■ENGINE CONTROL SYSTEM

1. General

The engine control system of the 4GR-FSE engine has the following features. The Engine ECU that controls this system is made by DENSO.

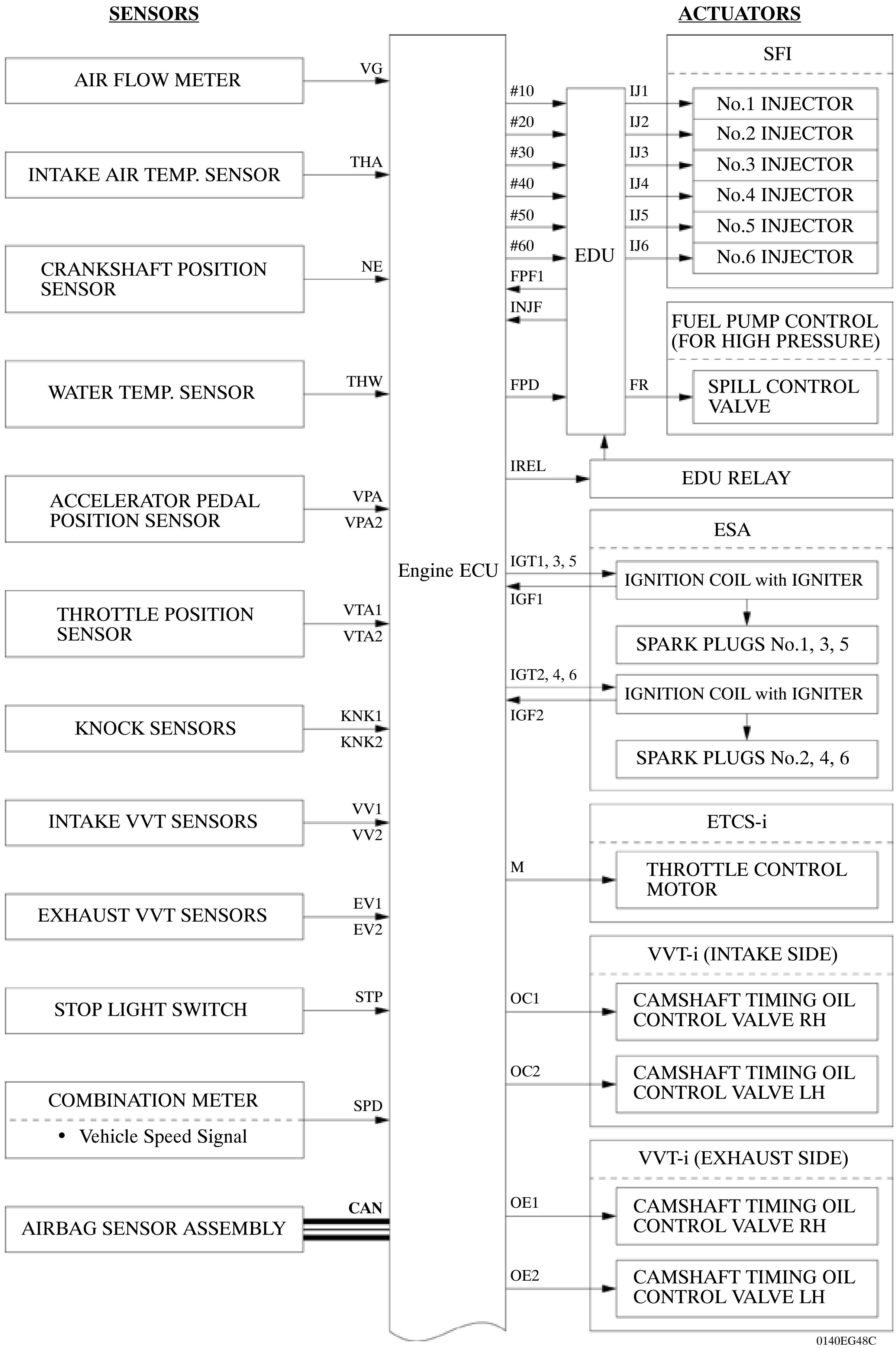
System		Outline
D-4 EFI (Electric Fuel Injection) [See page EG-61]		• An L-type EFI system directly detects the intake air volume with a hot-wire type mass air flow meter. • Unlike a conventional gasoline engine, the D-4 fuel injection system must precisely control both the injection timing and injection volume. • Based on the signals from various sensors, the Engine ECU controls the injection volume and injection timing to suit the engine speed and the engine load, in order to achieve an optimal state of combustion.
ESA (Electronic Spark Advance)		• Ignition timing is determined by the Engine ECU based on signals from various sensors. The Engine ECU corrects ignition timing in response to engine knocking. • This system selects the optimal ignition timing in accordance with the signals received from the sensors and sends (IGT) ignition signal to the igniter.
ETCS-i (Electronic Throttle Control System-intelligent) [See page EG-62]		Optimally controls the opening angle of the throttle valve in accordance with the accelerator pedal input and the engine and vehicle conditions.
Dual VVT-i (Variable Valve Timing-intelligent) [See page EG-65]		Controls the intake and exhaust camshafts to an optimal valve timing in accordance with the engine condition.
ACIS (Acoustic Control Induction System) [See page EG-71]		The intake air passages are switched based on engine speed and throttle valve opening angle to provide high performance in all engine speed ranges.
Electronic SCV (Swirl Control Valve) System [See page EG-73]		Optimally controls the air currents (to assist mixture stratification) in the combustion chamber by closing one of the independent intake ports in accordance with the engine coolant temperature and engine condition, in order to stabilize the combustion and improve performance.
Fuel Pump Control	For High Pressure Side	Regulates the fuel pressure within a range of 4 to 13 MPa in accordance with driving conditions.
	For Low Pressure Side [See page EG-75]	• Fuel pump operation is controlled by signals from the Engine ECU. • The fuel pump is stopped, when an SRS airbag is deployed in a frontal, side, or rear side collision.
Air Conditioning Cut-off Control		By turning the air conditioning compressor ON or OFF in accordance with the engine conditions, drivability is maintained.
Cooling Fan Control [See page EG-76]		Cooling fan operation is controlled by signals from the Engine ECU based on the engine coolant temperature sensor signal and air conditioner operation.
Starter Control (Cranking Hold Function) [See page EG-77]		Once the engine switch is pushed, this control operates the starter until the engine starts.
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.

(Continued)

System	Outline
Charging Control [See page EG-79]	The Engine ECU regulates the charging voltage of the alternator in accordance with the driving conditions and the charging state of the battery.
Evaporative Emission Control	The Engine ECU controls the purge flow of evaporative emission (HC) in the charcoal canister in accordance with engine conditions.
Engine Immobilizer	Prohibits fuel delivery and ignition if an attempt is made to start the engine with an invalid ignition key.
Diagnosis [See page EG-81]	When the Engine ECU detects a malfunction, the Engine ECU diagnoses and memorizes the information that relates to the fault.
Fail-Safe [See page EG-81]	When the Engine ECU detects a malfunction, the Engine ECU 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.



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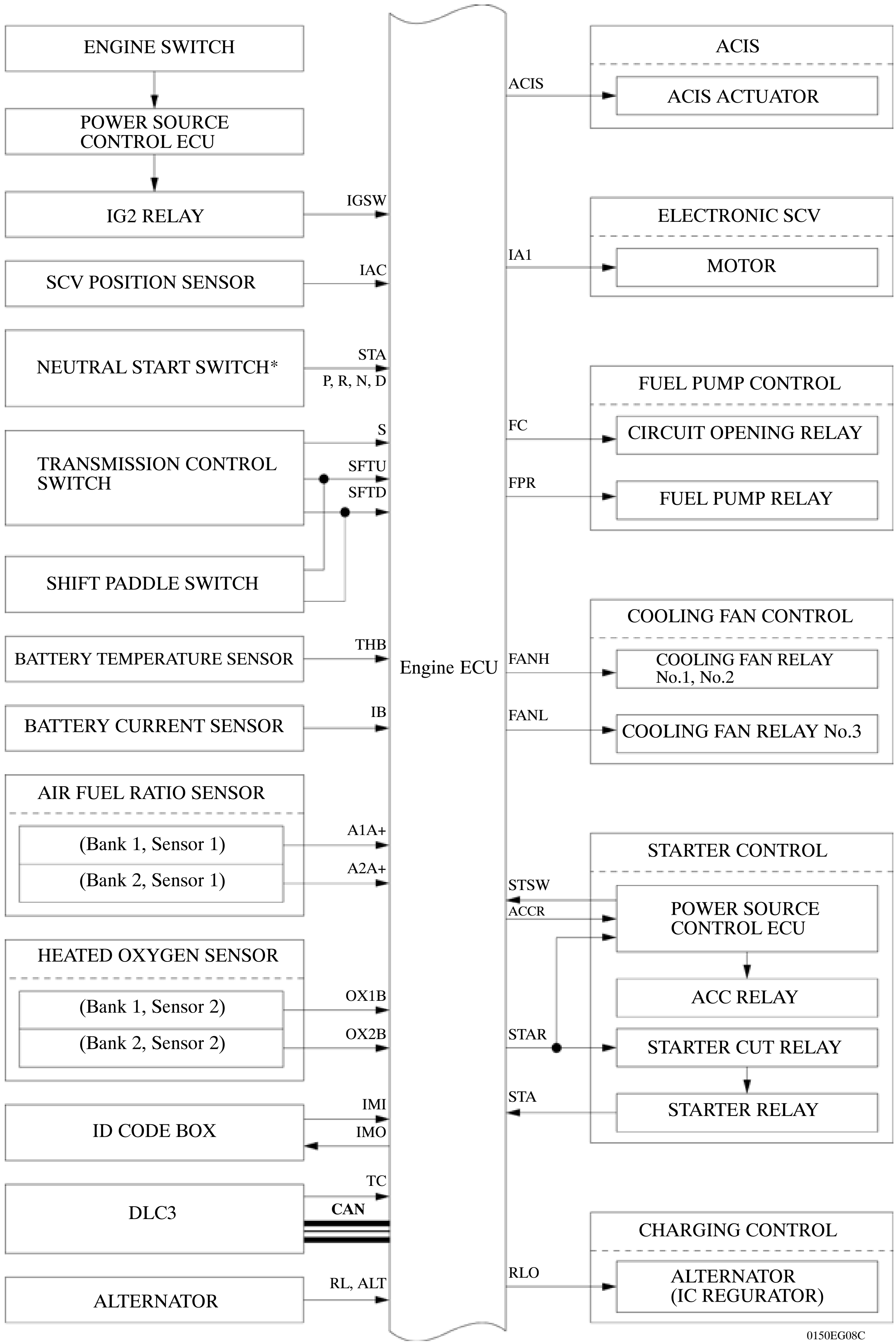
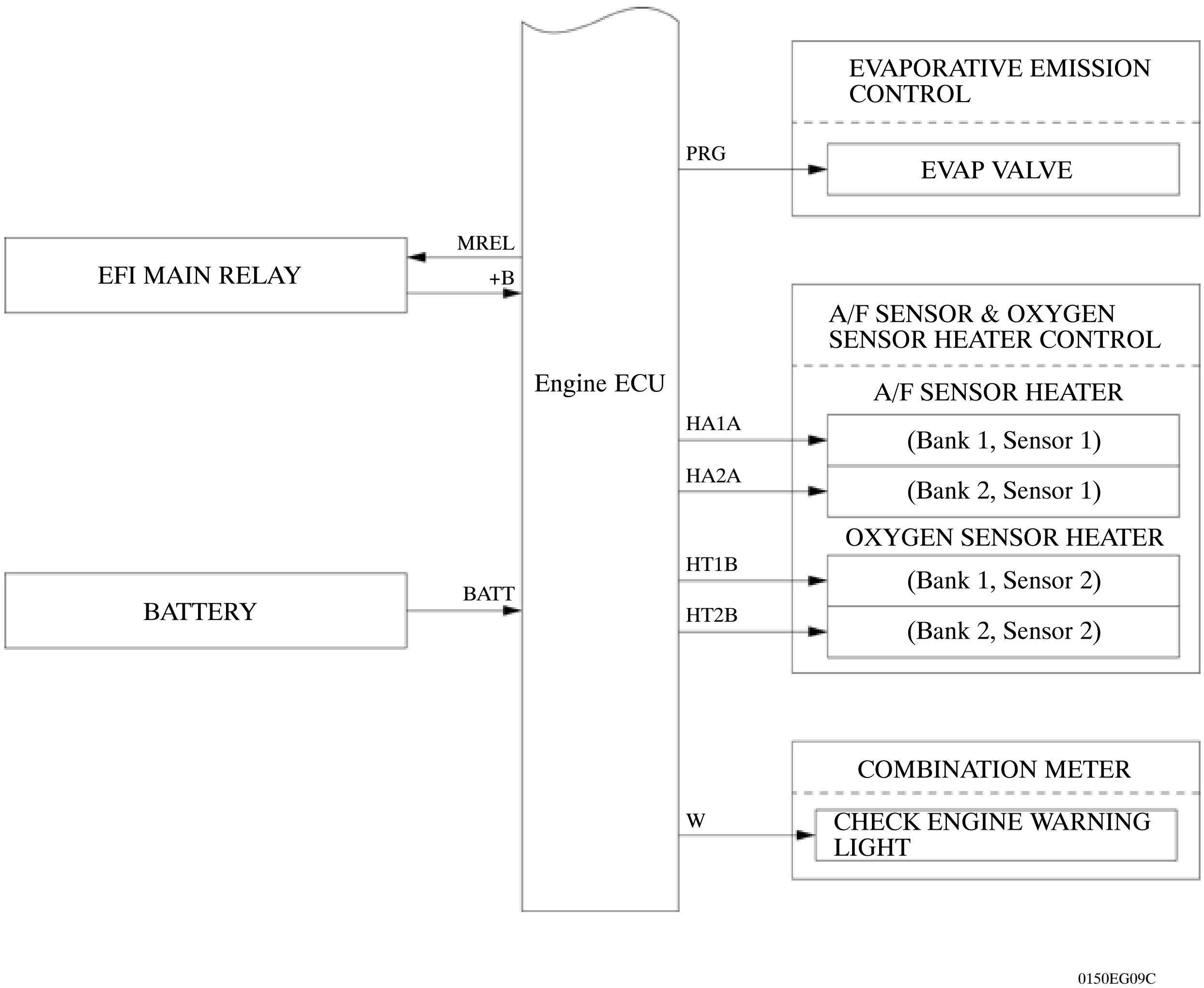
EG

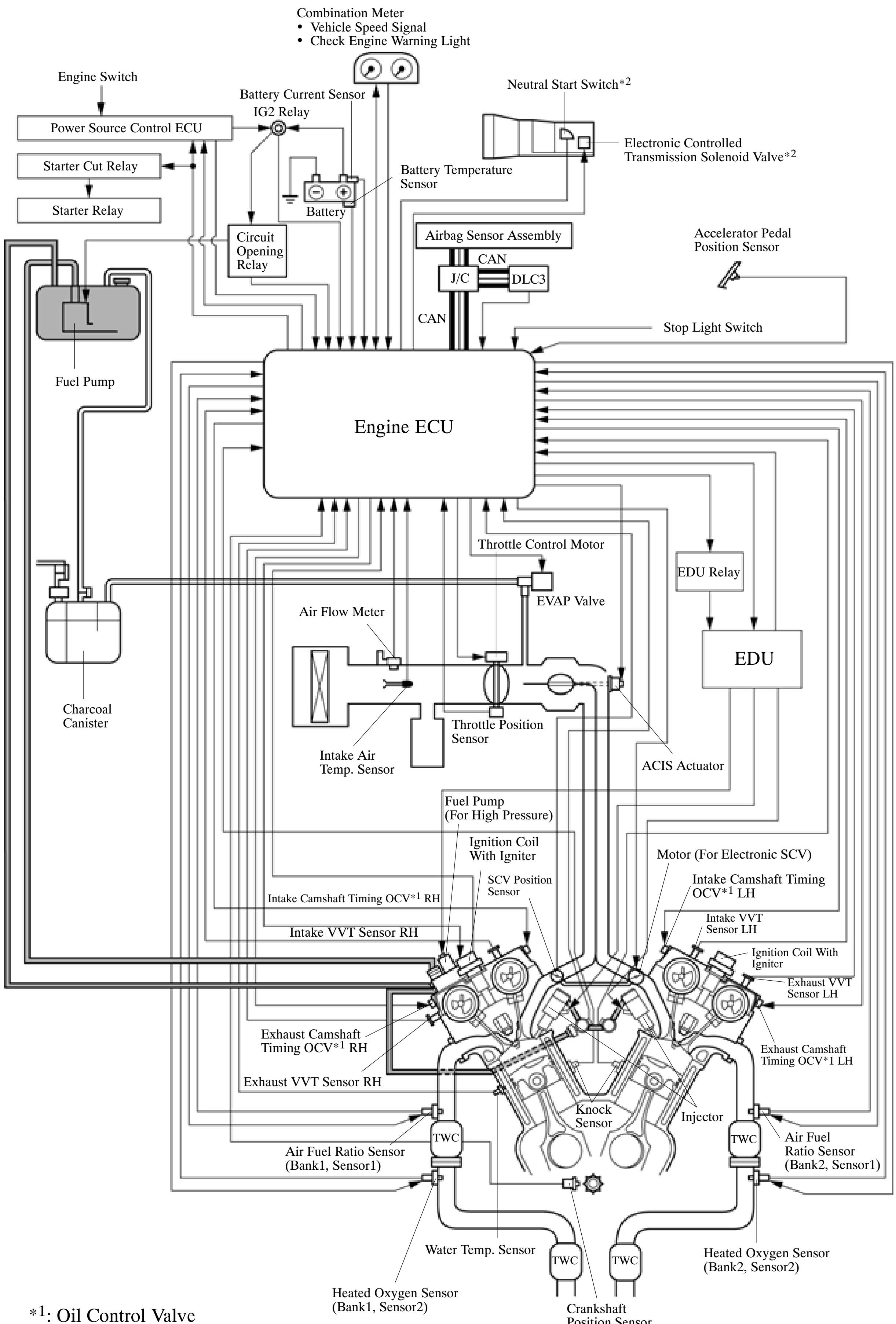


*: Only for A/T Models

(Continued)


EVAPORATIVE EMISSION CONTROL
PRG
EVAP VALVE
EFI MAIN RELAY
MREL
+B
A/F SENSOR & OXYGEN SENSOR HEATER CONTROL
A/F SENSOR HEATER
Engine ECU
HA1A
(Bank 1, Sensor 1)
HA2A
(Bank 2, Sensor 1)
OXYGEN SENSOR HEATER
HT1B
(Bank 1, Sensor 2)
BATTERY
BATT
HT2B
(Bank 2, Sensor 2)
COMBINATION METER
W
CHECK ENGINE WARNING LIGHT
0150EG09C

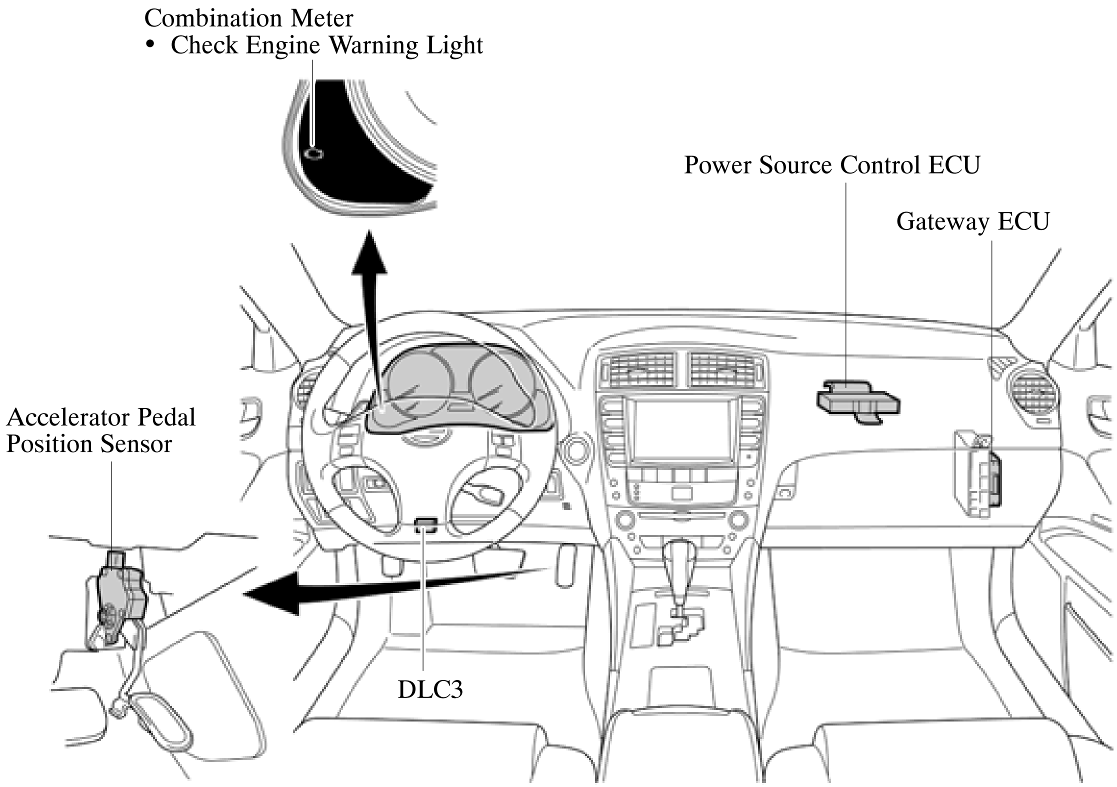
3. Engine Control System Diagram



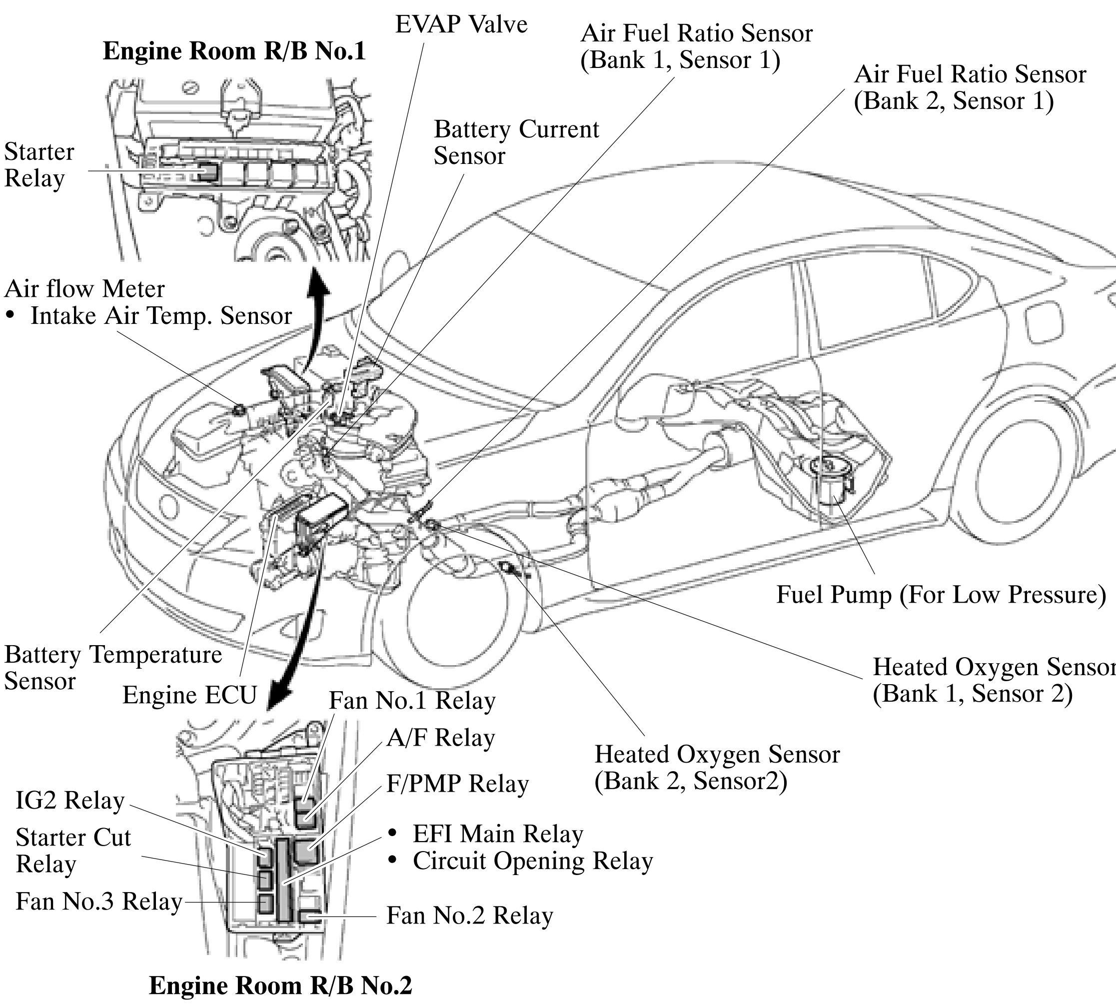
*1: Oil Control Valve
*2: Only for A/T Models

0150EG10C

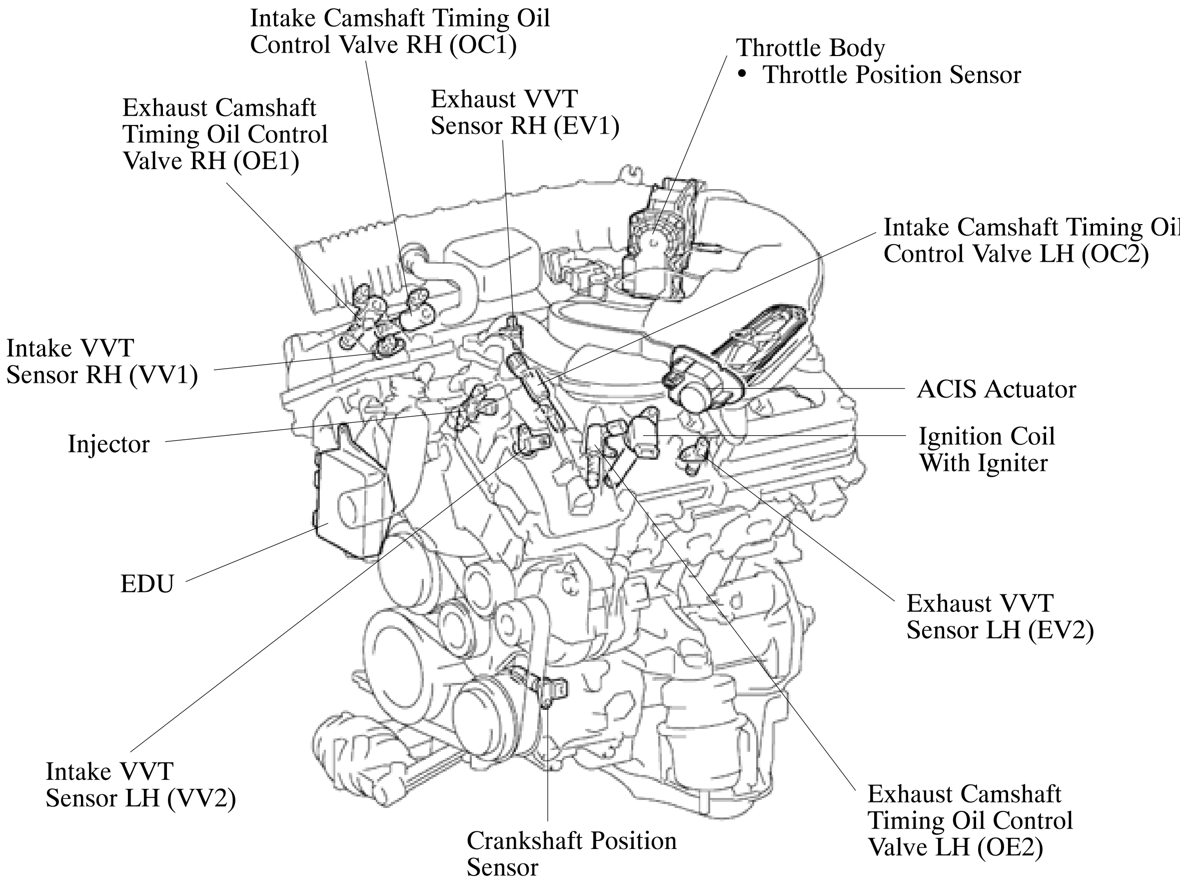
4. Layout of Main Components

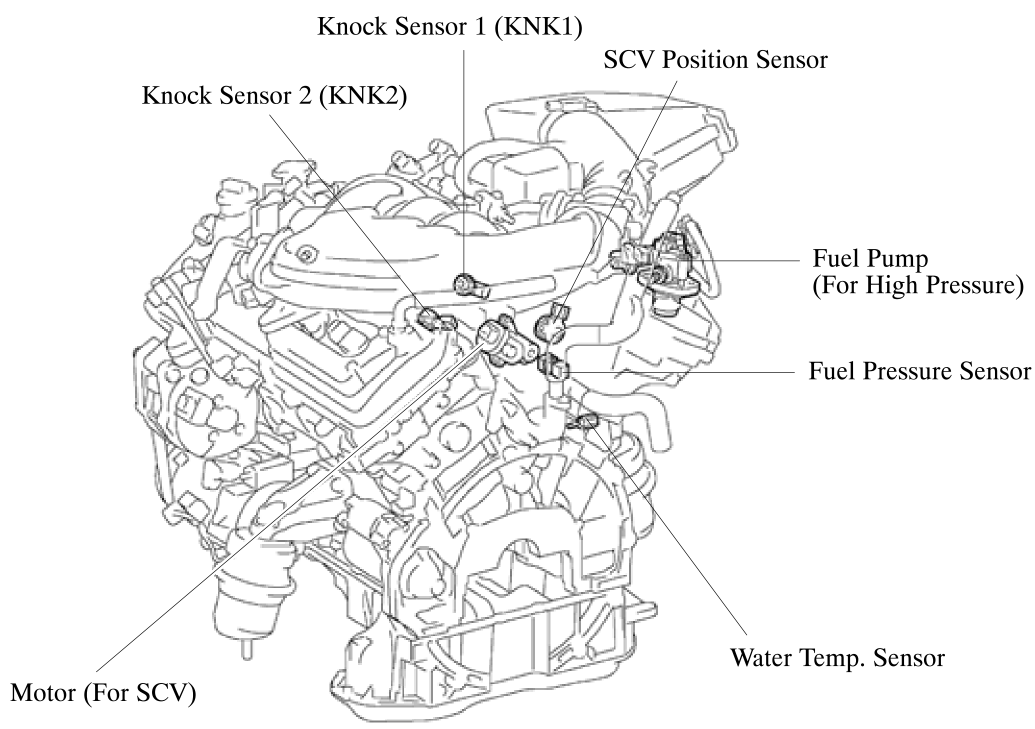


0150EG06Z



0150EG07Z


Intake Camshaft Timing Oil Control Valve RH (OC1)
Throttle Body
• Throttle Position Sensor
Exhaust Camshaft Timing Oil Control Valve RH (OE1)
Exhaust VVT Sensor RH (EV1)
Intake Camshaft Timing Oil Control Valve LH (OC2)
Intake VVT Sensor RH (VV1)
ACIS Actuator
Injector
Ignition Coil With Igniter
EDU
Exhaust VVT Sensor LH (EV2)
Intake VVT Sensor LH (VV2)
Exhaust Camshaft Timing Oil Control Valve LH (OE2)
Crankshaft Position Sensor


Knock Sensor 1 (KNK1)
SCV Position Sensor
Knock Sensor 2 (KNK2)
Fuel Pump (For High Pressure)
Fuel Pressure Sensor
Water Temp. Sensor
Motor (For SCV)

0150EG11Z

5. Main Component of Engine Control System

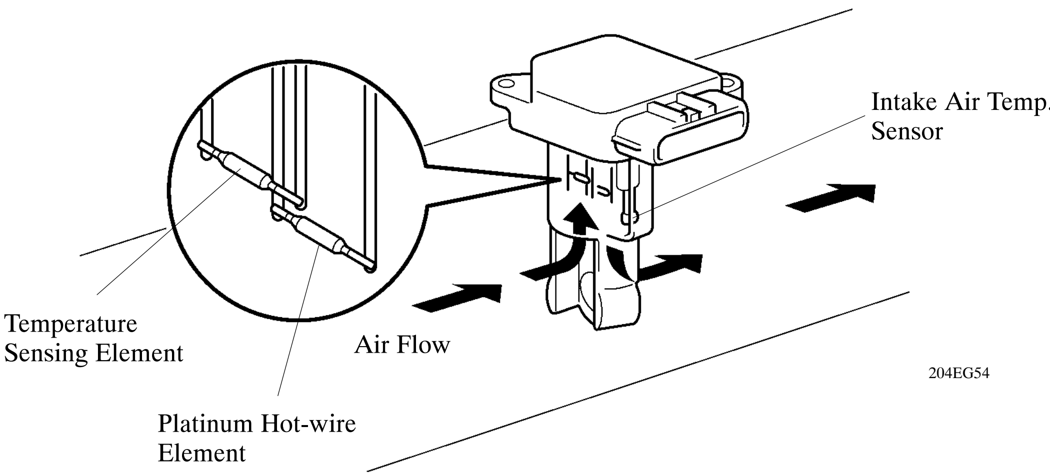
General

The main components of the 4GR-FSE engine control system are as follows:

Components		Outline	Quantity
Engine ECU		32-bit CPU	1
Air flow Meter		Hot-wire Type	1
Fuel Pressure Sensor [See page EG-33]		Semiconductor Type	1
Crankshaft Position Sensor (Rotor Teeth)		Pick-up Coil Type (36 – 2)	1
Intake VVT Sensor (Rotor Teeth)		MRE (Magnetic Resistance Element) Type (3)	1 each bank
Exhaust VVT Sensor (Rotor Teeth)		MRE (Magnetic Resistance Element) Type (3)	1 each bank
Accelerator Pedal Position Sensor		Linear (No-Contact) Type	1
Throttle Position Sensor		Linear (No-Contact) Type	1
Knock Sensor		Built-in Piezoelectric Type (Non-resonant Type/Flat Type)	1 each bank
Air Fuel Ratio Sensor	(Bank 1, Sensor 1)	Type with Heater (Planar Type)	1 each bank
	(Bank 2, Sensor 1)		
Heated Oxygen Sensor	(Bank 1, Sensor 2)	Type with Heater (Cup Type)	1 each bank
	(Bank 2, Sensor 2)		
Injector [See page EG-34]		High Pressure Slit Nozzle Type	6
EDU (Electronic Driver Unit) [See page EG-34]		Built-in DC/DC Converter	1

Air flow Meter

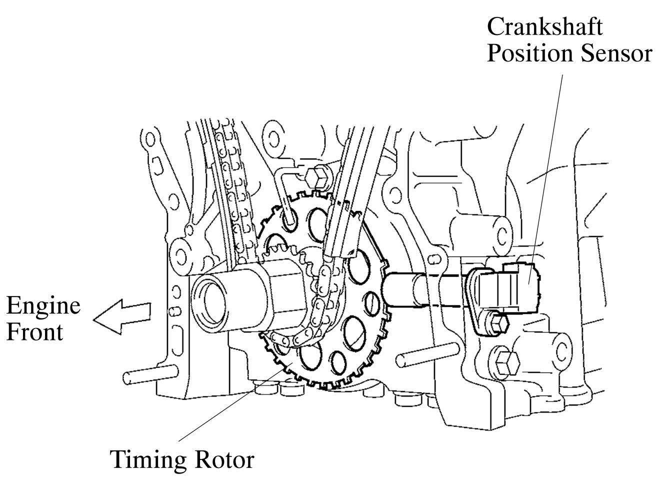
- This air flow meter, which is a plug-in type, allows a portion of the intake air to flow through the detection area. By directly measuring the mass and the flow rate of the intake air, the detection precision is improved and the intake air resistance is reduced.
- This air flow meter has a built-in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



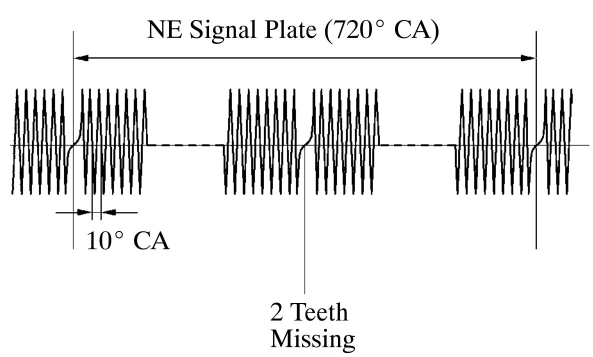
204EG54

Crankshaft Position Sensor

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



281EG79

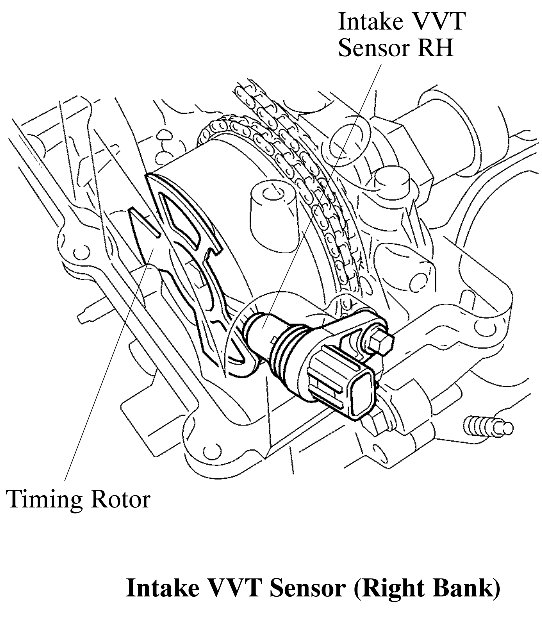


279EG50

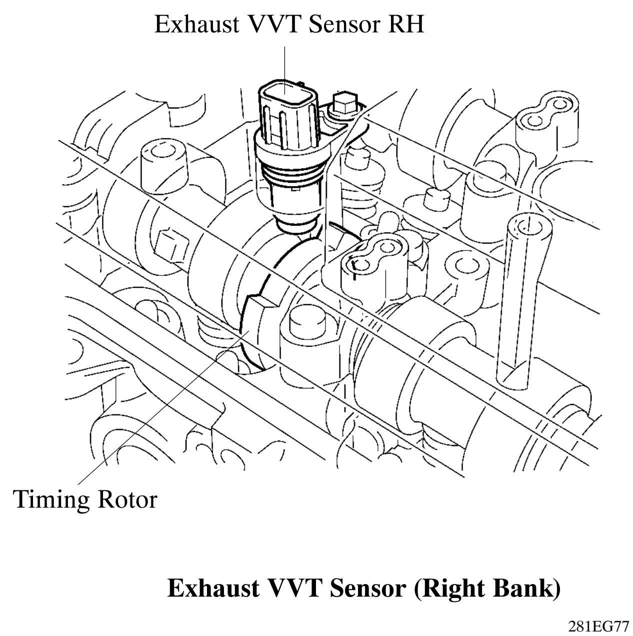
Intake and Exhaust VVT Sensors

1) General

MRE (Magnetic Resistance Element) type intake and exhaust 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.

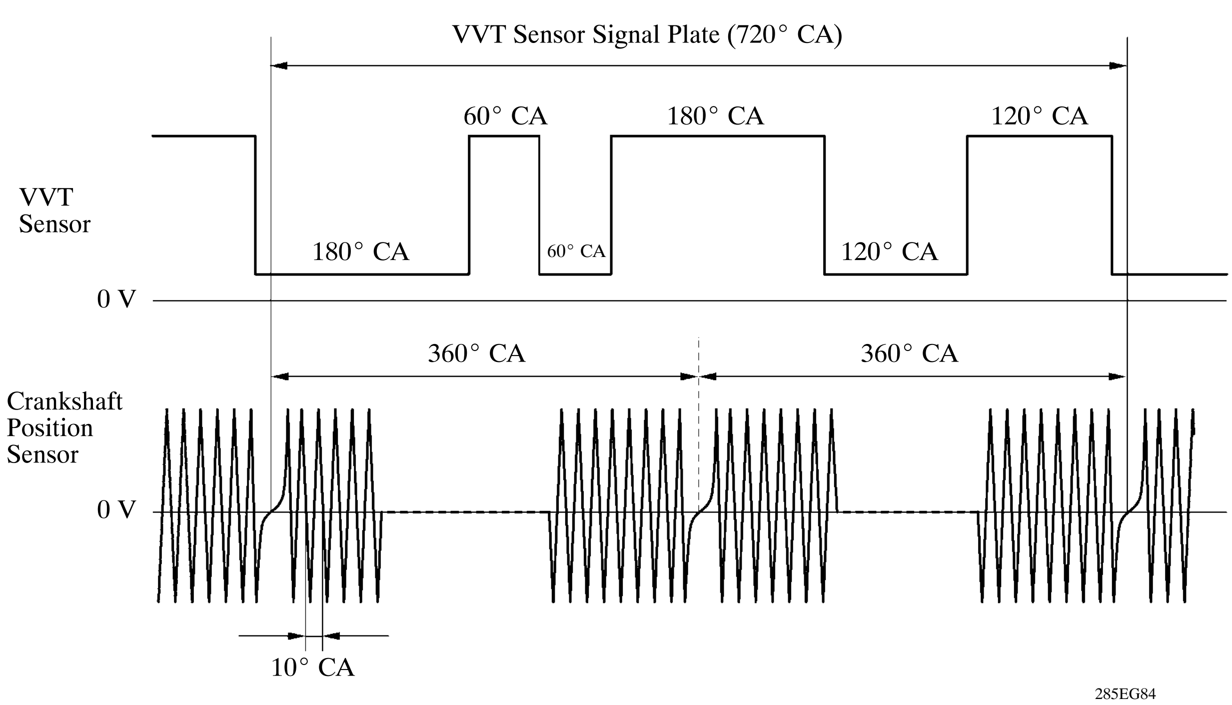


Intake VVT Sensor (Right Bank)



Exhaust VVT Sensor (Right Bank)

▶ Sensor Output Waveforms ◀

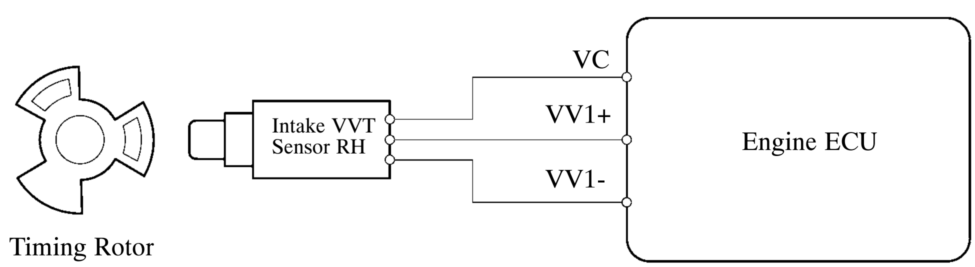


2) MRE Type VVT Sensor

- 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 Engine ECU changes to Hi or Lo. The Engine ECU detects the camshaft position based on this output voltage.
- The differences between an MRE type VVT sensor and a pickup coil type VVT sensor used on a conventional model are as follows.

Item	Sensor Type	
	MRE	Pick-up Coil
Signal Output	Constant digital output starts from low engine speeds.	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 signals input during a Hi/Lo output.	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.

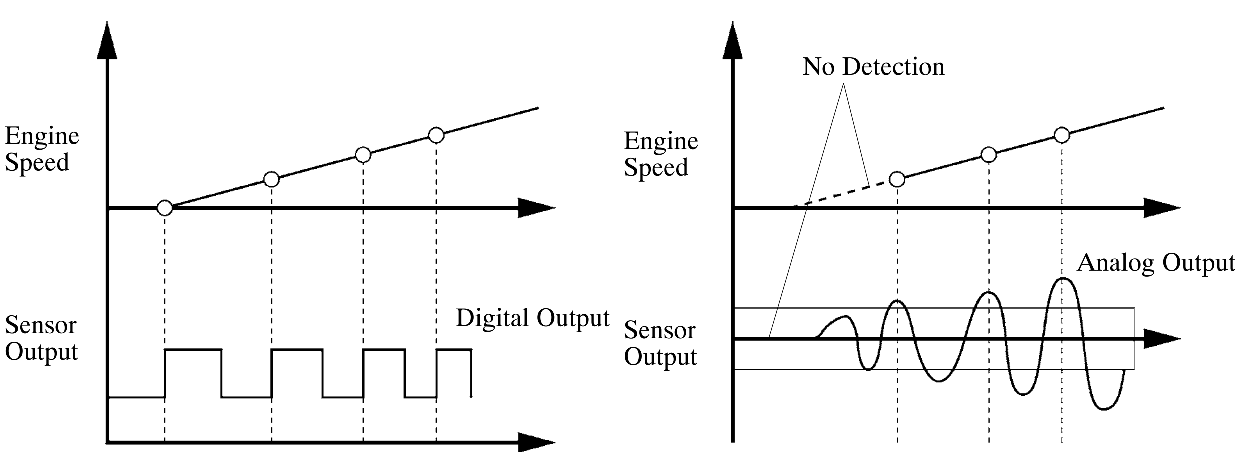
▶ Wiring Diagram ◀



Intake VVT Sensor RH

271EG160

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



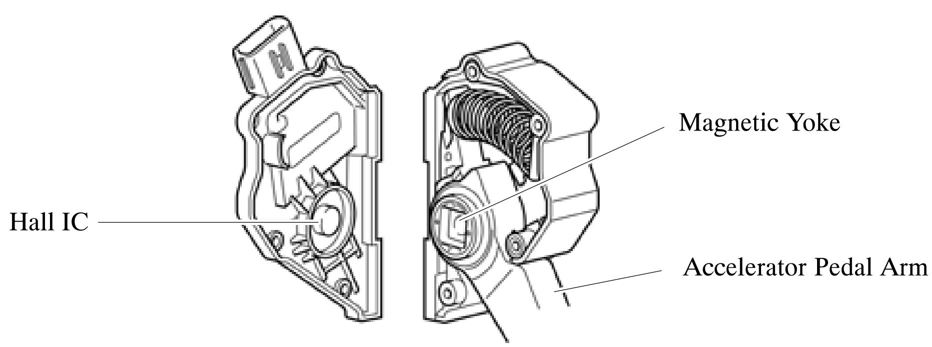
MRE Type **Pick-up Coil Type**

232CH41

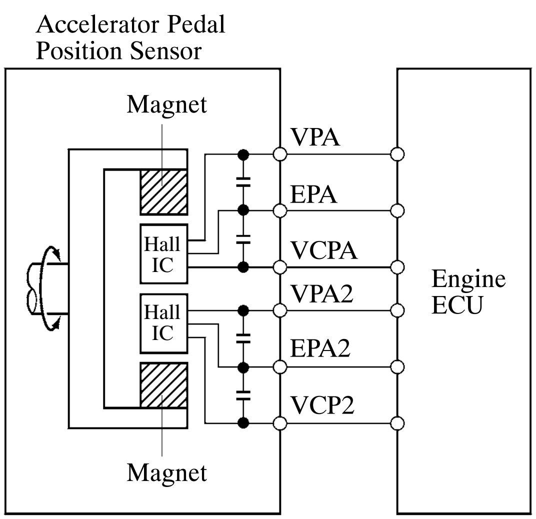
Accelerator Pedal Position Sensor

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

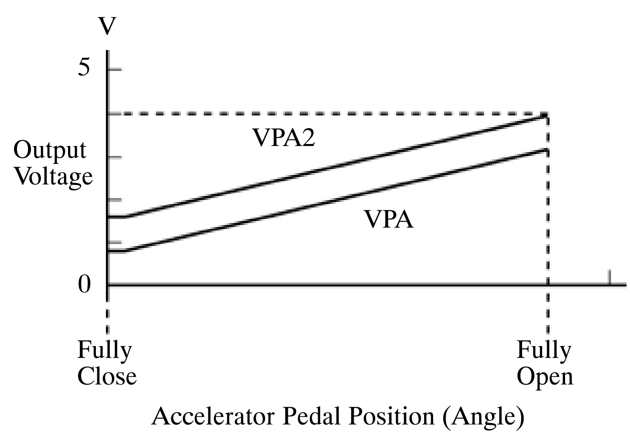
- A magnetic yoke is mounted at the base of the accelerator pedal arm. This yoke rotates around the Hall IC in accordance with the amount of effort that is applied to the accelerator pedal. The Hall IC converts the changes in the magnetic flux that occur into electrical signals, and outputs them in the form of accelerator pedal position signals to the Engine ECU.
- 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 Engine ECU.



0140EG125C



228TU24



0140EG126C

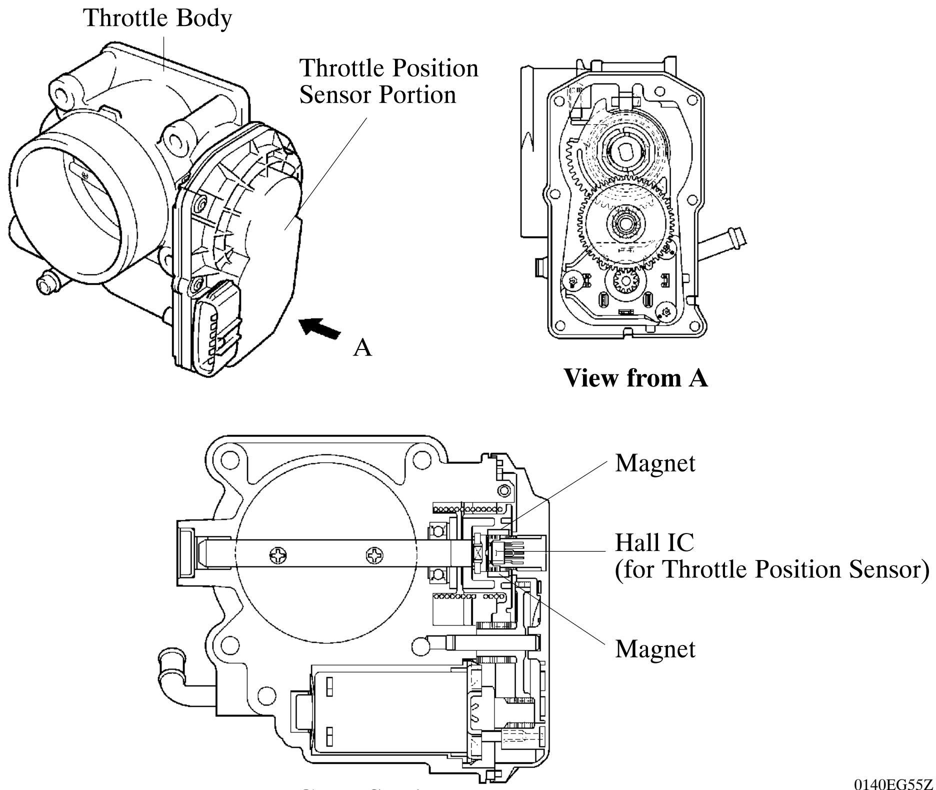
Service Tip

The inspection method differs from a conventional accelerator pedal position sensor because this sensor uses a Hall IC. For details, refer to the LEXUS IS250 Repair Manual (Pub. No. RM0150E).

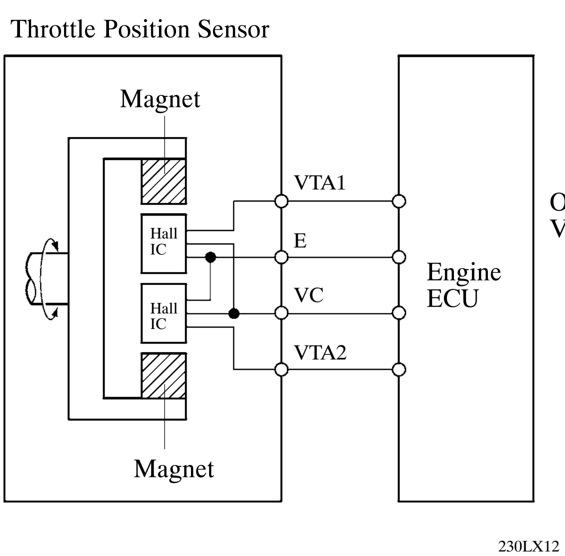
Throttle Position Sensor

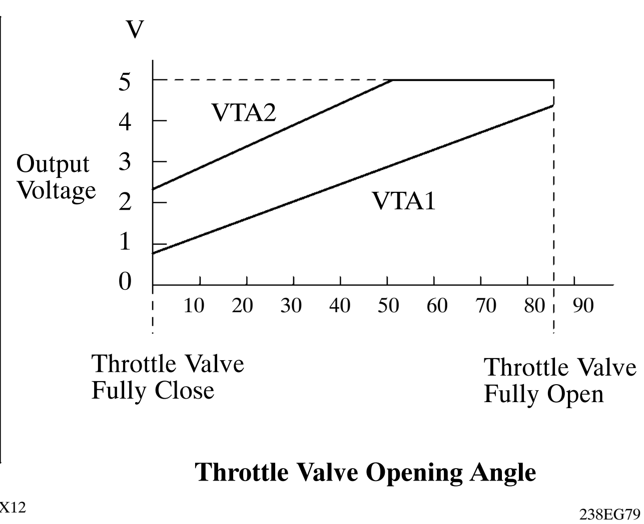
This non-contact type throttle position sensor uses a Hall IC, which is mounted on the throttle body.

- 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 Engine ECU.
- The Hall IC contains circuits for the main and sub signals. It converts the throttle valve opening angle into electric signals that have differing characteristics and outputs them to the Engine ECU.



Cross Section





Throttle Valve Opening Angle

Service Tip

The inspection method differs from a conventional throttle position sensor because this sensor uses a Hall IC. For details, refer to the LEXUS IS250 Repair Manual (Pub. No. RM0150E).

Knock Sensor (Flat Type)

1) General

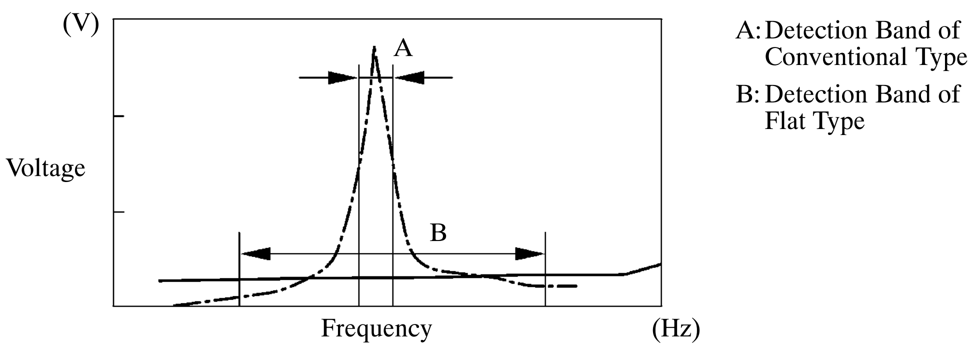
In a conventional type knock sensor (resonant type), a vibration plate is built into the sensor. This plate has the same resonance point as the knocking* frequency of the engine block. This sensor can only detect vibration in this frequency band.

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

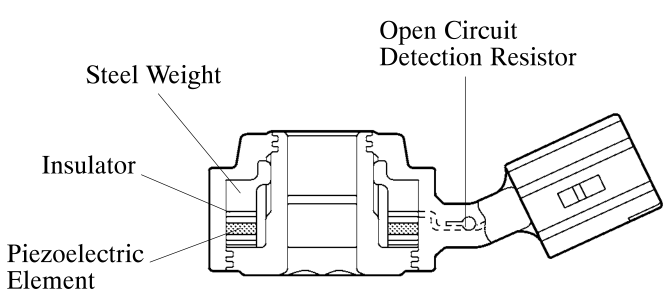


Characteristic of Knock Sensor

214EG04

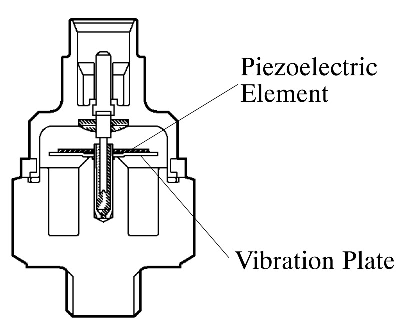
2) Construction

- A flat type knock sensor is installed to an engine by placing it over the stud bolt installed on the cylinder block. For this reason, a hole for the stud bolt 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

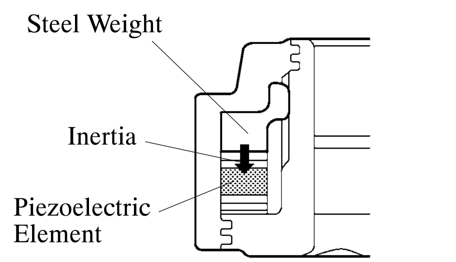


Conventional Type Knock Sensor (Resonant Type)

214CE02

3) Operation

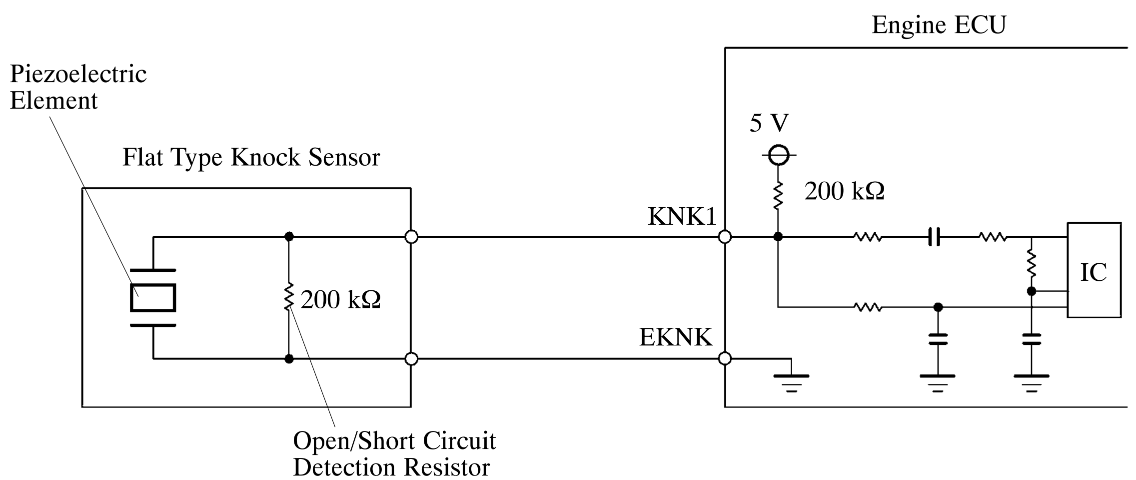
The knocking vibration is transmitted to the steel weight and its inertia applies pressure to the piezoelectric element. This action generates electromotive force (voltage).



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 Engine ECU keep the voltage at the terminal KNK1 of engine constant.
An IC (Integrated Circuit) in the Engine ECU is always monitoring the voltage of the terminal KNK1. If the open/short circuit occurs between the knock sensor and the Engine ECU, the voltage of the terminal KNK1 will change allowing the Engine ECU to detect the open/short circuit and store a DTC (Diagnostic Trouble Code).



214CE06

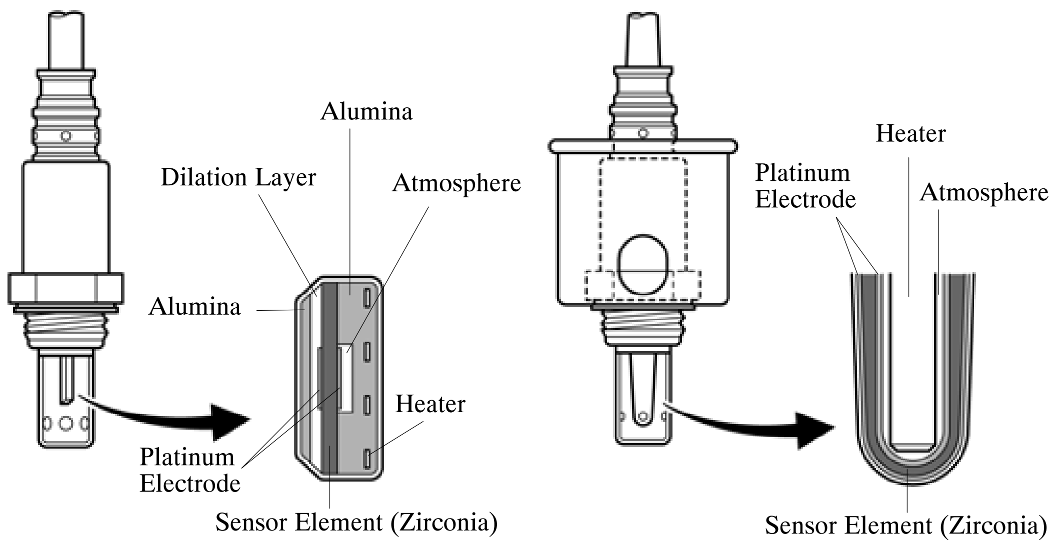
Service Tip

These knock sensors are mounted in the specific directions and angles. To prevent the right and left bank connectors from being interchanged, make sure to install each sensor in its prescribed direction.
For details, refer to the LEXUS IS250 Repair Manual (Pub. No. RM0150E).

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 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.

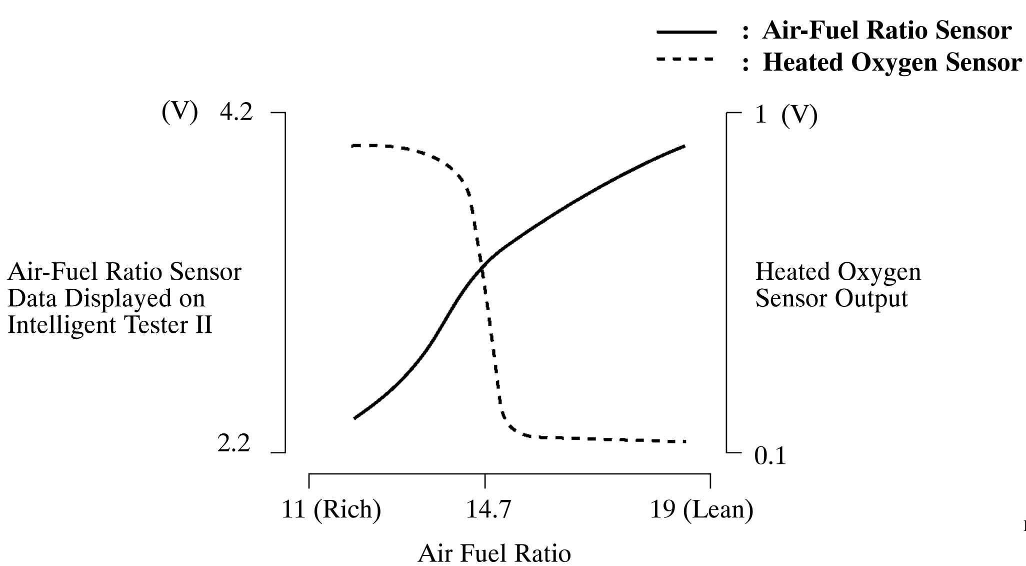


Air Fuel Ratio Sensor (Planar Type) **Heated Oxygen Sensor (Cup Type)**

0140EG56Z

2) Characteristic

As illustrated below, the 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 proportionate to the existing air-fuel ratio. The air-fuel ratio sensor converts the oxygen density to the current and sends it to the Engine ECU. As a result, the detection precision of the air-fuel ratio has been improved. The air-fuel ratio sensor data is read out by an intelligent tester II.



D13N11

*: This calculation value is used internally in Engine ECU and is not an Engine ECU terminal voltage.

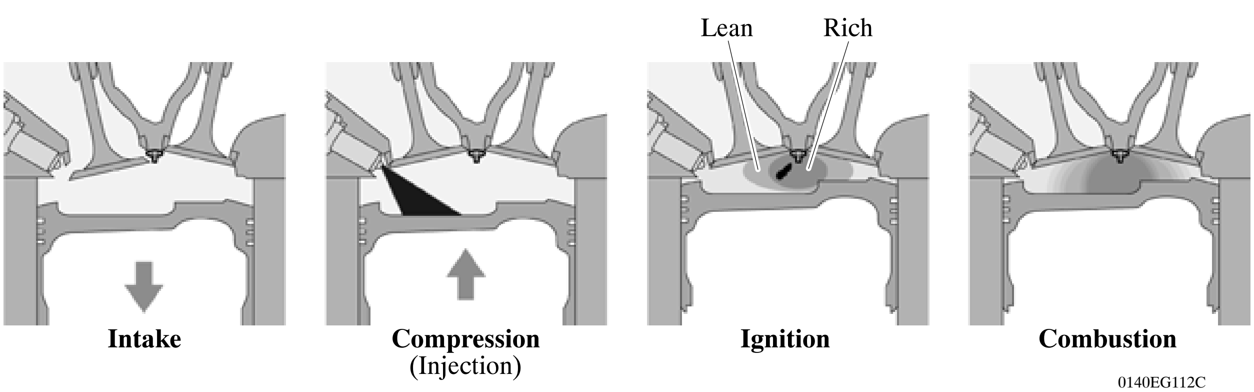
6. D-4 EFI (Electric Fuel Injection) System

General

- An L-type D-4 (Direct Injection 4-Stroke Gasoline Engine) EFI system directly detects the intake air mass with a hot wire type air flow meter.
- Unlike a conventional gasoline engine, the D-4 fuel injection system must precisely control both the injection timing (relative to the intake or compression stroke) and injection volume. In order to correctly inject the fuel directly into the cylinders on a gasoline engine that uses direct injection (D-4), the injection timing must be precisely controlled. This control of injection timing for a direct injection engine has a similar importance to ignition timing control an engine with conventional intake port type fuel injection. There is a significant difference between direct injection and synchronous injection that occurs on a conventional port injected engine.
- Based on the signals from various sensors, the Engine ECU controls the injection volume and injection timing to suit the engine speed and the engine load, in order to achieve an optimal state of combustion.
- To promote the warm-up of the catalyst following a cold start, this system effects lean-burn mixture control through use of a weak stratification combustion process.

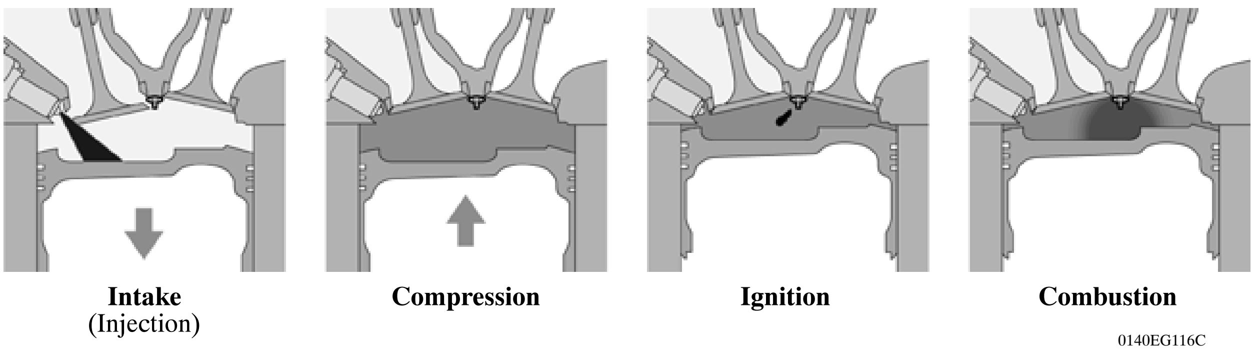
Weak Stratification Combustion

This process involves injecting fuel during the latter half of the compression stroke following a cold engine start. This produces a weak stratification combustion process. This process allows the use of a hotter burning lean mixture (approximately 16.0:1) when cold. The ability to run the engine on a leaner mixture when cold uses the injection of the fuel into the compression heated air in the cylinder (injection during latter stages of the compression stroke). This raises the combustion temperature, promotes rapid warm up of the catalyst, and significantly improves exhaust emission performance.



Homogeneous Combustion

By injecting fuel during the first half of the intake stroke, the engine creates a more homogeneous air-fuel mixture. In addition, by utilizing the heat of evaporation of the injected fuel to cool the compressed air, the engine has increased its charging efficiency and produces a higher power output.



7. ESA (Electronic Spark Advance) System

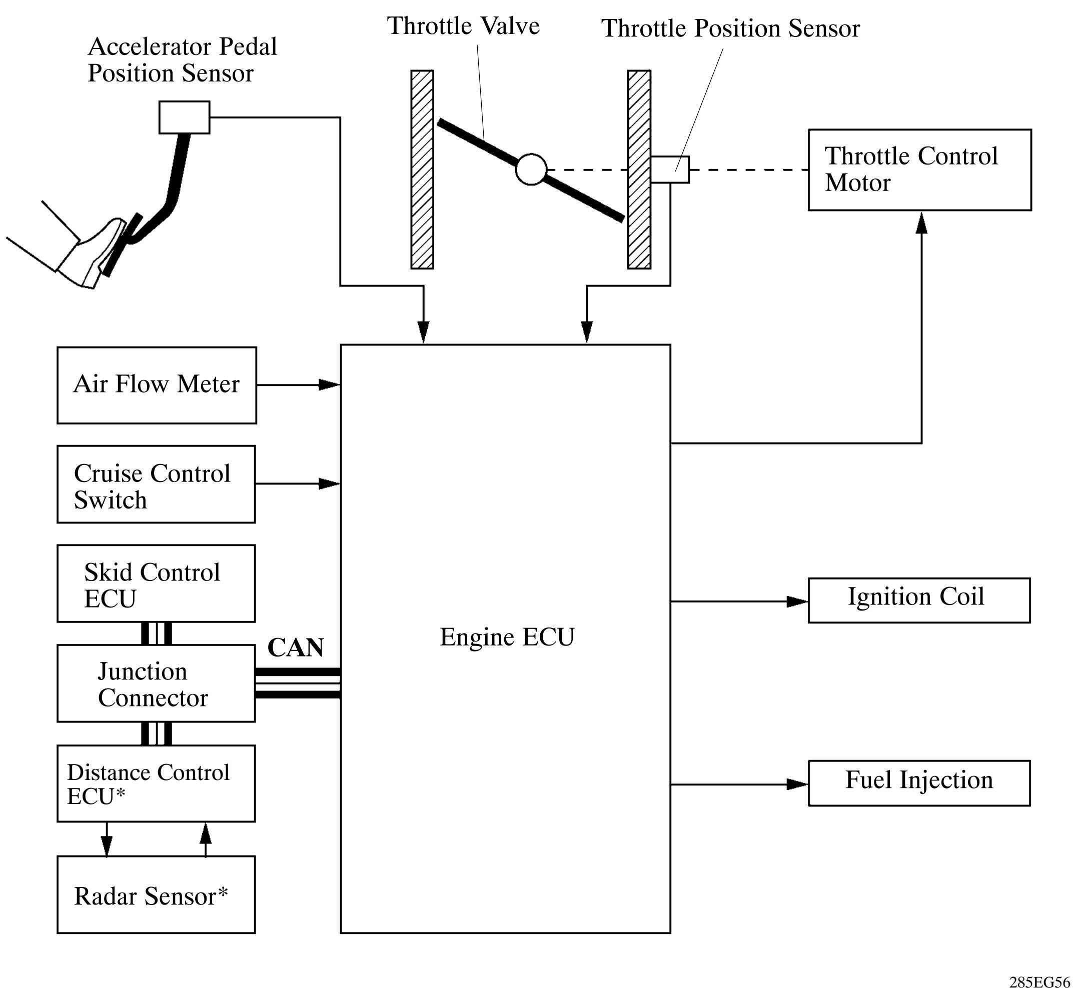
This system selects the optimal ignition timing in accordance with the signals received from the sensors and sends the (IGT) ignition signal to the igniter.

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

General

With a conventional throttle body, the throttle valve angle is determined invariably by the position of the accelerator pedal. In contrast, ETCS-i uses the Engine ECU to calculate the optimal throttle valve angle that is appropriate for the respective driving condition. The ETCS-i throttle uses a throttle control motor to control the angle.

▶ System Diagram ◀



*: With Dynamic Radar Cruise Control system

Control

1) General

ETCS-i provides the following functions:
- Non-linear throttle Control
- ISC (Idle Speed Control)
- TRC (Traction Control)
- VSC (Vehicle Stability Control)
- Cruise Control
- Dynamic Radar Cruise Control*

*: With Dynamic Radar Cruise Control system

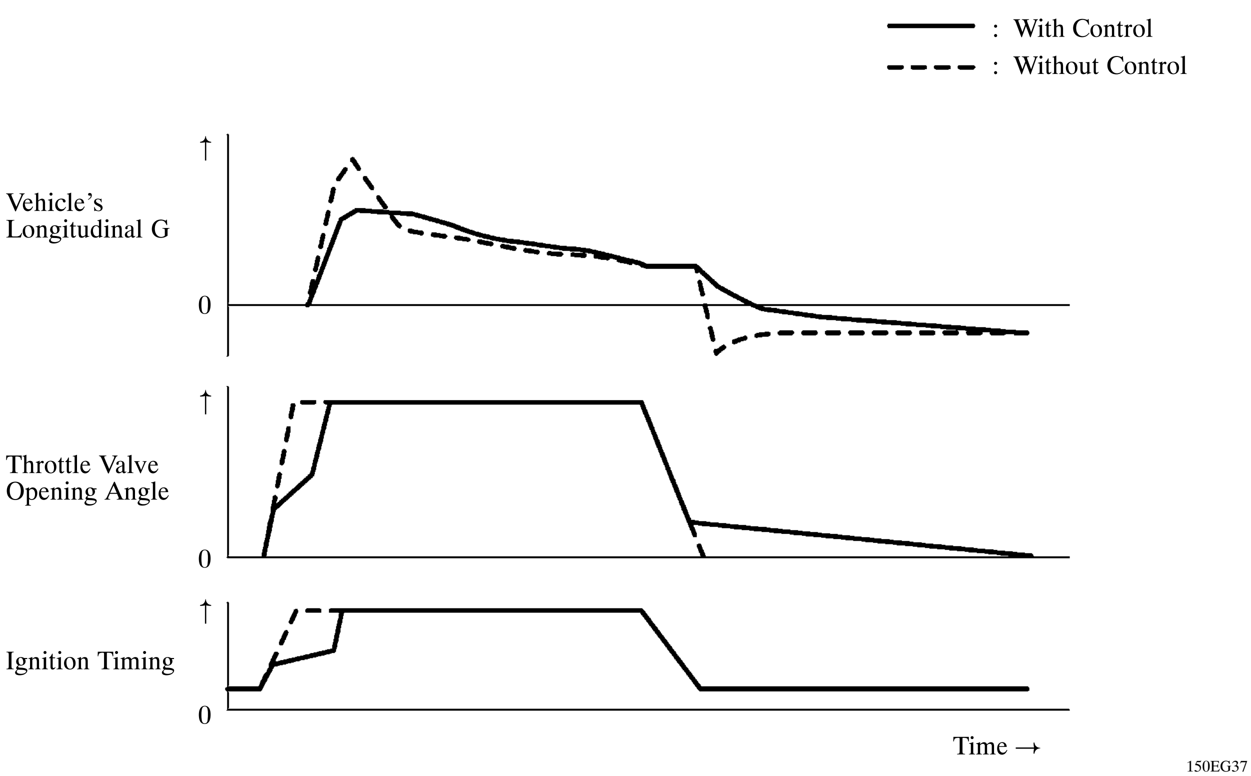
EG

2) Non-linear control

a. Normal-mode 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 ◀



b. Snow-mode Control

In situations in which low-μ (low friction) road surface conditions can be anticipated, such as when driving in the snow, the rate of throttle valve opening can be controlled to help vehicle stability while driving on the slippery surface. This is accomplished by turning on SNOW mode. Pressing the SNOW side of the pattern select switch activates this mode. This mode modifies the relationship and reaction of the throttle to the accelerator pedal, and assists the driver by reducing the engine output from that of a normal level.

3) Idle Speed Control

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

4) TRC Throttle Control

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

5) VSC Coordination Control

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

6) Cruise Control

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

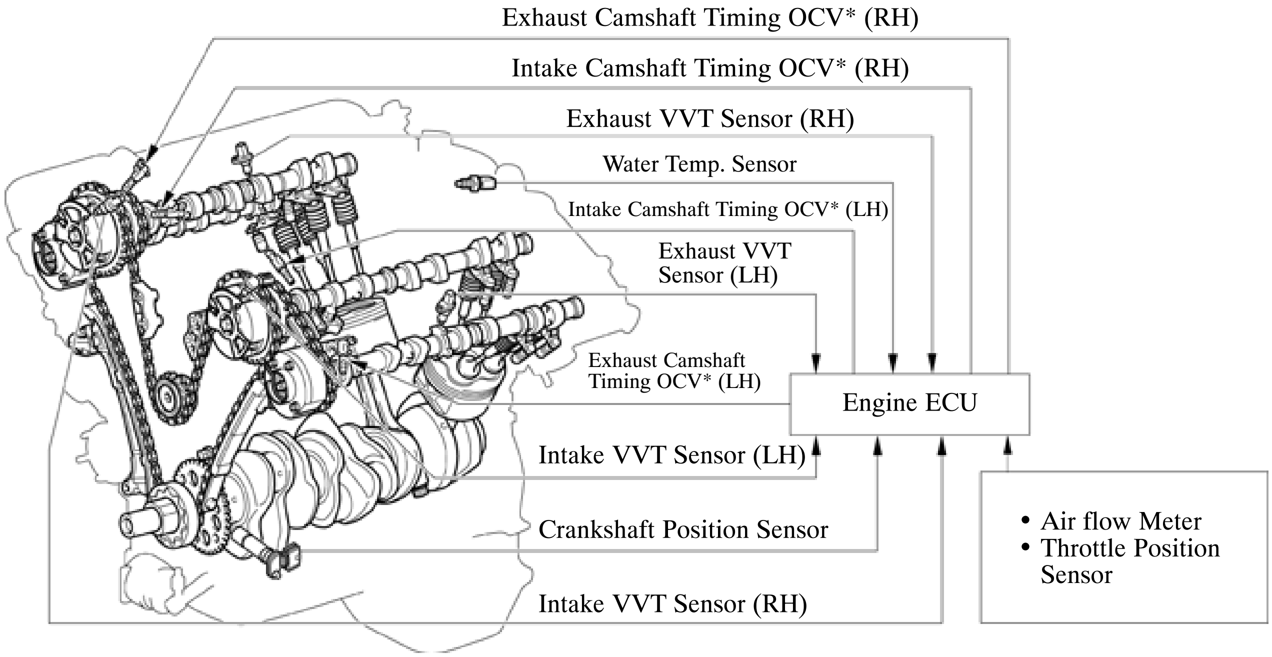
7) Dynamic Radar Cruise Control

The dynamic radar cruise control uses a radar sensor and distance control ECU to determine the distance between the radar cruise control equipped vehicle and the vehicle ahead, direction, and relative speed. Thus, the system can effect deceleration cruising control, follow up cruising control, cruising at a fixed speed control, and acceleration cruising control. To make these controls possible, the Engine ECU controls the throttle valve.

9. Dual VVT-i (Variable Valve Timing-intelligent) System

General

- The VVT-i system is designed to control the intake and exhaust camshafts within a range of 40° and 35° respectively (of Crankshaft Angle) to provide valve timing that is optimally suited to the engine condition. This improves torque in all the speed ranges as well as increasing fuel economy, and reducing exhaust emissions.



*: Oil Control Valve

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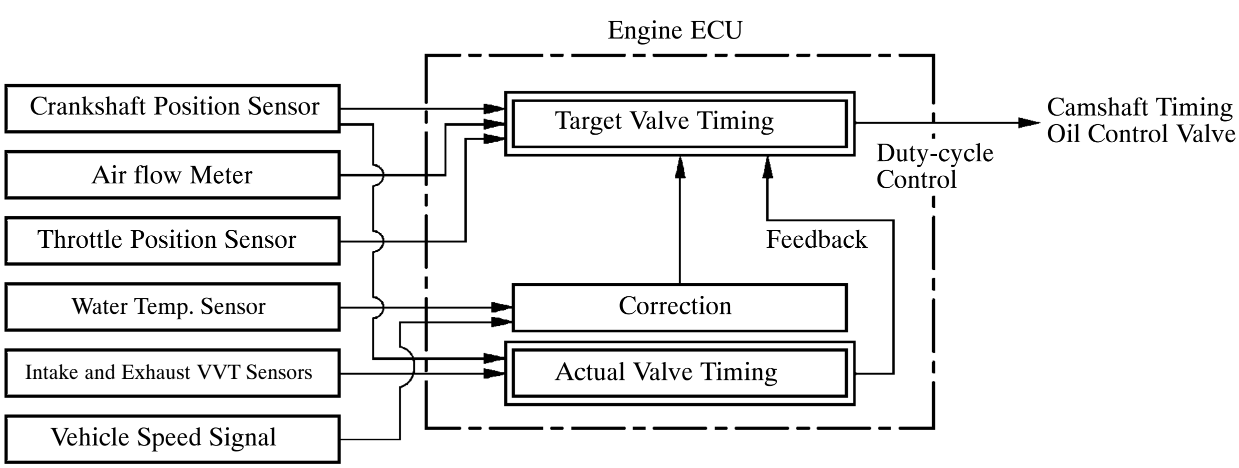
- Based on engine speed, intake air volume, throttle position and engine coolant temperature, the Engine ECU calculates optimal valve timing for all driving conditions. The Engine ECU also controls the camshaft timing oil control valves. In addition, the Engine ECU uses signals from the VVT sensors and the crankshaft position sensor to detect the actual valve timing, thus providing feedback control to achieve the target valve timing.



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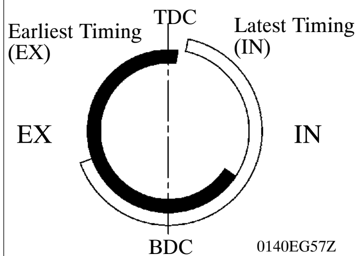
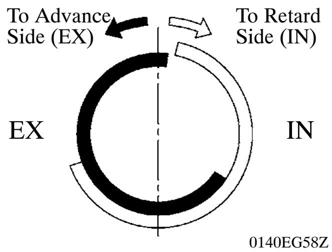
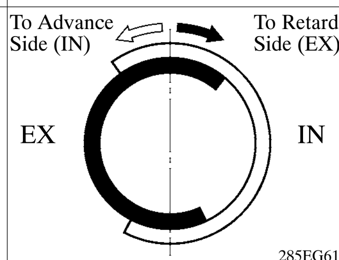
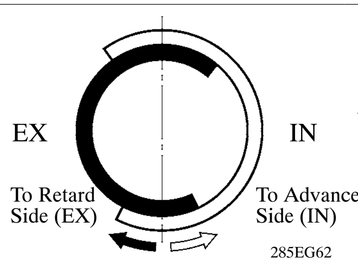
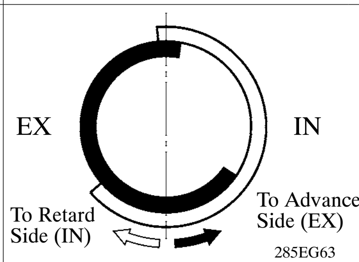
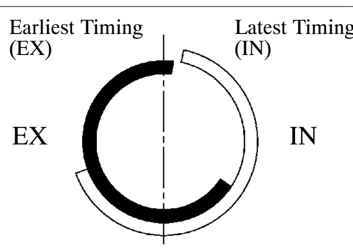
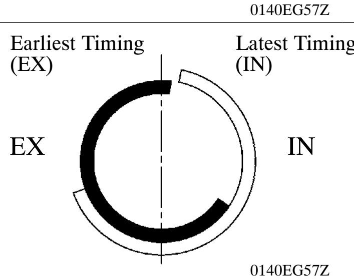
Effectiveness of the VVT-i System

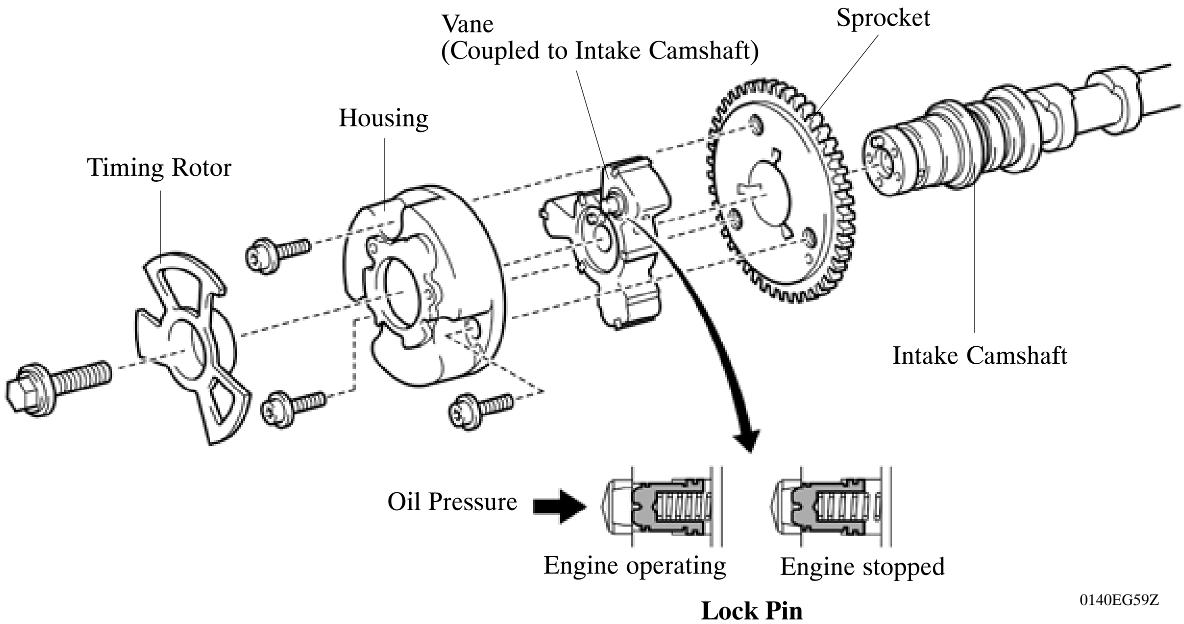
Operation State	Objective		Effect
During Idling		Eliminating overlap to reduce blow back to the intake side.	• Stabilized idling rpm • Better fuel economy
At Light Load		Eliminating overlap to reduce blow back to the intake side.	Ensured engine stability
At Medium Load		Increasing overlap increases internal EGR, reducing pumping losses.	• Better fuel economy • Improved emission control
In Low to Medium Speed Range with Heavy Load		Advancing the intake valve closing timing for volumetric efficiency improvement.	Improved torque in low to medium speed range
In High Speed Range With Heavy Load		Retarding the intake valve closing timing for volumetric efficiency improvement.	Improved output
At Low Temperatures		Eliminating overlap to reduce 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 minimize blow back to the intake side.	Improved startability

Construction

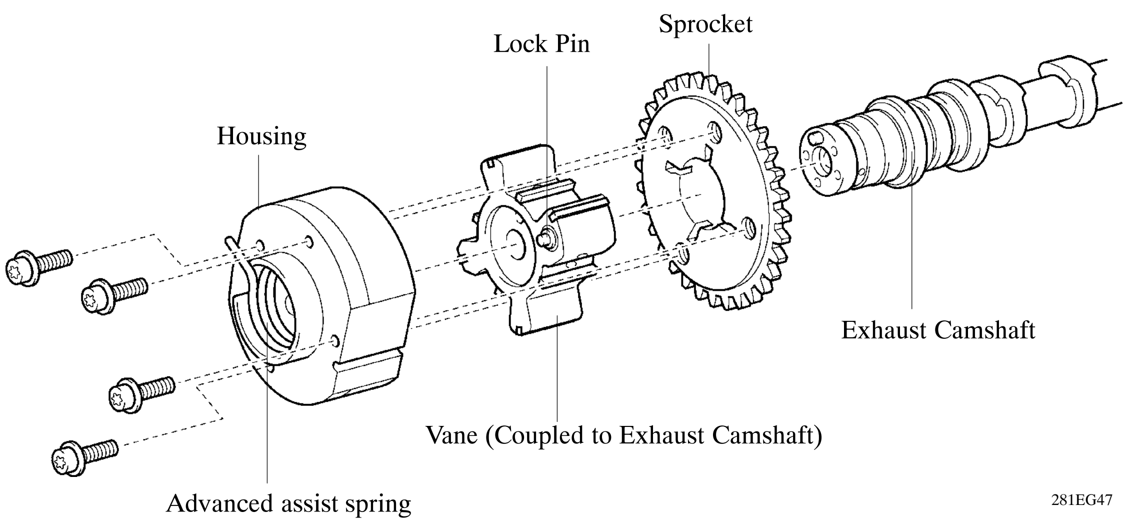
1) VVT-i Controller

- This controller consists of an outer housing that is driven by the timing chain sprocket, and a vane subassembly that is coupled to each camshaft.
- The intake side uses a VVT-i controller with 3 vanes, and the exhaust side uses one with 4 vanes.
- When the engine stops, the intake side VVT-i controller is locked to the most retarded angle by its lock pin, and the exhaust side controller is locked to the most advanced angle. This ensures excellent engine startability.
- The oil pressure sent from the advance or retard side passages of the intake and exhaust camshafts causes rotation of the VVT-i controller vane subassembly relative to the timing chain sprocket to vary the valve timing continuously.
- An advance assist spring is provided on the exhaust side VVT-i controller. This helps to apply torque in the advanced angle direction so that the vane lock pin securely engages with the housing when the engine stops.

▶ Intake Side VVT-i Controller ◀



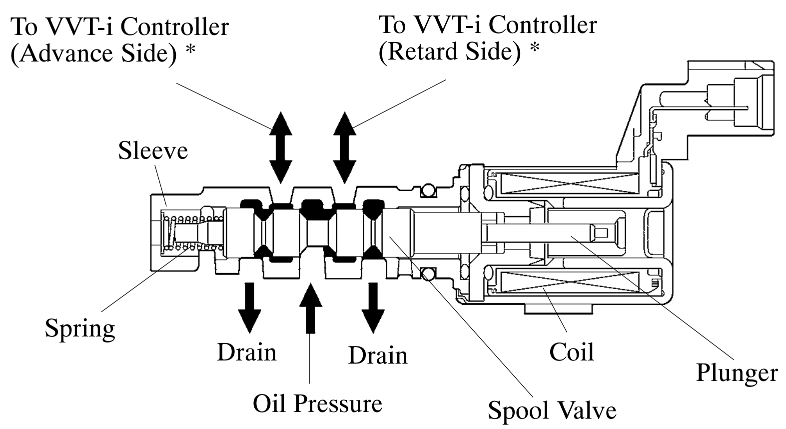
▶ Exhaust Side VVT-i Controller ◀



2) Camshaft Timing Oil Control Valve

This camshaft timing oil control valve controls the spool valve using duty-cycle control from the Engine ECU. This allows hydraulic pressure to be applied to the VVT-i controller advance or retard side. When the engine is stopped, the intake camshaft timing oil control valve will be in the retard position, and the exhaust side oil control valve will be in the advance position.

▶ Intake Camshaft Timing Oil Control Valve ◀



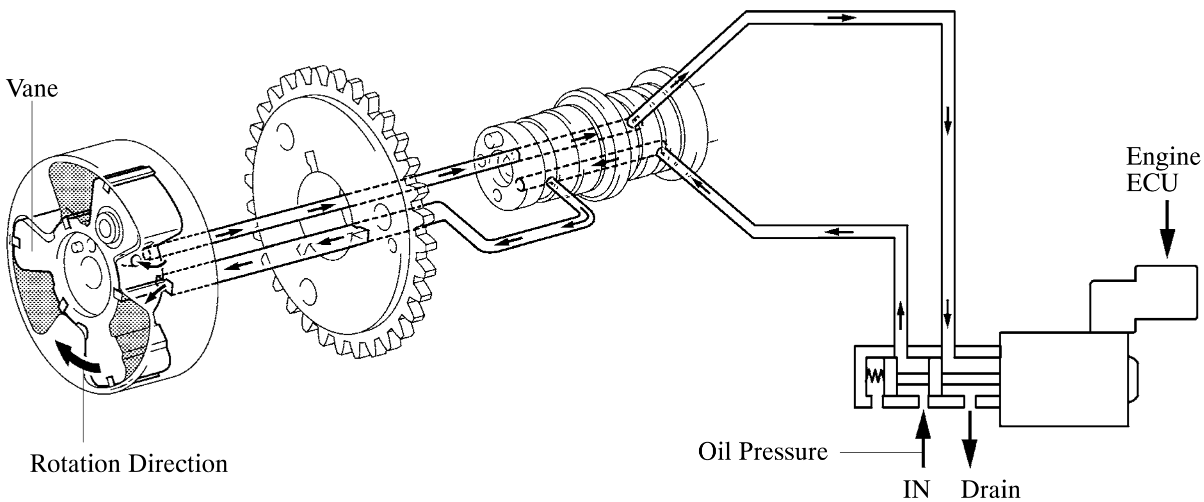
*: On the exhaust side oil control valve, the advance and retard sides are reversed.

Operation

1) Advance

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

▶ Intake Side ◀



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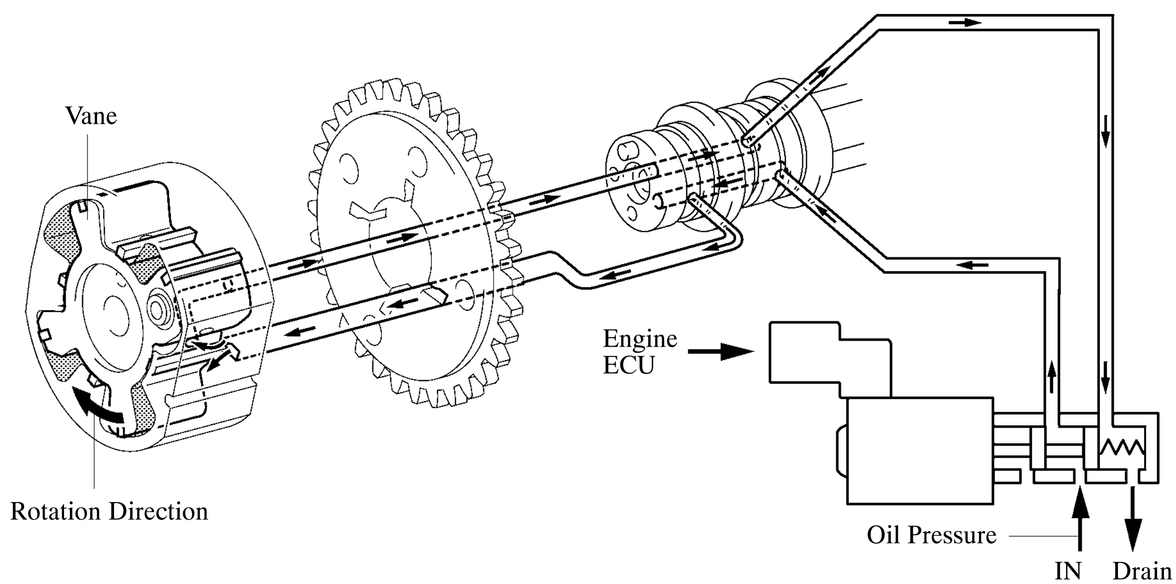
▶ Exhaust Side ◀



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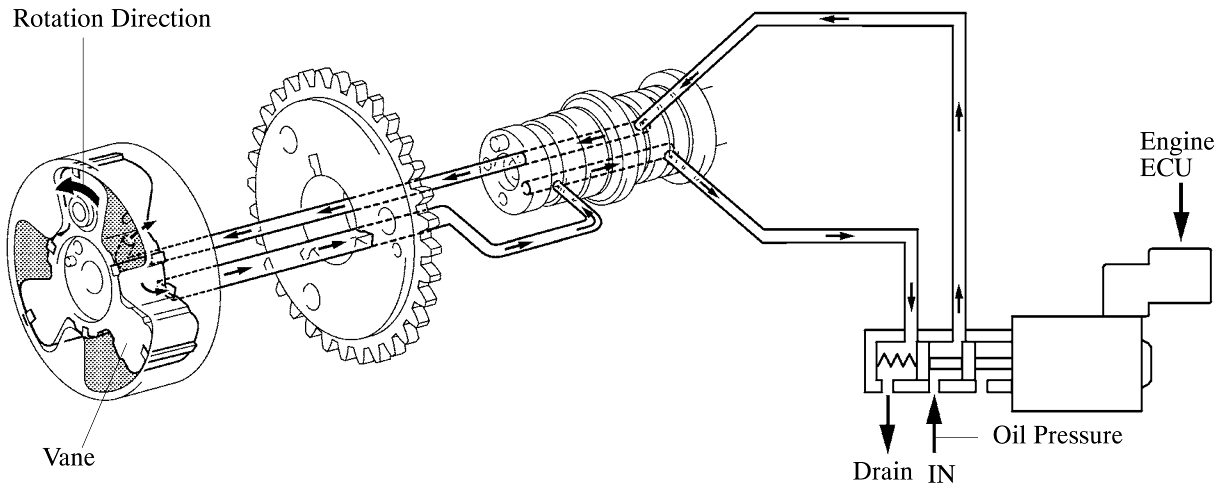
2) Retard

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

▶ Intake Side ◀



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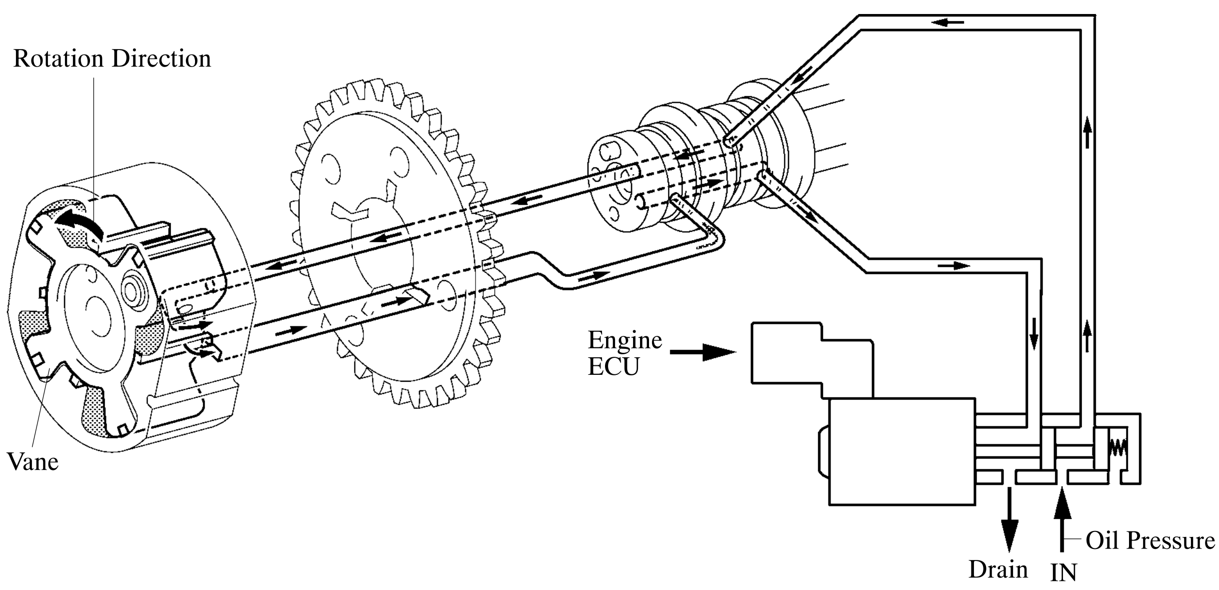
▶ Exhaust Side ◀



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3) Hold

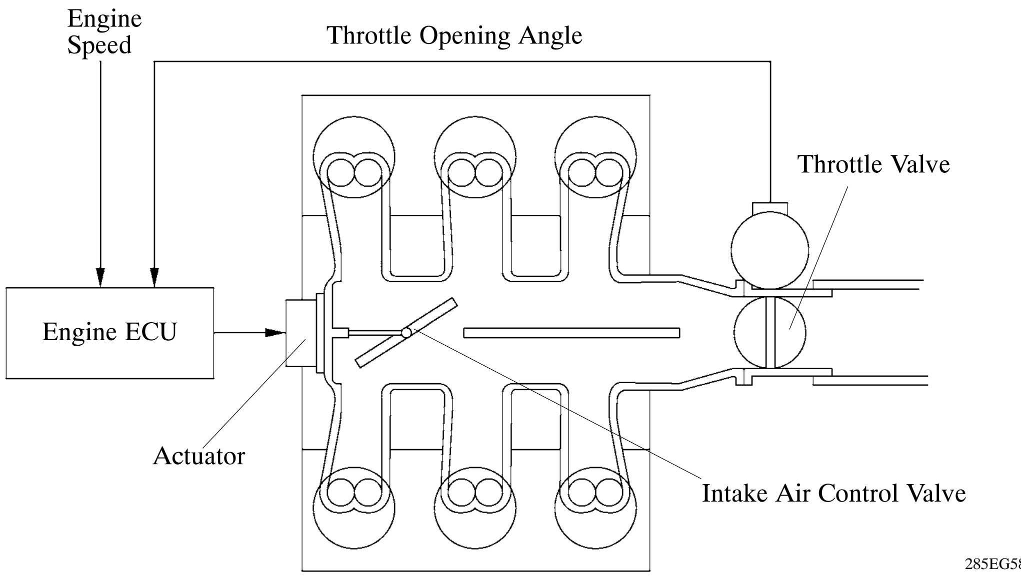
After reaching the target timing, the engine valve timing is maintained by keeping the camshaft timing oil control valve in the neutral position unless the engine operating conditions change.
This maintains the engine valve timing at the desired target position by preventing the engine oil from running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

10. ACIS (Acoustic Control Induction System)

General

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

▶ System Diagram ◀



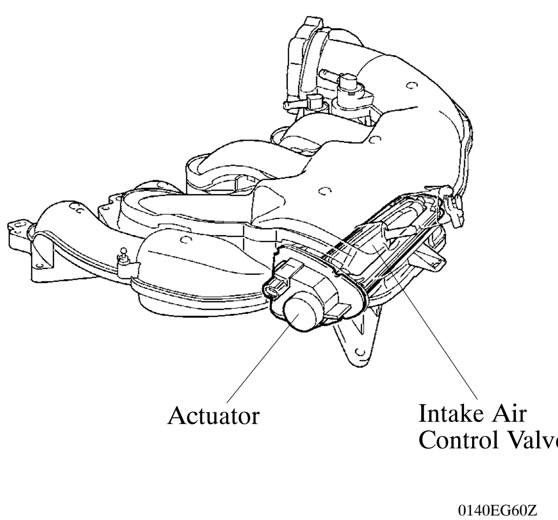
Construction

1) Intake Air Control Valve

The intake air control valve is installed in the intake air chamber. It opens and closes to provide two effective lengths of the intake manifold.

2) Actuator (Motor)

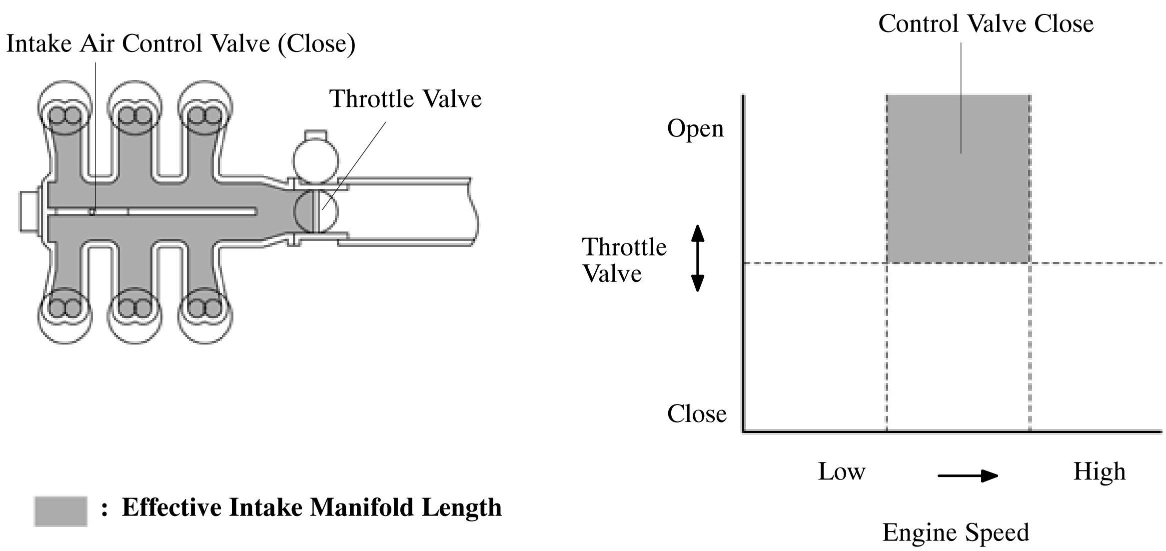
The actuator activates the intake air control valve based on signals from the Engine ECU.



Operation

1) Intake Control Valve Closed

While the engine is running at medium speed under high load, the Engine ECU causes the actuator to close the control valve. As a result, the effective length of the intake manifold is lengthened 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.



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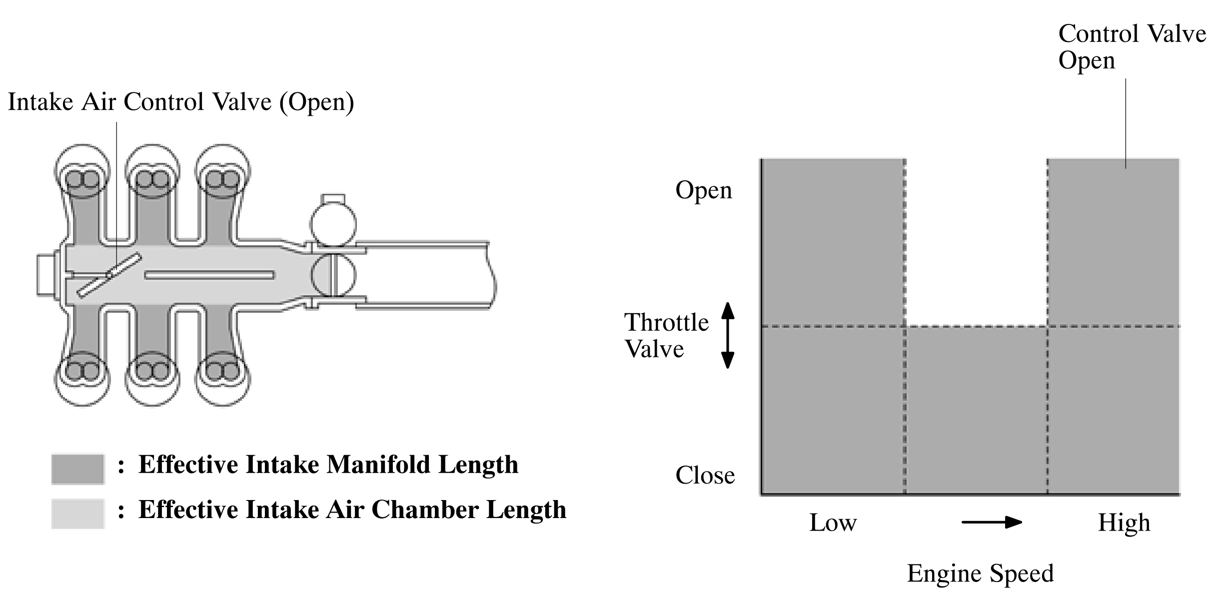
2) Intake Control Valve Open

Under any condition except when the engine is running at medium speed under high load, the Engine ECU causes the actuator to open the control valve. When the 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.



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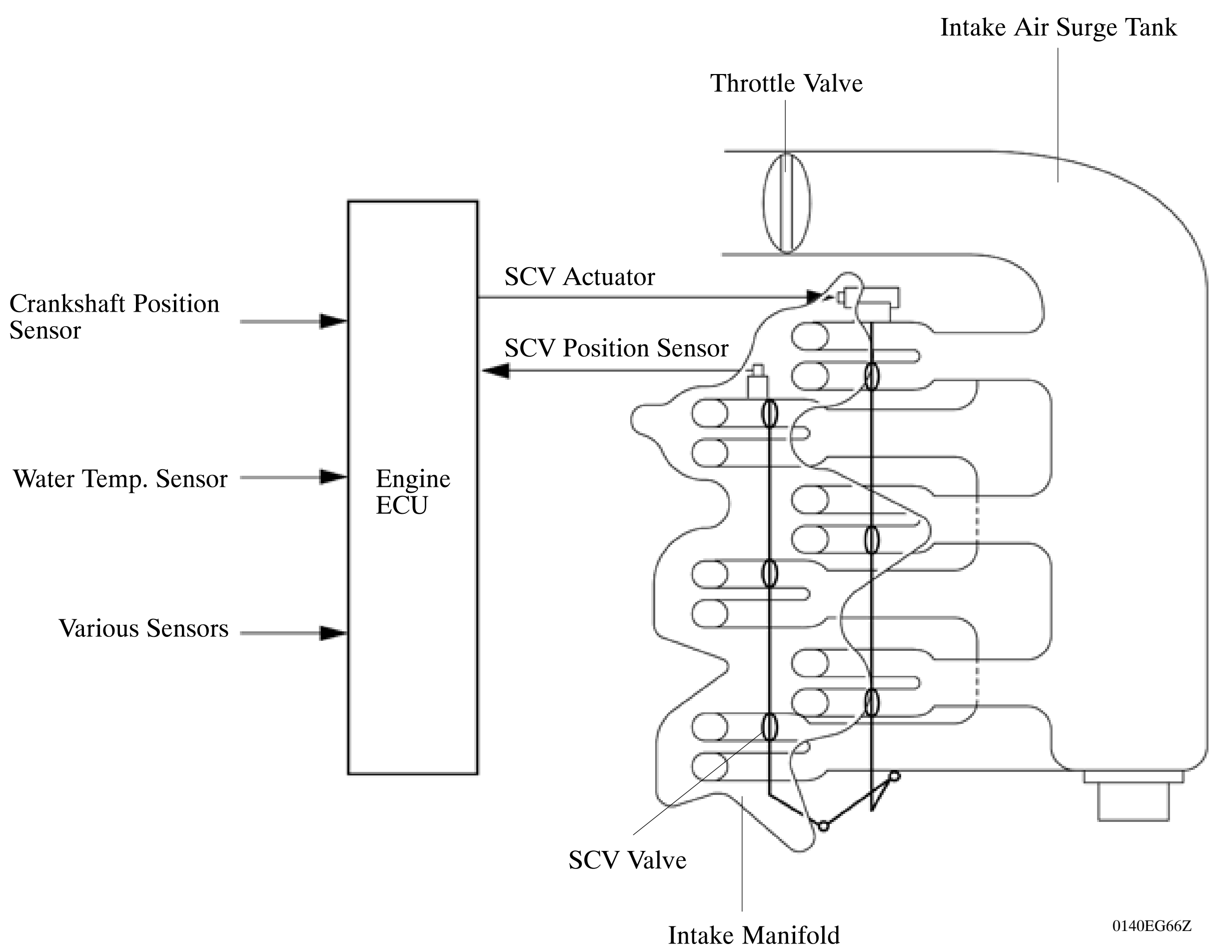
11. Electronic SCV (Swirl Control Valve) System

General

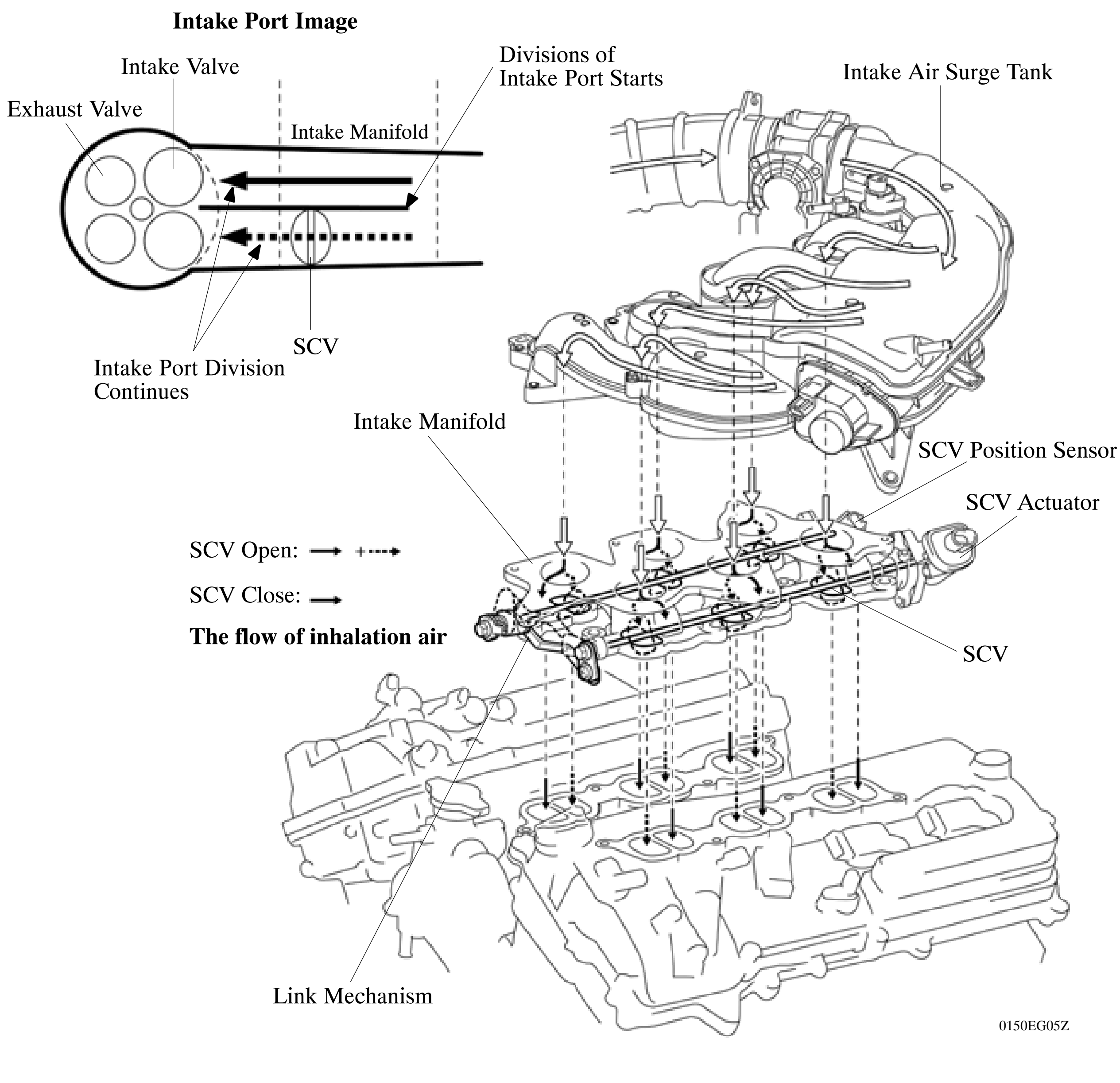
- The electronic SCV system mainly consists of swirl control valves, SCV position sensor, SCV actuator, and Engine ECU.
- The electronic SCV system closes one of the two independent intake ports for each cylinder according to the engine conditions. Closing the port optimally controls the airflow in the combustion chamber and improves the charging and combustion efficiency for low fuel consumption. The SCV system is located in the intake manifold.

▶ System Diagram ◀



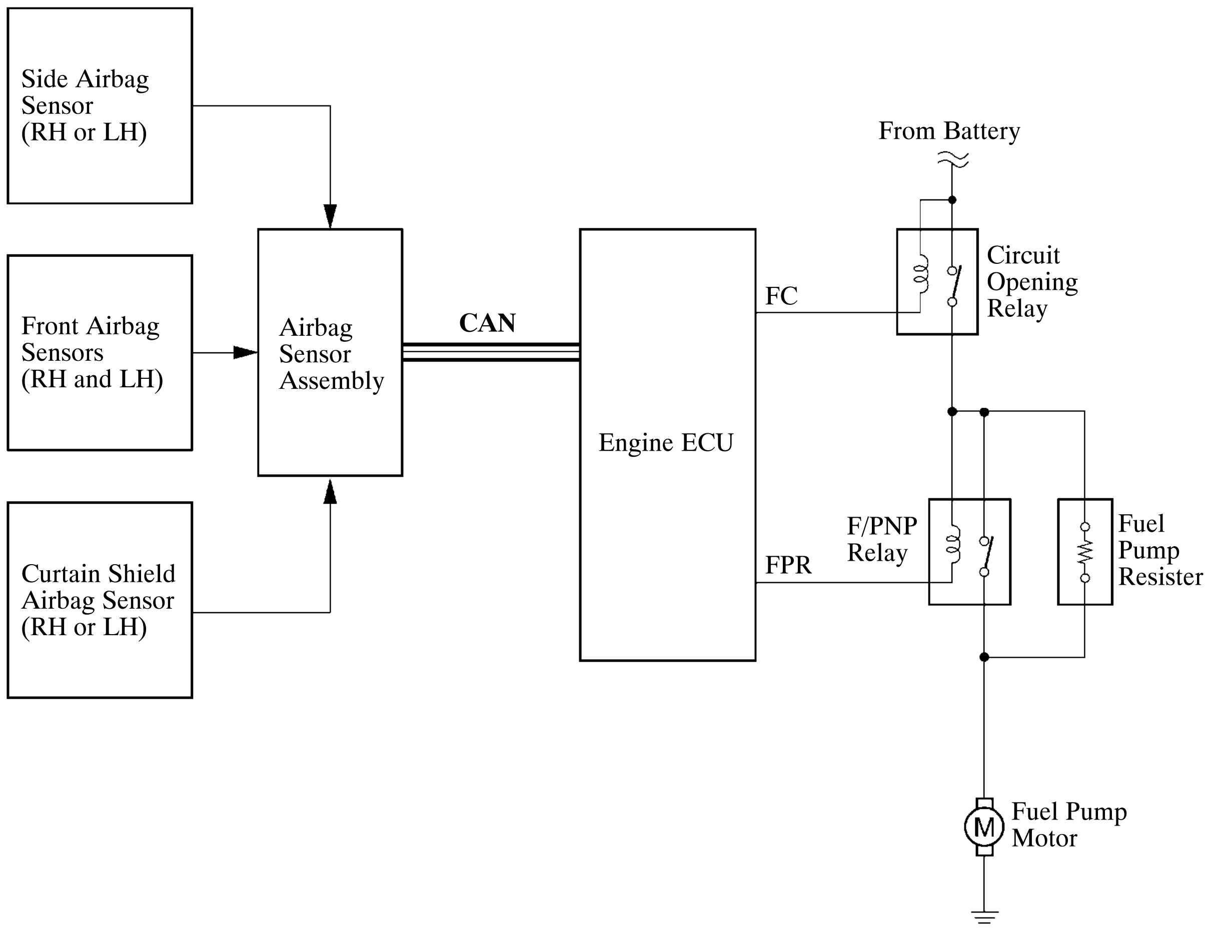
Construction and Operation

- One swirl control valve (SCV) is used for each cylinder. Each cylinder has two independent intake ports, one for each intake valve. The SCV is able to open or close one of these ports. The opening and closing of the swirl control valves is controlled by the Engine ECU.
- The SCVs for the left and right bank intake ports are connected by a link mechanism. They are activated by a single SCV actuator (compact DC motor).
- The Engine ECU activates the SCV actuator to open or close the swirl control valves based on engine speed, engine coolant temperature and driving conditions.
- Closing one of the ports accelerates the speed of the intake air that flows through the other port, strengthening the turbulence in the combustion chamber. This results in improved atomization of fuel when the coolant temperature is low, thus stabilizing combustion.
- When the engine is operating at low speed and low load conditions, the SCV remains fully closed. Thus, only one port is used for intake, in order to promote the mixture of air and fuel. This also accelerates the intake flow speed, which enhances combustion and improves fuel economy.
- When the engine is operating at high load conditions, the SCV opens to allow the intake of air to each cylinder through both ports. This increases the intake air volume and improves charging efficiency. At the same time, this creates a vertical swirl current (tumble current) in the combustion chamber to promote the mixture of air and fuel, thus improving performance.



12. Fuel Pump Control

- A fuel cut control system is used to stop the fuel pump once when any of the SRS airbags have deployed. With this system, when the airbag deployment signal from the airbag sensor assembly is detected by the Engine ECU, the Engine ECU turns OFF the circuit opening relay. After the fuel cut control has been activated, turning the ignition switch from OFF to ON cancels the fuel cut control, and the engine can be restarted.
- The fuel pump speed is controlled by the fuel pump relay and the fuel pump resister.



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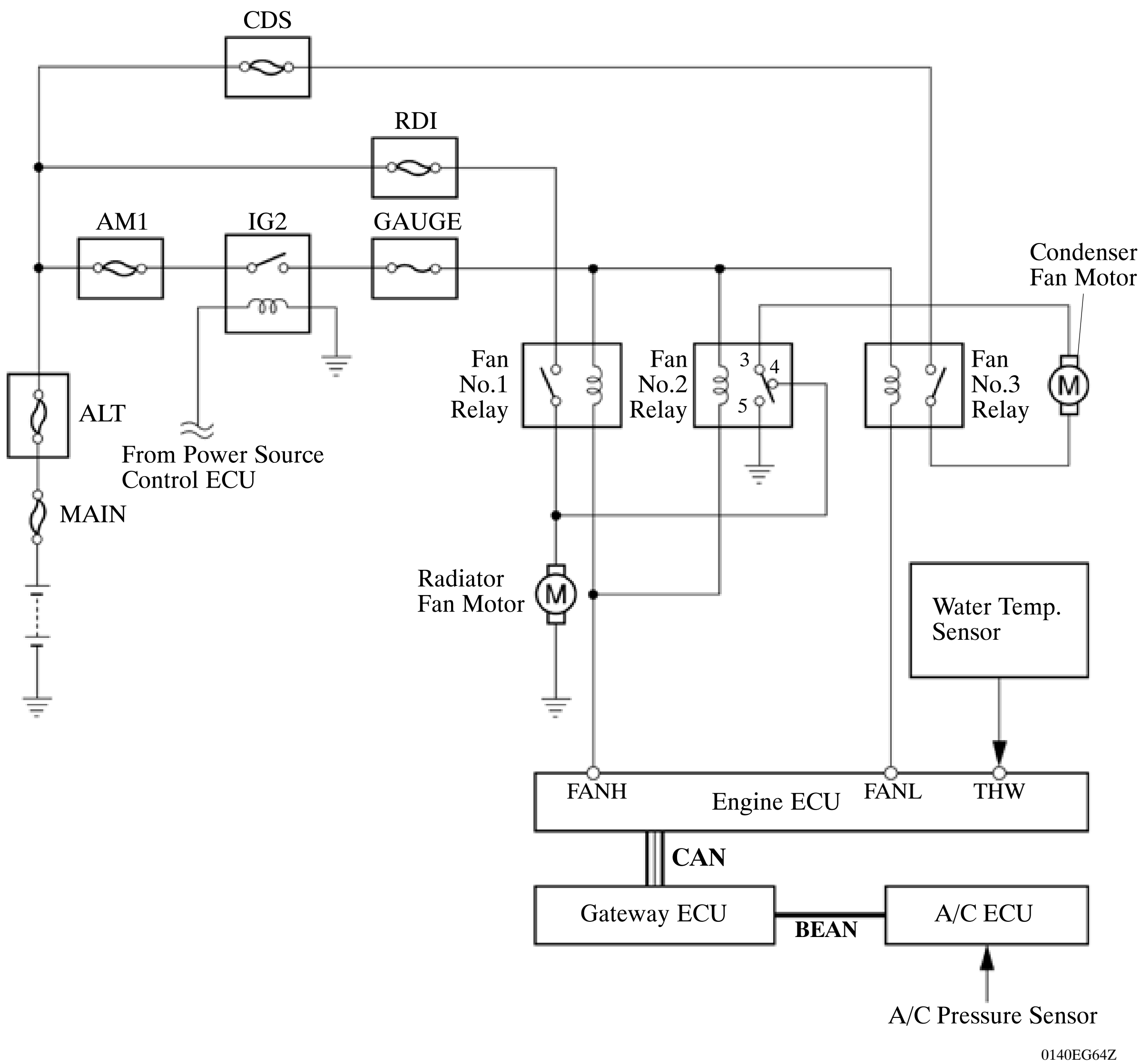
13. Cooling Fan Control

A cooling fan control system in which the Engine ECU controls the cooling fan speed in accordance with the engine coolant temperature and the air conditioner operating condition.

- The Engine ECU controls the cooling fan speed based on A/C pressure sensor signals and water temperature sensor signals. The A/C pressure sensor signals are sent from the A/C ECU to the Engine ECU via the Gateway ECU. This control is accomplished by operating the 2 fan motors in 2 stages at low speed (series connection) and high speed (parallel connection).

▶ Wiring Diagram ◀



▶ Cooling Fan Operation ◀

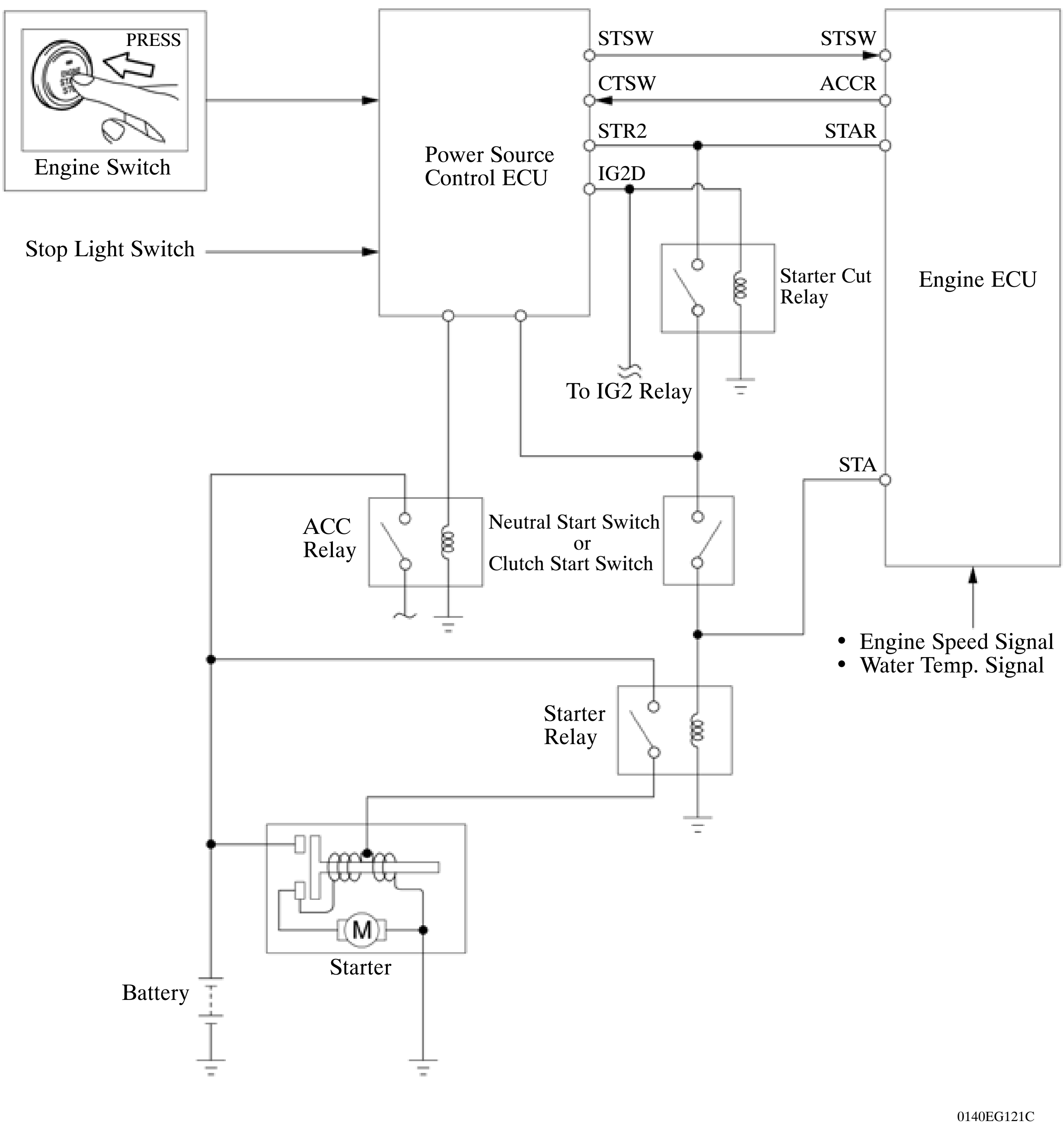
Air Conditioner Operating Condition	Engine Coolant Temperature	Relay Operation			Cooling Fan Motor Connection	Cooling Fan Operation
		No.1	No.2	No.3		
OFF	Low	OFF	3 to 4	OFF	OFF	OFF
	High	ON	3 to 5	ON	Parallel	High
A/C Pressure “Low”	Low	OFF	3 to 4	ON	Series	Low
A/C Pressure “High”	Low	OFF	3 to 4	ON	Series	Low
A/C Pressure “Low”	High	ON	3 to 5	ON	Parallel	High
A/C Pressure “High”	High	ON	3 to 5	ON	Parallel	High

14. Cranking Hold Function

General

- Once the engine switch is pressed, this function operates the starter until the engine starts, provided that the brake pedal (A/T) or clutch pedal (M/T) is depressed. This prevents application of the starter for an inadequate length of time and it also prevents the engine from being cranked after it has started.
- When the Engine ECU detects a start signal (STSW) from the Power Source Control ECU, it monitors engine speed (NE) and operates the starter until it determines that the engine has started. If the engine has already started, the Engine ECU will not operate the starter, even if the Engine ECU receives a start signal (STSW).

▶ System Diagram ◀

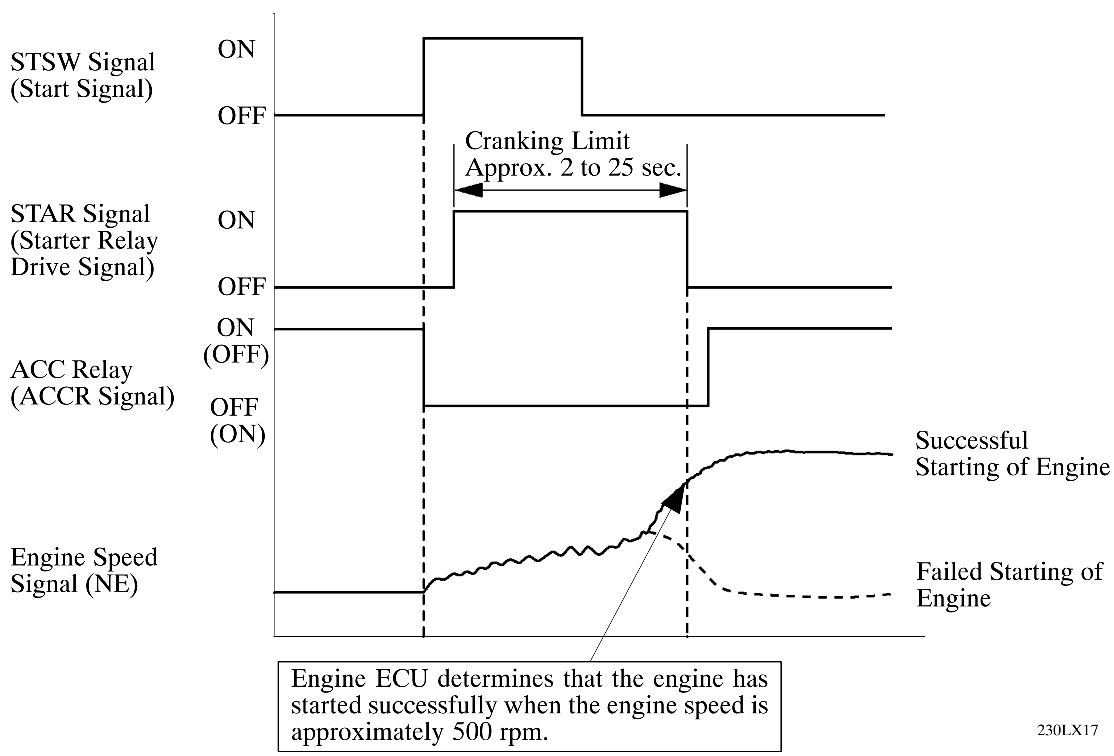


Operation

- When the Engine ECU detects a start signal (STSW) from the Power Source Control ECU, the Engine ECU outputs a starter cut relay drive signal (STAR) to the Power Source Control ECU.
- When the Engine ECU detects a start signal (STSW) from the Power Source Control ECU, the Engine ECU also outputs an ACC-cut request signal (ACCR) to the Power Source Control ECU.
- The STAR signal instructs the Power Source Control ECU to turn on the starter cut relay, and the IG2 Relay. The STAR signal is also the source of the power that flows through the neutral start switch (A/T) or clutch start switch (M/T) to the Starter Relay.
- The ACCR signal instructs the Power Source Control ECU to turn off the ACC relay, in order to prevent accessory light flickering from occurring while cranking.
- After the engine speed rises above approximately 500 rpm, the Engine ECU determines that the engine has started and stops the output of the STAR signal. This causes starter operation to stop and the Power Source Control ECU to turn on the ACC relay.
- If the engine does not start, the starter operates for a length of time that is based on coolant temperature. This can range from 25 seconds at lower temperatures to 2 seconds when the engine is at operating temperature.
- **This system has following safety features:**

- While the engine is running, the starter can not operate.
- The starter will stop operating once the engine has started, even if the start switch remains depressed.
- Starter operation is limited to a maximum of 30 seconds to protect the starter motor.
- The starter will stop if the Engine ECU cannot detect an engine speed signal (NE) while the starter is operating.

▶ Timing Chart ◀

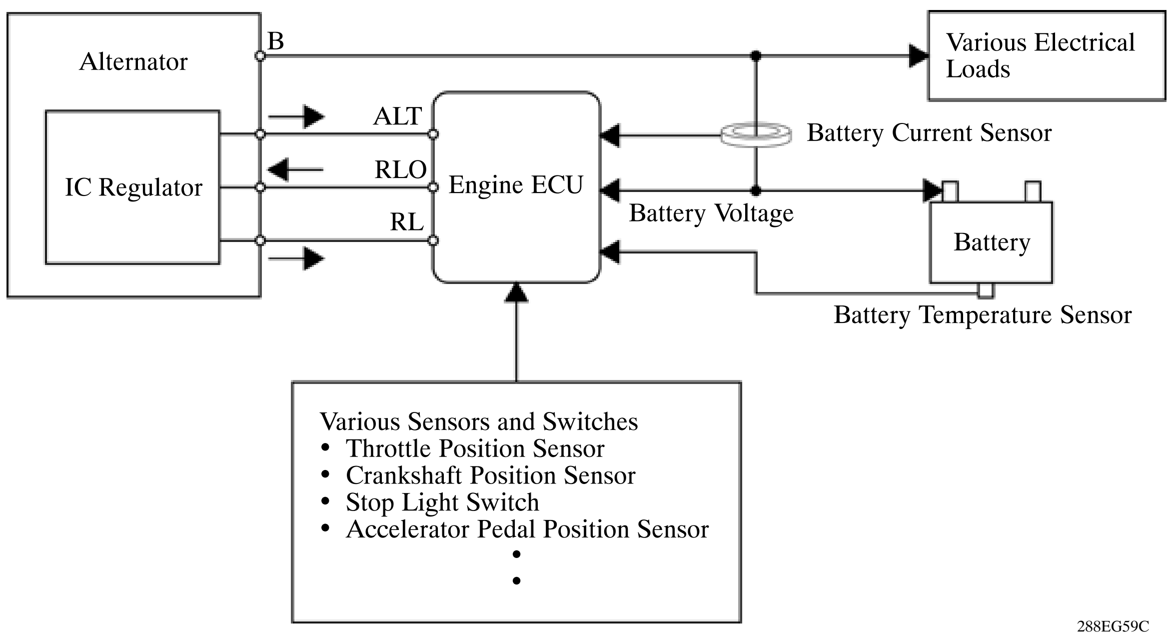


15. Charging Control

General

The charging control system controls the generated voltage of the alternator according to driving conditions for fuel economy. Voltage is generated while decelerating. During constant-speed driving, battery charging and discharging are repeated to maintain a constant battery voltage.

- This control consists of the engine ECU, battery current sensor, battery temperature sensor, alternator and various sensors and switches.
- The engine ECU detects driving condition based on signals from various sensors and switches, and detects charging condition based on signals from the alternator, battery current sensor and battery temperature sensor. Then the engine ECU outputs signals to the IC regulator to control the generated voltage of the alternator.



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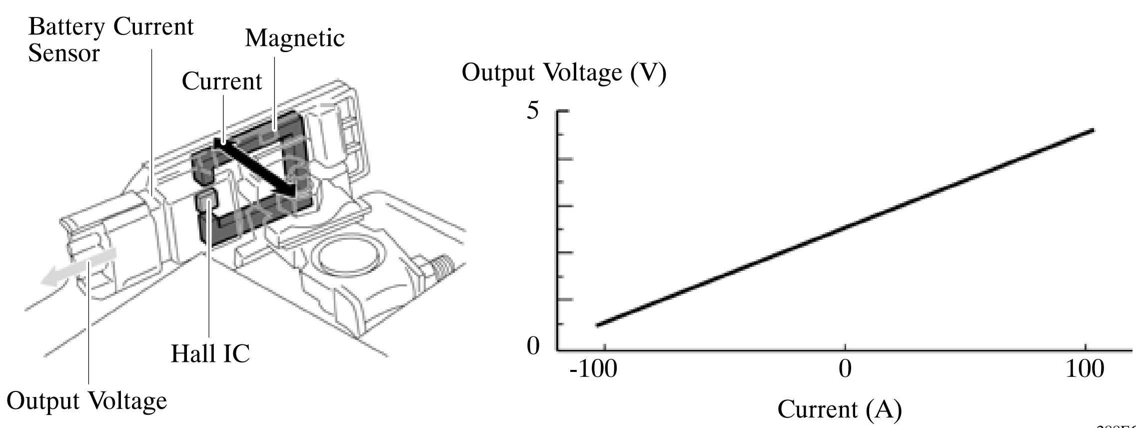
Battery Current Sensor

The battery current sensor detects the charged and discharged battery volume and sends the signal to the engine ECU. The battery current sensor consists of the Hall IC and magnetic. Hall IC is used to detect the battery volume by converting changes in magnetic flux density into voltage.



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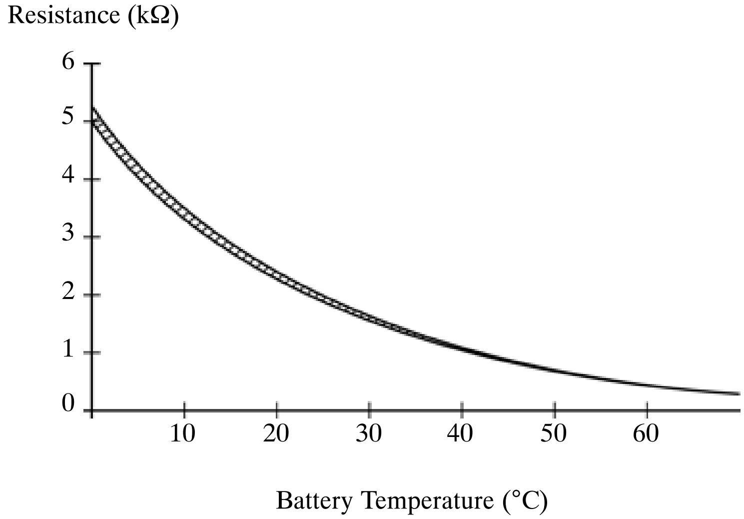
Battery Temperature Sensor

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



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16. Diagnosis

- When the Engine ECU detects a malfunction, the Engine ECU makes a diagnosis and memorizes the information that relates to the fault. Furthermore, the check engine warning light in the combination meter illuminates or blinks to inform the driver.
- The Engine ECU will also store the DTCs (Diagnostic Trouble Codes) of the malfunctions. The DTCs can be accessed by using the intelligent tester II.
- For details, see the LEXUS IS250 Repair Manual (Pub. No. RM0150E).

Service Tip

- The Engine ECU of the new IS250 uses the CAN protocol for diagnostic communication. Therefore, an intelligent tester II is required for accessing diagnostic data. For details, see the LEXUS IS250 Repair Manual (Pub. No. RM150E).
- To clear a DTC that is stored in the Engine ECU, use an intelligent tester II, disconnect the battery terminal or remove the EFI fuse for 1 minute or longer.

17. Fail-Safe

When the Engine ECU detects a malfunction, the Engine ECU stops or controls the engine according to the data already stored in the memory.

▶ Fail-Safe Chart ◀

DTC No.	Fail-Safe Operation	Fail-Safe Deactivation Conditions
P0031, P0032, P0051, P0052	Engine ECU turns off air-fuel ratio (A/F) sensor heater.	Engine switch OFF.
P0037, P0038, P0057, P0058	Engine ECU turns off heated oxygen (HO2) sensor heater.	Engine switch OFF.
P0087, P0088	• Stop the fuel pump for high pressure. • Limit the engine speed to 2,000 rpm or less.	"Pass" condition detected.
P0100, P0102, P0103	Engine ECU calculates ignition timing according to engine speed and throttle valve position.	"Pass" condition detected.
P0110, P0112, P0113	Engine ECU estimates IAT to be 20°C (68°F).	"Pass" condition detected.
P0115, P0117, P0118	Engine ECU estimates ECT to be 80°C (176°F).	"Pass" condition detected.
P0120, P0121, P0122, P0123, P0220, P0222, P0223, P0604, P0606, P0607, P0657, P2102, P2103, P2111, P2112, P2118, P2119, P2135	Engine ECU cuts off throttle actuator current and throttle valve returns to 6.5° throttle position by return spring. Engine ECU then adjusts engine output by controlling fuel injection (intermittent fuel-cut) and ignition timing in accordance with accelerator pedal opening angle to allow vehicle to continue at minimal speed*.	"Pass" condition detected and then engine switch turned off.
P0171, P0172, P0174, P0175	Air-furl ratio feedback control is stopped.	"Pass" condition detected and then engine switch turned off.
P0190, P0192, P0193	• Stop the fuel pump for high pressure. • Limit the engine speed to 2,000 rpm or less.	"Pass" condition detected and then engine switch turned off.

(Continued)

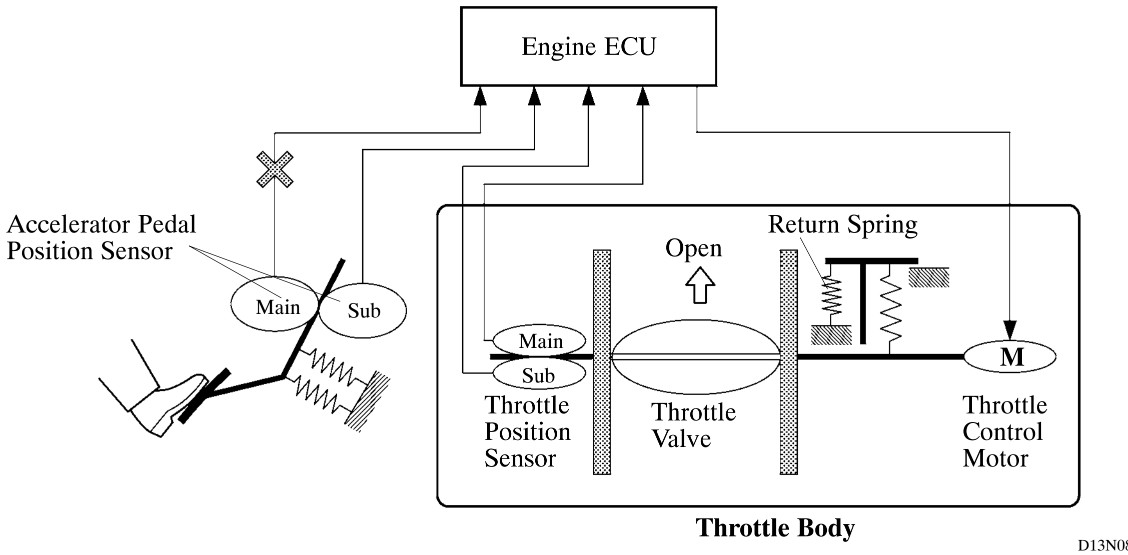
DTC No.	Fail-Safe Operation	Fail-Safe Deactivation Conditions
P0200, P0201, P0202, P0203, P0204, P0205, P0206, P12FF	• Stop fuel injection for an abnormal cylinder and related other cylinders. • Limit the engine speed to 3,000 rpm or less.	"Pass" condition detected and then engine switch turned off.
P0325, P0327, P0328, P0330, P0332, P0333	Engine ECU sets ignition timing to maximum retard.	Engine switch OFF.
P0351, P0356	Engine ECU cuts fuel.	"Pass" condition detected.
P0504	Accelerator pedal angle is fixed.	"Pass" condition detected.
P0516, P0517, P0560, P1550, P1551, P1552, P1602	The ECM requests the alternator to generate a fixed voltage.	"Pass" condition detected and then engine switch turned off.
P1235	• Stop the fuel pump for high pressure. • Limit the engine speed to 2,000 rpm or less.	"Pass" condition detected.
P2239, P2241, P2252, P2253, P2255, P2256	Air-fuel ratio feedback control is stopped.	"Pass" condition detected and then engine switch turned off.
P2120, P2121, P2122, P2123, P2125, P2127, P2128, P2138	Accelerator pedal position (APP) sensor has two sensor circuits: Main and Sub. If either of circuit malfunctions, Engine ECU controls engine using other circuit. If both of circuit malfunction, Engine ECU regards accelerator pedal as being released. As a result, throttle valve is closed and engine idles.	"Pass" condition detected and then engine switch turned off.

*: The vehicle can be driven slowly when the accelerator pedal is depressed firmly and slowly. If the accelerator pedal is depressed quickly, the vehicle may speed up and slow down erratically.

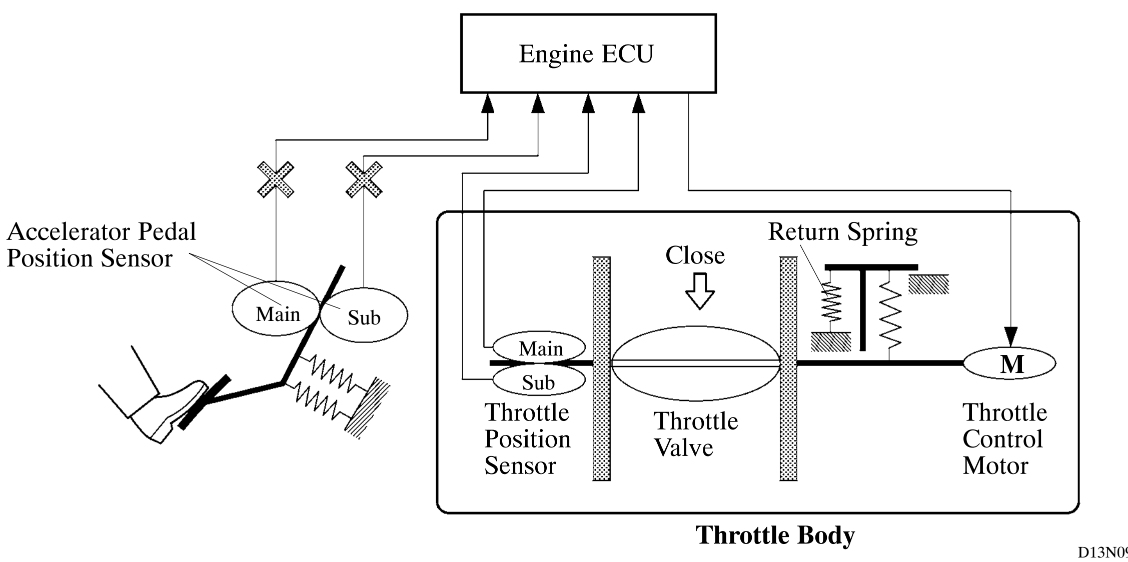
Fail-safe Operation due to Accelerator Pedal Position Sensor Trouble

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

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



- If both circuits malfunction, the Engine ECU 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.



Fail-safe Operation due to Throttle Position Sensor Trouble

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

- If a malfunction occurs in either of the sensor circuits, the Engine ECU detects the abnormal signal voltage difference between these two sensor circuits, cuts off the current to the throttle control motor, and switches to a failsafe mode.
- Then, the force of the return spring causes the throttle valve to return and stay at the 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 Engine ECU detects a malfunction in the throttle control motor system.