

# Engine Electrical System

**GENERAL**

**CHARGING SYSTEM**

ALTERNATOR  
BATTERY

**STARTING SYSTEM**

**STATOR**

**STARTER RELAY**

**PREHEATING SYSTEM**

## GENERAL

### SPECIFICATION EEC7BAAD

#### STARTING SYSTEM

Item		Specifications	
Starter	Type	Reduction drive (with planetary gear)	
	Rated voltage	12V, 2.0KW	
	No. of pinion teeth	9	
	No-load characteristics	Voltage	11.5V
		Amperage	120A, MAX
Speed		4,000rpm, MIN	

#### CHARGING SYSTEM

Item		Specifications
Alternator	Type	Battery voltage sensing
	Rated voltage	12V, 120A
	Voltage regulator	I.C regulator built-in type
	Regulator setting voltage	14.4 ± 0.3V
	Temperature compensation	-10 ± 3mV/°C
Battery	Type	CMF 90L
	Cold cranking amperage at -18°C (0°F)	720A
	Reserve capacity	160min
	Specific gravity at 20°C (77°F)	1.280 ± 0.01

#### NOTE

- *COLD CRANKING AMPERAGE is the amperage a battery can deliver for 30 seconds and maintain a terminal voltage of 7.2V or greater at a specified temperature.*
- *REVERSE CAPACITY RATING is amount of time a battery can deliver 25A and maintain a minimum terminal voltage of 10.5V at 26.7°C(80°F)*

#### PREHEATING SYSTEM

Item		Specifications
Glow plug	Rated voltage	DC 11V
	Current	16A ± 1.5A after 4 seconds loading at rated voltage
Glow plug relay	Rated voltage	DC 12V
	Operating voltage range	DC 9V ~ DC 16V
	Operating temperature range	-40°C ~ 120°C
	Rated load current	DC 12V, 70A

**TROUBLESHOOTING**

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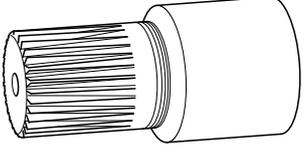
**CHARGING SYSTEM**

<b>Symptom</b>	<b>Suspect Area</b>	<b>Remedy</b>
Charging warning indicator does not light with ignition switch "ON" and engine off	Fuse blown Light burned out Wiring connection loose Electronic voltage regulator	Check fuses Replace light Tighten loose connections Replace voltage regulator
Charging warning indicator does not go out with engine running (Battery requires frequent recharging)	Drive belt loose or worn Battery cables loose, corroded or worn Fuse blown Fusible link blown Electronic voltage regulator or generator Wiring	Adjust tension or replace drive belt Repair or replace cables Check fuses Replace fusible link Test generator Repair wiring
Engine hesitates/poor acceleration Overcharge	Drive belt loose or worn Wiring connection loose or open circuit  Fusible link blown Poor grounding Electronic voltage regulator or generator Worn battery Electronic voltage regulator Voltage sensing wire	Adjust tension or replace drive belt Tighten loose connection or repair wiring Replace fusible link Repair Test generator, if faulty, repair or replace Replace battery Replace voltage regulator Repair wire

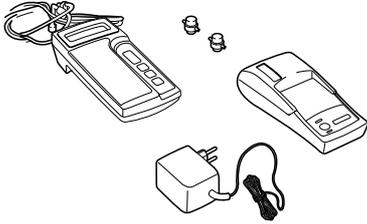
**STARTING SYSTEM**

<b>Symptom</b>	<b>Suspect Area</b>	<b>Remedy</b>
Engine will not crank	Battery charge low Battery cables loose, corroded or worn out Transaxle range switch (Vehicle with automatic transaxle only) Fusible link blown Starter motor faulty Ignition switch faulty	Charge or replace battery Repair or replace cables Adjust or replace switch  Replace fusible link Repair starter motor Inspect
Engine cranks slowly	Battery charge low Battery cables loose, corroded or worn out Starter motor	Charge or replace battery Repair or replace cables Repair starter motor
Starter keeps running	Starter motor Ignition switch	Repair starter motor Inspect
Starter spins but engine will not crank	Short in wiring Pinion gear teeth broken or starter motor Ring gear teeth broken	Repair wiring Repair starter motor Replace flywheel ring gear or torque converter

**SPECIAL SERVICE TOOL** ECC7A874

Tool (Number and name)	Illustration	Use
Alternator pulley remover wrench (09373-27000)	 <p style="text-align: right; font-size: small;">EBDD700A</p>	Removal and installation of alternator pulley

**REFERENCE SERVICE TOOLS**

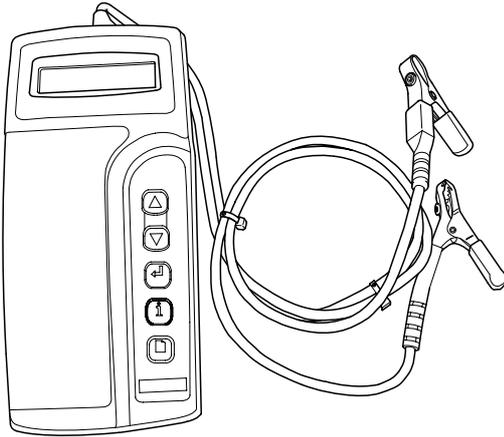
Tool (Number and name)	Illustration	Use
MCR-570 KIT Battery checker	 <p style="text-align: right; font-size: small;">LBLG001A</p>	For testing 12-volt automotive starting battery and for testing 12-volt charging system. (Using with Terminal Pinter_182-003A)

**THE MICRO 570 ANALYZER** E427CDBF

The MICRO 570 Analyzer provides the ability to test the charging and starting systems, including the battery, starter and generator.

**CAUTION**

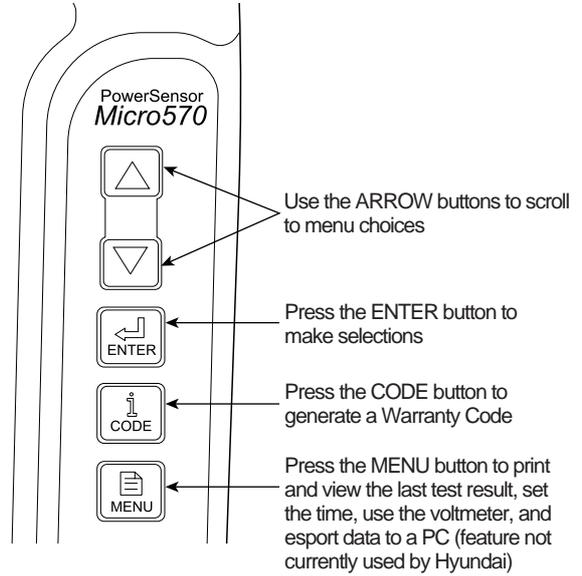
*Because of the possibility of personal injury, always use extreme caution and appropriate eye protection when working with batteries.*



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**KEYPAD**

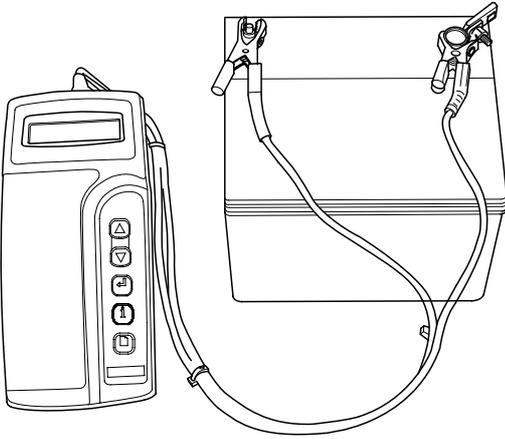
The MICRO570 button on the key pad provides the following functions :



EBRF005A

**BATTERY TEST PROCEDURE**

1. Connect the tester to the battery.
  - Red clamp to battery positive (+) terminal.
  - Black clamp to battery negative (-) terminal.

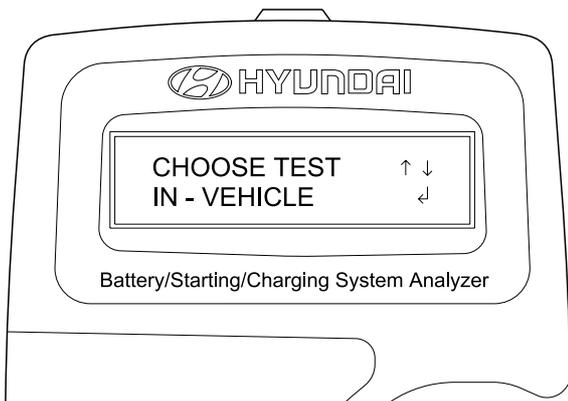


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**CAUTION**

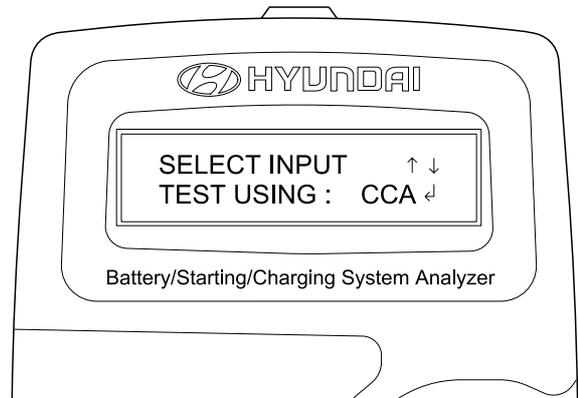
**Connect clamps securely. If "CHECK CONNECTION" message is displayed on the screen, reconnect clamps securely.**

2. The tester will ask if the battery is connected "IN A VEHICLE" or "OUT OF A VEHICLE". Make your selection by pressing the arrow buttons; then press ENTER.



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3. Choose either CCA or CCP and press the ENTER button.

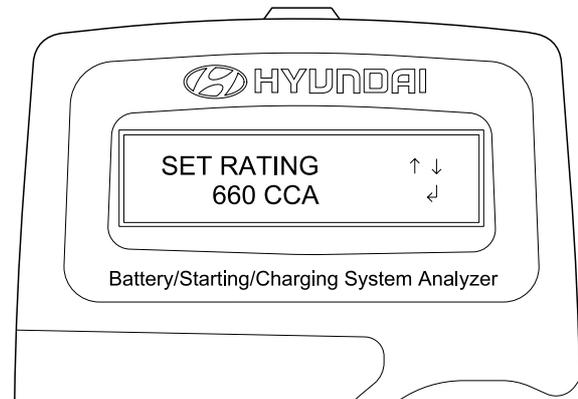


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**NOTE**

- CCA : Cold cranking amps, is an SAE specification for cranking batteries at -18°C (0°F).
- CCP : Cold cranking amps, is an SAE specification for korean manufacturer's for cranking batteries at -18°C (0°F).

4. Set the CCA value displayed on the screen to the CCA value marked on the battery label by pressing up and down buttons and press ENTER.



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**NOTE**

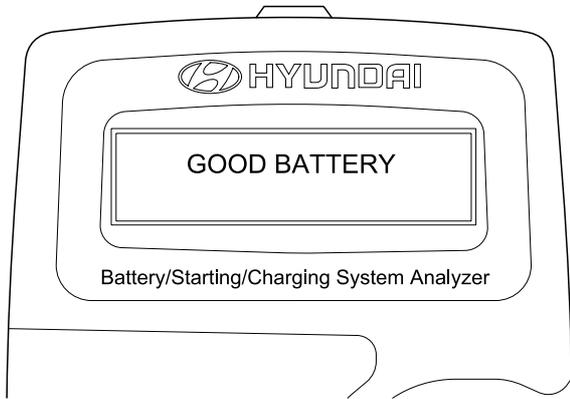
*The battery ratings(CCA) displayed on the tester must be identical to the ratings marked on battery label.*

- The tester (Micro570) displays battery test results including voltage and battery ratings. A relevant action must be given according to the test results by referring to the battery test results as shown in the table below.

**NOTE**

*The battery ratings (CCA) displayed on the tester must be identical to the ratings marked on battery label.*

- To conduct starter test, press ENTER.



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**BATTERY TEST RESULTS**

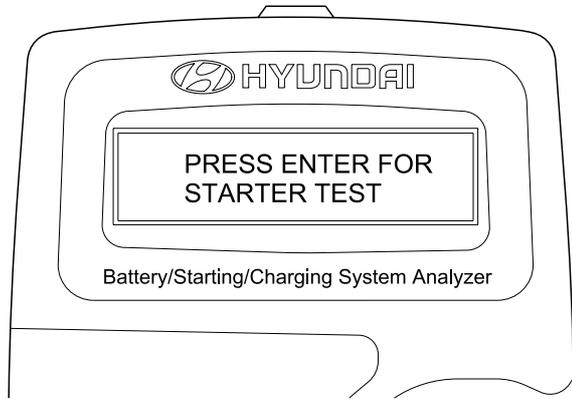
RESULT ON PRINTER	REMEDY
Good battery	No action is required
Good recharge	Battery is in a good state Recharge the battery and use
Charge & Retest	Battery is not charged properly => Charge and test the battery again (Failure to charge the battery fully may read incorrect measurement value)
Replace battery	=> Replace battery and recheck the charging system. (Improper connection between battery and vehicle cables may cause "REPLACE BATTERY", retest the battery after removing cables and connecting the tester to the battery terminal directly prior to replacing the battery)
Bad cell-replace	=> Charge and retest the battery. And then, test results may cause "REPLACE BATTERY", replace battery and recheck the charging system

**WARNING**

**Whenever filing a claim for battery, the print out of the battery test results must be attached.**

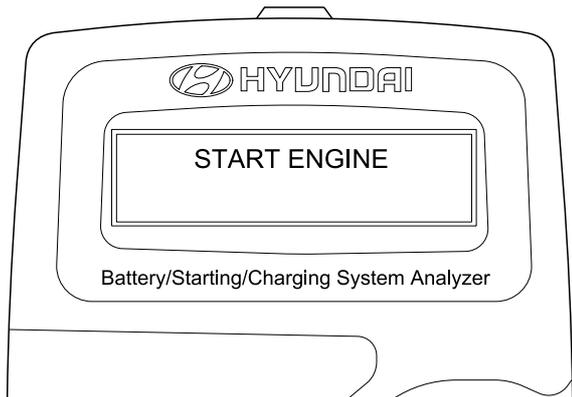
**STARTER TEST PROCEDURE**

1. After the battery test, press ENTER immediately for the starter test.



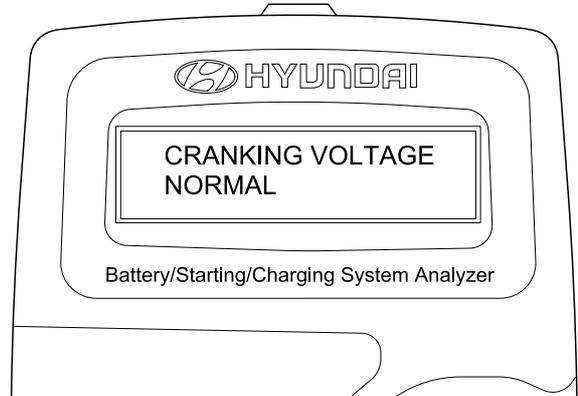
SCMEE6104L

2. After pressing ENTER key, start the engine.



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3. Cranking voltage and starter test results will be displayed on the screen. Take a relevant action according to the test results by referring to the starter test results as given below.



SCMEE6106L

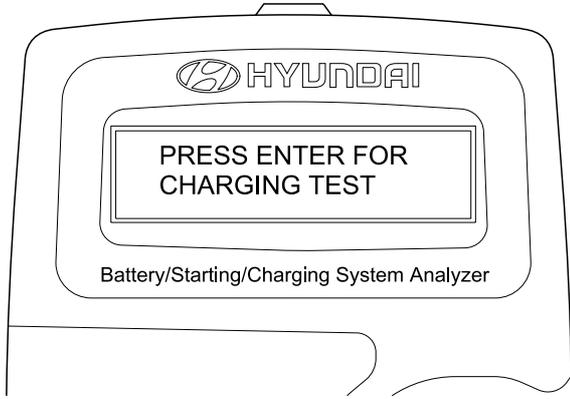
4. To continue charging system test, press ENTER.

## STARTER TEST RESULTS

RESULT ON PRINTER	REMEDY
Cranking voltage normal	System shows a normal starter draw
Cranking voltage low	Cranking voltage is lower than normal level => Check starter
Charge battery	The state of battery charge is too low to test => Charge the battery and retest
Replace battery	=> Replace battery => If the vehicle is not started though the battery condition of "Good and fully charged" is displayed. => Check wiring for open circuit, battery cable connection, starter and repair or replace as necessary.

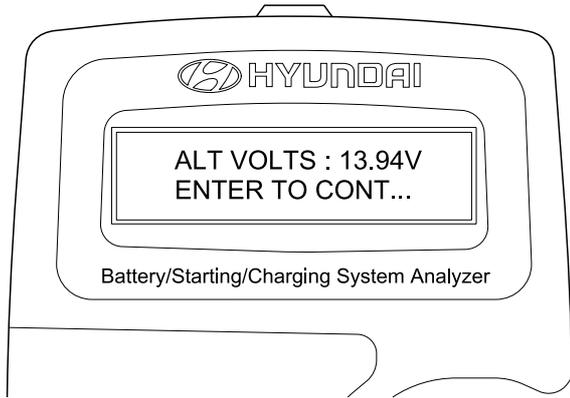
**CHARGING SYSTEM TEST PROCEDURE**

1. Press ENTER to begin charging system test.



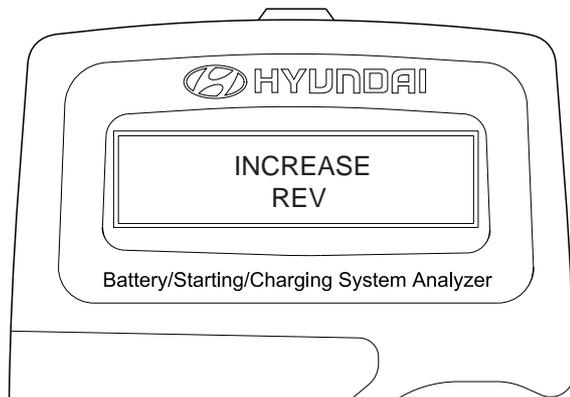
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2. ENTER button is pressed, the tester displays the actual voltage of generator. Press ENTER to test the charging system.



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3. The MICRO 570 will prompt you to rev the engine until the rev is detected. It will then collect the data.

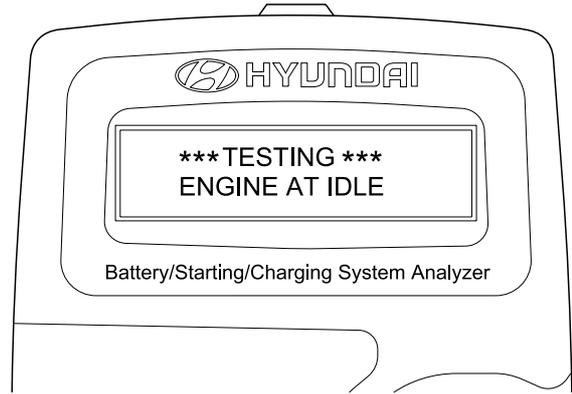


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4. Press ENTER.

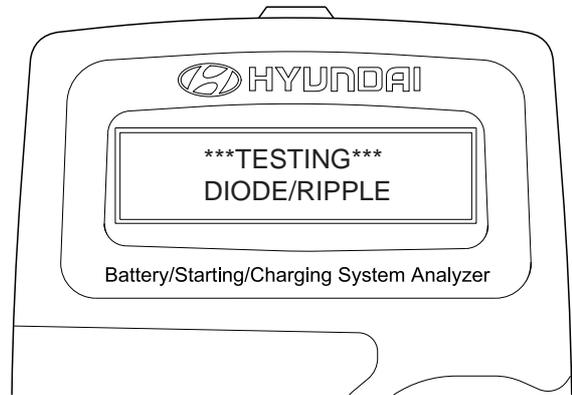
SCMEE6110L

5. The MICRO 570 will analyze the charging system output at idle for comparison to other readings.



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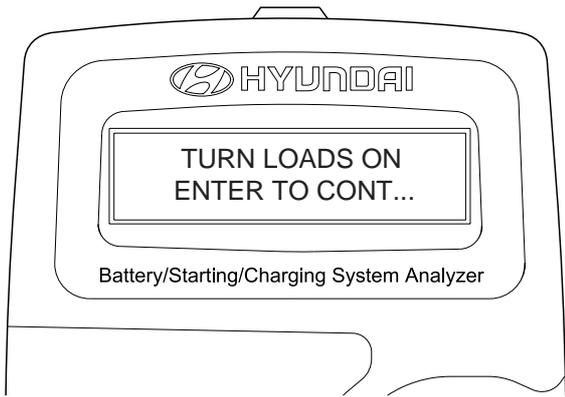
6. The MICRO 570 will detect the amount of ripple from the charging system to the battery. Excessive ripple usually means the stator is damaged or that one or more generator diodes have failed.



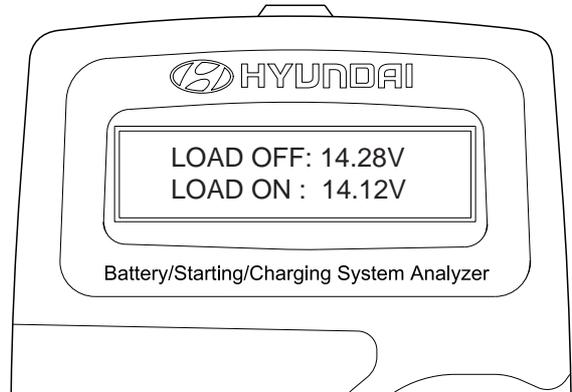
SCMEE6112L

7. The MICRO 570 will prompt you to turn on accessory loads. It will then test at idle and prompt you to rev the engine. The analyzer will determine if the charging system can provide enough current for the demands of the vehicle's electrical system.

8. After the test, the MICRO 570 will display the idle voltage, load voltage and the state results.



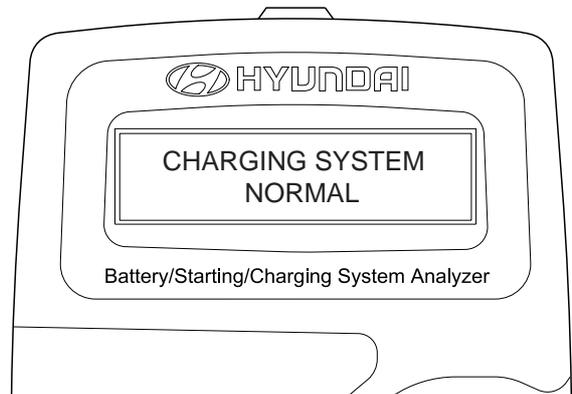
SCMEE6113L



SCMEE6114L

**NOTE**

When asked to turn on the accessory loads, turn on the blower to high(heater), the high beam headlights, and rear defogger. DO NOT use cyclical loads such as air conditioning or wind-shield wipers.



SCMEE6115L

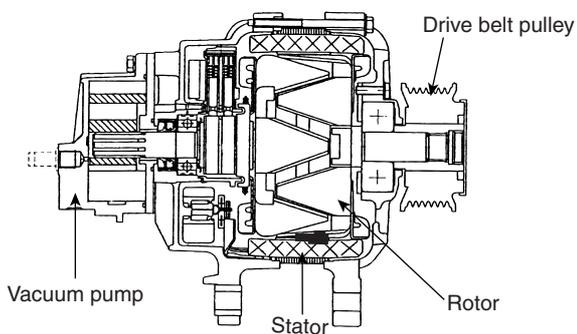
**CHARGING SYSTEM TEST RESULTS**

RESULT ON PRINTER	REMEDY
Charging system normal/Diode ripple normal	Charging system is normal
No charging voltage	Generator does not supply charging current to battery => Check belts, connection between generator and battery Replace belts or cable or generator as necessary
Low charging voltage	Generator does not supply charging current to battery and electrical load to system fully => Check belts and generator and replace as necessary
High charging voltage	The voltage from generator to battery is higher than normal limit during voltage regulating. => Check connection and ground and replace regulator as necessary => Check electrolyte level in the battery
Excess ripple detected	One or more diodes in the generator is not functioning properly => Check generator mounting and belts and replace as necessary

# CHARGING SYSTEM

## DESCRIPTION EDCABFCE

The conventional internal voltage detection type alternator controls the charging voltage regardless of the battery condition and according to the external load change so that it sometimes causes battery under or over charging or causes flickering of meters and lamps due to ripples of generated voltage resulting from load fluctuation. The figure below show the internal circuits of the alternator and voltage regulator.



LBIF018A

## ON-VEHICLE INSPECTION EE8EC6C0

### CAUTION

- **Check that the battery cables are connected to the correct terminals.**
- **Disconnect the battery cables when the battery is given a quick charge.**
- **Do not perform tests with a high voltage insulation resistance tester.**
- **Never disconnect the battery while the engine is running.**

### CHECK BATTERY VOLTAGE

1. After having driven the vehicle and in the case that 20 minutes have not passed after having stopped the engine, turn the ignition switch ON and turn on the electrical system (headlamp, blower motor, rear defogger etc.) for 60 seconds to remove the surface charge.
2. Turn the ignition switch OFF and turn off the electrical systems.
3. Measure the battery voltage between the negative (-) and positive (+) terminals of the battery.

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Standard voltage : 12.5~12.9V at 20°C (68°C)

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If the voltage is less than specification, charge the battery.

### CHECK BATTERY TERMINALS, FUSIBLE LINK AND FUSES

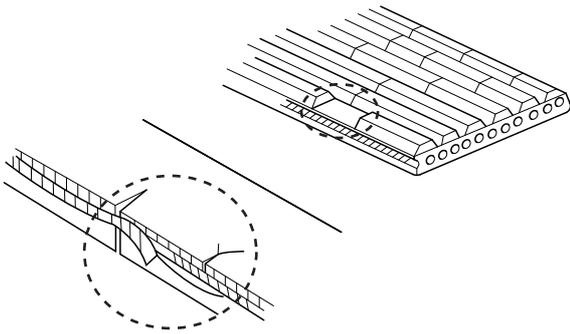
1. Check that the battery terminals are not loose or corroded.
2. Check the fusible link and fuses for continuity.

**INSPECT DRIVE BELT**

1. Visually check the belt for excessive wear, frayed cords etc.  
If any defect has been found, replace the drive belt.

**NOTE**

*Cracks on the rib side of a belt are considered acceptable. If the belt has chunks missing from the ribs, it should be replaced.*



LBIF019A

2. Using a belt tension gauge, measure the drive belt tension.

**VISUALLY CHECK ALTERNATOR WIRING AND LISTEN FOR ABNORMAL NOISES**

1. Check that the wiring is in good condition.
2. Check that there is no abnormal noise from the alternator while the engine is running.

**CHECK DISCHARGE WARNING LIGHT CIRCUIT**

1. Warm up the engine and then turn it off.
2. Turn off all accessories.
3. Turn the ignition switch "ON". Check that the discharge warning light is on.
4. Start the engine. Check that the light goes off.

If the light does not go off as specified, troubleshoot the discharge light circuit.

**INSPECT CHARGING SYSTEM****VOLTAGE DROP TEST OF ALTERNATOR OUTPUT WIRE**

This test determines whether or not the wiring between the alternator "B" terminal and the battery (+) terminal is good by the voltage drop method.

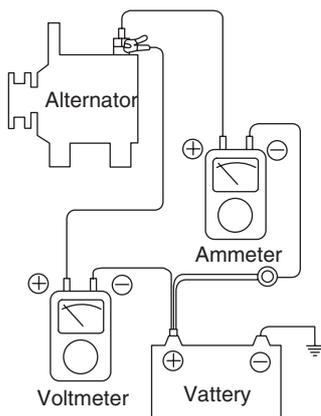
**PREPARATION**

1. Turn the ignition switch to "OFF".

**NOTE**

*To find abnormal conditions of the connection, actions should not be taken on the two terminals and each connection during the test.*

2. Connect a digital voltmeter between the alternator "B" terminal and battery (+) lead wire to the battery (+) terminal. Connect the (+) lead wire of the voltmeter to the "B" terminal and the (-) lead wire to the battery (+) terminal.



LBIF022A

**CONDITIONS FOR THE TEST**

1. Start the engine.
2. Switch on the headlamps, blower motor and so on. And then, read the voltmeter under this condition.

**RESULT**

1. The voltmeter may indicate the standard value.

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**Standard value:** 0.2V max.

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2. If the value of the voltmeter is higher than expected (above 0.2V max.), poor wiring is suspected. In this case check the wiring from the alternator "B" terminal to the fusible link to the battery (+) terminal. Check for loose connections, color change due to an overheated harness, etc. Correct them before testing again.
3. Upon completion of the test, set the engine speed at idle. Turn off the head lamps, blower motor and the ignition switch.

**OUTPUT CURRENT TEST**

This test determines whether or not the alternator gives an output current that is equivalent to the nominal output.

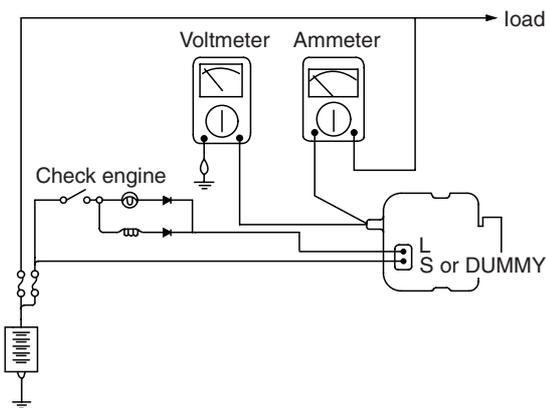
**PREPARATION**

1. Prior to the test, check the following items and correct as necessary.  
Check the battery installed in the vehicle to ensure that it is in good condition. The battery checking method is described in "BATTERY".  
The battery that is used to test the output current should be one that has been partially discharged. With a fully charged battery, the test may not be conducted correctly due to an insufficient load.  
Check the tension of the alternator drive belt.
2. Turn off the ignition switch.
3. Disconnect the battery ground cable.
4. Disconnect the alternator output wire from the alternator "B" terminal.
5. Connect a DC ammeter (0 to 150A) in series between the "B" terminal and the disconnected output wire. Be sure to connect the (-) lead wire of the ammeter to the disconnected output wire.

**NOTE**

*Tighten each connection securely, as a heavy current will flow. Do not rely on clips.*

6. Connect a voltmeter (0 to 20V) between the "B" terminal and ground. Connect the (+) lead wire to the alternator "B" terminal and (-) lead wire to a good ground.
7. Attach an engine tachometer and connect the battery ground cable.
8. Leave the engine hood open.



LBIF023A

**TEST**

1. Check to see that the voltmeter reads as the same value as the battery voltage. If the voltmeter reads 0V, and the open circuit in the wire between the alternator "B" terminal and battery (-) terminal, a blown fusible link or poor grounding is suspected.
2. Start the engine and turn on the headlights.
3. Set the headlights to high beam and the heater blower switch to HIGH, quickly increase the engine speed to 2,500 rpm and read the maximum output current value indicated by the ammeter.

**NOTE**

*After the engine starts up, the charging current quickly drops. Therefore, the above operation must be done quickly to read the maximum current value correctly.*

**RESULT**

1. The ammeter reading must be higher than the limit value. If it is lower but the alternator output wire is in good condition, remove the alternator from the vehicle and test it.

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**Limit value (90Aalternator): 63A min.**

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**NOTE**

- *The nominal output current value is shown on the nameplate affixed to the alternator body.*
- *The output current value changes with the electrical load and the temperature of the alternator itself. Therefore, the nominal output current may not be obtained. If such is the case, keep the headlights on the cause discharge of the battery, or use the lights of another vehicle to increase the electrical load.*  
*The nominal output current may not be obtained if the temperature of the alternator itself or ambient temperature is too high.*  
*In such a case, reduce the temperature before testing again.*

3. Upon completion of the output current test, lower the engine speed to idle and turn off the ignition switch.
4. Disconnect the battery ground cable.
5. Remove the ammeter and voltmeter and the engine tachometer.
6. Connect the alternator output wire to the alternator "B" terminal.
7. Connect the battery ground cable.

**REGULATED VOLTAGE TEST**

The purpose of this test is to check that the electronic voltage regulator controls voltage correctly.

**PREPARATION**

1. Prior to the test, check the following items and correct if necessary.  
Check that the battery installed on the vehicle is fully charged. For battery checking method, see "BATTERY".  
Check the alternator drive belt tension.
2. Turn ignition switch to "OFF".
3. Disconnect the battery ground cable.
4. Connect a digital voltmeter between the "B" terminal of the alternator and ground. Connect the (+) lead of the voltmeter to the "B" terminal of the alternator. Connect the (-) lead to good ground or the battery (-) terminal.
5. Disconnect the alternator output wire from the alternator "B" terminal.
6. Connect a DC ammeter (0 to 150A) in series between the "B" terminal and the disconnected output wire. Connect the (-) lead wire of the ammeter to the disconnected output wire.
7. Attach the engine tachometer and connect the battery ground cable.

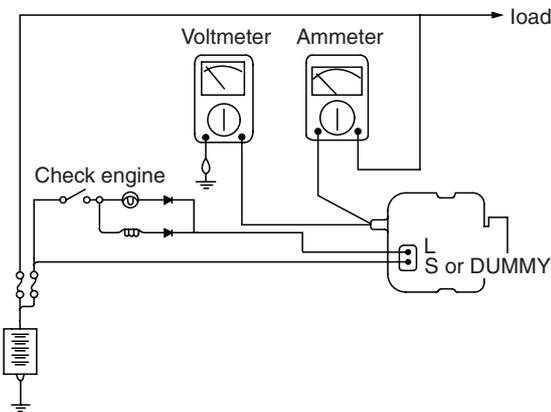
**RESULT**

1. If the voltmeter reading agrees with the value listed in the Regulating Voltage Table below, the voltage regulator is functioning correctly. If the reading is other than the standard value, the voltage regulator or the alternator is faulty.

**REGULATING VOLTAGE TABLE**

Voltage regulator ambient temperature °C (°F)	Regulating voltage (V)
-30 (-22)	14.1 ~ 15.2
20 (68)	14.1 ~ 14.7
120 (248)	13.3 ~ 14.7

2. Upon completion of the test, reduce the engine speed to idle, and turn off the ignition switch.
3. Disconnect the battery ground cable.
4. Remove the voltmeter and ammeter and the engine tachometer.
5. Connect the alternator output wire to the alternator "B" terminal.
6. Connect the battery ground cable.



LBIF024A

**TEST**

1. Turn on the ignition switch and check to see that the voltmeter indicates the following value.

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**Voltage:** Battery voltage

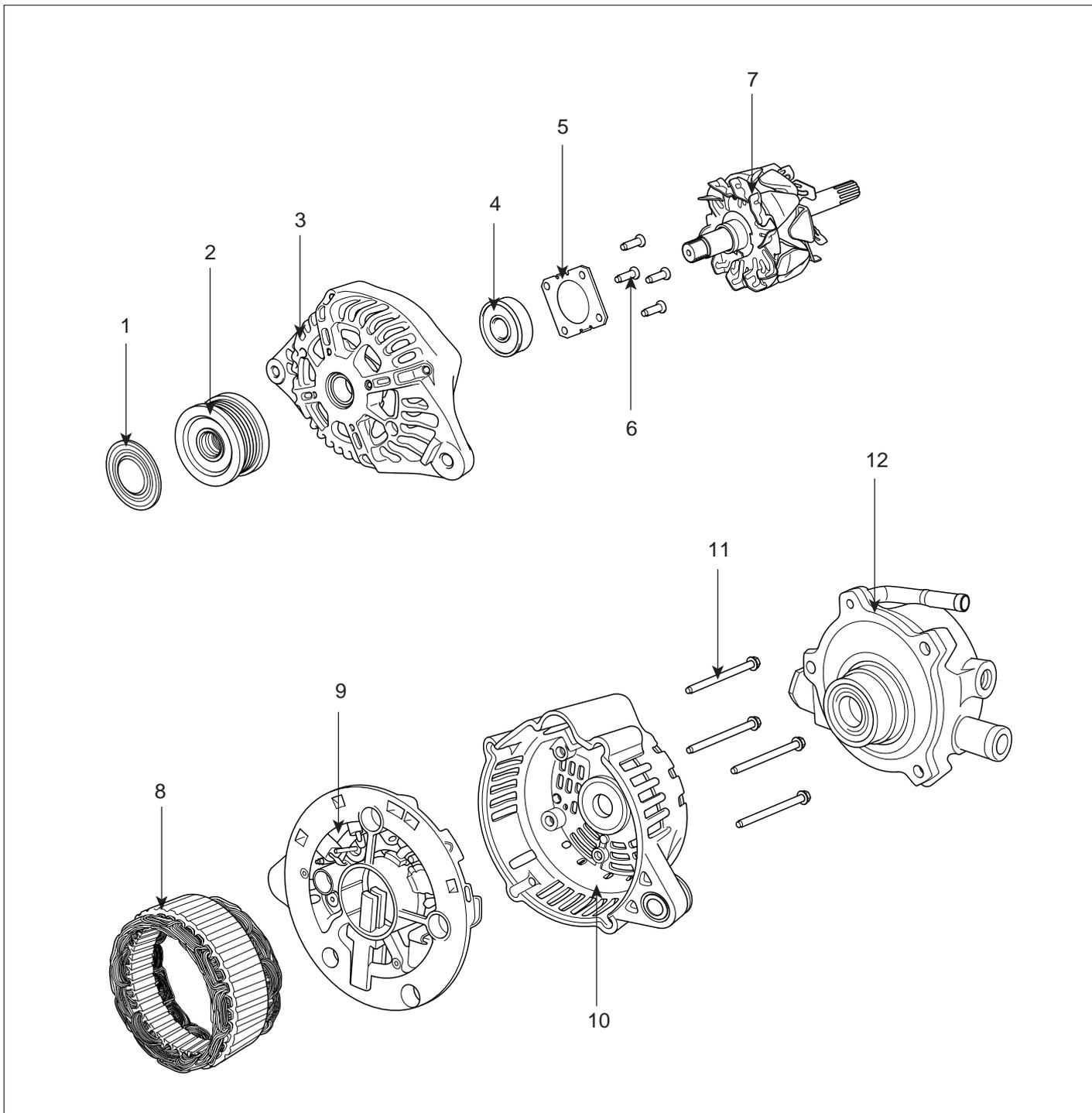
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If it reads 0V, there is an open circuit in the wire between the alternator "B" terminal and the battery and the battery (-), or the fusible link is blown.

2. Start the engine. Keep all lights and accessories off.
3. Run the engine at a speed of about 2,500 rpm and read the voltmeter when the alternator output current drops to 10A or less.

ALTERNATOR

COMPONENTS E7BABA5C

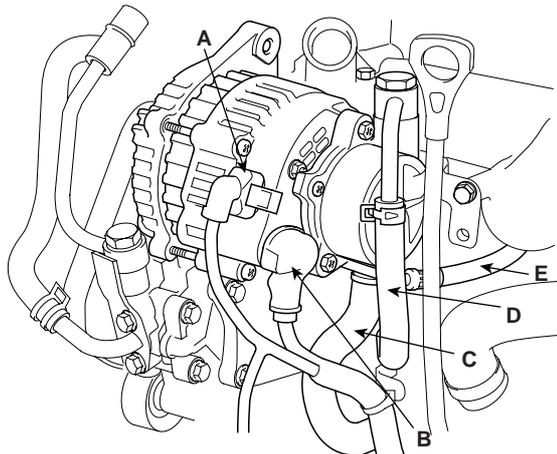


- |                  |                               |
|------------------|-------------------------------|
| 1. Pulley cover  | 7. Rotor                      |
| 2. Pulley        | 8. Stator                     |
| 3. Front frame   | 9. Brush & Regulator assembly |
| 4. Front bearing | 10. Rear frame                |
| 5. Bearing cover | 11. Through bolts             |
| 6. Bolts         | 12. Vacuum pump               |

**REPLACEMENT**

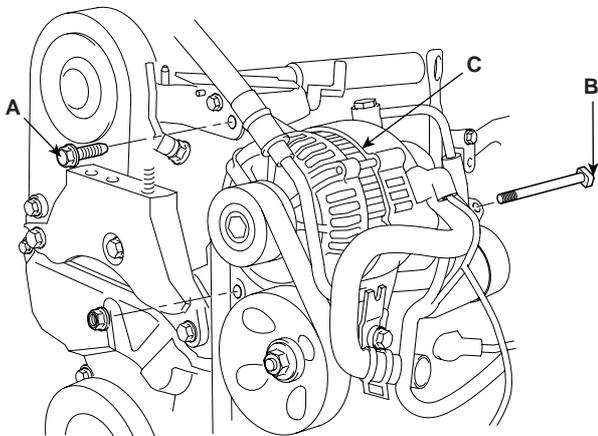
EB1AECC9

1. Disconnect the battery negative terminal first, then the positive terminal.
2. Disconnect the alternator connector(A) and "B" terminal cable(B) from the alternator.
3. Disconnect the vacuum pump oil drain hose(C), vacuum pump oil feed hose(D) and vacuum hose(E).



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4. Remove the mounting bolts(A,B) and the alternator(C).



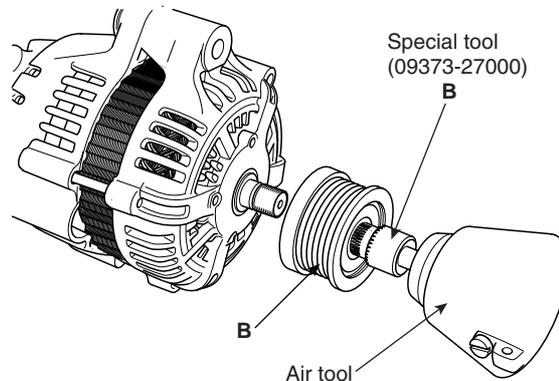
SCMEE6002D

5. Installation is the reverse of removal.

**DISASSEMBLY**

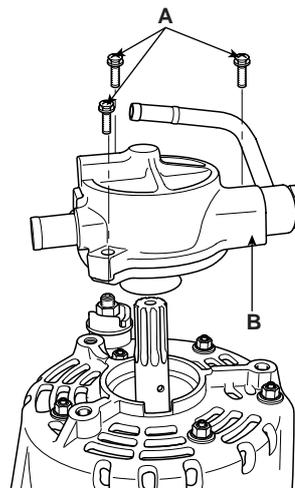
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1. Remove the pulley cover.
2. Remove the pulley(A) using the special tool(B).



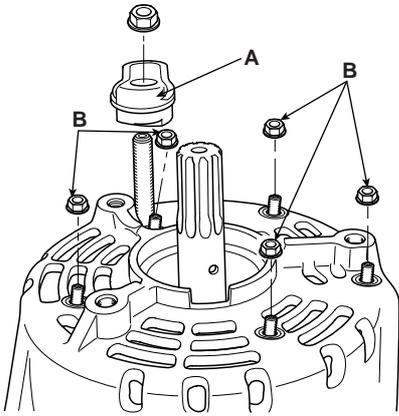
LBIF048A

3. After loosening the three bolts(A). Remove the vacuum pump(B).



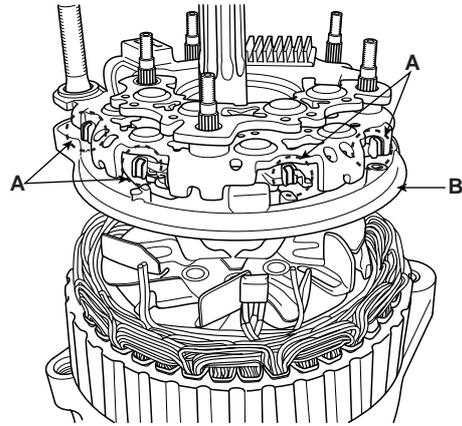
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4. Remove the B terminal insulator(A) and loosen the five rear cover mounting nuts(B).



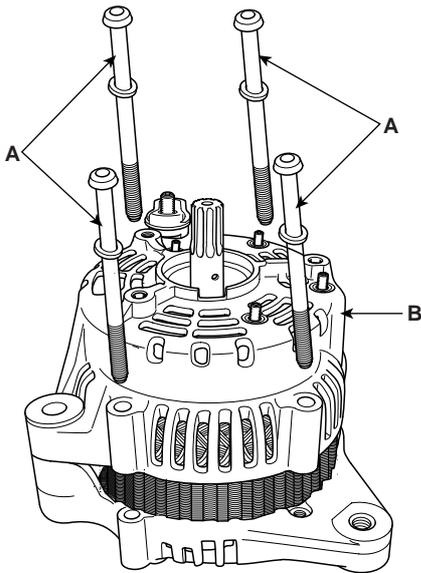
LBIF050A

6. After removing the weld between the stator lead and diode lead(A), remove the regulator assembly(B).



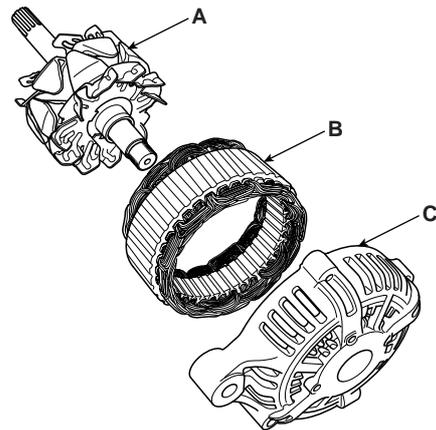
LBIF052A

5. After loosening the four through bolts(A), remove the rear cover(B).



LBIF051A

7. Separate the rotor(A), stator(B), and front cover(C).



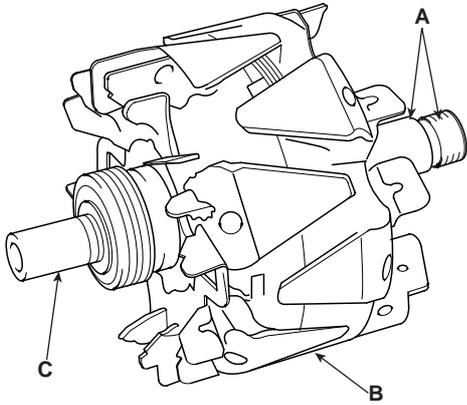
LBIF053A

8. Installation is the reverse of removal.

**INSPECTION** E00B85EA

**INSPECT ROTOR**

1. Check that there is continuity between the slip rings(A).

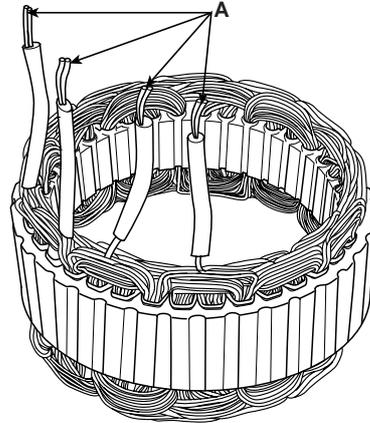


LBIF054A

2. Check that there is no continuity between the slip rings and the rotor(B) or rotor shaft(C).
3. If the rotor fails either continuity check, replace the alternator.

**INSPECT STATOR**

1. Check that there is continuity between each pair of leads(A).

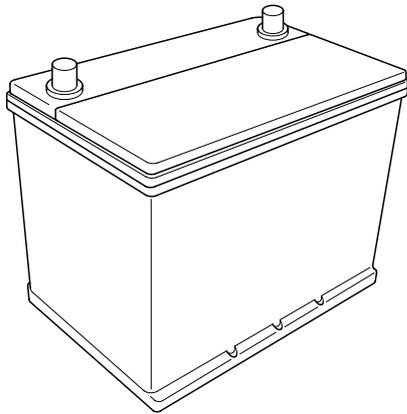


LBIF055A

2. Check that there is no continuity between each lead and the coil core.
3. If the coil fails either continuity check, replace the generator.

**BATTERY****DESCRIPTION** ECBDB3EF

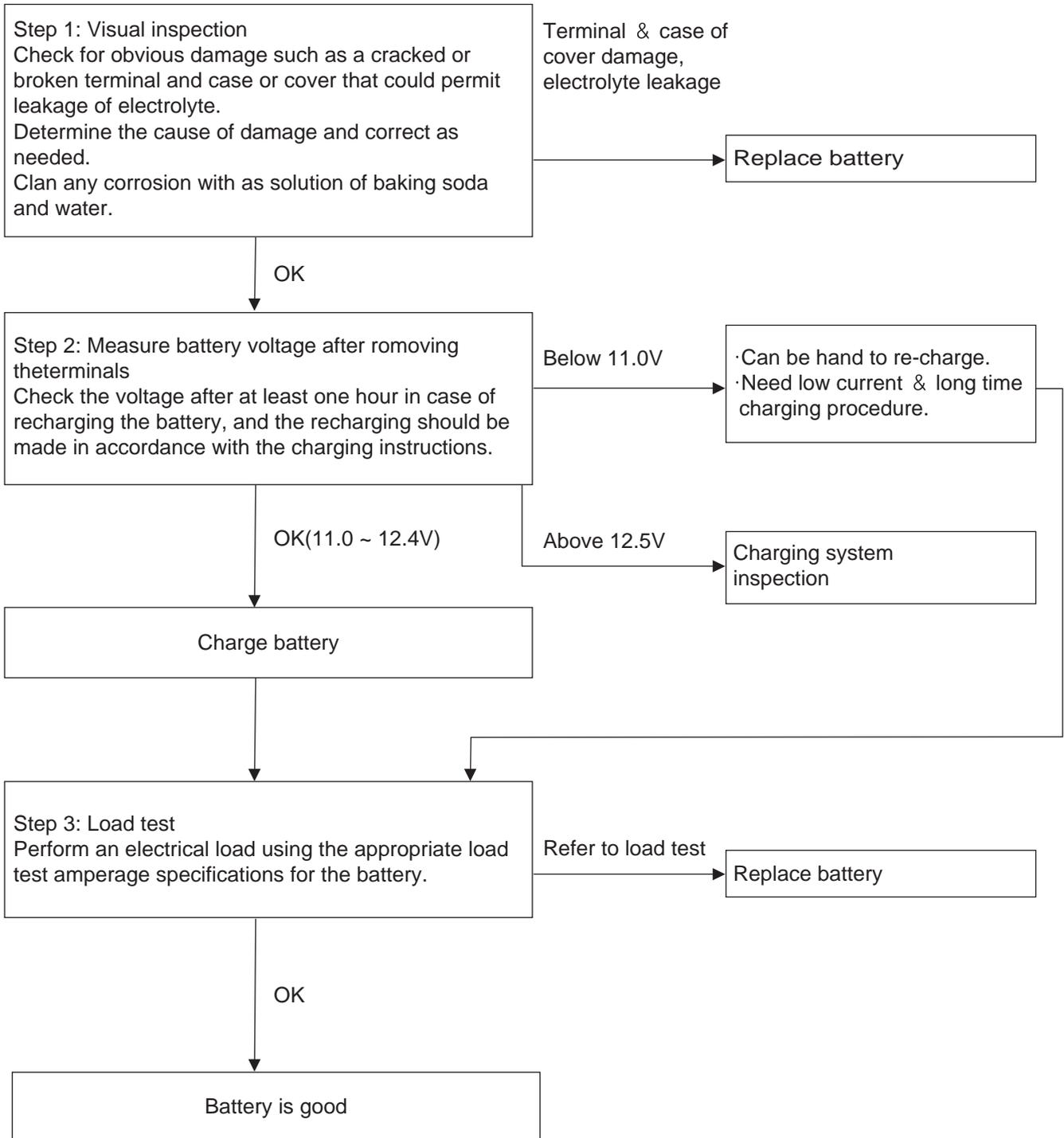
1. The maintenance-free battery is, as the name implies, totally maintenance free and has no removable battery cell caps.
2. Water never needs to be added to the maintenance-free battery.
3. The battery is completely sealed, except for small vent holes in the cover.



LBIF059A

**INSPECTION** EF4DE1EC

**CHECKING PROCEDURE OF BATTERY**



**CHECKING SHEET**

Inspection Items & contents	Judgment criteria	Remarks
<p><b>1. Acid Leakage</b>                      * Type of acid leakage                      - Leakage on the fusion part for joining the case and cover.                      - Leakage on the terminal part                      - Leakage on the other parts</p> <p>* Clean the wet part or wash it, then dry it before checking with naked eyes.                      * Determine a part where leakage might have occurred                      ; check it by tipping the battery, if the leakage takes place again.                      * Conduct a visual inspection for breakage, deformation, or cracks.</p>	1. Damage in the case or cover due to outside impact.	
	2. Acid leakage on the molding part of the case or cover. (weld line or gate hole)	
	3. Damage on the terminal or cracks in the cover.	
	4. Acid leakage due to the tipped battery or slant storage.	
	5. Acid leakage due to poor welding of the cover. (with no damage)	
<p><b>2. Outside damage and breakage</b>                      * Check with naked eyes.</p>	1. Outside damage due to causes without damage due to mistreatment.	
	2. Outside damage due to mistreatment.	
	3. Damage due to a spark between terminals.	
	4. Damage and breakage due to heat.	
<p><b>3. Measure the voltage for the battery</b>                      ; but wait at least one day before measuring in case of recharging, and recharging should be made in accordance with the charging instructions.</p>	1. 12.0V	Refer to load test
	2. 11.0V< battery voltage<12.0V due to over-discharge.	Refer to load test
	3. Below 11.0V due to charge condition failure.	Refer to load test
	4. Below 11.0V due to discharged for a long period.	Refer to load test
	5. Below 11.0V due to internal short circuit.	Refer to load test
<p><b>4. Load test</b>                      ; For 15 seconds with a half of the CCA electric current value, but the voltage on the discharging stage should be above 9.6V (27±5°C)                      - Conduct the test with a battery tester. (Refer to the tester manual)</p>	1. Load test result: below 9.5V	
	2. Load test result: above 9.6V	Mfg. Defect usable

**LOAD TEST**

1. Perform the following steps to complete the load test procedure for maintenance free batteries.
2. Connect the load tester clamps to the terminals and proceed with the test as follow :
  - a. If the battery has been on charge, remove the surface charge by connect a 300 ampere load for 15 seconds.
  - b. Connect the voltmeter and apply the specified load.
  - c. Read the voltage after the load has been applied for 15 seconds.
  - d. Disconnect the load.
  - e. Compare the voltage reading with the minimum and replace the battery if battery test voltage is below that shown in the voltage table.

Voltage(V)	Temperature
9.6	20°C (70°F) and above
9.5	16 °C (60 °F)
9.4	10 °C (50 °F)
9.3	4 °C (40 °F)
9.1	-1 °C (30 °F)
8.9	-7 °C (20 °F)
8.7	-12 °C (10 °F)
8.5	-18 °C (0 °F)

**NOTE**

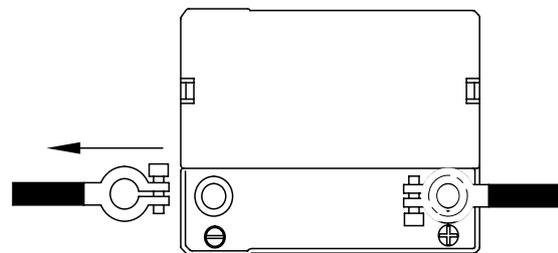
- If the voltage is less than shown in the table, the battery is good.
- If the voltage is greater than shown in the table, replace the battery.

**BATTERY DIAGNOSTIC TEST**

1. Make sure the ignition switch and all accessories are in the OFF position.
2. Disconnect the battery cables (negative first).
3. Remove the battery from the vehicle.

**CAUTION**

**Care should be taken in the event the battery case is cracked or leaking, to protect your skin from the electrolyte. Heavy rubber gloves (not the household type) should be worn when removing the battery.**



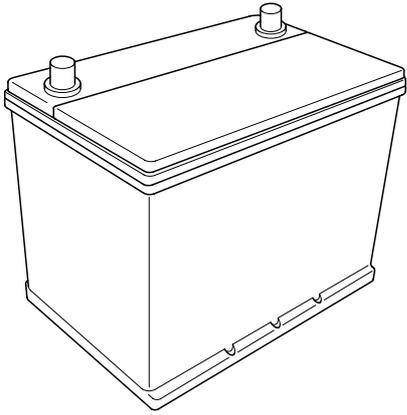
LBIF061A

4. Inspect the battery carrier for damage caused by the loss of electrolyte. If acid damage is present, it will be necessary to clean the area with a solution of clean warm water and baking soda. Scrub the area with a stiff brush and wipe off with a cloth moistened with baking soda and water.
5. Clean the top of the battery with the same solution as described in Step(3).
6. Inspect the battery case and cover for cracks. If cracks are present, the battery must be replaced.
7. Clean the battery posts with a suitable battery post tool.
8. Clean the inside surface of the terminal clamps with a suitable battery cleaning tool. Replace damaged or frayed cables and broken terminal clamps.
9. Install the battery in the vehicle.
10. Connect the cable terminals to the battery post, making sure the tops of the terminals are flush with the tops of the posts.
11. Tighten the terminal nuts securely.

12. Coat all connections with light mineral grease after tightening.

**CAUTION**

*When batteries are being charged, an explosive gas forms beneath the cover of each cell. Do not smoke near batteries being charged or which have recently been charged. Do not break live circuits at the terminals of batteries being charged. A spark will occur when the circuit is broken. Keep open flames away from the battery.*



LBIF059A

# STARTING SYSTEM

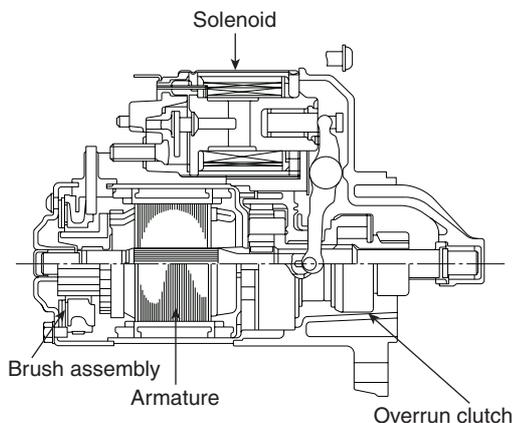
## DESCRIPTION EFE0D698

The starting system includes the battery, starter motor, solenoid switch, ignition switch, inhibitor switch(A/T), ignition lock switch, connection wires and the battery cable.

When the ignition key is turned to the start position, current flows and energizes the starter motor's solenoid coil.

The solenoid plunger and clutch shift lever are activated, and the clutch pinion engages the ring gear.

The contacts close and the starter motor cranks. In order to prevent damage caused by excessive rotation of the starter armature when the engine starts, the clutch pinion gear overruns.



LBIF063A

## INSPECTION E44C2FBC

### START TEST

#### NOTE

*The air temperature must be between 59 and 100°F (15 and 38°C) before testing.*

#### Recommended procedure :

- Use a starter system tester.
- Connect and operate the equipment in accordance with the manufacturer's instructions.
- Test and troubleshoot as described.

#### Alternate Procedure :

- Use the following equipment :
  - Ammeter, 0~400A
  - Voltmeter, 0~20V (accurate within 0.1 volt)
  - Tachometer, 0~1,200 rpm
- Hook up a voltmeter and ammeter as shown.

#### NOTE

*After this test, or any subsequent repair, reset the ECM/PCM to clear any codes.*

#### Check the Starter Engagement :

1. Remove the ECM(B+) fuse from the fuse/relay box.
2. Turn the ignition switch to START (III) with the shift lever in N or P position (A/T) or with the clutch pedal depressed (M/T). The starter should crank the engine.
  - If the starter does not crank the engine, go to step 3.
  - If it cranks the engine erratically or too slowly, go to "Check for Wear and Damage" on the next page.
3. Check the battery, battery positive cable, ground, starter cut relay, and the wire connections for looseness and corrosion. Test again.  
If the starter still does not crank the engine, go to step 4.
4. Unplug the connector from the starter.
5. Connect a jumper wire from the battery positive (+) terminal to the solenoid terminal.  
The starter should crank the engine.
  - If the starter still does not crank the engine, remove it, and diagnose its internal problem.
  - If the starter cranks the engine, go to step 6.
6. Check the ignition switch.
7. Check the starter relay.

8. Check the A/T gear position switch (A/T) or the clutch interlock switch (M/T).
9. Check for an open in the wire between the ignition switch and starter.

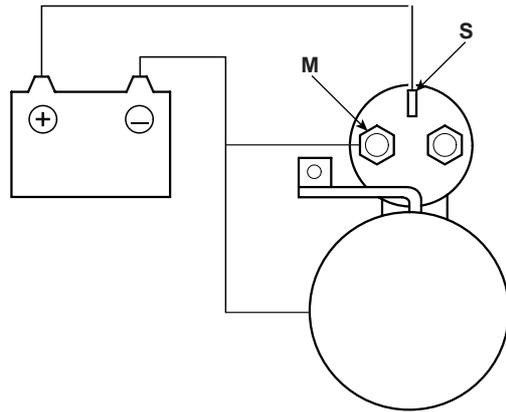
**CHECK FOR WEAR AND DAMAGE**

The starter should crank the engine smoothly and steadily. If the starter engages, but cranks the engine erratically, remove it, and inspect the starter drive gear and torque converter ring gear for damage.

Check the drive gear overrunning clutch for binding or slipping when the armature is rotated with the drive gear held. If damaged, replace the gears.

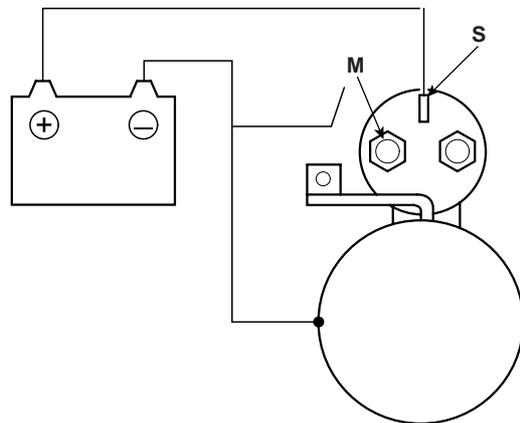
**STARTER SOLENOID TEST**

1. Disconnect the wires from the Sterminal and the M terminal.
2. Connect the battery as shown. If the starter pinion pops out, it is working properly. To avoid damaging the starter, do not leave the battery connected for more than 10 seconds.



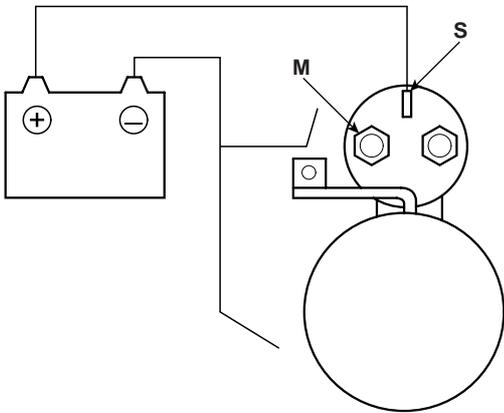
LBIF065A

3. Disconnect the battery from the M terminal. If the pinion does not retract, the hold-in coil is working properly. To avoid damaging the starter, do not leave the battery connected for more than 10 seconds.



LBIF066A

4. Disconnect the battery also from the body. If the pinion retracts immediately, it is working properly. To avoid damaging the starter, do not leave the battery connected for more than 10 seconds.



LBIF067A

### FREE RUNNING TEST

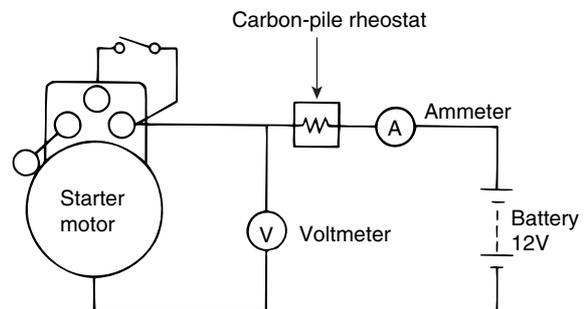
1. Place the starter motor in a vise equipped with soft jaws and connect a fully-charged 12-volt battery to starter motor as follows :
2. Connect a test ammeter (100-ampere scale) and carbon pile rheostat shown in the illustration.
3. Connect a voltmeter (15-volt scale) across starter motor.
4. Rotate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

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**Current** : Max. 120 Amps

**Speed** : Min. 4,000 rpm

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LBIF068A

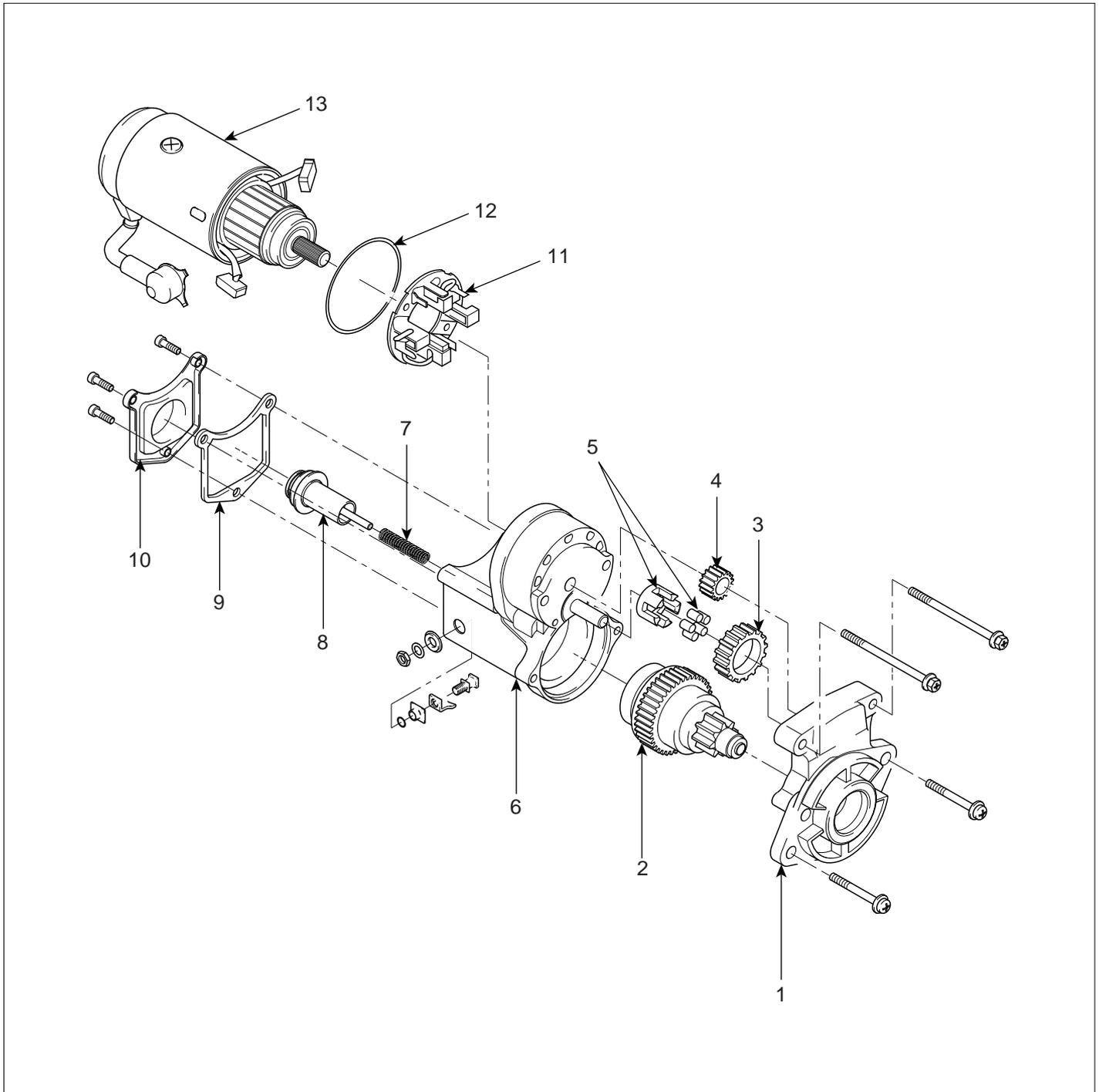
### CLEANING

E8C3711A

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

# STATER

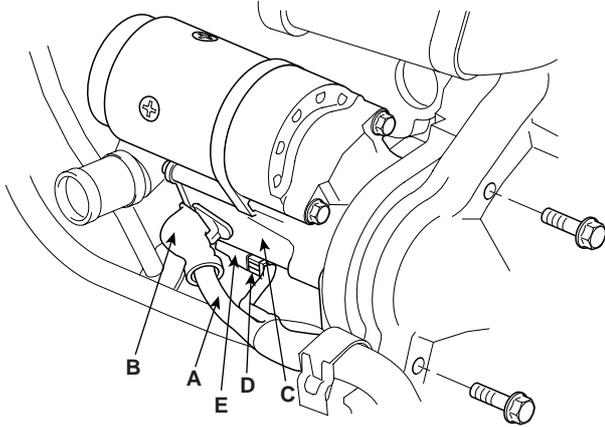
## COMPONENTS EBAF73D6



- |                            |                    |
|----------------------------|--------------------|
| 1. Front bracket           | 8. Magnetic switch |
| 2. Overrun clutch assembly | 9. Packing         |
| 3. Idle gear               | 10. Rear cover     |
| 4. Driver gear             | 11. Brush holder   |
| 5. Idle gear bearing       | 12. Packing        |
| 6. Housing                 | 13. Yoke assembly  |
| 7. Spring                  |                    |

**REPLACEMENT** E1BE77DD

1. Disconnect the battery negative cable.
2. Disconnect the starter cable(A) from the B terminal(B) on the solenoid(C), then disconnect the connector(D) from the S terminal(E).

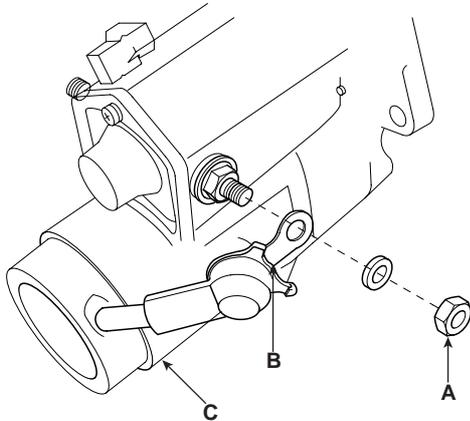


SCMEE6003D

3. Remove the 2 bolts holding the starter, then remove the starter.
4. Installation is the reverse of removal.
5. Connect the battery positive cable and negative cable to the battery.

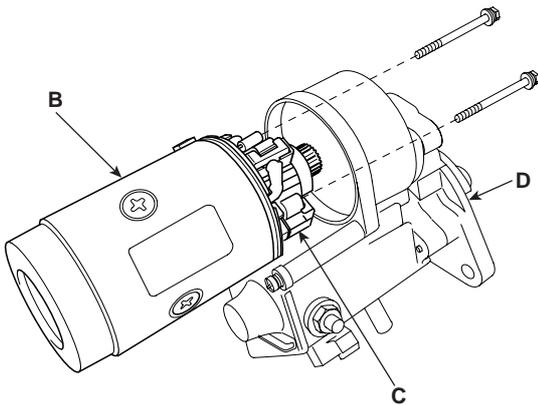
**DISASSEMBLY** E8534E61

1. Remove the nut(A) and disconnect the lead wire(B) from the magnetic switch terminal(C).



LBIF085A

2. Remove the 2 bolts(A) and pull out the yoke assembly(B) with the armature(C) from the front bracket(D).

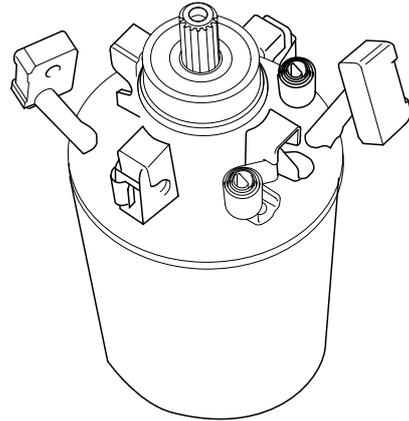


LBIF086A

3. Using a screwdriver, hold the spring tank back and disconnect the brush(A) from the brush holder(B). Disconnect the 2 brushes and remove the brush holder.

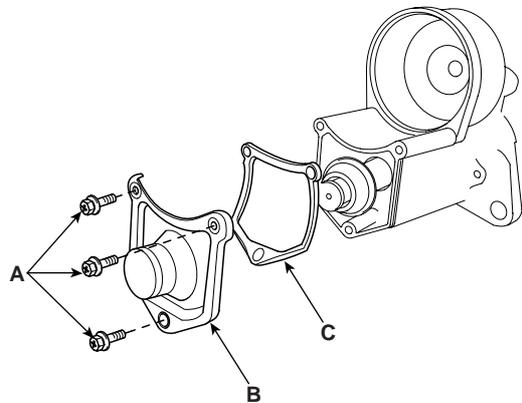
**NOTE**

*Check that the positive(+) lead wires are not grounded.*



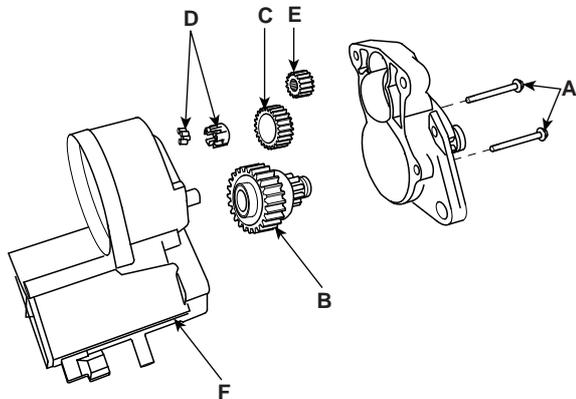
LBIF087A

4. Remove the 3 screws(A) and disconnect the housing rear cover(B) and packing(C).



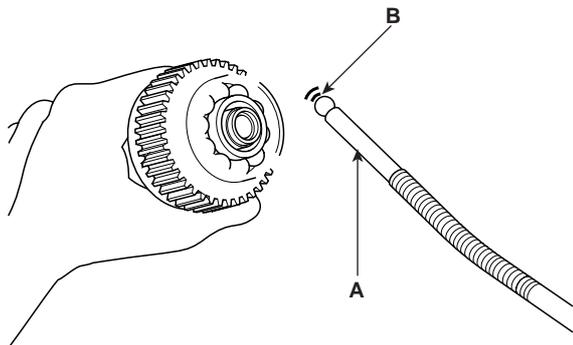
LBIF088A

5. Remove the magnetic switch(A) and spring coil(B).
6. Remove the 2 screws(A) and disconnect the clutch sub assembly(B), idle gear(C), idle gear bearing(D) and drive gear(E) from the housing(F).



LBIF090A

7. Using a magnetic finger(A), remove the steel ball(B) from the clutch shaft hole.

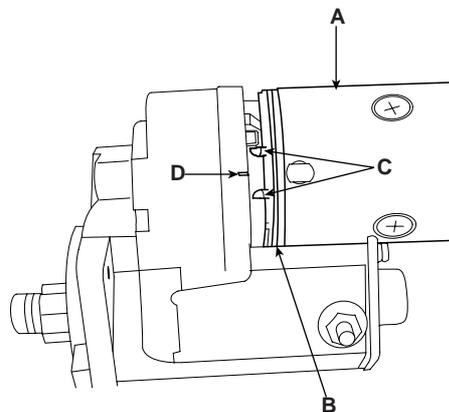


LBIF091A

8. Reassembly is the reverse of disassembly.

**NOTE**

*When installing the yoke assembly(A), use a new O-ring(B) and align the mark(C) on the housing to the mark(D) range of the brush holder.*

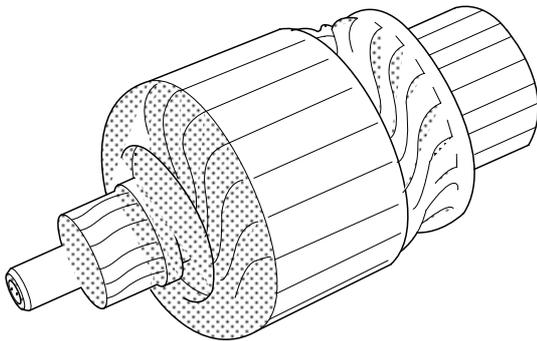


LBIF092A

**INSPECTION** E712D053

**ARMATURE INSPECTION AND TEST**

1. Remove the starter (see page EE-25).
2. Disassemble the starter as shown at the beginning of this procedure.
3. Inspect the armature for wear or damage from contact with the permanent magnet. If there is wear or damage, replace the armature.

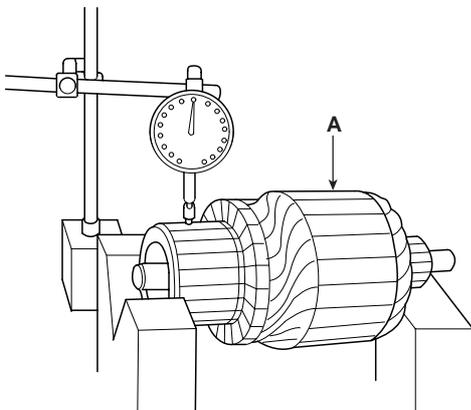


LBIF093A

4. Measure the commutator (A) runout.
  - If the commutator runout is within the service limit, check the commutator for carbon dust or brass chips between the segments.
  - If the commutator runout is not within the service limit, replace the armature.

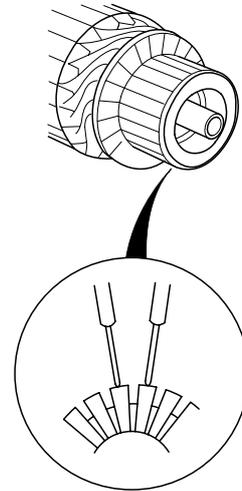
**Commutator Runout**

Standard (New) : 0.02mm (0.001 in.) max.  
 Service limit : 0.05mm (0.002 in.)



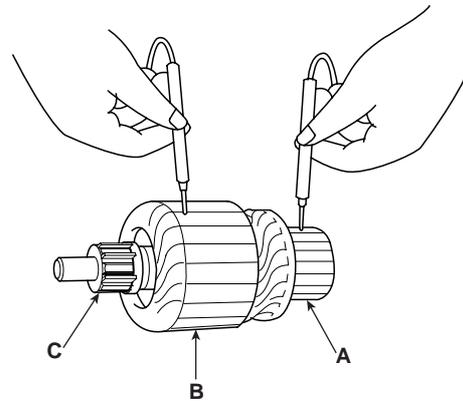
LBIF094A

5. Check for continuity between the segments of the commutator. If an open circuit exists between any segments, replace the armature.



LBIF095A

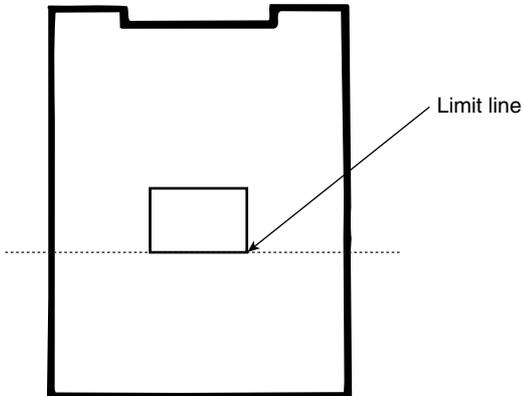
6. Check with an ohmmeter that no continuity exists between the commutator (A) and armature coil core (B), and between the commutator and armature shaft (C). If continuity exists, replace the armature.



LBIF096A

**INSPECT STARTER BRUSH**

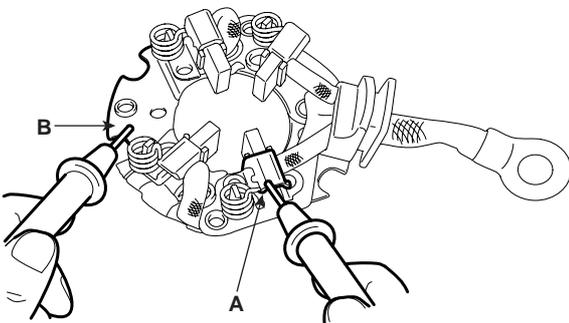
Brushes that are worn out, or oil-soaked, should be replaced.



LBIF097A

**STARTER BRUSH HOLDER TEST**

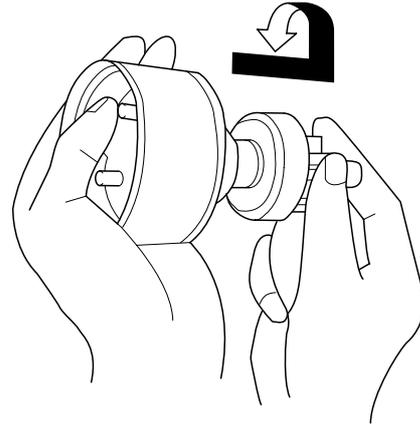
Check that there is no continuity between the (+) brush holder (A) and (-) brush holder (B). If there is no continuity, replace the brush holder assembly.



LBIF098A

**INSPECT OVERRUNNING CLUTCH**

1. Slide the overrunning clutch along the shaft. Replace it if it does not slide smoothly.
2. Rotate the overrunning clutch (A) both ways. Does it lock in one direction and rotate smoothly in reverse? If it does not lock in either direction or it locks in both directions, replace it.



LBIF099A

3. If the starter driver gear (B) is worn or damaged, replace the overrunning clutch assembly: the gear is not available separately. Check the condition of the flywheel or torque converter ring gear if the starter drive gear teeth are damaged.

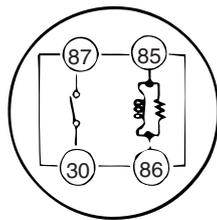
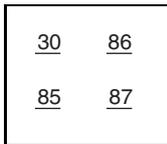
# STARTER RELAY

## INSPECTION EE48CFAA

1. Remove the fuse box cover.
2. Remove the starter relay.
3. Using an ohmmeter, check that there is continuity between each terminal.

Terminal	Continuity
30 - 87	NO
85 - 86	YES

4. Apply 12V to terminal 85 and ground to terminal 86. Check for continuity between terminals 30 and 87.

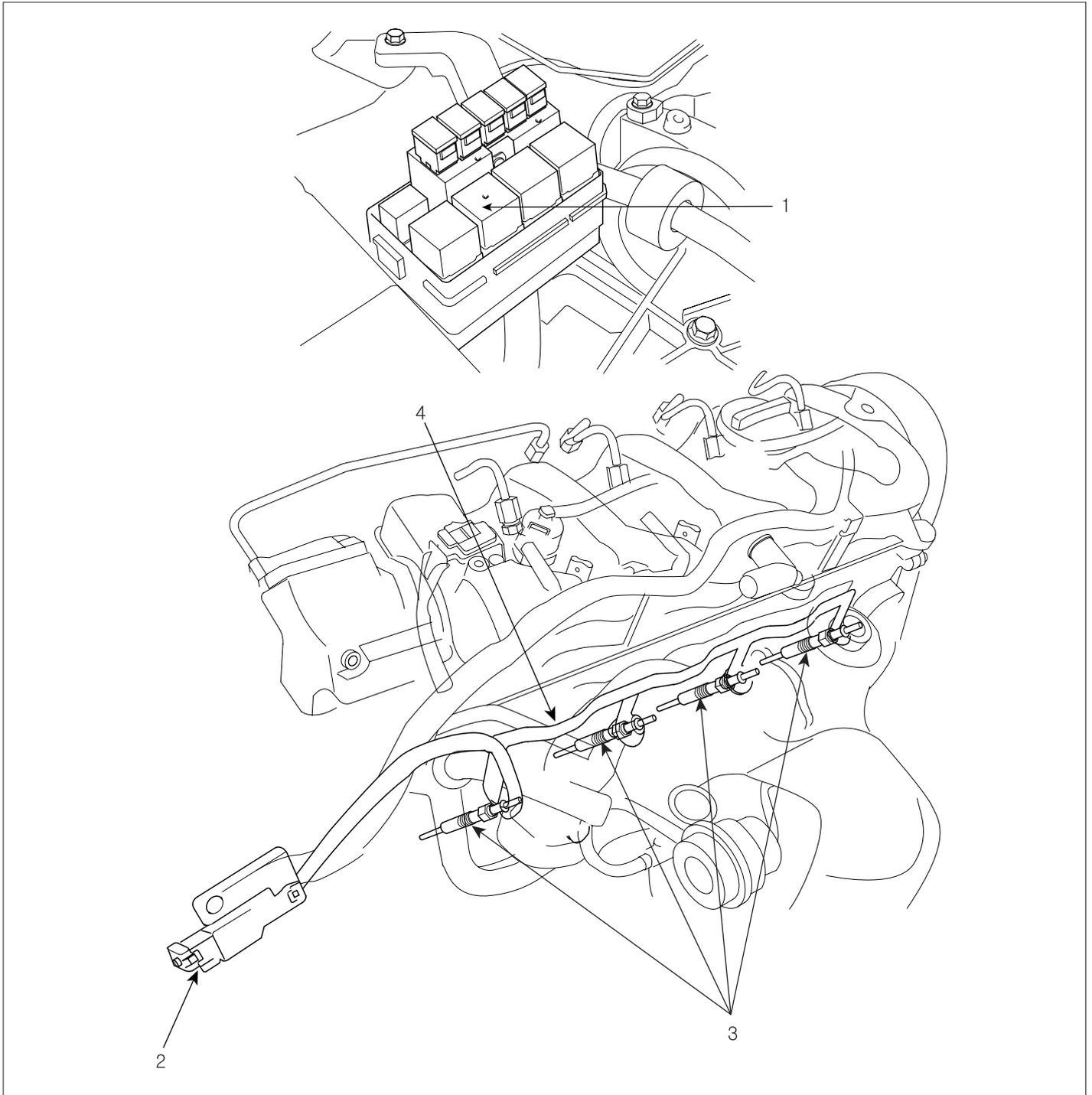


LDAD510B

5. If there is no continuity, replace the starter relay.
6. Install the starter relay.
7. Install the fuse box cover.

# PREHEATING SYSTEM

## COMPONENTS LOCATION E64278AC



- 1. Glow plug relay
- 2. Glow plug connector

- 3. Glow plug
- 4. Plate

**INSPECT PREHEATING SYSTEM** E812E6A0

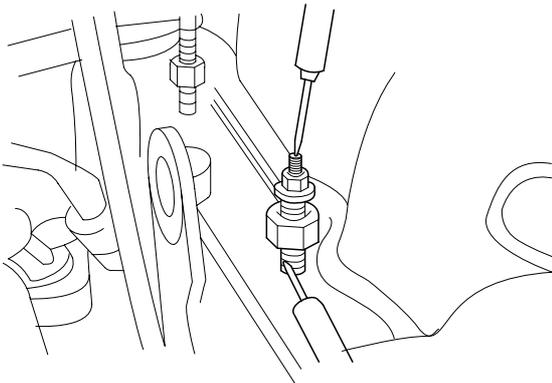
Conditions before inspection :  
 Battery voltage : 12V

1. Connect voltmeter between glow plug plate and plug body (ground).
2. Check indicated value on voltmeter with ignition switch ON.
3. Check that preheat indication lamp lights for about 6 seconds and indicates battery voltage (about 9V or over) for about 36 seconds immediately after ignition switch is turned on. [At cooling water temperature 20°C (68°F)]

**NOTE**

*Continuity time varies depending upon cooling water temperature.*

4. After checking 3, set ignition switch at START position.
5. The system is normal if battery voltage (about 9V or over) is generated for about 6 seconds during engine cranking and after start operation. [at cooling water temperature 20°C (68°F)]
6. When the voltage or continuity time is not normal, check the terminal voltage in glow control unit, and single parts.



LBIF117A

**INSPECT GLOW PLUS**

1. Check the continuity between the terminal and body as illustrated. Replace if discontinuity or with large resistance.

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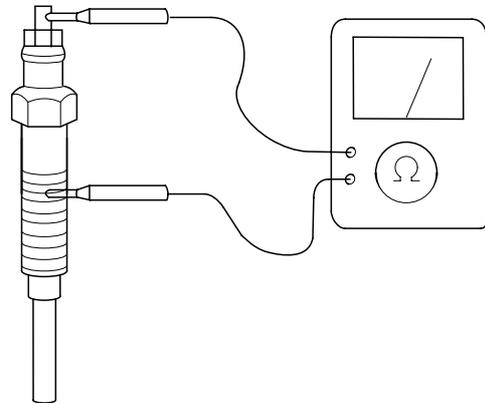
Standard value : 0.25Ω

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**CAUTION**

**Remove oil from plug before measuring as glow plug resistance is very small.**

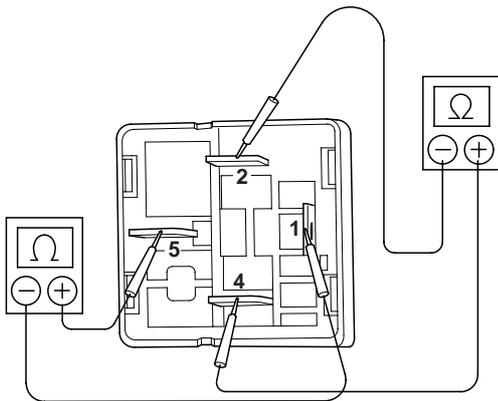
2. Check for rust on glow plug plate.
3. Check glow plug for damage.



LBIF118A

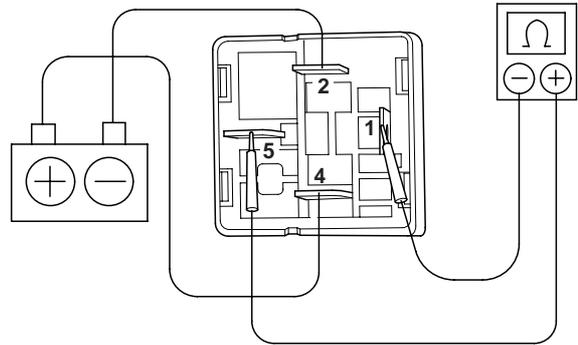
**INSPECT GLOW PLUG RELAY**

1. Remove the glow plug relay.
2. Inspect the relay continuity.
  - Using an ohmmeter, check that there is continuity between terminals 2 and 4.  
If there is no continuity, replace the relay.
  - Check that there is no continuity between terminals 1 and 5.  
If there is continuity, replace the relay.



LBIF119A

3. Inspect the relay operation.
  - Apply battery positive voltage across terminals 2 and 4.
  - Using an ohmmeter, check that there is continuity between terminals 1 and 5.  
If there is no continuity, replace the relay.



LBIF120A

4. Install the glow plug relay.