■ENGINE CONTROL SYSTEM

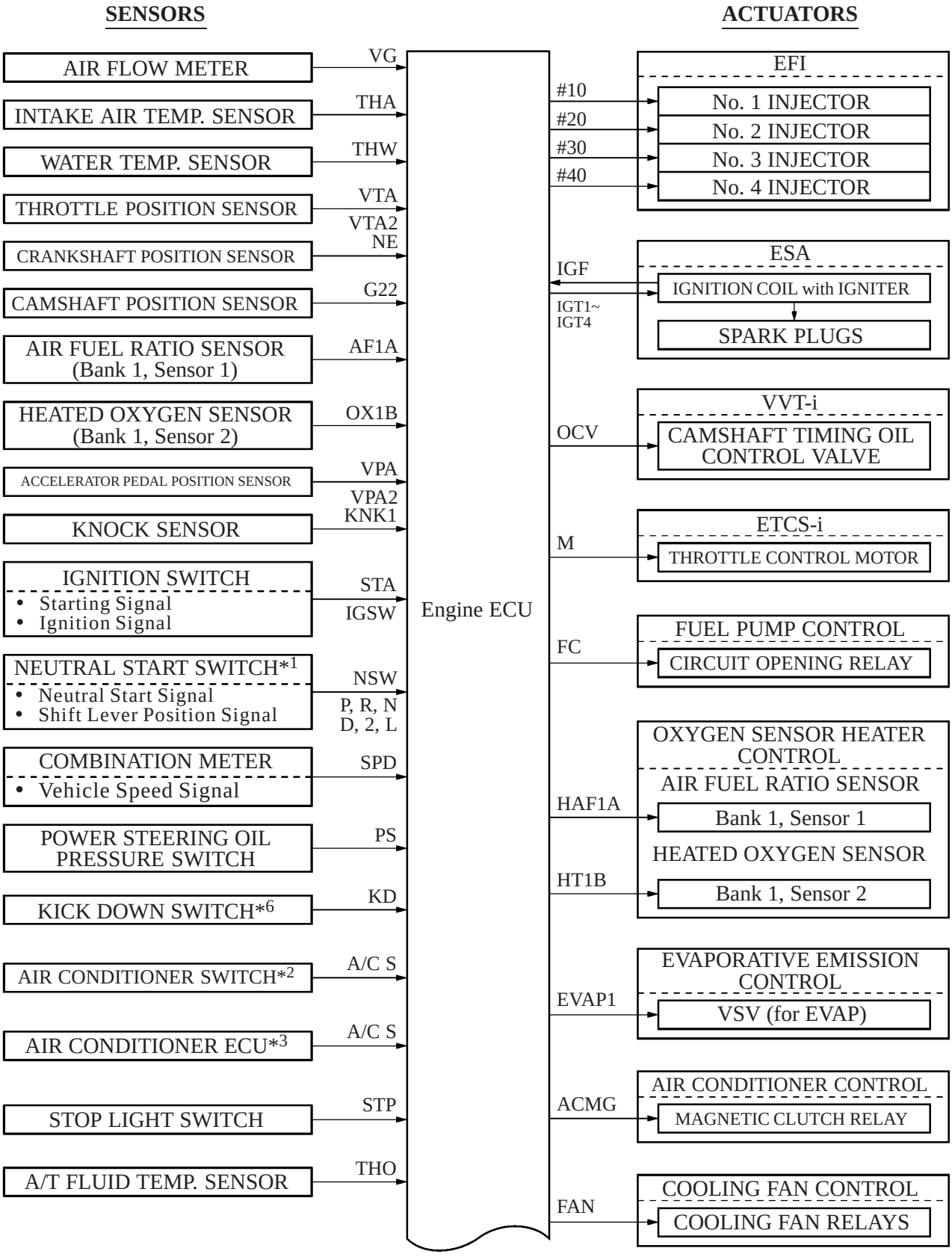
1. General

The engine control system of the 1AZ-FE and 2AZ-FE engines have following system.

System	Outline
EFI (Electronic Fuel Injection) (For details, see page EG-40)	• An L-type EFI system directly detects the intake air mass with a hot wire type air flow meter. • The fuel injection system is a sequential multiport fuel injection system.
ESA (Electronic Spark Advance) (For details, see page EG-40)	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.
ETCS-i (Electronic Throttle Control System-intelligent) (For details, see page EG-41)	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) (For details, see page EG-43)	Controls the intake camshaft to an optimal valve timing in accordance with the engine condition.
Fuel Pump Control	Fuel pump operation is controlled by signal from the engine ECU.
Air Fuel Ratio Sensor, Oxygen Sensor Heater Control	Maintains the temperature of the air fuel ratio sensor or oxygen sensor at an appropriate level to increase accuracy of detection of the oxygen concentration in the exhaust gas.
Evaporative Emission Control	The engine ECU controls the purge flow of evaporative emission (HC) in the charcoal canister in accordance with engine conditions.
Air Conditioner Cut-off Control	By turning the air conditioner compressor ON or OFF in accordance with the engine condition, drivability is maintained.
Cooling Fan Control (For details, see page EG-44)	Radiator cooling fan operation is controlled by water temperature sensor signal (THW) and the condition of the air conditioner operation.
Engine Immobiliser	Prohibits fuel delivery and ignition if an attempt is made to start the engine with an invalid ignition key.
Diagnosis (For details, see page EG-45)	• When the engine ECU detects a malfunction, the engine ECU diagnoses and memorizes the failed section. • To increase the speed for processing the signals, the 32-bit CPU of the engine ECU has been adopted
Fail-Safe (For details, see page EG-46)	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 in the 1AZ-FE and 2AZ-FE engine in the new Camry is as shown in the following chart.



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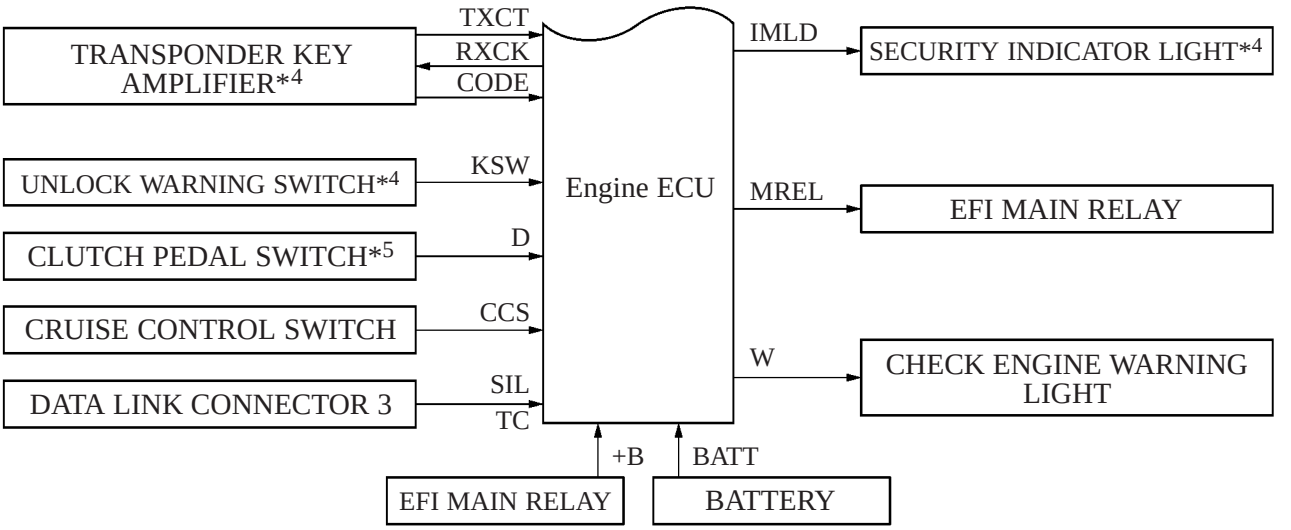

*1: Automatic Transaxle Model Only
*2: with Manual Air Conditioning System
*3: with Automatic Air Conditioning System
*4: with Engine Immobiliser System
*5: Manual Transaxle Model Only
*6: LHD Models for Europe

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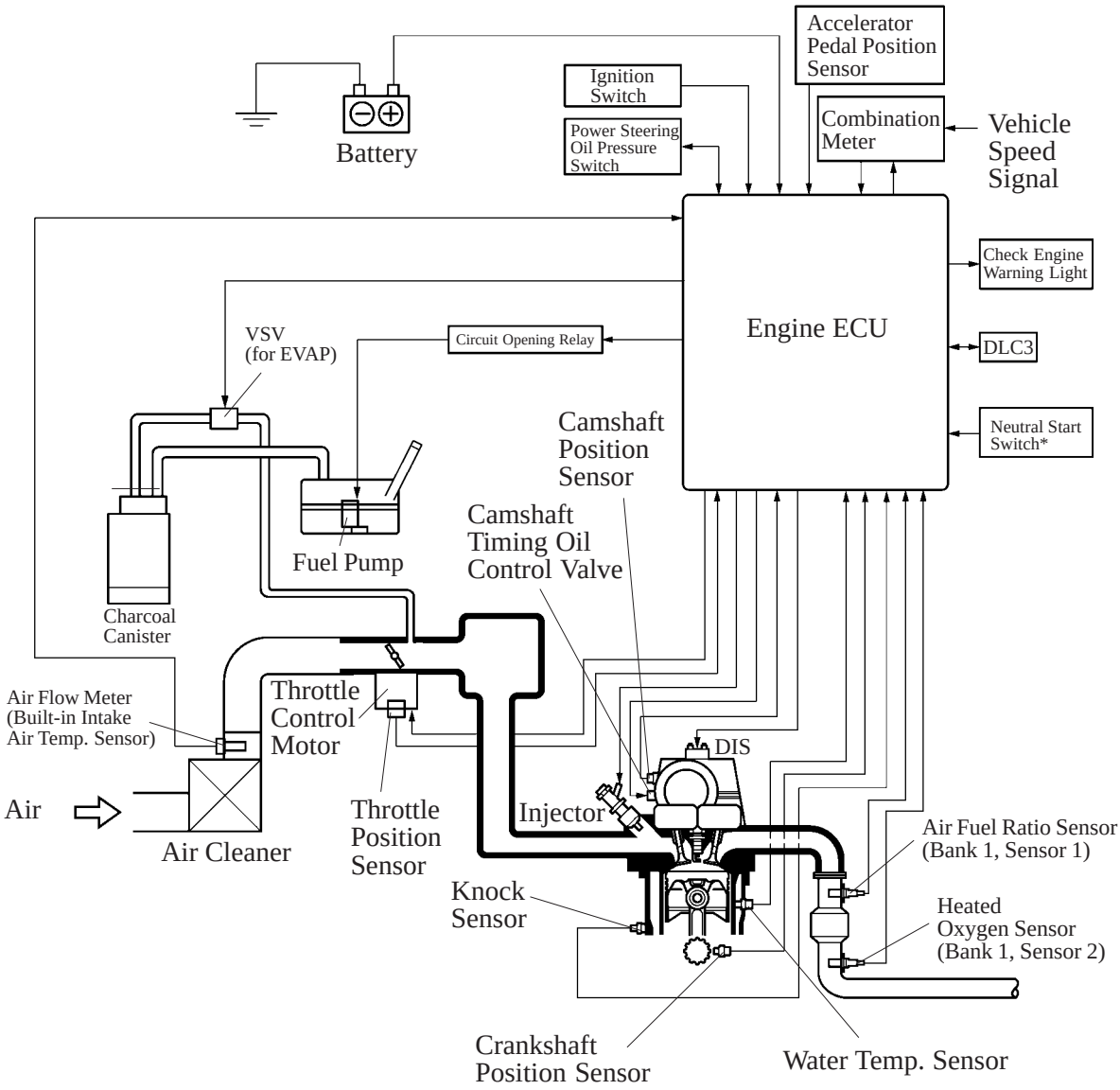
3. Engine Control System Diagram



*: Automatic Transaxle Model Only

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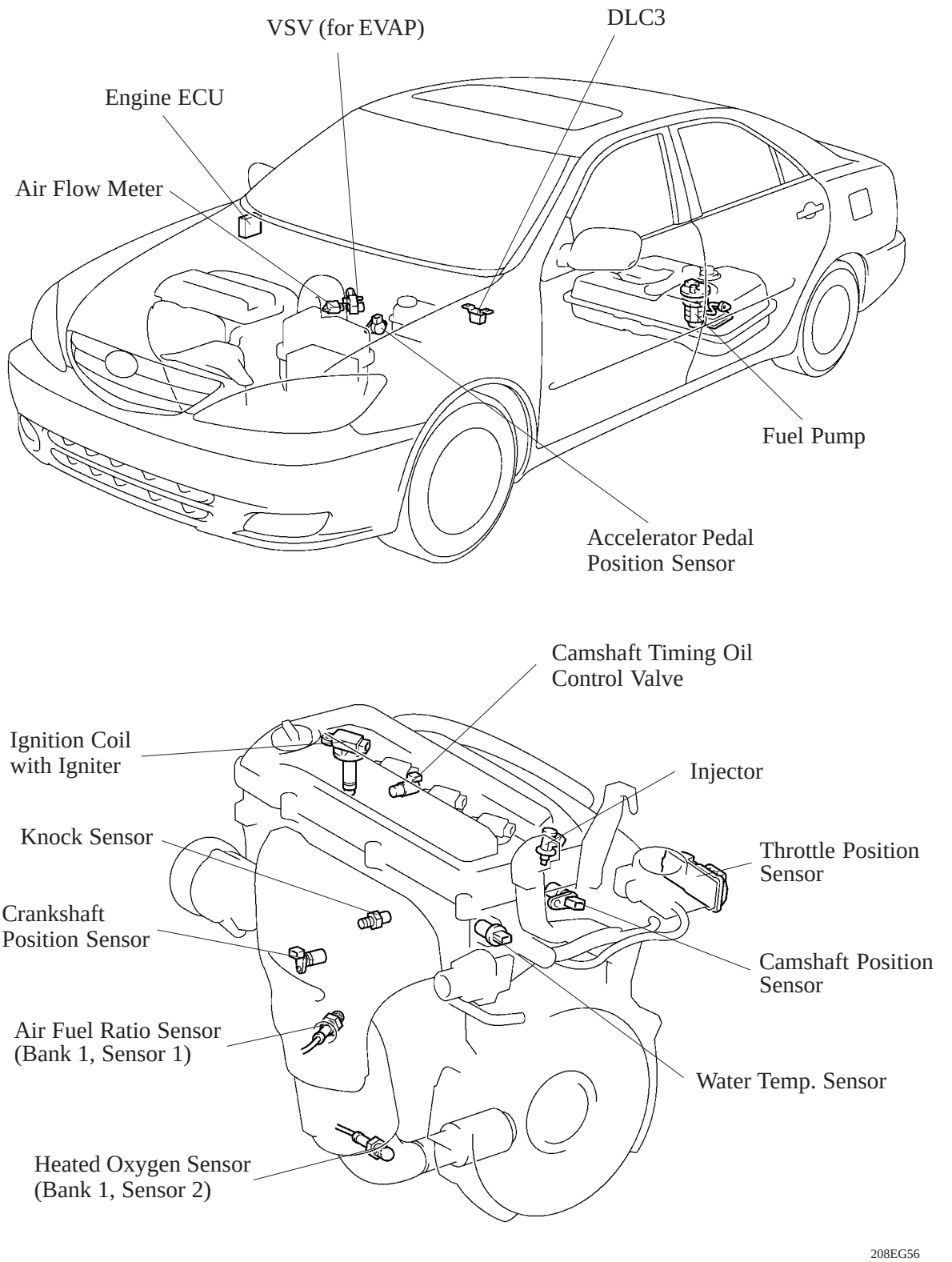
4. Layout of Main Components



5. Main Components of Engine Control System

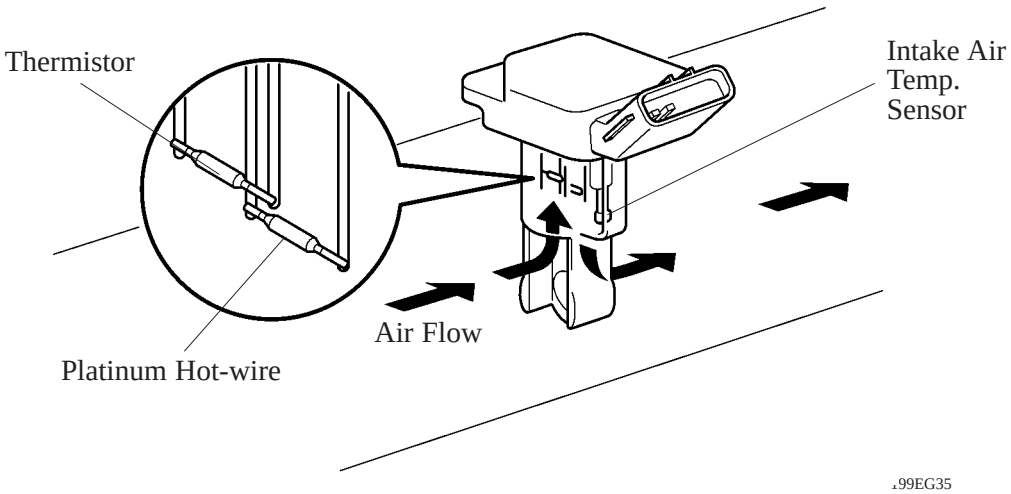
General

The following table compares the main components.

Components	Outline	Quantity
Engine ECU	32-bit ECU	1
Air Flow Meter	Hot-wire Type	1
Crankshaft Position Sensor (Rotor Teeth)	Pick-up Coil Type (36-2)	1
Camshaft Position Sensor (Rotor Teeth)	Pick-up Coil Type (3)	1
Throttle Position Sensor	Linear Type	1
Accelerator Pedal Position Sensor	Linear Type	1
Knock Sensor	Built-in Piezoelectric Type	1
Air Fuel Ratio Sensor	with Heater Type	1
Oxygen Sensor	with Heater Type	1
Injector	12-hole Type	4

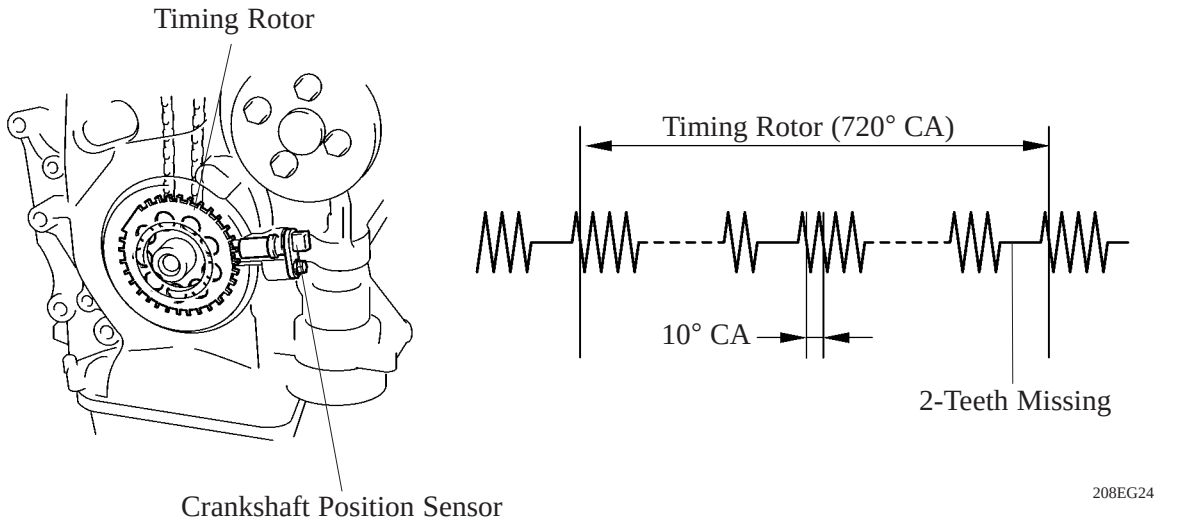
Air Flow Meter

- 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 has been improved and the intake air resistance has been reduced.
- This air flow meter has a built-in intake air temperature sensor.



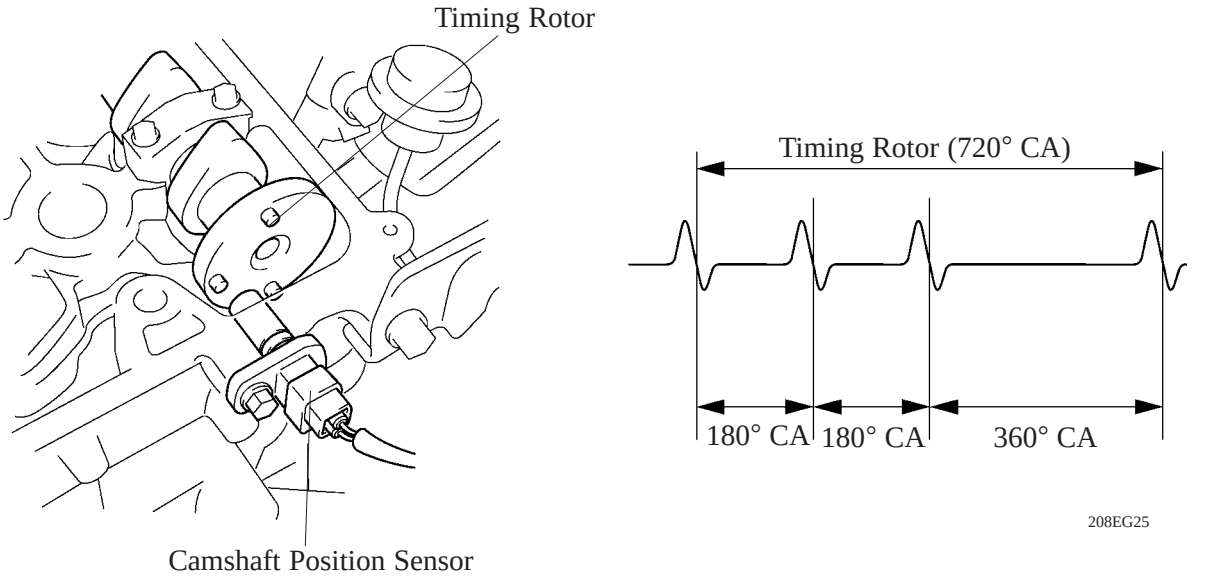
Crankshaft Position Sensor

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.



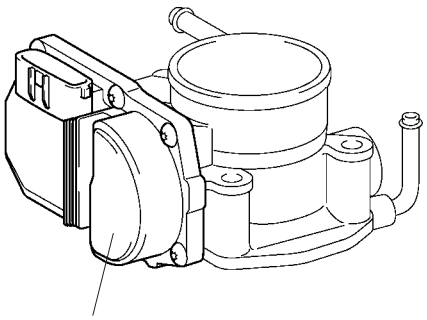
Camshaft Position Sensor

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 revolution of the crankshaft.

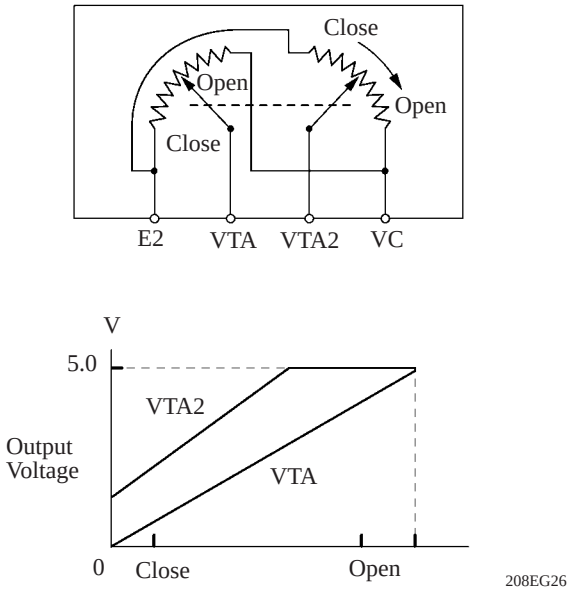


Throttle Position Sensor

This sensor converts the throttle valve opening angles into electronic signals with two differing characteristics and outputs them to the engine ECU. One is the VTA signal that linearly outputs the voltage along the entire range of the throttle valve opening angle. The other is the VTA2 signal that outputs an offset voltage.



Throttle Position Sensor



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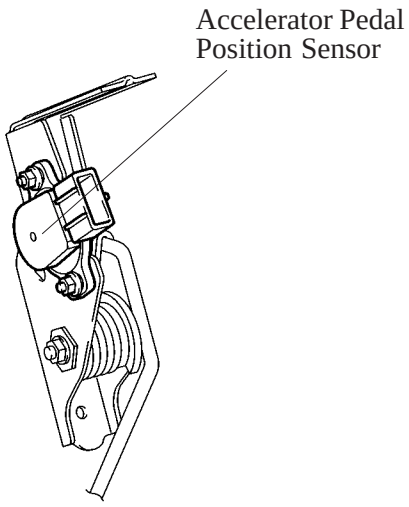
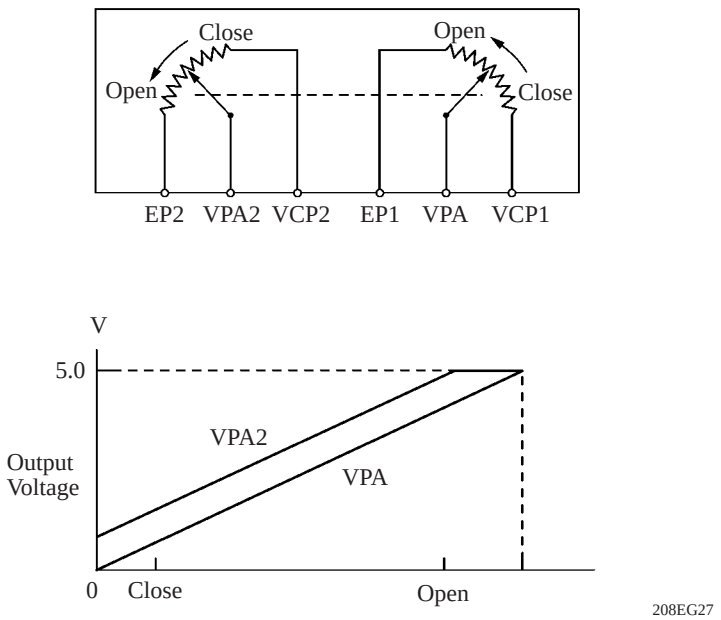
Accelerator Pedal Position Sensor

This sensor converts the accelerator pedal depressed angles into electric signals with two differing characteristics and outputs them to the engine ECU. One is the VPA signal that linearly outputs the voltage along the entire range of the accelerator pedal depressed angle. The other is the VPA2 signal that outputs on offset voltage.





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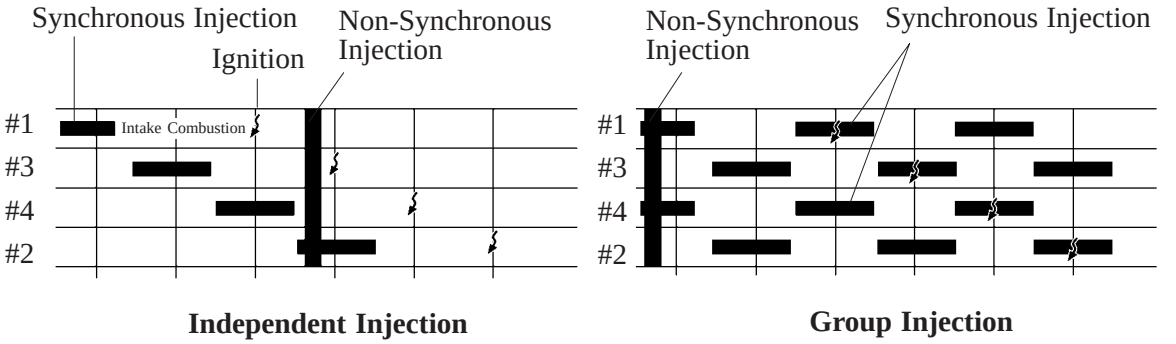
6. EFI (Electronic Fuel Injection) System

- An L-type EFI system directly detects the intake air mass with a hot wire type air flow meter.
- An independent injection system (in which fuel is injected once into each cylinder for each two revolution of the crankshaft) has been adopted.
  Also, when the engine is starting, a group injection system (in which fuel is injected once into two cylinders for each one revolution of the crankshaft) has been adopted.
- There are two types of fuel injection:

  a) One is synchronous injection in which corrections based on the signals from the sensors are added to the basic injection time so that injection occurs always at the same timing.

  b) The other is non-synchronous injection in which injection is effected by detecting the requests from the signals of the sensors regardless of the crankshaft angle.

  Furthermore, to protect the engine and improve fuel economy, the system effects fuel cutoff in which the injection of fuel is stopped temporarily in accordance with the driving conditions.



Independent Injection **Group Injection**

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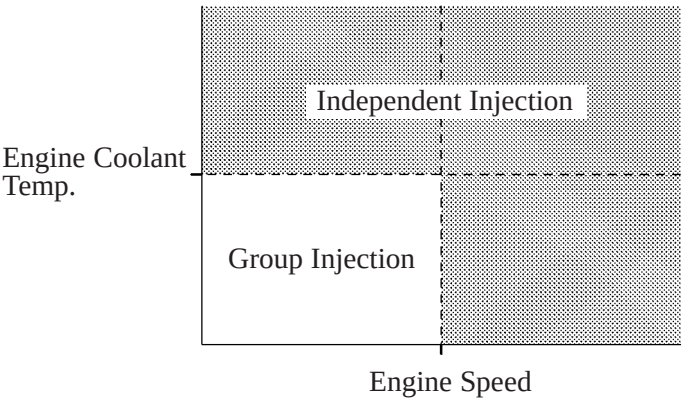

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7. ESA (Electronic Spark Advance)

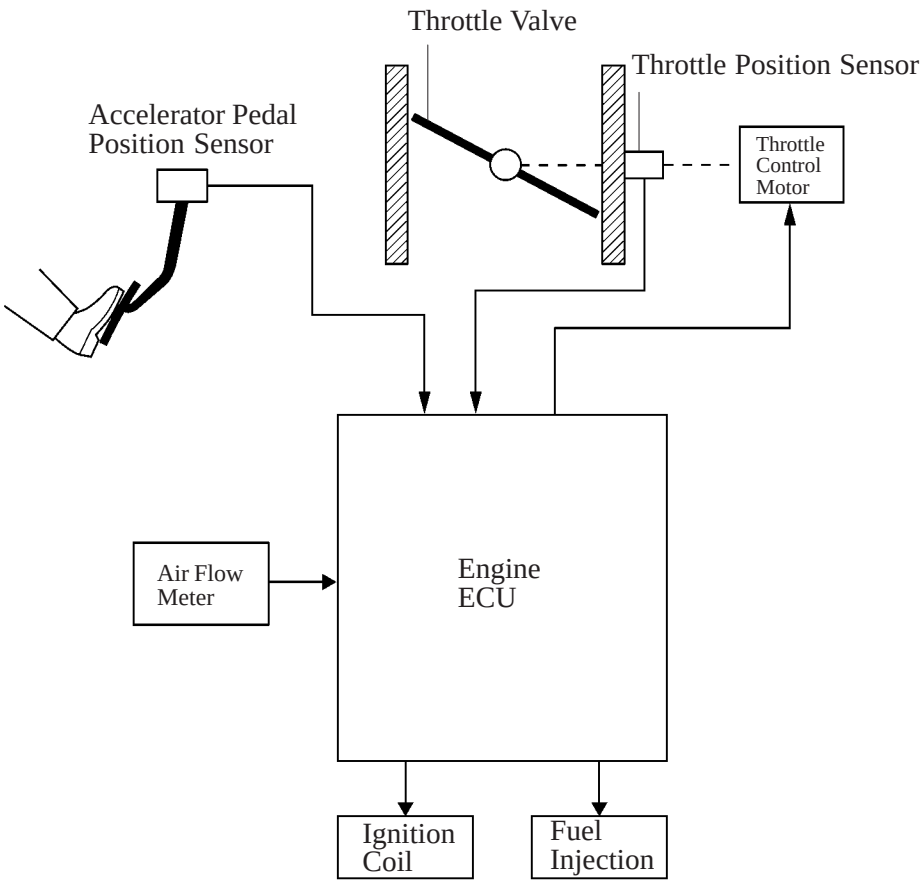
This system selects the optimal ignition timing in accordance with the signals received from the sensors and sends the (IGT) ignition signal to the igniter. The default ignition timing is set to 5° BTDC.

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

General

- In the conventional throttle body, the throttle valve opening in determined invariably by the amount of the accelerator pedal effort. In contrast, the ETCS-i uses the engine ECU to calculate the optimal throttle valve opening that is appropriate for the respective driving condition and uses a throttle control motor to control the opening.
- The accelerator cable and link have been discontinued, and an a accelerator position sensor has been provided on the accelerator pedal.

▶ System Diagram ◀



Operation

1) General

The engine ECU drives the throttle control motor by determining the target throttle valve opening in accordance with the respective vehicle operating condition.

- Idle Speed Control
- Shift Shock Reduction Control
- Cruise Control

2) Idle Speed Control

Controls the throttle valve in order to constantly effect ideal idle speed control.

3) Shift Shock Reduction Control

The throttle control is synchronized to the ECT (Electronically Controlled Transmission) control during the shifting of the transmission in order to reduce the shift shock.

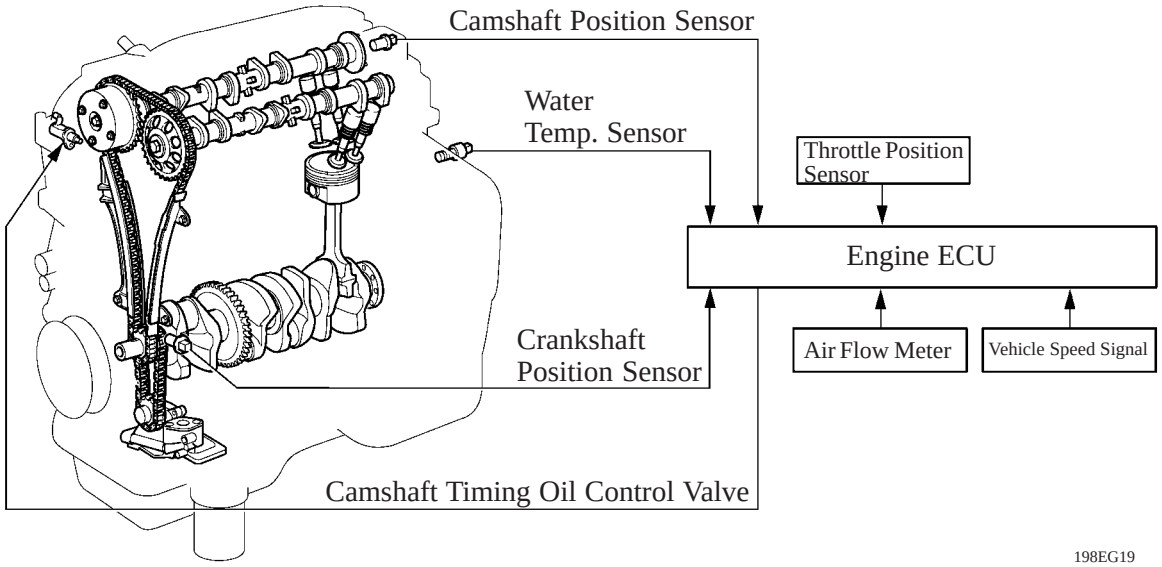
4) Cruise Control

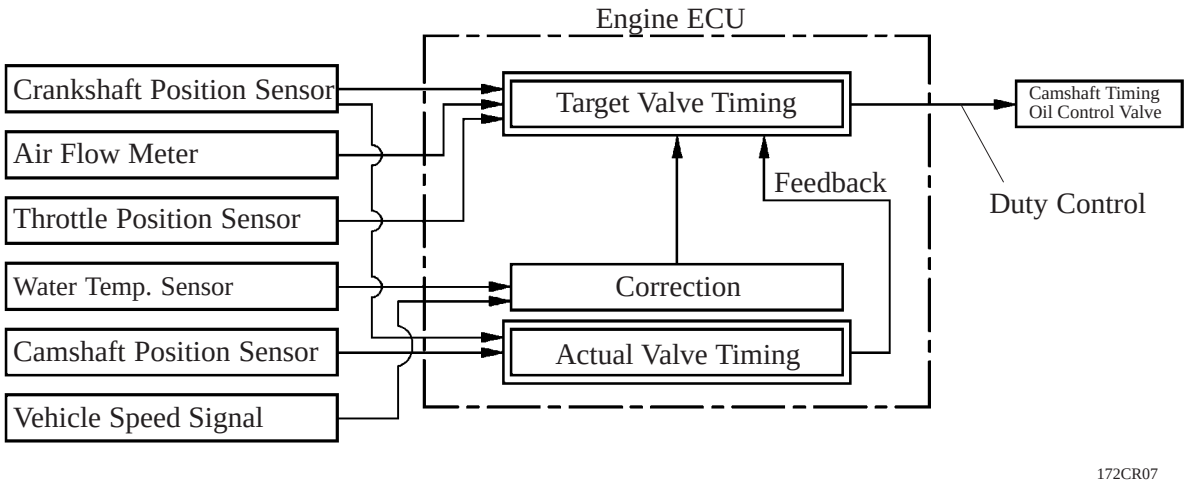
An engine ECU with an integrated cruise control ECU directly actuates the throttle valve to effect the operation of the cruise control.

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

General

The VVT-i system is designed to control the intake camshaft within a wide range of 50° (of crankshaft angle) to provide a valve timing that is optimally suited to the engine condition, thus realizing improved torque in all the speed ranges and fuel economy, and reduce exhaust emissions. The actual intake valve timing is feedback by means of the camshaft position sensor for constant control to the target valve timing.

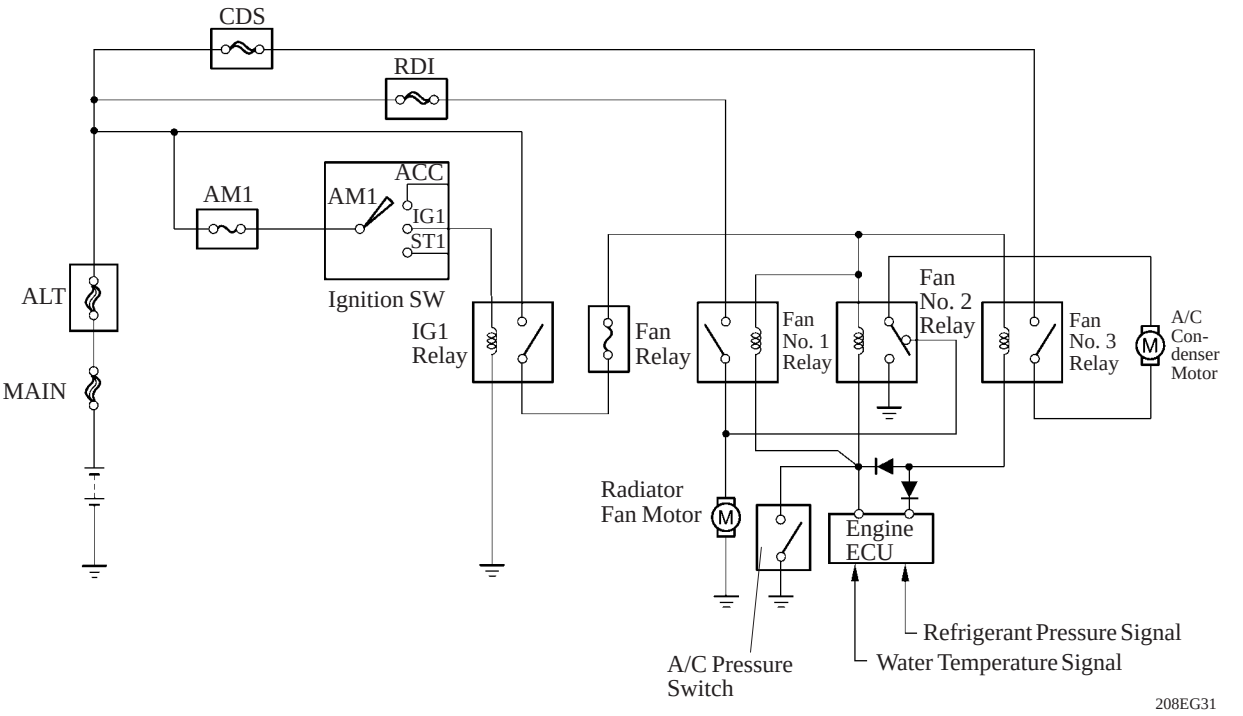




10. Cooling Fan Control

In contrast to the previous electric cooling fan system, the water temperature switch has been discontinued. Instead, by sharing the water temperature sensor to control the fan motor, a simpler system has been realized. This cooling fan control turns 3 fan relays ON/OFF in accordance with the water temperature and the operating conditions of the air conditioner system. When it is ON, the control is switched to operate the 2 fan motors at Low (serial) or High (parallel).

▶ Wiring Diagram ◀



▶ Cooling Fan Operation ◀

Air Conditioner Condition		Water Temperature	
Compressor	Refrigerant Pressure	About 94°C (201°F) or Lower	About 95.5°C (204°F) or Higher
OFF	1.2 MPa (12.5 kgf/cm^2, 177.8 psi) or Lower	OFF	High
ON	1.2 MPa (12.5 kgf/cm^2, 177.8 psi) or Lower	Low	High
	1.5 MPa (15.5 kgf/cm^2, 220.5 psi) or Higher	High	High

11. Diagnosis

When the engine ECU detects a malfunction, the engine ECU 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 engine ECU will also store the DTCs of the malfunctions.
The DTCs can be accessed the use of the hand-held tester.

Service Tip

The length of time to clear the DTC via the battery terminal has been changed from the previous 10 seconds to 1 minute.

12. Fail-Safe

General

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 Control List ◀

Location of Malfunction	Description Control
Air Flow Meter	In case of a signal malfunction, the engine could operate poorly or the catalyst could overheat if the engine continues to be controlled with the signals from the sensors. Therefore, the engine ECU effects control by using the values in the engine ECU or stops the engine.
Accelerator Pedal Position Sensor (For details, see page EG-85)	In case of a signal malfunction, the engine ECU calculates the accelerator pedal opening angle that is limited by the dual system sensor value and continues effecting throttle valve control. If both system malfunction, the engine ECU considers that the accelerator pedal is fully closed.
Throttle Position Sensor (For details, see page EG-86)	In case of a signal malfunction, the engine ECU cuts off the current to the throttle control motor. The throttle valve returns to the prescribed opening by the force of the return spring. The engine ECU then adjusts the engine output by controlling the fuel injection and ignition timing in accordance with the accelerator pedal opening angle to enable the vehicle to continue driving.
Water Temp. Sensor and Intake Air Temp. Sensor	In case of a signal malfunction, the use of the values from the sensors will make the air-fuel ratio become too rich or too lean, which could causes the engine to stall or to run poorly during cold operation. Therefore, the engine ECU fixes the air-fuel ratio to the stoichiometric ratio and uses the constant values of 80°C water temperature and 20°C intake air temperature to perform the calculation.
Knock Sensor	In case of a malfunction in the knock sensor or in the knocking signal system (open or short circuit), the engine could become damaged if the timing is advanced despite the presence of knocking. Therefore, if a malfunction is detected in the knock sensor system, the engine ECU turns the timing retard correction of the knock sensor into the maximum retard value.
Ignition Coil (with Igniter)	In case of a malfunction in the ignition system, such as an open circuit in the ignition coil, the catalyst could be become overheated due to engine misfire. Therefore, if the (IGf) ignition signal is not input twice or more in a row, the engine ECU determines that a malfunction occurred in the ignition system and stops only the injection of fuel into the cylinder with the malfunction.
Camshaft Position Sensor	In case of a signal malfunction (open or short circuit) or a mechanical malfunction, the engine ECU stops the VVT-i control.