■ENGINE CONTROL SYSTEM

1. General

The following list shows engine control comparison between 2AD-FHV engine and 2AD-FTV engine. The engine ECU that controls these system is made by DENSO.

System	Outline	2AD-FHV	2AD-FTV
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 (See page EG-140)	Based on the signals received from the sensors, the engine ECU controls fuel pressure using the SCV (Suction Control Valve) and pressure discharge valve according to the engine condition.	○	—
	Based on the signals received from the sensors, the engine ECU controls fuel pressure using the SCV according to the engine condition.	—	○
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 EG-141)	Based on the signals received from the sensors, the engine ECU controls exhaust fuel addition injector to purify NOx, PM and sulfur.	○	—
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 EG-143)	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.	○	○

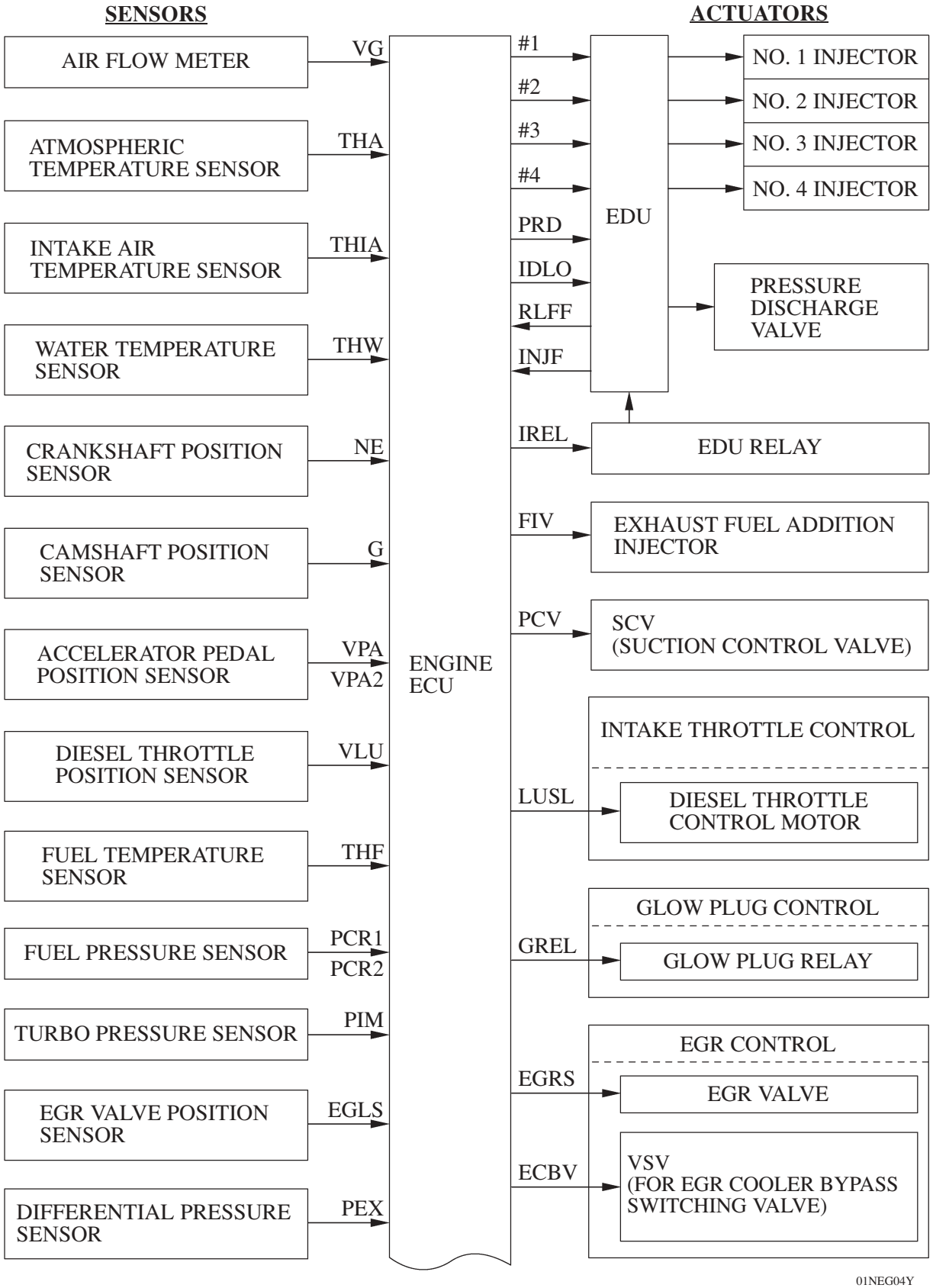
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System	Outline	2AD-FHV	2AD-FTV
Intake Throttle Control	Based on the signals received from the various sensors, the engine ECU determines diesel throttle control valve position in accordance with engine condition.	○	○
	Fully closes the diesel throttle control valve in order to reduce the vibration when the engine is stopped.	○	○
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.	○	○
Cooling Fan Control (See page EG-53)	Cooling fan operation is controlled by signals from the engine ECU based on the water temperature sensor signal and the condition of the air conditioner operation.	○	○
Engine Immobilizer	Prohibits fuel injection if an attempt is made to start the engine with an invalid key.	○	○
Cranking Hold Function* (Starting Control) (See page EG-55)	Once the engine switch is pushed, this control continues to operate the starter until the engine is started.	○	○
Charging Control (See page EG-57)	The engine ECU regulates the charging voltage of the alternator in accordance with the driving conditions and the charging state of the battery.	○	○
Oil Maintenance Management System (See page EG-105)	When the engine ECU determines engine oil and oil filter deterioration, the master warning light and engine oil change reminder light turn on to inform the driver.	○	○
Diagnosis (See page EG-107)	When the engine ECU detects a malfunction, the engine ECU diagnoses and memorizes the failed section.	○	○
Fail-safe (See page EG-144)	When the engine ECU detects a malfunction, the engine ECU stops or controls the engine according to the data already stored in the memory.	○	○

*: Models with Smart Entry & Start System

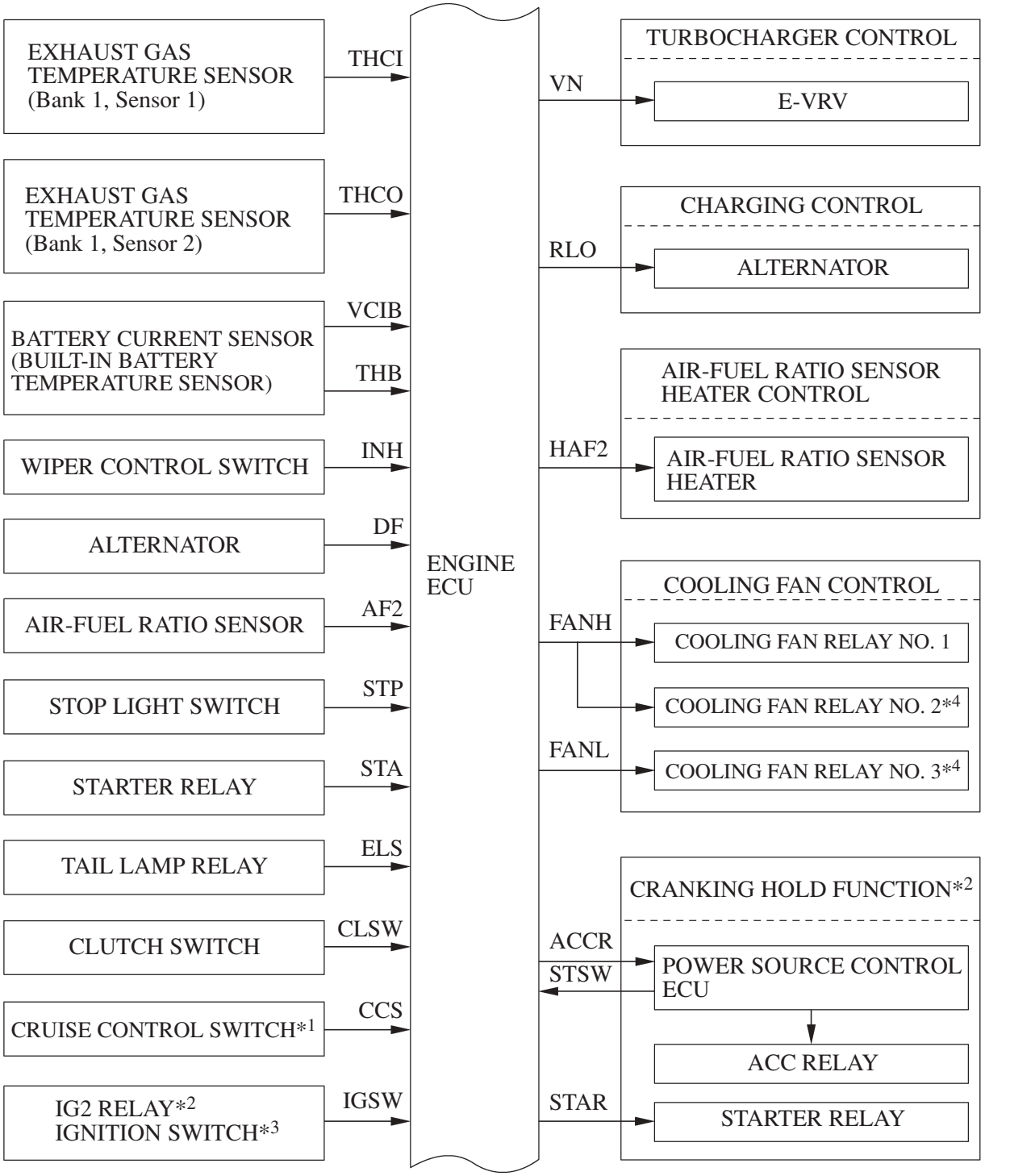
2. Construction

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



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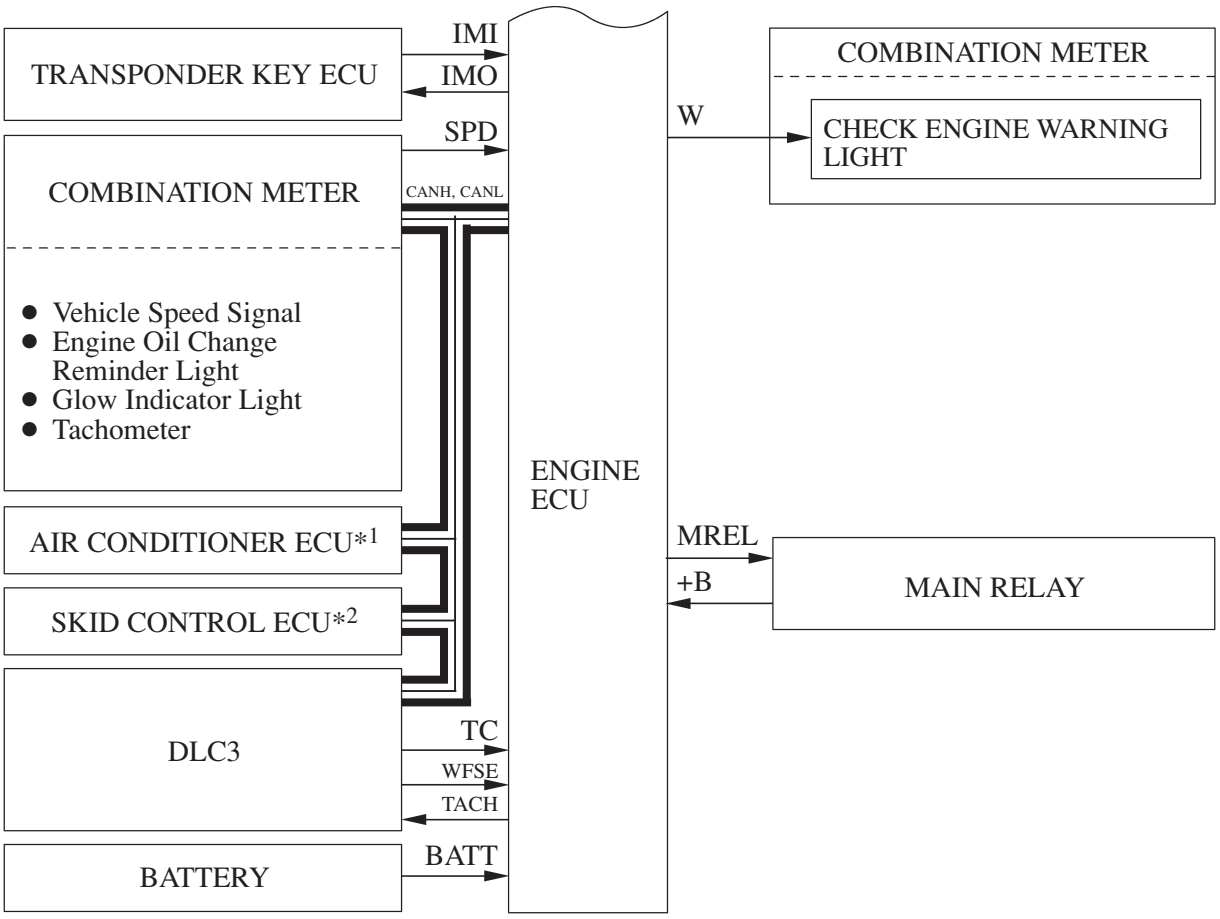
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*1: Models with Cruise Control System
*2: Models with Smart Entry & Start System
*3: Models without Smart Entry & Start System
*4: Models with Air Conditioner



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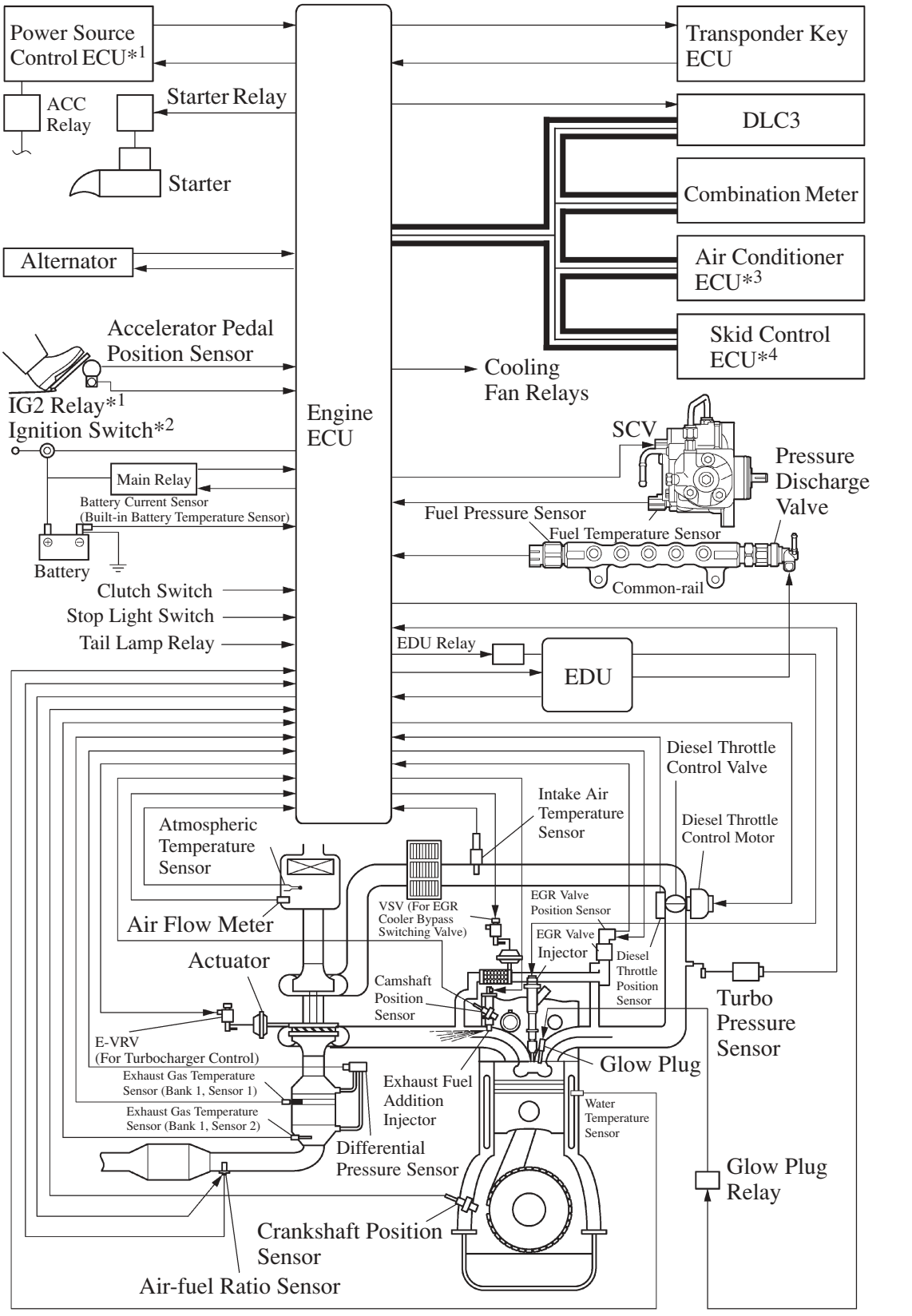
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*1: Models with Air Conditioner

*2: Models with Vehicle Stability Control System

EG

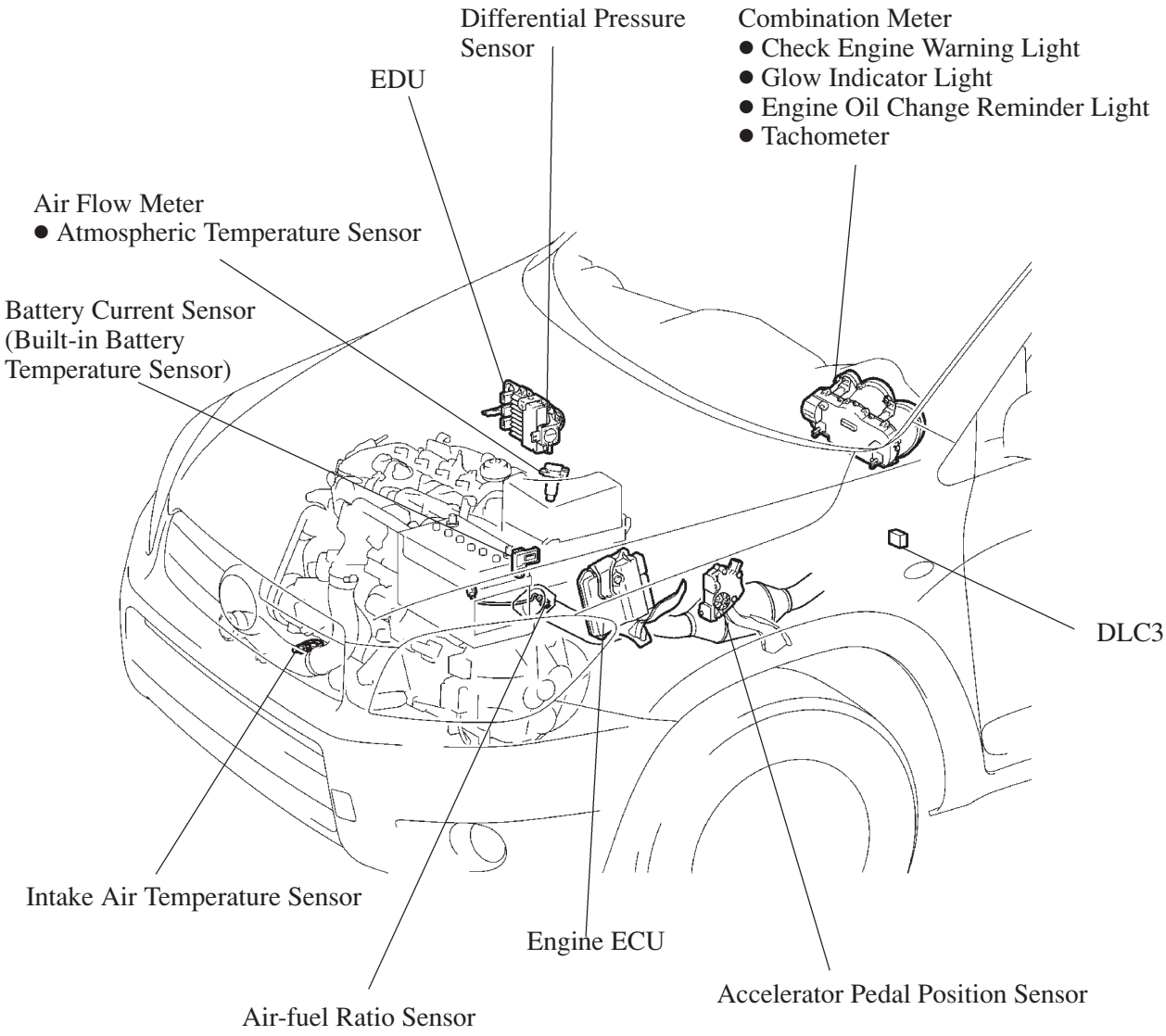
3. Engine Control System Diagram



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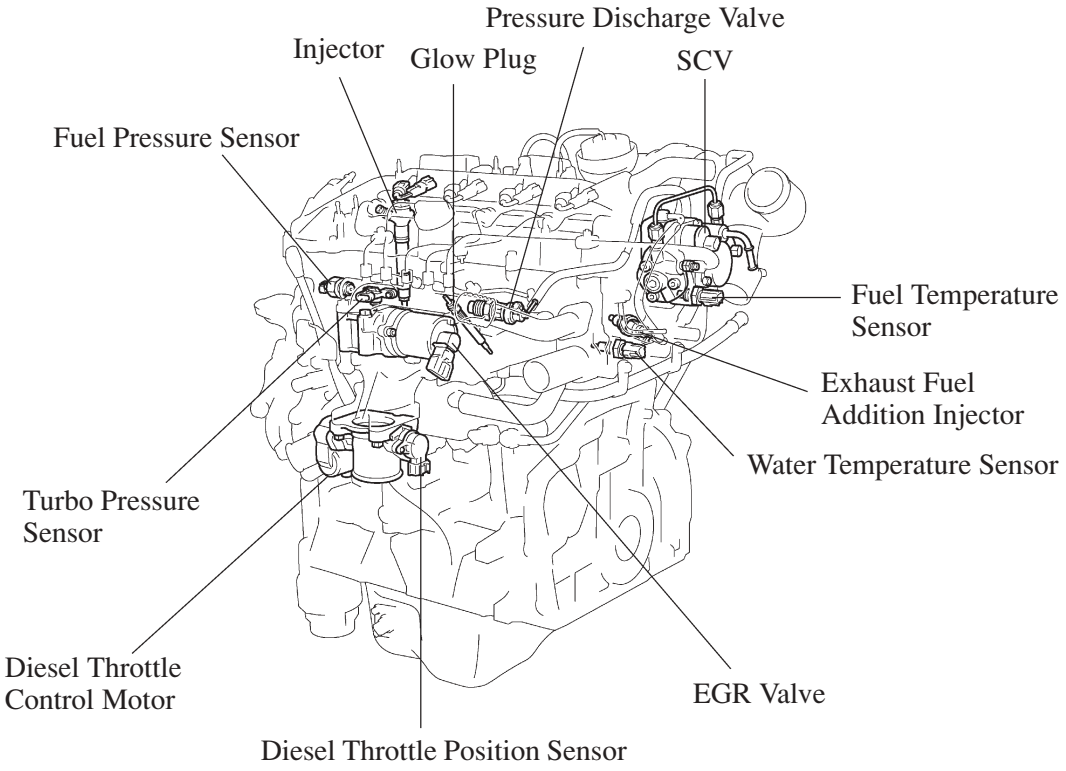
*1: Models with Smart Entry & Start System
*2: Models without Smart Entry & Start System
*3: Models with Air Conditioner
*4: Models with Vehicle Stability Control System

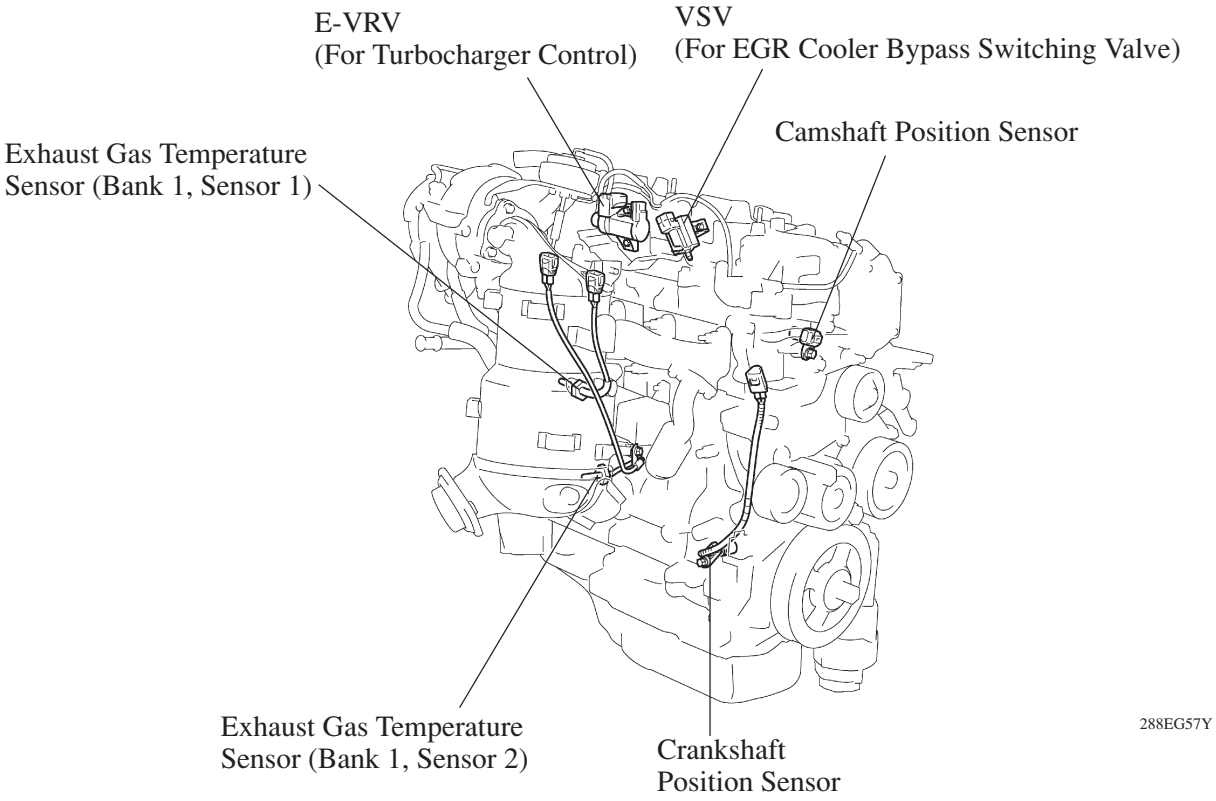
4. Layout of Main Components



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EG


Pressure Discharge Valve
Injector
Glow Plug
SCV
Fuel Pressure Sensor
Fuel Temperature Sensor
Exhaust Fuel Addition Injector
Water Temperature Sensor
Turbo Pressure Sensor
Diesel Throttle Control Motor
EGR Valve
Diesel Throttle Position Sensor


E-VRV
(For Turbocharger Control)
VSV
(For EGR Cooler Bypass Switching Valve)
Camshaft Position Sensor
Exhaust Gas Temperature Sensor (Bank 1, Sensor 1)
Exhaust Gas Temperature Sensor (Bank 1, Sensor 2)
Crankshaft Position Sensor
288EG57Y

5. Main Components of Engine Control System

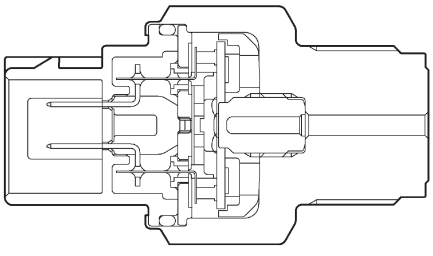
General

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

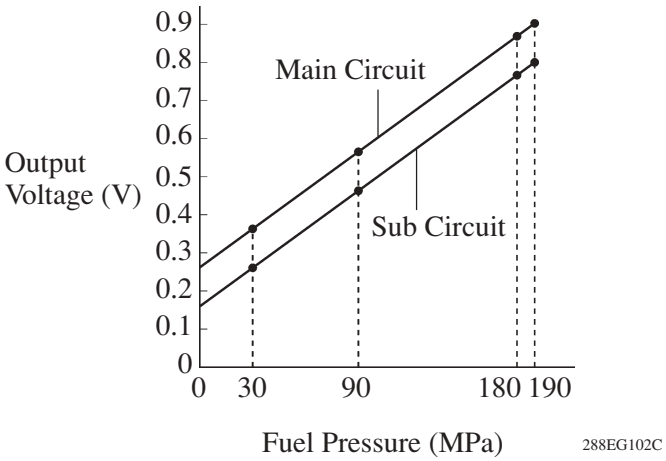
Components		Outline	Quantity
Engine ECU		32-bit CPU	1
EDU		Including a Built-in DC-DC Converter	1
Air Flow Meter		Hot-wire Type	1
Crankshaft Position Sensor (Rotor Teeth)		Pick-up Coil Type (36-2)	1
Camshaft Position Sensor (Rotor Teeth)		Pick-up Coil Type (1)	1
Fuel Pressure Sensor		Semiconductor Strain Gauge Type (Two Circuits 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	Bank 1, Sensor 1	Thermistor Type	1 each
	Bank 1, Sensor 2		
Air-fuel Ratio Sensor		Type with Heater (Planar Type)	1

Fuel Pressure Sensor

- The fuel pressure sensor outputs a signal that represents the fuel pressure in the common-rail to the engine ECU in order to constantly regulate the fuel at an optimal pressure.
- The fuel pressure sensor contains two circuits (main and sub), which enable the engine ECU to constantly compare the values detected by the two circuits. As a result, highly precise values can be detected, which also enable a higher level of fail-safe control.



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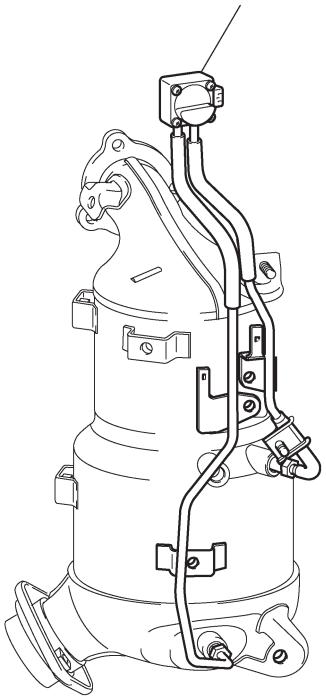


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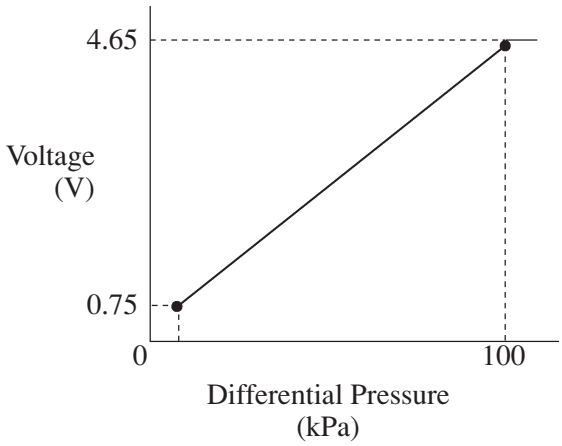
Differential Pressure Sensor

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

Differential Pressure Sensor



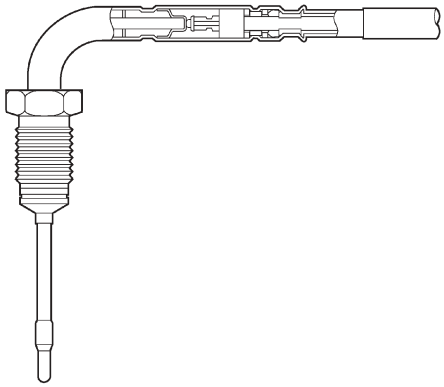
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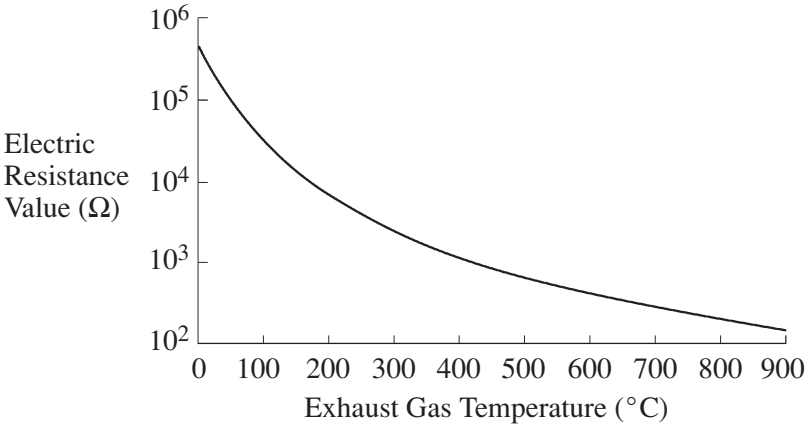
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Exhaust Gas Temperature Sensor

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



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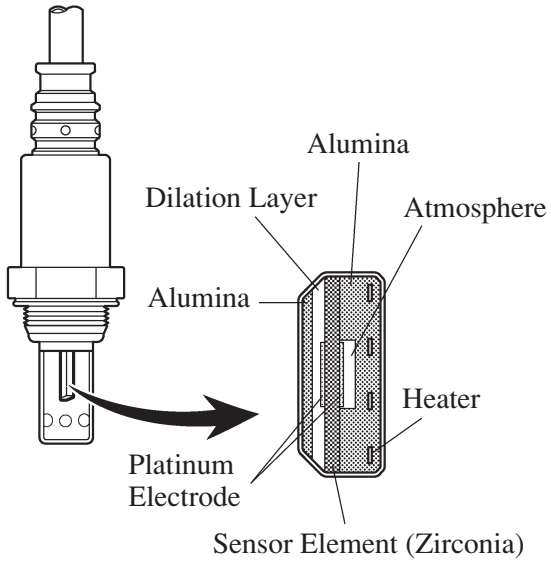


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Air-fuel Ratio Sensor

1) General

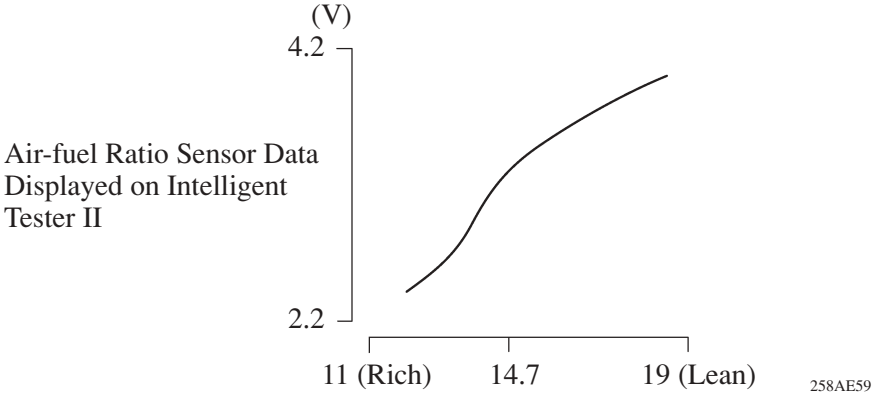
- The planar type air-fuel ratio sensor is used.
- The planar type air-fuel ratio sensor uses alumina, which excels in heat conductivity and insulation, to integrate a sensor element with a heater, thus improving the warm-up performance of the sensor.
- This sensor is based on a sensor that is developed 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 DPNR catalyst, detects the air-fuel ratio of gases which are purified through the DPNR catalyst.



Air-fuel Ratio Sensor (Planar Type) 288EG86Y

2) Characteristics

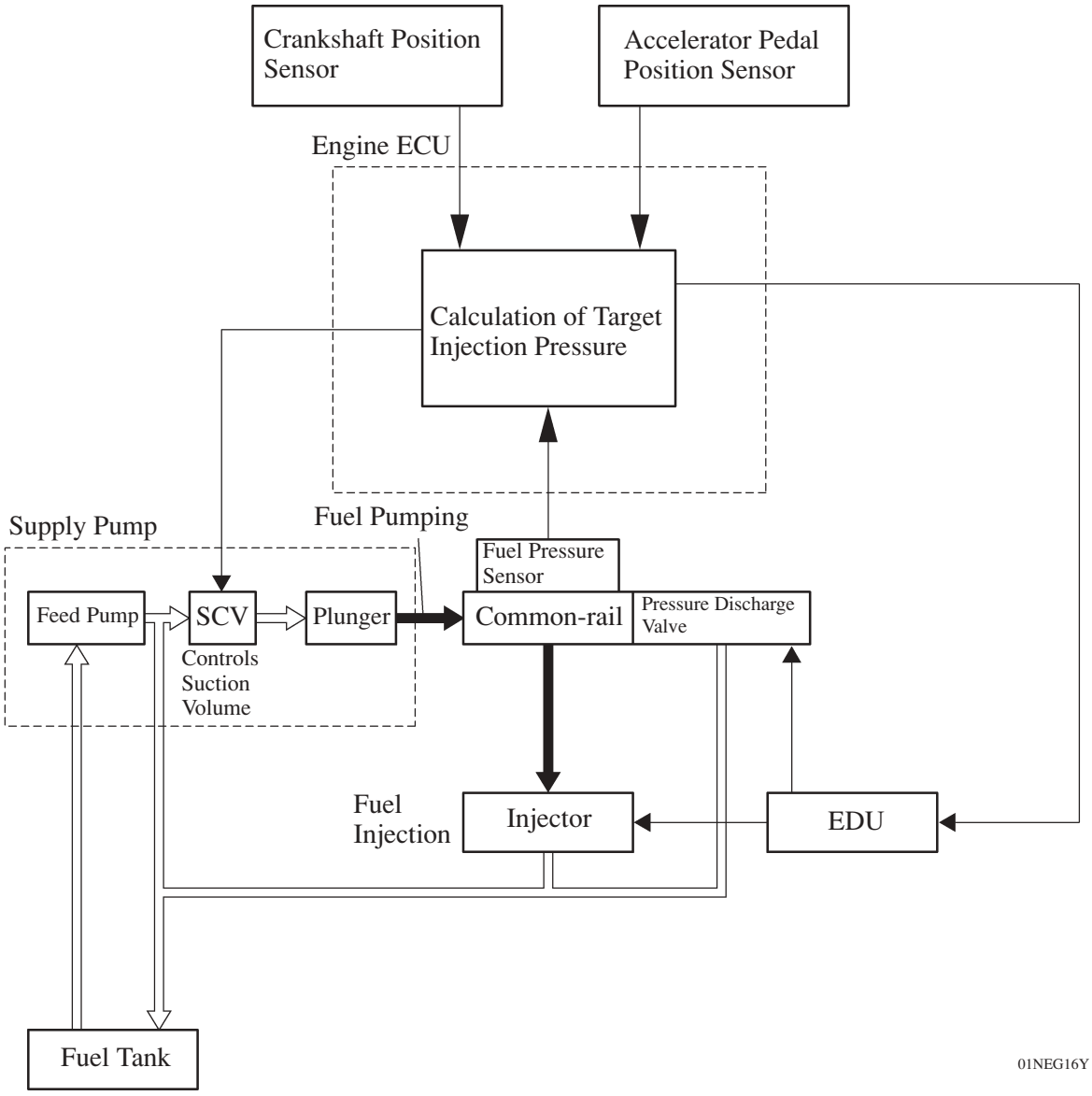
The air-fuel ratio sensor and the heated oxygen sensor differ in output characteristics.
The air-fuel ratio sensor data is approximately proportionate to the existing air-fuel ratio. The air-fuel ratio sensor converts the oxygen density to the current and sends it to the engine ECU.
As a result, the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



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6. Fuel Pressure Control

Engine ECU calculates the target injection pressure (25 – 180 MPa) based on the engine conditions which are the signals from the accelerator pedal position sensor and the crankshaft position sensor.
To control fuel pressure, signals sent to SCV (Suction Control Valve) of the supply pump regulate the suction volume and signals sent to pressure discharge valve of the common-rail regulate the discharge volume, so that the pressure detected by the fuel pressure sensor matches the target injection pressure.

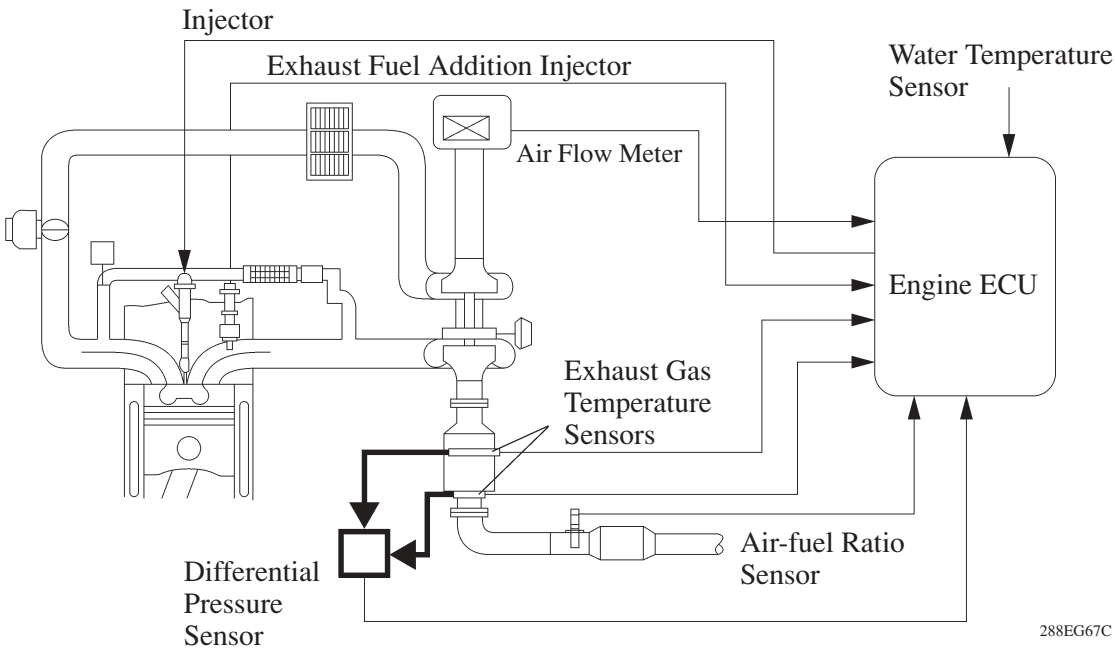


7. Catalyst Support Control

General

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

- The catalyst support control consists of the NOx reduction control, PM reduction control, and sulfur poison recovery control.



NOx Reduction Control

The engine ECU calculates the amount of NOx in the catalytic converter based on fuel injection volume, intake air mass, and exhaust gas temperature and operates the injectors and exhaust fuel addition injector for NOx reduction control.
As a result of these injectors, the air-fuel ratio in the exhaust gas becomes rich to purify NOx.

- Fuel efficiency momentarily drops during this control.

PM Reduction Control

If the DPNR catalyst temperature becomes low, catalytic converter performance decreases, resulting in an increase of the amount of PM stuck in the filter substrate. When the engine ECU detects clogs in the filter substrate based on engine operating condition and signals from the differential pressure sensor, it operates the injectors and exhaust fuel addition injector for PM reduction.

- As a result of these injectors, the air-fuel ratio in the exhaust gas becomes rich and active oxygen is generated by NOx reduction control.
- At the same time, filter substrate temperature becomes high and PM reacts with active oxygen and changes into CO_2 for purification.
- Fuel efficiency drops during this control.

Sulfur Poison Recovery Control

The engine ECU calculates the sulfur volume in the catalytic converter based on the accumulated data of fuel injection volume and operates the injectors and exhaust fuel addition injector for sulfur position recovery control.
As a result of these injectors, the air-fuel ratio in the exhaust gas becomes rich for sulfur purification.

- Fuel efficiency drops during this control.

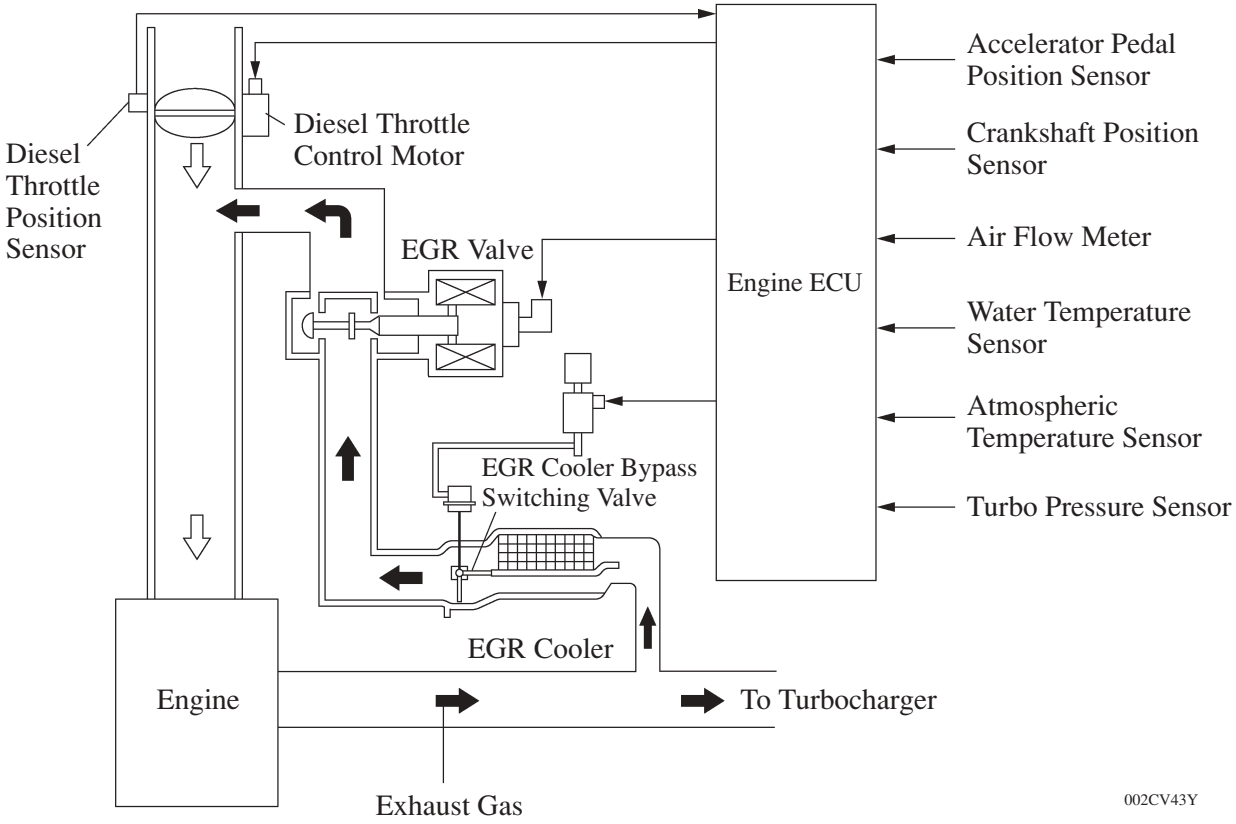
Service Tip

- When replacing the exhaust manifold converter with a new one, it is necessary to perform initialization of the DPNR 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 DPNR 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 DPNR 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 DPNR catalyst deteriorate data history in the engine ECU using the intelligent tester II. When DPNR catalyst deteriorate history initialization is not performed, DTC P1601 is stored in the engine ECU and the check engine warning light comes on.

For details, refer to the RAV4 Repair Manual (Pub. No. RM01N0E).

8. 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.



9. Fail-safe

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 Chart ◀

DTC	Fail-safe Operation	Fail-safe Deactivation Conditions
P0087	Limits the engine power.	Engine switch OFF*1 / Ignition switch OFF*2
P0088	Limits the engine power.	Engine switch OFF*1 / Ignition switch OFF*2
P0093	After shunt driving control is performed for 1 minute, engine stalls.	Engine switch OFF*1 / Ignition switch OFF*2
P0095, P0097, P0098	Intake air (intake manifold) temperature is fixed at 145°C (293°F).	“Pass” condition detected
P0100, P0102, P0103	Limits the engine power.	“Pass” condition detected
P0105, P0107, P0108	Turbo pressure is fixed value.	“Pass” condition detected
P0110, P0112, P0113	Intake air (air flow meter) temperature is fixed value.	“Pass” condition detected,
P0115, P0117, P0118	Fuel temperature is fixed at specified value.	“Pass” condition detected
P0120, P0122, P0123	Limits the engine power.	Engine switch OFF*1 / Ignition switch OFF*2
P0168	Limits the engine power.	“Pass” condition detected
P0180, P0182, P0183	Fuel temperature is fixed at 40°C (104°F).	“Pass” condition detected
P0190, P0191, P0192, P0193	Limits the engine power.	Engine switch OFF*1 / Ignition switch OFF*2
P0200	Limits the engine power.	Engine switch OFF*1 / Ignition switch OFF*2
P0234	Limits the engine power.	Engine switch OFF*1 / Ignition switch OFF*2
P0335	Limits the engine power.	“Pass” condition detected
P0340	Limits the engine power.	“Pass” condition detected
P0400	Limits the engine power.	Engine switch OFF*1 / Ignition switch OFF*2
P0405, P0406 P0488	Limits the engine power.	Engine switch OFF*1 / Ignition switch OFF*2

*1: Models with Smart Entry & Start System

*2: Models without Smart Entry & Start System

(Continued)

DTC	Fail-safe Operation	Fail-safe Deactivation Conditions
P0500	Vehicle speed is fixed at 0 km/h (0 mph).	"Pass" condition detected
P0544, P0545 P0546	Limits the engine power.	Engine switch OFF*1/ Ignition switch OFF*2
P0627	Limits the engine power.	"Pass" condition detected
P1229	Limits the engine power.	Engine switch OFF*1/ Ignition switch OFF*2
P1251	Limits the engine power.	Engine switch OFF*1/ Ignition switch OFF*2
P1271	Limits the engine power.	Engine switch OFF*1/ Ignition switch OFF*2
P1272	Limits the engine power.	Engine switch OFF*1/ Ignition switch OFF*2
P1386	● Low or excess fuel addition volume: No fail-safe operation. ● Low fuel addition volume or stuck open: Limits the engine power (driving at engine speed of up to approximately 80 km/h [50 mph] is permitted).	Engine switch OFF*1/ Ignition switch OFF*2
P1425, P1427, P1428	Differential pressure is fixed value.	Engine switch OFF*1/ Ignition switch OFF*2
P1611	Limits the engine power.	Engine switch OFF*1/ Ignition switch OFF*2
P1625	Limits the engine power.	"Pass" condition detected
P2002	Limits the engine power.	Engine switch OFF*1/ Ignition switch OFF*2
P2031, P2032, P2033	Limits the engine power.	Engine switch OFF*1/ Ignition switch OFF*2
P2120, P2121, P2122, P2123, P2125, P2127, P2128, P2138	Limits the engine power.	Engine switch OFF*1/ Ignition switch OFF*2
P2226, P2228, P2229	Atmospheric pressure is fixed value.	"Pass" condition detected

*1: Models with Smart Entry & Start System
*2: Models without Smart Entry & Start System

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