PERFORMANCE

Power Train

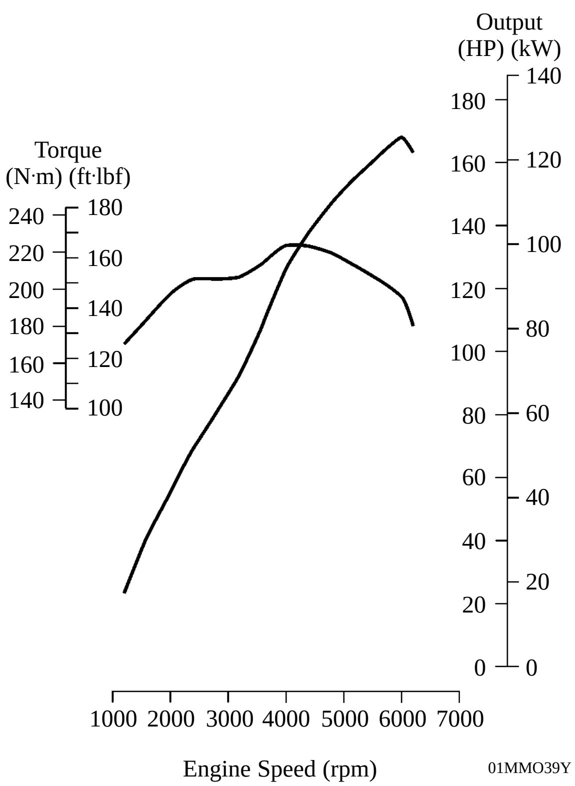
Engine

- The 2AZ-FE engine has been carried over from the ’05 model. This engine realizes high performance, quietness, fuel economy, and clean emissions through the use of the VVT-i (Variable Valve Timing-intelligent) system, DIS (Direct Ignition System), and ETCS-i (Electronic Throttle Control System-intelligent).
- A new 2GR-FE engine is used. It realizes high performance, quietness, fuel economy, and clean emission through the use of the Dual VVT-i (Dual Variable Valve Timing-intelligent) system, DIS, and ETCS-i.

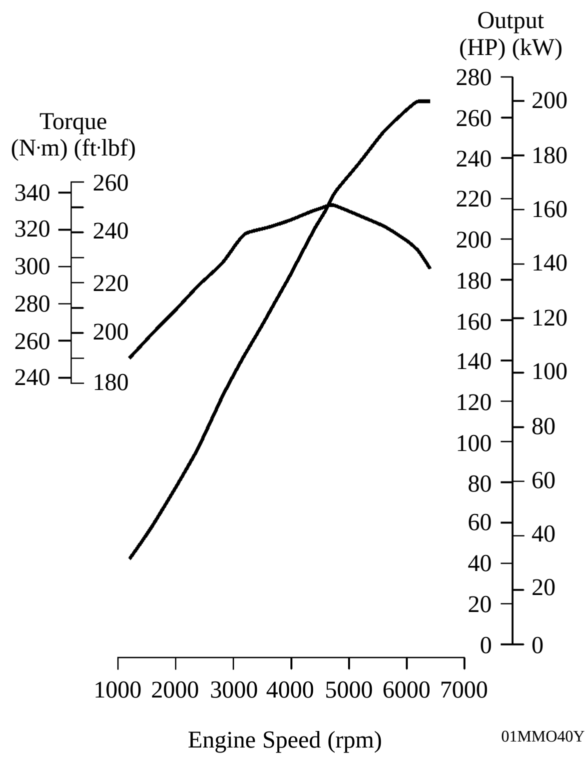
Engine Type	2AZ-FE	2GR-FE
No. of Cyls. & Arrangement	4-cylinder, In-line Type	6-cylinder, V Type
Valve Mechanism	16-valve DOHC, Chain Drive (with VVT-i)	24-valve DOHC, Chain Drive (with Dual VVT-i)
Displacement cm^3 (cu. in.)	2362 (144.2)	3456 (210.9)
Bore x Stroke mm (in.)	88.5 x 96.0 (3.48 x 3.78)	94.0 x 83.0 (3.70 x 3.27)
Compression Ratio	9.8 : 1	10.8 : 1
Maximum Output [SAE-NET]*	124 kW @ 6000 rpm (166 HP @ 6000 rpm)	200 kW @ 6200 rpm (268 HP @ 6200 rpm)
Maximum Torque [SAE-NET]*	224 N·m @ 4000 rpm (165 ft·lbf @ 4000 rpm)	336 N·m @ 4700 rpm (248 ft·lbf @ 4700 rpm)

*: Maximum output and torque rating are determined by revised SAE J1349 standard.

▶ 2AZ-FE Engine ◀



▶ 2GR-FE Engine ◀



Transaxle

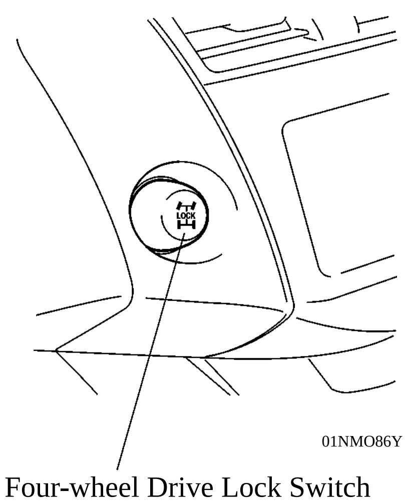
- The U140F and U241E 4-speed automatic transaxles have been carried over from the ’05 model.
- New U151E and U151F 5-speed automatic transaxles are used.
- A new GF1A transfer is used.

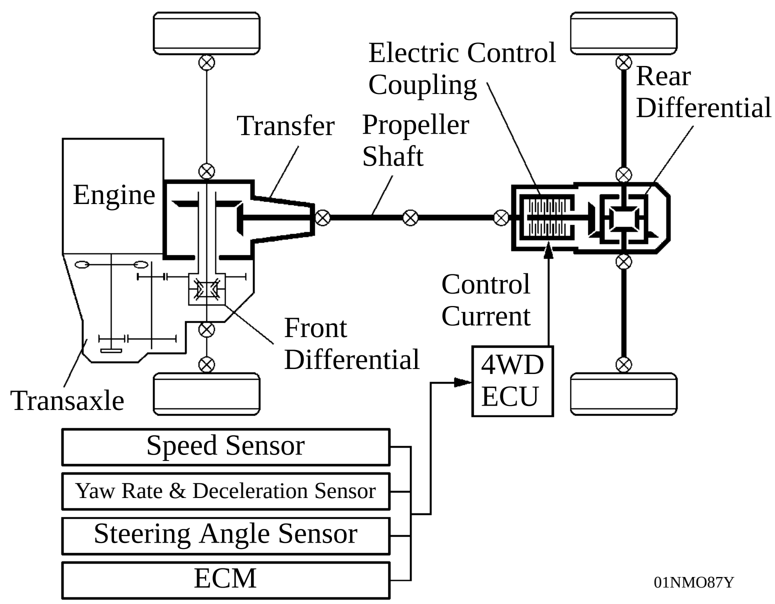
Transaxle Type		4-speed Automatic		5-speed Automatic	
		U140F	U241E	U151F	U151E
Transfer Type		GF1A	—	GF1A	—
Combination with Engine		2AZ-FE		2GR-FE	
Drive Type		4WD	2WD	4WD	2WD
Gear Ratio*	1st	3.938	3.943	4.235	←
	2nd	2.194	2.197	2.360	←
	3rd	1.411	1.413	1.517	←
	4th	1.019	1.020	1.047	←
	5th	—	—	0.756	←
	Reverse	3.141	3.145	3.378	←

*: Counter Gear Ratio Included

Active Torque Control 4WD System

- A new active torque control 4WD system with an electric control coupling is used.
- The active torque control 4WD system, which has an electric control coupling in the front part of the rear differential, transmits torque to the rear wheels when needed, and only in the amount needed, based on information provided by various sensors.
- By operating the four-wheel drive lock switch provided on the instrument panel, the driver can select the following modes: the AUTO mode to optimally control the torque that is transmitted to the rear wheels, and the LOCK mode that locks the torque that is transmitted to the rear wheels to the maximum amount.





System Configuration Diagram

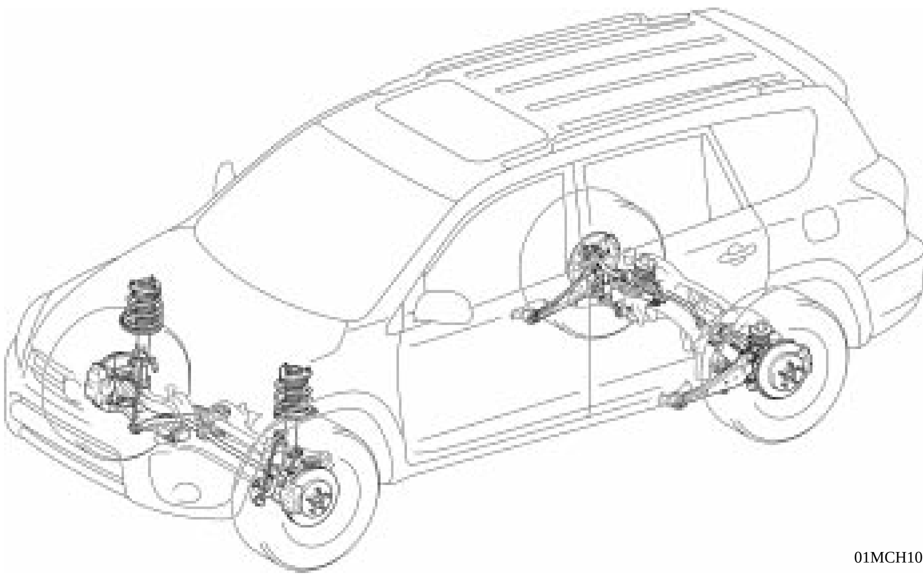
Chassis

Front Suspension

Type	MacPherson Strut Type Independent Suspension

Rear Suspension

Type	Double Wishbone Type Independent Suspension



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Steering

Type	EPS (Electronic Power Steering)
Gear Type	Rack & Pinion

Brake

Front Brake Type	Ventilated Disc
Front Rotor Size	15 inch: 275 x 25 mm (10.82 x 0.87 in.)*[1] 16 inch: 296 x 28 mm (11.84 x 1.10 in.)*[2]
Rear Brake Type	Solid Disc
Rear Rotor Size	15 inch: 281 x 12 mm (11.24 x 0.48 in.)
Parking Brake Type	Lever Type
Brake Control	ABS (Anti-lock Brake System) with EBD (Electronic Brake force Distribution) & Brake Assist & TRAC (Traction Control) & Hill-start Assist Control*[3] & DAC (Downhill Assist Control)*[3] & VSC (Vehicle Stability Control)*[4]

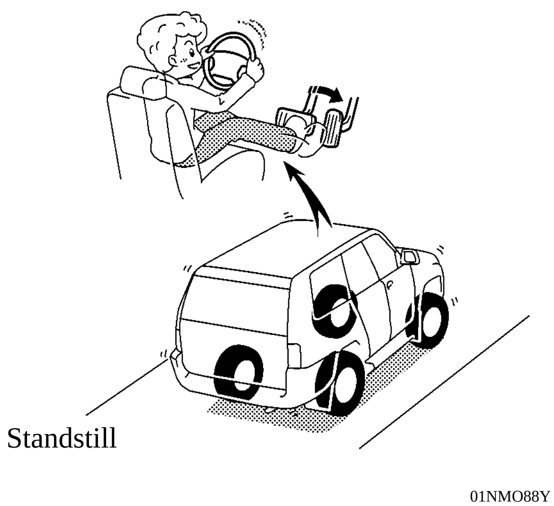
*[1]: 2AZ-FE Engine Models with Rear No. 1 Seat Only
*[2]: 2GR-FE Engine Models and Models with Rear No. 2 Seat
*[3]: Standard Equipment on 2GR-FE Engine Models and Models with Rear No. 2 Seat
*[4]: 2WD models have been provided with Auto LSD (Limited Slip Differential).

Enhanced VSC System

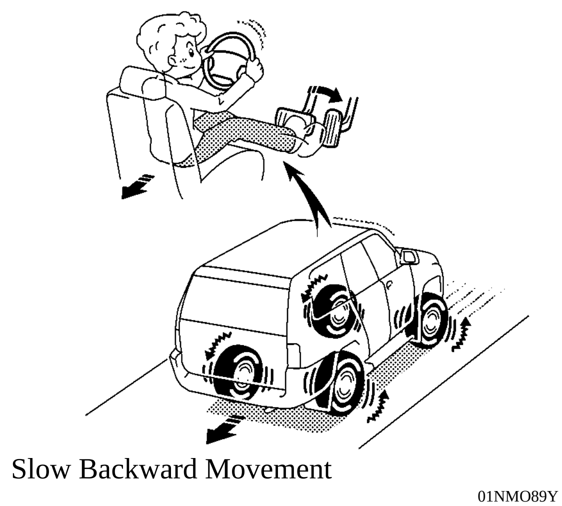
- The enhanced VSC (Vehicle Stability Control) system is standard equipment on all models.
- In addition to the ABS, TRAC, and VSC controls provided by the conventional system, the enhanced VSC system effects cooperative control with the EPS (Electric Power Steering) and active torque control 4WD system in order to realize excellent driving stability and maneuverability.
- See CH-92 for details on the enhanced VSC system.

Hill-start Assist Control

- The hill-start assist control is standard equipment on the 2GR-FE engine models and the models with rear No. 2 seat.
- When the driver transfers his/her foot from the brake pedal to the accelerator pedal while starting off on an uphill, the hill-start assist control momentarily maintains the hydraulic pressure in the wheel cylinders of the four wheels, in order to prevent the vehicle from rolling backward.
- The hill-start assist control used on the ’06 model effects control to prevent the vehicle from rolling backward. This control has evolved further from the hill-start assist control of the ’05 model, which slowed the backward rolling of the vehicle while starting off on a hill.
- See CH-120 for details on the hill-start assist control.



’06 Model



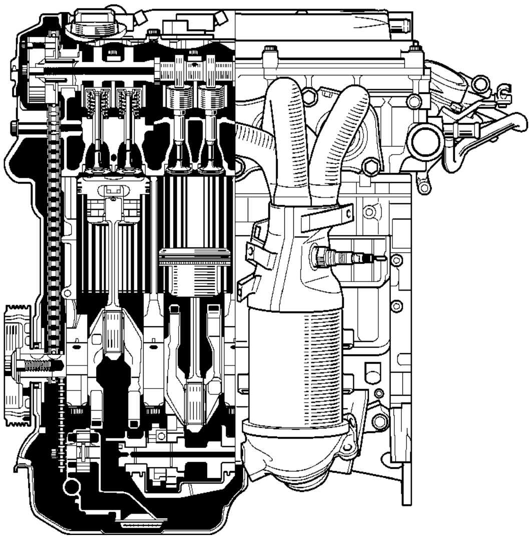
’05 Model

ENGINE

2AZ-FE ENGINE

■DESCRIPTION

The 2AZ-FE engine is an in-line, 4-cylinder, 2.4-liter, 16-valve DOHC engine. This engine uses the VVT-i (Variable Valve Timing-intelligent) system, DIS (Direct Ignition System), ETCS-i (Electronic Throttle Control System-intelligent). It has been developed to realize high performance, quietness, fuel economy and clean emission.



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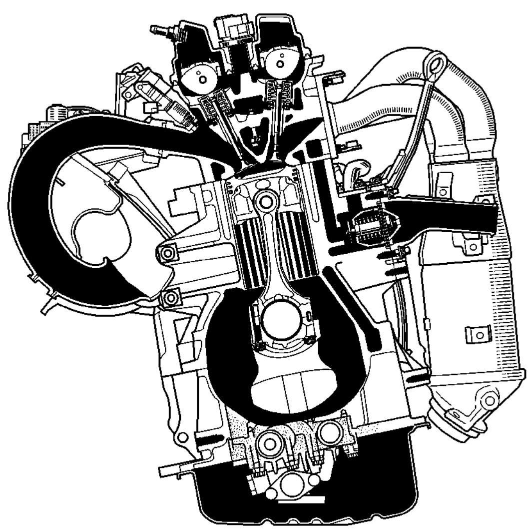

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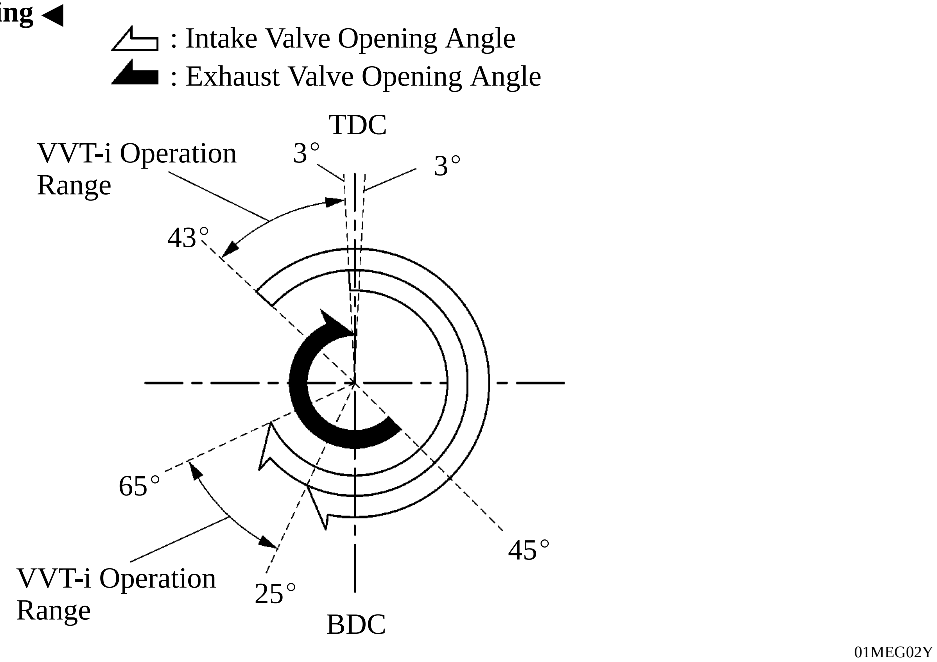
▶ Engine Specifications ◀

No. of Cyls. & Arrangement				4-cylinder, In-line
Valve Mechanism				16-valve DOHC, Chain Drive (with VVT-i)
Combustion Chamber				Pentroof Type
Manifolds				Cross-flow
Fuel System				SFI
Ignition System				DIS
Displacement			cm^3 (cu. in.)	2362 (144.1)
Bore x Stroke			mm (in.)	88.5 x 96.0 (3.48 x 3.78)
Compression Ratio				9.8 : 1
Max. Output*[1]			(SAE-NET)	124 kW @ 6000 rpm (166 HP @ 6000 rpm)
Max. Torque*[1]			(SAE-NET)	224 N·m @ 4000 rpm (165 ft-lbf @ 4000 rpm)
Valve Timing	Intake	Open		3° - 43° BTDC
		Close		65° - 25° ABDC
	Exhaust	Open		45° BBDC
		Close		3° ATDC
Firing Order				1 - 3 - 4 - 2
Research Octane Number				91 or higher
Octane Rating				87 or higher
Oil Grade				ILSAC
Tailpipe Emission Regulation				ULEV-II, SFTP
Evaporative Emission Regulation				LEV-II, ORVR
Engine Service Mass*[2] (Reference)			kg (lb)	138 (304.2)

*[1]: Maximum output and torque rating is determined by revised SAE J1349 standard.
*[2]: Weight shows the figure with oil and water fully filled.

▶ Valve Timing ◀



FEATURES OF 2AZ-FE ENGINE

The 2AZ-FE engine has achieved the following performance through the use of the items listed below.

(1) High performance and reliability

(2) Low noise and vibration

(3) Lightweight and compact design

(4) Good serviceability

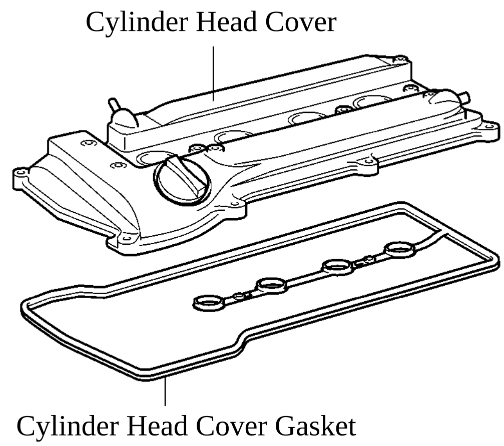
(5) Clean emission and fuel economy

Section	Item	(1)	(2)	(3)	(4)	(5)
Engine Proper	A cylinder block made of aluminum alloy along with a magnesium alloy die-cast cylinder head cover is used.			○		
	A taper squish shape is used for the combustion chamber.	○				○
	A resin gear balance shaft is used.		○	○		
Valve Mechanism	A timing chain and chain tensioner are used.		○	○	○	
	The shim-less type valve lifters are used.	○		○		
	The VVT-i system is used.	○				○
Intake and Exhaust System	A chacoal filter is used in the air cleaner cap.					○
	Intake manifold made of plastic is used.			○		
	The linkless-type throttle body is used.			○	○	
	A thin-wall ceramic TWC (Three-Way Catalytic converter) is used.					○
Fuel System	The fuel returnless system is used.			○	○	○
	Quick connectors are used to connect the fuel hose with the fuel pipe.			○	○	○
	12-hole type fuel injectors with high atomizing performance are used.	○				○
Ignition System	Iridium-tipped spark plugs are used.	○			○	
Charging System	The segment conductor type generator is used.	○	○	○		
Starting System	PS (Planetary reduction-Segment conductor motor) type starter is used.	○		○		
Engine Control System	The ETCS-i is used.	○				○
	The DIS (Direct Ignition System) makes ignition timing adjustment unnecessary.	○			○	○
	The non-contact type sensor is used in the throttle position sensor.	○				
	The planar type air-fuel ratio sensor is used.					○

■ENGINE PROPER

1. Cylinder Head Cover

- A lightweight magnesium alloy die-cast cylinder head cover is used.
- Acrylic rubber, which excels in heat resistance and reliability, is used for the cylinder head cover gasket.



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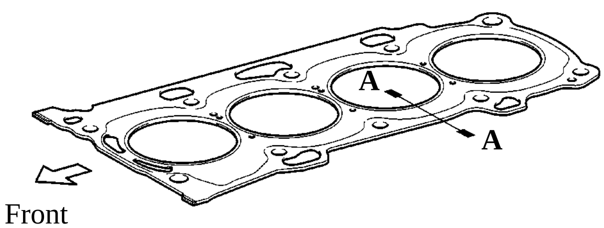
2. Cylinder Head Gasket

A steel-laminate type cylinder head gasket is used. A shim has been added around the cylinder bore to increase the sealing surface, thus improving the sealing performance and durability.



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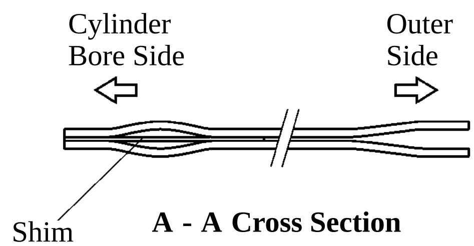

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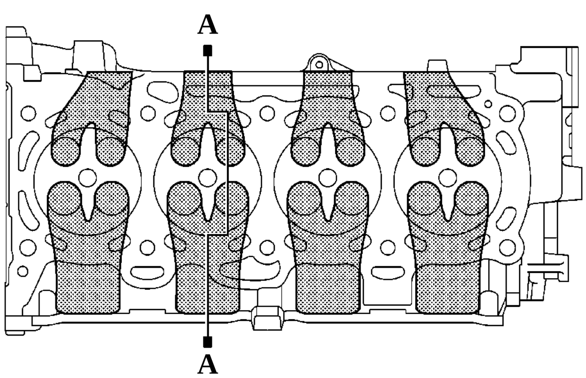
3. Cylinder Head

- Through the adoption of the taper squish combustion chamber, the engine knocking resistance and fuel efficiency have been improved.
- An upright intake port is used to improve the intake efficiency.
- Installing the injectors in the cylinder head enables the injectors inject fuel as close as possible to the combustion chamber. This prevents the fuel from adhering to the intake port walls, which reduces HC exhaust emissions.
- The routing of the water jacket in the cylinder head has been optimized to realize the high cooling performance. In addition, a water bypass passage has been provided below the exhaust ports to reduce the number of parts and the weight.

Exhaust Side



Intake Side

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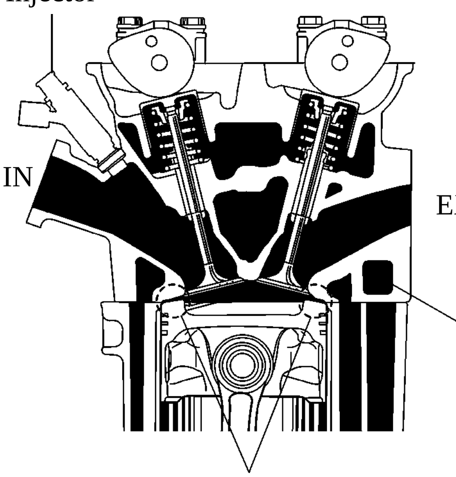

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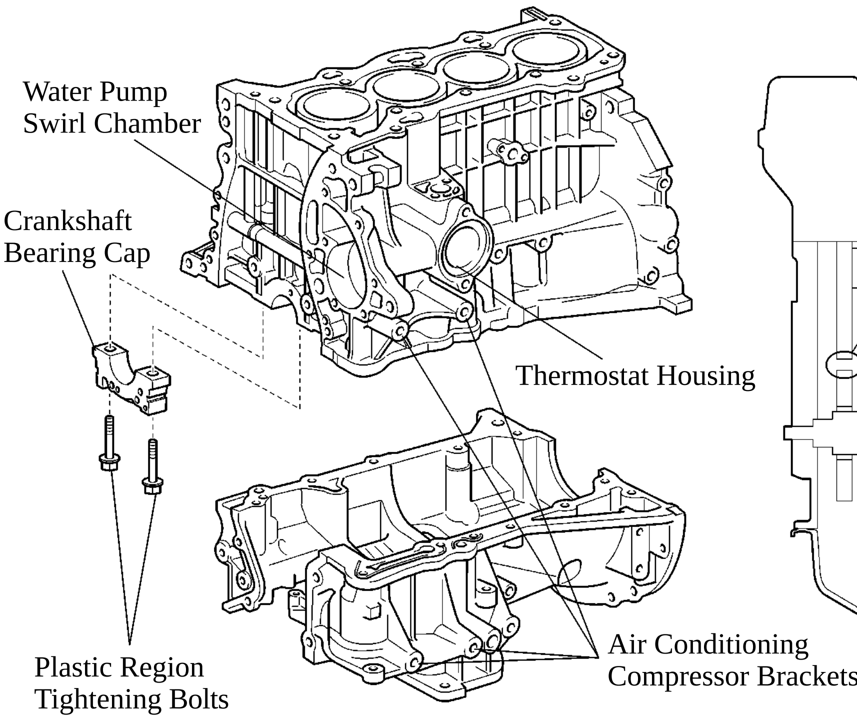
A - A Cross Section

4. Cylinder Block

- Lightweight aluminum alloy is used for the cylinder block.
- By producing the thin cast-iron liners and cylinder block as a unit, compaction is realized.
- Air passage holes are provided in the crankshaft bearing area of the cylinder block. As a result, the air at the bottom of the cylinder flows smoother, and pumping loss (back pressure at the bottom of the piston generated by the piston's reciprocal movement) is reduced to improve the engine's output.
- The oil filter and the air conditioning compressor brackets are integrated into the crankcase. Also, the water pump swirl chamber and thermostat housing are integrated into the cylinder block.



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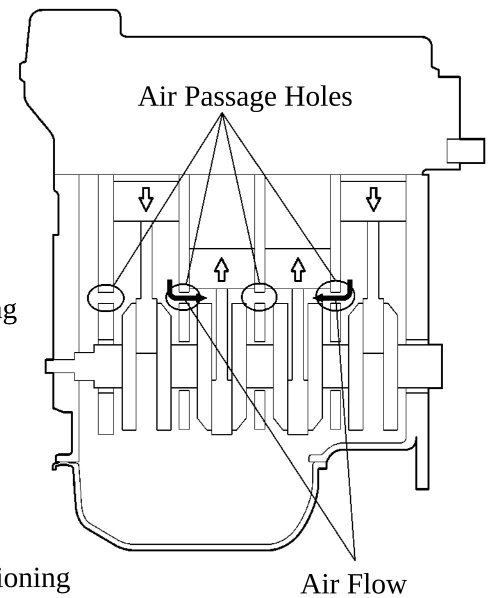
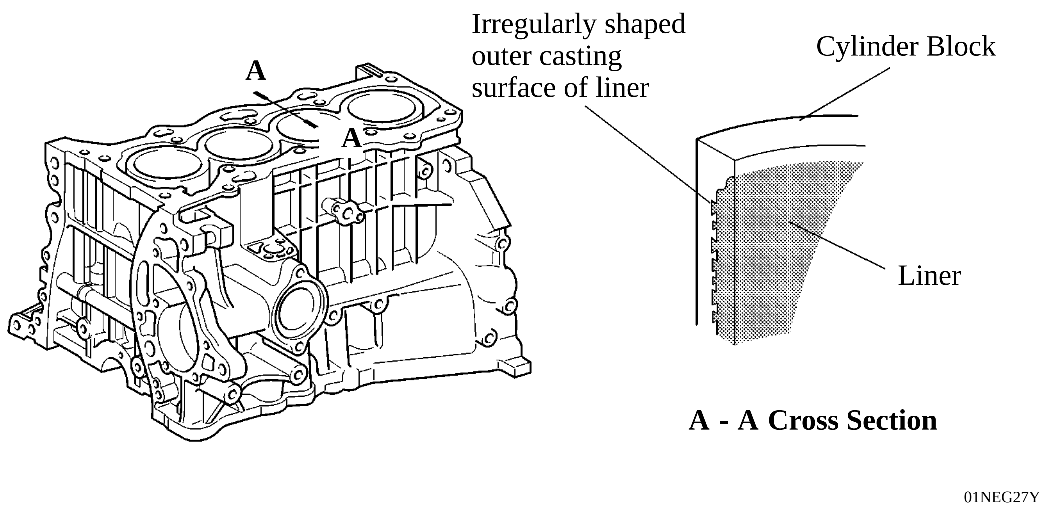
▶ Air Flow During Engine Revolution ◀



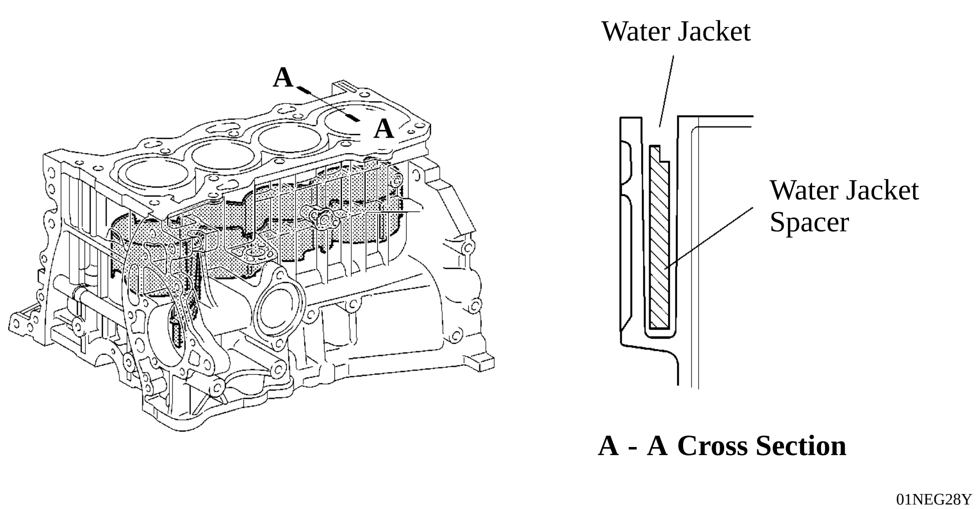
DR011EG22

> **NOTICE**
>
> Never attempt to machine the cylinder because it has a thin liner thickness.

- The liners are the spiny-type, which have been manufactured so that their casting exteriors form large irregular surfaces in order to enhance the adhesion between the liners and the aluminum cylinder block. The enhanced adhesion helps heat dissipation, resulting in a lower overall temperature and heat deformation of the cylinder bores.

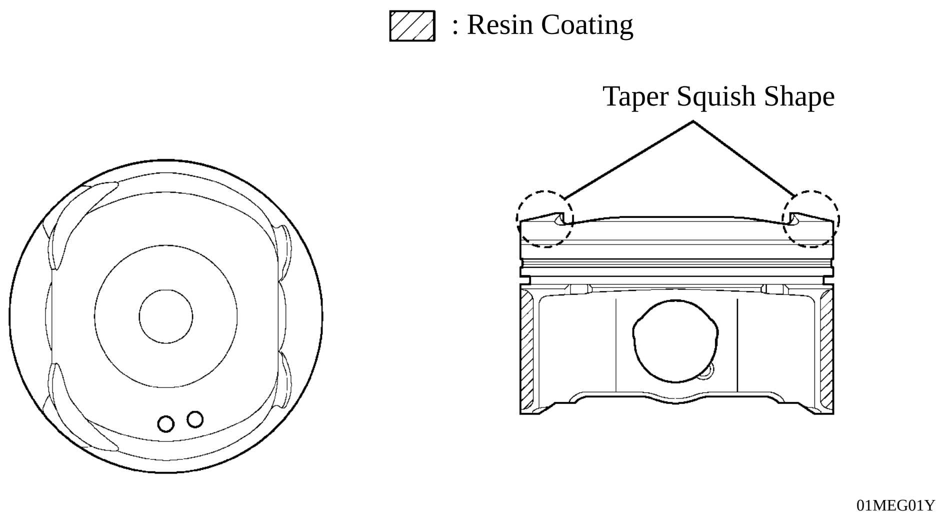


- Water jacket spacers are provided in the water jacket of the cylinder block.
- They suppress the water flow in the center of the water jackets, guide the coolant above and below the cylinder bores, and ensure uniform temperature distribution. As a result, the viscosity of the engine oil that acts as a lubricant between the bore walls and the pistons can be lowered, thus reducing friction.



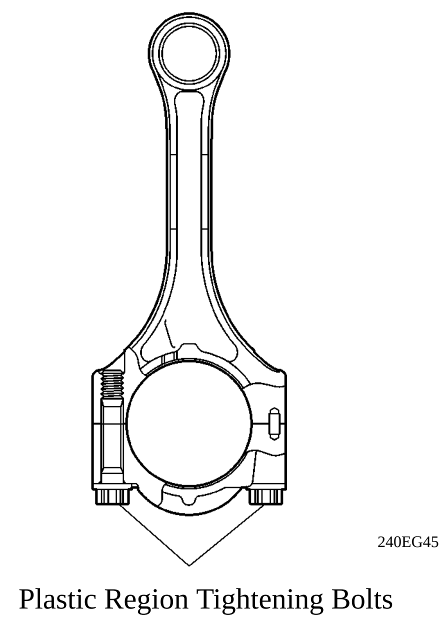
5. Piston

- The piston is made of aluminum alloy and skirt area is made compact and lightweight.
- The piston head portion uses a taper squish shape to improve the fuel combustion efficiency.
- The piston skirt has been coated with resin to reduce the friction loss.



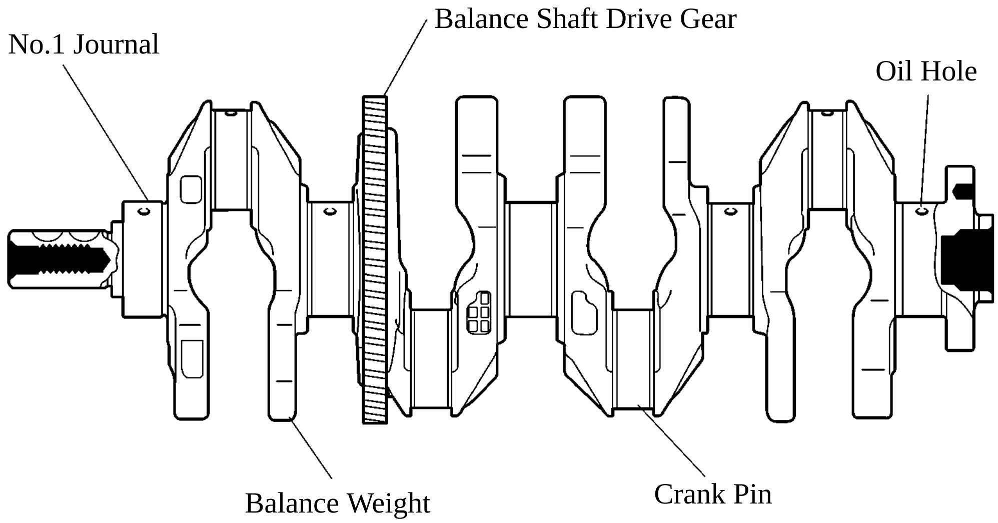
6. Connecting Rod

- The connecting rods and caps are made of high-strength steel for weight reduction.
- Nut-less type plastic region tightening bolts are used on the connecting rod for a lighter design.
- The connecting rod bearings are reduced in width to reduce friction.



7. Crankshaft

- The forged crankshaft has 5 journals and 8 balance weights.
- The crankshaft is made of forged steel.
- Pin and journal fillets are roll-finished to maintain adequate strength.
- The balance shaft drive gear is provided for the crankshaft.



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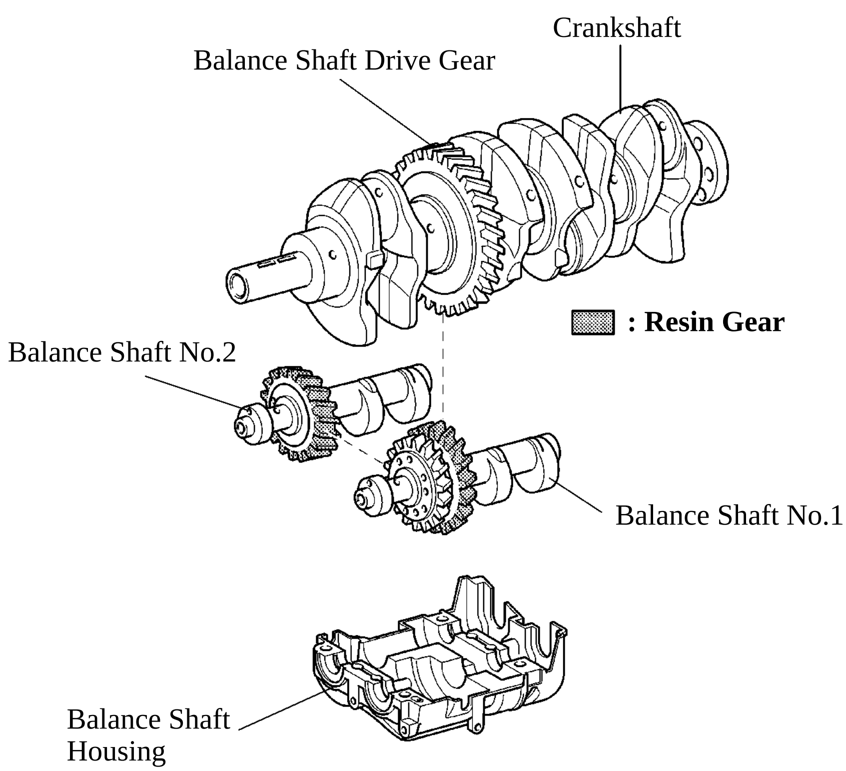
8. Balance Shaft

General

- A balance shaft is used to reduce vibrations.
- The crankshaft directly drives the No. 1 balance shaft.
- In addition, a resin gear is used on the driven side to suppress noise and offer lightweight design.



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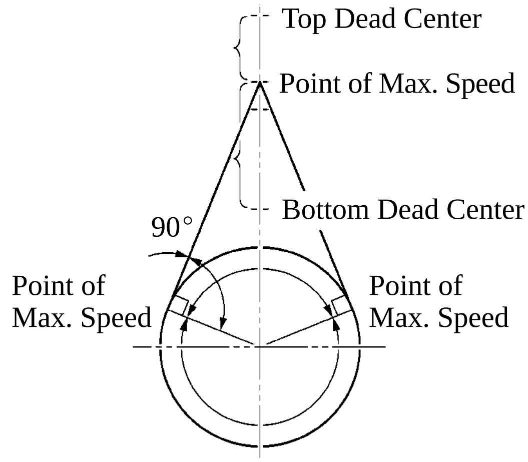
Operation

In the in-line 4-cylinder engine, the crankshaft angle for cylinders No.1 and No.4 are exactly at the opposite (180°) position of cylinders No.2 and No.3. Therefore, the inertial force of the pistons and the connecting rods of the former 2 cylinders and of the latter 2 cylinders almost cancel each other. However, because the position at which the piston reaches its maximum speed is located toward the top dead center from the center of the stroke, the upward inertial force is greater than the downward inertial force. This unbalanced secondary inertial force is generated twice for each rotation of the crankshaft.



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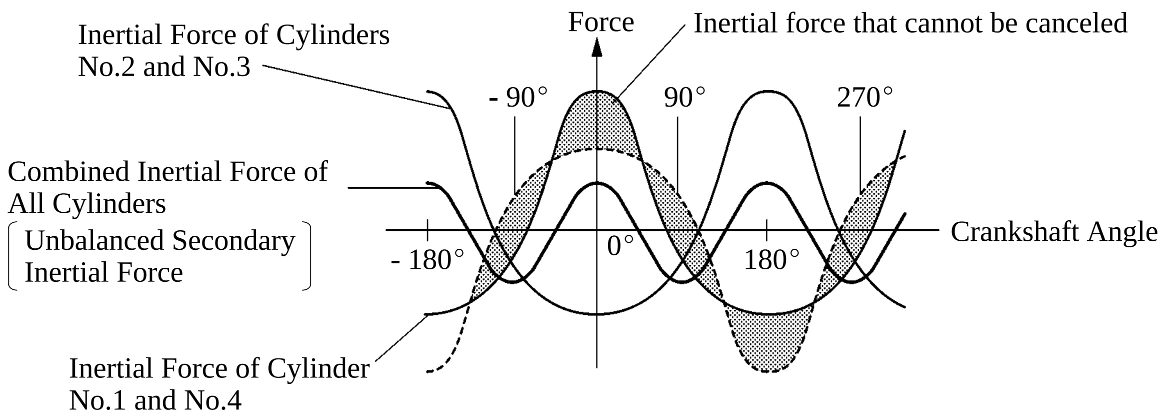
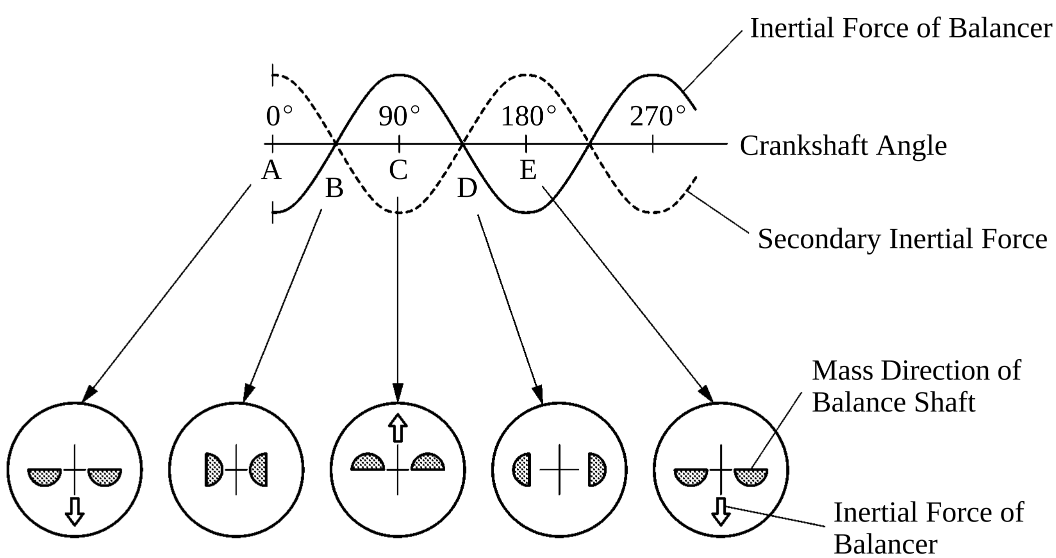


Inertial Force Generated by the In-line 4 Cylinders

286EG72

To cancel the unbalanced secondary inertial force, 2 balance shafts are rotated twice for each rotation of the crankshaft and generate inertial force in the opposite direction. Also, in order to cancel the inertial force generated by the balance shaft itself, the balance shaft actually consists of 2 shafts rotating in opposite directions.



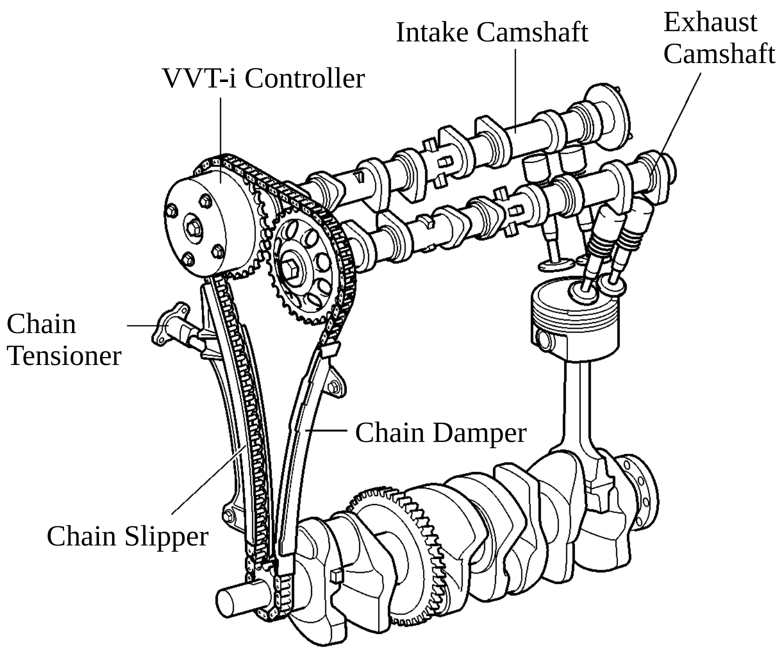
Mass Direction of Balance Shaft at Crankshaft Angle

286EG73

■VALVE MECHANISM

1. General

- The VVT-i system is used to improve fuel economy, engine performance and reduce exhaust emissions. For details of VVT-i system, see page EG-48.
- The intake and exhaust camshafts are driven by a timing chain.
- Along with the increase in the amount of valve lift, the shim-less type valve lifter is used. This valve lifter increases the cam contact surface.



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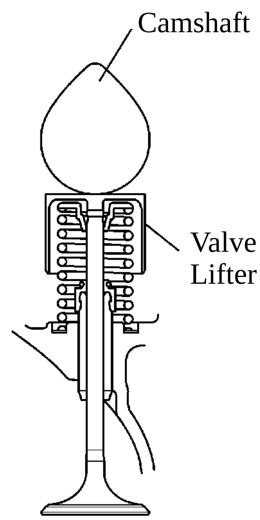

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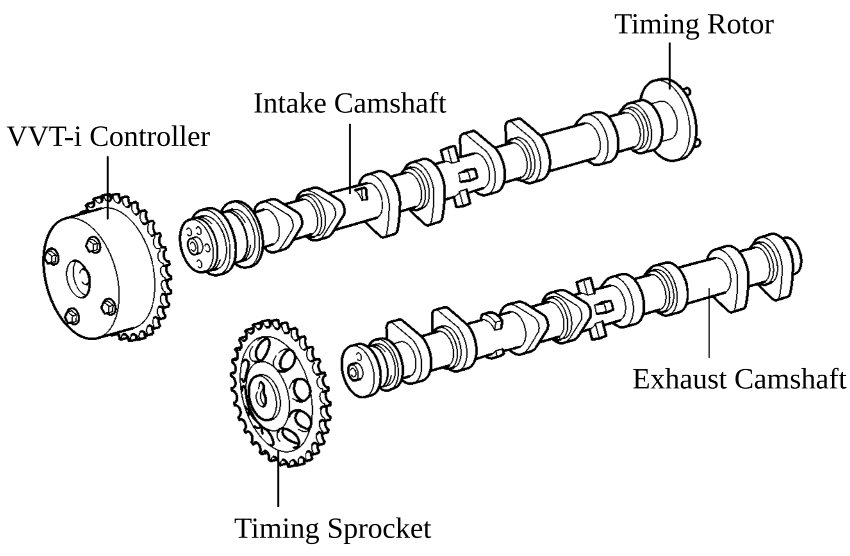
Service Tip

The adjustment of the valve clearance is accomplished by selecting and replacing the appropriate valve lifters.
A total of 35 valve lifters are available in 0.02 mm (0.008 in.) increments, from 5.06 mm (0.199 in.) to 5.74 mm (0.226 in.). For details, refer to 2006 RAV4 Repair Manual (Pub. No. RM01M1U).

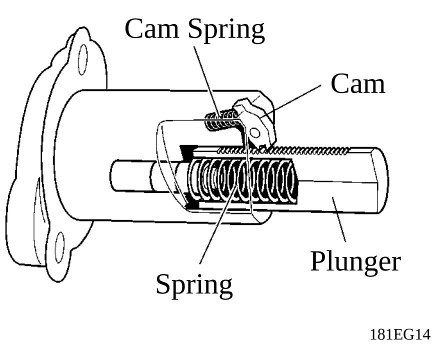
2. Camshaft

- The intake camshaft is provided with timing rotor to trigger the camshaft position sensor.
- In conjunction with the adoption of the VVT-i system, an oil passage is provided in the intake camshaft in order to supply engine oil pressure to the VVT-i system.
- A VVT-i controller has been installed on the front of the intake camshaft to vary the timing of the intake valves.

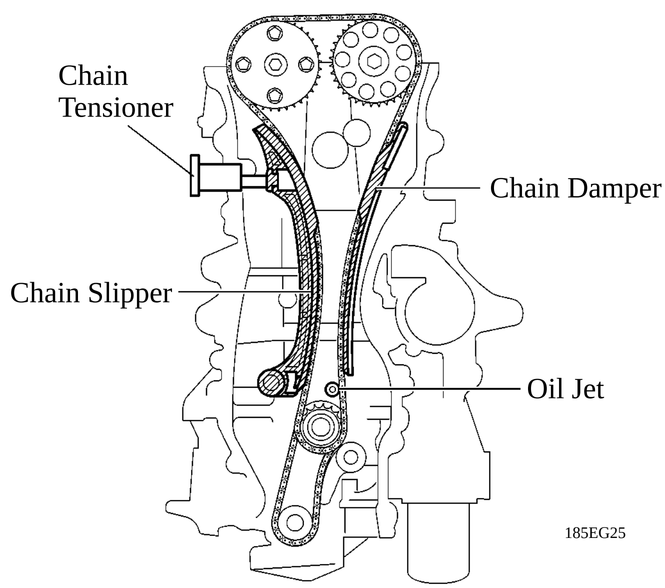


3. Timing Chain

- A roller chain with an 8 mm (0.315 in.) pitch is used to make the engine more compact.
- The timing chain is lubricated by an oil jet.
- The chain tensioner uses a spring and oil pressure to maintain proper chain tension at all times.
- The chain tensioner suppresses noise generated by the timing chain.
- A ratchet type non-return mechanism is used.
- To achieve excellent serviceability, the chain tensioner is constructed so that it can be removed and installed from the outside of the timing chain cover.



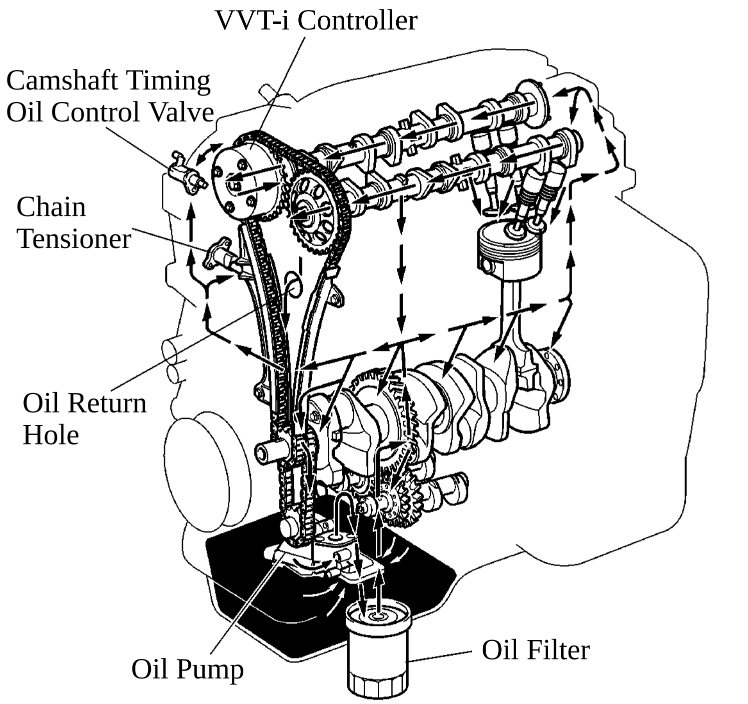
Chain Tensioner



■LUBRICATION SYSTEM

1. General

- The lubrication circuit is fully pressurized and oil passes through an oil filter.
- The trochoid gear type oil pump is chain-driven by the crankshaft.
- The oil filter is attached downward from the crankcase to improve serviceability.
- Along with the adoption of the VVT-i system, the cylinder head is provided with a VVT-i controller and a camshaft timing oil control valve. This system is operated by the engine oil.



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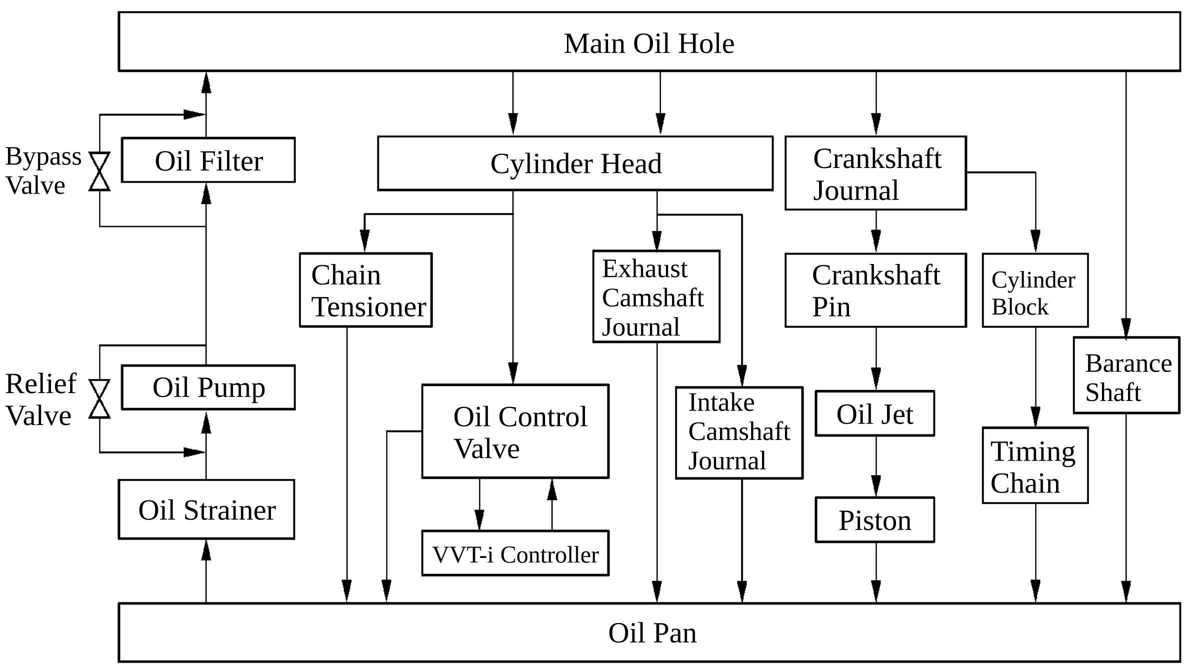
▶ Oil Circuit ◀



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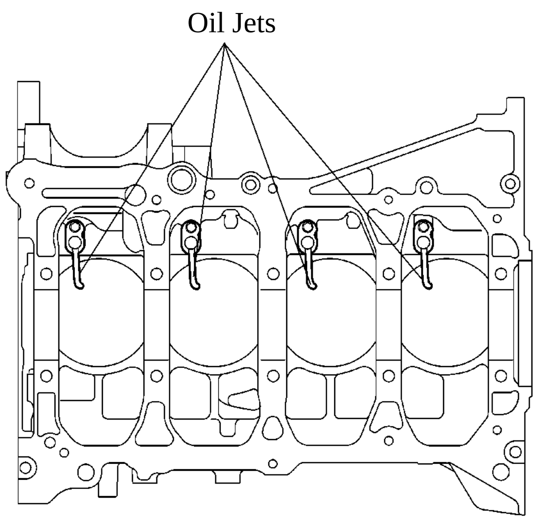
▶ Oil Capacity ◀

Liters (US qts, Imp. qts)

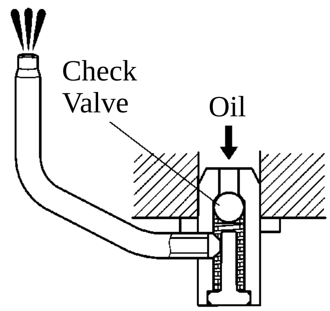
Dry	5.0 (5.3, 4.4)
with Oil Filter	4.3 (4.5, 3.8)
without Oil Filter	4.1 (3.8, 3.1)

2. Oil Jet

- Piston oil jets for cooling and lubricating the pistons are used in the cylinder block.
- These oil jets contain a check valve to prevent oil from being fed when the oil pressure is low. This prevents the overall oil pressure in the engine from dropping.



Bottom Side View

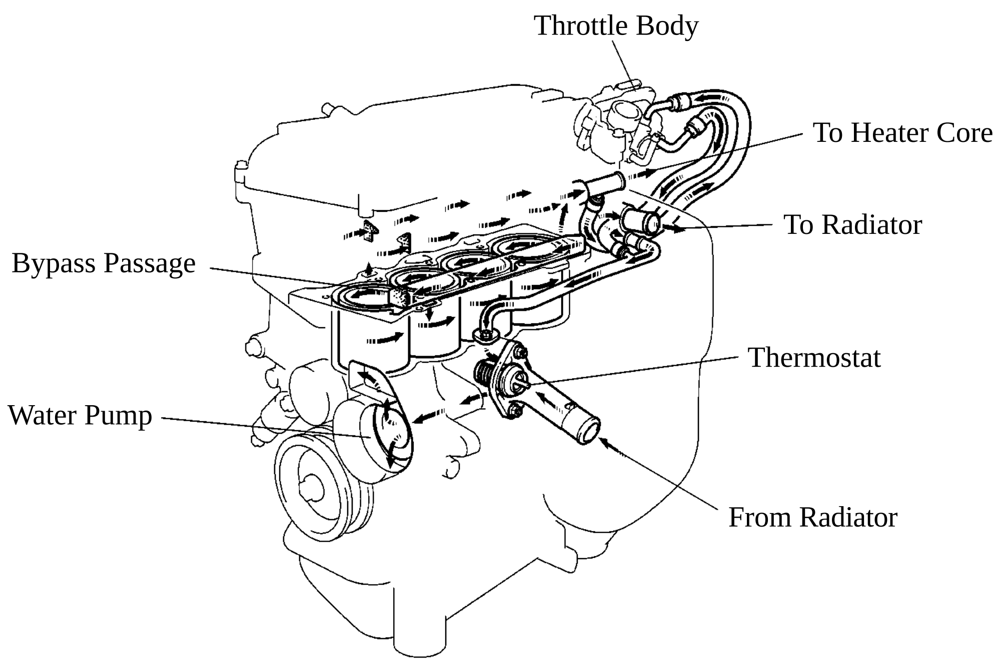


Oil Jet Cross Section

01NEG34Y

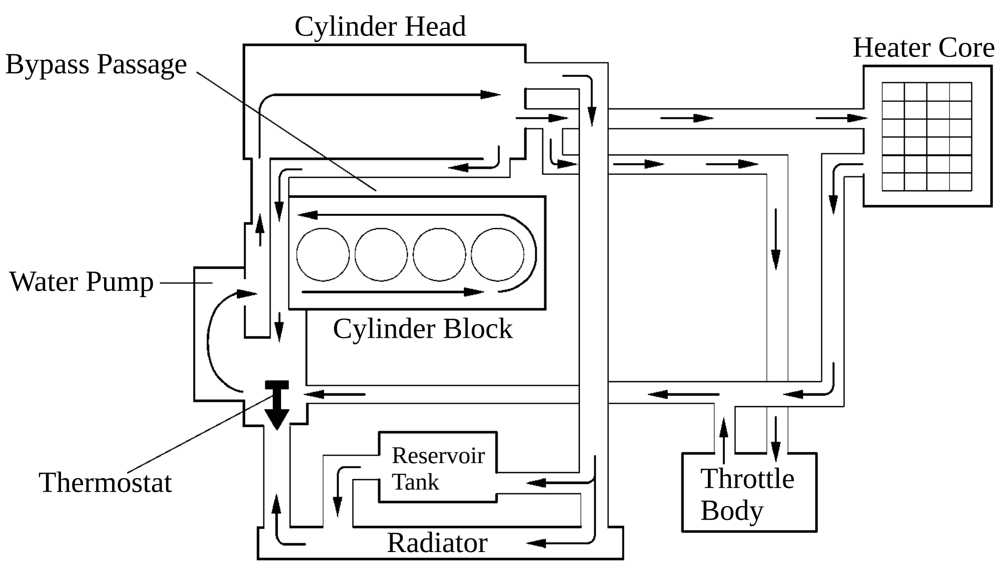
■COOLING SYSTEM

- The cooling system uses a pressurized forced-circulation system with pressurized reservoir tank.
- A thermostat with a bypass valve is located on the water inlet housing to maintain suitable temperature distribution in the cooling system.
- An aluminum radiator core is used for weight reduction.
- The flow of the engine coolant makes a U-turn in the cylinder block to ensure a smooth flow of the engine coolant. In addition, a bypass passage is enclosed in the cylinder head and the cylinder block.
- Warm water from the engine is sent to the throttle body to prevent freeze-up.
- The TOYOTA genuine Super Long Life Coolant (SLLC) is used.



01NEG35Y

▶ System Diagram ◀



01NEG59Y

▶ Engine Coolant Specifications ◀

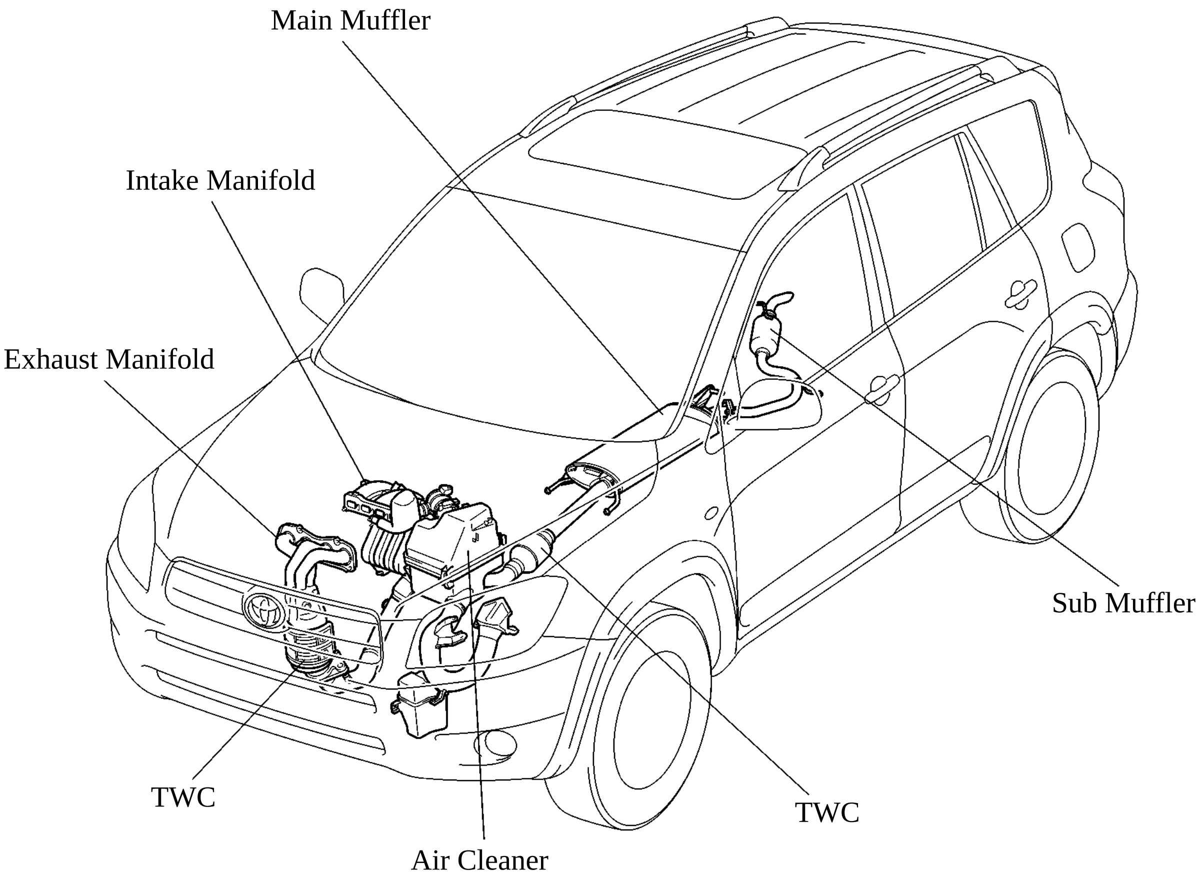
Engine Coolant	Type		TOYOTA genuine Super Long Life Coolant (SLLC) or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite and non-borate coolant with long-life hybrid organic acid technology (coolant with long-life hybrid organic acid technology is a combination of low phosphates and organic acids.) Do not use plain water alone.
	Color		Pink
	Capacity Liters (US qts, Imp. qts)	M/T	6.6 (7.0, 5.8)
		A/T	6.7 (7.1, 5.9)
	Maintenance Intervals	First Time	100,000 mile (160,000 km)
		Subsequent	Every 50,000 mile (80,000 km)
Thermostat	Opening Temperature	°C (°F)	80 - 84 (176 - 183)

- SLLC is pre-mixed (the U.S.A. models: 50 % coolant and 50 % deionized water, the Canada. models: 55 % coolant and 45 % deionized water). Therefore, no dilution is needed when SLLC in the vehicle is added or replaced.
- If LLC is mixed with SLLC, the interval for LLC (every 25,000 miles / 40,000 km or 24 months whichever comes first) should be used.
- You can also apply the new maintenance interval (every 50,000 miles / 80,000 km) to vehicles initially filled with LLC (red-colored), if you use SLLC (pink-colored) for the engine coolant change.

■INTAKE AND EXHAUST SYSTEM

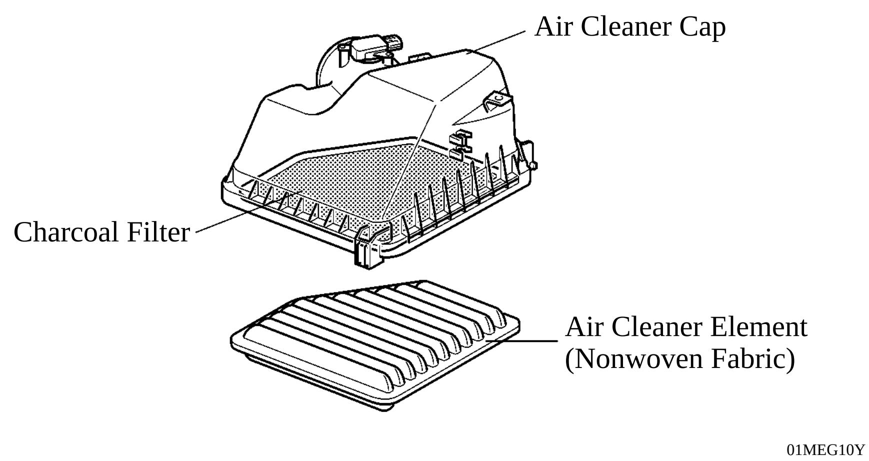
1. General

- The linkless-type throttle body is used to realize excellent throttle control.
- ETCS-i (Electronic Throttle Control System-intelligent) is used to provide excellent throttle control. For details, see page EG-43.
- A plastic intake manifold is used for weight reduction.
- A stainless steel exhaust manifold is used for weight reduction.



2. Air Cleaner

- A nonwoven, full-fabric type air cleaner element is used.
- A charcoal filter, which adsorbs the HC that accumulates in the intake system when the engine is stopped, is used in the air cleaner cap in order to reduce evaporative emissions.

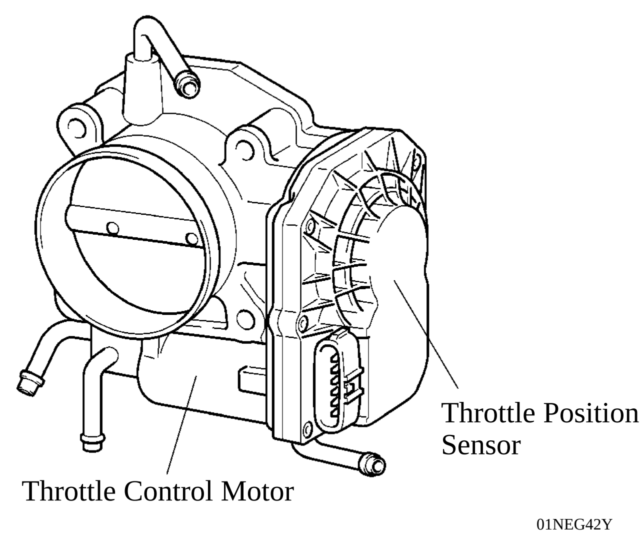


Service Tip

The charcoal filter, which is maintenance-free, cannot be removed from the air cleaner cap.

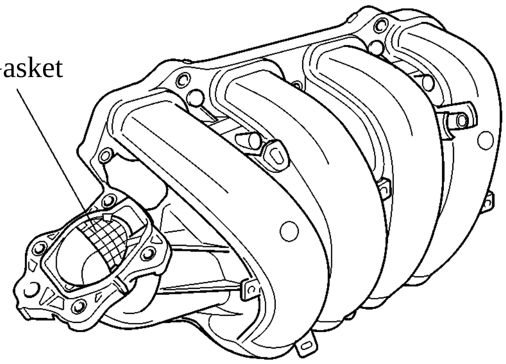
3. Throttle Body

- The linkless-type throttle body is used and it realizes excellent throttle control.
- A DC motor with excellent response and minimal power consumption is used for the throttle control motor. The ECM performs the duty ratio control of the direction and the amperage of the current that flows to the throttle control motor in order to regulate the opening angle of the throttle valve.



4. Intake Manifold

- The intake manifold has been made of plastic to reduce the weight and the amount of heat transferred from the cylinder head. As a result, it has become possible to reduce the intake air temperature and improve the intake volumetric efficiency.
- A mesh type gasket is used, in order to reduce the intake noise.



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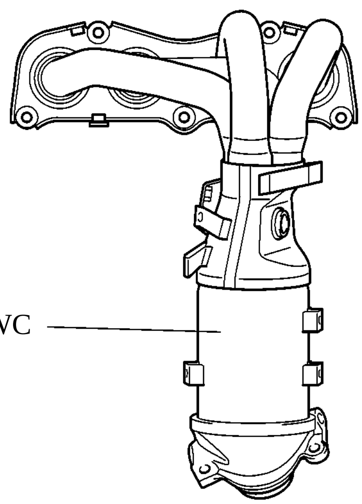
5. Exhaust Manifold

A stainless steel exhaust manifold is used for improving the warm-up of TWC (Three-Way Catalytic converter) and for weight reduction.



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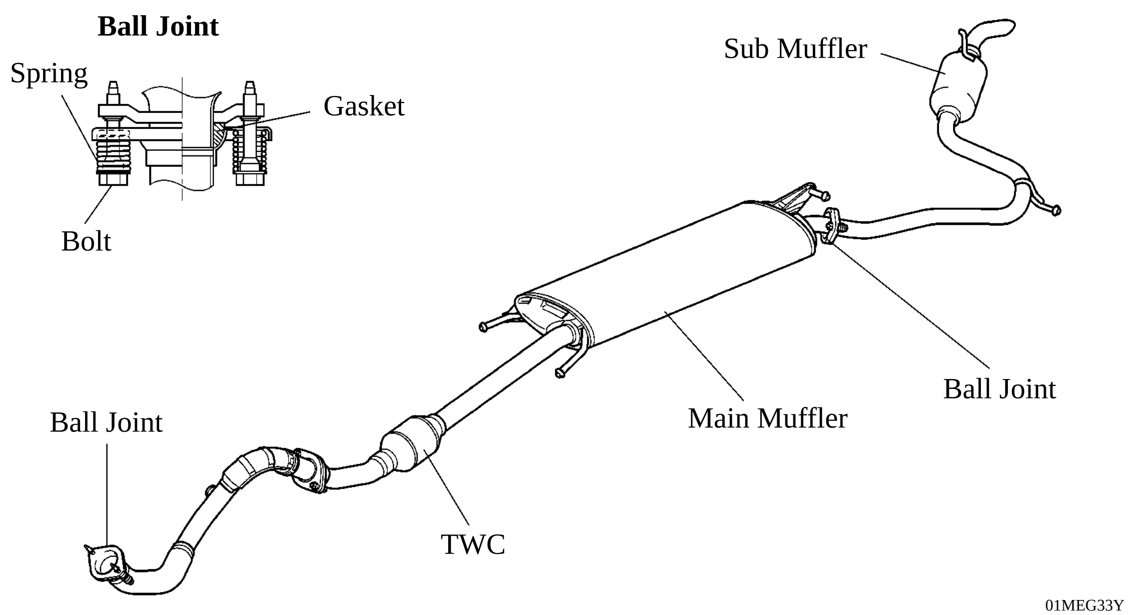
6. Exhaust Pipe

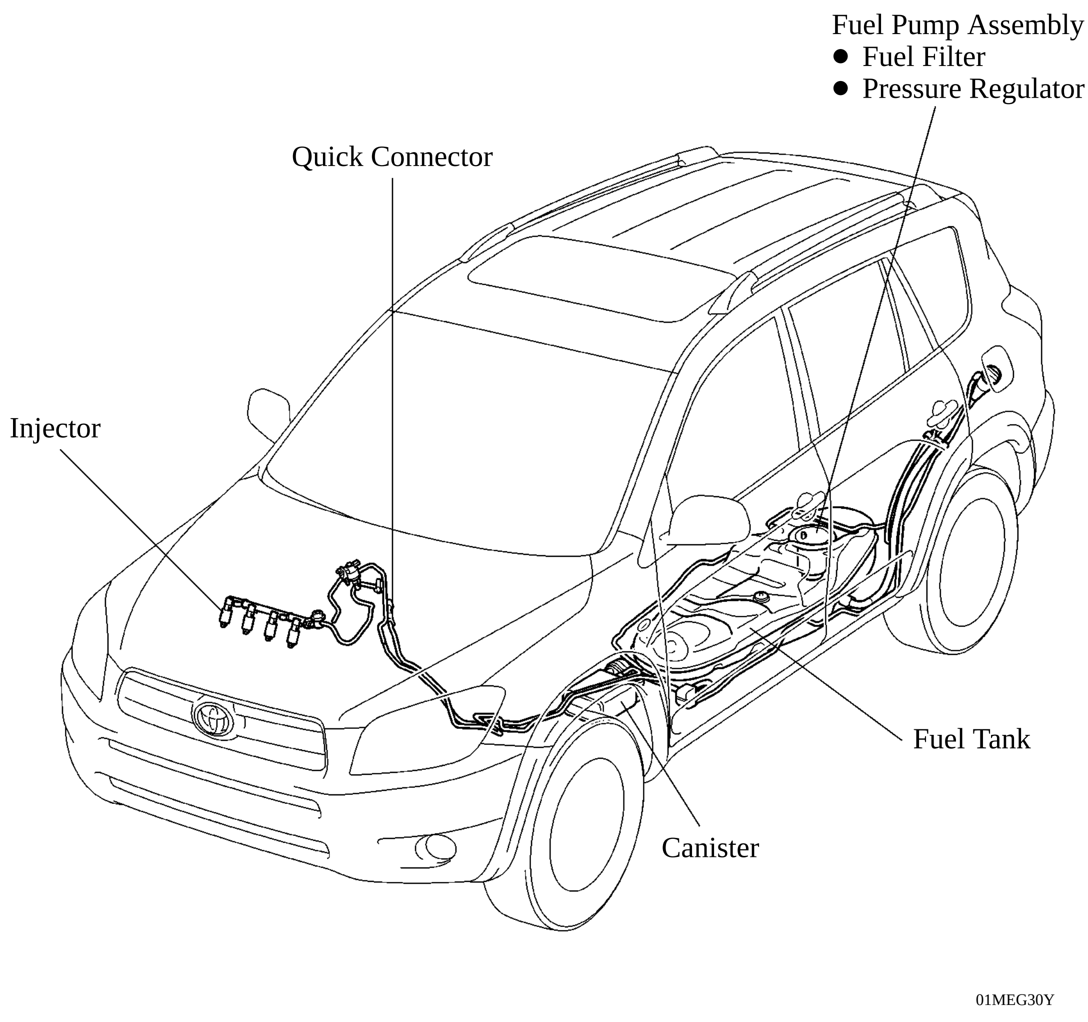
- The exhaust pipe uses two ball joints in order to achieve a simple construction and ensured reliability.
- The TWC can improve exhaust emission by optimizing the cell density and the wall thickness.



FUEL SYSTEM

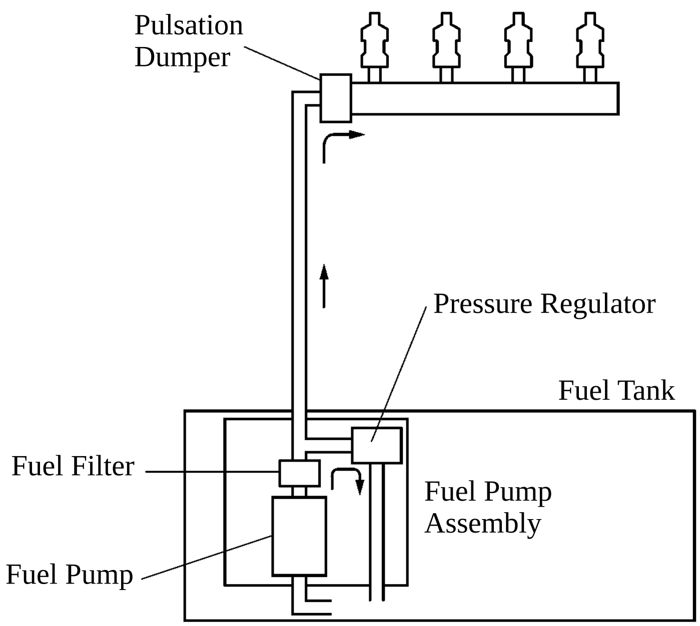
1. General

- The fuel returnless system is used to reduce evaporative emissions.
- A fuel cut control is used to stop the fuel pump when the SRS airbag is deployed in a front or side collision. For details, see page EG-53.
- A quick connector is used in the fuel main pipe to improve serviceability.
- The 12-hole type fuel injector is used.
- The ORVR (On-board Refueling Vapor Recovery) system is used. For details, see page EG-54.



2. Fuel Returnless System

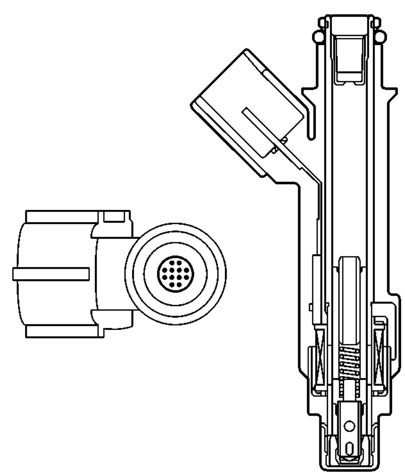
Fuel returnless system is used to reduce the evaporative emission. As shown below, by integrating the fuel filter and pressure regulator with fuel pump assembly, the fuel return system in which the fuel returns from the engine area is discontinued and temperature rise inside the fuel tank is prevented.



185EG16

3. Fuel Injector

The 12-hole type injector is used. By modifying its injector nozzle to a taper shape, this injector has achieved high atomizing performance of fuel. In addition, the injector provides good performance with the lightweight moving parts and the optimized magnetic circuit.

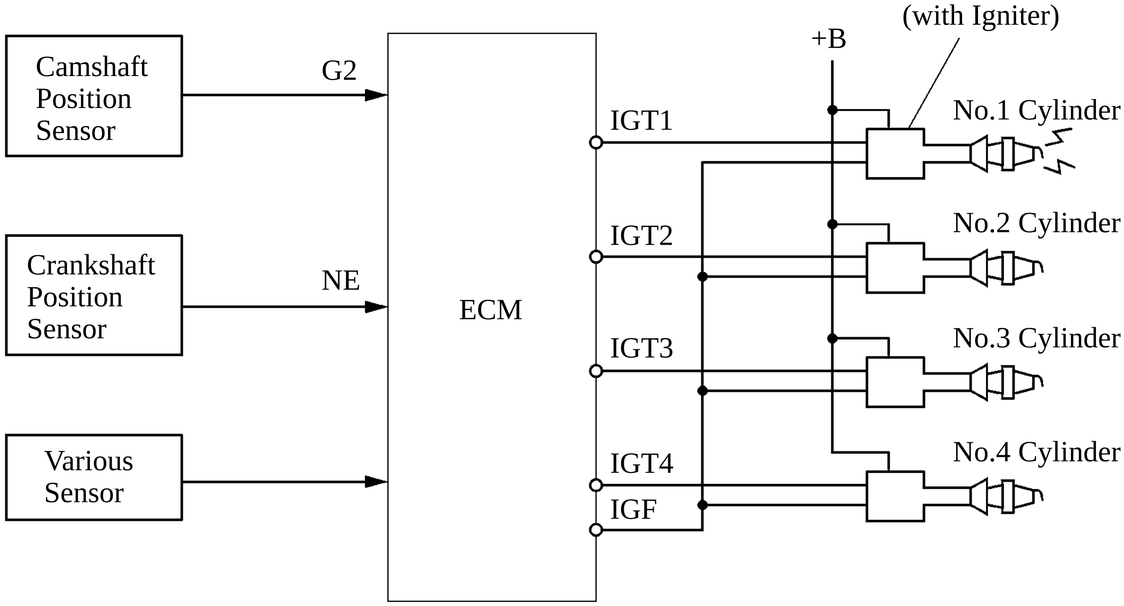


DR011EG18

IGNITION SYSTEM

1. General

- A DIS (Direct Ignition System) is used. The DIS improves the ignition timing accuracy, reduces high-voltage loss, and enhances the overall reliability of the ignition system by eliminating the distributor.
- The DIS in this engine is an independent ignition system which has one ignition coil (with igniter) for each cylinder.
- Iridium-tipped spark plugs are used.



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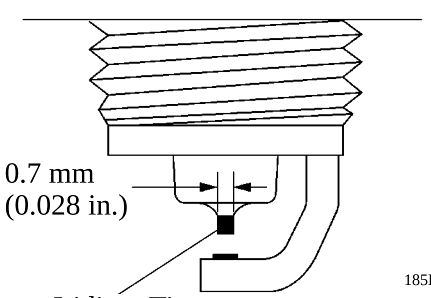
2. Spark Plug

Iridium-tipped spark plugs are used to improve ignition performance while maintaining the same durability of the platinum-tipped spark plugs.



185EG38

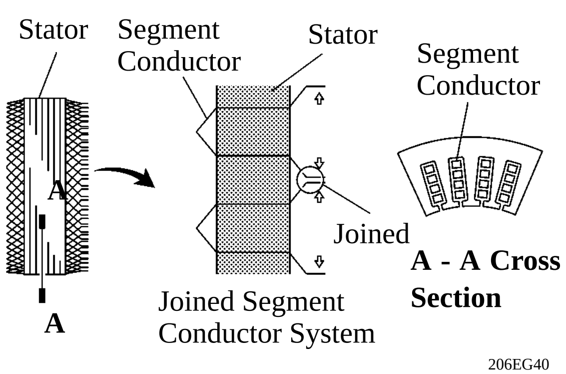
▶ Specifications ◀

DENSO	SK20R11
NGK	IFR6A11
Plug Gap	1.0 - 1.1 mm (0.039 - 0.043 in.)

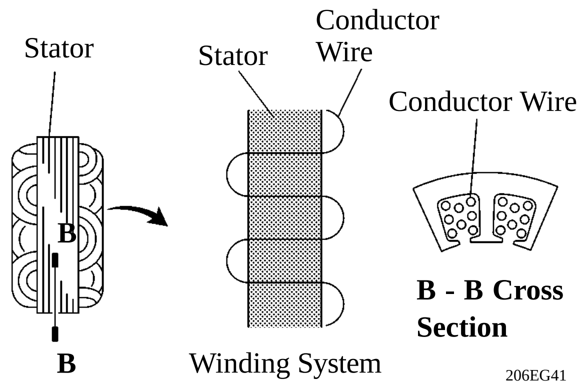
■ CHARGING SYSTEM

1. Segment Conductor Type Generator

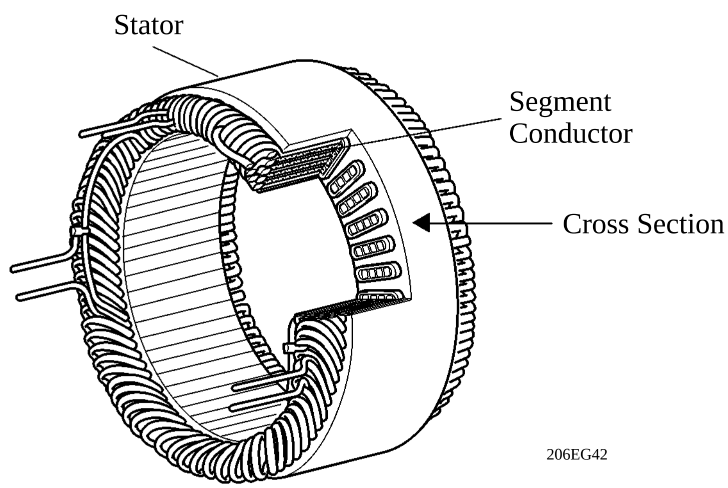
- A compact and lightweight segment conductor type generator that generates high amperage output in a highly efficient manner is used.
- This generator has a joined segment conductor system in which multiple segment conductors are welded together to form the stator. Compared to the conventional winding system, the electrical resistance is reduced due to the shape of the segment conductors, and their arrangement helps to make the generator compact.



Segment Conductor Type Generator



Conventional Type Generator

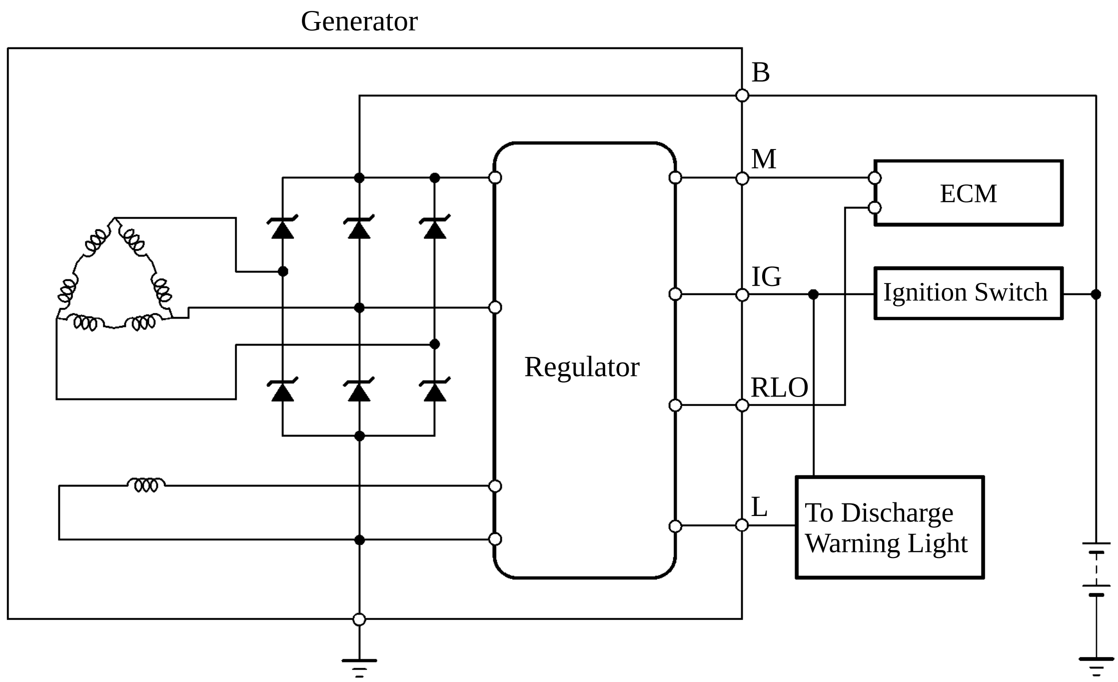


Stator of Segment Conductor Type Generator

▶ Specifications ◀

Type	SE0
Rated Voltage	12 V
Rated Output	100 A
Initial Output Starting Speed	Max. 1,500 rpm

▶ Wiring Diagram ◀



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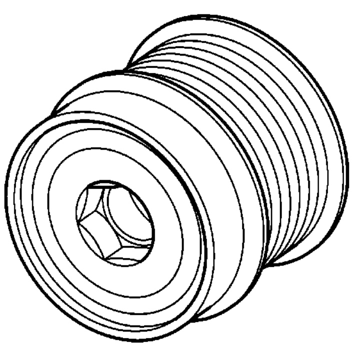
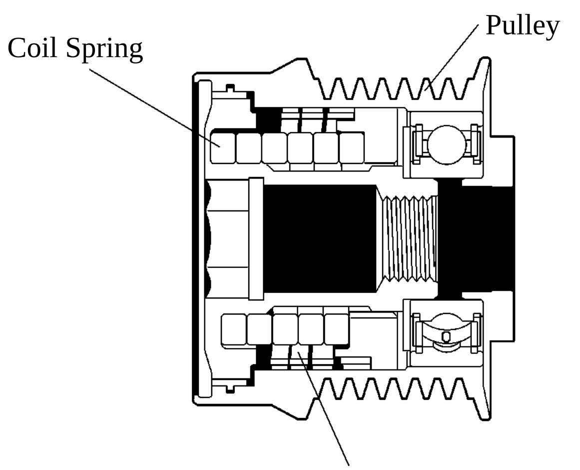
2. Generator Pulley

- A helical coil type one-way clutch is used on the generator pulley in order to reduce the load that acts on the auxiliary equipment belt.
- The pulley mounting nut and the generator pulley have been integrated to achieve a compact construction.



281EG12

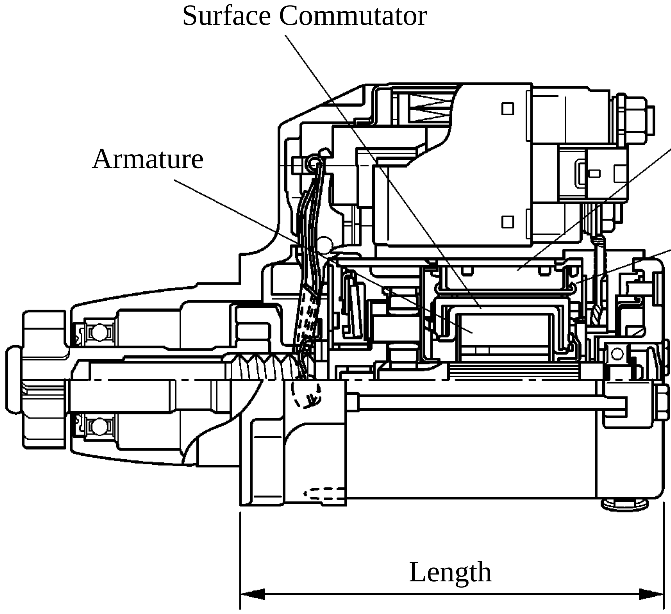


281EG13

■STARTING SYSTEM

1. General

- A compact and lightweight PS (Planetary reduction-Segment conductor motor) type starter is used.
- Because the PS type starter contains an armature that uses square-shaped conductors, and its surface functions as a commutator, it has resulted in both improving its output torque and reducing its overall length.
- In place of the field coil used in the conventional type starter, the PS type starter uses two types of permanent magnets: main magnets and interpolar magnets. The main magnets and interpolar magnets have been efficiently arranged to increase the magnetic flux and to shorten the length of the yoke.



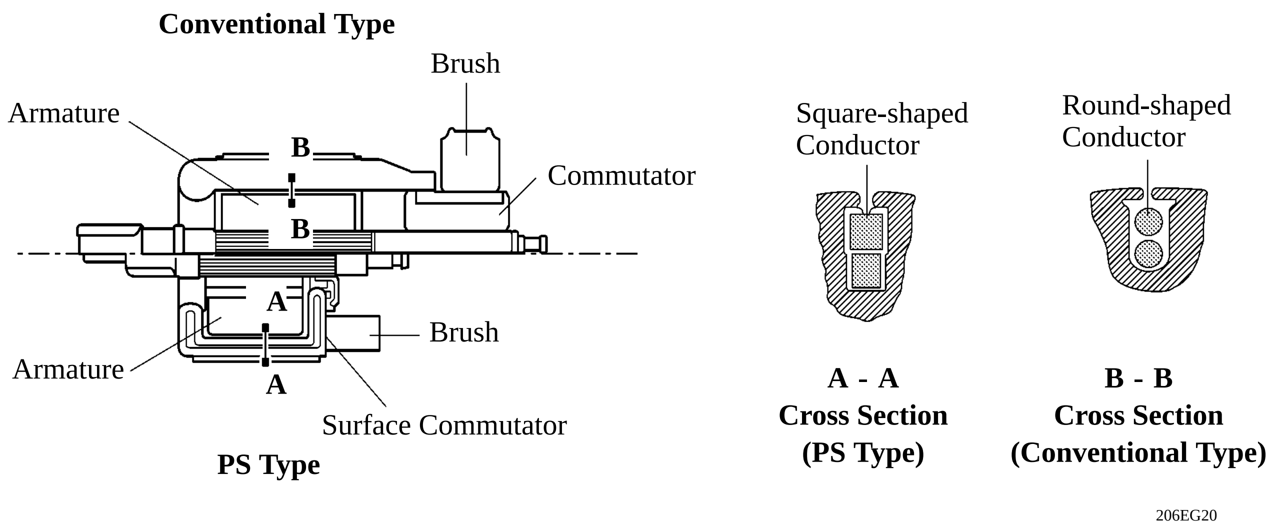
▶ Specifications ◀

Starter Type		PS Type
Rating Output		1.7 kW
Rating Voltage		12 V
Length*[1]	mm (in.)	128 (5.04)
Weight	g (lb)	2950 (6.50)
Rotational Direction*[2]		Counterclockwise

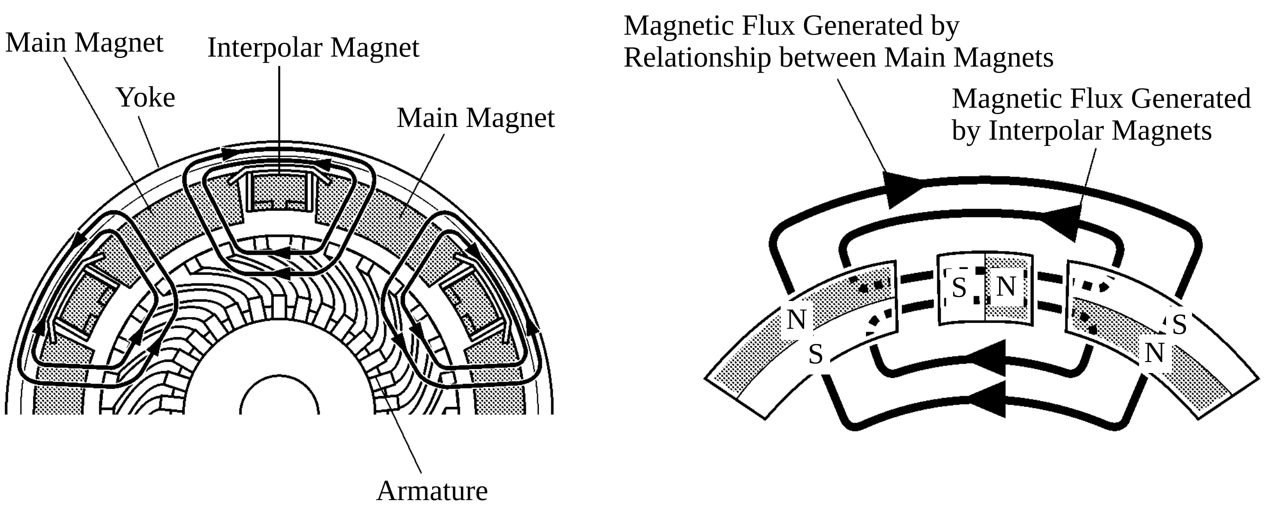
*[1]: Length from the mounted area to the rear end of the starter
*[2]: Viewed from pinion side

2. Construction

- Instead of constructing the armature coil with conventional type round-shaped conductor wires, the PS type starter uses square conductors. With this type of construction, the same conditions that are realized by winding numerous round-shaped conductor wires can be achieved without increasing the mass. As a result, the output torque has been increased, and the armature coil has been made more compact.
- Because the surface of the square-shaped conductors that are used in the armature coil functions as a commutator, the overall length of the PS type starter has been shortened.



- Instead of the field coils used in the conventional type starter, the PS type starter uses two types of permanent magnets: the main magnets and the interpolar magnets. The main and interpolar magnets are arranged alternately inside the yoke, allowing the magnetic flux that is generated between the main and interpolar magnets to be added to the magnetic flux that is generated by the main magnets.
  In addition to increasing the amount of magnetic flux, this construction shortens the overall length of the yoke.

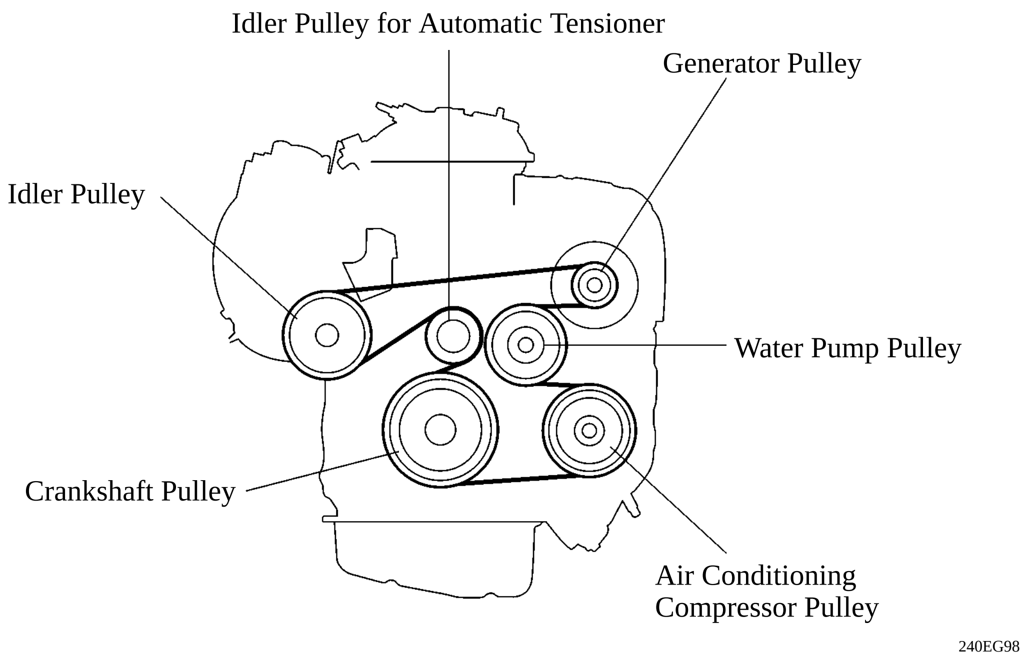


Cross Section of Yoke

■ SERPENTINE BELT DRIVE SYSTEM

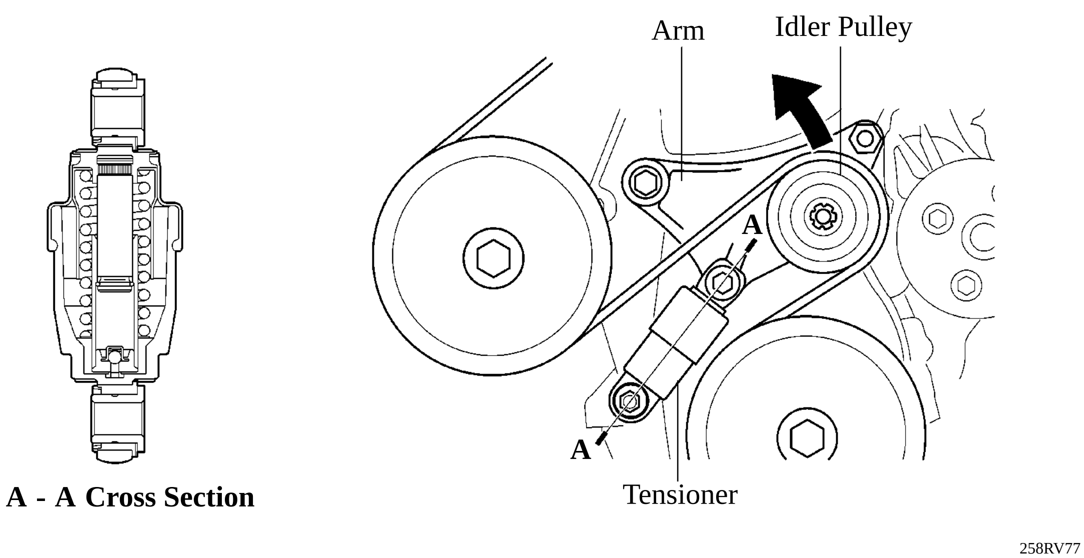
1. General

- Accessory components are driven by a serpentine belt consisting of a single V-ribbed belt. It reduces the overall engine length, weight and the number of engine parts.
- An automatic tensioner eliminates the need for tension adjustment.



2. Automatic Tensioner

The automatic tensioner consists of an idler pulley and a tensioner. The idler pulley maintains belt tension by the force of the spring that is located in the tensioner.



■ENGINE CONTROL SYSTEM

1. General

The engine control system for the 2AZ-FE engine has the following systems.

System	Outline
SFI Sequential Multiport Fuel Injection	● An L-type SFI system directly detects the intake air volume with a hot-wire type mass air flow meter. ● The fuel injection system is a sequential multiport fuel injection system.
ESA Electronic Spark Advance	Ignition timing is determined by the ECM based on signals from various sensors. The ECM corrects ignition timing in response to engine knocking.
ETCS-i Electronic Throttle Control System-intelligent (See page-43)	Optimally controls the throttle valve opening in accordance with the amount of accelerator pedal effort and the condition of the engine and the vehicle.
	● A linkless-type is used, without an accelerator cable. ● An accelerator pedal position sensor is provided on the accelerator pedal. ● A non-contact type throttle position sensor and accelerator pedal position sensor are used.
VVT-i Variable Valve Timing-intelligent (See page EG-48)	Controls the intake camshaft to an optimal valve timing in accordance with the engine condition.
Air-fuel Ratio Sensor, Oxygen Sensor Heater Control	Maintains the temperature of the air-fuel ratio sensor or oxygen sensor at an appropriate level to realize accuracy of detection of the oxygen concentration in the exhaust gas.
Air Conditioning Cut-off Control	By turning the air conditioning compressor ON or OFF in accordance with the engine condition, drivability is maintained.
Cooling Fan Control (See page EG-52)	Radiator cooling fan operation is controlled by signals from ECM based on the engine coolant temperature sensor signal and the condition of the air conditioning operation.
Fuel Pump Control (See page EG-53)	● Fuel pump operation is controlled by signal from the ECM. ● The fuel pump is stopped when the SRS driver's and front passenger's airbags are deployed.
Evapotative Emission Control (See page EG-54)	The ECM controls the purge flow of evaporative emissions (HC) in the canister in accordance with engine conditions.
	Approximately five hours after the ignition switch has been turned OFF, the ECM operates the canister pump module to detect any evaporative emission leakage occurring in the EVAP (evaporative emission) control system through changes in the 0.02 in. leak pressure.
Charging Control (See page EG-65)	The ECM regulates the charging voltage of the generator in accordance with the driving conditions and the charging state of the battery.

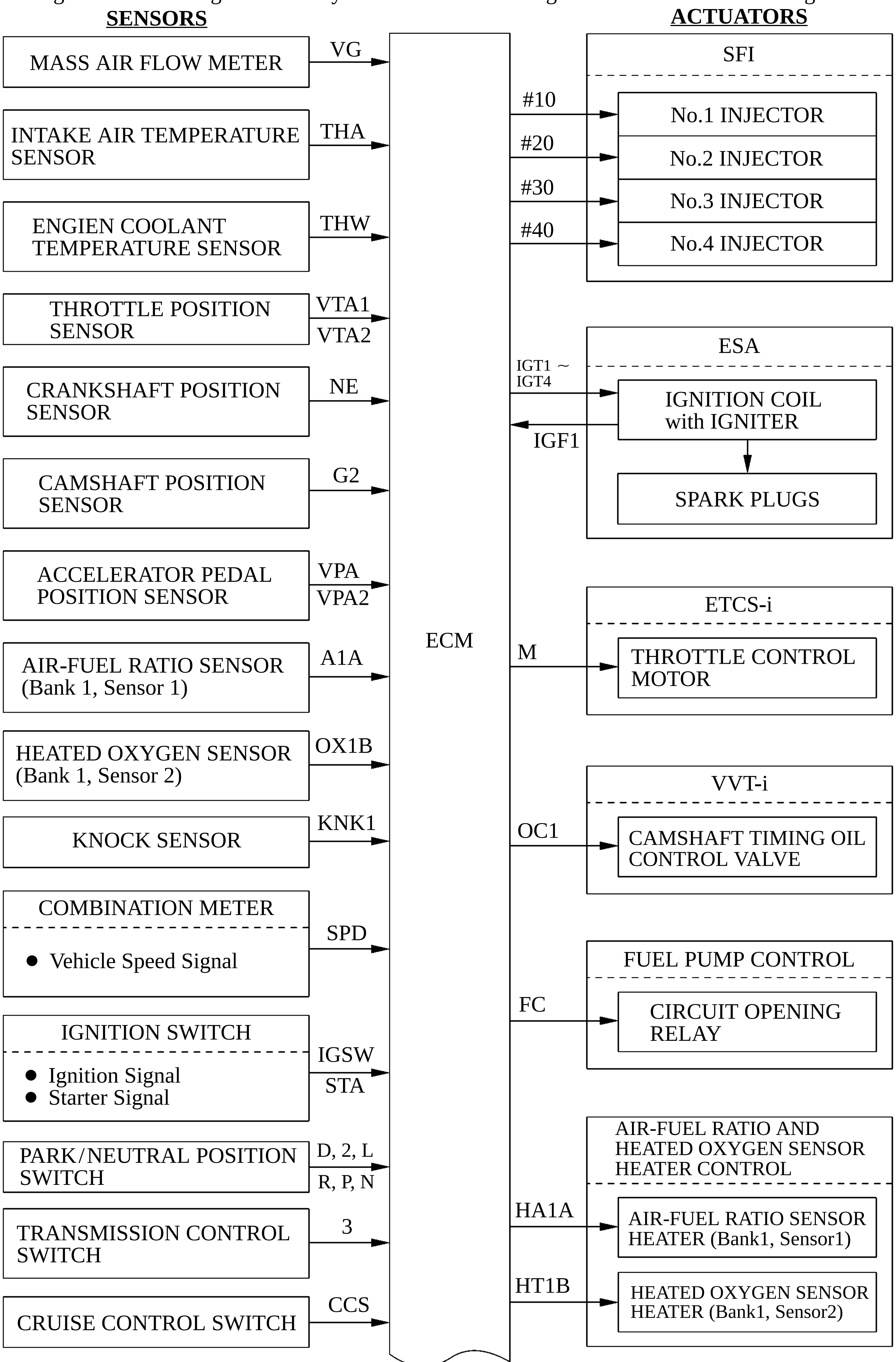
(Continued)

System	Outline
Engine Immobilizer*[2]	Prohibits fuel delivery and ignition if an attempt is made to start the engine with an invalid ignition key.
Diagnosis (See page EG-67)	When the ECM detects a malfunction, the ECM diagnoses and memorizes the failed section.
Fail-safe (See page EG-67)	When the ECM detects a malfunction, the ECM stops or controls the engine according to the data already stored in memory.

*[2]: Models with Engine Immobilizer System

2. Construction

The configuration of the engine control system in the 2AZ-FE engine is shown in the following chart.



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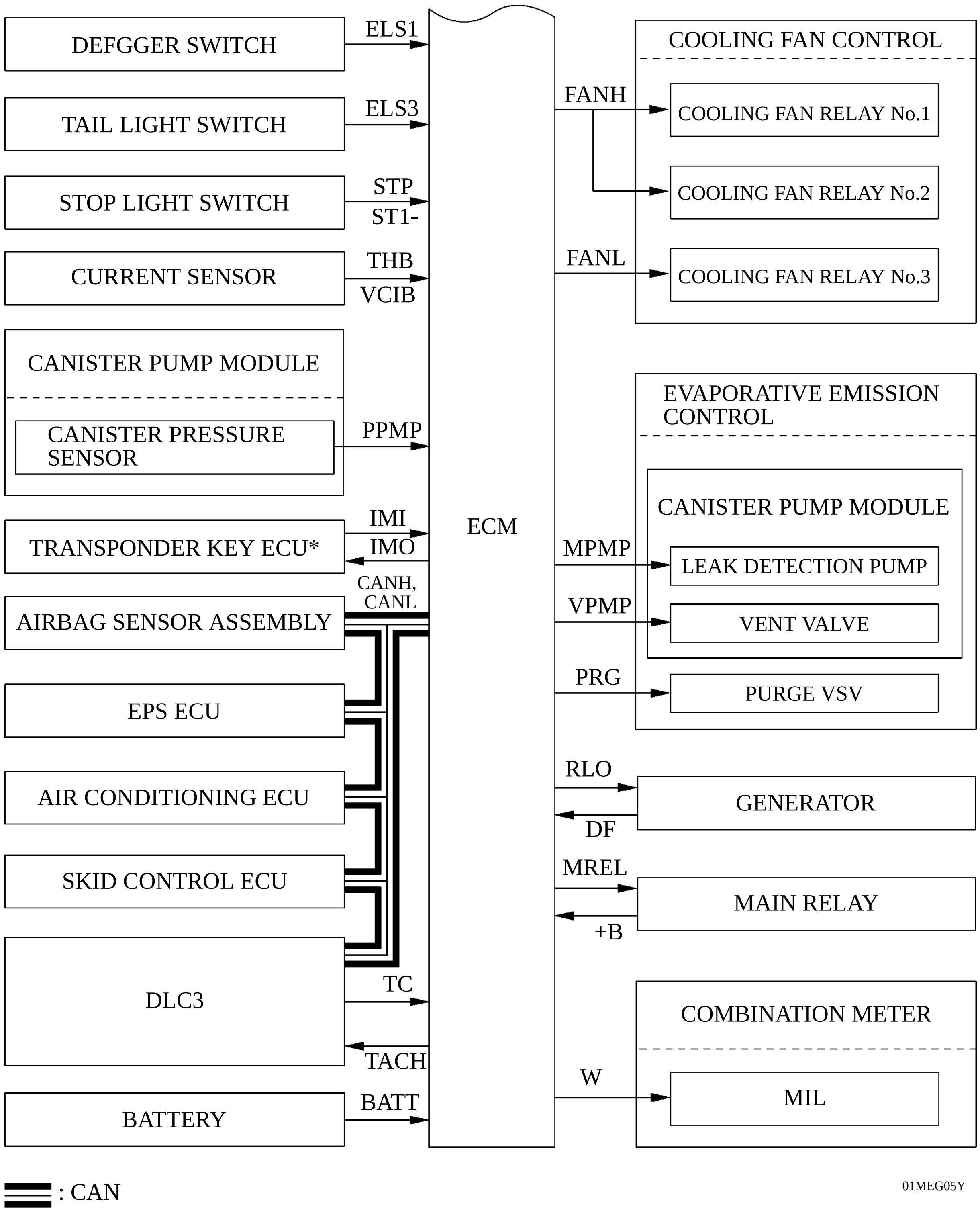
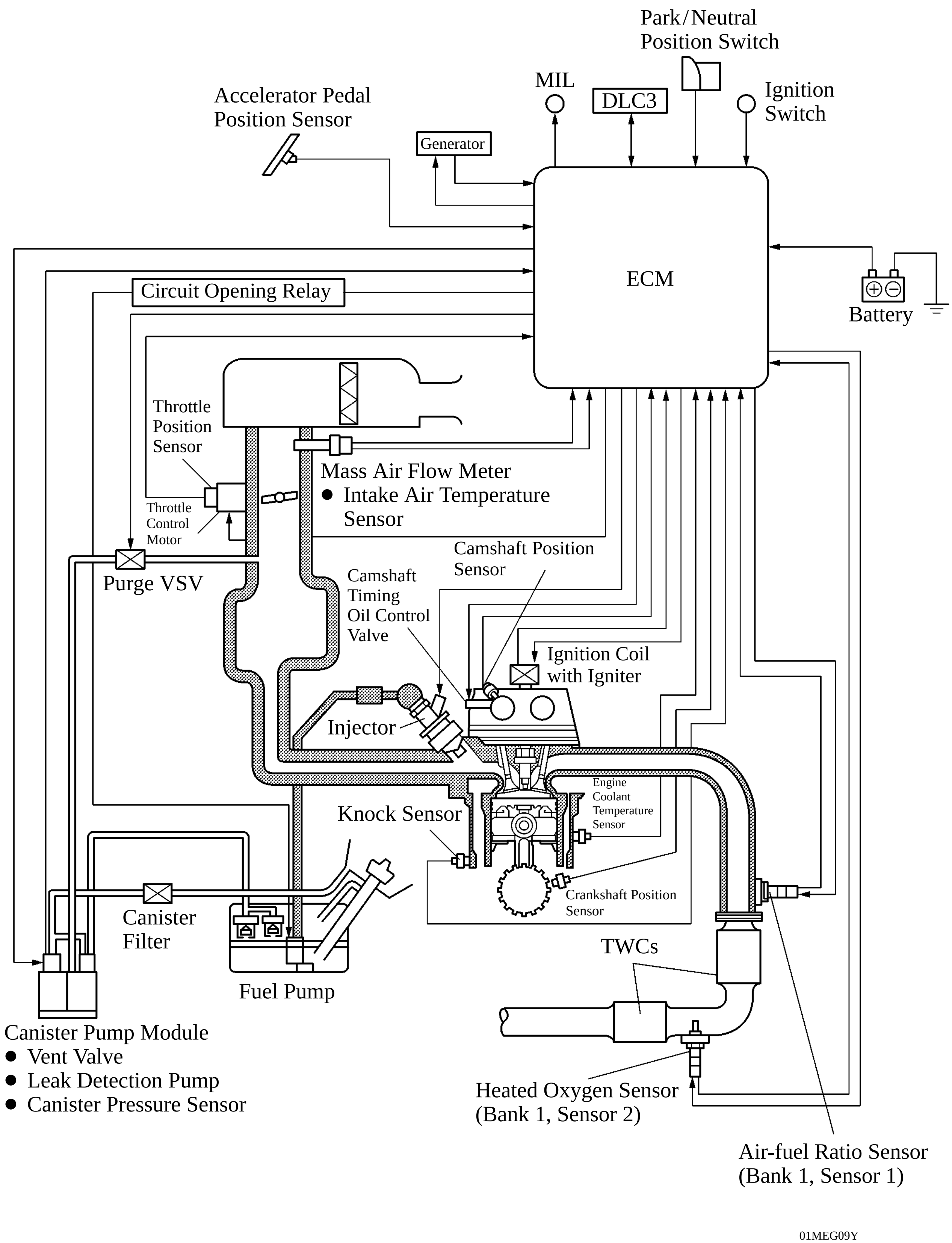
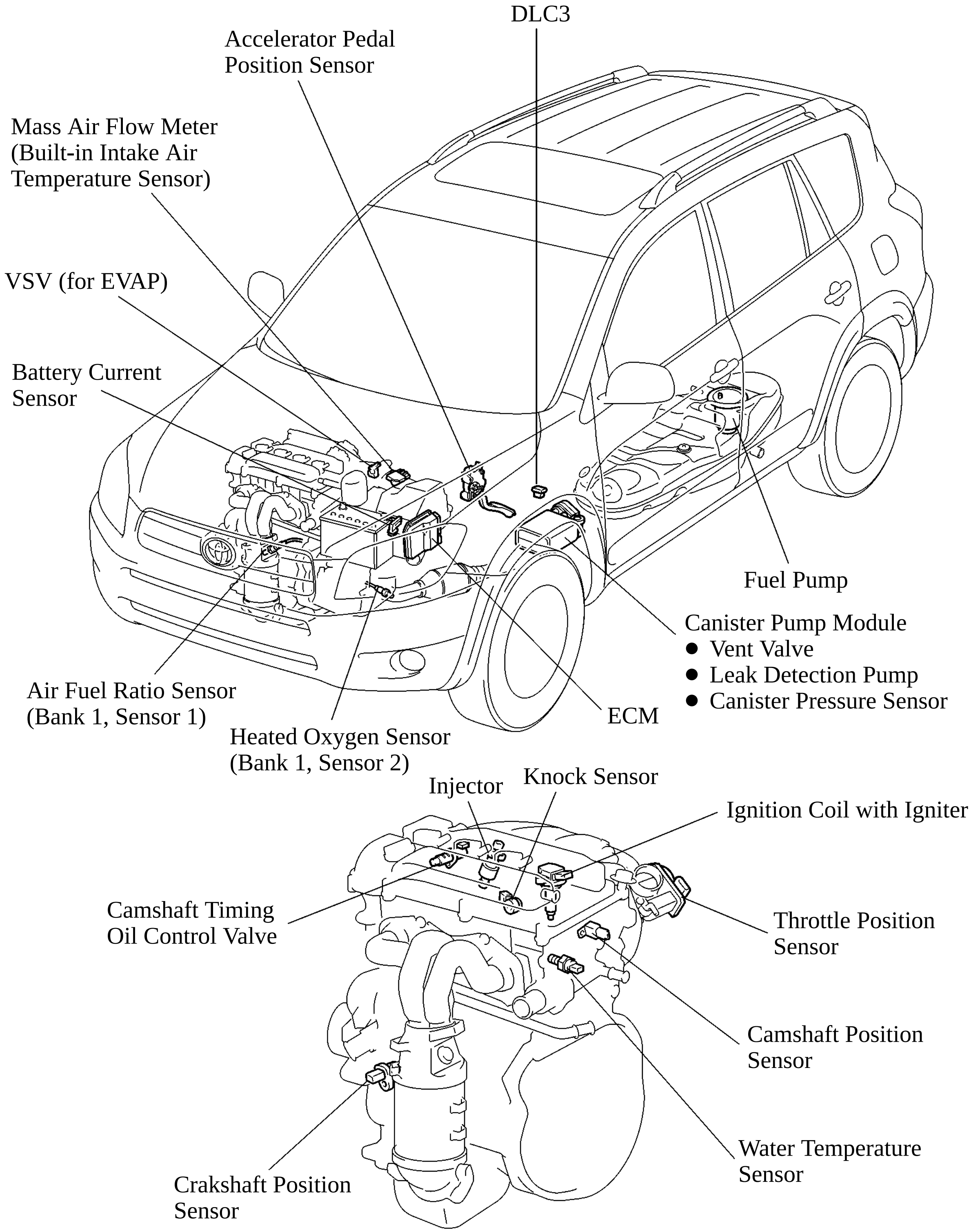


*: Models with Engine Immobilizer System

3. Engine Control System Diagram



4. Layout of Main Components



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5. Main Components of Engine Control System

General

The main components of the 2AZ-FE engine control system are as follows:

Component	Outline	Quantity
ECM	32-bit CPU	1
Mass Air Flow Meter	Hot-wire Type	1
Crankshaft Position Sensor (Rotor Teeth)	Pick-up Coil Type (36-2)	1
Camshaft Position Sensor (Rotor Teeth)	Pick-up Coil Type (3)	1
Throttle Position Sensor	Non-contact Type	1
Accelerator Pedal Position Sensor	Non-contact Type	1
Knock Sensor	Built-in Piezoelectric Element Type (Flat Type)	1
Air-fuel Ratio Sensor (Bank 1, Sensor 1)	Type with Heater (Planar Type)	1
Heated Oxygen Sensor (Bank 1, Sensor 2)	Type with Heater (Cup Type)	1
Injector	12-hole Type	4

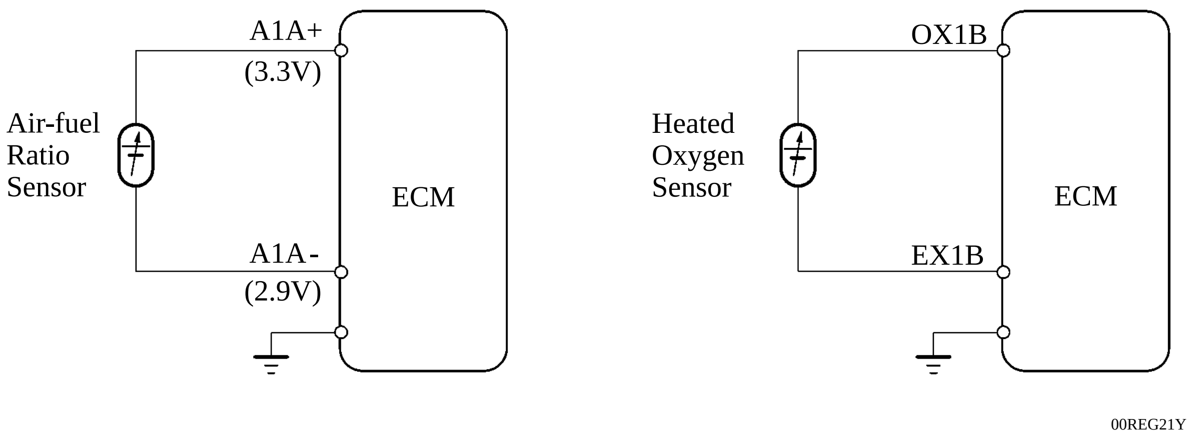
ECM

The 32-bit CPU of the ECM is used to increase the speed for processing the signals.

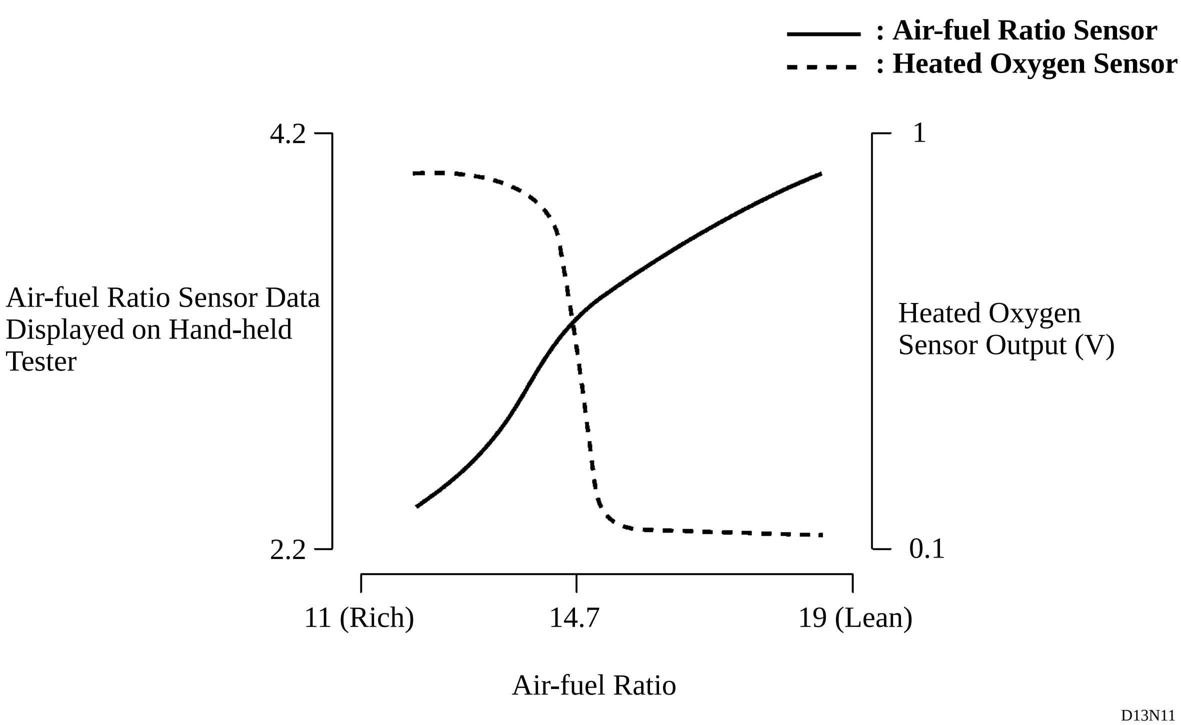
Air-fuel Ratio Sensor and Heated Oxygen Sensor

1) General

- The air-fuel ratio sensor and heated oxygen sensor differ in output characteristics.
- Approximately 0.4V is constantly applied to the air-fuel ratio sensor, which outputs an amperage that varies in accordance with the oxygen concentration in the exhaust emission. The ECM converts the changes in the output amperage into voltage in order to linearly detect the present air-fuel ratio. The air-fuel ratio sensor data is read out by the hand-held tester.
- The output voltage of the heated oxygen sensor changes in accordance with the oxygen concentration in the exhaust emission. The ECM uses this output voltage to determine whether the present air-fuel ratio is richer or leaner than the stoichiometric air-fuel ratio.

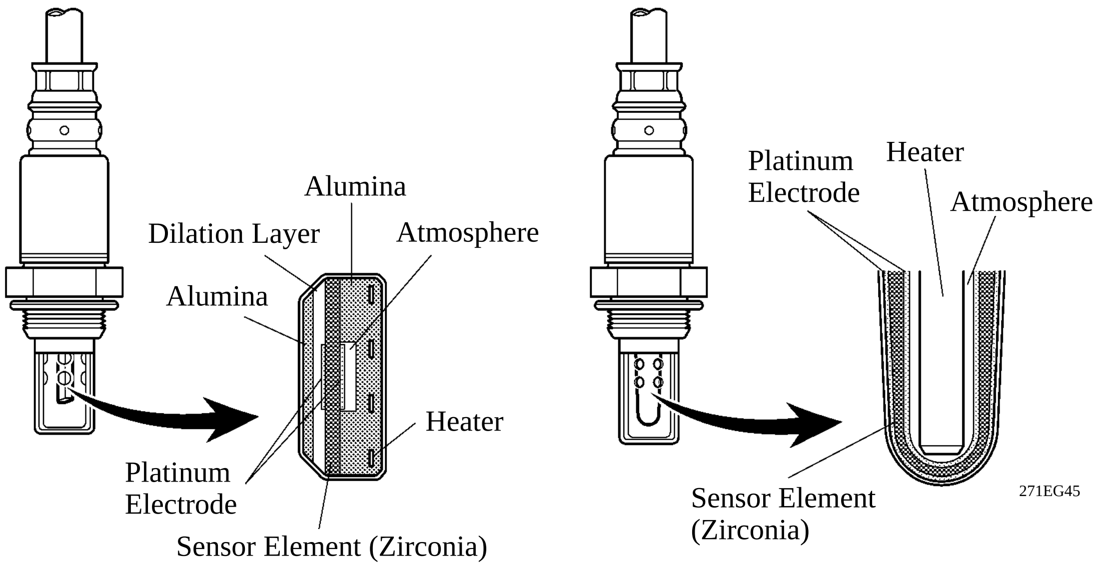


Air-fuel Ratio Sensor Circuit **Heated Oxygen Sensor**



2) Construction

- The basic construction of the air-fuel ratio sensor and heated oxygen sensor is the same. However, they are divided into the cup type and the planar type, according to the different types of heater construction that are used.
- The cup type sensor contains a sensor element that surrounds a heater.
- The planar type sensor uses alumina, which excels in heat conductivity and insulation, to integrate a sensor element with a heater, thus realizing the excellent warm-up performance of the sensor.



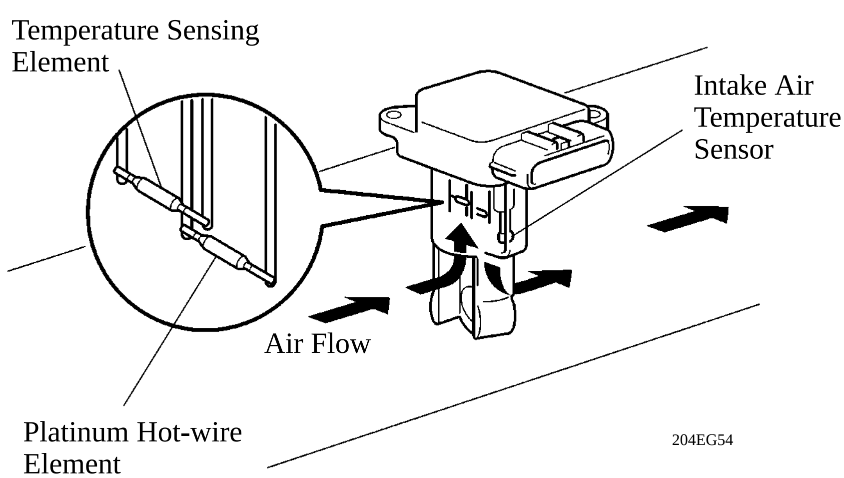
Planar Type Air-fuel Ratio Sensor **Cup Type Heated Oxygen Sensor**

▶ Warm-up Specification ◀

Sensor Type	Planar Type	Cup Type
Warm-up Time	Approx. 10 sec.	Approx. 30 sec.

Mass Air Flow Meter

- The compact and lightweight mass air flow meter, which is a plug-in type, allows a portion of the intake air to flow through the detection area. By directly measuring the mass and the flow rate of the intake air, the detection precision is ensured and the intake air resistance is reduced.
- This mass air flow meter has a built-in intake air temperature sensor.

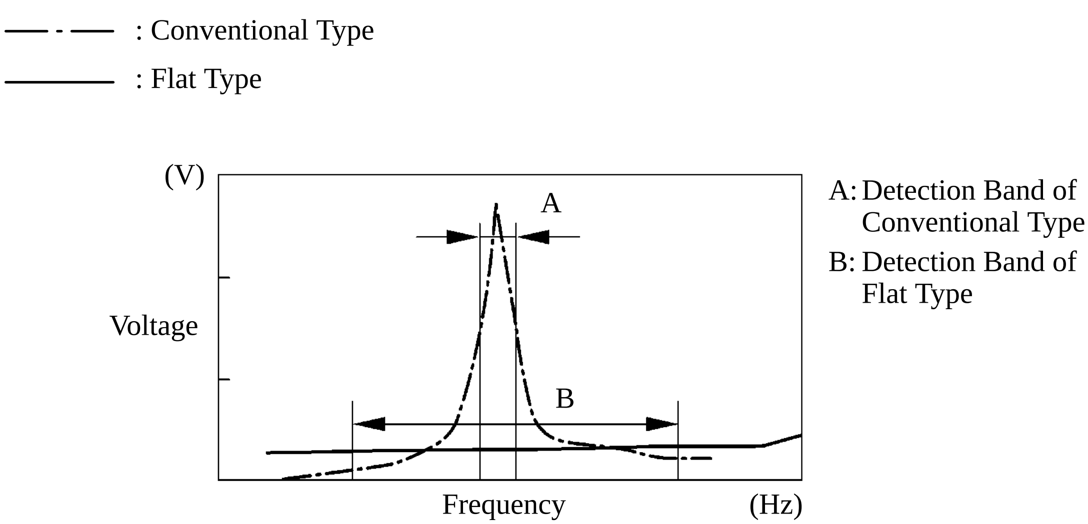


Knock Sensor (Flat Type)

1) General

In the conventional type knock sensor (resonant type), a vibration plate which has the same resonance point as the knocking frequency of the engine is built in and can detect the vibration in this frequency band.
On the other hand, a flat type knock sensor (non-resonant type) has the ability to detect vibration in a wider frequency band from about 6 kHz to 15 kHz, and has the following features.

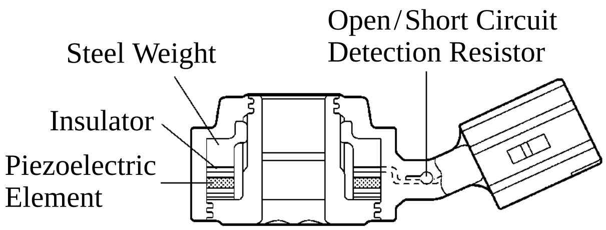
- The engine knocking frequency will change a bit depending on the engine speed. The flat type knock sensor can detect the vibration even when the engine knocking frequency is changed. Thus the vibration detection ability is increased compared to the conventional type knock sensor, and a more precise ignition timing control is possible.



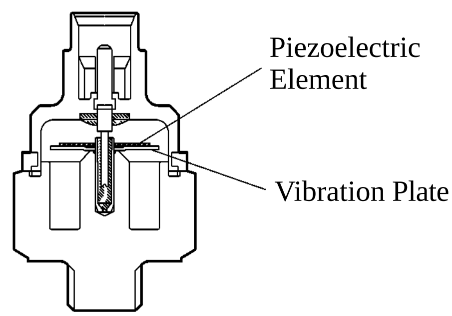
Characteristic of Knock Sensor 214CE04

2) Construction

- The flat type knock sensor is installed on the engine through the stud bolt installed on the cylinder block. For this reason, a hole for the stud bolt is running through the center of the sensor.
- Inside of the sensor, a steel weight is located on the upper portion and a piezoelectric element is located under the weight through the insulator.
- The open/short circuit detection resistor is integrated.



Flat Type Knock Sensor (Non-resonant Type) 214CE01

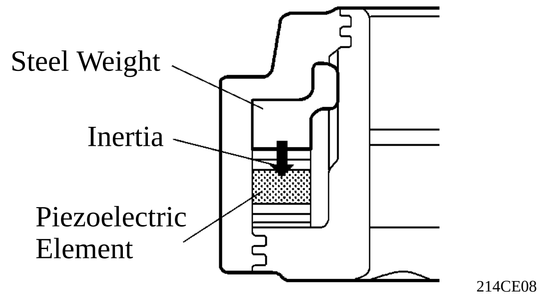


214CE02

Conventional Type Knock Sensor (Resonant Type)

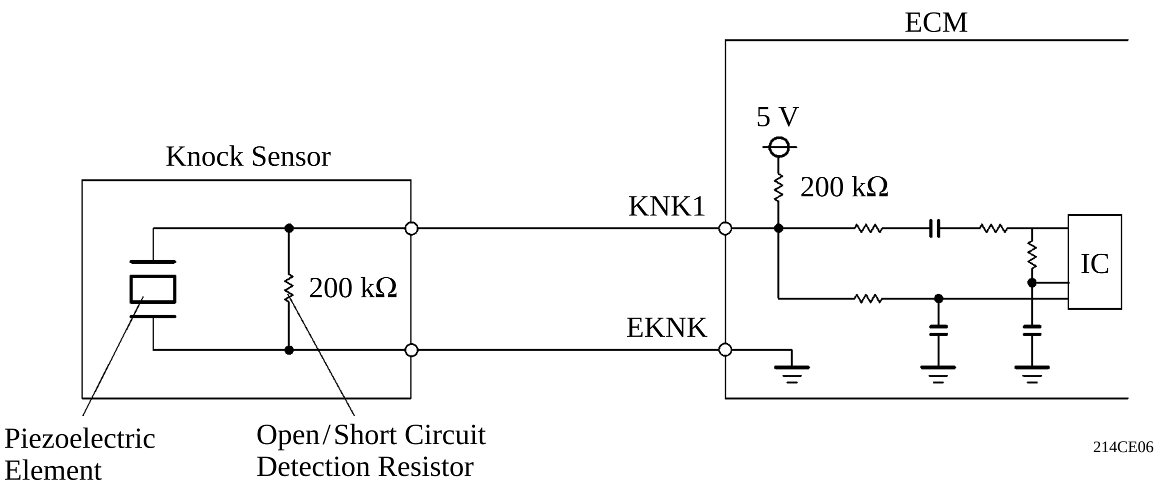
3) Operation

The knocking vibration is transmitted to the steel weight and its inertia applies pressure to the piezoelectric element. The action generates electromotive force.



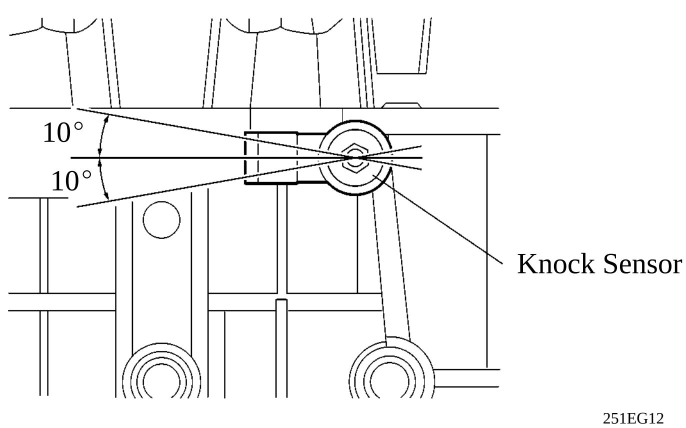
4) Open/Short Circuit Detection Resistor

While the ignition is ON, the open/short circuit detection resistor in the knock sensor and the resistor in the ECM keep constant the voltage at the terminal KNK1 of engine.
An IC (Integrated Circuit) in the ECM is always monitoring the voltage of the terminal KNK1. If the open/short circuit occurs between the knock sensor and the ECM, the voltage of the terminal KNK1 will change and the ECM detects the open/short circuit and stores DTC (Diagnostic Trouble Code).



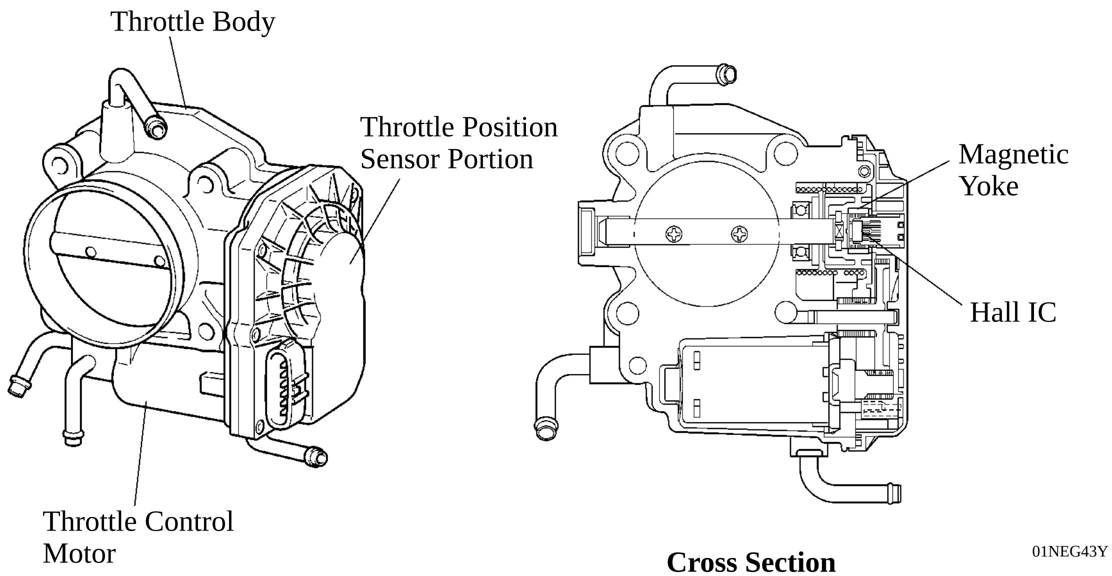
Service Tip

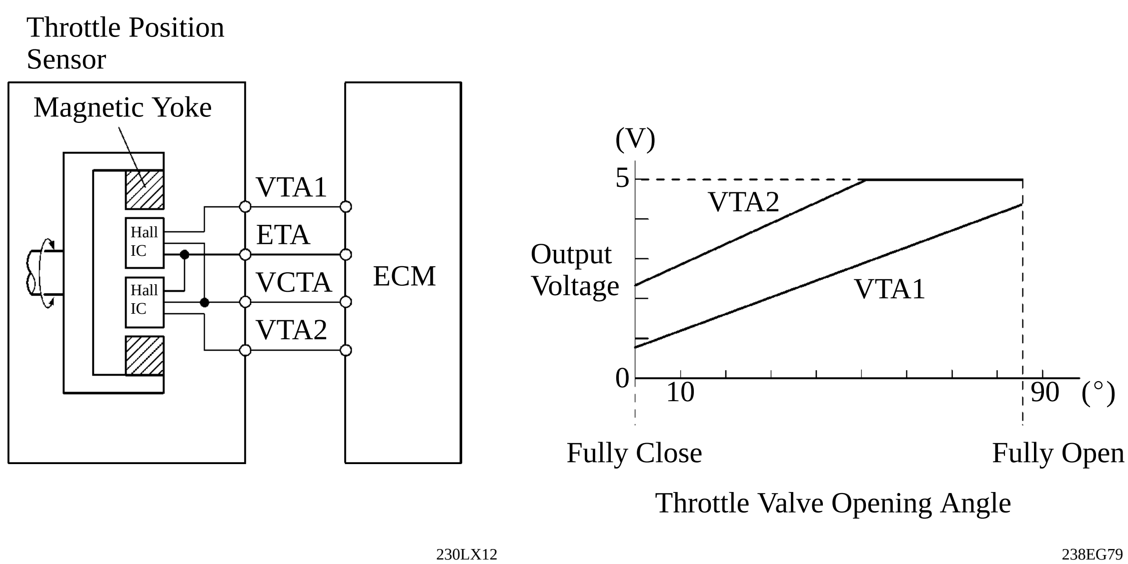
- In accordance with the adoption of an open/short circuit detection resistor, the inspection method for the sensor has been changed. For details, refer to the 2006 RAV4 Repair Manual (Pub. No. RM01M1U).
- To prevent the water accumulation in the connecter, make sure to install the flat type knock sensor in the position as shown in the following illustration.



Throttle Position Sensor

The throttle position sensor is mounted on the throttle body to detect the opening angle of the throttle valve. The throttle position sensor converts the magnetic flux density that changes when the magnetic yoke (located on the same axis as the throttle shaft) rotates around the Hall IC into electric signals to operate the throttle control motor.





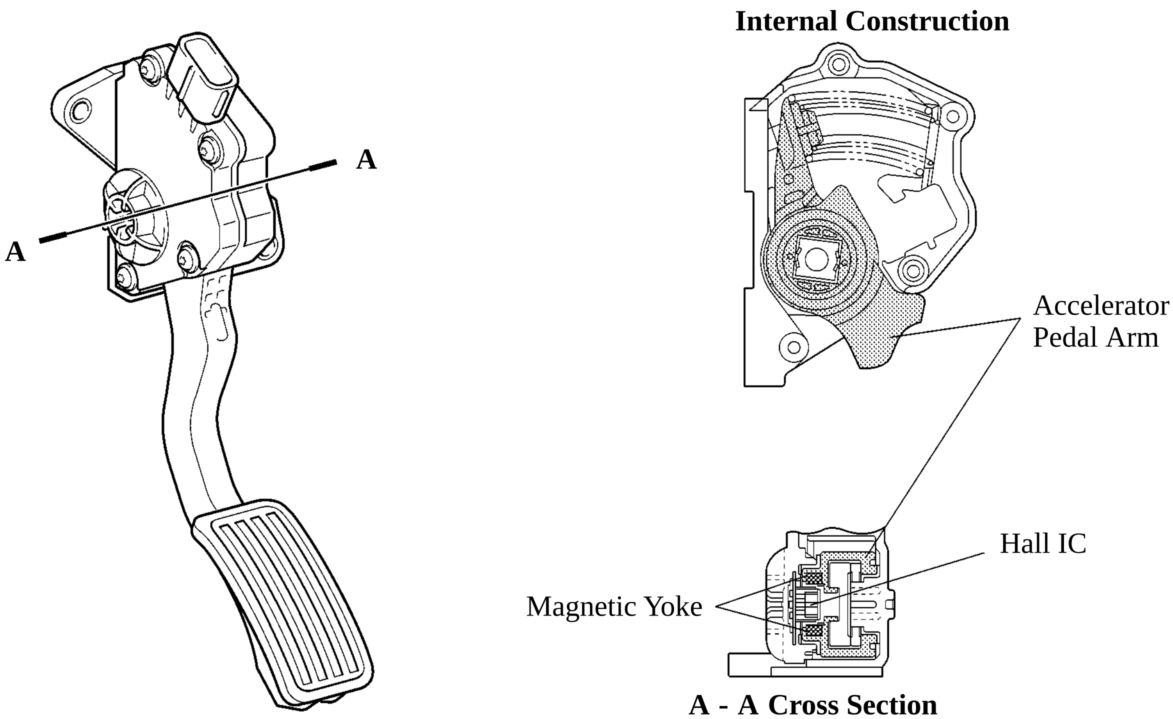
Service Tip

The inspection method differs from the conventional contact type throttle position sensor because this non-contact type sensor uses a Hall IC.
For details, refer to the 2006 RAV4 Repair Manual (Pub. No. RM01M1U).

Accelerator Pedal Position Sensor

The non-contact type accelerator pedal position sensor uses a Hall IC.

- The magnetic yoke that is mounted at the accelerator pedal arm rotates around the Hall IC in accordance with the amount of effort that is applied to the accelerator pedal. The Hall IC converts the changes in the magnetic flux at that time into electrical signals, and outputs them as accelerator pedal effort to the ECM.
- The Hall IC contains circuits for the main and sub signals. It converts the accelerator pedal depressed angles into electric signals with two differing characteristics and outputs them to the ECM.



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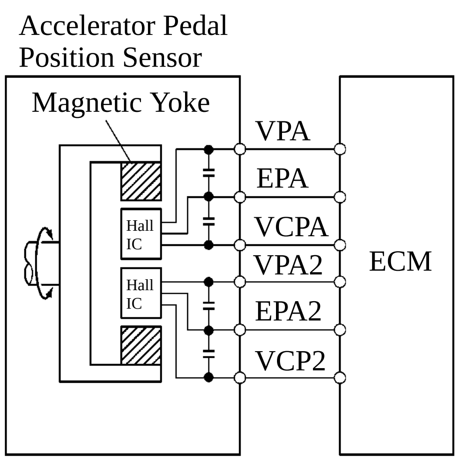
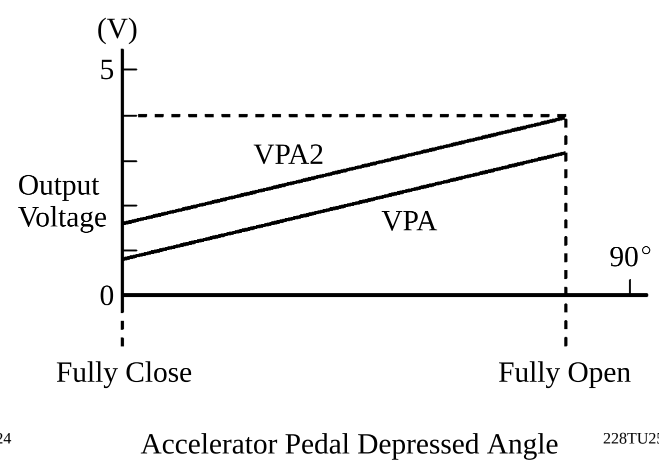


228TU24



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Service Tip

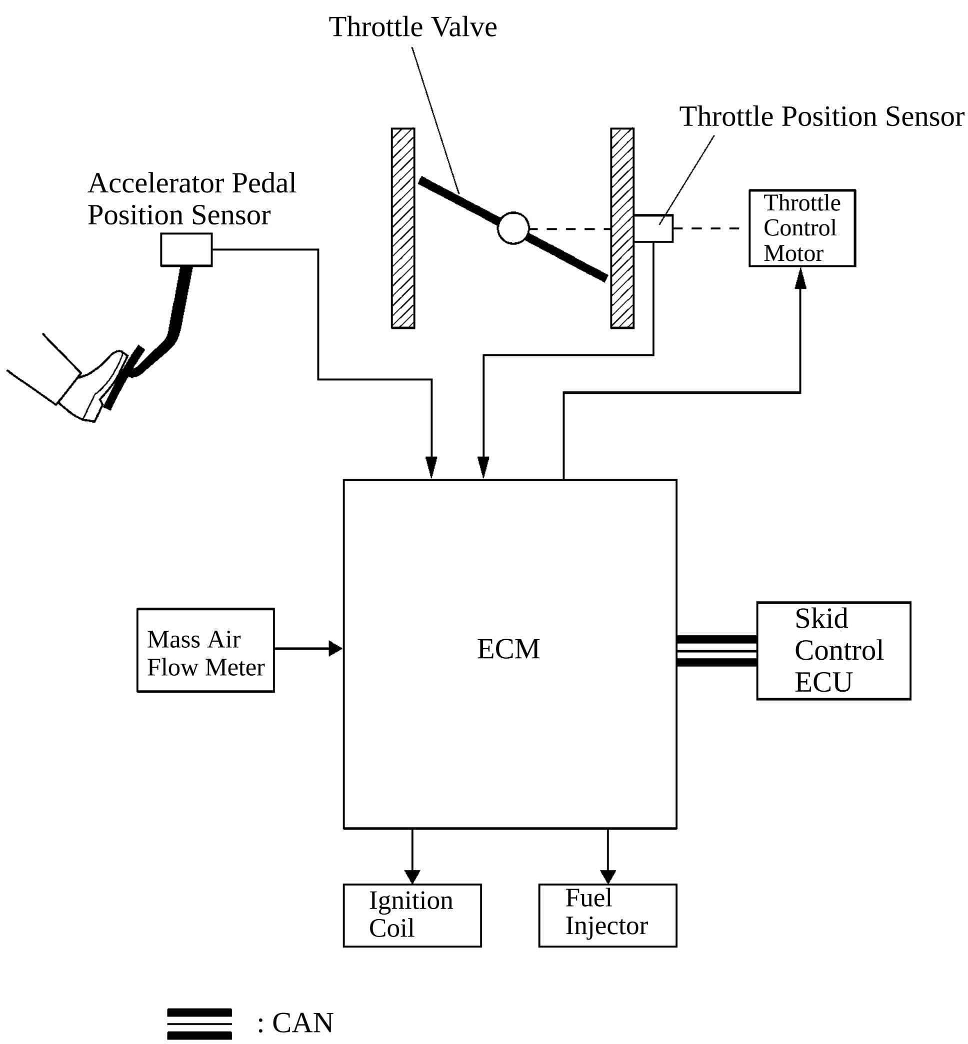
The inspection method differs from the conventional contact type accelerator pedal position sensor because this non-contact type sensor uses a Hall IC.
For details, refer to the 2006 RAV4 Repair Manual (Pab. No. RM01M0U).

6. ETCS-i (Electronic Throttle Control System-intelligent)

General

- The ETCS-i is used, providing excellent throttle control in all the operating ranges. In the 2AZ-FE engine, the accelerator cable has been discontinued, and an accelerator pedal position sensor has been provided on the accelerator pedal.
- In the conventional throttle body, the throttle valve opening is determined by the amount of the accelerator pedal effort. In contrast, the ETCS-i uses the ECM to calculate the optimal throttle valve opening that is appropriate for the respective driving condition and uses a throttle control motor to control the opening.
- The ETCS-i controls the IAC (Idle Air Control) system, the TRAC (Traction Control), VSC (Vehicle Stability Control) system and curise control system.
- In case of an abnormal condition, this system switches to the limp mode.

▶ System Diagram ◀



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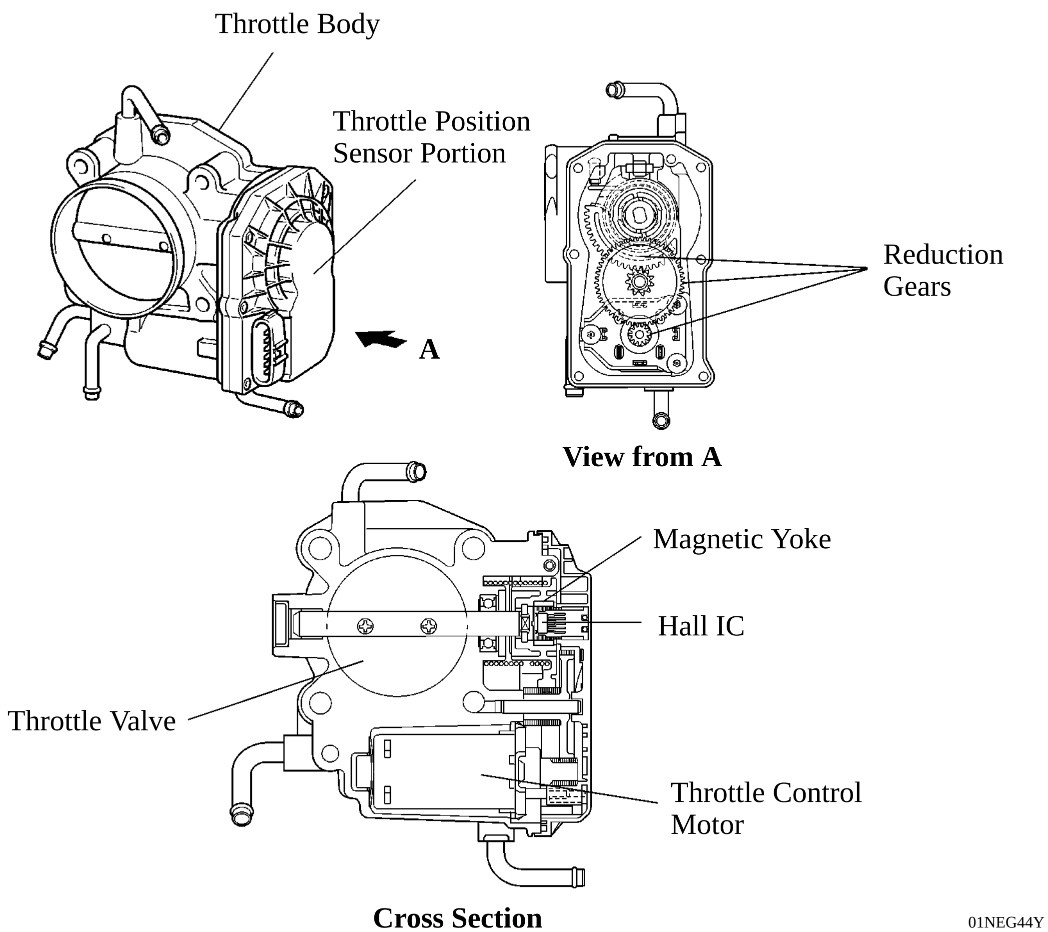
Construction



1) Throttle Position Sensor

The throttle position sensor is mounted on the throttle body, to detect the opening angle of the throttle valve.

2) Throttle Control Motor

A DC motor with excellent response and minimal power consumption is used for the throttle control motor. The ECM performs the duty ratio control of the direction and the amperage of the current that flows to the throttle control motor in order to regulate the opening of the throttle valve.

Operation

1) General

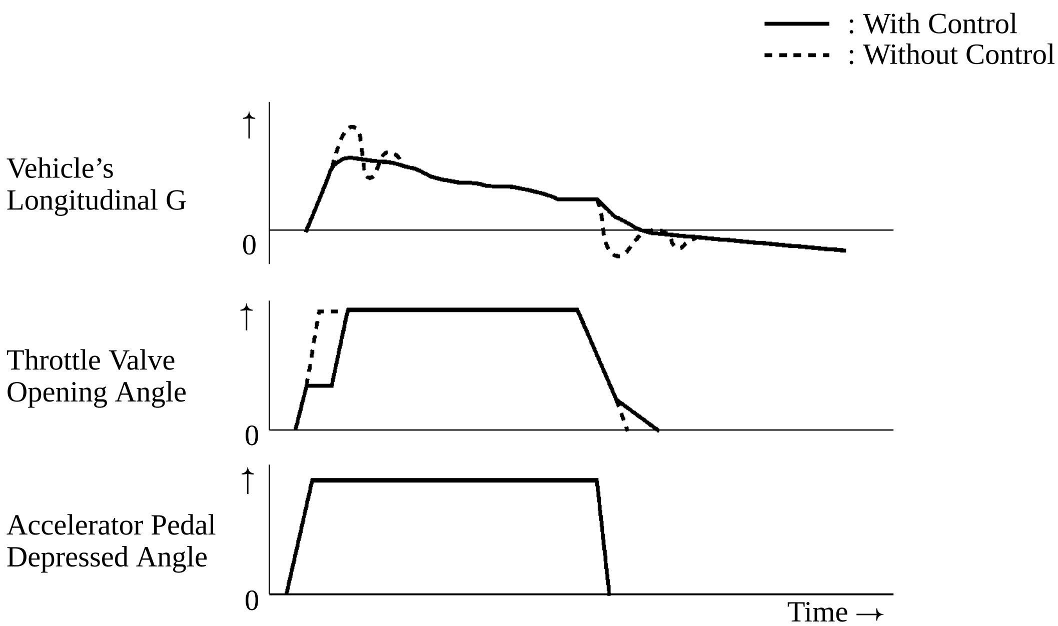
The ECM drives the throttle control motor by determining the target throttle valve opening in accordance with the respective operating condition.

- Non-linear Control
- Idle Air Control
- TRAC Throttle Control
- VSC Coordination Control
- Cruise Control

2) Normal Throttle Control (Non-linear Control)

It controls the throttle to an optimal throttle valve opening that is appropriate for the driving condition such as the amount of the accelerator pedal effort and the engine speed in order to realize excellent throttle control and comfort in all operating ranges.

▶ Control Examples During Acceleration and Deceleration ◀



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3) Idle Air Control

The ECM controls the throttle valve in order to constantly maintain an ideal idle speed.

4) TRAC Throttle Control

As part of the TRAC system, the throttle valve is closed by a demand signal from the skid control ECU if an excessive amount of slippage is created at a driving wheel, thus facilitating the vehicle in providing excellent stability and driving force.

5) VSC Coordination Control

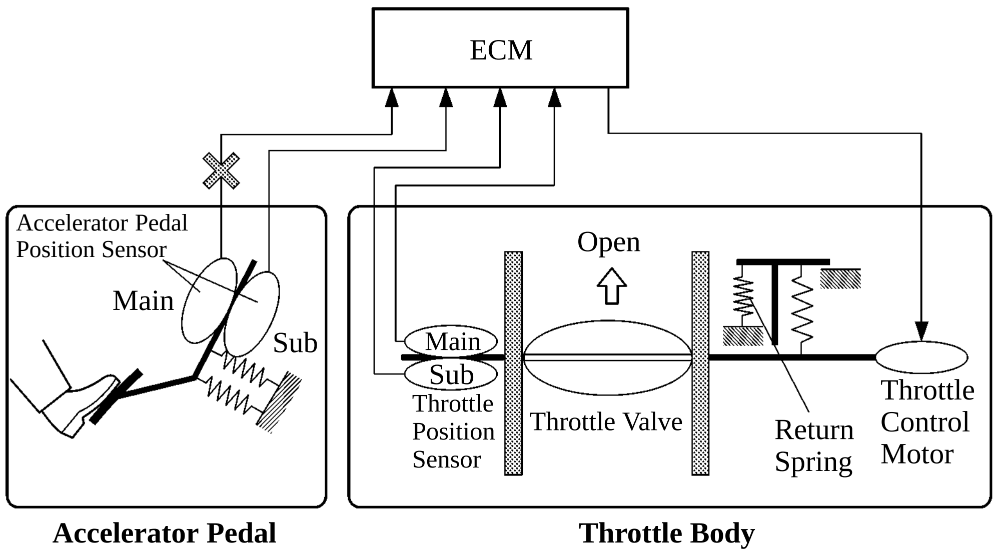
In order to bring the effectiveness of the VSC system control into full play, the throttle valve opening angle is controlled by effecting a coordination control with the skid control ECU.

6) Cruise Control

An ECM with an integrated cruise control ECU directly actuates the throttle valve for operation of the cruise control.

Fail-safe of Accelerator Pedal Position Sensor

- The accelerator pedal position sensor is comprised of two (main, sub) sensor circuits. If a malfunction occurs in either one of the sensor circuits, the ECM detects the abnormal signal voltage difference between these two sensor circuits and switches to the limp mode. In the limp mode, the remaining circuit is used to calculate the accelerator pedal depressed angle, in order to operate the vehicle under the limp mode control.



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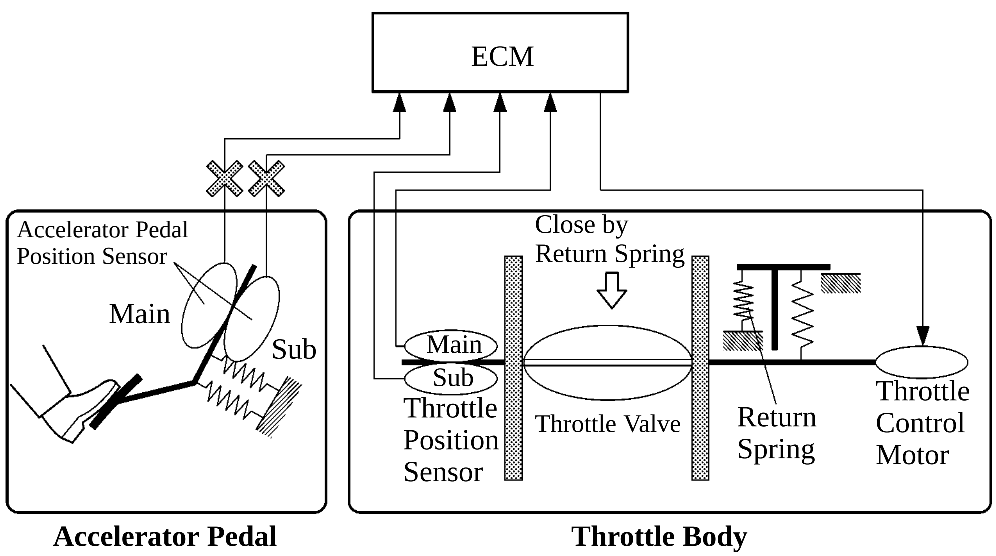
- If both circuits have malfunctions, the ECM detects the abnormal signal voltage from these two sensor circuits and stops the throttle control. At this time, the vehicle can be driven within its idling range.



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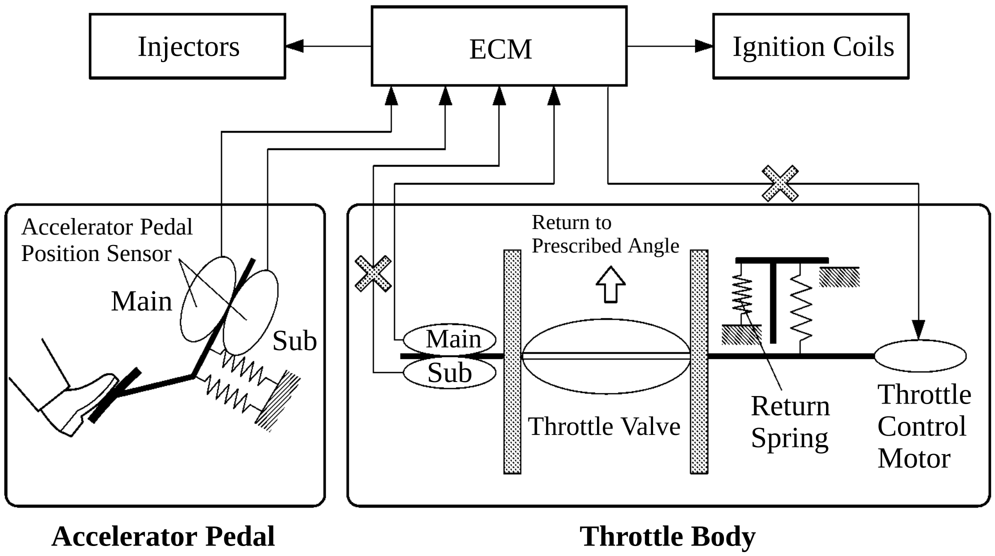
Fail-safe of Throttle Position Sensor

- The throttle position sensor is comprised of two (main, sub) sensor circuits. If a malfunction occurs in either one or both of the sensor circuits, the ECM detects the abnormal signal voltage difference between these two sensor circuits, cuts off the current to the throttle control motor, and switches to the limp mode. Then, the force of the return spring causes the throttle valve to return and stay at the prescribed opening angle. At this time, the vehicle can be driven in the limp mode while the engine output is regulated through the control of the fuel injection (intermittent fuel-cut) and ignition timing in accordance with the accelerator opening.
- The same control as above is effected if the ECM detects a malfunction in the throttle control motor system.



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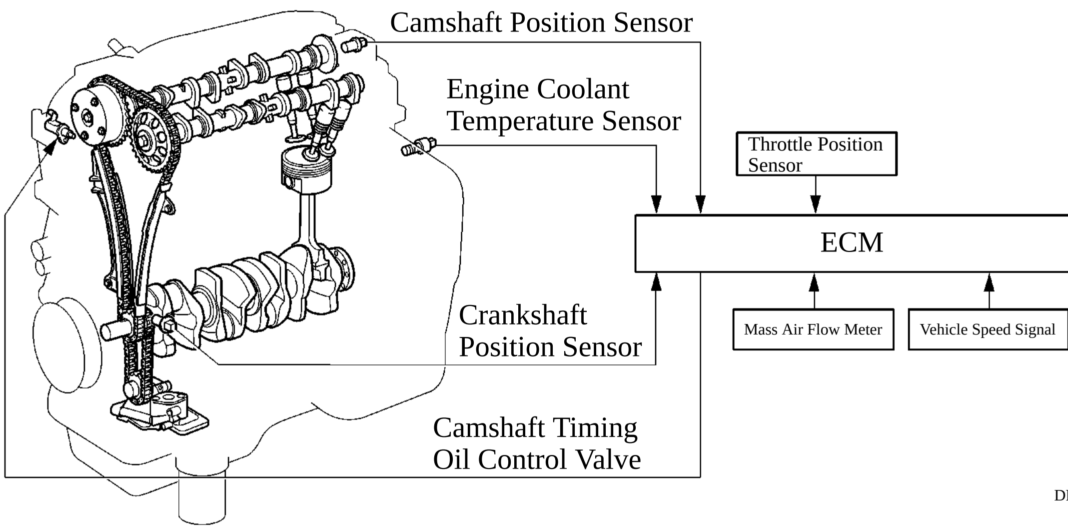
7. VVT-i (Variable Valve Timing-intelligent) System

General

- The VVT-i system is designed to control the intake camshaft within a range of 40° (of Crankshaft Angle) to provide valve timing that is optimally suited to the engine condition. This realizes proper torque in all the speed ranges as well as realizing excellent fuel economy, and reducing exhaust emissions.



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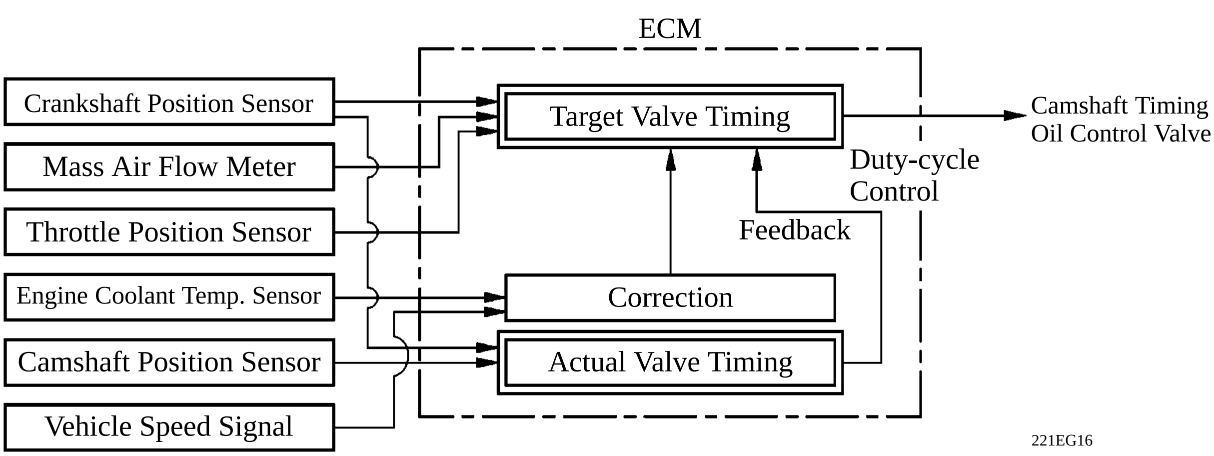
- Using the engine speed signal, vehicle speed signal, and the signals from mass air flow meter, throttle position sensor and engine coolant temperature sensor, the ECM can calculate optimal valve timing for each driving condition and controls the camshaft timing oil control valve. In addition, the ECM uses signals from the camshaft position sensor and crankshaft position sensor to detect the actual valve timing, thus providing feedback control to achieve the target valve timing.



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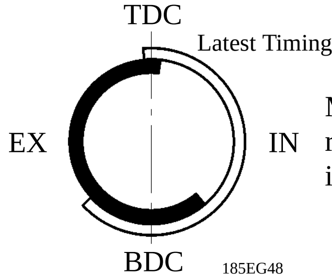
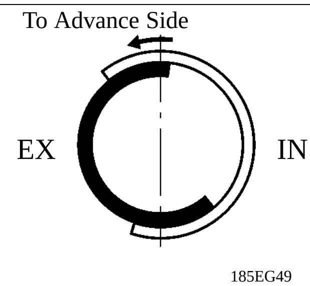
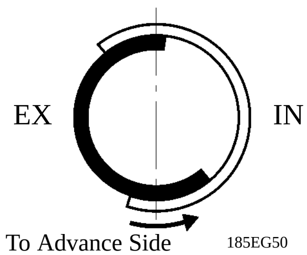
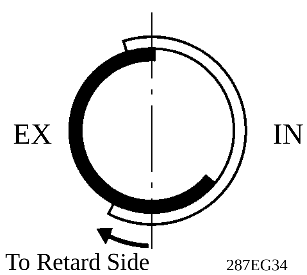
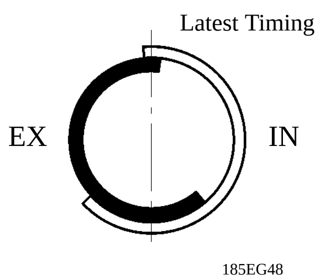
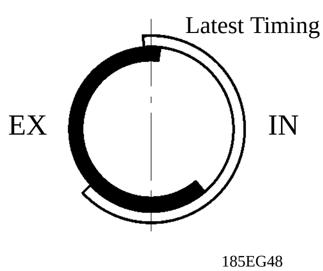
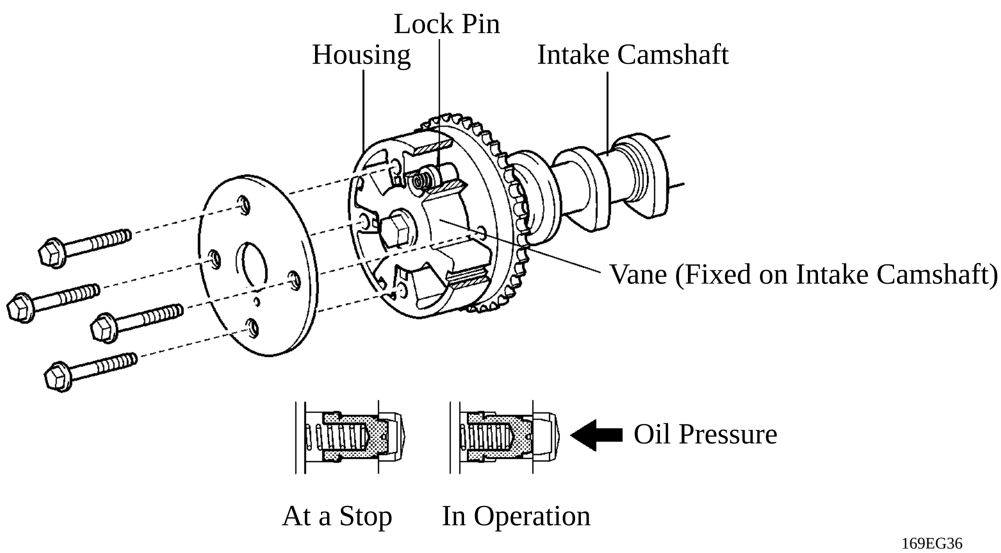
Effectiveness of the VVT-i System

Operation State	Objective	Effect
● During Idling ● At Light Load	 Minimizing overlap to reduce blowback to the intake side	● Stabilized idling rpm ● Better fuel economy
At Medium Load	 Increasing overlap increases internal EGR, reducing pumping loss	● Better fuel economy ● Improved emission control
In Low to Medium Speed Range with Heavy Load	 Advancing the intake valve close timing for volumetric efficiency improvement	Improved torque in low to medium speed range
In High Speed Range with Heavy Load	 Retarding the intake valve close timing for volumetric efficiency improvement	Improved output
At LowTemperature	 Minimizing overlap to prevent blowback to the intake side leads to the lean burning condition, and stabilizes the idling speed at fast idle	● Stabilized fast idle rpm ● Better fuel economy
● Upon Starting ● Stopping the Engine	 Minimizing overlap to minimize blowback to the intake side	Improved startability

Construction

1) VVT-i Controller

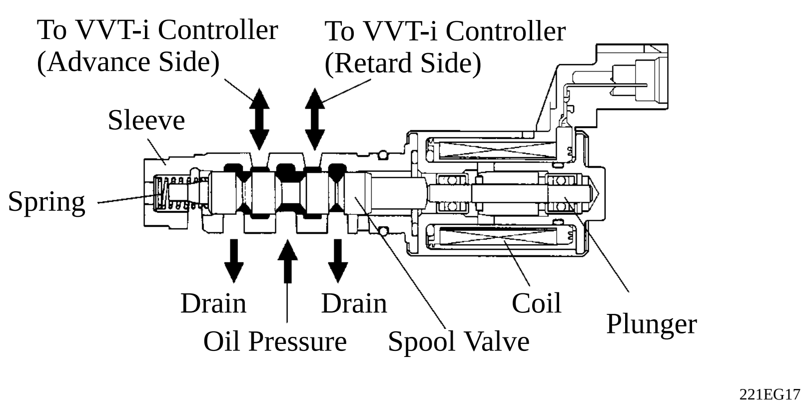
This controller consists of the housing driven by the timing chain and the vane fixed on the intake camshaft.
The oil pressure sent from the advance or retard side path at the intake camshaft causes rotation in the VVT-i controller vane circumferential direction to vary the intake valve timing continuously.
When the engine is stopped, the intake camshaft will be in the most retarded state to ensure startability.
When hydraulic pressure is not applied to the VVT-i controller immediately after the engine has been started, the lock pin locks the movement of the VVT-i controller to prevent a knocking noise.



Lock Pin

2) Camshaft Timing Oil Control Valve

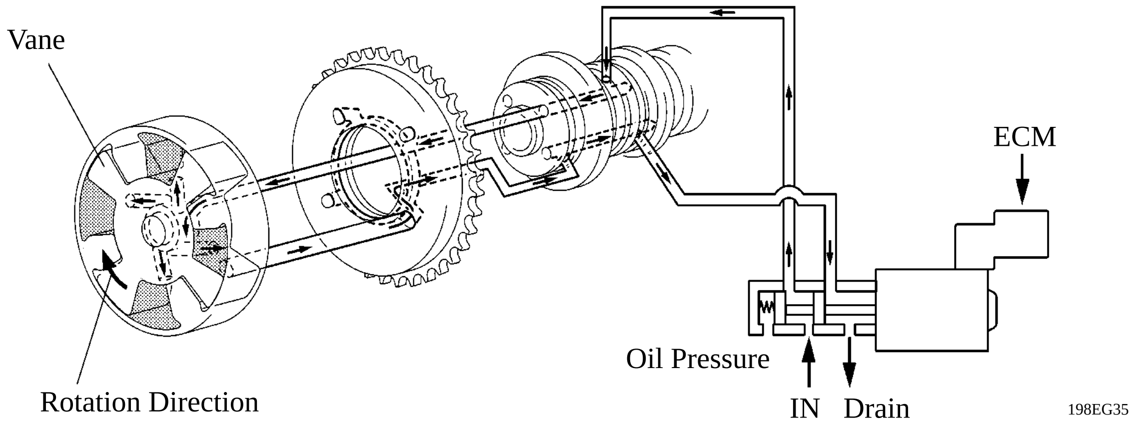
This camshaft timing oil control valve controls the spool valve position in accordance with the duty-cycle control from the ECM. This allows hydraulic pressure to be applied to the VVT-i controller advance or retard sides. When the engine is stopped, the camshaft timing oil control valve is in the most retarded state.



Operation

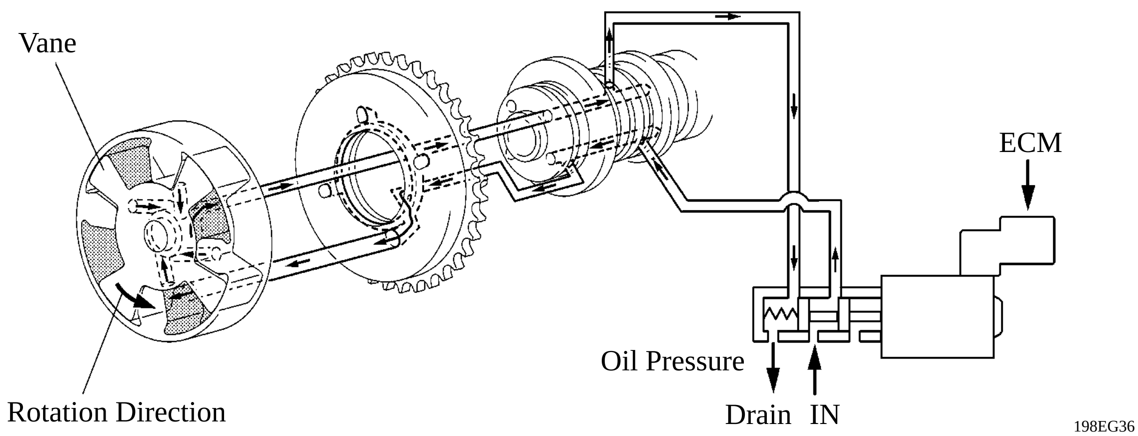
1) Advance

When the camshaft timing oil control valve is operated as illustrated below by the advance signals from the ECM, the resultant oil pressure is applied to the advance side vane chamber to rotate the camshaft in the advance direction.



2) Retard

When the camshaft timing oil control valve is operated as illustrated below by the retard signals from the ECM, the resultant oil pressure is applied to the retard side vane chamber to rotate the camshaft in the retard direction.



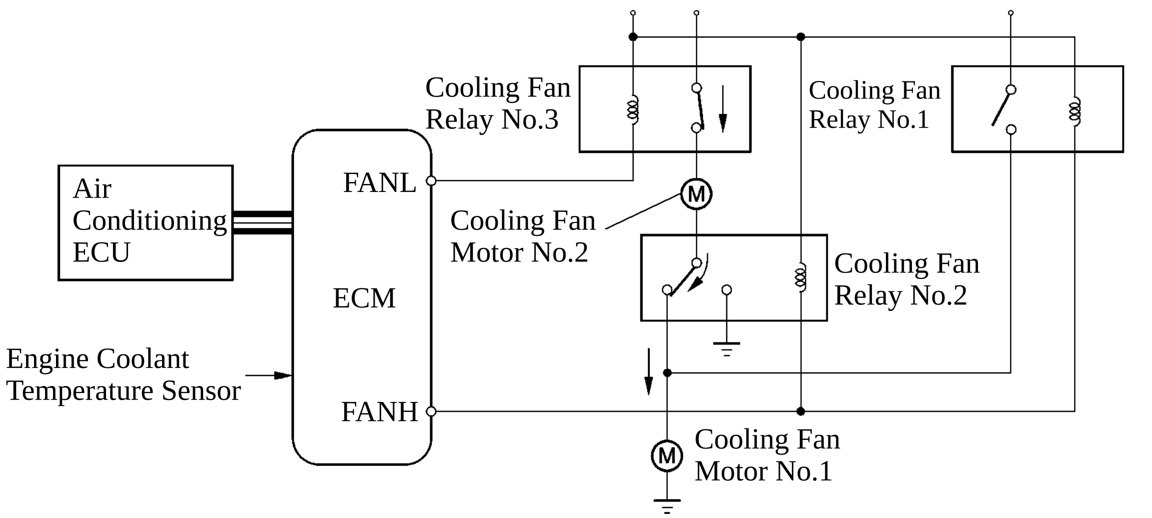
3) Hold

After reaching the target timing, the valve timing is held by keeping the camshaft timing oil control valve in the neutral position unless the traveling state changes.
This adjusts the valve timing at the desired target position and prevents the engine oil from running out when it is unnecessary.

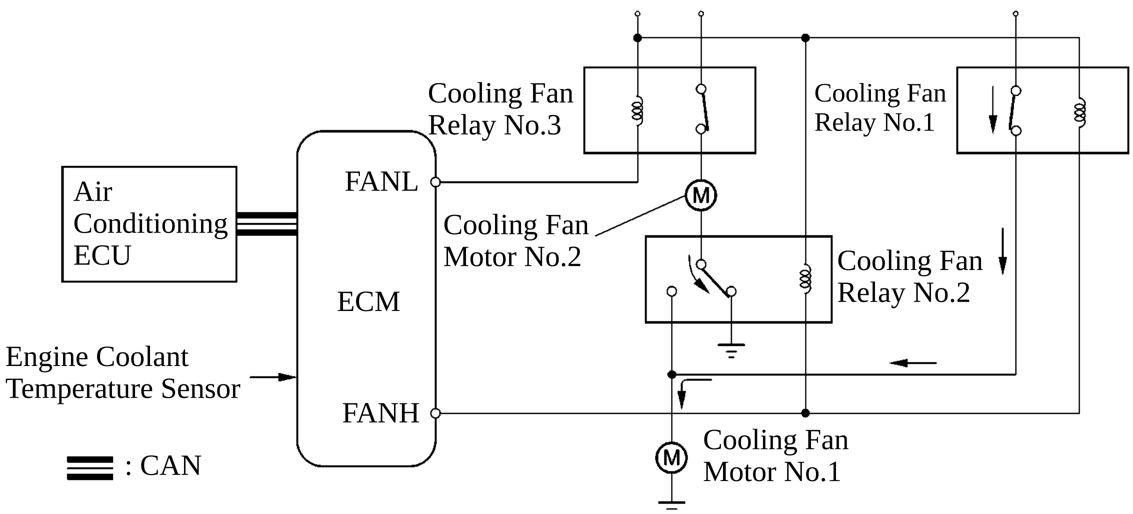
8. Cooling Fan Control

On the models with air conditioning, the ECM controls the operation of the cooling fan in two speeds (Low and High) based on the engine coolant temperature sensor signal and the air conditioning ECU signal. This control is accomplished by operating the 2 fan motors in 2 stages through low speed (series connection) and high speed (parallel connection).

▶ Wiring Diagram ◀



Low Speed (Series Connection)



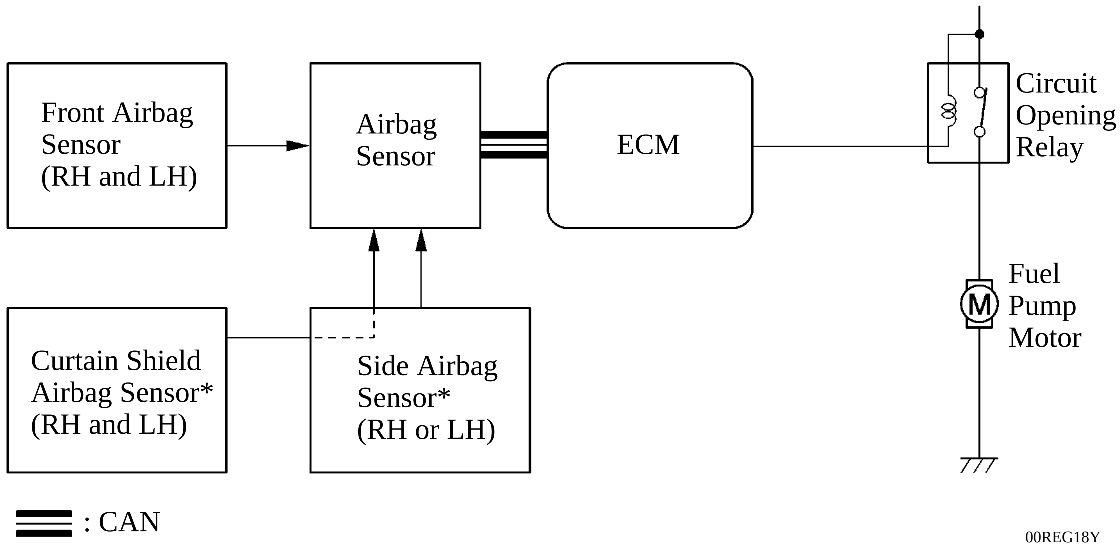
High Speed (Parallel Connection) 01NEG10Y

▶ Cooling Fan Operation ◀

Air Conditioning Condition		Engine Coolant Temperature °C (°F)	
A/C Compressor	Refrigerant Pressure	94 (201.2) or lower	95.5 (203.9) or higher
OFF	1.2 MPa (12.5 kgf/cm^2, 178 psi) or lower	OFF	High
ON	1.2 MPa (12.5 kgf/cm^2, 178 psi) or lower	Low	High
	1.2 MPa (12.5 kgf/cm^2, 178 psi) or higher	High	High

9. Fuel Pump Control

A fuel cut control is used to stop the fuel pump when the SRS airbag is deployed at the front collision. In this system, the airbag deployment signal from the airbag sensor is detected by the ECM, which turns OFF the circuit opening relay.
After the fuel cut control has been activated, turning the ignition switch from OFF to ON cancels the fuel cut control, and the engine can be restarted.



*: Models with SRS Driver, Front Passenger, Side and Curtain Shield Airbags

10. EVAP (evaporative Emission) Control System

General

The EVAP (evaporative emission) control system prevents the vapor gas that is created in the fuel tank from being released directly into the atmosphere.

- The canister stores the vapor gas that has been created in the fuel tank.
- The ECM controls the purge VSV in accordance with the driving conditions in order to direct the vapor gas into the engine, where it is burned.
- In this system, the ECM checks the evaporative emission leak and outputs DTC (Diagnostic Trouble Code) in the event of a malfunction. An EVAP (evaporative emission) leak check consists of an application of a vacuum pressure to the system and monitoring the changes in the system pressure in order to detect a leakage.
- This system consists of the purge VSV, canister, refueling valve, canister pump module, and ECM.
- The ORVR (Onboard Refueling Vapor Recovery) function is provided in the refueling valve.
- The canister pressure sensor has been included to the canister pump module.
- The canister filter has been provided on the fresh air line. This canister filter is maintenance-free.
- The followings are the typical conditions for enabling an EVAP leak check:

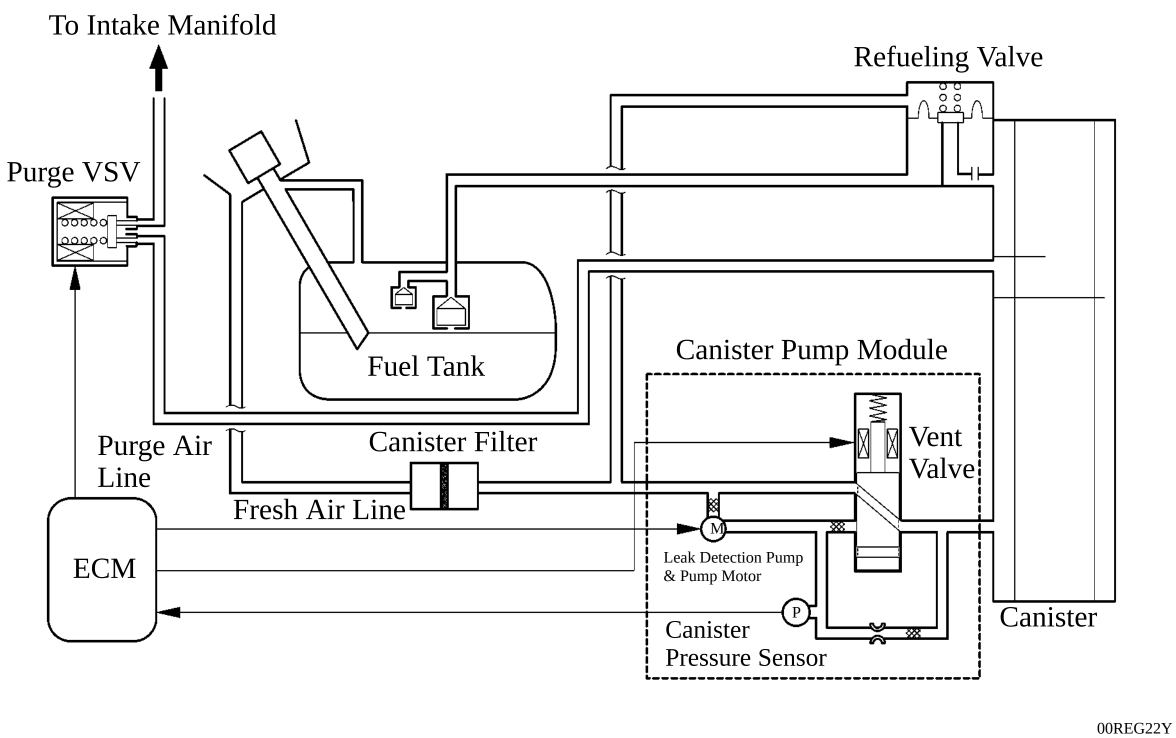
Typical Enabling Condition	● Five hours have elapsed after the engine has been turned OFF*. ● Altitude: Below 2400 m (8000 feet) ● Battery voltage: 10.5 V or more ● Ignition switch: OFF ● Engine coolant temperature: 4.4 to 35°C (40 to 95°F) ● Intake air temperature: 4.4 to 35°C (40 to 95°F)

*: If engine coolant temperature does not drop below 35°C (95°F), this time should be extended to 7hours. Even after that, if the temperature is not less than 35°C (95°F), the time should be extended to 9.5 hours.

Service Tip

- The canister pump module performs the EVAP leak check. This check is done approximately five hours after the engine is turned off. So you may hear sound coming from underneath the luggage compartment for several minutes. It does not indicate a malfunction.
- The pinpoint pressure test procedure is carried out by pressurizing the fresh air line that runs from the pump module to the air filler neck. For details, refer to the 2006 RAV4 Repair Manual (Pub. No. RM01M1U).

System Diagram



Function of Main Components

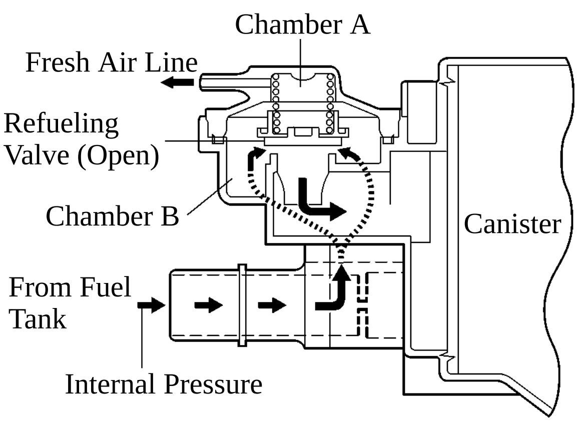
Component		Function
Canister		Contains activated charcoal to absorb the vapor gas that is created in the fuel tank.
Refueling Valve		Controls the flow rate of the vapor gas from the fuel tank to the canister when the system is purging or during refueling.
	Restrictor Passage	Prevents a large amount of vacuum during purge operation or system monitoring operation from affecting the pressure in the fuel tank.
Fresh Air Line		Fresh air goes into the canister and the cleaned drain air goes out into the atmosphere.
Canister Pump Module	Vent Valve	Opens and closes the fresh air line in accordance with the signals from the ECM.
	Leak Detection Pump	Applies vacuum pressure to the EVAP control system in accordance with the signals from the ECM.
	Canister Pressure Sensor	Detects the pressure in the EVAP control system and sends the signals to the ECM.
Purge VSV		Opens in accordance with the signals from the ECM when the system is purging, in order to send the vapor gas that was absorbed by the canister into the intake manifold. In system monitoring mode, this valve controls the introduction of the vacuum into the fuel tank.
Canister Filter		Prevents dust and debris in the fresh air from entering the system.
ECM		Controls the canister pump module and purge VSV in accordance with the signals from various sensors, in order to achieve a purge volume that suits the driving conditions. In addition, the ECM monitors the system for any leakage and outputs a DTC if a malfunction is found.

Construction and Operation

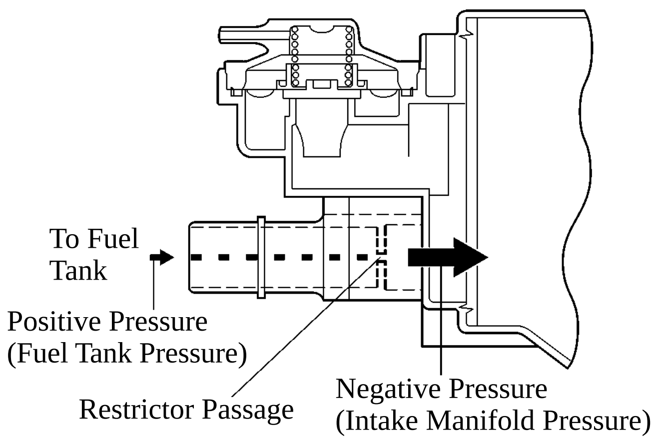
1) Refueling Valve

The refueling valve consists of the chamber A, chamber B, and restrictor passage. A constant atmospheric pressure is applied to the chamber A.

- During refueling, the internal pressure of the fuel tank increases. This pressure causes the refueling valve to lift up, allowing the vapor gas to enter the canister.
- The restrictor passage prevents the large amount of vacuum that is created during purge operation or system monitoring operation from entering the fuel tank, and limits the flow of the vapor gas from the fuel tank to the canister. If a large volume of vapor gas recirculates into the intake manifold, it will affect the air-fuel ratio control of the engine. Therefore, the role of the restrictor passage is to help prevent this from occurring.



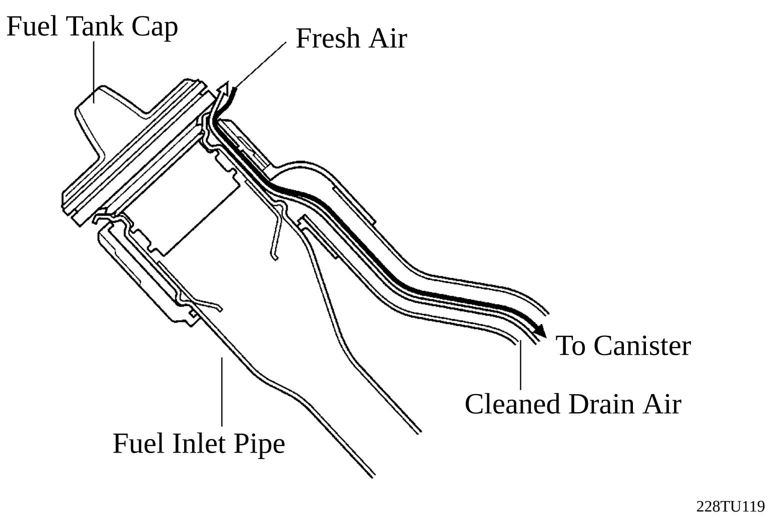
During Refueling



During Purge Operation or System Monitoring Operation

2) Fuel Inlet (Fresh Air Line)

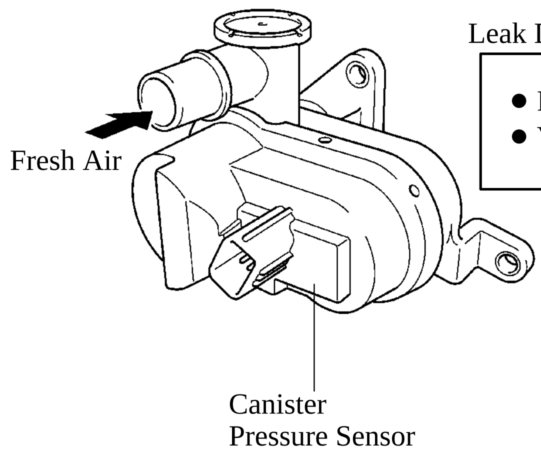
In accordance with the change of structure of the EVAP control system, the location of a fresh air line inlet has been changed from the air cleaner section to the near fuel inlet. The flesh air from the atmosphere and drain air cleaned by the canister will go in and out of the system through the passage shown below.



3) Canister Pump Module

Canister pump module consists of the vent valve, leak detection pump, and canister pressure sensor.

- The vent valve switches the passages in accordance with the signals received from the ECM.
- A DC type brushless motor is used for the pump motor.
- A vane type vacuum pump is used.



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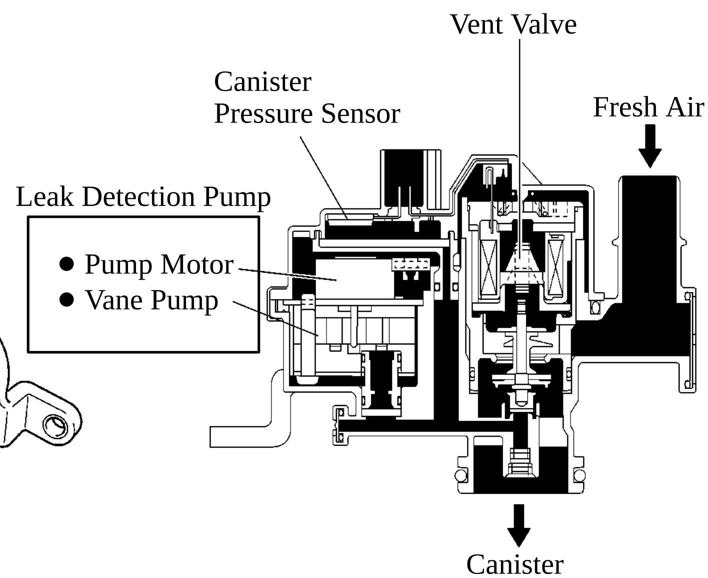

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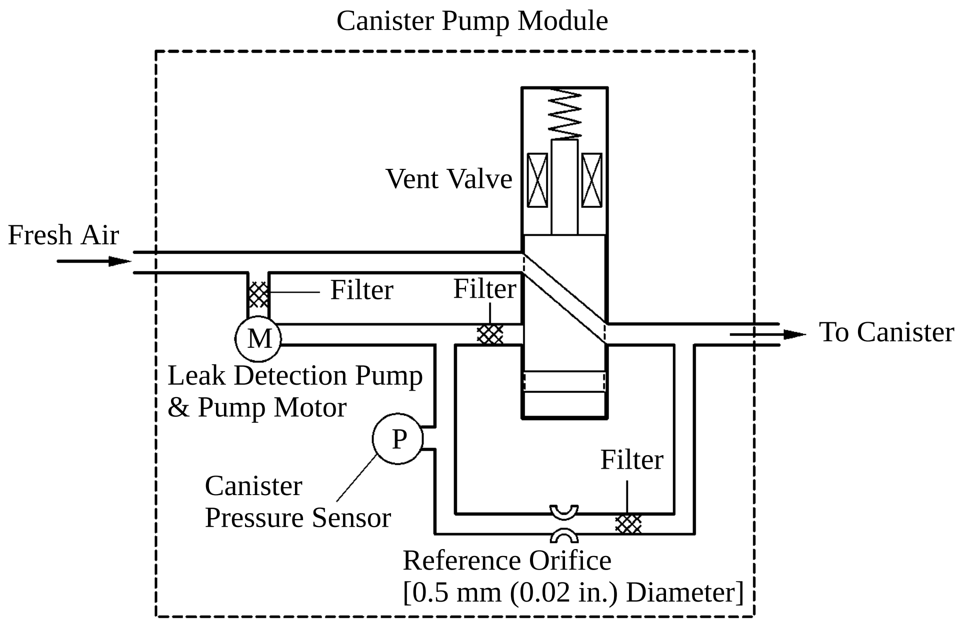
▶ Simple Diagram ◀



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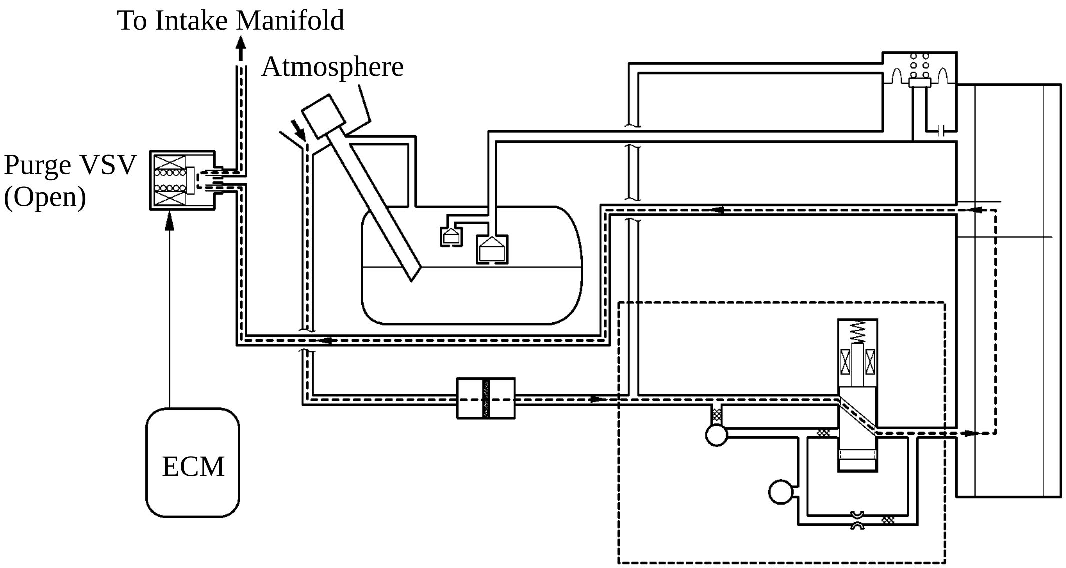
System Operation

1) Purge Flow Control

When the engine has satisfied the predetermined conditions (closed loop, engine coolant temperature above 74°C (165°F), etc.), the stored vapor gas are purged from the canister whenever the purge VSV is opened by the ECM.
The ECM will change the duty ratio cycle of the purge VSV, thus controlling purge flow volume. Purge flow volume is determined by intake manifold pressure and the duty ratio cycle of the purge VSV. Atmospheric pressure is allowed into the canister to ensure that purge flow is constantly maintained whenever purge vacuum is applied to the canister.



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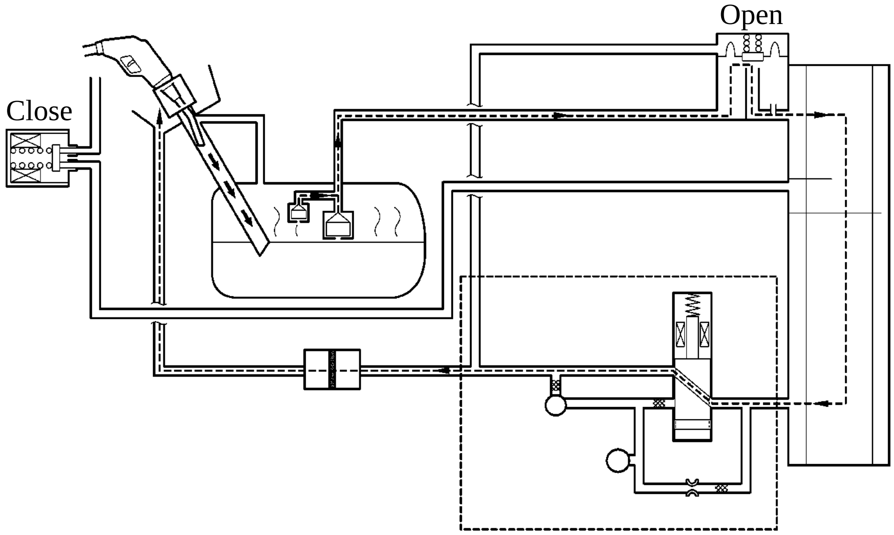
2) ORVR (On-board Refueling Vapor Recovery)

When the internal pressure of the fuel tank increases during refueling, this pressure causes the diaphragm in the refueling valve to lift up, allowing the vapor gas to enter the canister. Because the vent valve is always open (even when the engine is stopped) when the system is in a mode other than the monitoring mode, the air that has been cleaned through the canister is discharged outside the vehicle via the fresh air line. If the vehicle is refueled in the monitoring mode, the ECM will recognize the refueling by way of the canister pressure sensor, which detects the sudden pressure increase in the fuel tank, and will open the vent valve.



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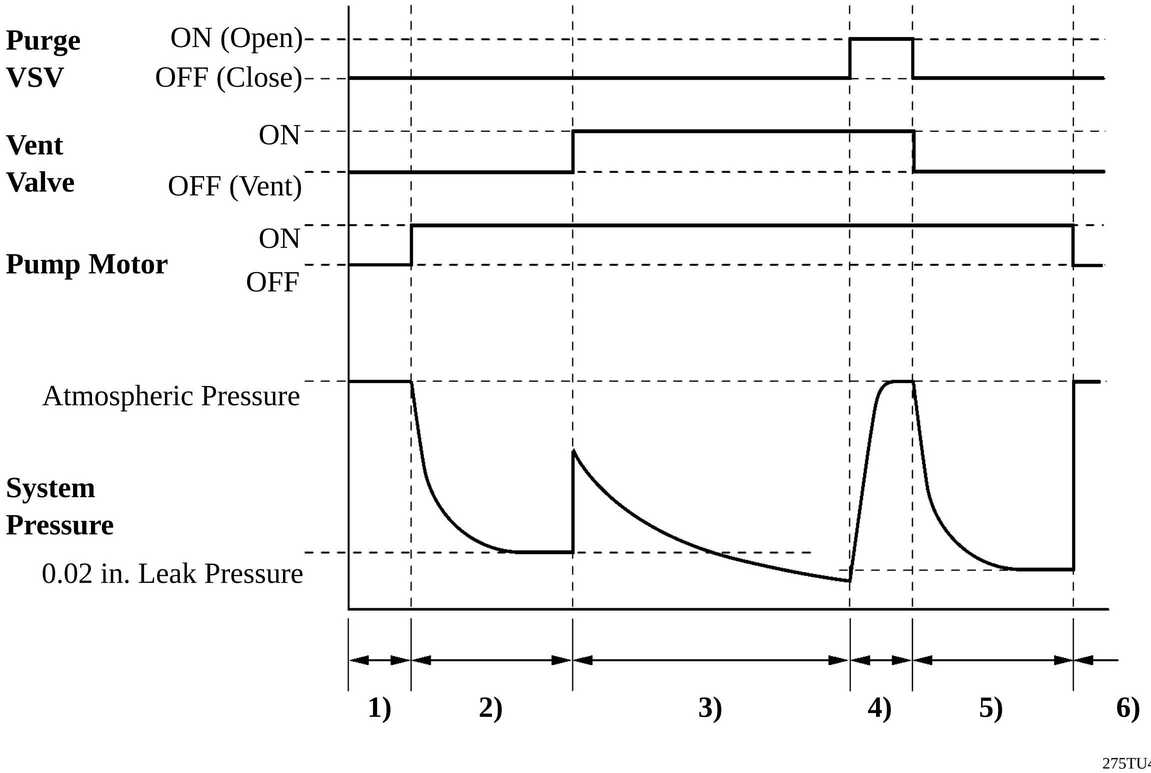
3) EVAP Leak Check

a. General

The EVAP leak check operates in accordance with the following timing chart:

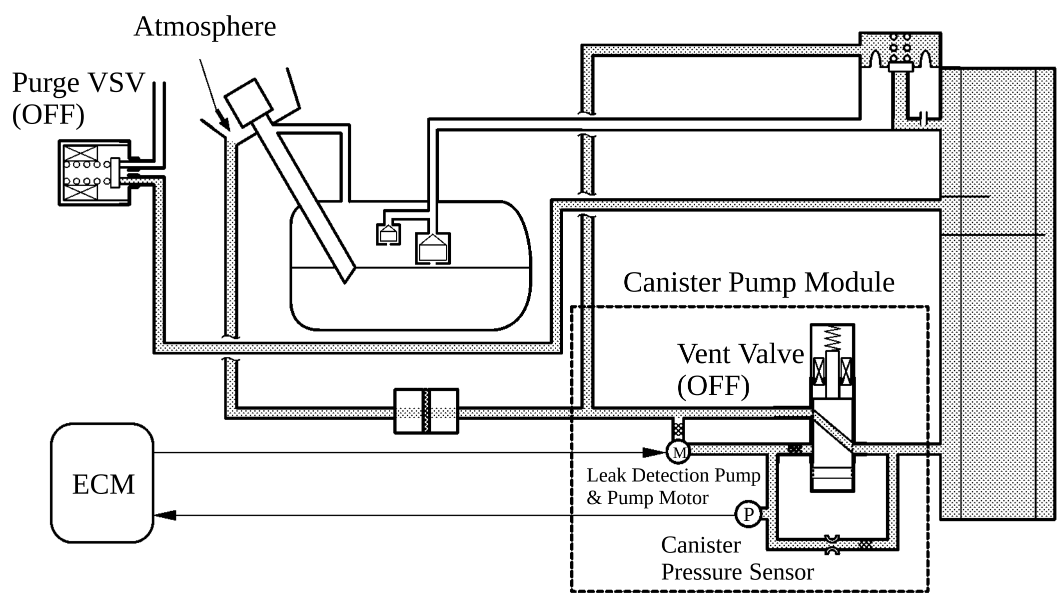
▶ Timing Chart ◀



Order	Operation	Description	Time
1)	Atmospheric Pressure Measurement	ECM turns vent valve OFF (vent) and measures EVAP control system pressure to memorize atmospheric pressure.	10 sec.
2)	0.02 in. Leak Pressure Measurement	Leak detection pump creates negative pressure (vacuum) through 0.02 in. orifice and the pressure is measured. ECM determines this as 0.02 in. leak pressure.	60 sec.
3)	EVAP Leak Check	Leak detection pump creates negative pressure (vacuum) in EVAP control system and EVAP control system pressure is measured. If stabilized pressure is larger than 0.02 in. leak pressure, ECM determines EVAP control system has a leakage. If EVAP control system pressure does not stabilize within 12 minutes, ECM cancels EVAP monitor.	Within 12 min.
4)	Purge VSV Monitor	ECM opens purge VSV and measures EVAP control system pressure increase. If increase is large, ECM interprets this as normal.	10 sec.
5)	Repeat 0.02 in. Leak Pressure Measurement	Leak detection pump creates negative pressure (vacuum) through 0.02 in. orifice and pressure is measured. ECM determines this as 0.02 in. leak pressure.	60 sec.
6)	Final Check	ECM measures atmospheric pressure and records monitor result.	—

b. Atmospheric Pressure Measurement

1) When the ignition switch is turned OFF, the purge VSV and vent valve are turned OFF. Therefore, the atmospheric pressure is introduced into the canister.
2) The ECM measures the atmospheric pressure through the signals provided by the canister pressure sensor.
3) If the measurement value is out of standards, the ECM actuates the leak detection pump in order to monitor the changes in the pressure.



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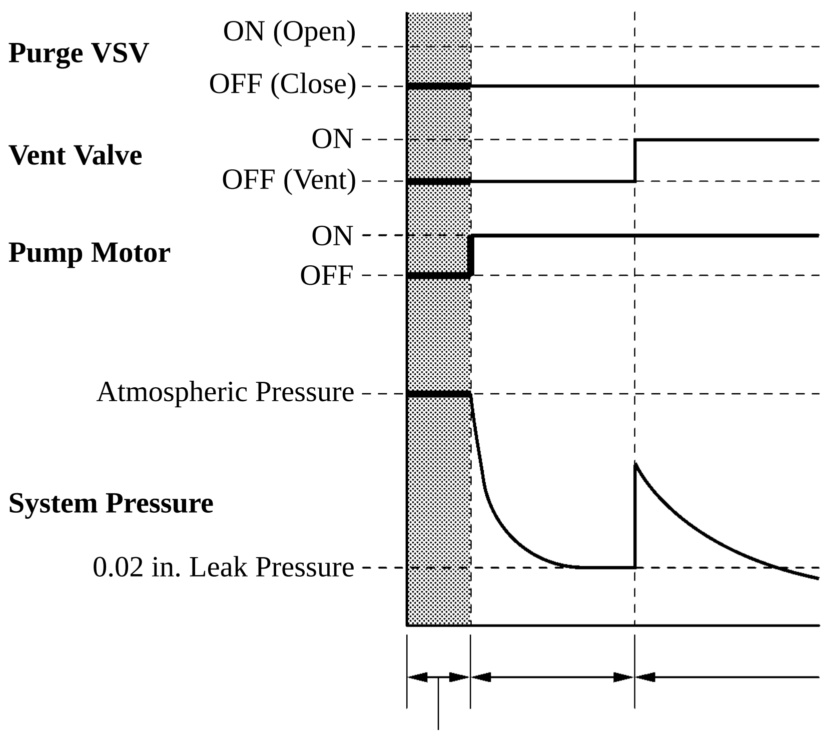

Atmospheric Pressure Measurement

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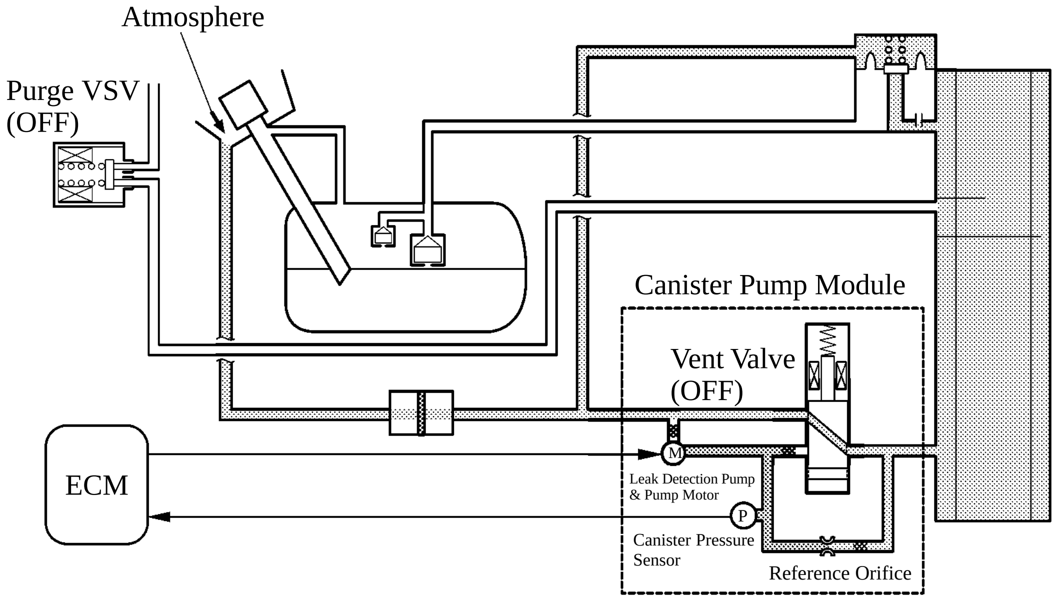
c. 0.02 in. Leak Pressure Measurement

1) The vent valve remains OFF, and the ECM introduces atmospheric pressure into the canister and actuates the leak detection pump in order to create a negative pressure.
2) At this time, the pressure will not decrease beyond a 0.02 in. leak pressure due to the atmospheric pressure that enters through a 0.02 in. diameter reference orifice.
3) The ECM compares the logic value with this pressure, and stores it as a 0.02 in. leak pressure in its memory.
4) If the measurement value is below the standard, the ECM will determine that the reference orifice is clogged and store DTC (Diagnostic Trouble Code) P043E in its memory.
5) If the measurement value is above the standard, the ECM will determine that a high flow rate pressure is passing through the reference orifice and store DTCs (Diagnostic Trouble Codes) P043F, P2401 and P2402 in its memory.



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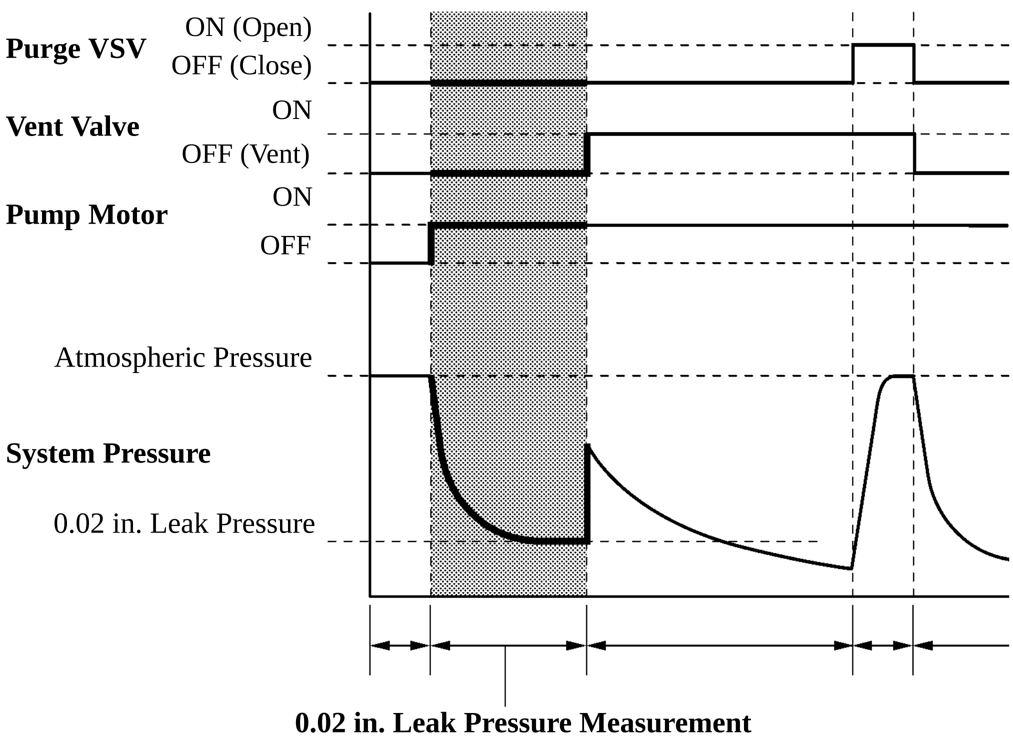

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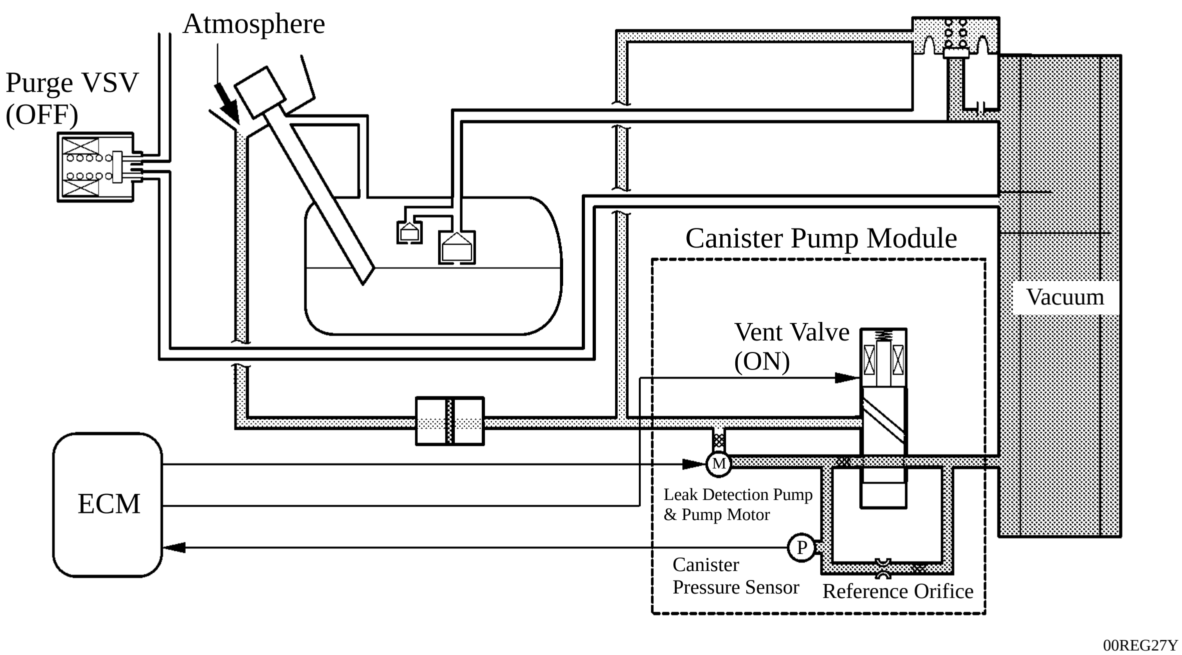
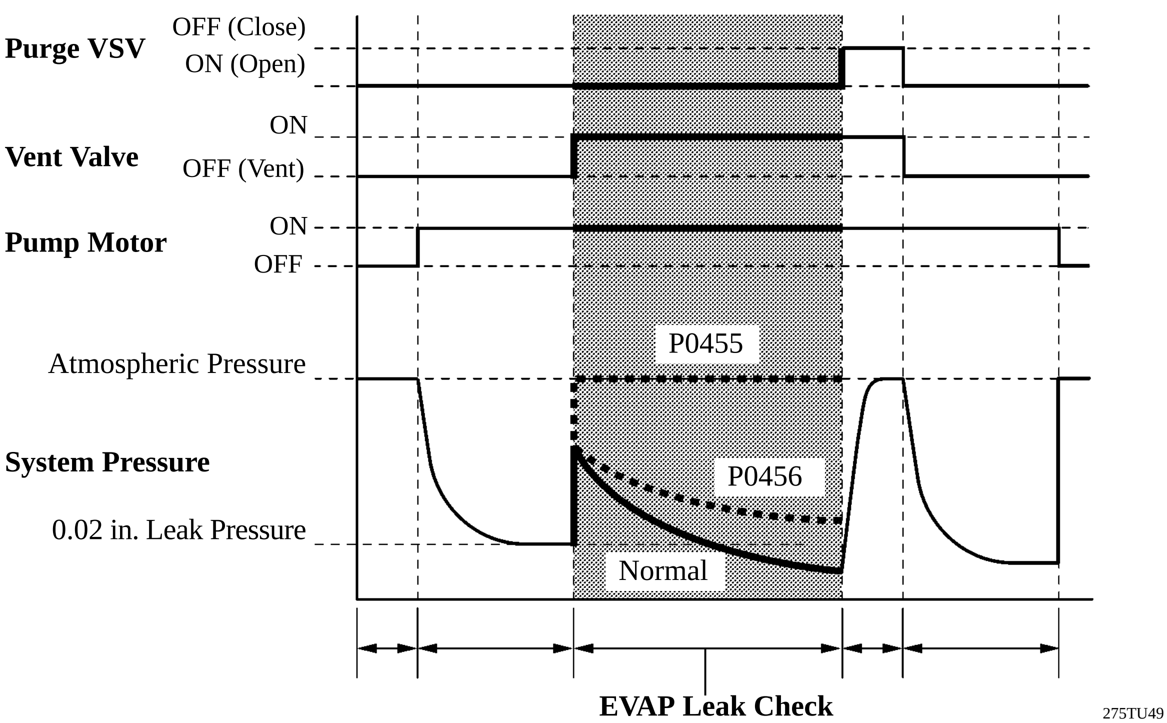
d. EVAP Leak Check

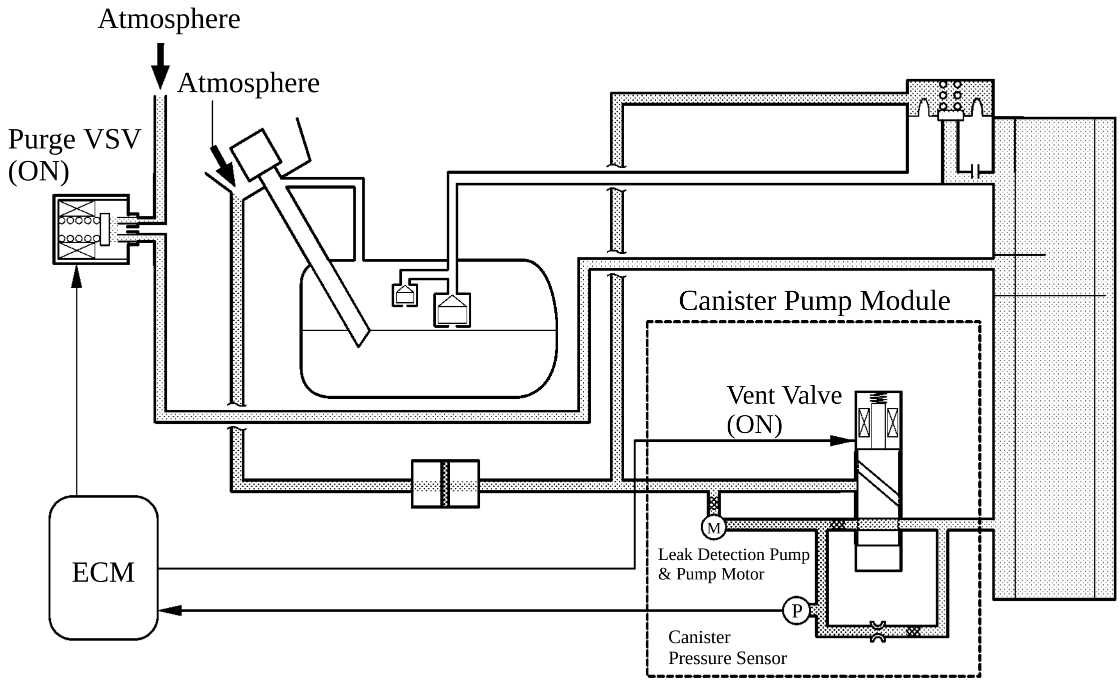
1) While actuating the leak detection pump, the ECM turns ON the vent valve in order to introduce a vacuum into the canister.
2) When the pressure in the system stabilizes, the ECM compares this pressure with the 0.02 in. leak pressure in order to check for a leakage.
3) If the measurement value is below the 0.02 in. leak pressure, the ECM determines that there is no leakage.
4) If the measurement value is above the 0.02 in. leak pressure and near atmospheric pressure, the ECM determines that there is a gross leakage (large hole) and stores DTC P0455 in its memory.
5) If the measurement value is above the 0.02 in. leak pressure, the ECM determines that there is a small leakage and stores DTC P0456 in its memory.





e. Purge VSV Monitor

1) After completing an EVAP leak check, the ECM turns ON (open) the purge VSV with the leak detection pump actuated, and introduces the atmospheric pressure from the intake manifold to the canister.
2) If the pressure change at this time is within the normal range, the ECM determines the condition to be normal.
3) If the pressure is out of the normal range, the ECM will stop the purge VSV monitor and store DTC P0441 in its memory.



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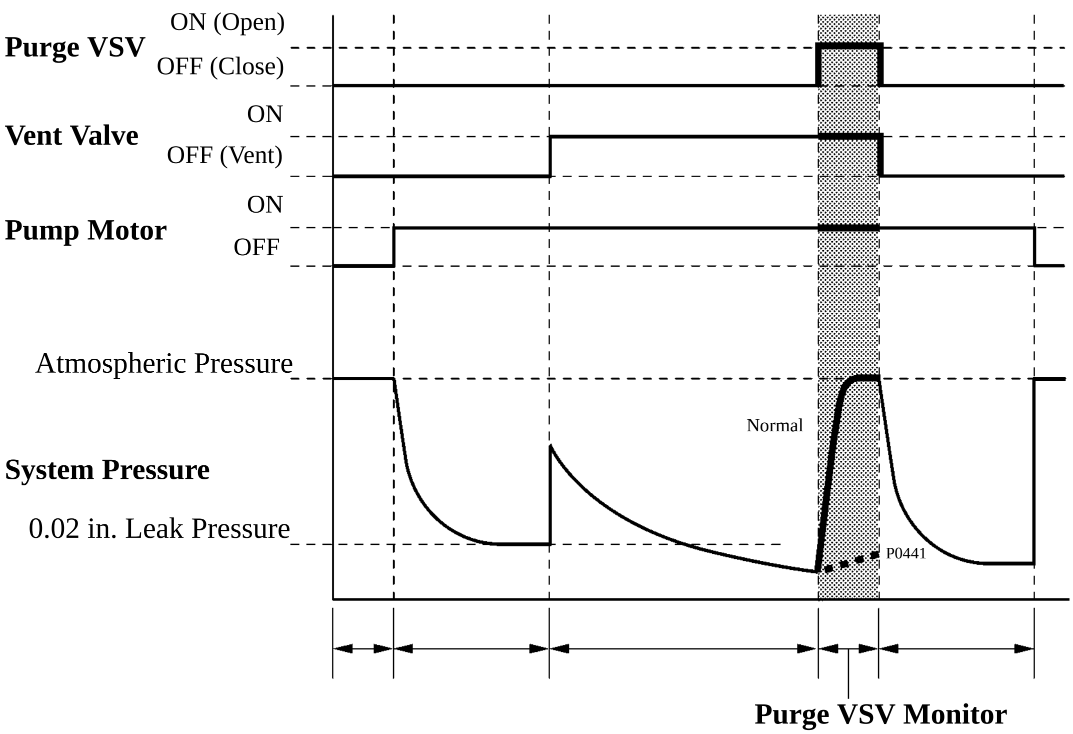

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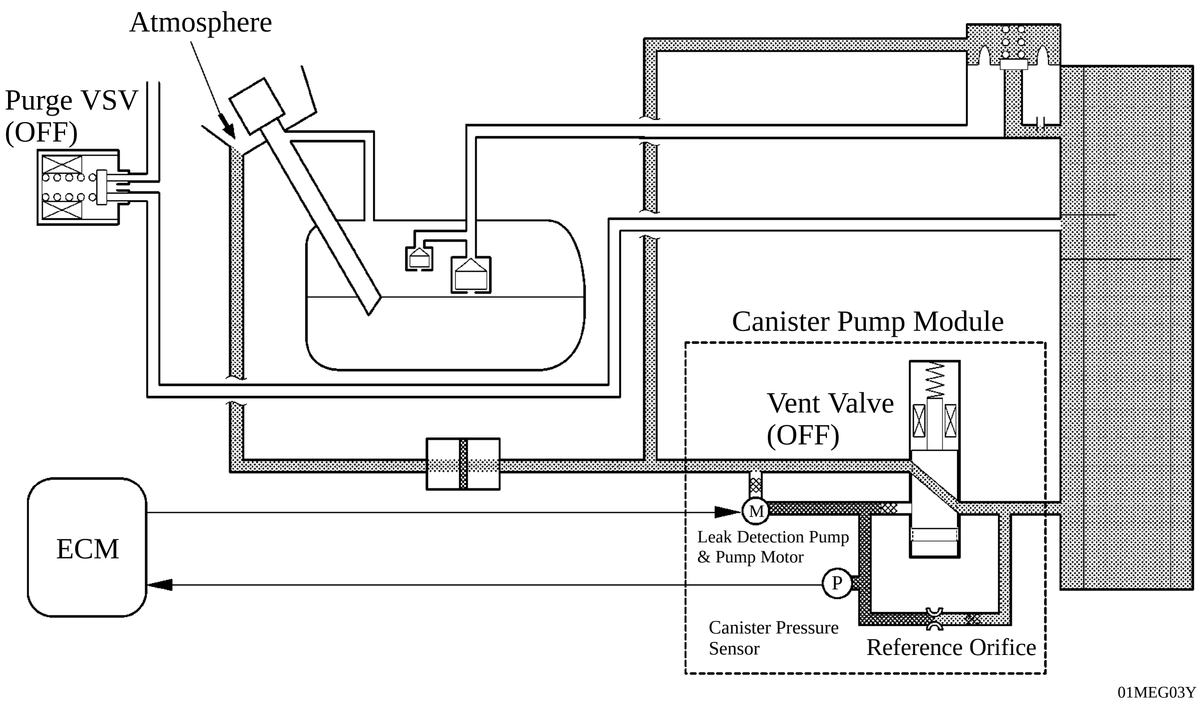
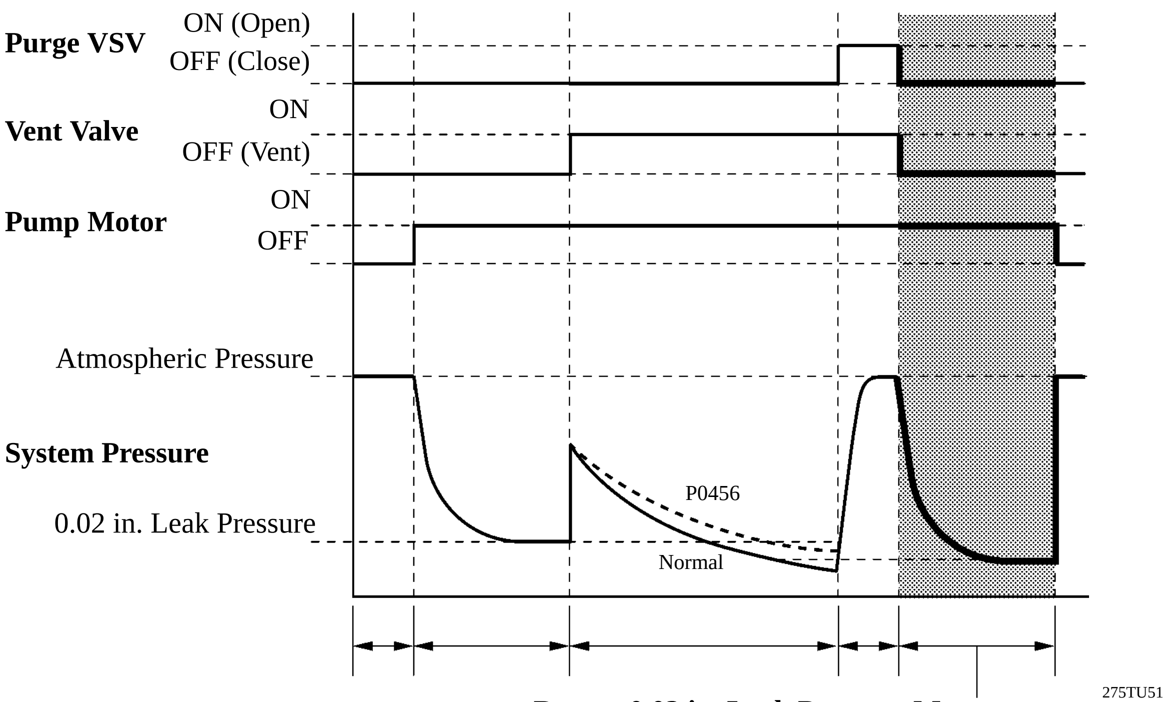
f. Repeat 0.02 in. Leak Pressure Measurement

1) While the ECM operates the vacuum pump, the purge VSV and vent valve turn off and a repeat 0.02 in. leak pressure measurement is performed.
2) The ECM compares the measured pressure with the pressure during EVAP leak check.
3) If the pressure during the EVAP leak check is below the measured value, the ECM determines that there is no leakage.
4) If the pressure during the EVAP leak check is above the measured value, the ECM determines that there is a small leakage and stores DTC P0456 in its memory.





Repeat 0.02 in. Leak Pressure Measurement

11. Charging Control

General

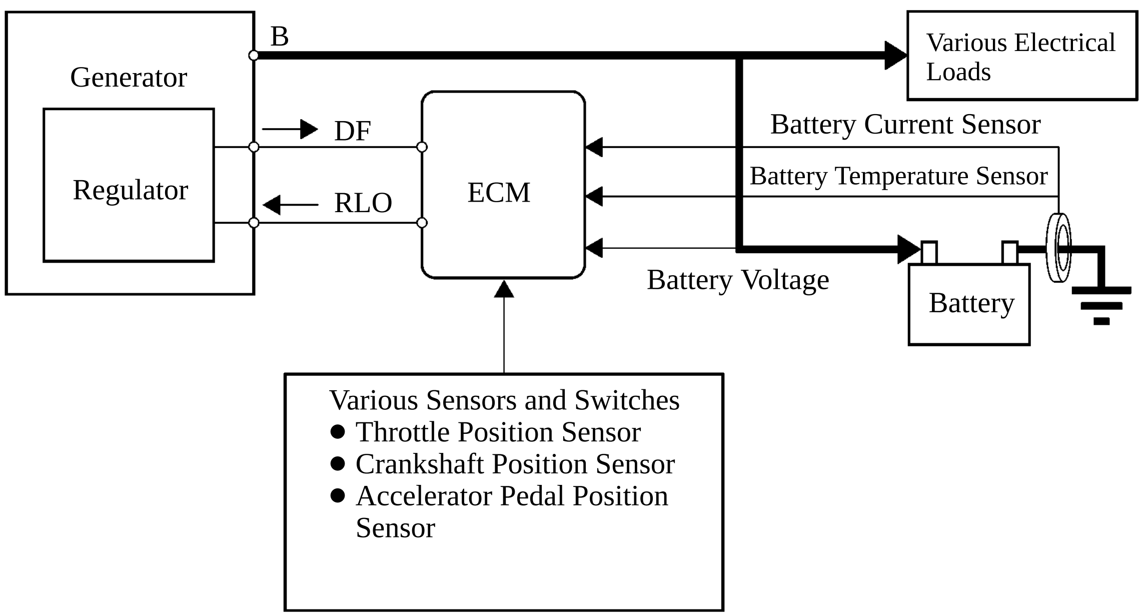
This system lowers the generated voltage when the vehicle is idling or is being driven at a constant speed, and raises the generated voltage when the vehicle is decelerating. This reduces the load on the engine as a result of the electric generation of the generator, thus contributing to the fuel economy of the engine. During acceleration, this system regulates the generated voltage in order to place the amperage estimation value close to the target value.

- This control consists of the ECM, battery current sensor with a built-in battery temperature sensor, generator, and various sensors and switches.
- The ECM detects driving condition based on signals from various sensors and switches, and detects charging condition based on signals from the generator, battery current sensor and battery temperature sensor. Then the ECM outputs signals to the IC regulator to control the genetated voltage of the generator.

The ECM stops the charging control and the generator switches to normal power generation mode under the following conditions:

- Low battery capacity
- Low or high battery temparature
- Wipers operating or blower motor operating with tail lamp relay ON

▶ System Diagram ◀



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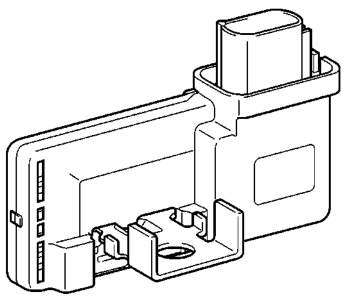
Battery Current Sensor

Installed on the negative terminal of the battery, this sensor detects the amount of charging and discharging amperage of the battery and sends signal to the ECM. Based on this signal, the ECM calculates the battery capacity. A Hall IC is used for detecting the amount of charging and discharging amperage. The changes that occur in the magnetic flux density in the core as a result of the charging and amperage of the battery are converted and output as voltage.



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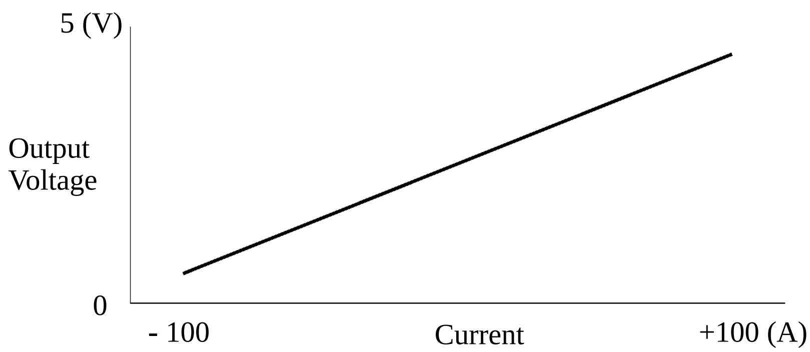

Characteristic of Current Sensor

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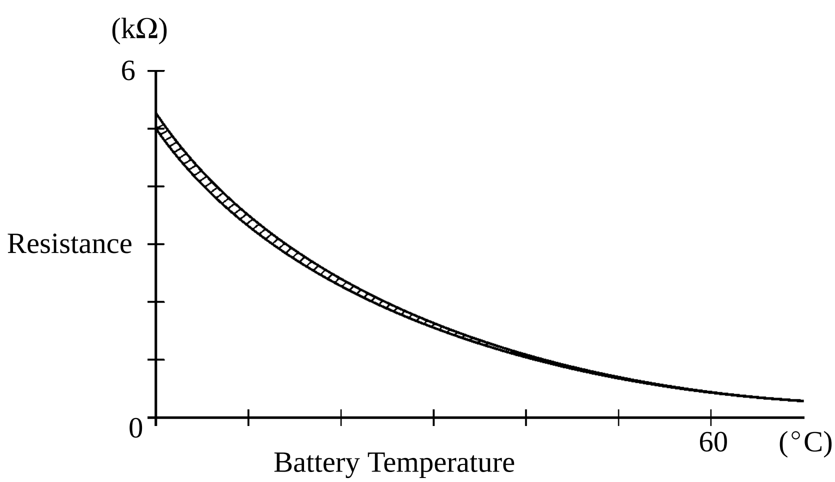
Batter Temperature Sensor

- The battery temperature sensor is built into the battery current sensor.
- The battery characteristic (battery internal resistance) of taking in current for charging varies according to battery electrolyte temperature. If the electrolyte temperature is too low or too high, the battery internal resistance will increase, resulting in early deterioration. To prevent this, the battery temperature sensor changes its resistance as shown below to detect the temperature.



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Fail-safe

Due to a failure in the battery current sensor or battery temperature sensor, the ECM may determine the necessity of performing a fail-safe operation. Then, the ECM stops the charging control and the generator switches to the normal power generation mode.
When the ECM detects a malfunction in a sensor, the ECM memorizes the DTC (Diagnostic Trouble Code). The MIL (Malfunction Indicator Lamp) does not illuminate.

▶ DTC Chart ◀

DTC No.	Detection Item	DTC No.	Detection Item
P0516	Battery Temperature Sensor Circuit Low	P1551	Battery Current Sensor Circuit Low
P0517	Battery Temperature Sensor Circuit High	P1552	Battery Current Sensor Circuit High
P0560	System Voltage	P1602	Detection of Battery
P1550	Battery Current Sensor Circuit		

12. Diagnosis

- When the ECM detects a malfunction, the ECM makes a diagnosis and memorizes the failed section. Furthermore, the MIL in the combination meter illuminates or blinks to inform the driver.
- The ECM will also store the DTCs of the malfunctions. The DTCs can be accessed by the use of the hand-held tester.
- For details, refer to the 2006 RAV4 Repair Manual (Pub. No. RM01M1U).

Service Tip

To clear the DTC that is stored in the ECM, use a hand-held tester or disconnect the battery terminal or remove the EFI fuse for 1 minute or longer.

13. Fail-safe

When a malfunction is detected at any of the sensors, there is a possibility of an engine or other malfunction occurring if the ECM were to continue to control the engine control system in the normal way. To prevent such a problem, the fail-safe function of the ECM either relies on the data stored in memory to allow the engine control system to continue operating, or stops the engine if a hazard is anticipated. For details, refer to the 2006 RAV4 Repair Manual (Pub. No. RM01M1U).