5. Main Component of Engine Control System

General

The main components of the 2UR-FSE engine control system are as follows:

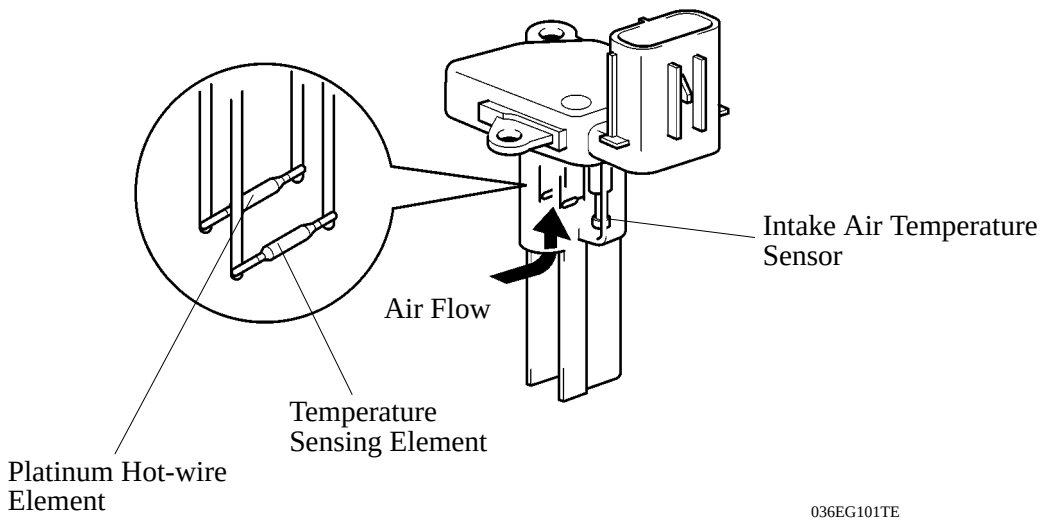
Components	Outline	Quantity	Function
ECM	32-bit CPU	1	The ECM optimally controls the SFI, ESA and ISC to suit the operating conditions of the engine in accordance with the signals provided by the sensors.
Mass Air Flow Meter [See page EG-67]	Hot-wire Type	2	This sensor has a built-in hot-wire to directly detect the intake air mass.
Intake Air Temperature Sensor	Thermistor Type	2	This sensor detects the intake air temperature by means of an internal thermistor.
Crankshaft Position Sensor [See page EG-68]	MRE Type (Rotor Teeth/36-2)	1	This sensor detects the engine speed and the crankshaft position.
Camshaft Position Sensor [See page EG-68]	MRE Type (Rotor Teeth/3)	1	This sensor detects the camshaft position and performs the cylinder identification.
Intake VVT Sensor [See page EG-68]	MRE Type (Rotor Teeth/3)	1 each bank	This sensor detects the actual valve timing.
Exhaust VVT Sensor [See page EG-68]	MRE Type (Rotor Teeth/3)	1 each bank	This sensor detects the actual valve timing.
Throttle Position Sensor [See page EG-71]	Hall IC Type (No-contact Type)	1	This sensor detects the throttle valve opening angle.
Knock Sensor [See page EG-72]	Built-in Piezoelectric Element (Flat Type)	2 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-74]	Cup Type with Heater	1 each bank	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 [See page EG-74]	Planar Type with Heater	1 each bank	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.
Exhaust Gas Temperature Sensor [See page EG-75]	Thermistor Type	2 each bank	This sensor detects the exhaust gas temperatures in the HC adsorber and catalyst by using a thermistor.
Engine Coolant Temperature Sensor	Thermistor Type	1	This sensor detects the engine coolant temperature by means of an internal thermistor.
Injector (For Port Injection) [See page EG-48]	12-hole Type	8	This injector contains an electro-magnetically operated nozzle to inject fuel into the intake port.

(Continued)

Components	Outline	Quantity	Function
Injector (For Direct Injection) [See page EG-49]	High Pressure Double Slit Nozzle Type	8	This injector contains a high-pressure electro-magnetically operated nozzle to inject fuel directly into the cylinder.
Injector Driver (EDU) [See page EG-49]	Built-in DC/DC Converter	2	The injector driver converts the signals from the ECM into high-voltage, high-amperage current in order to drive the direct injection injectors.
Camshaft Control Motor [See page EG-85]	EDU-integrated (Brushless Type DC Motor)	1 each bank	The rotational movement of the camshaft control motor changes the intake valve timing by operating the camshaft control actuator in accordance with the signals received from the ECM.
Camshaft Timing Oil Control Valve [See page EG-89]	Electro-magnetic Coil Type	1 each bank	The camshaft timing oil control valve changes the exhaust 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

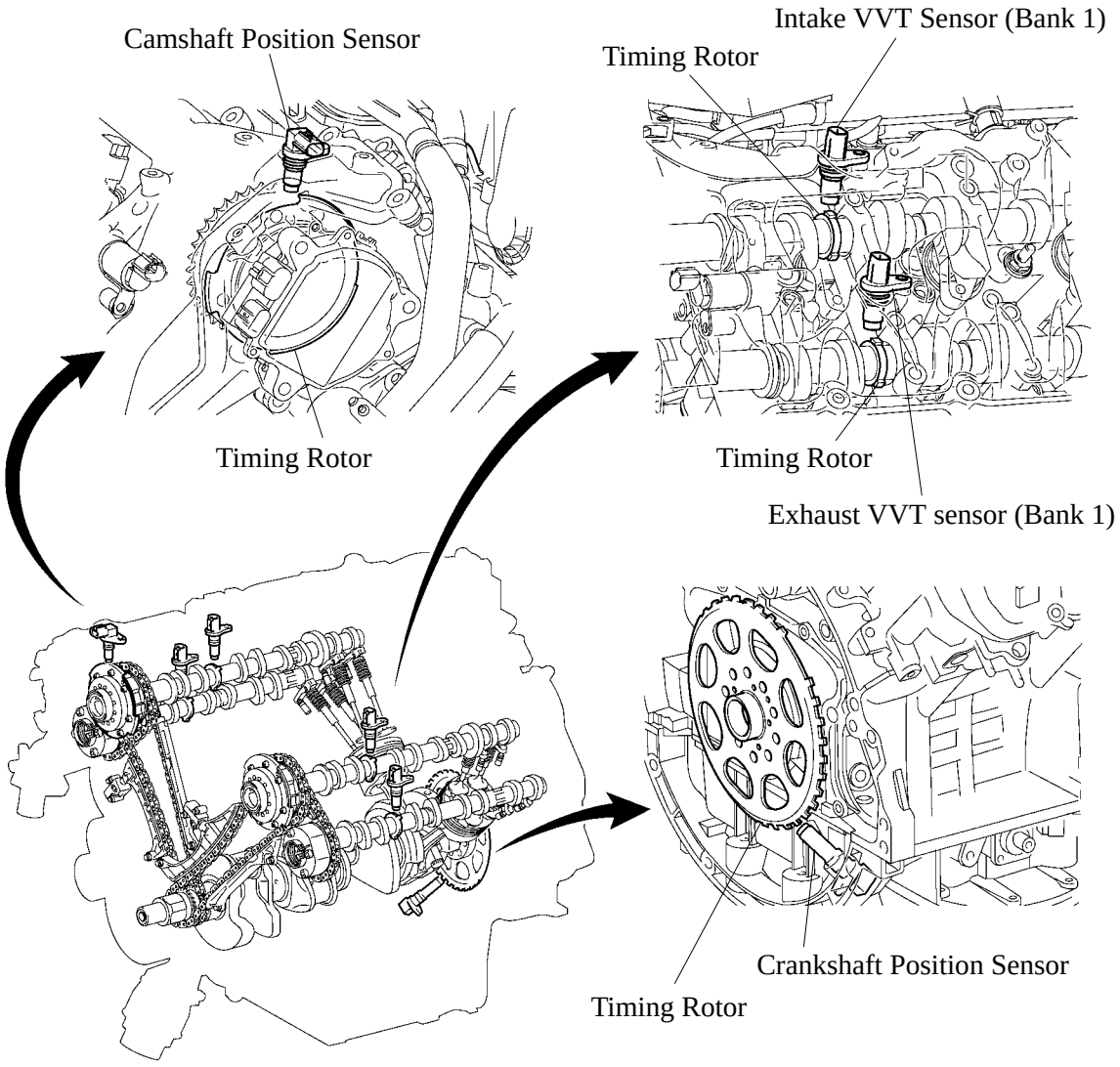
- This mass air flow meter, which is a plug-in type, allows a portion of the intake air to flow through the detection area. By directly measuring the mass and the flow rate of the intake air, the detection precision is improved and the intake air resistance is reduced.
- This mass air flow meter has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



Crankshaft Position and Camshaft Position and VVT Sensors

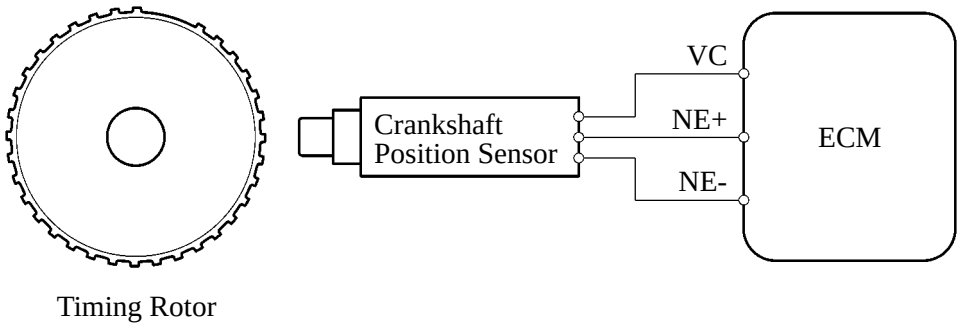
1) General

- The MRE (Magnetic Resistance Element) sensors are used for the crankshaft position, camshaft position, and VVT sensors.
- The timing rotor for the crankshaft position sensor is installed on the back end of the crankshaft. The timing rotor has 34 teeth, with 2 teeth missing, at 10° intervals. Based on these teeth, the crankshaft position sensor transmits crankshaft position signals (NE signal) consisting of 33 Hi/Lo output pulses every 10° per revolution of the crankshaft, and 1 Hi/Lo output pulse every 30°. The ECM uses the NE signal for detecting the crankshaft position as well as for detecting the engine speed. It uses the missing teeth signal for determining the top-dead-center.
- The camshaft position sensor uses a timing rotor that is installed on the front end of the intake camshaft sprocket of the right bank. Based on the timing rotor, the sensor outputs camshaft position signals (G2 signal) consisting of 6 (3 Hi output, 3 Lo output) pulses for every 2 revolutions of the crankshaft. The ECM compares the G2 and NE signals to detect the camshaft position and identify the cylinder.
- The intake and exhaust VVT sensors use timing rotors that are installed on the intake and exhaust camshafts of each bank. Based on the timing rotors, the sensors output VVT position signals consisting of 6 (3 Hi output, 3 Lo output) pulses for every 2 revolutions of the crankshaft. The ECM compares these VVT position signals to the NE signal to detect the actual valve timing.



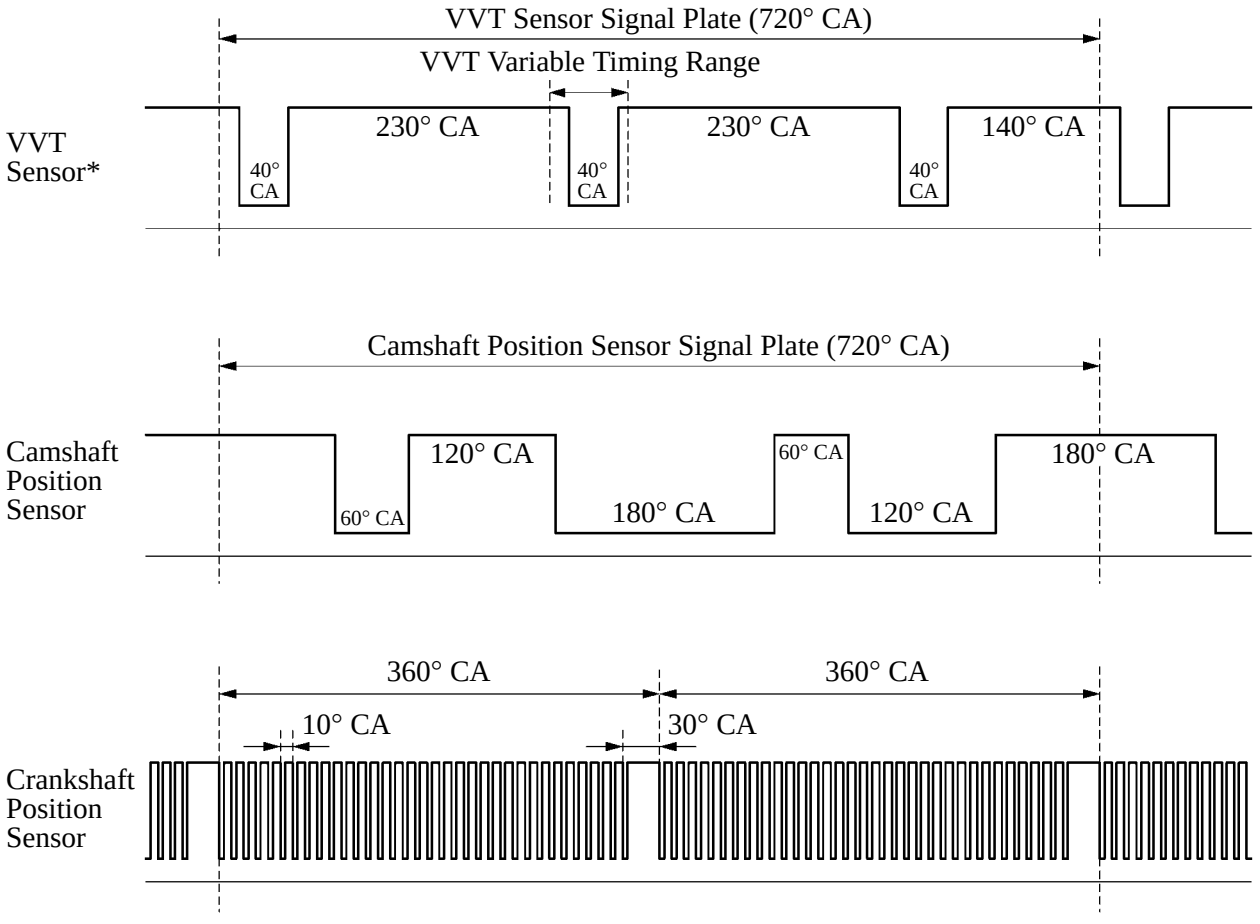
05AEG57TE

▶ Wiring Diagram ◀



Crankshaft Position Sensor Circuit

▶ Sensor Output Waveforms ◀

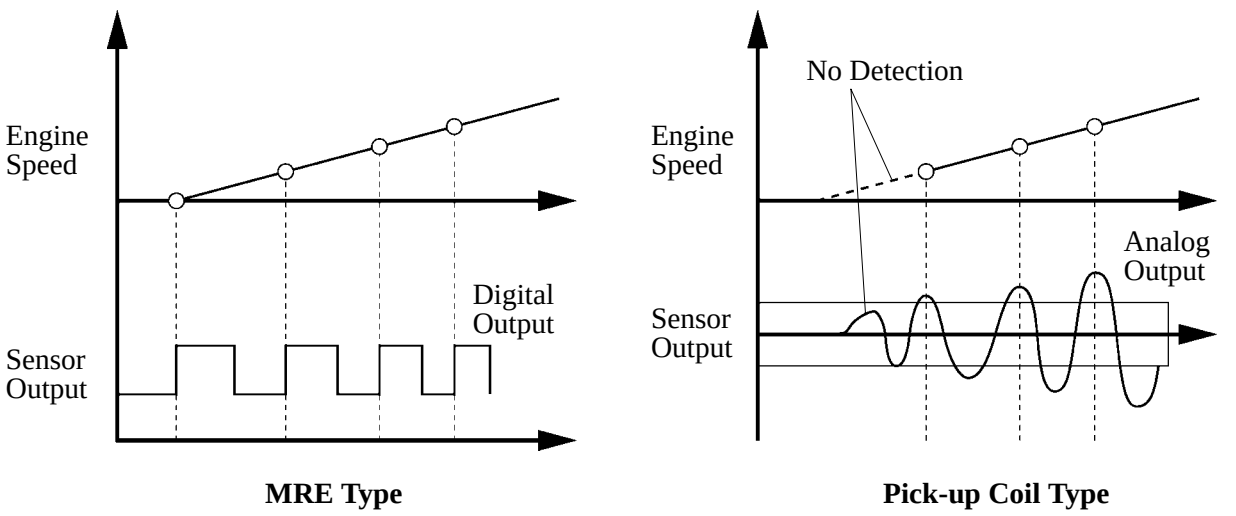


*: This is an example of an output waveform of the intake VVT sensor (bank 2).

2) MRE Type Sensor

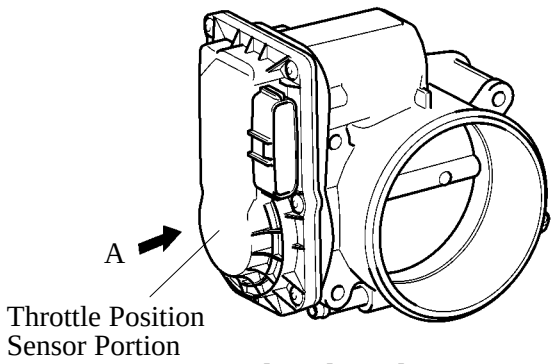
- The MRE type sensor consists of an MRE, a magnet and a sensor.
- The direction of the magnetic field changes due to the different shapes (protruded and non-protruded portions) of the timing rotor, which passes by the sensor. As a result, the resistance of the MRE changes, and the output voltage to the ECM changes to Hi or Lo. Based on the switching timing of the Hi/Lo output voltage, the ECM detects the positions of the crankshaft and camshaft.
- The differences between the MRE type sensor and the pick-up coil type sensor used on a conventional model are as follows.
  - An MRE type sensor outputs a constant level of Hi/Lo digital signals regardless of the engine speed. Therefore, an MRE type sensor can detect the positions of the crankshaft and camshaft at an early stage of cranking.
  - A pickup coil type sensor outputs analog signals with levels that change with engine speed.

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

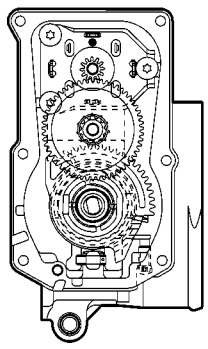


Throttle Position Sensor

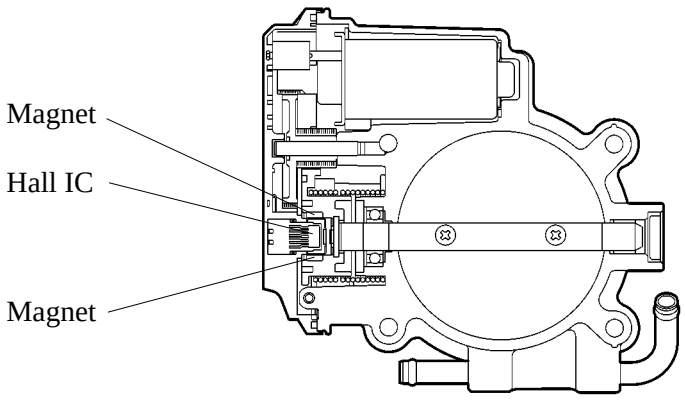
- The no-contact type throttle position sensor uses a Hall IC, which is mounted on the throttle body.
- The Hall IC is surrounded by a magnetic yoke. The Hall IC converts the changes that occur in the magnetic flux at that time into electrical signals and outputs them in the form of a throttle valve 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.



Throttle Body

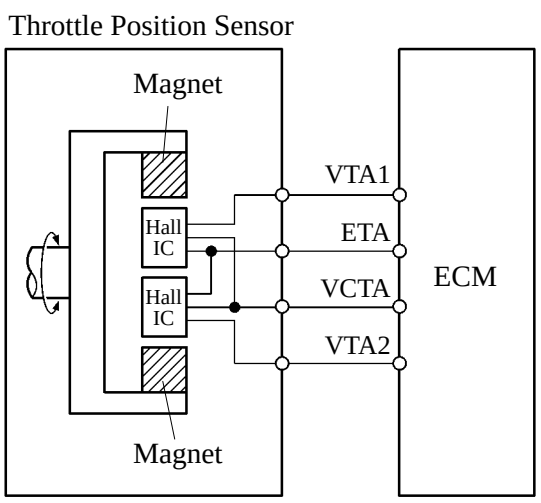


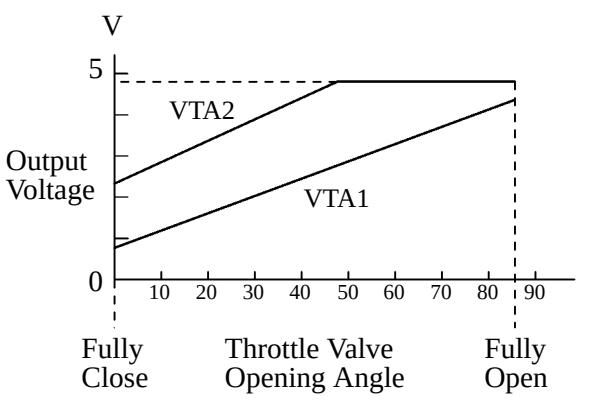
View from A



Cross Section

036EG102TE





02HEG57Y

Service Tip

The inspection method differs from a conventional throttle position sensor because this sensor uses a Hall IC. For details, refer to the 2008 LEXUS LS600hL Repair Manual (Pub. No. RM05A0U).

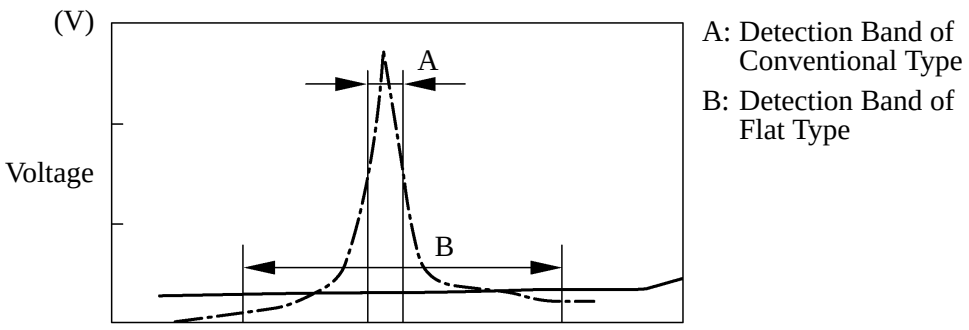
Knock Sensor (Flat Type)

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:

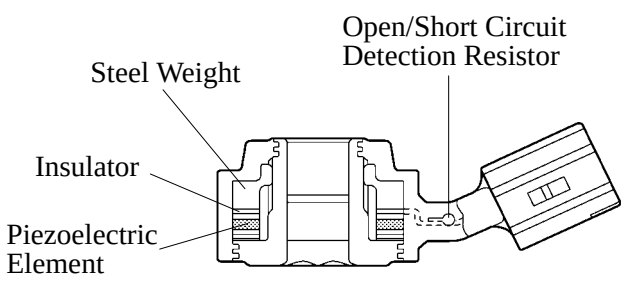
- The engine knocking frequency will change a bit depending on the engine speed. The flat type knock sensor can detect vibration even when the engine knocking frequency is changed. Thus the vibration detection ability is increased compared to the conventional type knock sensor, and a more precise ignition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



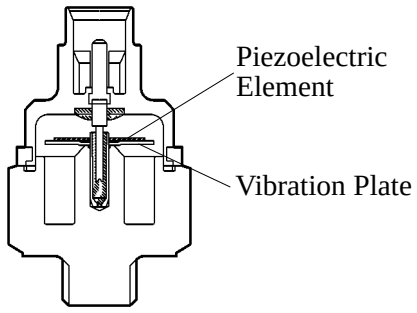
Characteristic of Knock Sensor 214CE04

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.



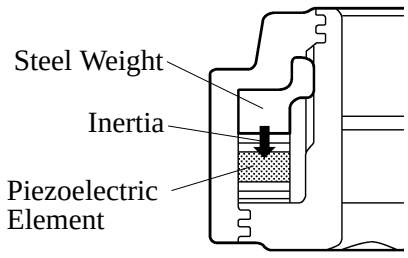
Flat Type Knock Sensor (Non-resonant Type) 214CE01



Conventional Type Knock Sensor (Resonant Type) 214CE02

3) Operation

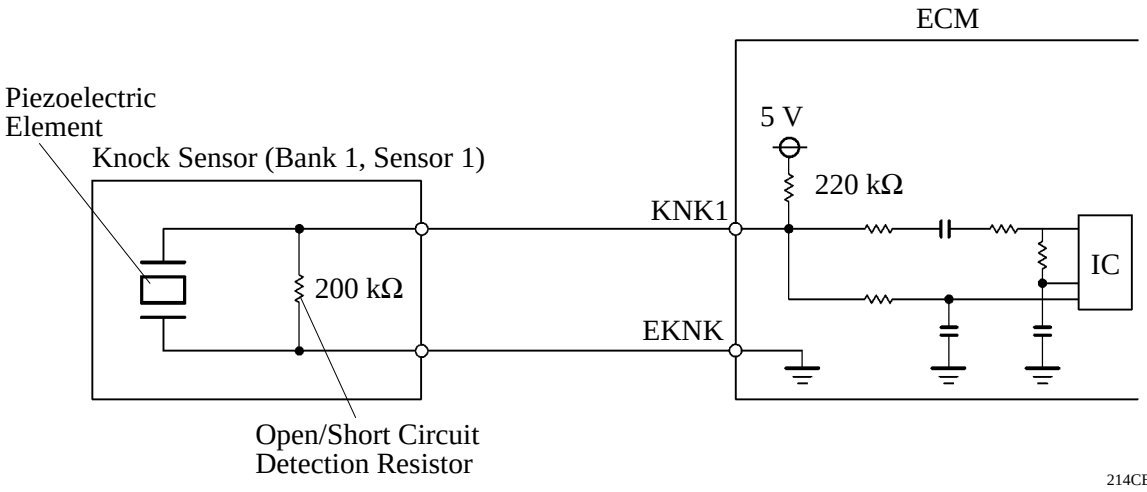
The knocking vibration is transmitted to the steel weight and its inertia applies pressure to the piezoelectric element. The action generates electromotive force.



214CE08

4) Open/Short Circuit Detection Resistor

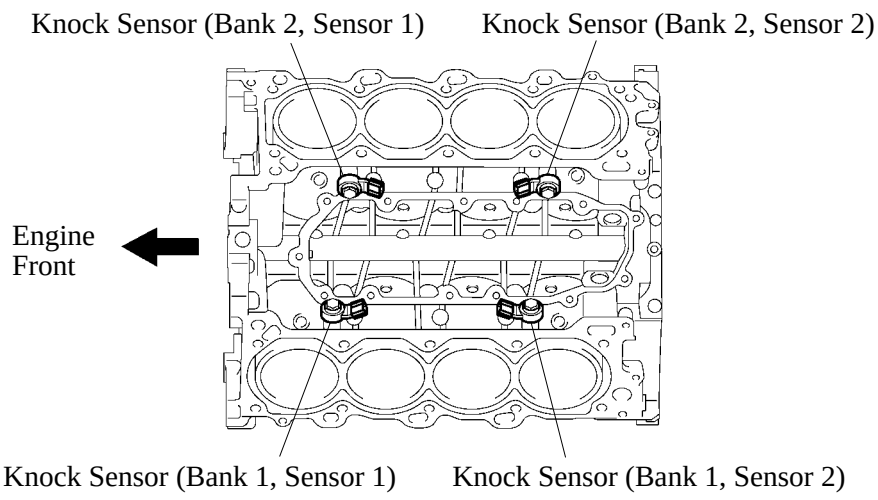
During the power source is IG-ON, the open/short circuit detection resistor in the knock sensor and the resistor in the ECM keep the voltage at the terminal KNK1 of engine constant.
An IC (Integrated Circuit) in the ECM is always monitoring the voltage of the terminal KNK1. If the open/short circuit 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 the specific directions as illustrated. For details, refer to the 2008 LEXUS LS600hL Repair Manual (Pub. No. RM05A0U).

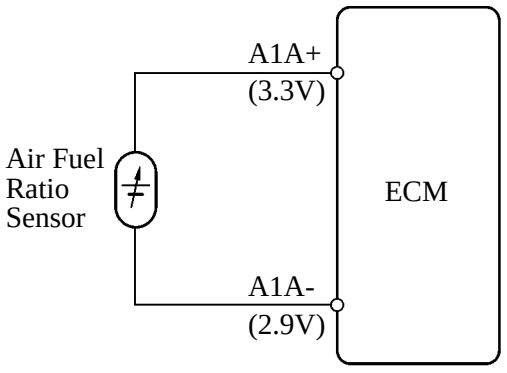


036EG104TE

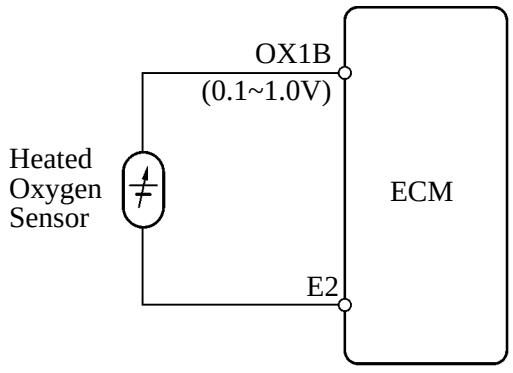
Air Fuel Ratio Sensor and Heated Oxygen Sensor

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.

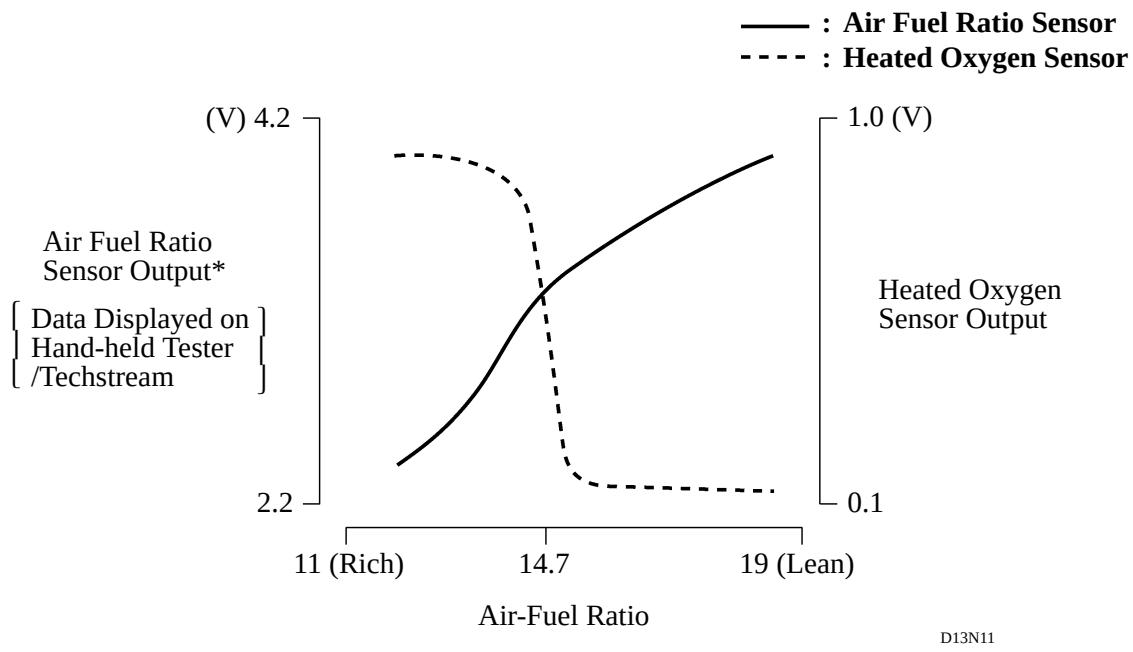


Air Fuel Ratio Sensor Circuit
(Bank 1, Sensor 1)



Heated Oxygen Sensor Circuit
(Bank 1, Sensor 2)

02HEG56Y

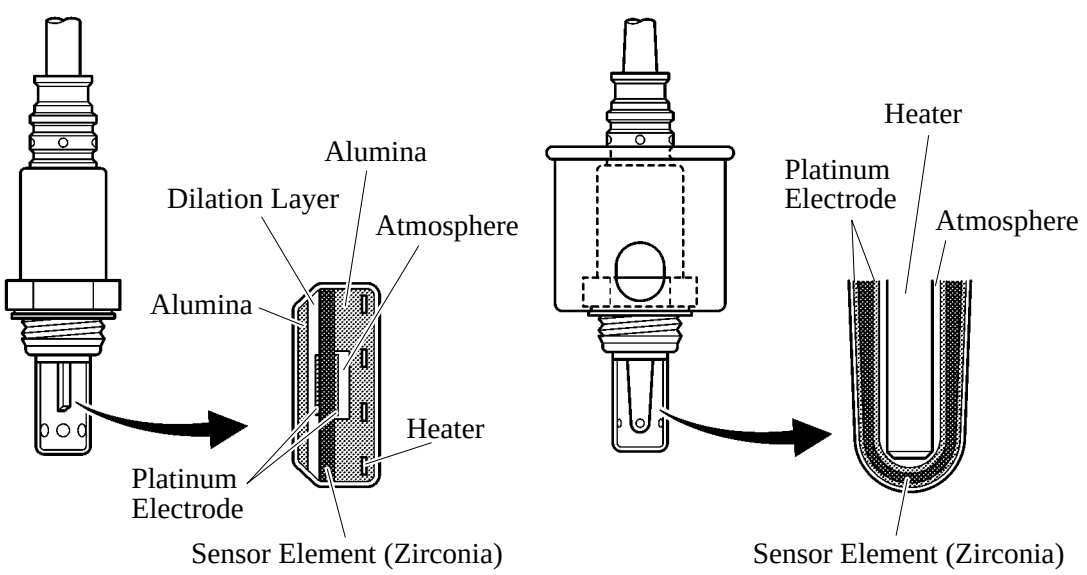


D13N11

*: 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.

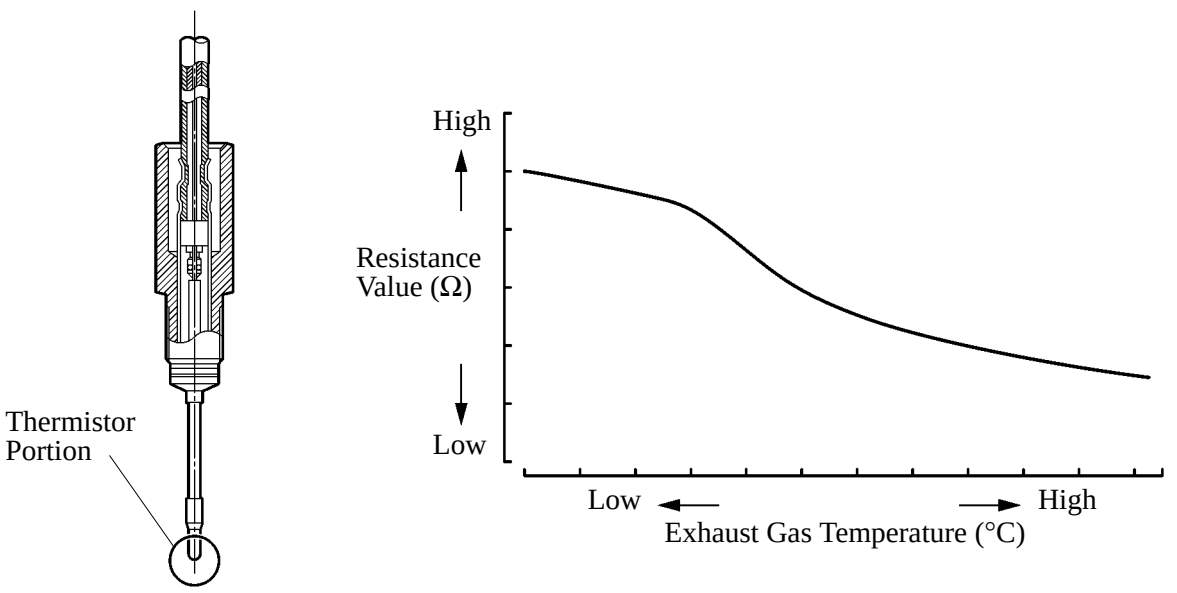


Planar Type Air Fuel Ratio Sensor **Cup Type Heated Oxygen Sensor**

036EG152Z

Exhaust Gas Temperature Sensor

A thermistor type exhaust gas temperature sensor is used and measures exhaust gas temperatures in the HCAC adsorber and catalyst to monitor the open or close status of the HCAC valve in the HCAC system.



Cross Section

05AEG49TE