## 6. Engine Control System

### General

The engine control system for the 2AD-FTV engine has following systems.

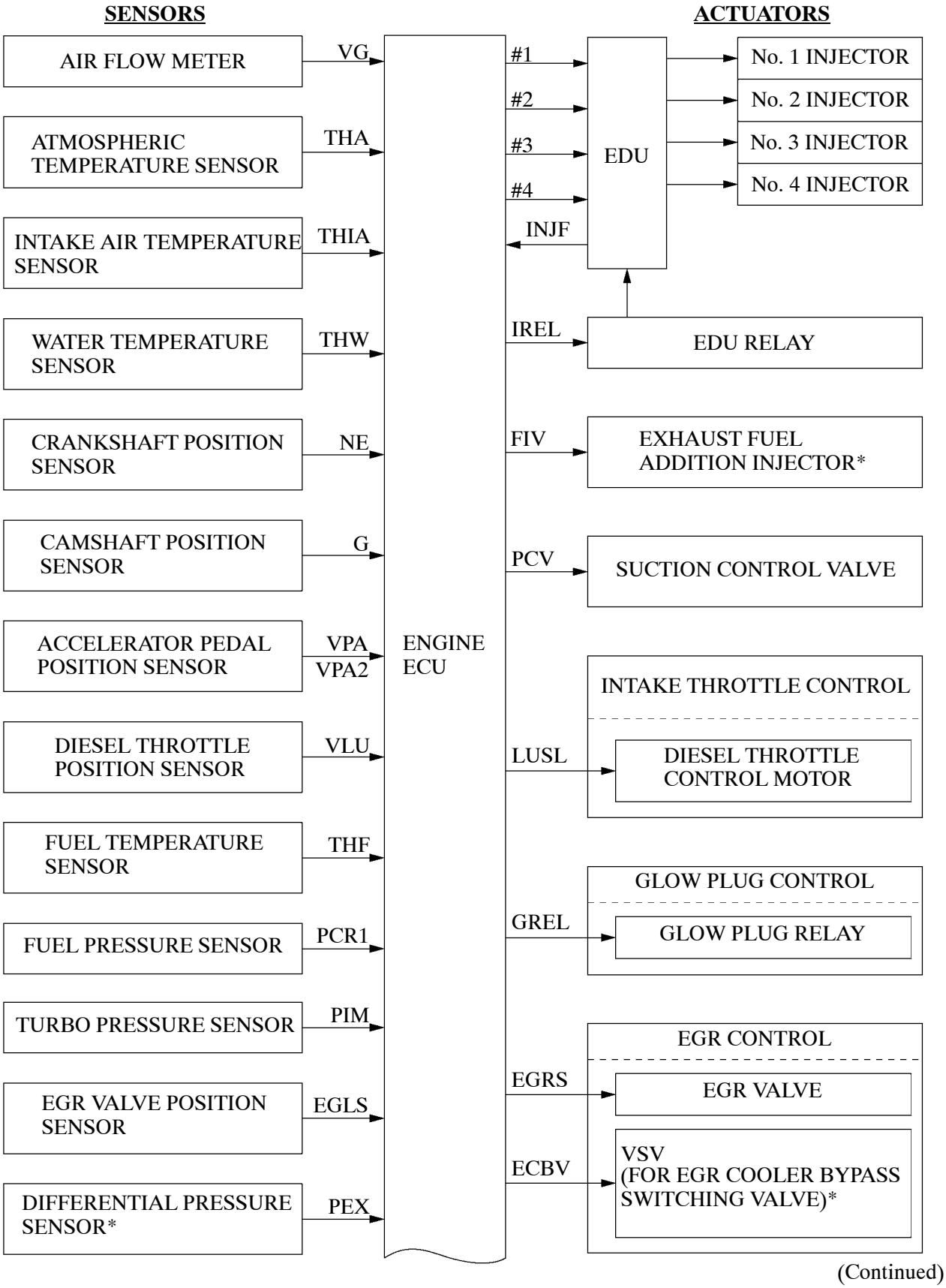
| System | Outline | With DPF | Without DPF |
|---|---|---|---|
| Fuel Injection Volume Control | Based on the signals received from the sensors, the engine ECU determines the fuel injection volume in accordance with the engine condition. | ○ | ○ |
| Fuel Injection Timing Control | Based on the signals received from the sensors, the engine ECU determines the fuel injection timing in accordance with the engine condition. | ○ | ○ |
| Fuel Pressure Control | Based on the signals received from the sensors, the engine ECU controls fuel pressure using the SCV according to engine conditions. | ○ | ○ |
| Pilot Injection Control | Based on the signals received from the various sensors, the engine ECU determines pilot injection volume, timing, and interval (between pilot injection and main injection) in accordance with the engine condition. | ○ | ○ |
| Catalyst Support Control [See page 103] | Based on the signals received from the sensors, the engine ECU controls exhaust fuel addition injector to purify PM. | ○ | — |
| Idle Speed Control | The engine ECU determines the idle speed in accordance with the engine condition, and controls the fuel injection volume in order to maintain the target idle speed. | ○ | ○ |
| Glow Plug Control | Controls the length of time when the current is applied to the glow plugs, in accordance with water temperature. | ○ | ○ |
| EGR Control [See page 104] | Based on the signals received from the sensors, the engine ECU determines the EGR volume via EGR valve and diesel throttle control valve in accordance with the engine condition. | — | ○ |
| | Based on the signals received from the sensors, the engine ECU determines the EGR volume via EGR valve, EGR cooler bypass switching valve and diesel throttle control valve in accordance with the engine condition. | ○ | — |
| Turbo Pressure Control | Based on the signals received from the sensors, the engine ECU controls the actuator via E-VRV in accordance with the engine condition. | ○ | ○ |
| Intake Throttle Control | ● Based on the signals received from the various sensors, the engine ECU determines throttle position in accordance with engine condition.<br>● Fully closes the diesel throttle control valve in order to reduce the vibration when the engine is stopped. | ○ | ○ |

(Continued)

| System | Outline | With DPF | Without DPF |
|---|---|---|---|
| Charging Control | The engine ECU regulates the charging voltage of the alternator in accordance with the driving conditions and the charging state of the battery | ○ | ○ |
| Air-fuel Ratio Sensor Heater Control | Maintains the temperature of the air-fuel ratio sensor at an appropriate level to increase accuracy of detection of the oxygen concentration in the exhaust gas. | ○ | — |
| Air Conditioner Cut-off Control | By controlling the air conditioner compressor ON or OFF in accordance with the engine condition, drivability is maintained. | ○ | ○ |
| Engine Immobilizer | Prohibits fuel injection if an attempt is made to start the engine with an invalid ignition key. | ○ | ○ |
| Oil Maintenance Management System | When the engine ECU determines engine oil deterioration, the engine oil change reminder light turns ON to inform the driver. | ○ | ○ |
| Diagnosis [See page 105] | When the engine ECU detects a malfunction, the engine ECU diagnoses and memorizes the failed section. | ○ | ○ |
| Fail-safe [See page 105] | When the engine ECU detects a malfunction, the engine ECU stops or controls the engine according to the data already stored in the memory. | ○ | ○ |

### Construction

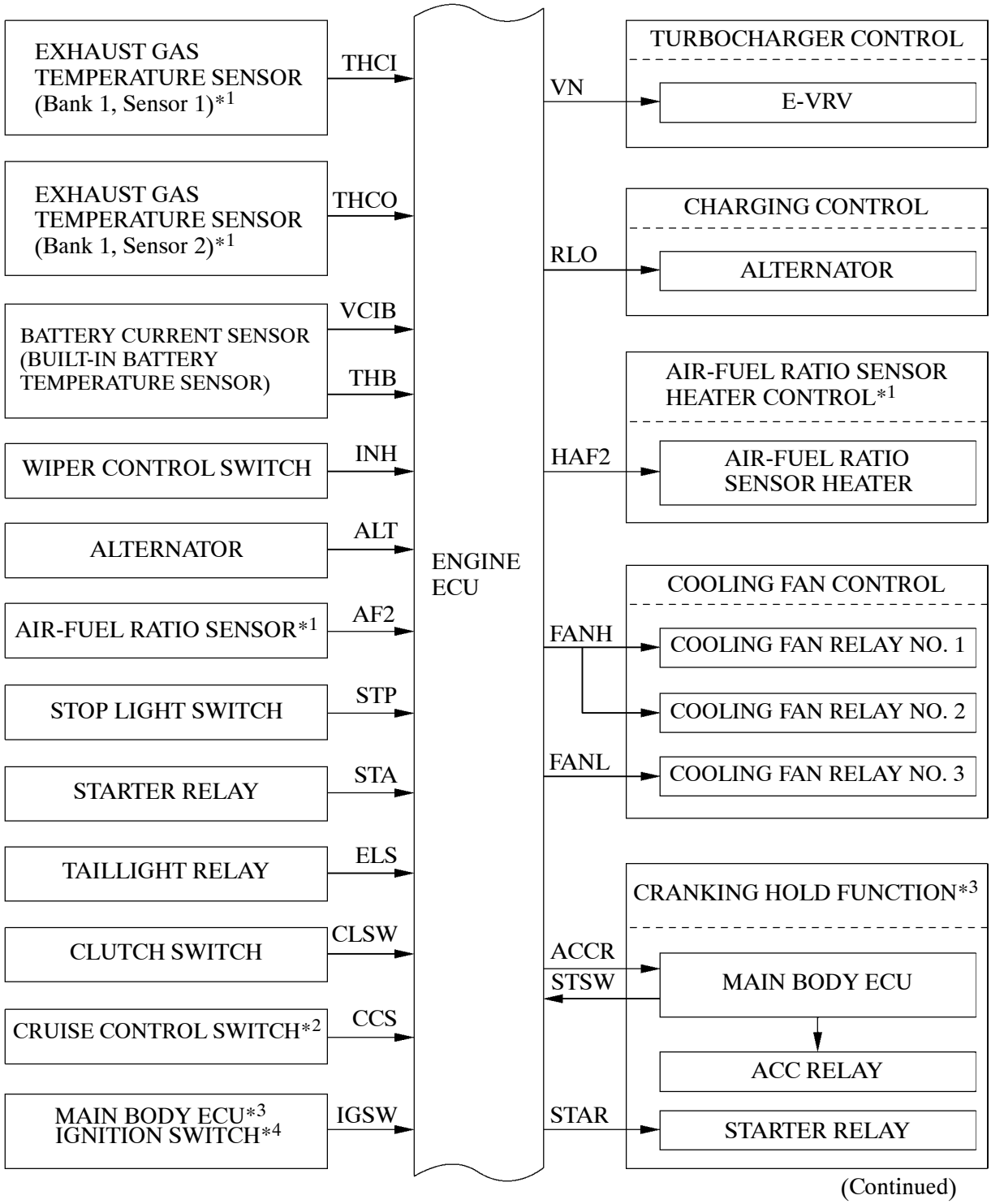
The configuration of the engine control system is as shown in the following chart.




(Continued)

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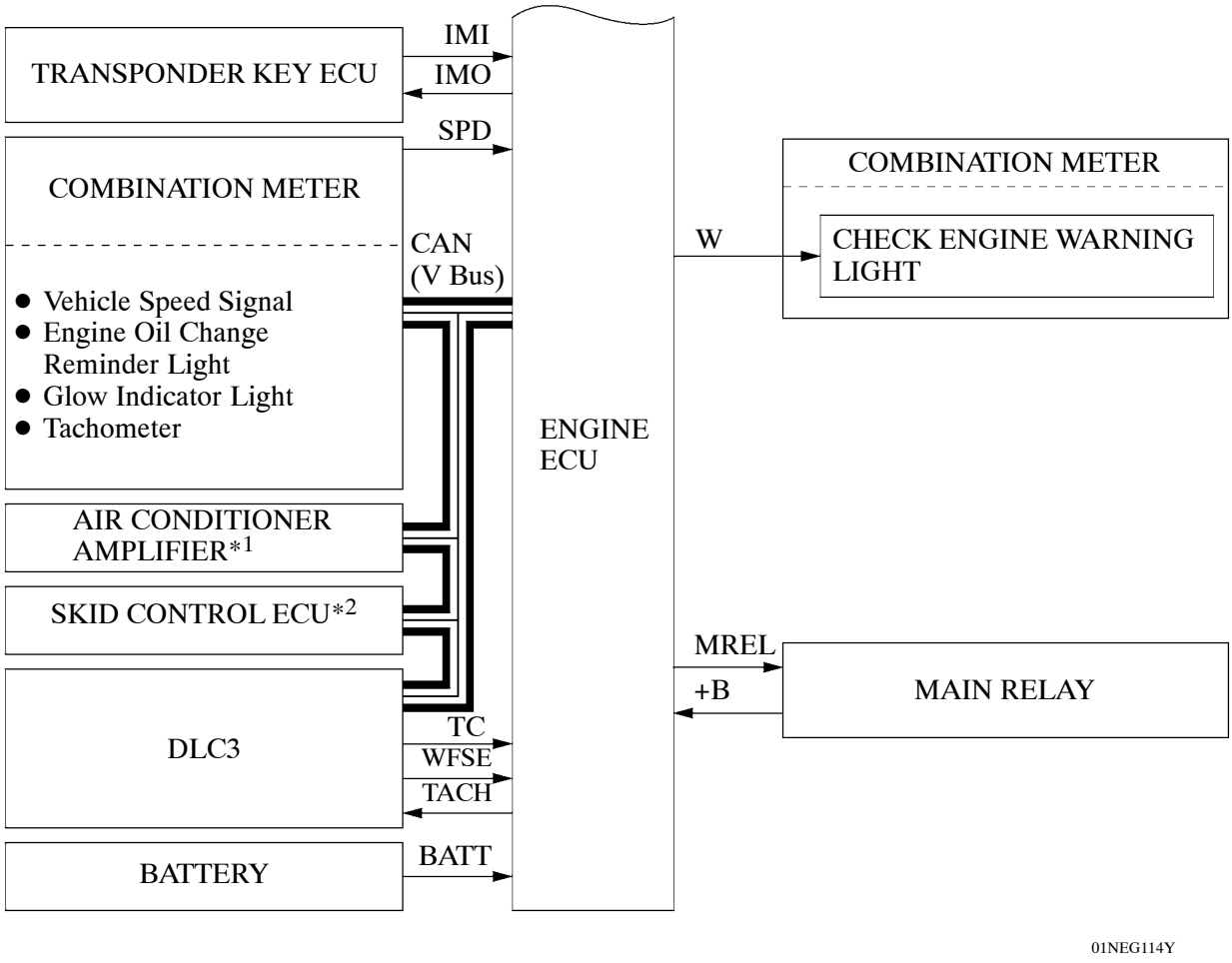
*: Only for DPF Catalyst Models




(Continued)

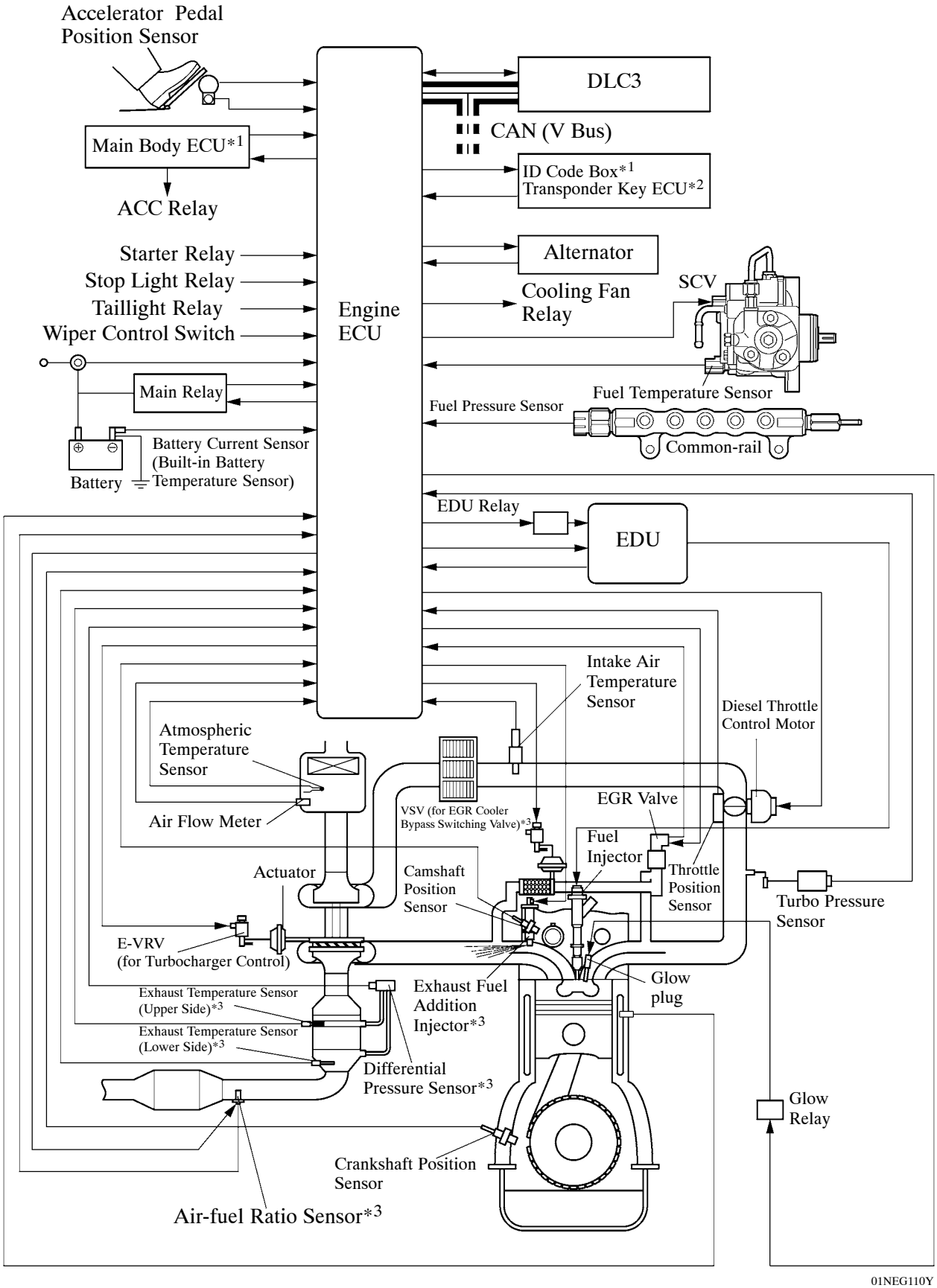
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*1: Only for DPF Catalyst Models
*2: Models with Cruise Control System
*3: Models with Smart Entry & Start System
*4: Models without Smart Entry & Start System




*1: Models with Air Conditioner
*2: Models with VSC (Vehicle Stability Control) System

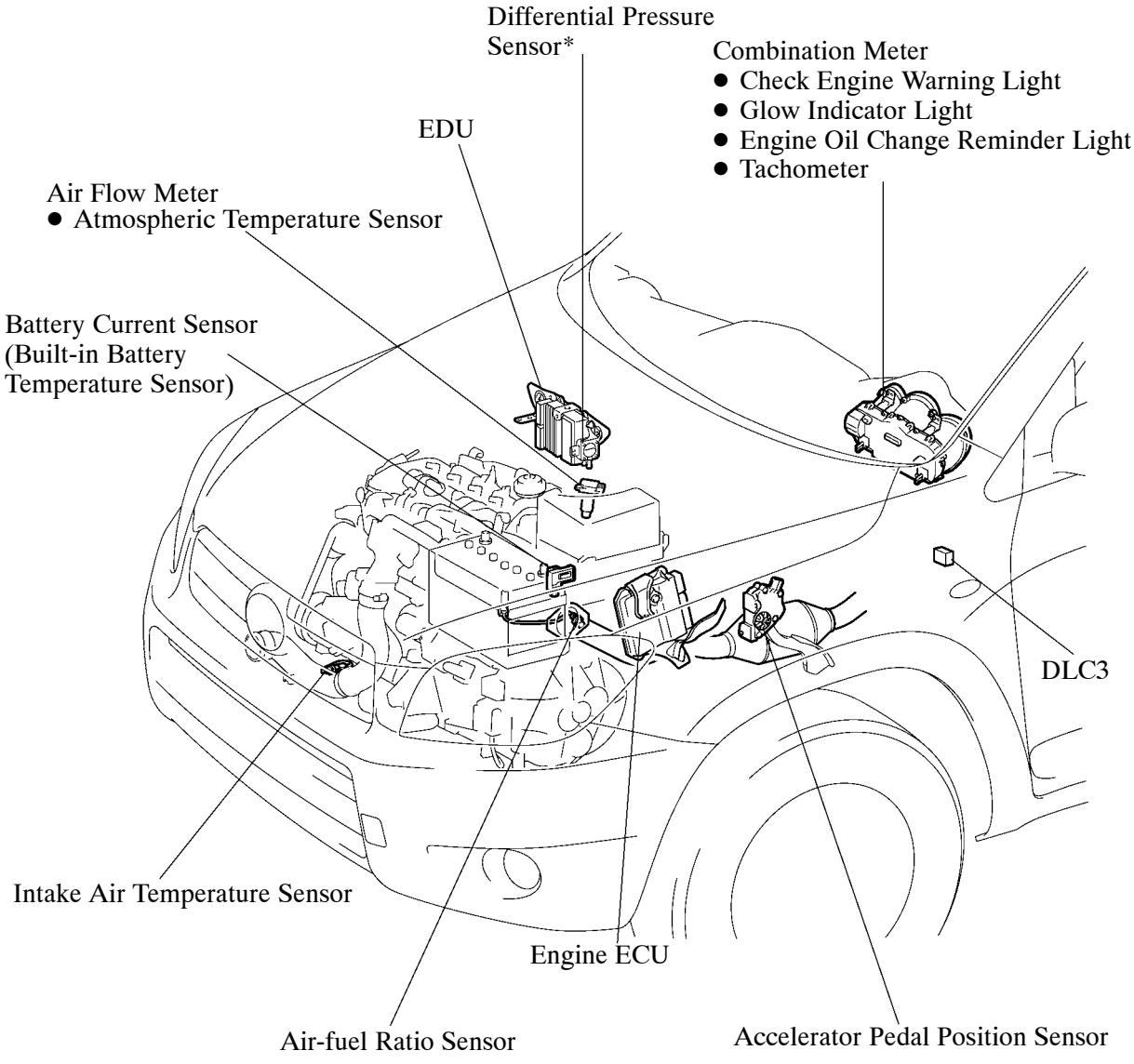
## Engine Control System Diagram



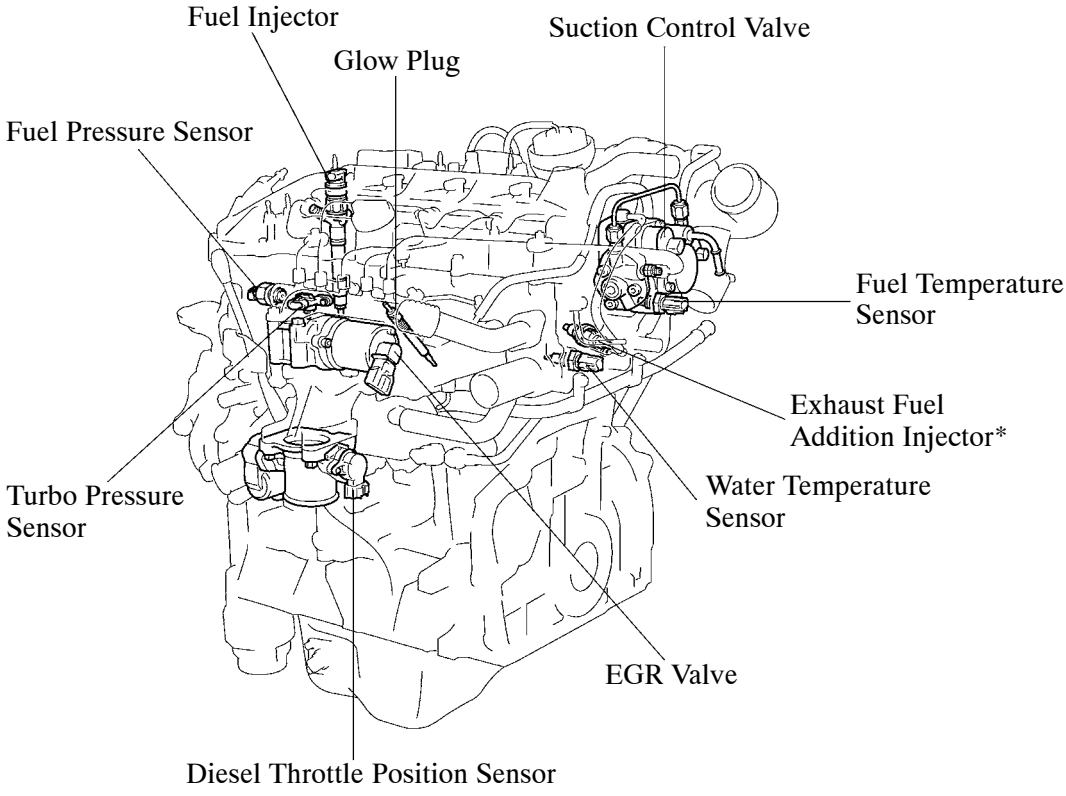

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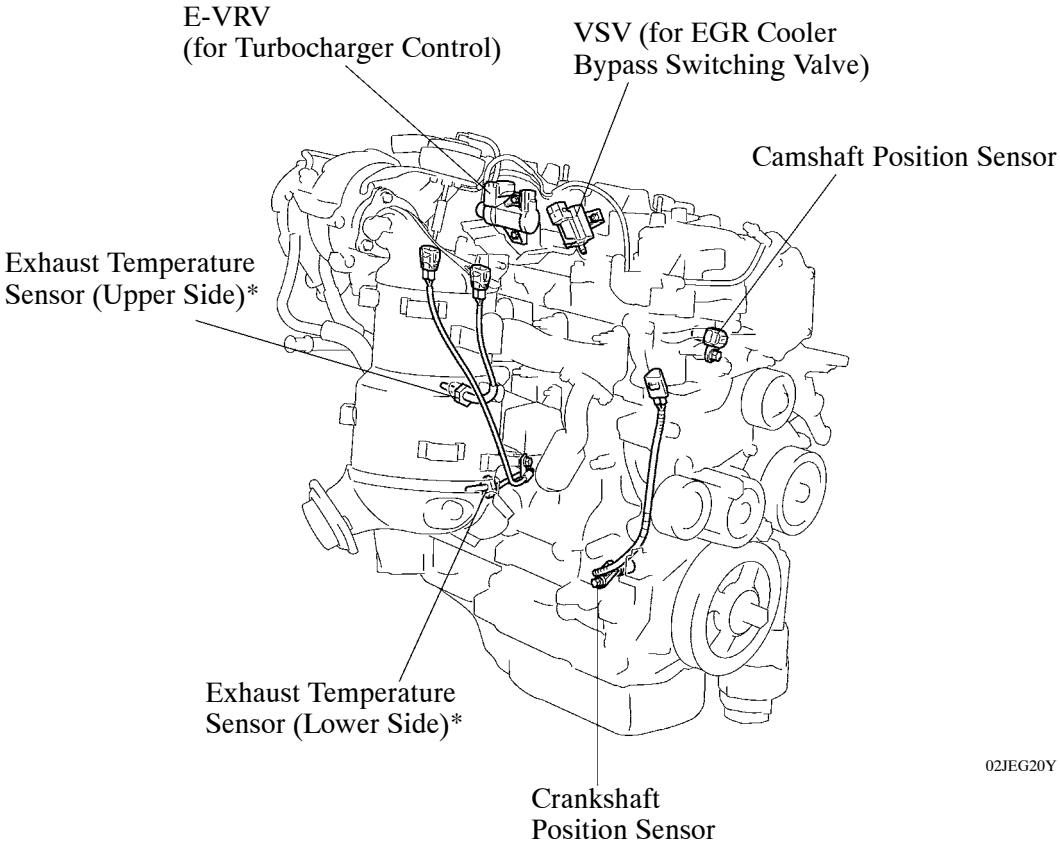
*1: Models with Smart Entry & Start System
*2: Models without Smart Entry & Start System
*3: Only for DPF Catalyst Models

### Layout of Main Components




*: Only for DPF Catalyst Models




*: Only for DPF Catalyst Models

## Main Components of Engine Control System

### 1) General

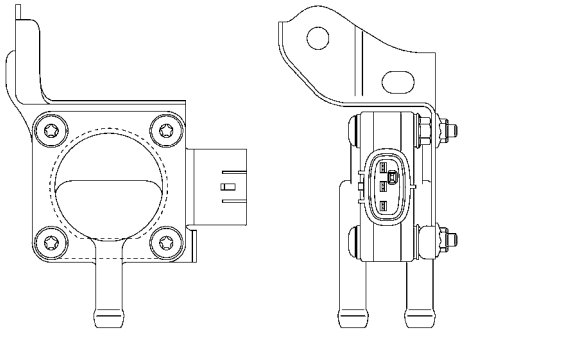
The main components of the 2AD-FTV engine control system are as follows:

| Components | | Outline | Quantity |
|---|---|---|---|
| Engine ECU | | 32-bit CPU | 1 |
| EDU | | Including a built-in DC-DC converter | 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 (1) | 1 |
| Fuel Pressure Sensor | | Semiconductor Strain Gauge Type (One Circuit Type) | 1 |
| Accelerator Pedal Position Sensor | | Non-contact Type | 1 |
| Diesel Throttle Position Sensor | | Non-contact Type | 1 |
| Differential Pressure Sensor* | | Semiconductor Strain Gauge Type | 1 |
| Exhaust Gas Temperature Sensor* | Upper Side | Thermistor Type | 1 each |
| | Lower Side | | |
| Air-fuel Ratio Sensor* | | Type with Heater (Planar Type) | 1 |

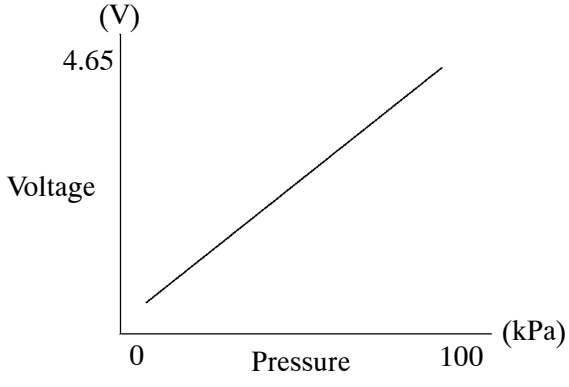
*: Only for DPF Catalyst Models

### 2) Differential Pressure Sensor

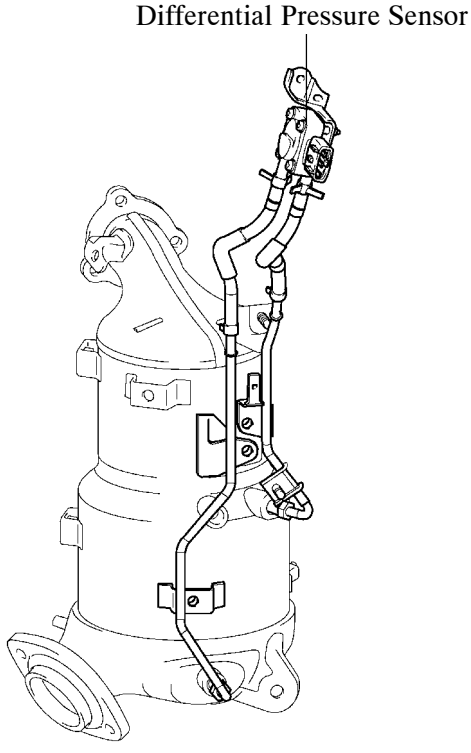
- The differential pressure sensor measures the pressure differences between front and back of the DPF catalyst with PM in order to detect the clogging.
- The sensor is mounted on the cowl, where the effects of vibration are minimal. The DPF catalyst and the sensor are connected with pipes and hoses.



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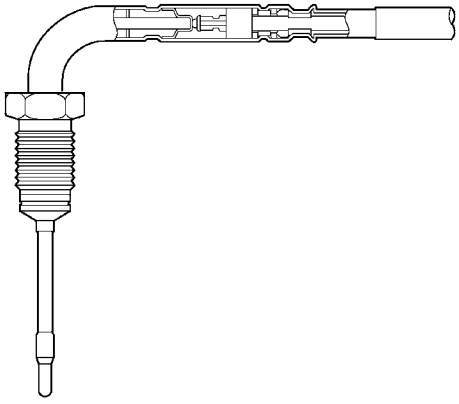

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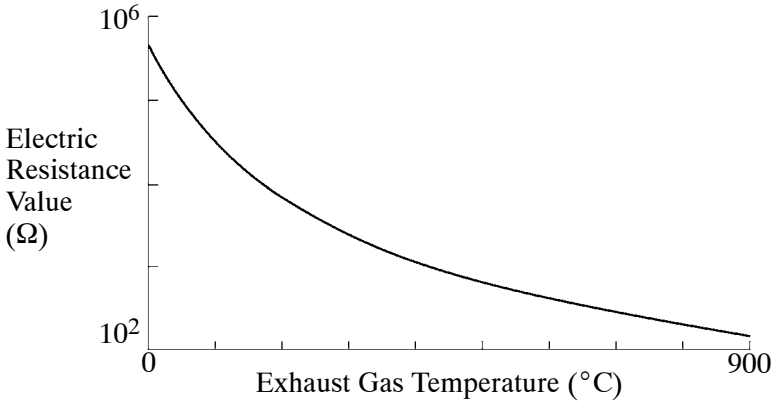

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### 3) Exhaust Gas Temperature Sensor

The exhaust gas temperature sensor, which is a thermistor type, is installed in front and back of the DPF catalyst, in order to detect the temperature of the catalyst.



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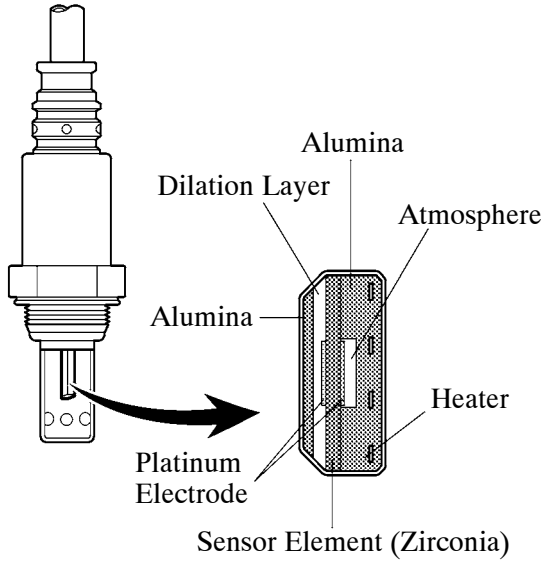



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### 4) Air-fuel Ratio Sensor

#### a. General

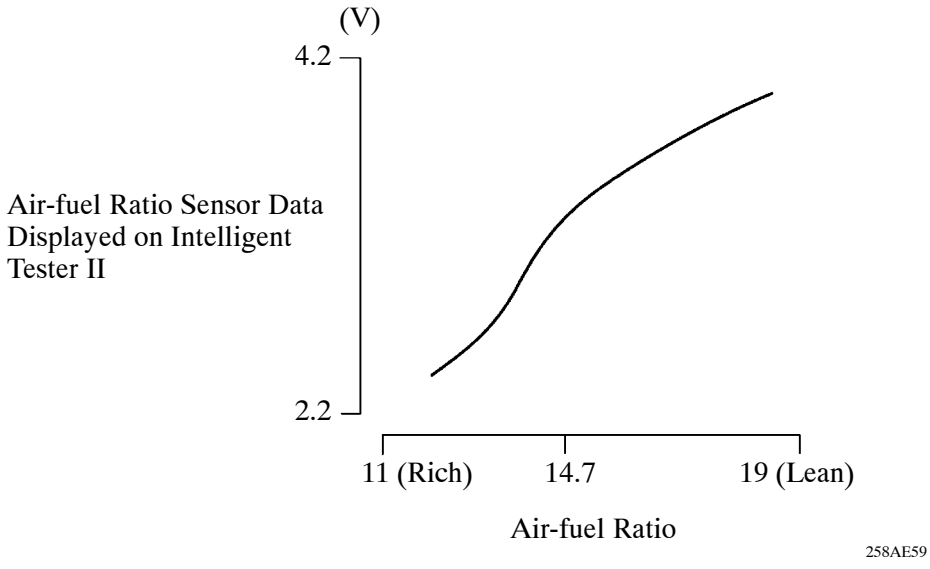
- The planar type air-fuel ratio sensor is used.
- The planar type air-fuel ratio sensor uses alumina, which excels in heat conductivity and insulation, to integrate a sensor element with a heater, thus improving the warm-up performance of the sensor.
- This sensor is based on a sensor that is developed for gasoline engines. Its cover is changed for diesel engine applications in order to eliminate the influences of the sensor temperature and the PM. This sensor, which is mounted after the DPF catalyst, detects the air-fuel ratio after the gases is reduced.




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**b. Characteristics**

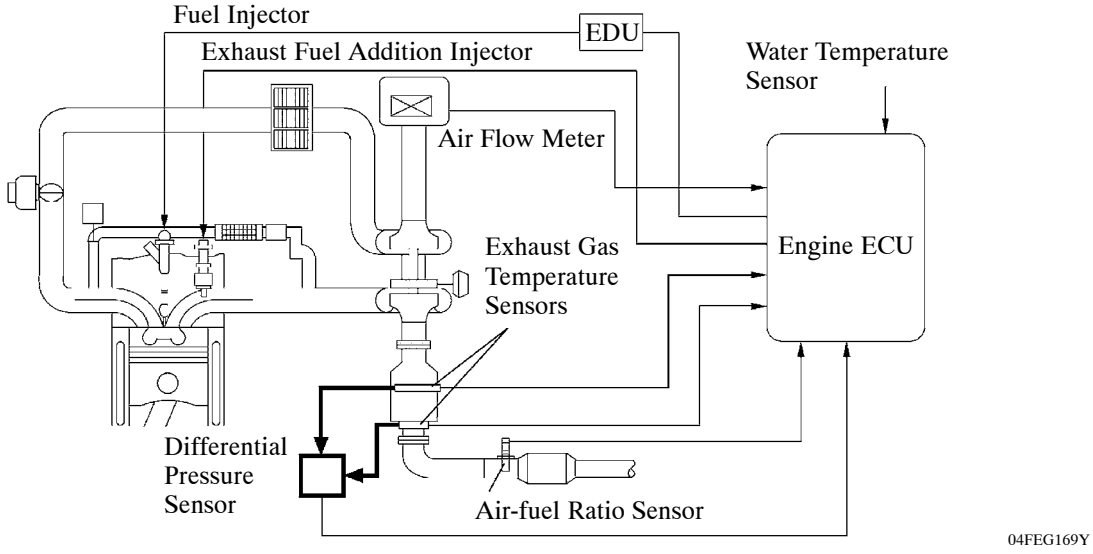
The air-fuel ratio sensor and the heated oxygen sensor differ in output characteristics.
The air-fuel ratio sensor data is approximately proportionate to the existing air-fuel ratio. The air-fuel ratio sensor converts the oxygen density to the current and sends it to the engine ECU.
As a result, the detection precision of the air-fuel ratio has been improved. The air-fuel ratio sensor data is read out by an intelligent tester II.



## Catalyst Support Control

### 1) General

The engine ECU judges manifold converter condition based on injection volume, engine speed and signals from the air flow meter, water temperature sensor, two exhaust gas temperature sensors, and differential pressure sensor to control the fuel injectors and exhaust fuel addition injector for catalyst support control.




### 2) PM Reduction Control

If the DPF catalyst temperature becomes low, catalyst performance decreases, resulting in an increase of the amount of PM stuck in the filter substrate. The engine ECU detects that the filter substrate is clogged by calculating the accumulated volume of the PM discharged by the engine. To reduce PM, the engine ECU controls the injection timing and the injection frequency of the injectors, and activates the exhaust addition injector.

- At the same time, filter substrate temperature becomes high and PM reacts with oxygen and changes into $CO_2$ for purification.
- Fuel efficiency drops during this control.

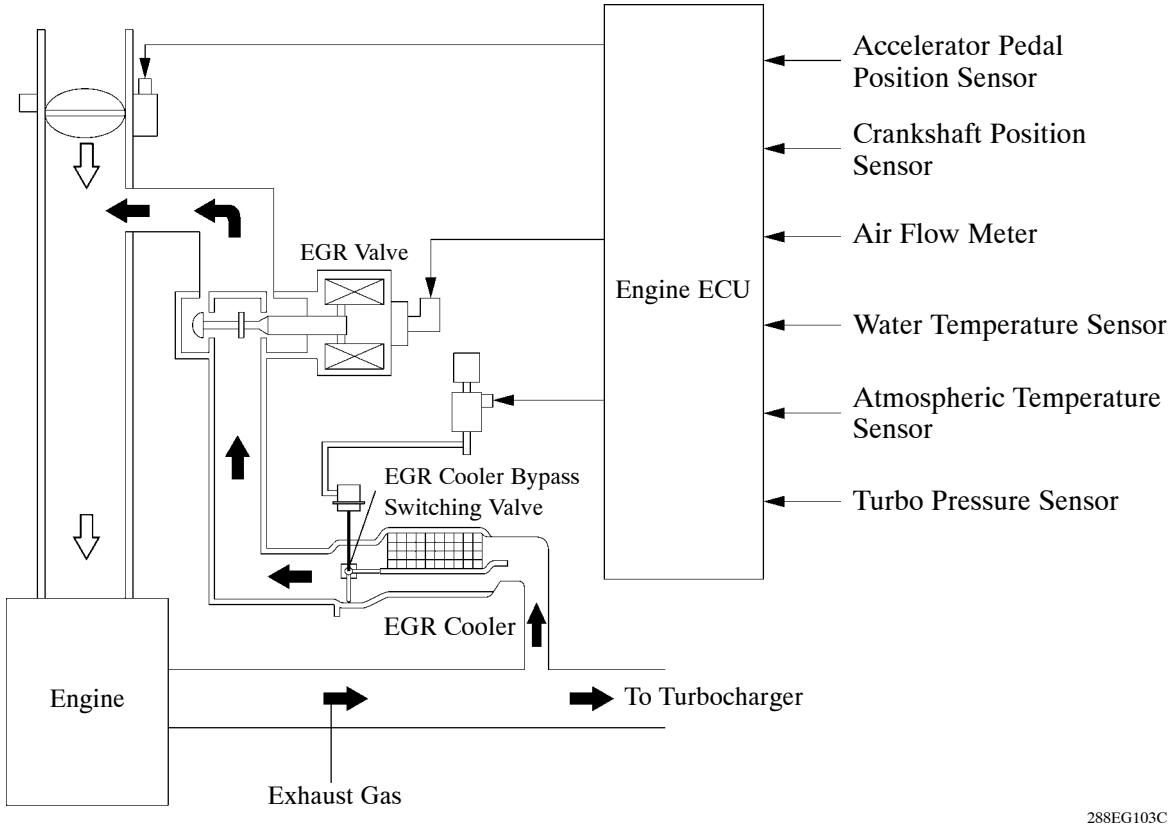
**Service Tip**

- When replacing the exhaust manifold converter with a new one, it is necessary to perform initialization of the DPF catalyst deteriorate data history in the engine ECU by using the intelligent tester II.
- When replacing the engine ECU with a new one, it is necessary to read DPF catalyst deteriorate data history from the installed engine ECU and then transfer that data history to the new engine ECU by using the intelligent tester II. When the DPF catalyst deteriorate data history is not transferred, DTC (Diagnostic Trouble Code) P1601 is stored in the engine ECU, and the check engine warning light comes ON.
- When replacing both the exhaust manifold converter and the engine ECU, it is necessary to perform initialization of the DPF catalyst deteriorate data history in the engine ECU using the intelligent tester II. When DPF catalyst deteriorate history initialization is not performed, DTC (Diagnostic Trouble Code) P1601 is stored in the engine ECU and the check engine warning light comes ON.

For details, refer to the RAV4 Repair Manual Supplement.

## EGR Control

By sensing the engine driving conditions, the engine ECU operates the EGR valve, diesel throttle control motor and VSV (for EGR cooler bypass switching valve) and regulates the amount of EGR gas.



### Diagnosis

- The diagnosis uses the EURO-OBD (Europe On-Board Diagnosis) that complies with European regulations.
- When the engine ECU detects a malfunction, the engine ECU makes DTCs (Diagnostic Trouble Codes) and memorizes the failed section. Furthermore, the check engine warning light in the combination meter illuminates to inform the driver.
- The engine ECU will also store the DTCs (Diagnostic Trouble Codes) of the malfunctions. The DTC can be accessed by using the intelligent tester II.
- For details, refer to the RAV4 Repair Manual Supplement.

**Service Tip**

To clear the DTC that is stored in the engine ECU, use an intelligent tester II, disconnect the battery terminal or remove the EFI fuse for 1 minute or longer.

### Fail-safe

When a malfunction is detected by any of the sensors, there is a possibility of an engine or other malfunction occurring if the engine ECU were to continue to control the engine control system in the normal way. To prevent such a problem, the fail-safe function of the engine ECU 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 RAV4 Repair Manual Supplement.