
ENGINE ELECTRICAL

CONTENTS

16109000097

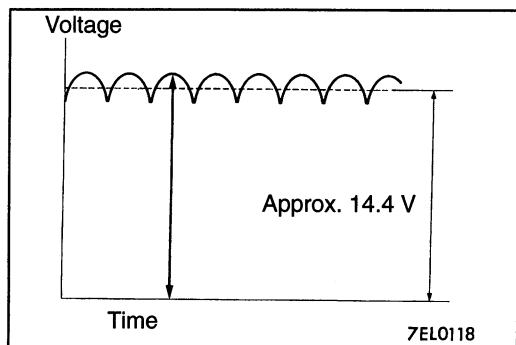
CHARGING SYSTEM	2	GENERAL INFORMATION	22
GENERAL INFORMATION	2	SERVICE SPECIFICATIONS	23
SERVICE SPECIFICATIONS	3	SPECIAL TOOL	23
SPECIAL TOOL	3	ON-VEHICLE SERVICE	24
ON-VEHICLE SERVICE	4	Ignition Coil Check	24
Alternator Output Line Voltage Drop Test ...	4	Power Transistor Check	24
Output Current Test	5	Resistive Cord Check	25
Regulated Voltage Test	6	Detonation Sensor Check	25
Waveform Check Using An Analyzer	8	Spark Plug Check and Cleaning	25
ALTERNATOR	10	Crank Angle Sensor, Camshaft Position Sensor Check	26
STARTING SYSTEM	15	Waveform Check Using An Analyzer	26
GENERAL INFORMATION	15	Ignition Primary Voltage Waveform Check ..	30
SERVICE SPECIFICATIONS	16	IGNITION SYSTEM	34
STARTER MOTOR	16	CAMSHAFT POSITION SENSOR AND CRANKSHAFT POSITION SENSOR	36
IGNITION SYSTEM	22	DETONATION SENSOR	37

CHARGING SYSTEM

16100010136

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.

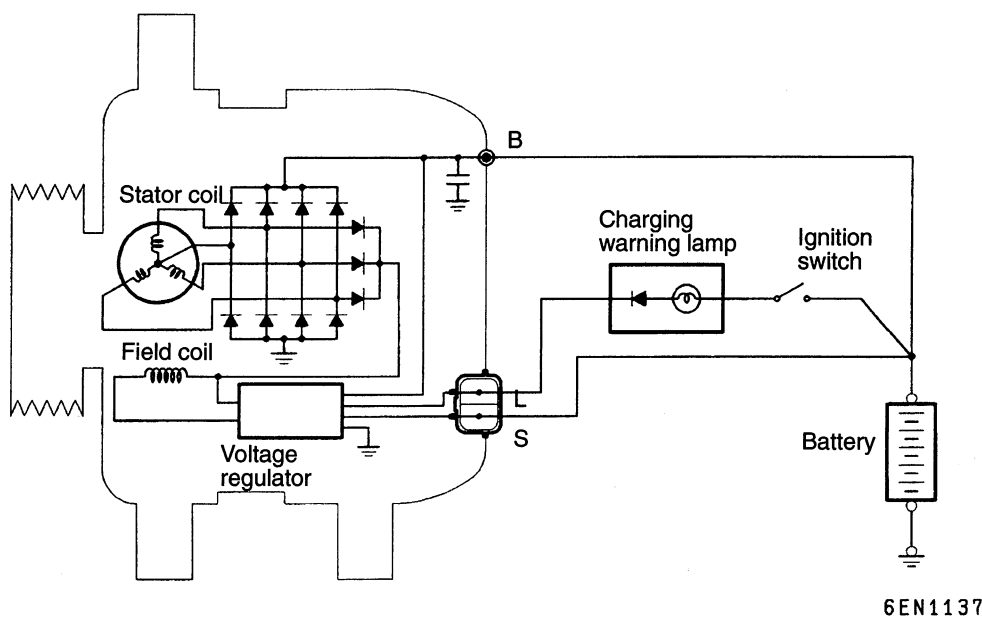
When the stator coil begins to generate power after the engine is started, the field coil is excited by the output current of the stator coil.

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 approx. 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

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

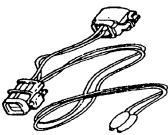
SERVICE SPECIFICATIONS

16100030095

Items	Standard value	Limit
Alternator output line voltage drop (at 30A) 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	3–5	–

SPECIAL TOOL

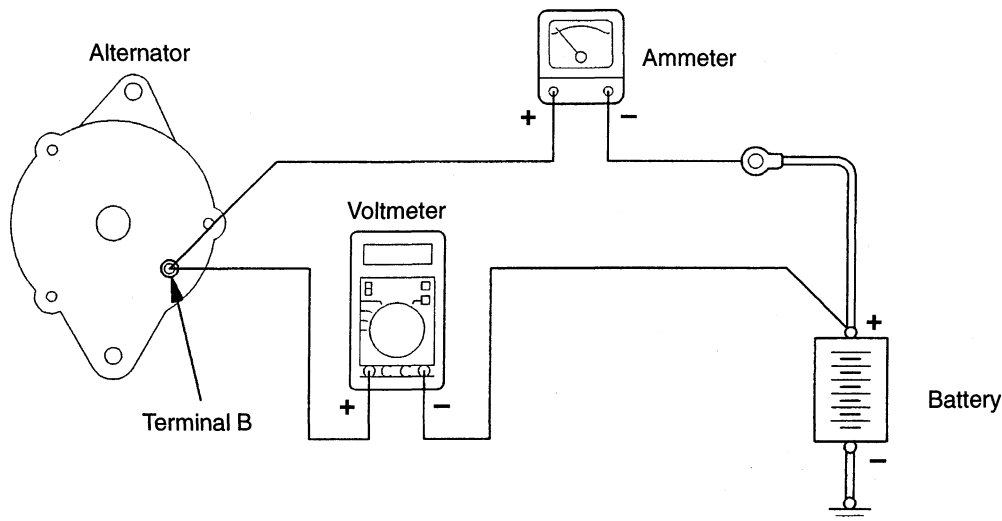
16100060049

Tool	Number	Name	Use
	MD998467	Alternator harness connector	Checking the alternator (S terminal voltage)

ON-VEHICLE SERVICE

16100090130

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 11A – On-vehicle Service.)
 - Fusible link
 - Abnormal noise from the alternator while the engine is running
- (2) Turn the ignition switch off.
- (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) Connect a tachometer. (For the procedure for connecting the tachometer, refer to GROUP 11A – On-vehicle Service.)
- (7) Reconnect the negative battery cable.
- (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

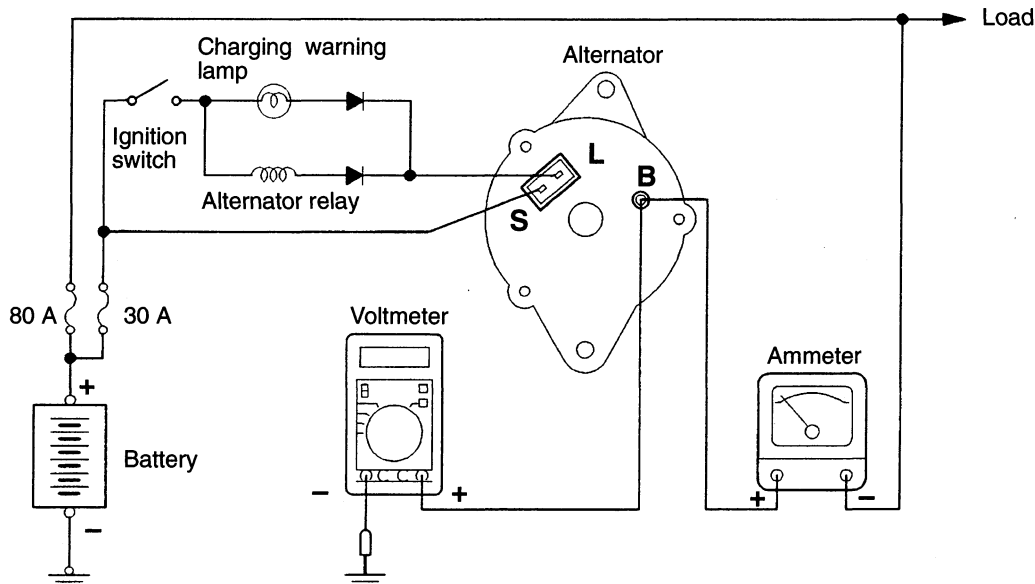
When the alternator output is high and the value displayed on the ammeter does not decrease until 30 A, set the value to 40 A. Read the value displayed on the voltmeter at this time. If the ammeter displays 40A, the voltage should be within 0.4 V.

(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 all lamps and the ignition at idle.
 (14) Disconnect the negative battery cable.
 (15) Disconnect the ammeter, voltmeter and tachometer.
 (16) Connect the alternator output wire to the alternator "B" terminal.
 (17) Connect the negative battery cable.

OUTPUT CURRENT TEST

16100100130



6EN1140

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 used 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 11A – On-vehicle Service.)
- Fusible link
- Abnormal noise from the alternator while the engine is running.

(2) Turn the ignition switch off.

(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 a tachometer. (For the procedure for connecting the tachometer, refer to GROUP 11A – On-vehicle Service.)
- (7) Connect the negative battery cable.
- (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

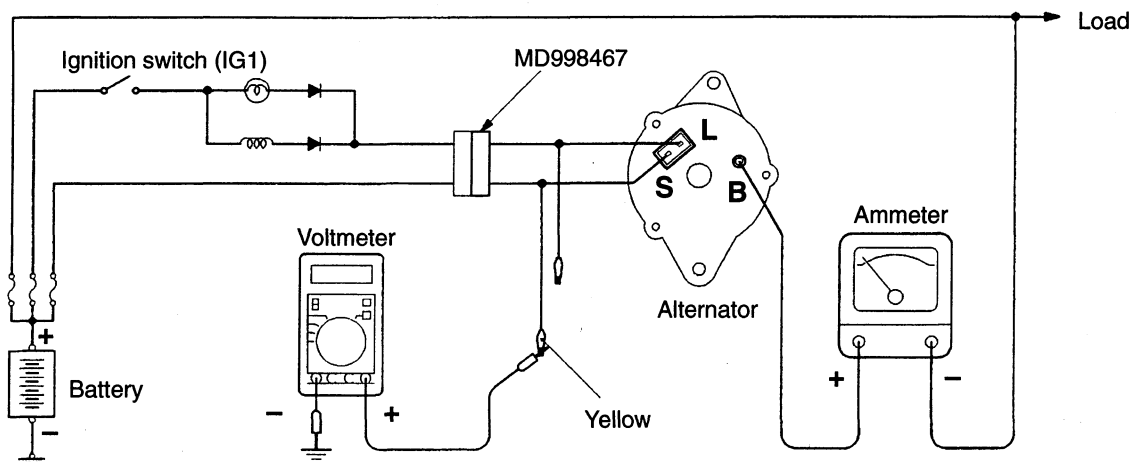
NOTE

- 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 off.
- (15) Disconnect the negative battery cable.
- (16) Disconnect the ammeter, voltmeter and tachometer.
- (17) Connect the alternator output wire to the alternator “B” terminal.
- (18) Connect the negative battery cable.

REGULATED VOLTAGE TEST

16100110133



6EN1141

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 11A – On-vehicle Service.)
 - Fusible link
 - Abnormal noise from the alternator while the engine is running
- (2) Turn off the ignition switch.
- (3) Disconnect the negative battery cable.
- (4) Connect a digital-type voltmeter between the alternator “S” terminal and the 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) Connect a tachometer. (Refer to GROUP 11A – On-vehicle Service.)
- (8) Reconnect the negative battery cable.

- (9) Turn the ignition switch to the ON position and check that the reading on the voltmeter is equal to the battery voltage.

NOTE

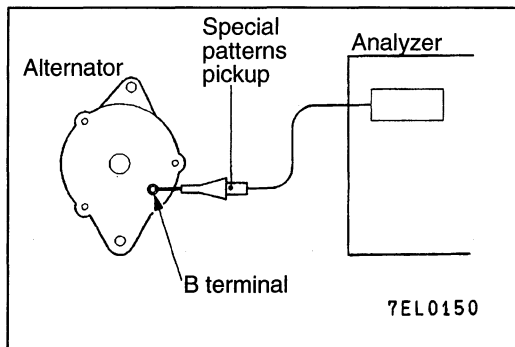
If the voltage is 0 V, the cause is probably an open circuit in the wire or fusible link between the alternator “S” terminal and the battery (+) terminal.

- (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 off.
- (17) Disconnect the negative battery cable.
- (18) Disconnect the ammeter, voltmeter and tachometer.
- (19) Connect the alternator output wire to the alternator “B” terminal.
- (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 ANALYZER

16100120112

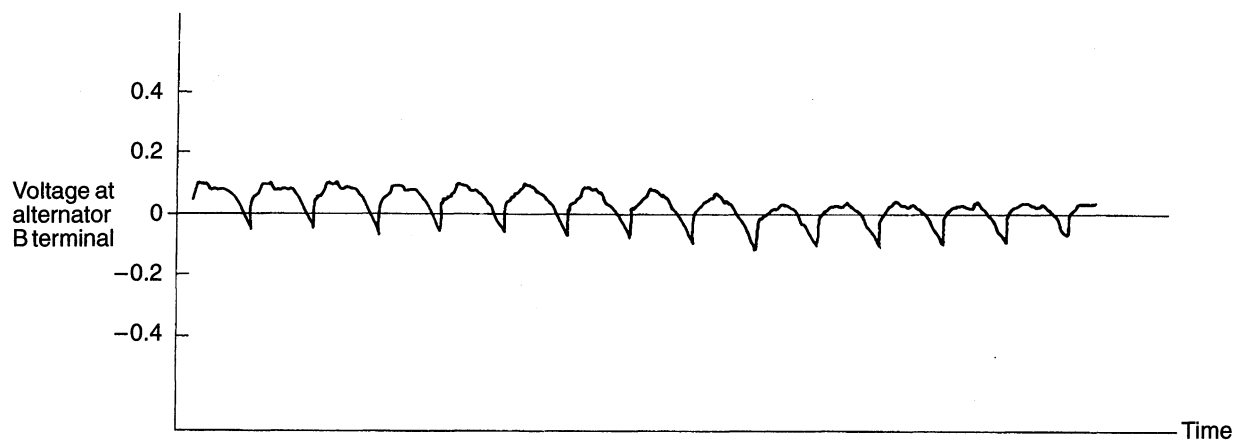
MEASUREMENT METHOD

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

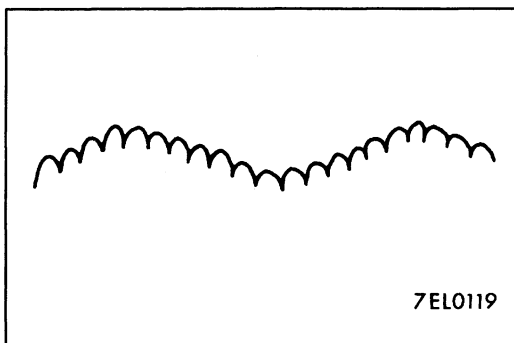
STANDARD WAVEFORM

Observation Conditions

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



7EL0115



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.

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 At this time, the charging warning lamp is illuminated.	• Open supplementary diode
Example 3  A7EL0122	• Broken wire in stator coil		

ALTERNATOR

16100140156

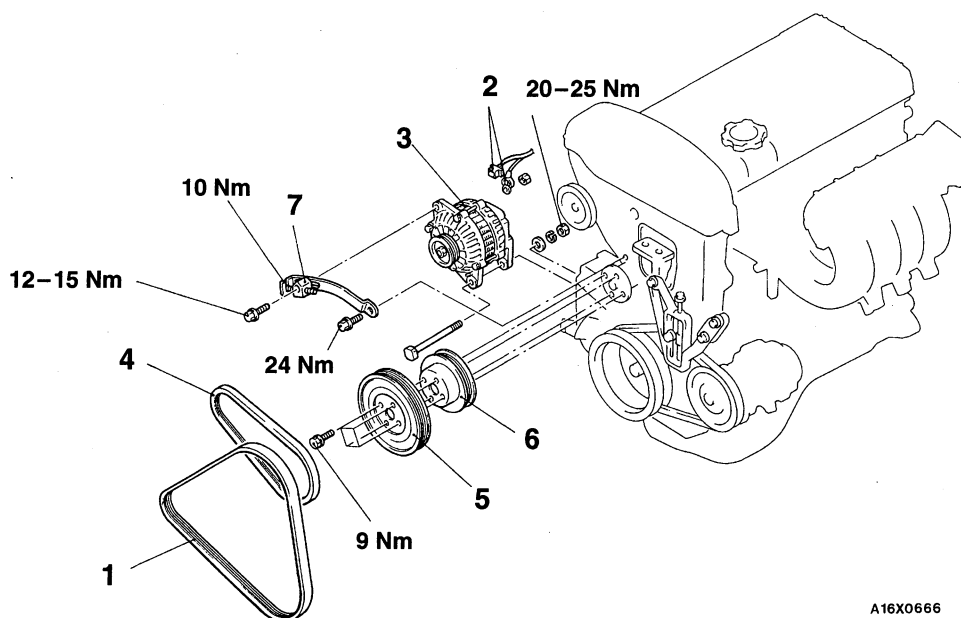
REMOVAL AND INSTALLATION

Pre-removal Operation

Under Cover Side Panel Removal

Post-installation Operation

- Drive Belt Tension Adjustment
(Refer to GROUP 11A – On-vehicle Service.)
- Under Cover Side Panel Installation

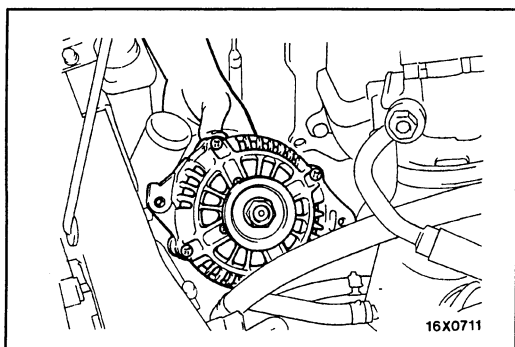


A16X0666

Removal steps

1. Drive belt (Alternator)
2. Alternator harness connector
3. Alternator
4. Drive belt (power steering)

5. Water pump pulley
6. Power steering oil pump pulley
7. Alternator brace



16X0711

REMOVAL SERVICE POINT

◀A▶ ALTERNATOR REMOVAL

- (1) Remove the mounting bolt of the power steering oil pump, and hold the oil pump above the engine mount bracket. Use shop towel, etc. to prevent scarring or scratching of the rocker cover

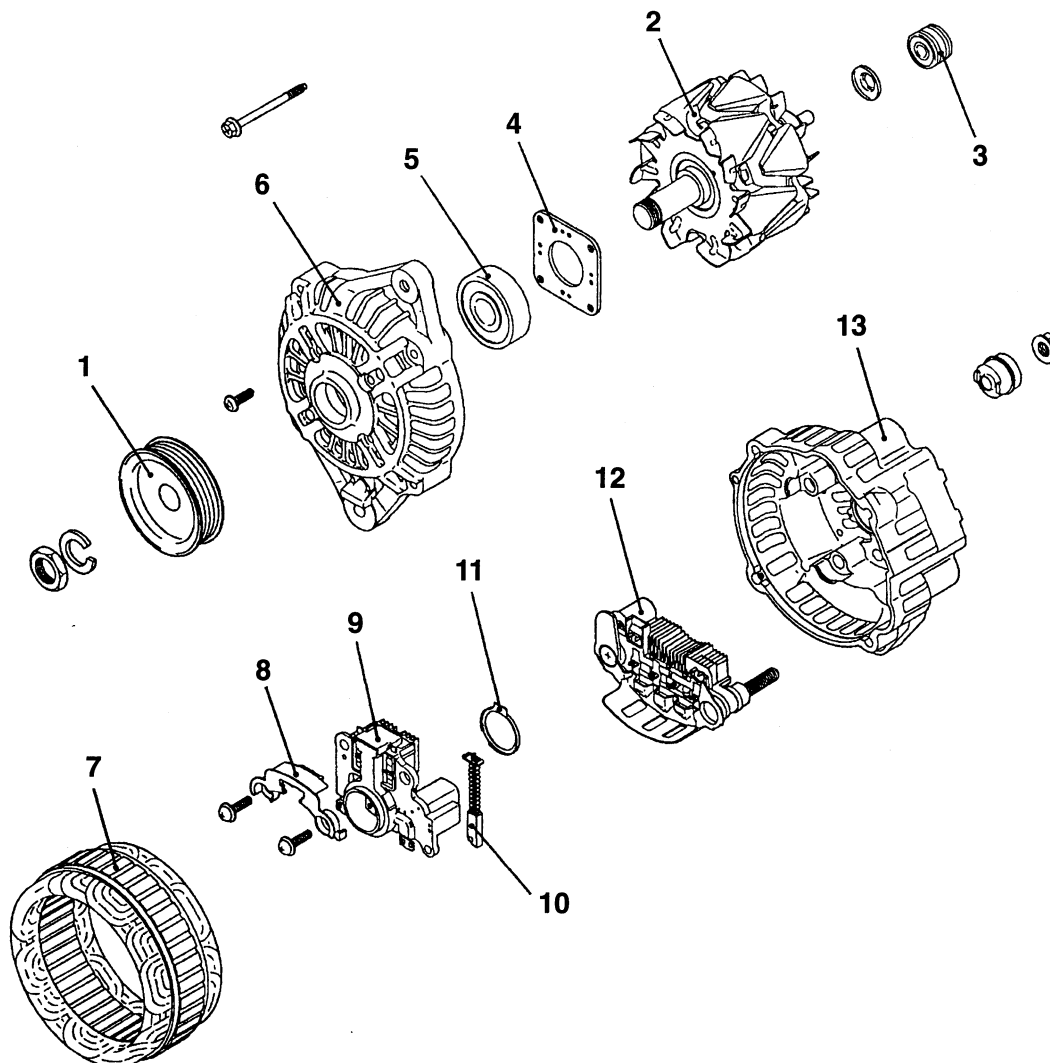
NOTE

Do not disconnect the oil pump hose.

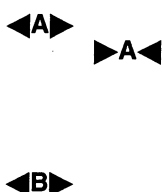
- (2) With the alternator facing as shown in the figure, remove upwards.

DISASSEMBLY AND REASSEMBLY

16100160114

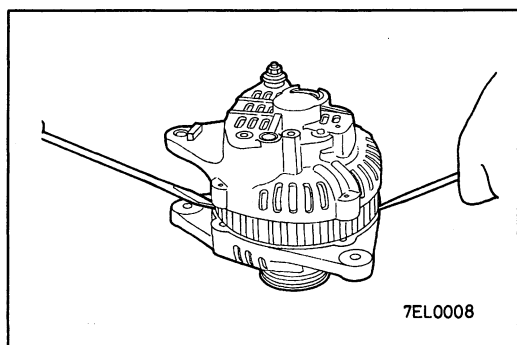


Z6EN0878

Disassembly steps

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

8. Plate
9. Regulator and brush holder
10. Brush
11. Slinger
12. Rectifier
13. Rear bracket



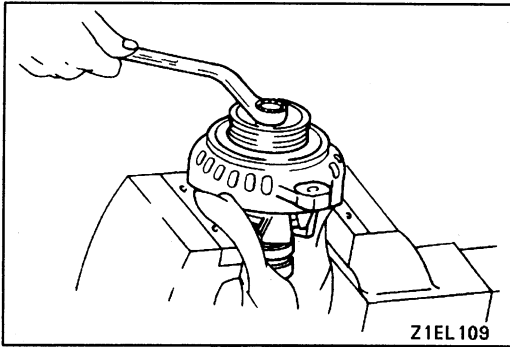
7EL0008

DISASSEMBLY SERVICE POINTS**◀A▶ GENERATOR PULLEY REMOVAL**

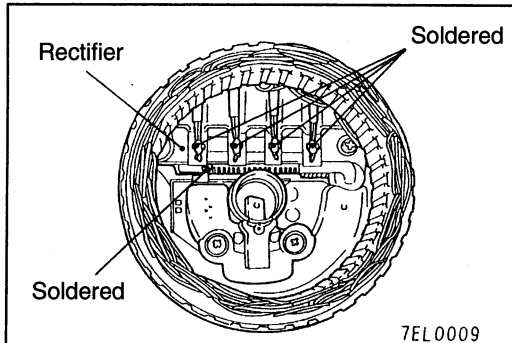
- (1) Remove the bolts.
- (2) Insert a flat-tipped screwdriver between front bracket and stator core and pry downwards.

Caution

Do not insert screwdriver too deep, or stator coil will be damaged.



- (3) Clamp the rotor in a vice with soft jaws.
- (4) After removing the nut, remove the pulley and front bracket from the rotor.

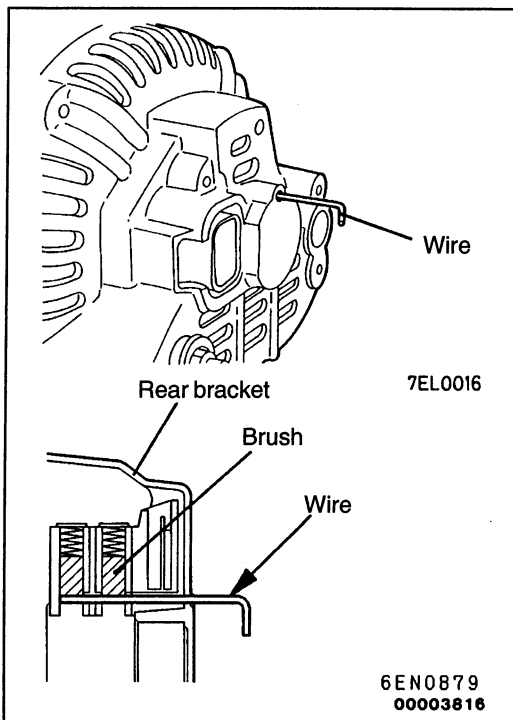


◀B▶ STATOR REMOVAL

- (1) When removing stator, unsolder stator leads soldered to main diodes on rectifier.
- (2) When removing rectifier from brush holder, unsolder two soldered points to rectifier.

Caution

- (1) When soldering or unsoldering, use care to make sure that heat of soldering iron is not transmitted to diodes for a long period. Finish soldering or unsoldering in as short a time as possible.
- (2) Use care that no undue force is exerted to leads of diodes.

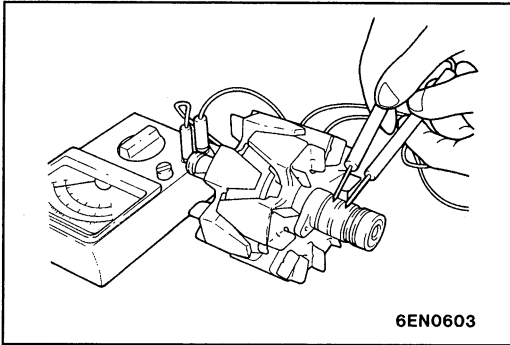


REASSEMBLY SERVICE POINT

16100170117

▶A◀ ROTOR ASSEMBLY INSTALLATION

Before rotor is attached to rear bracket, insert wire through small hole made in rear bracket to lift brush. After rotor has been installed, remove the wire.

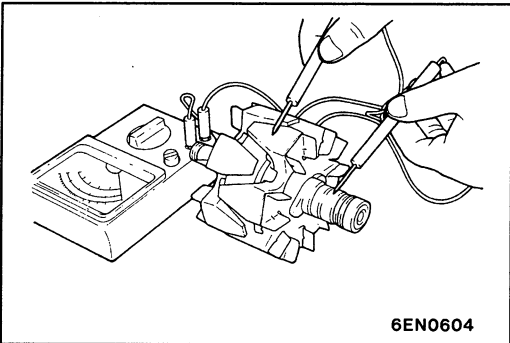


INSPECTION

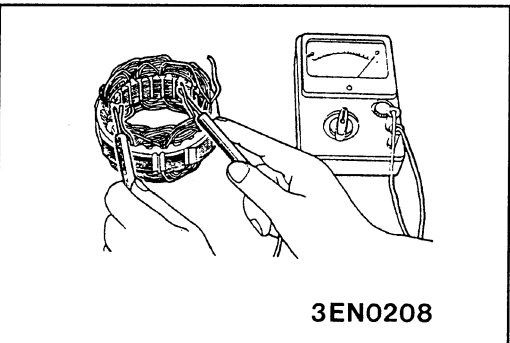
ROTOR CHECK

- (1) Check field coil for continuity. Check to ensure that there is no continuity between slip rings. If resistance is too small, it means that there is a short circuit. If there is no continuity or if there is a short circuit, replace rotor assembly.

Standard value: 3–5 Ω

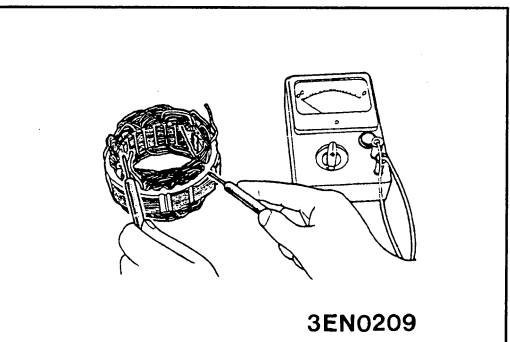


- (2) Check rotor coil for grounding. Check to ensure that there is no continuity between slip ring and core. If there is continuity, replace rotor assembly.

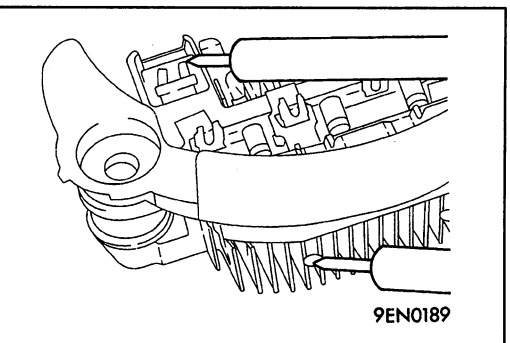


STATOR CHECK

- (1) Make continuity test on stator coil. Check to ensure that there is continuity between coil leads. If there is no continuity, replace stator assembly.



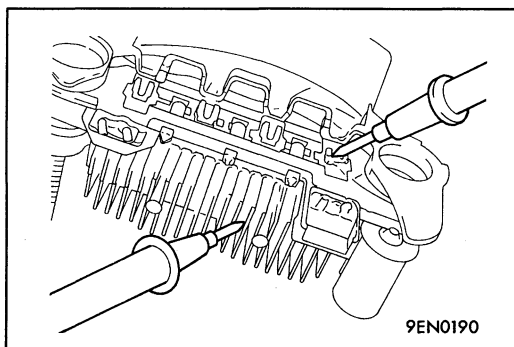
- (2) Check coil for grounding. Check to ensure that there is no continuity between coil and core. If there is continuity, replace stator assembly.



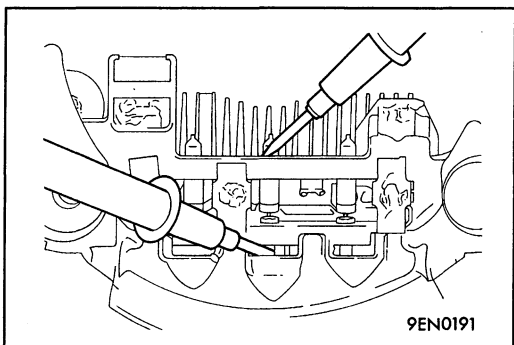
RECTIFIERS CHECK

(1) Positive Rectifier Test

Check for continuity between positive rectifier and stator coil lead connection terminal with an ohmmeter. If there is continuity in both directions, diode is shorted. Replace the rectifier assembly.

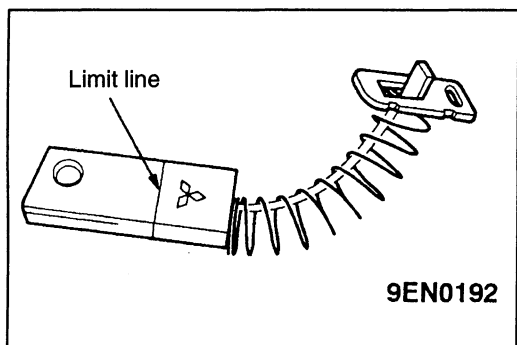
**(2) Negative Rectifier Test**

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.

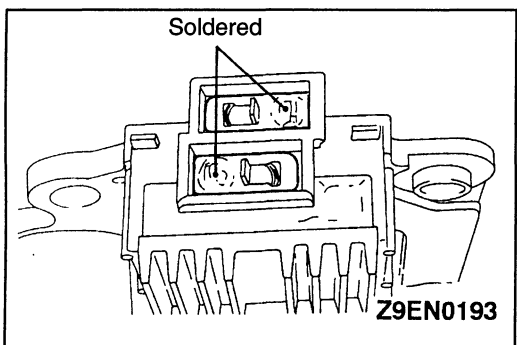
**(3) Diode Trio Test**

Check three diodes for continuity by connecting an ammeter to both ends of each diode.

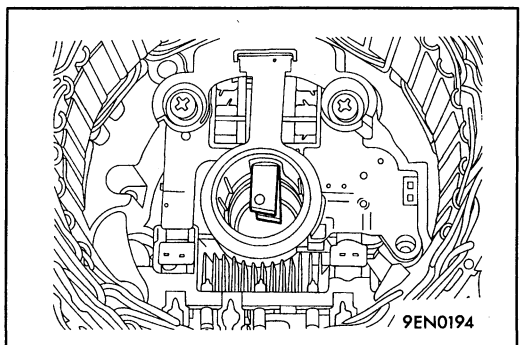
If there is no continuity in both directions, diode is faulty and rectifier assembly must be replaced.

**BRUSH REPLACEMENT**

- (1) Replace the brush by the following procedures if it has been worn to the limit line.



- (2) Unsolder pigtail and remove old brush and spring.



- (3) When installing a new brush, push the brush in the brush holder as shown in the illustration, and solder the lead wire.

STARTING SYSTEM

16200010115

GENERAL INFORMATION

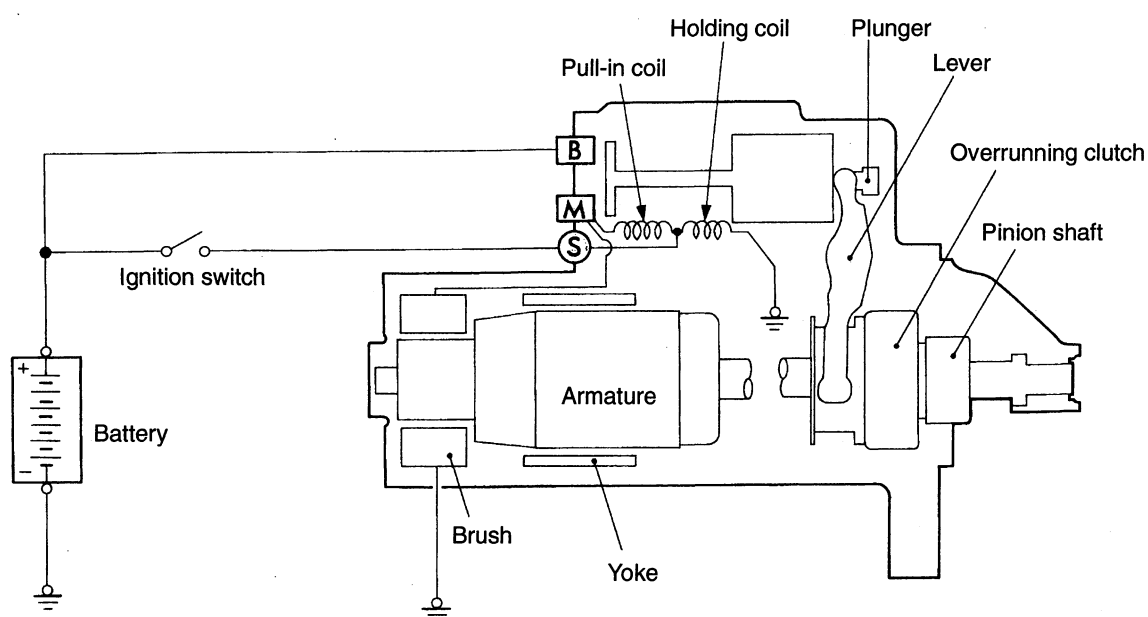
If the ignition switch is turned to the “START” position, current flows in the coil provided inside magnetic switch, attracting the plunger. When the plunger is attracted, the lever connected to the plunger is actuated to engage the starter clutch. On the other hand, attracting the plunger will turn on the magnetic switch, allowing the B terminal and M terminal to conduct. Thus, current flows to

engage the starter motor.

When the ignition switch is returned to the “ON” position after starting the engine, the starter clutch is disengaged from the ring gear.

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

SYSTEM DIAGRAM



6EN0939

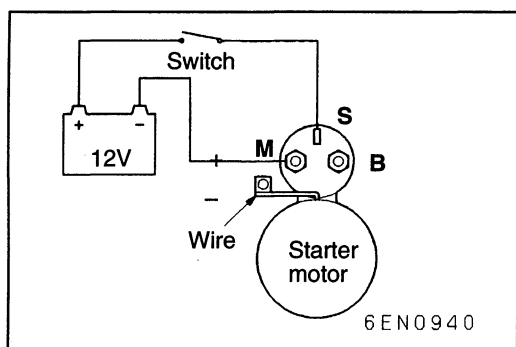
STARTER MOTOR SPECIFICATIONS

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

SERVICE SPECIFICATIONS

16200030074

Items		Standard value	Limit
Pinion gap mm		0.5–2.0	–
Free running characteristic	Terminal voltage V	11	–
	Current A	Max. 90	–
	Speed r/min	3,000 or more	–
Commutator outer diameter mm		29.4	28.4
Commutator runout mm		0.05	0.1
Commutator undercut mm		0.5	0.2
Brush length mm		–	11



STARTER MOTOR

16200110105

INSPECTION

PINION GAP ADJUSTMENT

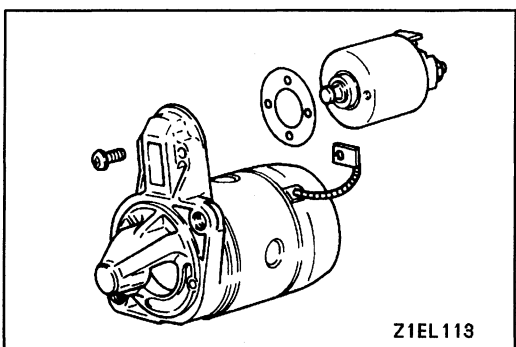
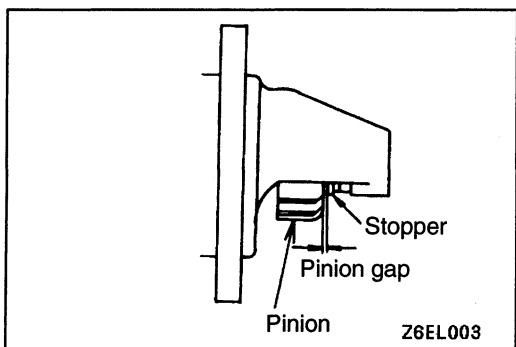
1. Disconnect field coil wire from M-terminal of magnetic switch.
2. Connect a 12V battery between S-terminal and M-terminal.
3. Set switch to "ON", and pinion will move out.

Caution

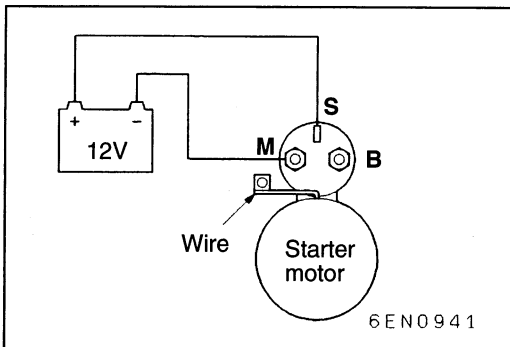
This test must be performed quickly (in less than 10 seconds) to prevent coil from burning.

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.

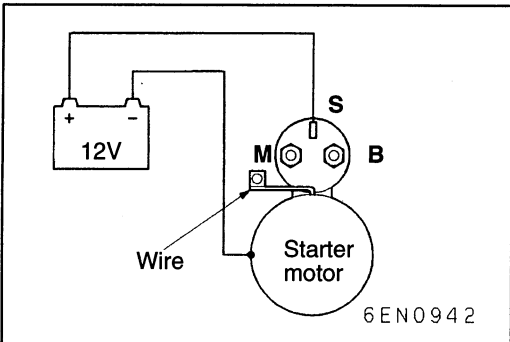
**MAGNETIC SWITCH PULL-IN TEST**

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

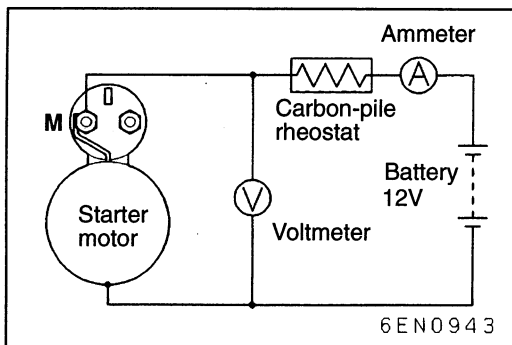
**MAGNETIC SWITCH HOLD-IN TEST**

1. Disconnect field coil wire from M-terminal of magnetic switch.
2. Connect a 12V 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 vice equipped with soft jaws and connect a fully-charged 12-volt 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-volt 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 11V.
7. Confirm that the maximum amperage is within the specifications and that the starter motor turns smoothly and freely.

Standard value: max. 90 Amps

MAGNETIC SWITCH RETURN TEST

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

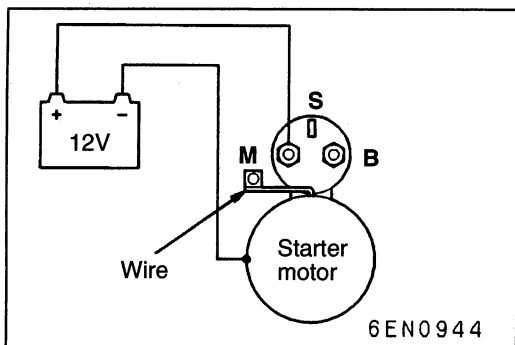
Caution

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.

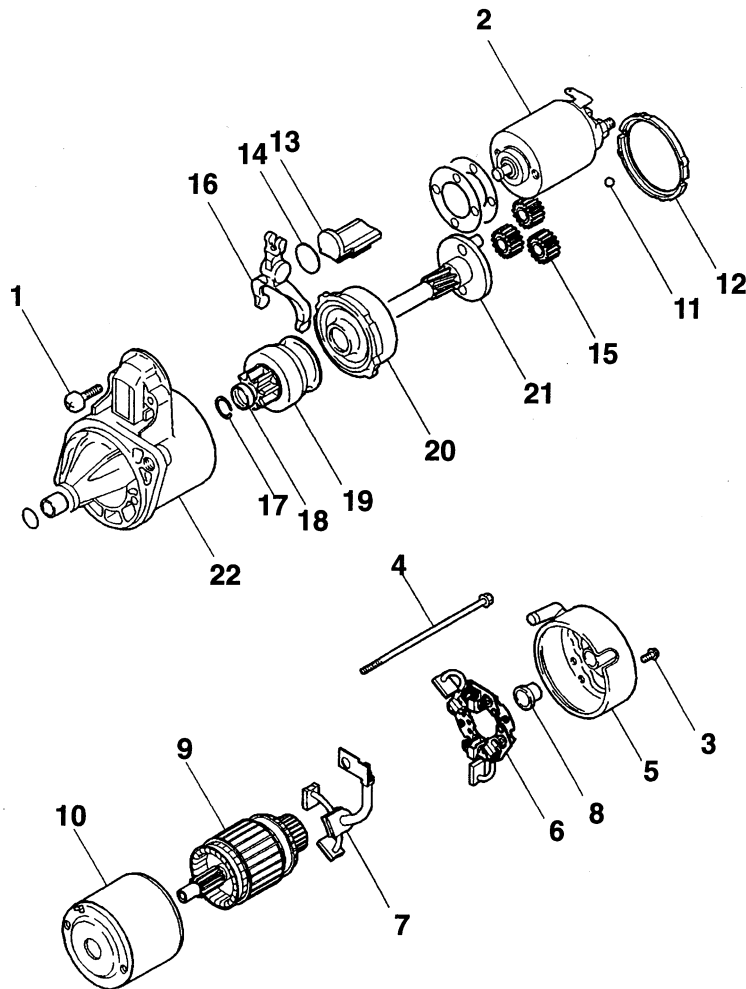
Caution

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



DISASSEMBLY AND REASSEMBLY

16200120146



6EN1139

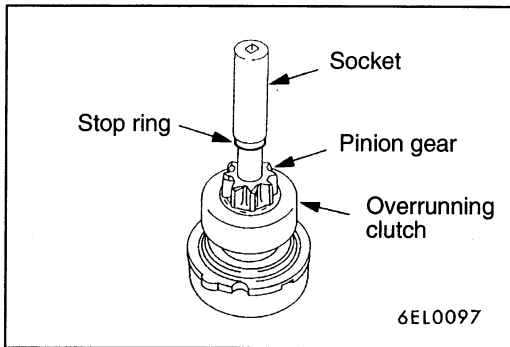
Disassembly steps

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

12. Packing A
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

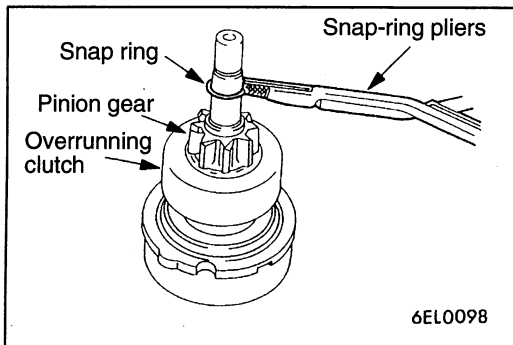
**DISASSEMBLY SERVICE POINTS****◀A▶ ARMATURE / BALL REMOVAL****Caution**

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



◀B▶ 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.

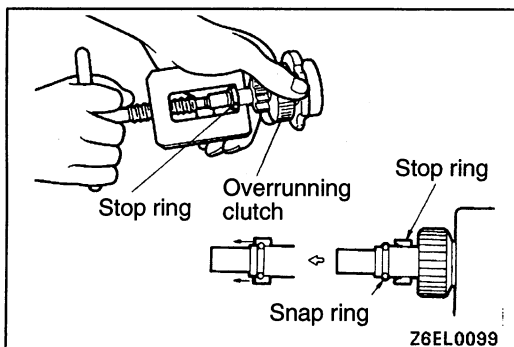
STARTER MOTOR PARTS CLEANING

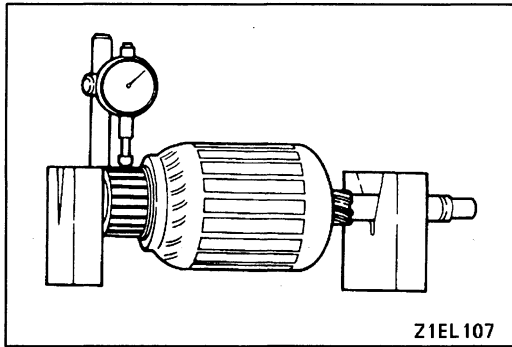
1. Do not immerse parts in cleaning solvent. Immersing the yoke and field coil assembly and/or armature will damage insulation. Wipe these parts with a cloth only.
2. Do not immerse drive unit in cleaning solvent. Overrunning clutch is pre-lubricated at the factory and solvent will wash lubrication from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

REASSEMBLY SERVICE POINTS

▶A◀ STOP RING/SNAP RING INSTALLATION

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

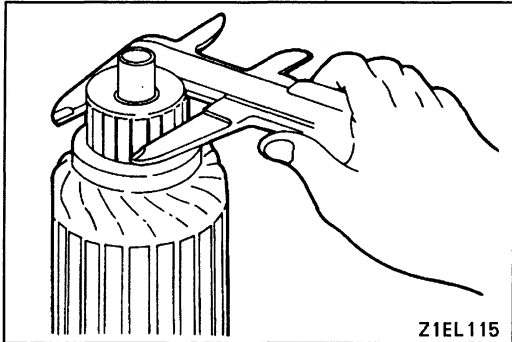


**INSPECTION**

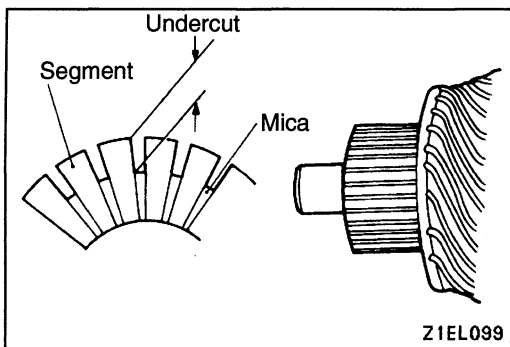
16200130149

COMMUTATOR CHECK

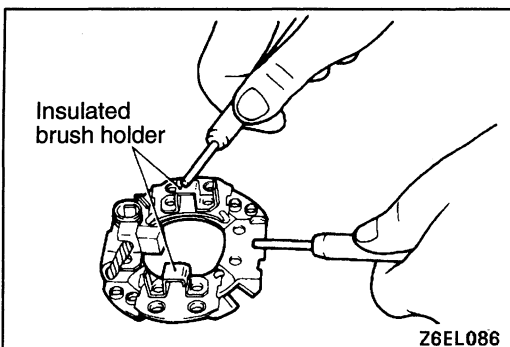
1. Place the armature in a pair of "V" blocks and check the runout with a dial indicator.

Standard value: 0.05 mm**Limit: 0.1 mm**

2. Measure the commutator outer diameter.

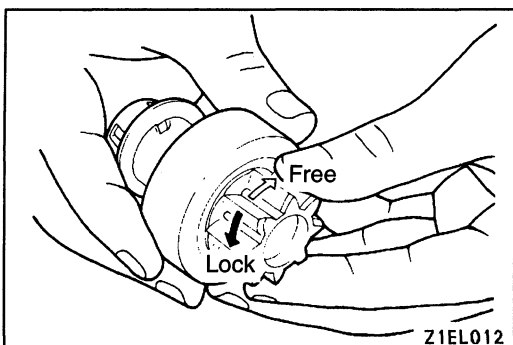
Standard value: 29.4 mm**Limit: 28.4 mm**

3. Check the undercut depth between segments.

Standard value: 0.5 mm**Limit: 0.2 mm****BRUSH HOLDER CHECK**

Check the continuity between brush holder plate and brush holder.

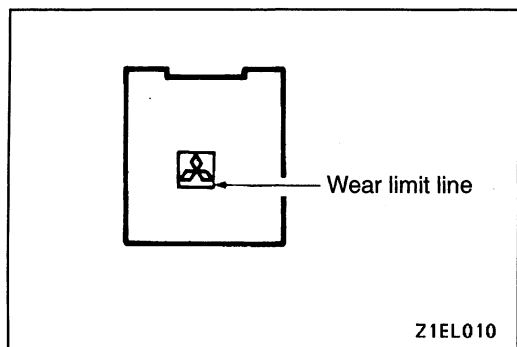
If there is no continuity, the brush holder is in order.

**OVERRUNNING CLUTCH CHECK**

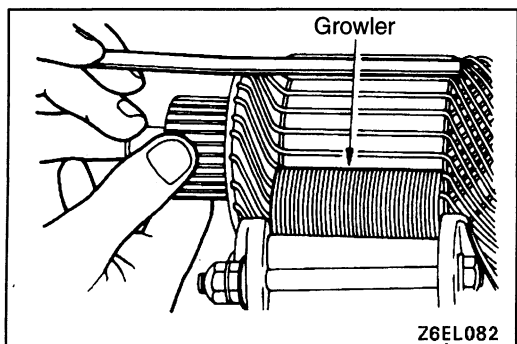
1. While holding clutch housing, rotate the pinion. Drive pinion should rotate smoothly in one direction, but should not rotate in opposite direction. If clutch does not function properly, replace overrunning clutch assembly.
2. Inspect pinion for wear or burrs. If pinion is worn or burred, replace overrunning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

FRONT AND REAR BRACKET BUSHING CHECK

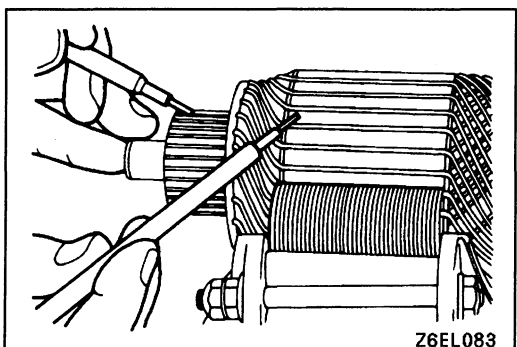
Inspect bushing for wear or burrs. If bushing is worn or burred, replace front bracket assembly or rear bracket assembly.

**BRUSH CHECK**

1. Brushes that are worn beyond wear limit line, or are oil-soaked, should be replaced.
2. When replacing ground brush, slide the brush from brush holder by prying retainer spring back.

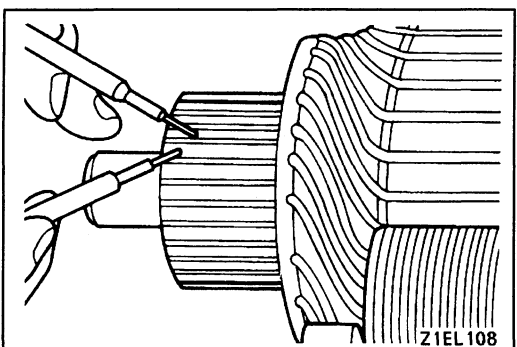
**ARMATURE TEST****ARMATURE SHORT-CIRCUIT TEST**

1. Place armature in a growler.
2. 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.

IGNITION SYSTEM

16300010101

GENERAL INFORMATION

This system is provided with two ignition coils (A and B) and two power transistors (A and B) for the No. 1 and No. 4 cylinders, and 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.

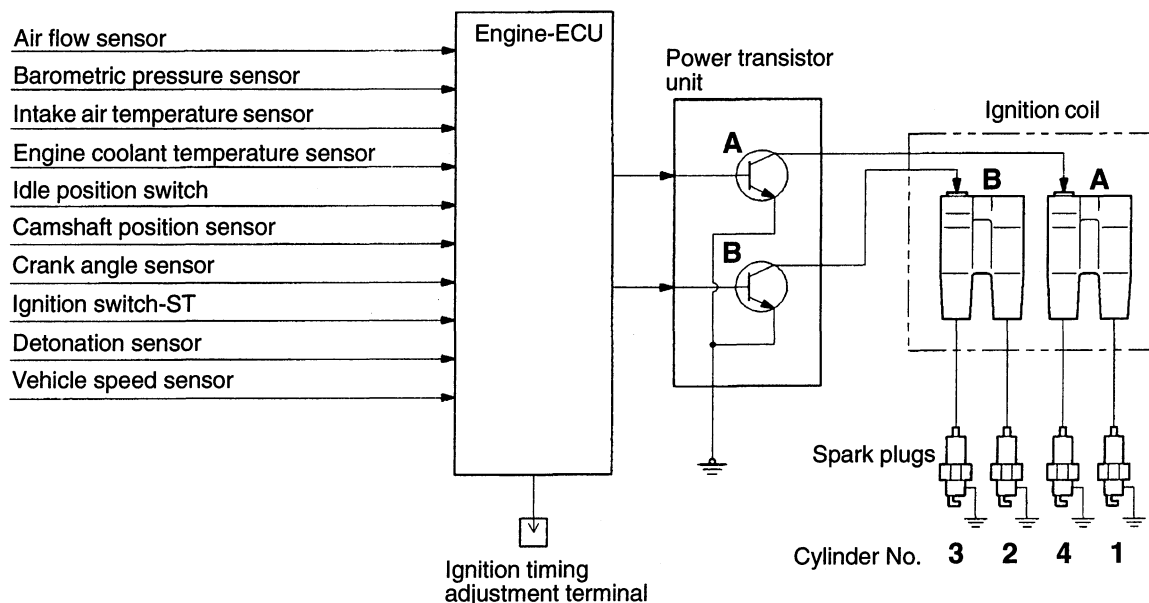
In the same way, when the primary current flowing in ignition coil B is interrupted, the high voltage thus generated is applied to the spark plugs of No. 2 and No. 3 cylinders.

The engine control unit controls the two power transistors (A and B) to turn them alternately ON and OFF. This causes the primary currents in the ignition coils (A and B) to be alternately interrupted and allowed to flow to fire the cylinders in the order 1-3-4-2.

The engine control unit 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.

When the engine is cold or operated 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.



6EN1138

IGNITION COIL SPECIFICATION

Items	Specifications
Type	Molded 2 coil

SPARK PLUG SPECIFICATION

Items	Specifications
Type	NGK BPR6ES-11
	NIPPON DENSO W20EPR-11

SERVICE SPECIFICATIONS

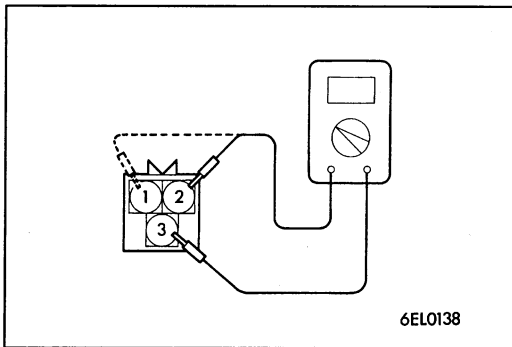
16300030114

Items	Standard value	Limit
Ignition coil	Primary coil resistance Ω	0.70–0.86
	Secondary coil resistance $k\Omega$	11.3–15.3
Spark plug gap mm	1.0–1.1	–
Resistive cord resistance $k\Omega$	–	max. 22

SPECIAL TOOL

1630060090

Tool	Tool number	Name	Use
	MD998478	Harness connector (3 pin, square)	Inspection of ignition primary voltage (connection of ignition coil connector)



ON-VEHICLE SERVICE

16300120132

IGNITION COIL CHECK

Primary Coil Resistance

Measure the resistance between connector terminal 3 (power) and each coil terminal.

Measuring point:

No. 1 – No. 4 cylinder side coil; 2-3

No. 2 – No. 3 cylinder side coil; 1-3

Standard value: 0.70–0.86Ω

Secondary Coil Resistance

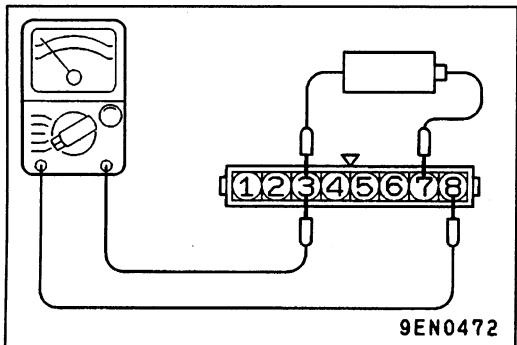
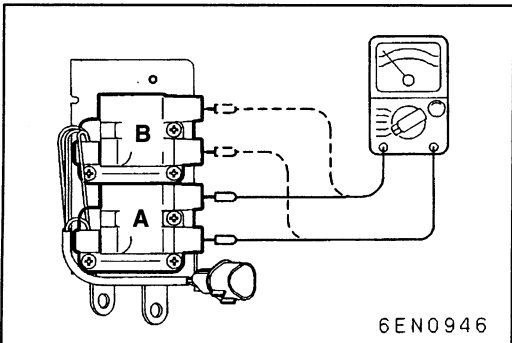
Measure the resistance between coil high voltage terminals.

Measuring point:

No. 1 – No. 4 cylinder side coil; A

No. 2 – No. 3 cylinder side coil; B

Standard value: 11.3–15.3 kΩ



POWER TRANSISTOR CHECK

16300130098

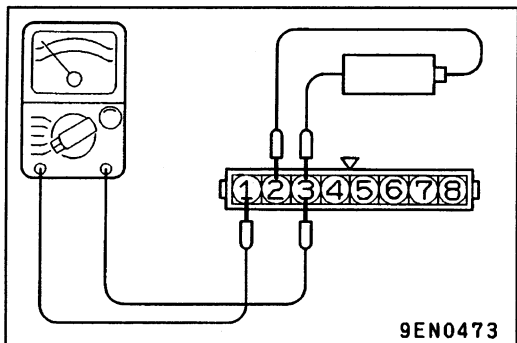
NOTE

An analogue-type ohmmeter should be used.

No. 1 – No. 4 coil side

Voltage: 1.5V	Terminal No.		
	3	7	8
When current is flowing	⊖ ○	⊕ ○	○
When current is not flowing			

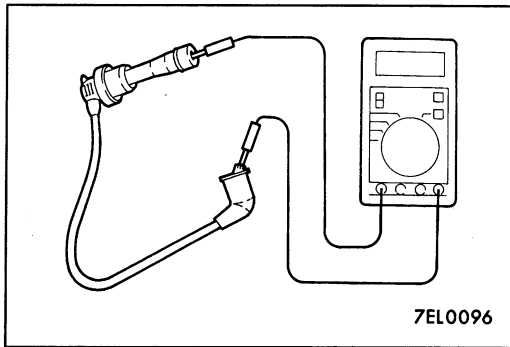
Replace the power transistor if there is a malfunction.



No. 2 – No. 3 coil side

Voltage: 1.5V	Terminal No.		
	1	2	3
When current is flowing	○	⊕ ○	⊖ ○
When current is not flowing			

Replace the power transistor if there is a malfunction.

**RESISTIVE CORD CHECK**

16300140084

Measure the resistance of the all spark plug leads.

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

Limit: max. 22 kΩ

DETONATION SENSOR CHECK

16300180055

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

NOTE

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

SPARK PLUG CHECK AND CLEANING

16300150155

1. Remove the spark plug cables.

Caution

When pulling the spark plug cable boot from the plug, always hold the boot, not the cable.

2. Remove the spark plugs.
3. Check for a burned-out electrode or damaged insulator. Check for even burning.
4. Remove carbon deposits with wire brush or plug cleaner. Remove sand from plug screw with compressed air.
5. Use a gap gauge to check the plug gap.

Standard value: 1.0–1.1 mm

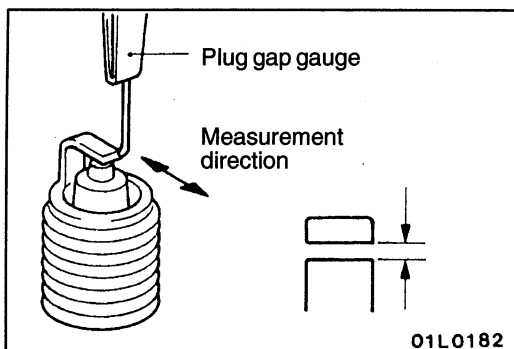
If the plug gap is not within the standard value range, adjust by bending the earth electrode.

6. Clean the engine plug holes.

Caution

Do not allow foreign matter to enter the cylinders.

7. Install the spark plugs.



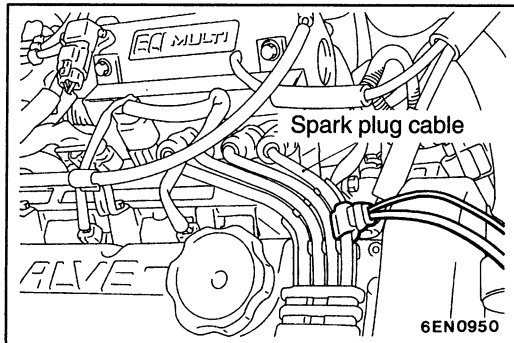
**CRANK ANGLE SENSOR, CAMSHAFT
POSITION SENSOR CHECK**

16300260209

Refer to GROUP 13A – Troubleshooting.

WAVEFORM CHECK USING AN ANALYZER

16300170182

Ignition Secondary Voltage 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 wave form observation (No.1 cylinder - No.4 cylinder, No.2 cylinder - No.3 cylinder). However, wave form observation is only applicable for the cylinder with the spark plug cable clamped by the secondary pickup.

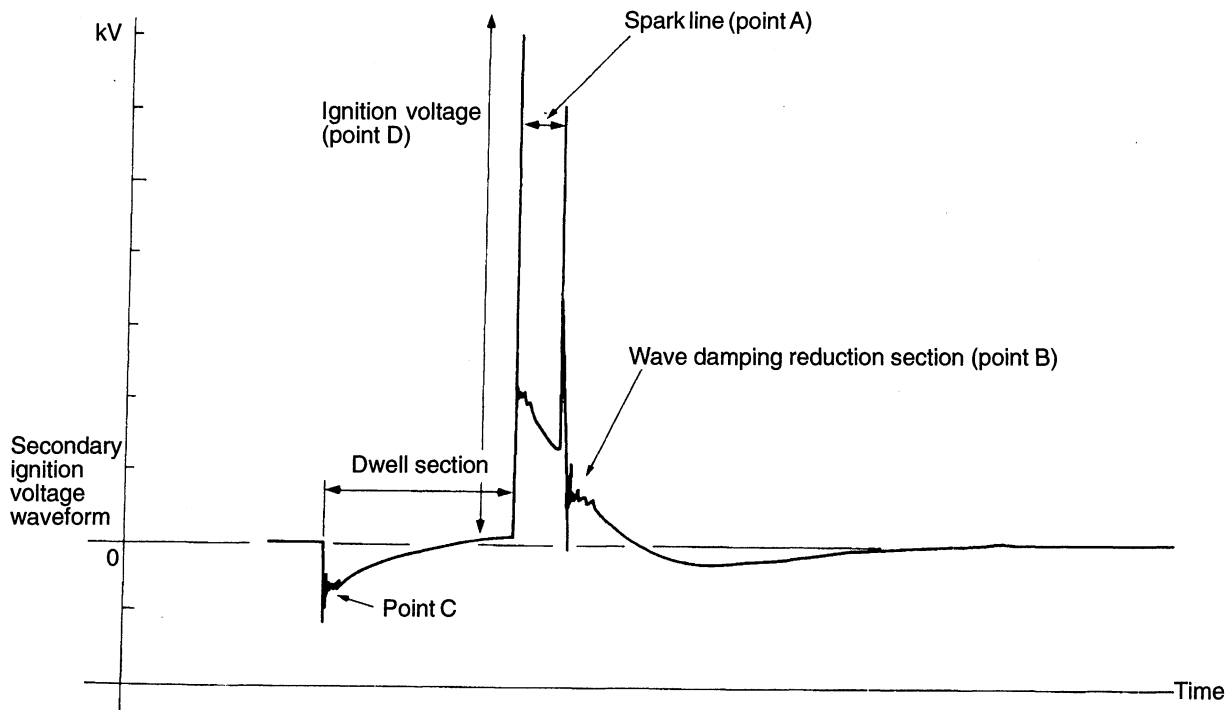
2. Clamp the spark plug cable with the Trigger pickup.

NOTE

1. Clamp the trigger pickup to the same spark plug cable clamped by the secondary pickup.
2. Identifying which cylinder waveform pattern is displayed can be difficult. For reference, remember that the wave form pattern of the cylinder attached to the secondary pickup will be displayed as stable.

STANDARD WAVEFORM**Observation Conditions**

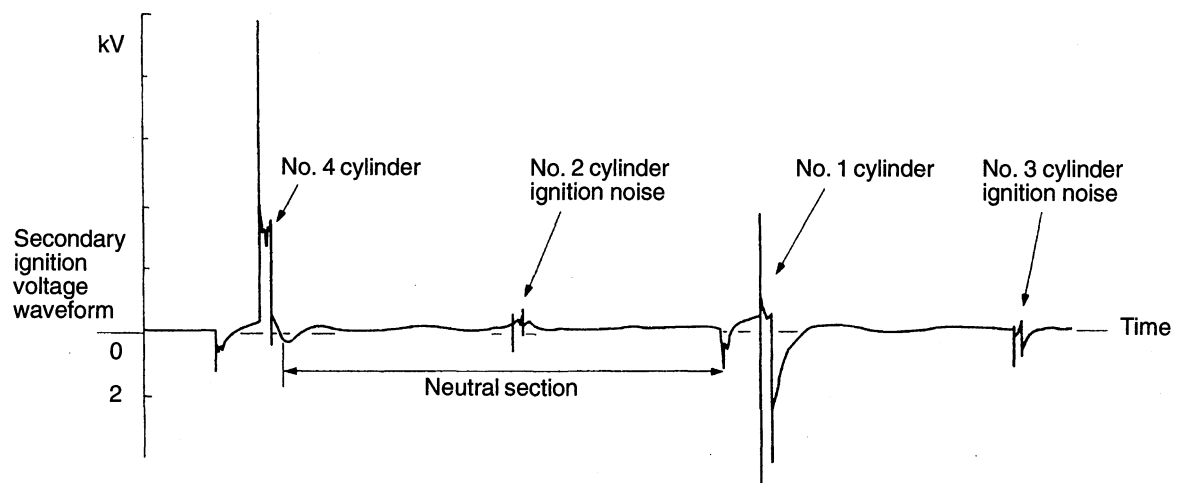
FUNCTION	SECONDARY
PATTERN HEIGHT	HIGH (or LOW)
PATTERN SELECTOR	RASTER
Engine revolutions	Kerb idle speed



7EL0147

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

PATTERN SELECTOR	DISPLAY
------------------	---------



6EL0183

WAVEFORM OBSERVATION POINTS

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

Spark line		Plug gap	Condition of electrode	Compression force	Concentration of air mixture	Ignition timing	Spark plug cable
Length	Long	Small	Normal	Low	Rich	Advanced	Leak
	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 vibrations in reduction vibration section (Refer to abnormal waveform example 5)

Number of vibrations	Coil and condenser
3 or more	Normal
Less than 3	Abnormal

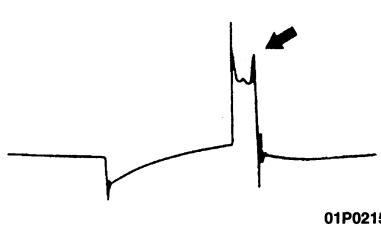
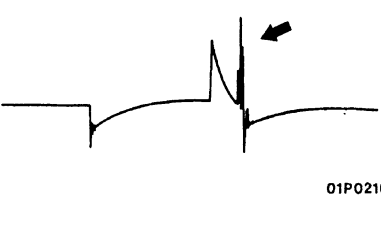
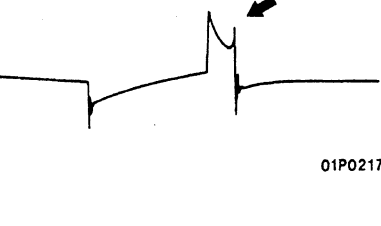
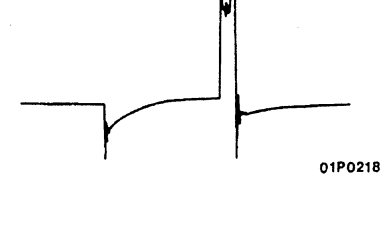
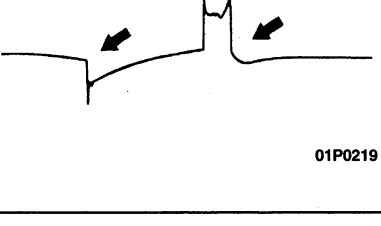
Point C: Number of vibrations at beginning of dwell section (Refer to abnormal waveform example 5)

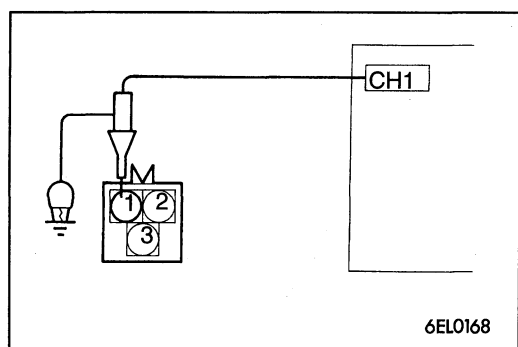
Number of vibrations	Coil
5–6 or higher	Normal
Less than 5	Abnormal

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

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

ABNORMAL WAVEFORMS EXAMPLES

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, long, and 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, long, and 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 not properly connected, creating more than one spark from the plug.
Example 5  01P0219	No waves in wave damping section	Short in ignition coil.



IGNITION PRIMARY VOLTAGE WAVEFORM CHECK

1. Disconnect the ignition coil connector and connect the special tool (harness connector: MD998478) in between.
2. Connect the analyzer primary pickup to the ignition coil connector terminal 1 (black clip on the special tool) when observing the No. 2 – No. 3 cylinder group, terminal 2 (red clip) for the No. 1 – No. 4 cylinder group.
3. Connect the primary pickup earth terminal.
4. Clamp the spark plug with the trigger pickup.

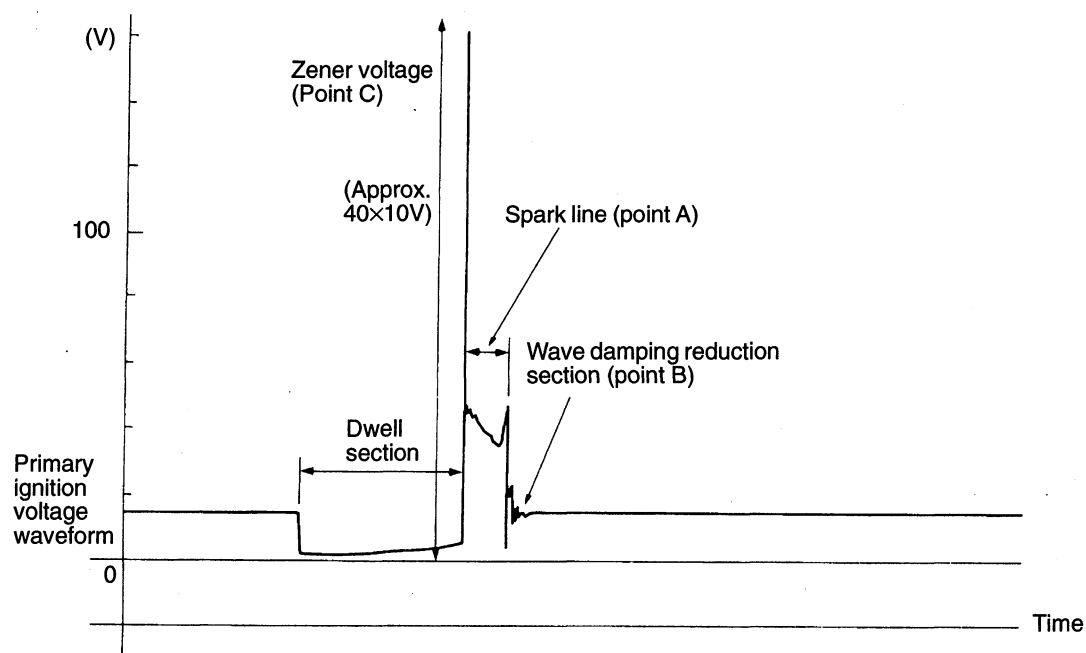
NOTE

1. Clamp the spark plug cable for No.1 and No.3 cylinders of the same group with the cylinder that is connected to the primary pickup.
2. The wave pattern of either cylinder in the same group will appear at the left edge of the screen.

STANDARD WAVEFORM

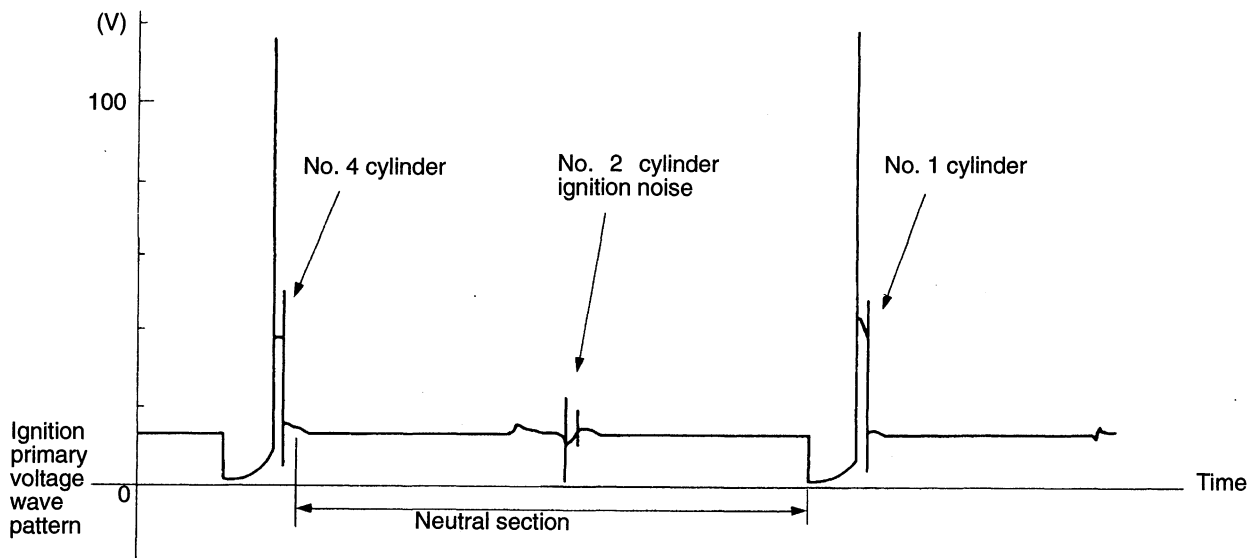
Observation Conditions

FUNCTION	SECONDARY
PATTERN HEIGHT	HIGH (OR LOW)
PATTERN SELECTOR	RASTER
Engine revolutions	Curb idle speed



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

PATTERN SELECTOR	DISPLAY
------------------	---------



6EL0185

WAVEFORM OBSERVATION POINTS

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

Spark line		Plug gap	Condition of electrode	Compression force	Concentration of air mixture	Ignition timing	High tension 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	–	–	–	–

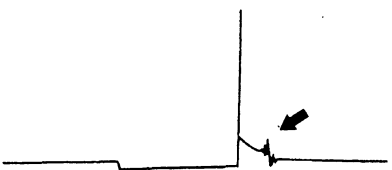
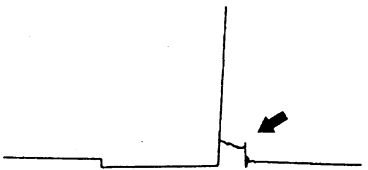
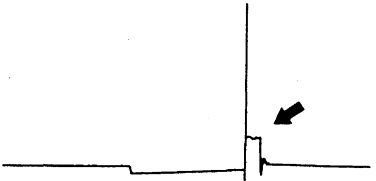
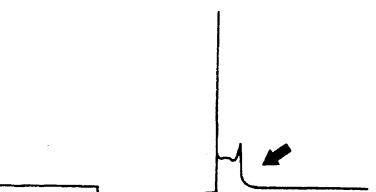
Point B: Number of vibrations in reduction vibration section (Refer to abnormal waveform example 5)

Number of vibrations	Coil, condenser
3 or higher	Except above
Normal	Abnormal

Point C: Height of Zener voltage

Height of Zener voltage	Probable cause
High	Problem in Zener diode
Low	Abnormal resistance in primary coil circuit

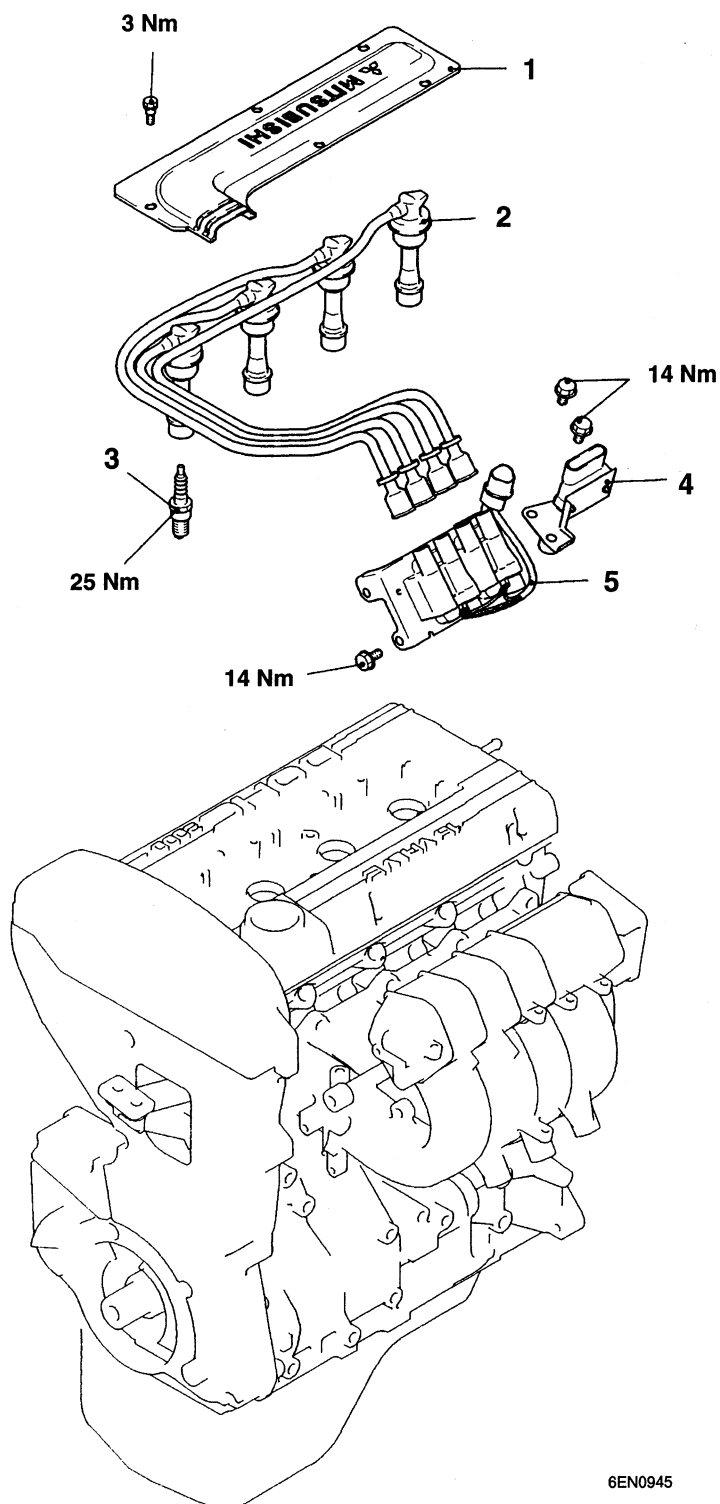
ABNORMAL WAVEFORMS EXAMPLES

Abnormal waveform	Wave characteristics	Cause of problem
Example 1  01P0210	Spark line is high and short.	Spark plug gap is too large.
Example 2  01P0211	Spark line is low, long, and 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  01P0212	Spark line is low, long, and sloping. However, there is almost no spark line distortion.	Spark plug gap is fouled.
Example 4  01P0213	Spark line is high and short.	Spark plug cable is not properly connected, creating more than one spark from the plug
Example 5  01P0214	No waves in wave damping section	Short in ignition coil.

IGNITION SYSTEM

16300320105

REMOVAL AND INSTALLATION



6EN0945

Removal steps



1. Center cover
2. Spark plug cables
3. Spark plugs
4. Power transistor
5. Ignition coil

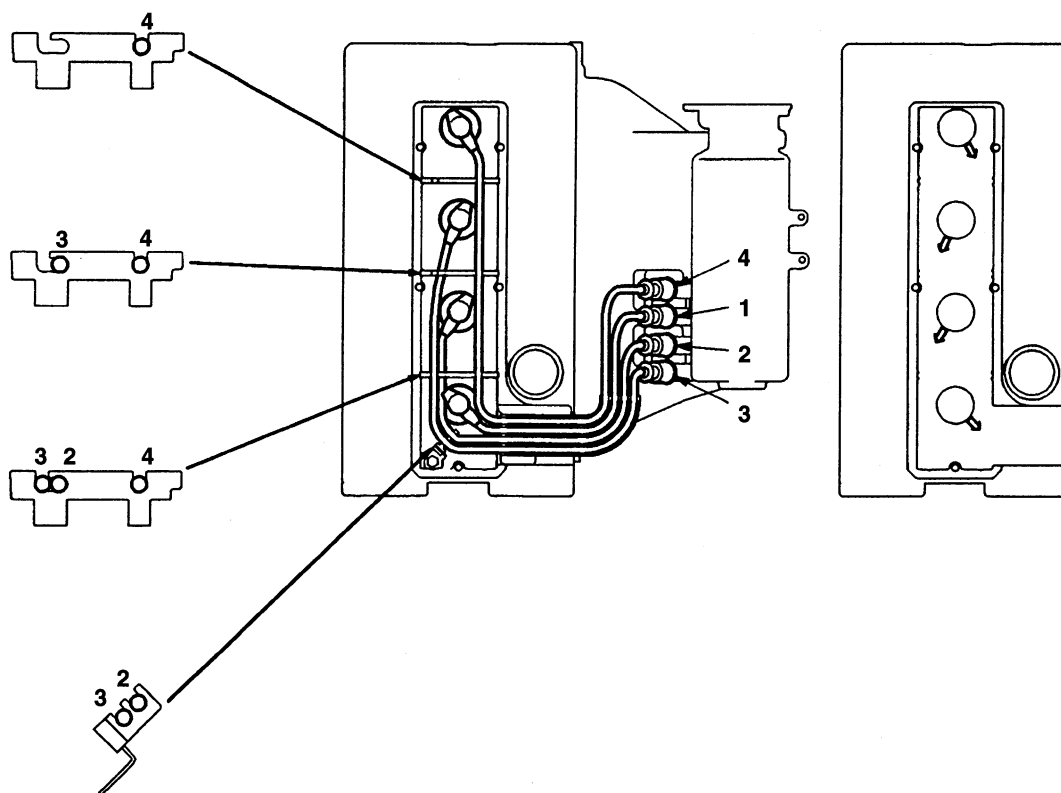
INSTALLATION SERVICE POINT**►A◄ SPARK PLUG CABLE INSTALLATION**

Improper arrangement of spark plug cables will induce voltage between the cables, causing misfiring and developing a surge at acceleration in high-speed operation.

Therefore, be careful to arrange the spark plug cables properly by the following procedure.

1. Install the spark plug cable clamps as shown in the illustration.
2. The numerals on the support and clamp indicate the spark plug cable No.
3. Pay attention to the following items when the spark plug cables are installed.
 - (1) Install the cables securely to avoid possible contact with metal parts.
 - (2) Install the cables neatly, ensuring they are not too tight, loose, twisted or kinked.

*The spark plug cables should each be routed in the directions indicated by the arrows on the rocker cover.



6EN0947

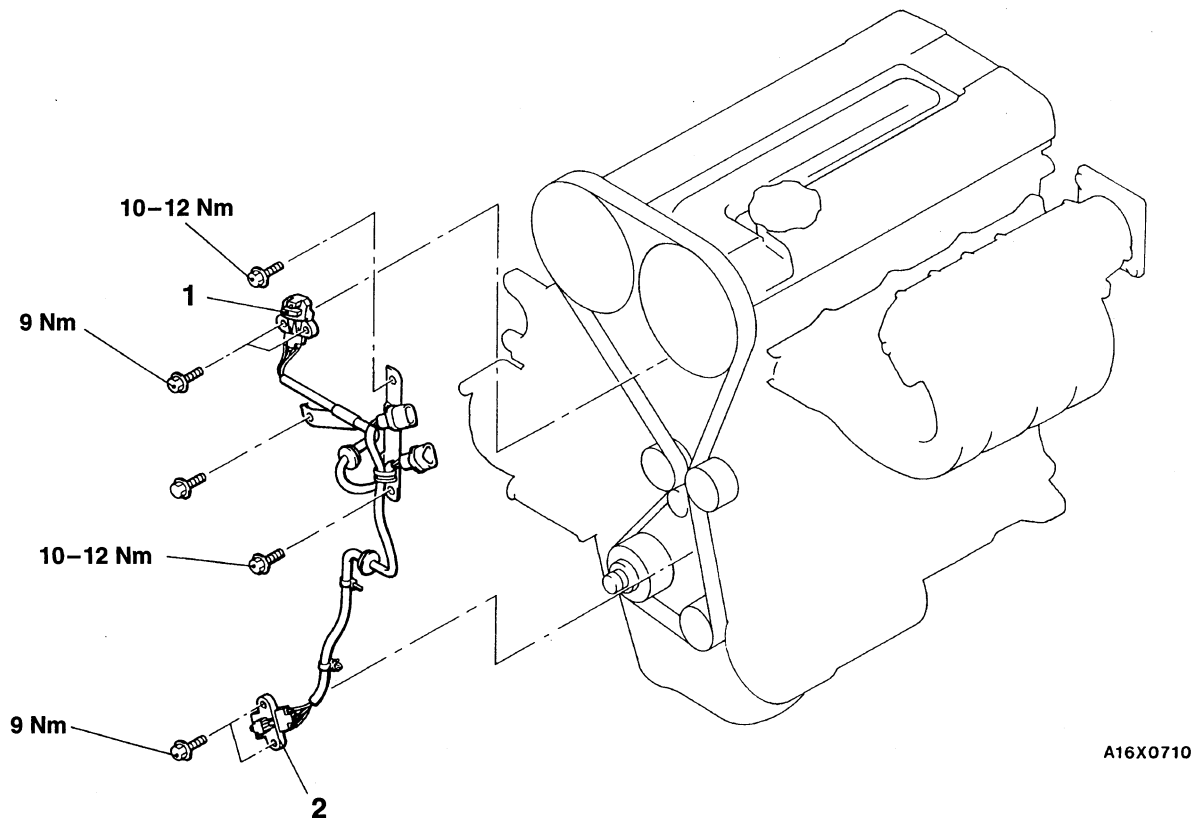
CAMSHAFT POSITION SENSOR AND CRANKSHAFT POSITION SENSOR

16300250114

REMOVAL AND INSTALLATION

Pre-removal and Post-installation Operation

- Timing Belt Removal and Installation
(Refer to GROUP 11A.)
- Intake Camshaft Sprocket Removal and Installation
(Refer to GROUP 11A.)



A16X0710

Removal steps

1. Camshaft position sensor
2. Crank angle sensor

INSPECTION

16300260216

CAMSHAFT POSITION SENSOR, CRANK ANGLE SENSOR CHECK

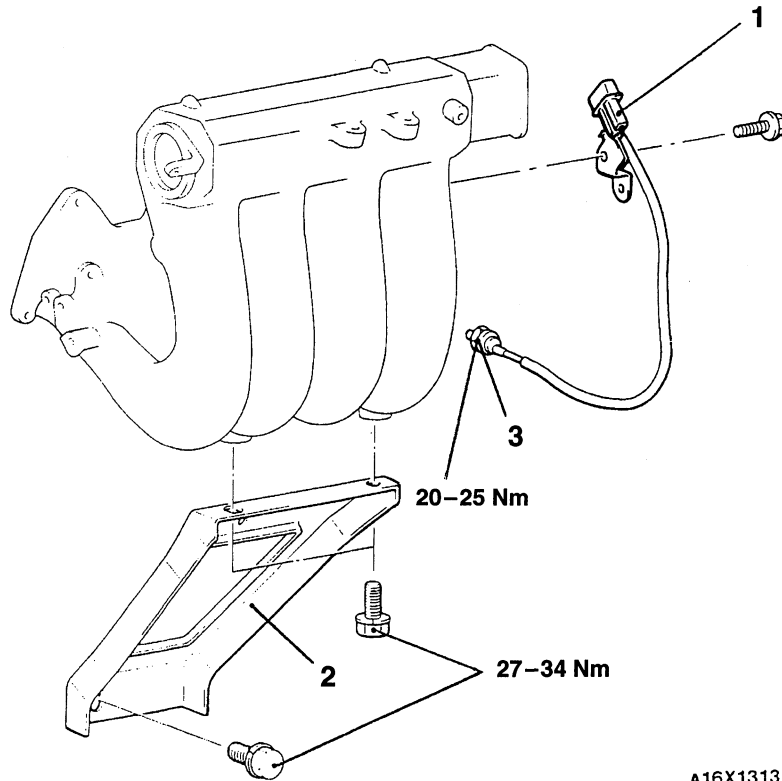
Refer to GROUP 13A – Troubleshooting.

DETONATION SENSOR

16300280106

REMOVAL AND INSTALLATION

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



A16X1313

Removal steps

1. Detonation sensor connector
2. Intake manifold stay
3. Detonation sensor

Caution

Do not subject the detonation sensor to any shocks.

INSPECTION

16300290109

DETONATION SENSOR CHECK

Refer to GROUP 13A – Troubleshooting.

NOTES