

GROUP 16

ENGINE ELECTRICAL

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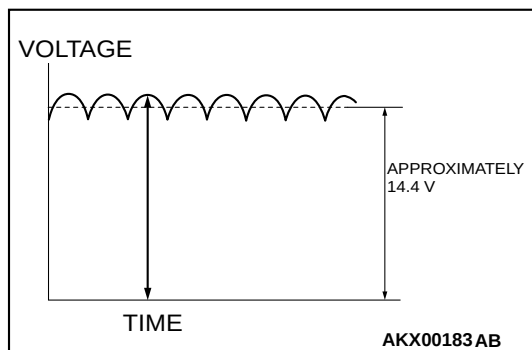
CHARGING SYSTEM

GENERAL DESCRIPTION

M1161000100351

The charging system charges the battery with the generator output to keep the battery charged at a constant level during varying electrical load.

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 at left.

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

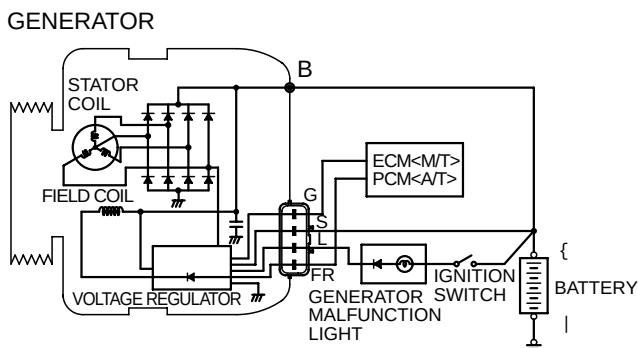
When the ignition switch is turned on, current flows in the field coil and initial excitation of the field coil occurs.

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.

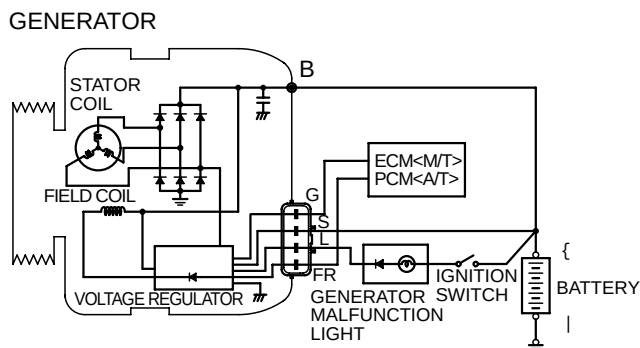
The generator output voltage rises as the field current increases and it falls as the field current decreases. When the battery positive voltage (generator S terminal voltage) reaches a regulated voltage of approximately 14.4 V, the field current is cut off. When the battery positive voltage drops below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

When the field current is constant, the generator output voltage rises as the engine speed increases.

<2.0L ENGINE>



<2.4L ENGINE>



AK301799AB

CHARGING SYSTEM DIAGNOSIS

M1161000700245

TROUBLESHOOTING HINTS

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

- Check the bulb.

Generator malfunction light dose 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.

The generator malfunction light illuminates dimly.

- Check the diode (inside the combination meter) for a short-circuit.

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, Chassis Electrical – Battery – On-vehicle Service – Battery Check [P.54A-4.](#))

YES : Go to Step 2.

NO : Charge or replace the battery.

STEP 2.

Q: Is the generator drive belt in good condition? (Refer to GROUP 00, General – Maintenance Service – 9. Drive Belt (For Generator, Power Steering Oil Pump and A/C Compressor) (Check Condition) [P.00-45.](#))

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, Chassis Electrical – Ignition Switch – Ignition Switch – Inspection [P.54A-9.](#))
 - Check for burnt-out generator malfunction light.
 - Check the generator. (Refer to Charging System – Generator Assembly – Inspection [P.16-20.](#))
 - Check the generator malfunction light-related circuits.

STEP 4.

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

YES : Go to Step 5.

NO : Check the generator (Refer to Charging System – Generator Assembly – Inspection [P.16-20.](#))

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 Charging System – On-vehicle Service – Wave Pattern Check Using an Oscilloscope [P.16-13.](#))

YES : Go to Step 7.

NO : Check the generator. (Refer to Charging System – Generator Assembly – Inspection [P.16-20.](#))

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 Charging System – On-vehicle Service – Output Current Test [P.16-10.](#))

YES : Go to Step 9.

NO : Check the generator (Refer to Charging System – Generator Assembly – Inspection [P.16-20.](#))

STEP 9.

Q: Is the regulated voltage normal? (Refer to Charging System – On-vehicle Service – Regulated Voltage Test [P.16-12.](#))

YES : Go to Step 10.

NO : Check the generator (Refer to Charging System – Generator Assembly – Inspection [P.16-20.](#))

STEP 10.

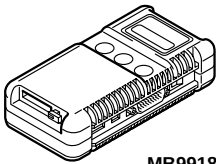
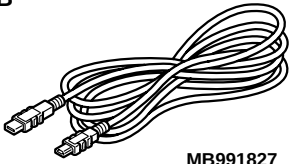
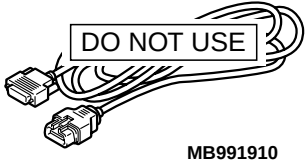
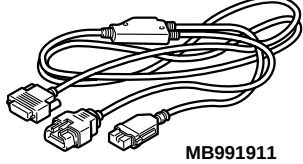
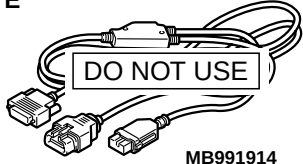
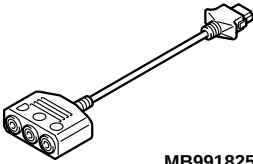
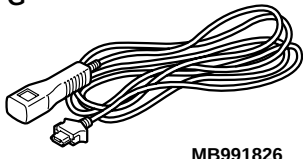
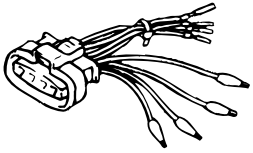
Q: Is the voltage drop in the generator output line normal?

YES : Generator is normal. Check other systems.

NO : Check the output line.

SPECIAL TOOLS

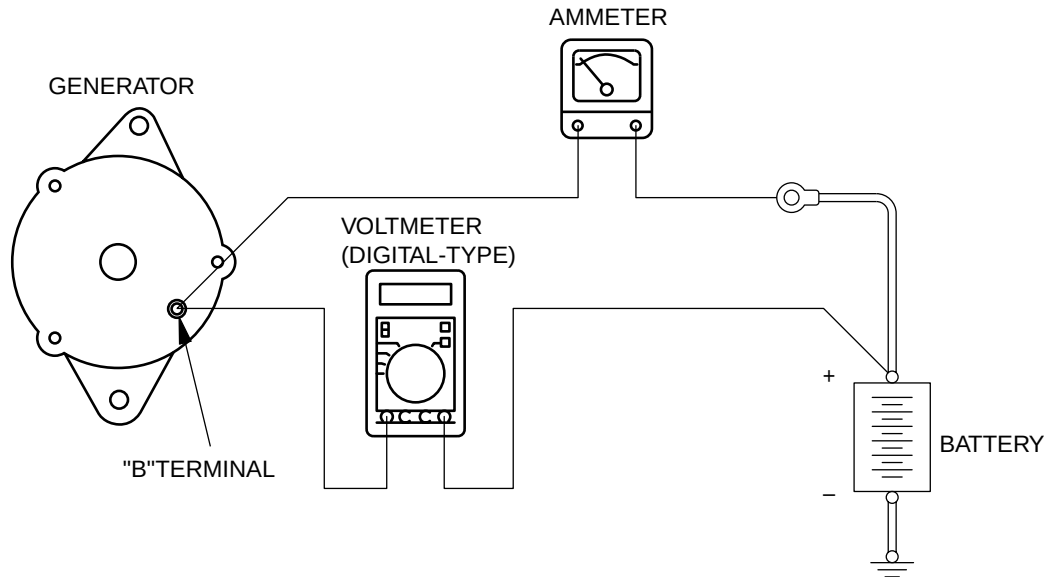
M1161000600293

TOOL	TOOL NUMBER AND NAME	SUPERSESION	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 MUT-III sub assembly A: Vehicle communication interface (V.C.I.) B: MUT-III USB cable C: MUT-III main harness A (Vehicles with CAN communication system) D: MUT-III main harness B (Vehicles without CAN communication system) E: MUT-III main harness C (for Daimler Chrysler models only) F: MUT-III adapter harness G: MUT-III trigger harness	MB991824-KIT <i>NOTE: G: MB991826</i> <i>MUT-III Trigger Harness is not necessary when pushing V.C.I. ENTER key.</i>	Checking of engine idle speed CAUTION MUT-III Main Harness B (MB991911) should be used. MUT-III main harness A and C should not be used for this vehicle.
	MB991519 Generator harness connector	MIT530 Micrd 530 charging system tester.	Checking of generator ("S" terminal voltage)

ON-VEHICLE SERVICE

GENERATOR OUTPUT LINE VOLTAGE DROP TEST

M1161000900357



AKX00185AB

Required Special Tool:

MB991958: Scan Tool (MUT-III Sub Assembly)

- MB991824: V.C.I.
- MB991827: MUT-III USB Cable
- MB991911: MUT-III Main Harness B

This test determines whether the wiring from the generator "B" terminal to the positive battery terminal (including the fusible link) is in 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
 - Generator drive belt tension (Refer to GROUP 00, General – Maintenance Service – 9. Drive Belt (For Generator, Power Steering Oil Pump and A/C Compressor) (Check Condition) [P.00-45.](#))
 - 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. Disconnect the generator output wire from the generator "B" terminal and connect a DC test ammeter with a range of 0 – 100 A in series between the "B" terminal and the disconnected output wire. (Connect the positive lead of the ammeter to the "B" terminal, and then connect the negative lead of the ammeter to the disconnected output wire.)

NOTE: A clamp-type ammeter which enables measurements to be taken without disconnecting the generator output wire is recommended. If the voltage may have dropped due to a bad connection at generator "B" terminal and the generator "B" terminal is loosened when the test ammeter is connected, the connection will be completed at this time and the possibility of finding the problem will be reduced.

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 then connect the negative lead of the voltmeter to the positive battery cable.)
6. Reconnect the negative battery cable.
7. Connect an engine tachometer or scan tool MB991958.
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.

Limit value: maximum 0.3 V

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

In this case the limit value becomes maximum 0.4 V.

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.

11. If the value displayed on the voltmeter is above the limit value, there is probably a malfunction in the generator output wire. 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.

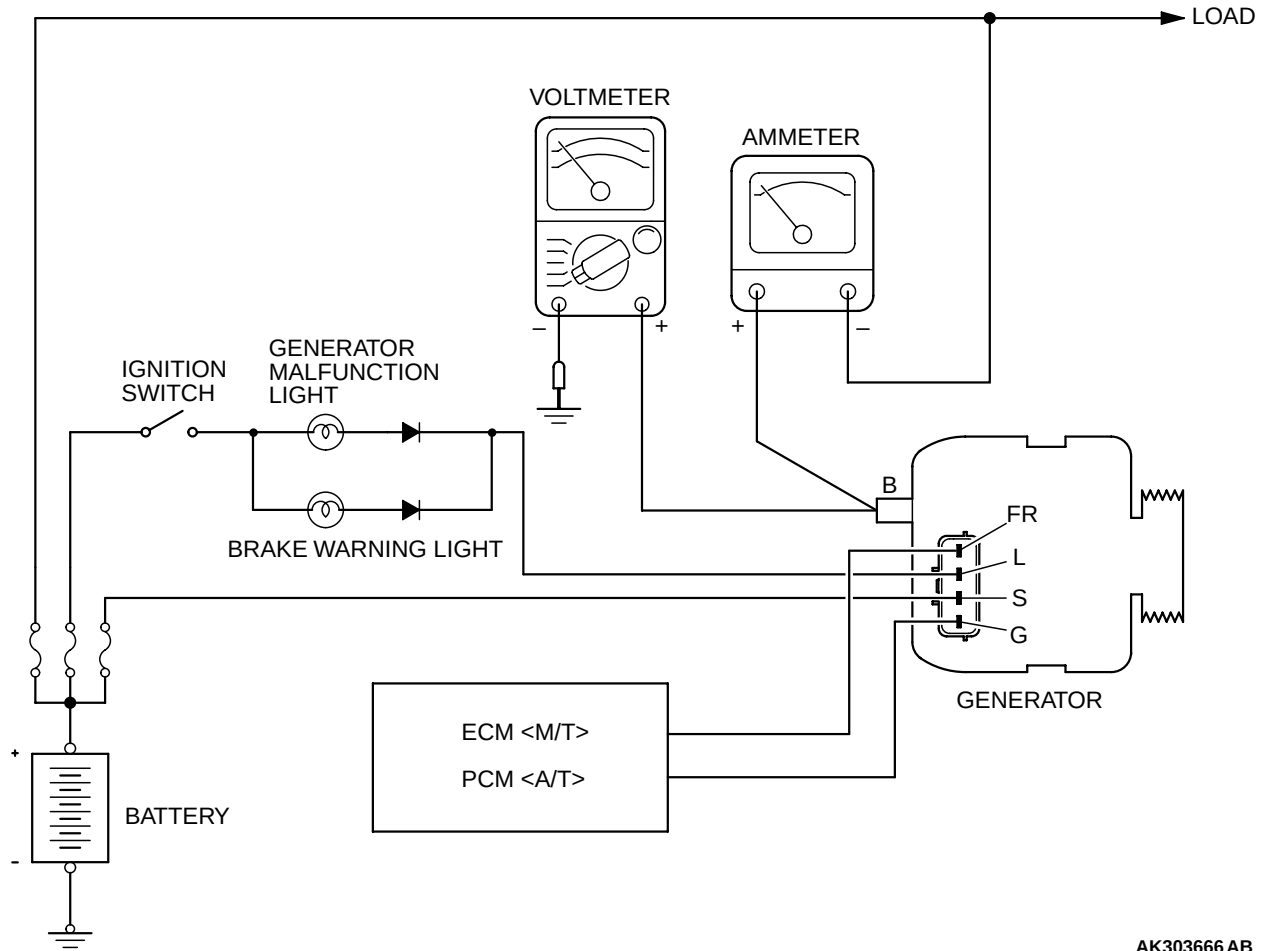
12. After the test, run the engine at idle.
13. Turn off all lights and turn the ignition switch to the "LOCK" (OFF) position.

NOTE: Vehicles for Canada, the headlight, tail-light, etc. remain lit even when the lighting switch is in "OFF" position.

14. Disconnect the engine tachometer or scan tool MB991958.
15. Disconnect the negative battery cable.
16. Disconnect the ammeter and voltmeter and engine tachometer.
17. Connect the generator output wire to the generator "B" terminal.
18. Connect the negative battery cable.

OUTPUT CURRENT TEST

M1161001000380



AK303666 AB

Required Special Tool:

MB991958: Scan Tool (MUT-III Sub Assembly)

- MB991824: V.C.I.
- MB991827: MUT-III USB Cable
- MB991911: MUT-III Main Harness B

This test determines whether the generator outputs normal current.

⚠ 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, Chassis Electrical – Battery – On-vehicle Service – Battery Check [P.54A-4.](#))

NOTE: The battery to be used should be slightly discharged. The load in a fully-charged battery will be insufficient and the test may not be able to be carried out correctly.

- Generator drive belt tension (Refer to GROUP 00, General – Maintenance Service – 9. Drive Belt (For Generator, Power Steering Oil Pump and A/C Compressor) (Check Condition) [P.00-45.](#))
 - 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.

⚠ WARNING

Never use clips to connect the line. Loose connections (e.g. using clips) will lead to a serious accident because of high current.

4. Disconnect the generator output wire from the generator "B" terminal and connect a DC test ammeter with a range of 0 – 100 A in series between the "B" terminal and the disconnected output wire. (Connect the positive lead of the ammeter to the "B" terminal, and then connect the negative lead of the ammeter to the disconnected output wire.)

NOTE: A clamp-type ammeter which enables measurements to be taken without disconnecting the generator output wire is recommended.

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.
7. Connect an engine tachometer or scan tool MB991958.
8. Leave the hood open.
9. Check to be sure that the reading on the voltmeter is equal to the battery positive 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 battery positive terminal.

10. After turning the light switch on and turning on the headlights, start the engine.

NOTE: Because the current from the battery will soon drop after the engine is started, step 11 should be carried out as quickly as possible in order to obtain the maximum current output value.

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 value: 70 % of nominal current output

NOTE: For the nominal current output, refer to the Generator Specifications.

NOTE: The current output value will depend on the electrical load and the temperature of the generator body.

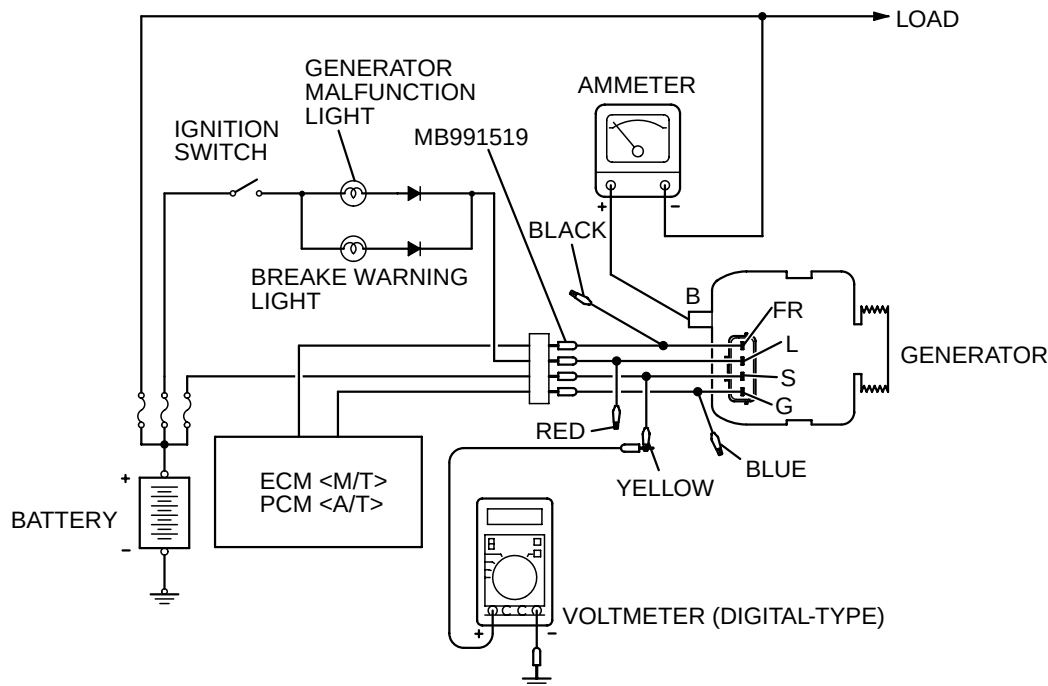
NOTE: If the electrical load is small while testing, the specified level of current may not be output even though the generator is normal. In such cases, increase the electrical load by leaving the headlights turned on for some time to discharge the battery or by using the lighting system in another vehicle, and then test again.

NOTE: 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 speed after the test.
14. Turn the ignition switch to the "LOCK" (OFF) position.
15. Disconnect the engine tachometer or scan tool MB991958.
16. Disconnect the negative battery cable.
17. Disconnect the ammeter, voltmeter, and engine tachometer.
18. Connect the generator output wire to the generator "B" terminal.
19. Connect the negative battery cable. Run the engine for 10 minutes at an idle after reconnecting negative battery cable.

REGULATED VOLTAGE TEST

M1161001100376



AK303667 AB

Required Special Tools:

- MB991958: Scan Tool (MUT-III Sub Assembly)
 - MB991824: V.C.I.
 - MB991827: MUT-III USB Cable
 - MB991911: MUT-III Main Harness B
- MB991519: Generator Harness Connector

This test determines whether the voltage regulator is 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 to be sure that the battery installed in the vehicle is fully charged. (Refer to GROUP 54A, Chassis Electrical – Battery – On-vehicle Service – Battery Check P.54A-4.)
- Generator drive belt tension (Refer to GROUP 00, General – Maintenance Service – 9. Drive Belt (For Generator, Power Steering Oil Pump and A/C Compressor) (Check Condition) P.00-45.)
- Fusible link

- No 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 the special tool (Generator harness connector: MB991519) to connect a digital-type voltmeter between the generator "S" terminal and the 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. Disconnect the generator output wire from the generator "B" terminal.
 6. Connect a DC test ammeter with a range of 0 – 100 A in series between the "B" terminal and the disconnected output wire. (Connect the positive lead of the ammeter to the "B" terminal, and then connect the negative lead of the ammeter to the disconnected output wire.)
 7. Reconnect the negative battery cable.
 8. Connect an engine tachometer or scan tool MB991958.

9. Turn the ignition switch to the "ON" position and check that the reading on the voltmeter is equal to the battery positive 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 battery positive terminal.

10. Check to be sure that all lights and accessories are off.
11. Start the engine.
12. Increase the engine speed to 2,500 r/min.
13. Read the value displayed on the voltmeter when the current output by the generator becomes 10 A or less.

14. If the voltage reading is within the value in the voltage regulation table, then the voltage regulator is operating normally.

If the voltage is outside the standard value, there is a malfunction of the voltage regulator or the generator (Refer to the following table).

15. After the test, lower the engine speed to the idle speed.
16. Turn the ignition switch to the "LOCK" (OFF) position.
17. Disconnect the negative battery cable.
18. Disconnect the ammeter, voltmeter and engine tachometer.
19. Connect the generator output wire to the generator "B" terminal.
20. Connect the negative battery cable.

VOLTAGE REGULATION TABLE

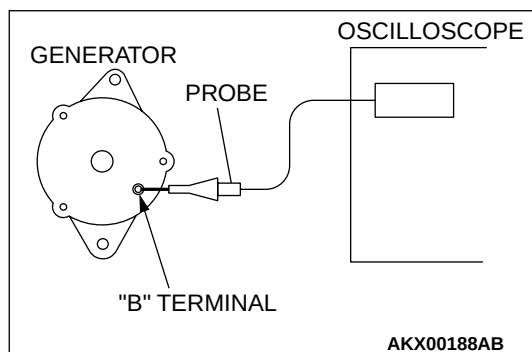
INSPECTION TERMINAL	VOLTAGE REGULATOR AMBIENT TEMPERATURE [°C (°F)]	STANDARD VALUE (V)
Terminal "S"	-20 (-4)	14.2 – 15.4
	20 (68)	13.9 – 14.9
	60 (140)	13.4 – 14.5
	80 (176)	13.1 – 14.5

WAVE PATTERN CHECK USING AN OSCILLOSCOPE

M1161001200180

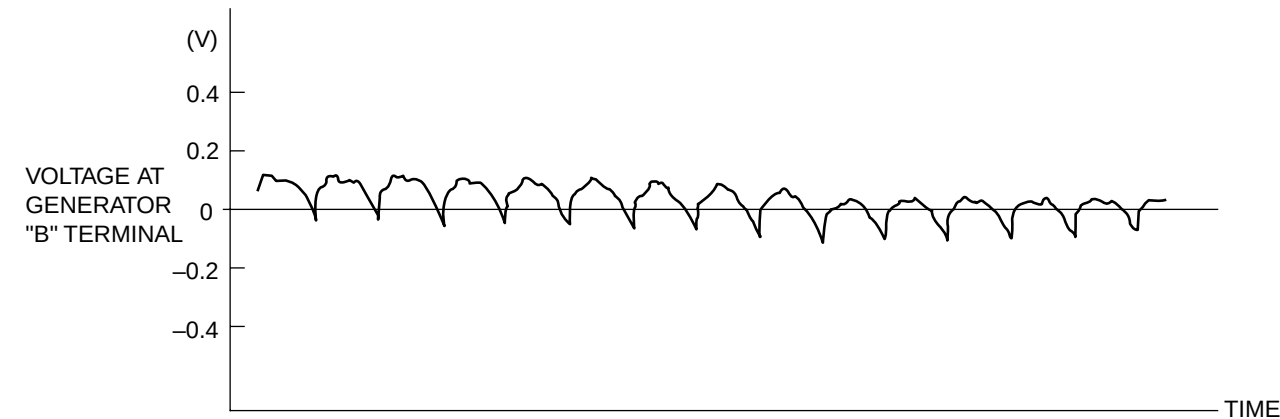
MEASUREMENT METHOD

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

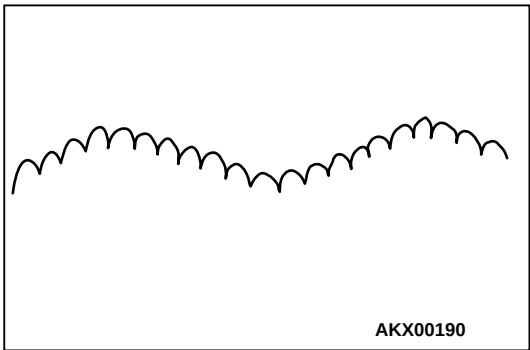


STANDARD WAVEFORM

Observation Conditions	
FUNCTION	SPECIAL PATTERNS
Pattern height	Variable
Variable knob	Adjust while viewing the wave pattern
Pattern selector	Raster
Engine revolutions	Curb idle speed



AKX00189AB



AKX00190

NOTE: The voltage waveform of the generator "B" terminal can undulate as shown at left. This waveform is produced when the regulator operates according to fluctuations in the generator load (current), and is normal for the generator. If the ripple height is abnormally high (approximately 2 V or more during idling), the wires between the generator "B" terminal and the battery have broken due to fuse blowing, etc. The generator is usually operating properly.

ABNORMAL WAVEFORMS EXAMPLES

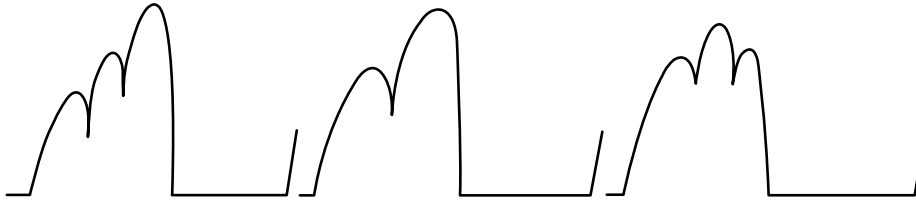
NOTE: The size of the waveform patterns can differ greatly, depending on the adjustment of the variable knob on the oscilloscope.

NOTE: 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.)

NOTE: Check the conditions of the generator malfunction light (illuminated/not illuminated) also, and carry out a total check.

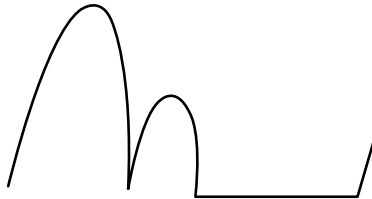
ABNORMAL WAVEFORMS

- Example 1
PROBABLE CAUSE: Open circuit in diode



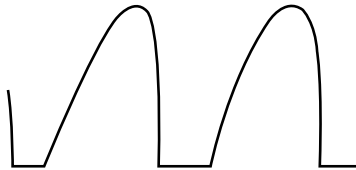
AKX00191

- Example 2
PROBABLE CAUSE: Short-circuit in diode



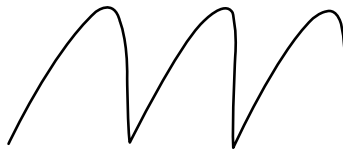
AKX00192

- Example 3
PROBABLE CAUSE: Open circuit in stator coil



AKX00193

- Example 4
PROBABLE CAUSE: Short-circuit in stator coil



AKX00194

GENERATOR ASSEMBLY

REMOVAL AND INSTALLATION <2.0L ENGINE>

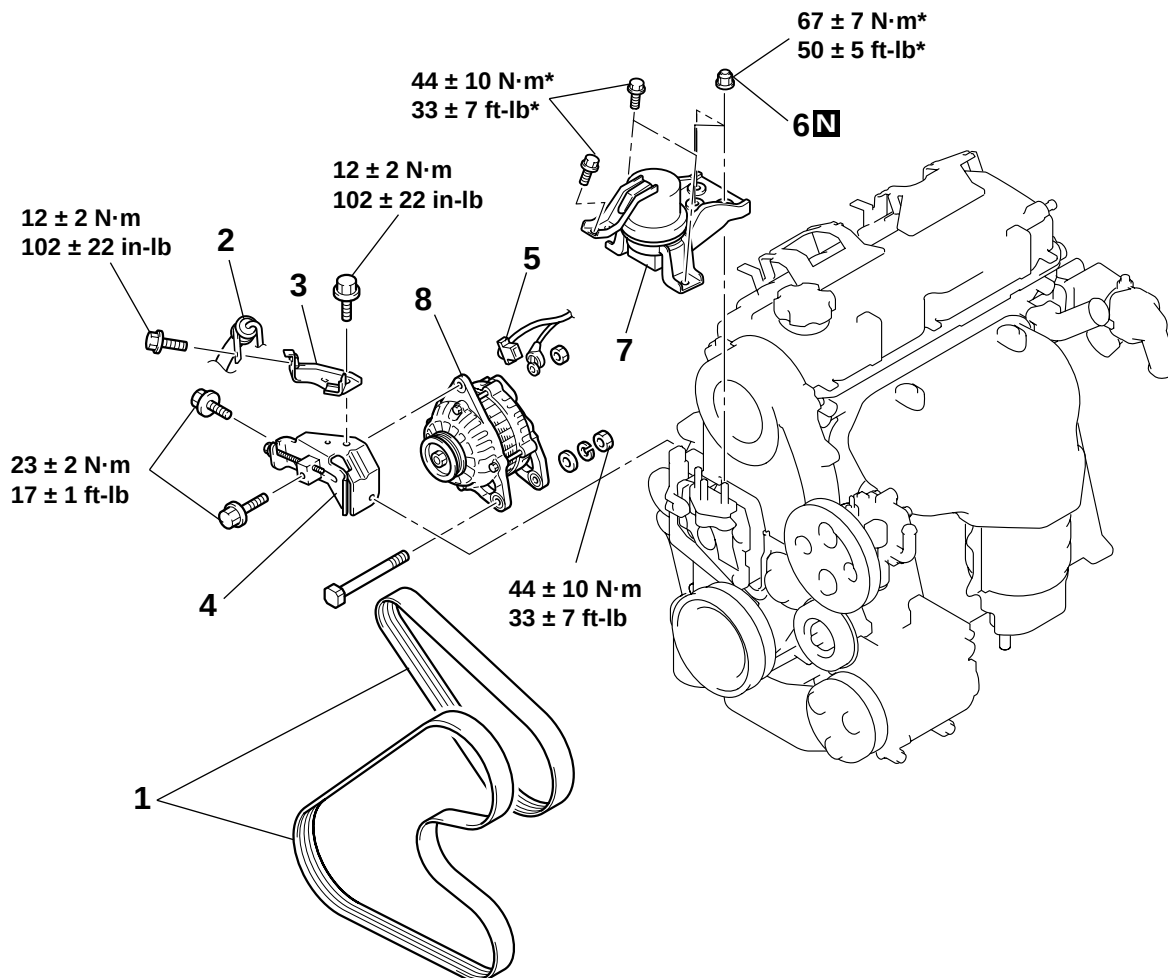
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CAUTION

*: Indicates parts which should be initially tightened, and then fully tightened after placing the vehicle horizontally and loading the full weight of the engine on the vehicle body.

Post-installation Operation

Drive Belt Tension Adjustment (Refer to GROUP 11A, On-vehicle Service [P.11A-7.](#))



AC100803 AC

REMOVAL STEPS

1. DRIVE BELT
2. PRESSURE HOSE CLAMP <<A>>
3. POWER STEERING OIL LINE BRACKET
4. GENERATOR ADJUSTING BRACE <>
5. GENERATOR CONNECTOR

REMOVAL STEPS (Continued)

6. SELF-LOCKING NUTS
7. ENGINE FRONT MOUNTING BRACKET <VEHICLES WITH ABS>
8. GENERATOR

REMOVAL SERVICE POINT

<<A>> ENGINE FRONT MOUNTING BRACKET <VEHICLES WITH ABS> REMOVAL

1. Remove all the power steering hose clamp mounting bolts.
2. Jack up and support the engine assembly, and remove the engine front mounting bracket.
3. Tilt the engine to remove the generator.

<> GENERATOR REMOVAL

Remove the generator from above the vehicle.

REMOVAL AND INSTALLATION <2.4L ENGINE>

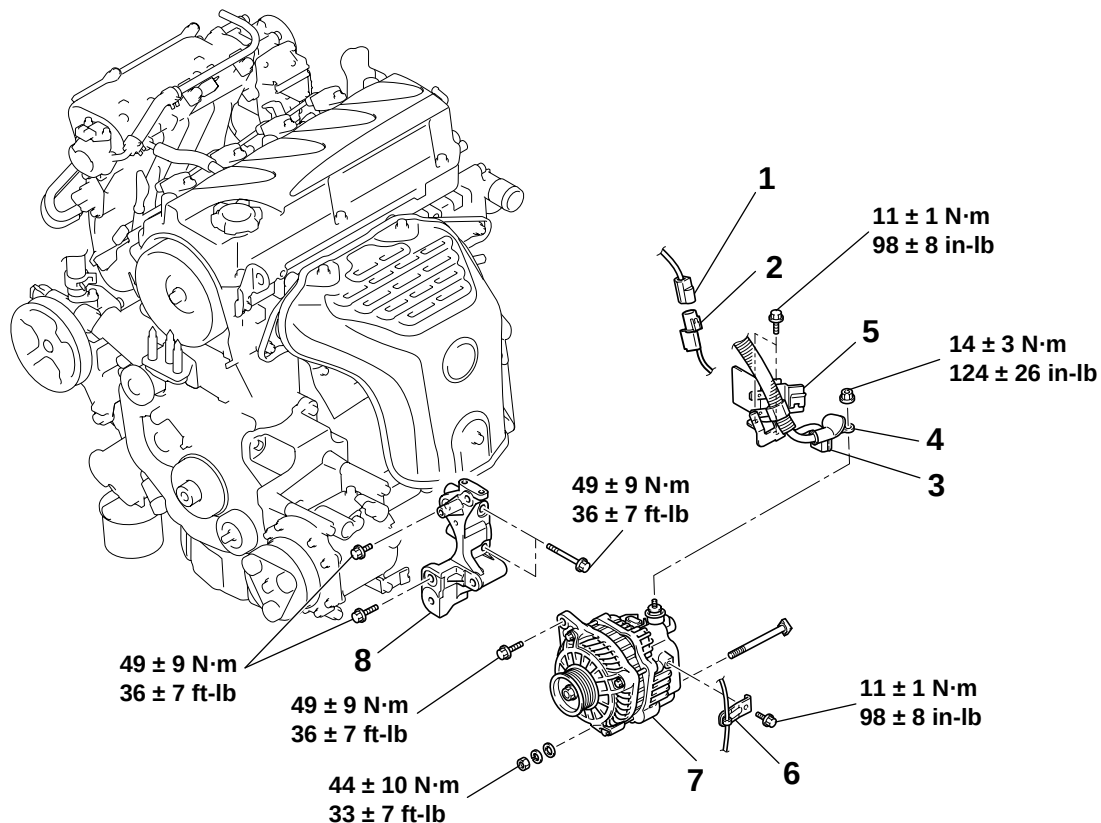
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Pre-removal Operation

- Under Cover Removal.
- Drive Belt Removal (Refer to GROUP 11C, Crankshaft Pulley [P.11C-25](#)).
- Exhaust Manifold Heat Protector Removal (Refer to GROUP 15, Exhaust Manifold [P.15-12](#)).

Post-installation Operation

- Exhaust Manifold Heat Protector Installation (Refer to GROUP 15, Exhaust Manifold [P.15-12](#)).
- Drive Belt Installation (Refer to GROUP 11C, Crankshaft Pulley [P.11C-25](#)).
- Drive Belt Tension Check (Refer to [P.11C-8](#)).
- Under Cover Installation.



AC305096AB

REMOVAL STEPS

1. A/C COMPRESSOR ASSEMBLY CONNECTOR
2. A/C COMPRESSOR ASSEMBLY CONNECTOR CLAMP
3. GENERATOR CONNECTOR
4. GENERATOR TERMINAL
5. CONNECTOR BRACKET

<<A>>

REMOVAL STEPS (Continued)

6. HARNESS BRACKET
7. GENERATOR
 - TIMING BELT LOWER COVER (REFER TO GROUP 11C, TIMING BELT [P.11C-48](#)).
8. GENERATOR MOUNTING BRACKET

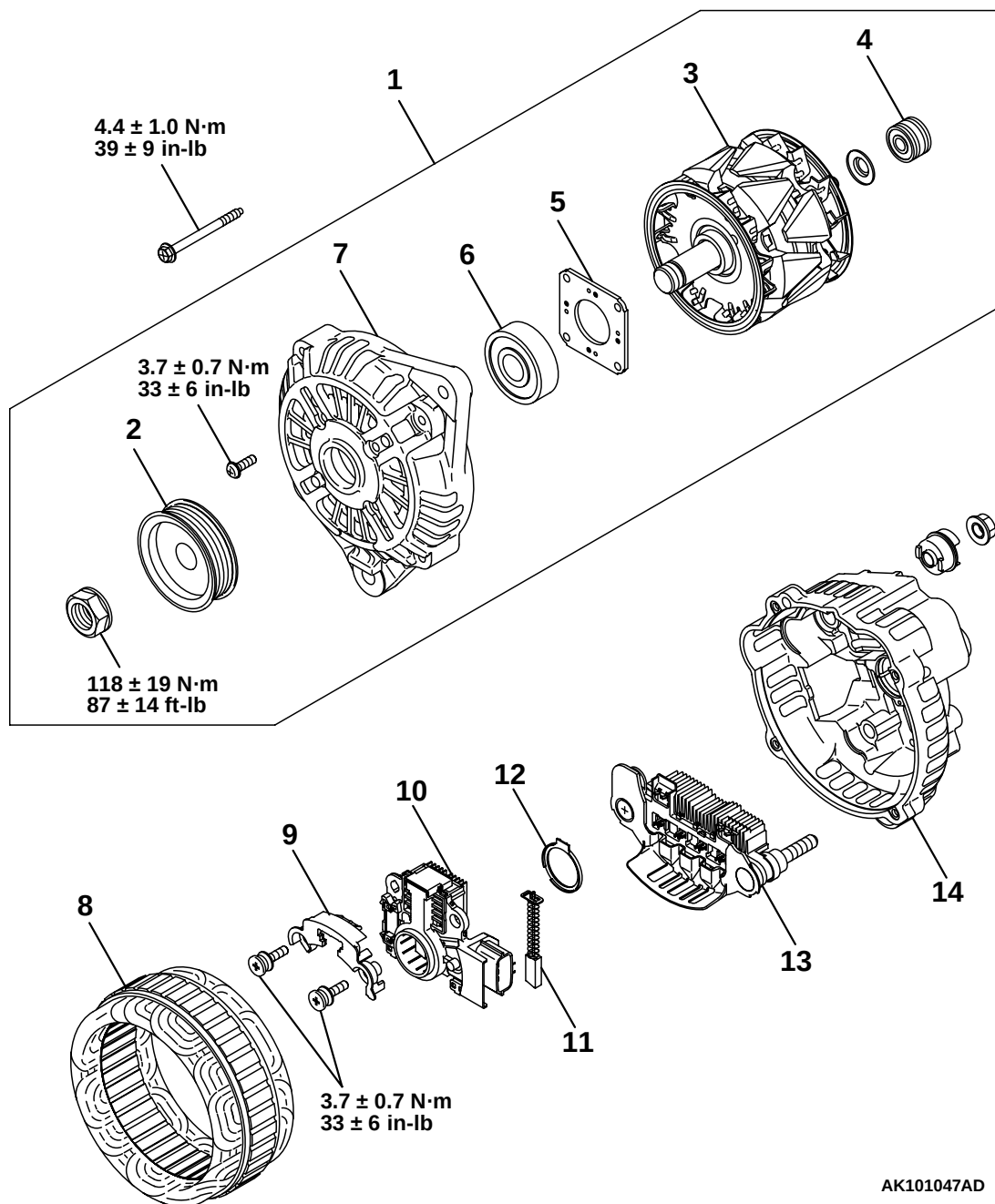
REMOVAL SERVICE POINT

<<A>> GENERATOR REMOVAL

Remove the generator from above the vehicle.

DISASSEMBLY AND ASSEMBLY

M1161001600177



AK101047AD

DISASSEMBLY STEPS

- <<A>>
<>
>>B<<
1. FRONT BRACKET ASSEMBLY
 2. GENERATOR PULLEY
 3. ROTOR ASSEMBLY
 4. REAR BEARING
 5. BEARING RETAINER
 6. FRONT BEARING
 7. FRONT BRACKET

DISASSEMBLY STEPS (Continued)

- <<C>>
<<C>> >>A<<
8. STATOR
 9. PLATE
 10. REGULATOR ASSEMBLY
 11. BRUSH
 12. SLINGER
 13. RECTIFIER
 14. REAR BRACKET

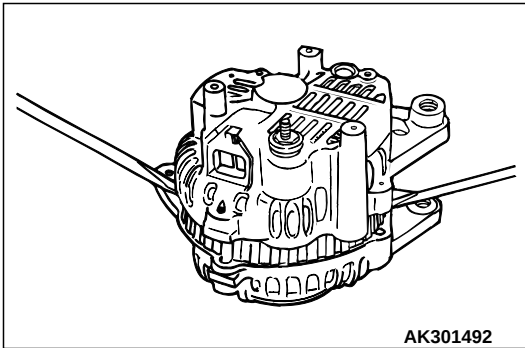
DISASSEMBLY SERVICE POINTS

<<A>> FRONT BRACKET ASSEMBLY REMOVAL

CAUTION

Do not insert a screwdriver too deep. The stator coil will be damaged.

Insert a flat-tipped screwdriver between the front bracket assembly and the stator core, and pry it downward to separate the stator and front bracket assembly.

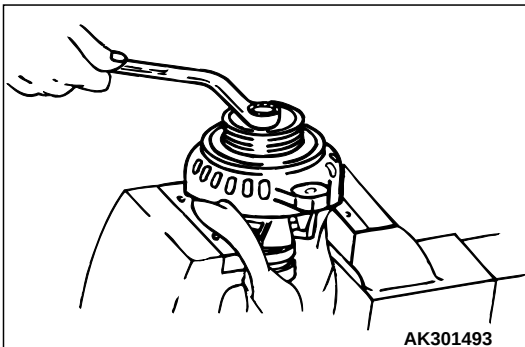


<> GENERATOR PULLEY REMOVAL

CAUTION

Do not damage the rotor.

Set the pulley upward, clamp the rotor in a vise, and remove the pulley.

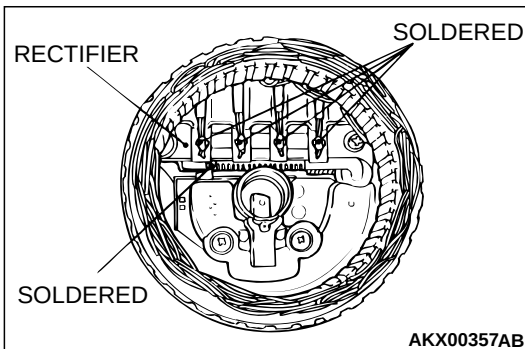


<<C>> STATOR REMOVAL

CAUTION

- Check that the heat from the soldering iron is not transmitted to the diode for a long time.
- Use care that no undue force is exerted to leads of diodes.

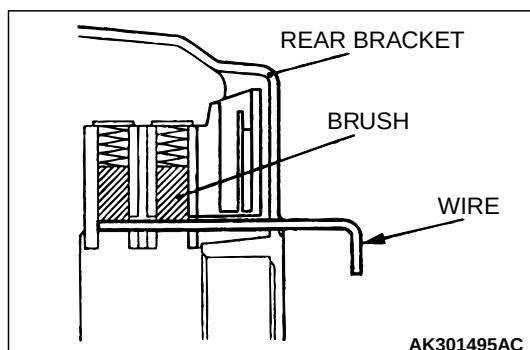
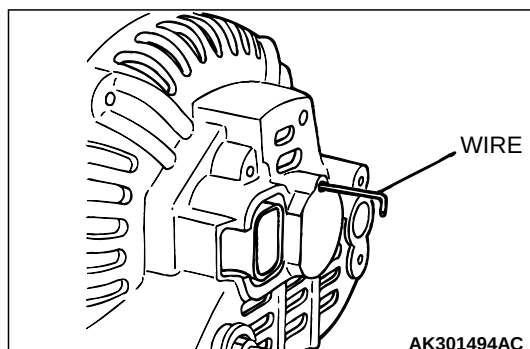
1. Use a soldering iron (180 to 250 W) to unsolder the stator. This work should be completed within approximately four seconds, to prevent heat from transferring to the diode.
2. When removing the rectifier from the regulator assembly, unsolder the points soldered on the rectifier.



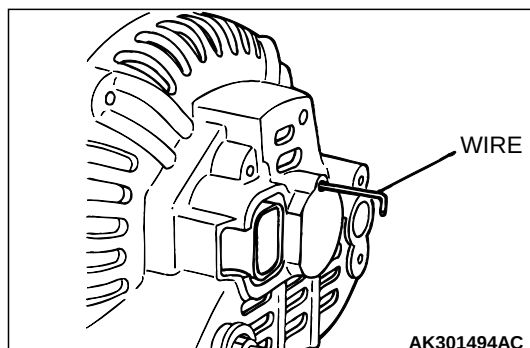
ASSEMBLY SERVICE POINTS**>>A<< REGULATOR ASSEMBLY INSTALLATION**

After installing the regulator assembly, insert a wire through the hole provided on the rear bracket while pressing down on the brush, and secure the brush.

NOTE: By inserting a wire, the brush will be secured in place, and the installation of the rotor will be easier.

**>>B<< ROTOR ASSEMBLY INSTALLATION**

After installing the rotor, remove the wire used to secure the brush.

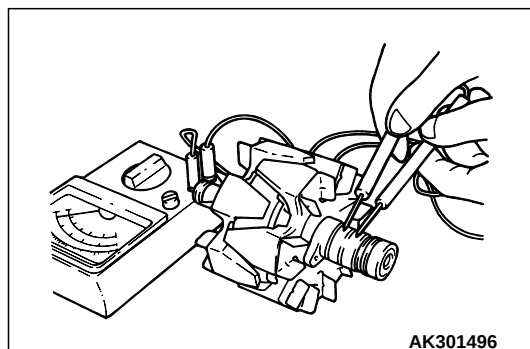
**INSPECTION**

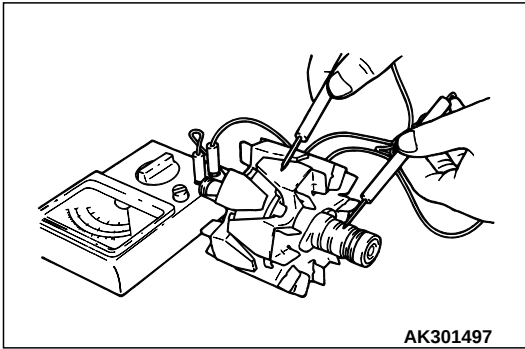
M1161001700163

ROTOR CHECK

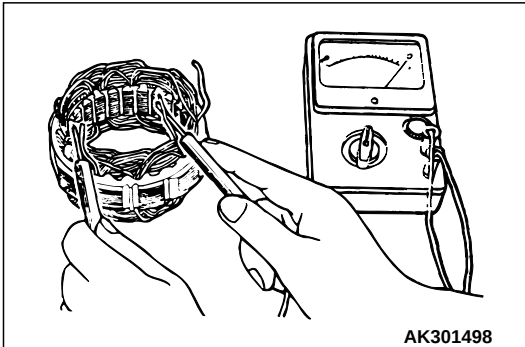
1. Check for continuity between the slip rings of the field coil. If the resistance value is not within the standard value, replace the rotor.

Standard value: approximately 2 – 5 Ω



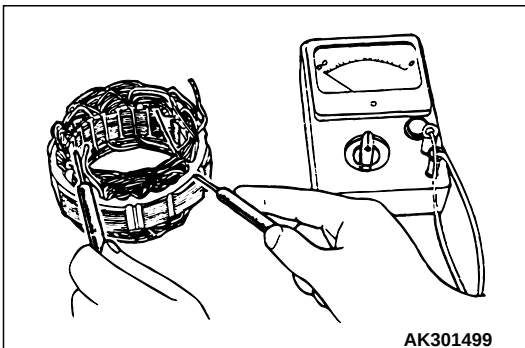


2. Check for continuity between the slip ring and the core. If there is continuity, replace the rotor.

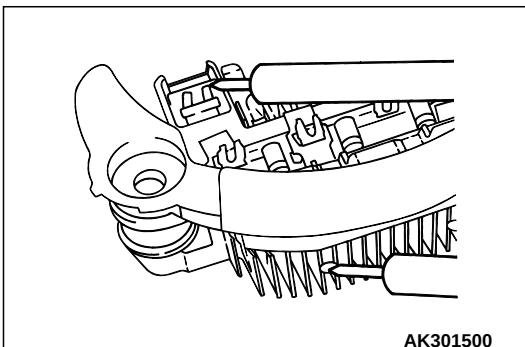


STATOR CHECK

1. Check for continuity between the coil lead. If there is no continuity, replace the stator.

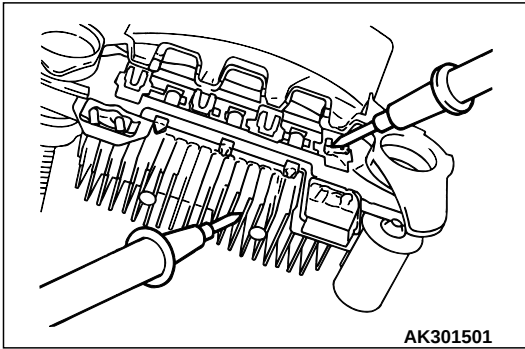


2. Check for continuity between the coil and the core. If there is continuity, replace the stator.

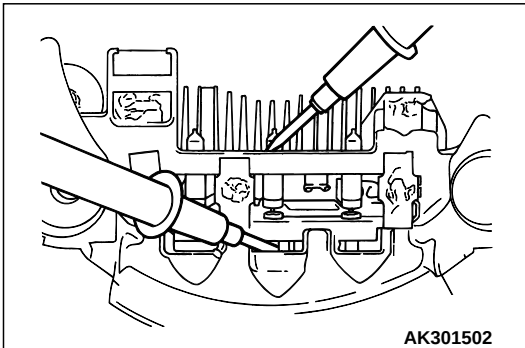


RECTIFIER CHECK

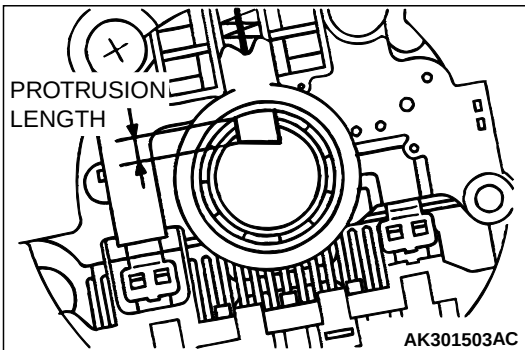
1. Check for continuity between the positive rectifier and the stator coil lead connection terminal with a tester. If there is continuity between the terminals, the diode is shorted, so replace the rectifier.



2. Check for continuity between the negative rectifier and the stator coil lead connection terminal with a tester. If there is continuity between the terminals, the diode is grounded, so replace the rectifier.



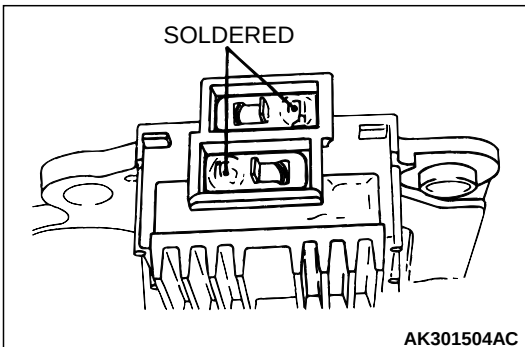
3. Check for continuity of the three diodes by connecting an ohmmeter to both ends of each diode. If there is continuity between the directions, or if there is no continuity, the diode is damaged, so replace the rectifier.



BRUSH CHECK

1. Replace the brush if the brush protrusion length shown in the illustration is below the minimum limit value.

Minimum limit: 2 mm (0.08 inch)



2. The brush can be removed by unsoldering the brush lead wire.
3. When installing a new brush, push the brush in to the brush holder, and solder the lead wire.

STARTING SYSTEM

GENERAL DESCRIPTION

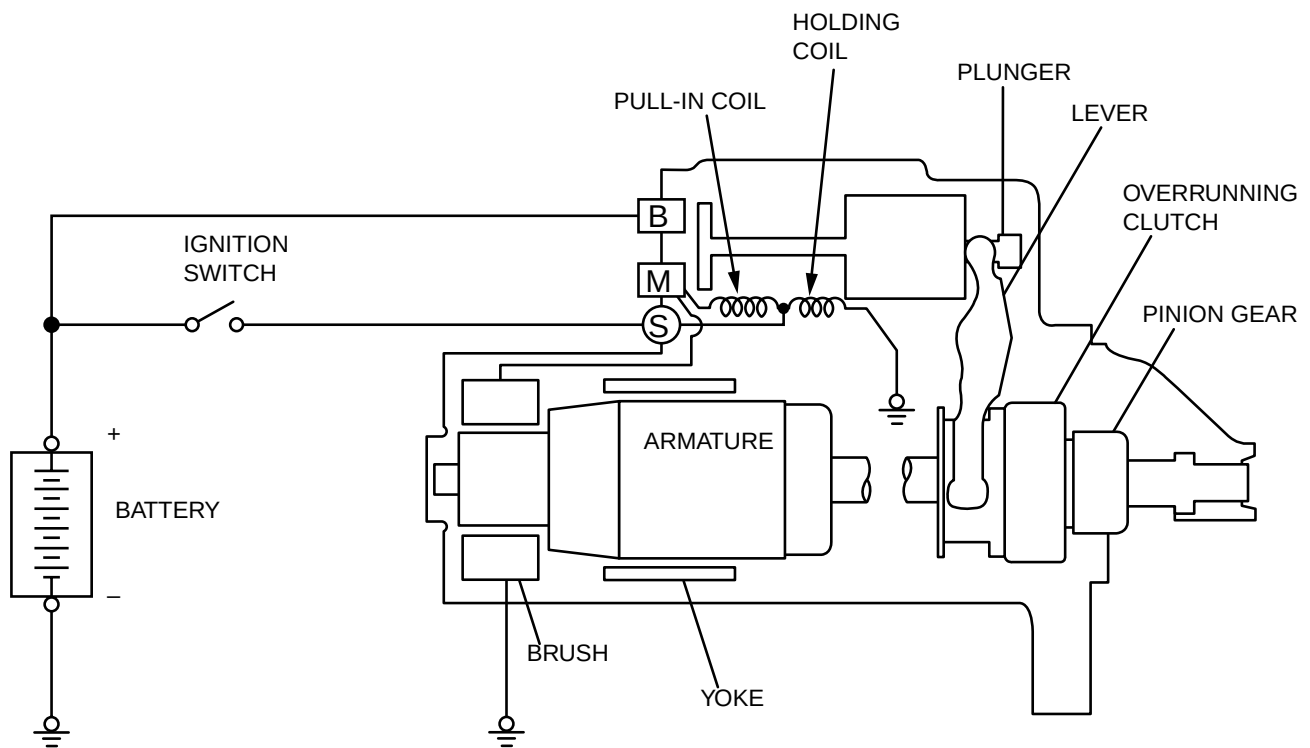
If the ignition switch is turned to the "START" position, current flows in the coil provided inside magnetic switch, attracting the plunger. When the plunger is attracted, the lever connected to the plunger is actuated to engage the starter clutch.

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, the starter clutch is disengaged from the ring gear.

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

M1162000100213



AK202970AC

OPERATION

- For models equipped with M/T, the interlock switch contact is switched OFF when the clutch pedal is depressed. When the ignition switch is then switched to the "ST" position, electricity flows to the starter relay and the starter motor, the contact (magnetic switch) of the starter is switched ON and the starter motor is activated.

NOTE: If the ignition switch is switched to the "ST" position without the clutch pedal being depressed, electricity flows to the starter relay (coil), the interlock switch (contacts) and to ground, with the result that the contacts of the starter relay are switched OFF, and because the power to the starter motor is thereby interrupted, the starter motor is not activated.

- For models equipped with A/T, when the ignition switch is switched to the "ST" position while the selector lever is at the "P" or "N" position, the contact (magnetic switch) of the starter is switched ON and the starter motor is activated.

STARTING SYSTEM DIAGNOSIS

M1162000700271

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 connection at the battery terminals and starter.
- Check the transmission range switch. <A/T>
- Check starter relay. <M/T>
- Check the interlock switch. <M/T>

The starter motor doesn't stop

- Check the starter (magnetic switch).

TROUBLESHOOTING GUIDE

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

** 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, Chassis Electrical – Battery – On-vehicle Service – Battery 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, Chassis Electrical – Ignition Switch – Ignition Switch – Inspection [P.54A-9.](#))
 - Check the starter relay and interlock switch.
<M/T>
 - Check the transmission range switch. (Refer to GROUP 23A, Automatic Transaxle – On-vehicle Service – Essential Service – Transmission Range Switch Check [P.23A-339.](#)) <A/T>
 - 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 cable 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 Starting System – Starter Motor – Inspection [P.16-29.](#))

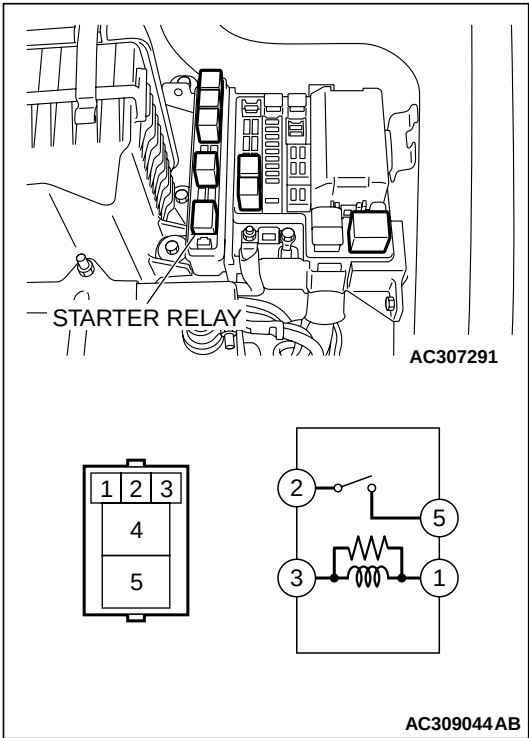
YES : Excessive rotational resistance of the engine.

NO : Replace the starter motor.

ON-VEHICLE SERVICE

STARTER RELAY CHECK <M/T>

M1162001400206



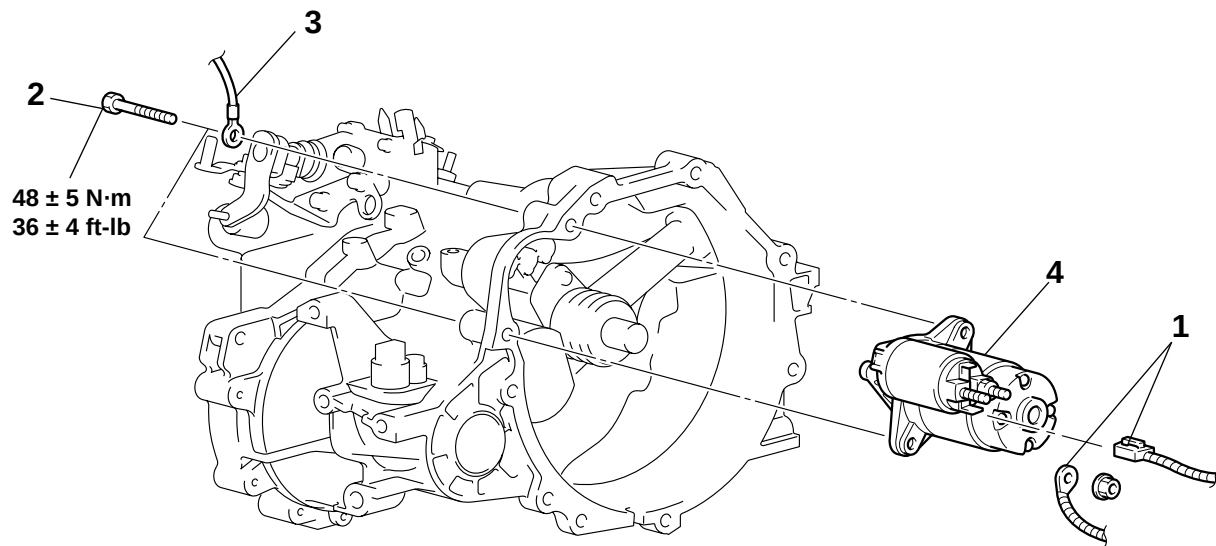
BATTERY VOLTAGE	TERMINAL NO. TO BE CONNECTED TO TESTER	CONTINUITY TEST RESULTS
Not applied	2 – 5	Open circuit
Connect terminal No.1 and battery (-) terminal. Connect terminal No.3 and battery (+) terminal.	2 – 5	Less than 2 ohms

STARTER MOTOR ASSEMBLY REMOVAL AND INSTALLATION <2.0L ENGINE>

M1162001000695

Pre-removal and Post-installation Operation

Air Cleaner Removal and Installation (Refer to GROUP 15,
Air Cleaner [P.15-4.](#))



AC100950 AC

REMOVAL STEPS

1. STARTER CONNECTOR,
TERMINAL
2. STARTER BOLT

<<A>>

REMOVAL STEPS (Continued)

3. GROUND CABLE
4. STARTER ASSEMBLY

REMOVAL SERVICE POINT

<<A>> STARTER ASSEMBLY REMOVAL

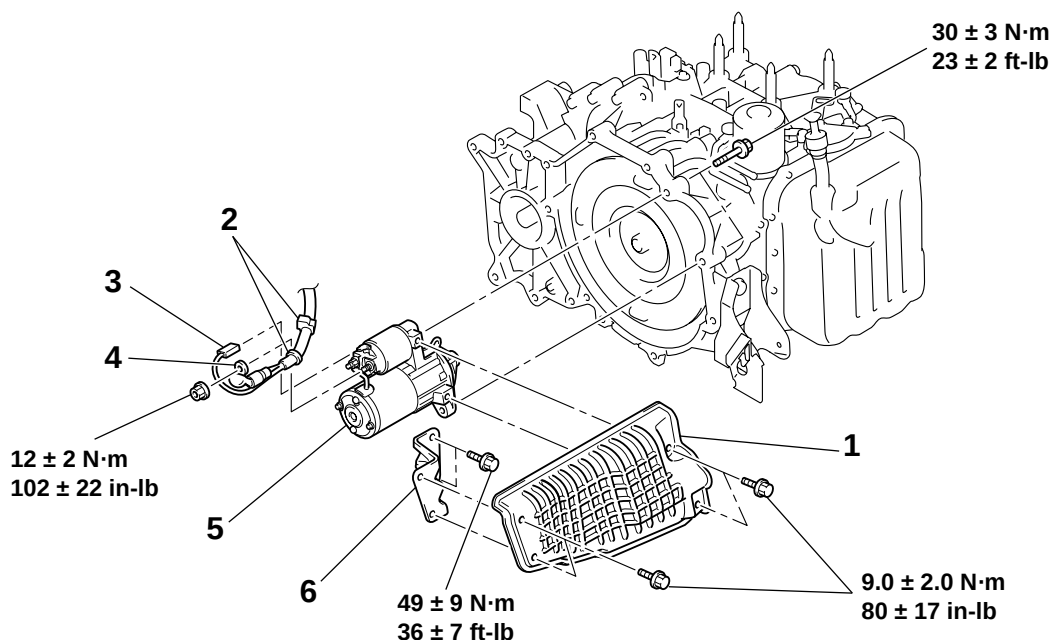
Remove the starter assembly from above the vehicle.

REMOVAL AND INSTALLATION <2.4L ENGINE>

M1162001000684

Pre-removal and Post-installation Operation

- Air Duct Removal and Installation (Refer to GROUP 15, Air Cleaner P.15-4).
- Exhaust Manifold Heat Protector Removal and Installation (Refer to GROUP 15, Exhaust Manifold P.15-12).



AC305106AB

REMOVAL STEPS

1. STARTER COVER
2. HARNESS CLAMP
3. STARTER CONNECTOR

<<A>>

REMOVAL STEPS (Continued)

4. STARTER TERMINAL
5. STARTER ASSEMBLY
6. STARTER COVER BRACKET

REMOVAL SERVICE POINT**<<A>> STARTER ASSEMBLY REMOVAL**

Remove the starter assembly from above the vehicle.

INSPECTION

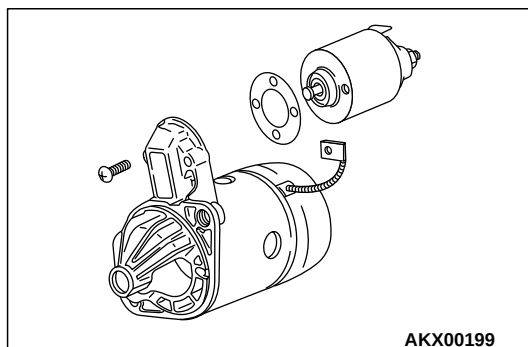
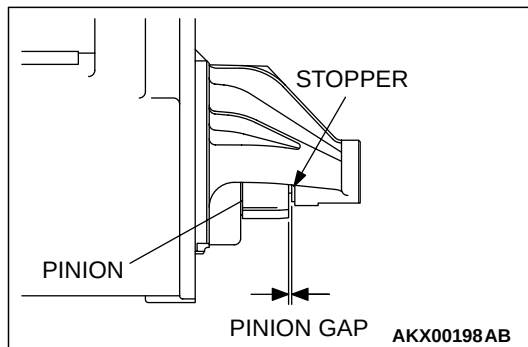
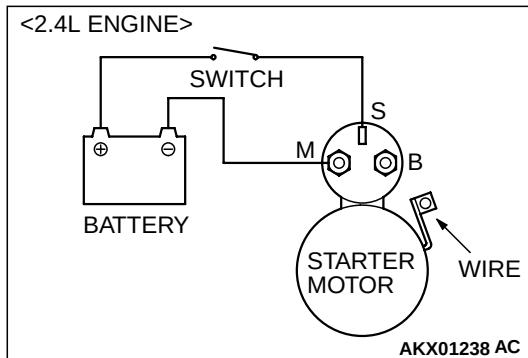
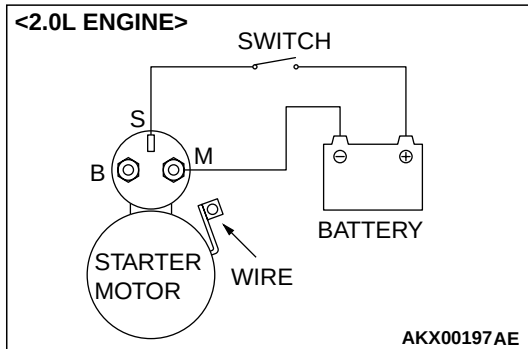
PINION GAP ADJUSTMENT

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.

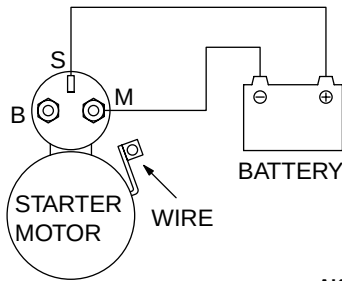


4. Check the pinion-to-stopper clearance (pinion gap) with a feeler gauge.

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

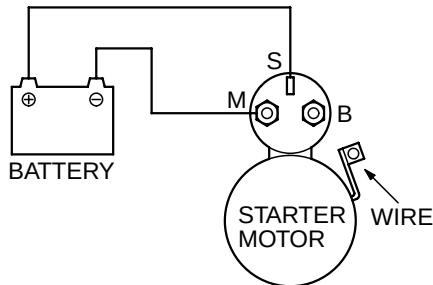
5. If the pinion gap is out of specification, adjust by adding or removing gasket(s) between the magnetic switch and front bracket.

<2.0L ENGINE>



AKX00200 AE

<2.4L ENGINE>



AKX01242 AB

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 magnetic switch.

MAGNETIC SWITCH HOLD-IN TEST

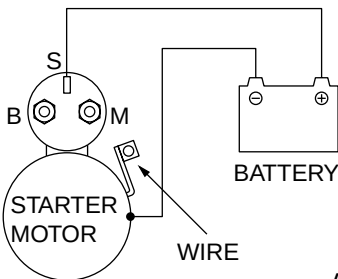
1. Disconnect the field coil wire from the M-terminal of the magnetic switch.

⚠ CAUTION

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

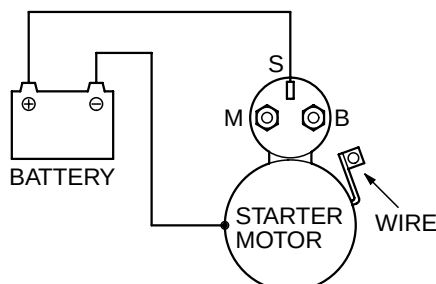
2. Connect a 12-volt battery between the S-terminal and body.
3. Manually slide out the overrunning clutch as far as the pinion stopper position.
4. If the pinion remains out, everything is operating properly. If the pinion returns, the hold-in circuit is open. Replace the magnetic switch.

<2.0L ENGINE>

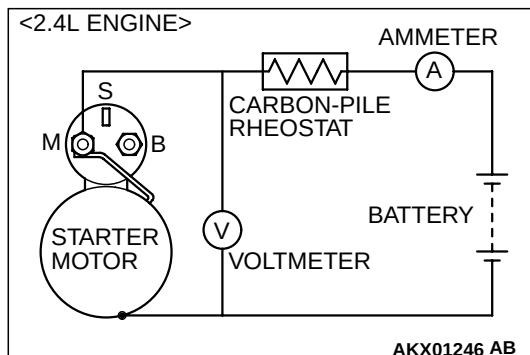
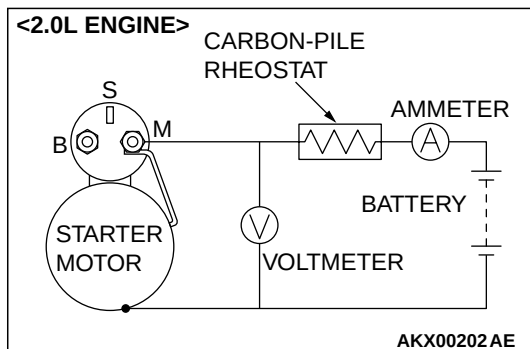


AKX00201 AE

<2.4L ENGINE>



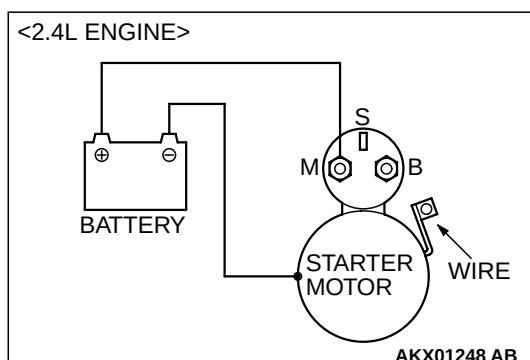
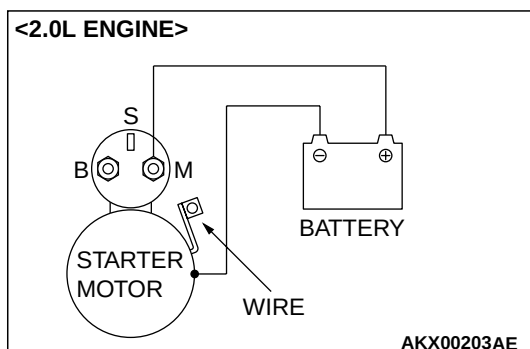
AKX01244 AB



FREE RUNNING TEST

1. Place the starter motor in a bench-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 carbon pile 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 positive voltage shown by the voltmeter is 11 V.
7. Confirm that the maximum amperage is within the specifications and that the starter motor turns smoothly and freely.

Current: maximum 90 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

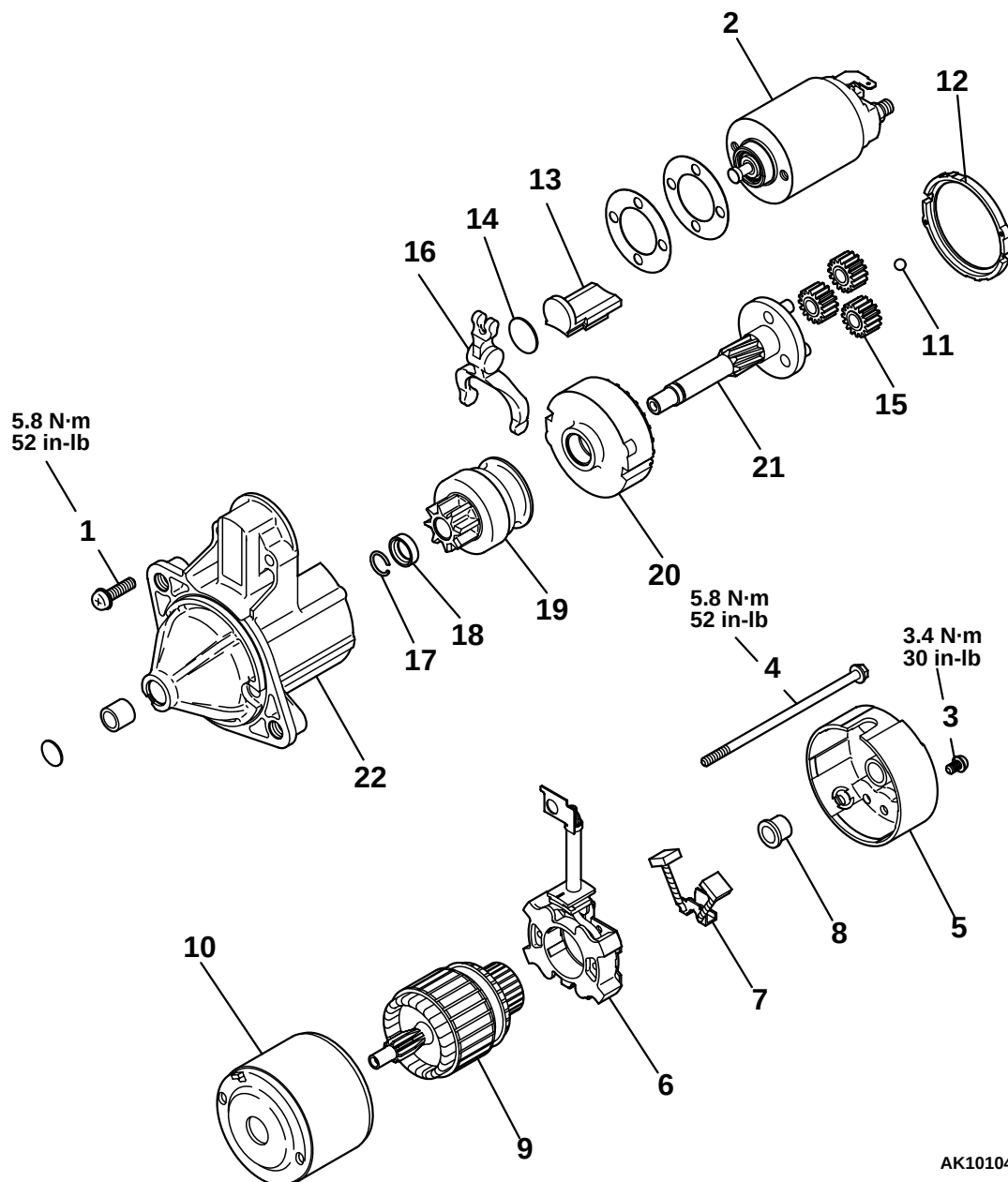
Be careful not to get your fingers caught when pulling out the pinion.

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 magnetic switch.

DISASSEMBLY AND ASSEMBLY

M1162001200213

<2.0L ENGINE>



AK101048AB

DISASSEMBLY STEPS

1. SCREW
2. MAGNETIC SWITCH
3. SCREW
4. SCREW
5. REAR BRACKET
6. BRUSH HOLDER
7. BRUSH
8. REAR BEARING
9. ARMATURE
10. YOKE ASSEMBLY
11. BALL
12. PACKING A

DISASSEMBLY STEPS

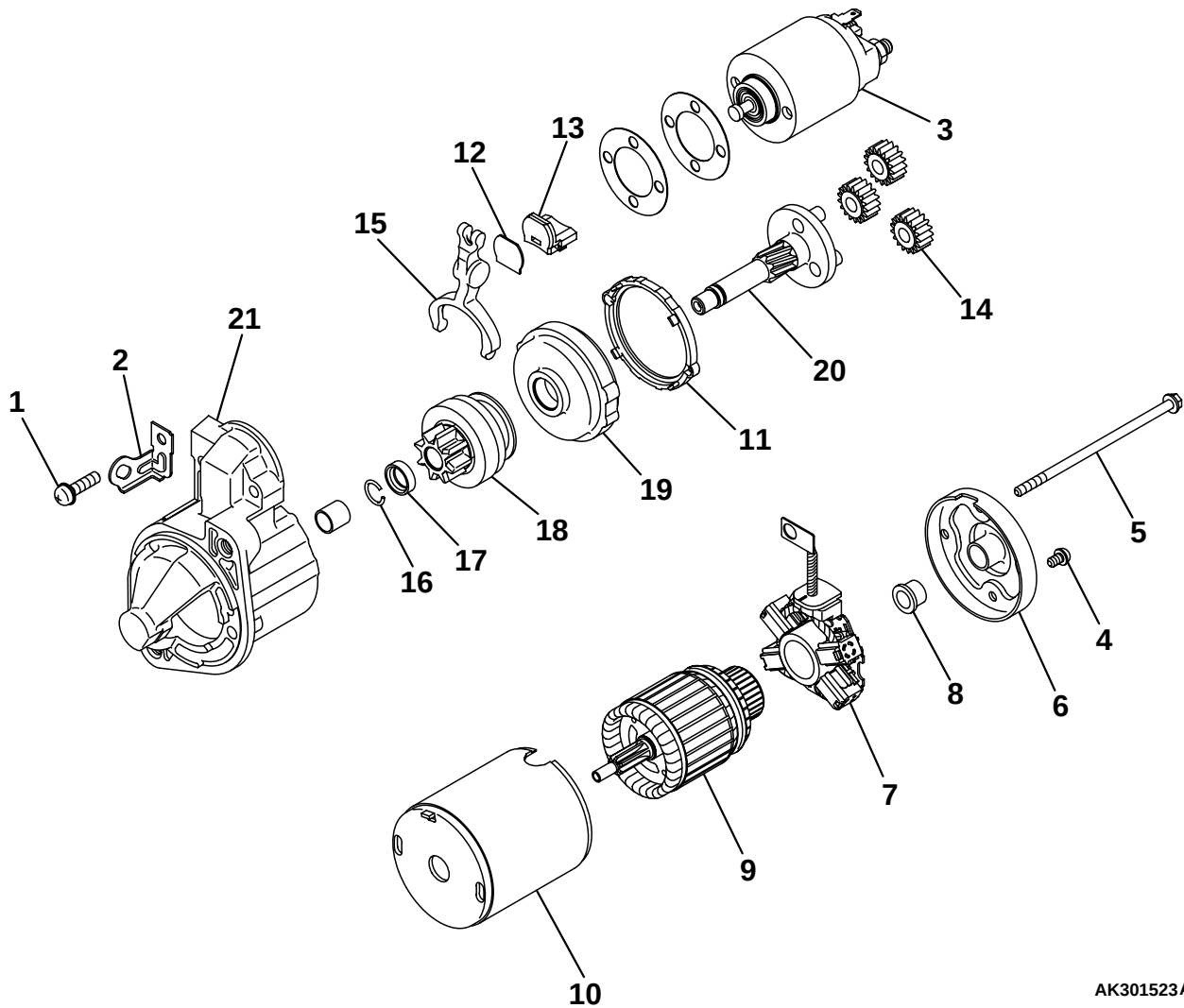
13. PACKING B
14. PLATE
15. PLANETARY GEAR
16. LEVER
17. SNAP RING
18. STOP RING
19. OVERRUNNING CLUTCH
20. INTERNAL GEAR
21. PLANETARY GEAR HOLDER AND PINION SHAFT
22. FRONT BRACKET

<<C>> >>A<<
<<C>> >>A<<

<<A>>

<<A>>

<2.4L ENGINE>



AK301523AC

DISASSEMBLY STEPS

1. SCREW
2. BRACKET
3. MAGNETIC SWITCH
4. SCREW
5. SCREW
6. REAR BRACKET
7. BRUSH HOLDER ASSEMBLY
8. REAR BEARING
9. ARMATURE
10. YOKE ASSEMBLY
11. PACKING A

DISASSEMBLY STEPS

12. PACKING B
13. PLATE
14. PLANETARY GEAR
15. LEVER
16. SNAP RING
17. STOP RING
18. OVERRUNNING CLUTCH
19. INTERNAL GEAR
20. PLANETARY GEAR HOLDER
21. FRONT BRACKET

<>

<<C>> >>A<<

<<C>> >>A<<

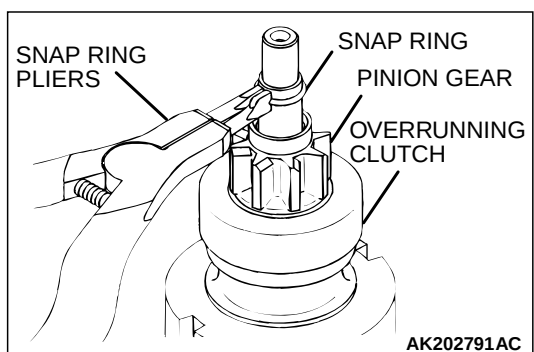
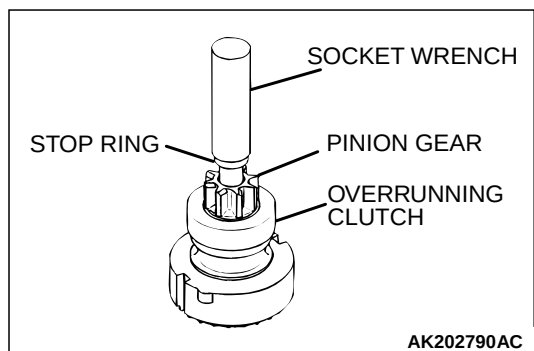
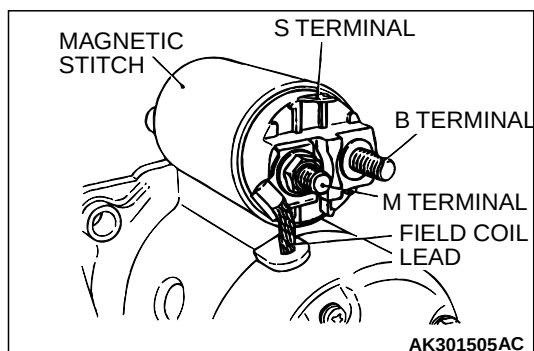
DISASSEMBLY SERVICE POINTS**<<A>> ARMATURE AND BALL REMOVAL****⚠ CAUTION**

When removing the armature, take care not to lose the ball (which is used as a bearing) in the armature end.

<> MAGNETIC SWITCH REMOVAL**⚠ CAUTION**

Do not clamp the yoke assembly with a vise.

Disconnect the lead from the M terminal of the magnetic switch.

**<<C>> SNAP RING AND STOP RING REMOVAL**

1. Press a long socket wrench to the stop ring. Then tap the socket wrench to remove the stop ring to the pinion gear side.
2. After removing the snap ring (by using snap-ring pliers), remove the stop ring and the overrunning clutch.

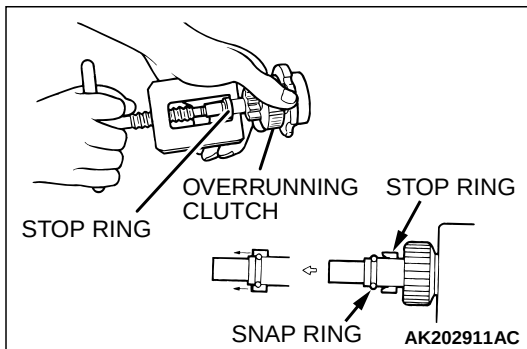
STARTER MOTOR PART CLEANING

1. Do not immerse parts in cleaning solvent. Immersing the yoke and field coil assembly and/or armature will damage insulation. Wipe these parts with a shop towel only.
2. Do not immerse the drive unit in cleaning solvent. The overrunning clutch is pre-lubricated at the factory and solvent will wash lubrication from the clutch.
3. The drive unit may be cleaned with a brush moistened with cleaning solvent and wiped dry with a shop towel.

ASSEMBLY SERVICE POINT

>>A<< STOP RING AND SNAP RING INSTALLATION

Using a suitable pulling tool, pull the overrunning clutch stop ring over the snap ring.



INSPECTION

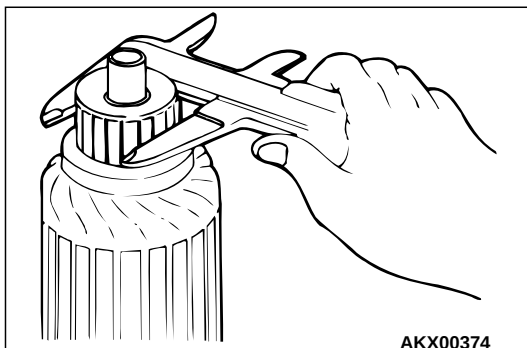
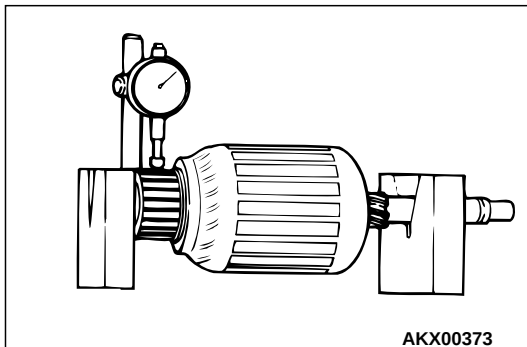
M1162001300168

COMMUTATOR CHECK

1. Place the armature on a pair of V-blocks, and check the deflection by using a dial gauge.

Standard value: 0.05 mm (0.002 inch)

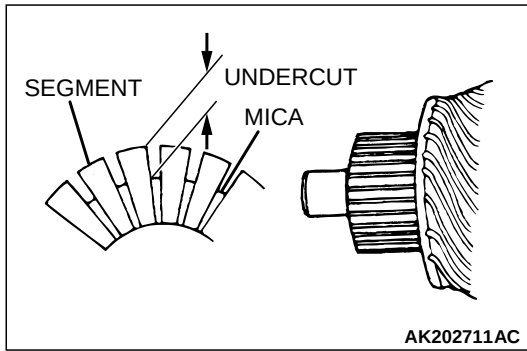
Limit: 0.1 mm (0.004 inch)



2. Check the outer diameter of the commutator.

Standard value: 29.4 mm (1.16 inch)

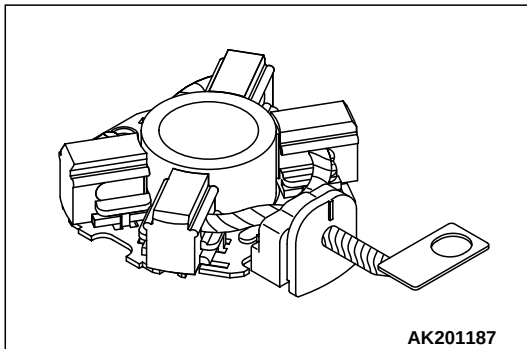
Minimum limit: 28.8 mm (1.13 inch)



3. Check the depth of the undercut between segments.

Standard value: 0.5 mm (0.02 inch)

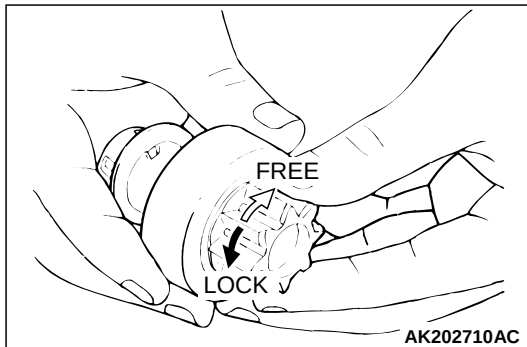
Minimum limit: 0.2 mm (0.008 inch)



BRUSH HOLDER

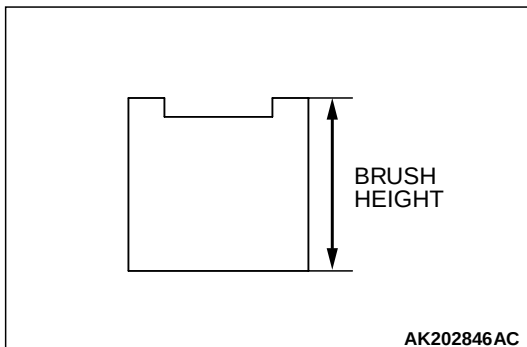
Push the brush into the brush holder to make sure that the spring is working on the brush.

If the spring is not working, replace the brush holder.



OVERRUNNING CLUTCH

1. Make sure that the pinion cannot be turned counterclockwise, and can be turned clockwise freely.
2. Check the pinion for abnormal wear and damage.



BRUSHES

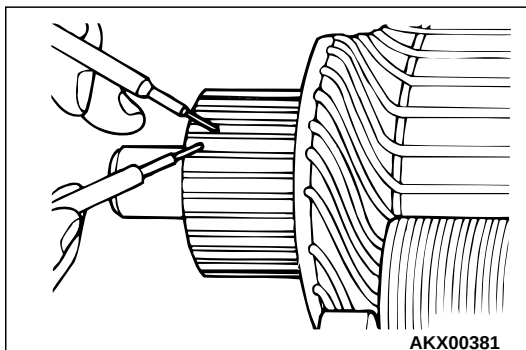
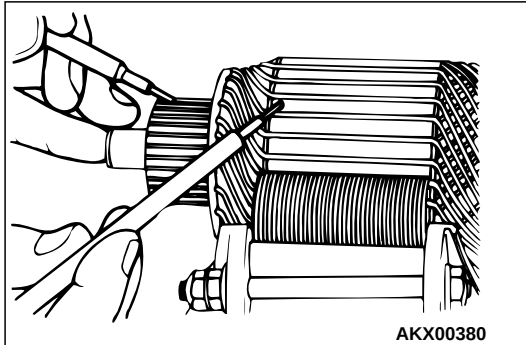
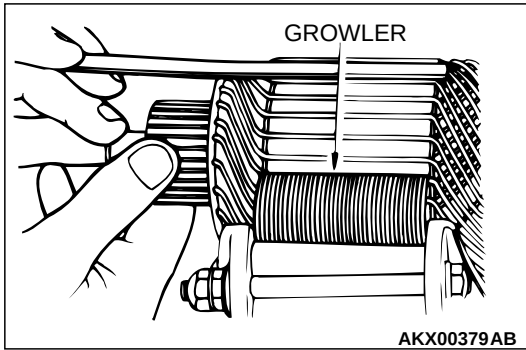
1. Check the commutator contacting surface of each brush for abnormal roughness. Also check the height of the brush. Replace the brush holder if the height is lower than the limit.

Limit: 7.0 mm (0.27 in)

2. When the contact surface of the brush is rectified or the brush holder is replaced, recondition the contact surface with sandpaper wrapped around the commutator.

ARMATURE CHECK

1. Check that the armature coil is not grounded.
2. Place the armature in a growler.
3. Hold a thin steel blade parallel and just above the armature while slowly rotating in the growler. A shorted armature will cause a blade to vibrate and be attracted to the core. Replace the shorted armature.



4. Check the insulation between the armature coil cores and the commutator segments. They are normal if there is no continuity.
5. Check for continuity between the segments. The condition is normal if there is continuity.

IGNITION SYSTEM

GENERAL DESCRIPTION

<2.0L ENGINE>

This system is provided with two ignition coils (A and B) with built-in ignition power transistors for the number 1 and number 4 cylinders, and number 2 and number 3 cylinders respectively.

Interruption of the current flowing in the primary side of ignition coil A generates a high voltage in the secondary side of ignition coil A.

The high voltage generated is applied to the spark plugs of number 1 and number 4 cylinders to generate sparks. At the time that the sparks are generated at both spark plugs, if one cylinder is at the compression stroke, the other cylinder is at the exhaust stroke, so that ignition of the compressed air/fuel mixture occurs only for the cylinder which is on the compression stroke.

In the same way, when the primary current flowing in ignition coil B is interrupted, the high voltage thus generated is applied to the spark plugs of number 2 and number 3 cylinders.

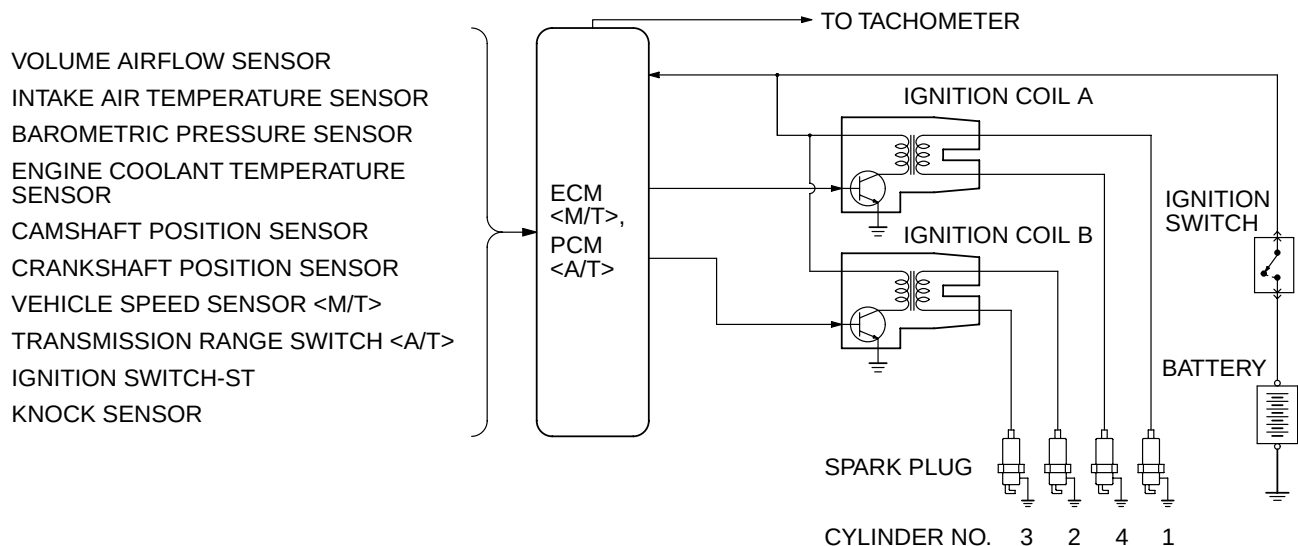
M1163000100313

The engine control module (ECM) or powertrain control module (PCM) controls the two ignition power transistors to turn them 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 – 4 – 2.

The ECM or PCM determines which ignition coil should be controlled by means of the signals from the camshaft position sensor and from 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 operated at high altitudes, the ignition timing is slightly advanced to provide optimum performance.



AK100055 AH

<2.4L ENGINE>

This system is provided with four ignition coils with built-in ignition power transistors for each of the cylinders.

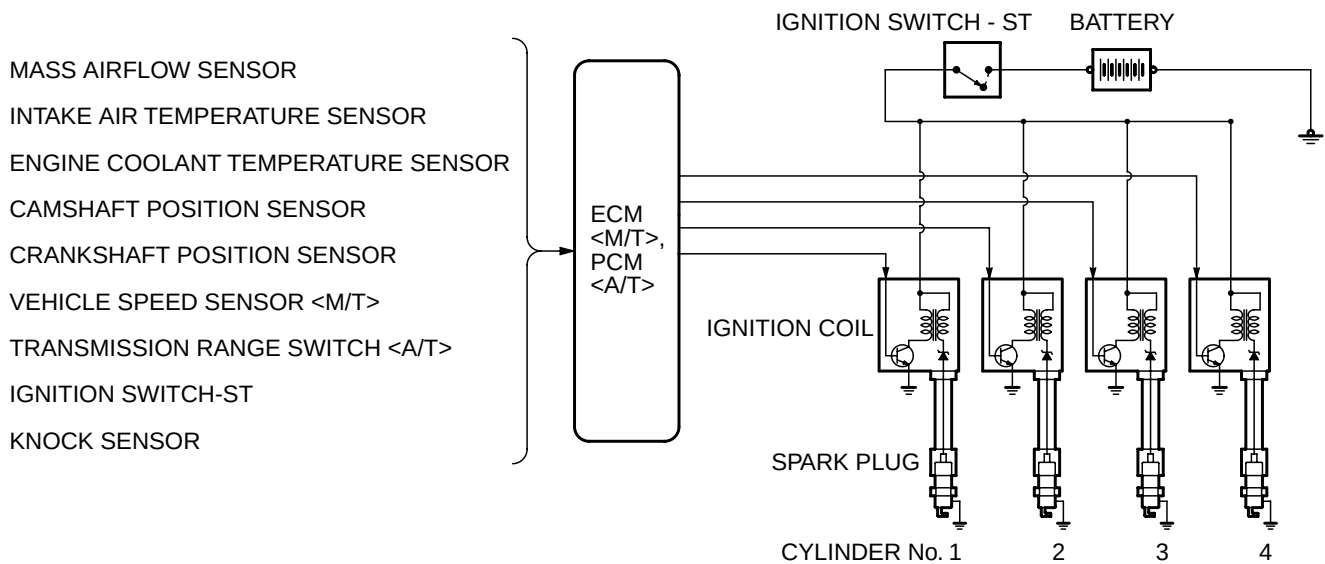
Interruption of the primary current flowing in the primary side of ignition coil generates a high voltage in the secondary side of ignition coil.

The engine control module (ECM) or powertrain control module (PCM) controls the four ignition power transistors to turn them 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 1-3-4-2.

The ECM or PCM determines which ignition coil should be controlled by means of the signals from the camshaft position sensor which is incorporated in the camshaft and from the crankshaft position sensor which is incorporated in the crankshaft.

It also detects the crankshaft position to provide ignition at the most appropriate timing in response to the engine operation conditions.

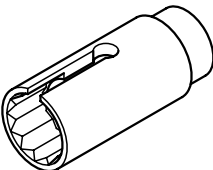
When the engine is cold or operated at high altitudes, the ignition timing is slightly advanced to provide optimum performance.



AK304112AC

SPECIAL TOOL

M1163000600330

TOOL	TOOL NUMBER AND NAME	SUPERSESSION	APPLICATION
	MD998773 Knock sensor wrench	MD998773-01	Knock sensor removal and installation

ON-VEHICLE SERVICE

KNOCK CONTROL SYSTEM CHECK

M1163001800092

Check the knock sensor circuit if diagnostic trouble code, No. P0325 is shown.

<2.0L ENGINE>

Refer to GROUP 13A, Multiport Fuel Injection (MFI) <2.0L Engine> – Multiport Fuel Injection (MFI) Diagnosis – Diagnostic Trouble Code Procedures – DTC P0325 : Knock Sensor Circuit [P.13A-365](#).

<2.4L ENGINE>

Refer to GROUP 13B, Multiport Fuel Injection (MFI) <2.4L Engine> – Multiport Fuel Injection (MFI) Diagnosis – Diagnostic Trouble Code Procedures – DTC P0325 : Knock Sensor Circuit [P.13B-324](#).

IGNITION COIL CHECK

M1163001200368

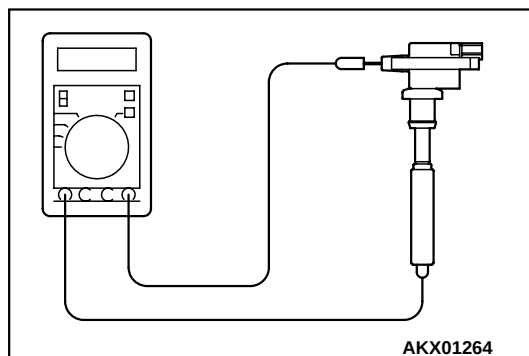
<2.0L ENGINE>

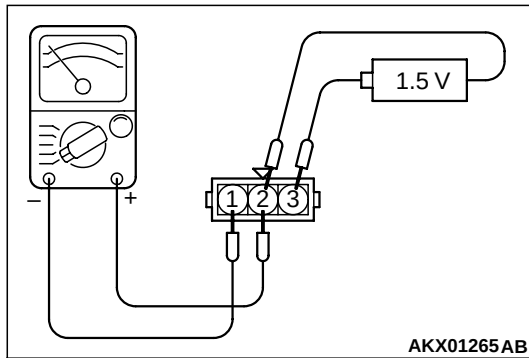
Check by the following procedure, and replace the coil if there is a malfunction.

SECONDARY COIL RESISTANCE CHECK

Measure the resistance between the high-voltage terminals of the ignition coil.

Standard value: 8.5 – 11.5 k Ω



PRIMARY COIL AND IGNITION POWER TRANSISTOR
CONTINUITY CHECK

NOTE: An analog-type ohmmeter should be used.

NOTE: Connect the negative probe of the ohmmeter to terminal 1.

⚠ CAUTION

This test must be performed quickly (in less than 10 seconds) to prevent coil from burning and ignition power transistor from breaking.

1. Connect and disconnect 1.5 V battery between terminals 2 and 3, and observe the ohmmeter whether there is continuity or not.
2. If results do not agree with the table below, replace the primary coil and ignition power transistor assembly.

1.5 V POWER SUPPLY BETWEEN 2 – 3	CONTINUITY BETWEEN 1 – 2
Current flowing	Yes
Current not flowing	No

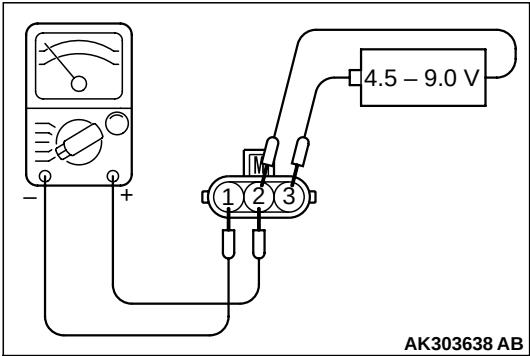
IGNITION COIL CHECK

M1163001200357

<2.4L ENGINE>

Check by the following procedure, and replace the coil if there is a malfunction.

PRIMARY COIL AND IGNITION POWER TRANSISTOR
CONTINUITY CHECK



NOTE: An analog-type ohmmeter should be used.

NOTE: Connect the negative probe of the ohmmeter to terminal 1.

⚠ CAUTION

This test must be performed quickly (in less than 10 seconds) to prevent coil from burning and ignition power transistor from breaking.

1. Connect and disconnect 4.5 – 9.0 V battery between terminal No. 2 and No. 3, and observe the ohmmeter whether there is continuity or not.
2. If results do not agree with the table below, replace the primary coil and ignition power transistor assembly.

4.5 – 9.0 V POWER SUPPLY BETWEEN 2 – 3	CONTINUITY BETWEEN 1 – 2
Current flowing	Yes
Current not flowing	No

SECONDARY COIL CHECK

NOTE: It is impossible to check the secondary coil through the continuity check as a diode is integrated in the secondary coil circuit of this ignition coil. Accordingly, check the secondary coil in the following procedure.

1. Disconnect the ignition coil connector.
2. Remove the ignition coil and install a new spark plug to the ignition coil.
3. Connect the ignition coil connector.
4. Ground the side electrode of the spark plug and crank the engine.
5. Check that spark is produced between the electrodes of the spark plug.
6. If no spark plug is produced, replace the ignition coil with a new one and recheck.
7. If spark is produced with the new ignition coil, replace the old one as it is faulty. If no spark is produced again, the ignition circuit is suspected as faulty. Check the ignition circuit.

SPARK PLUG CABLE RESISTANCE CHECK

M1163001400135

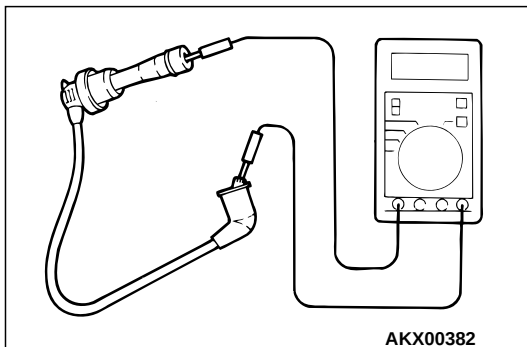
<2.0L ENGINE>

Measure the resistance of the all spark plug leads.

1. Check the cap and coating for cracks.
2. Measure the resistance.

Limit: 19 k Ω

3. If resistance is greater than 19 k Ω , replace the cable.

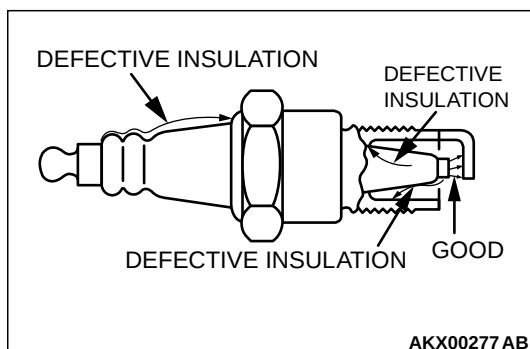
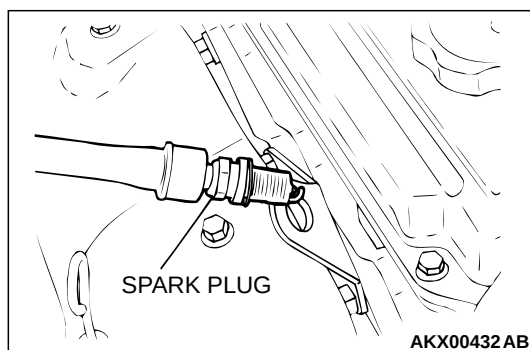


SPARK PLUG TEST

M1163001500121

<2.4L ENGINE>

1. Remove the spark plug and connect to the ignition coil.



2. Ground the spark plug outer electrode (body), and crank the engine.

Check that there is an electrical discharge between the electrodes at this time.

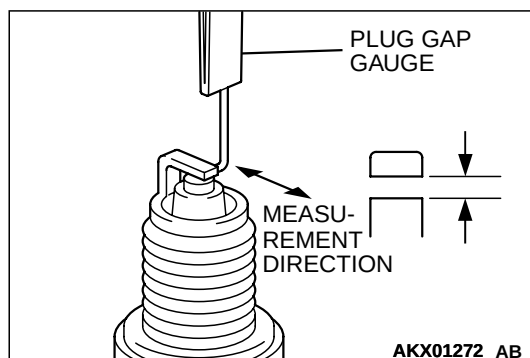
SPARK PLUG CHECK AND CLEANING

M1163004300375

<2.0L ENGINE>

1. Check that the plug is not burned, that the insulator plug is not damaged, and that the seizure state is good.
2. If cleaning is required due to carbon deposits, etc., clean using a plug cleaner or wire brush, etc.
3. Check the plug gap using a plug gap gauge, and adjust if not within the standard value.

Standard value: 1.0 – 1.1 mm (0.039 – 0.043 inch)



SPARK PLUG CHECK AND CLEANING

M1163004300364

<2.4L ENGINE>

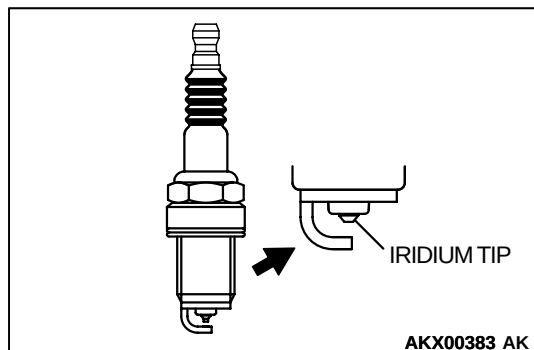
⚠ CAUTION

- Do not attempt to adjust the gap of the iridium plug.
- Cleaning of the iridium plug may result in damage to the iridium tips. Therefore, if carbon deposits must be removed, use a plug cleaner and complete cleaning within 20 seconds to protect the electrode. Do not use a wire brush.

Check the plug gap and replace if the limit is exceeded.

Standard value: 0.7 – 0.8 mm (0.028 – 0.031 inch)

Limit: 1.2 mm (0.047 inch)



CAMSHAFT POSITION SENSOR CHECK

M1163004400220

<2.0L ENGINE>

Refer to GROUP 13A, Multiport Fuel Injection (MFI) <2.0L Engine> – Multiport Fuel Injection (MFI) Diagnosis – Diagnostic Trouble Code Procedures – DTC P0340 : Camshaft Position Sensor Circuit [P.13A-388](#).

<2.4L ENGINE>

Refer to GROUP 13B, Multiport Fuel Injection (MFI) <2.4L Engine> – Multiport Fuel Injection (MFI) Diagnosis – Diagnostic Trouble Code Procedures – DTC P0340 : Camshaft Position Sensor Circuit [P.13B-346](#).

CRANKSHAFT POSITION SENSOR CHECK

M1163004500283

<2.0L ENGINE>

Refer to GROUP 13A, Multiport Fuel Injection (MFI) <2.0L Engine> – Multiport Fuel Injection (MFI) Diagnosis – Diagnostic Trouble Code Procedures – DTC P0335 : Crankshaft Position Sensor Circuit [P.13A-371](#).

<2.4L ENGINE>

Refer to GROUP 13B, Multiport Fuel Injection (MFI) <2.4L Engine> – Multiport Fuel Injection (MFI) Diagnosis – Diagnostic Trouble Code Procedures – DTC P0335 : Crankshaft Position Sensor Circuit [P.13B-330](#).

**IGNITION SECONDARY VOLTAGE WAVE
PATTERN CHECK USING AN OSCILLOSCOPE**

M1163001700211

<2.0L ENGINE>**MEASUREMENT METHOD**

1. Clamp the spark plug cable (Number 1 or 3) with the secondary pickup.

NOTE: Because of the two-cylinder simultaneous ignition system, the waves for two cylinders in each group appear during wave observation. However, wave observation is carried out for the cylinder (Number 1 or 3) with the spark plug cable which has been clamped by the secondary pickup.

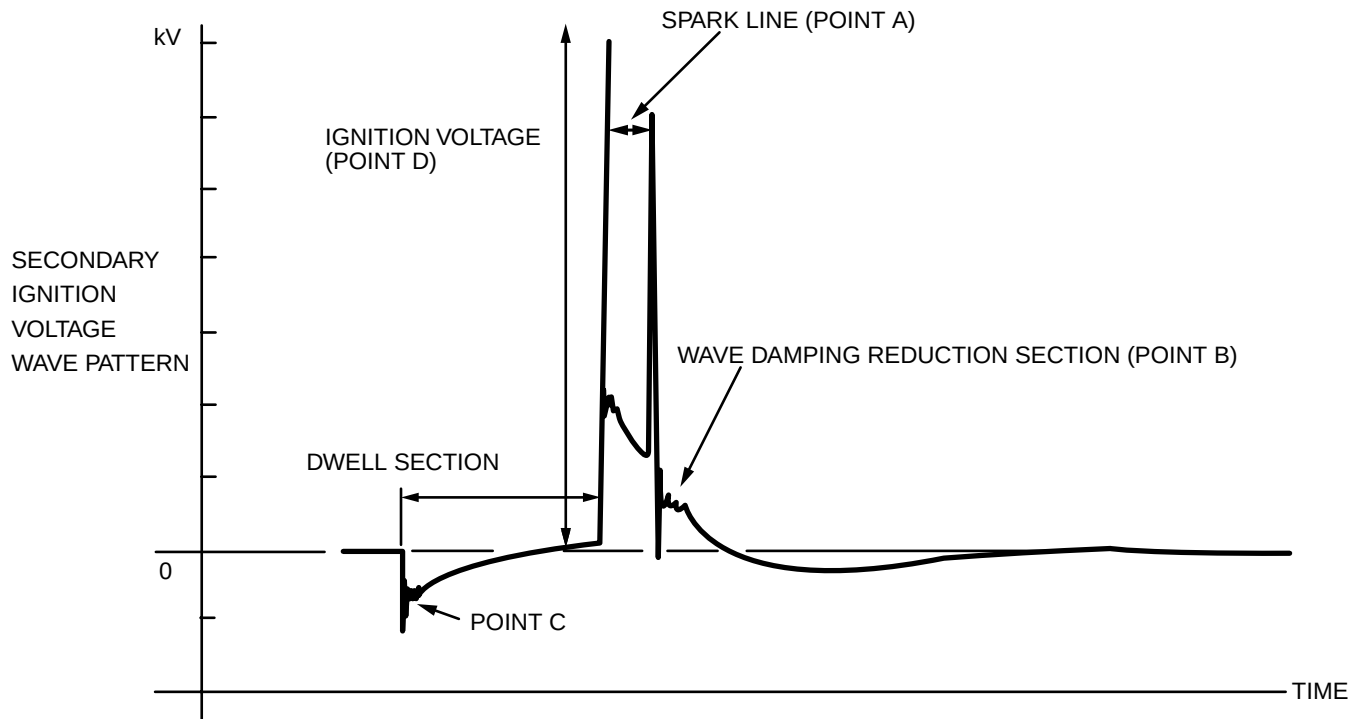
NOTE: Identification of which cylinder wave pattern is displayed can be difficult, but the wave pattern of the cylinder which is clamped by the secondary pickup will be stable, so this can be used as a reference.

2. Clamp the spark plug cable (Number 1 or 3) with the trigger pickup.

NOTE: Clamp the same spark plug cable as the one which has been clamped by the secondary pickup.

STANDARD WAVE PATTERN

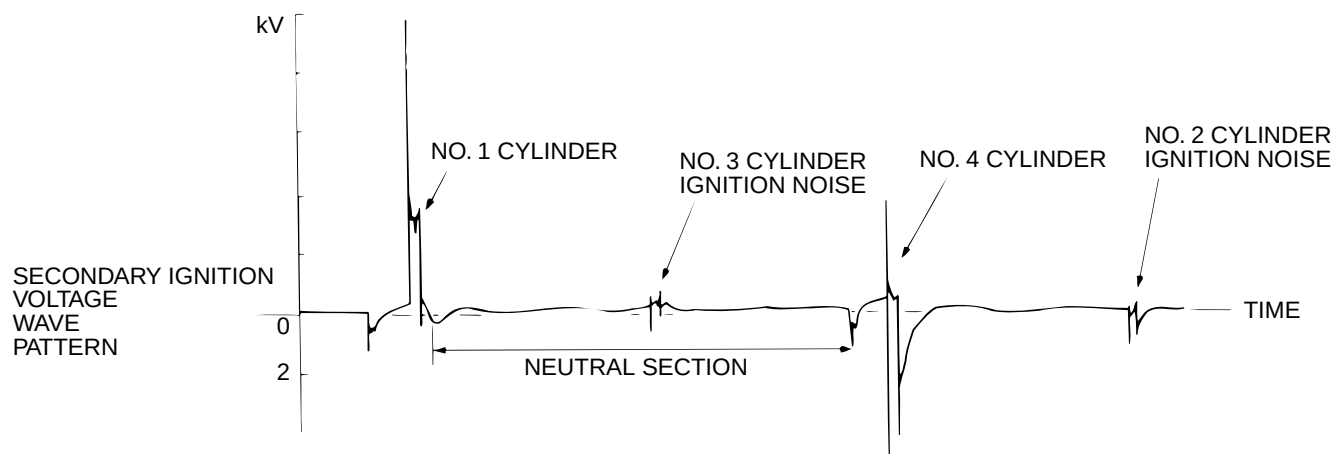
Settings	
FUNCTION	SECONDARY
Pattern height	High (or low)
Pattern selector	Raster
Engine speed	Curb idle speed



AKX00278AB

Settings

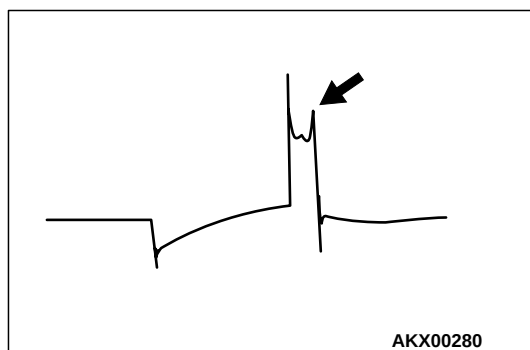
Pattern selector	Display
Pattern height	High (or low)
Engine speed	Curb idle speed



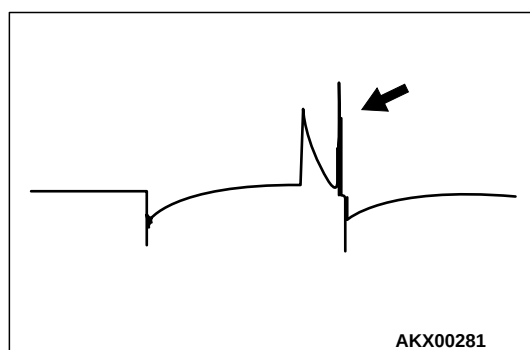
AKX01275AB

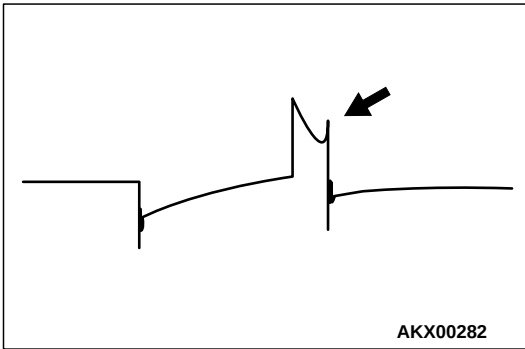
ABNORMAL WAVEFORMS EXAMPLES**Example 1**

- Wave characteristics:
Spark line is high and short.
- Cause of problem:
Spark plug gap is too large.

**Example 2**

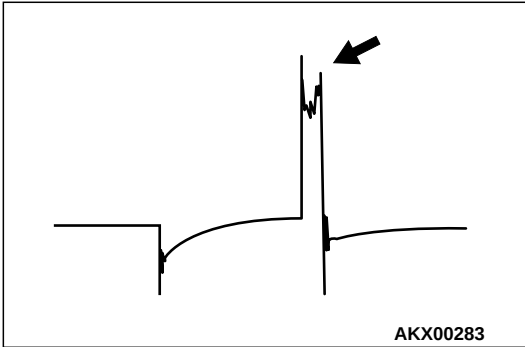
- Wave characteristics:
Spark line is low and long, and is sloping. Also, the second half of the spark line is distorted. This could be a result of misfiring.
- Cause of problem:
Spark plug gap is too small.





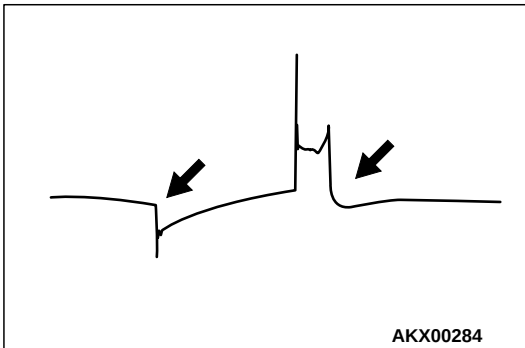
Example 3

- Wave characteristics:
Spark line is low and long, and is sloping. However, there is almost no spark line distortion.
- Cause of problem:
Spark plug gap is fouled.



Example 4

- Wave characteristics:
Spark line is high and short. Difficult to distinguish between this and abnormal wave pattern example 1.
- Cause of problem:
Spark plug cable is not properly connected. (Causing a dual ignition)



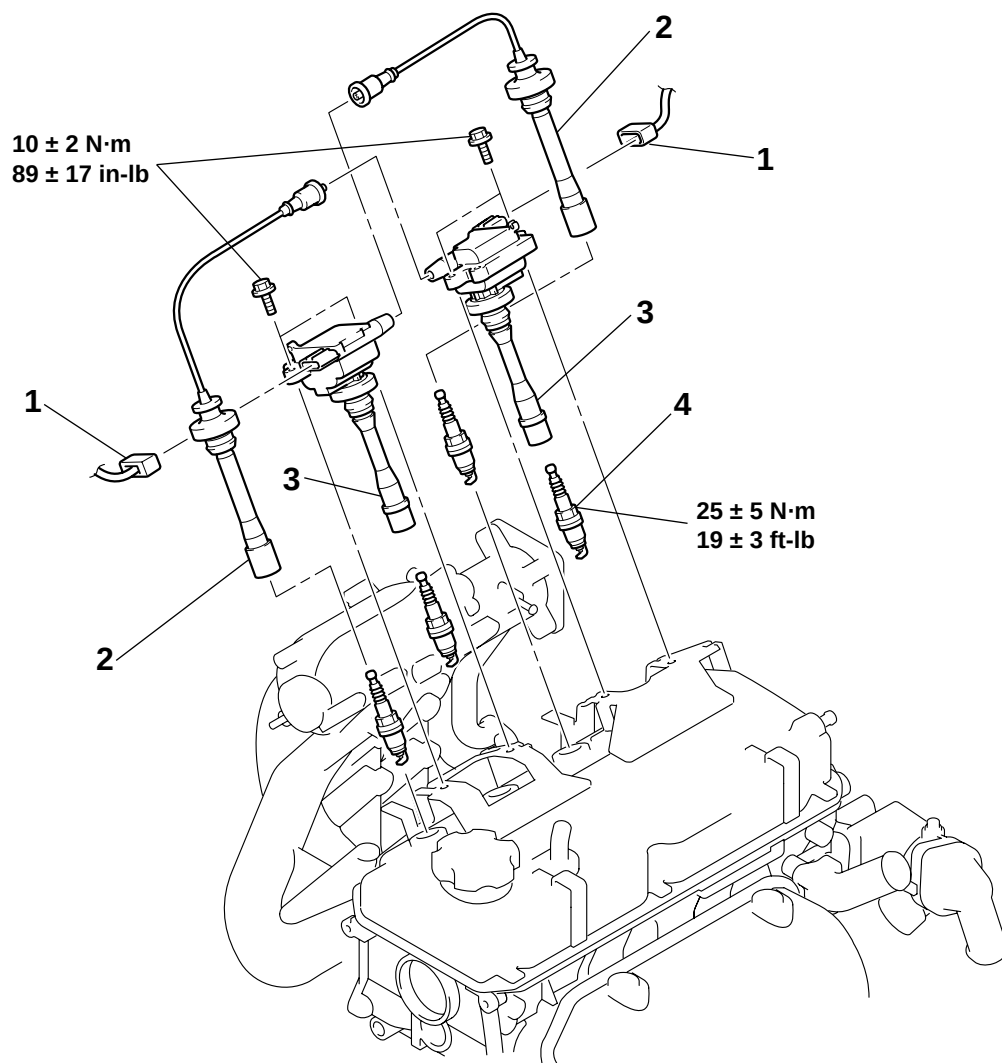
Example 5

- Wave characteristics:
No waves in wave damping section
- Cause of problem:
Short in ignition coil.

IGNITION COIL

REMOVAL AND INSTALLATION <2.0L ENGINE>

M1163004000482



AC100802AB

REMOVAL STEPS

1. IGNITION COIL CONNECTOR
2. SPARK PLUG CABLE

REMOVAL STEPS (Continued)

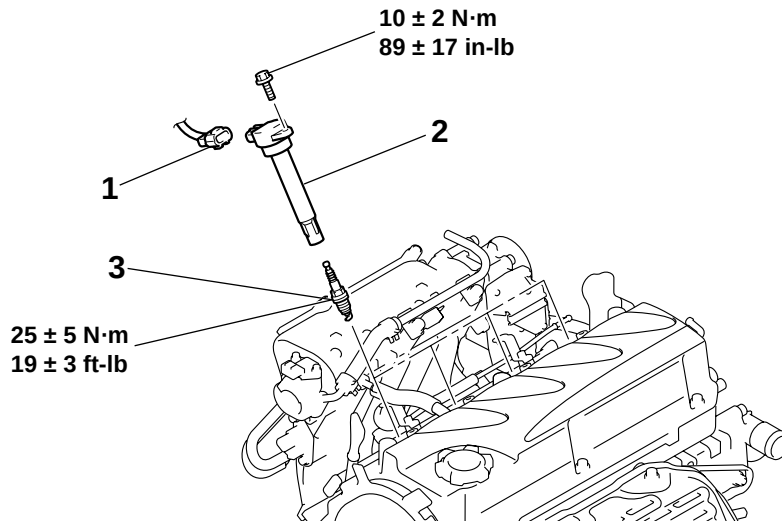
3. IGNITION COIL
4. SPARK PLUG

REMOVAL AND INSTALLATION <2.4L ENGINE>

M1163004000471

Pre-removal and Post-installation Operation

Resonator Removal and Installation (Refer to GROUP 15, Intake Manifold [P.15-8](#)).



AC305115 AB

REMOVAL STEPS

1. IGNITION COIL CONNECTORS

REMOVAL STEPS (Continued)

2. IGNITION COILS
3. SPARK PLUGS

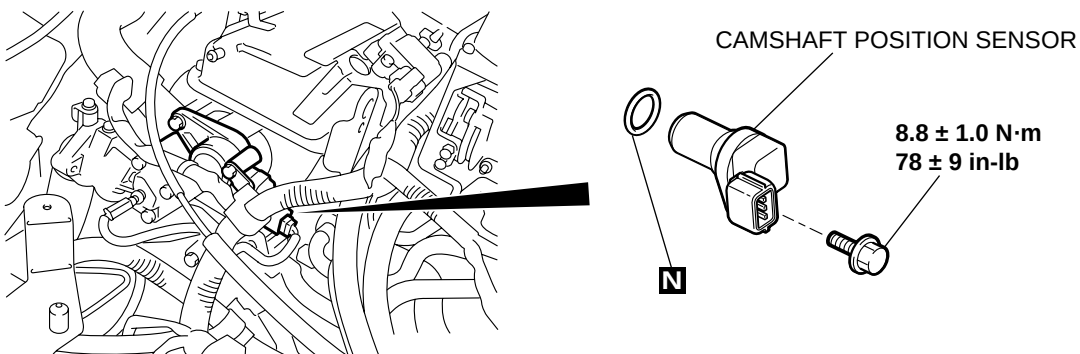
CAMSHAFT POSITION SENSOR

REMOVAL AND INSTALLATION <2.0L ENGINE>

M1163003400506

Pre-removal and Post-installation Operation

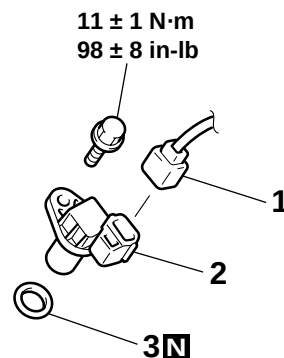
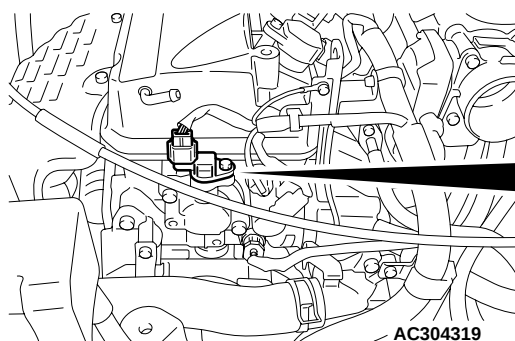
Air Cleaner Removal and Installation (Refer to GROUP 15, Air Cleaner [P.15-4](#).)



AC100959 AB

REMOVAL AND INSTALLATION <2.4L ENGINE>

M1163003400498

AC302233
AC305127AB**REMOVAL STEPS**

1. CAMSHAFT POSITION SENSOR CONNECTOR

REMOVAL STEPS (Continued)

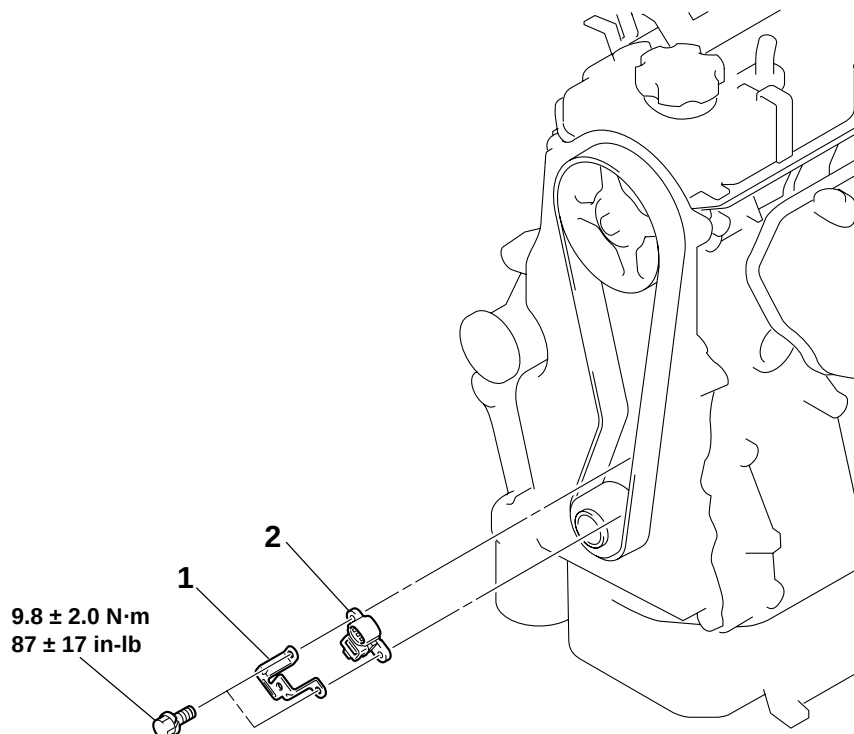
2. CAMSHAFT POSITION SENSOR
3. O-RING

CRANKSHAFT POSITION SENSOR
REMOVAL AND INSTALLATION <2.0L ENGINE>

M1163003500503

Pre-removal and Post-installation Operation

Timing Belt Cover Removal and Installation (Refer to GROUP 11A, Timing Belt [P.11A-45.](#))

**REMOVAL STEPS**

1. BRACKET
2. CRANKSHAFT POSITION SENSOR

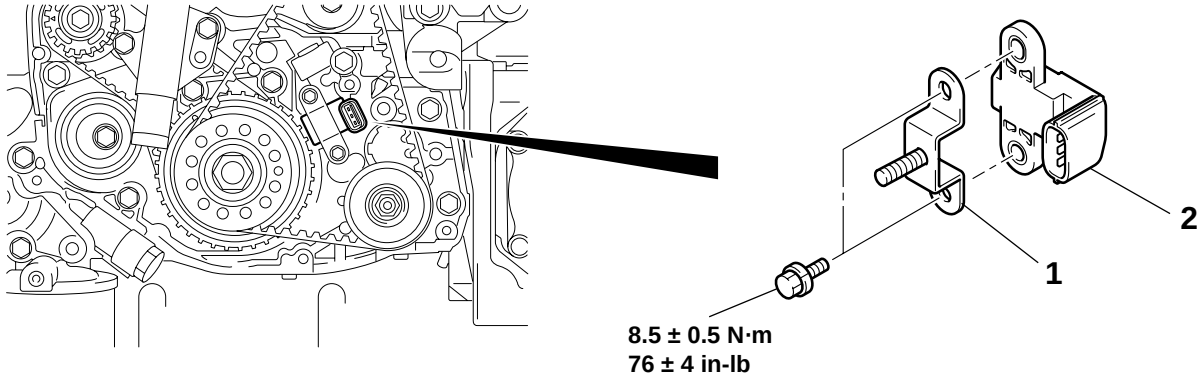
AC100804 AB

REMOVAL AND INSTALLATION <2.4L ENGINE>

M1163003500495

Pre-removal and Post-installation Operation

Timing Belt Lower Cover Removal and Installation (Refer to GROUP 11C, Timing Belt [P.11C-48](#)).



AC305391AB

REMOVAL STEPS

1. TIMING BELT LOWER COVER BRACKET
2. CRANKSHAFT POSITION SENSOR

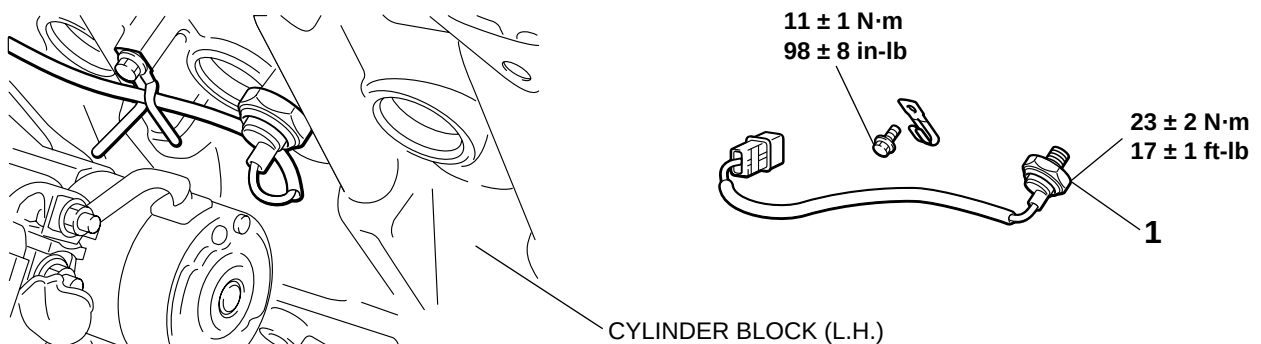
KNOCK SENSOR

REMOVAL AND INSTALLATION <2.0L ENGINE>

M1163002800619

Pre-removal and Post-installation Operation

Intake Manifold Stay Removal and Installation (Refer to GROUP 15, Intake Manifold [P.15-6](#).)



AC101025AB

REMOVAL

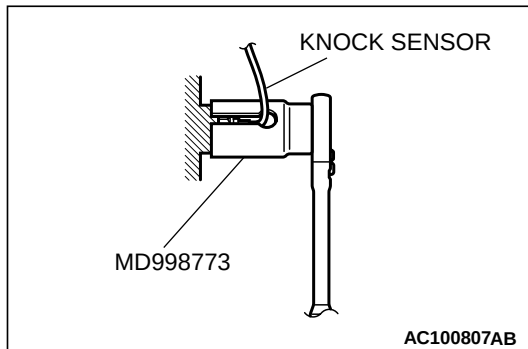
- <<A>> >>A<< 1. KNOCK SENSOR

Required Special Tool:

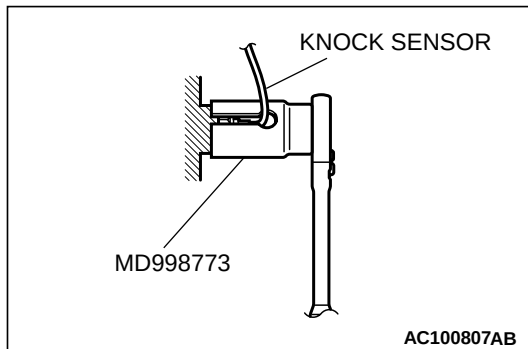
MD998773: Knock Sensor Wrench

REMOVAL SERVICE POINT**<<A>> KNOCK SENSOR REMOVAL**

Use special tool MD998773 to remove the knock sensor.

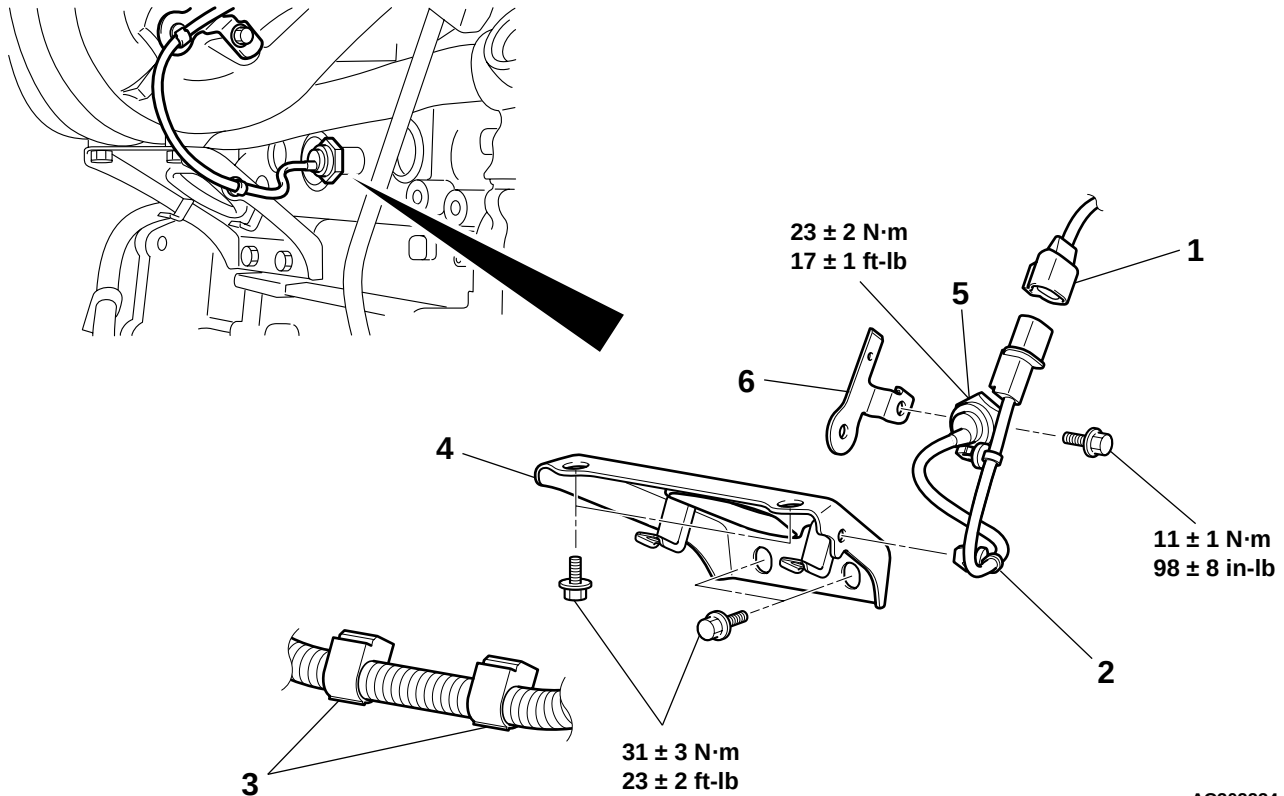
**INSTALLATION SERVICE POINT****>>A<< KNOCK SENSOR INSTALLATION**

Use special tool MD998773 to install the knock sensor.



REMOVAL AND INSTALLATION <2.4L ENGINE>

M1163002800608



AC302234
AC305130 AB

REMOVAL STEPS

1. KNOCK SENSOR CONNECTOR
2. KNOCK SENSOR CLAMP
3. HARNESS CLAMP
4. INTAKE MANIFOLD STAY

<<A>> >>A<<

REMOVAL STEPS (Continued)

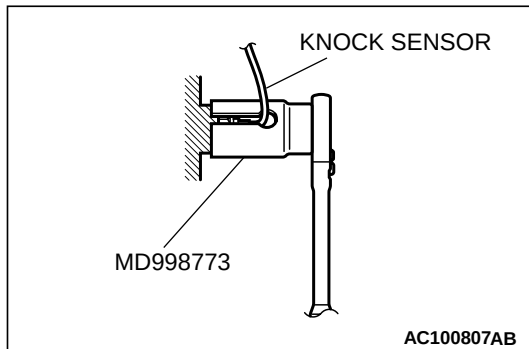
5. KNOCK SENSOR
6. KNOCK SENSOR CONNECTOR BRACKET

Required Special Tool:

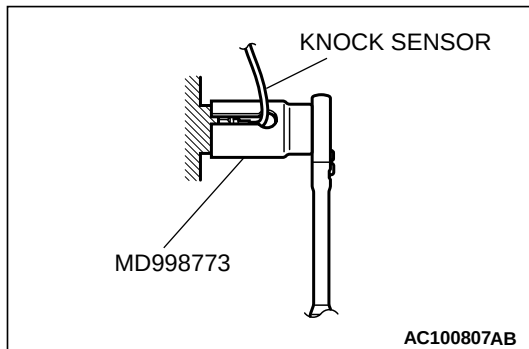
MD998773: Knock Sensor Wrench

REMOVAL SERVICE POINT**<<A>> KNOCK SENSOR REMOVAL**

Use special tool MD998773 to remove the knock sensor.

**INSTALLATION SERVICE POINT****>>A<< KNOCK SENSOR INSTALLATION**

Use special tool MD998773 to install the knock sensor.



SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

M1163003700068

ITEM	SPECIFICATION
Charging system	
Bearing retainer bolt <2.0L ENGINE>	3.7 ± 0.7 N·m (33 ± 6 in-lb)
Connector bracket bolt <2.4L ENGINE>	11 ± 1 N·m (98 ± 8 in-lb)
Engine front mounting bracket nut <2.0L ENGINE>	67 ± 7 N·m (50 ± 5 ft-lb)
Engine front mounting bracket bolt <2.0L ENGINE>	44 ± 10 N·m (33 ± 7 ft-lb)
Front bracket assembly bolt <2.0L ENGINE>	4.4 ± 1.0 N·m (39 ± 9 in-lb)
Generator adjusting brace bolt <2.0L ENGINE>	23 ± 2 N·m (17 ± 1 ft-lb)
Generator bolt <2.0L ENGINE>	23 ± 2 N·m (17 ± 1 ft-lb)
Generator bolt <2.4L ENGINE>	49 ± 9 N·m (36 ± 7 ft-lb)
Generator mounting bracket bolt <2.4L ENGINE>	49 ± 9 N·m (36 ± 7 ft-lb)
Generator nut	44 ± 10 N·m (33 ± 7 ft-lb)
Generator pulley nut <2.0L ENGINE>	118 ± 19 N·m (87 ± 14 ft-lb)
Generator terminal nut <2.4L ENGINE>	14 ± 3 N·m (124 ± 26 in-lb)
Harness bracket bolt <2.4L ENGINE>	11 ± 1 N·m (98 ± 8 in-lb)
Power steering oil line bracket bolt <2.0L ENGINE>	12 ± 2 N·m (102 ± 22 in-lb)
Pressure hose clamp bolt <2.0L ENGINE>	12 ± 2 N·m (102 ± 22 in-lb)
Regulator assembly bolt <2.0L ENGINE>	3.7 ± 0.7 N·m (33 ± 6 in-lb)
Starting system	
Magnetic switch screw <2.0L ENGINE>	5.8 ± 1.6 N·m (52 ± 14 in-lb)
Rear bracket screw <2.0L ENGINE>	3.4 ± 1.0 N·m (30 ± 9 in-lb)
Starter bolt <2.0L ENGINE>	48 ± 5 N·m (36 ± 4 ft-lb)
Starter bolt <2.4L ENGINE>	30 ± 3 N·m (23 ± 2 ft-lb)
Starter cover bolt <2.4L ENGINE>	9.0 ± 2.0 N·m (80 ± 17 in-lb)
Starter cover bracket bolt <2.4L ENGINE>	49 ± 9 N·m (36 ± 7 ft-lb)
Stator screw <2.0L ENGINE>	5.8 ± 1.6 N·m (52 ± 14 in-lb)
Starter terminal nut <2.4L ENGINE>	12 ± 2 N·m (102 ± 22 in-lb)
Ignition system	
Camshaft position sensor bolt <2.0L ENGINE>	8.8 ± 1.0 N·m (78 ± 9 in-lb)
Camshaft position sensor bolt <2.4L ENGINE>	11 ± 1 N·m (98 ± 8 in-lb)
Crankshaft position sensor bolt <2.0L ENGINE>	9.8 ± 2.0 N·m (87 ± 17 in-lb)
Crankshaft position sensor bolt <2.4L ENGINE>	8.5 ± 0.5 N·m (76 ± 4 in-lb)
Ignition coil bolt	10 ± 2 N·m (89 ± 17 in-lb)
Intake manifold stay bolt <2.4L ENGINE>	31 ± 3 N·m (23 ± 2 ft-lb)
Knock sensor	23 ± 2 N·m (17 ± 1 ft-lb)
Knock sensor connector bracket bolt <2.4L ENGINE>	11 ± 1 N·m (98 ± 8 in-lb)
Knock sensor clamp bolt <2.0L ENGINE>	11 ± 1 N·m (98 ± 8 in-lb)
Spark plug	25 ± 5 N·m (19 ± 3 ft-lb)

GENERAL SPECIFICATIONS

M1161000200303

<2.0L ENGINE>

ITEMS	SPECIFICATIONS
Generator	
Type	Positive battery positive voltage sensing
Identification number	A2TB7391
Part No.	MD375835
Rated output V/A	12/90
Voltage regulator	Electronic built-in type
Starter motor	
Type	Reduction drive with planetary gear
Identification number	M0T87581
Part No.	MD377649
Rated output kW/V	1.3/12
Voltage regulator	8
Ignition coil	
Type	Molded 2-coil
Spark plugs	
NGK	BKR5E-11
DENSO	K16PR-U11
CHAMPION	RC10YC4

<2.4L ENGINE>

ITEMS	SPECIFICATIONS
Generator	
Type	Positive battery positive voltage sensing
Identification number	A3TG1192
Part No.	MN183450
Rated output V/A	12/110
Voltage regulator	Electronic built-in type
Starter motor	
Type	Reduction drive with planetary gear
Identification number	M0T20671
Part No.	MN153444
Rated output kW/V	1.4/12
No. of pinion teeth	8
Ignition coil	
Type	Molded 4 coil
Spark plugs	
NGK	LZFR6AI

SERVICE SPECIFICATIONS

M1161000300355

ITEMS			STANDARD VALUE	LIMIT
Generator				
Regulated voltage (Ambient temperature at voltage regulator)		−20°C (−4°F)	14.2 – 15.4	–
		20°C (68°F)	13.9 – 14.9	–
		60°C (140°F)	13.4 – 14.5	–
		80°C (176°F)	13.1 – 14.5	–
Generator output line voltage drop (at 30A) V			–	Maximum 0.3
Output current			–	70% of normal output current
Field coil resistance Ω			Approximately 2 – 5	–
Brush protrusion length mm (in)			–	Minimum 2 (0.08)
Starter motor				
Free running characteristics	2.0L Engine	Terminal voltage V	11	–
		Current A	90	–
		Speed r/min	2,500 or more	–
	2.4L Engine	Terminal voltage V	11	–
		Current A	90	–
		Speed r/min	2,000 or more	–
Pinion gap mm (in)			0.5 – 2.0 (0.02 – 0.07)	–
Commutator run-out mm (in)			0.05 (0.002)	Minimum 0.1 (0.004)
Commutator diameter mm (in)			29.4 (1.16)	Minimum 28.8 (1.13)
Undercut depth mm (in)			0.5 (0.02)	Minimum 0.2 (0.008)
Ignition parts				
Ignition secondary coil resistance at 20°C (68°F) kΩ			8.5 – 11.5	–
Spark plug gap mm (in)	2.0L Engine	1.0 – 1.1 (0.039 – 0.043)	–	
	2.4L Engine	0.7 – 0.8 (0.028 – 0.031)	1.2 (0.047)	
Resistor wire resistance kΩ			–	Maximum 19

NOTES