■ENGINE CONTROL SYSTEM

1. General

The engine control system of the 1VD-FTV engine has the following system.

System	Outline
Fuel Injection Volume Control (See page 69)	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 70)	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 71)	Based on the signals received from the sensors, the engine ECU controls fuel pressure using the SCV (Suction Control Valve) according to the engine condition.
Pilot Injection Control (See page 72)	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.
During Starting Control (See page 73)	To facilitate startability, the engine ECU optimally controls the injection volume and injection timing during starting.
Idle Speed Control (See page 74)	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 the engine water temperature.
Throttle Control (See page 75)	Based on the signals received from the various sensors, the engine ECU determines throttle valve position in accordance with the engine condition.
	Fully close the throttle valve in order to reduce the vibration when the engine is stopped.
Turbo Pressure Control (See page 75)	Based on the signals received from the sensors, the engine ECU controls the actuator via E-VRV in accordance with the engine condition.
EGR Control (See page 76)	Based on the signals received from the sensors, the engine ECU determines the EGR volume via EGR valve and throttle valve in accordance with the engine condition.

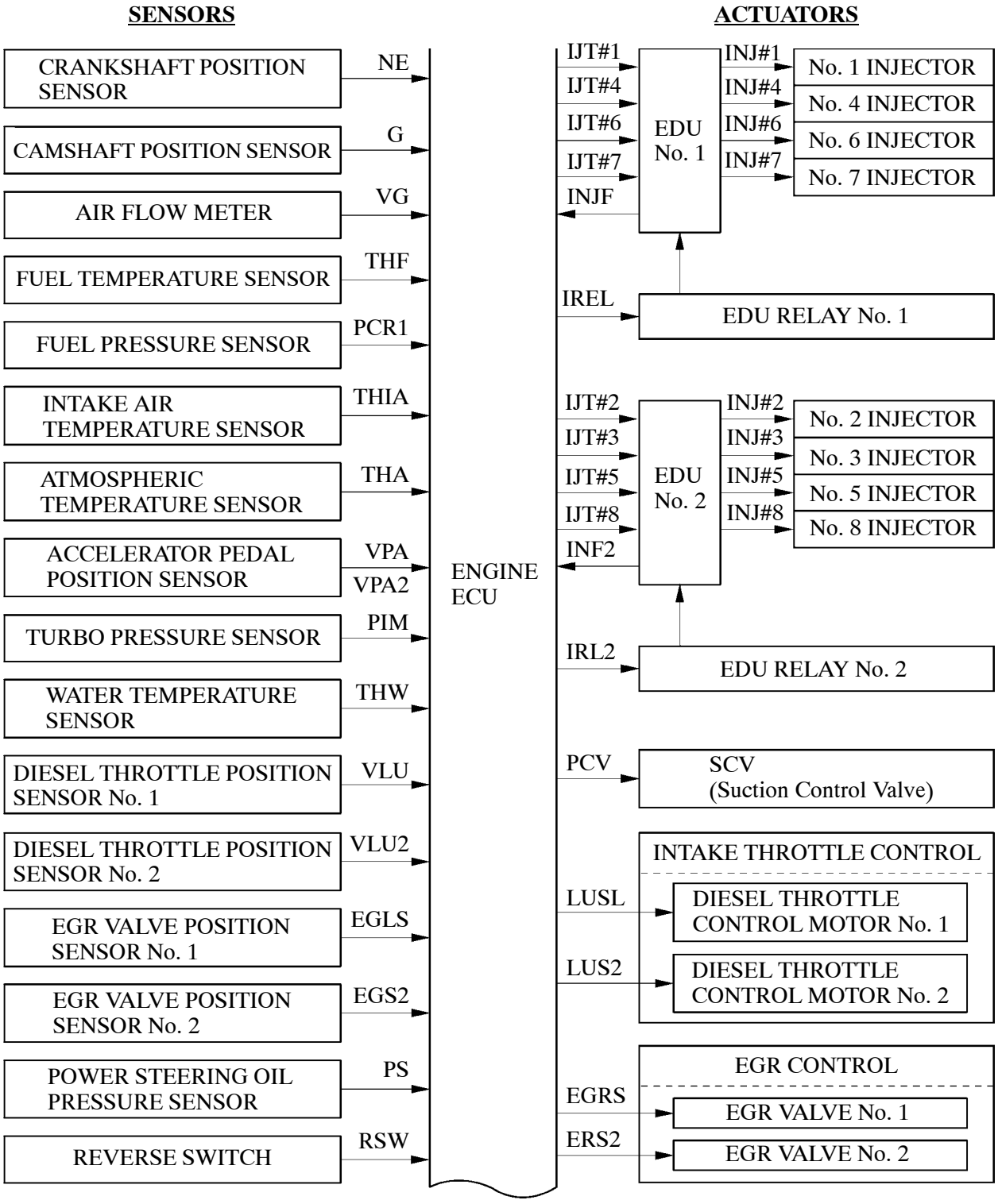
(Continued)

Air Conditioner Cut-off Control*	By controlling the air conditioner compressor ON or OFF in accordance with the engine condition, drivability is maintained.
Engine Immbilizer	Prohibits fuel injection if an attempt is made to start the engine with an invalid ignition key.
Diagnosis (See page 77)	When the engine ECU detects a malfunction, the engine ECU diagnoses and memorizes the failed section.
Fail-safe (See page 77)	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 Air Conditioner System

2. Construction

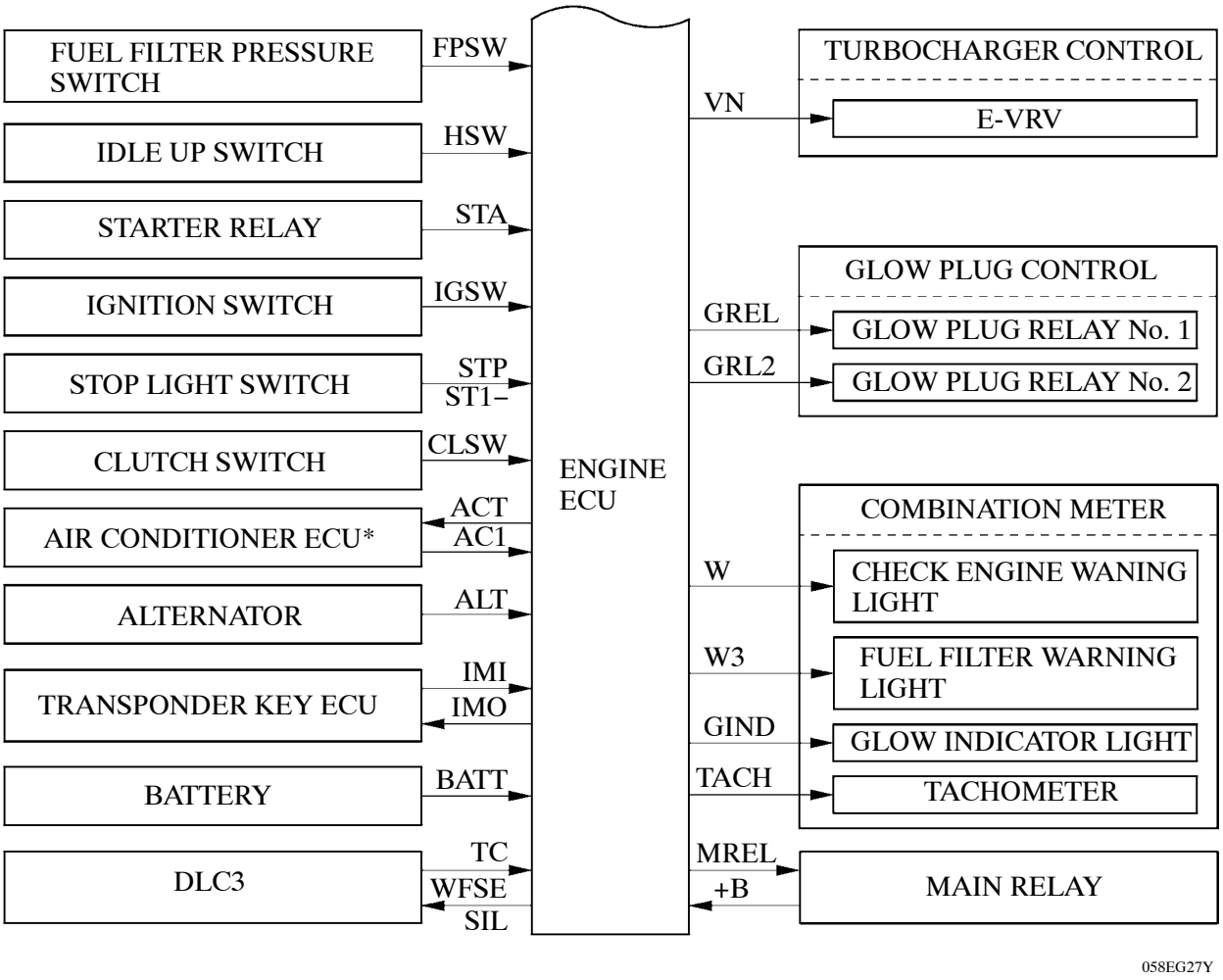
The configuration of the engine control system is as shown in the following chart.



(Continued)

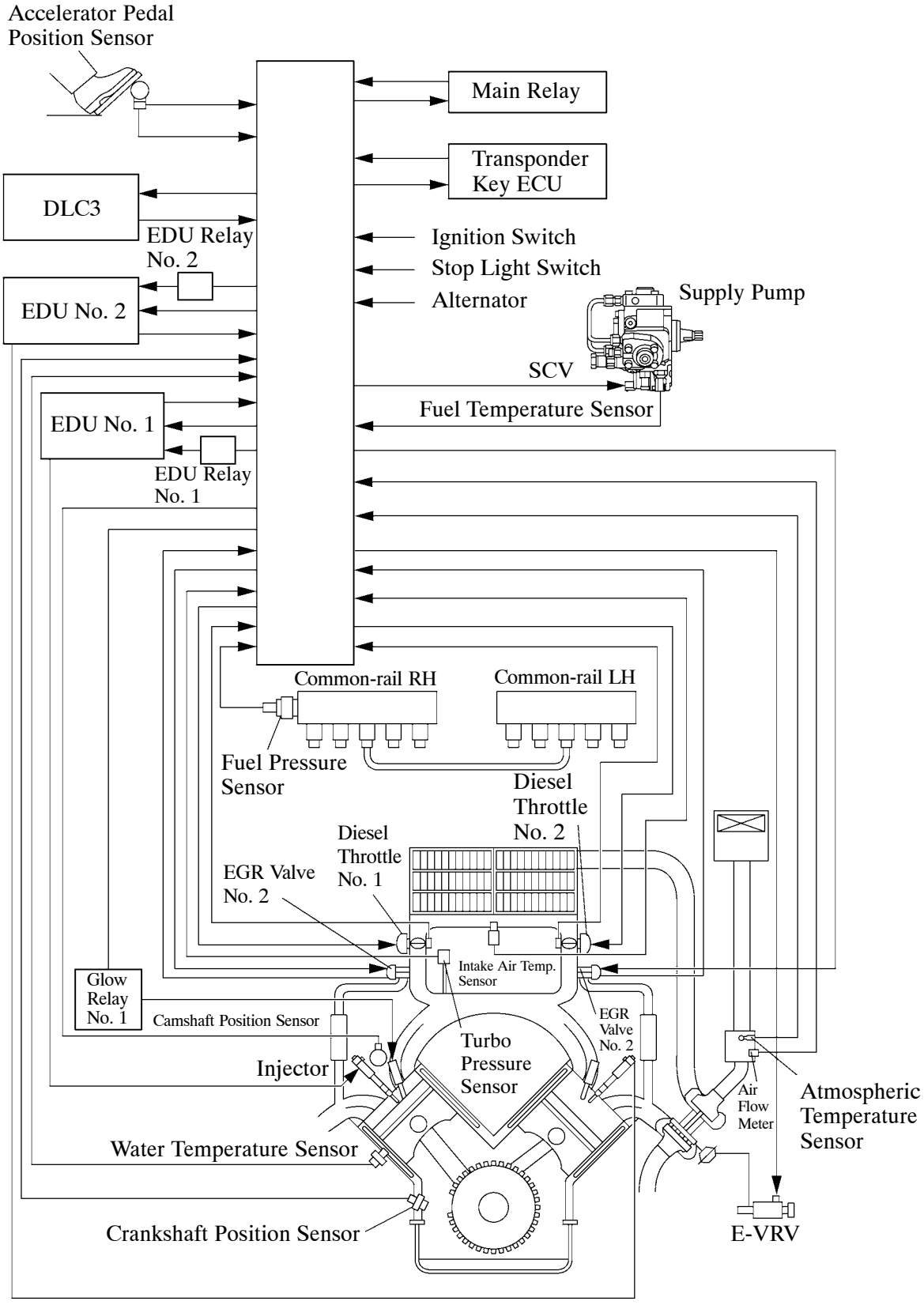
058EG26Y

NF



*: Models with Air Conditioner System

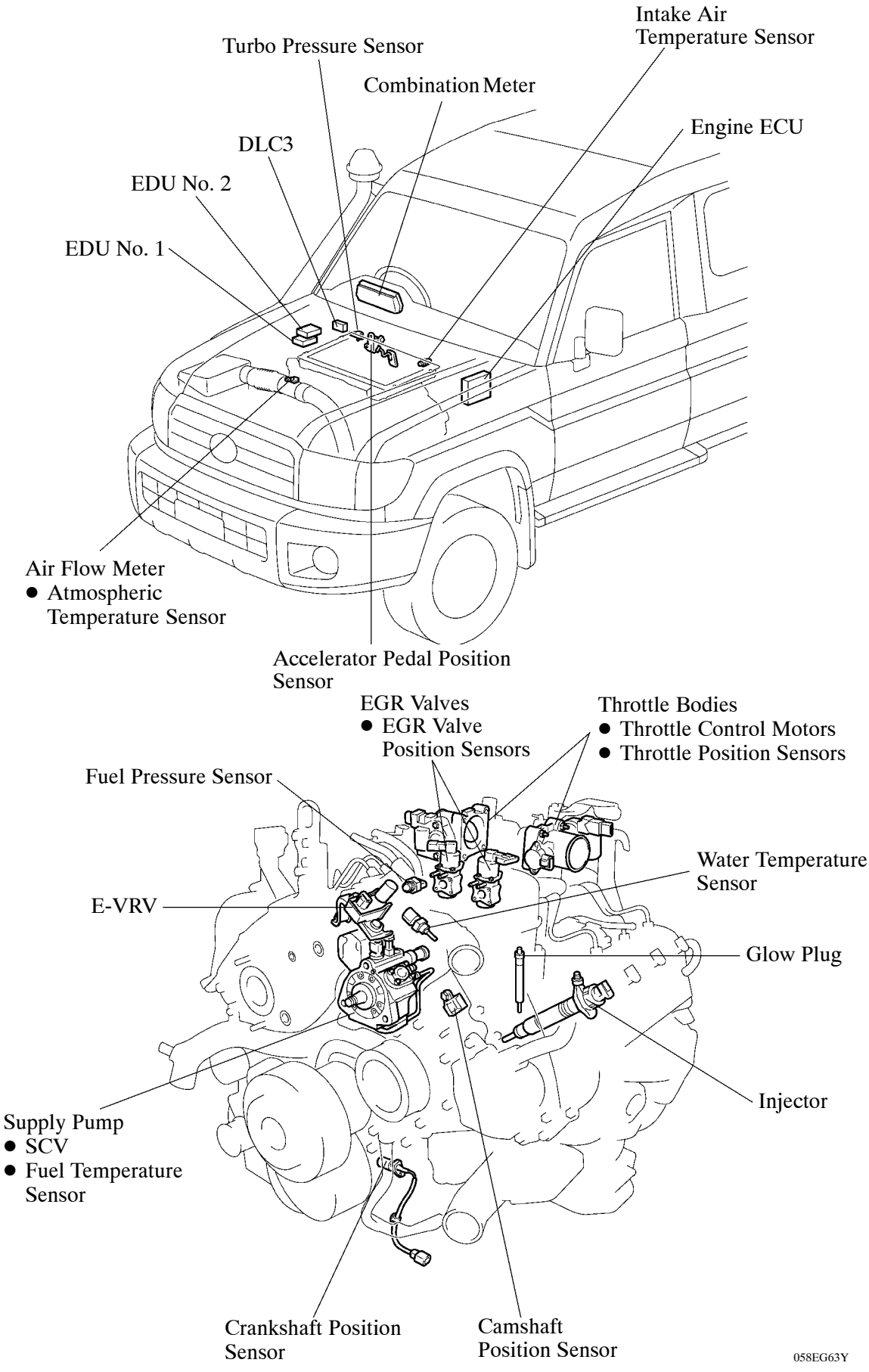
3. Engine Control System Diagram



058EG62Y

NF

4. Layout of Main Components



5. Main Components of Engine Control System

General

The main components of the engine control system are as follows:

Components	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	2	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/1)	1	This sensor performs the cylinder identification.
Air Flow Meter	Hot-wire Type	1	This sensor uses a built-in hot-wire to directly detect the intake air mass and flow rate.
Atmospheric Temperature Sensor	Thermistor Type	1	● This sensor, which is provided at the air cleaner outlet, detects the atmospheric temperature by means of an internal thermistor. ● This sensor is built into the air flow meter.
Water Temperature Sensor	Thermistor Type	1	This sensor detects the engine water temperature by means of an internal thermistor.
Intake Air Temperature Sensor	Thermistor Type	1	This sensor detects the intake air temperature after the intercooler.

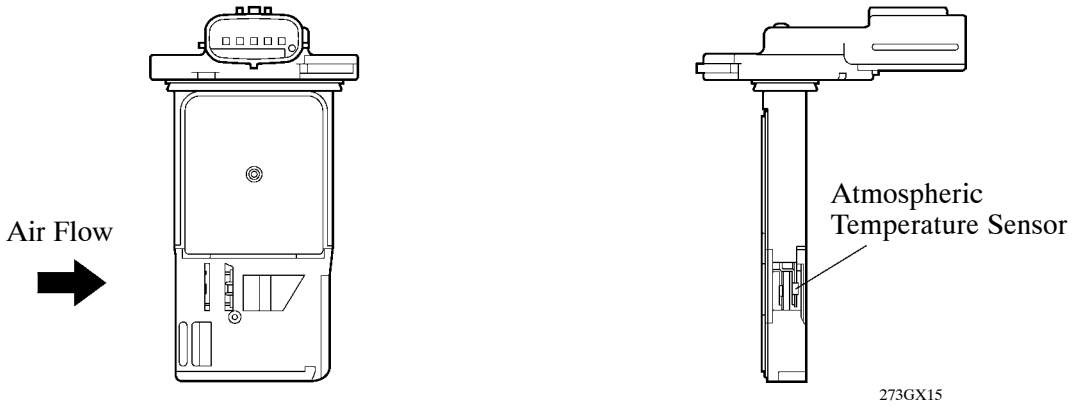
(Continued)

Components	Outline	Quantity	Function
Fuel Temperature Sensor	Thermistor Type	1	This sensor detects the fuel temperature in the supply pump by means of an internal thermistor.
Throttle Position Sensor	Non-contact Type	2	This sensor detects the throttle valve opening angle.
Accelerator Pedal Position Sensor	Non-contact Type	1	This sensor detects the amount of pedal effort applied to the accelerator pedal.
EGR Valve Position Sensor	Contact Type	2	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 engine ECU, and a fuel volume that suits the SCV position is drawn into the pumping portion (plunger portion).
Injector	9-hole Type	8	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.

Air Flow Meter

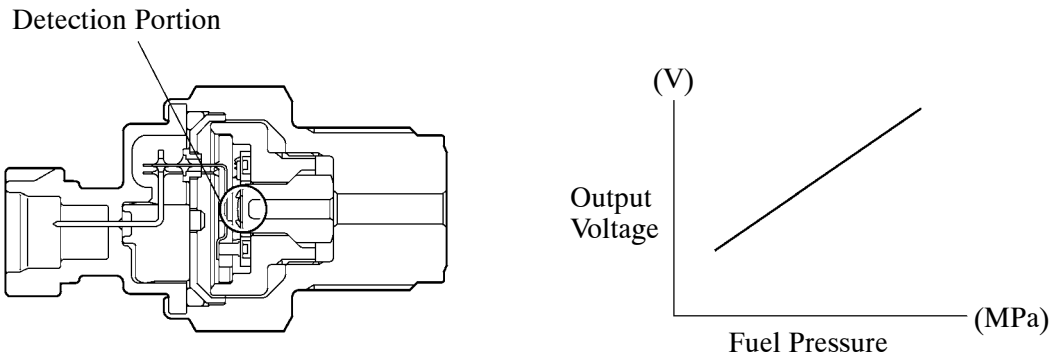
The air flow meter of diesel engine uses precise fuel injection volume control and EGR control to realize clean emission.

- The slotted drop-in type air flow meter is used, and this 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 is ensured and the intake air resistance is reduced.
- The air flow meter has a built-in atmospheric temperature sensor.



Fuel Pressure Sensor

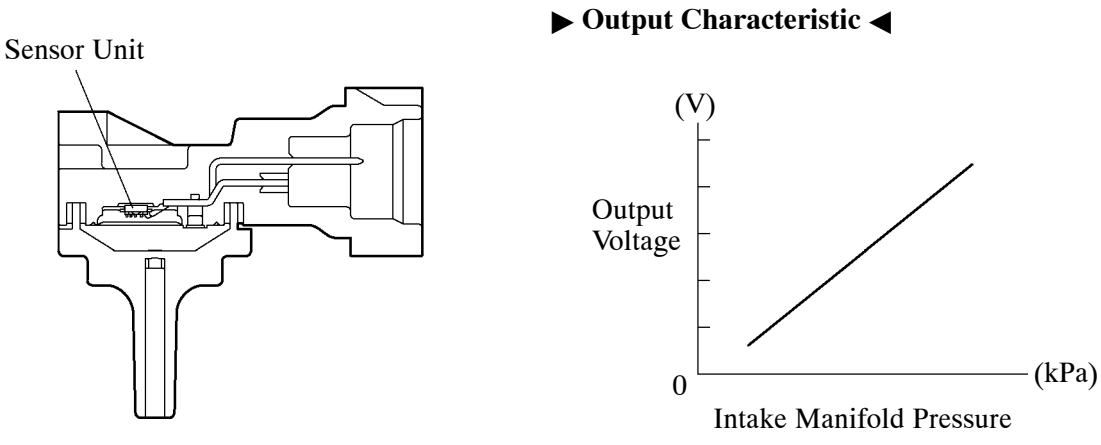
The fuel pressure sensor consists of a semiconductor which utilizes the characteristic of a silicon chip that changes its electrical resistance when pressure is applied to it. This sensor is mounted on the common-rail, outputs a signal that represents the fuel pressure in the common-rail to the engine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



058EG64Y

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.

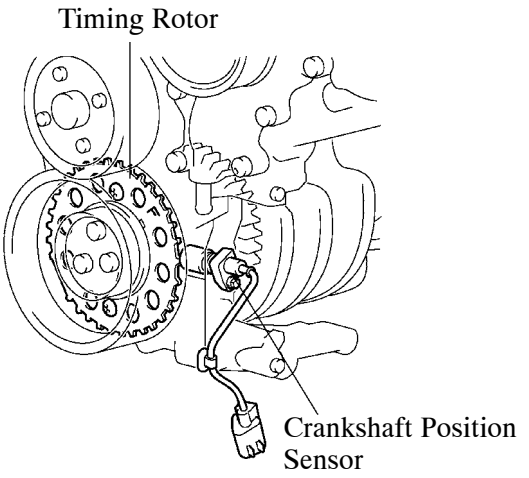


032EG37Y

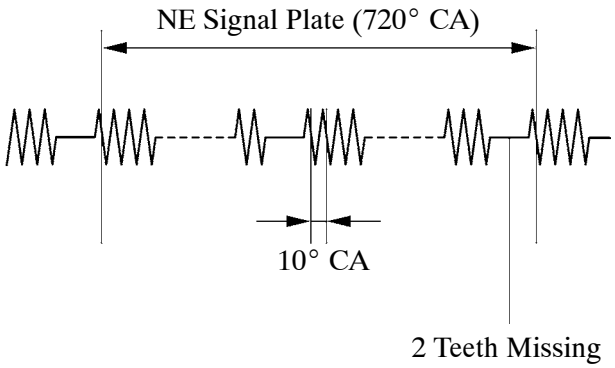
NF

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.



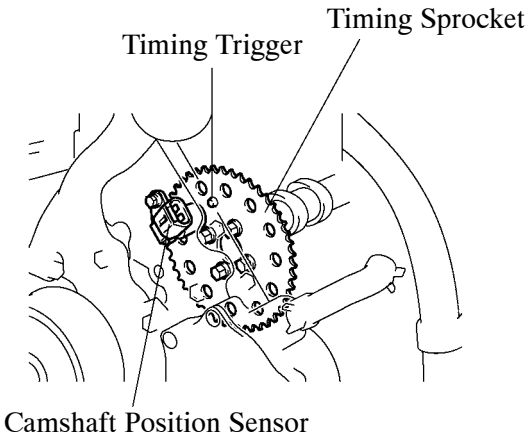
058EG56Y



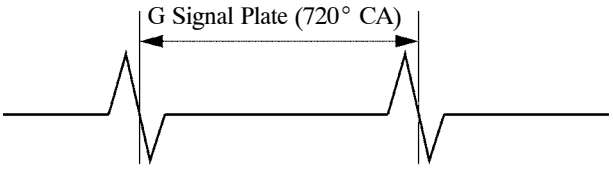
240EG90

Camshaft Position Sensor

The Hall element type camshaft position sensor is used to detect the camshaft position. The sensor generates one signal in every two revolutions of the crankshaft by using the timing trigger of the timing sprocket.



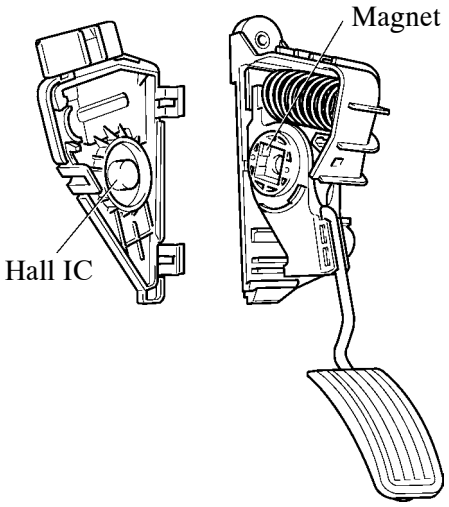
058EG57Y



288EG95C

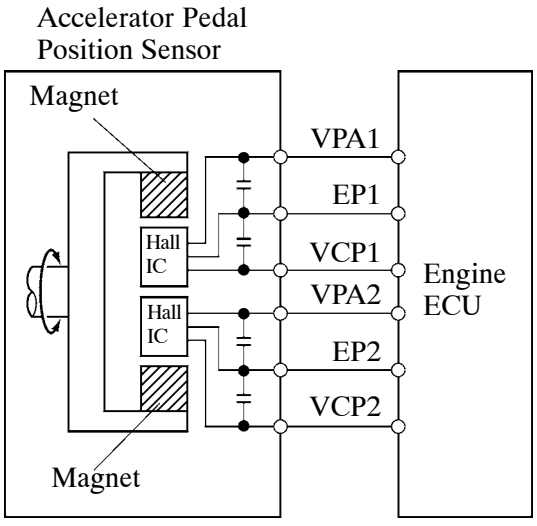
Accelerator Pedal Position Sensor

The accelerator pedal position sensor converts the acceleration pedal depressing angles into electrical signals with two differing characteristics and outputs them to the engine ECU. One is the VPA1 signal that linearly outputs the voltage along the entire range of the accelerator pedal depressed angle. The other is the VPA2 signal that outputs an offset voltage.



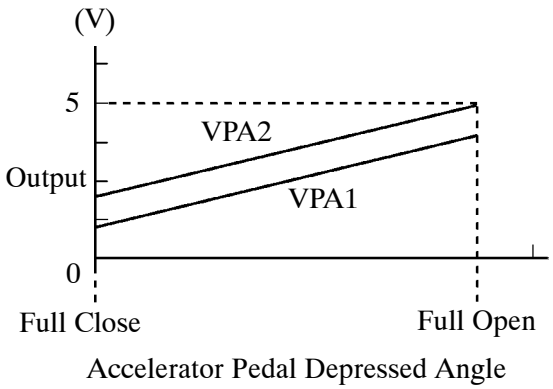
286EG12

▶ System Diagram ◀



228TU24

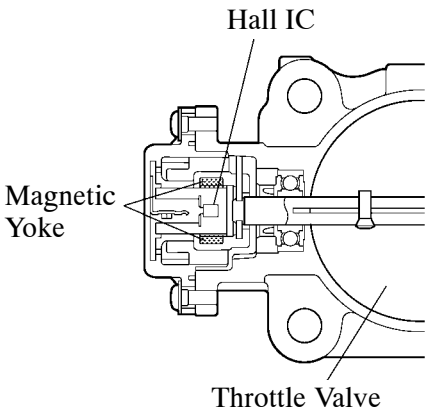
▶ Output Characteristic ◀



228TU25

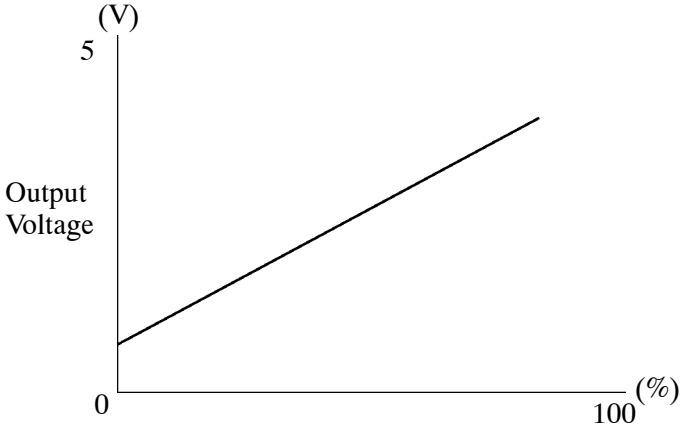
Throttle Position Sensor

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 that of the throttle valve shaft) rotates around the Hall IC into electric signals to operate the throttle control motor.



271EG82

▶ Output Characteristic ◀

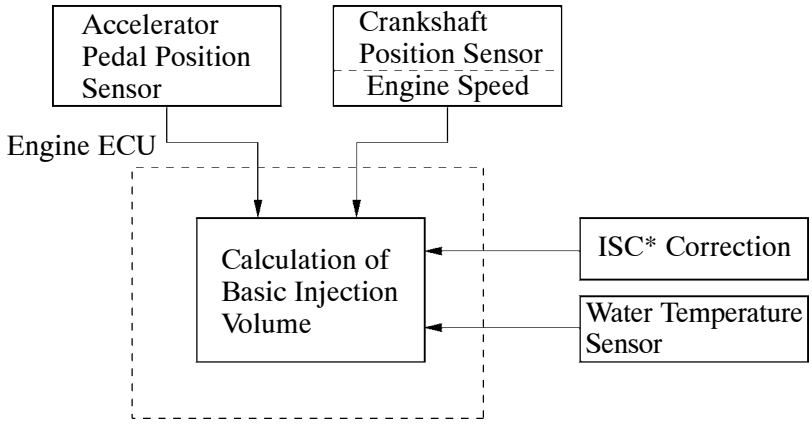


271EG83

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.

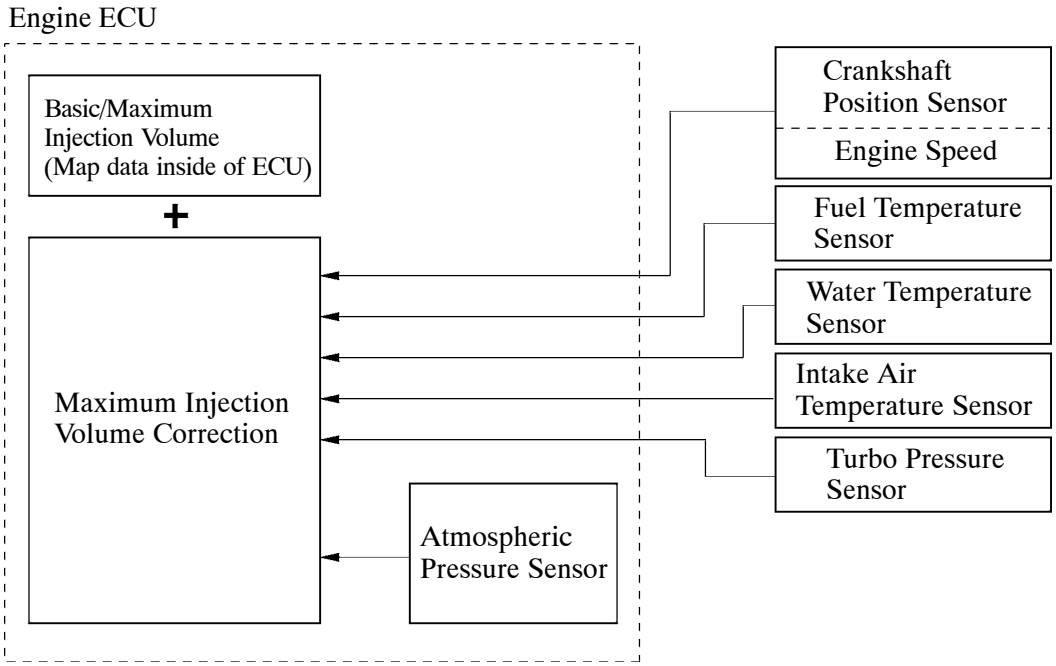
▶ Basic Injection Volume ◀



058EG29Y

*: Idle Speed Control

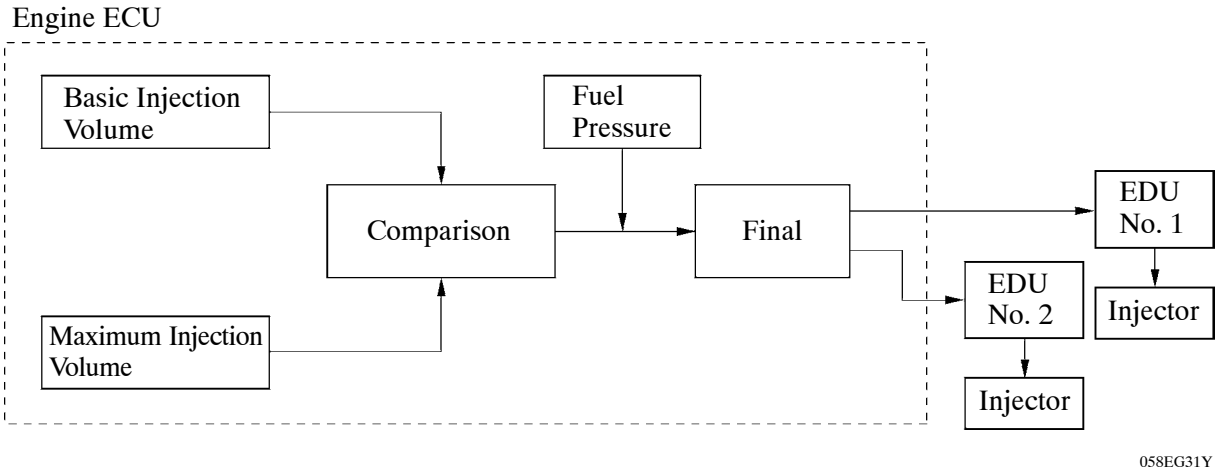
▶ Maximum Injection Volume ◀



058EG30Y

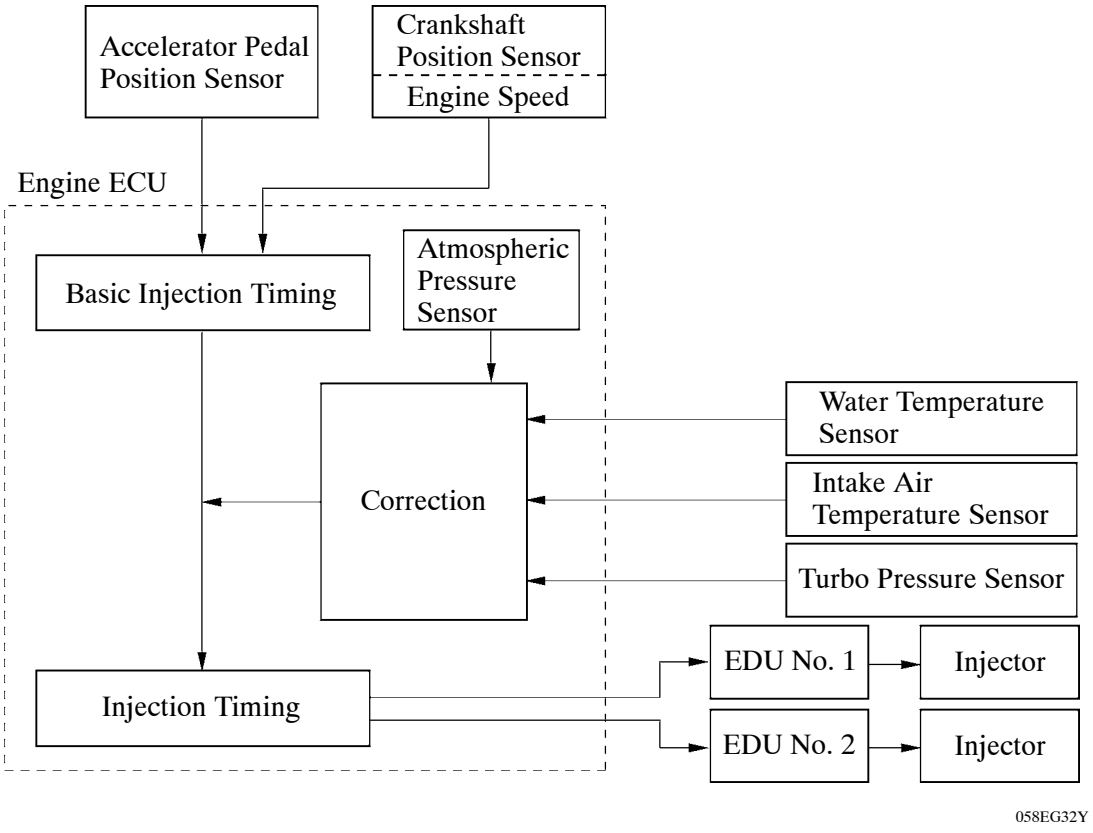
NF

▶ Final Injection Volume Decision ◀



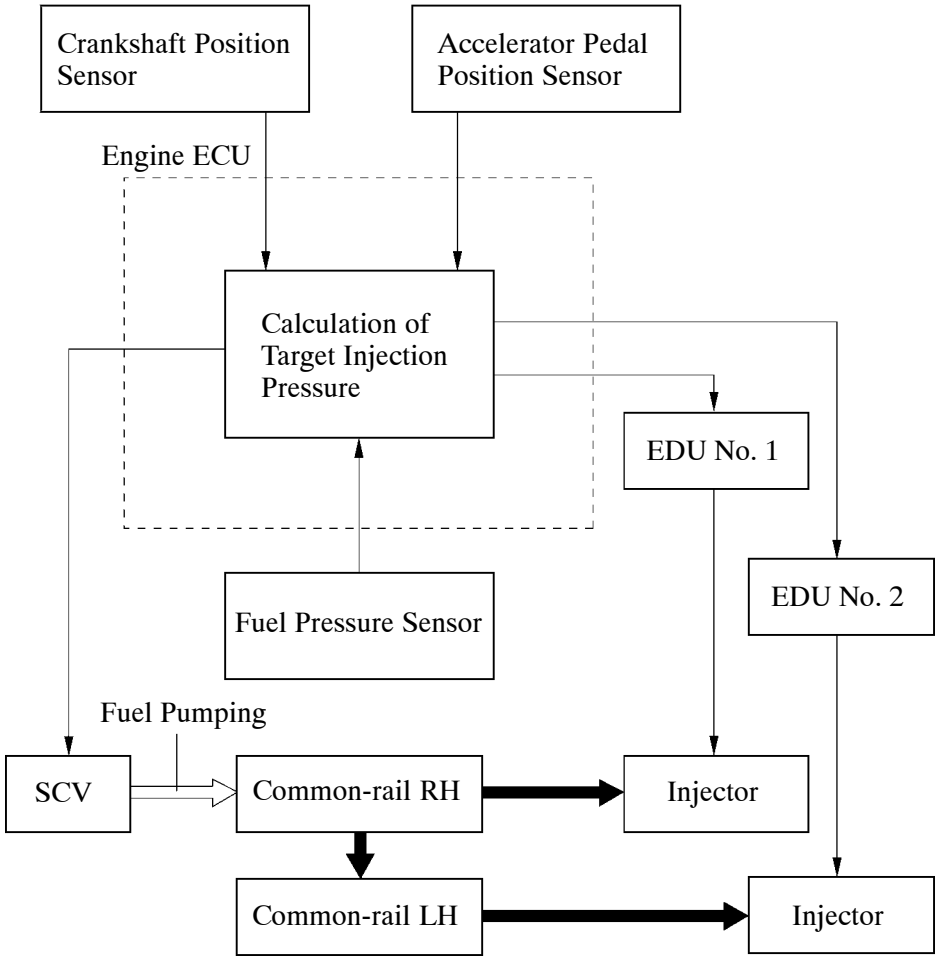
7. Fuel Injection Timing Control

Fuel injection timing is controlled as shown below.



8. Fuel Pressure Control

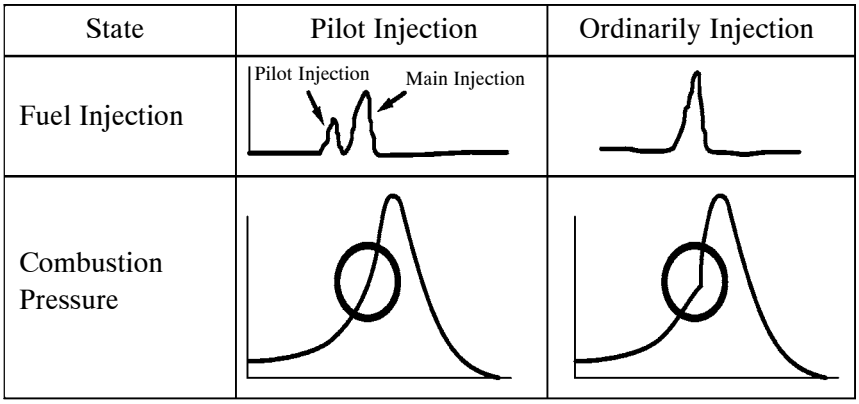
The engine ECU calculates the target injection pressure (25 – 157 MPa) based on the engine conditions, that are the signals from the accelerator pedal position sensor and the crankshaft position sensor.
To control fuel pressure, signals sent to SCV (Suction Control Valve) of the supply pump regulate the pumping volume, so that the pressure detected by the fuel pressure sensor matches the target injection pressure.



058EG33Y

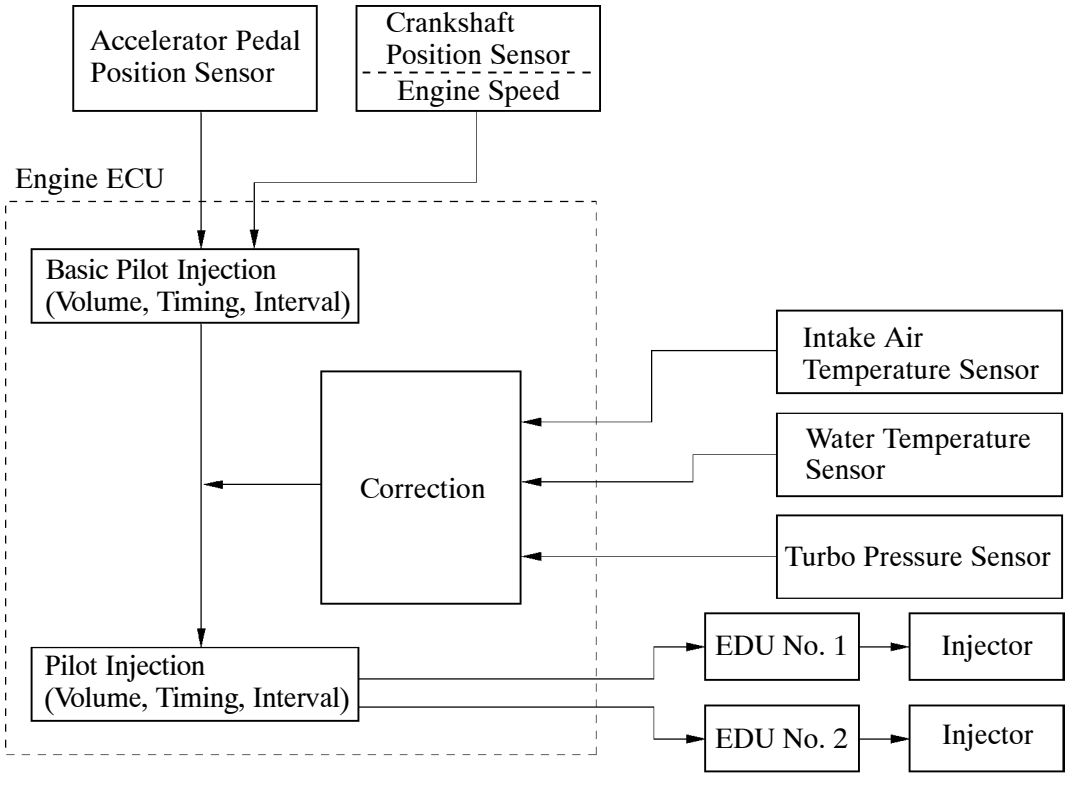
9. Pilot Injection Control

- Pilot injection is a method that provides auxiliary fuel injection before the main 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.



168EG23

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

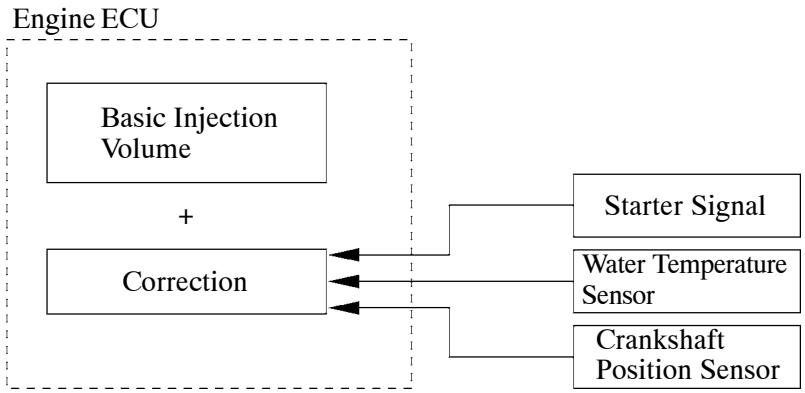


058EG34Y

10. During Starting Control

Injection Volume Control

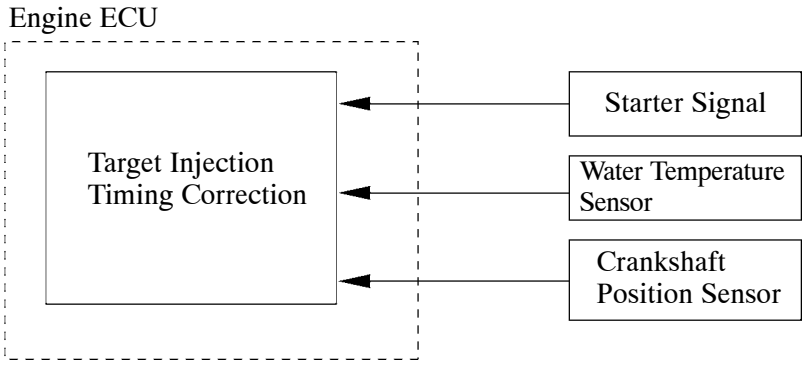
The starting injection volume is determined by adjusting the basic injection volume in accordance with the starter ON signals (ON time), water temperature sensor signals and engine speed signal. When the engine is cold, the water temperature will be lower and the injection volume will be greater.



224EG50

Injection Timing Control

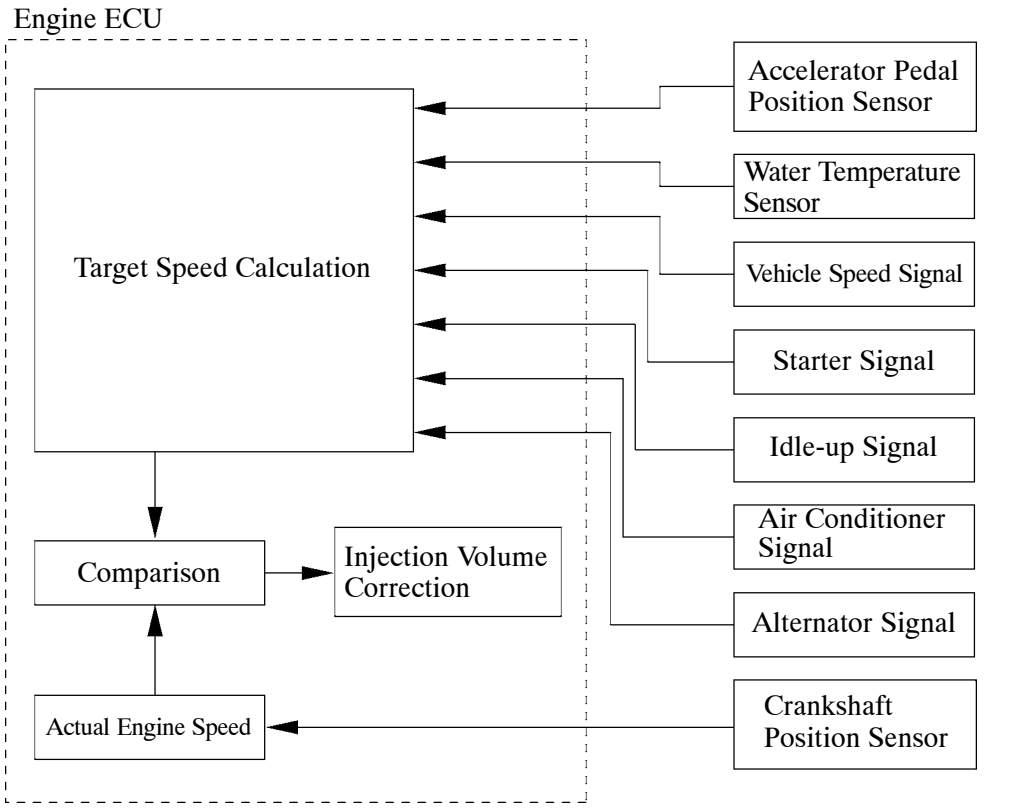
To determine the starting injection timing, the target injection timing is corrected in accordance with the starter signals, water temperature, and engine speed.
When the water temperature is low, if the engine speed is high, the injection timing is advanced.



224EG51

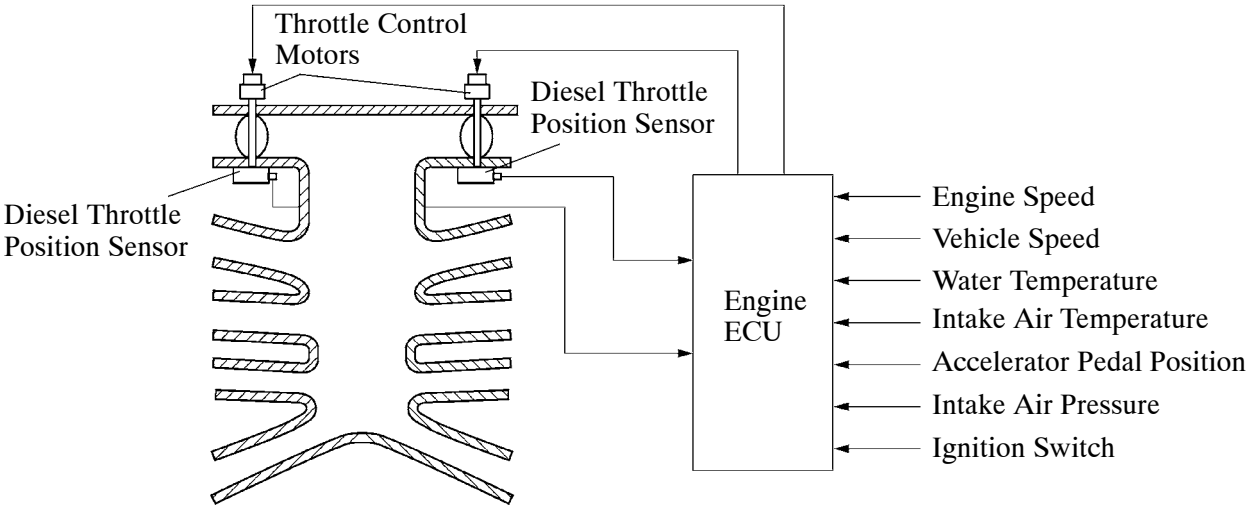
11. Idle Speed Control

Fuel injection timing is controlled as shown below.



12. Throttle Control

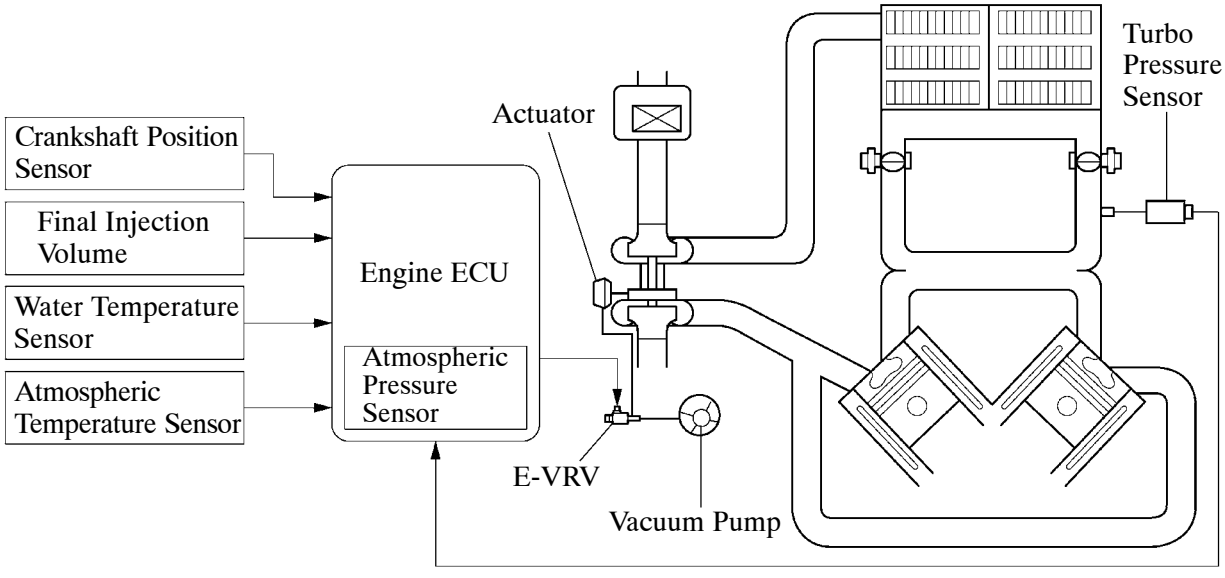
The opening of the throttle valve is controlled by the engine ECU in accordance with engine conditions. As a result, the noise that is generated during idling and deceleration, as well as the noise and vibration that are generated when the engine is stopped, have been reduced.



13. Turbo Pressure Control

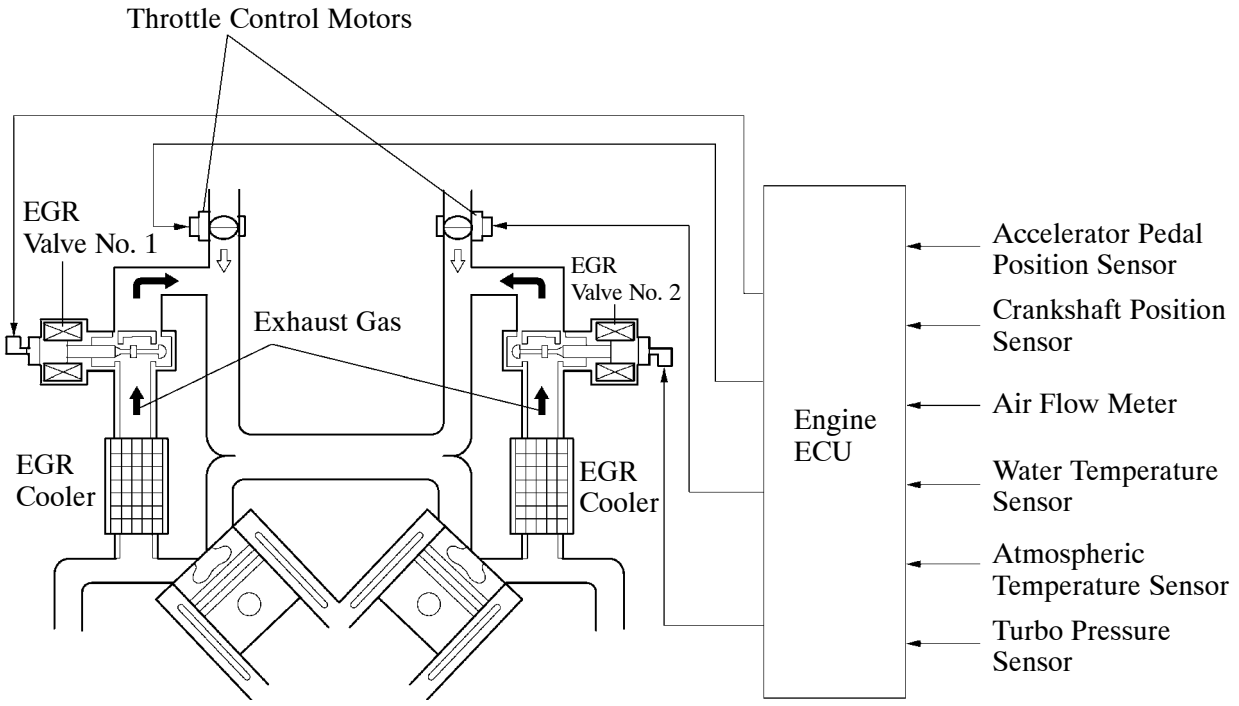
The engine ECU calculates an optimal turbo pressure in accordance with the driving conditions (engine speed, injection volume, atmospheric pressure, and water temperature). It controls the variable nozzle so that the turbo pressure detected by the turbo pressure sensor matches the calculated turbo pressure.

- The variable nozzle vane located in the turbine area controls the turbo pressure. The actuator that is directly connected to this nozzle actuates it. The actuator is actuated by the vacuum pressure that has been regulated by the E-VRV (for turbocharger control) in accordance with the signals from the engine ECU.



14. EGR Control

- This system is designed to reduce and control NOx formation due to a slight reduction of peak temperature in the engine combustion chamber, which is accomplished by introducing a small amount of inert gas into intake manifold.
- By sensing the engine driving conditions, the engine ECU operates the EGR valve and throttle control motor, and regulates the amount of exhaust gas.



15. Diagnosis

- 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 also stores the DTCs (Diagnostic Trouble Codes) of the malfunctions. The DTCs can be read by connecting the SST (09843-18040) to the TC and CG terminals of the DLC3, and observing the blinking of the check engine warning light (2-digit code), or by connecting the intelligent tester II to the DLC3 (5-digit code).
- By using the intelligent tester II, the 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 detects its last data of malfunction.
- For details, refer to the Land Cruiser Repair Manual (Pub. No. RM0580E).

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.

16. 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 Land Cruiser Repair Manual (Pub. No. RM0580E).