■ ENGINE CONTROL SYSTEM

1. General

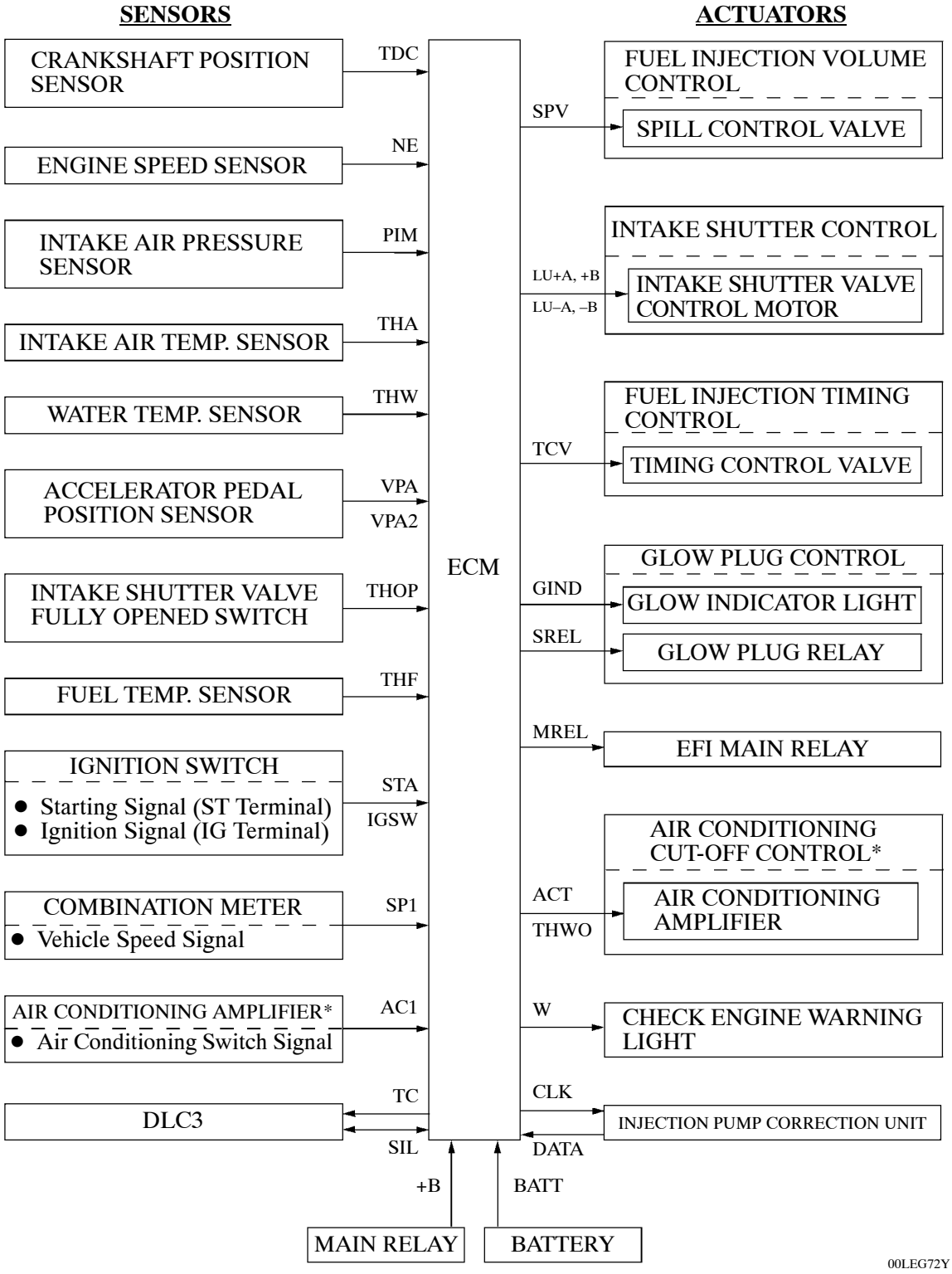
The engine control system for the 5L-E engine has following system.

System	Outline
Fuel Injection Volume Control (See Page EG-162)	Based on the signals received from the sensors, the ECM determines the fuel injection volume in accordance with the engine condition.
Fuel Injection Timing Control (See Page EG-164)	Based on the signals received from the sensors, the ECM determines the fuel injection timing in accordance with the engine condition.
Idle Speed Control (See Page EG-165)	The ECM 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.
Intake Shutter Control (See Page EG-166)	Fully closes the intake shutter valve (throttle valve) in order to reduce the vibration when the engine is stopped.
Air Conditioning Cut-off Control*	By controlling the air conditioning compressor on or off in accordance with the engine condition, driveability is maintained.
Diagnosis (See Page EG-167)	When the ECM detects a malfunction, it diagnoses and memorizes the failed section.
Fail-safe (See Page EG-167)	When the ECM detects a malfunction, it stops or controls the engine according to the data already stored in the memory.

*: Models with air conditioning

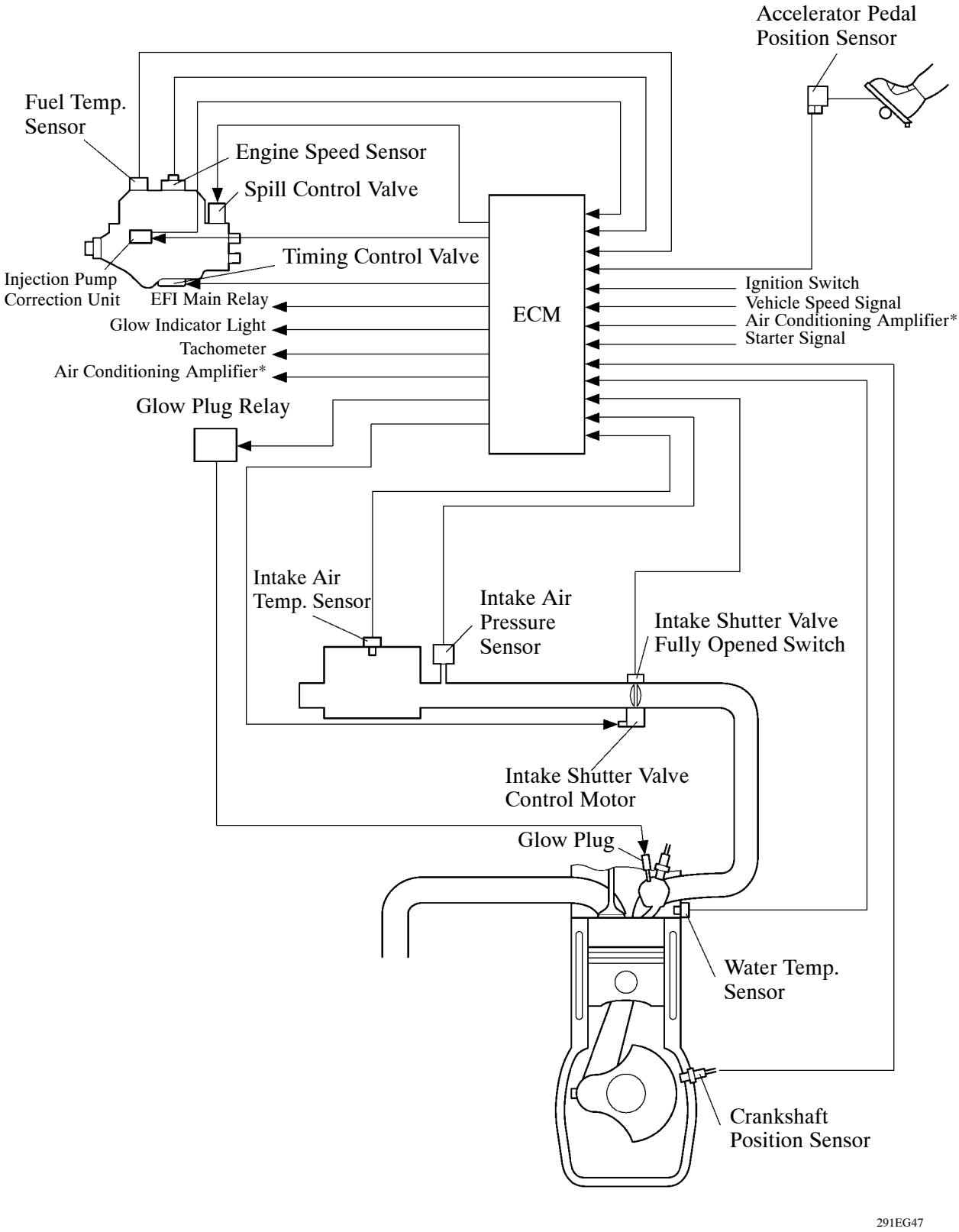
2. Construction

The configuration of the engine control system in 5L-E engine is shown in the following chart.



*: Models with air conditioning

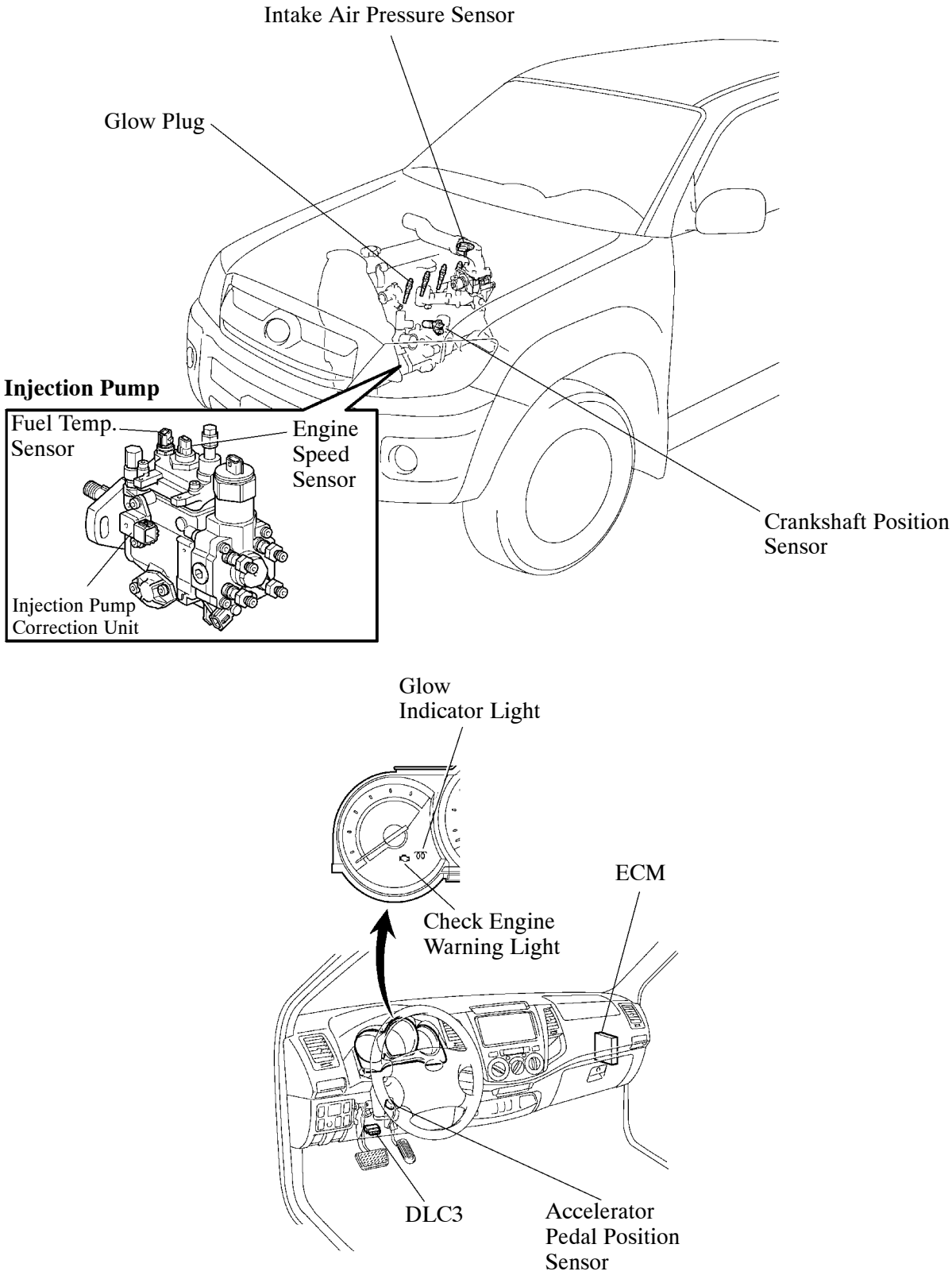
3. Engine Control System Diagram



*: Models with air conditioning

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4. Layout of Main Components



5. Main Components of Engine Control System

General

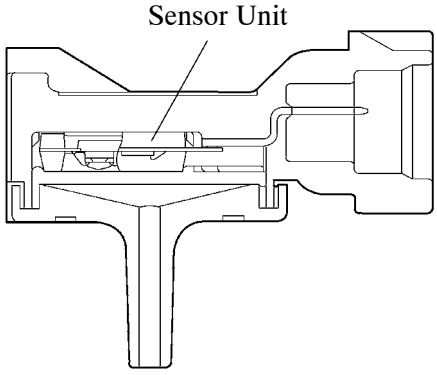
The main components of the 5L-E engine control system are as follows:

Components	Outline	Quantity	Function
ECM	16-bit CPU	1	The ECM 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.
Intake Air Pressure Sensor	Semiconductor Silicon Chip Type	1	This sensor uses built-in semiconductors to detect the intake manifold pressure.
Intake Air Temperature Sensor	Thermistor Type	1	This sensor detects the intake air temperature by means of an internal thermistor.
Crankshaft Position Sensor (Rotor Teeth/1)	Pick-up Coil Type	1	This sensor detects the engine speed and performs the cylinder identification.
Accelerator Pedal Position Sensor	Non-contact Type	1	This sensor detects the amount of pedal effort applied to the accelerator pedal.
Water Temperature Sensor	Thermistor Type	1	This sensor detects the engine coolant temperature by means of an internal thermistor.
Engine Speed Sensor (Rotor Teeth/56-8)	Pick-up Coil Type	1	This sensor is attached to the roller ring in the injection pump to detect the engine speed.
Spill Control Valve	Solenoid Valve Type	1	This valve controls the fuel injection volume in accordance with the signals received from the ECM.
Timing Control Valve	Duty Solenoid Type	1	This valve controls the fuel injection timing based on signals from the ECM.
Fuel Temperature Sensor	Thermistor Type	1	This sensor detects the fuel temperature in the injection pump by means of an internal thermistor.

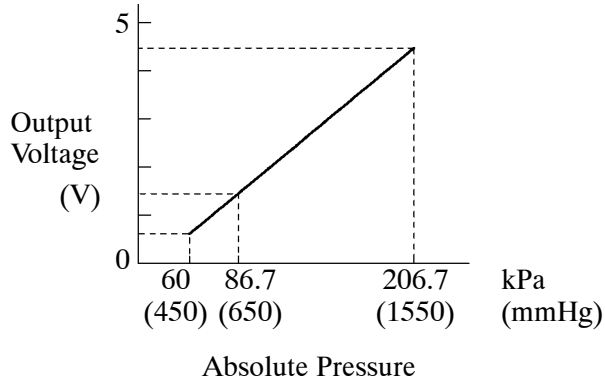
Intake Air Pressure Sensor

- The intake air pressure sensor is mounted on the intake manifold flange.
- It 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 pressure into an electrical signal, and sends it to the ECM in an amplified form.

▶ Intake Air Pressure Sensor Output Characteristics ◀



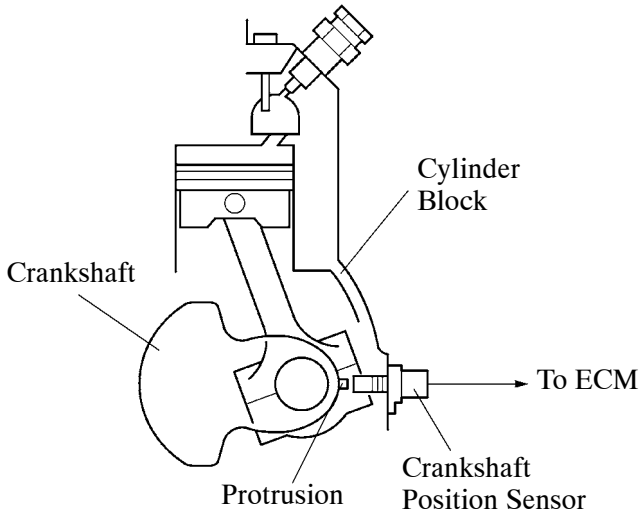
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Crankshaft Position Sensor

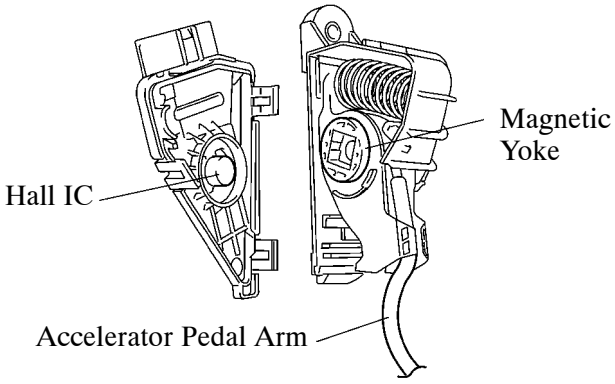
The crankshaft position sensor is installed on the cylinder block. Using the protrusion that is provided on the crankshaft, the sensor generates one signal for every revolution. This signal is then sent to the ECM as a crankshaft position signal.



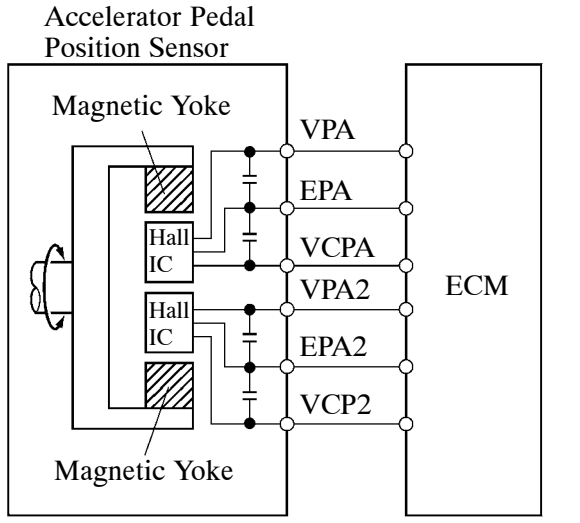
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Accelerator Pedal Position Sensor

The magnetic yoke that is mounted at the base of the accelerator pedal arm rotates around the Hall IC in accordance with the amount of effort that is applied to the accelerator pedal. The Hall IC converts the changes in the magnetic flux that occur into electrical signals, and outputs them in the form of accelerator pedal effort to the ECM.

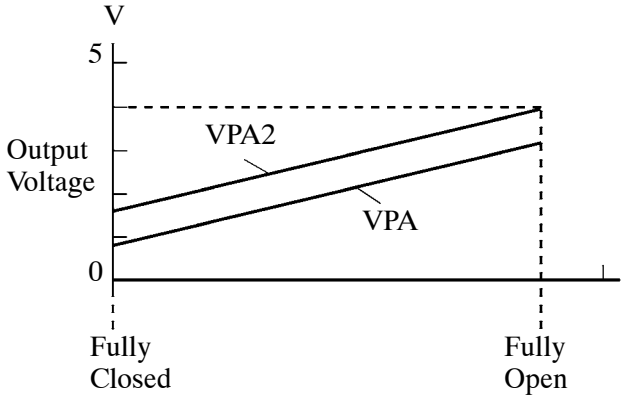


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▶ Accelerator Pedal Position Sensor Output Characteristics ◀



228TU25

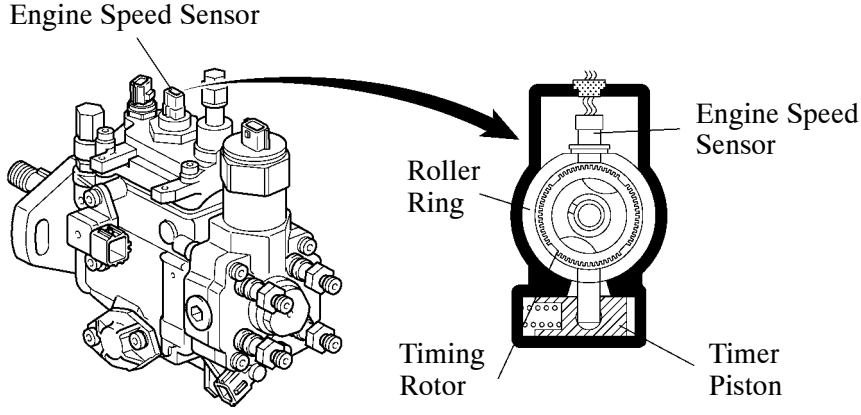
Service Tip

The inspection method differs from the conventional accelerator pedal position sensor because this sensor uses a Hall IC. For details, refer to the Hilux Repair Manual.

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Engine Speed Sensor

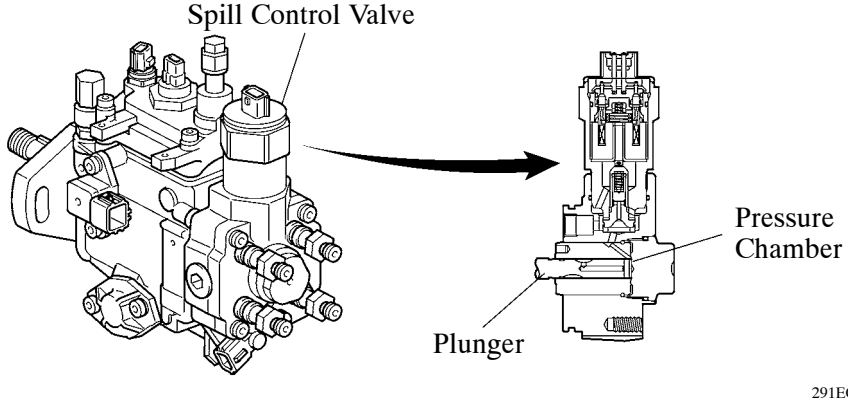
The engine speed sensor is attached to the roller ring in the injection pump to detect the engine speed. The timing rotor attached to the drive shaft is missing 2 teeth at each of the 4 locations, and generates a signal every 11.25° (crankshaft angle) with its 56 teeth.



291EG22

Spill Control Valve

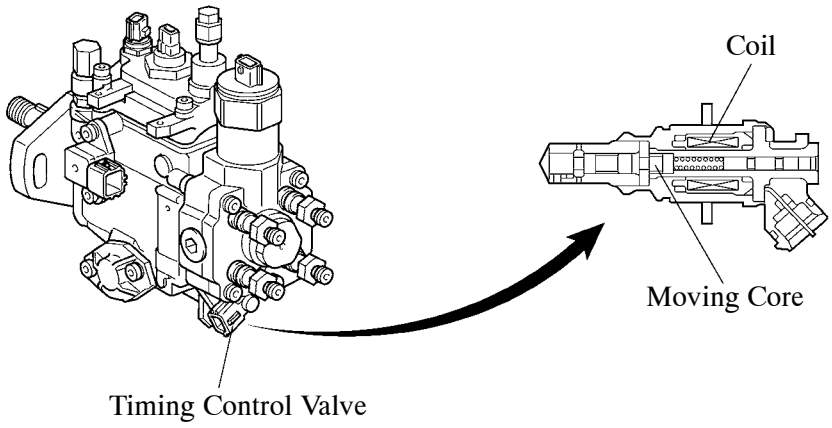
The spill control valve controls the fuel injection volume in accordance with the signals received from the ECM. When the current applied to the spill control valve is shut off, the valve in the spill control valve opens by the difference in pressures. Thus, the pressure in the plunger decreases causing the injection nozzle to stop injection fuel.
The length of time until the spill control valve is turned off is the same as the fuel injection time. Thus, the fuel injection volume is controlled by increasing or decreasing the length of time until the spill control valve is turned off.



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Timing Control Valve

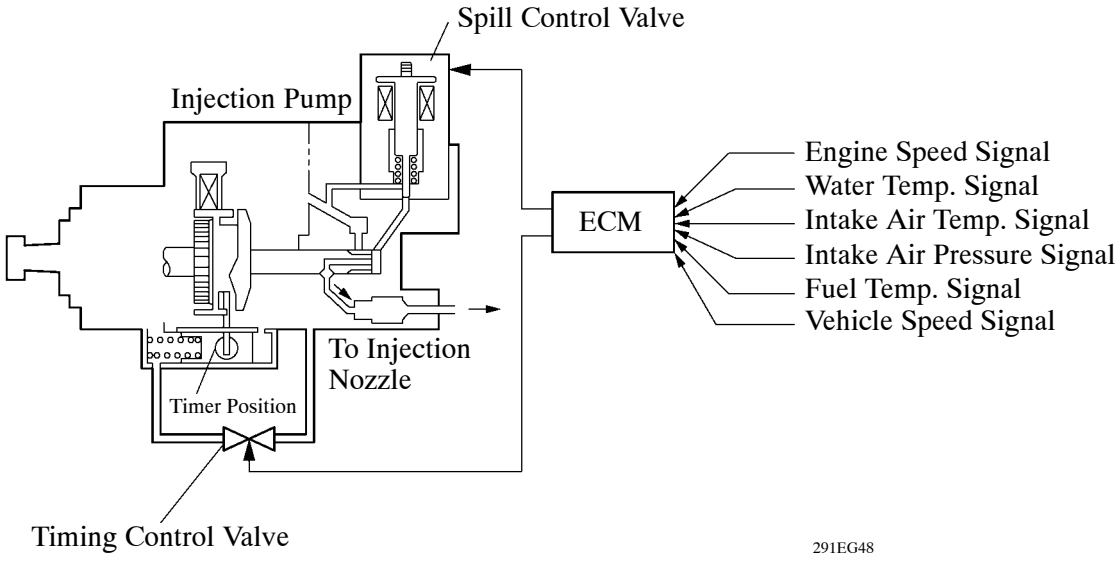
In accordance with the signals from the ECM, the timing control valve opens the valve in the fuel passage between the high-pressure chamber and the low-pressure chamber, thus controlling the injection timing. When the current flows to the coil of the timing control valve, the stator core becomes an electromagnet to push and compress the spring. This causes the moving core to retract and open the fuel passage.



291EG24

6. Fuel Injection Volume Control

Based on sensor signals, the ECM controls the fuel injection volume by calculating the fuel injection volume that is appropriate for the engine condition.



Function of ECM

The ECM calculates the basic injection volume based on the accelerator pedal opening and engine speed, and the maximum injection volume for the engine condition. The two injection volumes are compared, and the lesser of the two is selected. A correction value, which is obtained via the fuel pump calibration unit, is added to that injection volume, thus determining the fuel injection volume.

1) Basic Injection Volume

Determined in accordance with the throttle opening and the engine speed.

2) Maximum Injection Volume

Based on the signals received from the sensors, correction values are added to the theoretically required injection volume (basic maximum injection volume) to determine the maximum injection volume during engine operation.

a. Basic maximum injection volume

Determined in accordance with the engine speed.

b. Intake air pressure correction

Corrects the basic maximum injection volume in accordance with the intake air pressure.

c. Intake air temperature correction

Corrects the variance in the air-fuel ratio that is created by the difference in the density of the intake air in accordance with the intake air temperature. The higher the intake air temperature becomes, the smaller the injection volume becomes.

d. Fuel temperature correction

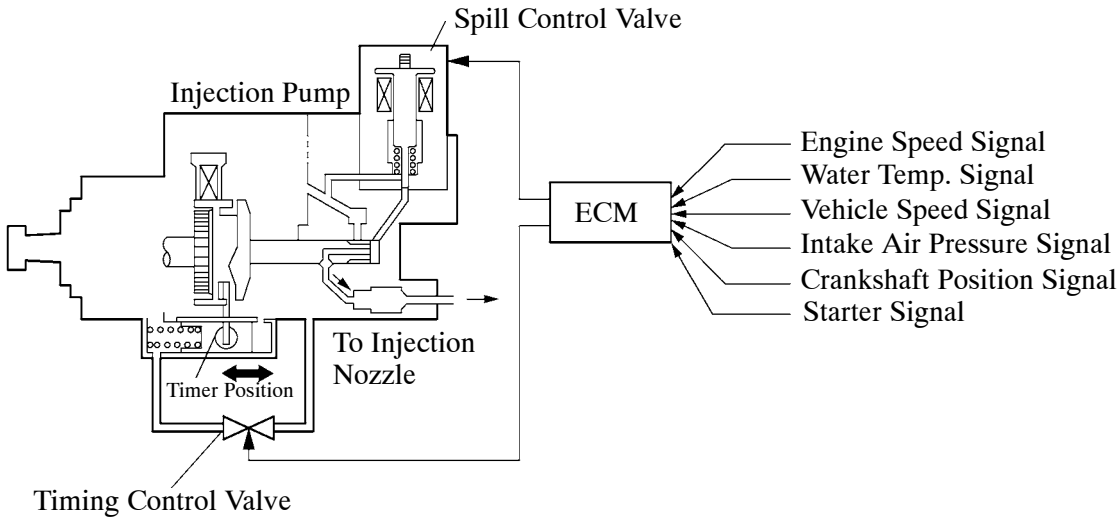
Corrects the variance in the injection volume that is created by the difference in the density of the fuel in accordance with the fuel temperature. The higher the fuel temperature becomes, the larger the injection volume becomes.

3) Starting Injection Volume Control

Determines the fuel injection volume during starting in accordance with the starting signal and the water temperature signal. When the engine is cold, the lower the water temperature becomes, the larger the injection volume becomes.

7. Fuel Injection Timing Control

Based on signals received from the sensors, the ECM calculates and controls the fuel injection timing that is optimal for the engine condition.



Function of ECM

The ECM adds the corrections from the sensor signals to the basic fuel injection timing to calculate the fuel injection timing that is optimal for the engine condition.

1) Basic Injection Timing

The basic injection timing is determined in accordance with the injection volume and the engine speed.

2) Injection Timing Correction

a. Intake air pressure correction

Corrects the basic fuel injection timing in accordance with the intake air pressure. The injection timing is advanced when the intake air pressure is low such as in high altitude areas.

b. Water temperature correction

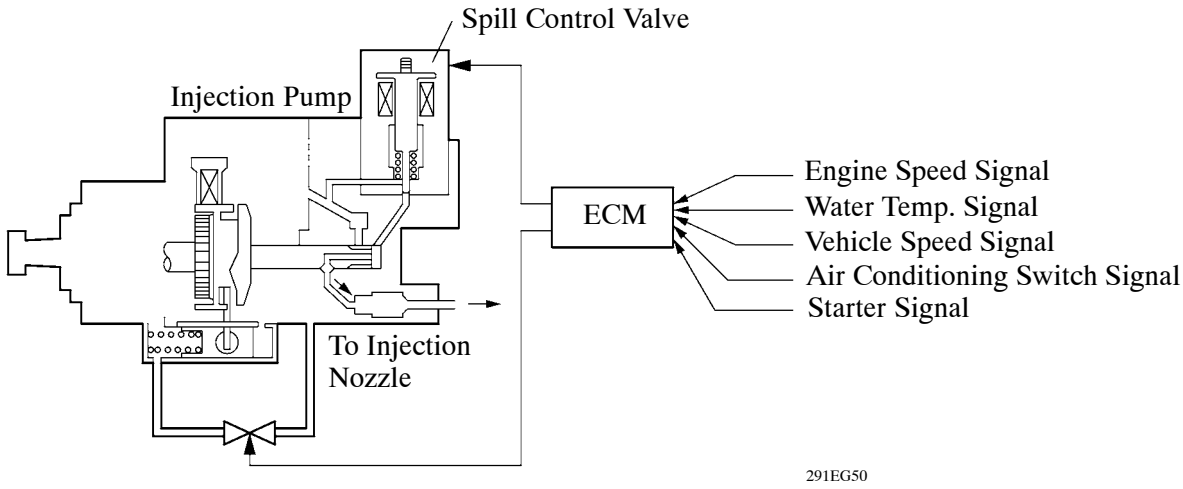
Corrects the basic fuel injection timing in accordance with the water temperature. The injection timing is advanced when the water temperature is low.

3) Starting Injection Timing control

The starting injection timing is determined in accordance with the starting signal, water temperature signal, and engine speed. The injection timing is advanced when the water temperature is low and engine speed is high.

8. Idle Speed Control

In this system, the ECM calculates the target engine speed in accordance with the engine condition, and determines the fuel injection volume, thus controlling the idle speed.



Function of ECM

1) Feedback Control

During idling, the feedback control controls the injection volume to achieve the target idle speed, if there is a difference between the target idle speed calculated by the ECM and the actual idle speed.

2) Warm-up Control

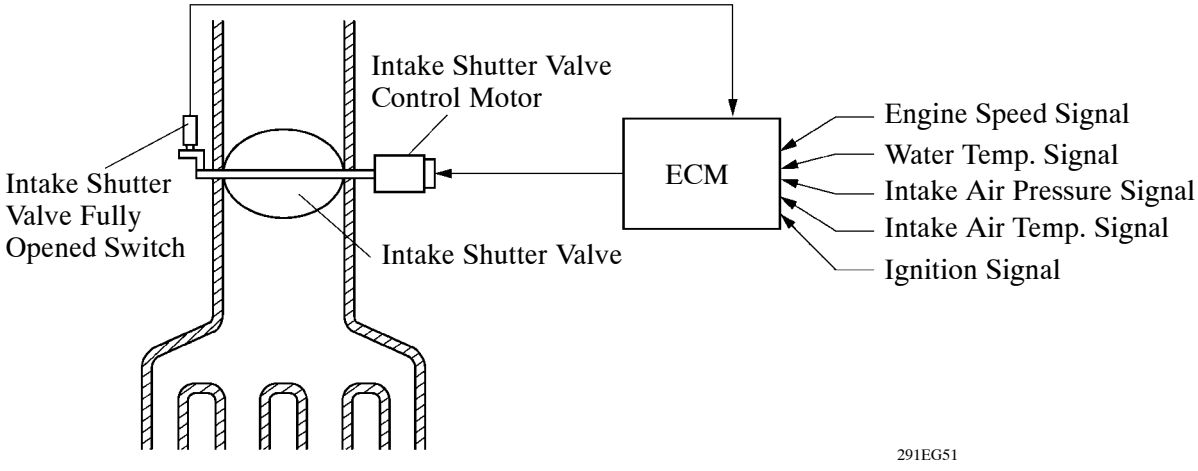
Controls the injection volume during warm-up, in accordance with water temperature, to achieve an optimal fast idle speed.

3) Engine Speed Changes Estimate Control

Immediately after the air conditioning switch is engaged, the idle speed can be affected by the change in the load that is applied to the engine. To prevent this symptom, the engine speed changes estimate control increases or decreases the injection volume before the idle speed changes.

9. Intake Shutter Control

The opening of the intake shutter valve (throttle valve) is controlled by the ECM in accordance with the engine conditions.
This reduces the noise that is generated during idling and deceleration, as well as the noise and vibration that is generated when the engine is stopped.



10. Diagnosis

- The diagnosis system of the 5L-E engine uses the M-OBD (Multiplex On-Board Diagnosis).
- When the ECM detects a malfunction, the it 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 of this.
- The 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.
- The ECM can output freeze-frame data to the intelligent tester II. This data is stored in the ECM at the very moment when the ECM has detected its last data of malfunction.
- All the DTCs have been made to correspond to the SAE controlled codes.
- For details, refer to the Hilux Repair Manual.

11. 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 ECM continues to control the engine control system in the normal way. To prevent such a problem, the fail-safe function of the ECM 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 Hilux Repair Manual.