GROUP 16

ENGINE ELECTRICAL

CONTENTS

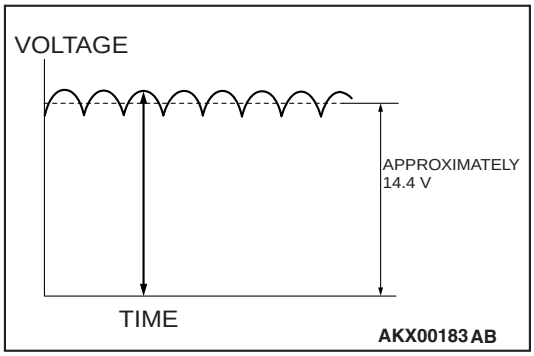
CHARGING SYSTEM

GENERAL DESCRIPTION

M1161000100588

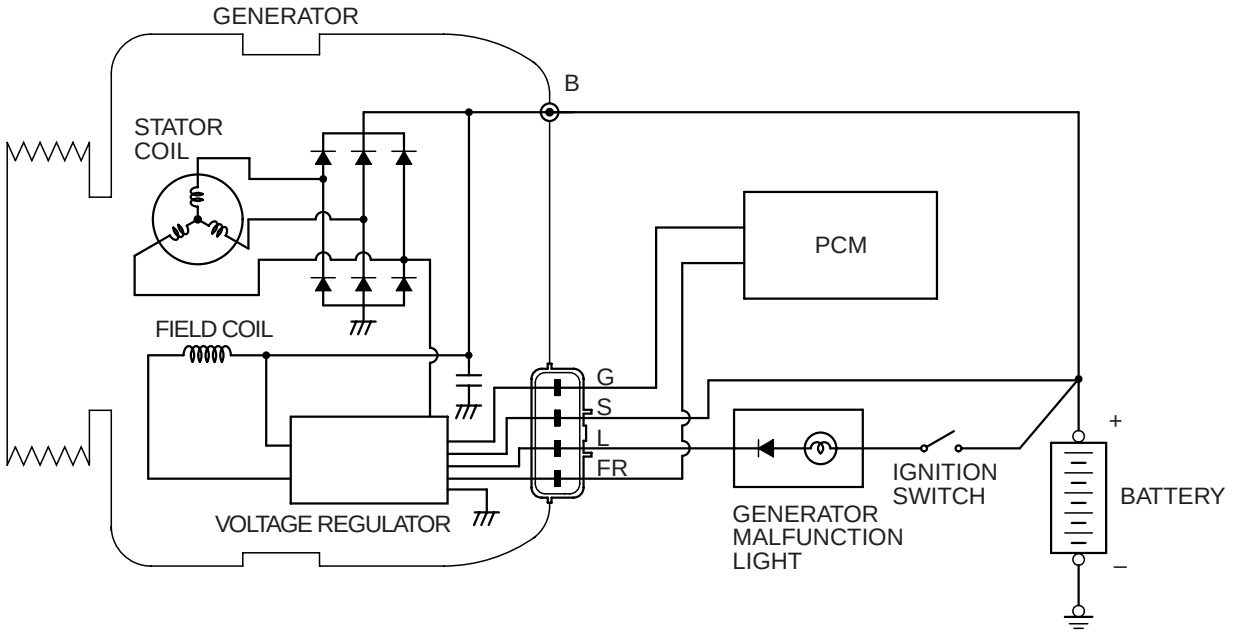
The charging system charges the battery with the generator output to keep the battery charged at a constant level during varying electrical load.

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



CHARGING SYSTEM DIAGNOSIS

M1161000700342

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-5.)

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 <Body and Chasis> – Maintenance Service – Drive Belt (For Generator and Water Pump, Power Steering Pump) (Check Condition) P.00-43.)

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-39.)
- Check for burnt-out generator malfunction light.
- Check the generator. (Refer to Charging System – Generator Assembly – Inspection P.16-17.)
- 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.16-17.)

STEP 5.

Q: Is an oscilloscope available?

YES : Go to Step 6 .
NO : Go to Step 7.

STEP 6.

Q: Dose the oscilloscope show a normal wave pattern? (Refer to Charging System – On-vehicle Service – Wave Pattern Check Using an Oscilloscope P.16-11.)

YES : Go to Step 7.
NO : Check the generator. (Refer to Charging System – Generator Assembly – Inspection P.16-17.)

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.16-8.)

YES : Go to Step 9 .
NO : Check the generator (Refer to Charging System – Generator Assembly – Inspection P.16-17.)

STEP 9.

Q: Is the regulated voltage normal? (Refer to Charging System – On-vehicle Service – Regulated Voltage Test P.16-10.)

YES : Go to Step 10 .
NO : Check the generator (Refer to Charging System – Generator Assembly – Inspection P.16-17.)

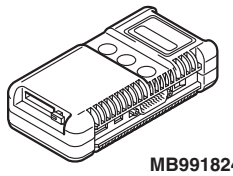
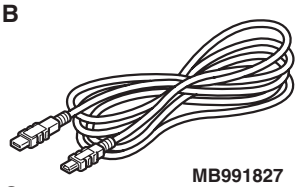
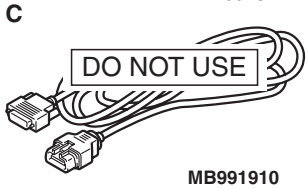
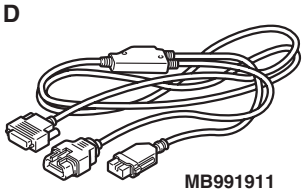
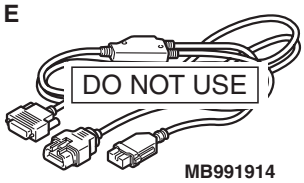
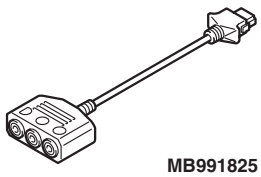
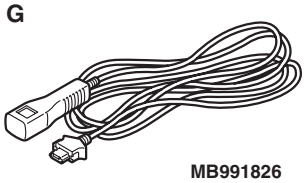
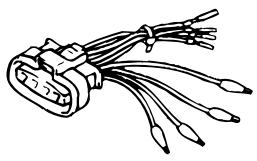
STEP 10.

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

YES : Generator is normal. Check other systems.
NO : Check the output line.

SPECIAL TOOL

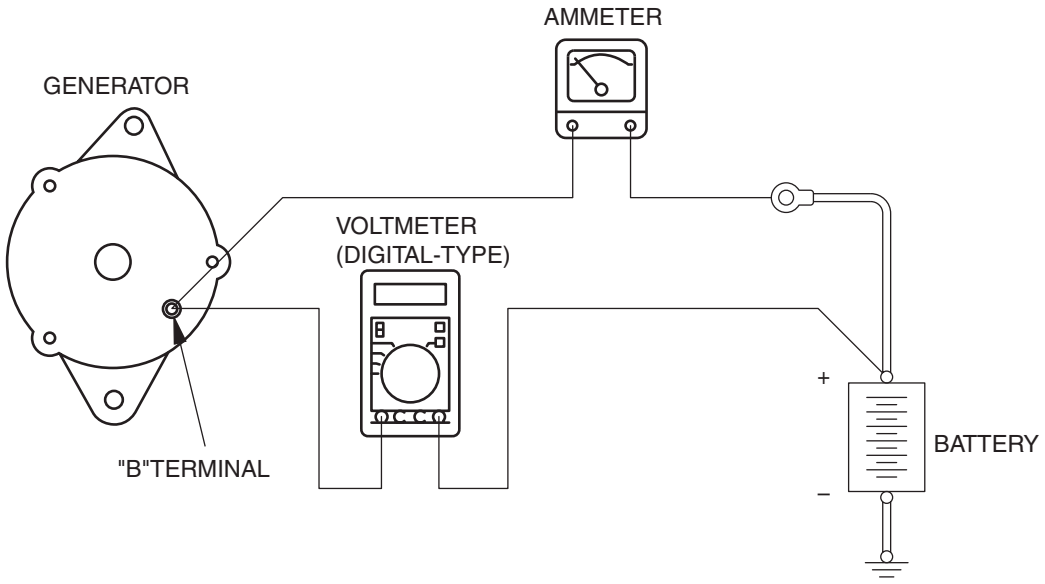
M1161000600497

TOOL	TOOL NUMBER AND NAME	SUPERSESSION	APPLICATION
A  MB991824 B  MB991827 C  MB991910 D  MB991911 E  MB991914 F  MB991825 G  MB991826 MB991958	MB991958 Scan tool (MUT-III sub assembly) A: MB991824 Vehicle communication interface (V.C.I.) B: MB991827 MUT-III USB cable C: MB991910 MUT-III main harness A (Vehicles with CAN communication system) D: MB991911 MUT-III main harness B (Vehicles without CAN communication system) E: MB991914 MUT-III main harness C (for Daimler Chrysler models only) F: MB991825 MUT-III measurement adapter G: MB991826 MUT-III trigger harness	MB991824-KIT *NOTE: G: MB991826 MUT-III Trigger Harness is not necessary when pushing V.C.I. ENTER key.*	Checking of engine speed **⚠ CAUTION** **If you connect MUT-III main harness A to a vehicle without CAN communication system to use the MUT-III, a pulse signal may interfere with the simulated vehicle speed lines, thus causing the MUT-III inoperative. Therefore, use the MUT-III main harness B (MB991911) instead.**
	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

M1161000900562



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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

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 <Body and Chasis> – Maintenance Service – Drive Belt (For Generator, Water Pump and Power Steering Pump) (Check Condition) P.00-43.)
   - 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 – 120 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.

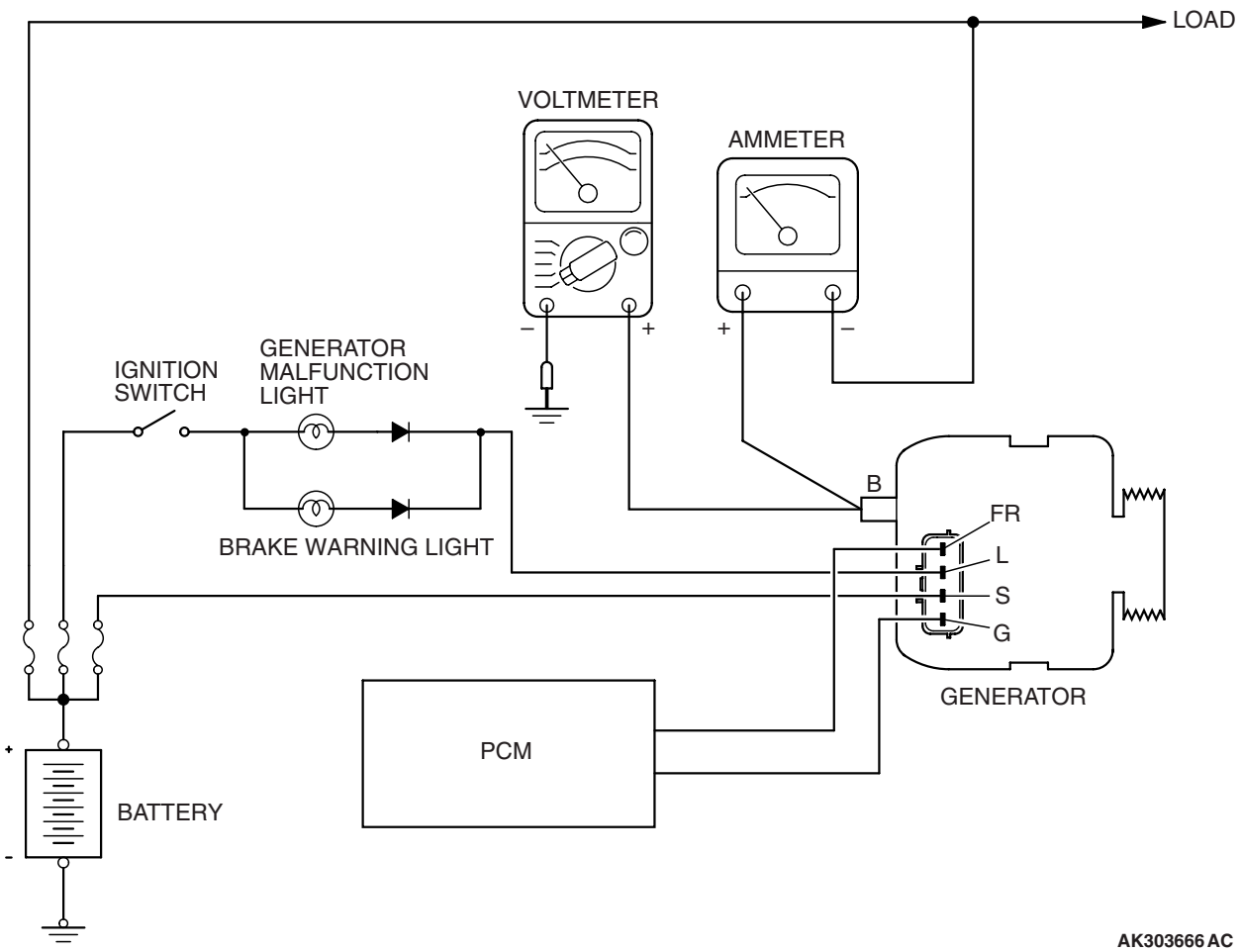
16.Disconnect the ammeter and voltmeter and engine tachometer.

17.Connect the generator output wire to the generator "B" terminal.

18.Connect the negative battery cable.

OUTPUT CURRENT TEST

M1161001000584



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

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-5.)

     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 <Body and Chasis> – Maintenance Service – Drive Belt (For Generator and Water Pump, Power Steering Pump) (Check Condition) P.00-43.)
   - 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 – 120 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 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 highest 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.

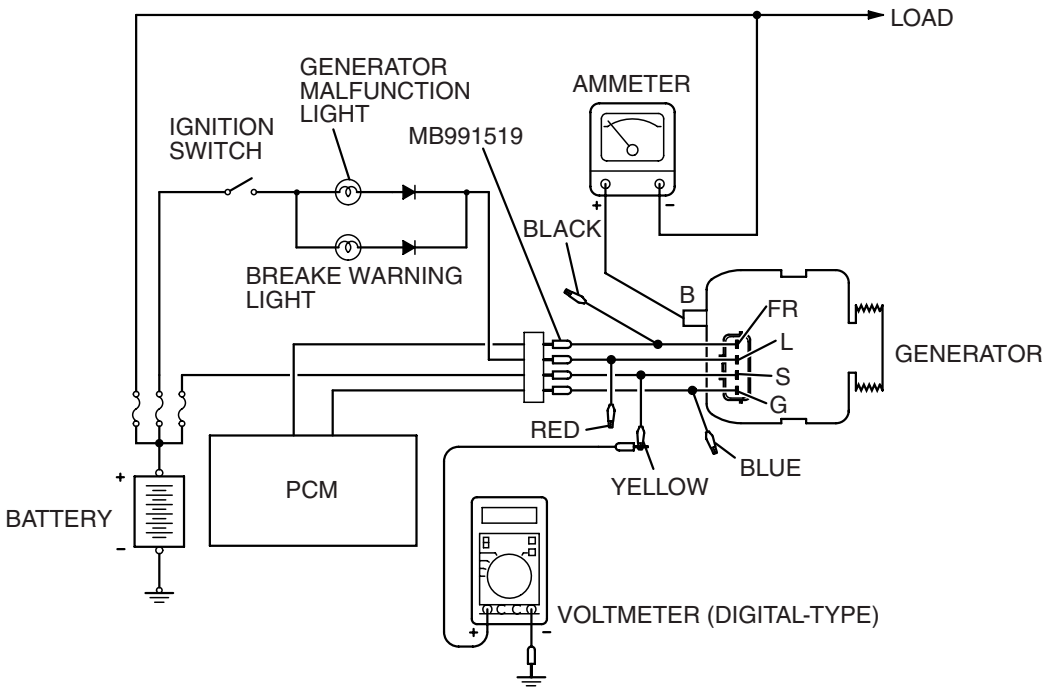
    NOTE: If the electrical load is small while testing, the specified level of current may not be output even though the generator is normal. In such cases, increase the electrical load by leaving the headlights turned on for some time to discharge the battery or by using the lighting system in another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

M1161001100570



AK303667 AC

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-5.)
   - Generator drive belt tension (Refer to GROUP 00, General <Body and Chasis> – Maintenance Service – Drive Belt (For Generator and Water Pump, Power Steering Pump) (Check Condition) P.00-43.)
   - 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 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 – 120 A in series between the "B" terminal and the disconnected output wire. (Connect the positive load 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.

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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.

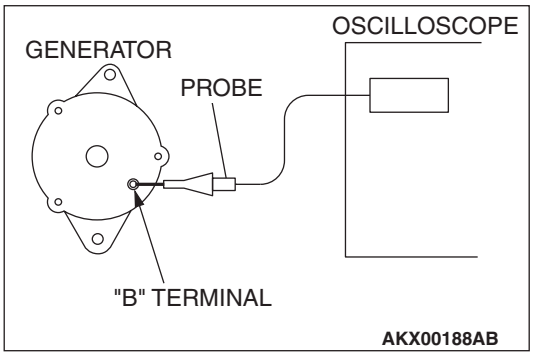
    If the voltage is outside the standard value, there is a malfunction of the voltage regulator or the generator (Refer to the following table).
15. After the test, lower the engine speed to the idle speed.
16. Turn the ignition switch to the "LOCK" (OFF) position.
17. Disconnect the negative battery cable.
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

M1161001200265

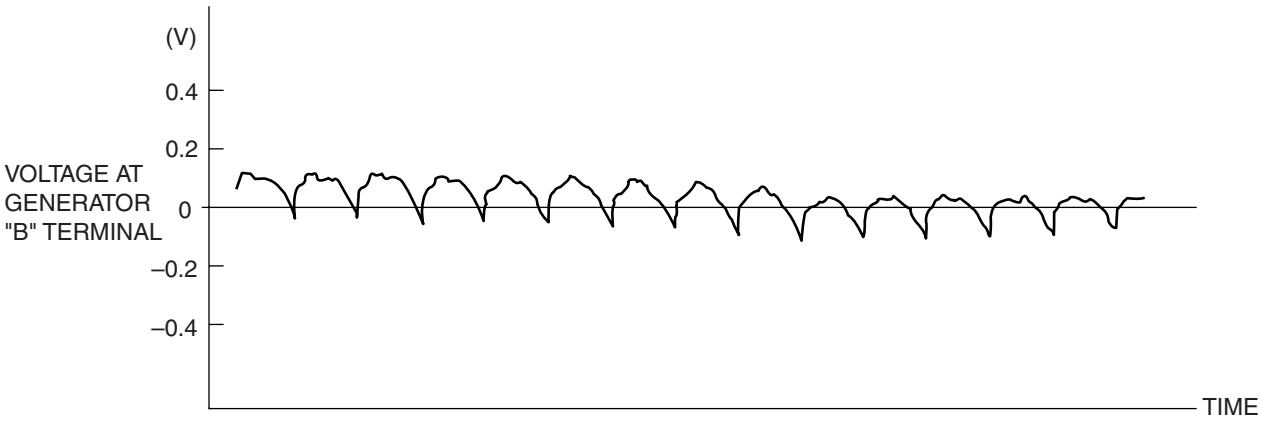


MEASUREMENT METHOD

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



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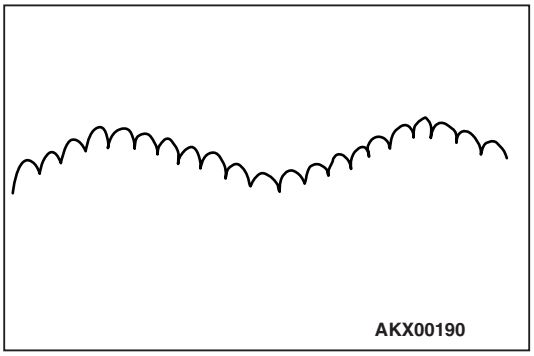

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NOTE: The voltage waveform of the generator "B" terminal can undulate as shown at left. This waveform is produced when the regulator operates according to fluctuations in the generator load (current), and is normal for the generator.
If the ripple 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

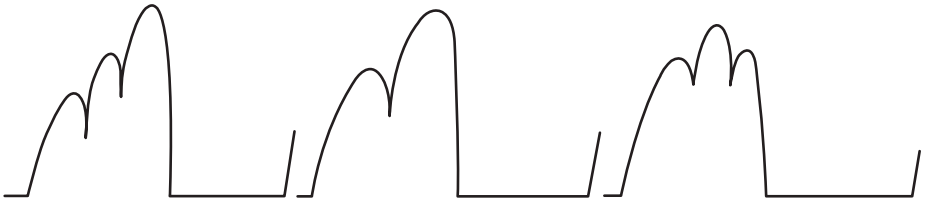
NOTE: The size of the waveform patterns can differ greatly, depending on the adjustment of the variable knob on the oscilloscope.

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



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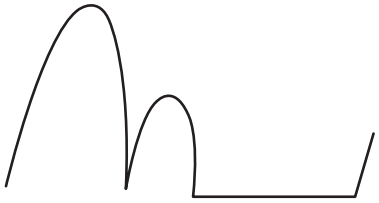
- Example 2
  PROBABLE CAUSE: Short-circuit in diode



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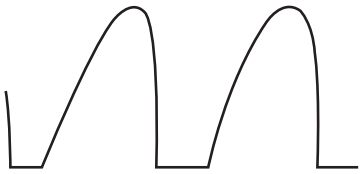
- Example 3
  PROBABLE CAUSE: Open circuit in stator coil



AKX00193

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

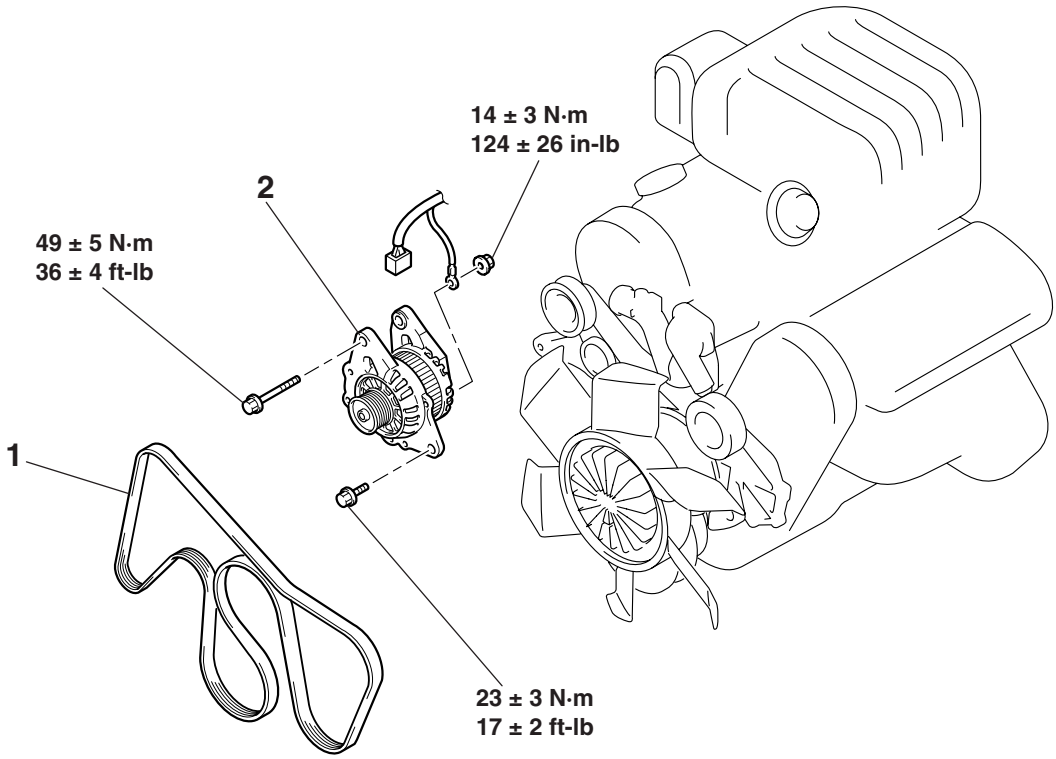
AKX00194

GENERATOR ASSEMBLY

REMOVAL AND INSTALLATION

M1161001401187

Pre-removal Operation	Post-installation Operation
• Under Cover Removal • Air Cleaner Removal (Refer to GROUP 15, Air Cleaner P.15-6.)	• Drive Belt Tension Check (Refer to GROUP 00, Maintenance Service P.00-43.) • Under Cover • Air Cleaner Installation (Refer to GROUP 15, Air Cleaner P.15-6.)



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REMOVAL STEPS

1. DRIVE BELT
2. GENERATOR

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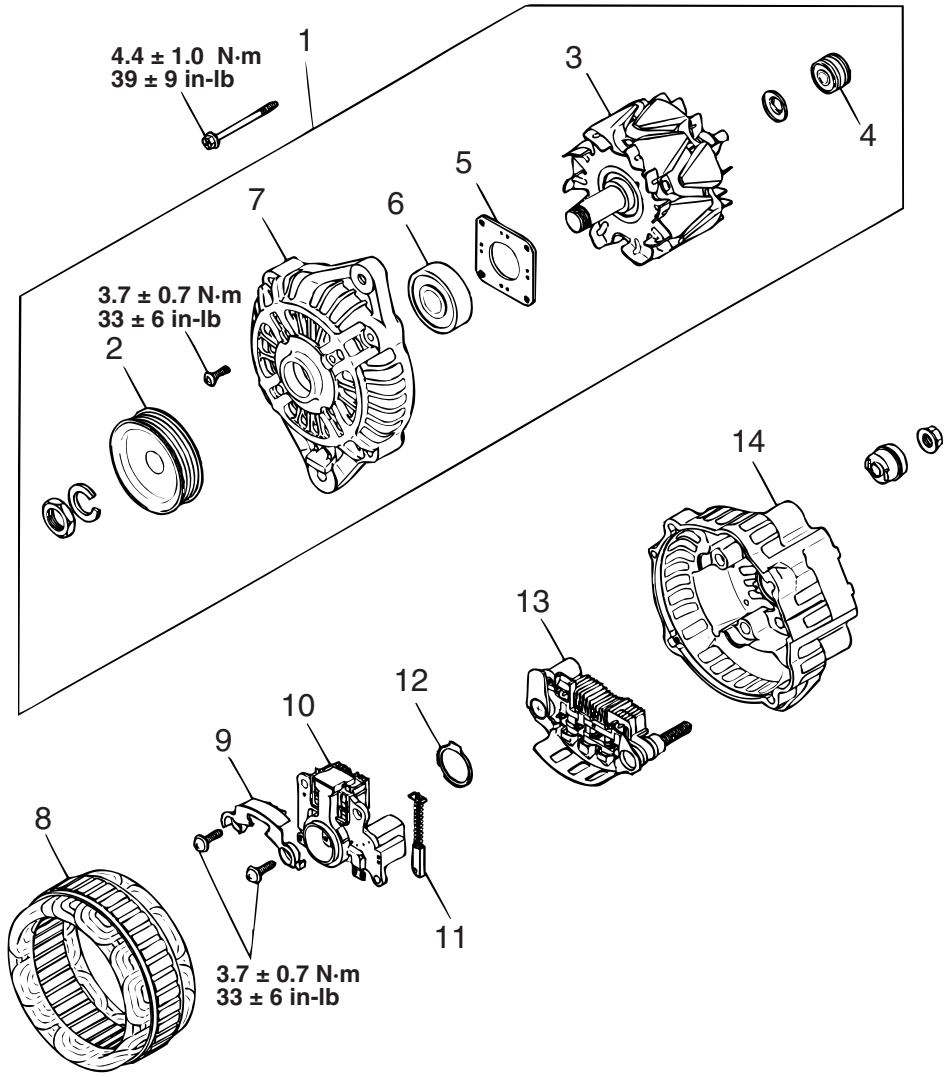
DISASSEMBLY AND ASSEMBLY

M1161001600263



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

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

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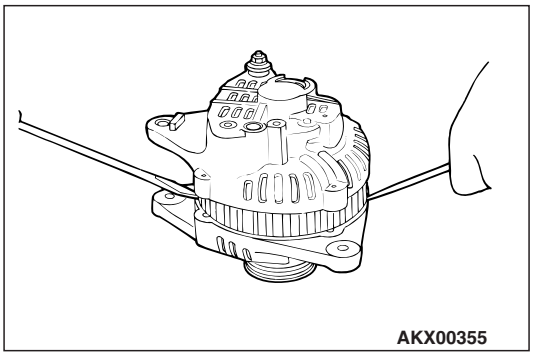
DISASSEMBLY SERVICE POINTS

<<A>> FRONT BRACKET ASSEMBLY REMOVAL

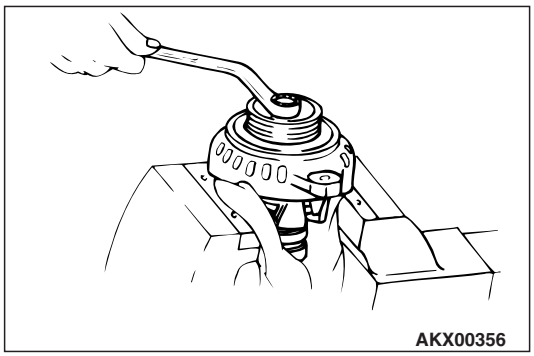

AKX00355

⚠ 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.

<<B>> GENERATOR PULLEY REMOVAL

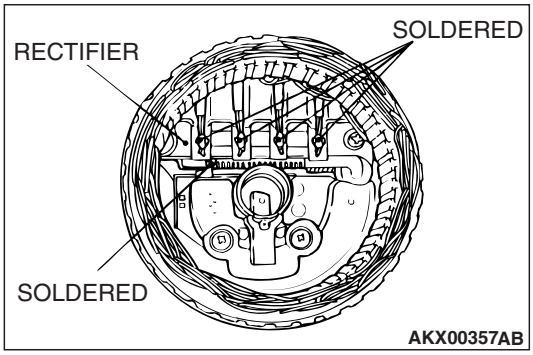

AKX00356

⚠ CAUTION

Make sure not to damage the rotor.

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

<<C>> STATOR REMOVAL



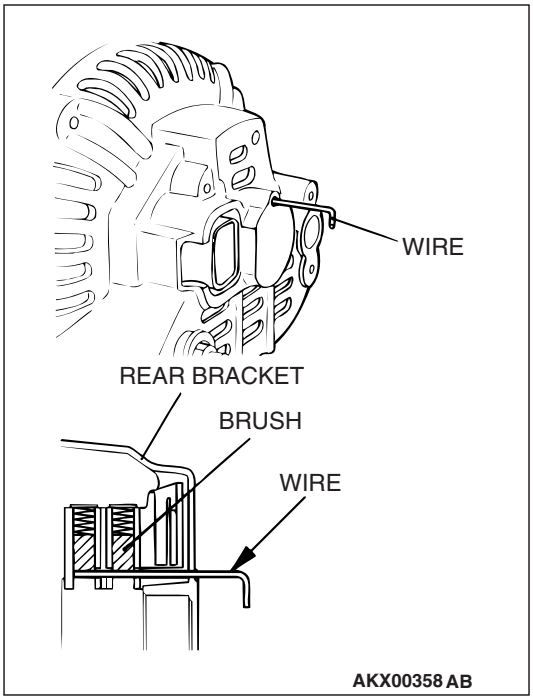
AKX00357AB

⚠ 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 complete 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.

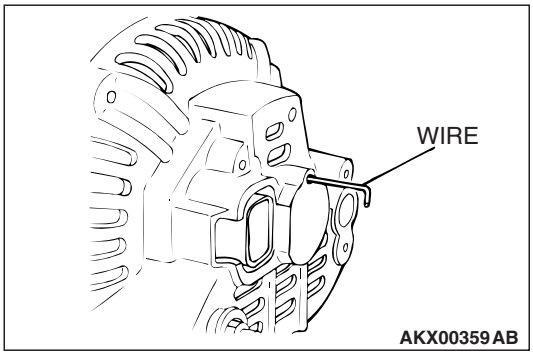
ASSEMBLY SERVICE POINTS



>>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.

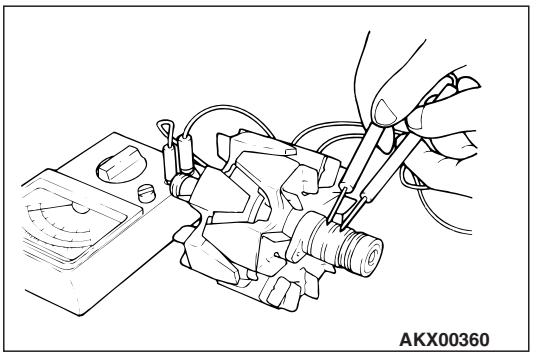


>>B<< ROTOR ASSEMBLY INSTALLATION

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

INSPECTION

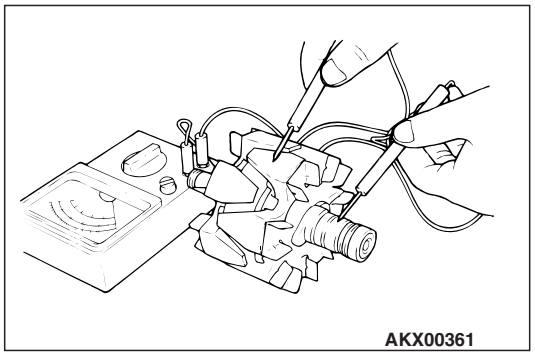
M1161001700237



ROTOR CHECK

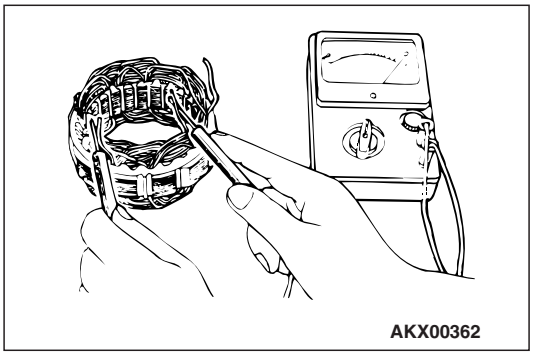
1. Check the continuity between the slip rings of the field coil. If the resistance value is not within the standard value, replace the rotor.

   Standard value: approximately 2 – 5 Ω

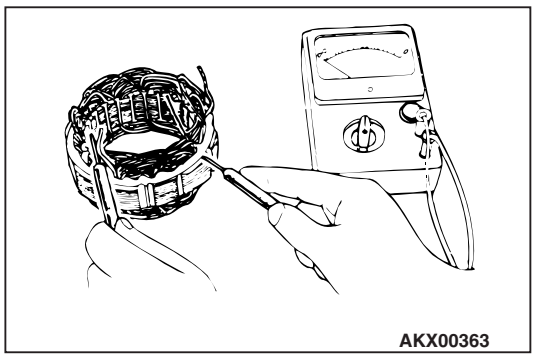

AKX00361

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

STATOR CHECK

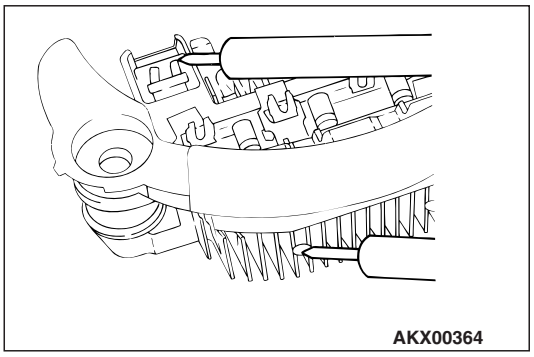

AKX00362

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

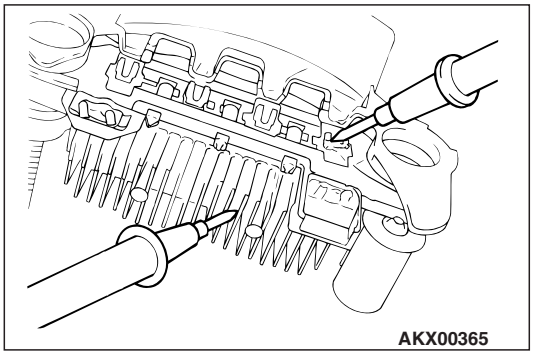

AKX00363

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

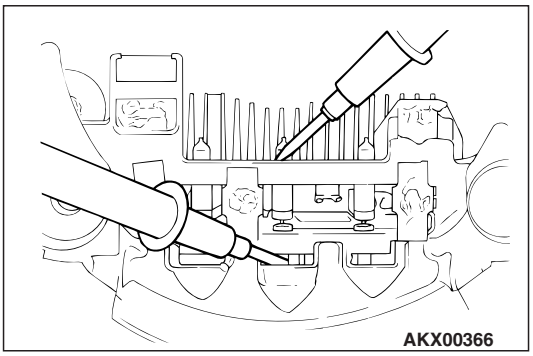
RECTIFIER CHECK


AKX00364

1. Check the 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.

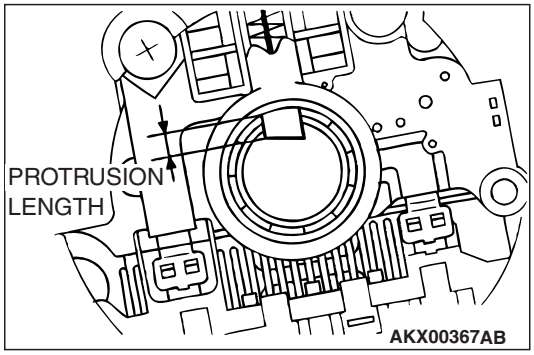

AKX00365

2. Check the 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.


AKX00366

3. Check the 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.

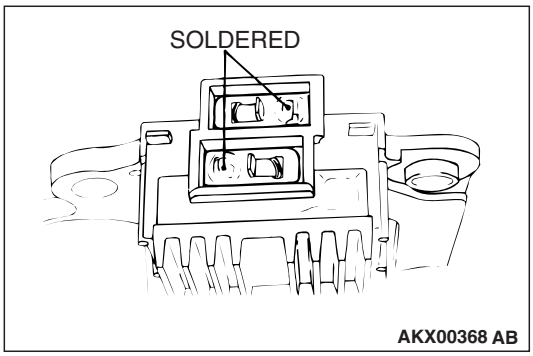
BRUSH CHECK



AKX00367AB

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)



AKX00368 AB

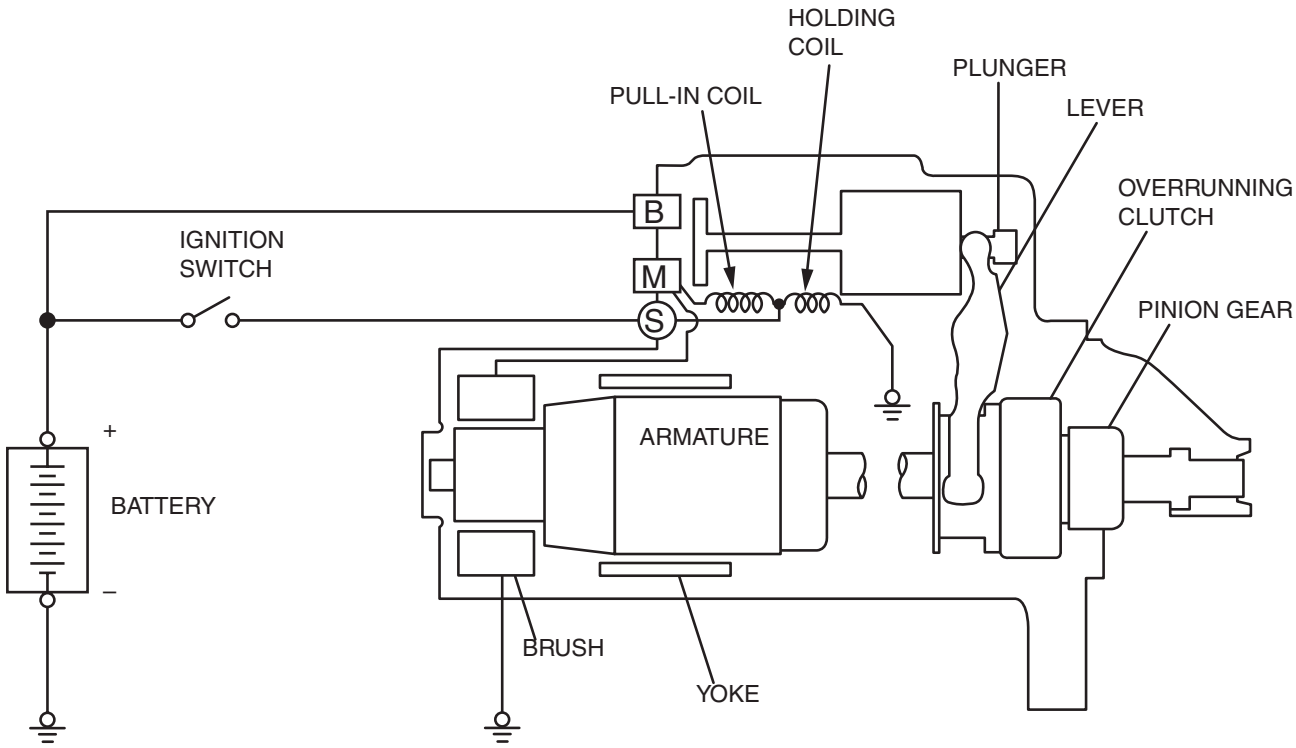
2. The brush can be removed by unsoldering the brush lead wire.
3. When installing a new brush, push the brush in to the brush holder, and solder the lead wire.

STARTING SYSTEM

GENERAL DESCRIPTION

M1162000100398

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.



AK202970AC

OPERATION

When the ignition switch is switched to the "ST" position while the selector lever is at the "P" or "N" range, the contact (magnetic switch) of the starter is switched ON and the starter motor is activated.

STARTING SYSTEM DIAGNOSIS

M1162000700408

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, Chassis Electrical – Battery – On-vehicle Service – Battery Check P.54A-5.)

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 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-39.)
- Check the transmission range switch.(Refer to GROUP 23A, Automatic Transmission – On-vehicle Service – Essential Service – Transmission Range Switch Continuity Check P.23A-549.)
- 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 Starting System – Starter Motor Assembly – Inspection P.16-17.)

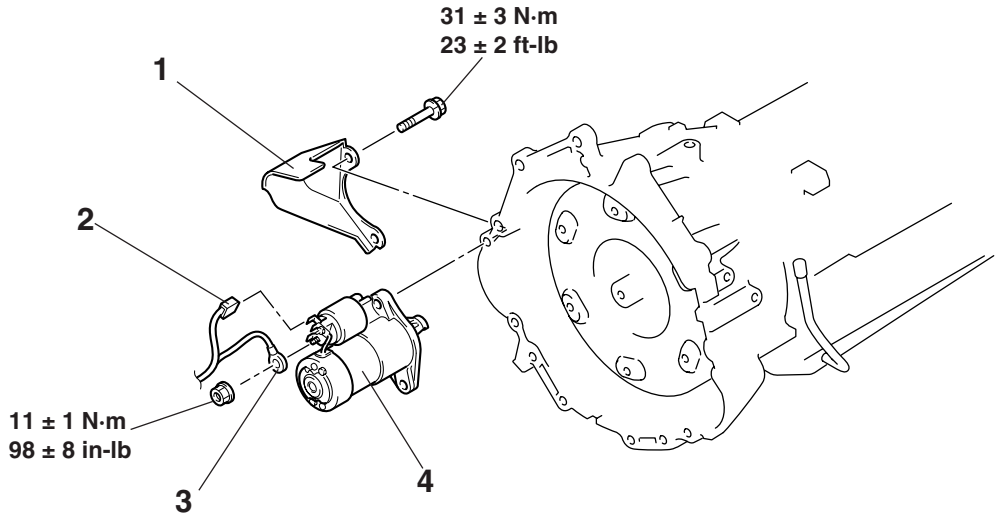
YES : Excessive rotational resistance of the engine.
NO : Replace the starter motor.

STARTER MOTOR ASSEMBLY

REMOVAL AND INSTALLATION

M1162001001148

Pre-removal and Post-installation Operation
- Under Cover Removal and Installation



ACX02077AC

REMOVAL STEPS
1. STARTER COVER
2. STARTER CONNECTOR

REMOVAL STEPS (Continued)
3. STARTER TERMINAL
4. STARTER ASSEMBLY

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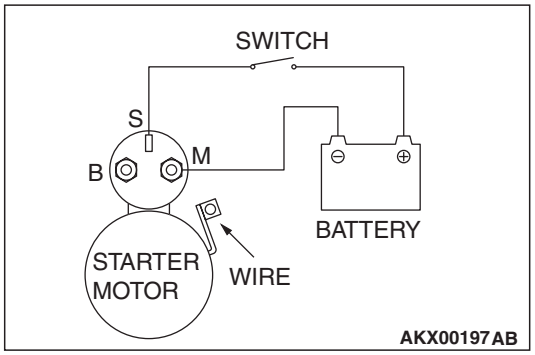
INSPECTION

M1162001100294

PINION GAP ADJUSTMENT

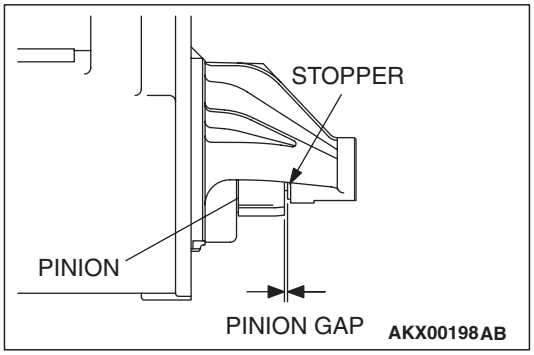


1. Disconnect the field coil wire from the M-terminal of the magnetic switch.
2. Connect a 12-volt battery between the S-terminal and M-terminal.

⚠ CAUTION

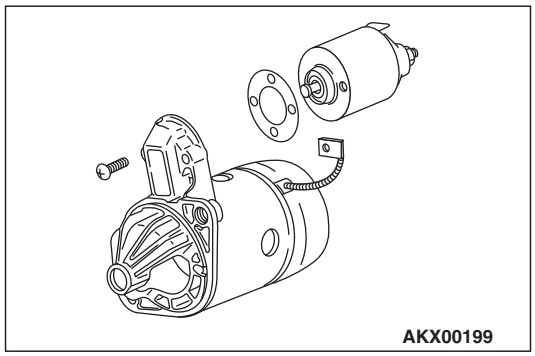
This test must be performed quickly (in less than 10 seconds) to prevent the coil from burning.

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



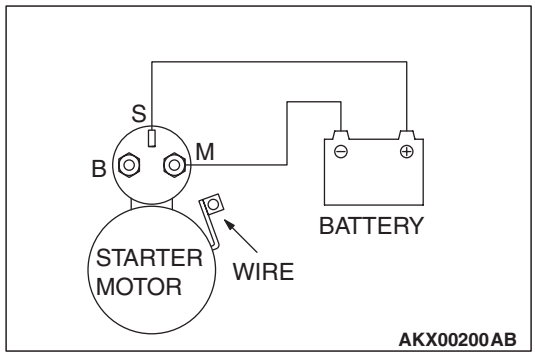
4. Check the pinion-to-stopper clearance (pinion gap) with a feeler gauge.

   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.

MAGNETIC SWITCH PULL-IN TEST

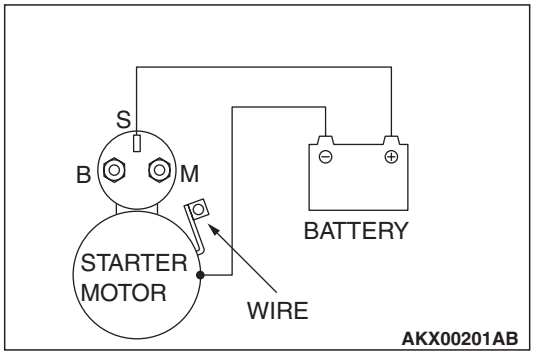


1. Disconnect the field coil wire from the M-terminal of the magnetic switch.

⚠ 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.



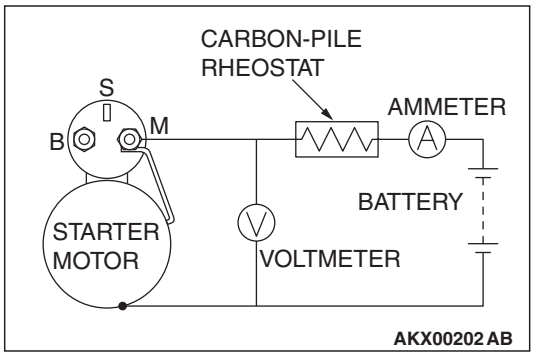
MAGNETIC SWITCH HOLD-IN TEST

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.

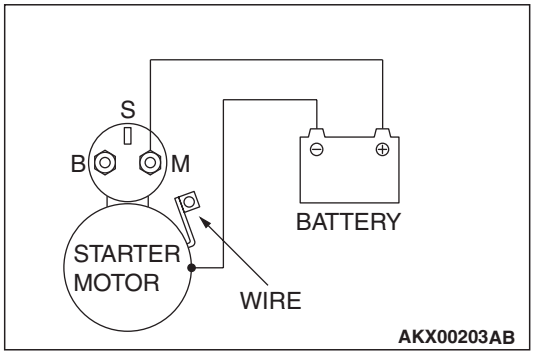
2. Connect a 12-volt battery between the S-terminal and body.
3. Manually pull out the pinion as far as the pinion stopper position.
4. If the pinion remains out, everything is operating properly. If the pinion moves in, the hold-in circuit is open. Replace the magnetic switch.



FREE RUNNING TEST

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 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.

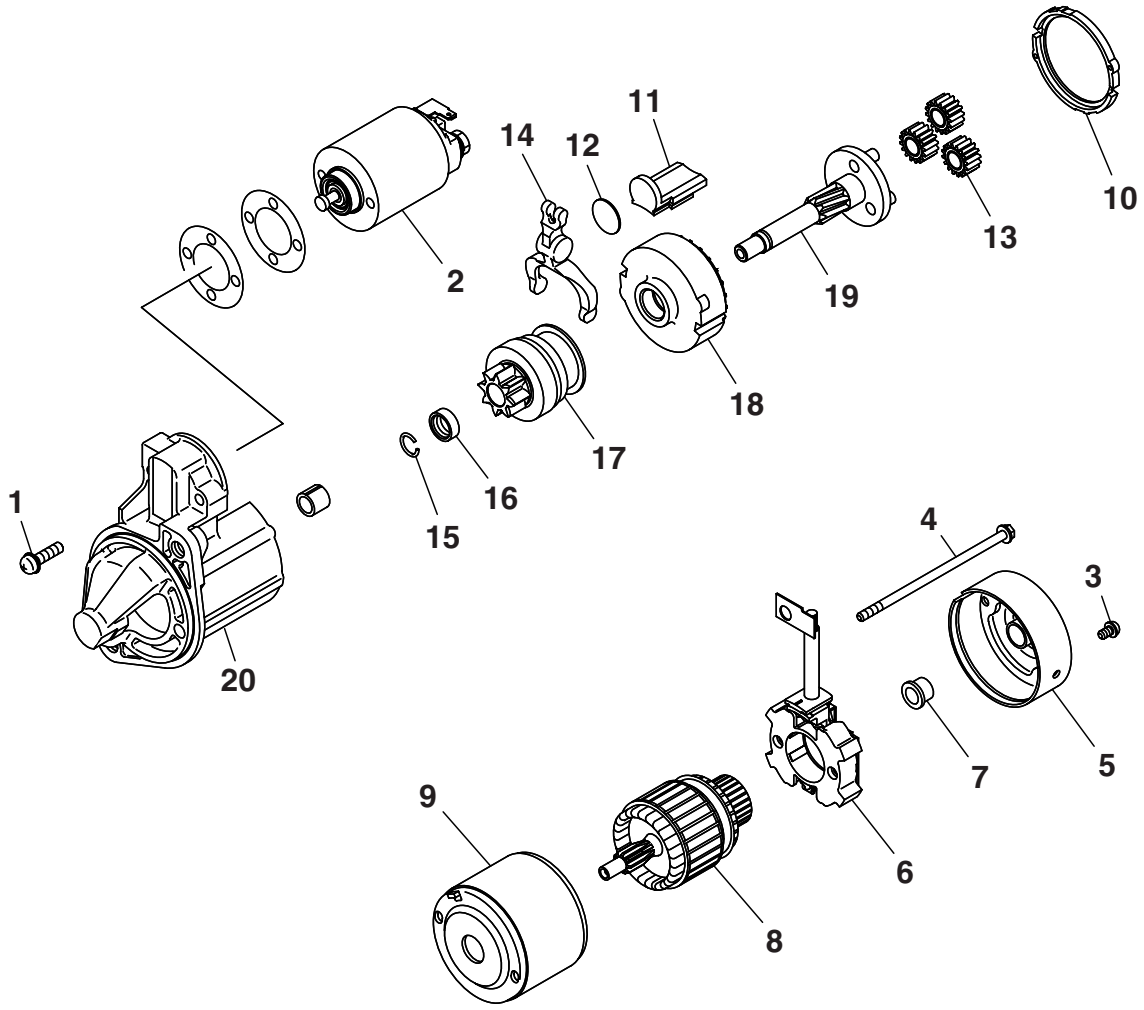
⚠ WARNING

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

M1162001200310



AK304675AE

	DISASSEMBLY STEPS
	1. SCREW
<<**A**>>	2. MAGNETIC SWITCH
	3. SCREW
	4. SCREW
	5. REAR BRACKET
	6. BRUSH HOLDER ASSEMBLY
	7. REAR BEARING
	8. ARMATURE
	9. YOKE ASSEMBLY
	10. PACKING A
	11. PACKING B
	12. PLATE
	13. PLANETARY GEAR
	14. LEVER
<<**B**>> >>**A**<<	15. SNAP RING
<<**B**>> >>**A**<<	16. STOP RING
	17. OVERRUNNING CLUTCH
	18. INTERNAL GEAR
	19. PLANETARY GEAR HOLDER
	20. FRONT BRACKET

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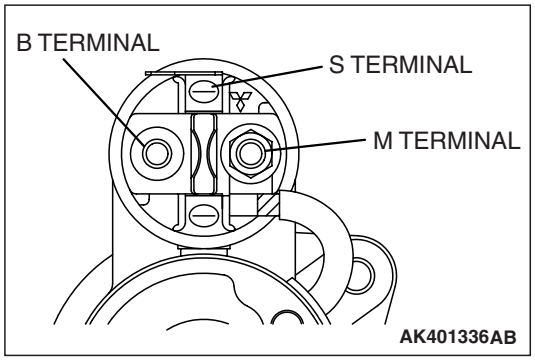
DISASSEMBLY SERVICE POINTS

<<A>> MAGNETIC SWITCH REMOVAL

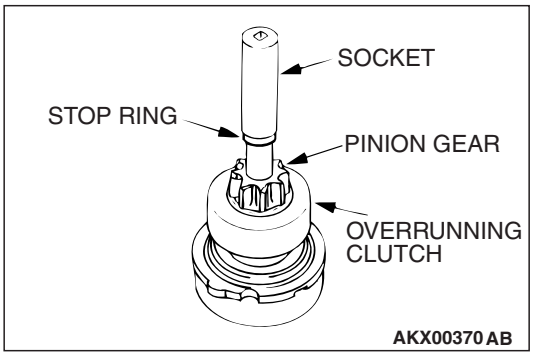


⚠ CAUTION

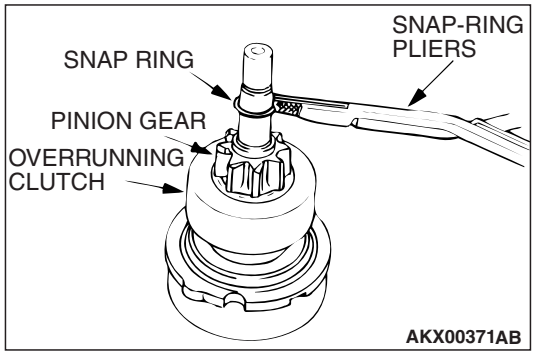
Do not clamp the yoke assembly with a vise.

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

<<B>> SNAP RING AND STOP RING REMOVAL



1. Press a long socket wrench of appropriate size to the stop ring. Then tap the socket wrench to remove the stop ring to the pinion gear side.

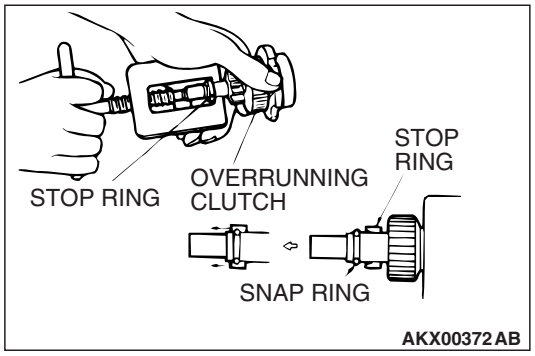


2. After removing the snap ring (by using snap-ring pliers), remove the stop ring and the overrunning clutch.

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. 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



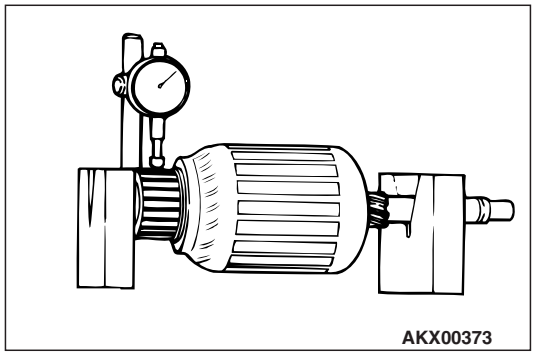
>>A<< STOP RING AND SNAP RING INSTALLATION

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

INSPECTION

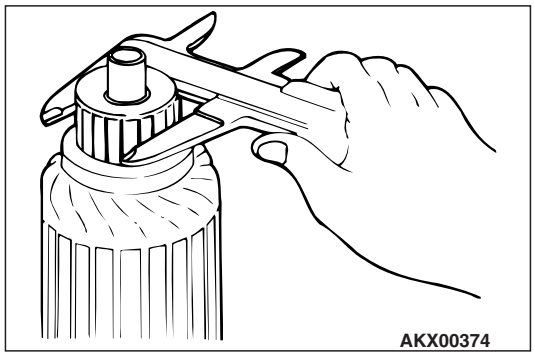
M1162001300254

COMMUTATOR CHECK



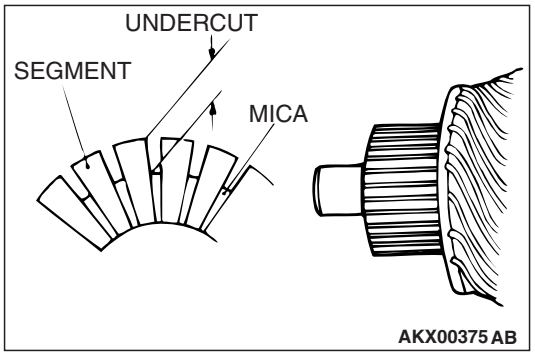
1. Place the armature on a pair of V-blocks, and check the deflection by using a dial gauge.

   Standard value: 0.05 mm (0.002 inch)
   Limit: 0.1 mm (0.004 inch)



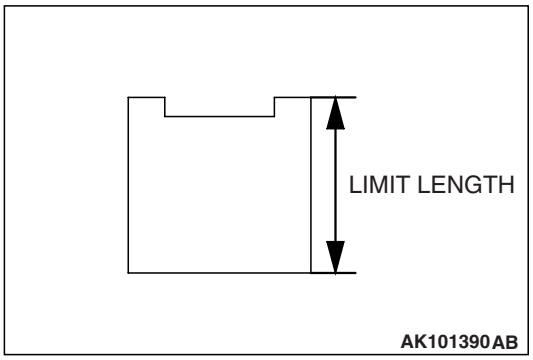
2. Check the outer diameter of the commutator.

   Standard value: 29.4 mm (1.16 inches)
   Minimum limit: 28.8 mm (1.13 inches)



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)

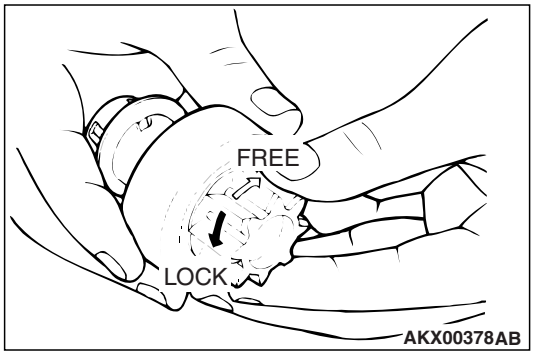


BRUSH CHECK

1. Check the brush for roughness of the surface that contacts the commutator and check the brush length.Replace the brush holder if this measurement exceeds the limit.

   Minimum limit: 7.0 mm (0.28 inch)

2. In the case contacting surface has been corrected or the brush has been replaced, correct the contacting surface by winding sandpaper around the commutator.



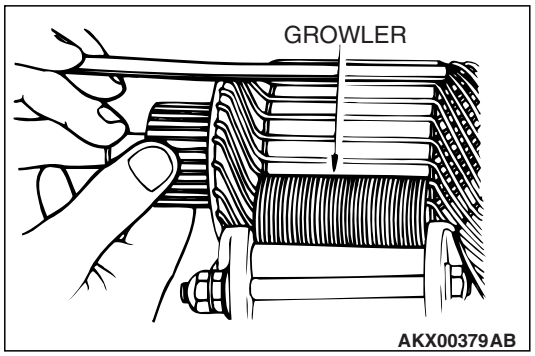
OVERRUNNING CLUTCH CHECK

1. While holding the clutch housing, rotate the pinion. The drive pinion should rotate smoothly in one direction, but should not rotate in opposite direction. If the clutch does not function properly, replace the overrunning clutch assembly.
2. Inspect the pinion for wear or burrs. If the pinion is worn or burred, replace the overrunning clutch assembly. If the pinion is damaged, also inspect the ring gear for wear or burrs.

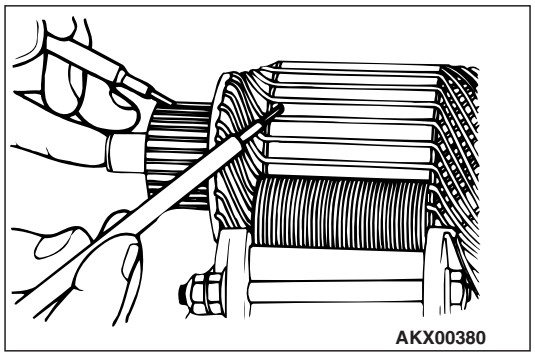
FRONT AND REAR BRACKET BUSHING CHECK

Inspect the bushing for wear or burrs. If the bushing is worn or burred, replace the front bracket assembly or rear bracket assembly.

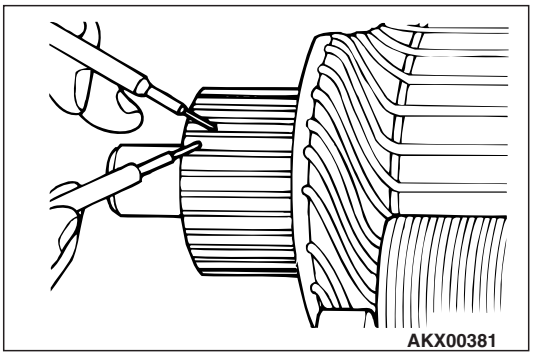
ARMATURE CHECK



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 while rotating the armature slowly in the growler. A shorted armature will cause a blade to vibrate and be attracted to the core. Replace the shorted armature.

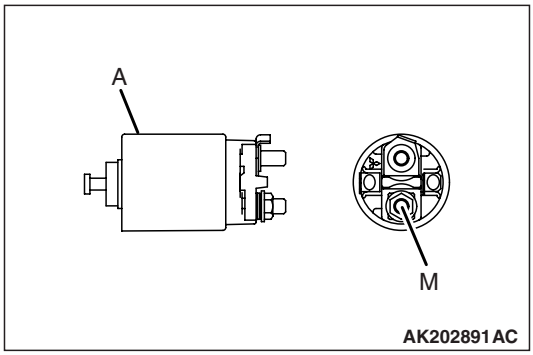


4. Check the insulation between the armature coil cores and the commutator segments. They are normal if there is no continuity.

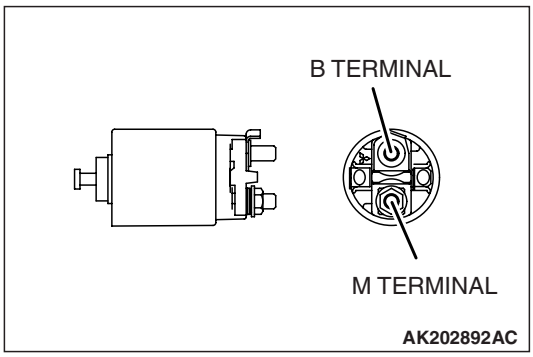


5. Check for continuity between the segments. The condition is normal if there is continuity.

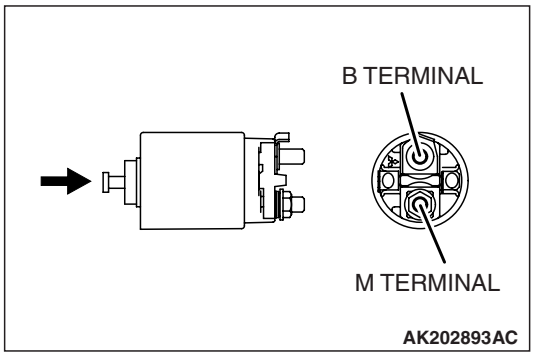
MAGNETIC SWITCH



1. Coil open circuit test
   - Check that there is continuity between the M terminal and body A.
   - If there is no continuity, replace the magnetic switch.



2. Contact fusion check
   - Check that there is no continuity between the B terminal and M terminal.
   - If there is continuity, replace the magnetic switch.



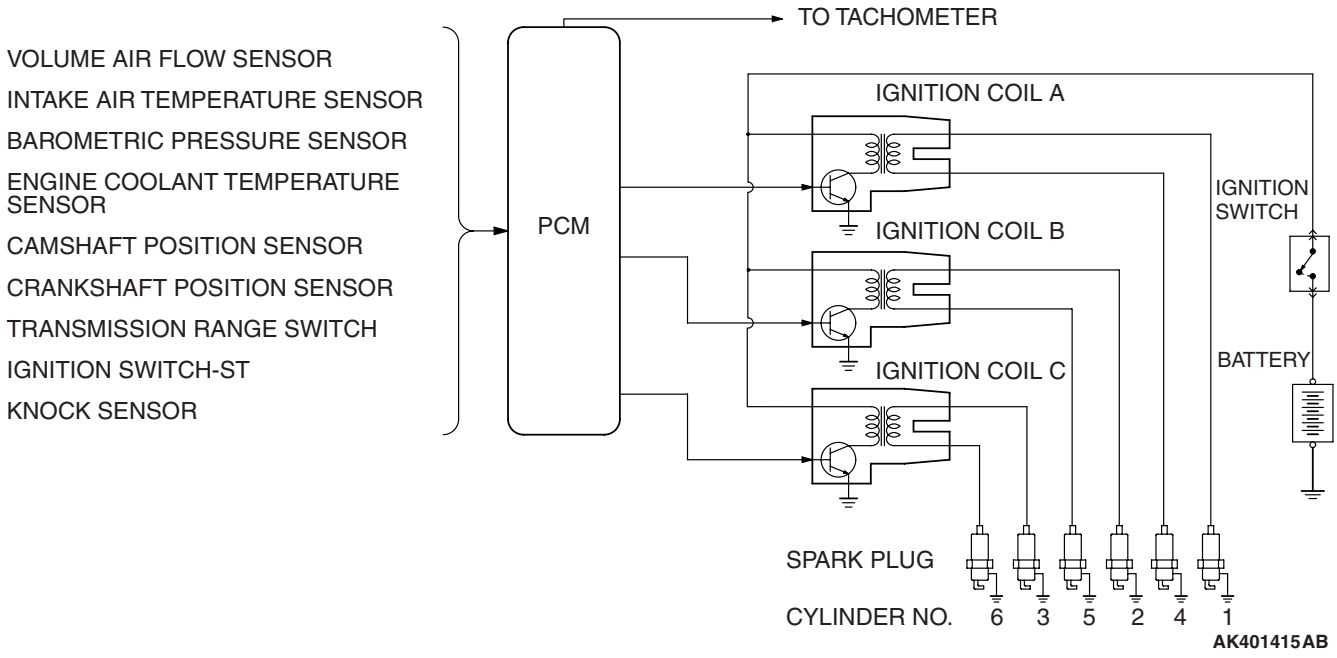
3. Switch contact check
   - Push the indicated end of the magnetic switch with a strong force to close the internal contacts. Without releasing the switch end, check that there is continuity between the B terminal and M terminal.
   - If there is no continuity, replace the magnetic switch.

IGNITION SYSTEM

GENERAL DESCRIPTION

M1163000100539

This system is provided with three ignition coils (A, B and C) with bult-in three ignition power transistors for the number 1 and number 4 cylinders, number 2 and number 5 cylinders and number 3 and number 6 cylinders respectively.
Interruption of the primary 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 thus 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 at 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 5 cylinders, and when the primary current flowing in ignition coil C is interrupted, the high voltage thus generated is applied to the spark plugs of number 3 and number 6 cylinders.
The powertrain control module (PCM) controls the three ignition power transistors to turn them alternately ON and OFF. This causes the primary currents in the ignition coils (A, B and C) to be alternately interrupted and allowed to flow to fire the cylinders in the order 1-2-3-4-5-6.
The 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.



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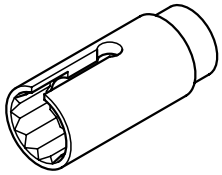
SPECIAL TOOLS

M1163000600341

TOOL	TOOL NUMBER AND NAME	SUPERSESSION	APPLICATION
 MB991348	MB991348 Test harness set	MB991348-01	Inspection of ignition primary voltage (ignition power transistor connection)
	MD998773 Knock sensor wrench	Tool not available	Knock sensor removal and installation

ON-VEHICLE SERVICE

KNOCK CONTROL SYSTEM CHECK

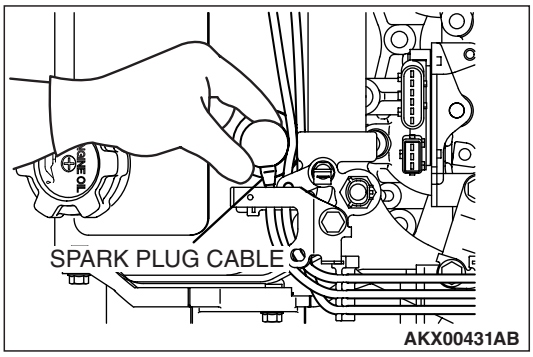
M1163001800207

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

Refer to GROUP 13A, Multiport Fuel Injection (MFI) – Multiport Fuel Injection (MFI) Diagnosis – Diagnostic Trouble Code Procedures – DTC P0325 : Knock Sensor Circuit P.13A-476.

SPARK PLUG CABLE TEST

M1163000900137



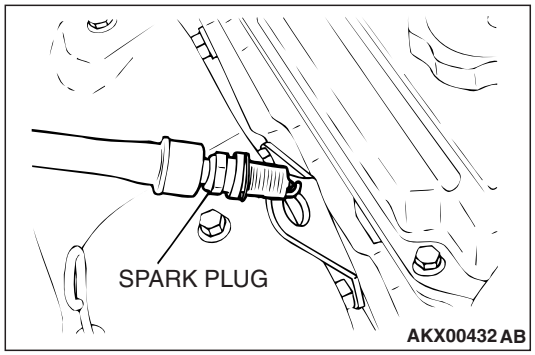
⚠ WARNING

Wear rubber gloves while performing this test.

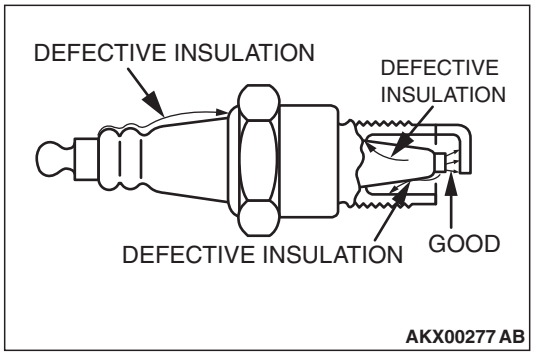
1. Disconnect, one at a time, each of the spark plug cables while the engine is idling to check whether the engine's running performance changes or not.
2. If the engine performance does not change, check the resistance of the spark plug cable, and check the spark plug itself.

SPARK PLUG TEST

M1163001500154



1. Remove the spark plug and connect to the spark plug cable.



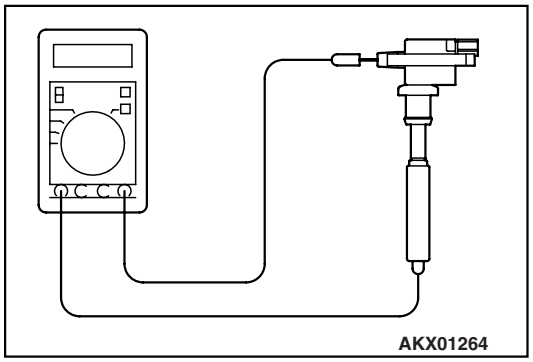
2. Ground the spark plug outer electrode (body), and crank the engine.
   Check that there is an electrical discharge between the electrodes at this time.

IGNITION COIL CHECK

M1163001200539

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

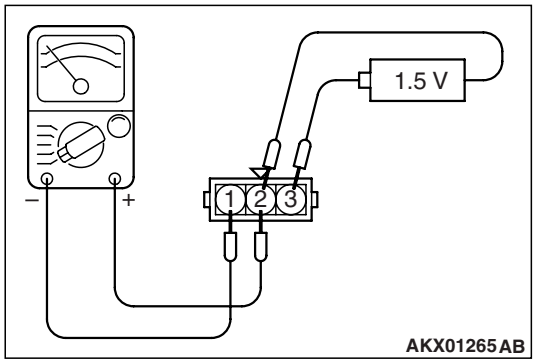
SECONDARY COIL RESISTANCE CHECK



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

Standard value: 8.5 – 11.5 kΩ

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

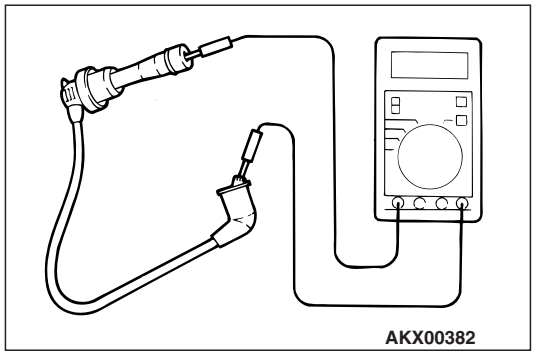
This test must be performed quickly (in less than 10 seconds) to prevent coil from burning and ignition power transistor from breaking.

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

SPARK PLUG CABLE RESISTANCE CHECK

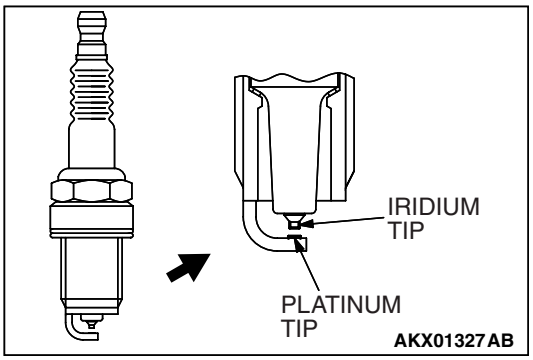
M1163001400179



Measure the resistance of the all spark plug leads.

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

   Limit: 19 kΩ



SPARK PLUG CHECK AND CLEANING

M1163004300591

⚠ CAUTION

- **Do not attempt to adjust the gap of the iridium plug.**
- **Cleaning of the iridium plug may result in damage to the iridium and platinum 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: 0.95 mm (0.037 inch)

CAMSHAFT POSITION SENSOR CHECK

M1163004400402

Refer to GROUP 13A, Multiport Fuel Injection (MFI) – Multiport Fuel Injection (MFI) Diagnosis – Diagnostic Trouble Code Procedures – DTC P0340 : Camshaft Position Sensor Circuit P.13A-501.

CRANKSHAFT POSITION SENSOR CHECK

M1163004500465

Refer to GROUP 13A, Multiport Fuel Injection (MFI) – Multiport Fuel Injection (MFI) Diagnosis – Diagnostic Trouble Code Procedures – DTC P0335 : Crankshaft Position Sensor Circuit P.13A-483.

IGNITION SECONDARY VOLTAGE WAVE PATTERN CHECK USING AN OSCILLOSCOPE

M1163001700277

MEASUREMENT METHOD

1. Clamp the spark plug cable (Number 1, 3 or 5) 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, 3 or 5) with the spark plug cable which has been clamped by the secondary pickup.

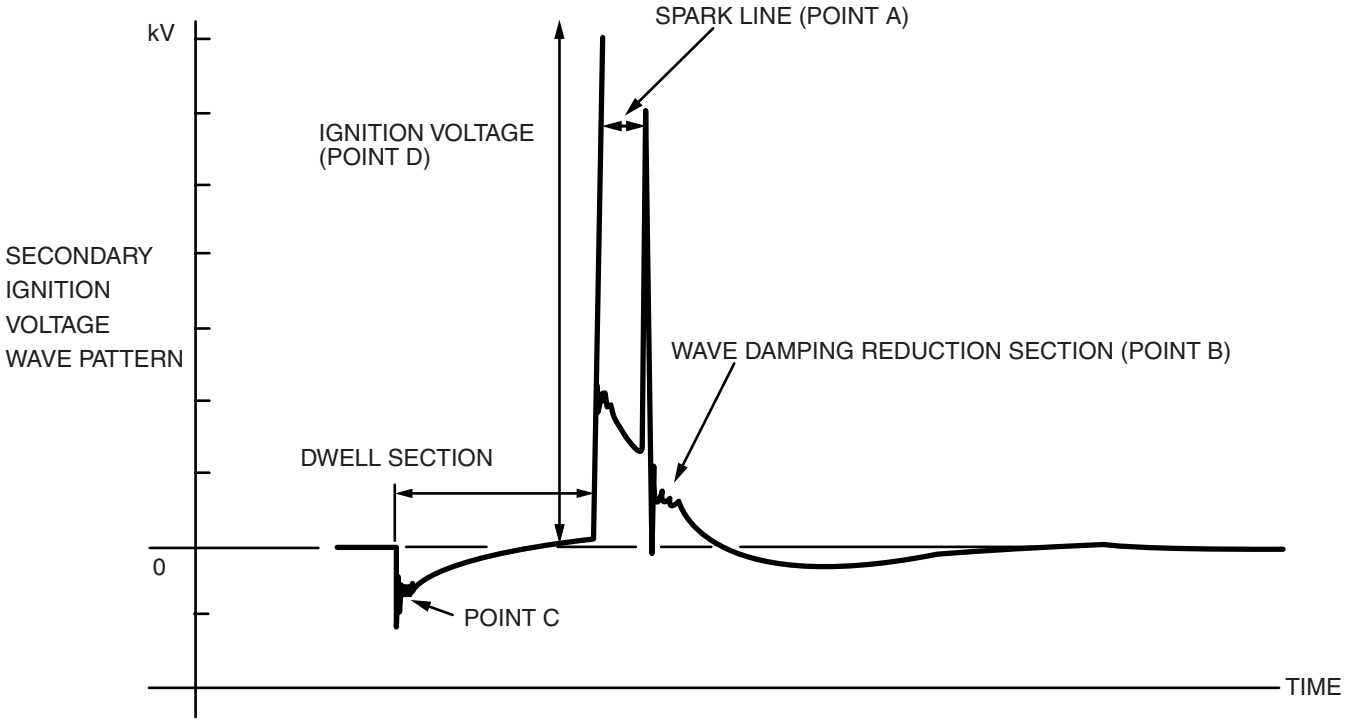
   NOTE: Identification of which cylinder wave pattern is displayed can be difficult, but the wave pattern of the cylinder which is clamped by the secondary pickup will be stable, so this can be used as a reference for identification.

2. Clamp the spark plug cable (Number 1, 3 or 5) with the trigger pickup.

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

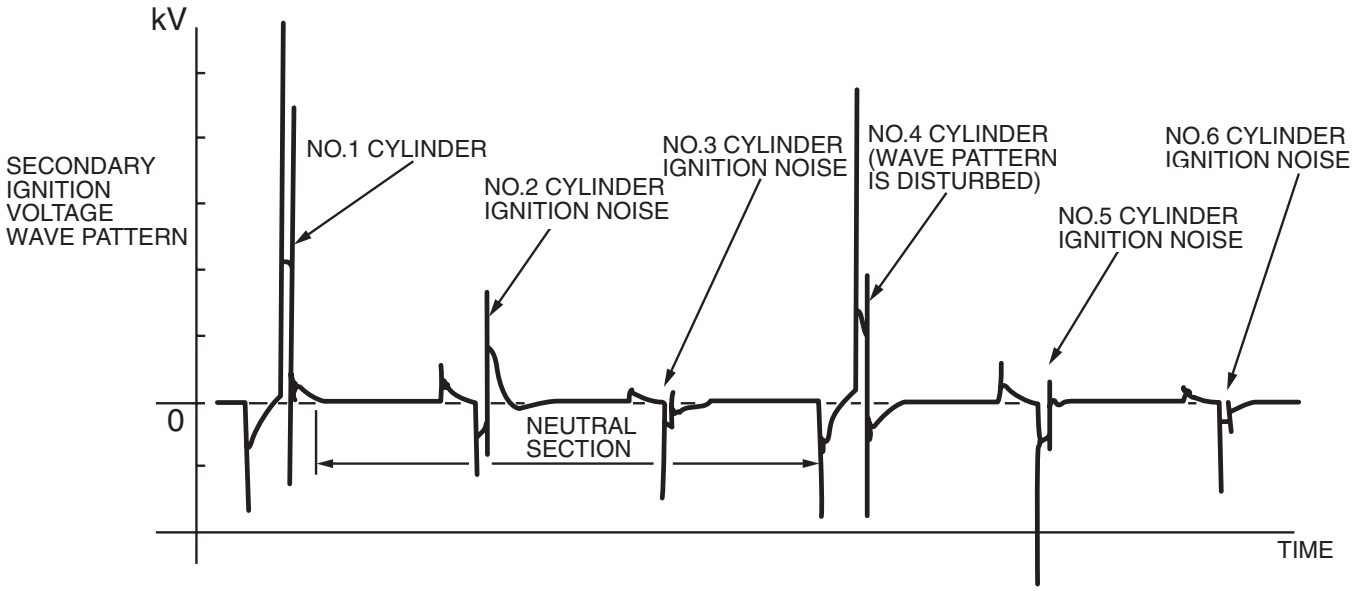
STANDARD WAVEPATTERN

Observation Conditions	
FUNCTION	**SECONDARY**
Pattern height	High (or low)
Pattern selector	Raster
Engine revolutions	Curb idle speed



AKX00278AB

Observation Conditions (Only pattern selector below changes from the above conditions.)	
Pattern selector	Display



AKX00279 AB

WAVEFORM OBSERVATION POINTS

Point A:

The height, length and slope of the spark line (refer to abnormal waveform examples 1, 2, 3 and 4) show the following trends.

SPARK LINE		PLUG GAP	STATUS OF ELECTRODES	COMPRESSION FORCE	CONCENTRATION OF AIR MIXTURE	IGNITION TIMING	SPARK PLUG CABLE
Length	Long	Small	Normal	Low	Rich	Advanced	Leak
Length	Short	Large	Large wear	High	Lean	Retarded	High resistance
Height	High	Large	Large wear	High	Lean	Retarded	High resistance
Height	Low	Small	Normal	Low	Rich	Advanced	Leak
Slope		Large	Plug is fouled	–	–	–	–

Point B:

Number of vibrations in reduction vibration section (Refer to Abnormal Waveform Example 5)

NUMBER OF VIBRATIONS	COIL AND CAPACITOR
Three or more	Normal
Except above	Abnormal

Point C:

Number of vibrations at beginning of dwell section (Refer to Abnormal Waveform Example 5)

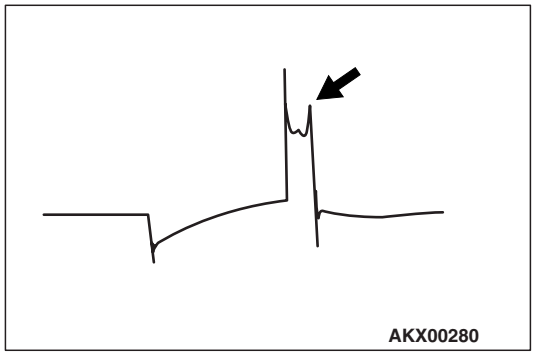
NUMBER OF VIBRATIONS	COIL
5 – 6 or higher	Normal
Except above	Abnormal

Point D:

Ignition voltage height (distribution per each cylinder) shows the following trends.

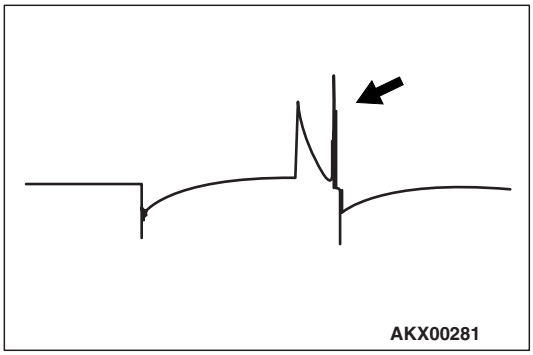
IGNITION VOLTAGE	PLUG GAP	CONDITION OF ELECTRODE	COMPRESSION FORCE	CONCENTRATION OF AIR MIXTURE	IGNITION TIMING	SPARK PLUG CABLE
High	Large	Large wear	High	Lean	Retarded	High resistance
Low	Small	Normal	Low	Rich	Advanced	Leak

ABNORMAL WAVEFORMS EXAMPLES



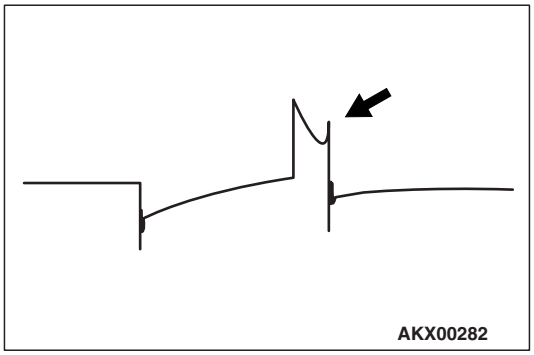
Example 1

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



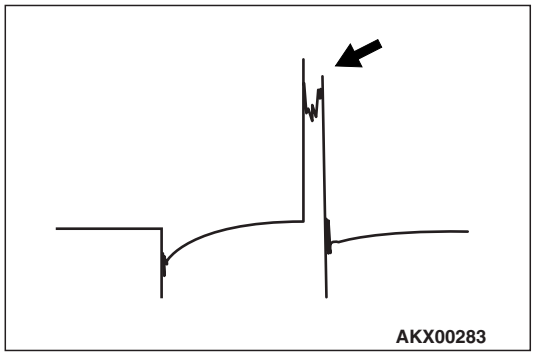
Example 2

- 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.



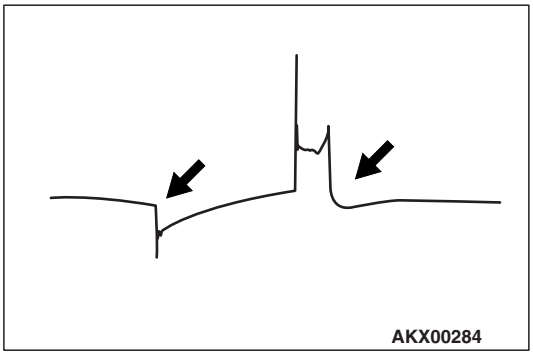
Example 3

- 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
  Layer short in ignition coil.

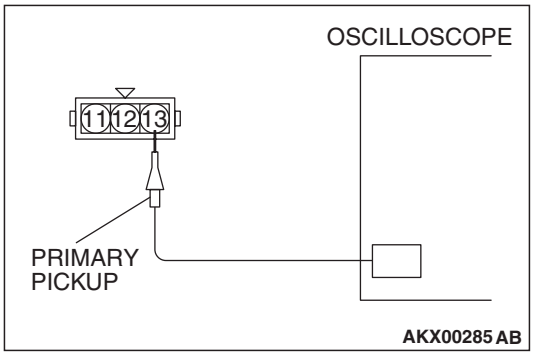
IGNITION PRIMARY VOLTAGE WAVE PATTERN CHECK USING AN OSCILLOSCOPE

M1163004600116

MEASUREMENT METHOD

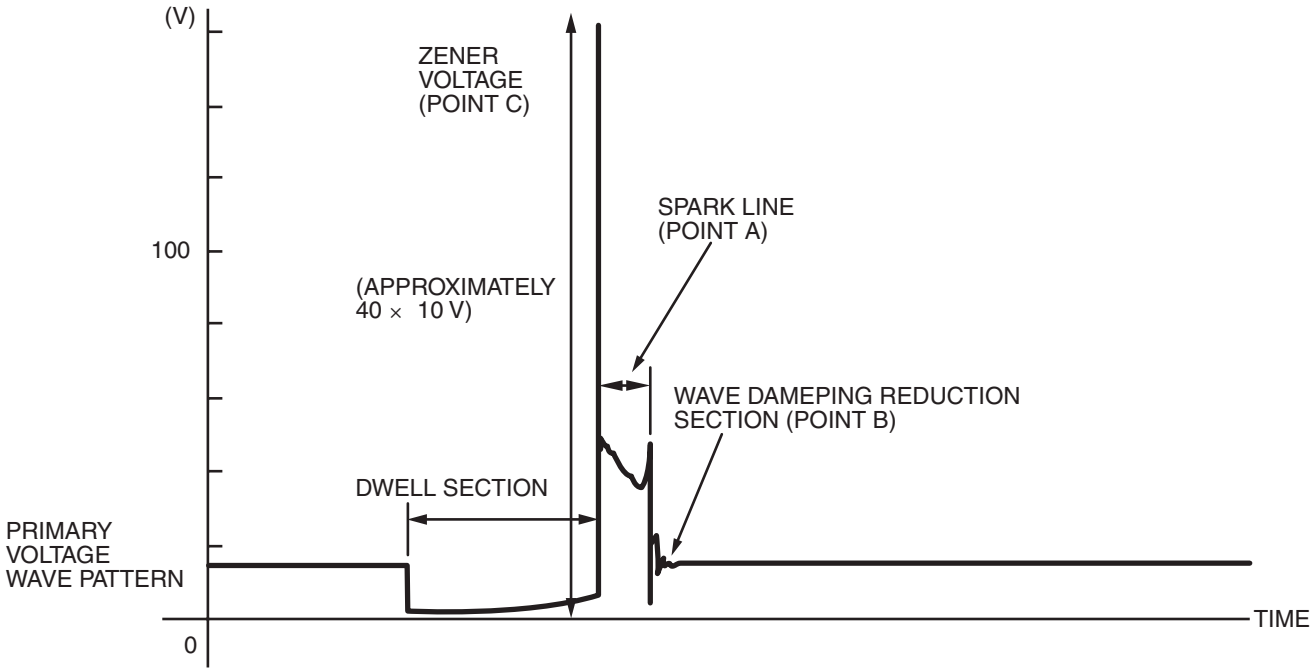
Required Special Tool:
MB991348: Test Harness Set

1. Disconnect the ignition power transistor connector and connect the test harness set of the special tool (MB991348) in between. All terminals should be connected.
2. When observing the number 1 – 4 cylinder group, connect the primary pickup of the oscilloscope probe to ignition power transistor side connector terminal (13).
   For the number 2 – 5 cylinder group, connect to terminal (12) and for the number 3 – 6 cylinder group, connect to terminal (11).
3. Ground the primary pickup ground terminal.
4. Clamp the spark plug cable with the trigger pickup.
   NOTE: Clamp the spark plug cable of cylinder number 1, 3 or 5 which belongs to the same group as the cylinder to which the primary pickup is connected.
   NOTE: The wave pattern of any cylinder in the same group appears from the left side of the screen.



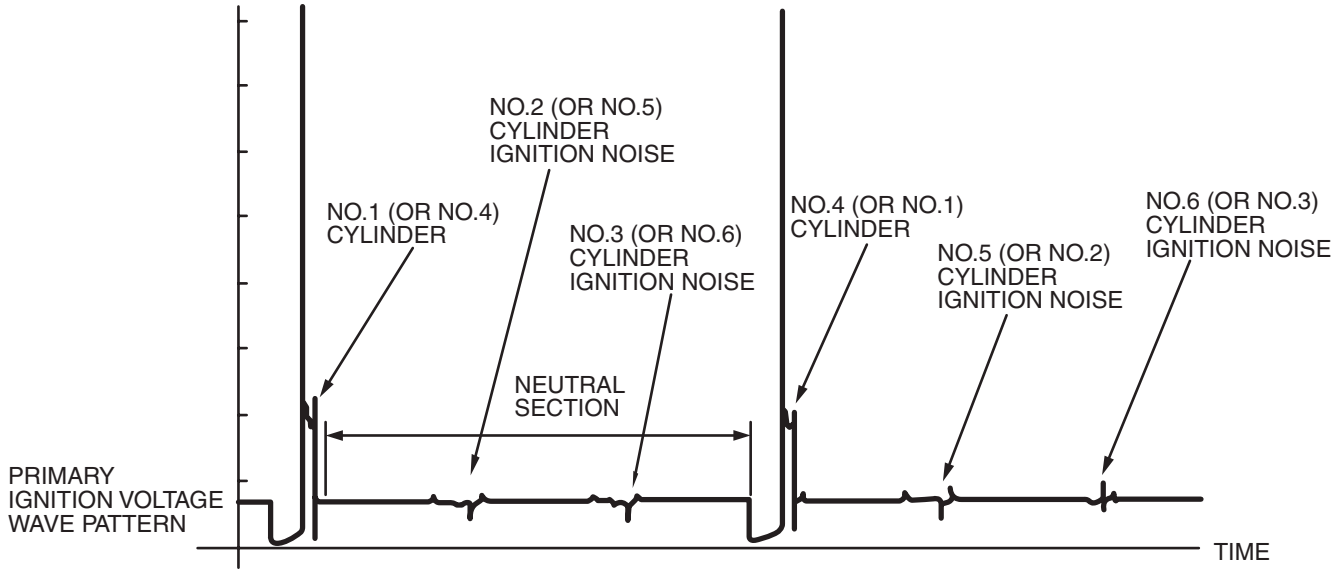
STANDARD WAVE PATTERN

Observation conditions	
FUNCTION	**SECONDARY**
Pattern height	High (or low)
Pattern selector	Raster
Engine speed	Curb idle speed



AKX00286AB

Observation conditions (Only pattern selector below changes from the above conditions.)	
Pattern selector	Display



AKX00287AB

WAVEFORM OBSERVATION POINTS

Point A:

The height, length and slope of the spark line (refer to abnormal waveform examples 1, 2, 3 and 4) show the following trends.

SPARK LINE		PLUG GAP	CONDITION OF ELECTRODE	COMPRESSION FORCE	CONCENTRATION OF AIR MIXTURE	IGNITION TIMING	SPARK PLUG CABLE
Length	Long	Small	Normal	Low	Rich	Advanced	Leak
Length	Short	Large	Large wear	High	Lean	Retarded	High resistance
Height	High	Large	Large wear	High	Lean	Retarded	High resistance
Height	Low	Small	Normal	Low	Rich	Advanced	Leak
Slope		Large	Plug is fouled	–	–	–	–

Point B:

Number of vibration in reduction vibration section (Refer to Abnormal Waveform Example 5)

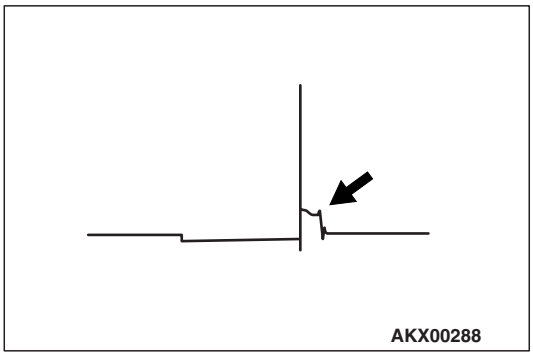
NUMBER OF VIBRATIONS	COIL, CAPACITOR
3 or higher	Except above
Normal	Abnormal

Point C:

Height of Zener voltage

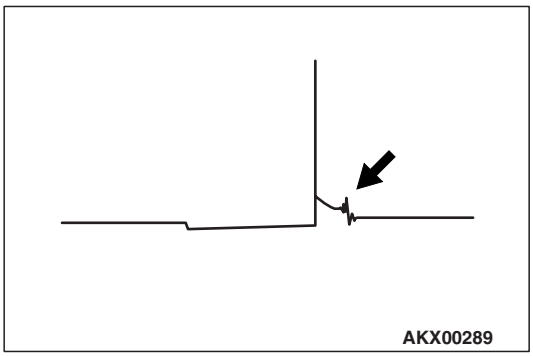
HEIGHT OF ZENER VOLTAGE	PROBABLE CAUSE
High	Problem in zener diode
Low	Abnormal resistance in primary coil circuit

ABNORMAL WAVEFORMS EXAMPLES



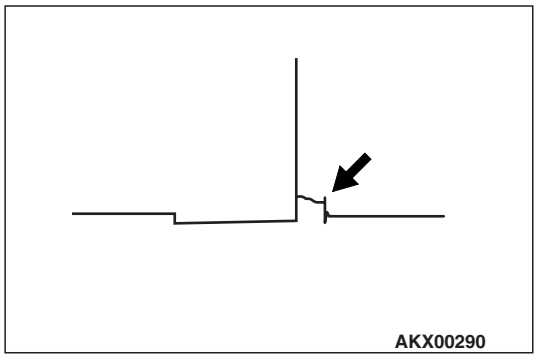
Example 1

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



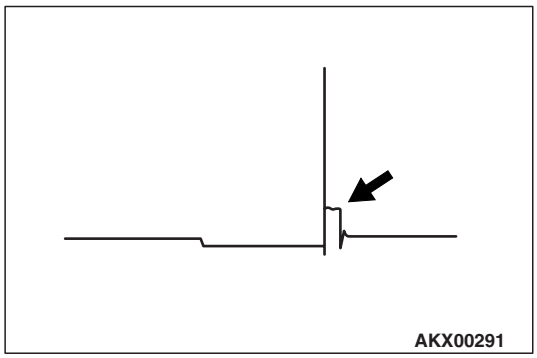
Example 2

- 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.



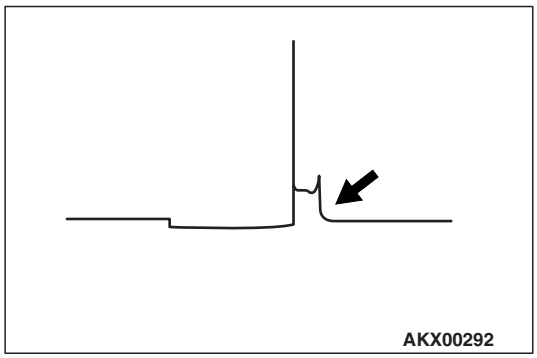
Example 3

- 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
- Cause of problem
  Spark plug cable is not properly connected. (Causing a dual ignition)



Example 5

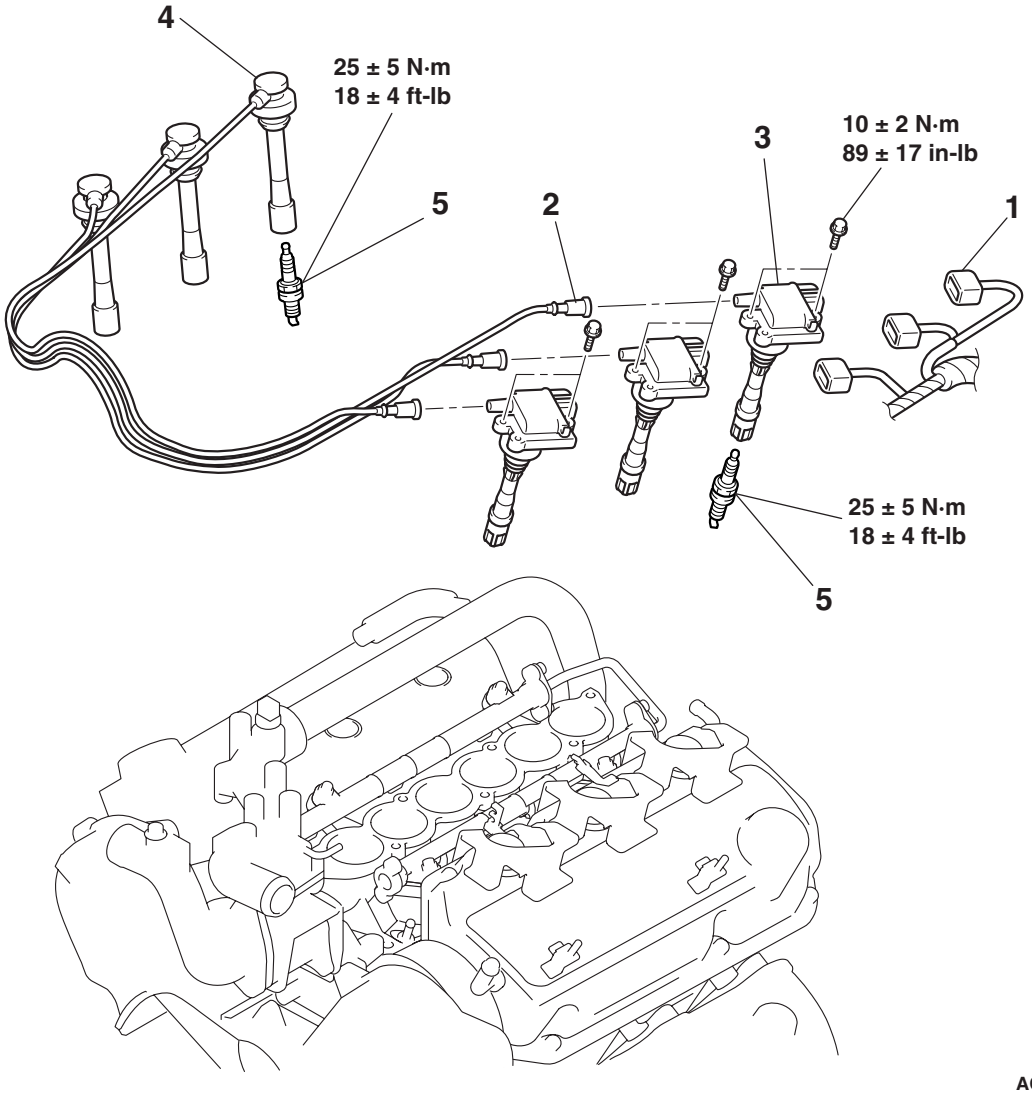
- Wave characteristics
  No waves in wave damping section
- Cause of problem
  Layer short in ignition coil.

IGNITION COIL

REMOVAL AND INSTALLATION

M1163004000686

Pre-removal and Post-installation Operation
- Air Cleaner Removal and Installation (Refer to GROUP 15, Air Cleaner P.15-6.)



AC204093AB

REMOVAL STEPS
1. IGNITION COIL CONNECTOR
2. SPARK PLUG CABLE CONNECTION
3. IGNITION COIL ASSEMBLY

REMOVAL STEPS (Continued)
- INTAKE MANIFOLD PLENUM (REFER TO GROUP 15, INTAKE MANIFOLD P.15-7.)
4. SPARK PLUG CABLE
5. SPARK PLUG

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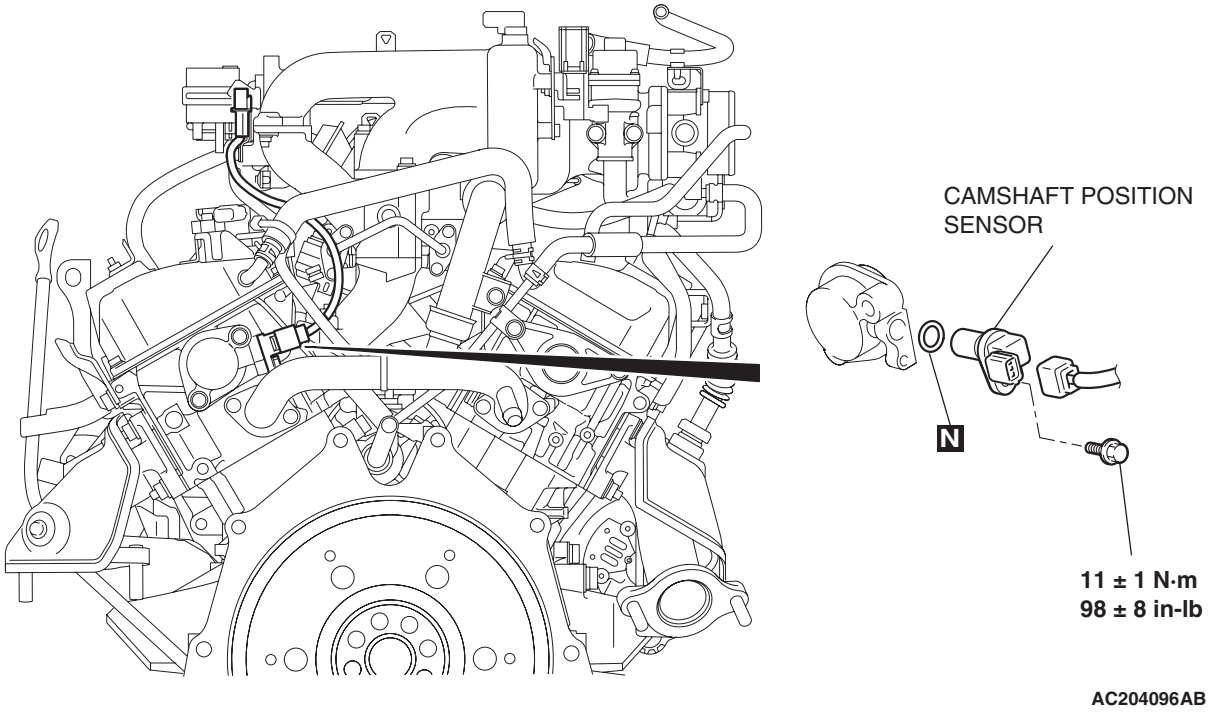
CAMSHAFT POSITION SENSOR

REMOVAL AND INSTALLATION

M1163003400346



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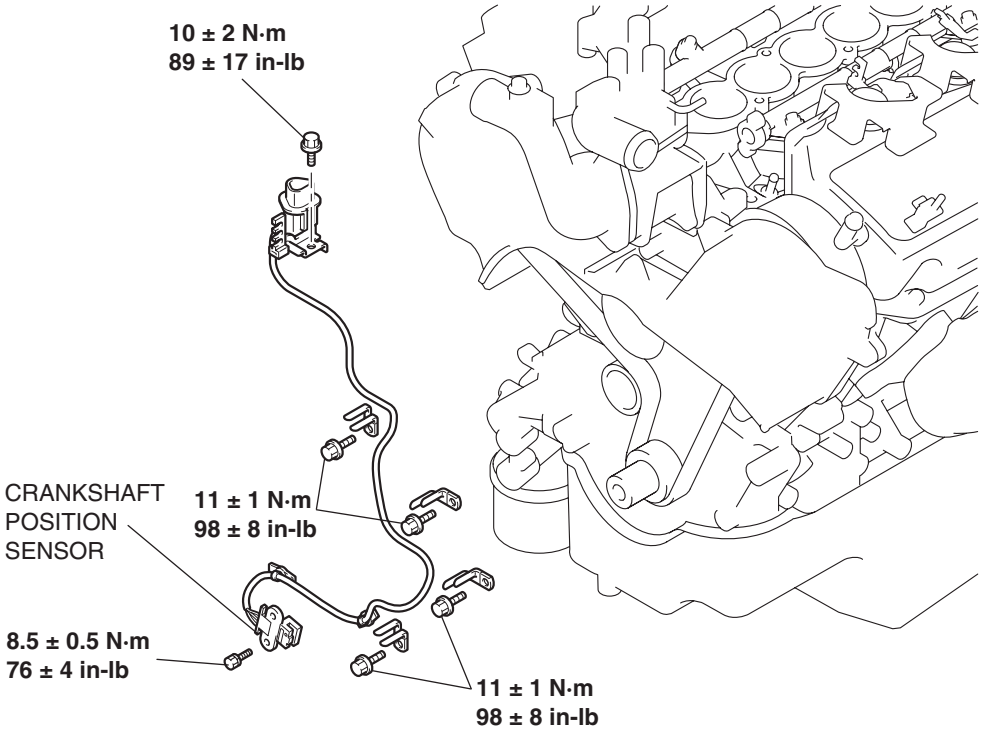
CRANKSHAFT POSITION SENSOR

REMOVAL AND INSTALLATION

M1163003500729

Pre-removal and Post-installation Operation
- Timing Belt Lower Cover Removal and Installation (Refer to GROUP 11A, Timing Belt P.11A-35.)



AC204073 AC

KNOCK SENSOR

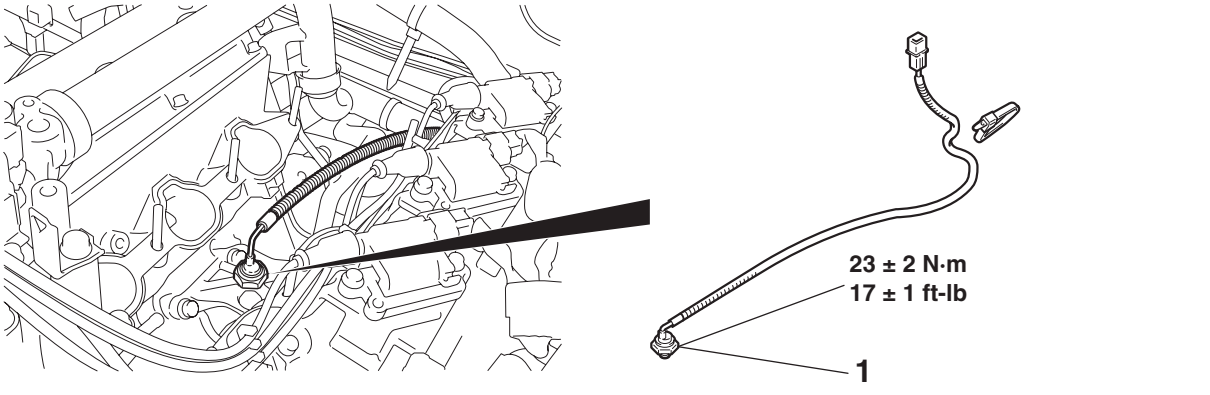
REMOVAL AND INSTALLATION

M1163002801151

⚠ CAUTION

When the knock sensor replacement is performed, use scan tool MB991958 to initialize the learning value (Refer to GROUP 00, Initialization Procedure for Learning Value in MFI Engine P.00-23).

Pre-removal and Post-installation Operation
- Intake Manifold Removal and Installation (Refer to GROUP 15, Intake Manifold P.15-7.)



AC204095 AB

REMOVAL

<<**A**>> >>**A**<< 1. KNOCK SENSOR

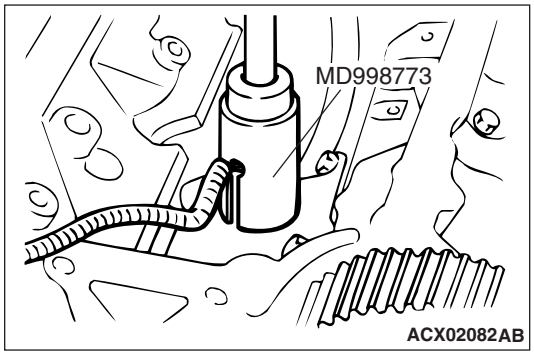
Required Special Tool:

MD998773: Knock Sensor Wrench

REMOVAL SERVICE POINT

<<A>> KNOCK SENSOR REMOVAL

Use special tool MD998773 to remove the knock sensor.



ACX02082AB

INSTALLATION SERVICE POINT

>>A<< KNOCK SENSOR INSTALLATION

Use special tool MD998773 to install the knock sensor.

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SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

M1161002100584

ITEM	SPECIFICATION
Charging system	
Generator bolt	23 ± 3 N·m (17 ± 2 ft-lb)
Generator bolt	49 ± 5 N·m (36 ± 4 ft-lb)
Generator harness terminal bolt	14 ± 3 N·m (124 ± 26 in-lb)
Starting system	
Starter bolt	31 ± 3 N·m (23 ± 2 ft-lb)
Starter harness terminal bolt	11 ± 1 N·m (98 ± 8 in-lb)
Ignition system	
Camshaft position sensor bolt	11 ± 1 N·m (98 ± 8 in-lb)
Crankshaft position sensor bolt	8.5 ± 0.5 N·m (76 ± 4 in-lb)
Crankshaft position sensor connector bolt	10 ± 2 N·m (89 ± 17 in-lb)
Crankshaft position sensor harness clamp bolt	11 ± 1 N·m (98 ± 8 in-lb)
Ignition coil bolt	10 ± 2 N·m (89 ± 17 in-lb)
Knock sensor	23 ± 2 N·m (17 ± 1 ft-lb)
Spark plug	25 ± 5 N·m (18 ± 4 ft-lb)

GENERAL SPECIFICATIONS

M1161000200392

ITEMS	SPECIFICATIONS
Generator	
Type	Positive battery positive voltage sensing
Identification number	A3TG2291
Part No.	MN163999
Rated output V/A	12/110
Voltage regulator	Electronic built-in type
Starter motor	
Type	Reduction drive with planetary gear
Identification number	M0T20472
Part No.	MN176584
Rated output kW/V	1.3/12
No. of pinion teeth	8
Ignition coil	
Type	Molded 3 coil
Spark plugs	
NGK	IFR6S
DENSO	SK20PR-A8

SERVICE SPECIFICATIONS

M1161000300504

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 – 14.6	–
	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)		–	2 (0.08)
Starter motor			
Free running characteristics	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)	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 coil resistance at 20°C (68°F9) Ω		8.5 – 11.5	–
Spark plug gap mm (in)		0.7 –0.8 (0.028 – 0.031)	0.95 (0.037)
Resistor wire resistance kΩ		–	Maximum 19

NOTES