■ENGINE CONTROL SYSTEM

1. General

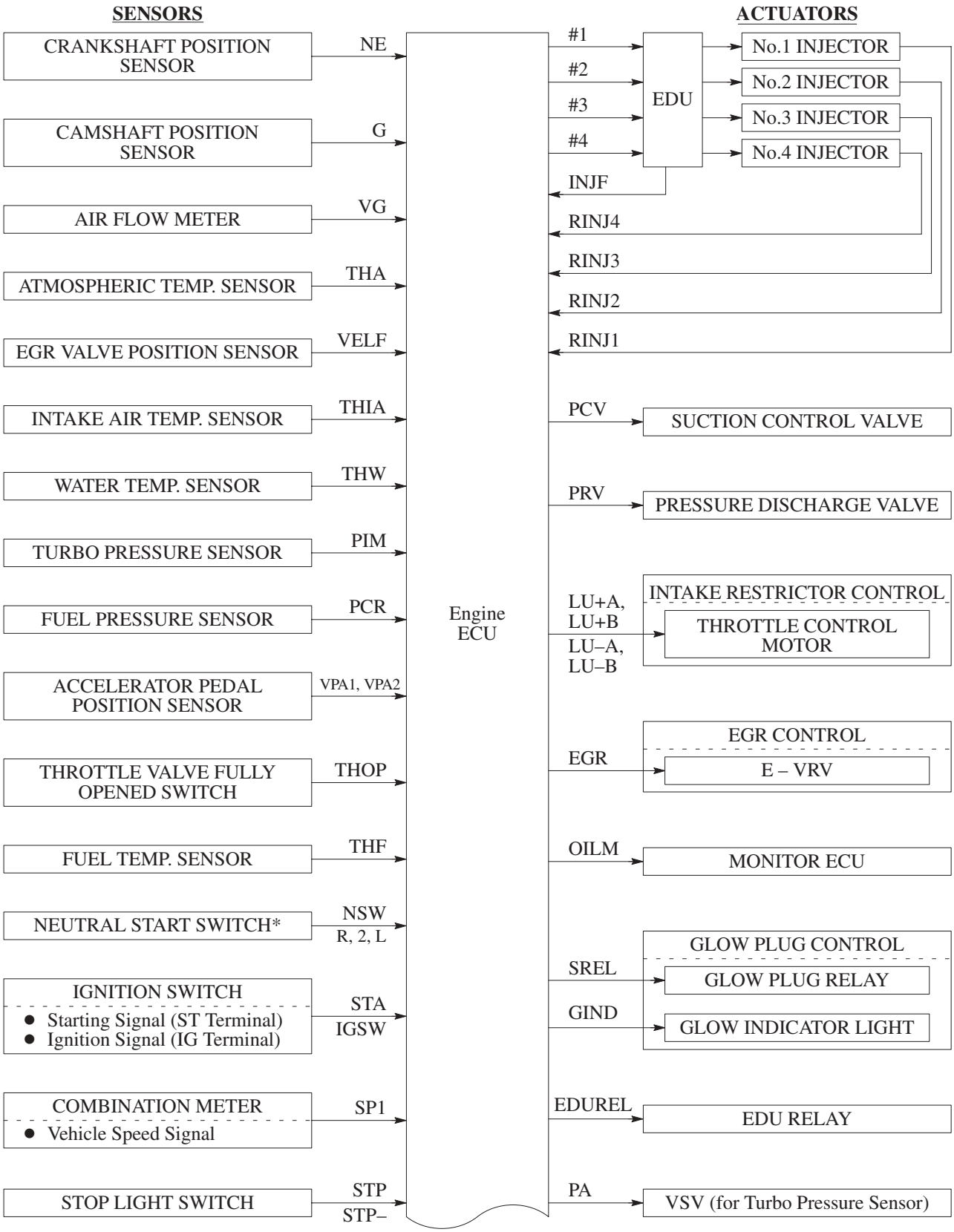
▶ System Comparison List ◀

System	Outline	2KD-FTV	1KD-FTV
Fuel Injection Volume Control (See page 54)	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 55)	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 59)	Based on the signals received from the sensors, the engine ECU determines the fuel pressure via SCV*1 and pressure discharge valve in accordance with the engine condition.	○	—
Fuel Pressure Control	Based on the signals received from the sensors, the engine ECU determines the fuel pressure via SCV in accordance with the engine condition.	—	○
Pilot Injection Control (See page 58)	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.	○	○
Idle Speed Control (See page 56)	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 engine coolant temperature.	○	○
EGR Control (See page 61)	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.	○	○
Turbo Pressure Control	Based on the signals received from the sensors, the engine ECU controls the actuator via VRV in accordance with the engine condition.	—	○
Intake Restrictor Control	Fully close the throttle in order to reduce the vibration when the engine is stopped.	○	○
Exhaust Gas Control System (See page 62)	Based on the signals received from the sensors, the engine ECU controls the exhaust control valve in accordance with the engine condition.	○	—
Air Conditioner*2 Cut-Off Control	By controlling the air conditioner compressor ON or OFF in accordance with the engine condition, drivability is maintained.	○	○
Engine Immobiliser*3	Prohibits fuel injection if an attempt is made to start the engine with an invalid ignition key.	○	○
Diagnosis (See page 63)	When the engine ECU detects a malfunction, the engine ECU diagnoses and memorizes the failed section.	○	○
Fail-safe (See page 64)	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: Suction Control Valve
*2: with Air Conditioner System
*3: with Engine Immobiliser System

2. Construction

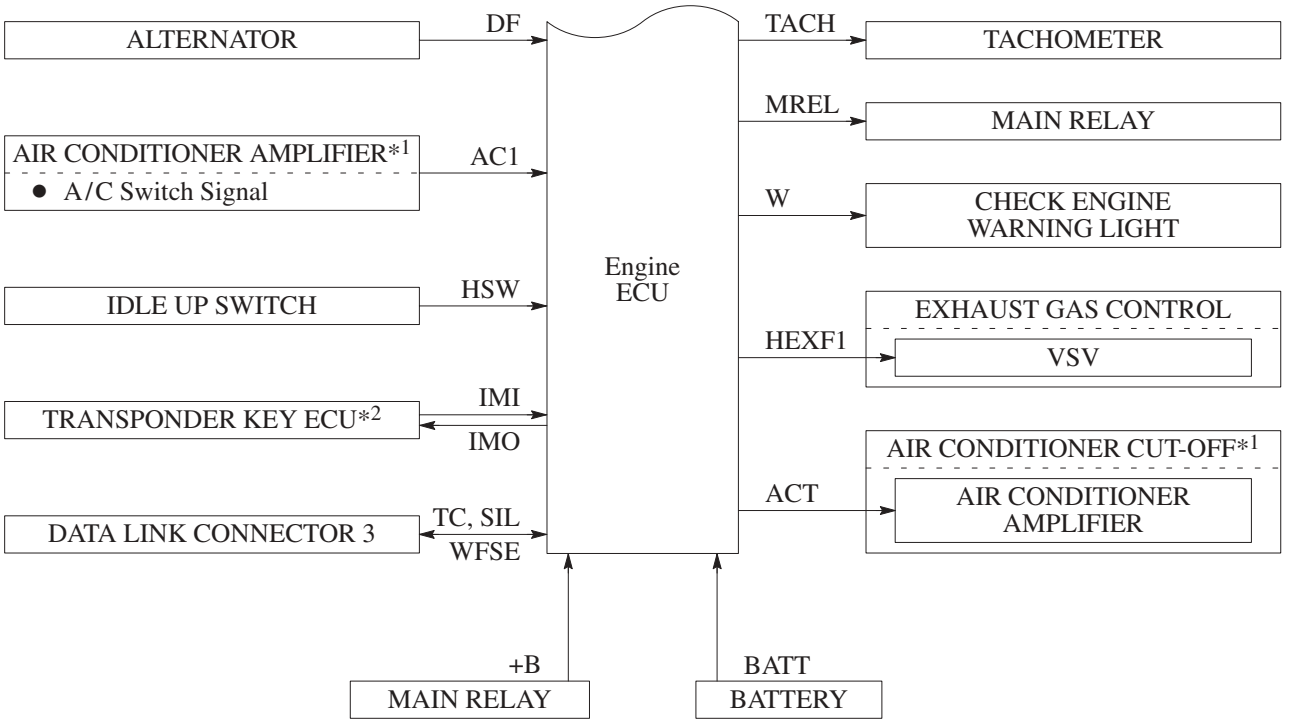
The configuration of the engine control system in the 2KD-FTV engine is shown in the following chart.



(Continued)

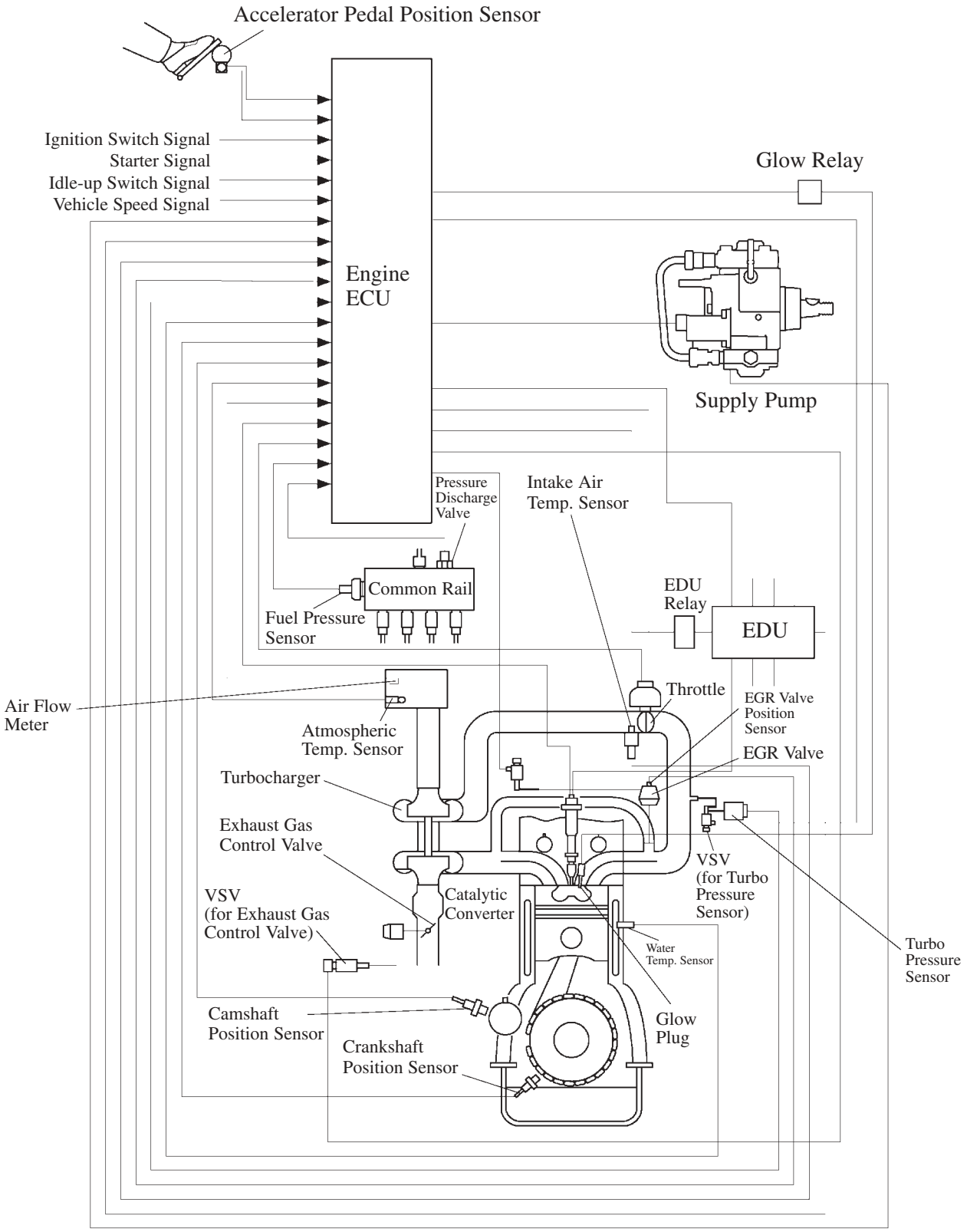
*: Models with Automatic Transmission

NF



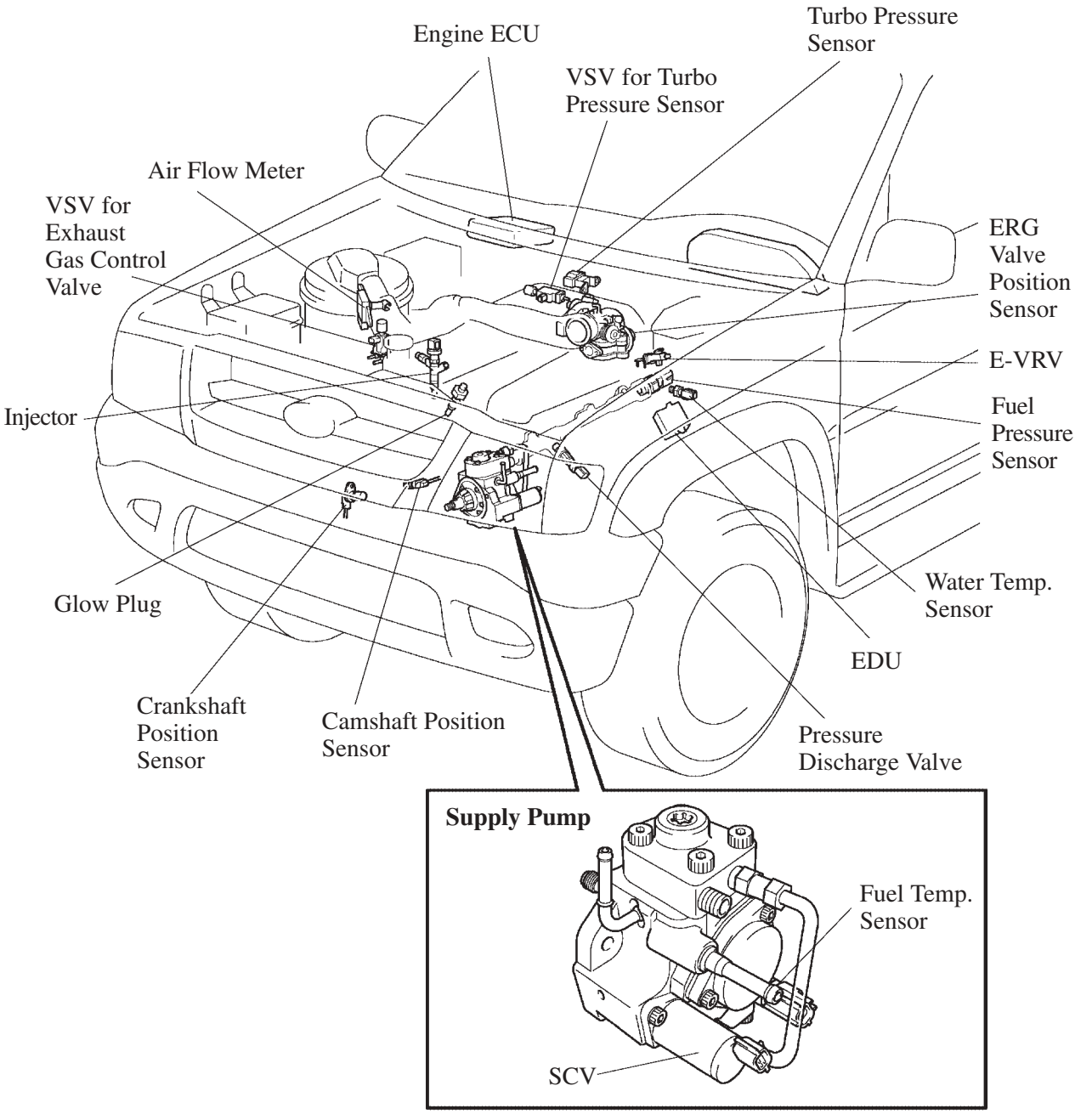
*1: with Air Conditioner System
*2: with Engine Immobiliser System

3. Engine Control System Diagram



215EG40

4. Layout of Main Components



210EG62

5. Main Component of Engine Control System

General

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

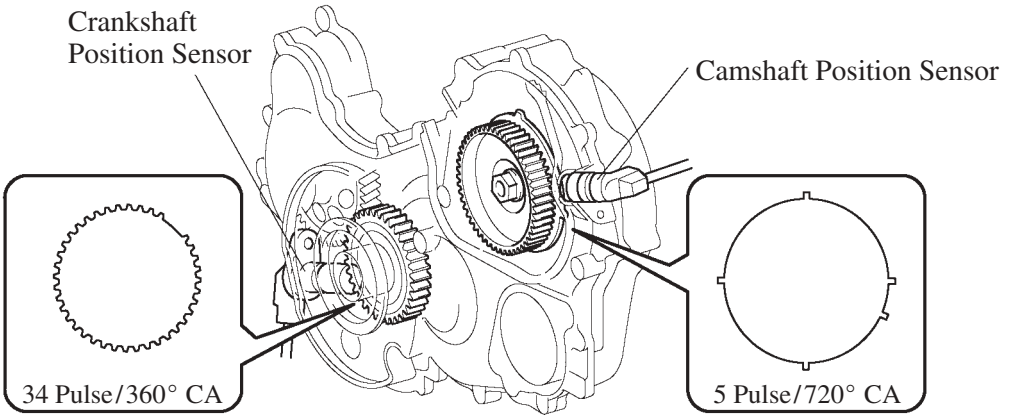
Components	Outline	Quantity
Engine ECU	32-bit CPU	1
Air Flow Meter	Hot-wire Type	1
Crankshaft Position Sensor (Rotor Teeth)	Pick-up Coil Type (36-2)	1
Camshaft Position Sensor (Rotor Teeth)	Pick-up Coil Type (5)	1
Accelerator Pedal Position Sensor	Linear Type	2 (Main, Sub)
EDU	DC/DC Converter	1

Engine ECU

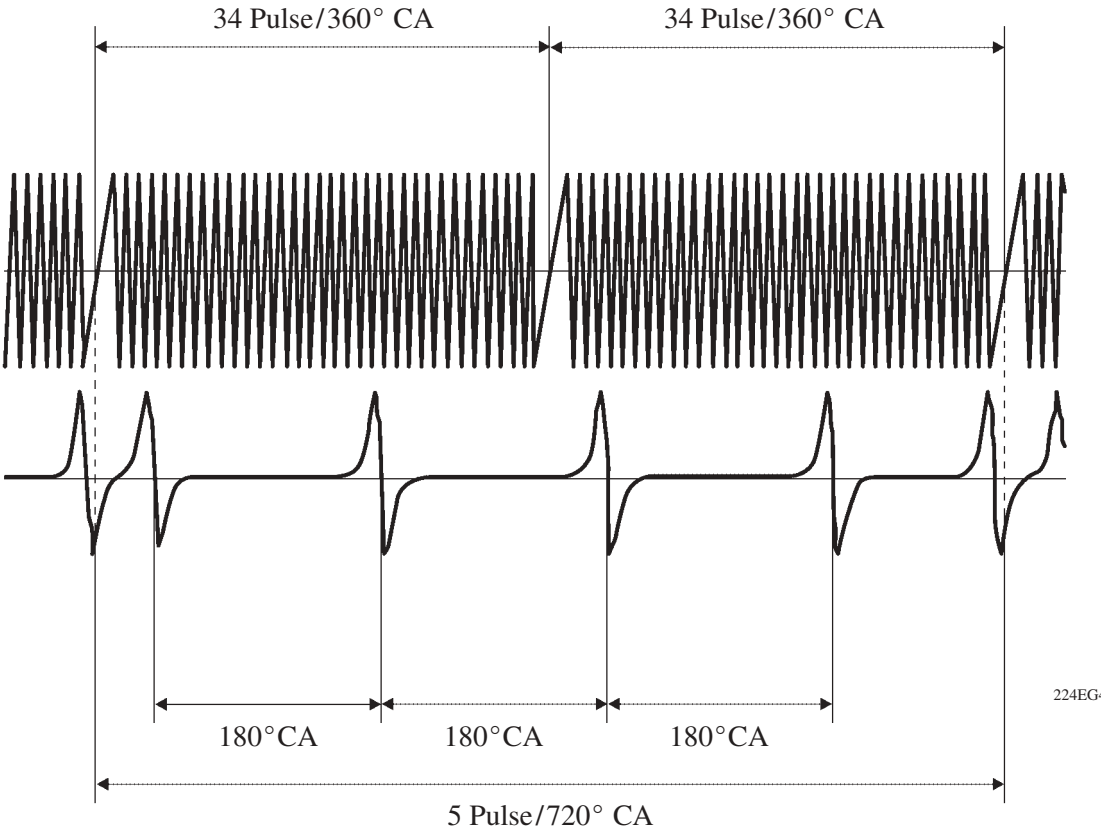
- Each of the 2WD model engine and the 4WD model engine is equipped with an engine ECU that contains an engine control program that differs from each other. However, both engine models share the same mechanical components.
- The 32-bit CPU of the engine ECU has been adopted to increase the speed for processing the signals.

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 pulse for every 2 revolution of the crankshaft.



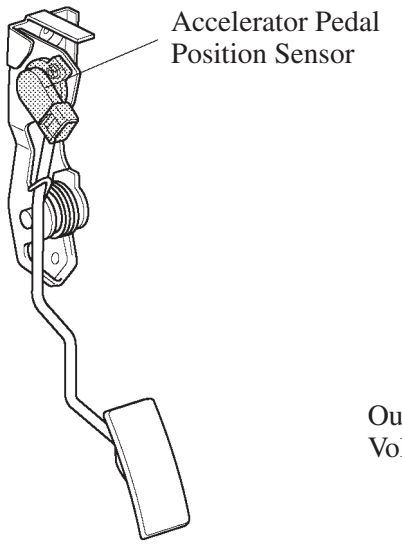
224EG41



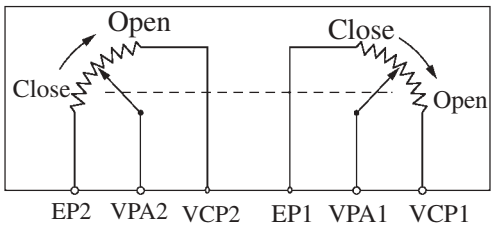
224EG42

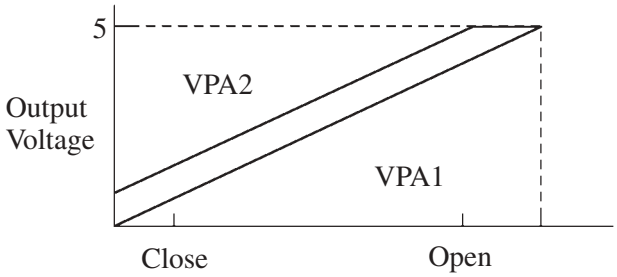
Accelerator Pedal Position Sensor

This sensor converts the accelerator pedal depressed angles into electric 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 on offset voltage.



210EG36





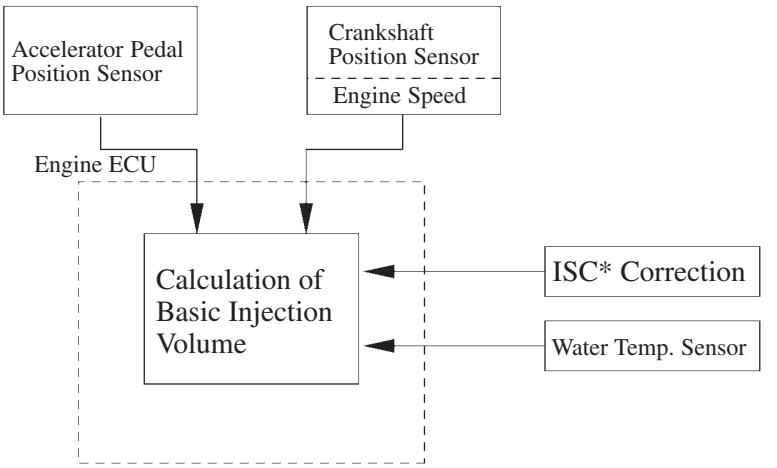
Accelerator Pedal Depressed Angle

199EG40

6. Fuel Injection Volume Control

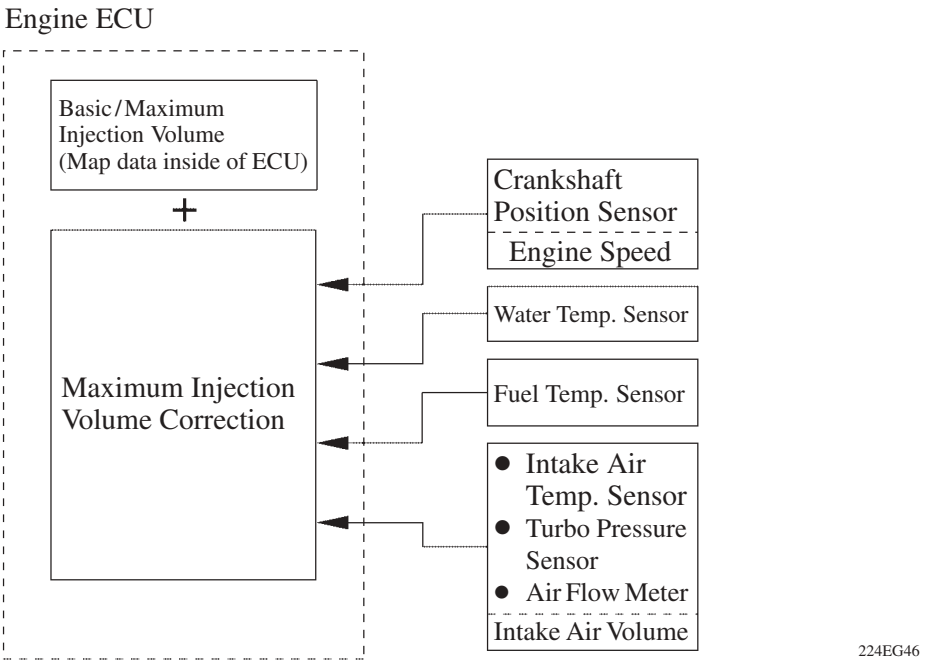
The engine ECU calculates two types of values: the basic injection volume and the maximum injection volume. Then, the engine ECU compares the basic and maximum injection volumes, and determines the smaller calculated value to be the final injection volume.

▶ Basic Injection Volume ◀

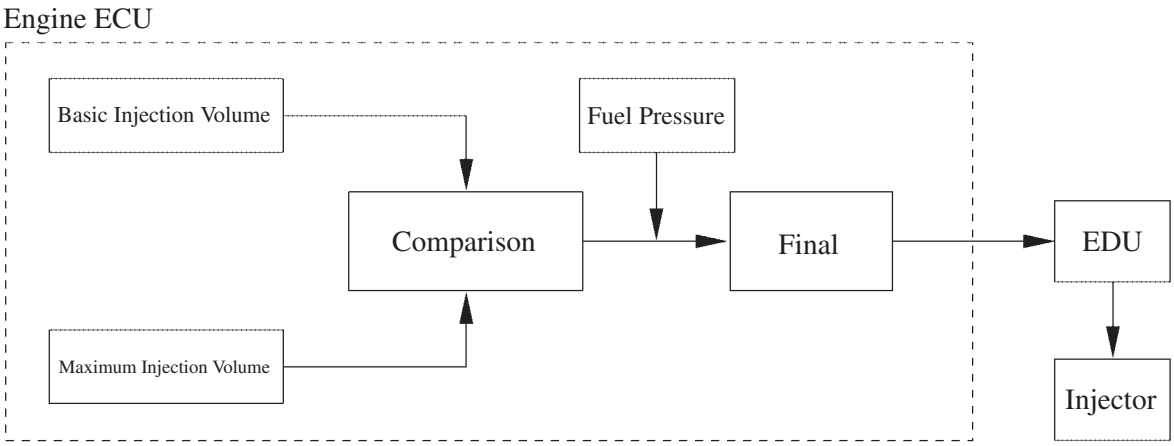


*: Idle Speed Control

▶ Maximum Injection Volume ◀



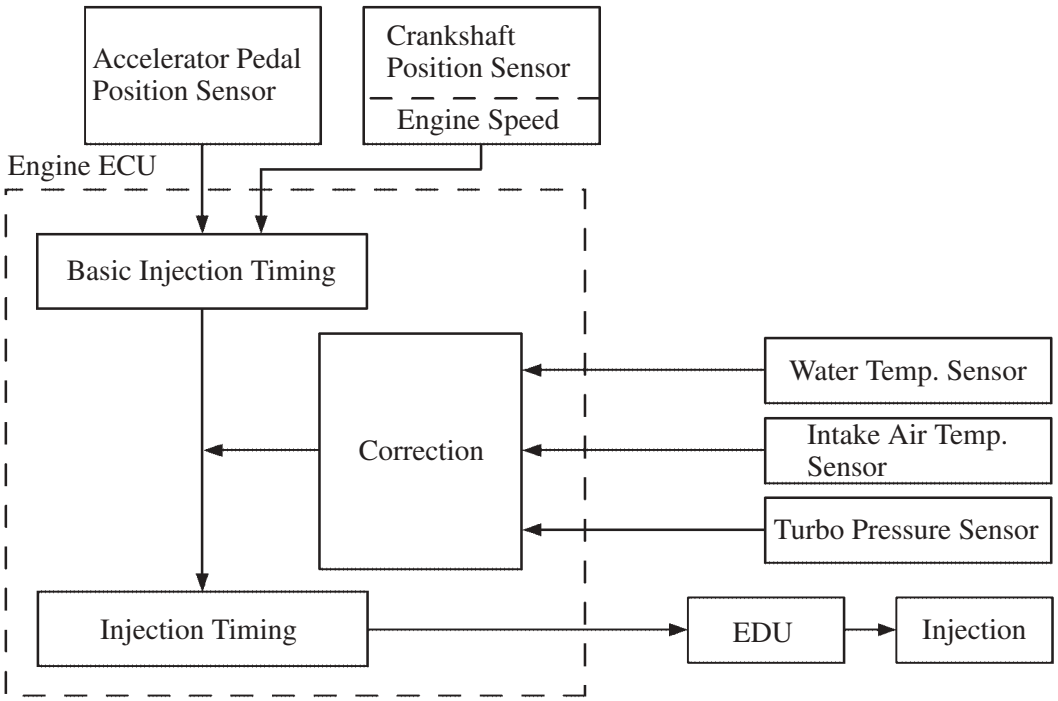
▶ Final Injection Volume Decision ◀



224EG48

7. Fuel Injection Timing Control

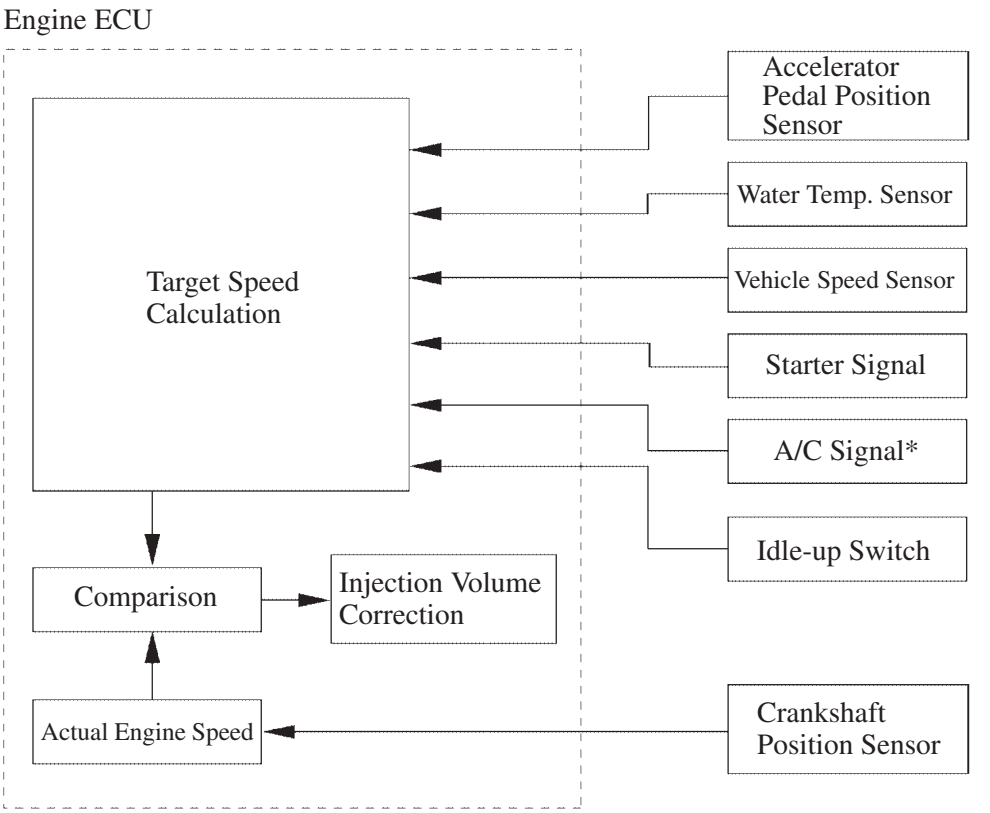
Fuel injection timing is controlled as shown below.



201EG45

8. Idle Speed Control

ISC correction is controlled as shown below.

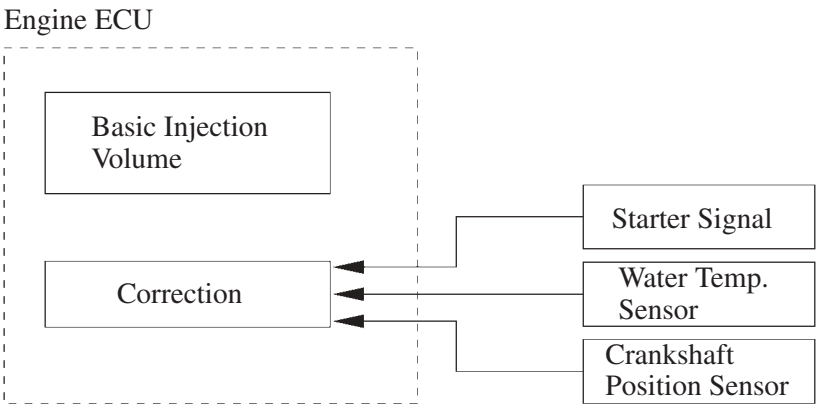


*: with Air Conditioner

224EG64

9. Injection Volume Control During Starting

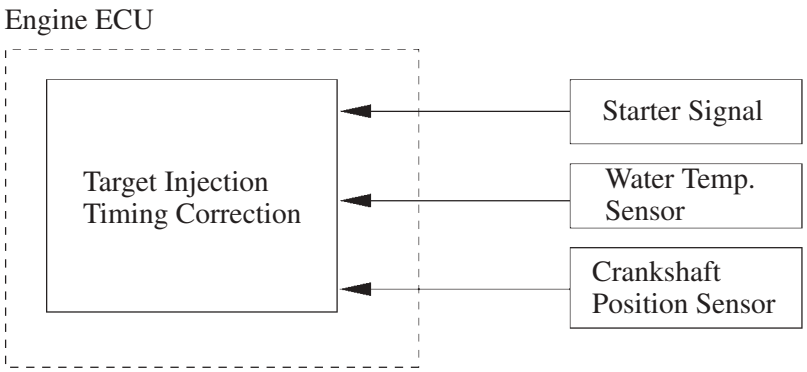
The starting injection volume is determined by adjusting the basic injection volume in accordance with the starter ON signals (ON time) and coolant temperature sensor signals and engine speed signal. When the engine is cold, the coolant temperature will be lower and the injection volume will be greater.



224EG50

10. Injection Timing Control During Starting

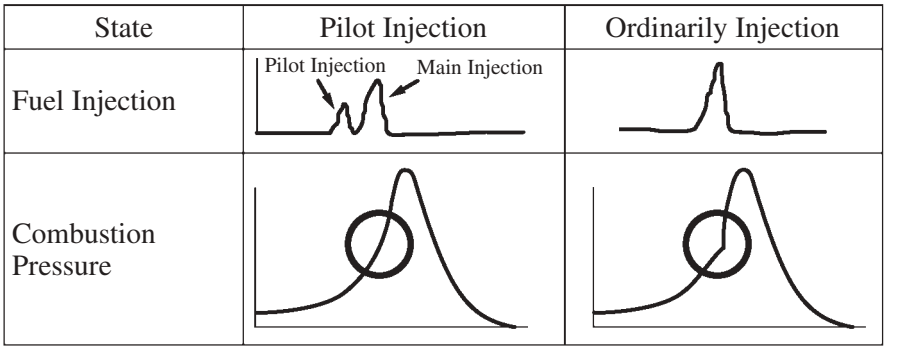
To determine the starting injection timing, the target injection timing is corrected in accordance with the starter signals, water temperature, and engine speed.
When the water temperature is low, if the engine speed is high, the injection timing is advanced.



224EG51

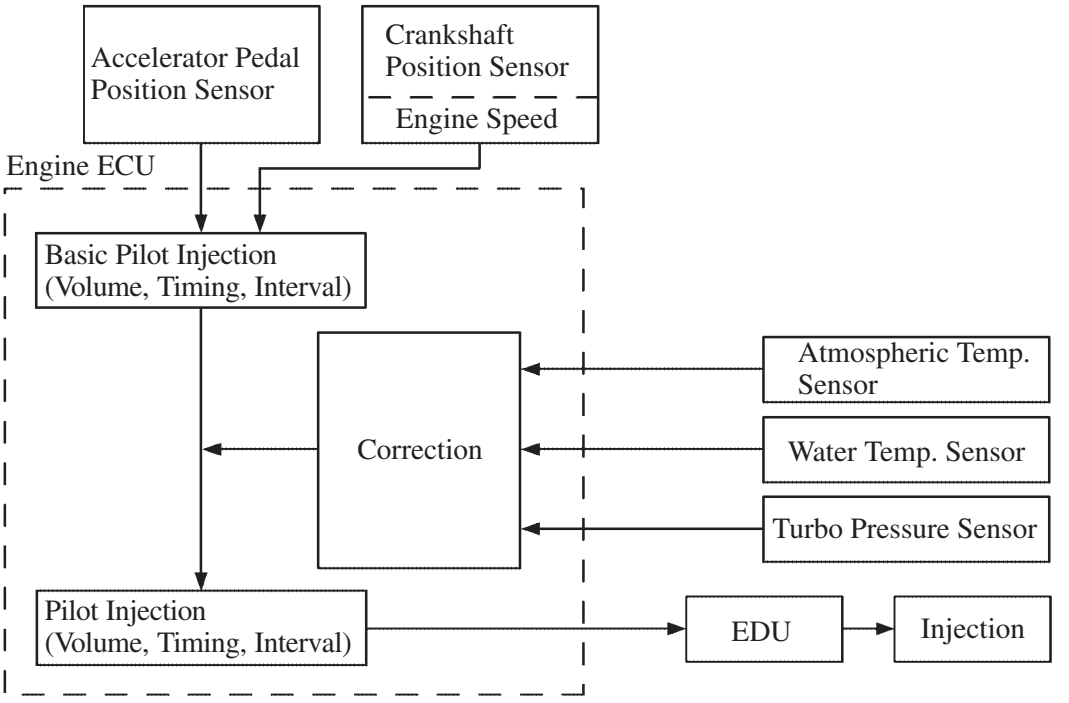
11. Pilot Injection Control

- Pilot injection is a method that provides an 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.



168EG23

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

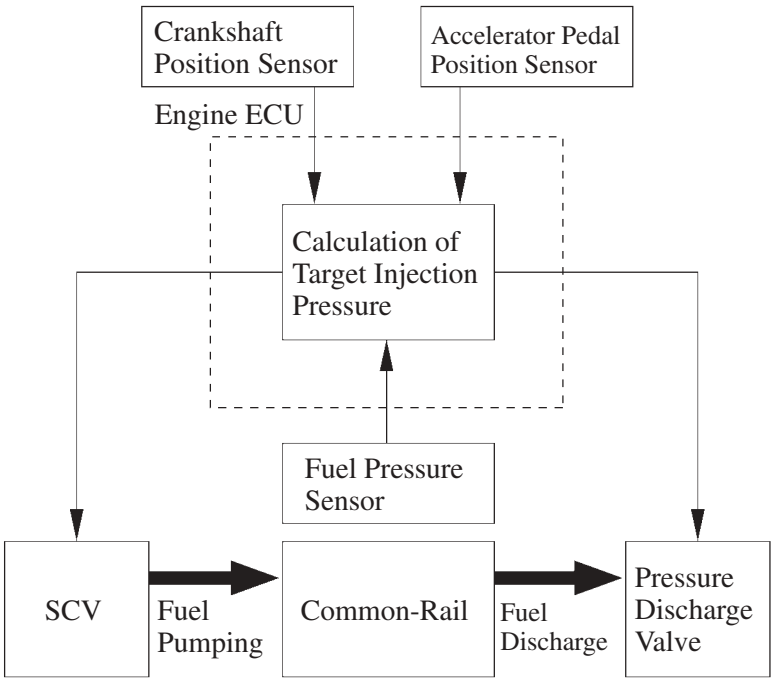


201EG45

12. Fuel Pressure Control

General

Engine ECU calculates the target injection pressure (30 ~ 135 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 of the supply pump regulate the pumping 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.



224EG52

System Operation

1) Fuel Pumping

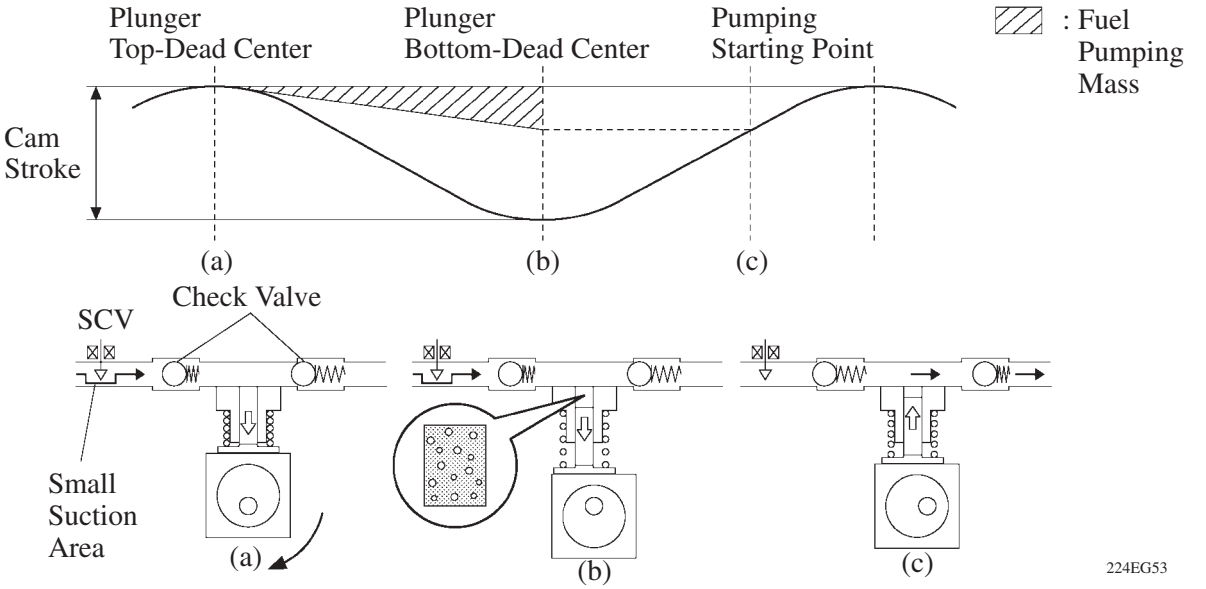
- The engine ECU controls the opening of the SCV in order to regulate the volume of fuel that is pumped by the supply pump to the common-rail. Consequently, the fuel pressure in the common-rail is controlled to the target injection pressure.

▶ SCV Opening Small ◀

(a) When the opening of the SCV is small, the fuel suction area is kept small, which decrease the transferble fuel quantitiy.

(b) The plunger strokes fully, however, the suction volume becomes small due to the small suction srea. Therefore, the difference of the volume between the geometry volume and the suction volume is in vacuum condition.

(c) Pumping will start at the time when the fuel pressure has become higher than the commom-rail pressure.

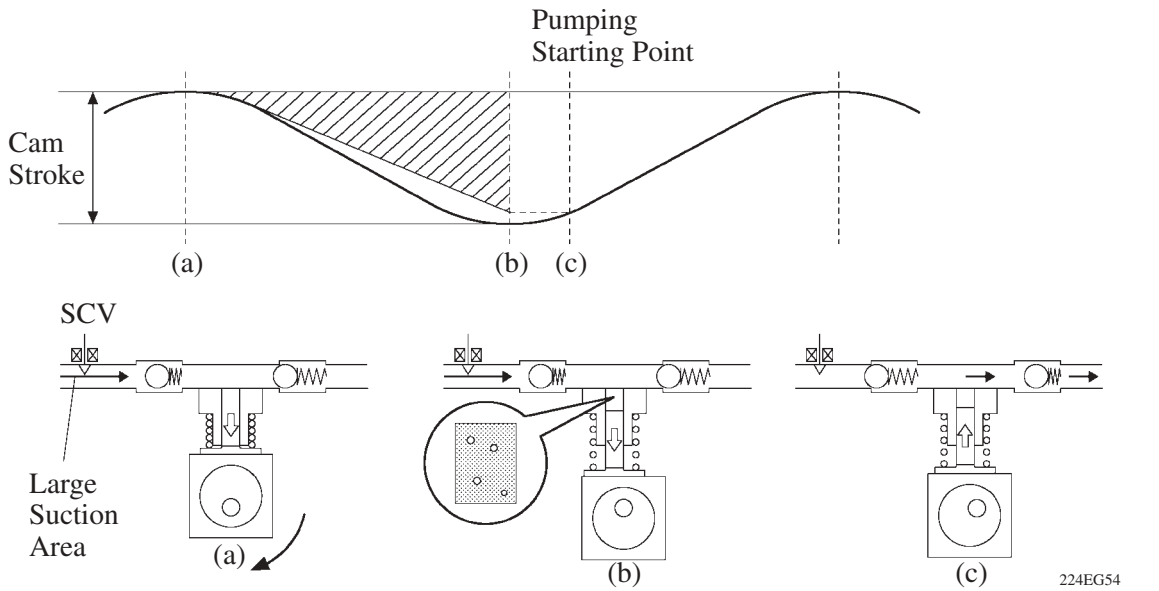


▶ SCV Opening Large ◀

(a) When the opening of the SCV is large, the fuel suction area is kept large, which increase the transferable fuel quantity.

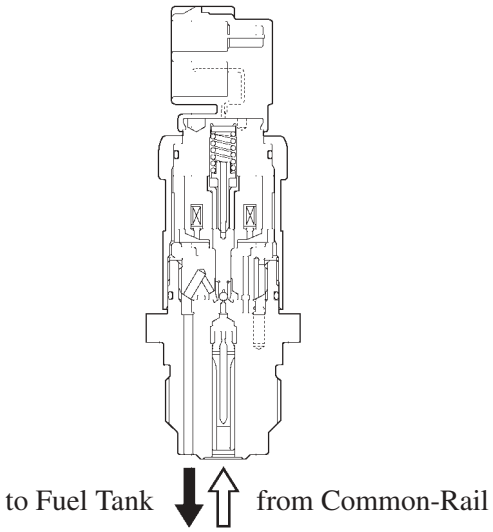
(b) If the plunger strokes fully, the suction volume will increase because the suction area is large.

(c) Pumping will start at the time when the fuel pressure has become higher than the common-rail pressure.



2) Fuel Discharge

When the fuel pressure in the common-rail becomes higher than the target injection pressure, the engine ECU discharges the fuel by way of the pressure discharge valve in order to control the fuel pressure to the target injection pressure.

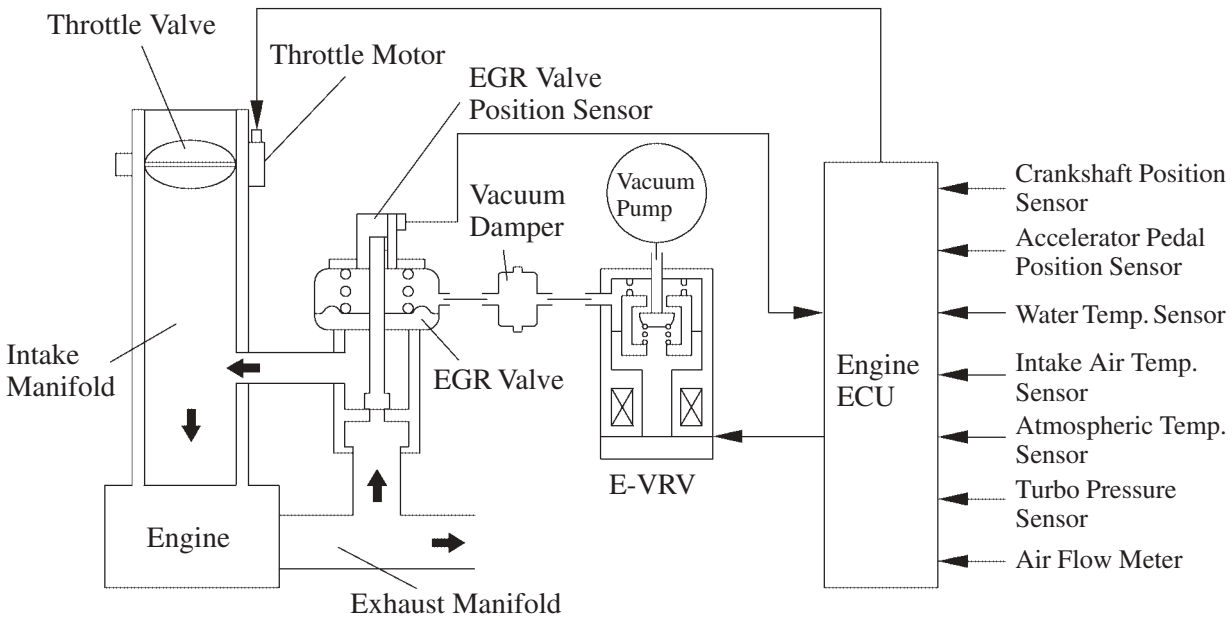


Pressure Discharge Valve

224EG55

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, which controls the magnitude of vacuum introduced into diaphragm of EGR valve and throttle opening position with stepping motor and the amount of recirculating exhaust gas is regulated.



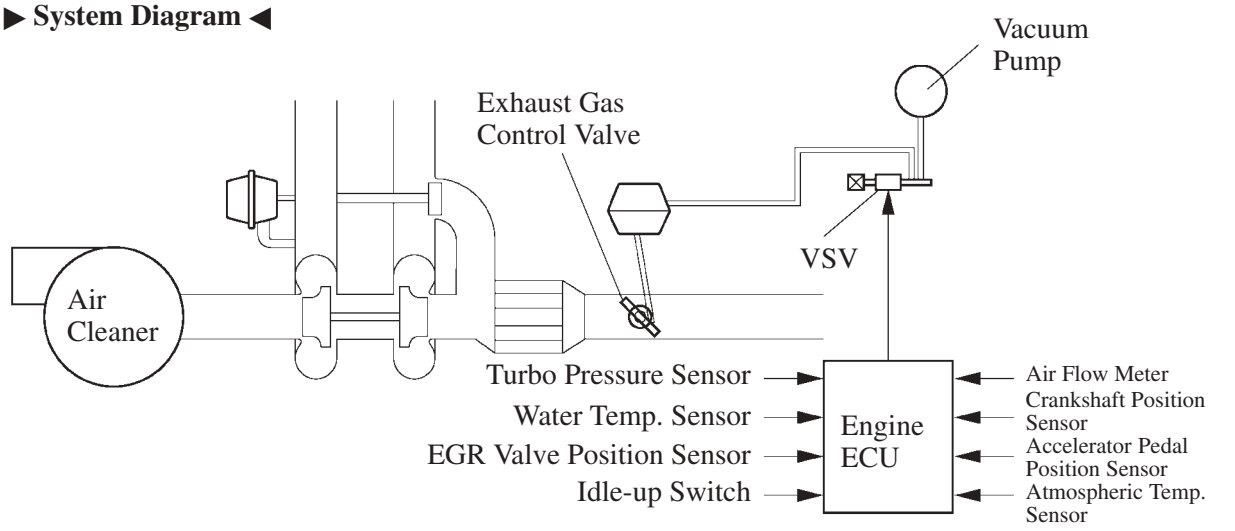
224EG60

14. Exhaust Gas Control System

General

This system actuates the VSV to control the exhaust gas control valve located in the exhaust manifold in order to increase the exhaust pressure. As a result, the exhaust temperature and the engine load increase, thus improving warm-up performance and heater performance.

▶ System Diagram ◀

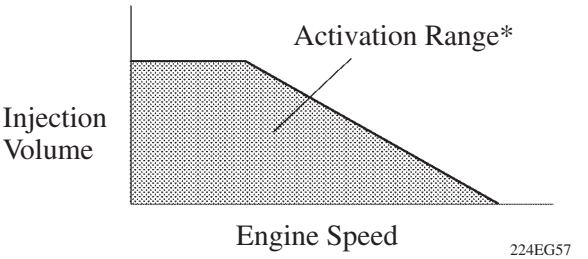


224EG56

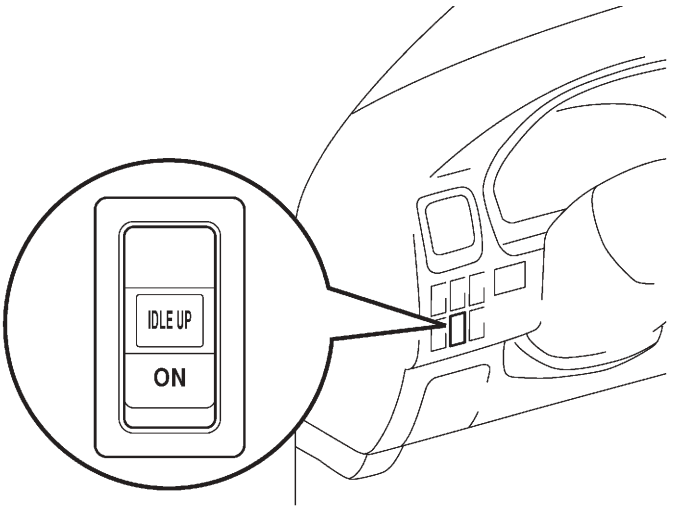
System Operation

This system activates when the IDEL UP switch is ON and all the activating conditions given below have been met.

1) EGR operating
2) Water temperature under 70°C
3) Atmospheric temperature under 5°C
4) A minimum of 10 seconds have elapsed after the engine has been started.
5) Engine speed and injection volume are within the conditions given in the diagram on the right.



224EG57



210EG63

LHD Model

*: Extremely low torgue and low engine speed

15. Diagnosis

When the engine ECU detects a malfunction, the engine ECU makes a diagnosis and memorizes the failed section. Furthermore, check engine warning light in the combination meter illuminates or blinks to inform the driver. The engine will also store the DTCs (Diagnosis Trouble Codes) of the malfunctions.
The DTCs 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 lamp. They can also be accessed by connecting a hand-held tester.

– Changes (from 1KD-FTV engine) –

The DTCs listed below have been added or discontinued.

▶ Added DTC ◀

DTC No.	Detection Item
31	Turbo Pressure Sensor Circuit Malfunction
33	Exhaust Gas Control System Malfunction
39	Fuel Temp. Sensor Circuit Malfunction
78	Fuel Pump Circuit Malfunction (Pressure Discharge Valve Malfunction)
96	EGR Valve Position Sensor Circuit Malfunction

▶ Discontinued DTC ◀

DTC No.	Detection Item
34	Step Motor for Turbocharger Control Circuit Malfunction
34	Turbocharger System Malfunction
34	Turbocharger Stick Detected (Close)
34	Turbocharger Stick Detected (Open)
35	Turbo Pressure Sensor Malfunction

Service Tip

The length of time to clear the DTC via the battery terminal has been changed from the previous 10 seconds to 1 minute.

16. 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 Control List ◀

Location of Malfunction	Description of Control
Accelerator Pedal Position Sensor	The accelerator pedal position sensor comprises two (main, sub) circuits. ● If a malfunction occurs in either one of the sensor circuits, the engine ECU detects, the abnormal signal voltage difference between these two sensor circuits and switches to the limp mode. In the limp mode, the remaining circuits is used to calculate the injection control, in order to operate the vehicle under limp mode control. ● If both systems malfunction, the engine ECU considers that the accelerator pedal is fully closed.
Water Temp. Sensor	In case of a signal malfunction, the engine ECU fixes the uses the constant values of 110°C (230.0°F) water temperature to perform the calculation. However, in case that the fuel temperature is less than 15°C (59.0°F), a fuel temperature sensor controls as a substitute for a water temperature sensor.
Intake Air Temp. Sensor	In case of a signal malfunction, the engine ECU fixes the uses the constant values of 150°C (302.0°F) intake air temperature to perform the calculation.
Fuel Temp. Sensor	In case of a signal malfunction, the engine ECU fixes the uses the constant values of 40°C (104.0°F) fuel temperature to perform the calculation.
Turbo Pressure Sensor	In case of a signal malfunction, the engine ECU calculates the injection volume limited by the turbo pressure fixed value and continues effecting injection control.
Exhaust Gas Control Valve	The engine ECU determines that the exhaust control valve is stuck closed in accordance with the value of the turbo pressure sensor signal. When the exhaust gas control system is not activated, and the turbo pressure from the turbo pressure sensor is low, the engine ECU determines that the exhaust gas control valve is stuck closed. To protect the engine, the engine ECU sets the accelerator pedal opening to a fixed value in order to limit the engine output.