■ ENGINE CONTROL SYSTEM

1. General

The engine control system of the 1GR-FE engine has the following system.

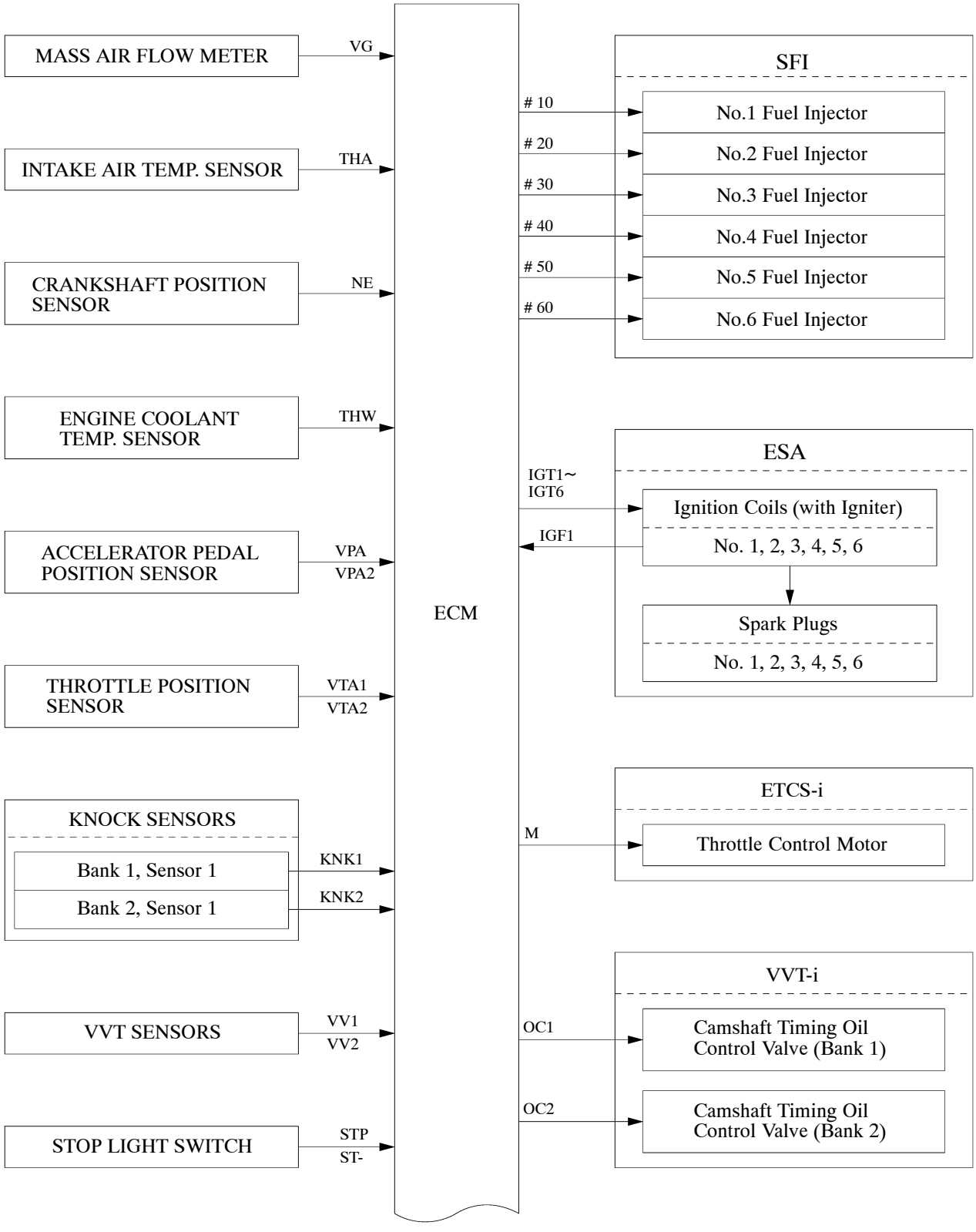
System	Outline
SFI (Sequential Multiport Fuel Injection)	• An L-type SFI system directly detects the intake air mass using a hot wire type air flow meter. • An independent injection system (in which fuel is injected once into each intake port for each two revolutions of the crankshaft) is used. • Fuel injection takes two forms: - Synchronous injection, in which injection always occurs at the same timing relative to the firing order. - The non-synchronous injection in which injection is effected regardless of the crankshaft angle. • This system performs group injection when the engine coolant temperature is extremely low and the engine is operating at a low speed.
ESA (Electronic Spark Advance)	• Ignition timing is determined by the ECM based on signals from various sensors. The ECM corrects ignition timing in response to engine knocking. • 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.
ETCS-i (Electronic Throttle Control System-intelligent) [See page EG-60]	Optimally controls the throttle valve opening in accordance with the amount of accelerator pedal effort and the condition of the engine and the vehicle.
VVT-i (Variable Valve Timing-intelligent) [See page EG-62]	Controls the intake camshaft to optimal valve timing in accordance with the engine condition.
ACIS (Acoustic Control Induction System) [See page EG-66]	The intake air passages are switched according to the engine speed and throttle valve opening angle to provided high performance in all speed ranges.
Fuel Pump Control [See page EG-68]	• Based on signals from the ECM, the fuel pump ECU controls the fuel pump to 3 stages. • The fuel pump is stopped when the SRS airbag is deployed in a frontal, side, or side rear collision.
Starter Control (Cranking Hold Function) [See page EG-70]	Once the engine switch is pushed, this control continues to operate the starter until the engine is started.
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
Air Conditioning Cut-off Control	By turning the air conditioning compressor ON or OFF in accordance with the engine condition, drivability is maintained.
Evaporative Emission Control	The ECM 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 key.
Diagnosis [See page EG-72]	When the ECM detects a malfunction, the ECM records the malfunction and memorizes information related to the fault.
Fail-safe [See page EG-72]	When the ECM detects a malfunction, the ECM stops or controls the engine according to the data already stored in the memory.

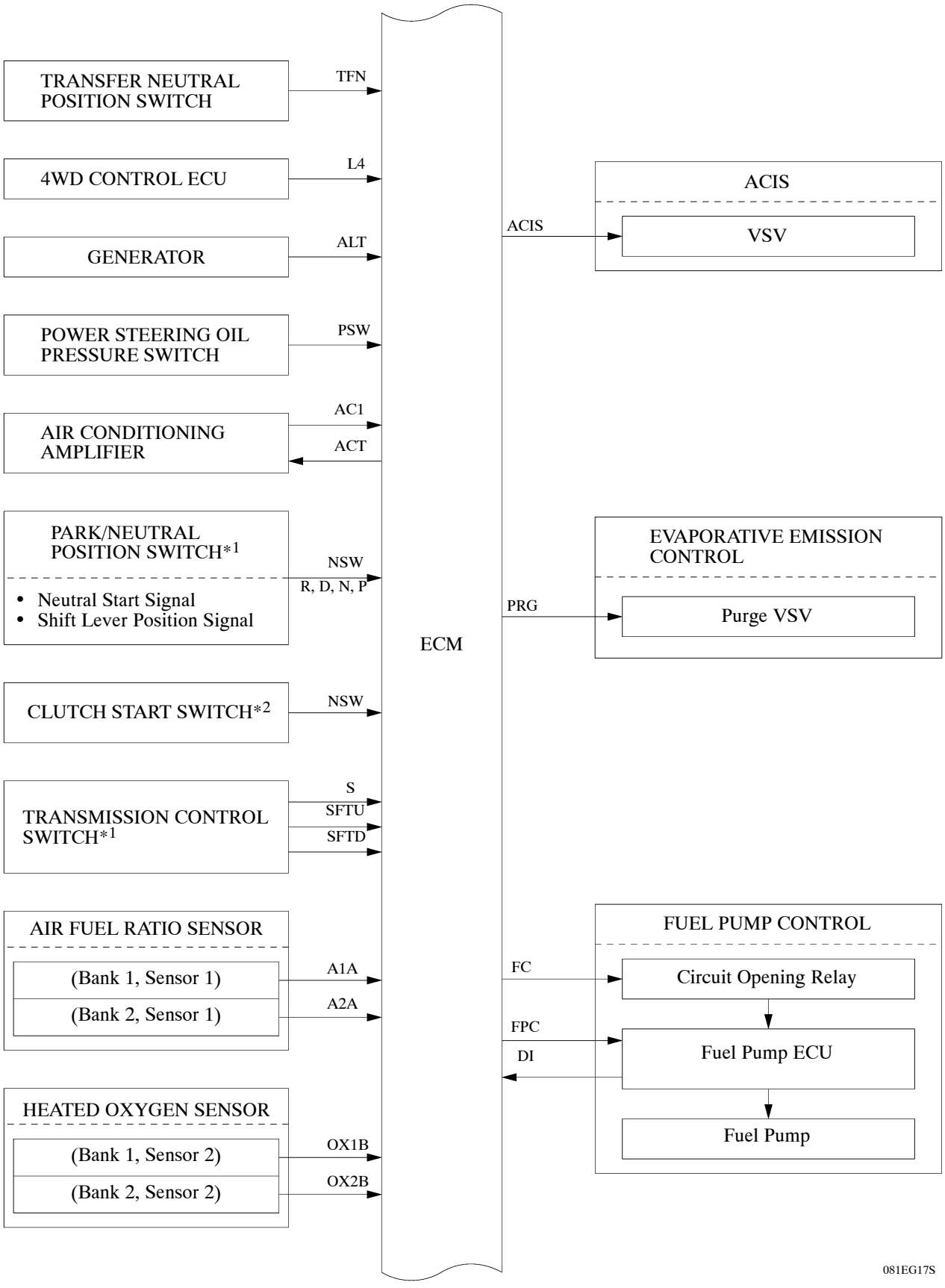
2. Construction

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

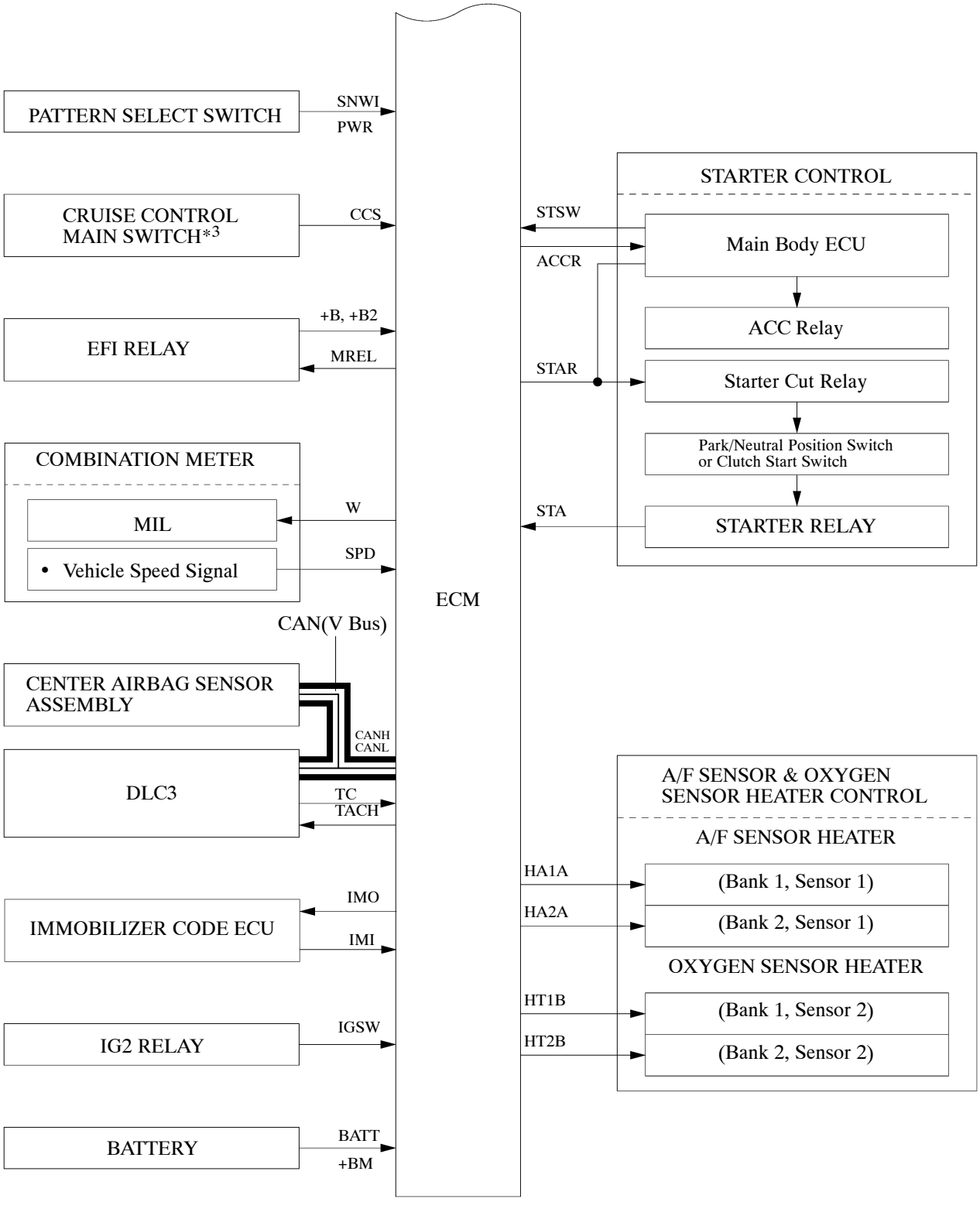


081EG16S

(Continued)


TRANSFER NEUTRAL POSITION SWITCH
TFN
4WD CONTROL ECU
L4
GENERATOR
ALT
POWER STEERING OIL PRESSURE SWITCH
PSW
AIR CONDITIONING AMPLIFIER
AC1
ACT
PARK/NEUTRAL POSITION SWITCH*1
• Neutral Start Signal
• Shift Lever Position Signal
NSW
R, D, N, P
CLUTCH START SWITCH*2
NSW
TRANSMISSION CONTROL SWITCH*1
S
SFTU
SFTD
AIR FUEL RATIO SENSOR
(Bank 1, Sensor 1)
(Bank 2, Sensor 1)
A1A
A2A
HEATED OXYGEN SENSOR
(Bank 1, Sensor 2)
(Bank 2, Sensor 2)
OX1B
OX2B
ECM
ACIS
ACIS
VSV
EVAPORATIVE EMISSION CONTROL
PRG
Purge VSV
FUEL PUMP CONTROL
FC
Circuit Opening Relay
FPC
DI
Fuel Pump ECU
Fuel Pump
081EG17S

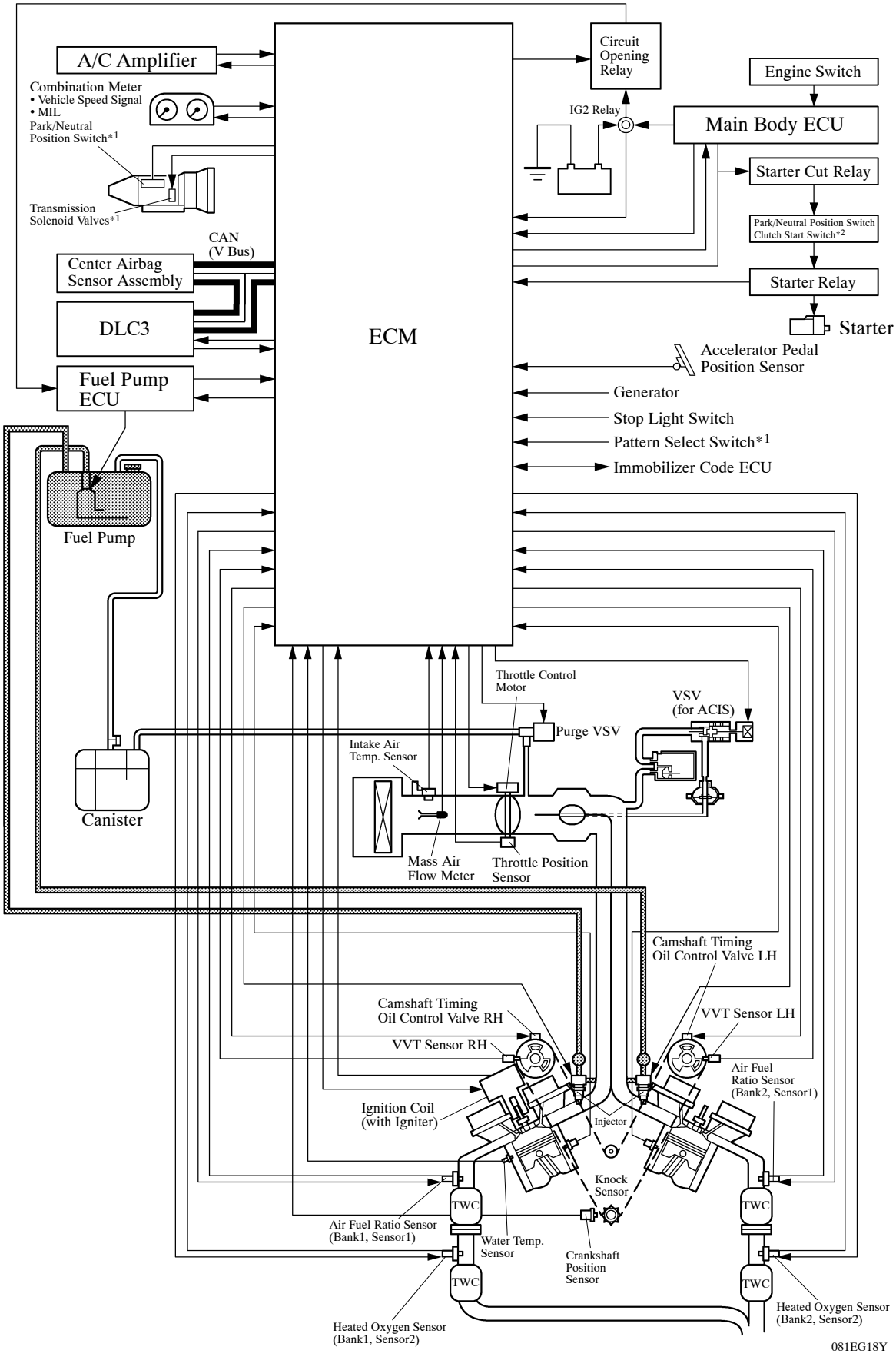
(Continued)



081EG22S

*1: Only for models with automatic transmission
*2: Only for models with manual transmission
*3: Only for models with cruise control system

3. Engine Control System Diagram

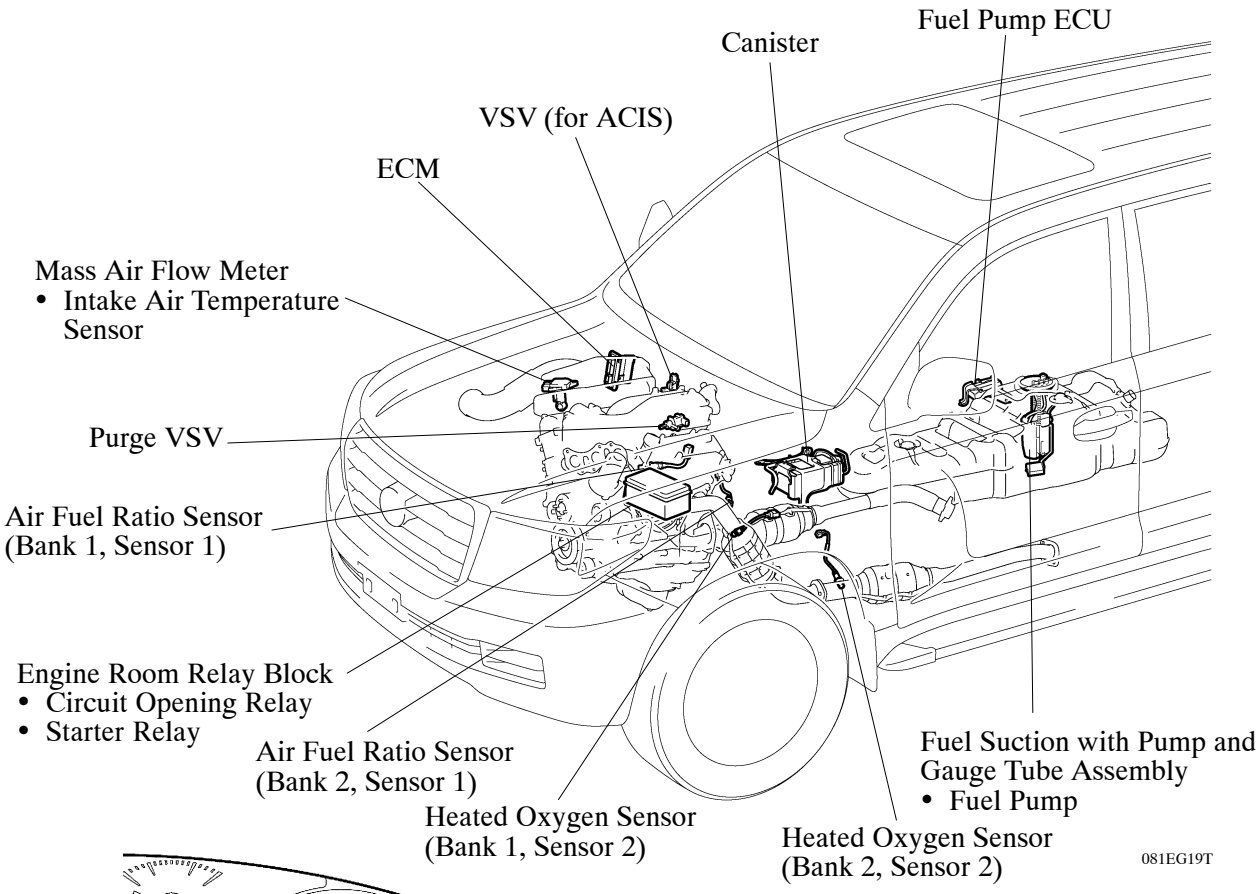


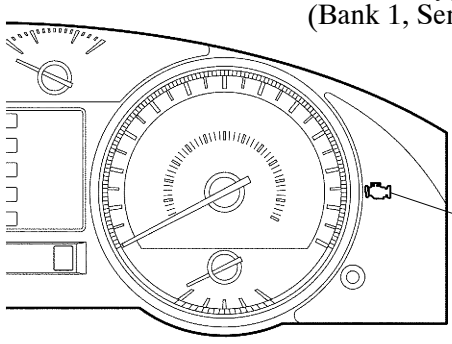
*1: Only for models with automatic transmission

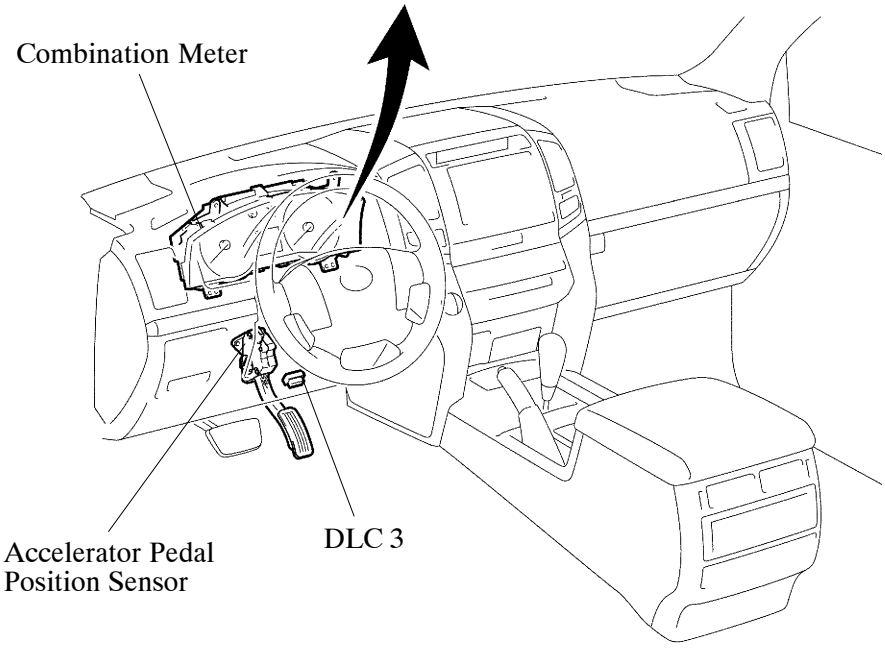
*2: Only for models with manual transmission

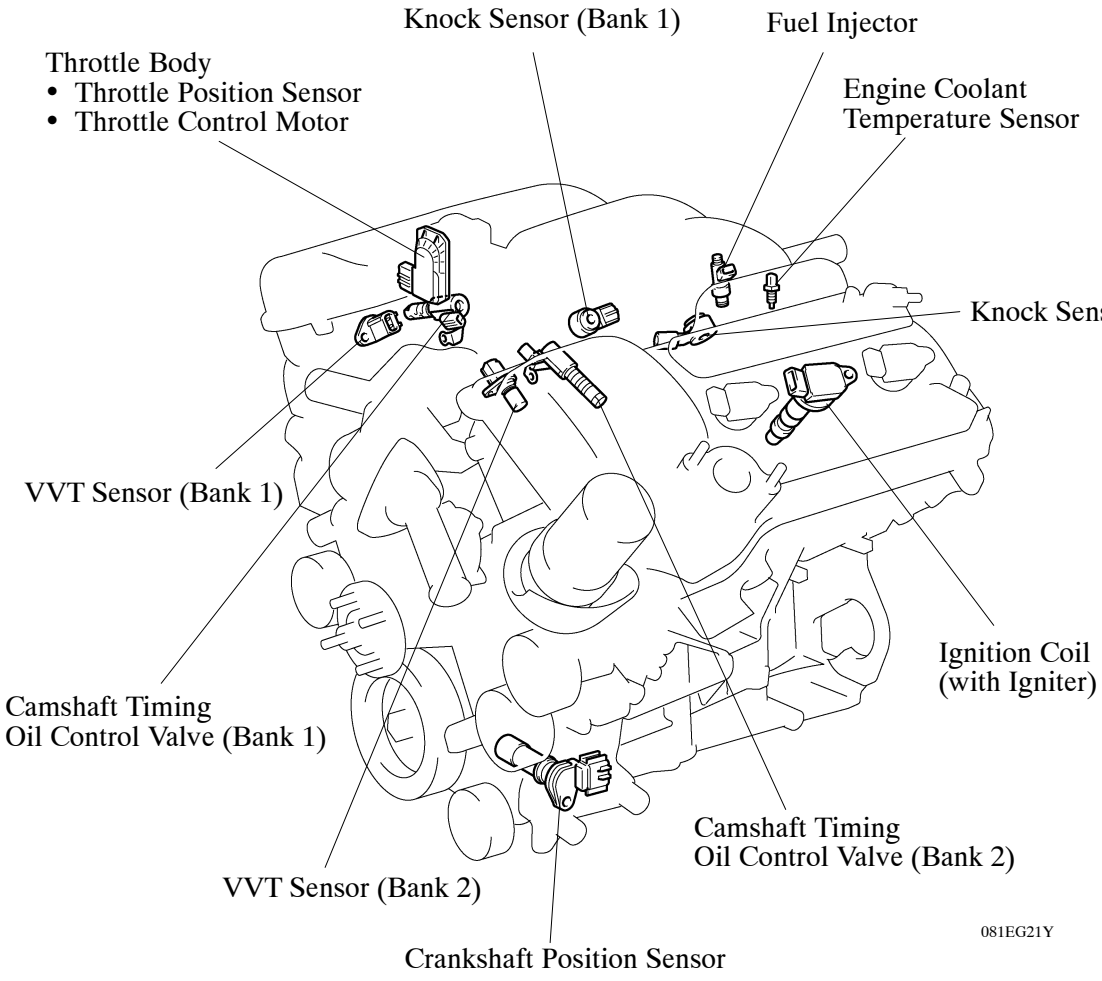
EG

4. Layout of Main Components








Knock Sensor (Bank 1)
Fuel Injector
Throttle Body
• Throttle Position Sensor
• Throttle Control Motor
Engine Coolant Temperature Sensor
Knock Sensor (Bank 2)
VVT Sensor (Bank 1)
Ignition Coil (with Igniter)
Camshaft Timing Oil Control Valve (Bank 1)
Camshaft Timing Oil Control Valve (Bank 2)
VVT Sensor (Bank 2)
Crankshaft Position Sensor
081EG21Y

5. Main Components of Engine Control System

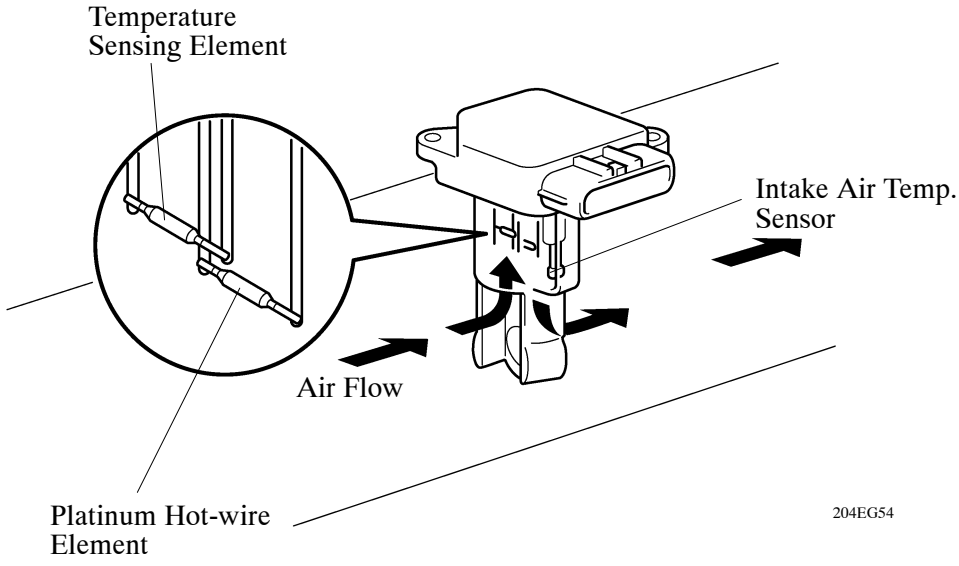
General

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

Components	Outline	Quantity	Function
ECM	32-bit CPU (DENSO)	1	The ECM optimally controls the SFI, ESA and ISC to suit the operating conditions of the engine in accordance with the signals provided by the sensors.
Mass Air Flow Meter [See page EG-51]	Hot-wire Type	1	This sensor has a built-in hot-wire to directly detect the intake air mass and flow rate.
Intake Air Temperature Sensor	Thermistor Type	1	This sensor detects the intake air temperature by means of an internal thermistor.
Crankshaft Position Sensor [See page EG-52]	Pick-up Coil Type (Rotor Teeth /36-2)	1	This sensor detects the engine speed and performs the cylinder identification.
VVT Sensor [See page EG-52]	MRE Type (Rotor Teeth /3)	1 each bank	This sensor performs the cylinder identification.
Accelerator Pedal Position Sensor [See page EG-54]	No-contact Type	1	This sensor detects the amount of pedal effort applied to the accelerator pedal.
Throttle Position Sensor [See page EG-55]	No-contact Type	1	This sensor detects the throttle valve opening angle.
Knock Sensor [See page EG-56]	Built-in Piezoelectric Type (Flat Type)	1 each bank	This sensor detects an occurrence of the engine knocking indirectly from the vibration of the cylinder block caused by the occurrence of engine knocking.
Heated Oxygen Sensor [See page EG-58]	Cup Type with Heater	1 each bank	This sensor detects the oxygen concentration in the exhaust gas by measuring the electromotive force which is generated in the sensor itself.
Air Fuel Ratio Sensor [See page EG-58]	Planar Type with Heater	1 each bank	As with the oxygen sensor, this sensor detects the oxygen concentration in the exhaust gas. However, it detects the oxygen concentration in the exhaust gas linearly.
Engine Coolant Temperature Sensor	Thermistor Type	1	This sensor detects the engine coolant temperature by means of an internal thermistor.
Fuel Injector [See page EG-29]	12-Hole Type	6	This fuel injector contains an electro-magnetically operated nozzle to inject fuel into the intake port.
Camshaft Timing Oil Control Valve [See page EG-64]	Electro-Magnetic Coil Type	2 each bank	The camshaft timing oil control valve changes the valve timing by switching the oil passage that acts on the VVT-i controller in accordance with the signals received from the ECM.

Mass Air Flow Meter

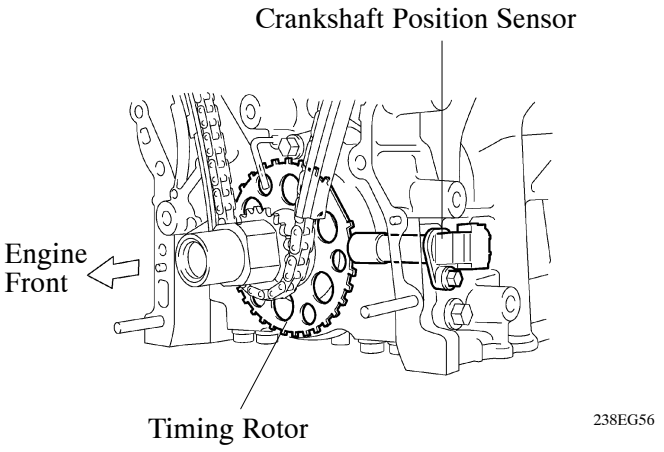
- This mass air flow meter, which is a plug-in type, allows a portion of the intake air to flow through the detection area. By directly measuring the mass and the flow rate of the intake air, the detection precision is improved and the intake air resistance is reduced.
- This mass air flow meter has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

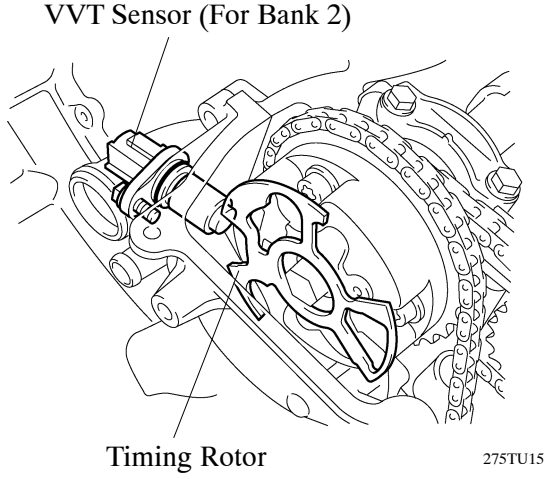


Crankshaft and VVT Sensors

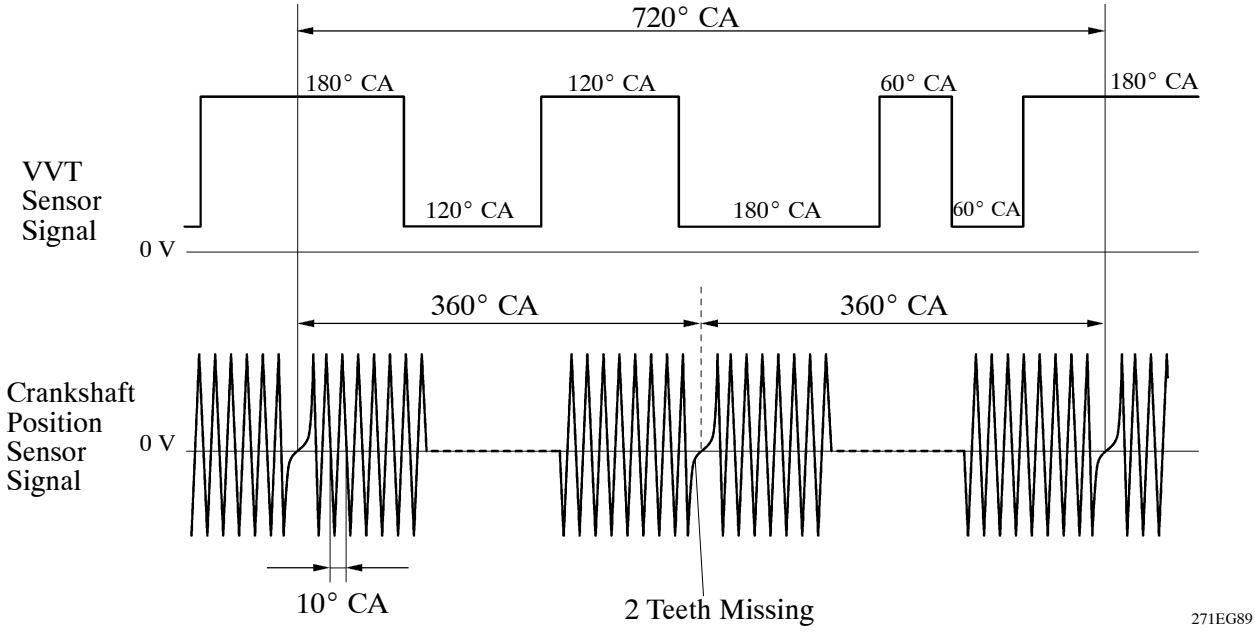
1) General

- Pick up coil type crankshaft position sensor is used. 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 missing teeth are used to determine the top-dead-center.
- MRE (Magnetic Resistance Element) type VVT sensor is 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 3 (3 Hi output, 3 Lo output) for every 2 revolutions of the crankshaft.





▶ Sensor Output Waveforms ◀

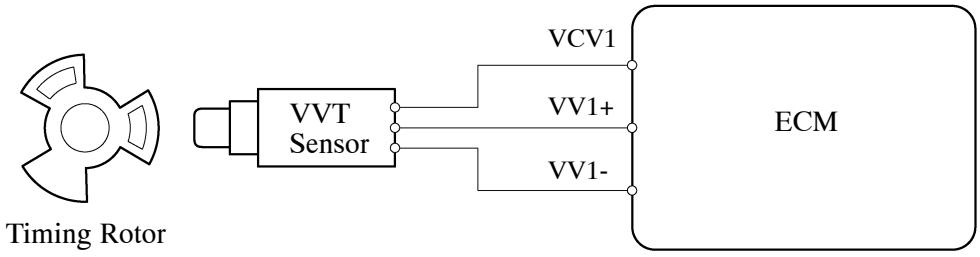


2) MRE type VVT Sensor

- The MRE type VVT sensor consists of an MRE, a magnet and a sensor. The direction of the magnetic field changes due to the different shapes (protruded and non-protruded 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.
- The differences between the MRE type VVT sensor and the pickup coil type VVT sensor used on the conventional model are as follows.

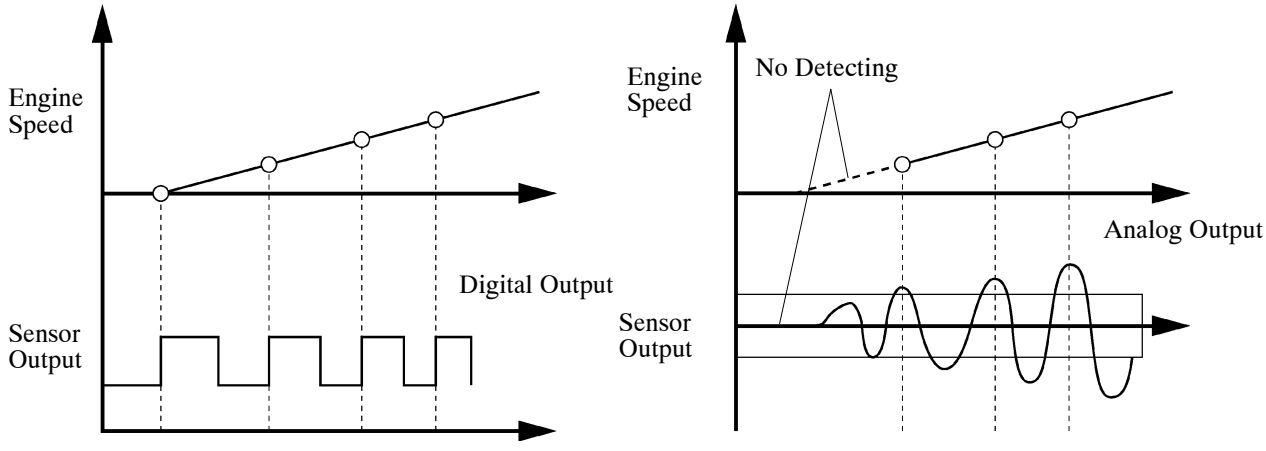
Item	Sensor Type	
	MRE	Pick up Coil
Signal Output	Constant digital output starts from low engine speeds	Analog output changes with the engine speed
Camshaft Position Detection	Detection based on the waveforms output throughout the timing rotor speed range	Detection based on the waveforms output as the protruded portion of the timing rotor passes

▶ Wiring Diagram◀



271EG160

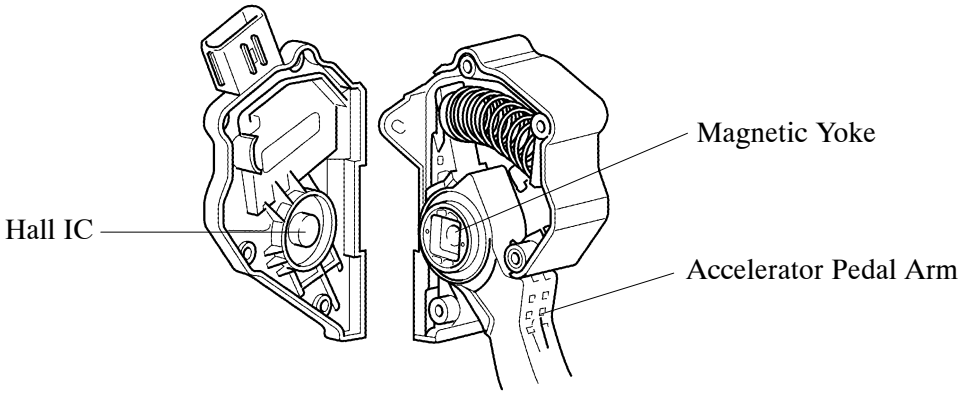
▶ MRE Type and Pickup Coil Type Output Waveform Image Comparison ◀



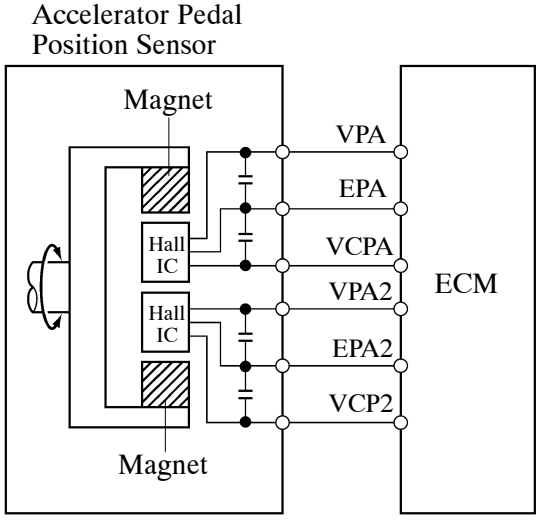
232CH41

Accelerator Pedal Position Sensor

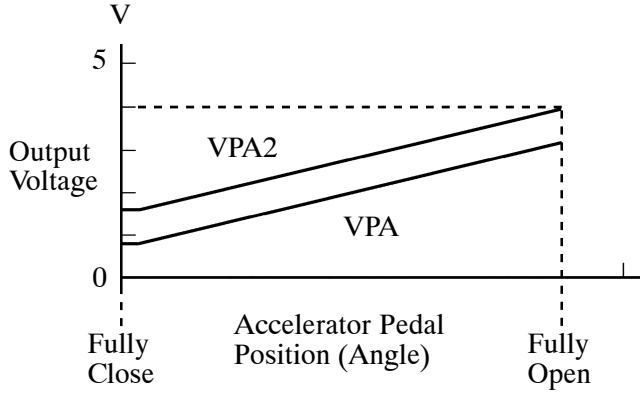
- The no-contact type accelerator pedal position sensor uses a Hall IC, which is mounted on the accelerator pedal arm.
- A magnetic yoke is mounted at the base of the accelerator pedal arm. This yoke rotates around the Hall IC in accordance with the amount of effort that is applied to the accelerator pedal. The Hall IC converts the changes that occur in the magnetic flux 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.



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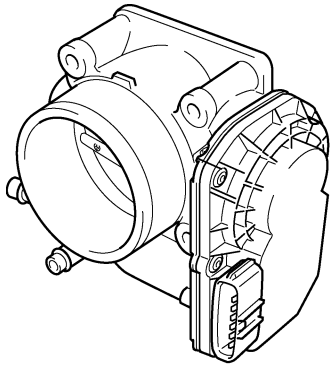
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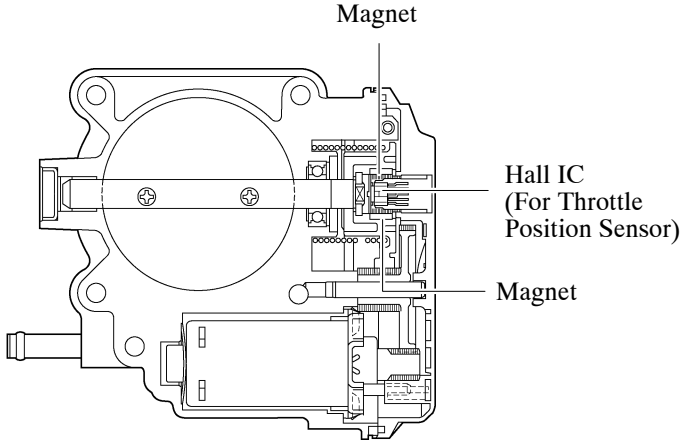


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Throttle Position Sensor

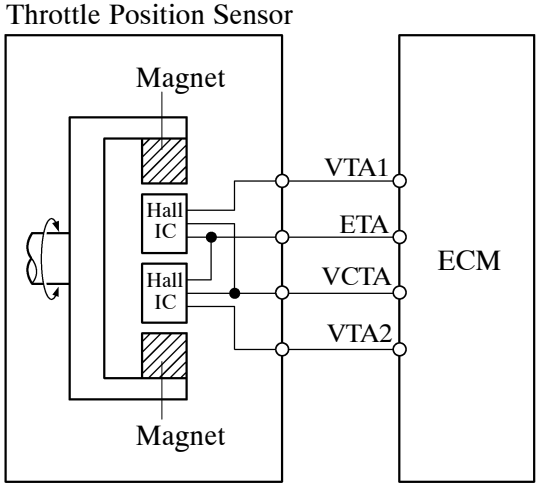
- The no-contact type throttle position sensor uses a Hall IC, which is mounted on the throttle body.
- The Hall IC is surrounded by a magnetic yoke. The Hall IC converts the changes that occur in the magnetic flux into electrical signals, and outputs them in the form of throttle valve position signals to the ECM.
- The Hall IC contains circuits for the main and sub signals. It converts the throttle valve opening angle into two electrical signals that have differing characteristics and outputs them to the ECM.

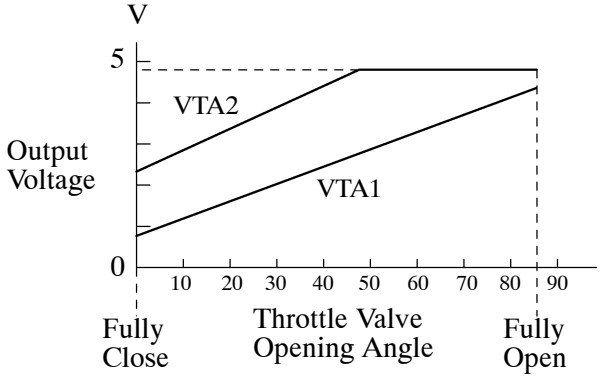




Cross Section

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02HEG57Y

Knock Sensor (Flat Type)

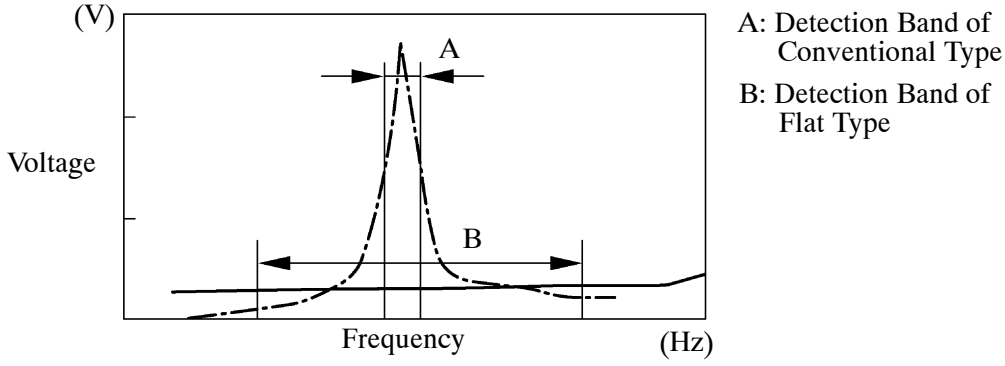
1) General

In the conventional type knock sensor (resonant type), a vibration plate, which has the same resonance point as the knocking frequency of the engine, is built-in and can detect the vibration in this frequency band.

On the other hand, a flat type knock sensor (non-resonant type) has the ability to detect vibration in a wider frequency band from about 6 kHz to 15 kHz, and has the following features:

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

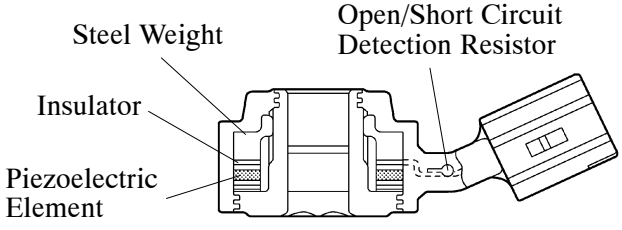
—·— : Conventional Type
——— : Flat Type



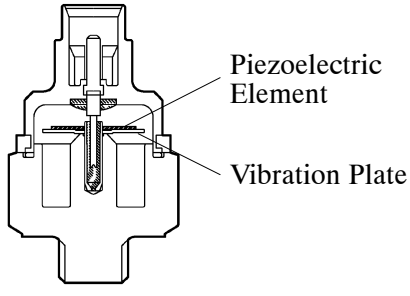
Characteristic of Knock Sensor 214CE04

2) Construction

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



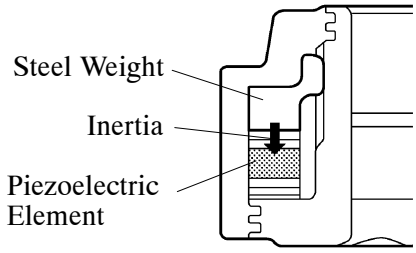
Flat Type Knock Sensor (Non-resonant Type) 214CE01



Conventional Type Knock Sensor (Resonant Type) 214CE02

3) Operation

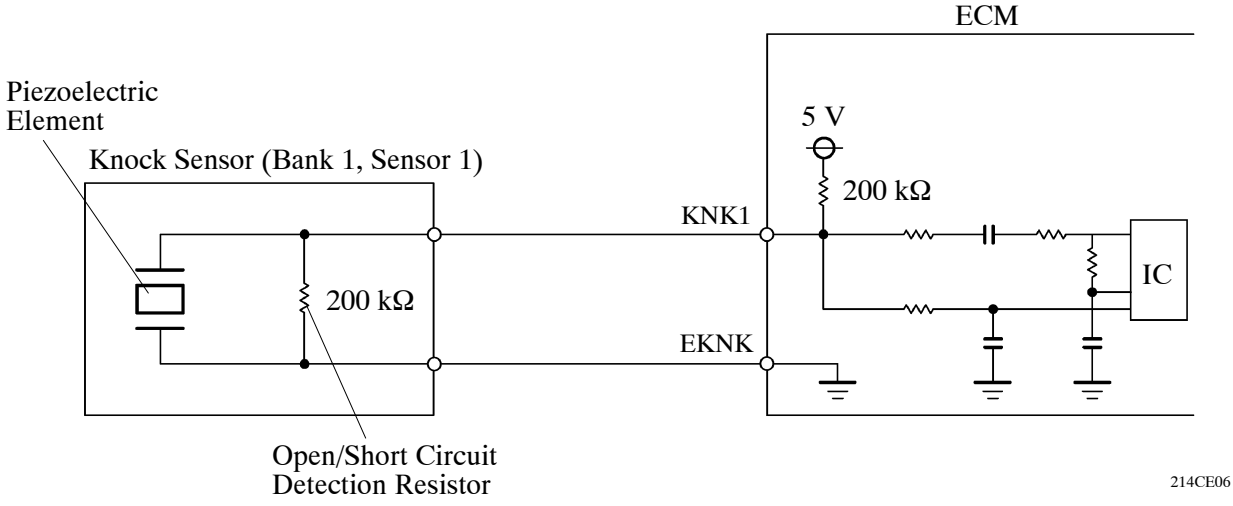
The knocking vibration is transmitted to the steel weight and its inertia applies pressure to the piezoelectric element. The action generates electromotive force.



214CE08

4) Open/Short Circuit Detection Resistor

During the power source is IG-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 and the ECM detects the open/short circuit and stores DTC (Diagnostic Trouble Code).



214CE06

Service Tip

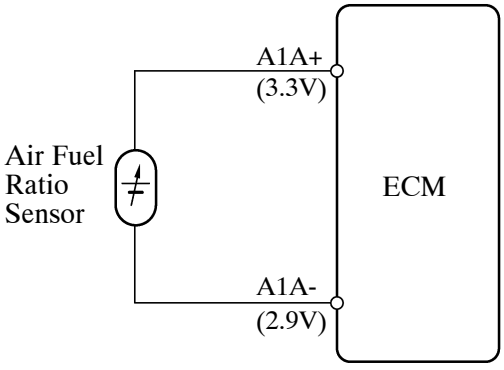
These knock sensors are mounted in specific directions at specific angles. To prevent the right and left bank wiring connectors from being interchanged, make sure to install each sensor in its prescribed direction. For details, refer to the Land Cruiser (Station Wagon) Repair Manual (Pub. No. RM0810E).

EG

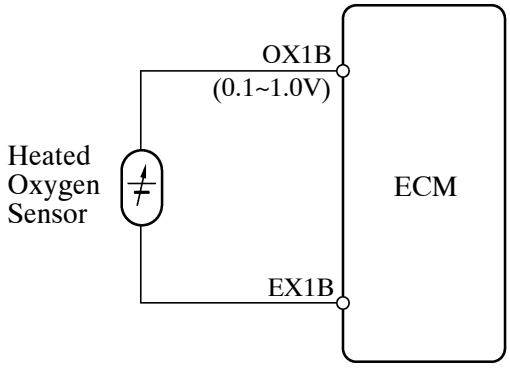
Air Fuel Ratio Sensor and Heated Oxygen Sensor

1) General

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

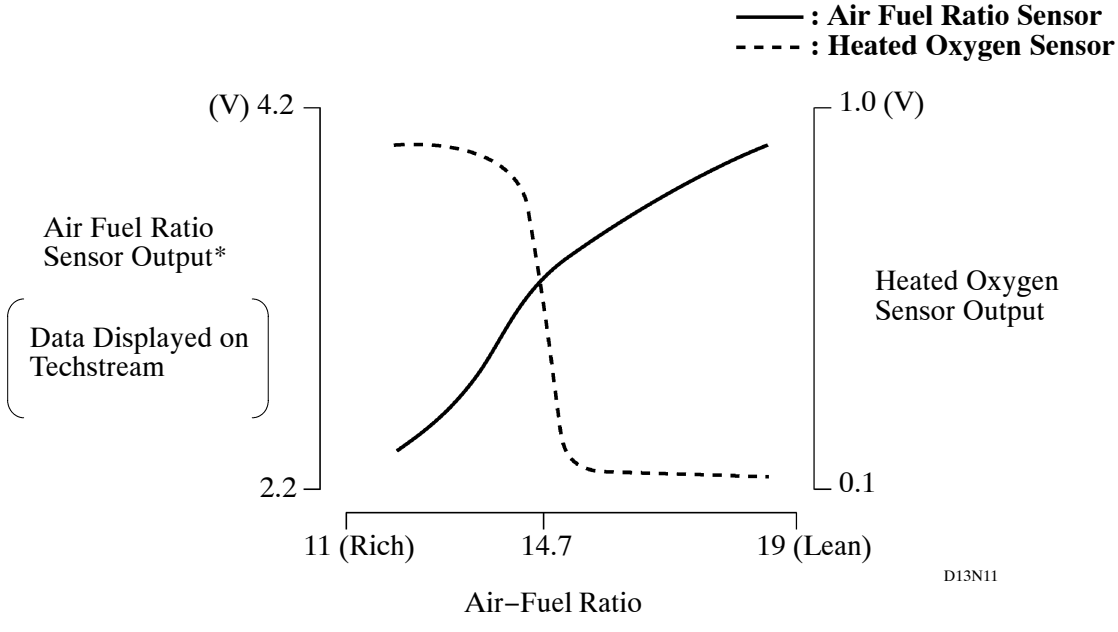


Air Fuel Ratio Sensor Circuit (Bank 1, Sensor 1)



Heated Oxygen Sensor Circuit (Bank 1, Sensor 2)

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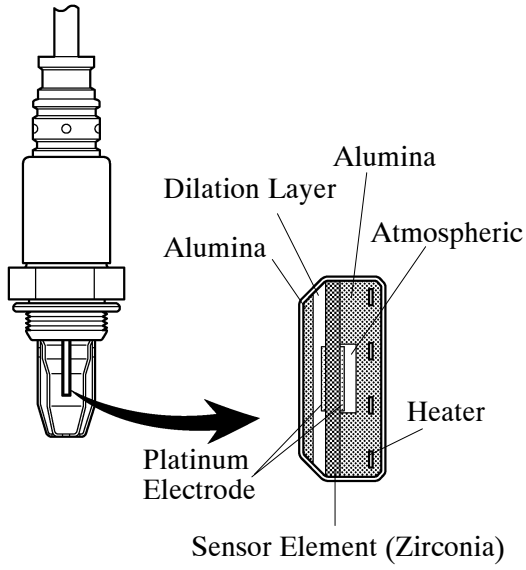


D13N11

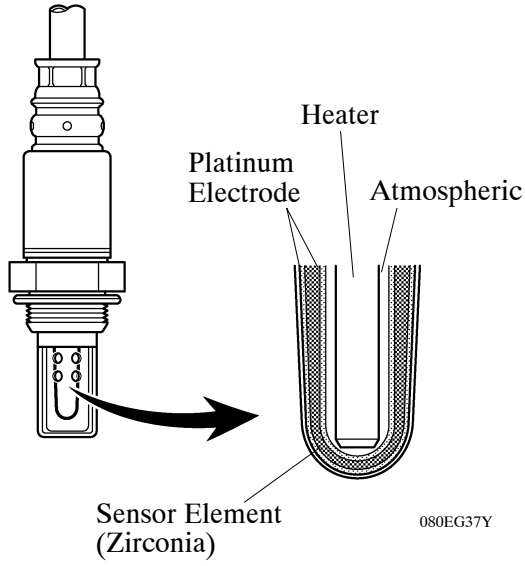
*: This calculation value is used internally in the ECM, and is not an ECM terminal voltage.

2) Construction

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



Air Fuel Ratio Sensor (Planar Type)*



Heated Oxygen Sensor (Cup Type)*

*: The illustrations above are intended to show the differences in the basic construction between the cup type sensor and the planner type sensor, so the illustrated sensor shapes may differ from the actual ones.

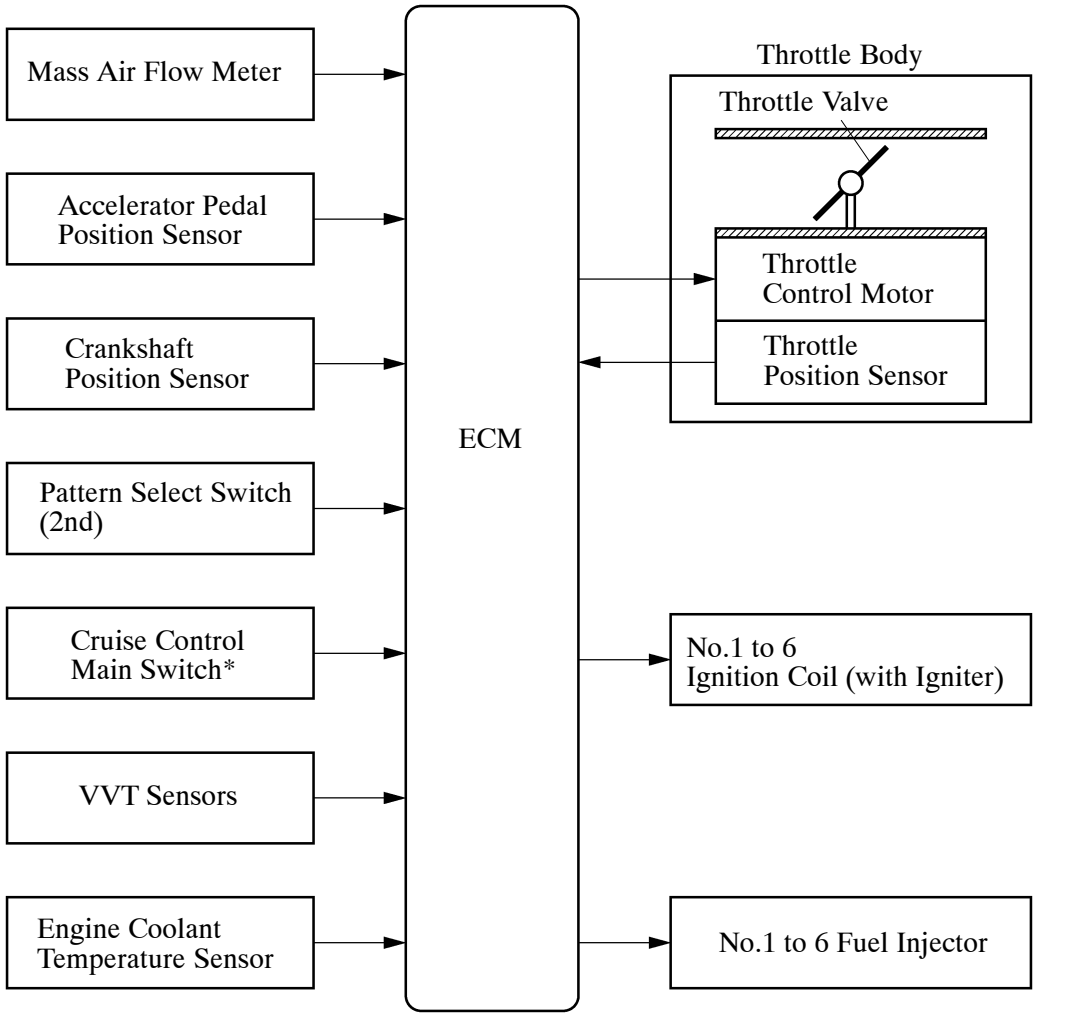
EG

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

General

- In the conventional throttle body, the throttle valve angle is determined invariably by the amount of the accelerator pedal effort. In contrast, 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.
- In case of an abnormal condition, this system transfers to the fail-safe mode. For details, see page EG-73.

▶ System Diagram ◀



*: Optional Equipment

Control

1) General

The ETCS-i consists of the following functions:
- Normal Throttle Control (non-linear control)
- ISC (Idle Speed Control)
- Cruise Control (optional equipment)

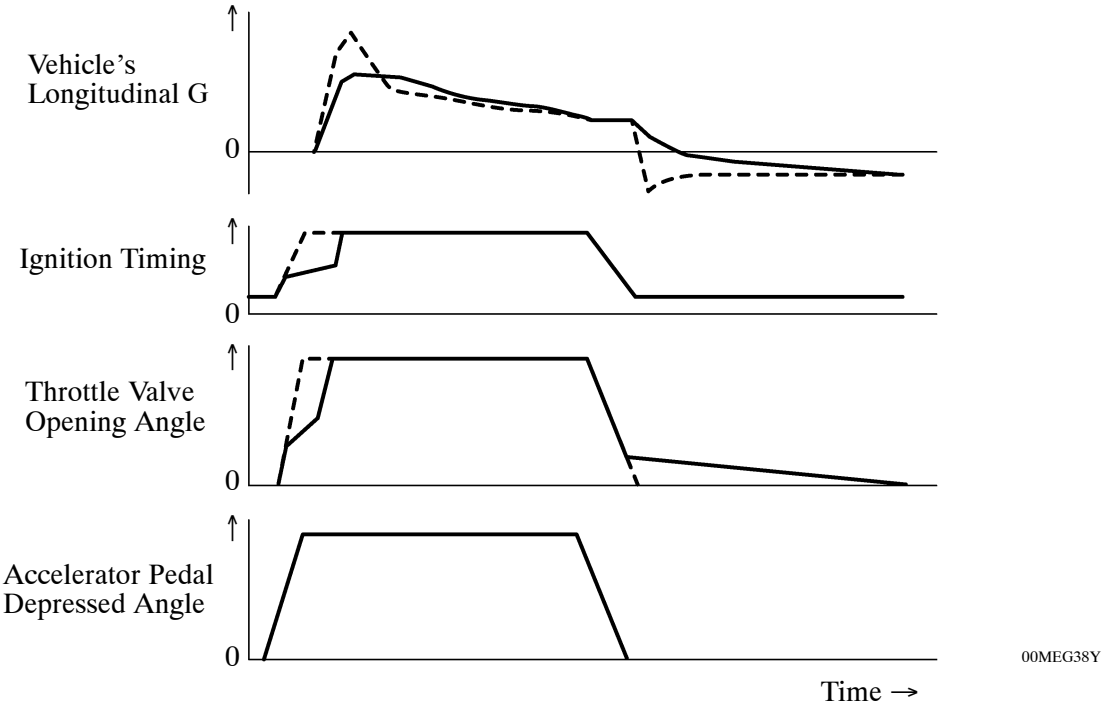
2) Normal Throttle Control (Non-linear Control)

a. General

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

▶ Conceptual Diagrams of Engine Control During Acceleration and Deceleration ◀

——— : With Control
- - - - : Without Control



b. 2nd Start Control (Only for models with Automatic Transmission)

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 2nd start control. Pressing the 2nd side of the pattern select switch activates this control. This control 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 ECM controls the throttle valve in order to constantly maintain an ideal idle speed.

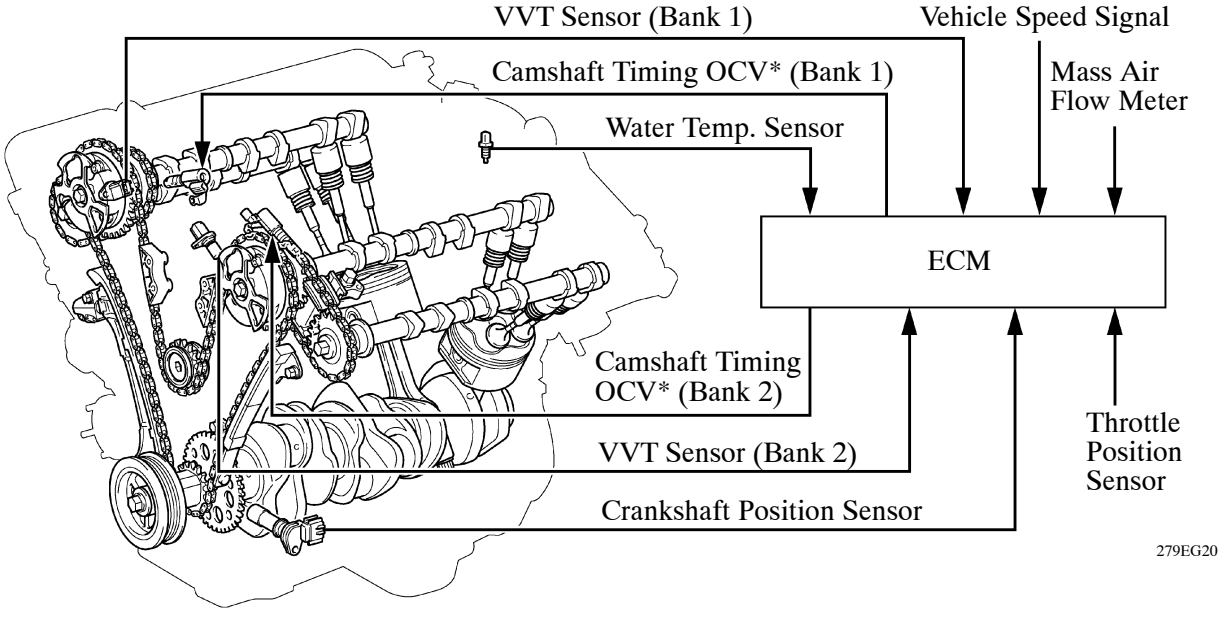
4) Cruise Control

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

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

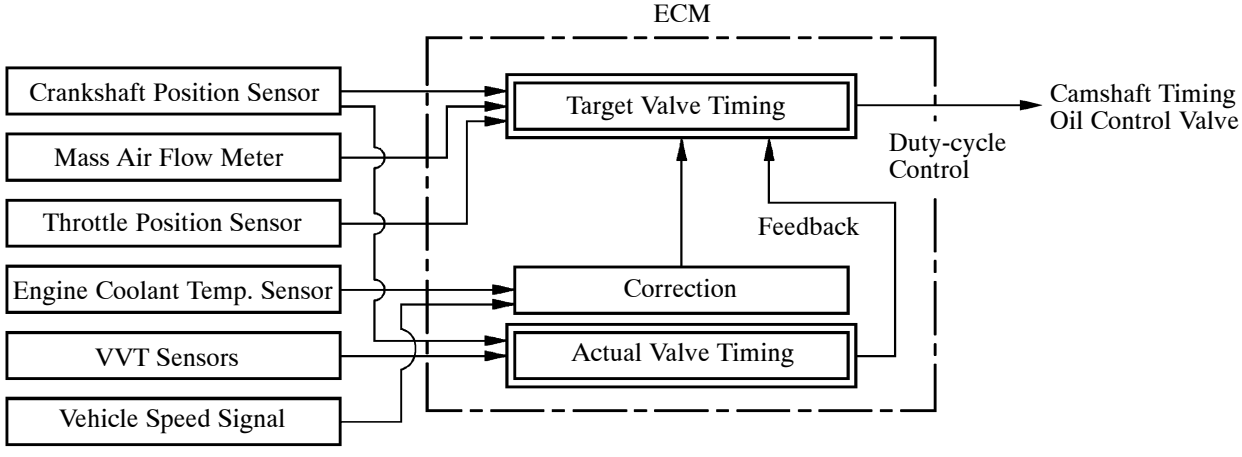
General

- 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 condition. This improves torque in all the speed ranges as well as increasing fuel economy, and reducing exhaust emissions.

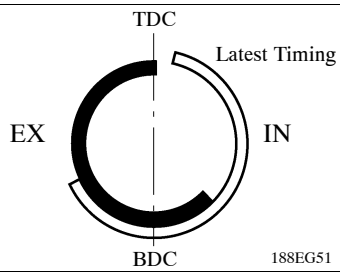
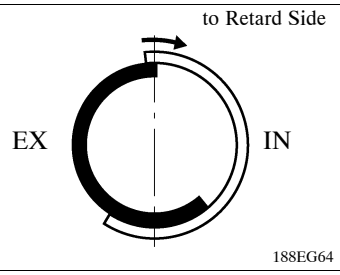
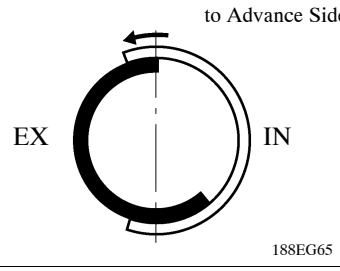
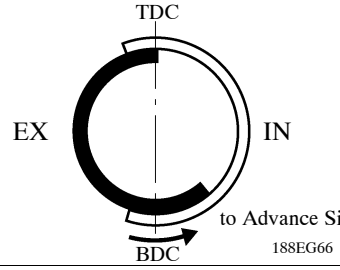
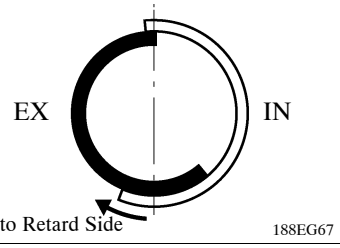
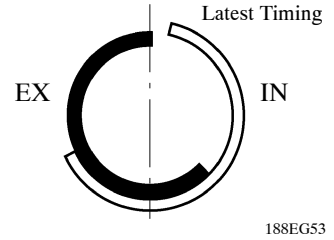
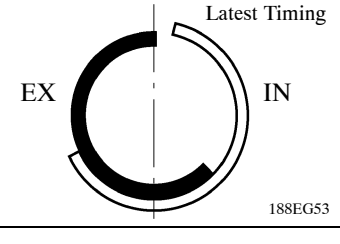


*: Oil Control Valve

- By using the engine speed, intake air mass, throttle position, engine coolant temperature and vehicle speed, the ECM can calculate optimal valve timing for each driving condition and controls the camshaft timing oil control valve. In addition, the ECM uses signals from the VVT 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

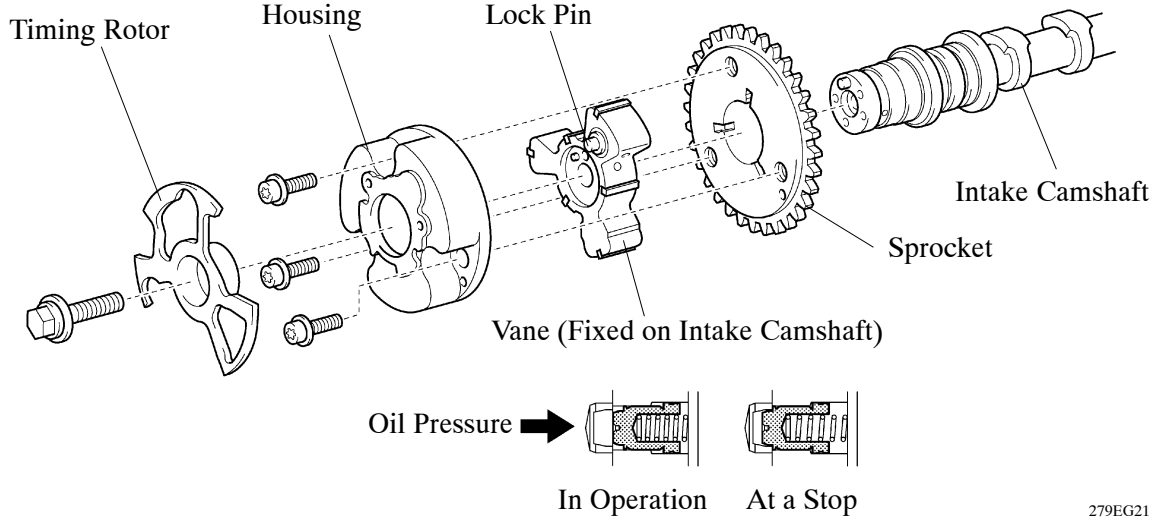
Operation State	Objective		Effect
During Idling		Eliminating overlap to reduce blow back to the intake side	• Stabilized idling rpm • Better fuel economy
At Light Load		Minimizing overlap to reduce blow back to the intake side.	Ensured engine stability
At Medium Load		Increasing overlap to increase internal EGR to reduce pumping loss	• Better fuel economy • Improved emission control
In Low to Medium Speed Range with Heavy Load		Advancing the intake valve close timing for volumetric efficiency improvement	Improved torque in low to medium speed range
In High Speed Range with Heavy Load		Retarding the intake valve close timing for volumetric efficiency improvement	Improved output
At Low Temperatures		Eliminating overlap to prevent blow back to the intake side and stabilizes the idling speed at fast idle.	• Stabilized fast idle rpm • Better fuel economy
• Upon Starting • Stopping the Engine		Eliminating overlap to reduce blow back to the intake side	Improved startability

EG

Construction

1) VVT-i Controller

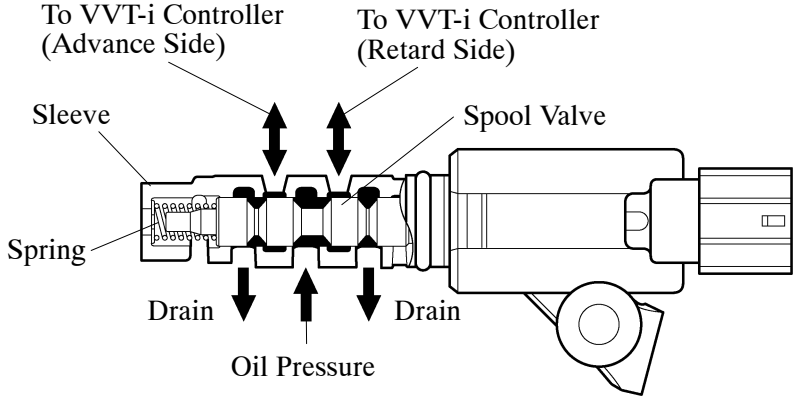
This controller consists of the housing driven from the timing chain and the vane coupled with the intake camshaft. The oil pressure sent from the advance or retard side path at the intake camshaft causes rotation in the VVT-i controller vane circumferential direction to vary the intake valve timing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



Lock Pin

2) Camshaft Timing Oil Control Valve

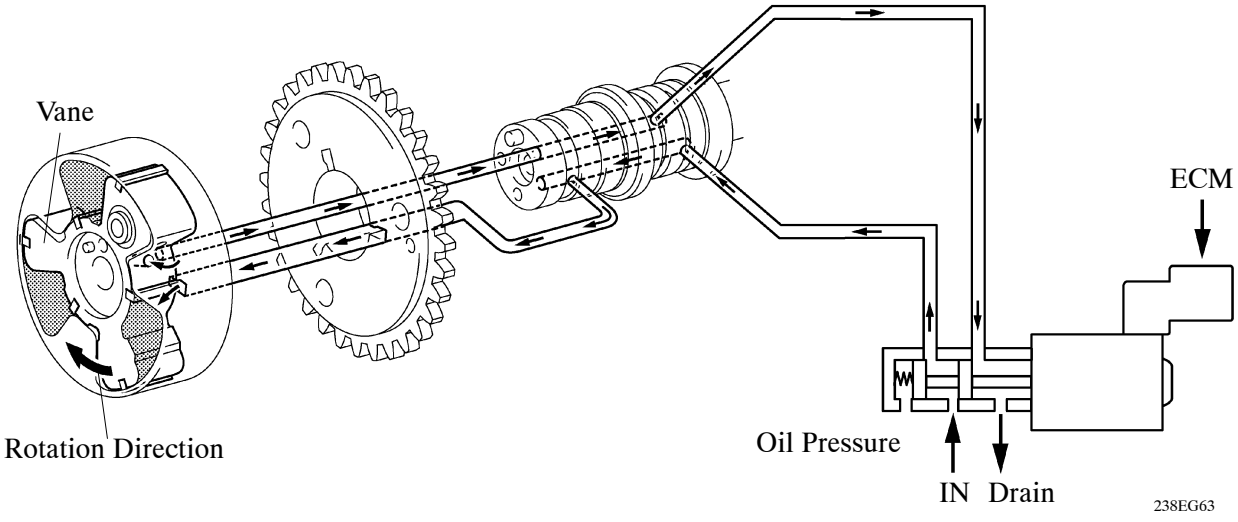
This camshaft timing oil control valve controls the spool valve using duty-cycle control from the ECM. This allows hydraulic pressure to be applied to the VVT-i controller advance or retard side. When the engine is stopped, the camshaft timing oil control valve is in the most retard position.



Operation

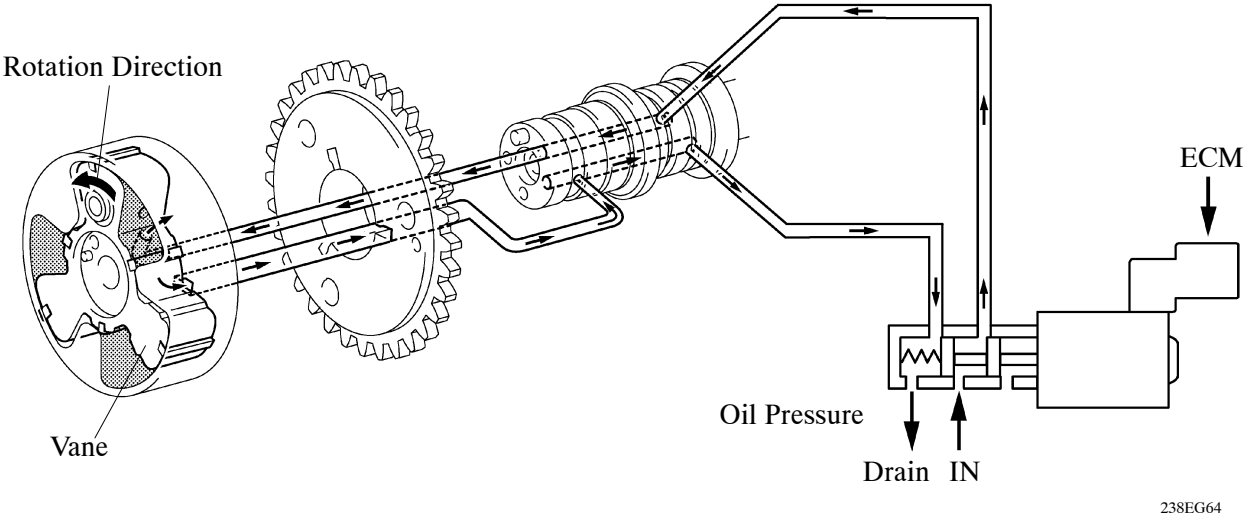
1) Advance

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.



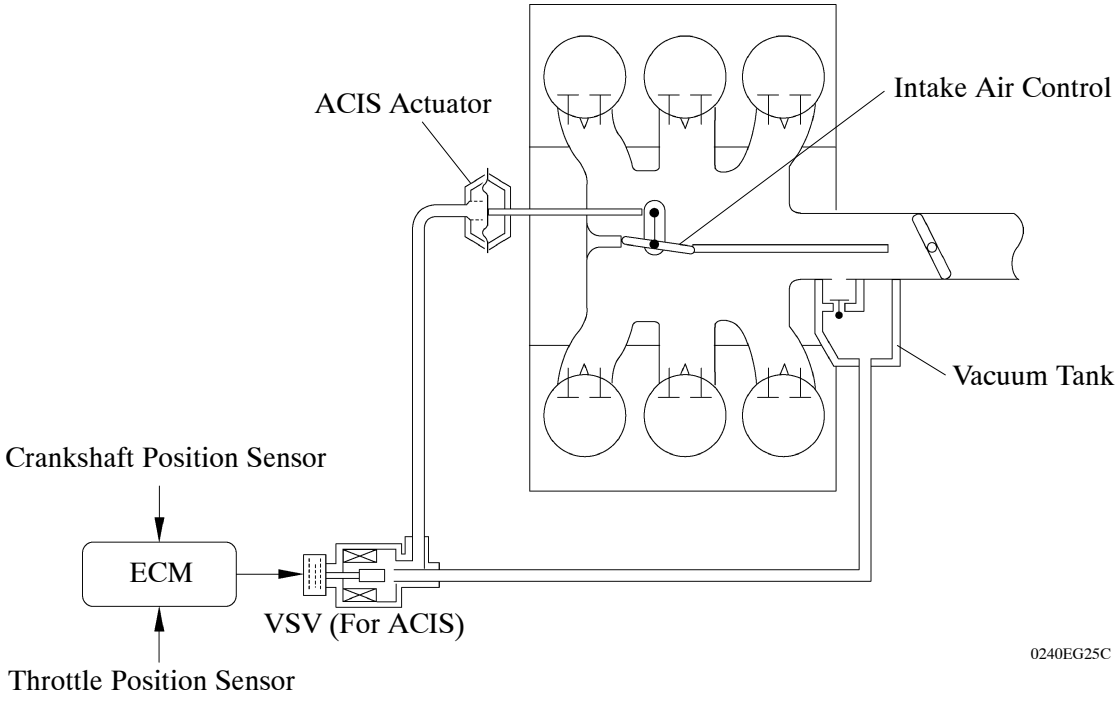
3) Hold

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

8. ACIS (Acoustic Control Induction System)

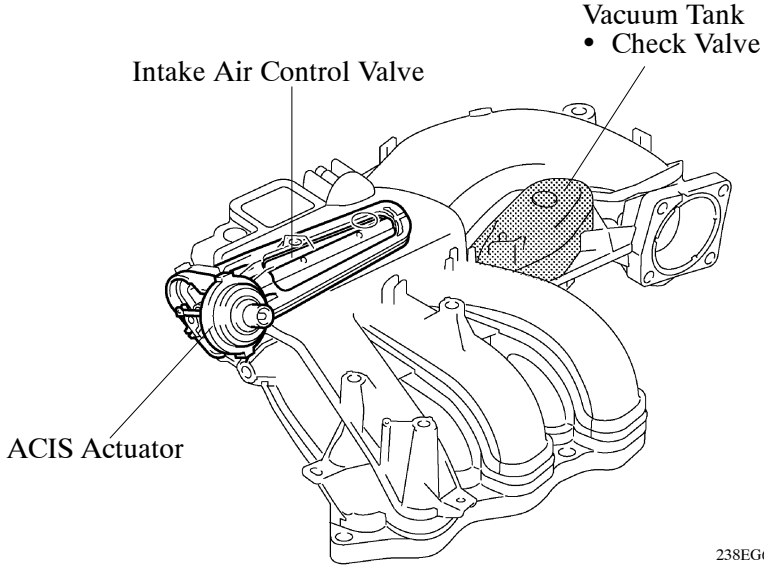
General

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.



Intake Air Control Valve and Vacuum Tank

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

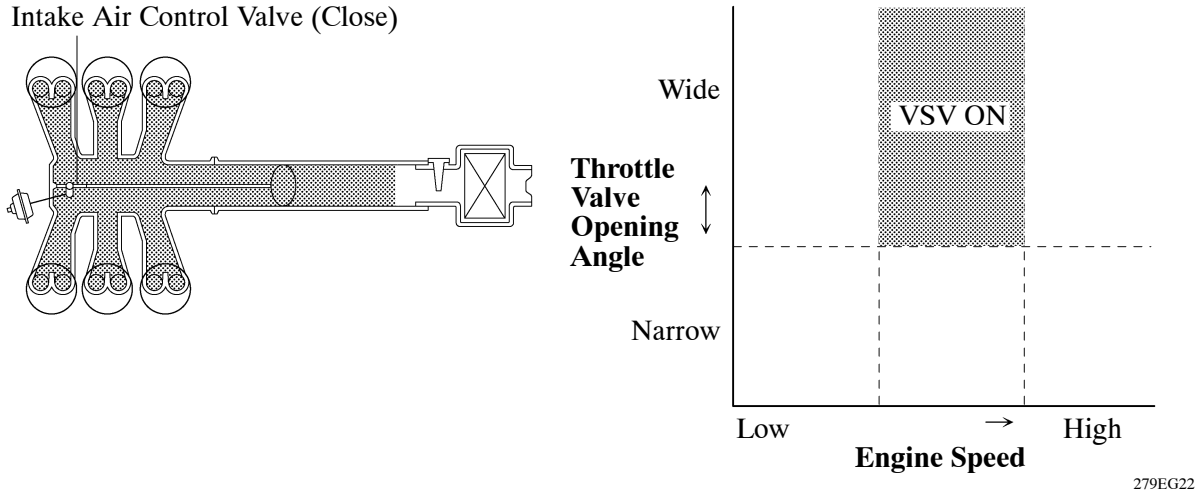


Operation

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

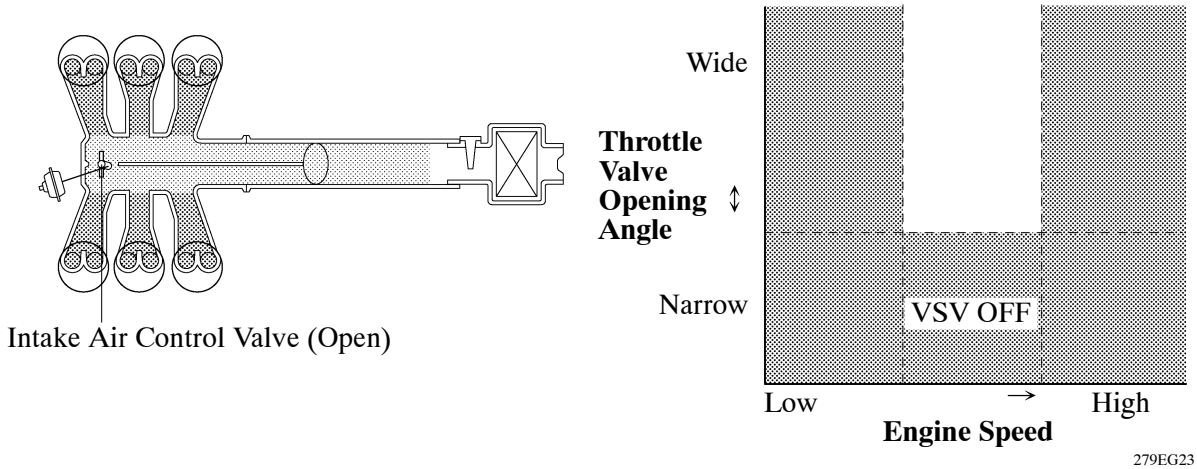


2) Intake Air Control Valve Open (VSV OFF)

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



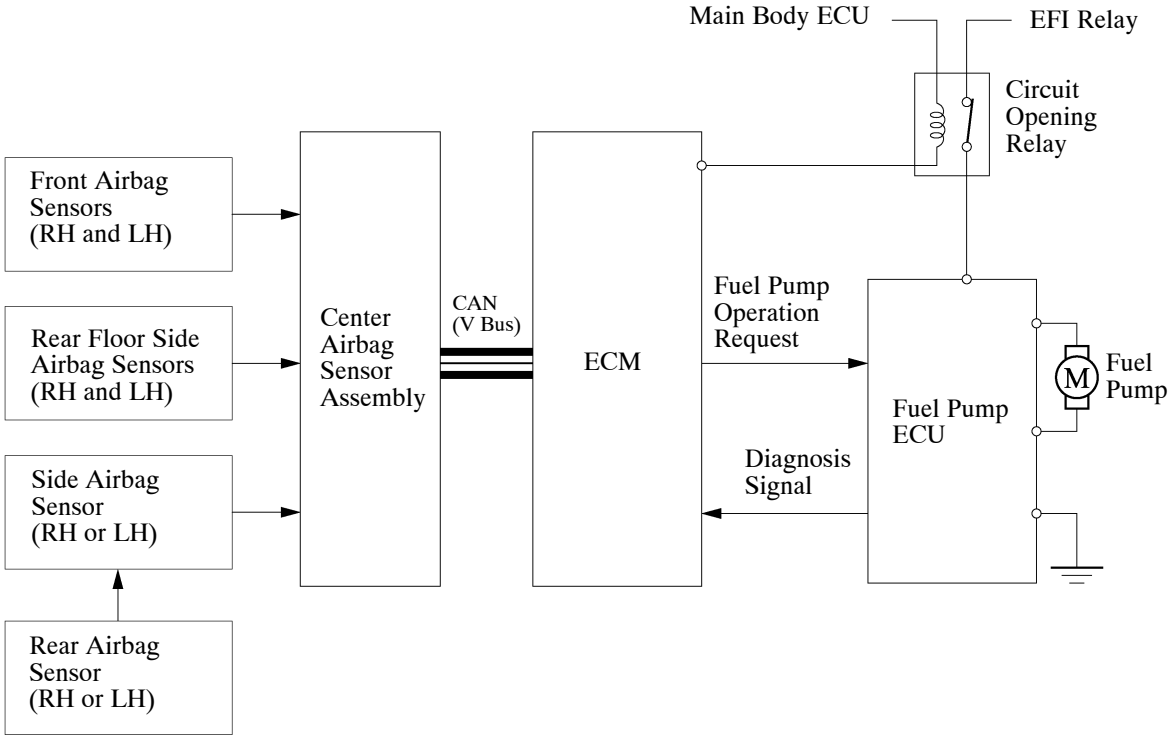
9. Fuel Pump Control

General

In this vehicle, there are 2 types of fuel pump control. The fuel pump is controlled to an optimum speed to match the engine operating conditions, and the fuel pump operation is cut when the SRS airbags deploy.

- The ECM transmits a fuel pump operation request signal to the fuel pump ECU that corresponds to the engine operating conditions. The fuel pump ECU receives this request signal and controls the speed of the fuel pump in 3 stages. As a result, under light engine loads, fuel pump speed is kept low to reduce electric power loss.
- A fuel cut control is used to stop the fuel pump when any of the SRS airbags deploy. In this control, if an airbag deployment signal from the center airbag sensor assembly is detected by the ECM, the ECM will turn OFF the circuit opening relay. As a result, the power supply to fuel pump ECU is stopped, causing the fuel pump to stop operating. After the fuel cut control has been activated, turning the power source from OFF to IG-ON cancels the fuel cut control, and the engine can be restarted.

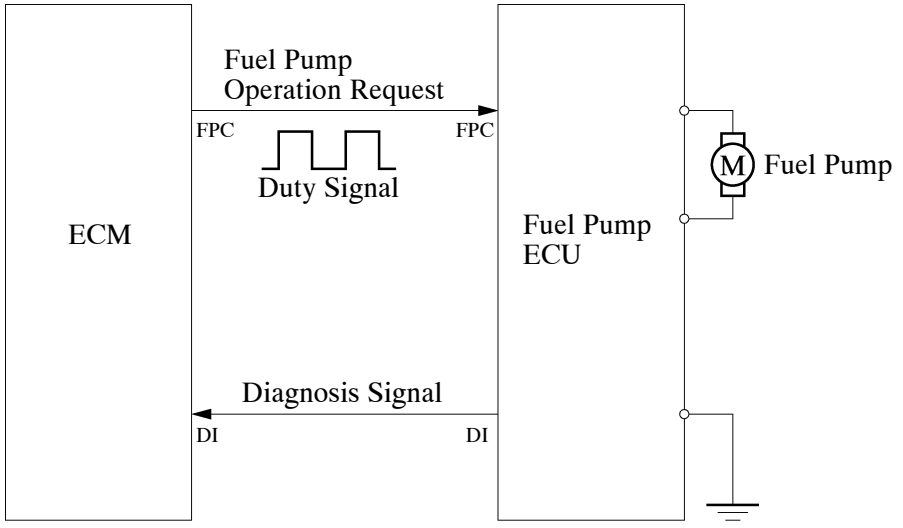
▶ System Diagram ◀



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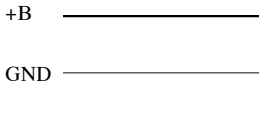
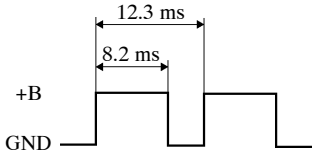
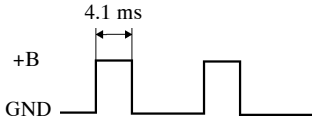
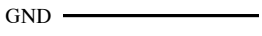
Fuel Pump ECU

- The fuel pump ECU controls fuel pump speed by receiving a duty cycle signal (FPC terminal input) from the ECM, control is performed to three stages.
- The fuel pump ECU also detects failures in the input and output circuits at the fuel pump ECU and transmits the failure status to the ECM.



04E0EG24C

▶ FPC Terminal Input ◀

FPC Input Signal (Duty Signal)	Fuel Pump Speed
 04E0EG25C	Hi
 04E0EG26C	Middle
 04E0EG27C	Low
 04E0EG28C	Stop

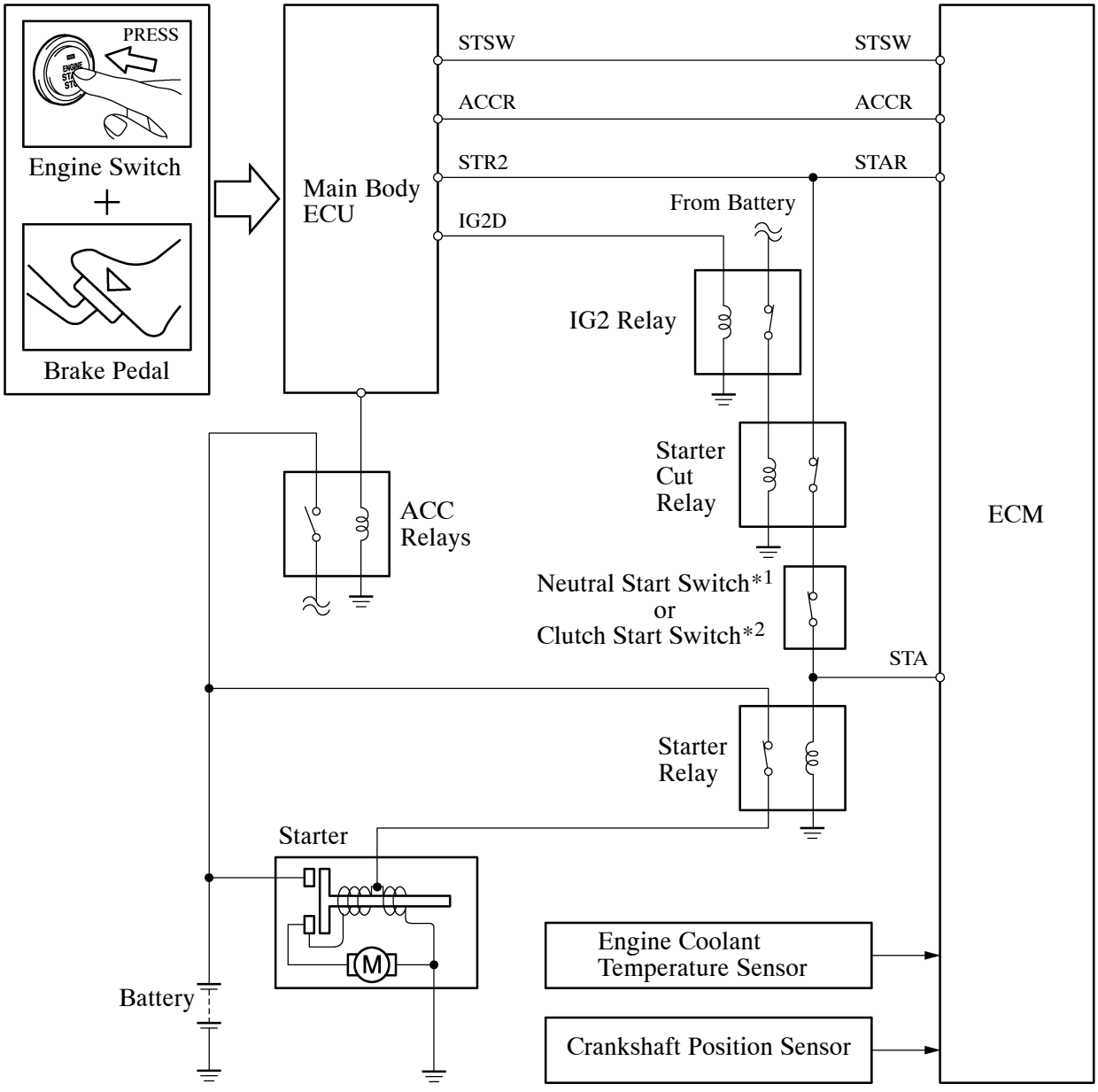
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10. Cranking Hold Function

General

- Once the engine switch is pressed, this function continues to operate the starter until the engine has started, provided that the brake pedal (A/T) or clutch pedal (M/T) is depressed. This prevents starting failure and the engine from being cranked after it has started.
- When the ECM detects a start signal from the main body ECU, this system monitors the engine speed (NE signal) and continues to operate the starter until it has determined that the engine has started. Furthermore, even if the ECM detects a start signal from the main body ECU, this system will not operate the starter if the ECM has determined that the engine has already started.

▶ System Diagram ◀



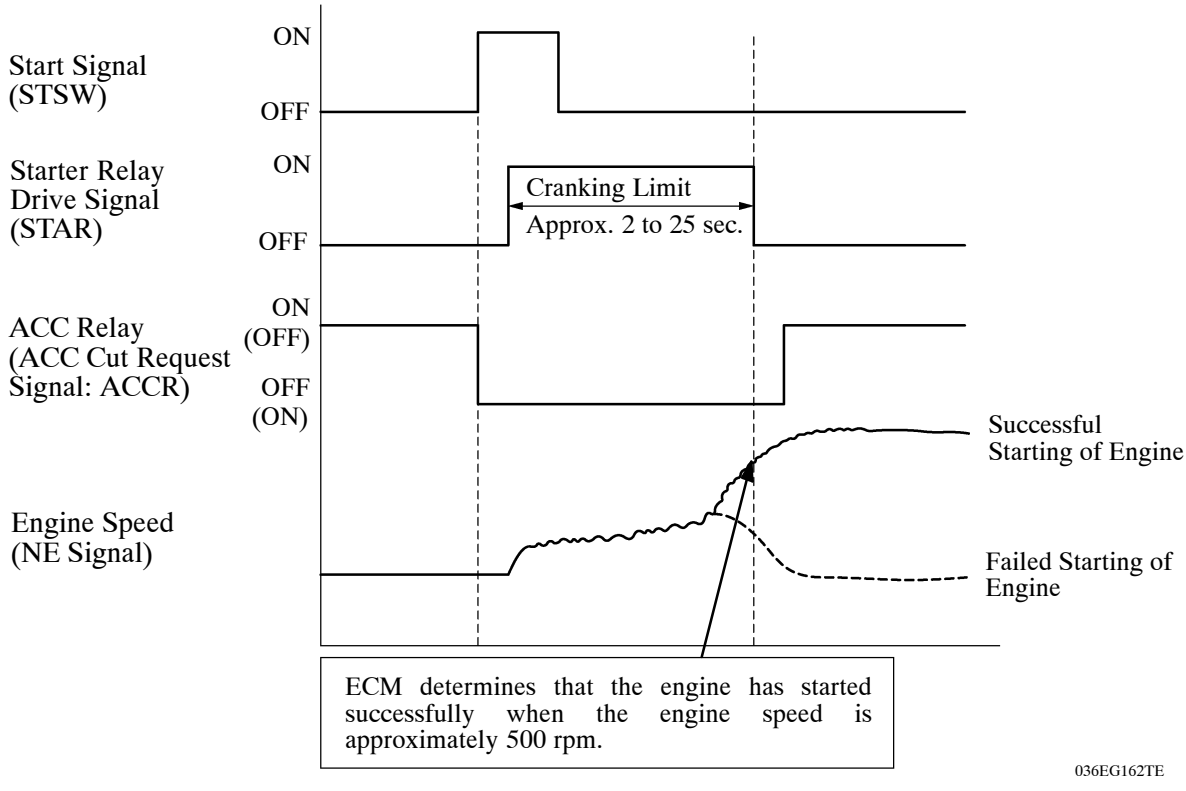
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*1: Models with Automatic Transmission
*2: Models with Manual Transmission

Operation

- As indicated in the below timing chart, when the ECM detects a STSW signal (start signal) from the main body ECU, the ECM outputs STAR signal (starter relay drive signal) through the starter cut relay to the starter relay and actuates the starter. The ECM also outputs ACCR signal (ACC cut request signal) to the main body ECU. Thus, the main body ECU will not energize the ACC relay.
- After the starter operates and the engine speed becomes higher than approximately 500 rpm, the ECM determines that the engine has started and stops the output of the STAR signal to the starter relay and the output of ACCR signal to the main body ECU. Thus, the starter operation stops and the main body ECU energize the ACC relay.
- If the engine has any failure and does not start, the starter operates as long as its maximum continuous operation time and stops automatically. The maximum continuous operation time is approximately 2 seconds through 25 seconds depending on the engine coolant temperature condition. When the engine coolant temperature is extremely low, it is approximately 25 seconds and when the engine is warmed up sufficiently, it is approximately 2 seconds.
- This system cuts off the current that powers the accessories while the engine is cranking to prevent the accessory illumination from operating intermittently due to the unstable voltage that is associated with the cranking of the engine.
- This system has following protection features:
  - While the engine is running normally, the starter does not operate.
  - Even if the driver keeps pressing the engine switch, the ECM stops the output of the STAR and ACCR signals when the engine speed becomes higher than 1200 rpm. Thus, the starter operation stops and the main body ECU energize the ACC relay.
  - In case the driver keeps pressing the engine switch and the engine does not start, the ECM stops the output of the STAR and ACCR signals after 30 seconds have elapsed. Thus, the starter operation stops and the main body ECU energize the ACC relay.
  - In case the ECM cannot detect an engine speed signal while the starter is operating, the ECM will immediately stop the output of the STAR and ACCR signals. Thus, the starter operation stops and the main body ECU energize the ACC relay.

▶ Timing Chart ◀



11. Diagnosis

- When the ECM detects a malfunction, the ECM makes a diagnosis and memorizes the failed section. Furthermore, the check engine warning light in the combination meter illuminates or blinks to inform the driver.
- The ECM will also store the DTC (Diagnostic Trouble Code) of the malfunctions. The DTC can be accessed by using the intelligent tester II.
- For details, refer to the Land Cruiser (Station Wagon) Repair Manual (Pub. No. RM0810E).

Service Tip

To clear the DTC that is stored in the ECM, use the intelligent tester II, disconnect the battery terminal or remove the EFI MAIN fuse and ETCS fuse for 1 minute or longer.

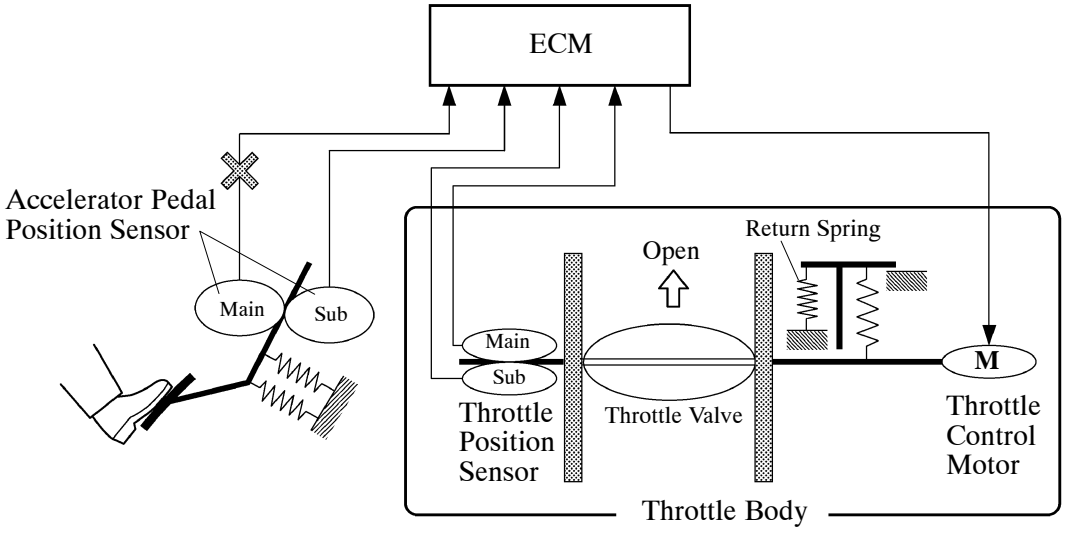
12. Fail-safe

General

When a malfunction is detected at any of the sensors, there is a possibility of an engine or other malfunction occurring if the ECM were to continue to control the engine control system in the normal way. To prevent such a problem, the fail-safe function of the ECM either relies on the data stored in memory to allow the engine control system to continue operating, or stops the engine if a hazard is anticipated. For details, refer to the Land Cruiser (Station Wagon) Repair Manual (Pub. No. RM0810E).

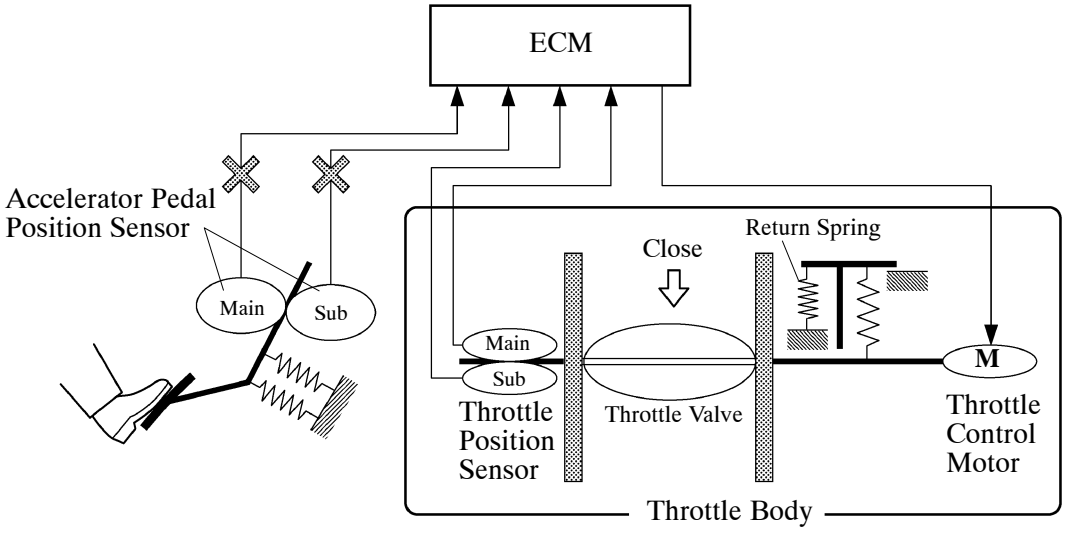
Fail-safe Operation due to Accelerator Pedal Position Sensor Trouble

- The accelerator pedal position sensor comprises two (Main, Sub) sensor circuits.
- If a malfunction occurs in either of the sensor circuits, the 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.



D13N08

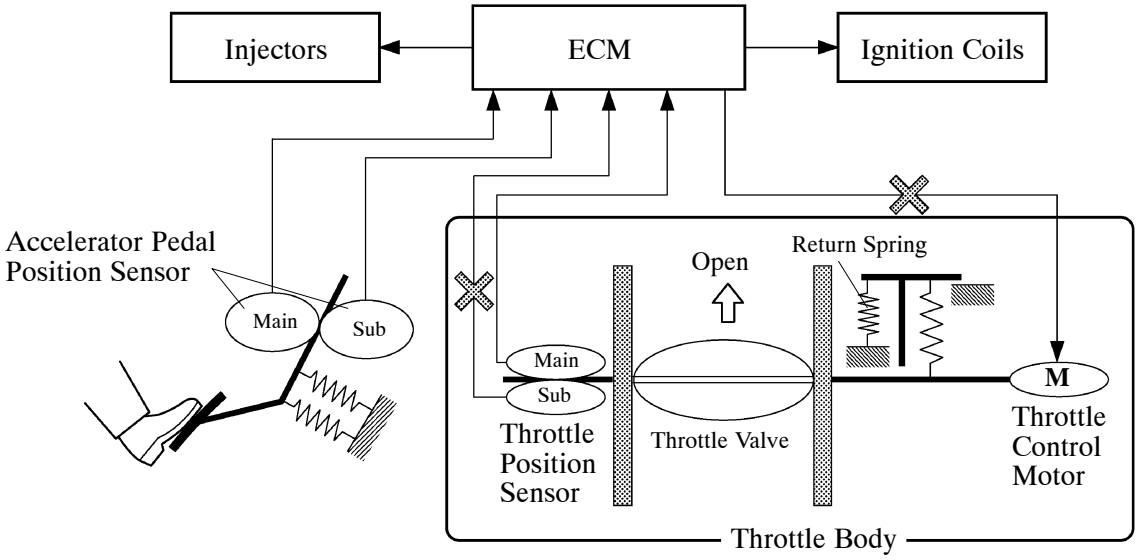
- If both circuits malfunction, the ECM detects the abnormal signal voltage from these two sensor circuits and discontinues the throttle control. At this time, the vehicle can be driven within its idling range.



D13N09

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 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 the prescribed base opening position. At this time, the vehicle can be driven in the fail-safe 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 system.



D13N10