

GROUP 13Aa

MULTI PORT FUEL INJECTION (MFI)

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GENERAL INFORMATION

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The Multiport Fuel Injection System consists of sensors which detect the engine conditions, the ENGINE CONTROL MODULE (ECM) which controls the system based on signals from these sensors, and actuators which operate under the control of the ECM. The ECM carries out activities such as fuel injection control, idle air control, and ignition timing control. In addition, the ECM is equipped with several diagnostic test modes which simplify troubleshooting when a problem develops.

FUEL INJECTION CONTROL

The injector drive times and injection timing are controlled so that the optimum air/fuel mixture is supplied to the engine to correspond to the continually-changing engine operation conditions. A single injector is mounted at the intake port of each cylinder. Fuel is sent under pressure from the fuel tank to the fuel injectors by the fuel pump, with the pressure being regulated by the fuel pressure regulator. The regulated fuel is distributed to each of the injectors. Fuel injection is normally carried out once for each cylinder for every two rotations of the crankshaft. The firing order is 1-2-3-4-5-6. Each cylinder has a dedicated fuel injector. This is called multiport. The ECM provides a richer air/fuel mixture by carrying out "open-loop" control when the engine is cold or operating under high load conditions in order to maintain engine performance. In addition, when the engine is under normal operating temperature after warming-up, the ECM controls the air/fuel mixture by using the heated oxygen sensor signal to carry out "closed-loop" control. The closed-loop control achieves the theoretical air/fuel mixture ratio where the catalytic converter can obtain the maximum cleaning performance.

THROTTLE VALVE OPENING CONTROL

This system electrically controls the opening of the throttle valve. The ECM detects the amount of travel of the accelerator pedal via the accelerator pedal position sensor, and controls the actuation of the throttle actuator control motor, which is mounted on the throttle body, in order to attain the target throttle valve opening that has been predetermined in accordance with driving conditions.

IDLE AIR CONTROL

The idle speed is kept at the optimum speed by controlling the amount of air that passes through the throttle valve in accordance with changes in idling conditions and engine load during idling.

The ECM drives the throttle actuator control motor to keep the engine running at the pre-set idle target speed in accordance with the engine coolant temperature and A/C and other electrical load. In addition, when the air conditioning switch is turned off and on while the engine is idling, the throttle actuator control motor adjusts the throttle valve pass-through air amount according to the engine load conditions to avoid fluctuations in the engine speed.

IGNITION TIMING CONTROL

The ignition power transistor located in the ignition primary circuit turns ON and OFF to control the primary current flow to the ignition coil. This controls the ignition timing to provide the optimum ignition timing with respect to the engine operating conditions. The ignition timing is determined by the ECM from engine speed, intake air volume, engine coolant temperature, and atmospheric pressure.

DIAGNOSTIC TEST MODE

- When a fault is detected in one of the sensors or actuators related to emission control, the Malfunction Indicator Lamp (SERVICE ENGINE SOON or Check Engine Lamp) illuminates to warn the driver.
- When a fault is detected in one of the sensors or actuators, a diagnostic trouble code corresponding to the fault is stored in the ECM.
- The RAM data inside the ECM that is related to the sensors and actuators can be read with the scan tool. In addition, the actuators can be controlled by scan tool MB991958 (M.U.T.-III sub assembly) under certain circumstances.

OTHER CONTROL FUNCTIONS**Fuel Pump Control**

- Turns the fuel pump relay ON so that current is supplied to the fuel pump while the engine is cranking or running.

GENERAL INFORMATION

A/C Compressor Clutch Relay Control

- Turns the compressor clutch of the A/C ON and OFF.

Generator Output Current Control

- Prevent generator output current from increasing suddenly and idle speed from dropping at times such as when the headlights are turned on.

Evaporative Emission Purge Control

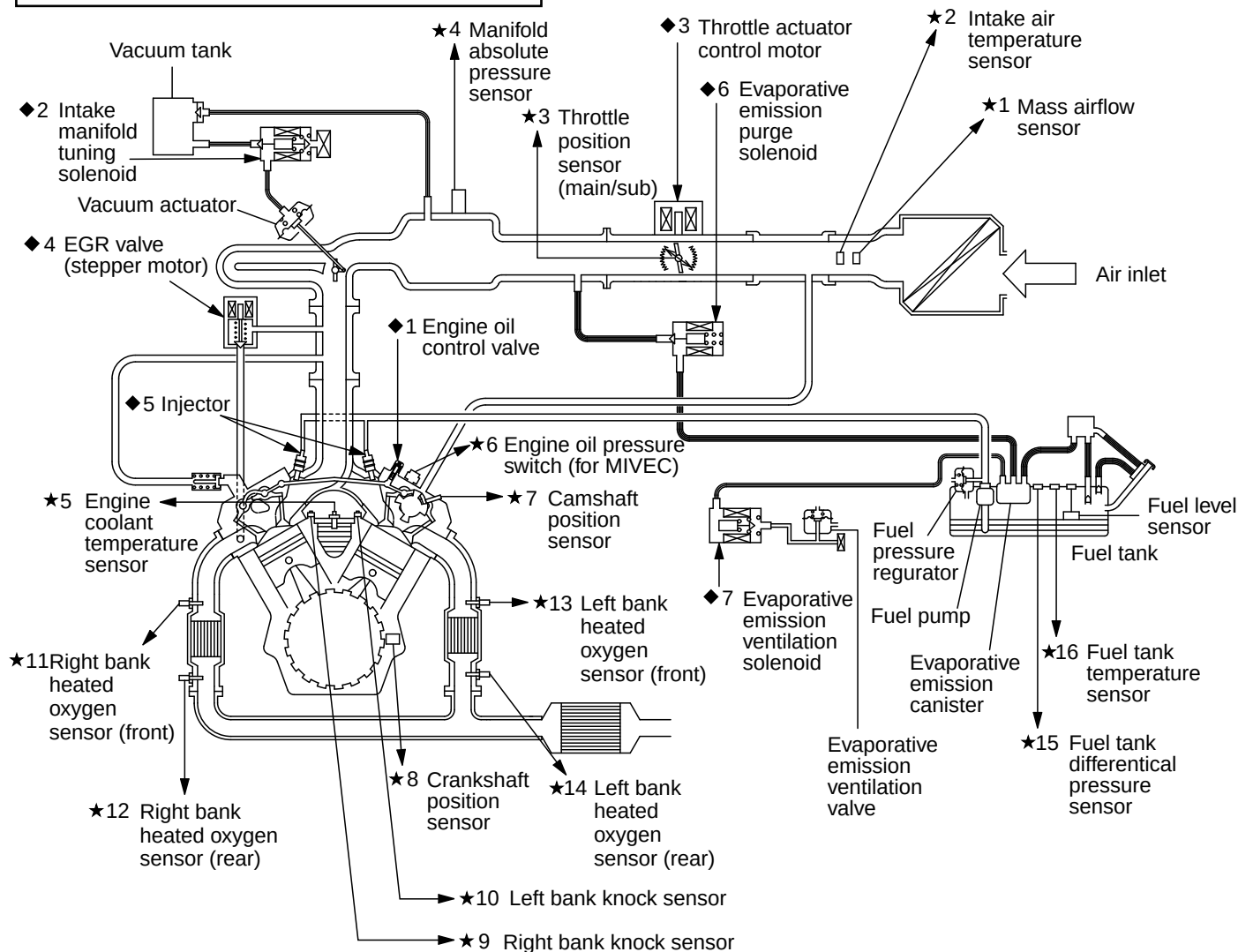
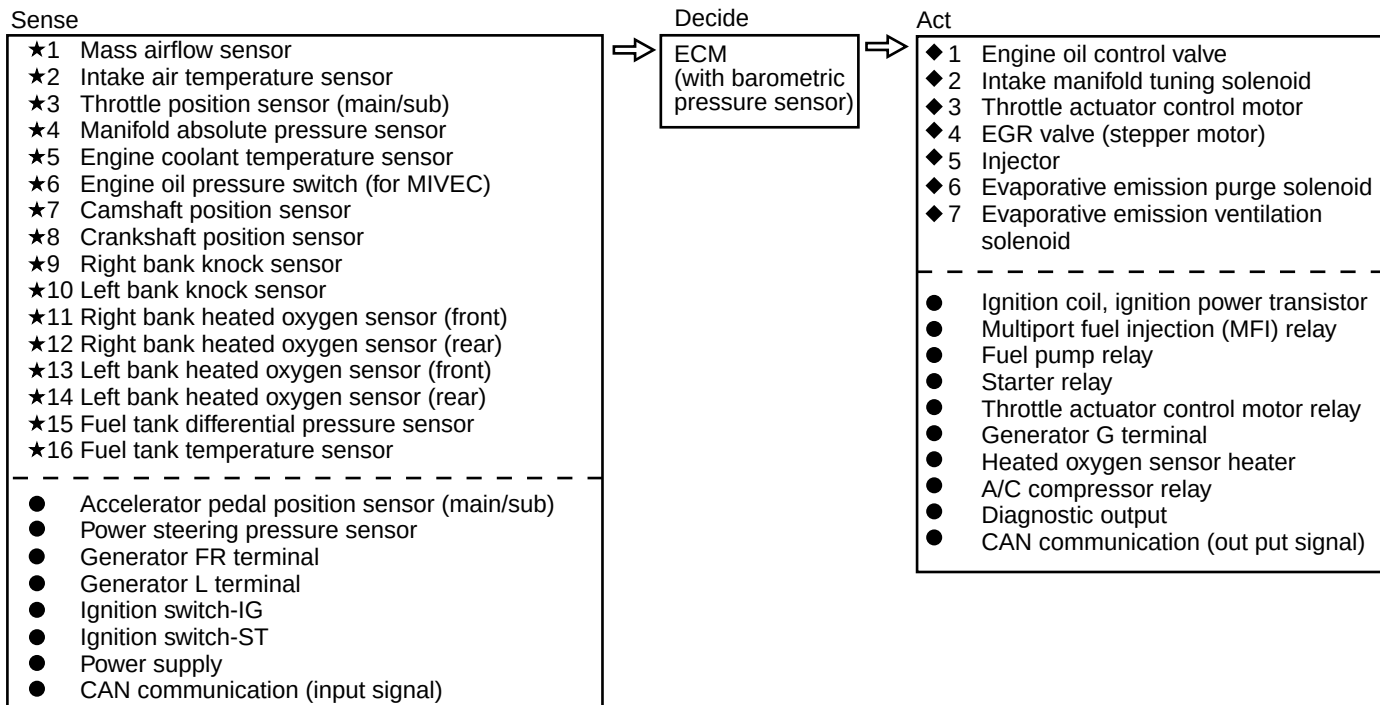
- (Refer to GROUP 17, Emission Control System - Evaporative Emission System - General Description P.17c-3.)

EGR Control

- (Refer to GROUP 17, Emission Control System - Exhaust Gas Recirculation (EGR) System - General Description P.17c-13.)

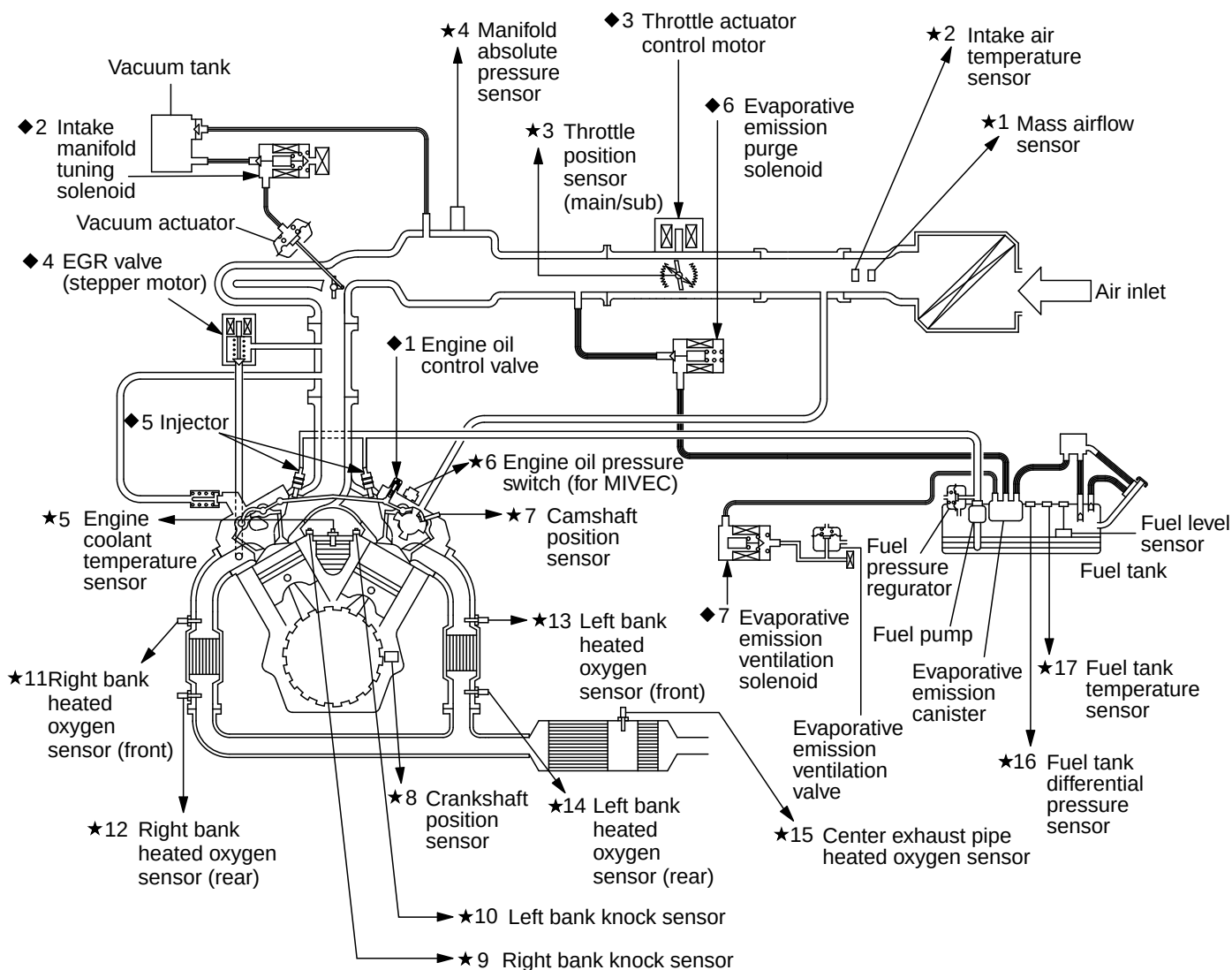
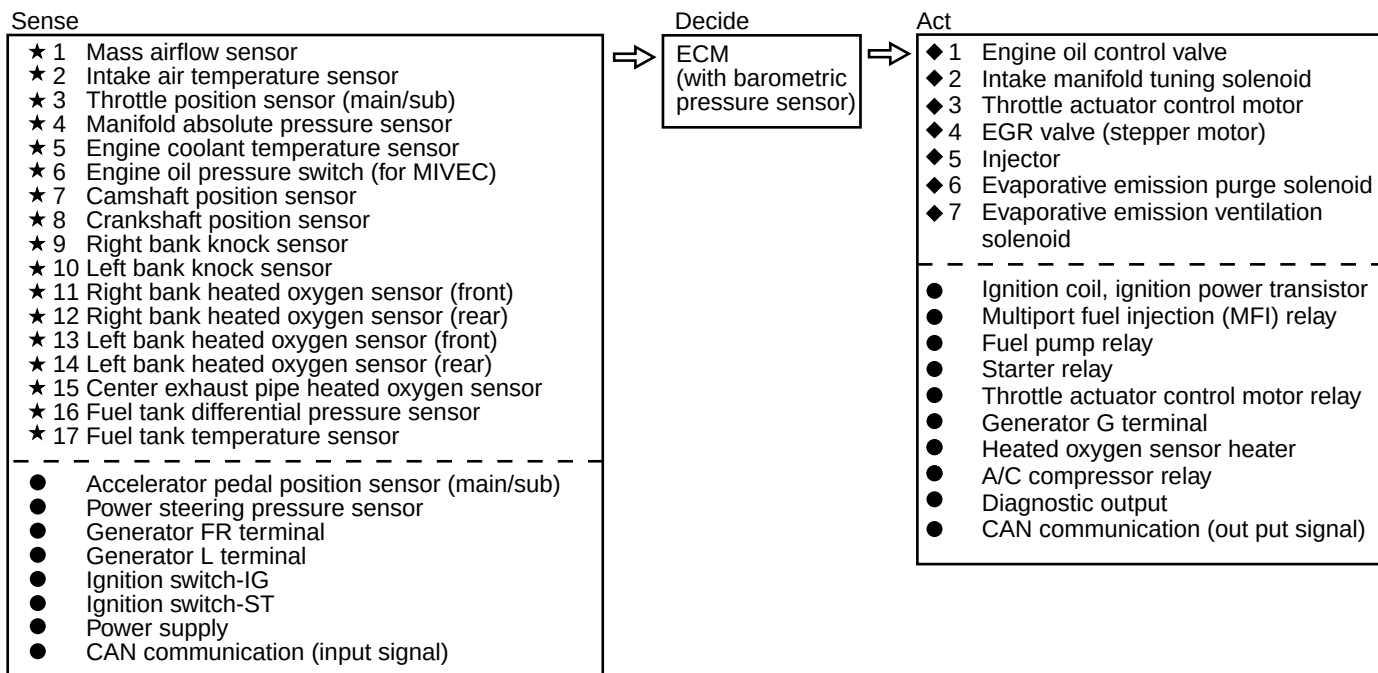
MULTIPOINT FUEL INJECTION (MFI) SYSTEM DIAGRAM

<Except for California>



*NOTE: For the vacuum routing, refer to GROUP 17,
Emission Control - Vacuum Hoses - Vacuum Hose
Routing P. 17c-5*

<California>



*NOTE: For the vacuum routing, refer to GROUP 17,
Emission Control - Vacuum Hoses - Vacuum Hose
Routing P. 17c-5*

SPECIFICATION(S)

GENERAL SPECIFICATION(S)

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ITEMS		SPECIFICATIONS
Throttle body	Throttle bore mm (in.)	65 (2.56)
	Throttle position sensor	Hall element type
	Throttle actuator control motor	DC motor type, having brushes
Engine control module (ECM)	Identification model No.	E6T70475 <Federal-FWD>
		E6T70476 <Federal-AWD>
		E6T70477 <California-FWD>
		E6T70478 <California-AWD>
Sensors	Mass airflow sensor	Heat sensitizing type
	Barometric pressure sensor	Semiconductor type
	Intake air temperature sensor	Thermistor type
	Engine coolant temperature sensor	Thermistor type
	Heated oxygen sensor	Zirconia type
	Accelerator pedal position sensor	Hall element type
	Camshaft position sensor	Magneto resistance element type
	Crankshaft position sensor	Magneto resistance element type
	Knock sensor	Piezoelectric type
	Power steering pressure sensor	Semiconductor type
	Manifold absolute pressure sensor	Semiconductor type
Actuators	Multiport fuel injection (MFI) relay	Contact switch type
	Fuel pump relay	Contact switch type
	Throttle actuator control motor relay	Contact switch type
	Injector type and number	Electromagnetic type, 6
	Injector identification mark	JLN240B
	Engine oil control valve	Duty cycle type solenoid valve
	Exhaust gas recirculation (EGR) valve	Stepper motor type
	Evaporative emission purge solenoid	Duty cycle type solenoid valve
	Intake manifold tuning solenoid	ON/OFF control type solenoid valve

SERVICE SPECIFICATION(S)

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ITEMS	STANDARD VALUE
Fuel pressure kPa (psi)	Approximately 324 (47) at curb idle

**MULTIPOINT FUEL INJECTION (MFI)
SPECIFICATION(S)**

ITEMS		STANDARD VALUE
Intake air temperature sensor resistance kΩ	-20°C (-4°F)	13 - 17
	0°C (32°F)	5.3 - 6.7
	20°C (68°F)	2.3 - 3.0
	40°C (104°F)	1.0 - 1.5
	60°C (140°F)	0.56 - 0.76
	80°C (176°F)	0.30 - 0.45
Engine coolant temperature sensor resistance kΩ	-20°C (-4°F)	14 - 17
	0°C (32°F)	5.1 - 6.5
	20°C (68°F)	2.1 - 2.7
	40°C (104°F)	0.9 - 1.3
	60°C (140°F)	0.48 - 0.68
	80°C (176°F)	0.26 - 0.36
Heated oxygen sensor output voltage V		0.6 - 1.0
Heated oxygen sensor heater resistance Ω	Front	4.5 - 8.0 [at 20°C (68°F)]
	Rear, Center exhaust pipe	11 - 18 [at 20°C (68°F)]
Injector coil resistance Ω		10.5 - 13.5 [at 20°C (68°F)]
Throttle actuator control motor coil resistance Ω		0.3 - 80 [at 20°C (68°F)]
Engine oil control valve coil resistance Ω		6.9 - 7.9 [at 20°C (68°F)]

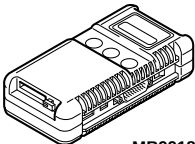
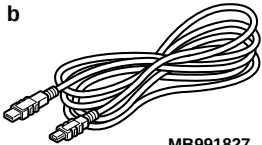
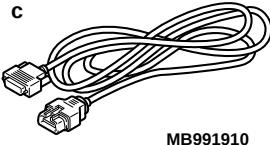
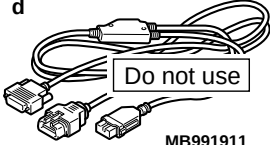
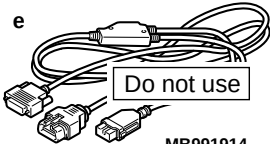
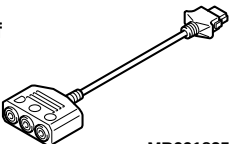
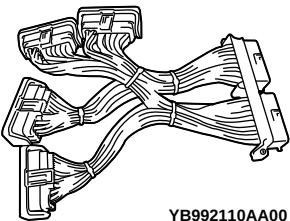
SEALANT AND ADHESIVE

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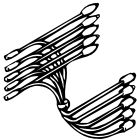
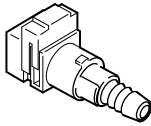
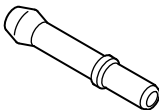
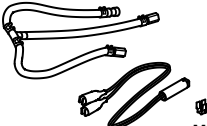
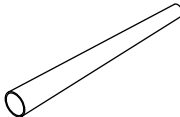
ITEM	SPECIFIED SEALANT
Engine coolant temperature sensor threaded portion	3M™ AAD part number 8731 or equivalent

SPECIAL TOOLS

M11301000006USA0000010000

TOOL	TOOL NUMBER AND NAME	SUPERSESSION	APPLICATION
a  MB991824 b  MB991827 c  MB991910 d  MB991911 e  MB991914 f  MB991825 g  MB991826 YB991958 AA00	MB991958 A: MB991824 B: MB991827 C: MB991910 D: MB991911 E: MB991914 F: MB991825 G: MB991826 M.U.T.-III sub assembly A: Vehicle Communication Interface (V.C.I.) B: M.U.T.-III USB Cable C: M.U.T.-III Main Harness A (Vehicles with CAN communication system) D: M.U.T.-III Main Harness B (Vehicles without CAN communication system) E: M.U.T.-III Main Harness C (for Daimler Chrysler models only) F: M.U.T.-III Measurement Adapter G: M.U.T.-III Trigger Harness	MB991824-KIT <i>NOTE: G: MB991826 M.U.T.-III Trigger Harness is not necessary when pushing V.C.I. ENTER key.</i>	• Reading diagnostic trouble code • MFI system inspection • Measurement of fuel pressure CAUTION For vehicles with CAN communication, use M.U.T.-III main harness A to send simulated vehicle speed. If you connect M.U.T.-III main harness B instead, the CAN communication does not function correctly.
 YB992110AA00	MB992110 Power plant ECU check harness	-	• Inspection using an oscilloscope • Inspection of the engine control module (ECM) terminal voltage check

**MULTIPOINT FUEL INJECTION (MPI)
SPECIAL TOOLS**

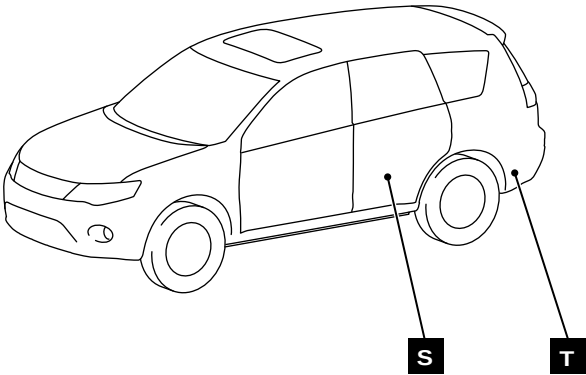
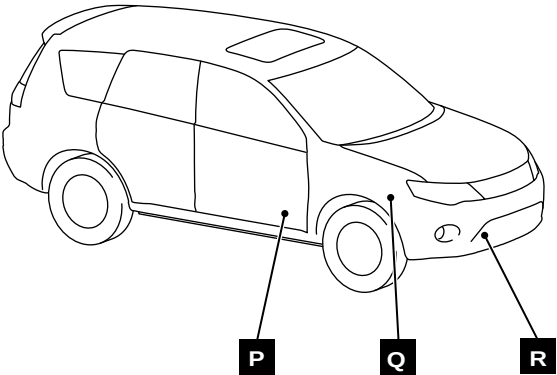
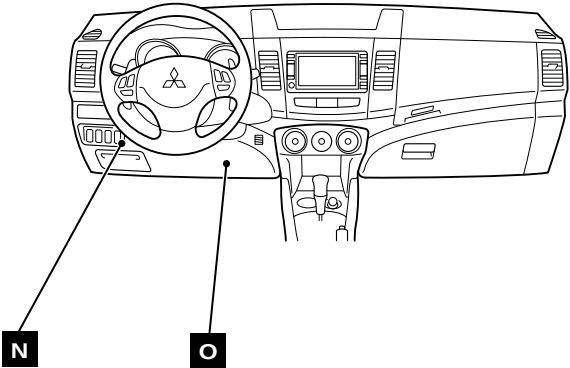
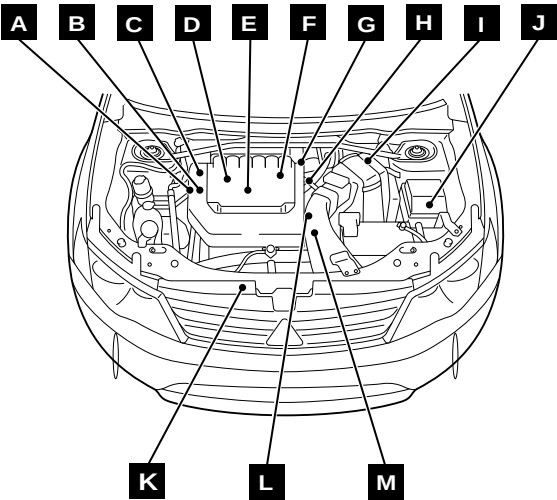
TOOL	TOOL NUMBER AND NAME	SUPERSESSION	APPLICATION
	MB991709 Test harness set	MB991709-01	Inspection using an oscilloscope
 MB991658	MB991658 Test harness set	Tool not available	• Inspection using an oscilloscope • Adjustment of accelerator pedal position sensor • Inspection of heated oxygen sensor
	MD998464 Test harness (4 pin, square)	MD998464-01	Inspection of heated oxygen sensor
	MB991316 Test harness (4 pin, square)	Tool not available	Inspection of heated oxygen sensor
 MB992049	MB992049	MB992049-01	Measurement of fuel pressure
 MB992001	MB992001	MB992049-01	Measurement of fuel pressure
 MB991981	MB991981 Fuel pressure gauge set	Tool not available	Measurement of fuel pressure
 MB992076	MB992076	Injector test set	Measurement of fuel pressure
 YB992106AA00	MB992106 O-ring installer	-	Installation of O-ring on injector injection nozzle side

ON-VEHICLE SERVICE

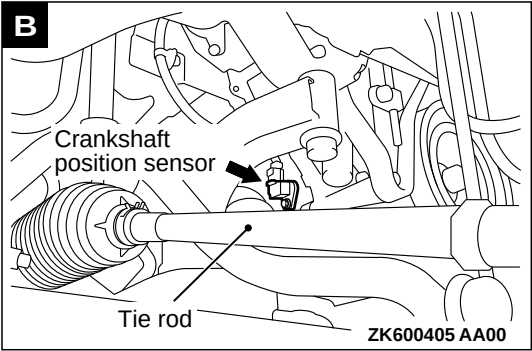
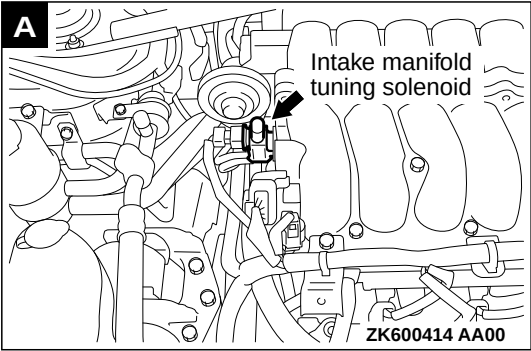
COMPONENT LOCATION

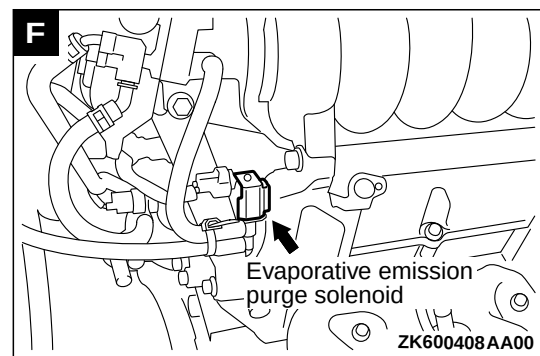
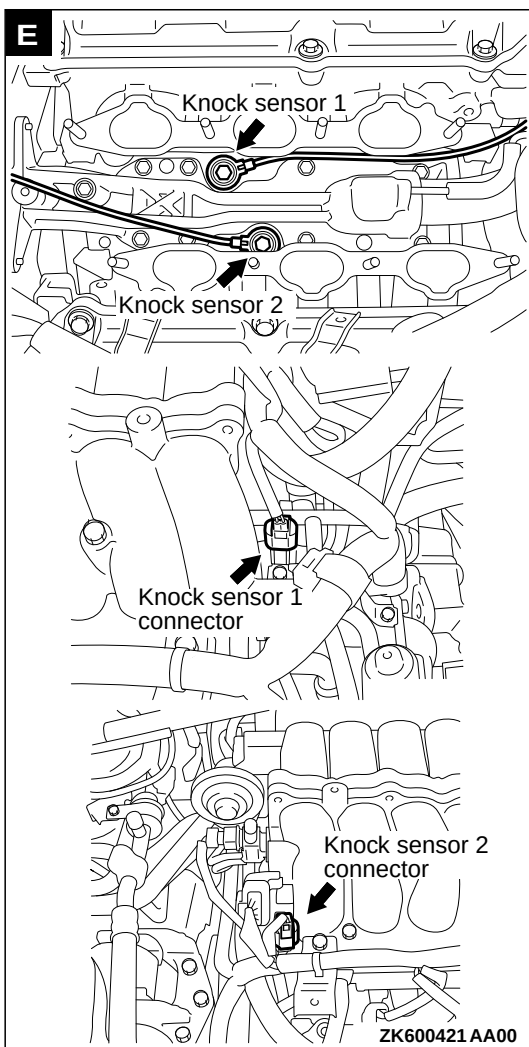
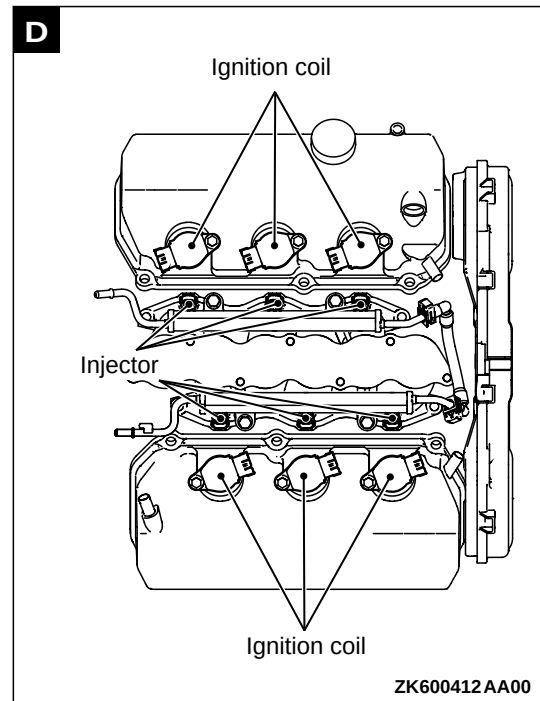
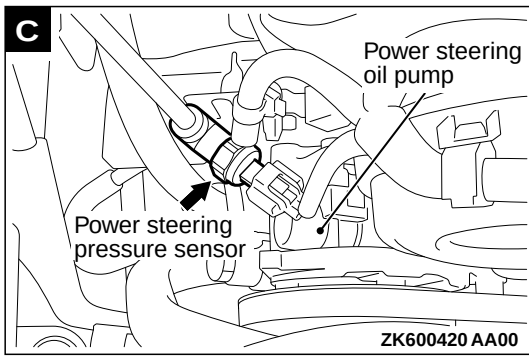
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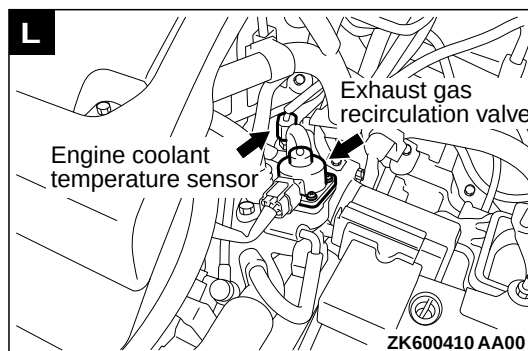
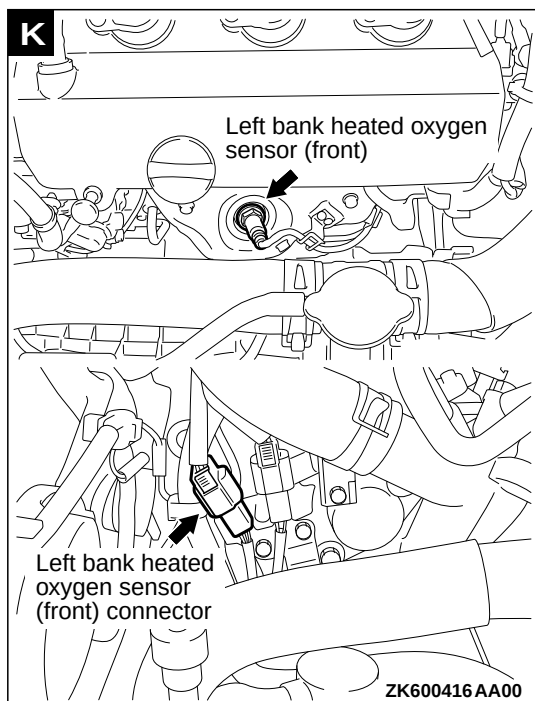
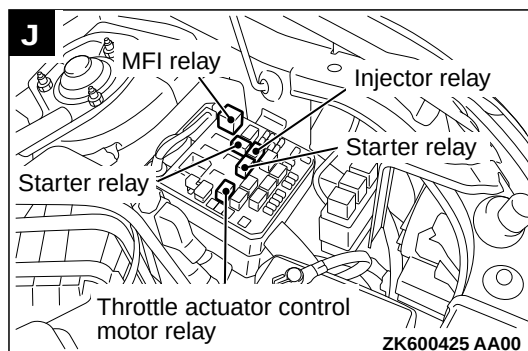
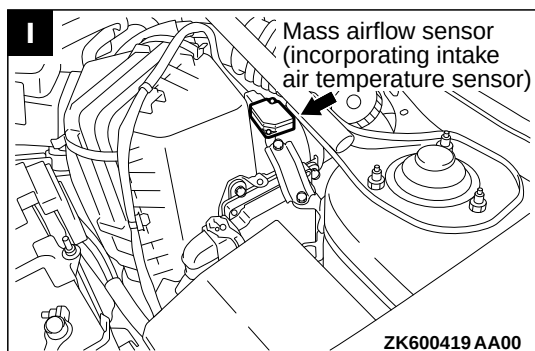
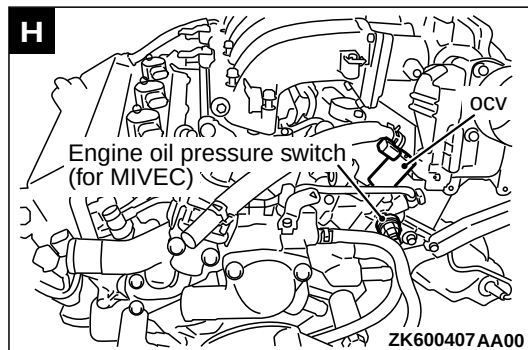
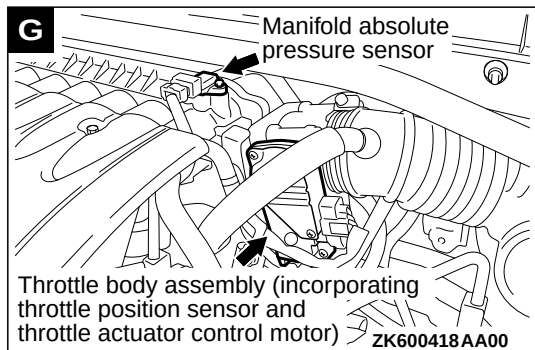
NAME	SYMBOL	NAME	SYMBOL
Accelerator pedal position sensor	O	Injector relay	J
Camshaft position sensor	M	Intake manifold turning solenoid	A
Crankshaft position sensor	B	Knock sensor 1	E
Center exhaust pipe heated oxygen sensor	P	Knock sensor 2	E
Engine coolant temperature sensor	L	Left bank heated oxygen sensor (front)	K
Engine oil control valve	H	Left bank heated oxygen sensor (rear)	R
Engine oil pressure switch (for MIVEC)	H	Manifold absolute pressure sensor	G
Evaporative emission purge solenoid	F	Mass airflow sensor (with built-in intake air temperature sensor)	I
Evaporative emission ventilation solenoid	T	Multiport fuel injection (MFI) relay	J
Exhaust gas recirculation (EGR) valve (Stepper motor)	L	Power steering pressure sensor	C
Fuel pump relay	N	Right bank heated oxygen sensor (front)	Q
Fuel tank differential pressure sensor	S	Right bank heated oxygen sensor (rear)	Q
Fuel pump module (with built-in fuel tank temperature sensor)	S	Starter relay	J
		Throttle actuator control motor	G
Ignition coil	D	Throttle actuator control motor relay	J
Injector	D	Throttle position sensor	G

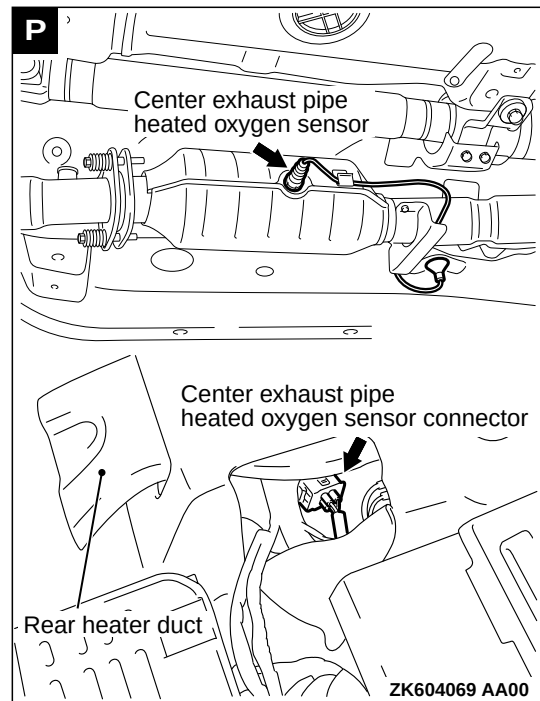
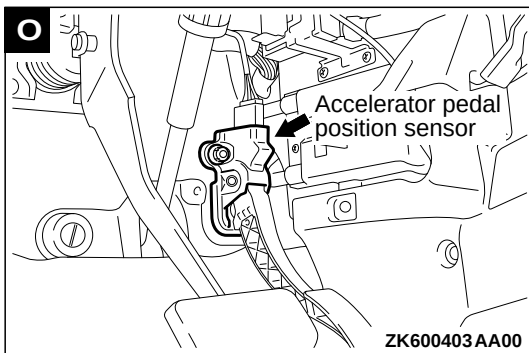
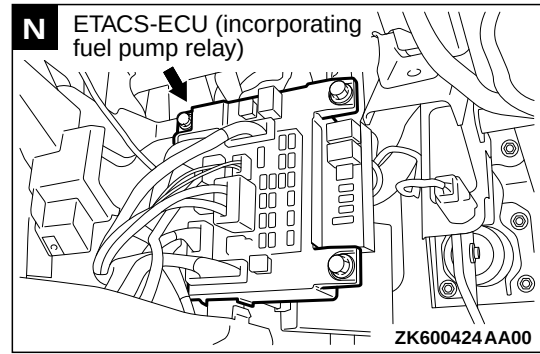
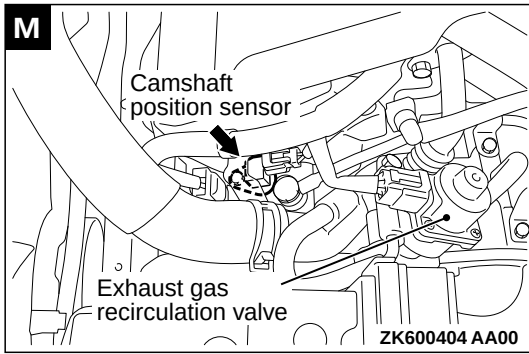


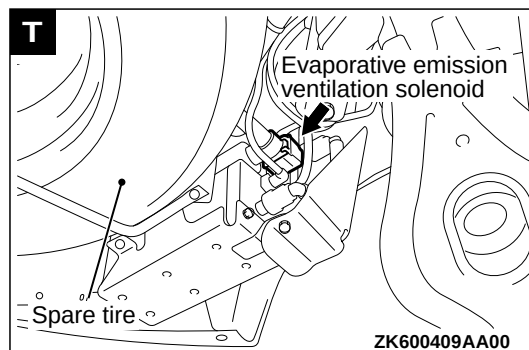
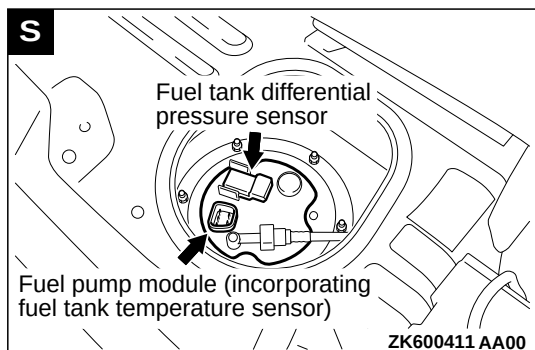
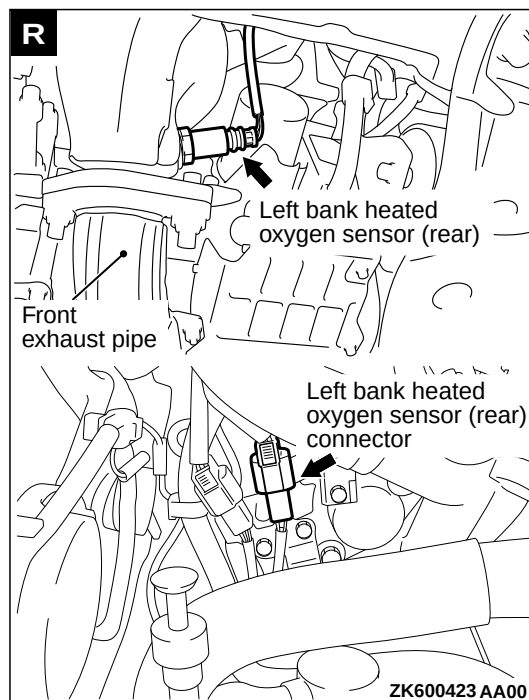
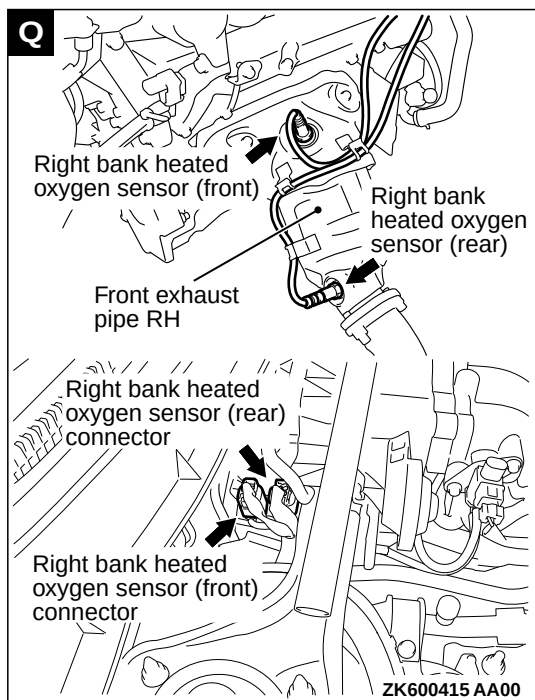
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THROTTLE BODY (THROTTLE VALVE AREA) CLEANING

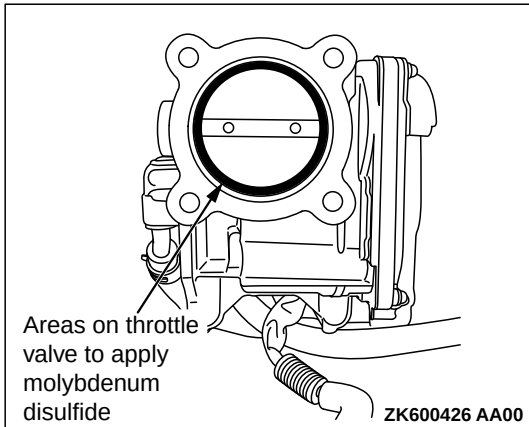
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⚠ WARNING

If the throttle valve is in operation, a finger might be injured as the result of being caught by the throttle valve. Make sure that the ignition switch is surely in "LOCK"(OFF) position before the service in order that the throttle valve cannot be operation.

⚠ CAUTION

- When the throttle body cleaning is performed, use scan tool MB991958 to initialize the learning value (Refer to GROUP 00, Initialization Procedure for Learning Value in MFI Engine).
- Do not spray the cleaning solvent directly to the throttle valve.



- Make sure the cleaning solvent does not enter the motor and the sensor through the shaft.
- Do not remove molybdenum, which is applied around the throttle valve of the throttle body.

1. Remove the throttle body.
2. Spray cleaning solvent on a clean cloth.
3. Wipe off the dirt around the throttle valve with the cloth sprayed with cleaning solvent.
4. Attach the throttle body.

FUEL PRESSURE TEST

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Required Special Tools:

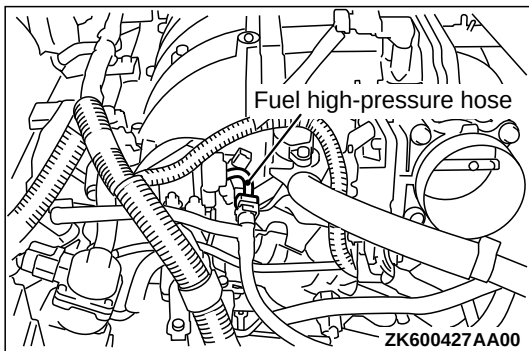
- MB991958: Scan tool (M.U.T.-III Sub Assembly)
 - MB991824: V.C.I.
 - MB991827: USB Cable
 - MB991910: Main Harness A
- MB991981: Fuel Pressure Gauge Set
- MB992001: Hose Adaptor
- MB992049: Quick Connector
- MB992076: Injector Test Set

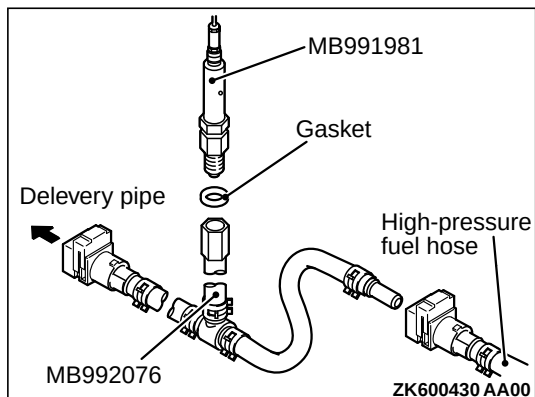
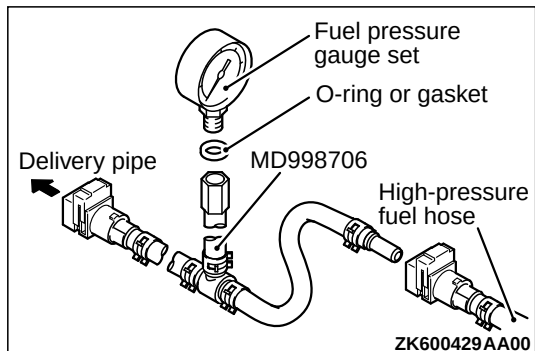
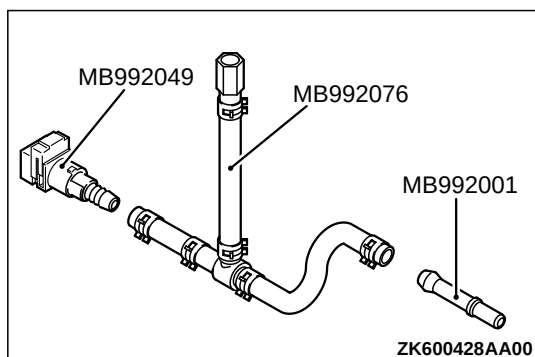
1. Release residual pressure from the fuel line to prevent fuel spray. (Refer to P.13Aa-20.)

⚠ WARNING

To prevent a fire, cover the hose connection with shop towels to prevent splashing of fuel that could be caused by some residual pressure in the fuel pipe line.

2. Disconnect the fuel high-pressure hose at the fuel rail side.





3. Assemble the special tool MB992076 (injector test set) of special tool as shown in figure.

4. Remove either the installation adapter for the injector or another adapter.

5. Install the special tool MB992049 (quick connector) and the special tool MB992001 (hose adapter) to the hose without the adapter.

6. Assemble the fuel pressure measurement tools as follows.

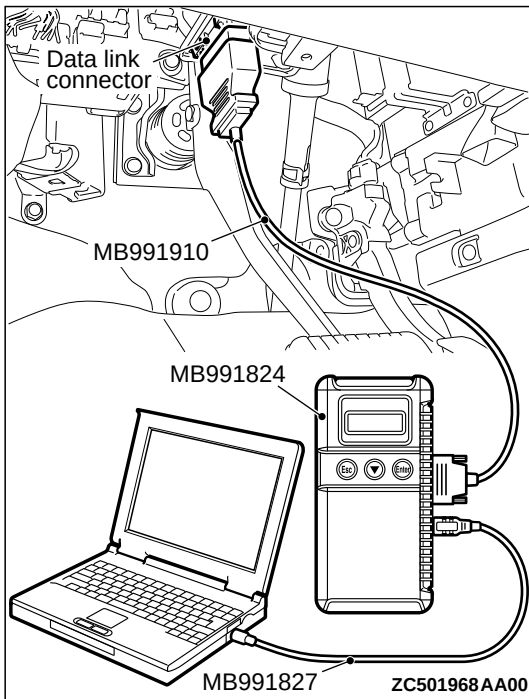
<When using the fuel pressure gauge>

- Via a suitable O-ring or gasket, install the fuel pressure gauge to the special tool that has already assembled as described.

<When using special tool MB991981 (fuel pressure gauge set)>

- Via a gasket, install the special tool MB991981 (fuel pressure gauge set) into the special tool that has already assembled as described.

7. Install the assembled fuel pressure measurement tools between the fuel rail and fuel high-pressure hose.



CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool MB991958.

8. Connect scan tool MB991958 to the data link connector.
9. Use Actuator test 9 to drive the fuel pump. Check that there is no fuel leaking from any section when the fuel pump is operating.
10. Stop the fuel pump.
11. Start the engine and run at idle.
12. Measure fuel pressure while the engine is running at idle.
Standard value: Approximately 324 kPa (47 psi) at curb idle
13. Check to see that fuel pressure at idle does not drop even after the engine has been revved several times.
14. If any of fuel pressure measured in steps 12 to 13 is out of specification, troubleshoot and repair according to the table below.

SYMPTOM	PROBABLE CAUSE	REMEDY
*Fuel pressure too low *Fuel pressure drops after revving	Clogged fuel filter	Replace fuel filter
	Fuel leaking to return side due to poor fuel regulator valve seating or settled spring	Replace fuel pressure regulator
	Low fuel pump delivery pressure	Replace fuel pump
Fuel pressure too high	Binding valve in fuel pressure regulator	Replace fuel pressure regulator

15. Stop the engine and observe fuel pressure gauge reading. It is normal if the reading does not drop within two minutes. If it does, observe the rate of drop and troubleshoot and repair according to the table below. Start, then stop the engine.
 - (1) Squeeze the fuel supply line closed to confirm leak-down occurs from defective fuel pump check valve.
 - (2) If pressure continues to drop with both fuel lines squeezed closed, injector(s) are leaking.

SYMPTOM	PROBABLE CAUSE	REMEDY
Fuel pressure drops gradually after engine is stopped	Leaky injector	Replace injector
	Leaky fuel regulator valve seat	Replace fuel pressure regulator
Fuel pressure drops sharply immediately after engine is stopped	Check valve in fuel pump is held open	Replace fuel pump

16. Release residual pressure from the fuel pipe line. (Refer to P.13Aa-20.)

WARNING

Cover the hose connection with shop towels to prevent splash of fuel that could be caused by some residual pressure in the fuel pipe line.

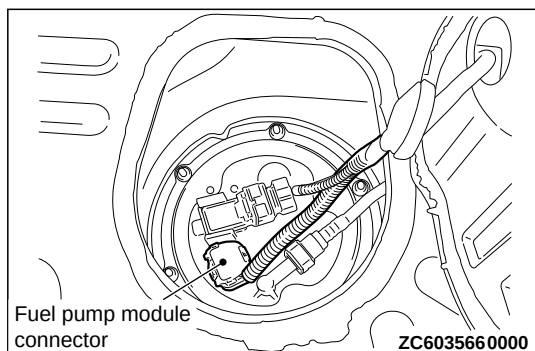
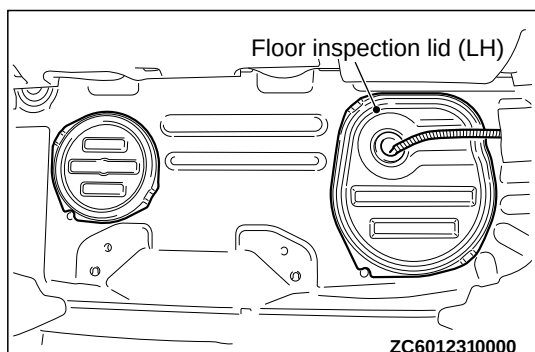
17. Remove the fuel pressure gauge and special tool from the delivery pipe.
18. Fit the fuel high-pressure hose to the delivery pipe.
19. Check for fuel leaks.
 - (1) Use scan tool MB991958 to operate the fuel pump.
 - (2) Check the fuel line for leaks and repair as needed.
20. Disconnect scan tool MB991958.

FUEL PUMP CONNECTOR DISCONNECTION (HOW TO REDUCE PRESSURIZED FUEL LINES)

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When removing the fuel pipes and fuel hoses, follow the procedure below to release fuel pressure in the line and prevent fuel from running out, because fuel pressure in the fuel line is high.

1. Remove the rear seat assembly (Refer to GROUP 52A, Second Seat Assembly P.52A-21) and turn up the floor carpet.
2. Remove the floor inspection lid (LH).

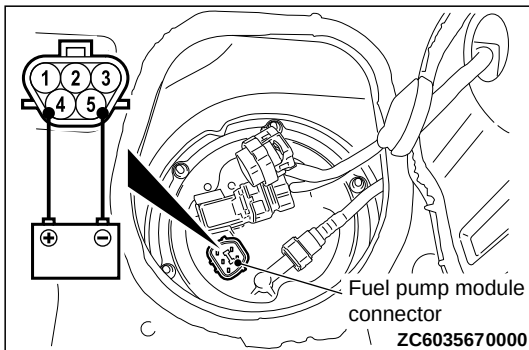
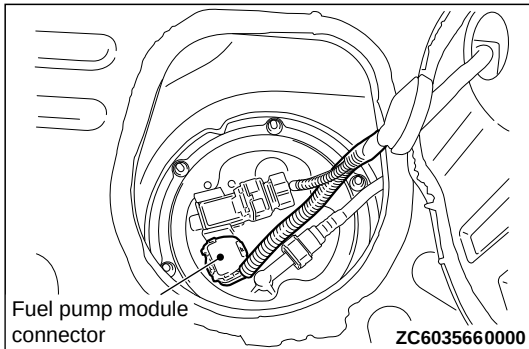
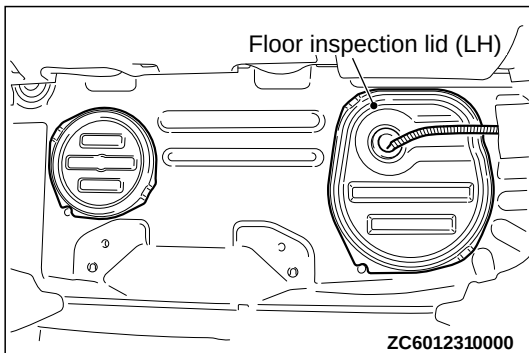


3. Remove the connector of fuel pump module.
4. Crank the engine for at least two seconds.
5. If the engine does not start, turn the ignition switch to the "LOCK" (OFF) position.
6. If the engine starts, turn the ignition switch to the "LOCK" (OFF) position after the engine stops.
7. Connect the fuel pump module connector.
8. Install the floor inspection lid (LH).
9. Return the floor carpet to the original condition and install the rear seat assembly (Refer to GROUP 52A, Second Seat Assembly P.52A-21).

FUEL TANK PUMP OPERATION CHECK

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1. Using the scan tool, activate the fuel tank pump (integrated in the fuel tank pump module) to check the fuel tank pump operation.



2. If the fuel tank pump does not operate, follow the procedure below to check the pump for operation. If it is normal, check the driving circuit.

- (1) Turn the ignition switch to the "LOCK" (OFF) position.
- (2) Remove the rear seat assembly (Refer to GROUP 52A, Second Seat Assembly P.52A-21) and turn up the floor carpet.
- (3) Remove the floor inspection lid (LH).
- (4) Disconnect the connector of the fuel pump module.
- (5) When the battery is connected to the fuel pump module connector (fuel pump module side), check that the pump operating sound can be heard. When the pump operating sound cannot be heard, replace the fuel pump module. (Refer to GROUP 13B, On-Vehicle Service - Fuel Pump Module Replacement P.13B-7) <FWD> or (Refer to GROUP 13B, On-Vehicle Service - Fuel Pump Module Replacement P.13B-9) <AWD>.

NOTE: The operating sound of the fuel pump is difficult to be heard because the pump is in-tank type. Therefore, remove the fuel filler cap to check the sound from the fuel filler port.

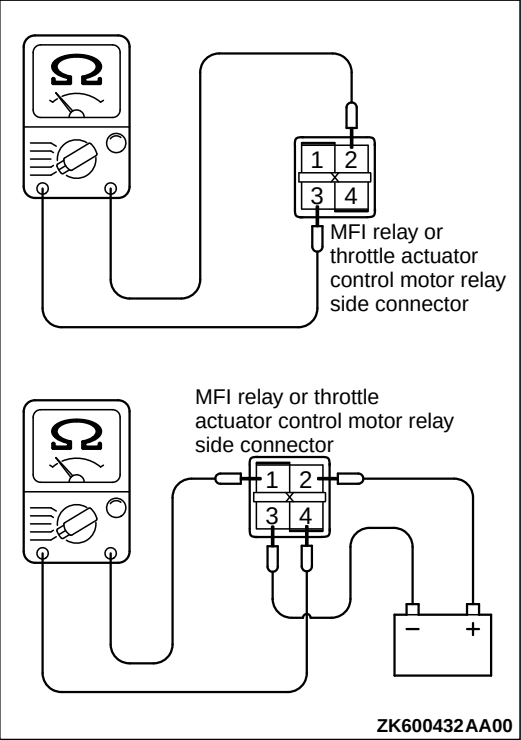
- (6) Connect the fuel pump module connector.
- (7) Install the floor inspection lid (LH).
- (8) Return the floor carpet to the original condition and install the rear seat assembly (Refer to GROUP 52A, Second Seat Assembly P.52A-21).

MULTIPOINT FUEL INJECTION (MFI) RELAY
CONTINUITY CHECK

M11301000500USA0000010000

Inspect the MFI relay for continuity in accordance with the chart shown below.

BATTERY VOLTAGE	TERMINAL NO. TO BE CONNECTED TO BATTERY	TERMINAL NO. TO BE CONDUCTED
Not supplied	-	1 - 3
Supplied	1 - 3	2 - 4

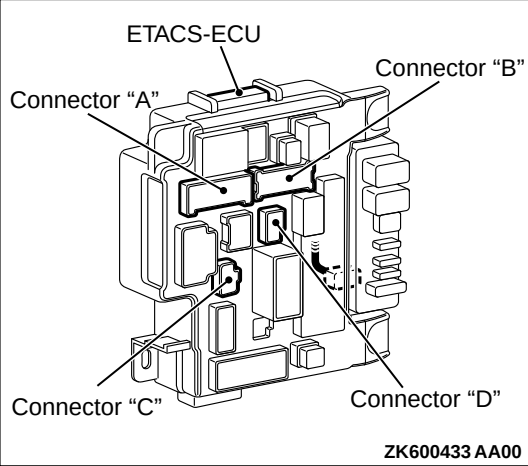


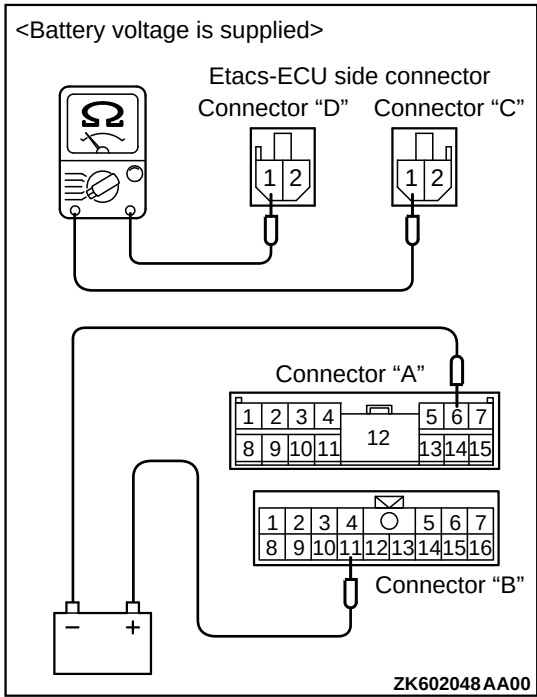
FUEL PUMP RELAY CONTINUITY CHECK

M11301000330USA0000010000

Inspect the fuel pump relay for continuity in accordance with the chart shown below.

BATTERY VOLTAGE	TERMINAL NO. TO BE CONNECTED TO BATTERY	TERMINAL NO. TO BE CONDUCTED
Not supplied	-	6 (Connector "A") - 11 (Connector "B")
Supplied	6 (Connector "A") - 11 (Connector "B")	1 (Connector "C") - 1 (Connector "D")



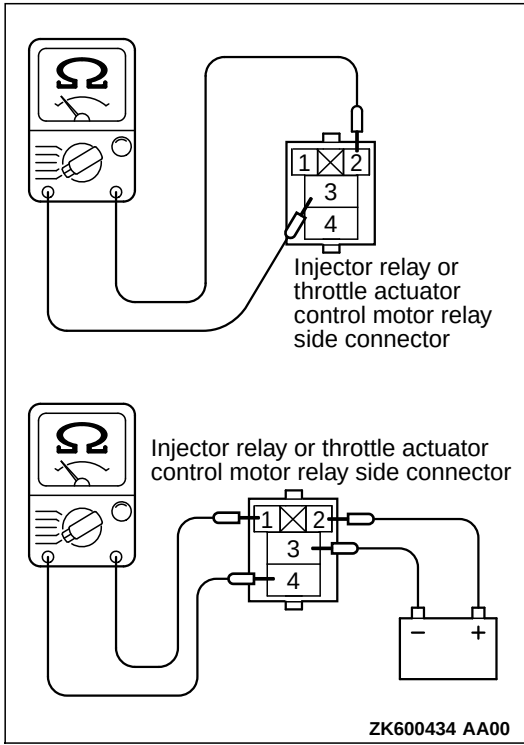


INJECTOR RELAY AND THROTTLE ACTUATOR CONTROL MOTOR RELAY CONTINUITY CHECK

M11301000903USA0000010000

Inspect the Injector relay and throttle actuator control motor relay for continuity in accordance with the chart shown below.

BATTERY VOLTAGE	TERMINAL NO. TO CONNECTED TO BATTERY	TERMINAL NO. TO CONDUCTED
Not supplied	-	1 - 2
Supplied	1 - 2	3 - 4



INTAKE AIR TEMPERATURE SENSOR CHECK

M11301000028USA0000010000

- 1. Disconnect the mass airflow sensor connectors.
- 2. Measure resistance between terminals 1 and 4.

Standard value:
13 - 17 kΩ [at -20°C (-4°F)]
5.3 - 6.7 kΩ [at 0°C (32°F)]
2.3 - 3.0 kΩ [at 20°C (68°F)]
1.0 - 1.5 kΩ [at 40°C (104°F)]
0.56 - 0.76 kΩ [at 60°C (140°F)]
0.30 - 0.45 kΩ [at 80°C (176°F)]

- 3. If not within specifications, replace the mass airflow sensor.
- 4. Measure resistance while heating the sensor using a hair dryer.

Normal condition:

TEMPERATURE	RESISTANCE (kΩ)
Higher	Smaller

- 5. If resistance does not decrease as heat increases, replace the mass airflow sensor.

ENGINE COOLANT TEMPERATURE SENSOR CHECK

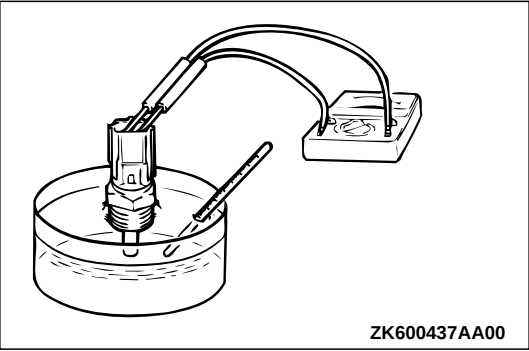
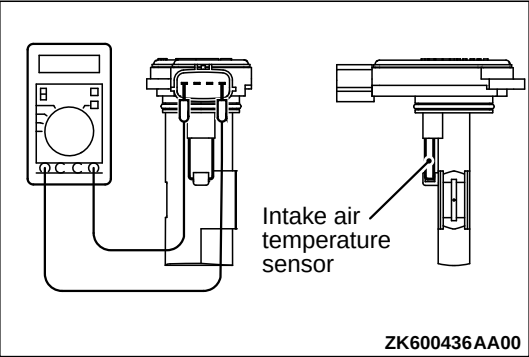
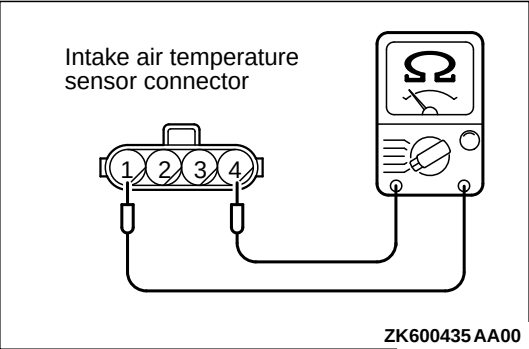
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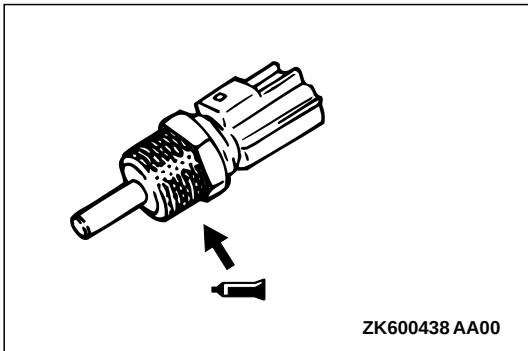
CAUTION

Be careful not to touch the connector (resin section) with the tool when removing and installing.

- 1. Drain engine coolant, then remove the engine coolant temperature sensor.
- 2. With the temperature sensing portion of engine coolant temperature sensor immersed in hot water, check the resistance.

Standard value:
14 - 17 kΩ [at -20°C (-4°F)]
5.1 - 6.5 kΩ [at 0°C (32°F)]
2.1 - 2.7 kΩ [at 20°C (68°F)]
0.9 - 1.3 kΩ [at 40°C (104°F)]
0.48 - 0.68 kΩ [at 60°C (140°F)]
0.26 - 0.36 kΩ [at 80°C (176°F)]





3. If resistance deviates from the standard value greatly, replace the sensor.
4. Apply 3M™ AAD part number 8731 or equivalent to threaded portion.
5. Install the engine coolant temperature sensor and tighten it to the specified torque.

Tightening torque: 30 ± 9 N·m (22 ± 7 ft-lb)

HEATED OXYGEN SENSOR CHECK

M11301000050USA0000010000

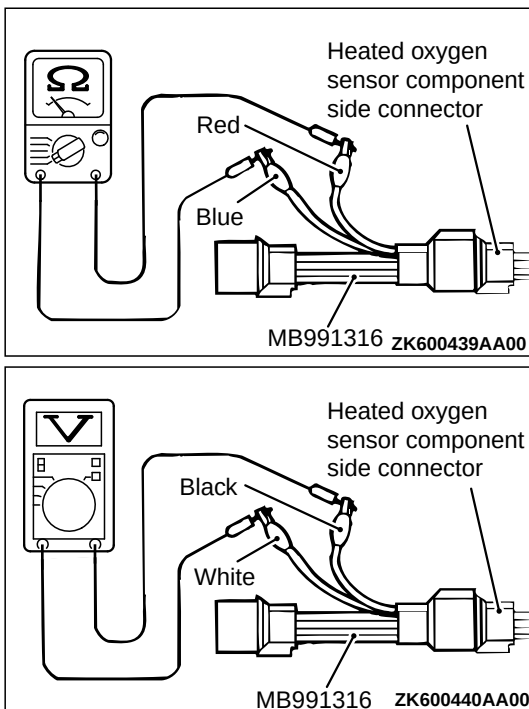
Required Special Tools:

- MB991958: Scan tool (M.U.T.-III Sub Assembly)
- MB991824: V.C.I.
- MB991827: USB Cable
- MB991910: Main Harness A
- MB991316: Test Harness
- MD998464: Test Harness
- MB991658: Test Harness

<Right bank heated oxygen sensor (front)>

1. Disconnect the heated oxygen sensor connector and connect special tool MB991316 to the connector on the heated oxygen sensor side.
2. Make sure that there is continuity [4.5-8.0 ohms at 20°C (68°F)] between terminal No. 1 (red clip) and terminal No. 3 (blue clip) on the heated oxygen sensor connector.
3. If there is no continuity, replace the heated oxygen sensor.
4. Warm up the engine until engine coolant is 80°C (176°F) or higher.
5. Rev the engine for 5 minutes or more with the engine speed of 4,500 r/min.
6. Connect a digital voltage meter between terminal No. 2 (black clip) and terminal No. 4 (white clip).
7. While repeatedly revving the engine, measure the heated oxygen sensor output voltage.

Standard value:



ENGINE	HEATED OXYGEN SENSOR OUTPUT VOLTAGE	REMARKS
When revving engine	0.6 - 1.0 V	If you make the air/fuel ratio rich by revving the engine repeatedly, a normal heated oxygen sensor will output a voltage of 0.6 - 1.0 V.

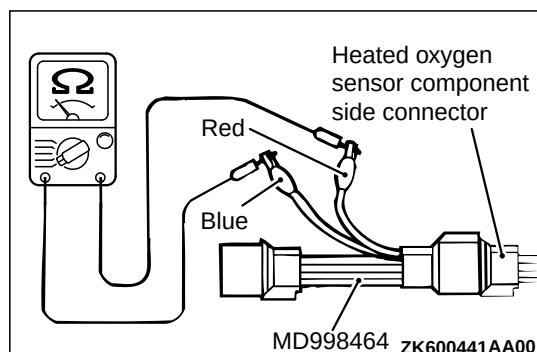
⚠ CAUTION

- Be very careful when connecting the jumper wire; incorrect connection can damage the oxygen sensor.
- Be careful the heater is broken when voltage of beyond 8V is applied to the oxygen sensor heater.

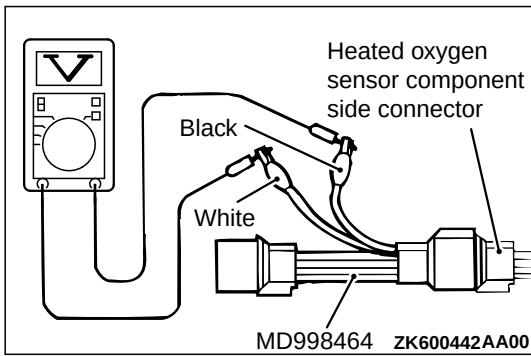
NOTE: If the sufficiently high temperature (of approximate 400° C or more) is not reached although the oxygen sensor is normal, the output voltage would be possibly low although the rich air-fuel ratio. Therefore, if the output voltage is low, use a jumper wire to connect terminal No. 1 (red clip of special tool) and terminal No. 3 (blue clip of special tool) of the oxygen sensor with a (+) terminal and (-) terminal of 8 V power supply respectively, then check again.

- If the output voltage is not within the standard value, replace the heated oxygen sensor.

NOTE: For removal and installation of the heated oxygen sensor, refer to GROUP 15, Exhaust Pipe and Main Muffler .

**<Left bank heated oxygen sensor (front)>**

- Disconnect the heated oxygen sensor connector and connect special tool MD998464 to the connector on the heated oxygen sensor side.
- Make sure that there is continuity [4.5-8.0 ohms at 20°C (68° F)] between terminal No. 1 (red clip) and terminal No. 3 (blue clip) on the heated oxygen sensor connector.
- If there is no continuity, replace the heated oxygen sensor.
- Warm up the engine until engine coolant is 80°C (176°F) or higher.
- Rev the engine for 5 minutes or more with the engine speed of 4,500 r/min.
- Connect a digital voltage meter between terminal No. 2 (black clip) and terminal No. 4 (white clip).
- While repeatedly revving the engine, measure the heated oxygen sensor output voltage.



Standard value:

ENGINE	HEATED OXYGEN SENSOR OUTPUT VOLTAGE	REMARKS
When revving engine	0.6 - 1.0 V	If you make the air/fuel ratio rich by revving the engine repeatedly, a normal heated oxygen sensor will output a voltage of 0.6 - 1.0 V.

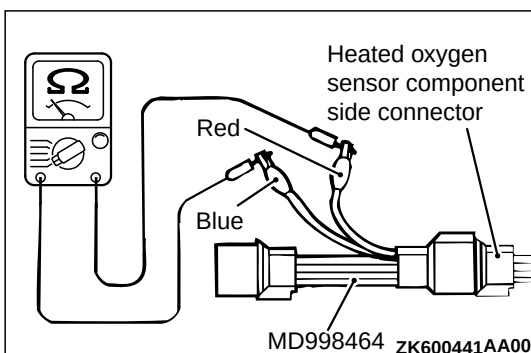
CAUTION

- Be very careful when connecting the jumper wire; incorrect connection can damage the oxygen sensor.
- Be careful the heater is broken when voltage of beyond 8V is applied to the oxygen sensor heater.

NOTE: If the sufficiently high temperature (of approximate 400° C or more) is not reached although the oxygen sensor is normal, the output voltage would be possibly low although the rich air-fuel ratio. Therefore, if the output voltage is low, use a jumper wire to connect terminal No. 1 (red clip of special tool) and terminal No. 3 (blue clip of special tool) of the oxygen sensor with a (+) terminal and (-) terminal of 8 V power supply respectively, then check again.

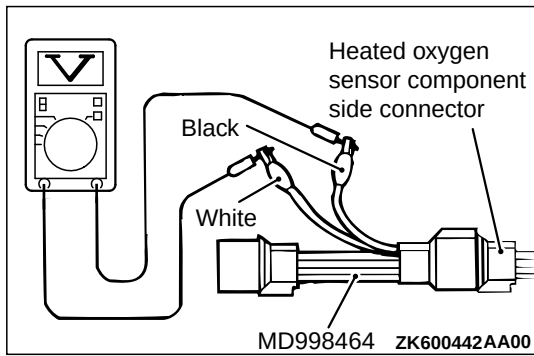
8. If the output voltage is not within the standard value, replace the heated oxygen sensor.

NOTE: For removal and installation of the heated oxygen sensor, refer to GROUP 15, Exhaust Pipe and Main Muffler P. 15-16.



<Right bank heated oxygen sensor (rear)>

1. Disconnect the heated oxygen sensor connector and connect special tool MD998464 to the connector on the heated oxygen sensor side.
2. Make sure that there is continuity [11-18 ohms at 20°C (68°F)] between terminal No. 1 (red clip) and terminal No. 3 (blue clip) on the heated oxygen sensor connector.
3. If there is no continuity, replace the heated oxygen sensor.
4. Warm up the engine until engine coolant is 80°C (176°F) or higher.
5. Drive at 50 km/h (31 mph) or more for 10 minutes.
6. Connect a digital voltage meter between terminal No. 2 (black clip) and terminal No. 4 (white clip).



7. Measure the output voltage of the heated oxygen sensor under the following driving.

- Transaxle: 2 nd
- Drive with wide open throttle
- Engine: 3,500 r/min or more

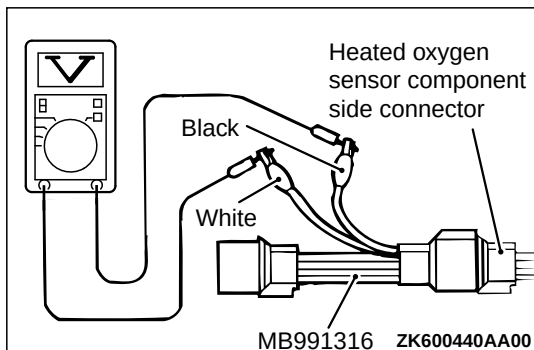
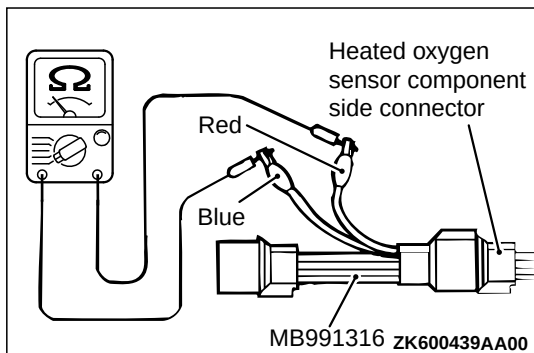
Standard value:

HEATED SENSOR VOLTAGE	OXYGEN OUTPUT	REMARKS
0.6 - 1.0 V		High load operation makes air/fuel ratio richer and normal heated oxygen sensor also can output voltage of 0.6 - 1.0 V.

8. If the output voltage is not within the standard value, replace the heated oxygen sensor.

NOTE: If the sufficiently high temperature (of approximate 400° C or more) is not reached although the oxygen sensor is normal, the output voltage would be possibly low although the rich air-fuel ratio.

NOTE: For removal and installation of the heated oxygen sensor, refer to GROUP 15, Exhaust Pipe and Main Muffler P. 15-16.



<Left bank heated oxygen sensor (rear)>

1. Disconnect the heated oxygen sensor connector and connect special tool MB991316 to the connector on the heated oxygen sensor side.
2. Make sure that there is continuity [11-18 ohms at 20°C (68°F)] between terminal No. 1 (red clip) and terminal No. 3 (blue clip) on the heated oxygen sensor connector.
3. If there is no continuity, replace the heated oxygen sensor.
4. Warm up the engine until engine coolant is 80°C (176°F) or higher.
5. Drive at 50 km/h (31 mph) or more for 10 minutes.
6. Connect a digital voltage meter between terminal No. 2 (black clip) and terminal No. 4 (white clip).
7. Measure the output voltage of the heated oxygen sensor under the following driving.

- Transaxle: 2 nd
- Drive with wide open throttle
- Engine: 3,500 r/min or more

Standard value:

HEATED SENSOR VOLTAGE	OXYGEN OUTPUT	REMARKS
0.6 - 1.0 V		High load operation makes air/fuel ratio richer and normal heated oxygen sensor also can output voltage of 0.6 - 1.0 V.

8. If the output voltage is not within the standard value, replace the heated oxygen sensor.

NOTE: If the sufficiently high temperature (of approximate 400° C or more) is not reached although the oxygen sensor is normal, the output voltage would be possibly low although the rich air-fuel ratio.

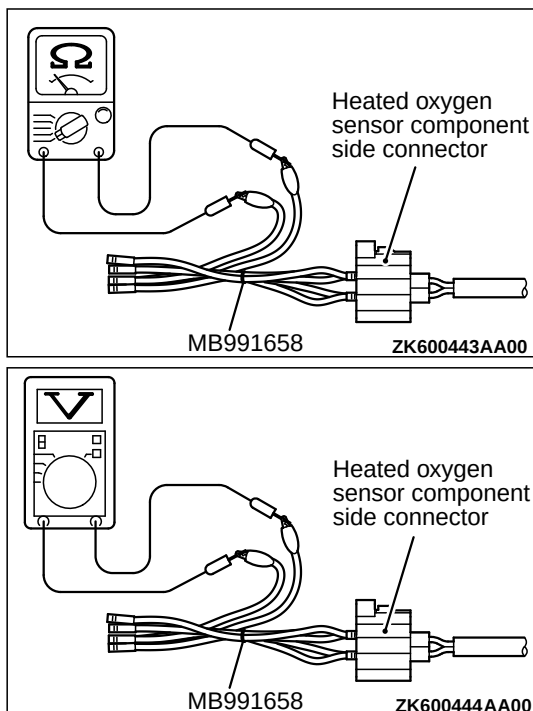
NOTE: For removal and installation of the heated oxygen sensor, refer to GROUP 15, Exhaust Pipe and Main Muffler P. 15-16.

<Center exhaust pipe heated oxygen sensor>

1. Disconnect the heated oxygen sensor connector and connect special tool MB991658 to the connector on the heated oxygen sensor side.
2. Make sure that there is continuity [11-18 Ω at 20°C (68°F)] between terminal No. 1 and terminal No. 2 on the heated oxygen sensor connector.
3. If there is no continuity, replace the heated oxygen sensor.
4. Warm up the engine until engine coolant is 80°C (176°F) or higher.
5. Drive at 50 km/h (31 mph) or more for 10 minutes.
6. Connect a digital voltage meter between terminal No. 3 and terminal No. 4.
7. Measure the output voltage of the heated oxygen sensor under the following driving.
 - Transaxle: 2 nd
 - Drive with wide open throttle
 - Engine: 3,500 r/min or more

Standard value:

HEATED SENSOR VOLTAGE	OXYGEN OUTPUT	REMARKS
0.6 - 1.0 V		High load operation makes air/fuel ratio richer and normal heated oxygen sensor also can output voltage of 0.6 - 1.0 V.



8. If the output voltage is not within the standard value, replace the heated oxygen sensor.

NOTE: If the sufficiently high temperature (of approximate 400° C or more) is not reached although the oxygen sensor is normal, the output voltage would be possibly low although the rich air-fuel ratio.

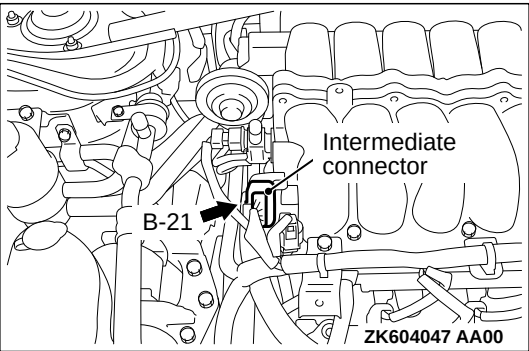
NOTE: For removal and installation of the heated oxygen sensor, refer to GROUP 15, Exhaust Pipe and Main Muffler P. 15-16.

INJECTOR CHECK

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Right bank side (number 1, 3, 5 cylinders)

1. Disconnect the intermediate connector B-21.



2. Measure the resistance between the injector intermediate connector terminals.

Standard value:

INJECTOR No.	MEASUREM ENT TERMINAL	RESISTANCE
No. 1	6 - 7	10.5 - 13.5 Ω [20°C (68°F)]
No. 3	6 - 8	
No. 5	6 - 9	

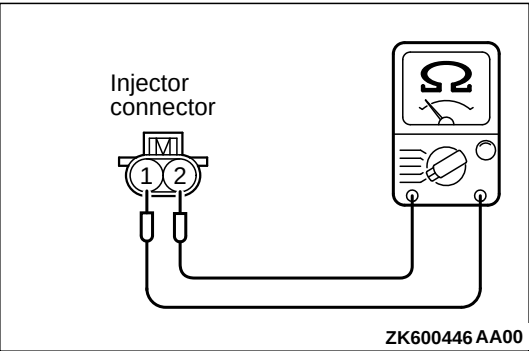
3. Connect the injector intermediate connector.

Left bank side (number 2, 4, 6 cylinders)

1. Disconnect the injector connector.
2. Measure the resistance between injector side connector terminals 1 and 2.

Standard value: 10.5 - 13.5 ohms [at 20°C (68°F)]

3. Connect the injector connector.



THROTTLE ACTUATOR CONTROL MOTOR CHECK

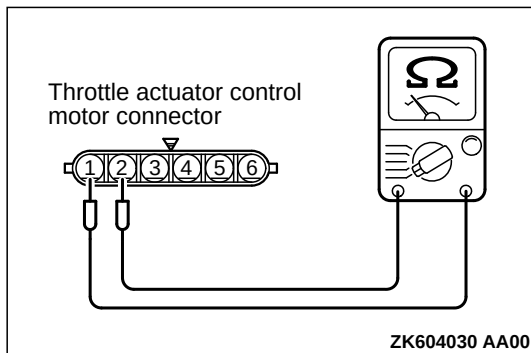
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<Operation Inspection>

1. Disconnect the air intake hose from the throttle body.
2. Set the ignition switch to the "ON" position.
3. Operate the accelerator pedal and confirm that the throttle valve is opening and closing accordingly.

<Checking the Terminal Resistance>

1. Disconnect the throttle position sensor connector.
2. Measure the resistance between terminal No. 1 and No. 2.
Standard value: 0.3 - 80 Ω [at 20°C (68°F)]
3. If resistance is outside the standard value, replace the throttle body assembly.



ENGINE OIL CONTROL VALVE CHECK

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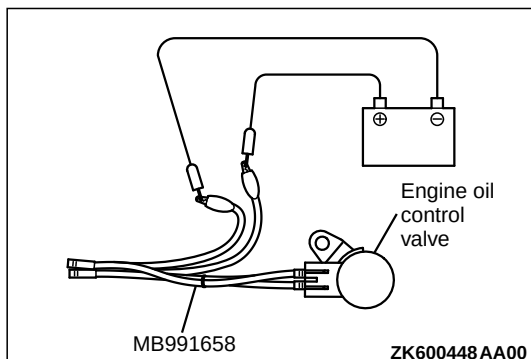
Checking the Operation Sound

1. Disconnect the engine oil control valve connector.

⚠ CAUTION

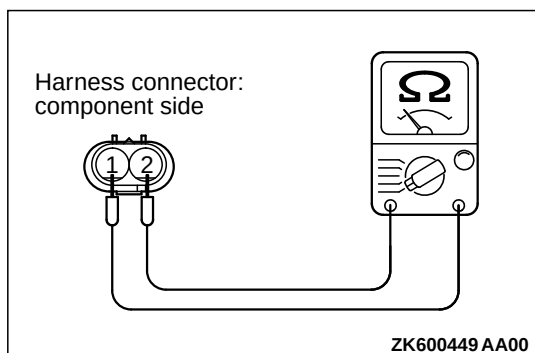
To prevent the coil from burning, keep the duration of the voltage application as short as possible.

2. Check that the operation sound of the engine oil control valve can be heard when the positive battery voltage is supplied to the engine oil control valve. (Use the jumper wires to connect terminal No. 2 of the engine oil control valve connector to the positive battery terminal and terminal No. 1 to the negative battery terminal.)
3. If the operation sound cannot be heard, replace the engine oil control valve.



Checking the Coil Resistance

1. Disconnect the engine oil control valve connector.



2. Measure resistance between terminal No. 1 and terminal No. 2 of the connector at the engine oil control valve side.

Standard value: 6.9 - 7.9 Ω [at 20°C (68°F)]

3. If resistance is not within the standard value, replace the engine oil control valve.

EVAPORATIVE EMISSION PURGE SOLENOID CHECK

M11301000056USA0000010000

Refer to GROUP 17, Emission Control System - Evaporative Emission System - Evaporative Emission Purge Solenoid Check P.17c-12.

EVAPORATIVE EMISSION VENTILATION SOLENOID CHECK

M11301000904USA0000010000

Refer to GROUP 17, Emission Control System - Evaporative Emission Canister and Fuel Tank Pressure Relief Valve - Evaporative Emission Canister and Fuel Tank Pressure Relief Valve Inspection P.17c-19.

EGR VALVE CHECK

M11301000515USA0000010000

Refer to GROUP 17, Emission Control System - Exhaust Gas Recirculation (EGR) System - EGR Valve Check P.17c-16.

INTAKE MANIFOLD TUNING SOLENOID CHECK

M11301000905USA0000010000

Refer to GROUP 15, Intake and Exhaust System - On-vehicle Service - Intake Manifold Tuning Solenoid Check P.15-2.

INJECTOR

REMOVAL AND INSTALLATION

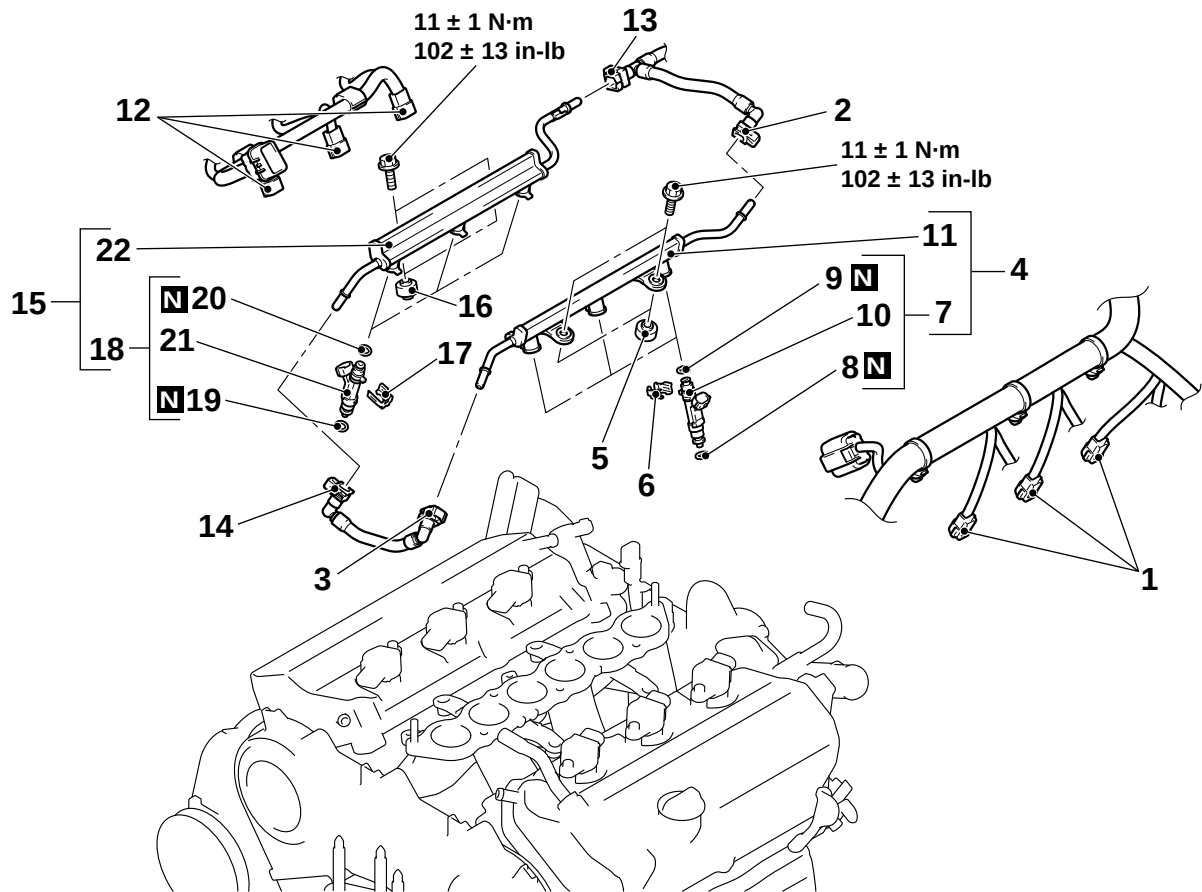
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Pre-removal Operation

- Fuel Discharge Prevention (Refer to P.13Aa-20).
- Intake Manifold Plenum Removal (Refer to GROUP 15, Intake Manifold Plenum P.15-7).

Post-installation Operation

- Intake Manifold Plenum Installation (Refer to GROUP 15, Intake Manifold Plenum P.15-7).
- Fuel Leakage Inspection.



ZC600513AA00

Removal steps

- | | | |
|-------|-------|---------------------------------------|
| | 1. | Fuel injector connector |
| <<A>> | >>E<< | 2. Fuel high pressure hose connection |
| <<A>> | >>E<< | 3. Fuel high pressure hose connection |
| <> | | 4. Fuel rail and injector assembly |
| | 5. | Insulators |
| >>D<< | 6. | Fuel injector support |
| >>C<< | 7. | Fuel injector assembly |
| >>B<< | 8. | O-ring |
| >>A<< | 9. | O-ring |
| | 10. | Fuel injectors |
| | 11. | Fuel rail left |
| | 12. | Fuel injector connector |

Removal steps

- | | | |
|-------|-------|--|
| <<A>> | >>E<< | 13. Fuel high pressure hose connection |
| <<A>> | >>E<< | 14. Fuel high pressure hose connection |
| <> | | 15. Fuel rail and injector assembly |
| | | 16. Insulators |
| >>D<< | | 17. Fuel injector support |
| >>C<< | | 18. Fuel injector assembly |
| >>B<< | | 19. O-ring |
| >>A<< | | 20. O-ring |
| | | 21. Fuel injectors |
| | | 22. Fuel rail right |

Required Special Tool:

•MB992106: O-ring installer

REMOVAL SERVICE POINTS

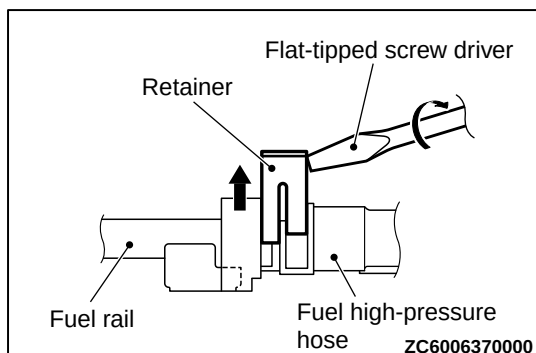
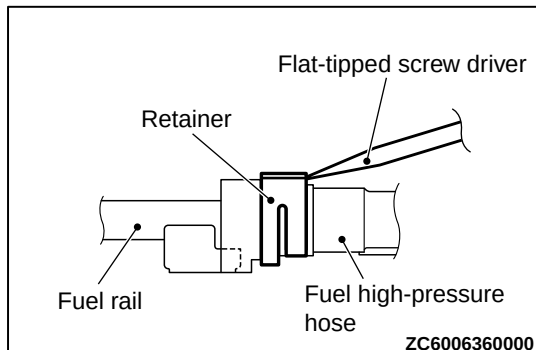
<<A>> FUEL HIGH-PRESSURE HOSE DISCONNECTION

CAUTION

Do not kink the fuel high-pressure hose as it is made of plastics.

1. Insert a flat-tipped screwdriver [width 6 mm (0.24 inch), thickness 1 mm (0.04 inch)] to the retainer.

2. Turn the flat-tipped screwdriver approximately 90° to the arrowed direction, and lift the retainer to unlock and disconnect the fuel high-pressure hose.



<> FUEL RAIL AND INJECTOR ASSEMBLY REMOVAL

CAUTION

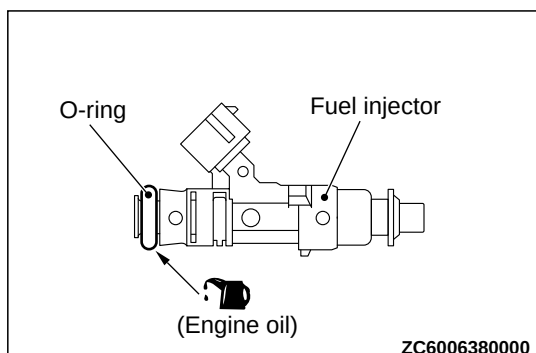
Do not drop the fuel injector.

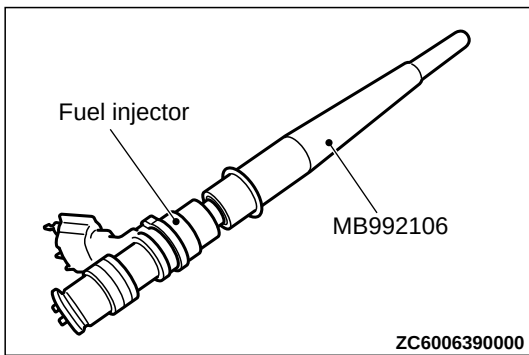
Remove the fuel rail with the fuel injectors attached to it.

INSTALLATION SERVICE POINTS

>>A<< O-RING INSTALLATION

1. Apply a drop of new engine oil to the O-ring.
2. While turning the fuel injector to right and left, install the O-ring to the fuel injector with a caution not to damage the O-ring.





>>B<< O-RING INSTALLATION

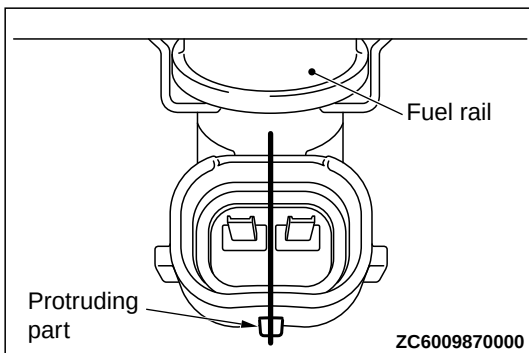
1. Apply a drop of new engine oil to the O-ring.
2. Using the special tool MB992106, install the O-ring to the fuel injector without damaging the O-ring.

>>C<< FUEL INJECTOR ASSEMBLY INSTALLATION

CAUTION

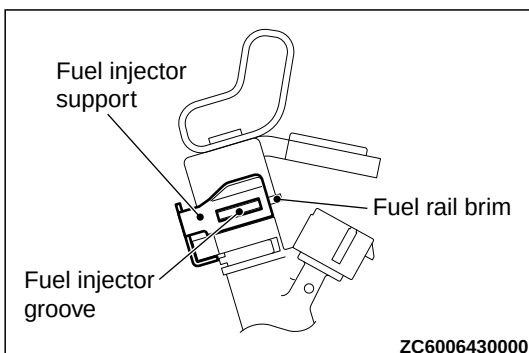
Do not let the engine oil get into the fuel rail.

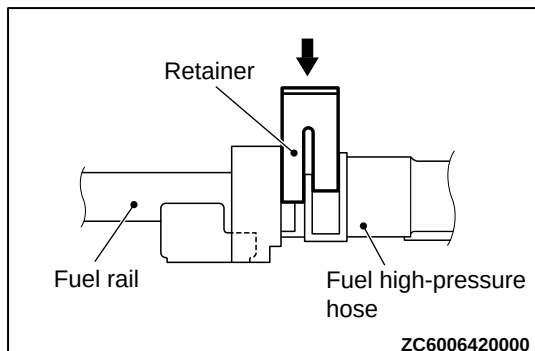
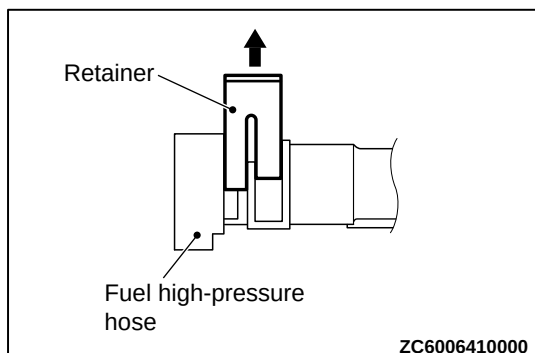
1. Apply a drop of new engine oil to the O-ring.
2. Turning the fuel injector assembly to right and left, install it to the fuel rail with a caution not to damage the O-ring. After the mounting, check for its smooth rotation. At this time, check that the projection of the fuel injector assembly is in the center.
3. If the rotation is not smooth, the O-ring may be caught. Remove the fuel injector assembly and check the O-ring for damage. Then, reinsert it to the fuel rail and check for its smooth rotation.



>>D<< FUEL INJECTOR SUPPORT INSTALLATION

Install the fuel injector support to the fuel injector groove and fuel rail flange, and fix the fuel injector assembly and fuel rail.



**>>E<< FUEL HIGH-PRESSURE HOSE CONNECTION**

1. Pull up the lock of fuel high-pressure hose to unlock before installing.
2. Install the fuel high-pressure hose to the fuel rail securely and push the lock of fuel high-pressure hose downward and lock thoroughly.
3. After installing, slightly pull the fuel high-pressure hose and ensure that there is no disengaged fuel high-pressure hose. Also confirm that there is approximately 1 mm (0.04 inch) play at this time.

THROTTLE BODY ASSEMBLY**REMOVAL AND INSTALLATION****⚠ CAUTION**

•When the throttle body assembly replacement is performed, use scan tool MB991958 to initialize the learning value (Refer to GROUP 00, Precautions Before Service - Initialization Procedure for Learning Value in MFI Engine P. 00-30).

Pre-removal Operation

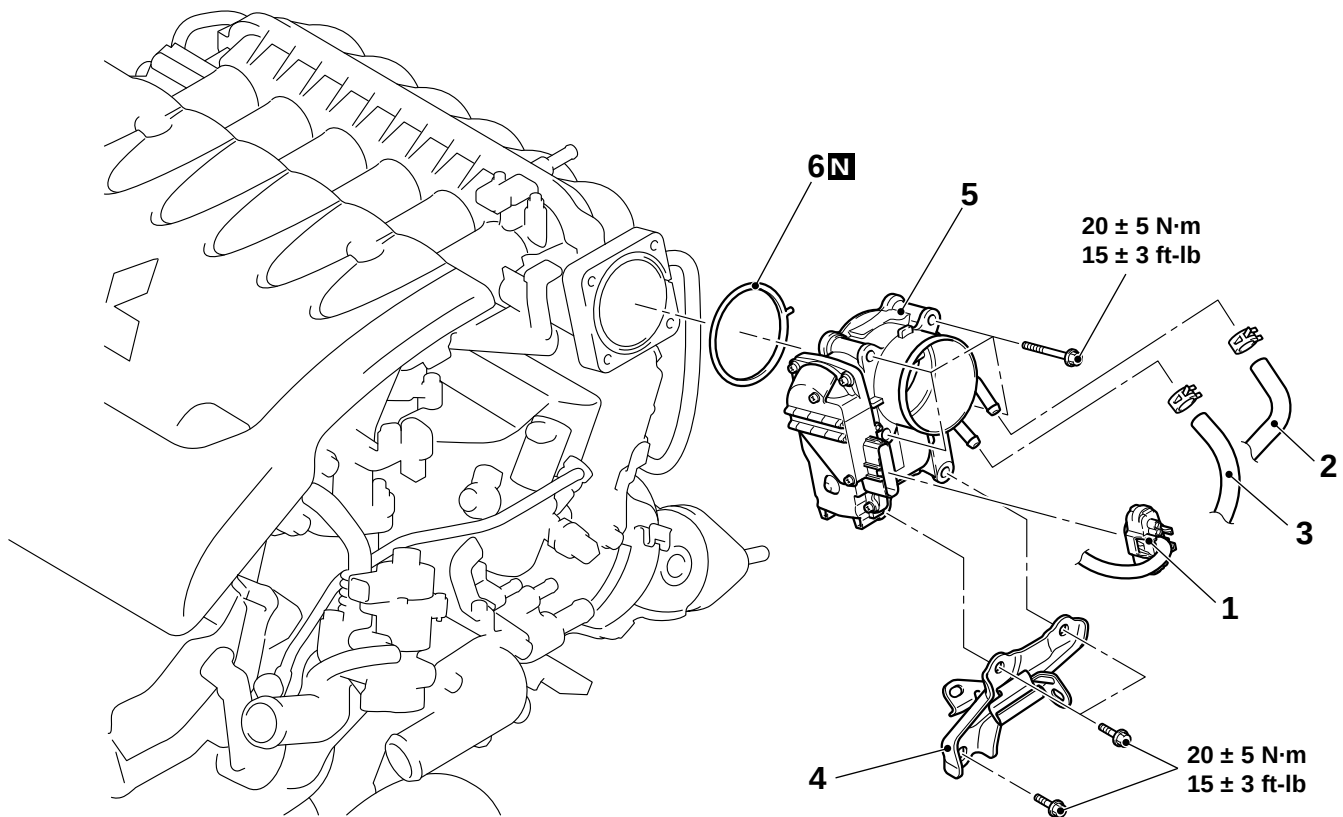
- Engine Coolant Draining (Refer to GROUP 14, On-vehicle Service - Engine Coolant Replacement P.14-15).
- Air Intake Hose Removal (Refer to GROUP 15, Air Cleaner P. 15-6).

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•Do not loosen the fixing screws for the resin cover of throttle body assembly. If the screws are loosened, the sensor incorporated in the resin cover becomes misaligned and the throttle body cannot work normally.

Post-installation Operation

- Air Intake Hose Installation (Refer to GROUP 15, Air Cleaner P.15-6).
- Engine Coolant Refilling (Refer to GROUP 14, On-vehicle Service - Engine Coolant Replacement P.14-15).



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Removal steps

- >>A<< · Initialization procedure (Installation only)
1. Throttle position sensor connector
 2. Water hose connection
 3. Water hose connection

Removal steps

4. Throttle body stay
5. Throttle body assembly
6. Gasket

INSTALLATION SERVICE POINT

>>A<< INITIALIZATION PROCEDURE

Turn the ignition switch on then off, and keep it off for at least 10 seconds.

ENGINE CONTROL MODULE (ECM)

REMOVAL AND INSTALLATION

⚠ CAUTION

•When the ECM is replaced, do not replace the immobilizer ECU (WCM) or KOS-ECU simultaneously. When replacing a several

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ECUs, always replace one ECU at a time, and register the necessary IDs using the scan tool MB991958. (Refer to GROUP 42B, Diagnosis - ID Code Registration Judgment Table P.42B-12.) <Vehicle with KOS> (Refer to GROUP 42C, Diagnosis - ID Code Registration Necessity Judgment Table P.42C-8.) <Vehicle with WCM>

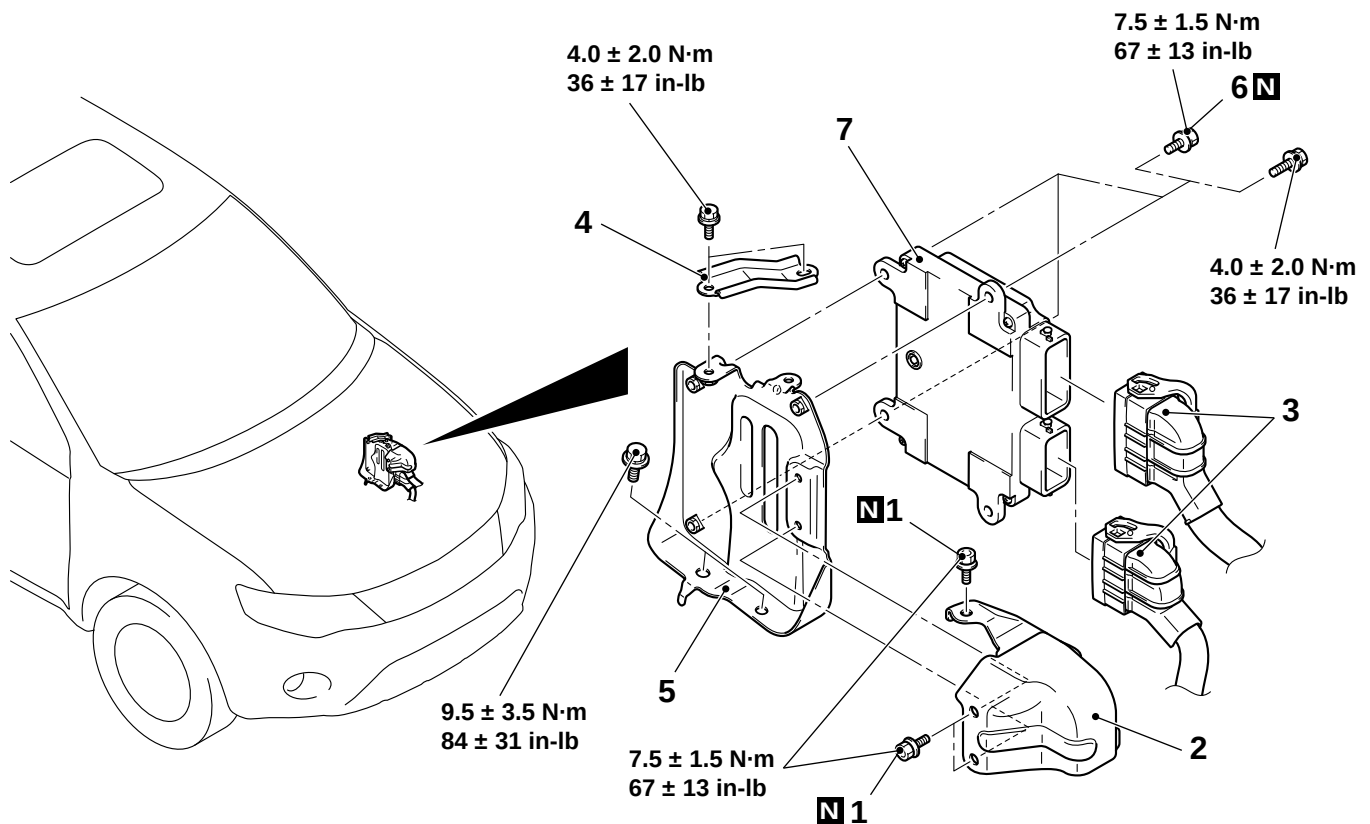
• After the ECM replacement, idling speed may become unstable because the MFI engine learning is not completed. To make it stable, let the system learn the idling. (Refer to GROUP 00, Precautions Before Service - Learning Procedure for Idling in MFI Engine P.00-31.)

• After the ECM replacement, register a key code using the scan tool MB991958. [Refer to GROUP 00, Precautions Before Service - How to Perform Vehicle Identification Number (VIN) Writing P. 00-26.]

• To replace the ECM, use an ECM for which the vehicle identification number entry and coding are completed. If diagnostic trouble code No. P0630 vehicle identification number-related or No. P1676 variant coding-related is set in the ECM, replace it with an ECM to which the same vehicle identification number has been entered and the same coding has been made as for the relevant vehicle.

Pre-removal and Post-installation Operation

• Air Cleaner Assembly Removal and Installation (Refer to GROUP 15, Air Cleaner P.15-6).



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Removal steps

- >>B<< Initialization procedure (Installation only)
- <<A>> >>A<< 1. Break off bolts <Vehicles for Canada>
2. ECM connector cover <Vehicles for Canada>
3. ECM connectors

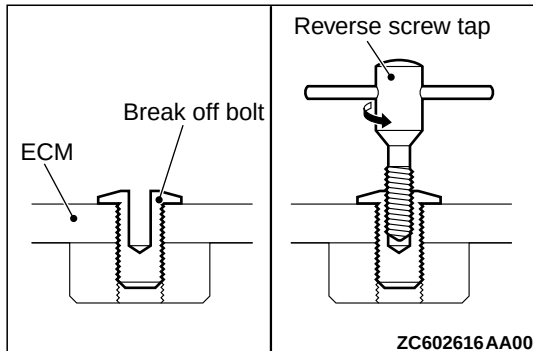
Removal steps

- <<A>> >>A<< 4. ECM stay
5. ECM bracket assembly
6. Break off bolts <Vehicles for Canada>
7. ECM

REMOVAL SERVICE POINT

<<A>> BREAK-OFF BOLTS REMOVAL <VEHICLES FOR CANADA>

1. Drill in the break-off bolt a hole deep enough for the tap to stand.
2. Remove the break-off bolt with a left-hand tap.



INSTALLATION SERVICE POINTS

>>A<< BREAK-OFF BOLTS INSTALLATION <VEHICLES FOR CANADA>

Tighten until the head of break-off bolt is broken off.

>>B<< INITIALIZATION PROCEDURE

Turn the ignition switch on then off, and keep it off for at least 10 seconds.

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MULTIPOINT FUEL INJECTION (MFI)

MEMO