

GROUP 16

ENGINE ELECTRICAL

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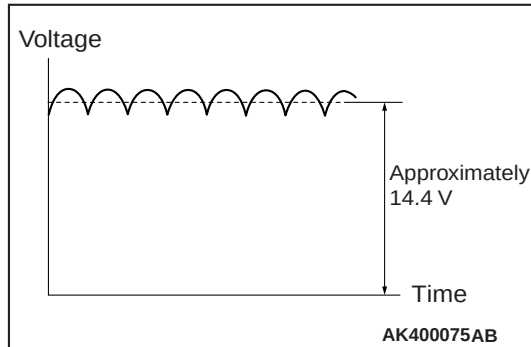
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CHARGING SYSTEM

GENERAL INFORMATION

The charging system uses the generator output to keep the battery charged at a constant level under various electrical loads.

OPERATION



Rotation of the excited field coil generates AC voltage in the stator. This alternating current is rectified through diodes to DC voltage having a waveform shown in the illustration.

The average output voltage fluctuates slightly with the generator load condition.

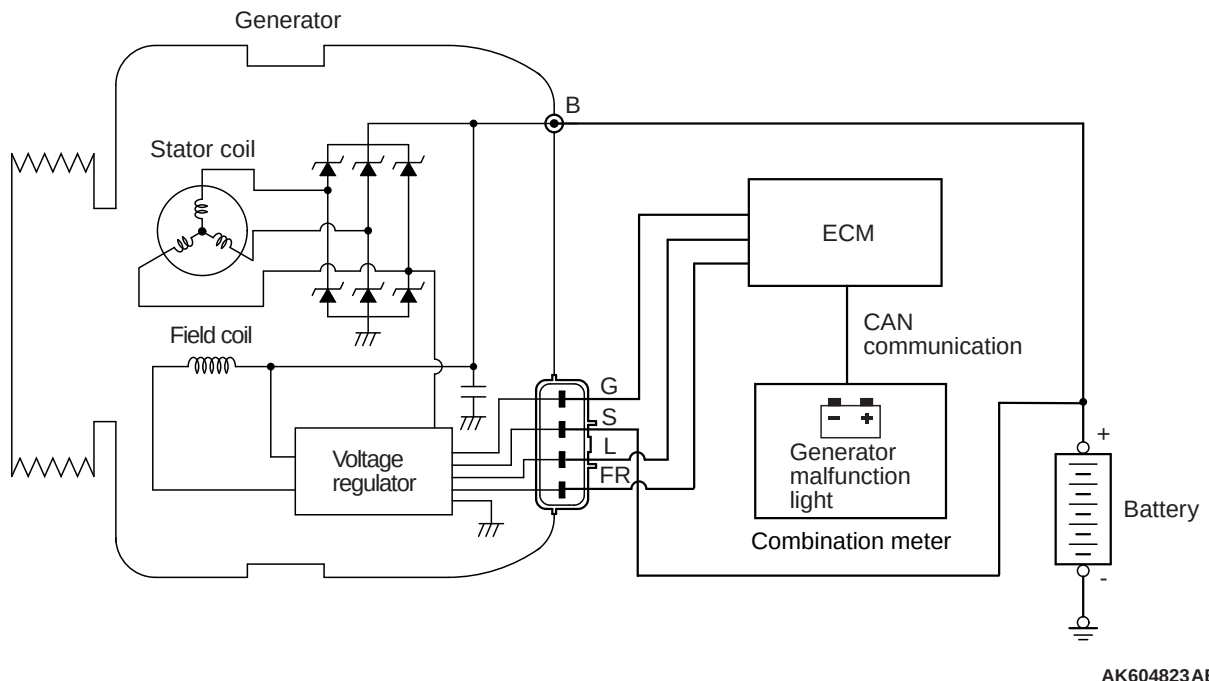
When the ignition switch is turned on, current flows in the field coil and initial excitation of the field coil occurs.

When the stator coil begins to generate power after the engine is started, the field coil is excited by the output current of the stator coil.

The generator output voltage rises as the field current increases and it falls as the field current decreases. When the battery voltage (generator "S" terminal voltage) reaches a regulated voltage of approximately 14.4 V, the field current is cut off. When the battery voltage drops below the regulated voltage, the voltage regulator regulates the output voltage to a constant level by controlling the field current.

In addition, when the field current is constant, the generator output voltage rises as the engine speed increases.

SYSTEM DIAGRAM



GENERATOR SPECIFICATIONS

Item	Specification
Type	Battery voltage sensing
Rated output V/A	12/85
Voltage regulator	Electronic built-in type

SERVICE SPECIFICATIONS

M1161000301392

Item		Standard value	Limit
Generator output line voltage drop (at 30 A) V		–	Maximum 0.3
Output current		–	70 % of normal output current
Regulated voltage ambient temperature at voltage regulator V	–20°C (–4°F)	14.2 – 15.4	–
	20°C (68°F)	13.9 – 14.9	–
	60°C (140°F)	13.4 – 14.6	–
	80°C (176°F)	13.1 – 14.5	–

CHARGING SYSTEM DIAGNOSIS

M1161000700609

TROUBLESHOOTING HINTS

Generator malfunction light does not go on when the ignition switch is turned to ON, before the engine starts.

- Check the generator malfunction light.

Generator malfunction light does not switch off after the engine starts.

- Check the IC voltage regulator inside the generator.

Discharged or overcharged battery.

- Check the IC voltage regulator inside the generator.

TROUBLESHOOTING GUIDE

The charging system troubleshooting guide is shown in the following steps.

STEP 1.

Q: Is the battery in good condition? (Refer to GROUP 54A – Battery, On-vehicle Service, Fluid Level and Specific Gravity Check P.54A-4).

YES : Go to Step 2.

NO : Charge or replace the battery.

STEP 2.

Q: Is the drive belt in good condition? (Refer to GROUP 11A – On-vehicle Service, Drive Belt Tension Check and Adjustment P.11A-8).

YES : Go to Step 3.

NO : Adjust the belt tension or replace the belt.

STEP 3.

Q: Does the generator malfunction light come on when the ignition switch is turned on?

YES : Go to Step 4.

NO : Check the ignition switch (Refer to GROUP 54A – Ignition Switch, Ignition Switch Check [P.54A-12](#)).
Check the generator malfunction light and its related circuits.
Check the generator.

STEP 4.

Q: Does the generator malfunction light go out after starting the engine?

YES : Go to Step 5.

NO : Check the generator.

STEP 5.

Q: Is an oscilloscope available?

YES : Go to Step 6.

NO : Go to Step 7.

STEP 6.

Q: Does the oscilloscope show a normal wave pattern? (Refer to [P.16-13](#)).

YES : Go to Step 7.

NO : Check the generator.

STEP 7.

- Engine: 2,500 r/min
- Headlight: ON (high beam)
- Voltage between generator terminal B and the positive battery terminal
OK: 0.5 V or less
- Voltage between the negative battery terminal and generator body
OK: 0.5 V or less

Q: Are the generator output line and ground line in good condition?

YES : Go to Step 8.

NO : Check the generator output line and ground line.

STEP 8.

Q: Is the output current normal? (Refer to [P.16-9](#)).

YES : Go to Step 9.

NO : Check the generator.

STEP 9.

Q: Is the regulated voltage normal? (Refer to [P.16-11](#)).

YES : Go to Step 10.

NO : Check the generator.

STEP 10.

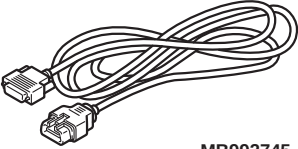
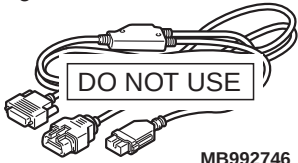
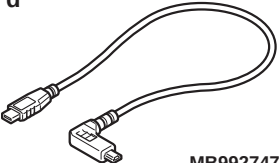
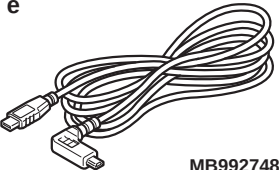
Q: Is the voltage drop in the generator output line normal?

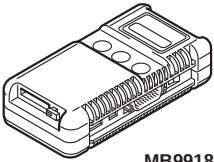
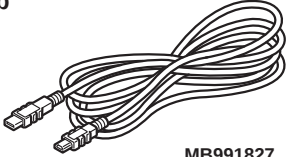
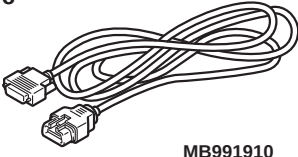
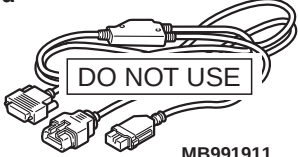
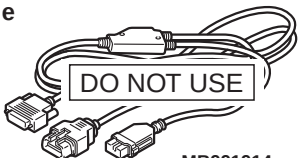
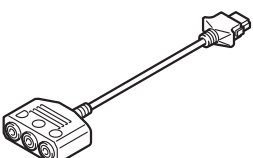
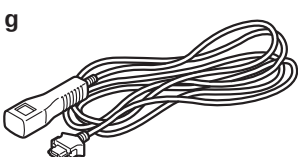
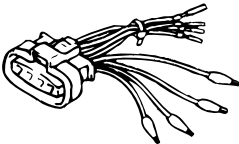
YES : Generator is normal. Check other systems.

NO : Check the output line.

SPECIAL TOOLS

M1161000601188

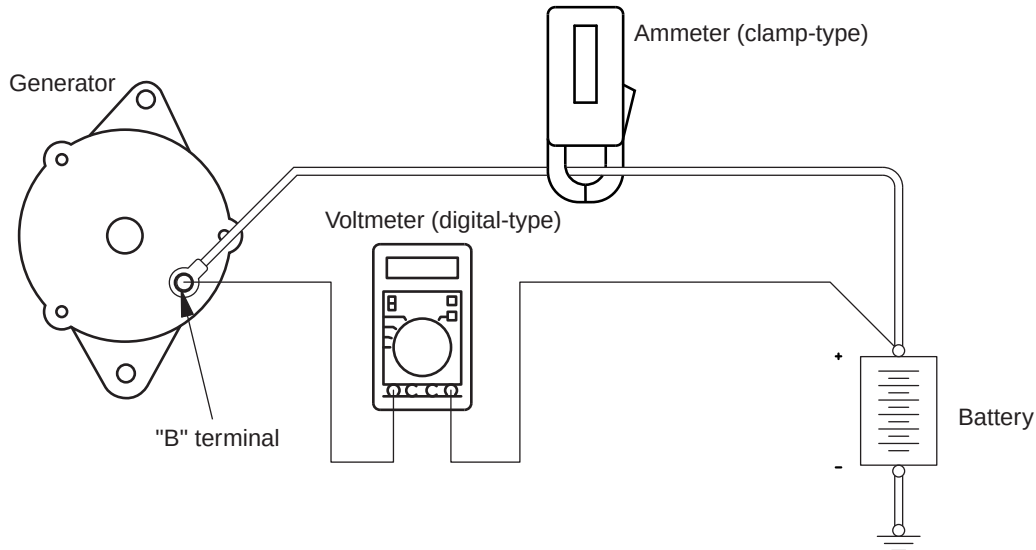
Tool	Tool number and name	Supersession	Application
a  MB992744	a. MB992744 b. MB992745 c. MB992746 d. MB992747 e. MB992748	—	Checking the engine speed
b  MB992745	a. Vehicle communication interface-Lite (V.C.I.-Lite)		
c  MB992746	b. V.C.I.-Lite main harness A (for vehicles with CAN communication)		
d  MB992747	c. V.C.I.-Lite main harness B (for vehicles without CAN communication)		
e  MB992748 ACB05421AB	d. V.C.I.-Lite USB cable short e. V.C.I.-Lite USB cable long		

Tool	Tool number and name	Supersession	Application
a  MB991824 b  MB991827 c  MB991910 d  MB991911 e  MB991914 f  MB991825 g  MB991826 MB991958	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 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>	⚠ CAUTION M.U.T.-III main harness A (MB991910) should be used. M.U.T.-III main harness B and C should not be used for this vehicle. Checking the engine speed
	MB991519 Generator test harness	MIT530 Micrd 530 charging system tester.	Checking the generator ("S" terminal voltage)

ON-VEHICLE SERVICE

GENERATOR OUTPUT LINE VOLTAGE DROP
TEST

M1161000902126



AK203361AD

This test determines whether the wiring from the generator "B" terminal to the positive battery terminal (including the fusible line) is in a good condition or not.

⚠ WARNING

Battery posts, terminals and related accessories contain lead and lead compounds. Wash hands after handling.

1. Always be sure to check the following before the test.
 - Generator installation
 - Drive belt tension (Refer to GROUP 11A – On-Vehicle Service, Drive Belt Tension Check and Adjustment [P.11A-8](#)).
 - Fusible link
 - Abnormal noise from the generator while the engine is running
2. Turn the ignition switch to the "LOCK" (OFF) position.
3. Disconnect the negative battery cable.
4. Set a clamp-type DC test ammeter to the generator "B" terminal output wire.

NOTE: Disconnecting the generator output wire and connecting the ammeter may not thoroughly diagnose an generator output line resistance increase problem because of an insufficient connection between terminal "B" and the output wire.

5. Connect a digital-type voltmeter between the generator "B" terminal and the positive battery terminal. (Connect the positive lead of the voltmeter to the "B" terminal and connect the negative lead of the voltmeter to the positive battery cable).
6. Reconnect the negative battery cable.

 CAUTION

To prevent damage to scan tool (M.U.T.-III), always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool (M.U.T.-III).

7. Connect scan tool (M.U.T.-III) to the data link connector [Refer to GROUP 13A – Diagnostic Function, How to Connect the Scan Tool (M.U.T.-III) [P.13A-10](#)].
8. Leave the hood open.
9. Start the engine.
10. With the engine running at 2,500 r/min, turn the headlights and other lights on and off to adjust the generator load so that the value displayed on the ammeter is slightly above 30 A.
Adjust the engine speed by gradually decreasing it until the value displayed on the ammeter is 30 A. Take a reading of the value displayed on the voltmeter at this time.

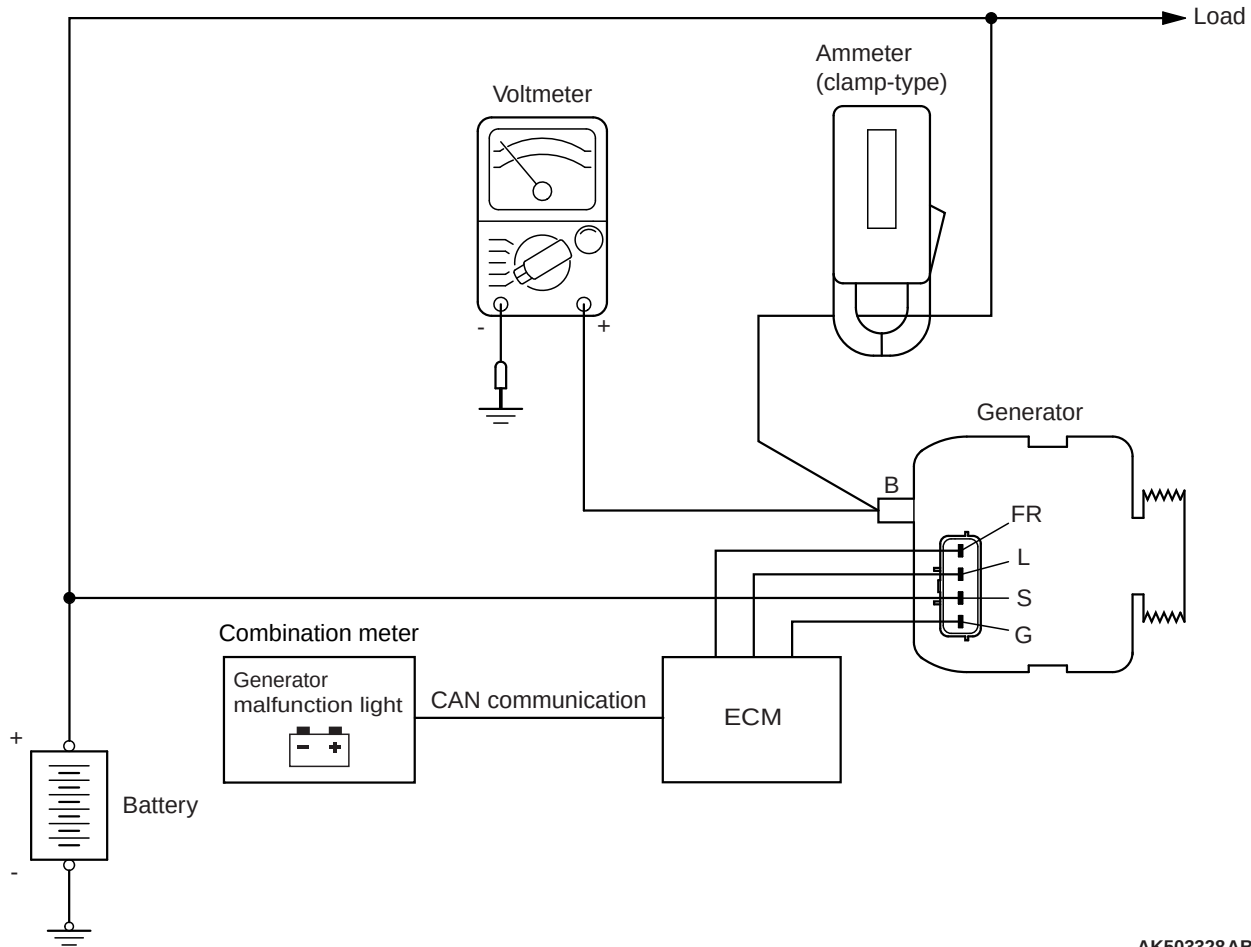
Limit: Maximum 0.3 V

NOTE: When the generator output is high and the value displayed on the ammeter does not decrease until 30 A, set the value to 40 A. Read the value displayed on the voltmeter at this time. When the value range is 40 A, the limit is maximum 0.4 V.

11. If the value displayed on the voltmeter is above the limit value, there is probably a malfunction in the generator output wire, so check the wiring between the generator "B" terminal and the positive battery terminal (including fusible link).
If a terminal is not sufficiently tight or if the harness has become discolored due to overheating, repair and then test again.
12. After the test, run the engine at idle.
13. Turn off all lights.
14. Turn the ignition switch to the "LOCK" (OFF) position.
15. Disconnect the scan tool (M.U.T.-III) to the data link connector.
16. Disconnect the negative battery cable.
17. Disconnect the ammeter and voltmeter.
18. Connect the negative battery cable.

OUTPUT CURRENT TEST

M1161001002449



AK503328AB

This test determines whether the generator output current is normal.

⚠ WARNING

Battery posts, terminals and related accessories contain lead and lead compounds. Wash hands after handling.

1. Before the test, always be sure to check the following.
 - Generator installation
 - Battery (Refer to GROUP 54A – Battery, On-Vehicle Service, Battery Test [P.54A-5](#)).

NOTE: The battery should be slightly discharged. The load needed by a fully-charged battery is insufficient for an accurate test.

- Drive belt tension (Refer to GROUP 11A – On-Vehicle Service, Drive Belt Tension Check and Adjustment [P.11A-8](#)).
 - Fusible link
 - Abnormal noise from the generator while the engine is running.
2. Turn the ignition switch to the "LOCK" (OFF) position.
 3. Disconnect the negative battery cable.

4. Set a clamp-type DC test ammeter to the generator "B" terminal output wire.

NOTE: Disconnecting the generator output wire and connecting the ammeter may not thoroughly diagnose an output current drop problem because of an insufficient connection between terminal "B" and the output wire.

5. Connect a voltmeter with a range of 0 – 20 V between the generator "B" terminal and the ground (Connect the positive lead of the voltmeter to the "B" terminal, and then connect the negative lead of the voltmeter to the ground).
6. Connect the negative battery cable.

 CAUTION

To prevent damage to scan tool (M.U.T.-III), always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool (M.U.T.-III).

7. Connect scan tool (M.U.T.-III) to the data link connector [Refer to GROUP 13A – Diagnostic Function, How to Connect the Scan Tool (M.U.T.-III) [P.13A-10](#)].
8. Leave the hood open.
9. Check that the reading on the voltmeter is equal to the battery voltage.

NOTE: If the voltage is 0 V, the cause is probably an open circuit in the wire or fusible link between the generator "B" terminal and the positive battery terminal.
10. Turn the light switch on to turn on headlights and then start the engine.
11. Immediately after setting the headlights to high beam and turning the heater blower switch to the high revolution position, increase the engine speed to 2,500 r/min and read the maximum current output value displayed on the ammeter.

Limit: 70 % of normal current output

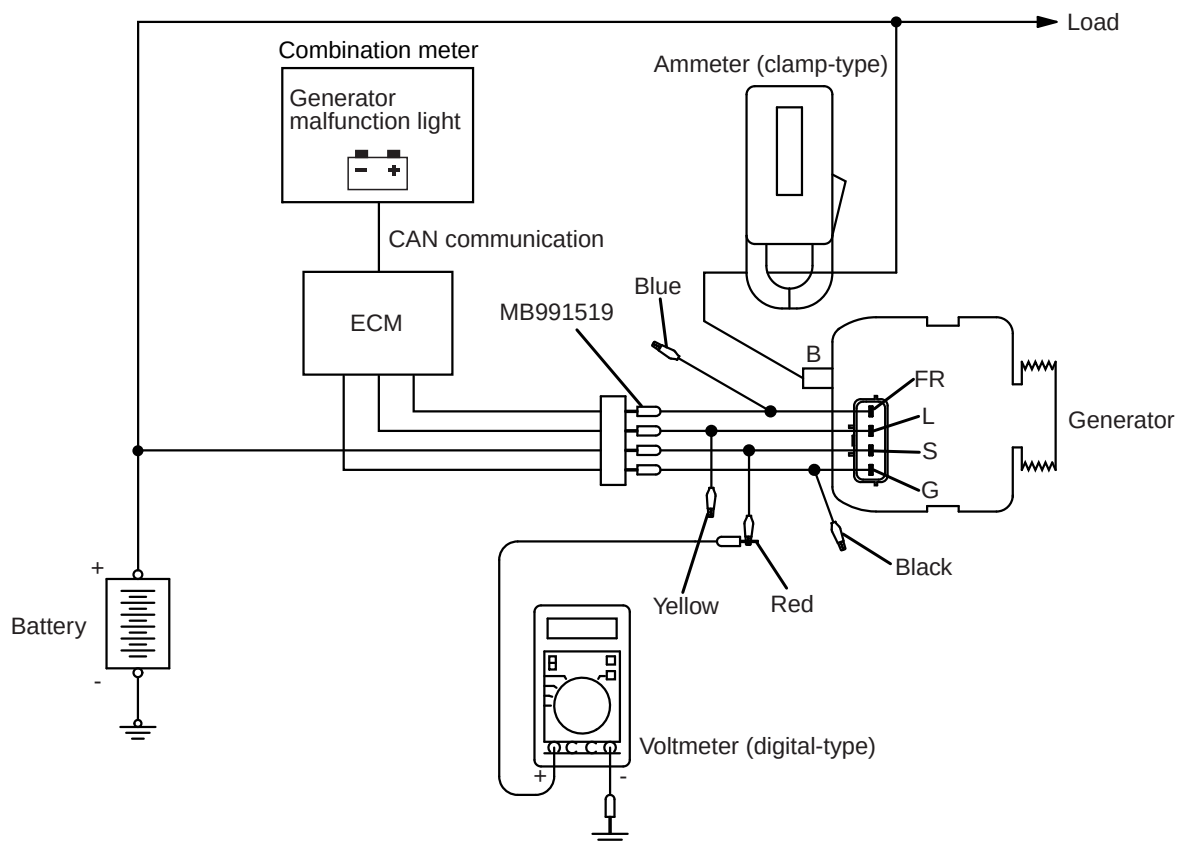
NOTE:

- For the nominal current output, refer to the Generator Specifications.
- Because the current from the battery will soon drop after the engine is started, the above step should be carried out as quickly as possible in order to obtain the maximum current output value.
- The current output value will depend on the electrical load and the temperature of the generator body.
- If the electrical load is small while testing, the specified level of current may not be output even though the generator is normal. In such cases, increase the electrical load by leaving the headlights turned on for some time to discharge the battery or by using the lighting system in another vehicle, and then test again.
- The specified level of current also may not be output if the temperature of the generator body or the ambient temperature is too high. In such cases, cool the generator and then test again.

12. The reading on the ammeter should be above the limit value. If the reading is below the limit value and the generator output wire is normal, remove the generator from the engine and check the generator.
13. Run the engine at idle after the test.
14. Turn the ignition switch to the "LOCK" (OFF) position.
15. Disconnect the scan tool (M.U.T.-III) to the data link connector.
16. Disconnect the negative battery cable.
17. Disconnect the ammeter and voltmeter.
18. Connect the negative battery cable.

REGULATED VOLTAGE TEST

M1161001102479



AK503329 AB

This test determines whether the voltage regulator correctly controlling the generator output voltage.

⚠ WARNING

Battery posts, terminals and related accessories contain lead and lead compounds. Wash hands after handling.

1. Always be sure to check the following before the test.
 - Generator installation
 - Check that the battery installed in the vehicle is fully charged (Refer to GROUP 54A – Battery, On-Vehicle Service, Battery Test [P.54A-5](#)).

- Drive belt tension (Refer to GROUP 11A – On-Vehicle Service, Drive Belt Tension Check and Adjustment [P.11A-8](#)).
 - Fusible link
 - Abnormal noise from the generator while the engine is running
2. Turn the ignition switch to the "LOCK" (OFF) position.
 3. Disconnect the negative battery cable.
 4. Use special tool generator test harness (MB991519) to connect a digital voltmeter between the generator "S" terminal and ground (Connect the positive lead of the voltmeter to the "S" terminal, and then connect the negative lead of the voltmeter to a secure ground or to the negative battery terminal).
 5. Set a clamp-type DC test ammeter to the generator "B" terminal output wire.

NOTE: The way of disconnecting the generator output wire and of connecting the ammeter is possibly not found the problem that the output current is dropping due to the insufficient connection between terminal "B" and the output wire.

6. Reconnect the negative battery cable.

⚠ CAUTION

To prevent damage to scan tool (M.U.T.-III), always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool (M.U.T.-III).

7. Connect scan tool (M.U.T.-III) to the data link connector [Refer to GROUP 13A – Diagnostic Function, How to Connect the Scan Tool (M.U.T.-III) [P.13A-10](#)].
8. Turn the ignition switch to the "ON" position and check that the reading on the voltmeter is equal to the battery voltage.

NOTE: If the voltage is 0 V, the cause is probably an open circuit in the wire or fusible link between the generator "S" terminal and the positive battery terminal.

9. Turn all lights and accessories off.
10. Start the engine.
11. Increase the engine speed to 2,500 r/min.
12. Read the value displayed on the voltmeter when the generator output current generator becomes 15 A or less.
13. If the voltage reading conforms to the value in the voltage regulation table, then the voltage regulator is operating normally.

If the voltage is not within the standard value, there is a malfunction of the voltage regulator or of the generator.

NOTE: When the voltage is approximately 12.8 V, the G-terminal is supposed to have a short circuit to the ground. Check the circuits relating to the G-terminal on the generator (Refer to GROUP 13A – Diagnosis, Symptom Chart [P.13A-52](#)).

14. After the test, lower the engine speed to the idle speed.
15. Turn the ignition switch to the "LOCK" (OFF) position.

16. Disconnect the scan tool (M.U.T.-III) to the data link connector.
17. Disconnect the negative battery cable.
18. Disconnect the ammeter and voltmeter.
19. Remove the special tool, and return the connector to the original condition.
20. Connect the negative battery cable.

Voltage Regulation Table

Standard value:

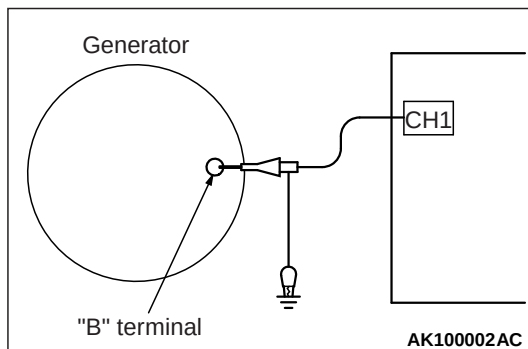
Inspection terminal	Voltage regulator ambient temperature °C (°F)	Voltage V
Terminal "S"	-20 (-4)	14.2 – 15.4
	20 (68)	13.9 – 14.9
	60 (140)	13.4 – 14.6
	80 (176)	13.1 – 14.5

WAVEFORM CHECK USING AN OSCILLOSCOPE

M1161001201514

MEASUREMENT METHOD

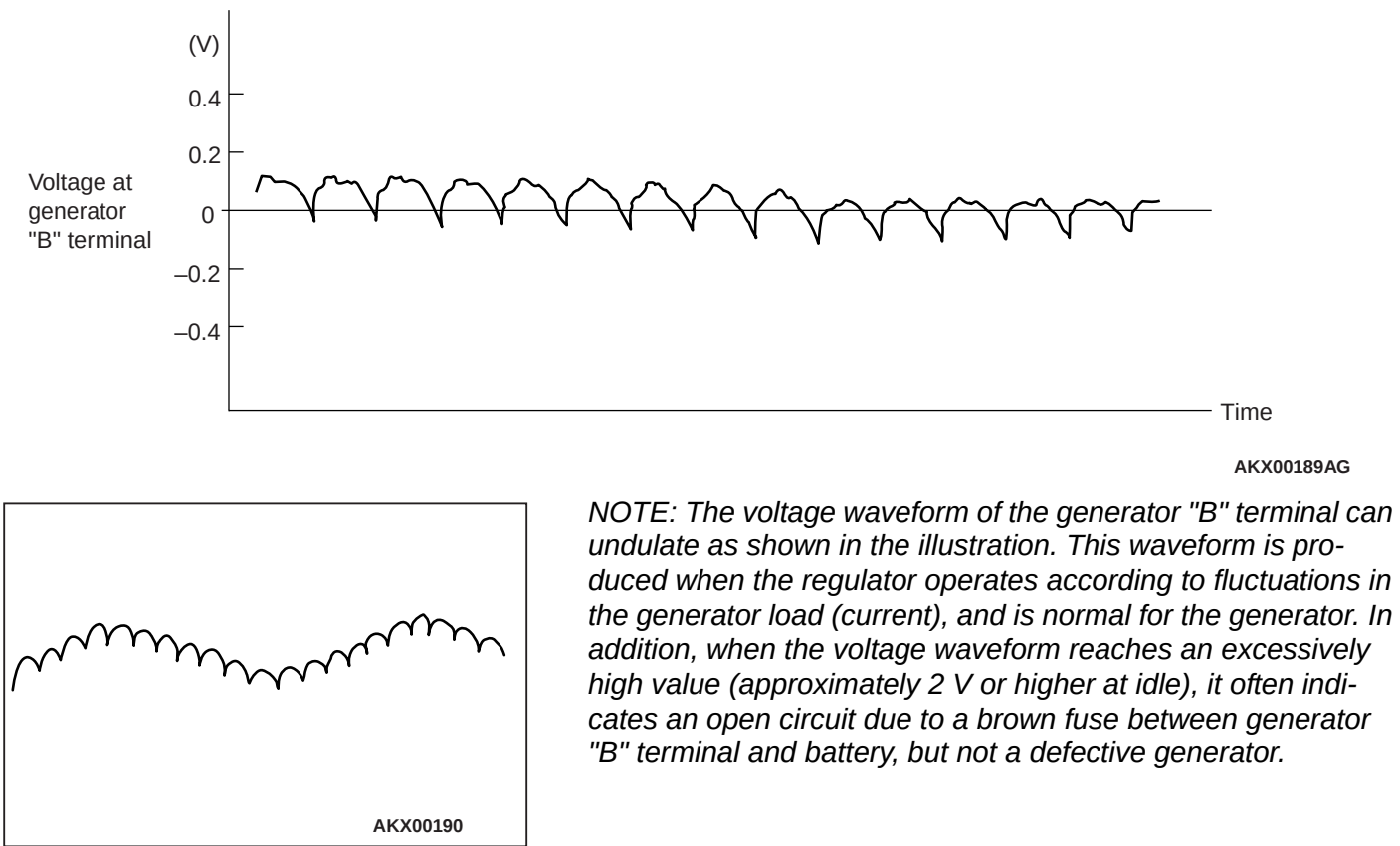
Connect the oscilloscope special patterns pick-up to the generator "B" terminal.



STANDARD WAVEFORM

Observation Conditions

Function	Special pattern
Pattern height	Variable
Variable knob	Adjust while viewing the waveform.
Pattern selector	Raster
Engine speed	Curb idle speed

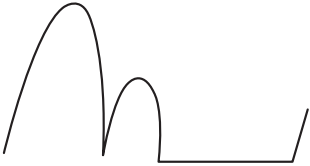


EXAMPLE OF ABNORMAL WAVEFORMS

NOTE:

- 1. The size of the waveform patterns differs largely, depending on the adjustment of the variable knob on the oscilloscope.
- 2. Identification of abnormal waveforms is easier when there is a large output current (regulator is not operating). (Waveforms can be observed when the headlights are illuminated).
- 3. Check the conditions of the generator malfunction light (illuminated/not illuminated). Also, check the charging system totally.

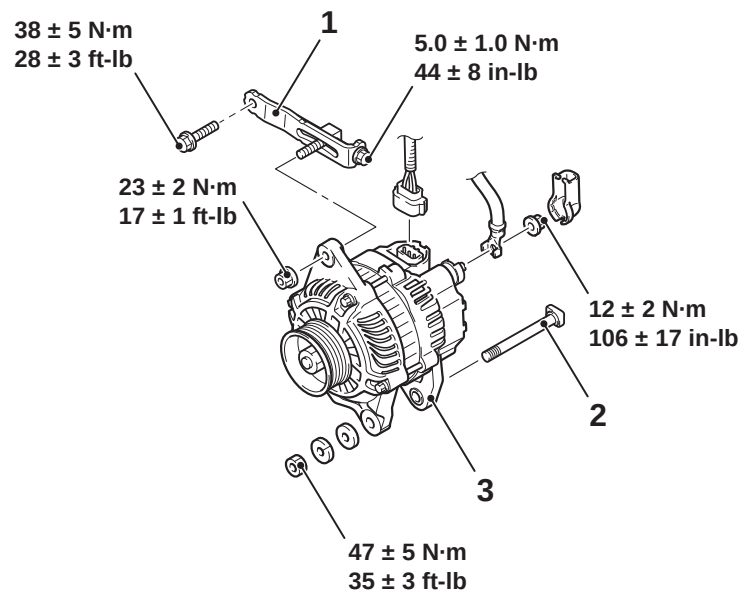
Abnormal waveform	Problem cause
Example 1 AKX00191	Open diode

Abnormal waveform	Problem cause
Example 2  AKX00192	Short in diode
Example 3  AKX00193	Broken wire in stator coil
Example 4  AKX00194	Short in stator coil

GENERATOR ASSEMBLY
REMOVAL AND INSTALLATION

M1161001403989

Pre-removal Operation • Drive Belt Removal (Refer to GROUP 11A – Crankshaft Pulley P.11A-18).	Post-installation Operation • Drive Belt Installation (Refer to GROUP 11A – Crankshaft Pulley P.11A-18).
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ACB03450AB

- Removal steps**
1. Generator brace

<<A>> >>A<<
<>

- Removal steps (Continued)**
2. Generator pivot bolt
 3. Generator assembly

REMOVAL SERVICE POINTS

<<A>> GENERATOR PIVOT BOLT REMOVAL

Slide the radiator lower hose clip and then remove the generator pivot bolt.

<> GENERATOR ASSEMBLY REMOVAL

Remove the generator assembly from above the vehicle.

INSTALLATION SERVICE POINT

>>A<< GENERATOR PIVOT BOLT INSTALLATION

Install the generator pivot bolt and then reposition the radiator lower hose clip in its original position.

STARTING SYSTEM

GENERAL INFORMATION

If the ignition switch is turned to the "START" position, engine control module (ECM) turns ON the starter relay, current flows in the pull-in and holding coils provided inside magnetic switch, attracting the plunger. When the plunger is attracted, the lever connected to the plunger is actuated to engage the overrunning clutch with the pinion gear.

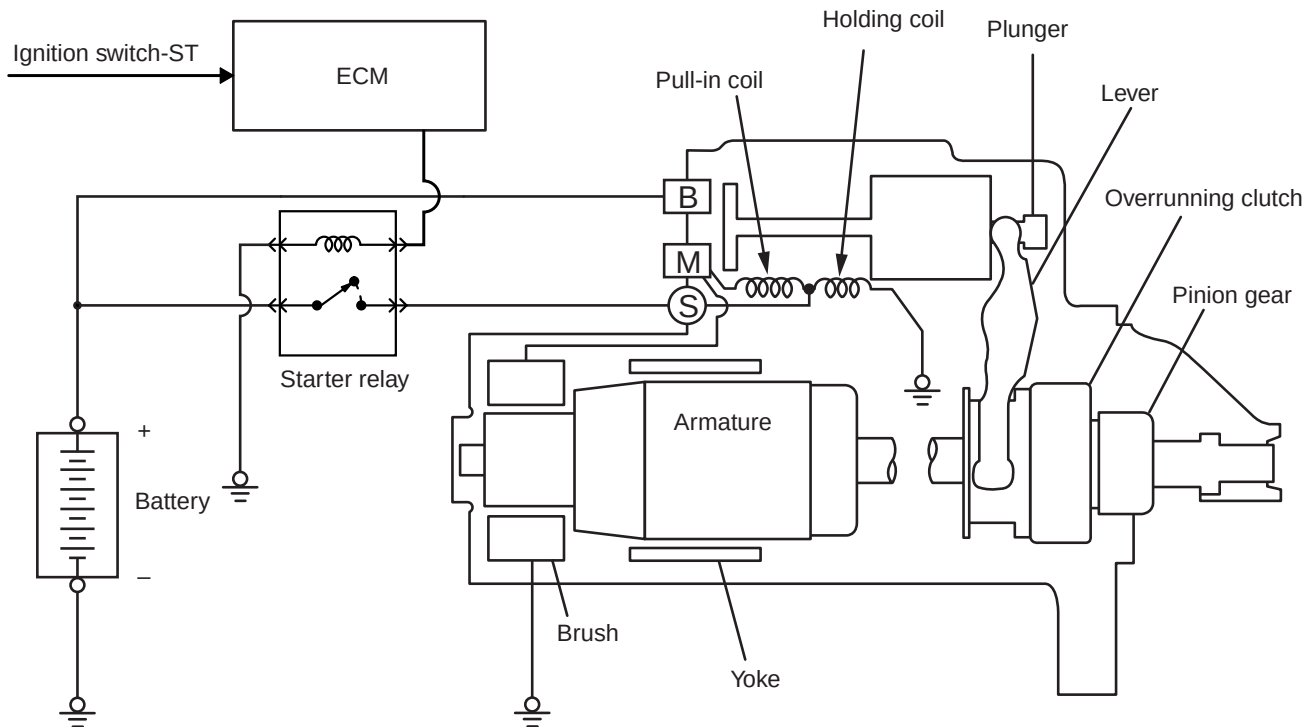
On the other hand, attracting the plunger will turn on the magnetic switch, allowing the "B" terminal and "M" terminal to conduct. Thus, current flows to engage the starter motor.

When the ignition switch is returned to the "ON" position after starting the engine, ECM turns OFF the starter relay, the pinion gear is disengaged from the ring gear.

An overrunning clutch is provided between the pinion and the armature shaft, to prevent damage to the starter.

M1162000101324

SYSTEM DIAGRAM



AKB00551 AD

STARTER MOTOR SPECIFICATIONS

Item	Specification
Type	Direct drive
Rated output kW/V	0.95/12
Number of pinion teeth	8

SERVICE SPECIFICATION

M1162000300723

Item	Standard value
Pinion gap mm (in)	0.5 – 2.0 (0.02 – 0.07)

STARTING SYSTEM DIAGNOSIS

M1162000700583

TROUBLESHOOTING HINTS

The starter motor does not operate at all.

⚠ WARNING

Battery posts, terminals and related accessories contain lead and lead compounds. Wash hands after handling.

- Check the starter (coil).
- Check for poor contact at the battery terminals and starter.
- Check the transmission range switch.

The starter motor doesn't stop

- Check the starter (magnetic switch).

TROUBLESHOOTING GUIDE

The starting system troubleshooting guide is shown in the following steps.

⚠ WARNING

Battery posts, terminals and related accessories contain lead and lead compounds. Wash hands after handling.

STEP 1.

Q: Is the battery in good condition? (Refer to GROUP 54A – Battery, On-vehicle Service, Fluid Level and Specific Gravity Check [P.54A-4](#)).

YES : Go to Step 2.

NO : Charge or replace the battery.

STEP 2.

- Disconnect the starter motor S (solenoid) terminal connector.
- Using a jumper wire, apply battery positive voltage to the starter motor S (solenoid) terminal.
- Check the engine condition.
OK: Turns normally

Q: Does the starter motor operate normally?

- YES :**
- Check the ignition switch (Refer to GROUP 54A – Ignition Switch, Ignition Switch Check [P.54A-12](#)).
 - Check the starter relay system [Refer to GROUP 13A – Diagnosis, Symptom Procedures, Ignition Switch – ST System and Starter Relay System [P.13A-564](#) <M/T>, [P.13A-570](#) <CVT>].
 - Check the transmission range switch (Refer to GROUP 23A – On-vehicle Service, Essential Service, Transmission Range Switch Continuity Check [P.23A-123](#)) <CVT>.
 - Check the line between the battery and starter motor S (solenoid) terminal.

NO : Go to Step 3.

STEP 3.

- Check the cable between starter B (battery) terminal and battery positive terminal for connection and continuity.

Q: Is the starter cable in good condition?

YES : Go to Step 4.

NO : Repair or replace the cable.

STEP 4.

- Check the connection and the continuity of the cable between the starter motor body and the negative battery terminal.

Q: Is the ground line in good condition?

YES : Go to Step 5.

NO : Repair or replace the cable.

STEP 5.

Q: Is the starter motor in good condition? (Refer to [P.16-22](#)).

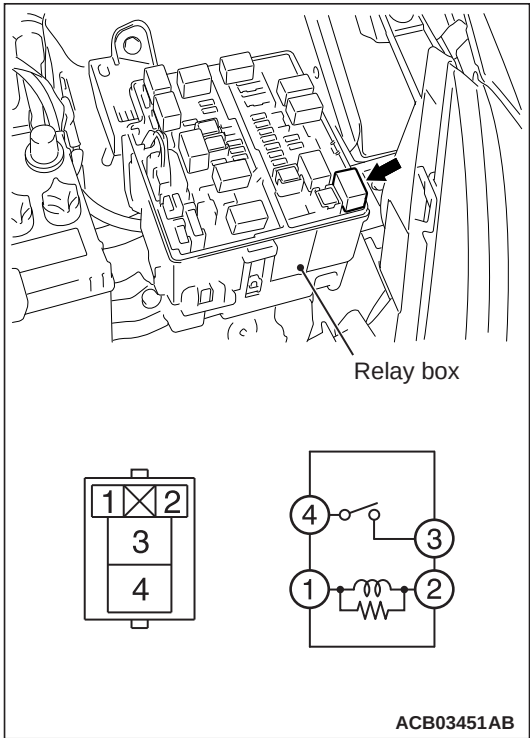
YES : Excessive rotational resistance of the engine.

NO : Replace the starter motor.

ON-VEHICLE SERVICE

STARTER RELAY CONTINUITY CHECK

M1162001401191



Battery voltage	Terminal number to be connected to tester	Continuity test results
Not applied	4 – 3	Open circuit
Connect terminal No.1 and positive battery terminal. Connect terminal No.2 and negative battery terminal.		Continuity (less than 2 ohms)

STARTER MOTOR ASSEMBLY

REMOVAL AND INSTALLATION

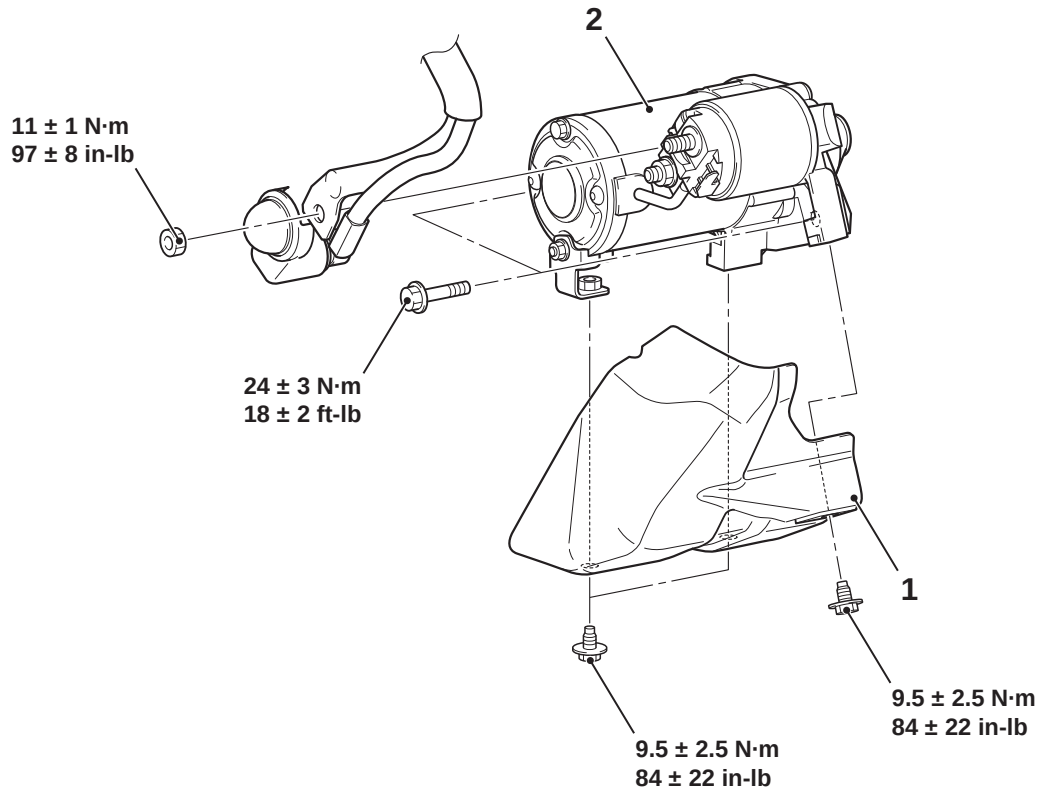
M1162001003337

Pre-removal Operation

- Engine Room Under Cover Front Removal (Refer to GROUP 51 – Under Cover [P.51-15](#)).

Post-installation Operation

- Engine Room Under Cover Front Installation (Refer to GROUP 51 – Under Cover [P.51-15](#)).



ACB03452AB

Removal steps

1. Starter cover
2. Starter assembly

<<A>>

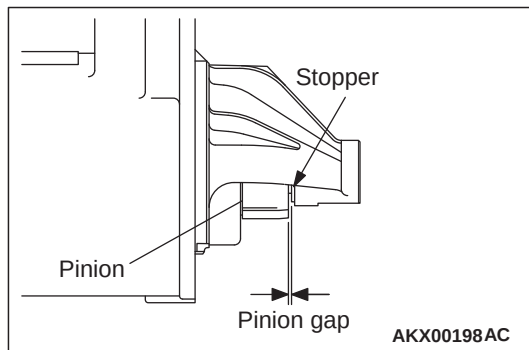
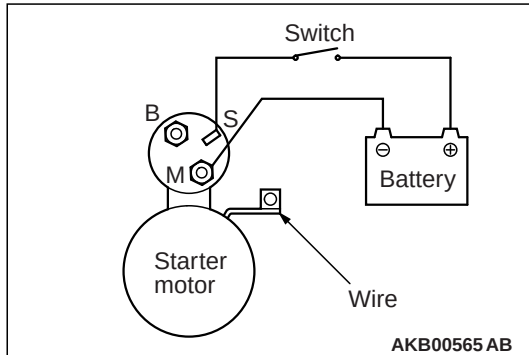
REMOVAL SERVICE POINT

<<A>>STARTER ASSEMBLY REMOVAL

Remove the starter assembly from below the vehicle.

INSPECTION

PINION GAP ADJUSTMENT



1. Disconnect the field coil wire from the M-terminal of the magnetic switch.
2. Connect a 12-volt battery between the S-terminal and M-terminal.

CAUTION

This test must be performed quickly (in less than 10 seconds) to prevent the coil from burning.

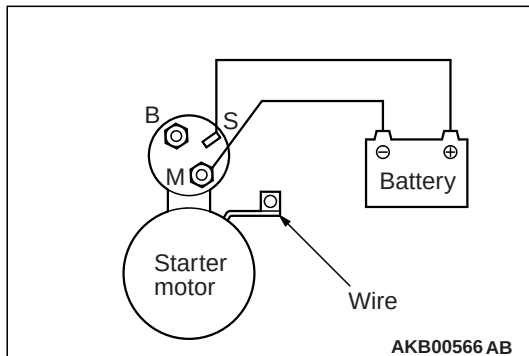
3. Set the switch to "ON", and the pinion will move out.

4. Check the pinion-to-stopper clearance (pinion gap) with a feeler gauge.

Standard value: 0.5 – 2.0 mm (0.02 – 0.07 inch)

5. If the pinion gap is out of specification, replace the starter motor.

MAGNETIC SWITCH PULL-IN TEST



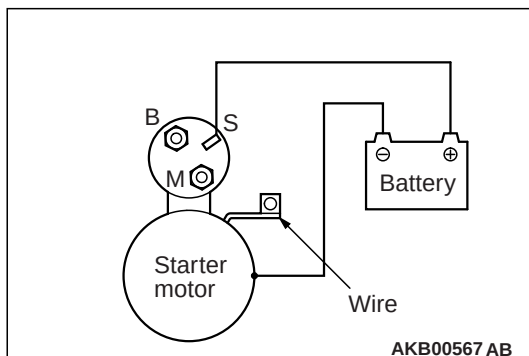
1. Disconnect the field coil wire from the M-terminal of the magnetic switch.

CAUTION

This test must be performed quickly (in less than 10 seconds) to prevent the coil from burning.

2. Connect a 12-volt battery between the S-terminal and M-terminal.
3. If the pinion moves out, the pull-in coil is good. If it doesn't, replace the starter motor.

MAGNETIC SWITCH HOLD-IN TEST

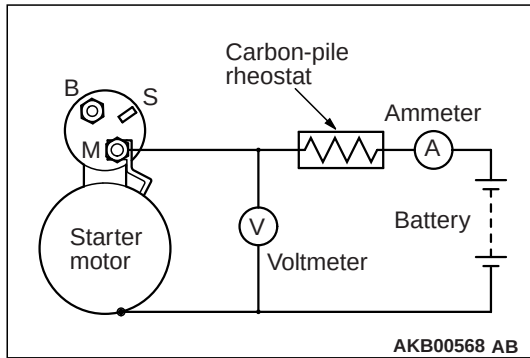


1. Disconnect the field coil wire from the M-terminal of the magnetic switch.

CAUTION

This test must be performed quickly (in less than 10 seconds) to prevent the coil from burning.

2. Connect a 12-volt battery between the S-terminal and body.
3. Manually pull out the pinion as far as the pinion stopper position.
4. If the pinion remains out, everything is in order. If the pinion moves in, the hold-in circuit is open. Replace the starter motor.



1. Place the starter motor in a vise equipped with soft jaws and connect a fully-charged 12-volt battery to the starter motor as follows:
2. Connect a test ammeter (100-ampere scale) and carbon pile rheostat in series between the positive battery terminal and starter motor terminal.
3. Connect a voltmeter (15-volt scale) across the starter motor.
4. Rotate the rheostat to full-resistance position.
5. Connect the battery cable from the negative battery terminal to the starter motor body.
6. Adjust the rheostat until the battery voltage shown on the voltmeter is 11.5 V.
7. Confirm that the maximum amperage is within the specifications and that the starter motor turns smoothly and freely.

Current: Maximum 40 Amps

MAGNETIC SWITCH RETURN TEST

1. Disconnect the field coil wire from the M-terminal of the magnetic switch.

CAUTION

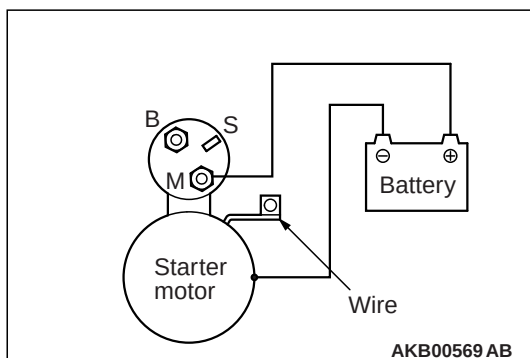
This test must be performed quickly (in less than 10 seconds) to prevent the coil from burning.

2. Connect a 12-volt battery between the M-terminal and body.

WARNING

Be careful not to get your fingers caught when pulling out the pinion.

3. Pull the pinion out and release. If the pinion quickly returns to its original position, everything is operating properly. If it doesn't, replace the starter motor.



IGNITION SYSTEM

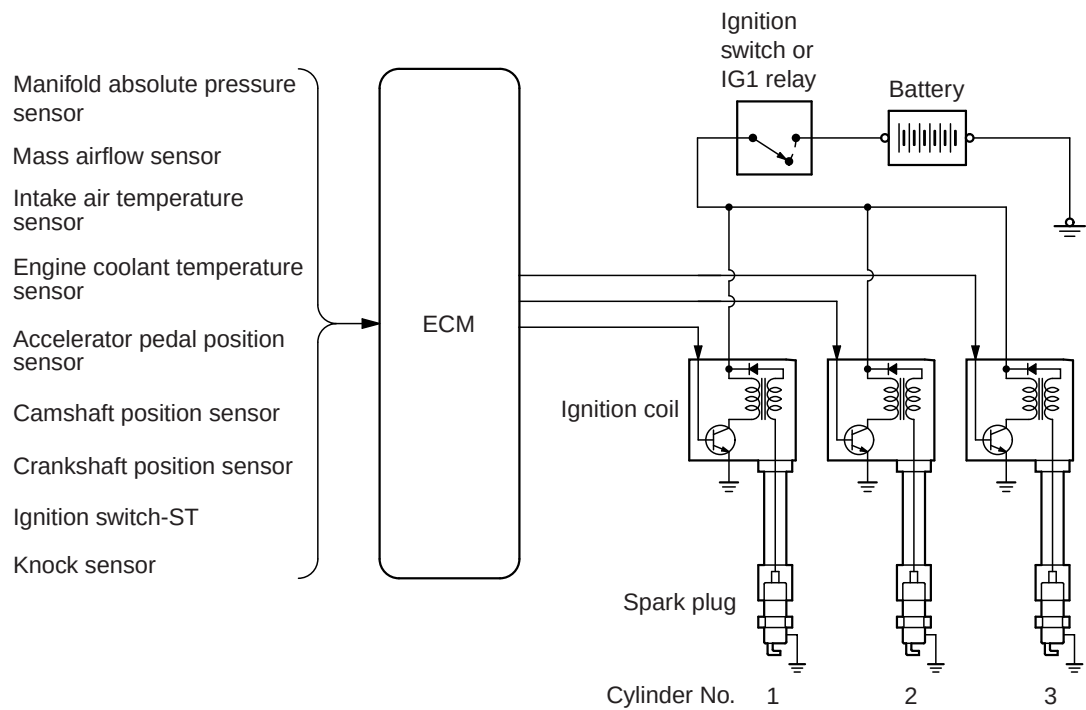
GENERAL INFORMATION

This system is equipped with three ignition coils with built-in power transistors for each of the cylinders. Interruption of the primary current flowing in the primary side of an ignition coil generates a high voltage in the secondary side of ignition coil. The high voltage thus generated is applied to the spark plugs to generate sparks. The engine control module (ECM) turns the power transistors inside the ignition coils alternately on and off. This causes the primary currents in the ignition coils to be alternately interrupted and allowed to flow to fire the cylinders in the order 1-3-2.

The ECM determines which ignition coil should be controlled by means of the signals from the camshaft position sensor and the crankshaft position sensor. It also detects the crankshaft position, in order to provide ignition at the most appropriate timing in response to the engine operation conditions. When the engine is cold or running at high altitudes, the ignition timing is slightly advanced to provide optimum performance. Furthermore, if knocking occurs, the ignition timing is gradually retarded until knocking ceases.

M1163000102052

SYSTEM DIAGRAM



AKB00730AC

IGNITION COIL SPECIFICATION

Item	Specification
Type	Molded 3-coil

SPARK PLUG SPECIFICATION

Item	Specification
NGK	LZFR5BI11

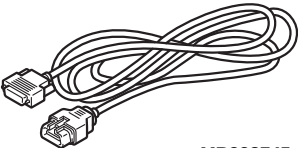
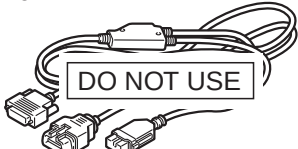
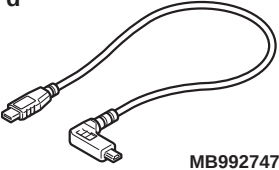
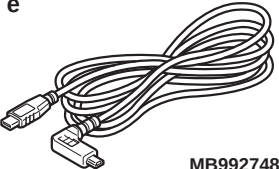
SERVICE SPECIFICATIONS

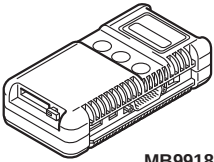
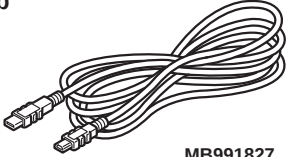
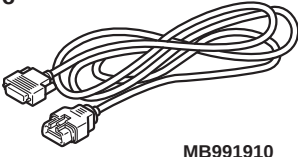
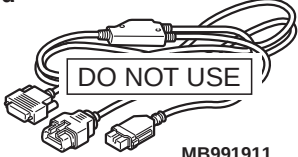
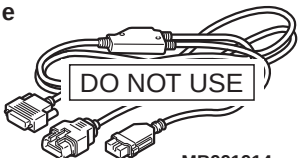
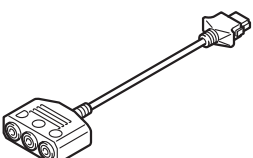
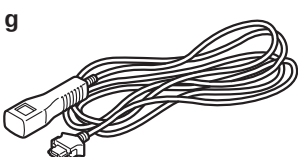
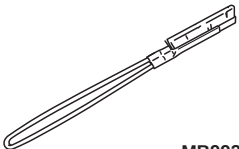
M1163000301633

Item	Standard value	Limit
Spark plug gap mm (in)	1.0 – 1.1 (0.040 – 0.043)	1.5 (0.06)
Spark plug insulation resistance MΩ	–	Minimum 10

SPECIAL TOOLS

M1161000601199

Tool	Tool number and name	Supersession	Application
a  MB992744	a. MB992744 b. MB992745 c. MB992746 d. MB992747 e. MB992748	–	Reading the diagnostic trouble code
b  MB992745	a. Vehicle communication interface-Lite (V.C.I.-Lite) b. V.C.I.-Lite main harness A (for vehicles with CAN communication)		
c  MB992746	c. V.C.I.-Lite main harness B (for vehicles without CAN communication) d. V.C.I.-Lite USB cable short e. V.C.I.-Lite USB cable long		
d  MB992747			
e  MB992748 ACB05421AB			

Tool	Tool number and name	Supersession	Application
a  MB991824 b  MB991827 c  MB991910 d  MB991911 e  MB991914 f  MB991825 g  MB991826 MB991958	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 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>	⚠ CAUTION M.U.T.-III main harness A (MB991910) should be used. M.U.T.-III main harness B and C should not be used for this vehicle. Reading the diagnostic trouble code
 MB992273	MB992273 Spark plug brush	—	Cleaning spark plug

ON-VEHICLE SERVICE

IGNITION COIL CHECK

M1163001201598

NOTE: It is impossible to carry out an easy check using a circuit tester because a diode and so on are integrated into the inside circuit of this ignition coil. Accordingly, check the ignition coil in the following procedure.

 CAUTION

To prevent damage to scan tool (M.U.T.-III), always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool (M.U.T.-III).

1. Turn the ignition switch to the "LOCK" (OFF) position and then connect scan tool (M.U.T.-III) to the data link connector [Refer to GROUP 13A – Diagnostic Function, How to Connect the Scan Tool (M.U.T.-III) [P.13A-10](#)].
2. Make sure the diagnostic trouble codes are not stored using scan tool (M.U.T.-III). If stored, record the code No. Carry out the troubleshooting for the stored codes and solve the problems even if not related to the ignition.
3. Disconnect the injector connectors on all of the cylinders.
4. Disconnect the ignition coil connector.
5. Remove the ignition coil and install a good spark plug to the ignition coil.
6. Connect the ignition coil connector.
7. Ground the side electrode of the spark plug and crank the engine.
8. Check that spark is produced between the electrodes of the spark plug.
9. If the spark plug has weak sparks or no sparks, carry out the same check using a good ignition coil. If there are strong sparks on this check with a good ignition coil, it becomes clear there is a problem with the ignition coil. Replace the ignition coil with a new one. If there are no sparks on this check with a good ignition coil, there is probably a problem with the ignition circuit. Check the ignition circuit.
10. Using scan tool (M.U.T.-III), make sure whether the diagnostic trouble codes are stored due to the check, or not. Except the codes stored in Step 2, clear the codes all together if they are present. And then, carry out the troubleshooting about the codes recorded.
11. Turn the ignition switch to the "LOCK" (OFF) position, and then disconnect the scan tool (M.U.T.-III).

SPARK PLUG CHECK AND CLEANING

M1163004302887

⚠ CAUTION

- Never attempt to adjust the gap of the iridium plug.
- Do not attempt to clean the iridium plug using a wire brush because it may result in damage to the electrode. When the iridium plug is cleaned, use special tool spark plug brush (MB992273).

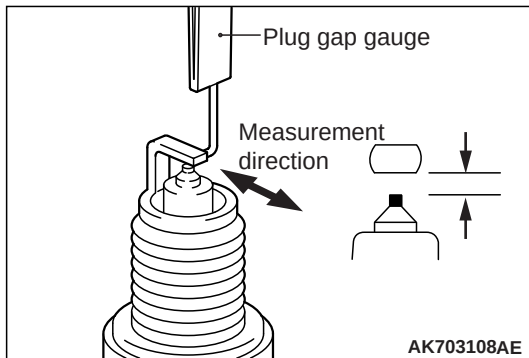
NOTE: Obey the maintenance interval of the relevant vehicle for the spark plug replacement. If the plug gap and insulation resistance are normal, check the plug condition and clean if necessary.

SPARK PLUG GAP CHECK

Check the plug gap with the wire type plug gap gauge. Replace it if the limit is exceeded.

Standard value: 1.0 – 1.1 mm (0.040 – 0.043 inch)

Limit: 1.5 mm (0.06 inch)

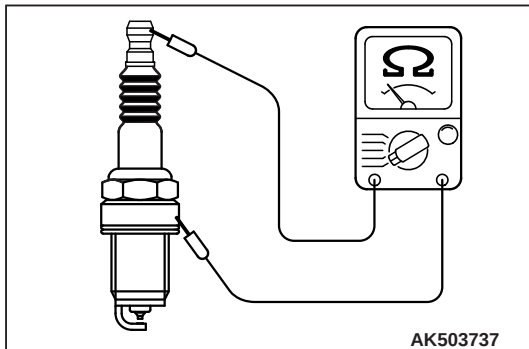


SPARK PLUG INSULATION RESISTANCE CHECK

1. Measure the insulation resistance of the spark plug. If the insulation resistance of the spark plug is under the limited value, clean the spark plug (Refer to [P.16-28](#)).

Limit: Minimum 10 MΩ

2. After cleaning, measure the insulation resistance again. Replace the plug unless it is within the limited value.



SPARK PLUG CLEANING

1. Sufficiently apply the brake cleaner to the plug end.

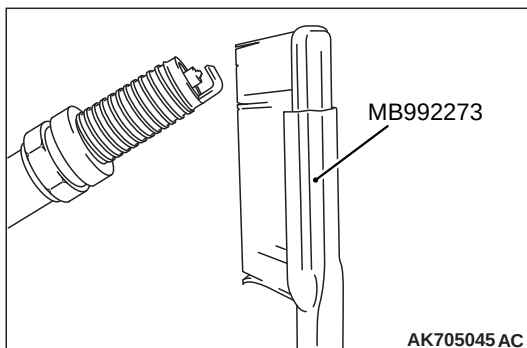
NOTE: Repeatedly applying the brake cleaner is acceptable during the cleaning.

2. Using special tool spark plug brush (MB992273), intensively clean the electrode for 1 to 2 minutes.

NOTE: Even if using strong force, the electrode is not damaged.

NOTE: In case of insufficient cleaning, it is permissible to take longer than 2 minutes for cleaning.

3. After the cleaning, sufficiently remove and then dry both of the carbon and the brake cleaner on the plug, using a waste cloth or air blowing.



CAMSHAFT POSITION SENSOR CHECK

M1163004401063

Check the camshaft position sensor circuit if self-diagnostic trouble code, No. P0340 is shown.

(Refer to GROUP 13A – Diagnosis, Diagnostic Trouble Code Procedures, DTC P0340 Camshaft Position Sensor System [P.13A-267](#)).

CRANKSHAFT POSITION SENSOR CHECK

M1163004501112

Check the crankshaft position sensor circuit if self-diagnostic trouble code, No. P0335 is shown.

(Refer to GROUP 13A – Diagnosis, Diagnostic Trouble Code Procedures, DTC P0335 Crankshaft Position Sensor System [P.13A-260](#)).

KNOCK SENSOR CHECK

M1163002900713

Check the knock sensor circuit if self-diagnostic trouble code, No. P0327 or P0328 is shown.

(Refer to GROUP 13A – Diagnosis, Diagnostic Trouble Code Procedures, DTC P0327 Knock Sensor Circuit Low [P.13A-255](#)).

(Refer to GROUP 13A – Diagnosis, Diagnostic Trouble Code Procedures, DTC P0328 Knock Sensor Circuit High [P.13A-258](#)).

IGNITION COIL

REMOVAL AND INSTALLATION

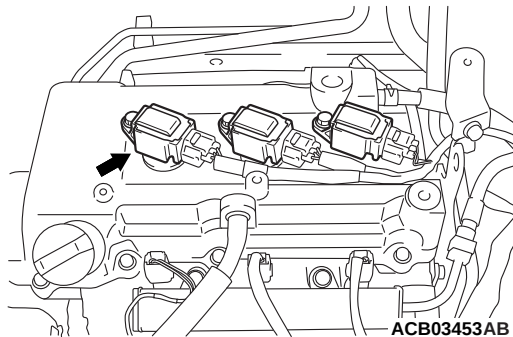
M1163004002284

Pre-removal Operation

- Air Cleaner Assembly Removal (Refer to GROUP 15 – Air Cleaner [P.15-5](#)).

Post-installation Operation

- Air Cleaner Assembly Installation (Refer to GROUP 15 – Air Cleaner [P.15-5](#)).



For the removal and installation procedures, refer to GROUP 11B – Generator and Ignition System [P.11B-10](#).

CAMSHAFT POSITION SENSOR

REMOVAL AND INSTALLATION

M1163003402201

⚠ CAUTION

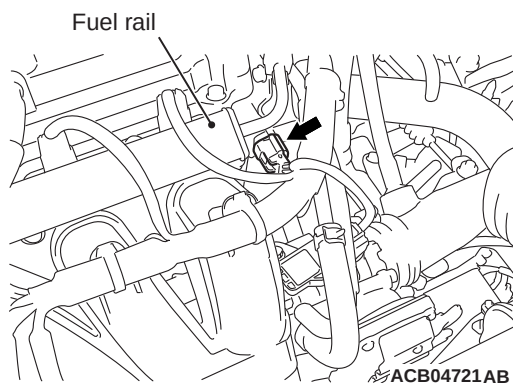
- When removing or installing the camshaft position sensor, be careful not to apply impact to the sensor.
- Do not reuse the camshaft position sensor that has been dropped.

Pre-removal Operation

- Air Cleaner Assembly Removal (Refer to GROUP 15 – Air Cleaner [P.15-5](#)).

Post-installation Operation

- Air Cleaner Assembly Installation (Refer to GROUP 15 – Air Cleaner [P.15-5](#)).



For the removal and installation procedures, refer to GROUP 11B – Water Hose and Pipe [P.11B-19](#).

CRANKSHAFT POSITION SENSOR

REMOVAL AND INSTALLATION

M1163004801759

CAUTION

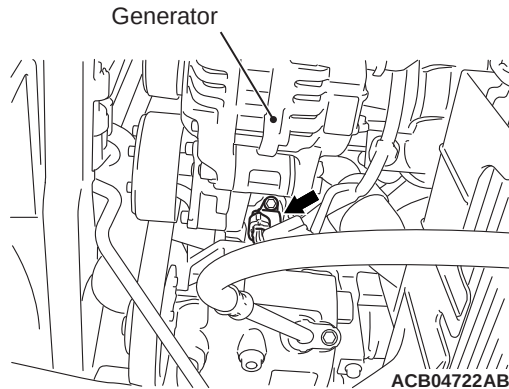
- When removing or installing the crankshaft position sensor, be careful not to apply impact to the sensor.
- Do not reuse the crankshaft position sensor that has been dropped.

Pre-removal Operation <Vehicles with A/C>

- Drive Belt Removal (Refer to GROUP 11A – Crankshaft Pulley [P.11A-18](#)).
- A/C Compressor and Clutch Assembly Removal (Refer to GROUP 11A – Engine Assembly [P.11A-46](#)).

Post-installation Operation <Vehicles with A/C>

- A/C Compressor and Clutch Assembly Installation (Refer to GROUP 11A – Engine Assembly [P.11A-46](#)).
- Drive Belt Installation (Refer to GROUP 11A – Crankshaft Pulley [P.11A-18](#)).



For the removal and installation procedures, refer to GROUP 11B – Water Hose and Pipe [P.11B-19](#).

KNOCK SENSOR

REMOVAL AND INSTALLATION

M1163002802949

⚠ CAUTION

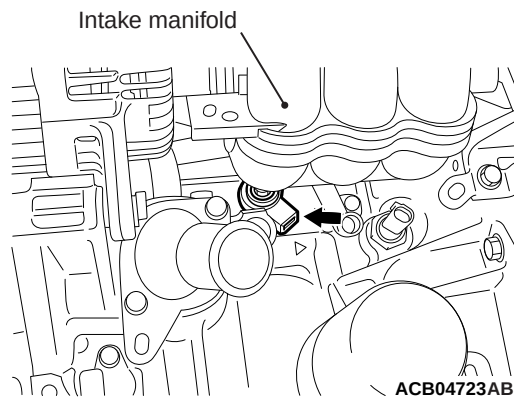
When the knock sensor is replaced, initialize the learned value using scan tool (M.U.T.-III) (Refer to GROUP 00 – Precautions before Service, Initialization Procedure for Learning Value in MFI Engine P.00-41).

Pre-removal Operation

- Engine Room Under Cover Front Removal (Refer to GROUP 51 – Under Cover P.51-15).
- Oil Filter Removal (Refer to GROUP 12 – On-vehicle Service, Oil Filter Replacement P.12-5).
- Oil Filter Cover Removal (Refer to GROUP 11B – Oil Pan and Timing Chain Case P.11B-23).

Post-installation Operation

- Oil Filter Cover Installation (Refer to GROUP 11B – Oil Pan and Timing Chain Case P.11B-23).
- Oil Filter Installation (Refer to GROUP 12 – On-vehicle Service, Oil Filter Replacement P.12-5).
- Engine Room Under Cover Front Installation (Refer to GROUP 51 – Under Cover P.51-15).



For the removal and installation procedures, refer to GROUP 11B – Water Hose and Pipe P.11B-19.