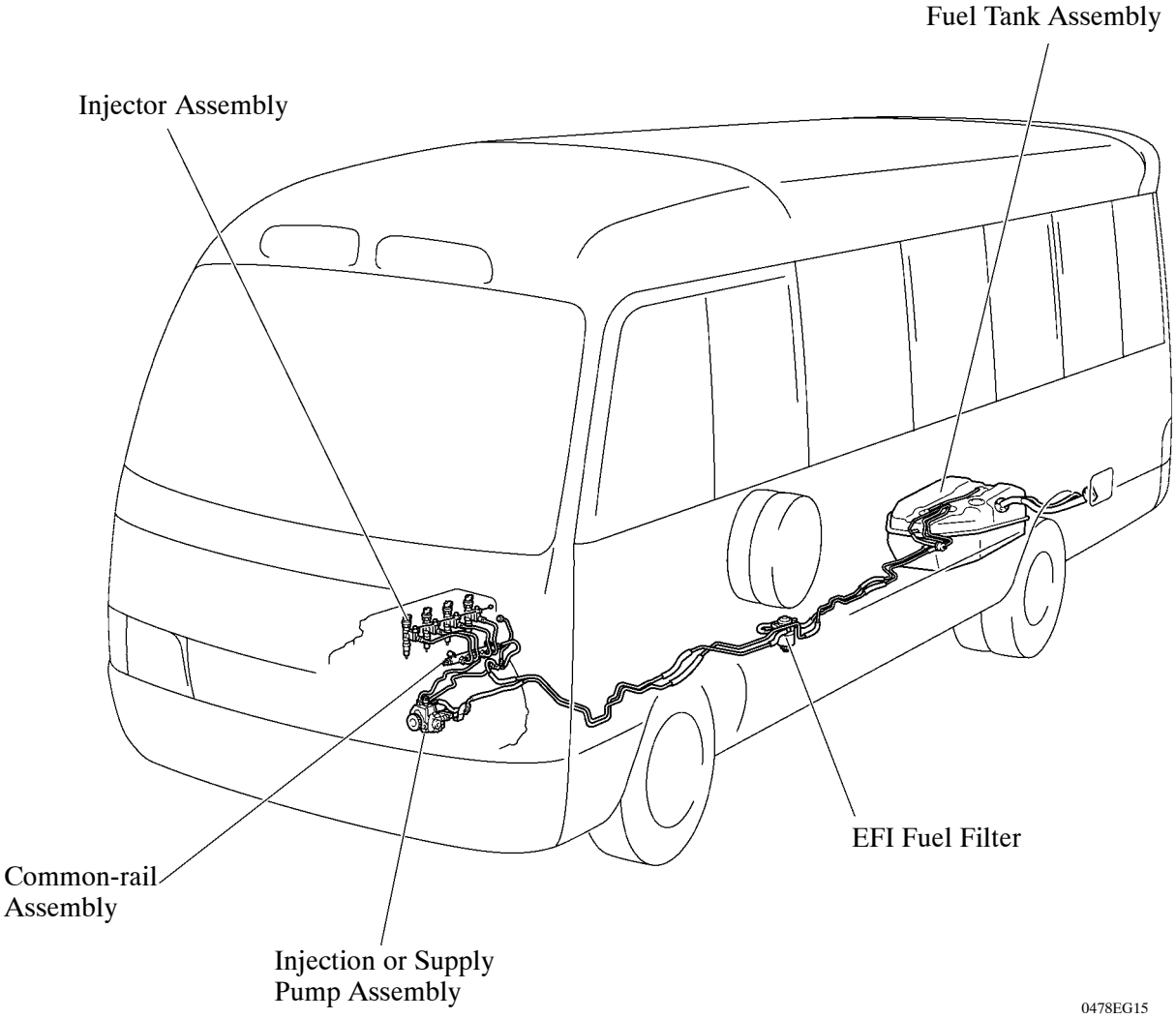
■ FUEL SYSTEM

1. General

- A common-rail system is used.
- An injection or supply pump assembly that produces super high pressure (max. 135 MPa) and low drive torque is used.
- A new type of solenoid-valve-controlled injector assembly which is suited to high injection pressurization is used.

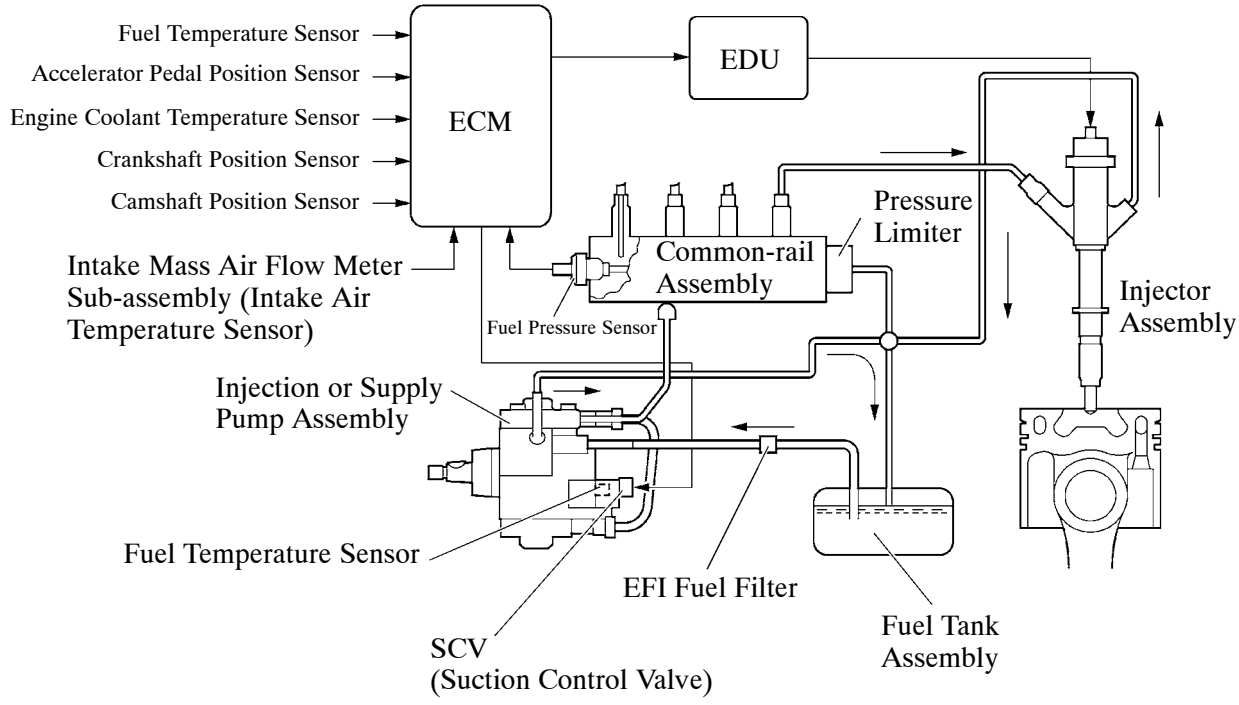


2. Common-rail System

1) General

- In the common-rail system, the pressurized fuel provided by the injection or supply pump assembly is stored in the common-rail and injected by the solenoid injectors.
- The common-rail system stores the fuel, which has been pressurized by the pump, in the common-rail assembly. Because the common-rail assembly constantly accumulates a stable injection pressure without being affected by engine speed or load, this system is able to constantly provide a stable injection pressure, even when the engine is operating at low speeds.
- The ECM transmits signals to the injector solenoid valves via the EDU (Electronic Driver Unit) in order to precisely control the fuel injection timing and injection volume.

▶ System Diagram ◀



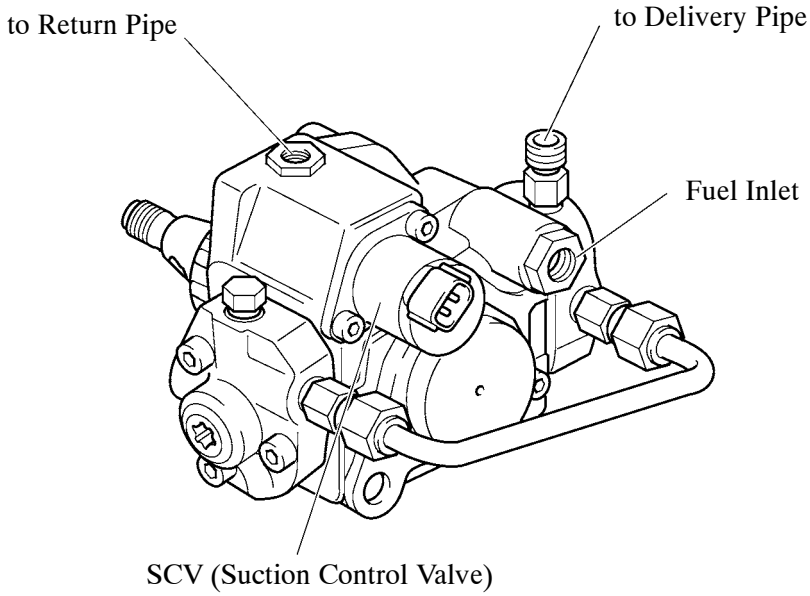
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2) Main Components of Common-rail System

a. Supply Pump

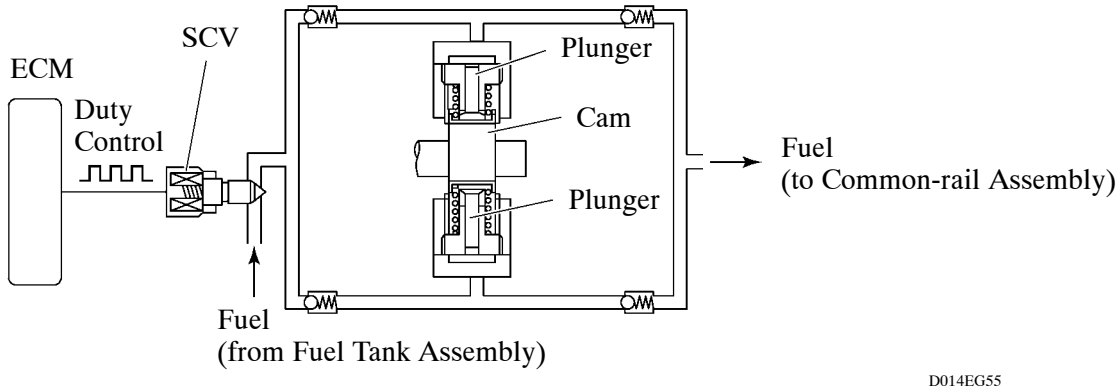
i) General

- The injection or supply pump assembly, which is driven by the crankshaft, pumps fuel to the common-rail assembly.
- The suction and pumping of fuel have been divided into 2 systems in order to stabilize the fuel supply.



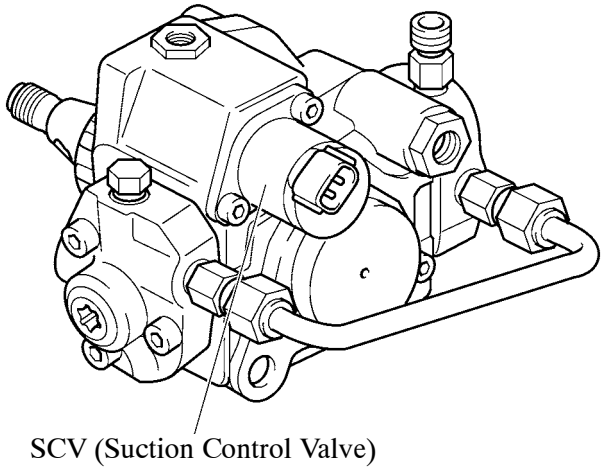
ii) SCV (Suction Control Valve)

- The ECM determines the target fuel pressure based on the load condition.
- The ECM adjusts the SCV opening angle by the duty control function to reach the target fuel pressure.
- The suction control valve adjusts the fuel pressure in the range of 30 MPa to 135 MPa.

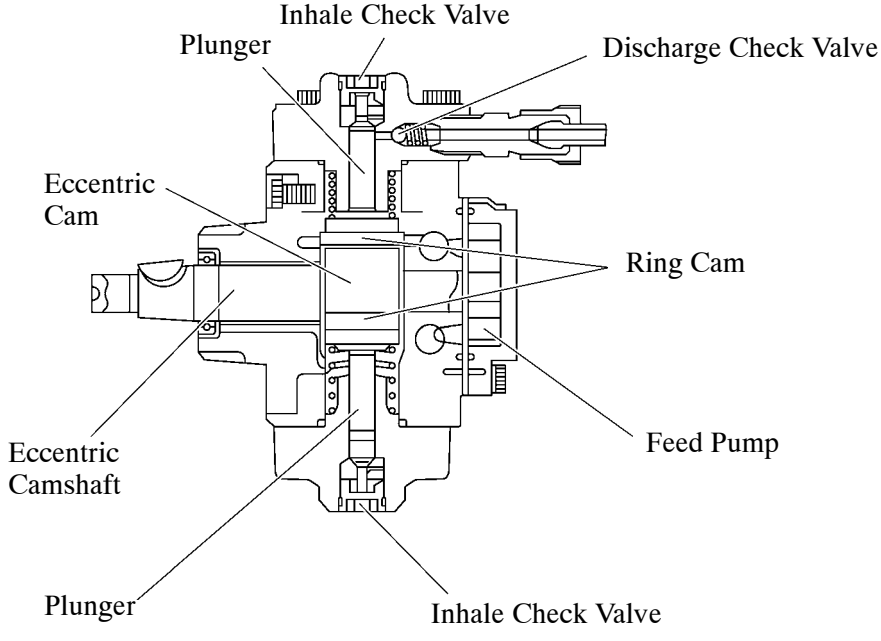


iii) Construction

- The drive force of the pump outputs in the following order: the crankshaft, the idle gears, the gear that is attached to the front of the pump, and the ring cam.
- The injection or supply pump assembly consists of 4 portions: a pump body to pump pressurized fuel, a discharge check valve to regulate the fuel flow rate, a suction control valve to regulate the fuel pressure at the inlet to the inhale check valve, and a feed pump to supply fuel to the pump body. The injection or supply pump assembly draws an appropriate amount of fuel and feeds pressurized fuel into the common-rail assembly.
- The eccentric cam alternately moves 2 plungers via the ring cam.
- The 2 plungers are horizontally opposed, so when 1 plunger is in a suction stroke, the other is in a pumping stroke. The 2 plungers repeat these strokes in order to ensure a constant and stable delivery of fuel.



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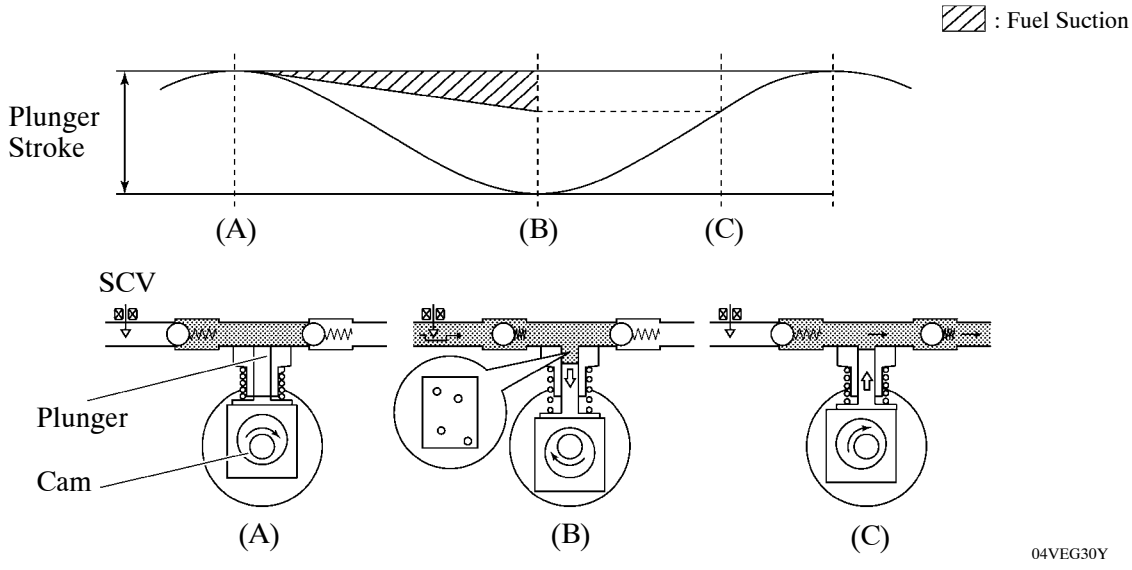
iv) Operation

- **Small Opening of Suction Control Valve**

– When the opening of the suction control valve is small, the fuel suction passage narrows and slows down the fuel flow.

– Even if the plunger reaches its maximum stroke, the volume of fuel drawn in by the plunger becomes restricted because the fuel suction passage is restricted. (See “B” in the diagram.)

– The injection or supply pump assembly discharges fuel when the cam pushes the plunger upward and the fuel discharge pressure becomes higher than the fuel pressure in the common-rail assembly. (See “C” in the diagram.)



(A) Plunger Top-Dead-Center

(B) Plunger Bottom-Dead-Center

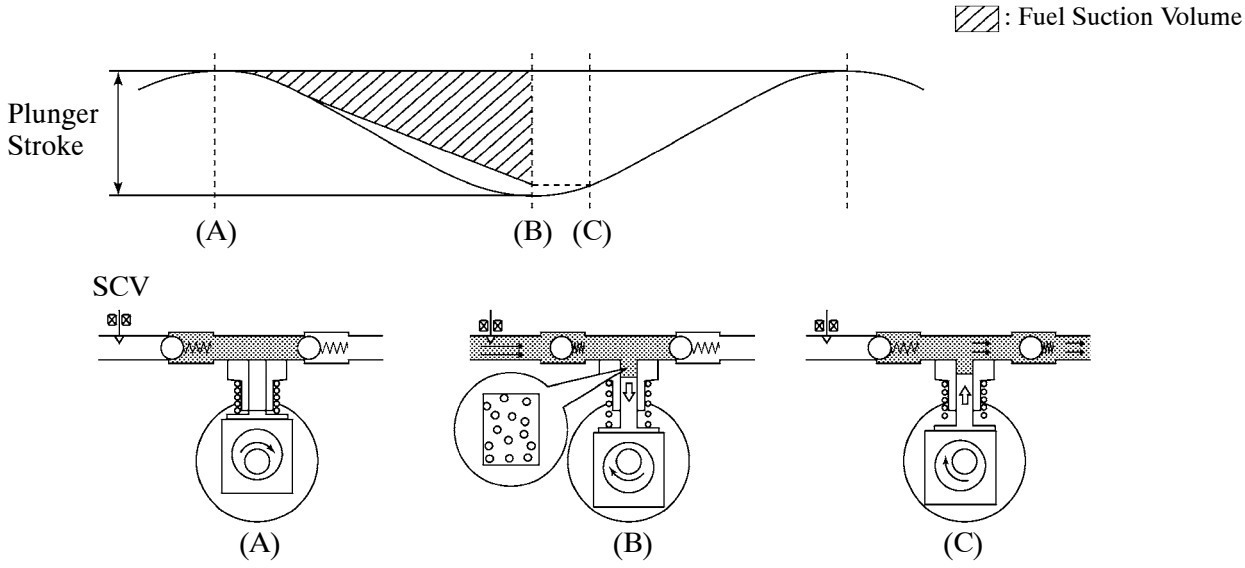
(C) Compression Starting Point

- **Large Opening of Suction Control Valve**

– When the opening of the suction control valve is large, the fuel suction passage widens and facilitates the fuel flow.

– When the plunger reaches its maximum stroke, the plunger draws an ample volume of fuel because the fuel suction passage is not restricted. (See “B” in the diagram.)

– The injection or supply pump assembly discharges fuel when the cam pushes the plunger upward and the fuel discharge pressure becomes higher than the fuel pressure in the common-rail assembly. (See “C” in the diagram.)



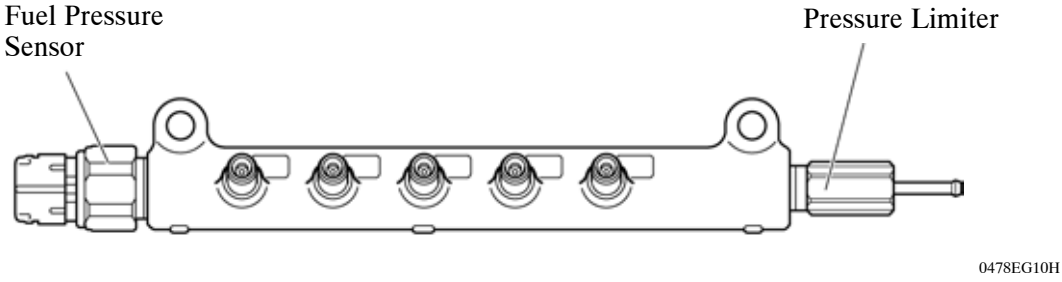
(A) Plunger Top-Dead-Center

(B) Plunger Bottom-Dead-Center

(C) Compression Starting Point

b. Common-rail

- The function of the common-rail assembly is to store the fuel that has been pressurized by the injection or supply pump assembly. The common-rail assembly is provided with a fuel pressure sensor that detects the fuel pressure in the common-rail assembly, and a pressure limiter that mechanically relieves the pressure in case the internal pressure of the common-rail assembly rises abnormally.
- An orifice is provided at the outlet of the common-rail assembly to each injector in order to minimize fuel pressure pulsations.
- The fuel pressure sensor outputs a signal that represents the fuel pressure in the common-rail assembly to the ECM in order to constantly regulate the fuel at an optimal pressure.
- The valve opening pressure of the pressure limiter has been optimized in accordance with the increase in the injection or supply pump assembly pressure.

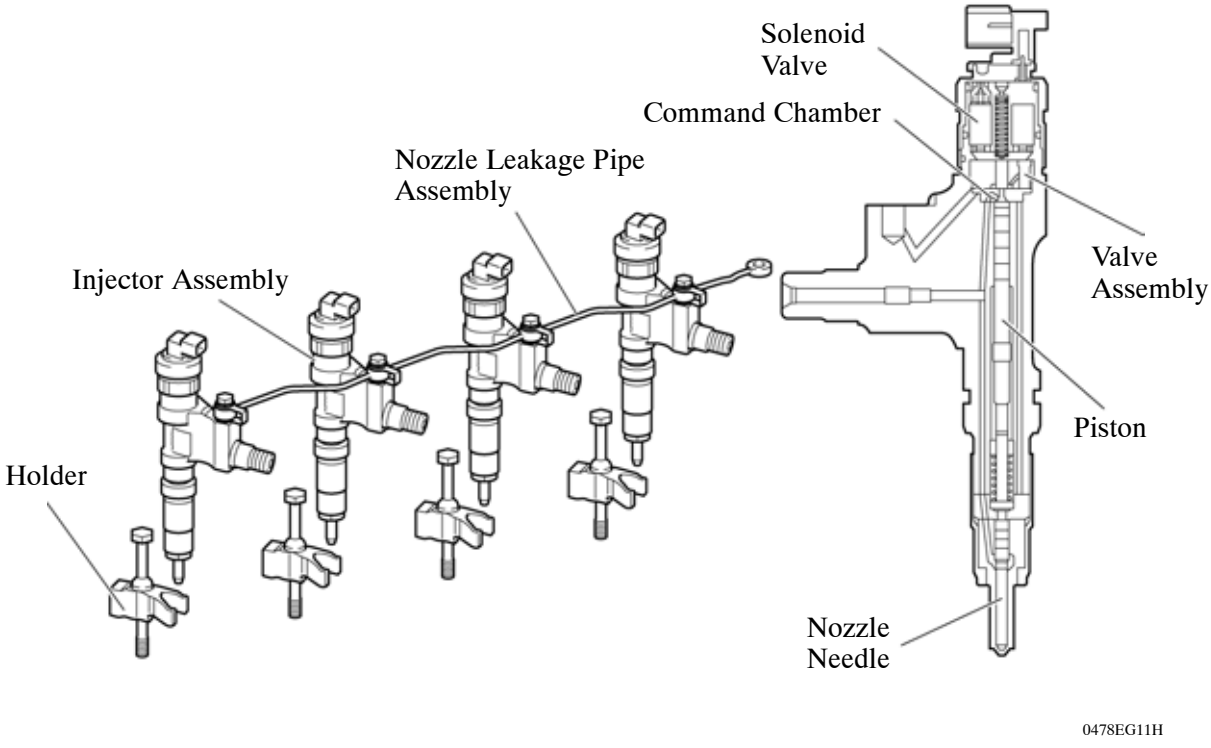


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c. Injector

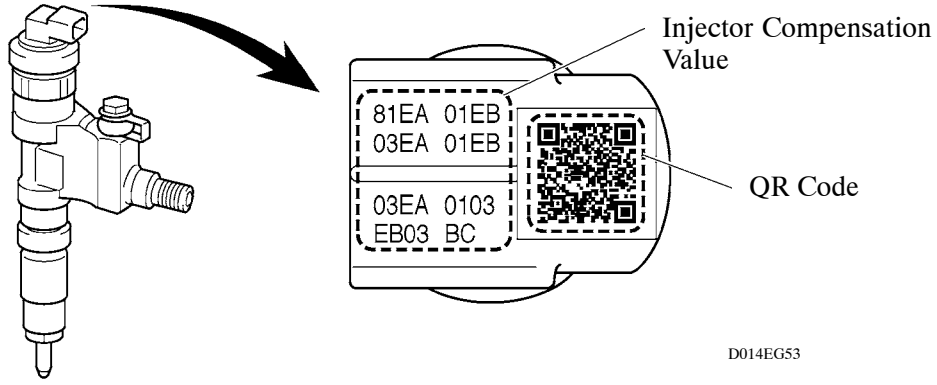
i) General

- Because this system uses solenoid injectors in which solenoid valves open and close the fuel passages, the ECM can precisely control the fuel injection volume and injection timing. Thus, this system minimizes the generation of black smoke, which is peculiar to diesel engines.
- Each injector assembly consists of a nozzle needle, piston, and solenoid valve.
- An injector assembly compensation value and QR (Quick Response) code containing encoded characteristics of the injector assembly are printed on each injector assembly.
- The injector assembly compensation value and QR code contain various pieces of information regarding the injector assembly, such as model code and injection volume values.



Service Tip

- If the ECM is replaced, use the Global TechStream (GTS) and input the injector compensation values of all 4 injectors. If an injector assembly is replaced, input the injector assembly compensation value of the replaced injector assembly. Then, the proper compensation will be made so that the injection volume precision prior to the replacement will remain unchanged. For details, refer to the Repair Manual.
- The QR code, which requires a special scan tool, is not used at TOYOTA dealers.



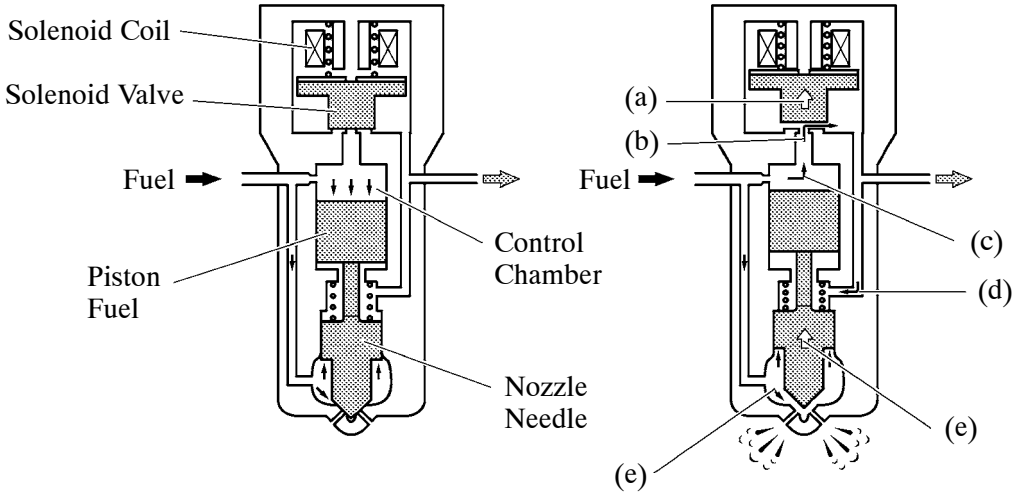
— REFERENCE —

What is QR (Quick Response) Code?

- *QR code, a matrix symbology consisting of an array of nominally square cells, allows omni-directional, high-speed reading of large amounts of data.*
- *QR code encodes many types of data such as numeric, alphanumeric, kanji, kana and binary code. A maximum of 7,089 characters (numeric) can be encoded.*
- *QR code (2D code) contains information in the vertical and horizontal directions, whereas a bar code contains data in one direction only. QR code (2D code) holds a considerably greater volume of information than a bar code.*

ii) Operation

(a) When electrical current is applied to the solenoid coil, it pulls the solenoid valve up.
(b) The orifice of the control chamber opens, allowing the fuel to flow out.
(c) The fuel pressure in the control chamber drops.
(d) Simultaneously, fuel flows from the orifice to the bottom of the piston, which raises the piston.
(e) As a result, the piston raises the nozzle needle to inject fuel.

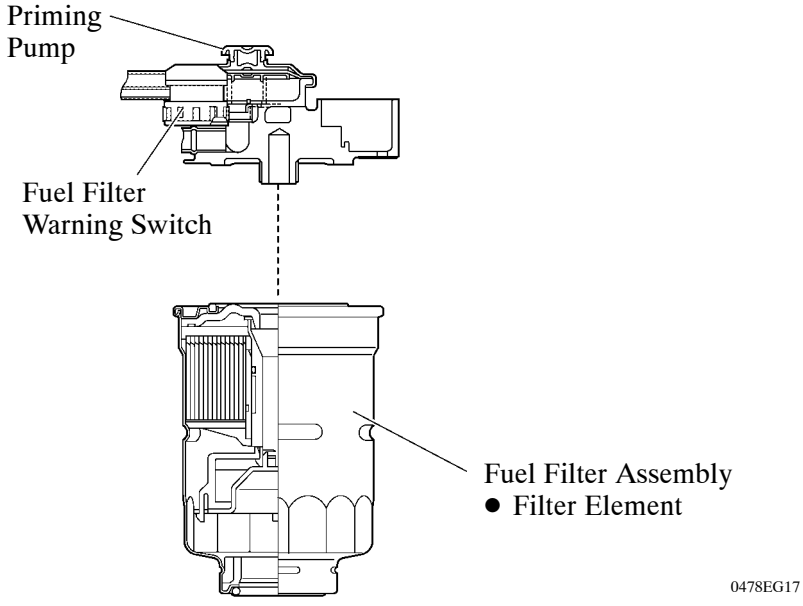


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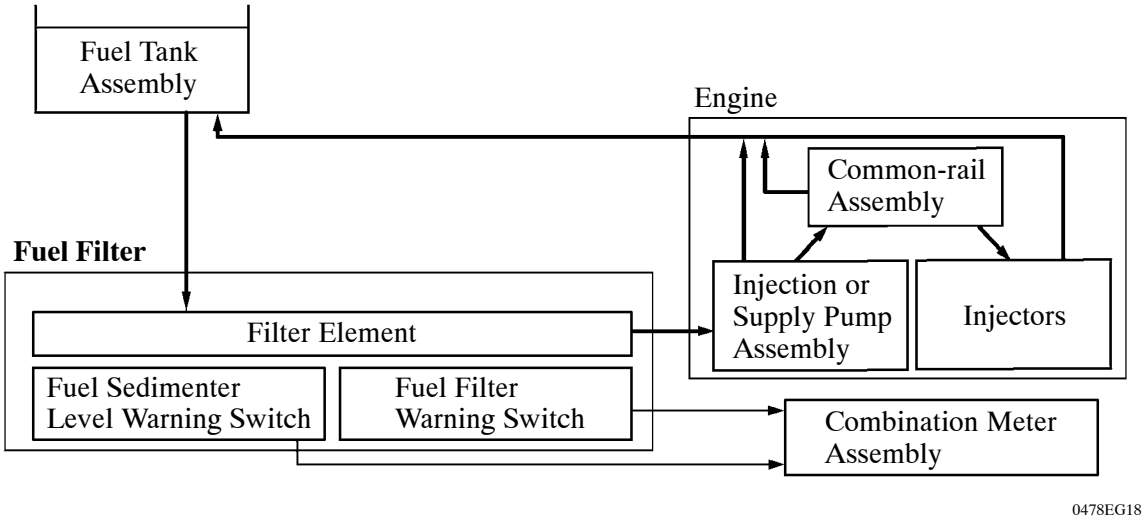
3. Fuel Filter

1) General

- The EFI fuel filter consists of a fuel filter element integrated with the fuel filter housing.
- A fuel filter with a built-in sedimenter is used.
- A fuel sedimenter level warning switch, which detects when water, etc. has accumulated beyond a specific level, is provided in the sedimenter section. When the fuel sedimenter level warning switch turns ON, the warning indicator light of the combination meter illuminates to alert the driver.
- A fuel filter warning switch is provided in the fuel filter.



▶ System Diagram ◀



2) Fuel Filter Warning Switch

- A fuel filter warning switch, which turns ON/OFF when the internal vacuum of the filter increases, is provided in the EFI fuel filter. This switch, which turns OFF when the internal vacuum of the fuel filter increases to a predetermined level, is connected by a wire to the combination meter assembly.
- When the fuel filter warning switch detects that the internal vacuum of the EFI fuel filter has increased (by way of the fuel filter warning switch OFF signal), it determines that the fuel filter has become clogged. Then, it illuminates the fuel system warning light on the combination meter assembly to urge the driver to replace the EFI fuel filter.

