DENSO

MZR-CD2.2 Engine

COMMON RAIL SYSTEM (CRS) SERVICE MANUAL: Operation

Issued : February 2009
Revised : October 2009

Applicable Vehicle :

Manufacturer	Vehicle Name
MAZDA	MAZDA3
	MAZDA6
	CX-7

DENSO CORPORATION

00400689EA

Revision History

Date	Revision Contents
2009.10	• Added applicable vehicles and products. • Added system information for the CX-7. ✓ Sensor Operation ✓ Selective Catalytic Reduction (SCR) System ✓ DIAGNOSTIC TROUBLE CODES (DTC) ✓ Engine ECU External Wiring Diagrams ✓ ECU Connector Terminal Layout

Operation Section

1. PRODUCT APPLICATION INFORMATION

1.1 Outline

- The MAZDA3 has undergone a full model change. In addition, the engine used in the MAZDA6 has been changed. As a result, the MZR-CD 2.2 engine is now used in both the MAZDA3, and MAZDA6. Further, the Common Rail System (CRS) has been modified due to the aforementioned engine change. For CRS basics, refer to the "COMMON RAIL SYSTEM SERVICE MANUAL -OPERATION (Doc ID:00400534EA)". Modifications made due to the model change are listed below.
  - Maximum injection pressure increased to 200 MPa.
  - Run Dry Prevention (RDP) control added.
  - Microinjection quantity learning control added.
  - Diesel Particulate Filter (DPF) system added.
- As a result of a model change to the MAZDA CX-7 beginning from October 2009, the CX-7 now also uses the MZR-CD 2.2 engine. The MZD-CD 2.2 engine in the CX-7 is equipped with the Selective Catalytic Reduction (SCR) system. The SCR system dramatically reduces the quantity of NOx exhaust, and achieves superior environmental protection functionality suited to the stringent European emission standards stipulated in the "EURO 5" regulations.
  In comparison to the CRS used in the MAZDA3 and MAZDA6, the CRS for the CX-7 includes the following additional system. An explanation of this system has been added to this manual.
  - Refer to [Selective Catalytic Reduction (SCR) System] on P1-29
- Unless otherwise noted, the explanations for each control and part applies to all three vehicles mentioned in this manual.

1.2 Applicable Vehicles

Model Name	Engine	Engine Displacement	Destination	Line Off Period
MAZDA3	MZR-CD 2.2	2.2 L	Europe	January 2009
MAZDA6				May 2008
CX-7				October 2009

1.3 System Component Part Numbers

MAZDA3/MAZDA6

Part Name	DENSO Part Number	Manufacturer Part Number	Remarks
Supply Pump	294000-062#	R2AA13800	
Injector	295050-001#	R2AA13H50	
Rail	095440-115#	R2AA13GC0	
Engine ECU	275800-837#	R2AJ18881	MAZDA3 low output engine
	275800-838#	R2AK18881	MAZDA3 high output engine
	275800-839#	R2AW18881	MAZDA3 for Australia
	275800-914#	R2AA18881	MAZDA6 low output engine
	275800-915#	R2AB18881	MAZDA6 intermediate output engine
	275800-916#	R2AC18881	MAZDA6 high output engine
	275800-917#	R2AG18881	MAZDA6 for Australia
Manifold Absolute Pressure (MAP) Sensor	079800-744#	RF7J18211	
Crankshaft Position Sensor (NE)	949979-191#	R2AA18221A	
Camshaft Position Sensor (TDC)			
Mass Air Flow (MAF) Meter	197400-201#	ZL0113215	
Coolant Temperature Sensor	179700-022#	B59318840A	
Exhaust Temperature Sensor	265600-244#	R2AJ187G0A	MAZDA3
	265600-245#	R2AK187G0A	
	265600-199#	RF8G187G0	MAZDA6
	265600-200#	RF8H187G0	
A/F Sensor	211200-437#	R2AJ188G1A	MAZDA3
	211200-438#	R2AA188G1	MAZDA6
Differential Pressure Sensor	104990-172#	R2AJ182B5	MAZDA3
	104990-153#	RF8G182B5	MAZDA6
Accelerator Pedal Module	198800-348#	CC3041600	
Diesel Throttle	197920-007#	R2AA136B0	

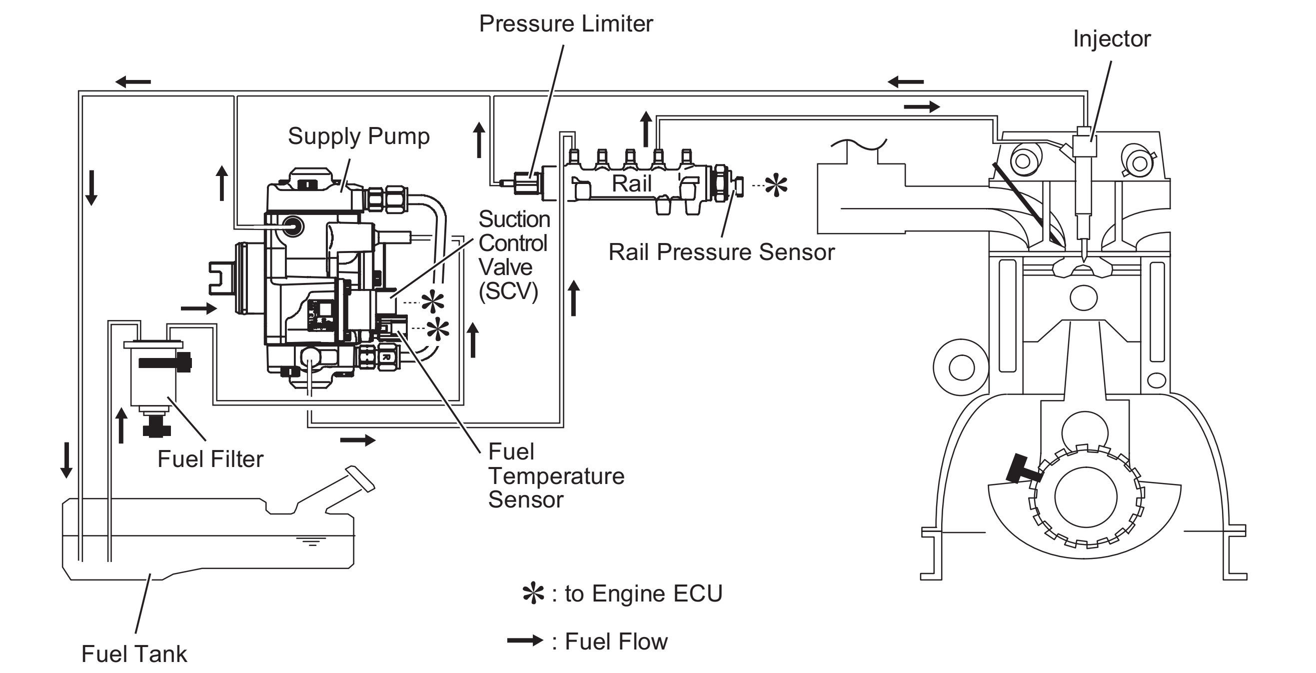
CX-7

Part Name	DENSO Part Number	Manufacturer Part Number	Remarks
Supply Pump	294000-062#	R2AA13800	
Injector	295050-001#	R2AA13H50	
Rail	095440-115#	R2AA13GC0	
Engine ECU	275800-949#	R2AX18881D	
Manifold Absolute Pressure (MAP) Sensor	079800-744#	RF7J18211	
Crankshaft Position Sensor (NE)	949979-191#	R2AA18221	
Camshaft Position Sensor (TDC)			
Mass Air Flow (MAF) Meter	197400-224#	L3K913215	
Coolant Temperature Sensor	179700-022#	B59318840A	
Exhaust Temperature Sensor 1	265600-261#	R2AX187G0B	
Exhaust Temperature Sensor 2	265600-262#	R2BA187G0B	
Exhaust Temperature Sensor 3	265600-263#	R2BB187G0B	
A/F Sensor	211200-441#	R2AX188G1	
Differential Pressure Sensor	104990-155#	R2AX182B5	
Accelerator Pedal Module	198800-736#	L20641600A	Right-hand driver vehicles
	198800-739#	EG2141600A	Left-hand driver vehicles
Diesel Throttle	197920-007#	R2AA136B0	

2. SYSTEM OUTLINE

2.1 Configuration and Operation

- The primary CRS components are shown in the figure below.



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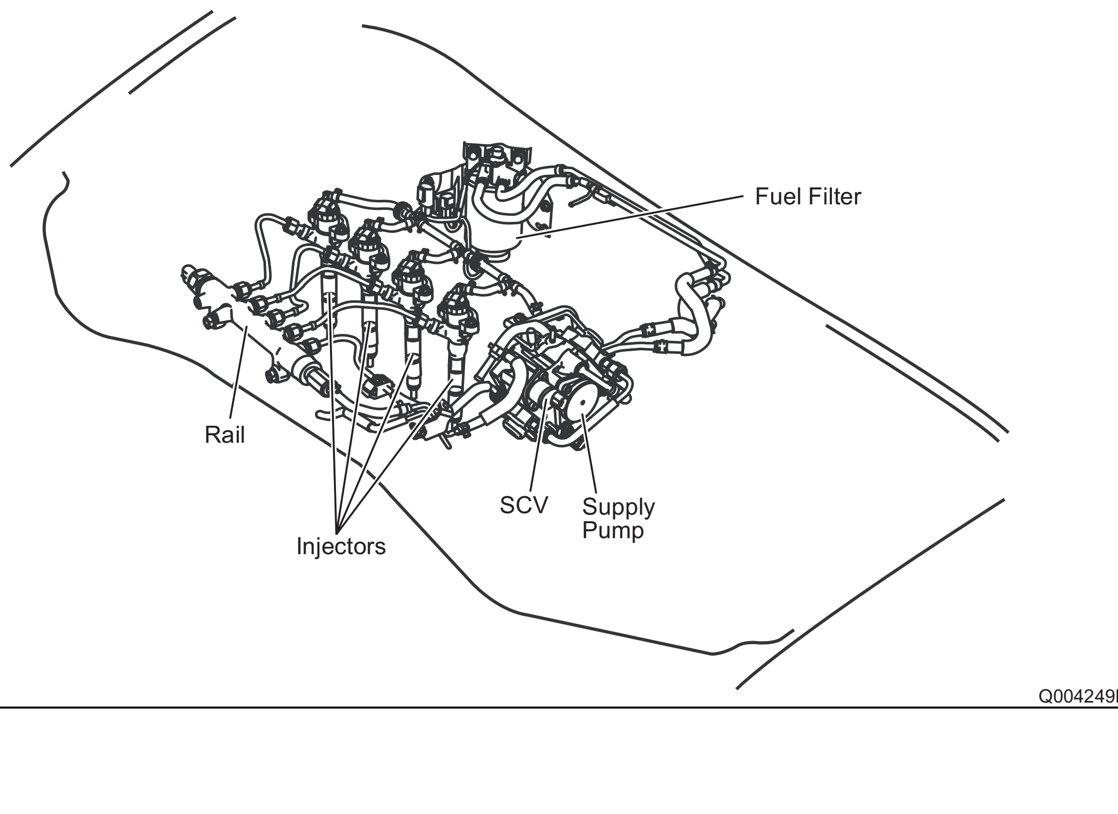
2.2 Component Mounting Locations

- The mounting locations for primary CRS system components are shown in the figure below.



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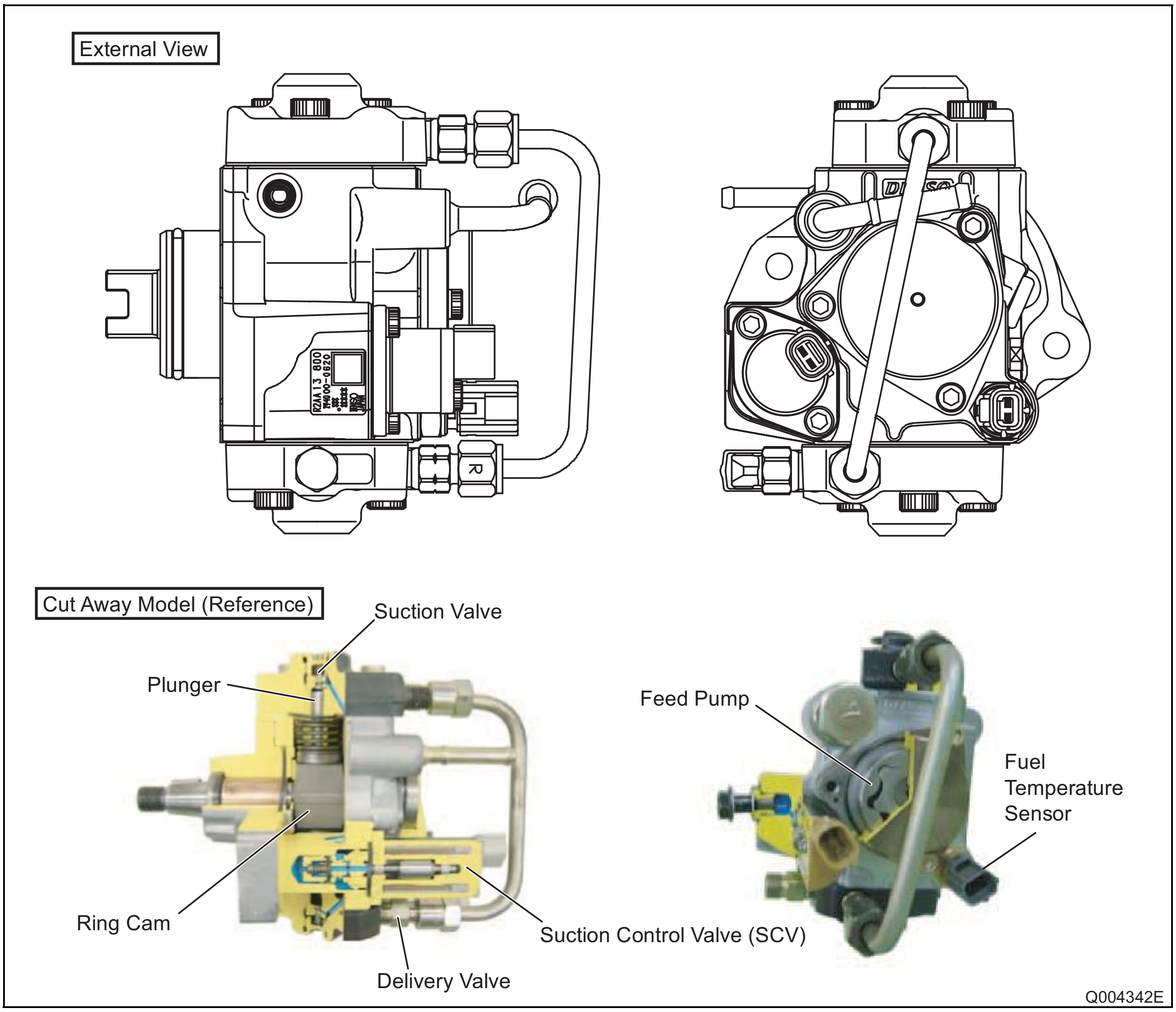
3. SUPPLY PUMP

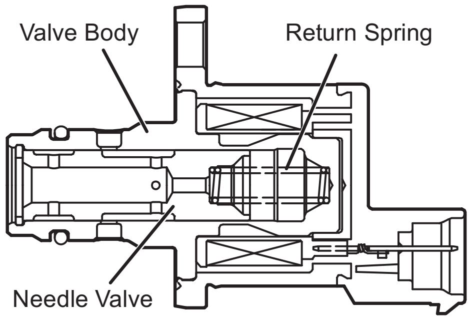
3.1 Outline

- The supply pump equipped with the Mazda3 and Mazda6 uses a compact (SV2) Suction Control Valve (SCV), the same as prior to the model change.



3.2 Suction Control Valve (SCV)

- The SCV is a linear type solenoid valve. The length of time that the ECU applies current to the SCV is controlled (duty cycle control) in order to regulate the volume of fuel suctioned into the pumping area. Since only the volume of fuel required for the target rail pressure is drawn in, the drive load on the supply pump decreases, thus resulting in improved fuel economy.



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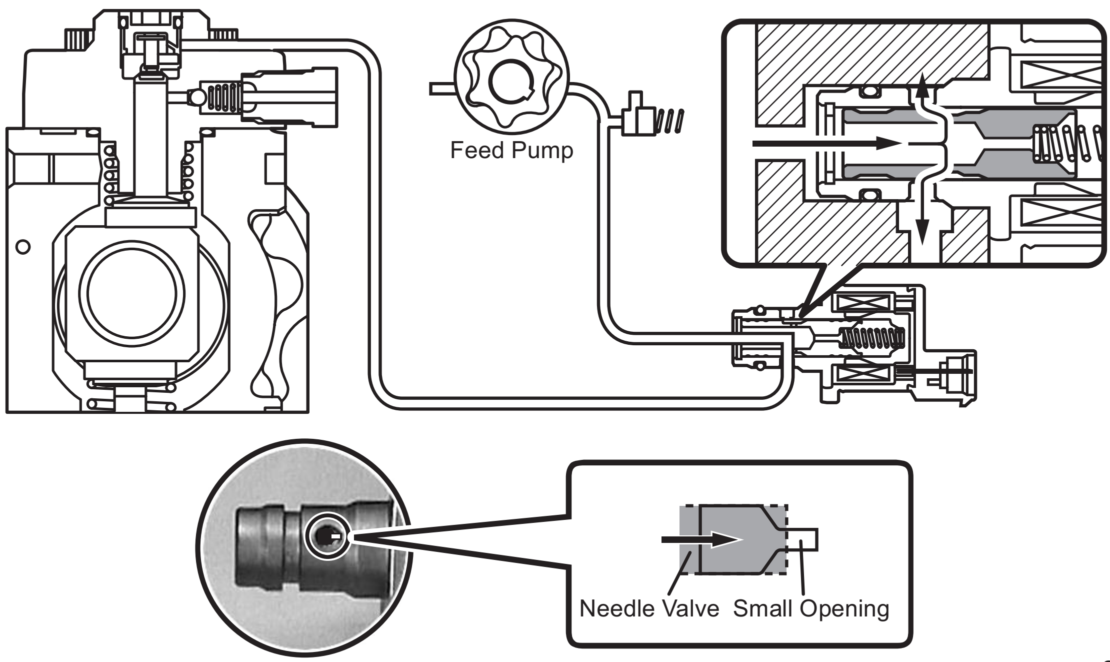
(1) SCV opening small (duty on time long - Refer to the "Relationship between actuation signal and current" figure.)

- When the SCV opening is small, the fuel suction area is kept small, thereby decreasing the transferable fuel volume.



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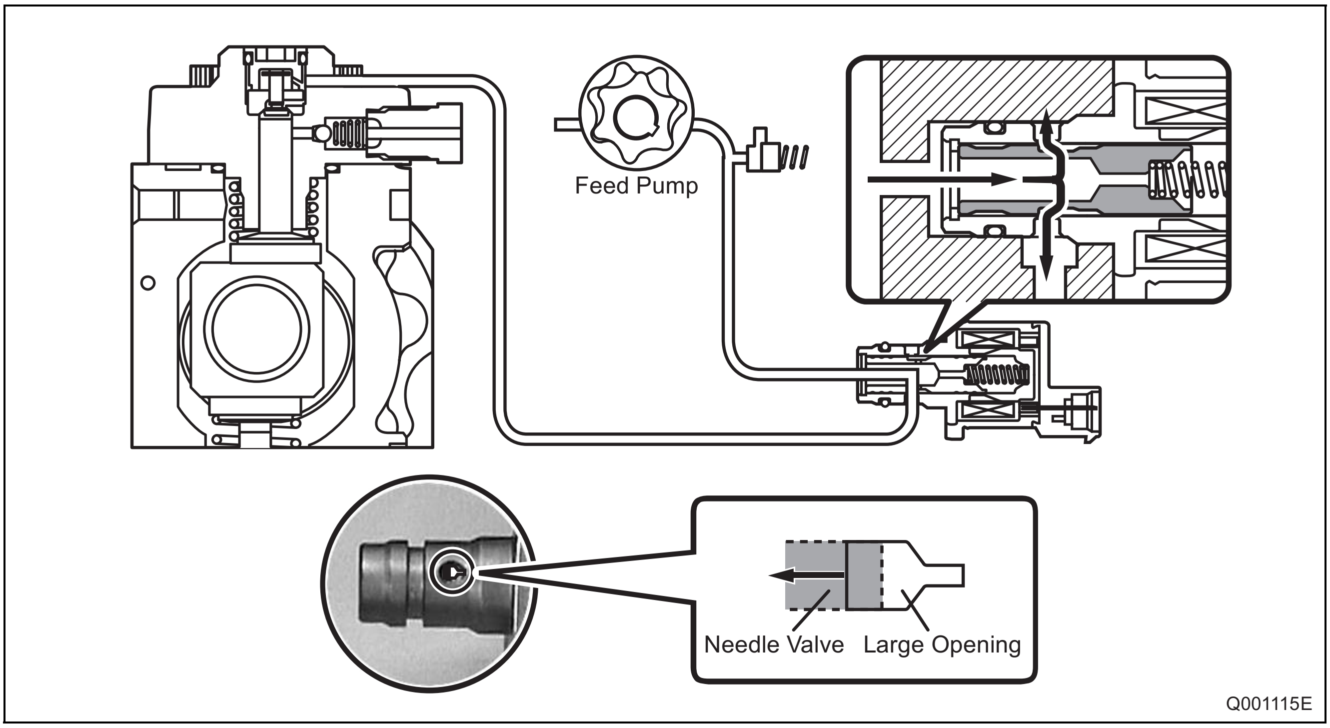
(2) SCV opening large (duty on time short - Refer to the "Relationship between actuation signal and current" figure.)

- When the SCV opening is large, the fuel suction area is kept large, thereby increasing the transferable fuel volume.



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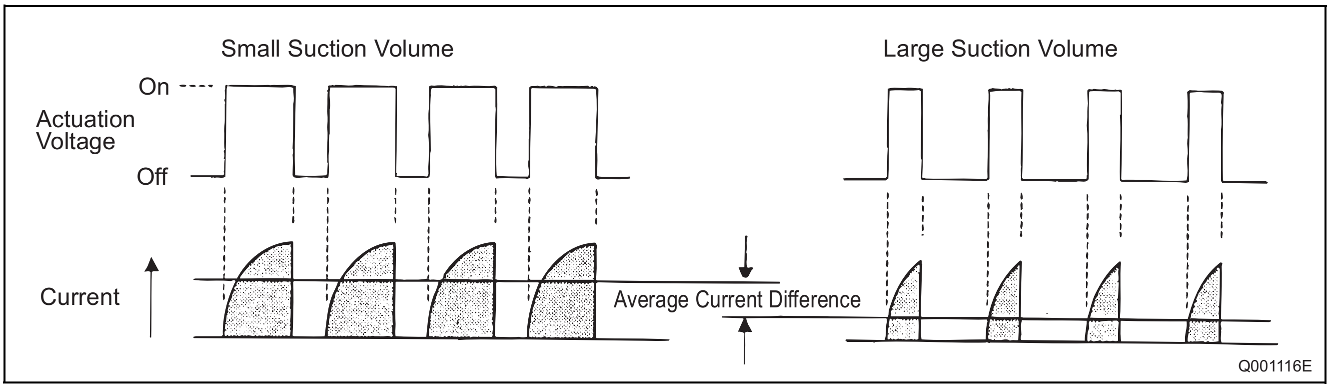
(3) Relationship between actuation signal and current



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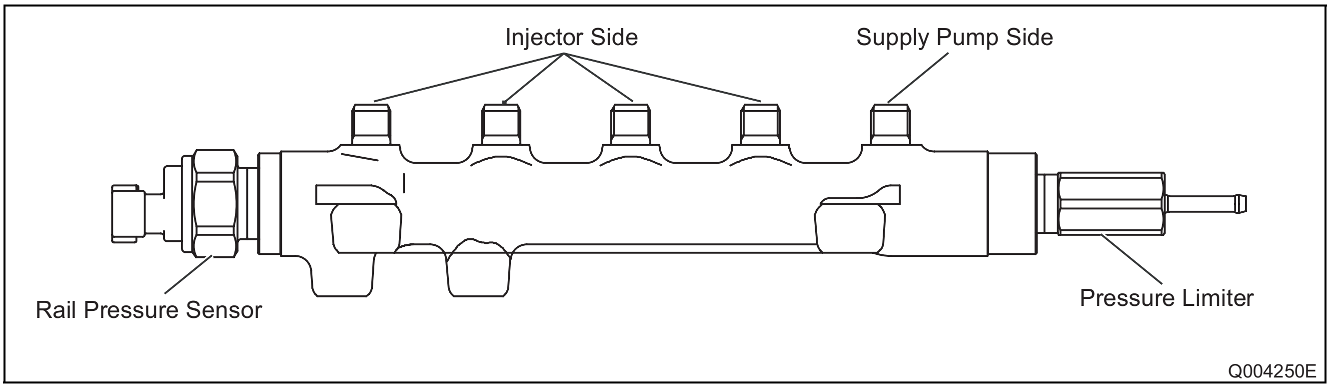
4. RAIL

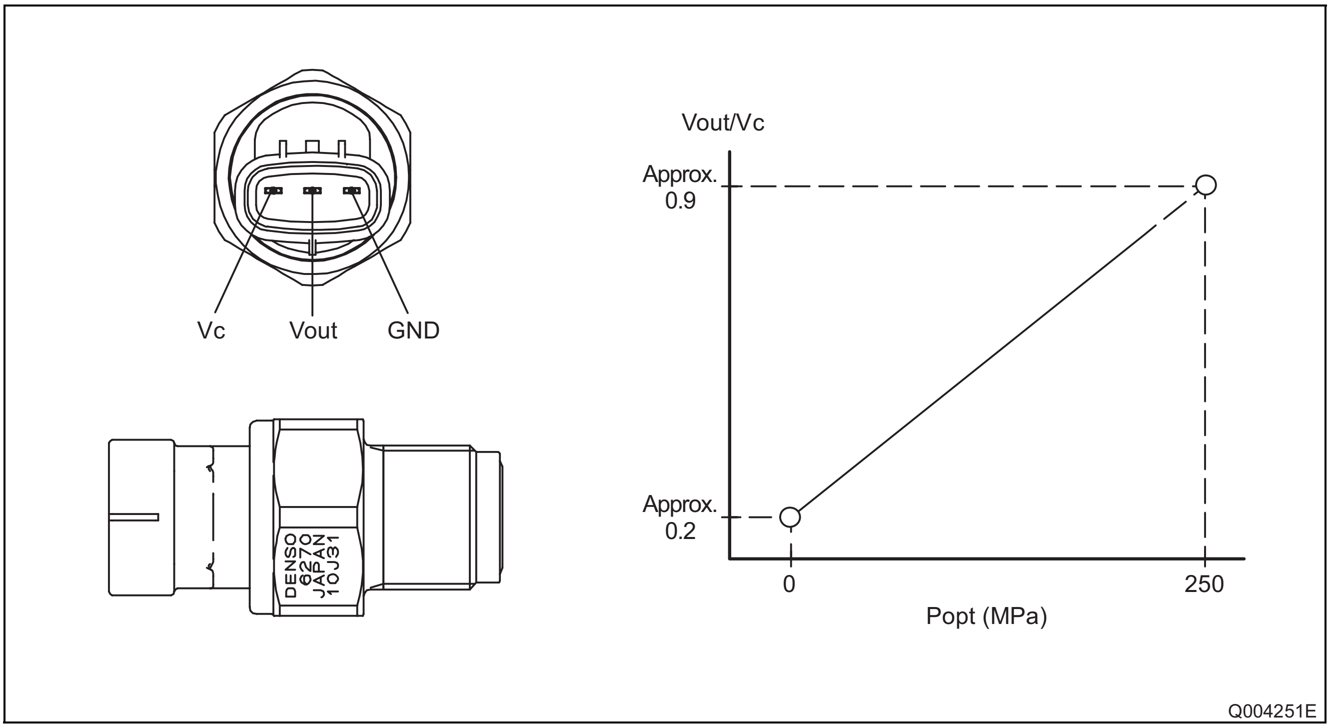
4.1 Outline

- The rail stores high-pressure fuel delivered from the supply pump for distribution to the individual injector for each cylinder. A rail pressure sensor, and pressure limiter are attached to the rail.
- The rail pressure sensor detects the fuel pressure within the rail, and sends a corresponding signal to the engine ECU. The engine ECU then controls fuel pressure based on the aforementioned signal information. The pressure limiter releases fuel from the rail when the rail internal pressure becomes abnormally high.



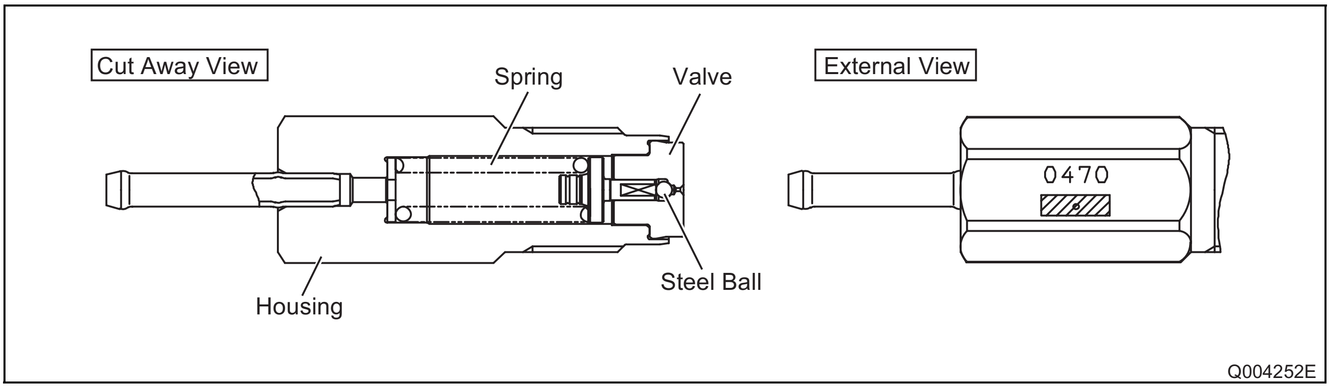
4.2 Rail Pressure Sensor

- The rail pressure sensor detects the fuel pressure in the rail, and sends a corresponding signal to the engine ECU. The sensor is made from a semiconductor that uses the Piezo resistive effect to detect changes in electrical resistance based on the pressure applied to the elemental silicon. In comparison to the old model, the current sensor is compatible with high pressure.



4.3 Pressure Limiter

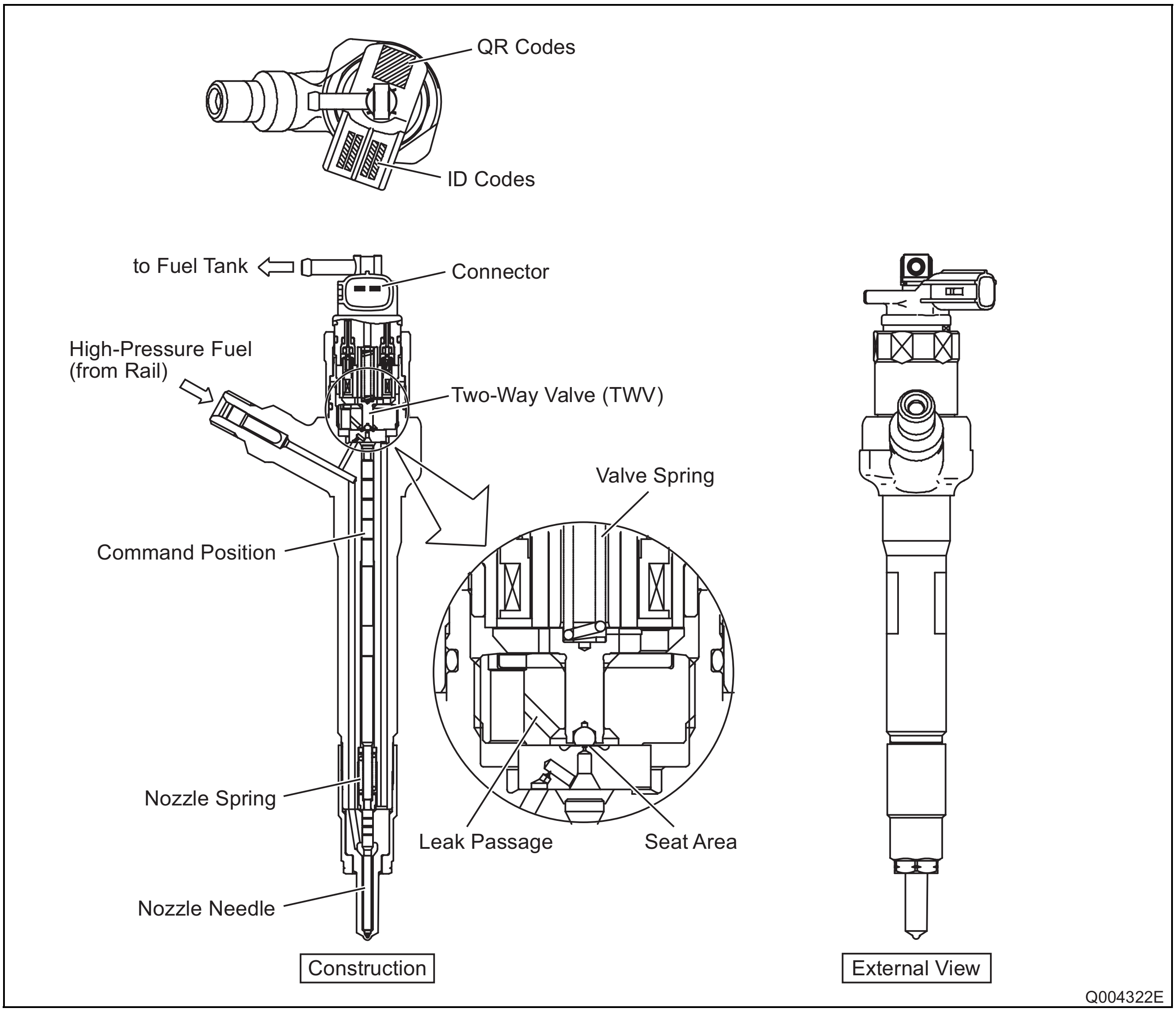
- The pressure limiter releases fuel when the internal rail pressure becomes abnormally high. The pressure limiter opens when internal pressure reaches 241 MPa (2458 kg/cm2), and closes when rail pressure reaches a given set pressure. Fuel released from the pressure limiter is returned to the fuel tank.



5. INJECTOR

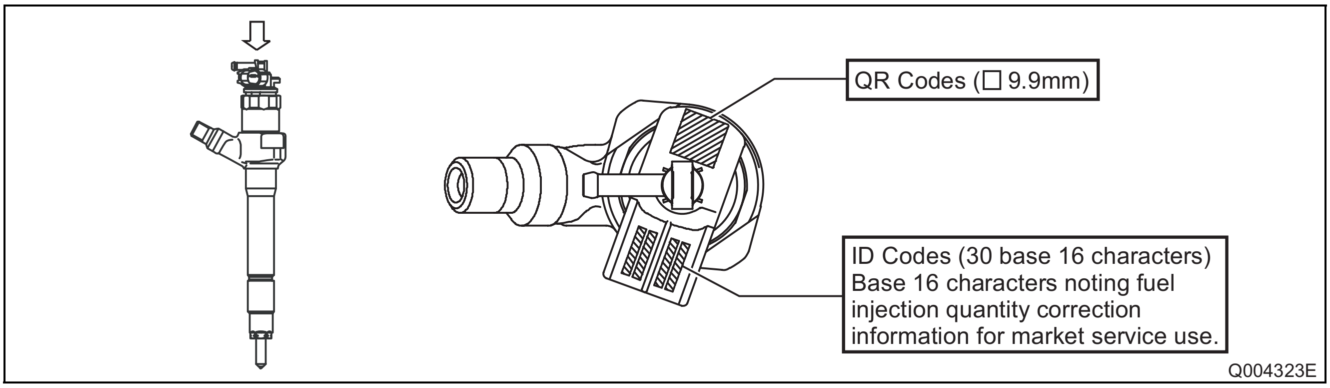
5.1 Outline

- The G3 type injectors equipped in the MAZDA3, MAZDA6 and CX-7 can inject fuel at extremely high pressure (200 MPa). As a result, the atomization of the fuel mist from the nozzle has been improved, leading to increased combustion efficiency, and reduced exhaust gas quantity.

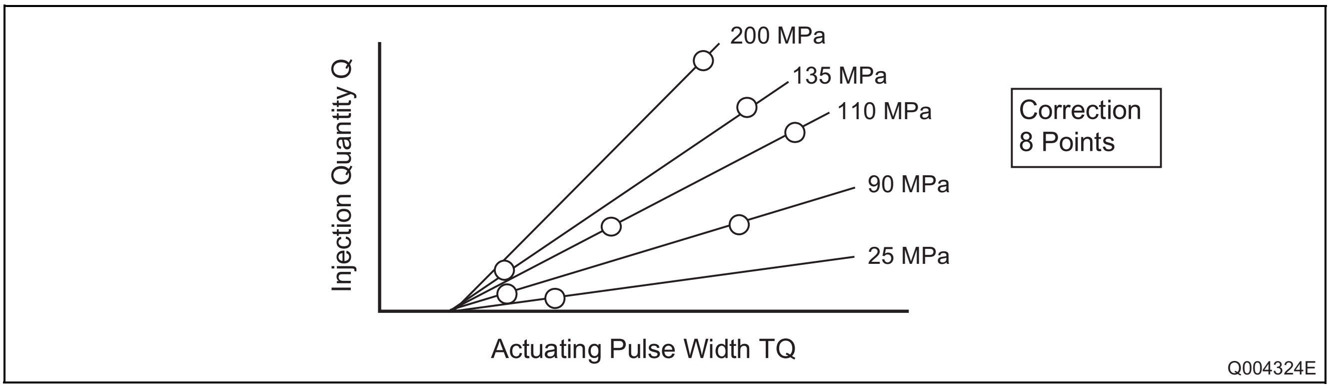


5.2 Quick Response (QR) Codes

- Conventionally, injectors were corrected during replacement using a correction resistor. However, QR codes have been adopted to improve injection quantity precision.

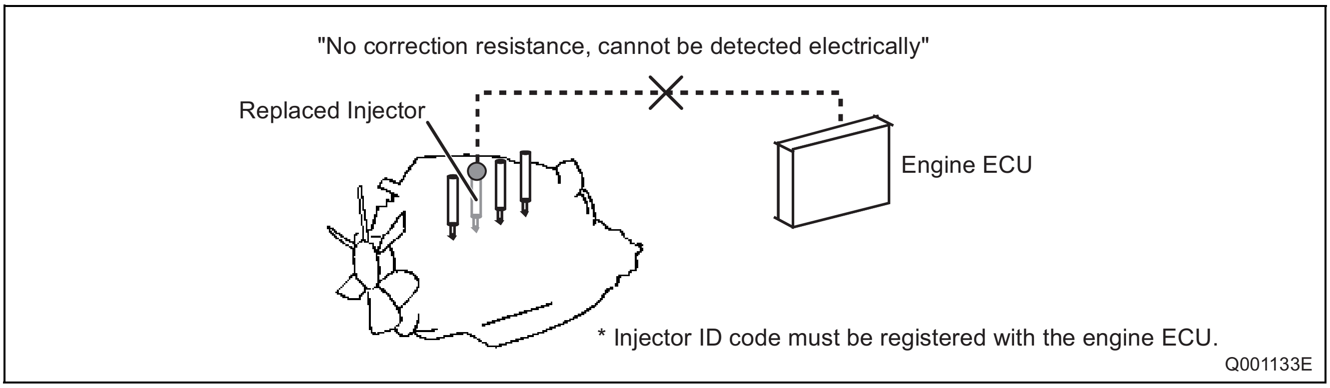


- QR codes have resulted in a substantial increase in the number of fuel injection quantity correction points, greatly improving precision. The characteristics of the engine cylinders have been further unified, primarily contributing to improvements in combustion efficiency, and reductions in exhaust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

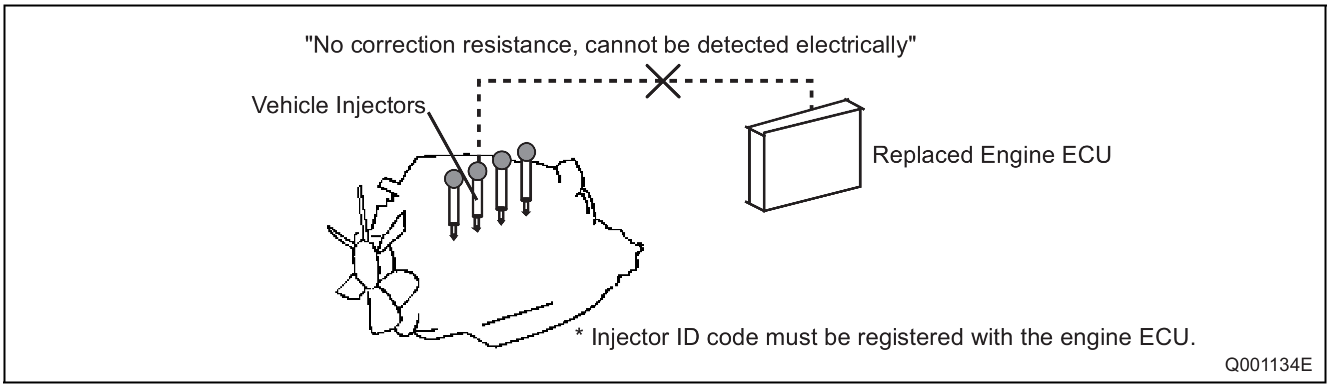


(1) Repair procedure changes (reference)

- 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 malfunctions such as rough idling and noise will result). The ID codes are registered in the ECU at a MAZDA dealer using approved MAZDA tools.



Injector Replacement

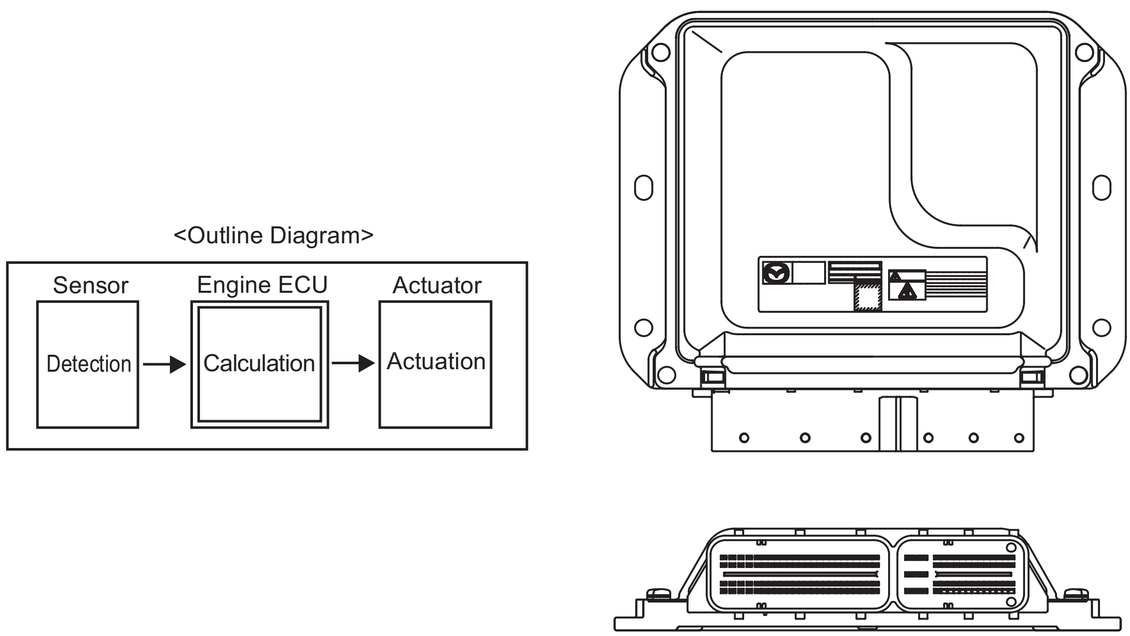


Engine ECU Replacement

6. OPERATION OF CONTROL SYSTEM COMPONENTS

6.1 Engine Electronic Control Unit (ECU)

- The engine ECU is the command center that controls the fuel injection system, as well as overall engine operation.



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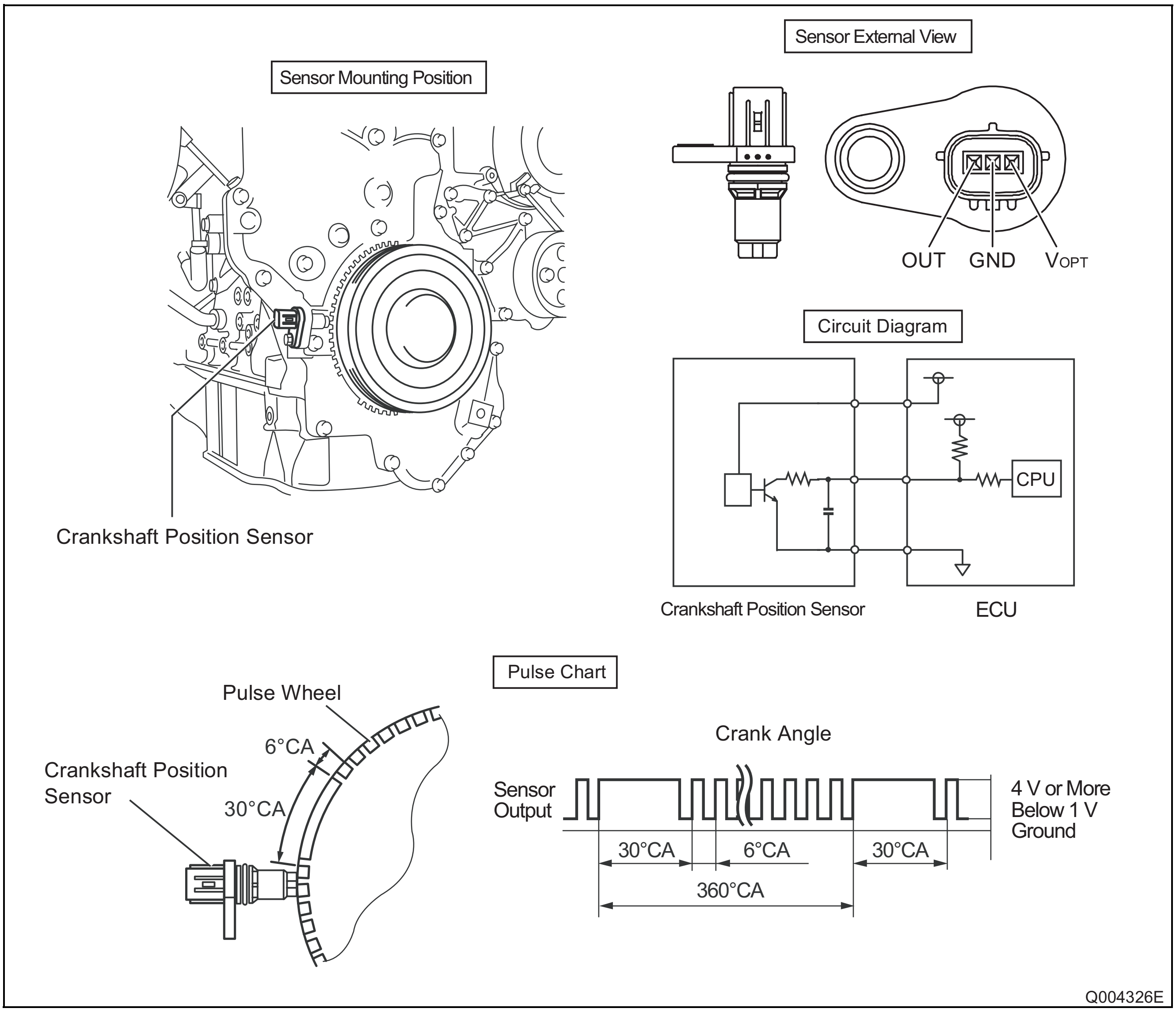
6.2 Sensor Operation

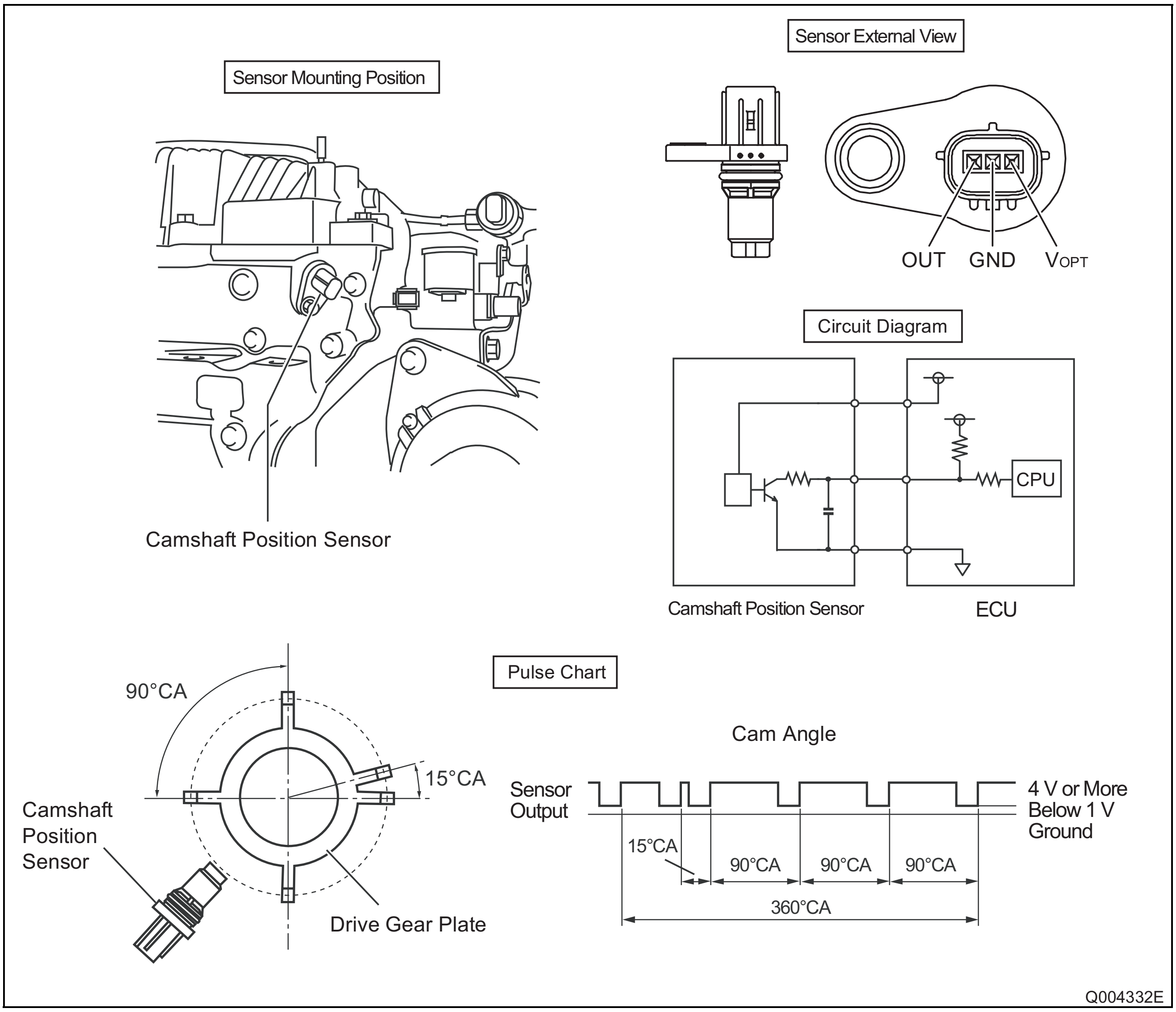
(1) Crankshaft position sensor (NE sensor)

- The pulse wheel attached to the crankshaft pulley has 56 projections and spaces with 6° of crank angle between each projection.
- The NE sensor consists of an IC with an integrated Magneto Resistance Element (MRE) and signal processing circuit, as well as a magnet. Sensor output signal reliability has been improved by using the MRE, resulting in the detection signal amplitude being wider compared to the Hall element.
- Signal detection utilizes special characteristics of the MRE to change the electrical resistance corresponding to the magnetic field and magnetic flux changes.
- The change in magnetic flux detected by the MRE (MRE output) is turned into short waves or rectangular waves at the signal processing circuit, and then inputted to the ECU as a sensor output signal.
- If the NE sensor is removed, installed, or replaced, magnetized objects such as metal shavings adhering to the sensor may cause fluctuations in the magnetic flux of the MRE. As a result, engine control may be adversely affected due to abnormal sensor output.



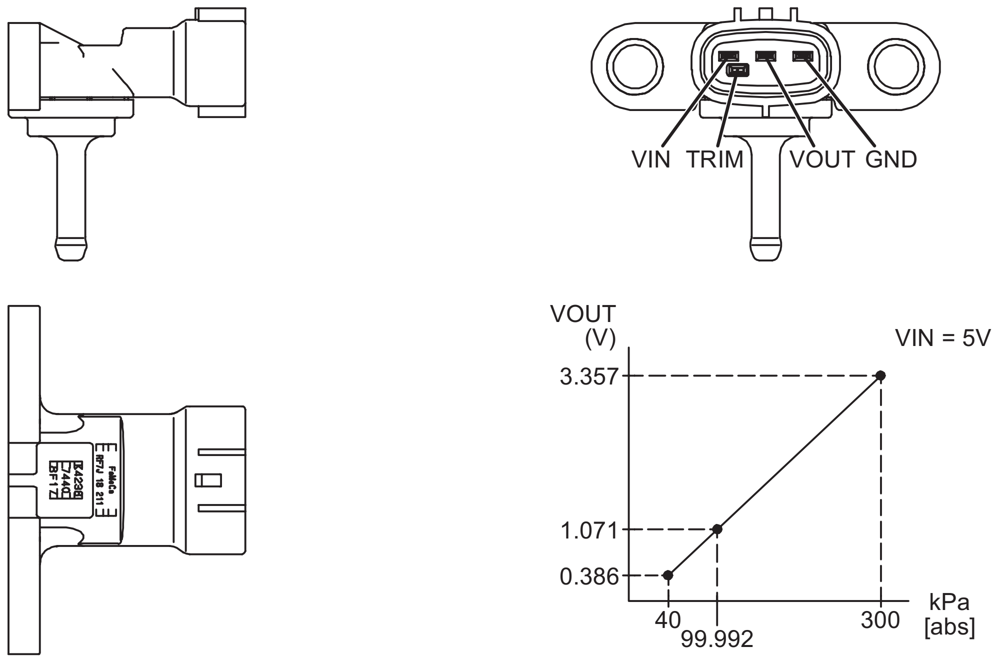
(2) Camshaft position sensor (TDC sensor)

- The TDC sensor consists of an IC with an integrated Magneto Resistance Element (MRE) and signal processing circuit, and a magnet. Sensor output signal reliability has been improved by using the MRE, resulting in the detection signal amplitude being wider compared to the Hall element.
- Signal detection utilizes special characteristics of the MRE to change the electrical resistance corresponding to the magnetic field and magnetic flux changes.
- The change in magnetic flux detected by the MRE (MRE output) is turned into short waves or rectangular waves at the signal processing circuit, and then inputted to the ECU as a sensor output signal.
- Five pulses are detected for every one rotation of the camshaft via the projections on the drive gear plate (component with drive gear) installed on the rear of the camshaft.
- If the TDC sensor is removed, installed, or replaced, magnetized objects such as metal shavings adhering to the sensor may cause fluctuations in the magnetic flux of the MRE. As a result, engine control may be adversely affected due to abnormal sensor output.



(3) Manifold Absolute Pressure (MAP) sensor

- The MAP sensor is a semiconductor type pressure sensor, which utilizes the electrical resistance of the silicon element. The electrical resistance changes with the fluctuations in the pressure applied to the silicon element.



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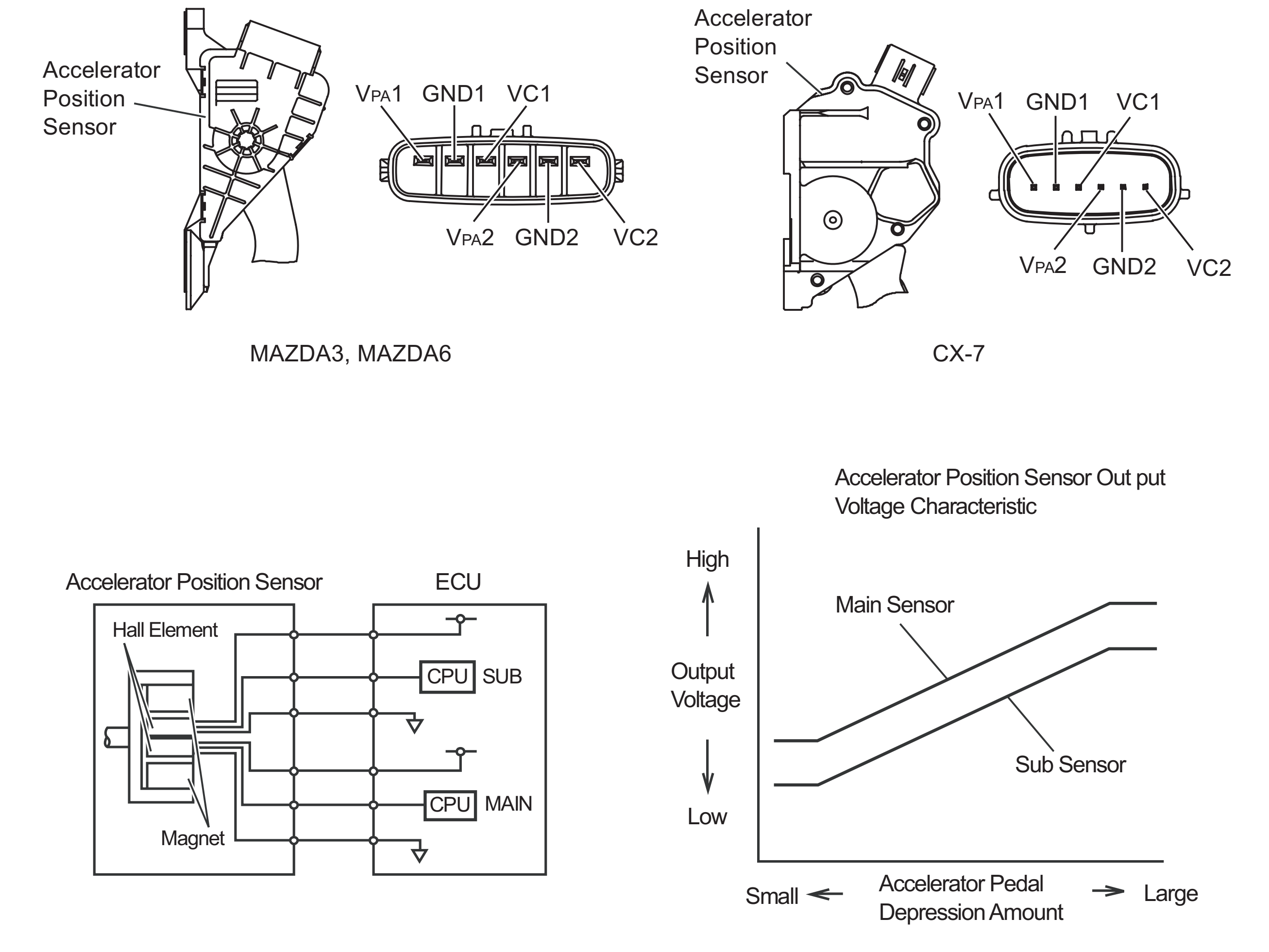
(4) Accelerator pedal module

- The accelerator pedal module is a single unit consisting of the accelerator position sensor, and accelerator pedal.
- A Hall element sensor is used for the detecting element. Durability is improved through the use of a non-contact type sensor.
- There are both main and sub accelerator position sensors, and the accelerator position is detected by both the main and sub systems.
- As a result, even if one of the sensors malfunctions, the correct accelerator position can be detected.



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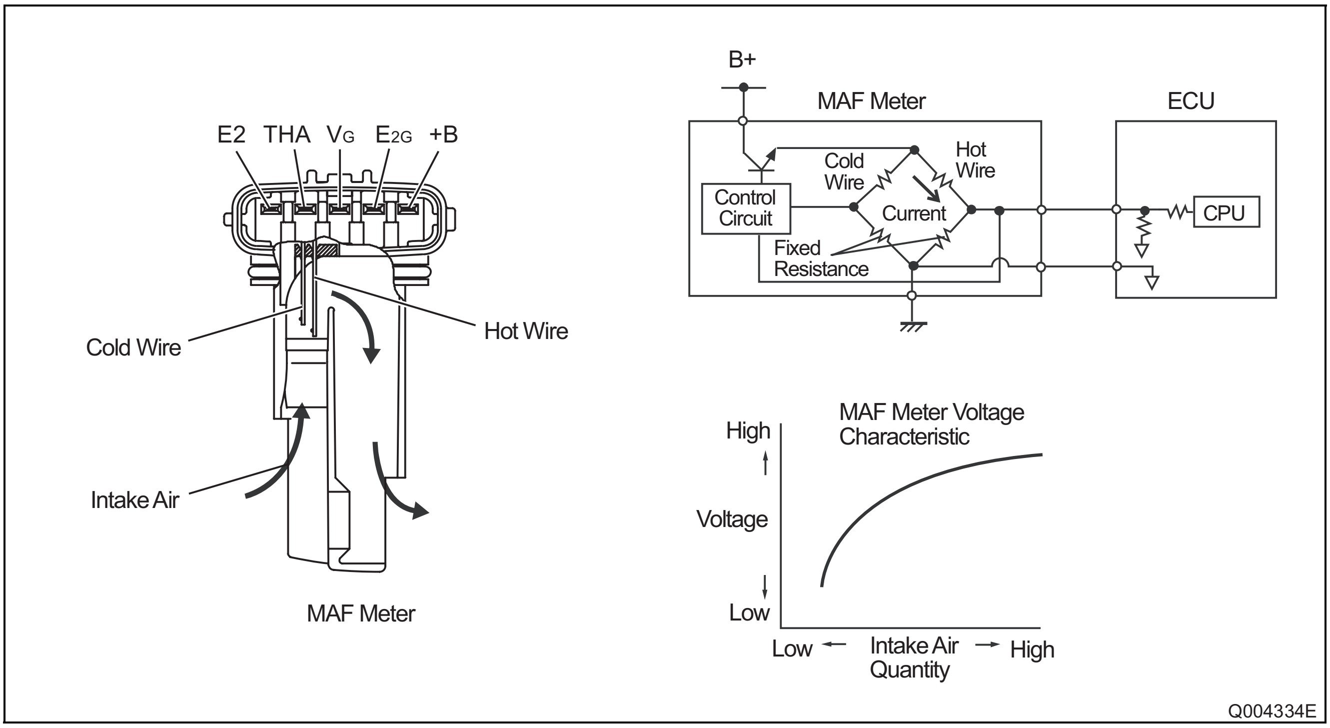
(5) Mass Air Flow (MAF) meter

- The MAF meter is attached to the air cleaner.
- The MAF meter is built into the intake air temperature sensor.
- The MAF meter converts the mass intake air flow quantity into a voltage.
- When the temperature of the metal in the sensor decreases, sensor resistance lowers. Using this characteristic, the hot wire captures heat from the flow of intake air, and converts the intake airflow quantity to a voltage.
- The cold wire converts intake air density to a voltage using the ambient temperature of the cold wire. This conversion is accomplished by using the characteristic of air whereby the intake air density decreases due to the increase in intake air temperature.
- The voltages obtained by the hot wire (intake airflow amount) and the cold wire are compared. The electric potential is then stabilized by supplying the voltage difference to the transistor. The voltage supplied to the hot wire is then output as the mass intake air flow quantity.



7. CONTROL SYSTEM

7.1 Outline

(1) Sensor system

Sensor Name	Function	Fuel Injection	Rail Pressure	Intake Restriction	EGR	VGT	DPF
Mass Air Flow (MAF) Sensor	Uses a hot wire to detect the intake airflow rate.				○		
Air Temperature Sensor	Located in the air flow meter, this sensor detects the intake air temperature.	○	○	○	○	○	○
Intake Air Temperature Sensor	Detects the intake WAF sensor after the turbocharger.	○			○	○	
Coolant Temperature Sensor	Detects the water temperature.	○	○	○	○	○	○
Rail Pressure Sensor	Detects the fuel pressure in the rail.	○	○				
Fuel Temperature Sensor	Detects the fuel temperature in the supply pump.	○	○				
MAP Sensor	Detects the intake air pressure.	○		○	○	○	○
Air Pressure Sensor	Detects the air pressure.	○		○	○	○	○
Accelerator Position Sensor	Attached to the accelerator pedal, this sensor detects the position of the accelerator pedal.	○		○	○	○	○
Crankshaft Position Sensor (NE sensor)	Detects the engine speed based on the crankshaft position.	○	○	○	○	○	○
Camshaft Position Sensor (TDC sensor)	Identifies the cylinder based on the rotation of the rotor attached to the camshaft.	○					
Starter Signal	Starter voltage signal during starting.	○	○	○	○	○	○
Vehicle Speed Sensor	Detects the vehicle speed.	○			○		○
A/F Sensor (UHEGO)	Detects the exhaust gas A/F value.	○			○		○
Differential Pressure Sensor	Detects pressure both before and after the DPF.						○
Exhaust Temperature Sensor 1	Detects the exhaust temperature before the DPF.	○					○
Exhaust Temperature Sensor 2	Detects the exhaust temperature inside the DPF.	○					○
Exhaust Temperature Sensor 3	Detects the exhaust temperature after the DPF.	○					○
Engine Compartment Temperature Sensor	Detects the ambient temperature in the vicinity of the engine compartment differential pressure sensor.						○

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Sensor Name	Function	Fuel Injection	Rail Pressure	Intake Restriction	EGR	VGT	DPF
EGR Valve Lift Sensor	Detects the EGR valve position.				○		
Throttle Position Sensor	Detects the diesel throttle position.			○			
Turbo Lift Sensor	Detects the turbo nozzle position.					○	

(2) Actuator system

Actuator Name	Function	Fuel Injection	Rail Pressure	Intake Restriction	EGR	VGT	DPF	A/C	Start Up
Main Relay	Supplies power to the system.	○	○	○	○	○	○	○	○
Injector	Precisely injects fuel.	○							
Suction Control Valve (SCV)	Controls the volume of fuel that is supplied to the supply pump.	○	○						
EGR Valve DC Motor	Controls the vacuum that is applied to the EGR valve.				○				
VGT E-VRV	Controls the vacuum that is applied to the turbo.					○			
Electronic Control Throttle DC Motor	Controls the vacuum that is applied to the intake suction valve.			○			○		
Fan Relay	Controls the duration of time that current is applied to the electric fan.								
A/C Relay	Supplies power to the A/C.							○	
Starter Relay	Supplies power to the starter.								○
EGR Cooler Bypass Valve	Bypasses the EGR cooler.				○				

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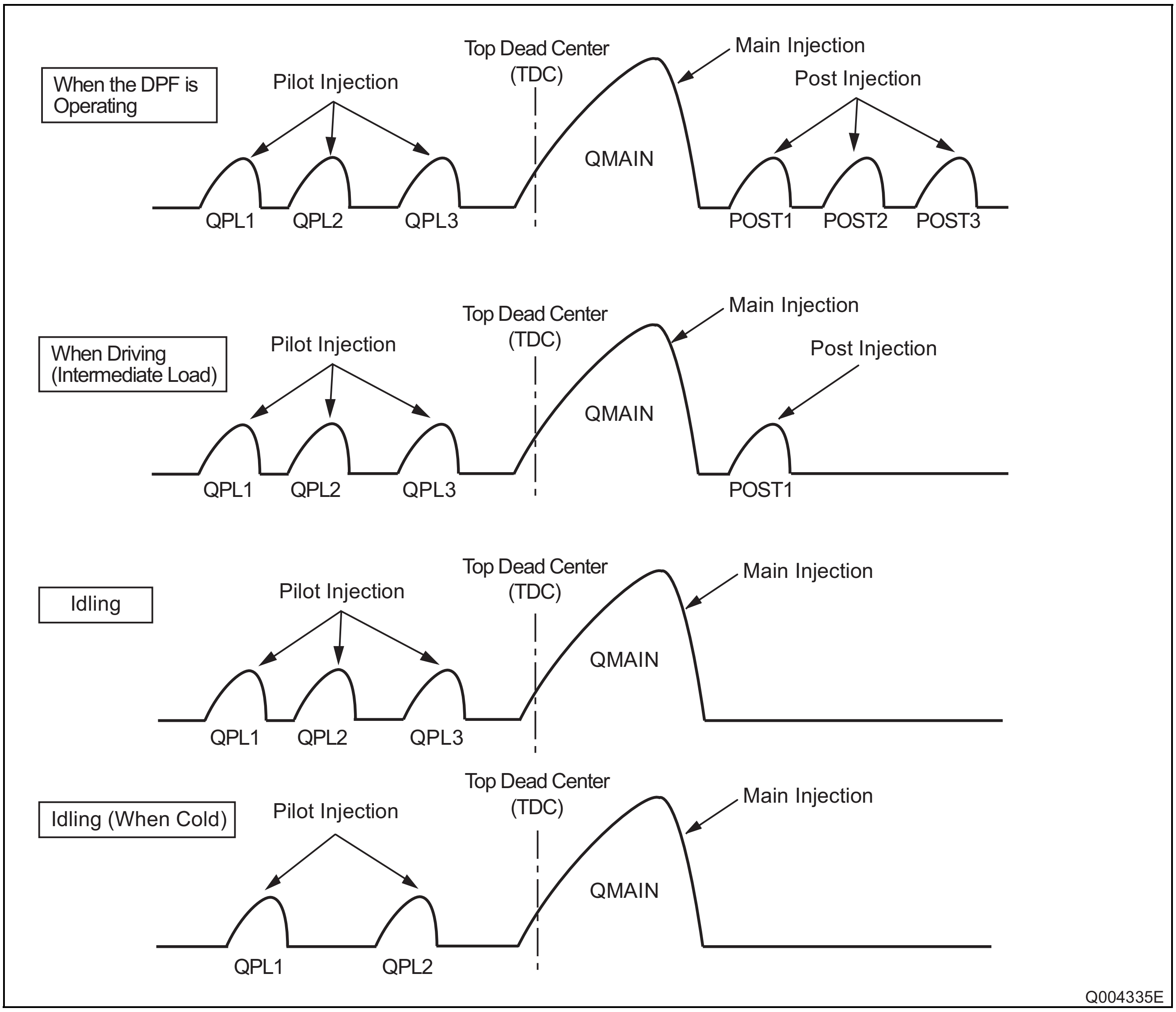
(3) Control system

Control Name	Function
Fuel Injection Control	Controls injector fuel injection timing and injection quantity by adding corrections based on the signals from the sensors to the basic injection duration. The basic injection duration is calculated in accordance with the engine conditions.
Rail Pressure Control	Controls the rail pressure in accordance with the engine conditions by sending signals to the SCV of the supply pump.
VGT Control	Controls the boost pressure in accordance with the operating conditions by calculating the signals that are output to the E-VRV.
Intake Restriction Control	Controls the opening of the intake restriction mechanism in accordance with the driving conditions.
EGR Control	Controls the opening of the EGR valve in accordance with operating conditions by calculating the output signals.
Glow Plug Relay Control	Controls the duration of the current applied to the glow plug relay in accordance with the water temperature when the engine is started.
Air Conditioner Cutoff Control	Cuts off the air conditioner during acceleration to improve drivability.
Diagnosis	Illuminates a warning light to alert the driver if a failure occurs in the computer.
Auto Cruise Control	Initiates feedback control so that the actual vehicle speed matches the speed set in accordance with the cruise control switch.
DSC Control	Initiates traction control and ABS control in accordance with the driving conditions.
DPF Control	Data from the differential pressure sensor, exhaust temperature sensor, and MAF meter are accumulated in the DPF and used to estimate the Particulate Matter (PM) volume, and to perform proper PM combustion.
Fan Control	Controls fan rotational speed in accordance with engine conditions. For the MAZDA3 and CX-7, the fan is operated via duty control; for the MAZDA6, the fan is operated via relay control.

7.2 Fuel Injection Timing Control

- The figure below shows representative injection patterns. Injection patterns change according to engine load conditions.



7.3 Idle Speed Control

Engine speed control during Diesel Particulate Filter (DPF) manual regeneration

- Idle speed control calculates the PM quantity based on the input signal from the exhaust gas pressure sensor, and controls engine speed. The PM quantity is made to correspond with the target engine speed during DPF manual regeneration.

Engine speed during DPF manual regeneration (when normal engine speed = 1,750 rpm)

- If there is abnormal combustion of soot during DPF manual regeneration, the exhaust gas temperature increases, which may damage the DPF. Under the aforementioned conditions, post injection is stopped and the engine speed is increased to 2,500 rpm. Damage is thus prevented by rapidly sending low-temperature exhaust gas to the oxidation catalytic converter to cool the DPF.

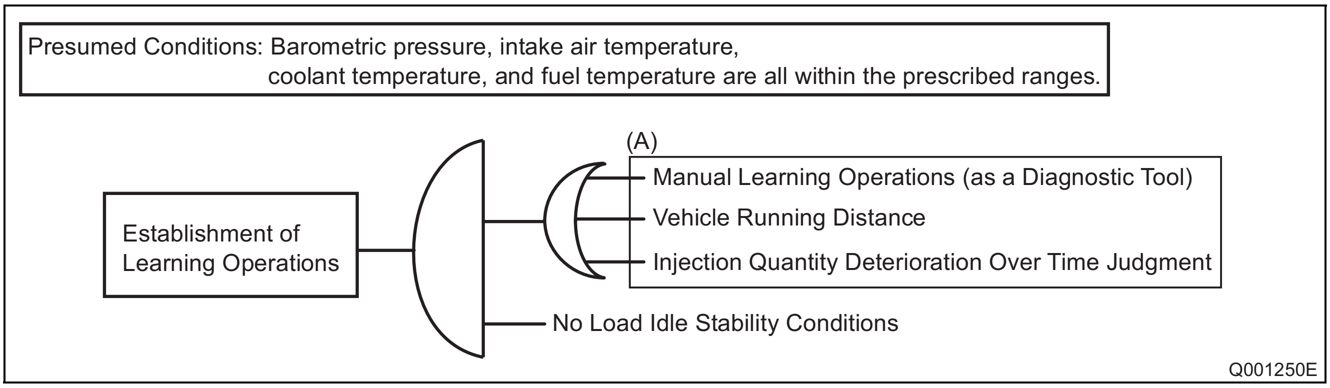
7.4 Microinjection Quantity Learning Control

Outline

- Microinjection quantity learning control is used in every vehicle engine (injector) to preserve the accuracy of the pilot injection quantity. Microinjection quantity learning control is first performed when shipped from the factory (L/O), and later is automatically performed every time the vehicle runs a set distance (for details, see item "A"). As a result, the accuracy of each injector can be preserved not only initially, but also as deterioration in injection occurs over time. Microinjection quantity learning control stores correction values in the ECU. During normal driving operations, these correction values are used to make modifications to the injection commands, resulting in accurate microinjection.

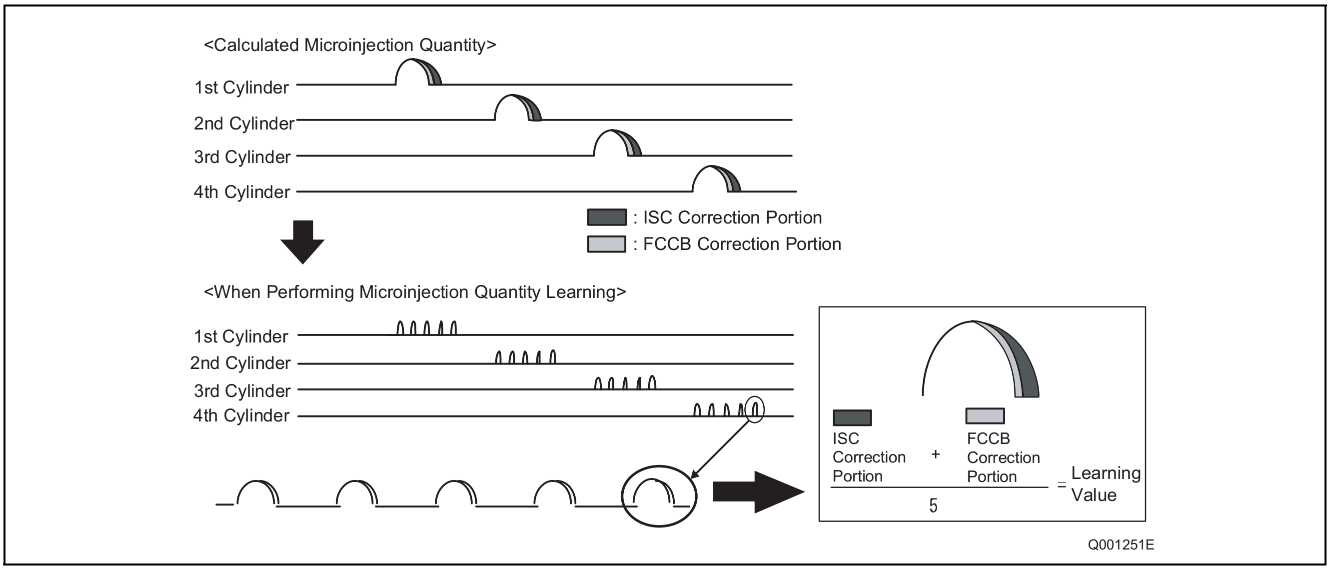
Learning operations

- For every two no load, idle instability conditions established (see item "(A)" below), microinjection quantity learning takes place. In addition, it is also possible to perform microinjection quantity learning control manually as a diagnostic tool.



Operational outline

- Microinjection quantity learning control applies ISC (target speed correction quantity) and FCCB (cylinder-to-cylinder correction quantity) controls. ISC and FCCB feed back the injection quantity based on engine rotational speed. Corrections are then applied to each cylinder from ISC and FCCB correction information to calculate the corrected injection quantity. Further, microinjection quantity learning control divides injection into five separate injections. Under these conditions, the "learning value" is calculated as the corrected injection quantities for ISC and FCCB divided by five injections.



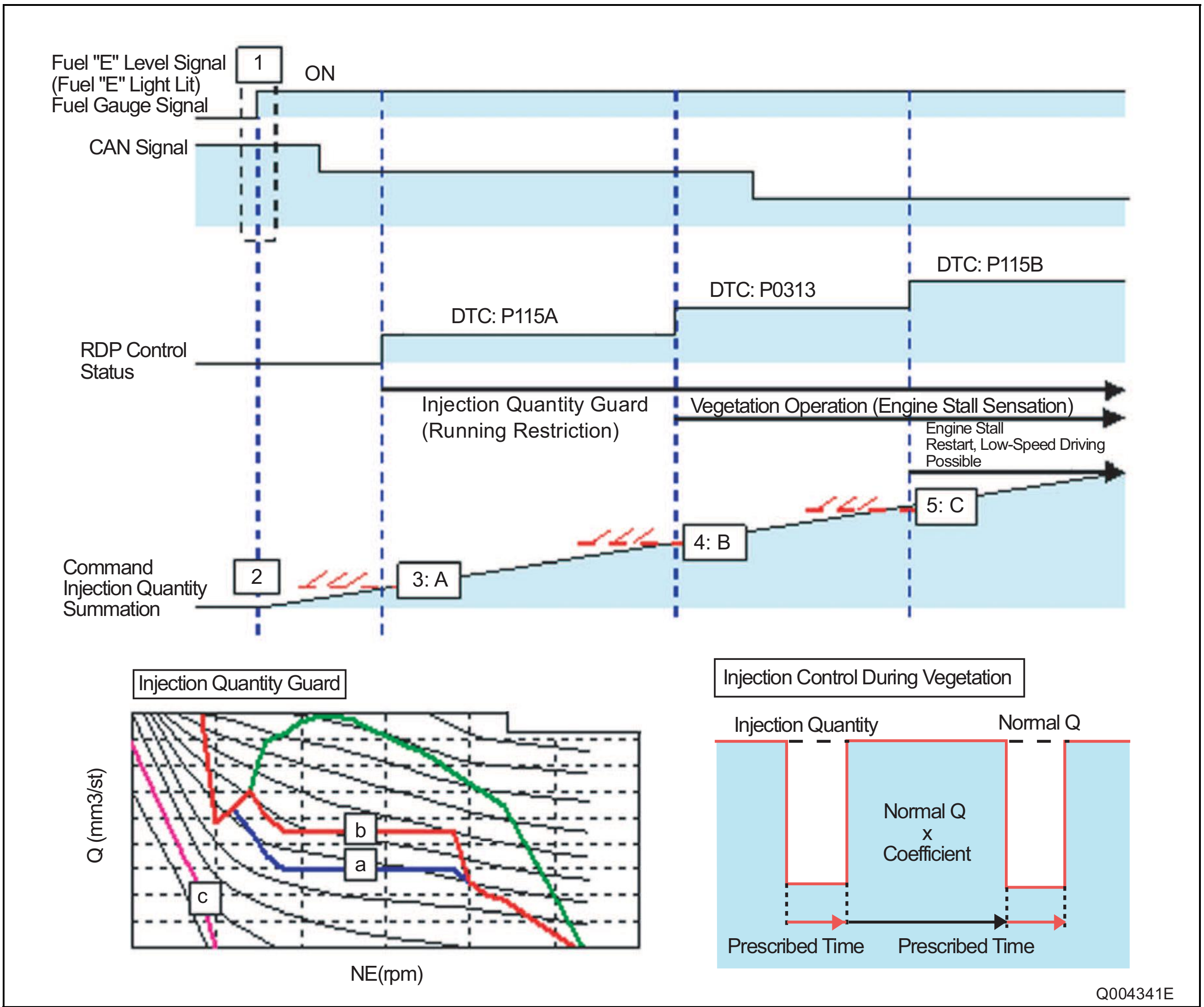
7.5 Run Dry Prevention (RDP) Control

Outline

- When the diesel fuel is completely expended, engine restartability may worsen. To prevent the aforementioned situation, a pseudo-gas shortage condition is created, alerting the driver that fuel is in short supply. The driver is thus prompted to refuel the vehicle, therefore avoiding an actual empty fuel tank.

Operation

- The engine is operated according to processes 1 through 5 in the figure below.
  - 1: A fuel gauge "E" level signal is inputted to the engine ECU via CAN communication.
  - 2: The engine ECU command injection quantity begins to be summed.
  - 3: When the summed value for the engine ECU internal command injection quantity is greater than "A", the injection quantity guard is set to value "a", and output control is initiated. DTC: P115A is detected.
  - 4: When the summed value for the engine ECU internal command injection quantity is greater than "B", the injection quantity guard is set to value "b", and hesitation operation is initiated. For details on injection quantity control during hesitation, refer to the figure below. DTC: P0313 is detected.
  - 5: When the summed value for the engine ECU internal command injection quantity is greater than "C", the engine is stopped. In addition, the injection quantity guard is set to value "c", enabling restart and low-speed driving. DTC: P115B is detected.



7.6 Diesel Particulate Filter (DPF) System

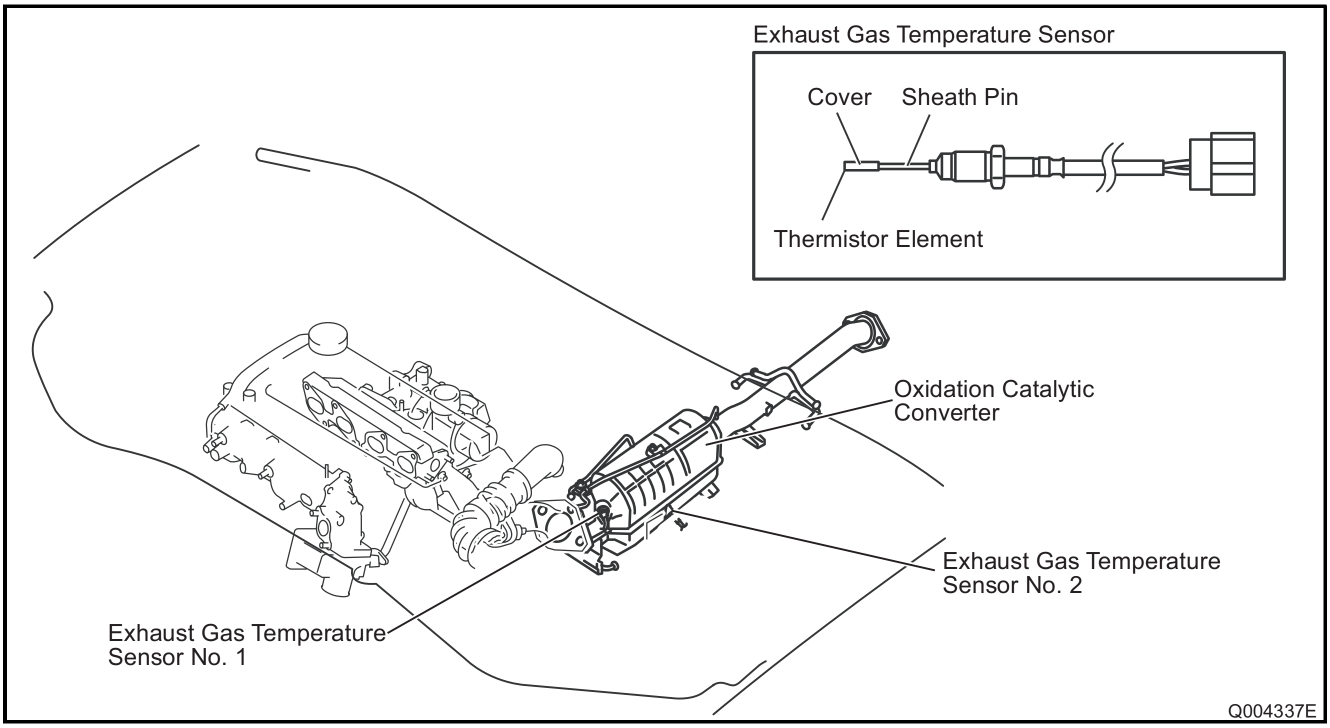
Outline

- The DPF collects and removes Particulate Matter (PM) from the exhaust gas.
- The DPF is located behind the catalyst relative to the direction of exhaust gas flow. The catalytic converter and DPF are integrated into one housing.
- The DPF is a silicon carbide honey-comb type filter. The filter ends are blocked in sequence, and small holes on the wall inside the filter accumulate PM. The accumulated PM is then burned and eliminated.
- The DPF has a platinum coated surface.

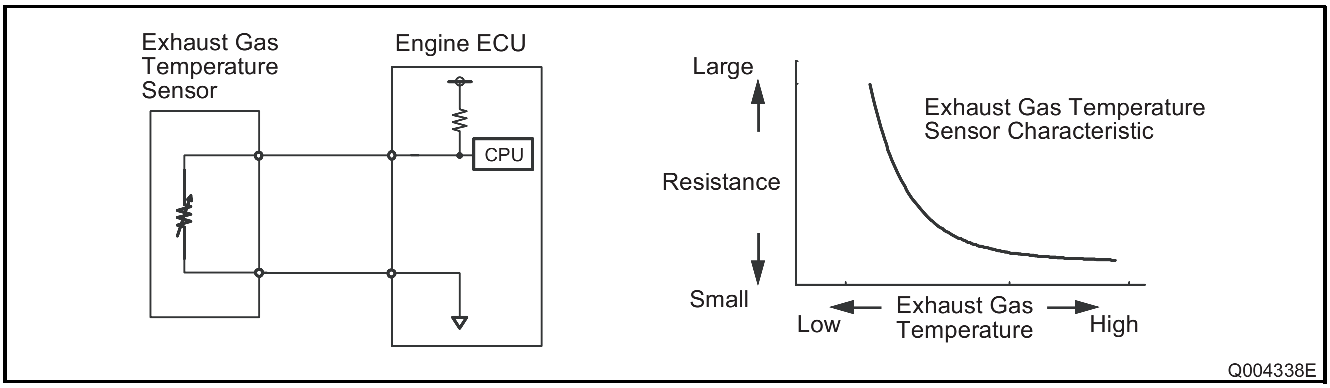
(1) Other sensors

Exhaust gas temperature sensor

- Exhaust gas temperature sensor no. 1: Detects the exhaust gas temperature before flowing into the oxidation catalyst to check if the temperature is within the catalytic activity range.
- Exhaust gas temperature sensor no. 2: Detects the exhaust gas temperature before flowing into the DPF to check if the temperature is at the target temperature for DPF manual regeneration.
- Exhaust gas temperature sensors are attached at two locations on the oxidation catalytic converter.
- The exhaust gas temperature sensors utilize thermistor elements in which the resistance value varies according to the exhaust gas temperature.

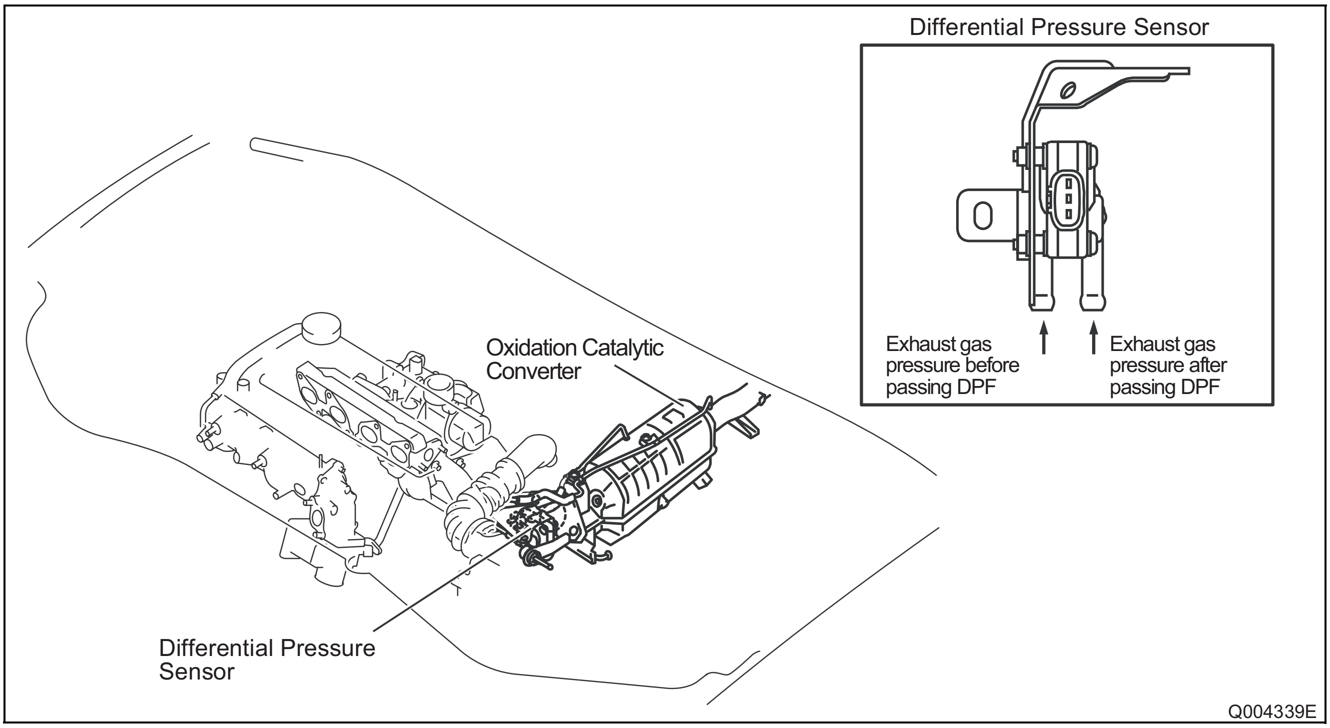


- When the exhaust gas temperature increases, the resistance value decreases. Conversely, when the exhaust gas temperature decreases, the resistance value increases.

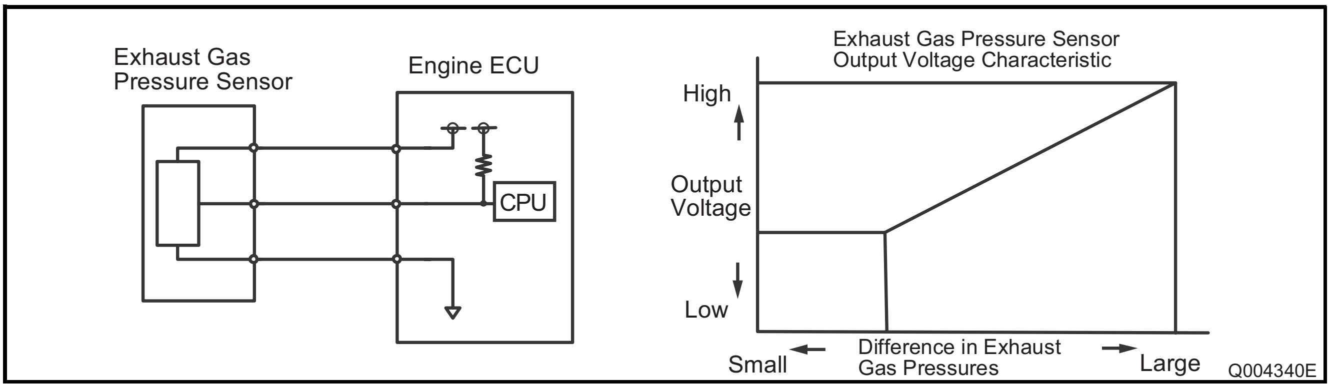


Differential pressure sensor

- The differential pressure sensor detects the difference in pressure between the exhaust gas pressure before and after the DPF. This pressure difference is used to predict the amount of PM accumulation in the DPF.



- The differential pressure sensor converts the exhaust gas pressure values before and after the DPF to voltage signals, then outputs the signals to the engine ECU.
- The differential pressure sensor is a semiconductor type in which a difference in electrical potential occurs when pressure is applied.
- Output voltage from the differential pressure sensor increases as the difference in exhaust gas pressures increases.



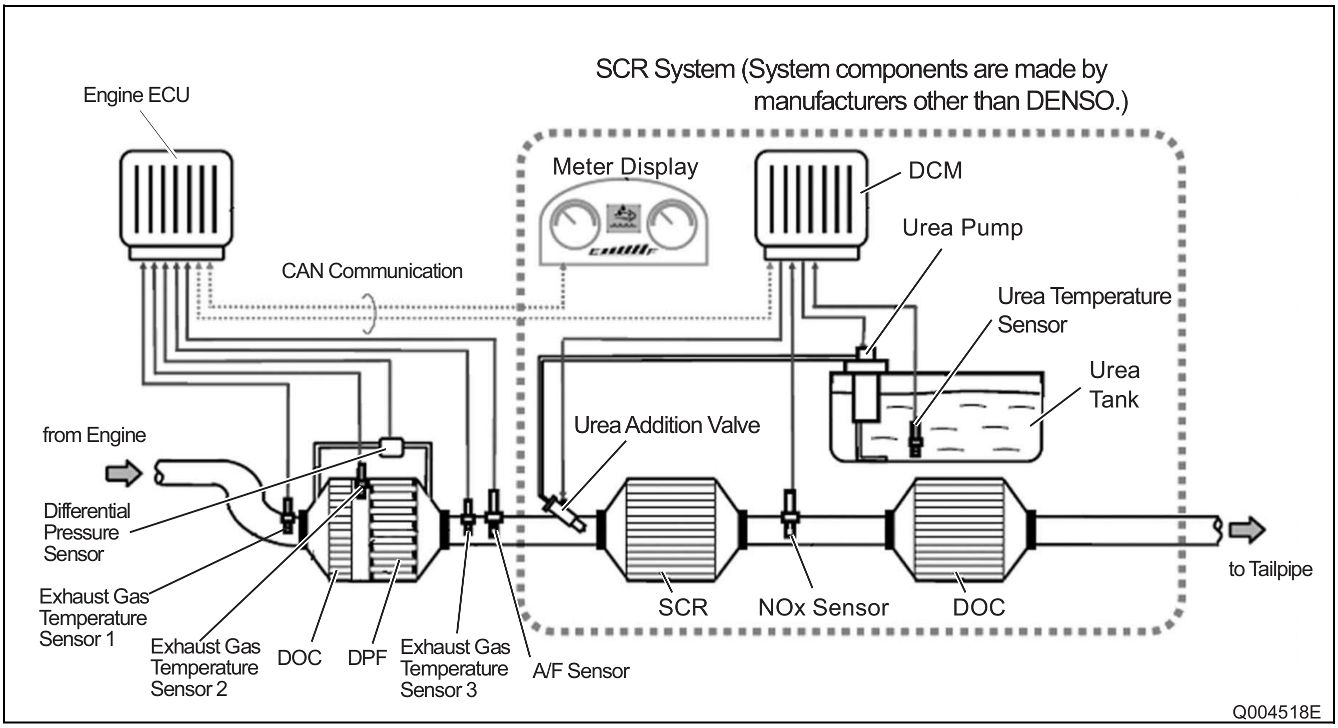
7.7 Selective Catalytic Reduction (SCR) System

Outline

- The SCR system is only specified for the MAZDA CX-7.

 The SCR system is an exhaust gas cleaning system that injects an aqueous solution of urea known as "AdBlue" into the exhaust pipe just before the catalyst to create a chemical reaction with the exhaust gas. As a result, approximately 40% of the NOx contained in the exhaust gas is converted into non-hazardous nitrogen. Until now, the SCR system was large, and was therefore only equipped in heavy-duty vehicles. However, beginning with the "AdBlue" storage tank mounted under the CX-7 trunk, the entire SCR system has been made compact and lightweight. MAZDA is the first automobile manufacturer in Japan to equip the SCR system in a passenger vehicle.

 SCR system components are made by manufacturers other than DENSO. However, the DENSO engine ECU calculates the NOx exhaust quantity, and conducts CAN communication.



SCR

- The SCR is a urea selective type reduction catalyst. Urea is used to chemically decompose and convert the NOx contained in the exhaust gas into non-hazardous materials. Urea is added to the exhaust gas via injection, causing NOx decomposition. The resulting non-hazardous water (H20) and nitrogen gas (N2) are then discharged.

8. DIAGNOSTIC TROUBLE CODES (DTC)

8.1 About the Codes Shown in the Table

- The "SAE" DTC indicates codes that are output through the use of the STT (WDS.)
  (SAE: Society of Automotive Engineers)

8.2 DTC Table

DTC	Diagnosis Item	Applicable Vehicle			MIL Lit
		MAZDA3	MAZDA6	CX-7	
P0563	System Voltage High	Yes	Yes	Yes	Yes
P0562	System Voltage Low	Yes	Yes	Yes	Yes
P0118	Engine Coolant Temperature 1 Circuit High	Yes	Yes	Yes	Yes
P0117	Engine Coolant Temperature 1 Circuit Low	Yes	Yes	Yes	Yes
P0116	Engine Coolant Temperature 1 Circuit Range/ Performance	Yes	Yes	Yes	Yes
P0098	Intake Air Temperature Sensor 2 Circuit High	Yes	Yes	Yes	Yes
P0097	Intake Air Temperature Sensor 2 Circuit Low	Yes	Yes	Yes	Yes
P0096	Intake Air Temperature Sensor 2 Circuit Range/ Performance	Yes	Yes	Yes	Yes
P0113	Intake Air Temperature Sensor 1 Circuit High	Yes	Yes	Yes	Yes
P0112	Intake Air Temperature Sensor 1 Circuit Low	Yes	Yes	Yes	Yes
P0111	Intake Air Temperature Sensor 1 Circuit Range/ Performance	Yes	Yes	Yes	Yes
P0183	Fuel Temperature Sensor "A" Circuit High	Yes	Yes	Yes	Yes
P0182	Fuel Temperature Sensor "A" Circuit Low	Yes	Yes	Yes	Yes
P0181	Fuel Temperature Sensor "A" Circuit Range/ Performance	Yes	Yes	Yes	Yes (Unlit only for the MAZDA6)
P0193	Fuel Rail Pressure Sensor "A" Circuit High	Yes	Yes	Yes	Yes
P0192	Fuel Rail Pressure Sensor "A" Circuit Low	Yes	Yes	Yes	Yes
P0191	Fuel Rail Pressure Sensor "A" Circuit Range/ Performance	Yes	Yes	Yes	Yes
P0108	Manifold Absolute Pressure (MAP)/Barometric Pressure Circuit High Input	Yes	Yes	Yes	Yes
P0107	MAP/Barometric Pressure Circuit Low Input	Yes	Yes	Yes	Yes
P0106	MAP/Barometric Pressure Circuit Range/ Performance	Yes	Yes	Yes	Yes
P2229	Barometric Pressure Circuit High	Yes	Yes	Yes	Yes

DTC	Diagnosis Item	Applicable Vehicle			MIL Lit
		MAZDA3	MAZDA6	CX-7	
P2228	Barometric Pressure Circuit Low	Yes	Yes	Yes	Yes
P2227	Barometric Pressure Circuit Range/Performance	Yes	Yes	Yes	Yes
P0123	Throttle/Pedal Position Sensor/Switch "A" Circuit High	Yes	Yes	Yes	Yes
P0122	Throttle/Pedal Position Sensor/Switch "A" Circuit Low	Yes	Yes	Yes	Yes
P0121	Throttle/Pedal Position Sensor/Switch "A" Circuit Range/Performance	Yes	Yes	Yes	Yes
P0223	Throttle/Pedal Position Sensor/Switch "B" Circuit High	Yes	Yes	Yes	Yes
P0222	Throttle/Pedal Position Sensor/Switch "B" Circuit Low	Yes	Yes	Yes	Yes
P0103	Mass or Volume Air Flow "A" Circuit High Input	Yes	Yes	Yes	Yes
P0102	Mass or Volume Air Flow "A" Circuit Low Input	Yes	Yes	Yes	Yes
P0101	Mass or Volume Air Flow "A" Circuit Range/ Performance	Yes	Yes	Yes	Yes
P0406	Exhaust Gas Recirculation (EGR) Sensor "A" Circuit High	Yes	Yes	Yes	Yes
P0405	EGR Sensor "A" Circuit Low	Yes	Yes	Yes	Yes
P0545	Exhaust Gas Temperature Sensor Circuit Low	Yes	Yes	Yes	Yes
P0546	Exhaust Gas Temperature Sensor Circuit High	Yes	Yes	Yes	Yes
P2032	Exhaust Gas Temperature Sensor Circuit Low	No	No	Yes	Yes
P2033	Exhaust Gas Temperature Sensor Circuit High	No	No	Yes	Yes
P0548	Exhaust Gas Temperature Sensor Circuit Low	Yes	Yes	No	Yes
P0549	Exhaust Gas Temperature Sensor Circuit High	Yes	Yes	No	Yes
P242C	Exhaust Gas Temperature Sensor Circuit Low	No	No	Yes	No
P242D	Exhaust Gas Temperature Sensor Circuit High	No	No	Yes	No
P2455	Diesel Particulate Filter (DPF) Differential Pressure Sensor Circuit High	Yes	Yes	Yes	Yes
P2454	DPF Differential Pressure Sensor Circuit Low	Yes	Yes	Yes	Yes
P1392	Glow Plug Voltage High	Yes	Yes	Yes	No
P1391	Glow Plug Voltage Low	Yes	Yes	Yes	No
P0132	O2 Sensor Circuit High Voltage (Bank 1)	Yes	Yes	Yes	Yes
P0131	O2 Sensor Circuit Low Voltage (Bank 1)	Yes	Yes	Yes	Yes
P0152	O2 Sensor Circuit High Voltage (Bank 2)	Yes	Yes	Yes	Yes
P0151	O2 Sensor Circuit Low Voltage (Bank 2)	Yes	Yes	Yes	Yes
P0134	O2 Sensor Circuit No Activity Detected	Yes	Yes	Yes	Yes
P0030	HO2S Heater Control Circuit	Yes	Yes	Yes	Yes
P0133	O2 Sensor Circuit Slow Response	Yes	Yes	Yes	Yes

DTC	Diagnosis Item	Applicable Vehicle			MIL Lit
		MAZDA3	MAZDA6	CX-7	
P2148	Fuel Injector Group "A" Supply Voltage Circuit High	Yes	Yes	Yes	Yes
P2151	Fuel Injector Group "B" Supply Voltage Circuit High	Yes	Yes	Yes	Yes
P2147	Fuel Injector Group "A" Supply Voltage Circuit Low	Yes	Yes	Yes	Yes
P2150	Fuel Injector Group "B" Supply Voltage Circuit Low	Yes	Yes	Yes	Yes
P1378	Injector Low Charge	Yes	Yes	Yes	Yes
P0201	Injector Circuit/Open - Cylinder 1	Yes	Yes	Yes	Yes
P0203	Injector Circuit/Open - Cylinder 3	Yes	Yes	Yes	Yes
P0204	Injector Circuit/Open - Cylinder 4	Yes	Yes	Yes	Yes
P0202	Injector Circuit/Open - Cylinder 2	Yes	Yes	Yes	Yes
P2146	Fuel Injector Group "A" Supply Voltage Circuit/ Open	Yes	Yes	Yes	Yes
P2149	Fuel Injector Group "B" Supply Voltage Circuit/ Open	Yes	Yes	Yes	Yes
P1379	Injector Overcharge	Yes	Yes	Yes	Yes
P062A	Fuel Pump "A" Control Circuit Range/Performance	Yes	Yes	Yes	Yes
P0093	Fuel System Leak Detected - Large Leak	Yes	Yes	Yes	Yes
P0342	Camshaft Position Sensor "A" Circuit Low	Yes	Yes	Yes	Yes
P0341	Camshaft Position Sensor "A" Circuit Range/ Performance	Yes	Yes	Yes	Yes
P0337	Crankshaft Position Sensor "A" Circuit Low	Yes	Yes	Yes	Yes
P0336	Crankshaft Position Sensor "A" Circuit Range/ Performance	Yes	Yes	Yes	Yes
P0512	Starter Request Circuit	Yes	Yes	Yes	Yes
P0704	Clutch Switch Input Circuit Malfunction	Yes	Yes	Yes	Yes
P0234	Turbocharger/Supercharger Overboost Condition	Yes	Yes	Yes	No
P0299	Turbocharger/Supercharger Underboost	Yes	Yes	Yes	Yes
P0402	Exhaust Gas Recirculation (EGR) Flow Excessive	Yes	Yes	Yes	Yes
P0401	EGR Flow Insufficiency Detected	Yes	Yes	Yes	Yes
P1196	Main Relay Abnormality	Yes	Yes	Yes	No
P0016	Crankshaft Position - Camshaft Position Correlation	Yes	Yes	Yes	Yes
P0301	Cylinder 1 Misfire Detected	Yes	Yes	Yes	Yes
P0302	Cylinder 2 Misfire Detected	Yes	Yes	Yes	Yes
P0303	Cylinder 3 Misfire Detected	Yes	Yes	Yes	Yes
P0304	Cylinder 4 Misfire Detected	Yes	Yes	Yes	Yes
P0219	Engine Overspeed Condition	Yes	Yes	Yes	No
P0088	Fuel Rail/System Pressure - Too High	Yes	Yes	Yes	Yes
P0607	Control Module Performance	Yes	Yes	Yes	No

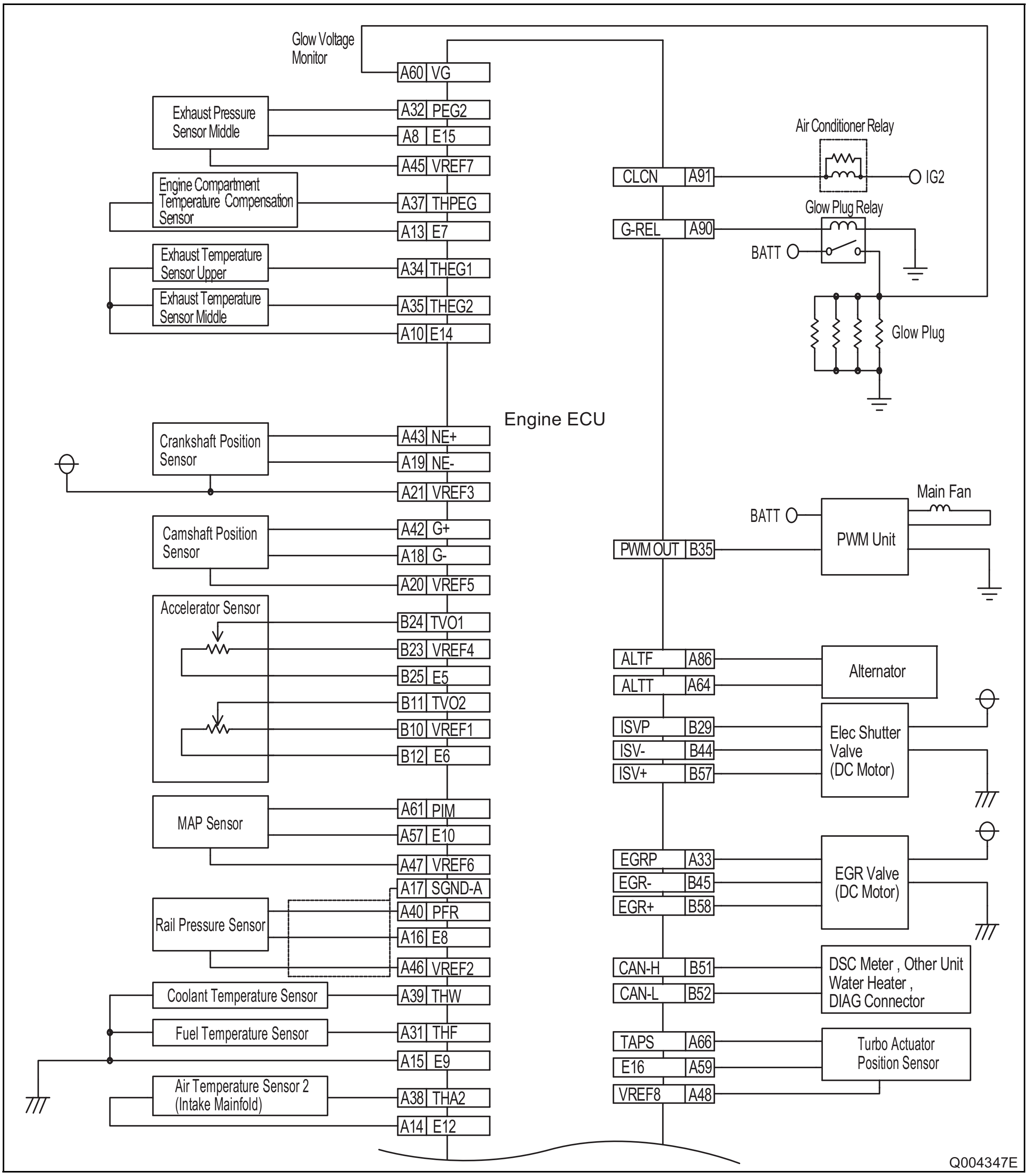
DTC	Diagnosis Item	Applicable Vehicle			MIL Lit
		MAZDA3	MAZDA6	CX-7	
P0606	ECM/PCM Processor	Yes	Yes	Yes	Yes
P0605	Internal Control Module Read Only Memory (ROM) Error	Yes	Yes	Yes	Yes
P0500	Vehicle Speed Sensor "A"	Yes	Yes	Yes	Yes
P0571	Brake Switch "A" Circuit	Yes	Yes	Yes	No
P0579	Cruise Control Multi-Function Input "A" Circuit Range/Performance	Yes	Yes	Yes	No
P0581	Cruise Control Multi-Function Input "A" Circuit High	Yes	Yes	Yes	No
P1281	Pump Protective Fill Plug	Yes	Yes	Yes	Yes
P1329	Pump Exchange Fill Plug	Yes	Yes	Yes	Yes
P2622	Throttle Position Output Circuit High	Yes	Yes	Yes	Yes
P2621	Throttle Position Output Circuit Low	Yes	Yes	Yes	Yes
P1589	Diesel Throttle Valve Stuck	Yes	Yes	Yes	Yes
P2101	Throttle Actuator Control Motor Circuit Range/ Performance	Yes	Yes	Yes	Yes
P0404	EGR Control Circuit Range/Performance	Yes	Yes	Yes	Yes
P0400	EGR Flow	Yes	Yes	Yes	Yes
P0403	EGR Control Circuit	Yes	Yes	Yes	Yes
P252F	Engine Oil Level Too High	Yes	Yes	Yes	No
P0850	Park/Neutral Switch Input Circuit	Yes	Yes	Yes	Yes
P0045	Turbocharger/Supercharger Boost Control Solenoid "A" Circuit/Open	Yes	Yes	Yes	Yes
P0072	Ambient Air Temperature Sensor Circuit Low	Yes	Yes	Yes	Yes
P0073	Ambient Air Temperature Sensor Circuit High	Yes	Yes	Yes	Yes
P0071	Ambient Air Temperature Sensor Range/ Performance	Yes	Yes	Yes	No
P2456	Diesel Particulate Filter (DPF) Differential Pressure Sensor Circuit Intermittent/Erratic	Yes	Yes	Yes	Yes
P2002	Particulate Trap Efficiency Below Threshold	Yes	Yes	Yes	Yes
P2453	DPF Differential Pressure Sensor Circuit Range/ Performance	Yes	Yes	Yes	No
P2452	DPF Differential Pressure Sensor Circuit	Yes	Yes	Yes	No
P1260	Immobilizer Abnormality-DTC at EPATS	Yes	Yes	Yes	No
U3000	Control Module	Yes	Yes	Yes	No
P1675	QR Data Failure To Write Malfunction	Yes	Yes	Yes	Yes
P1676	QR Data Malfunction	Yes	Yes	Yes	Yes
P1676	QR Correction Information Input Malfunction	Yes	Yes	Yes	Yes
P0154	O2 Sensor Circuit No Activity Detected	Yes	Yes	Yes	Yes
P253F	Engine Oil Deteriorated	Yes	Yes	Yes	No

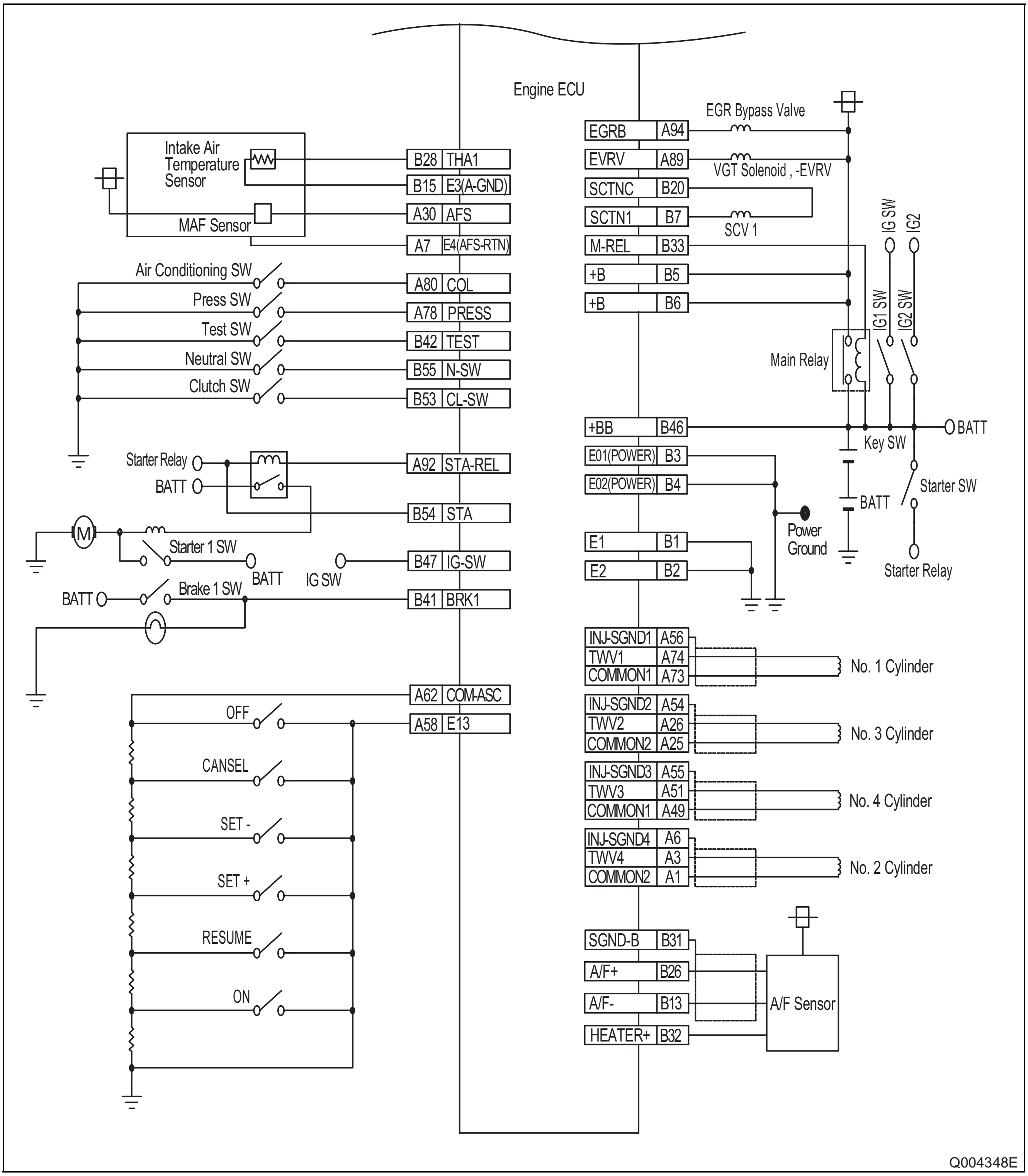
DTC	Diagnosis Item	Applicable Vehicle			MIL Lit
		MAZDA3	MAZDA6	CX-7	
P1303	EGR DC Motor EGR Initial Rise Abnormality	Yes	Yes	Yes	No
P2458	DPF Regeneration Duration	Yes	Yes	Yes	No
P2463	DPF Regeneration Duration	Yes	Yes	Yes	Yes
P242F	DPF Restriction - Ash Accumulation	Yes	Yes	Yes	Yes
P0601	Internal Control Module Memory Checksum Error	Yes	Yes	Yes	Yes
U0073	Control Module Communication Bus Off	Yes	Yes	Yes	No
U0121	Lost Communication With Anti-Lock Brake System (ABS) Control Module	Yes	No	No	Yes
U0121	Lost Communication With Dynamic Stability Control (DSC)	No	Yes	Yes	Yes (Lit only for the MAZDA6)
U0155	Lost Communication With Instrument Panel Cluster (IPC) Control Module	Yes	Yes	Yes	No
P0602	Control Module Programming Error	Yes	Yes	Yes	Yes
P0610	Control Module Vehicle Options Error	Yes	Yes	Yes	Yes
P2002	Particulate Trap Efficiency Below Threshold	Yes	Yes	Yes	No
P115A	Run Dry Prevention (RDP) Control Status 1	Yes	Yes	Yes	No
P0313	Misfire Detected with Low Fuel	Yes	Yes	Yes	No
P115B	RDP Status 3 Engine Stall	No	Yes	Yes	No
P167B	Learning Unadministered (Failure to Start)	Yes	Yes	Yes	No
P1200	Learning Incomplete (Failure to Finish)	Yes	Yes	Yes	No
P2565	Turbocharger Boost Control Position Sensor "A" Circuit High	Yes	Yes	Yes	Yes
P2564	Turbocharger Boost Control Position Sensor "A" Circuit Low	Yes	Yes	Yes	Yes
P245D	EGR Cooler Bypass Control Circuit High	Yes	Yes	Yes	Yes
P245C	EGR Cooler Bypass Control Circuit Low	Yes	Yes	Yes	Yes
P2459	DPF Regeneration Frequency	Yes	Yes	Yes	No
P2105	Throttle Actuator Control System - Forced Engine Shutdown	Yes	Yes	Yes	No
P0442	Selective Catalytic Reduction (SCR) Abnormality 1	No	No	Yes	Yes
P0442	SCR Abnormality 2	No	No	Yes	No
P0442	SCR Abnormality 3	No	No	Yes	No
P0115	SCR CAN Communication Abnormality	No	No	Yes	Yes

9. CONTROL SYSTEM COMPONENTS

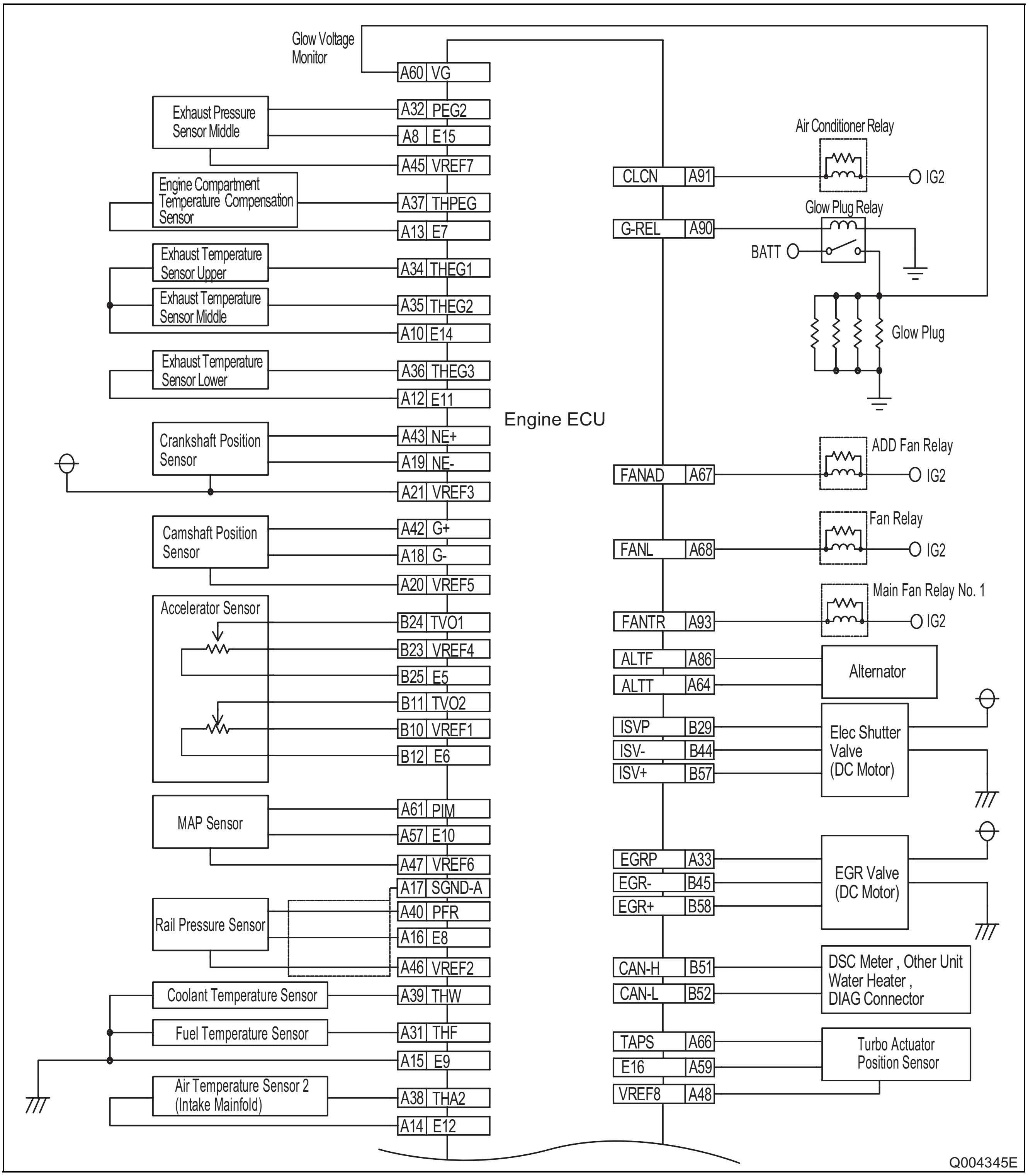
9.1 Engine ECU External Wiring Diagrams

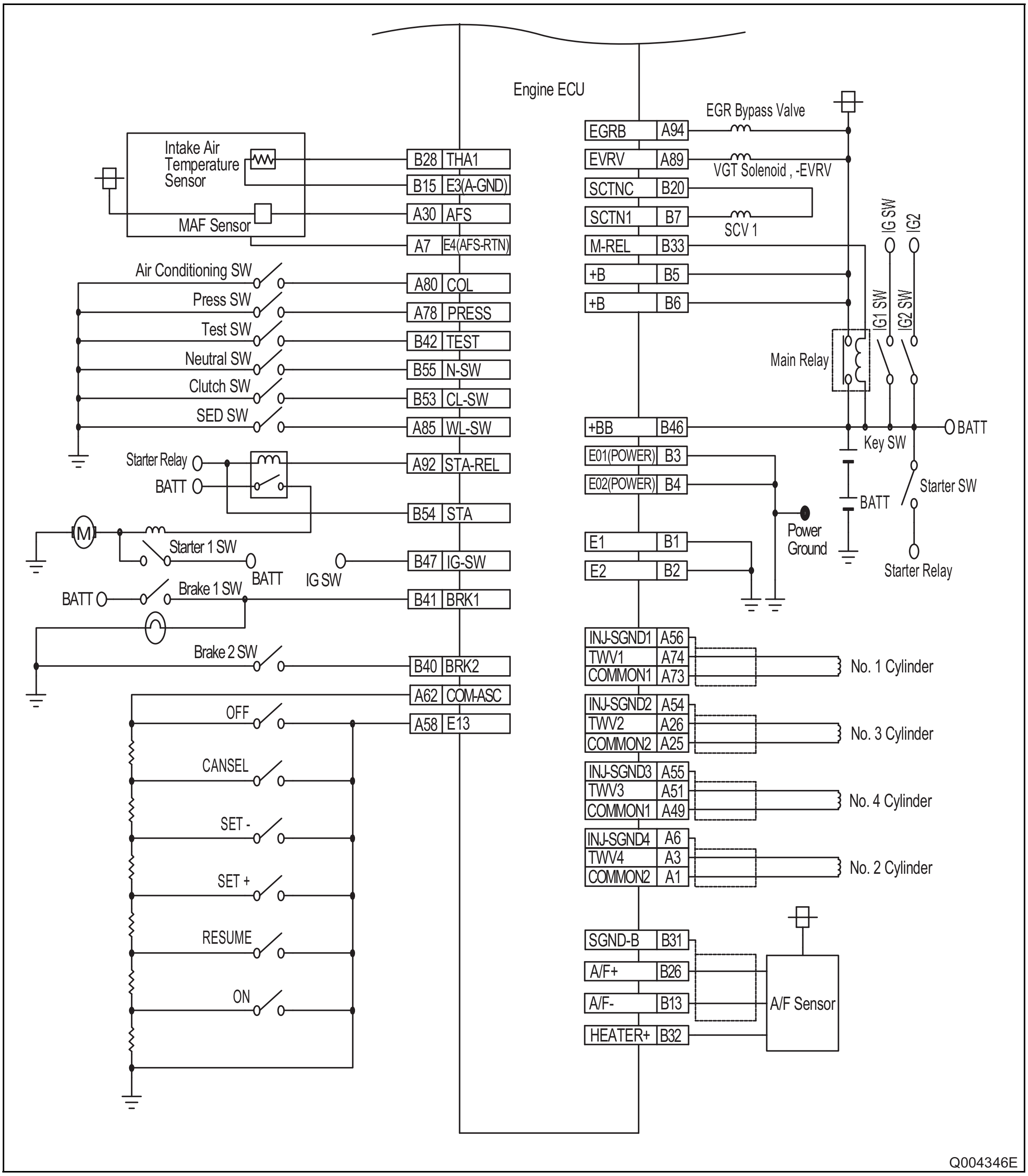
(1) MAZDA3



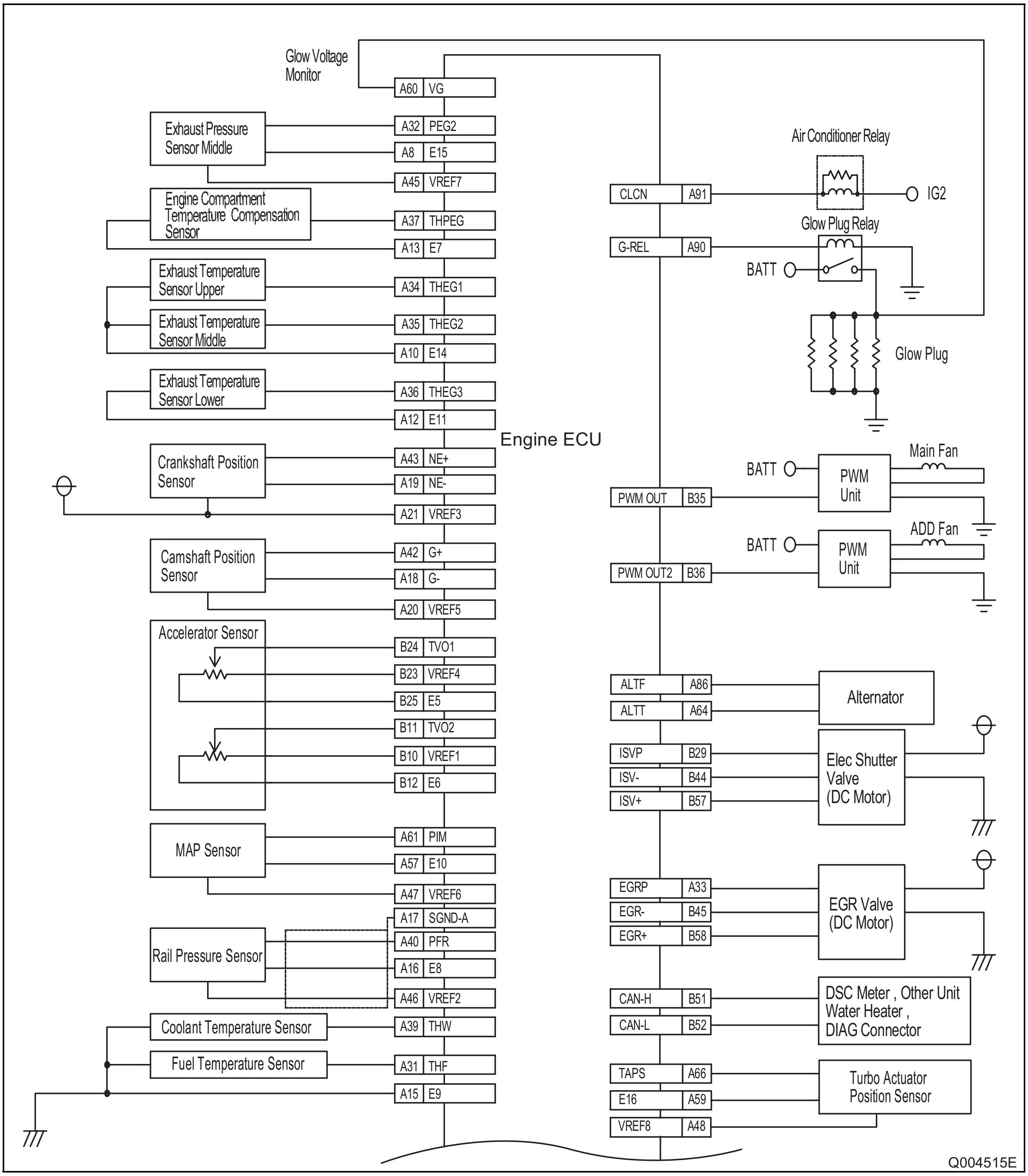

Engine ECU
Intake Air Temperature Sensor
MAF Sensor
B28 THA1
B15 E3(A-GND)
A30 AFS
A7 E4(AFS-RTN)
Air Conditioning SW
Press SW
Test SW
Neutral SW
Clutch SW
A80 COL
A78 PRESS
B42 TEST
B55 N-SW
B53 CL-SW
Starter Relay
BATT
A92 STA-REL
B54 STA
M
Starter 1 SW
BATT
IG SW
B47 IG-SW
BATT
Brake 1 SW
B41 BRK1
A62 COM-ASC
A58 E13
OFF
CANSEL
SET -
SET +
RESUME
ON
EGR Bypass Valve
EGRB A94
EVRV A89
VGT Solenoid , -EVRV
SCTNC B20
SCTN1 B7
SCV 1
M-REL B33
+B B5
+B B6
IG SW
IG2
IG1 SW
IG2 SW
Main Relay
+BB B46
BATT
Key SW
E01(POWER) B3
E02(POWER) B4
Starter SW
BATT
Power Ground
E1 B1
E2 B2
Starter Relay
INJ-SGND1 A56
TWV1 A74
COMMON1 A73
No. 1 Cylinder
INJ-SGND2 A54
TWV2 A26
COMMON2 A25
No. 3 Cylinder
INJ-SGND3 A55
TWV3 A51
COMMON1 A49
No. 4 Cylinder
INJ-SGND4 A6
TWV4 A3
COMMON2 A1
No. 2 Cylinder
SGND-B B31
A/F+ B26
A/F- B13
HEATER+ B32
A/F Sensor
Q004348E

(2) MAZDA6

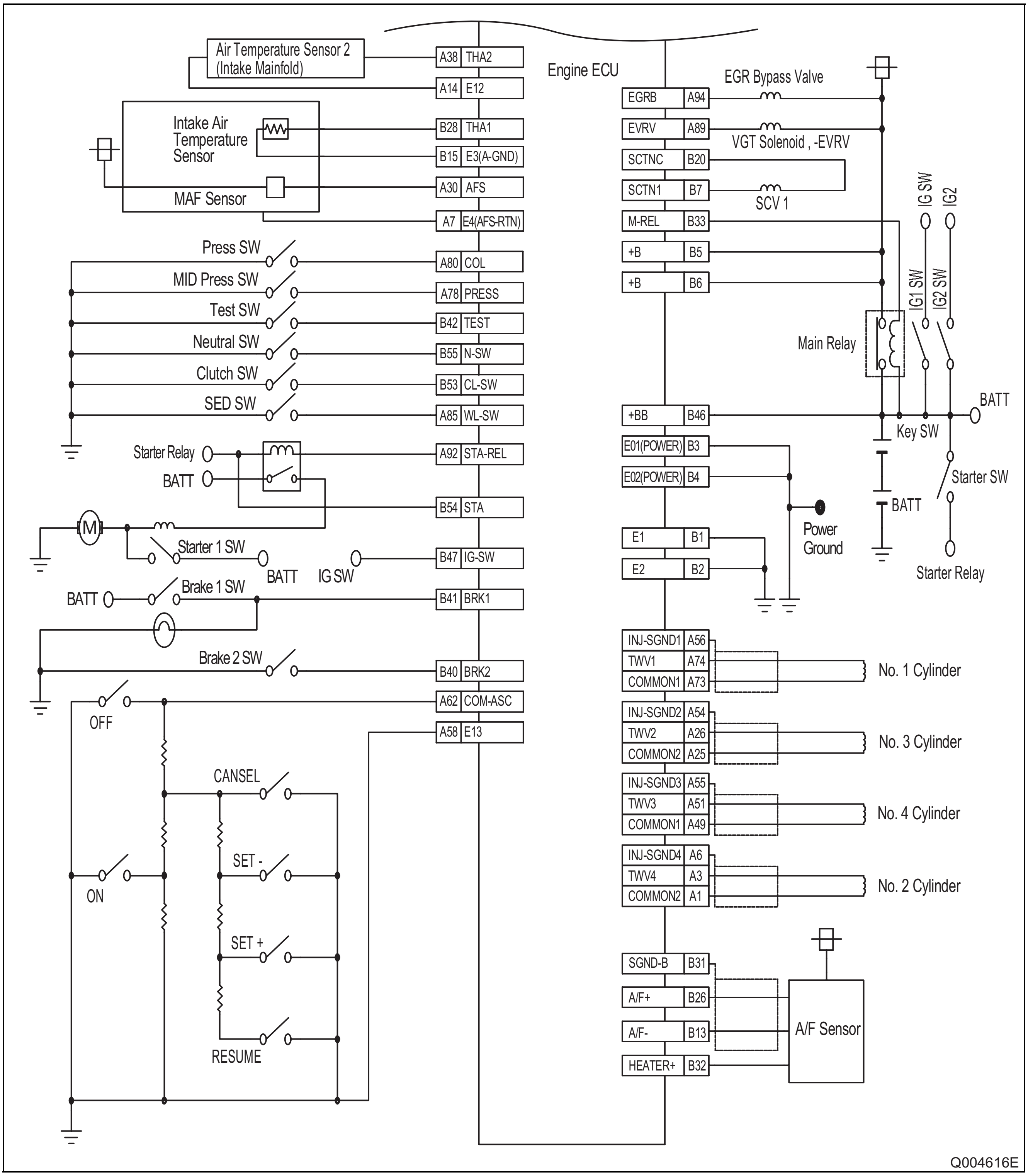

Glow Voltage Monitor
A60 VG
Exhaust Pressure Sensor Middle
A32 PEG2
A8 E15
A45 VREF7
Engine Compartment Temperature Compensation Sensor
A37 THPEG
A13 E7
Exhaust Temperature Sensor Upper
A34 THEG1
Exhaust Temperature Sensor Middle
A35 THEG2
A10 E14
Exhaust Temperature Sensor Lower
A36 THEG3
A12 E11
Crankshaft Position Sensor
A43 NE+
A19 NE-
A21 VREF3
Camshaft Position Sensor
A42 G+
A18 G-
A20 VREF5
Accelerator Sensor
B24 TVO1
B23 VREF4
B25 E5
B11 TVO2
B10 VREF1
B12 E6
MAP Sensor
A61 PIM
A57 E10
A47 VREF6
A17 SGND-A
Rail Pressure Sensor
A40 PFR
A16 E8
A46 VREF2
Coolant Temperature Sensor
A39 THW
Fuel Temperature Sensor
A31 THF
A15 E9
Air Temperature Sensor 2 (Intake Mainfold)
A38 THA2
A14 E12
Engine ECU
Air Conditioner Relay
CLCN A91
IG2
Glow Plug Relay
G-REL A90
BATT
Glow Plug
ADD Fan Relay
FANAD A67
IG2
Fan Relay
FANL A68
IG2
Main Fan Relay No. 1
FANTR A93
IG2
ALTF A86
ALTT A64
Alternator
ISVP B29
ISV- B44
ISV+ B57
Elec Shutter Valve (DC Motor)
EGRP A33
EGR- B45
EGR+ B58
EGR Valve (DC Motor)
CAN-H B51
CAN-L B52
DSC Meter , Other Unit Water Heater , DIAG Connector
TAPS A66
E16 A59
VREF8 A48
Turbo Actuator Position Sensor
Q004345E


Engine ECU
Intake Air Temperature Sensor
MAF Sensor
B28 THA1
B15 E3(A-GND)
A30 AFS
A7 E4(AFS-RTN)
Air Conditioning SW
Press SW
Test SW
Neutral SW
Clutch SW
SED SW
A80 COL
A78 PRESS
B42 TEST
B55 N-SW
B53 CL-SW
A85 WL-SW
Starter Relay
BATT
A92 STA-REL
B54 STA
Starter 1 SW
BATT
IG SW
B47 IG-SW
BATT
Brake 1 SW
B41 BRK1
Brake 2 SW
B40 BRK2
A62 COM-ASC
A58 E13
OFF
CANSEL
SET -
SET +
RESUME
ON
EGR Bypass Valve
EGRB A94
EVRV A89
VGT Solenoid , -EVRV
SCTNC B20
SCTN1 B7
SCV 1
M-REL B33
+B B5
+B B6
IG SW
IG2
IG1 SW
IG2 SW
Main Relay
+BB B46
BATT
Key SW
E01(POWER) B3
E02(POWER) B4
Starter SW
BATT
Power Ground
E1 B1
E2 B2
Starter Relay
INJ-SGND1 A56
TWV1 A74
COMMON1 A73
No. 1 Cylinder
INJ-SGND2 A54
TWV2 A26
COMMON2 A25
No. 3 Cylinder
INJ-SGND3 A55
TWV3 A51
COMMON1 A49
No. 4 Cylinder
INJ-SGND4 A6
TWV4 A3
COMMON2 A1
No. 2 Cylinder
SGND-B B31
A/F+ B26
A/F- B13
HEATER+ B32
A/F Sensor
Q004346E

(3) CX-7



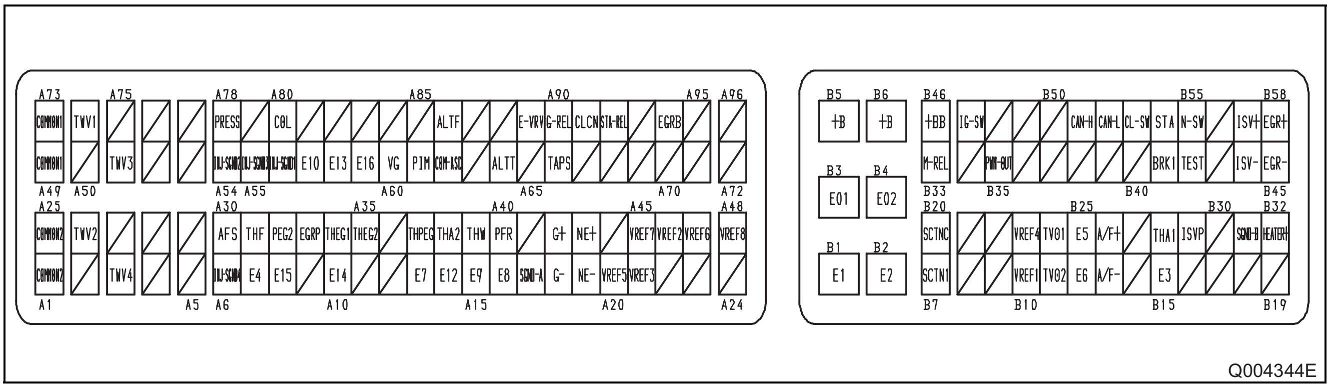
Glow Voltage Monitor
A60 VG
Exhaust Pressure Sensor Middle
A32 PEG2
A8 E15
A45 VREF7
Engine Compartment Temperature Compensation Sensor
A37 THPEG
A13 E7
Exhaust Temperature Sensor Upper
A34 THEG1
Exhaust Temperature Sensor Middle
A35 THEG2
A10 E14
Exhaust Temperature Sensor Lower
A36 THEG3
A12 E11
Engine ECU
Crankshaft Position Sensor
A43 NE+
A19 NE-
A21 VREF3
Camshaft Position Sensor
A42 G+
A18 G-
A20 VREF5
Accelerator Sensor
B24 TVO1
B23 VREF4
B25 E5
B11 TVO2
B10 VREF1
B12 E6
MAP Sensor
A61 PIM
A57 E10
A47 VREF6
A17 SGND-A
Rail Pressure Sensor
A40 PFR
A16 E8
A46 VREF2
Coolant Temperature Sensor
A39 THW
Fuel Temperature Sensor
A31 THF
A15 E9
Air Conditioner Relay
CLCN A91
IG2
Glow Plug Relay
G-REL A90
BATT
Glow Plug
Main Fan
BATT
PWM Unit
PWM OUT B35
ADD Fan
BATT
PWM Unit
PWM OUT2 B36
ALTF A86
ALTT A64
Alternator
ISVP B29
ISV- B44
ISV+ B57
Elec Shutter Valve (DC Motor)
EGRP A33
EGR- B45
EGR+ B58
EGR Valve (DC Motor)
CAN-H B51
CAN-L B52
DSC Meter , Other Unit Water Heater , DIAG Connector
TAPS A66
E16 A59
VREF8 A48
Turbo Actuator Position Sensor
Q004515E



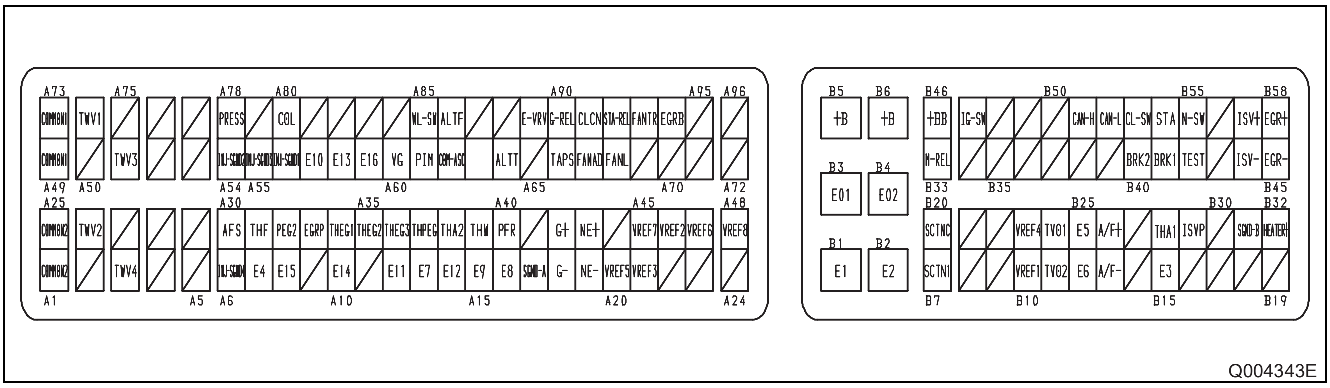
Engine ECU
Air Temperature Sensor 2 (Intake Mainfold)
A38 THA2
A14 E12
Intake Air Temperature Sensor
B28 THA1
B15 E3(A-GND)
MAF Sensor
A30 AFS
A7 E4(AFS-RTN)
Press SW
A80 COL
MID Press SW
A78 PRESS
Test SW
B42 TEST
Neutral SW
B55 N-SW
Clutch SW
B53 CL-SW
SED SW
A85 WL-SW
Starter Relay
BATT
A92 STA-REL
B54 STA
M
Starter 1 SW
BATT
IG SW
B47 IG-SW
BATT
Brake 1 SW
B41 BRK1
Brake 2 SW
B40 BRK2
OFF
A62 COM-ASC
A58 E13
CANSEL
ON
SET -
SET +
RESUME
EGR Bypass Valve
EGRB A94
EVRV A89
VGT Solenoid , -EVRV
SCTNC B20
SCTN1 B7
SCV 1
M-REL B33
+B B5
+B B6
IG SW
IG2
IG1 SW
IG2 SW
Main Relay
BATT
+BB B46
Key SW
E01(POWER) B3
E02(POWER) B4
Starter SW
BATT
Power Ground
E1 B1
E2 B2
Starter Relay
INJ-SGND1 A56
TWV1 A74
COMMON1 A73
No. 1 Cylinder
INJ-SGND2 A54
TWV2 A26
COMMON2 A25
No. 3 Cylinder
INJ-SGND3 A55
TWV3 A51
COMMON1 A49
No. 4 Cylinder
INJ-SGND4 A6
TWV4 A3
COMMON2 A1
No. 2 Cylinder
SGND-B B31
A/F+ B26
A/F- B13
HEATER+ B32
A/F Sensor
Q004616E

9.2 ECU Connector Terminal Layout

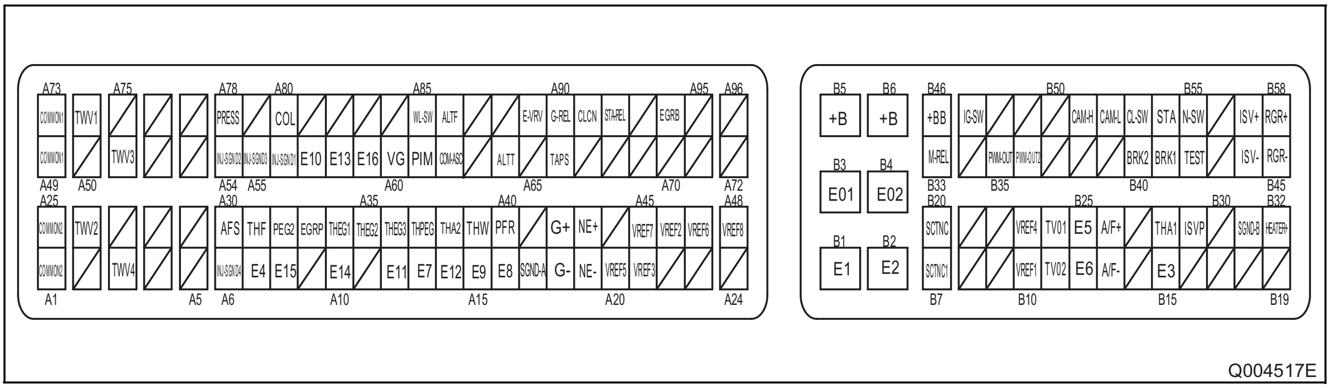
- Changes have been made to the ECU. Terminal layouts are as per the figures below.



MAZDA3



MAZDA6



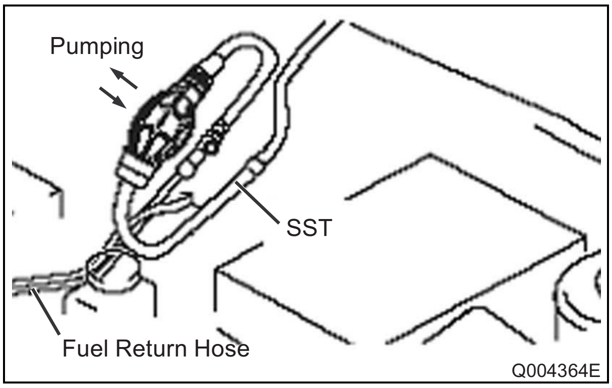
CX-7

10. AIR BLEEDING FROM THE FUEL INTAKE LINE

10.1 Attention

- Do not operate the starter motor for 10 seconds or longer at a time. After 10 seconds, switch the ignition to ON and allow the starter motor to cool for 30 seconds before attempting to start the engine again.

10.2 Procedure



1) Disconnect the fuel return hose.
2) Connect the Special Service Tool (SST).
3) Operate the SST several times.
   a. Operate the hand pump unit of the SST until firm when squeezed.
   b. Squeeze and hold the hand pump unit for 10 seconds.
   c. Release the hand pump.
   d. Repeat steps b and c once again.
4) Disconnect the SST.
5) Connect the fuel return hose.

Attention
Continuously cranking the engine for over 30 seconds may damage the battery and starter.

6) Crank the engine for less than 30 seconds, then stop for 5 to 10 seconds until the engine starts.
   If the engine does not start, return to step 1.

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