

■ ENGINE CONTROL SYSTEM

1. General

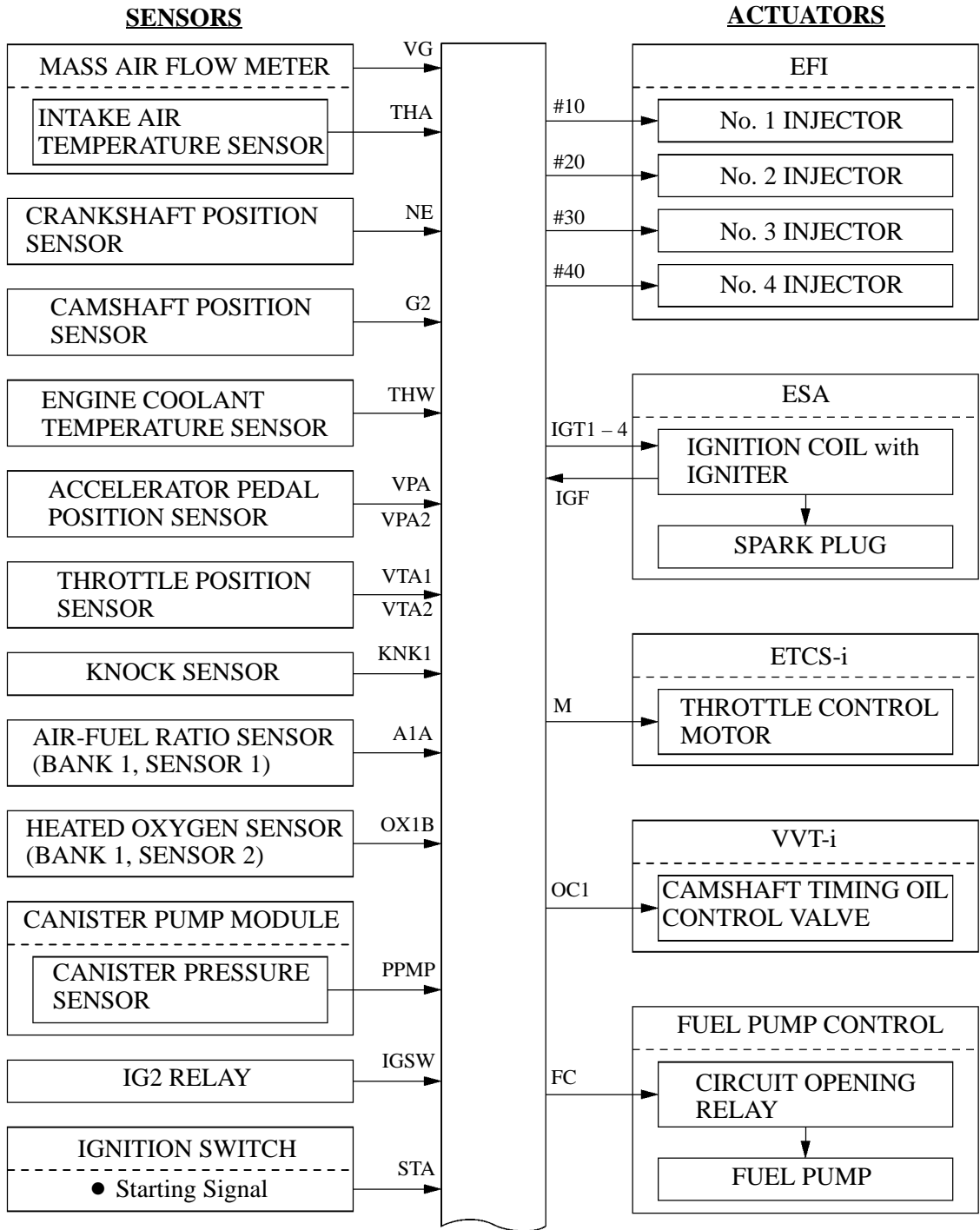
The engine control system for the 2AZ-FE engine has the following systems.

System	Outline
SFI (Sequential Multiport Fuel Injection)	<ul style="list-style-type: none"> ● An L-type SFI system directly detects the intake air mass with a hot wire type mass air flow meter. ● The fuel injection system is a sequential multiport fuel injection system. ● Fuel injection takes two forms: Synchronous injection, which always takes place with the same timing in accordance with the basic injection duration and an additional correction based on the signals provided by the sensors. Non-synchronous injection, which takes place at the time an injection request based on the signals provided by the sensors is detected, regardless of the crankshaft position. ● Synchronous injection is further divided into group injection during a cold start, and independent injection after the engine is started.
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.
ETCS-i (Electronic Throttle Control System-intelligent [See page EG-115])	Optimally controls the throttle valve opening angle 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-120]	Controls the intake camshaft to an optimal valve timing in accordance with the engine condition.
Air-fuel Ratio Sensor and Heated Oxygen Sensor Heater Control	Maintains the temperature of the air-fuel ratio sensor or heated oxygen sensor at an appropriate level to realize accuracy of detection of the oxygen concentration in the exhaust gas.
Air Conditioning Cut-off Control	By turning the air conditioning compressor ON or OFF in accordance with the engine condition, drivability is maintained.
Cooling Fan Control [See page EG-124]	Radiator cooling fan operation is controlled by signals from ECM based on the engine coolant temperature sensor signal and the condition of the air conditioning operation.
Fuel Pump Control [See page EG-125]	<ul style="list-style-type: none"> ● Fuel pump operation is controlled by signal from the ECM. ● The fuel pump is stopped when the SRS airbags are deployed.

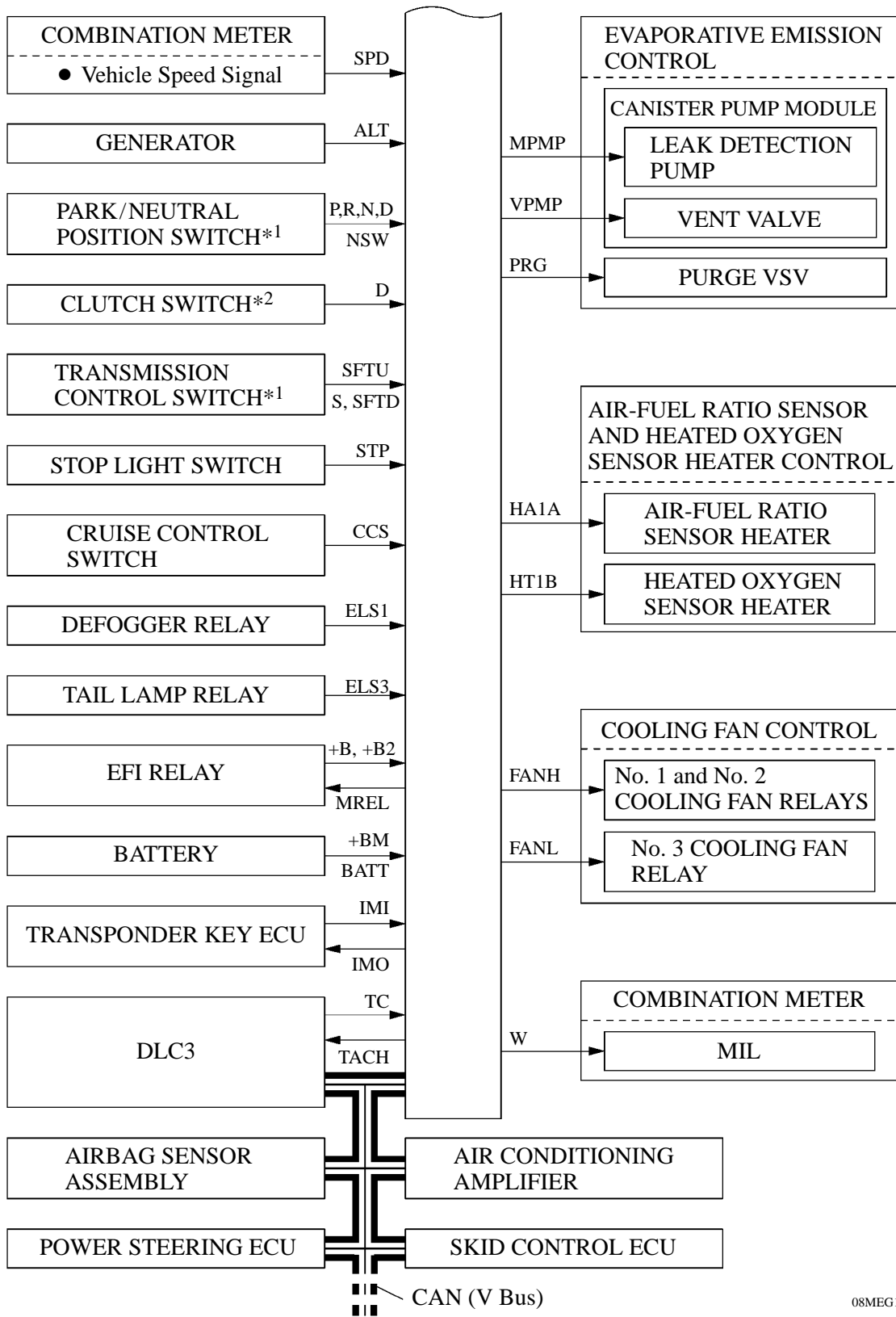
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System	Outline
Evaporative Emission Control [See page EG-126]	The ECM controls the purge flow of evaporative emissions (HC) in the canister in accordance with engine conditions.
	Approximately five hours after the ignition switch has been turned OFF, the ECM operates the canister pump module to detect any evaporative emission leakage occurring in the EVAP (evaporative emission) control system through changes in the 0.02 in. leak pressure.
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-127]	When the ECM detects a malfunction, the ECM diagnoses and memorizes the failed section.
Fail-safe [See page EG-127]	When the ECM detects a malfunction, the ECM stops or controls the engine according to the data already stored in memory.

2. Construction



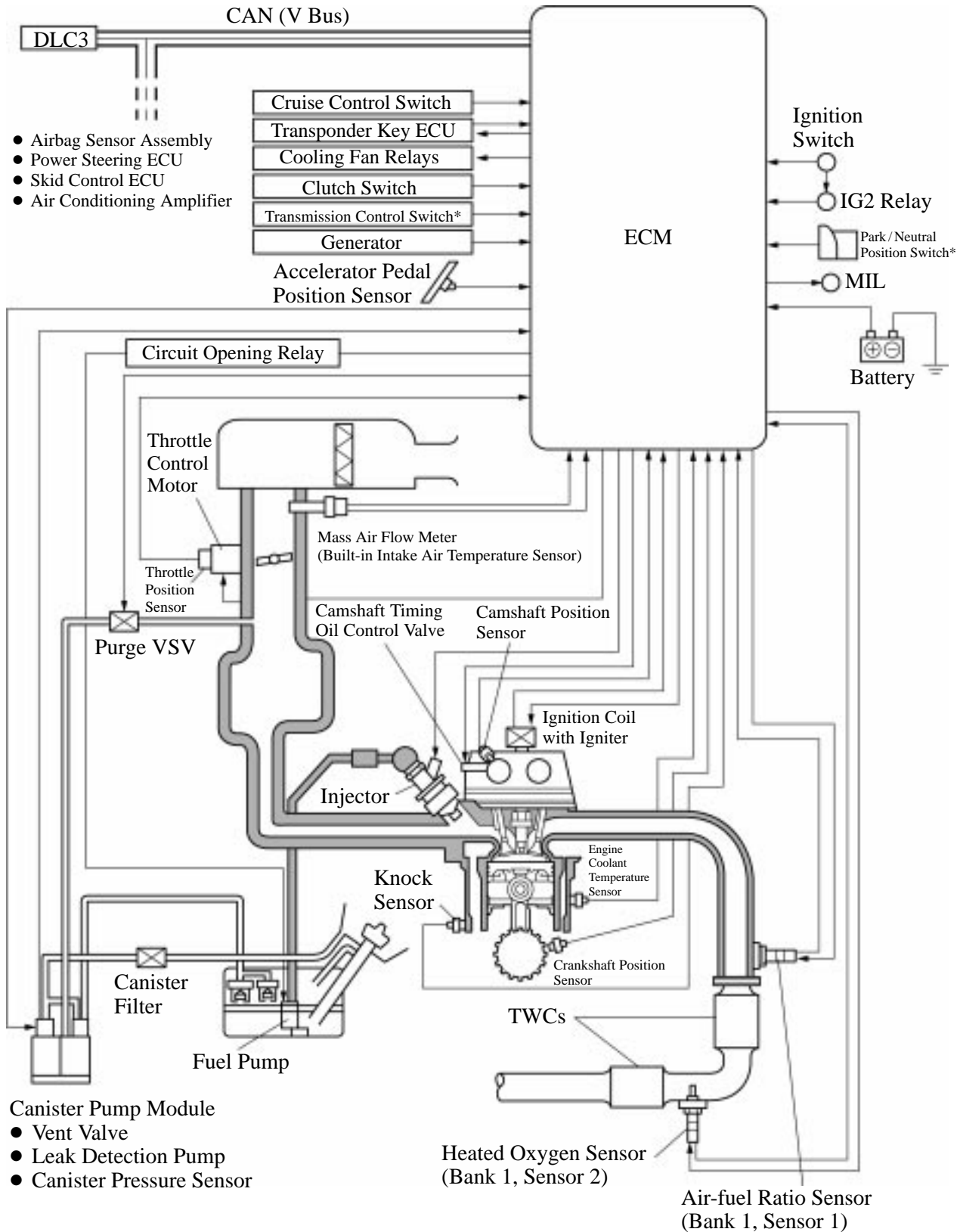
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*1: Automatic Transaxle Models
 *2: Manual Transaxle Models

3. Engine Control System Diagram

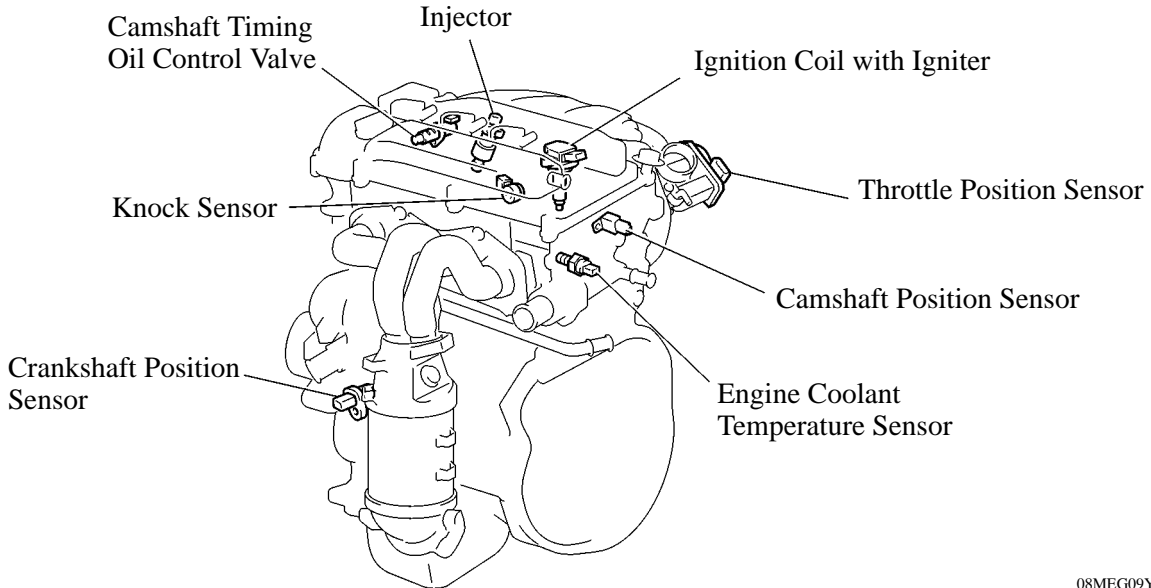
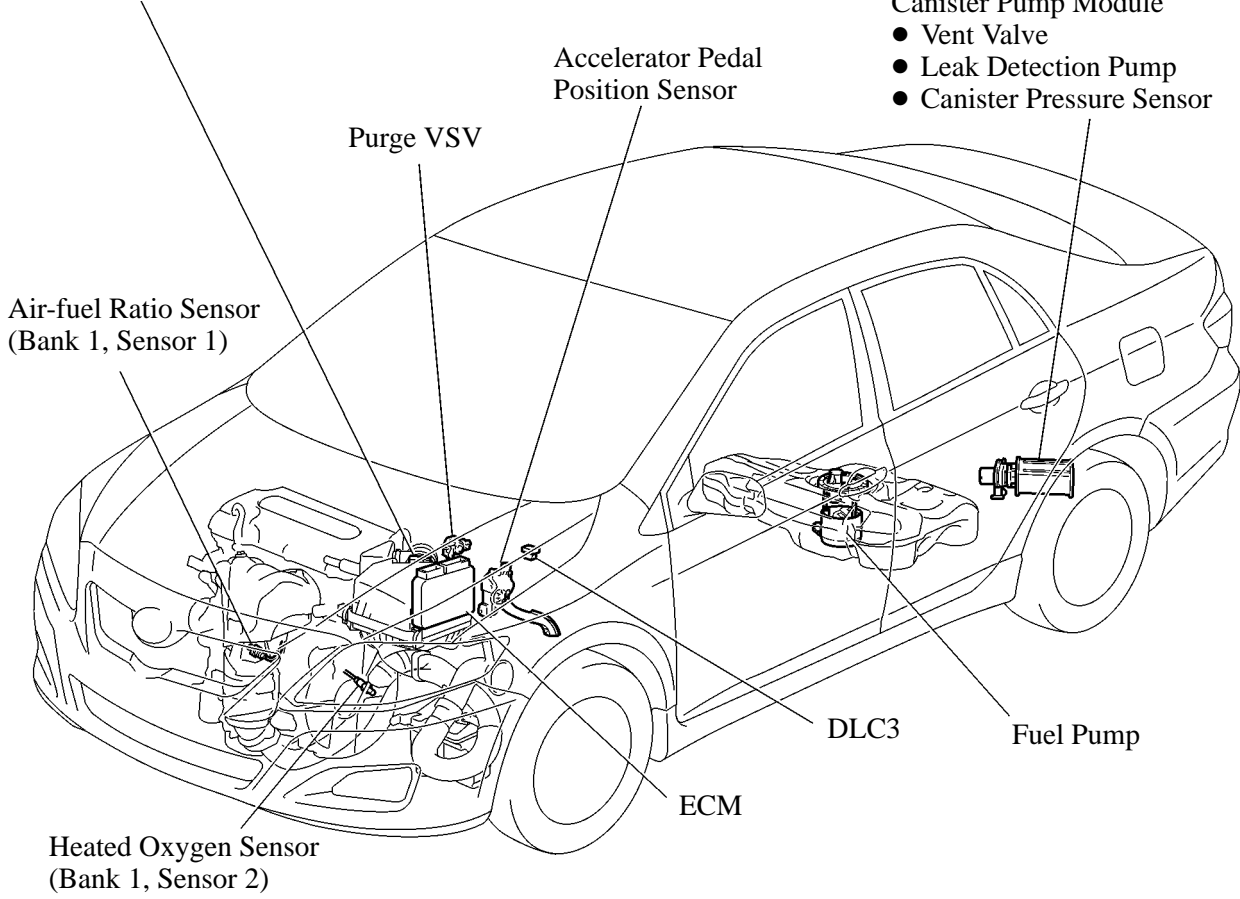


*: Automatic Transaxle Models

4. Layout of Main Components

Mass Air Flow Meter
(Built-in Intake Air Temperature Sensor)

- Canister Pump Module
- Vent Valve
- Leak Detection Pump
- Canister Pressure Sensor



5. Main Components of Engine Control System

General

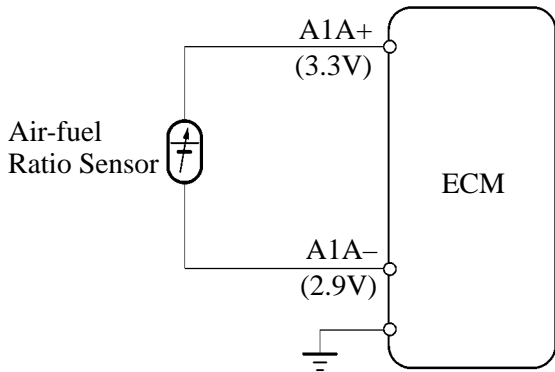
The main components of the 2AZ-FE engine control system are as follows:

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)	Cup Type with Heater	1	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)	Planar Type with Heater	1	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.
Intake Air Temperature Sensor	Thermistor Type	1	This sensor detects the intake air temperature by means of an internal thermistor.
Crankshaft Position Sensor (Rotor Teeth)	Pick-up Coil Type (36-2)	1	This sensor detects the engine speed and performs the cylinder identification.
Camshaft Position Sensor (Rotor Teeth)	Pick-up Coil Type (36-2)	1	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.
Knock Sensor	Built-in Piezoelectric Type (Flat Type)	1	This sensor detects an occurrence of the engine knocking indirectly from the vibration of the cylinder block caused by the occurrence of engine knocking.
Accelerator Pedal Position Sensor	Non-contact Type	1	This sensor detects the amount of pedal effort applied to the accelerator pedal.
Throttle Position Sensor	Non-contact Type	1	This sensor detects the throttle valve opening angle.
Fuel Injector	12-hole Type	4	The injector is an electromagnetically-operated nozzle which injects fuel in accordance with signals from the ECM.

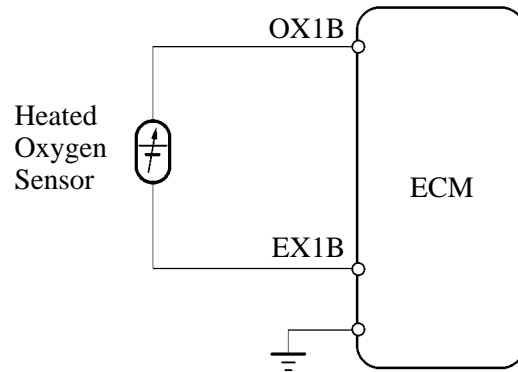
Air-fuel Ratio Sensor and Heated Oxygen Sensor

1) General

- The air-fuel ratio sensor and heated oxygen sensor differ in output characteristics.
- 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 emission. The ECM converts the changes in the output amperage into voltage in order to linearly detect the present air-fuel ratio. The air-fuel ratio sensor data is read out by the Techstream.
- The output voltage of the heated oxygen sensor changes in accordance with the oxygen concentration in the exhaust emission. The ECM uses this output voltage to determine whether the present air-fuel ratio is richer or leaner than the stoichiometric air-fuel ratio.

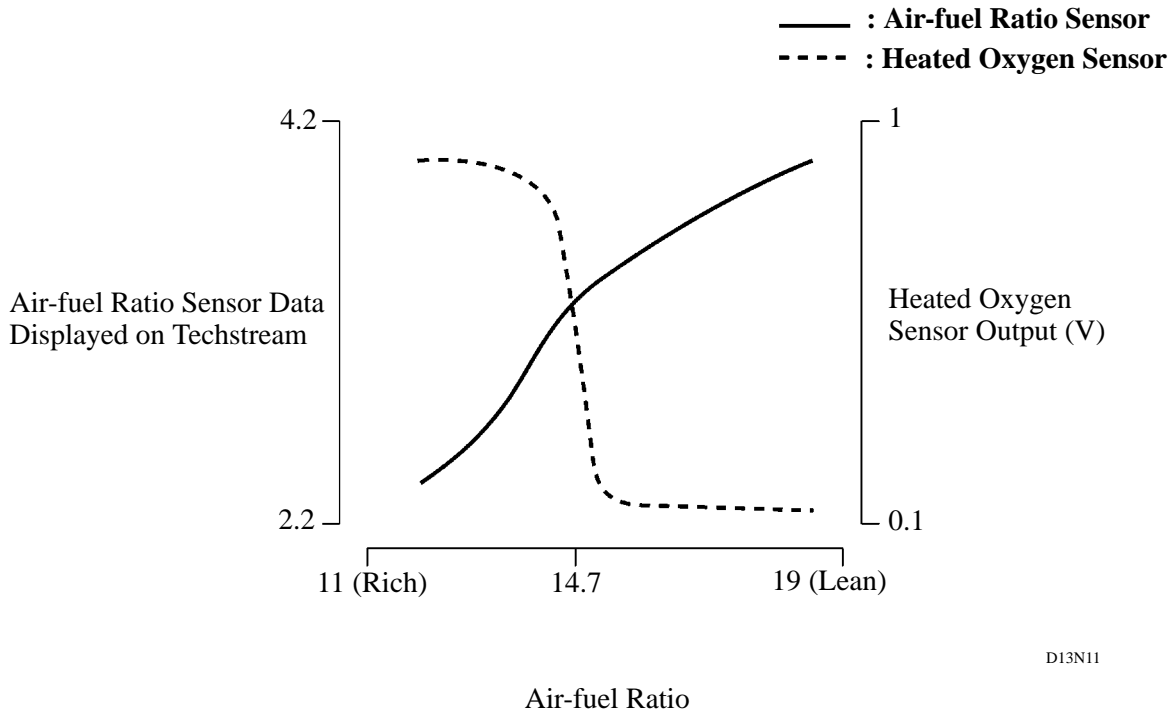


Air-fuel Ratio Sensor Circuit



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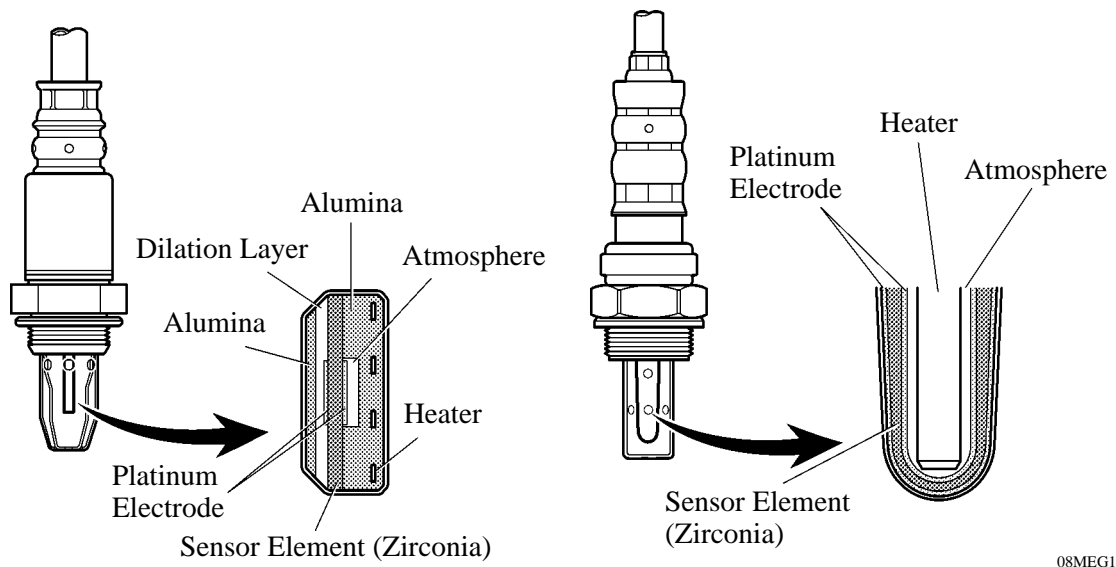
Heated Oxygen Sensor Circuit



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2) Construction

- The basic construction of the air-fuel ratio sensor and heated oxygen 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 realizing the excellent warm-up performance of the sensor.



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Planar Type Air-fuel Ratio Sensor

Cup Type Heated Oxygen Sensor

► Warm-up Specification ◀

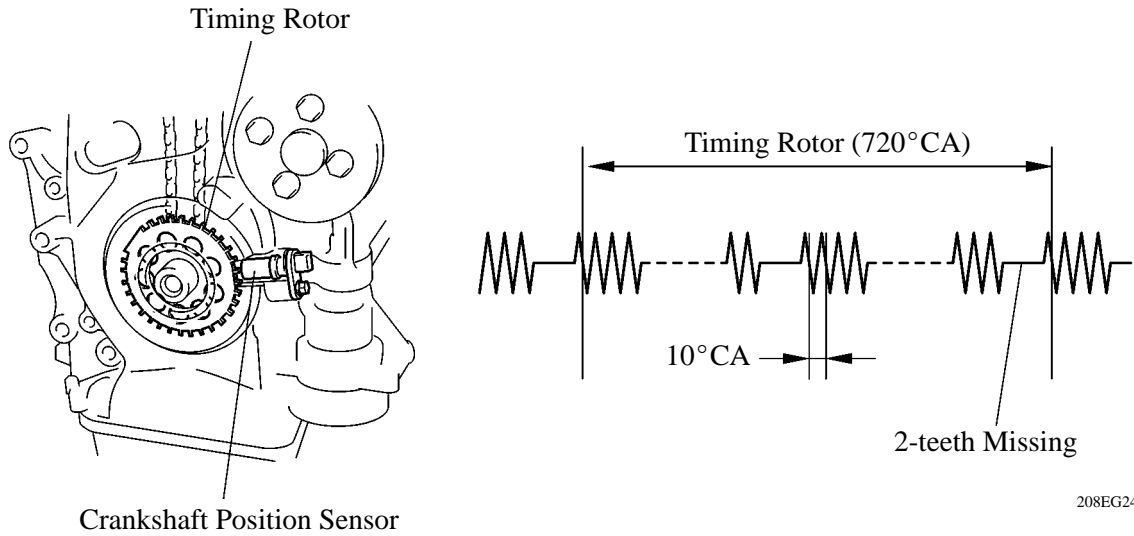
Sensor Type	Planar Type	Cup Type
Warm-up Time	Approx. 10 sec.	Approx. 30 sec.

Mass Air Flow Meter

The mass air flow meter which is the same type as that of the 2ZR-FE engine is used. For details, see page EG-36.

Crankshaft Position Sensor

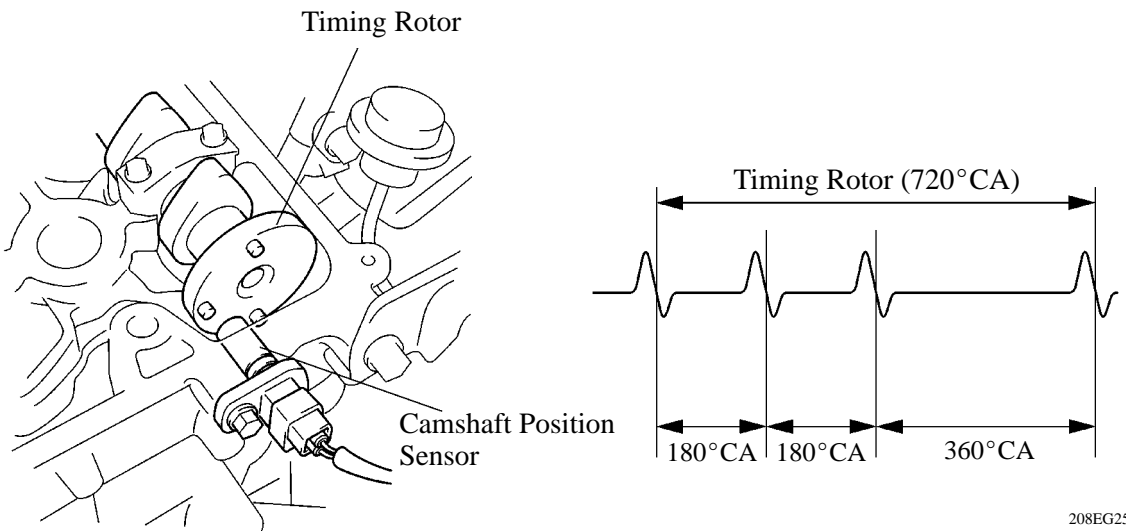
The timing rotor of the crankshaft consists of 34 teeth, with 2 teeth missing. The crankshaft position sensor outputs the crankshaft rotation signals every 10°, and the missing teeth are used to determine the top-dead-center.



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Camshaft Position Sensor

The camshaft position sensor is mounted on the left bank of cylinder head. To detect the camshaft position, a protrusion that is provided on the timing pulley is used to generate 1 pulse for every 2 revolutions of the crankshaft.



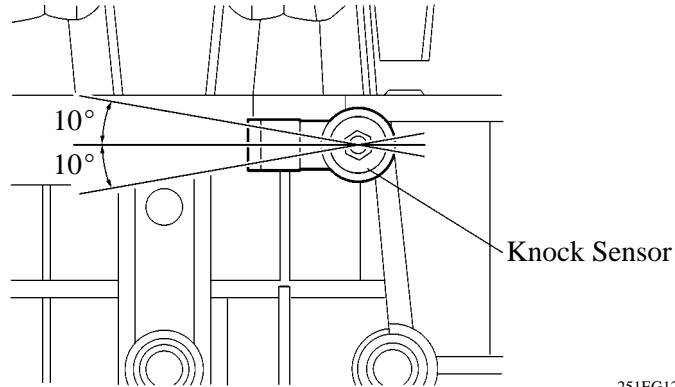
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Knock Sensor (Flat Type)

The knock sensor which is the same type as that of the 2ZR-FE engine is used. For details, see page EG-42.

Service Tip

- In accordance with the adoption of an open/short circuit detection resistor, the inspection method for the sensor has been changed. For details, refer to the 2009 Corolla Repair Manual (Pub. No. RM08M0U).
- To prevent the water accumulation in the connector, make sure to install the flat type knock sensor in the position as shown in the following illustration.

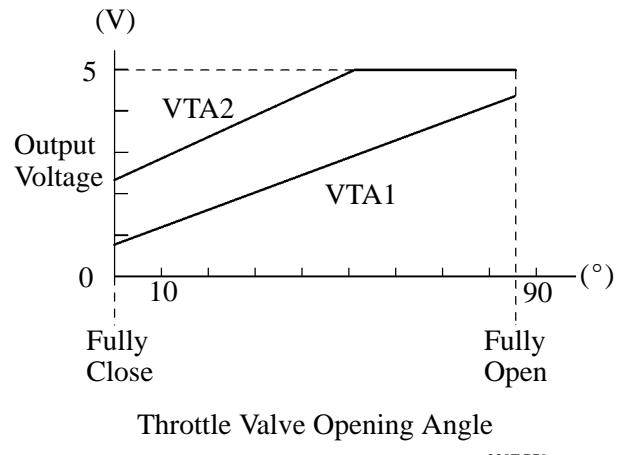
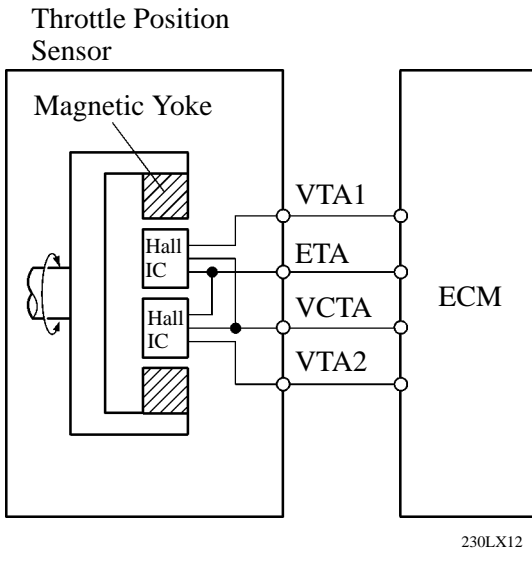
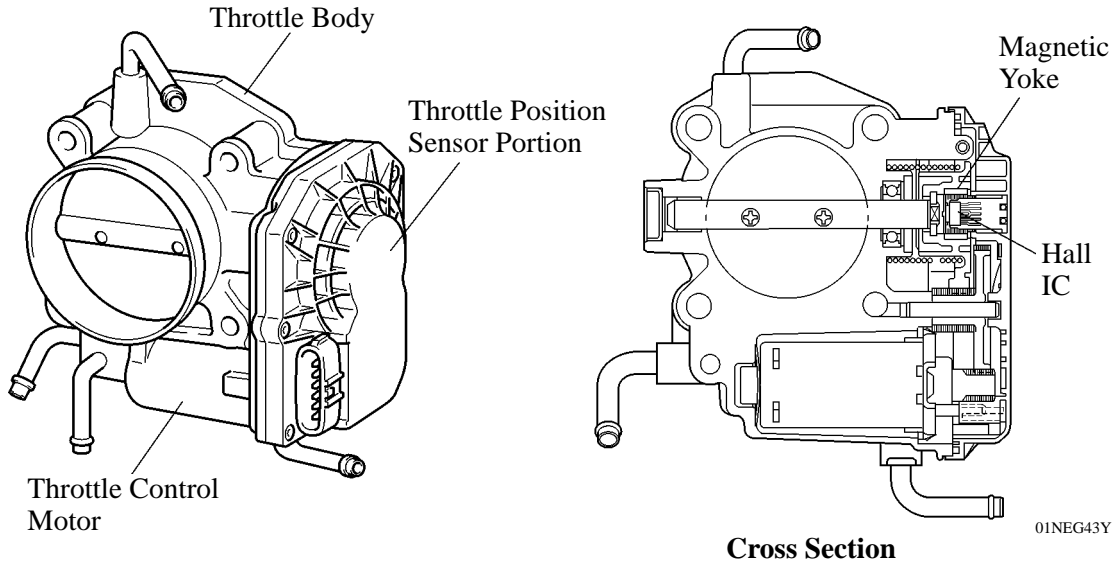


Accelerator Pedal Position Sensor

The accelerator pedal position sensor which is the same type as that of the 2ZR-FE engine is used. For details, see page EG-40.

Throttle Position Sensor

The throttle position sensor is mounted on the throttle body to detect the opening angle of the throttle valve. The throttle position sensor converts the magnetic flux density that changes when the magnetic yoke (located on the same axis as the throttle shaft) rotates around the Hall IC into electric signals to operate the throttle control motor.



Service Tip

The inspection method differs from the conventional contact type throttle position sensor because this non-contact type sensor uses a Hall IC.

For details, refer to the 2009 Corolla Repair Manual (Pub. No. RM08M0U).