
ENGINE ELECTRICAL

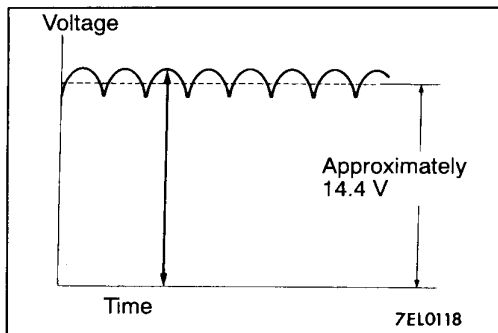
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CHARGING SYSTEM

GENERAL INFORMATION

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 at left. 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.

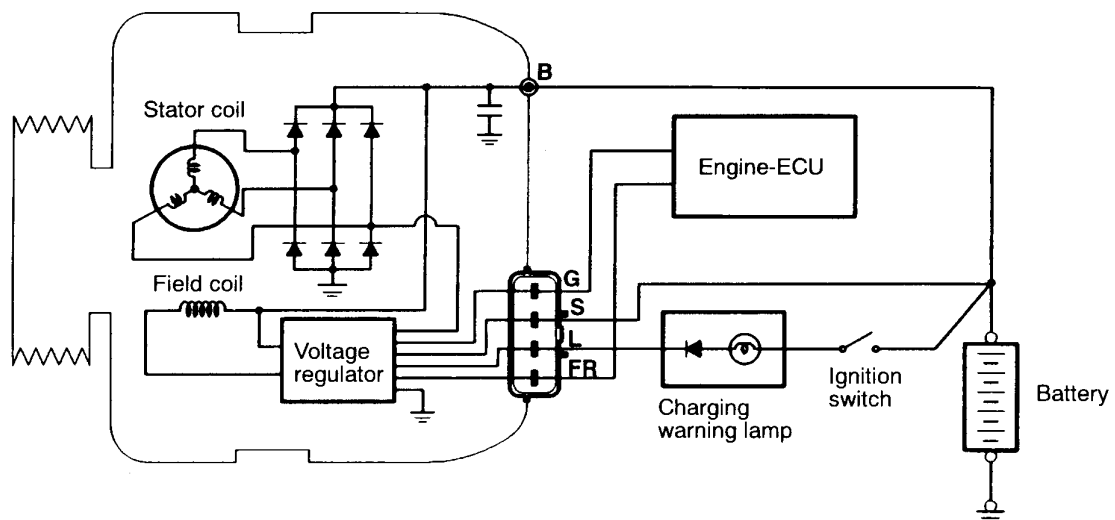
When the stator coil begins to generate power after the engine is started, the field coil is excited by the output current of the stator coil.

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



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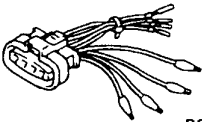
ALTERNATOR SPECIFICATIONS

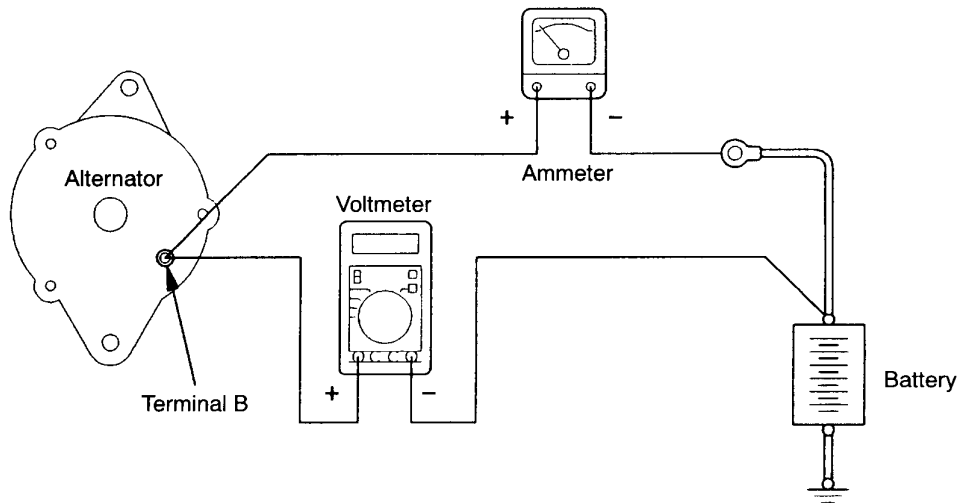
Items	Specifications
Type	Battery voltage sensing
Rated output V/A	12/90
Voltage regulator	Electronic built-in type

SERVICE SPECIFICATIONS

Items	Standard value	Limit
Alternator output line voltage drop (at 30 A) V	–	max. 0.3
Regulated voltage ambient temp. 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
Rotor coil resistance Ω	Approx. 3 – 5	–
Protrusion length of brush mm	–	2

SPECIAL TOOL

Tool	Number	Name	Use
 B991519	MB991519	Alternator test harness	Checking the alternator (S terminal voltage)

ON-VEHICLE SERVICE**ALTERNATOR OUTPUT LINE VOLTAGE DROP TEST**

9EN0468

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
 - Alternator drive belt tension (Refer to GROUP 11 – On-vehicle Service.)
 - 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) Disconnect the alternator output wire from the alternator "B" terminal and connect a DC test ammeter with a range of 0 – 100 A in series

between the "B" terminal and the disconnected output wire. (Connect the (+) lead of the ammeter to the "B" terminal, and then connect the (-) lead of the ammeter to the disconnected output wire.)

NOTE

An inductive-type ammeter which enables measurements to be taken without disconnecting the alternator output wire should be recommended. Using this equipment will lessen the possibility of a voltage drop caused by a loose "B" terminal connection.

- (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 a tachometer or the MUT-II.
(Refer to GROUP 11 – On-vehicle Service.)
- (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: max. 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 max. 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 and the ignition switch.

- (14) Remove the tachometer or the MUT-II.

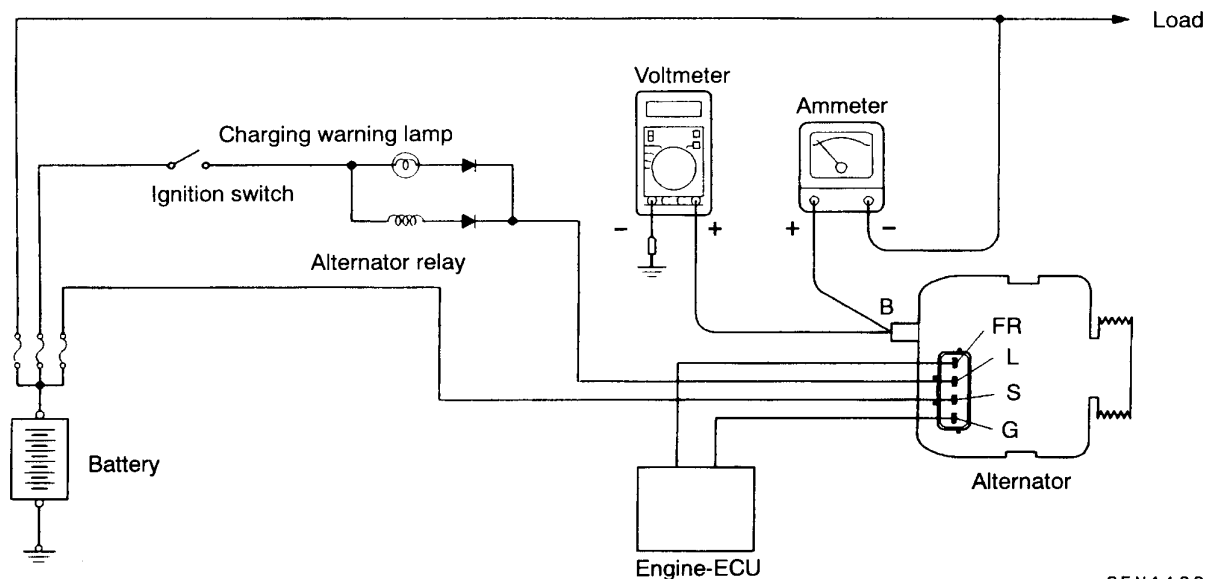
- (15) Disconnect the negative battery cable.

- (16) Disconnect the ammeter and voltmeter.

- (17) Connect the alternator output wire to the alternator "B" terminal.

- (18) Connect the negative battery cable.

OUTPUT CURRENT TEST



6EN1162

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 54 – Battery.)

NOTE

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

- Alternator drive belt tension (Refer to GROUP 11 – On-vehicle Service.)
 - 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) Disconnect the alternator output wire from the alternator “B” terminal. Connect a DC test ammeter with a range of 0 – 100 A in series between the “B” terminal and the disconnected output wire. (Connect the (+) lead of the ammeter to the “B” terminal. Connect the (–) lead of the ammeter to the disconnected output wire.)

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.

NOTE

An inductive-type ammeter which enables measurements to be taken without disconnecting the alternator output wire should be recommended.

- (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 a tachometer or the MUT-II. (Refer to GROUP 11 – On-vehicle Service.)
- (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.

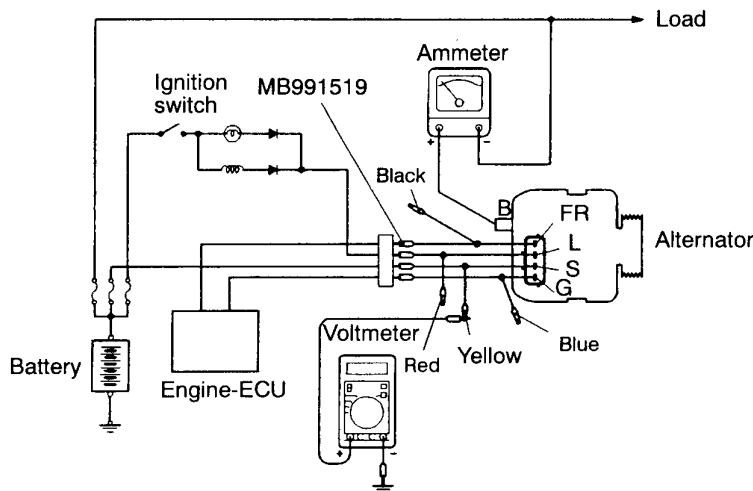
Limit: 70 % of normal current output

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 tachometer or the MUT-II.
- (16) Disconnect the negative battery cable.
- (17) Disconnect the ammeter and voltmeter.
- (18) Connect the alternator output wire to the alternator “B” terminal.
- (19) Connect the negative battery cable.

REGULATED VOLTAGE TEST



6AE0355

This test determines whether the voltage regulator is 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 54 – Battery.)
- Alternator drive belt tension (Refer to GROUP 11 – On-vehicle Service.)
- 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) Disconnect the alternator output wire from the alternator “B” terminal.

(6) Connect a DC test ammeter with a range of 0 – 100 A in series between the “B” terminal and the disconnected output wire. (Connect the (+) lead of the ammeter to the “B” terminal. Connect the (–) lead of the ammeter to the disconnected output wire.)

(7) Reconnect the negative battery cable.

(8) Connect a tachometer or the MUT-II. (Refer to GROUP 11 – On-vehicle Service.)

(9) 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.

(10) Turn all lamps and accessories off.

(11) Start the engine.

(12) Increase the engine speed to 2,500 r/min.

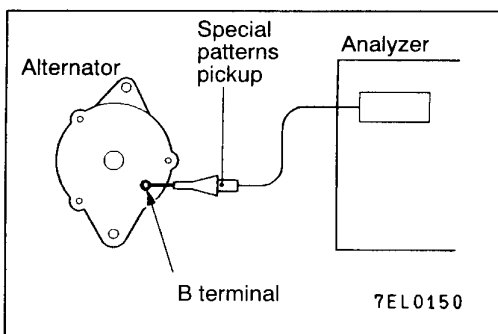
(13) Read the value displayed on the voltmeter when the alternator output current alternator becomes 10 A or less.

- (14) 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.
- (15) After the test, lower the engine speed to the idle speed.
- (16) Turn the ignition switch to the "LOCK" (OFF) position.
- (17) Remove the tachometer or the MUT-II.
- (18) Disconnect the negative battery cable.
- (19) Disconnect the ammeter and voltmeter.
- (20) Connect the alternator output wire to the alternator "B" terminal.
- (21) Remove the special tool, and return the connector to the original condition.
- (22) 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



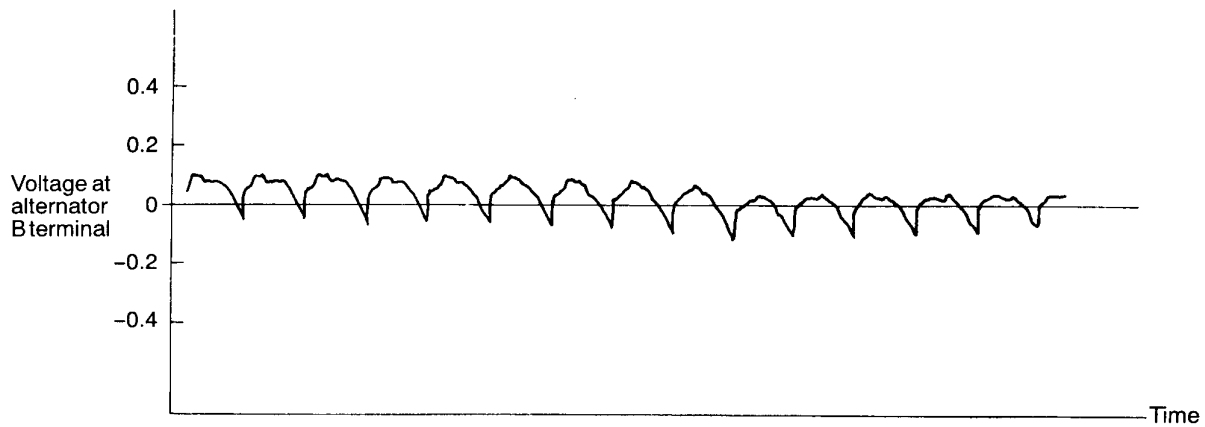
WAVEFORM CHECK USING AN ANALYZER MEASUREMENT METHOD

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

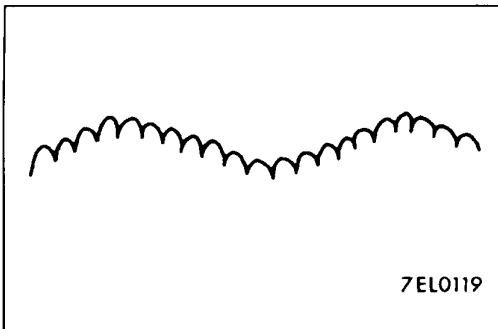
STANDARD WAVEFORM

Observation Conditions

FUNCTION	SPECIAL PATTERNS
PATTERN HEIGHT	VARIABLE
VARIABLE knob	Adjust while viewing the waveform.
PATTERN SELECTOR	RASTER
Engine speed	Curb idle speed



7EL0115



7EL0119

NOTE

The voltage waveform of the alternator B terminal can undulate as shown at left. 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 blown fuse between alternator B terminal and battery, but not a defective alternator.

EXAMPLES OF ABNORMAL WAVEFORMS

NOTE

1. The size of the waveform patterns differs largely, depending on the adjustment of the variable knob on the analyzer.
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 waveforms	Problem cause	Abnormal waveforms	Problem cause
Example 1  A7EL0120	Open diode	Example 4  A7EL0123	Short in stator coil
Example 2  A7EL0121	Short in diode	Example 5  A7EL0124	Open supplementary diode
Example 3  A7EL0122	Broken wire in stator coil	At this time, the charging warning lamp is illuminated.	

ALTERNATOR

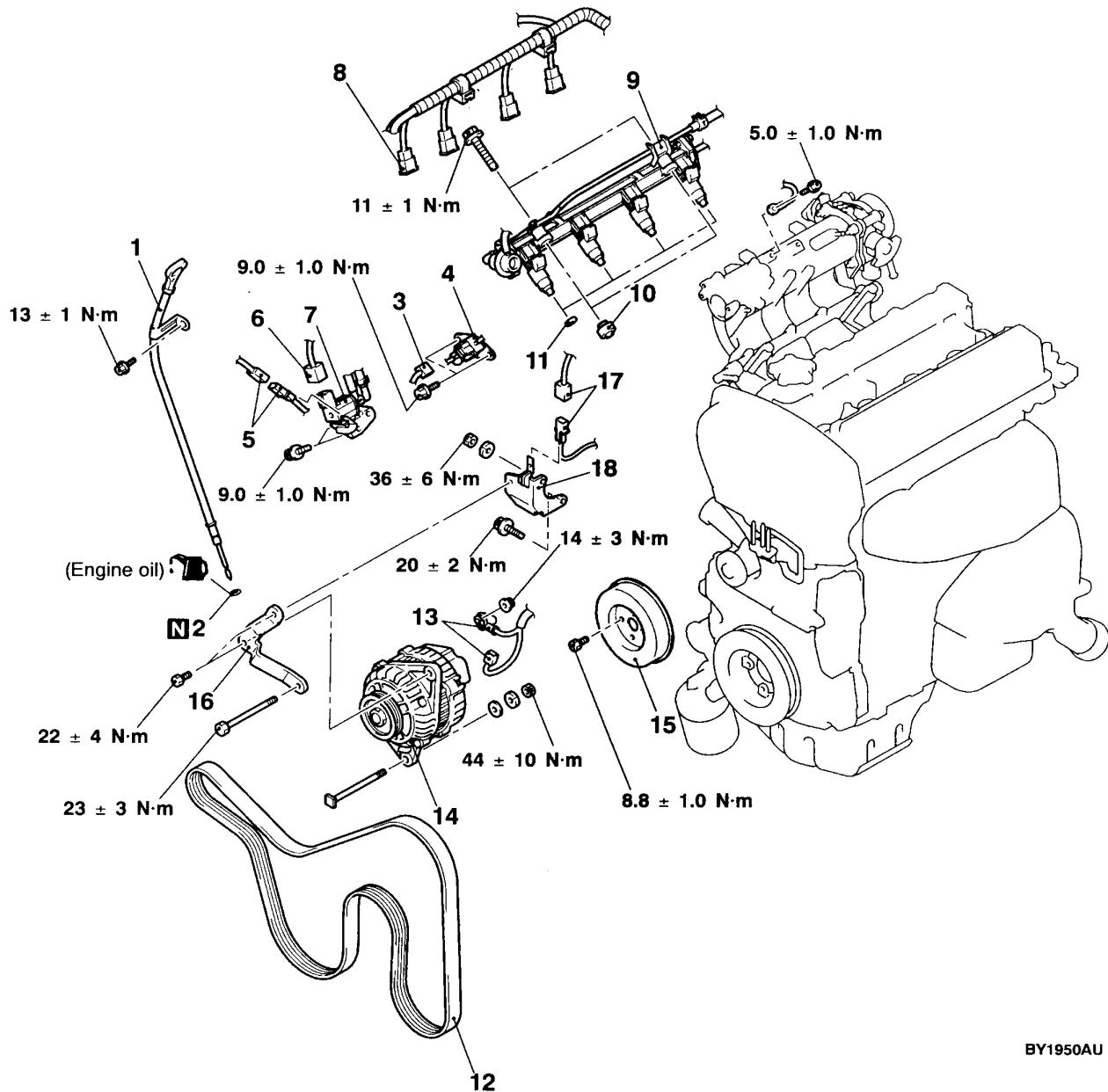
REMOVAL AND INSTALLATION

Caution

If the vehicle is equipped with the Brembo disc brake, during maintenance, take care not to contact the parts or tools to the caliper because the paint of caliper will be scratched.

Pre-removal and Post-installation Operation

- Under Cover Removal and Installation (Refer to GROUP 51 – Front Bumper.)
- Drive Belt Tension Check (Refer to GROUP 11A – On-vehicle Service.) <After installation only>
- Strut Tower Bar Removal and Installation (Refer to GROUP 42.)
- Crossmember Bar Removal and Installation (Refer to GROUP 32 – Engine Roll Stopper, Centermember.)
- Front Exhaust Pipe Assembly Removal and Installation (Refer to GROUP 15.)



BY1950AU

Removal steps

1. Oil level gauge and guide assembly
2. O-ring
3. Fuel pressure solenoid valve connector
4. Fuel pressure solenoid valve assembly
5. Detonation sensor connector
6. Purge control solenoid valve connector
7. Purge control solenoid valve assembly
8. Injector connector
9. Delivery pipe, injector, and fuel pressure regulator assembly

◀B▶

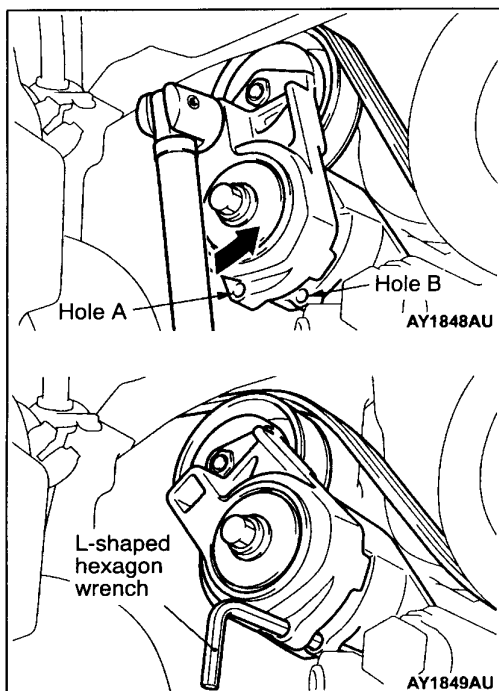
◀C▶

10. Insulator
11. Insulator
12. Drive belt
13. Alternator connector
- Engine mounting (Refer to GROUP 32.)
14. Alternator
15. Water pump pulley
16. Alternator brace
17. Oxygen sensor connector
18. Alternator brace stay

◀A▶

REMOVAL SERVICE POINTS**◀A▶ DELIVERY PIPE, INJECTOR, AND FUEL PRESSURE REGULATOR ASSEMBLY REMOVAL**

After loosening the installed parts, set the related parts aside to make some space for removing the alternator.

**◀B▶ DRIVE BELT REMOVAL**

Due to the adoption of the Serpentine drive system with the auto-tensioner, the following operation is required:

1. Insert the 12.7sq. spinner handle into the tool hole of the auto-tensioner and rotate it counterclockwise until the auto-tensioner reaches to the stopper.
2. Align hole A with hole B for fixing by inserting the L-shaped hexagon wrench, then remove the drive belt.

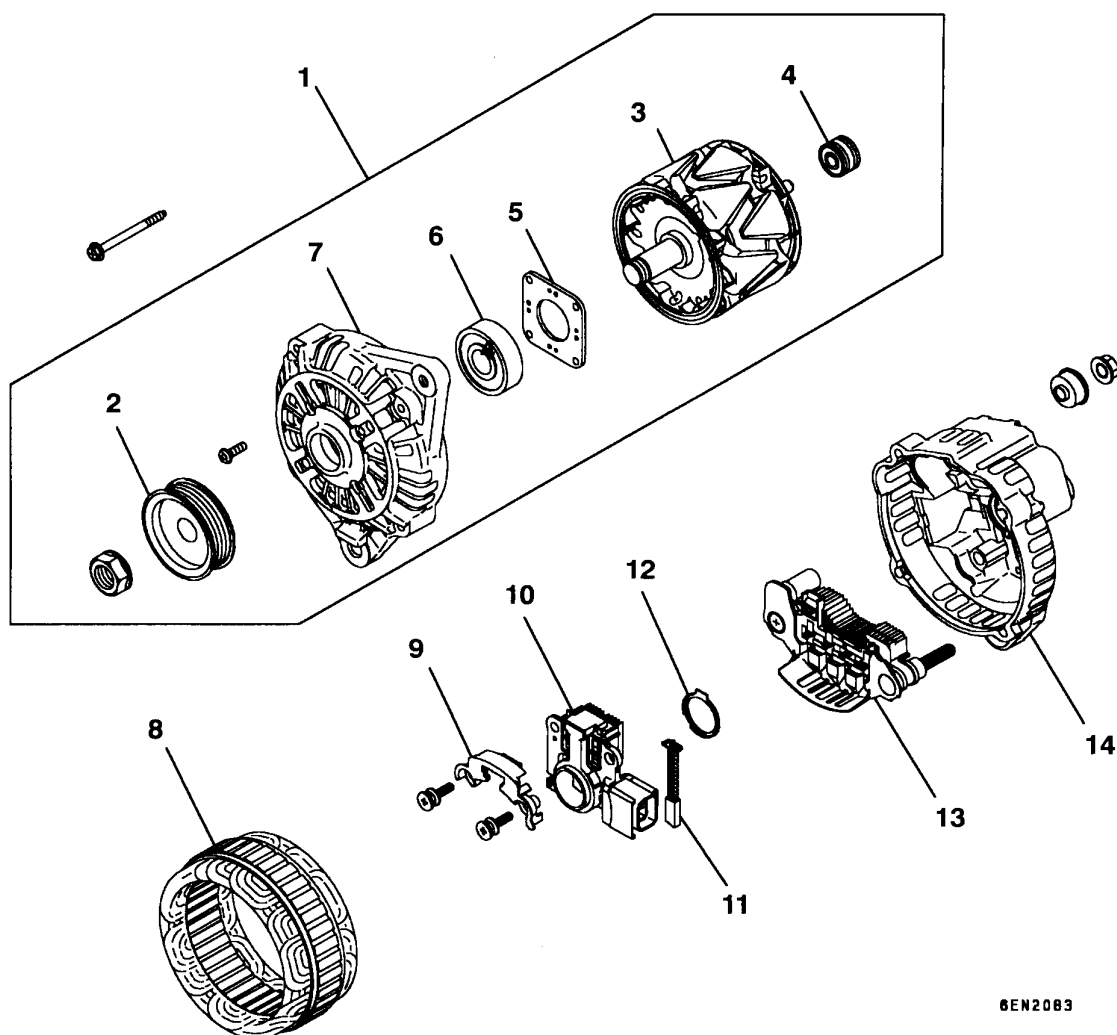
Caution

When the drive belt is reused, use a chalk to indicate an arrow of rotation direction on the back of the belt so that it can be re-assembled in the same direction as before.

◀C▶ ALTERNATOR REMOVAL

Push up the engine with a garage jack to the top and remove the alternator upward from the engine room.

DISASSEMBLY AND REASSEMBLY



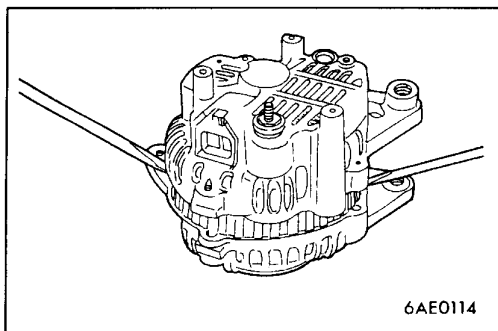
6EN2083

Disassembly steps

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



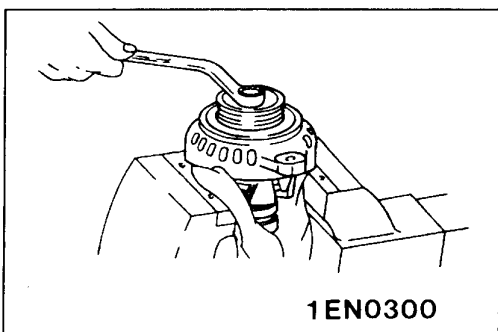
8. Stator
9. Plate
10. Regulator assembly
11. Brush
12. Packing
13. Rectifier
14. Rear bracket

**DISASSEMBLY SERVICE POINTS****◀A▶ FRONT BRACKET ASSEMBLY REMOVAL**

Insert a flat tip screwdrivers or the like in the clearance between the front bracket assembly and stator core, to pry open and separate the stator and front bracket.

Caution

Do not insert a screwdriver too far, or the stator coil gets damaged.

**◀B▶ ALTERNATOR PULLEY REMOVAL**

Face pulley side upward, fix the rotor with a work bench and remove the pulley.

Caution

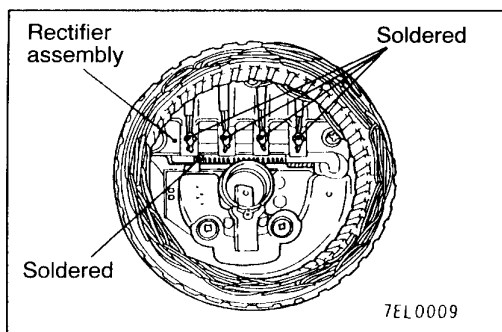
Use care not to damage the rotor.

◀C▶ STATOR/REGULATOR ASSEMBLY REMOVAL

1. Unsolder the stator with a soldering iron (180 to 250 W). Complete this work within four seconds not to transfer heat to the diode.
2. When removing rectifier from the regulator assembly, remove the soldered sections to rectifier.

Caution

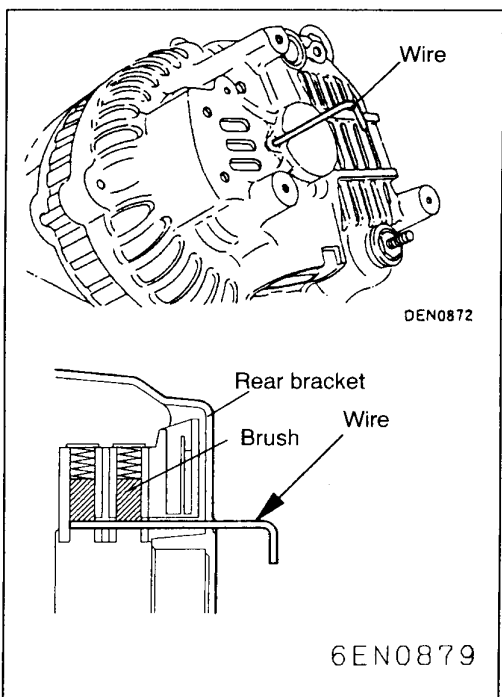
- (1) Use care to make sure that the heat of the soldering iron is not transmitted to the diodes for a long period.
- (2) Use care that no undue force is exerted to the lead wires of the diodes.

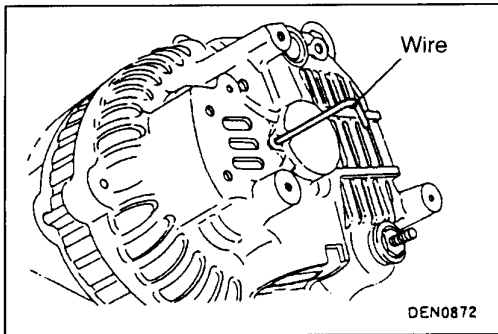
**REASSEMBLY SERVICE POINTS****▶A◀ REGULATOR ASSEMBLY INSTALLATION**

After installing the regulator assembly, insert a wire into the hole provided on the rear bracket while pressing in the brush to fix the brush.

NOTE

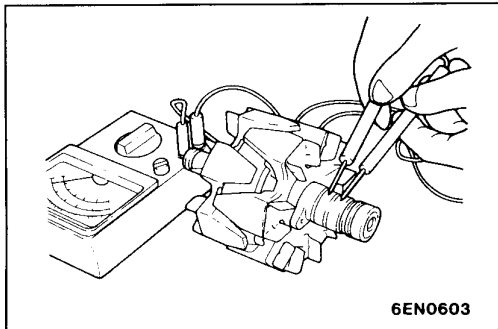
The brush is fixed when a wire is inserted, making rotor installation easier.





►B◄ ROTOR INSTALLATION

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

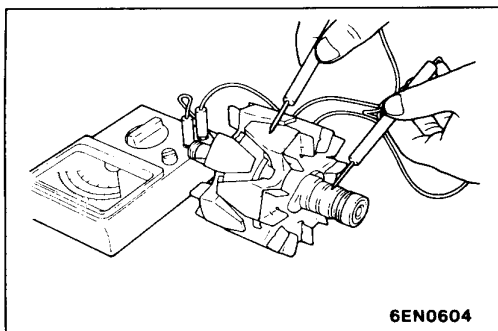


INSPECTION

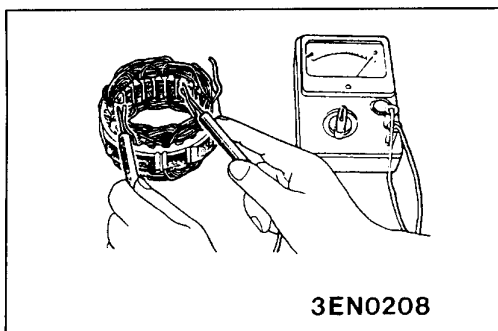
ROTOR CHECK

1. Check the continuity between the rotor coil slip rings, and replace the rotor if the resistance value is not at the standard value.

Standard value: 3 – 5 Ω

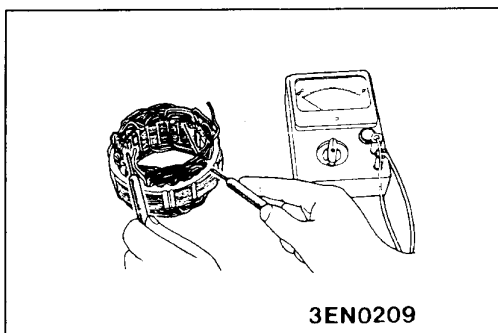


2. Check the continuity between the slip ring and core, and if there is continuity, replace the rotor.

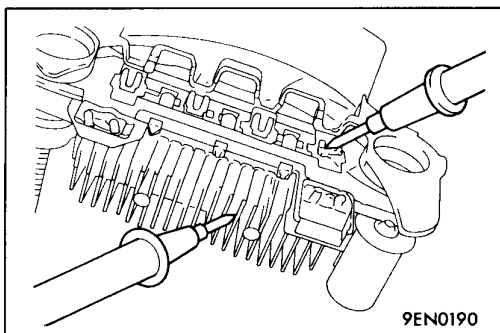


STATOR CHECK

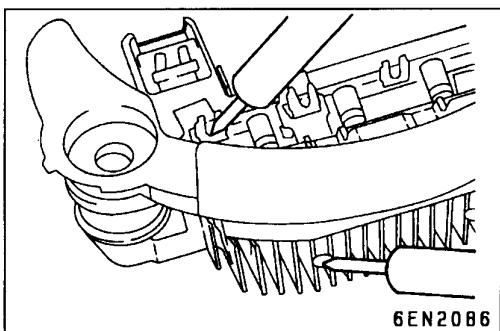
1. Check the continuity between the coil leads, and if there is continuity, replace the stator.



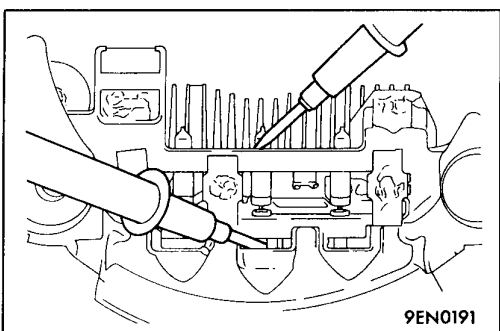
2. Check the continuity between the coil and core, and if there is continuity, replace the stator.

**RECTIFIERS CHECK**

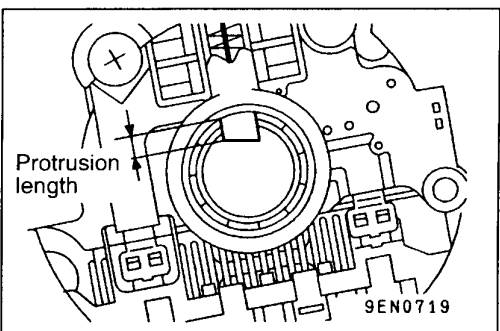
1. Inspect the (+) heat sink by checking the continuity between the (+) heat sink and stator coil lead wire connection terminal using a tester probe.
If there is a continuity at both, the diode is short circuited, so replace the rectifier.



2. Inspect the (-) heat sink by checking the continuity between the (-) heat sink and stator coil lead wire connection terminal using a tester probe.
If there is a continuity at both, the diode is short circuited, so replace the rectifier.

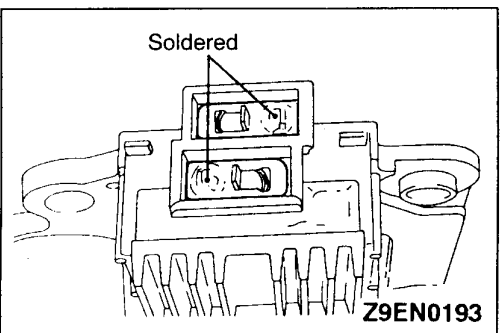


3. Check the diode trio by connecting an ohmmeter to both ends of each diode and check the continuity of the three diodes.
If there is a continuity at both ends, or if there is no continuity, the diode is damaged so replace the rectifier.

**BRUSH CHECK**

1. Measure the length of the brush protrusion shown in the illustration, and replace the brush if the measured value is below the limit value.

Limit: 2 mm or less



2. The brush can be removed if the solder of the brush lead wire is removed.
3. When installing a new brush, insert the brush into the holder as shown in the illustration, and then solder the lead wires.

STARTING SYSTEM

GENERAL INFORMATION

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.

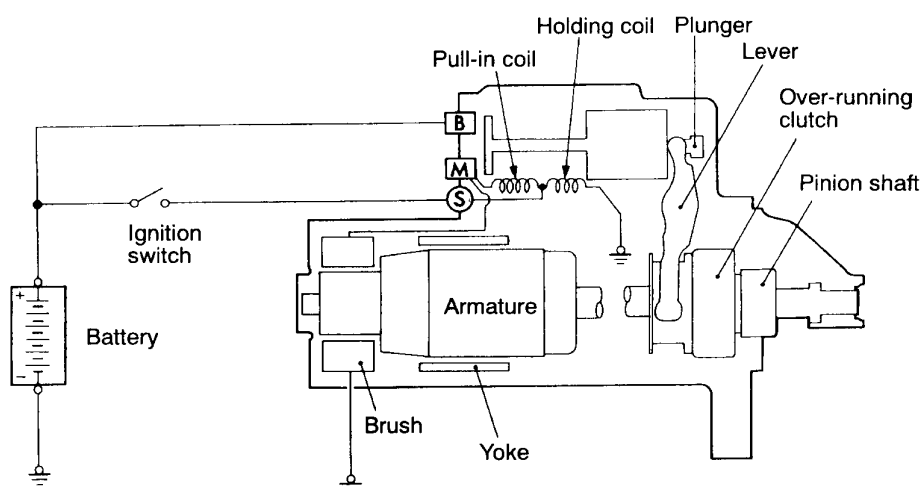
On the other hand, attracting the plunger will turn on the magnetic switch, allowing the B terminal

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



6EN0939

STARTER MOTOR SPECIFICATIONS

Items	Specifications
Type	Reduction drive with planetary gear
Rated output kW/V	1.2/12
No. of pinion teeth	8

SERVICE SPECIFICATIONS

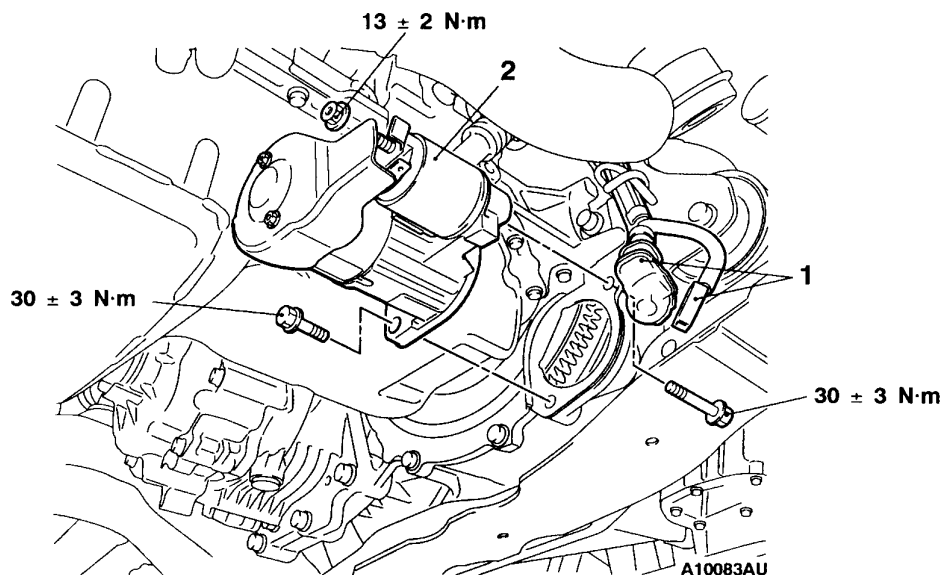
Items	Standard value	Limit
Pinion gap mm	0.5 – 2.0	–
Commutator outer diameter mm	29.4	28.8
Commutator runout mm	0.05	0.1
Commutator undercut mm	0.5	0.2
Brush length mm	–	7.0

STARTER

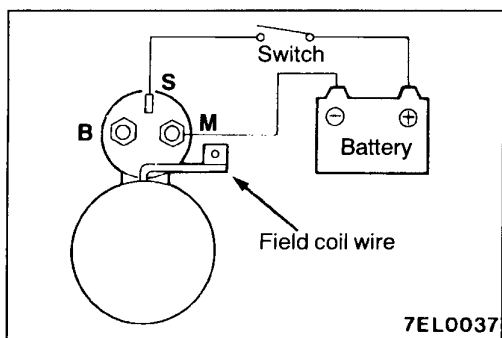
REMOVAL AND INSTALLATION

Pre-removal and Post-installation Operation

- Under Cover Removal and Installation (Refer to GROUP 51 – Front Bumper.)
- Crossmember Bar Removal and Installation (Refer to GROUP 32 – Engine Roll Stopper, Centermember.)
- Front Exhaust Pipe Assembly Removal and Installation (Refer to GROUP 15.)


Removal steps

1. Starter connector
2. Starter



INSPECTION

PINION GAP ADJUSTMENT

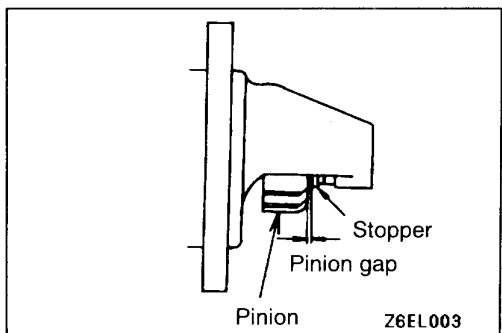
1. Disconnect field coil wire from M-terminal of magnetic switch.
2. Connect a 12 V battery between S-terminal and M-terminal.
3. Set switch to "ON" position, and pinion will move out.

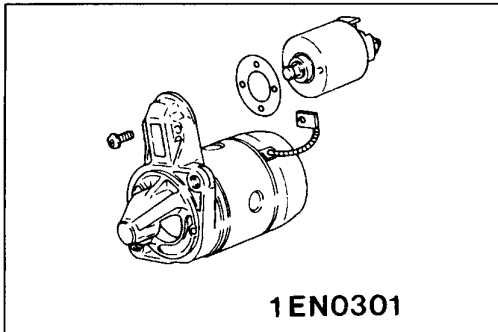
Caution

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

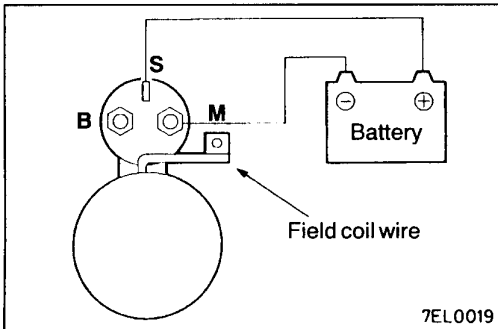
4. Check pinion to stopper clearance (pinion gap) with a thickness gauge.

Standard value: 0.5 – 2.0 mm





5. If pinion gap is out of specification, adjust by adding or removing gaskets between magnetic switch and front bracket.



MAGNETIC SWITCH PULL-IN TEST

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

Caution

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

3. If pinion moves out, then pull-in coil is good. If it doesn't, replace magnetic switch.

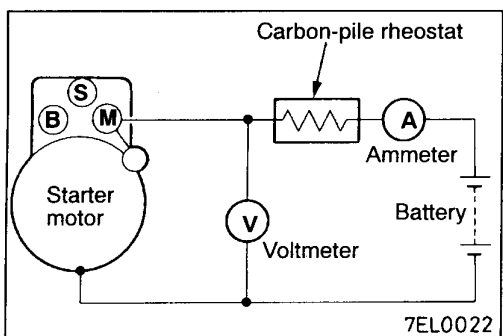
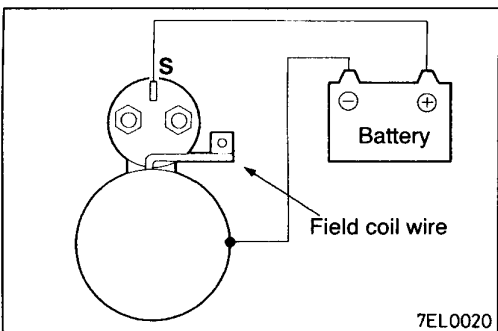
MAGNETIC SWITCH HOLD-IN TEST

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

Caution

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

3. Manually pull out the pinion as far as the pinion stopper position.
4. If pinion remains out, everything is in order. If pinion moves in, hold-in circuit is open. Replace magnetic switch.

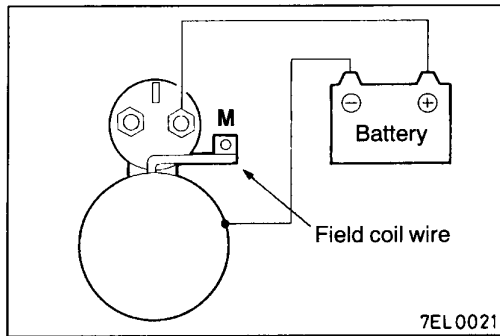


FREE RUNNING TEST

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

Current:

max. 90 A

**MAGNETIC SWITCH RETURN TEST**

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

Caution

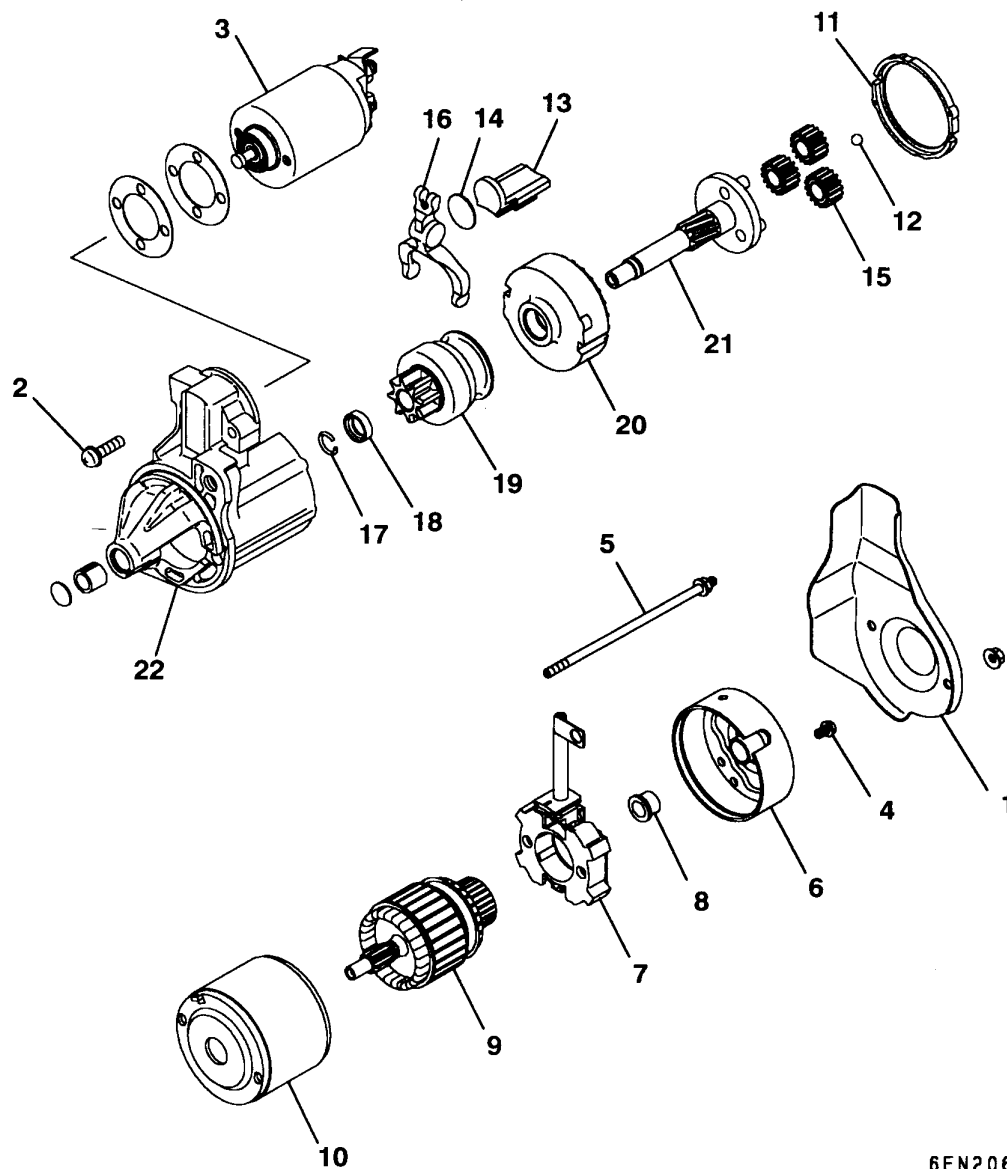
This test must be performed quickly (in less than 10 seconds) to prevent coil from burning.

3. Pull pinion out and release. If pinion quickly returns to its original position, everything is in order. If it doesn't, replace magnetic switch.

Caution

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

DISASSEMBLY AND REASSEMBLY



6EN2060

Disassembly steps

◀A▶

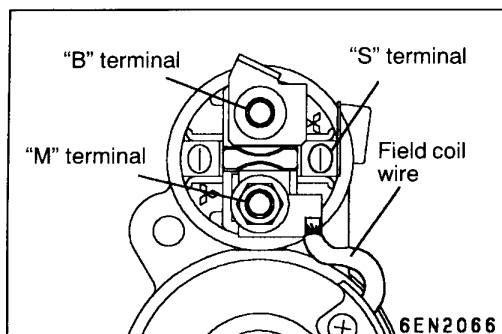
1. Cover
2. Screw
3. Magnetic switch
4. Screw
5. Through
6. Rear bracket
7. Brush holder
8. Rear bearing
9. Armature
10. Yoke assembly
11. Ball

◀B▶

◀B▶

◀C▶
◀C▶▶A▶
▶A▶

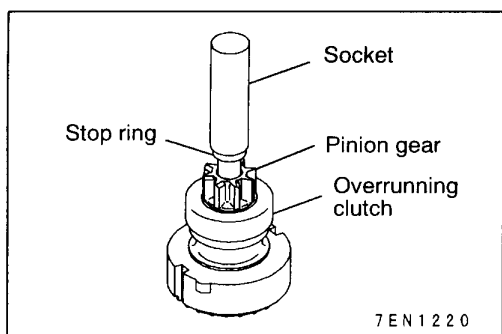
12. Packing A
13. Packing B
14. Plate
15. Planetary gear
16. Lever
17. Snap ring
18. Stop ring
19. Overrunning clutch
20. Internal gear
21. Planetary gear holder
22. Front bracket

**DISASSEMBLY SERVICE POINTS****◀A▶ MAGNETIC SWITCH REMOVAL**

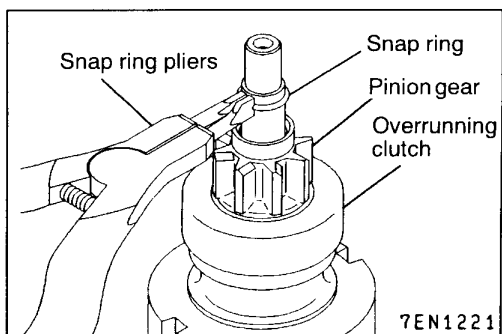
Disconnect field coil wire from "M" terminal of magnetic switch.

◀B▶ ARMATURE/BALL REMOVAL**Caution**

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

**◀C▶ SNAP RING/STOP RING REMOVAL**

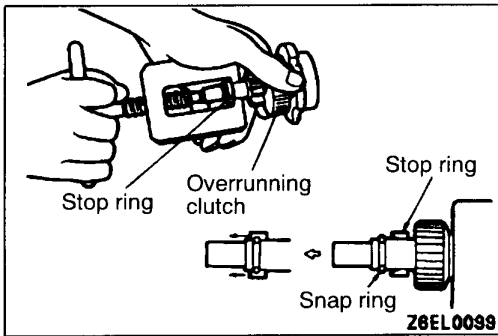
1. Press stop ring off snap ring with a suitable socket.



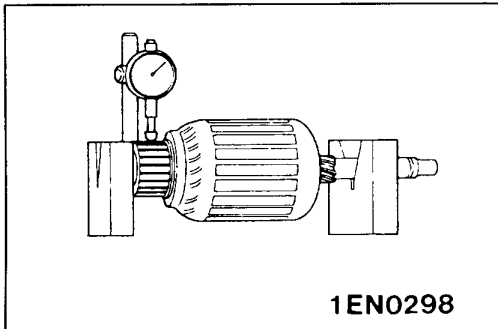
2. Remove snap ring with snap ring pliers and then remove stop ring and overrunning clutch.

STARTER MOTOR PARTS CLEANING

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

**REASSEMBLY SERVICE POINT****►A◄ STOP RING/SNAP RING INSTALLATION**

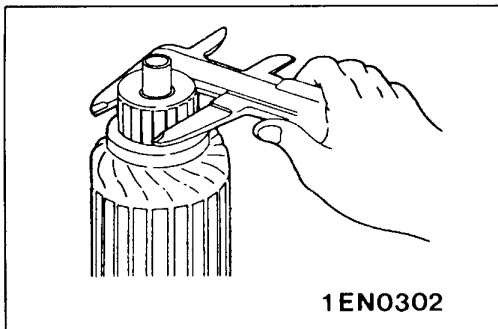
Using a suitable pulling tool, pull overrunning clutch stop ring over snap ring.

**INSPECTION****COMMUTATOR CHECK**

1. Place the armature in a pair of "V" blocks and check the runout with a dial indicator.

Standard value: 0.05 mm

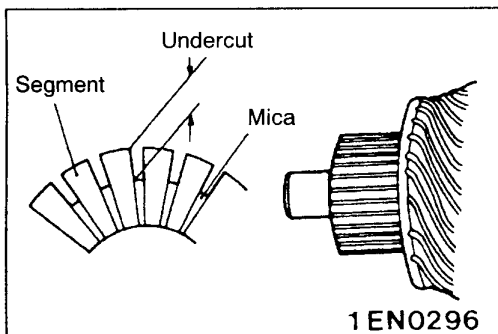
Limit: 0.1 mm



2. Measure the commutator outer diameter.

Standard value: 29.4 mm

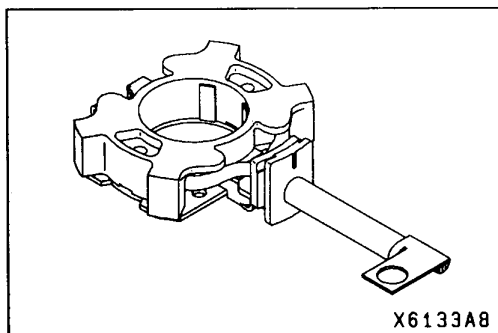
Limit: 28.8 mm



3. Check the undercut depth between segments.

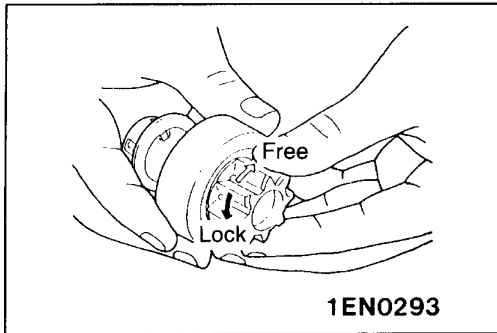
Standard value: 0.5 mm

Limit: 0.2 mm

**BRUSH HOLDER CHECK**

Confirm that the spring is activated when the brush is pressed into the brush holder by hand.

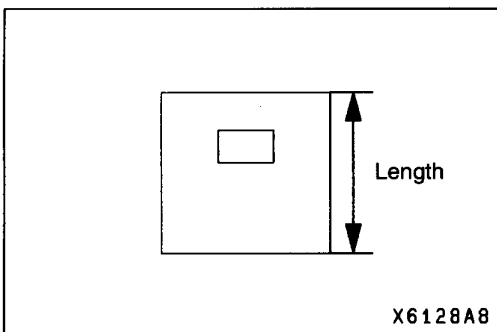
Replace the brush holder if the spring is not activated.

**OVERRUNNING CLUTCH CHECK**

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

FRONT AND REAR BRACKET BUSHING CHECK

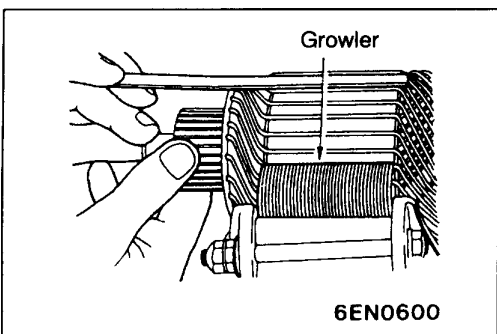
Inspect bushing for wear or burrs. If bushing is worn or burred, replace front bracket assembly or rear bracket assembly.

**BRUSH REPLACEMENT**

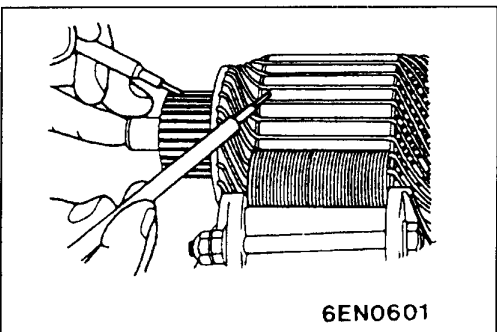
1. Check the surface contacting the commutator for roughness and the brush length.

Limit value: 7.0 mm

2. If the limit is exceeded, replace the brush holder.

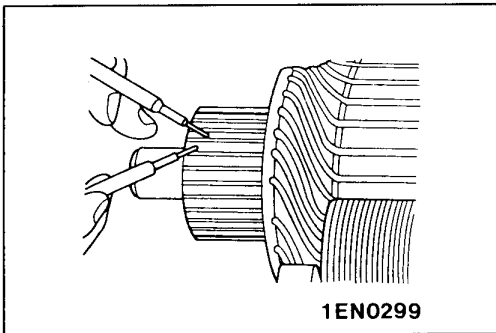
**ARMATURE TEST****ARMATURE COIL SHORT-CIRCUIT TEST**

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

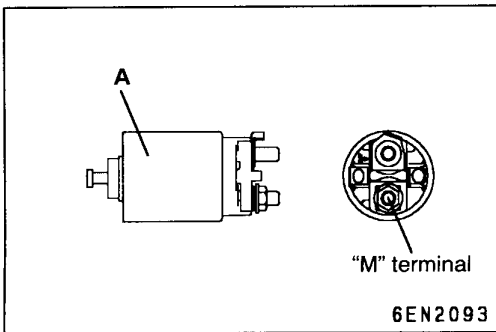
**ARMATURE COIL EARTH TEST**

Check the insulation between each commutator segment and armature coil core.

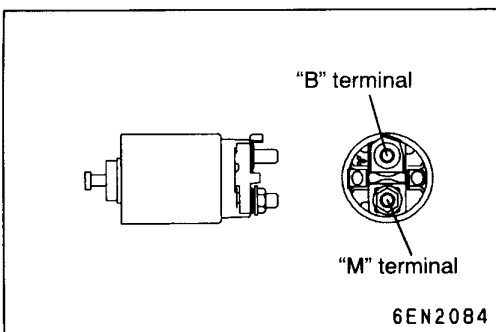
If there is no continuity, the insulation is in order.

**ARMATURE COIL OPEN-CIRCUIT INSPECTION**

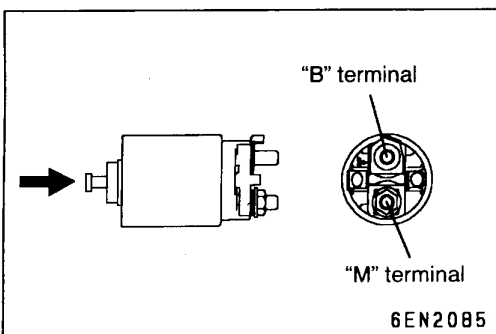
Check the continuity between segments. If there is continuity, the coil is in order.

**MAGNETIC SWITCH****COIL DISCONNECTION TEST**

- Confirm that there is continuity between the "M" terminal and body A.
- If there is no continuity, replace the magnetic switch.

**CONTACT CONTACTING STATE CHECK**

- Confirm that there is no continuity between the "B" terminal and "M" terminal.
- If there is continuity, replace the magnetic switch.

**CONTACT CONTACTING STATE CHECK**

- Press the end of the magnetic switch in with force, and close the internal contact. Confirm that there is continuity between the "B" terminal and "M" terminal in this state.
- If there is no continuity, replace the magnetic switch.

IGNITION SYSTEM

GENERAL INFORMATION

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

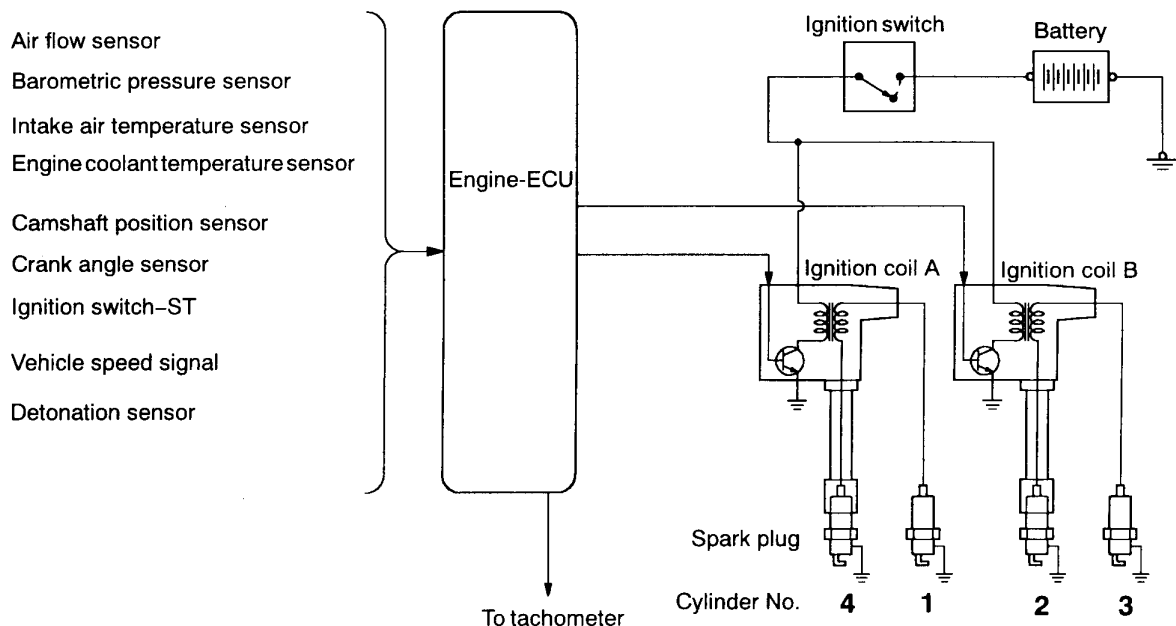
causes the primary currents in the ignition coils to be alternately interrupted and allowed to flow to fire the cylinders in the order 1-3-4-2.

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



Y6092AU

IGNITION COIL SPECIFICATIONS

Items	Specifications
Type	Molded 2-coil

SPARK PLUG SPECIFICATIONS

Items	Specifications
NGK	IGR7A-G
DENSO	VW22PR-DA7

SERVICE SPECIFICATIONS**IGNITION COIL**

Items	Standard value
Secondary coil resistance k Ω	8.5 – 11.5

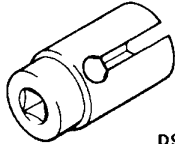
SPARK PLUG

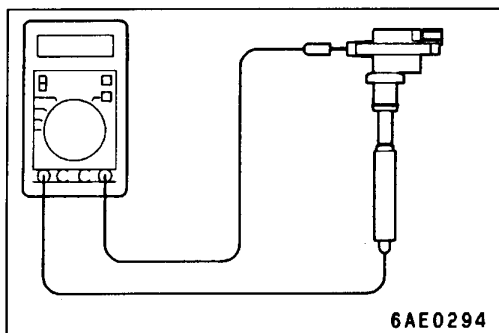
Items	Standard value	Limit
Spark plug gap mm	0.6 – 0.7	0.75

RESISTIVE CORD

Items	Limit
Resistance k Ω	max. 22

SPECIAL TOOL

Tool	Number	Name	Use
 D998773	MD998773	Detonation sensor wrench	Detonation sensor removal and installation



ON-VEHICLE SERVICE

IGNITION COIL (WITH BUILT-IN POWER TRANSISTOR) CHECK

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

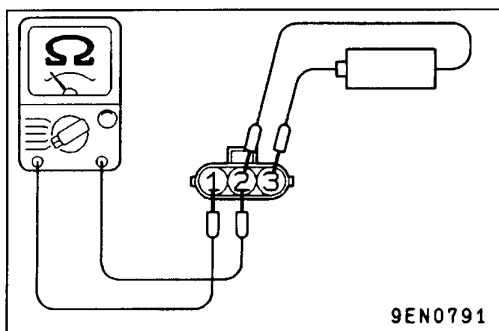
PRIMARY COIL AND POWER TRANSISTOR CONTINUITY CHECK

NOTE

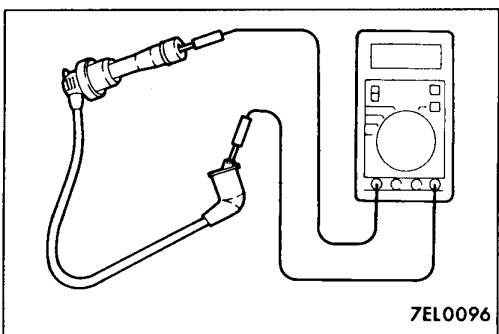
1. An analogue-type circuit tester should be used.
2. Connect the negative (–) probe of the circuit tester to terminal 1.

Caution

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



1.5V power across 2–3	Continuity across 1–2
When energized	Yes
When not energized	No



RESISTIVE CORD CHECK

Measure the resistance of the all spark plug cables.

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

Limit: Max. 22 kΩ

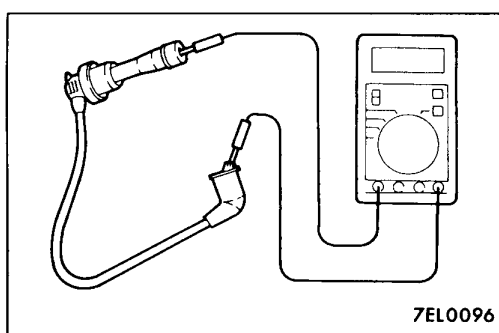
SPARK PLUG CHECK, CLEANING AND REPLACEMENT**SPARK PLUG GAP CHECK****Caution**

1. Do not adjust the gap of the iridium plug.
2. Cleaning of the iridium plug could damage the tip of the electrode. Thus, if the plug must be cleaned because of soot, etc., use a plug cleaner and clean within a short time of 20 seconds or less to protect the electrode. Do not use a wire brush, etc.
3. Even when the functions of the iridium plug are normal, the electrode section may be blackened. However, the adhered carbon has properties that easily burned off compared to the conventional type, so there is no problem. Check the quality of the spark plug by checking the insulation resistance.

Check the plug gap, and replace if the checked value is more than the limit value.

Standard value, limit value:

Maker	Model	Standard value (mm)	Limit value (mm)
NGK	IGR7A-G	0.6 – 0.7	0.75
DENSO	VW22PR-DA7	0.6 – 0.7	0.75

**SPARK PLUG INSULATION RESISTANCE CHECK**

Measure the insulation resistance of the spark plug, and replace if the measured value is less than the limit value.

Limit value: 1 MΩ

CAMSHAFT POSITION SENSOR CHECK

Refer to GROUP 13A – Troubleshooting.

CRANK ANGLE SENSOR CHECK

Refer to GROUP 13A – Troubleshooting.

DETONATION SENSOR CHECK

Check the detonation sensor circuit if self-diagnosis code, No. 31 is shown.

NOTE

For information concerning the self-diagnosis codes, refer to GROUP 13A – Troubleshooting.

WAVEFORM CHECK USING AN ANALYZER**Ignition Secondary Voltage Waveform Check
MEASUREMENT METHOD**

1. Clamp the secondary pickup around the spark plug cable.

NOTE

- (1) The peak ignition voltage will be reversed when the spark cables No. 2 and No. 4, or No. 1 and No. 3 cylinders are clamped.
- (2) 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.
- (3) 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.

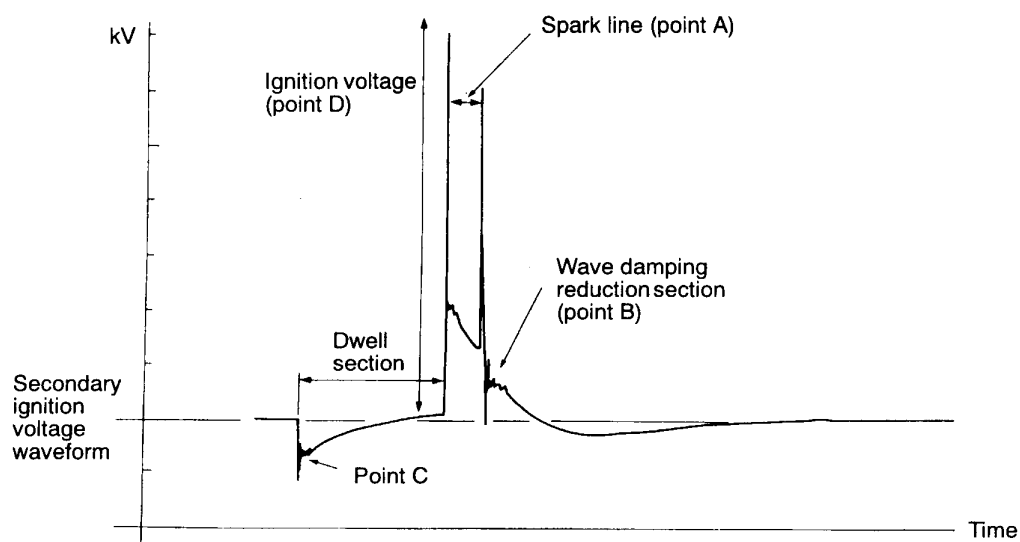
2. Clamp the spark plug cable with the trigger pickup.

NOTE

Clamp the trigger pickup to the same spark plug cable clamped by the secondary pickup.

STANDARD WAVEFORM**Observation Conditions**

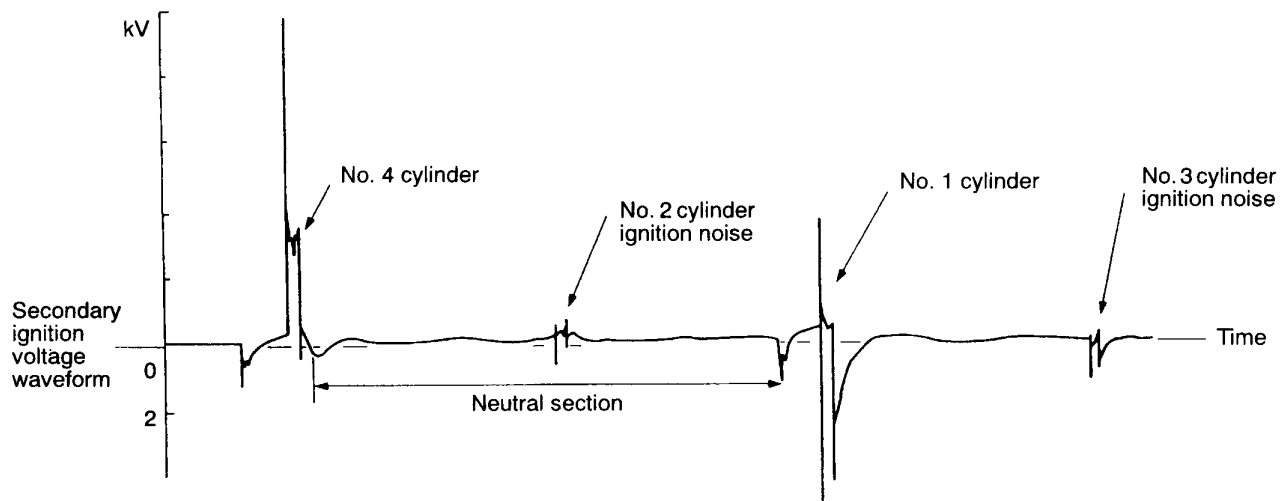
Function	Secondary
Pattern height	High (or Low)
Pattern selector	Raster
Engine revolutions	Curb idle speed



7EL0147

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

Pattern selector	Display
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6EL0183

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
Three or more	Normal
Except above	Abnormal

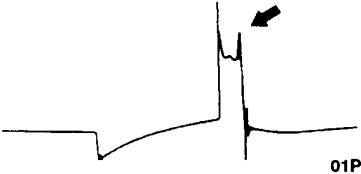
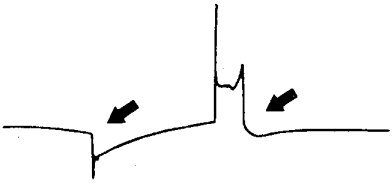
Point C: Number of vibrations at beginning of dwell section (Refer to abnormal waveform example 5)

Number of vibrations	Coil
5 – 6 or higher	Normal
Except above	Abnormal

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

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

EXAMPLES OF ABNORMAL WAVEFORMS

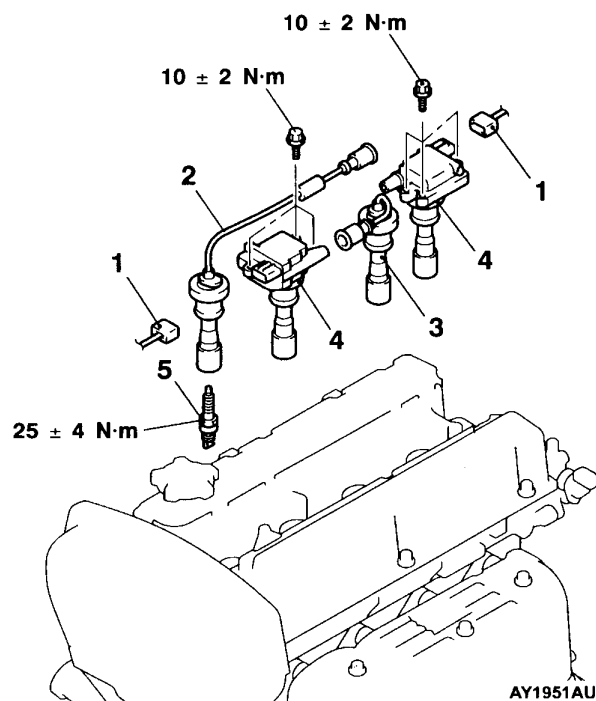
Abnormal waveform	Wave characteristics	Cause of problem
Example 1  01P0215	Spark line is high and short.	Spark plug gap is too large.
Example 2  01P0216	Spark line is low and long, and is sloping. Also, the second half of the spark line is distorted. This could be a result of misfiring.	Spark plug gap is too small.
Example 3  01P0217	Spark line is low and long, and is sloping. However, there is almost no spark line distortion.	Spark plug gap is fouled.
Example 4  01P0218	Spark line is high and short. Difficult to distinguish between this and abnormal waveform example 1.	Spark plug cable is nearly falling off. (Causing a dual ignition)
Example 5  01P0219	No waves in wave damping section.	Layer short in ignition coil

IGNITION COIL

REMOVAL AND INSTALLATION

Pre-removal and Post-installation Operation

Center Cover Removal and Installation (Refer to GROUP 11A – Camshaft and Camshaft Oil Seal.)

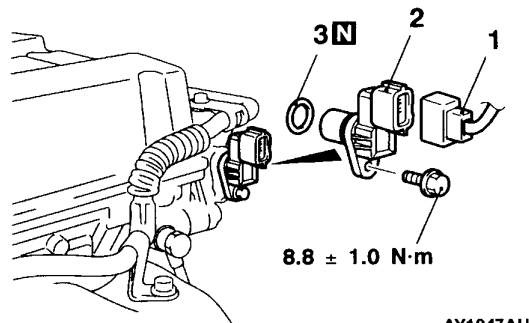
**Removal steps**

1. Ignition coil connector
2. Spark plug cable No.1
3. Spark plug cable No.3

4. Ignition coil
5. Spark plug

CAMSHAFT POSITION SENSOR

REMOVAL AND INSTALLATION



Removal steps

1. Camshaft position sensor connector
2. Camshaft position sensor
3. O-ring

CRANK ANGLE SENSOR

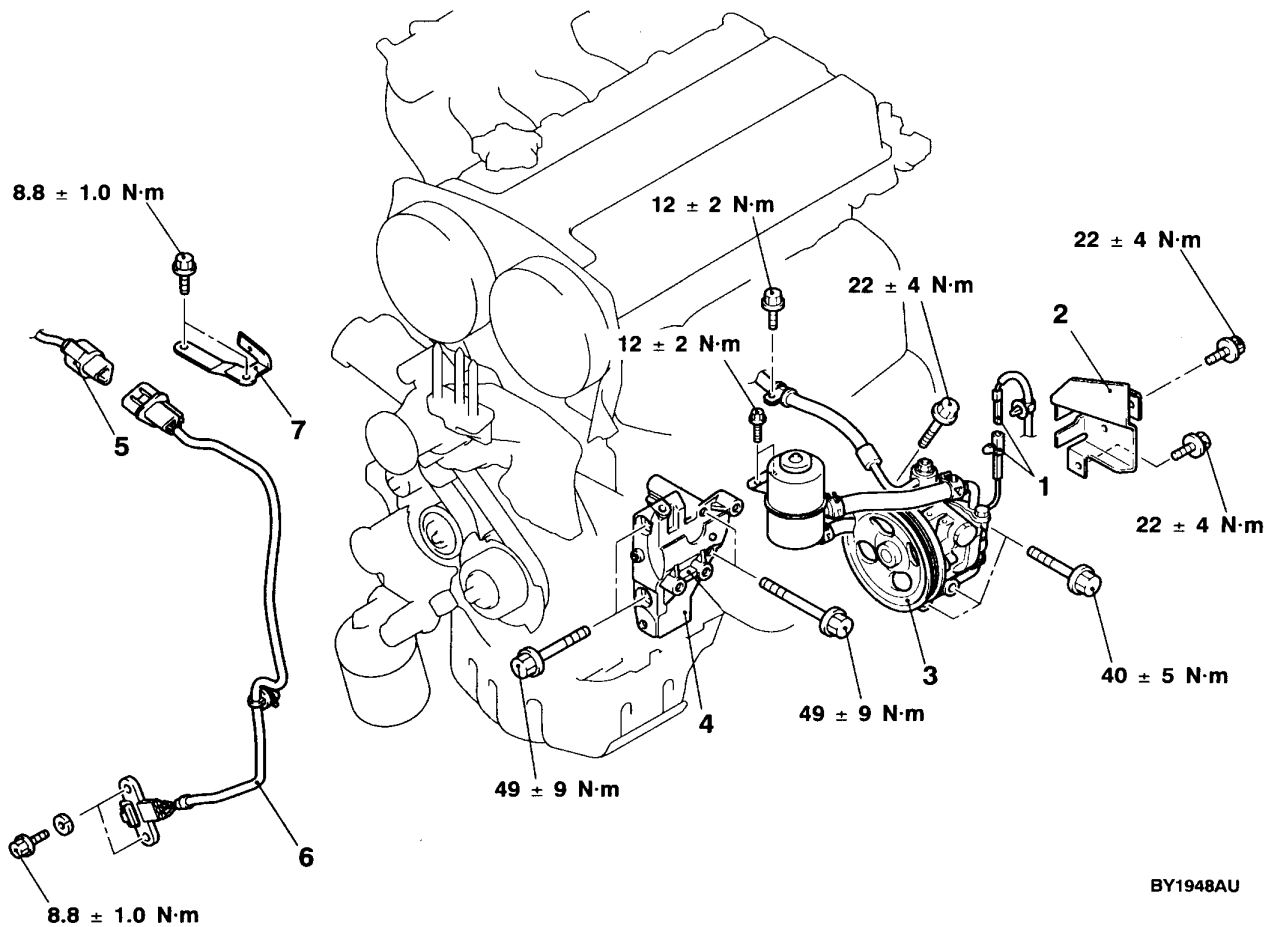
REMOVAL AND INSTALLATION

Caution

If the vehicle is equipped with the Brembo disc brake, during maintenance, take care not to contact the parts or tools to the caliper because the paint of caliper will be scratched.

Pre-removal and Post-installation Operation

- Center Cover Removal and Installation (Refer to GROUP 11A – Camshaft and Camshaft Oil Seal.)
- Timing Belt Removal and Installation (Refer to GROUP 11A.)
- Reserve Tank Removal and Installation (Refer to GROUP 14 – Radiator.)



BY1948AU

Removal steps

1. Power steering oil pressure switch connector
2. Heat protector
3. Power steering oil pump, bracket and oil reservoir assembly

4. Power steering oil pump bracket
5. Crank angle sensor connector
6. Crank angle sensor
7. Connector bracket

**REMOVAL SERVICE POINT**
◀A▶ POWER STEERING OIL PUMP, BRACKET AND OIL RESERVOIR ASSEMBLY REMOVAL

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

NOTE

Tie the removed oil pump with a rope and set aside where they cannot hinder the removal of the power steering oil pump bracket.

DETONATION SENSOR

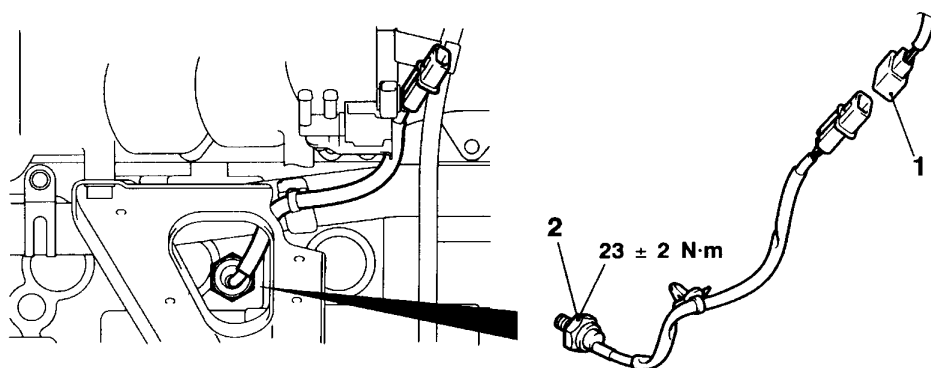
REMOVAL AND INSTALLATION

Caution

Do not give any impact during removal and installation of detonation sensor.

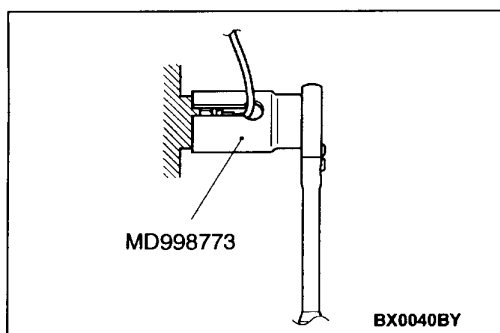
Pre-removal and Post-installation Operation

Intake Manifold Stay Removal and Installation (Refer to GROUP 15 – Intake Manifold.)



Removal steps

- ◀A▶ ▶A▶
1. Detonation sensor connector
 2. Detonation sensor



REMOVAL SERVICE POINT

◀A▶ DETONATION SENSOR REMOVAL

INSTALLATION SERVICE POINT

▶A▶ DETONATION SENSOR INSTALLATION