



DENSO



TOYOTA 1KD/2KD ENGINE
COMMON RAIL SYSTEM (CRS)



Issued : September 2009

DENSO CORPORATION

00400706E

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1. PRODUCT APPLICATION INFORMATION

1.1 OUTLINE

- Minor changes have been made to the TOYOTA LAND CRUISER, PRADO, DYNA, and IMV. As a result, a portion of the Common Rail System (CRS) equipped with the 1KD-FTV and 2KD-FTV engines has changed. The construction, operation, and control of main CRS components (supply pump, injectors, rail) are identical to the components described in the previously issued "Common Rail System for TOYOTA HILUX/KIJYANG INNOVA/INNOVA 1KD/2KD (Doc ID: 00400077)". Primary changes and additions are listed below.
 - The supply pump Suction Control Valve (SCV) has been changed from the SV2 type to the SV1 type. (refer to P1-6)
 - The rail pressure limiter has been replaced with a pressure discharge valve. (refer to P1-8)
 - The injectors have been changed from the G2 type to the G3 type. (refer to P1-9)
 - Microinjection quantity learning control, and wide-range cylinder correction control have been added to injector control. (refer to P1-11)

1.2 Applicable Vehicles

Vehicle Name	Engine Type	Engine Displacement	Remarks
LAND CRUISER PRADO	1KD-FTV	3.0 L	August 2009
DYNA			
IMV	1KD/2KD-FTV	3.0 L/2.5 L	

1.3 Applicable Product List

LAND CRUISER PRADO

Part Name	DENSO Part Number	Manufacturer Part Number	Remarks
Supply Pump	294000-110#	22100-30140	
Injector	295050-020#	23670-30400	
Rail	095440-095#	23810-30100	
Engine ECU	275900-045#	89661-60N10	AT, 4WD, Europe, Australia, Euro 4
	275900-046#	89661-60N30	AT, 4WD, Middle East, General, Euro 3, 2
	275900-047#	89661-60N50	AT, 4WD, Middle East, General, Euro 0
	275900-048#	89661-60N20	MT, 4WD, Europe, Australia, Euro 4
	275900-049#	89661-60N40	MT, 4WD, Middle East, General, Euro 3, 2
	275900-050#	89661-60N60	MT, 4WD, Middle East, General, Euro 0
EDU	131000-155#	89871-25010	

Part Name	DENSO Part Number	Manufacturer Part Number	Remarks
Crankshaft Position Sensor	029600-143#	90919-05066	
Camshaft Position Sensor	029600-116#	90919-05052	
Accelerator Pedal Module	198800-742#	78110-60030	
Manifold Absolute Pressure (MAP) Sensor	079800-780#	89421-20200	
Coolant Temperature Sensor	179700-045#	89422-33030	
Intake Air Temperature Sensor	071500-237#	89727-60010	
Exhaust Gas Recirculation (EGR) Valve	101397-123#	25800-30190	

DYNA

Part Name	DENSO Part Number	Manufacturer Part Number	Remarks
Supply Pump	294000-070#	22100-30090	SCV: 294200-004#
Injector	295050-007#	23670-30380	Different connector, for use with cylinders 1 and 2
	295050-008#	23670-30390	
Rail	095440-095#	23810-30100	
Engine ECU	275900-053#	89661-25290	MT, 2WD, Europe, Euro 4 (C/D), with charging regulation when starting
	275900-054#	89661-25300	MT, 2WD, Europe, Euro 4 (C/D), without charging regulation when starting
EDU	101310-570#	89870-25030	
	101310-581#	89870-25040	
Crankshaft Position Sensor	029600-143#	90919-05066	
Camshaft Position Sensor	029600-116#	90919-05052	
Accelerator Pedal Module	198300-302#	89281-35020	
MAP Sensor	079800-780#	89421-20200	
Coolant Temperature Sensor	179700-045#	89422-33030	
Intake Air Temperature Sensor	071500-237#	89727-60010	

Part Name	DENSO Part Number	Manufacturer Part Number	Remarks
Throttle Position Sensor	192300-201#	15081-3F00B	
EGR Valve	101397-118#	25800-30140	
	101397-121#	25800-30150	

IMV

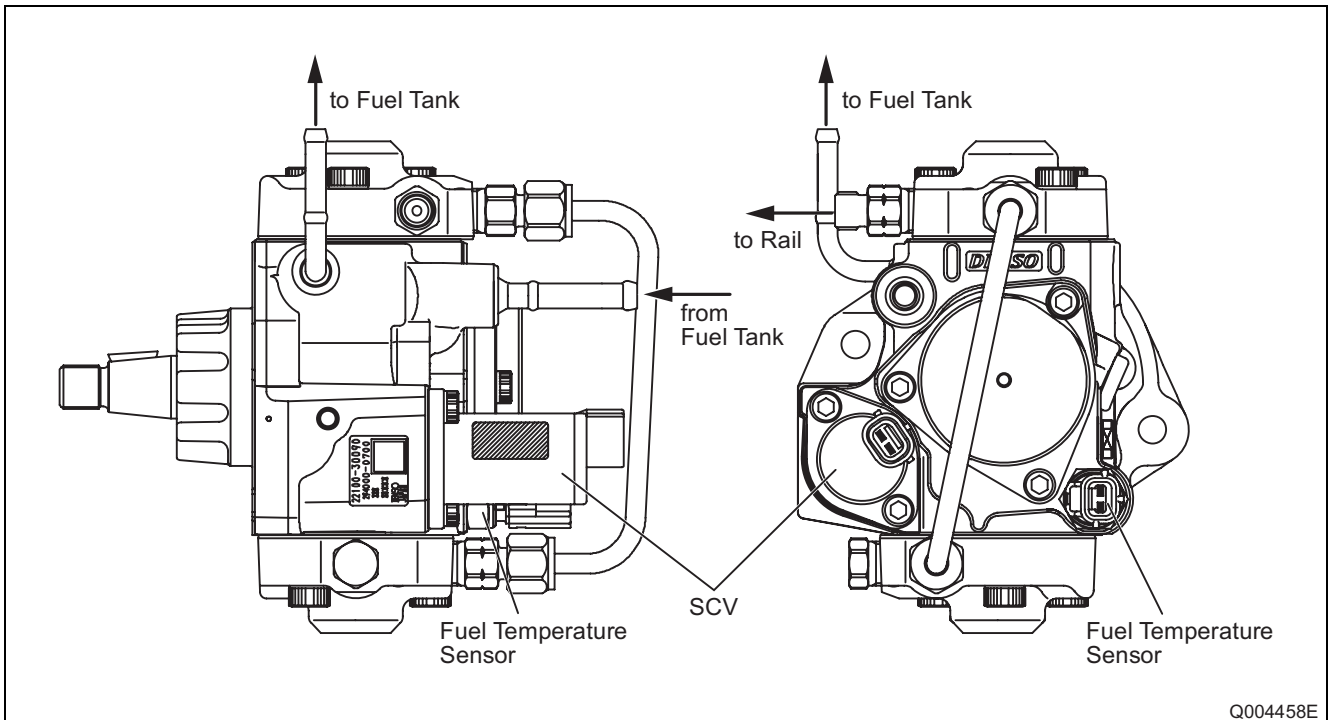
Part Name	DENSO Part Number	Manufacturer Part Number	Remarks
Supply Pump	294000-094#	22100-30120	1KD, Europe, low lubrication
	294000-070#	22100-30090	1KD/2KD, Thailand
	SM294000-090#	22100-0L060	1KD, Europe, Australia, Thailand
	SM294000-091#	22100-0L070	1KD/2KD, Europe, Thailand, India, low lubrication
Injector	295050-020#	23670-30400	1KD/2KD
	295050-021#	23670-30410	2KD
	SM295050-018#	23670-0L090	1KD/2KD
	SM295050-019#	23670-0L100	2KD
Rail	095440-095#	23810-30100	1KD/2KD
	SM095440-095#	23810-0L030	1KD/2KD
Engine ECU	MA275900-055#	89661-0KN00	1KD, MT, PT-4WD, Europe, Euro 4
	MA275900-056#	89661-0KN20	1KD, MT, 2WD, Australia, Euro 4
	MA275900-057#	89661-0KN30	1KD, MT, PT-4WD, Australia, Euro 4
	MA275900-058#	89661-0KN40	1KD, AT, PT-4WD, Europe, Euro 4
	MA275900-059#	89661-0KN60	1KD, AT, PT-4WD PRE, Australia, Euro 4
	MA275900-060#	89661-0KN80	2KD, MT, 2WD, Europe, Euro 4 Class 2
	MA275900-061#	89661-0KP00	2KD, MT, 2WD, Europe, Euro 4 Class 3
	MA275900-062#	89661-0KP20	2KD, MT, PT-4WD, Europe, Euro 4
	MA275900-063#	89661-0KP40	2KD, MT, 2WD PRE, Thailand, Euro 3
	MA275900-064#	89661-0KP50	2KD, MT, PT-4WD, Thailand, Euro 3
	RB275900-065#	89661-0KN10	1KD, MT, PT-4WD, Europe, Euro 4
	RB275900-066#	89661-0KN50	1KD, AT, PT-4WD, Europe, Euro 4
	RB275900-067#	89661-0KN90	2KD, MT, 2WD, Europe, Euro 4 Class 2
	RB275900-068#	89661-0KP10	2KD, MT, 2WD, Europe, Euro 4 Class 3
Engine ECU	RB275900-069#	89661-0KP30	2KD, MT, PT-4WD, Europe, Euro 4
	HA275900-070#	89661-0KN70	1KD, MT, FT-4WD, India, Euro 4 (W/O OBD)
	HA275900-071#	89661-0KP60	2KD, MT, 2WD, India, Euro 4 (W/O OBD)
EDU	101310-590#	89870-71070	
	101310-591#	89870-71080	

Part Name	DENSO Part Number	Manufacturer Part Number	Remarks
Crankshaft Position Sensor	029600-063#	90919-05025	
Camshaft Position Sensor	029600-115#	90919-05050	
MAP Sensor	079800-913#	89421-20200	
Coolant Temperature Sensor	179700-045#	89421-71030	
Intake Air Temperature Sensor	170400-602#	89424-12010	
EGR Valve	101397-113#	25800-30100	
	101397-114#	25800-30110	
	101397-116#	25800-30120	

2. SUPPLY PUMP

2.1 Change Item

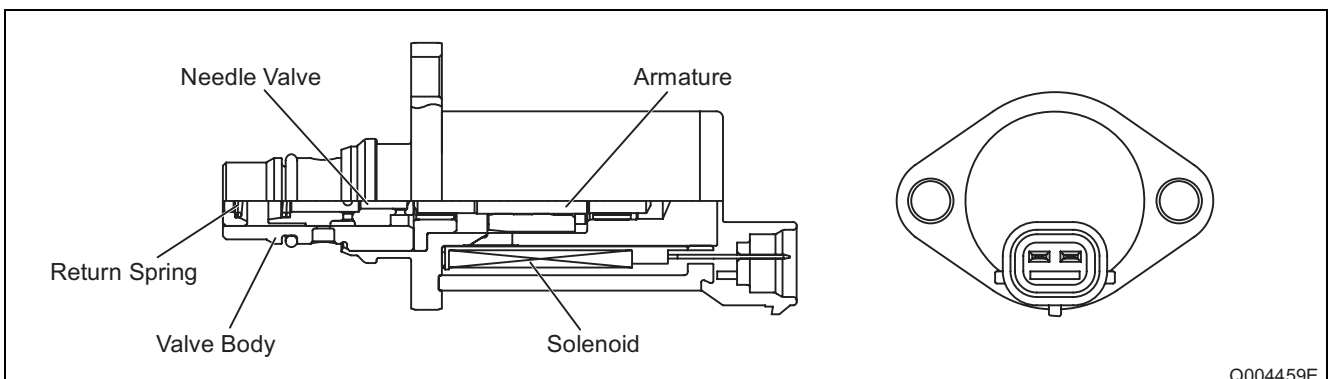
- The supply pump Suction Control Valve (SCV) has been changed from the SV2 type to the SV1 type. (Refer to [SCV types (SV1, SV2)] on P1-7.)



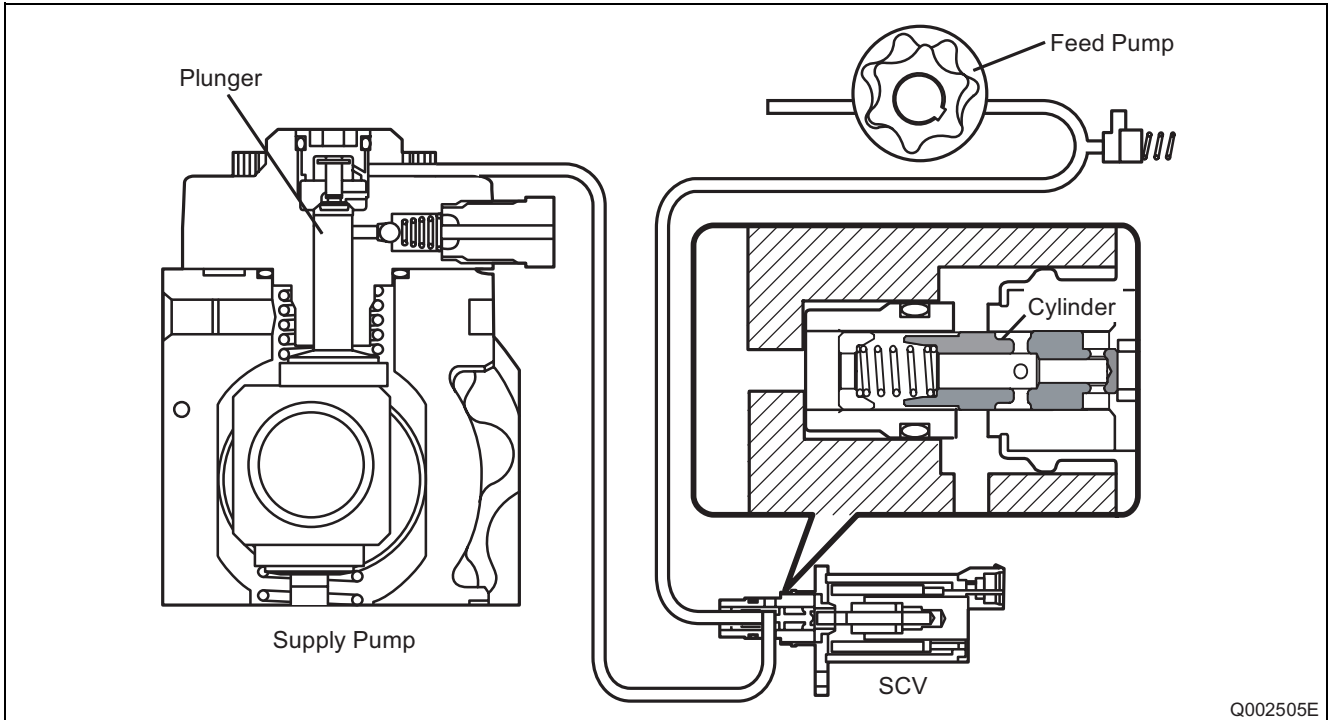
Q004458E

2.2 Suction Control Valve (SCV)

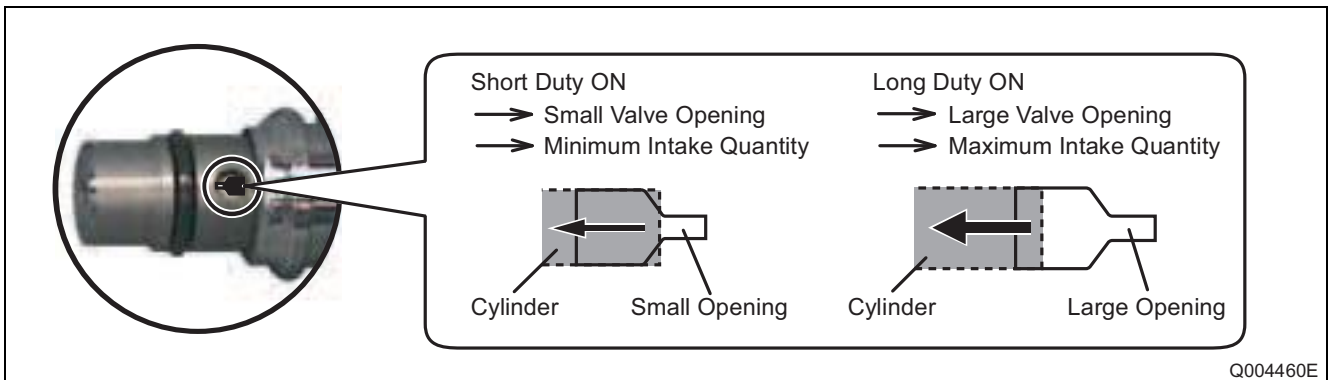
- The supply pump is equipped with a normally closed type SCV.
- When the solenoid is energized, the needle valve is pressed upon (in the compact SCV, the cylinder is pulled upon) by the armature, completely opening the fuel passage and supplying fuel to the plunger. (Total quantity suctioned → Total quantity discharged)
- When power is removed from the solenoid, the return spring presses the needle valve back to the original position, closing the fuel passage.
- The solenoid is actuated by duty ratio control. Fuel is supplied in an amount corresponding to the open surface area of the passage, which depends on the duty ratio. The fuel is then discharged by the plungers.



Q004459E



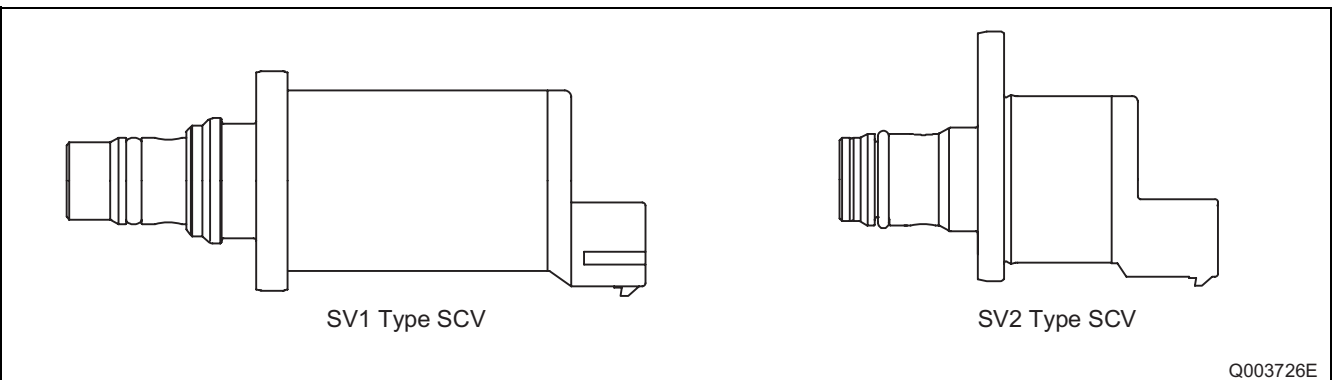
Operational Concept Diagram



Operation

(1) SCV types (SV1, SV2)

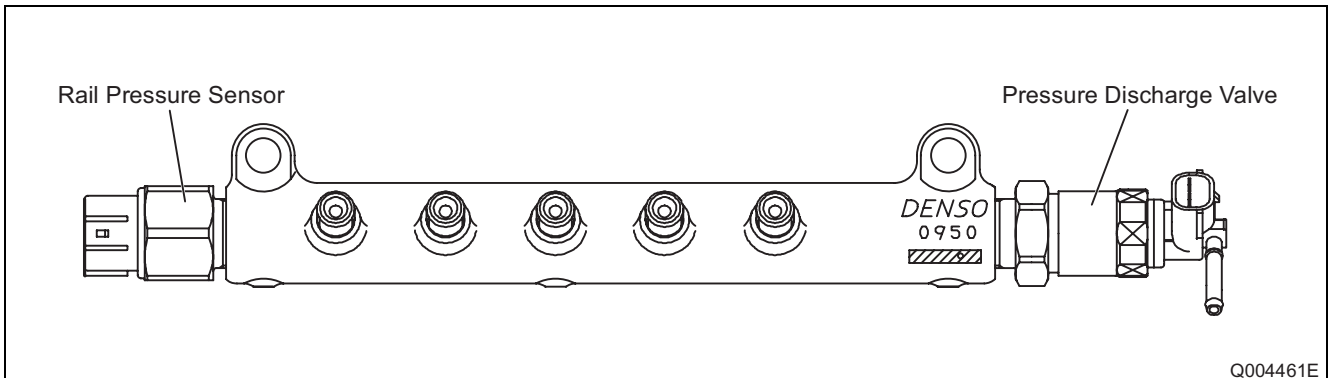
- The SCV is available in the SV1 type and SV2 type. The SV2 is a compact SCV, while the SV1 is a bit larger than the SV2.



3. RAIL

3.1 Change Item

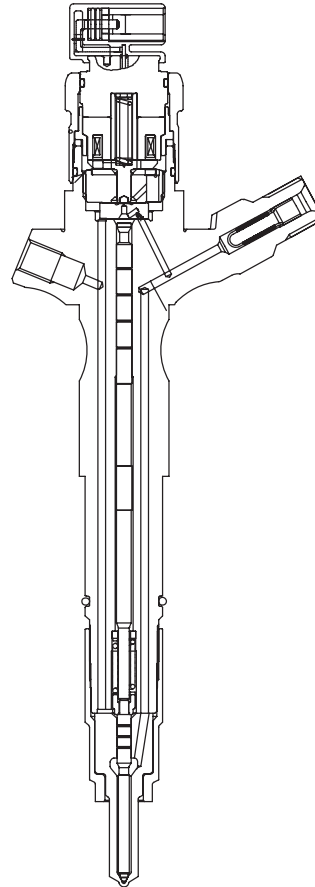
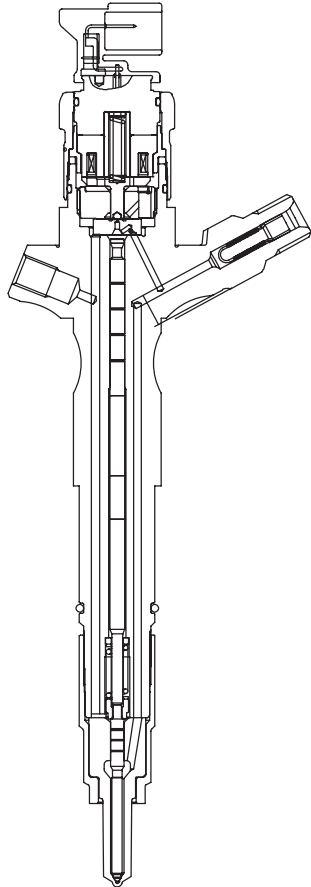
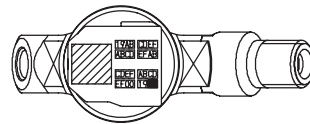
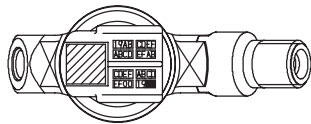
- Beginning from August 2006 model vehicles, a pressure discharge valve is used in place of the rail pressure limiter. The engine ECU control and an actuation circuit (EDU) control the pressure discharge valve.



4. INJECTOR

4.1 Change Items

- The injectors used with the 1KD-FTV and 2KD-FTV engines have been changed from the G2 type to the G3 type. In comparison to the G2 type injector, the G3 type injector has the following characteristics:
 - The nozzle shape, and shape of the high-pressure seal service have been changed, resulting in a more high-pressure resistant structure.
 - The G3 injector is more highly responsive due to changes to the nozzle and solenoid valve.
- In consideration of the mounting measurements, the overall length for the 295050-008# injector (for use with cylinders 1 and 2 in the DYNA) has been made shorter by 5.5 mm.

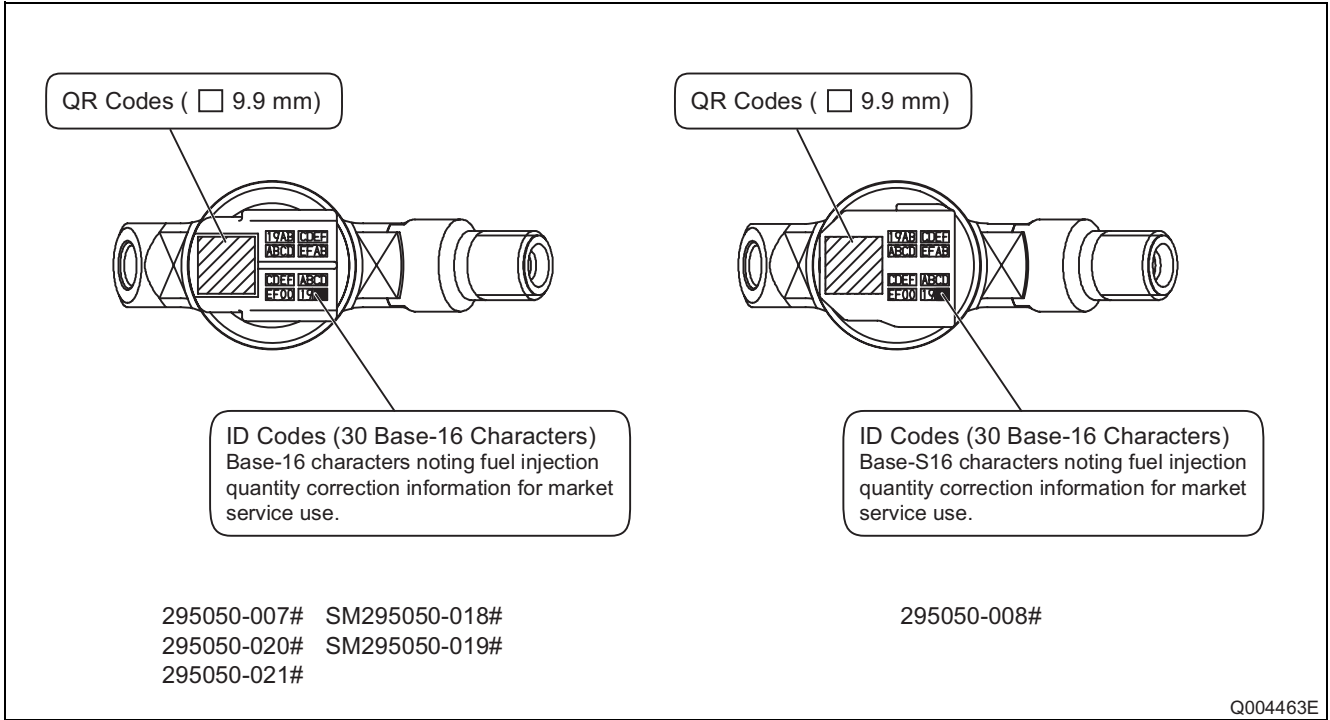


295050-007# SM295050-018#
295050-020# SM295050-019#
295050-021#

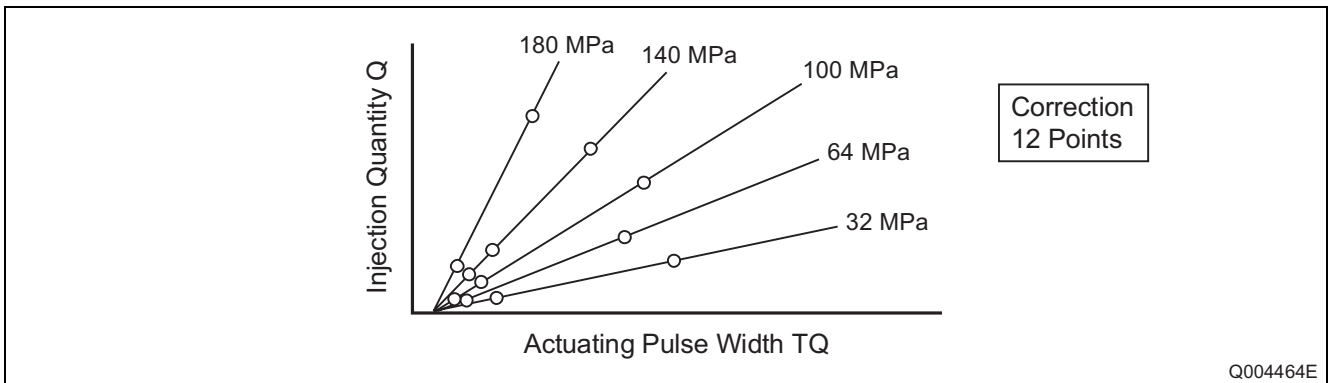
295050-008#

4.2 Quick Response (QR) Codes

- QR codes are used to improve the accuracy of the injector injection quantity. The code from the vehicle assembly line is read, then entered into the engine ECU. Similar to the assembly line process, when performing service, the ID code is read by a diagnostic tool, and entered into the engine ECU.



- The injection quantity correction points contained in the injector QR code are shown in the figure below.



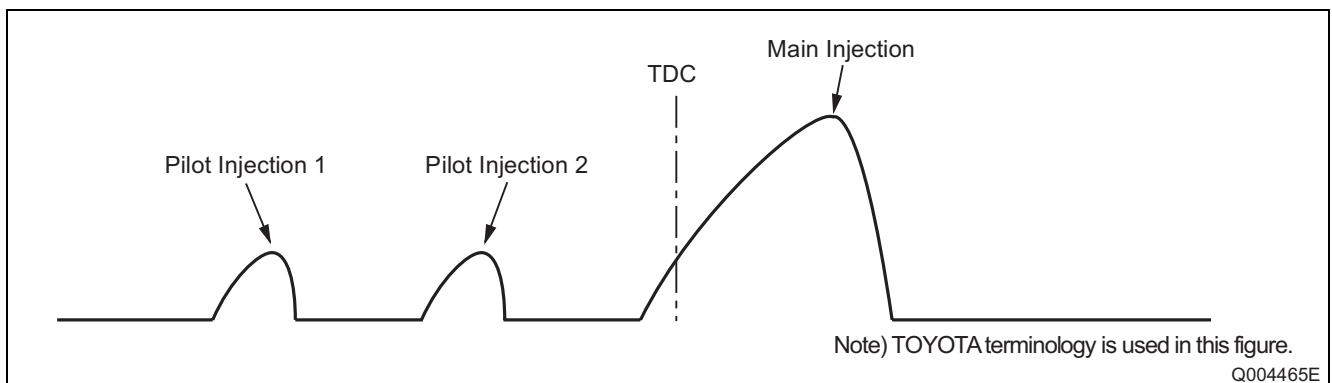
5. FUEL INJECTION CONTROL

5.1 Change Item

- Microinjection quantity learning control, and wide-range cylinder correction control have been added to the CRS equipped with the 1KD-FTV and 2KD-FTV engines.

5.2 Injection Pattern

- In this CRS system, injection occurs a maximum of three times. Under normal operations, fuel injection control is performed with a pilot injection and a main injection. However, an additional pilot injection is added when the engine is started at cold temperatures, as well as when the engine is operating in the low-temperature, low-rotation speed range.



5.3 Microinjection Quantity Learning Control

(1) Outline

- In microinjection quantity learning control, the actual injector injection quantity is estimated from the change in engine rotational speed that accompanies a very small injection. The difference between the estimated actual injection quantity, and the injection quantity command value at that time are learned by the engine ECU. This difference is then used to correct the actual injection quantity.

(2) Goal

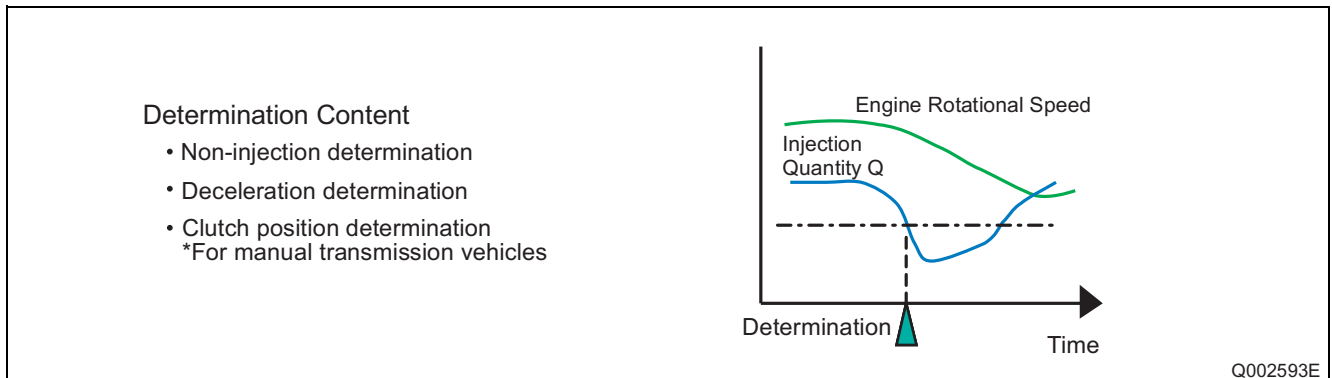
- Microinjection quantity learning control is used to accomplish the following: 1) to minimize injection quantity deviations due to injector deterioration over time, and 2) to prevent both engine running noise due to misfires and exhaust smoke.

(3) Control outline

- Microinjection quantity learning control is automatically performed approximately every 2000 km of normal vehicle operation, and is completed after the vehicle has traveled approximately 500 km. Actual learning takes place during the following processes.

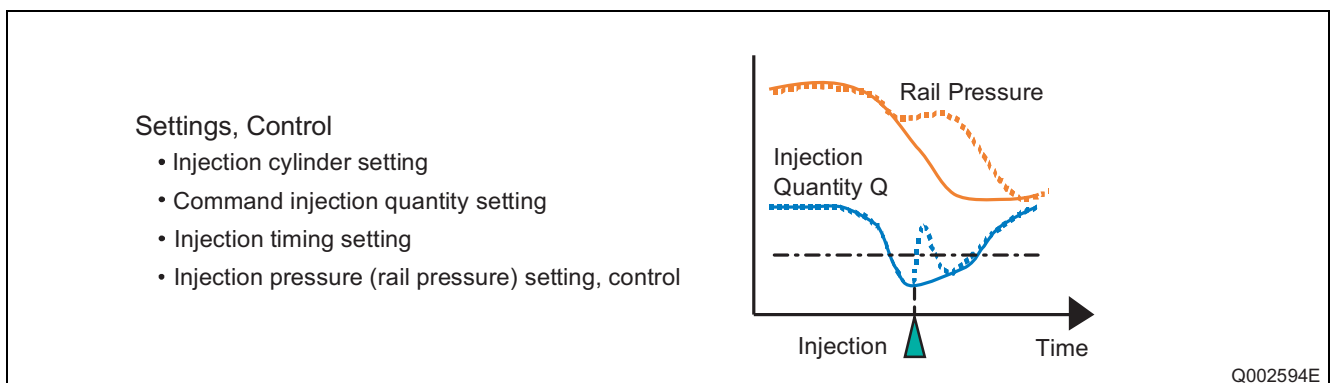
Determination for learning conditions

- ✓ Microinjection quantity learning control is performed when the following two engine operations are established: 1) a reduction in vehicle speed, and 2) injection is cut off. In the determination process, the engine ECU then judges whether or not the conditions for learning have been met. The figure below shows the specific details for learning determinations.



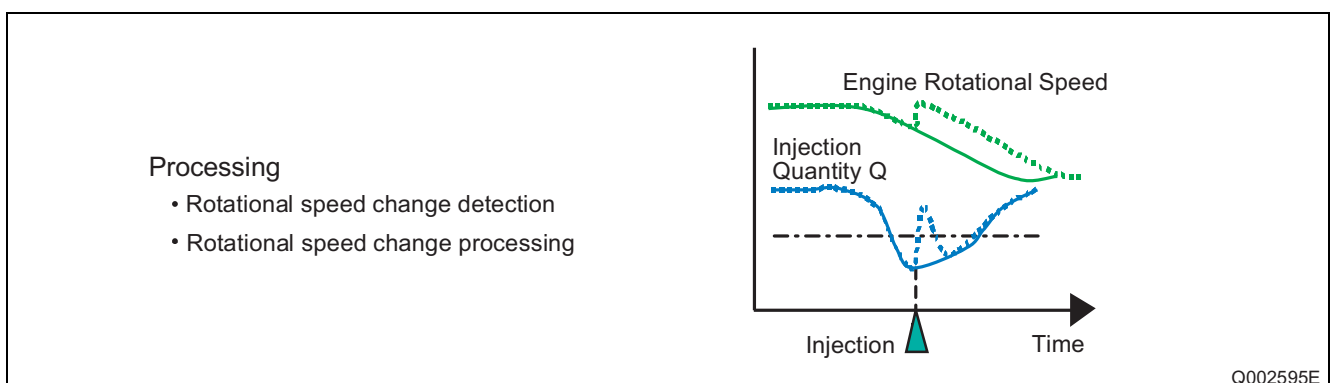
Single microinjection operation

- ✓ Under the single microinjection operation process, microinjection is performed once the following items are set: 1) the cylinder for which learning will be performed, and 2) the injection quantity. The figure below shows the specific settings and controls for a single microinjection.



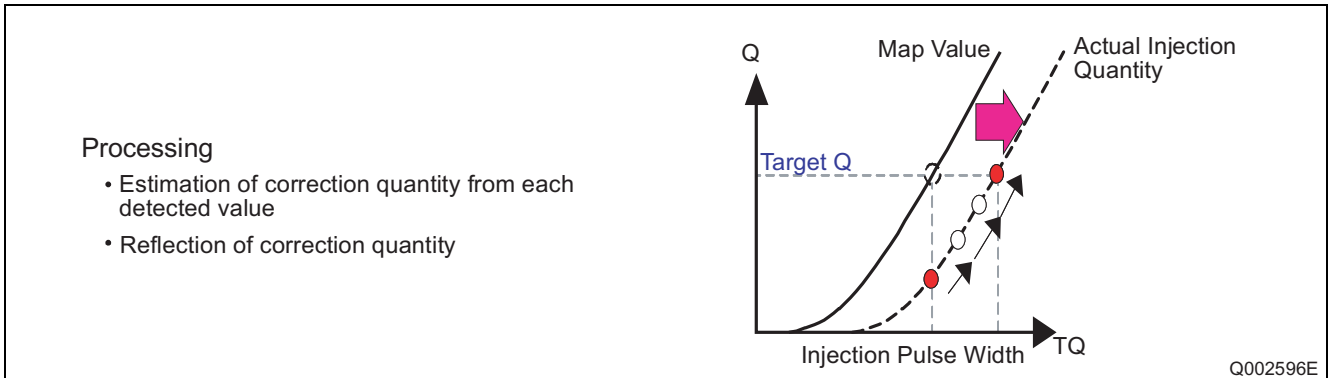
Detecting the change in rotational speed via injection

- ✓ In this process, the change in rotational speed can be detected using the set microinjection. The figure below shows the processing for calculating changes in rotational speed.



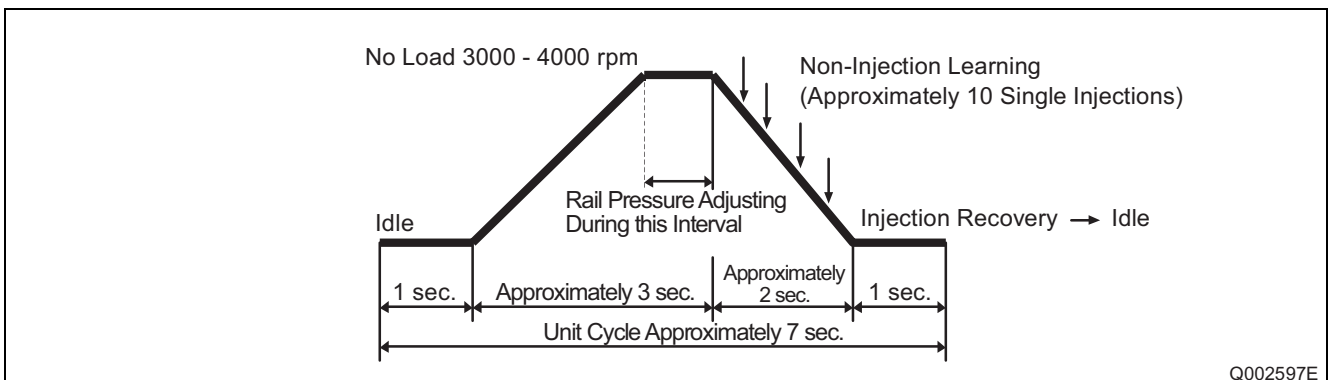
Correcting the injection pulse width (TQ), and actual injection quantity (Q) characteristics

- ✓ In this process, the actual injection quantity is estimated from the set microinjection, and the change in rotational speed. The actual injection quantity is then corrected such that the value equals the target injection quantity. The figure below shows the processing for the aforementioned corrections.



[REFERENCE]

- Learning must be performed manually when either an injector (or injectors), or the engine ECU is replaced. As per the figure below, diagnostic tools are used to perform learning while the engine is operating.



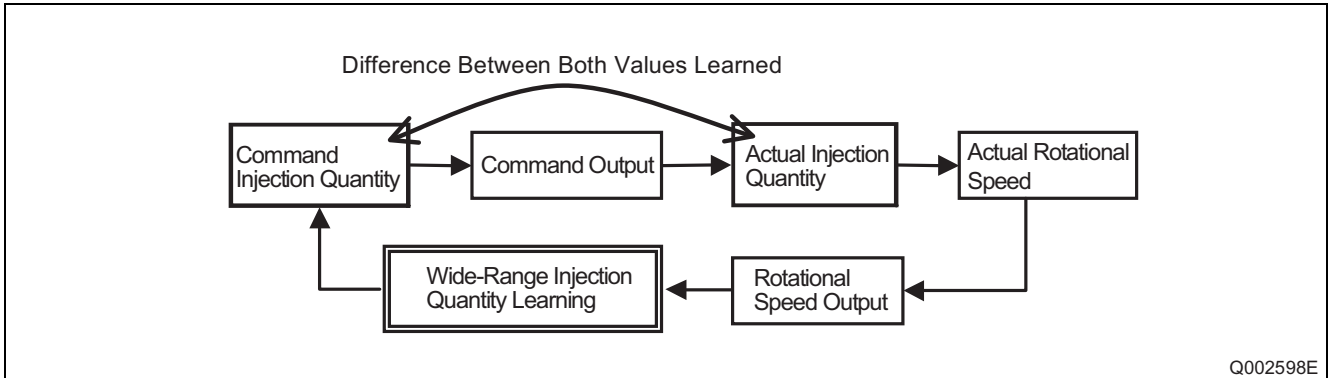
5.4 Wide-Range Cylinder Correction Control

(1) Outline

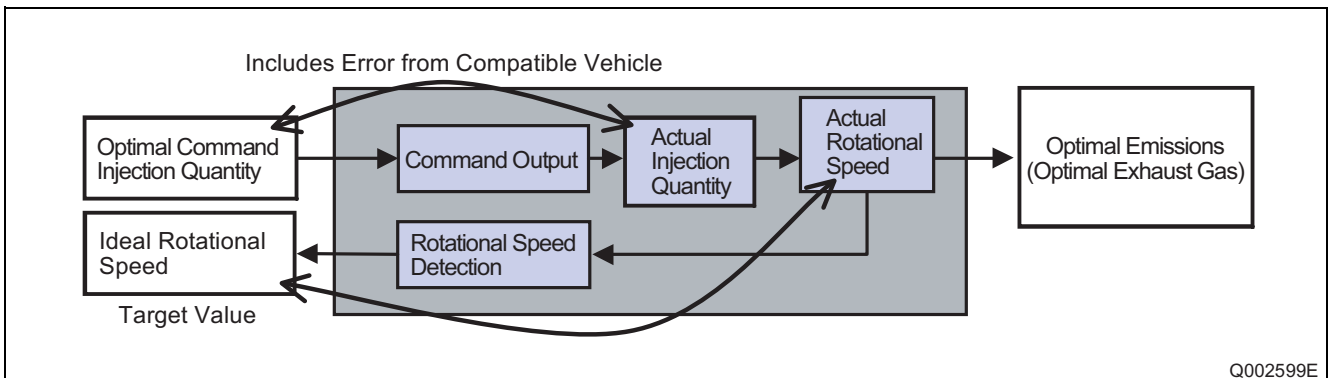
- In wide-range cylinder correction control, the combustion state for each cylinder is detected based on the crankshaft position sensor (NE) signal. The injection quantity across all the cylinders can then be averaged by correcting the injection quantity for each injector. Wide-range cylinder correction control corrects the conventional FCCB control (idle speed stabilization control) performed at idle speed in all regions of rotation.

(2) Control outline

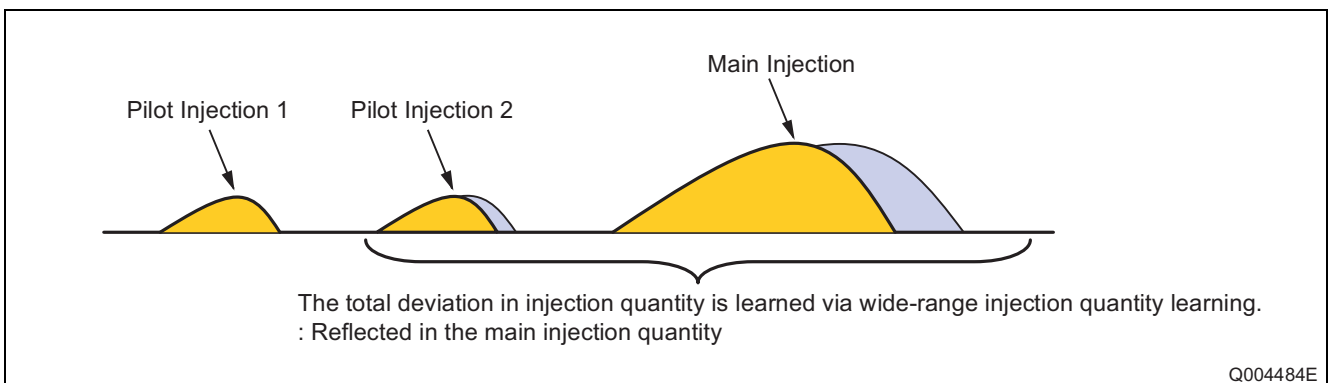
- The difference between the final injection quantity and the actual injection quantity are learned based on the loop in the figure below. Next, the following two items are compared: 1) the results of the actual injection quantity estimate based on the ideal state for NE input, and 2) the results of the actual injection quantity estimate based on the actual NE input (detected value.)



- Finally, the optimal emission state is found as shown in the figure below.



- The correction below shows pilot injection 2 and main injection.



6. DIAGNOSTIC TROUBLE CODES (DTC)

6.1 DTC Table

DTC		Detection Item
SAE Code	Malfunction Indicator Lamp (MIL)	
P00AF	Yes	Variable Nozzle Turbo (VNT) Driver Abnormality, Position Request Signal Abnormality
P0046	Yes	VNT Nozzle Sliding Abnormality
P0047	Yes	VNT Motor Circuit Open
P0048	Yes	VNT Motor Circuit Short
P0069	Yes	Pressure Difference Abnormality Between Boost Pressure and Atmospheric Pressure
P0087	Yes	Rail Pressure Sensor Abnormality
P0088	Yes	Pressure Discharge Valve Abnormality
P0093	Yes	Fuel Leak
P0095	Yes	Intake Air Temperature Sensor System Abnormality
P0097	Yes	Intake Air Temperature Sensor Low
P0098	Yes	Intake Air Temperature Sensor High
P0101	Yes	Mass Air Flow (MAF) Meter Out of Range
P0102	Yes	MAF Meter Low
P0103	Yes	MAF Meter High
P0105	Yes	Manifold Absolute Pressure (MAP) Sensor System Abnormality
P0106	Yes	MAP Sensor Out of Range
P0107	Yes	MAP Sensor Low
P0108	Yes	MAP Sensor High
P0110	Yes	Intake Air Temperature Sensor System Abnormality
P0112	Yes	Intake Air Temperature Sensor Low
P0113	Yes	Intake Air Temperature Sensor High
P0115	Yes	Coolant Temperature Sensor System Abnormality
P0116	Yes	Coolant Temperature Sensor Circuit Range/Performance
P0117	Yes	Coolant Temperature Sensor Low
P0118	Yes	Coolant Temperature Sensor High
P0122	Yes	Diesel Throttle Position Sensor Low
P0123	Yes	Diesel Throttle Position Sensor High
P0168	Yes	High Fuel Temperature Abnormality
P0180	Yes	Fuel Temperature Sensor System Abnormality

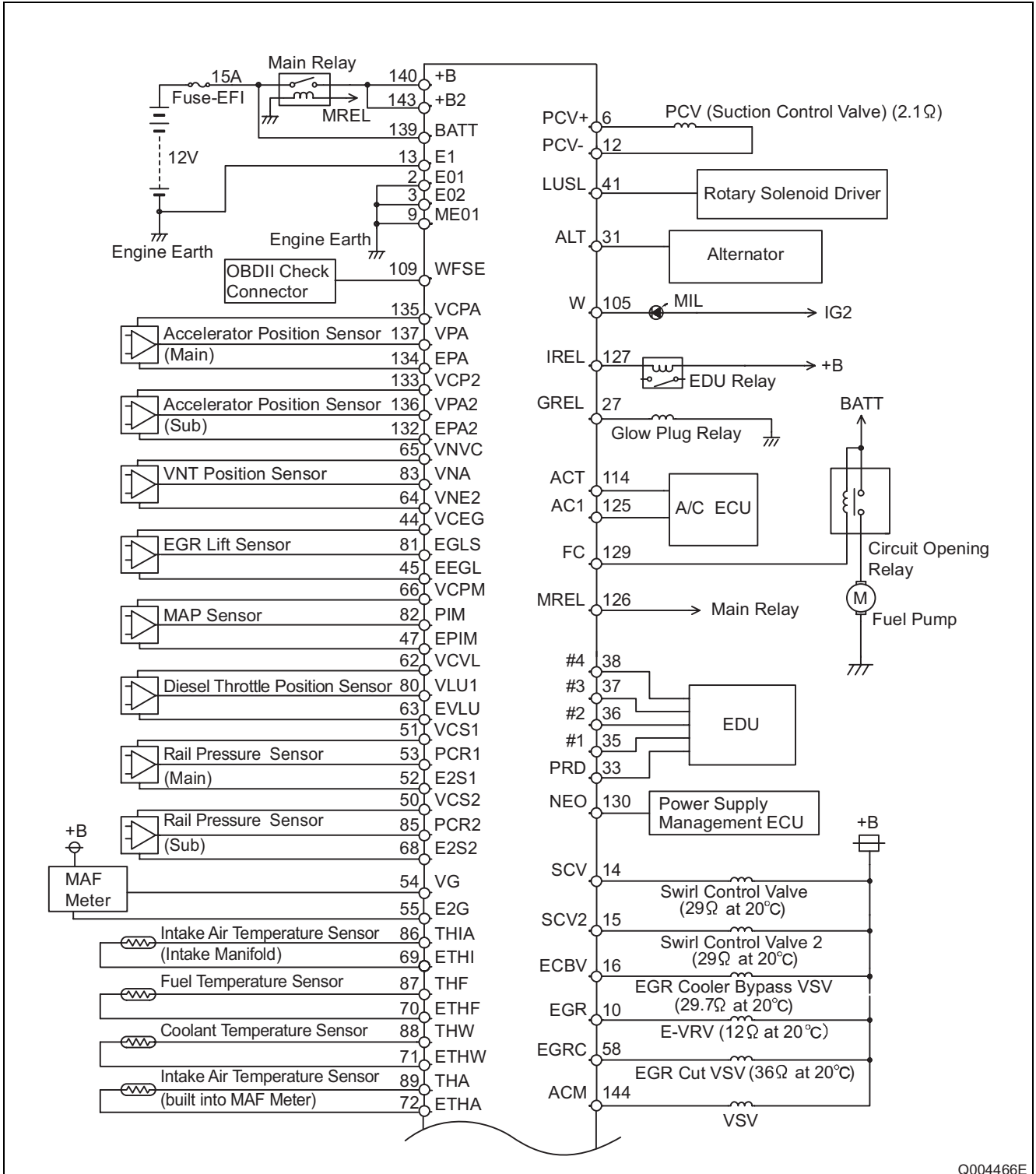
DTC		Detection Item
SAE Code	Malfunction Indicator Lamp (MIL)	
P0182	Yes	Fuel Temperature Sensor Low
P0183	Yes	Fuel Temperature Sensor High
P0190	Yes	Rail Pressure Sensor System Abnormality
P0191	Yes	Rail Pressure Sensor Characteristics Abnormality
P0192	Yes	Rail Pressure Sensor Low
P0193	Yes	Rail Pressure Sensor High
P0200	Yes	EDU Circuit Abnormality
P0299	Yes	VNT Closed Abnormality
P0335	Yes	Crankshaft Position Sensor Abnormality
P0339	No	Crankshaft Position Sensor Power Flicker
P0340	Yes	Camshaft Position Sensor Open Circuit
P0400	Yes	Exhaust Gas Recirculation (EGR) Flow Volume Abnormality
P0405	Yes	EGR Lift Sensor Low
P0406	Yes	EGR Lift Sensor High
P0488	Yes	EGR Throttle Motor System Abnormality
P0489	Yes	EGR E-VRV Low
P0490	Yes	EGR E-VRV High
P0500	Yes	Vehicle Speed Sensor System Abnormality
P0503	—	Vehicle Speed Sensor Power Flicker Noise
P0504	No	Stop Lamp Switch System Abnormality
P0516	—	Battery Temperature Sensor Low
P0517	—	Battery Temperature Sensor High
P0560	Yes	Battery Abnormality
P0571	—	Stop Lamp Switch (Open, Short)
P0575	—	Cruise Cancel Circuit Abnormality
P0606	Yes	Engine ECU Internal Abnormality
P0607	Yes	Control Module Performance
P060A	Yes	Engine ECU Monitor CPU Abnormality
P060B	Yes	Engine ECU Peripheral Circuit Abnormality
P0617	Yes	Starter Circuit High
P0627	Yes	Supply Pump SCV Abnormality (Open, Short)
P0724	Yes	Stop Lamp Switch Abnormality
P1229	Yes	Supply Pump Abnormality (Overfeed)
P1238	Yes	Injector Injection Abnormality
P1251	Yes	VNT Abnormality (Power Flicker)
P1264	Yes	VNT Driver Abnormality

DTC		Detection Item
SAE Code	Malfunction Indicator Lamp (MIL)	
P1271	Yes	Pressure Discharge Valve System Abnormality
P1272	Yes	Pressure Discharge Valve (Stuck Closed)
P1496	Yes	Intake Air Temperature Sensor Low
P1497	Yes	Intake Air Temperature Sensor High
P1550	—	Battery Current Sensor Abnormality
P1551	—	Battery Current Sensor Low
P1552	—	Battery Current Sensor High
P1570	—	Laser Sensor Abnormality
P1572	—	Laser Sensor Optical Axis Misalignment
P1575	—	Warning Buzzer Abnormality
P1578	—	Brake System Abnormality
P1601	Yes	Injector ID Code Abnormality, Unregistered
P1602	—	Battery Low Voltage
P1604	No	Poor Start Judgment
P1605	No	Unstable Idle
P1607	Yes	Cruise Control CPU Abnormality
P1611	Yes	Internal IC Abnormality
P1615	—	DSS1 ECU Communication Abnormality
P1616	—	Vehicle Control ECU Communication Abnormality
P1617	—	Vehicle Control ECU Abnormality
P1630	—	VSC ↔ ENG Communication Abnormality (VSC → ENG)
P1631	—	VSC ↔ ENG Communication Abnormality (ENG → VSC)
P2006	Yes	Swirl Control Valve Stuck Fully Closed Abnormality
P2009	Yes	Swirl Control Valve VSV Abnormality - Low
P2010	Yes	Swirl Control Valve VSV Abnormality - High
P2120	Yes	Accelerator Position Sensor No. 1 (Open)
P2121	Yes	Accelerator Position Sensor (Out of Range)
P2122	Yes	Accelerator Position Sensor No. 1 (Open) Low
P2123	Yes	Accelerator Position Sensor No. 1 (Open) High
P2125	Yes	Accelerator Position Sensor No. 2 (Open)
P2127	Yes	Accelerator Position Sensor No. 2 (Open) Low
P2128	Yes	Accelerator Position Sensor No. 2 (Open) High
P2138	Yes	Accelerator Position Sensor No. 1/ No. 2 Open
P2226	Yes	Atmospheric Pressure Sensor (Open)
P2228	Yes	Atmospheric Pressure Sensor Low
P2229	Yes	Atmospheric Pressure Sensor High

DTC		Detection Item
SAE Code	Malfunction Indicator Lamp (MIL)	
P245C	Yes	EGR Cooler Bypass Actuation VSV Low
P245D	Yes	EGR Cooler Bypass Actuation VSV High
P2501	—	Alternator Abnormality
P2563	Yes	VNT Position Sensor Characteristics Discrepancy
P2564	Yes	VNT Position Sensor 1 Open
P2565	Yes	VNT Position Sensor 1 Short
P2588	Yes	VNT Position Sensor 2 Open
P2589	Yes	VNT Position Sensor 2 Short
U0100	—	Vehicle Control ECU Communication Abnormality
U0101	Yes	TCM ECU CAN Communication Abnormality
U0122	—	VSC ↔ ENG Communication Abnormality (VSC → ENG)
U0123	—	Yaw Rate Sensor Communication Abnormality
U0126	—	Steering Sensor Communication Abnormality
U0235	—	Laser Sensor Communication Abnormality (Sensor → Vehicle ECU)
U1102	—	Laser Sensor Communication Abnormality (Vehicle ECU → Sensor)
U1104	—	DSS1 ECU Communication Abnormality

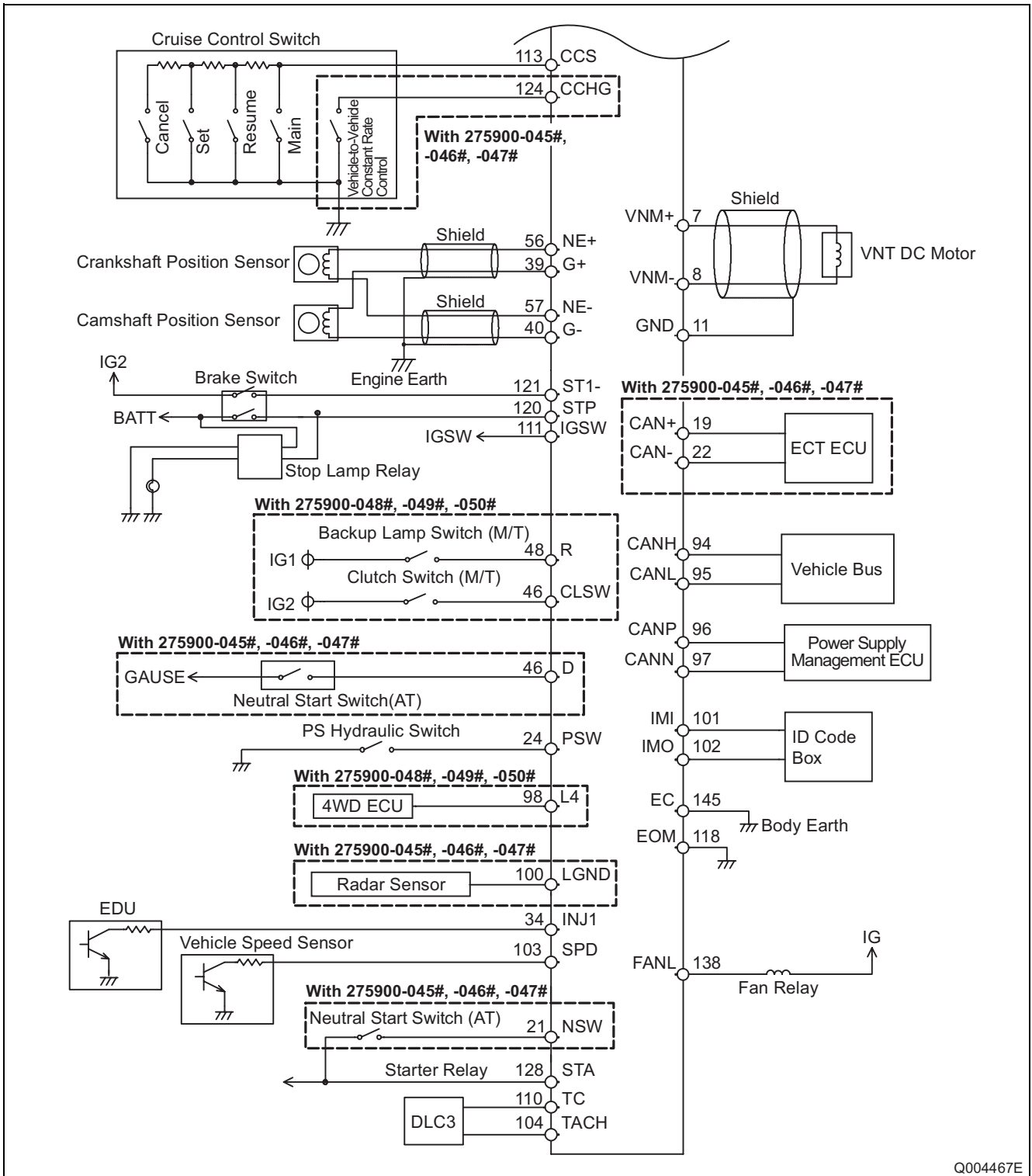
7. ENGINE ECU

7.1 LAND CRUISER PRADO



Q004466E

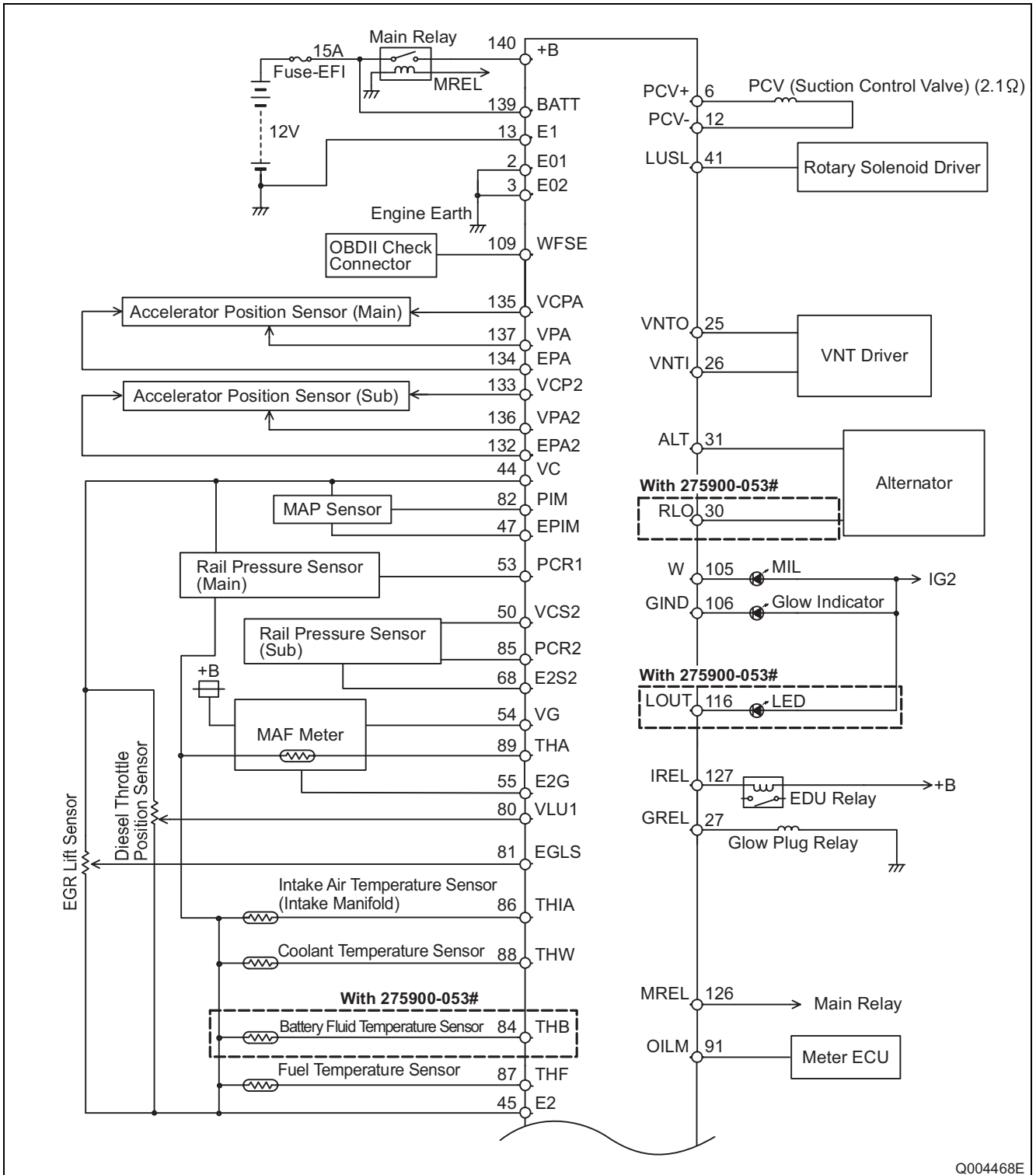
Engine ECU External Wiring Diagrams (1)



Q004467E

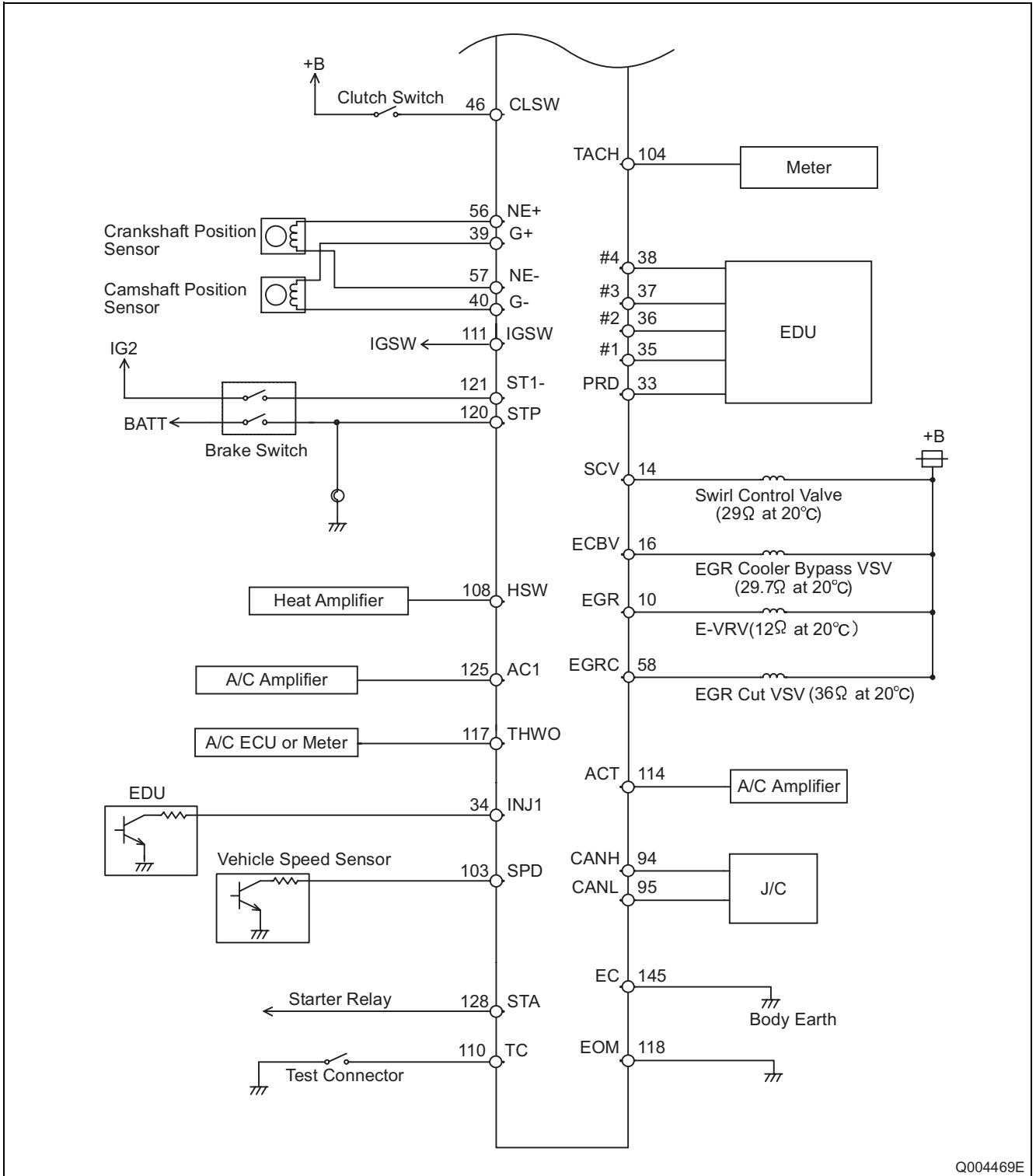
Engine ECU External Wiring Diagrams (2)

7.2 DYNA



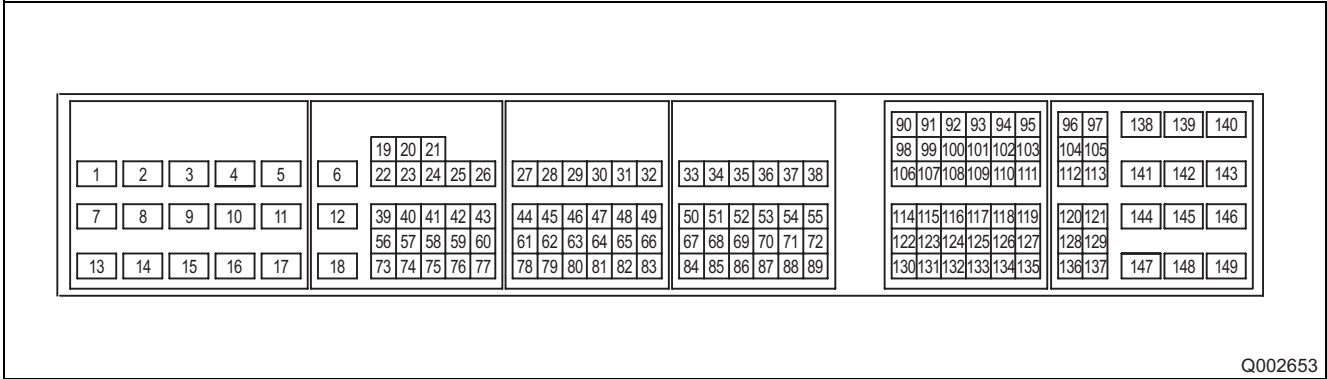
Q004468E

Engine ECU External Wiring Diagrams (1)



Q004469E

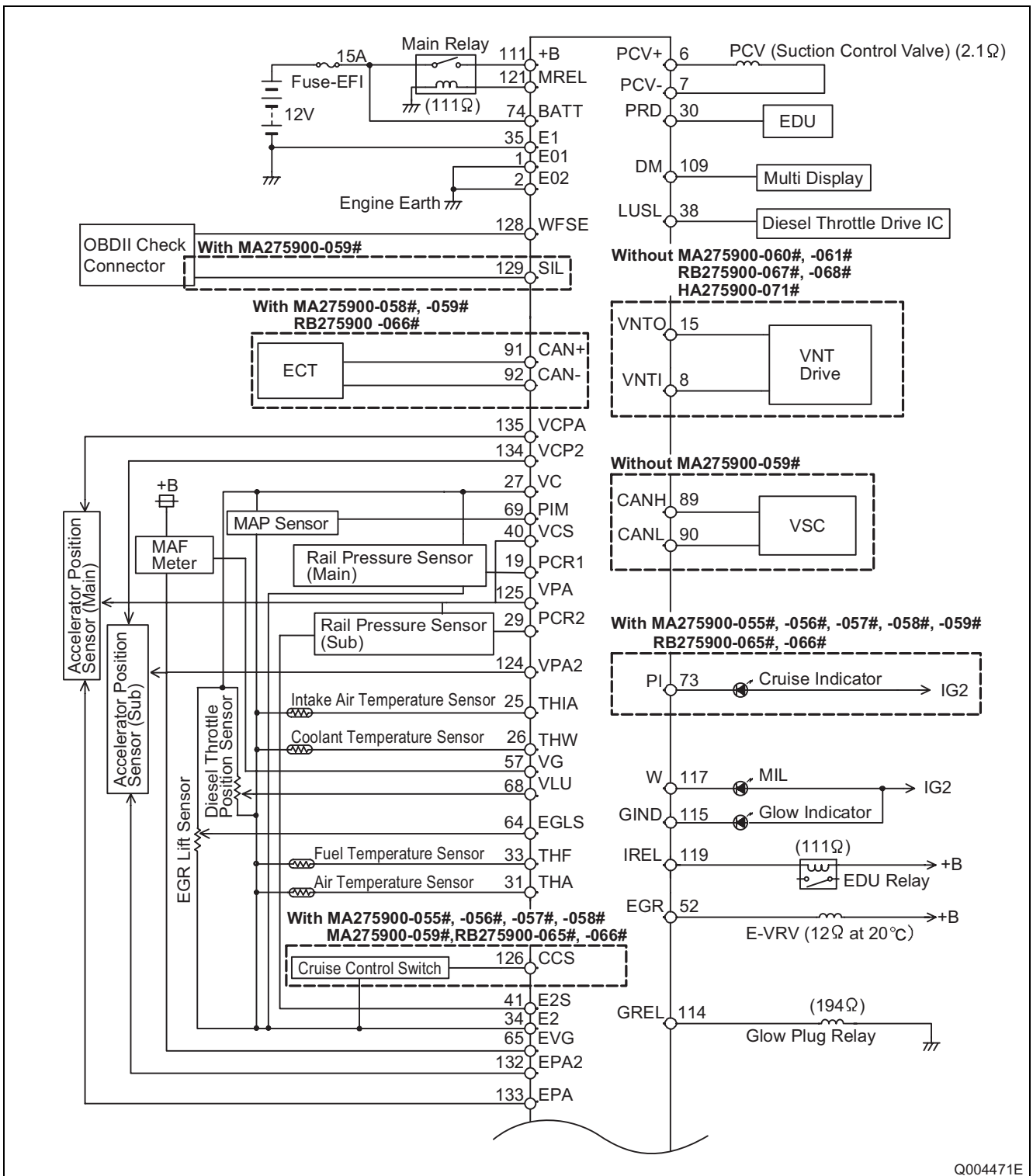
Engine ECU External Wiring Diagrams (2)



Q002653

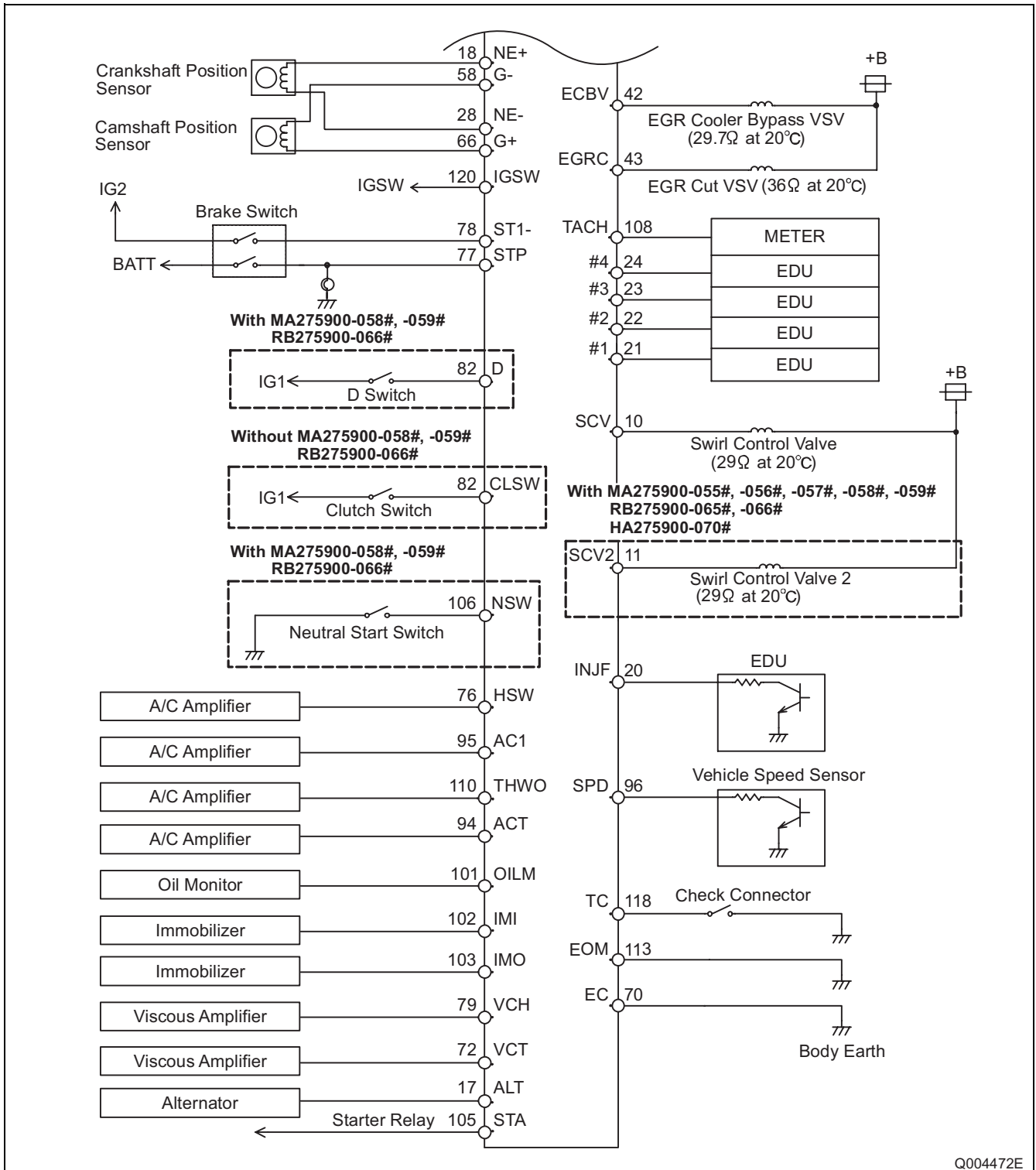
Engine ECU Connector Terminal Layout

7.3 IMV



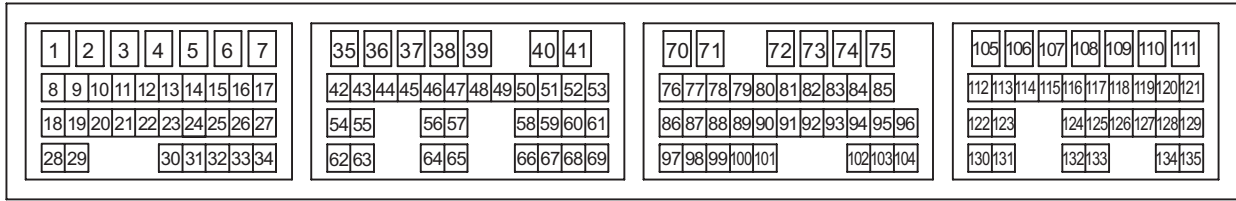
Q004471E

Engine ECU External Wiring Diagrams (1)



Q004472E

Engine ECU External Wiring Diagrams (2)



Q004470E

Engine ECU Connector Terminal Layout

