SERVICE BULLETIN

FUEL INJECTION PUMP
NEW PRODUCTS

E-ECD 02-01
June, 2002

DENSO AUTHORIZED ECD SERVICE DEALER ONLY

SUBJECT: New Common Rail System (ECD-U2P) for NISSAN

1. Application

Manufcturer	Model Name	Engine	Destination
NISSAN	X-Trail	YD22	Europe
	Primera		

2. System Components Parts Number

2.1. X-Trail

Parts Name	DENSO P/N	Manufacturer P/N	Remarks
Supply pump	097300-0050	16700-8H800	HP2
Injector	095000-0510	16600-8H800	
ECU	275800-1184	23710-8H800	
EDU	131000-1190	22710-8H810	
Commom rail	095440-0302	17520-8H801	
Crank position sensor	029600-1170	23731-8H810	
	029600-1180	23731-8H800	
Accelerator position sensor	198800-0020	18002-8H800	
	198800-0030	18002-8H810	
	198800-0070	18002-8H803	
	198800-0080	18002-8H813	

2.2. Primera

Parts Name	DENSO P/N	Manufacturer P/N	Remarks
Supply pump	097300-0050	16700-8H800	HP2
Injector	095000-0880	16600-AU600	
ECU	275800-1362	23710-AU600	
EDU	131000-1190	22710-8H810	
Commom rail	095440-0302	17520-8H801	
Crank position sensor	029600-1170	23731-8H810	
	029600-1180	23731-8H800	
Accelerator position sensor	198800-0050	18002-AU600	
	198800-0060	18002-AU610	

3. Outline

In a common rail system, fuel is stored at a high pressure in an accumulator chamber called a common rail, from which the highly pressurized fuel is fed to the solenoid-controlled injectors, which in turn, inject fuel into the cylinders. The characteristic of this system is the ability of the engine ECU to independently control the injection system (injection pressure, rate, and timing), without being influenced by the engine speed or load. It can therefore maintain a stable injection pressure even in the low engine speed range, which dramatically reduces the emission of black smoke that is typical of diesel engines during start-offs and acceleration. As a result, this system enables the engine to emit cleaner exhaust gases, produce less emissions, and generate a higher power output. (This system complies with the exhaust gas regulations enacted the SETP3 European exhaust gas regulations.)

3.1. System Characteristics

(1) Injection Pressure Control

- Injects fuel at a high pressure, even in the low engine speed range.
- Optimized control minimizes particulate and NOx emissions.

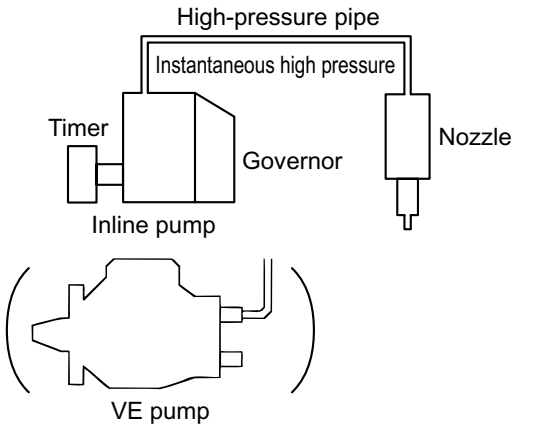
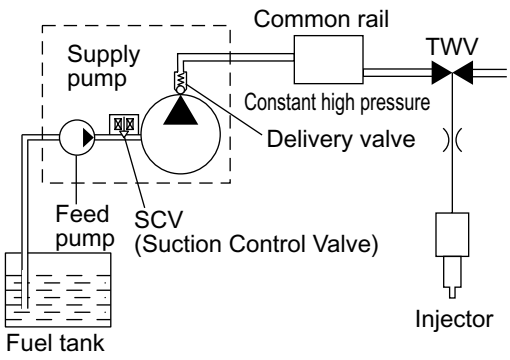
(2) Injection Timing Control

- Optimally controls the timing to suit driving conditions.

(3) Injection Rate Control

- Provides pilot injection, an extremely small volume of fuel injected before the main injection.

3.2. Comparison to the Conventional System

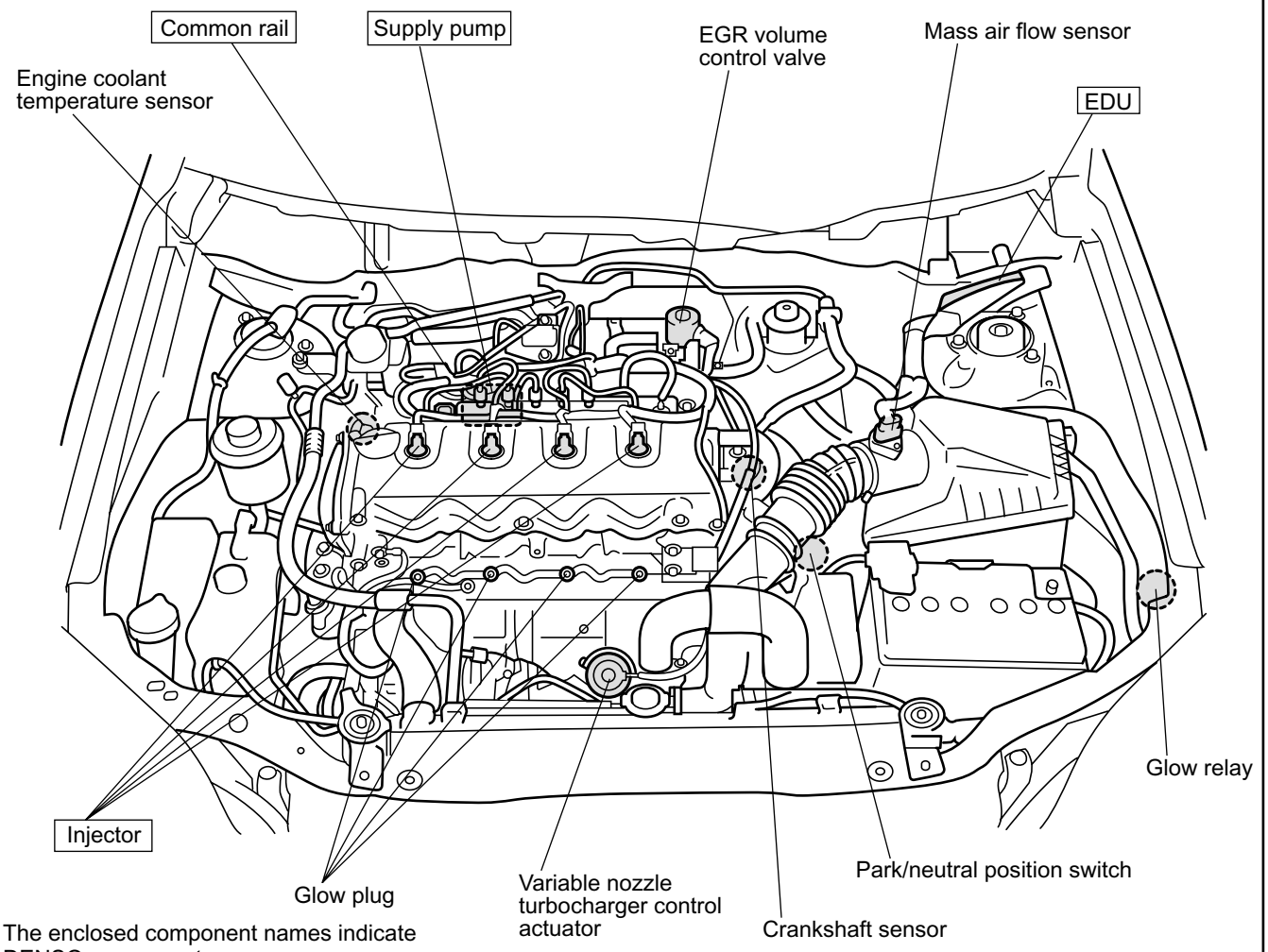
System	Inline pump/VE pump	Common rail system
		
Injection Volume Control	Pump (governor)	ECU, Injector (TWV)*1
Injection Timing Control	Pump (timer)	ECU, Injector (TWV)*1
Pressure rise	Pump	ECU, supply pump
Distribution	Pump	ECU, common rail
Injection pressure control	Dependent on pump speed and injection volume	ECU, supply pump (SCV)*2

*1: TWV = Two-Way Valve
*2: SCV = Suction Control Valve

QC0001

4. Outline of System

4.1. Main System Components



The enclosed component names indicate DENSO components.

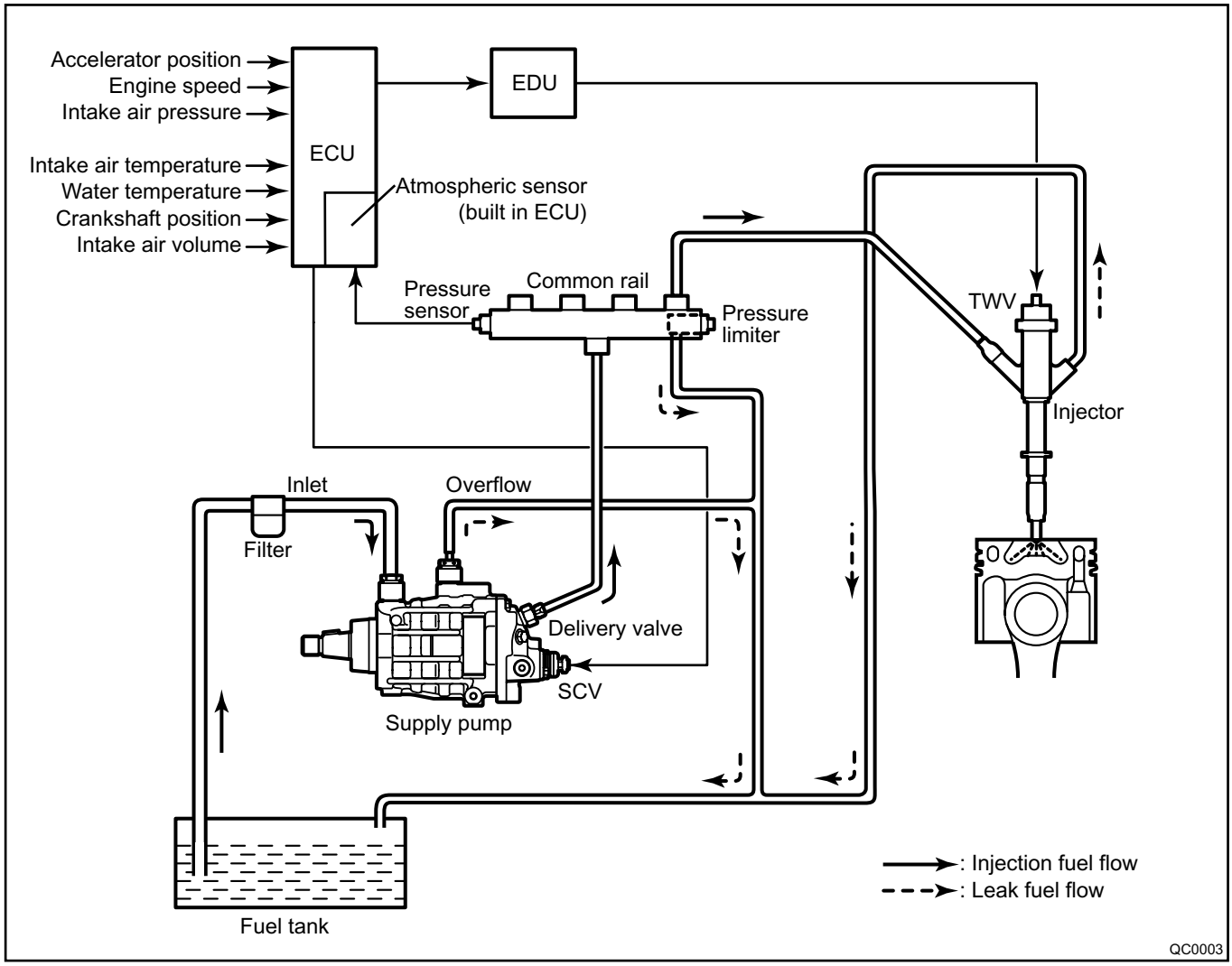
4.2. Outline of Composition and Operation

(1) Composition

- The ECD-U2P system is comprised primarily of a supply pump, common rail, injectors, ECU, and EDU.

(2) Operation

- The supply pump draws fuel from the fuel tank, pressurizes it to a high pressure, and pumps it to the common rail. The volume of fuel discharged from the supply pump controls the pressure in the common rail. The SCV (Suction Control Valve) in the supply pump effects this control in accordance with the command received from the ECU.
- The fuel that is stored under pressure in the common rail is fed via the high-pressure pipe and injected at a high pressure (25 to 135 MPa) through the injector.
- The rate and timing of the fuel that is injected from the injector are determined by the length of time and the timing in which the current is applied to the injector by the EDU in accordance with the signals from the ECU.
- While the ECU controls the injection of fuel through the injector, it monitors the internal pressure of the common rail through the pressure sensor, in order to verify that the actual injection pressure matches the injection pressure commanded by the ECU.



4.3. Fuel System and Control System

(1) Fuel System

This system comprises the route through which diesel fuel flows from the fuel tank to the supply pump, via the common rail, and is injected through the injector, as well as the route through which the fuel returns to the tank via the overflow pipe.

(2) Control System

In this system, the engine ECU controls the fuel injection system in accordance with the signals received from various sensors. The components of this system can be broadly divided into the following three types: Sensors; ECU; and Actuators.

[Sensors]

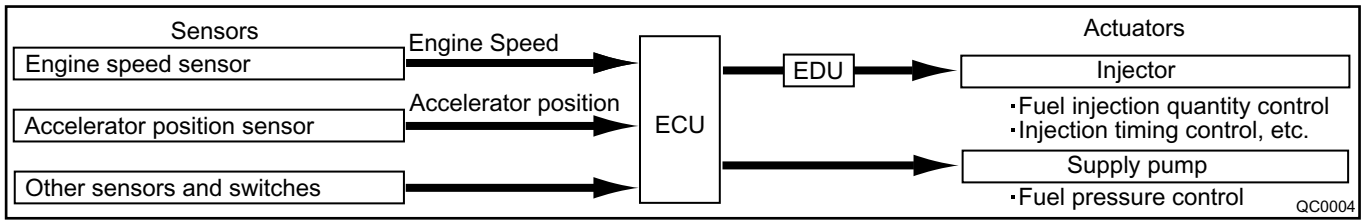
Detects the conditions of the engine and the driving conditions and converts them into electrical signals.

[ECU]

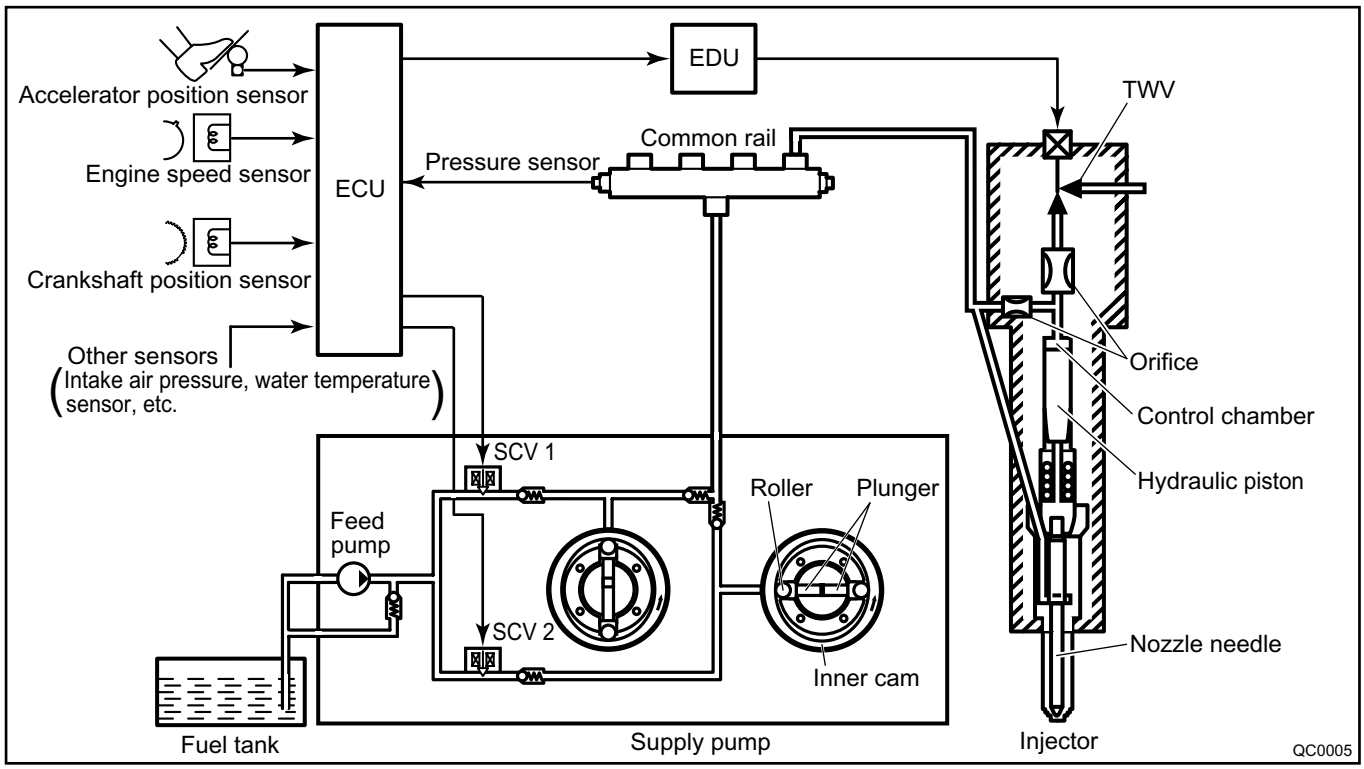
Performs calculations based on the electrical signals received from the sensors and sends them to the actuators in order to achieve optimal conditions.

[Actuators]

Operate in accordance with electrical signals received from the ECU.



Injection system control is effected by electronically controlling the actuators. The injection quantity and the injection timing are determined by controlling the length of time that the current is applied to the TWV (Two-Way Valve) in the injector and controlling its timing. The injection pressure is determined by controlling the SCV (Suction Control Valve) in the supply pump.



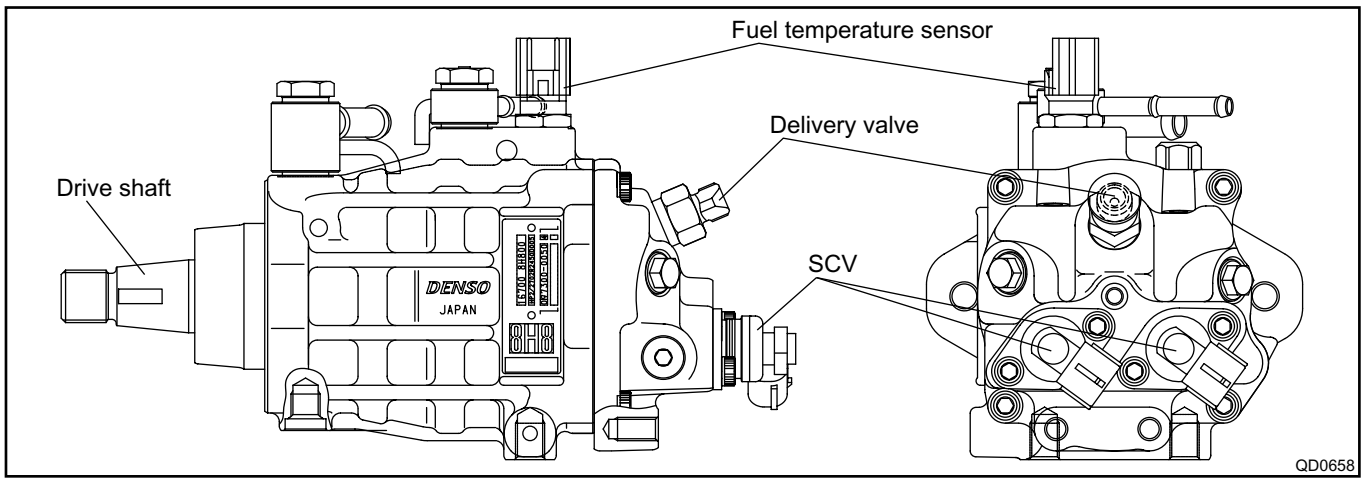
5. Description of Main Components

5.1. Supply Pump

(1) Outline

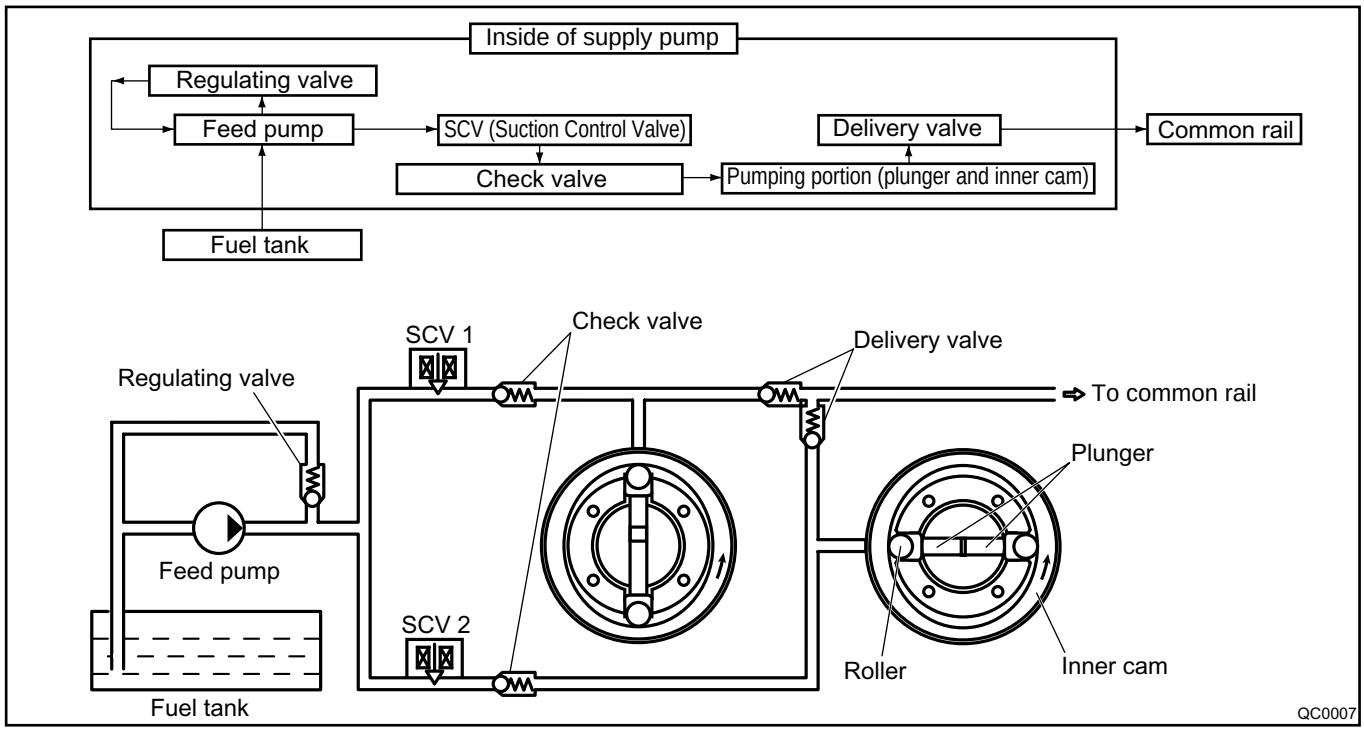
- For pumping fuel, an inner cam and plunger mechanism has been adopted in the supply pump. It is a tandem configuration in which two of these mechanisms are arranged axially in order to reduce their actuation peak torque and to realize a compact package.
- The control of the fuel that is discharged to the common rail is effected by the SCV (Suction Control Valve), which reduces the actuating load of the supply pump and restrains the temperature of the fuel from rising.
- Because the pumping portion of the supply pump has adopted a tandem configuration, its actuating peak torque is one-half that of a single pump with the same discharge capacity.

(2) Construction

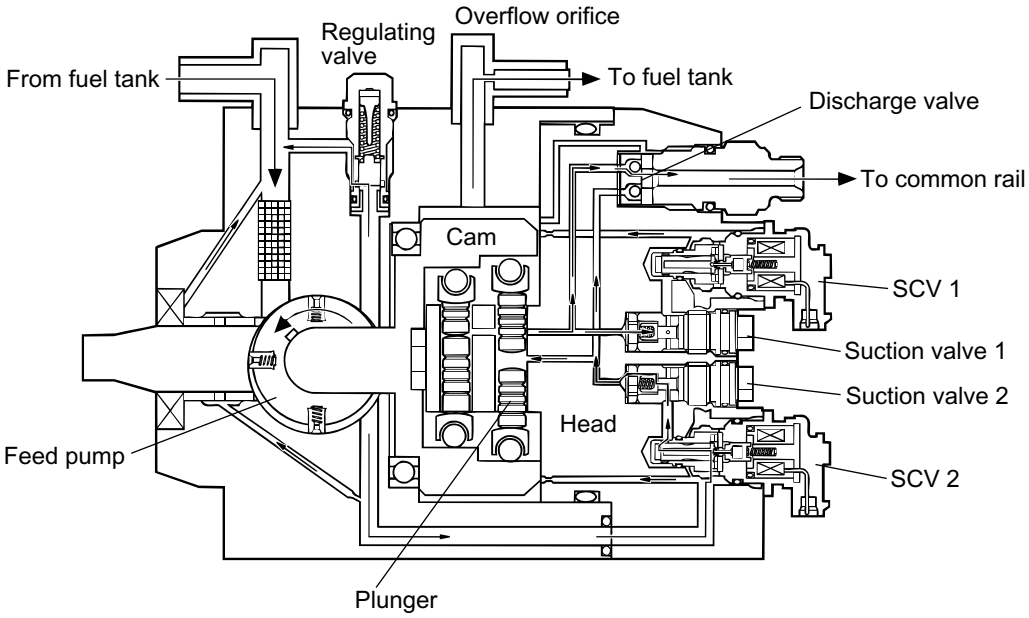


(3) Supply Pump Internal Fuel Flow

The fuel that is drawn from the fuel tank passes through the route in the supply pump as illustrated, and is fed into the common rail.



The flow of fuel is described on a model that resembles an actual injection pump.



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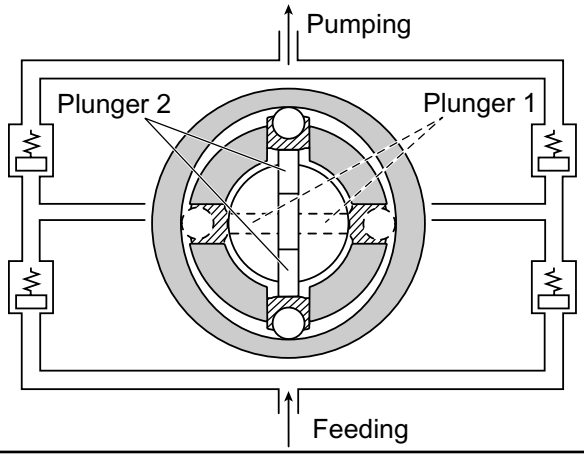
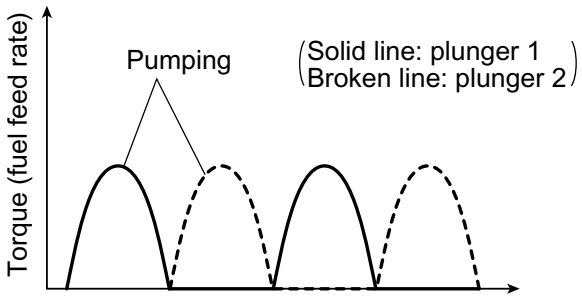
(4) Supply Pump Actuating Torque

Composition	Torque pattern
	

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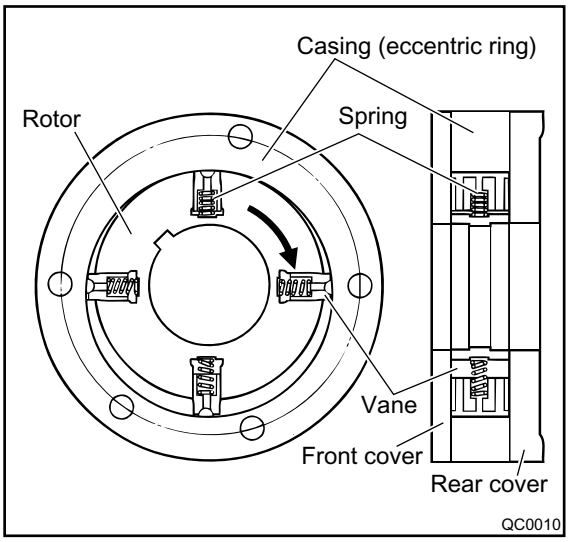
5.2. Description of Supply Pump Components

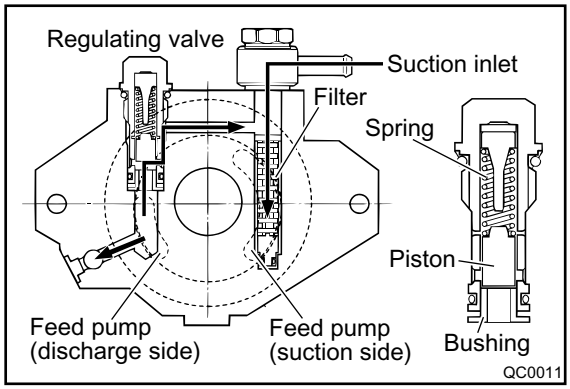
(1) Feed Pump

A four-vane type pump has been adopted. The rotation of the drive shaft causes the feed pump rotor to rotate and the vane to move by sliding along the inner surface of the casing (eccentric ring). The pump draws fuel from the tank along with the rotation of the vanes, and discharges the fuel to the SCV and the pumping portion. A spring is inserted in each pump to ensure its pushing force to the inner surface of the ring, thus minimizing the fuel leak in the pump.



(2) Regulating Valve

The regulating valve is provided in order to keep the feed pressure of the fuel below a prescribed level. When the pump speed increases and the feed pressure exceeds the set pressure of the regulating valve, the valve opens by overcoming the spring force, thus returning the fuel to the suction side.



(3) SCV (Suction Control Valve)

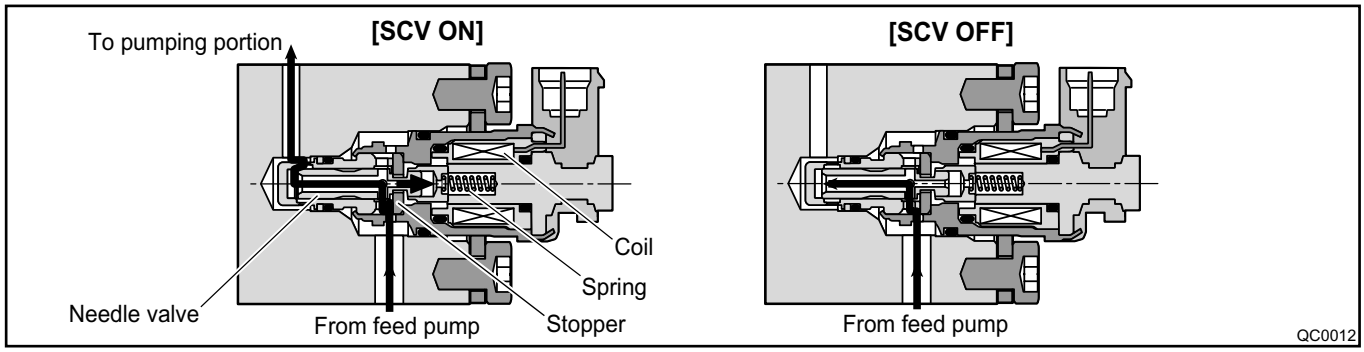
A solenoid type valve has been adopted. The ECU controls the length of time that the current is applied to the SCV in order to control the volume of fuel that is drawn into the pumping portion. Because only the volume of fuel that is required for achieving the target common rail pressure is drawn in, the actuating load of the supply pump decreases, thus improving fuel economy.

[SCV ON]

When the current is applied to the coil, the needle valve pulls up, causing the fuel to be drawn into the pumping portion.

[SCV OFF]

When the current to the coil is stopped, the valve closes, causing the suction of fuel to end.

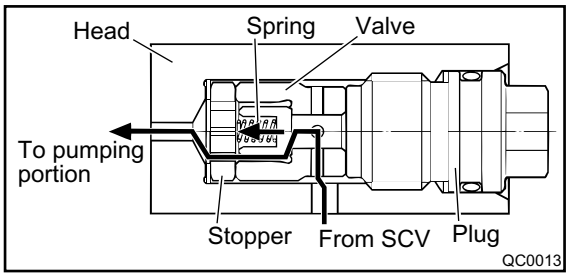


(4) Check Valve

The check valve is provided between the SCV and the pumping portion in order to prevent the high-pressure fuel in the pumping portion from flowing back to the SCV.

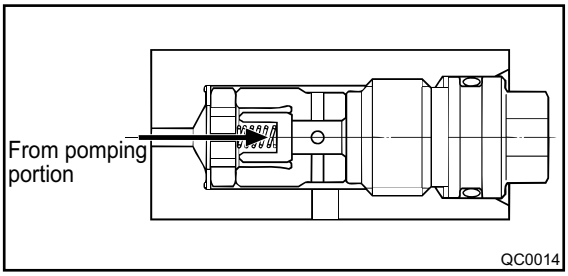
[Check Valve Open]

When the fuel is being drawn in (SCV ON), the feed pressure causes the valve to open, allowing the fuel to be drawn into the pumping portion.



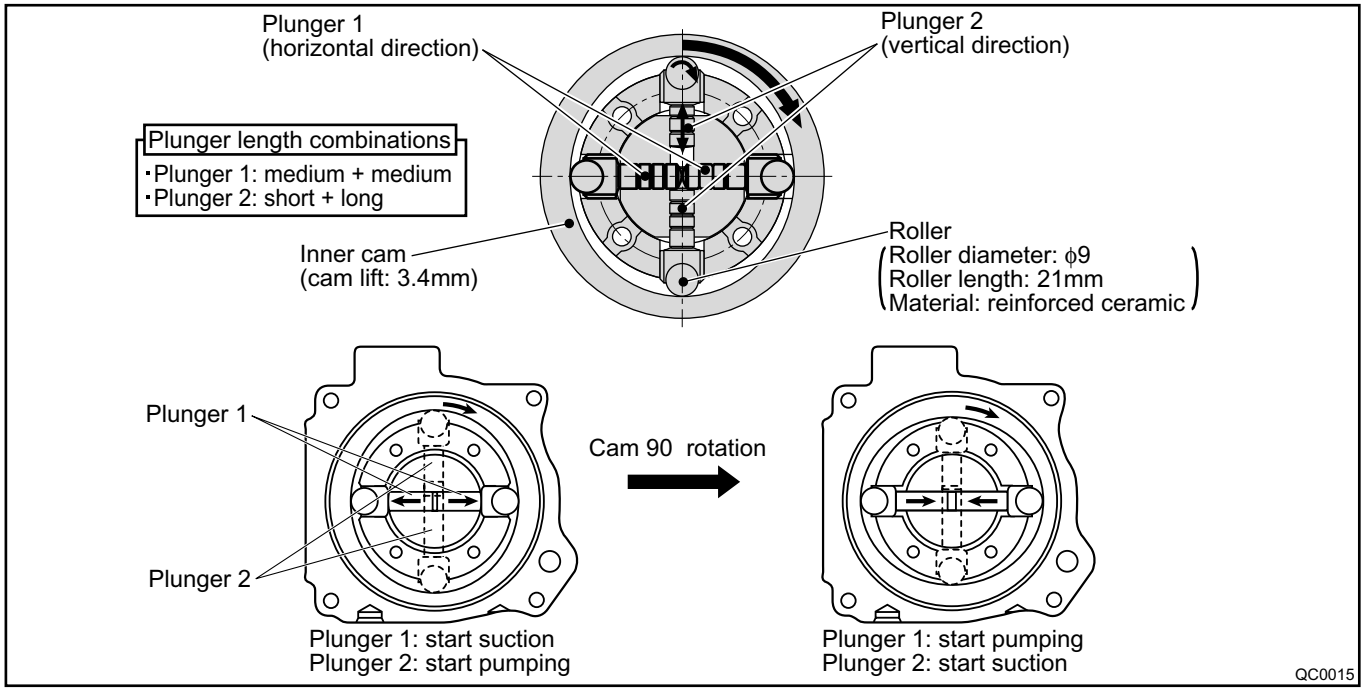
[Check Valve Closed]

When the fuel is being pumped (SCV OFF), the high-pressure fuel from the pumping portion causes the valve to close, preventing the fuel from flowing in the direction of the SCV.

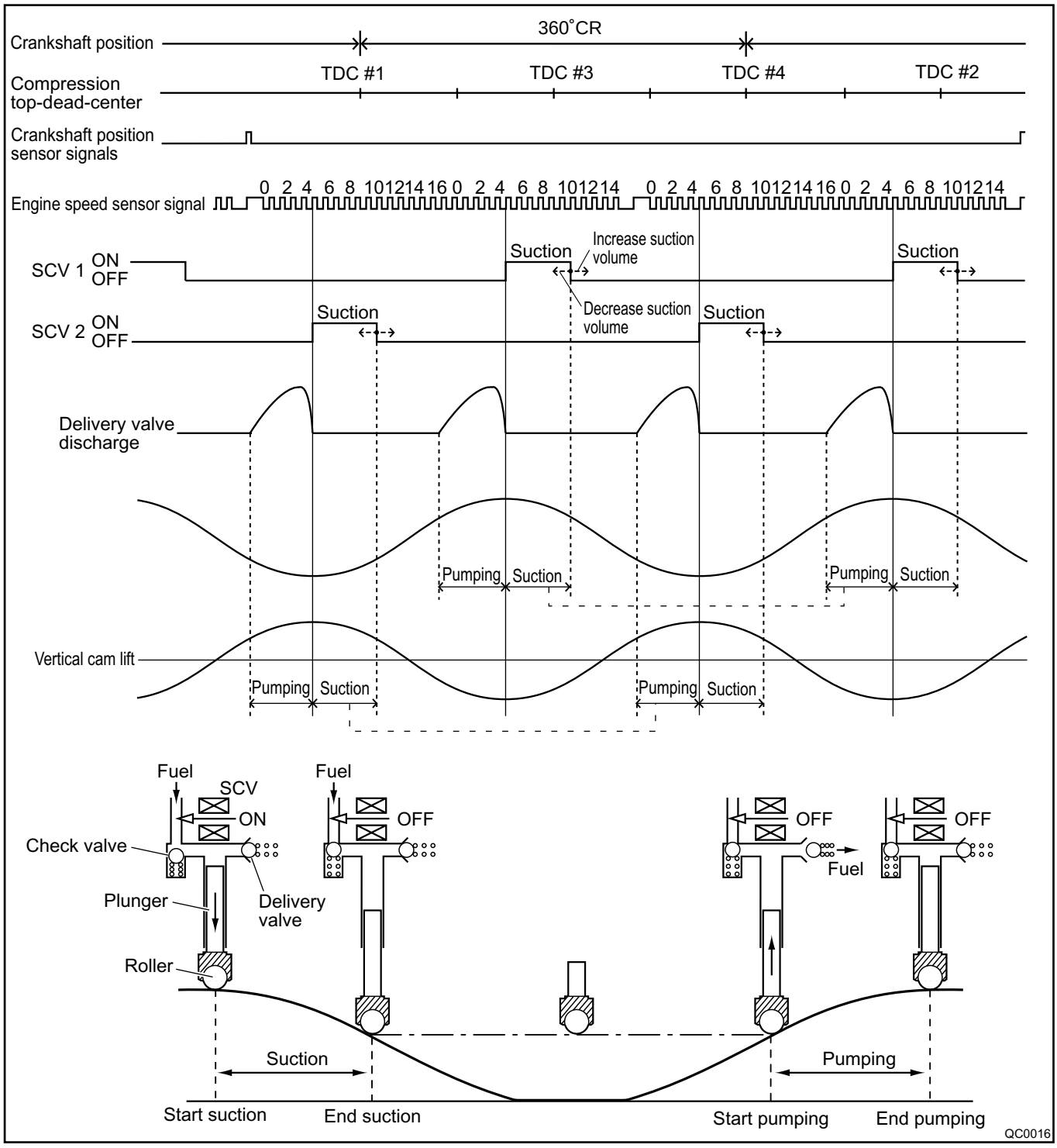


(5) Pumping Portion (Inner Cam and Plunger)

- This portion draws in the fuel that is discharged by the feed pump and pumps the fuel to the common rail. Because the drive shaft and the inner cam have an integral construction, the rotation of the drive shaft directly becomes the rotation of the inner cam.
- Two plungers (which comprise a tandem system) are placed inline inside the inner cam: plunger-1 in the horizontal direction, and plunger-2 in the vertical direction. Because the phases of their suction and pumping strokes are staggered 180 degrees apart from each other (one for suction and the other for discharge), a total of four discharges are provided to the common rail for every revolution of the supply pump. A groove in provided in the circumferential direction of each plunger to improve its sliding performance

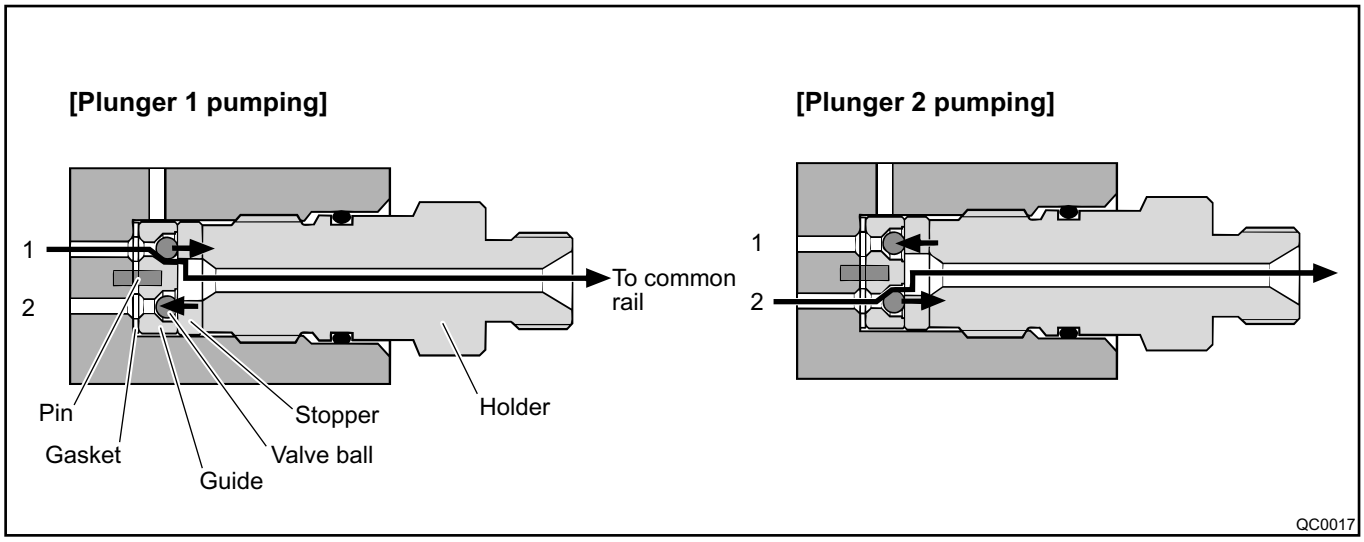


- Because the engine speed sensor signal keeps the suction start timing (SCV ON) constant (determined by the pump speed), the fuel suction volume is regulated by controlling the suction end timing (SCV OFF) as illustrated. In other words, turning OFF the SCV earlier reduces the suction volume, while turning it OFF later increases the suction volume.
- During the suction stroke, the fuel feed pressure is applied to the plunger, which causes the plunger to move along the exterior of the cam surface and stop at the position when the suction ends. Because the suction volume varies between 0 and 100%, the roller does not maintain contact with the cam surface from the time suction is completed until pumping starts, except during the maximum suction period.



(6) Delivery Valve

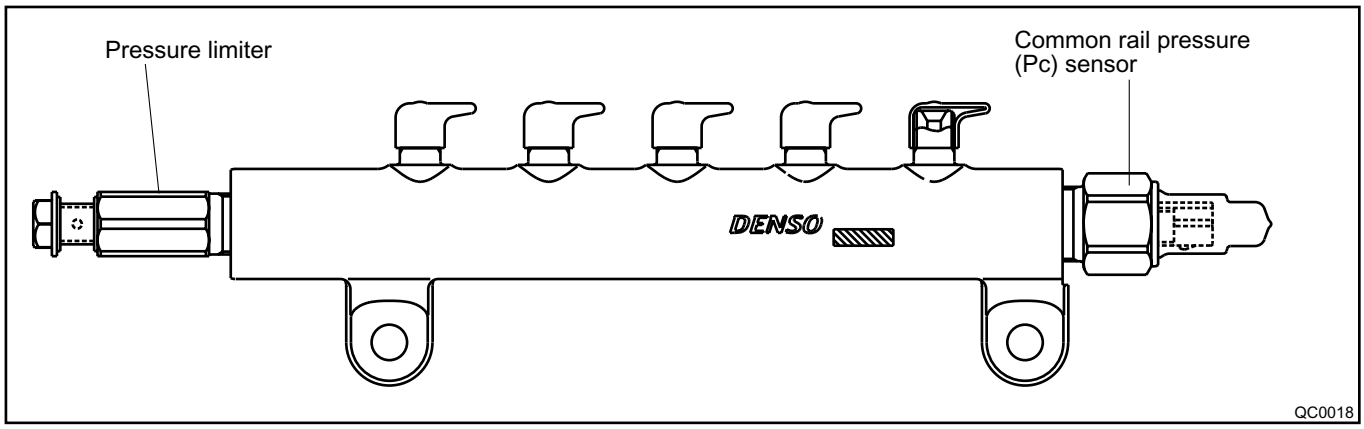
Two valve balls are provided inside a single delivery valve in order to alternately pump the high-pressure fuel that is fed from plungers 1 and 2. When the pressure of the fuel on the plunger side becomes higher than that of the common rail side, the valve opens and discharges the fuel.



5.3. Common Rail

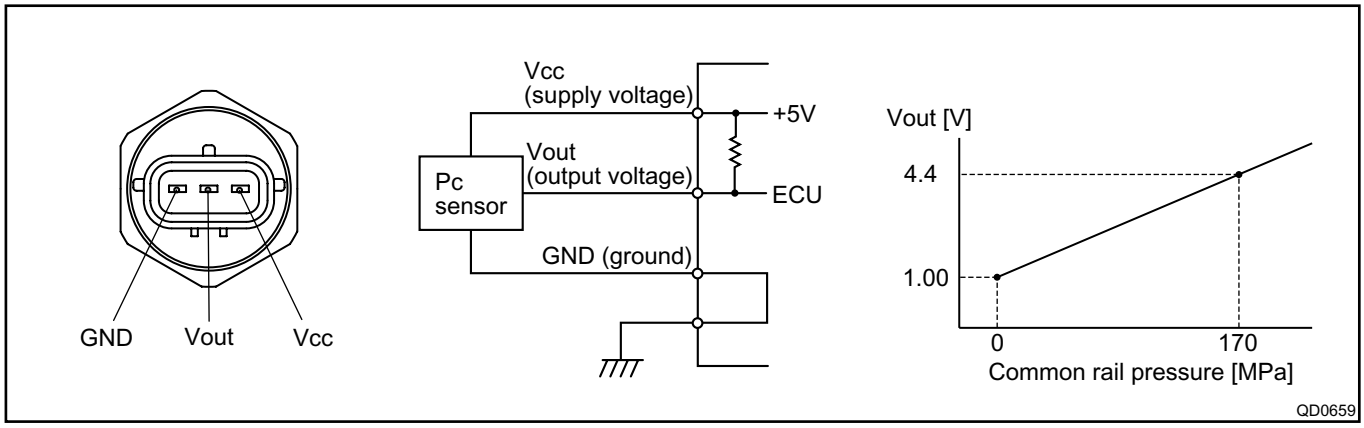
(1) Outline

The common rail stores the high-pressure fuel (0 to 135 MPa) that is pumped from the supply pump and distributes it to the injectors of the cylinders. A common rail pressure (Pc) sensor and a pressure limiter are installed on the common rail.



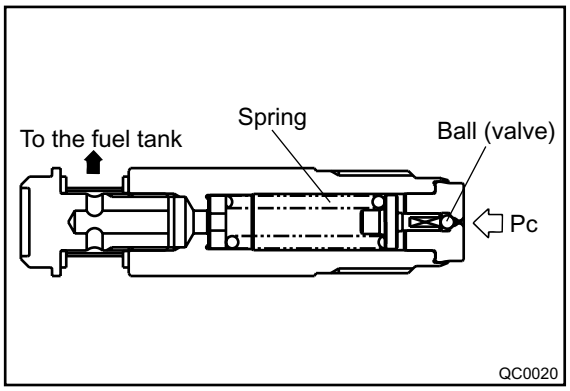
(2) Common Rail Pressure (Pc) Sensor

This sensor detects the fuel pressure in the common rail and sends its signal to the ECU. It is a semi-conductor type pressure sensor that utilizes the characteristic in which the electrical resistance changes when pressure is applied to silicon.



(3) Pressure Limiter (made by another manufacturer)

The pressure limiter relieves the pressure by opening the valve if an abnormally high pressure is generated. It opens when the pressure in the common rail reaches approximately 170 MPa, and recovers at approximately 40 MPa. The fuel that is leaked by the pressure limiter returns to the fuel tank.



5.4. Injector

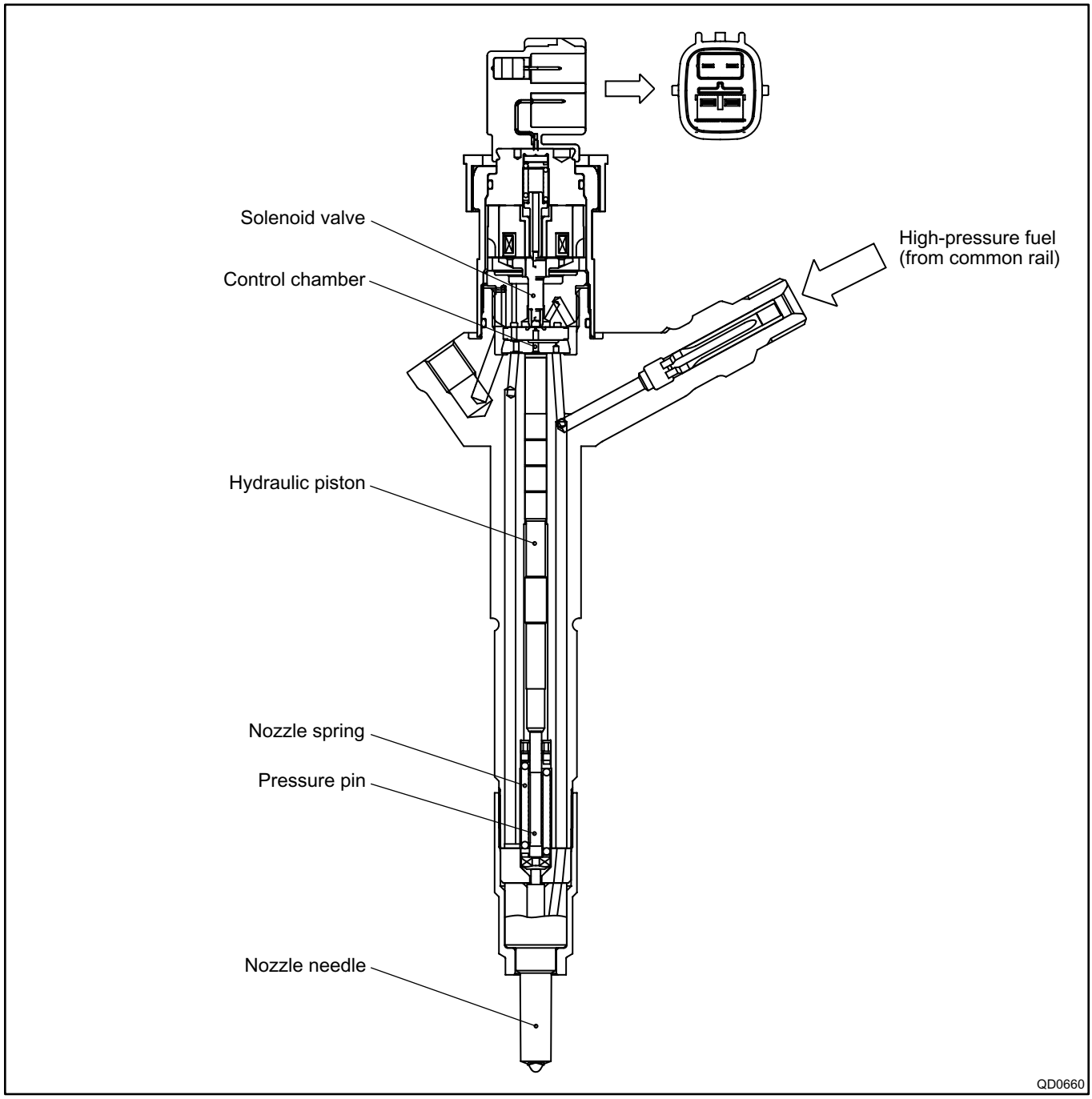
(1) Outline

The injectors inject the high-pressure fuel from the common rail into the combustion chambers at the optimum injection timing, rate, and spray condition in accordance with the commands received from the ECU.

[Characteristics]

- A compact, energy-saving, solenoid-control type TWV (Two-Way Valve) injector has been adopted.
- A hollow screw with a damper is fitted in the fuel leak pipe connection to improve the injector's injection precision.

(2) Construction



(3) Operation

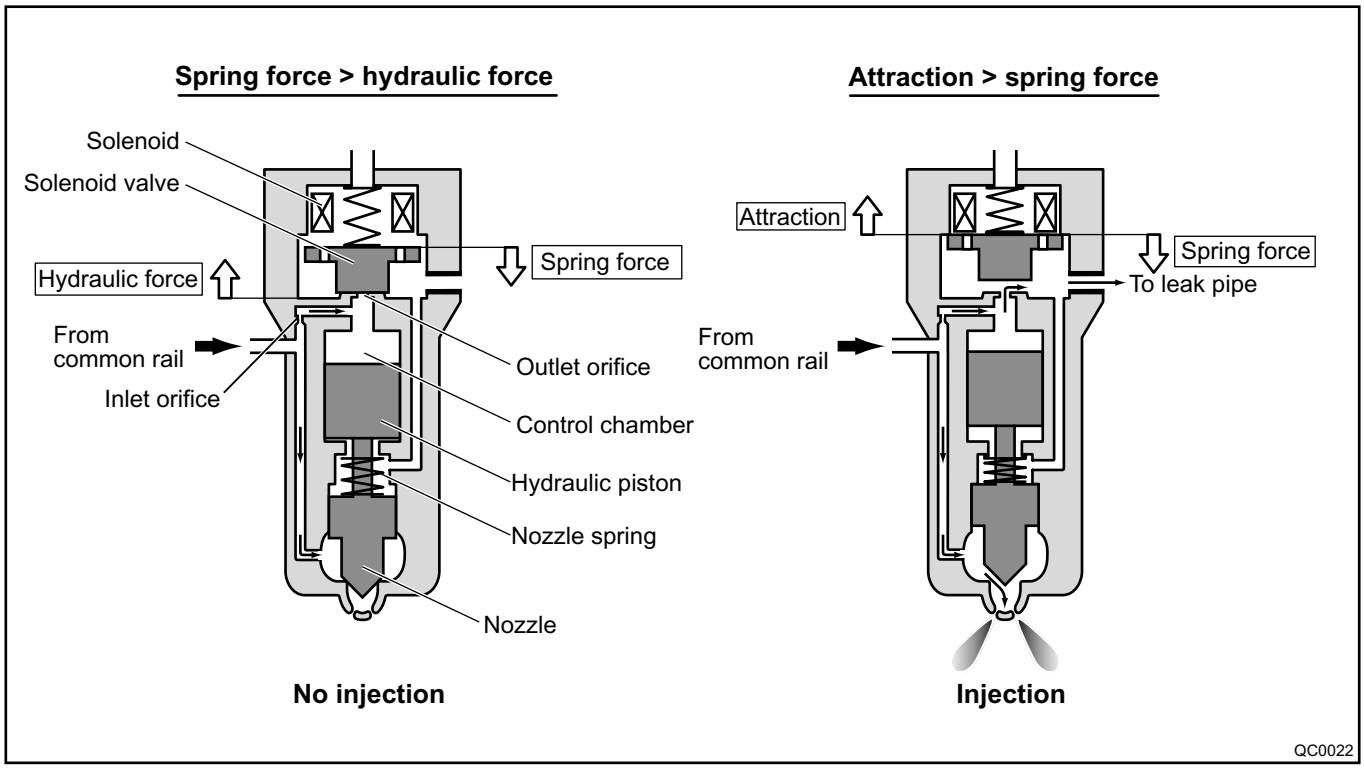
The TWV solenoid valve opens and closes the outlet orifice to regulate the pressure in the control chamber and to control the starting and the ending of injection.

[No injection]

- When no current is supplied to the solenoid, the spring force is stronger than the hydraulic pressure in the control chamber. Thus, the solenoid valve is pushed downward, effectively closing the outlet orifice. For this reason, the hydraulic pressure that is applied to the command piston causes the nozzle spring to become compressed, which causes the nozzle needle to close, without allowing the fuel to be injected.

[Injection]

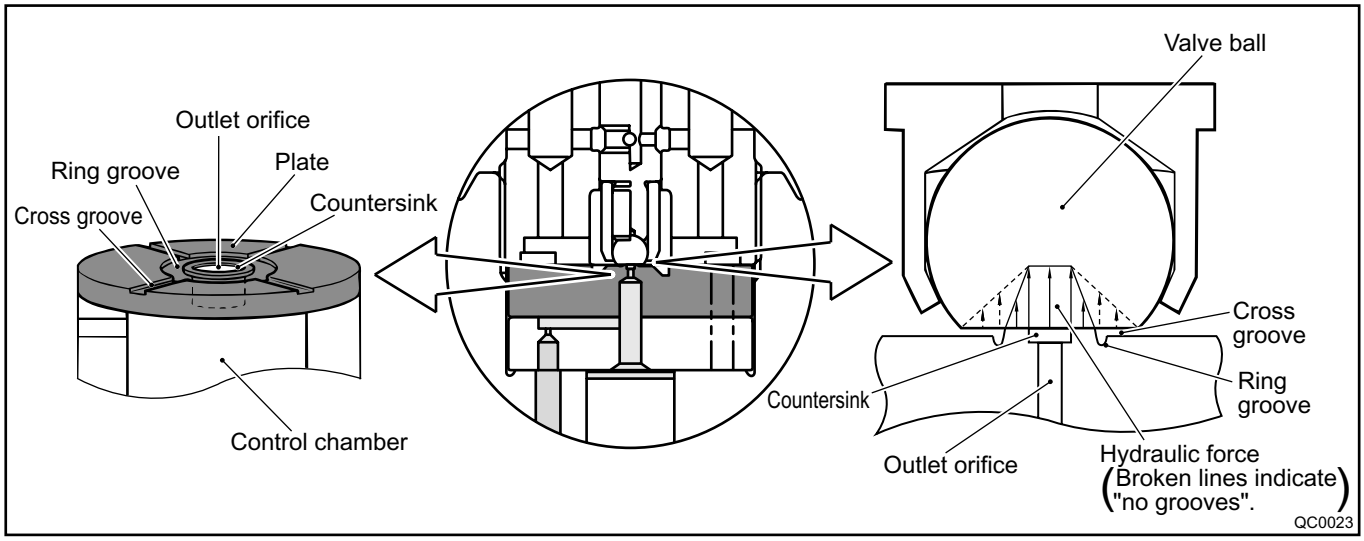
- When the current is initially applied to the solenoid, the attraction of the solenoid pulls the solenoid valve up, effectively opening the outlet orifice and allowing the fuel to flow out of the control chamber. After the fuel flows out, the pressure in the control chamber diminishes, which causes the hydraulic piston to be pulled up. This causes the nozzle needle to ascend and the injection to start.
- The fuel that flows past the outlet orifice flows to the leak pipe and below the hydraulic piston. The fuel that flows below the piston lifts the piston upward, which helps to improve the nozzle's opening and closing response.
- When the current continues to be applied to the solenoid, the nozzle reaches its maximum lift, where the injection rate is also at the maximum level. When the current to the solenoid is cut off, the solenoid valve descends, quickly closing the nozzle needle and thus ending the injection.



(4) New features

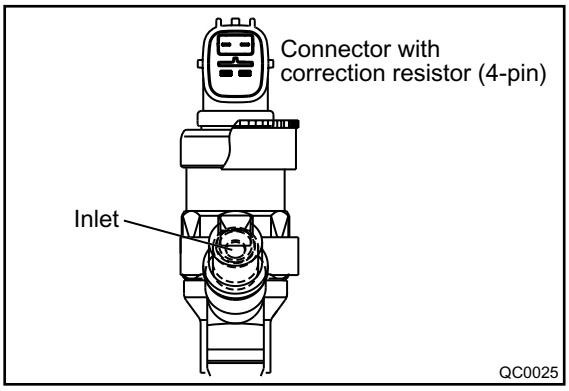
[Construction of Solenoid Valve and Shape of Orifice Plate]

- A ball having a flat surface is fitted inside the solenoid valve to realize a flat-surface sealing method. The change in this construction has resulted in a more compact injector.
- A ring-shaped groove and cross grooves are made in the outlet orifice plate to reduce the hydraulic pressure that is applied to the solenoid valve. In addition, a counter bore is provided in the outlet orifice to minimize the variances in the fuel outflow volume. Thus, the injector has been made more compact and energy efficient, and its injection precision has been improved.



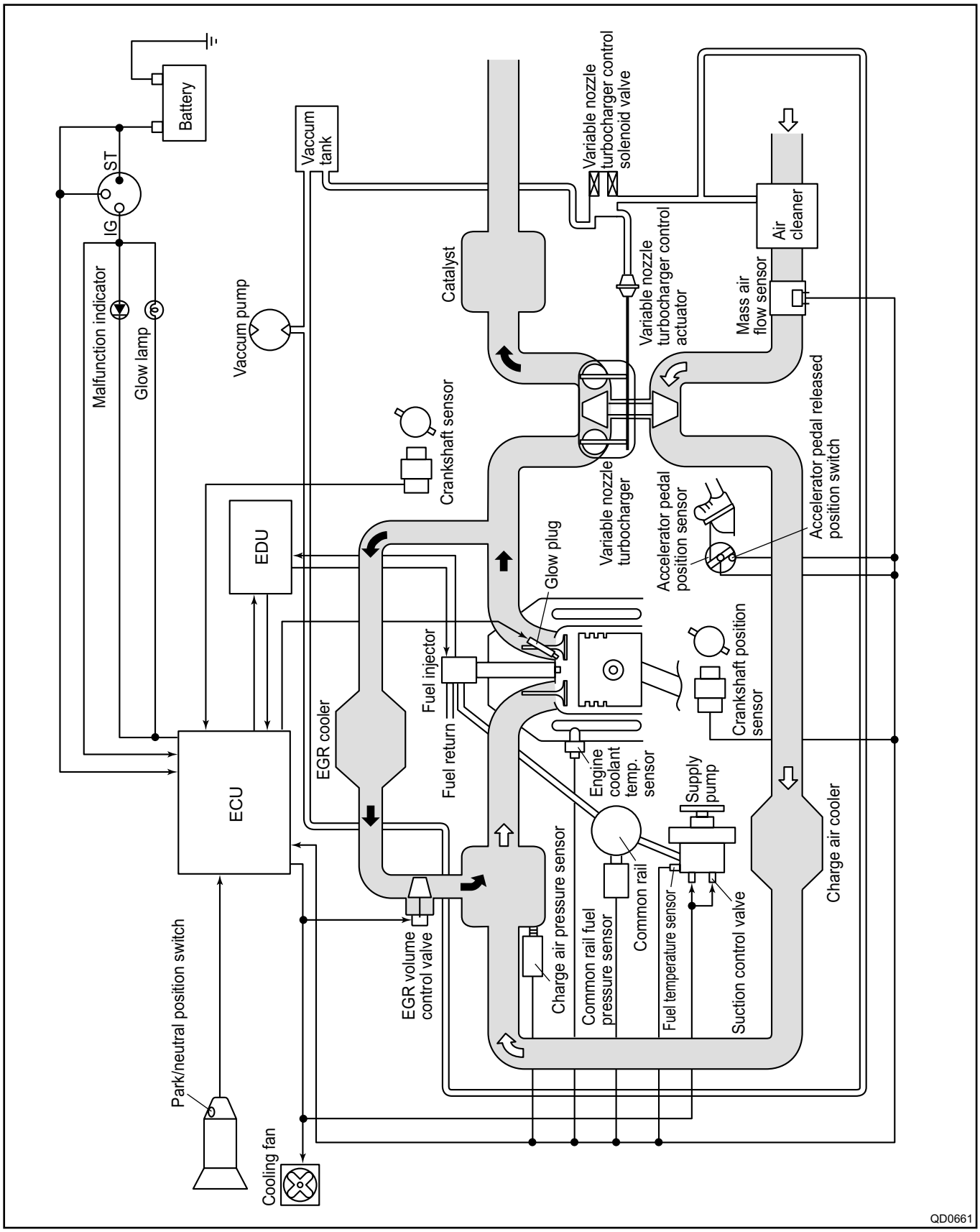
[Connector with Correction Resistor]

A correction resistor is provided in the connector (4-pin connector) of each injector to minimize the variances in the injection volume among the cylinders (adjusted in the production line).



6. Description of Control System Components

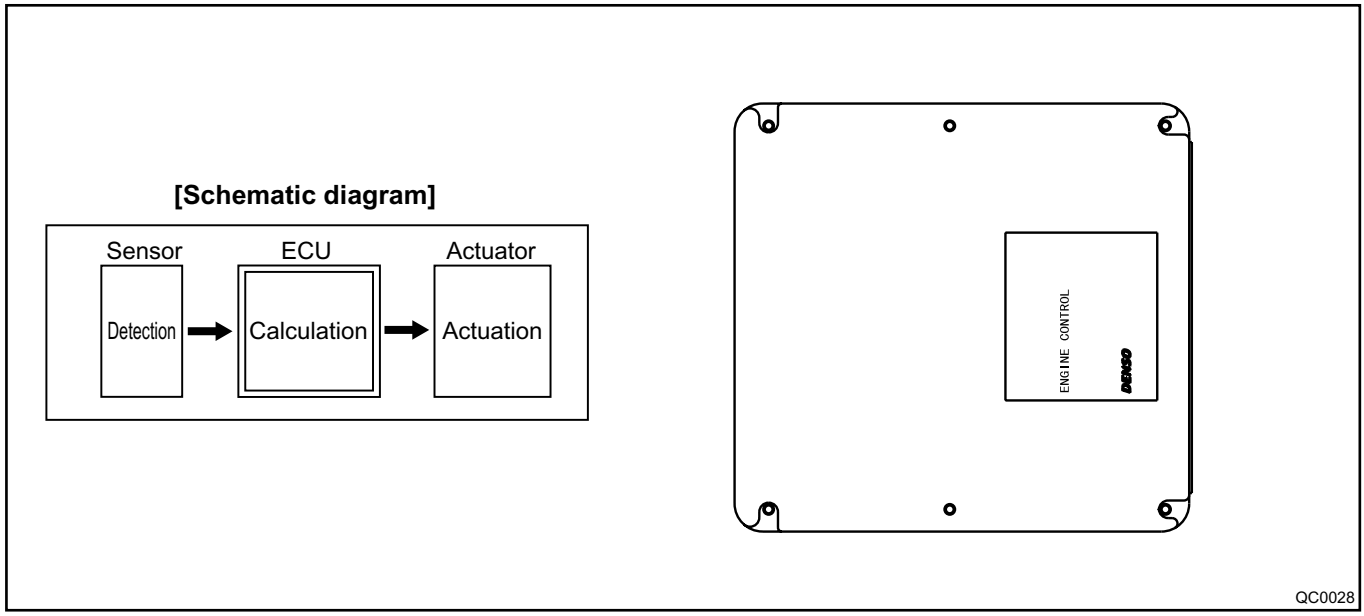
6.1. Engine Control System Diagram



6.2. ECU (Electronic Control Unit)

(1) Outline

This is the command center that controls the fuel injection system and the engine operation in general.



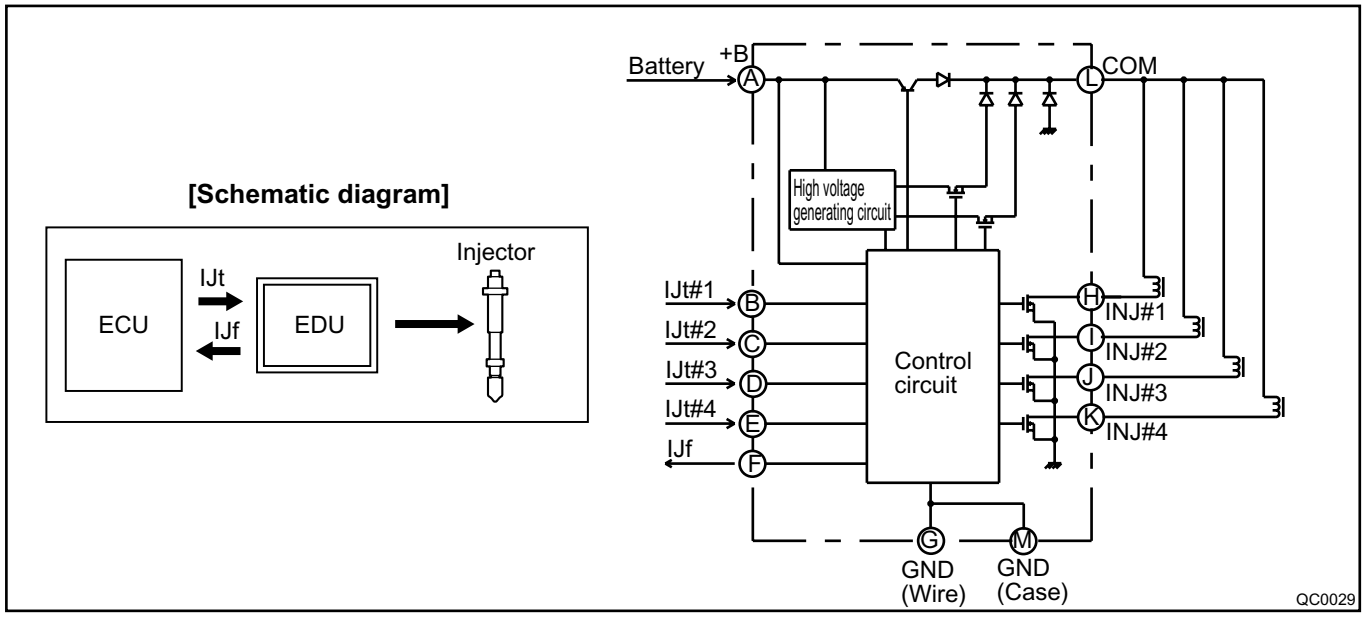
6.3. EDU (Electronic Driving Unit)

(1) Outline

The EDU has been adopted to support the high-speed actuation of the injectors. The high-speed actuation of the injector solenoid valve is made possible through the use of a high-voltage generating device (DC/DC converter).

(2) EDU operation

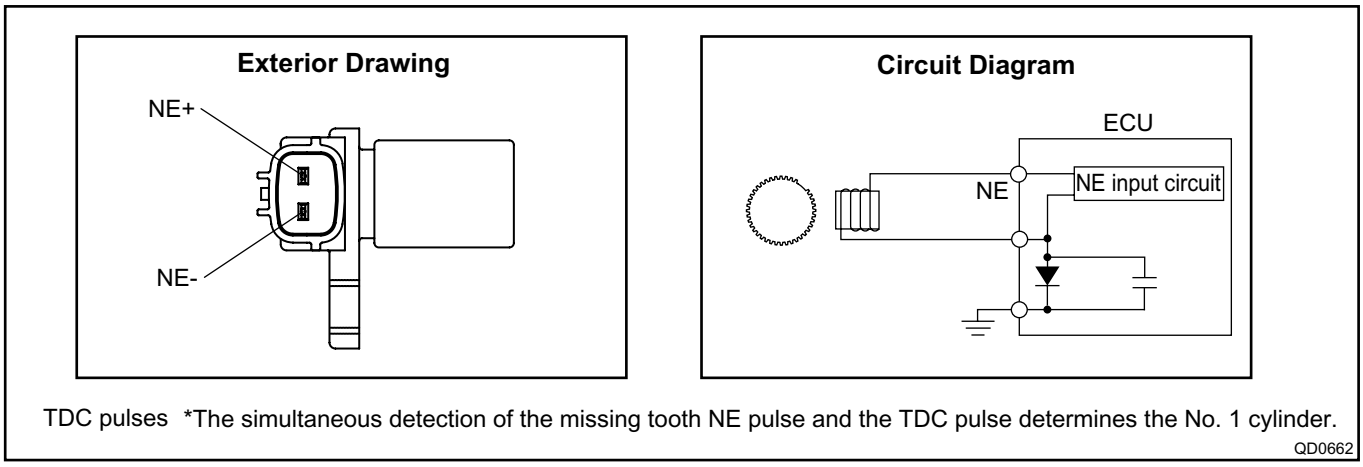
The high-voltage generating device converts the battery voltage into high voltage. Based on the signals received from the sensors, the ECU transmits signals to terminals B through E of the EDU. Upon receiving these signals, the EDU outputs the signals to the injectors via terminals H through K. At this time, the injection confirmation signal Ijf is output from terminal F.



6.4. Description of Sensors

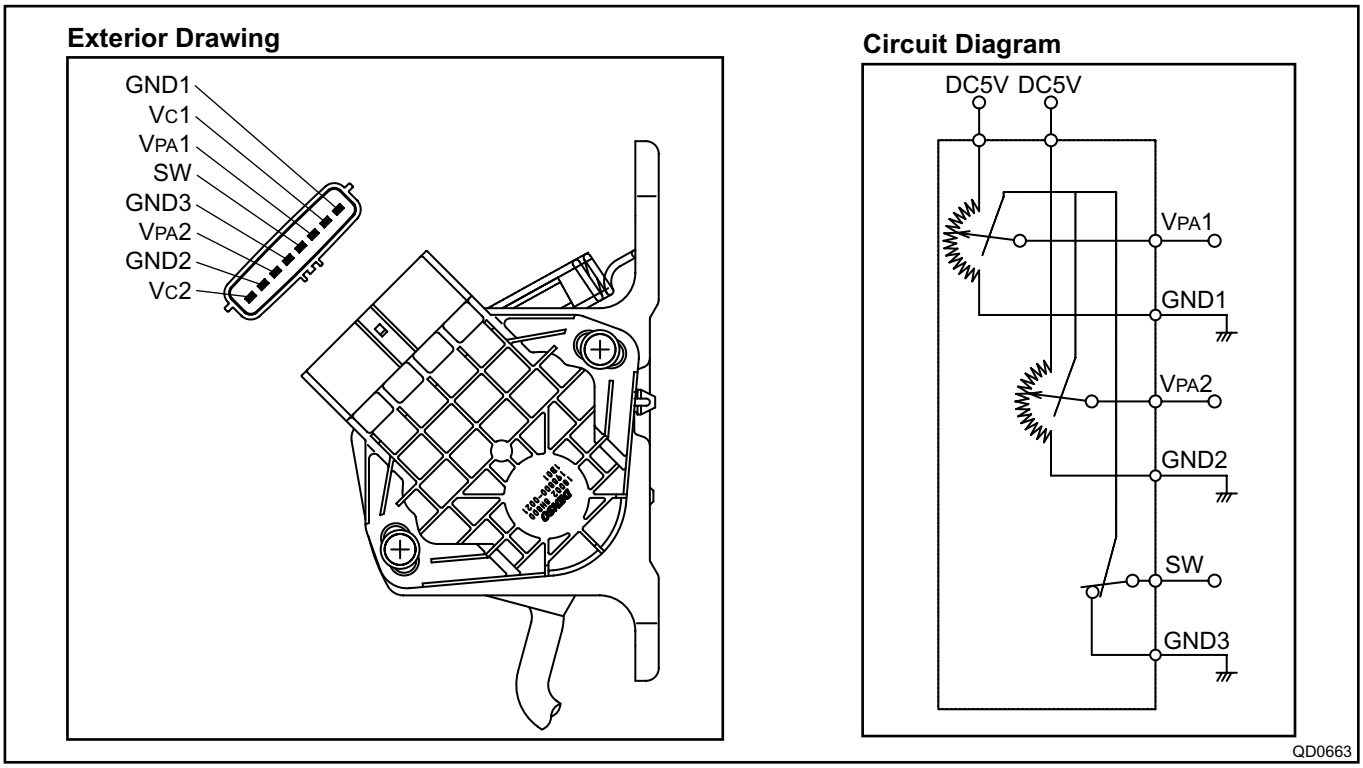
(1) Engine Speed Sensor

An NE pulsar that is attached to the crankshaft timing gear outputs a signal for detecting the engine speed.



(2) Accelerator Position Sensor

It is a contact point type sensor that has a lever that rotates in unison with the accelerator pedal. The voltage (VPA1, VPA2) of the output terminal varies in accordance with the rotational angle of the lever. The voltage is output through two systems, in case of problems such as an open circuit in the sensor.



7. Control Systems

7.1. Various Types of Controls

(1) Outline

The fuel injection quantity and timing are controlled more appropriately than by the mechanical governor or the timer that are used in conventional injection pumps.
The system controls the timing and the length of time in which the current is applied to the injectors. This is accomplished by performing the calculations needed by the ECU in accordance with the signals from the various sensors provided on the engine and on the vehicle. As a result, optimal injection is realized at an optimal injection timing.

(2) Fuel Injection Rate Control Function

The fuel injection rate control function controls the rate of the fuel volume that is injected through the nozzle orifices within a given unit of time.

(3) Fuel Injection Quantity Control Function

The fuel injection quantity control function replaces the conventional governor function. It controls the fuel injection to an optimal injection quantity based on the engine speed and accelerator position signals.

(4) Fuel Injection Timing Control Function

The fuel injection timing control function replaces the conventional timer function. It controls the injection to an optimal timing based on the engine speed and the injection quantity.

(5) Fuel Injection Pressure Control Function (Common Rail Pressure Control Function)

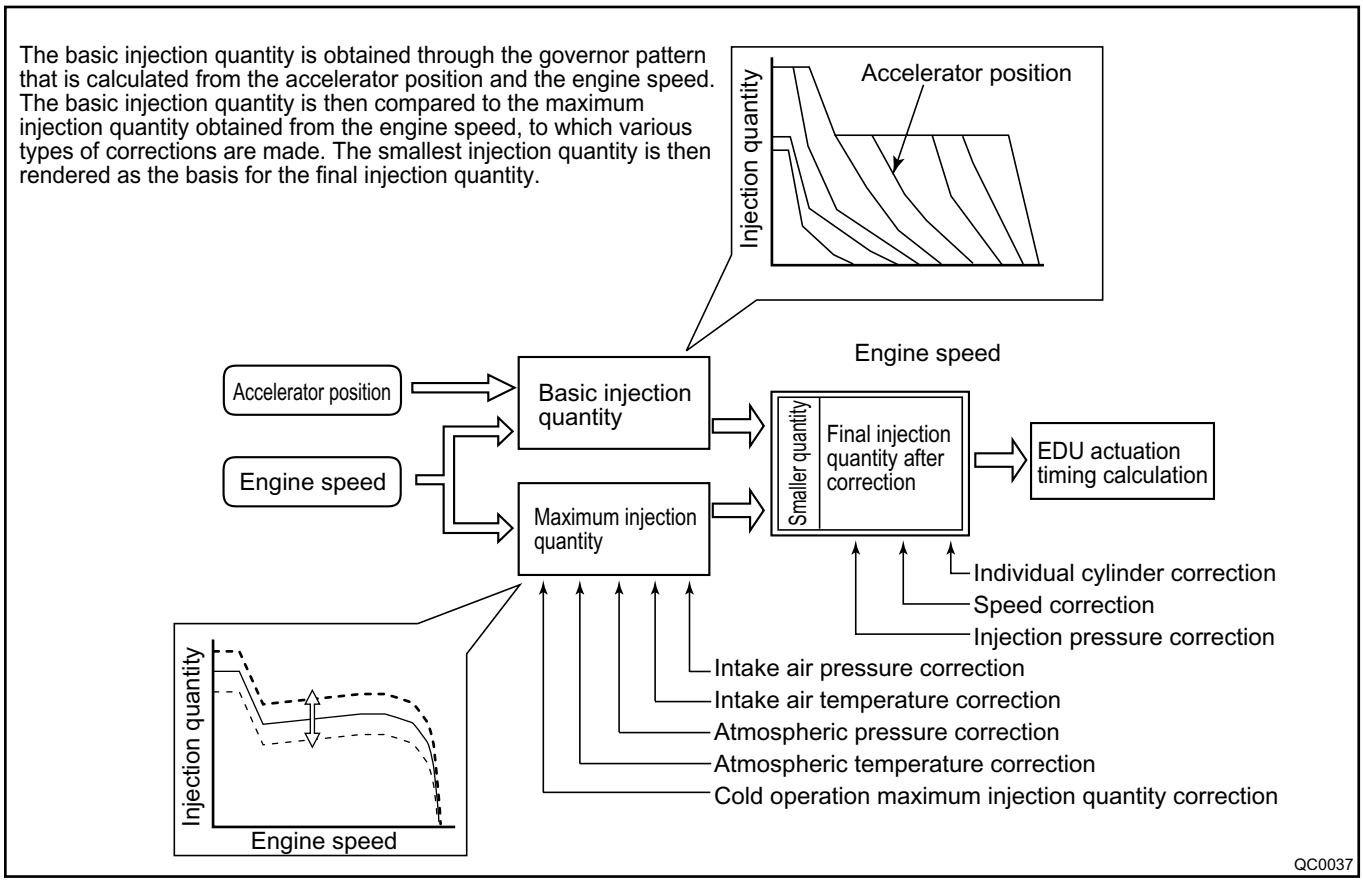
The fuel injection pressure control function (common rail pressure control function) controls the discharge volume of the pump by measuring the fuel pressure at the common rail pressure sensor and feeding it back to the ECU. It effects pressure feedback control so that the discharge volume matches the optimal (command) value that is set in accordance with the engine speed and the injection quantity

7.2. Fuel Injection Quantity Control

(1) Outline

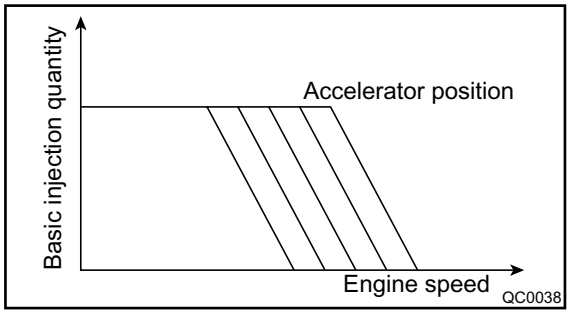
Determines the fuel injection quantity by adding water temperature, fuel temperature, intake air temperature, and intake air pressure corrections to the basic injection quantity that is calculated by the engine control unit based on the engine operating conditions and driving conditions.

(2) Injection Quantity Calculation Method



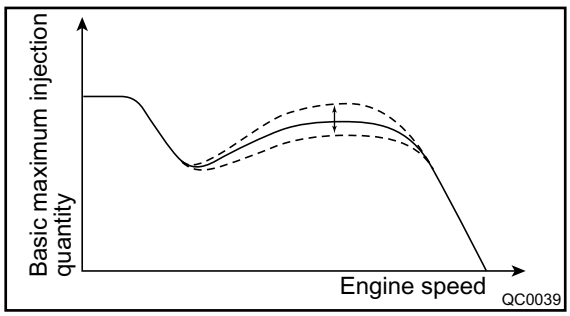
(3) Basic Injection Quantity

The basic injection quantity is determined by the engine speed (NE) and the accelerator position. The injection quantity is increased when the accelerator position signal is increased while the engine speed remains constant.



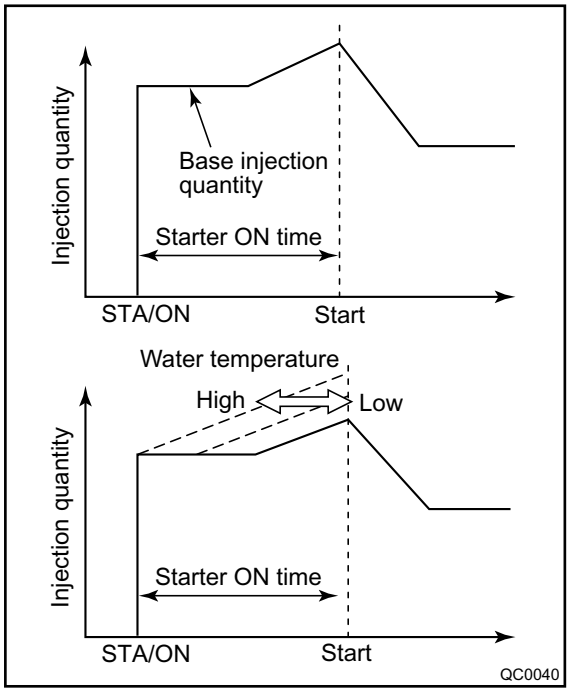
(4) Maximum Injection Quantity

The maximum injection quantity is calculated by adding the intake air pressure correction, intake air temperature correction, atmospheric pressure correction, atmospheric temperature correction, and the cold operation maximum injection volume correction to the basic maximum injection volume that is determined by the engine speed.



(5) Starting Injection Quantity

When the starter switch is turned ON, the injection quantity is calculated in accordance with the starting base injection volume and the starter ON time. The base injection quantity and the inclination of the quantity increase/decrease change in accordance with the water temperature and the engine speed.



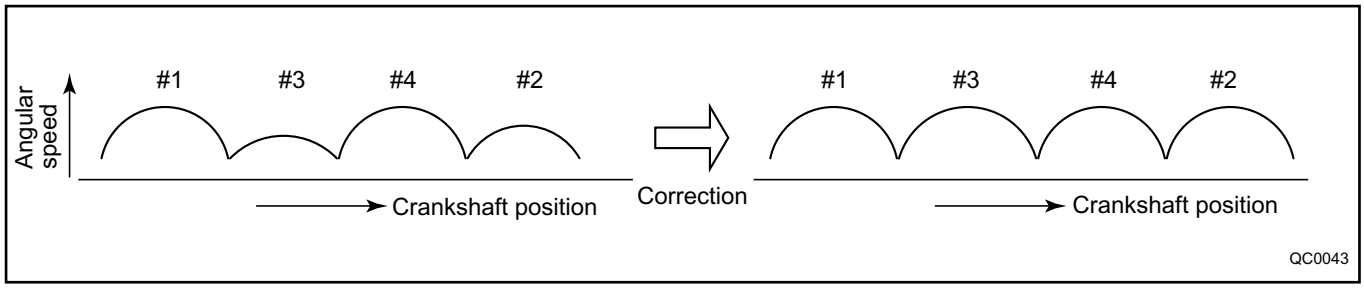
(6) Idle Speed Control System (ISC)

This system controls the idle speed by regulating the injection quantity in order to match the actual speed to the target speed that is calculated by the computer.

The target speed varies by the type of transmission (manual or automatic), whether the air conditioner is ON or OFF, the shift position, and the state of the coolant water temperature.

(7) Idle Vibration Reduction Control

To reduce engine vibrations during idle, this function compares the angular speeds (times) of the cylinders and regulates the injection quantity for the individual cylinders if the difference is great, in order to achieve a smooth engine operation.



7.3. Fuel Injection Timing Control

(1) Outline

The fuel injection timing is controlled by varying the timing in which the current is applied to the injectors.

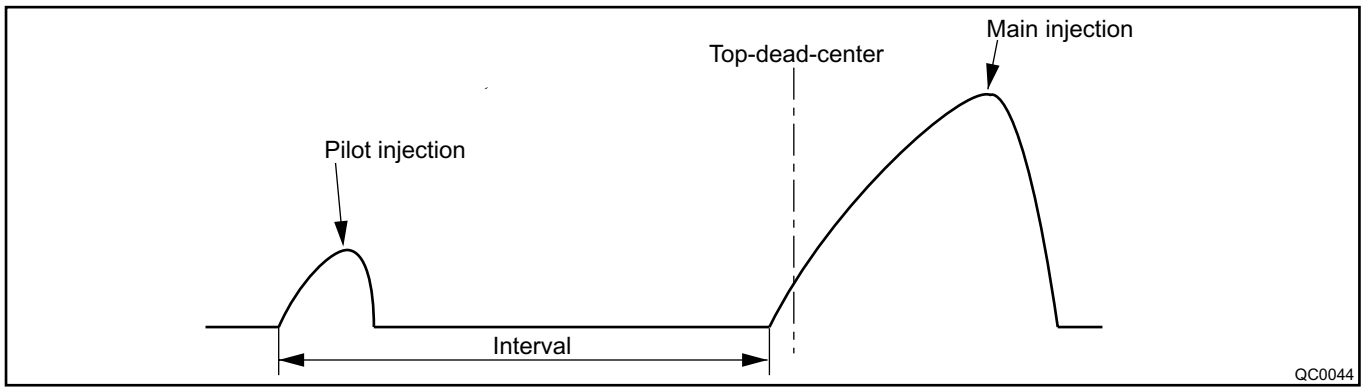
(2) Main and Pilot Injection Timing Control

[Main Injection Timing]

The basic injection timing is calculated from the engine speed (NE pulse) and the final injection quantity, to which various types of corrections are added in order to determine the optimal main injection timing.

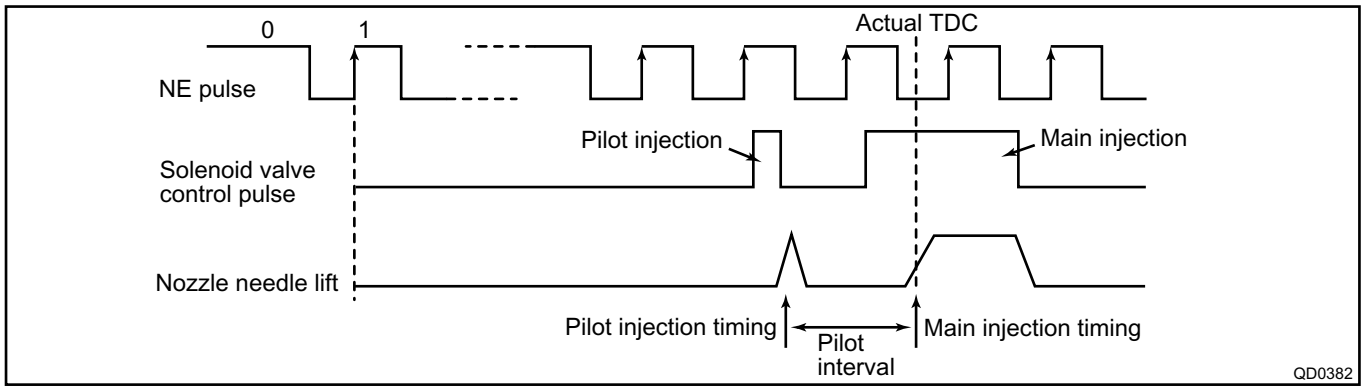
[Pilot Injection Timing (Pilot Interval)]

The pilot injection timing is controlled by adding the pilot interval to the main injection. The pilot interval is calculated based on the final injection quantity, engine speed, water temperature, atmospheric temperature, and atmospheric pressure (map correction). During starting, this timing is calculated based on the water temperature and speed.

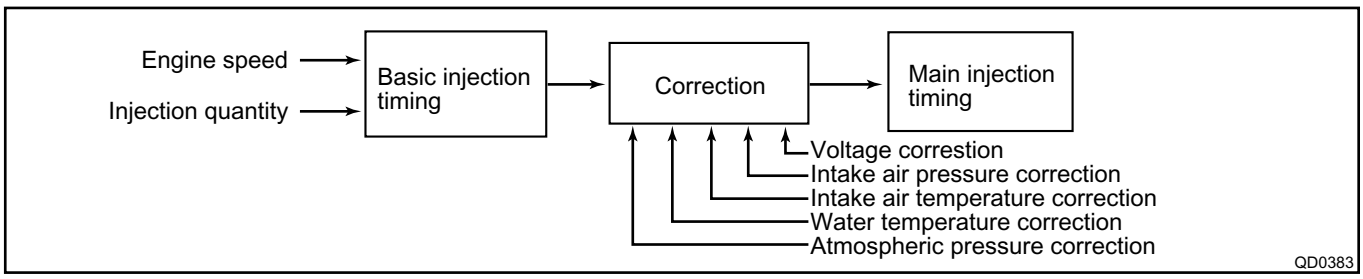


(3) Injection Timing Calculation Method

[Control Timing Outline]

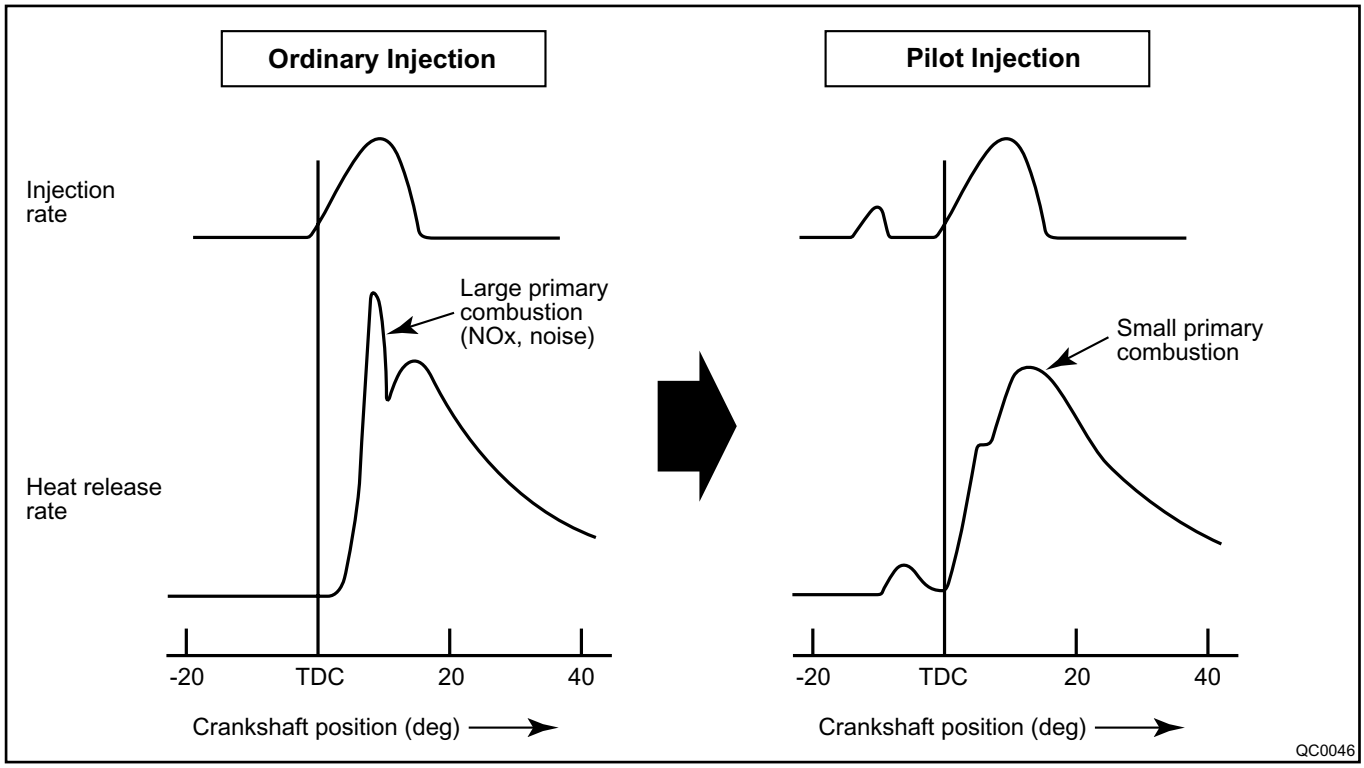


[Injection Timing Calculation Method]



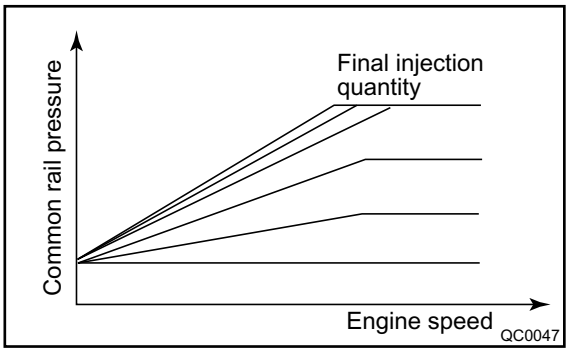
7.4. Fuel Injection Rate Control

While the injection rate increases with the adoption of high-pressure fuel injection, the ignition lag, which is a lag that occurs from the time that fuel is injected until its combustion starts cannot be shortened beyond a certain value. As a result, the quantity of fuel that is injected up to the time that ignition takes place increases, prompting an explosive combustion at once, simultaneously with ignition. This is the cause of a large amount of NOx and noise. To counteract this situation, pilot injection is provided to keep the initial injection at the minimum requirement rate, to dampen the primary explosive combustion, and to reduce NOx and noise.



7.5. Fuel Injection Pressure Control

A value that is determined by the final injection quantity and the engine speed is calculated. During the starting of the engine, the calculation is based on the water temperature and the engine speed.



7.6. Other Controls

a: Limit maximum injection volume

b: Gradual acceleration injection volume

c: Gradual deceleration injection volume

d: Post-acceleration damping injection volume

e: Reference injection volume

f: Fuel cutoff

g: EGR

h: Turbo control

i: Swirl control

j: Intake restriction

k: Glowplug relay

8. DTC (Diagnosis Trouble Codes) Table

8.1. About the Codes shown in the table

- The “SAE” under the DTC code indicates the codes that are output when the STT DST-1 is used, and the “Light” indicates the codes that are output when the CHECK ENGINE warning light is used. (SAE: Society of Automotive Engineers, U.S.A.)
- If multiple DTCs are output, they are shown in order starting with the lowest number.

8.2. Diagnosis Trouble Code Details

Code No.	Diagnosis Item	Description of Diagnosis	Inspection Area
P0100	Mass airflow meter system	An excessively high or low voltage from the sensor is sent to ECU.	•Harness or connectors (The sensor circuit is open or shorted.) •Mass air flow sensor
P0115	Engine coolant temp. sensor	An excessively high or low voltage from the sensor is sent to ECU.	•Harness or connectors (The sensor circuit is open or shorted.) •Engine coolant temperature sensor
P0120	Accelerator position sensor	An improper voltage signal from accelerator pedal positon sensor 1 and/or 2 is send to ECU.	•Harness or connectors (The sensor circuit is open or shorted.) •Accelerator pedal position sensor 1 •Accelerator pedal position sensor 2 •Accelerator pedal released position switch
P0190	Fuel pressure sensor system	An excessively high or low voltage from the sensor is entered to ECU.	•Harness or connectors (The sensor circuit is open or shorted.) •Common rail fuel pressure sensor
P0201	CYL 1 injector system	Injector No.1 does not operate normally.	•Harness or connectors (Injector circuit is open or shorted.) •Electronic drive unit •Fuel injector
P0202	CYL 2 injector system	Injector No.2 does not operate normally.	
P0203	CYL 3 injector system	Injector No.3 does not operate normally.	
P0204	CYL 4 injector system	Injector No.4 does not operate normally.	

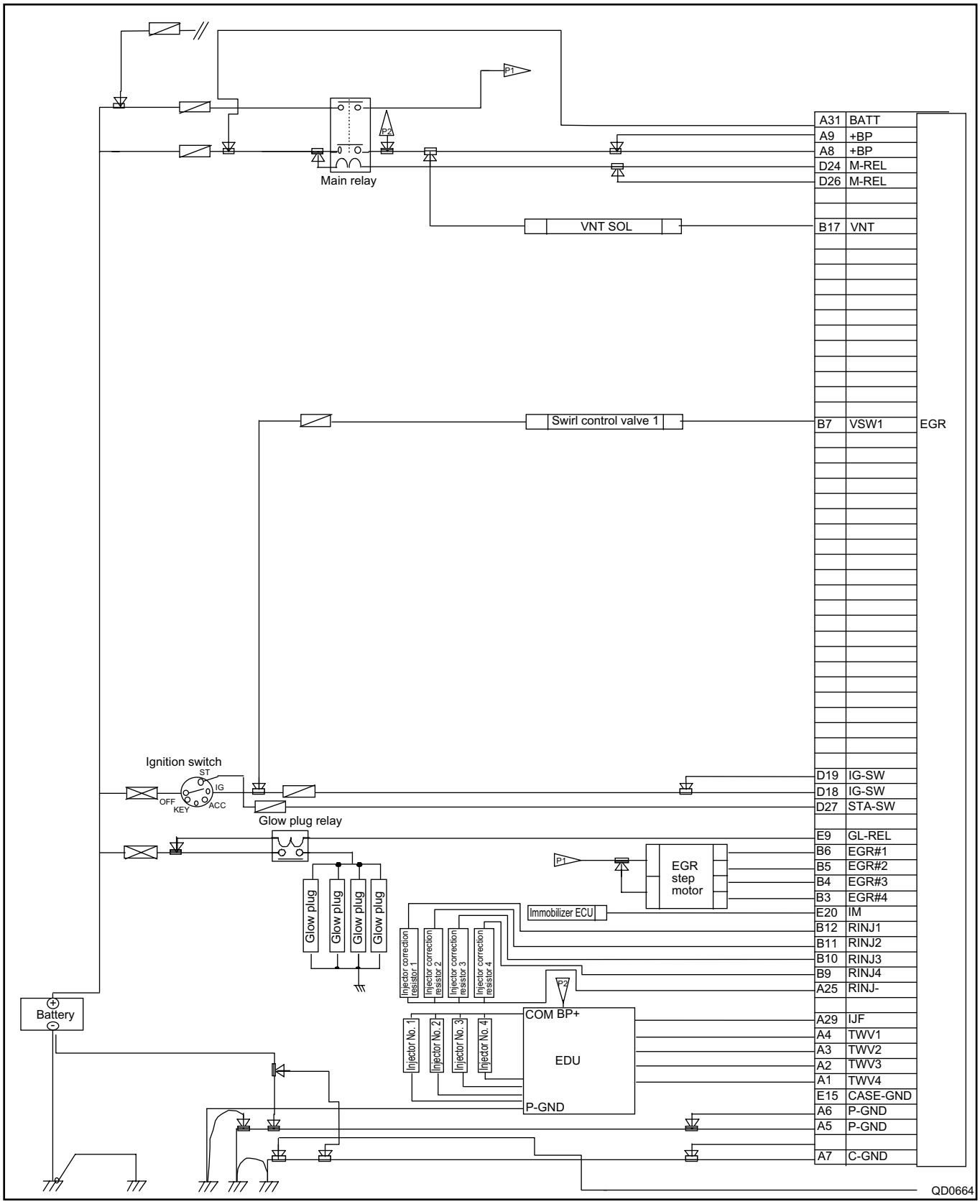
Code No.	Diagnosis Item	Description of Diagnosis	Inspection Area
P0235	Boost pressure	A: An excessively high or low voltage from the sensor is sent to ECU.	•Harness or connectors (The sensor circuit open or shorted.) •Charge air pressure sensor
		B: The ECU detects the variable nozzle turbocharger control actuator is stuck. MI will not light up for this malfunction.	•Harness or connectors (The solenoid valve circuit is shorted.) •Variable nozzle turbocharger control actuator
P0335	Crankshaft position sensor system	An improper voltage signal from the sensor is sent to ECU during running and cranking.	•Harness or connectors (The sensor circuit is open or shorted.) •Crankshaft position sensor (TDC)
P0340	Engine speed sensor system	An improper voltage signal from the sensor is sent to ECU during running and cranking.	•Harness or connectors (The sensor circuit is open or shorted.) •Camshaft position sensor
P0500	Vehicle speed sensor	The almost 0 km/h (0 MPH) signal from vehicle speed sensor is sent to ECU even when vehicle is being driven.	•Harness or connectors (The CAN communication line is open or shorted.) •Wheel sensor •Combination meter •ABS actuator and electric unit (control unit)
P1107	Atomospheric pressure sensor	An excessively high or low voltage from the absolute pressure sensor (built-into ECU) is sent to ECU.	•ECU
P1180	Fuel temp. sensor system	An excessively high or low voltage from the sensor is sent to ECU.	•Harness or connectors (The sensor circuit is open or shorted.) •Fuel temperature sensor
P1216	EDU abnormal	EDU feed back signal is not normal pattern.	•Harness or connectors (Injector drive circuit is open or shorted.) •Electronic drive unit •Fuel injectors

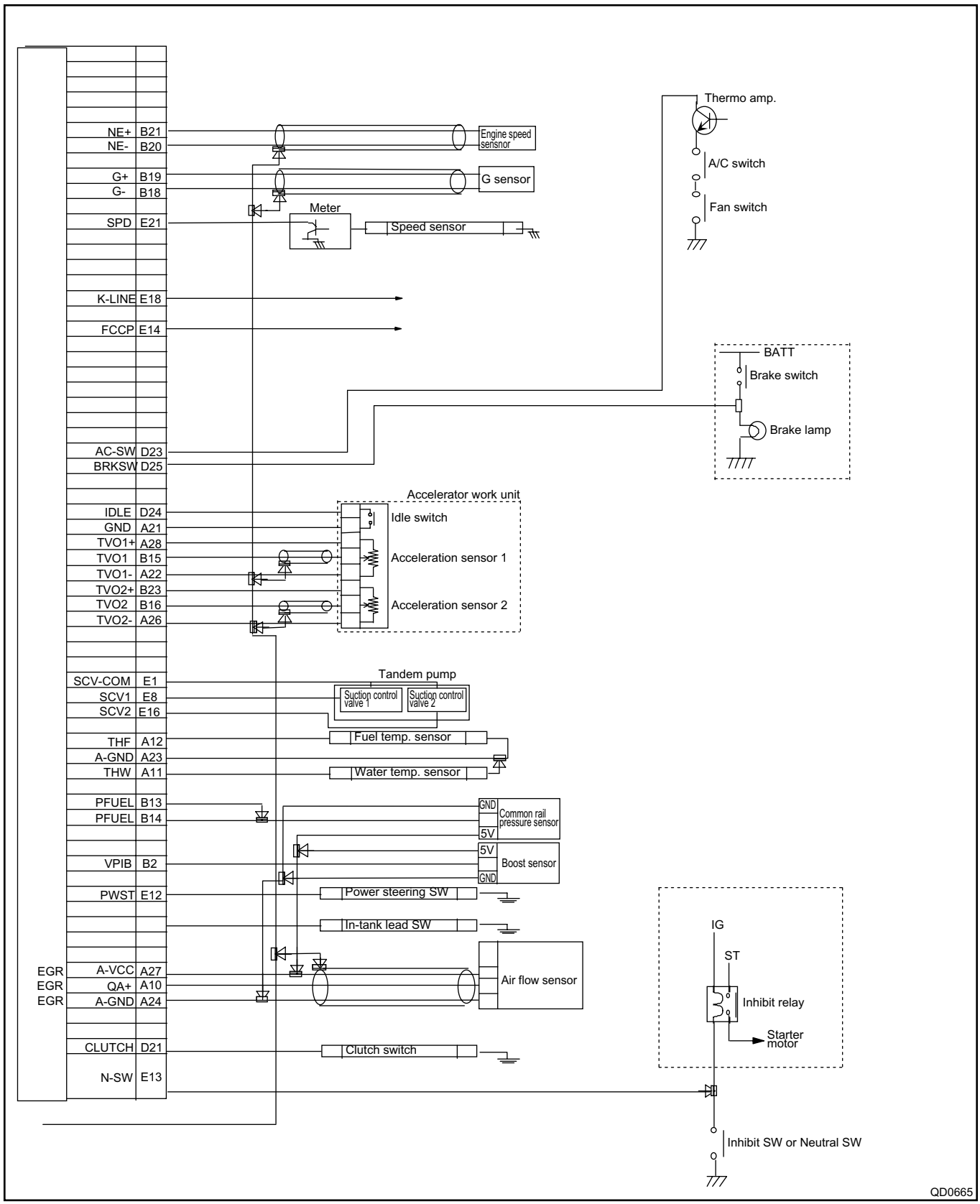
Code No.	Diagnosis Item	Description of Diagnosis	Inspection Area
P1217	Overheat detected	Cooling fan does not operate properly (Overheat). Cooling fan system does not operate properly (Overheat). Engine coolant was not added to the system using the proper filling method.	•Harness or connectors (The cooling fan circuit is open or shorted.) •Harness or connectors (The CAN communication line is open or shorted.) •Cooling fan •Radiator hose •Radiator •Radiator cap •Water pump •Thermostat •Engine coolant temperature sensor
P1233	SCV 1 system	Suction control valve 1 and/or 2 does not operate normally.	•Harness or connectors (Fuel supply pump suction control valve circuit is open or shorted.) •Suction control valve 1 •Suction control valve 2
P1234	SCV 2 system		
P1301	INJ 1 correction resistor	An excessively high or low voltage from fuel injector No.1 adjustment resistor is sent to ECU.	•Harness or connectors (Injector adjustment resister circuit is open or shorted.) •Fuel injector adjustment resistor
P1302	INJ 2 correction resistor	An excessively high or low voltage from fuel injector No.2 adjustment resistor is sent to ECU.	
P1303	INJ 3 correction resistor	An excessively high or low voltage from fuel injector No.3 adjustment resistor is sent to ECU.	
P1304	INJ 4 correction resistor	An excessively high or low voltage from fuel injector No.4 adjustment resistor is sent to ECU.	
P1305	Fuel pump (fuel leakage)	The relation between the output signal to suction control valve and input signal from common rail fuel pressure sensor is not in normal range.	•Suction control valve •Fuel tube •Common rail •Fuel pressure relief valve

Code No.	Diagnosis Item	Description of Diagnosis	Inspection Area
P1510	Idling switch faulty	The ralation between accelerator pedal position sensor 1, 2 signals and accelerator pedal position switch signal is not in the normal range during the specified acclerator pedal positions.	•Harness or connectors (Accelerator pedal released position switch circuit is open or shorted.) •Accelerator pedal released position switch
P1606	ECU abnormal	ECU calculation function is malfunctioning.	•ECU
P1621	ECU relay system	An irregular voltage signal from the ECU relay is sent to ECU.	•Harness or connectors (ECU relay circuit is open or shorted.) •ECU relay
P1660	Battery voltage	An abnormally high or low voltage from the battery is sent to ECU.	•Incorrect jump starting •Battery •Alternator •ECU

9. External Wiring Diagram

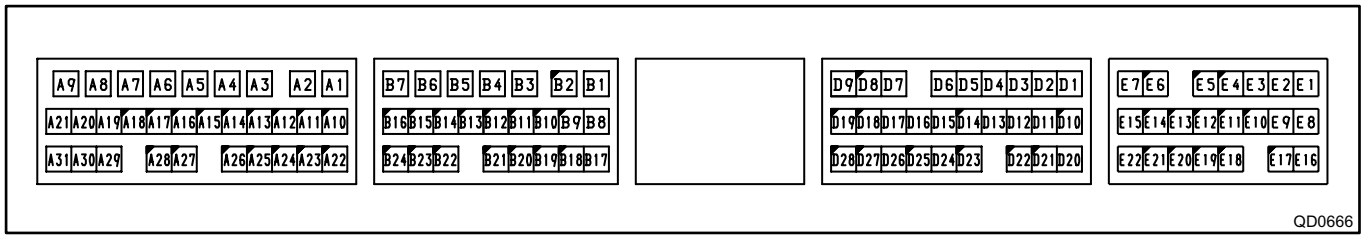
9.1. ECU External Wiring Diagram




NE+ B21
NE- B20
G+ B19
G- B18
SPD E21
K-LINE E18
FCCP E14
AC-SW D23
BRKSW D25
IDLE D24
GND A21
TVO1+ A28
TVO1 B15
TVO1- A22
TVO2+ B23
TVO2 B16
TVO2- A26
SCV-COM E1
SCV1 E8
SCV2 E16
THF A12
A-GND A23
THW A11
PFUEL B13
PFUEL B14
VPIB B2
PWST E12
EGR A-VCC A27
EGR QA+ A10
EGR A-GND A24
CLUTCH D21
N-SW E13
Engine speed sensnor
G sensor
Meter
Speed sensor
Thermo amp.
A/C switch
Fan switch
BATT
Brake switch
Brake lamp
Accelerator work unit
Idle switch
Acceleration sensor 1
Acceleration sensor 2
Tandem pump
Suction control valve 1
Suction control valve 2
Fuel temp. sensor
Water temp. sensor
GND
Common rail pressure sensor
5V
5V
Boost sensor
GND
Power steering SW
In-tank lead SW
Air flow sensor
Clutch switch
IG
ST
Inhibit relay
Starter motor
Inhibit SW or Neutral SW
QD0665

9.2. ECU Connector Diagram

(1) ECU Connector Pin Layout



(2) Terminal Connections

No.	Pin Symbol	Connections	No.	Pin Symbol	Connections
A1	TWV4	EDU #4	A17	—	
A2	TWV3	EDU #3	A18	—	
A3	TWV2	EDU #2	A19	—	
A4	TWV1	EDU #1	A20	—	
A5	P-GND	Power ground	A21	C-GND	Signal ground
A6	P-GND	Power ground	A22	TVO1-	Sensor ground
A7	C-GND	Signal ground	A23	A-GND	Sensor ground
A8	+BP	+BP (Main relay)	A24	QA-	Sensor ground
A9	+BP	+BP (Main relay)	A25	RINJ-	Sensor ground
A10	QA+	Airflow meter	A26	TVO2-	Sensor ground
A11	THW	Water temp. sensor	A27	A-VCC	Sensor 5V
A12	THF	Fuel temp. sensor	A28	TVO1+	Sensor 5V
A13	—		A29	IJF	EDU injector pulse monitor signal
A14	—		A30	—	
A15	—		A31	BATT	Battery
A16	—				
B1	—		B13	PFUEL	Common rail pressure sensor
B2	VPIB	Boost pressure sensor	B14	PFUEL	Common rail pressure sensor
B3	EGR#4	EGR stepping motor B phase	B15	TVO1	Acceleration sensor 1 input
B4	EGR#3	EGR stepping motor $\overline{A}$ phase	B16	TVO2	Acceleration sensor 2 input
B5	EGR#2	EGR stepping motor $\overline{B}$ phase	B17	VNT	VNT SOL (EVRV)
B6	EGR#1	EGR stepping motor A phase	B18	G-	G sensor -
B7	VSW1	Swirl control valve	B19	G+	G sensor +
B8	—		B20	NE-	Engine speed sensor -
B9	RINJ4	Injection correction resistor #4	B21	NE+	Engine speed sensor +
B10	RINJ3	Injection correction resistor #3	B22	—	
B11	RINJ2	Injection correction resistor #2	B23	TVO2+	A-VCC for TVO2
B12	RINJ1	Injection correction resistor #1	B24	—	
D1	—		D15	—	
D2	—		D16	—	
D3	—		D17	—	
D4	—		D18	IG-SW	Ignition switch
D5	—		D19	IG-SW	Ignition switch
D6	—		D20	—	
D7	—		D21	CLUTCH	Clutch switch
D8	—		D22	—	
D9	—		D23	—	
D10	—		D24	M-REL	Main relay
D11	—		D25	BRKSW	Brake switch
D12	—		D26	M-REL	Main relay
D13	—		D27	STA-SW	Starter switch
D14	IDLE	Idle switch	D28	—	

No.	Pin Symbol	Connections	No.	Pin Symbol	Connections
E1	SCV-COM	Suction control valve H	E12	PWST	Power steering switch
E2	—		E13	N-SW	Neutral start switch
E3	—		E14	FCCP	ROM writer acceptor switch
E4	—		E15	CASE-GND	Case ground
E5	—		E16	SCV2	Suction control valve 2 L
E6	—		E17	—	
E7	—		E18	K-LINE	KWP 2000 K-LINE
E8	SCV1	Suction control valve 1 L	E19	—	
E9	GL-REL	Glow plug relay	E20	(IM)	(Immobilizer ECU)
E10	CAN-L	CAN communication L	E21	(SPD)	(Vehicle speed sensor)
E11	CAN-H	CAN communication H	E22	—	

9.3. EDU External Wiring Diagram