

**DENSO**

**Diesel Injection Pump**

# **SERVICE MANUAL**

**Common Rail System for HINO Dutral /  
TOYOTA Dyna N04C-T# Type Engine**

**OPERATION**

**November, 2003**

**DENSO CORPORATION**

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## 1. Product Application List

### 1-1. Vehicle Specifications

Vehicle Name	Engine Model	Exhaust Volume
HINO DUTRO / TOYOTA DYNA	N04C-TF	4.0L

### 1-2. Component Part Numbers

Product Name	HINO Part Number	DENSO Part Number
Supply Pump	22730-1261B	294000-0191
Rail	22760-1170A	095440-0490
Injector	23910-1271A	095000-5321
Engine ECU	89660-37460	101758-6580
EDU	89870-37030	101310-5391
APM (Accelerator Pedal Module)	78100-37550	198800-3150
NE Sensor	89411-1630A	029600-1361
TDC Sensor	89410-1570A	949979-1310
Coolant Temperature Sensor	83420-1250A	071560-0110
AFM (Mass Airflow Meter)	22204-21010	197400-2000
Intake Air Temperature Sensor	89441-4310A	071500-2490
Turbo Pressure Sensor	89390-1080A	079800-5890
EGR-V	17350-1170A	135000-7051
Exhaust Gas Temperature Sensor	89441-37020 (IN)	265600-0600 (IN)
	89441-37030 (OUT)	265600-0530 (OUT)

## 2. Common Rail System Outline

### 2-1. Background to Development

- The common rail system was developed primarily to cope with exhaust gas regulations for diesel engines, and is a diesel injection control system with the following aims:
  - To further improve fuel economy;
  - To reduce noise;
  - To achieve high power output.

### 2-2. System Characteristics

- The common rail system uses a type of accumulation chamber called a rail to store pressurized fuel, and injectors that contain electronically controlled solenoid valves to inject the pressurized fuel into the cylinders. Because the engine ECU controls the injection system (injection pressure, injection rate, and injection timing), the injection system is independent, and thus unaffected by the engine speed or load. This ensures a stable injection pressure at all times, particularly in the low engine speed range, and dramatically decreases the amount of black smoke ordinarily emitted by a diesel engine during start-up and acceleration. As a result, exhaust gas emissions are cleaner and reduced, and higher power output is achieved.

#### A. Injection Pressure Control

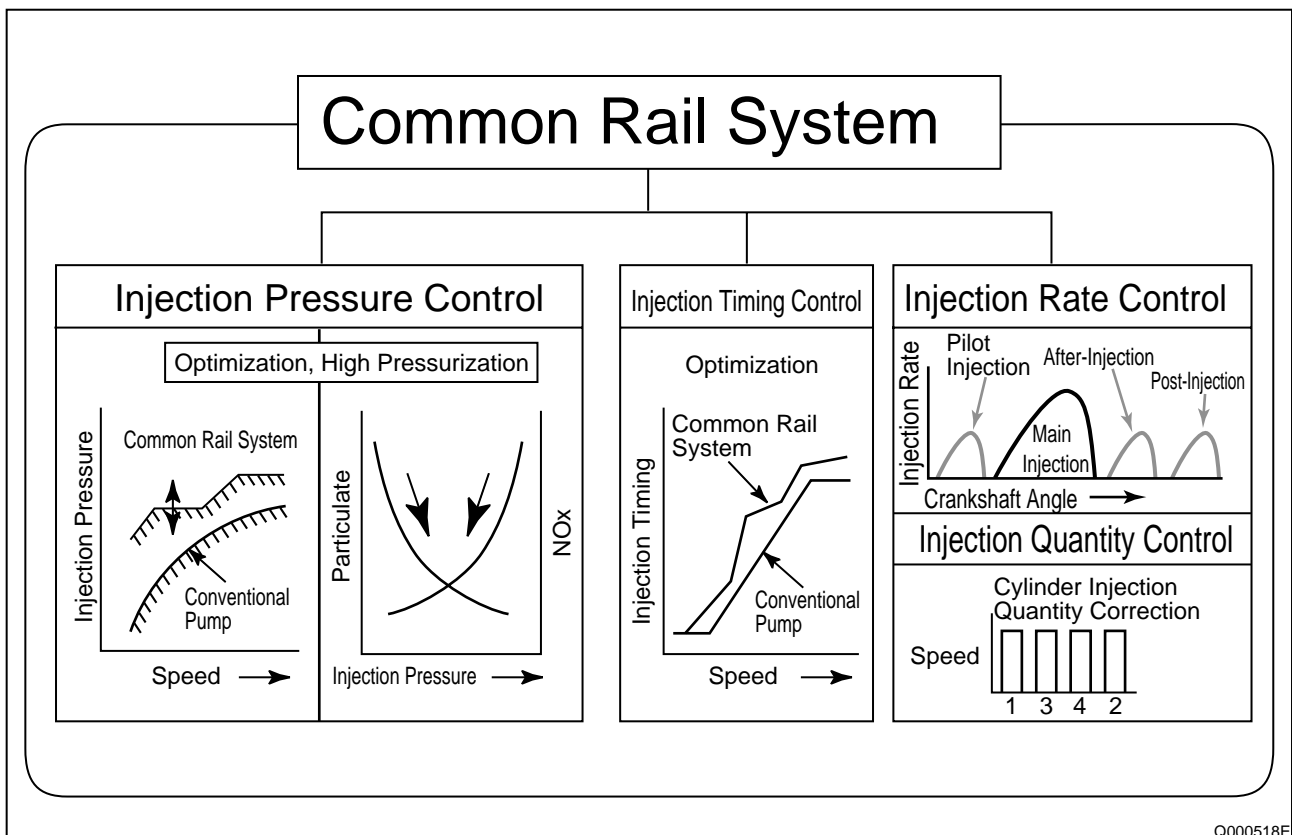
- Enables high-pressure injection even at low engine speeds.
- Optimizes control to minimize particulate matter and NOx emissions.

#### B. Injection Timing Control

- Enables finely tuned optimized control in accordance with driving conditions.

#### C. Injection Rate Control

- Pilot injection control injects a small amount of fuel before the main injection.



2-3. Comparison to The Conventional System

System	In-Line & VE Pumps	Common Rail System
Injection Quantity Control	Pump (Governor)	Engine ECU, Injector (TWV)*1
Injection Timing Control	Pump (Governor)	Engine ECU, Injector (TWV)*1
Rising Pressure	Pump	Engine ECU, Supply Pump
Distributor	Pump	Engine ECU, Rail
Injection Pressure Control	Dependent upon speed and injection quantity	Engine ECU, Supply Pump (SCV)*2

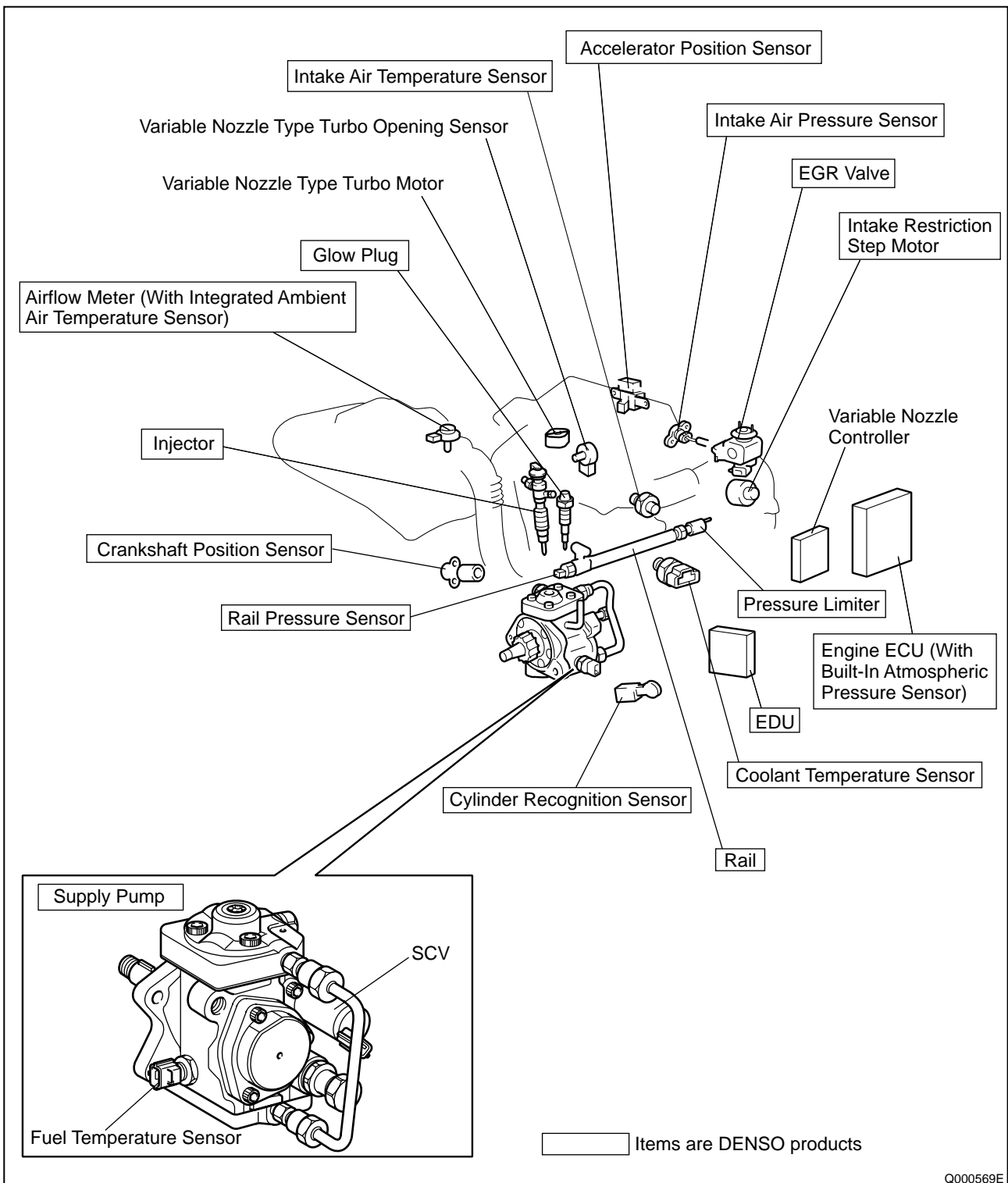
\*1 TWV: Two Way Valve

\*2 SCV: Suction Control Valve

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### 3. Outline of TOYOTA / HINO Small Truck Common Rail System

#### 3-1. Main System Components

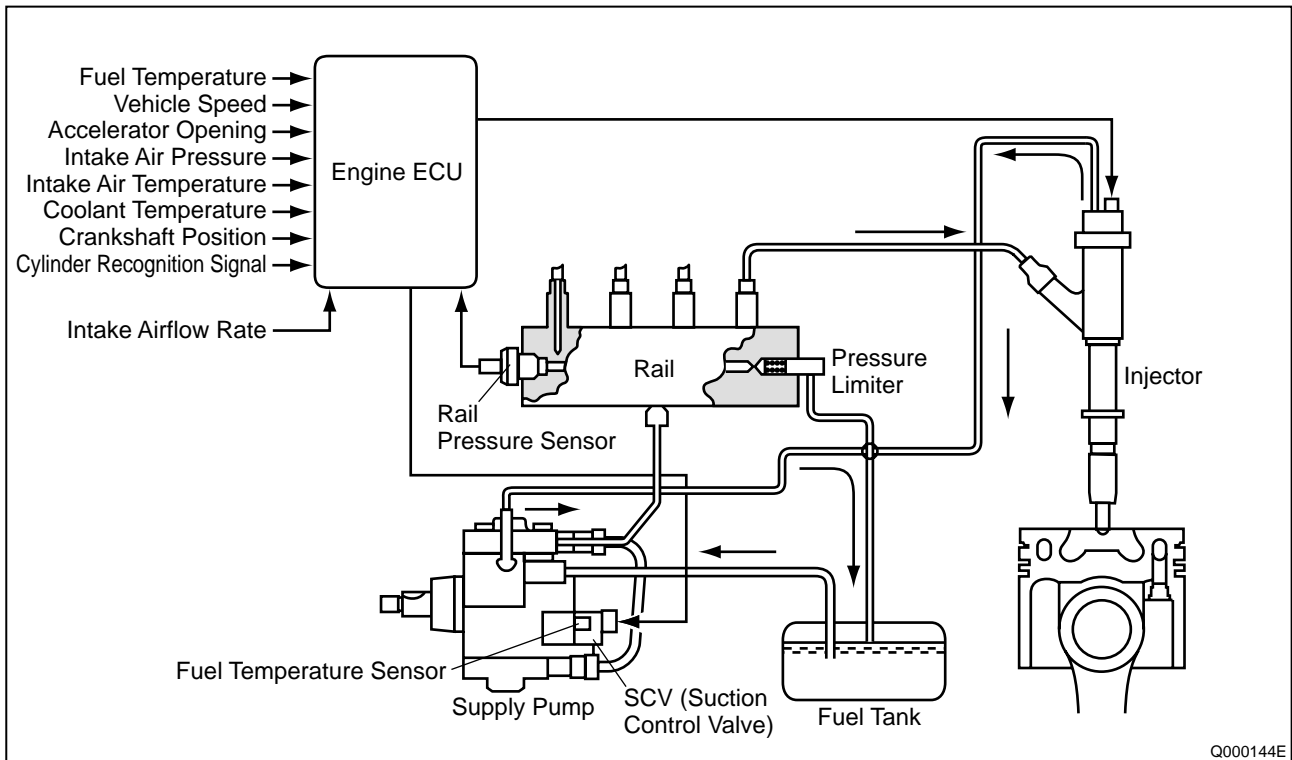


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### 3-2. Outline of Composition and Operation

#### A. Composition

The common rail system consists primarily of a supply pump, rail, injectors, and engine ECU.



#### B. Operation

##### a. Supply Pump (HP3)

The supply pump draws fuel from the fuel tank, and pumps the high pressure fuel to the rail. The quantity of fuel discharged from the supply pump controls the pressure in the rail. The SCV (Suction Control Valve) in the supply pump effects this control in accordance with commands received from the engine ECU.

##### b. Rail

The rail is mounted between the supply pump and the injector, and stores the high-pressure fuel.

##### c. Injector (G2 Type)

This injector replaces the conventional injection nozzle, and achieves optimal injection by effecting control in accordance with signals from the engine ECU. Signals from the engine ECU determine the duration and timing in which current is applied to the injector. This in turn, determines the quantity, rate and timing of the fuel that is injected from the injector. QR codes noting the characteristics of each vehicle are inscribed on the injector, and this data is sent to the ECU when the engine ECU or injectors are replaced. This enables software to be adjusted to the mechanical characteristics of each injector.

##### d. Engine ECU

The engine ECU calculates data received from the sensors to comprehensively control the injection quantity, timing and pressure.

### 3-3. Fuel System and Control System

#### A. Fuel System

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

#### B. Control System

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

##### a. Sensors

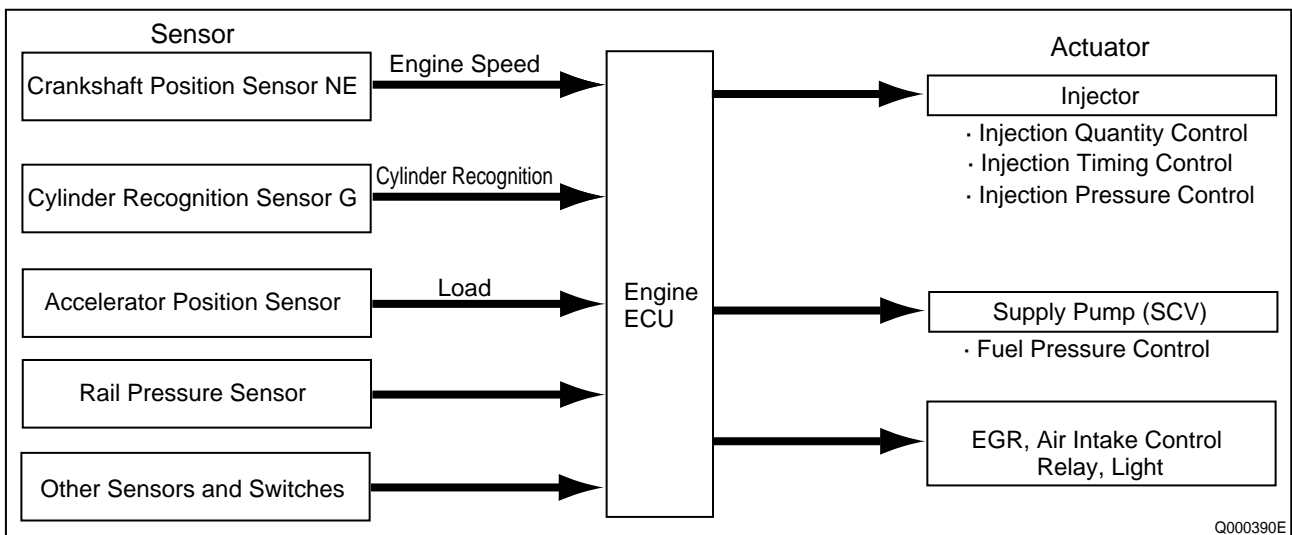
Detect the engine and driving conditions, and convert them into electrical signals.

##### b. Engine ECU

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

##### c. Actuators

Operate in accordance with electrical signals received from the ECU. Injection system control is undertaken by electronically controlling the actuators. The injection quantity and timing are determined by controlling the duration and timing in which current is applied to the TWV (Two-Way Valve) in the injector. Injection pressure is determined by controlling the SCV (Suction Control Valve) in the supply pump.



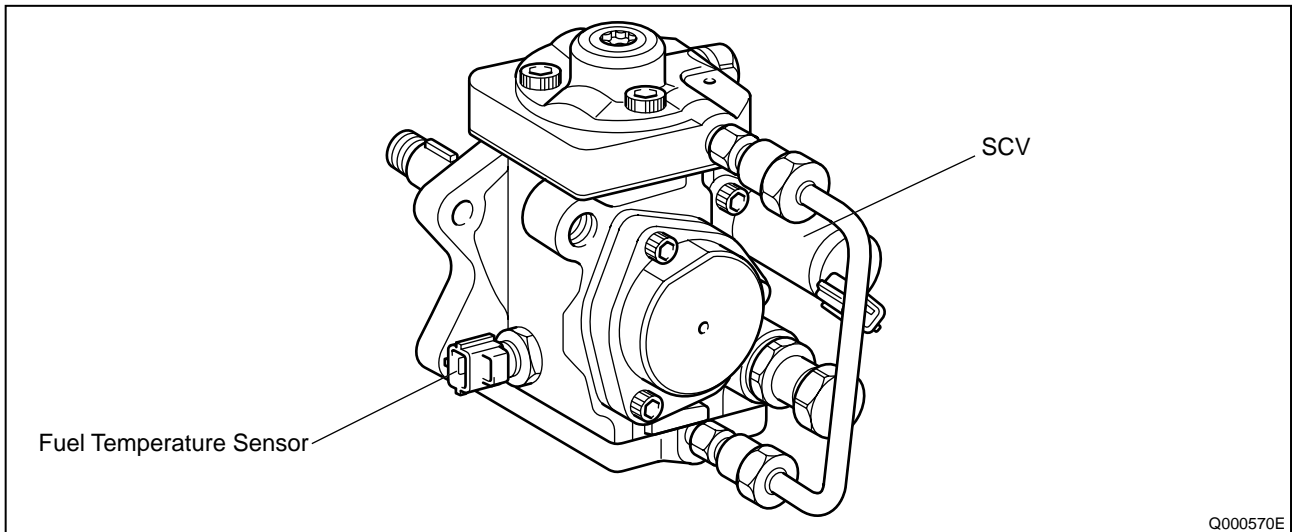


#### 4. Description of Main Components

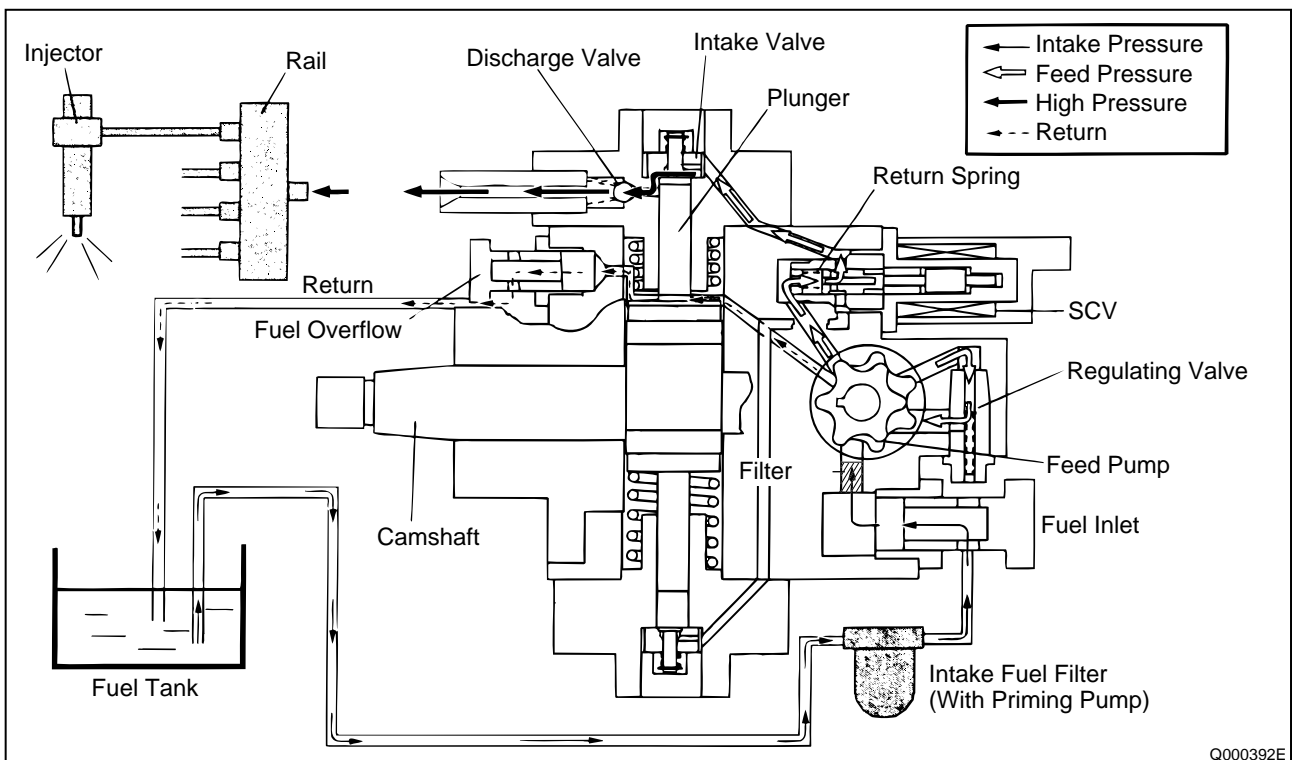
##### 4-1. Supply Pump (HP3)

###### A. Outline

- The supply pump consists primarily of the pump body (camshaft (eccentric cam), ring cam, and plungers), SCV (Suction Control Valve), fuel temperature sensor, and feed pump.

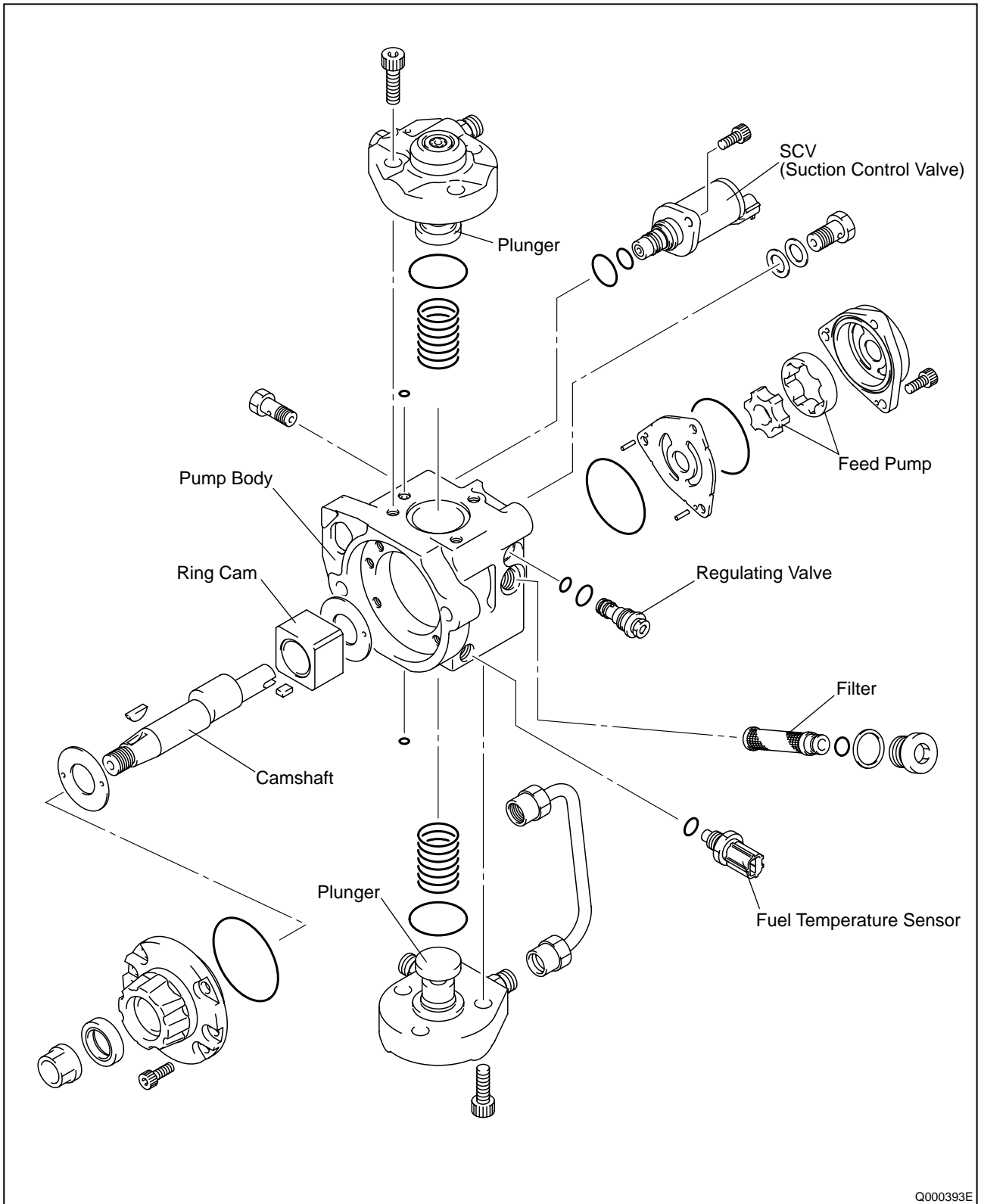


- The two plungers are positioned vertically on the outer ring cam for compactness.
- The engine drives the supply pump at a ratio of 1:1. The supply pump has a built-in feed pump (trochoid type), and draws the fuel from the fuel tank, sending it to the plunger chamber.
- The internal camshaft drives the two plungers, and they pressurize the fuel sent to the plunger chamber and send it to the rail. The quantity of fuel supplied to the rail is controlled by the SCV, using signals from the engine ECU. The SCV is a normally open type (the intake valve opens during de-energization).



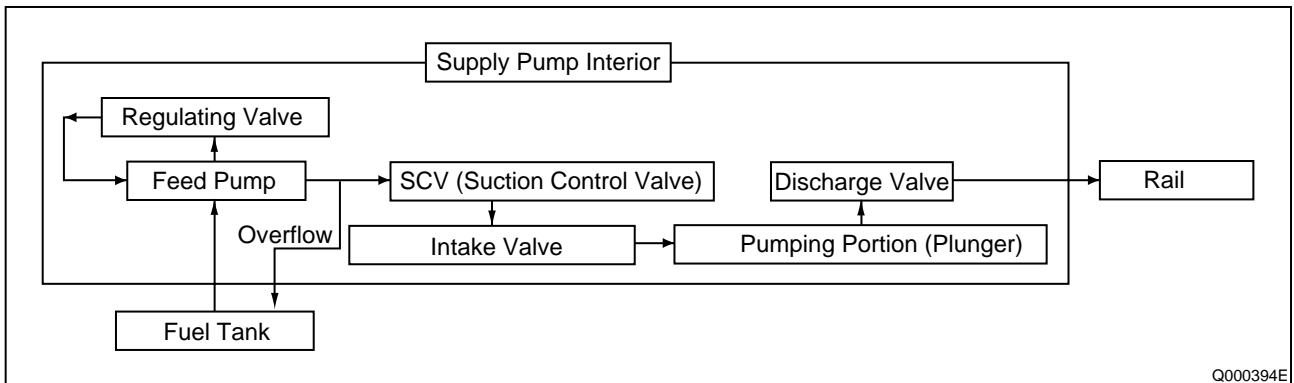
- The supply pump in the common rail system with DPNR has a fuel cut valve (FCV). The FCV is provided to enable manual shut-off if a fuel leak occurs in the fuel addition valve passage.

a. Supply Pump Exploded Diagram



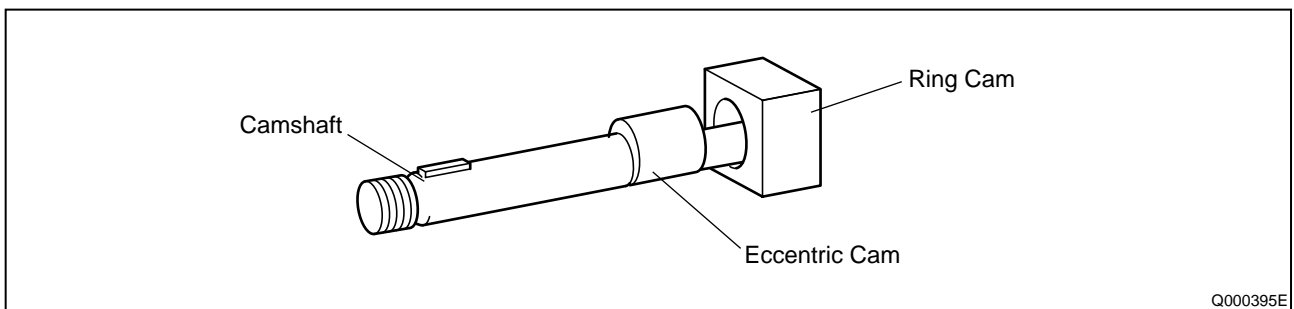
## B. Supply Pump Internal Fuel Flow

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

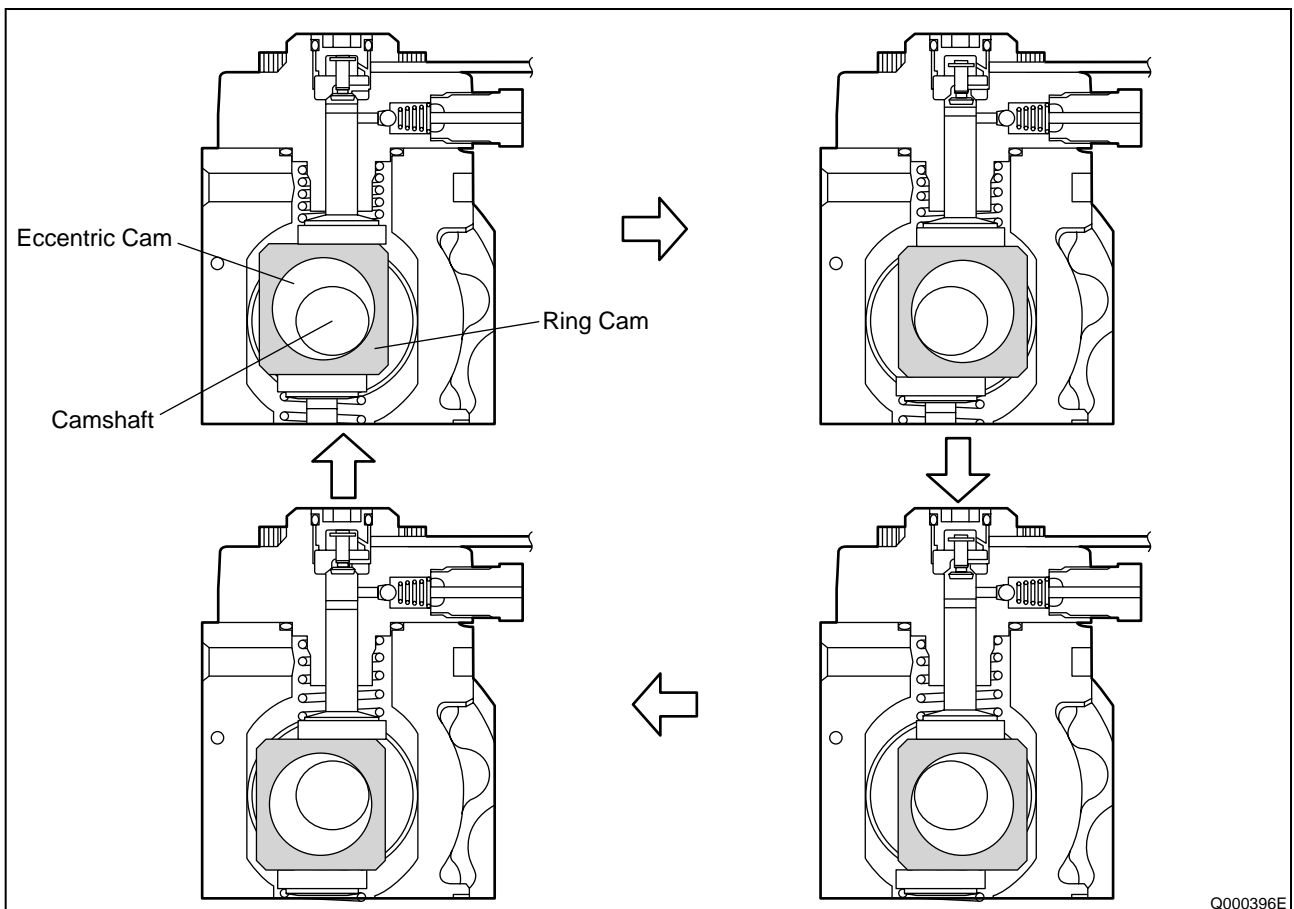


## C. Construction of Supply Pump

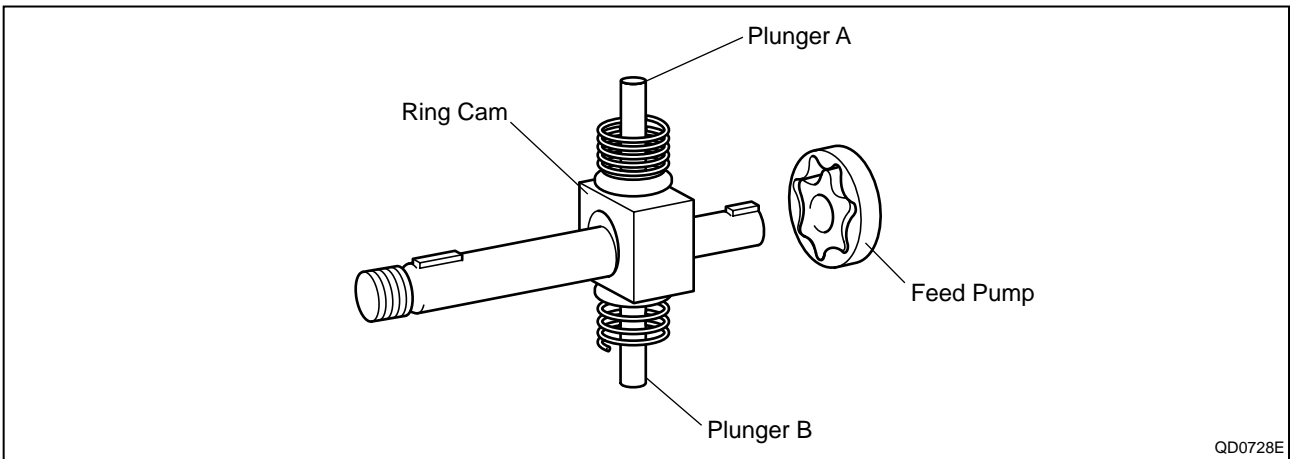
- The eccentric cam is formed on the camshaft and is attached to the ring cam.



- As the camshaft rotates, the eccentric cam rotates eccentrically, and the ring cam moves up and down while rotating.

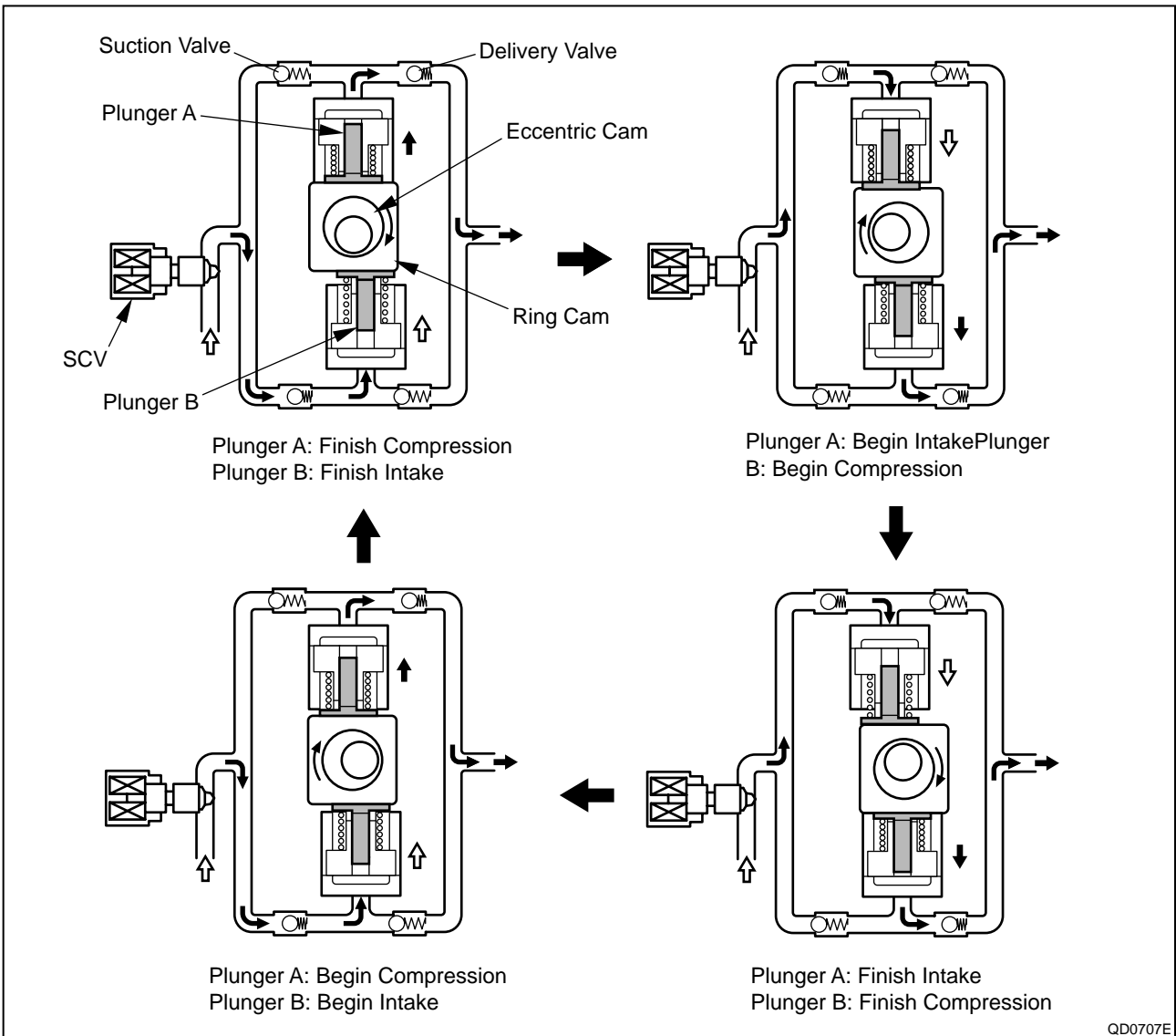


- The plunger and the suction valve are mounted on top of the ring cam. The feed pump is connected to the rear of the camshaft.



#### D. Supply Pump Operation

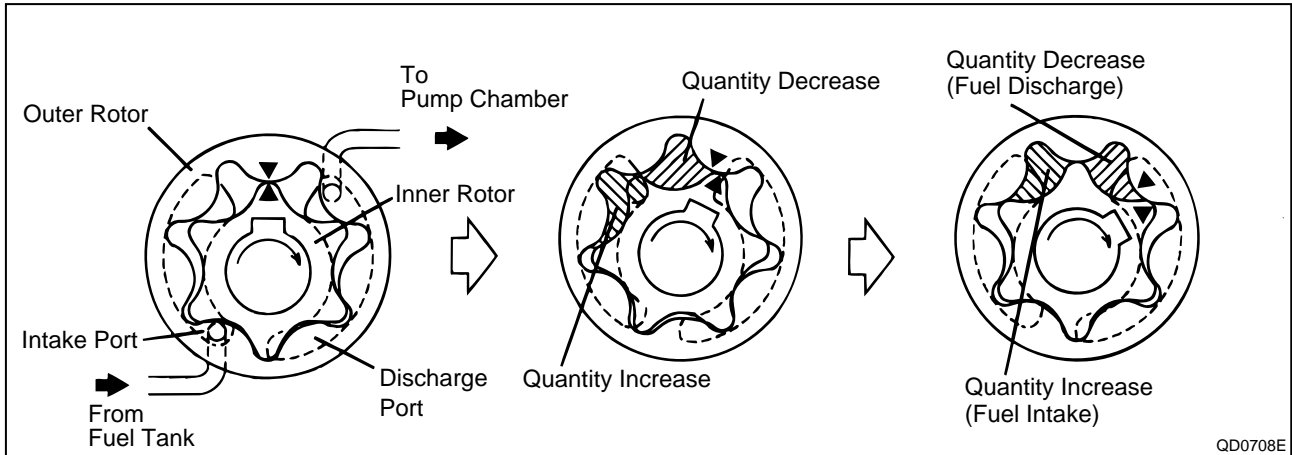
As shown in the illustration below, the rotation of the eccentric cam causes the ring cam to push Plunger A upwards. Due to the spring force, Plunger B is pulled in the opposite direction to Plunger A. As a result, Plunger B draws in fuel while Plunger A pumps it to the rail.



## E. Description of Supply Pump Components

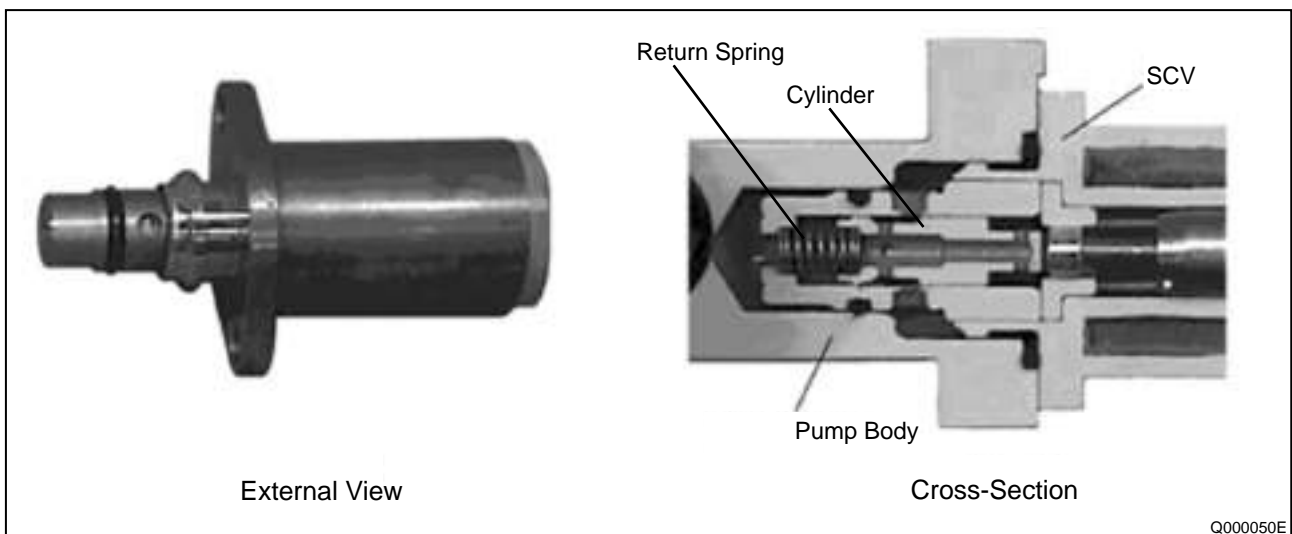
### a. Feed Pump

The trochoid type feed pump integrated into the supply pump, draws fuel from the fuel tank and feeds it to the two plungers via the fuel filter and the SCV (Suction Control Valve). The feed pump is driven by the camshaft. With the rotation of the inner rotor, the feed pump draws fuel from its suction port and pumps it out through the discharge port. This is done in accordance with the space that increases and decreases with the movement of the outer and inner rotors.

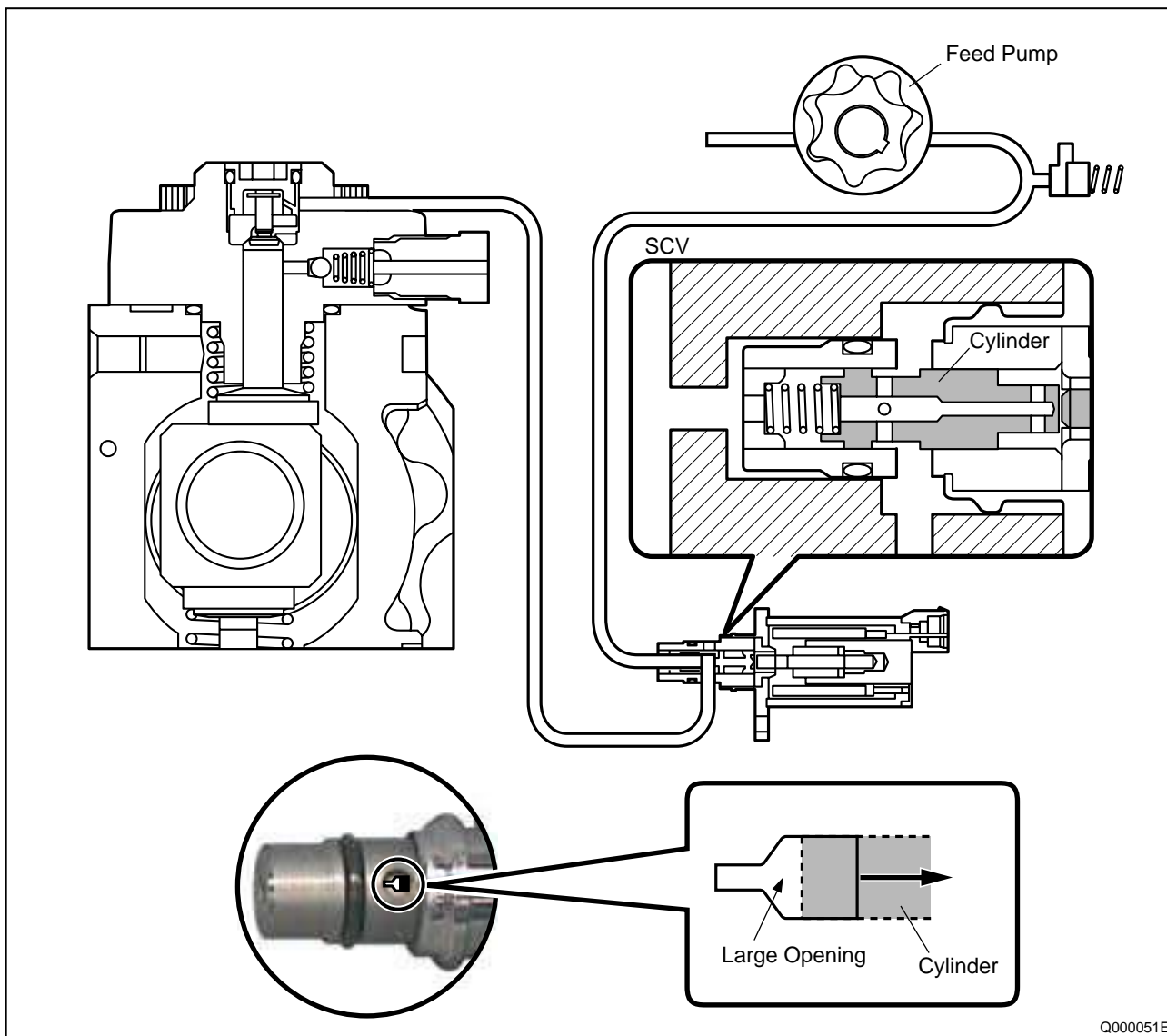


### b. SCV (Suction Control Valve: Normally Open Type)

- A linear solenoid type valve has been adopted. The ECU controls the duty ratio (the duration in which current is applied to the SCV), in order to control the quantity of fuel that is supplied to the high-pressure plunger.
- The supply pump drive load decreases because intake fuel quantity is controlled to achieve the target rail pressure.
- When current flows to the SCV, the internal armature moves in accordance with the duty ratio. The fuel quantity is regulated by the cylinder, which moves in connection with the armature to block the fuel passage.
- With the SCV OFF, the return spring pushes the cylinder, completely opening the fuel passage and supplying fuel to the plungers. (Full quantity intake => full quantity discharge.)
- When the SCV is ON, the return spring contracts and closes the fuel passage.
- By turning the SCV ON/OFF, fuel is supplied in an amount corresponding to the drive duty ratio and then discharged by the plungers.

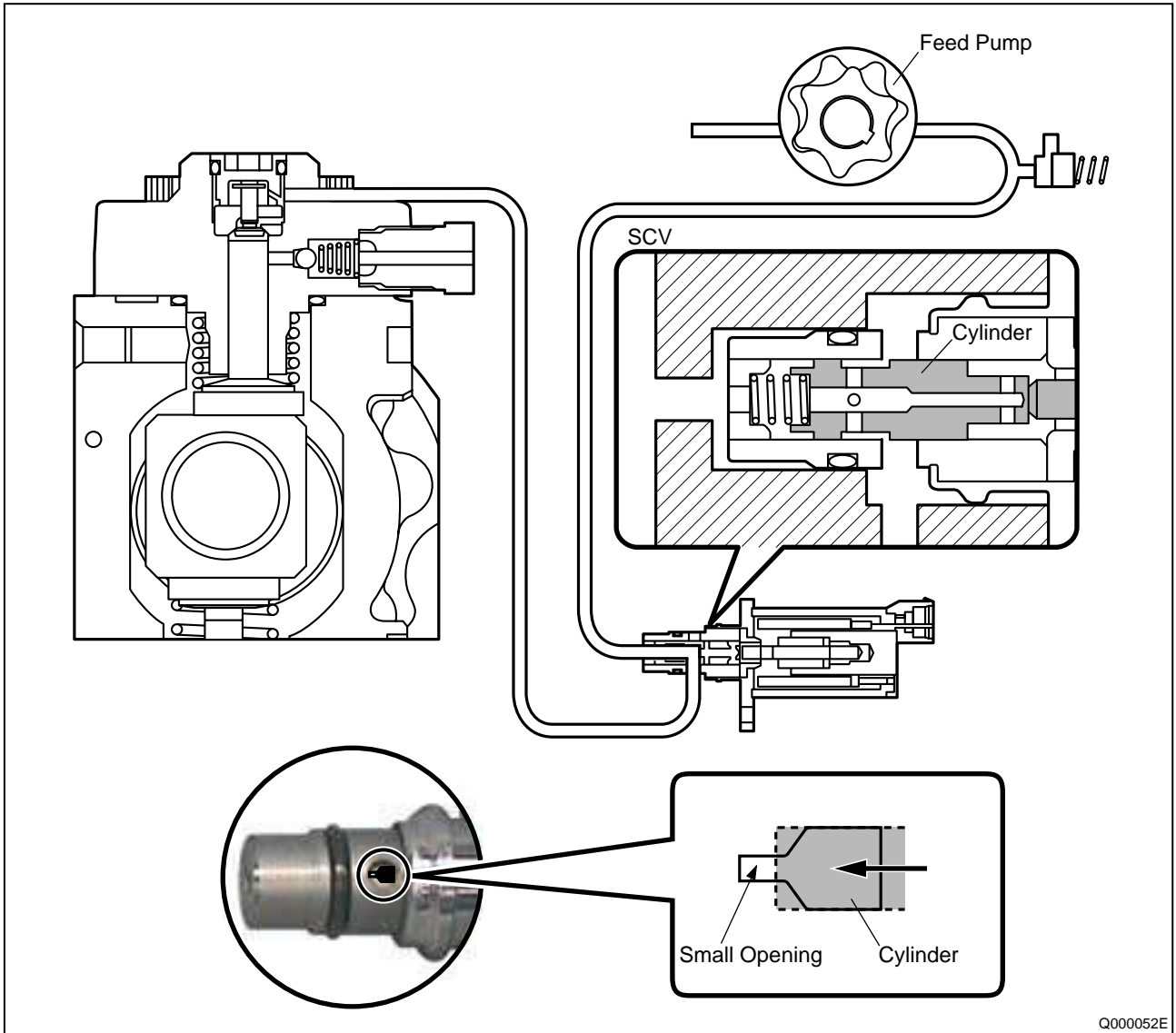


- Short duty ON => large valve opening => maximum intake quantity



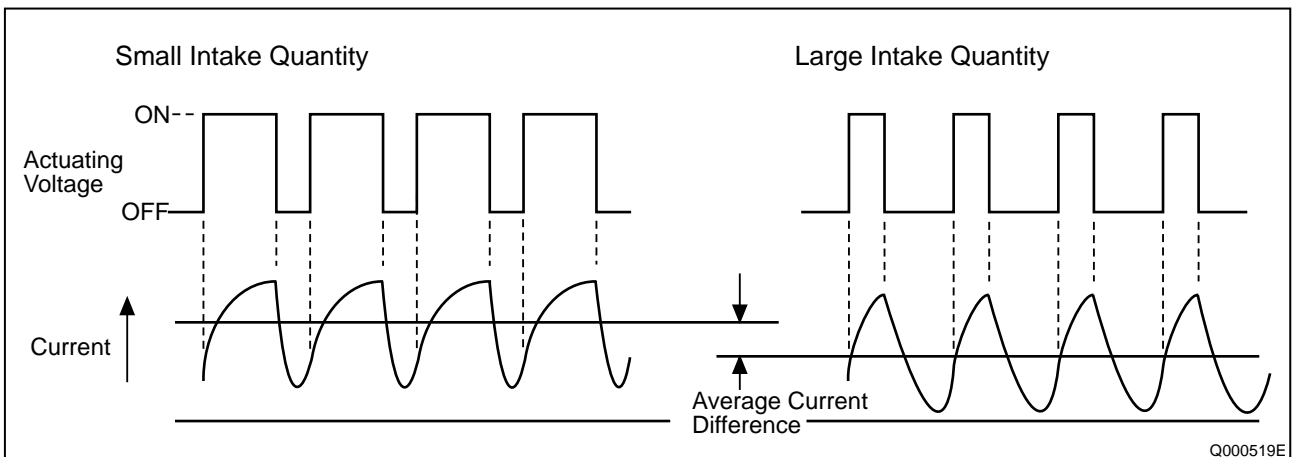
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- Long duty ON => small valve opening => minimum intake quantity



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- Relationship between the drive signal and current (magnetomotive force)

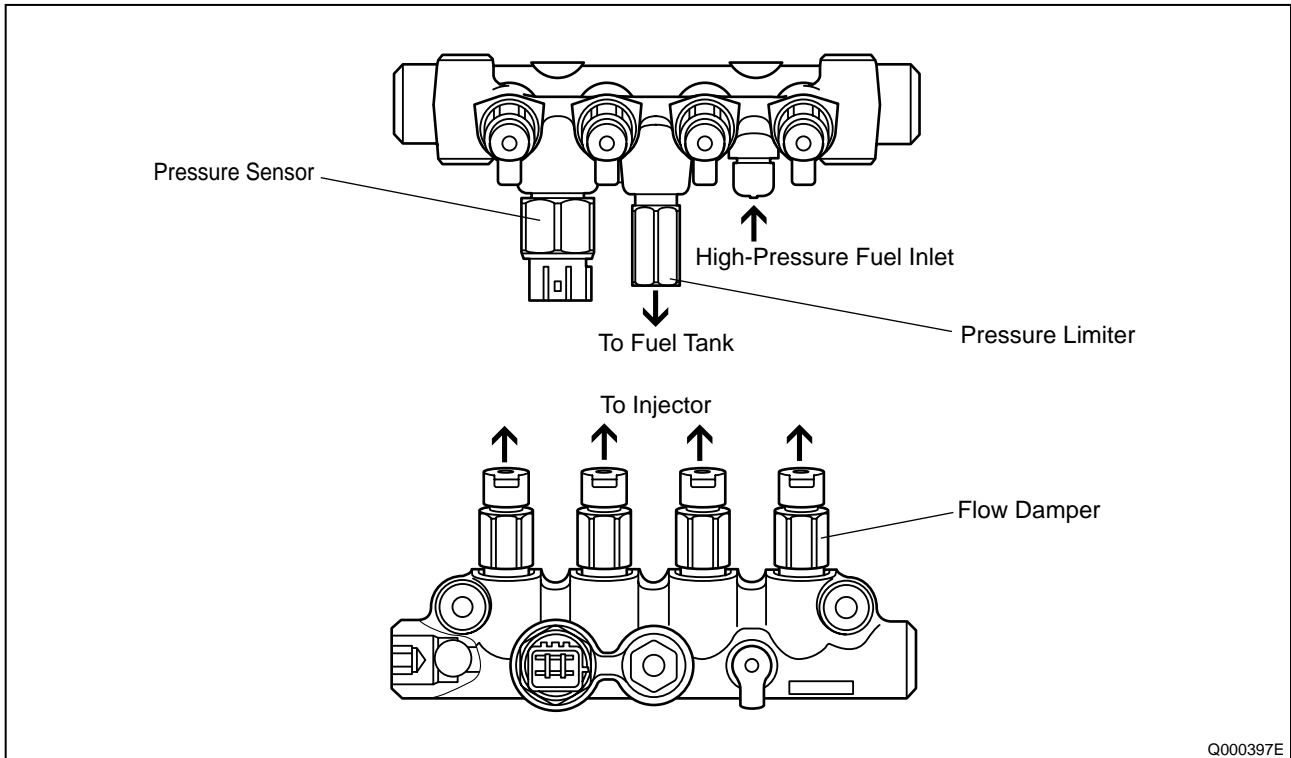


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## 4-2. Rail

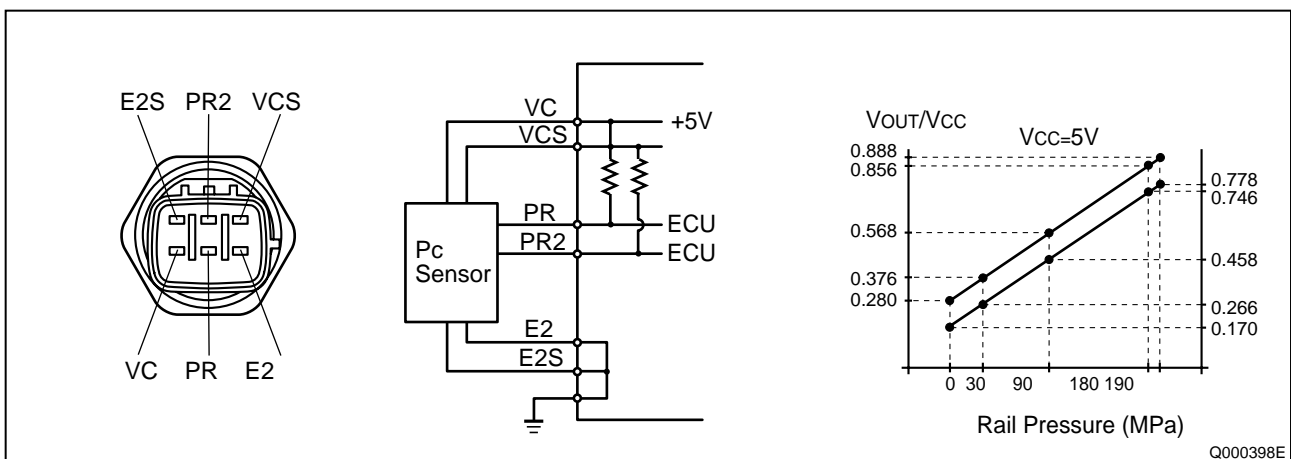
### A. Outline

The rail stores pressurized fuel that has been delivered from the supply pump and distributes it to each cylinder injector. A pressure sensor and a pressure limiter are adopted in the rail. The pressure sensor detects the fuel pressure in the rail and sends a signal to the ECU. The ECU controls the supply pump SCV and the fuel pressure in the rail based on this signal.



### B. Fuel Pressure Sensor

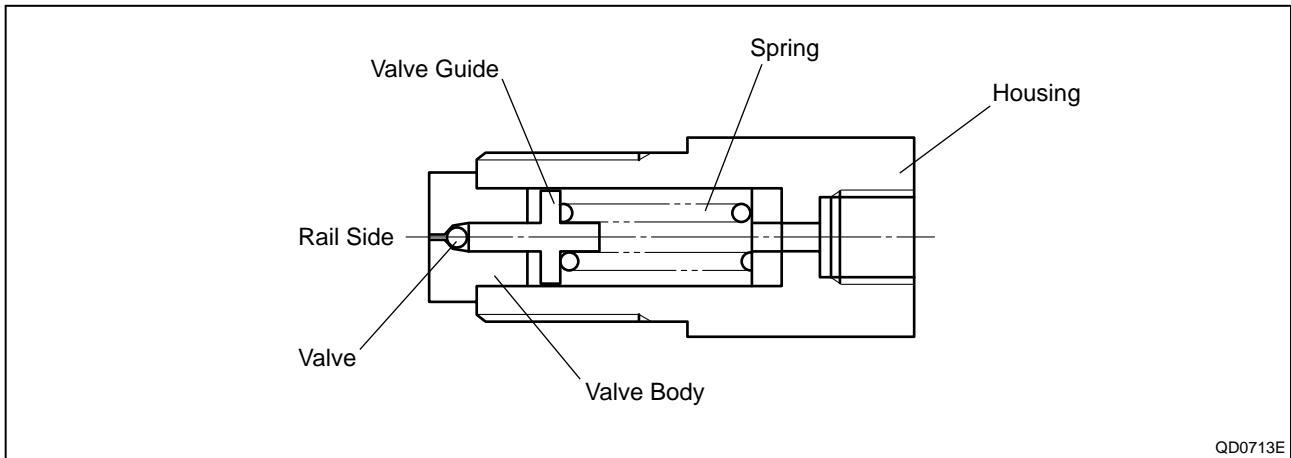
This sensor detects fuel pressure in the rail and sends a signal to the ECU. It is a semi-conductor piezo resistance type pressure sensor that utilizes the characteristic whereby electrical resistance changes when pressure is applied to a metal diaphragm. There are two output voltage systems as a backup in the event of a malfunction.





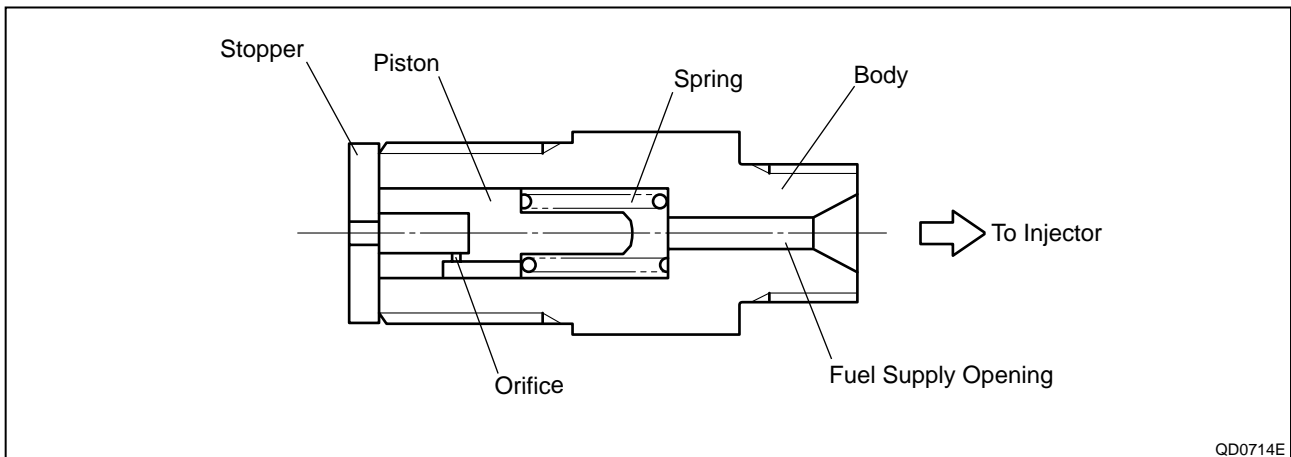
### C. Pressure Limiter

When pressure in the rail is abnormally high, the pressure limiter opens the valve to relieve pressure. The valve opens when pressure in the rail reaches approximately 200 MPa (2039kg/cm<sup>2</sup>), and closes when pressure falls to approximately 50 MPa. Fuel leaked by the pressure limiter returns to the fuel tank.



### D. Flow Damper

The flow damper is a buffer for pressure pulsations in the rail, and shuts-off the supply of fuel when a leak occurs downstream of the flow damper. The flow damper piston performs a damper role for pressure pulsations occurring in the rail, and performs cushioning through the spring drag and orifice passing resistance. If a fuel leak occurs in the injection pipe or the injector, the pressure of the fuel supplied through the orifice on the downstream side of the flow damper, and the spring drag and fuel pressure applied to the piston face prior to the orifice become unbalanced. As a result, the piston end closes the fuel supply outlet, stopping the supply of fuel. It reopens when pressure in the rail reaches approximately 1 MPa (4kg/cm<sup>2</sup>).

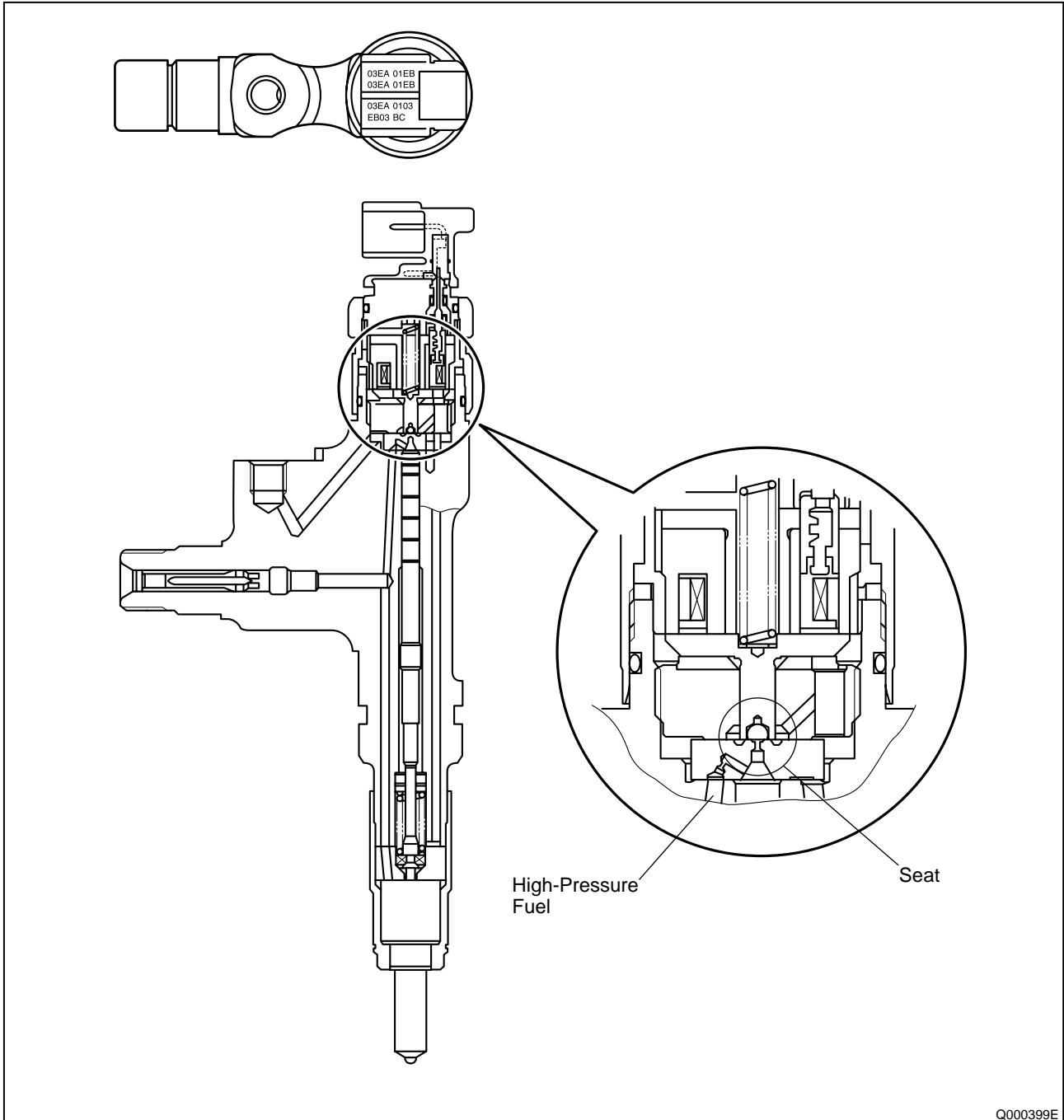


### 4-3. Injector

#### A. Outline

- The injectors inject high-pressure fuel into the combustion chambers at the optimum injection quantity, timing, rate, and spray condition, in accordance with commands received from the ECU.
- A compact, energy-saving solenoid-control type TWV (Two-Way Valve) injector has been adopted.

#### B. Construction



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### C. Operation

The TWV (Two-Way Valve) solenoid valve opens and closes the outlet orifice passage to control both the pressure in the control chamber, and the start and end of injection.

#### a. No injection

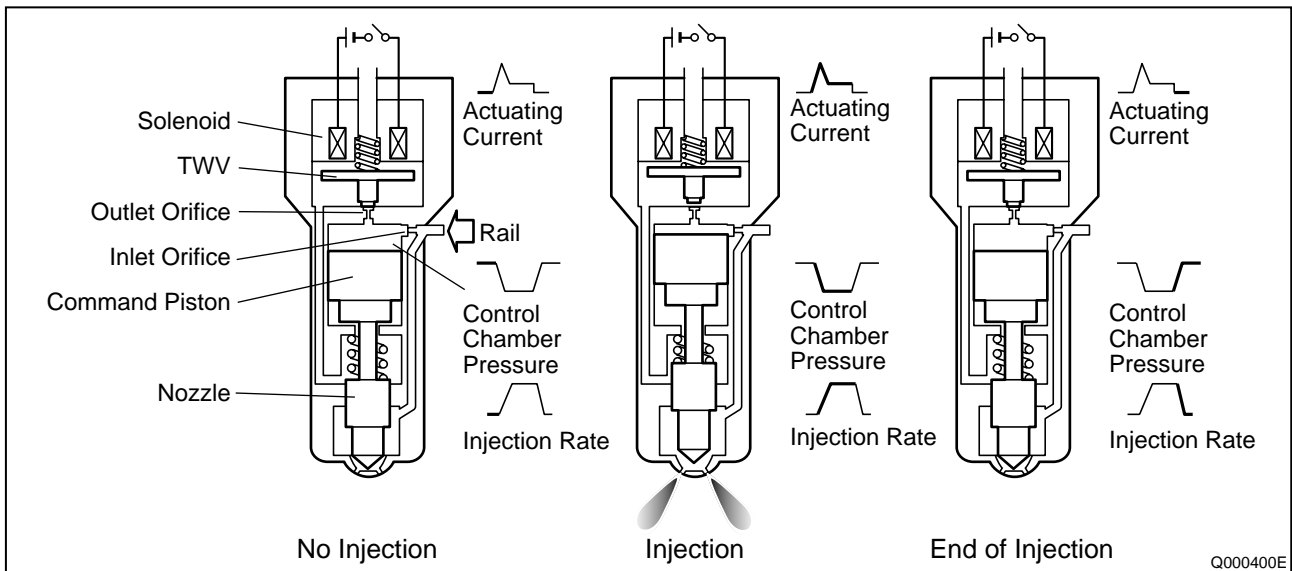
When no current is supplied to the solenoid, the TWV (solenoid valve) is pushed downward by the spring, closing the outlet orifice. This equalizes the control chamber pressure forcing the command piston down, and the pressure forcing the nozzle needle up. A state of no injection results because the nozzle needle closes due to the nozzle spring force and the difference in areas to which pressure is being applied.

#### b. Injection

When current is initially applied to the solenoid, the attraction of the solenoid pulls the TWV (solenoid valve) up, opening the outlet orifice and allowing fuel to flow out of the control chamber. After the fuel flows out, pressure in the control chamber decreases, pulling the command piston up. This causes the nozzle needle to rise and injection to start.

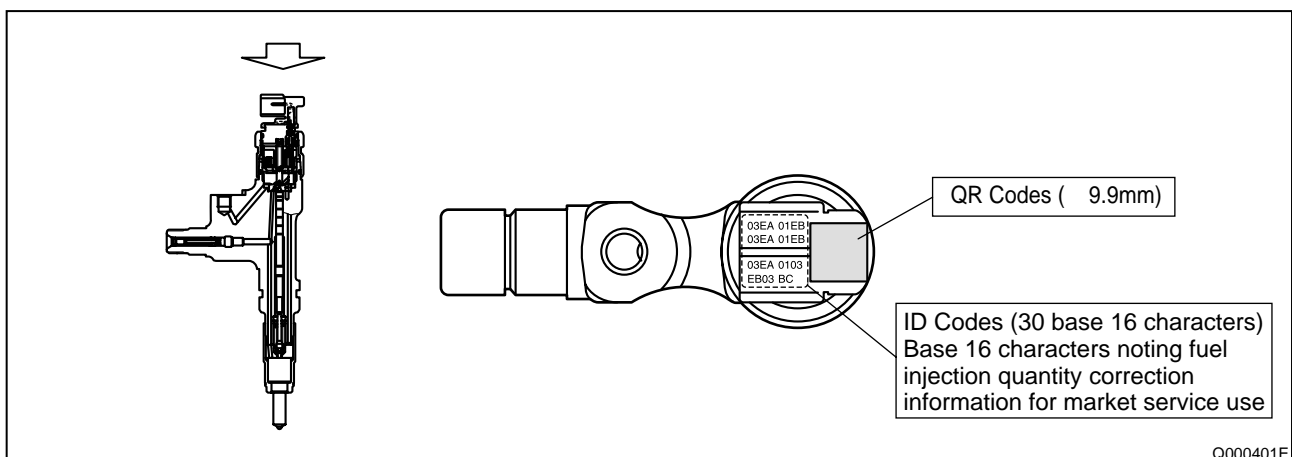
#### c. Injection Ends

When 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 current to the solenoid is turned OFF, the TWV (solenoid valve) falls and closes the orifice. Fuel then flows into the control chamber via the inlet orifice, increasing pressure and causing the nozzle needle to close immediately and injection to stop.

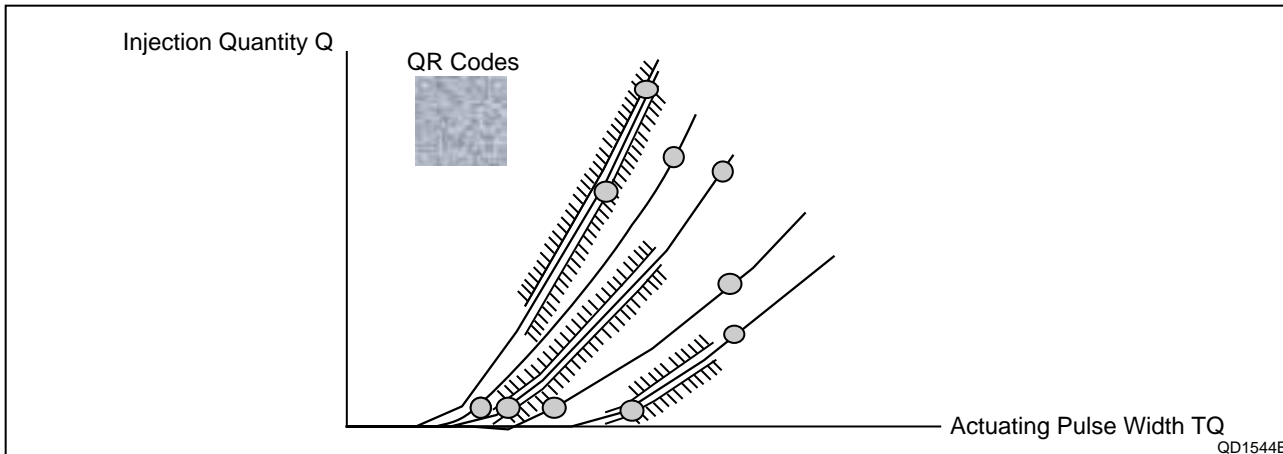


### D. QR Codes

- Conventionally the whole injector Ass'y was replaced during injector replacement, but QR (Quick Response) codes have been adopted to improve injector quantity precision.



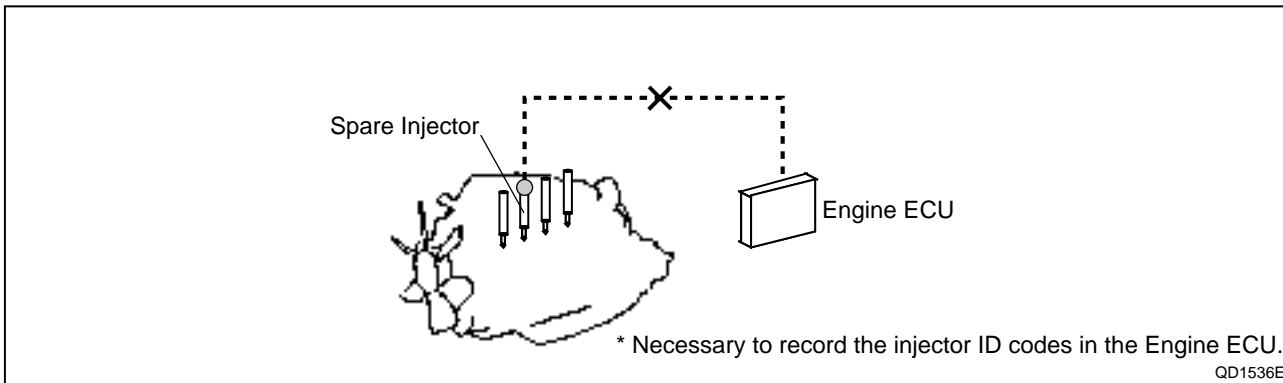
- QR codes have resulted in a substantial increase in the number of fuel injection quantity correction points, greatly improving precision. The characteristics of the engine cylinders have been further unified, contributing to improvements in combustion efficiency, reductions in exhaust gas emissions and so on.



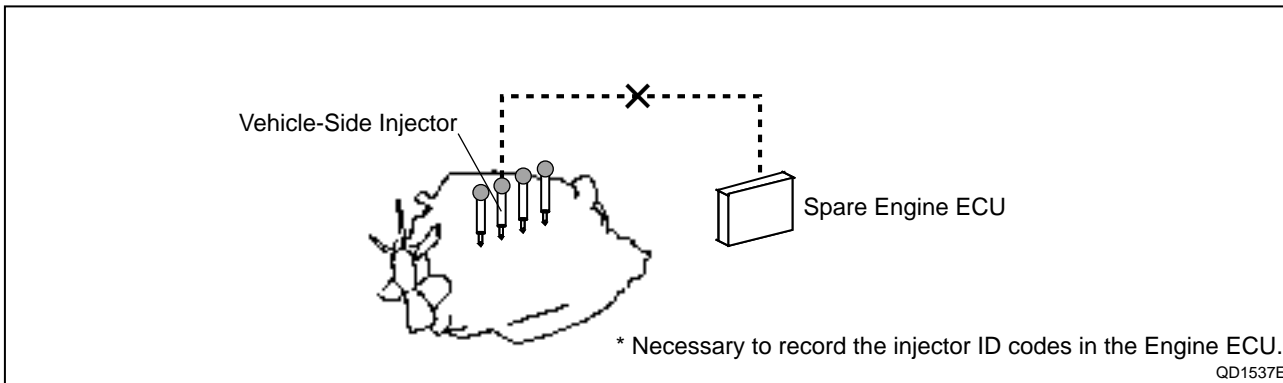
### E. Repair Procedure Changes

When replacing injectors with QR codes, or the engine ECU, it is necessary to record the ID codes in the ECU. (If the ID codes for the installed injectors are not registered correctly, engine failure such as rough idling and noise will result). Use specialized HINO service tools at a HINO dealer to record the ID codes.

#### a. Replacing the Injector



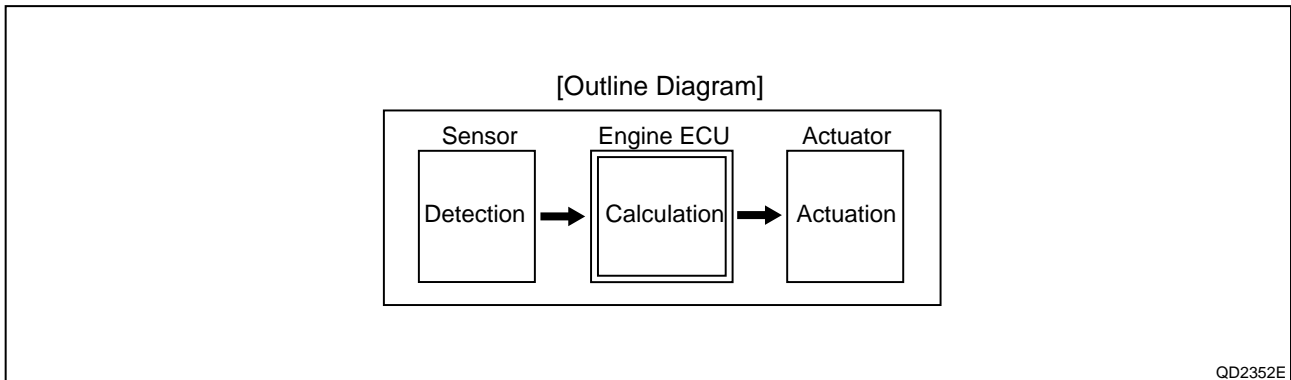
#### b. Replacing the Engine ECU



#### 4-4. Engine ECU (Electronic Control Unit)

##### A. Outline

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



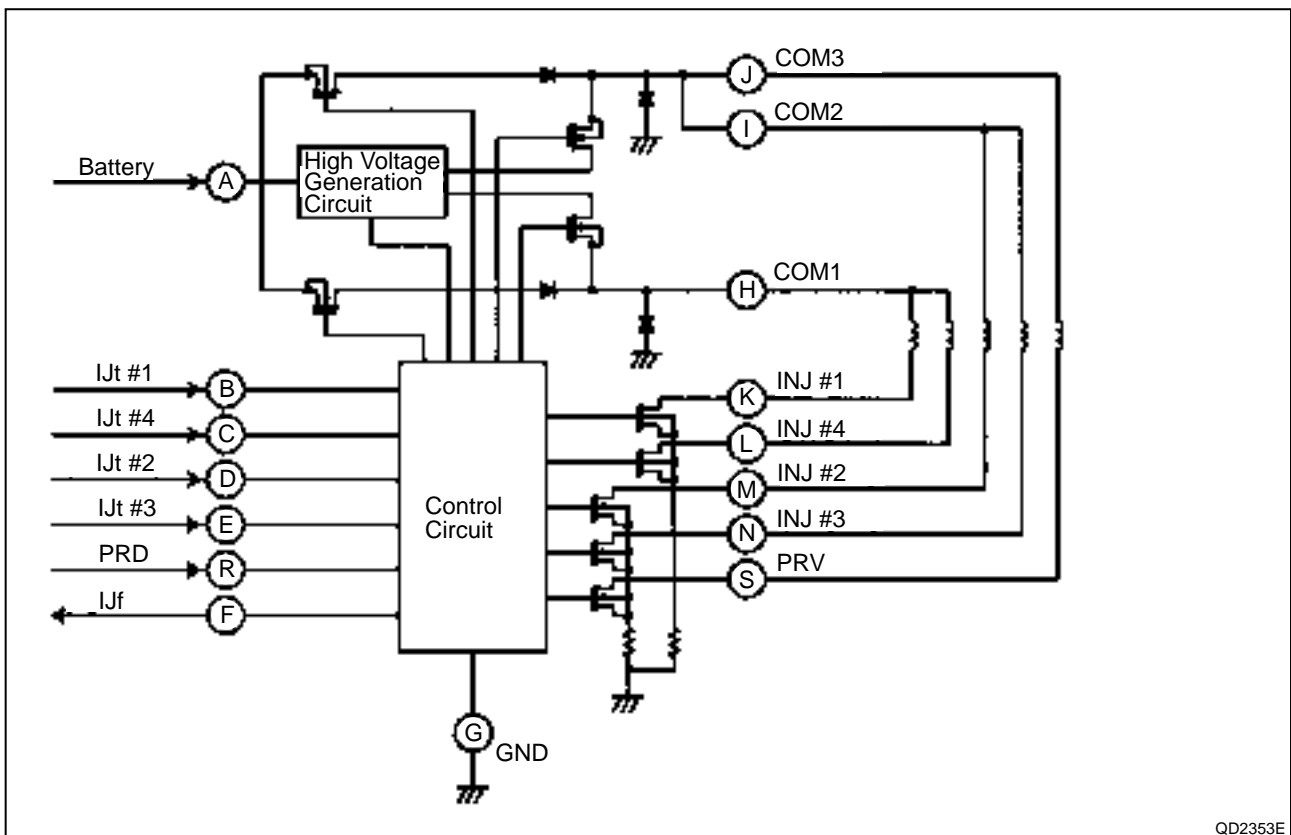
#### 4-5. EDU (Electronic Driving Unit)

##### A. Outline

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

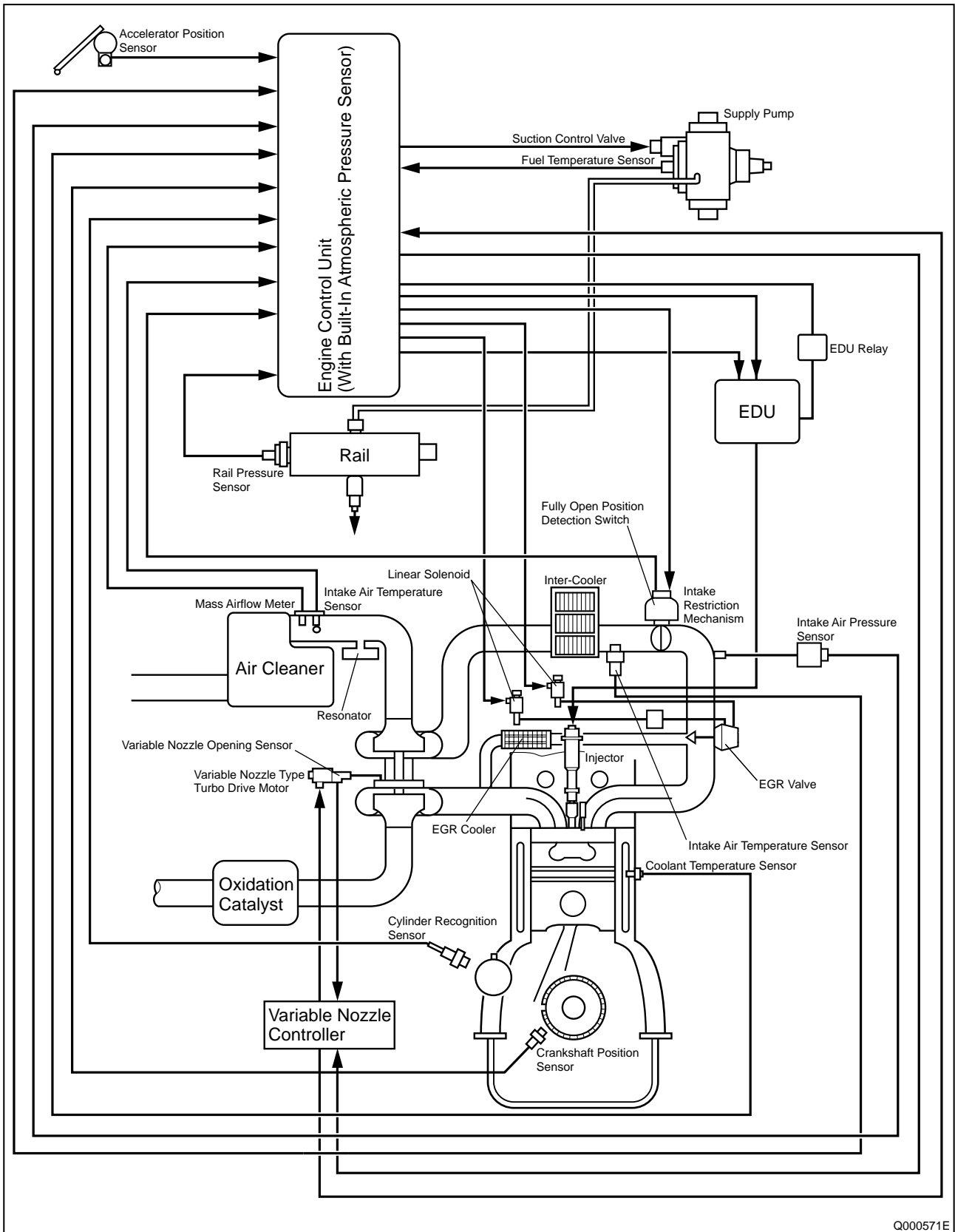
##### B. Operation

The high-voltage generating device converts the battery voltage into high voltage. The engine ECU sends signals to terminals B through E of the EDU in accordance with the signals from each sensor. Upon receiving these signals, the EDU outputs signals to the injectors from terminals K through N. At this time, terminal F outputs the Ijf injection verification signal to the ECU.



## 5. Description of Control System Components

### 5-1. Block Diagram



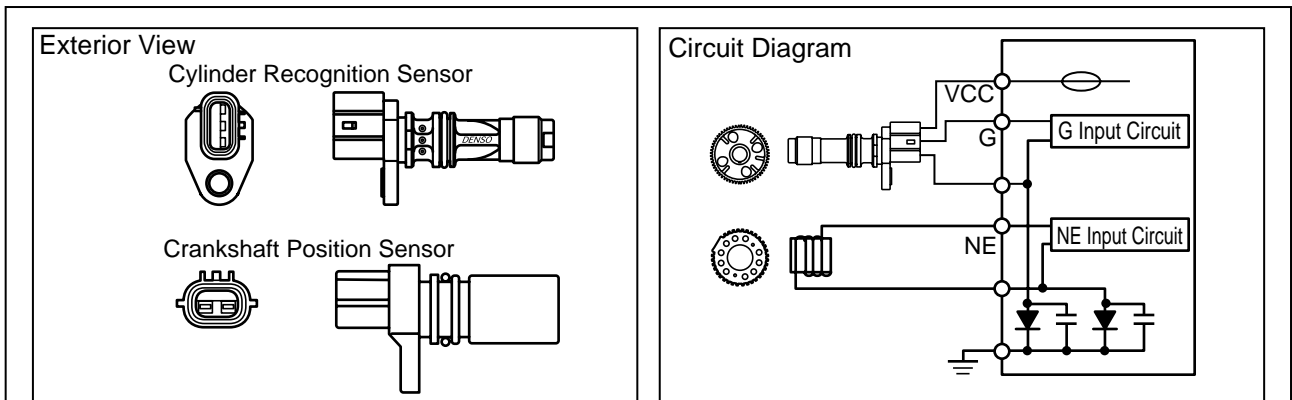
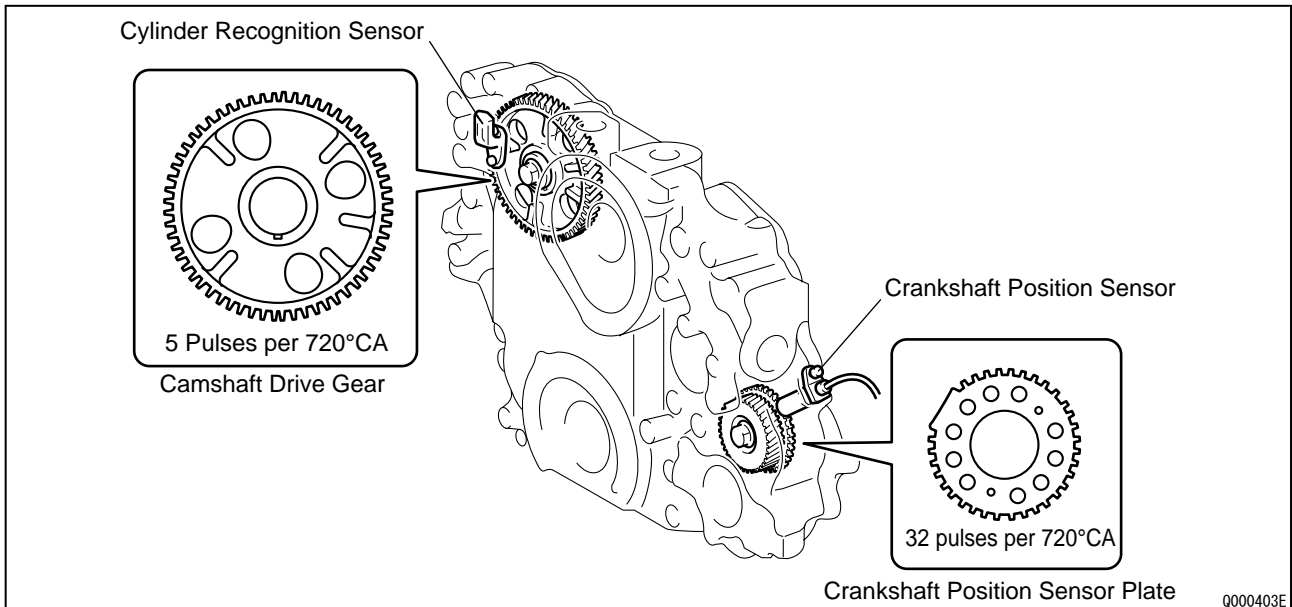
## 5-2. Description of Sensors

### A. Crankshaft Position Sensor (NE)

An NE pulsar attached to the crankshaft timing gear outputs a crankshaft angle detection signal. The pulsar gear contains 34 cogs, with 2 cogs missing (for 2 pulses), and the sensor outputs 34 pulses per 360°CA.

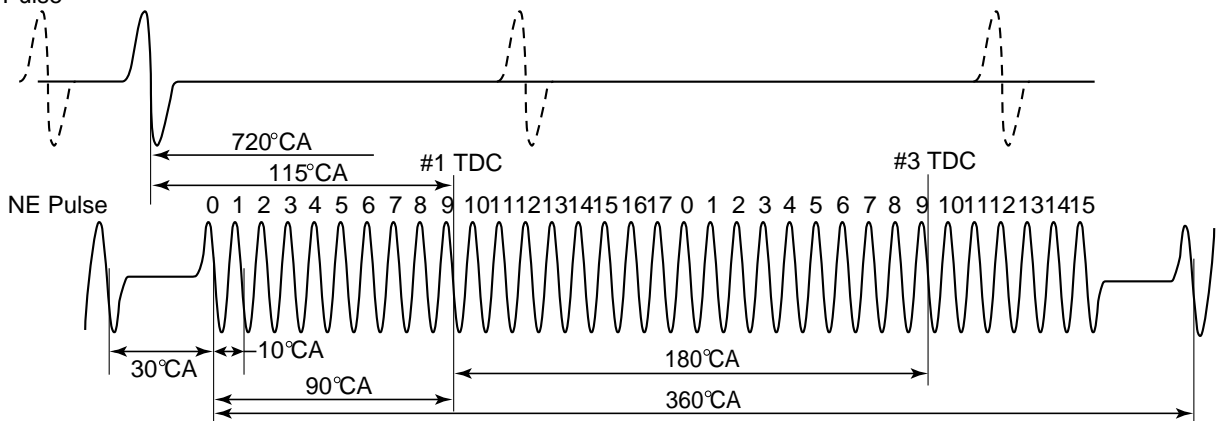
### B. Cylinder Recognition Sensor (G)

A cylinder identification pulsar (G pulsar) is attached to the supply pump timing gear, and it outputs a cylinder identification signal. The sensor outputs 4 + 1 pulses for every two revolutions of the engine, and the 5th pulse is used for cylinder recognition.



Cylinder Recognition Pulse

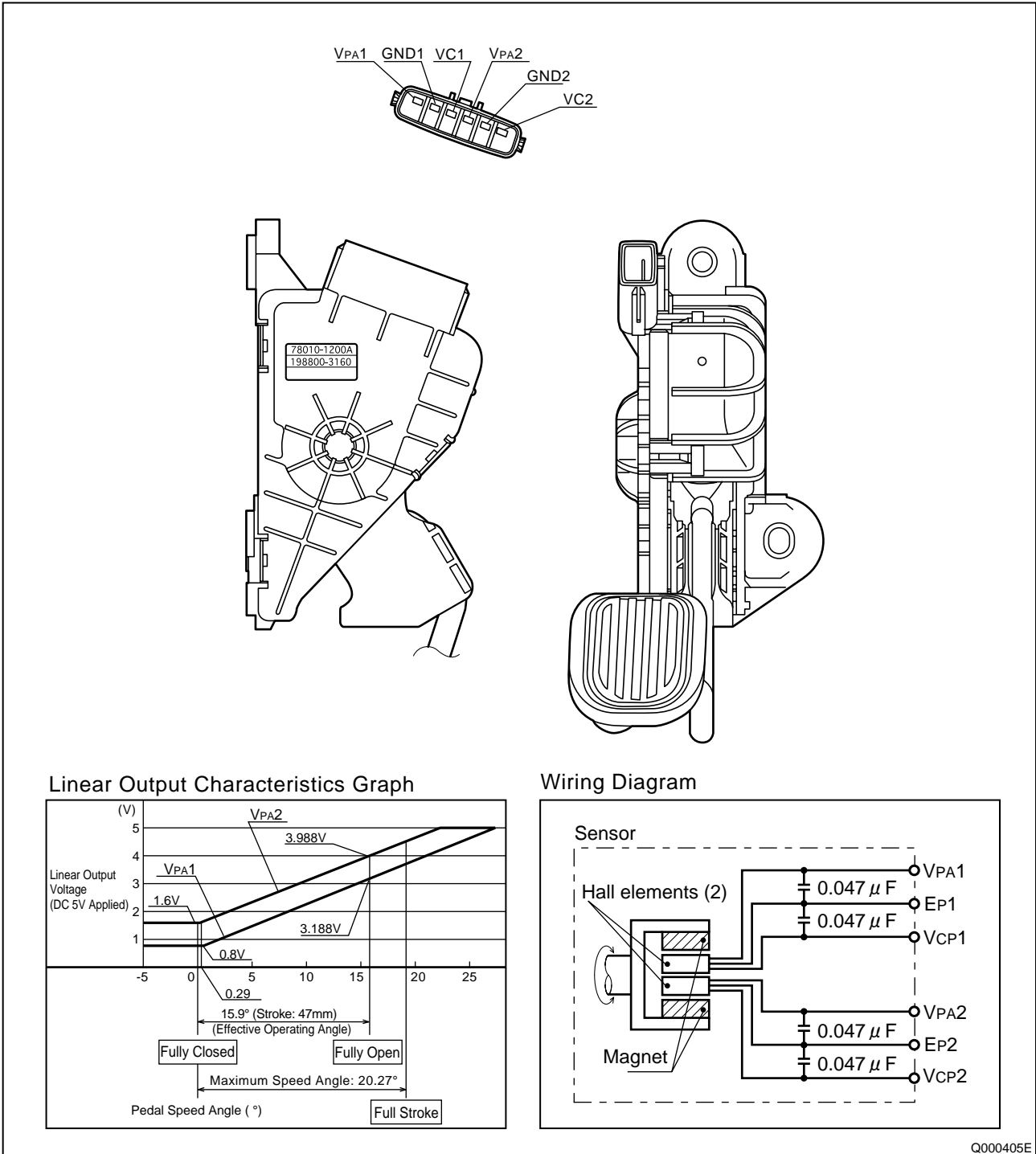
\*The engine ECU identifies the No. 1 cylinder when it detects the missing cog NE pulse and the cylinder recognition pulse simultaneously.



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### C. Accelerator Position Sensor

This is a non-contact type sensor. A lever rotates in unison with the accelerator pedal, and the output terminal voltage (VPA1, VPA2) varies in accordance with the rotational angle of the lever. As a safety measure against problems such as an open circuit, the sensor contains two output voltage systems. (The output voltage has an offset of 0.8V.)

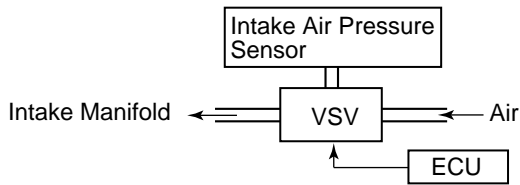
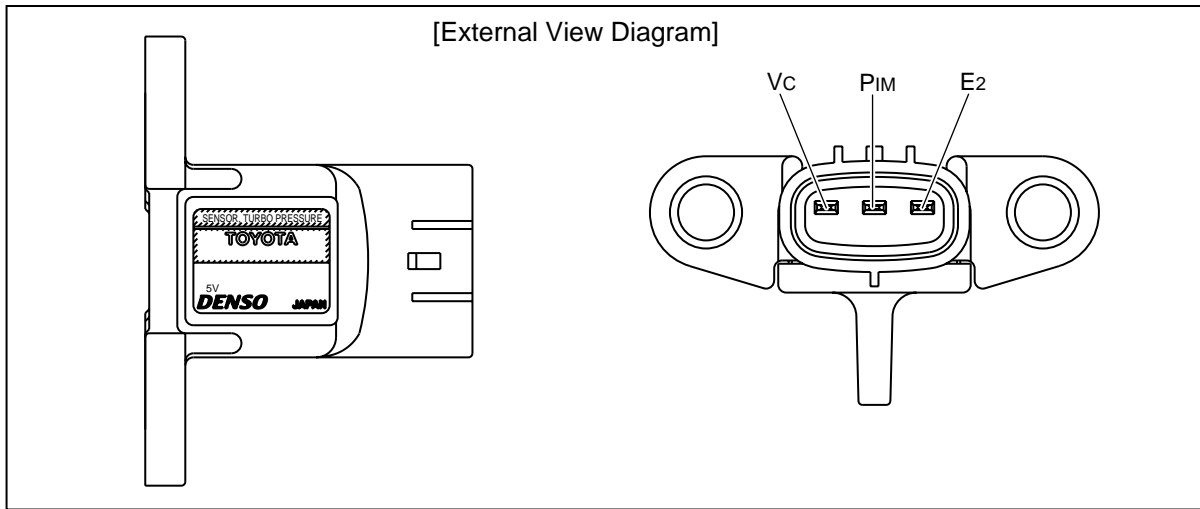


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#### D. Intake Air Pressure Sensor

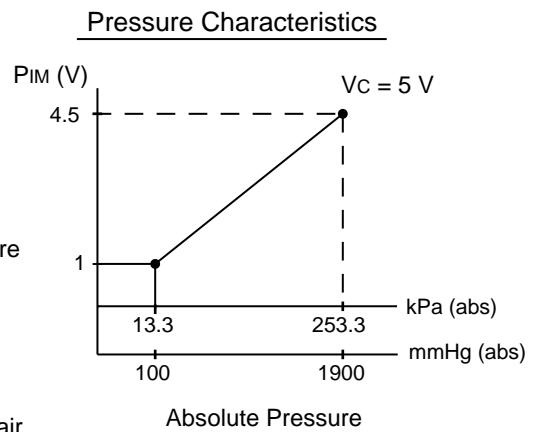
This is a type of semi-conductor pressure sensor. It utilizes the characteristic whereby electrical resistance changes when pressure is applied to silicon crystal. Because a single sensor is used to measure both intake air pressure and atmospheric pressure, a VSV is used to alternate the measurements.



**Atmospheric pressure measurement conditions:**  
 The VSV turns ON for 150 msec to detect the atmospheric pressure when one of the below conditions "(1)" to "(3)" are present.

- (1) Engine speed = 0rpm
- (2) Starter ON
- (3) Stable idling.

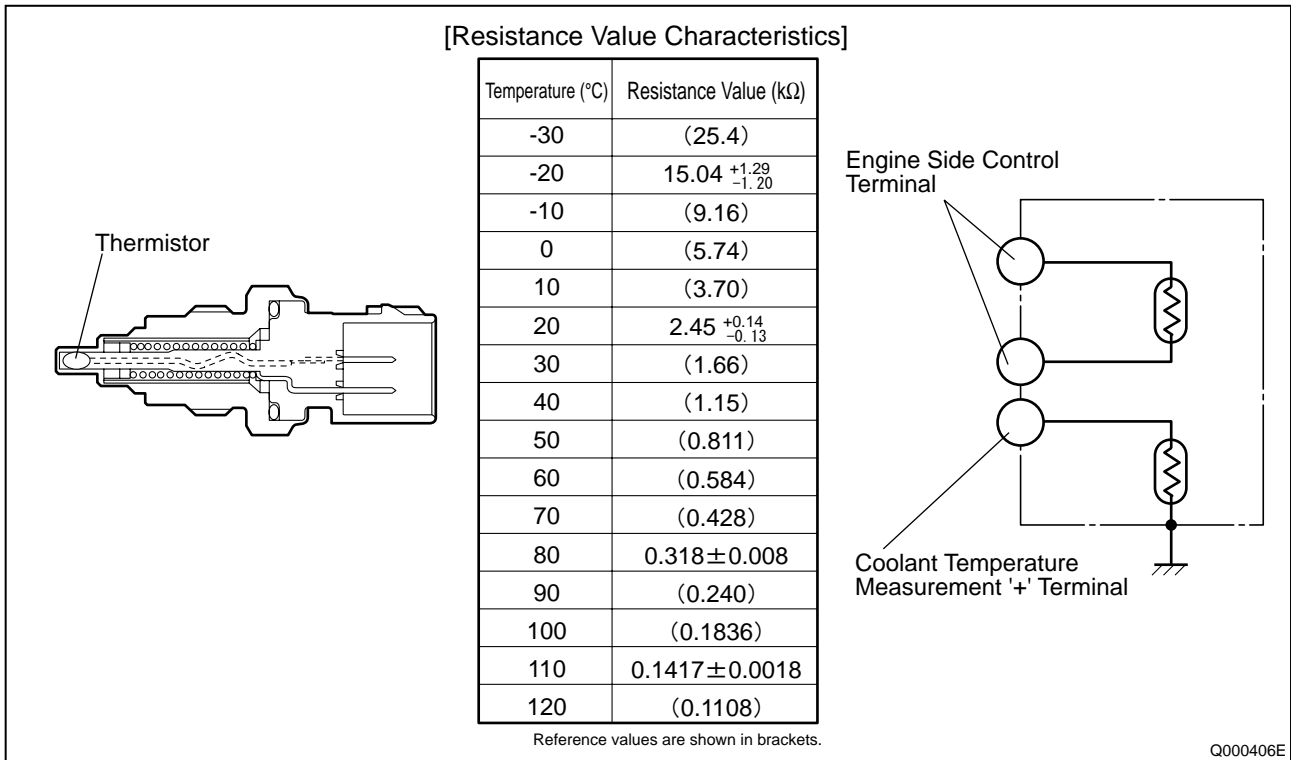
**Intake air pressure measurement conditions:**  
 The VSV turns OFF to detect the intake air pressure if the intake air pressure measurement conditions are absent.



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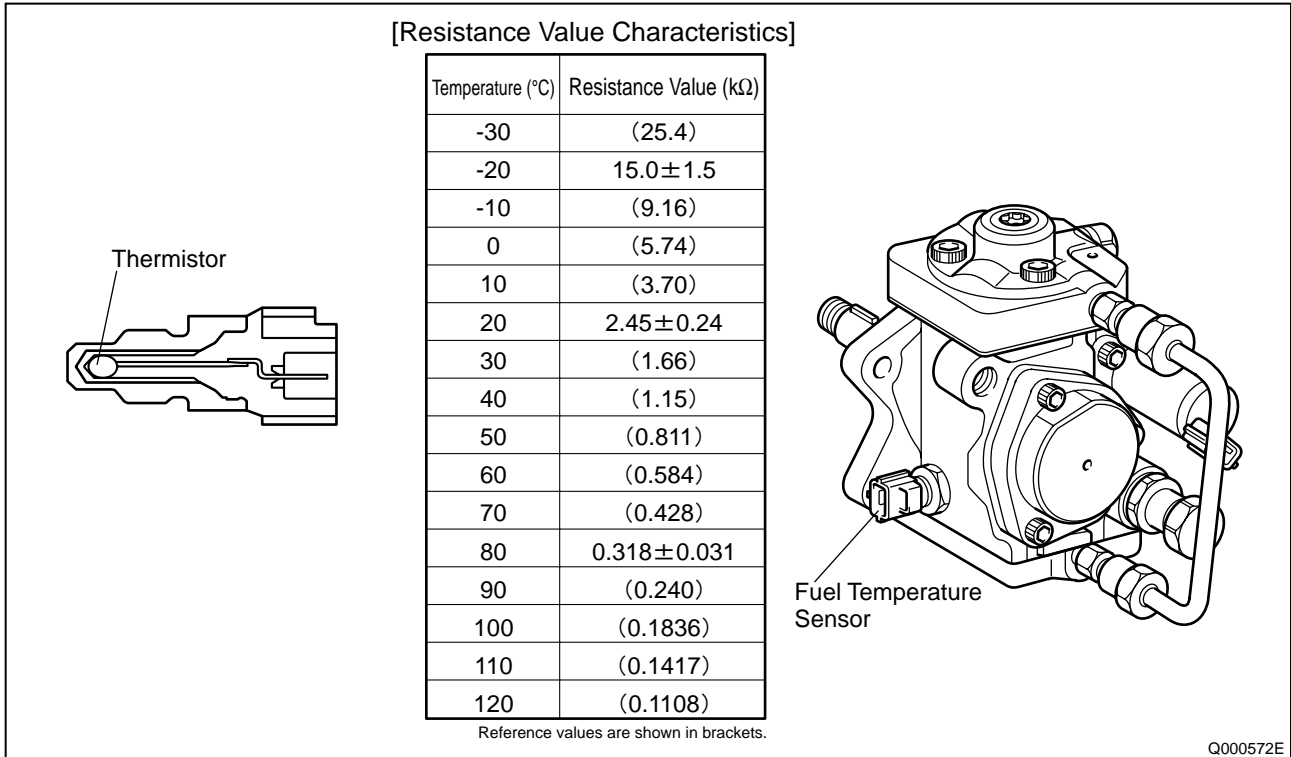
### E. Coolant Temperature Sensor (THW)

- The coolant temperature sensor is installed to the engine cylinder block and detects the engine coolant temperature.
- The sensor uses a thermistor with a characteristic which varies resistance according to temperature. The change in resistance value is used to detect changes in coolant temperature.
- The thermistor characteristic is such that the resistance value decreases as the temperature increases.



## F. Fuel Temperature Sensor (THF)

- The fuel temperature sensor detects the fuel temperature from its mounting on the supply pump, and sends a signal to the engine ECU.
- The detection component utilizes a thermistor.



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## 6. Various Types of Controls

### 6-1. Common Rail System Outline

#### A. Control Outline

- This system effects more appropriate control of the fuel injection quantity and injection timing than the mechanical governor or timer used in the conventional injection pump.
- The engine ECU performs the necessary calculations in accordance with the engine and each of the sensors installed on the vehicle. It thus controls the timing and duration of time in which current is applied to the injectors, in order to realize both optimal injection and injection timing.

#### B. Fuel Injection Rate Control Function

This is the pilot injection control, which injects a small amount of fuel before the main injection.

#### C. 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.

#### D. Fuel Injection Timing Control Function

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

#### E. Fuel Injection Pressure Control Function (Rail Pressure Control Function)

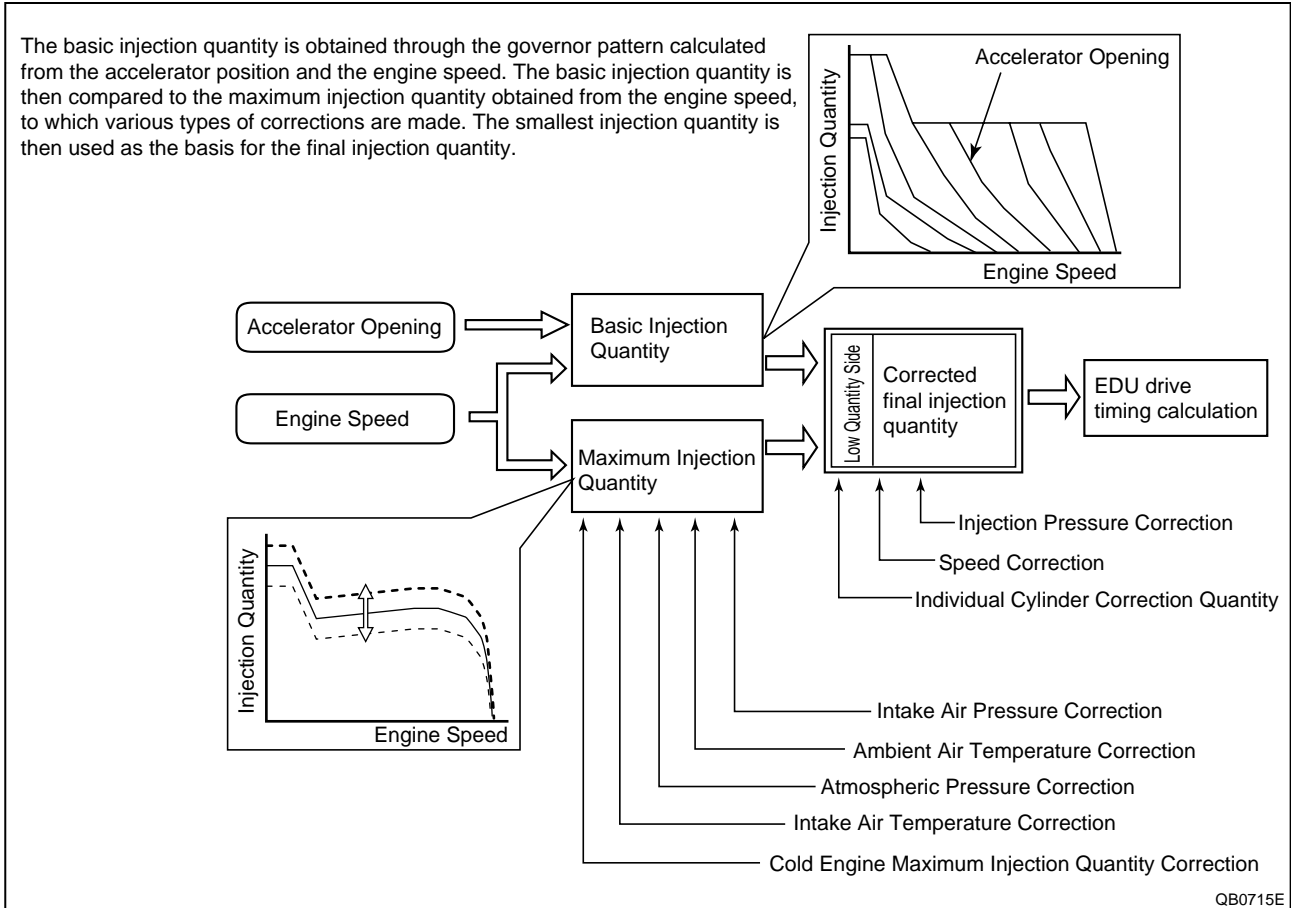
The fuel injection pressure control function (rail pressure control) controls the pump discharge quantity by measuring the fuel pressure at the rail pressure sensor and feeding it back to the ECU. It effects pressure feedback control so that the discharge volume matches the optimal (command) value set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

## 6-2. Fuel Injection Quantity Control

### A. Outline

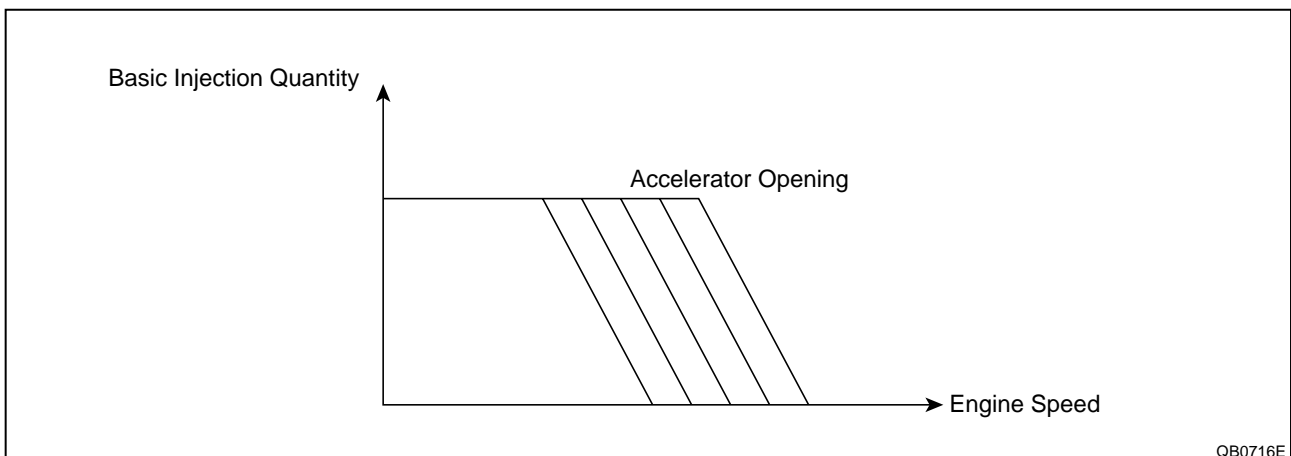
This control determines the fuel injection quantity by adding coolant temperature, fuel temperature, intake air temperature, and intake air pressure corrections to the basic injection quantity. The engine ECU calculates the basic injection quantity based on the engine operating conditions and driving conditions.

### B. Injection Quantity Calculation Method



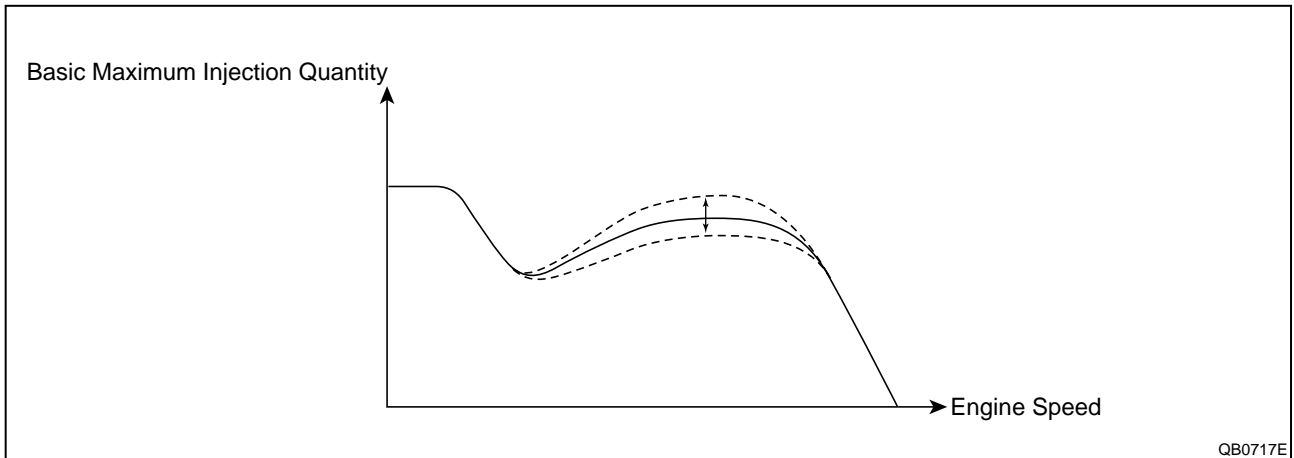
### C. Basic Injection Quantity

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



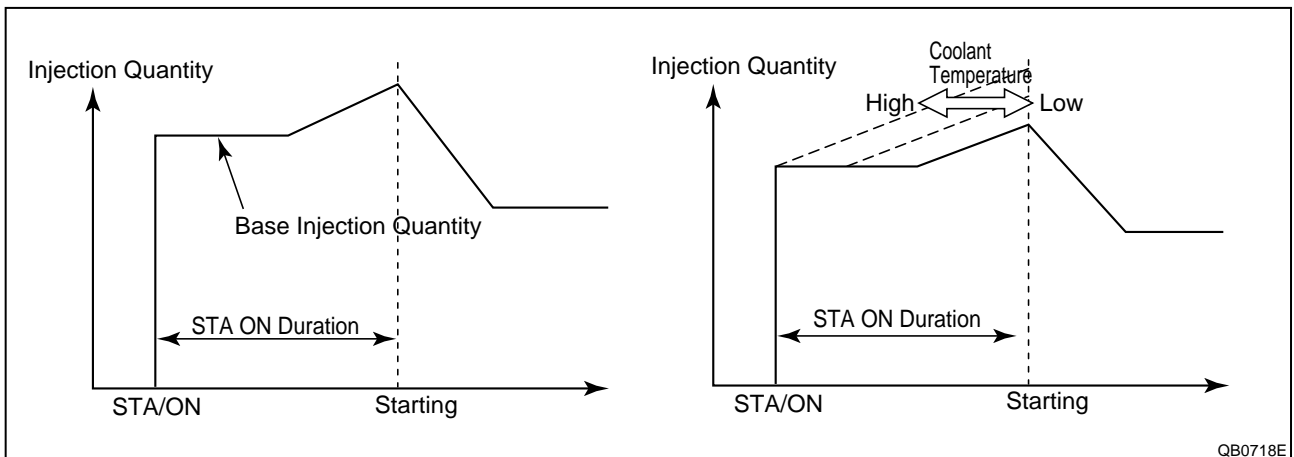
#### D. Maximum Injection Quantity

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 quantity correction to the basic maximum injection quantity that is determined by the engine speed.



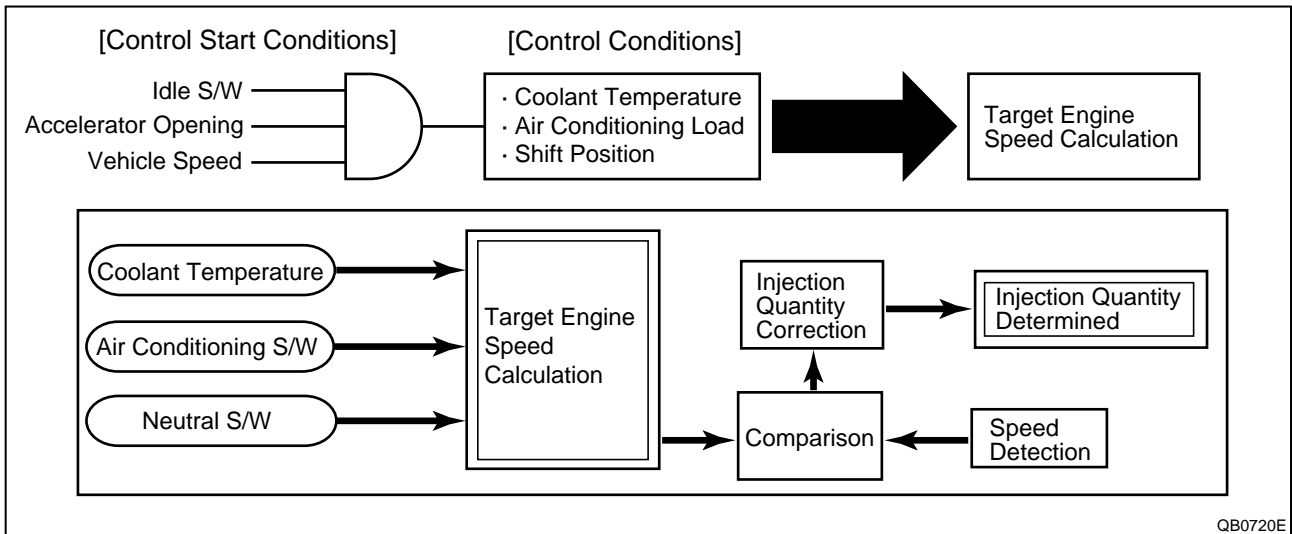
#### E. Starting Injection Quantity

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



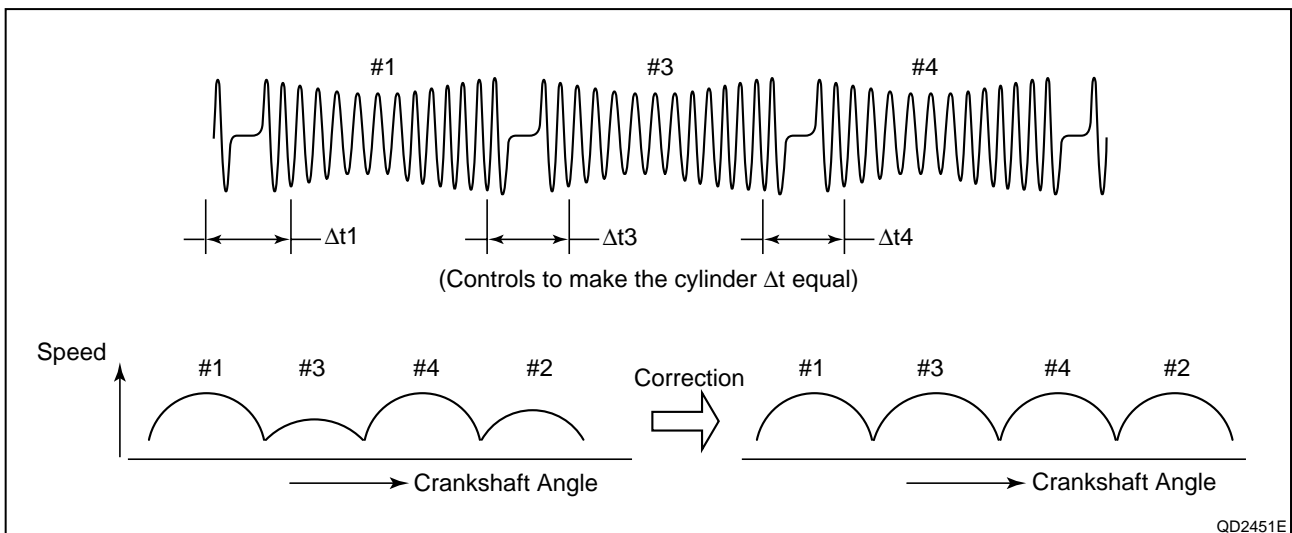
### F. Idle Speed Control (ISC) System

This system controls the idle speed by regulating the injection quantity in order to match the actual speed to the target speed calculated by the engine ECU.



### G. Idle Vibration Reduction Control

This control reduces engine vibration during idle. To achieve smooth engine operation, it compares the angle speeds (times) of the cylinders and regulates injection quantity for each individual cylinder in the event of a large difference.



### 6-3. Fuel Injection Timing Control

#### A. Outline

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

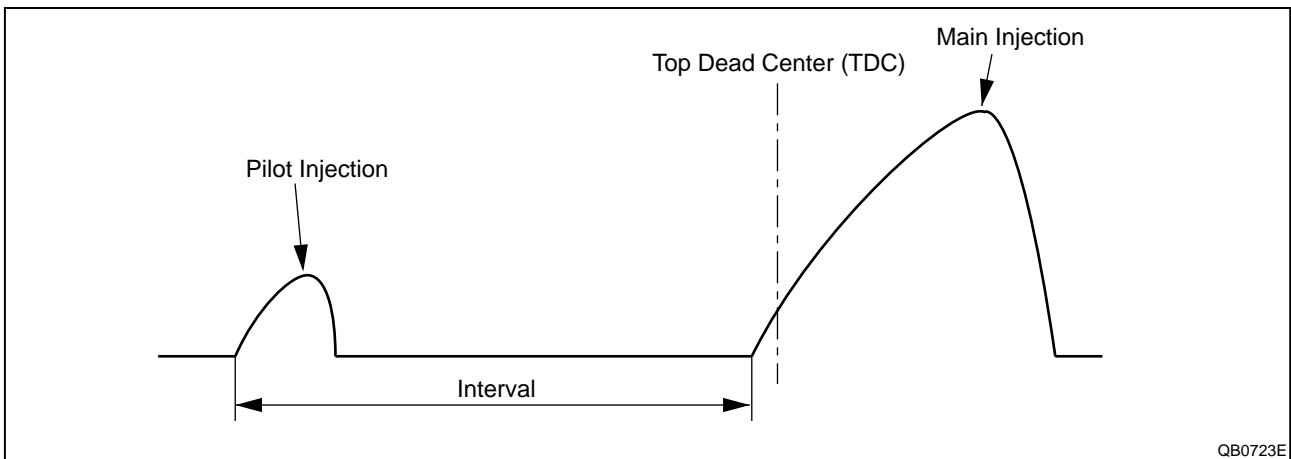
#### B. Main and Pilot Injection Timing Control

##### a. Main Injection Timing

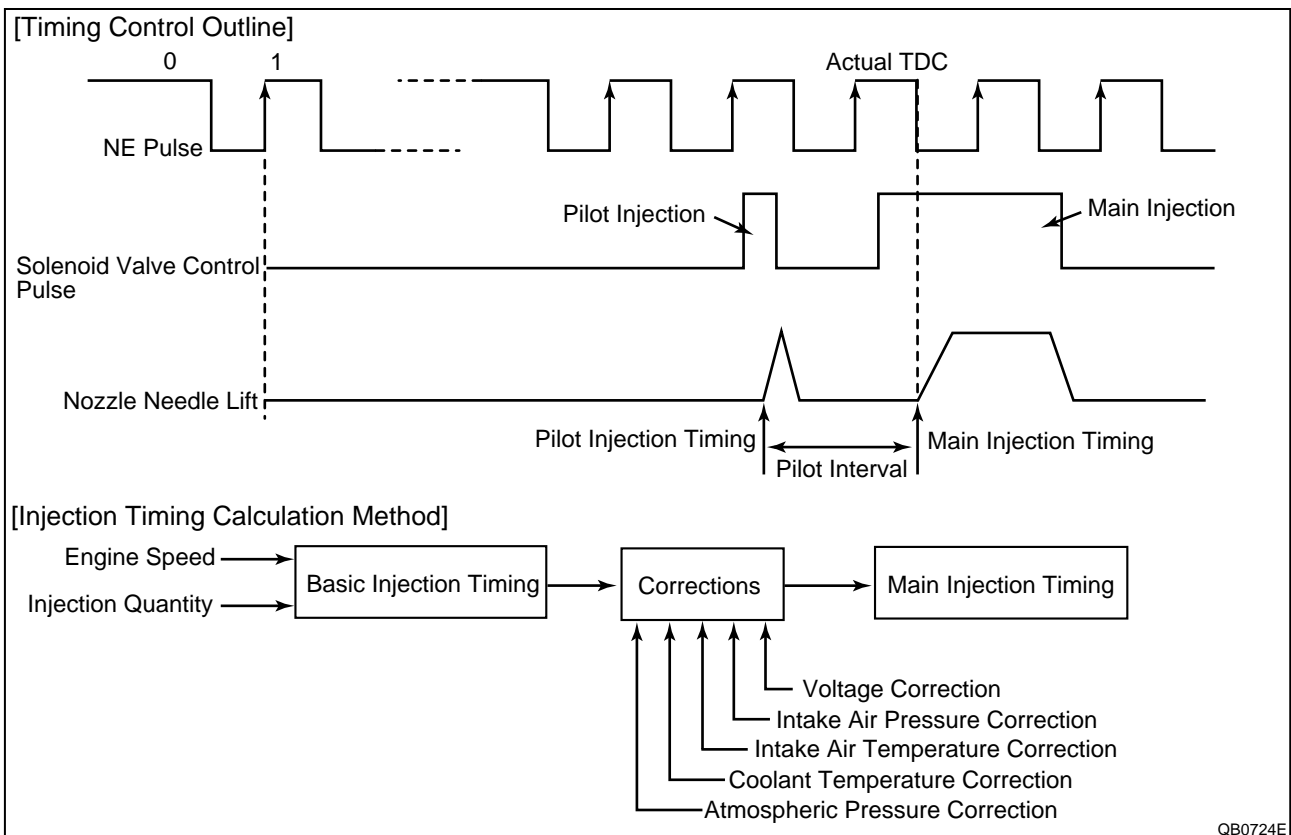
The engine ECU calculates the basic injection timing based on the engine speed and final injection quantity, and adds various types of corrections in order to determine the optimal main injection timing.

##### b. Pilot Injection Timing (Pilot Interval)

Pilot injection timing is controlled by adding a pilot interval value to the main injection. The pilot interval is calculated based on the final injection quantity, engine speed, coolant temperature, atmospheric temperature, and atmospheric pressure (map correction). The pilot interval at the time the engine is started is calculated from the coolant temperature and engine speed.



#### C. Injection Timing Calculation Method

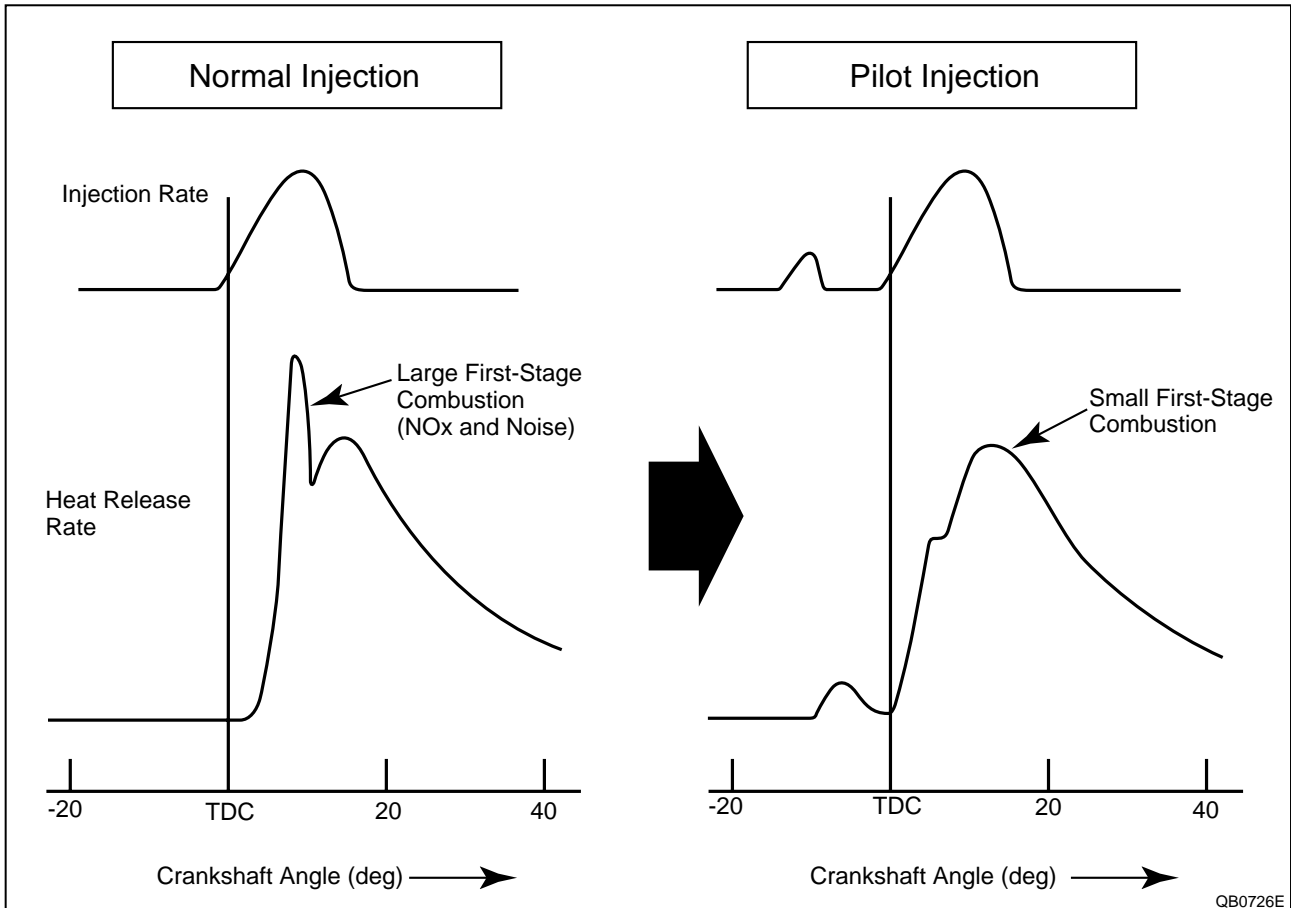




## 6-4. Fuel Injection Rate Control

### A. Outline

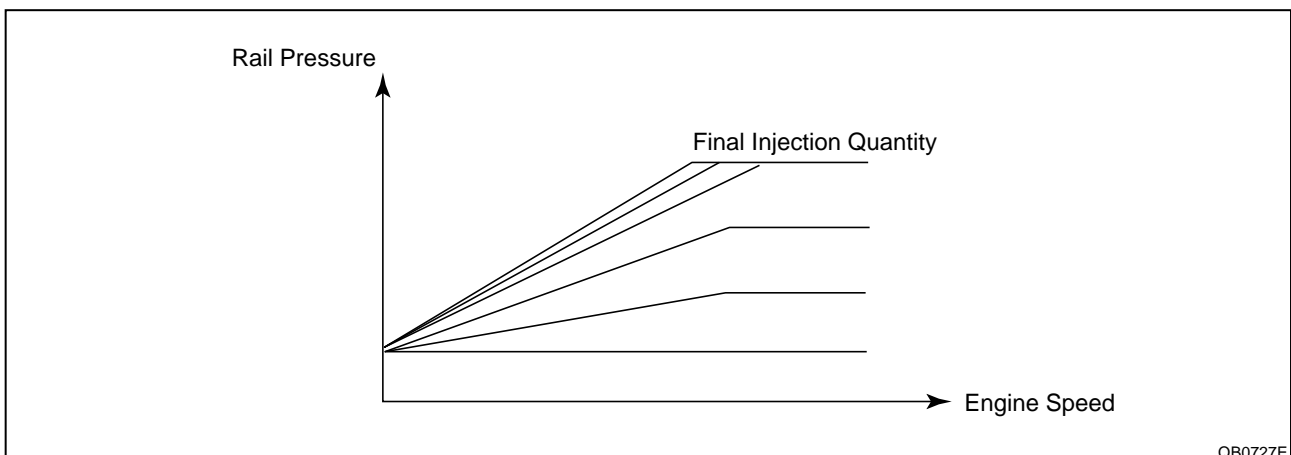
- While the injection rate increases with the adoption of high-pressure fuel injection, the ignition lag, which is the delay from the start of injection to the beginning of combustion, cannot be shortened to less than a certain value. As a result, there is an increase in the quantity of fuel injected before ignition, and this results in an explosive combustion at the time of ignition, increasing both NO<sub>x</sub> and noise.
- For this reason, pilot injection is provided to minimize the initial ignition rate, prevent the explosive first-stage combustion, and reduce noise and NO<sub>x</sub>.



## 6-5. Fuel Injection Pressure Control

### A. Outline

A value is calculated based on the final injection quantity and the engine speed. The calculation is based on the coolant temperature and engine speed during start-up.

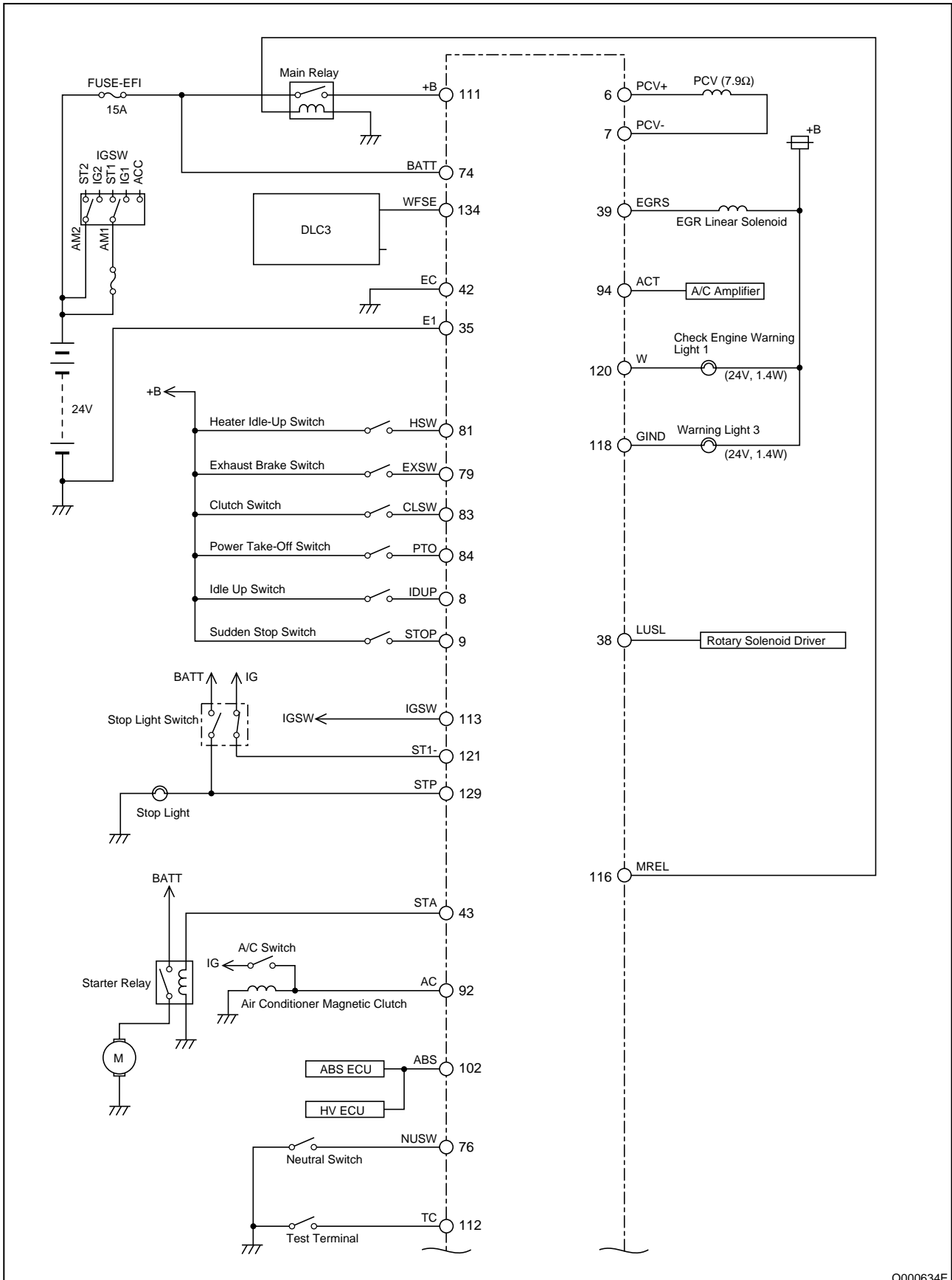


## 7. Other (ECU Related)

### 7-1. ECU External Wiring and Terminal Layout

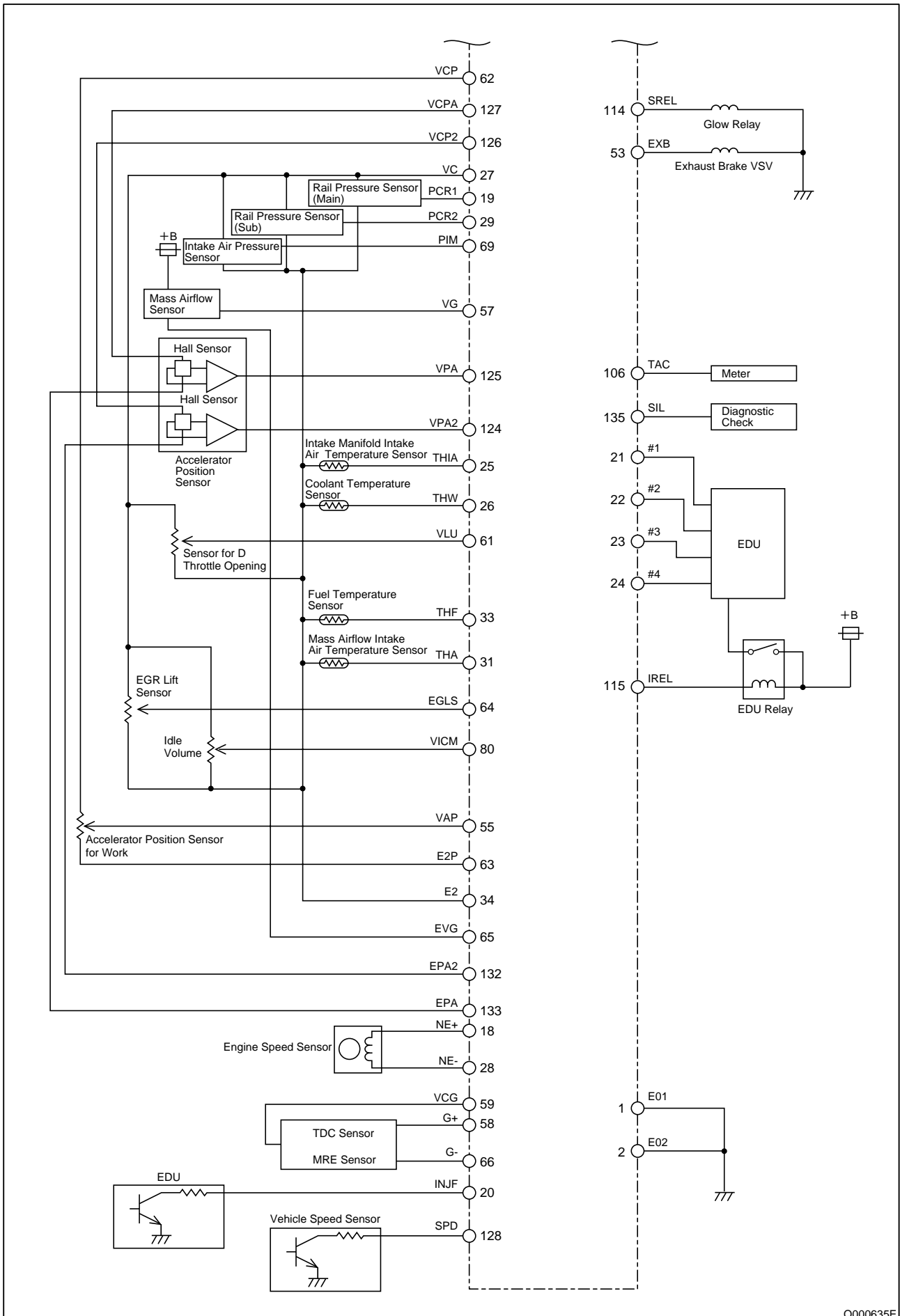
- This is an example of the N04C-TF engine.

#### A. ECU External Wiring Diagram



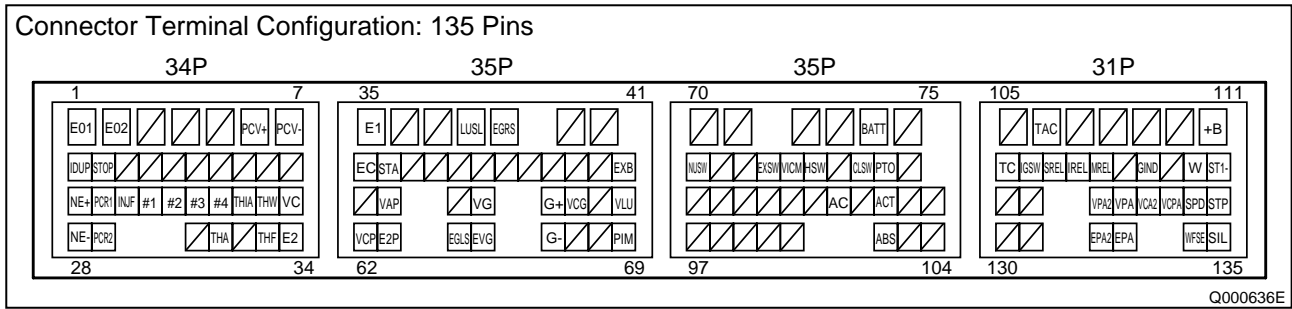
Q000634E

## B. ECU External Wiring Diagram



Q000635E

### C. ECU Terminal Layout



### D. Connector Terminal Input/Output Details

#### a. 34 Pins

No.	Signal	Connection	Input/Output Relationship	No.	Signal	Connection	Input/Output Relationship
1	E01	Power ground (engine ground)		18	NE+	Crankshaft Position Sensor	(36-2) Cogs / 360°CA
2	E02	Power ground (engine ground)		19	PCR1	Rail pressure sensor	30MPa=>1.88V, 180MPa=>4.28V
3	—			20	INJF	EDU	EDU fail signal
4	—			21	#1	EDU	Injection signal
5	—			22	#2	EDU	Injection signal
6	PCV+	Pump control valve	Coil resistance 7.9Ω (Ta=20°C)	23	#3	EDU	Injection signal
7	PCV-	Pump control valve		24	#4	EDU	Injection signal
8	IDUP	Idle-up SW	Terminal is "H" during idle-up request.	25	THIA	Intake air temperature sensor (high response)	20°C=>2.43kΩ, 60°C=>584.1Ω, 100°C=>183.6Ω
9	STOP	Emergency stop SW	Terminal is "H" during emergency stop.	26	THW	Coolant temperature sensor	-20°C=>15.04kΩ, 20°C=>2.45kΩ, 80°C=>318Ω
10	—			27	VC		Sensor power supply (+5V)
11	—			28	NE-	Crankshaft Position Sensor	
12	—			29	PCR2	Rail pressure sub-sensor	30MPa=>1.33V, 180MPa=>3.73V
13	—			30	—		
14	—			31	THA	Intake air temperature sensor (built into AFM)	-20°C=>14.7kΩ, 20°C=>2.43kΩ, 60°C=>590Ω

No.	Signal	Connection	Input/Output Relationship	No.	Signal	Connection	Input/Output Relationship
15	—			32	—		
16	—			33	THF	Fuel temperature sensor	-20°C=>15.04kΩ, 20°C=>2.45kΩ, 80°C=>318Ω
17	—			34	E2	Sensor ground	

b. 35 Pins

No.	Signal	Connection	Input/Output Relationship	No.	Signal	Connection	Input/Output Relationship
35	E1	Ground (engine ground)		53	EXB	Exhaust brake VSV	Coil resistance 50Ω (Ta=20°C)
36	—			54	—		
37	—			55	VAP	Accelerator position sensor for work	5°=>0.2V, 45°=>2.5V, 85°=>4.7V
38	LUSL	D throttle driver IC	Opening side when terminal is "L"	56	—		
39	EGRS	EGR linear solenoid	Coil resistance 28Ω (Ta=20°C)	57	VG	Mass airflow meter	1.6g/s=>1V, 170g/s=>4.4V
40	—			58	G+	Cylinder recognition sensor	4+1 Cogs / 720°CA
41	—			59	VCG	Cylinder recognition sensor power supply	(+5 V)
42	EC	Case ground		60	—		
43	STA	Starter relay	Terminal is "H" during starter energization.	61	VLU	Sensor for D throttle opening	13.5=>0.69V, thereafter 0.04V/°
44	—			62	VCP	Power supply for the accelerator position sensor for work	(+5 V)
45	—			63	E2P	Accelerator position sensor GND for work	
46	—			64	EGLS	EGR lift sensor	Fully closed: 4V, fully open: 1.3V
47	—			65	EVG	Mass airflow meter GND	
48	—			66	G-	Cylinder recognition sensor	
49	—			67	—		

No.	Signal	Connection	Input/Output Relationship	No.	Signal	Connection	Input/Output Relationship
50	—			68	—		
51	—			69	PIM	Boost pressure sensor	93kPa=>0.345V, 370kPa=>4.5V
52	—						

c. 35 Pins

No.	Signal	Connection	Input/Output Relationship	No.	Signal	Connection	Input/Output Relationship
70	—			88	—		
71	—			89	—		
72	—			90	—		
73	—			91	—		
74	BATT	Battery		92	AC	Air conditioner MG relay	Terminal is "H" during air conditioner operation
75	—			93	—		
76	NUSW	Neutral SW	Terminal is "L" except when neutral.	94	ACT	Air conditioning amplifier	"L" during air conditioning cutoff request.
77	—			95	—		
78	—			96	—		
79	EXSW	Exhaust brake SW	Terminal is "H" during exhaust brake operation.	97	—		
80	VICM	Idle-speed volume SW	20°=>0.71V, 300°=>4.28V	98	—		
81	HSW	Warm-up SW	Terminal is "H" during heater idle-up request.	99	—		
82	—			100	—		
83	CLSW	Clutch SW	Terminal is "H" when pedal is not depressed.	101	—		
84	PTO	Power take-off SW	Terminal is "H" during PTO operation.	102	ABS	ABS-ECU	"L" during ABS operation
85	—			103	—		
86	—			104	—		
87	—						

d. 31 Pins

No.	Signal	Connection	Input/Output Relationship	No.	Signal	Connection	Input/Output Relationship
105	—			121	ST1-	Stop light SW	Brake operation terminal "L"
106	TAC	Meter	Engine speed output: 3 pulses / 360°CA	122	—		
107	—			123	—		
108	—			124	VPA2	Accelerator position sub-sensor	0.27°=>0.8V, thereafter 0.153V/°
109	—			125	VPA	Main accelerator position sensor	0.27°=>0.8V, thereafter 0.153V/°
110	—			126	VCP2	Accelerator position sensor sub-power supply	(+5 V)
111	+B	Main Relay	Power supply	127	VCPA	Accelerator position sensor main power supply	(+5 V)
112	TC	Diagnostic checker		128	SPD	Vehicle speed sensor (MRE)	4 pulses / revolution (637 revolutions at 60km/h)
113	IGSW	Ignition SW	Terminal is "H" during ignition switch ON.	129	STP	Stop light SW	Terminal is "H" during brake operation.
114	SREL	Glow relay	Coil current 0.37A (Ta=20°C)	130	—		
115	IREL	EDU relay	Coil current 0.086A (Ta=20°C)	131	—		
116	MREL	Main relay	Coil current 0.086A (Ta=20°C)	132	EPA2	Accelerator position sub-sensor GND	
117	—			133	EPA	Accelerator position main sensor GND	
118	GIND	Glow plug indicator light	1.4W @ 24V	134	WFSE	Flash write tool	"L" during writing
119	—			135	SIL	Diagnostic checker	
120	W	Check engine light	1.4W @ 24V				

## 7-2. Diagnostic Trouble Code

Diagnostic Code		Detection Trip	Lamp Output	Check	Memory	Item
SAE	TCCS		CE			
P0030 / P0031 / P0130 / P0131 / P0132	21	1	O	×	O	A/F sensor (B1S1)
P0036 / P0037 / P0136 / P0137 / P0138	27	1	O	×	O	A/F sensor (B1S2)
P0087	49	1	O	×	O	Rail pressure abnormality (fixed output)
P0088	78	1	O	×	O	Pump valve abnormality (high-pressure in rail)
P0093	78	1	O	×	O	Fuel leak abnormality
P0095 / P0097 / P0098	23	1	O	O	O	Intake air temperature sensor No.2 (post-turbo intake air temperature sensor)
P0100 / P0102 / P0103	31	1	O	×	O	Mass airflow meter
P0105 / P0107 / P0108	35	1	O	O	O	Pressure sensor
P0110 / P0112 / P0113	24	1	O	O	O	Intake air temperature sensor
P0115 / P0117 / P0118	22	1	O	O	O	Coolant temperature sensor
P0120 / P0122 / P0123	41	1	O	O	O	Throttle sensor
P0168	39	1	O	×	O	Abnormally high fuel temperature
P0180 / P0182 / P0183	39	1	O	O	O	Fuel temperature sensor
P0190 / P0192 / P0193	49	1	O	O	O	Rail pressure sensor with back-up sensor
P0191	49	1	O	O	O	Rail pressure sensor with back-up sensor (out-of-range)
P0200	97	1	O	×	O	EDU abnormality (engine part diagnostic)
P0234	34	1	O	×	O	VN turbo abnormality (closed-side abnormality)
P0263	78	1	×	×	O	Injector abnormality (FCCB abnormality) (No. 1 cylinder)
P0266	78	1	×	×	O	Injector abnormality (FCCB abnormality) (No. 2 cylinder)
P0269	78	1	×	×	O	Injector abnormality (FCCB abnormality) (No. 3 cylinder)
P0272	78	1	×	×	O	Injector abnormality (FCCB abnormality) (No. 4 cylinder)
P0299	34	1	×	×	O	VN turbo abnormality (open-side abnormality)
P0335	13	1	O	×	O	Crankshaft position sensor (open circuit / phase difference /power flicker)
P0335	12	1	O	×	O	Crankshaft position sensor (open circuit)
P0339	13	1	O	×	O	Crankshaft position sensor (NE power flicker)
P0340	12	1	O	×	O	Cylinder recognition sensor (open circuit, power flicker)



Diagnostic Code		Detection Trip	Lamp Output	Check	Memory	Item
SAE	TCCS		CE			
P0340	12	1	O	×	O	Cylinder recognition sensor (during start-up)
P0400	71	1	O	×	O	EGR (FLOW MALFUNCTION)
P0400	71	1	O	×	O	EGR-V
P0405 / P0406	96	1	×	O	O	Lift sensor
P0488	15	1	O	×	O	Intake restriction motor control system
P0500	42	1	O	O	O	Vehicle speed sensor (MT)
P0504	51	1	×	×	O	STP light switch
P0607	89	1	O	×	O	CPU abnormality
P0627	78	1	O	×	O	Pump abnormality (open/short circuit)
P1133	00	1	O	O	O	Exterior accelerator position No. 1 sensor is HIGH
P1143	19	1	O	O	O	Throttle knob is HIGH
P1229	78	1	O	×	O	Pump valve abnormality
P1238	78	2	O	×	O	Injector injection abnormality
P1251	34	1	O	×	O	VN turbo (power flicker)
P1530	92	1	×	×	O	Emergency stop switch system
P1601	89	1	O	×	O	Multiple-point injector correction (EEPROM abnormality)
P1611	17	1	O	×	O	Internal IC abnormality
P1611	17	1	O	×	O	RUN pulse abnormality
P1674	36	1	O	×	O	Exhaust brake VSV system
P2120 / P2122 / P2123 / P2125 / P2127 / P2128 / P2138	19	1	O	×	O	Accelerator position sensor
P2121	19	1	O	×	O	Accelerator position sensor (out-of-range)
P2226 / P2228 / P2229	A5	1	O	O	O	Atmospheric pressure sensor (open circuit)