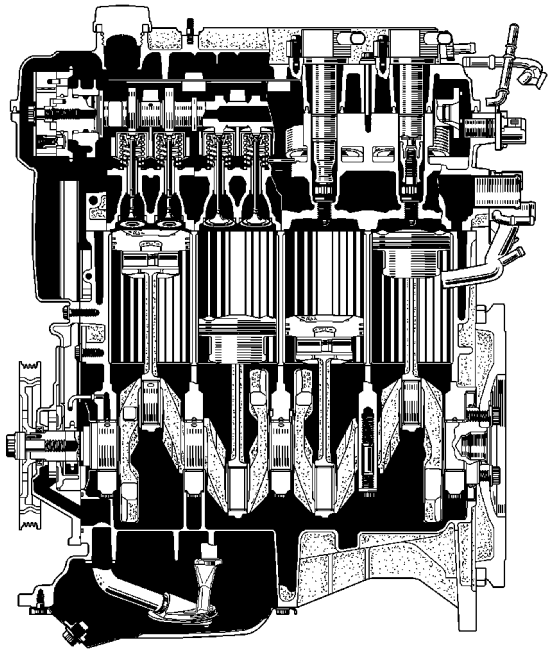
1NZ-FE ENGINE

■DESCRIPTION

The 1NZ-FE engine is a in-line, 4-cylinder, 1.5 liter, 16-valve DOHC engine.
The VVT-i (Variable Valve Timing-intelligent) system, DIS (Direct Ignition System) and ETCS-i (Electronic Throttle Control System-intelligent) are used on this engine in order to realize high performance, quietness, fuel economy and clean emission.



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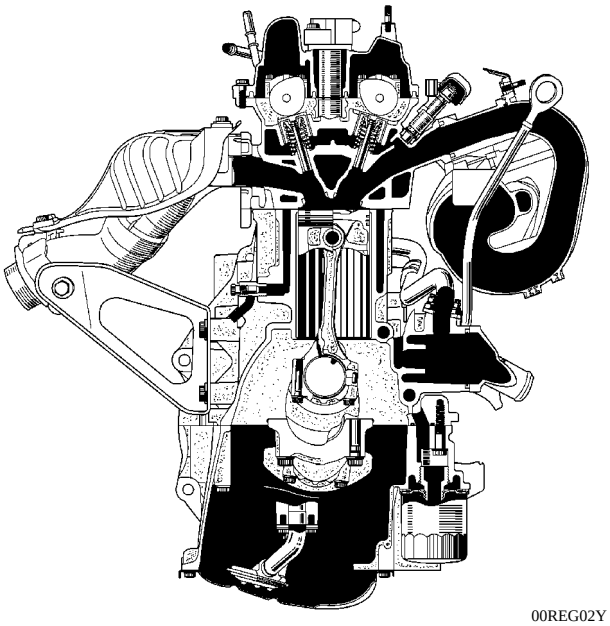

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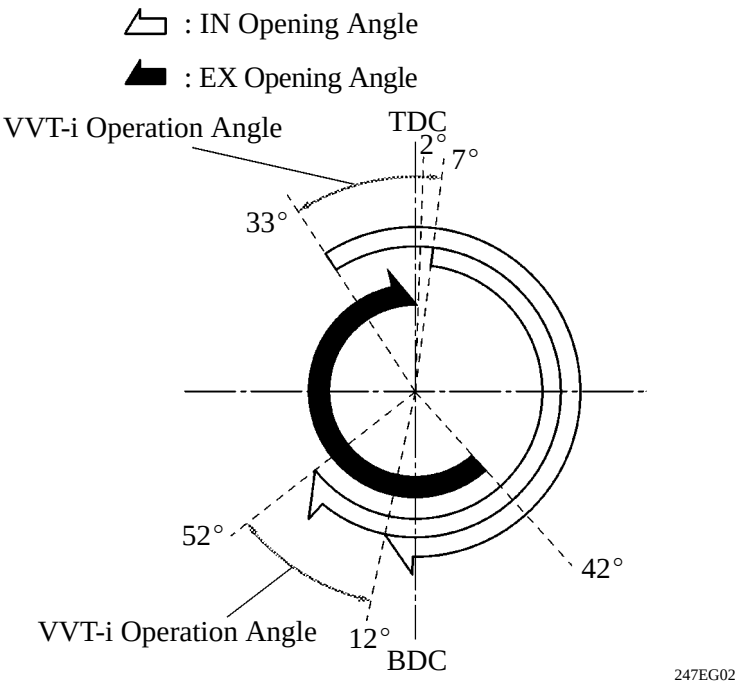
▶ Engine Specifications ◀

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.)		1497 (91.3)
Bore x Stroke	mm (in.)		75.0 x 84.7 (2.95 x 3.33)
Compression Ratio			10.5 : 1
Max. Output*1	(SAE-NET)		79 kW @ 6000 rpm (106 HP @ 6000 rpm)
Max. Torque*1	(SAE-NET)		139 N·m @ 4200 rpm (103 ft lbf @ 4200 rpm)
Valve Timing	Intake	Open	-7 ° - 33° BTDC
		Close	52° - 12° ABDC
	Exhaust	Open	42° BBDC
		Close	2° ATDC
Firing Order			1 - 3 - 4 - 2
Research Octane Number			90 or higher
Octane Rating			87 or higher
Oil Grade			ILSAC
Tailpipe Emission Regulation			TIRE2, ULEV-II
Evaporative Emission Regulation			ORVR
Engine Service Mass*2 (Reference)	kg (lb)	M/T	83.2 (183.4)
		A/T	77.8 (171.5)

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

▶ Valve Timing ◀



■FEATURES OF 1NZ-FE ENGINE

The 1NZ-FE engine has been able to achieve the following performance through the adoption of the items listed below.

(1) High performance and fuel economy

(2) Low noise and vibration

(3) Lightweight and compact design

(4) Good serviceability

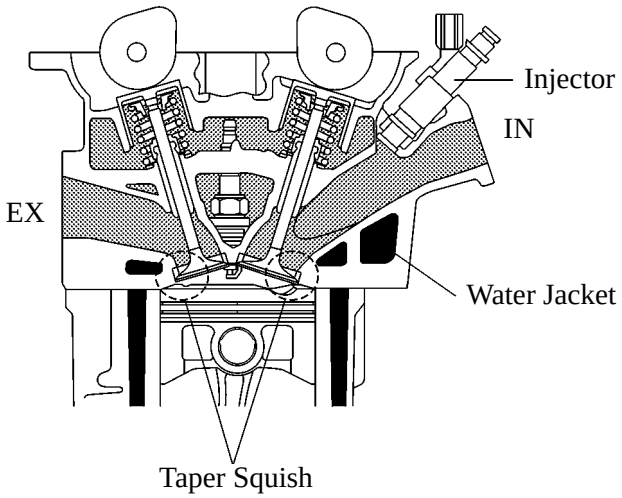
(5) Clean emission

Section	Item	(1)	(2)	(3)	(4)	(5)
Engine Proper	A cylinder block made of aluminum is used.			○		
	An offset crankshaft is used.	○	○			○
	The taper squish shape is used for the combustion chamber.	○				○
Valve Mechanism	A timing chain and chain tensioner are used.	○		○	○	
	The VVT-i system is used.	○				○
Intake and Exhaust System	Intake manifold made of plastic is used.			○		
	The linkless-type throttle body is used.			○	○	
	A stainless steel exhaust manifold is used.			○		
	Two TWCs (Three Way Catalytic Converter) are used.					○
	A rearward exhaust layout is used to realize the early activation of the catalyst.					○
Fuel System	12-hole type injector is used.	○				○
	The fuel returnless system is used.			○	○	○
	Quick connectors are used to connect the fuel hose with the fuel pipes.				○	
Ignition System	The long-reach type spark plugs are used.	○				
	The DIS (Direct Ignition system) makes ignition timing adjustment unnecessary.	○			○	○
Engine Control System	The ETCS-i (Electronic Throttle Control System-intelligent) is used.	○				○
	The non-contact sensor is used in the throttle position sensor and accelerator pedal position sensor.	○				
	The cranking hold function is used.	○				
	Evaporative emission control system is used.					○
	The use of an air fuel ratio sensor allows for precise control.					○

■ENGINE PROPER

1. Cylinder Head

- The injectors are installed in the cylinder head to reduce the distance from injector to intake valve, thus it prevents the fuel from adhering to the intake port walls, and reduce exhaust emissions.
- The routing of the water jacket in the cylinder head is optimized to achieve high cooling performance.
- Through the use of the taper squish combustion chamber, the engine's knocking resistance and fuel efficiency have been improved.



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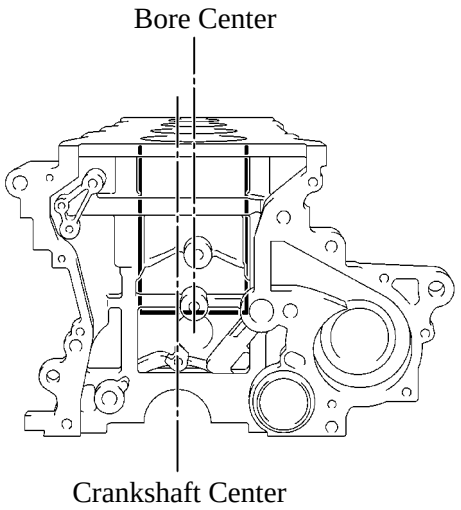
2. Cylinder Block

- Lightweight aluminum alloy is used for the cylinder block.
- Through the use of the offset crankshaft, the bore center is shifted 12 mm (0.472 in.) towards the intake, in relation to the crankshaft center. Thus, the side force to cylinder wall is reduced when the maximum pressure is applied, which contributes to fuel economy.



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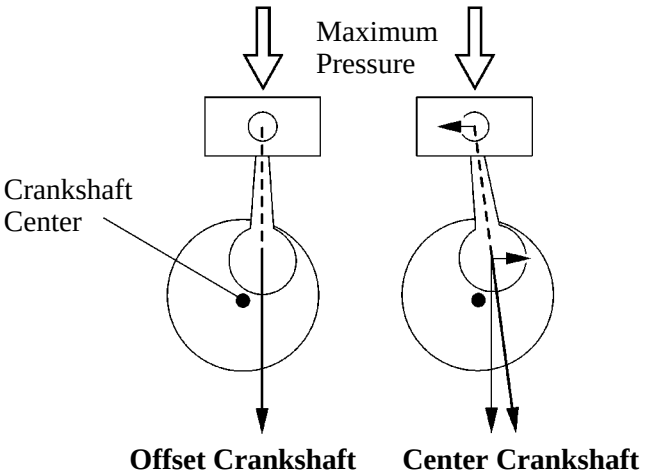
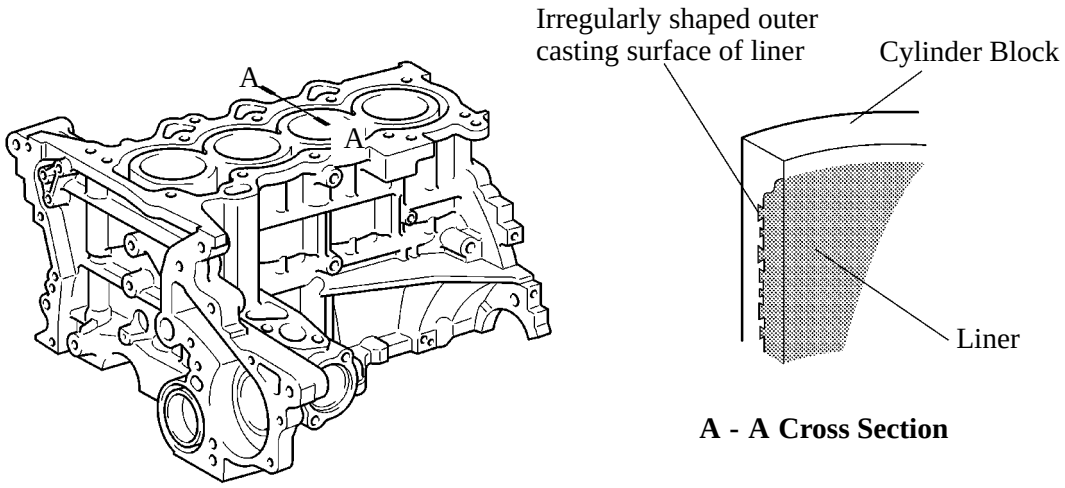


193EG05

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



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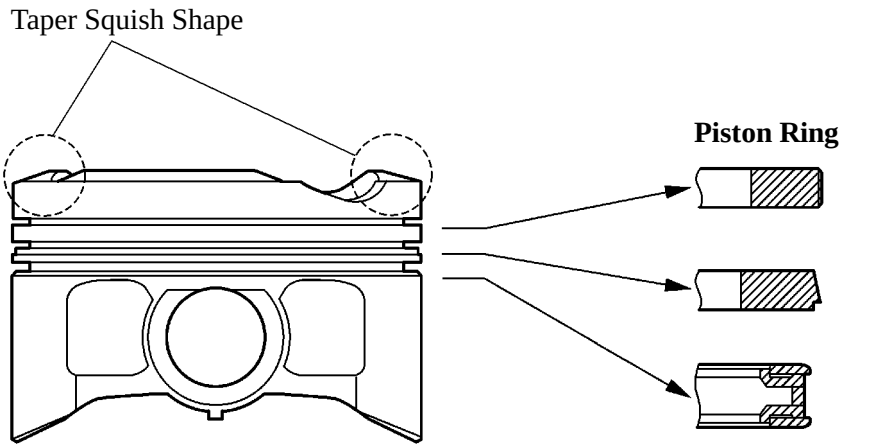
3. Piston

- The piston is made of aluminum alloy
- The piston head portion is used a taper squish shape to accomplish fuel combustion efficiency.
- Semi floating type piston pins are used.
- By increasing the machining precision of the cylinder bore diameter, only one size of piston is available.



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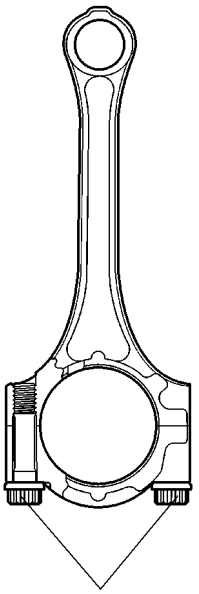
4. Connecting Rod

- The connecting rods and caps are made of high strength steel for weight reduction.
- Nutless-type plastic region tightening bolts are used for a light design.

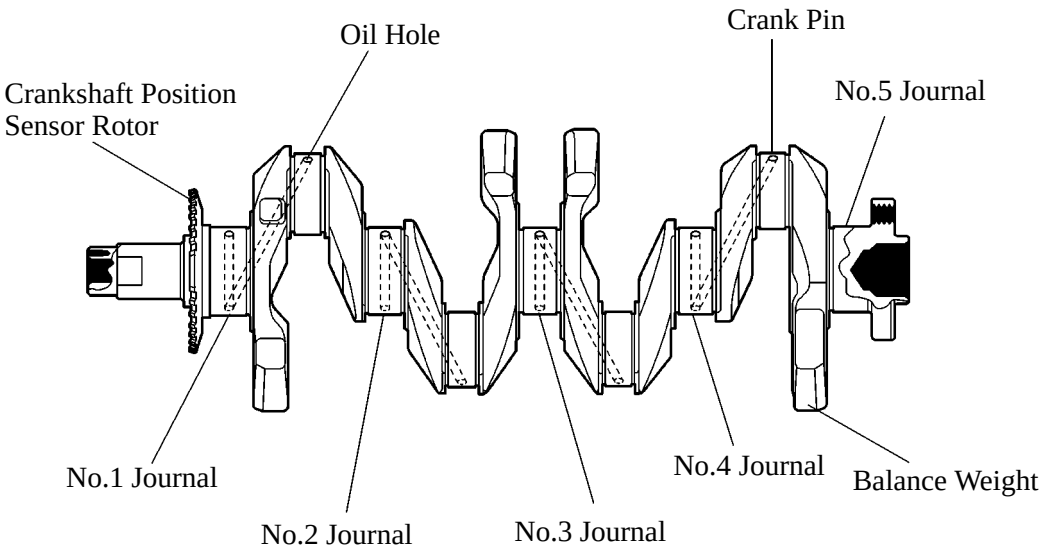


Plastic Region Tightening Bolts

171EG07

5. Crankshaft

- The diameter and width of the pins and journals have been reduced, and the pins for the No.1 and No.4 cylinders have been made highly rigid to realize a lightweight and low-friction performance.
- The crankshaft has 5 journals and 4 balance weights.
- A crankshaft position sensor rotor is pressed into the crankshaft to realize an integrated configuration.



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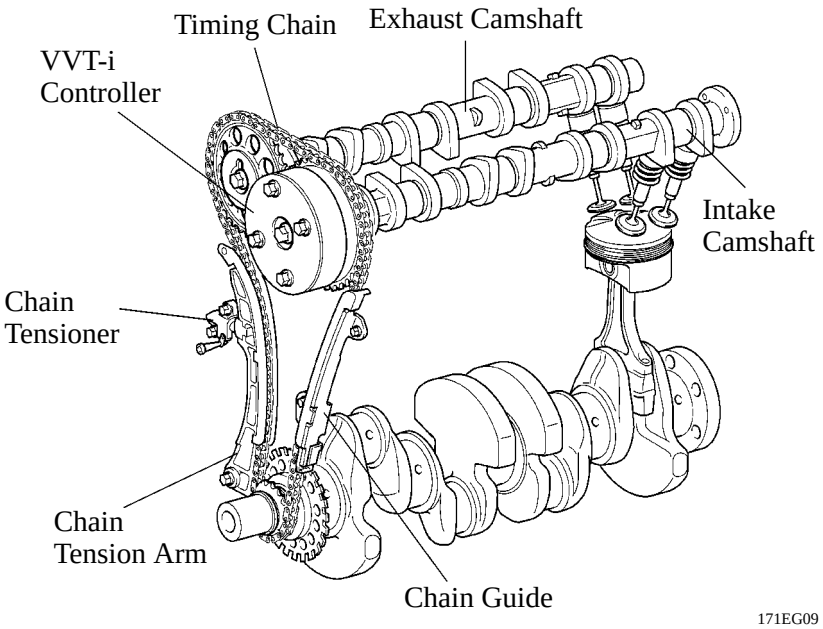
■VALVE MECHANISM

1. General

- The shimless type valve lifter is used to increase the amount of the valve lift.
- The intake and exhaust camshafts are driven by a timing chain.
- The VVT-i system is used to realize fuel economy, engine performance and reduce exhaust emissions. For details of VVT-i control, see page EG-41.



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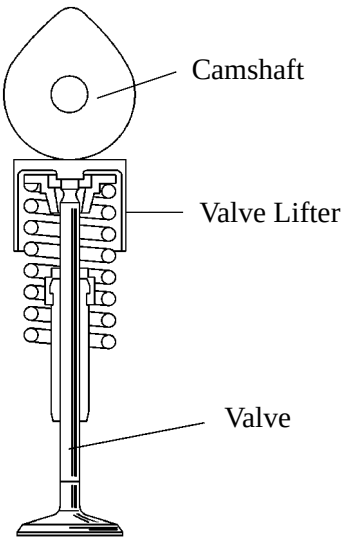

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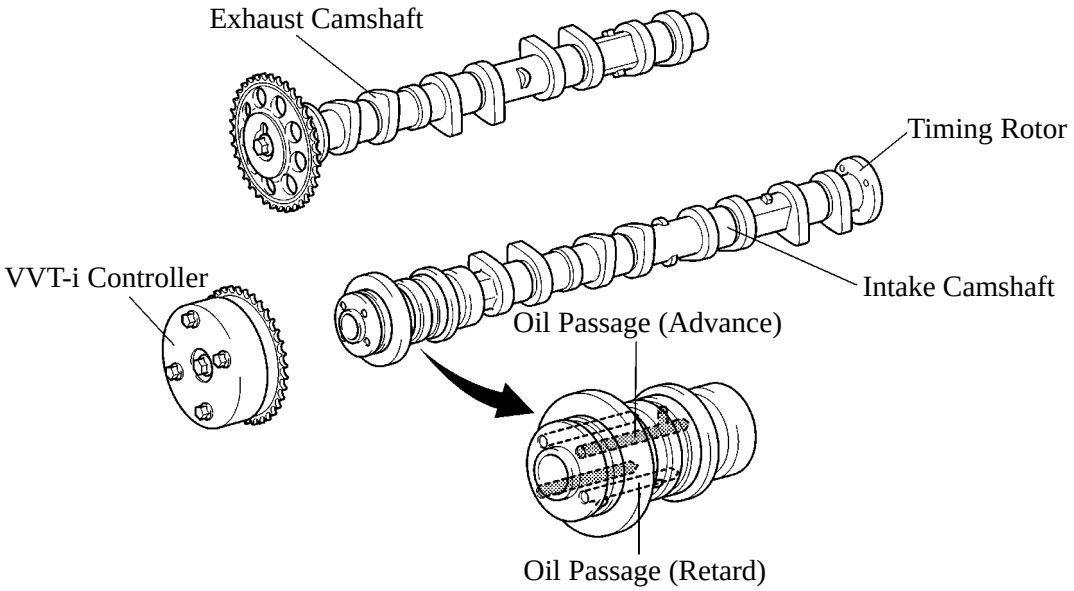
Service Tip

The adjustment of the valve clearance is accomplished by selecting and replacing the appropriate valve lifters. Adjusting valve lifters are available in 35 increments of 0.020 mm (0.0008 in.), from 5.060 mm (0.1992 in.), to 5.740 mm (0.2260 in.).
For details, refer to 2006 Yaris Repair Manual (Pub. No. RM00R0U).

2. Camshaft

- Oil passages are provided in the intake camshaft in order to supply engine oil to the VVT-i system.
- A VVT-i controller is provided on the front of the intake camshaft to vary the timing of the intake valves.
- A Timing rotor is provided behind the intake camshaft to trigger the camshaft position sensor.

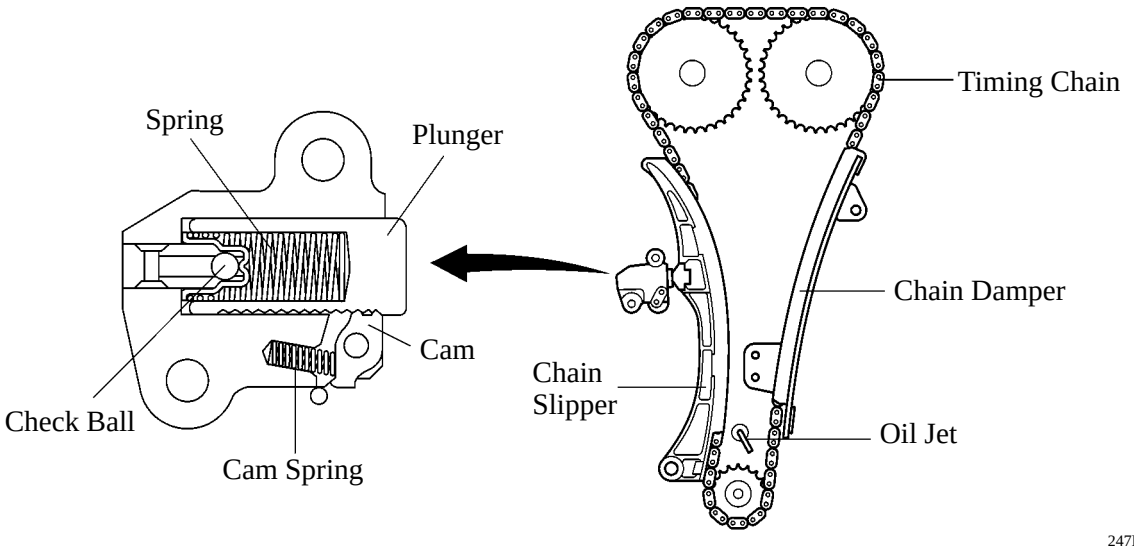


247EG08

3. Timing Chain and Chain Tensioner

- A roller type timing chain with an 8.0 mm (0.315 in.) pitch is used to make the engine compact and reduce noise.
- The timing chain is lubricated by an oil jet.
- The chain tensioner uses a spring and oil pressure to maintain proper chain tensioner at all times. The chain tensioner suppresses noise generated by the timing chain.
- A ratchet type non-return mechanism is used in the chain tensioner.

▶ Chain Tensioner ◀



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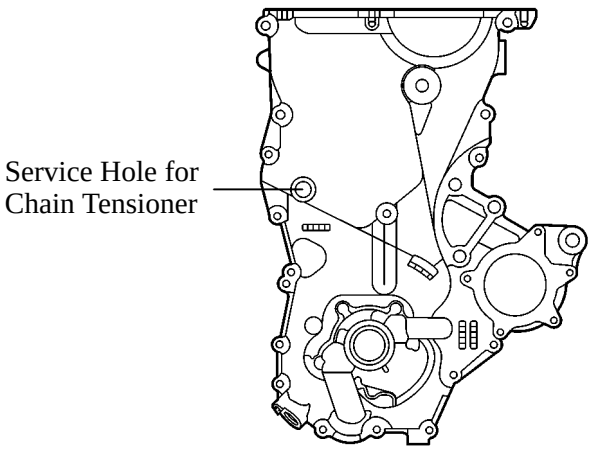
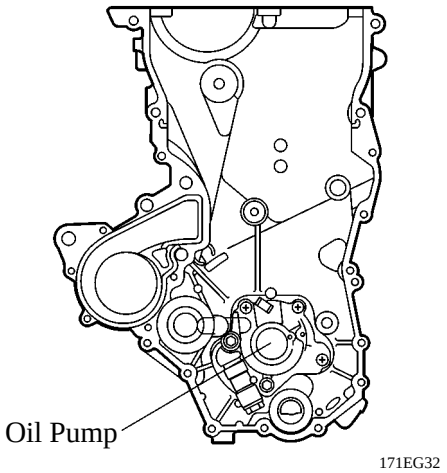
4. Timing Chain Cover

- A single-piece, aluminum diecast timing chain cover that entirely seals the front portion of the cylinder block and cylinder head is used.
- A service hole for the chain tensioner is provided in the timing chain cover to improve serviceability.



Front View

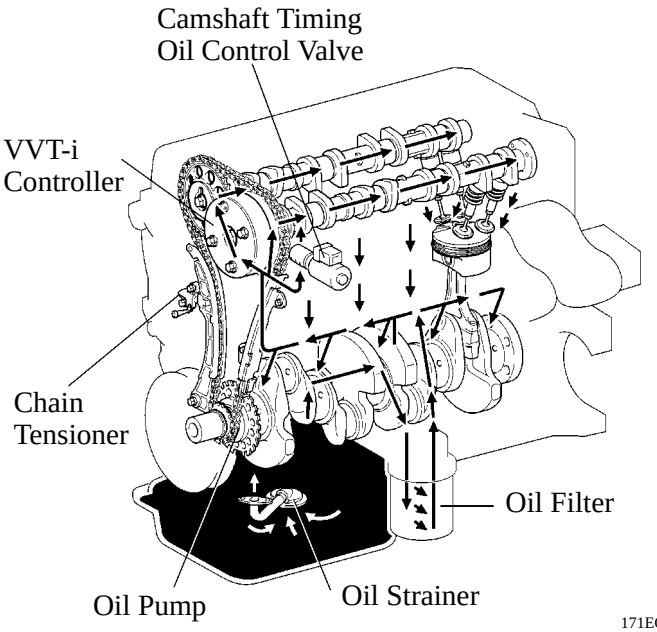


Back View

■LUBRICATION SYSTEM

1. General

- The lubrication circuit is fully pressurized and oil passes through an oil filter.
- A trochoid gear type oil pump, which is driven directly by the crankshaft, is provided in the front of the cylinder block.
- The oil filter is installed diagonally downward from the side of the cylinder block to realize excellent serviceability.
- The intake camshaft is provided with a VVT-i controller, and cylinder head is provided with a camshaft timing oil control valve. This system is operated by the engine oil.



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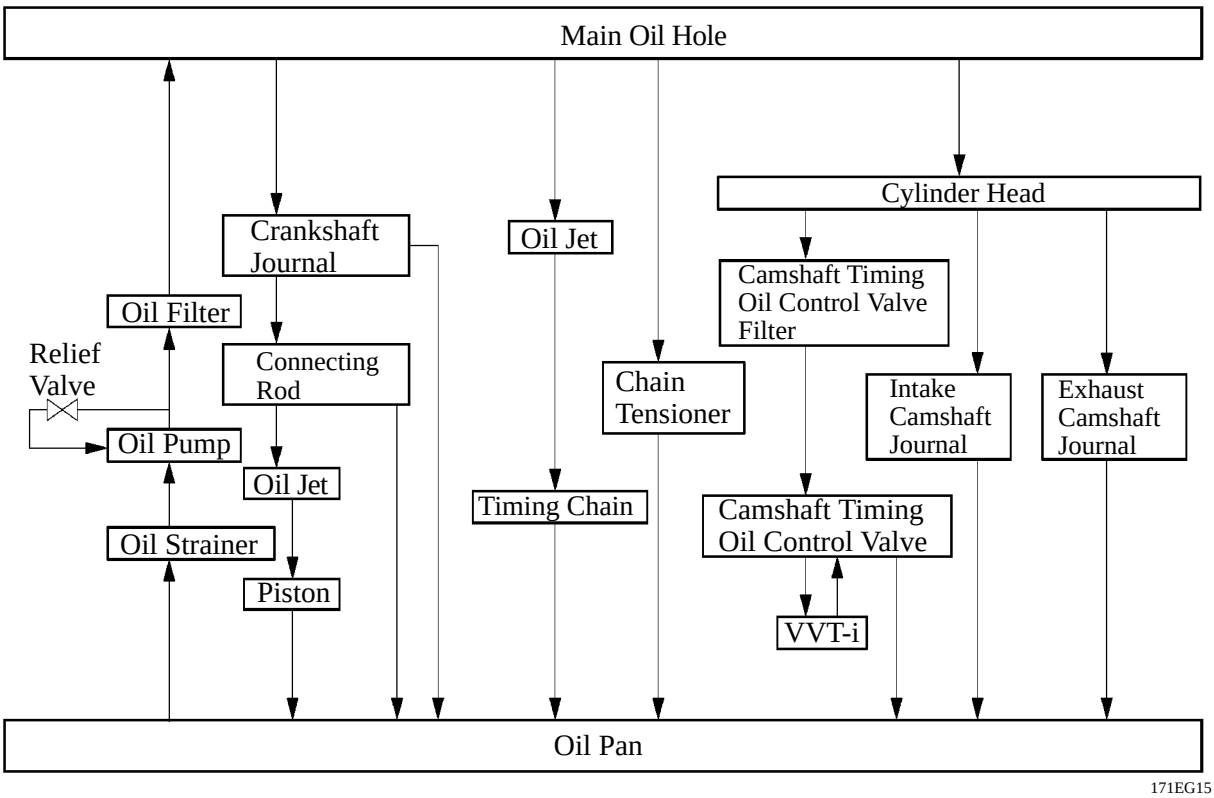
▶ **Oil Capacity** ◀ Liter (US qts, Imp qts)

Dry	4.1 (4.3, 3.6)
with Oil Filter	3.7 (3.9, 3.3)
without Oil Filter	3.4 (3.6, 3.0)

▶ **Oil Circuit** ◀



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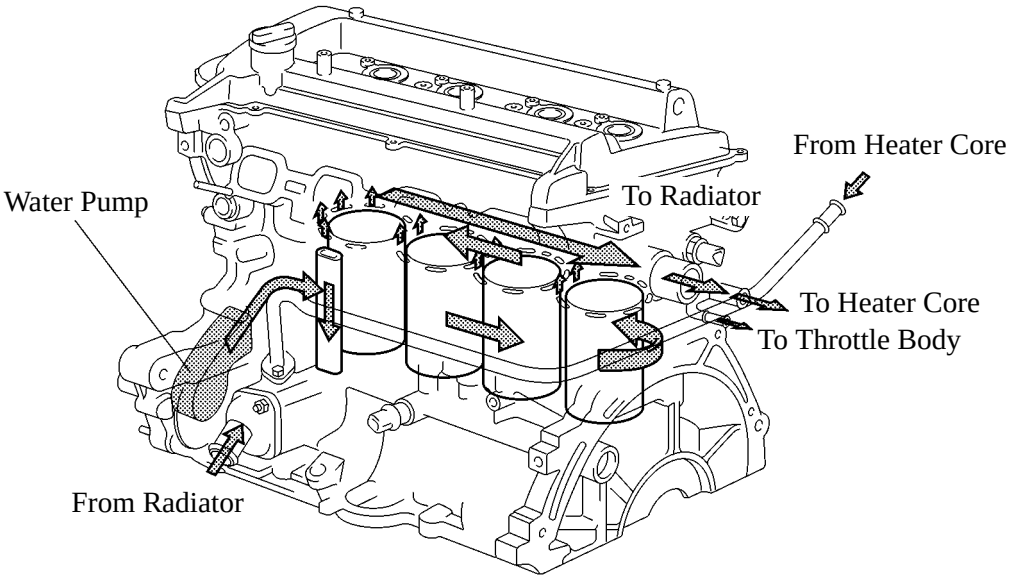
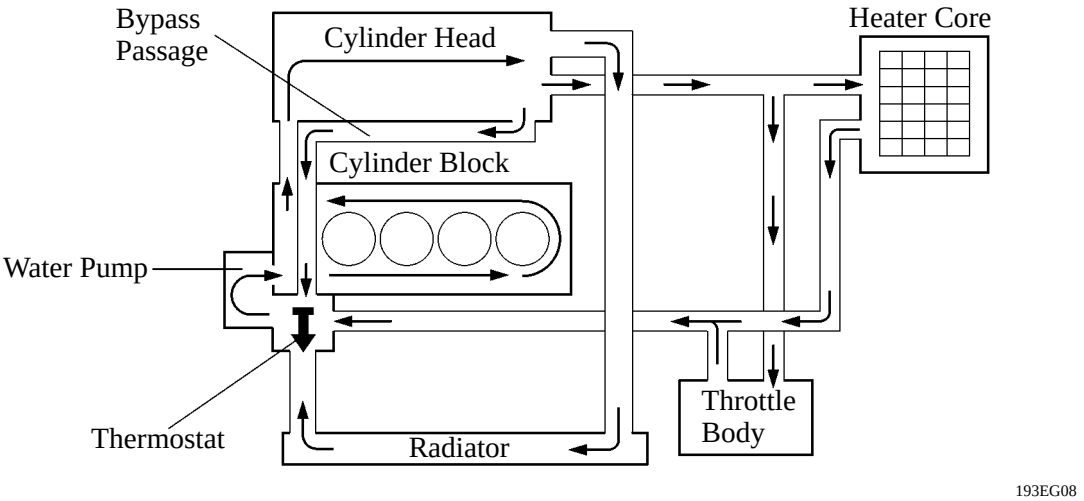
■COOLING SYSTEM

- The cooling system is a pressurized, forced-circulation type.
- 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.
- A single cooling fan provides both the cooling and air conditioner performance.
- The TOYOTA genuine Super Long Life Coolant (SLLC) is used.



▶ System Diagram ◀



▶ Engine Coolant Specifications ◀

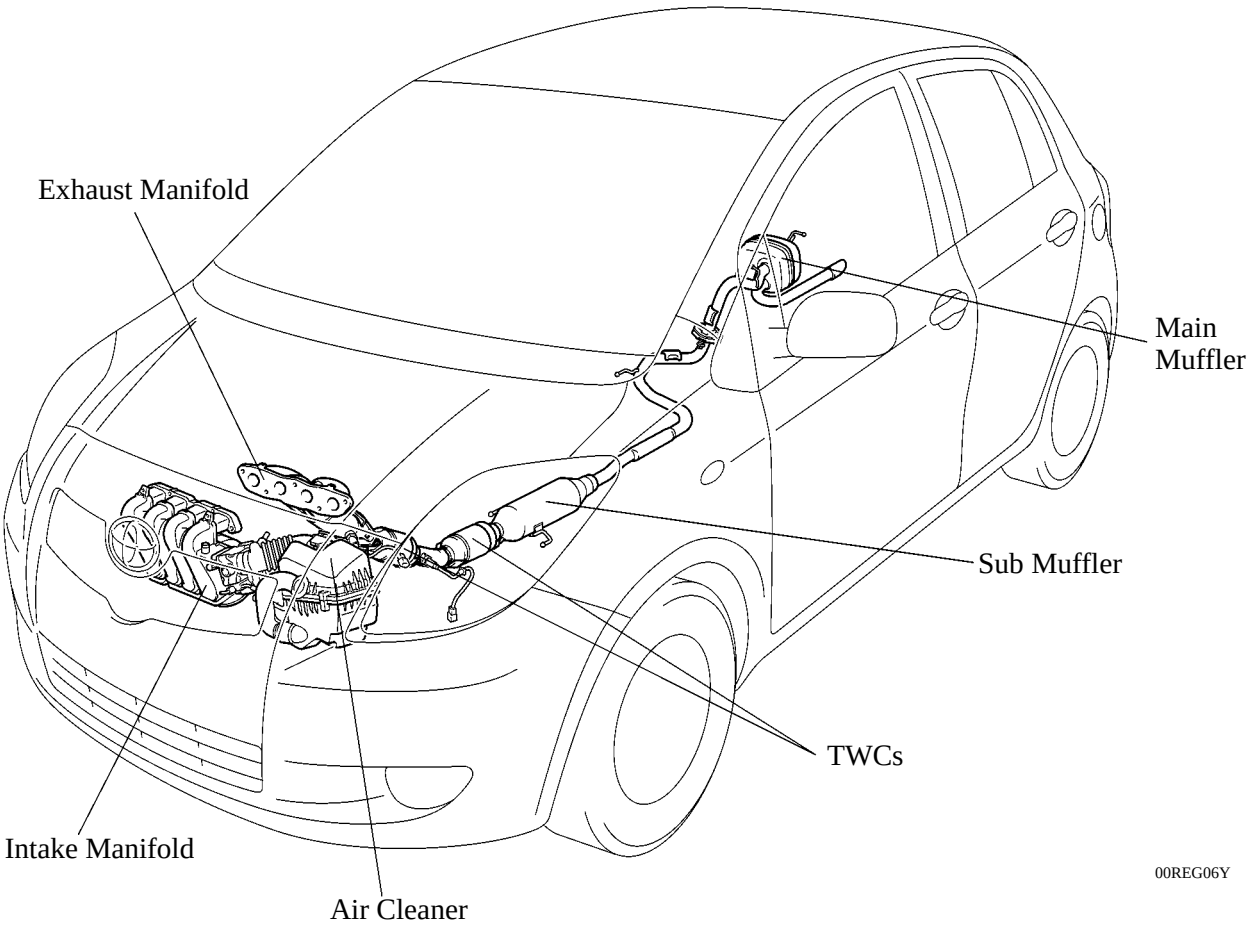
Engine Coolant	Type		TOYOTA genuine Super Long Life Coolant (SLLC) or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite and non-borate coolant with long-life hybrid organic acid technology (coolant with long-life hybrid organic acid technology is a combination of low phosphates and organic acids.) Do not use plain water alone.
	Color		Pink
	Capacity Liters (US qts, Imp. qts)	M/T	4.8 (5.1, 4.2)
		A/T	4.7 (5.0, 4.1)
	Maintenance Intervals	First Time	100,000 miles (160,000 km)
		Subsequent	Every 50,000 miles (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 (ever 40,000 km/24,000 miles or 24 months) should be used.

■INTAKE AND EXHAUST SYSTEM

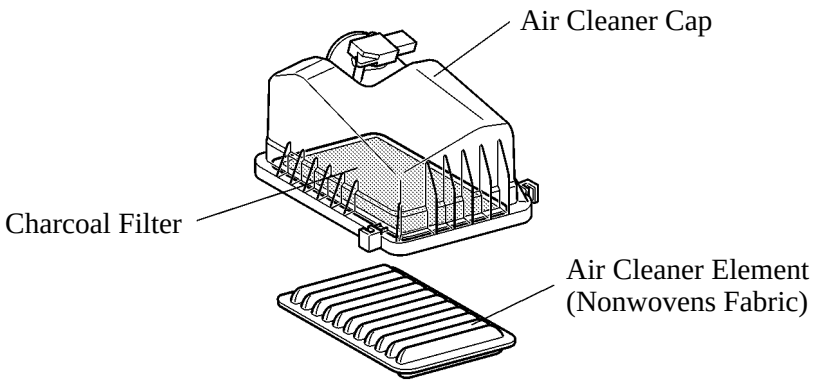
1. General

- A plastic intake manifold is used for weight reduction.
- The linkless-type throttle body is used to realize excellent throttle control.
- ETCS-i (Electronic Throttle Control System-intelligent) provides excellent throttle control. For details, see page EG-36.
- The exhaust pipe uses a ball joint in order to achieve a simple construction and reliability.



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.



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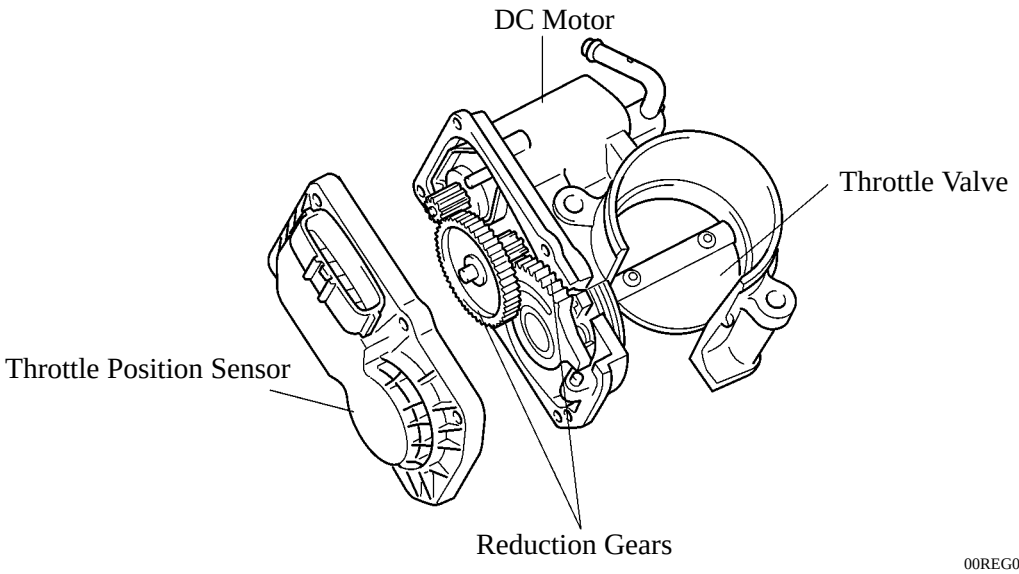
Service Tip

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.



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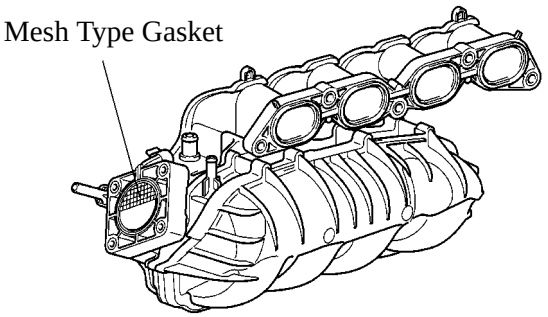
4. Intake Manifold

- 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 temperature and improve the intake volumetric efficiency.
- A mesh type gasket is used in order to reduce the intake noise.



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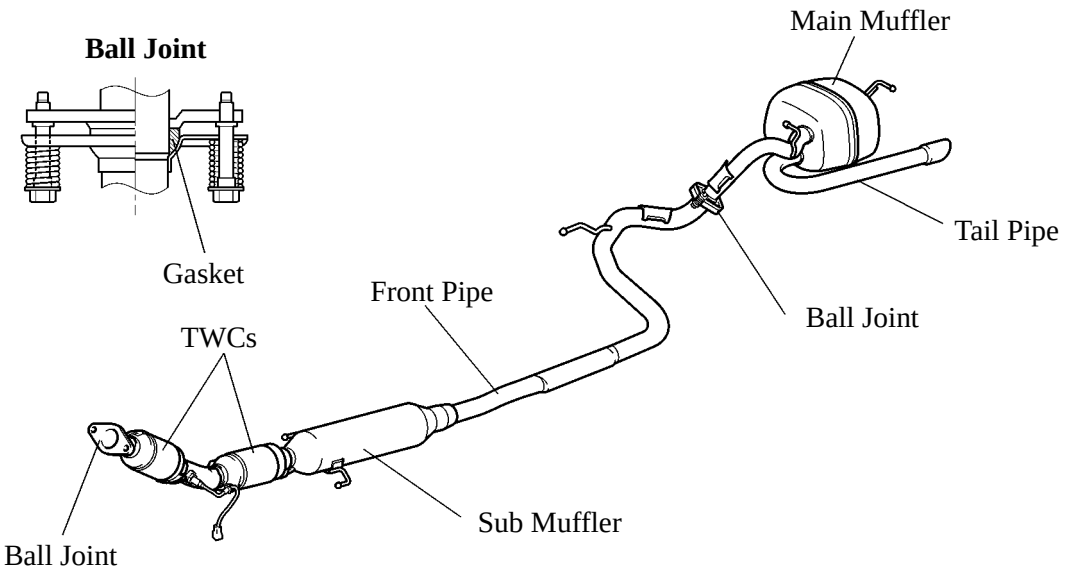
5. Exhaust Pipe and Muffler

A ball joint is used to joint the exhaust manifold to the exhaust front pipe, and the exhaust front pipe to the exhaust tail pipe. As a result, a simple construction and improved reliability have been realized.



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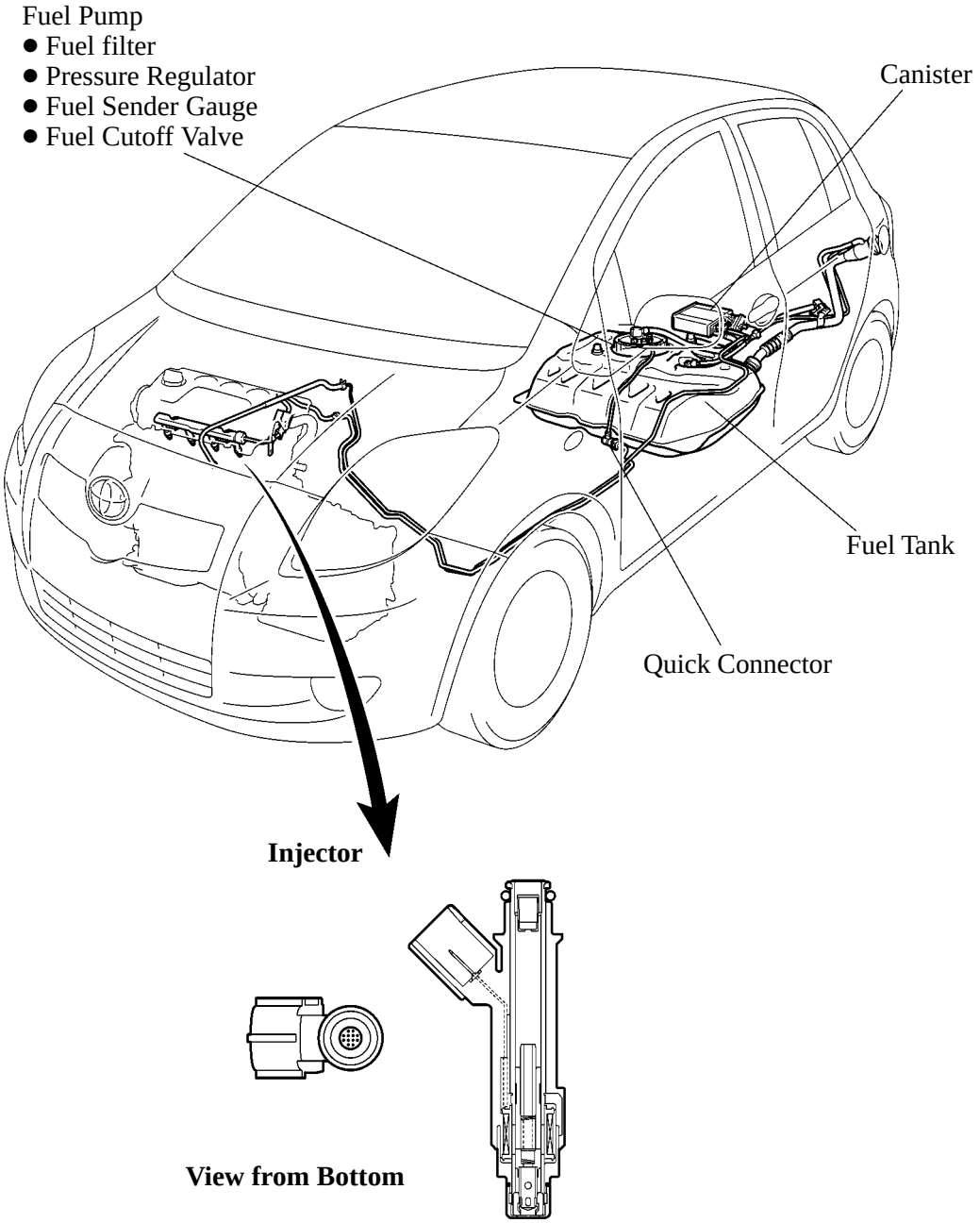
■FUEL SYSTEM

1. General

- The fuel returnless system is used to reduce evaporative emissions.
- A fuel tank made of multi-layer plastic is used.
- 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-45.
- A quick connector is used to connect the fuel pipe with the fuel hose to realize excellent serviceability.
- A compact 12-hole type injector is used to ensure the atomization of fuel.
- The ORVR (On-Board Refueling Vapor Recovery) system is used. For details, see page EG-46.



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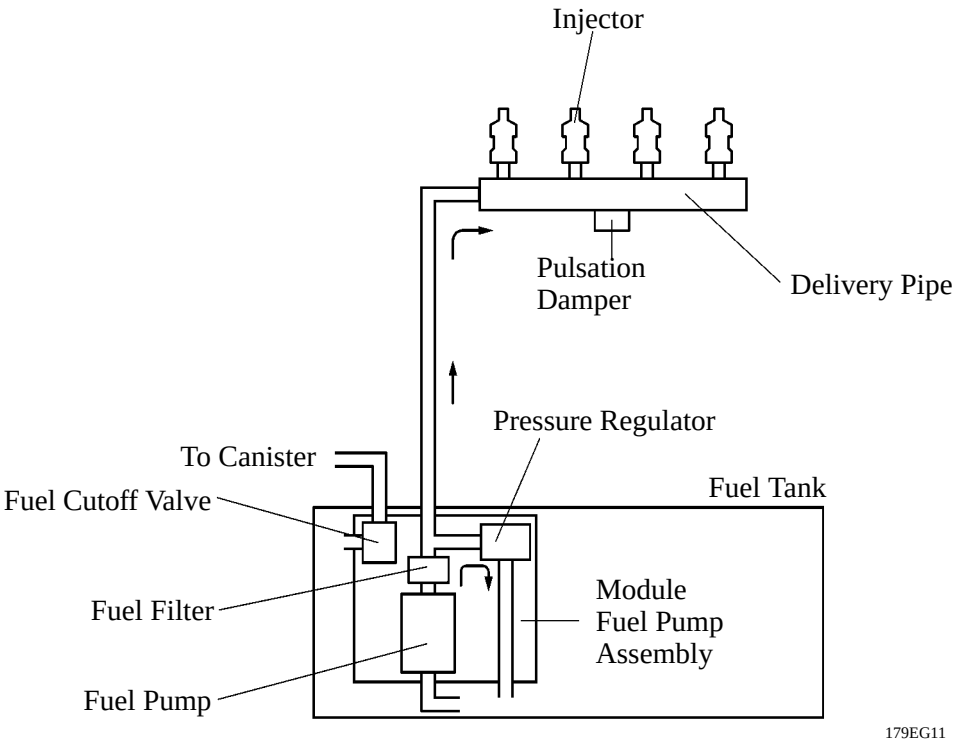
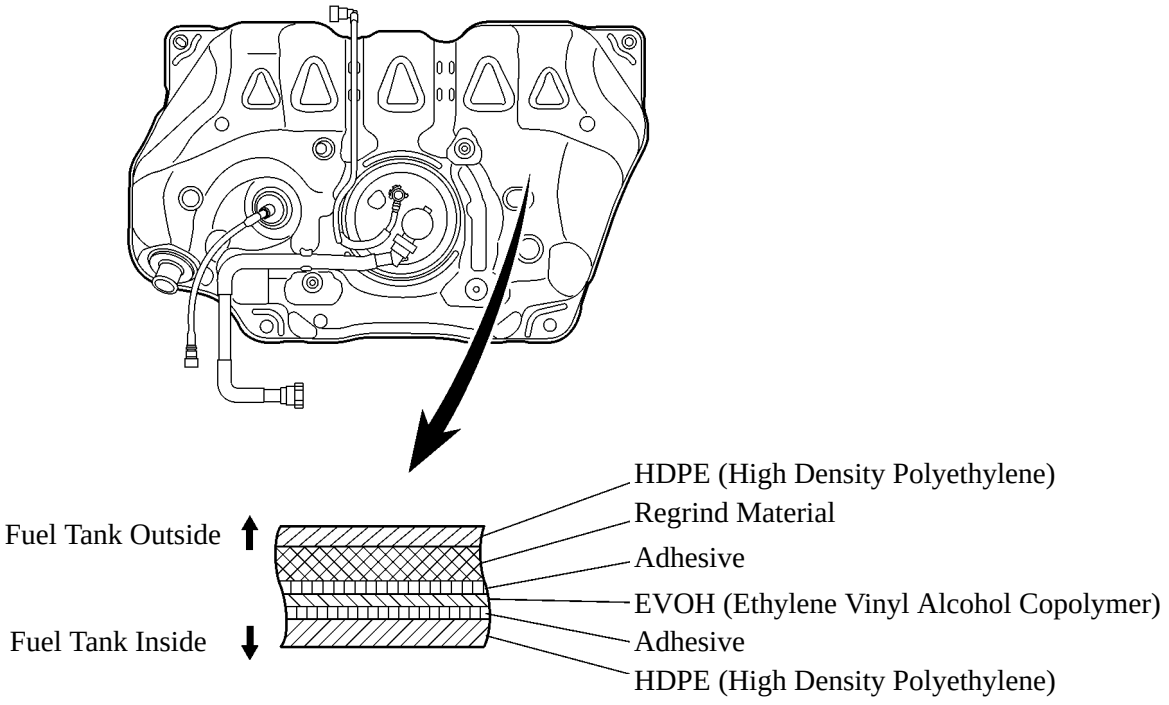
2. Fuel Returnless System

This system is used to reduce the evaporative emission. As shown below, integrating the fuel filter, pressure regulator, fuel sender gauge, and fuel cutoff valve with module fuel pump assembly enables to discontinue the return of fuel from the engine area and prevent temperature rise inside the fuel tank.



3. Fuel Tank

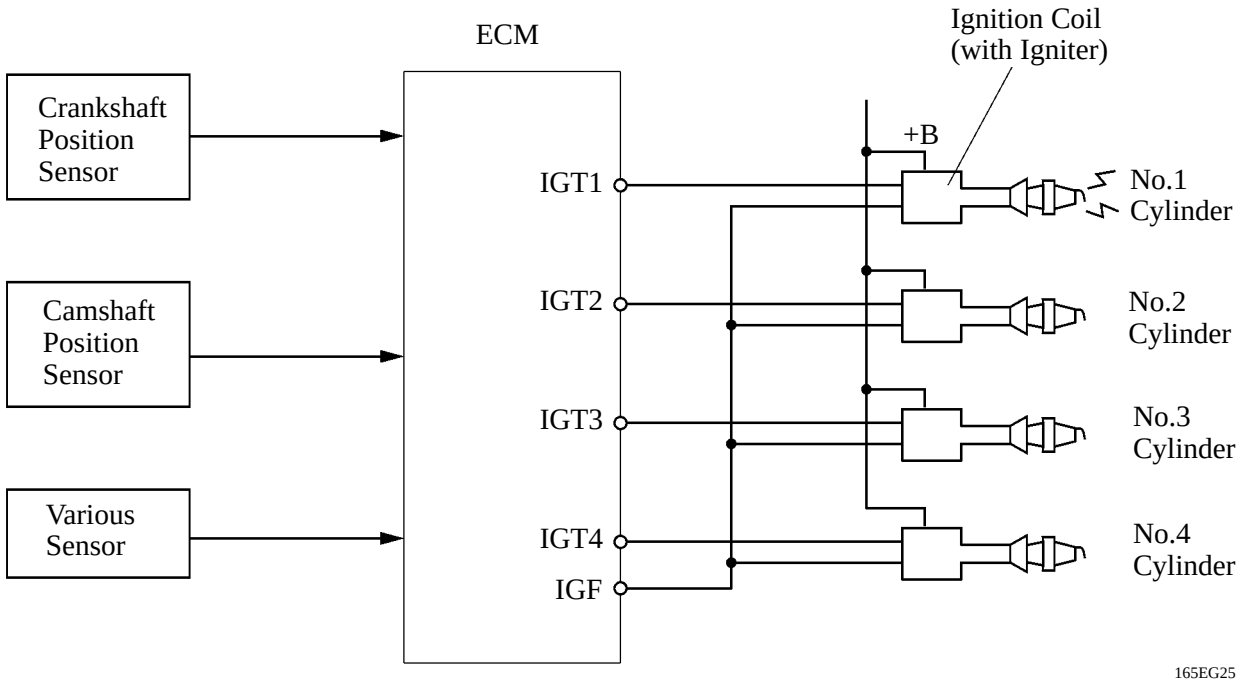
Low permeability has been realized through the use of the multi-layered plastic fuel tank. This fuel tank consists of six layers using four types of materials.



■IGNITION SYSTEM

1. General

- A DIS (Direct Ignition System) is used. The DIS in this engine is an independent ignition system, which has one ignition coil for each cylinder. The DIS ensures the ignition timing accuracy, reduces high-voltage loss, and realizes the overall reliability of the ignition system by eliminating the distributor.
- The spark plug caps, which connect to the spark plugs, are integrated with the ignition coils. Also, the igniters are enclosed to simplify the system.
- Long-reach type iridium-tipped spark plugs are used.



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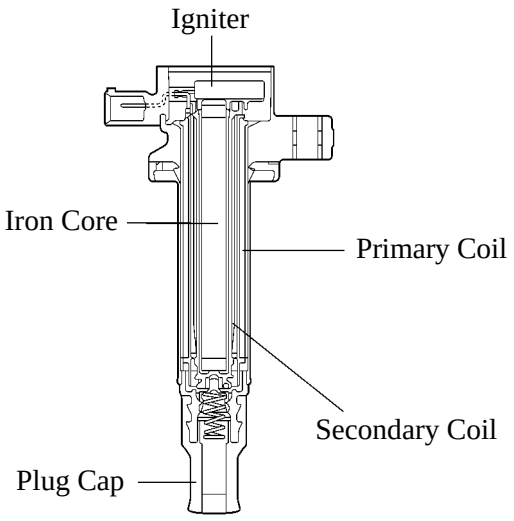
▶ Ignition Coil with Igniter ◀



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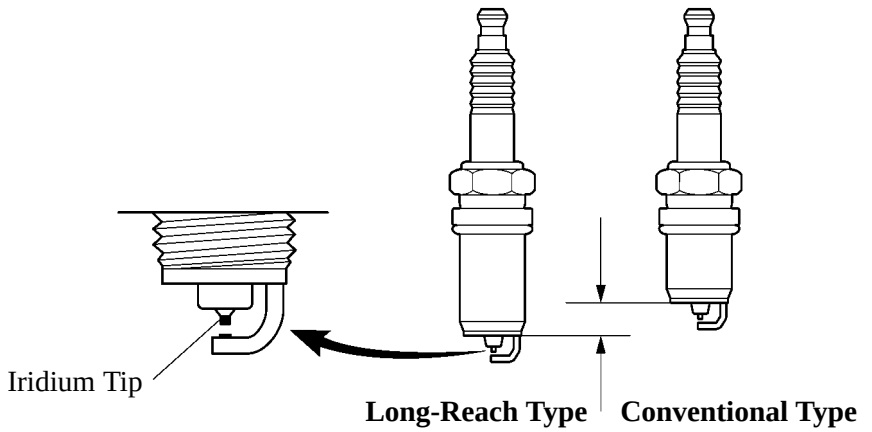
2. Spark Plug

- Long-reach type iridium-tipped spark plugs are used.
- Long-reach type of spark plugs allows the area of the cylinder head to receive the spark plugs to be made thick. Thus, the water jacket can be extended near the combustion chamber, which contributes to cooling performance.
- Iridium-tipped spark plugs are used to realize a 100,000 km (62,500 mile) maintenance-free operation. By making the center electrode of iridium, the same ignition performance as the platinum-tipped type spark plug and excellent of durability have been realized.



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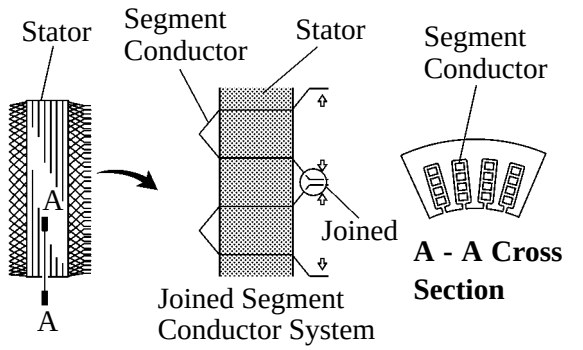
▶ Specification ◀

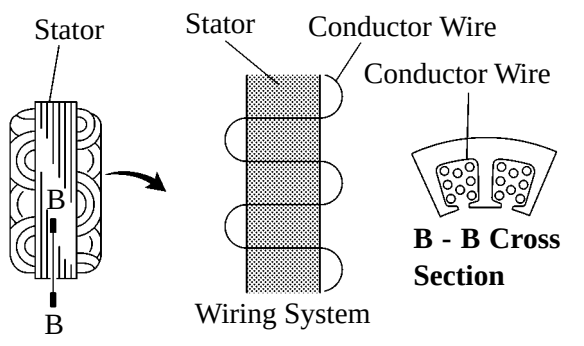
DENSO		SK16R11
NGK		IFR5A-11
Plug Gap	mm (in.)	1.1 (0.043)

■CHARGING SYSTEM

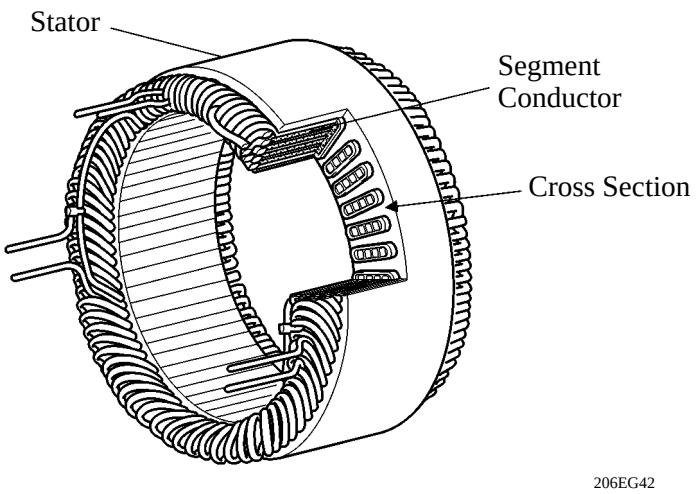
- A compact and lightweight segment conductor type generator that generates high amperage output in a highly efficient manner is used as standard equipment.
- This generator has a joined segment conductor system, in which multiple segment conductors are welded together to form the stator. Compared to the conventional wiring 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

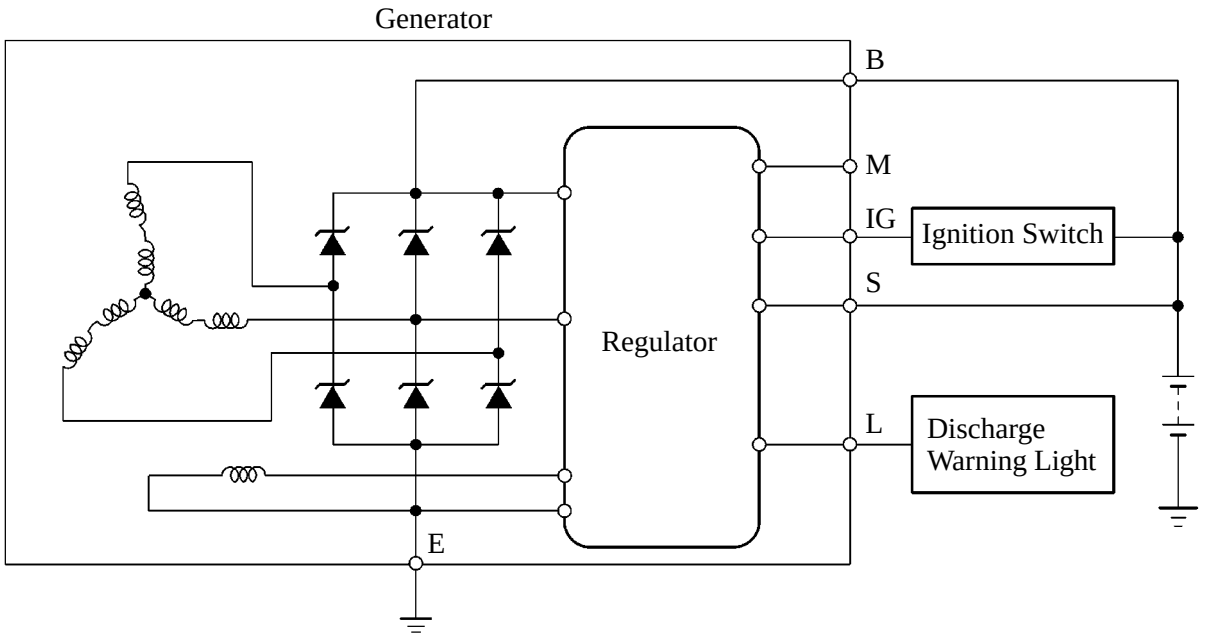


Stator of Segment Conductor Type Generator

▶ Specifications ◀

Type	SE08
Rated Voltage	12 V
Rated Output	80 A
Initial Output Starting Speed	1,250 rpm Max.

▶ Wiring Diagram ◀



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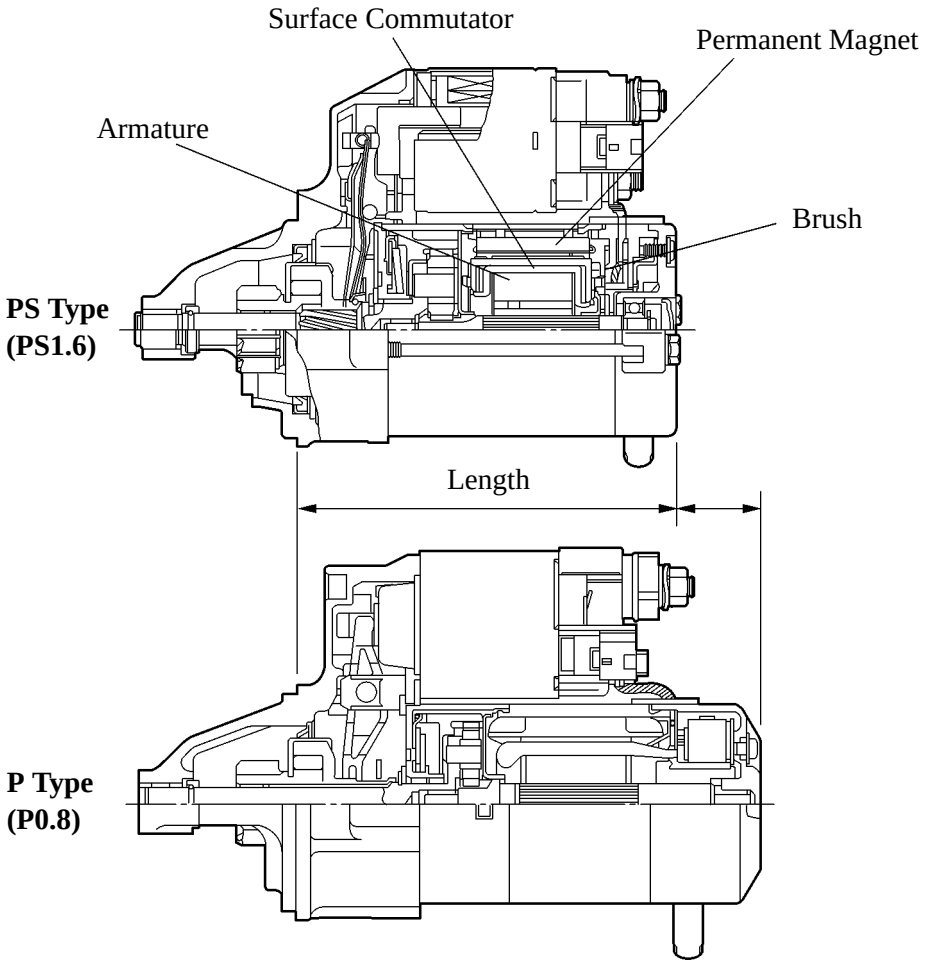
■STARTING SYSTEM

1. General

- A P (conventional planetary reduction) type starter is used in the models for U.S.A.
- A PS (planetary reduction-segment conductor motor) type starter is used in the models for Canada and cold areas of the U.S.A.



▶ Specification ◀

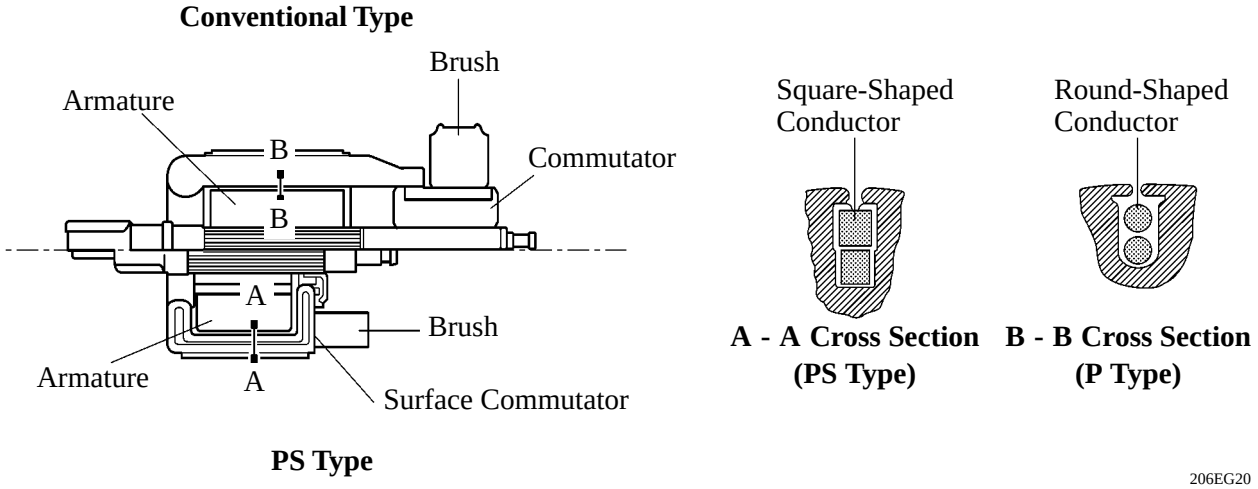
Destination	U.S.A.	Canada, Cold Areas of U.S.A.
Starter Type	P Type	PS Type
Rating Output	0.8 kW	1.6 kW
Rating Voltage	12 V	←
Length*1 mm (in.)	154 (6.1)	133 (5.2)
Weight g (lb)	2800 (6.2)	←
Rotation Direction*2	Clockwise	←

*1: Length from the mounted area to the rear end of the starter
*2: Viewed from Pinion Side

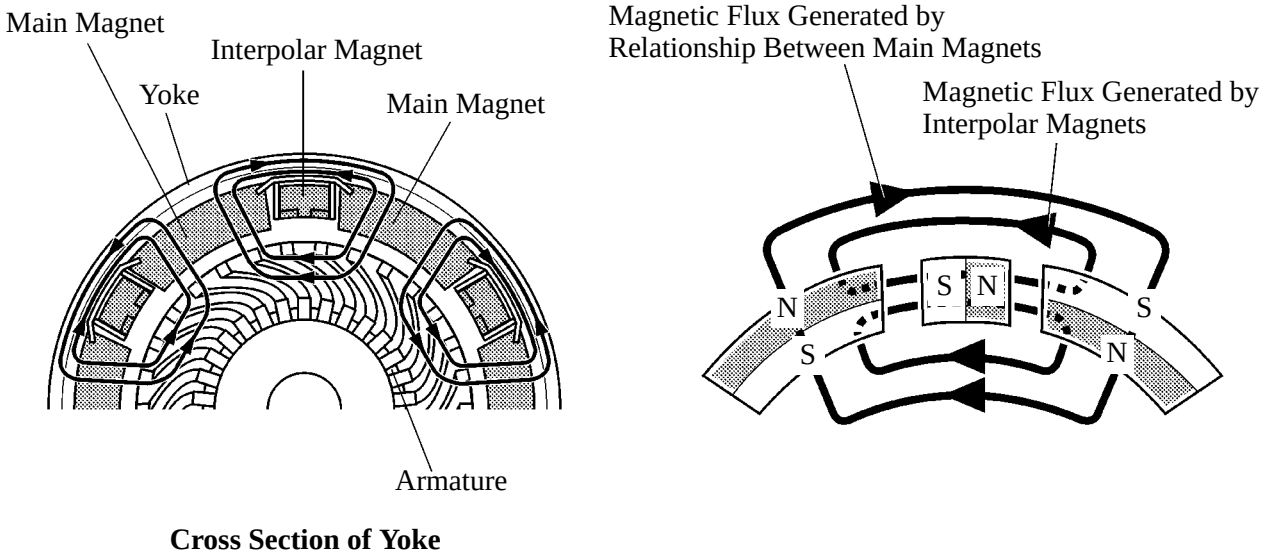
2. PS (Planetary reduction-Segment conductor motor) Type Starter

Construction

- Instead of constructing the armature coil with P type of 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 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 P 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.



■ENGINE CONTROL SYSTEM

1. General

The engine control system for the 1NZ-FE engine has the following systems.

System	Outline	'06 Model	'05 Model
SFI (Electronic Fuel Injection)	An L-type EFI system detects the intake air mass with a hot-wire type air flow meter.	○	○
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 EG-36	Optimally controls the throttle valve opening in accordance with the amount of accelerator pedal effort and the condition of the engine and vehicle.	○	-
	● A linkless-type is used without an accelerator. ● 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-41	Controls the intake camshaft to optimal valve timing in accordance with the engine condition.	○	○
Fuel Pump Control See page EG-45	● Fuel pump operation is controlled by signals from the ECM. ● The operation of the fuel pump will stop when the airbag is deployed.	○	○
Air Fuel Ratio Sensor and 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.	○	-
Oxygen Sensor Heater Control	Maintains the temperature of the oxygen sensor at an appropriate level to realize accuracy of detection of the oxygen concentration in the exhaust gas.	-	○
Evaporative Emission Control See page EG-46	The ECM controls the purge flow of evaporative emissions (HC) in the canister in accordance with engine conditions.	○	○
	Using 3 VSVs and a vapor pressure sensor, the ECM detects any evaporative emission leakage occurring between the fuel tank and charcoal canister through changes in the fuel tank pressure.	-	○
	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 evaporative emission control system through changes in the reference orifice pressure.	○	-
Air Conditioner Cut-off Control*1	By turning the air conditioner compressor OFF in accordance with the engine condition, drivability is maintained.	○	○
Cooling Fan Control See page EG-56	Cooling fan operation is controlled by signals from ECM based on the engine coolant temperature sensor signal (THW).	○	○

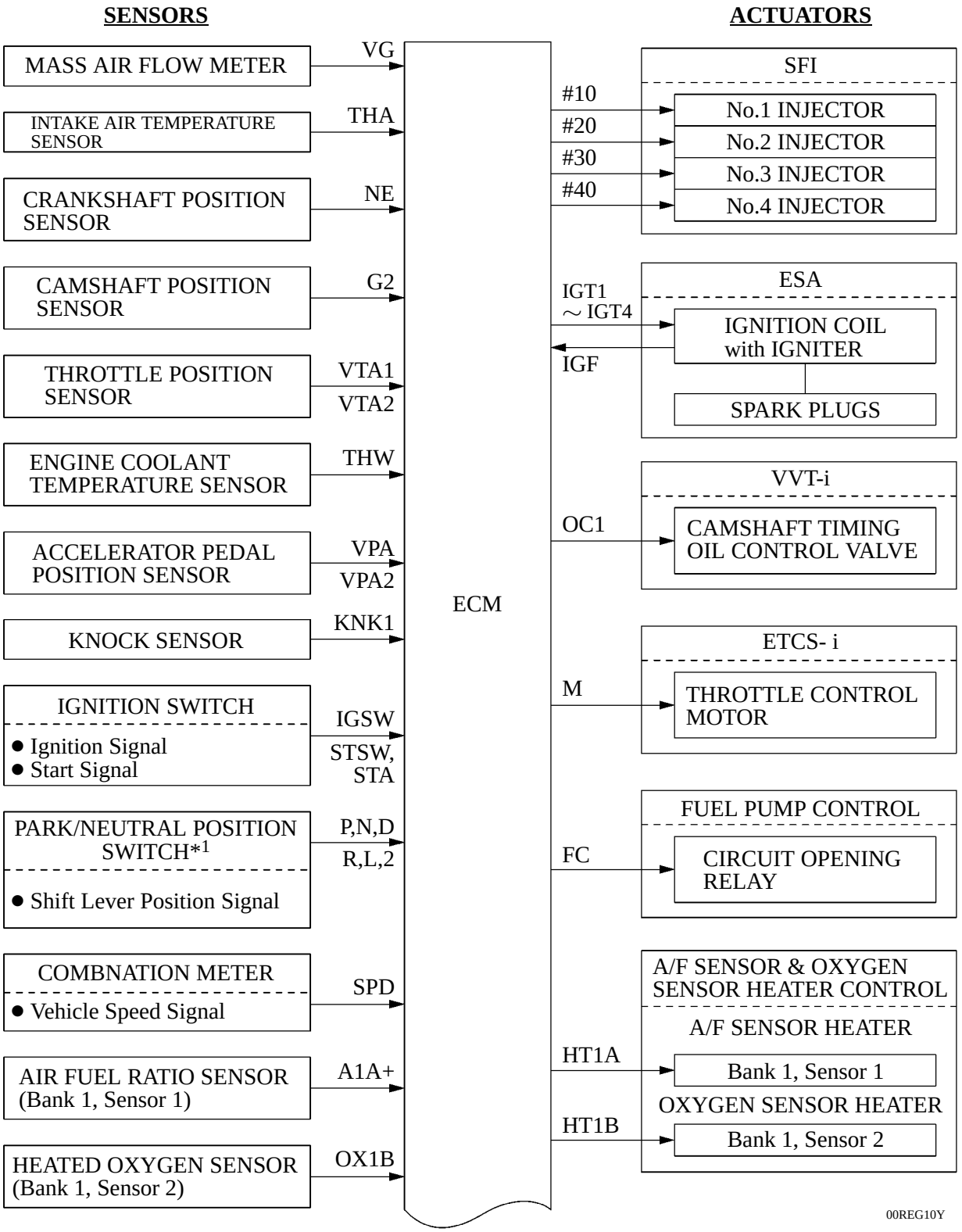
*1: for Models with Air Conditioning System

System	Outline	'06 Model	'05 Model
Starter Control (Cranking Hold Function) See Page EG-57	Once the ignition switch is turned to the START position, this control continues to operate the starter until the engine is started.	○	-
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-59	When the ECM detects a malfunction, the ECM diagnoses and memorizes the failed section.	○	○
Fail-Safe See Page EG-59	When the ECM detects a malfunction, the ECM stops or controls the engine according to the data already in memory.	○	○

*2: for Models with Engine Immobilizer System

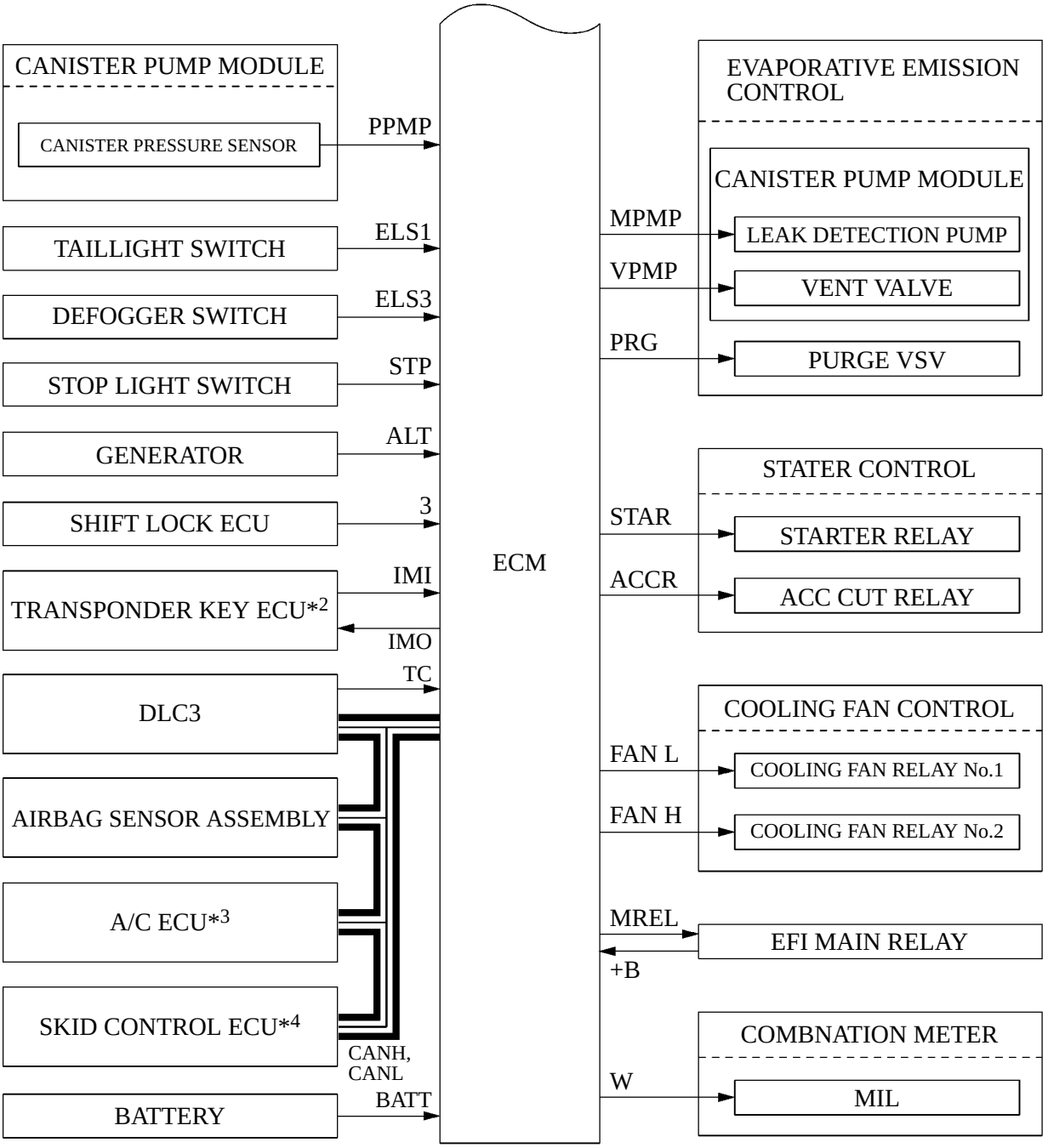
2. Construction

The configuration of the engine control system in the 1NZ-FE engine is shown in the following chart.



(Continued)

*1: for Automatic Transaxle Models



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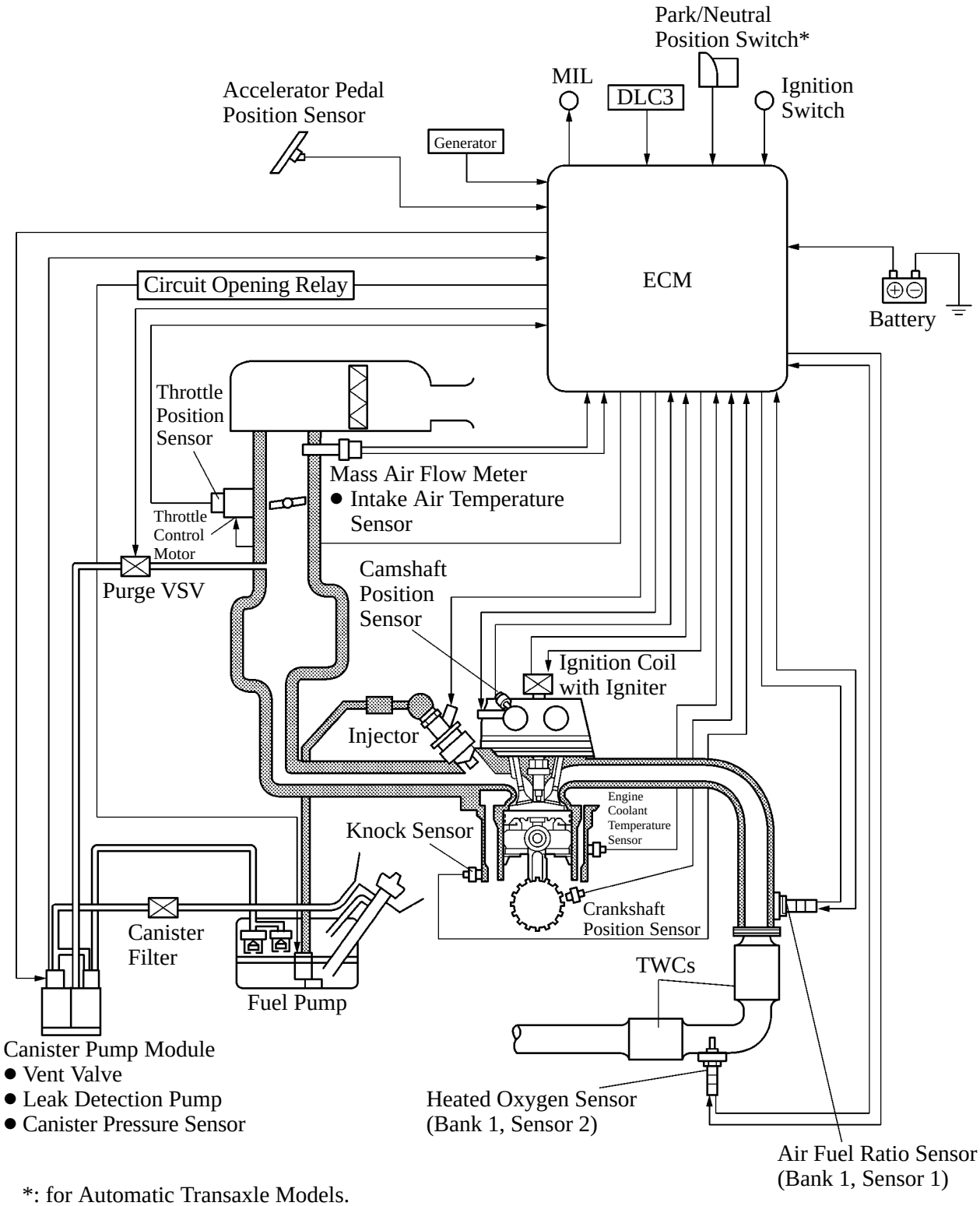
*2: for Models with Engine Immobilizer System
*3: for Models with Air Conditioning System
*4: for ABS Models

3. Engine Control System Diagram



*: for Automatic Transaxle Models.

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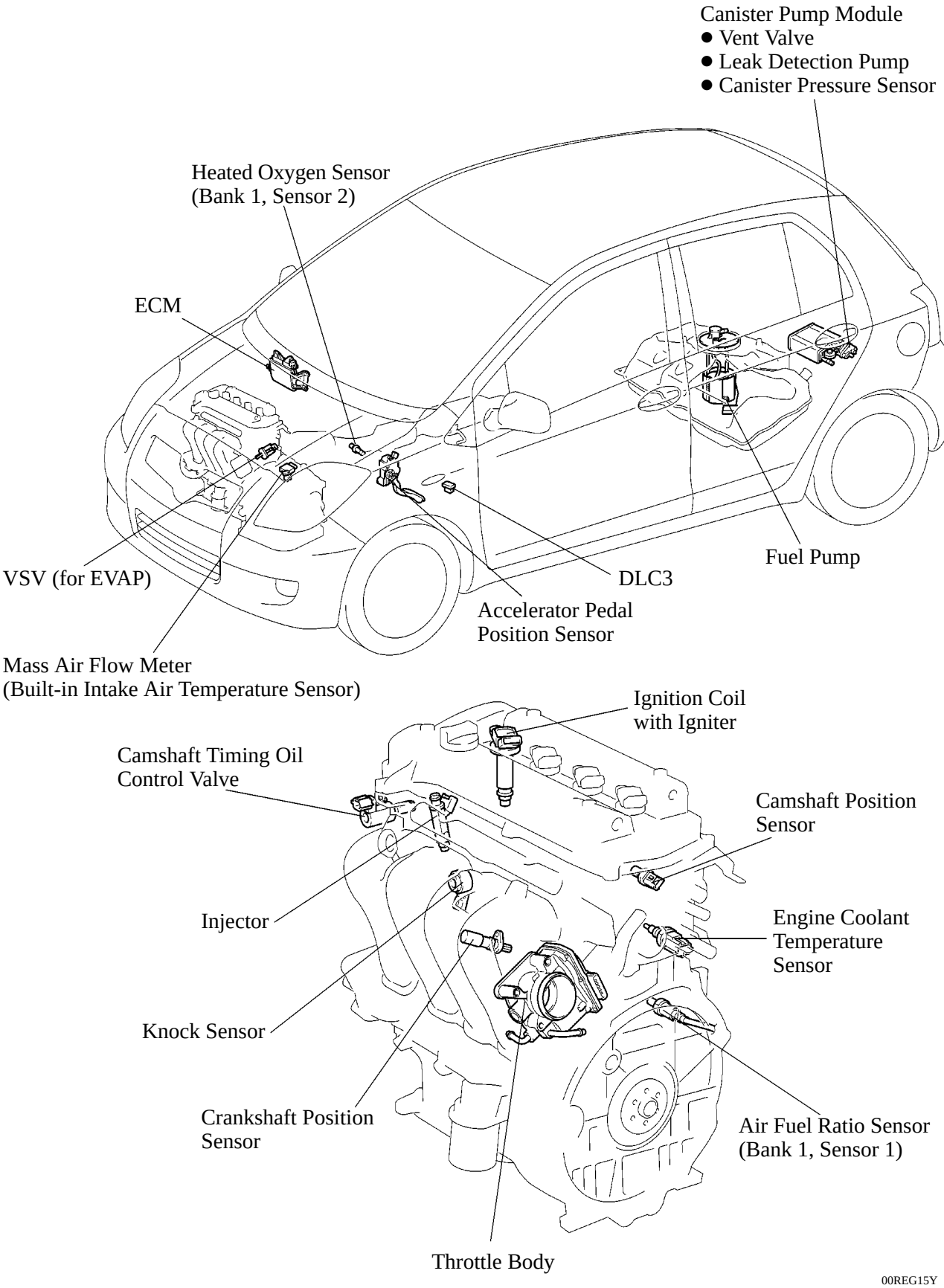
4. Layout of Main Components



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5. Main components of Engine Control System

General

The main components of the 1NZ-FE engine control system are as follows:

Components	Outline	Quantity	Function
ECM	32-bit CPU	1	The ECM optimally controls the SFI, ESA, and IAC to suit the operating conditions of the engine in accordance with the signals provided by the sensors.
Air Fuel Ratio Sensor (Bank 1, Sensor 1)	Planar Type with Heater	1	As with the heated oxygen sensor, this sensor detects the oxygen concentration in the exhaust emission. However, it detects the oxygen concentration in the exhaust emission linearly.
Heated Oxygen Sensor (Bank 1, Sensor 2)	Cup Type with Heater	1	This sensor detects the oxygen concentration in the exhaust emission by measuring the electromotive force which is generated in the sensor itself.
Mass Air Flow Meter	Hot-wire Type	1	This sensor has a built-in hot-wire to directly detect the intake air mass.
Crankshaft Position Sensor (Rotor Teeth)	Pickup Coil Type (36-2)	1	This sensor detects the engine speed and performs the cylinder identification.
Camshaft Position Sensor (Rotor Teeth)	Pickup Coil Type (3)	1	This sensor performs the cylinder identification.
Engine Coolant Temperature Sensor	Thermistor Type	1	This sensor detects the engine coolant temperature by means of an internal thermistor.
Intake Air Temperature Sensor	Thermistor Type	1	This sensor detects the intake air temperature by means of an internal thermistor.
Knock Sensor	Non-resonant Flat Type	1	This sensor detects an occurrence of the engine knocking indirectly from the vibration of the cylinder block caused by the occurrence of engine knocking.
Throttle Position Sensor	Non-contact Type	1	This sensor detects the throttle valve opening angle.
Accelerator Pedal Position Sensor	Non-contact Type	1	This sensor detects the amount of pedal effort applied to the accelerator pedal.
Injector	12-Hole Type	4	The injector is an electromagnetically-operated nozzle which injects fuel in accordance with signals from the ECM.

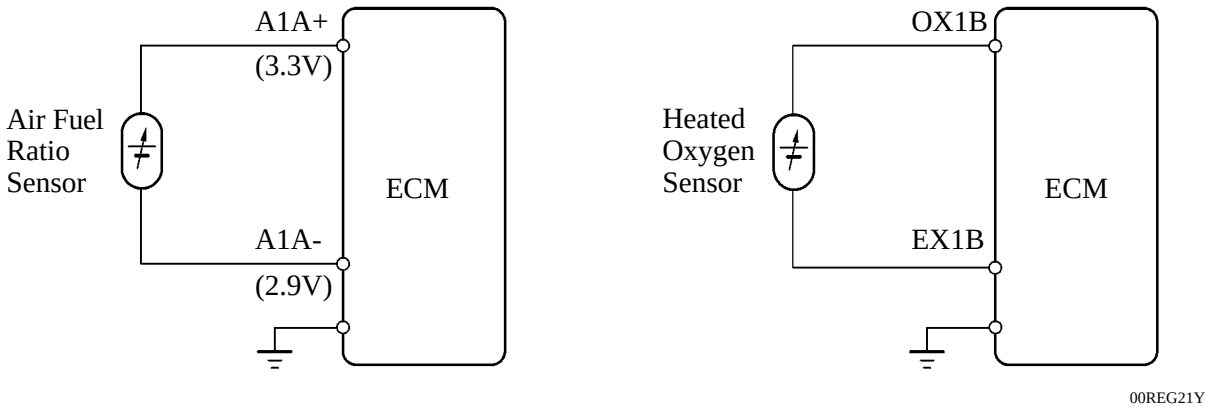
ECM

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

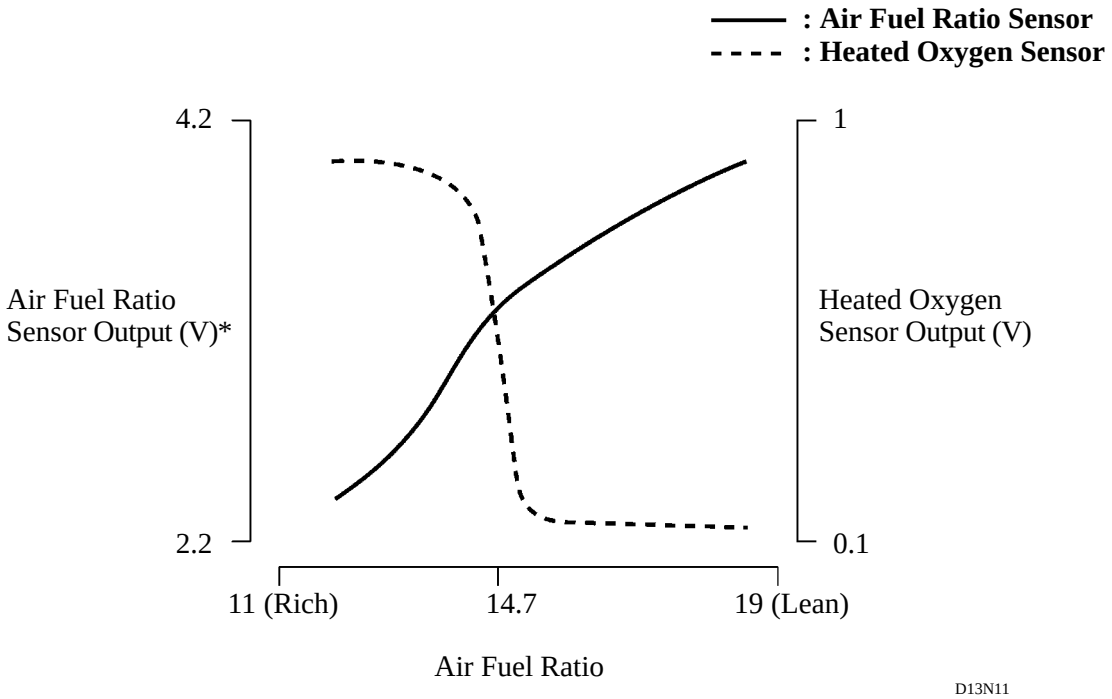
Air Fuel Ratio Sensor and Heated Oxygen Sensor

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 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.



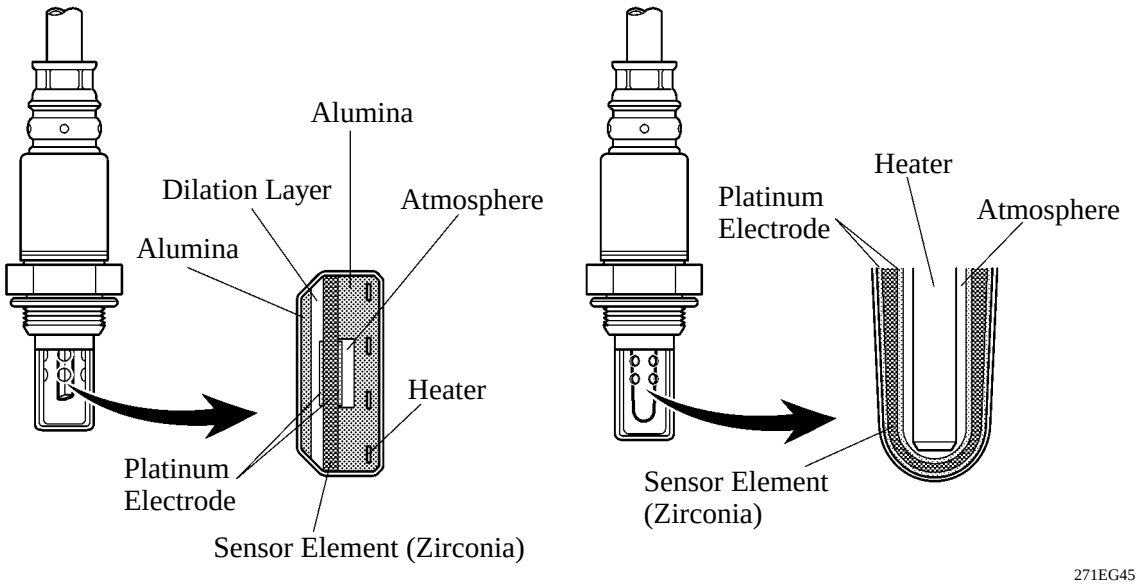
Air Fuel Ratio Sensor Circuit **Heated Oxygen Sensor Circuit**



*: This calculation value is used internally in the ECM, and is not an ECM terminal voltage.

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 planer 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.



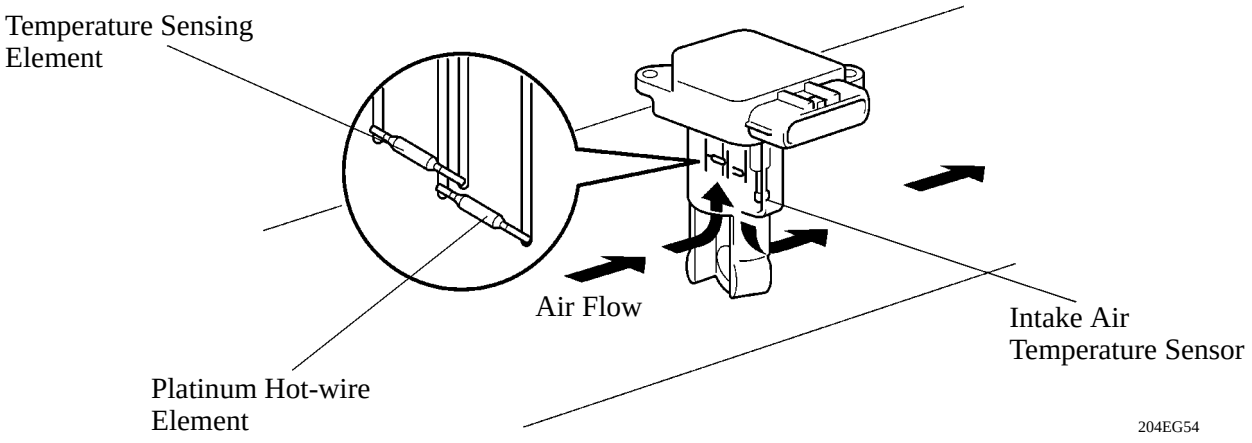
Planer Type Air Fuel Ratio Sensor **Cup Type Heated Oxygen Sensor**

▶ Warm-up Specification ◀

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

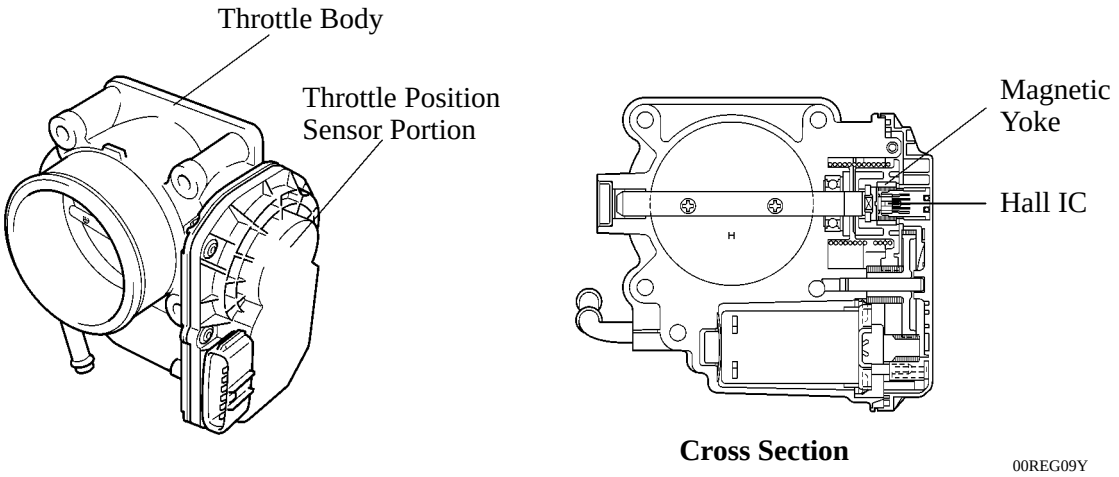
Mass Air Flow Meter

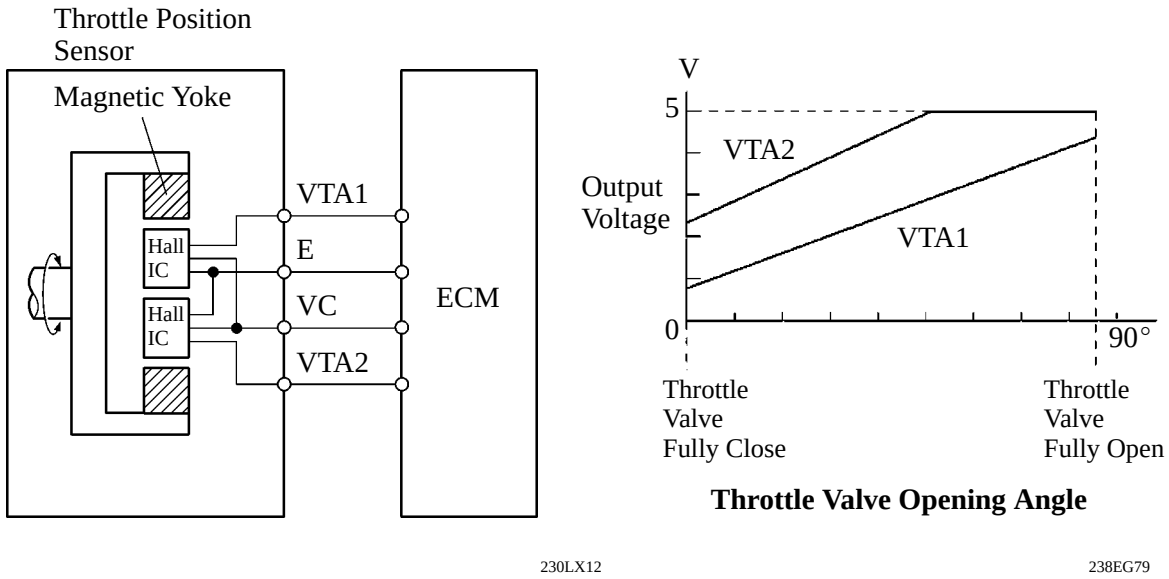
- The compact and lightweight mass air flow meter, which is a plug-in type, allows a portion of the intake air to flow through the detection area. By directly measuring the mass and the flow rate of the intake air, the detection precision is ensured and the intake air resistance is reduced.
- This mass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



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.





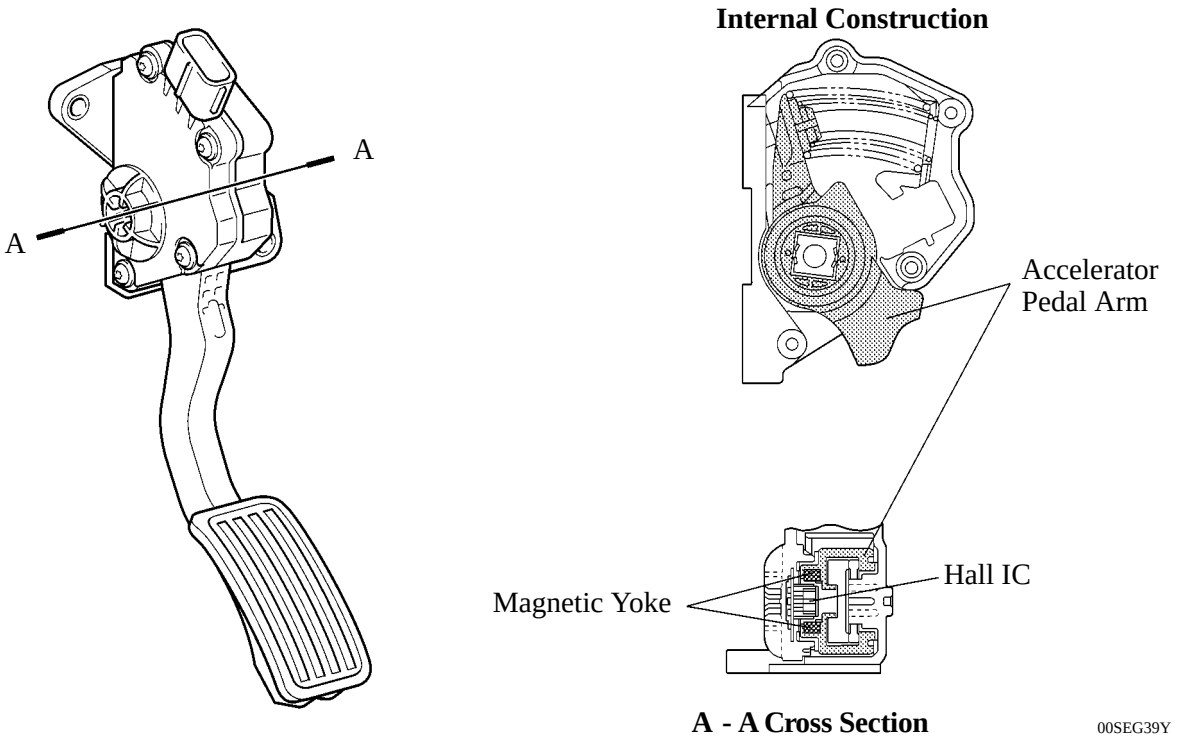
Service Tip

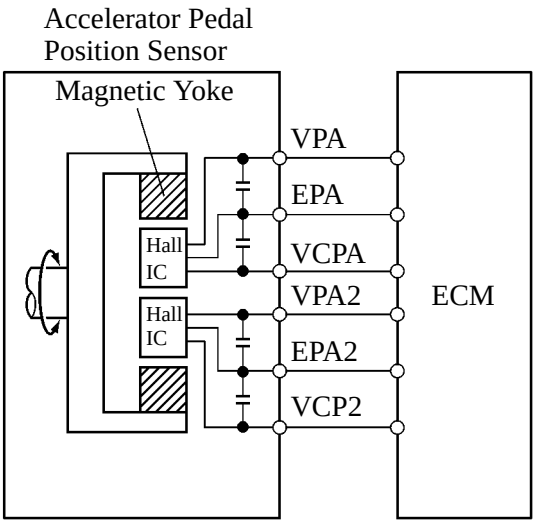
The inspection method differs from the conventional contact type throttle position sensor because this non-contact type sensor uses a Hall IC.
For details, refer to the 2006 Yaris Repair Manual (Pub. No. RM00R0U).

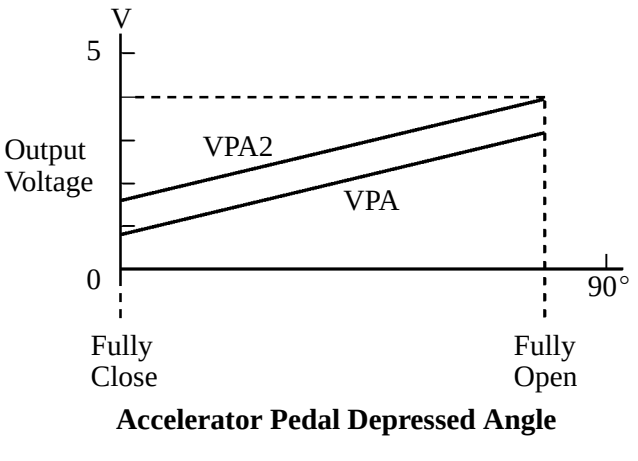
Accelerator Pedal Position Sensor

The non-contact type accelerator pedal position sensor used 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 that occur at that time into electrical signals, and outputs them as of accelerator pedal effort to the ECM.
- The Hall IC contains circuits for the main and sub signals. It converts the accelerator pedal depressing angles into electric signals with two differing characteristics and outputs them to the ECM.







Service Tip

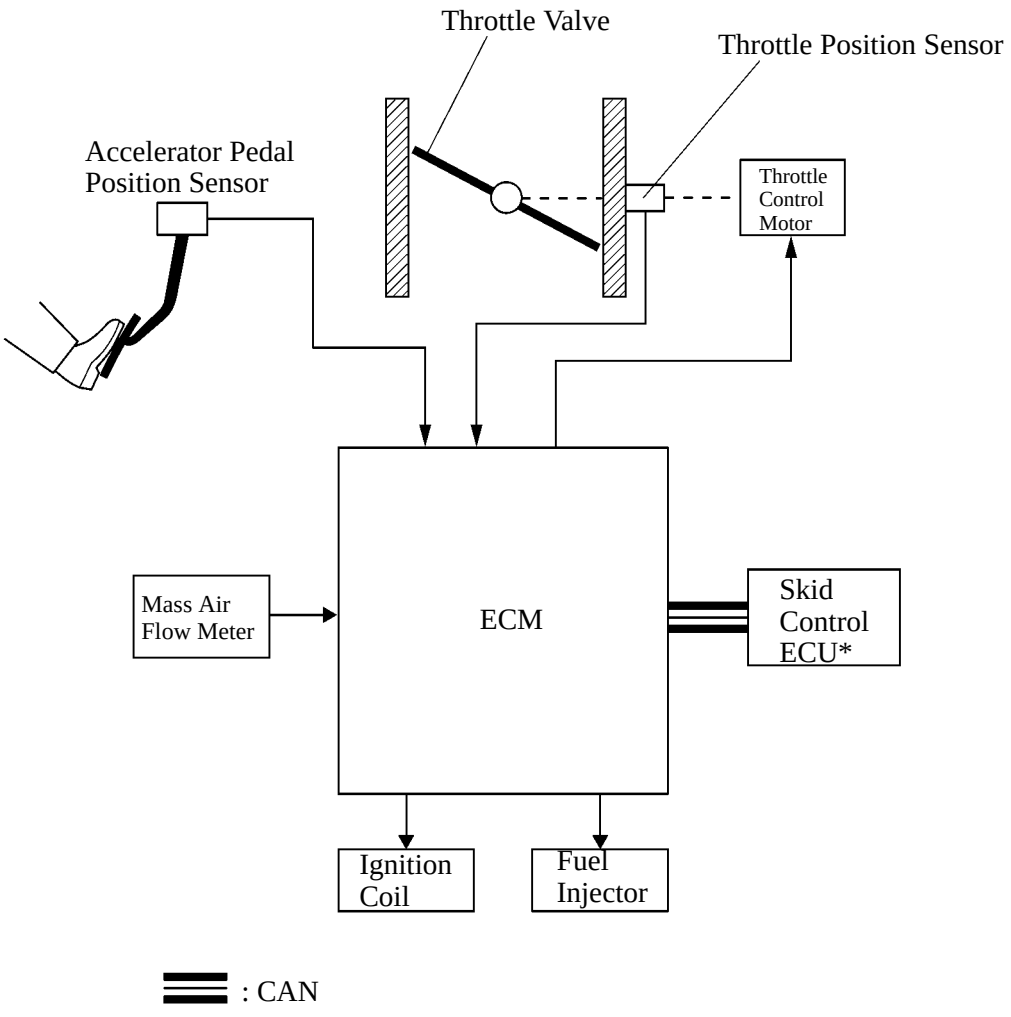
The inspection method differs from the conventional contact type accelerator pedal position sensor because this non-contact type sensor uses a Hall IC.
For details, refer to the 2006 Yaris Repair Manual (Pub. No. RM00R0U).

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

General

- The ETCS-i is used, providing excellent throttle control in all the operating ranges.
- 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 invariably 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 and cruise control system.
- In case of an abnormal condition, this system switches to the limp mode.

▶ System Diagram ◀



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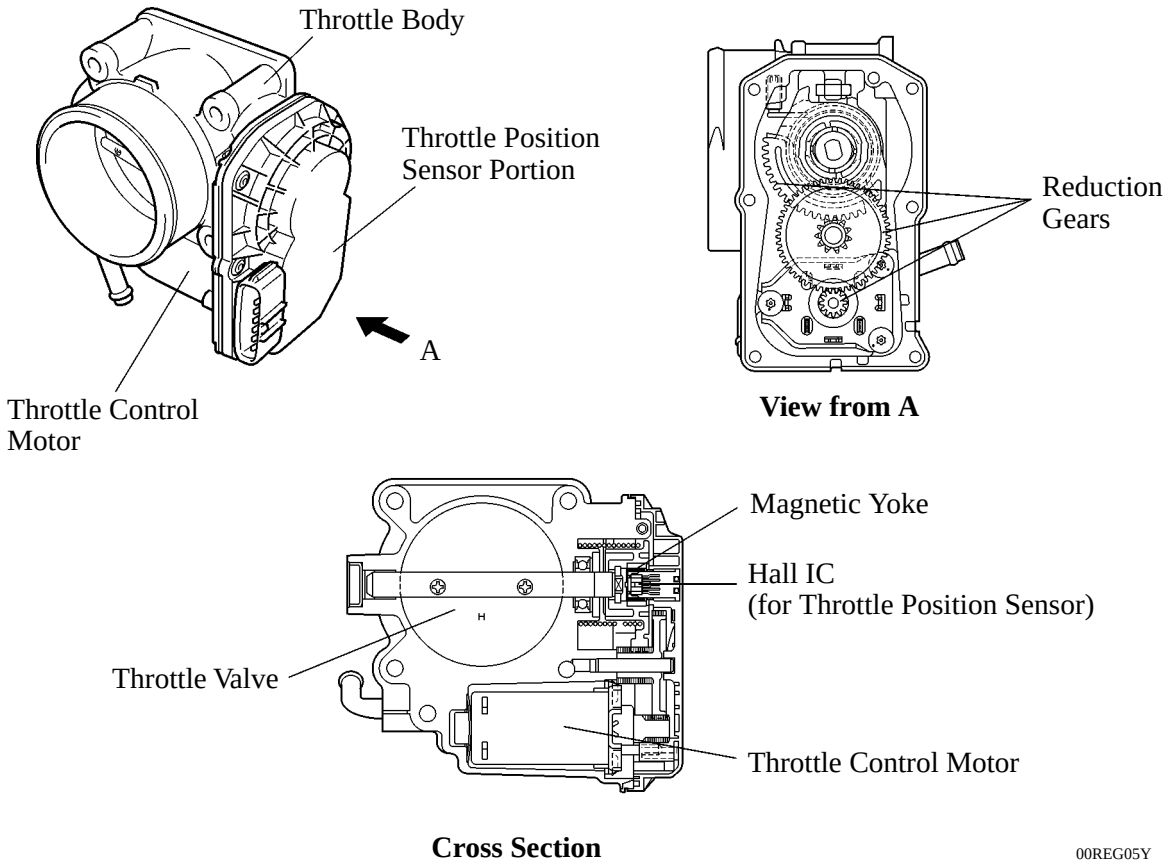
*: for ABS Models

Construction



1) Throttle Position Sensor

The throttle position sensor is mounted on the throttle body to detect the opening angle of the throttle valve. For details, refer to Main Components of Engine Control System section on page EG-34.

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

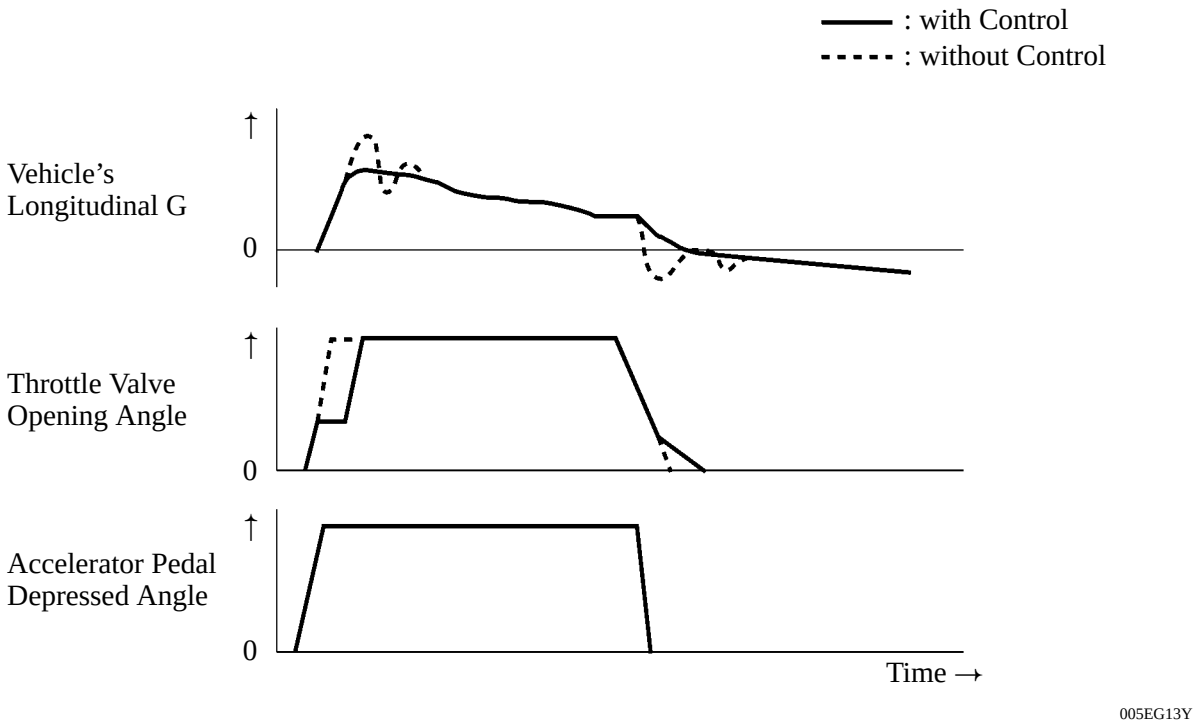
The ECM drives the throttle control motor by determining the target throttle valve opening in accordance with the respective operating condition.

- Non-Linear Control
- Idle Air Control

2) 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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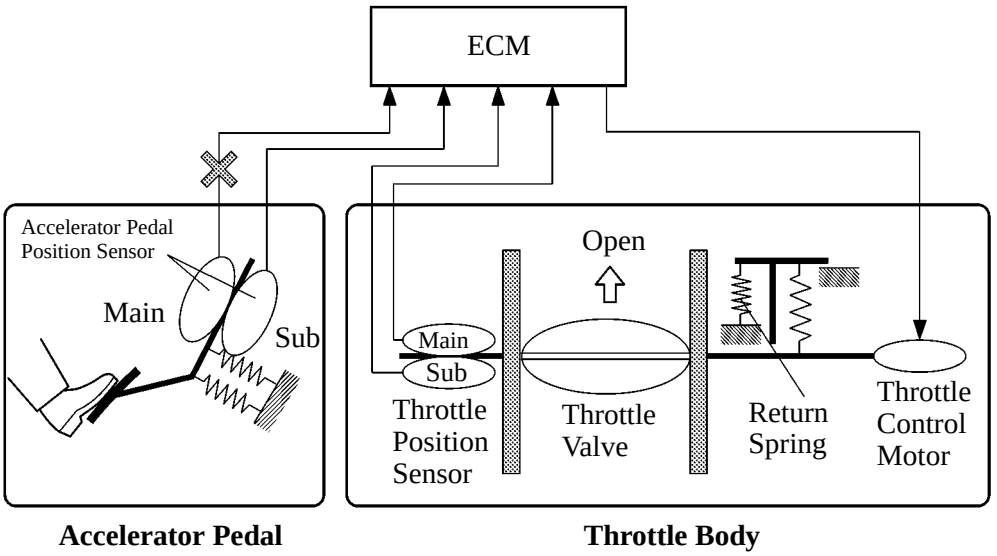
3) Idle Air Control

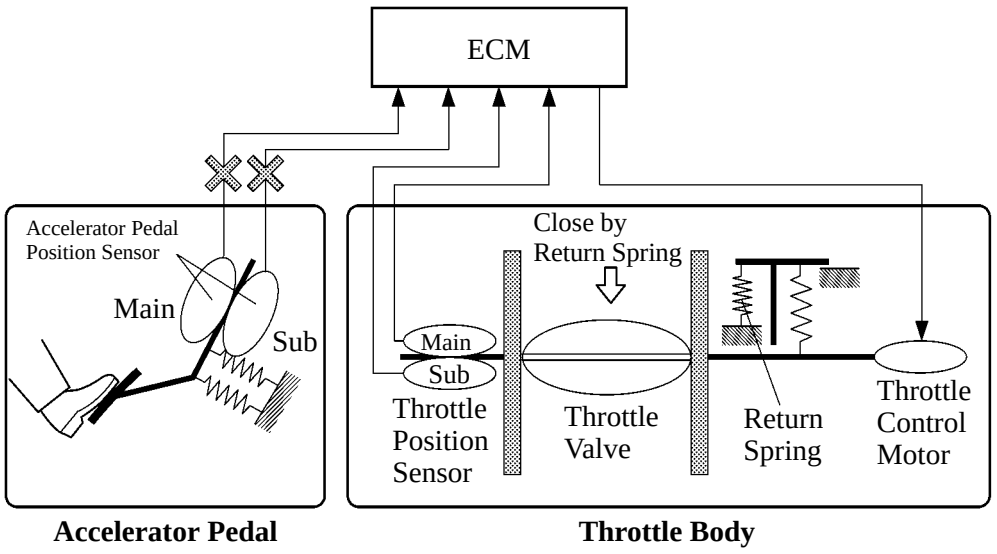
The ECM controls the throttle valve in order to constantly maintain an ideal idle speed.

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 limp mode control.

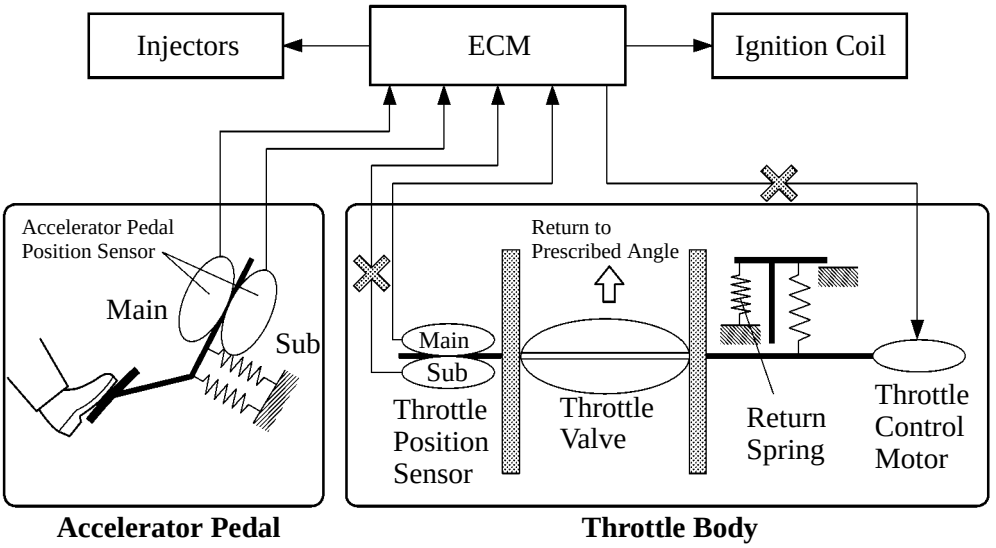


- If both circuits have malfunctions, the ECM detects the abnormal signal voltage from these two sensor circuits and discontinues the throttle control. At this time, the vehicle can be driven within its idling range.



Fail-Safe of Throttle Position Sensor

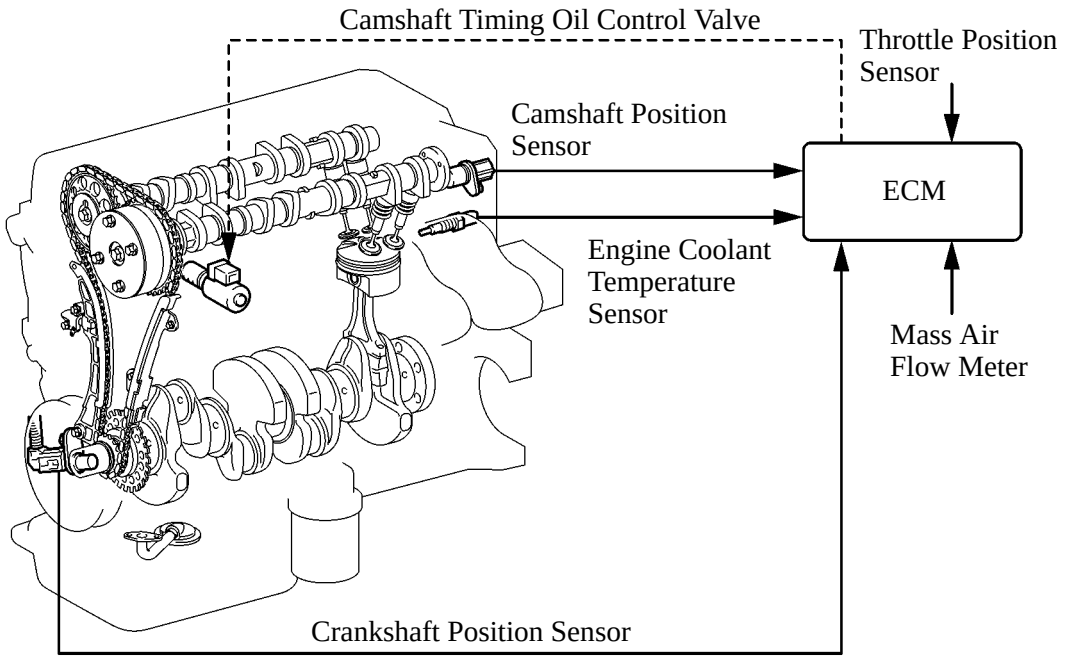
- The throttle position sensor is comprised of two (main, sub) sensor circuits. If a malfunction occurs in either one or both of the sensor circuits, the ECM detects the abnormal signal voltage difference between these two sensor circuits, cuts off the current to the throttle control motor, and switches 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.



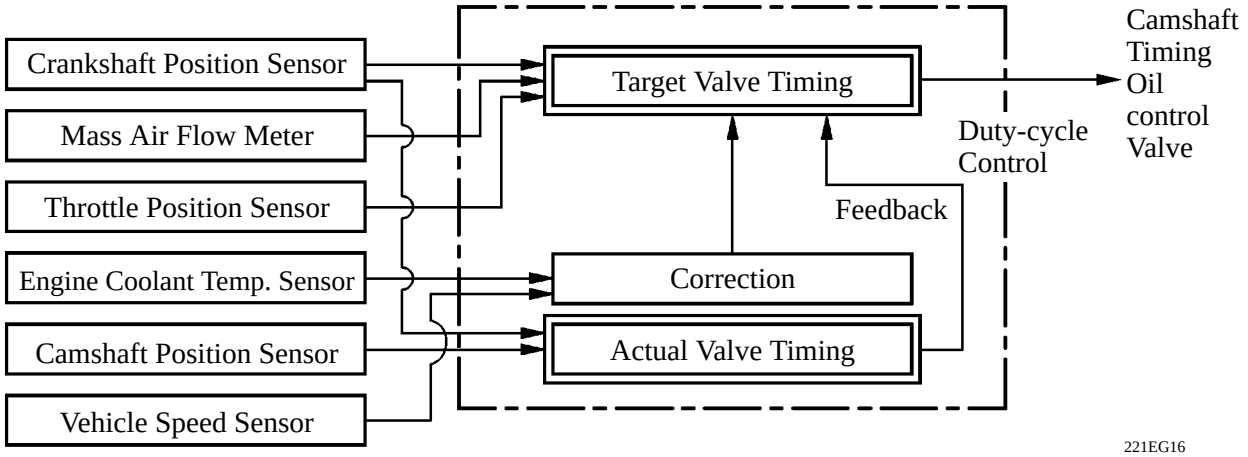
7. VVT-i (Variable Valve Timing-intelligent) System

General

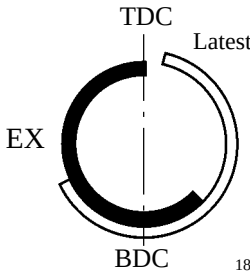
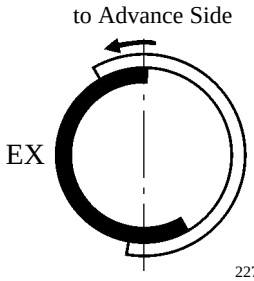
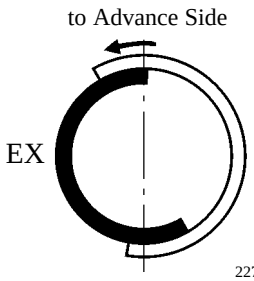
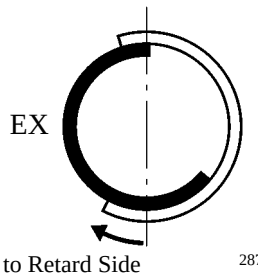
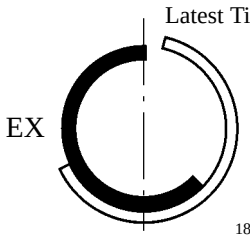
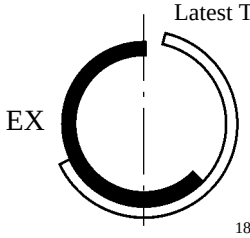
- The VVT-i system is designed to control the intake camshaft within a range of 40° (of Crankshaft Angle) to provide valve timing that is optimally suited to the engine condition. This realizes proper torque in all the speed ranges as well as realizing excellent fuel economy, and reducing exhaust emissions.



- Using the engine speed signal, vehicle speed signal, and the signals from mass air flow meter, throttle position sensor and water temperature sensor, the engine ECU can calculate optimal valve timing for each driving condition and controls the camshaft timing oil control valve. In addition, the engine ECU 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.



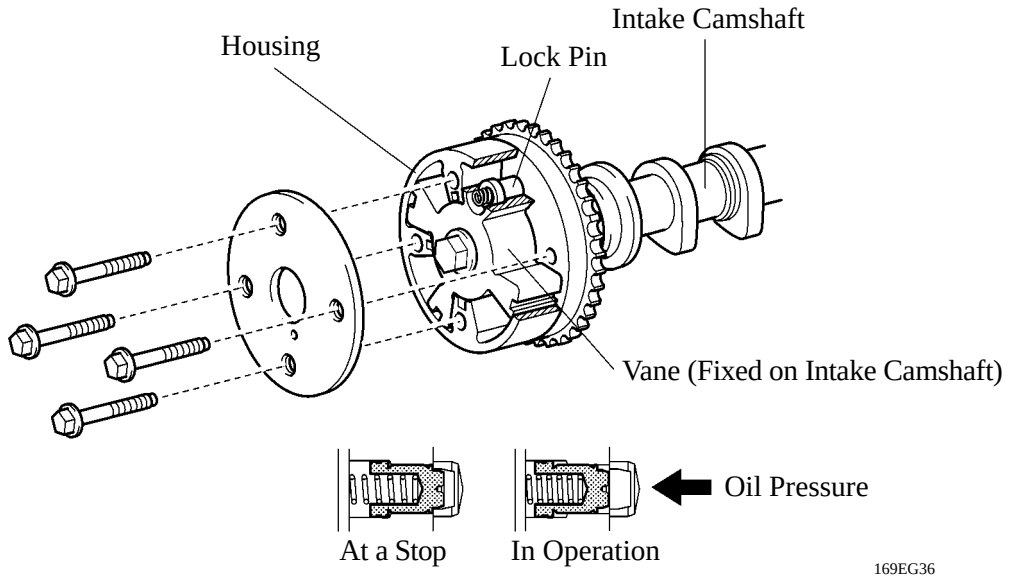
Effectiveness of the VVT-i System

Operation State	Objective	Effect
● During Idling ● At Light Load	 Eliminating overlap to reduce blow back to the intake side	● Stabilized idling rpm ● Better fuel economy
At medium Load	 Increasing overlap to increase internal EGR to reduce 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 Low Temperature	 Eliminating overlap to prevent blow back 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	 Eliminating overlap to reduce blow back to the intake side	Improved startability

Construction

1) VVT-i Controller

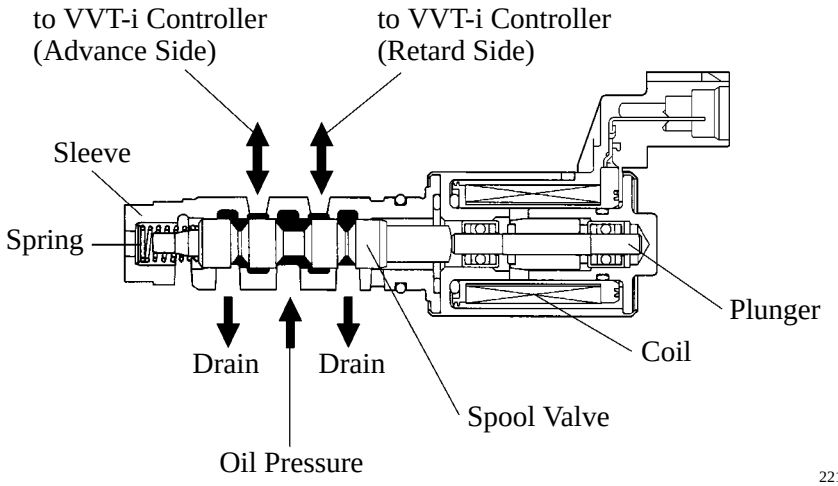
This controller consists of the housing driven from the timing chain and the vane coupled with the intake camshaft.
The oil pressure sent from the advance or retard side path at the intake camshaft causes rotation in the VVT-i controller vane circumferential direction to vary the intake valve timing 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

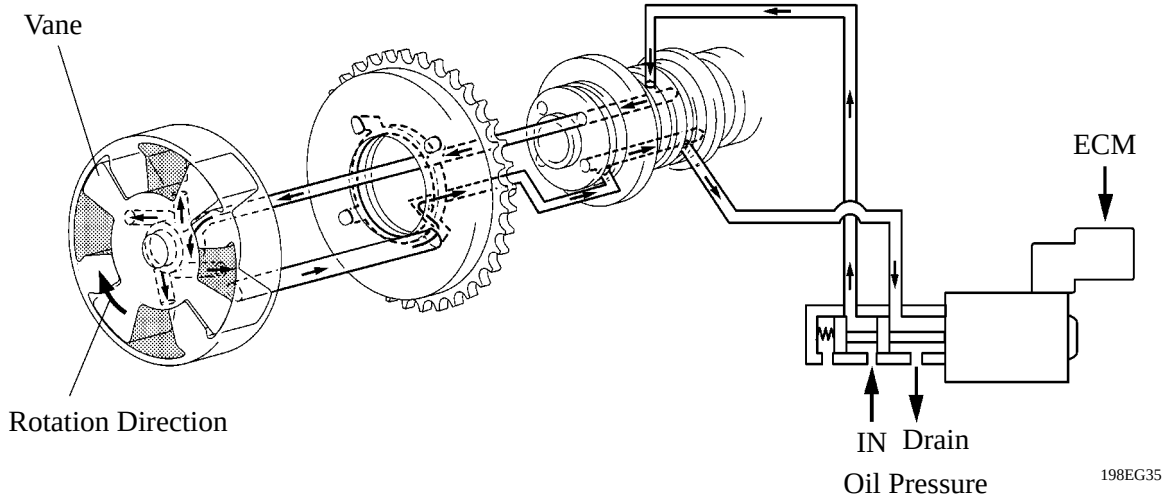
This camshaft timing oil control valve controls the spool valve position in accordance with the duty-cycle control from the ECM. This allows hydraulic pressure to be applied to the VVT-i controller advance or retard side. When the engine is stopped, the camshaft timing oil control valve is in the most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



Operation

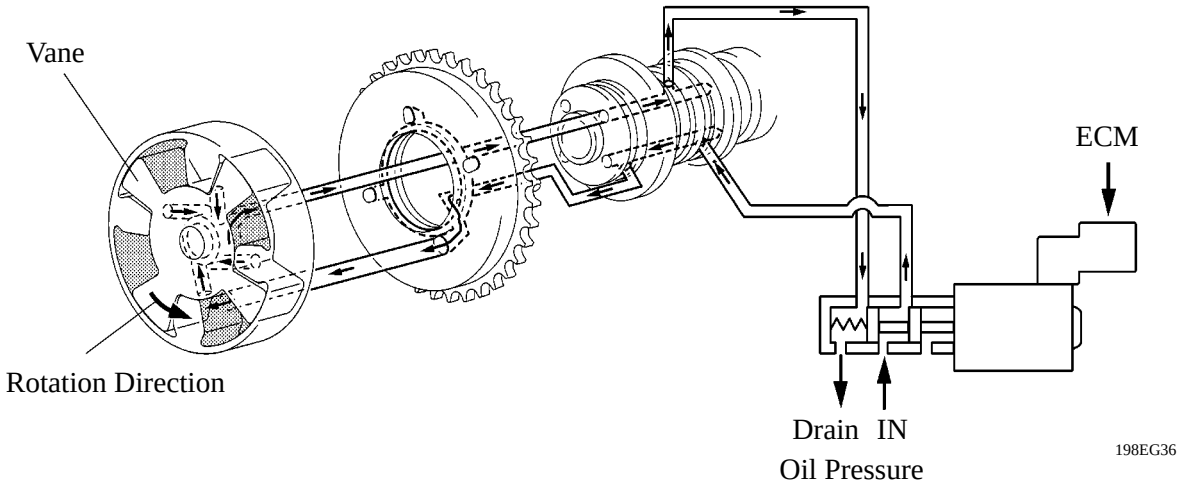
1) Advance

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 timing advance side vane chamber to rotate the camshaft in the timing 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 timing retard side vane chamber to rotate the camshaft in the timing retard direction.

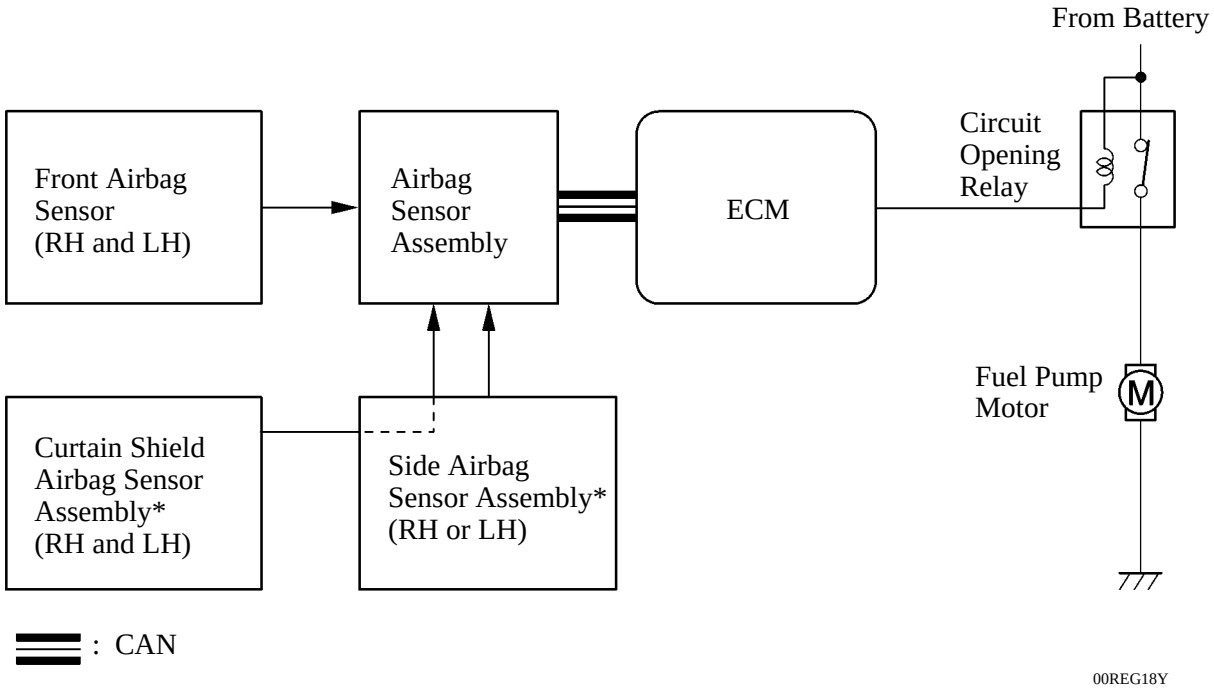


3) Hold

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. Fuel Pump Control

A fuel cut control is used to stop the fuel pump when the SRS airbag is deployed at the front, side or rear side collision.
In this system, the airbag deployment signal from the airbag assembly is detected by the ECM, and it 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, thus can be restarted.



*: Option Equipment

9. Evaporative Emission Control System

General

The 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 Codes) in the event of a malfunction. An 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 evaporative emission 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)

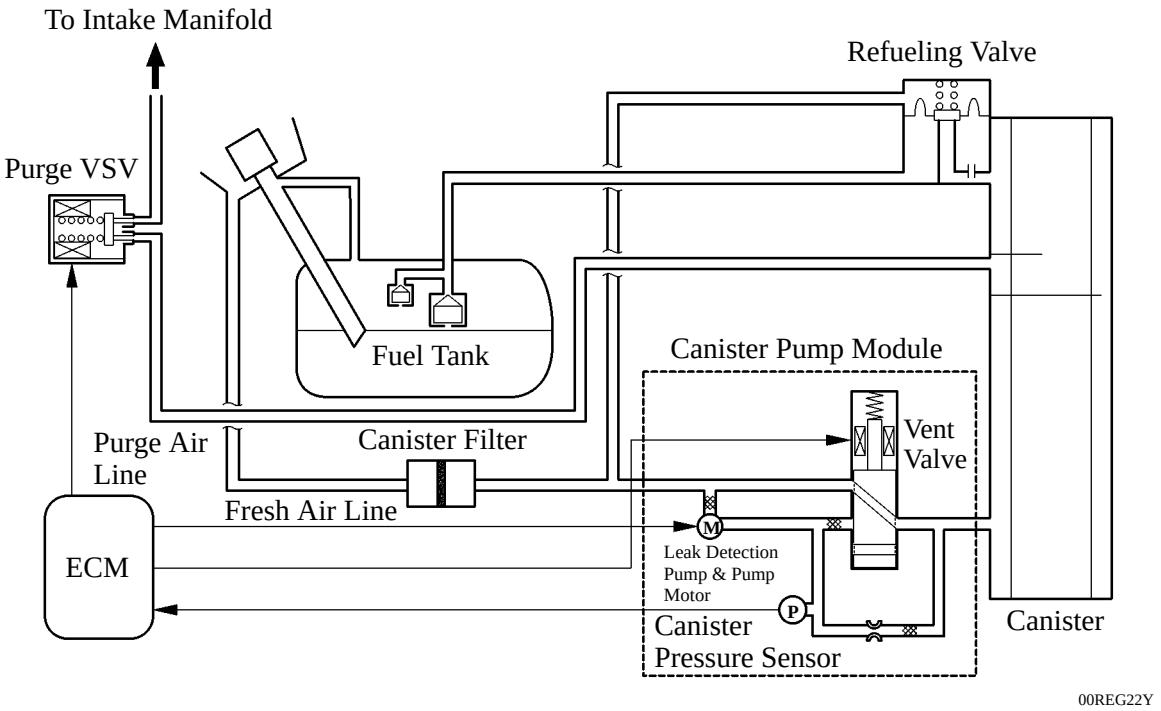
*: If engine coolant temperature does not drop below 35°C (95°F), this time should be extended to 7 hours. Even after that, if the temperature is not less than 35°C (95°F), the time should be extended to 9.5 hours.

Service Tip

The canister pump module performs fuel evaporative emission leakage 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, see the 2006 Yaris Repair Manual (Pub. No. RM00R0U).

System Diagram



Function of Main Components

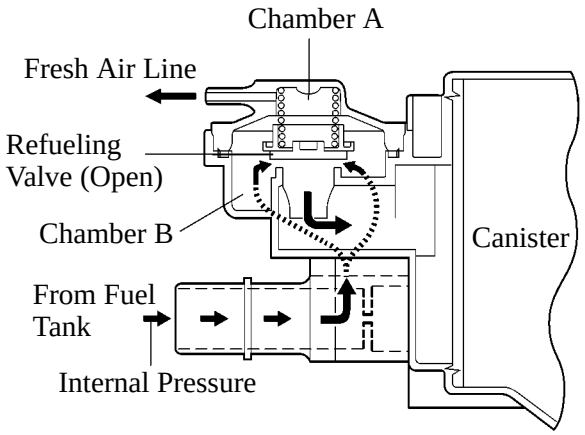
Component		Function
Canister		Contains activated charcoal to absorb the vapor gas that is created in the fuel tank.
Refueling Valve		Controls the flow rate of the vapor gas from the fuel tank to the canister when the system is purging or during refueling.
	Restrictor Passage	Prevents a large amount of 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 evaporative emission system in accordance with the signals from the ECM.
	Canister Pressure Sensor	Detects the pressure in the evaporative emission 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 chamber A, chamber B, and the restrictor passage. A constant atmospheric pressure is applied to chamber A.

- During refueling, the internal pressure of the fuel tank increases. This pressure causes the refueling valve to lift up, allowing the fuel vapors 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

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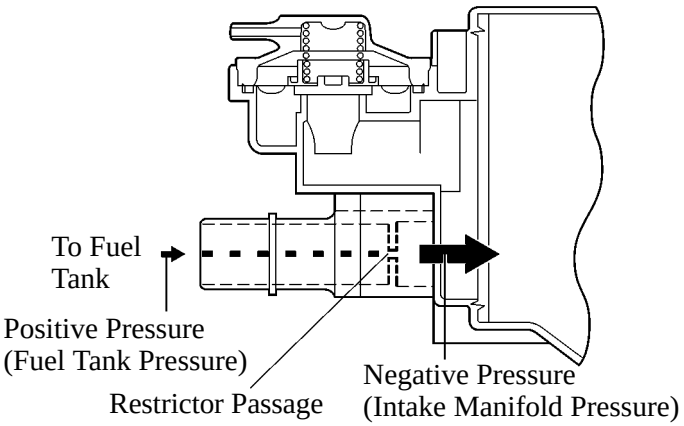
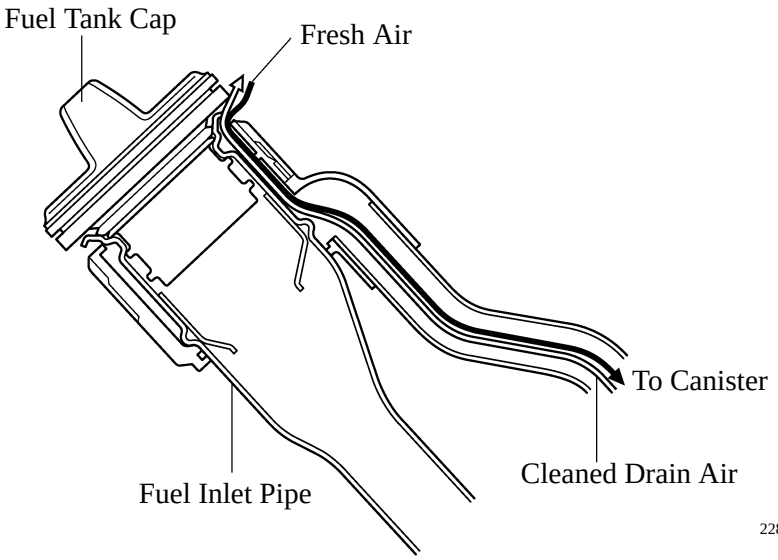


During Purge Operation or System Monitoring Operation

D13N07

2) Fuel Inlet (Fresh Air Line)

In accordance with the change of structure of the evaporative emission 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.

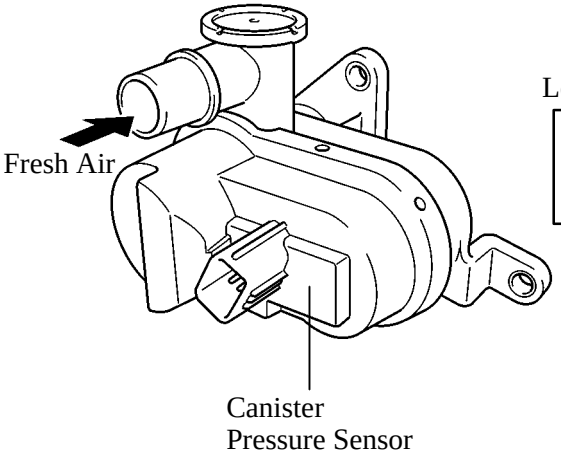


228TU119

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 brush less motor is used for the pump motor.
- A vane type vacuum pump is used.



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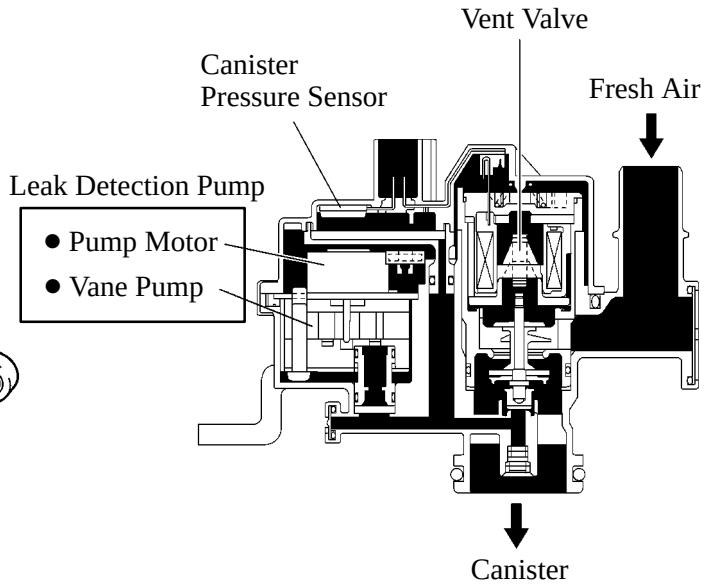
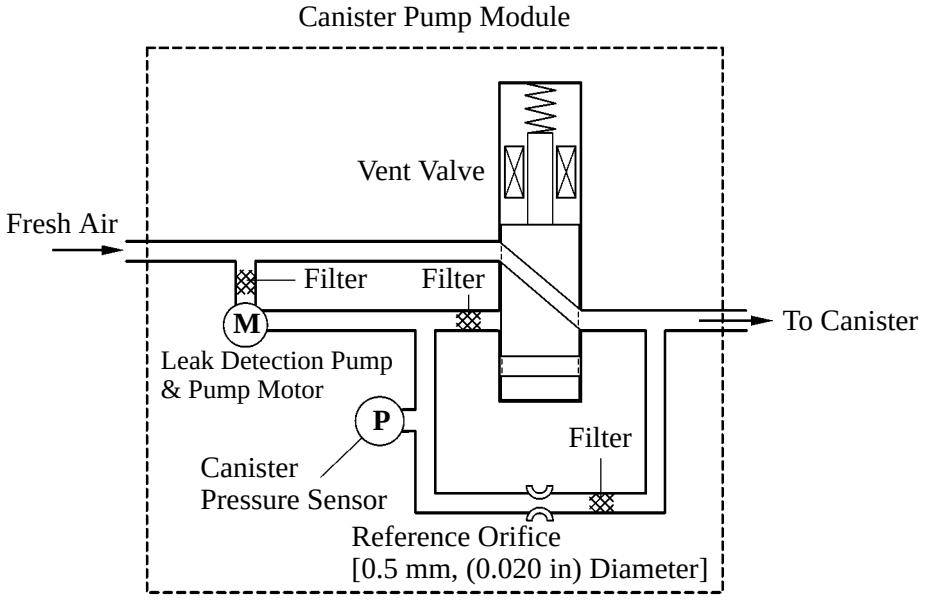


279EG26

▶ Simple Diagram ◀



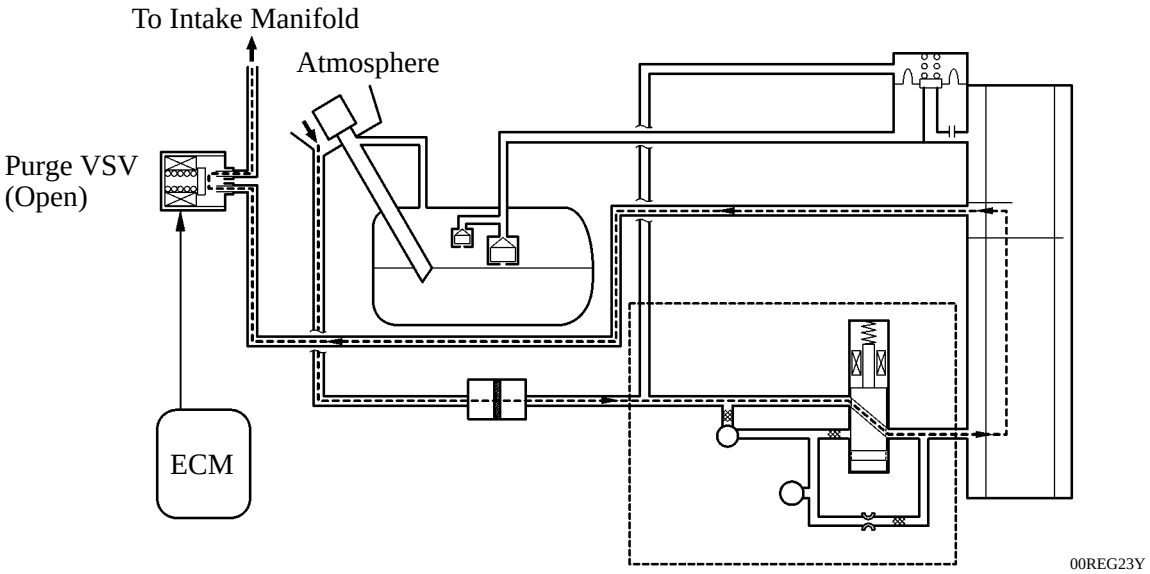
D13N17

System Operation

1) Purge Flow Control

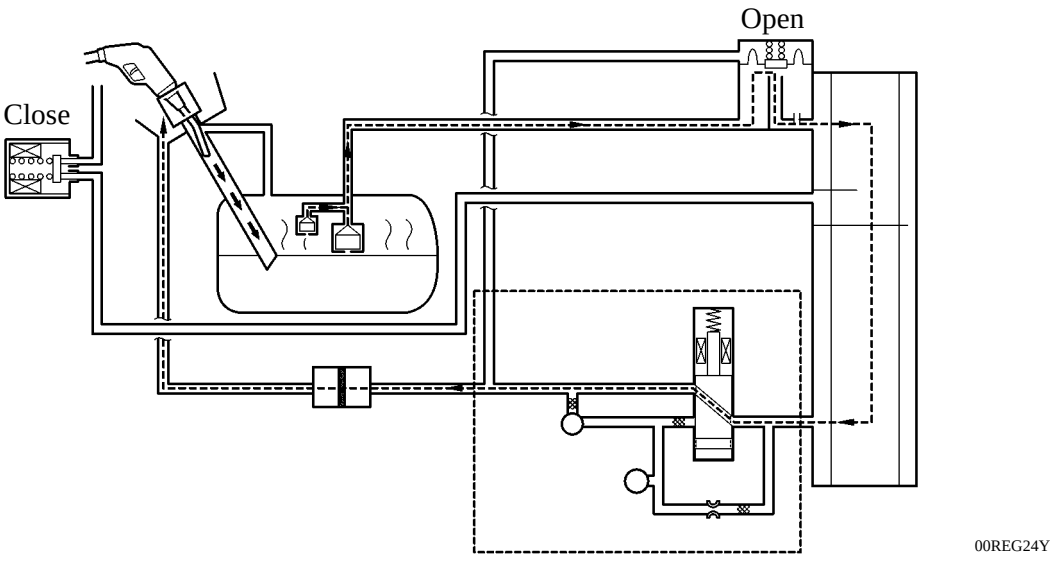
When the engine has reached predetermined parameters (closed loop, engine coolant temperature above 74°C (165°F), etc.), stored fuel vapors are purged from the canister whenever the purge VSV is opened by the ECM.

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.



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 fuel vapors 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.

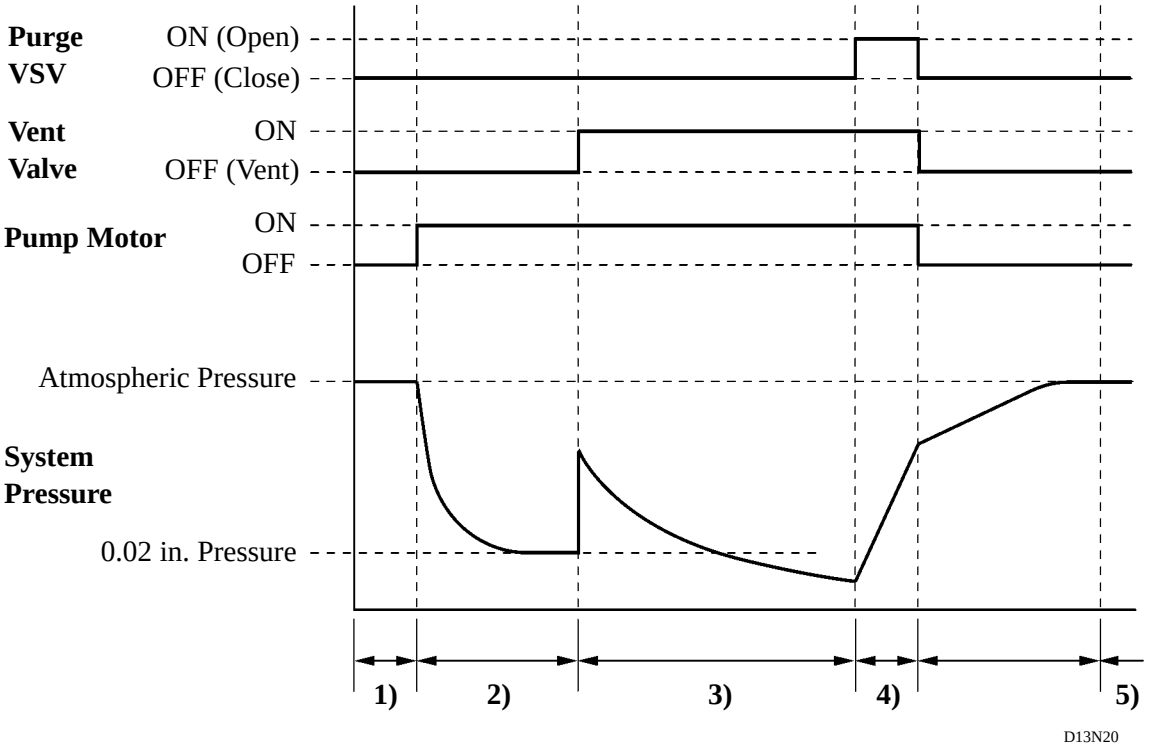


3) EVAP Leak Check

a. General

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

▶ Timing Chart ◀



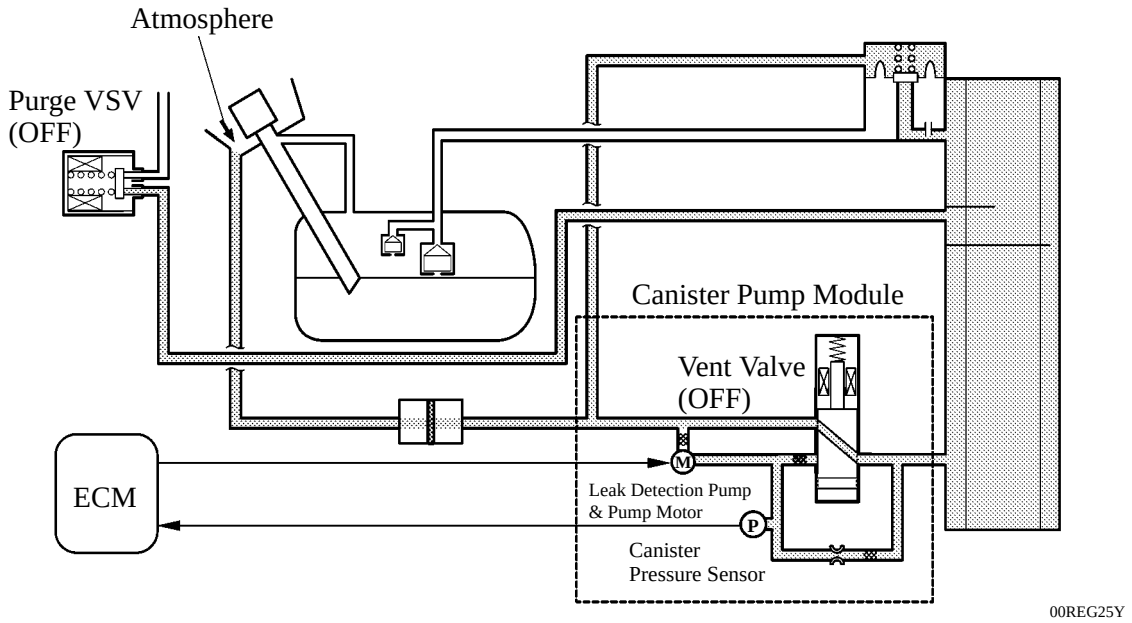
Order	Operation	Description	Time
1)	Atmospheric Pressure Measurement	ECM turns vent valve OFF (vent) and measures EVAP system pressure to memorize atmospheric pressure.	10 sec.
2)	0.02 in. Leak Pressure Measurement	Leak detection pump creates negative pressure (vacuum) through 0.02 in. orifice and the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

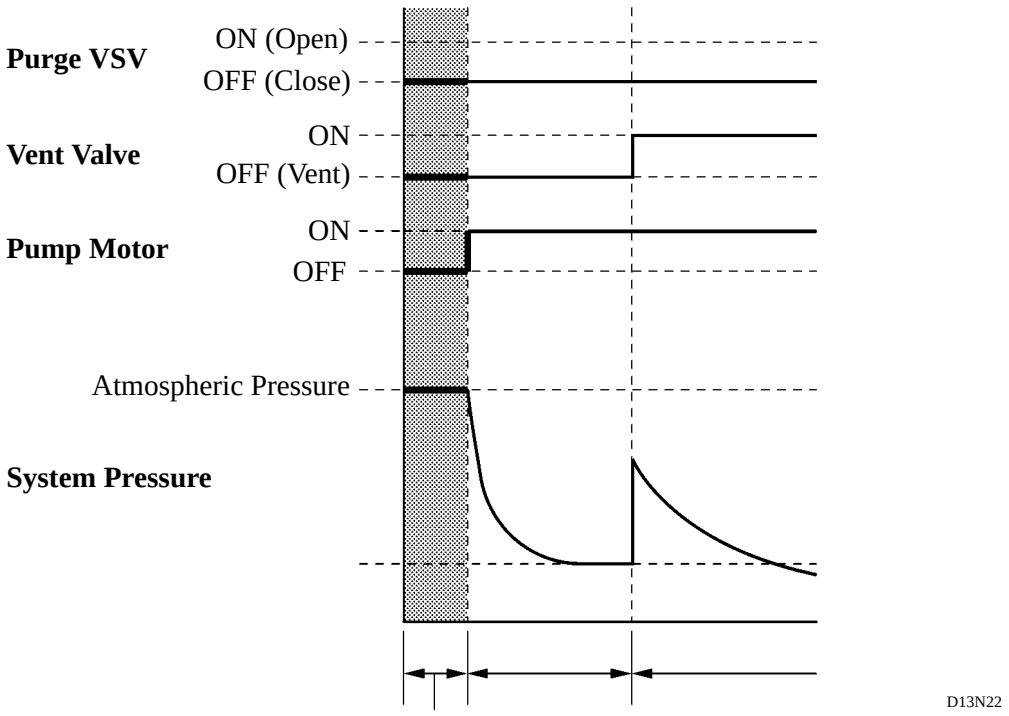
b. Atmospheric Pressure Measurement

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.

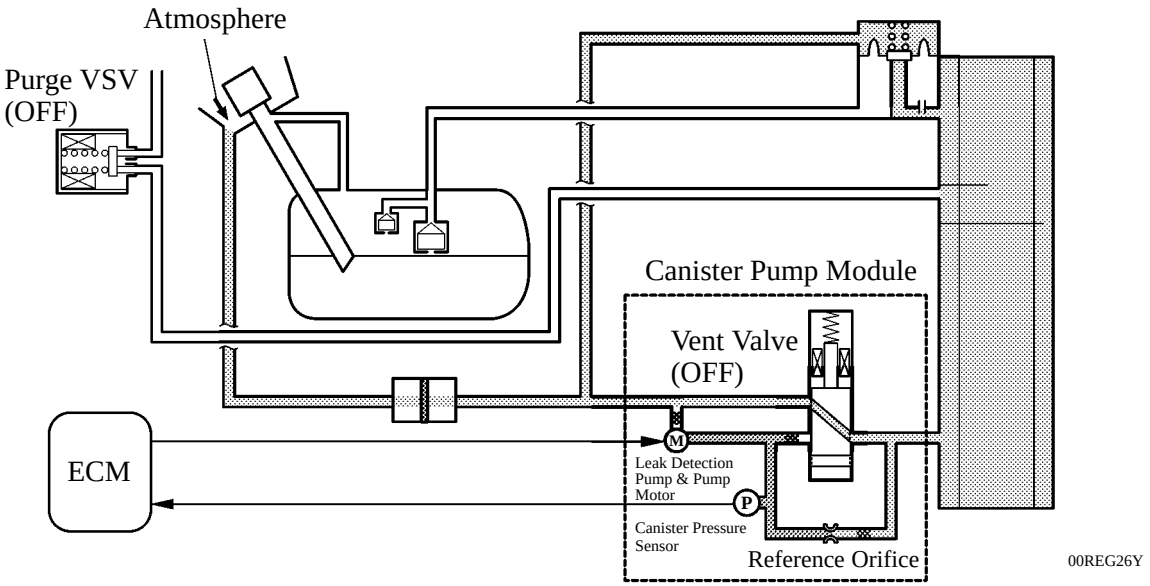


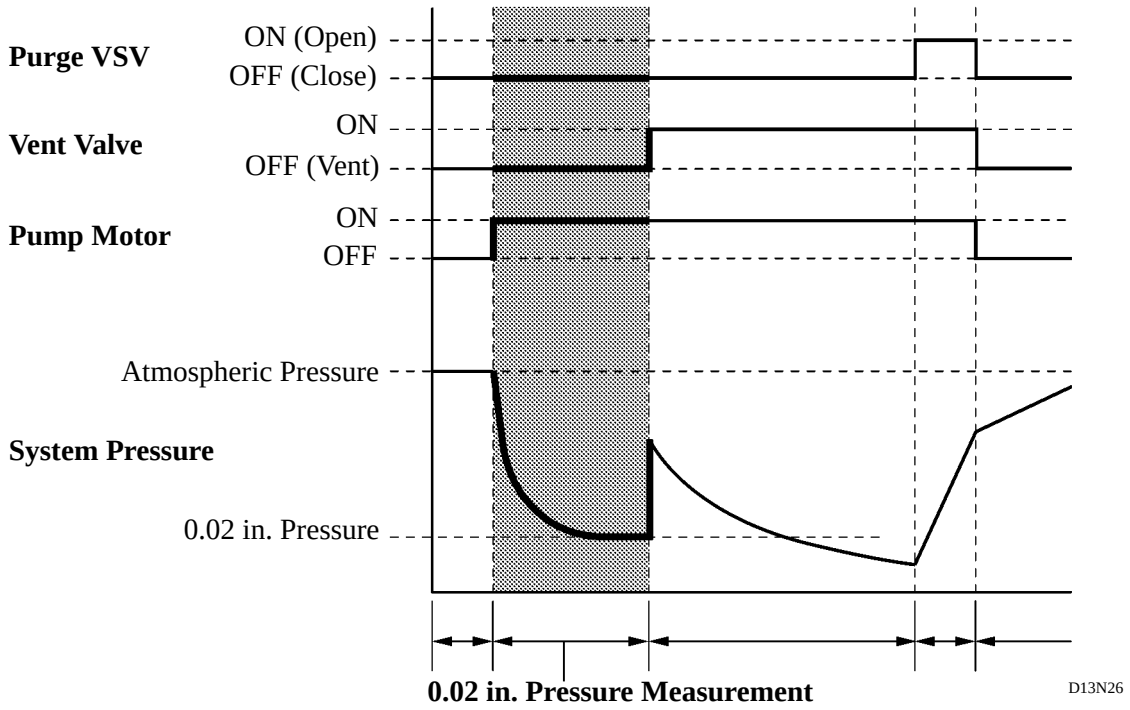


Atmospheric Pressure Measurement

c. 0.02 in. Leak Pressure Measurement

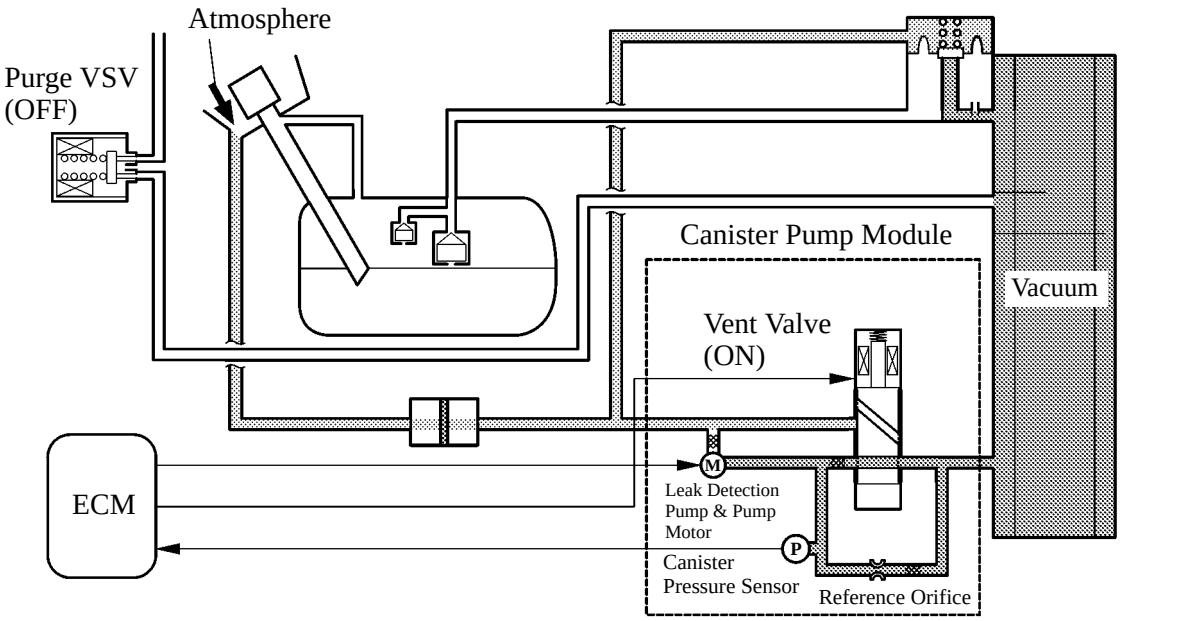
1) The vent valve remains off, and the ECM introduces atmospheric pressure into the canister and actuates the leak detection pump in order to create a negative pressure.
2) At this time, the pressure will not decrease beyond a 0.02 in. pressure due to the atmospheric pressure that enters through a 0.02 in. diameter reference orifice measuring 0.5 mm (0.02 in.).
3) The ECM compares the logic value and 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, P2402, and P2422 in its memory.





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 and the 0.02 in. pressure in order to check for a leakage.
3) If the detection value is below the 0.02 in. pressure, the ECM determines that there is no leakage.
4) If the detection value is above the 0.02 in. 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 detection value is above the 0.02 in. pressure, the ECM determines that there is a small leakage and stores DTC P0456 in its memory.



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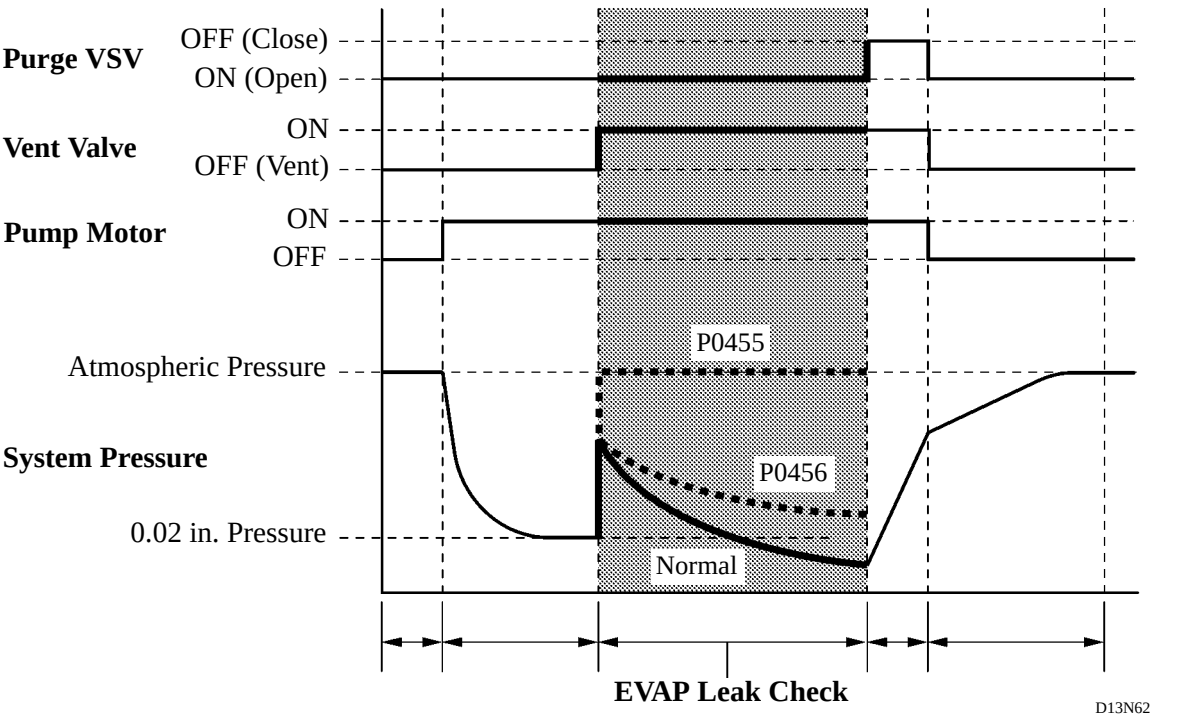


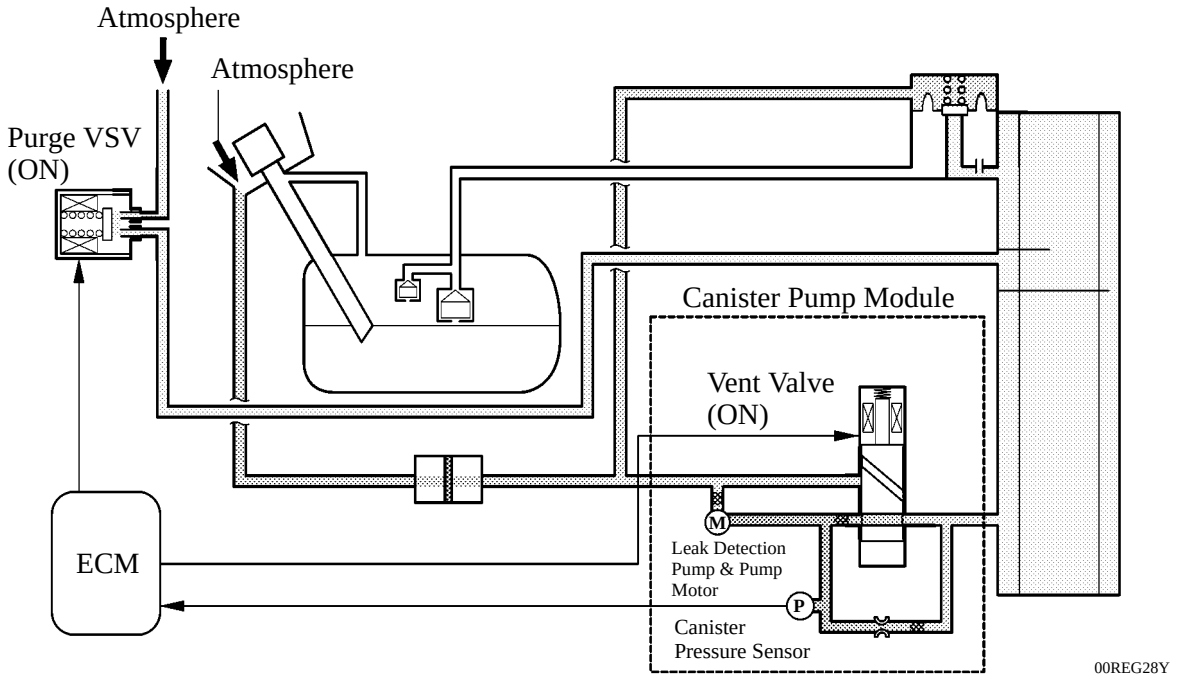
D13N62

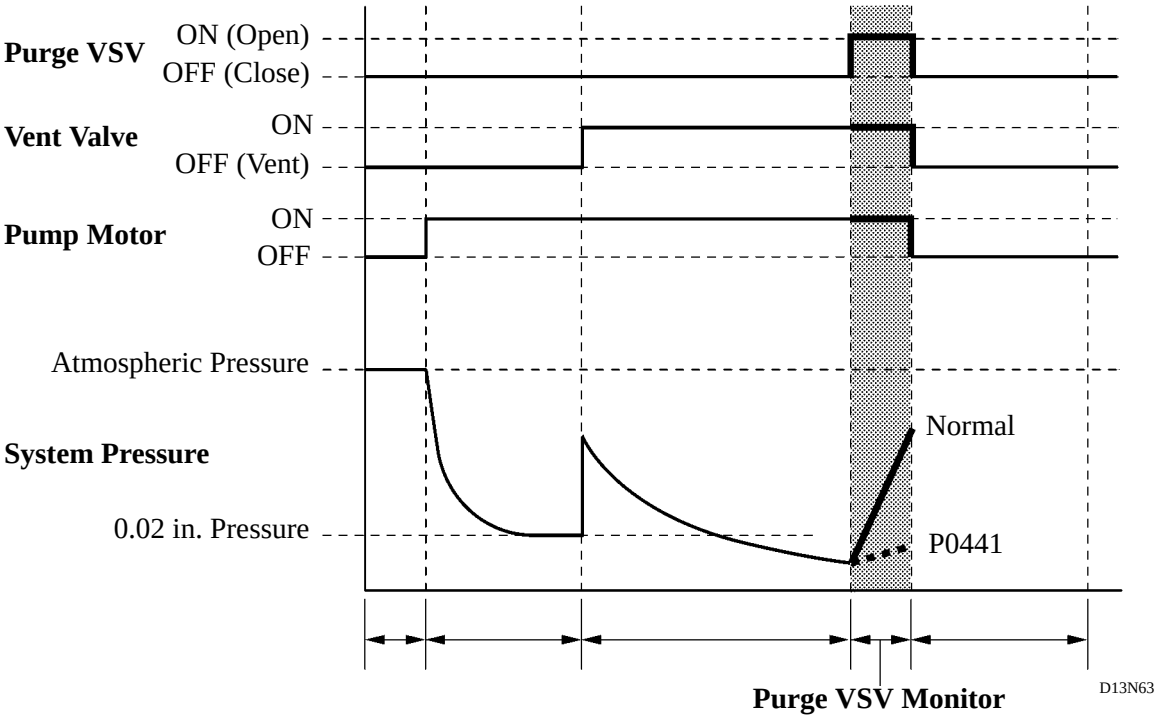
e. Purge VSV Monitor

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.

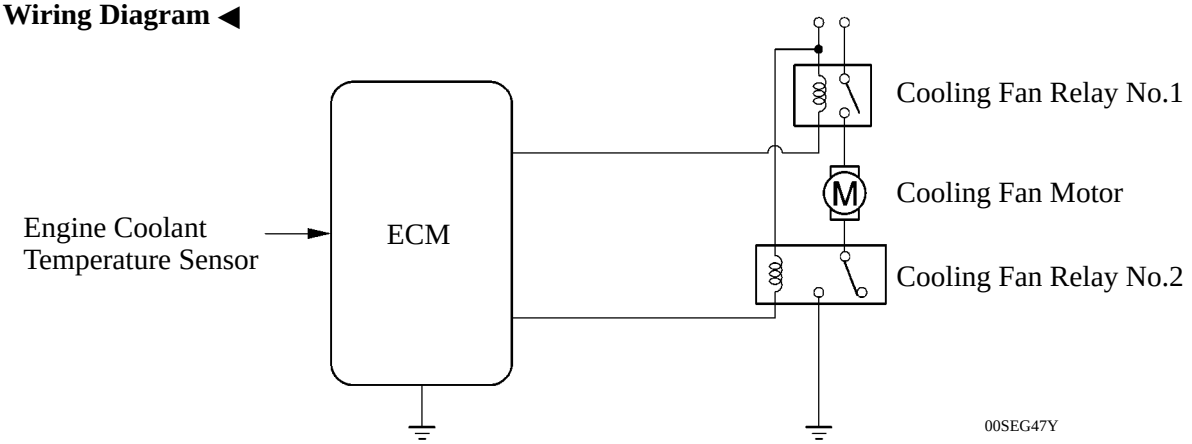




10. Cooling Fan Control

- On the models without air conditioning, the ECM controls the operation of the cooling fan based on the engine coolant temperature sensor signal.

▶ Wiring Diagram ◀

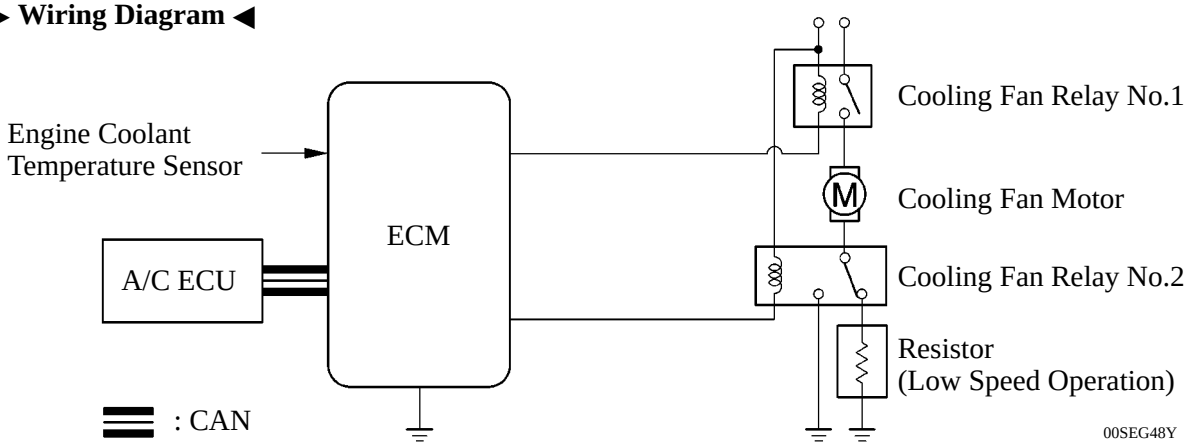


▶ Cooling Fan Operation ◀

Engine Coolant Temperature	Low	High
Cooling Fan Operation	OFF	ON

- On the models with air conditioning, the ECM controls the operation of the cooling fan in two speeds (Low and Hi) based on the engine coolant temperature sensor signal and the A/C ECU signal.
  The Low speed operation is accomplished by applying the current through a resistor, which reduces the speed of the cooling fan.

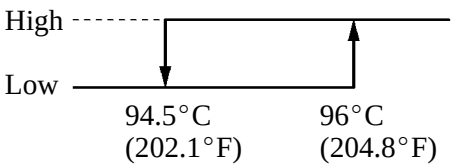
▶ Wiring Diagram ◀



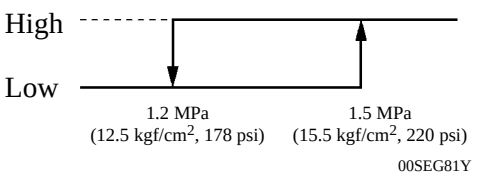
▶ Cooling Fan Operation ◀

Engine Coolant Temperature*1	Air Conditioning Condition		Cooling Fan Operation
	A/C Switch	Refrigerant Pressure*2	
Low	OFF	Low	OFF
	ON	Low	Low
	ON	High	High
High	OFF	Low	High
	ON	Low	High
	ON	High	High

*1: Judgmental standard of engine coolant temperature



*2: Judgmental standard of refrigerant pressure

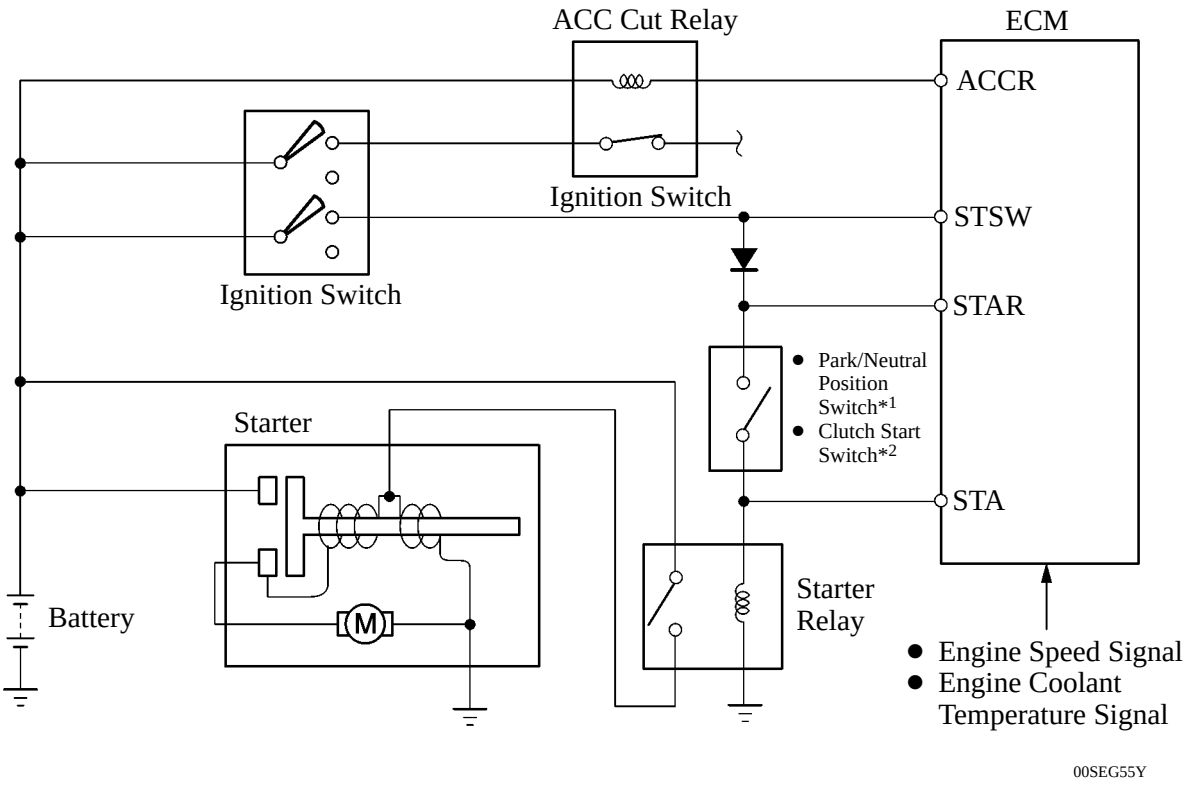


11. Cranking Hold Function

General

- Once the ignition switch is turned to the START position, this control continues to operate the starting until the engine starts, without having to hold the ignition switch in the START position. This prevents starting failures and the engine from being cranked after the engine has started.
- When the ECM detects a start signal from the ignition switch, this system monitors the engine speed (NE) signal and continues to operate the starter until it determines that the engine has started.

▶ System Diagram ◀

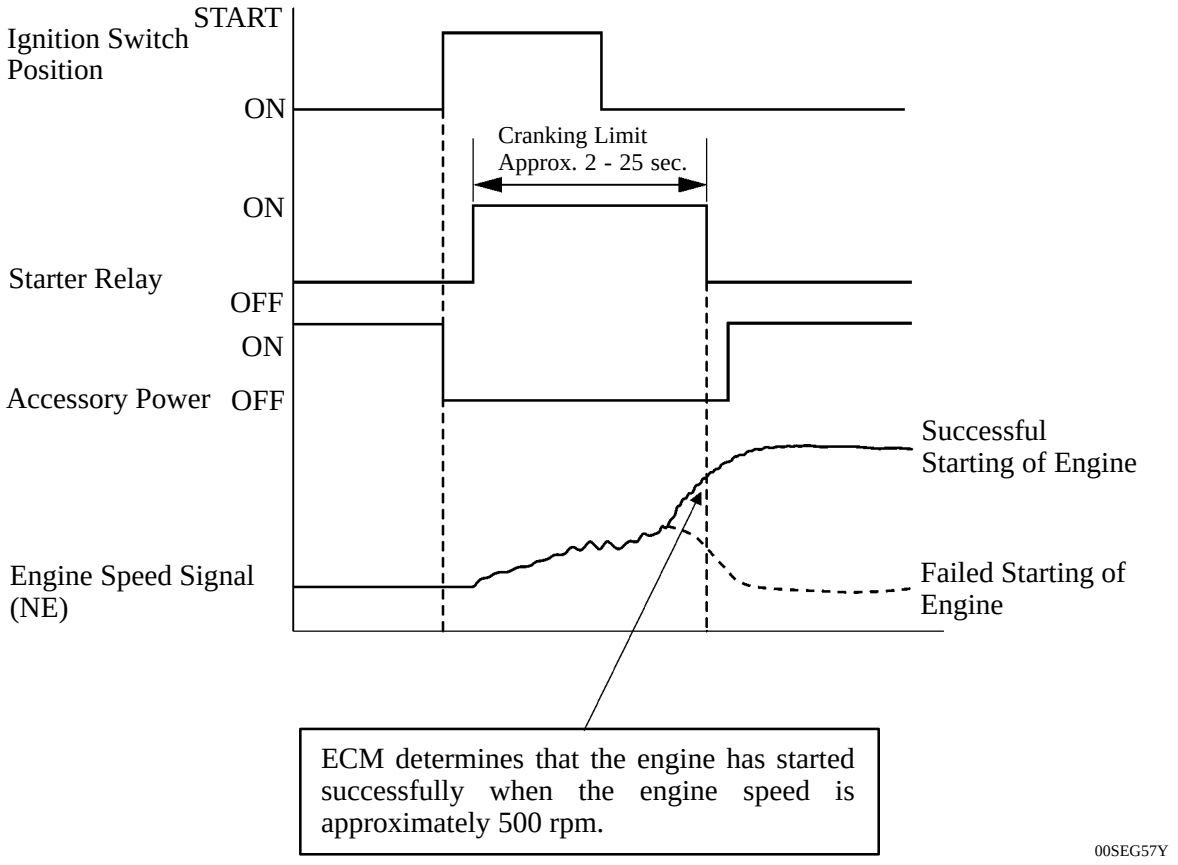


*1: for Automatic Transaxle Models
*2: for Manual Transaxle Models

Operation

- As indicated in the following timing chart, when the ECM detects a start signal from the ignition switch, it energizes the starter relay to operate the starter. If the engine is already running, the ECM will not energize the starter relay.
- After the starter operates and the engine speed becomes higher than approximately 500 rpm, the ECM determines that the engine has started and stops the operation of the starter.
- If the engine has any failure and does not work, the starter operates as long as its maximum continuous operation time and stops automatically. The maximum continuous operation time is approximately 2 seconds through 25 seconds depending on the engine coolant temperature condition. When the engine coolant temperature is extremely low, it is approximately 25 seconds and when the engine is warmed up sufficiently, it is approximately 2 seconds.
- In case that the starter begins to operate, but cannot detect the engine speed signal, the ECM will stop the starter operation immediately.

▶ Timing Chart ◀



12. Diagnosis

- When the ECM detects a malfunction, the ECM makes a diagnosis and memorizes the failed section. Furthermore, the MIL (Malfunction Indicator Lamp) 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.
- To comply with the OBD-II regulations, all the DTCs (Diagnostic Trouble Codes) have been made to correspond to the SAE controller codes. Some of the DTCs have been further divided into smaller detection areas than in the past, and new DTCs have been assigned to them. For details, refer to the 2006 Yaris Repair Manual (Pub. No. RM00R0U).

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 Yaris Repair Manual (Pub. No. RM00R0U).

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