5. Main Component of Engine Control System

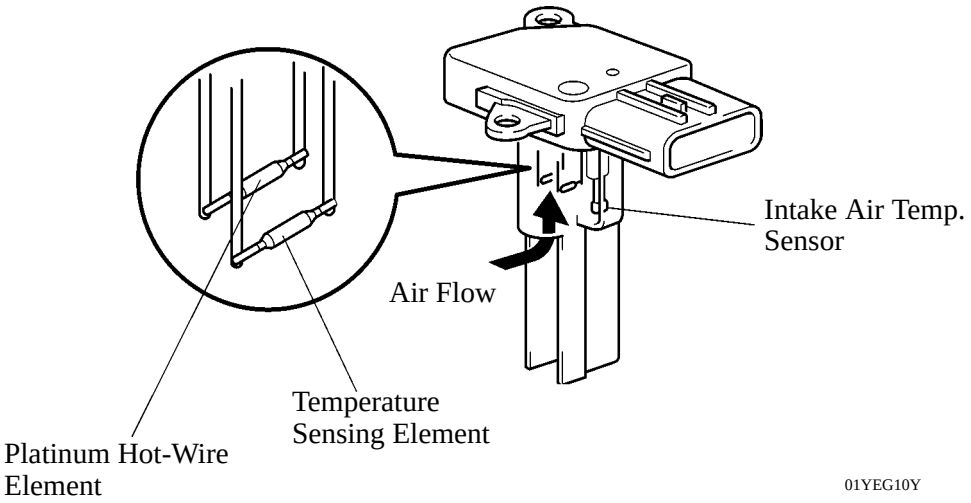
General

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

Components	Outline	Quantity	Function
ECM	32-bit CPU	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.
Oxygen Sensor (Bank 1, Sensor 2) (Bank 2, Sensor 2)	Cup Type with Heater	2	This sensor detects the oxygen concentration in the exhaust emission by measuring the electromotive force which is generated in the sensor itself.
Air-fuel Ratio Sensor (Bank 1, Sensor 1) (Bank 2, Sensor 1)	Planar Type with Heater	2	As with the oxygen sensor, this sensor detects the oxygen concentration in the exhaust emission. However, it detects the oxygen concentration in the exhaust emission linearly.
Mass Air Flow Meter	Hot-wire Type	1	This sensor has a built-in hot-wire to directly detect the intake air mass.
Crankshaft Position Sensor (Rotor Teeth)	Pick-up Coil Type (36-2)	1	This sensor detects the engine speed and performs the cylinder identification.
Intake VVT Sensor LH, RH (Rotor Teeth)	MRE Type (3)	2	This sensor performs the cylinder identification.
Exhaust VVT Sensor LH, RH (Rotor Teeth)	MRE Type (3)	2	This sensor performs the cylinder identification.
Engine Coolant Temperature Sensor	Thermistor Type	1	This sensor detects the engine coolant temperature by means of an internal thermistor.
Intake Air Temperature Sensor	Thermistor Type	1	This sensor detects the intake air temperature by means of an internal thermistor.
Knock Sensor (Bank 1), (Bank 2)	Built-in Piezoelectric Type (Flat Type)	2	This sensor detects an occurrence of the engine knocking indirectly from the vibration of the cylinder block caused by the occurrence of engine knocking.
Throttle Position Sensor	Non-contact Type	1	This sensor detects the throttle valve opening angle.
Accelerator Pedal Position Sensor	Non-contact Type	1	This sensor detects the amount of pedal effort applied to the accelerator pedal.
Injector	12-Hole Type	6	The injector has an electromagnetically-operated nozzle which injects fuel in accordance with signals from the ECM.

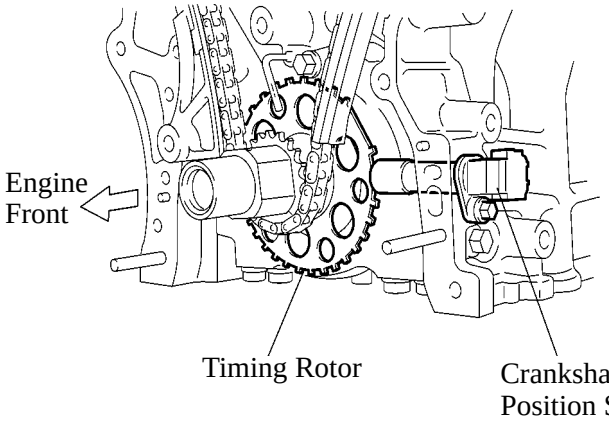
Mass Air Flow Meter

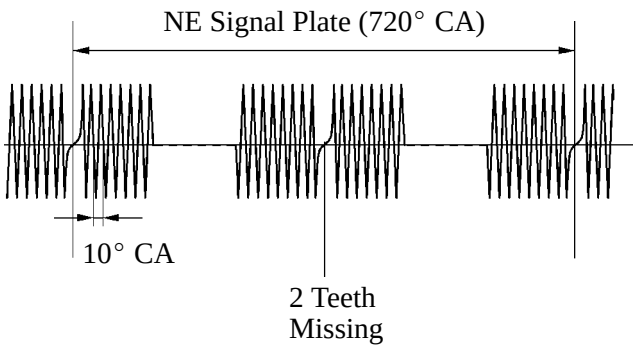
- This mass air flow meter, which is a plug-in type, allows a portion of the intake air to flow through the detection area. By directly measuring the mass and the flow rate of the intake air, the detection precision is improved and the intake air resistance is reduced
- This mass air flow meter has a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



Crankshaft 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 missing teeth are used to determine the top-dead-center.

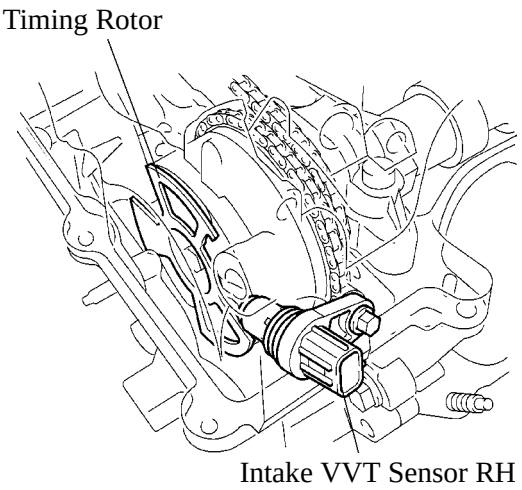




Intake and Exhaust VVT Sensors

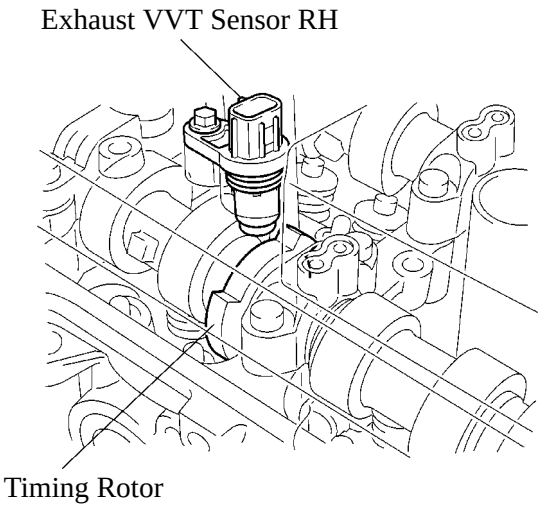
1) General

The 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.



Right Bank

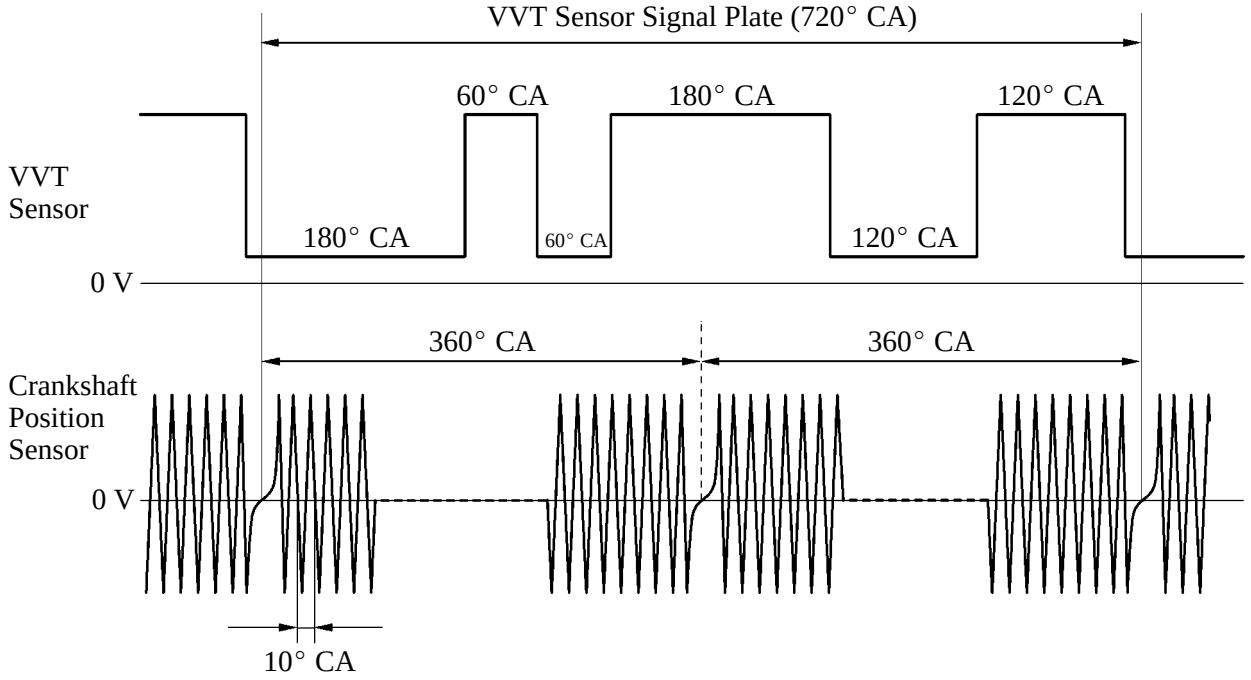
285EG82



Right Bank

285EG83

▶ Sensor Output Waveforms ◀



285EG84

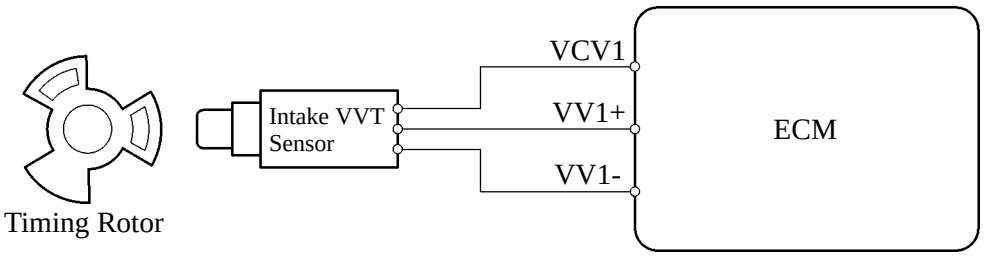
2) MRE Type VVT Sensor

- 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 pick-up 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 is made by comparing the NE signals with the Hi/Lo output switch timing due to the protruded/non-protruded portions of the timing rotor, or made based on the number of the input NE signals during Hi/Lo outputs.	Detection is made by comparing the NE signals with the change of waveform that is output when the protruded portion of the timing rotor passes.

NF

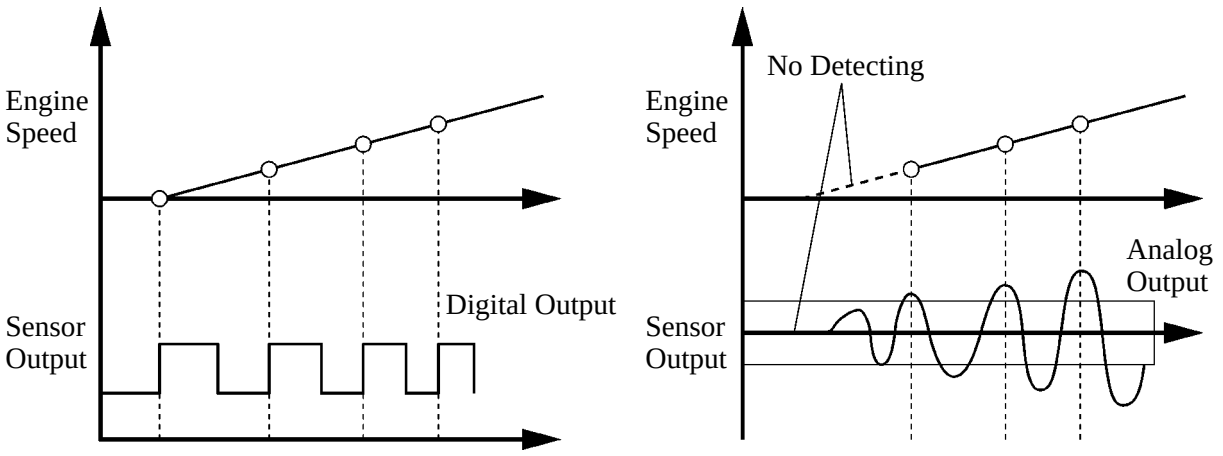
▶ Wiring Diagram ◀



Intake VVT Sensor (Right Bank)

271EG160

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



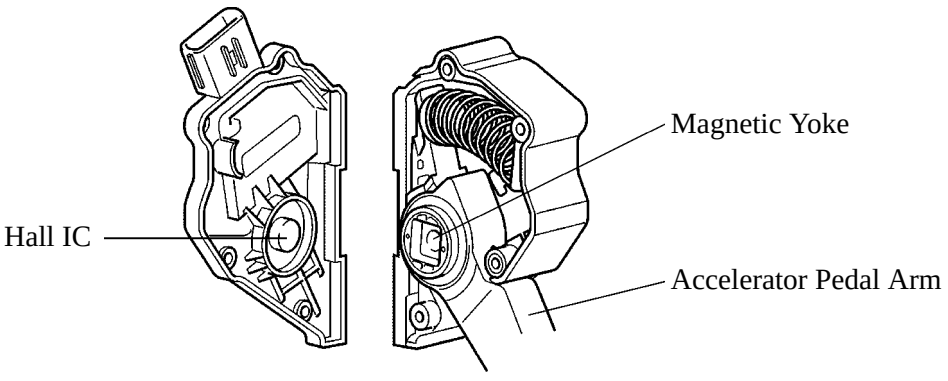
MRE Type **Pick-up Coil Type**

232CH41

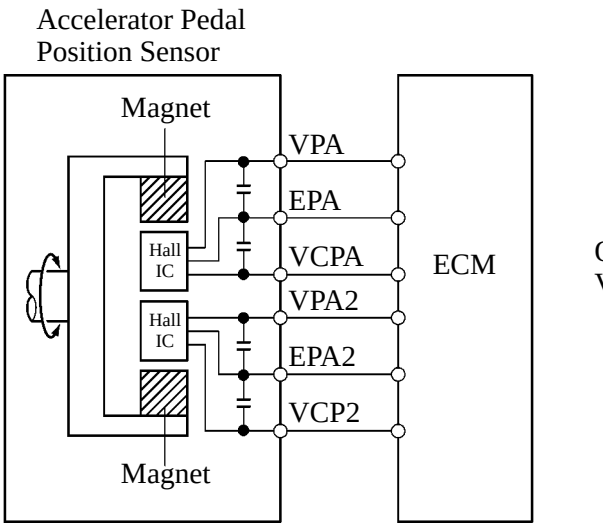
Accelerator Pedal Position Sensor

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

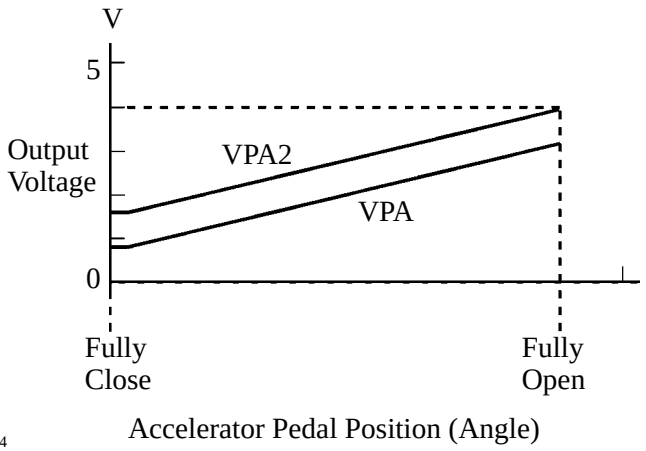
- The magnetic yoke is mounted at the base of the accelerator pedal arm. This yoke rotates around the Hall IC in accordance with the amount of effort that is applied to the accelerator pedal. The Hall IC converts the changes in the magnetic flux that occur into electrical signals, and outputs them in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



0140EG125C



228TU24



0140EG126C

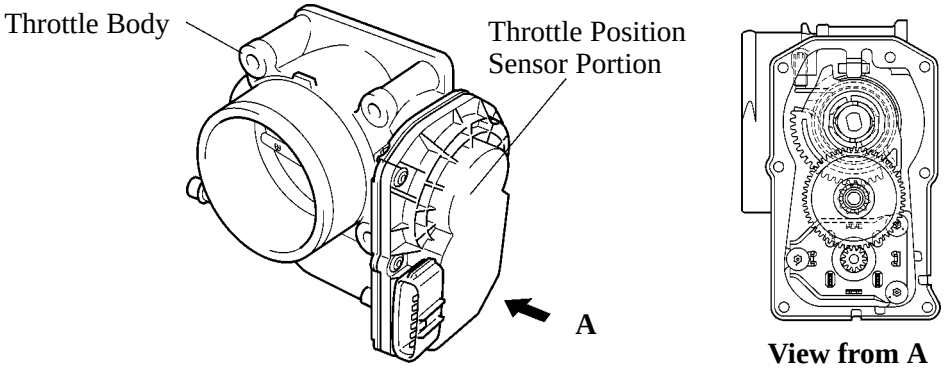
Service Tip

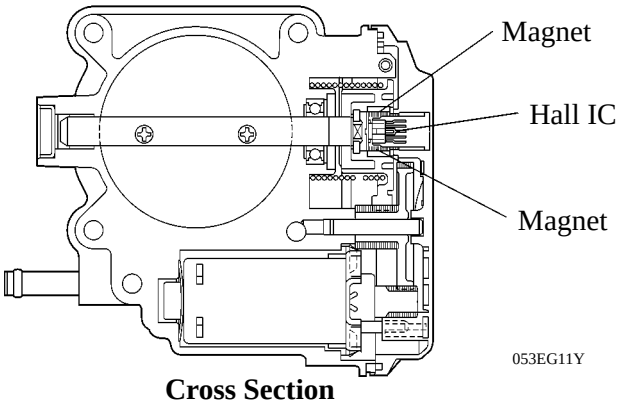
The inspection method differs from a conventional accelerator pedal position sensor because this sensor uses a Hall IC. For details, refer to the 2007 Sienna Repair Manual (Pub. No. RM0530U).

Throttle Position Sensor

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

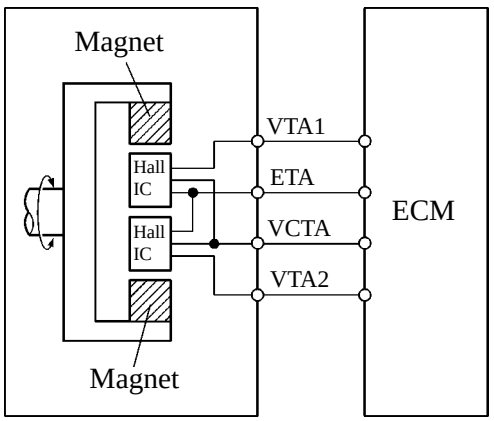
- The Hall IC is surrounded by a magnetic yoke. The Hall IC converts the changes that occur in the magnetic flux at that time into electrical signals and outputs them in the form of a throttle valve effort to the ECM.
- The Hall IC contains circuits for the main and sub signals. It converts the throttle valve opening angles into electric signals with two differing characteristics and outputs them to the ECM.

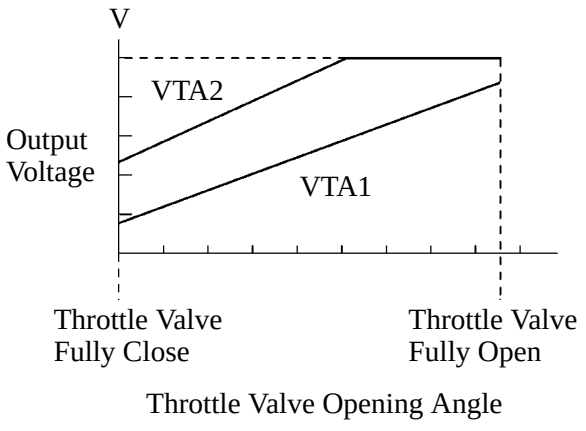




Cross Section

Throttle Position Sensor





Service Tip

The inspection method differs from a conventional throttle position sensor because this sensor uses a Hall IC. For details, refer to the 2007 Sienna Repair Manual (Pub. No. RM0530U).

Knock Sensor (Flat Type)

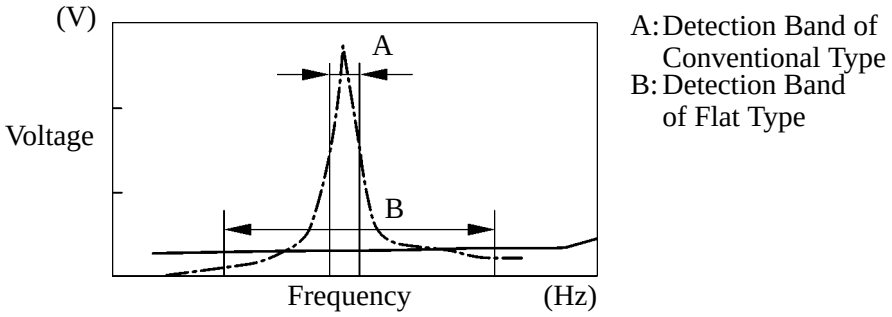
1) General

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.

- 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

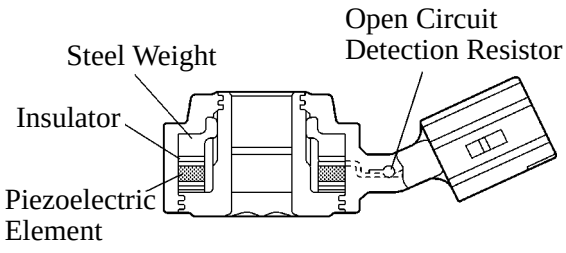
——— : Flat Type



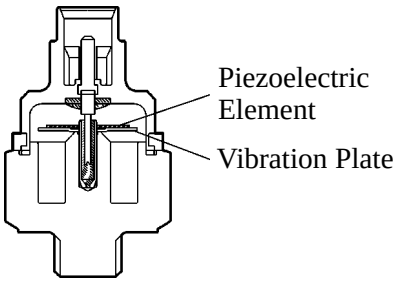
Characteristic of Knock Sensor

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 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.



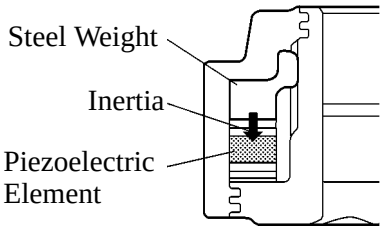
Flat Type Knock Sensor (Non-resonant Type)



Conventional Type Knock Sensor (Resonant Type)

3) Operation

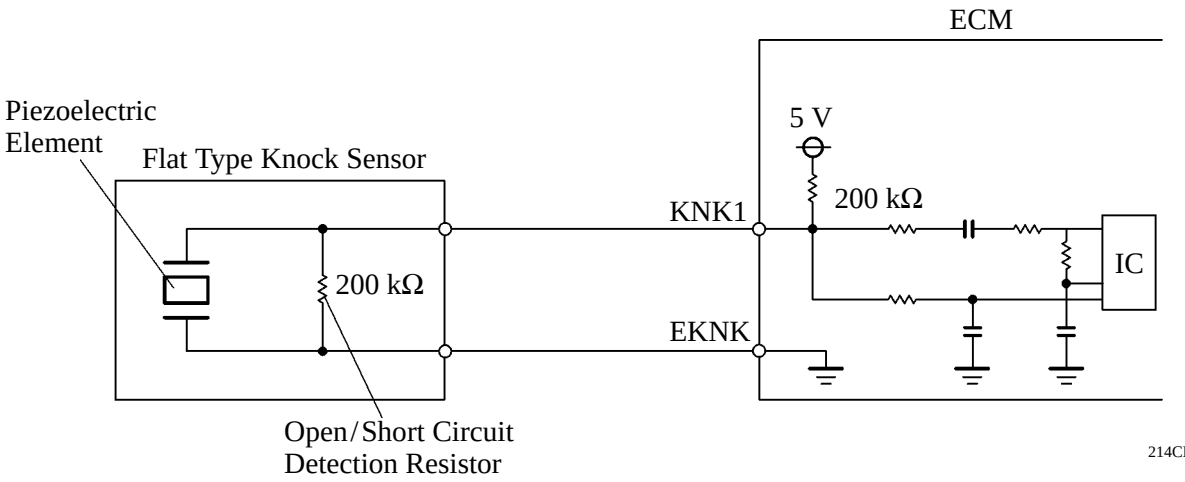
The knocking vibration is transmitted to the steel weight and its inertia applies pressure to the piezoelectric element. The action generates electromotive force.



214CE08

4) Open/Short Circuit Detection Resistor

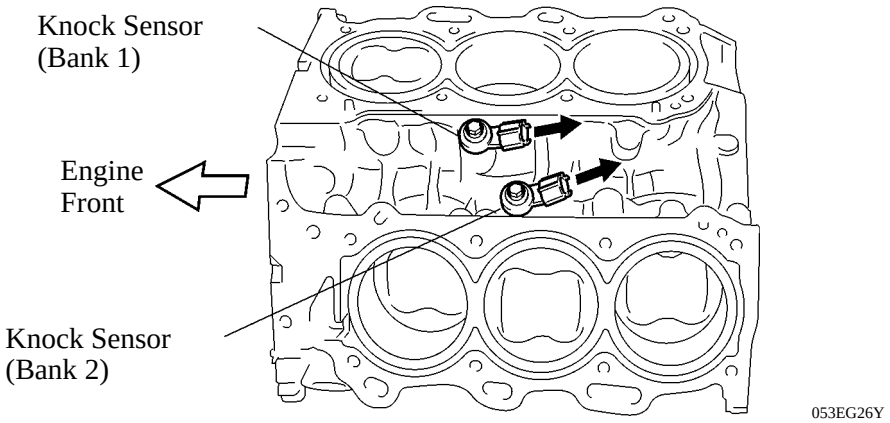
During the ignition is ON, the open/short circuit detection resistor in the knock sensor and the resistor in the ECM keep the voltage at the terminal KNK1 of engine constant.
An IC (Integrated Circuit) in the ECM is always monitoring the voltage of the terminal KNK1. If the open/short circuit occurs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



214CE06

Service Tip

These knock sensors are mounted in the specific directions and angles as illustrated. To prevent the right and left bank connectors from being interchanged, make sure to install each sensor in its prescribed direction.

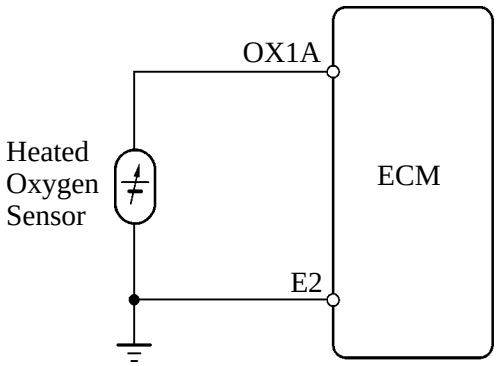


053EG26Y

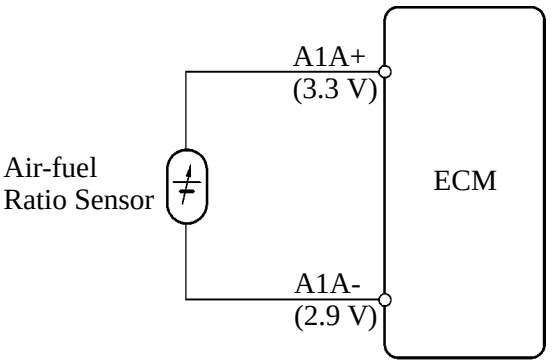
Heated Oxygen Sensor and Air-fuel Ratio Sensor

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 0.4 V 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.

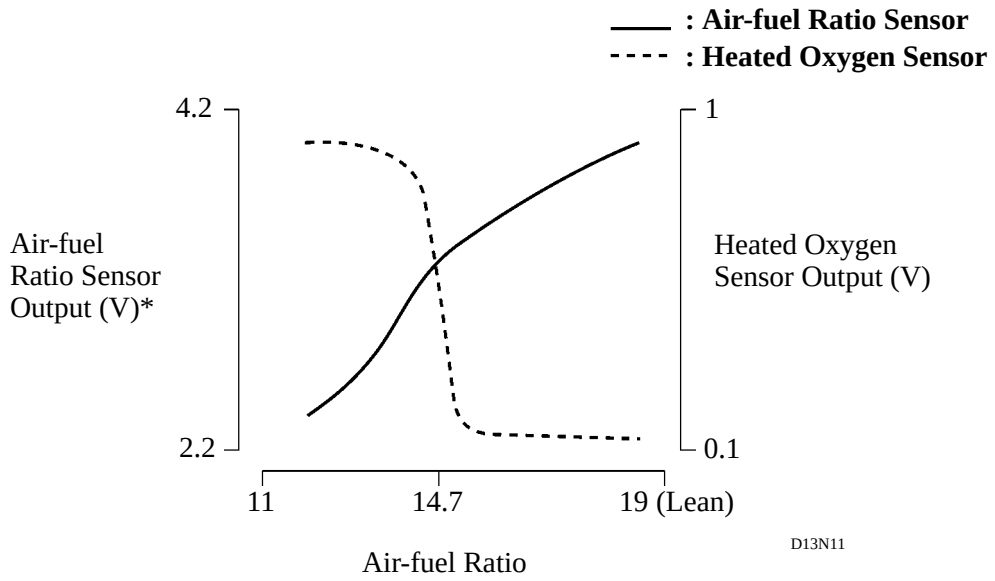


Heated Oxygen Sensor Circuit



Air-fuel Ratio Sensor Circuit

271EG44

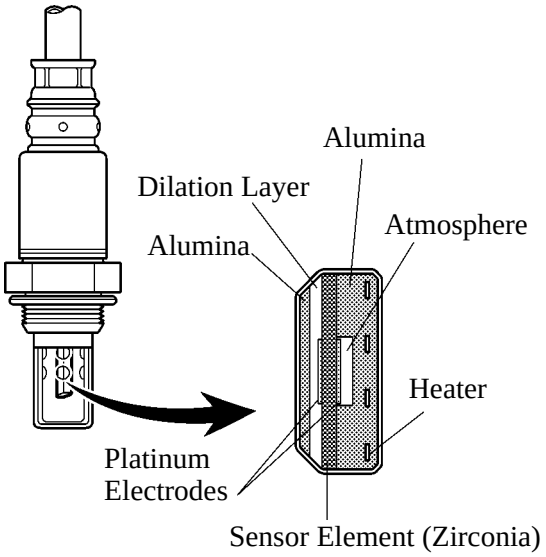


D13N11

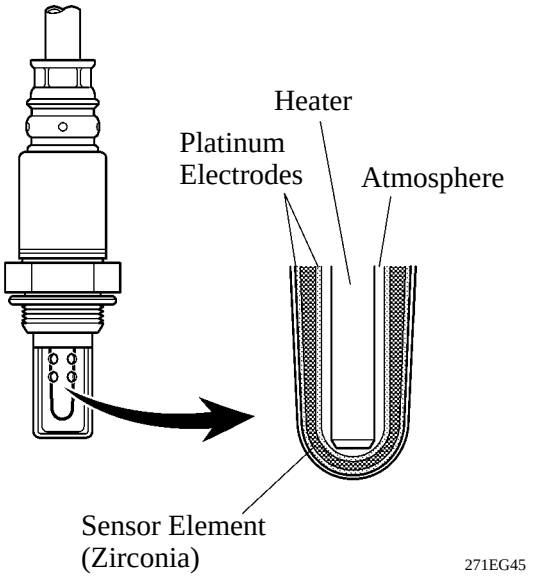
*: This calculation value is used internally in the ECM, and is not an ECM terminal voltage.

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.



Planar Type Air-fuel Ratio Sensor



Cup Type Heated Oxygen Sensor