■ ENGINE CONTROL SYSTEM

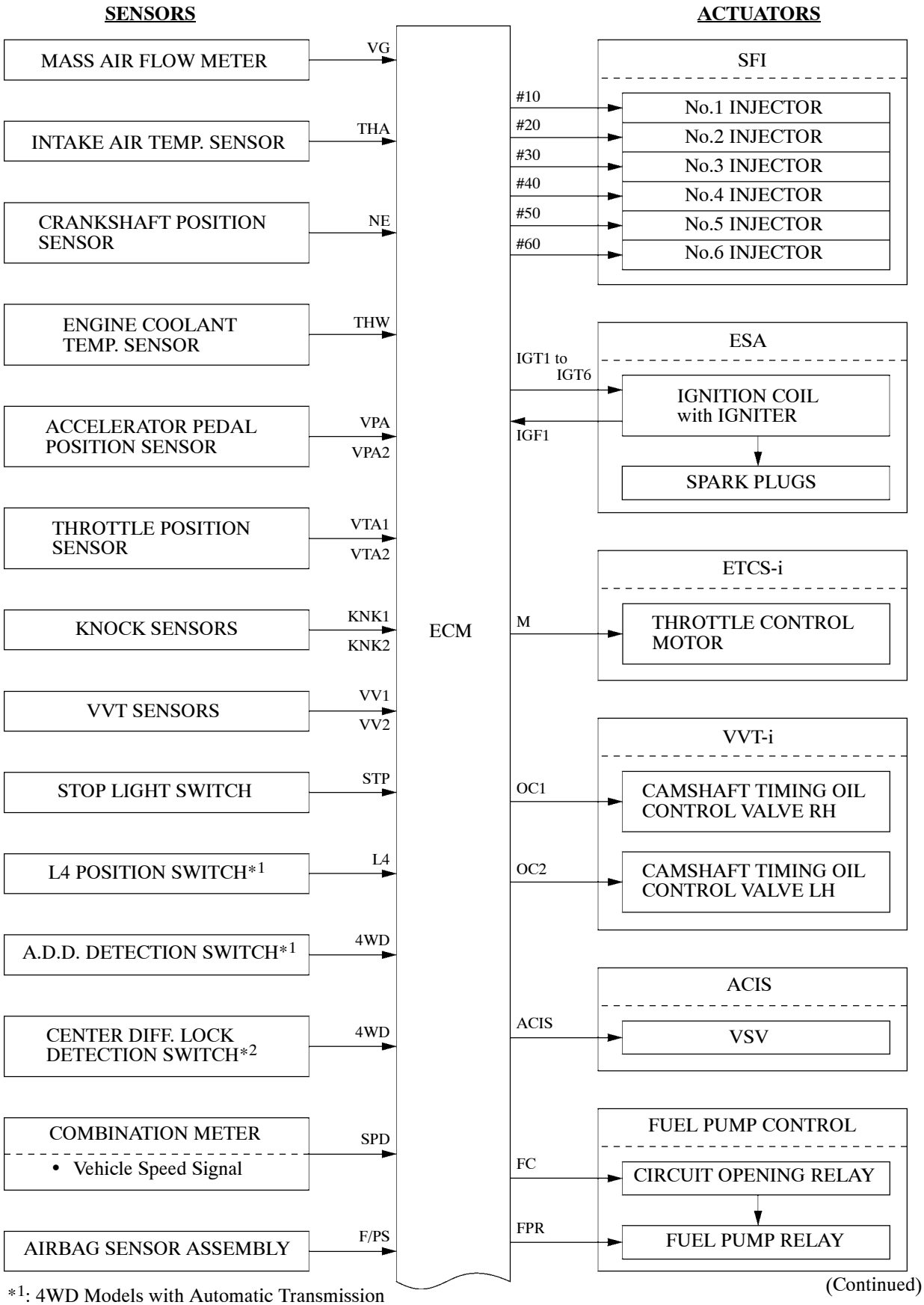
1. General

The engine control system of the 1GR-FE engine has the following features. The ECM that controls this system is made by DENSO.

System	Outline
SFI (Sequential Multiport Fuel Injection) [See page EG-49]	An L-type SFI system detects the intake air volume with a hot-wire type mass air flow meter.
ESA (Electronic Spark Advance)	• This ECM determines the optimal ignition timing in accordance with the signals received from the sensors and sends (IGT) ignition signal to the igniter. • The ECM corrects ignition timing in response to engine knocking.
ETCS-i (Electronic Throttle Control System-intelligent)	Optimally controls the opening angle of the throttle valve in accordance with the accelerator pedal input and the engine and vehicle conditions.
VVT-i (Variable Valve Timing-intelligent) [See page EG-52]	Controls the intake camshaft to optimal valve timing in accordance with the engine condition.
ACIS (Acoustic Control Induction System) [See page EG-57]	The intake air passages are switched based on engine speed and throttle valve opening angle to provide high performance in all engine speed ranges.
Fuel Pump Control [See page EG-60]	• The ECM controls fuel pump speed by switching the circuit to the fuel pump resistor. • The fuel pump is stopped when the SRS airbag is deployed in a frontal, side, or rear side collision.
Air Fuel Ratio Sensor and Oxygen Sensor Heater Control	Maintains the temperature of the air fuel ratio sensors or oxygen sensors at an appropriate level to increase the detection accuracy of the exhaust gas oxygen concentration.
Evaporative Emission Control [See page EG-61]	• The ECM controls the purge flow of evaporative emission (HC) in the charcoal canister in accordance with engine conditions. • Approximately five hours after the ignition switch has been turned OFF, the ECM operates the pump module to detect any evaporative emission leakage occurring between the fuel tank and the charcoal canister. The ECM can detect leaks by monitoring for changes in the fuel tank pressure.
Air Conditioning Cut-off Control	By turning the air conditioning compressor ON or OFF in accordance with the engine condition, drivability is maintained.
Diagnosis [See page EG-73]	When the ECM detects a malfunction, the ECM records the malfunction and memorizes information related to the fault.
Fail-Safe [See page EG-73]	When the ECM detects a malfunction, the ECM stops or controls the engine according to the data already stored in the memory.

2. Construction

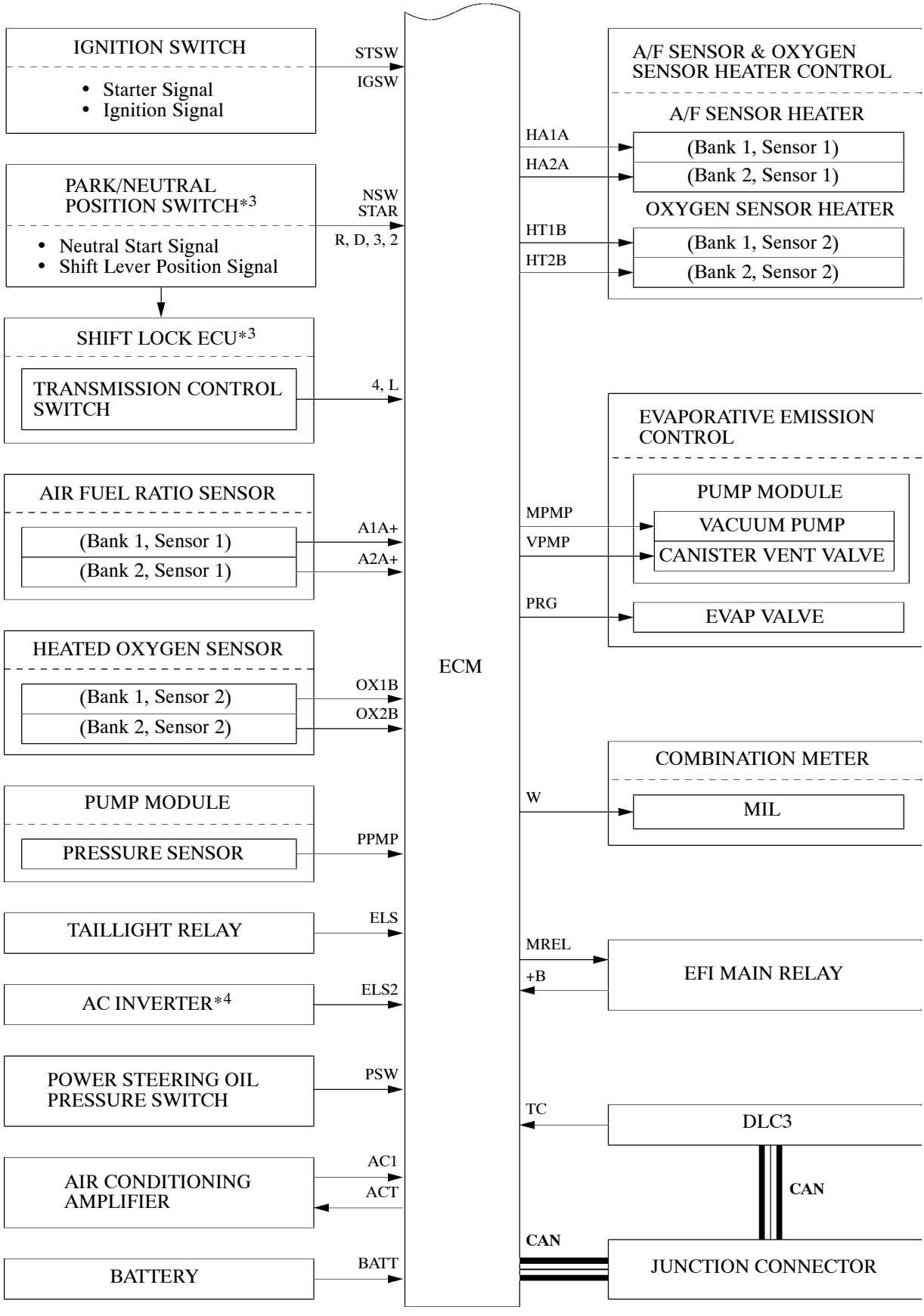
The configuration of the engine control system is as shown in the following chart.



(Continued)

*1: 4WD Models with Automatic Transmission
*2: 4WD Models with Manual Transmission

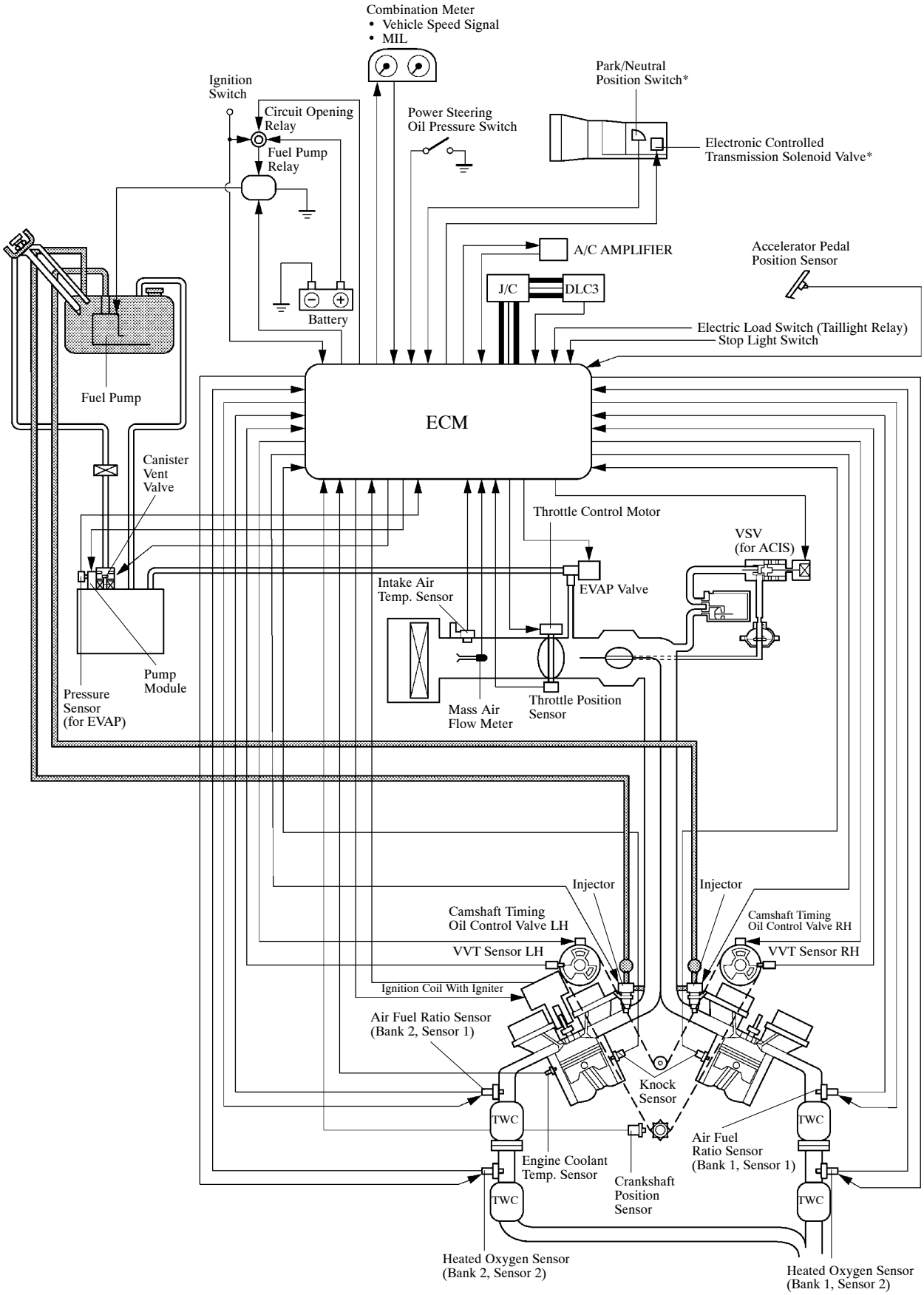
0240EG36C



*3: Models with Automatic Transmission
*4: Models with Power Outlet Socket (AC 115V, 400W)

0240EG37C

3. Engine Control System Diagram

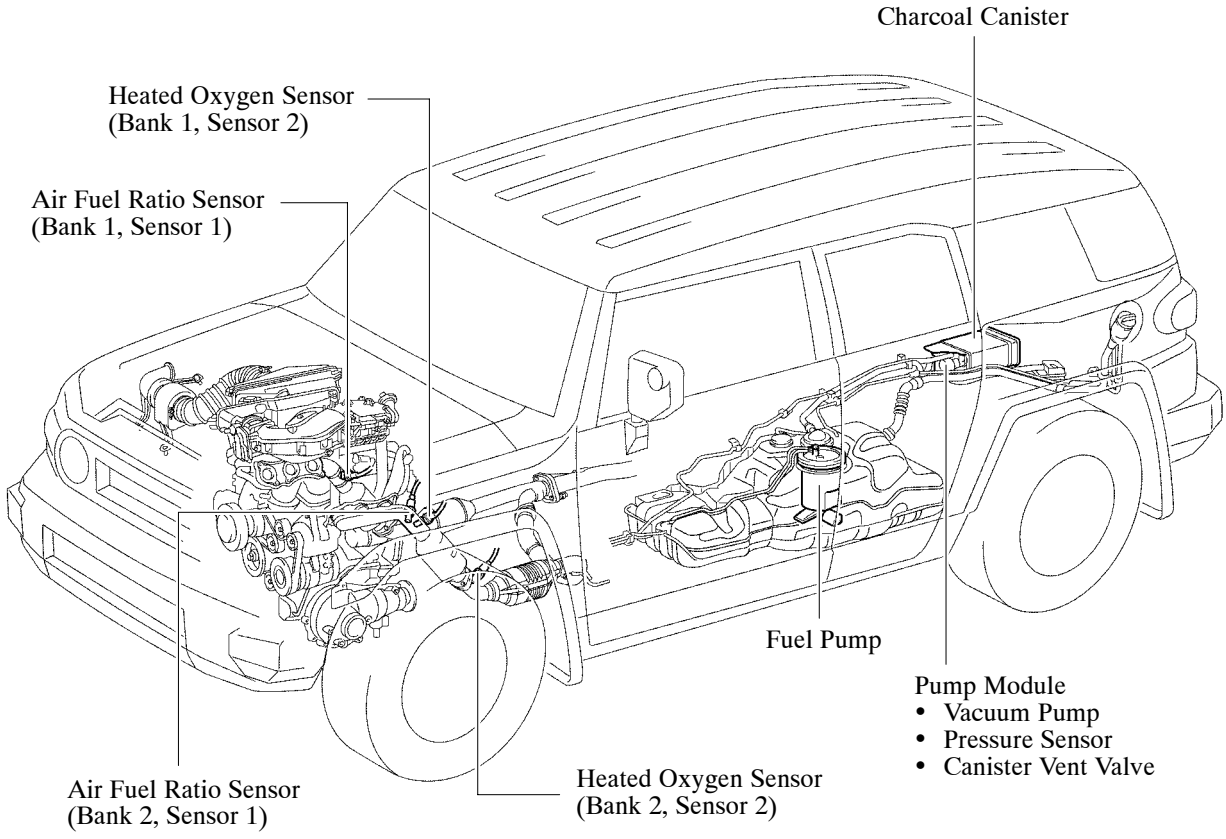


*: Only for A/T Models

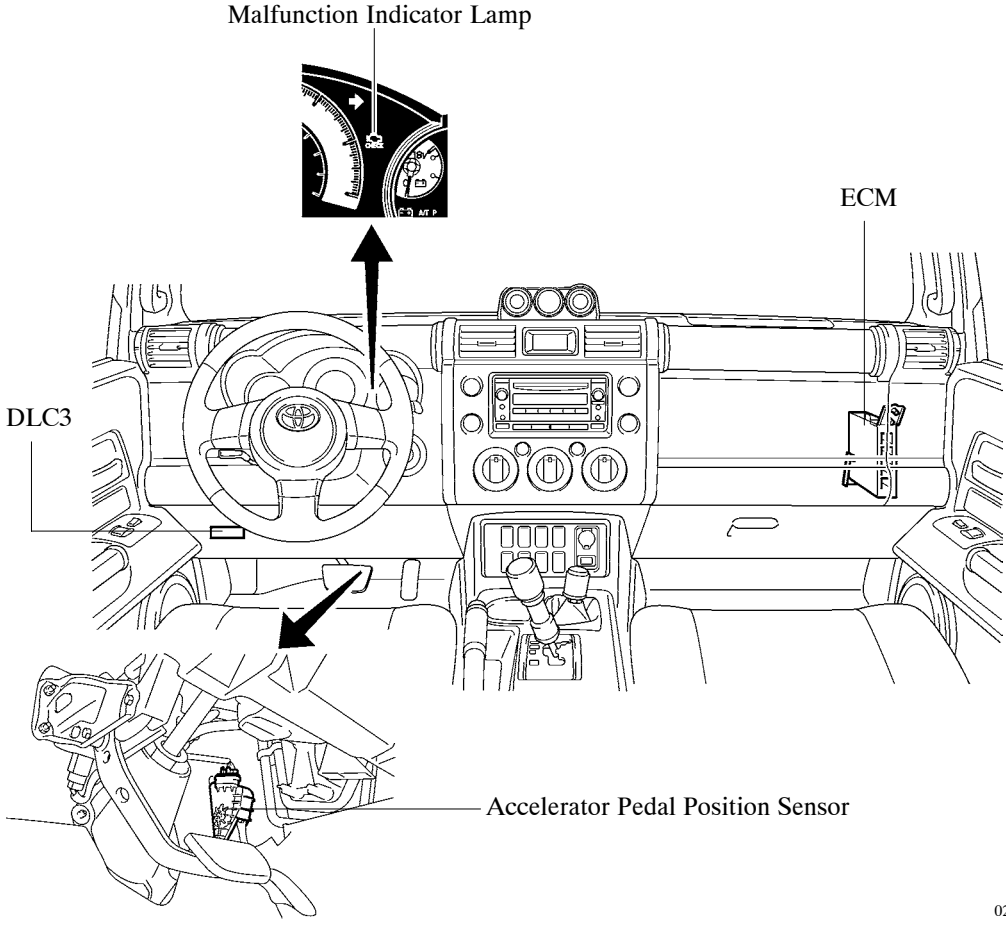
279EG03

EG

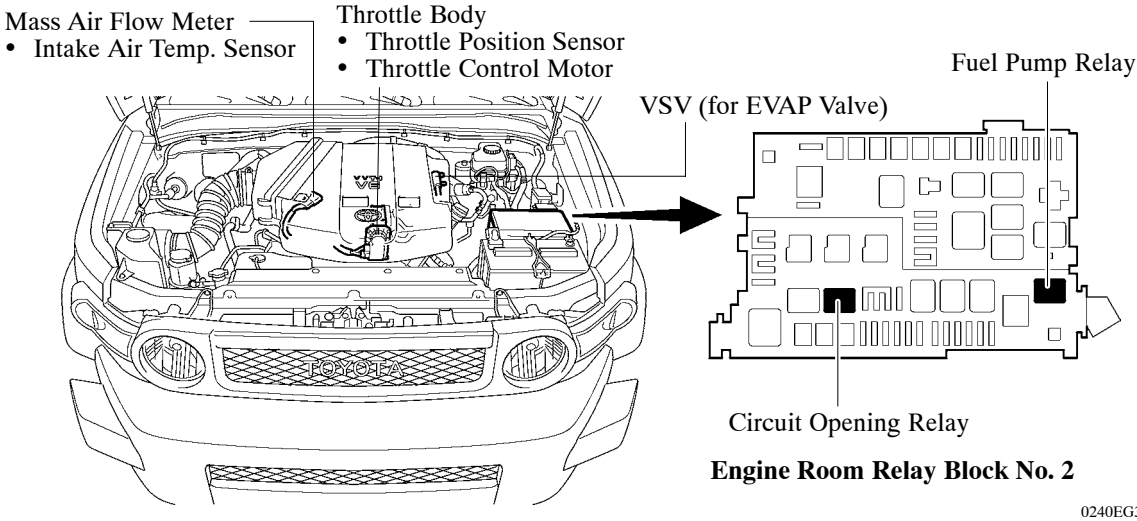
4. Layout of Main Components

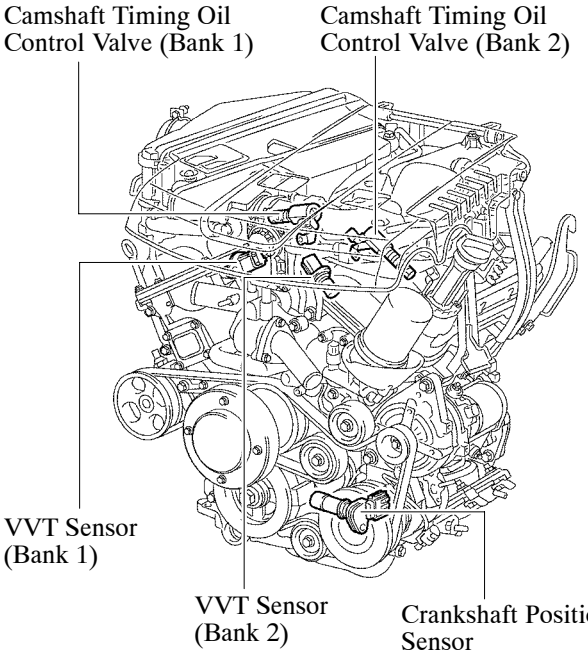


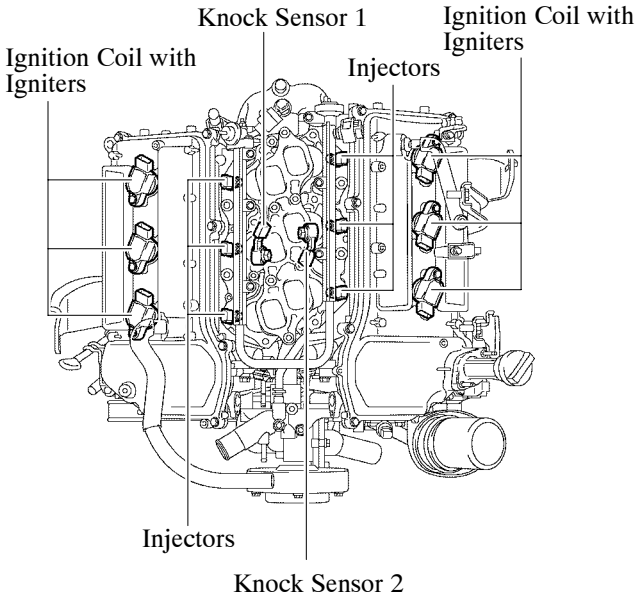
0240EG31Z

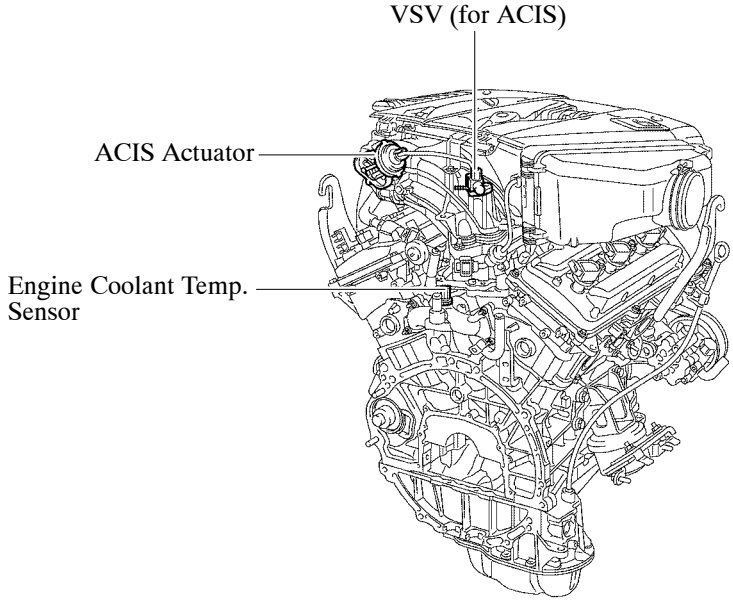


0240EG34CS


Mass Air Flow Meter
• Intake Air Temp. Sensor
Throttle Body
• Throttle Position Sensor
• Throttle Control Motor
VSV (for EVAP Valve)
Fuel Pump Relay
Circuit Opening Relay
Engine Room Relay Block No. 2
0240EG35CS


Camshaft Timing Oil Control Valve (Bank 1)
Camshaft Timing Oil Control Valve (Bank 2)
VVT Sensor (Bank 1)
VVT Sensor (Bank 2)
Crankshaft Position Sensor


Knock Sensor 1
Ignition Coil with Igniters
Ignition Coil with Igniters
Injectors
Injectors
Knock Sensor 2


VSV (for ACIS)
ACIS Actuator
Engine Coolant Temp. Sensor
0240EG32Z

EG

5. Main Components of Engine Control System

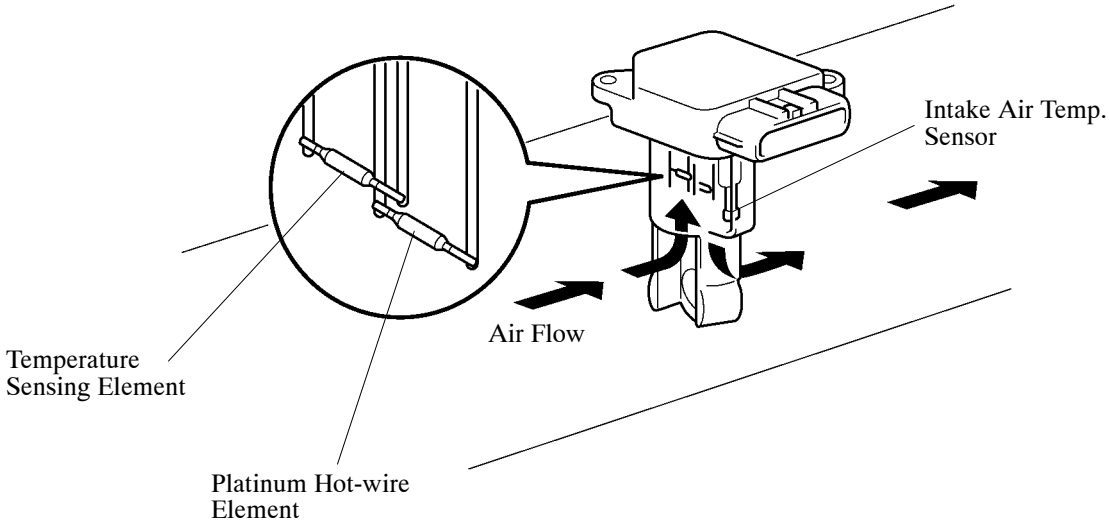
General

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

Components		Outline	Quantity
ECM (Supplier)		32-bit CPU (DENSO)	1
Mass Air Flow Meter		Hot-wire Type	1
Crankshaft Position Sensor (Rotor Teeth)		Pick-up Coil Type (36 - 2)	1
VVT Sensors (Rotor Teeth)		MRE (Magnetic Resistance Element) Type (3)	2 (1 each bank)
Accelerator Pedal Position Sensor		Linear (Non-Contact) Type	1
Throttle Position Sensor		Linear (Non-Contact) Type	1
Knock Sensors		Built-in Piezoelectric Type (Non-resonant Type/Flat Type)	2 (1 each bank)
Air Fuel Ratio Sensors	Bank 1, Sensor 1	Heated Type (Planar Type)	2 (1 each bank)
	Bank 2, Sensor 1		
Heated Oxygen Sensors	Bank 1, Sensor 2	Heated Type (Cup Type)	2 (1 each bank)
	Bank 1, Sensor 2		
Injectors		12-hole Type	6

Mass Air Flow Meter

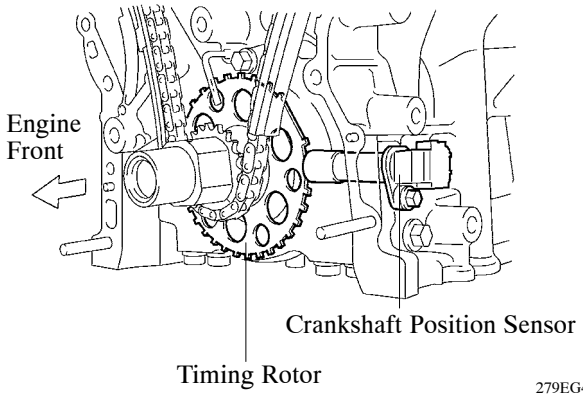
- This mass air flow meter, which is a plug-in type, allows a portion of the intake air to flow through the detection area. By directly measuring the mass and the flow rate of the intake air, the detection precision is improved and the intake air resistance is reduced.
- This mass air flow meter has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



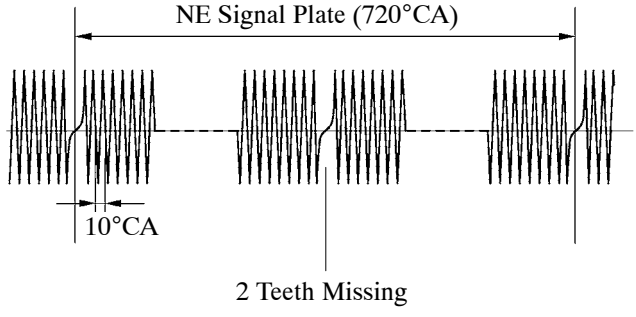
204EG54

Crankshaft Position Sensor

The timing rotor of the crankshaft consists of a 34 tooth plate with 2 teeth missing. The crankshaft position sensor outputs a crankshaft rotation signal every 10° of crankshaft rotation, and the change of the signal due to the missing teeth is used to determine top-dead-center.



279EG49



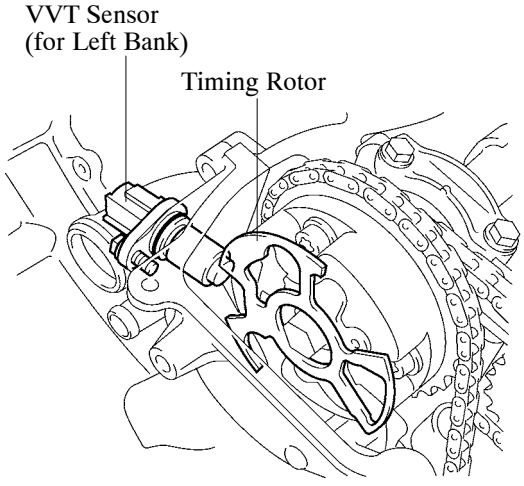
279EG50

VVT Sensor

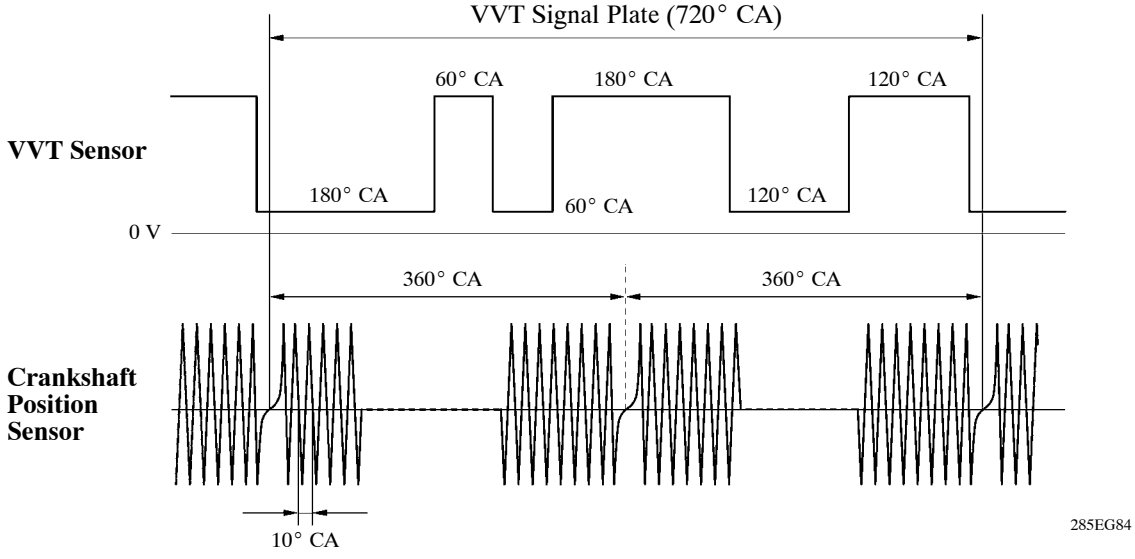
1) General

MRE (Magnetic Resistance Element) type intake VVT sensors are used. To detect the camshaft position, a timing rotor that is secured to the camshaft in front of the VVT controller is used to generate 6 (3 Hi Output, 3 Lo Output) pulses for every 2 revolutions of the crankshaft.

- An MRE type VVT sensor consists of an MRE, a magnet and a sensor. The direction of the magnetic field changes due to the profile (protruding and non-protruding portions) of the timing rotor, which passes by the sensor. As a result, the resistance of the MRE changes, and the output voltage to the ECM changes to Hi or Lo. The ECM detects the camshaft position based on this output voltage.



275TU15



285EG84

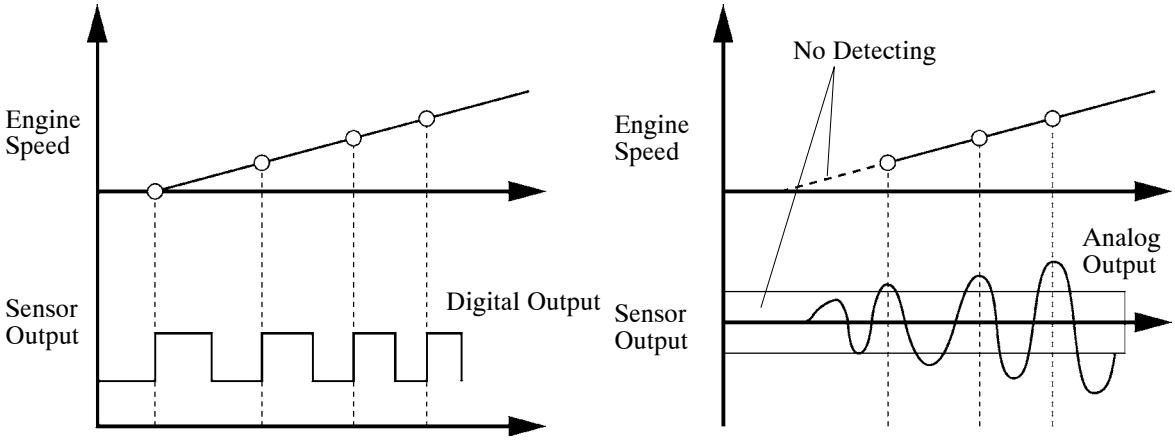
Correlation of Output Waveform between VVT sensor and Crankshaft Position Sensor

2) MRE Type VVT Sensor

The differences between an MRE type VVT sensor and a pickup coil type VVT sensor are as follows.

Sensor Type	MRE Type Sensor	Pick-up Coil Type Sensor
Signal Output	Constant digital output starts from low engine speed.	Analog output changes with the engine speed.
Camshaft Position Detection	Camshaft position detection is made by comparing the NE signal with the Hi/Lo output switch timing of the VVT sensor which is due to the protruding/non-protruding portions of the timing rotor. Camshaft detection can also be made based on the number of the NE (engine speed) signals input during a Hi/Lo output cycle.	Detection is made by comparing the NE signals with the change of waveform that is output when the protruding portion of the timing rotor passes.

▶ MRE Type and Pick-up Coil Type output Waveform Image Comparison ◀



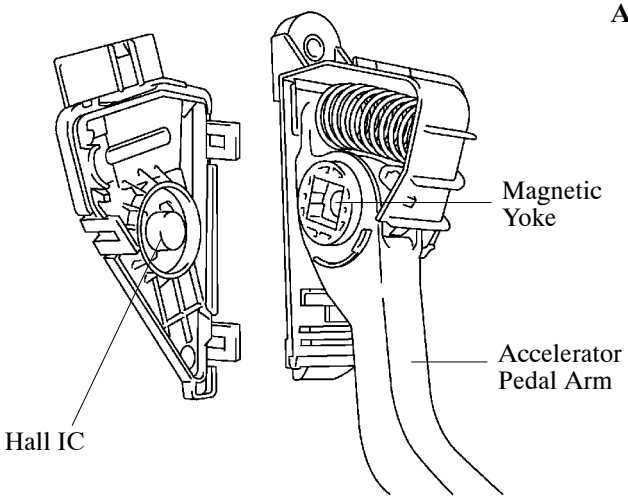
MRE Type **Pick-up Coil Type**

232CH41

Accelerator Pedal Position Sensor

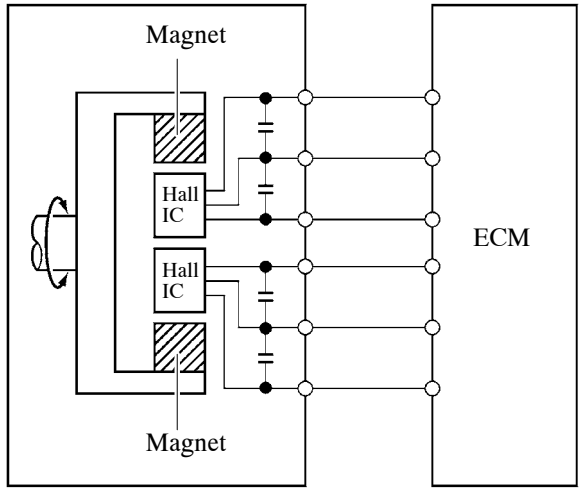
This non-contact type accelerator pedal position sensor uses a Hall IC, which is mounted on the accelerator pedal arm.

- A magnetic yoke is mounted at the base of the accelerator pedal arm. This yoke 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 into electrical signals, and outputs them in the form of accelerator pedal position signals to the ECM.
- The Hall IC contains two circuits, one for the main signal, and one for the sub signal. It converts the accelerator pedal position (angle) into electric signals that have differing characteristics and outputs them to the ECM.

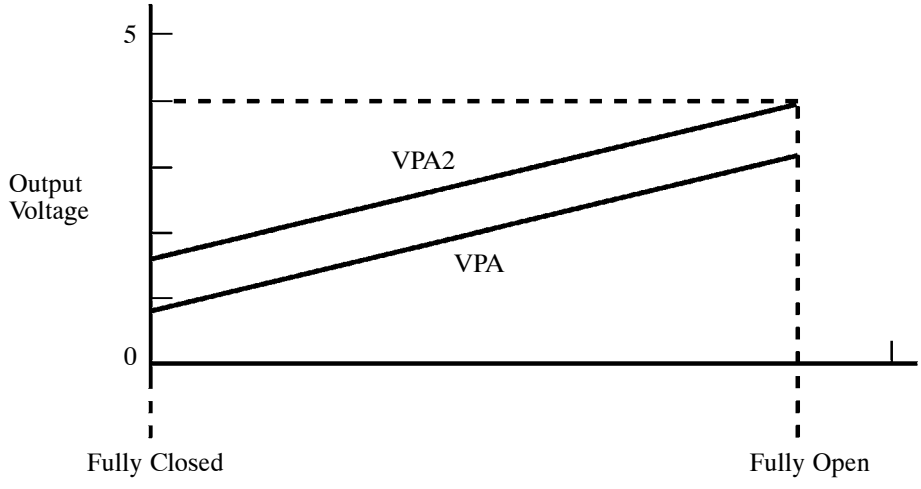


279EG17

Accelerator Pedal Position Sensor



228TU24



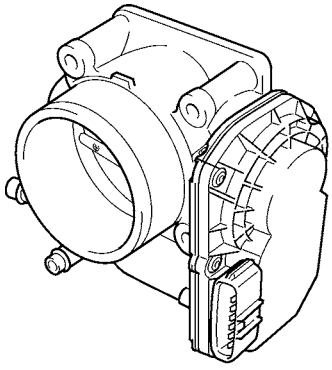
228TU25

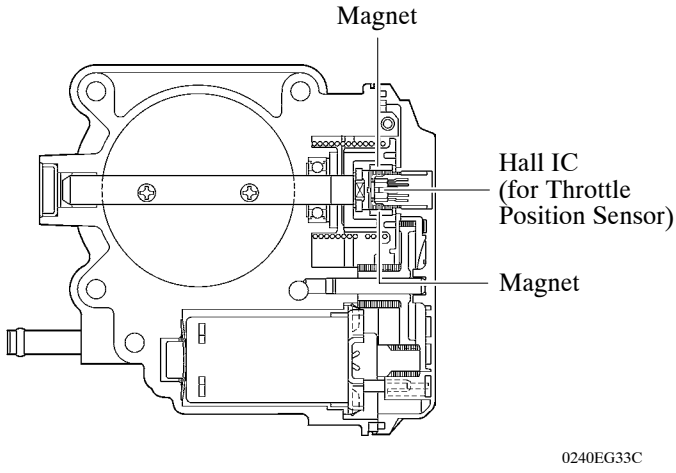
Accelerator Pedal Position (Angle)

Throttle Position Sensor

This non-contact type throttle position sensor is mounted on the throttle body, and it uses a Hall IC.

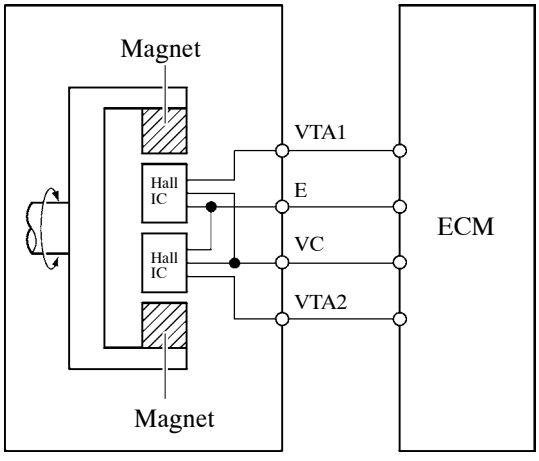
- The Hall IC is surrounded by a magnetic yoke. The Hall IC converts the changes that occur in the magnetic flux into electrical signals, and outputs them in the form of throttle valve position signals to the ECM.
- The Hall IC contains circuits for the main and sub signals. It converts the throttle valve opening angle into electrical signals that have differing characteristics and outputs them to the ECM.



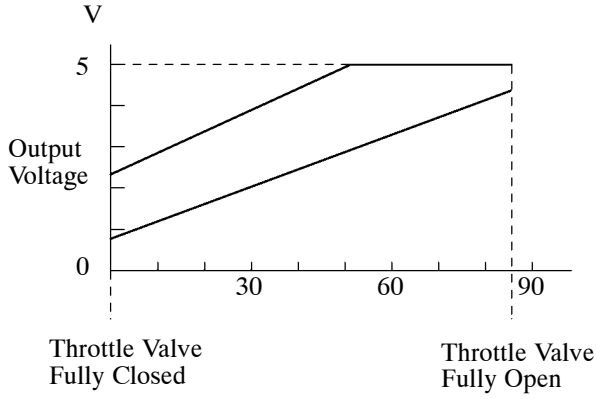


0240EG33C

Cross Section



230LX12



Throttle Valve Opening Angle

238EG79

Knock Sensor (Flat Type)

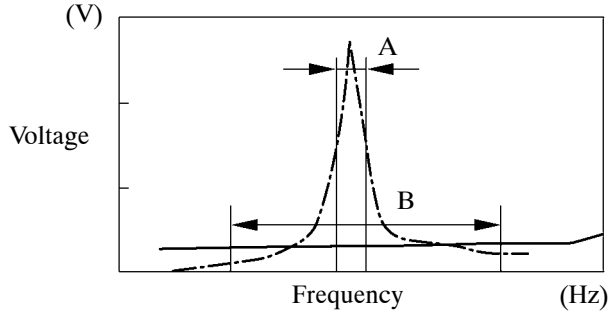
1) General

In a conventional type knock sensor (resonant type), a vibration plate is built into the sensor. This plate has the same resonance point as the knocking* frequency of the engine block. This sensor can only detect vibration in this frequency band.
The other type of knock sensor, 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). It has the following features:

- The engine knocking frequency will vary slightly depending on the engine speed. The flat type knock sensor can detect vibration even when the engine knocking frequency changes. Due to the use of the flat type knock sensor, the vibration detection ability is increased compared to a conventional type knock sensor, and more precise ignition timing control is possible.

*: The term “Knock” or “Knocking” is used in this case to describe either preignition or detonation of the air fuel mixture in the combustion chamber. This preignition or detonation refers to the air fuel mixture being ignited earlier than is advantageous.
This use of “Knock” or “Knocking” is not primarily used to refer to a loud mechanical noise that may be produced by an engine.

—— - —— : Resonance Characteristic of Conventional Type
———— : Resonance Characteristic of Flat Type



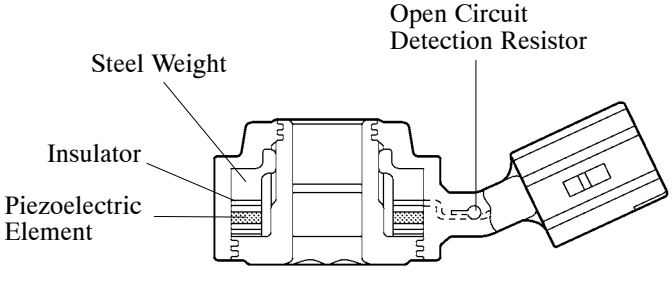
A: Detection Band of Conventional Type
B: Detection Band of Flat Type

Characteristics of Knock Sensors

214CE04

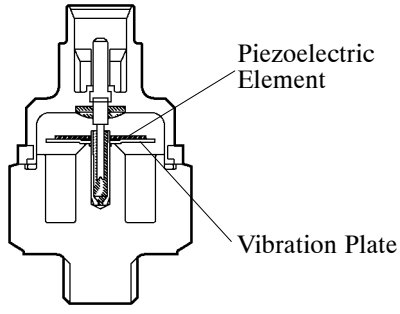
2) Construction

- A flat type knock sensor is installed to an engine by placing it over the stud installed on the cylinder block. For this reason, a hole for the stud exists in the center of the sensor.
- In the sensor, a steel weight is located in the upper portion. An insulator is located between the weight and a piezoelectric element.
- An open/short circuit detection resistor is integrated in the sensor.



Flat Type Knock Sensor (Non-Resonant Type)

214CE01

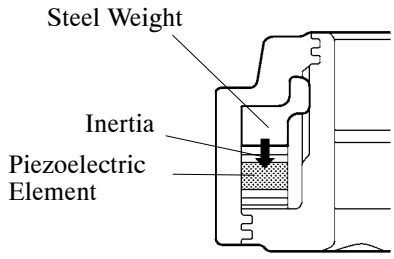


Conventional Type Knock Sensor (Resonant Type)

214CE02

3) Operation

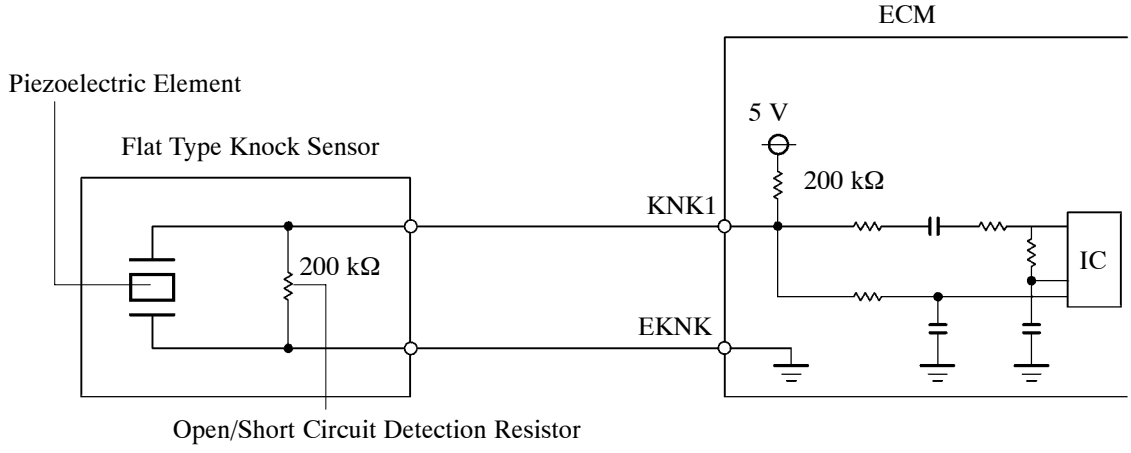
The knocking vibration is transmitted to the steel weight and its inertia applies pressure to the piezoelectric element. This action generates electromotive force (voltage).



214CE08

4) Open/Short Circuit Detection Resistor

When the ignition is ON, the open/short circuit detection resistor in the knock sensor and the resistor in the ECM keep the voltage at the terminal KNK1 of engine constant.
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 allowing the ECM to detect the open/short circuit and store a DTC (Diagnostic Trouble Code).



214CE06

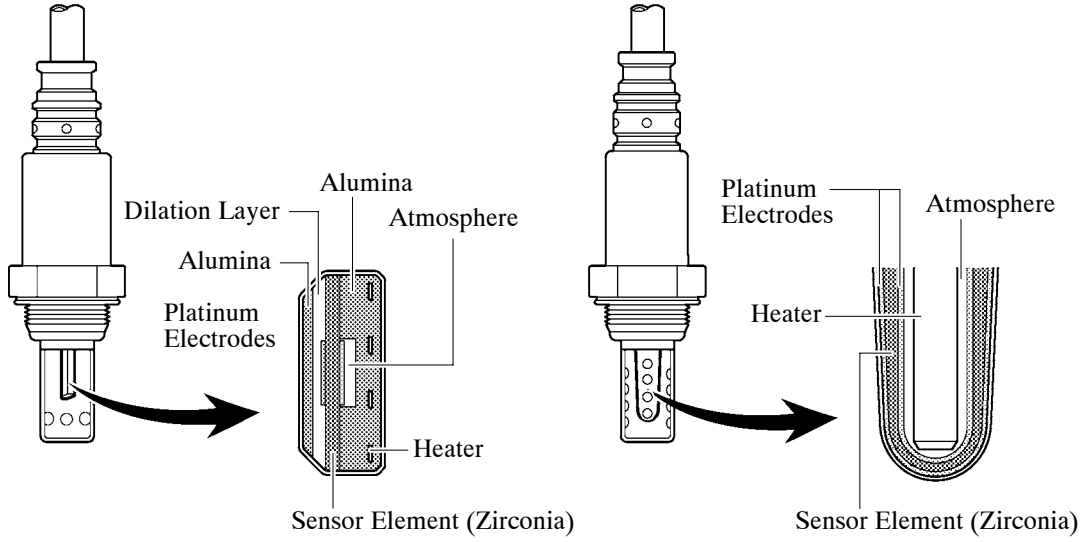
Service Tip

These knock sensors are mounted in specific directions at specific angles. To prevent the right and left bank wiring connectors from being interchanged, make sure to install each sensor in its prescribed direction. For details, refer to the 2007 FJ Cruiser Repair Manual (Pub. No. RM0240U).

Air Fuel Ratio Sensor and Heated Oxygen Sensor

1) General

- A planar type air-fuel ratio sensor and a cup type heated oxygen sensor are used.
- The basic construction of the oxygen sensor and the air-fuel ratio 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 planar type air-fuel ratio sensor uses alumina, which excels in heat conductivity and electrical insulation, to integrate a sensor element with a heater, thus improving the warm-up performance of the sensor.
- The cup type heated oxygen sensor contains a sensor element that surrounds a heater.

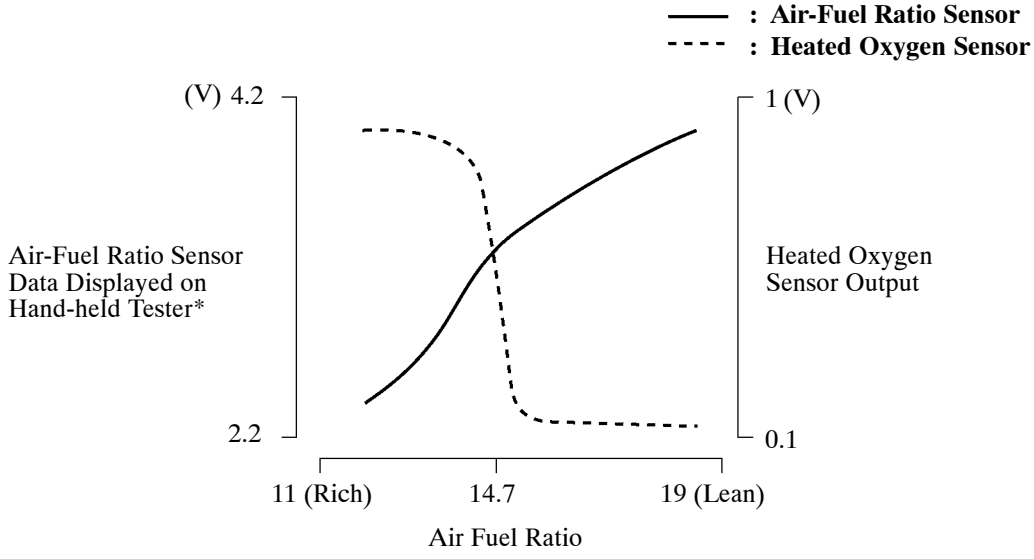


Air Fuel Ratio Sensor (Planar Type) **Heated Oxygen Sensor (Cup Type)**

279EG18

2) Characteristics

As illustrated below, a conventional heated oxygen sensor is characterized by a sudden change in its output voltage at the threshold of the stoichiometric air-fuel ratio (14.7:1). In contrast, the air-fuel ratio sensor data is approximately proportional to the existing air-fuel ratio. The air-fuel ratio sensor converts the oxygen density to current and sends it to the ECM. As a result, the detection precision of the air-fuel ratio has been improved. The air-fuel ratio sensor data can be viewed using a hand-held tester.



D13N11

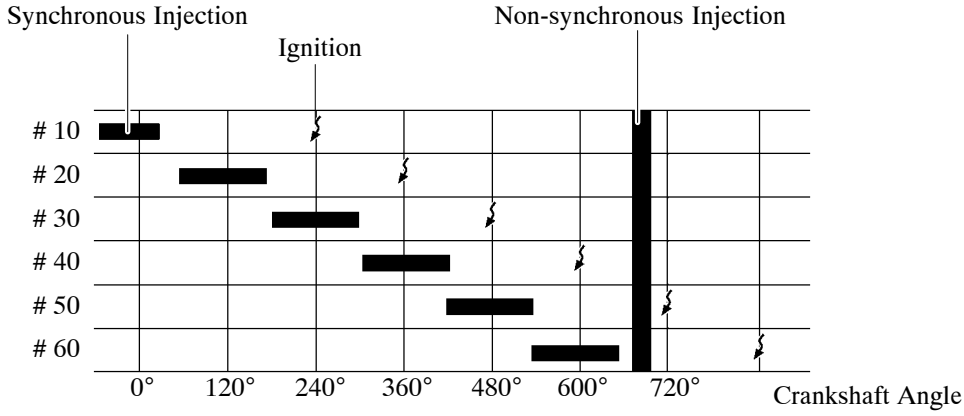
*: This value is calculated internally in the ECM and is not an ECM terminal voltage.

6. SFI (Sequential Multiport Fuel Injection) System

- An L-type SFI system directly detects the intake air mass with a hot wire type mass air flow meter.
- An independent injection system (in which fuel is injected once into each intake port for each two revolutions of the crankshaft) is used.
- There are two types of fuel injection:
  a) One is synchronous injection, in which injection always occurs at the same timing relative to the firing order.
  b) The other is non-synchronous injection in which injection is effected regardless of the crankshaft angle.

Furthermore, to protect the engine and improve fuel economy, the system effects fuel cutoff in which the injection of fuel is stopped temporarily in accordance with the driving conditions.

- This system performs group injection when the engine coolant temperature is extremely low and the engine is operating at a low speed.



Sequential Multiport Fuel Injection

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

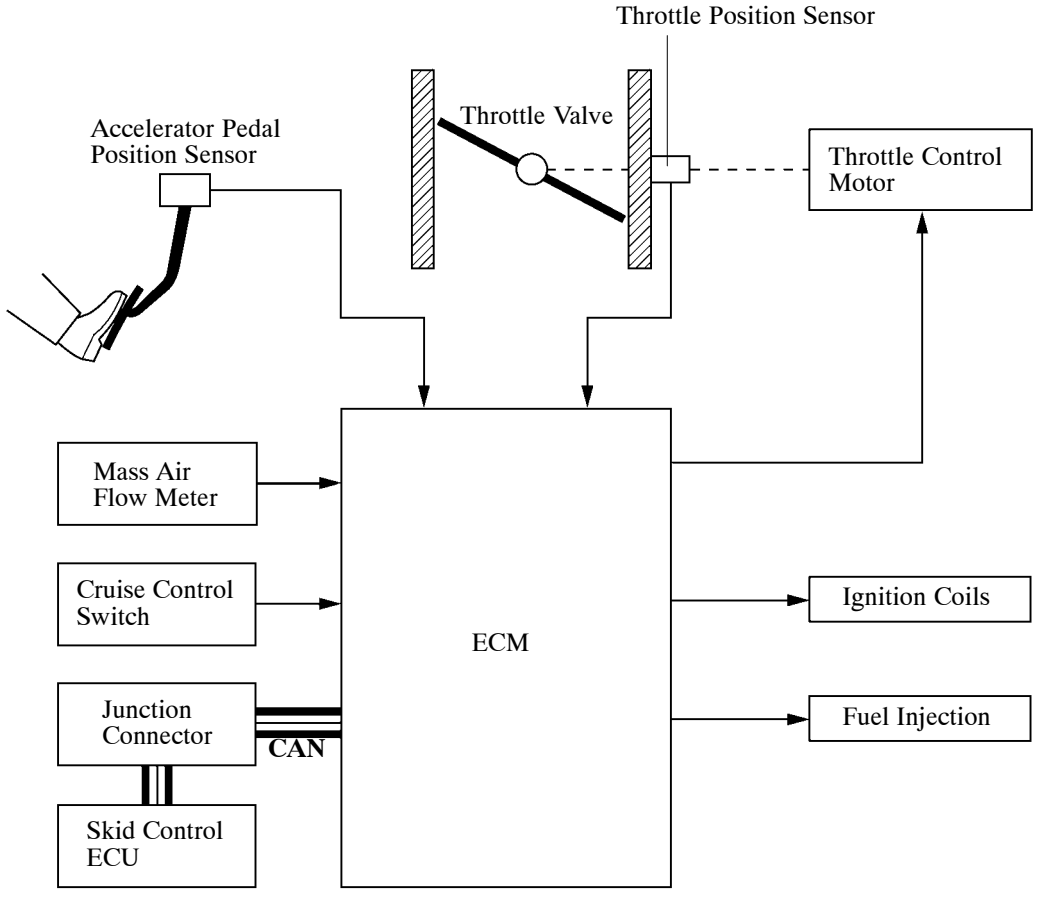
General

ETCS-i uses the ECM to calculate the optimal throttle valve angle that is appropriate for the respective driving condition and uses a throttle control motor to control the angle.
The ETCS-i consists of the following five functions:

- Normal Throttle Control (non-linear control)
- ISC (Idle Speed Control)
- TRAC (Traction Control), AUTO LSD*1 or A-TRAC*2 (Active Traction Control)
- VSC* (Vehicle Stability Control) Coordination Control
- Cruise Control*

*1: 2WD Models *2: 4WD Models with Rear Diff. Lock

▶ System Diagram ◀

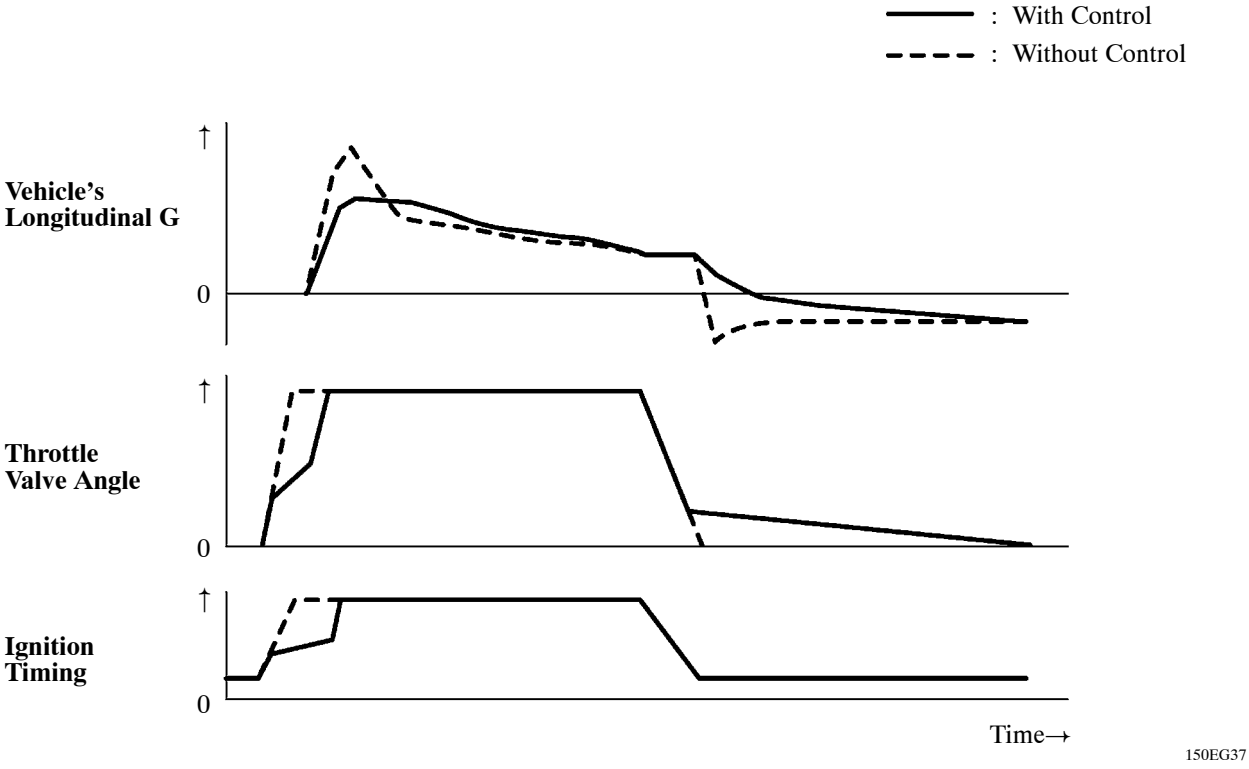


279EG19

Normal Throttle Control (Non-linear Control)

Controls the throttle to an optimal throttle valve angle that is appropriate for the driving condition based on information 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 ◀



Idle Speed Control

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

TRAC, AUTO LSD, or A-TRAC

As part of the TRAC, AUTO LSD, or A-TRAC, the throttle valve opening is reduced by a demand signal sent from the Skid Control ECU to the ECM. This demand signal will be sent if an excessive amount of slippage occurs at a drive wheel, thus facilitating vehicle stability and the application of an appropriate amount of power to the road.

VSC Coordination Control

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

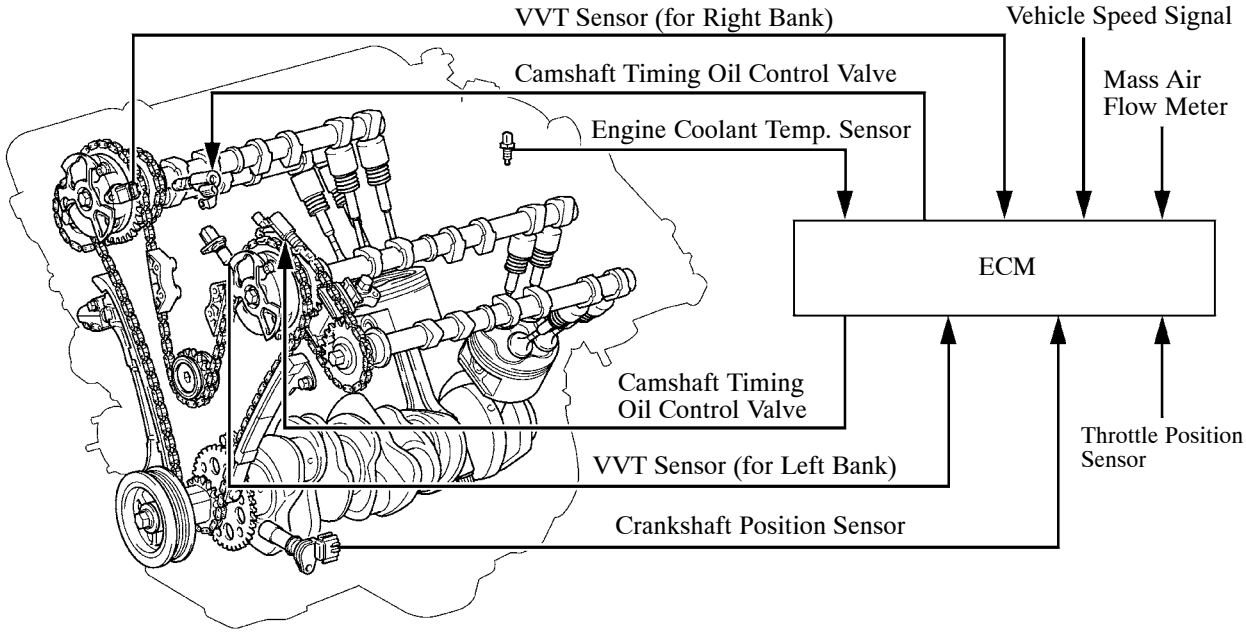
Cruise Control

The ECM directly actuates the throttle valve for operation of the cruise control.

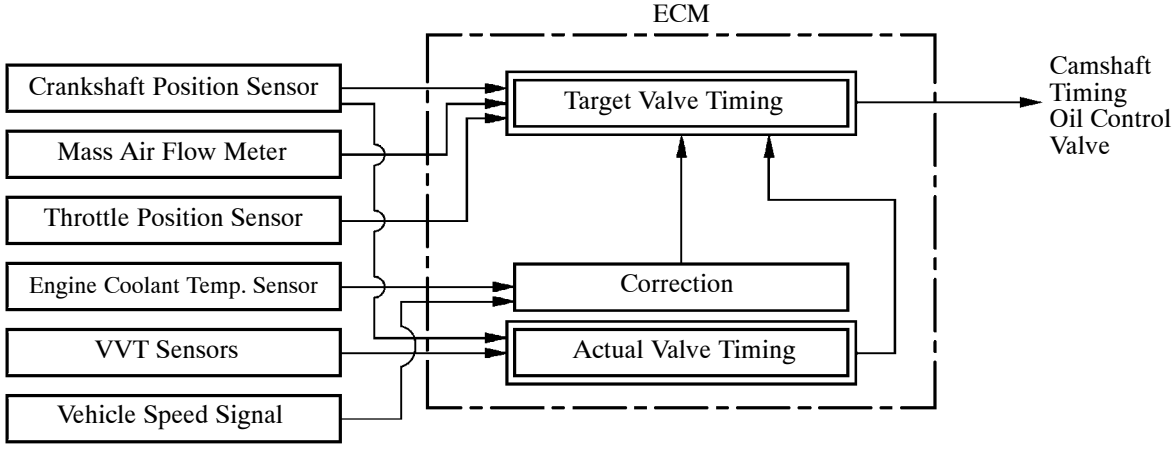
8. VVT-i (Variable Valve Timing-intelligent) System

General

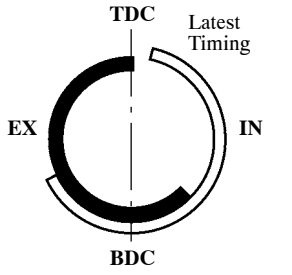
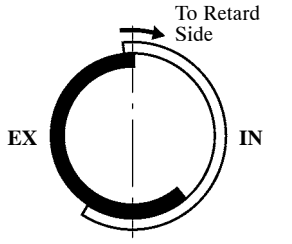
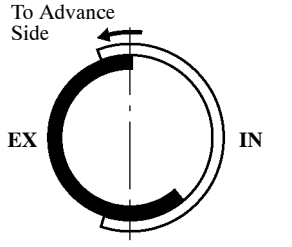
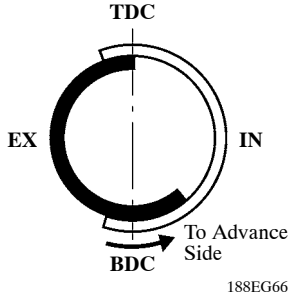
- The VVT-i system is designed to control the intake camshaft within a range of 50° (of Crankshaft Angle) to provide valve timing that is optimally suited to the engine operating conditions. This improves torque in all engine speed ranges as well as increasing fuel economy, and reducing exhaust emissions.



- By using the engine speed, intake air volume, throttle position and engine coolant temperature, the ECM calculates 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 the crankshaft position sensor to detect the actual valve timing, thus providing feedback control to achieve the target valve timing.

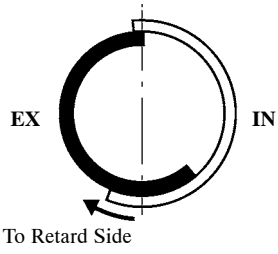
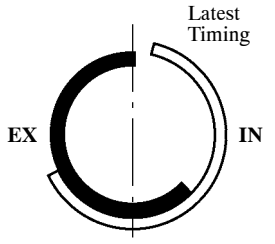
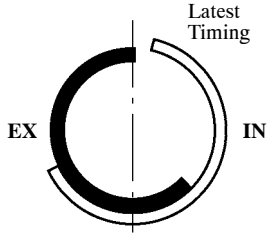


Effectiveness of the VVT-i System

Operation State	Objective		Effect
During Idle	 188EG51	Eliminating overlap reduces blow back to the intake side.	• Stabilized idling rpm • Better fuel economy
At Light Load	 188EG64	Eliminating overlap reduces blow back to the intake side.	Ensured engine stability
At Medium Load	 188EG65	Increasing overlap increases internal EGR, reducing pumping losses.	• Better fuel economy • Improved emission control
In Low to Medium Speed Range with Heavy Load	 188EG66	Advancing the intake valve closing timing allows for volumetric efficiency improvement.	Improved torque in low to medium speed range

(Continued)

EG

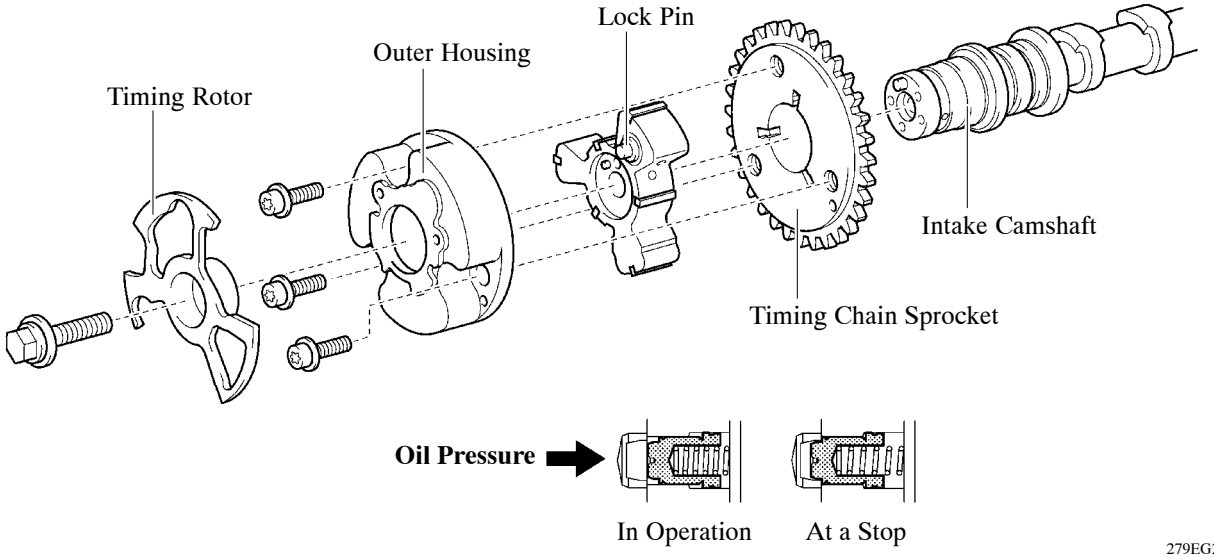
Operation State	Objective		Effect
In High Speed Range with Heavy Load		Retarding the intake valve closing timing allows for volumetric efficiency improvement.	Improved output
At Low Temperatures		Eliminating overlap prevents blow back to the intake side and stabilizes the idling speed at fast idle.	• Stabilized fast idling rpm • Better fuel economy
• Upon Starting • Stopping the Engine		Eliminating overlap reduces blow back to the intake side.	Improved startability

Construction

1) VVT-i Controller

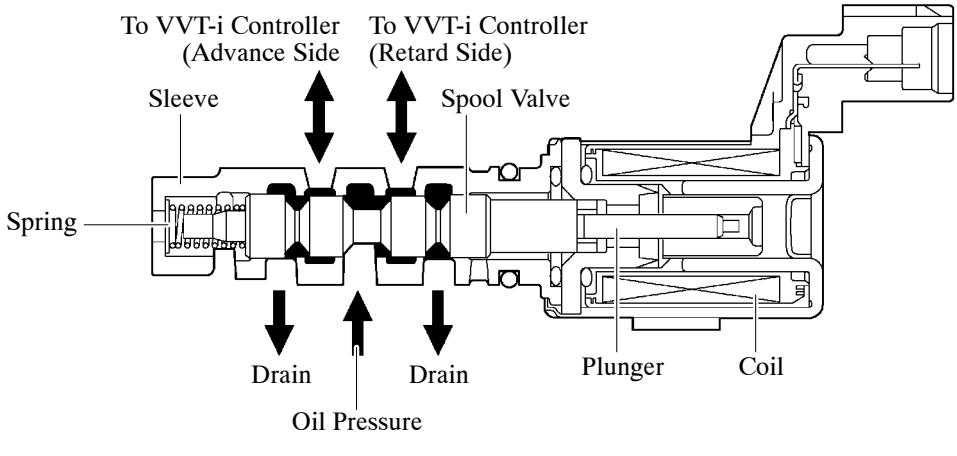
The VVT-i controller consists of an outer housing that is driven by the timing chain sprocket, and a vane subassembly that is coupled to intake camshaft.

- The oil pressure sent from the advance or retard side passage of the intake camshaft causes rotation of the VVT-i controller vane subassembly relative to the timing chain sprocket to vary the valve timing continuously (steplessly).
- When the engine stops, the VVT-i controller is locked to the most retarded angle by its lock pin. This ensures engine stability.



2) Camshaft Timing Oil Control Valve

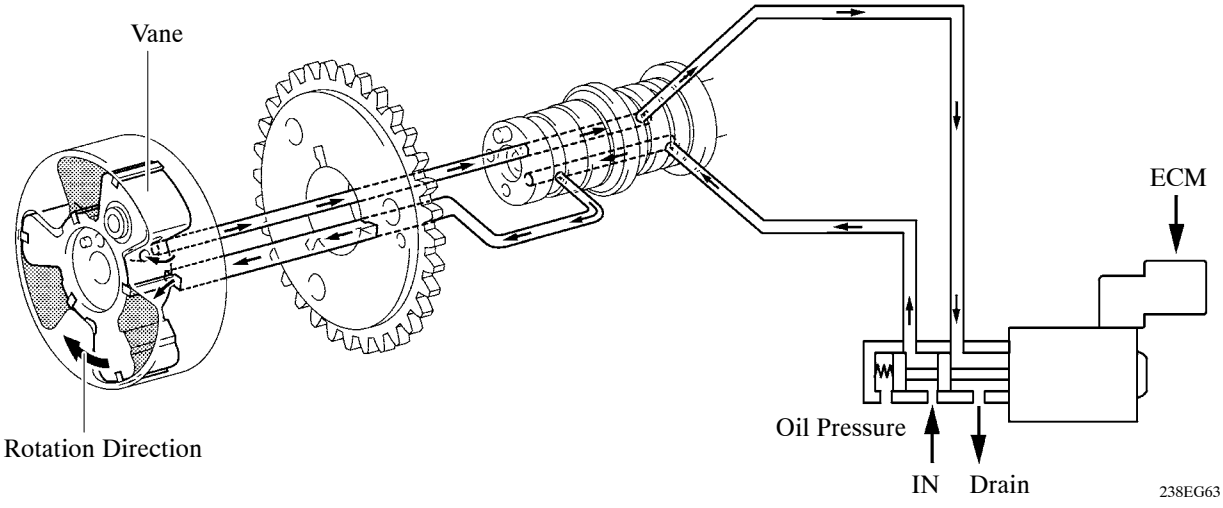
The camshaft timing oil control valve controls its spool valve using duty-cycle control from the ECM. This allows hydraulic pressure to be applied to the VVT-i controller advance or retard side. When the engine is stopped, the camshaft timing oil control valve will move to the most retarded state.



Operation

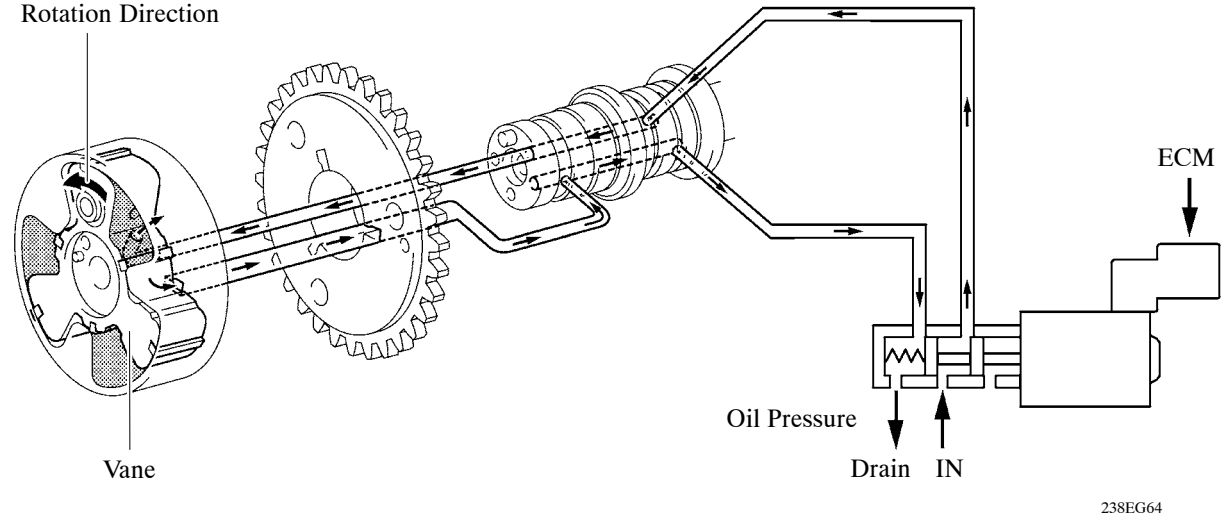
1) Advance

When the camshaft timing oil control valve is positioned 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 positioned 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

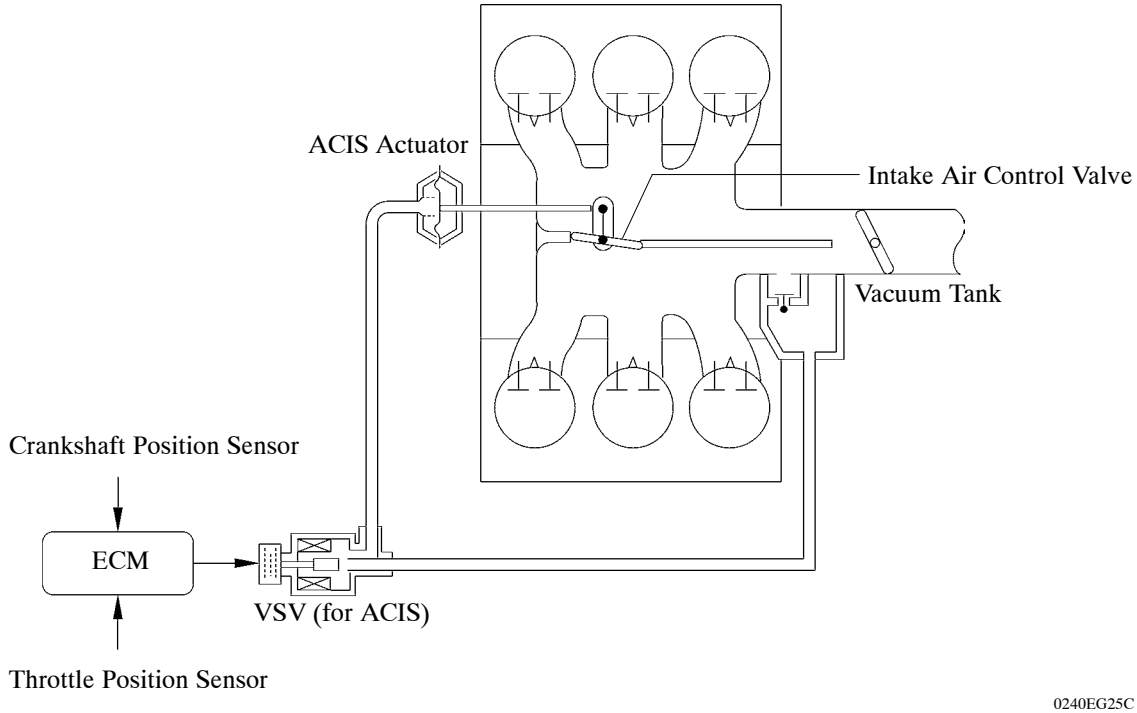
After reaching the target timing, the engine valve timing is maintained by keeping the camshaft timing oil control valve in the neutral position unless the engine operating conditions change.
This maintains the engine valve timing at the desired target position by preventing the engine oil from running out of the oil control valve.

9. ACIS (Acoustic Control Induction System)

General

The ACIS uses the intake air control valve as a bulkhead to divide the intake manifold into 2 stages. The intake air control valve is opened and closed to vary the effective length of the intake manifold in accordance with engine speed and throttle valve opening angle.
This increases the power output in all ranges from low to high engine speeds.

▶ System Diagram ◀



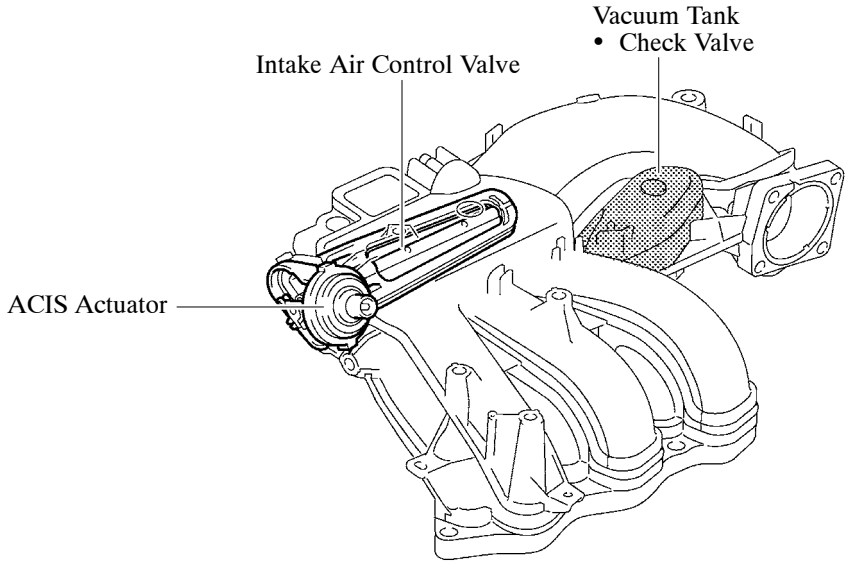
0240EG25C

Construction

1) Intake Air Control Valve and Vacuum Tank

The intake air control valve and the vacuum tank are installed in the intake air chamber.

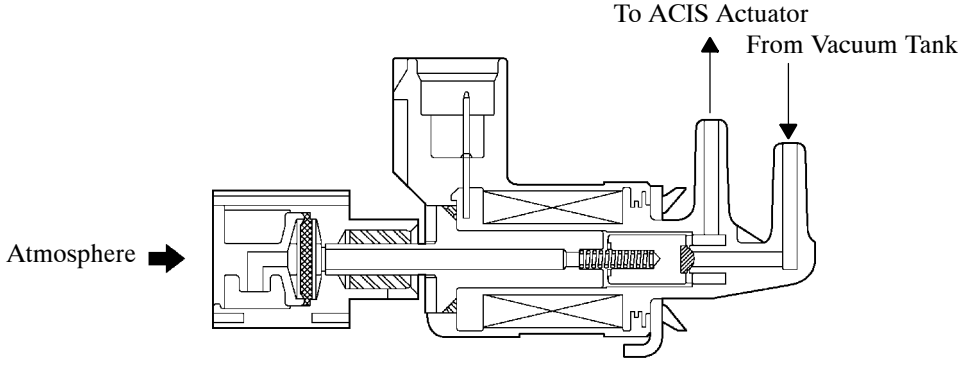
- The intake air control valve opens and closes to make two effective lengths of the intake manifold possible.
- The vacuum tank is equipped with an internal check valve. The check valve stores the vacuum that is used for application of the ACIS actuator in order to maintain the intake air control valve fully closed even during low-vacuum conditions.



238EG65

2) VSV (Vacuum Switching Valve)

Controls the vacuum that is applied to the ACIS actuator based on the ACIS signal that is output by the ECM.



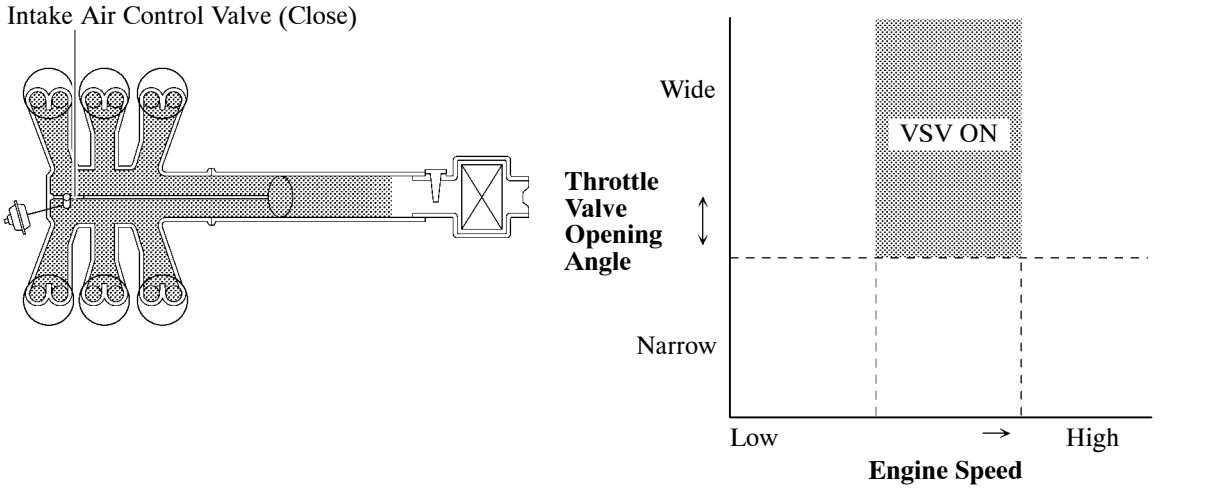
238EG78

Operation

1) Intake Air Control Valve Close (VSV ON)

The ECM activates the VSV to match the longer pulsation cycle of the intake air charge. The vacuum from the VSV acts on the diaphragm chamber of the ACIS actuator. This closes the intake air control valve. As a result, the effective length of the intake manifold is increased and the intake efficiency in the medium speed range is improved due to the dynamic effect (inertia) of the intake air, thereby increasing power output in this engine speed range.

: Effective Intake Manifold Length



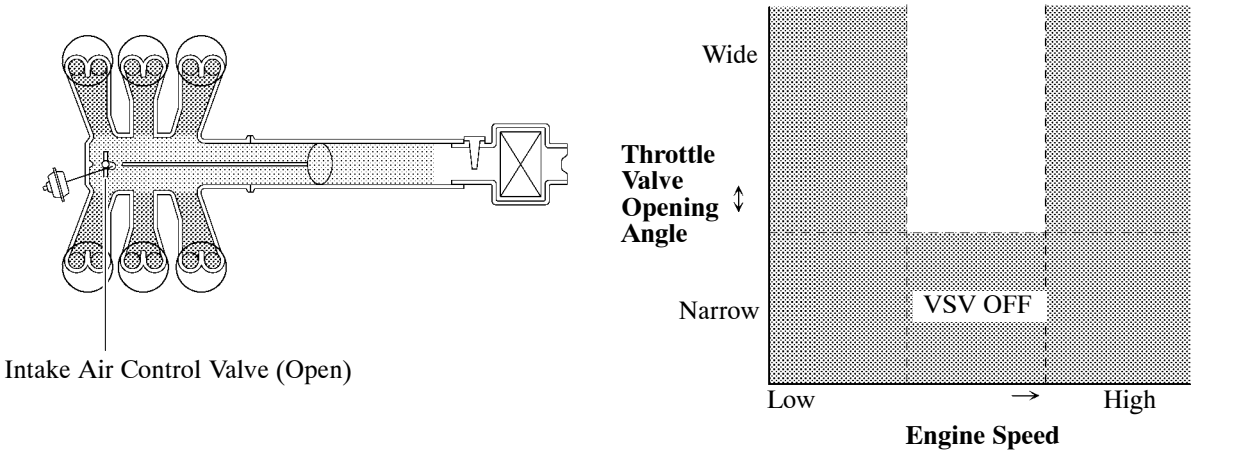
279EG22

2) Intake Air Control Valve Open (VSV OFF)

The ECM deactivates the VSV to match the shorter pulsation cycle of the intake air. Deactivating the VSV allows atmospheric air into the diaphragm chamber of the ACIS actuator opening the intake air control valve. When the intake air control valve is open, the effective length of the intake air chamber is shortened and peak intake efficiency is shifted to the low-to-high engine speed range, thus providing greater output at low-to-high engine speeds.

: Effective Intake Manifold Length

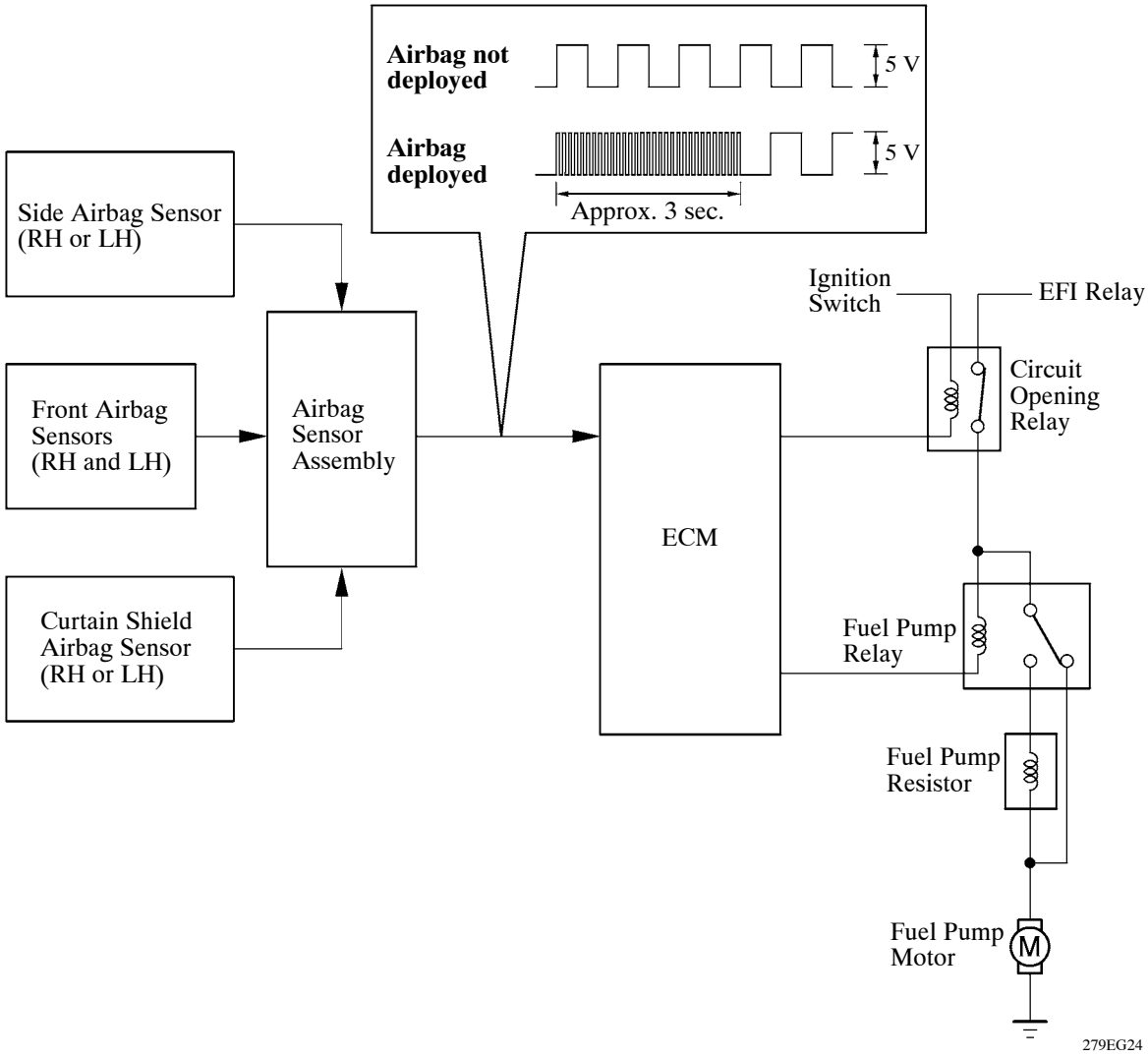
: Effective Intake Air Chamber Length



279EG23

10. Fuel Pump Control

- Fuel pump speed is controlled by the ECM, using the fuel pump relay and the fuel pump resistor.
- A fuel cut control is used to stop the fuel pump when any of the SRS airbags are deployed. In this control, if an airbag deployment signal from the Airbag Sensor Assembly is detected by the ECM, the ECM will turn 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.



11. Evaporative Emission Control System

General

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

- The charcoal canister stores the fuel vapor that has been created in the fuel tank.
- The ECM controls the EVAP valve in accordance with the driving conditions in order to direct the fuel vapor into the engine, where it is burned.
- Using this system, the ECM checks for evaporative emission leaks and stores DTC (Diagnostic Trouble Codes) in the event of a malfunction. An evaporative emission leak check consists of an application of a vacuum to the evaporative emission system and monitoring the system for changes in pressure in order to detect a leak.
- This system consists of an EVAP valve, charcoal canister, refueling valve, pump module, and ECM.
- An ORVR (Onboard Refueling Vapor Recovery) function is provided in the refueling valve.
- The pressure sensor has been integrated with the pump module.
- An air filter has been provided on the fresh air line. This air filter is maintenance-free.
- An EVAP service port is not used.
- The following are typical conditions that enable 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)

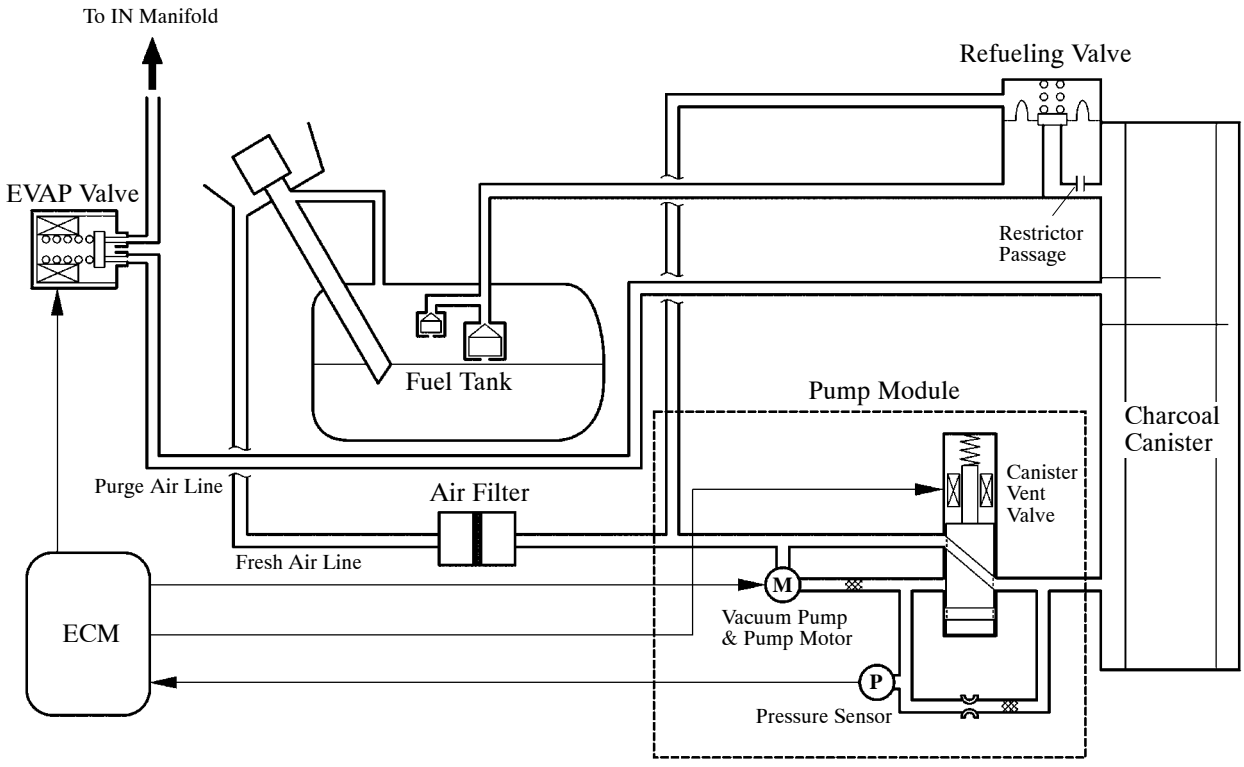
*: If engine coolant temperature does not drop below 35°C (95°F), this time should be extended to 7 hours. Even after that, if the temperature is not less than 35°C (95°F), the time should be extended to 9.5 hours.

Service Tip

The pump module performs a fuel evaporative emission leakage check. This check is done approximately five hours after the engine is turned off. Sound may be heard coming from underneath the vehicle near the fuel tank for several minutes. This does not indicate a malfunction.

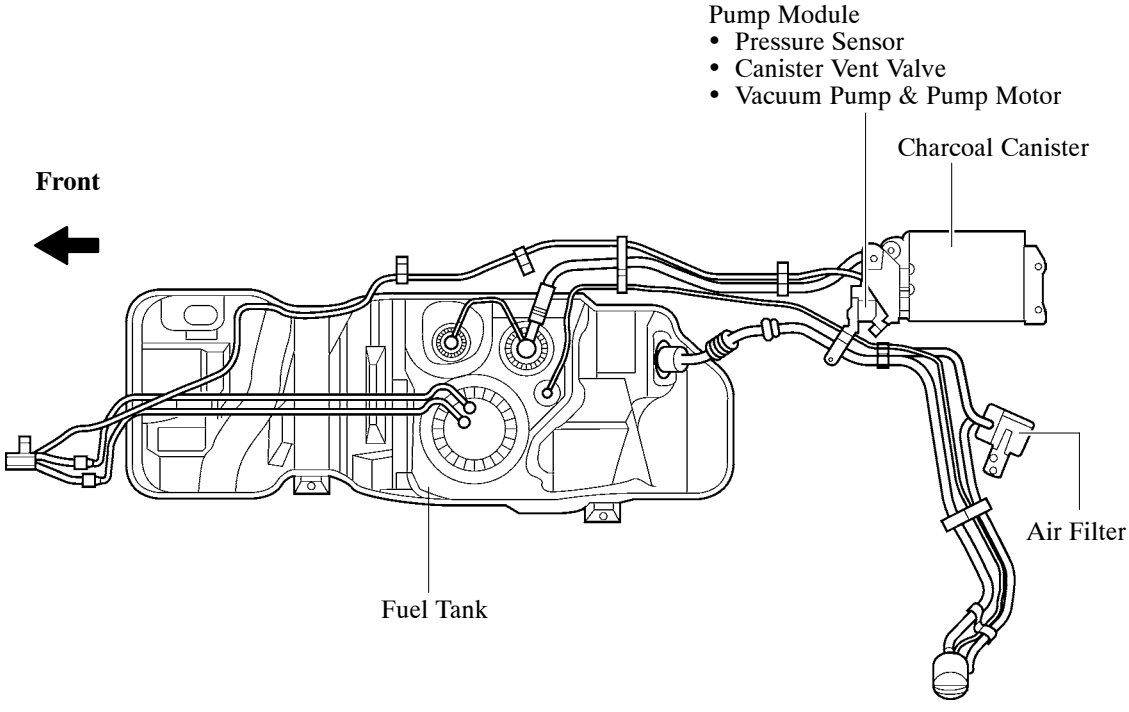
- Pinpoint pressure test procedure is adopted by pressurizing the fresh air line that runs from the pump module to the air filler neck. For details, see the 2007 FJ Cruiser Repair Manual (Pub. No. RM0240U).

System Diagram



060XA15C

Layout of Main Components



0240EG26C

Function of Main Components

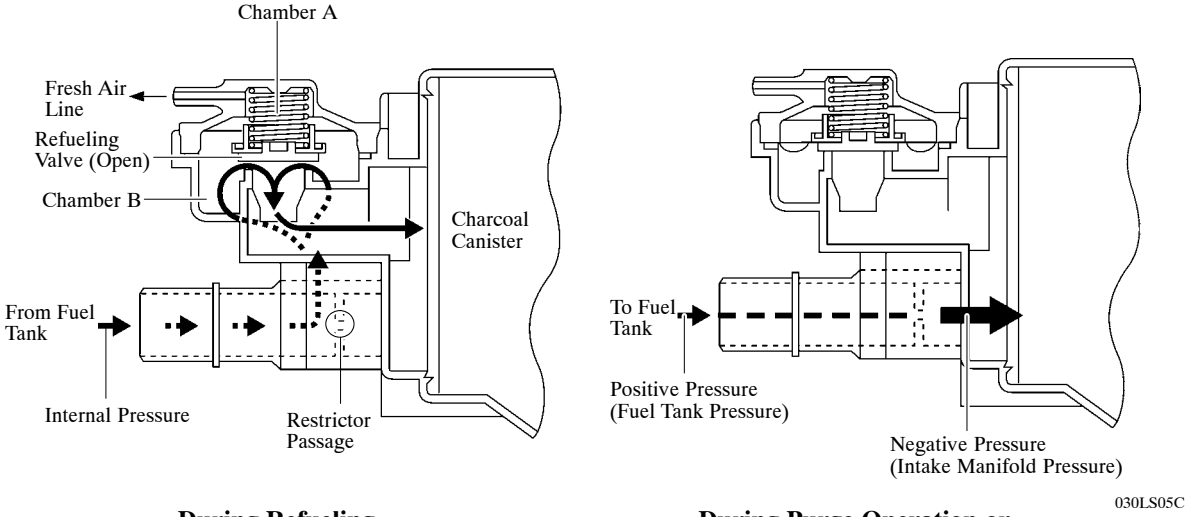
Component		Function
Charcoal Canister		Contains activated charcoal to absorb the fuel vapor that is created in the fuel tank.
Refueling Valve		Controls the flow rate of the fuel vapor from the fuel tank to the charcoal canister when the system is purging or during refueling.
	Restrictor Passage	Prevents 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 charcoal canister and the cleaned drain air goes out into the atmosphere.
Pump Module	Canister Vent Valve	Opens and closes the fresh air line in accordance with the signals from the ECM.
	Vacuum Pump & Pump Motor	Applies vacuum pressure to the evaporative emission system in accordance with the signals from the ECM.
	Pressure Sensor	Detects the pressure in the evaporative emission system and sends the signals to the ECM.
EVAP Valve		Opens in accordance with the signals from the ECM when the system is purging, in order to send the fuel vapor that was absorbed by the charcoal canister into the intake manifold. In system monitoring mode, this valve controls the introduction of the vacuum into the fuel tank.
Air Filter		Prevents dust and debris in the fresh air from entering the system.
ECM		Controls the pump module and the EVAP valve 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 stores a DTC if a malfunction is found.

Construction and Operation

1) Refueling Valve

The refueling valve consists of chamber A, chamber B, and a 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 charcoal 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 fuel vapor from the fuel tank to the charcoal canister. If a large volume of fuel vapor enters 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.

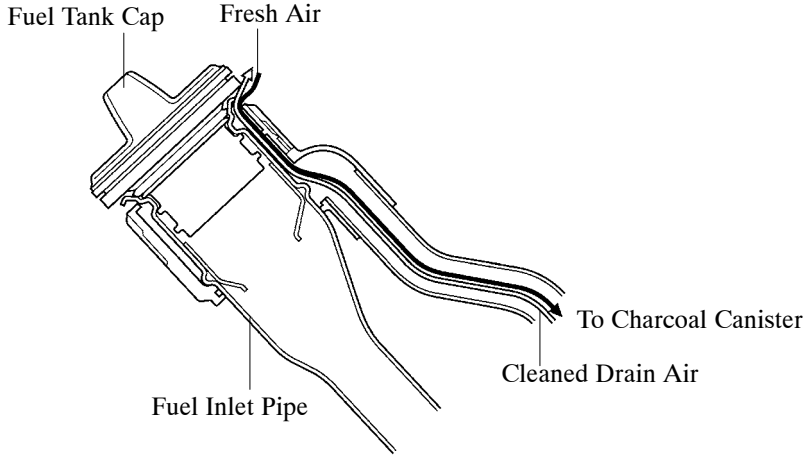


During Refueling

During Purge Operation or System Monitoring Operation

2) Fuel Inlet (Fresh Air Inlet)

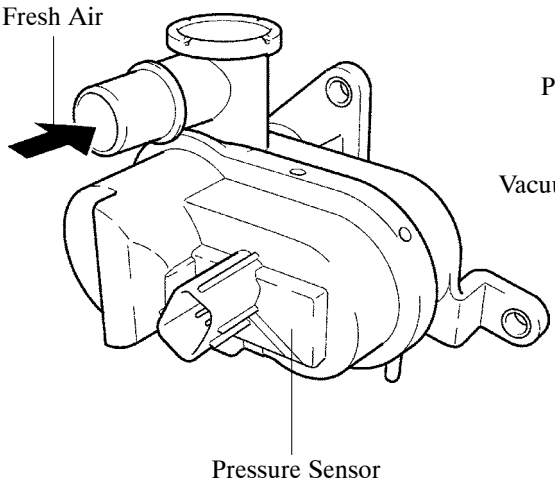
This evaporative emission control system has its fresh air line inlet located near the fuel inlet. The fresh air from the atmosphere and drain air cleaned by the charcoal canister will go in and out of the system through the passage shown below.



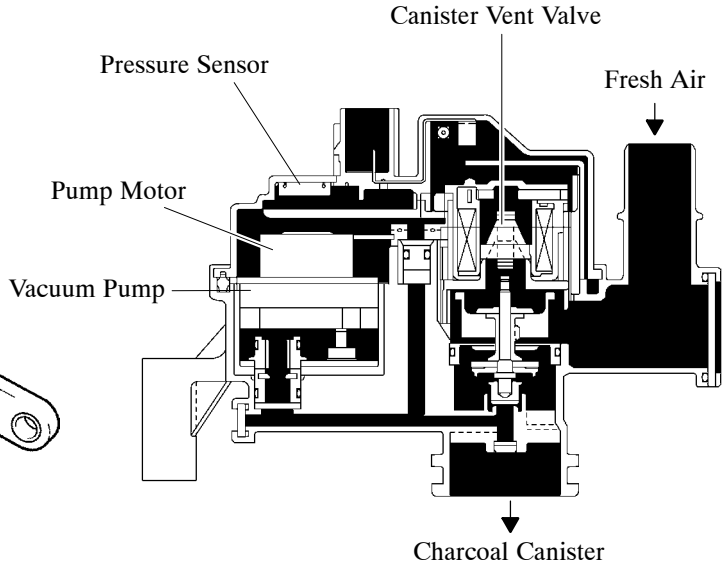
3) Pump Module

The pump module consists of the canister vent valve, pressure sensor, vacuum pump, and pump motor.

- The canister 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.

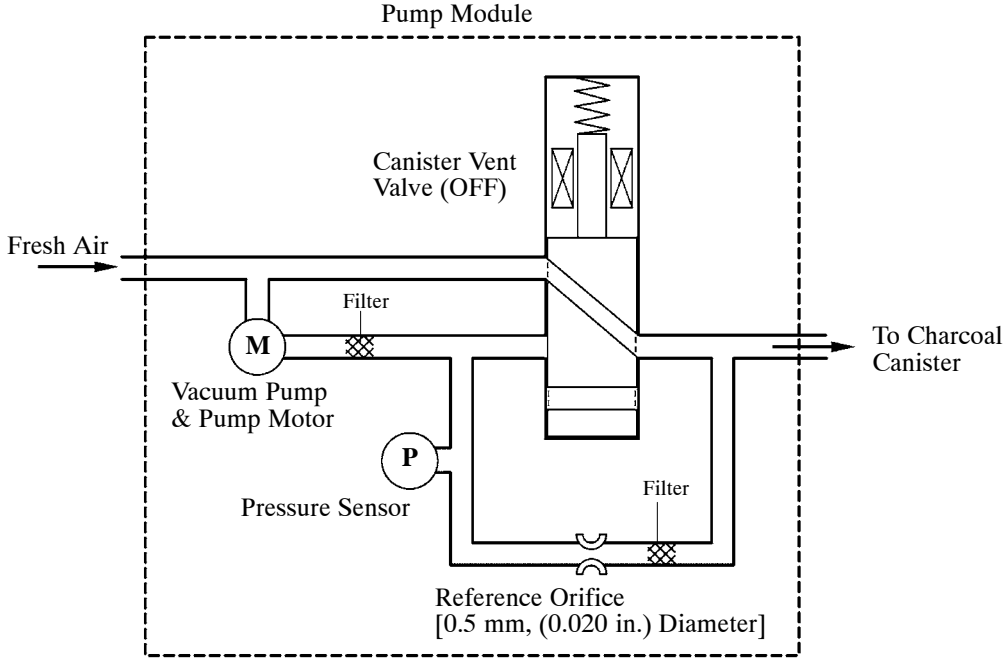


D13N15



D13N16

▶ Simple Diagram ◀

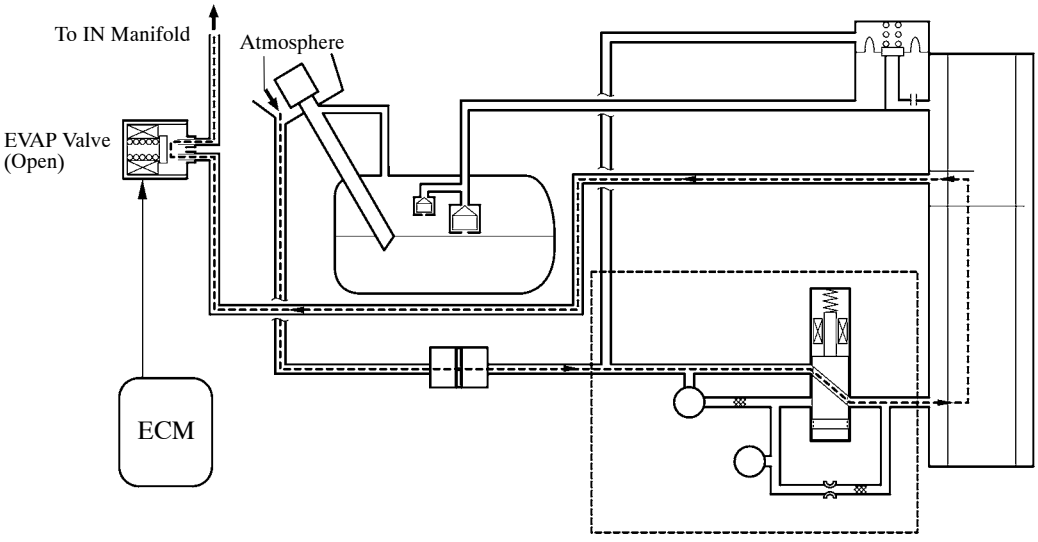


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System Operation

1) Purge Flow Control

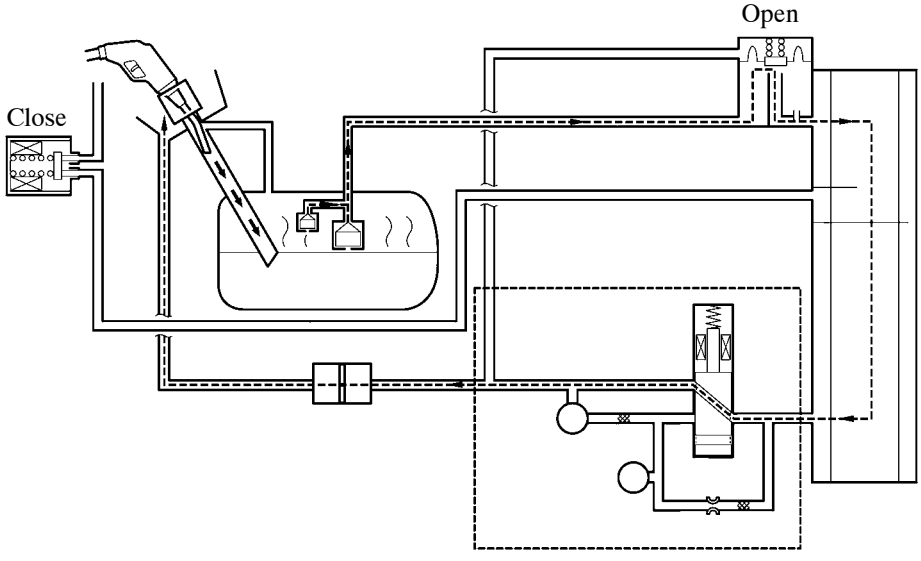
When the engine has reached a predetermined state (closed loop, engine coolant temp. above 80°C (176 °F), etc), stored fuel vapor is purged from the charcoal canister whenever the EVAP valve is opened by the ECM.
The ECM will change the duty ratio cycle of the EVAP valve, thus controlling purge flow volume. Purge flow volume is determined by intake manifold pressure and the duty ratio cycle of the EVAP valve. Atmospheric pressure is allowed into the charcoal canister to ensure that purge flow is constantly maintained whenever purge vacuum is applied to the charcoal canister.



060XA17C

2) ORVR (Onboard 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. This allows the fuel vapor to enter the charcoal canister. The air that has been cleaned through the charcoal canister is discharged outside the vehicle via the fresh air line because the canister vent valve is always open when the system is in a mode other than the monitoring mode (even when the engine is stopped). If the vehicle is refueled in system monitoring mode, the ECM will recognize the refueling by way of the pressure sensor, which detects the sudden pressure increase in the fuel tank, and will open the canister vent valve.



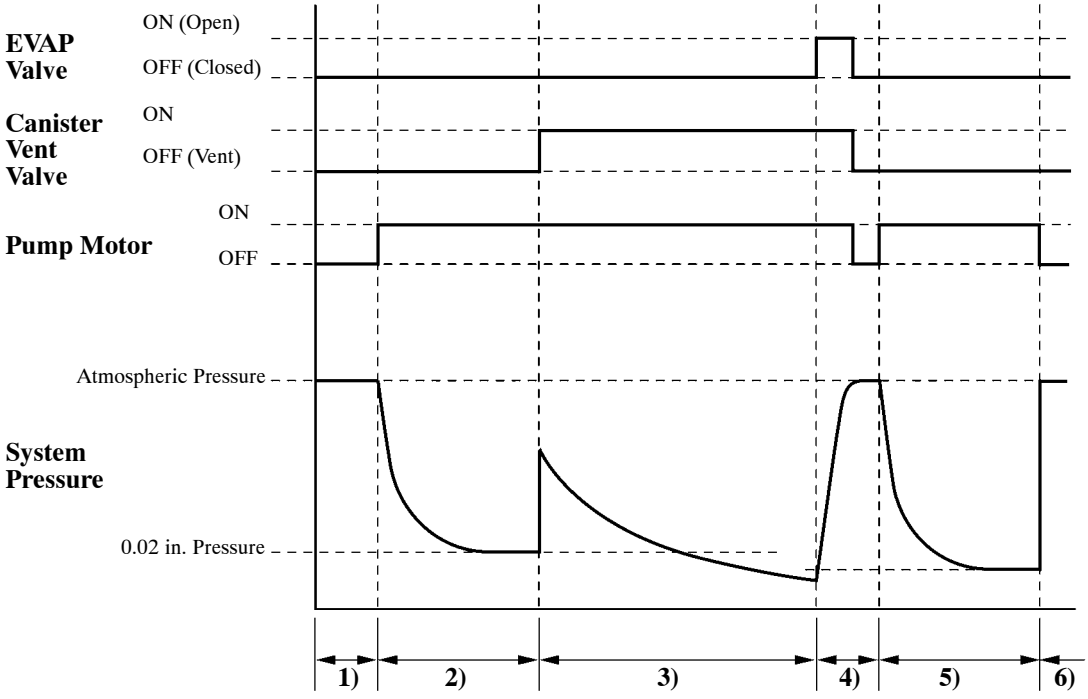
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3) EVAP Leak Check

a. General

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

▶ Timing Chart ◀

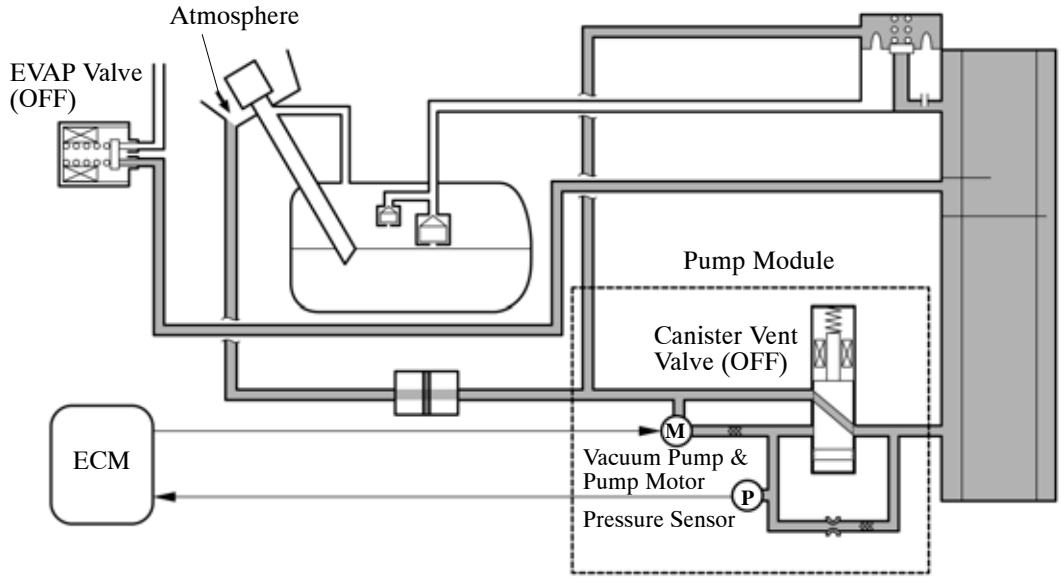


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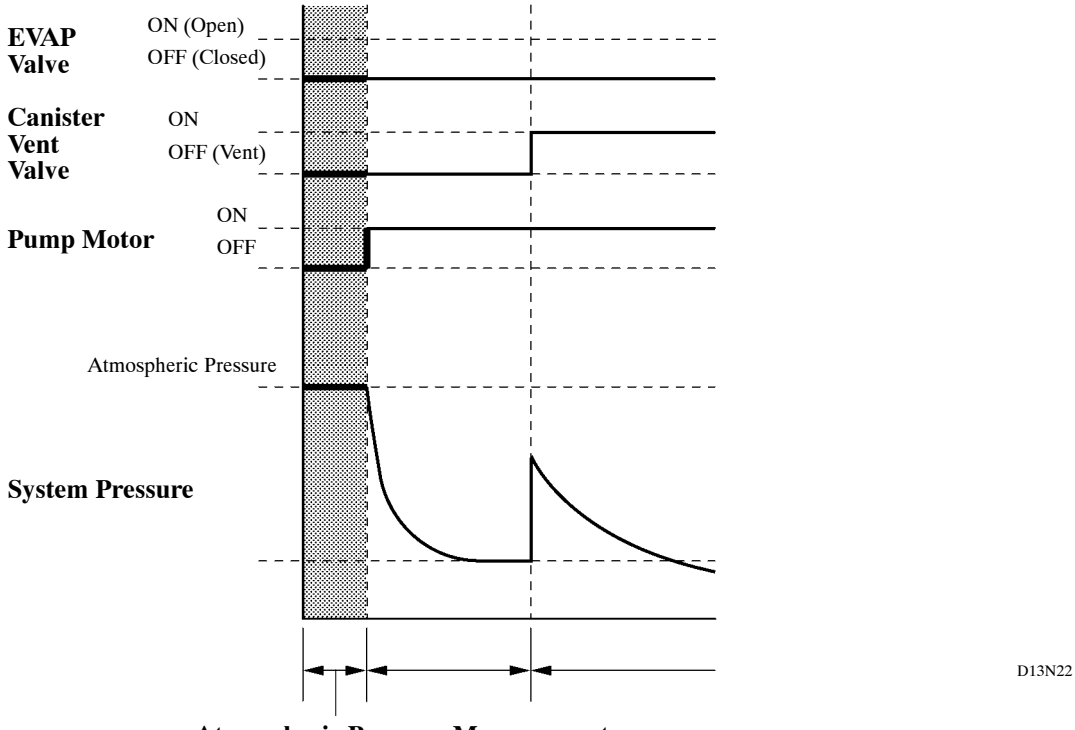
Order	Operation	Description	Time
1)	Atmospheric Pressure Measurement	The ECM turns the canister vent valve OFF (vent) and measures EVAP system pressure to determine the atmospheric pressure.	—
2)	0.02 in. Leak Pressure Measurement	The vacuum pump creates negative pressure (vacuum), which is limited by a 0.02 in. orifice. The pressure is measured, and the ECM determines this as the 0.02 in. leak pressure.	20 sec.
3)	EVAP Leak Check	The vacuum pump creates negative pressure (vacuum) in EVAP system and EVAP system pressure is measured. If the pressure after stabilization is greater than the 0.02 in. leak pressure, the ECM determines that the EVAP system has a leak. If EVAP pressure does not stabilize within 15 minutes, ECM cancels EVAP monitor.	Within 15 min.
4)	EVAP Valve Monitor	The ECM opens the EVAP valve and measures the EVAP pressure increase. If the increase is large, ECM interprets this as normal.	10 sec.
5)	Repeat 0.02 in. Leak Pressure Measurement	The vacuum pump creates negative pressure (vacuum) that passes through the 0.02 in. orifice and pressure is measured. The ECM determines this as 0.02 in. leak pressure.	20 sec.
6)	Final Check	The ECM measures atmospheric pressure and records the result of the monitor operation.	—

b. Atmospheric Pressure Measurement

1) When the ignition switch is turned OFF, the EVAP valve and the canister vent valve are turned OFF. Therefore, atmospheric pressure is introduced into the charcoal canister.
2) The ECM records the atmospheric pressure measured by the pressure sensor.
3) If the measurement value is out of range, the ECM actuates the vacuum pump in order to monitor the changes in the pressure.



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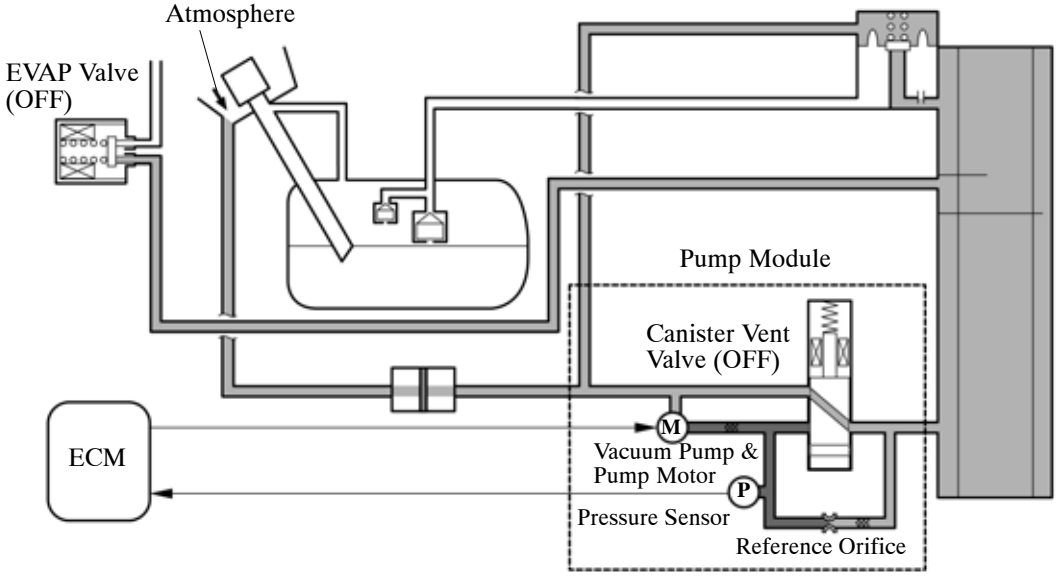
D13N22

Atmospheric Pressure Measurement

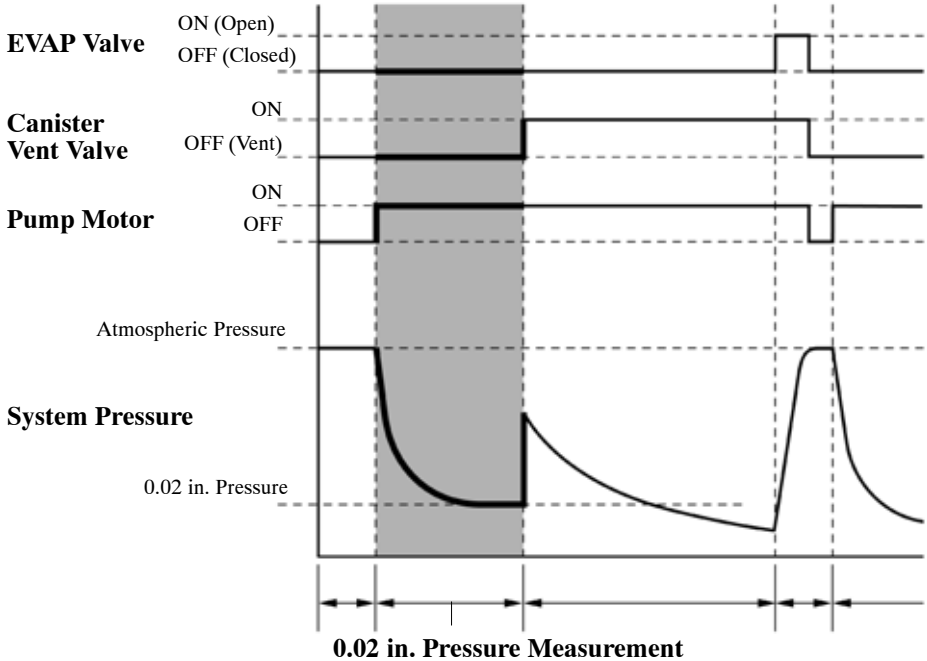
c. 0.02 in. Leak Pressure Measurement

The purpose of this measurement is to confirm vacuum pump operation, and to provide a baseline measurement value that will be used for comparison in subsequent leak test steps.

1) The canister vent valve remains off, the ECM allows atmospheric pressure into the charcoal canister and actuates the vacuum pump, creating a vacuum in the piping close to the pressure sensor.
2) At this time, the pressure will not decrease below what is referred to as the 0.02 in. pressure due to the atmospheric pressure that enters the piping close to the pump and sensor through the 0.02 in. diameter reference orifice.
3) The ECM compares its standard and this pressure. If the pressure is within the acceptable range the ECM stores this pressure as the 0.02 in. leak pressure in its memory.
4) If the pressure 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 pressure is above the standard, the ECM will determine that a high flow rate is passing through the reference orifice and store DTCs P043F, P2401 and P2402 in its memory.



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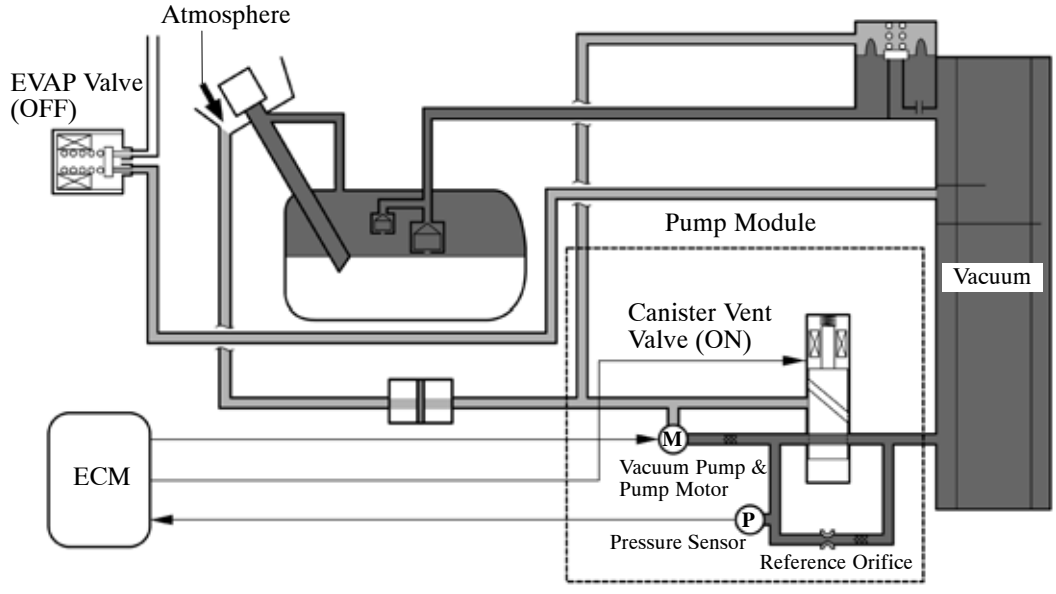


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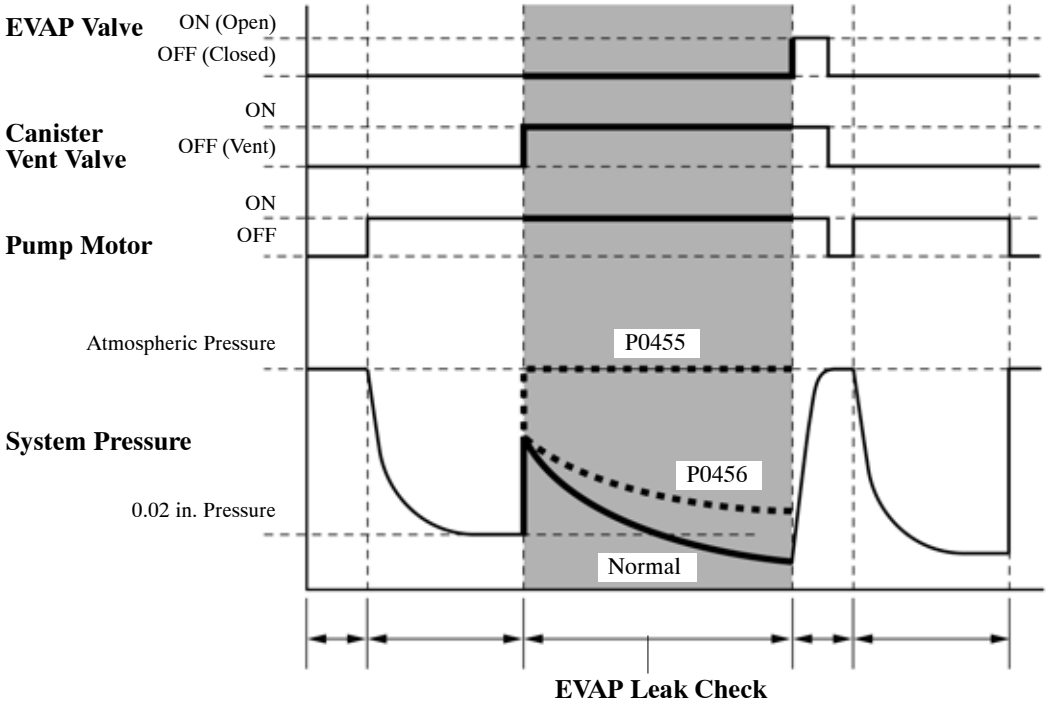
0.02 in. Pressure Measurement

d. EVAP Leak Check

1) While actuating the vacuum pump, the ECM turns the canister vent valve on in order to introduce a vacuum into the charcoal canister.
2) When the pressure in the system stabilizes, the ECM compares this pressure and the 0.02 in. pressure in order to determine if leakage is occurring.
3) If the detected value is below the 0.02 in. pressure, the ECM determines that a leak is not occurring.
4) If the detected value is above the 0.02 in. pressure and near atmospheric pressure, the ECM determines that there is a gross leak (large hole) and stores DTC P0455 in its memory.
5) If the detected value is above the 0.02 in. pressure, the ECM determines that there is a small leak (minor leakage) and stores DTC P0456 in its memory.



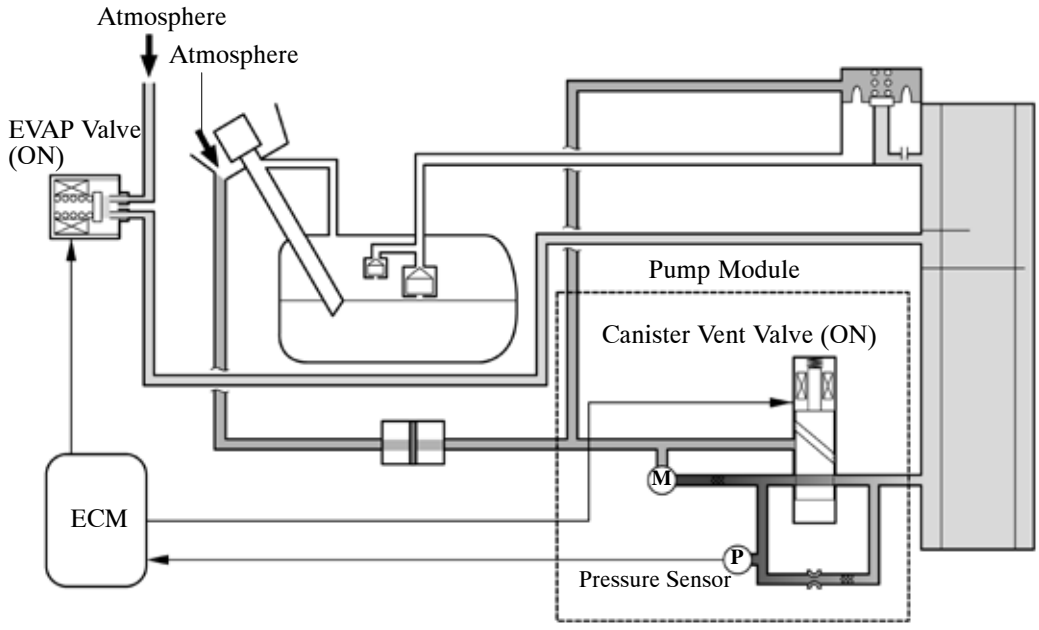
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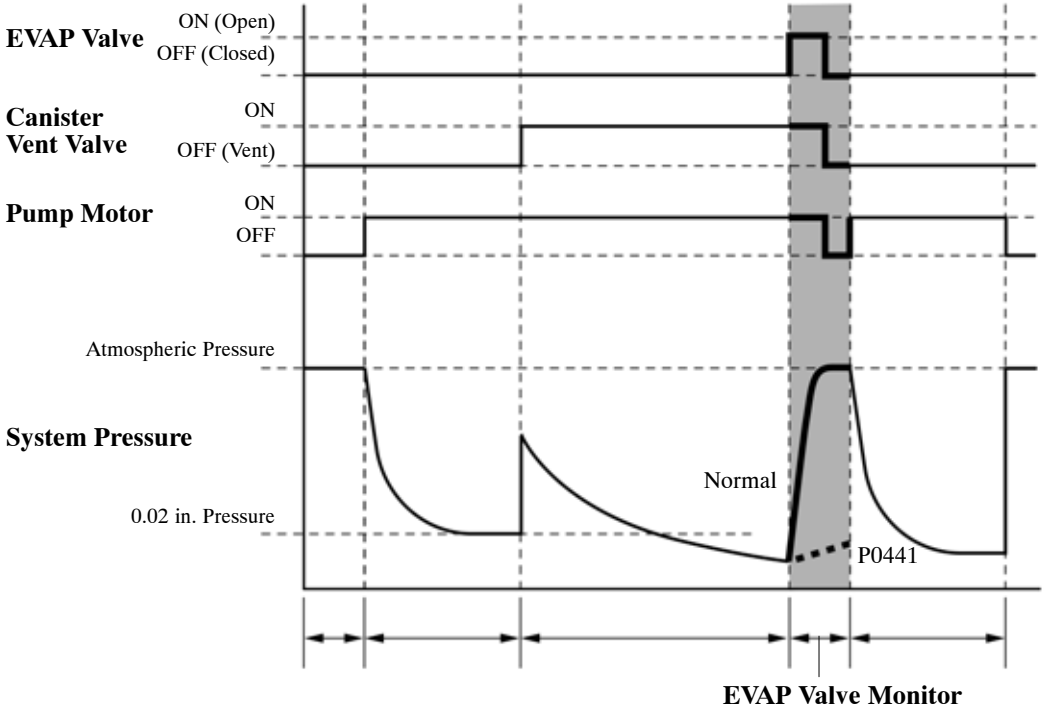
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e. EVAP Valve Monitor

1) After completing an EVAP leak check, the ECM turns the EVAP valve on with the vacuum pump still actuated, and introduces atmospheric pressure from the intake manifold to the charcoal canister.
2) If the pressure change at this time is within the normal range (a pressure change occurs), the ECM determines the condition of the EVAP valve to be normal.
3) If the pressure change is out of the normal range (insufficient pressure change occurs), the ECM will stop the EVAP valve monitor and store DTC P0441 in its memory.



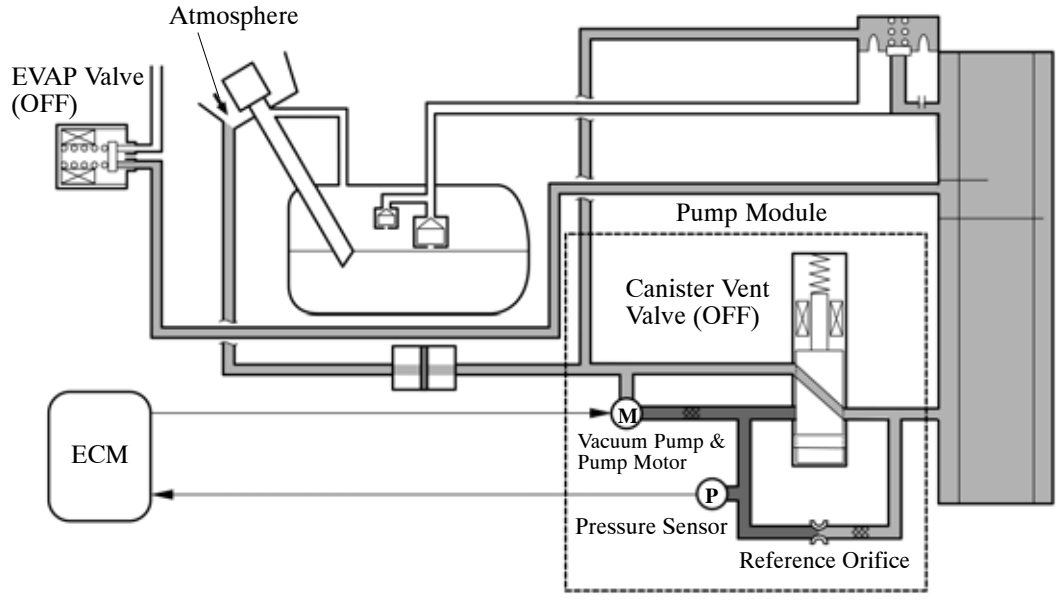
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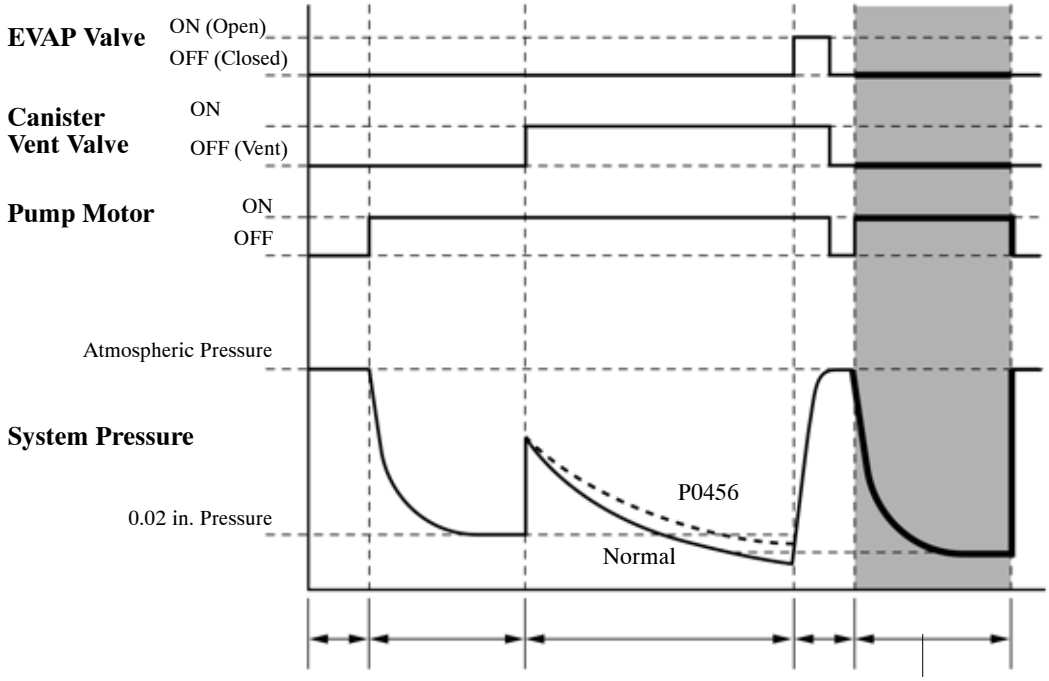
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f. Repeat 0.02 in. Leak Pressure Measurement

1) While the ECM operates the vacuum pump, the EVAP valve and canister vent valve are turned 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 leak and stores DTC P0456 in its memory.



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12. Diagnosis

- When the ECM detects a malfunction, the ECM records the fault and memorizes the information that relates to the fault. Furthermore, it illuminates or blinks the MIL (Malfunction Indicator Lamp) in the combination meter to inform the driver.
- The ECM will also store the DTCs (Diagnostic Trouble Codes) of the malfunctions. The DTCs can be accessed using the hand-held tester.
- For details, see the 2007 FJ Cruiser Repair Manual (Pub. No. RM0240U).

Service Tip

- The ECM uses the CAN protocol for diagnostic communication. Therefore, a hand-held tester and a dedicated adapter [CAN VIM (Vehicle Interface Module)] are required for accessing diagnostic data.
- To clear a DTC that is stored in the ECM, use a hand-held tester, disconnect the battery terminal or remove the EFI fuse for 1 minute or longer.

For details, see the 2007 FJ Cruiser Repair Manual (Pub. No. RM0240U).

13. Fail-Safe

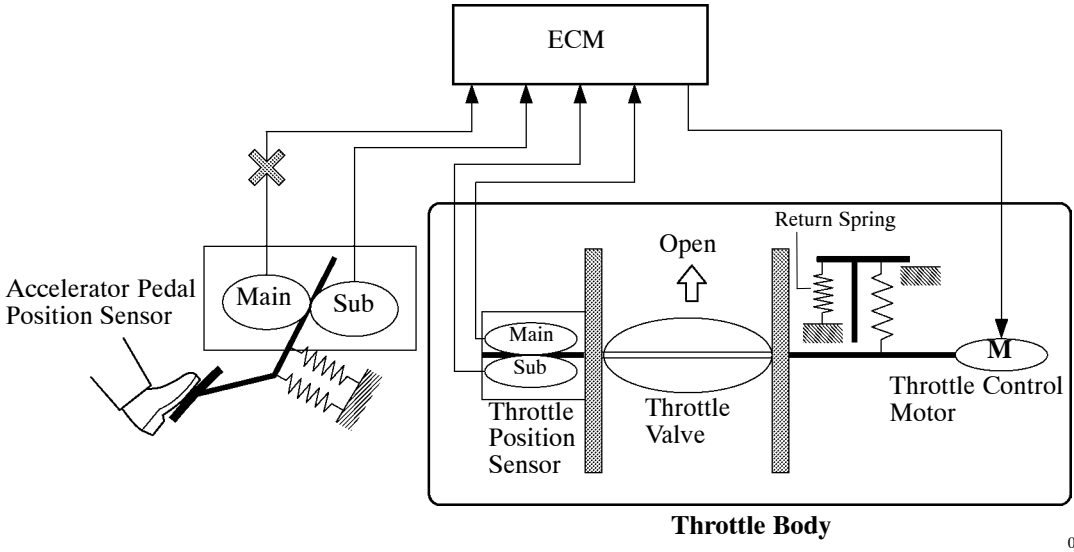
General

When the ECM detects a malfunction, the ECM stops or controls the engine according to the data already stored in the memory.
For details of the fail-safe chart, see the 2007 FJ Cruiser Repair Manual (Pub. No. RM0240U).

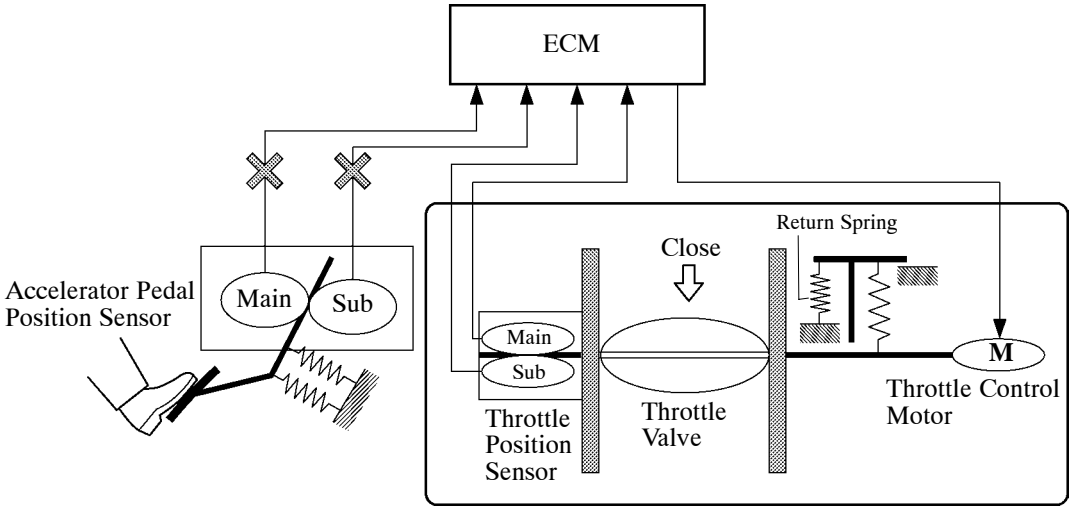
Fail-safe Operation due to Accelerator Pedal Position Sensor Trouble

The accelerator pedal position sensor contains two (Main, Sub) sensor circuits.

- If a malfunction occurs in either of the sensor circuits, the ECM detects the abnormal signal voltage difference between these two sensor circuits and switches into a fail-safe mode. In this fail-safe mode, the remaining circuit is used to calculate the accelerator pedal opening, in order to operate the vehicle under fail-safe mode control.



- If both circuits malfunction, the ECM detects the abnormal signal voltage from these two sensor circuits and discontinues throttle control. At this time, the vehicle can be driven using the power generated by the engine at idle.



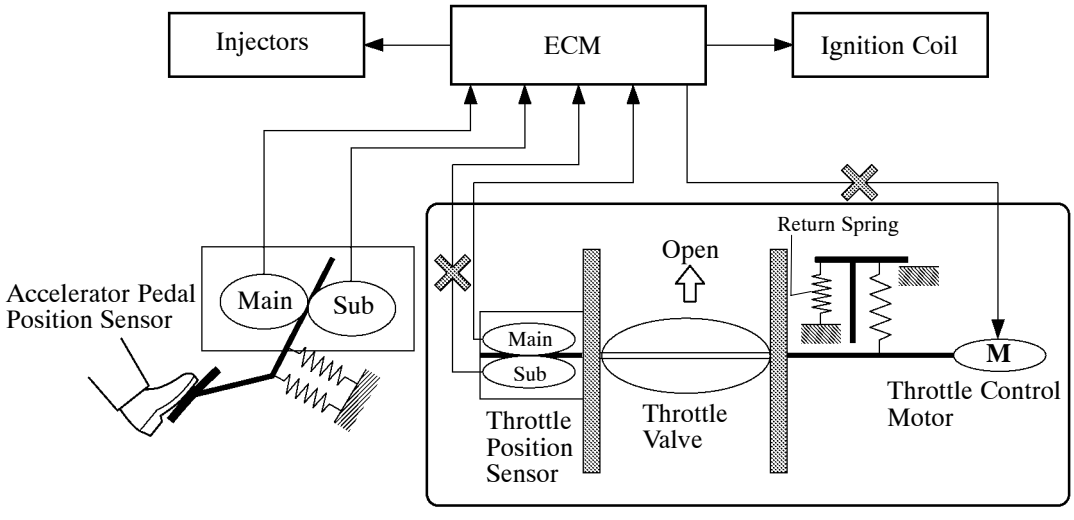
Throttle Body

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Fail-safe Operation due to Throttle Position Sensor Trouble

The throttle position sensor contains two (Main, Sub) sensor circuits.

- If a malfunction occurs in either 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 a fail-safe mode.
- Then, the force of the return spring causes the throttle valve to return and stay at its prescribed base opening position. At this time, the vehicle can be driven in the failsafe mode while the engine output is regulated through control of the fuel injection and ignition timing in accordance with the accelerator pedal position.
- The same control as above is effected if the ECM detects a malfunction in the throttle control motor.



Throttle Body

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