GROUP 16

ENGINE ELECTRICAL

CONTENTS

Continued on next page

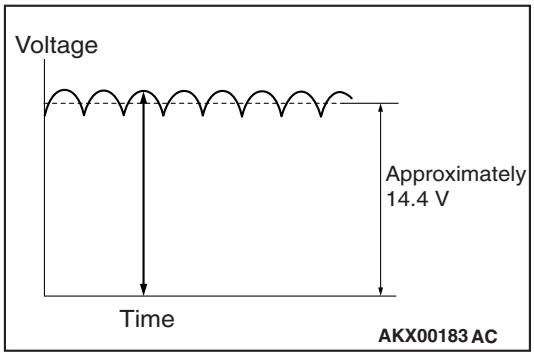
CHARGING SYSTEM

GENERAL INFORMATION

M1161000100566

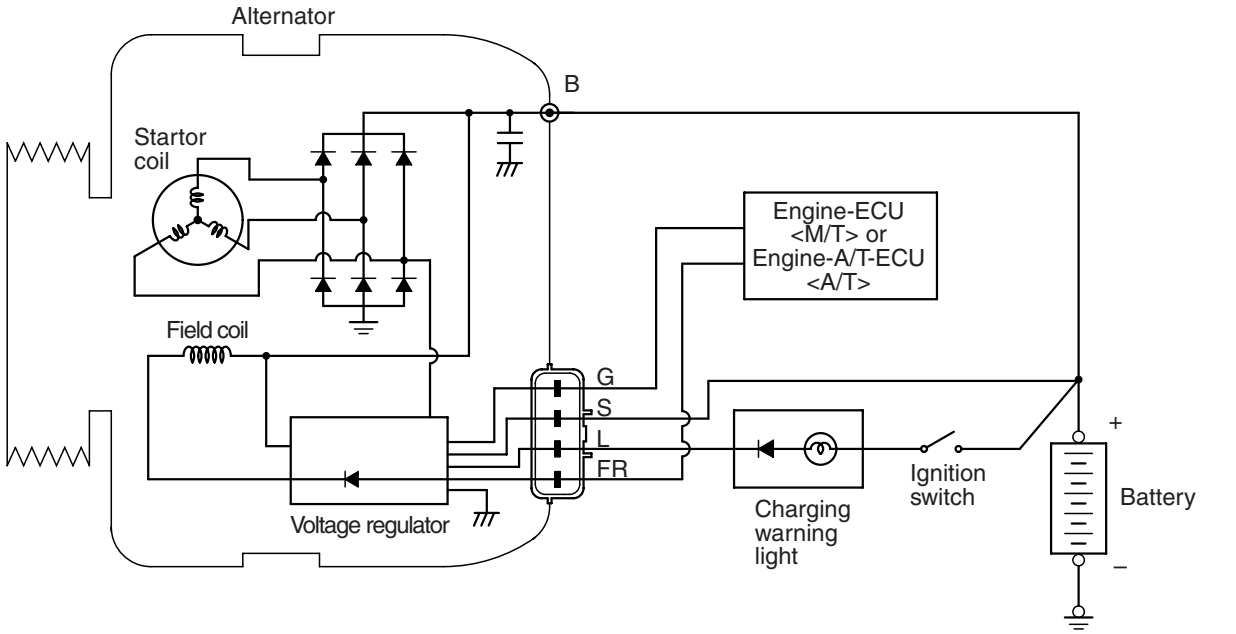
The charging system uses the alternator output to keep the battery charged at a constant level under various electrical loads.

OPERATION



Rotation of the excited field coil generates AC voltage in the stator.
This alternating current is rectified through diodes to DC voltage having a waveform shown in the illustration.
The average output voltage fluctuates slightly with the alternator 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 alternator output voltage rises as the field current increases and it falls as the field current decreases. When the battery voltage (alternator "S" terminal voltage) reaches a regulated voltage of approximately 14.4 V, the field current is cut off.
When the battery voltage drops below the regulated voltage, the voltage regulator regulates the output voltage to a constant level by controlling the field current.
In addition, when the field current is constant, the alternator output voltage rises as the engine speed increases.

SYSTEM DIAGRAM



ALTERNATOR SPECIFICATIONS

Item	Specifications
Type	Battery voltage sensing
Rated output V/A	12/110
Voltage regulator	Electronic built-in type

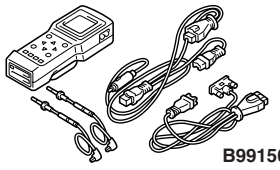
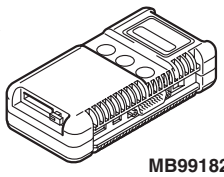
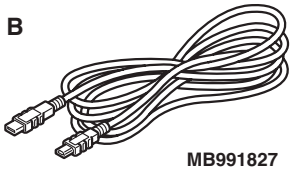
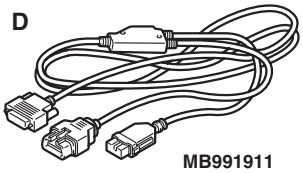
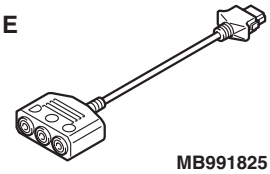
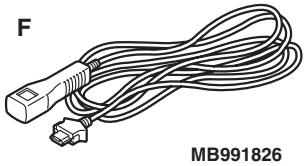
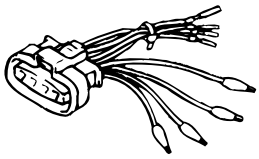
SERVICE SPECIFICATIONS

M1161000300377

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

SPECIAL TOOLS

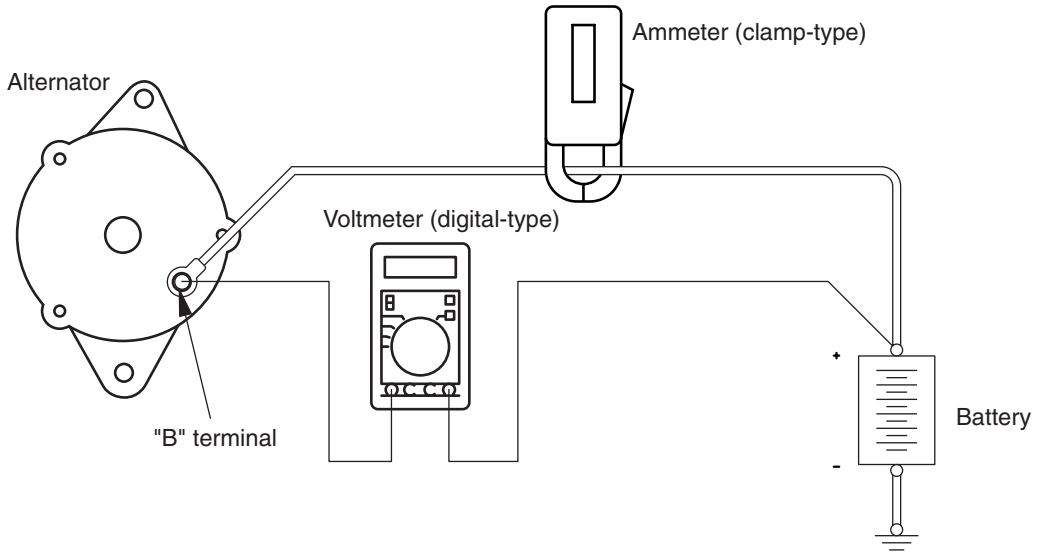
M1161000600301

Tool	Number	Name	Use
 B991502	MB991502	M.U.T.-II sub assembly	Checking the idle speed
A  MB991824 B  MB991827 C  DO NOT USE MB991910 D  MB991911 E  MB991825 F  MB991826 MB991955	MB991955 A: MB991824 B: MB991827 C: MB991910 D: MB991911 E: MB991825 F: MB991826	M.U.T.-III sub assembly A: Vehicle communication interface (V.C.I.) B: M.U.T.-III USB cable C: M.U.T.-III main harness A (Vehicles with CAN communication system) D: M.U.T.-III main harness B (Vehicles without CAN communication system) E: M.U.T.-III measurement adapter F: M.U.T.-III trigger harness	Checking the idle speed
	MB991519	Alternator test harness	Checking the alternator ("S" terminal voltage)

ON-VEHICLE SERVICE

ALTERNATOR OUTPUT LINE VOLTAGE DROP TEST

M1161000900573



AK203361AD

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

1. Always be sure to check the following before the test.
   - Alternator installation
   - Drive belt tension

   (Refer to P.11A-7, GROUP 11A – On-Vehicle Service.) <4G63 Non-turbo>
   (Refer to P.11C-7, GROUP 11C – On-Vehicle Service.) <4G63 Turbo>
   (Refer to P.11E-7, GROUP 11E – On-Vehicle Service.) <4G69>
   - Fusible link
   - Abnormal noise from the alternator while the engine is running
2. Turn the ignition switch to the "LOCK" (OFF) position.
3. Disconnect the negative battery cable.
4. Connect a clamp-type DC test ammeter with a range of 0 – 150 A to the alternator "B" terminal output wire.

   NOTE: The way of disconnecting the alternator output wire and of connecting the ammeter is possibly not found the problem that the output current is dropping due to the insufficient connection between terminal "B" and the output wire.
5. Connect a digital-type voltmeter between the alternator "B" terminal and the battery (+) terminal. [Connect the (+) lead of the voltmeter to the "B" terminal and the connect the (-) lead of the voltmeter to the battery (+) cable].
6. Reconnect the negative battery cable.
7. Connect the M.U.T.-II/III
8. Leave the hood open.
9. Start the engine.
10. With the engine running at 2,500 r/min, turn the headlamps and other lamps on and off to adjust the alternator load so that the value displayed on the ammeter is slightly above 30 A.

    Adjust the engine speed by gradually decreasing it until the value displayed on the ammeter is 30 A. Take a reading of the value displayed on the voltmeter at this time.

    Limit: maximum 0.3 V

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

11.If the value displayed on the voltmeter is above the limit value, there is probably a malfunction in the alternator output wire, so check the wiring between the alternator "B" terminal and the 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 lamps.

14.Turn the ignition switch to the "LOCK" (OFF) position.

15.Remove the M.U.T.-II/III.

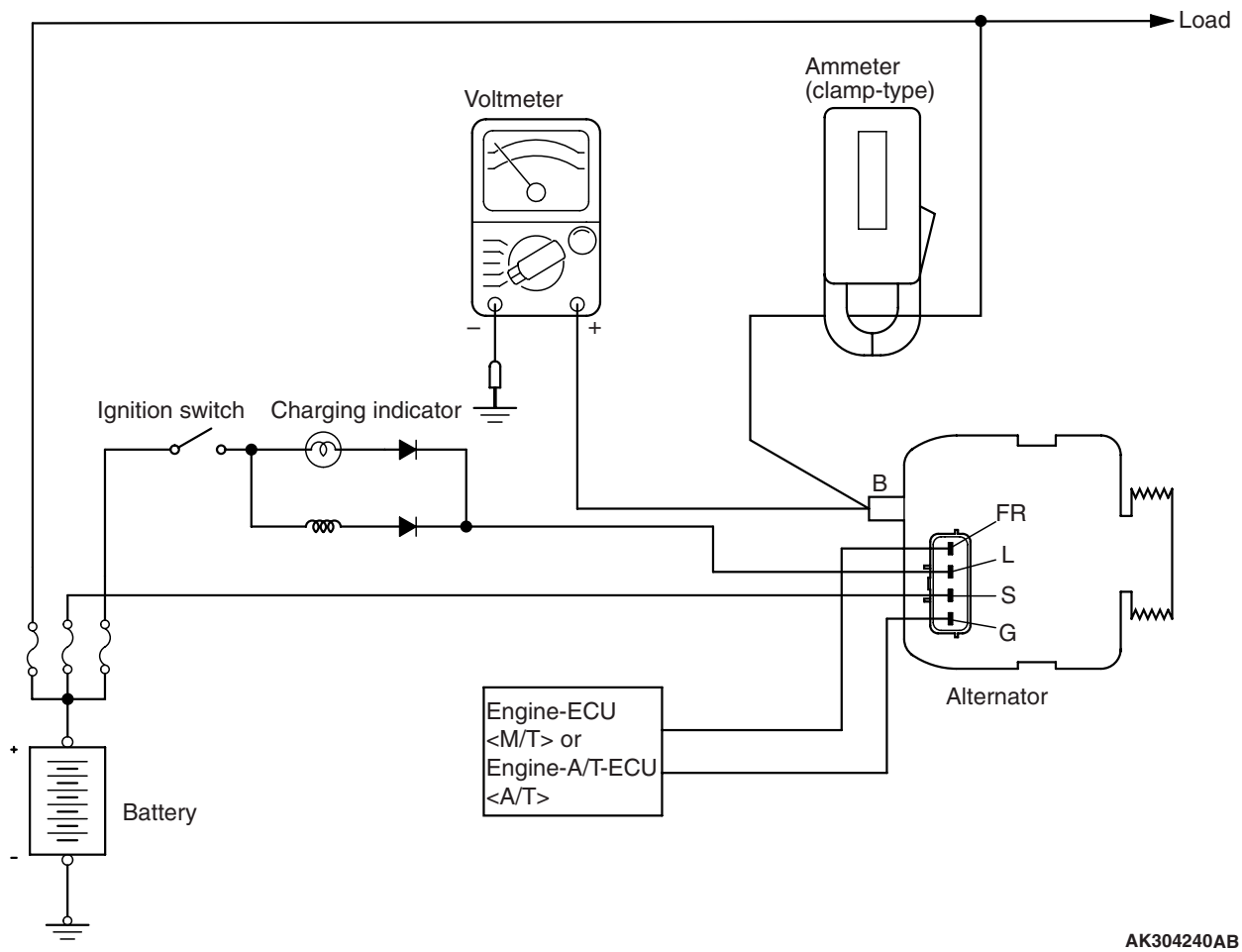
16.Disconnect the negative battery cable.

17.Disconnect the ammeter and voltmeter.

18.Connect the negative battery cable.

OUTPUT CURRENT TEST

M1161001000595



AK304240AB

This test determines whether the alternator output current is normal.

1. Before the test, always be sure to check the following.
   - Alternator installation
   - Battery (Refer to P.54A-7, GROUP 54A – Battery – On-Vehicle Service.)

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

   - Drive belt tension

(Refer to P.11A-7, GROUP 11A – On-Vehicle Service.) <4G63 Non-turbo>
(Refer to P.11C-7, GROUP 11C – On-Vehicle Service.) <4G63 Turbo>
(Refer to P.11E-7, GROUP 11E – On-Vehicle Service.) <4G69>

   - Fusible link
   - Abnormal noise from the alternator while the engine is running.

2. Turn the ignition switch to the "LOCK" (OFF) position.
3. Disconnect the negative battery cable.

⚠ CAUTION

Never use clips but tighten bolts and nuts to connect the line. Otherwise loose connections (e.g. using clips) will lead to a serious accident because of high current.

4. Connect a clamp-type DC test ammeter with a range of 0 – 150 A to the alternator "B" terminal output wire.

   NOTE: The way of disconnecting the alternator output wire and of connecting the ammeter is possibly not found the problem that the output current is dropping due to the insufficient connection between terminal "B" and the output wire.
5. Connect a voltmeter with a range of 0 – 20 V between the alternator "B" terminal and the earth [Connect the (+) lead of the voltmeter to the "B" terminal, and then connect the (-) lead of the voltmeter to the earth].
6. Connect the negative battery cable.
7. Connect the M.U.T.-II/III
8. Leave the hood open.
9. Check that the reading on the voltmeter is equal to the battery voltage.

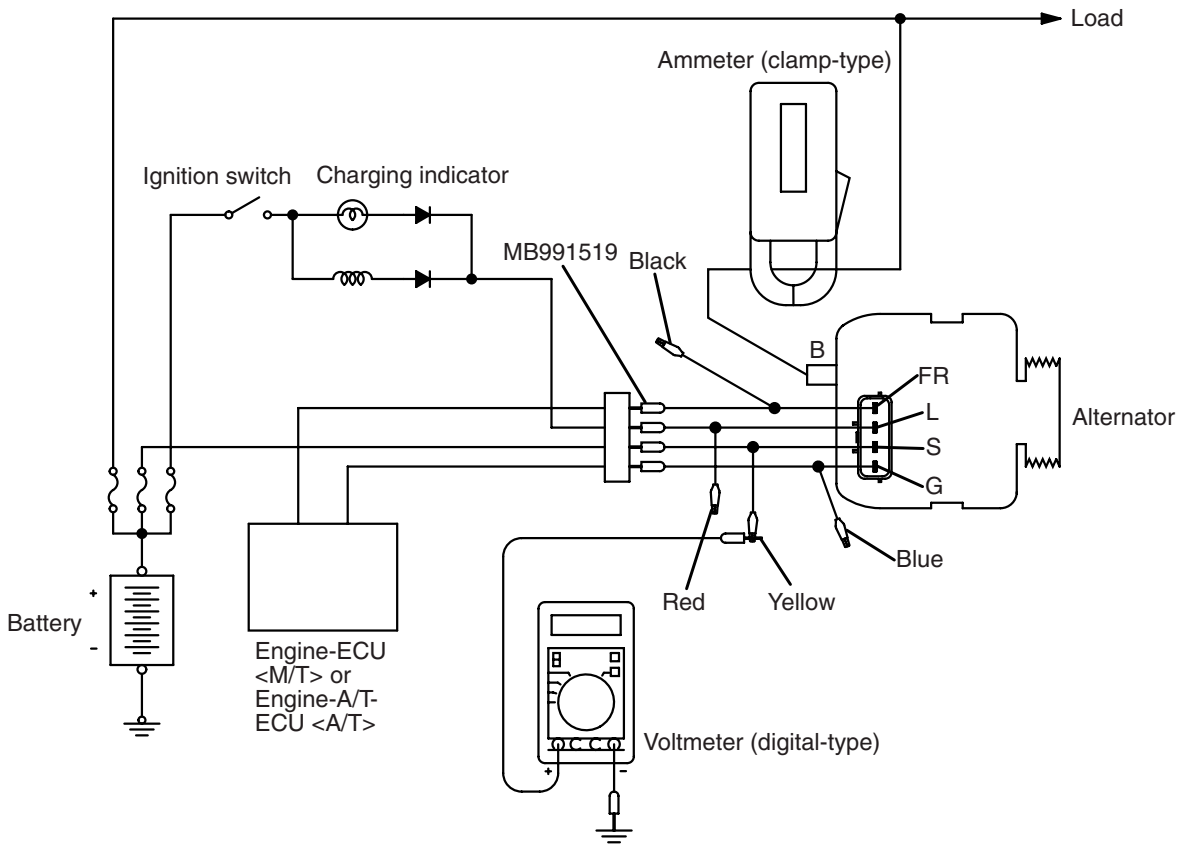
   NOTE: If the voltage is 0 V, the cause is probably an open circuit in the wire or fusible link between the alternator "B" terminal and the battery (+) terminal.
10. Turn the light switch on to turn on headlamps and then start the engine.
11. Immediately after setting the headlamps to high beam and turning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

    Limit: 70 % of normal current output

    NOTE:
    - *For the nominal current output, refer to the Alternator Specifications.*
    - *Because the current from the battery will soon drop after the engine is started, the above step should be carried out as quickly as possible in order to obtain the maximum current output value.*
    - *The current output value will depend on the electrical load and the temperature of the alternator body.*
    - *If the electrical load is small while testing, the specified level of current may not be output even though the alternator is normal. In such cases, increase the electrical load by leaving the headlamps turned on for some time to discharge the battery or by using the lighting system in another vehicle, and then test again.*
    - *The specified level of current also may not be output if the temperature of the alternator body or the ambient temperature is too high. In such cases, cool the alternator 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 alternator output wire is normal, remove the alternator from the engine and check the alternator.
13. Run the engine at idle after the test.
14. Turn the ignition switch to the "LOCK" (OFF) position.
15. Remove the M.U.T.-II/III.
16. Disconnect the negative battery cable.
17. Disconnect the ammeter and voltmeter.
18. Connect the negative battery cable.

REGULATED VOLTAGE TEST

M1161001100581



AK304241 AB

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

1. Always be sure to check the following before the test.
   - Alternator installation
   - Check that the battery installed in the vehicle is fully charged.

(Refer to P.54A-5, GROUP 54A – Battery – On-Vehicle Service.)

   - Drive belt tension

(Refer to P.11A-7, GROUP 11A – On-Vehicle Service.)<4G63 Non-turbo>
(Refer to P.11C-7, GROUP 11C – On-Vehicle Service.)<4G63 Turbo>
(Refer to P.11E-7, GROUP 11E – On-Vehicle Service.)<4G69>

   - Fusible link
   - Abnormal noise from the alternator 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 Alternator test harness (MB991519) to connect a digital voltmeter between the alternator "S" terminal and earth [Connect the (+) lead of the voltmeter to the "S" terminal, and then connect the (-) lead of the voltmeter to a secure earth or to the battery (-) terminal].
5. Connect a clamp-type DC test ammeter with a range of 0 – 150 A to the alternator "B" terminal output wire.

   NOTE: The way of disconnecting the alternator output wire and of connecting the ammeter is possibly not found the problem that the output current is dropping due to the insufficient connection between terminal "B" and the output wire.
6. Reconnect the negative battery cable.
7. Connect the M.U.T.-II/III
8. Turn the ignition switch to the "ON" position and check that the reading on the voltmeter is equal to the battery voltage.

   NOTE: If the voltage is 0 V, the cause is probably an open circuit in the wire or fusible link between the alternator "S" terminal and the battery (+) terminal.
9. Turn all lamps and accessories off.

10.Start the engine.
11.Increase the engine speed to 2,500 r/min.
12.Read the value displayed on the voltmeter when the alternator output current alternator becomes 10 A or less.
13.If the voltage reading conforms to the value in the voltage regulation, then the voltage regulator is operating normally.

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

14.After the test, lower the engine speed to the idle speed.
15.Turn the ignition switch to the "LOCK" (OFF) position.
16.Remove the M.U.T.-II/III.
17.Disconnect the negative battery cable.
18.Disconnect the ammeter and voltmeter.
19.Connect the alternator output wire to the alternator "B" terminal.
20.Remove the special tool, and return the connector to the original condition.
21.Connect the negative battery cable.

Voltage Regulation Table

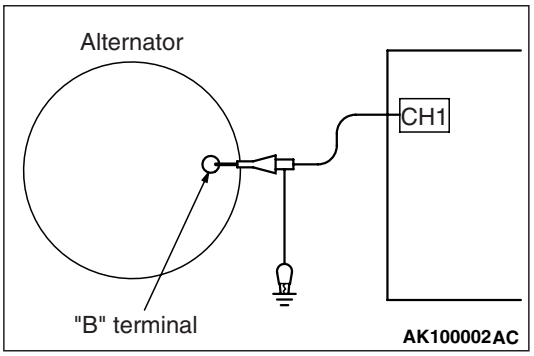
Standard value:

Inspection terminal	**Voltage regulator ambient temperature °C**	**Voltage V**
Terminal "S"	−20	14.2 – 15.4
	20	13.9 – 14.9
	60	13.4 – 14.6
	80	13.1 – 14.5

WAVEFORM CHECK USING AN OSCILLOSCOPE

M1161001200179

MEASUREMENT METHOD

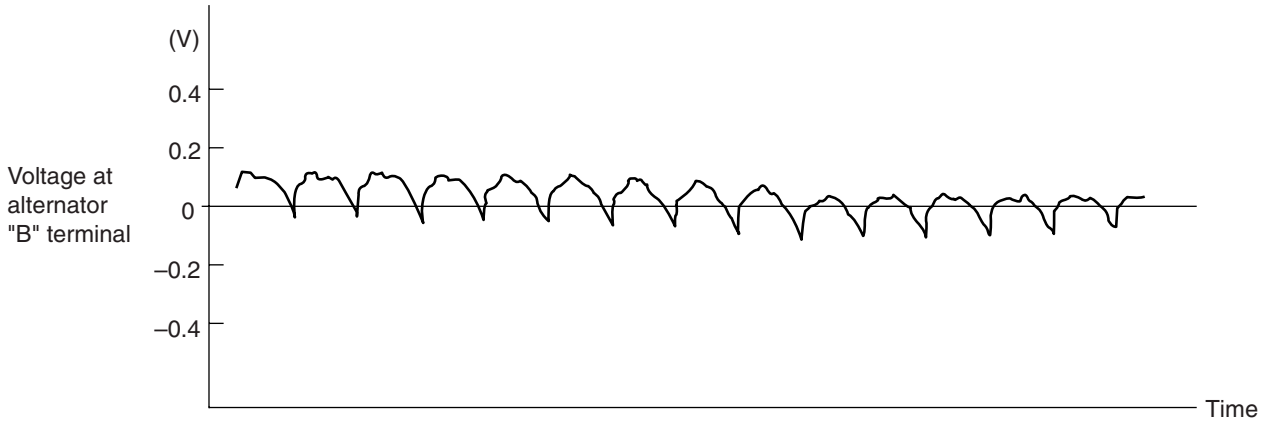


Connect the oscilloscope special patterns pick-up to the alternator "B" terminal.

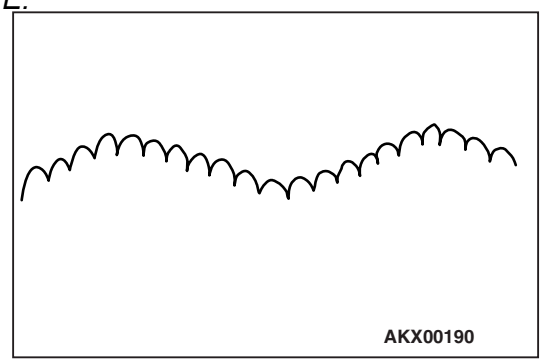
STANDARD WAVEFORM

Observation Conditions

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



NOTE:

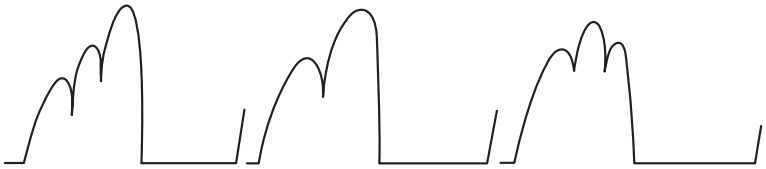
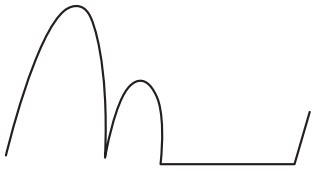
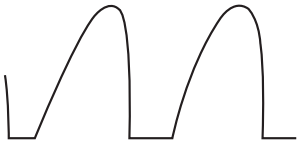


The voltage waveform of the alternator "B" terminal can undulate as shown in the illustration. This waveform is produced when the regulator operates according to fluctuations in the alternator load (current), and is normal for the alternator. In addition, when the voltage waveform reaches an excessively high value (approximately 2 V or higher at idle), it often indicates an open circuit due to a brown fuse between alternator "B" terminal and battery, but not a defective alternator.

EXAMPLE OF ABNORMAL WAVEFORMS

NOTE:

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

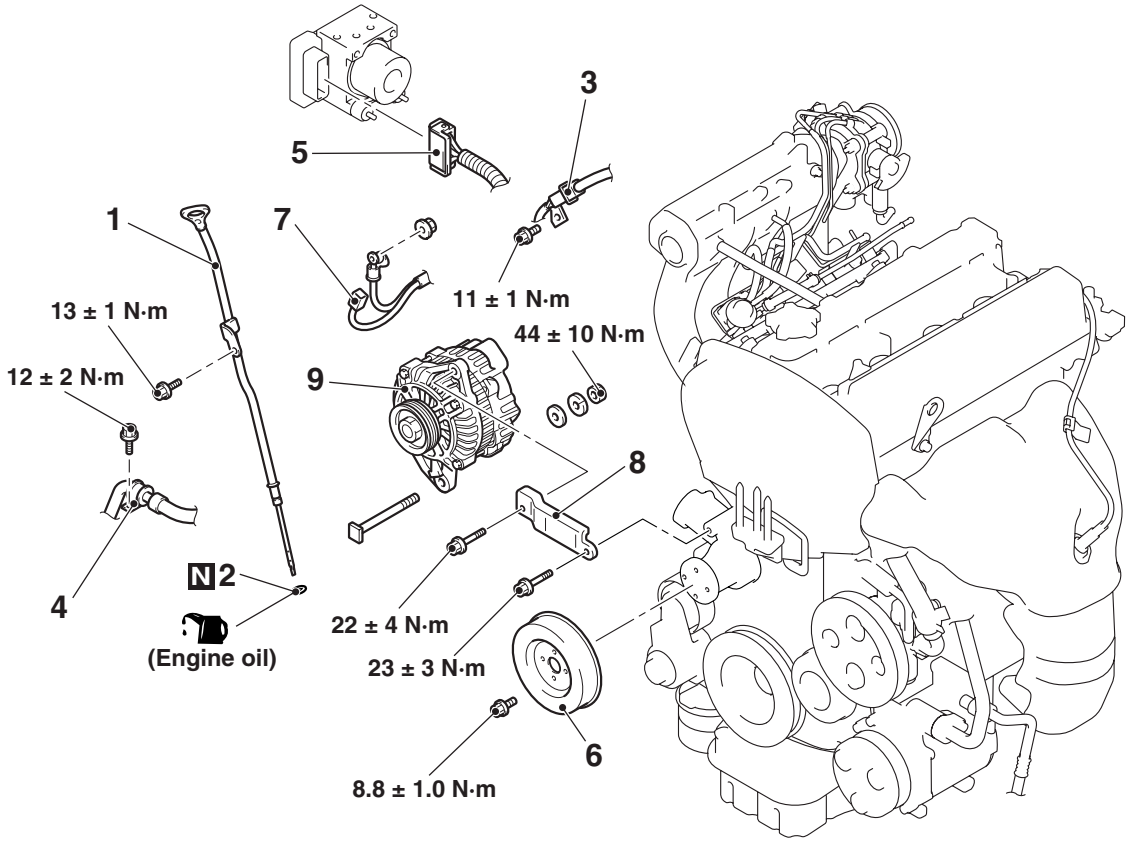
Abnormal waveform	Problem cause
Example 1  AKX00191	Open diode
Example 2  AKX00192	Short in diode
Example 3  AKX00193	Broken wire in stator coil
Example 4  AKX00194	Short in stator coil

ALTERNATOR ASSEMBLY

REMOVAL AND INSTALLATION <4G63-NON-TURBO>

M1161001400894

Pre-removal Operation	Post-installation Operation
• Under Cover Removal (Refer to GROUP 51, Under Cover P.51-31). • Drive Belt Removal (Refer to GROUP 11A, Crankshaft Pulley P.11A-17).	• Drive Belt Installation (Refer to GROUP 11A, Crankshaft Pulley P.11A-17). • Drive Belt Tension Adjustment (Refer to GROUP 11A, On-vehicle Service P.11A-7). • Under Cover Installation (Refer to GROUP 51, Under Cover P.51-31).



AC301643AB

Removal steps
1. Oil level gauge and guide
2. O-ring
3. Detonation sensor harness connector and clamp
4. Power steering oil pressure hose clamp

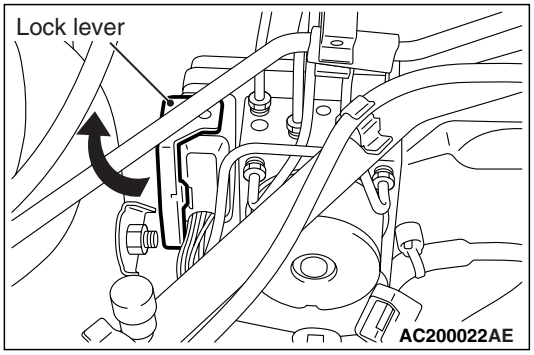
<<A>>

<<B>>

Removal steps (Continued)
5. Harness connector
6. Water pump pulley
7. Alternator connector
8. Alternator brace
9. Alternator assembly

REMOVAL SERVICE POINT

<<A>> HARNESS CONNECTOR DISCONNECTION



Move the lock lever of the ABS-ECU connector as shown in the illustration, and then disconnect the harness connector.

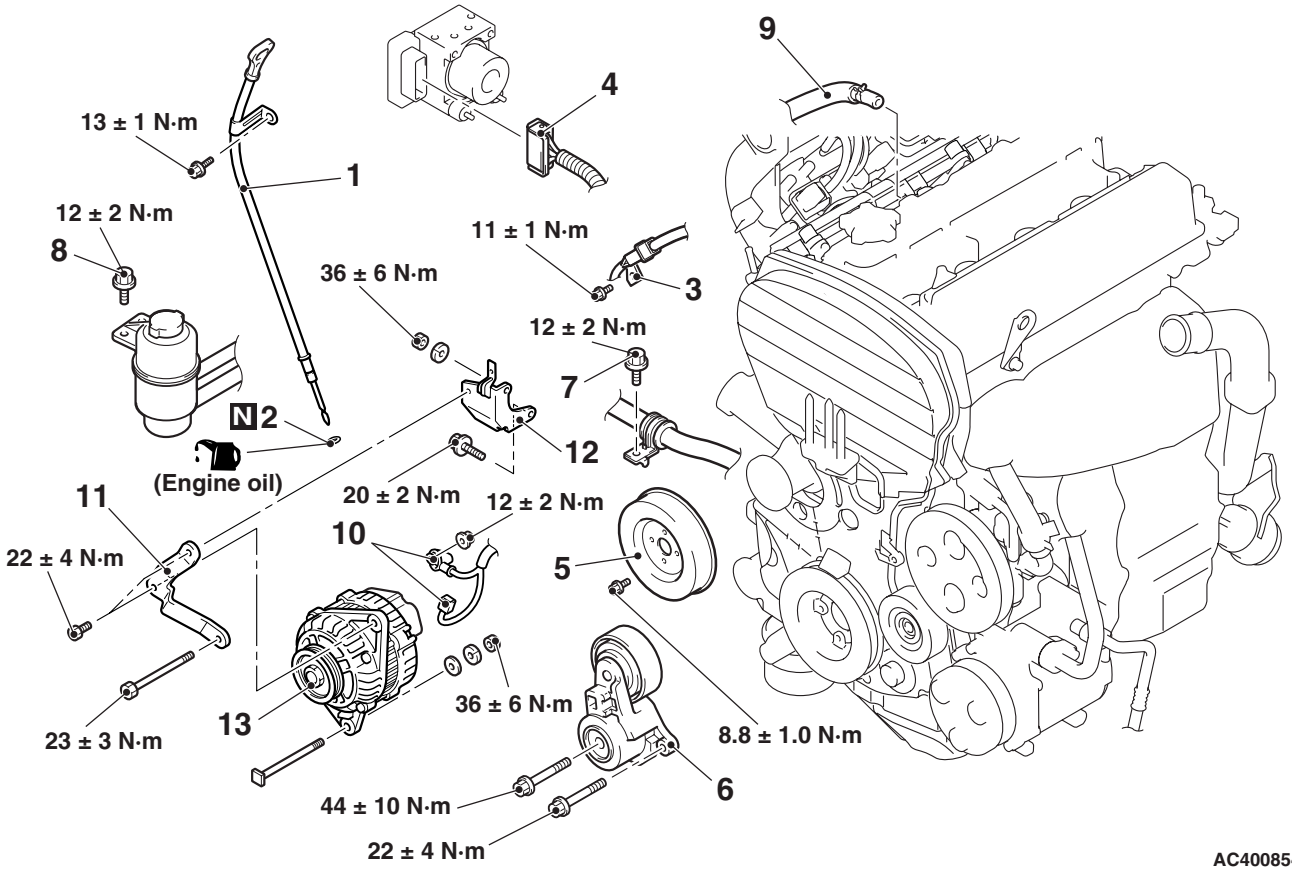
<<B>> ALTERNATOR ASSEMBLY REMOVAL

Remove the alternator assembly from above the vehicle.

REMOVAL AND INSTALLATION <4G63-TURBO>

M1161001400861

Pre-removal Operation	Post-installation Operation
• Under Cover Removal (Refer to GROUP 51, Under Cover P.51-31). • Intercooler Removal (Refer to GROUP 15, Intercooler P.15-9). • Drive Belt Removal (Refer to GROUP 11C, Crankshaft Pulley P.11C-16).	• Drive Belt Installation (Refer to GROUP 11C, Crankshaft Pulley P.11C-16). • Drive Belt Tension Adjustment (Refer to GROUP 11C, On-vehicle Service P.11C-7). • Intercooler Installation (Refer to GROUP 15, Intercooler P.15-9). • Under Cover Installation (Refer to GROUP 51, Under Cover P.51-31).



AC400854AB

Removal steps

1. Oil level gauge and guide
2. O-ring
3. Detonation sensor harness connector and clamp

<<A>>

4. Harness connector
5. Water pump pulley
6. Auto-tensioner
7. Power steering oil pressure hose clamp

Removal steps (Continued)

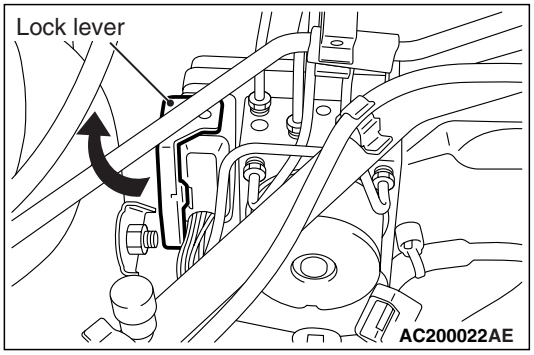
8. Power steering oil reservoir connecting bolts
   - Engine front mounting bracket (Refer to GROUP 32, Engine mounting P.32-7).
9. Rocker cover PCV hose
10. Alternator connector
11. Alternator brace
12. Alternator brace stay

<<B>>

13. Alternator assembly

REMOVAL SERVICE POINTS

<<A>> HARNESS CONNECTOR DISCONNECTION



Move the lock lever of the ABS-ECU connector as shown in the illustration, and then disconnect the harness connector.

<<B>> ALTERNATOR ASSEMBLY REMOVAL

⚠ CAUTION

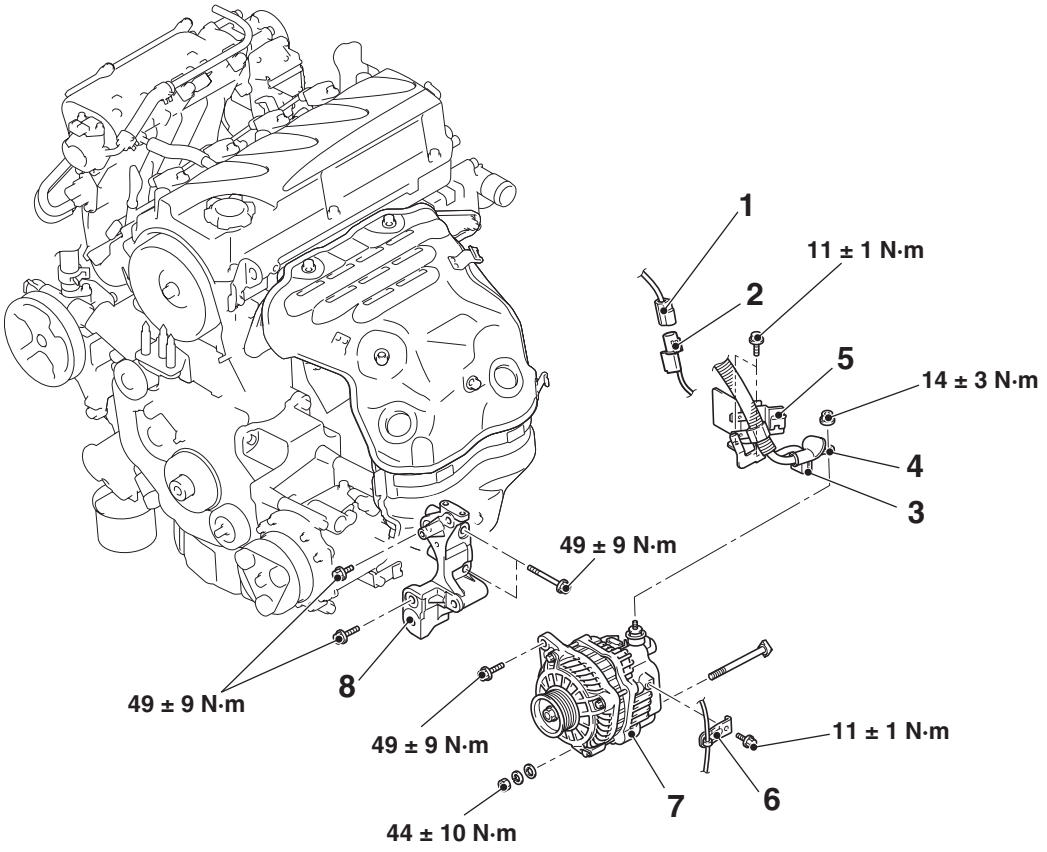
Be careful not to strike the A/C compressor with the vehicle body.

1. Jack up the engine fully.
2. Remove the alternator assembly from above the vehicle.

REMOVAL AND INSTALLATION <4G69>

M1161001400872

Pre-removal Operation	Post-installation Operation
• Under Cover Removal (Refer to GROUP 51, Under Cover P.51-31). • Drive Belt Removal (Refer to GROUP 11E, Crankshaft Pulley P.11E-17).	• Drive Belt Installation (Refer to GROUP 11E, Crankshaft Pulley P.11E-17). • Drive Belt Tension Check (Refer to GROUP 11E, On-vehicle Service P.11E-7). • Under Cover Installation (Refer to GROUP 51, Under Cover P.51-31).



Removal steps

1. A/C compressor assembly connector
2. A/C compressor assembly connector clamp
3. Alternator connector
4. Alternator terminal

<<A>>

Removal steps (Continued)

5. Connector bracket
6. Harness bracket
7. Alternator assembly
   - Timing belt lower cover (Refer to GROUP 11E, Timing Belt P.11E-36).
8. Alternator mounting bracket

REMOVAL SERVICE POINT

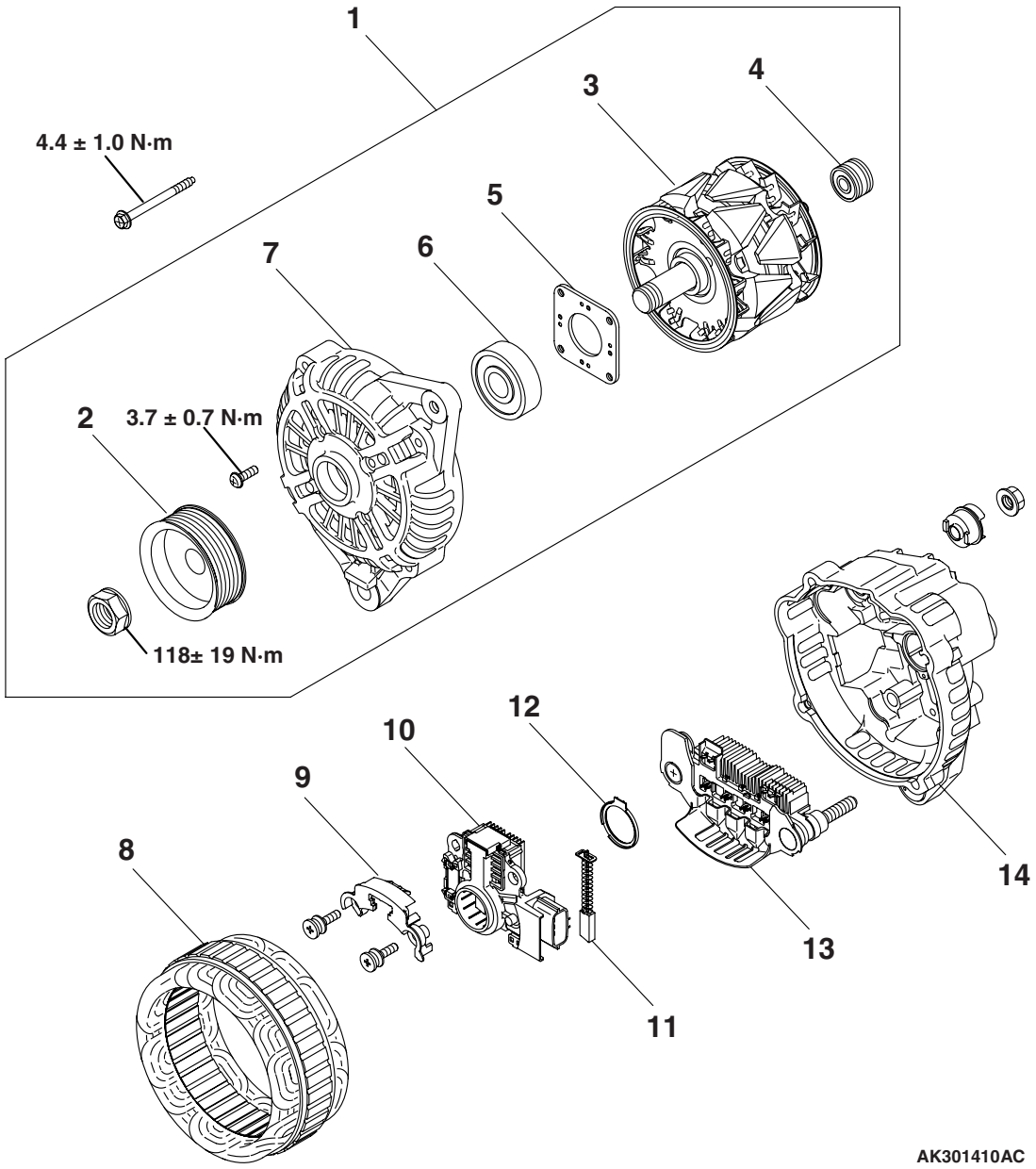
<<A>> ALTERNATOR ASSEMBLY REMOVAL

Remove the alternator assembly from above the vehicle.

DISASSEMBLY AND REASSEMBLY

M1161001600230

<Except 4G69>



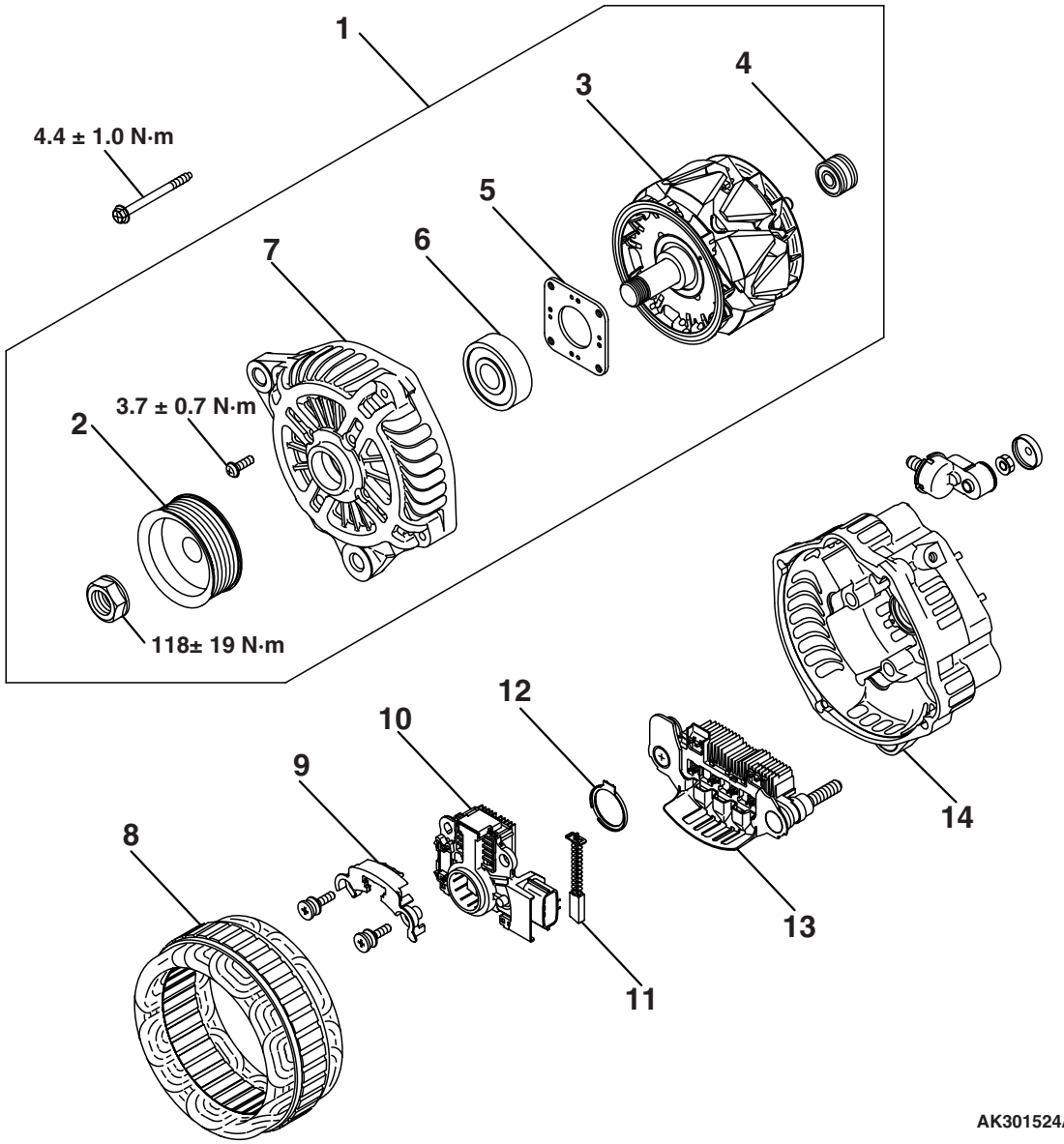
Disassembly steps

<<A>> 1. Front bracket assembly
<<B>> 2. Alternator pulley
>>B<< 3. Rotor
4. Rear bearing
5. Bearing retainer
6. Front bearing
7. Front bracket

Disassembly steps (Continued)

<<C>> 8. Stator
9. Plate
<<C>> >>A<< 10. Regulator assembly
11. Brush
12. Rubber packing
13. Rectifier
14. Rear bracket

<4G69>



Disassembly steps

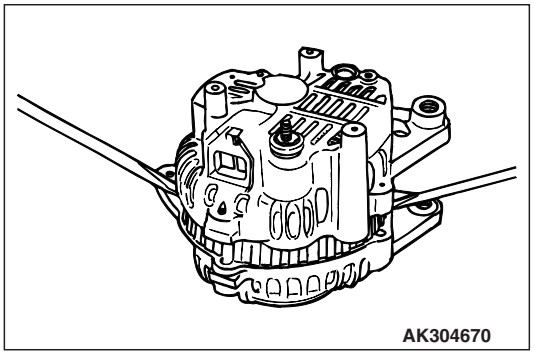
<<**A**>> 1. Front bracket assembly
<<**B**>> 2. Alternator pulley
>>**B**<< 3. Rotor
4. Rear bearing
5. Bearing retainer
6. Front bearing
7. Front bracket

Disassembly steps (Continued)

<<**C**>> 8. Stator
9. Plate
<<**C**>> >>**A**<< 10. Regulator assembly
11. Brush
12. Rubber packing
13. Rectifier
14. Rear bracket

DISASSEMBLY SERVICE POINTS

<<A>> FRONT BRACKET ASSEMBLY REMOVAL

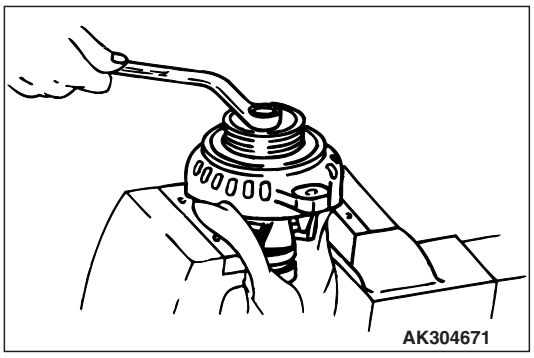


⚠ CAUTION

Do not insert the screwdriver blades too deep. Doing so could damage the stator coil.

Insert the blades of screwdrivers between the front bracket assembly and stator core, and pry and separate them with the screwdrivers.

<<B>> ALTERNATOR PULLEY REMOVAL

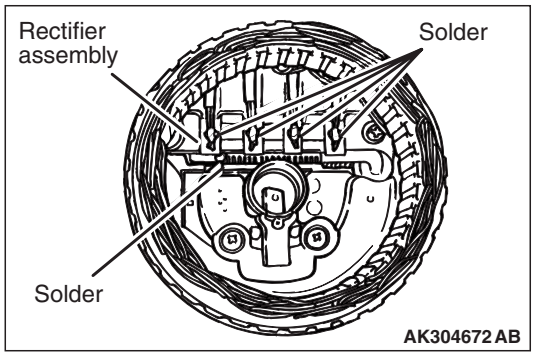


⚠ CAUTION

Perform operation carefully not to damage the rotor.

Clamp the rotor in a vise with the pulley facing up to remove the pulley.

<<C>> STATOR / REGULATOR ASSEMBLY REMOVAL



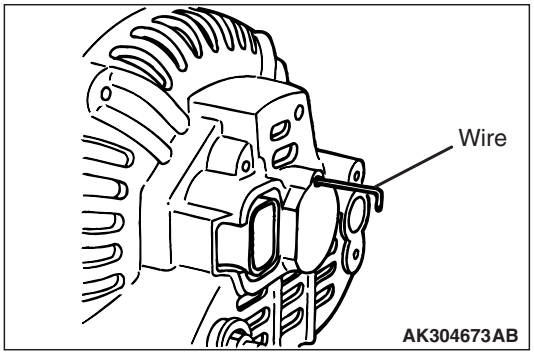
⚠ CAUTION

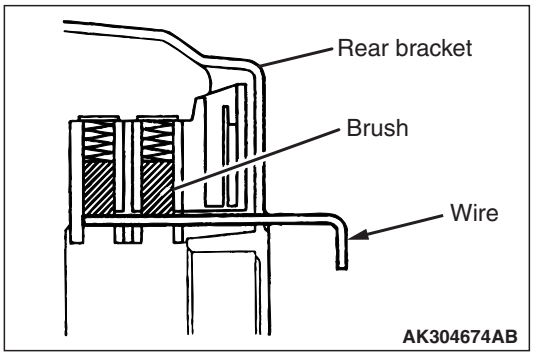
- **Use a 180 – 250 W soldering iron, and finish unsoldering within four seconds. Diodes will be damaged by heat if unsoldering time is too long.**
- **Avoid applying undue force to the diode leads.**

1. Unsolder the stator leads from the main diode of the rectifier assembly when the stator is removed.
2. When removing the rectifier assembly from the regulator assembly, undo the soldered points on the rectifier assembly.

REASSEMBLY SERVICE POINTS

>>A<< REGULATOR ASSEMBLY INSTALLATION

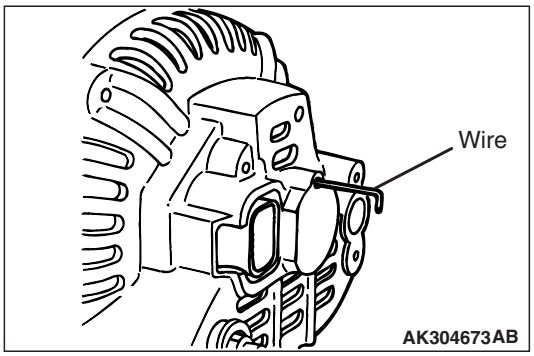




After installing the regulator assembly, insert a piece of wire through the hole in the rear bracket while pressing the brush to keep the brush against movement.

NOTE: Holding the brush with the wire facilities installation of the rotor.

>>B<< ROTOR INSTALLATION

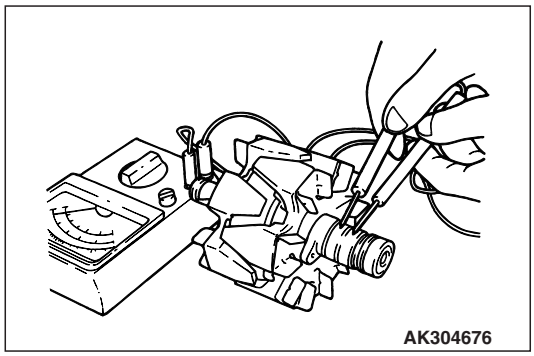


Remove the brush holding wire after the rotor has been installed.

INSPECTION

M1161001700204

ROTOR

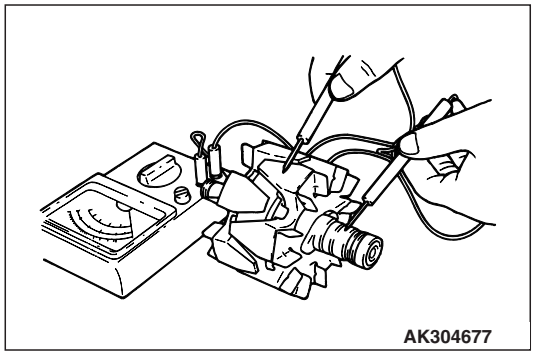


1. Measure the resistance between the two slip rings of the rotor coil to check the continuity between them.

   Replace the rotor if the resistance is not within the standard value range.

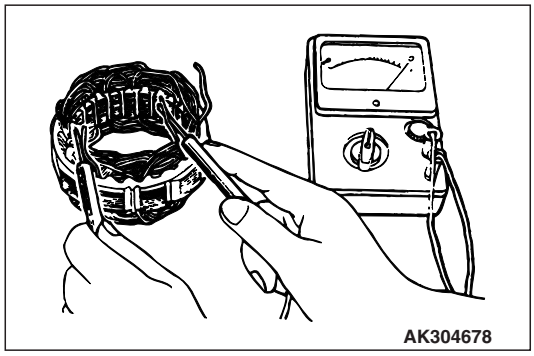
   Standard value: 3 – 5 Ω

2. Check the continuity between the slip rings and core.



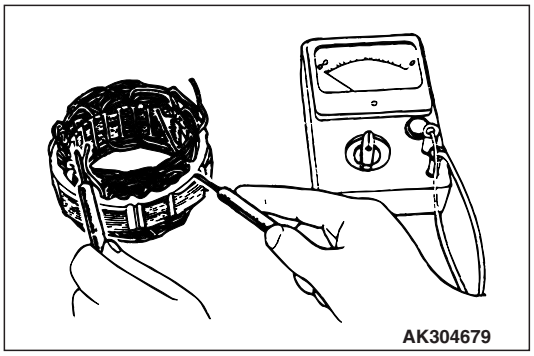
3. If continuity is present, replace the rotor.

STATOR



1. Check the continuity between coil leads.

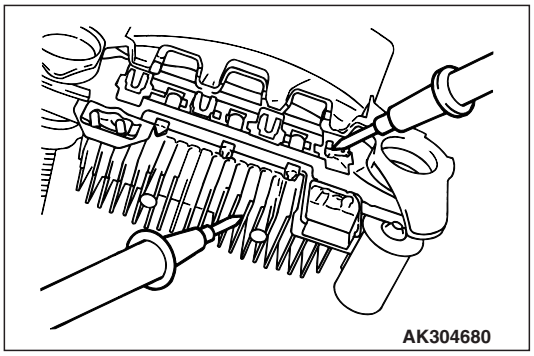
   If there is no continuity, replace the stator.



2. Check the continuity between coil and core.

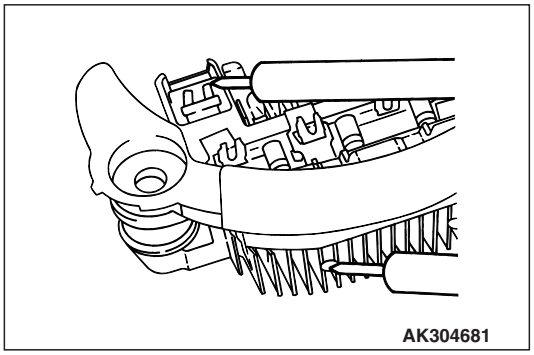
   If there is no continuity, replace the stator.

RECTIFIER ASSEBMLY



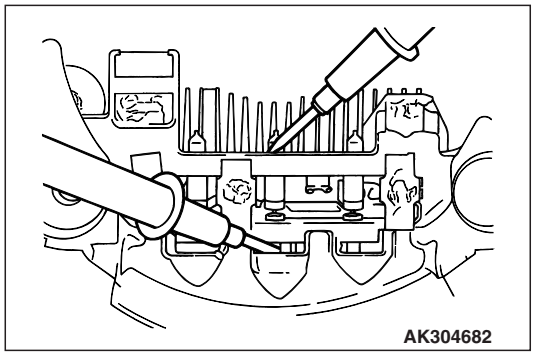
1. Check the condition of the (+) heat sink by checking continuity between the (+) heat sink and each of the stator coil lead connecting terminals.

   If continuity is present for both terminals, the diode is shorted. Replace the rectifier assembly.



2. Check the condition of the (−) heat sink by checking continuity between the (−) heat sink and each of the stator coil lead connecting terminals.

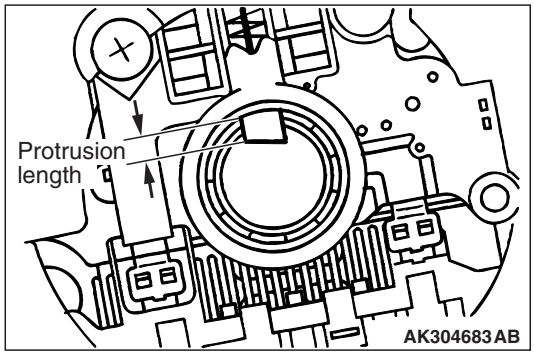
   If continuity is present in both directions, the diode is shorted. Replace the rectifier assembly.



3. Check the condition of the diode trio by testing continuity of each of the three diodes using a circuit tester connected to both sides of the diode. Connect in a polarity and then reverse the polarity for each test.

   If continuity exists or no continuity exists for both polarities, the diode is defective. Replace the rectifier assembly if any of the diodes is defective.

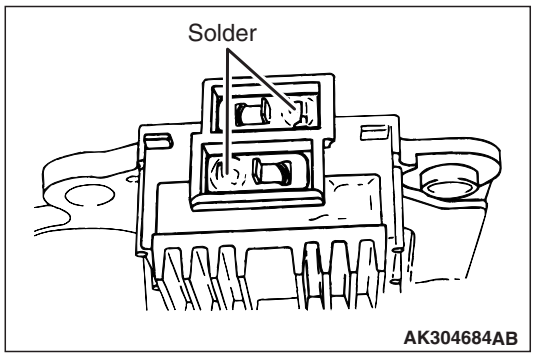
BRUSH



1. Measure the length of the protrusion of the brush. Replace the brush if the protrusion length is shorter than the limit.

   Limit: 2 mm minimum

2. Unsolder the lead of the brush. The brush will come out, becoming ready for removal.



3. Install a new brush by pushing it into the holder as shown in the drawing and soldering the lead.

STARTING SYSTEM

GENERAL INFORMATION

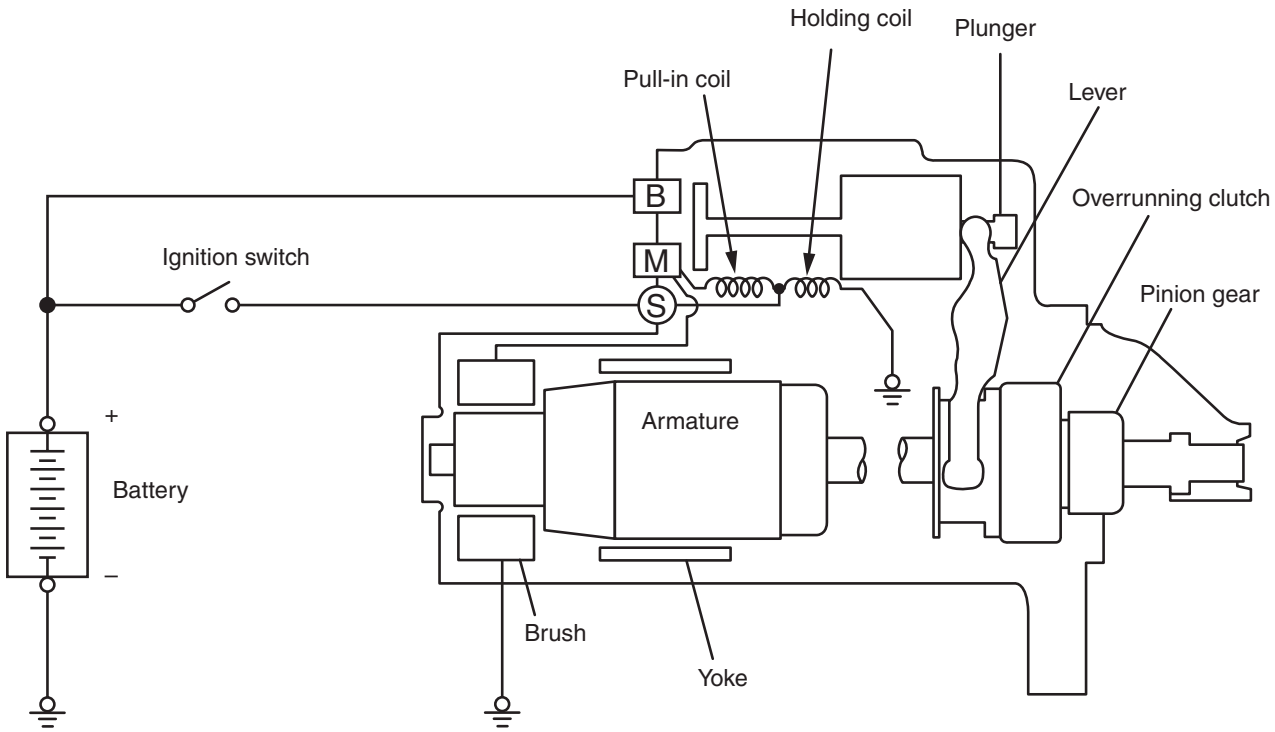
M1162000100376

If the ignition switch is turned to the "START" position, current flows in the pull-in and holding coils provided inside magnetic switch, attracting the plunger, When the plunger is attracted, the lever connected to the plunger is actuated to engage the 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.

SYSTEM DIAGRAM



AK202970 AB

STARTER MOTOR SPECIFICATIONS

Item	Specification
Type	Reduction drive with planetary gear
Rated output kW/V	1.4/12 <Non-turbo> 1.2/12 <Turbo>
Number of pinion teeth	8

SERVICE SPECIFICATIONS

M1162000300079

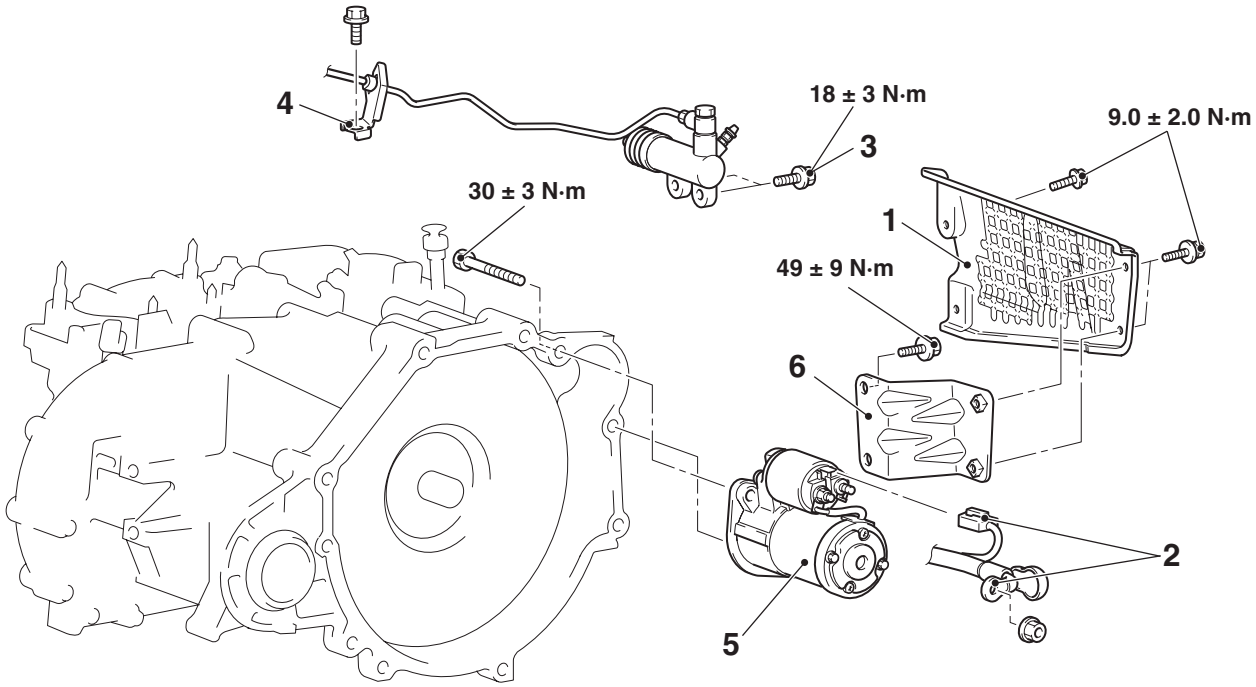
Item	Standard value	Limit
Pinion gap mm	0.5 – 2.0	–
Commutator run-out mm	0.05	0.1
Commutator diameter mm	29.4	28.8
Undercut depth mm	0.5	0.2

STARTER MOTOR ASSEMBLY

REMOVAL AND INSTALLATION
<4G63-NON-TURBO>

M1162001000918

Pre-removal and Post-installation Operation
- Resonator and Air Intake Duct Removal and Installation (Refer to GROUP 15, Air Cleaner P.15-6).
- Under Cover Removal and Installation (Refer to GROUP 51, Under Cover P.51-31).



AC301550AB

Removal steps
1. Starter cover
2. Starter connector and terminal
3. Clutch release cylinder connecting bolts
4. Clutch hose clamp

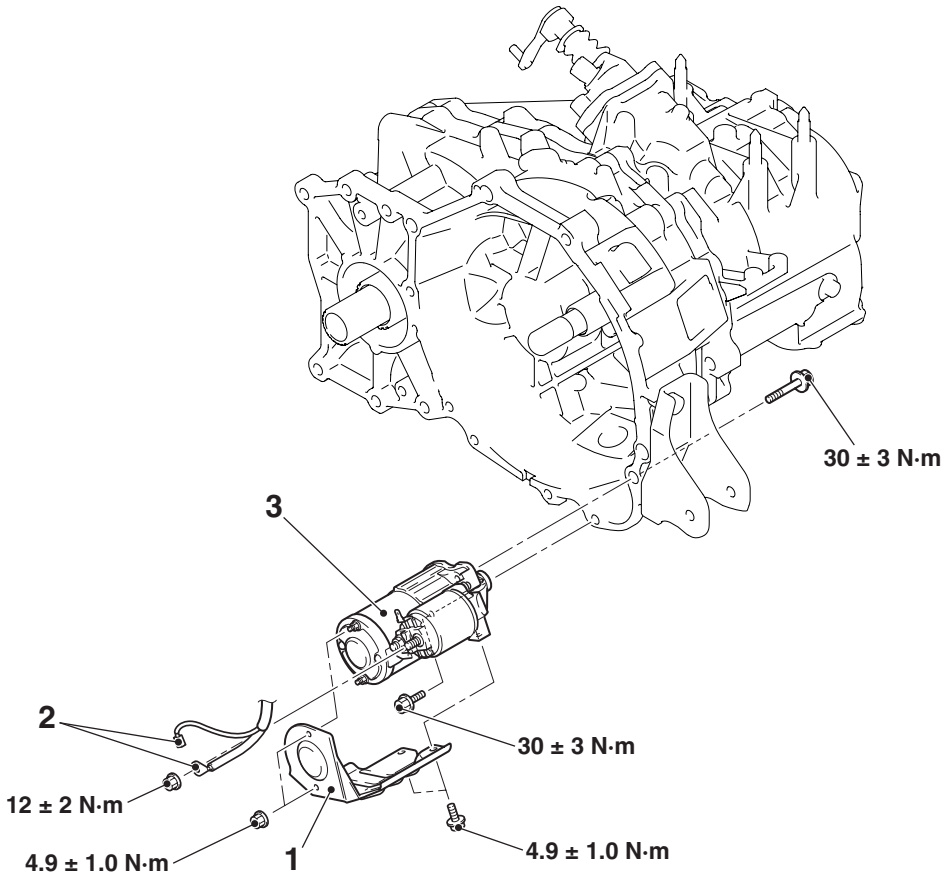
<<A>>
5. Starter assembly
6. Starter cover bracket

REMOVAL SERVICE POINT
<<A>> STARTER ASSEMBLY REMOVAL
Remove the starter assembly from above the vehicle.

REMOVAL AND INSTALLATION <4G63-TURBO>

M1162001000899

Pre-removal and Post-installation Operation
Front Exhaust Pipe Removal and Installation (Refer to GROUP 15, Exhaust Pipe and Main Muffler P.15-27).



AC400855 AB

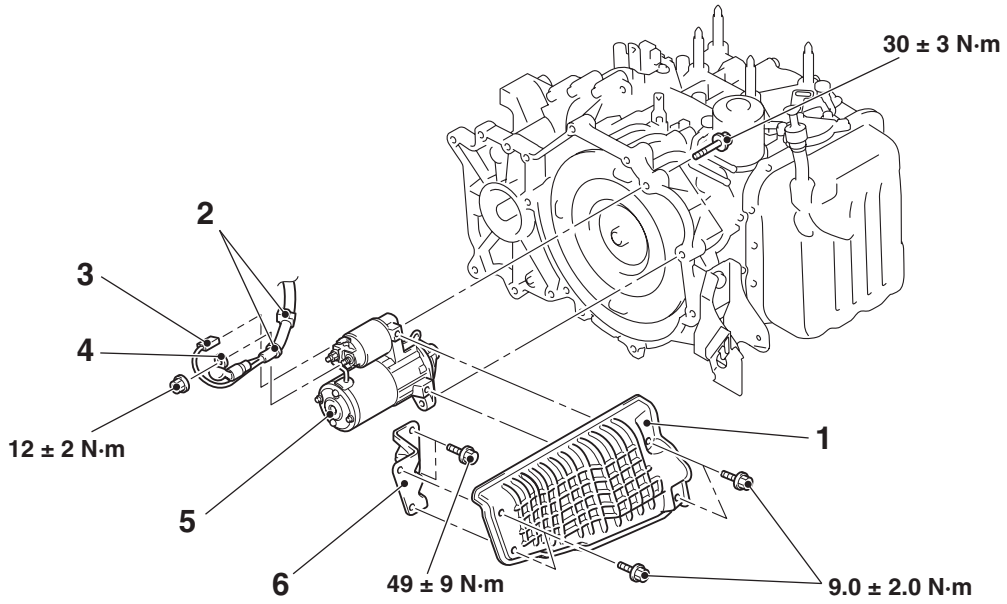
Removal steps
1. Starter cover

Removal steps (Continued)
2. Starter connector and terminal
3. Starter assembly

REMOVAL AND INSTALLATION <4G69>

M1162001000639

Pre-removal and Post-installation Operation
- Air Duct Removal and Installation (Refer to GROUP 15, Air Cleaner P.15-8).
- Exhaust Manifold Heat Protector Removal and Installation (Refer to GROUP 15, Exhaust Manifold P.15-20).



AC305106 AC

Removal steps
1. Starter cover
2. Harness clamp
3. Starter connector
4. Starter terminal
<<A>> 5. Starter assembly
6. Starter cover bracket

REMOVAL SERVICE POINT

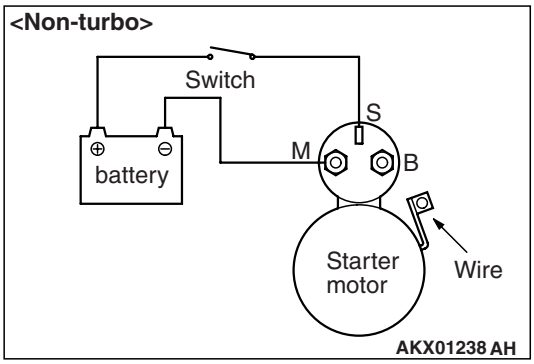
<<A>> STARTER ASSEMBLY REMOVAL

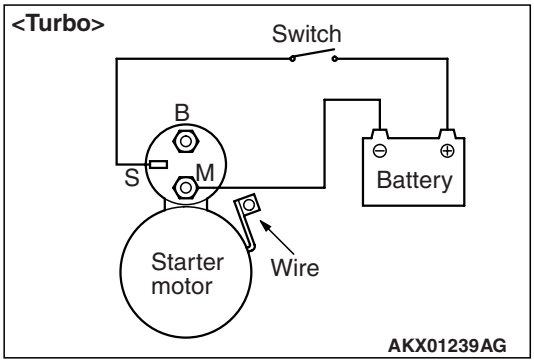
Remove the starter assembly from above the vehicle.

STARTER MOTOR ASSEMBLY INSPECTION

M1162001100357

PINION GAP ADJUSTMENT



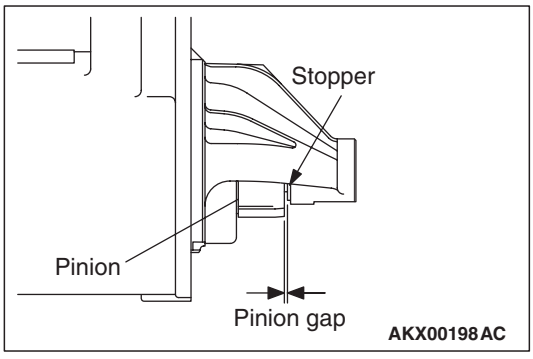


1. Disconnect the field coil wire from the M-terminal of the magnetic switch.
2. Connect a 12-volt battery between the S-terminal and M-terminal.

⚠ CAUTION

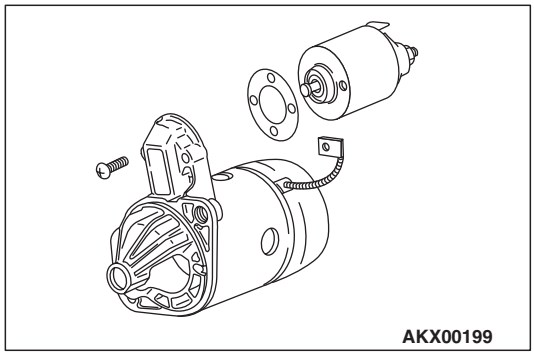
This test must be performed quickly (in less than 10 seconds) to prevent the coil from burning.

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



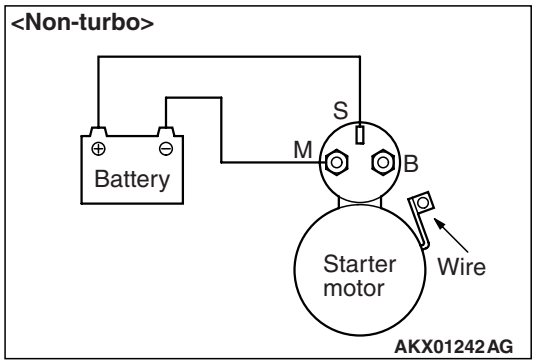
4. Check the pinion-to-stopper clearance (pinion gap) with a feeler gauge.

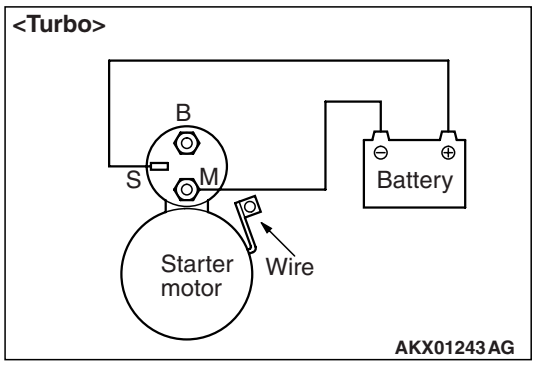
   Standard value: 0.5 – 2.0 mm



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





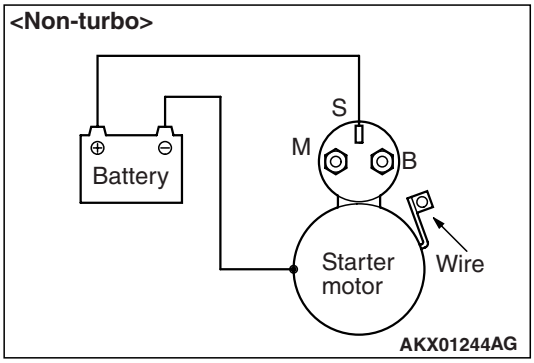
1. Disconnect the field coil wire from the M-terminal of the magnetic switch.

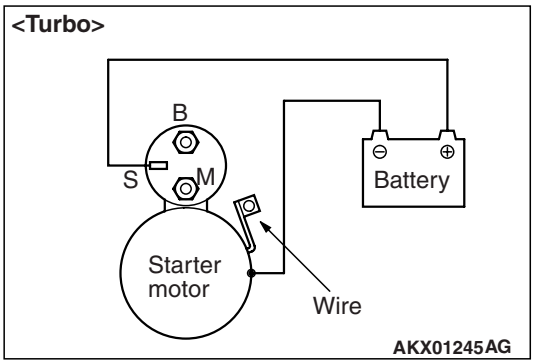
⚠ CAUTION

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





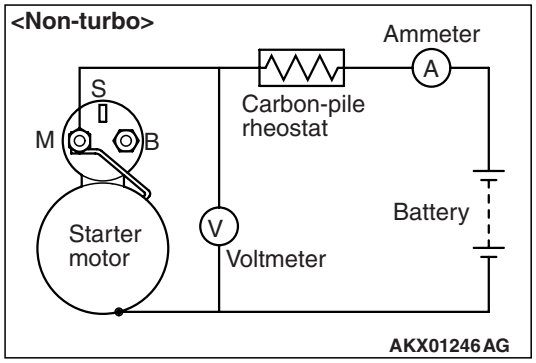
1. Disconnect the field coil wire from the M-terminal of the magnetic switch.

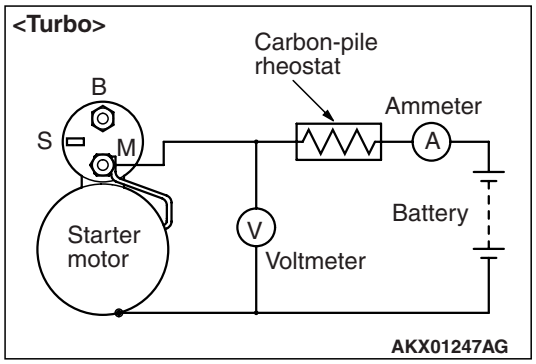
⚠ CAUTION

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 in order. If the pinion moves in, the hold-in circuit is open. Replace the magnetic switch.

FREE RUNNING TEST



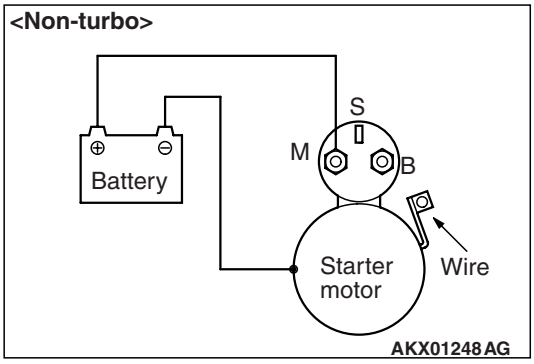


1. Place the starter motor in a vise equipped with soft jaws and connect a fully-charged 12-volt battery to the starter motor as follows:
2. Connect a test ammeter (100-ampere scale) and carbon pile rheostat in series between the positive battery terminal and starter motor terminal.
3. Connect a voltmeter (15-volt scale) across the starter motor.
4. Rotate the rheostat to full-resistance position.
5. Connect the battery cable from the negative battery terminal to the starter motor body.
6. Adjust the rheostat until the battery positive voltage shown on the voltmeter is 11 V.
7. Confirm that the maximum amperage is within the specifications and that the starter motor turns smoothly and freely.

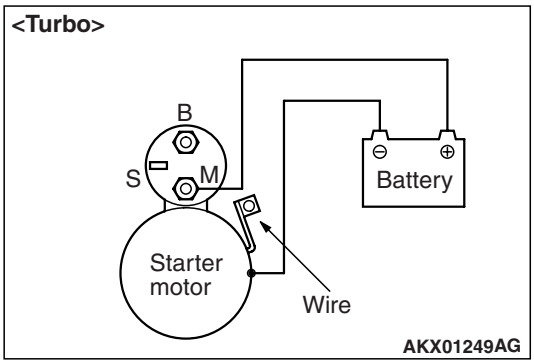
   Current: maximum 95 Amps

MAGNETIC SWITCH RETURN TEST

<Non-turbo>



<Turbo>



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.

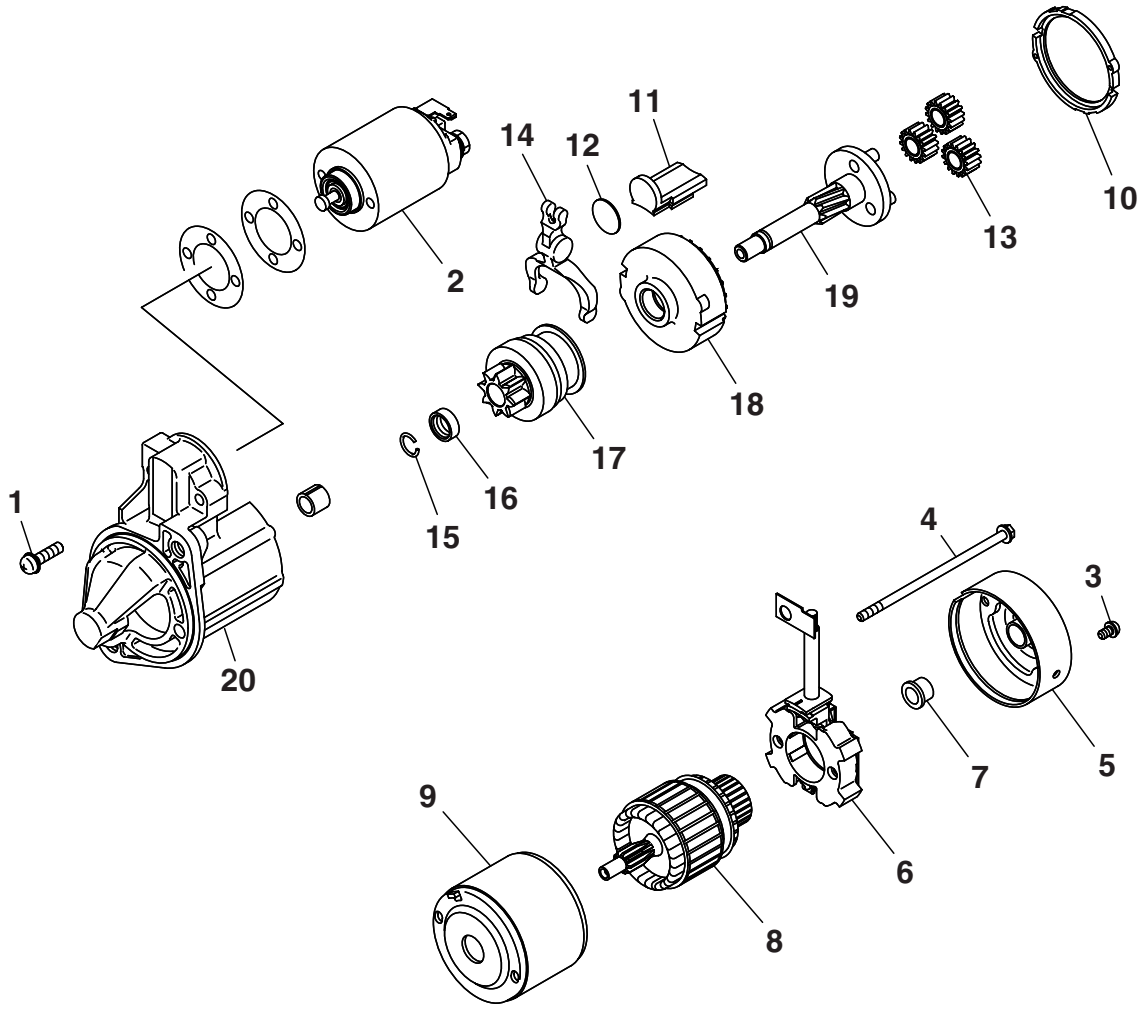
⚠ WARNING

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 REASSEMBLY

M1162001200280



AK304675AB

Disassembly steps

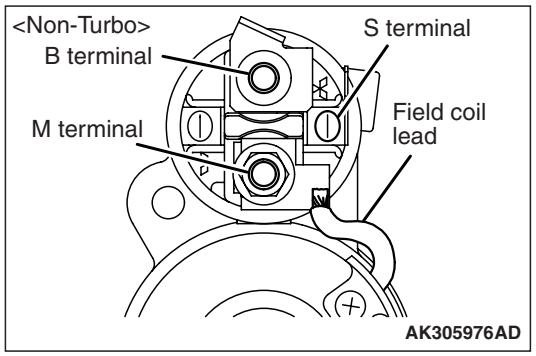
1. Screw
<<**A**>> 2. Magnetic switch
3. Screw
4. Bolt
5. Rear bracket
6. Brush holder
7. Rear bearing
8. Armature
9. Yoke assembly
10. Packing A

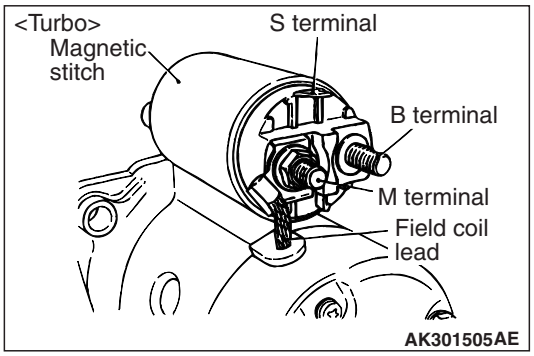
Disassembly steps (Continued)

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 shaft
20. Front bracket

DISASSEMBLY SERVICE POINTS

<<A>> MAGNETIC SWITCH REMOVAL



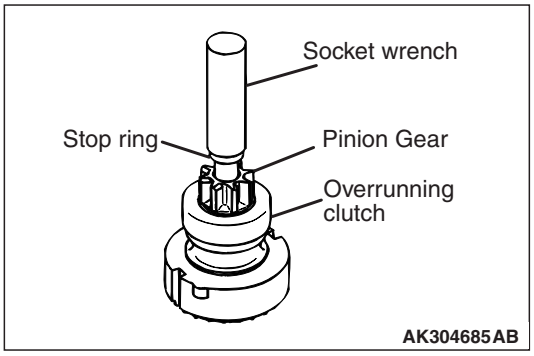


⚠ CAUTION

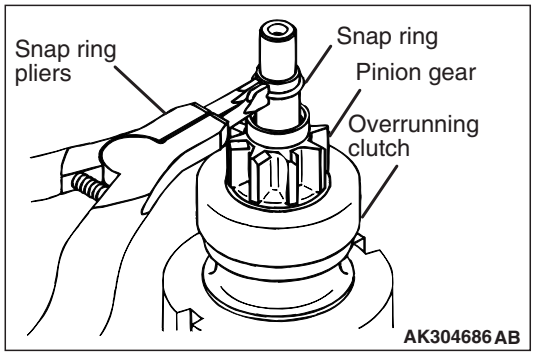
Do not clamp the yoke assembly with a vise.

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

<<B>> SNAP RING/STOP RING REMOVAL



1. Apply a long socket wrench of an appropriate size to the stop ring and strike the wrench to drive out the stop ring toward the pinion gear side.



2. Remove the snap ring with snap ring pliers, then remove the stop ring and overrunning clutch.

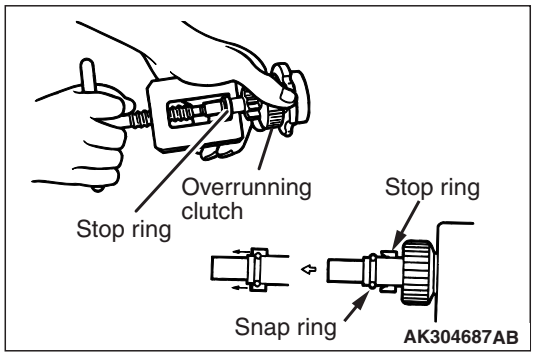
STARTER MOTOR PARTS CLEANING

Never clean in a solvent such starter motor parts as the magnetic switch, brush holder, and armature. If they are soaked in a solvent, their insulation could be impaired. When these parts require cleaning, wipe off contamination with cloth.

1. Never soak the drive unit in a solvent. If it is washed in a solvent, the grease having been packed in the overrunning clutch at the factory will be washed out. Wipe the drive unit with cloth if it requires cleaning.

REASSEMBLY SERVICE POINTS

>>A<< STOP RING/SNAP RING INSTALLATION

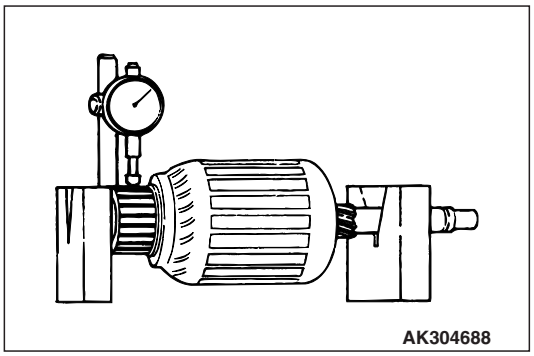


Use a suitable puller to pull the stop ring until it gets over the snap ring.

INSPECTION

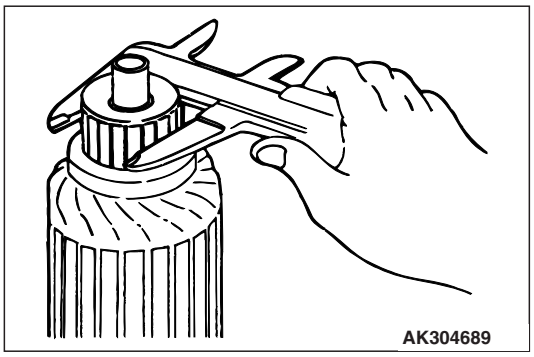
M1162001300221

COMMUTATOR



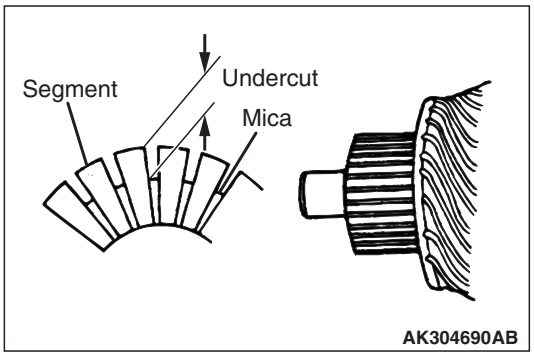
1. Support the armature with a pair of V block and turn it to measure the runout of the surface not rubbed by the brushes using a dial gauge.

   Standard value: 0.05 mm or less
   Limit: 0.1 mm



2. Measure the diameter of the commutator.

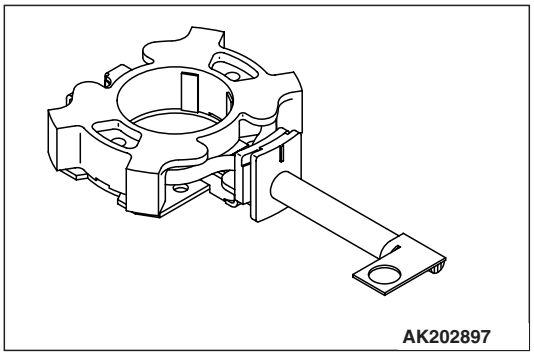
   Standard value: 29.4 mm
   Limit: 28.8 mm



3. Measure the depth of the undercut between segments.

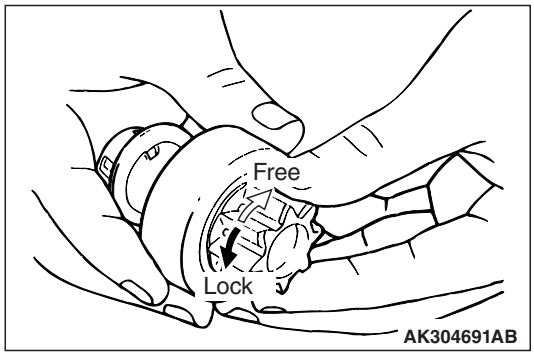
   Standard value: 0.5 mm
   Limit: 0.2 mm

BRUSH HOLDER



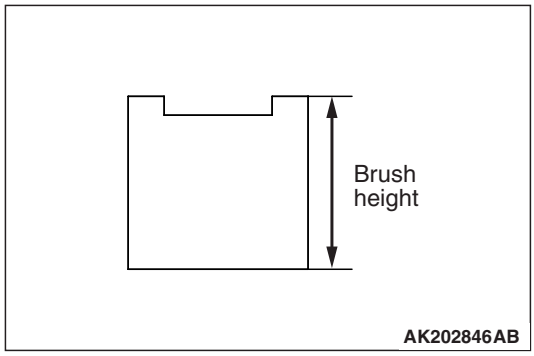
Push the brush into the brush holder to make sure that the spring is working on the brush.
If the spring is not working, replace the brush holder.

OVERRUNNING CLUTCH



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

BRUSHES



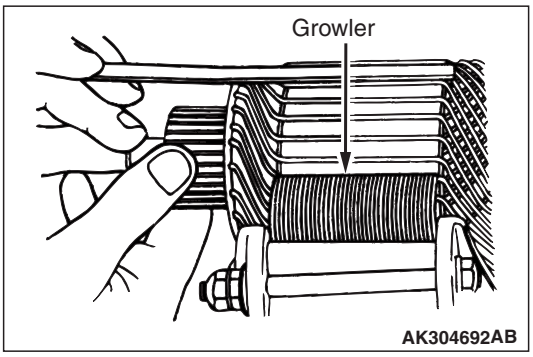
1. Check the commutator contacting surface of each brush for abnormal roughness. Also check the height of the brush. Replace the brush holder if the height is lower than the limit.

   Limit: 7.0 mm

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 COIL

1. Check the armature coil for short circuit as follows:

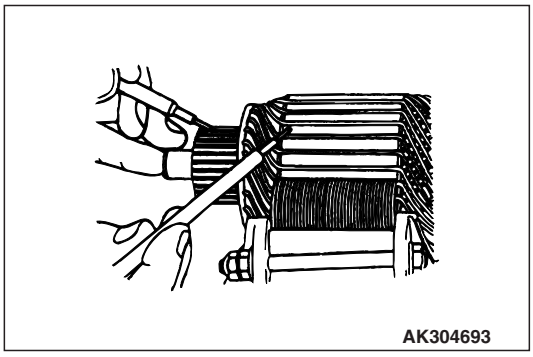


2. Set the armature in a growler.

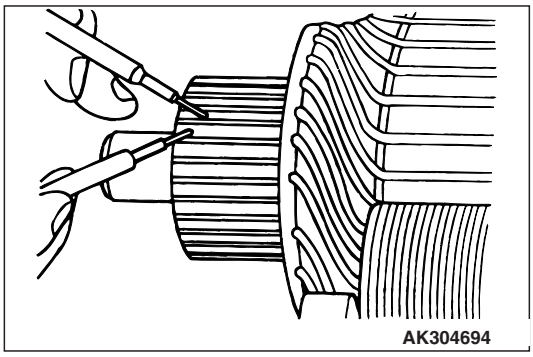
⚠ CAUTION

Clean the surface of the armature thoroughly before performing the test.

3. While holding a thin strip of iron against the armature in parallel with its axis, turn the armature slowly. The armature is normal if the iron strip is not attracted to the armature or it does not vibrate.

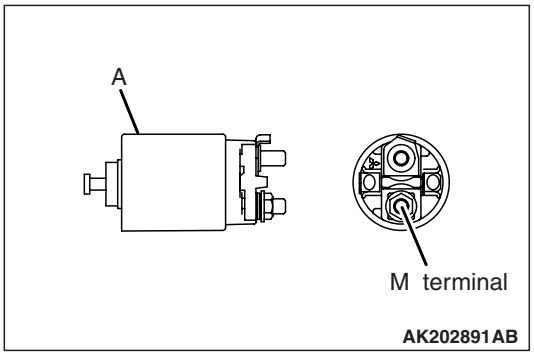


4. Check the insulation between commutator segments and armature coils. The armature coils are properly insulated if no continuity is present.

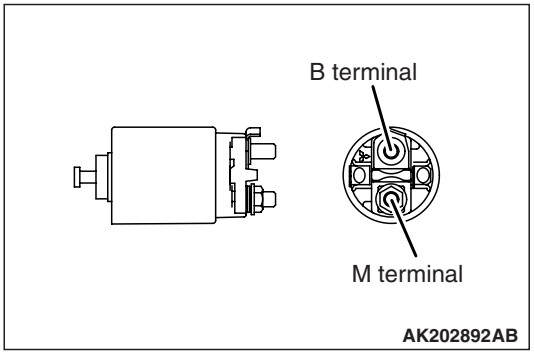


5. Check continuity between a segment and another. There is no open circuit in the tested coil if there is continuity.

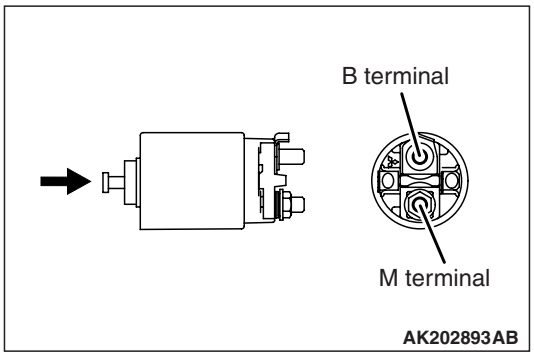
MAGNETIC SWITCH



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.

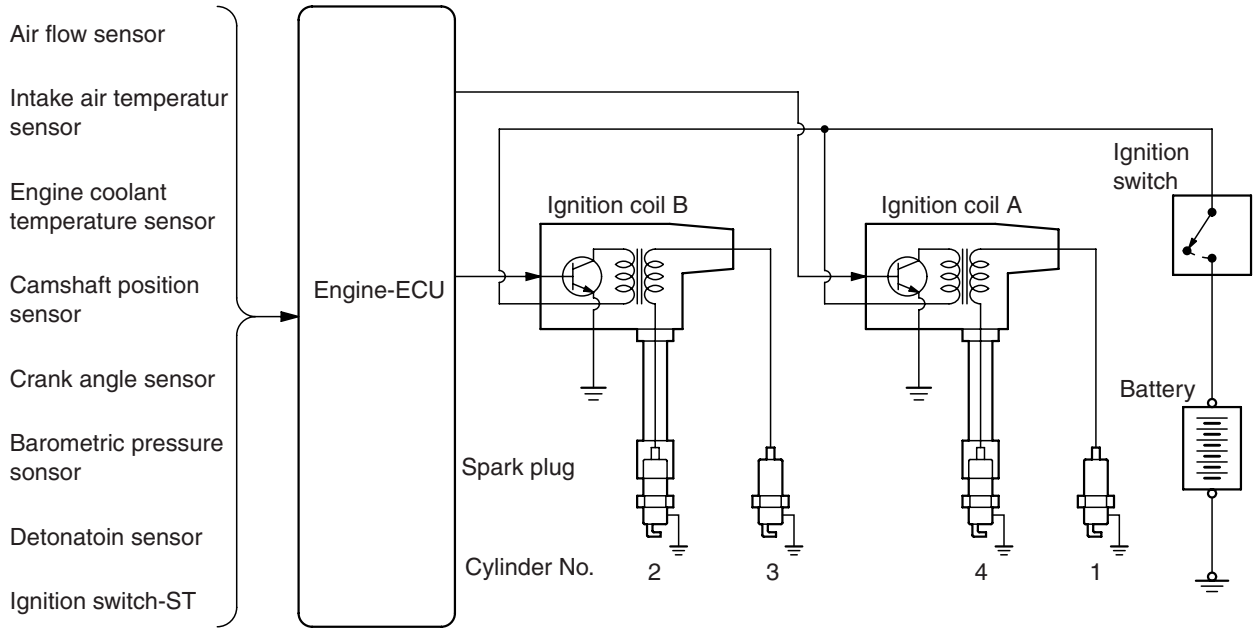
IGNITION SYSTEM

GENERAL INFORMATION <4G63>

M1163000100465

This system is equipped with two ignition coils (A and B) with built-in power transistors for the No. 1 and No. 4 cylinders and the No. 2 and No. 3 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 No. 1 and No. 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 No. 2 and No. 3 cylinders.
The engine-ECU turns the two power transistors inside the ignition coils alternately on and off. This causes the primary currents in the ignition coils to be alternately interrupted and allowed to flow to fire the cylinders in the order 1-3-4-2.
The engine-ECU 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 crank angle sensor which is incorporated in the crankshaft. It also detects the crankshaft position in order to provide ignition at the most appropriate timing in response to the engine operation conditions. 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.
When the automatic transmission shifts gears, the ignition timing is also retarded in order to reduce output torque, thereby alleviating shifting shocks.

SYSTEM DIAGRAM



AK101074 AI

IGNITION COIL SPECIFICATION

Item	Specification
Type	Molded 2-coil

SPARK PLUG SPECIFICATIONS

Item	Specification
NGK	IGR6A11 <Non-turbo> IGR6A <Turbo>

GENERAL INFORMATION <4G69>

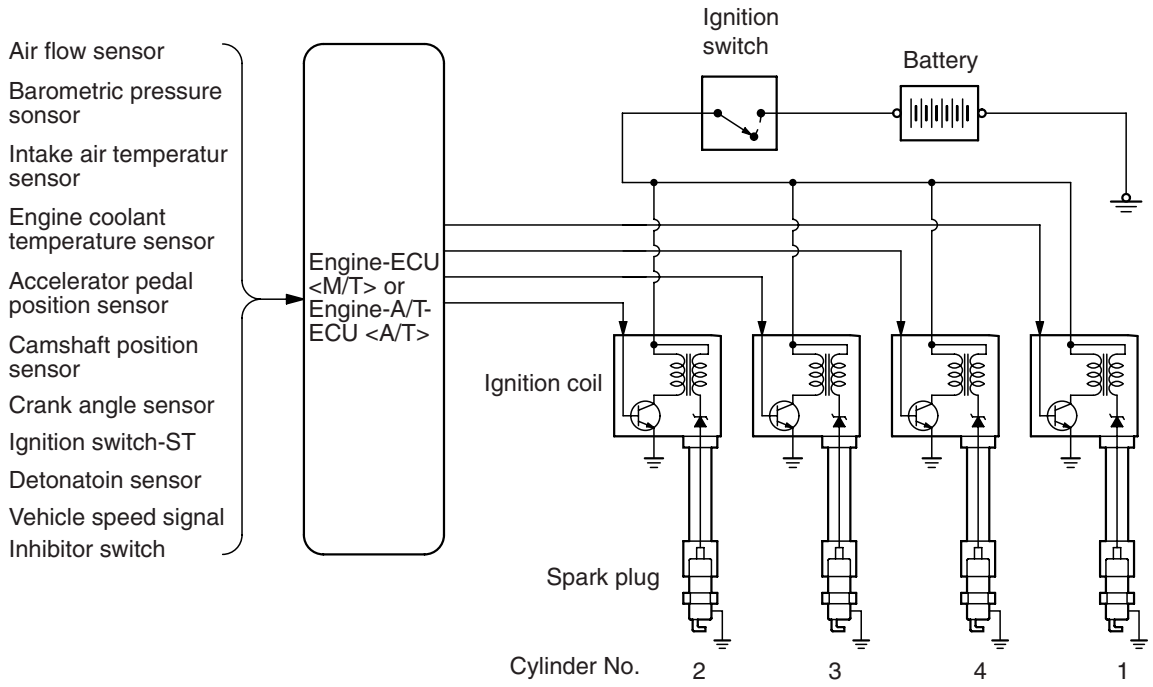
M1163000100476

This system is equipped with four ignition coils with built-in power transistors for each of the cylinders. Interruption of the primary current flowing in the primary side of an ignition coil generates a high voltage in the secondary side of ignition coil. The high voltage thus generated is applied to the spark plugs to generate sparks. The engine-ECU <M/T> or engine-A/T-ECU <A/T> turns the power transistors inside the ignition coils alternately on and off.This causes the primary currents in the ignition coils to be alternately interrupted and allowed to flow to fire the cylinders in the order 1-3-4-2.

The engine-ECU <M/T> or engine-A/T-ECU <A/T> determines which ignition coil should be controlled by means of the signals from the camshaft position sensor and the crank angle sensor. It also detects the crankshaft position, in order to provide ignition at the most appropriate timing in response to the engine operation conditions.

When the engine is cold or running at high altitudes, the ignition timing is slightly advanced to provide optimum performance. Furthermore, if knocking occurs, the ignition timing is gradually retarded until knocking ceases.

SYSTEM DIAGRAM



AK303631AB

IGNITION COIL SPECIFICATION

Item	Specification
Type	Molded 4-coil

SPARK PLUG SPECIFICATIONS

Item	Specification
NGK	LZFR6AI

SERVICE SPECIFICATIONS

M1163000300328

IGNITION COIL <4G63>

Item	Standard value
Secondary coil resistance kΩ	8.5 – 11.5

SPARK PLUG

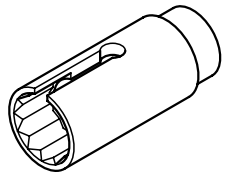
Item		Standard value	Limit
Spark plug gap mm	4G63	1.0 – 1.1 <Non-turbo> 0.7 – 0.8 <Turbo>	1.3 <Non-turbo> 0.95 <Turbo>
	4G69	0.7 – 0.8	1.2

RESISTIVE CORD <4G63>

Item	Standard value	Limit
Resistance kΩ	–	Maximum 19

SPECIAL TOOL

M1163000600200

Tool	Number	Name	Use
	MD998773	Detonation sensor wrench	Detonation sensor removal and installation

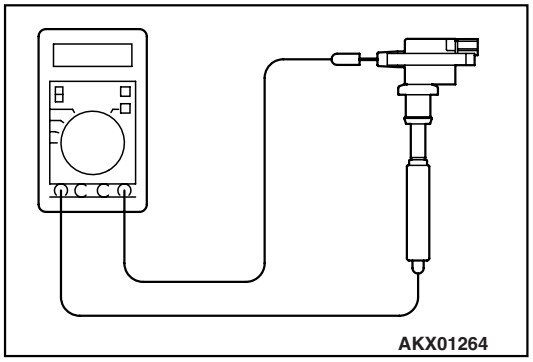
ON-VEHICLE SERVICE

IGNITION COIL (WITH BUILT-IN POWER TRANSISTOR) CHECK <4G63>

M1163001200409

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

SECONDARY COIL RESISTANCE CHECK

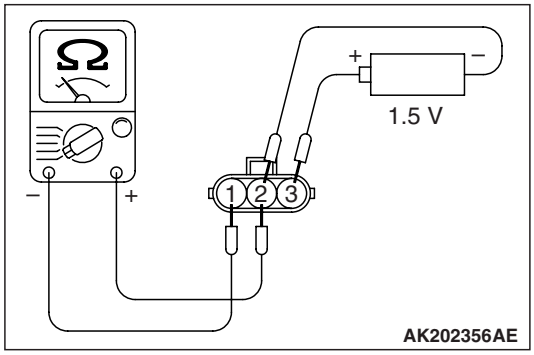


Measure the resistance between the high-voltage terminals of the ignition coil.

Standard value: 8.5 – 11.5 kΩ

PRIMARY COIL AND POWER TRANSISTOR CONTINUITY CHECK

NOTE:



An analogue-type circuit tester should be used.

- *Connect the negative (-) prove of the circuit tester to terminal No. 1.*

⚠ CAUTION

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

Connect and disconnect 1.5 V battery between terminal No. 2 and No. 3, and observe the ohmmeter whether there is continuity or not.

1.5 V power supply between 2 – 3	Continuity between 1 – 2
When current is flowing	Continuity
When current is not flowing	No continuity

IGNITION COIL (WITH BUILT-IN POWER TRANSISTOR) CHECK <4G69>

M1163001200391

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

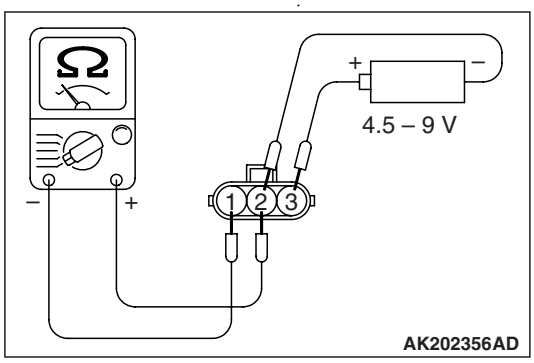
SECONDARY COIL RESISTANCE CHECK

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. Earth 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.

PRIMARY COIL AND POWER TRANSISTOR CONTINUITY CHECK

NOTE:



An analogue-type circuit tester should be used.

- *Connect the negative (-) prove of the circuit tester to terminal No. 1.*

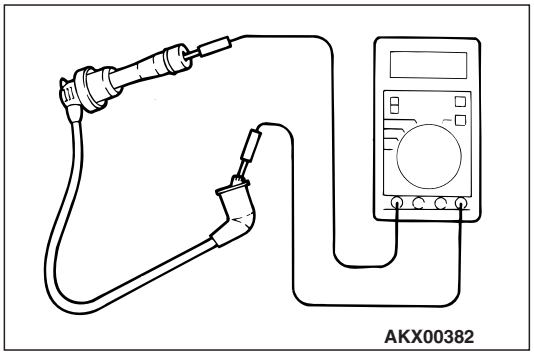
⚠ CAUTION

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

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.

4.5 – 9 V power supply between 2 – 3	**Continuity between 1 – 2**
When current is flowing	Continuity
When current is not flowing	No continuity

RESISTIVE CORD CHECK <4G63>



M1163001400146

Measure the resistance of the all spark plug cables.

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

Limit: Maximum 19 kΩ

SPARK PLUG CHECK AND CLEANING

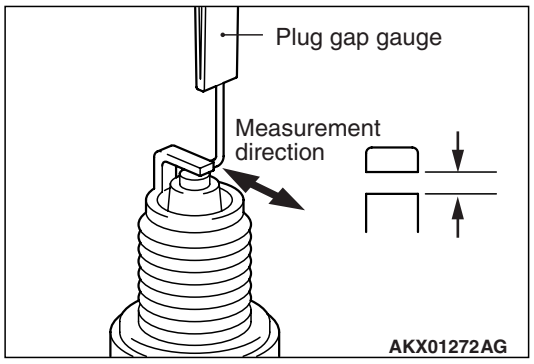
M1163004301099

⚠ CAUTION

- **Never attempt to adjust the gap of the iridium plug.**
- **Do not attempt to clean the spark plug because it may result in damage to the electrode. However, if remarkable carbon deposits must be removed, using a plug cleaner, complete the cleaning within 20 seconds to protect the electrode. Do not use a wire brush.**

NOTE: As the prospective distance for this spark plug replacement is 100,000 km. If the plug gap and insulation resistance are normal, check the plug state and clean it if necessary.

SPARK PLUG GAP CHECK

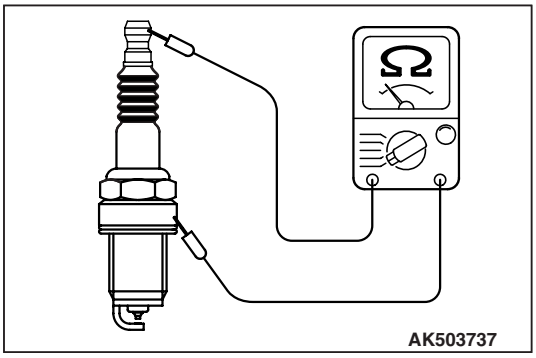


Check the plug gap with the wire type plug gap gauge. Replace it if the limit is exceeded.

Standard value, limit:

Manufacturer	Type	Standard value (mm)	Limit (mm)
NGK <4G63-Non-turbo>	IGR6A11	1.0 – 1.1	1.3
NGK <4G63-Turbo>	IGR6A	0.7 – 0.8	0.95
NGK <4G69>	LZFR6AI	0.7 – 0.8	1.2

SPARK PLUG INSULATION RESISTANCE CHECK



1. Measure the insulation resistance. If the insulation resistance of the spark plug is under the limited value, clean the plug within 20 seconds using a plug cleaner.
2. After cleaning, measure the insulation resistance again. Replace the plug unless it is within the limited value.

Limit: Minimum 10 MΩ

CAMSHAFT POSITION SENSOR CHECK

M1163004400383

Check the camshaft position sensor circuit if self-diagnosis code, No. P0340 is shown.
(Refer to P.13A-134, GROUP 13A – Troubleshooting – Inspection procedure for diagnosis code.) <4G63 Non-turbo>
(Refer to P.13B-155, GROUP 13B – Troubleshooting – Inspection procedure for diagnosis code.) <4G63 Turbo>
(Refer to P.13C-180, GROUP 13C – Troubleshooting – Inspection procedure for diagnosis code.) <4G69>

CRANK ANGLE SENSOR CHECK

M1163004500443

Check the crank angle sensor circuit if self-diagnosis code, No. P0335 is shown.
(Refer to P.13A-124, GROUP 13A – Troubleshooting – Inspection procedure for diagnosis code.) <4G63 Non-turbo>
(Refer to P.13B-145, GROUP 13B – Troubleshooting – Inspection procedure for diagnosis code.) <4G63 Turbo>
(Refer to P.13C-170, GROUP 13C – Troubleshooting – Inspection procedure for diagnosis code.) <4G69>

DETONATION SENSOR CHECK

M1163002900144

Check the detonation sensor circuit if self-diagnosis code, No. P0325 is shown.
(Refer to P.13A-121, GROUP 13A – Troubleshooting – Inspection procedure for diagnosis code.) <4G63 Non-turbo>
(Refer to P.13B-141, GROUP 13B – Troubleshooting – Inspection procedure for diagnosis code.) <4G63 Turbo>
(Refer to P.13C-167, GROUP 13C – Troubleshooting – Inspection procedure for diagnosis code.) <4G69>

IGNITION SECONDARY VOLTAGE WAVEFORM CHECK USING AN OSCILLOSCOPE <4G63>

M1163001700233

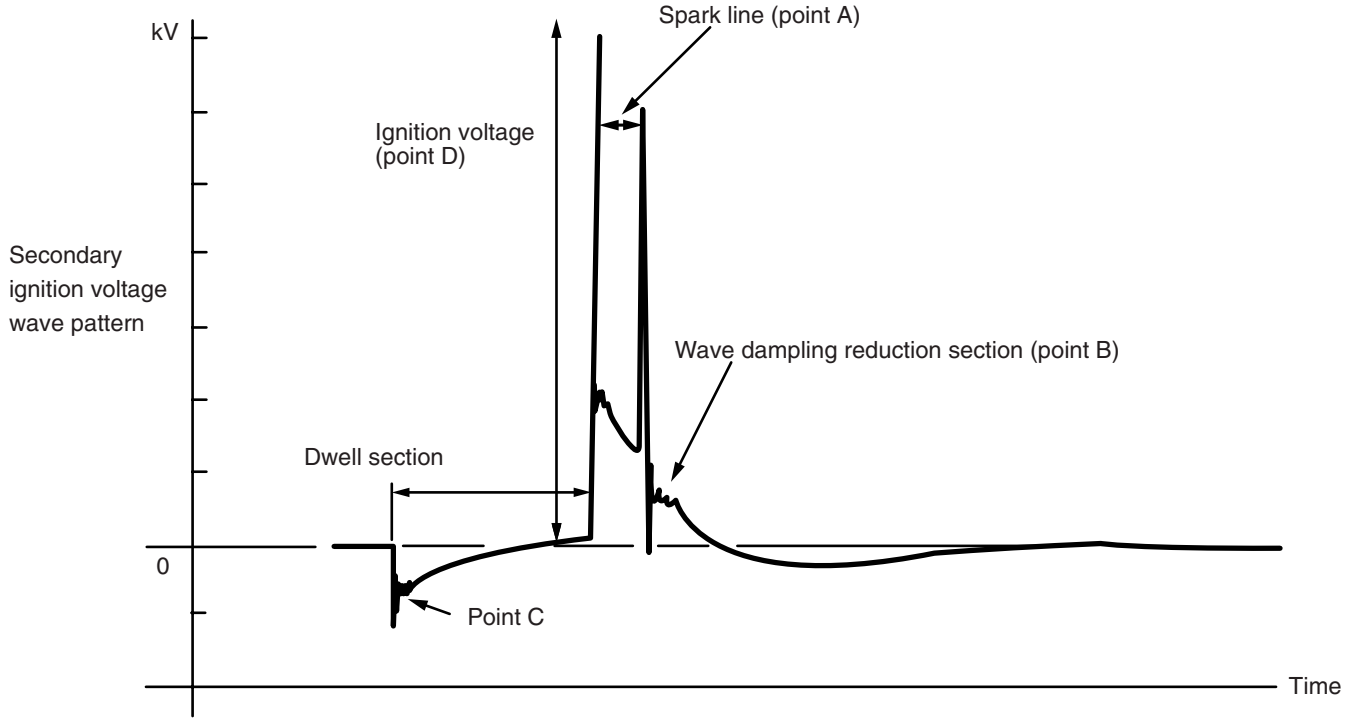
MEASUREMENT METHOD

1. Clamp the secondary pickup around the spark plug cable.
   NOTE:
   - *The peak ignition voltage will be reversed when the spark plug cables No. 2 and No. 4, or No. 1 and No. 3 cylinders are clamped.*
   - *Because of the two-cylinder simultaneous ignition system, the waveforms for two cylinders in each group appear during waveform observation (No. 1 cylinder - No. 4 cylinder, No. 2 cylinder - No. 3 cylinder). However, waveform observation is only applicable for the cylinder with the spark plug cable clamped by the secondary pickup.*
   - *Identifying which cylinder waveform is displayed can be difficult. For reference, remember that the waveform of the cylinder attached to the secondary pickup will be displayed as stable.*
2. Clamp the spark plug cable with the trigger pickup.
   NOTE: Clamp the trigger pickup to the same spark plug cable clamped by the secondary pickup.

STANDARD WAVEFORM

Observation Conditions

Function	Secondary
Pattern height	High (or Low)
Pattern selector	Raster
Engine revolutions	Curb idle speed



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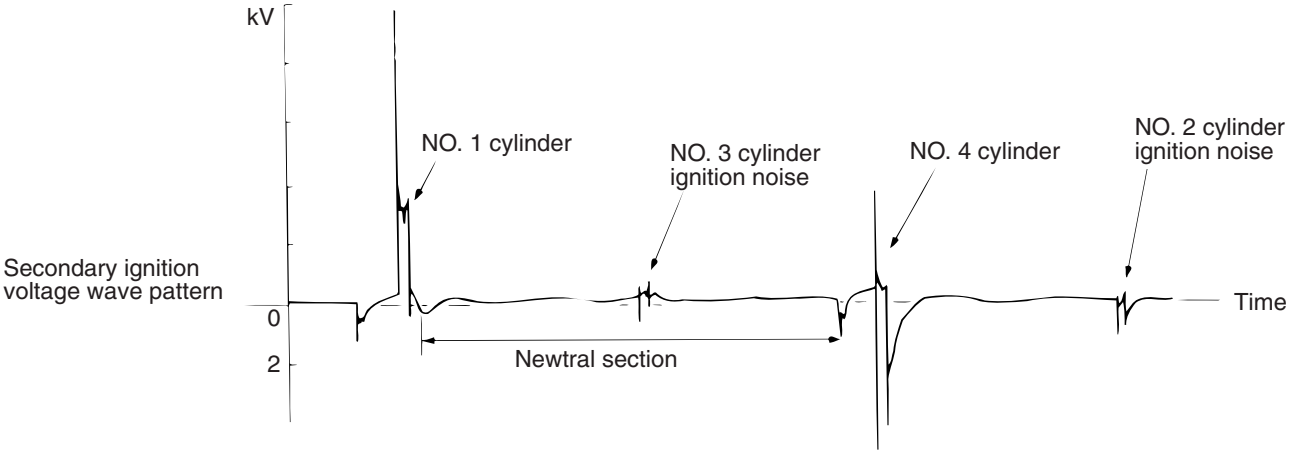
Observation Conditions (The only change from above condition is the pattern selector.)

Pattern selector	Display



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WAVEFORM OBSERVATION POINTS

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

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
	Short	Large	Large wear	High	Lean	Retarded	High resistance
Height	High	Large	Large wear	High	Lean	Retarded	High resistance
	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 and condenser
3 or more	Normal
Except above	Abnormal

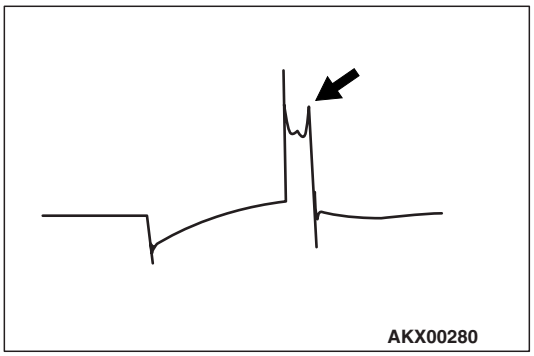
Point C: Number of vibrations at beginning of dwell section (Refer to abnormal waveform example 5)

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.

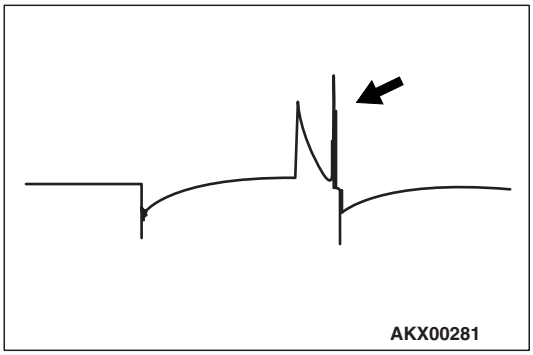
Ignition voltage	Plug gap	Condition of electrode	Compression force	Concentration of air mixture	Ignition timing	Spark plug cable
High	Large	Large wear	High	Lean	Retarded	High resistance
Low	Small	Normal	Low	Rich	Advanced	Leak

EXAMPLES OF ABNORMAL WAVE-FORMS



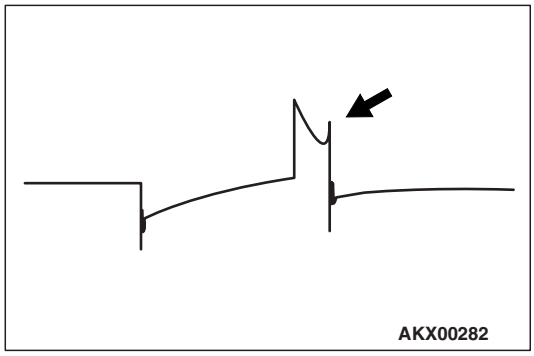
Example 1

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



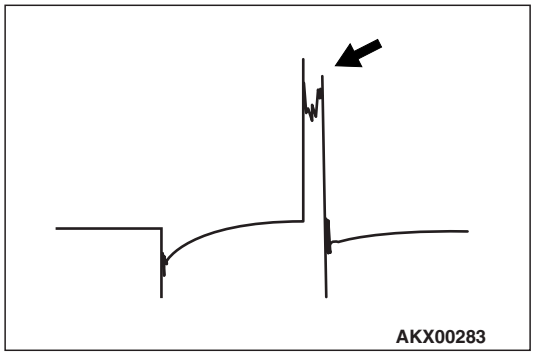
Example 2

- 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.



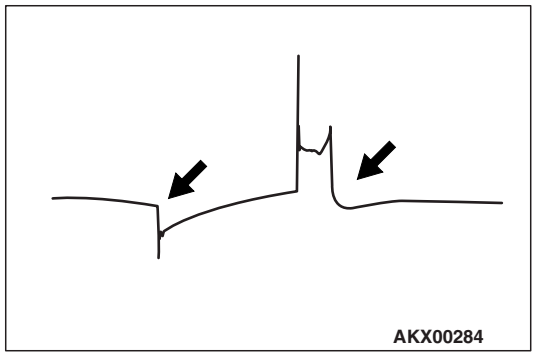
Example 3

- 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 waveform example 1.
- Cause of problem
  Spark plug cable is nearly falling off (Causing a dual ignition).



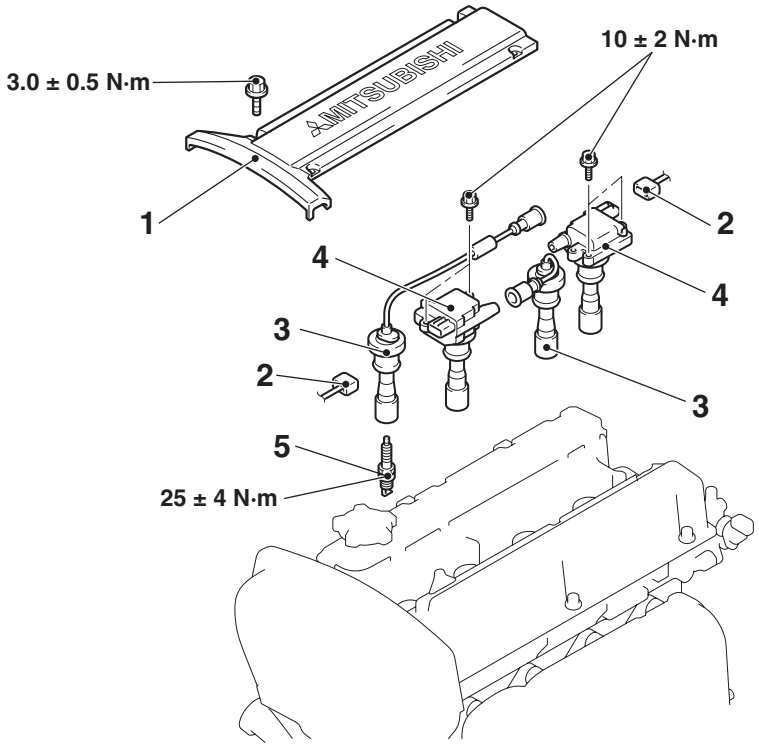
Example 5

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

IGNITION COIL

REMOVAL AND INSTALLATION
<4G63-NON-TURBO>

M1163004000642



AC301786AB

Removal steps

1. Rocker cover centre cover
2. Ignition coil connector
3. Spark plug cable

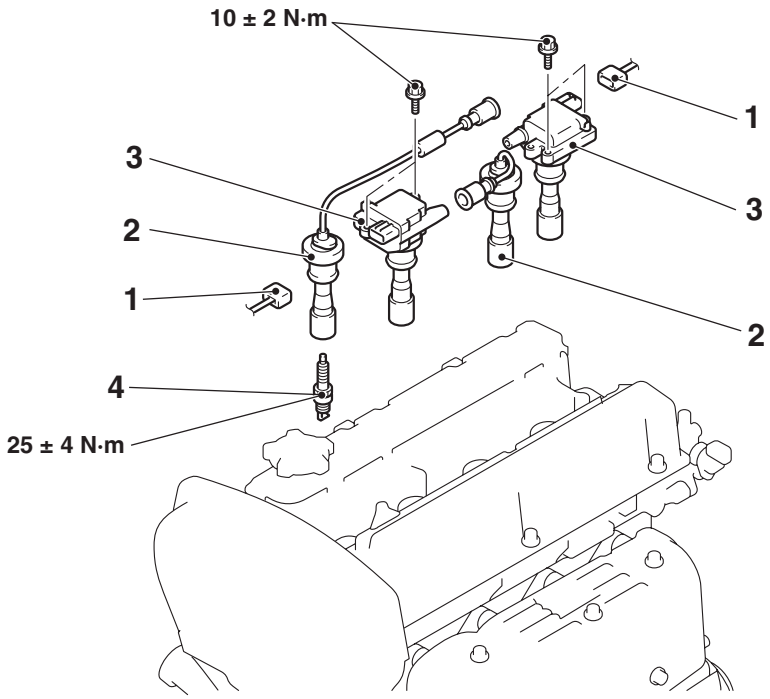
Removal steps (Continued)

4. Ignition coil
5. Spark plug

REMOVAL AND INSTALLATION <4G63-TURBO>

M1163004000620

Pre-removal and Post-installation Operation
- Intercooler Removal and Installation (Refer to GROUP 15, Intercooler P.15-9).
- Rocker cover centre cover Removal and Installation (Refer to GROUP 11C, Camshaft and Valve Stem Seal P.11C-17).



AC201868 AC

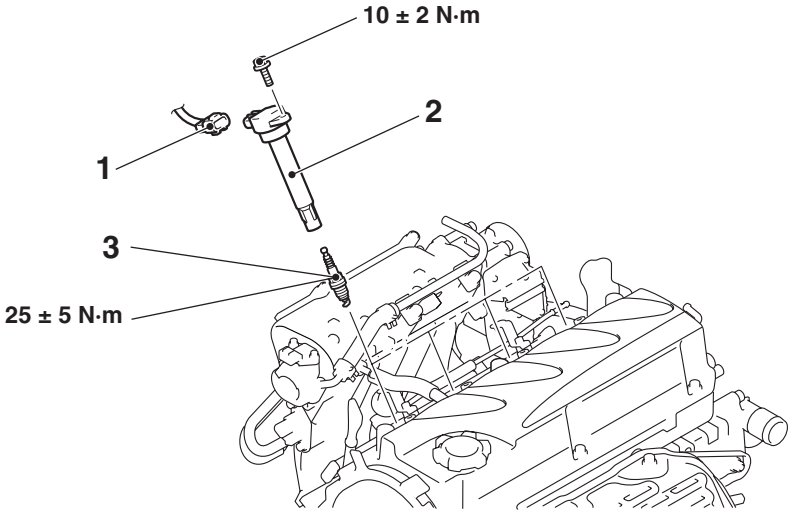
Removal steps
1. Ignition coil connector
2. Spark plug cable

Removal steps (Continued)
3. Ignition coil
4. Spark plug

REMOVAL AND INSTALLATION <4G69>

M1163004000501

Pre-removal and Post-installation Operation
Resonator Removal and Installation (Refer to GROUP 15, Air Cleaner P.15-8).



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Removal steps
1. Ignition coil connectors

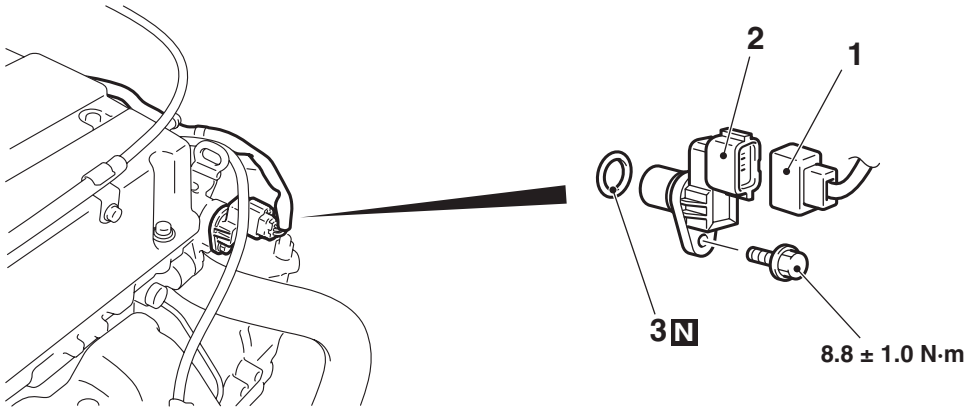
Removal steps (Continued)
2. Ignition coils
3. Spark plugs

CAMSHAFT POSITION SENSOR

REMOVAL AND INSTALLATION

M1163003400595

<4G63-Non-Turbo>

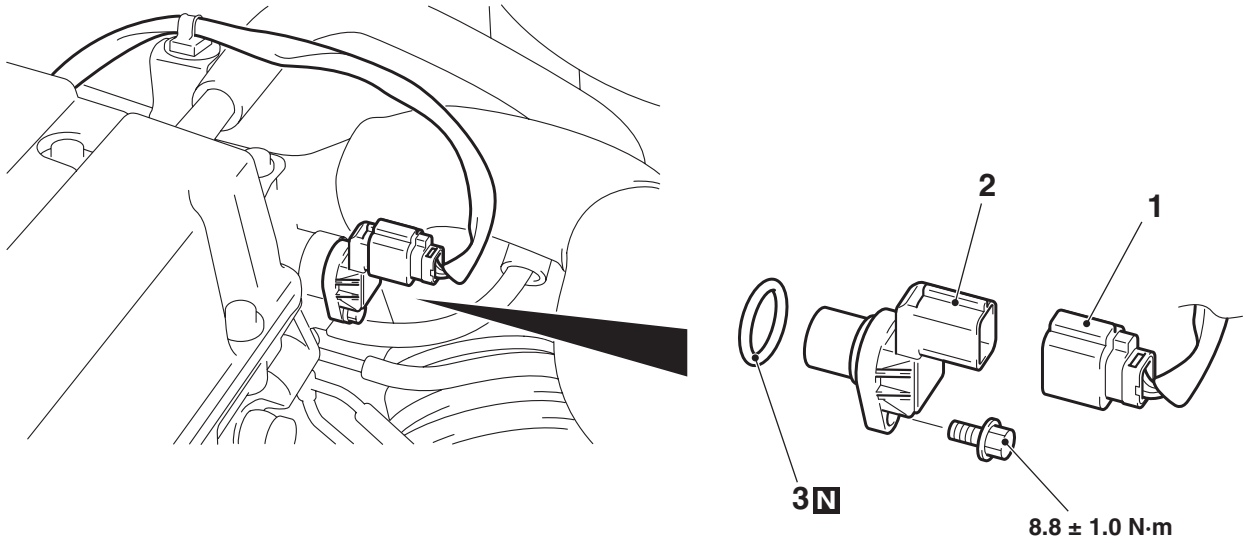


AC301556AB

Removal steps
1. Camshaft position sensor connector connection

Removal steps (Continued)
2. Camshaft position sensor
3. O-ring

<4G63-Turbo>

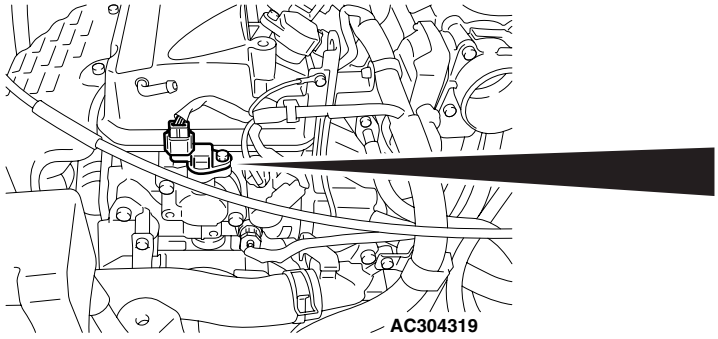


AC201869AC

Removal steps
1. Camshaft position sensor connector connection

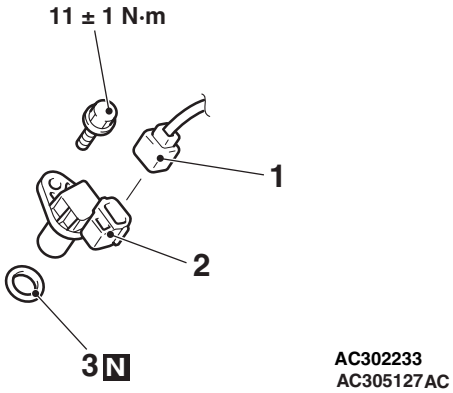
Removal steps (Continued)
2. Camshaft position sensor
3. O-ring

<4G69>



Removal steps

1. Camshaft position sensor connector connection



Removal steps (Continued)

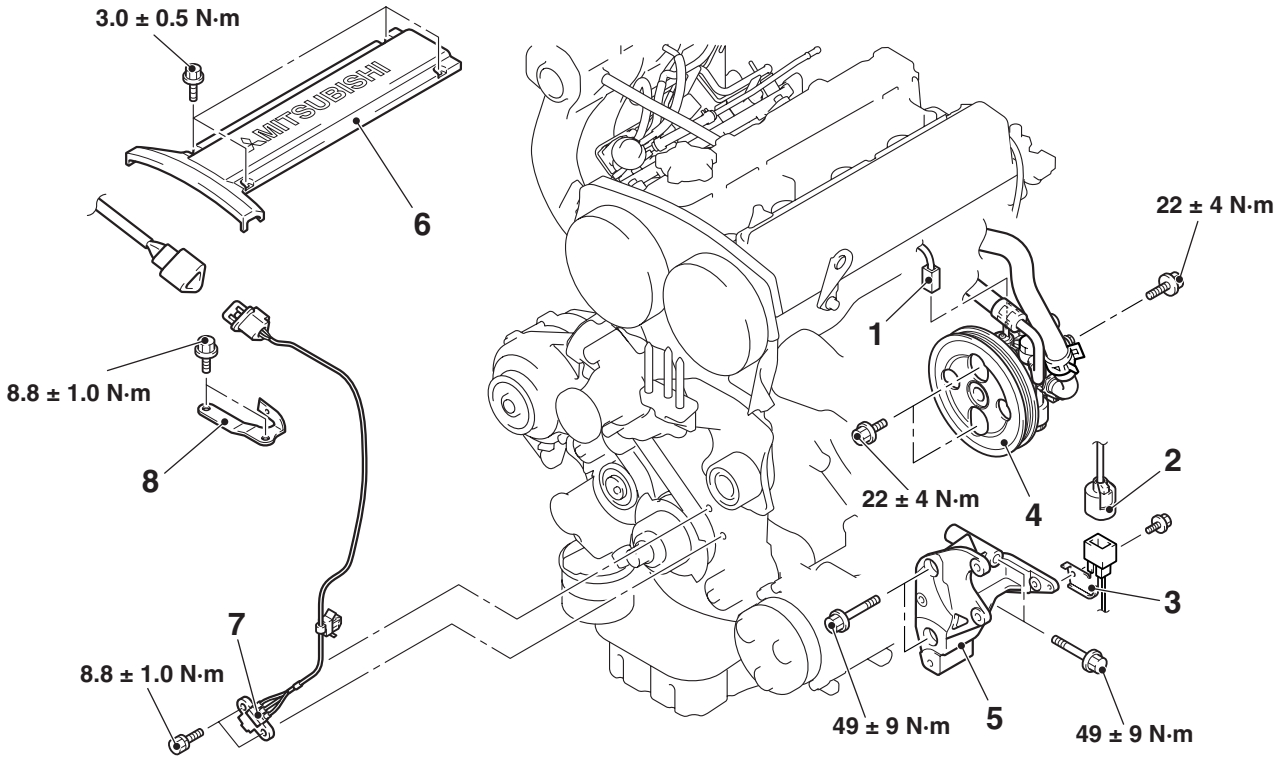
2. Camshaft position sensor
3. O-ring

CRANKSHAFT POSITION SENSOR

REMOVAL AND INSTALLATION <4G63-NON-TURBO>

M1163003500796

Pre-removal and Post-installation Operation
Timing Belt Removal and Installation (Refer to GROUP 11A, Timing Belt P.11A-40).



AC301612

Removal steps

1. Power steering pressure switch connector
2. A/C compressor connector
3. A/C compressor connector clamp
<<A>> 4. Power steering oil pump assembly
5. Power steering oil pump bracket
6. Rocker cover centre cover
7. Crankshaft position sensor
8. Crankshaft position sensor connector bracket

REMOVAL SERVICE POINT

<<A>> POWER STEERING OIL PUMP ASSEMBLY REMOVAL

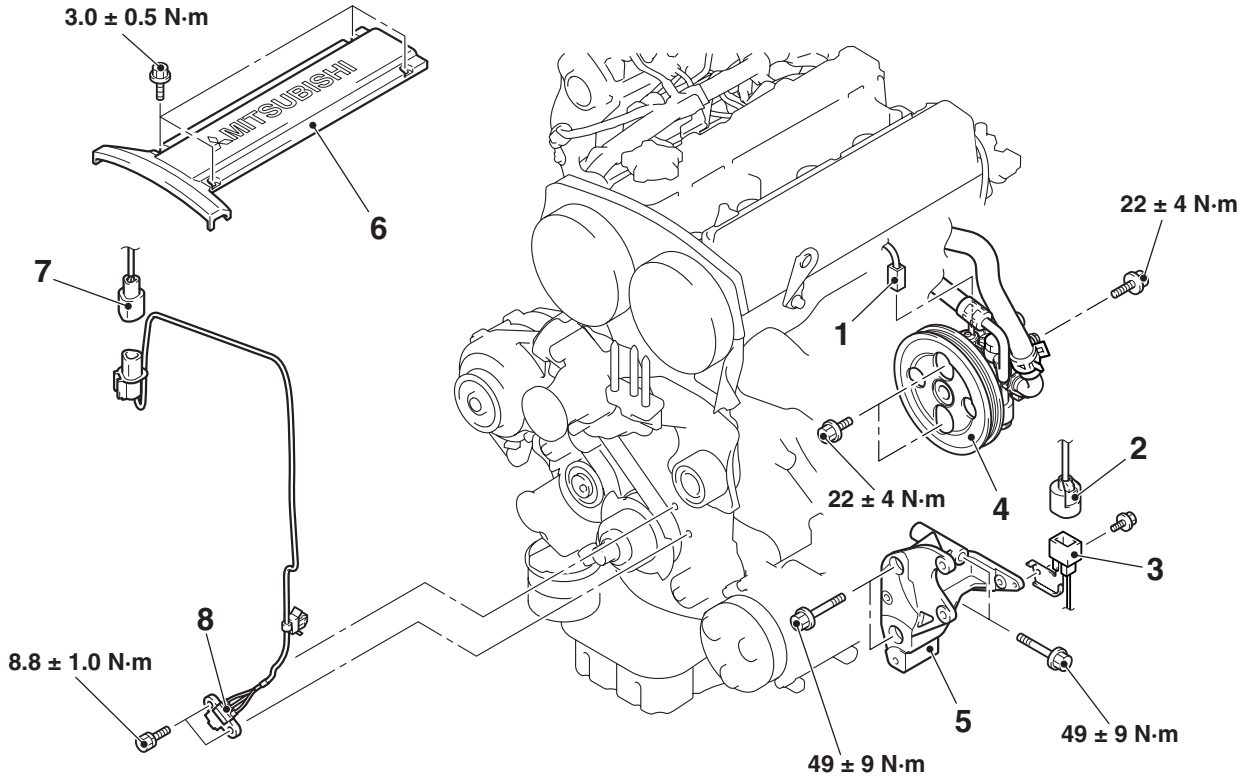
Remove the power steering oil pump assembly from the bracket with the hose attached.

NOTE: Place the removed power steering oil pump assembly in a place where it will not be a hindrance when removing and installing and secure it with a cord or wire.

REMOVAL AND INSTALLATION <4G63-TURBO>

M1163003500592

Pre-removal and Post-installation Operation
Timing Belt Removal and Installation (Refer to GROUP 11C, Timing Belt P.11C-34).



AC400851AB

Removal steps

1. Power steering pressure switch connector
2. A/C compressor connector
3. A/C compressor connector clamp
<<A>> 4. Power steering oil pump assembly
5. Power steering oil pump bracket
6. Rocker cover centre cover
7. Crankshaft position sensor connector
8. Crankshaft position sensor

REMOVAL SERVICE POINT

<<A>> POWER STEERING OIL PUMP ASSEMBLY REMOVAL

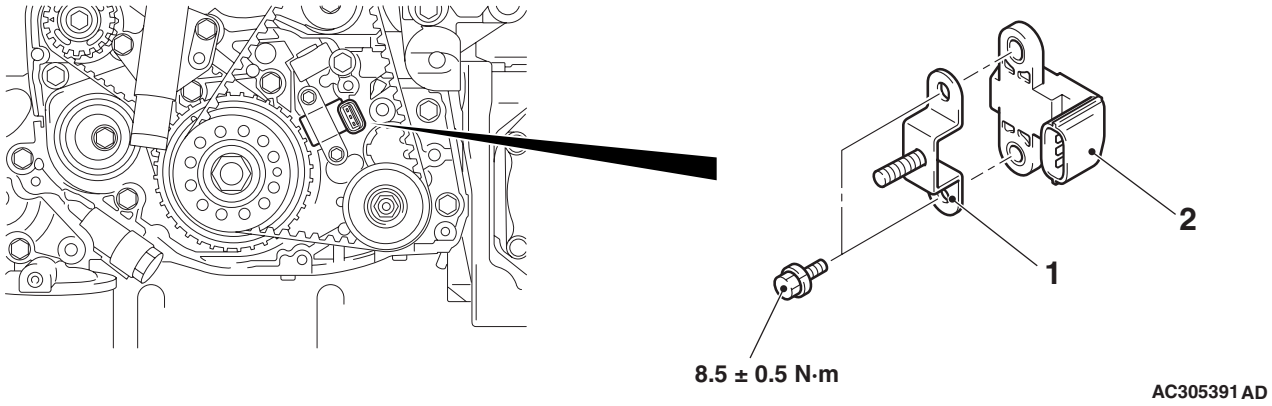
Remove the power steering oil pump assembly from the bracket with the hose attached.

NOTE: Place the removed power steering oil pump assembly in a place where it will not be a hindrance when removing and installing and secure it with a cord or wire.

REMOVAL AND INSTALLATION <4G69>

M1163003500600

Pre-removal and Post-installation Operation
Timing Belt Lower Cover Removal and Installation (Refer to GROUP 11E, Timing Belt P.11E-36).



Removal steps

1. Timing belt lower cover bracket
2. Crankshaft position sensor

DETONATION SENSOR

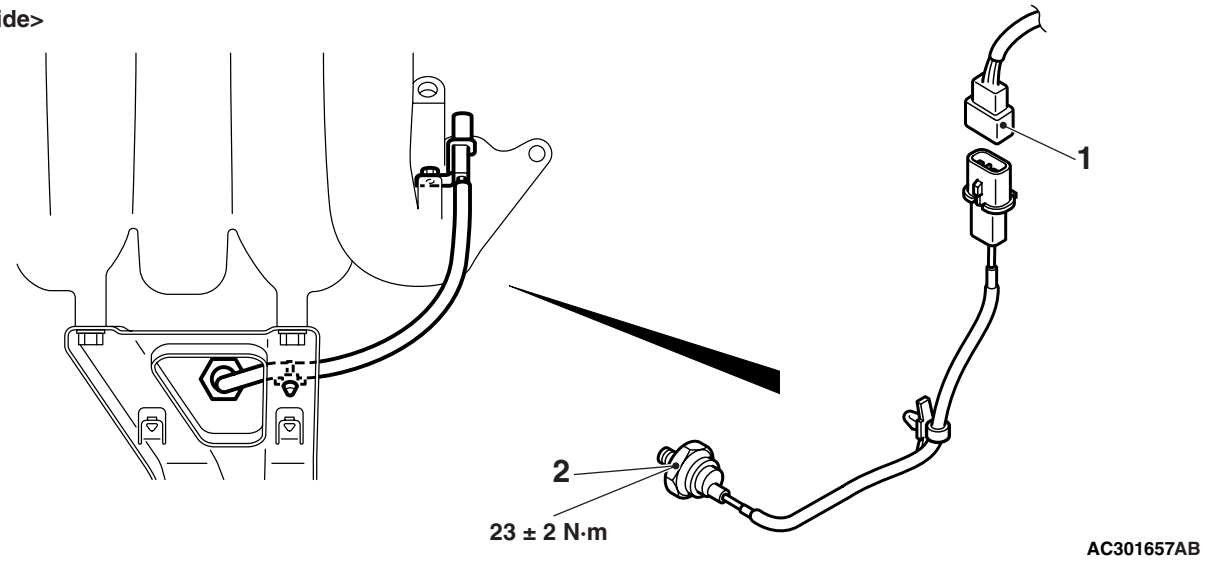
REMOVAL AND INSTALLATION <4G63-NON-TURBO, 4G63-TURBO>

M1163002801203

⚠ CAUTION

- **When the detonation sensor replacement is performed, use the M.U.T.-II/III to initialise the learning value (Refer to GROUP 00, Precautions Before Service – Initialisation Procedure for Learning Value in MPI Engine P.00-21).**
- **Do not drop or hit the detonation sensor against other components. Internal damage may result, and the detonation sensor will need to be replaced.**

<Intake side>

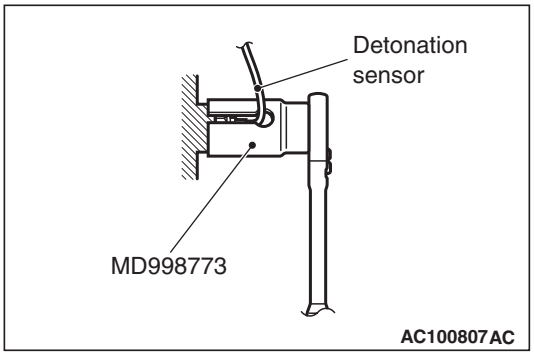


Removal steps

1. Detonation sensor connector connection

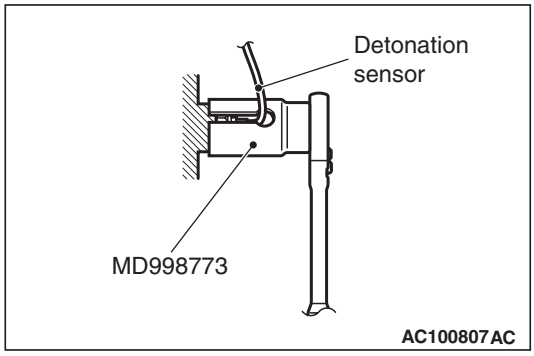
<<A>> >>A<< 2. Detonation sensor

REMOVAL SERVICE POINT <<A>> DETONATION SENSOR REMOVAL



Use special tool detonation sensor wrench (MD998773) to remove the detonation sensor.

INSTALLATION SERVICE POINT >>A<< DETONATION SENSOR INSTALLATION



Use special tool detonation sensor wrench (MD998773) to tighten the detonation sensor to the specified torque.

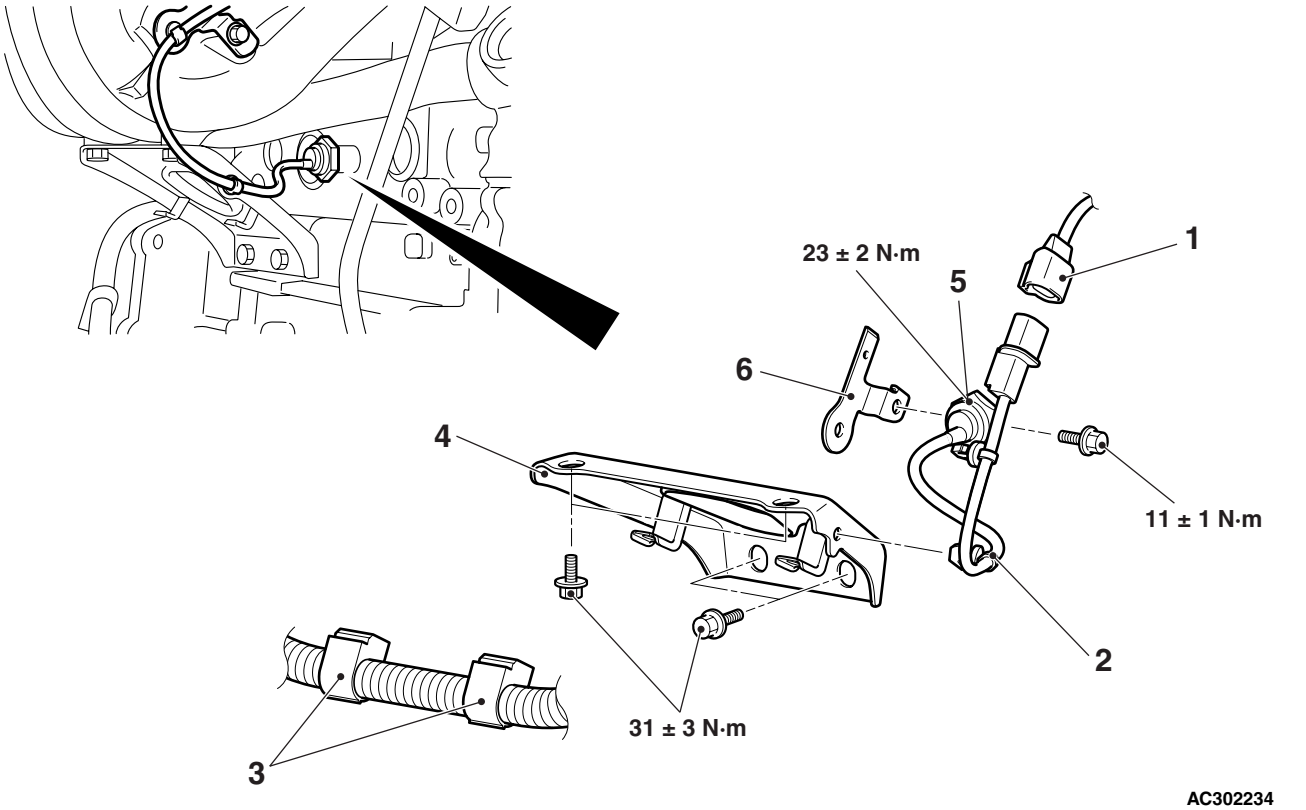
REMOVAL AND INSTALLATION <4G69>

M1163002801214

⚠ CAUTION

- **When the detonation sensor replacement is performed, use the M.U.T.-II/III to initialise the learning value (Refer to GROUP 00, Precautions Before Service – Initialisation Procedure for Learning Value in MPI Engine P.00-21).**
- **Do not drop or hit the detonation sensor against other components. Internal damage may result, and the detonation sensor will need to be replaced.**

Pre-removal and Post-installation Operation
Air Cleaner Removal and Installation (Refer to GROUP 15, Air Cleaner P.15-8).



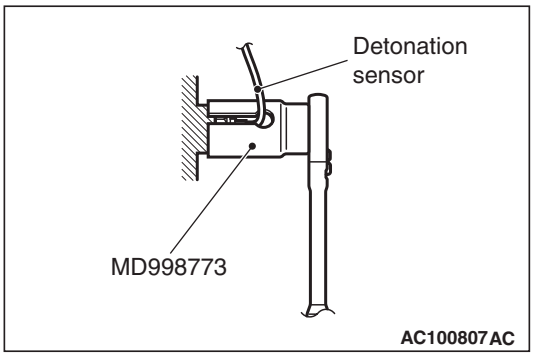
Removal steps
1. Detonation sensor connector connection
2. Detonation sensor clamp
3. Harness clamp

<<A>> >>A<<

Removal steps (Continued)
4. Intake manifold stay
5. Detonation sensor
6. Detonation sensor connector bracket

REMOVAL SERVICE POINT

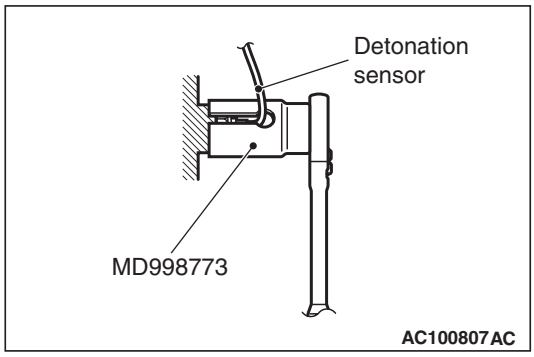
<<A>> DETONATION SENSOR REMOVAL



Use special tool detonation sensor wrench (MD998773) to remove the detonation sensor.

INSTALLATION SERVICE POINT

>>A<< DETONATION SENSOR INSTALLATION



Use special tool detonation sensor wrench (MD998773) to tighten the detonation sensor to the specified torque.

NOTES