIATIONS

id040000100100

04

ABS	Antilock Brake System
CAN	Controller Area Network
CM	Control Module
CPU	Central Processing Unit
EBD	Electronic Brakeforce Distribution
HU	Hydraulic Unit
IDS	Integrated Diagnostic Software
IG	Ignition
LF	Left Front
LR	Left Rear
OFF	Switch Off
ON	Switch On
PDS	Portable Diagnostic Software
PID	Parameter Identification
RF	Right Front
RR	Right Rear
SW	Switch
4×4	4-wheel 4-drive

BRAKE FEATURES

id040000100200

Improved safety	• Large power brake unit adopted • Electronic brakeforce distribution (EBD) control adopted • Antilock brake system (ABS) adopted
Improved braking force	• Large diameter front disc brakes adopted • Large diameter rear disc brakes adopted (Integrated with parking drum brake)
Improved serviceability	• Enhanced malfunction diagnosis system for use with IDS/PDS
Size and weight reduction	• Integrated construction of the hydraulic unit (HU) and control module (CM) adopted for the DSC HU/CM

BRAKE SPECIFICATIONS

id040000100300

Item			Specification
Brake pedal	Type		Suspended design
	Pedal lever ratio		3.6
	Max. stroke	(mm {in})	130.5 {5.138}
Master cylinder	Type		Tandem
	Cylinder bore	(mm {in})	26.9 {1.06}
Front brake (disc)	Type		Ventilated disc
	Cylinder bore	(mm {in})	66 {2.6}
	Disc plate dimensions	(mm {in})	303 × 26 {11.9 × 1.0}
Rear brake (disc)	Type		Solid disc
	Cylinder bore	(mm {in})	40.2 {1.58}
	Disc plate dimensions	(mm {in})	302 × 12 {11.9 × 0.47}
Power brake unit	Type		Vacuum multiplier, tandem diaphragm
Rear wheel braking force control device	Type		Electronic brakeforce distribution (EBD)
Brake piping	Piping layout		X pattern
Parking brake	Type		Mechanical design, rear two-wheel braking
	Operating method (application/release)		Hand-operated lever
Brake fluid	Type		SAE J1703, FMVSS 116 DOT-3

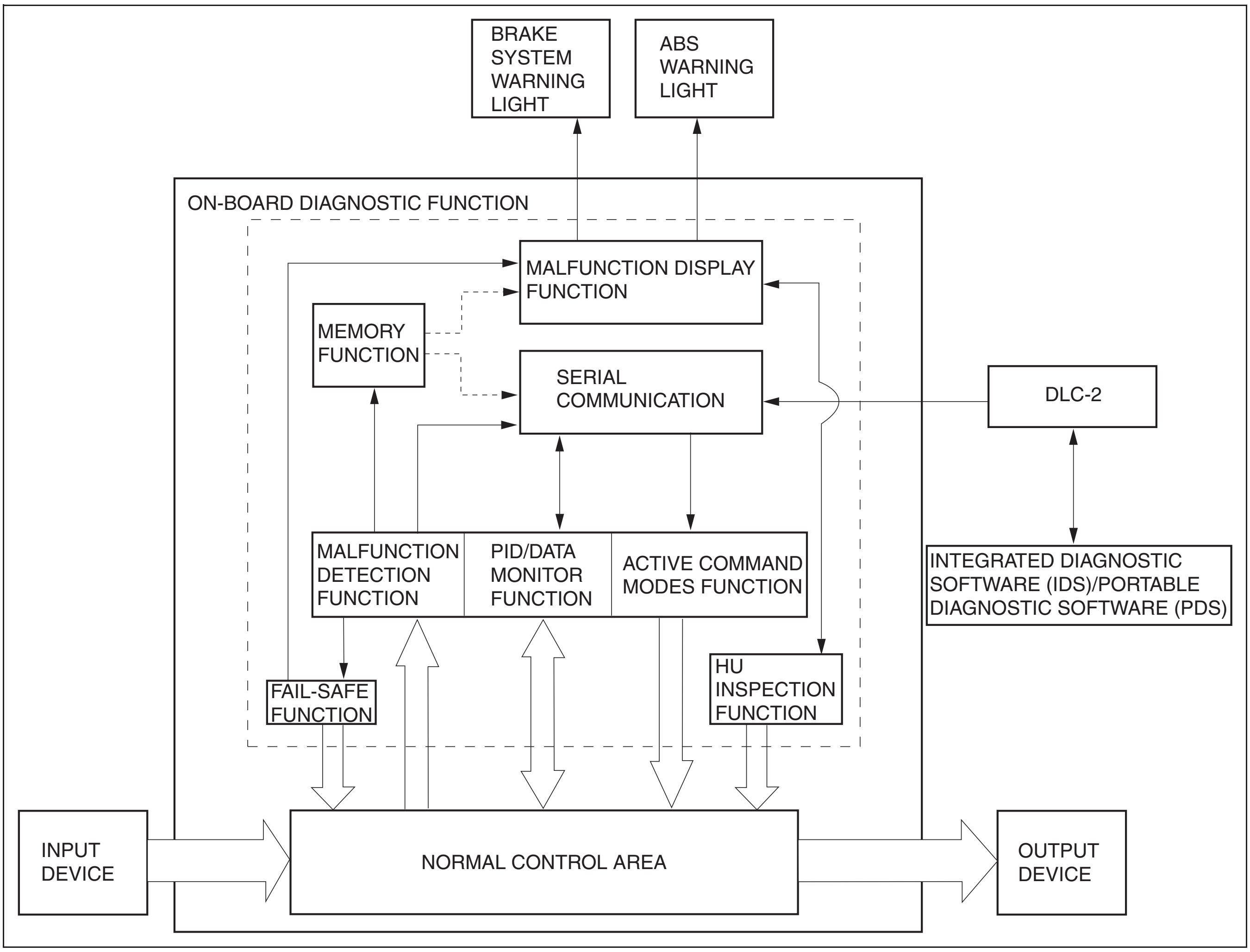
04-02 ON-BOARD DIAGNOSTIC [L3]

ON-BOARD DIAGNOSTIC SYSTEM OUTLINE[L3]

id0402a1181400

- The on-board diagnostic system consists of a malfunction detection system that detects abnormalities in input/output signals when the ignition switch is at the ON position, a PID/data monitor function that reads out specified input/output signals and a active command modes function that allows for override operation of output parts (such as solenoid valves).
- The data link connector 2 (DLC-2), which groups together all the connectors used for malfunction diagnosis and detecting/repair into a single location, has been adopted, thereby improving serviceability. Diagnosis is performed by connecting the Integrated Diagnostic Software (IDS)/Portable Diagnostic Software (PDS) to the DLC-2.
- In addition to DTC read-out, the IDS/PDS is used to clear DTCs using the display screen of the diagnostic tester, and to access the PID/data monitor and active command modes functions, providing enhanced malfunction diagnosis and improved serviceability.

Block Diagram



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ON-BOARD DIAGNOSTIC SYSTEM[L3]

id0402a1181300

Malfunction Detection Function

- The malfunction detection function detects malfunctions in the input/output signal system of the ABS HU/CM when the ignition switch is at the ON position.
- When the ABS HU/CM is started up, the following malfunction detection operations are performed:
  — The ABS and brake system warning lights illuminate for **approx. 3.0 s** when the ignition switch is turned to the ON position to inspect for open circuits in the lights. At the same time, the fail-safe relay is operated, and the input/output signals of each part is monitored for malfunction diagnosis. Also, the first time the vehicle speed is **approx. 10 km/h {6.2 mph} or more** the pump motor is operated and malfunction diagnosis is performed again. After that, input/output signals are regularly monitored for malfunction determination.
- When malfunctions are detected, the corresponding lights are illuminated to alert the driver. DTCs are output through the CAN_H and CAN_L terminals of the DLC-2 using the external tester communication function. At the same time, malfunction detection results are sent to the memory and fail-safe functions.

Memory Function

- The memory function stores DTCs of malfunctions in input/output signal systems. With this function, once a DTC is stored it is not cleared after the ignition switch has been turned off (LOCK position), even if the malfunctioning signal system has returned to normal.
- Since the ABS HU/CM has a built-in non-volatile memory, DTCs are not cleared even if the battery is removed. Therefore, it is necessary to clear the memory after performing repairs. Refer to the Workshop Manual for the DTC clearing procedure.

Fail-safe Function

- When the malfunction detection function determines a malfunction, each light illuminates to advise the driver. At this time, the fail-safe function controls the ABS and EBD as shown in the fail-safe function table.

Warning
- **If EBD control is suspended the rear wheels could lock-up before the front wheels. If this occurs, the vehicle could swerve and become unstable. Therefore always inspect the system immediately if EBD control is suspended.**

Fail-safe Function Malfunction Contents

Malfunction location	DTC	Fail-safe function			
		Warning light illumination status		Control status	
	IDS/PDS display	ABS warning light	Brake system warning light (when parking brake is released)	ABS control	EBD control
ABS HU/CM	B1342	Illuminated	Illuminated	Disabled	Disabled
Power supply system	B1676	Illuminated	Illuminated	Disabled	Disabled
			Not illuminated *1		Enabled*1
ABS HU/CM configuration system	B2477	Illuminated	Not illuminated	Disabled	Enabled
PCM communication	B2900	Illuminated	Not illuminated	Disabled	Enabled
Pump motor, motor relay	C1095	Illuminated	Not illuminated	Disabled	Enabled
ABS wheel-speed sensor	C1145	Illuminated	Not illuminated *2	Disabled	Enabled*3
	C1155				
	C1165				
	C1175				
LF ABS sensor rotor	C1233	Illuminated	Not illuminated *2	Disabled	Enabled*3
	C1234				
	C1235				
	C1236				
G-sensor*4	C1730	Illuminated	Not illuminated	Disabled	Enabled
PCM communication	C1805	Illuminated	Not illuminated	Disabled	Enabled
G-sensor*4	C2769	Illuminated	Not illuminated	Disabled	Enabled
	C2770				

Malfunction location	DTC	Fail-safe function			
		Warning light illumination status		Control status	
	IDS/PDS display	ABS warning light	Brake system warning light (when parking brake is released)	ABS control	EBD control
CAN line	U1900	Not illuminated *4	Not illuminated *4	Enabled	Enabled
	U2023				

*1 : Detected if condition of **9.7 V±0.3 V or less** continues for **210 ms or more**.
*2 : Illuminates when two wheels or more have a malfunction.
*3 : Control disabled when two wheels or more have a malfunction.
*4 : Illuminates depending on malfunction contents.

ON-BOARD DIAGNOSTIC PID/DATA MONITOR FUNCTION[L3]

id0402a1181200

- The PID/data monitor function is used for optionally selecting input/output signal monitor items preset in the ABS HU/CM and reading them out in real-time.

PID/DATA Monitor Table

IDS/PDS display	Input/output part name	Unit/Operation (IDS/PDS display)
ABSLF_I	LF inlet solenoid valve	On/Off
ABSLF_O	LF outlet solenoid valve	On/Off
ABSLR_I	LR inlet solenoid valve	On/Off
ABSLR_O	LR outlet solenoid valve	On/Off
ABSRF_I	RF inlet solenoid valve	On/Off
ABSRF_O	RF outlet solenoid valve	On/Off
ABSRR_I	RR inlet solenoid valve	On/Off
ABSRR_O	RR outlet solenoid valve	On/Off
BOO_ABS	Brake switch	On/Off
BRK_FLUID	Brake fluid level sensor	OK/Low
CCNTABS	DTC (amount detected)	—
LONG_ACCL	G-sensor (Built into ABS HU/CM)	G
LF_WSPD	ABS wheel-speed sensor (LF)	Km/h, MPH
LR_WSPD	ABS wheel-speed sensor (LR)	Km/h, MPH
RF_WSPD	ABS wheel-speed sensor (RF)	Km/h, MPH
RR_WSPD	ABS wheel-speed sensor (RR)	Km/h, MPH

ON-BOARD DIAGNOSTIC ACTIVE COMMAND MODES FUNCTION[L3]

id0402a1180900

- The Active command modes function is used for optionally selecting active command modes items of input/output parts preset in the ABS HU/CM, and to operate them regardless of CM control.
- To protect the hydraulic unit interior, operate output related parts for only **10 s or less** when using the active command modes function.

Active Command Modes Table

Command name	Output device	Operation	Operating condition
LF_INLET	LF inlet solenoid valve	On/Off	Ignition switch at ON
LF_OUTLET	LF outlet solenoid valve		
LR_INLET	LR inlet solenoid valve		
LR_OUTLET	LR outlet solenoid valve		
PMP_MOTOR	Pump motor		
RF_INLET	RF inlet solenoid valve		
RF_OUTLET	RF outlet solenoid valve		
RR_INLET	RR inlet solenoid valve		
RR_OUTLET	RR outlet solenoid valve		

ON-BOARD DIAGNOSTIC EXTERNAL TESTER COMMUNICATION FUNCTION[L3]

id0402a1181100

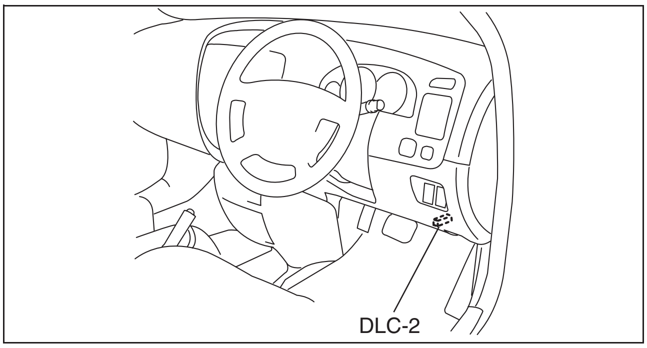
- The external tester communication function enables communication of diagnostic data (DTC read-outs, input/output signal read-outs, and operation of input/output parts) between the ABS HU/CM and an external tester.

Connections/Communication Contents

	External Tester	
	IDS/PDS	
	Connection	Communication method
On-board diagnostic (Malfunction detection function)	Input/output: CAN_H, CAN_L terminals	Serial communication
PID/data monitor function	Input/output: CAN_H, CAN_L terminals	Serial communication
Active command modes function	Input/output: CAN_H, CAN_L terminals	Serial communication

Serial communication

- Serial communication (two-way communication) allows for multiple data to be sent and received instantly along the same line.
- By connecting the IDS/PDS to the DLC-2, diagnostic data can be sent and received between the IDS/PDS and the ABS HU/CM using the CAN_H and CAN_L terminals (within the DLC-2).
- The ABS HU/CM receives the command signals of the malfunction detection function, PID/data monitor function, and the active command modes function from the IDS/PDS, and sends DTCs and data regarding the operating condition and status of each input/output part to the IDS/PDS.



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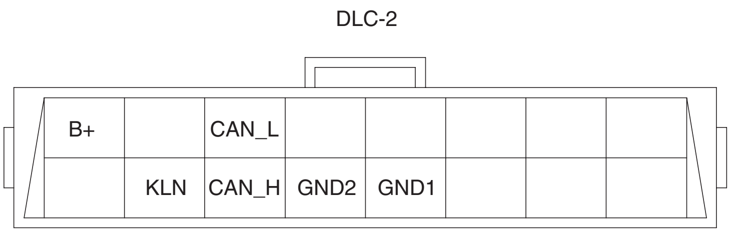
Malfunction detection function	Signal received	Signal sent
Malfunction detection function	DTC verification signal	DTC
PID/data monitor function	Command signal to read selected monitor item	Monitored data for requested monitor item
Active command modes function	Operation command signal for selected active command modes item	Output part drive signal

ON-BOARD DIAGNOSTIC DLC-2 CONSTRUCTION[L3]

id0402a1181000

- A connector (DLC-2) conforming to International Organization for Standardization (ISO) standards has been added.
- Shape and terminal arrangement as stipulated by the ISO 15031-3 (SAE J1962) international standard has been adopted for this connector. The connector has a 16-pin construction that includes the CAN_H, CAN_L, KLN, GND1, GND2 and B+ terminals.



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Terminal	Function
KLN	Serial communication terminal (Malfunction diagnosis use)
CAN_L	Serial communication terminal (LO)
CAN_H	Serial communication terminal (HI)
GND1	Body GND terminal
GND2	Serial communication GND terminal
B+	Battery power supply terminal

04-11 CONVENTIONAL BRAKE SYSTEM

CONVENTIONAL BRAKE SYSTEM OUTLINE

id041100100100

Warning

- **Blistering or swelling of rubber parts may indicate contamination of the brake fluid by a petroleum-based substance. New rubber parts must be installed in the system if contaminated and the entire hydraulic brake system must be flushed with clean brake fluid to prevent recontamination.**

- The conventional brake system consists of the following parts:
  — Master cylinder
  — Front brake calipers
  — Rear brake calipers
  — Brake pipes/hoses
- The brake system consists of two circuits, one between LF and RR, and the other between RF and LR, set in an X pattern.

BRAKE FLUID OUTLINE

id041100182400

Warning

- **Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with eyes. Wash hands thoroughly after handling. If brake fluid contacts eyes, flush eyes with running water for 15 minutes. Get medical attention if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately. Failure to follow these instructions may result in personal injury.**

- Never reuse brake fluid drained or bled from the system.
- Never use any brake fluid that has been stored in an open container.
- Never mix different types of brake fluids.

BRAKE PIPES/HOSES OUTLINE

id041100182500

Caution

- **Never use copper tubing. It is subject to wear, cracking, and corrosion which could result in brake tube malfunction.**

- Steel tubing is used throughout the brake hydraulic system. All brake tube fittings must be correctly double-flared to provide strong leakproof connections.
- If a section of brake tube is damaged, the entire section must be removed and a new tube of the same type, size, shape, and length installed.
- When installing new hydraulic brake lines, hoses, or connectors, tighten all connections securely. After installation, perform brake bleeding.

MASTER CYLINDER CONSTRUCTION/OPERATION

id041100182700

- The master cylinder is a dual-piston type. The master cylinder operates as follows:
  - When the brake pedal is depressed, pressure is applied by mechanical linkage to the primary and secondary pistons.
  - Brake master cylinder pistons apply hydraulic pressure to the two hydraulic circuits.
- The master cylinder consists of the following parts:
  - Reservoir tank
  - Master cylinder body
  - Primary piston
  - Secondary piston
  - Snap ring
- Whenever the brake master cylinder is removed from the power brake unit, new nuts must be installed.

RESERVOIR TANK CONSTRUCTION

id041100182800

Note
- New seals must always be installed if the reservoir tank is removed from the master cylinder.

- The reservoir tank includes the following characteristics:
  - Installed to the master cylinder.
  - Holds the brake fluid supply for the brake calipers and wheel cylinders.
  - Provides visual fluid level markings.
  - Contains built-in brake fluid level sensor.

BRAKE FLUID LEVEL SENSOR CONSTRUCTION/OPERATION

id041100182600

- The brake fluid level sensor is integrated with the reservoir tank. It consists of a float containing a magnet and a reed switch mounted in the bottom of the brake master cylinder reservoir.
- When the brake fluid in the brake master cylinder reservoir reaches a predetermined level, the float and magnet actuate the reed switch that causes the brake warning indicator to illuminate. Loss of brake fluid from either the primary (front) or secondary (rear) system causes this system to activate.
- If the brake fluid level sensor becomes inoperative, a new brake master cylinder reservoir must be installed.

POWER BRAKE UNIT CONSTRUCTION/OPERATION

id041100100900

- The brake booster consists of the following parts:
  - Power brake unit
  - Vacuum hose
  - Check valve
- The power brake booster reduces the effort required to push the brake pedal to actuate the brakes.
- The vacuum hose supplies vacuum to the power brake unit.
- The check valve closes when the engine is turned off and traps engine vacuum in the power brake unit.

FRONT BRAKE (DISC) OUTLINE

id041100182300

- The front brake (disc) consists of the following parts:
  - Piston seal
  - Piston
  - Dust seal
  - Caliper
  - Bleeder screw
  - Bleeder cap
  - Disc plate
  - Mounting support
  - Dust cover
  - Disc pad
- The front brake (disc) consists of a single piston caliper and a ventilated disc plate.
- The brake pads are held in the disc calipers by two front disc caliper bolts.
- To remove the dust cover, the steering knuckle must be removed.

FRONT BRAKE (DISC) OPERATION

id041100182200

- The brake pedal is connected to the brake master cylinder. When the brake pedal is depressed, brake fluid is pushed through the double-walled steel lines and flexible hoses to the brake calipers.
- The caliper piston expands towards the brake pads and lining, pressing these against the braking surface of the front disc brake rotor.
- When the brake pedal is released, the pressure is relieved, returning the caliper piston and the disc pad to the unapplied position.

REAR BRAKE (DISC) OUTLINE

id041100182100

- The rear brake (disc) consists of the following parts:
  — Piston seal
  — Piston
  — Dust seal
  — Caliper
  — Bleeder screw
  — Bleeder cap
  — Disc plate
  — Mounting support
  — Disc pad
- The rear brake (disc) consists of a single piston caliper and a solid disc plate.
- The brake pads are held in the disc calipers by two rear disc caliper bolts.

REAR BRAKE (DISC) OPERATION

id041100182000

- The brake pedal is connected to the brake master cylinder. When the brake pedal is depressed, brake fluid is pushed through the double-walled steel lines and flexible hoses to the brake calipers.
- The caliper piston expands towards the brake pads and lining, pressing these against the braking surface of the rear disc plate.
- When the brake pedal is released, the pressure is relieved, returning the caliper piston and the disc pad to the unapplied position.

04-12 PARKING BRAKE SYSTEM

PARKING BRAKE SYSTEM OUTLINE

id041200100100

- The parking brake system consists of the following parts:
  — Front parking brake cable
  — Parking brake lever
  — Equalizer
  — Parking brake switch
  — Rear parking brake cable

04-13A ANTILOCK BRAKE SYSTEM [L3]

ABS OUTLINE[L3]

id0413a1183600

- The ABS HU/CM, integrating both the hydraulic unit (HU) and control module (CM), has been adopted, resulting in size and weight reduction.
- Electronic brakeforce distribution (EBD) control has been adopted, resulting in improved safety and handling stability.

Caution
- **The ABS will not operate normally under the following conditions:**
  - **— With tires that are not of the specified size, manufacturer or tread pattern, or not inflated according to specification**
  - **— With tires that have significant comparative wear variation**
  - **— With tire chains**
  - **— With an emergency spare tire**

ABS HU FUNCTION[L3]

id0413a1184400

- The ABS HU adjusts the fluid pressure to the caliper pistons and wheel cylinders by controlling (on/off) each solenoid valve and pump motor according to signals from the ABS CM.

ABS HU STRUCTURE[L3]

id0413a1184500

- The ABS HU mainly consists of the inlet/outlet solenoid valves, pump motor (pump), and reservoir.

Function Of Main Component Parts

Part Name	Function
Inlet solenoid valve	• Adjusts the fluid pressure in each brake system according to ABS CM signals.
Outlet solenoid valve	• Adjusts the fluid pressure in each brake system according to ABS CM signals.
Reservoir	• Temporarily stores the brake fluid from the caliper pistons and wheel cylinders to ensure smooth pressure reduction.
Pump	• Returns brake fluid stored in the reservoir tank back to the master cylinder.
Pump motor	• Operates the pump according to ABS CM signals.

ABS CM FUNCTION[L3]

id0413a1183900

- The ABS CM detects the vehicle wheel speeds based on the signals from the four ABS wheel-speed sensors. The CM calculates the rotation condition of each wheel from the relation between the detected vehicle wheel speed and the estimated (based on the detected speed) vehicle speed from there on. It then accordingly controls brake fluid pressure to each wheel to prevent lock-up.

Function Table

Function Name	Contents
ABS control function	• Controls brake fluid pressure when braking to maintain directional stability, ensure steerability and reduce stopping distance.
Electronic brakeforce distribution (EBD) control function	• Constantly controls proper distribution of brake fluid pressure to the front and rear wheels according to vehicle load, road surface and vehicle speed conditions to prevent early lock-up of the rear wheels.
CAN communication function	• Outputs the vehicle wheel-speed signal and ABS system warning control data via CAN lines.
On-board diagnostic system	• Main components of the ABS control system have a self-diagnosis function. In case a malfunction occurs, warning lights illuminate to alert the driver, and at the same time a DTC is stored in the ABS HU/CM. • When a malfunction is determined as a result of the on-board diagnostic test, system control is suspended or limited to prevent any dangerous situation while driving.

ABS CONTROL OUTLINE[L3]

id0413a1184200

Features

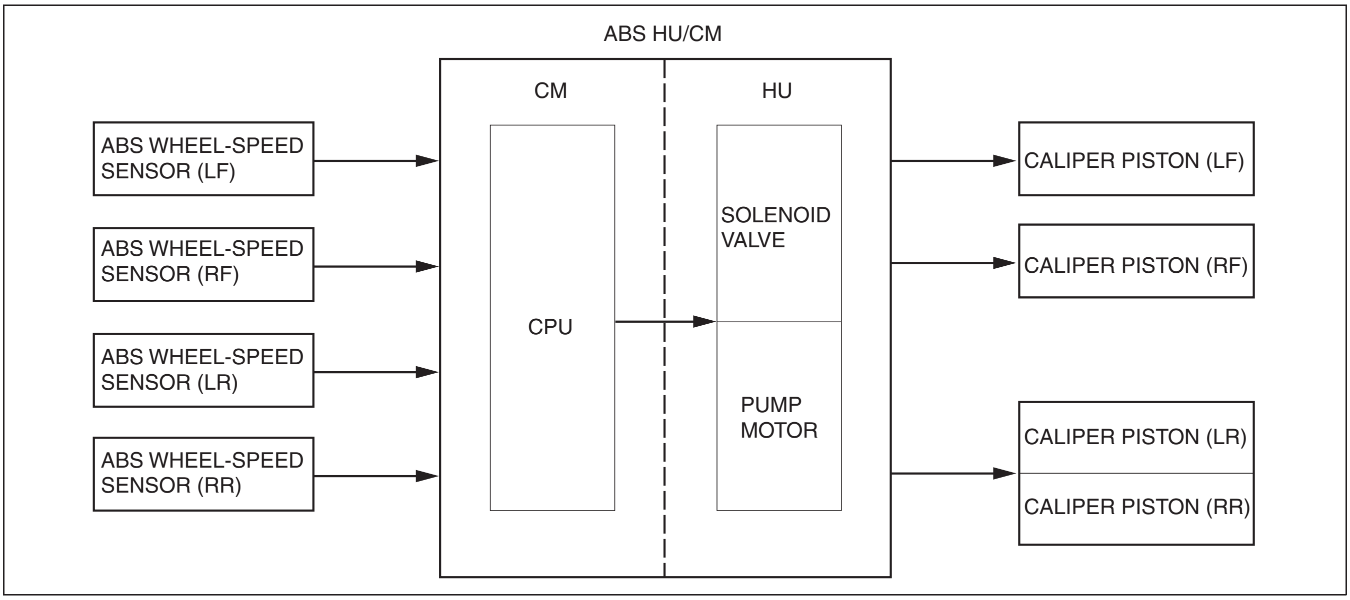
- ABS control occurs when wheel slip is determined by the ABS CM (based on the four ABS wheel-speed sensors). Then, the ABS HU pump motor, inlet and outlet solenoid valves are operated and brake fluid pressure is controlled accordingly to prevent wheel lock-up.
- Use of ABS control during emergency braking or on slippery road surfaces allows directional stability to be maintained, steerability ensured and stopping distance to be reduced.
- The ABS control system has independent front wheel control and unified control (select low) for the rear wheels.

Note

- Select low control: A control system in which the left and right vehicle wheel speeds are compared and brake fluid pressure is controlled according to the wheel most likely to lock-up.

Structure

Block Diagram



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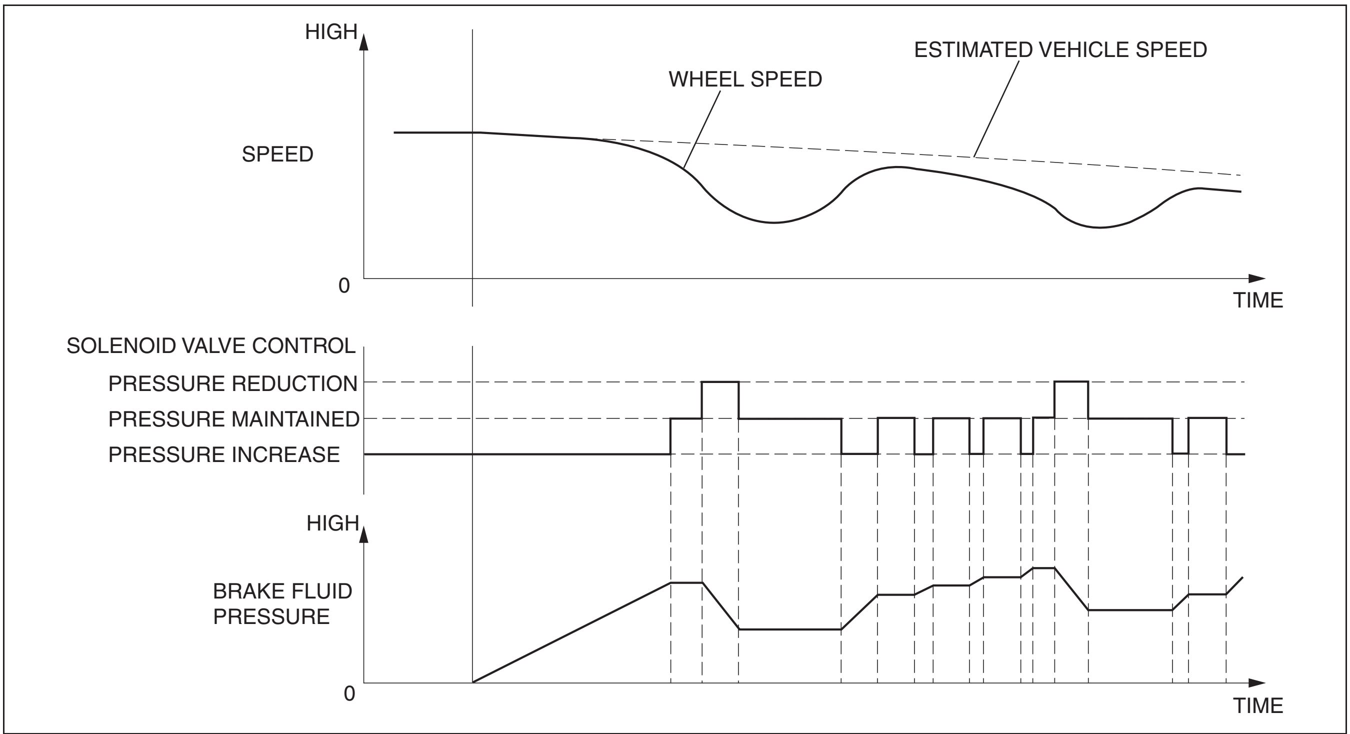
ABS CONTROL OPERATION[L3]

id0413a1184100

- When the ABS CM determines wheel slip conditions based on the signals from the ABS wheel-speed sensors during braking, the ABS CM operates the ABS HU inlet and outlet solenoid valves, reducing and maintaining brake fluid pressure in accordance with the wheel slip factors. Then, when the wheel slip condition has passed, brake fluid pressure is increased and maintained, ensuring braking with a constantly stable brake force.

Operation Condition Transition Diagram



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ELECTRONIC BRAKEFORCE DISTRIBUTION (EBD) CONTROL OUTLINE[L3]

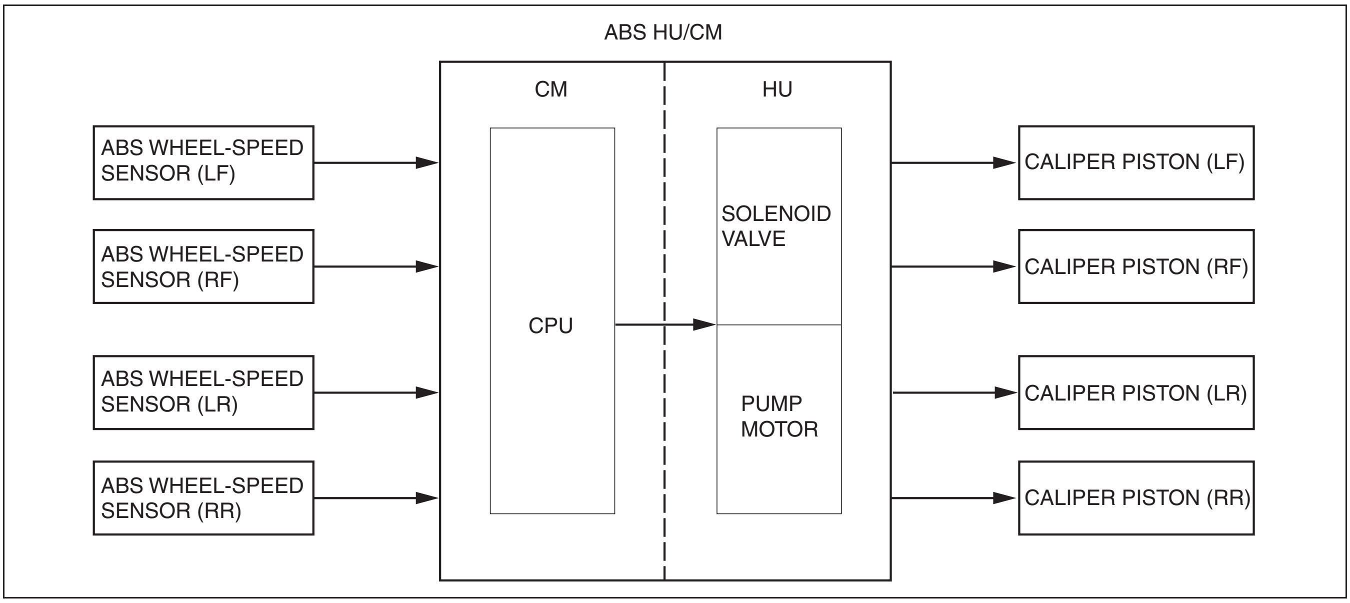
id0413a1184800

Features

- EBD control uses the ABS system to control brake fluid pressure distribution to the rear wheels so that they do not lock-up prior to the front wheels during brake control, thereby preventing the loss of handling stability.
- EBD control has independent control systems for both the front and rear wheels.
- EBD control constantly and properly distributes brake fluid pressure regardless of vehicle weight.

Structure

Block Diagram



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ELECTRONIC BRAKEFORCE DISTRIBUTION (EBD) CONTROL OPERATION[L3]

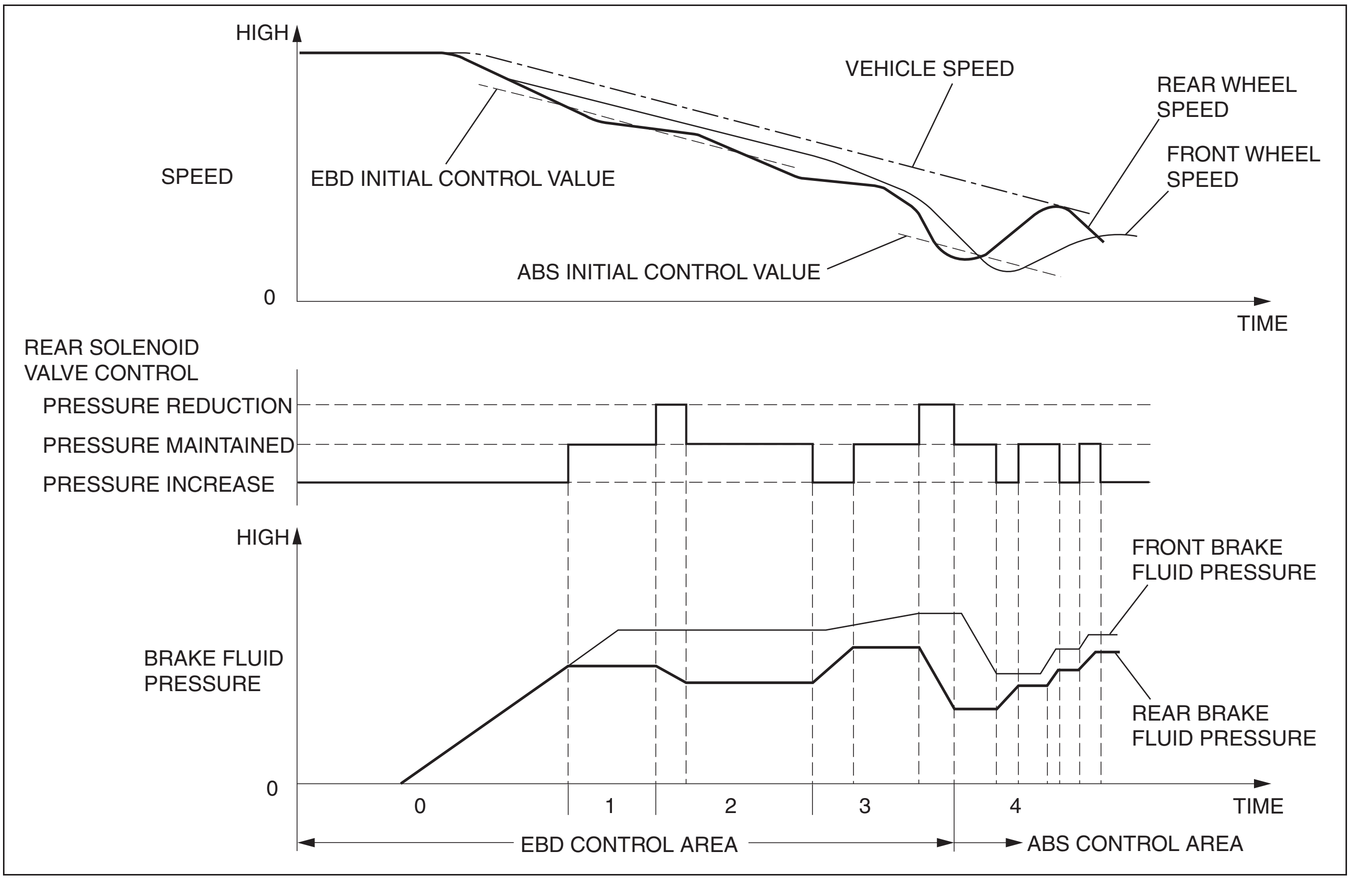
id0413a1184700

- EBD control detects the slip ratio between the front and rear wheels from the ABS wheel-speed sensor signals. If the slip ratio of the rear wheels as compared to the front wheels is larger than the fixed limit, the ABS HU/CM reduces brake pressure being distributed to the rear wheels. Due to this, brake pressure distribution is constantly controlled in the proper proportion and in relation to vehicle load, road surface conditions and vehicle speed.
- Determination of the rear wheel slip ratio, based on a comparison of the lowest front wheel speed and the estimated vehicle speed with the rear wheel speeds, is divided into conditions 0-4 shown in the table below.
- The ABS HU outlet and inlet solenoid valves are operated and the brake fluid pressure controlled according to these conditions.
- If ABS control conditions are met during EBD control, EBD control is stopped and ABS control is given priority.

Status	Rear wheel slip ratio determination	EBD control	Solenoid valve	Comment
0	No slip	No Control	Pressure increase	—
1	α%—β%	Control	Pressure maintained	—
2	β% or more	Control	Pressure reduction/ maintained	—
3	After EBD control, slip ratio is γ%	Control	Pressure increase/ maintained	—
4	Front wheel slip ratio is δ% or more	Control	Pressure reduction/ maintained/ increase	ABS control operates

α—δ:Specified value

Operating Condition Transition Diagram



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CONTROLLER AREA NETWORK (CAN) OUTLINE[L3]

id0413a1184600

- The ABS HU/CM sends and receives data to and from other modules via the CAN system. Refer to BODY & ACCESSORIES for a detailed explanation of the CAN. (See 09-40-1 MULTIPLEX COMMUNICATION SYSTEM[L3].)

Data sent

- Wheel speeds of all four wheels
- Brake system warning light illumination request
- ABS warning light illumination request
- Brake system configuration data

Data received

- Engine data
- Transmission data
- Tire data
- Vehicle data

ABS WHEEL SPEED SENSOR OUTLINE[L3]

id0413a1183800

- The ABS system uses four “active” sensors to detect the speed of each wheel. The teeth on the ABS sensor rotor rotate past the stationary sensor. As the teeth pass the sensor, a digital input signal is generated. The ABS CM uses the input to compute the speed of each wheel.

04-13B ANTILOCK BRAKE SYSTEM [AJ (3.0L Duratec)]

ABS OUTLINE[AJ (3.0L Duratec)]

id0413a2183600

- The ABS system consists of the following parts:
  — ABS HU
  — ABS CM
  — Rear ABS wheel-speed sensor
  — Rear ABS sensor rotor
  — Front ABS wheel-speed sensor
  — Front ABS sensor rotor
  — ABS indicator light (Yellow)
  — Brake system warning light (Red)

Caution
- **An active wheel speed sensor (AWSS) has replaced the passive coil type sensor (sine wave generating). Since the AWSS uses a microchip, the Integrated Diagnostic Software (IDS)/Portable Diagnostic Software (PDS) must always be used when inspecting the sensor. To prevent microchip breakage, never touch the sensor directly with the tester when measuring resistance.**

04

ABS HU CONSTRUCTION[AJ (3.0L Duratec)]

id0413a2184300

- The ABS HU consists of the following parts.
  — Brake pressure control valve block
  — Pump motor
- Replace the brake pressure control valve block and the pump motor together as a set.

ABS CM FUNCTION[AJ (3.0L Duratec)]

id0413a2183900

- The ABS CM is mounted on the ABS HU.
- It is an on-board diagnostic, non-repairable unit consisting of two microprocessors and the necessary circuitry for their operation. The ABS CM monitors system operation during normal driving as well as during anti-lock braking.
- ABS CM operation is as follows:
  — Under normal driving conditions, the microprocessor produces short test pulses to the solenoid valves that check the electrical system without any mechanical reaction.
  — Impending wheel lock conditions trigger signals from the ABS CM that open and close the appropriate solenoid valves. This results in moderate pulsations in the brake pedal.
  — The ABS CM used in 4×4 application includes a G-sensor.
- During normal braking, the brake pedal feel is identical to a standard brake system.
- Most faults that occur in the ABS will be stored as a diagnostic trouble code (DTC) in the ABS CM non-volatile memory. DTCs can be retried by following the on-board diagnostic procedures.

ABS CONTROL OUTLINE[AJ (3.0L Duratec)]

id0413a2184200

- ABS operation is as follows:
  — When the brakes are applied, fluid is forced from the master cylinder to the ABS HU inlet ports. This pressure is transmitted through four normally open solenoid valves contained inside the ABS HU and then through the outlet ports of the ABS HU to each wheel.
  — If the ABS CM senses a wheel is about to lock, based on ABS wheel speed sensor data, it closes the normally open solenoid valve for that circuit. This prevents any more fluid from entering that circuit.
  — The ABS CM then looks at the ABS wheel-speed sensor signal from the affected wheel(s) again.
  — If that wheel(s) is still decelerating, it opens the closed solenoid valve for that circuit.
  — Once the ABS-applied wheel comes back up to speed, the ABS CM returns the valves to their normal condition, allowing fluid to flow to the affected brake.
  — The ABS CM monitors the electromechanical components of the system.
  — A malfunction in the ABS system will cause the ABS CM to shut off or inhibit the system. However, normal power-assisted braking continues.
  — Malfunctions are indicated by a yellow ABS warning light in the instrument cluster.
  — The ABS system includes an on-board diagnostic function. When the ignition switch is turned to the ON position, the ABS CM performs a system self-diagnostic indicated by a **3 s** illumination of the yellow ABS warning light and the red brake system warning light (if the parking brake is released).
  — During vehicle operation, including normal and ABS braking, the ABS CM monitors all electrical anti-lock functions and some hydraulic operations.
  — Each time the vehicle is driven, as soon as vehicle speed reaches **approx. 20 km/h {12 mph}**, the ABS CM turns on the pump motor for **approx. 30 s**. This is a normal function of the self-diagnostic by the ABS CM.
  — Pedal pulsation coupled with noise while braking on loose gravel, bumps, wet or snowy roads is normal and indicates correct functioning of the vehicle's ABS system.

ELECTRONIC BRAKEFORCE DISTRIBUTION (EBD) CONTROL OUTLINE[AJ (3.0L Duratec)]

id0413a2184800

- EBD operates as follows:
  — The EBD control detects the front/rear wheel slip according to the signal of ABS wheel-speed sensors. If the slip ratio of the rear wheels as compared to the front wheels is larger than the fixed limit, the ABS HU/CM reduces brake pressure being distributed to the rear wheels. Brake force can, therefore, be proportioned optimally according to vehicle load and road surface conditions. If ABS control conditions are met during EBD control, EBD control is stopped and ABS control is given priority.

ABS WHEEL SPEED SENSOR OUTLINE[AJ (3.0L Duratec)]

id0413a2183800

- The ABS system uses four "active" sensors to detect the speed of each wheel. The teeth on the ABS sensor rotor rotate past the stationary sensor. As the teeth pass the sensor, a digital input signal is generated. The ABS CM uses the input to compute the speed of each wheel.

TRANSMISSION/TRANSAXLE

05
SECTION

05-00 OUTLINE

TRANSMISSION/TRANSAXLE ABBREVIATIONS

id050000100100

ABS	Antilock Brake System
ATF	Automatic Transaxle Fluid
ATX	Automatic Transaxle
B+	Battery Positive Voltage
CAN	Controller Area Network
CCM	Comprehensive Component Monitor
CKP	Crankshaft Position
DC	Drive Cycle
DLC	Data Link Connector
DTC	Diagnostic Trouble Code
EC-AT	Electronically Controlled Automatic Transaxle
ECT	Engine Coolant Temperature
EI	Electronic Ignition
EPC	Electronic Pressure Control
GND	Ground
IDS	Integrated Diagnostic Software
IG	Ignition
LP	Line Pressure
MAF	Mas Air Flow
MIL	Malfunction Indicator Lamp
O/D	Overdrive
OBD	On-board Diagnostic
OSS	Output Shaft Speed
PCM	Powertrain Control Module
PDS	Portable Diagnostic Software
PID	Parameter Identification
SSA	Shift Solenoid A
SSB	Shift Solenoid B
TCC	Torque Converter Clutch
TSS	Turbine Shaft Speed
TFT	Transaxle Fluid Temperature
TP	Throttle Position
TR	Transaxle Range
VSS	Vehicle Speed Sensor
1GR	First Gear
2GR	Second Gear
3GR	Third Gear
3-2 T/CCS	3-2 Timing/Coast Clutch Solenoid
4GR	Fourth Gear
4×4	4-wheel 4-drive

05

TRANSMISSION/TRANSAXLE FEATURES

id050000100200

ATX [GF4AX-EL]	
Superior shift quality	• Electronic clutch hydraulic engagement control adopted • Engine torque control when shifting adopted • Electronic shift timing control adopted
High efficiency, compactness, lightweight	• Variable displacement trochoid gear type oil pump adopted • Duty cycle type TCC solenoid adopted • Separate unit transfer adopted
Improved driveability	• 4×4 with 4×4 lock system adopted
Mis-shift prevention	• Key interlock mechanism adopted • Shift lock mechanism adopted
ATX [LA4AX-EL (CD4E)]	
Superior shift quality	• Direct electric shift control has been adopted • Adaptive learn strategy system has been adopted • Engine-transaxle total control system has been adopted
Improved driveability	• 4×4 with 4×4 lock system adopted
Mis-shift prevention	• Key interlock mechanism adopted • Shift lock mechanism adopted
Emergency bypass assurance	• A shift-lock release mechanism has been adopted

AUTOMATIC TRANSAXLE SPECIFICATIONS[LA4AX-EL (CD4E)]

id0500001003a6

Item			Specification
Gear ratio		1GR	2.889
		2GR	1.571
		3GR	1.000
		4GR	0.689
		Reverse	2.310
Final gear ratio			3.920
ATF	Type		Mercon® ATF XT-2-QDX
	Capacity (Approx. quantity)	(L {US qt, Imp qt})	9.0 {9.5, 7.9}
Hydraulic system (Number of drive/driven gear plates)	Forward clutch		3/3
	Coast clutch		2/2
	Direct clutch		4/4
	Reverse clutch		2/2
	Low/reverse clutch		3/3

AUTOMATIC TRANSAXLE SPECIFICATIONS[GF4AX-EL]

id0500001003a7

Item			Specification
Gear ratio		1GR	2.800
		2GR	1.540
		3GR	1.000
		4GR	0.700
		Reverse	2.333
Final gear ratio			4.375
ATF	Type		ATF M-III
	Capacity (Approx. quantity) (L {US qt, Imp qt})		8.0 {8.5, 7.0}
Torque converter stall torque ratio			2.00
Hydraulic system (Number of drive/driven gear plates)	Forward clutch		3/3
	Coasting clutch		2/3
	3-4 clutch		4/4
	Reverse clutch		2/2
	Low and reverse brake		4/4
Band servo	Servo diameter (Piston outer dia./ retainer inner dia.) (mm {in})		78.0/49.0 {3.07/1.93}
Planetary gear (Number of teeth)	Large sun gear		36
	Small sun gear		30
	Long pinion gear		24
	Short pinion gear		22
	Internal gear		84
Output gear (number of teeth)			16
Idle gear (number of teeth)			37
Front differential (number of teeth)	Ring gear		70
	Sun gear		51
Transfer gear (number of teeth)	Idle gear		22
	Ring gear		24
	Pinion gear		19

05

05-02A ON-BOARD DIAGNOSTIC [GF4AX-EL]

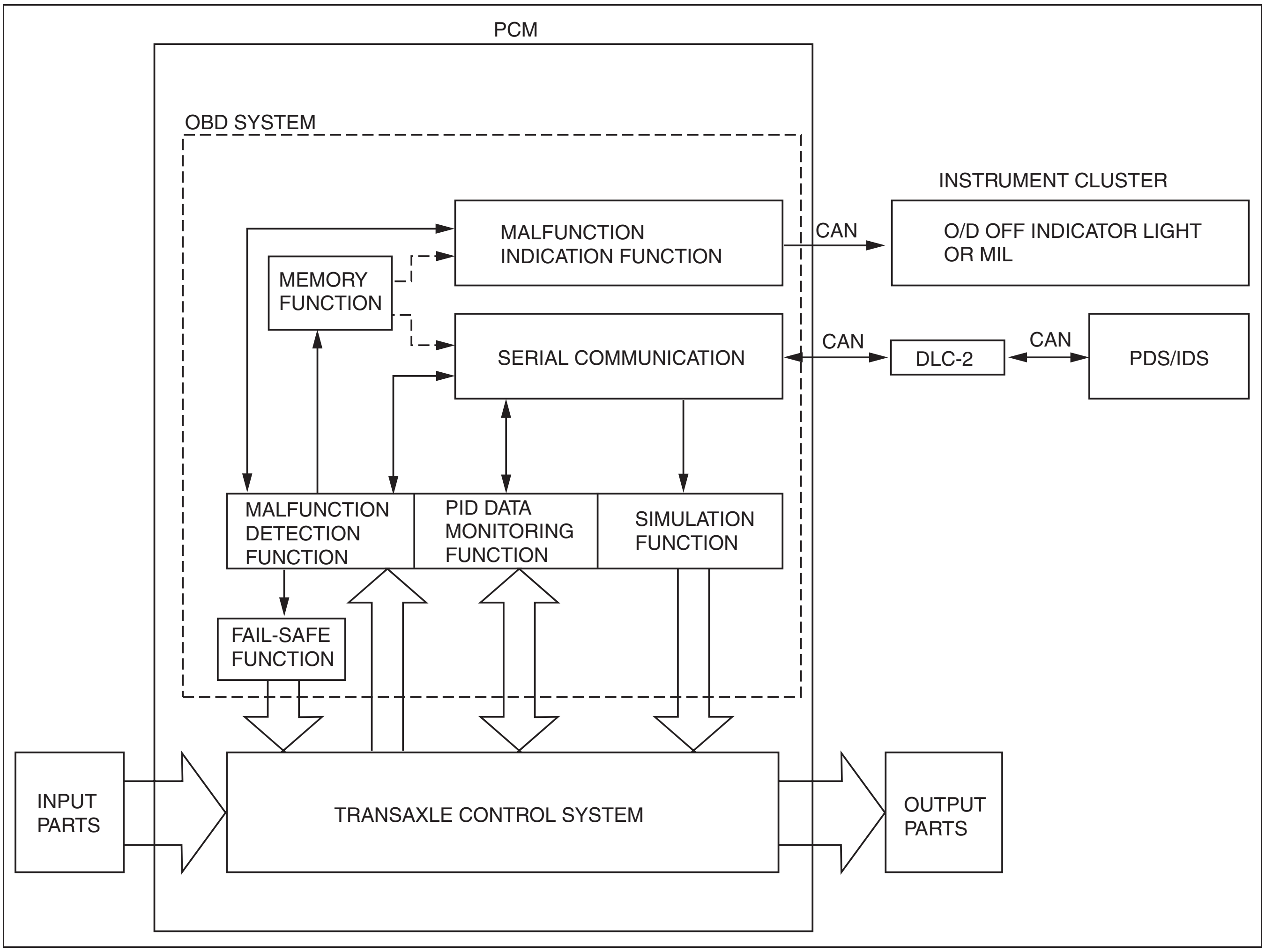
ON-BOARD DIAGNOSTIC (OBD) SYSTEM OUTLINE[GF4AX-EL]

id050204100100

- The OBD system has the following functions:
  — Malfunction detection function: Detects malfunctions of the input/output devices and system components of the ATX.
  — Fail-safe function: Fixes the output device function and input value of the sensors/switches to ensure minimum vehicle driveability when a malfunction is detected.
  — Memory function: Stores the DTC when a malfunction is detected.
  — PID data monitored function: Monitors the input/output signal and calculated value of the PCM, and sends the monitoring data to the PDS/IDS.
  — Simulation function: Allows override operation of simulation items for input/output system parts preset in the PCM.

ON-BOARD DIAGNOSTIC (OBD) SYSTEM BLOCK DIAGRAM[GF4AX-EL]

id050204100200



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MALFUNCTION DETECTION FUNCTION[GF4AX-EL]

id050204100300

Malfunction Detection Function

- In the malfunction detection function, the PCM detects malfunctions in the automatic transmission while driving.
- When vehicle driving conditions correspond with a preset malfunction detection condition, the PCM determines that the automatic transmission has a malfunction and stores the corresponding DTC.
- When a malfunction is detected, stored DTCs can be retrieved using the PDS/IDS connected to the DLC-2.

DTC Table

X: Available

DTC No.	Condition	MIL	O/D OFF	DC	Monitor item	Memory function
P0500	Vehicle speed signal circuit malfunction	ON	YES	2	CCM	X
P0705	Transaxle range (TR) switch circuit malfunction (short to ground)	ON	YES	1	CCM	X
P0706	Transaxle range (TR) switch circuit malfunction (open circuit)	ON	YES	2	CCM	X
P0711	Transaxle fluid temperature (TFT) sensor circuit range/ performance (stuck)	ON	YES	2	CCM	X
P0712	Transaxle fluid temperature (TFT) sensor circuit malfunction (short to ground)	ON	YES	1	CCM	X
P0713	Transaxle fluid temperature (TFT) sensor circuit malfunction (open circuit)	ON	YES	1	CCM	X
P0715	Input/turbine speed sensor circuit malfunction	ON	YES	1	CCM	X
P0731	Gear 1 incorrect (incorrect gear ratio detected)	ON	YES	2	CCM	X
P0732	Gear 2 incorrect (incorrect gear ratio detected)	ON	YES	2	CCM	X
P0733	Gear 3 incorrect (incorrect gear ratio detected)	ON	YES	2	CCM	X
P0734	Gear 4 incorrect (incorrect gear ratio detected)	ON	YES	2	CCM	X
P0741	Torque converter clutch (TCC) stuck off	ON	YES	2	CCM	X
P0743	Torque converter clutch (TCC) control solenoid circuit malfunction	ON	YES	1	CCM	X
P0745	Pressure control solenoid circuit malfunction	OFF	YES	1	CCM	X
P0753	Shift solenoid A circuit malfunction	ON	YES	1	CCM	X
P0758	Shift solenoid B circuit malfunction	ON	YES	1	CCM	X
P0763	Shift solenoid C circuit malfunction	ON	YES	1	CCM	X
P0768	3-2 timing solenoid circuit malfunction	OFF	YES	1	CCM	X
P1783	ATF overheating	OFF	YES	1	CCM	X

O/D OFF: O/D OFF indicator light flashing

MEMORY FUNCTION[GF4AX-EL]

id050204100400

- The memory function stores malfunction information detected in the malfunction detection function. Once malfunction information is stored, the memory will not be cleared even when the ignition switch is turned off (LOCK position) or the malfunction is repaired.
- The stored memory (malfunction information) can be cleared using the PDS/IDS, or by disconnecting the negative battery cable.

MALFUNCTION INDICATION FUNCTION[GF4AX-EL]

id050204100500

- The malfunction indication function illuminates the MIL or O/D OFF indicator light when the malfunction detection function determines that there is a malfunction.

FAIL-SAFE FUNCTION[GF4AX-EL]

id050204100600

- In the fail-safe function, minimum vehicle driveability is obtained by changing the signals that are determined to be irregular by the malfunction detection function to the preset values, and limiting PCM control.

DTC No.	On-board diagnostic function	Detection condition	Fail-safe	TCC
P0500	Vehicle speed signal circuit malfunction	• No vehicle speed signal is input to PCM when and engine coolant temperature is **60 °C {140 °F} or more**, input/turbine speed sensor signal is **1,050 rpm or more** and selector lever position is at D, 2, or 1 range.	• PCM calculation from input/turbine speed sensor signal	Enabled
P0705	Transaxle range (TR) switch circuit malfunction (short to ground)	• Two or more range signals are input from TR switch for **100 s or more**.	• The range position is assumed to be in D range and normal shift pattern is performed.	Enabled
P0706	Transaxle range (TR) switch circuit malfunction (open circuit)	• No transaxle range signal is input to PCM when and engine speed is **530 rpm or more**, vehicle speed is **20 km/h {12 mph} or more** and selector lever position is at R, D, 2, or 1 range.	• Gear position is fixed in 1GR when driving at under **6 km/h {3.7 mph}** or in 3GR when driving at over **6 km/h {3.7 mph}** if either of the following conditions arises: — The R position switch and D, 2,or 1 range switch are on at the same time. — The TR switch does not output any signals.	Enabled
P0711	Transaxle fluid temperature (TFT) sensor circuit range/performance (stuck)	• Fluctuation value of TFT sensor output voltage to PCM terminal 1U is **20 °C {68 °F} or less (3.6 V or more)** when vehicle is driven for **150 s or more** at vehicle speed between **25—59 km/h {15—36 mph}**, then **60 km/h {37 mph} or more** for **100 s or more**.	N/A	Enabled
P0712	Transaxle fluid temperature (TFT) sensor circuit malfunction (short to ground)	• Input voltage from the TR switch to PCM terminal 1U is **0.09 V or less**.	• Maximizes line pressure • Expand the lockup range	Enabled
P0713	Transaxle fluid temperature (TFT) sensor circuit malfunction (open circuit)	• Input voltage from the TR switch to PCM terminal 1U is **4.9 V or more** when the vehicle speed is **20 km/h {12 mph} or more**.		Enabled
P0715	Input/turbine speed sensor circuit malfunction	• No input/turbine speed sensor signal to PCM terminals 1M and 1Q when vehicle speed is **41 km/h {25 mph} or more** and selector lever position is at D, 2, or 1 range.	• Shift control is performed according to vehicle speed signal • Inhibits 4GR	Disabled
P0731	Gear 1 incorrect (incorrect gear ratio detected)	• Revolution ratio of input/turbine speed sensor to vehicle speed signal is 75 or less while in 1GR.	N/A	Enabled
P0732	Gear 2 incorrect (incorrect gear ratio detected)	• Revolution ratio of input/turbine speed sensor to vehicle speed signal is 44 or less or 75 or more while in 2GR.	N/A	Enabled
P0733	Gear 3 incorrect (incorrect gear ratio detected)	• Revolution ratio of input/turbine speed sensor to vehicle speed signal is 29 or less or 44 or more while in 3GR.	N/A	Enabled
P0734	Gear 4 incorrect (incorrect gear ratio detected)	• Revolution ratio of input/turbine speed sensor to vehicle speed signal is 29 or more while in 4GR.	N/A	Enabled
P0741	Torque converter clutch (TCC) stuck off	• Difference between engine speed and turbine speed more than 100 rpm while in 4GR and TCC operation.	N/A	Enabled
P0743	Torque converter clutch (TCC) control solenoid valve circuit malfunction	• If voltage is stuck at **0 V** or **B+** in TCC control solenoid valve control terminal 65 of the PCM when the solenoid valve operates according to PCM calculation.	• Maximizes line pressure	Disabled

DTC No.	On-board diagnostic function	Detection condition	Fail-safe	TCC
P0745	Pressure control solenoid valve circuit malfunction	• If voltage is stuck at **0 V** or **B+** in pressure control solenoid control valve control terminal 91 of the PCM when the solenoid valve operates according to PCM calculation.	• Pressure control solenoid valve operation is stopped and line pressure held at maximum	Disabled
P0753	Shift solenoid A circuit malfunction	• If voltage is stuck at **0 V** or **B+** in shift solenoid A control terminal 92 of the PCM when the solenoid valve operates according to PCM calculation.	• If one or two shift solenoid valves develop a malfunction, remaining normal shift solenoid valves are controlled to prevent loss of driveability as much as possible • If all shift solenoid valves develop malfunctions, then operation of all shift solenoid valves is stopped, and if in D or 2 range, then fixed in 3rd gear, or if in 1 range, then fixed in 1st gear	Disabled
P0758	Shift solenoid B circuit malfunction	• If voltage is stuck at **0 V** or **B+** in shift solenoid B control terminal 66 of the PCM when the solenoid valve operates according to PCM calculation.		Disabled
P0763	Shift solenoid C circuit malfunction	• If voltage is stuck at **0 V** or **B+** in shift solenoid C control terminal 40 of the PCM when the solenoid valve operates according to PCM calculation.		Disabled
P0768	3-2 timing solenoid valve circuit malfunction	• If voltage is stuck at **0 V** or **B+** in 3-2 timing solenoid valve control terminal 39 of the PCM when the solenoid valve operates according to PCM calculation.	• Operation of 3-2 timing solenoid valve is stopped	Disabled
P1783	ATF overheating	• ATF temperature is **138 °C {280 °F}** or more.	N/A	Enabled

PARAMETER IDENTIFICATION (PID) DATA MONITORING FUNCTION[GF4AX-EL]

id050204100700

- The PID mode allows access to certain data values, analog and digital input and output, calculations and system state information.

PID/DATA MONITOR AND RECORD Function Table

–: N/A

Monitor item	Definition	Unit/Condition	PCM terminal
GEAR	Gear commanded by module	1/2/3/4	–
HTM_CNT	Indicates number of high oil temperature mode (ATF temperature at 130 °C {266 °F} or more) operations	–	–
HTM_DIS	Indicates travel distance after operation of high oil temperature mode (ATF temperature at 130 °C {266 °F} or more)	km	–
LINEDES	Target line pressure	Pa	–
LPS	Pressure control solenoid control signal in PCM	%	1B
SOL 12S	Shift solenoid A control signal in PCM	On/Off	1E
SOL 23S	Shift solenoid B control signal in PCM	On/Off	1F
SOL 32T	3-2 timing solenoid vale control signal in PCM	On/Off	1C
SOL 34S	Shift solenoid C control signal in PCM	On/Off	1G
SOL TCC	TCC control solenoid valve control signal in PCM	On/Off	1H
TCIL	O/D OFF indicator light	On/Off	–
TCS	O/D OFF switch	On/Off	1O
TFT	Transaxle fluid temperature	°C	1U, 1AE
TFTV	Transaxle fluid signal voltage	V	1U, 1AE
TR	Transaxle range	P/R/N/D/S/L	1J, 1K, 1L, 1N, 1P, 1S
TRD	TR switch [D range]	On/Off	1L
TRL	TR switch [1 range]	On/Off	1K
TRN	TR switch [N position]	On/Off	1S
TRP	TR switch [P position]	On/Off	1N

Monitor item	Definition	Unit/Condition	PCM terminal
TRR	TR switch [R position]	On/Off	1J
TRS	TR switch [2 range]	On/Off	1P
TSS	Input/turbine speed	RPM	1M, 1Q

SIMULATION FUNCTION[GF4AX-EL]

id050204100800

- By using the PDS/IDS, simulation items for input/output parts preset in the PCM can be optionally selected and operated regardless of PCM control conditions.

Simulation Item Table

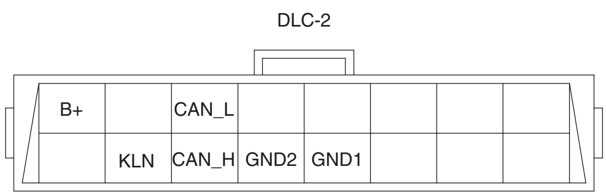
X: Available

Simulation item	Applicable component	Unit/ Condition	Operation		PCM terminal
			IG ON	Idle	
LPS	Pressure control solenoid valve	%	N/A	X	1B
SOL 12S	Shift solenoid A	On/Off	N/A	X	1E
SOL 23S	Shift solenoid B	On/Off	N/A	X	1F
SOL 32T	3-2 timing solenoid valve	On/Off	N/A	X	1C
SOL 34S	Shift solenoid C	On/Off	N/A	X	1G
SOL TCC	TCC control solenoid valve	On/Off	N/A	X	1H

DLC-2 OUTLINE[GF4AX-EL]

id050204100900

- A connector (DLC-2) conforming to International Organization for Standardization (ISO) standards has been adopted.
- Shape and terminal arrangement as stipulated by the ISO 15031-3 (SAE J1962) international standard has been adopted for this connector. The connector has a 16-pin construction that includes the B+, CAN_H, CAN_L, GND1, GND2 and KLN terminals.



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Terminal	Function
B+	Battery power supply terminal
CAN_L	Serial communication terminal (Lo)
CAN_H	Serial communication terminal (Hi)
GND1	Body ground terminal
GND2	Serial communication ground terminal
KLN	Serial communication terminal (Malfunction diagnosis use)

05

05-02B ON-BOARD DIAGNOSTIC [LA4AX-EL (CD4E)]

ON-BOARD DIAGNOSTIC (OBD) SYSTEM OUTLINE[LA4AX-EL (CD4E)]

id050207100100

- The OBD system has the following functions:
  — Malfunction detection function: Detects malfunctions of the input/output devices and system components of the ATX.
  — Fail-safe function: Fixes the output device function and input value of the sensors/switches to ensure minimum vehicle driveability when a malfunction is detected.
  — Memory function: Stores the DTC when a malfunction is detected.
  — PID data monitored function: Monitors the input/output signal and calculated value of the PCM, and sends the monitoring data to the PDS/IDS.
  — Simulation function: Allows override operation of simulation items for input/output system parts preset in the PCM.

05

ON-BOARD DIAGNOSTIC (OBD) SYSTEM BLOCK DIAGRAM[LA4AX-EL (CD4E)]

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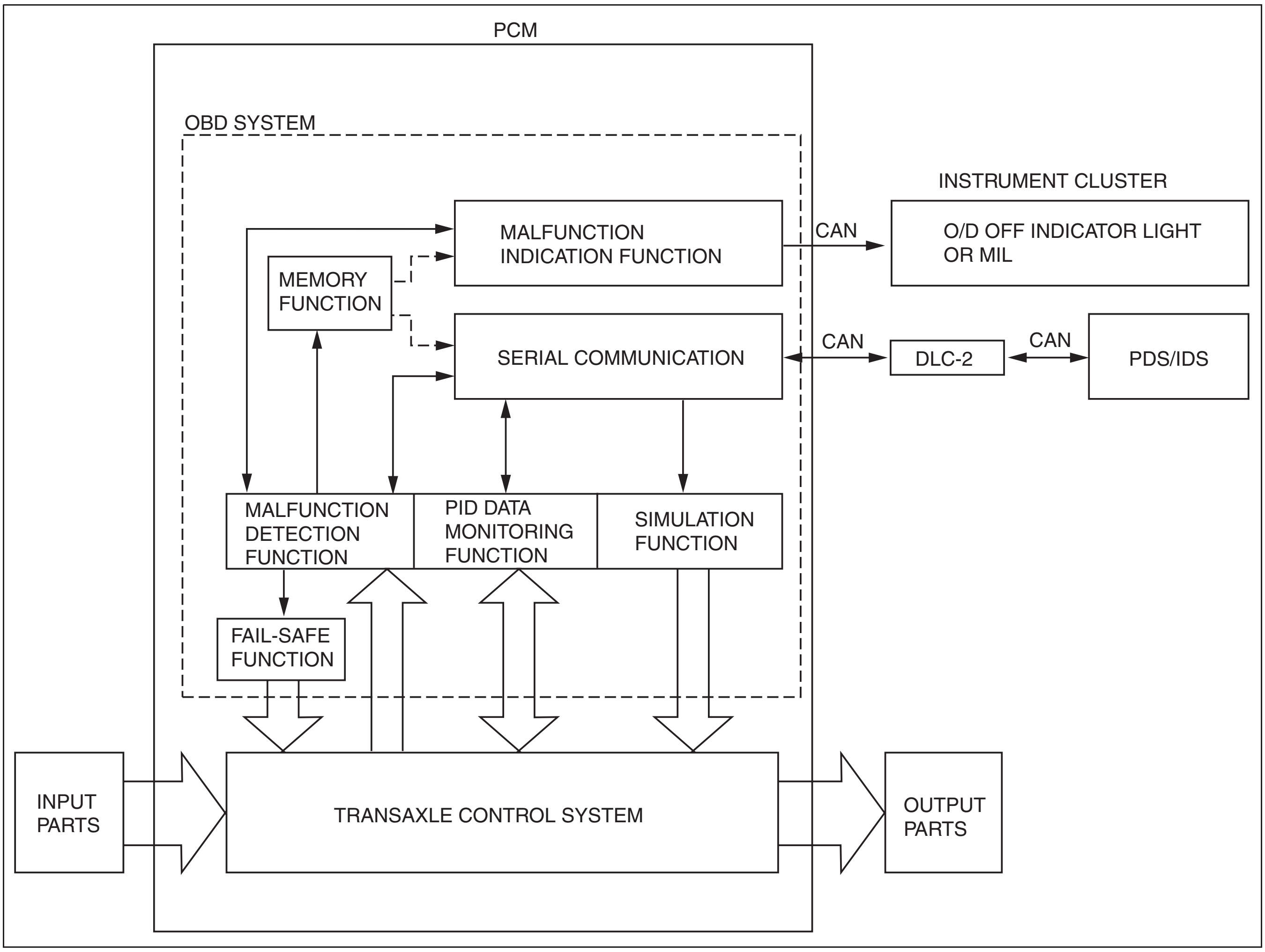

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MALFUNCTION DETECTION FUNCTION[LA4AX-EL (CD4E)]

id050207100300

Malfunction Detection Function

- In the malfunction detection function, the PCM detects malfunctions in the automatic transmission while driving.
- When vehicle driving conditions correspond with a preset malfunction detection condition, the PCM determines that the automatic transmission has a malfunction and stores the corresponding DTC.
- When a malfunction is detected, stored DTCs can be retrieved using the PDS/IDS connected to the DLC-2.

DTC Table

DTC No.	Condition
P0707	Transaxle range (TR) switch circuit malfunction (short to ground)
P0708	Transaxle range (TR) switch circuit malfunction (open circuit/short to power supply)
P0712	Transaxle fluid temperature (TFT) sensor circuit malfunction (short to ground)
P0713	Transaxle fluid temperature (TFT) sensor circuit malfunction (open circuit/short to power supply)
P0715	Turbine shaft speed (TSS) sensor malfunction
P0717	Turbine shaft speed (TSS) sensor signal is not input.
P0718	Turbine shaft speed (TSS) sensor intermittent signal input
P0720	Output shaft speed (OSS) sensor malfunction
P0721	Output shaft speed (OSS) sensor signal noise
P0722	Output shaft speed (OSS) sensor intermittent signal input
P0731	Gear 1 incorrect
P0732	Gear 2 incorrect
P0733	Gear 3 incorrect
P0734	Gear 4 incorrect
P0743	Torque converter clutch (TCC) control solenoid valve circuit malfunction
P0750	Shift solenoid A malfunction
P0751	Shift solenoid A malfunction
P0755	Shift solenoid B malfunction
P0756	Shift solenoid B malfunction
P1702	Transaxle range (TR) switch signal malfunction
P1705	Transaxle range (TR) switch circuit malfunction (P position)
P1711	Abnormal ATF temperature
P1713	ATF temperature signal stuck at low temperature.
P1714	Shift solenoid A malfunction
P1715	Shift solenoid B malfunction
P1718	ATF temperature stuck at high temperature.
P1742	Torque converter clutch solenoid malfunction
P1744	Abnormal lock-up (slipping)
P1746	Electronic pressure control (EPC) solenoid circuit malfunction (open circuit/short to power supply)
P1747	Electronic pressure control (EPC) solenoid circuit malfunction (short to ground)
P1751	Shift solenoid A malfunction
P1756	Shift solenoid B malfunction
P1760	Electronic pressure control (EPC) solenoid malfunction
P1780	O/D OFF switch circuit malfunction (open circuit/short to circuit)
P1783	ATF overheating
P1788	3-2 timing/coast clutch solenoid (3-2 T/CCS) circuit malfunction (open circuit/short to power supply)
P1789	3-2 timing/coast clutch solenoid (3-2 T/CCS) circuit malfunction (short to ground)

MEMORY FUNCTION[LA4AX-EL (CD4E)]

id050207100400

- The memory function stores malfunction information detected in the malfunction detection function. Once malfunction information is stored, the memory will not be cleared even when the ignition switch is turned off (LOCK position) or the malfunction is repaired.
- The stored memory (malfunction information) can be cleared using the PDS/IDS, or by disconnecting the negative battery cable.

MALFUNCTION INDICATION FUNCTION[LA4AX-EL (CD4E)]

id050207100500

- The malfunction indication function illuminates the MIL or O/D OFF indicator light when the malfunction detection function determines that there is a malfunction.

FAIL-SAFE FUNCTION[LA4AX-EL (CD4E)]

id050207100600

- In the fail-safe function, minimum vehicle driveability is obtained by changing the signals that are determined to be irregular by the malfunction detection function to the preset values, and limiting PCM control.

PARAMETER IDENTIFICATION (PID) DATA MONITORING FUNCTION[LA4AX-EL (CD4E)]

id050207100700

- The PID mode allows access to certain data values, analog and digital input and output, calculations and system state information.

PID/DATA MONITOR AND RECORD function table

Monitor item	Definition	Unit/Condition	PCM terminal
CCS	3-2 timing/coast clutch solenoid	On/Off	20
		kPa	20
CCSV	3-2 timing/coast clutch solenoid control signal voltage	V	20
EPC	Electronic presser control solenoid	kPa	81
EPCV	Electronic presser control solenoid control signal voltage	V	81
GEAR	Selected gear (Calculated from shift solenoids A and B)	1/2/3/4	–
GEAR_MAX	No.1 gear candidate	–	–
GEAR_RAT	Gear ratio	–	–
OSS	Output shaft speed	RPM	84
OSS_SRC	Output shaft speed	RPM	84
SSA/SS1	Shift solenoid A	On/Off	6
SSA/SS1_F	Shift solenoid A status	Yes Fault/No Fault	–
SSB/SS2	Shift solenoid B	On/Off	11
SSB/SS2_F	Shift solenoid B status	Yes Fault/No Fault	–
TC_SLIPACT	Actual torque converter slip value	RPM	–
TC_SLIPDSD	Expected torque converter slip value	RPM	–
TCC	Torque converter clutch control solenoid	%	54
		Engaged/Modulated/ OFF	54
TCC_F	Torque converter clutch control solenoid status	Yes Fault/No Fault	–
TCC_RAT	Transaxle slip ratio	–	–
TCIL	O/D OFF indicator light	On/Off	–
TCS	O/D OFF switch	Not Depressed/ Depressed	29
TFT	Transaxle fluid temperature	°C	37
		V	37
TFT_F	Transaxle fluid temperature status	Yes Fault/No Fault	37
TR	Transaxle range	D/R/OD Man2/Man 1/ P/N	64
TR_F	Transaxle range status	Yes Fault/No Fault	64
TR_V	Transaxle range signal voltage	V	64
TRAN_RAT	Transaxle gear ratio	–	–
TSS	Turbine shaft speed	RPM	59
TSS/ISS	Input shaft speed	RPM	59
TSS_SRC	Turbine shaft speed	RPM	59
TSSFM	TSS sensor failure mode	Yes Fault/No Fault	59

SIMULATION FUNCTION[LA4AX-EL (CD4E)]

id050207100800

- By using the PDS/IDS, simulation items for input/output parts preset in the PCM can be optionally selected and operated regardless of PCM control conditions.

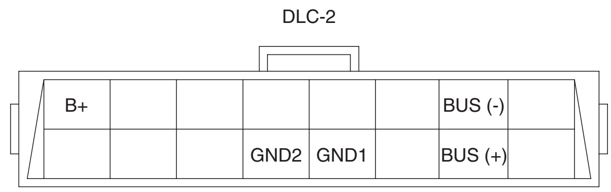
Simulation item table

Simulation item	Applicable component	Unit/Condition	PCM terminal
CCS	3-2 timing/coast clutch solenoid	On/Off	20
		kPa	20
EPC	Electronic presser control solenoid	kPa	81
SSA/SS1	Shift solenoid A	On/Off	6
SSB/SS2	Shift solenoid B	On/Off	11
TCC	Torque converter clutch control solenoid	%	54
		Engaged/Modulated/ OFF	54

DLC-2 OUTLINE[LA4AX-EL (CD4E)]

id050207100900

- A connector (DLC-2) conforming to International Organization for Standardization (ISO) standards has been adopted.
- Shape and terminal arrangement as stipulated by the ISO 15031-3 (SAE J1962) international standard has been adopted for this connector. The connector has a 16-pin construction that includes the BUS (–), BUS (+), GND1, GND2 and B+ terminals.



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Terminal	Function
B+	Battery power supply terminal
BUS (–)	Serial communication terminal (–)
BUS (+)	Serial communication terminal (+)
GND1	Body ground terminal
GND2	Serial communication ground terminal

05-17A AUTOMATIC TRANSAXLE [GF4AX-EL]

AUTOMATIC TRANSAXLE OUTLINE[GF4AX-EL]

id051703101700

- GF4AX-EL automatic transaxles have been adopted for L3 engine vehicles.
  — Duty cycle solenoid valves have been adopted to provide optimal hydraulic pressure control according to driving conditions.
  — A 3-2 timing solenoid valve has been adopted to provide engagement timing control of the 2-4 brake band and 3-4 clutch to soften shift shock.
  — A variable displacement, trochoid gear oil pump has been adopted to provide quiet and high-efficiency oil discharge.

AUTOMATIC TRANSAXLE CROSS-SECTIONAL VIEW[GF4AX-EL]

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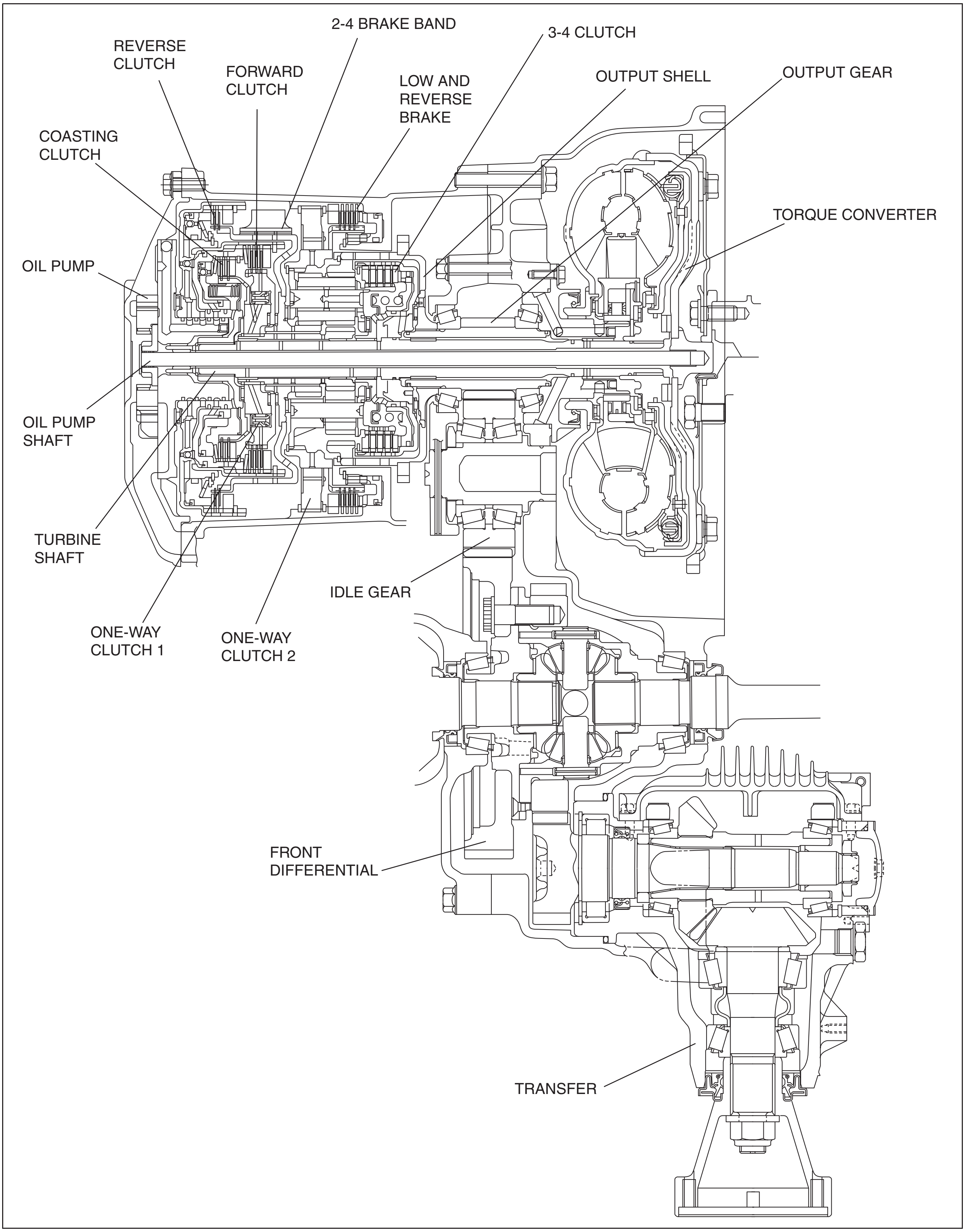

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EC-AT OPERATION CHART[GF4AX-EL]

id051703102100

Range	Mode	Gear position		Gear ratio	Shift pattern			Transaxle									Operation of shift solenoid		
					Shift	TCC	Engine brake	C1	C2	C3	C4	B1 Applied	B1 Released	B2	OWC 1	OWC 2	Shift solenoid A	Shift solenoid B	Shift solenoid C
P	-	-		-	-														×
R	-	Reverse		2.333	-	-	×				×			×				×	×
R	-	-	More than 30 km/h {19 mph}	2.333	-	-					×			×			×		
N	-	-	Less than 4 km/h {2.5 mph}	-	-														×
N	-	-	More than 5 km/h {3.1 mph}	-	-												×		
D	NORMAL (O/D OFF SWITCH OFF)	1 GR		2.800	↕			×							×	×		×	×
D	NORMAL (O/D OFF SWITCH OFF)	2 GR		1.540	↕			×				×			×		×	×	×
D	NORMAL (O/D OFF SWITCH OFF)	3 GR		1.000	↕		×	×	×	×		⊗	×		×		×		
D	NORMAL (O/D OFF SWITCH OFF)	O/D		0.700	↓	×	×	×		×		×			◎		×		×
D	NORMAL (O/D OFF SWITCH ON)	1 GR		2.800	↕			×							×	×		×	×
D	NORMAL (O/D OFF SWITCH ON)	2 GR		1.540	↕			×				×			×		×	×	×
D	NORMAL (O/D OFF SWITCH ON)	3 GR		1.000	↕		×	×	×	×		⊗	×		×		×		
D	NORMAL (O/D OFF SWITCH ON)	O/D *1		0.700		×	×	×		×		×			◎		×		×
2	-	2 GR		1.540	↑		×	×	×			×			×		×	×	
2	-	3 GR *1		1.000	↕		×	×	×	×		⊗	×		×		×		
2	-	O/D *1		0.700			×	×		×		×			◎		×		×
1	-	1 GR		2.800	↑		×	×	×					×	×			×	
1	-	2 GR *1		1.540			×	×	×			×			×		×	×	

*1 : Engine overspeed protection
× : Operating
⊗ : Operating but not contributing to transaxle power
◎ : Clutch is freewheeling and does not transmit power
↕ : Automatic shift according to set speed and throttle opening angle
C1 : Forward clutch
C2 : Coasting clutch
C3 : 3-4 clutch
C4 : Reverse clutch
B1 : 2-4 Brake band
B2 : Low and reverse brake
OWC1 : One-way clutch 1 (sprag type)
OWC2 : One-way clutch 2 (roller type)

BUE0517T229

POWERTRAIN OUTLINE[GF4AX-EL]

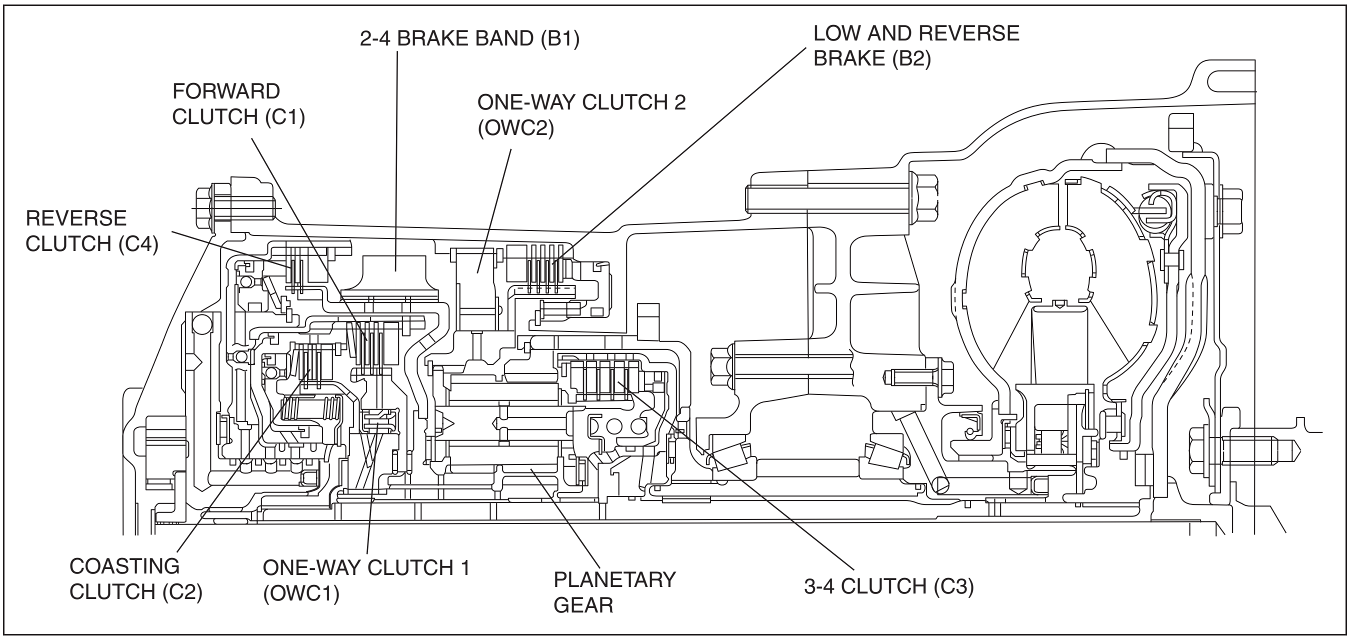
id051703107300

- Hydraulic fluid pumped through the control valve operates the clutches and brakes, and the planetary gear converts the driving force to one appropriate to vehicle driving conditions.

POWERTRAIN STRUCTURE[GF4AX-EL]

id051703107400

- The powertrain consists of four sets of multi-plate clutches, one set of multi-plate brakes, one set of band brakes, two sets of one-way clutches, and one Ravigneaux planetary gear set.



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POWERTRAIN OPERATION[GF4AX-EL]

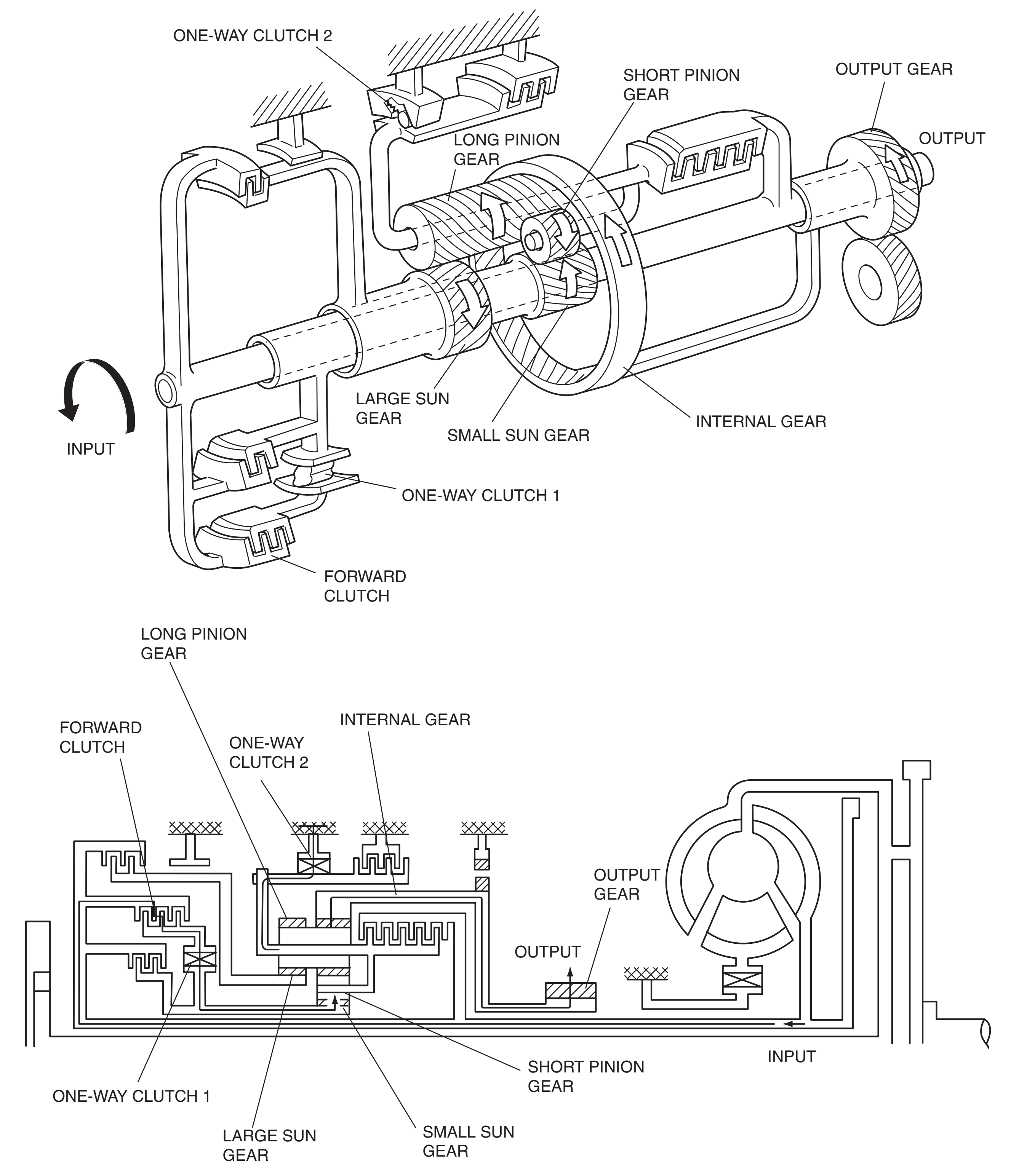
id051703107200

Component Parts And Their Movement

Symbol	Component part	Movement
C1	Forward clutch	• Transmits reverse forward drum rotation to small sun gear
C2	Coasting clutch	• Transmits reverse forward drum rotation to small sun gear (Accordingly, provides engine braking)
C3	3-4 clutch	• Transmits 3-4 clutch drum rotation to planetary carrier
C4	Reverse clutch	• Transmits reverse forward drum rotation to large sun gear
B1	2-4 brake band	• Locks 2-4 brake drum and large sun gear rotation
B2	Low and reverse brake	• Locks low and reverse brake hub rotation
OWC1	One-way clutch 1	• Transmits reverse forward drum rotation to small sun gear only when driven
OWC2	One-way clutch 2	• Locks planetary carrier rightward rotation
—	Planetary gear	• Converts driving force transmitted by operation of brakes and clutches, and transmits force to output gear (Performs shifting function)

Note
- Rotations are described as viewed from the oil pump side.

Power Flow
1GR



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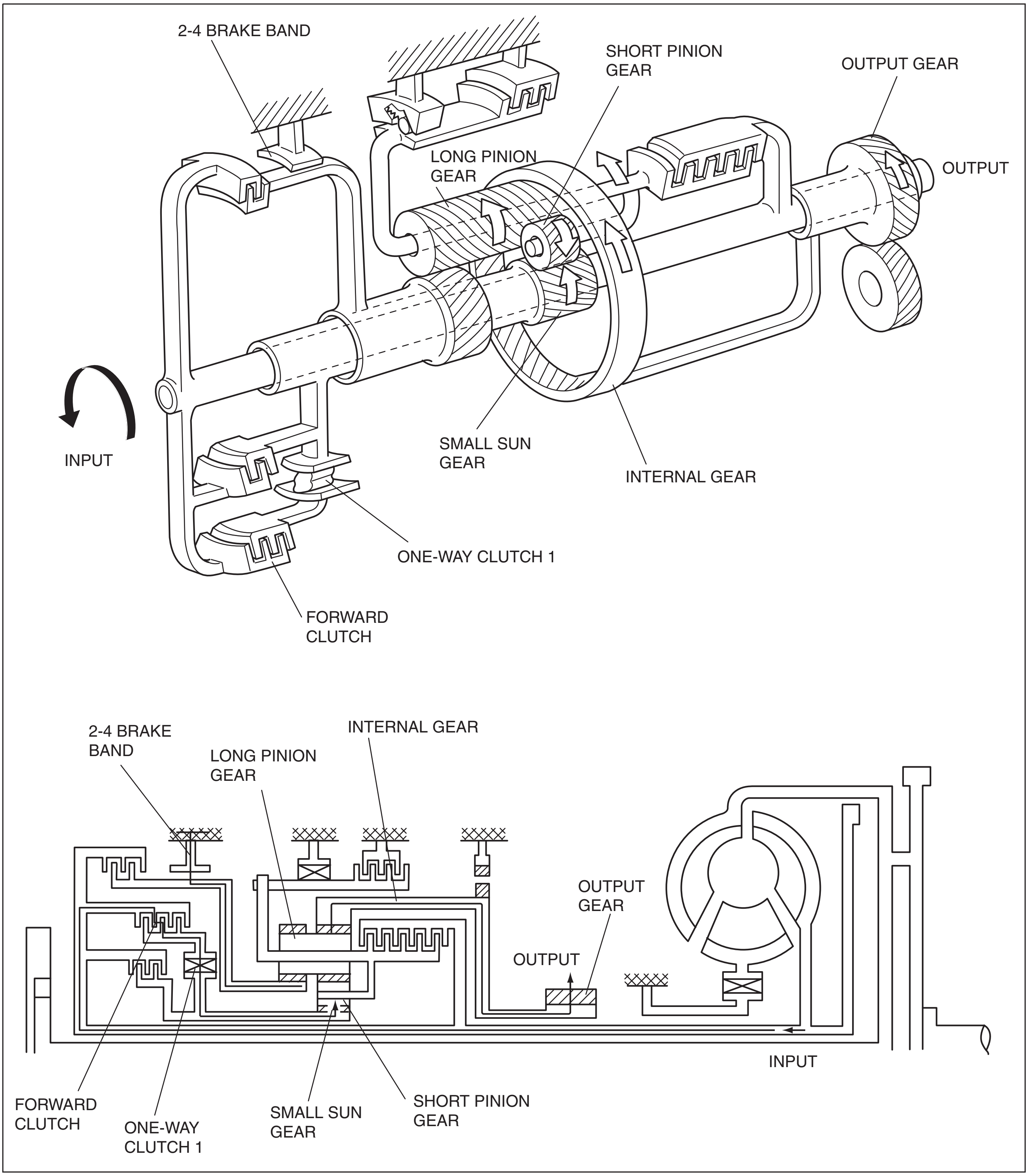
2GR



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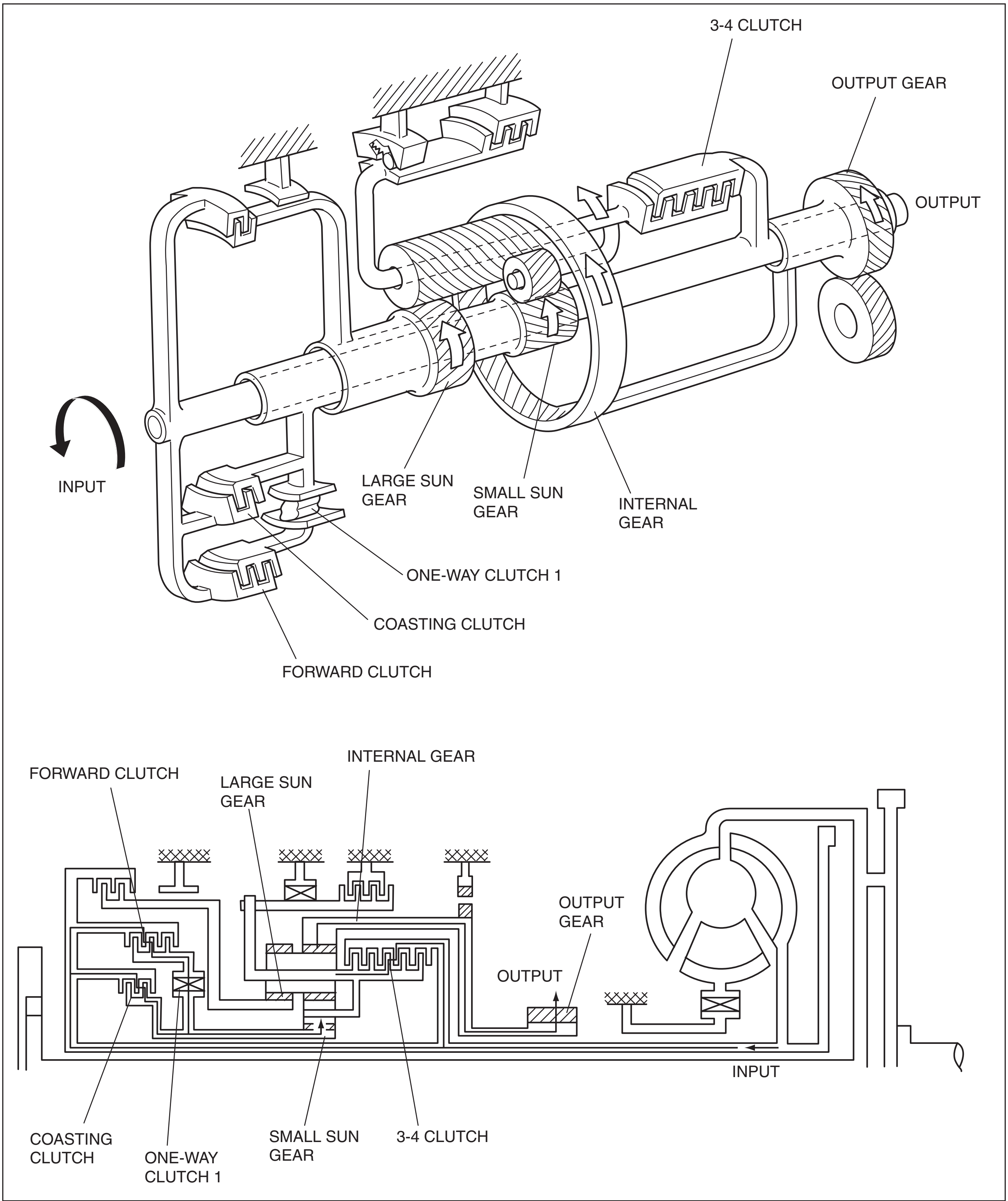
3GR



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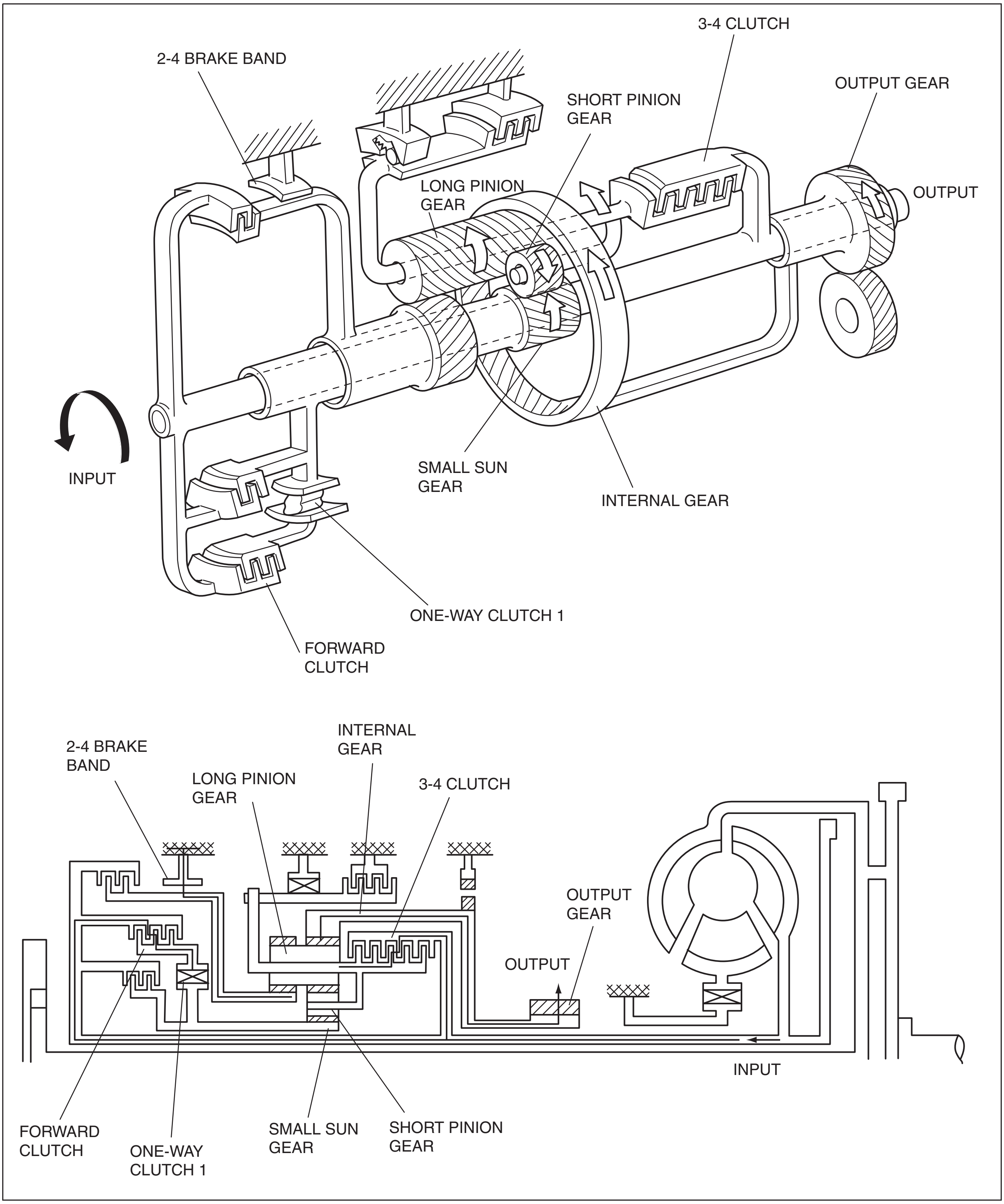
4GR



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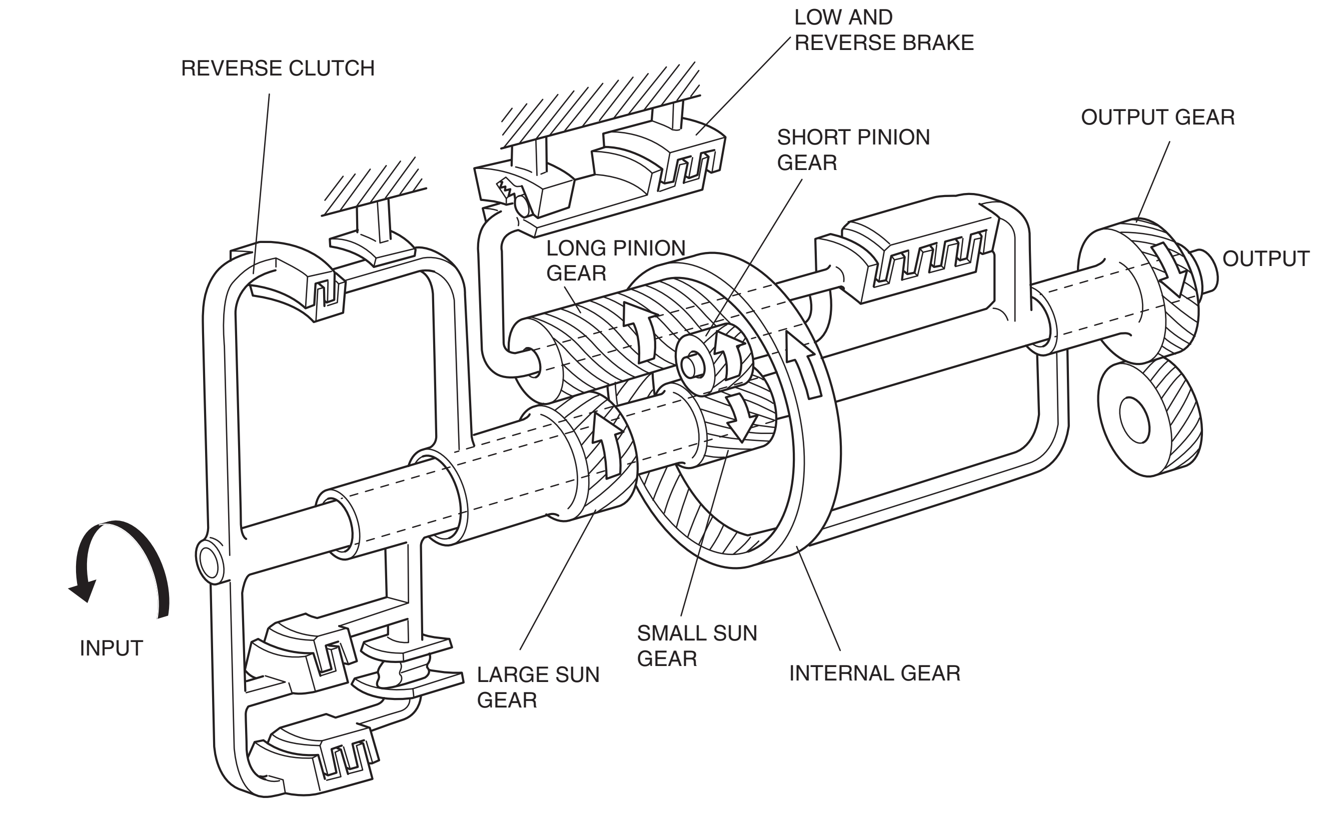
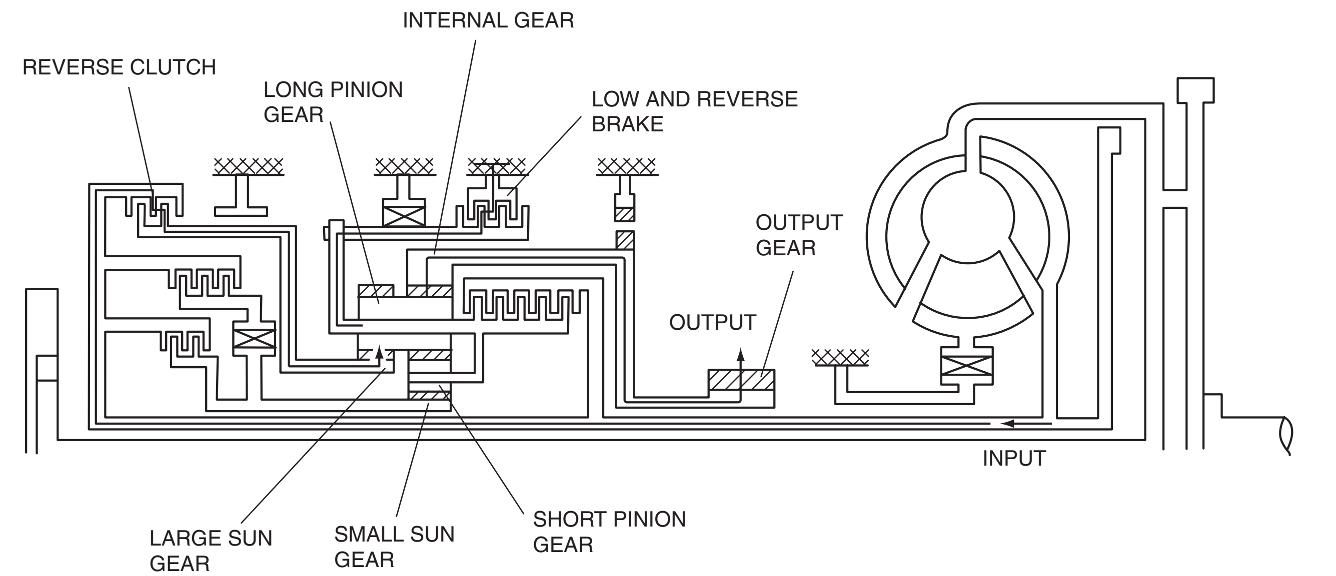
R position





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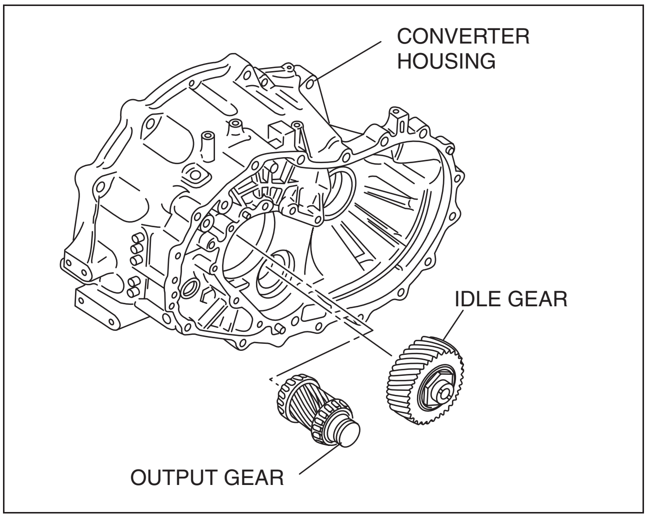
IDLE AND OUTPUT GEARS OUTLINE[GF4AX-EL]

id051703107700

- The shape of the idle and output gears' teeth surfaces have been optimized to improve reliability.



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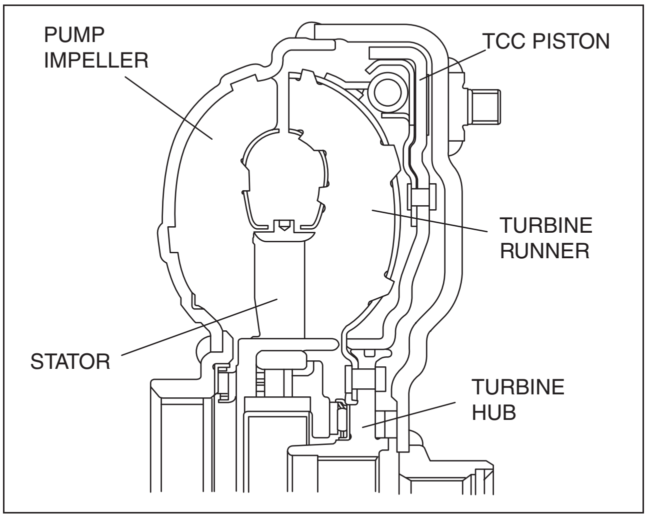
TORQUE CONVERTER OUTLINE[GF4AX-EL]

id051703100700

- A three-element, one-stage, two-phase torque converter with a TCC mechanism has been adopted.
- The vanes inside the torque converter are shaped to match engine output characteristics and thereby optimize that output to ensure sufficient transmission efficiency and torque conversion ratio.



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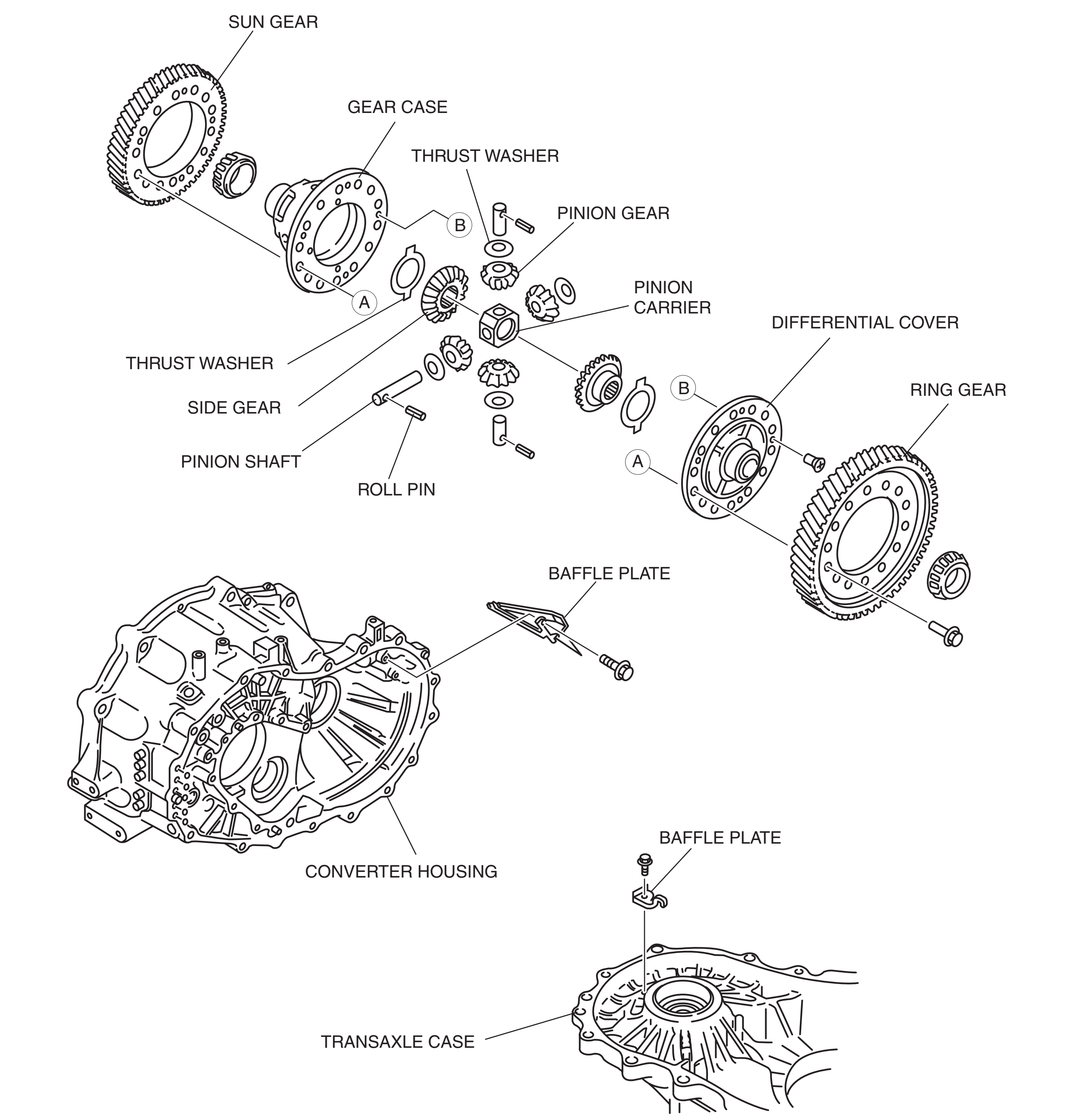
DIFFERENTIAL OUTLINE[GF4AX-EL]

id051703106500

- The differential pinion gear has been changed from a two-pinion to a four-pinion type to improve reliability.
- The shape of the ring gear's teeth surfaces has been optimized to improve reliability.
- A baffle plate has been added to the converter housing and transaxle case to improve reliability.



atraan00000300

HYDRAULIC CONTROL SYSTEM FUNCTION[GF4AX-EL]

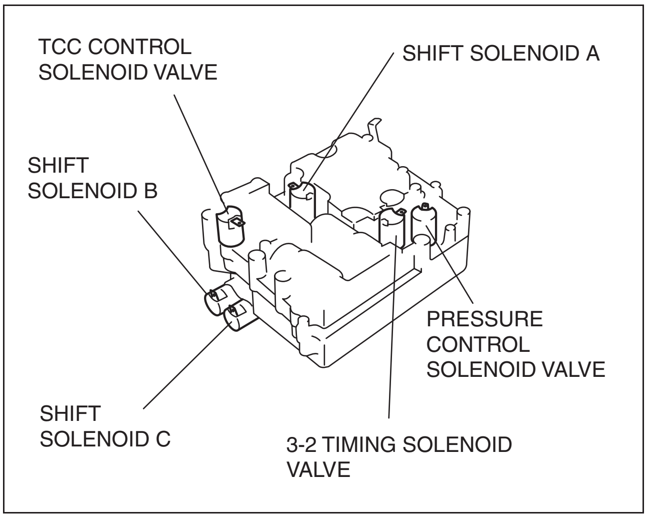
id051703106800

- The control system adjusts the pressure of hydraulic fluid pumped from the oil pump and interior valves are operated according to this variation in hydraulic pressure thereby operating functional component parts.

HYDRAULIC CONTROL SYSTEM OPERATION[GF4AX-EL]

id051703106900

- Hydraulic pressure formed at the oil pump is optimally adjusted according to engine load and driving conditions by the duty cycle pressure control solenoid valve. Shift valve hydraulic circuits are switched by means of on/off solenoid valves, thereby operating the powertrain clutches and brakes.

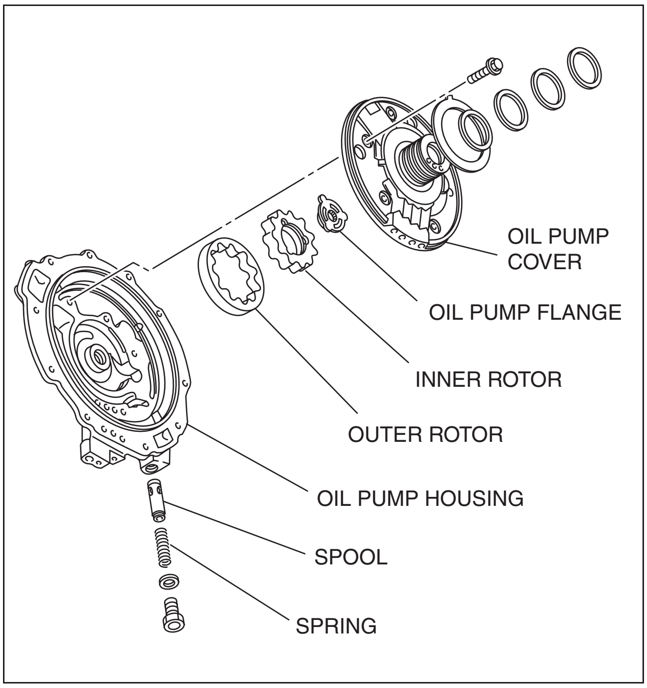


atraan00000301

OIL PUMP OUTLINE[GF4AX-EL]

id051703105600

- The variable displacement trochoid gear oil pump has been adopted, raising discharge efficiency and improving quiet operation. The pump sends fluid to the torque converter, provides lubrication of the powertrain system and forms the operating pressure for the hydraulic control system.



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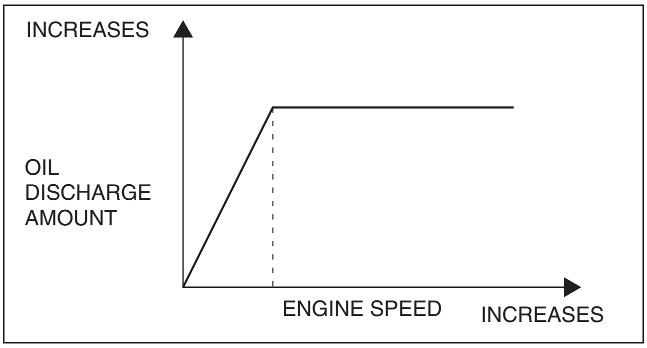
OIL PUMP OPERATION[GF4AX-EL]

id051703105500

- The variable displacement trochoid gear oil pump maintains oil discharge amount at a constant level when engine speed rises above a certain speed allowing no more oil than is necessary to be pumped. Due to this, torque loss is prevented and power efficiency is improved.



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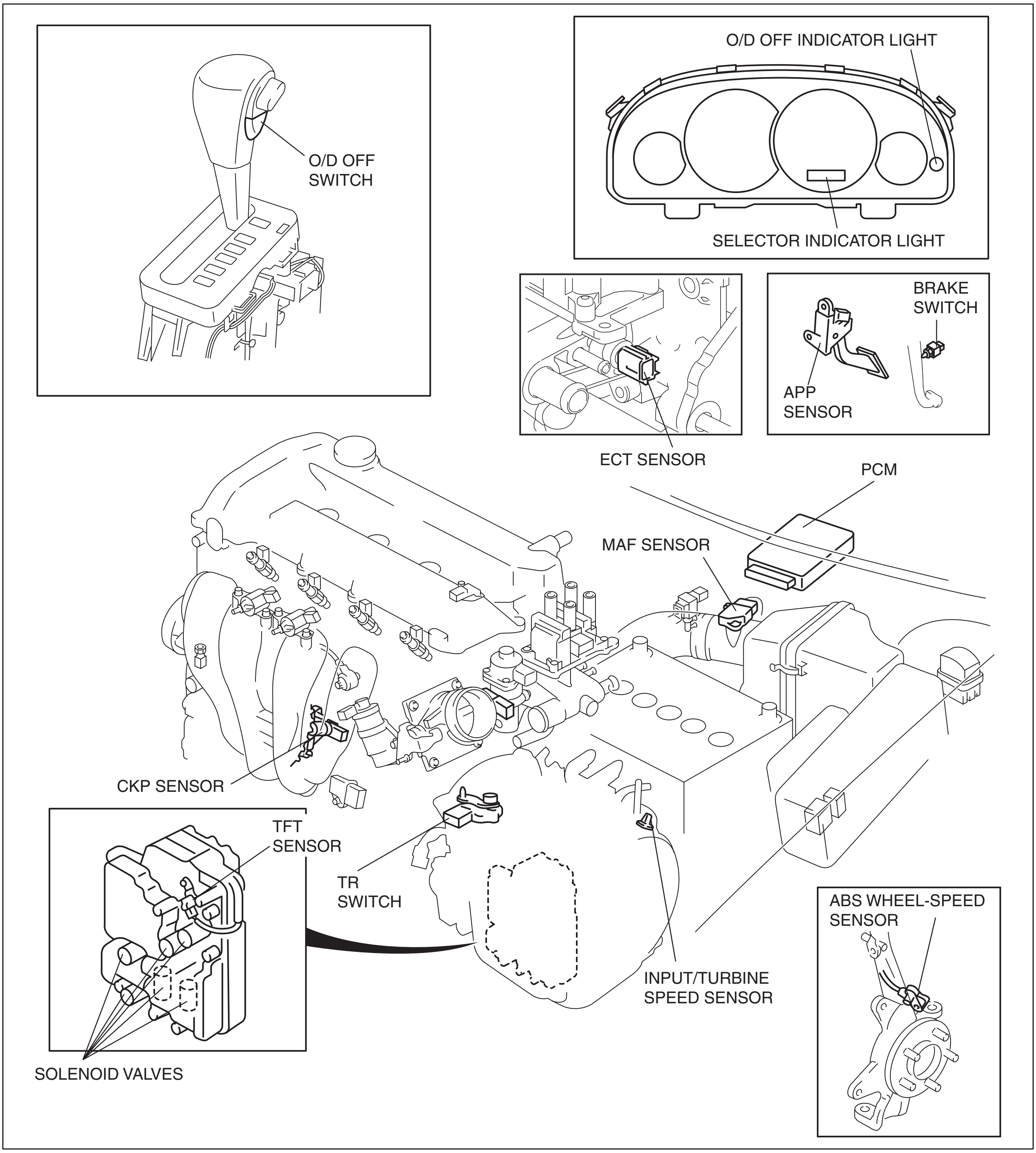
ELECTRONIC CONTROL SYSTEM OUTLINE[GF4AX-EL]

id051703104300

- The PCM, which integrates engine control, has been adopted for transaxle control to improve system efficiency.
- The PCM performs control according to electrical signals from each switch and sensor, as shown in the block diagram, and then it sends an electrical signals to the solenoid valves to control gear shift and TCC operations.
- The on-board diagnostic function constantly (ignition switch is at ON) monitors some of the sensors and there is a fail-safe function in case a malfunction develops.

ELECTRONIC CONTROL SYSTEM STRUCTURAL VIEW[GF4AX-EL]

id051703104400



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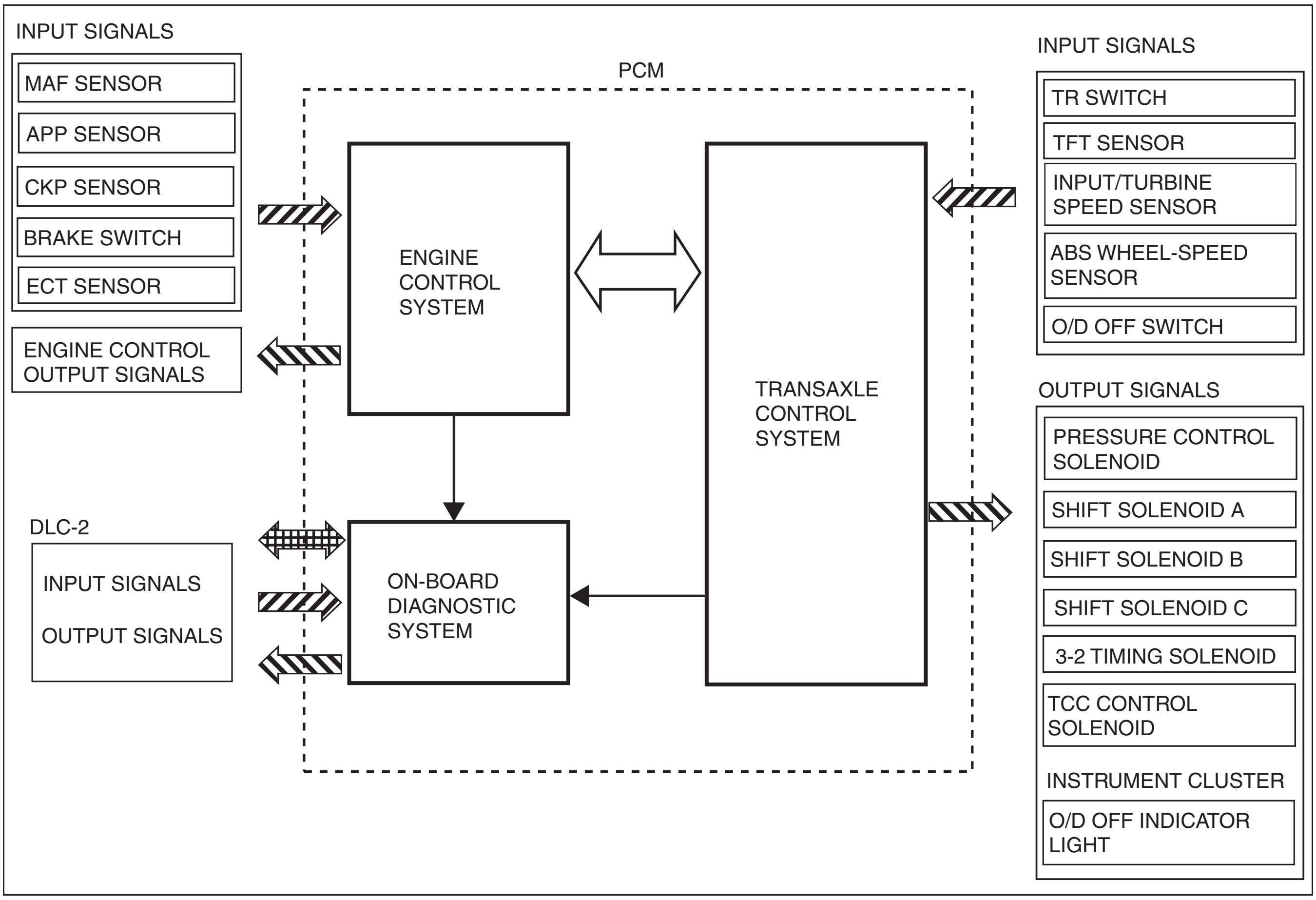
ELECTRONIC CONTROL SYSTEM BLOCK DIAGRAM[GF4AX-EL]

id051703100200



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COMPONENT DESCRIPTIONS (ELECTRONIC CONTROL)[GF4AX-EL]

id051703100400

Component Part		Function
Input	O/D OFF switch	• Selects/releases O/D off function
	TR switch	• Detects range position of selector lever
	TFT sensor	• Detects ATF temperature
	Input/turbine speed sensor	• Detects turbine shaft speed
	ABS wheel-speed sensor	• Detects vehicle speed
	APP sensor	• Detects accelerator opening angle
	CKP sensor	• Detects engine speed
	Brake switch	• Detects depressed brake pedal
	ECT sensor	• Detects engine coolant temperature
	MAF sensor	• Detects intake airflow amount
Input/ Output	CAN	• Sends/receives multiple data instantly between PDS/IDS and PCM using CAN communication

Component Part		Function
Output	Shift solenoid A	• Turn on/off according to electrical signals from PCM, switching hydraulic circuits accordingly to perform shifting
	Shift solenoid B	
	Shift solenoid C	
	TCC control solenoid	• Turns on/off according to electrical signals from PCM to control TCC
	3-2 timing solenoid	• Turns on/off according to electrical signals from PCM, switching hydraulic circuits accordingly to control shift timing
	Pressure control solenoid	• Turns on/off according to electrical signals (duty signals) from PCM to adjust line pressure to match driving conditions
	O/D OFF indicator light	• Illuminates to indicate status of O/D off function as controlled by O/D OFF switch • Blinks if a malfunction is determined by diagnostic function
	CAN	• Outputs DTCs stored in PCM memory

DUTY CYCLE SOLENOID VALVE FUNCTION[GF4AX-EL]

id051703105800

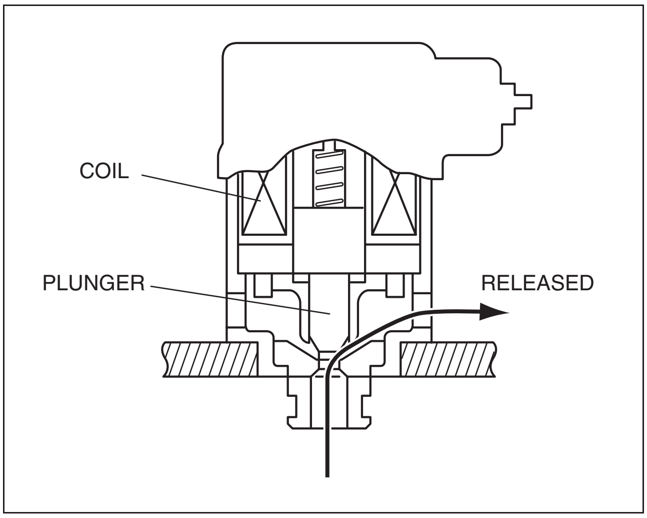
- Duty cycle solenoid valves are used for line pressure control.
- The on/off time during a single cycle of the line pressure solenoid is freely controlled between 0—100 % by a signal from the PCM, thereby adjusting hydraulic pressure according to vehicle driving conditions.

DUTY CYCLE SOLENOID VALVE OPERATION[GF4AX-EL]

id051703105900

On

- The coil is energized, drawing the plunger upward to open the drain port and release hydraulic pressure.



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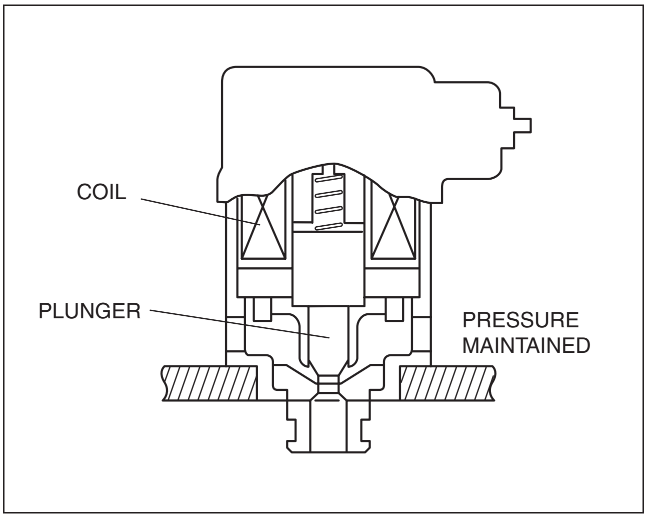
Off

- The plunger moves down due to spring force, closing the drain port to maintain hydraulic pressure.

ATF Flow	Solenoid Valve
Released	On
Pressure maintained	Off

- The smaller the duty ratio (percent of on time during a fixed cycle), the higher the hydraulic pressure and, inversely, the larger the duty ratio, the lower the hydraulic pressure.



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ON/OFF SOLENOID VALVE FUNCTION[GF4AX-EL]

id051703106000

- On/off solenoid valve application is as follows:

Solenoid Valve	Application
Shift solenoid A, B and C	Shifting
TCC control solenoid	TCC
3-2 timing solenoid	Shift timing

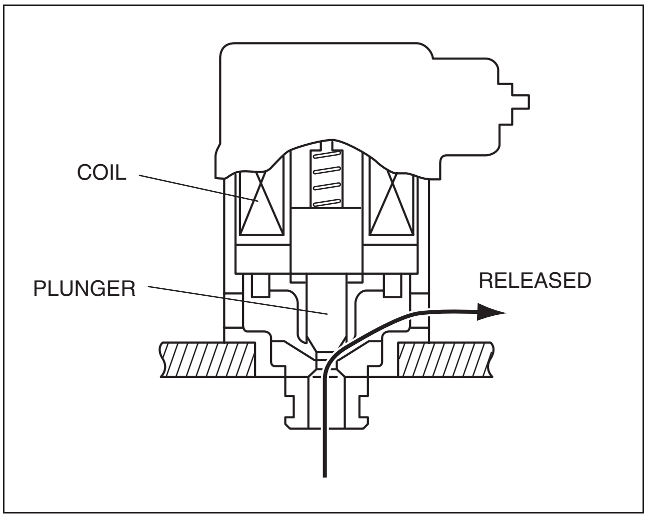
- On/off solenoid valves are controlled by on/off electrical signals from the PCM and the hydraulic circuits inside the control valve bodies are switched accordingly.

ON/OFF SOLENOID VALVE OPERATION[GF4AX-EL]

id051703106100

On

- The coil is energized, drawing the plunger upward to open the drain port and release hydraulic pressure.



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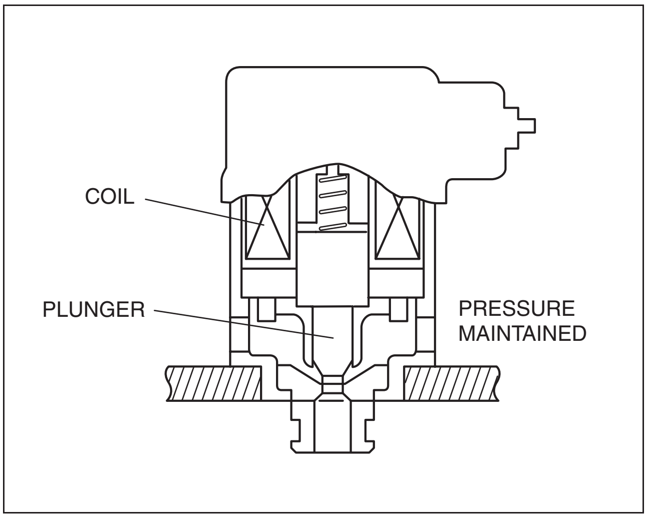
Off

- The plunger moves down due to spring force, closing the drain port to maintain hydraulic pressure.

ATF Flow	Solenoid Valve
Released	On
Pressure maintained	Off



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PCM FUNCTION[GF4AX-EL]

id051703104800

Function Table

Control Item	Contents
Shift control	• Detects engine load conditions and vehicle speed; shifts to optimum gear speed according to predetermined automatic shift diagram • Switches automatically into dedicated slope mode according to road gradient • Selects O/D off function according to operation of O/D OFF switch
Line pressure control	• Adjusts line pressure to match engine load and driving conditions using pressure control solenoid (duty cycle type) • Automatically switches to optimal line pressure for each gear when shifting occurs • Automatically switches to optimal line pressure when fluid temperature is low to speed up clutch and brake operation
3-2 timing control	• Temporarily switches 2-4 brake band engagement/release pressure and 3-4 clutch line pressure hydraulic circuits when shifting gears by on/off operation of 3-2 timing solenoid
Shift solenoid on/off timing control	• Switches 2-4 brake band engagement/release pressure, and 3-4 clutch and coasting clutch line pressure hydraulic circuits when shifting gears by on/off operation of shift solenoid A, B and C
Torque reduction control	• Temporarily reduces engine torque during gear shifting to improve shifting quality
TCC control	• Controls TCC according to predetermined TCC points
Diagnostic system	• Main components of ATX control system have self-diagnosis function; if malfunction occurs, O/D OFF indicator light flashes to warn driver and DTC is stored in PCM • When malfunction is determined as result of on-board diagnostic, driveability is preserved as much as possible by fail-safe function

05

PCM CONSTRUCTION[GF4AX-EL]

id051703104700

Relation of Control System and Input/Output Parts

Component	Control item						
	Shift control	Line pressure control	3-2 timing control	Shift solenoid on/off timing control	Torque reduction control	Torque converter clutch control	On-board diagnostic function
Input							
O/D OFF switch	X	X	X	X		X	
TR switch	X	X	X	X	X	X	
APP sensor	X	X	X	X	X	X	X
Input/turbine speed sensor	X	X	X	X	X	X	X
ABS wheel-speed sensor	O	X	X	X	X	O	X
Brake switch					X	X	
TFT sensor	X	X	X	X	X	X	X
ECT sensor					X	X	X
CKP sensor		X	X		X	X	X
MAF sensor	X				X		X
Input/Output							
CAN							X
Output							
Shift solenoid A	X			X			X
Shift solenoid B	X			X			X
Shift solenoid C	X			X			X
TCC control solenoid						X	X
3-2 timing solenoid			X				X
Pressure control solenoid		X					X
O/D OFF indicator light	X						X

X : Available
O : Back up

LINE PRESSURE CONTROL STRUCTURE[GF4AX-EL]

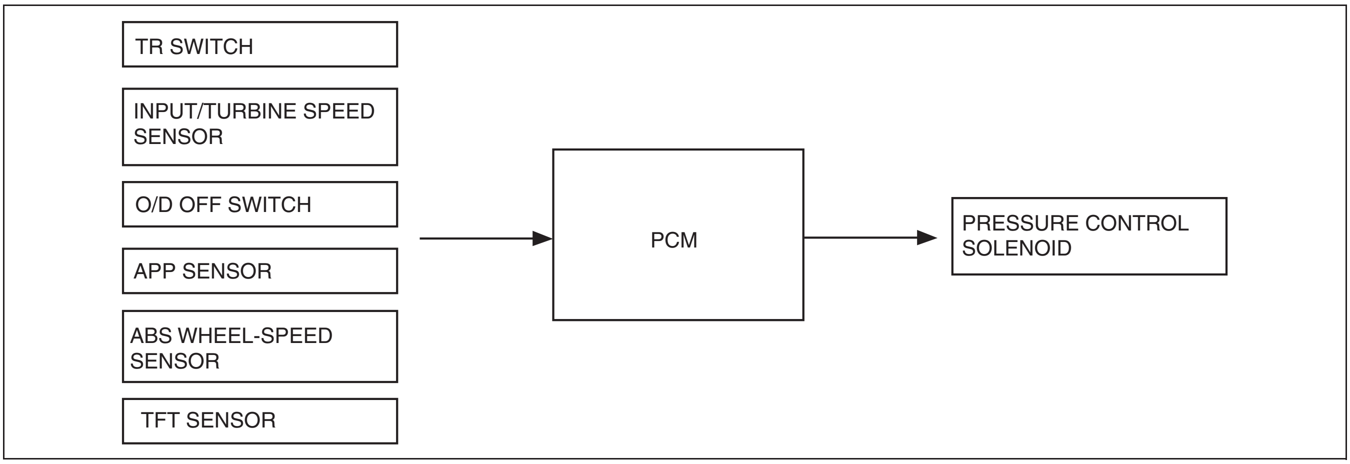
id051703104600

Features

- The APP sensor detects the throttle opening angle, sends an electrical signal to the PCM and the PCM controls the pressure control solenoid to adjust the pressure modifier pressure. This pressure modifier pressure is used as signal pressure for controlling the pressure regulator valve thereby optimally adjusting oil pump discharge pressure according to driving conditions.

Structure

Block Diagram



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LINE PRESSURE CONTROL OPERATION[GF4AX-EL]

id051703104500

Line Pressure Control (Normal)

- Line pressure is adjusted to provide clutches with the required pressure and maintain oil pump wear at a minimum.

Line Pressure Control (During Shifting)

- Predetermined line pressure characteristics that match engine driving force during shifting are utilized and an optimal characteristic is temporarily selected according to shift conditions in order to minimize transaxle shock.

Line Pressure Learning Control

- Line pressure learning control is performed to minimize shift shock and other negative characteristics due to deviation of parts and deterioration over time. Shift shock may increase after the negative battery cable is removed since this clears the learning data but the shock will gradually be reduced as the vehicle is driven.

SHIFT CONTROL STRUCTURE[GF4AX-EL]

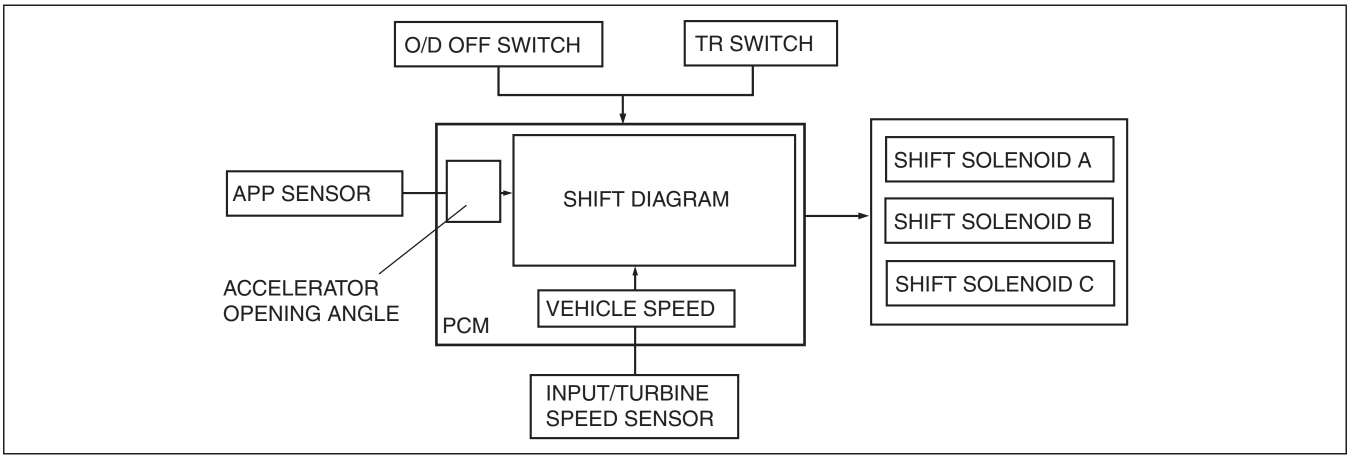
id051703106300

Features

- The PCM selects and determines automatic shift patterns based on determination of range and driving modes. Based on the selected pattern, and according to reverse and forward drum speeds (vehicle speed) and accelerator opening angle, a gear position is determined and the PCM sends a signal to the solenoid valves.

Structure

System Diagram



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SHIFT CONTROL OPERATION[GF4AX-EL]

id051703106200

Range Determination

- The interior switches of the TR switch turn on/off according to selector lever operation and these signals are used to detect lever position.
- The following switches are built into the TR switch and the corresponding range is determined by their on/off status.
  — P and N position switch
  — R position switch
  — D range switch
  — 2 range switch
  — 1 range switch

Driving Mode Determination

D range

- “Normal” or “O/D off” modes are determined based on the combination of the O/D OFF switch position and the ATF temperature.
- When the ATF temperature is high, the PCM switches automatically to dedicated high fluid temperature mode and the TCC point is shifted towards the low speed side.
- If the PCM determines, from engine load and acceleration rate, that the vehicle is driving on a slope, then dedicated slope mode is selected.

2 Range

- Fixed in 2GR.

1 Range

- Fixed in 1GR.

O/D Driving Inhibited Determination

- O/D driving is inhibited according to engine load conditions to provide stable driving characteristics.
- O/D driving is inhibited when the ATF temperature is low.

Shift Learning Control

- Shift learning control is performed to minimize shift shock and other negative characteristics due to deviation of parts and deterioration over time. Shift shock may increase after the negative battery cable is removed since this clears the learning data but the shock will gradually be reduced as the vehicle is driven.

3-2 TIMING CONTROL STRUCTURE[GF4AX-EL]

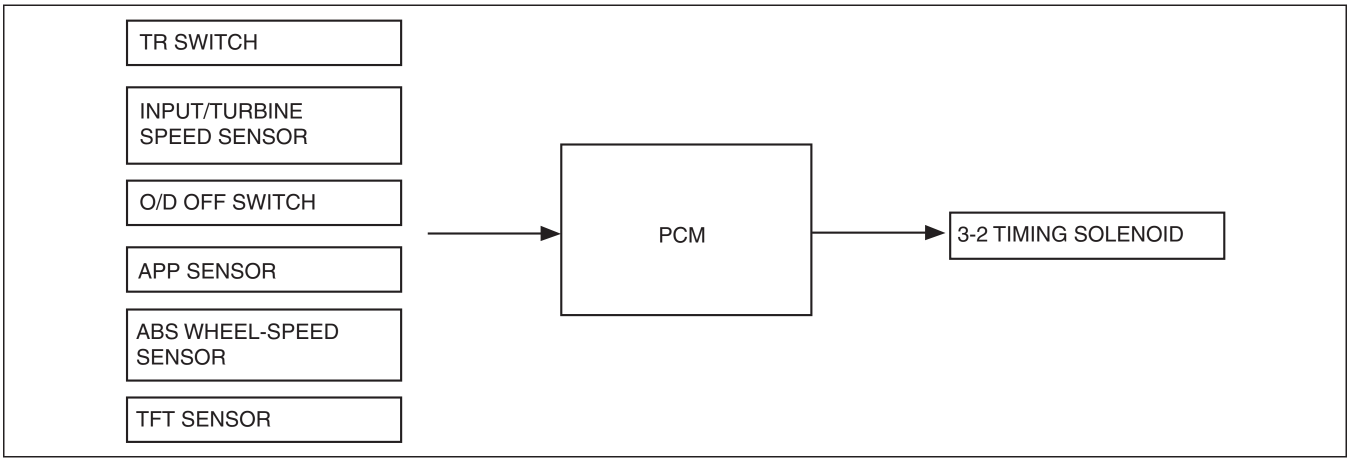
id051703104200

Features

- Based on input signals from switches and sensors, the PCM determines the optimal shift timing according to shift conditions and outputs corresponding on/off signals to the 3-2 timing solenoid, thereby reducing shift shock.

Structure

Block Diagram



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3-2 TIMING CONTROL OPERATION[GF4AX-EL]

id051703104100

3-2 Timing Control Determination

- The PCM performs control by sending an on/off signal to the 3-2 timing solenoid when the following shifting occurs: 1→2, 2→3, 3→O/D, O/D→3, 3→2, 3→1, and 2→1.
- 3-2 timing valve hydraulic circuits are switched according to 3-2 timing solenoid on/off operation and 2-4 brake band engagement and release pressures are momentarily bypassed to allow for timing control during shifting.

3-2 Timing Control Inhibited Determination

- The 3-2 timing solenoid remains off when any of the following conditions are met:
  — 3-2 timing solenoid has a malfunction
  — When in D or 2 ranges, and shift solenoid A, B or C has a malfunction
- If in 1 range and the shift solenoid A, B or C have a malfunction, the 3-2 timing solenoid remains on.

3-2 Timing Learning Control

- 3-2 timing learning control is performed to minimize shift shock and other negative characteristics due to deviation of parts and deterioration over time. Shift shock may increase after the negative battery cable is removed since this clears the learning data but the shock will gradually be reduced as the vehicle is driven.

SHIFT SOLENOID ON/OFF TIMING CONTROL STRUCTURE[GF4AX-EL]

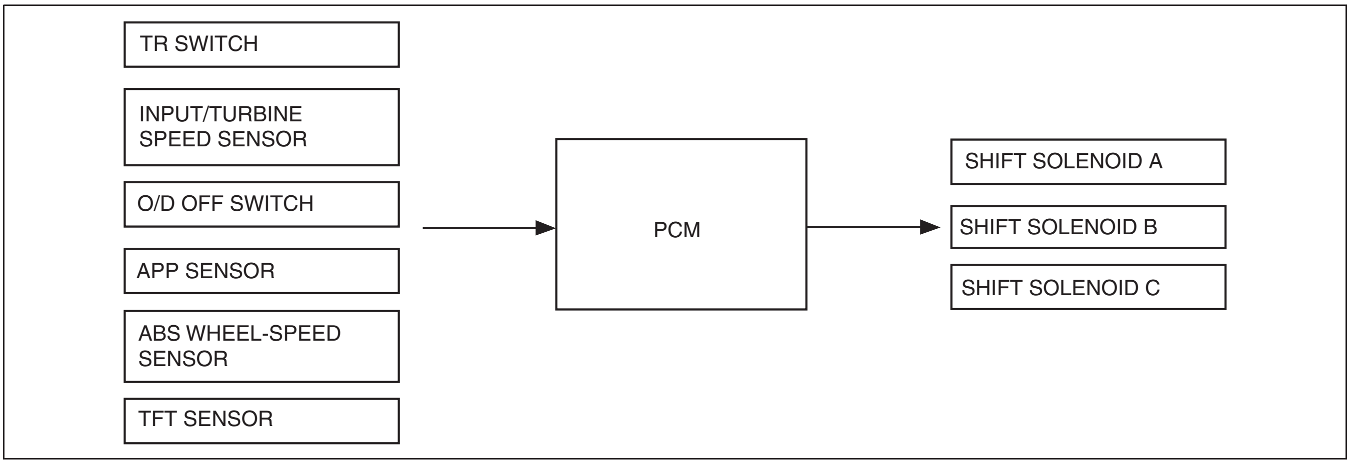
id051703105000

Features

- Based on input signals from switches and sensors, the PCM determines the optimal shift timing according to shift conditions and outputs corresponding on/off signals to the shift solenoid A, B and C, thereby reducing shift shock.

Structure

Block Diagram



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SHIFT SOLENOID ON/OFF TIMING CONTROL OPERATION[GF4AX-EL]

id051703104900

Shift Solenoid On/Off Timing Control

- Timing and pressure control is performed for the 2-4 brake band engagement and release, 3-4 clutch, and coasting clutch pressures by the switching of hydraulic paths of the 1-2, 2-3, and 3-4 shift valves according to the routing of separate solenoid patterns for each of the following shifts: 1→2, 2→3, 3→O/D, O/D→3, O/D→2, 3→2, 3→1, and 2→1.

Shift Solenoid On/Off Timing Control Inhibited Determination

- Shift solenoid on/off timing control is inhibited if the shift solenoid A, B or C have a malfunction.

TORQUE REDUCTION CONTROL STRUCTURE[GF4AX-EL]

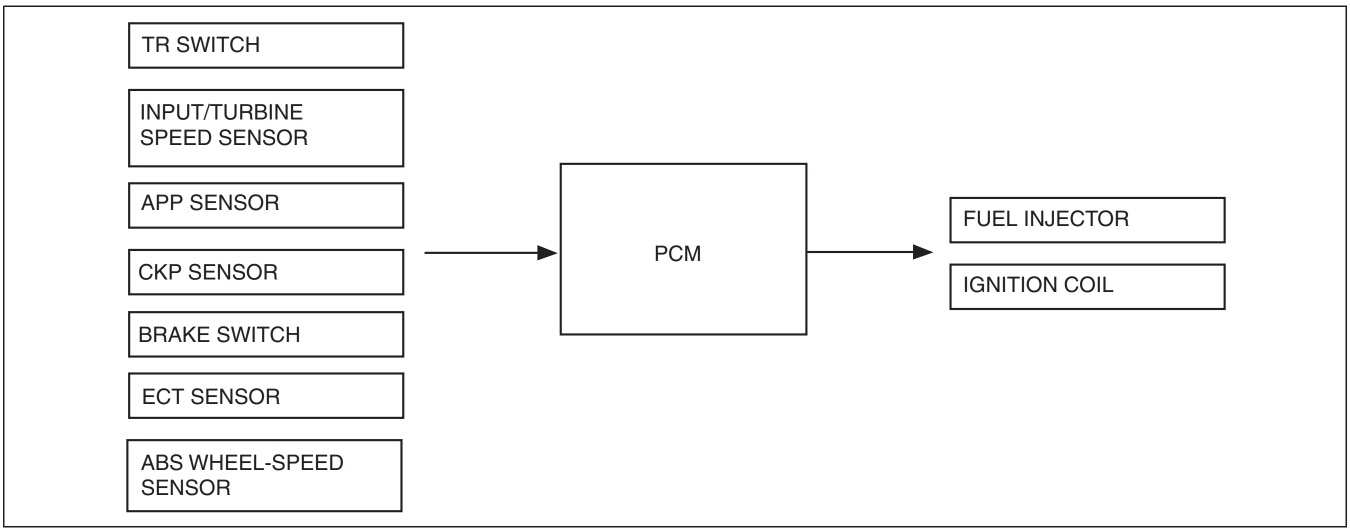
id051703105400

Features

- Fuel cut and spark retard control are performed during shifting, lowering engine torque momentarily to reduce shift shock.

Structure

Block Diagram



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TORQUE REDUCTION CONTROL OPERATION[GF4AX-EL]

id051703105300

- The PCM determines whether a torque reduction is possible based on signals received from various sensors and switches, and performs torque reduction control accordingly.

TORQUE CONVERTER CLUTCH (TCC) CONTROL STRUCTURE[GF4AX-EL]

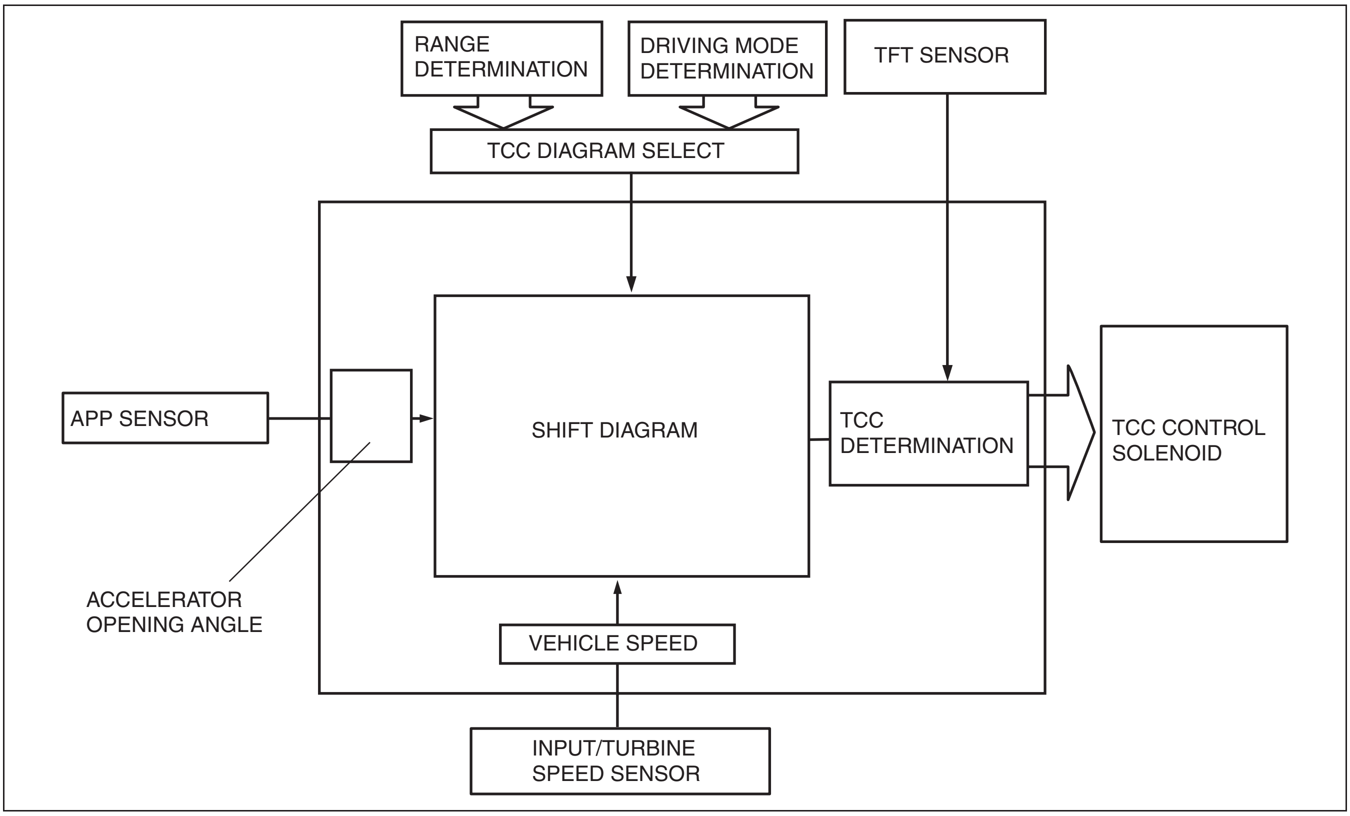
id051703105200

Features

- Based on signals input from sensors, and range and driving mode determination, the PCM selects and determines TCC and sends a signal to the TCC control solenoid to perform TCC.

Structure

System Diagram



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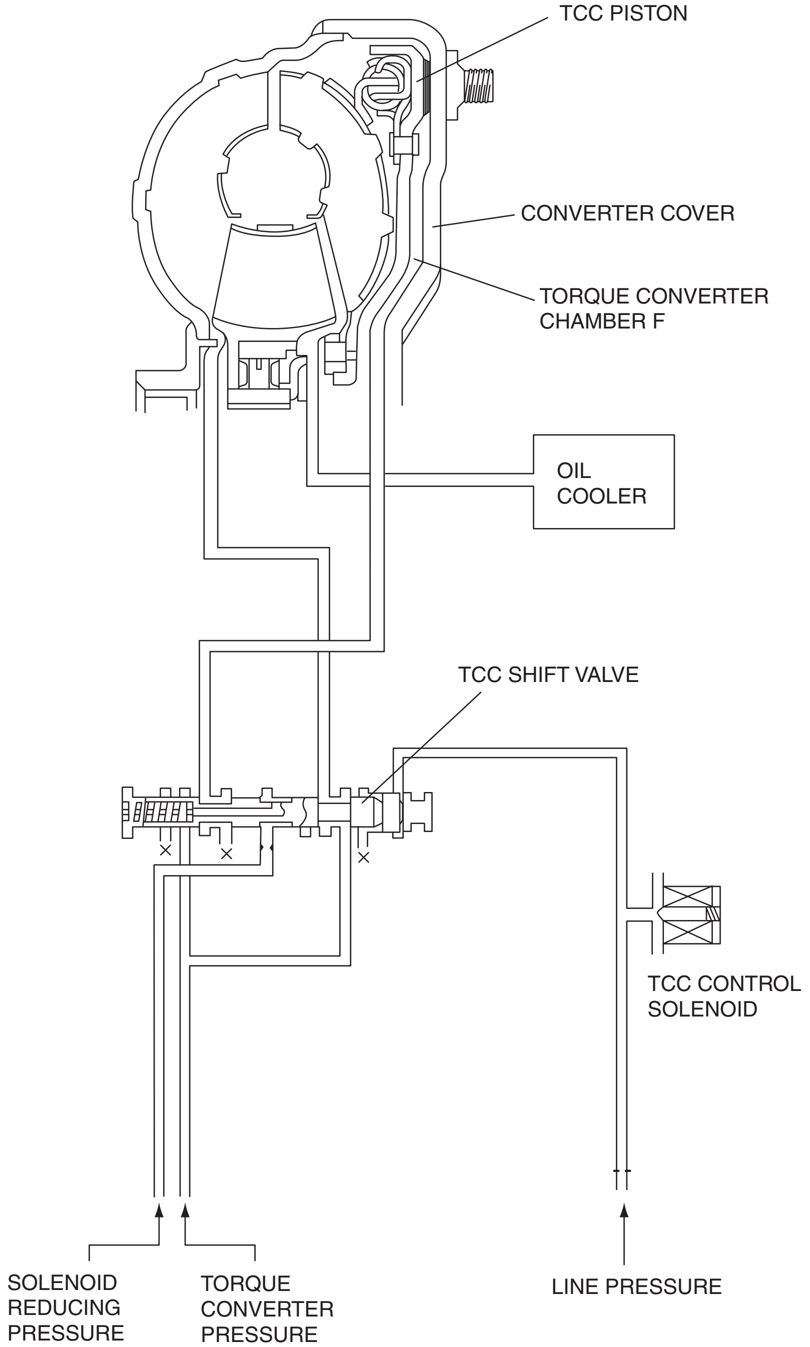
TORQUE CONVERTER CLUTCH (TCC) CONTROL OPERATION[GF4AX-EL]

id051703105100

TCC Engagement

- The PCM determines TCC engagement and sends an ON signal to the TCC control solenoid. The TCC shift valve is then pushed to the right due to spring force with no influence of line pressure. Due to this, the torque converter engagement pressure used in torque converter chamber F is released through the TCC shift valve, and the TCC piston is pressure-fixed against the converter cover effecting a complete TCC condition.



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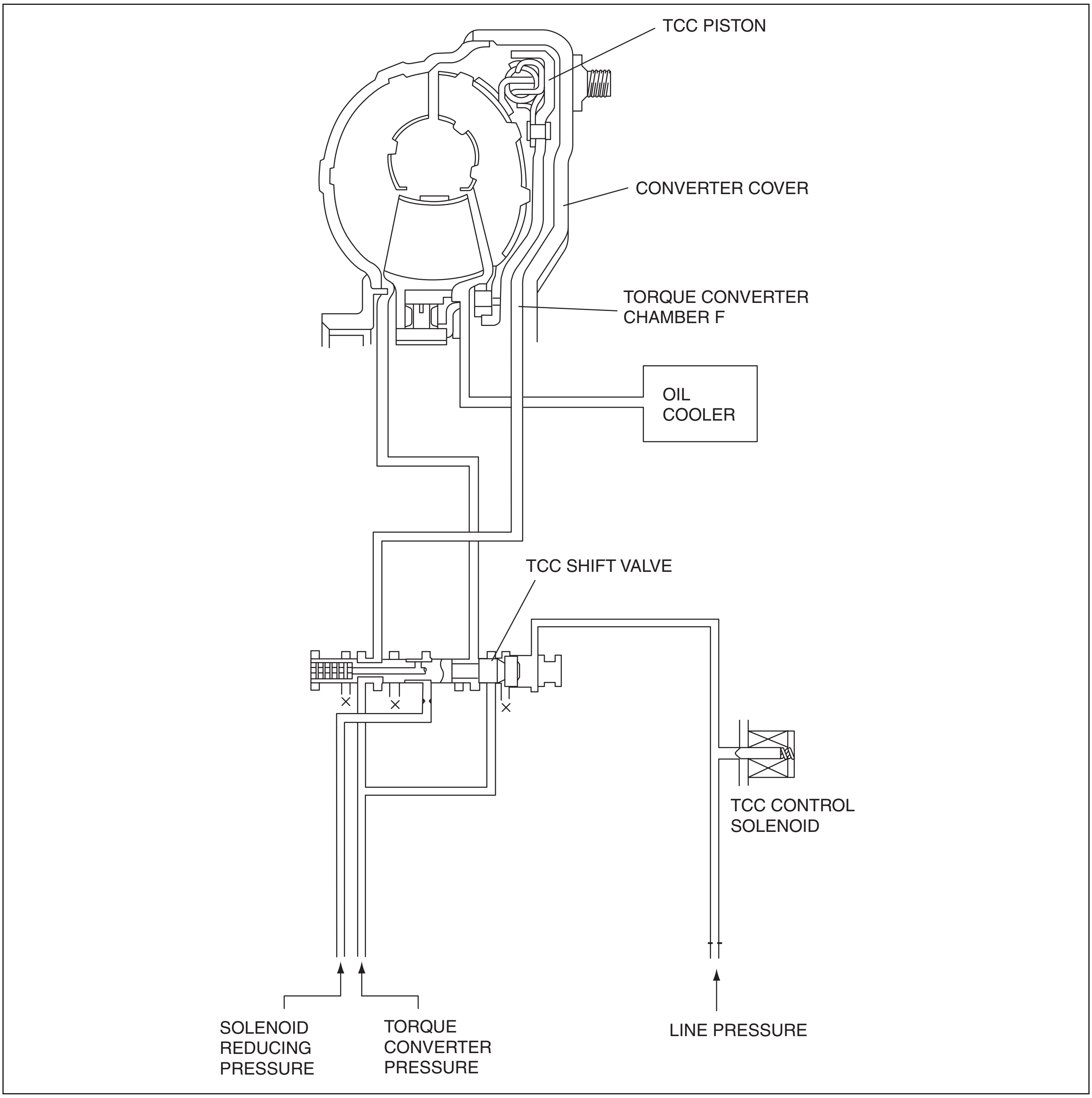
TCC Release

- The PCM determines TCC release and sends an OFF signal to the TCC control solenoid. The TCC shift valve is then moved to the left by line pressure acting on the right side. Due to this, the torque converter engagement pressure is not released, but flows from the torque converter engagement chamber to the torque converter release chamber, the TCC piston disengages from the converter cover and TCC is released.



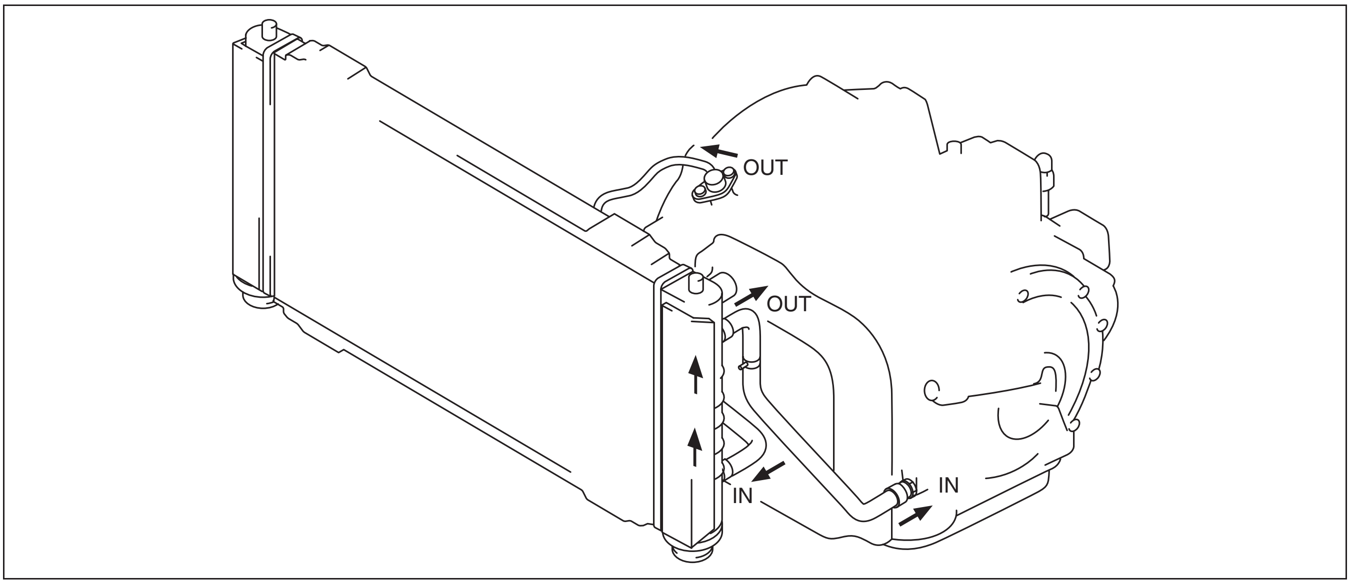
TCC Driving Inhibited Determination

- TCC driving is inhibited according to engine load conditions to improve driveability.
- If any one of the following conditions is met, TCC control is inhibited.
  - — Engine speed is less than set value
  - — Coolant temperature is less than set value
  - — Brake switch is on
  - — Not within TCC range
  - — Accelerator opening angle is more than set value

COOLING SYSTEM OUTLINE[GF4AX-EL]

id051703104000

- A water-cooled oil cooler (built into the radiator side tank) has been adopted.



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05

05-17B AUTOMATIC TRANSAXLE [LA4AX-EL (CD4E)]

AUTOMATIC TRANSAXLE OUTLINE[LA4AX-EL (CD4E)]

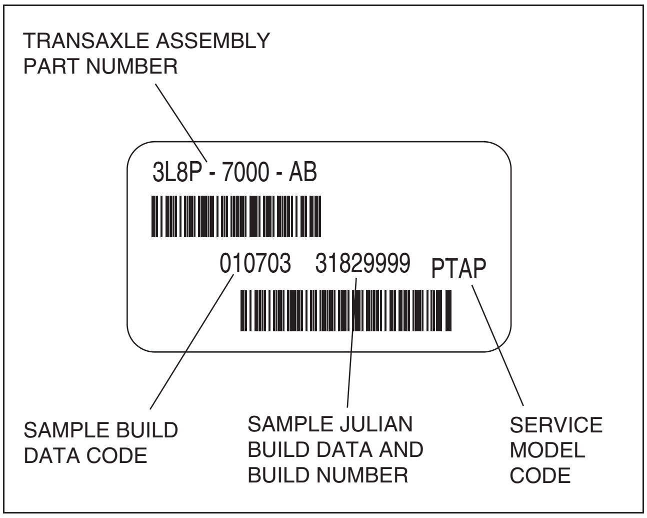
id051708101700

- The automatic transaxle is a four-speed, front wheel drive automatic transaxle with electronic controls for:
  — Electronic pressure control for shift quality
  — Shift scheduling
  — 3-2 shift timing
  — Engine braking using coast clutch
  — TCC control
- The transaxle features a four element torque converter with a TCC and a geartrain that includes:
  — Compound planetary gear set
  — Chain drive
  — Planetary gear set final drive
  — Pinion and side gear differential
- The hydraulic control system of the transaxle has five solenoids that control:
  — Shift feel, through line pressure control
  — Shift scheduling, through shift valve positioning control
  — Modulated application of the TCC
  — Timing of 3-2 shifts
  — Engine braking using coast clutch

IDENTIFICATION TAG OUTLINE[LA4AX-EL (CD4E)]

id051708107100

- When servicing the automatic transaxle, refer to the identification tag located on the case.



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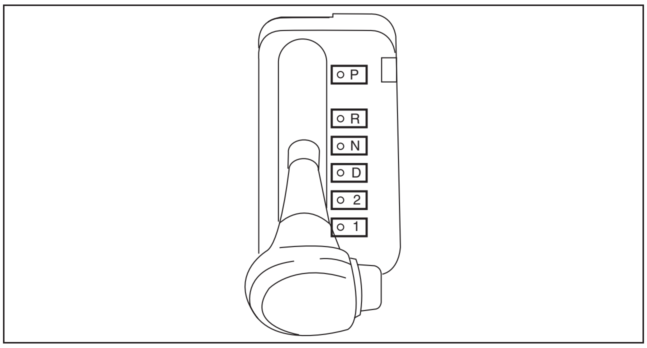
05

RANGE SELECTION[LA4AX-EL (CD4E)]

id051708107500

- The selector lever has six positions: P, R, N, D, 2, 1. In addition, a O/D OFF switch allows the driver to prevent a shift to 4th gear (Overdrive) and uses engine compression to help slow the vehicle (engine braking) in 2nd gear and 3rd gear.



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Park (P position)
- No powerflow is transferred through the transaxle in Park.
- A shift lever connected to a set of cams presses the parking pawl into the park gear on the driven sprocket. This locks the final drive and prevents the vehicle from rolling.
- For safety reasons, always apply the parking brake whenever the vehicle is parked.

Reverse (R position)
- Reverse allows the vehicle to be operated in a rearward direction, at a reduced gear ratio.
- Engine braking is provided in Reverse.

Neutral (N position)
- As in PARK, there is no power transferred through the transaxle in NEUTRAL. However, the final drive is not locked by the parking pawl, so the wheels are free to rotate.
- The vehicle may be started in Neutral.

Drive
- The Drive position provides all automatic shifts (1st gear through 4th gear), apply and release of the TCC, and maximum fuel economy during normal operation.
- Engine braking is provided in the 4th gear.
- 4th gear (Overdrive) may be canceled by depressing the O/D OFF switch that is located on the selector lever. Engine braking is also provided in 2nd gear and 3rd gear with the O/D OFF switch ON.

MANUAL 2
- Manual 2 provides a 2nd gear hold position after automatic or manual up-shift or down-shift.
- When Manual 2 is selected from a stop, the transaxle will start in 2nd gear for maximum traction on slippery surfaces.
- Engine braking is provided in 2nd gear when in the MANUAL 2 position.

MANUAL 1
- Manual 1 provides a 1st gear hold after automatic or manual down-shift.
- The transaxle is prevented from down-shifting into 1st gear above a specific speed approx. 48 km/h {30 mph} to protect the powertrain from over speeding.
- Engine braking is provided in Manual 1 position making it especially useful for descending steep grades.

SHIFT PATTERNS[LA4AX-EL (CD4E)]

id051708107600

Up-shifts
- The PCM has an adaptive learning strategy to electronically control the transaxle.
- The adaptive learning strategy will automatically adjust the shift feel to the driver demands. The first few miles of operation the transaxle may have abrupt shifts, but this is a normal operation and will correct itself.
- If the battery has been disconnected for longer than 20 min the shift tables will reset and need to be relearned.
- Up-shifting is controlled by the PCM. The PCM receives inputs from various engine and vehicle sensors along with driver demands to control shift scheduling, shift feel, and TCC operation.

Down-shifts
- Under certain conditions the transaxle will down-shift automatically to a lower gear range (without moving the selector lever).
- There are three categories of automatic down-shifts:
  — Coastdown
  — Torque demand
  — Forced or kickdown-shifts

Coastdown
- The coastdown down-shift occurs as the name indicates, when the vehicle is coasting down to a stop.

Torque Demand
- The torque demand down-shift occurs automatically during part throttle acceleration when the demand for torque is greater than the engine can provide at that gear ratio.
- The transaxle will disengage the TCC to provide added acceleration, if applied.

Kickdown
- For maximum acceleration, the driver can force a down-shift by pressing the accelerator pedal to the floor.
- A forced down-shift into 2nd gear is possible below 88 km/h {55 mph}.
- Below approx. 40 km/h {25 mph} a forced kickdown to 1st gear will occur.
- For all shift speeds, specifications are subject to variation due to tire size and engine calibration requirements.

TORQUE CONVERTER OUTLINE[LA4AX-EL (CD4E)]

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Outline of Operation
- The torque converter consists of four elements.
- The torque converter consists of an impeller, a turbine, a reactor, and a TCC for increased fuel economy.
- It couples the engine to the turbine shaft component, provides torque multiplication and absorbs engine shock from gear shifting.

Impeller and Cover
- The impeller and cover component drives the impeller blades and pump component.
- The impeller is primarily responsible for driving the turbine with hydraulic fluid by means of centrifugal force.
- The cover provides a mating surface for the TCC piston plate and damper component.

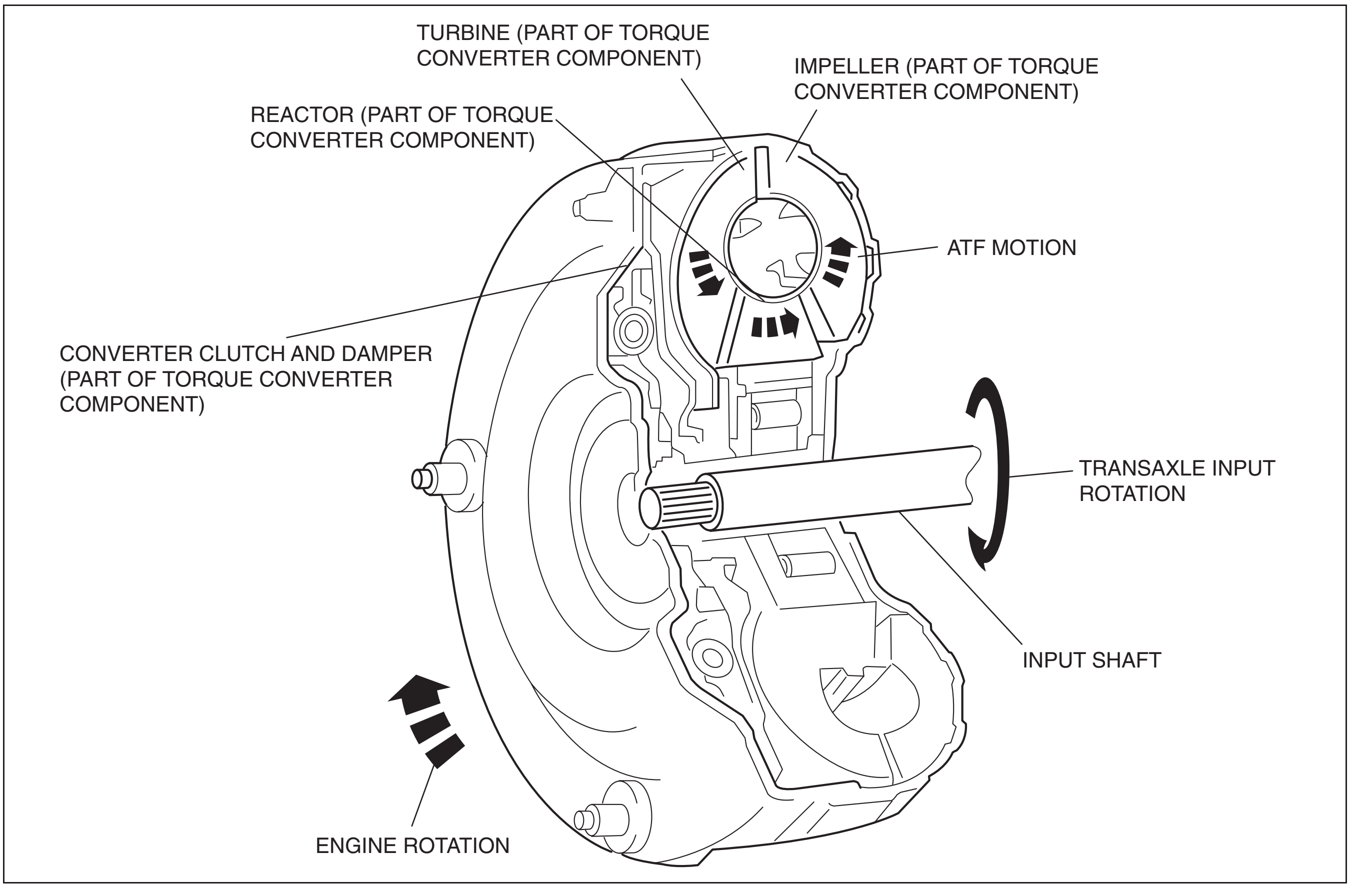
Turbine
- The turbine is driven by centrifugal ATF force from the impeller.
- The turbine transmits input torque to the drive chain and driven sprocket through the turbine shaft.

Reactor
- The reactor redirects ATF flow from the turbine back to the impeller so that ATF rotates in the same direction as the impeller. This action also assists in torque multiplication.

Torque Converter Clutch (TCC)
- The TCC provides a mechanical link or direct drive between the engine crankshaft and turbine shaft when applied.
- The application of TCC is controlled by the PCM.
- Under certain conditions, the PCM sends the appropriate signal to the TCC solenoid which allows fluid pressure within the torque converter to force the TCC piston plate and damper component against the cover creating a mechanical link between the engine and transaxle.

Turbine Shaft

- The turbine shaft connects the torque converter stator with the forward/coast/direct clutch cylinder.
- When applied, the forward/coast/direct clutch cylinder transmits input torque to the reverse/overdrive ring gear component, which also acts as the drive sprocket. This allows input torque to be transmitted from the torque converter to the drive chain and driven sprocket.



GEARTRAIN STRUCTURE[LA4AX-EL (CD4E)]

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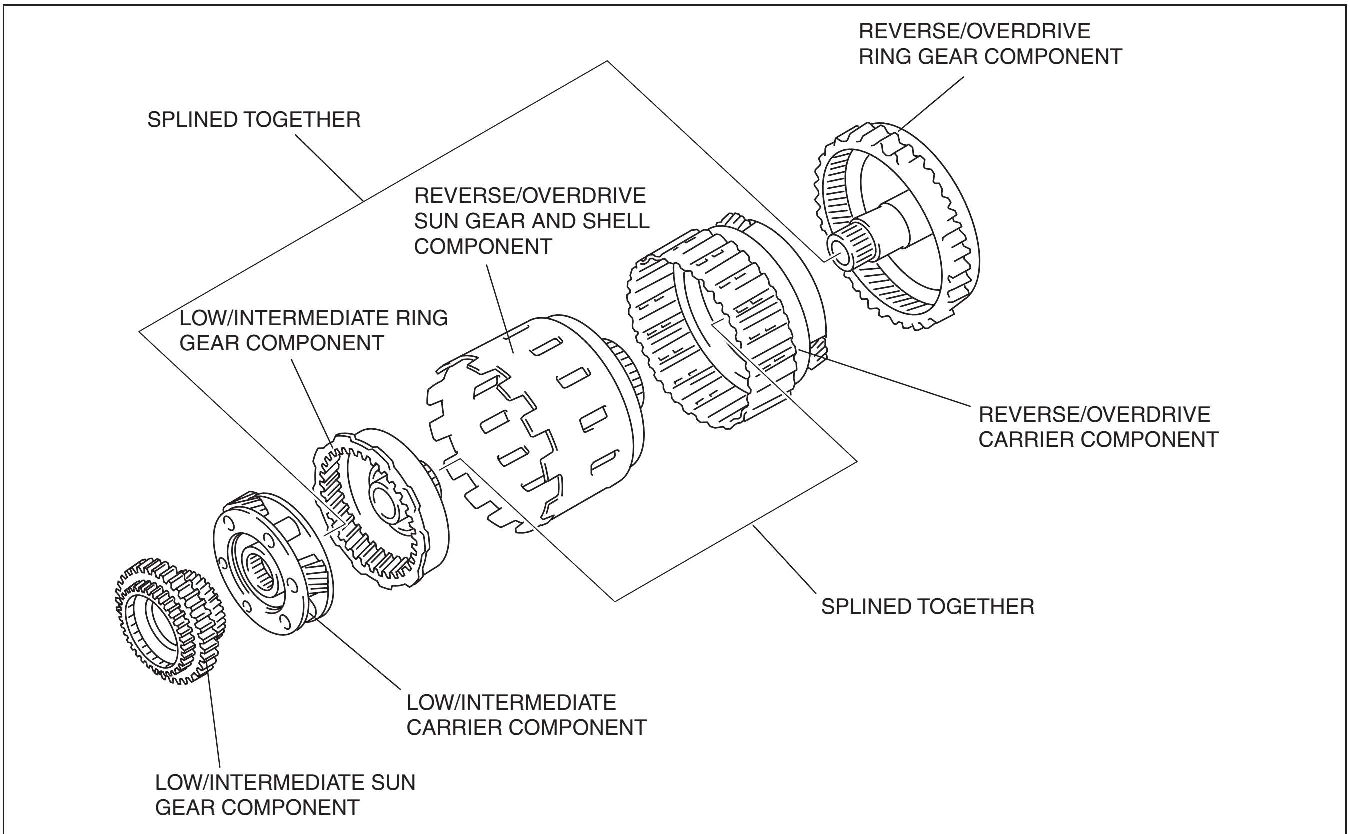
- The geartrain consists of the planetary gear set, apply components, and final drive gear set and differential.

Planetary Gear Set

- The automatic transaxle has two planetary gear set to provide operation in reverse and four forward speeds.
- The gear set are consists of the following components:
  - — Low/intermediate sun gear component
  - — Low/intermediate carrier component
  - — Low/intermediate ring gear component
  - — Reverse/overdrive sun gear and shell component
  - — Reverse/overdrive carrier component
  - — Reverse/overdrive ring gear component



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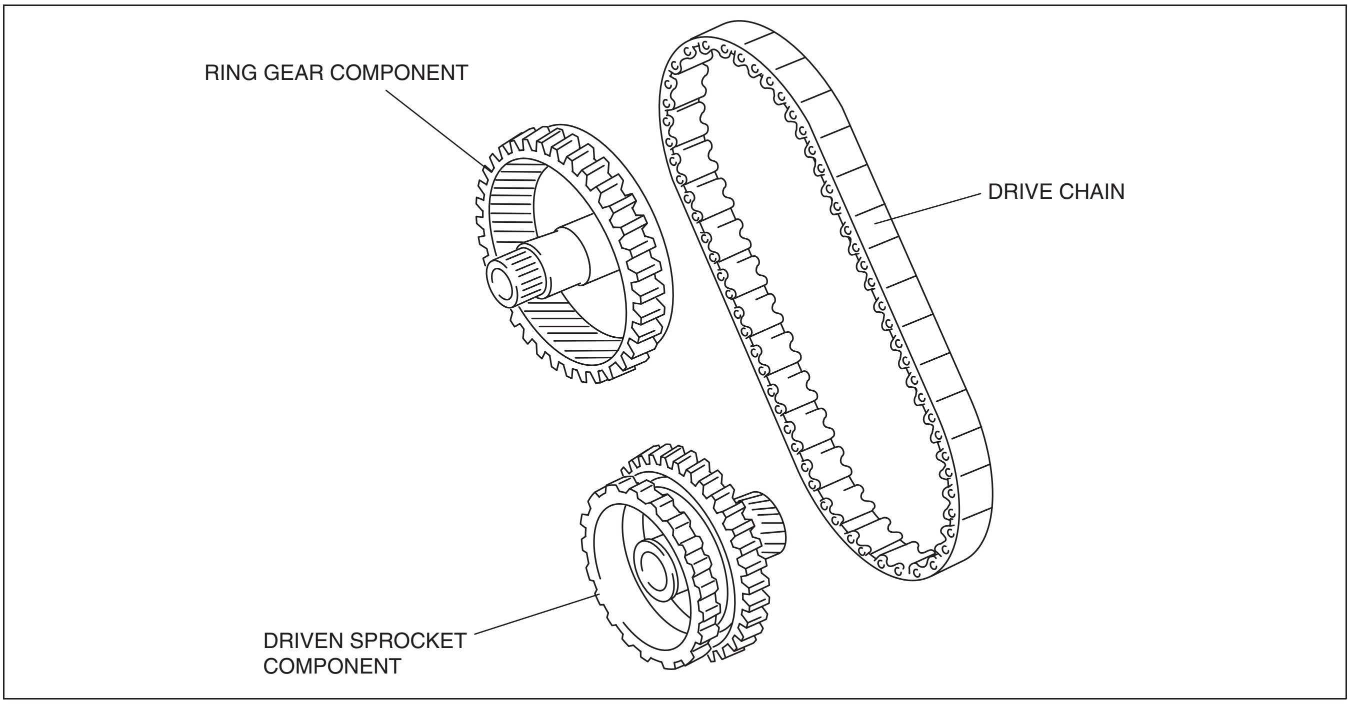
Drive Chain Component

- A chain drive transfers torque from the torque converter turbine to the planetary gear set.
- The chain drive consists of the following components:
  — Reverse/overdrive ring gear component (which acts as a drive sprocket)
  — Driven sprocket
  — Drive chain
- The drive chain connects the reverse/overdrive sun gear with the driven sprocket. The final drive sun gear located on top of the driven sprocket meshes with the final drive gear set.
- The final drive consists of a planetary gear set that transfers and multiplies torque from the planetary gear set to the differential.
- The final drive consists of the following components:
  — Final drive sun gear: is chain driven by the reverse/overdrive ring gear component and transfers torque to the final drive carrier.
  — Final drive carrier: the final drive carrier acts as the driven member and is part of the differential case.
  — Final drive ring gear: is held by the converter housing and is always the held member of the final drive planetary gear set.



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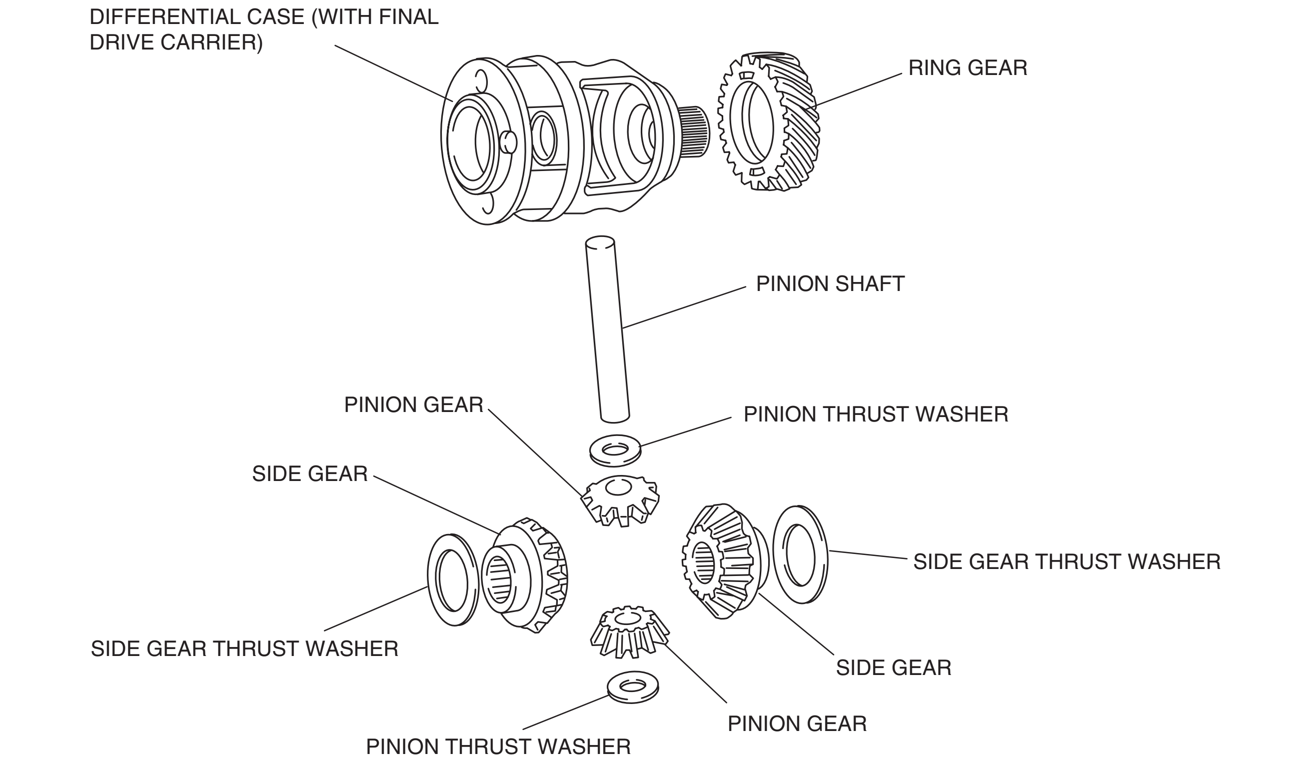
Differential

- The differential component drives the differential pinion gears and the differential side gears which in turn drive the front wheel drive shaft and joints, and provides differential action if driving wheels are turning at different speeds.
- The differential component consists of the following components:
  — Differential case (part of the final drive carrier)
  — Two pinion gears (supported by a pinion shaft)
  — Two side gears (supported by the differential case and drive shafts)



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APPLY COMPONENTS[LA4AX-EL (CD4E)]

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Intermediate and Overdrive Band

- The intermediate and overdrive band component holds the reverse clutch drum component to the transaxle case in 2nd gear and 4th gear. This action causes the reverse/overdrive sun gear and shell component to be held stationary in 2nd gear and 4th gear.

Intermediate and Overdrive Servo

- The intermediate and overdrive servo is the hydraulic actuator which applies the intermediate and overdrive band component.
- Line pressure is applied through the servo apply circuit where it works on one side of the servo piston. This forces the piston to move up the servo bore in the transaxle case, which moves the servo apply rod against one end of the intermediate and overdrive band component.
- Because the other end of the intermediate and overdrive band component is anchored to the transaxle case, the ends of the intermediate and overdrive band component are squeezed around the reverse clutch drum component, holding the reverse clutch drum component stationary.

Forward Clutch

- The forward clutch connects the turbine shaft to the outer race of the forward one-way clutch, which in turn drives the low/intermediate sun gear in all forward gear ranges. However, in 4th gear, the forward clutch transmits no power because the forward one-way clutch is overrunning.
- The forward clutch is a multi-disc clutch and is contained in the forward/coast/direct clutch cylinder component.

Direct Clutch

- The direct clutch connects the turbine shaft to the low/intermediate ring gear component when the vehicle is in 3rd gear and 4th gear.
- It is a multi-disc clutch and is contained in the forward/coast/direct clutch cylinder component.

Reverse Clutch

- The reverse clutch connects the turbine shaft to the reverse/overdrive sun gear and shell component when it is in reverse gear.
- It is a multi-disc clutch, and is contained in the reverse clutch drum component.

Coast Clutch

- The coast clutch is a multi-disc clutch located beneath the forward clutch in the forward/coast/direct clutch cylinder component.
- It connects the low/intermediate sun gear component to the turbine shaft component when the O/D OFF switch is ON with the selector lever in D range or when any manual gear is selected.

Low/Reverse Clutch

- The low/reverse clutch holds the reverse/overdrive carrier component to the transaxle case when the selector lever is shifted into the R position or 1 range.
- The low/reverse clutch is splined to the transaxle case and is a multi-disc clutch.

Forward One-Way Clutch

- The forward one-way clutch is a sprag type, one-way clutch.
- The forward one-way clutch combines with the forward clutch to connect the turbine shaft component to the low/intermediate sun gear component in 1st gear, 2nd gear, and 3rd gear.
- The forward one-way clutch overruns during all coasting operations and is always overrunning in 4th gear.

Low One-Way Clutch

- The low one-way clutch is a mechanical diode type one-way clutch which allows the transaxle case to hold the reverse/overdrive carrier stationary when the transaxle is in 1st gear.
- The low one-way clutch will only hold the reverse/overdrive carrier component during acceleration. When coasting, the low one-way clutch will overrun, disconnecting the final drive from the compound planetary gear set.

Clutch/Band Application Chart (reference)

Gear	2/4 Intermediate/ overdrive Band	Reverse Clutch	Direct Clutch	Forward Clutch	Forward One-way Clutch Drive	Forward One-way Clutch Coast	Coast Clutch	Low/ Reverse Clutch	Low One-way Clutch Drive	Low One-way Clutch Coast
REV		X						X		
1GR				X	X	OR			X	OR
2GR	X			X	X	OR			OR	OR
3GR			X	X	X	OR			OR	OR
4GR	X		X	X	OR	OR			OR	OR
M-3GR			X	X	X		X		OR	OR
M-2GR	X			X	X		X		OR	OR
M-1GR				X	X		X	X	X	

X : Transmits torque

OR: Overrunning

HYDRAULIC SYSTEM[LA4AX-EL (CD4E)]

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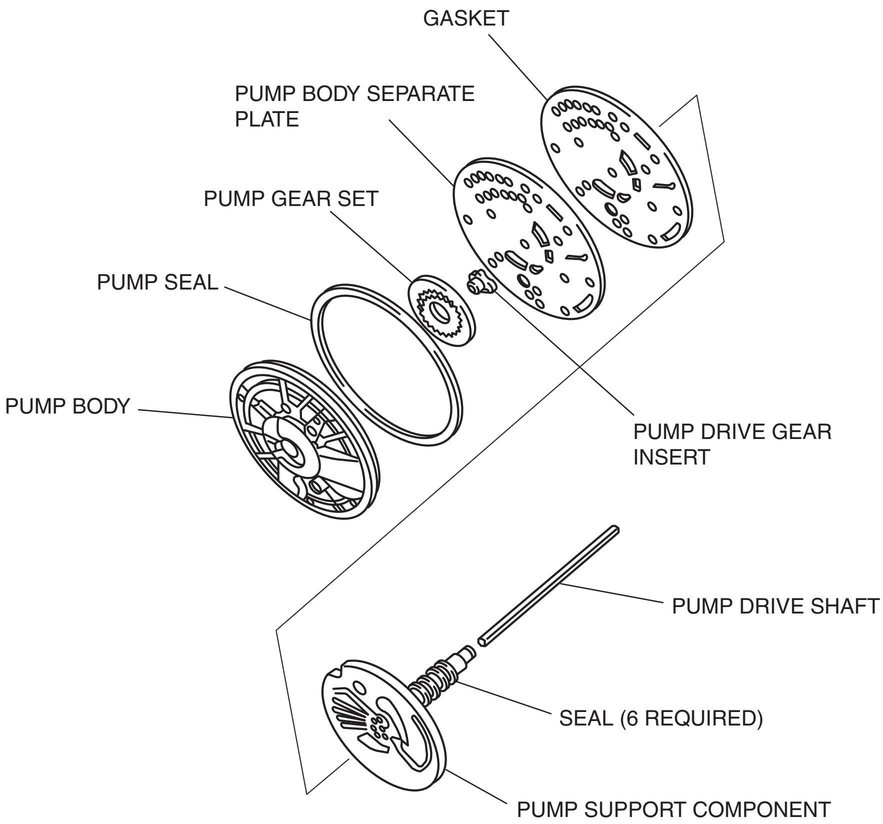
Structure

- The hydraulic system uses ATF to cool, lubricate, and provide hydraulic pressure to the hydraulic circuits within the transaxle.



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Oil Pump

- The pump provides the volume of ATF required to charge the torque converter, main control valve body, cooling system, lubrication system, and hydraulic apply devices.
- The transaxle uses a positive displacement gear and crescent-type pump which is shaft-driven by the torque converter.

Fluid Level and Filter

- ATF from the sump area (formed by the transaxle case and converter housing) flows through a filter to the pump.
- The filter has a recirculation port connected to the main control area of the case and receives ATF from the main regulator drain port. This provides ATF under pressure to aid the pump in higher efficiency operation.
- A thermostatic fluid control valve prevents foaming of ATF by maintaining a sump level below the rotating components.
- The two-piece chain drive cover prevents foaming by not allowing the chain to rotate in the ATF.
- A magnet on the underside of the chain cover collects unwanted magnetic material.

Main Control

- The main control houses the hydraulic valves and solenoid valves. These valves direct ATF flow, restrict ATF flow and change ATF pressure.
- The main control receives signals from the solenoid valve body and changes those signals into hydraulic actions. These actions control the operation of the hydraulic clutches and intermediate and overdrive band component, and supply lubrication to the transaxle.

Low/Reverse Accumulator

- The low/reverse accumulator cushions the application of the low/reverse clutch when the transaxle is shifted to either 1st gear or reverse gears.

2-4 Accumulator

- The 2-4 accumulator cushions the shift feel during intermediate and overdrive band applications.

Forward Accumulator

- The forward accumulator cushions when shifting into D, MANUAL 2 or MANUAL 1 range.

ELECTRONIC CONTROL SYSTEM[LA4AX-EL (CD4E)]

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- Shift timing, shift feel (line pressure) and TCC control in the automatic transaxle are controlled electronically by the PCM and its input/output network.
- The transaxle control is separate from the engine control strategy in the PCM, although some of the input signals are shared.
- Some input signals come from the engine-related sensors, MAF sensor, ECT sensor to give the PCM an idea of the load and climate in which the engine is operating under. Some other inputs are based on driver inputs, such as accelerator pedal position which is relayed to the PCM by the TP sensor. Still other inputs are provided by the transaxle itself, from sensors such as the TR switch (controlled by the placement of the selector lever) and the TFT sensor.
- Using all of these input signals, the PCM can determine when the time and conditions are right for a shift or TCC application. The PCM can also determine the line pressure needed to optimize shift feel. To accomplish these functions, the PCM controls five electronic solenoids, two on/off solenoids for shifting, one PWM solenoid for TCC control, an EPC solenoid for line pressure control, and a 3-2 T/CCS to control the release of the coast clutch and the coordinated release of the direct clutch and the apply of the low and intermediate band, during a 3-2 down-shift.

PCM

- The operation of the transaxle is controlled by the PCM. Many input sensors provide information to the PCM. The PCM sends the signals to the solenoids to control the transaxle.
- The PCM sends the signals to the solenoid valve body component (which is installed on the main control component) through the wiring harness to control the transaxle.

A/C Cycling Switch

- The A/C cycling switch is located on the suction accumulator/drier.
- When the A/C cycling switch contact closes, the PCM receives a signal voltage from the A/C cycling switch to indicate that the magnet clutch is engaged.
- The PCM uses the A/C cycling switch signal to adjust line pressure to compensate for the additional engine load.

Brake Switch

- The brake switch signals the PCM when the brakes are applied.
- The brake switch is closed when the brakes are depressed and open when they are released.
- The brake switch will also disengage TCC when the brakes are applied.

ECT Sensor

- The ECT detects the temperature of the engine coolant and supplies the information to the PCM.
- The PCM uses the ECT sensor to control TCC operation.

Electronic Ignition (EI) System

- The EI system consists of the PCM, a CKP sensor, and one multi-tower ignition coil.
- The CKP sensor sends a CKP signal to the PCM. The PCM then sends the appropriate ignition signal to the ignition coil. The PCM uses this signal in the transaxle shift strategy, as well as TCC control and line pressure control.
- Wide open throttle (WOT) shift control is also affected by the EI system input.

MAF Sensor

- The MAF sensor directly measures the mass of the air flowing into the engine.
- The MAF sensor output is a D.C. (analog) signal ranging from 0.5—5.0 V used by the PCM to calculate the injector pulse width for air/fuel ratio.
- For transaxle strategies, the MAF sensor is used for EPC, shift and TCC scheduling.

O/D OFF Switch

- The O/D OFF switch is a momentary contact switch.
- When the O/D OFF switch is pressed, a signal is sent to the PCM. The PCM energizes the O/D OFF indicator light and engages or disengages 4th gear operation and provides coast braking in 2nd gear and 3rd gear.

O/D OFF Indicator Light

- The O/D OFF indicator light is located in the instrument cluster and is labeled O/D OFF.
- The O/D OFF switch controls the on/off operation of the O/D OFF indicator light.
- When the driver initially presses the O/D OFF switch, the O/D OFF indicator light turns ON to indicate that transaxle operation in 4th gear is disabled. When the driver presses the O/D OFF switch again, the O/D OFF indicator light turns off.

TP Sensor
- The TP sensor is a potentiometer mounted on the throttle body.
- The TP sensor detects the position of the throttle plate and sends this information to the PCM as a varying voltage signal.
- If a fault occurs in the TP sensor circuit, the PCM will recognize that the TP sensor signal is out of specification. The PCM will then operate the transaxle at a high EPC pressure to prevent transaxle damage. The PCM also uses this signal for shift scheduling, EPC and TCC control.

Transaxle Fluid Temperature (TFT) Sensor
- The TFT sensor is located on the solenoid valve body. It is a temperature-sensitive device called a thermistor.
- The resistance value of the TFT sensor will vary with ATF temperature.
- The PCM monitors the voltage across the TFT sensor to determine the temperature of the ATF. The PCM uses this signal to determine shift scheduling and to control line pressure for cold and hot temperature operation. The PCM also inhibits TCC operation at low transaxle temperature and adjusts EPC pressures.

Transaxle Range (TR) Switch
- The TR switch incorporates a series of step down resistors which act as a voltage divider.
- The PCM monitors this voltage which corresponds to the position of the selector lever (P, R, N, D, 2, 1) to determine desired gear and EPC pressure.
- The TR switch is located on the top of the transaxle, and also contains the neutral/start and back-up light circuits.

Turbine Shaft Speed (TSS) Sensor
- The TSS sensor is a magnetic pick-up that sends a signal to the PCM that indicates turbine shaft input speed.
- The TSS sensor provides the TSS information for TCC control strategy. Also used in determining EPC pressure setting during shifts.

Output Shaft Speed (OSS) Sensor
- The OSS sensor is a magnetic pick-up which detects the park gear teeth rotation and sends a signal to the PCM as an indicator of the transaxle output shaft speed.
- The OSS signal is processed by the PCM for shift scheduling and inputs to other control modules such as: Electronic Speedometer, Trip Computer, Speed Control, Adaptive Damping, Auxiliary Warning and Radio CD.

Solenoid Valve Body Component
- The solenoid valve body component contains the TFT sensor, as well as five PCM controlled output devices:
  — EPC solenoid
  — SSA
  — SSB
  — 3-2 T/CCS
  — TCC solenoid
- The connector from the solenoid valve body component is located on top of the transaxle case, where connected to the PCM wiring harness.
- If the any components of the solenoid valve body component need replacement, replace the solenoid valve body as a single unit.

Solenoid Operation Chart

Position/range	PCM Commanded Gear	SSA	SSB	3-2T/CCS	TCC
P/N	—	OFF	ON	ON	OFF
R	—	OFF	ON/OFF	ON	*1
D (Normal mode)	1	ON	ON	ON	*1
	2	OFF	ON	ON	*2
	3	OFF	OFF	ON	*2
	4	ON	OFF	ON	*2
D (O/D OFF mode)	1	ON	ON	ON	*1
	2	OFF	ON	OFF	*2
	3	OFF	OFF	OFF	*2
2	2	OFF	ON	OFF	*2
2[*3]	3	OFF	OFF	OFF	*2
1	1	ON	ON	OFF	*1

Position/range	PCM Commanded Gear	SSA	SSB	3-2T/CCS	TCC
1[*2]	2	OFF	ON	OFF	[*2]
1[*3]	3	OFF	OFF	OFF	[*2]

[*1] : Not allowed by hydraulics

[*2] : PCM commanded

[*3] : When a manual pull-in occurs above a calibrated speed, the transaxle will not down-shift from the higher gear until the vehicle speed drops below this calibrated speed

Electronic Pressure Control (EPC) Solenoid

- The EPC solenoid is a VFS solenoid.
- The VFS solenoid is an electro-hydraulic actuator combining a solenoid and a regulating valve. This solenoid provides EPC which regulates LP and LM pressure. This is controlled by producing a resisting pressure to the main regulator and LM circuits. The LP and LM pressures control the clutch application pressures.

Torque Converter Clutch (TCC) Solenoid

- The TCC solenoid is a PWM style solenoid.
- The PWM solenoid is used to control the apply and release of the bypass clutch in the torque converter.
- By modulating the pulse width of the TCC solenoid the pressure in the S4 circuit varies modulating the apply and release of the bypass clutch in the torque converter.

3-2 Timing/Coast Clutch Solenoid (3-2 T/CCS)

- The 3-2 T/CCS is a VFS solenoid.
- The VFS solenoid is an electro-hydraulic actuator combining a solenoid and a regulating valve. It supplies pressure to the S3 circuit to control the release of the direct clutch and to apply the intermediate and overdrive band during a 3-2 down-shift. This solenoid also regulates the pressure in the S3 circuit to control the application and release of the coast clutch.

Shift Solenoid Component (SSA, SSB)

- Shift solenoids A and B provide gear selection of 1st gear through 4th gear by providing on/off pressure control to the shift valves.

COOLING SYSTEM CONSTRUCTION[LA4AX-EL (CD4E)]

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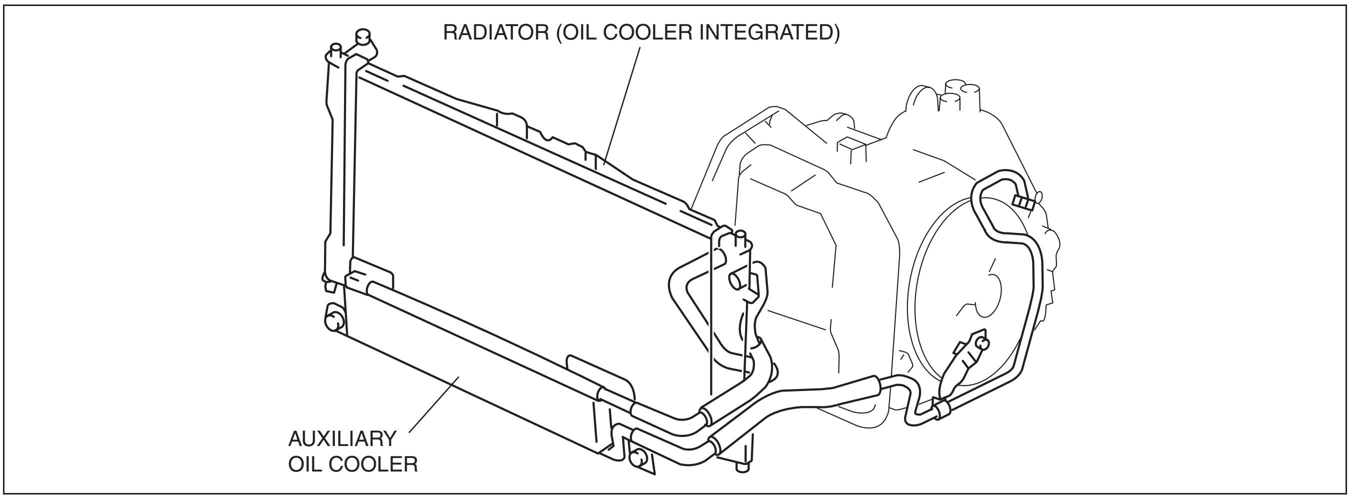
- All vehicles are equipped with an oil cooler integrated with the radiator which cannot be repaired separately.
- The integrated oil cooler transfers heat from the ATF to the engine coolant.
- The auxiliary oil cooler transfers heat from the ATF to the outside air.



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05-18 AUTOMATIC TRANSAXLE SHIFT MECHANISM

AUTOMATIC TRANSAXLE SHIFT MECHANISM OUTLINE

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- A floor-type shift mechanism has been adopted.
- To prevent inadvertent selection of the wrong gear, a key interlock device and a shift-lock device have been adopted.
- A shift-lock release lever, which allows release of the shift-lock by hand, has been adopted.

AUTOMATIC TRANSAXLE SHIFT MECHANISM STRUCTURAL VIEW

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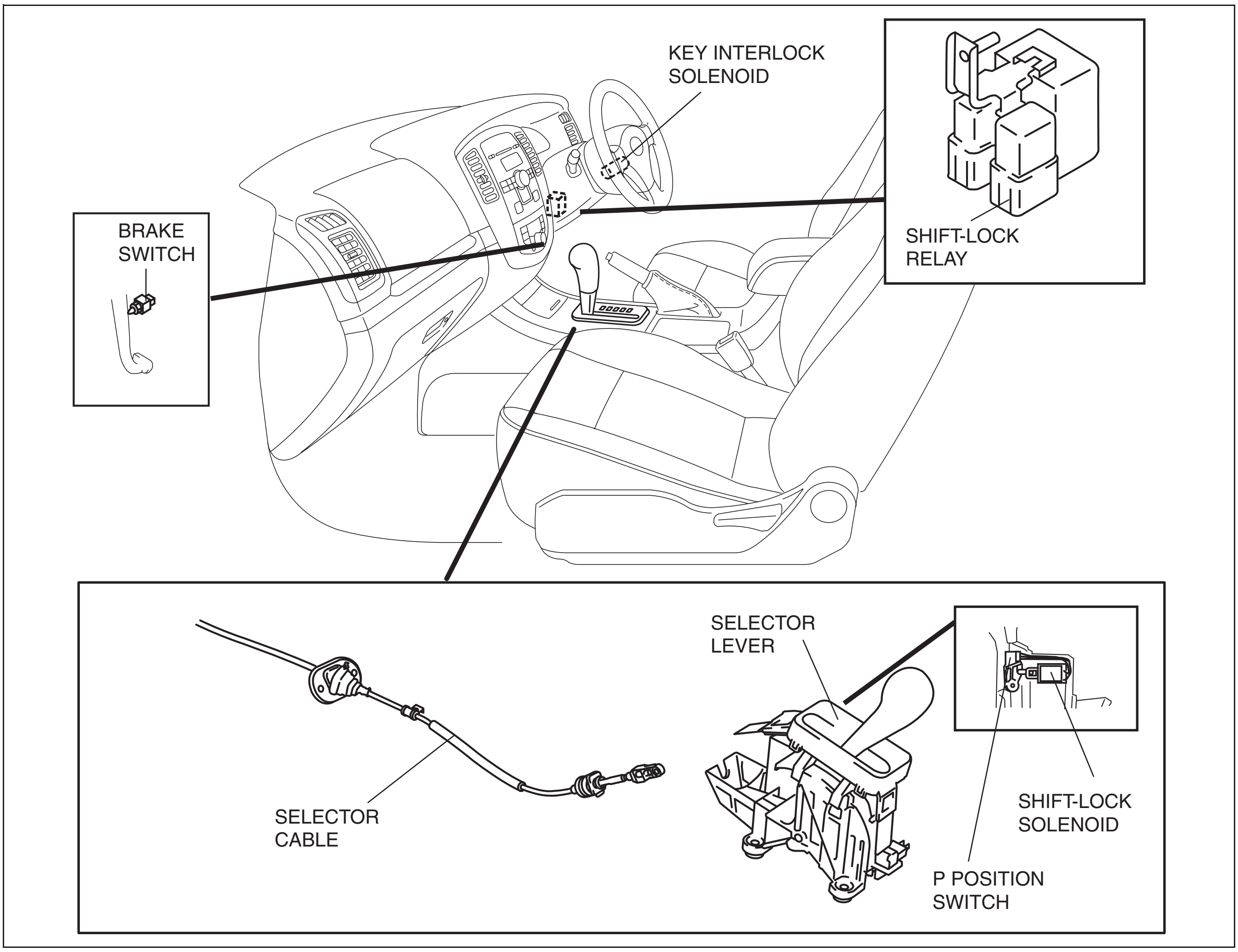

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05

SELECTOR LEVER OUTLINE

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- A floor-type shift mechanism has been adopted.

SELECTOR LEVER STRUCTURE

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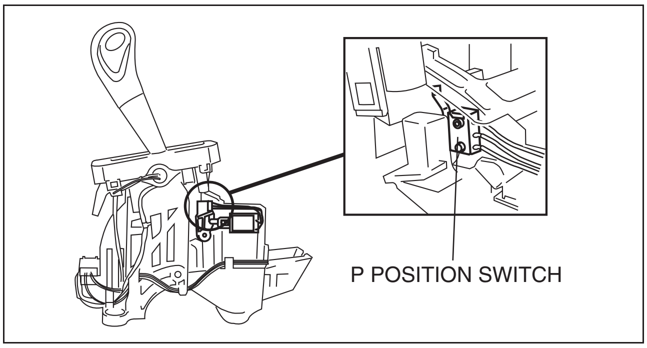
P Position Switch

Outline

- The P position switch detects whether or not the selector lever is in P position. When detected, the switch sends a “Not P position” signal to the key interlock solenoid.



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Operation

- The P position switch is an on/off type switch that turns on when the selector lever is any position besides the P position.

SHIFT-LOCK SYSTEM OUTLINE

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- The shift-lock system prevents the selector lever from being shifted out of Park unless the brake pedal is depressed.
- The shift-lock can be manually released by operating the shift-lock button.

SHIFT-LOCK SYSTEM STRUCTURE

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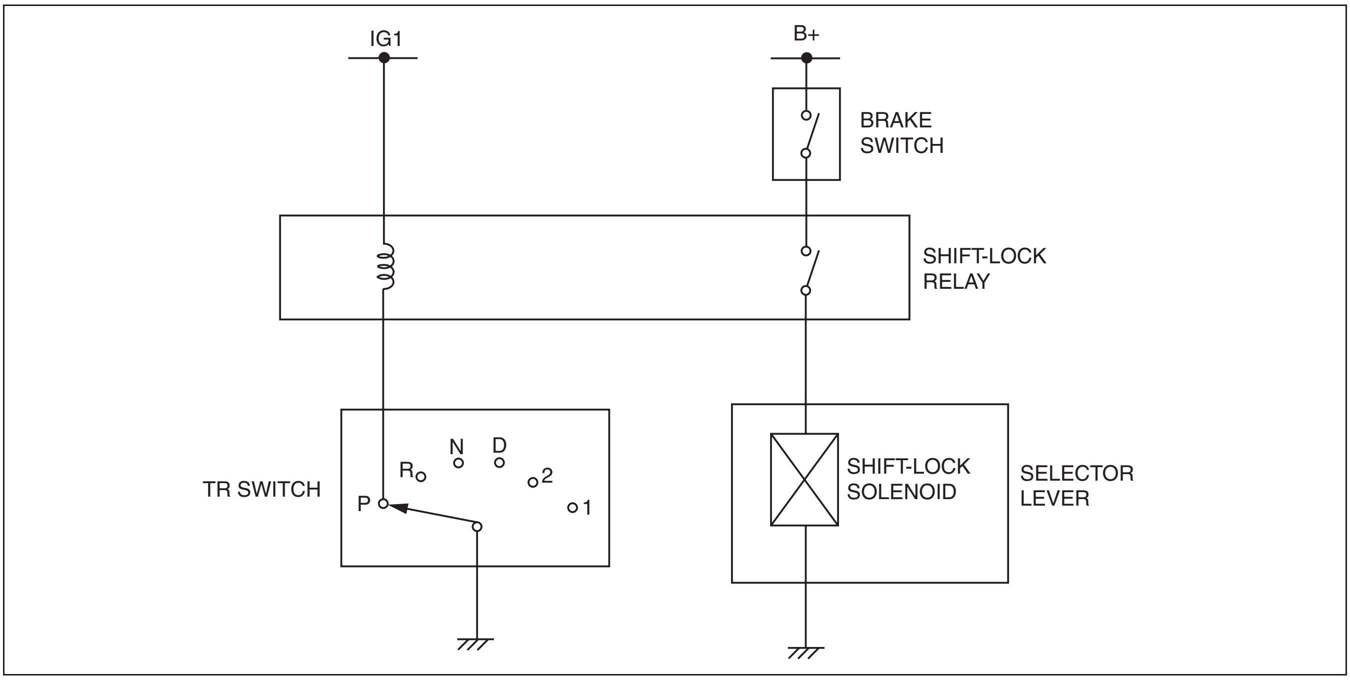
Structure

- The shift-lock system consists of the shift-lock relay, brake switch, TR switch, shift-lock solenoid, and selector lever component.



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Operation

- The shift-lock system prevents the selector lever from being moved out of P position. The ignition switch must be in the ON position and the brake pedal depressed to move the gear selector lever out of the P position. The brake pedal position is detected by the brake switch.
- The shift-lock release button will mechanically bypass the electronic portion of the shift-lock system and allow the selector lever to be moved out of P position. The shift-lock release button is part of the selector lever component.

KEY INTERLOCK SYSTEM OUTLINE

id051800100500

- The key interlock system allows the key to be removed only when the selector lever is in Park.

KEY INTERLOCK SYSTEM STRUCTURE

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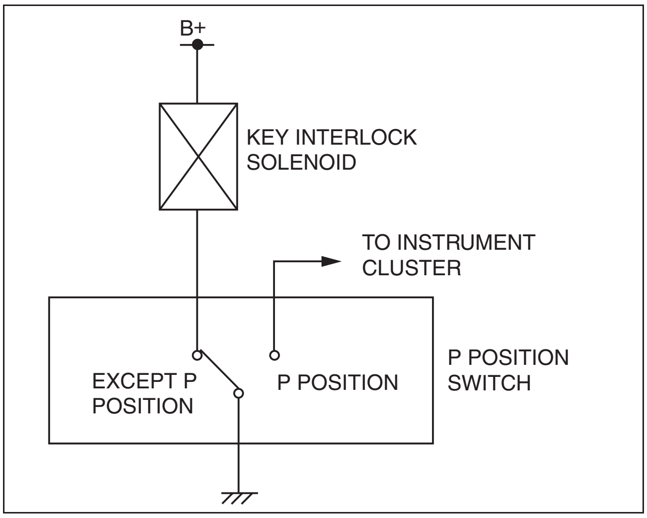
Structure

- The key interlock system consists of the P position switch (built-in selector lever component), key interlock solenoid, and steering lock.



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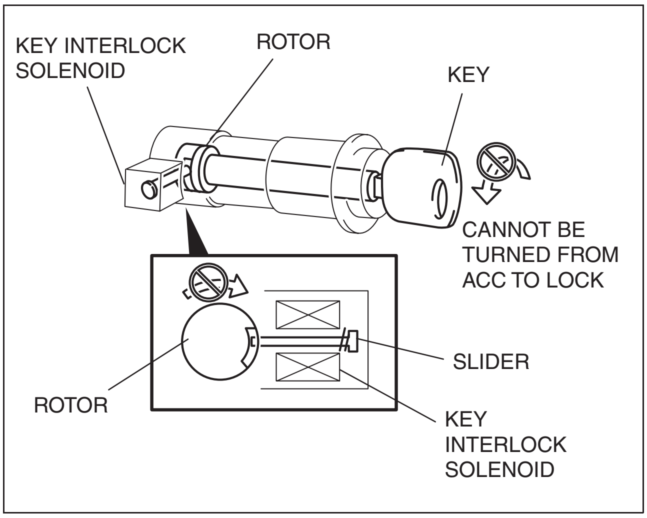
Operation

Position other than Park (key interlock operates)

- The key interlock solenoid is energized when the selector lever is any position other than the P position. When the key interlock solenoid is energized, the solenoid slider prevents the ignition switch rotor from rotating. Due to this, the key cannot be turned to the LOCK position.



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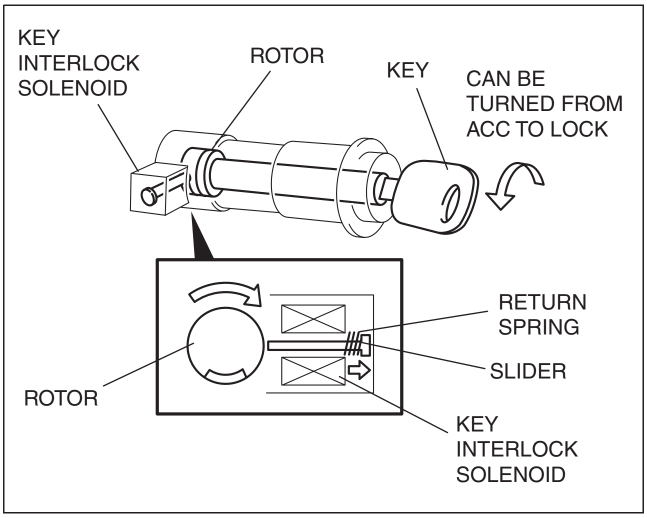
Park position (key interlock does not operate)

- The key interlock solenoid is not energized when the selector lever is in the P position. The key interlock solenoid slider is pulled by the return spring, releasing the rotor in the ignition switch. Due to this, the key can be turned to the LOCK position.



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STEERING

06 SECTION

06-00 OUTLINE

STEERING ABBREVIATIONS

id060000100400

ATF	Automatic Transaxle Fluid

STEERING OUTLINE

id060000100500

The power steering system is a rack and pinion system consisting of the following parts:
- Reserve tank
- Power steering oil pump
- Steering gear and linkage
- Cooling pipe
- Fluid line
- Steering column and shaft

STEERING SPECIFICATIONS

id060000100300

Item			Specification
Steering wheel	Outer diameter (mm {in})		372 {14.6}
	Lock to lock (Turns)		215/70R16 tire: 2.6 235/70R16 tire: 2.5
Steering gear	Type		Rack and pinion design
	Rack stroke (mm {in})		215/70R16 tire: 73.6 {2.90}×2 235/70R16 tire: 71.0 {2.80}×2
Steering column and shaft	Shaft type		Collapsible design
	Coupling type		Cross-shaped joint design
	Tilt amount (mm {in})		40 {1.6}
Power steering	Power assist system		Engine speed sensing
	Fluid specification	Type	ATF M-III or equivalent (e.g. Dexron®II)
		Fluid capacity* (approximate quantity) (L {US qt, Imp qt})	1.0 {1.1, 0.9}

* : When fluid reservoir tank is at maximum volume.

06-14 POWER STEERING

POWER STEERING OUTLINE

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- An engine speed-sensing power steering system has been adopted.

POWER STEERING STRUCTURAL VIEW

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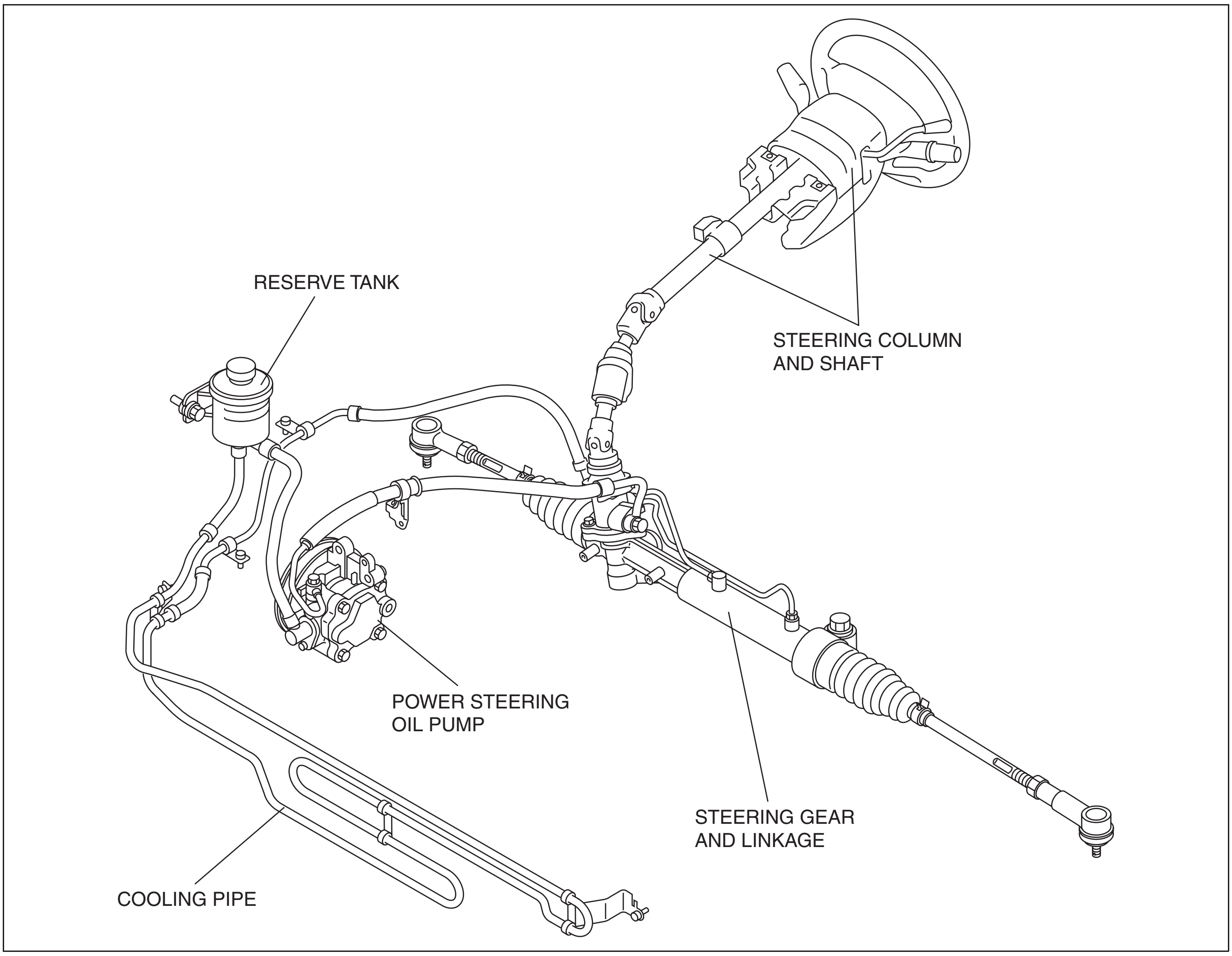
L3



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POWER STEERING OIL PUMP CONSTRUCTION

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- A size and weight reduced, vaned power steering oil pump has been adopted.

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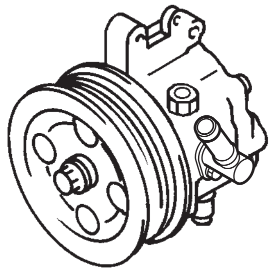

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HEATER, VENTILATION & AIR CONDITIONING (HVAC)

07 SECTION

07-00 OUTLINE

HVAC ABBREVIATION

id070000100100

A/C	Air Conditioning
AMB	Ambient
B+	Battery Positive Voltage
CPU	Central Processing Unit
DEF	Defroster
HI	High
IG	Ignition
LCD	Liquid Crystal Display
LO	Low
M	Motor
MAX	Maximum
MOS FET	Metal Oxide Semiconductor Field Effect Transistor
PCM	Powertrain Control Module
REC	Recirculate
SW	Switch

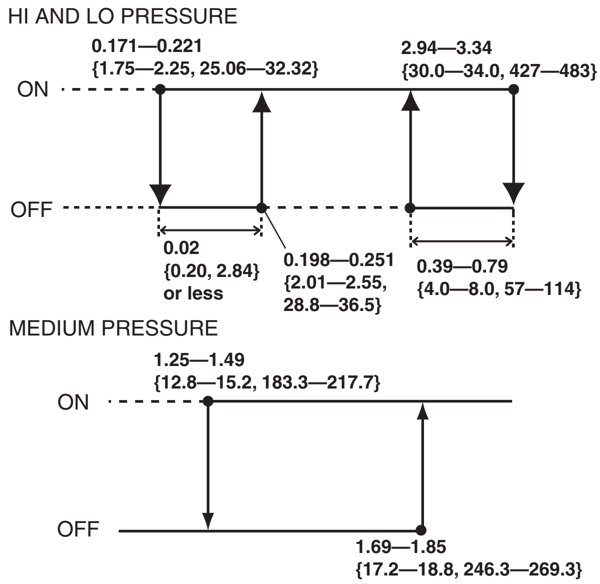
HVAC SPECIFICATIONS [FULL-AUTO AIR CONDITIONER]

id070000104700

Basic System

Item				Specification
Heating capacity			(kW {kcal/h})	4.302 {3,700}
Cooling capacity			(kW {kcal/h})	4.636 {3.987}
Refrigerant	Type			R-134a
	Regular amount (approx. quantity)		(g {oz})	800 {28.2}
A/C compressor	Lube oil	Type		FD45XG
		Sealed volume (approx. quantity)	(ml {cc, fl oz})	186—228 {186—228, 6.29—7.70}
Condenser	Type			Multiflow
	Radiated heat		(kW {kcal/h})	9.133 {7,854}
	Receiver/drier capacity		(ml {cc, fl oz})	240 {240, 8.11}
	Desiccant			Zeolite
Expansion valve	Type			Block type
Evaporator	Type			Double-tank drawn cup
Temperature control				Reheat full air mix type

Control System

Item			Specification
Airflow volume (during heater operation)	Blower motor	(m^3/h)	300
Airflow volume (during air conditioner operation)	Blower motor	(m^3/h)	410
Magnetic clutch clearance		(mm {in})	0.35—0.75 {0.014—0.029}
Fan type	Blower motor		Sirocco fan
Refrigerant pressure switch	Type		Triple-pressure
	Operating pressure	(MPa {kgf/cm², psi})	
Sensor	Solar radiation sensor		Photodiode
	Ambient temperature sensor		Thermistor
	Cabin temperature sensor		
	Evaporator temperature sensor		
	Water temperature sensor		
Actuator	Air intake actuator		Sliding contact type
	Air mix actuator		Potentiometer type
	Airflow mode actuator		

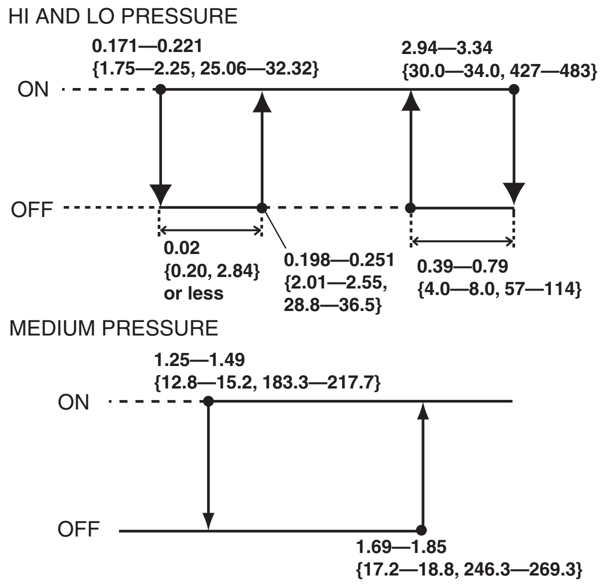
HVAC SPECIFICATIONS [MANUAL AIR CONDITIONER]

id070000104800

Basic System

Item				Specification
Heating capacity			(kW {kcal/h})	4.302 {3,700}
Cooling capacity			(kW {kcal/h})	4.636 {3.987}
Refrigerant	Type			R-134a
	Regular amount (approx. quantity)		(g {oz})	800 {28.2}
A/C compressor	Lube oil	Type		FD45XG
		Sealed volume (approx. quantity)	(ml {cc, fl oz})	186—228 {186—228, 6.29—7.70}
Condenser	Type			Multiflow
	Radiated heat		(kW {kcal/h})	9.133 {7,854}
	Receiver/drier capacity		(ml {cc, fl oz})	240 {240, 8.11}
	Desiccant			Zeolite
Expansion valve	Type			Block type
Evaporator	Type			Double-tank drawn cup
Temperature control				Reheat full air mix type

Control System

Item		Specification
Airflow volume (during heater operation)	Blower motor (m³/h)	300
Airflow volume (during air conditioner operation)	Blower motor (m³/h)	410
Magnetic clutch clearance (mm {in})		0.35—0.75 {0.014—0.029}
Fan type	Blower motor	Sirocco fan
Refrigerant pressure switch	Type	Triple-pressure
	Operating pressure (MPa {kgf/cm², psi})	
Sensor	Evaporator temperature sensor	Thermistor
Vacuum control moter	Defrost	Vacuum control type
	Panel vent	
	Footwell vent	
	Outside air inlet	

07

07-02 ON-BOARD DIAGNOSTIC

ON-BOARD DIAGNOSTIC FUNCTION OUTLINE

id070200100100

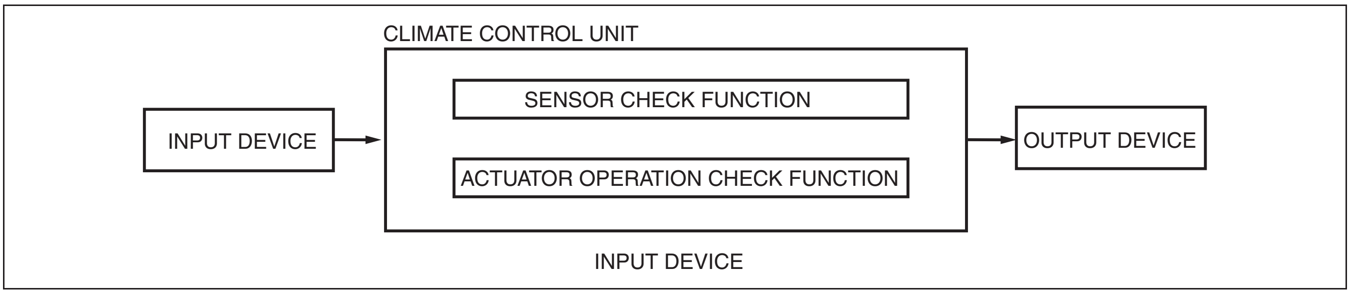
Features

- The on-board diagnostic function consists of a sensor check function, actuator operation check function.

ON-BOARD DIAGNOSTIC FUNCTION BLOCK DIAGRAM

id070200100200

BLOCK DIAGRAM



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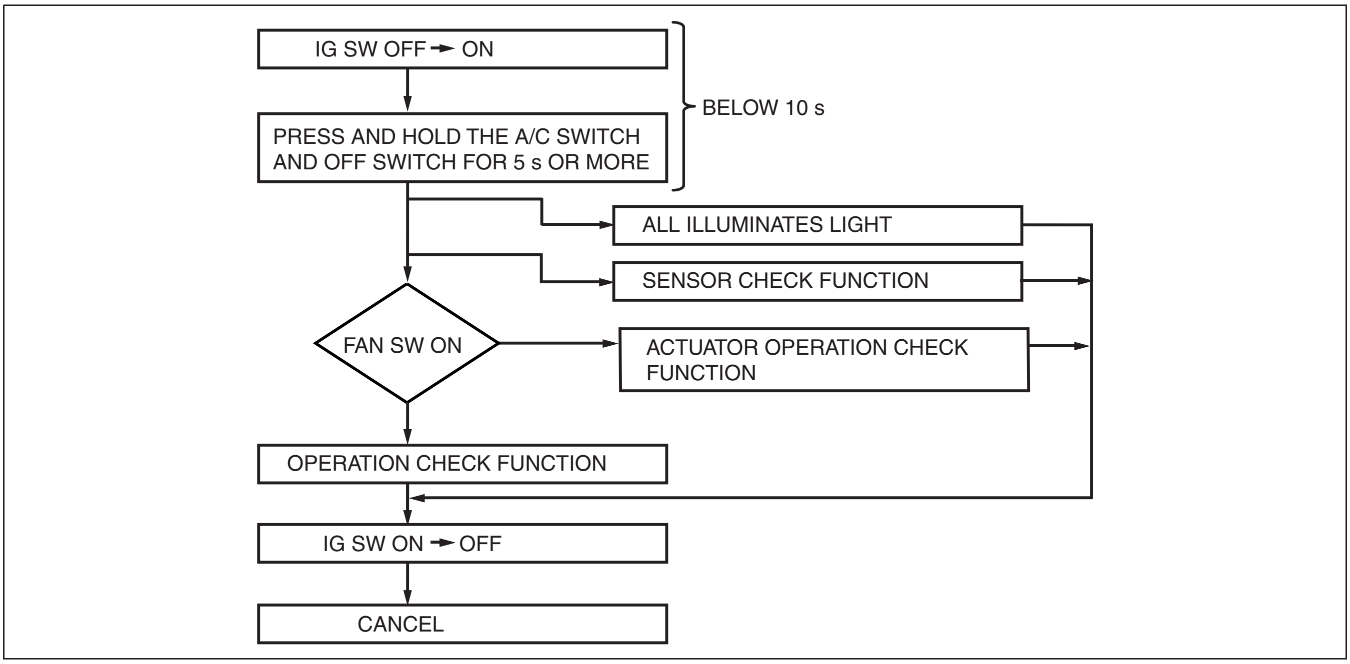
FLOW CHART



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ON-BOARD DIAGNOSTIC FUNCTION

id070200100300

Sensor Check Function

- Detects malfunctions in the evaporator temperature sensor, cabin temperature sensor, water temperature sensor, ambient temperature sensor, solar radiation sensor.
  If a malfunction is detected, DTC displayed on LCD and display blinking.
- If there is no malfunction, display lighting.

INSPECTION ITEM	DTC	LCD DISPLAY	
		NORMAL	MALFUNCTION
All sensor	S1.0	LIGHTING	BLINK
Evaporator temperature sensor	S1.1	LIGHTING	BLINK
Cabin temperature sensor	S1.2	LIGHTING	BLINK
Water temperature sensor	S1.3	LIGHTING	BLINK
Ambient temperature sensor	S1.4	LIGHTING	BLINK
Solar radiation sensor	S1.5	LIGHTING	BLINK

Actuator Operation Check Function

- Detects malfunctions in the airflow mode actuator and the air mix actuator.
  If a malfunction is detected, DTC displayed on LCD and display blinking. If there is no malfunction, the display lighting.

INSPECTION ITEM	DTC	LCD DISPLAY	
		NORMAL	MALFUNCTION
Airflow mode actuator and air mix actuator	S2.0	LIGHTING	BLINK
Air mix actuator (motor lock)	S2.1	LIGHTING	BLINK
Airflow mode actuator (motor lock)	S2.2	LIGHTING	BLINK
Air mix actuator (potentiometer)	S2.3	LIGHTING	BLINK
Airflow mode actuator (potentiometer)	S2.4	LIGHTING	BLINK

Fail-safe Function Table

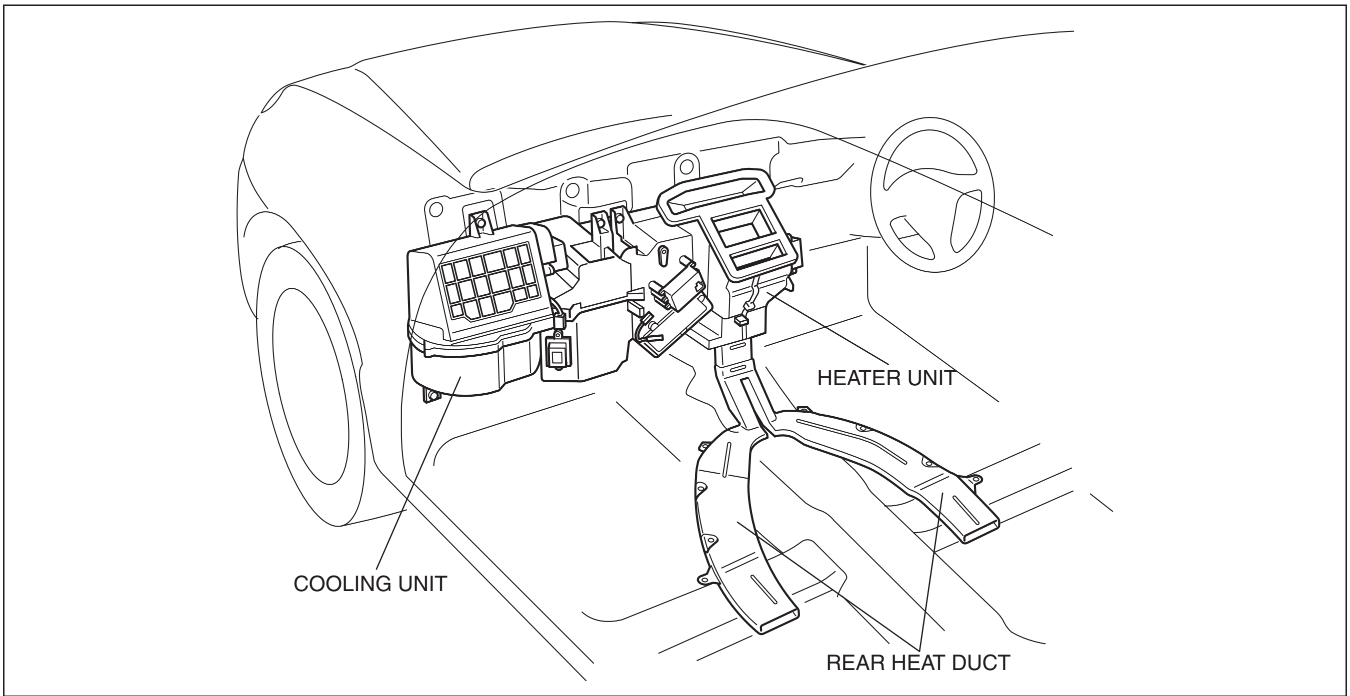
INSPECTION ITEM	CONDITION	MEASURES
Cabin temperature sensor Ambient temperature sensor	Nothing	• The sensor limits the operational voltage from the climate control unit for **approx. 18 s**.
Airflow mode actuator (motor lock)	Detects a malfunction in the actuator operation angle for **approx. 18 s** after the actuator has been operated.	• Stops the airflow mode actuator drive signal at the point a malfunction is determined
Air mix actuator (motor lock)	Detects a malfunction in the actuator operation angle for **approx. 18 s** after the actuator has been operated.	• Stops the air mix actuator drive signal at the point a malfunction is determined
Airflow mode actuator (potentiometer)	**below 0.06 V** or **4.96 V or more**	• Stops the airflow mode actuator drive signal at the point a malfunction is determined
Air mix actuator (potentiometer)	**below 0.06 V** or **4.96 V or more**	• Stops the air mix actuator drive signal at the point a malfunction is determined
Cabin temperature sensor	**below -40 °C {-40 °F}** or **80 °C {176 °F} or more**	• Cabin temperature sensor input value is set at **25 °C {77 °F}**
Ambient temperature sensor	**below -40 °C {-40 °F}** or **80 °C {176 °F} or more**	• Ambient temperature sensor input value is set at **20 °C {68 °F}**
Evaporator temperature sensor	**below -35 °C {-31 °F}** or **60 °C {140 °F} or more**	• Turn off a magnet clutch • Evaporator temperature sensor input value is set at **4.12 V**
Solar radiation sensor	**4.12 V or more**	• Solar radiation sensor input value is set at **4.12 V**
Water temperature sensor	**below -30 °C {-22 °F}** or **110 °C {230 °F} or more**	• Water temperature sensor input value is set at **80 °C {176 °F}**

07-11 BASIC SYSTEM

BASIC SYSTEM STRUCTURAL VIEW

id071100100200

Ventilation System



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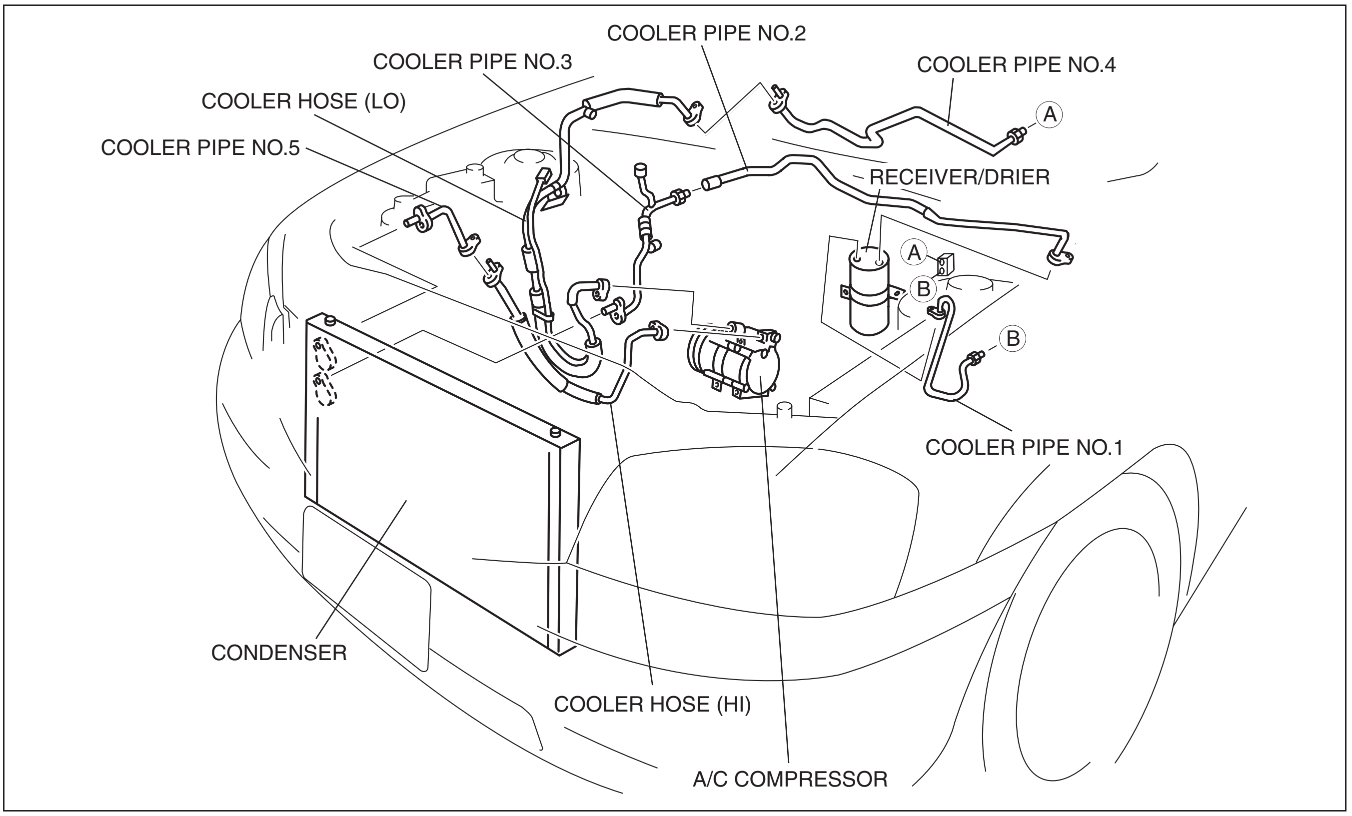
07

Refrigerant Line

L3



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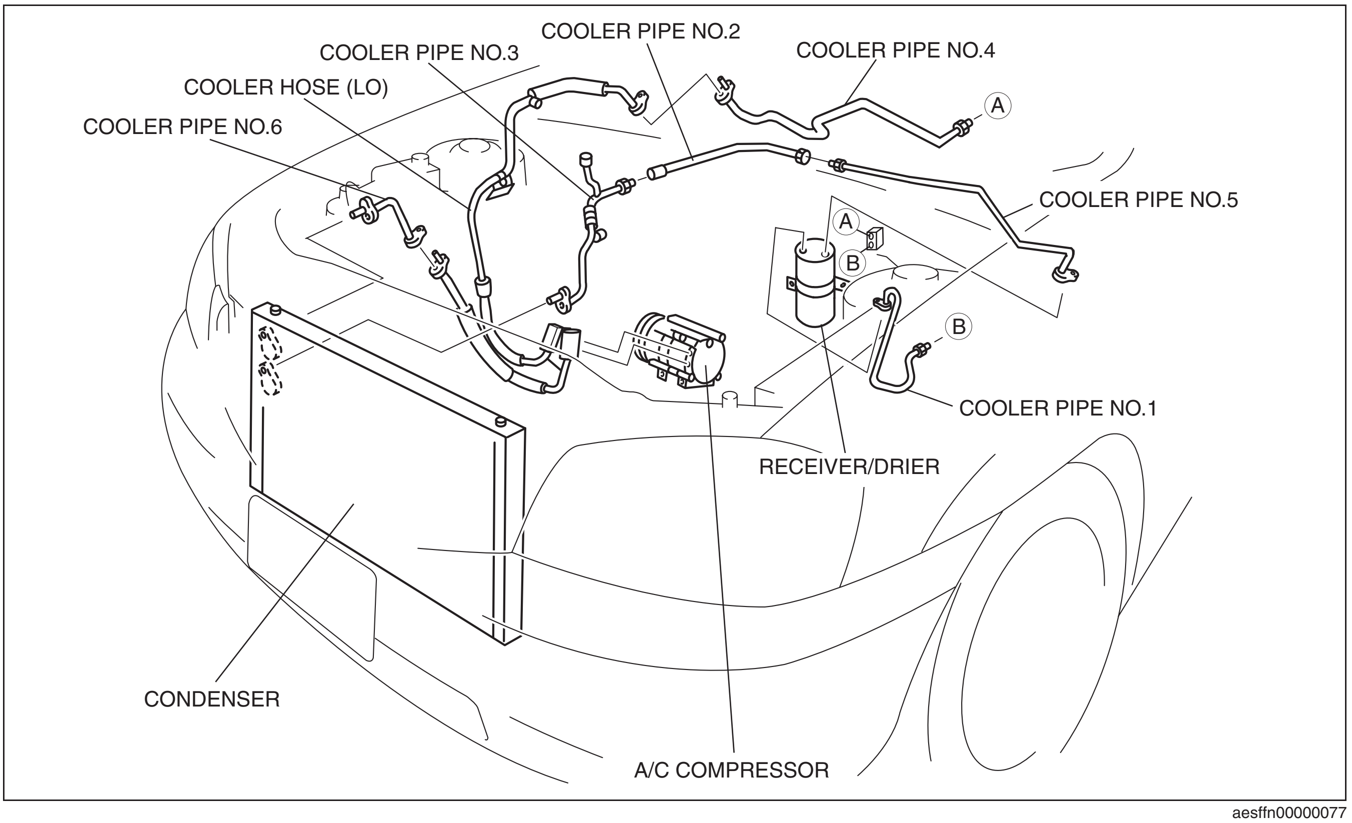
AJ (3.0L Duratec)



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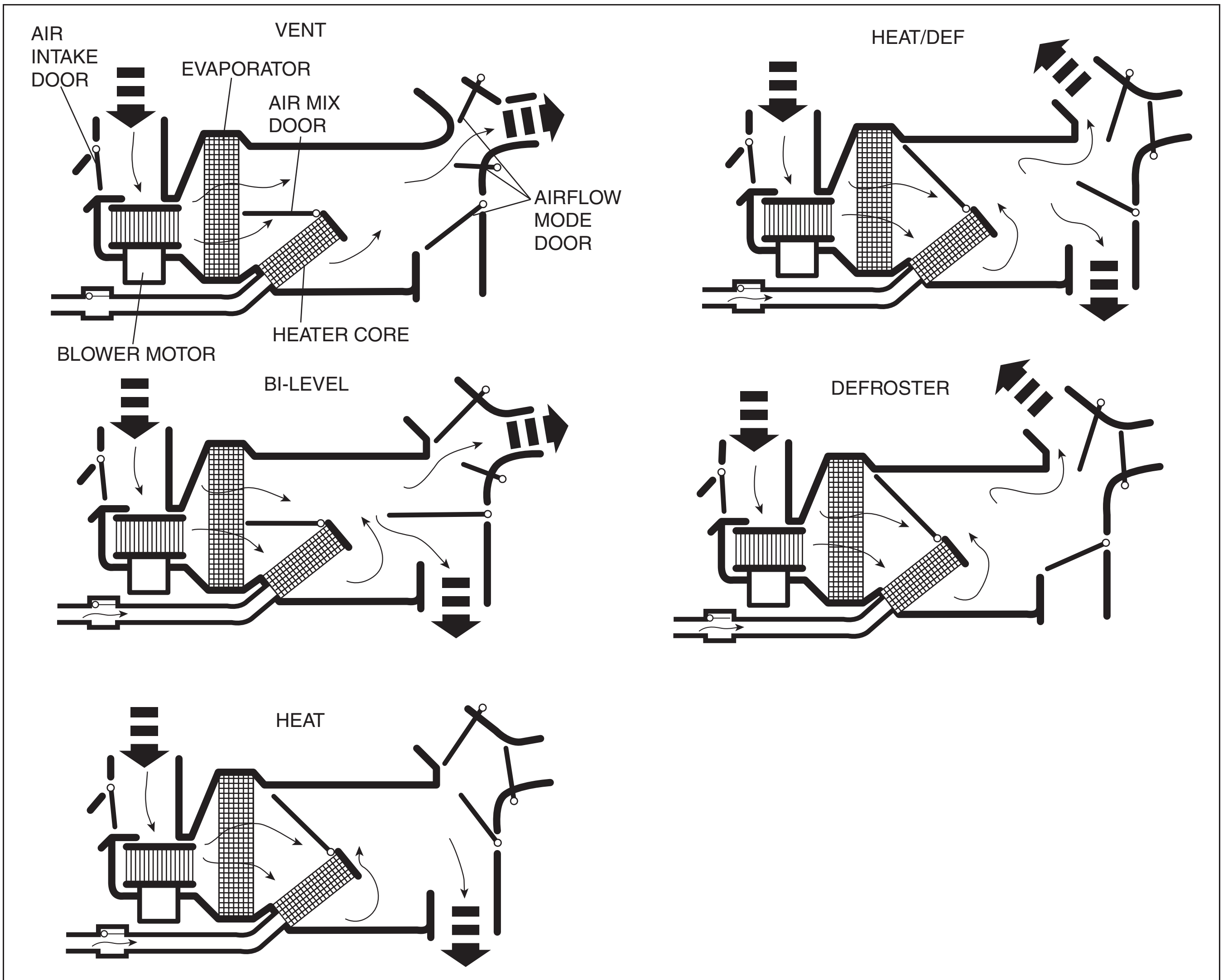
BASIC SYSTEM FLOW DIAGRAM

id071100100300

Ventilation System



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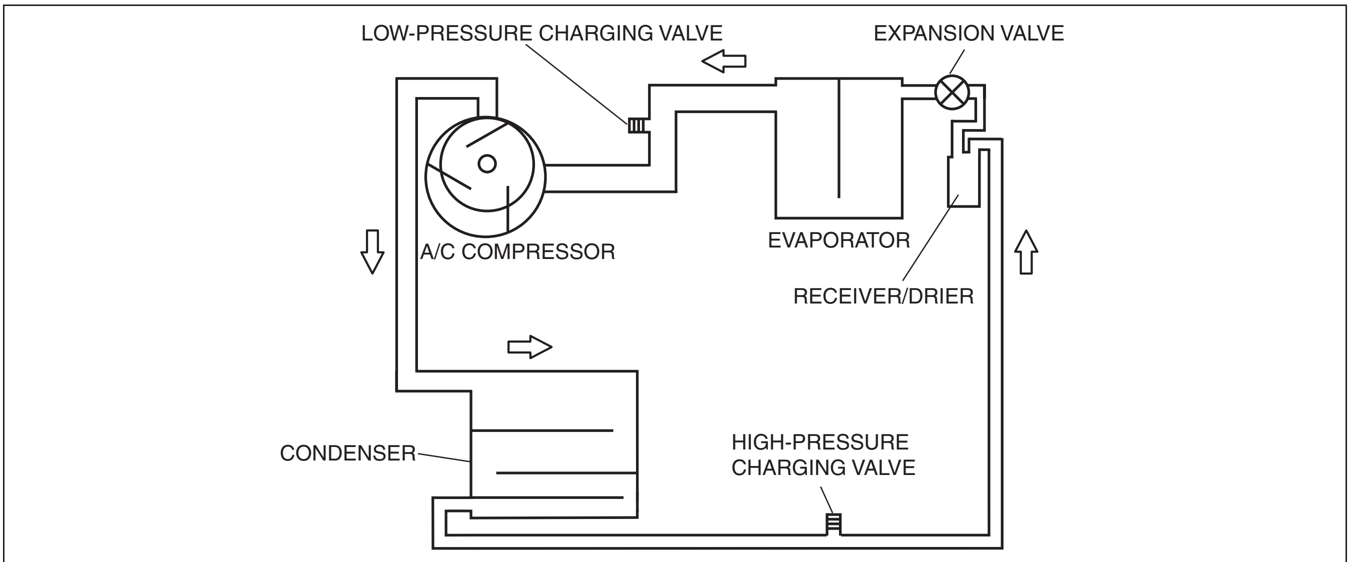
Refrigerant System

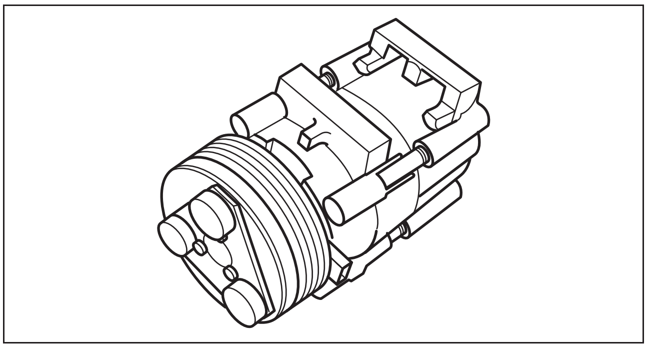


aesffn00000078

A/C COMPRESSOR CONSTRUCTION

id071100100600

- A 10-cylinder swash plate design utilizing the tangential design mount
- A one-piece lip-type seal (repaired from the front of the A/C compressor) is used to seal it at the shaft opening in the assembly.
- Five double-acting pistons operate within the cylinder assembly. The pistons are actuated by a swash plate that changes the rotating action of the shaft to a reciprocating force.
- Reed-type discharge valves are located between the cylinder assembly and the head at each end of the A/C compressor.



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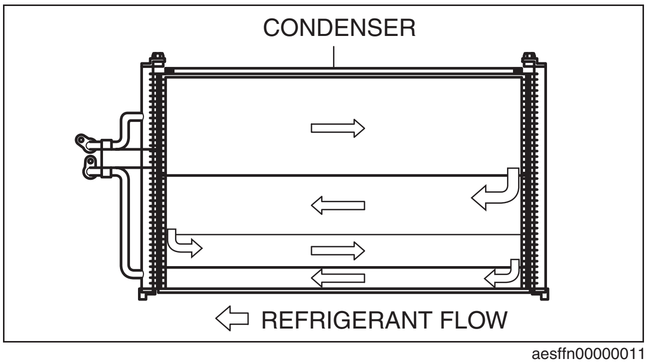
CONDENSER CONSTRUCTION

id071100100800

- It is an aluminum fin-and-tube design heat exchanger located in front of the vehicle radiator.
- It cools compressed refrigerant gas by allowing air to pass over the fins and tubes to extract heat and by condensing gas to liquid refrigerant as it is cooled.



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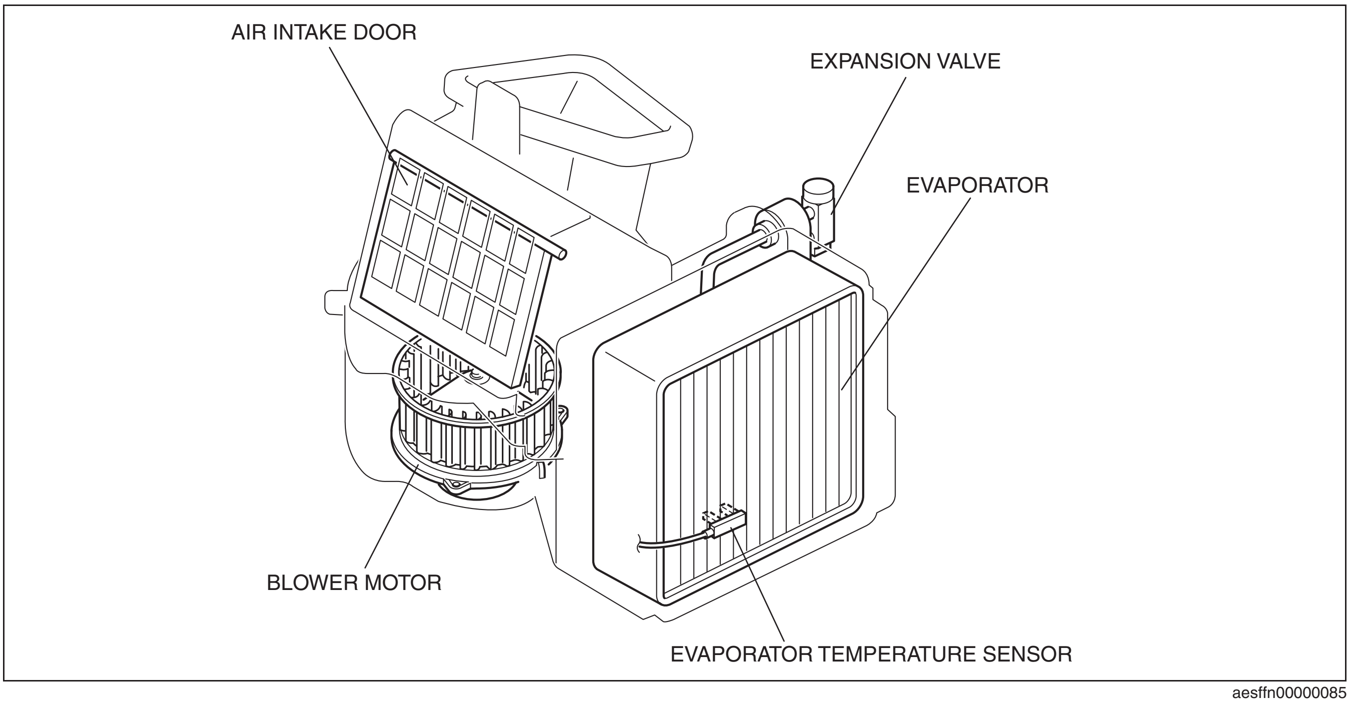
COOLING UNIT CONSTRUCTION

id071100806000



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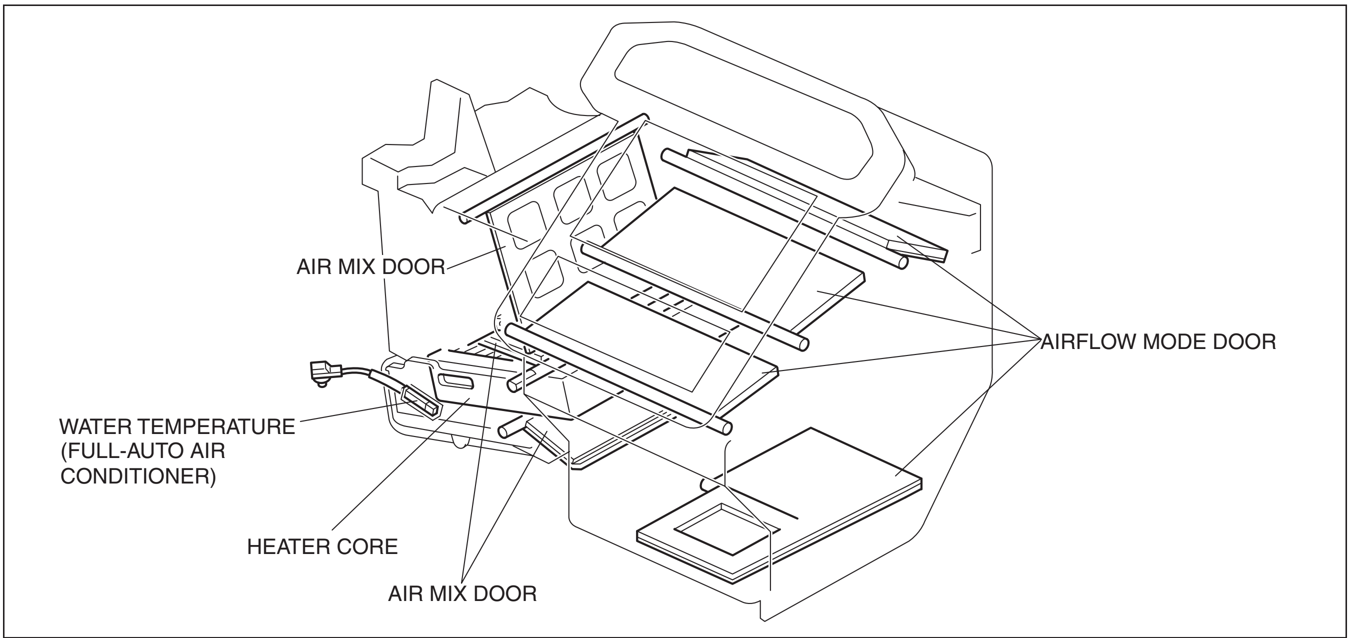
HEATER UNIT CONSTRUCTION

id071100806100

Construction



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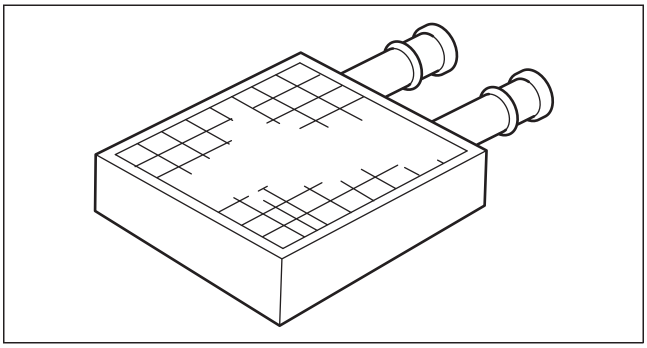
Heater Core Construction

- The heater core consists of fins and tubes arranged to extract heat from the engine coolant and transfer the heat to air passing through the heater core housing.

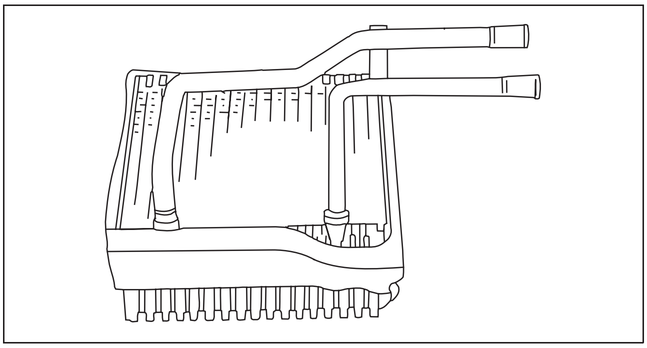


aesffn00000018

EVAPORATOR CONSTRUCTION/OPERATION

id071100806200

- A mixture of refrigerant and oil enters the bottom of the evaporator through the evaporator inlet tube and is routed so it flows through the partitioned first four plate/fin sections.
- The next four plate/fin sections are partitioned to force the refrigerant to flow toward the other end of the evaporator.
- The next five plate/fin sections are partitioned to force the refrigerant to flow toward the bottom of the evaporator.
- Refrigerant then continues through to the remaining five plate/fin sections and then moves out of the evaporator through the evaporator outlet tube.
- This W-pass flow pattern transfers the flow of refrigerant and oil through the evaporator.



aesffn00000013

REFRIGERANT LINES CONSTRUCTION

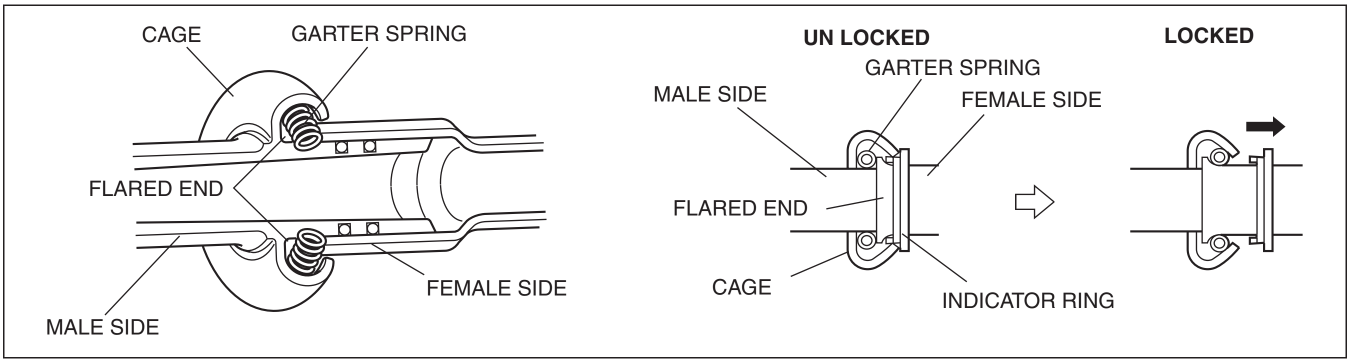
id071100806500

Construction

- The pipes in the refrigerant lines are made of aluminum alloy and the hoses are made of rubber (flexible hose).
- A high-pressure charging valve is located on the cooler pipe No.3 and a low-pressure charging valve is located on the cooler hose (LO).

Spring-lock Coupling

- Spring-lock coupling is used for pipe-to-pipe connections. As a result, pipes can be connected easily, maintenance of torque is unnecessary, and serviceability is improved.
- There is a garter spring in the cage on the male side of spring-lock coupling type and the end of the pipe on the female side is flared. When the pipes are being connected, the flared end of the female side forces the garter spring on the female side to expand, and by fully inserting the male side into the female side, the flared end is locked by the garter spring. When the cooler pipe No.3 is replaced, the additional indicator ring comes out after connecting, indicating that the flared end is locked.



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07-40 CONTROL SYSTEM

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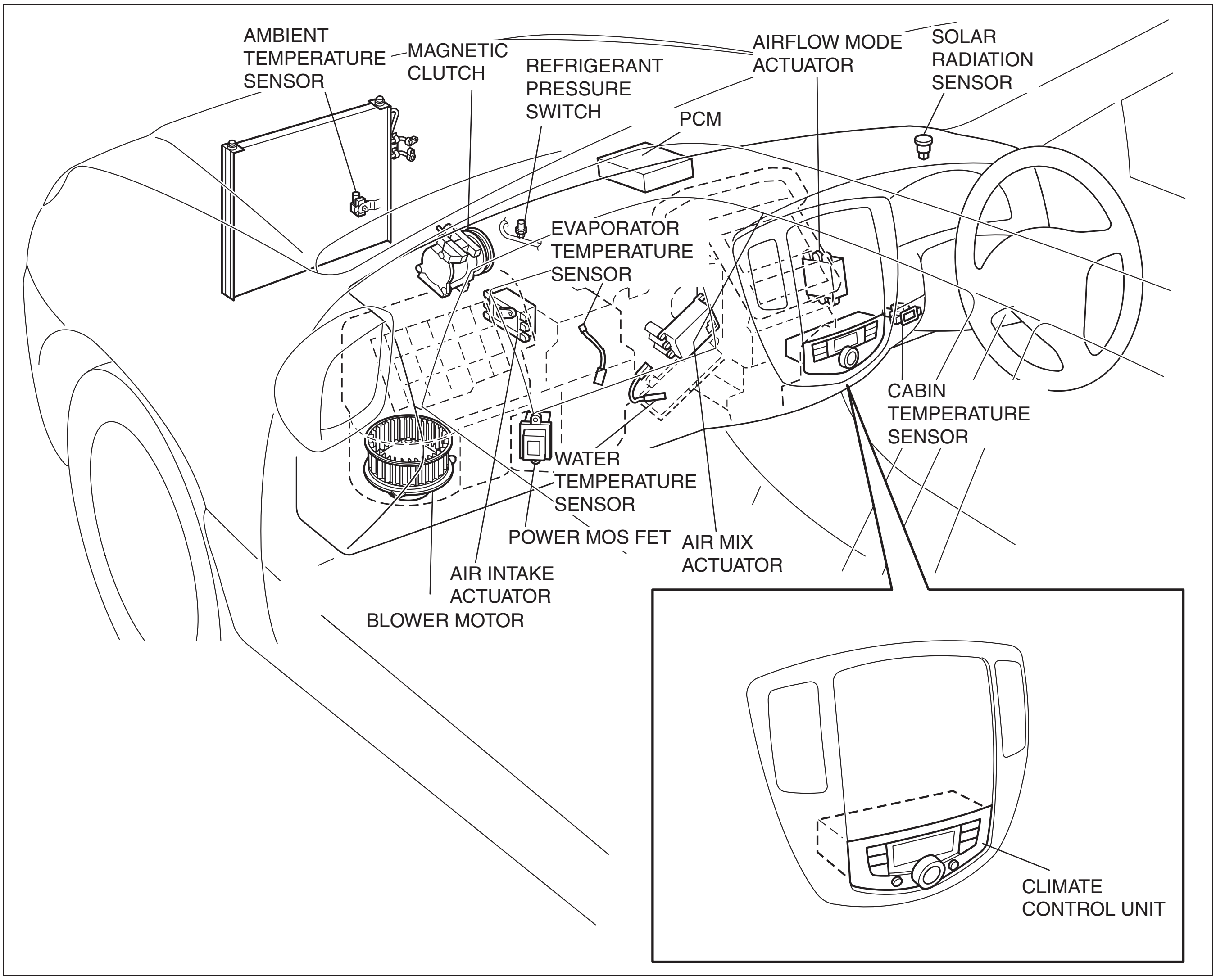
CONTROL SYSTEM OUTLINE

id074000100100

Improved marketability	• AMB (ambient) temperature switch adopted

CONTROL SYSTEM STRUCTURAL VIEW [FULL-AUTO AIR CONDITIONER]

id074000104100



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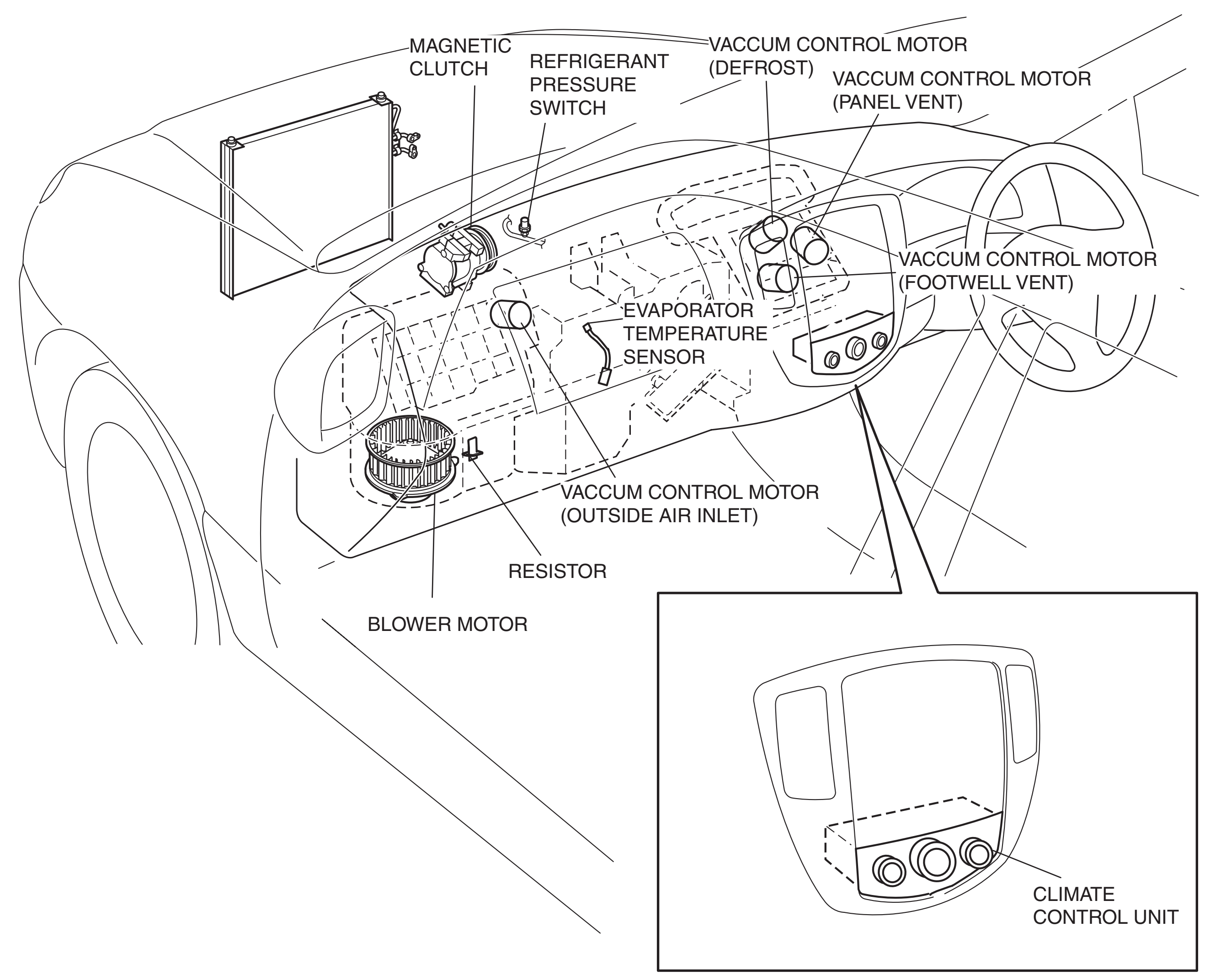
CONTROL SYSTEM STRUCTURAL VIEW [MANUAL AIR CONDITIONER]

id074000104200



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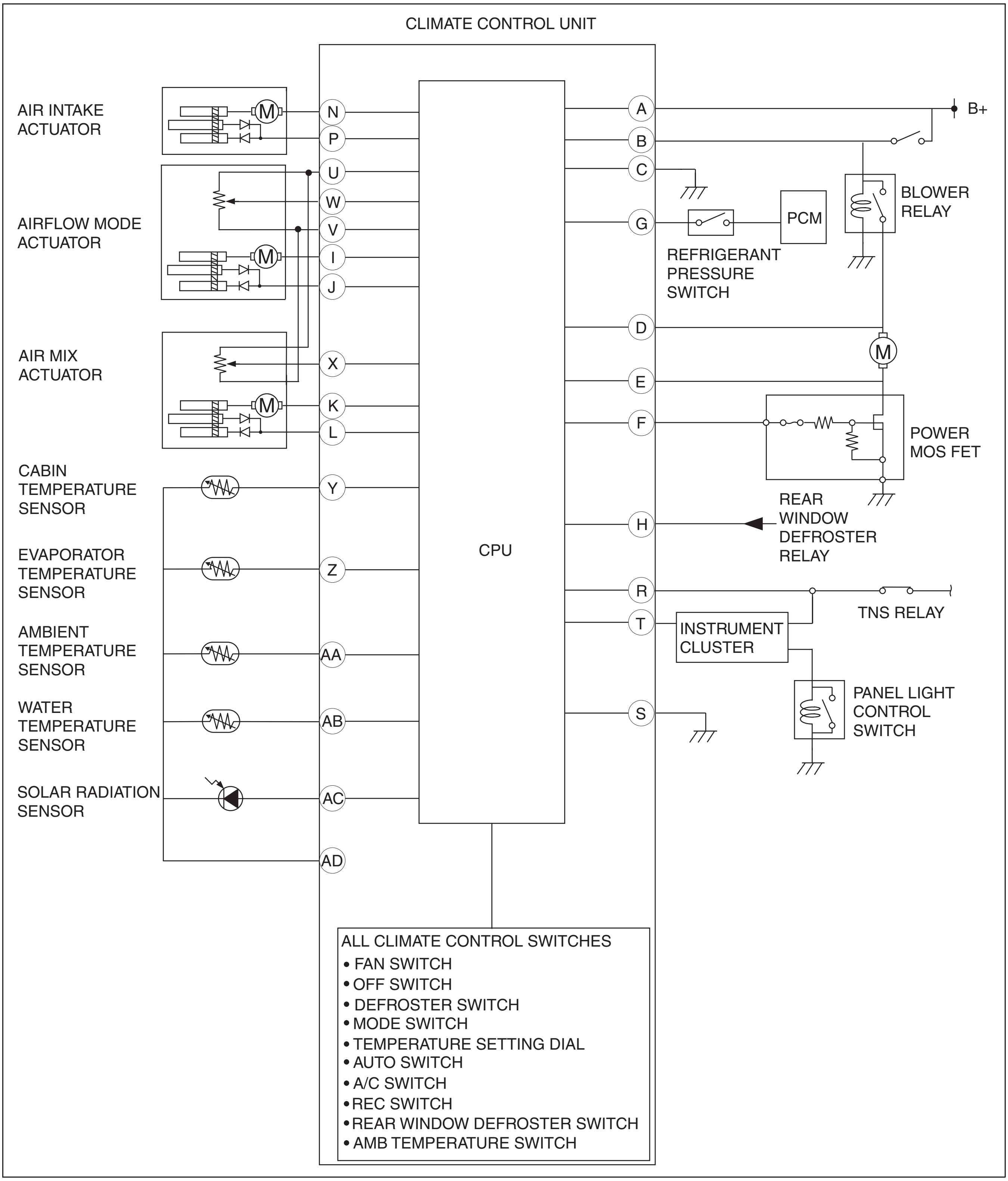
CONTROL SYSTEM WIRING DIAGRAM [FULL-AUTO AIR CONDITIONER]

id074000104300



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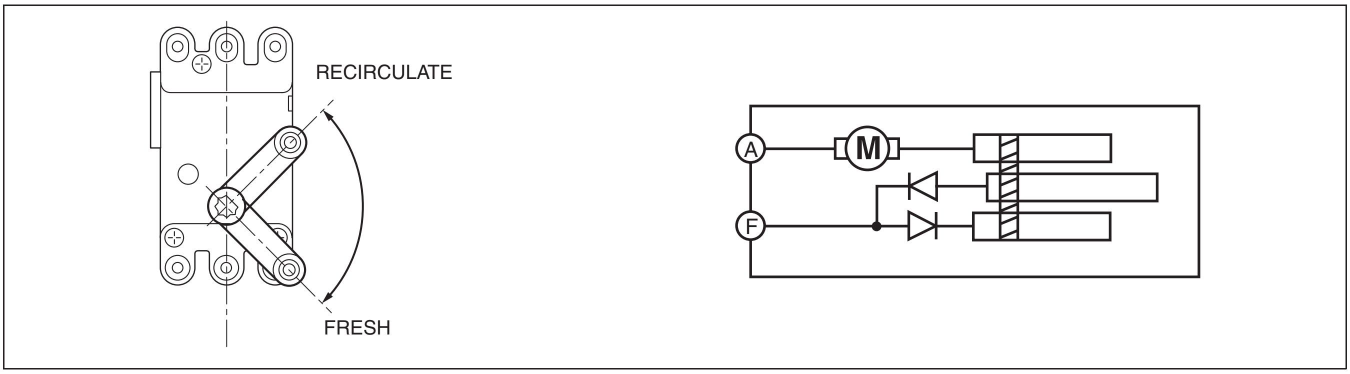
AIR INTAKE ACTUATOR CONSTRUCTION

id074000101700

- A sliding contact type has been adopted.



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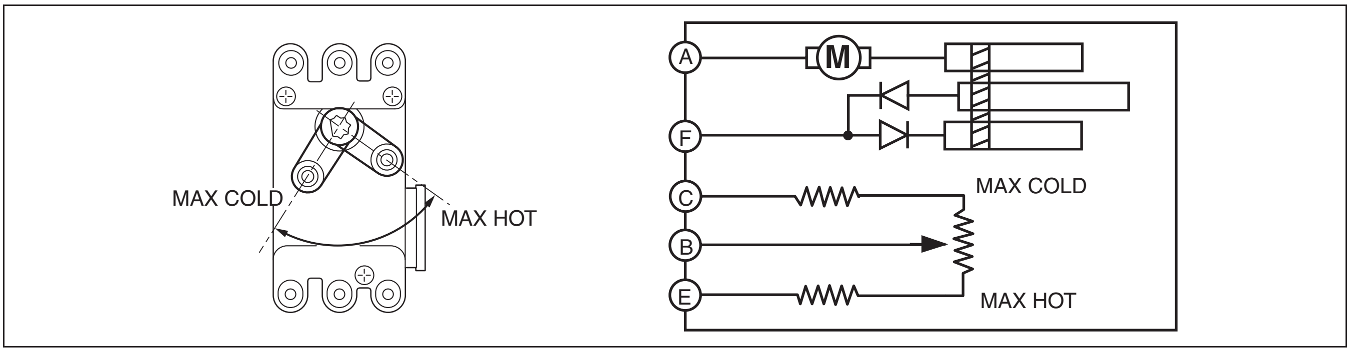
AIR MIX ACTUATOR CONSTRUCTION

id074000103600

- A potentiometer type has been adopted.



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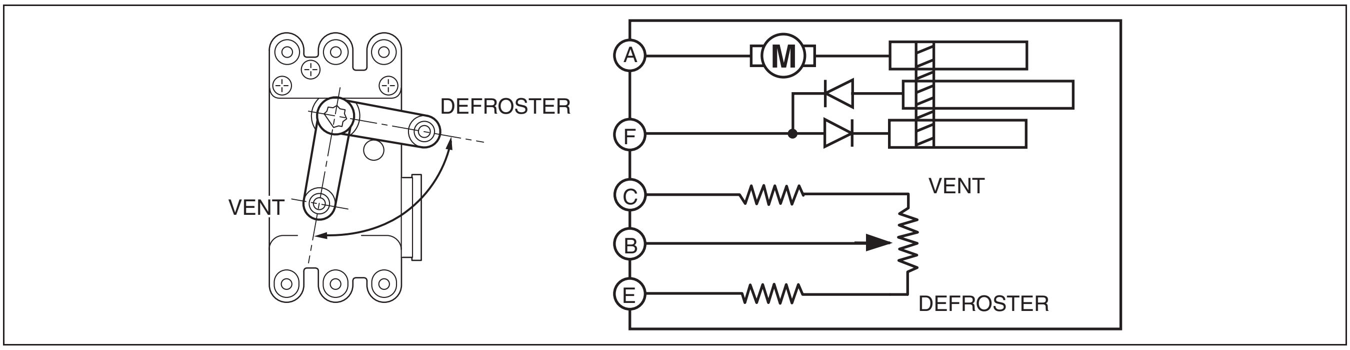
AIRFLOW MODE ACTUATOR CONSTRUCTION

id074000101800

- A potentiometer type has been adopted.



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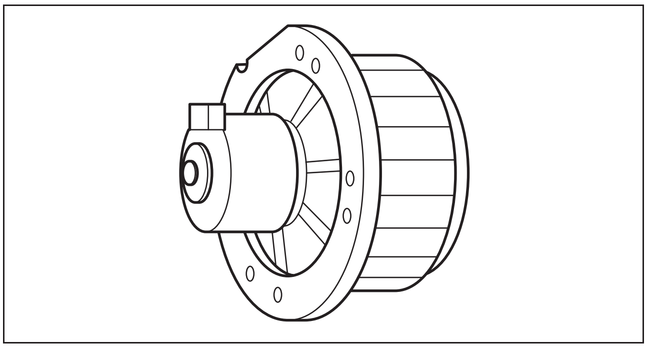
BLOWER MOTOR CONSTRUCTION

id074000101500

- The blower motor pulls air from the air inlet and forces it into the heater core housing where it is mixed and distributed.



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RESISTOR CONSTRUCTION

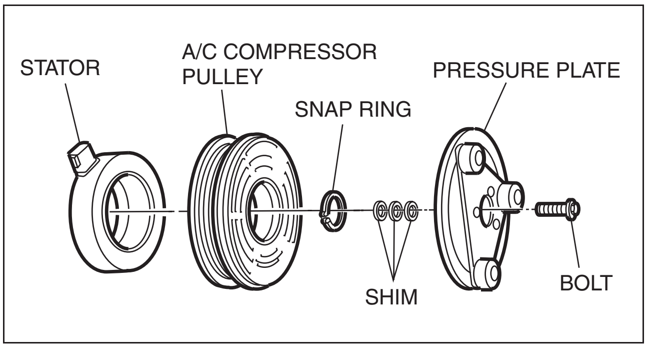
id074000101400

- The four-speed operation of the blower motor.
- The resistor located on the passenger side on the cooling unit behind the glove compartment.

MAGNETIC CLUTCH CONSTRUCTION

id074000101300

- Consists of the following parts:
  — Stator
  — A/C compressor pulley
  — Snap ring
  — Shim
  — Pressure plate
  — Bolt



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REFRIGERANT PRESSURE SWITCH CONSTRUCTION

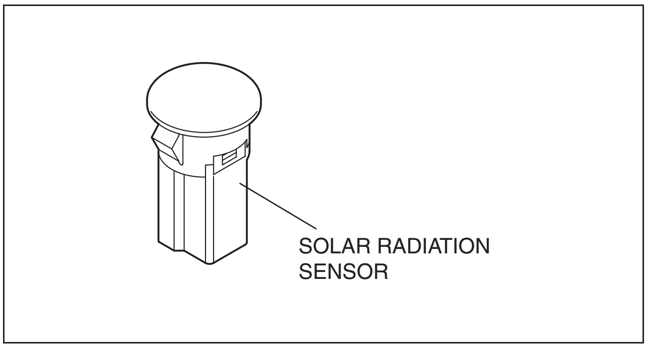
id074000103700

- The refrigerant pressure switch is used to interrupt A/C compressor operation in the event of high system discharge pressure.
- The refrigerant pressure switch is mounted on a Schrader valve-type fitting on the high pressure side of the condenser to evaporator line.
- A valve depressor, located inside the threaded end of the refrigerant pressure switch, is used to monitor the compressor discharge pressure.
- It is not necessary to discharge the refrigerant system to remove the refrigerant pressure switch.
- The refrigerant pressure switch has two sets of contacts. One electrical contact is normally closed.

SOLAR RADIATION SENSOR CONSTRUCTION

id074000103800

- A photo diode (light-receiving diode) has been adopted.



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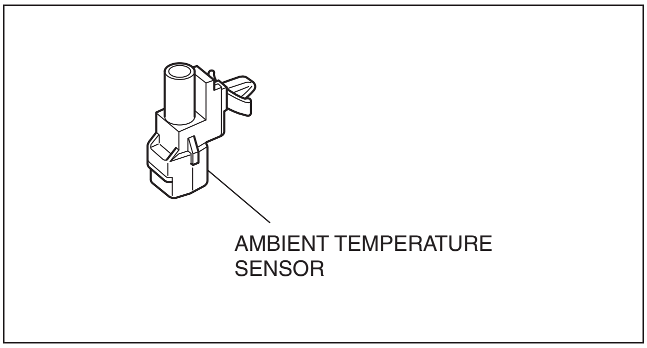
AMBIENT TEMPERATURE SENSOR CONSTRUCTION

id074000104000

- A thermistor type has been adopted.



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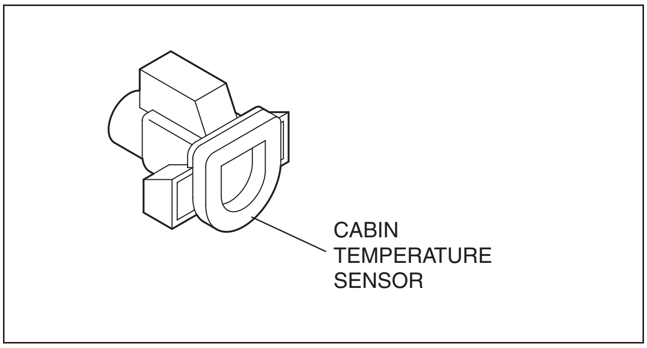
CABIN TEMPERATURE SENSOR CONSTRUCTION

id074000107100

- A thermistor has been adopted.



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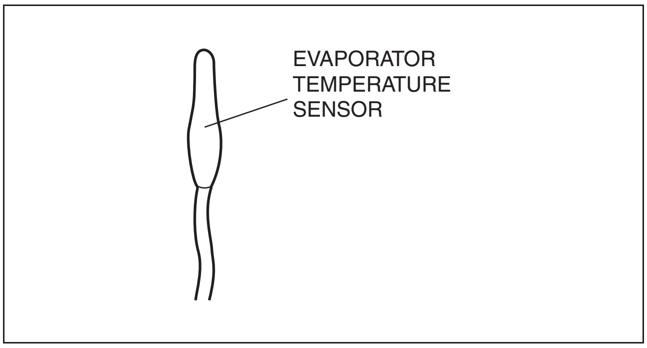
EVAPORATOR TEMPERATURE SENSOR CONSTRUCTION

id074000101600

- A thermistor type has been adopted.



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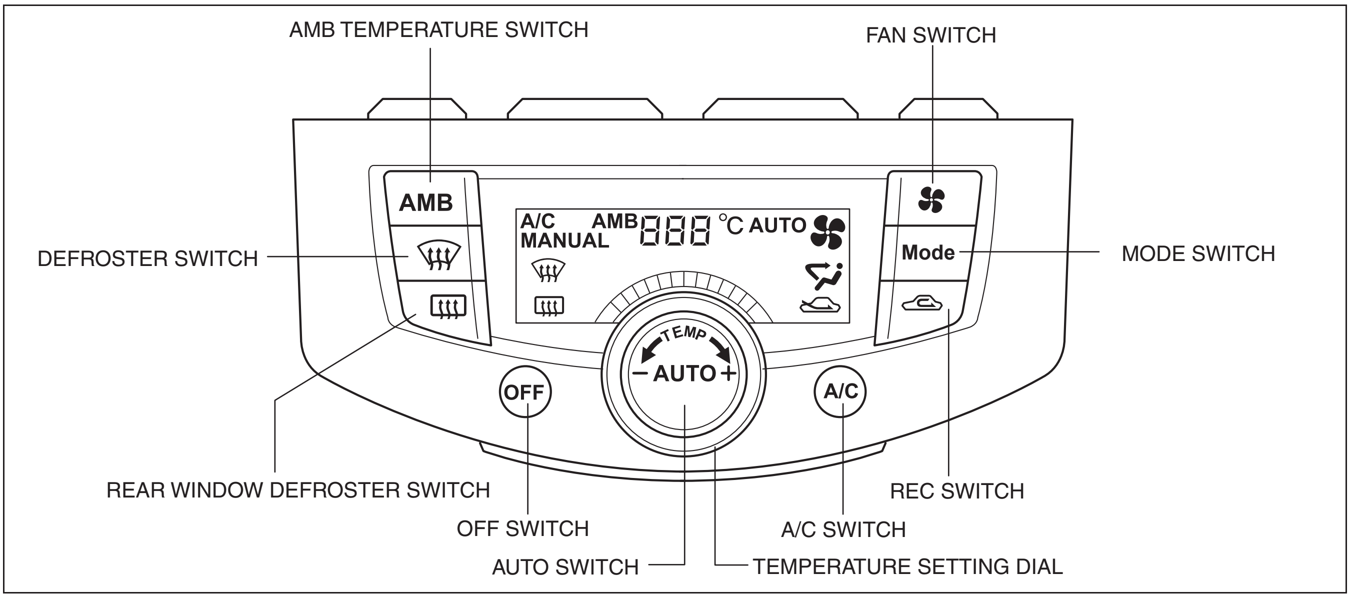
CLIMATE CONTROL UNIT CONSTRUCTION [FULL-AUTO AIR CONDITIONER]

id074000104600



aesffn00000040

Set Temperature Correction Function

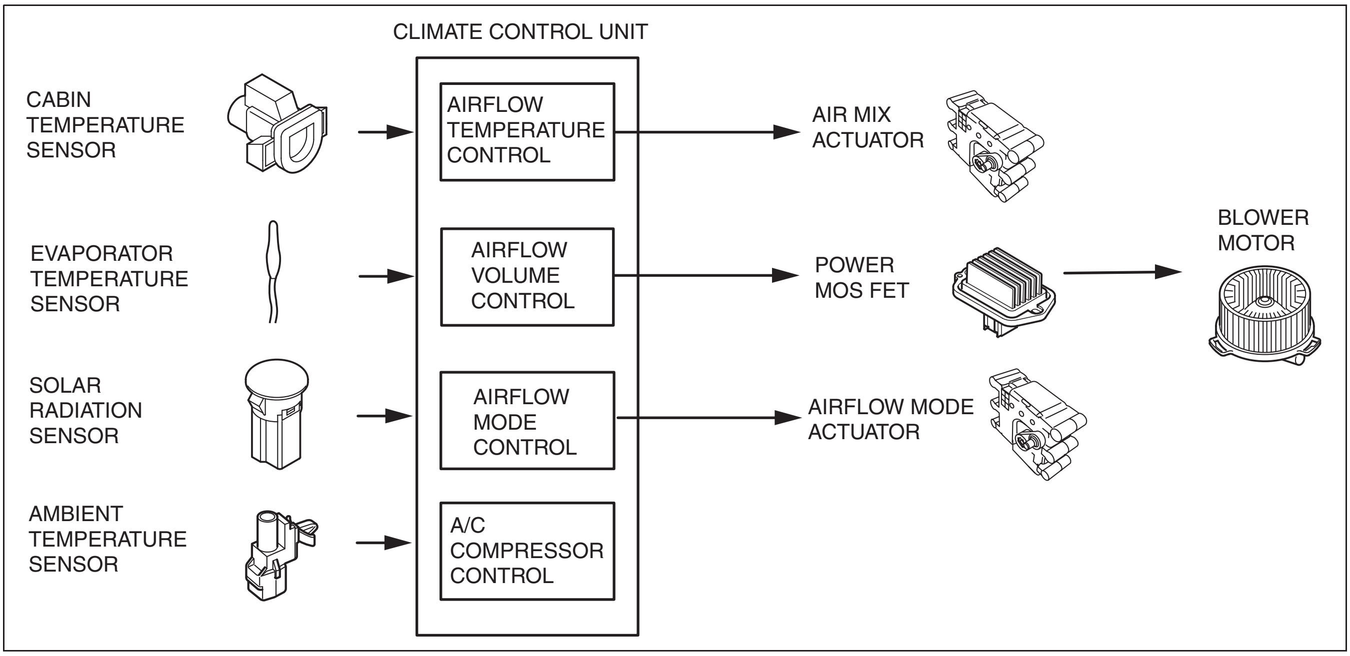
- Set temperature can be corrected in increments of **0.5 °C {0.9 °F}** between **-3.0 °C {-5.4 °F} to 3.0 °C {5.4 °F}** from the set temperature of **25 °C {77 °F}**.
- The initial correction value is set at **1.5 °C {2.7 °F}** . If the set value is changed, the value is recorded until it is changed again.

FULL-AUTO AIR CONDITIONER FUNCTION

id074000100600

Block Diagram

- The control system consists of input components (sensors), output components (actuators, magnetic clutch, power MOS FET, and other parts), and a control device (climate control unit).



aesffn00000056

Control Table

- The full-auto air conditioner system functions based on the four basic types of controls.

Basic control	Control description
Airflow temperature control	Airflow temperature automatic control
Airflow volume control	Airflow volume automatic control
	Airflow volume manual control
Airflow mode control	Airflow mode automatic control
	Airflow mode manual control
A/C compressor control	A/C compressor usually control

Control Type Transition by Switch Operation
Airflow temperature control, airflow volume control, airflow mode control air intake control, A/C compressor control

Operation switch		Airflow temperature control	Airflow volume control	Airflow mode control	Air intake control	A/C compressor control
OFF switch		OFF	OFF	OFF	OFF	OFF
AUTO switch		Automatic control	Automatic control	Automatic control	No change	Normal control
FAN switch	1	Automatic control	1st	No change	No change	No change
	2	Automatic control	2nd	No change	No change	No change
	3	Automatic control	3rd	No change	No change	No change
	4	Automatic control	4th	No change	No change	No change
MODE switch		Automatic control	No change	VENT → BI-LEVEL BI-LEVEL → HEAT HEAT → HEAT/DEF HEAT/DEF → VENT	No change	No change
DEFROSTER switch		Automatic control	4th	DEFROSTER	FRESH	Normal control
A/C switch	ON	Automatic control	No change	No change	No change	Normal control
	OFF	Automatic control	No change	No change	No change	Stop operation
REC switch		Automatic control	No change	No change	REC→FRESH FRESH→REC	No change
REAR DEFROSTER switch		Automatic control	No change	No change	No change	No change

07

AIRFLOW TEMPERATURE CONTROL OUTLINE

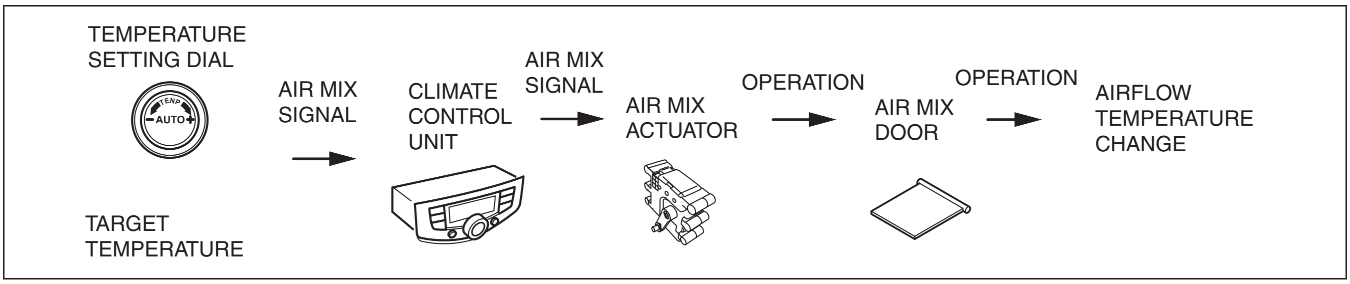
id074000102100

Features

- The airflow temperature is controlled automatically. The climate control unit controls the airflow temperature via the air mix actuator.

AIRFLOW TEMPERATURE CONTROL SYSTEM DIAGRAM

id074000102200



aesffn00000058

AIRFLOW TEMPERATURE CONTROL OPERATION

id074000102300

Airflow Temperature Automatic Control

- The climate control unit calculates the air mix actuator opening angle characteristic based on the set temperature, target temperature.
- Calculated control value is calculated according to the changes in the below list.
  1. Temperature around the heater core is corrected.
  2. The estimated airflow volume that passes through the heater core is estimated from the blower motor voltage control value and air mix actuator opening angle.
  3. The estimated air temperature that blows from the heater core is estimated from the corrected temperature around the heater core and the estimated airflow volume that passes through the heater core.
  4. The target value of the air mix actuator opening angle is calculated from the estimated air temperature that blows from the heater core, corrected temperature around the heater core, and target temperature.
  5. The actual opening angle of the air mix actuator is calculated from its target value.
  6. The target value of the air mix actuator opening angle is calculated from its potentiometer voltage.
  7. The air mix actuator is controlled while comparing each target volume.

AIRFLOW VOLUME CONTROL OUTLINE

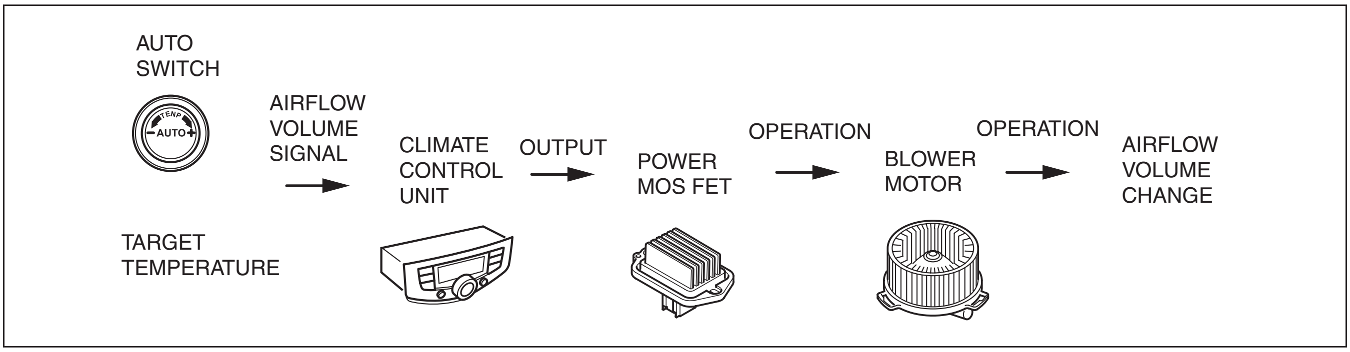
id074000102400

Features

- Consists of the airflow volume automatic and manual controls with the climate control unit controlling the airflow volume (blower motor applied voltage) via the power MOS FET.

AIRFLOW VOLUME CONTROL SYSTEM DIAGRAM

id074000102500



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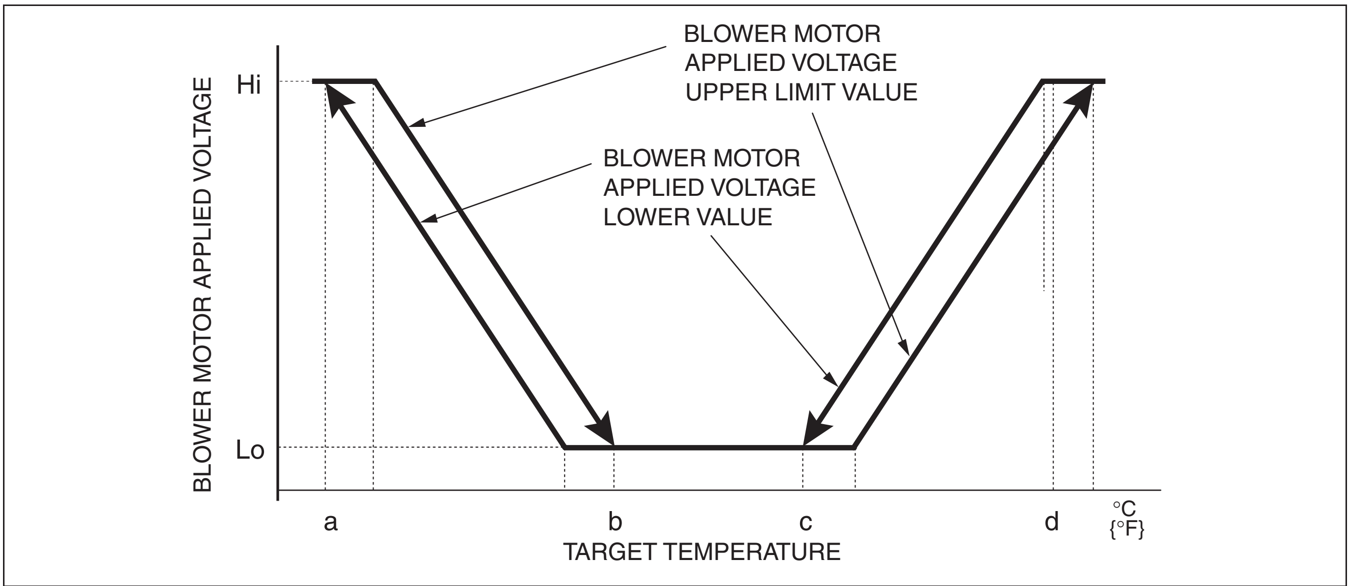
AIRFLOW VOLUME CONTROL OPERATION

id074000102600

Airflow Volume Automatic Control

1. The airflow volume during automatic airflow volume control is determined by the target temperature.
   - When the target temperature is in the a-b, c-d range, the upper/lower limit of the blower voltage is calculated and compared with the current upper/lower limit, and the blower voltage is updated only under the following conditions.
   - The current blower voltage is higher than the upper limit: Upper limit becomes the new blower voltage.
   - The current blower voltage is lower than the lower limit: Lower limit becomes the new blower voltage.
2. The fan speed changes non-step depending on the applied blower motor voltage.



atraan00000425

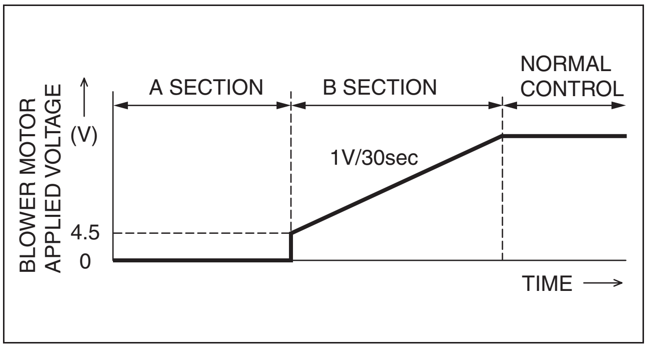
3. The AUTO airflow volume calculation results directly after the airflow volume switch is switched on are displayed.
4. The display of the subsequent auto airflow control calculations, based on the airflow volume output, are updated as shown.

Display	The blower control output range
LO	4.5 V —5.4 V
ML	5.5 V—6.5 V
MH	6.6V—10.9 V
HI	11.0 V or more

Correction

Engine coolant temperature correction (warm-up correction)

- Controls the blower motor applied voltage according to the increase in engine coolant temperature to prevent discomfort caused by a high volume of cold air blown from the vents in winter after starting the engine. However, the engine coolant temperature correction is not performed the water temperature is **40 °C {104 °F} or less**.



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Airflow Volume Manual Control

- The blower motor applied voltage (airflow volume) can be switched in four steps with the fan switch.

Fan switch	Blower motor applied voltage
1st	5.4 V
2nd	6.5 V
3rd	9.0 V
4th	B+

AIRFLOW MODE CONTROL OUTLINE

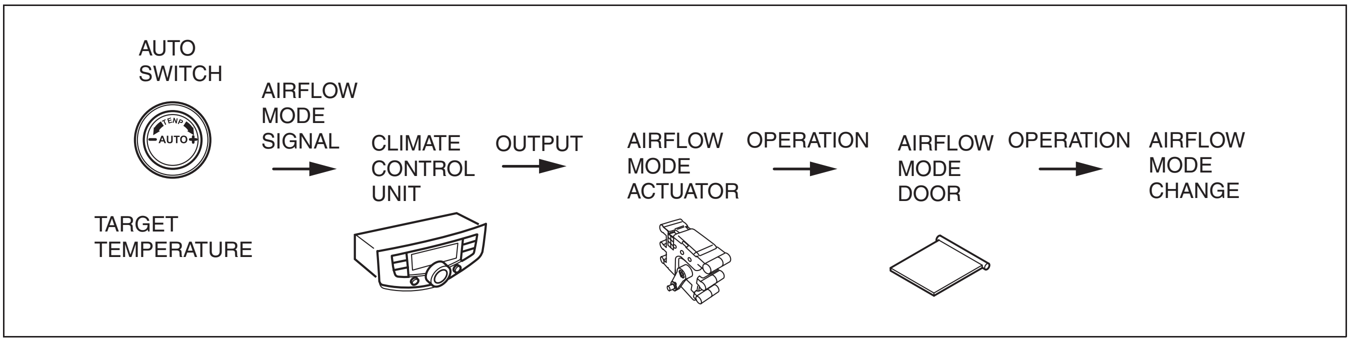
id074000102700

Features

- Consists of the airflow mode automatic and manual controls with the climate control unit controlling the airflow mode via the airflow mode actuator.

AIRFLOW MODE CONTROL SYSTEM DIAGRAM

id074000102800



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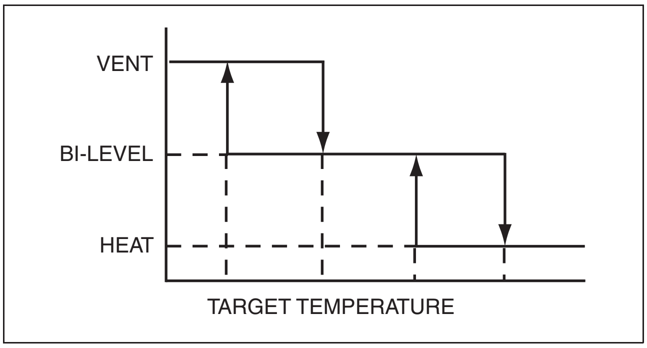
AIRFLOW MODE CONTROL OPERATION

id074000102900

Airflow Mode Automatic Control

- Automatic control determines the airflow mode based on the current target temperature.



atraan00000428

Airflow Mode Manual Control

- The airflow modes can be switched by operating the each mode switches and DEFROSTER switch.

Defroster Correction

- When the DEFROSTER switch is turn on, the air intake is FRESH to improve defrosting.

AIR INTAKE CONTROL OUTLINE

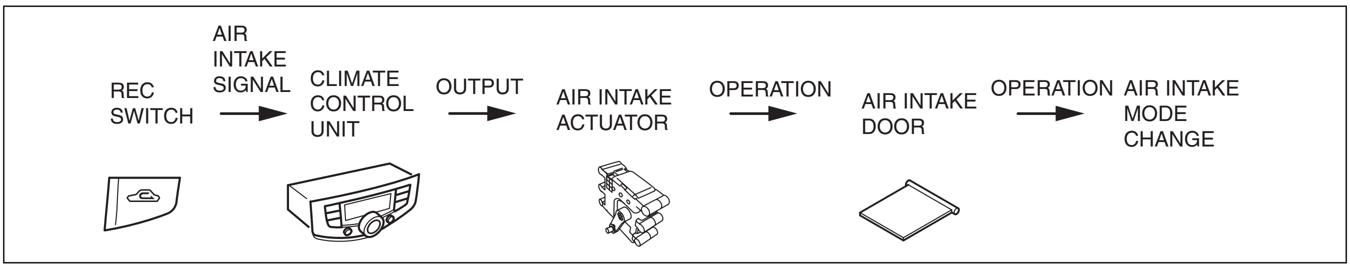
id074000103300

Features

- Consists of the manual control with the climate control unit controlling the air intake mode via the air intake actuator.

AIR INTAKE CONTROL SYSTEM DIAGRAM

id074000103400



aesffn00000063

AIR INTAKE CONTROL OPERATION

id074000103500

Air Intake Manual Control

- The air intake modes can be switched by operating the REC switch.

Air intake mode	REC switch operation
FRESH	Fixed to FRESH when the REC switch is turned on during REC mode.
REC	Fixed to REC when the REC switch is turned on during FRESH mode.

A/C COMPRESSOR CONTROL OUTLINE

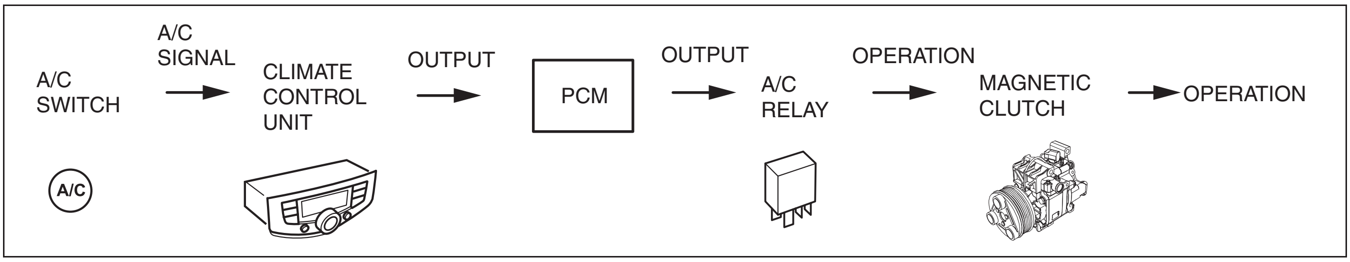
id074000103000

Features

- The A/C compressor control includes the A/C compressor usually control, and the climate control unit sends the A/C signal to the PCM to control the A/C compressor.

A/C COMPRESSOR CONTROL SYSTEM DIAGRAM

id074000103100



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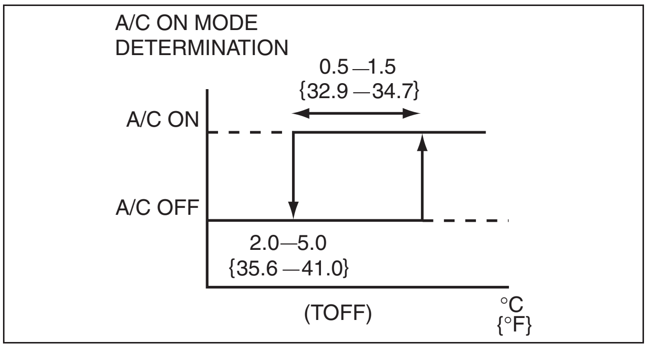
A/C COMPRESSOR CONTROL OPERATION

id074000103200

A/C Compressor Control

- The climate control unit calculates the OFF temperature (Toff) based on each sensors.
- In A/C on mode, the A/C signal (magnetic clutch) is turned on/off according to the OFF temperature (Toff).



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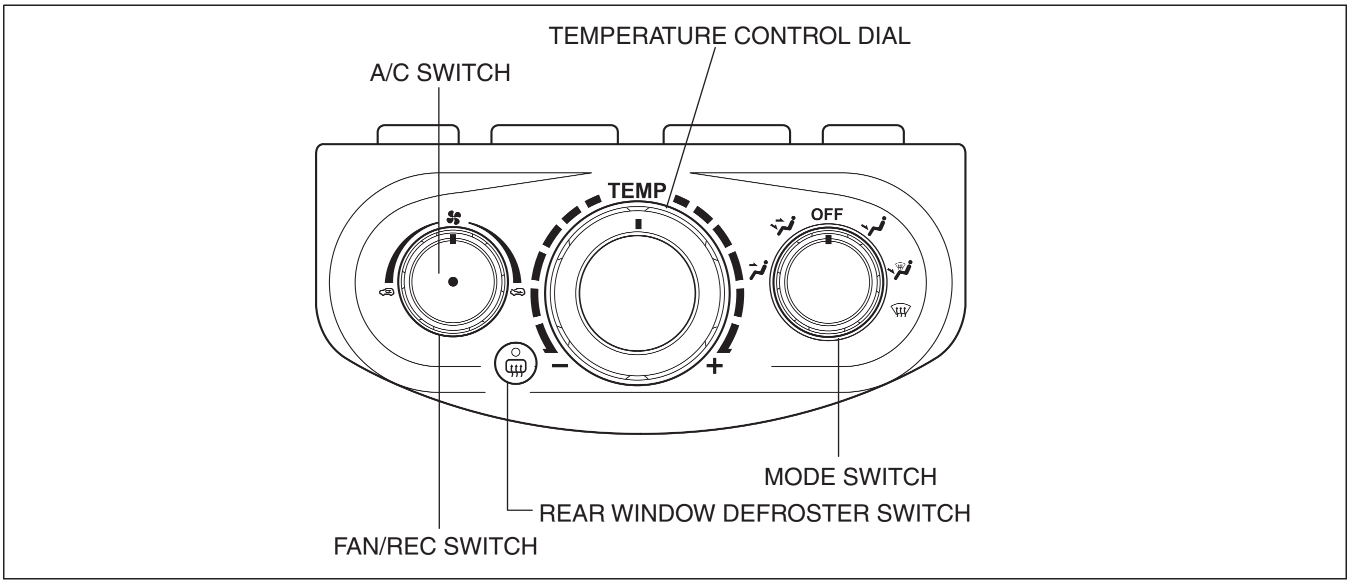
07

CLIMATE CONTROL UNIT CONSTRUCTION [MANUAL AIR CONDITIONER]

id074000104500



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RESTRAINTS

08 SECTION

08-00 OUTLINE

RESTRAINTS ABBREVIATIONS

id080000100100

ALR	Automatic Locking Retractor
DLC	Data Link Connector
DTC	Diagnostic Trouble Code
ELR	Emergency Locking Retractor
GEM	Generic Electronic Module
IDS	Integrated Diagnostic Software
ON	Switch On
PDS	Portable Diagnostic Software
PID	Parameter Identification
SAS	Sophisticated Air bag Sensor

RESTRAINTS FEATURES

id080000100200

- The air bags and pre-tensioner front buckles are designed to provide increased collision protection for front seat occupants in addition to that provided by the three-point front seat belt system. Seat belt use is necessary to obtain the best occupant protection and to receive the full advantage of the air bag system.
- The air bags and pre-tensioner front buckles consists of the following components:
  — SAS control module
  — Clock spring
  — Driver-side air bag module
  — Passenger-side air bag module
  — Driver-side side air bag module (Vehicles with side air bags)
  — Passenger-side side air bag module (Vehicles with side air bags)
  — Driver-side pre-tensioner front buckle
  — Passenger-side pre-tensioner front buckle

08-02 ON-BOARD DIAGNOSTIC

ON-BOARD DIAGNOSTIC SYSTEM OUTLINE

id080200100400

Features

- The air bag system has an on-board diagnostic function to facilitate the system diagnosis.
- The on-board diagnostic function has a function for detecting malfunctions in the air bag system-related parts, a memory function for storing detected malfunctions, and a PID/data monitor function for reading out specific input/output signals.
- Using the IDS/PDS, DTCs can be read out and deleted, and the PID/data monitoring function can be activated.
- The system has a fail-safe function to prevent the accidental activation of the air bags in case of an air bag system malfunction.

ON-BOARD DIAGNOSTIC SYSTEM FUNCTION

id080200100300

On-board Diagnostic Function

DTC reading/clearing (past malfunction indication)

- When the ignition switch is turned to the ON position, the SAS control module detects intermittent DTCs and module DTCs, and stores them in memory. The method for the DTCs from SAS control module has adopted a time-out control for determining the existence of malfunctions in the system. For the SAS control module to detect a malfunction, it is necessary for the malfunction to be present in the system for 1 min or more. For the SAS control module to determine that a malfunction has been cleared, a malfunction cannot present for 1 min or more. The actual time for the malfunction detection time-out differs according to each DTC. DTCs can be searched using the IDS/PDS. The DTC that is stored in the SAS control module is displayed on the IDS/PDS together with a simple definition of the DTC. If there are no DTCs stored, the IDS/PDS displays “PASS-SAS CONTROL MODULE”. If malfunctions have been cleared, the IDS/PDS can be used to clear DTCs from the memory of the SAS control module. Once 254 ignition switch operations have been recorded since a malfunction was last detected, DTCs will automatically be removed from memory. Once cleared, DTCs cannot be re-displayed, therefore record displayed DTCs before performing the clearing procedure. Malfunction DTCs can be redisplayed after performing the DTC clearing operation because DTCs cannot be cleared from the SAS control module.

Reading DTCs (present malfunction indication)

- The self test option is used to confirm that no electrical malfunctions exist in the air bag system. Upon entering the self test, the SAS control module will perform an electrical check of each electrical component in the system. If a concern is detected, a DTC is displayed on the IDS/PDS with a brief description of the DTC. Malfunctions detected during the self test are not stored in memory unless the same malfunction was also detected during normal vehicle operation. The self test should always be performed after any repair to confirm that the repair was successful. To run the self test, connect the IDS/PDS to the data link connector-2 (DLC-2), and follow the instructions on the IDS/PDS display. The SAS control module will run the self-test and display present malfunction DTCs on the screen.

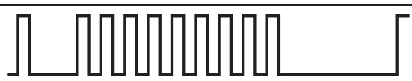
Fail-safe function

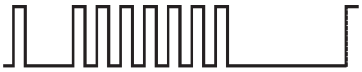
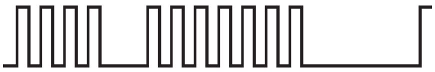
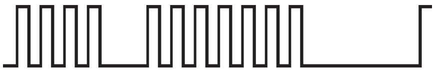
- If the SAS control module performance/function cannot be maintained due to any cause, the fail-safe function stops air bag system control and flashes the air bag system warning light to prevent the air bags from operating (deploying) accidentally.

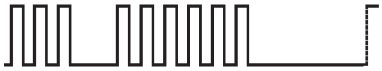
Memory function

- Stores malfunctions in the air bag system-related parts detected by the malfunction detection function, and the stored malfunction contents are not cleared even if the ignition switch is turned to the LOCK position or the negative battery cable is disconnected.

DTC table

DTC				System malfunction location
IDS/PDS display	Air bag system warning light			
	Flashing pattern		Priority ranking	
B1231	19		3	SAS control module activation (deployment) control frequency error
B1318	-	-	-	The power supply voltage decreases (less than 9 V)

DTC				System malfunction location
IDS/PDS display	Air bag system warning light			
	Flashing pattern		Priority ranking	
B1342	24		2	SAS control module internal malfunction
B1869	-	Warning sound	30	Air bag system warning light operation malfunction
B1870			31	Air bag system warning light circuit short to power supply
B1877	46		26	Driver-side pre-tensioner front buckle circuit resistance high
B1878	17		30	Driver-side pre-tensioner front buckle circuit short to power supply
B1879				Driver-side pre-tensioner front buckle circuit short to body ground
B1881	47		26	Passenger-side pre-tensioner front buckle circuit resistance high
B1882	18		31	Passenger-side pre-tensioner front buckle circuit short to power supply
B1883				Passenger side pre-tensioner front buckle circuit short to body ground
B1885	46		26	Driver-side pre-tensioner front buckle resistance low
B1886	47		27	Passenger-side pre-tensioner front buckle circuit resistance low
B1887	15		6	Driver-side air bag module circuit short to body ground
B1888	16		7	Passenger side air bag module circuit short to body ground
B1891	-	Warning sound	29	Air bag warning sound circuit short to power supply
B1892			28	Air bag warning sound short to body ground
B1916	15		8	Driver-side air bag module circuit short to power supply
B1921	21		4	SAS control module ground bracket resistance high
B1925	16		9	Passenger-side air bag module circuit short to power supply
B1932	32		10	Driver-side air bag module circuit resistance high
B1933	33		11	Passenger-side air bag module circuit resistance high
B1934	34		12	Driver-side air bag module circuit resistance low
B1935	35		13	Passenger-side air bag module circuit resistance low

IDS/PDS display	DTC: Air bag system warning light: Flashing pattern		Priority ranking	System malfunction location
B1992	36		21	Driver-side side air bag module circuit short to power supply
B1993			20	Driver-side side air bag module circuit short to body ground
B1994			22	Driver-side side air bag module circuit resistance high
B1995			23	Driver-side side air bag module circuit resistance low
B1996	37		25	Passenger-side side air bag module circuit short to power supply
B1997			24	Passenger-side side air bag module circuit short to body ground
B1998			26	Passenger-side side air bag module circuit resistance high
B1999			27	Passenger-side side air bag module circuit resistance low
B2440	43		17	Passenger-side side air bag sensor installation malfunction
B2441	42		16	Driver-side side air bag sensor installation malfunction
B2444	48		14	Driver-side side air bag sensor (internal circuit abnormal)
B2445	49		15	Passenger-side side air bag sensor (internal circuit abnormal)
C1414	29		5	Vehicle identification code error
U2017	44		18	Driver-side side air bag sensor (communication error)
U2018	45		19	Passenger-side side air bag sensor (communication error)

08

PID/Data Monitor Function

- The PID/data monitor and record option allows the state of parameter IDs (PIDs) to be read to aid in diagnosing the system. PIDs are real time measurements of parameters such as voltage and resistance, calculated by the SAS control module and sent to the IDS/PDS for display. Many of the PIDs supported by the SAS control module are calculated periodically and are, therefore, not true real time readings. To read PIDs, connect the IDS/PDS to the data link connector-2 (DLC-2) and follow the instructions on the IDS/PDS display. PIDs are updated continuously on the display.

PID/data monitor table
L3

PID name (definition)	Unit/ Operation	Operation Status (Reference)	Terminal
AB_BKTGN2	ohm	Air bag bracket ground resistance: ohms	-
CCNT_RCM	-	Indicates number of DTC	-
DABAGR	ohm	Driver-side air bag module resistance: ohms	2P, 2S
D_ABAGR			
DS_AB	ohm	Driver-side side air bag sensor resistance: ohms	1H, 1K
P_ABAGR	ohm	Passenger-side air bag module resistance: ohms	2G, 2J
DR_PTENS	ohm	Driver-side pre-tensioner front buckle resistance: ohms	2N, 2Z
PS_AB	ohm	Passenger-side side air bag sensor resistance: ohms	1B, 1E
PS_PTENS	ohm	Passenger-side pre-tensioner front buckle resistance: ohms	2F, 2I

AJ (3.0L Duratec)

PID name (definition)	Unit/ Operation	Operation Status (Reference)	Terminal
AB_BKTGN2	ohm	Air bag bracket ground resistance: ohms	-
CCNT_RCM	-	Indicates number of DTC	-
DABAGR	ohm	Driver-side air bag module resistance: ohms	2P, 2S
D_ABAGR			
D_BUKLE_R	ohm	Driver-side front buckle switch resistance: ohms	-
DR_PTENS	ohm	Driver-side pre-tensioner front buckle resistance: ohms	2N, 2Z
PABAGR	ohm	Passenger-side air bag module resistance: ohms	2G, 2J
P_ABAGR			
PS_PTENS	ohm	Passenger-side pre-tensioner front buckle resistance: ohms	2F, 2I
P_BUKLE_R	ohm	Passenger-side front buckle switch resistance: ohms	-
VID_1V	V	Vehicle ID#1 voltage	-
VID_2V	V	Vehicle ID#2 voltage	-
VID_3V	V	Vehicle ID#3 voltage	-

Active Command Mode Function

- This function allows for operation confirmation of the air bag warning light and chime. When the operation confirmation is performed, the warning light and the chime are activated simultaneously for approx. 4 s. Both devices deactivate automatically.

Active command mode table

Command name	Operation	Output part name	Terminal
WRNLMPCHM	ON/OFF	Air bag warning light, chime operation	2B, 2T

08-10 AIR BAG SYSTEM

AIR BAG SYSTEM CONSTRUCTION/OPERATION

id081000102100

Driver-side Air Bag Module

- The driver-side air bag module is installed in the steering wheel.
- The driver-side air bag module operates (deploys) after receiving a signal from the SAS control module.
- The driver-side air bag module has no sub-components.
- Four-spoke type module has been adopted.

Clock Spring

- The clock spring is installed on the steering column behind the steering wheel.
- The clock spring provides a continuous electrical path between the driver-side air bag module and the SAS control module.

Driver-side Side Air Bag Module

Note
- When installing a new side air bag module after the side air bag has operated (deployed), refer to the side air bag module removal/installation in the workshop manual.

- The driver-side side air bag module operates (deploys) after receiving a signal from the SAS control module which receives an input signal from the driver-side side air bag sensor.
- The driver-side side air bag module is replaced as a single component.
- The driver-side side air bag module is installed in the driver′s seat.

Passenger-side Air Bag Module

- The passenger-side air bag module has no separately repairable parts and is installed as a single component.
- The passenger side air bag module is installed in the left side of the dashboard.

Passenger-side Side Air Bag Module

Note
- When installing a new side air bag module after the side air bag has operated (deployed), refer to the side air bag module removal/installation in the workshop manual.

- The passenger-side side air bag module operates (deploys) after receiving a signal from the SAS control module which receives an input signal from the passenger-side side air bag sensor.
- The passenger-side side air bag module is replaced as a single component.
- The passenger-side air bag module is installed in the passenger′s seat.

Pre-tensioner Front Buckle
As part of the air bag system, the safety belt buckles are equipped with pre-tensioners. The safety belt buckle pre-tensioners remove excess slack from the safety belt webbing. If the SAS control module detects a crash force exceeding the specification, it operates (deploys) the pre-tensioners.

SAS Control Module

The SAS control module executes the following functions.

- Sends a signal to the inflators to operate (deploy) the air bags in the event of a deployable crash.
- Sends a signal to the pre-tensioner front buckles to operate (deploy) in the event of a deployable crash.
- Monitors the air bag system for malfunctions.
- Illuminates the air bag warning system light if a malfunction is detected.
- Flashes the air bag warning system light to indicate the lamp malfunction code that is detected.
- Communicates through the data link connector-2 (DLC-2) the current or past diagnostic trouble codes (DTCs).
- Sends a signal to the GEM to operate a chime if the air bag warning light does not function and another air bag system malfunction exists.

Note
- The safety sensor is built into the SAS control module and cannot be serviced separately.

The SAS control module monitors the SRS air bag system for possible malfunctions. If a malfunction is detected while the ignition switch is in the ON position, the SAS control module will flash the air bag system warning light in the instrument cluster.

When the ignition is cycled (turned off and then on), the air bag indicator illuminates for 6 s and then turns off for 2 s. After diagnosing, the air bag system warning light flashes a two-digit LFC for any current air bag system malfunction. If an air bag system malfunction exists, the air bag system warning light will flash the LFC 5 times, and then remain illuminated for the rest of the key cycle. The SAS control module will also communicate the current and past DTCs through the DLC-2, to the IDS/PDS. If the air bag system warning light does not function, and the system detects a malfunction, the SAS control module will send a signal to the GEM to operate an audible chime. The chime is a series of five sets of five tone bursts. If the chime is heard, the air bag system and the air bag system warning light require repair.

LFCs are prioritized. If two or more malfunctions occur at the same time, the malfunction having the highest priority will be displayed. After that malfunction has been corrected, the next highest priority malfunction will be displayed.

The SAS control module includes a backup power supply. This feature provides sufficient backup power to operate (deploy) the air bags in the event that the ignition circuit is damaged in a collision before the safing and air bag sensors determine that an operation (deployment) is required. The backup power supply will deplete its stored energy approximately 1 min after the negative battery cable is disconnected.

Electrical System

The electrical system supports the air bag system as follows:

- The electrical system is powered from the battery through the ignition circuit.
- The electrical system provides the electrical path from the SAS control module to the air bag modules.
- The electrical system provides the electrical path from the SAS control module to the pre-tensioner front buckles.
- The electrical system provides the electrical path from the SAS control module to the side air bag sensors (equipped vehicles only).
- The electrical system provides the electrical path from the SAS control module to the air bag system warning light.
- The electrical system provides the electrical path from the SAS control module to the data link connector-2 (DLC-2).
- The electrical system provides the electrical path from the SAS control module to the GEM.

Sensor

Warning
- **The SAS control module orientation is critical for correct system operation. If a vehicle equipped with an air bag system has been involved in a collision in which the center tunnel area has been damaged, inspect the mounting and bracket for deformation. If damaged, the SAS control module must be replaced whether or not the air bags have operated (deployed). In addition, make sure the area of the SAS control module mounting is restored to its original condition.**

The vehicle′s air bag system employs three air bag sensors. One of the sensors is integral to the SAS control module and is not serviceable separately. In addition, there are two side air bag sensors located in the B-pillars on the left and right. The SAS control module is mounted on the center tunnel under the instrument panel. Installation orientation is critical for correct operation of all air bag sensors.

Side Air Bags

The driver-side and passenger-side side air bags are installed in the seat back frames.

Front seat back trim on seat backs with side air bags installed cannot be repaired. Replace the front seat back trim. Cleaning is allowable.

If a side air bag has operated (deployed), replace with a new seat back pad, trim, and side air bag module. If necessary, install a new seat back frame.

08-11 SEAT BELT

SEAT BELT SYSTEM CONSTRUCTION/OPERATION

id081100100100

Warning

- **All seat belt components including retractors, buckles, front seat belt buckle support components (slide bar) (equipped vehicles only), seat belt height adjusters (equipped vehicles only), child restraint seat anchor, (equipped vehicles only), and installed hardware should be inspected after any collision. All seat belt components should be replaced unless a qualified technician finds the components show no damage and operate properly. Seat belt components not in use during a collision should also be inspected and replaced if either damage or improper operation is noted.**

Warning

- **Each seating position in the vehicle has a specific seat belt component which consists of one buckle and one plate. The seat belt component is designed to be used as a pair and is not to be used across seating positions.**

The seat belt system consists of the following parts:

- Front seat belt retractors and guides secured to the body behind the B-pillar trim.
- Driver and passenger-side seat belt buckle and pre-tensioners secured to the front seat cushion frame component.
- Rear outboard seat belt retractors secured to the body behind the trunk side trim.
- Rear passenger-side seat belt buckle component secured to the floor pan under the rear seat cushion.
- Rear center and rear driver-side seat belt buckle component secured to the floor pan under the seat cushion.
- Child-restraint seat anchors installed to the roof near the liftgate.

The seat belts for the front and rear seats is a continuous-loop, three-point system. The combination lap and shoulder belt (continuous-loop) uses a common sliding plate and retractor.

Front Seat Belt Buckle and Pre-tensioner Component

The driver and passenger side seat belt buckle and pre-tensioner are secured to the front seat cushion frame component. This allows the front seat belt buckle end to move with the front seat.
The belt and buckle component pre-tensioner is a pyrotechnic device that removes excess webbing from the seat belt system. The belt, buckle, and pre-tensioner component uses the same air bag sensor system as the air bag system. When the belt, buckle, and pre-tensioner component operates (deploys), the buckle moves downward, pulling excess webbing from the lap and shoulder seat belts.
If the seat belt buckle and pre-tensioner component operates (deploys), a new component must be installed.

Lap and Shoulder Belt—Dual Locking Mode

Warning

- **A rear-facing child-restraint seat should never be placed in the front seats.**

The dual locking mode retractor on the shoulder belt portion of the combination lap/shoulder seat belt for both front occupant seating positions and both rear outboard seating positions, operates in two ways. The driver single locking mode retractor on the shoulder belt portion of the combination lap/shoulder seat belt works only in the vehicle sensitive mode.

1. In the emergency locking retractor (ELR) mode, the seat belt retractor allows the occupant freedom of movement, locking tight only on hard braking, hard cornering, or impacts of **approx. 8 km/h (5 mph)** or more. The front and rear seat belt retractors can also be made to lock by pulling/jerking on the belt.
2. In the automatic locking retractor (ALR) mode, the shoulder belt retractor automatically locks and remains locked when the combination lap/shoulder seat belt is buckled and does not allow the occupant freedom of movement. This mode provides a tight lap/shoulder belt fit on the occupant and on a child-restraint seat.
3. When the combination lap/shoulder belt is unbuckled and allowed to retract completely, the retractor switches to the emergency locking retractor (ELR) mode.

The automatic locking mode must be used when installing a child-restraint seat in the front outboard passenger and rear seating positions.

08

Attaching Tether Strap to Child-Restraint Seat

Some manufacturers make child-restraint seats that include a tether strap that goes over the back of the vehicle seat and attaches to an anchoring point. Other manufacturers offer the tether strap as an accessory. Contact the manufacturer of the child-restraint seat for information about ordering a tether strap.
Child-restraint seat anchors are manufactured into the vehicle.

Seat Belt Warning System

The seat belt warning light illuminates and a chime sounds to remind the occupants to fasten their seat belts.
The conditions of operation for the seat belt warning light and chime are as follows:

- If the driver's seat belt is not buckled before the ignition switch is turned to the ON position, the seat belt warning light illuminates for **1—2 min** and the warning chime sounds for **4—8 s**.
- If the driver's seat belt is buckled while the seat belt warning light is illuminated and the reminder chime is sounding, the seat belt warning light and reminder chime turn off.
- If the driver's seat belt is buckled before the ignition switch is turned to the ON position, the seat belt warning light and reminder chime remain off.

BODY & ACCESSORIES

09
SECTION

09-00 OUTLINE

BODY AND ACCESSORIES ABBREVIATIONS

id090000100100

ACC	Accessories
BJB	Battery Junction Box
CAN	Controller Area Network
CJB	Central Junction Box
CM	Control Module
GEM	Generic Electronic Module
HI	Hight
IDS	Integrated Diagnostic Software
IG	Ignition
INT	Intermittent
LCD	Liquid Crystal Display
LF	Left Front
LO	Low
OFF	Switch Off
ON	Switch On
PATS	Passive Anti-Theft System
PCM	Powertrain Control Module
PDS	Portable Diagnostic Software
P/W	Power Window
RF	Right Front
SCP	Standard Corporate Protocol
TNS	Tail Number Side Light

BODY AND ACCESSORIES FEATURES

id090000100300

Improved marketability	• Power window system adopted • Power door lock system adopted • Keyless entry system adopted • Sunroof adopted • Front fog lights adopted
Improved safety	• Uni-body structure adopted
Improved security	• Immobilizer system adopted • Theft-deterrent system adopted
Improved visibility	• Outer mirrors with built-in front side turn lights have been adopted
Simplified wiring harness	• Multiple communication system adopted

09-10 BODY PANELS

BODY PANEL INSULATION AND NOISE SUPPRESSION

id091000100100

Insulation and noise suppression material is made of urethane, PVC and recycled felt. Insulation and noise suppression material have been installed to the following parts:

- Lower part of the roof panel
- Upper part of the dashboard
- Side cowl area
- Front and rear floor areas
- A, B and D pillars
- Rear part of the trunk side trim

BODY PANEL OUTLINE

id091000100200

The body consists of a uni-body, open cowl construction.
The body consists of a hood, front fender, doors, fuel-filler lid, and a liftgate that are all made of lightweight steel with tightening bolts that allow for removal.

BUMPER STRUCTURE

id091000100300

The bumper system consists of the following parts:

- Front bumper
- Front bumper reinforcement
- Rear bumper
- Rear bumper reinforcement

CRUSHABLE ZONE CONSTRUCTION

id091000100400

The crushable zone consists of the following parts:

- Air deflector
- Cowl grille
- Front fender
- Front fender splash shield
- Hood
- Hood hinge

HOOD CONSTRUCTION

id091000100500

The hood consists of the following parts:

- Hood latch striker
- Hood latch
- Hood latch release handle and cable
- Hood hinge
- Hood stay
- Shroud seal weatherstrip

The hood is installed to the body with two hood hinges and is supported by the hood stay when it is opened.

09-11 DOORS AND LIFTGATE

DOOR CONSTRUCTION

id091100100100

The door system consists of the following parts:
- Door checker
- Front doors
- Front door lock striker
- Front door hinge
- Front door weatherstrip
- Rear doors
- Rear door latch striker
- Rear door hinge
- Rear door weatherstrip

The doors are installed to the body with two pin-type hinges and are equipped with door catchers that restrict door movement.
The front and rear doors consist of the following parts:
- Door lock switch (front doors only)
- Outer handle
- Inner handle
- Door key cylinder (Driver side)
- Door key cylinder (Passenger side)
- Door latches consist of the following parts:
  — Door key cylinder switch
  — Door lock actuator
  — Door switch

LIFTGATE CONSTRUCTION

id091100100200

The liftgate system consists of the following parts:
- Liftgate
- Liftgate hinge
- Liftgate stay damper
- Liftgate lock striker
- Liftgate weatherstrip

The liftgate is installed to the body with two liftgate hinges. The liftgate stay damper is of use in supporting the liftgate when it is opened.
The liftgate consists of the following parts:
- Liftgate door lock actuator
- Liftgate key cylinder
- Rear liftgate glass
- Rear liftgate glass switch
- Rear liftgate glass outer handle
- The liftgate latch remote control consists of the following part:
  — Liftgate outer handle
- The liftgate latch consists of the following part:
  — Liftgate switch

09-12 GLASS/WINDOWS/MIRRORS

GLASS STRUCTURE

id091200101800

The windshield consists of the following parts:
- Standard plastic and glass laminate safety glass
- Window opening flange bonded with sealant adhesive

The liftgate window glass consists of the following parts:
- Reinforced glass
- Filament
- Two liftgate window glass hinges
- Two liftgate window glass stay dampers
- Rear wiper
- Striker

The quarter window glass consists of the following parts:
- Reinforced glass
- Window opening flange with studs
- Butyl sealant

REAR WINDOW DEFROSTER OPERATION

id091200101700

The rear window defroster is activated by the rear window defroster switch located on the meter hood. When the rear window defroster switch is activated, power is supplied to the rear window defroster switch on indicator and the rear window defroster relay located in the battery junction box (BJB). When the rear window defroster relay coil is energized, voltage from the BJB is supplied to the liftgate glass filament.

POWER WINDOW SYSTEM OPERATION

id091200101100

The power operated windows are activated by switches on each passenger door or by a multiple switch on the driver door. The driver door power window main switch is a two stage switch and incorporates the auto-open/close feature.
Voltage to the power window system is suppled through ignition relay No.2/ACC delay relay and P/W 30 A fuse. When the ignition relay is energized, voltage is supplied to all power window switches. When a power window switch is activated, power and ground paths are supplied to the appropriate side of the power window regulator to drive it in the desired direction.
The IG OFF timer operation is active when the ignition switch is moved from ACC or ON to the OFF/LOCK position, or when the LF and RF doors are closed.
The IG OFF timer operation will be deactivated when:
- The LF door is open and the ignition switch is in the OFF/LOOK or KEY-OUT position.
- The RF door is open and the ignition switch is in the OFF/LOOK or KEY-OUT position.
- 40 seconds have elapsed since the ignition switch was changed from ACC or ON position to the OFF/LOOK position.

THE POWER WINDOW SYSTEM COMPONENTS

id091200101600

The power window system consists of the following parts:
- Front door glass (reinforced glass)
- Rear door glass (reinforced glass)
- Power window main switch
- Power window subswitch
- Power window regulator
- Power window motor

Power Window Switch
- Located on each door trim panel.
- May be used to raise or lower both passenger side and driver side windows using the power window main switch on the driver door.
- Includes a power-cut function that is controlled using the power window main switch on the driver door.

OUTER MIRROR COMPONENTS

id091200101900

The outer mirror consists of the following parts:

- Outer mirror
- Power outer mirror switch
- Front side turn light
- Electric retractable outer mirror (if equipped)
- Retractable mirror switch (if equipped)

The outer mirror is controlled manually and through the power outer mirror switch.
The retractable outer mirror is controlled through the retractable mirror switch.

09-13 SEATS

SEAT CONSTRUCTION

id091300100600

The seats consist of the following parts:
- Slide adjuster
- Slide adjuster with a lift dial (Driver’s seat)
- Lumbar support (Driver’s seat)
- Side cover (Outboard)
- Side cover (Inboard)
- Pole guide
- Front seat backs
- Front seat cushions
- 6:4 width ratio rear seat cushions
- 6:4 width ratio rear seat backs
- Rear seat recliner knuckles
- Rear seat headrests
- Rear seat recliner covers
- Pre-tensioner front buckle (Front seat)

09-14 SECURITY AND LOCKS

THEFT-DETERRENT SYSTEM CONSTRUCTION

id091400103500

The theft-deterrent system consists of the following parts:

- Door key cylinder switches
- Liftgate key cylinder switch
- Generic electronic module (GEM)
- Door latch and door lock actuator
- Transmitter
- Bonnet switch/bracket assembly
- Theft-deterrent horn (located on right side upper apron)

THEFT-DETERRENT SYSTEM OPERATION

id091400100800

The theft-deterrent system feature provides an audible and visual alarm when unauthorized access to the vehicle is detected. When an intrusion is detected by any door, liftgate or liftgate glass latch switches, or the bonnet switch, an open signal is sent to the generic electronic module (GEM). When the GEM receives a signal indicating intrusion into the vehicle, the GEM cycles a ground supply to the horn and flasher relays. The relays close causing the flashers to flash and the horn to sound. The theft-deterrent system feature does not arm until 20 seconds elapses after the GEM receives a lock command and detects all latch switches are closed. If all switches are closed the flashers will flash. The theft-deterrent system will disarm only when:

- UNLOCK is pressed on the transmitter.
- A damaged encoded ignition key.
- UNLOCK is received from the door or liftgate key cylinder switches.
- Ignition switch is turned to ON.

POWER DOOR LOCK SYSTEM OUTLINE

id091400100900

The power door locks can be actuated by the door key cylinder. The door lock cylinder switch is an internal part of the door latch. Turning the key cylinder to the lock position will lock all doors. Turning the lock cylinder to the unlock position will unlock all doors.

If equipped with slam-locking, the doors can be locked if any door is ajar. If not equipped with slam-locking, when the driver’s door is ajar and the doors are locked with a door key cylinder, the transmitter or a door lock switch, all doors will automatically unlock after 0.6 seconds.

POWER DOOR LOCK SYSTEM OPERATION

id091400101000

The generic electronic module (GEM) controls the power door lock and keyless entry system. Lock and unlock operation is achieved through the use of internal relays in the GEM. The relays are all door lock, all door unlock and driver door unlock. The normal path of the relays is to ground.

Pressing the door lock control switch to lock or unlock sends a ground signal to the GEM. The same GEM terminal is used for lock and unlock input. The unlock signal is a direct connection to ground. The lock signal is altered by an internal resistor in the door lock control switch. This varied resistance identifies the lock or unlock command to the GEM.

The door locks can also be controlled by the door key cylinder switches. Turning the door key cylinder switch to lock or unlock, sends a ground signal to the GEM. When the GEM receives the signal, current is supplied to the actuator and all the door lock and unlock relays are grounded.

The GEM will prevent the doors from being locked if the driver’s door is in the ajar position. If a lock command is received by the GEM and the driver’s door is ajar, the GEM will immediately actuate the all door unlock after 0.6 seconds. (If not equipped with slam-locking) If the driver’s door is ajar, the door ajar switch is open. If a lock command is carried out, the actuator switch will change states to the lock position and the circuit will be interrupted. The GEM will interpret the input from the terminals and determine the door is ajar. The GEM will then activate all door unlock.

DOUBLE LOCKING SYSTEM OPERATION

id091400103600

When the GEM receives a valid lock command from a control lock switch, key cylinder switch or the remote keyless entry transmitter it grounds the internal all lock relay supplying lock voltage to the actuators. The GEM starts an internal timer as soon as the lock command is received. If a second lock command is received from a key cylinder switch or remote keyless entry transmitter within three seconds of the original lock command, the GEM will ground a second internal relay, supplying voltage to the lock actuators again. The two voltages are supplied to the actuators through separate terminals of the GEM connector and separate terminals on the actuators. The ground remains constant through the GEM internal unlock relay. If the vehicle is equipped with a perimeter alarm system, the alarm will arm after the prearming timer expires. The doors and liftgate must be closed for the double lock to function. If the door ajar circuit is at open, double lock will be disabled. The double lock voltage will not be actuated if the ignition switch is in ON, the key is in the ignition or an unlock command is received within the timing period.

KEYLESS ENTRY SYSTEM CONSTRUCTION/OPERATION

id091400103700

The keyless entry system consists of the following parts:
- Two-button transmitter
- Generic electronic module (GEM)

The transmitter has the following door lock system functions:
- Unlocks all doors.
- Locks all doors.
- Turns the interior light on (when unlocking), and off (when locking).
- Up to four transmitters can be programmed.

Note
- When the ignition switch is in the ON or ACC position, transmitter input is not received.

Additional transmitters can be programmed. When programming an additional transmitter, reprogram all transmitters that are to be used.

If equipped with anti-theft, to confirm that the doors have been locked and that the anti-theft system has armed, press the LOCK button again, within three seconds of the first press. The parking lamp will flash once if the doors have locked and all doors and hood are closed.
The transmitter sends a signal that is received by the GEM internal antenna. Depending on the signal received, the GEM module will lock all doors or unlock all doors. If the lock signal is received again within three seconds the double lock feature will engage (if equipped).

IMMOBILIZER SYSTEM (PATS) CONSTRUCTION

id091400103800

The immobilizer system consists of the following parts:
- Security light
- Encoded ignition key
- Coil antenna
- Power train control module (PCM)
- Standard corporate protocol (SCP) communication network

IMMOBILIZER SYSTEM (PATS) OPERATION

id091400103900

The immobilizer system uses radio frequency identification technology to deter a drive away theft.
The immobilizer system uses a specially encoded ignition key. Each encoded ignition key contains a permanently installed electronic device called a transponder. Each transponder contains a unique electronic identification code of over four quadrillion possible combinations.
Each encoded ignition key must be programmed into the vehicle's powertrain control module (PCM) before it can be used to start the engine. There are special diagnostic repair procedures described in this section that must be performed if a new encoded ignition key is necessary.
The coil antenna communicates with the encoded ignition key. The coil antenna is located behind the steering wheel column and contains a coil antenna connected to a compact electronic module. During each vehicle start sequence, the coil antenna reads the encoded ignition key identification code and sends data to the PCM.
The control functions are contained in the PCM. This module performs all of the immobilizer functions, such as receiving the identification code from the encoded ignition key and controlling the engine start/off. The PCM initiates the key interrogation sequence when the ignition switch is turned to the ON or START position.
All elements of the immobilizer system must be functional before the engine can be started. If any of the components are not working correctly, the engine will not start.
The immobilizer system uses a visual security light. The security light will prove out for three seconds when the ignition switch is turned to the ON or START position under normal operation. If there is an immobilizer system malfunction, the security light will either flash rapidly or glow steadily when the ignition switch is turned to the ON or START position. The immobilizer system also flashes the security light every two seconds when the ignition is turned off to act as a visual theft deterrent. The security light is located in the instrument cluster. The security light is controlled through the standard corporate protocol (SCP) communication network. The PCM sends the security light signal through the SCP communications network to the instrument cluster. The instrument cluster then triggers the security light to illuminate.
The immobilizer system will be activated and will disable the vehicle from starting if any of the following occur:

- An incorrectly coded ignition key.
- A damaged encoded ignition key.
- An unprogrammed key.
- A non-encoded key (key has no electronics).
- Damaged wiring harness.
- A damaged coil antenna.
- A damaged PCM.
- A module communications network malfunction.

09-15 SUNROOF

SUNROOF CONSTRUCTION

id091500100800

The sunroof consists of the following parts:
- Deflector
- Overhead console
- Glass panel
- Sunroof motor
- Sunroof relay
- Sunshade
- Sunroof switch
- Drain hoses

The sunroof is an electronically operated panel that can be opened or closed by depressing the sunroof switch located inside the vehicle on the overhead console. It also has a one-touch open feature.
When the rearward side of sunroof switch is pressed, the sunroof moves back into the storage space between the headliner and the roof.
The sunroof can be moved to the fully closed position by pressing the forward side of the switch and holding it until the sunroof is fully closed.
When the sunroof is in the fully closed position, the rear portion can be raised to the vent position to provide ventilation by pressing the forward side of the switch. The sunroof can be closed by pressing the rearward side of the switch.

SUNROOF OPERATION

id091500100900

The sunroof is an electronically operated panel that can be opened or closed using the sunroof switch. Actuating either the forward or rearward side of the switch supplies a ground to the sunroof relay. The sunroof relay supplies the power to the sunroof motor when the switch is pressed. The vent and soft-stop functions are controlled by the sunroof relay and an internal sunroof position switch within the sunroof motor. These positions are obtained when an internal motor cam opens the sunroof position switch removing the ground from the switch.

09-16 EXTERIOR TRIM

EXTERIOR TRIM CONSTRUCTION

id091600100300

The exterior trim consists of the following parts:
- Fender moldings
- Front door moldings
- Luggage rack
- Radiator grille
- Rear door moldings
- Side step moldings

09-17 INTERIOR TRIM

DASHBOARD CONSTRUCTION

id091700100400

The dashboard consists of the following parts:
- Glove compartment
- Instrument cluster
- Meter hood
- Dashboard panel top cover
- Steering column cover
- Utility compartment
- Passenger-side air bag module

FLOOR CONSOLE CONSTRUCTION

id091700100500

The floor console consists of the following parts:
- Arm rest
- Floor console
- Rear cup holders
- Storage compartment

HEADLINER CONSTRUCTION

id091700100600

The headliner consists of the following parts:
- Light switches
- Sunroof switch (Vehicles with sunroof only)
- Sunglasses compartment
- Interior light/map lights
- Cargo compartment light

09-18 LIGHTING SYSTEMS

LIGHTING SYSTEMS SPECIFICATION

id091800100200

Item		Specifications (W) × number
Exterior light bulb capacity	Headlight bulb (high-beam/low-beam)	60/51 × 2
	Front turn light bulb	21 × 2
	Parking light bulb	5 × 2
	Front side turn light bulb (Non-LED)	5 × 2
	Front side turn light bulb (LED)	2.26 × 2
	Front fog light bulb	55 × 2
	Brake light/taillight bulb (LED)	4.5/2.3 × 2
	Rear turn light bulb	21 × 2
	Back-up light bulb	16 × 2
	License plate light bulb	5 × 2
	High-mount brake light bulb	5 × 4
Interior light bulb capacity	Map light bulb	5 × 2
	Map/Interior light bulb	5 × 2 / 8 × 1
	Interior light bulb (Type A)	10 × 1
	Interior light bulb (Type B)	8 × 1
	Cargo compartment light bulb	10 × 1
	Vanity mirror illumination bulb	1.8 × 1

EXTERIOR LIGHTING SYSTEM CONSTRUCTION

id091800102800

The exterior lighting system consists of the following parts:
- Headlight
- Front turn light/front side turn light
- Parking light
- Front fog light
- Front side turn light
- High-mount brake light
- Rear turn light
- Back-up light
- Brake/taillight
- License plate light
- Front fog light switch
- TR switch

The headlight switch is integrated into the combination switch.

INTERIOR LIGHTING SYSTEM CONSTRUCTION

id091800101000

The interior lighting system consists of the following parts:

- Map light
- Interior light
- Cargo compartment light
- Generic electronic module (GEM)
- Map light switch
- Interior light switch
- Cargo compartment light switch

Map/Interior Light

The map/interior light has a three position switch: OFF, DOOR, and ON. The map/ interior light automatically illuminates if any door is opened when the switch is at the DOOR position.

Cargo compartment light

The cargo compartment light is located in the cargo area and has a three position switch: OFF, DOOR, and ON. The light is operated by integral switch in the liftgate switch.

INTERIOR LIGHTING SYSTEM OPERATION

id091800102900

The generic electronic module (GEM) supplies voltage and ground to the courtesy lights when any of the following inputs are received:

- Any door is opened
- Liftgate or liftgate glass is opened
- Keyless entry unlock signal is received
- Key cylinder switch turned to unlock

The courtesy lights are turned off when any of the following conditions exist:

- All the doors, liftgate, and liftgate glass are closed.
- The ignition switch is turned to the ON position.
- The key cylinder switches are turned to lock.
- A keyless entry lock signal received.

The illuminated entry feature is a separate function which also activates the interior lights. It functions as follows: The GEM illuminates the interior lights at 80 percent brightness when an unlock signal is received from a keyless entry transmitter or key cylinder switch, or a door handle is lifted when locked. If no door opened signal is received, the GEM will turn the interior lights off. The illuminated entry feature will be canceled when any of the following conditions are met:

- The remote transmitter lock button is pressed and the map/interior light control is not activated.
- The ignition switch is at the ON or START position and the map/interior light control is not activated.

Battery Saver

The GEM is equipped with a battery saver which will turn the lights off after 45 minutes of inactivity. This feature is an internal function of the GEM software.

09-19 WIPER/WASHER SYSTEM

WINDSHIELD WIPERS AND WASHER SYSTEM STRUCTURE

id091900102000

The windshield wiper and washer system consists of the following:

- Windshield wiper blade
- Windshield wiper arm
- Windshield wiper motor
- Windshield wiper and washer switch
- Generic electronic module (GEM)
- Washer tank
- Windshield washer motor
- Windshield washer nozzle

WINDSHIELD WIPER AND WASHER SYSTEM OPERATION

id091900101900

The wiper system has six different operation modes: off mode, low-speed mode, high-speed mode, interval mode, one-touch wiper mode, and wash mode.

Off Mode
There is no windshield wiper motor activity, and the windshield wiper motor is in the PARK position.

Low-Speed Mode
The windshield wiper motor is set to a low-speed setting. The wiper/washer switch provides voltage to the windshield wiper motor through the low-speed circuit. The windshield wiper motor provides ground through a dedicated ground circuit.

High-speed mode
The windshield wiper motor is set to a high-speed setting. The wiper/washer switch provides voltage to the windshield wiper motor through the high-speed circuit. The windshield wiper motor provides ground through a dedicated ground circuit.

Interval Mode
The windshield wiper motor is set to a low-speed setting. The windshield wiper interval relay is activated at the beginning of each wipe and deactivated when the windshield wiper motor park switch reaches the run position. The interval relay is integrated in the wiper/washer switch.
When the wiper/washer switch is in the interval (INT) position, the windshield wipers will make a single sweep followed by a pause.

One-Touch Wiper Mode
If the wiper/washer switch are held between 0.10.3 s with the mode switch in the off position, the wiper system will provide one low-speed wipe with no wash.

Wash Mode
To engage the windshield washer, pull the wiper/washer switch toward the steering wheel. When the wiper/washer switch is in the OFF or INT position, the windshield wiper/washer will run as long as the lever is pulled. When the knob is released, the washer will stop immediately, but the windshield wipers will continue to run for two to three sweeps, then return to the OFF position.

REAR WIND WIPERS AND WASHER SYSTEM STRUCTURE

id091900101700

The rear window wiper and washer system consists of the following:
- Rear wiper blade
- Rear wiper arm
- Rear wiper motor
- Rear wiper and washer switch
- Generic electronic module (GEM)
- Washer tank
- Rear washer motor
- Rear washer hose
- Rear window washer hose check valve
- Rear washer nozzle

REAR WIPER AND WASHER SWITCH OPERATION

id091900101800

The generic electronic module (GEM) allows operation of the rear window wiper functions when the ignition switch is in the ON or ACC position only. The GEM controls the cycling of the rear window wiper motor through the rear window wiper relay.
There are four modes of operation: off mode, interval mode, on mode, and wash mode.

Note
- The GEM does not control the rear window washer, only the rear window wiper.

Off Mode
In the off mode, there is no rear wiper motor activity and rear wiper motor is in the PARK position.

Interval Mode
When the wiper/washer switch is placed in the interval position, the GEM activates the wipe cycle of the rear window wiper motor. Once the wiper cycle has reached the LOW position, after the initial wipe, the GEM will start a cyclical timing function.

On Mode
The GEM cycles the rear window wiper motor continuously at a set-speed setting. The GEM provides ground to activate the rear window wiper relay.

Wash Mode
When the wiper/washer switch is pressed and held for 0.1 s or more, the GEM supplies ground through the wiper/washer switch and cycles the rear window wiper motor three times.

09-20 ENTERTAINMENT

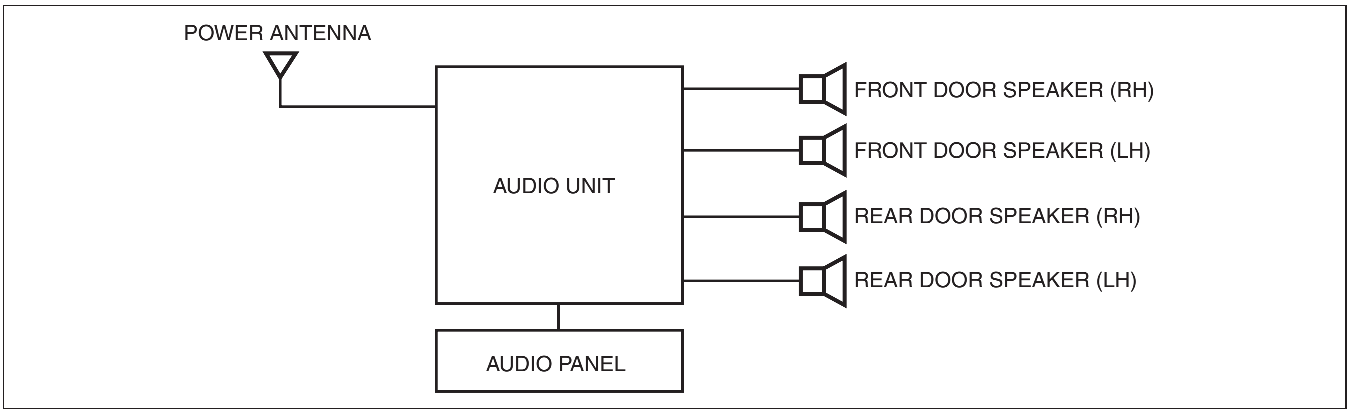
ENTERTAINMENT OUTLINE

id092000100100

- The audio system consists of the following parts:
  - — Audio unit (AM/FM tuner, and CD player or CD changer)
  - — Audio panel
- Unit availability depends on vehicle grade.
- An audio control switch is equipped on the steering wheel for audio operation.
  - — Front door speaker
  - — Rear door speaker

AUDIO SYSTEM BLOCK DIAGRAM

id092000100300



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09

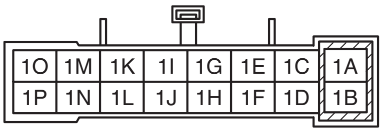
AUDIO SYSTEM SPECIFICATIONS

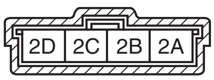
id092000100400

Audio Unit

Item			Specification
Rated voltage		(V)	12
Frequency band	AM	(kHz)	531—1710
	FM	(MHz)	87.5—108.0
Audio amplifier maximum output power		(W)	45×4
Output impedance		(ohm)	4

Terminal Layout and Signal

Terminal		Signal
	1A	Left front speaker (+)
	1B	—
	1C	—
	1D	—
	1E	M-ANT
	1F	ACC
	1G	TEL MUTE
	1H	Rear door speaker LH (-)
	1I	B+
	1J	Rear door speaker RH (-)
	1K	Rear door speaker RH (+)
	1L	Front door speaker RH (-)
	1M	Front door speaker RH (+)
	1N	Front door speaker LH (+)
	1O	Front door speaker LH (-)
	1P	Rear door speaker LH (+)

Terminal		Signal
	2A	Dimmer (+)
	2B	Dimmer (-)
	2C	Steering switch (+)
	2D	Steering switch (-)

ON-BOARD DIAGNOSTIC SYSTEM OUTLINE

id092000101700

- The on-board diagnostic system has a self-diagnostic function to help technicians locate malfunctions.

ON-BOARD DIAGNOSTIC SYSTEM FUNCTION

id092000101800

Display Function

- When an error occurs, the LCD displays the error messages.

Screen display Error messages	Possible cause	Inspection
ERROR 1	Disc is dirty, or is upside down. A disc that has data other than CD-DA type is loaded.	Check the disc.
ERROR 2	Disc has scratches.	Check the disc.
ERROR 3	No operation by some cause.	If normal operation is not restored, remove the unit and waiting for repairs.
NO DISC	No disc in the changer (magazine)	Insert discs into the changer (magazine)

Note

- This table was created based on quoted material from Panasonic Taiwan Co., Ltd. Technical Maintenance Instructions.

AUDIO CONTROL SWITCH OUTLINE

id092000100500

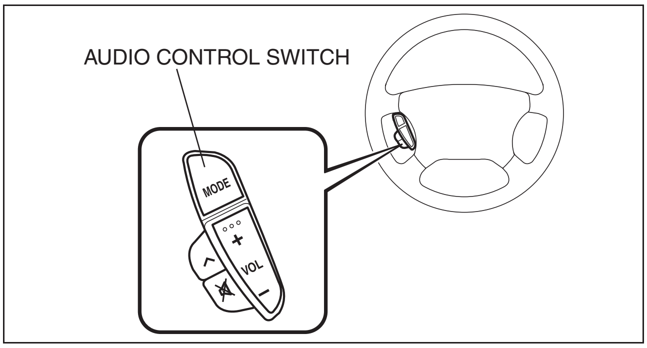
- A remote control for the audio system, with simplified design for easy operation, has been adopted.

AUDIO CONTROL SWITCH CONSTRUCTION/OPERATION

id092000100600

Construction

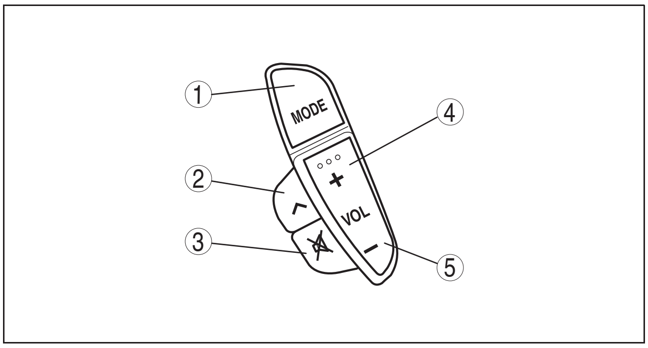
- The audio control switch is located on the steering wheel.



aesffn00000101

Operation

No.	Button (component)	Function
1	Mode button	Selects the audio mode (AM→FM1→FM2→CD/CD changer)
2	AUTO scan button	Selects radio stations
	AUTO track button	Changes tracks
3	Mute button	Mute
4	Volume button (+)	Volume up
5	Volume button (-)	Volume down



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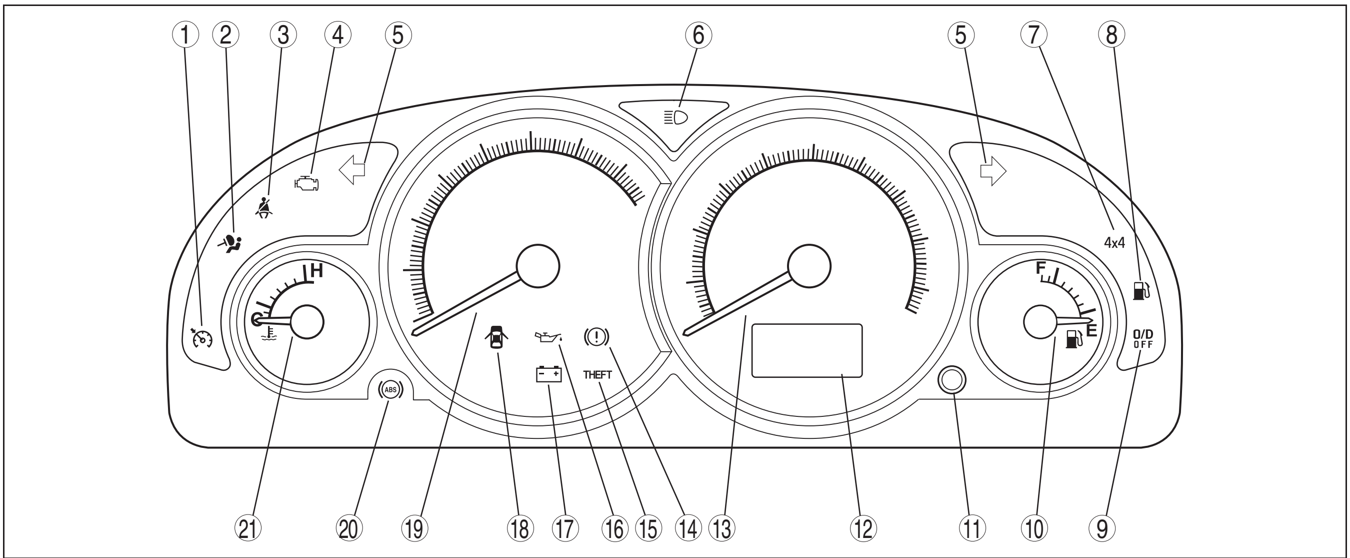
09-22 INSTRUMENTATION/DRIVER INFO.

INSTRUMENT CLUSTER OUTLINE

id092200100200

- The instrument cluster consists of the following meters, gauges, and warning/indicator lights.



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1	Cruise control indicator light
2	Air bag system warning light
3	Seat belt warning light
4	MIL
5	Turn indicator light
6	High-beam indicator light
7	4x4 indicator light (4x4)
8	Fuel-level warning light
9	O/D OFF indicator light (ATX)
10	Fuel gauge
11	Odometer/tripmeter switch

12	LCD (Odometer/trip meter, selector indicator light)
13	Speedometer
14	Brake system warning light
15	Security light (with immobilizer system)
16	Oil pressure warning light
17	Generator warning light
18	Door ajar warning light
19	Tachometer
20	ABS warning light (with ABS)
21	Water temperature gauge

09

INSTRUMENT CLUSTER FUNCTION

id092200100100

- The instrument cluster is a hybrid electronic cluster (HEC). The instrument cluster performs transmission and reception of information via standard corporate protocol (SCP) (J1850) or CAN. To perform diagnosis, it is necessary to understand the following items:
  - — Input signal origin
  - — All information necessary in order for equipment to operate.
  - — Which module (s) receive (s) the input or command message.
  - — Does the module which received the input, control the output of the equipment, or does it output a message over the SCP (J1850) or CAN line to another module?
  - — Which module controls the output of the feature.
- The instrument cluster diagnoses and verifies that all warning/indicator miniature bulbs and monitored systems are functioning correctly. When the ignition switch is in the ON position with the engine off, the following warning indicators will illuminate:
  - — MIL
  - — Generator warning light
  - — Oil pressure warning light
  - — ABS warning light
  - — Seat belt warning light
  - — Air bag system warning light
  - — Brake system warning light
  - — Fuel-level warning light
  - — Security light (vehicles with immobilizer system)
  - — O/D OFF indicator light

Gauge Indication System

- The gauge indication systems use stepping motor-type gauges mounted in the instrument cluster. No adjustment, calibration, or maintenance is necessary for any of the gauges. The gauges cannot be installed separately.

Speedometer

- The instrument cluster receives the vehicle speed signal from the powertrain control module (PCM) via the SCP (J1850) or CAN line network. If the instrument cluster receives no signal, the speedometer will default to 0.0 km/h (0.0 mph).

Odometer

- The vehicle is equipped with two odometers. The primary odometer shows cumulative distance. The second odometer is the trip and tenths odometer.

Tachometer

- The tachometer is electrically operated and indicates engine speed in a range of 0 to 8,000 rpm. The tachometer receives the signal via the SCP (J1850) or CAN line from the PCM. If the rpm information sent to the instrument cluster is invalid or missing, the instrument cluster will default the tachometer to 0.0 rpm.

Fuel gauge

- The instrument cluster receives the fuel signal via hard-wired circuitry from the fuel pump unit. The fuel pump unit changes resistance according to the amount of fuel in the fuel tank and varies the current flow through the fuel gauge. A low resistance will result in a lower gauge indication, while a high resistance will result in a higher gauge indication. The fuel gauge is controlled by the instrument cluster microprocessor and varies the position according to data received from the fuel pump unit.

Water temperature gauge

- The instrument cluster receives the engine coolant temperature signal from the PCM via the SCP (J1850) or CAN line and displays the information on the water temperature gauge. If the instrument cluster receives no signal the water temperature gauge will default to the COLD position.

Oil pressure warning light

- The oil pressure warning light is hard-wired to the oil pressure switch. The oil pressure switch is a normally closed switch. When the engine is off or has no oil pressure the switch is closed, providing a ground path to turn on the light. When the engine is running and there is oil pressure present, the switch is opened and no ground is provided.

Generator warning light

- The generator warning light is hard-wired to the generator and illuminates when the generator output is insufficient to maintain the battery charged.

Air bag system warning light

- The air bag warning light is hard-wired to the SAS control module. When the air bag system is operating correctly, the air bag warning light illuminates for approx. 6 s when the ignition switch is turned to the ON position. It only illuminates after starting if a malfunction is present in the air bag system.

Malfunction indicator lamp

- When the ignition switch is in the ON position the bulb will diagnose. During vehicle operation, the malfunction indicator lamp (MIL) illuminates when the PCM has detected a malfunction. If a malfunction is detected the PCM sends a signal to the instrument cluster via the SCP (J1850) or CAN line and turns on the MIL lamp.

High-beam indicator light

- The high beam indicator is hard-wired to the steering column light switch and illuminates when the headlights are placed in the high beam position or the flash-to-pass position.

Turn indicator light

- The RH or LH turn indicator lights are hard-wired to the steering column light switch and illuminate intermittently relative to the position of the turn signal switch on the steering column.

Brake system warning light

- The brake system warning light has multiple functions. It illuminates when the parking brake is applied, when the brake fluid level is low or when a fault is detected in the anti-lock brake system (ABS). It utilizes both hard-wired circuitry and the instrument cluster microprocessor. The bulb diagnosis occurs for approx. 3 s after turning the ignition switch to the ON position. The brake system warning light will go out following diagnosis if the brake fluid level is correct, the parking brake is released, and no ABS malfunction is detected.

ABS warning light (with ABS)

- The ABS warning light illuminates when the ABS HU/CM detects a malfunction in the system. If a malfunction is detected, the ABS HU/CM sends a signal to the instrument cluster and the instrument cluster illuminates the ABS warning light.

Seat belt warning light

- The seat belt warning light illuminates when the driver seat belt is not fastened. The driver seat belt retractor switch (part of the retractor) is hard-wired to the instrument cluster and provides the input into the instrument cluster signaling when the seat belt is connected. The instrument cluster then illuminates the bulb depending on the seat belt retractor position.

Security light (with immobilizer system)

- The security light located in the instrument cluster is controlled by a signal sent via the SCP (J1850) or CAN line from the PCM.

4x4 indicator light (4x4)

- The 4x4 indicator light is hard-wired to the 4x4 control module and illuminates when the four-wheel drive is selected.

Door ajar warning light

- The door ajar indicator is hard-wired to the generic electronic module (GEM) and will illuminate when any of the doors, or the liftgate, are opened.

Fuel-level warning light

- The fuel-level warning light diagnoses for 3 s when the ignition is turned to the ON position. The indicator will then remain on if the fuel level is less than approx. 10 L.

O/D OFF indicator light

- The O/D OFF indicator light will illuminate when the transaxle overdrive has been turned off. The instrument cluster receives a switch status signal via the SCP (J1850) or CAN line from the PCM.

Selector indicator light

- The instrument cluster selector indicator light is a liquid crystal display (LCD) that displays the transmission range selected. Two sets of input signals are necessary for the indicator to operate correctly. The instrument cluster receives the transaxle range signal via hard-wired circuitry from the transmission range selector and displays the appropriate range in the LCD. The park interlock solenoid provides the second input. If the park interlock input is not present, the P range will not be highlighted in the LCD display.

Cruise control indicator light
- The cruise control indicator light will illuminate when the cruise control system is operated.

Warning Systems
- The warning chime module is built into the instrument cluster. The system consists of the following components:
  — Instrument cluster
  — Seat belt retractor switch, an integral part of the driver seat belt retractor
  — Door lock switch
  — Ignition switch
  — Light switch

Seat belt warning chime
- The seat belt warning chime alerts that the seat belt is not fastened. The seat belt chime will sound when the driver seat belt is not fastened and the ignition switch is turned from the off to the ON or START position. The seat belt warning chime will stop when the seat belt is fastened or when the ignition is turned off.
- The seat belt warning chime input signals are:
  — The ignition switch position
  — Driver's seat belt retractor switch

R-position warning alarm
- The reverse warning chime sounds when the vehicle is in reverse gear while the ignition switch is in the ON position.
- The reverse warning chime inputs signals are:
  — Ignition switch in the ON position
  — Transaxle range switch

Door ajar warning chime
- The door ajar warning chime sounds when the front driver side door or front passenger side door becomes ajar while the ignition switch is in the ON position.
- The door ajar warning chime will stop when the door is closed or when the ignition switch is turned off.
- The door ajar warning chime input signals are:
  — Ignition switch in the ON position
  — Door switch

Headlight on warning chime
- The headlight on warning chime sounds if the parking lamps or the headlights are left on after the key has been removed from the ignition switch lock cylinder and the driver door is opened.
- The warning chime will stop when any of the above conditions are removed.
- The headlight-on warning chime input signals are:
  — Ignition switch
  — Light switch
  — Door switch (driver-side)

Key in ignition warning chime
- The warning sounds if the key is left in the ignition switch lock cylinder when the driver door is opened and the ignition switch is in the OFF or ACC position.
- The warning chime will stop when any of the above conditions are removed.
- The key in ignition warning chime input signals are:
  — Ignition switch
  — Door switch (driver-side)

HORN OUTLINE

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- The horn system consists of the following parts:
  — Horn switch (Driver-side air bag module)
  — Horn
  — Horn relay
  — Clock spring

09-40 CONTROL SYSTEM

MULTIPLEX COMMUNICATION SYSTEM[L3]

id0940001003a5

Simplified wiring harness	• CAN system adopted for communication between PCM, ABS HU/CM and instrument cluster
Improved serviceability	• On-board diagnostic system (OBD) adopted

MULTIPLEX COMMUNICATION SYSTEM WIRING DIAGRAM[L3]

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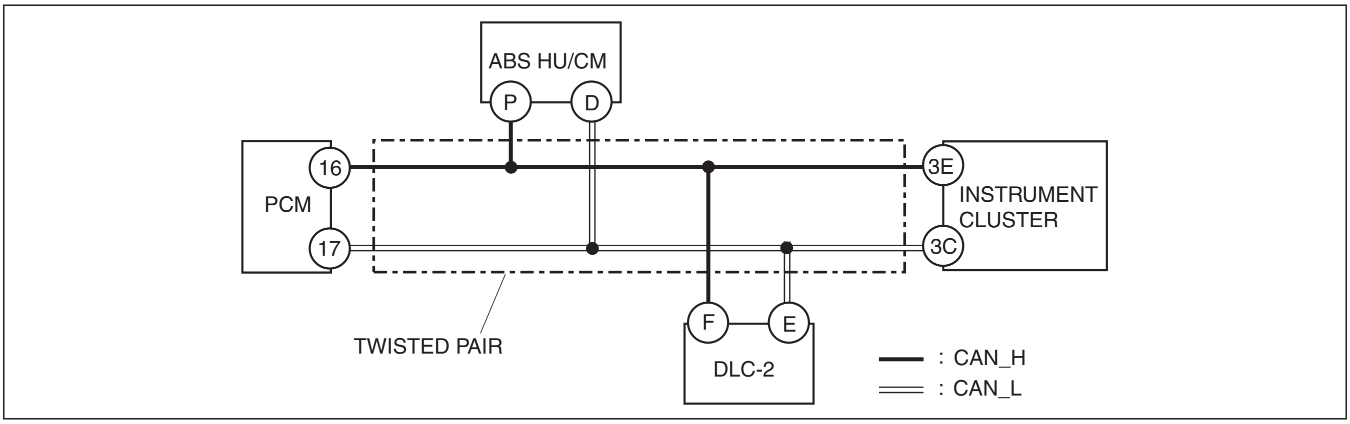

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MULTIPLEX COMMUNICATION SYSTEM CONSTRUCTION/OPERATION[L3]

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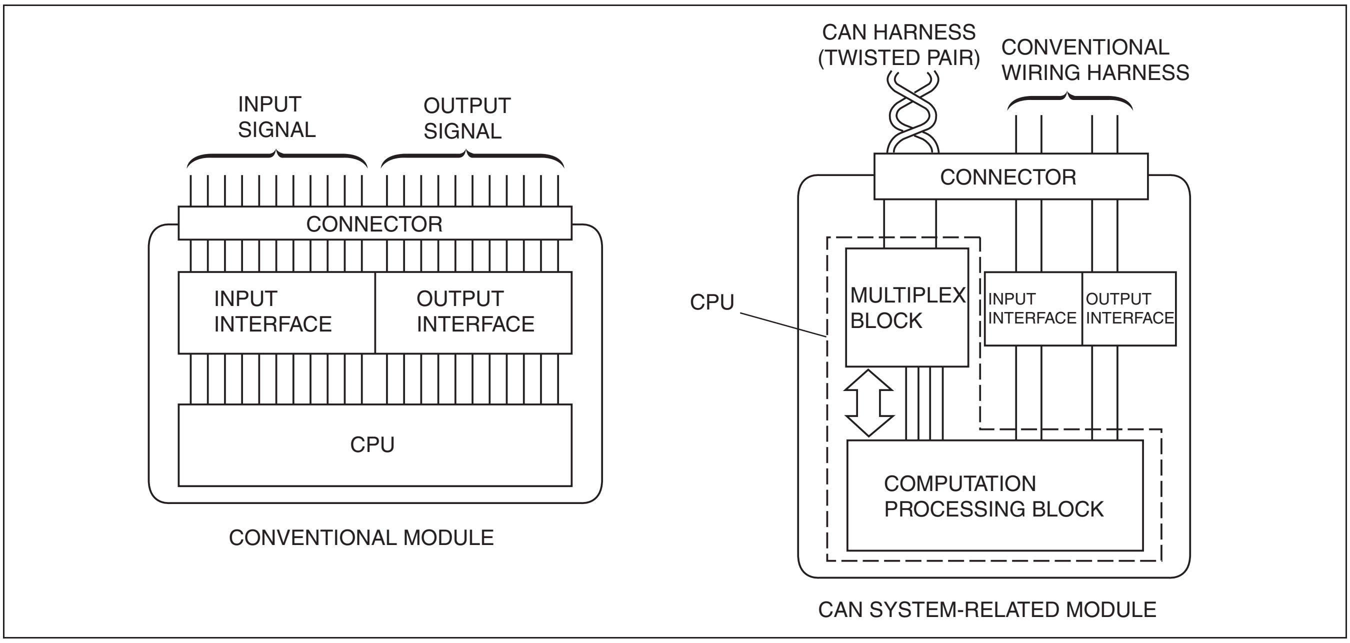
CAN System-Related Module Construction

- A CAN system-related module is composed of a power circuit, CPU, and input/output interface.
- Module size has been reduced due to the elimination of redundant parts of the input/output interface used in conventional types of electronic modules.
- The CPU (multiplex block) controls all signals exchanged via the bus lines (multiplex communication system wiring harnesses).
- Communication with non-multiplex parts is carried out using conventional input/output interface.
- The functions of each component are shown below.

Component		Function
Power circuit		Supplies power to CPU and vicinity, and to input/output interface.
CPU	Computation processing block	In addition to conventional CPU function, when transmission is necessary, transmitted data is stored in a multiplex block. When the multiplex block receives a request to read stored data, transmitted data is read from the multiplex block.
	Multiplex block	Transmits data received from bus lines to computation processing block. In addition, sends transmitted data stored from computation processing block to bus lines.
Input interface circuit		Converts information signals from switches to electrical signals that can be input to CPU.
Output interface circuit		Converts electrical signals output from CPU for operating motors and other parts.



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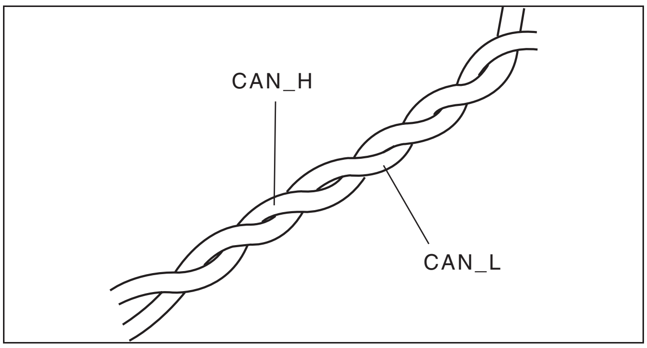
Twisted Pair Construction

- The CAN system uses two spirally twisted wires called a twisted pair, and each wire, bus line A (CAN_L) and bus line B (CAN_H), has unique characteristics.
- Both bus lines are opposite phase voltage so that emitted noise is lessened and exterior noise interference is not easily received.



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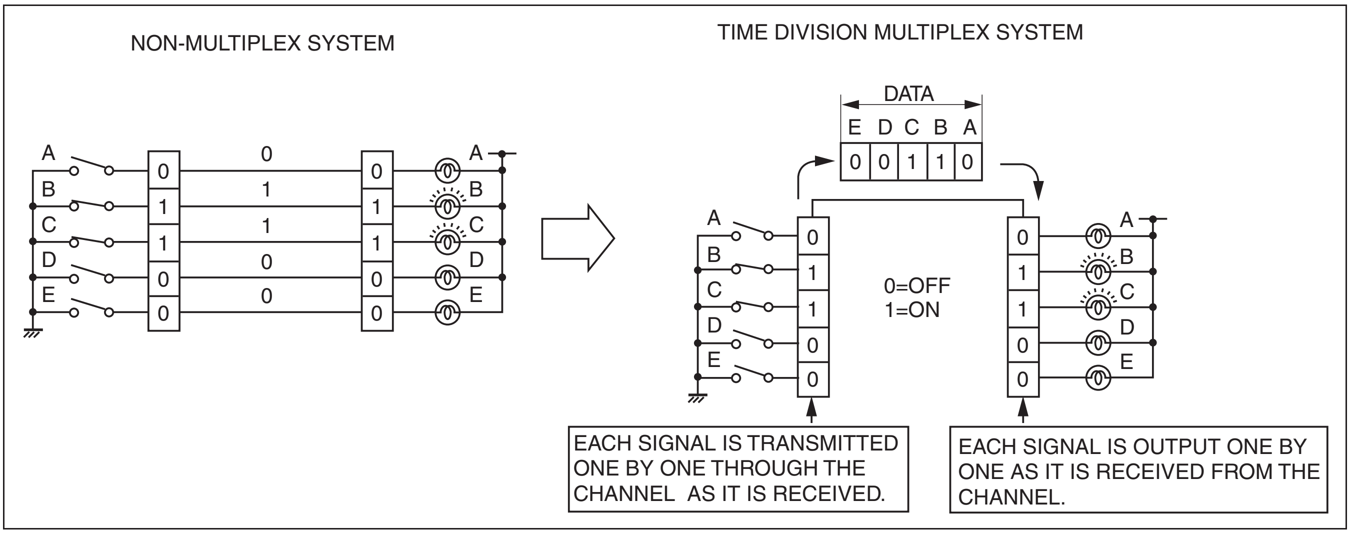
CAN System Outline

- For information exchange between electronic modules in a conventional system, separate information signals are required. However, with the CAN system, it is possible to send a large amount of information via a small wiring harness by sending multiple signals at varying times over one channel. This is referred to as time division multiplexing.

CAN System Operation

Time Division Multiplex

- In the conventional, non-multiplex system, in order to control the illumination of the five bulbs, one switch and one channel was necessary for each bulb. For bulbs B and C to illuminate, switches B and C must be connected and electricity must flow through each transmission channel.
- With the time multiplex system, this can be done through a single wire. The channel is comprised of five data signal transmitters which transmit either a “0” or “1” signal to indicate whether a bulb turns ON or OFF. For example, to illuminate bulbs B and C, transmitters B and C transmit a “1” and transmitters A, D, and E transmit a “0”. When the receiver receives these signal, bulbs B and C are illuminated.



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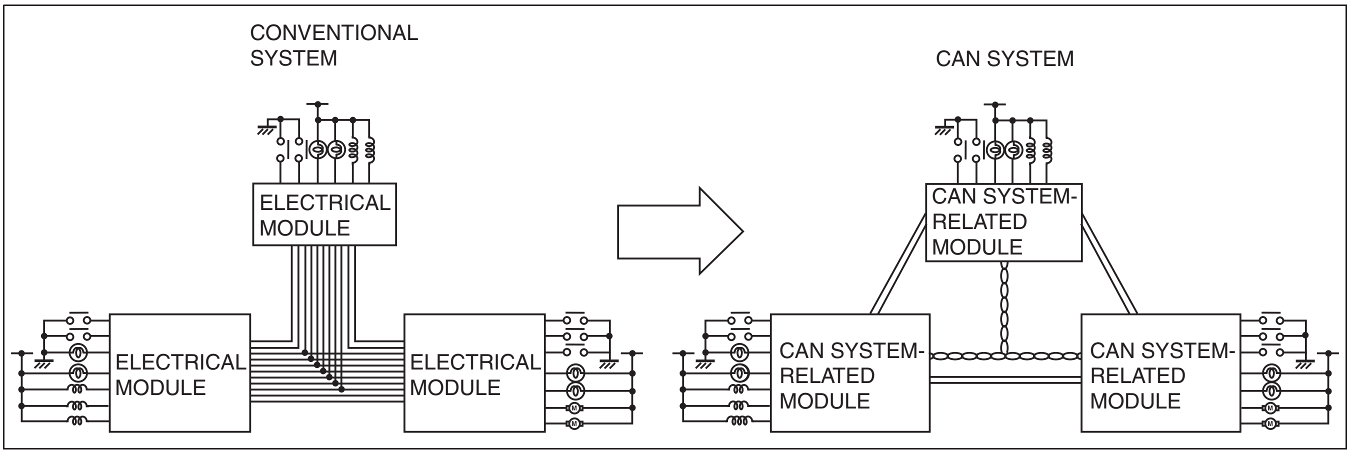
Vehicle CAN System

- By rearranging the multiple signal, common information between the electronic modules is transmitted and received via the twisted pairs.
- The signal transmitted by one CAN system-related module is sent via twisted pairs to all the CAN system-related modules, but only the corresponding module(s) receives the signal and performs the appropriate operation.



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CAN Signal Table

- Sending/receiving of CAN signals is as follows:

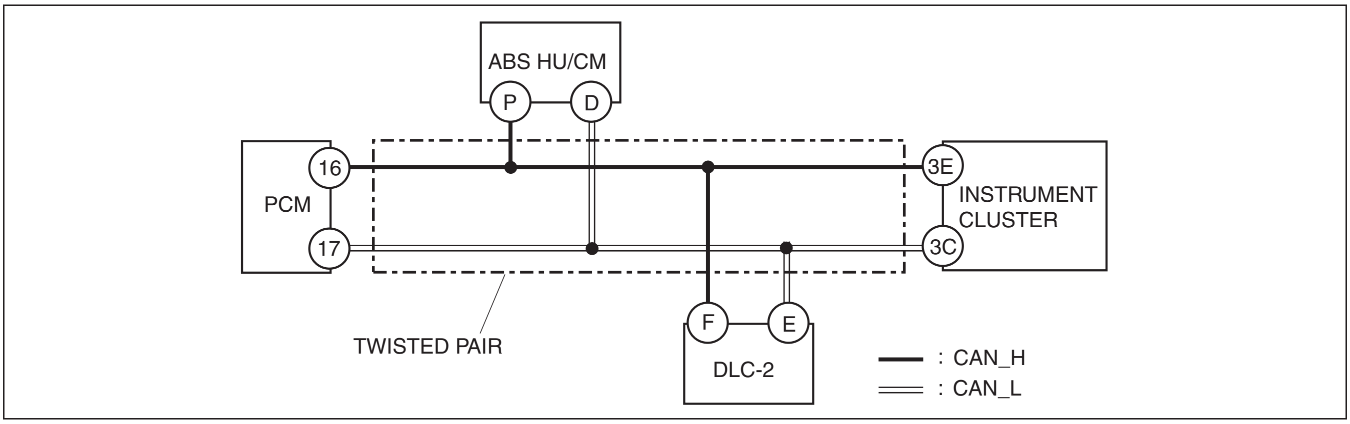
OUT: Output (Sends signal)
IN: Input (Receives signal)

Signal	CAN system-related module		
	PCM	ABS HU/CM	Instrument cluster
Engine speed	OUT	—	IN
Vehicle speed	OUT	—	IN
Brake system warning light illumination request	—	OUT	IN
ABS warning light illumination request	—	OUT	IN
ECT	OUT	—	IN
Distance travelled	OUT	—	IN
Engine warning light illumination request	OUT	—	IN
O/D OFF indicator light illumination request	OUT	—	IN
Generator warning light illumination request	OUT	—	IN
Wheel speed (LF, RF, LR, RR)	IN	OUT	—
Engine specification	OUT	IN	—

ON-BOARD DIAGNOSTIC SYSTEM OUTLINE

- CAN system-related modules have an on-board diagnostic function that is able to determine malfunction locations when there is an irregularity in the CAN system.
- The on-board diagnostic function has a malfunction detection function that detects irregularities in CAN system-related parts, a memory function that stores detected malfunctions, and a display function that displays the location and contents of malfunctions via DTC output.
- DTCs can be read out and cleared using the IDS/PDS.
- The CAN system has a fail-safe function. When a malfunction occurs in the CAN system, the transmission module sends a warning signal, the receiving module illuminates the warning light, and the fail-safe function performs control to safeguard the system.

On-Board Diagnostic System Construction/Operation
Block Diagram



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Malfunction detection function

- Detects irregularities in the input/output signals of CAN system-related modules.
- The DTC for the detected malfunction is output to the DLC-2, and the detected result is also sent to the memory, display, and fail-safe functions.

Fail-safe function

- When the malfunction detection function determines that there is an irregularity, the fail-safe function illuminates a warning light to advise the driver and controls input and output parts to allow safe driving.

Memory function
- Stores DTCs for malfunctions of the input/output signal system, as determined by the malfunction detection function.

Display function
- Outputs the signal for a malfunction determined by the malfunction detection function as a DTC to the DLC-2.
- DTCs can be read out using the IDS/PDS.

DTC table

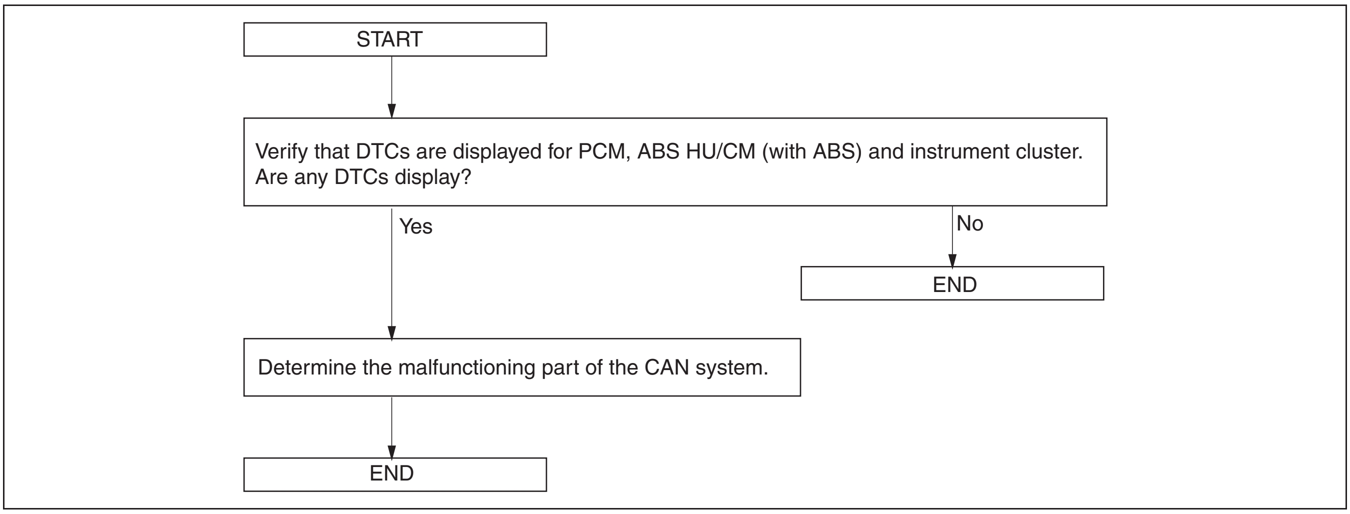
DTC	Malfunction location	DTC Output Unit
U0073	Module communication error	• PCM • Instrument cluster
U0121	Communication error	PCM
U1900	Communication error	• ABS HU/CM • Instrument cluster
U2023	Abnormal data	ABS HU/CM

PID/data monitor function
- The PID/data monitor function is used for optionally selecting input/output signal monitor items preset in the instrument cluster and reading them out in real-time.
- PIDs can be read out using the IDS/PDS.

IDS/PDS display	Status	Description	Monitor module	Terminal
ABS_MSG	Present	Communication circuit between ABS HU/CM and monitor module is normal	Instrument cluster	3E, 3C
	Not Present	Communication circuit between ABS HU/CM and monitor module is not normal		
PCM_MSG	Present	Communication circuit between PCM and monitor module is normal		
	Not Present	Communication circuit between PCM and monitor module is not normal		

Malfunction Location Determination
- The on-board diagnostic function can determine CAN system malfunction locations by verifying the detected DTC information from each module.
- Refer to the display function for a detailed explanation of DTCs. (See 09-40-5 Display function.)

Flowchart



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Example (PCM-related wiring harness open circuit)

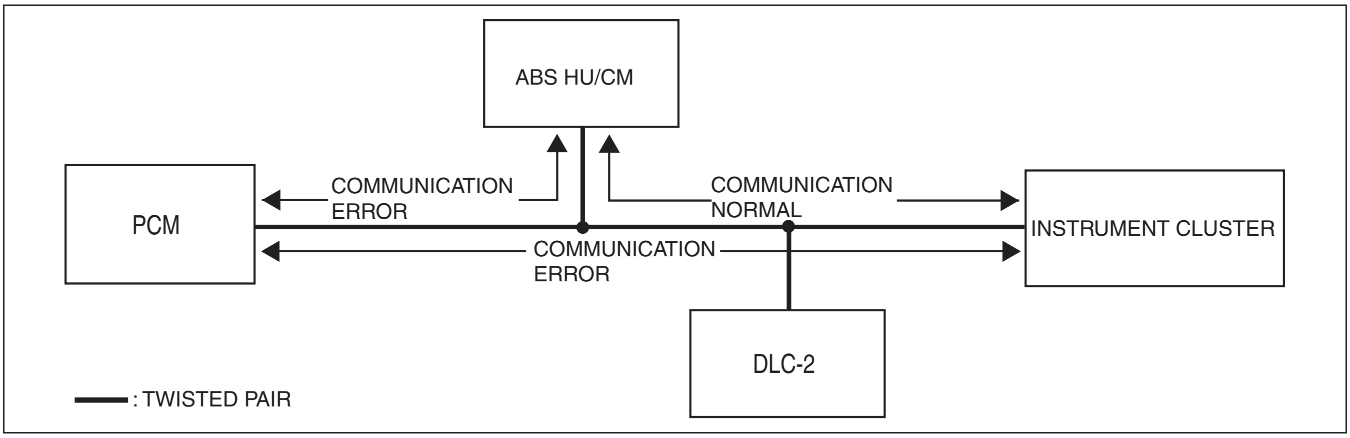
Note
- This example applies to the PCM, ABS HU/CM, and instrument cluster.

1. DTCs for CAN system-related modules are verified using the IDS/PDS.

Module	DTC	Probable malfunction location
PCM	U0073	PCM-related CAN system malfunction
	U0121	Communication error
ABS HU/CM	U2523	Communication error
Instrument cluster	U1900	Communication error

2. Instrument cluster PIDs are verified using the IDS/PDS.

PID	DTC	Probable malfunction location
PCM_MSG	Not Present	Communication error between the instrument cluster and the PCM
ABS_MSG	Present	Normal communication between instrument cluster and ABS HU/CM



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3. If there is a communication error between the instrument cluster and PCM, even if the communication between the ABS HU/CM and the instrument cluster is normal, it is probable that there is a malfunction in the PCM or PCM-related wiring harnesses.

COMMUNICATION NETWORK OUTLINE[AJ (3.0L Duratec)]

id0940001002a6

- The communication network consists of the following parts:
  — Standard corporate protocol (SCP) communication network
  — International standards organization (ISO) communication network
  — Generic electronic module (GEM)
  — PCM
  — ABS HU/CM
  — SAS control module
  — Instrument cluster

COMMUNICATION NETWORK FUNCTION[AJ (3.0L Duratec)]

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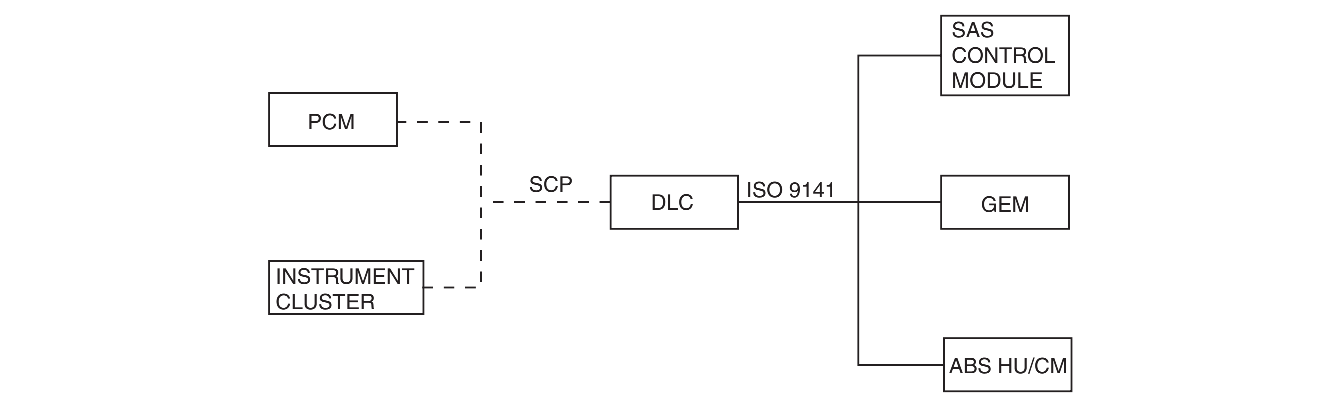
- The vehicle has two module communications networks. The standard corporate protocol (SCP) network, which is an unshielded twisted pair cable (data bus plus, circuit 914 [TN/OG] and data bus minus, circuit 915 [PK/LB]); and the international standards organization (ISO) 9141 network which is a single wire (circuit 70 [LB/WH]). The diagnostic tool can connect to both networks through the data link connector-2 (DLC-2). This makes diagnosis and testing of these systems easier by allowing one smart tester to be able to diagnose and control any module on the two networks from one connector. The DLC-2 can be found under the dashboard on the driver side.
- The SCP communication network will remain operational even with the severing of one of the bus wires. Communications will also continue if one of the bus wires is shorted to ground or power supply, or if some, but not all, termination resistors are lost.
- The ISO 9141 communication network does not permit inter-module communication. When the diagnostic tool communicates to modules on the ISO 9141 communication network, the diagnostic tool must ask for all information. The modules cannot initiate communications.
- Unlike the SCP, the ISO 9141 communication network will not function if the wire is shorted to ground or power supply. Also, if one of the modules on the ISO 9141 communication network loses power or shorts internally, communications to that module will fail.



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- The PCM is connected to the SCP communication network. The PCM controls the engine for better fuel economy, emissions control, and malfunction mode detection and storage.
- The immobilizer system is integrated into the PCM module. The PCM/immobilizer system is connected to the vehicle electrical system, the transceiver module, the vehicle SCP communications network and the security light located in the instrument cluster. The PCM module uses a microprocessor to control the system functions as well as illumination of the security light. The illumination command is sent from the PCM through the SCP communications network to the instrument cluster, which in turn sends power to the security light. The PCM module microprocessor stores the ignition key codes in non-volatile memory. The PCM and instrument cluster modules can be diagnosed through the DLC.
- The SAS control module is connected to the ISO 9141 communication network. The SAS control module controls the deployment of the air bags based on sensor input.
- The generic electronic module (GEM) is connected to the ISO 9141 communication network. The GEM controls a variety of systems
- The anti-lock brake system (ABS) control module is connected to the ISO 9141 communication network. The ABS module controls the brake pressure to the four wheels to keep the vehicle under control while braking.

GEM (GENERIC ELECTRONIC MODULE) OUTLINE

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- The GEM controls the following parts:
  — Rear wiper
  — Battery saver
  — Illuminated entry
  — Headlight control
  — Interior light control
  — Power door lock
  — Keyless entry system
  — Door ajar signal output

GEM (GENERIC ELECTRONIC MODULE) FUNCTION

id094000100600

- The GEM continuously monitors the sub-systems for malfunctions. If a malfunction is detected in a sub-system, the GEM records the malfunction as DTC.
- The correct ignition switch position is essential for the GEM operation. An incorrect ignition switch position signal sent to the GEM will cause mistaken or unexpected operation of the GEM.
- The GEM controls all of the following systems:
  — Rear wiper
  — Battery saver
  — Illuminated entry
  — Headlight control
  — Interior light control
  — Power door lock
  — Keyless entry system
  — Door ajar signal output

ALPHABETICAL INDEX

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