■ ENGINE CONTROL SYSTEM

1. General

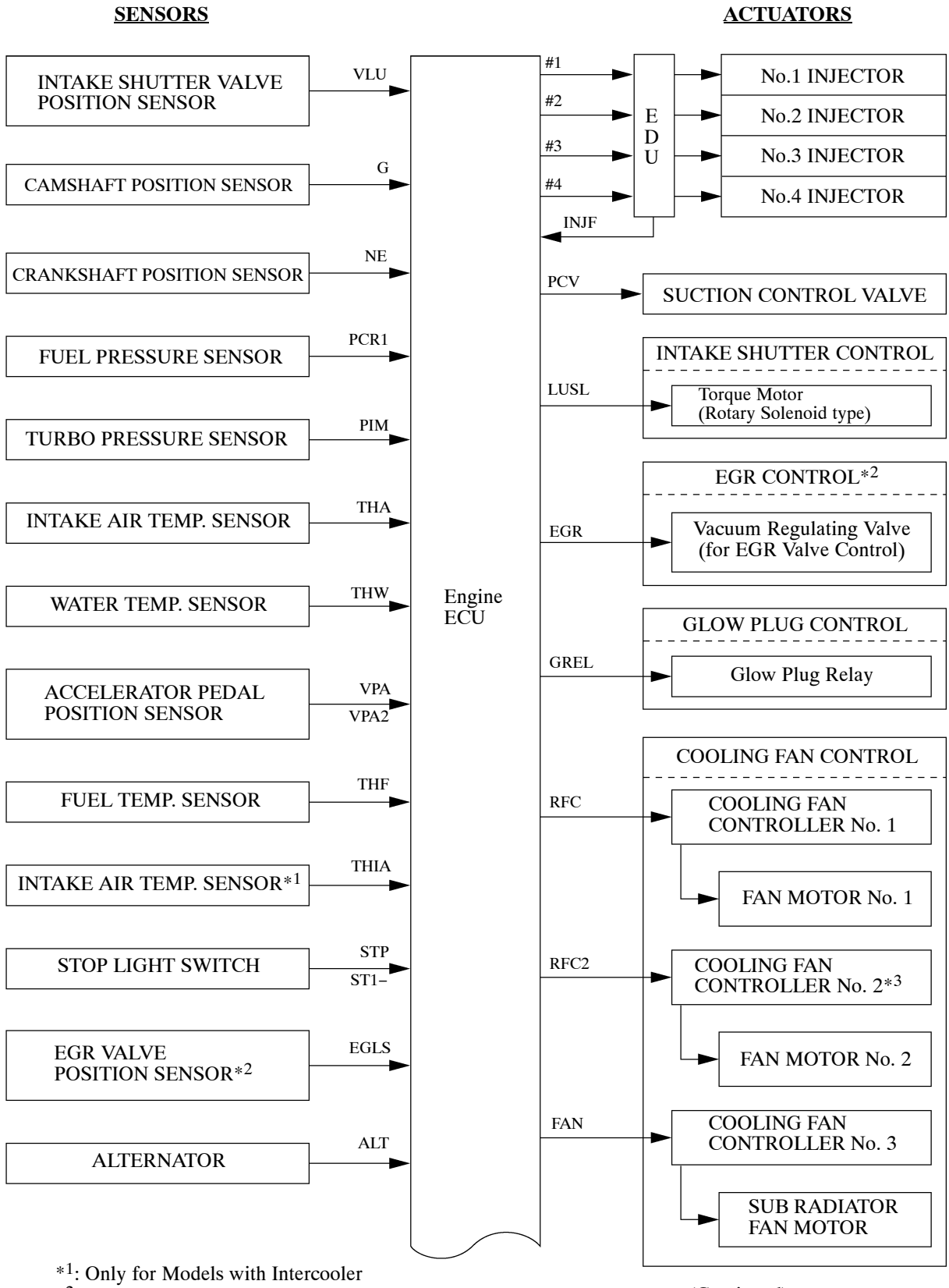
The engine control system of the 2KD-FTV engine has the following systems.

System	Outline
Fuel Injection Volume Control (See page EG-107)	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 (See page EG-108)	Based on the signals received from the sensors, the engine ECU determines the fuel injection timing in accordance with the engine condition.
During Starting Control (See page EG-109)	To facilitate startability, the engine ECU optimally controls the injection volume and injection timing during starting.
Idle Speed Control (See page EG-110)	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.
Fuel Pressure Control (See page EG-111)	Based on the signals received from the sensors, the engine ECU determines the fuel pressure via SCV (Suction Control Valve) in accordance with the engine condition.
Pilot Injection Control (See page EG-114)	Based on the signals received from the sensors, the engine ECU determines pilot injection volume/timing, and interval (between pilot injection and main injection) in accordance with the engine condition.
Glow Plug Control	Controls the length of time when the current is applied to the glow plugs, in accordance with the coolant temperature.
Intake Shutter Control (See page EG-115)	• Controls the intake shutter valve (throttle valve) opening angle in accordance with the engine condition. • Fully close the intake shutter valve (throttle valve) in order to reduce the vibration when the engine is stopped.
High Altitude Turbocharger Protection Control	Holds down the engine speed at high altitudes to prevent the turbocharger from overrunning.
EGR Control*1 (See page EG-115)	Controls the EGR volume via the EGR valve in accordance with the engine condition.
Cooling Fan Control (See page EG-116)	The engine ECU steplessly controls the speed of the fans in accordance with the engine coolant temperature, vehicle speed, engine speed, and air conditioning operating conditions. As a result, the cooling performance has been improved.
Air Conditioner Cut-Off Control*2	By controlling the air conditioner compressor ON or OFF in accordance with the engine condition, drivability is maintained.
Diagnosis (See page EG-117)	When the engine ECU detects a malfunction, the engine ECU diagnoses and memorizes a failed section.
Fail-Safe (See page EG-117)	When the engine ECU detects a malfunction, the engine ECU stops or controls the engine according to the data already stored in the memory.

*1: For Models with EGR control System
*2: For Models with Air Conditioner

2. Construction

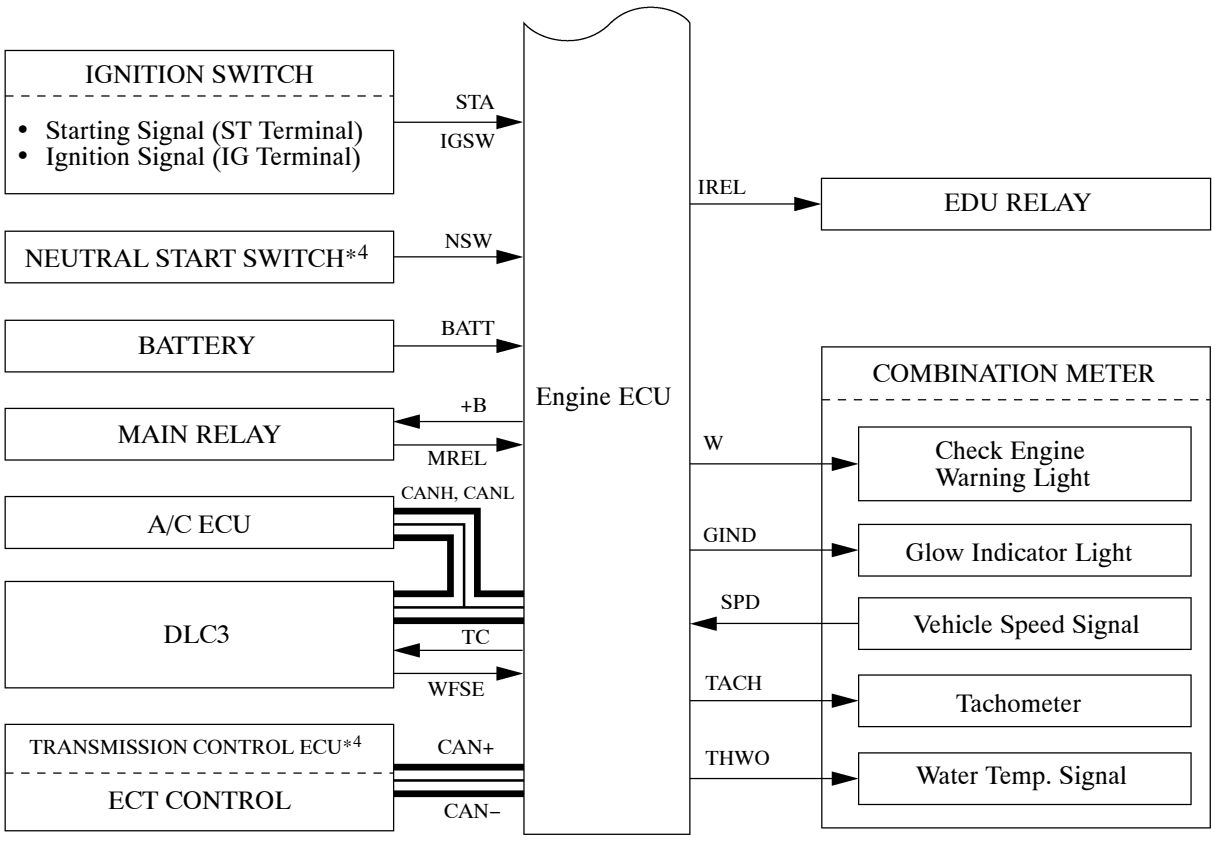
The configuration of the engine control system in the 2KD-FTV engine is as shown in the following chart.



*1: Only for Models with Intercooler
*2: Only for Models with EGR control System
*3: Only for Models with Air Conditioner System

(Continued)

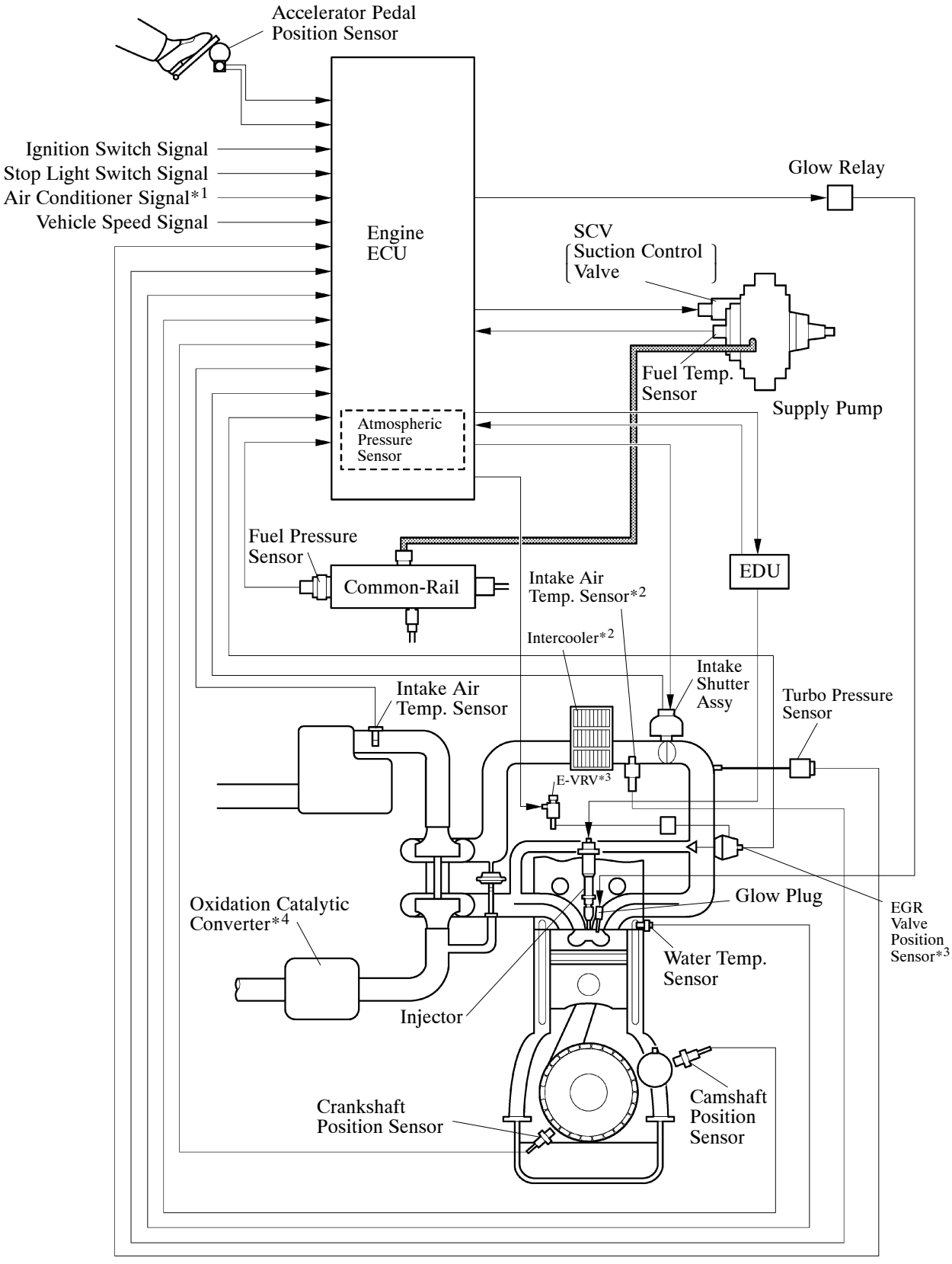
286EG24



*4: Only for Models with Automatic Transmission

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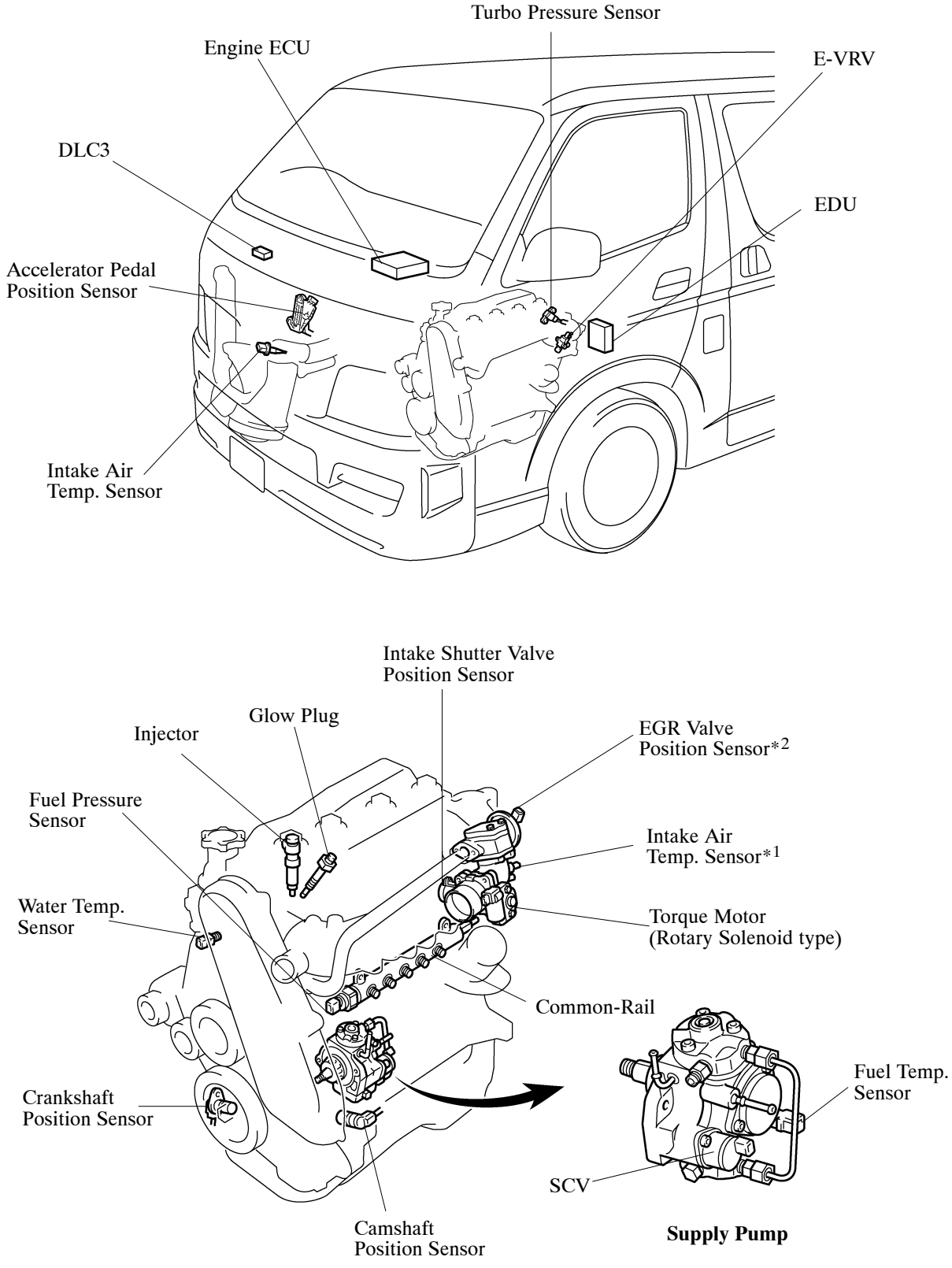
3. Engine Control System Diagram



*1: Only for Models with Air Conditioner
*2: Only for Models with Intercooler
*3: Only for Models with EGR control System
*4: Only for Models Complying with the EURO III Emission Regulation

286EG57

4. Layout of Main Components



*1: Only for Models with Intercooler
*2: Only for Models with EGR control System

5. Main Components of Engine Control System

General

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

Component	Outline	Quantity	Function
Engine ECU	32-bit CPU	1	The engine ECU effects overall control of the engine control system to suit the operating conditions of the engine in accordance with the signals provided by the sensors.
EDU	DC/DC Converter	1	The EDU is used to drive the injector at high speeds. The EDU has realized high-speed driving under high fuel pressure conditions through the use of a DC/DC converter that provides a high voltage, quick-charging system.
Turbo Pressure Sensor	Semiconductor Silicon Chip Type	1	This sensor uses built-in semiconductors to detect the intake manifold pressure.
Atmospheric Pressure Sensor	Semiconductor Silicon Chip Type	1	This sensor, which is built into the engine ECU, uses semiconductors to detect the atmospheric pressure.
Fuel Pressure Sensor	Semiconductor Strain Gauge Type	1	This sensor uses built-in semiconductors to detect the internal pressure of the common-rail.
Crankshaft Position Sensor	Pick-up Coil Type (Rotor Teeth/36-2)	1	This sensor detects the engine speed and performs the cylinder identification.
Camshaft Position Sensor	Pick-up Coil Type (Rotor Teeth/5)	1	This sensor performs the cylinder identification.
Water Temperature Sensor	Thermistor Type	1	This sensor detects the engine coolant temperature by means of an internal thermistor.
Intake Air Temperature Sensor	Thermistor Type	1	This sensor, which is provided at the air cleaner outlet, detects the intake air temperature by means of an internal thermistor.
Intake Air Temperature Sensor*1	Thermistor Type	1	This sensor, which is provided only on the models with an intercooler, detects the intake air temperature past the intercooler.
Fuel Temperature Sensor	Thermistor Type	1	This sensor detects the fuel temperature in the supply pump by means of an internal thermistor.
Intake Shutter Valve Position Sensor	No-contact Type	1	This sensor detects the intake shutter valve (throttle valve) opening angle.
Accelerator Pedal Position Sensor	No-contact Type	1	This sensor detects the amount of pedal effort applied to the accelerator pedal.
EGR Valve Position Sensor*2	Contact Type	1	This sensor detects the actual amount of the EGR valve opening.
SCV (Suction Control Valve)	Linear Solenoid Valve	1	The SCV position is controlled by the signals from the ECU, and a fuel volume that suits the SCV position is drawn into the pumping portion (plunger portion).
Injector	6-hole Type	4	The injector contains a solenoid valve that opens and closes to increase or decrease the pressure in the control chamber. This causes the nozzle needle to open and close the valve, which results in fuel injection.

*1: for Models with Intercooler
*2: for Models with EGR control System

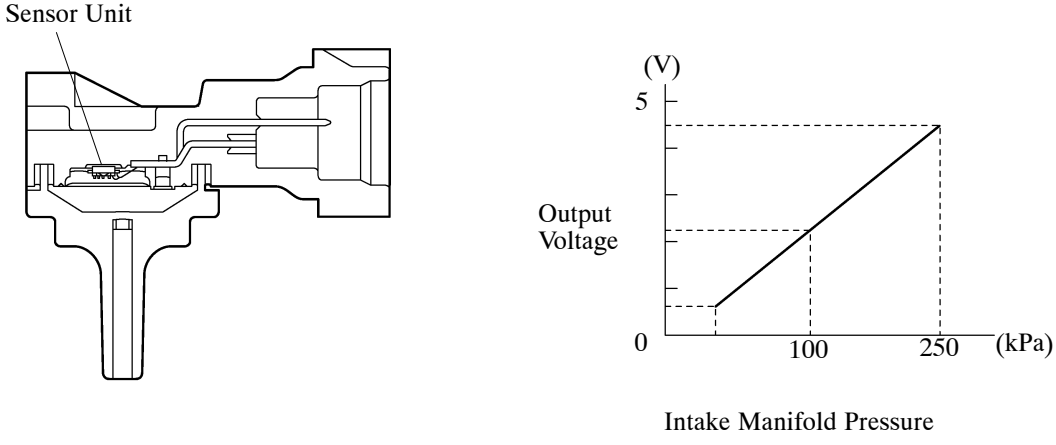
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Engine ECU

The 32-bit CPU of the engine ECU is used to increase the speed for processing the signals.

Turbo Pressure Sensor

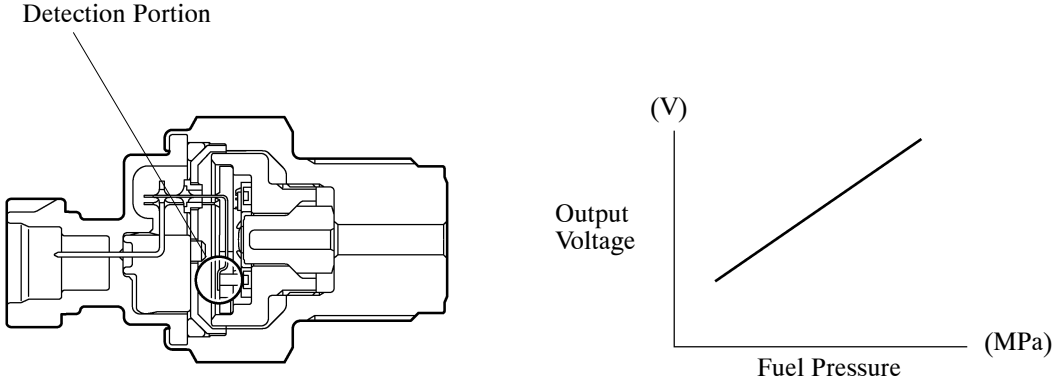
The turbo pressure sensor consists of a semiconductor which utilizes the characteristic of a silicon chip that changes its electrical resistance when pressure is applied to it. The sensor converts the intake air pressure into an electrical signal, and sends it to the engine ECU in an amplified form.



271EG136

Fuel Pressure Sensor

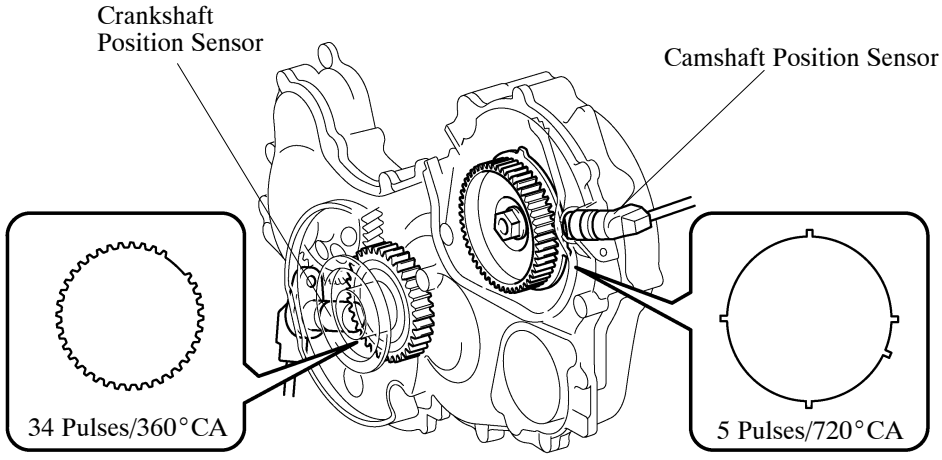
The fuel pressure sensor consists of a semiconductor which utilizes the characteristic of a silicon chip that changes its electrical resistance when pressure is applied to it. This sensor is mounted on the common-rail, and outputs a signal that represents the fuel pressure in the common-rail to the engine ECU, in order to constantly regulate the fuel at an optimal pressure.



271EG137

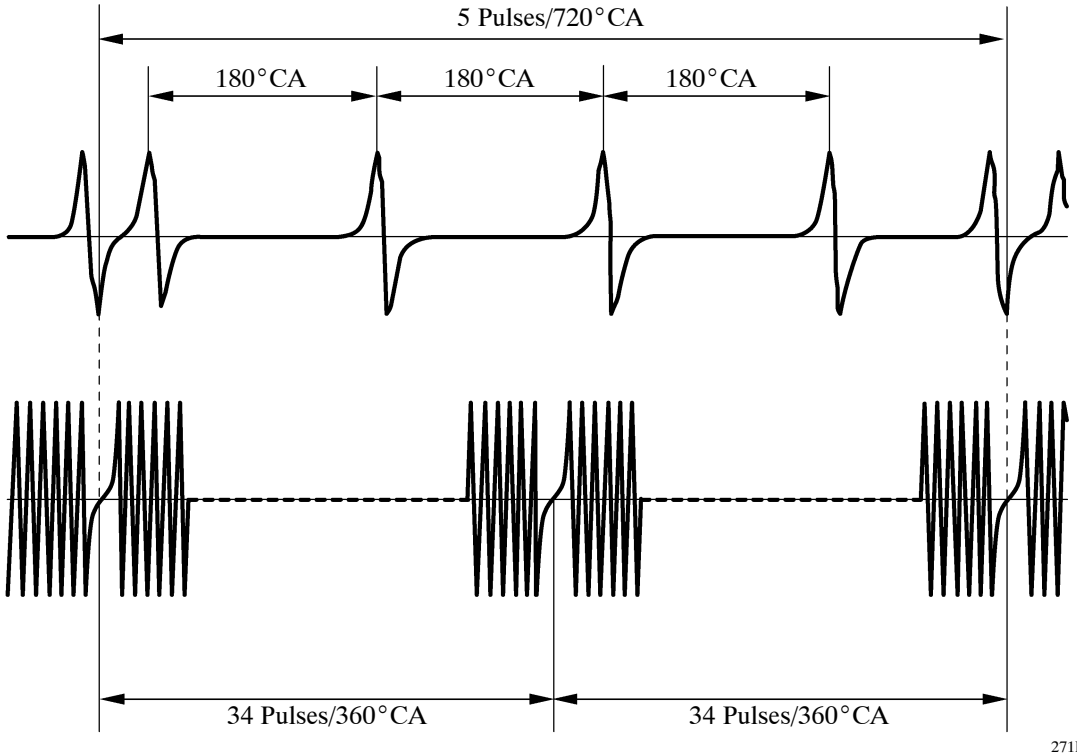
Crankshaft Position Sensor and Camshaft Position Sensor

- 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.
- To detect the camshaft position, a protrusion that is provided on the timing pulley is used to generate 5 pulses for every 2 revolutions of the crankshaft.



224EG41

▶ Sensor Output Waveforms ◀

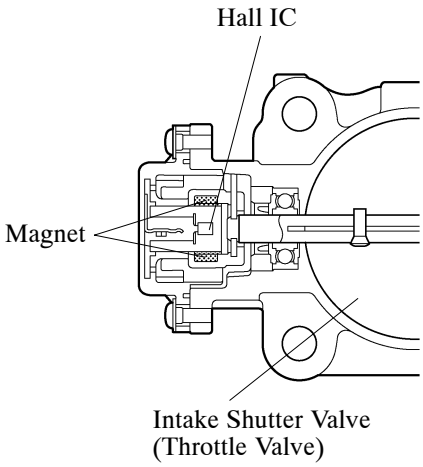


271EG138

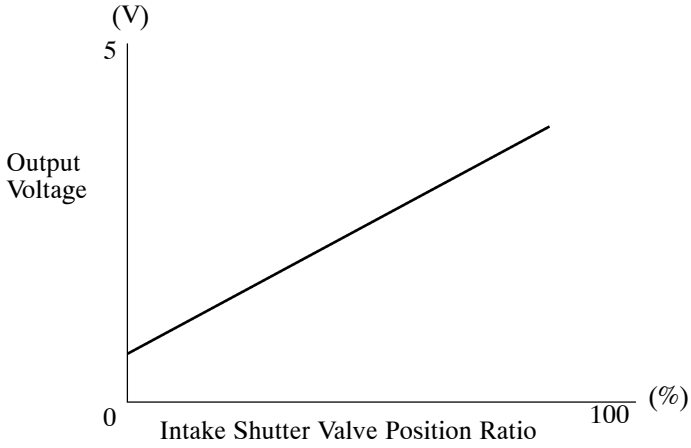
EG

Intake Shutter Valve Position Sensor

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



271EG82



271EG83

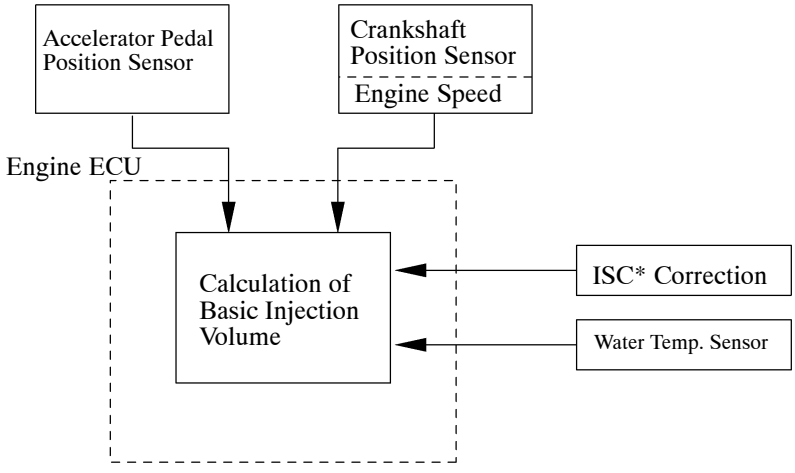
Accelerator Pedal Position Sensor

For details, see page EG-461 in the 2TR-FE engine.

6. Fuel Injection Volume Control

The engine ECU calculates two types of values: the basic injection volume and the maximum injection volume. Then, the engine ECU compares the basic and maximum injection volumes, and determines a smaller calculated value to be the final injection volume.

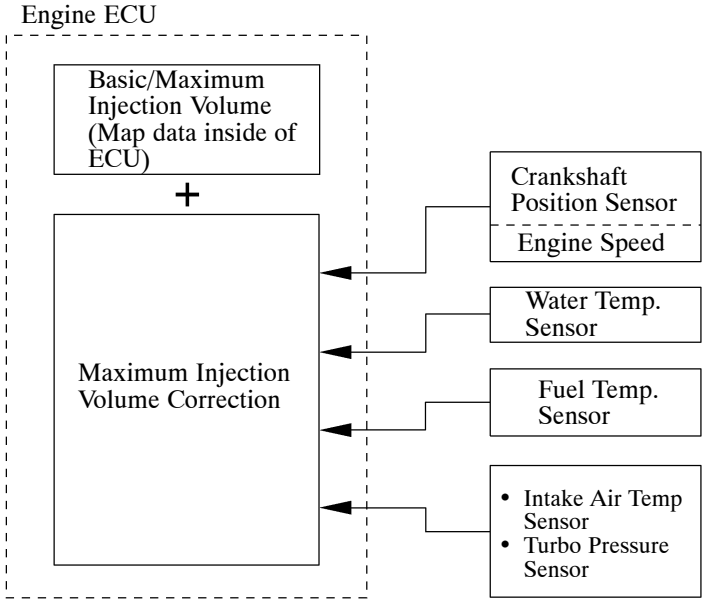
▶ Basic Injection Volume ◀



224EG44

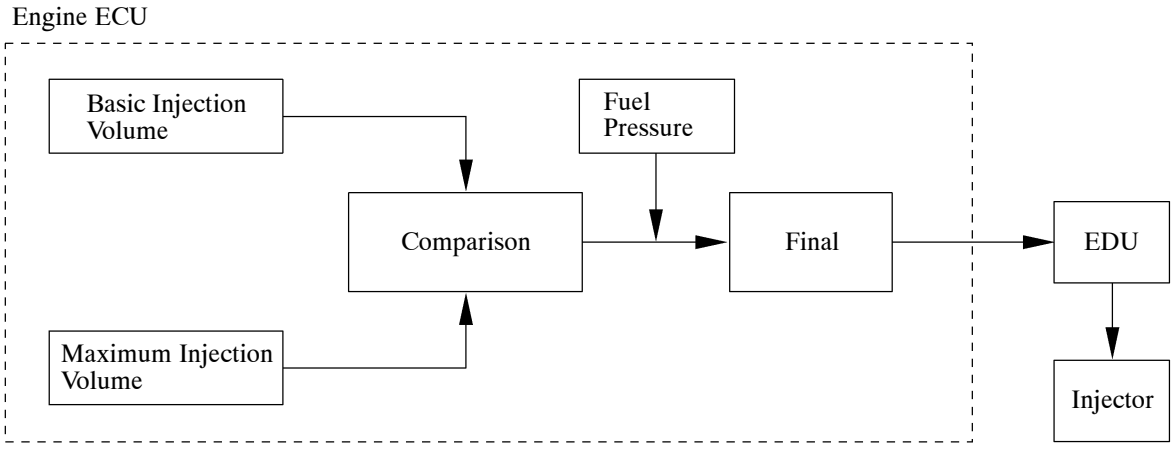
*: Idle Speed Control

▶ Maximum Injection Volume ◀



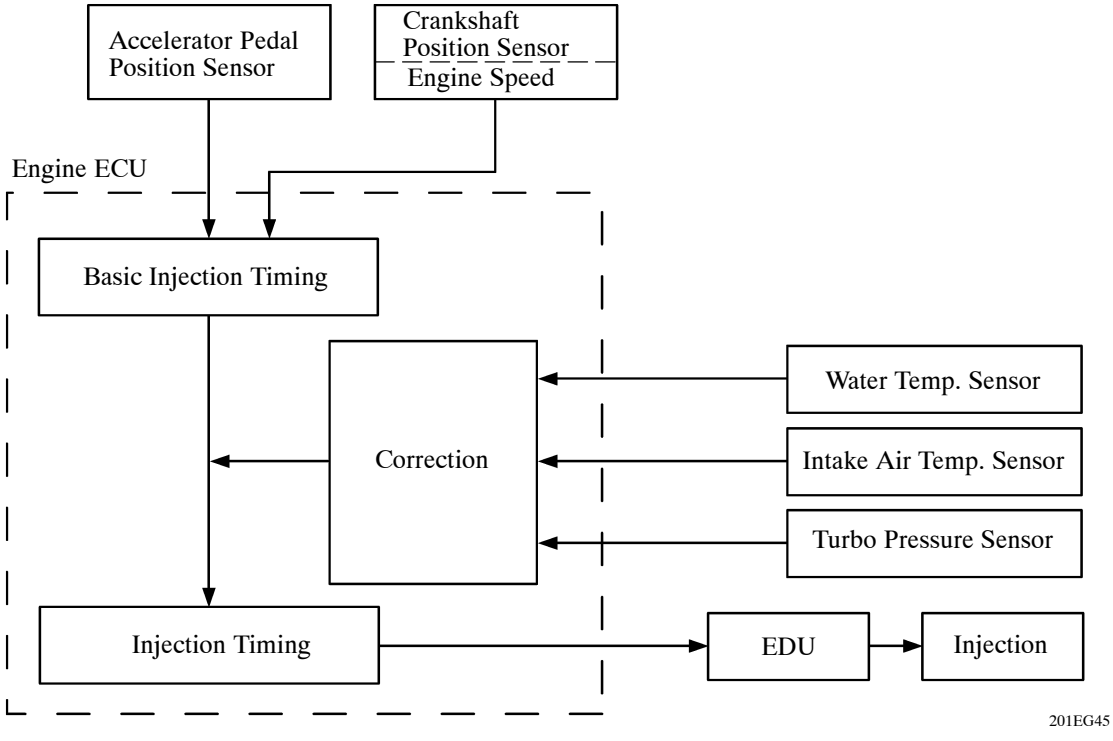
272EG27

▶ Final Injection Volume Decision ◀



7. Fuel Injection Timing Control

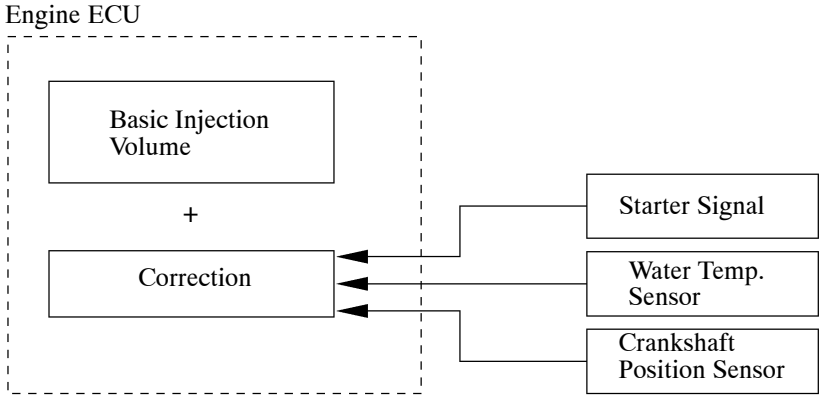
Fuel injection timing is controlled as shown below.



8. During Starting Control

Injection Volume Control

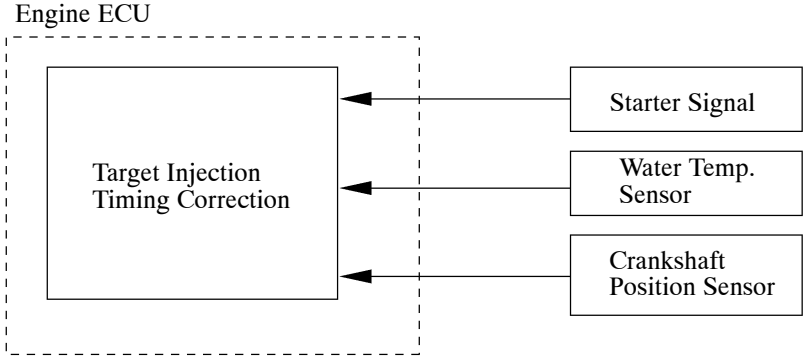
The starting injection volume is determined by adjusting the basic injection volume in accordance with the starter ON signals (ON time), water temperature sensor signals and engine speed signal. When the engine is cold, the coolant temperature will be lower and the injection volume will be greater.



224EG50

Injection Timing Control

To determine the starting injection timing, the target injection timing is corrected in accordance with the starter signals, water temperature, and engine speed.
When the water temperature is low, if the engine speed is high, the injection timing is advanced.

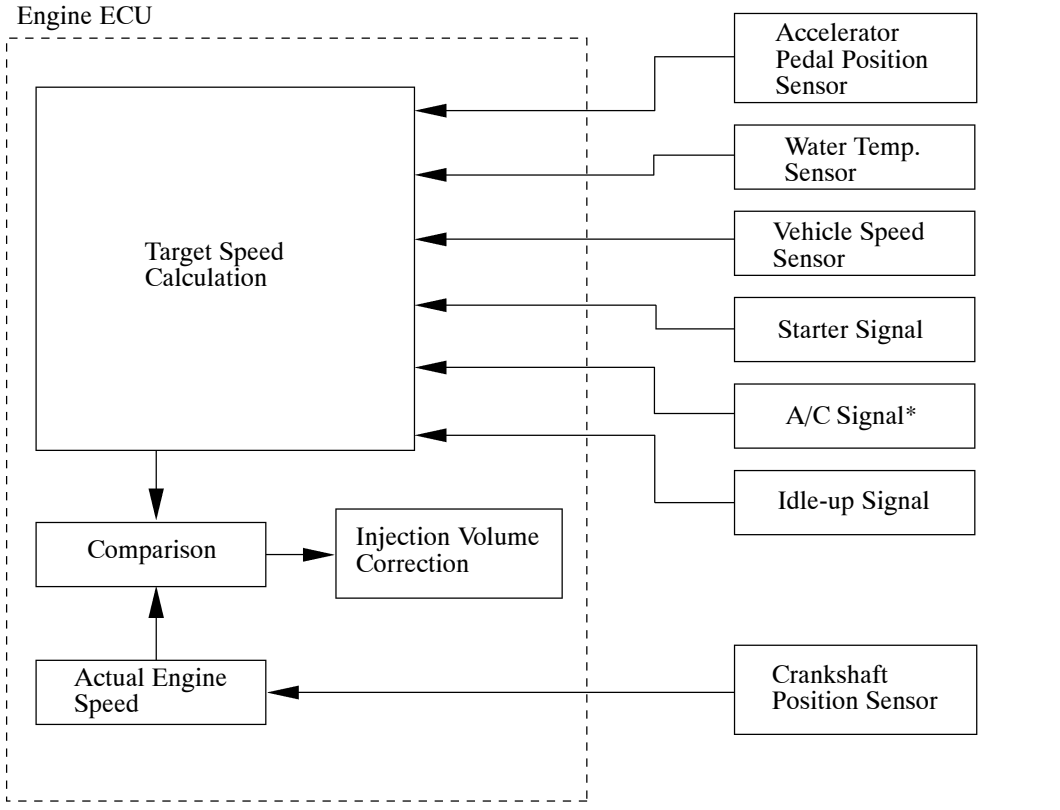


224EG51

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9. Idle Speed Control

Fuel injection timing is controlled as shown below.



233EG14

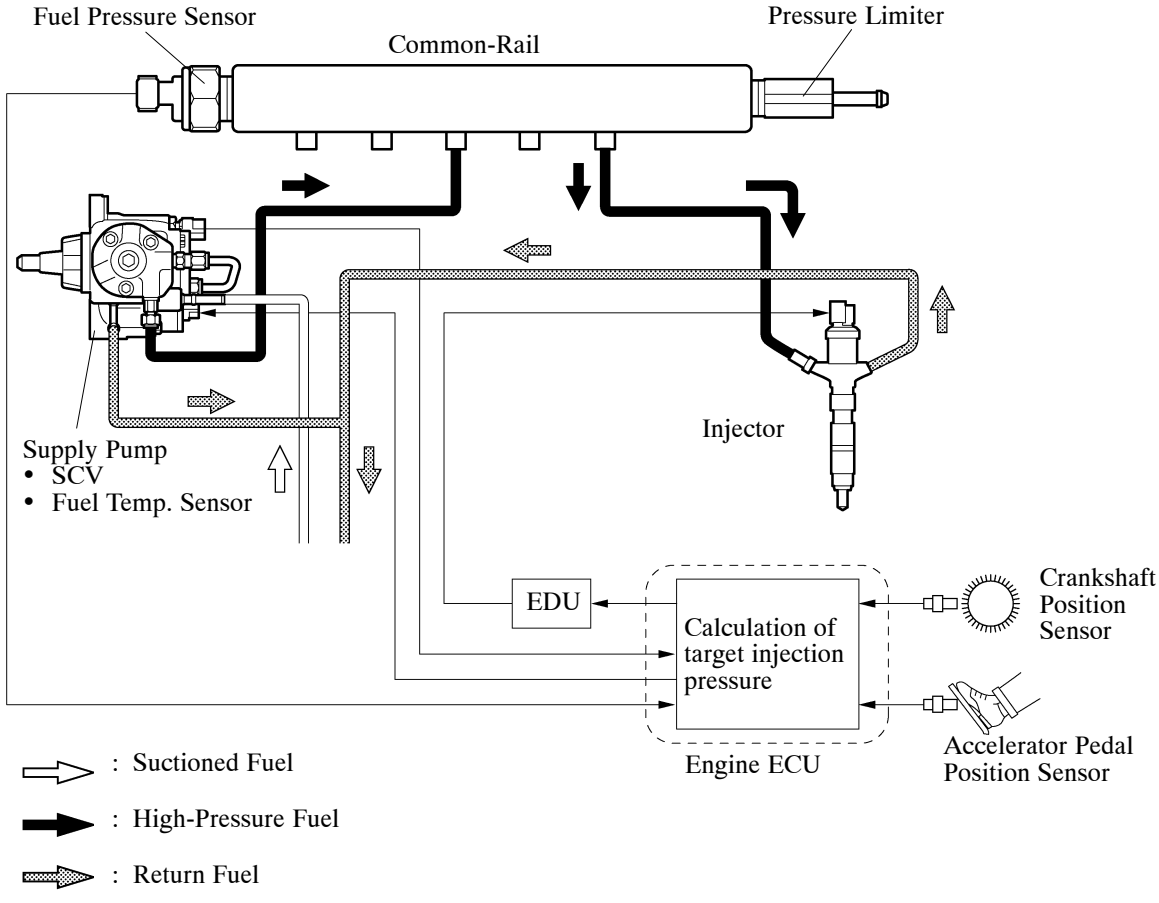
*: Only for Models with Air Conditioner

10. Fuel Pressure Control

General

Engine ECU calculates the target injection pressure (30-160 MPa) based on the engine conditions, which are detected through the signals from the acceleration 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 pumping volume, so that the pressure detected by the pressure sensor matches the target injection pressure.



286EG66

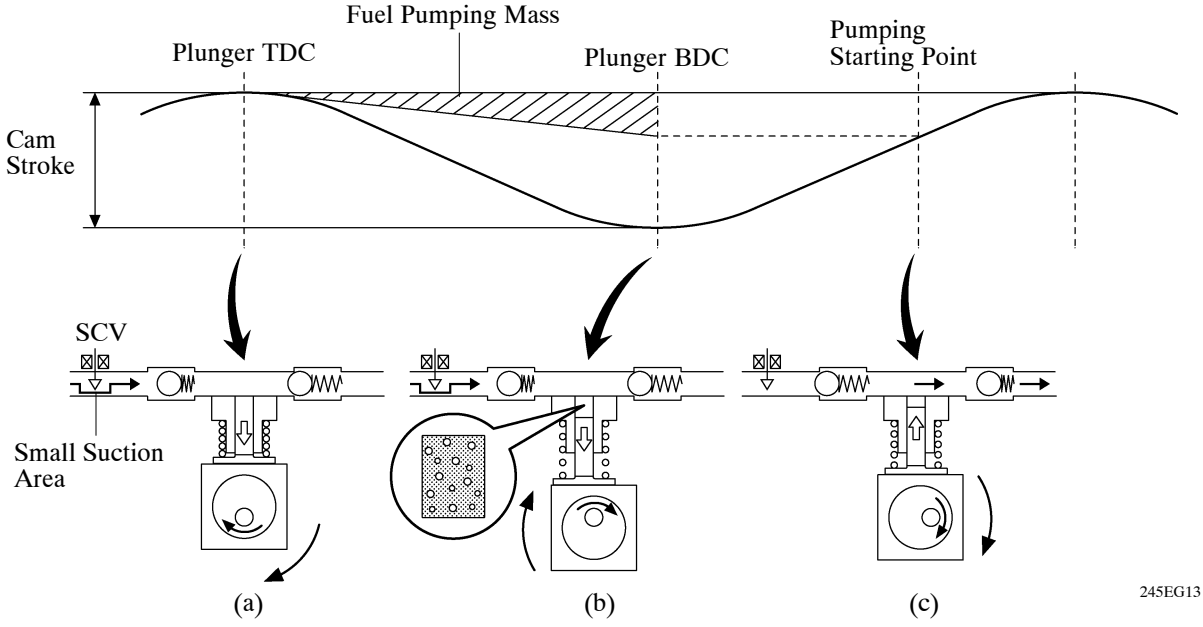
System Operation

1) General

The engine ECU controls the opening of the SCV in order to regulate the volume of fuel that is pumped by the supply pump to the common-rail. Consequently, the fuel pressure in the common-rail is controlled to the target injection pressure.

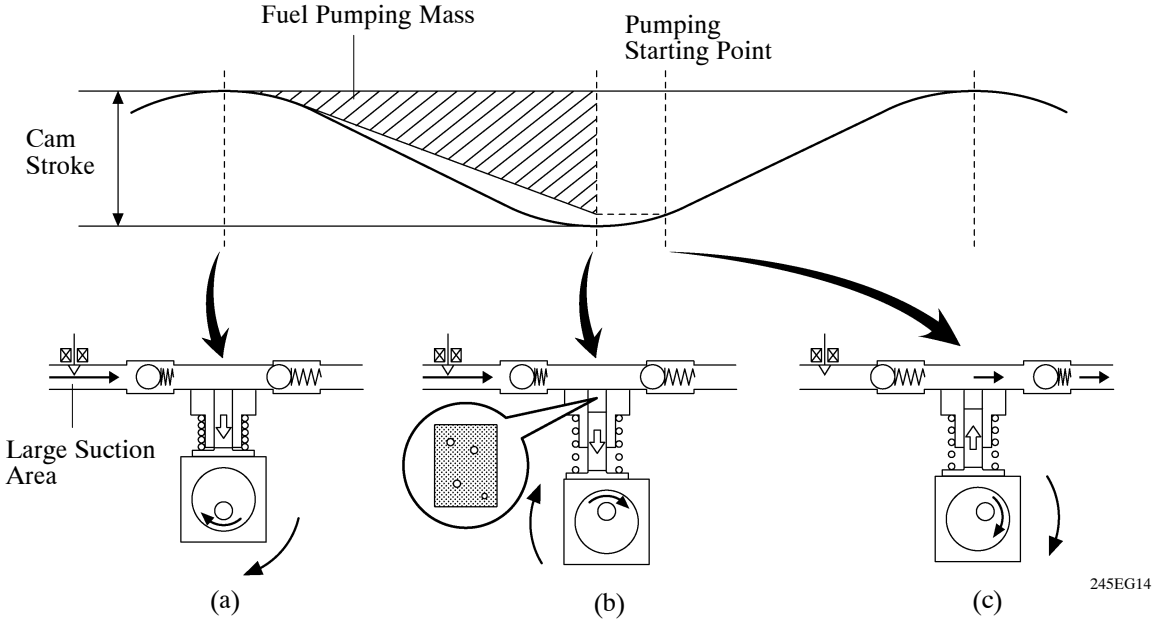
2) SCV Opening Small

(a) When the opening of the SCV is small, the fuel suction area is kept small, which decreases the transferable fuel quantity.
(b) The plunger strokes fully; however, the suction volume becomes small due to the small suction area. Therefore, the difference between the geometry volume and the suction volume produces vacuum condition.
(c) Pumping will start at the time when the fuel pressure has become higher than the common-rail pressure.



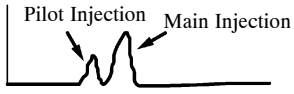
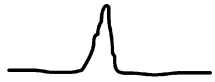
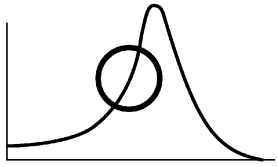
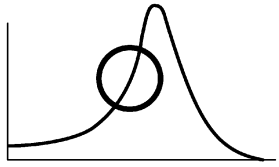
3) SCV Opening Large

(a) When the opening of the SCV is large, the fuel suction area is kept large, which increases the transferable fuel quantity.
(b) If the plunger strokes fully, the suction volume will increase because the suction area is large.
(c) Pumping will start at the time when the fuel pressure has become higher than the common-rail pressure.



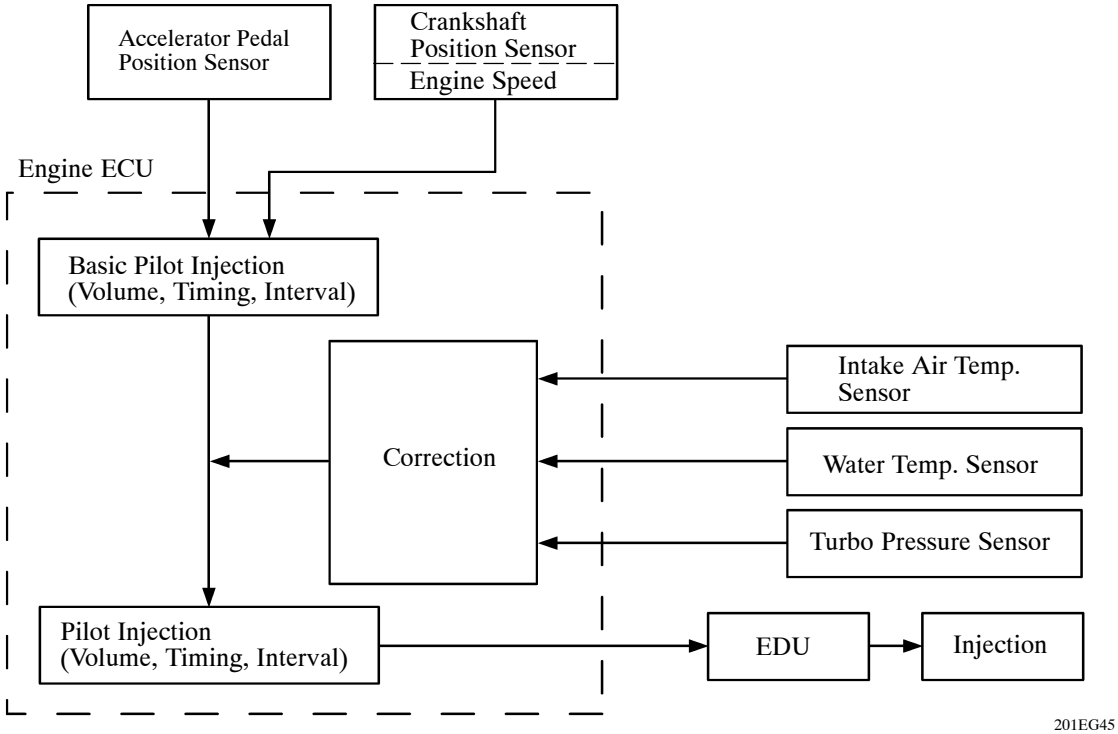
11. Pilot Injection Control

- Pilot injection is a method that provides auxiliary fuel injection before the main fuel injection takes place. The purpose of pilot injection is to gently start the combustion of the fuel of the main injection in order to reduce combustion noise.

State	Pilot Injection	Ordinarily Injection
Fuel Injection		
Combustion Pressure		

168EG23

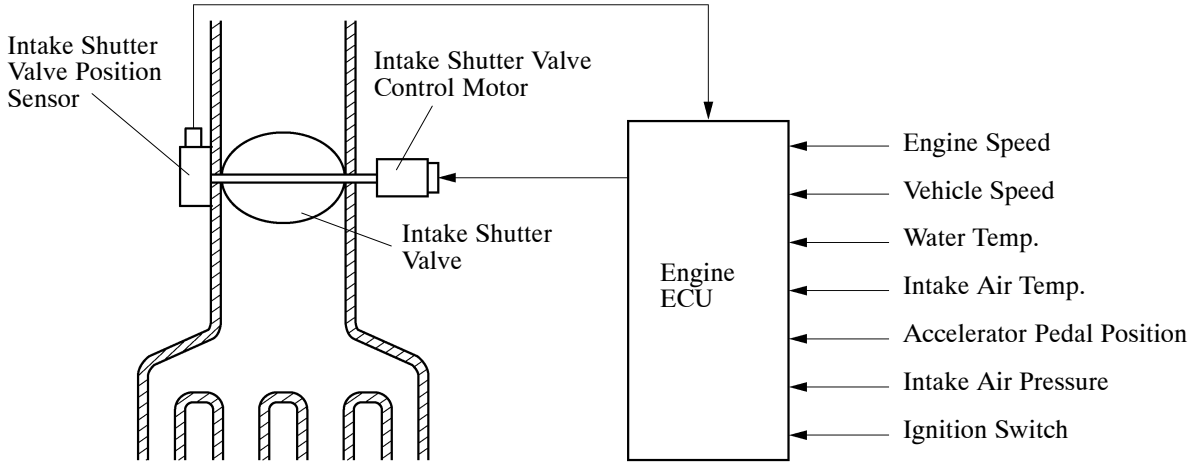
- During pilot injection, the pilot injection volume, timing, and interval (between pilot injection and main injection) are controlled as shown below.



201EG45

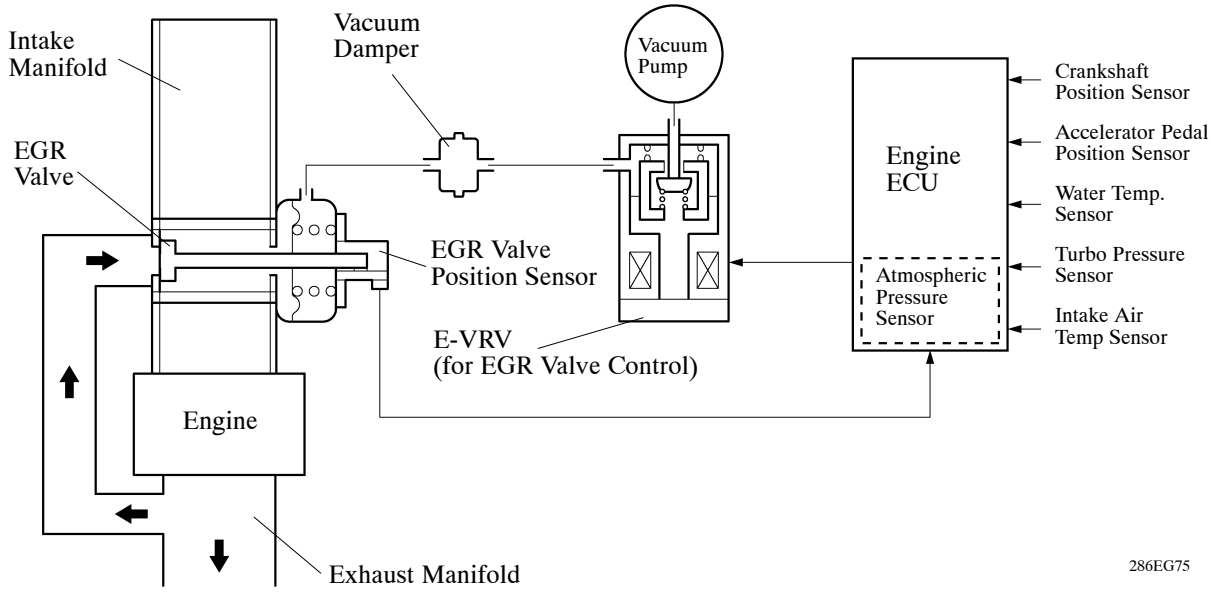
12. Intake Shutter Control

The opening of the intake shutter valve (throttle valve) that is installed on the intake manifold is controlled by the engine ECU in accordance with engine conditions.
As a result, the noise that is generated during idling and deceleration, as well as the noise and vibration that are generated when the engine is stopped, have been reduced.



13. EGR Control System

- By sensing the engine driving conditions and actual amount of EGR valve opening, the engine ECU electrically operates the E-VRV (for EGR valve control), which controls the magnitude of vacuum introduced into diaphragm of EGR valve, and the amount of recirculating exhaust gas is regulated. EGR valve opening lift is controlled by modulated negative pressure.
- The EGR function is stopped under the conditions given below to ensure drivability and to reduce diesel smoke.
  - While engine is cold
  - The vehicle is under high load condition.
  - During deceleration (The EGR operation at idle).

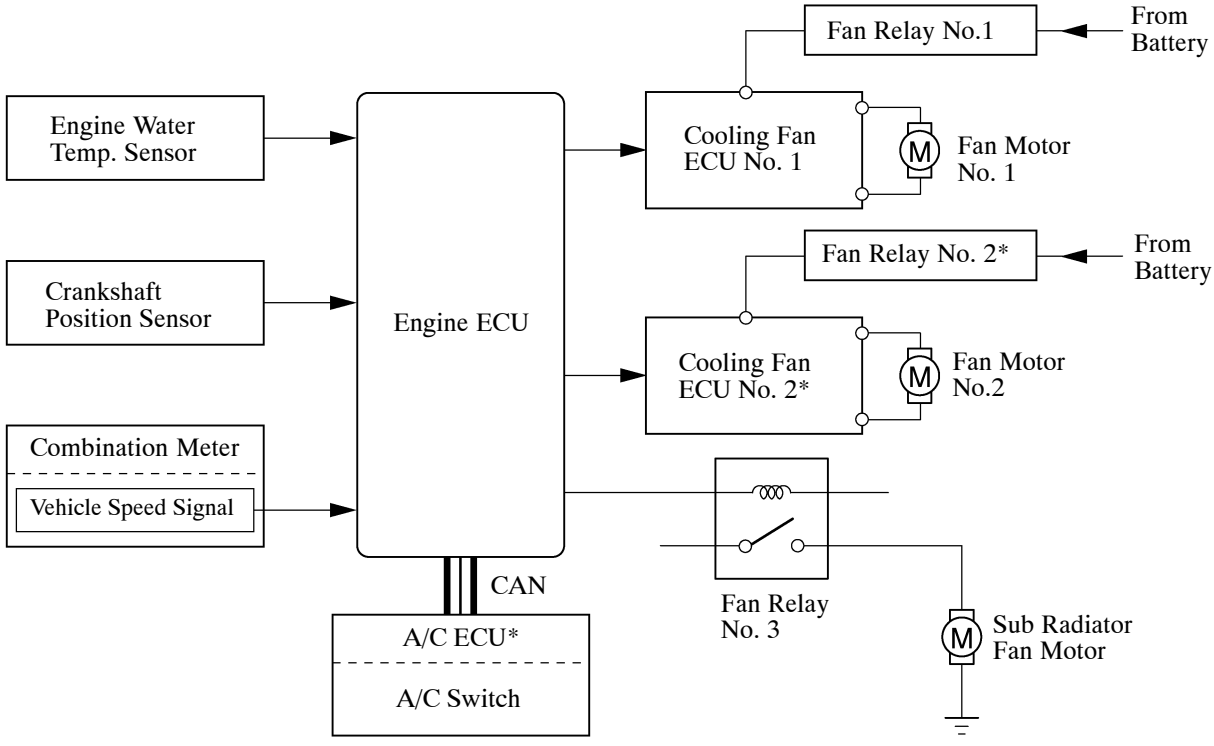


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14. Cooling Fan Control

General

- Radiator cooling fan control and sub radiator cooling fan control are used.
- For details of the radiator cooling fan control, see page EG-62 in the 2TR-FE engine.
- In the sub radiator cooling fan control, the engine ECU controls the sub radiator fan motor according to the engine coolant temperature.



*: Only for Models with Air Conditioner

286EG52

Operation

1) Radiator Cooling Fan

For details, see page EG-631 in the 2TR-FE engine.

2) Sub Radiator Cooling Fan

The engine ECU controls the operation of the cooling fan based on the water temp. sensor signals.

▶ Sub Cooling Fan Operating Temperature ◀

Cooling Fan Operation		OFF	ON
Water Temp.	°C (°F)	84 (179.6) or lower	89 (189.9) or higher

EG

15. 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.
- 2-digit DTCs (Diagnostic Trouble Codes) can be accessed by connecting the SST (09843-18040) to the DLC3 terminals TC and CG, and reading the blinking of the check engine warning light.
- By using the intelligent tester II, 5-digit DTCs and ECU data can be read out. Moreover, the ACTIVE TEST can be used to drive the actuator by means of the intelligent tester II.
- The engine ECU can output freeze-frame data to the intelligent tester II. This data is stored in the engine ECU at the very moment when the engine ECU has detected its last data of malfunction.
- All the DTCs have been made correspond to the SAE controlled codes. Some of the DTCs have been further divided into smaller detection areas than in the past, and new DTCs have been assigned to them.
- For details, refer to the Hiace Repair Manual (Pub. No. RM1171E).

Service Tip

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

16. Fail-Safe

When a malfunction is detected by any of the sensors, there is a possibility of an engine or another malfunction occurring if the 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 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 Hiace Repair Manual (Pub. No. RM1171E).