

## **CHAPTER 3:**

# **Engine Electrical System**

# **General information**



## TROUBLESHOOTING

### CHARGING SYSTEM

| Symptom                                                                                                | Suspect area                                                                                                                                                       | Remedy                                                                                                                                                                                             |
|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Charging warning indicator does not light with ignition switch "ON" and engine off.                    | a. Fuse blown<br>b. Light burned out<br>c. Poor wiring connection<br>d. Inferior electronic voltage regulator                                                      | a. Check fuses<br>b. Replace a lamp<br>c. Tighten loose connection<br>d. Replace voltage regulator                                                                                                 |
| Charging warning indicator does not go out with engine running. (Battery requires frequent recharging) | a. Drive belt loose or worn<br>b. Battery cable loose, corroded or worn<br>c. Inferior electronic voltage regulator or generator<br>d. Bad wiring connection       | a. Adjust belt tension or replace belt<br>b. Inspect cable connection, repair or replace cable<br>c. Replace voltage regulator or generator<br>d. Repair or replace wiring                         |
| Overcharge                                                                                             | a. Electronic voltage regulator<br>b. Voltage sensing wire                                                                                                         | a. Replace voltage regulator<br>b. Repair or replace wiring                                                                                                                                        |
| Discharge                                                                                              | a. Drive belt loose or worn<br>b. Wiring connection loose or short circuit<br>c. Electronic voltage regulator or generator<br>d. Poor grounding<br>e. Worn battery | a. Adjust belt tension or replace belt<br>b. Inspect wiring connection, repair or replace wiring<br>c. Replace voltage regulator or generator<br>d. Inspect ground or repair<br>e. Replace battery |

### STARTING SYSTEM

| Symptom                                 | Suspect area                                                                                                                                                                                                         | Remedy                                                                                                                                                 |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| Engine will not crank                   | a. Battery charge low<br>b. Battery cables loose, corroded or worn out<br>c. Transaxle range switch (Vehicle with automatic transaxle only)<br>d. Fuse blown<br>e. Starter motor faulty<br>f. Ignition switch faulty | a. Charge or replace battery<br>b. Repair or replace cables<br>c. Refer to AT group-automatic transaxle<br>d. Replace fuse<br>e. Replace<br>f. Replace |
| Engine cranks slowly                    | a. Battery charge low<br>b. Battery cables loose, corroded or worn out<br>c. Starter motor faulty                                                                                                                    | a. Charge or replace battery<br>b. Repair or replace cables<br>c. Replace                                                                              |
| Starter keeps running                   | a. Starter motor<br>b. Ignition switch                                                                                                                                                                               | a. Replace<br>b. Replace                                                                                                                               |
| Starter spins but engine will not crank | a. Short in wiring<br>b. Pinion gear teeth broken or starter motor<br>c. Ring gear teeth broken                                                                                                                      | a. Repair wiring or replace<br>b. Replace<br>c. Replace fly wheel or torque converter                                                                  |



## SPECIFICATION

### STARTING SYSTEM

| Item    |                         |          | J3 common rail |
|---------|-------------------------|----------|----------------|
| Starter | Rated voltage           |          | 12V, 2.0KW     |
|         | No. of pinion teeth     |          | 12             |
|         | No-load characteristics | Voltage  | 11.5V          |
|         |                         | Amperage | 190A, MAX      |
|         |                         | Speed    | 3,000rpm, MIN  |

### CHARGING SYSTEM

| Item      |                                          |  | J3 common rail              |
|-----------|------------------------------------------|--|-----------------------------|
| Generator | Type                                     |  | Battery voltage sensing     |
|           | Rated voltage                            |  | 12V, 120A                   |
|           | Voltage regulator type                   |  | I.C regulator built-in type |
|           | Regulator setting voltage                |  | 14.4 ± 0.3V                 |
|           | Temperature compensation                 |  | -10 ± 3mV/°C                |
| Battery   | Type                                     |  | CMF 100 AH      MF 80AH     |
|           | Cold cranking amperage at -18°C (-0.4°F) |  | 900A      660A              |
|           | Reserve capacity                         |  | 182min      145min.         |
|           | Specific gravity at 25°C (77°F)          |  | 1.280 ± 0.01      ←         |

#### NOTICE

- 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)

# **Charging System**



## DESCRIPTION

The charging system includes a battery, an generator with a built-in regulator, and the charging indicator light and wire.

The generator has eight built-in diodes, each rectifying AC current to DC current.

Therefore, DC current appears at generator "B" terminal.

In addition, the charging voltage of this generator is regulated by the battery voltage detection system in the regulator.

The generator is regulated by the voltage detection system. The main components of the generator are the rotor, stator, rectifier, capacitor, brushes, bearings and overrunning alternator pulley (OAP). The brush holder contains a built-in electronic voltage regulator.



## ON-VEHICLE INSPECTION

### CAUTION

- Check that the battery cables are connected to the correct terminals.
- Disconnect the battery cables when the battery is given a quick charge.
- Never disconnect the battery while the engine is running.

## CHECK BATTERY VOLTAGE

- If 20 minutes have not passed since the engine was stopped, 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.
- Turn the ignition switch OFF and turn off the electrical systems.
- Measure the battery voltage between the negative (-) and positive (+) terminals of the battery.

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

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

## CHECK THE BATTERY TERMINALS AND FUSES

- Check that the battery terminals are not loose or corroded.
- Check the fuses for continuity.

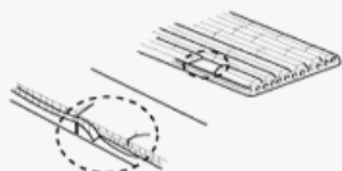
## INSPECT DRIVE BELT

Visually check the belt for excessive wear, frayed cords etc.

If any defect has been found, replace the drive belt.

### NOTICE

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



## VISUALLY CHECK ALTERNATOR WIRING AND LISTEN FOR ABNORMAL NOISES

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

## CHECK DISCHARGE WARNING LIGHT CIRCUIT

- Warm up the engine and then turn it off.
- Turn off all accessories.
- Turn the ignition switch "ON". Check that the discharge warning light is lit.
- Start the engine. Check that the light is lit.  
If the light does not go off as specified, troubleshoot the discharge light circuit.

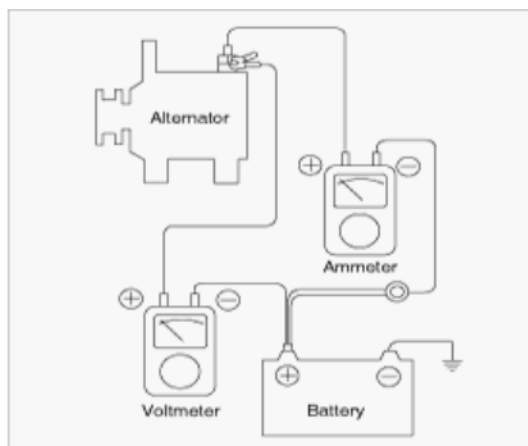
## INSPECT CHARGING SYSTEM

### 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".
2. Disconnect the output wire from the alternator "B" terminal. Connect the (+) lead wire of ammeter to the "B" terminal of alternator and the (-) lead wire of ammeter to the output wire. Connect the (+) lead wire of voltmeter to the "B" terminal of alternator and the (-) lead wire of voltmeter to the (+) terminal of battery.



## TEST

1. Start the engine.
2. Turn on the headlamps and blower motor, and set the engine speed until the ammeter indicates 20A. And then, read the voltmeter at this time.

## 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 battery (+) terminal. Check for loose connections, color change due to an over-heated harness, etc. Correct them before testing again.
3. Upon completion of the test, set the engine speed at idle. Turn off the headlamps, 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 normal output.

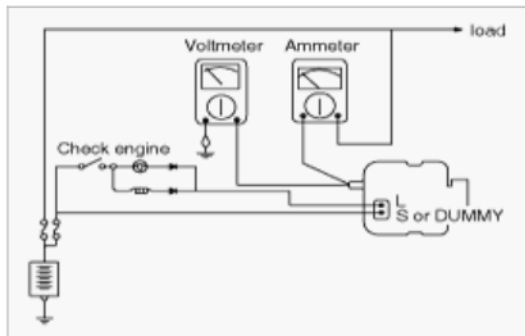
### PREPARATION

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 good condition. The battery checking method is described in the section "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. The belt tension check method is described in the section "Inspect 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.

### NOTICE

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.



## 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 alternator "B" terminal and battery (-) terminal or poor grounding is suspected.
2. Start the engine and turn on the headlamps.
3. Set the headlamps 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.

### NOTICE

After the engine start 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 : 70% of the rated current

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### NOTICE

- a. The nominal output current value is shown on the nameplate affixed to the alternator body.
- b. 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 headlamps 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.

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

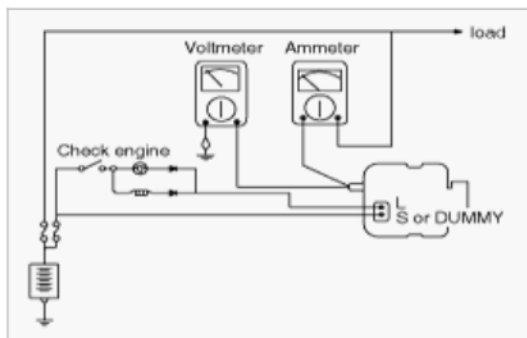
## REGULATED VOLTAGE TEST

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. The battery checking method is described in the section "Battery".  
Check the alternator drive belt tension. The belt tension check method is described in the section "Inspect drive belt".
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.

- 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.
- Attach the engine tachometer and connect the battery ground cable.



## TEST

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

Voltage: Battery voltage

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

- Start the engine. Keep all lights and accessories off.
- 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

## RESULT

- 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

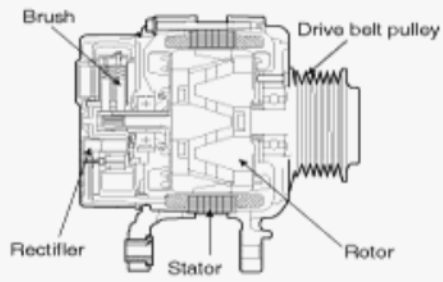
| Voltage regulator ambient temperature °C (°F) | Regulating voltage (V) |
|-----------------------------------------------|------------------------|
| -20 (-4)                                      | 14.2 ~ 15.4            |
| 20 (68)                                       | 14.0 ~ 15.0            |
| 60 (140)                                      | 13.7 ~ 14.9            |
| 80 (176)                                      | 13.5 ~ 14.7            |

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

# Alternator



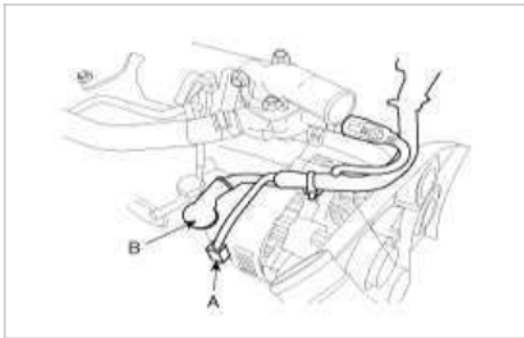
## COMPONENT



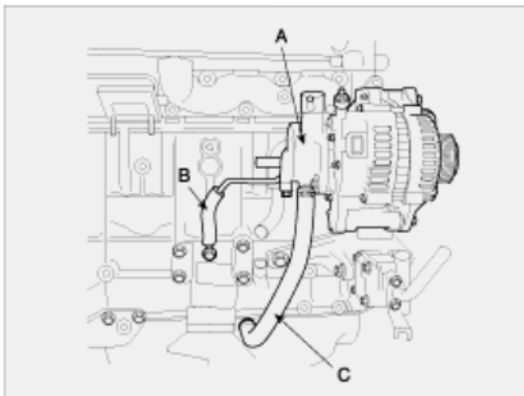


## REPLACEMENT

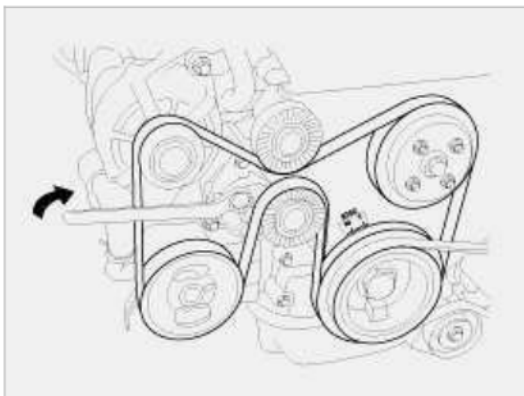
1. Disconnect the battery negative terminal first, then the positive terminal.
2. Disconnect the alternator connector(A) and "B" terminal cable(B).



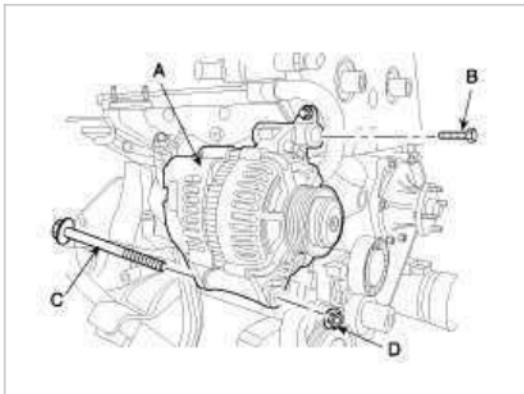
3. Remove the oil pipe(B), oil hose(C) from the vacuum pump(A).



4. Remove the drive belt.



5. Remove the mounting bolts(B,C) and nut(D) then remove the alternator(A).



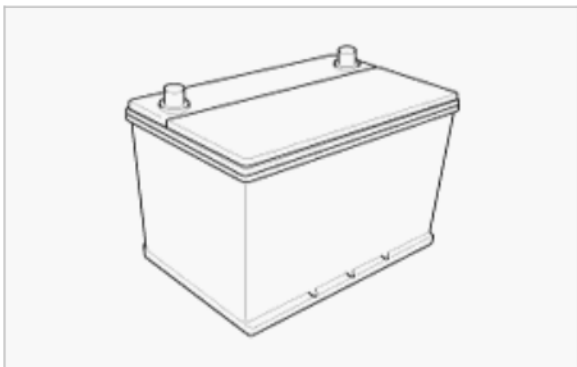
6. Installation is the reverse of removal.

# Battery



## DESCRIPTION

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.

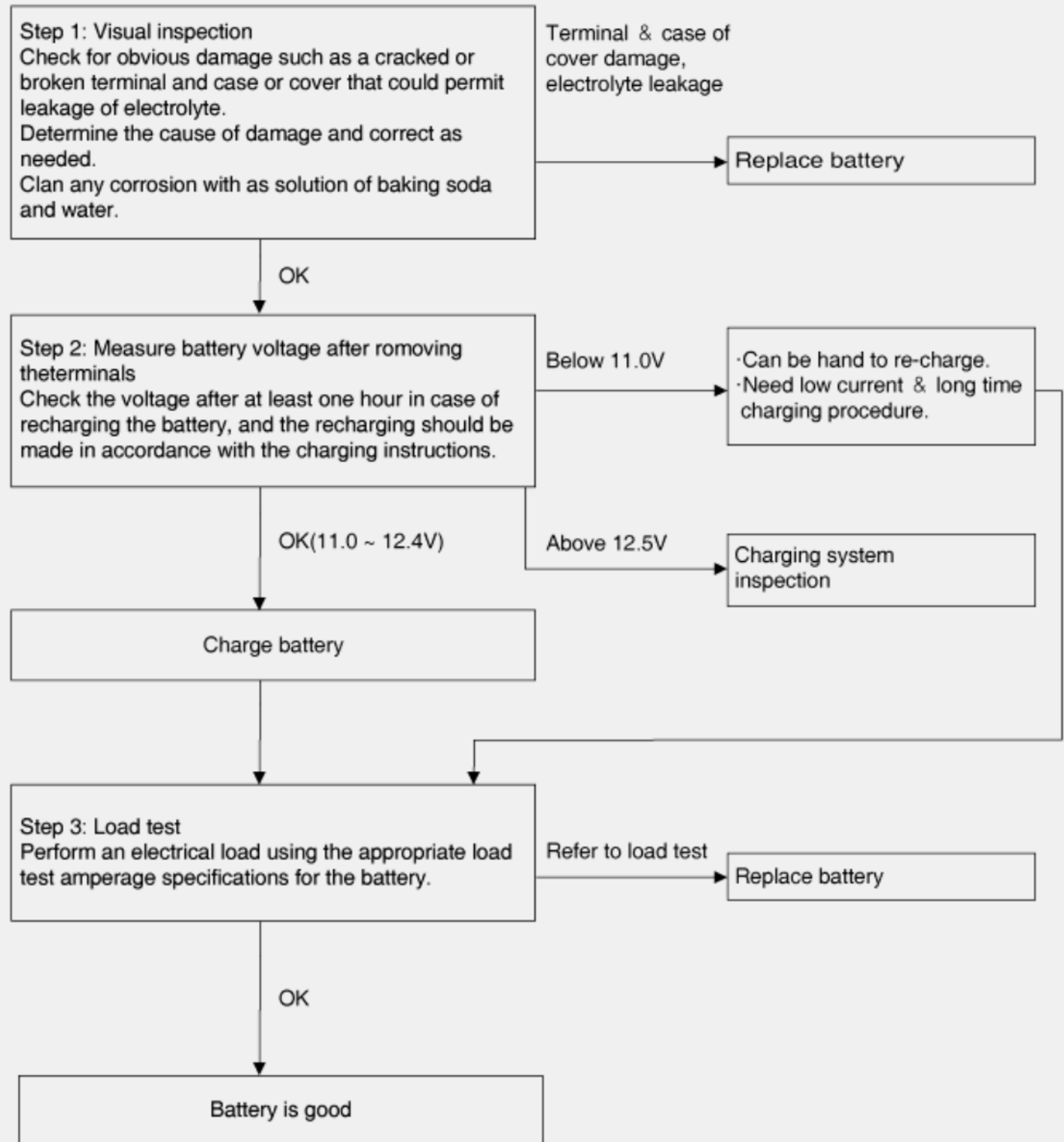




## INSPECTION

### BATTERY DIAGNOSTIC TEST (1)

#### CHECKING FLOW



## 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:

- (1) If the battery has been on charge, remove the surface charge by connect a 300ampere load for 15 seconds.
- (2) Connect the voltmeter and apply the specified load.
- (3) Read the voltage after the load has been applied for 15 seconds.
- (4) Disconnect the load.
- (5) Compare the voltage reading with the minimum and replace the battery if battery test voltage is below that shown in the voltage table.

| Voltage | Temperature             |
|---------|-------------------------|
| 9.6V    | 20°C (68.0°F) and above |
| 9.5V    | 16°C (60.8°F)           |
| 9.4V    | 10°C (50.0°F)           |
| 9.3V    | 4°C (39.2°F)            |
| 9.1V    | -1°C (30.2°F)           |
| 8.9V    | -7°C (19.4°F)           |
| 8.7V    | -12°C (10.4°F)          |
| 8.5V    | -18°C (-0.4°F)          |

#### NOTICE

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

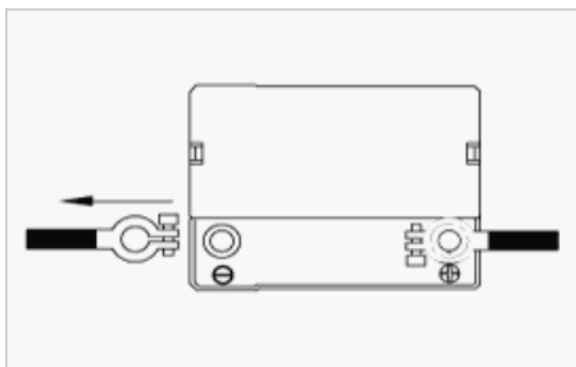
## BATTERY DIAGNOSTIC TEST (2)

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 wore when removing the battery.



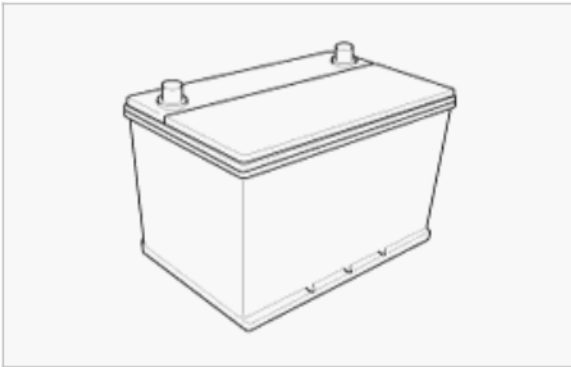
4. Inspect the battery tray for damage caused by the loss of electrolyte. If acid damage is present, it will be necessary to clean the area with a solution of clean warm water and baking soda. Scrub the area with a stiff brush and wipe off with a cloth moistened with baking soda and water.
5. Clean the top of the battery with the same solution as described above.
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 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 circuit at the terminals of batteries being charged.

A spark will occur when the circuit is broken. Keep open flames away from battery.



# Starting System



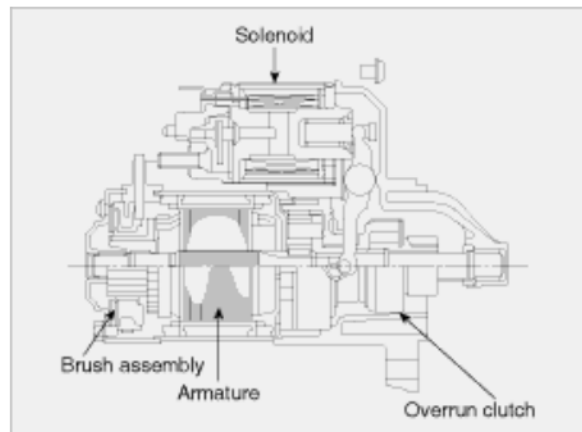
## DESCRIPTION

The starting system includes the battery, starter, 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.





## TROUBLESHOOTING

### STARTER CIRCUIT

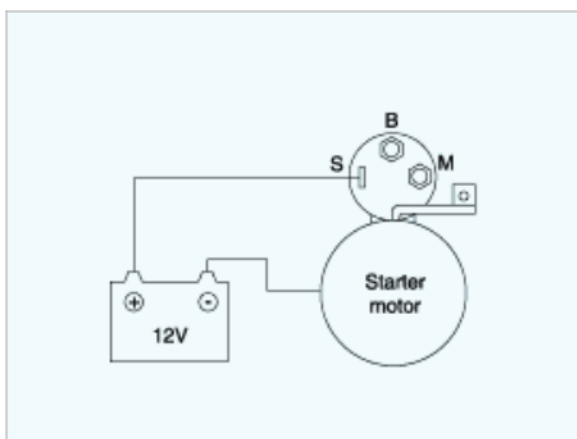
#### NOTICE

The battery must be in good condition and fully charged.

1. With the shift lever in N or P (A/T) or clutch pedal pressed (M/T), turn the ignition switch to "START"  
If the starter normally cranks the engine, starting system is OK. If the starter will not crank the engine at all, go to next step.  
If it won't disengage from the ring gear when you release key, check for the following until you find the cause.
  - a. Solenoid plunger and switch malfunction.
  - b. Dirty pinion gear or damaged overrunning clutch.
2. Check the battery condition. Check electrical connections at the battery, battery negative cable connected to the body, engine ground cables, and the starter for looseness and corrosion. Then try starting the engine again.  
If the starter cranks normally the engine, repairing the loose connection repaired the problem. The starting system is now OK.  
If the starter still does not crank the engine, go to next step.
3. Disconnect the connector from the S-terminal of solenoid. Connect a jumper wire from the B-terminal of solenoid to the S-terminal of solenoid.  
If the starter cranks the engine, go to next step.  
If the starter still does not crank the engine, remove the starter, and repair or replace as necessary.
4. Check the following items in the order listed until you find the open circuit.
  - a. Check the wire and connectors between the driver's under-dash fuse/relay box and the ignition switch, and between the driver's under-dash fuse/relay box and the starter.
  - b. Check the ignition switch (Refer to BE group - ignition system)
  - c. Check the transaxle range switch connector or ignition lock switch connector.
  - d. Inspect the starter relay.

### STATER SOLENOID TEST

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



3. Connect the field coil wire to the M-terminal.

#### CAUTION

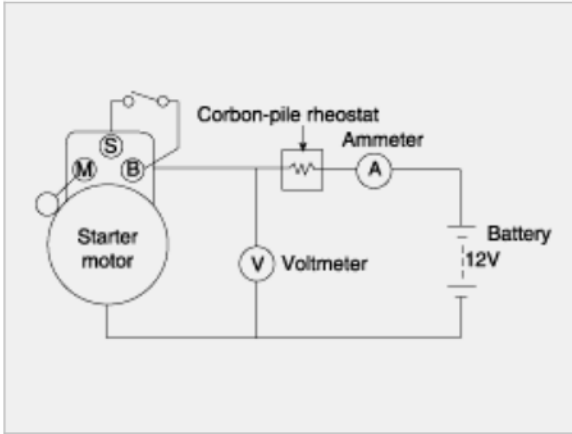
This test must be performed quickly (in less than 10 seconds) to prevent the coil from burning.

4. If the pinion moves out, the pull-in coil of solenoid is working properly.  
If the pinion does not move, replace the solenoid.

5. Disconnect the field coil wire from the M-terminal.
6. If the pinion has moved out, the hold-in coil of the solenoid is working properly.  
If the pinion moves in, replace the solenoid.

## 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 rheostats shown is 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 11volts.
7. Confirm that the maximum amperage is within the specifications and that the starter motor turns smoothly and freely.

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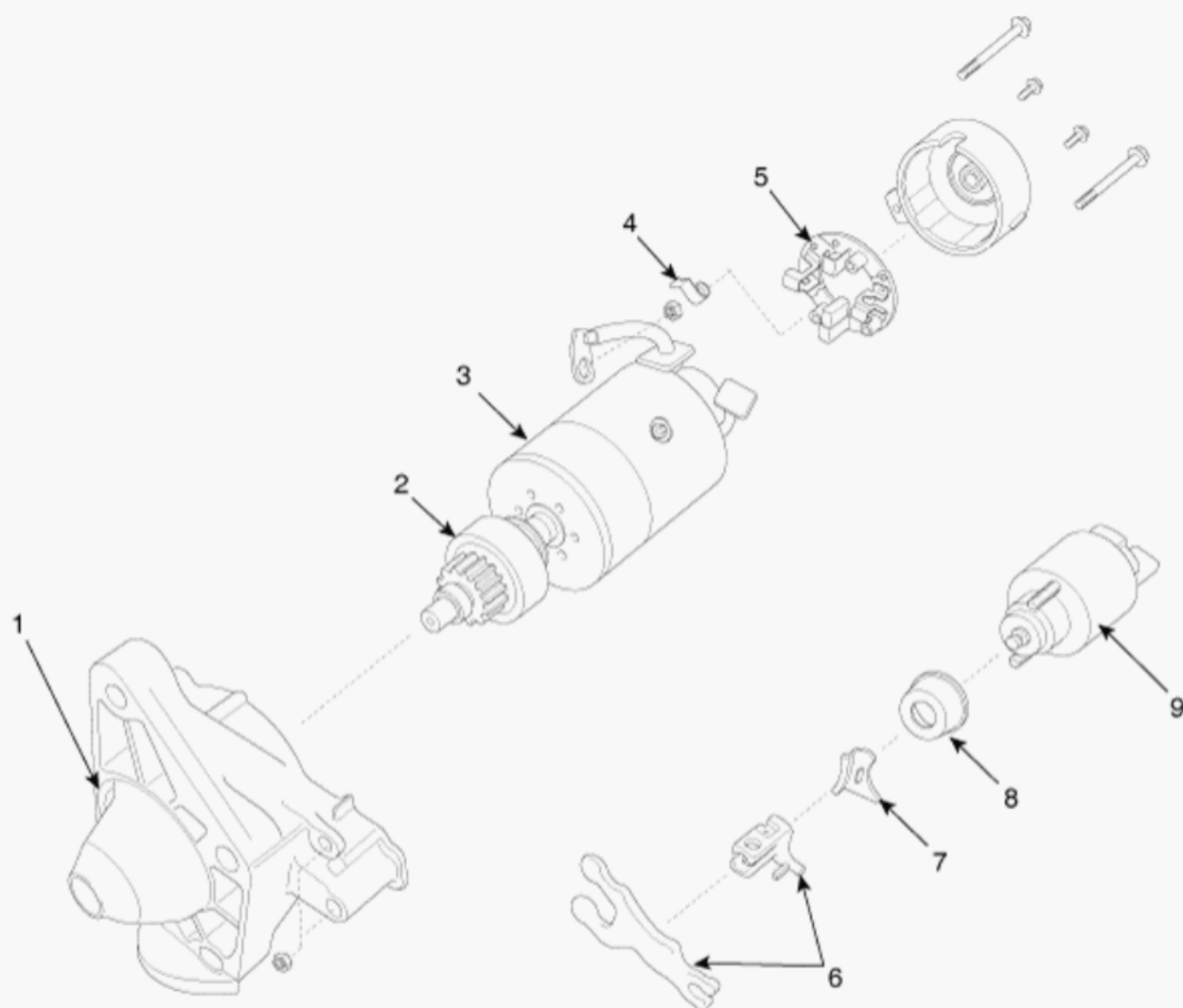
Current : Max.190 Amps

Speed : Min. 3,000 Rpm

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# Starter

## COMPONENT

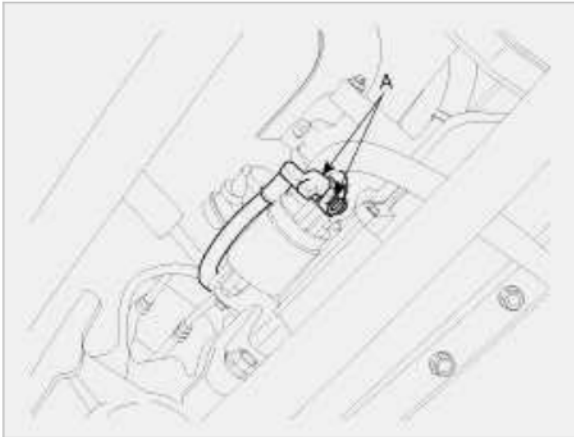


- |                               |                             |
|-------------------------------|-----------------------------|
| 1. Front bracket              | 6. Shift pork assembly      |
| 2. Overrun clutch assembly    | 7. Shim                     |
| 3. Yoke assembly and armature | 8. Dust cover               |
| 4. Spring brush               | 9. Magnetic switch assembly |
| 5. Brush holder assembly      |                             |



## REPLACEMENT

1. Disconnect the battery negative cable.
2. Remove the starter motor cable(A).



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.

# **Preheating System**



## INSPECT

Conditions before inspection :

Battery voltage : 12V

Cooling water temperature : Below 30°C (86°F)

(Disconnect the water temperature sensor connector).

### CAUTION

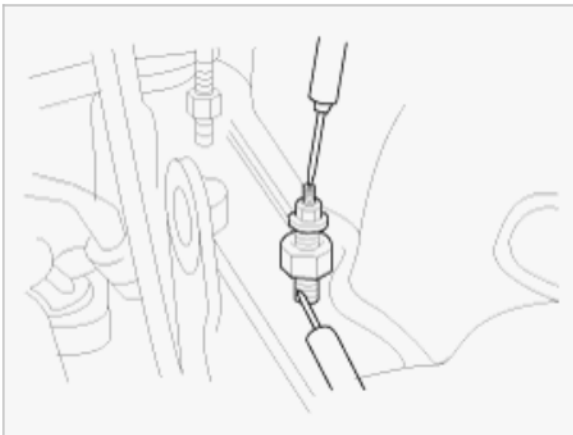
Reconnect the water temperature sensor connector after inspection.

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 (68.0°F)]

### NOTICE

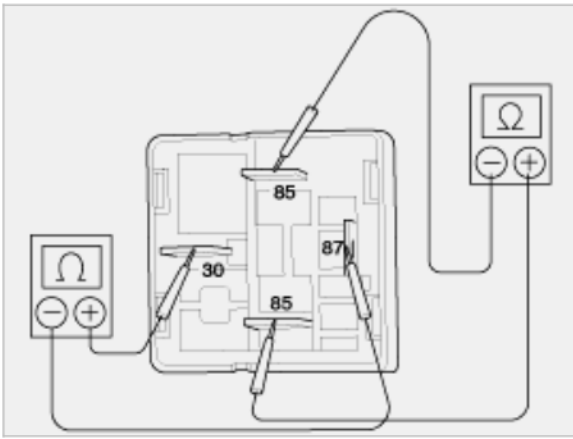
Continuity time varies depending upon cooling water temperature.

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 (68.0°F)]
6. When the voltage or continuity time is not normal, check the terminal voltage in glow control unit, and single parts.



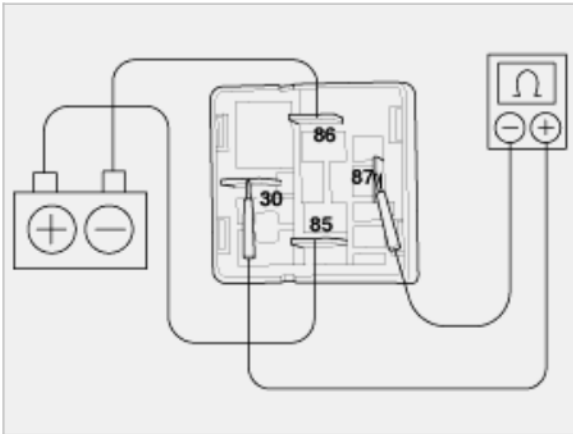
## GLOW PLUG RELAY

1. Remove the glow plug relay.
2. Inspect the relay continuity.
  - a. Using an ohmmeter, check that there is continuity between terminals 86 and 85.  
If there is no continuity, replace the relay.
  - b. Check that there is no continuity between terminals 87 and 30.  
If there is continuity, replace the relay.



3. Inspect the relay operation.

- a. Apply battery positive voltage across terminals 85 and 85.
- b. Using an ohmmeter, check that there is continuity between terminals 87 and 30.  
If there is no continuity, replace the relay.



4. Install the glow plug relay.