GROUP 16

ENGINE ELECTRICAL

CONTENTS

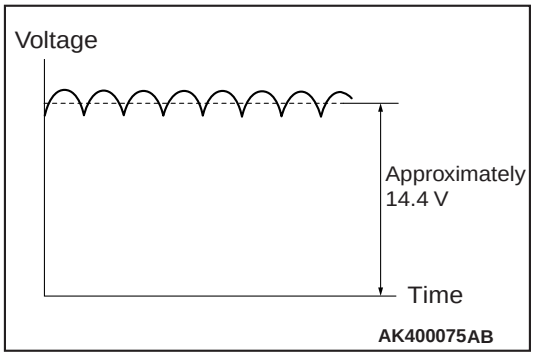
CHARGING SYSTEM

GENERAL INFORMATION

M1161000102153

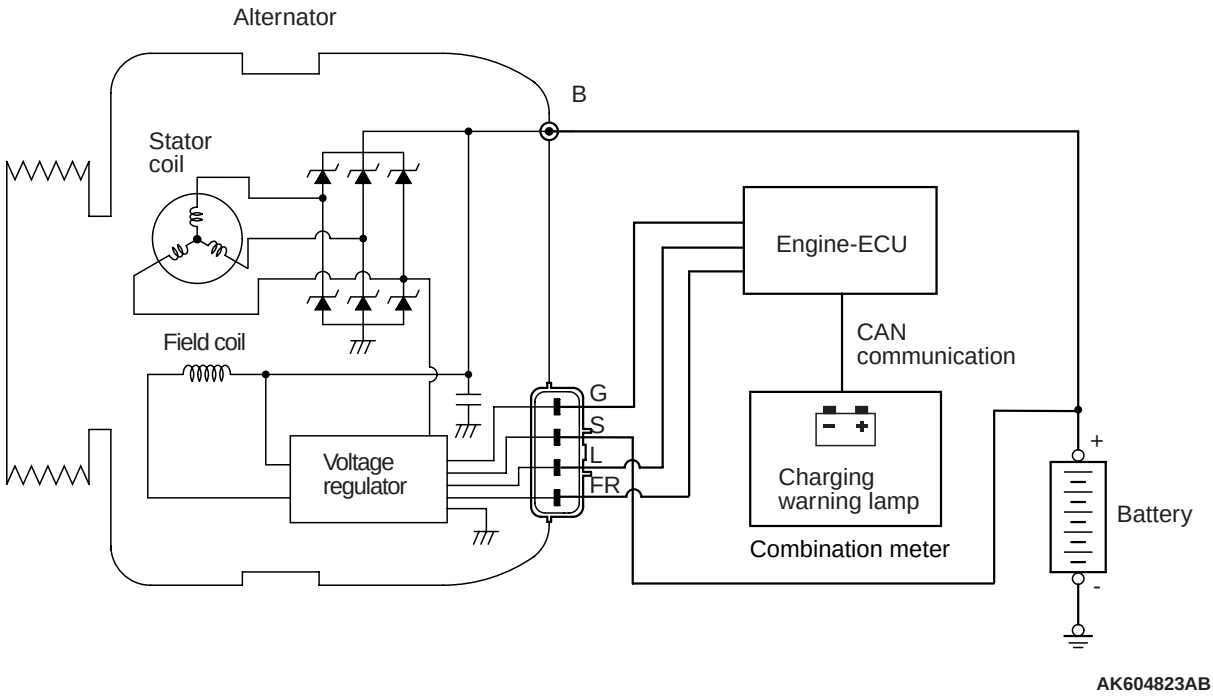
The charging system uses the alternator output to keep the battery charged at a constant level under various electrical loads.

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	4B1
Type	Battery voltage sensing
Rated output V/A	12/105

Item	4B1
Voltage regulator	Electronic built-in type

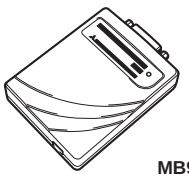
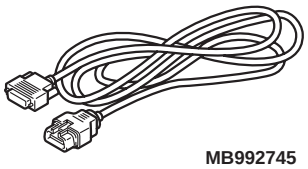
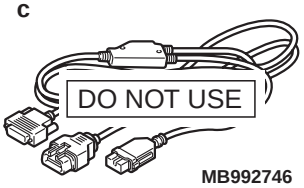
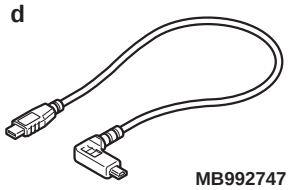
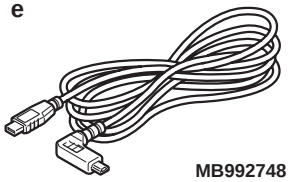
SERVICE SPECIFICATIONS

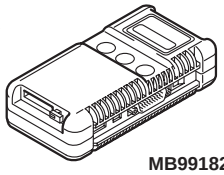
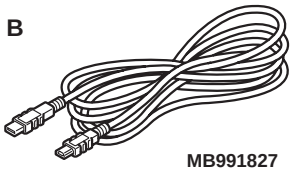
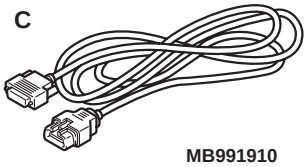
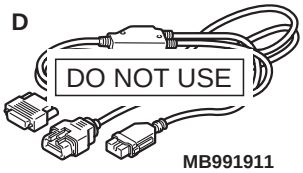
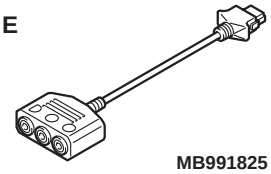
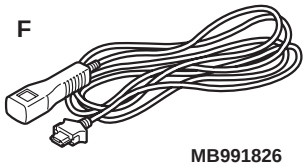
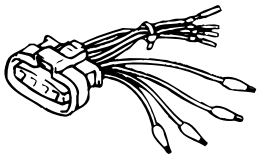
M1161000301400

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 TOOL

M1161000601207

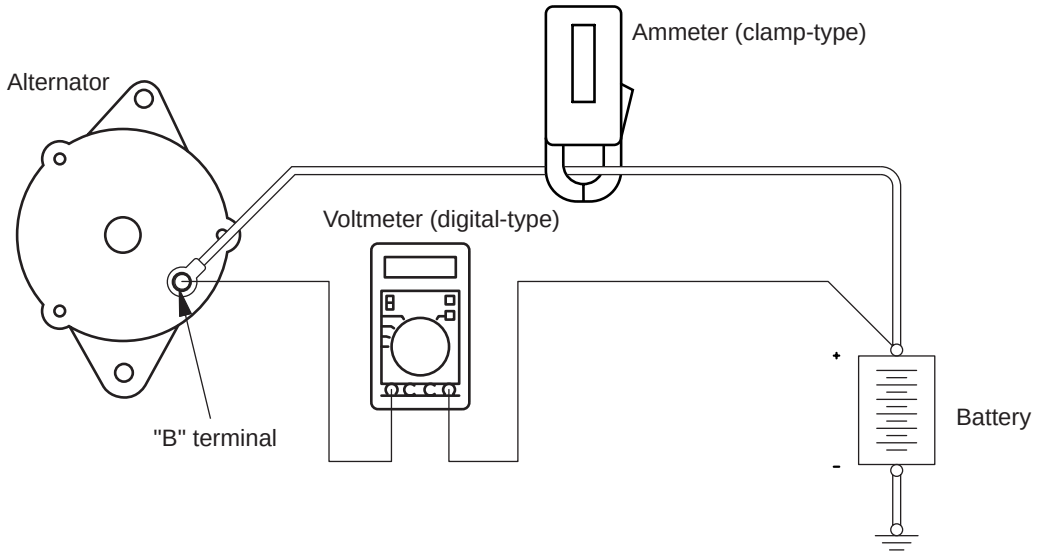
Tool	Number	Name	Use
a  MB992744 b  MB992745 c  MB992746 d  MB992747 e  MB992748 ACB05421AB	a. MB992744 b. MB992745 c. MB992746 d. MB992747 e. MB992748	a. Vehicle communication interface-Lite (V.C.I.-Lite) b. V.C.I.-Lite main harness A (for vehicles with CAN communication) c. V.C.I.-Lite main harness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

Tool	Number	Name	Use
A  MB991824 B  MB991827 C  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 engine speed **⚠ CAUTION** **For vehicles with CAN communication, use M.U.T.-III main harness A to send simulated vehicle speed. If you connect M.U.T.-III main harness B instead, the CAN communication does not function correctly.**
	MB991519	Alternator test harness	Checking the alternator ("S" terminal voltage)

ON-VEHICLE SERVICE

ALTERNATOR OUTPUT LINE VOLTAGE DROP TEST

M1161000902137



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 GROUP 11A – On-vehicle Service – Drive Belt Tension Check).
   - 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. Set a clamp-type DC test ammeter to the alternator "B" terminal output wire.

   NOTE: Disconnecting the alternator output wire and connecting the ammeter may not thoroughly diagnose an alternator output line resistance increase problem because of an insufficient connection between terminal "B" and the output wire.
5. Connect a digital-type voltmeter between the alternator "B" terminal and the battery (+) terminal. [Connect the (+) lead of the voltmeter to the "B" terminal and connect the (–) lead of the voltmeter to the battery (+) cable].
6. Reconnect the negative battery cable.
7. Connect the M.U.T.-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

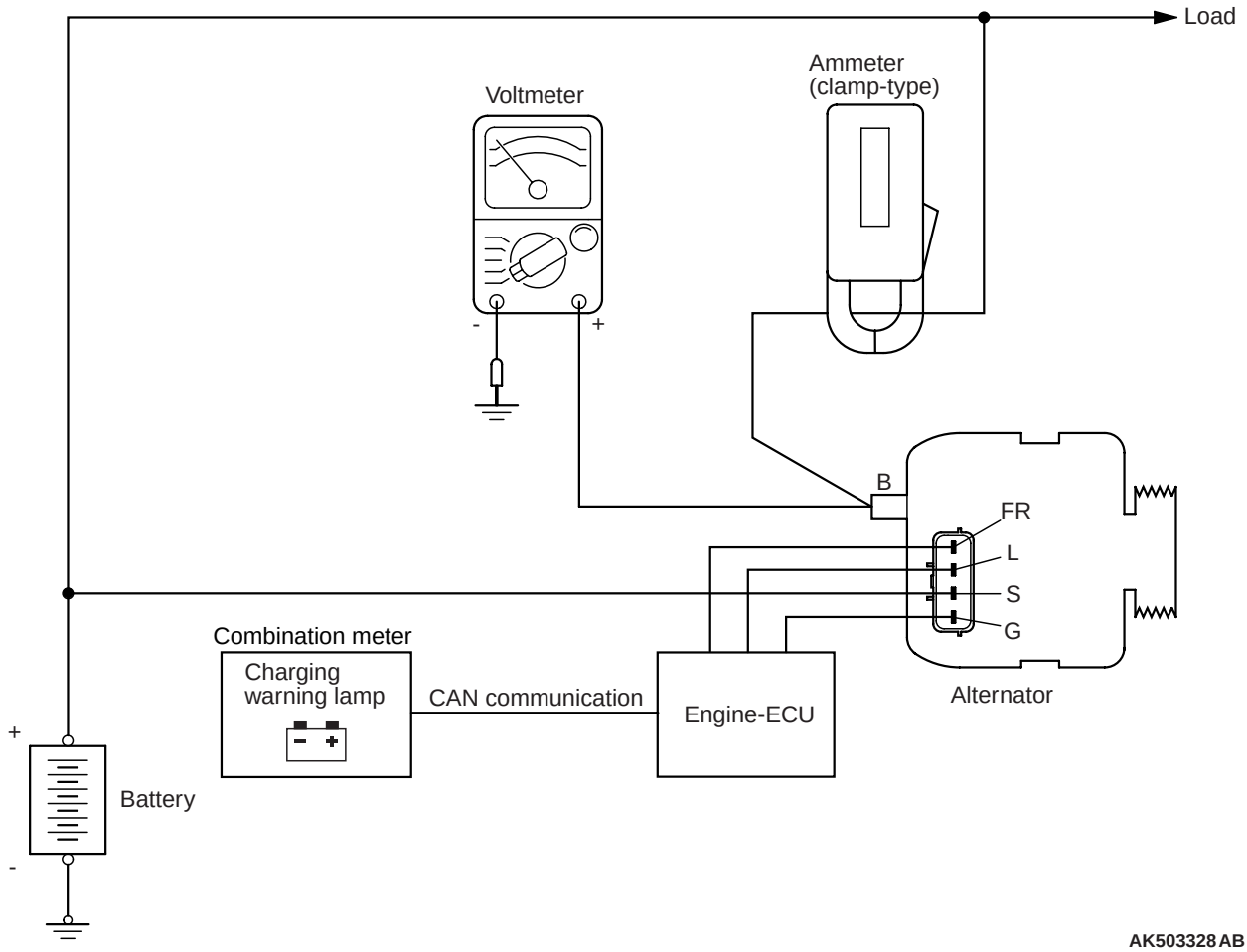
    NOTE: When the alternator output is high and the value displayed on the ammeter does not decrease until 30 A, set the value to 40 A. Read the value displayed on the voltmeter at this time. When the value range is 40 A, the limit is maximum 0.4 V.
11. If the value displayed on the voltmeter is above the 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 discoloured 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.Disconnect the M.U.T.-III.
16.Disconnect the negative battery cable.
17.Disconnect the ammeter and voltmeter.
18.Connect the negative battery cable.

OUTPUT CURRENT TEST

M1161001002450



AK503328 AB

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 GROUP 54A – Battery – On-vehicle Service – Battery Test .)

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

   - Drive belt tension

(Refer to GROUP 11A – On-vehicle Service – Drive Belt Tension Check).

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

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

5. Connect a voltmeter with a range of 0 – 20 V between the 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.-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.

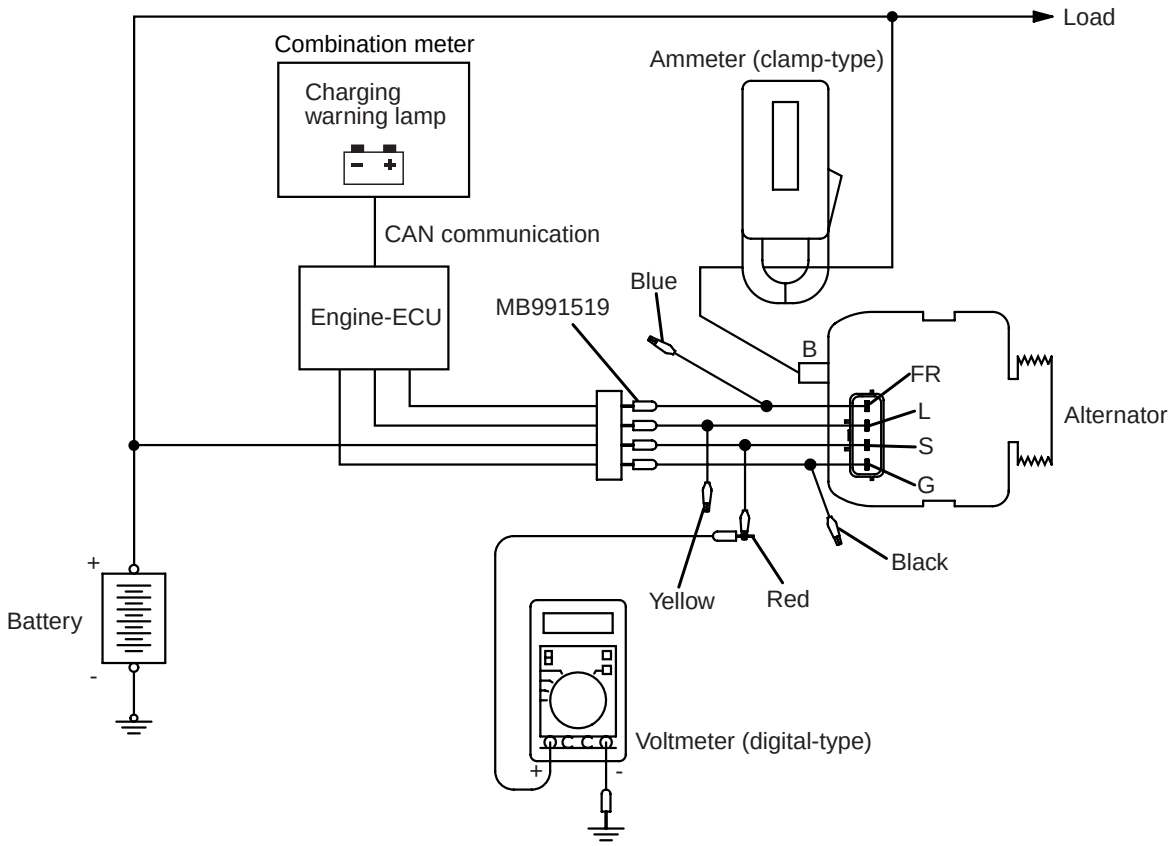
10. Turn the light switch on to turn on headlamps and then start the engine.
11. Immediately after setting the headlamps to high beam and turning the heater blower switch to the high revolution position, increase the engine speed to 2,500 r/min and read the maximum current output value displayed on the 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. Disconnect the M.U.T.-III.
16. Disconnect the negative battery cable.
17. Disconnect the ammeter and voltmeter.
18. Connect the negative battery cable.

REGULATED VOLTAGE TEST

M1161001102480



AK503329 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 GROUP 54A – Battery – On-vehicle Service – Battery Test .)

   - Drive belt tension

(Refer to GROUP 11A – On-vehicle Service – Drive Belt Tension Check)

   - 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. Set a clamp-type DC test ammeter to the alternator "B" terminal output wire.
6. Reconnect the negative battery cable.
7. Connect the M.U.T.-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.

    NOTE: Do not drive the vehicle after the engine starts.
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 15 A or less.
13. If the voltage reading conforms to the value in the voltage regulation table, then the voltage regulator is operating normally.

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

NOTE: When the voltage is approximately 12.8 V, the G-terminal is supposed to have a short circuit to the earth. Check the circuits relating to the G-terminal on the alternator.
(Refer to GROUP 13A – Troubleshooting – Inspection chart for trouble symptoms)

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

Voltage Regulation Table

STANDARD VALUE:

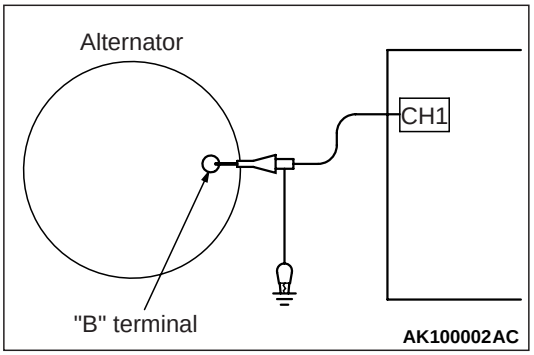
Inspection terminal	Voltage regulator ambient temperature °C	Voltage V
Terminal "S"	–20	14.2 – 15.4
	20	13.9 – 14.9
	60	13.4 – 14.6
	80	13.1 – 14.5

WAVEFORM CHECK USING AN OSCILLOSCOPE

M1161001201451

MEASUREMENT METHOD

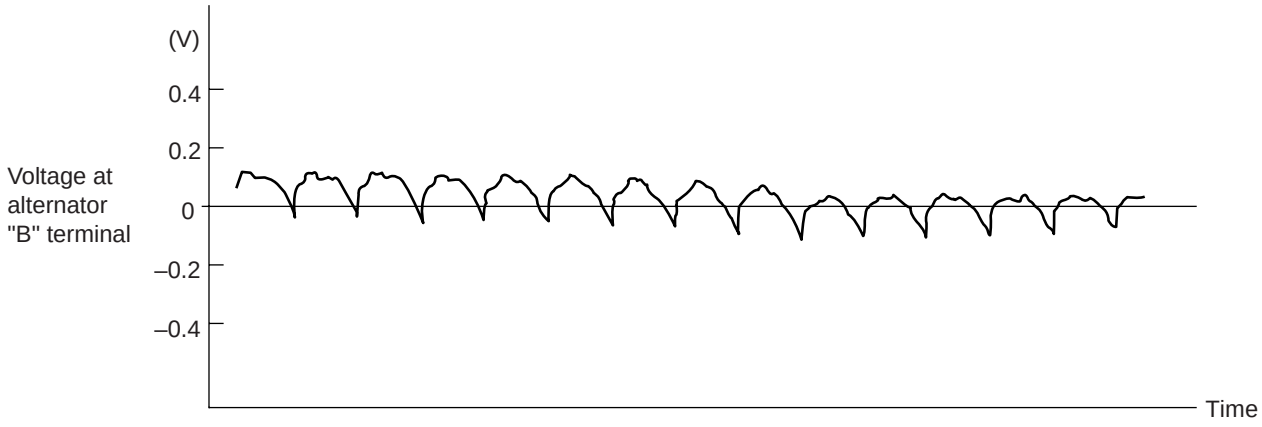
Connect the oscilloscope special patterns pick-up to the alternator "B" terminal.



STANDARD WAVEFORM

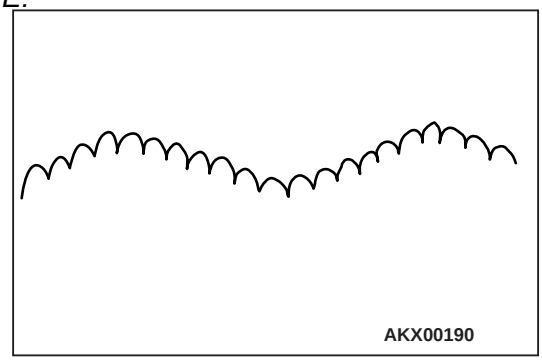
Observation Conditions

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



AKX00189AG

NOTE:



AKX00190

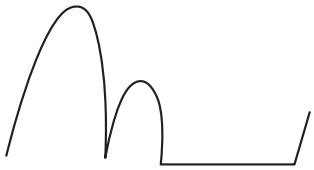
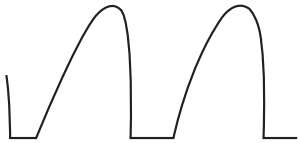
The voltage waveform of the alternator "B" terminal can undulate as shown in the illustration. This waveform is produced when the regulator operates according to fluctuations in the alternator load (current), and is normal for the alternator. In addition, when the voltage waveform reaches an excessively 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

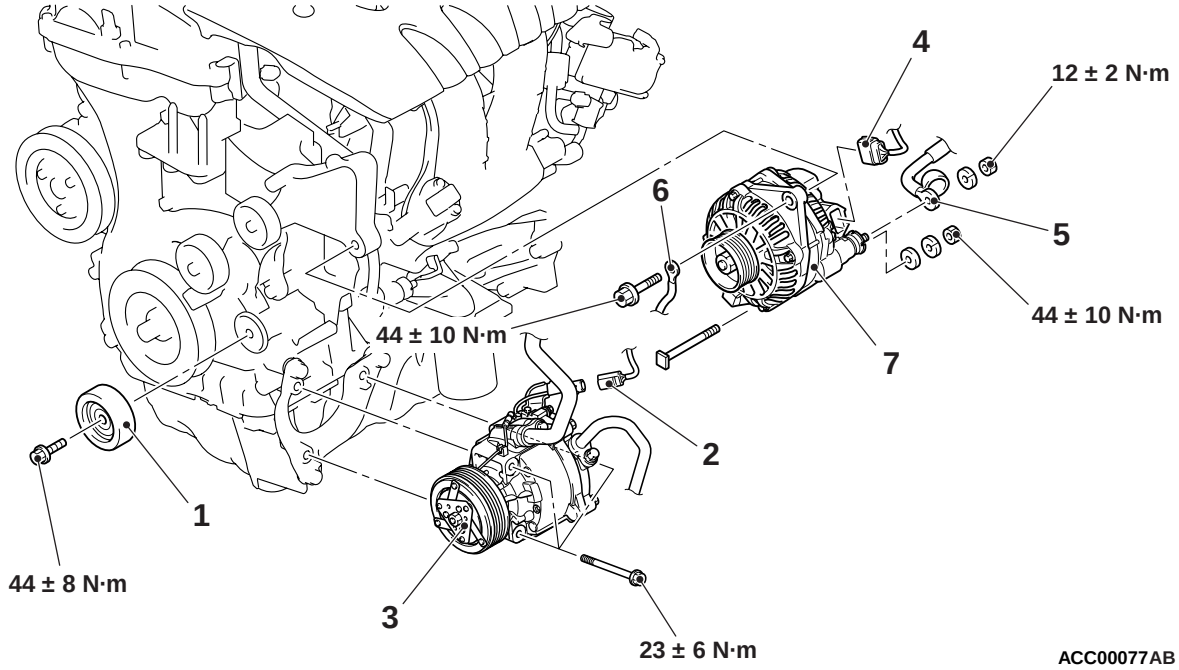
Abnormal waveform	Problem cause
Example 2  AKX00192	Short in diode
Example 3  AKX00193	Broken wire in stator coil
Example 4  AKX00194	Short in stator coil

ALTERNATOR ASSEMBLY

REMOVAL AND INSTALLATION

M1161001403912

Pre-removal operation	Post-installation operation
• Drive Belt Removal (Refer to GROUP 11A – Crankshaft Pulley).	• Drive Belt Installation (Refer to GROUP 11A – Crankshaft Pulley). • Drive Belt Tension Check (Refer to GROUP 11A – On-vehicle Service, Drive Belt Tension Check).



Removal steps

		1.	Idler pulley
		2.	A/C compressor and clutch assembly connector
<<**A**>>	>>**C**<<	3.	A/C compressor and clutch assembly
		4.	Alternator connector
		5.	Alternator terminal
	>>**B**<<	6.	Earth cable connection
<<**B**>>	>>**A**<<	7.	Alternator assembly

REMOVAL SERVICE POINTS

<<A>> A/C COMPRESSOR AND CLUTCH ASSEMBLY REMOVAL

1. Remove the A/C compressor and clutch assembly together with the hose from the bracket.
2. Tie the removed A/C compressor and clutch assembly with a string at a position where they will not interfere with the removal and installation of the alternator assembly.

>>B<< EARTH CABLE CONNECTION

<<B>> ALTERNATOR ASSEMBLY REMOVAL

Remove the alternator assembly to the downside.

INSTALLATION SERVICE POINTS

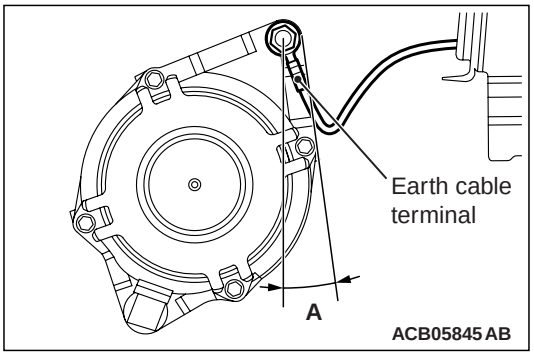
>>A<< ALTERNATOR ASSEMBLY INSTALLATION

1. Install the alternator to the accessory bracket.
2. Tighten the bolt on the upper side to the specified torque.

   Tightening torque: 44 ± 10 N·m

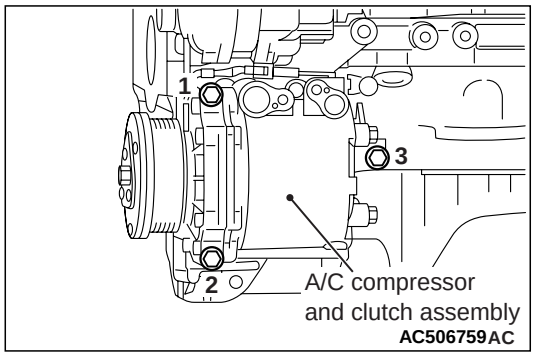
3. Tighten the nut on the lower side to the specified torque.

   Tightening torque: 44 ± 10 N·m



Install the earth cable within the area marked with A in the illustration.

>>C<< A/C COMPRESSOR AND CLUTCH ASSEMBLY INSTALLATION

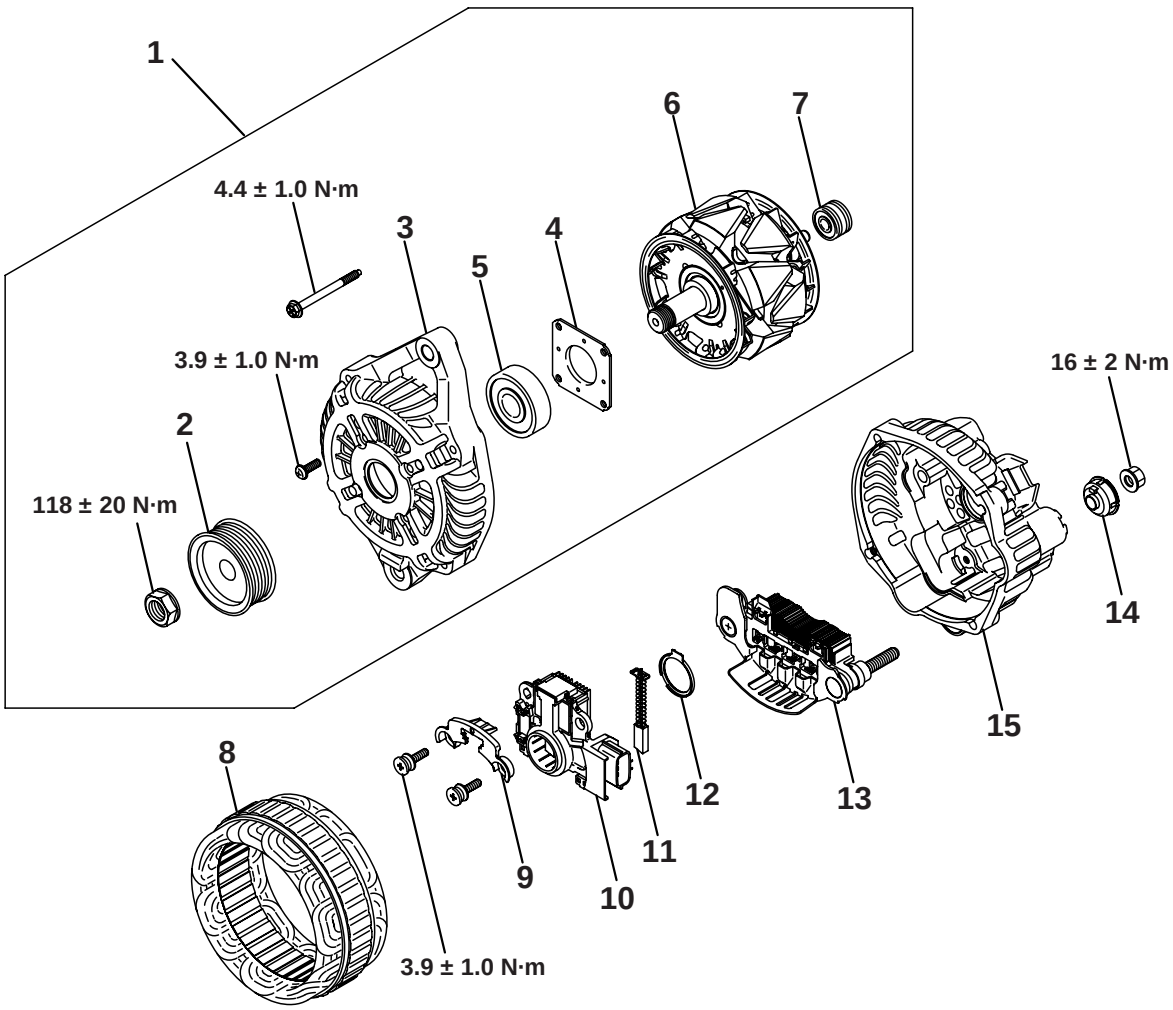


Tighten A/C compressor and clutch assembly mounting bolts to the specified torque in the order of number shown in the illustration.

Tightening torque: 23 ± 6 N·m

DISASSEMBLY AND REASSEMBLY

M1161001601073

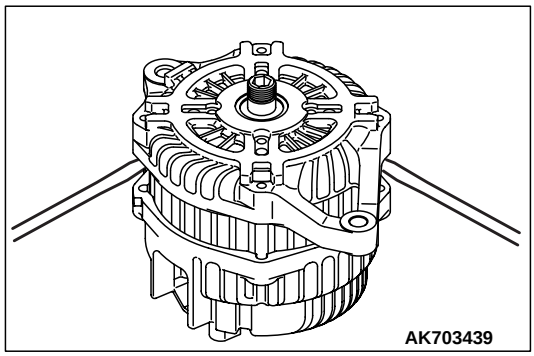


Disassembly steps

<<**A**>> 1. Front bracket assembly
<<**B**>> 2. Alternator pulley
3. Rotor
4. Rear bearing
5. Bearing retainer
6. Front bearing
>>**B**<< 7. Front bracket
<<**C**>> 8. Stator
9. Plate
<<**C**>> >>**A**<< 10. Regulator assembly
11. Brush
12. Rubber packing
13. Rectifier
14. Insulator
15. Rear bracket

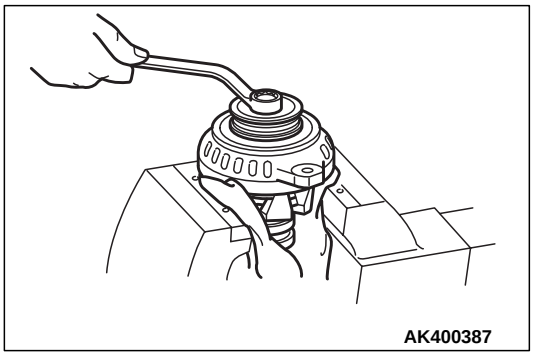
DISASSEMBLY SERVICE POINTS

<<A>> FRONT BRACKET REMOVAL



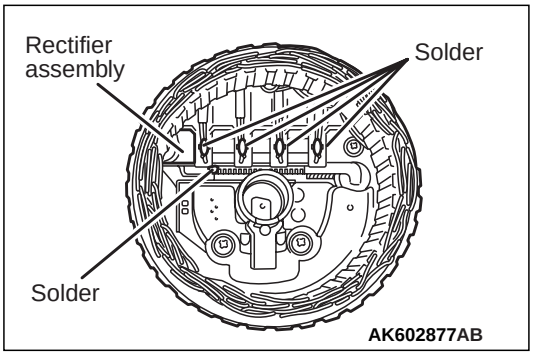
⚠ CAUTION
Do not insert the screwdriver blades too deep. Doing so could damage the stator coil.
Insert the blades of screwdrivers between the front bracket and stator core, and pry and separate them with the screwdrivers.

<<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 HOLDER REMOVAL

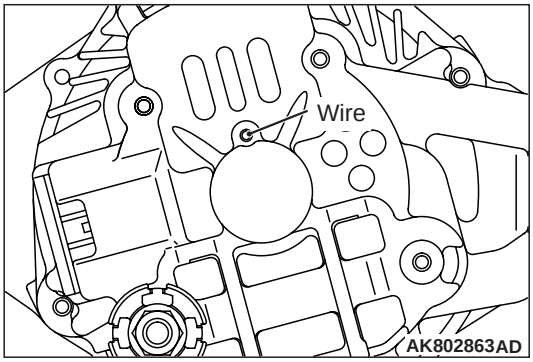


⚠ CAUTION
- **Use care that no undue force is exerted to lads of diodes.**
- **Check that the heat from the soldering iron is not transmitted to the diode for a long time.**

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, unsoldered on the rectifier.

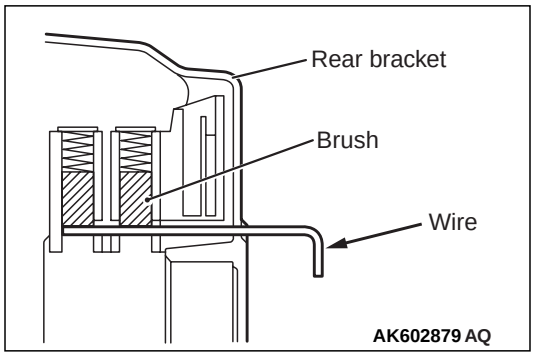
REASSEMBLY SERVICE POINTS

>>A<< REGULATOR ASSEMBLY INSTALLATION

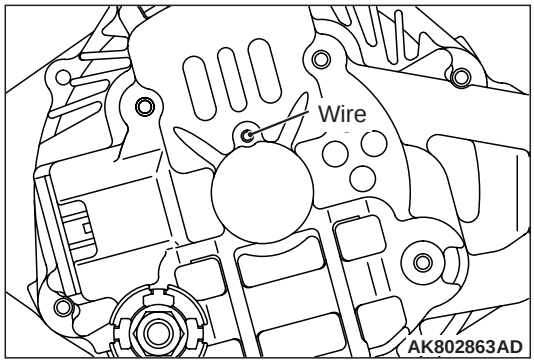


After installing the regulator assembly, insert a piece of wire through the hole in the rear bracket while pressing the brush to keep the brush against movement.

NOTE: Unless inserting the wire to fix the brush, the rotor installation is difficult.



>>B<< FRONT BRACKET INSTALLATION

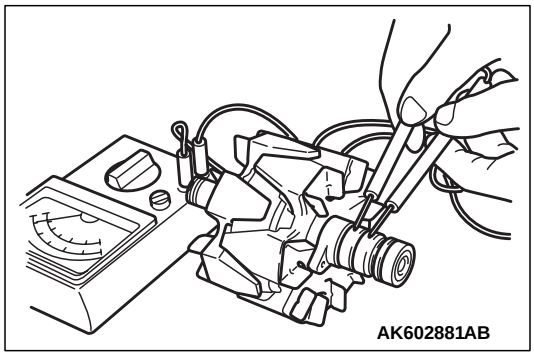


After installing the rotor, remove the wire used to secure the brush.

INSPECTION

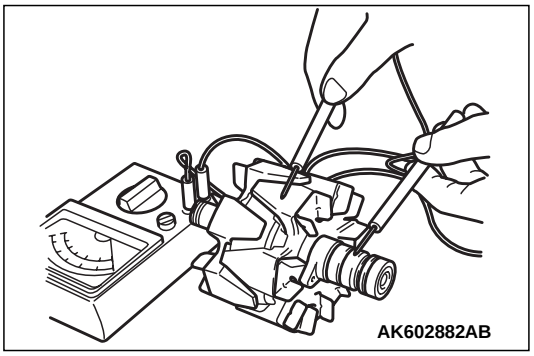
M1161001700914

ROTOR



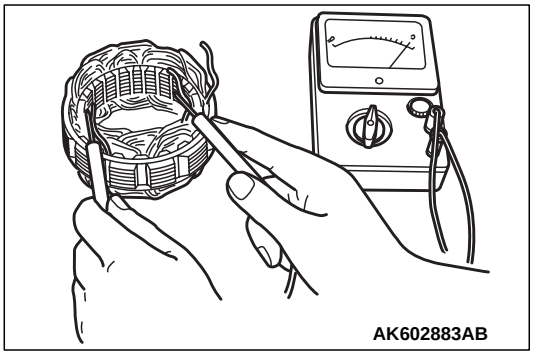
1. Check the rotor coil continuity. Make sure that there is continuity between the slip rings. Measure the rotor resistance. If it is excessively small, it indicates a shorted rotor. If there is no continuity or if it is shorted, replace the rotor assembly.

Standard value: 3 – 5 Ω

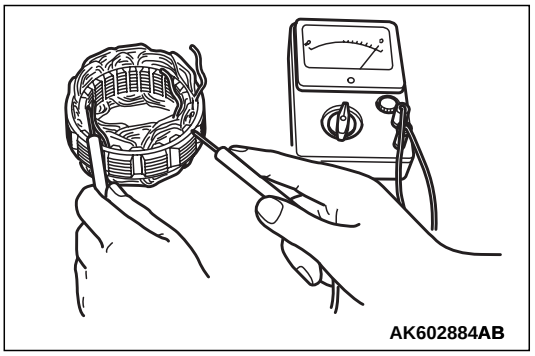


2. Check for rotor coil earthing. Make sure that there is no continuity between the slip ring and the core. Replace the rotor assembly if there is continuity.

STATOR

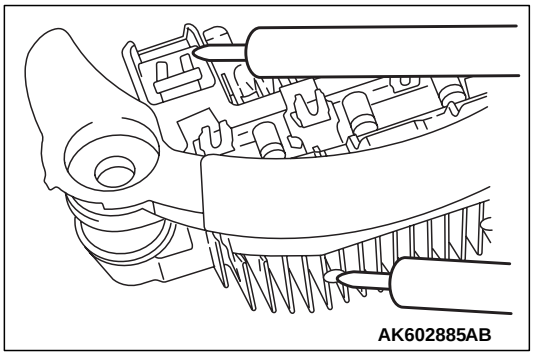


1. Check the stator continuity. Make sure that there is continuity between the coil leads. Replace the stator assembly if there is no continuity.



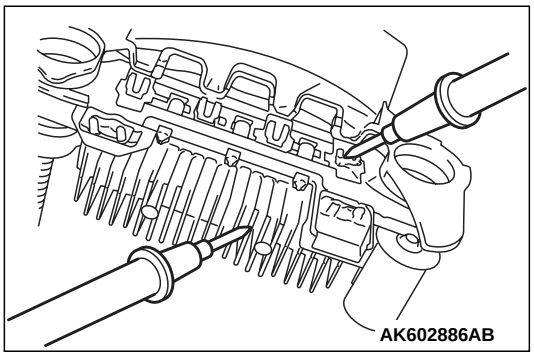
2. Check for coil earthing. Make sure that there is no continuity between the coil and the core. Replace the stator assembly if there is continuity.

RECTIFIERS



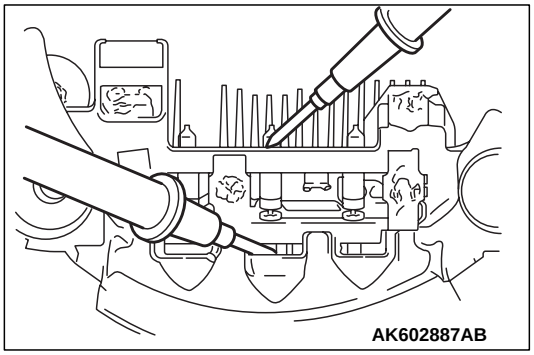
1. Positive Rectifier Test: Check for continuity between positive rectifier and stator coil lead connection terminal with a circuit tester.

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



2. Negative Rectifier Test: Check for continuity between negative rectifier and stator coil lead connection terminal.

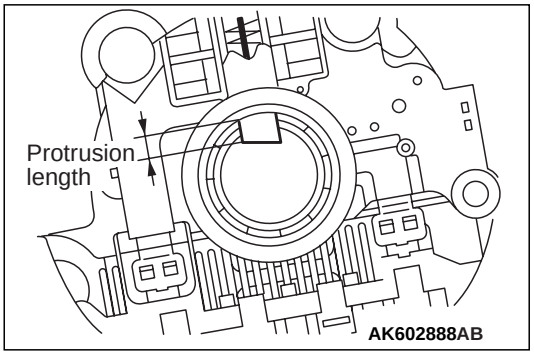
   If there is continuity in both directions, diode is shorted, and rectifier assembly must be replaced.



3. Diode Trio Test: Check three diodes for continuity by connecting an ammeter to both ends of each diode.

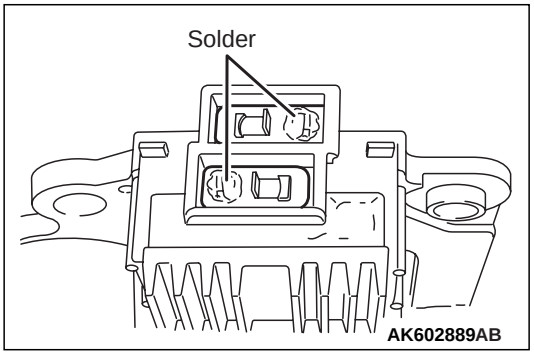
   If there is no continuity in both directions, diode is faulty and heatsink assembly must be replaced.

BRUSH



1. Replace the brush if its protrusion length is less than the limit.

   Limit: min. 2 mm



2. Unsolder pigtail and remove old brush and spring.

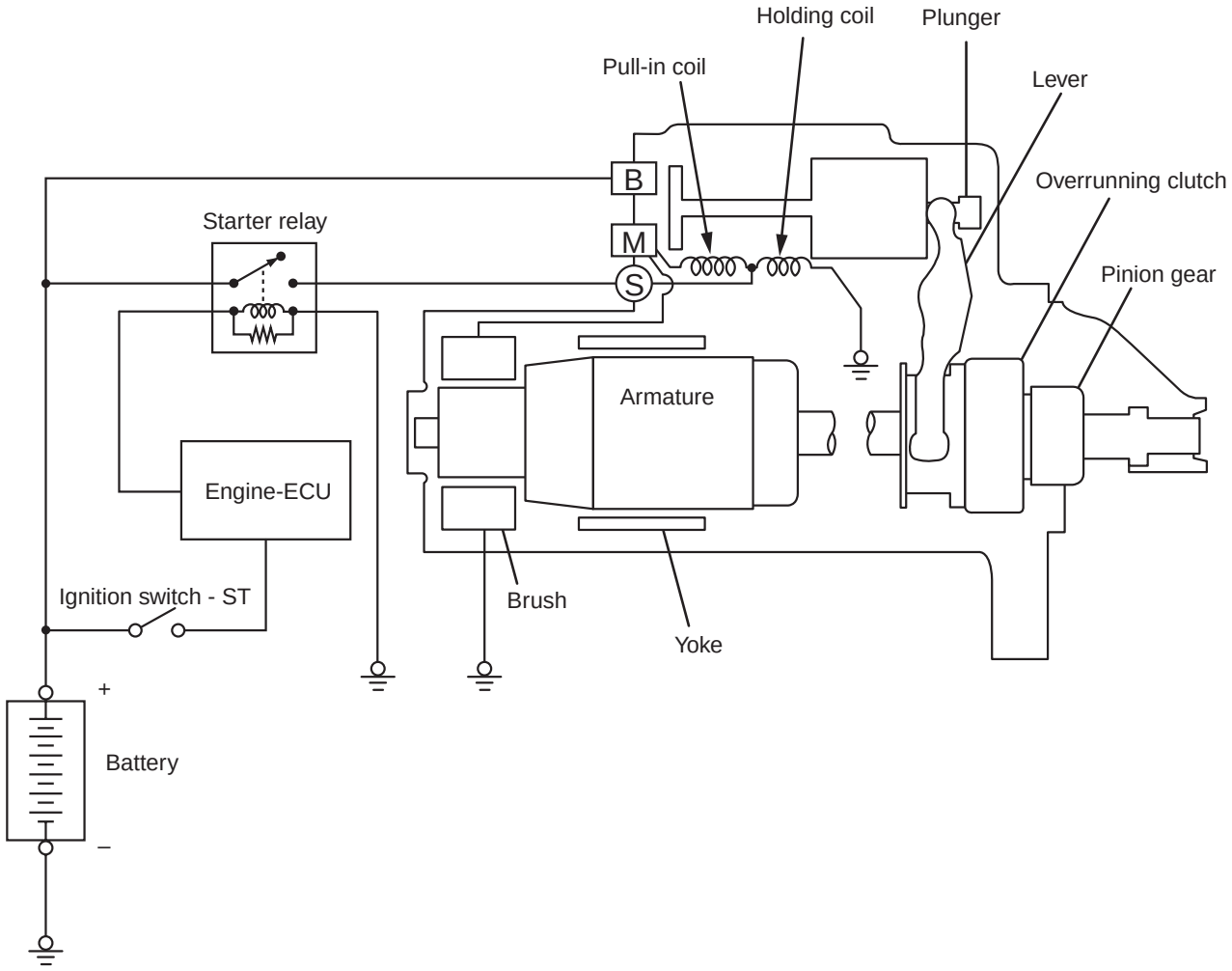
STARTING SYSTEM

GENERAL INFORMATION

M1162000101294

If the ignition switch is turned to the "START" position, engine-ECU turns ON the starter relay, current flows in the pull-in and holding coils provided inside magnetic switch, attracting the plunger, When the plunger is attracted, the lever connected to the plunger is actuated to engage the overrunning clutch with the pinion gear.
On the other hand, attracting the plunger will turn on the magnetic switch, allowing the "B" terminal and "M" terminal to conduct. Thus, current flows to engage the starter motor.
When the ignition switch is returned to the "ON" position after starting the engine, engine-ECU turns OFF the starter relay, the pinion gear is disengaged from the ring gear.
An overrunning clutch is provided between the pinion and the armature shaft, to prevent damage to the starter.

SYSTEM DIAGRAM



AK604152 AC

STARTER MOTOR SPECIFICATIONS

Item	4B1
Type	Reduction drive with planetary gear

Item	4B1
Rated output kW/V	1.3/12
Number of pinion teeth	8

SERVICE SPECIFICATIONS

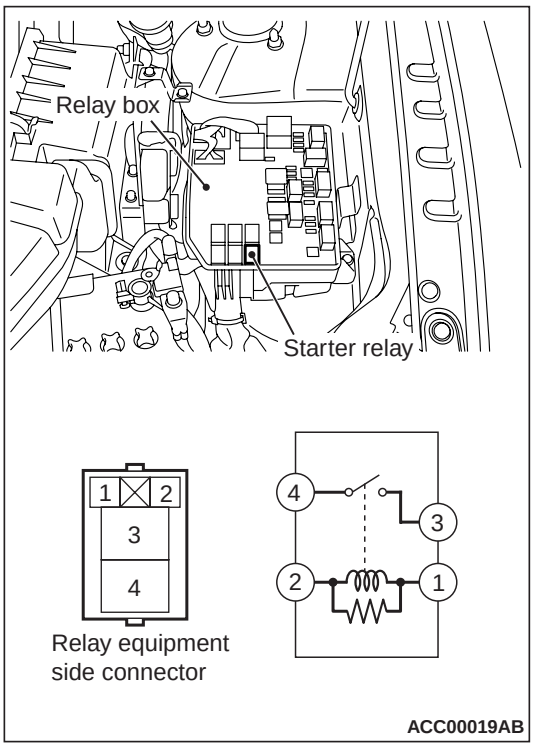
M1162000300734

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

ON-VEHICLE SERVICE

STARTER RELAY CONTINUITY CHECK

M1162001401179



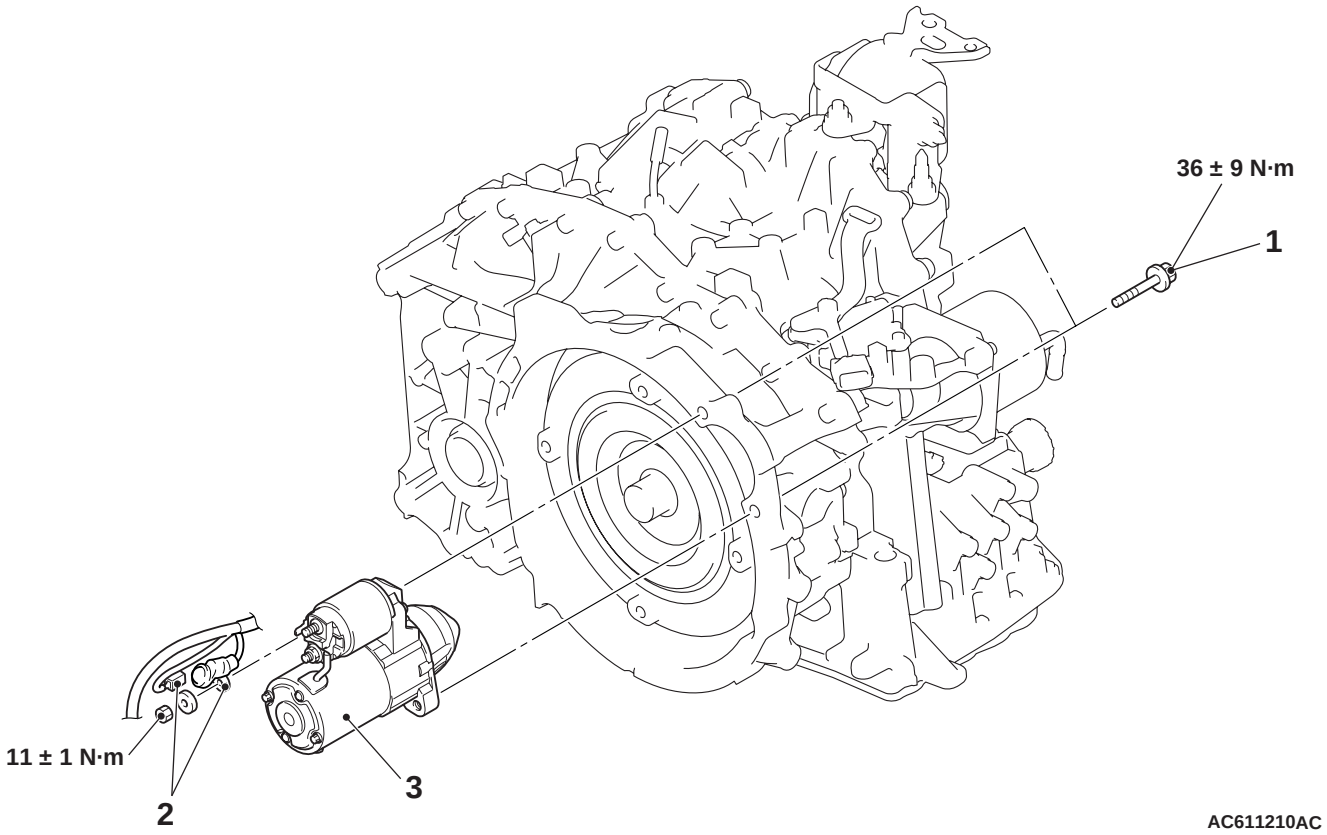
Battery voltage	Terminal No. to be connected to tester	Continuity test results
Not applied	3 – 4	Open circuit
Connect terminal No.1 to battery (–) terminal. Connect terminal No.2 to battery (+) terminal.	3 – 4	Continuity (less than 2 Ω)

STARTER MOTOR ASSEMBLY

REMOVAL AND INSTALLATION

M1162001003348

Pre-removal operation	Post-installation operation
• Air cleaner intake duct and air intake hose removal (Refer to GROUP 15 – Air cleaner). • Battery and battery tray removal (Refer to GROUP 54A – Battery). • Engine room under cover panel removal (Refer to GROUP 51 – Under cover).	• Engine room under cover panel installation (Refer to GROUP 51 – Under cover). • Battery and battery tray installation (Refer to GROUP 54A – Battery). • Air cleaner intake duct and air intake hose installation (Refer to GROUP 15 – Air cleaner).



Removal steps

<<**A**>> • Throttle body assembly mounting bolt (Refer to GROUP 13A – Throttle Body Assembly .)
1. Starter mounting bolt
<<**B**>> 2. Starter connector and terminal
<<**B**>> 3. Starter assembly

REMOVAL SERVICE POINTS

<<A>> THROTTLE BODY ASSEMBLY MOUNTING BOLT REMOVAL

1. Remove the throttle body assembly together with the water hose from the inlet manifold.
2. Tie the removed throttle body assembly with a string at a position where it will not interfere with the operation.

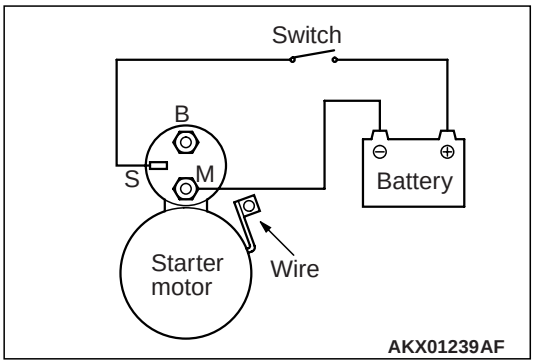
<<B>> STARTER CONNECTOR AND TERMINAL/STARTER ASSEMBLY REMOVAL

1. Slide the starter assembly, and remove the starter connector and terminal.
2. Remove the starter assembly from the lower front of the engine.

STARTER MOTOR ASSEMBLY INSPECTION

M1162001101305

PINION GAP ADJUSTMENT

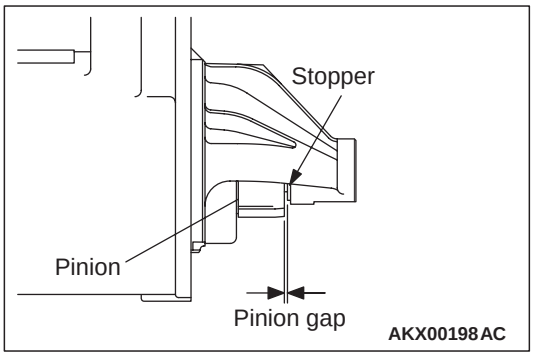


1. Disconnect the field coil wire from the M-terminal of the magnetic switch.
2. Connect a 12-volt battery between the S-terminal and M-terminal.

⚠ CAUTION

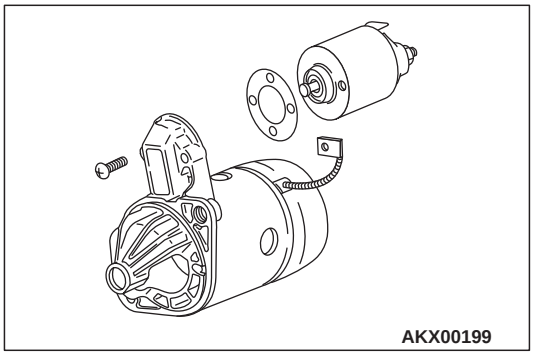
This test must be performed quickly (in less than 10 seconds) to prevent the coil from burning.

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



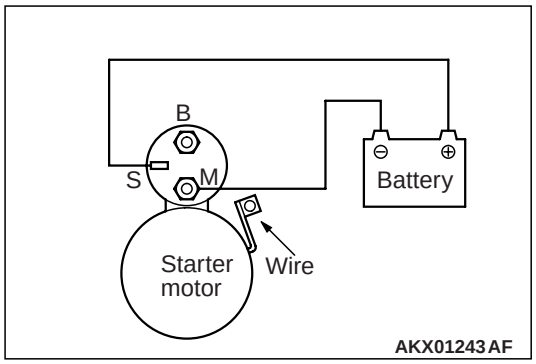
4. Check the pinion-to-stopper clearance (pinion gap) with a feeler gauge.

   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



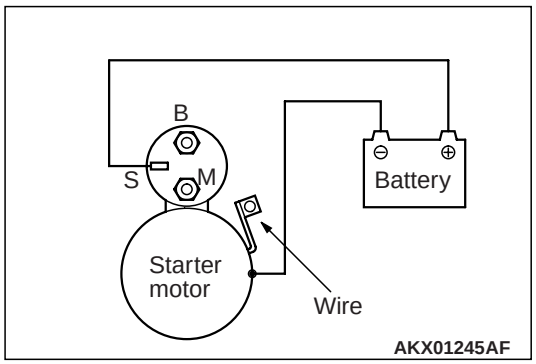
1. Disconnect the field coil wire from the M-terminal of the magnetic switch.

⚠ 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



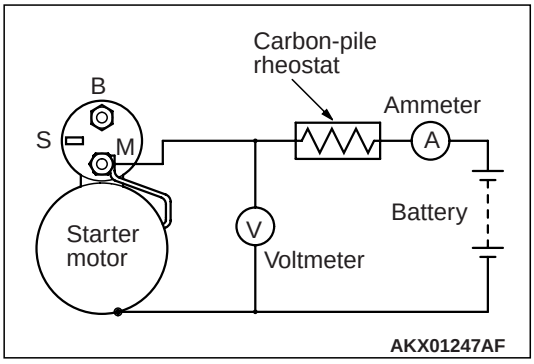
1. Disconnect the field coil wire from the M-terminal of the magnetic switch.

⚠ 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.

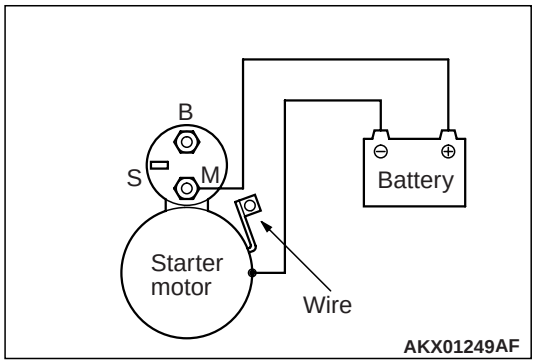
FREE RUNNING TEST



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 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 battery (–) terminal to the starter motor body.
6. Adjust the rheostat until the battery 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 90 A

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.

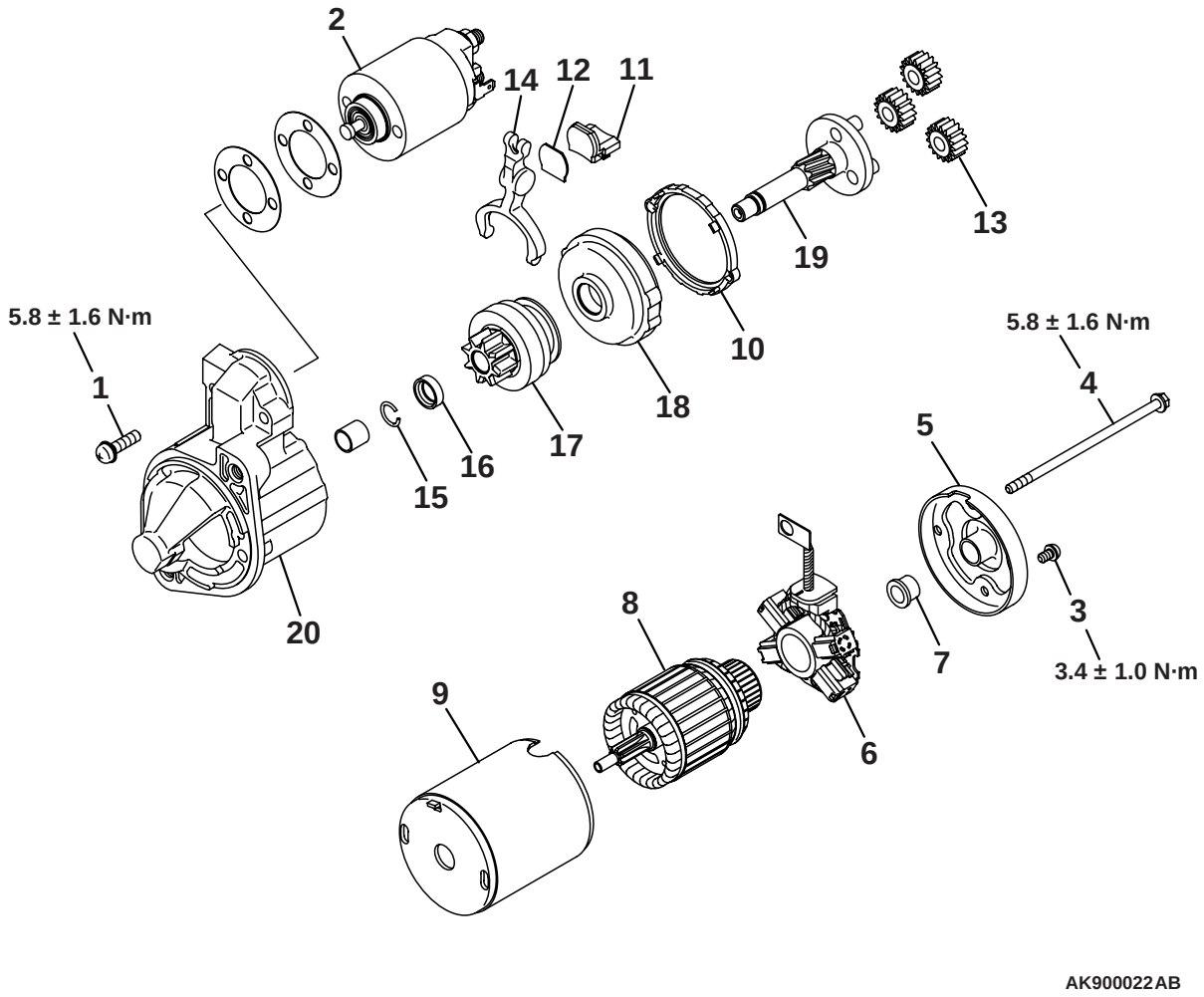
⚠ WARNING

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 REASSEMBLY

M1162001201023



Disassembly steps

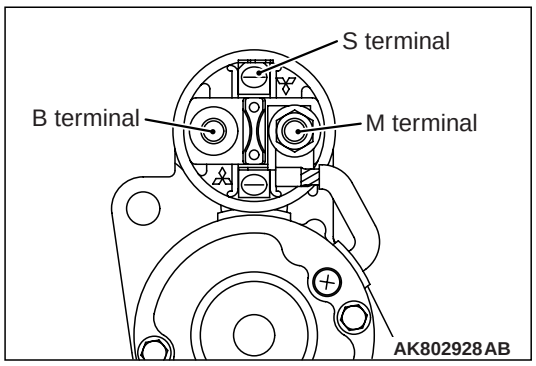
1. Screw
<<**A**>> 2. Magnetic switch
3. Screw
4. Bolt
5. Rear bracket
6. Brush holder
7. Rear bearing
8. Armature
9. Yoke assembly
10. Packing A
11. Packing B
12. Plate
13. Planetary gear
14. Lever
<<**B**>> >>**A**<< 15. Snap ring
<<**B**>> >>**A**<< 16. Stopper ring
17. Overrunning clutch
18. Internal gear

Disassembly steps (Continued)

19. Planetary gear shaft
20. Front bracket

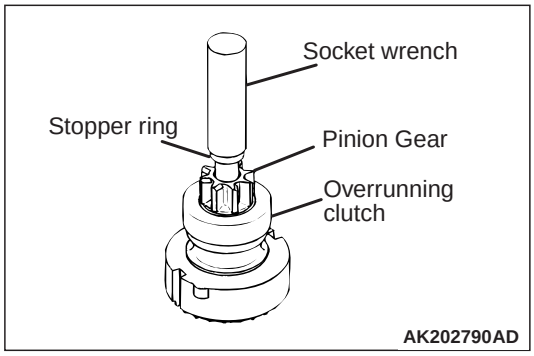
DISASSEMBLY SERVICE POINTS

<<A>> MAGNETIC SWITCH REMOVAL

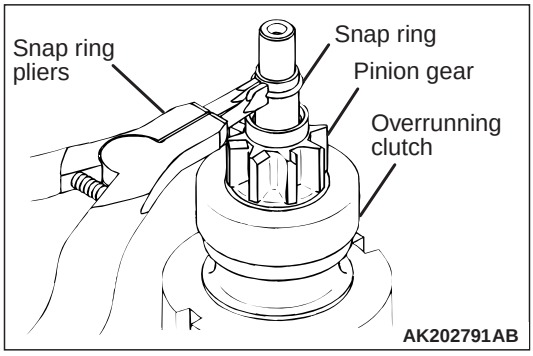


⚠ CAUTION
Do not clamp the yoke assembly with a vise.
Disconnect the lead from the M terminal of the magnetic switch.

<<B>> SNAP RING/STOPPER RING REMOVAL

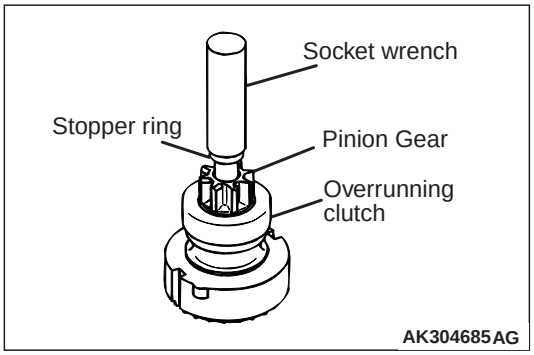


1. Apply a long socket wrench of an appropriate size to the stopper ring and strike the wrench to drive out the stop ring toward the pinion gear side.

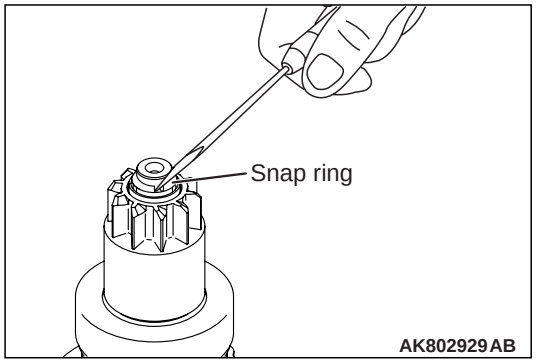


2. Remove the snap ring with snap ring pliers, then remove the stop ring and overrunning clutch.

<<C>> SNAP RING/STOPPER RING REMOVAL



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



2. After using the screwdriver to remove to remove the snap ring, remove the stop ring.

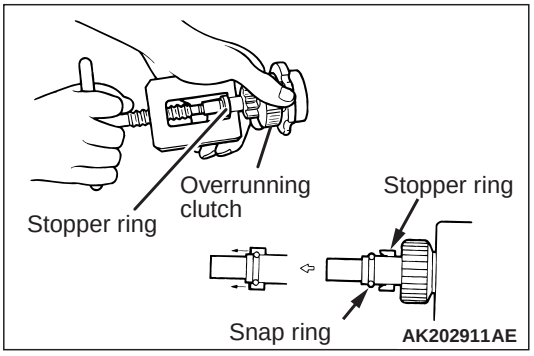
STARTER MOTOR PARTS CLEANING

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.

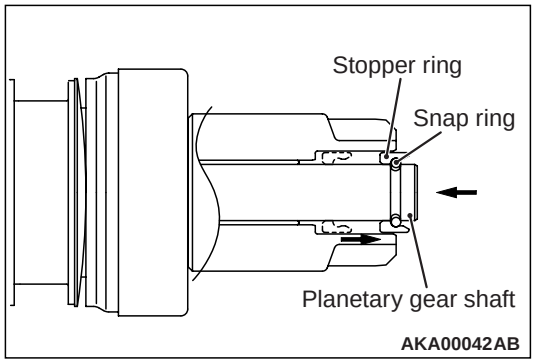
REASSEMBLY SERVICE POINTS

>>A<< STOPPER RING/SNAP RING INSTALLATION



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

>>B<< STOPPER RING/SNAP RING INSTALLATION

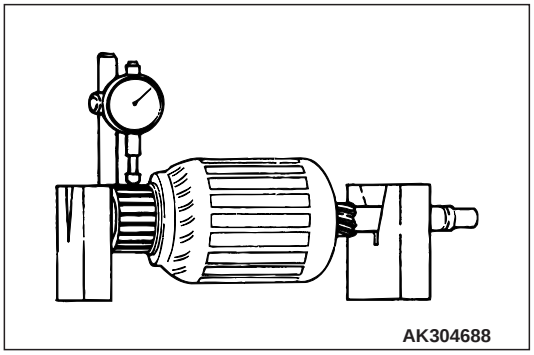


1. Install the stopper ring to the planetary gear shaft.
2. Install the snap ring to the planetary gear shaft.
3. Pull the planetary gear shaft to install the stopper ring to the position shown in the illustration.

INSPECTION

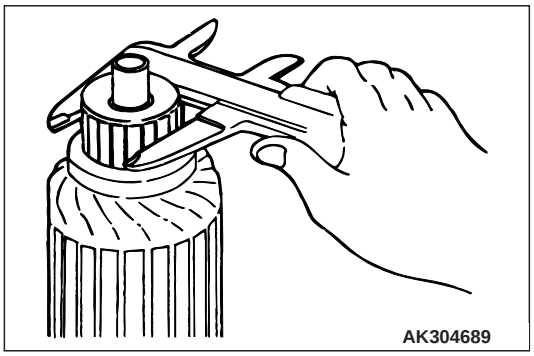
M1162001300760

COMMUTATOR



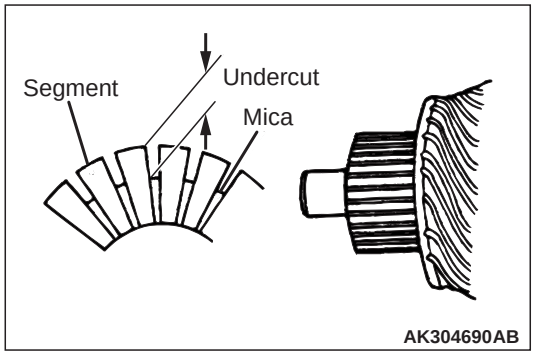
1. Support the armature with a pair of V block and turn it to measure the runout of the surface not rubbed by the brushes using a dial gauge.

   Standard value: 0.05 mm or less
   Limit: 0.1 mm



2. Measure the diameter of the commutator.

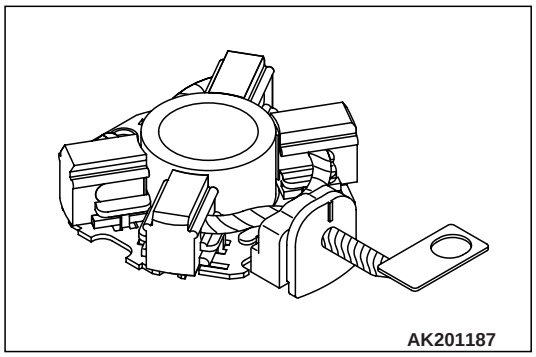
   Standard value: 29.4 mm
   Limit: 28.8 mm



3. Measure the depth of the undercut between segments.

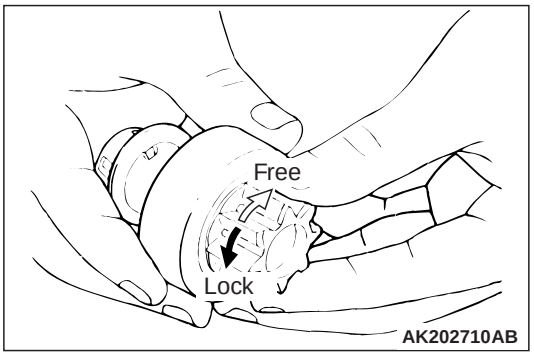
   Standard value: 0.5 mm
   Limit: 0.2 mm

BRUSH HOLDER



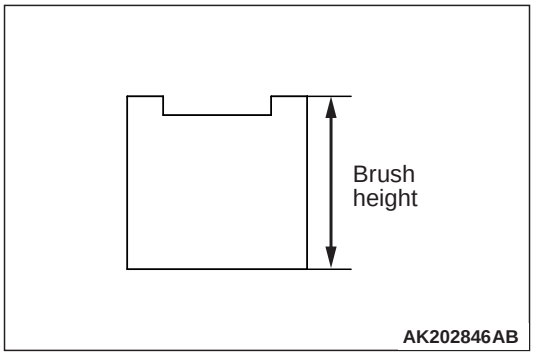
Push the brush into the brush holder to make sure that the spring is working on the brush.
If the spring is not working, replace the brush holder.

OVERRUNNING CLUTCH



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

BRUSHES



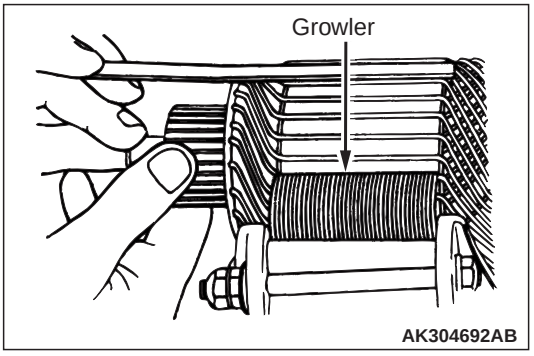
1. Check the commutator contacting surface of each brush for abnormal roughness. Also check the height of the brush. Replace the brush holder if the height is lower than the limit.

   Limit: 10 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.

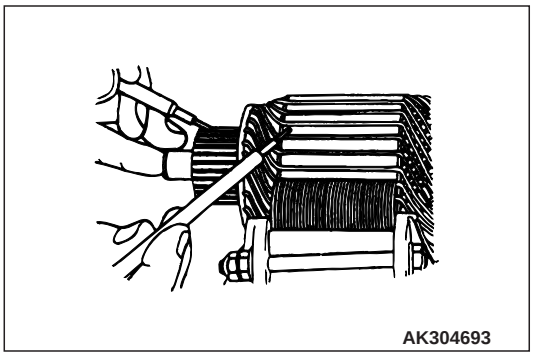


2. Set the armature in a growler.

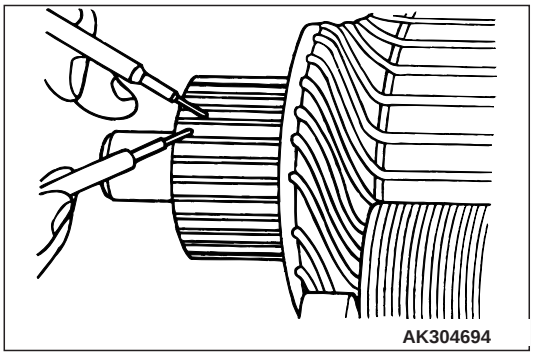
⚠ CAUTION

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.

IGNITION SYSTEM

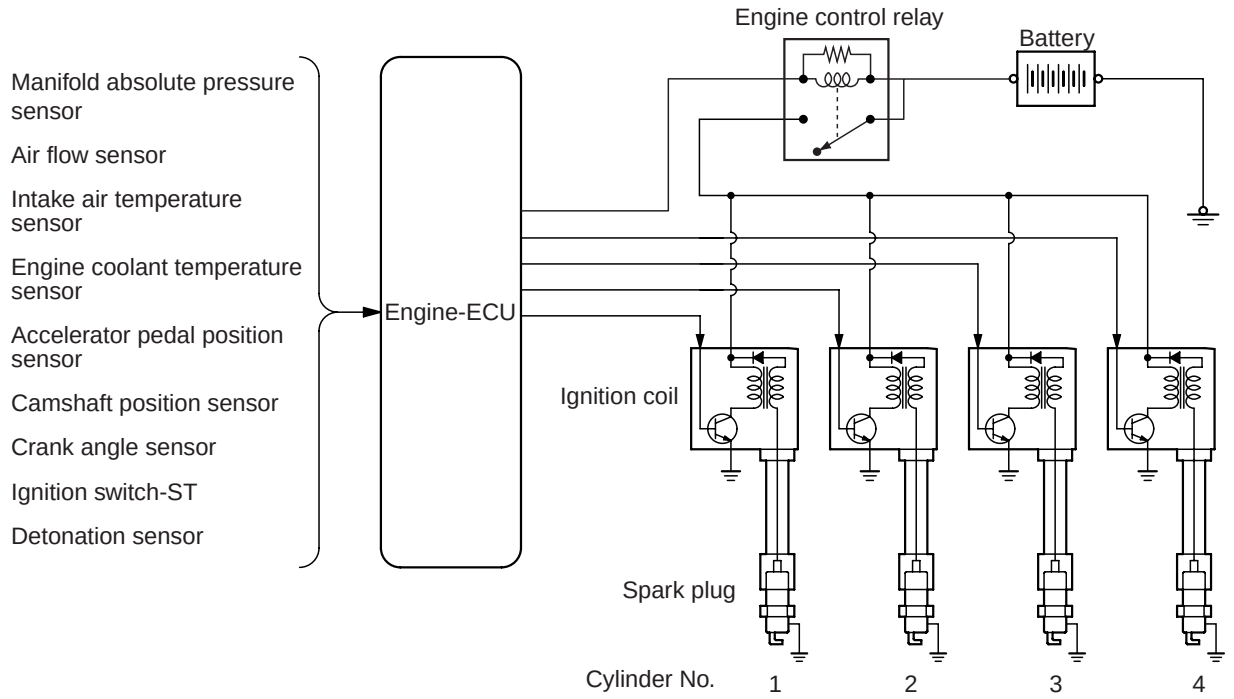
GENERAL INFORMATION

M1163000102018

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 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 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



AK503331AB

IGNITION COIL SPECIFICATION

Item	Specification
Type	Moulded 4-coil

SPARK PLUG SPECIFICATIONS

Item	4B11	4B12
NGK	FR6EI	FR5EI
DENSO	K20PSR-B8	K16PSR-B8

SERVICE SPECIFICATIONS

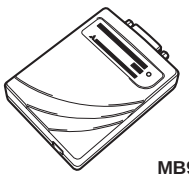
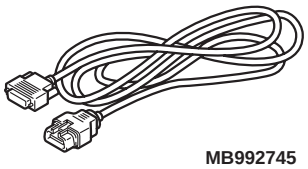
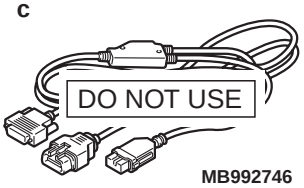
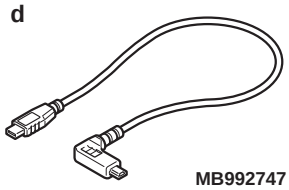
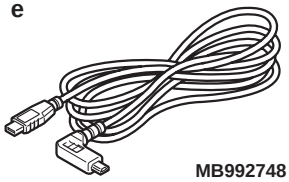
M1163000301644

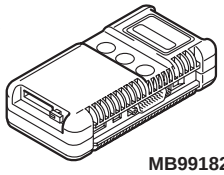
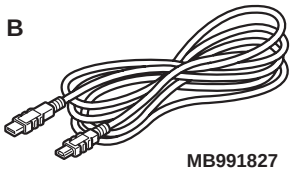
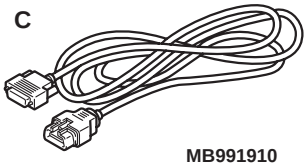
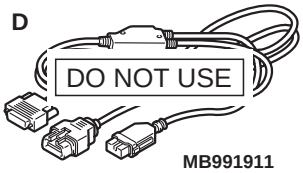
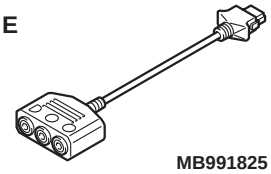
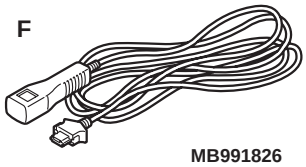
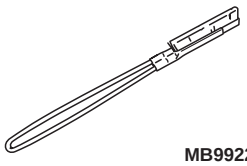
SPARK PLUG

Item	Standard value	Limit
Spark plug gap mm	0.7 – 0.8	1.2

SPECIAL TOOLS

M1163000600932

Tool	Number	Name	Use
a  MB992744 b  MB992745 c  MB992746 d  MB992747 e  MB992748 ACB05421AB	a. MB992744 b. MB992745 c. MB992746 d. MB992747 e. MB992748	a. Vehicle communication interface-Lite (V.C.I.-Lite) b. V.C.I.-Lite main harness A (for vehicles with CAN communication) c. V.C.I.-Lite main harness B (for vehicles without CAN communication) d. V.C.I.-Lite USB cable short e. V.C.I.-Lite USB cable long	Checking the idle speed

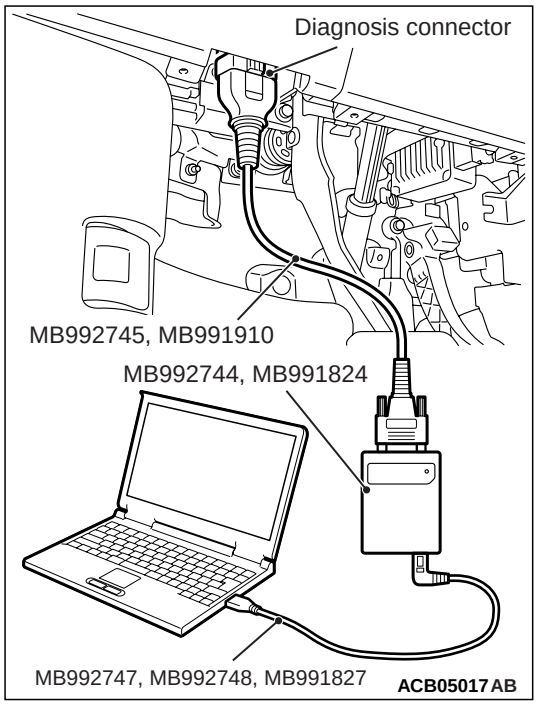
Tool	Number	Name	Use
A  MB991824 B  MB991827 C  MB991910 D  MB991911 E  MB991825 F  MB991826 MB991955	MB991955 A: MB991824 B: MB991827 C: MB991910 D: MB991911 E: MB991825 F: MB991826	M.U.T.-III sub assembly • A: Vehicle communication interface (V.C.I.) • B: M.U.T.-III USB cable • C: M.U.T.-III main harness 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 **⚠ CAUTION** **For vehicles with CAN communication, use M.U.T.-III main harness A to send simulated vehicle speed. If you connect M.U.T.-III main harness B instead, the CAN communication does not function correctly.**
 MB992273	MB992273	Spark plug brush	Cleaning the spark plug

ON-VEHICLE SERVICE

IGNITION COIL CHECK

M1163001201554

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



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

SPARK PLUG CHECK AND CLEANING

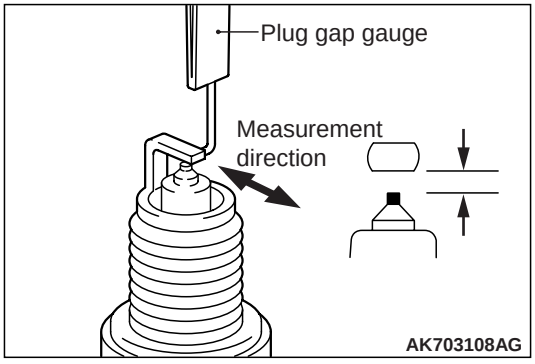
⚠ CAUTION

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

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

M1163004302898

SPARK PLUG GAP CHECK

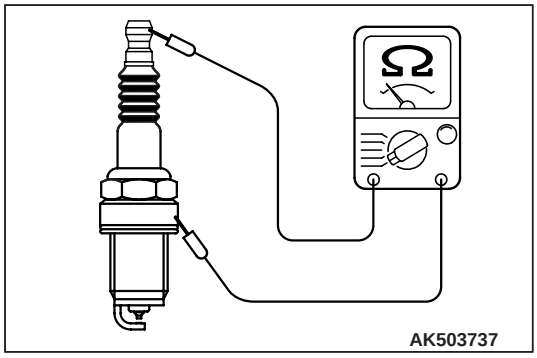


Check the plug gap with the wire type plug gap gauge. Replace it if the limit is exceeded.

Standard value, limit:

Manufacturer	Type	Standard value (mm)	Limit (mm)
NGK	FR6EI <4B11> FR5EI <4B12>	0.7 – 0.8	1.2
DENSO	K20PSR-B8 <4B11> K16PSR-B8 <4B12>	0.7 – 0.8	1.2

SPARK PLUG INSULATION RESISTANCE CHECK



1. Measure the insulation resistance of the spark plug. If the insulation resistance of the spark plug is under the limited value, clean the spark plug (Refer to).
2. After cleaning, measure the insulation resistance again. Replace the plug unless it is within the limited value.

   Limit: Minimum 10 MΩ

SPARK PLUG CLEANING

NOTE: Using a sand blast type plug cleaner, is recommended for the spark plug cleaning.

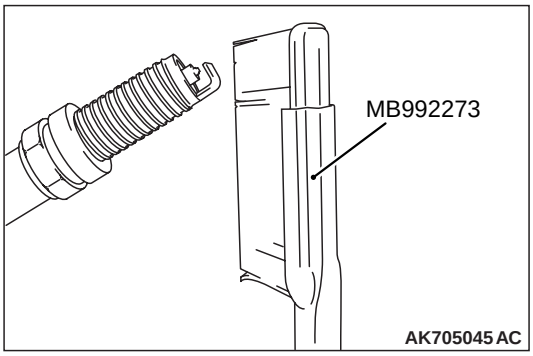
<When a sand blast type plug cleaner is used>

Cleaning must be carried out within 20 seconds to protect the electrode.

<When special tool spark plug brush (MB992273) is used>

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

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



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

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

   NOTE: In case of insufficient cleaning, it is permissible to take longer than 2 minutes for cleaning.
3. After the cleaning, sufficiently remove and then dry both of the carbon and the brake cleaner on the plug, using a waste cloth or air blowing.

CAMSHAFT POSITION SENSOR CHECK

M1163004401074

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

(Refer to GROUP 13A – Troubleshooting – Inspection procedure for diagnosis code – Code No. P0340 camshaft position sensor system .)

CRANK ANGLE SENSOR CHECK

M1163004501123

Check the crank angle sensor circuit if self-diagnosis code, No.P0335 is shown.

(Refer to GROUP 13A – Troubleshooting – Inspection procedure for diagnosis code – Code No. P0335 crank angle sensor system .)

DETONATION SENSOR CHECK

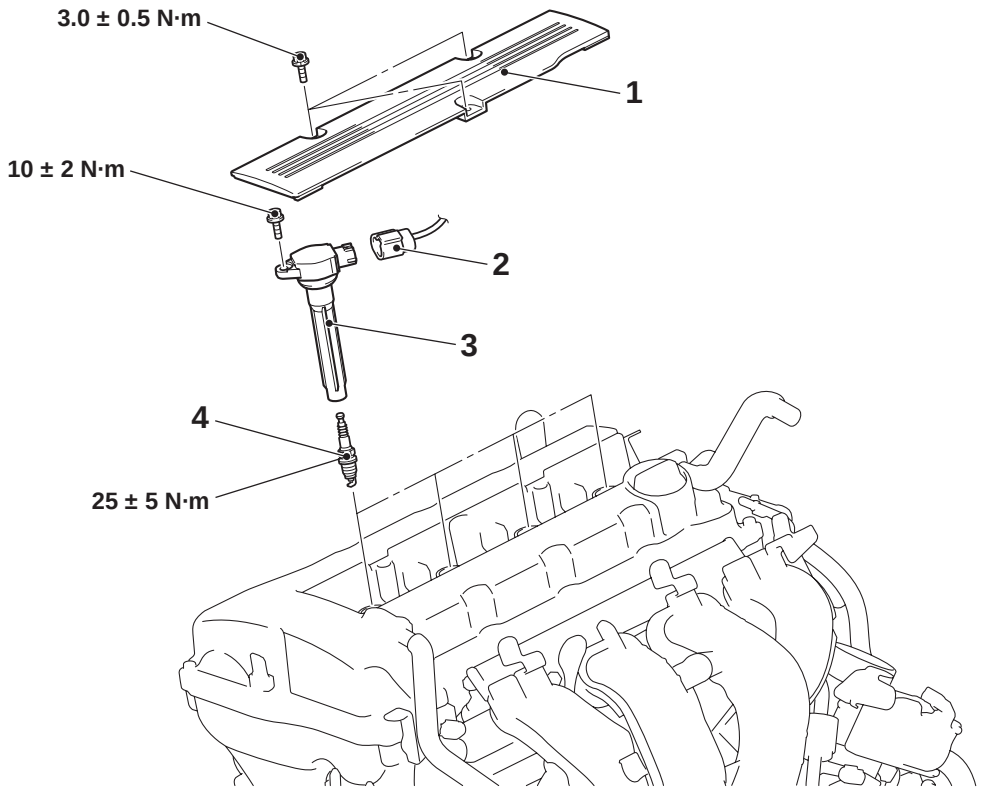
M1163002900724

Check the detonation sensor circuit if self-diagnosis code, No. P0327 or No. P0328 is shown.
(Refer to GROUP 13A – Troubleshooting – Inspection procedure for diagnosis code – Code No. P0327 detonation sensor circuit low input .)
(Refer to GROUP 13A – Troubleshooting – Inspection procedure for diagnosis code – Code No. P0328 detonation sensor circuit high input .)

IGNITION COIL

REMOVAL AND INSTALLATION

M1163004002295



ACB05840AB

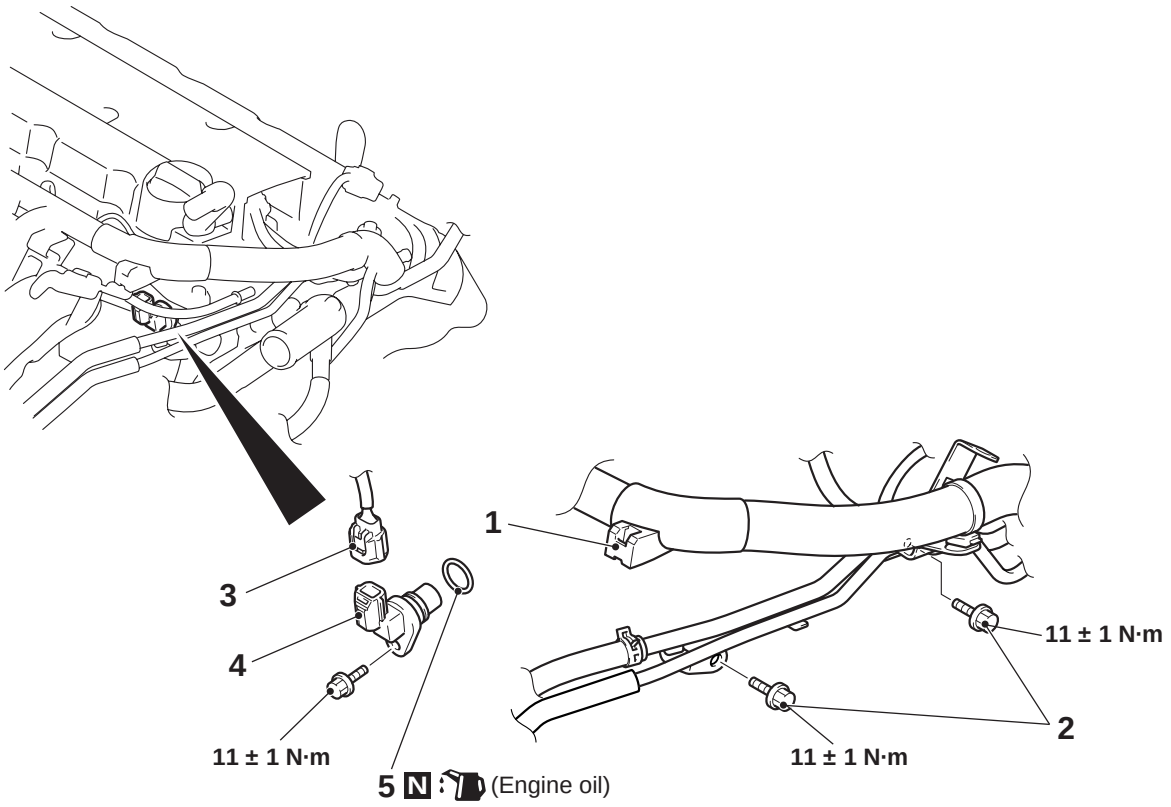
Removal steps
1. Rocker cover centre cover
2. Ignition coil connector

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

CAMSHAFT POSITION SENSOR

REMOVAL AND INSTALLATION

M1163003402171



Inlet camshaft position sensor removal steps

- Air cleaner cover and air intake hose (Refer to GROUP 15 – Air Cleaner)

1. Control harness clamp connection
2. Emission vacuum hose and pipe assembly mounting bolt

Inlet camshaft position sensor removal steps (Continued)

- Injector protector rear (Refer to GROUP 13A – Injector)

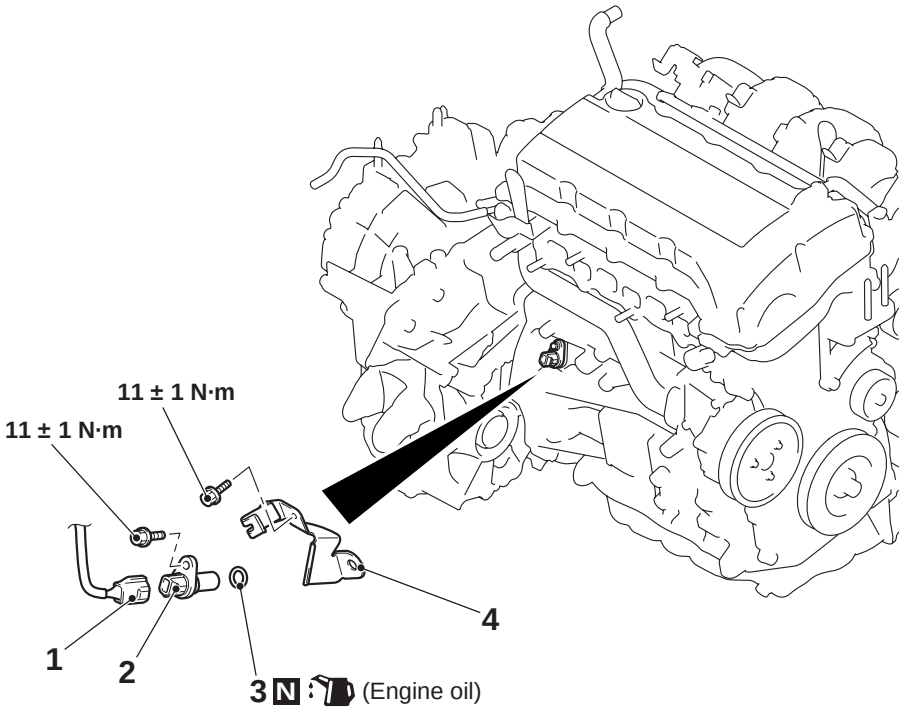
3. Inlet camshaft position sensor connector
4. Inlet camshaft position sensor
5. O-ring

CRANK ANGLE SENSOR

REMOVAL AND INSTALLATION

M1163004801748

Pre-removal and post-installation operation
- Air Cleaner Assembly Removal and Installation (Refer to GROUP 15 – Air Cleaner).



ACB05841AB

Removal steps
1. Crank angle sensor connector
2. Crank angle sensor
3. O-ring

Removal steps (Continued)
- Exhaust manifold bracket (Refer to GROUP 15 – Exhaust Manifold).

4. Crank angle sensor cover

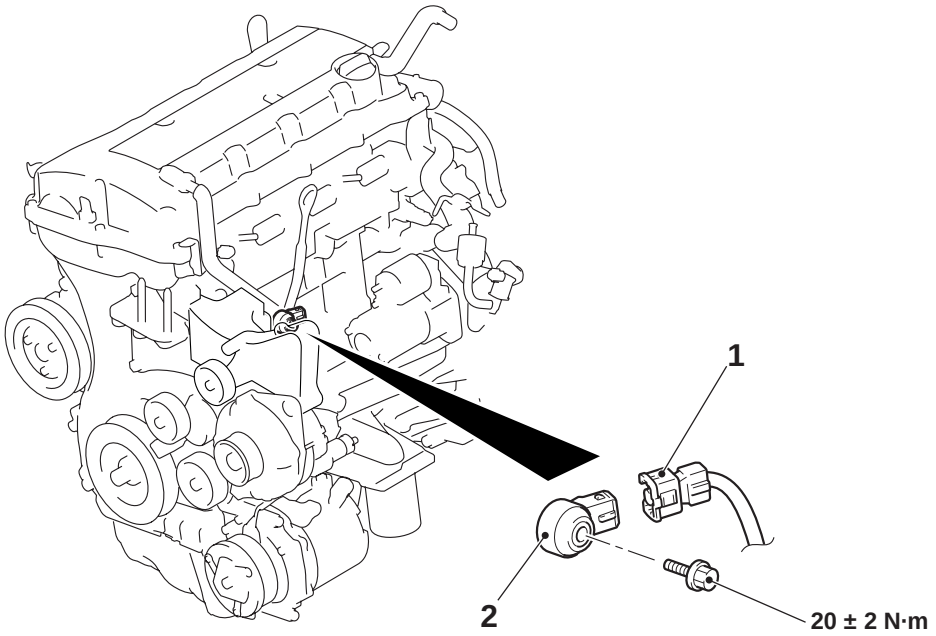
DETONATION SENSOR

REMOVAL AND INSTALLATION

M1163002802927

⚠ CAUTION

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



ACC00078AB

Removal steps

<<A>> • Throttle body assembly (Refer to GROUP 13A – Throttle Body Assembly) .
1. Detonation sensor connector
>>A<< 2. Detonation sensor

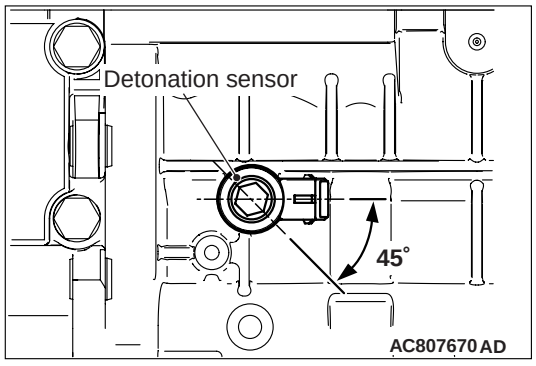
REMOVAL SERVICE POINT

<<A>> THROTTLE BODY MOUNTING BOLT REMOVAL

Remove the throttle body mounting bolts and put the throttle body aside so as not to interfere the detonation sensor connector disconnection.

INSTALLATION SERVICE POINT

>>A<< DETONATION SENSOR INSTALLATION



Set the connector of the detonation sensor to the area shown in the figure, and tighten the detonation sensor to the specified torque.

Tightening torque: 20 ± 2 N·m