

OPTIMA(TF/QF) > 2013 > G 2.4 GDI > Engine Electrical System

Engine Electrical System > General Information > Specifications

Specifications

Ignition System

Items		Specifications
Ignition coil	Primary resistance	$0.62 \pm 10\%$ (Ω)
	Secondary resistance	$7.0 \pm 15\%$ ($k\Omega$)
Spark plugs	Type	FXU16HR11
	Gap	1.0 ~ 1.1 mm (0.0394 ~ 0.0433 in.)

Starting System

Items			Specifications
Starter	Rated voltage		12V, 1.2kW
	No. of pinion teeth		11
	No-load characteristics	Voltage	11.5V
		Ampere	105A, MAX
		Speed	2,950rpm, MIN

Charging System

Items			Specifications
Alternator	Type		Battery voltage sensing
	Rate voltage		13.5 V, 110A
	Speed in use		1,000 ~ 18,000 rpm
	Voltage regulator		IC regulator built-in type
	Regulator setting voltage	External mode	ECU control
		Internal mode	$14.55 \pm 0.3V$
	Temperature compensation	External mode	ECU control
		Internal mode	$-3.5 \pm 2mV / ^\circ C$
Battery	Type		56-26FL
	Cold cranking amperage [at $-18^\circ C (-0.4^\circ F)$]		600A
	Reserve capacity		113min
	Specific gravity [at $25^\circ C (77^\circ F)$]		1.280 ± 0.01

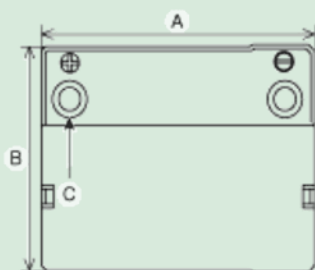
CAUTION

- 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.
- RESERVE CAPACITY RATING is amount of time a battery can deliver 25A and maintain a minimum terminal voltage of 10.5V at $26.7^\circ C (80.1^\circ F)$.

NOTE

Battery type notation : MF 4 8 - 2 3 G L
 ① ② ③ ④ ⑤

- ① : Battery type
 - MF : Maintenance Free
- ② : Battery capacity (5HR)
 - 48 : 48AH
- ③ : Battery length (A)
 - 23 : 230mm (9.06in)
- ④ : Battery width (B)
 - A : 127mm (5.00in)
 - B : 129mm (5.08in)
 - C : 132mm (5.20in)
 - D : 135mm (5.31in)
 - E : 154mm (6.06in)
 - F : 173mm (6.81in)
 - G : 175mm (6.89in)
 - H : 176mm (6.93in) or above
- ⑤ : Terminal location (C)
 - L : Positive terminal is left
 - R : Positive terminal is right



Engine Electrical System > General Information > Troubleshooting

Trouble Shooting

Ignition System

Symptom	Suspect area	Remedy
Engine will not start or is hard to start (Crank OK)	Ignition lock switch	Inspect ignition lock switch, or replace as required
	Ignition coil	Inspect ignition coil, or replace as required
	Spark plugs	Inspect spark plugs, or replace as required
	Ignition wiring disconnected or broken	Repair wiring, or replace as required
Rough idle or stalls	Ignition wiring	Repair wiring, or replace as required
	Ignition coil	Inspect ignition coil, or replace as required
Engine hesitates/poor acceleration	Spark plugs and spark plug cables	Inspect spark plugs / cable, or replace as required

	Ignition wiring	Repair wiring, or replace as required
Poor mileage	Spark plugs and spark plug cables	Inspect spark plugs / cable, or replace as required

Charging System

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

Starting System

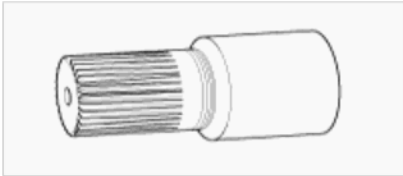
Symptom	Suspect area	Remedy
Engine will not crank	Battery charge low	Charge or replace battery
	Battery cables loose, corroded or worn out	Repair or replace cables
	Transaxle range switch (Vehicle with automatic transaxle only)	Refer to AT group-automatic transaxle
	Fuse blown	Replace fuse
	Starter faulty	Replace
	Ignition switch faulty	Replace
Engine cranks slowly	Battery charge low	Charge or replace battery
	Battery cables loose, corroded or worn out	Repair or replace cables
	Starter faulty	Replace
Starter keeps running	Starter	Replace
	Ignition switch	Replace
Starter spins but engine will not crank	Short in wiring	Repair wiring
	Pinion gear teeth broken or Starter	Replace

Ring gear teeth broken

Replace fly wheel or torque converter

Engine Electrical System > General Information > Special Service Tools

Special Service Tools

Tool (Number and name)	Illustration	Use
Alternator pulley remover wrench (09373-27000)		Removal and installation of alternator pulley

Engine Electrical System > Ignition System > Description and Operation

Description

Ignition timing is controlled by the electronic control ignition timing system. The standard reference ignition timing data for the engine operating conditions are preprogrammed in the memory of the ECM (Engine Control Module).

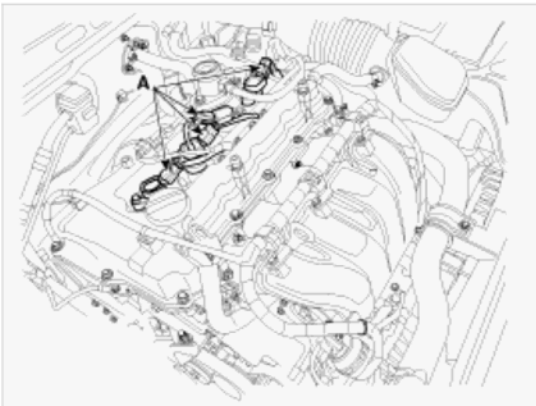
The engine operating conditions (speed, load, warm-up condition, etc.) are detected by the various sensors. Based on these sensor signals and the ignition timing data, signals to interrupt the primary current are sent to the ECM. The ignition coil is activated, and timing is controlled.

Engine Electrical System > Ignition System > Repair procedures

On-vehicle Inspection

Spark Test

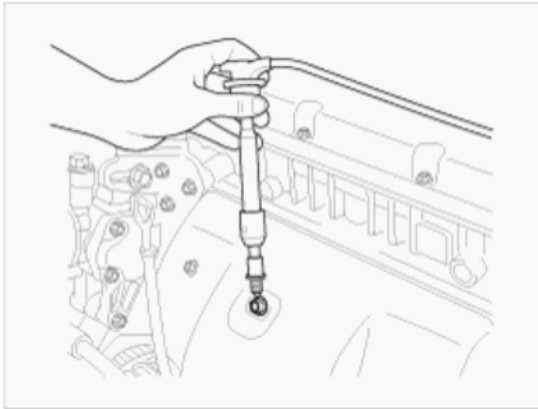
1. Disconnect the ignition coil connectors (A).



2. Remove the ignition coils (A).



3. Using a spark plug socket, remove the spark plug.
4. Install the spark plug to the ignition coil.
5. Ground the spark plug to the engine.

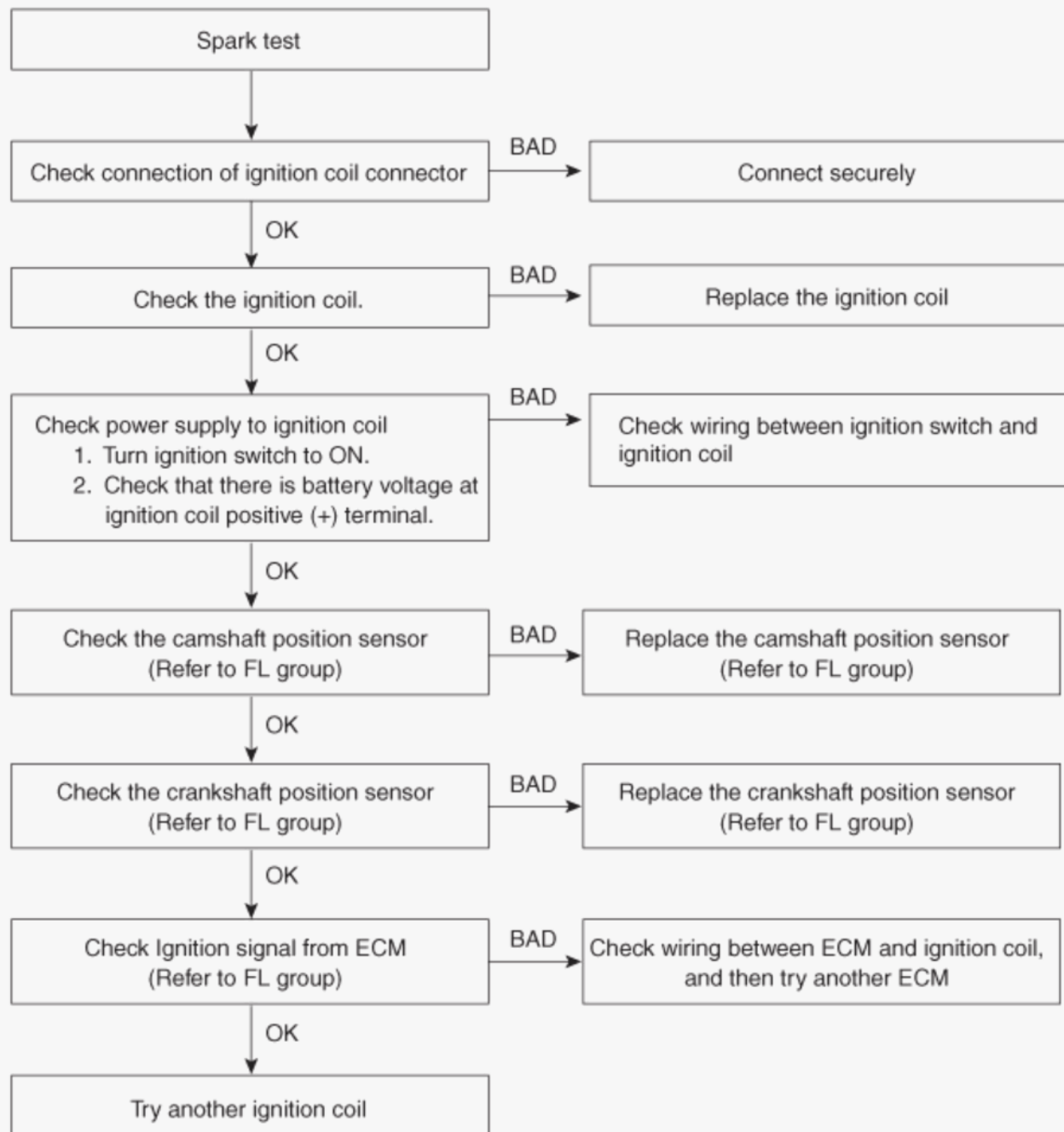


6. Check if spark occurs while engine is being cranked.

NOTE

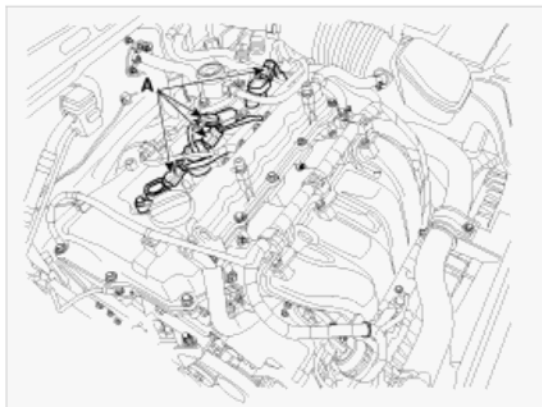
To prevent fuel being injected from injectors while the engine is being cranked, disconnect the injector connector. Crank the engine for no more than 5 ~ 10 seconds.

7. Inspect all the spark plugs.
8. Using a spark plug socket, install the spark plug.
9. Install the ignition coil.
10. Reconnect the ignition coil connector.



Inspect Spark Plug

1. Disconnect the ignition coil connectors (A).



2. Remove the ignition coils (A).

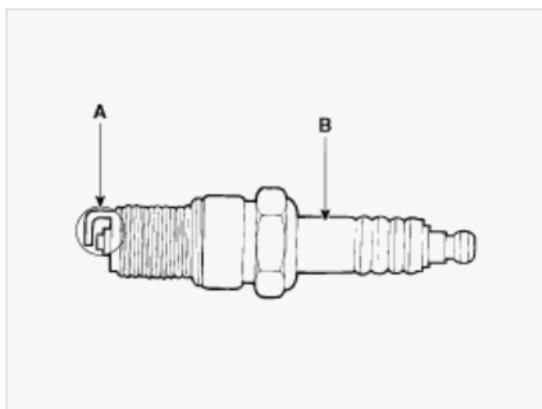


3. Using a spark plug socket, remove the spark plug.

CAUTION

Be careful that no contaminants enter through the spark plug holes.

4. Inspect the electrodes (A) and ceramic insulator (B).



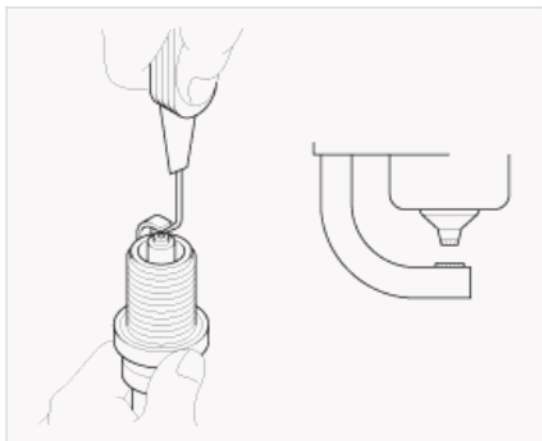
Inspection Of Electrodes

Condition	Dark deposits	White deposits
Description	- Fuel mixture too rich - Low air intake	- Fuel mixture too lean - Advanced ignition timing - Insufficient plug tightening torque

5. Check the electrode gap (A).

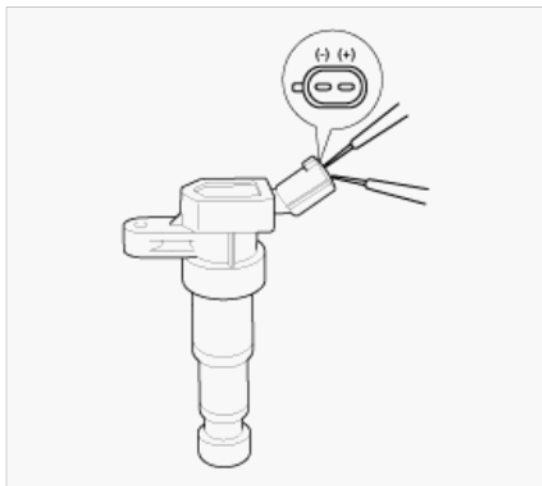
Standard

Unleaded : 1.0 ~ 1.1 mm (0.0394 ~ 0.0433 in.)



Inspect Ignition Coil

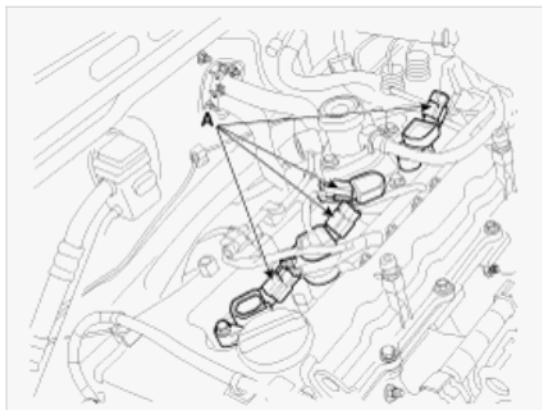
1. Measure the primary coil resistance between terminals (+) and (-).



Standard value: $0.62\Omega \pm 10\%$

Removal and Installation

1. Disconnect the ignition coil connectors (A).



2. Remove the ignition coils (A).

Tightening torque :

3.9 ~ 5.9N.m (0.4 ~ 0.6kgf.m, 2.9 ~ 4.3lb-ft)



3. Installation is the reverse of removal.

Engine Electrical System > Charging System > Description and Operation

Description

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

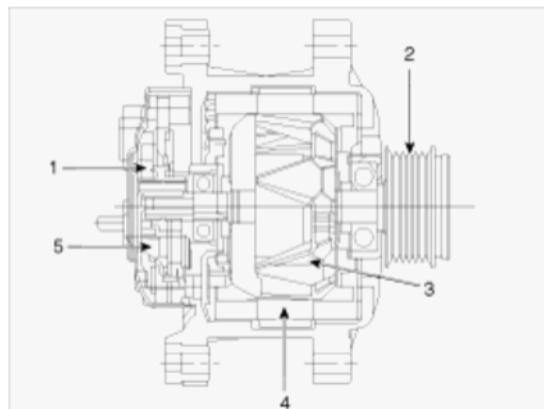
The Alternator has built-in diodes, each rectifying AC current to DC current.

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

In addition, the charging voltage of this alternator is regulated by the battery voltage detection system.

The main components of the alternator are the rotor, stator, rectifier, capacitor brushes, bearings and V-ribbed belt pulley.

The brush holder contains a built-in electronic voltage regulator.



1. Brush
2. Drive belt pulley
3. Rotor
4. Stator
5. Rectifier

Alternator Management System

Alternator management system controls the charging voltage set point in order to improve fuel economy, manage alternator load under various operating conditions, keep the battery charged, and protect the battery from over-charging. ECM controls generating voltage by duty cycle (charging control, discharging control, normal control) based on the battery conditions and vehicle operating conditions.

.The system conducts discharging control when accelerating a vehicle. Vehicle reduces an alternator load and consumes electric power from the battery.

The system conducts charging control when decelerating a vehicle. Vehicle increases an alternator load and charges a battery.

Engine Electrical System > Charging System > Repair procedures

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 The Battery Terminals And Fuses

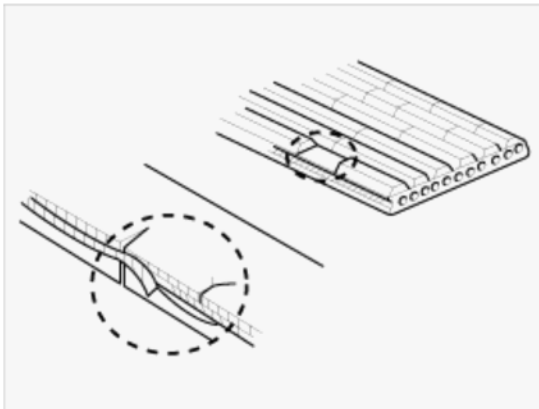
1. Check that the battery terminals are not loose or corroded.
2. Check the fuses for continuity.

Inspect Drive Belt

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

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.



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

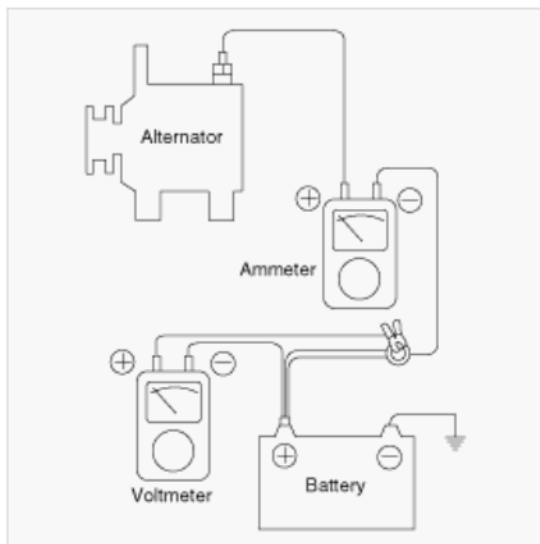
1. Warm up the engine and then turn it off.
2. Turn off all accessories.
3. Turn the ignition switch "ON". Check that the discharge warning light is lit.
4. Start the engine and Check that the light goes off.
If the light does not go off as specified, troubleshoot the discharge light circuit.

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.

Standard value: 0.2V max

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.

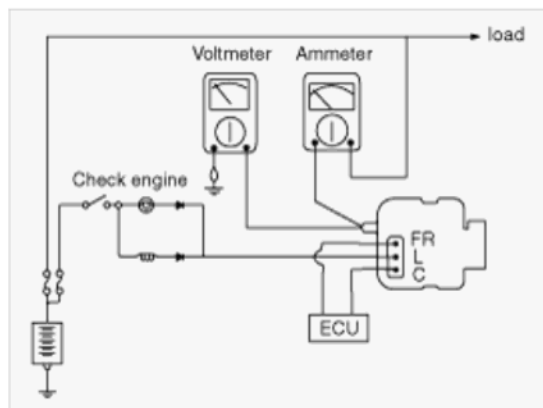
Preparation

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 in 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.
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.

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.



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.

NOTE

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.

Limit value : 60% of the voltage rate

NOTE

- The output current value changes with the electrical load and the temperature of the alternator itself. Due to temperature the maximum output current may not be obtained. If such is the case, keep the headlamps on 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.

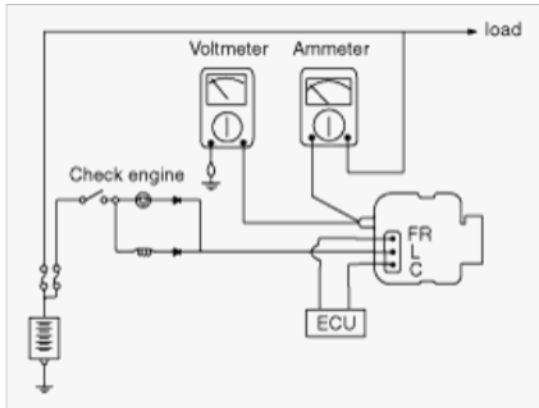
2. Upon completion of the output current test, lower the engine speed to idle and turn off the ignition switch.
3. Disconnect the battery ground cable.
4. Remove the ammeter and voltmeter and the engine tachometer.
5. Connect the alternator output wire to the alternator "B" terminal.
6. Connect the battery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



Test

1. 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.

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

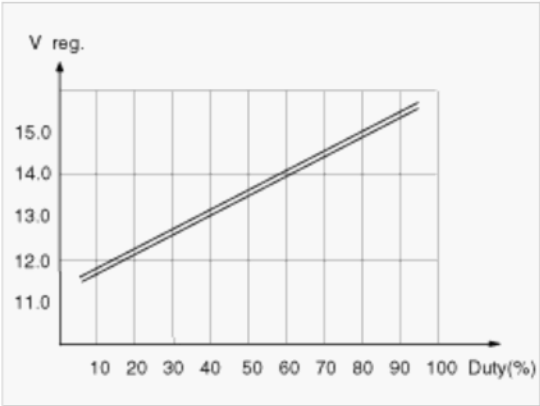
Result

1. If the voltmeter reading doesn't agree with the standard value, the voltage regulator or the alternator is faulty.
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.

Regulating Voltage Table (Internal mode)

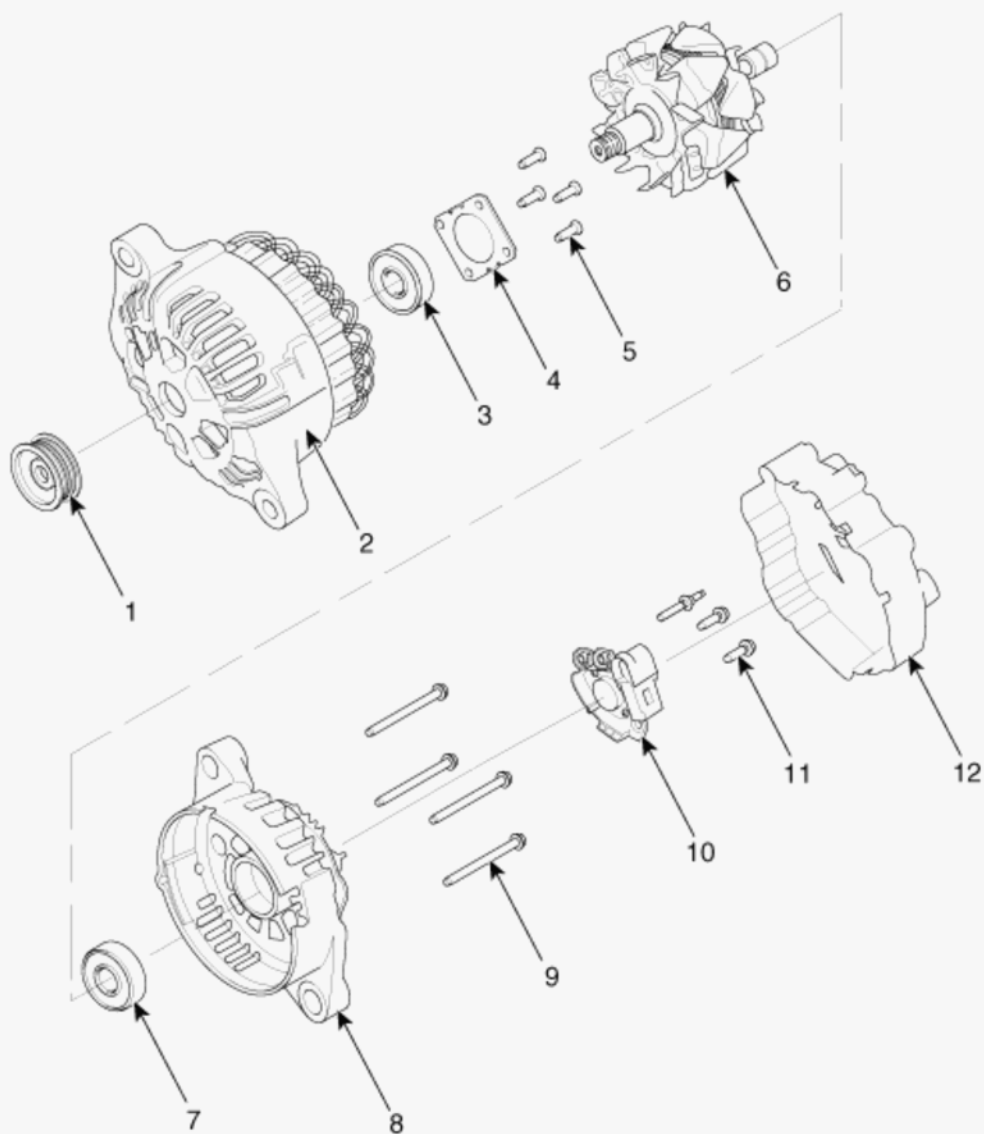
Voltage regulator ambient temperature °C (°F)	Regulating voltage (V)
-30 (-22)	14.1 ~ 15.0
25 (77)	14.0 ~ 14.7
130 (266)	13.5 ~ 14.6

Regulating Voltage Table (External mode)



Engine Electrical System > Charging System > Alternator > Components and Components Location

Components



1. Pulley
2. Front bracket
3. Front bearing
4. Bearing cover
5. Bearing cover bolt
6. Rotor

7. Rear bearing
8. Rear bracket
9. Through bolt
10. Brush holder assembly
11. Brush holder bolt
12. Rear cover

Engine Electrical System > Charging System > Alternator > Repair procedures

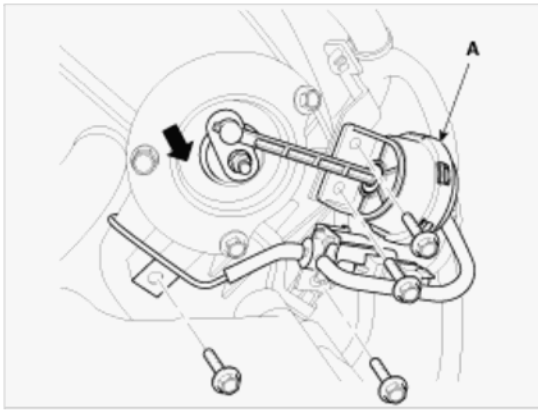
Removal and Installation

1. Disconnect the battery negative terminal first, then the positive terminal.

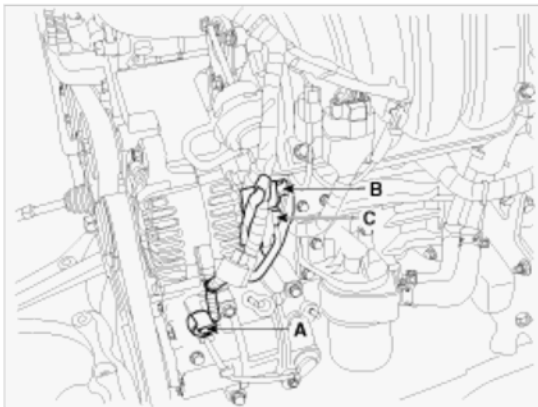
Tightening torque :

- (+) terminal : 7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
 (-) terminal : 4.0 ~ 6.0N.m (0.4 ~ 0.6kgf.m, 3.0 ~ 4.4lb-ft)

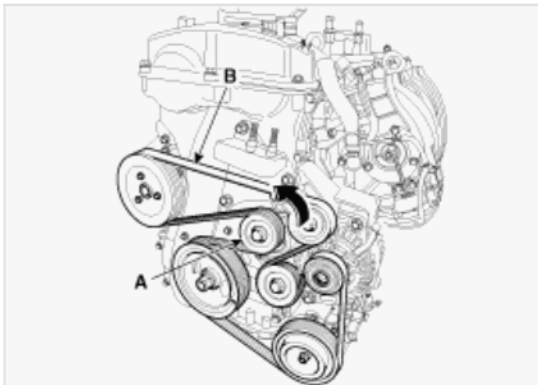
2. Remove the VIS (Variable intake system) actuator and valve (A).



3. Disconnect the A/C compressor switch connector (A) the alternator connector (B), and the cable from alternator "B" terminal (C).



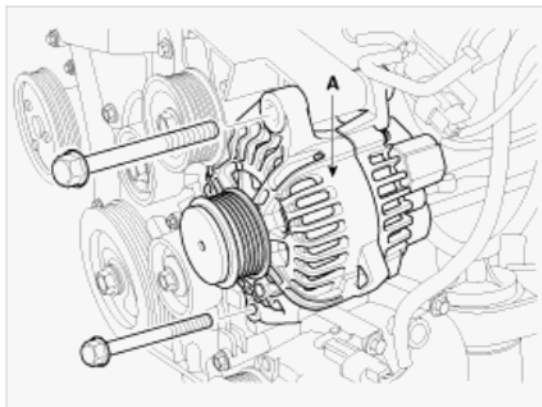
4. Remove the drive belt (B) after turning the drive belt tensioner (A) counterclockwise.



5. Pull out the through bolt and then remove the alternator (A).

Tightening torque :

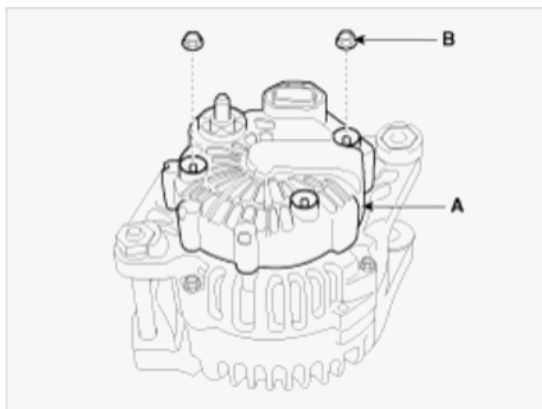
49.0 ~ 63.7N.m (5.0 ~ 6.5kgf.m, 36.2 ~ 47.0lb-ft)



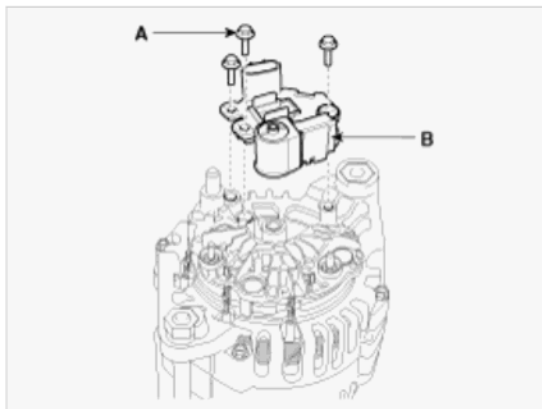
6. Installation is the reverse order of removal.

Disassembly

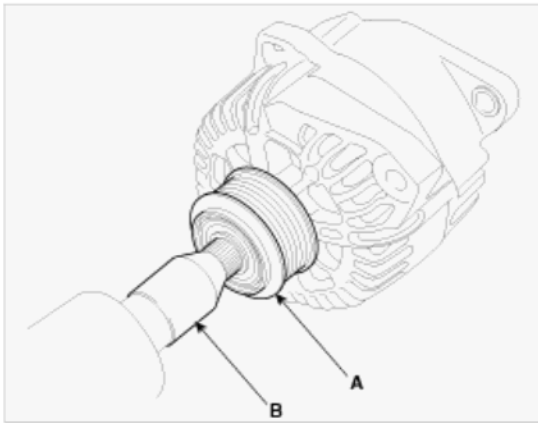
1. Remove the alternator cover (A) using a screw driver after loosening the nuts (B).



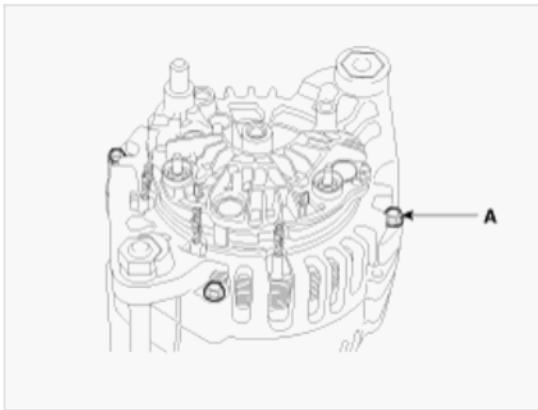
2. Loosen the mounting bolts (A) and disconnect the brush holder assembly (B).



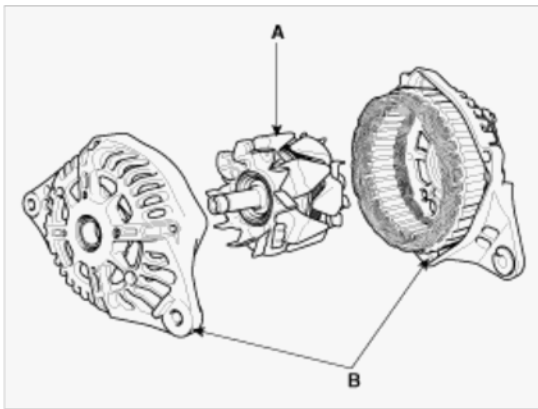
3. Remove the pulley (A) using the SST (09373-27000) (B).



4. Loosen the 4 through bolts (A).



5. Disconnect the rotor (A) and cover (B).

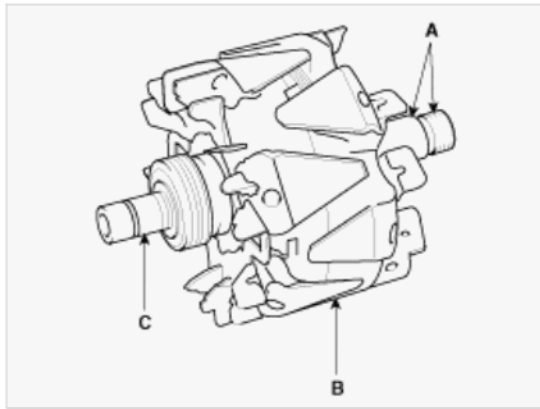


6. Reassembly is the reverse order of disassembly.

Inspection

Inspect Rotor

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



2. Check that there is no continuity between the slip rings and the rotor (B) or rotor shaft (A).
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).

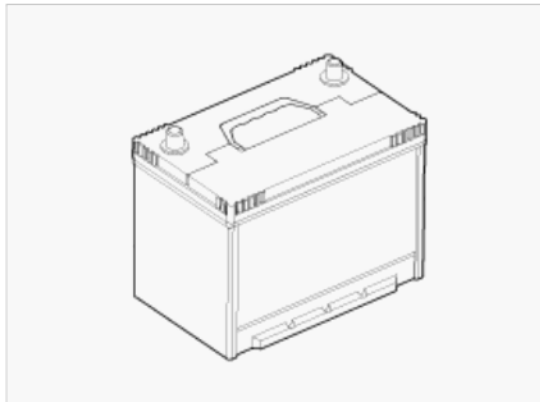


2. Check that there is no continuity between each lead and the coil core.
3. If the coil fails either continuity check, replace the alternator.

Engine Electrical System > Charging System > Battery > Description and Operation

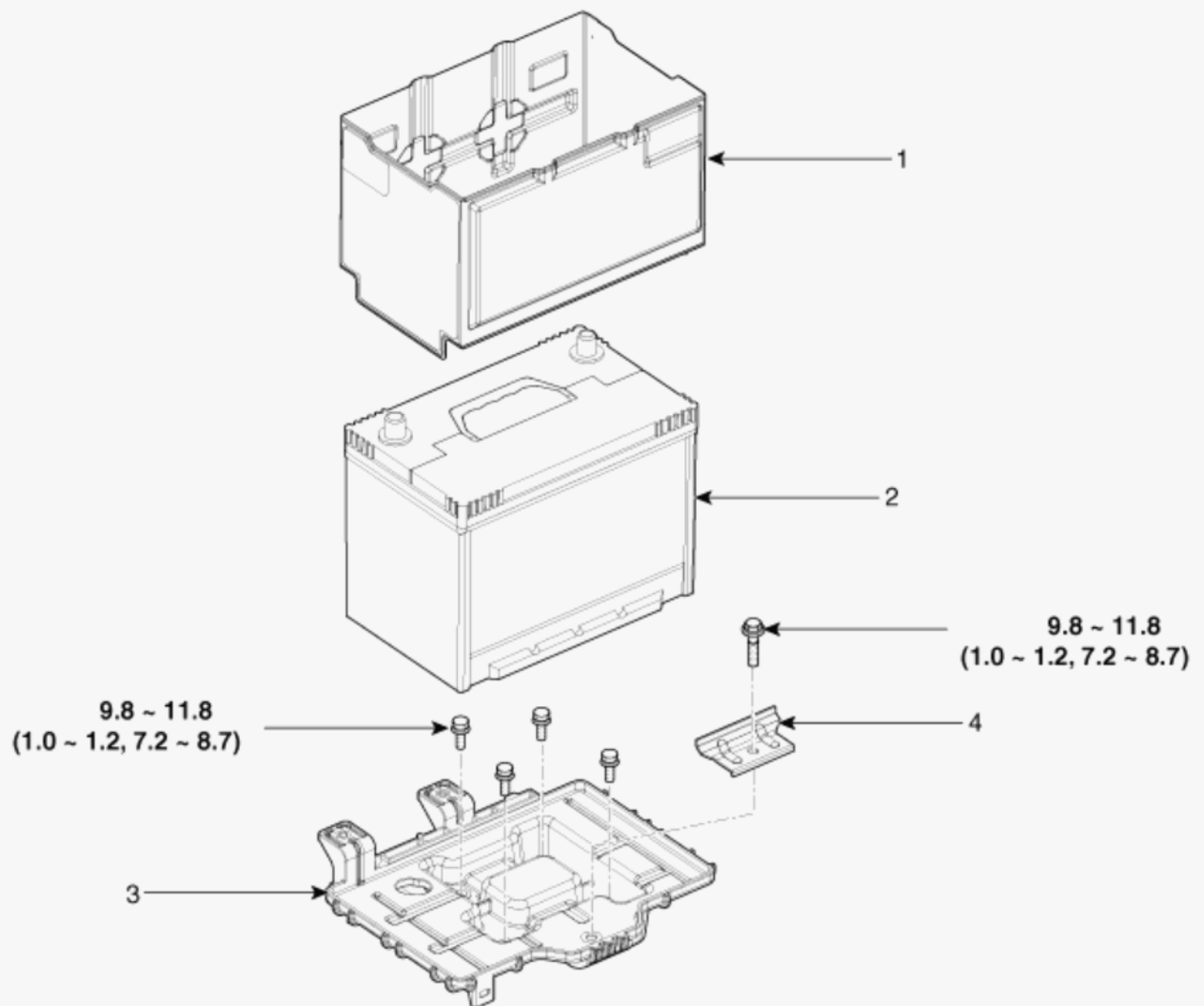
Description

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.



NOTE

After disconnecting then reconnecting the battery negative cable, reset some parts that require the reset procedures. (Refer to BE group - General Information)

Engine Electrical System > Charging System > Battery > Components and Components Location**Components**

Torque : N.m (kgf.m, lb-ft)

1. Battery insulation pad
2. Battery

3. Battery tray
4. Battery mounting bracket

Removal and Installation

1. Remove the air duct (A).
2. Disconnect the terminals (B) from the battery. The negative terminal first.

Tightening torque :

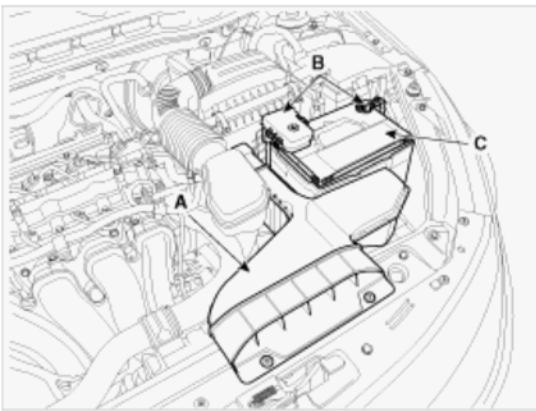
(+) terminal (A) : 7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)

(-) terminal (B) : 4.0 ~ 6.0N.m (0.4 ~ 0.6kgf.m, 3.0 ~ 4.4lb-ft)

3. Remove the battery insulation pad.
4. Remove the battery mounting bracket by loosening the mounting bolt and then remove the battery (C).

Tightening torque :

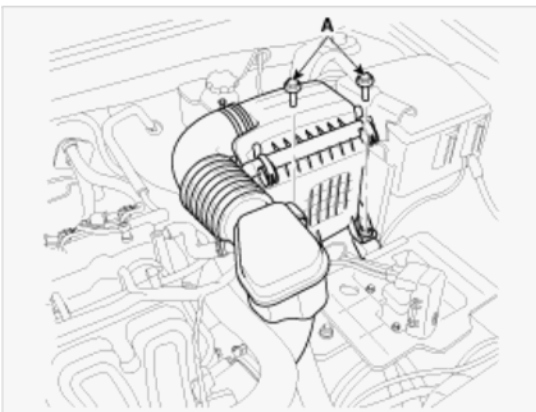
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



5. Remove the air cleaner assembly mounting bolts (A).

Tightening torque :

7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)



6. Disconnect the front connector (A) and then remove the battery tray (B).

Tightening torque :

9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



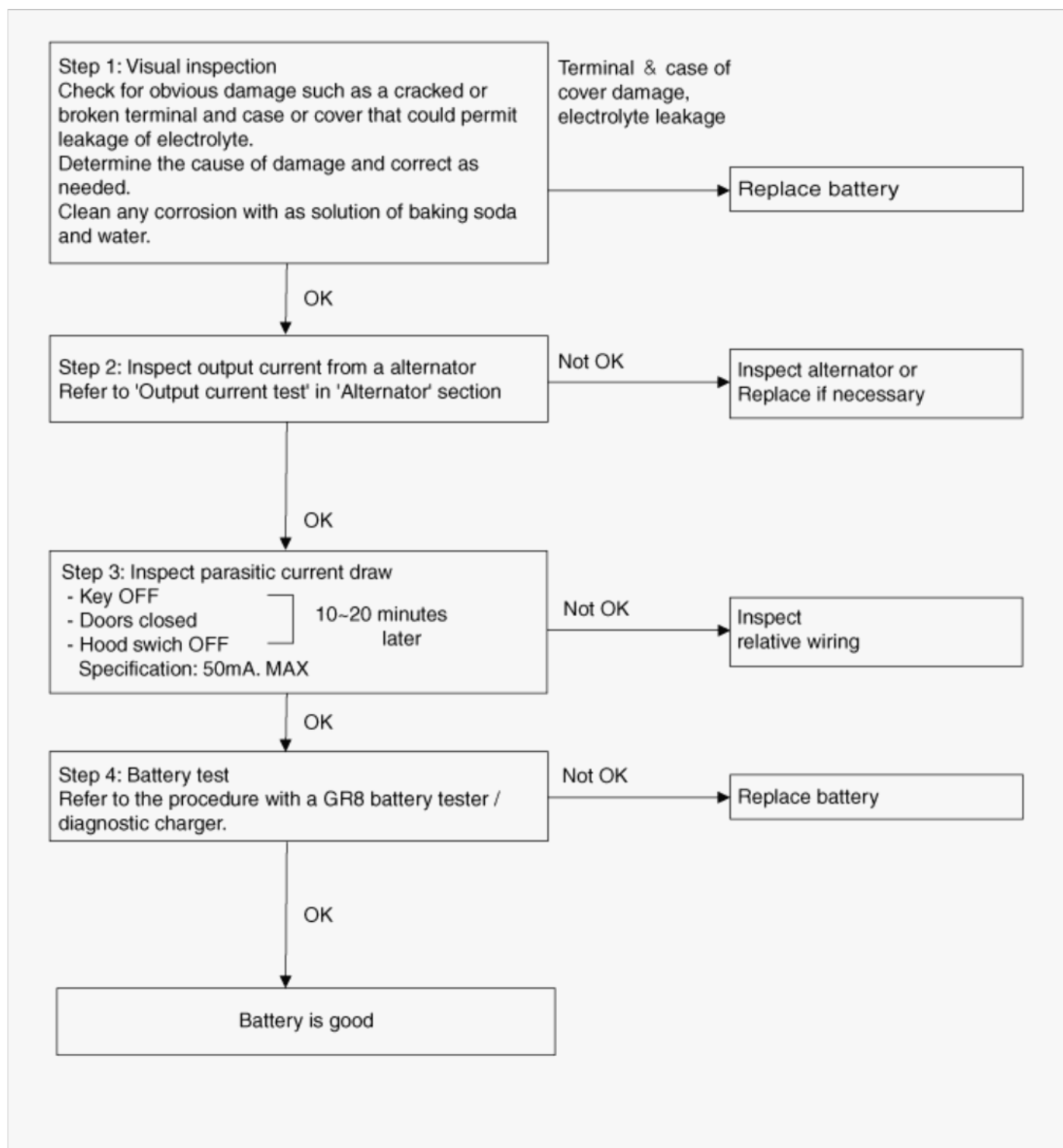
7. Installation is the reverse order of removal.

CAUTION

When installing the battery, fix the mounting bracket on the tray correctly.

Inspection

Battery Diagnostic Flow



Vehicle parasitic current inspection

1. Turn the all electric devices OFF, and then turn the ignition switch OFF.
2. Close all doors except the engine hood, and then lock all doors.
 - (1) Disconnect the hood switch connector.
 - (2) Close the trunk lid.
 - (3) Close the doors or remove the door switches.
3. Wait a few minutes until the vehicle's electrical systems go to sleep mode.

NOTE

For an accurate measurement of a vehicle parasitic current, all electrical systems should go to sleep mode. (It takes at least one hour or at most one day.) However, an approximate vehicle parasitic current can be measured after 10~20 minutes.

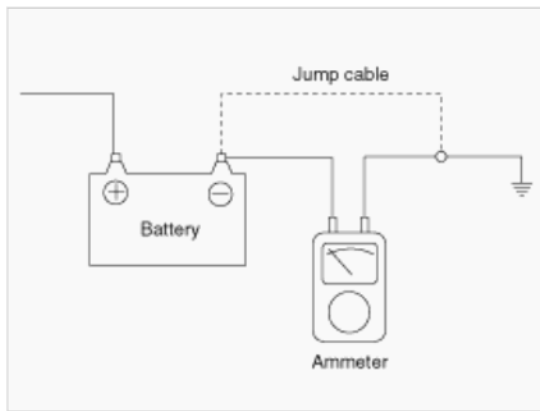
4. Connect an ammeter in series between the battery (-) terminal and the ground cable, and then disconnect the clamp from the battery (-) terminal slowly.

CAUTION

Be careful that the lead wires of an ammeter do not come off from the battery (-) terminal and the ground cable to prevent the battery from being reset. In case the battery is reset, connect the battery cable again, and then start the engine or turn the ignition switch ON for more than 10 sec. Repeat the procedure from No. 1.

To prevent the battery from being reset during the inspection,

- 1) Connect a jump cable between the battery (-) terminal and the ground cable.
- 2) Disconnect the ground cable from the battery (-) terminal.
- 3) Connect an ammeter between the battery (-) terminal and the ground cable.
- 4) After disconnecting the jump cable, read the current value of the ammeter.



5. Read the current value of the ammeter.
 - A. If the parasitic current is over the limit value, search for abnormal circuit by removing a fuse one by one and checking the parasitic current.
 - B. Check the parasitic current again, and search for suspected unit by removing a unit connected with the abnormal circuit one by one.

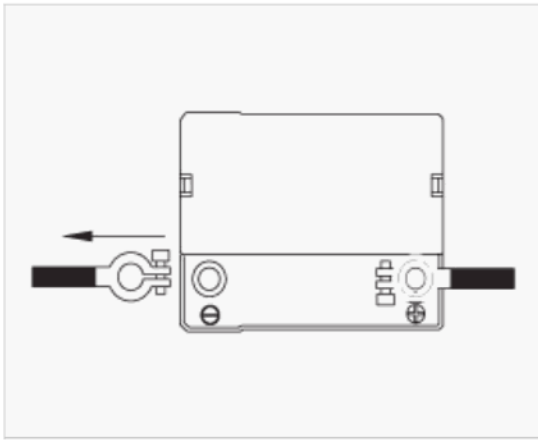
Limit value (after 10~20 min.) : Below 50mA

Cleaning

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.



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

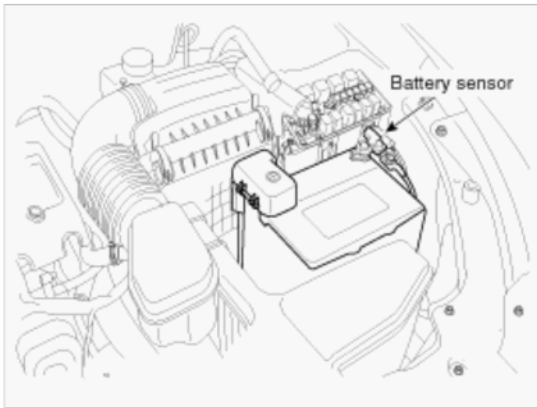
When batteries are being charged, an explosive gas forms beneath the cover of each cell. Do not smoke near batteries being charged or which have recently been charged. Do not break live circuit at the terminals of batteries being charged.

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

Engine Electrical System > Charging System > Battery Sensor > Description and Operation

Description

Vehicles have many control units that use more electricity. These units control their own system based on information from diverse sensors. It is important to have a stable power supply as there diverse sensors giving a variety of information. Battery sensor is mounted on battery (-) terminal. It transmits battery voltage, current, temperature information to ECM. ECM controls generating voltage by duty cycle based on these signals.



CAUTION

When battery sensor signal fault occurs, inspect the vehicle parasitic draw in advance after inspecting the sensor because the sensor will behave abnormally when the parasitic draw is more than 100mA. (Refer to vehicle parasitic current inspection)

NOTE

Perform the following process after replacing the battery sensor.

1. Ignition switch ON/OFF.
2. Park the vehicle about 4 hours.
3. After 4 hours later, check the SOC (State of charge) of battery using GDS.

CAUTION

For the vehicle equipped with a battery sensor, be careful not to damage the battery sensor when the battery is replaced or recharged.

1. When replacing the battery, it should be same one (type, capacity and brand) that is originally installed on your vehicle. If a battery of a different type is replaced, the battery sensor may recognize the battery to be abnormal.
2. When installing the ground cable on the negative post of battery, tighten the clamp with specified torque of 4.0~6.0N.m (0.4~0.6kgf.m, 3.0~4.4lb-ft). An excessive tightening torque can damage the PCB internal circuit and the battery terminal.
3. When recharging the battery, ground the negative terminal of the booster battery to the vehicle body. If the negative cable from a battery charger is connected to the negative terminal of the battery, the battery sensor can make an error. In this case, repeat the above process for battery sensor replacement (1~3) after disconnecting and reconnecting the battery connector.

Engine Electrical System > Starting System > Description and Operation

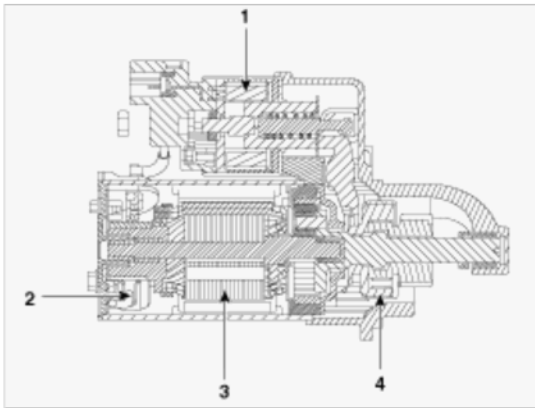
Description

The starting system includes the battery, starter, solenoid switch, ignition switch, inhibitor switch (A/T), clutch pedal switch (M/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.



- 1.Solenoid
- 2.Brush assembly
- 3.Armature
- 4.Overrun clutch

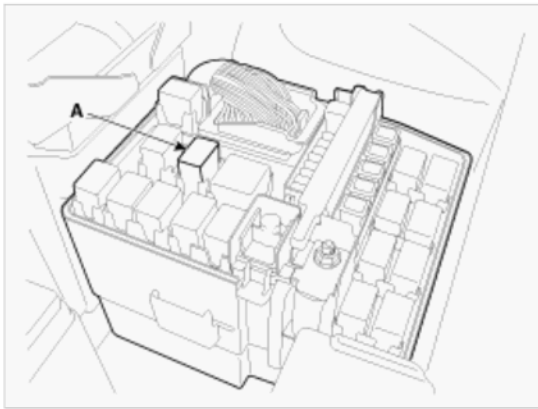
Engine Electrical System > Starting System > Repair procedures

Starter Circuit Troubleshooting

NOTE

The battery must be in good condition and fully charged.

1. Disconnect the fuel pump relay (A) in the fuse box.

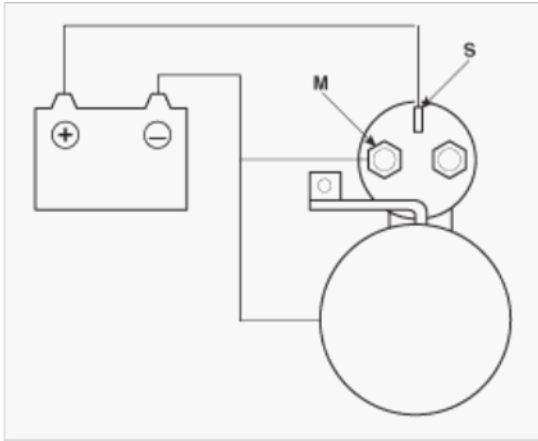


2. With the shift lever in N or P (A/T) or clutch pedal pressed (M/T), turn the ignition switch to "START"
If the starter normally cranks the engine, starting system is OK. If the starter will not crank the engine at all, go to next step.
If it won't disengage from the ring gear when you release key, check for the following until you find the cause.
 - A. Solenoid plunger and switch malfunction.
 - B. Dirty pinion gear or damaged overrunning clutch.
3. 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.
4. 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.

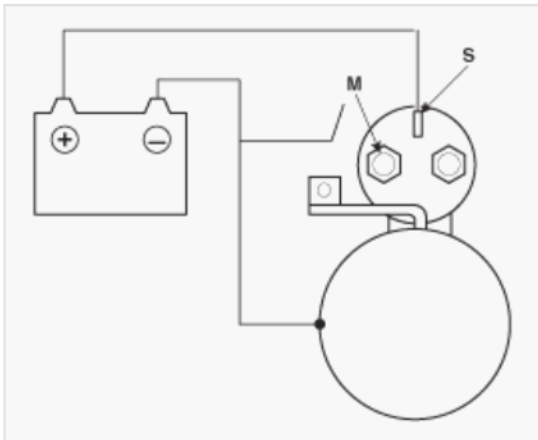
5. Check the following items in the order listed until you find the open circuit.
 - A. Check the wire and connectors between the driver's under-dash fuse/relay box and the ignition switch, and between the driver's under-dash fuse/relay box and the starter.
 - B. Check the ignition switch (Refer to BE group - Ignition System)
 - C. Check the transaxle range switch (A/T), clutch pedal switch (M/T), ignition lock switch and their connections.
 - D. Inspect the starter relay.

Starter Solenoid Test

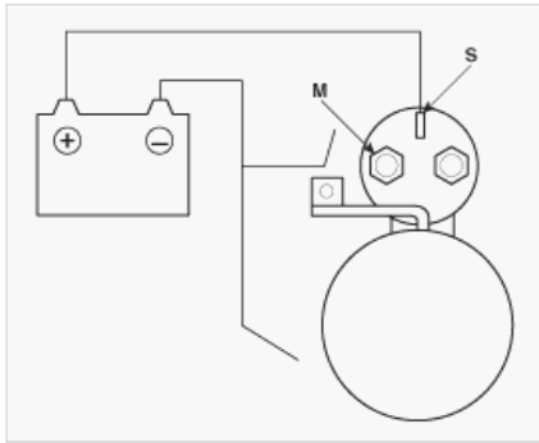
1. Disconnect the field coil wire from the M-terminal of solenoid switch.
2. Connect the battery as shown. If the starter pinion pops out, it is working properly. To avoid damaging the starter, do not leave the battery connected for more than 10 seconds.



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.

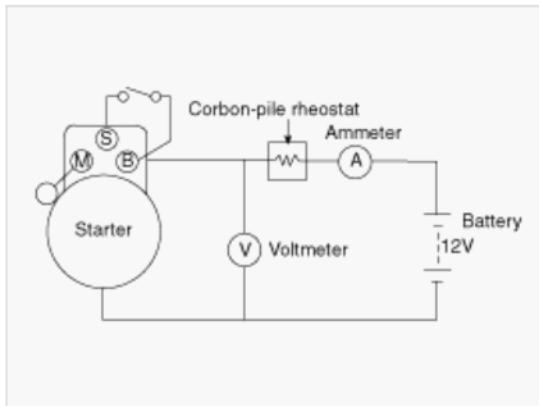


4. Disconnect the battery also from the body. If the pinion retracts immediately, it is working properly. To avoid damaging the starter, do not leave the battery connected for more than 10 seconds.



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 (150-ampere scale) and carbon pile rheostats as shown in the illustration.
3. Connect a voltmeter (15-volt scale) across starter motor.



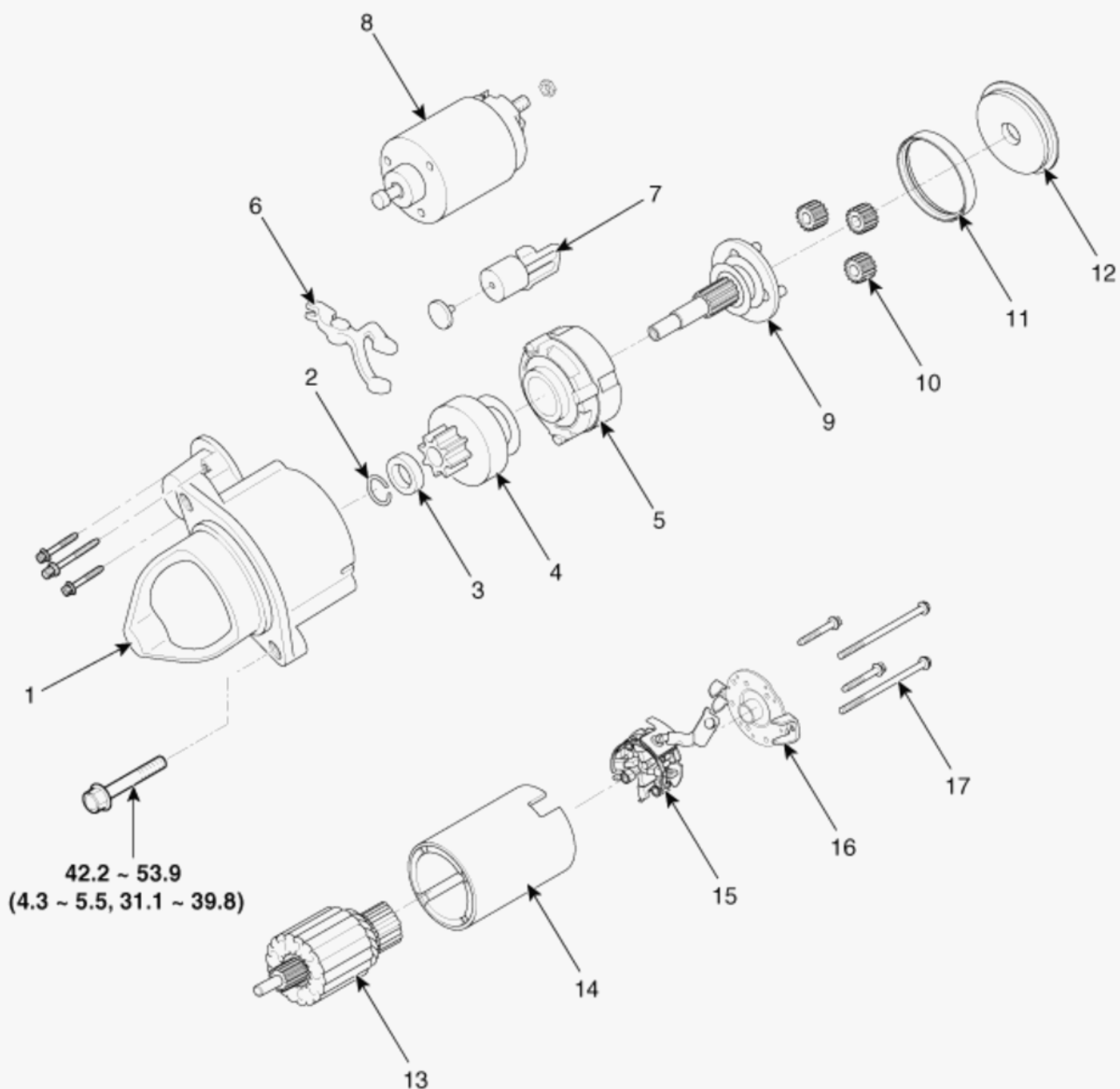
4. Rotate carbon pile to the off position.
5. Connect the battery cable from battery's negative post to the starter motor body.
6. Adjust until battery voltage shown on the voltmeter reads 11.5volts.
7. Confirm that the maximum amperage is within the specifications and that the starter motor turns smoothly and freely.

Current : 105A, MAX

Speed : 2,950 rpm, MIN

Engine Electrical System > Starting System > Starter > Components and Components Location

Components



Torque : N.m (kgf.m, lb-ft)

1. Front bracket	7. Lever packing	13. Armature assembly
2. Stop ring	8. Magnet switch assembly	14. Yoke assembly
3. Stopper	9. Planet shaft assembly	15. Brush holder assembly
4. Overrun clutch assembly	10. Planetary gear assembly	16. Rear bracket
5. Internal gear assembly	11. Packing	17. Through bolt
6. Lever	12. Shield	

Engine Electrical System > Starting System > Starter > Repair procedures

Removal and Installation

1. Disconnect the battery negative terminal.

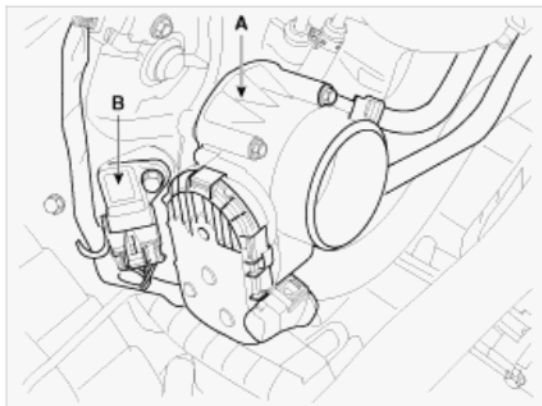
Tightening torque :

4.0 ~ 6.0N.m (0.4 ~ 0.6kgf.m, 3.0 ~ 4.4lb-ft)

2. Remove the engine cover and the air cleaner assembly. (Refer to EM group)
3. Remove the under cover. (Refer to EM group)
4. Remove the ETC (Electronic throttle control) module (A) and MAPS (Manifold absolute pressure sensor & IATS (Intake air temperature sensor) (B).

Tightening torque:

9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



5. Remove the intake manifold stay (A).

Tightening torque:

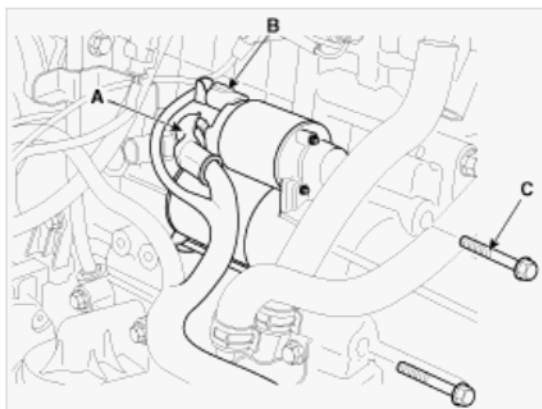
18.6 ~ 23.5 N.m (1.9 ~ 2.4 kgf.m, 13.7 ~ 17.4 lb-ft)



6. Disconnect the starter cable (A) from the B terminal on the solenoid, then disconnect the connector (B) from the S terminal.
7. Remove the 2 bolts (C) holding the starter, then remove the starter.

Tightening torque :

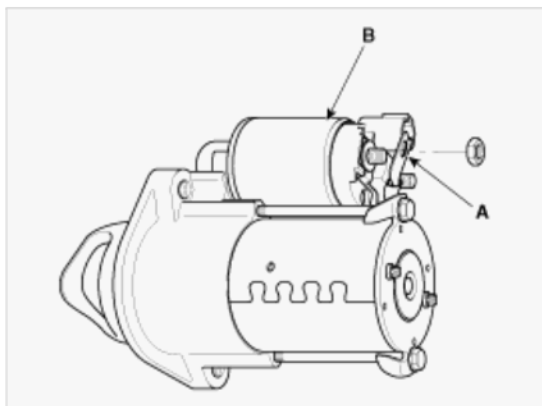
42.2 ~ 53.9N.m (4.3 ~ 5.5kgf.m, 31.1 ~ 39.8lb-ft)



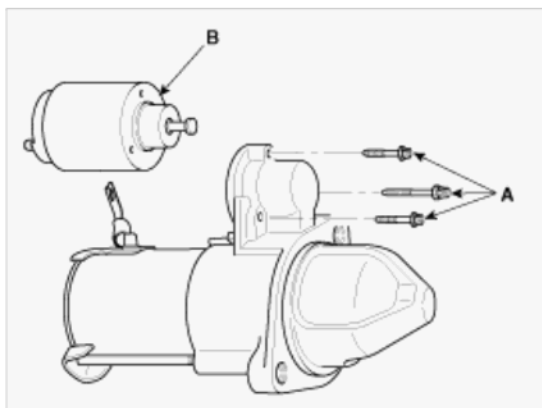
8. Installation is the reverse of removal.

Disassembly

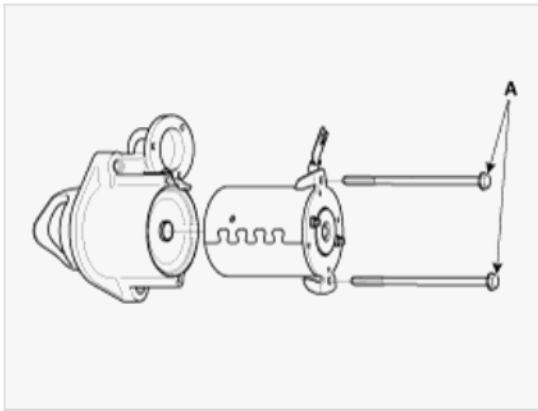
1. Disconnect the M-terminal (A) on the magnet switch assembly (B).



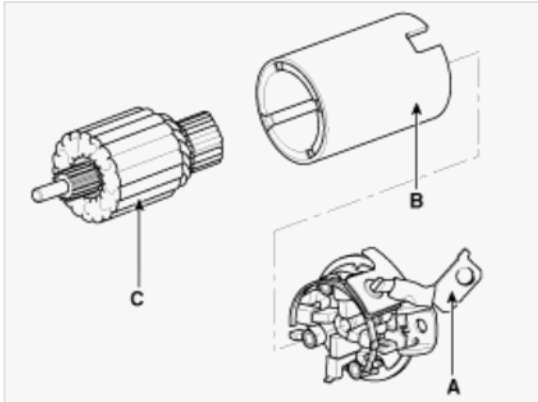
2. After loosening the screws (A), detach the magnet switch assembly (B).



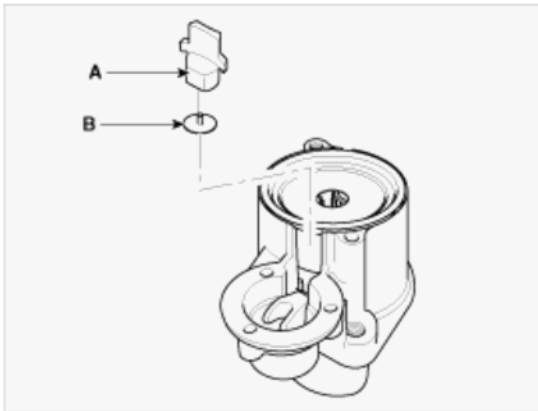
3. Loosen the through bolts (A).



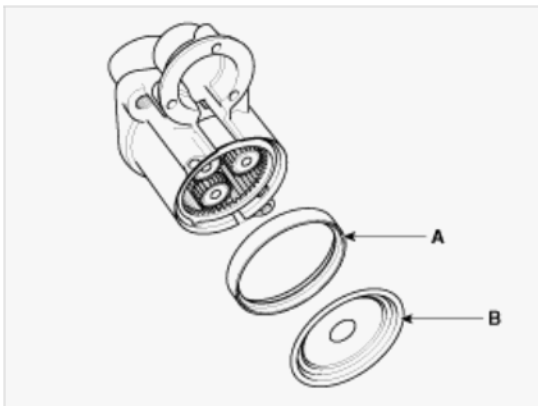
4. Remove the brush holder assembly (A), yoke (B) and armature (C).



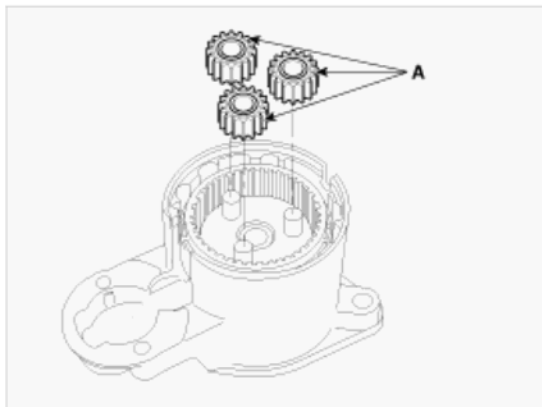
5. Remove the lever plate (B) and lever packing (A).



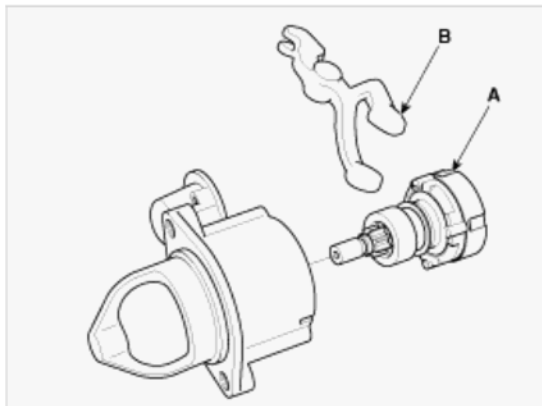
6. Remove the packing (A) and shield (B).



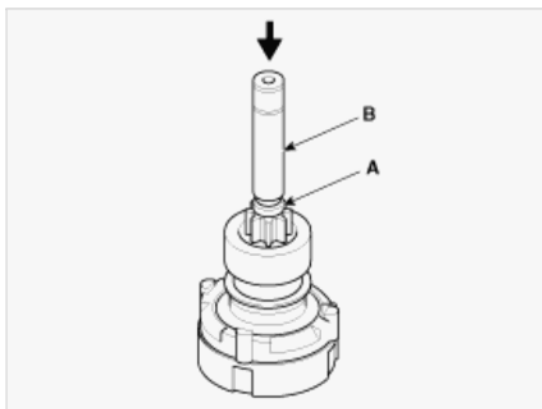
7. Disconnect the planet gear (A).



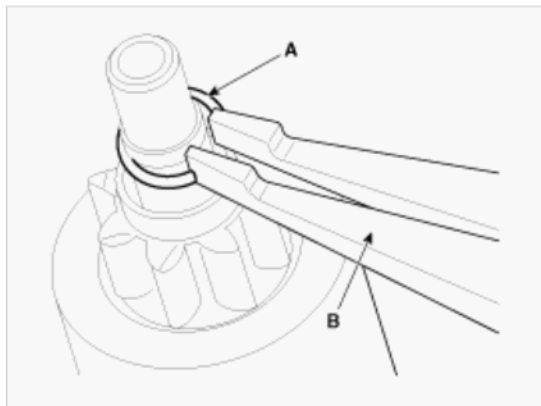
8. Disconnect the planet shaft assembly (or reducer assembly) (A) and lever (B).



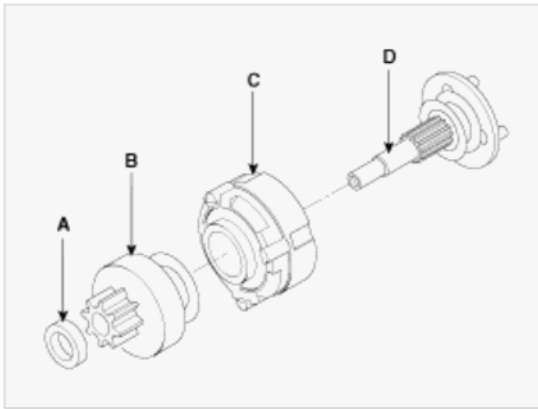
9. Press the stopper (A) using a socket (B).



10. After removing the stop ring (A) using stop ring pliers (B).

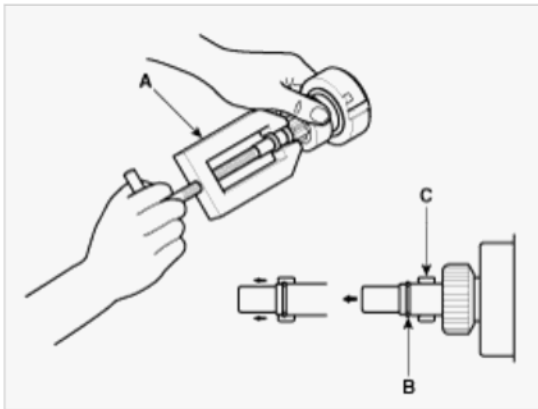


11. Disconnect the stopper (A), overrunning clutch (B), internal gear (C), planet shaft (or drive shaft) (D).



NOTE

Using a suitable pulling tool (A), pull the overrunning clutch stopper (C) over the stop ring (B).

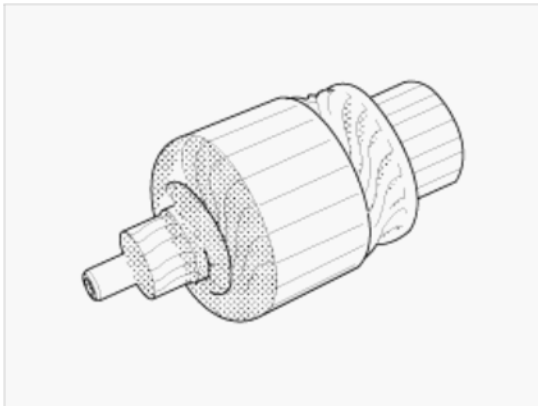


12. Reassembly is the reverse of disassembly.

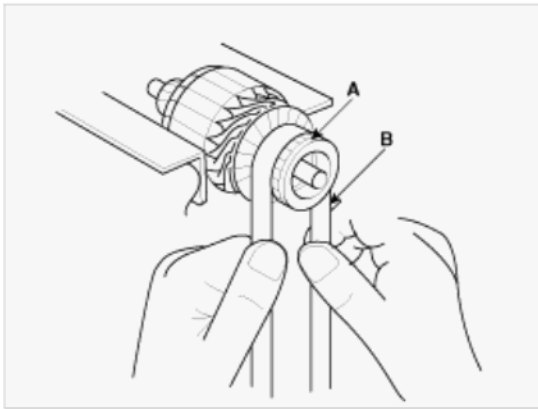
Inspection

Armature Inspection And Test

1. Remove the starter.
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.



4. Check the commutator (A) surface. If the surface is dirty or burnt, resurface with emery cloth or a lathe within the following specifications, or recondition with #500 or #600 sandpaper (B).



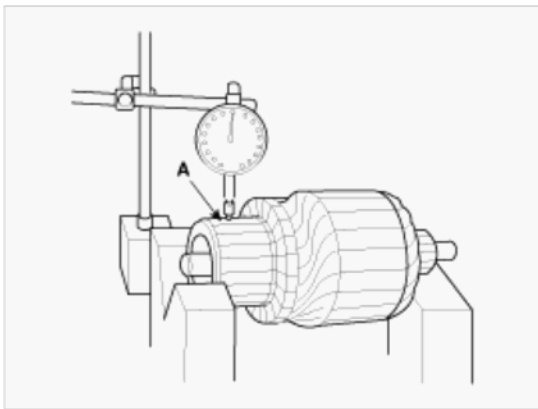
5. Measure the commutator (A) runout.

- A. If the commutator runout is within the service limit, check the commutator for carbon dust or brass chips between the segments.
- B. If the commutator run out is not within the service limit, replace the armature.

Commutator runout

Standard (New): 0.02mm (0.0007in.) max

Service limit: 0.05mm (0.0020in.)

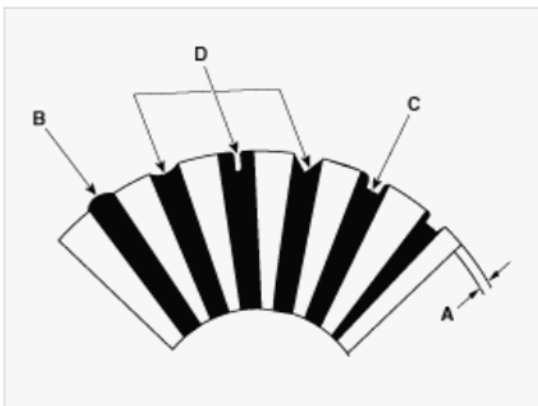


6. Check the mica depth (A). If the mica is too high (B), undercut the mica with a hacksaw blade (B) to the proper depth. Cut away all the mica (C) between the commutator segments. The undercut should not be too shallow, too narrow, or v-shaped (D).

Commutator mica depth

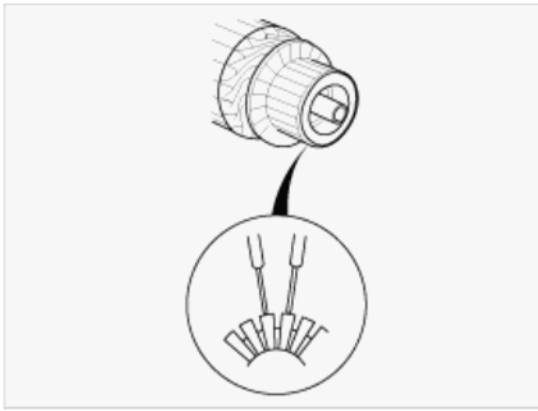
Standard (New) : 0.7 ~ 0.9mm (0.0276 ~ 0.0354in)

Limit : 0.4mm (0.0157 in.)

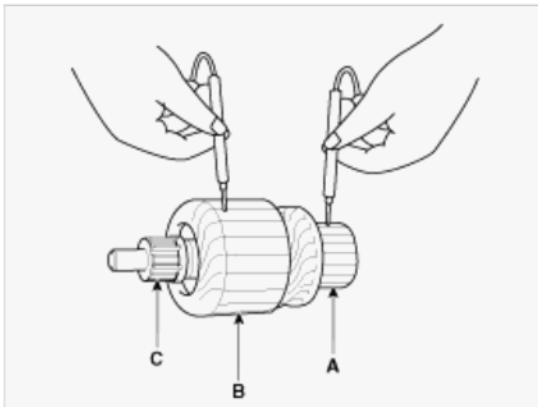


7. Check for continuity between the segments of the commutator. If an open circuit exists between any segments, replace

the armature.

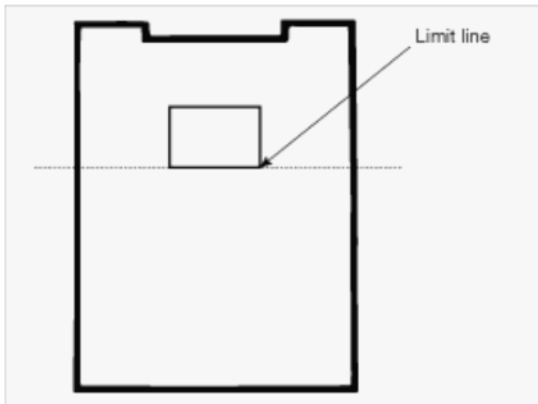


8. Check with an ohmmeter that no continuity exists between the commutator (A) and armature coil core (B), and between the commutator and armature shaft (C). If continuity exists, replace the armature.



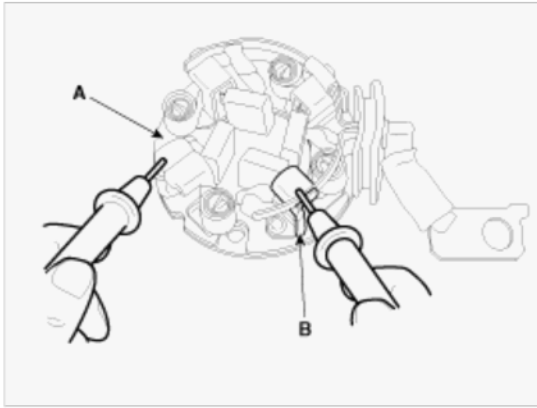
Inspect Starter Brush

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



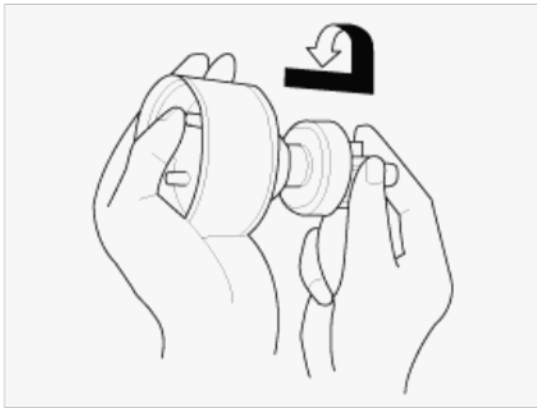
Starter Brush Holder Test

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



Inspect Overrunning Clutch

1. Slide the overrunning clutch along the shaft.
Replace it if does not slide smoothly.
2. Rotate the overrunning clutch 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.



3. If the starter drive gear 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.

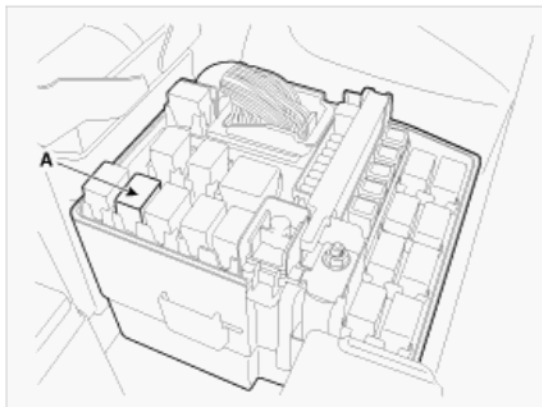
Cleaning

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.

Engine Electrical System > Starting System > Starter Relay > Repair procedures

Inspection

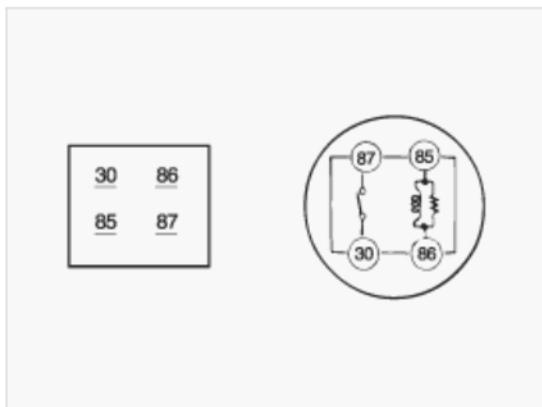
1. Remove the fuse box cover.
2. Remove the starter relay (A).



3. Using an ohmmeter, check that there is continuity between each terminal.

Terminal	Continuity
30 - 87	NO
85 - 86	YES

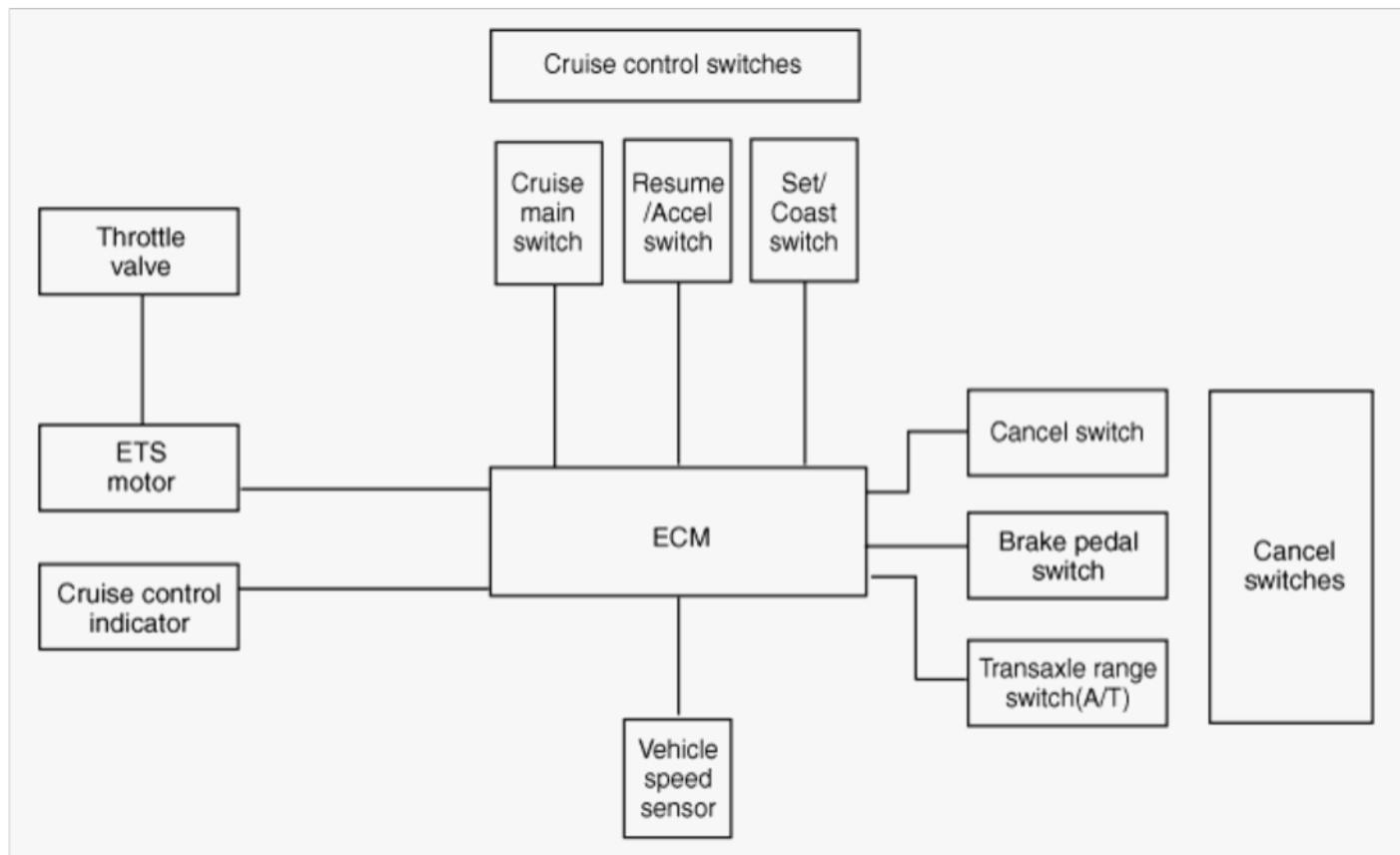
4. Apply 12V to terminal 85 and ground to terminal 86.
Check for continuity between terminals 30 and 87.



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

Engine Electrical System > Cruise Control System > Schematic Diagrams

System Block Diagram



Component Parts And Function Outline

Component part		Function
Vehicle speed sensor		Converts vehicle speed to pulse.
ECM		Receives signals from sensor and control switches.
Cruise control indicator		Illuminate when CRUISE main switch is ON (Built into cluster)
Cruise control switches	ON/OFF switch	Switch for automatic speed control power supply.
	Resume/Accel switch	Controls automatic speed control functions by Resume/Accel switch (Set/Coast switch)
	Set/Coast switch	
Cancel switches	Cancel switch	Sends cancel signals to ECM.
	Brake pedal switch	
	Transaxle range switch (A/T)	
ETS motor		Regulates the throttle valve to the set opening by ECM.

* ETS : Electronic Throttle System

Engine Electrical System > Cruise Control System > Description and Operation

Cruise Control

The cruise control system is engaged by the cruise "ON/OFF" main switch located on right of steering wheel column. The system has the capability to cruise, coast, accelerate and resume speed.

It also has a safety interrupt, engaged upon depressing brake or shifting select lever.

The ECM is the control module for this system. The main components of cruise control system are mode control switches, transmission range switch, brake switch, vehicle speed sensor, ECM and ETS motor that connect throttle body.

The ECM contains a low speed limit which will prevent system engagement below a minimum speed of 40km/h (25mph).

The operation of the controller is controlled by mode control switches located on steering wheel.

Transmission range switch and brake switch are provided to disengage the cruise control system. The switches are on brake pedal bracket and transmission. When the brake pedal is depressed or select lever shifted, the cruise control system is electrically disengaged and the throttle is returned to the idle position.

Cruise main switch (ON/OFF)

The cruise control system is engaged by pressing the cruise "ON/OFF" main switch. Pressing the cruise "ON/OFF" main switch again releases throttle, clears cruise memory speed, and puts vehicle in a non-cruise mode.

Set/Coast switch (SET/-)

The "SET/-" switch located on right of steering wheel column has two functions.

The set function - Push the "SET/-" switch and release it at the desired speed. The SET indicator light in the instrument cluster will illuminate. Release the accelerator pedal. The desired speed will automatically be maintained.

The coast function - Push the "SET/-" switch and hold it when the cruise control is on. The vehicle will gradually slow down. Release the switch at the desired speed. The desired speed will be maintained.

Push the "SET/-" switch and release it quickly. The cruising speed will decrease by 1.6km/h (1.0mph).

Resume/Accel switch (RES/+)

The "RES/+" switch located on right of steering wheel column has two functions.

The resume function - If any method other than the cruise "ON/OFF" main switch was used to cancel cruising speed temporarily and the system is still activated, the most recent set speed will automatically resume when the "RES/+" switch is pushed. It will not resume, however, if the vehicle speed has dropped below approximately 40km/h (25mph).

The accel function - Push the "RES/+" switch and hold it when the cruise control is on. The vehicle will gradually accelerate. Release the switch at the desired speed. The desired speed will be maintained.

Push the "RES/+" switch and release it quickly. The cruising speed will increase by 1.6km/h (1.0mph).

Cancel switch (CANCEL)

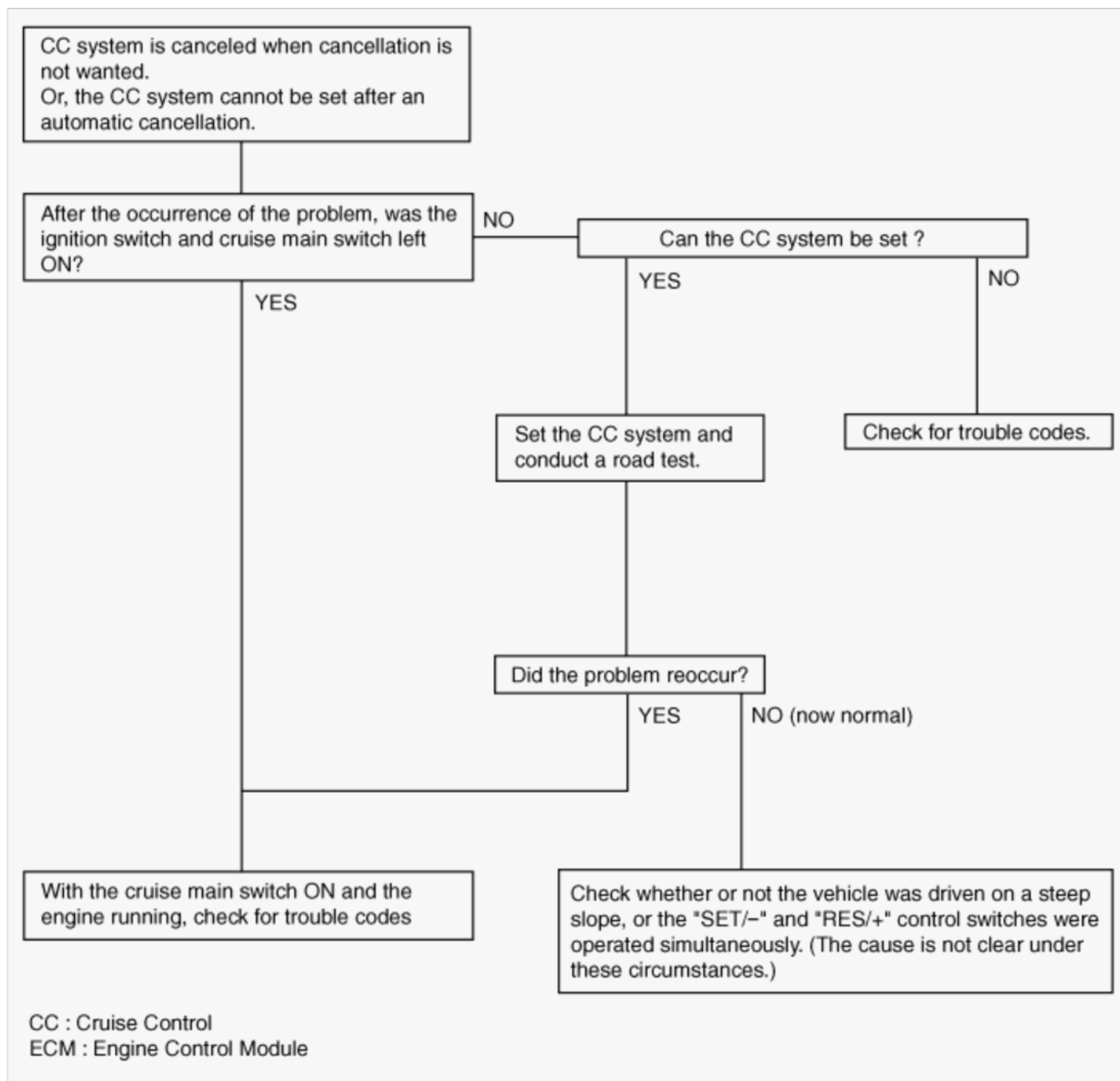
The cruise control system is temporarily disengaged by pushing the "CANCEL" switch.

Cruise speed canceled by this switch can be recovered by pushing the "RES/+" switch.

Engine Electrical System > Cruise Control System > Troubleshooting

Trouble Symptom Charts

Trouble Symptom 1



Trouble Symptom 2

Trouble symptom	Probable cause	Remedy
The set vehicle speed varies greatly upward or downward "Surging" (repeated alternating acceleration and deceleration) occurs after setting	Malfunction of the vehicle speed sensor circuit	Repair the vehicle speed sensor system, or replace the part
	Malfunction of ECM	Check input and output signals at ECM

Trouble Symptom 3

Trouble symptom	Probable cause	Remedy
The CC system is not canceled when the brake pedal is depressed	Damaged or disconnected wiring of the brake pedal switch	Repair the harness or replace the brake pedal switch
	Malfunction of the ECM signals	Check input and output signals at ECM

Trouble Symptom 4

Trouble symptom	Probable cause	Remedy
The CC system is not canceled when the shift lever is moved to the "N" position (It is canceled, however, when the brake pedal is depressed)	Damaged or disconnected wiring of inhibitor switch input circuit	Repair the harness or repair or replace the inhibitor switch
	Improper adjustment of inhibitor switch	
	Malfunction of the ECM signals	Check input and output signals at ECM

Trouble Symptom 5

Trouble symptom	Probable cause	Remedy
Cannot decelerate (coast) by using the "SET/−" switch	Temporary damaged or disconnected wiring of "SET/−" switch input circuit	Repair the harness or replace the "SET/−" switch
	Malfunction of the ECM signals	Check input and output signals at ECM

Trouble Symptom 6

Trouble symptom	Probable cause	Remedy
Cannot accelerate or resume speed by using the "RES/+" switch	Damaged or disconnected wiring, or short circuit, or "RES/+" switch input circuit	Repair the harness or replace the "RES/+" switch
	Malfunction of the ECM signals	Check input and output signals at ECM

Trouble Symptom 7

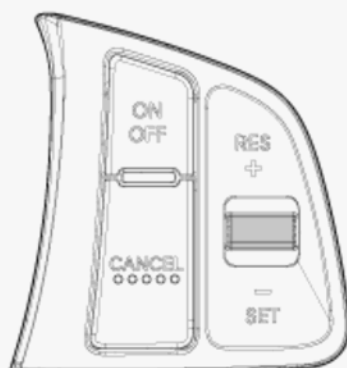
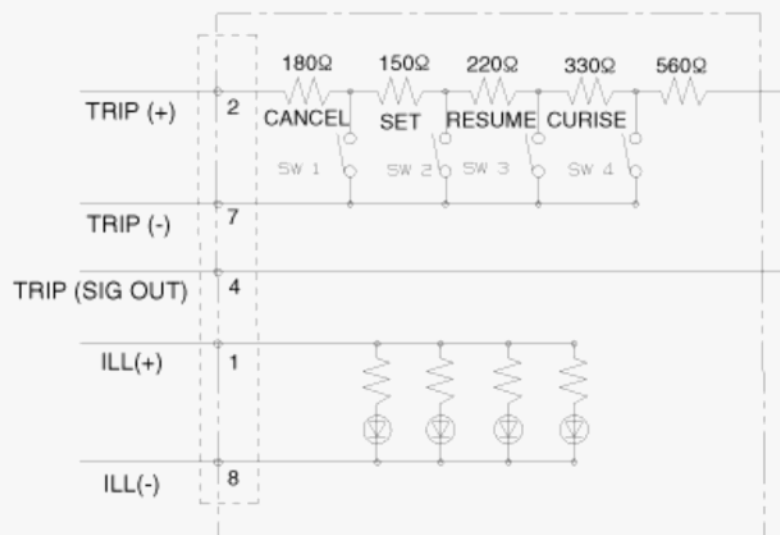
Trouble symptom	Probable cause	Remedy
CC system can be set while driving at a vehicle speed of less than 40km/h (25mph), or there is no automatic cancellation at that speed	Malfunction of the vehicle-speed sensor circuit	Repair the vehicle speed sensor system, or replace the part
	Malfunction of the ECM signals	Check input and output signals at ECM

Trouble Symptom 8

Trouble symptom	Probable cause	Remedy
The cruise main switch indicator lamp does not illuminate (But CC system is normal)	Damaged or disconnected bulb of cruise main switch indicator lamp	Repair the harness or replace the part.
	Harness damaged or disconnected	

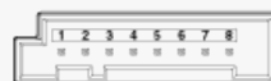
Engine Electrical System > Cruise Control System > Cruise Control Switch > Schematic Diagrams

Circuit Diagram



[Cruise Control Switch]

Cruise Control S/W Connector



No	Connector
1	ILL (+)
2	TRIP (+)
3	-
4	TRIP (SIG OUT)
5	-
6	-
7	TRIP (-)
8	ILL (-)

Engine Electrical System > Cruise Control System > Cruise Control Switch > Repair procedures

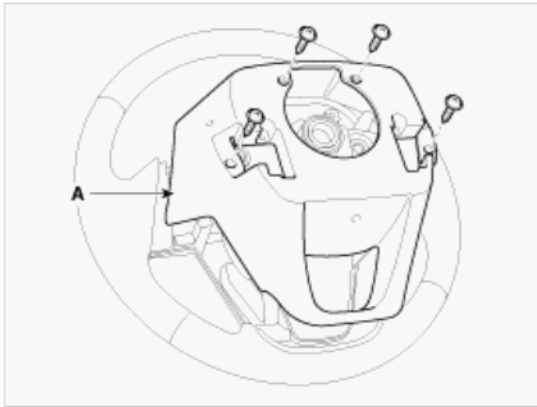
Removal and Installation

1. Disconnect the battery negative terminal.

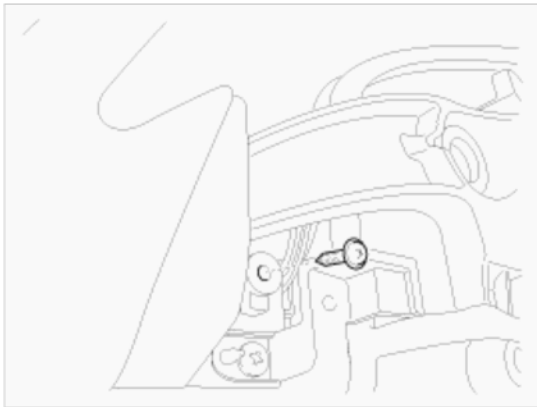
Tightening torque :

4.0 ~ 6.0N.m (0.4 ~ 0.6kgf.m, 3.0 ~ 4.4lb-ft)

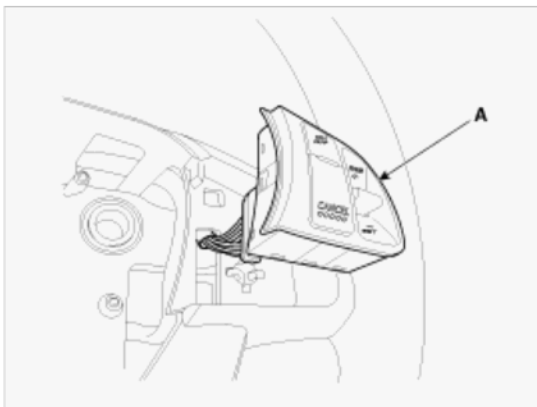
2. Remove the driver airbag module. (Refer to the RT group - "Airbag module")
3. Remove the steering wheel. (Refer to the ST group - "Steering column and shaft")
4. Remove the steering wheel cover (A) after loosening the screws.



5. loosening the screws at rear side of switch.



6. Disconnect the cruise control switch connector and then remove the switch (A).



NOTE

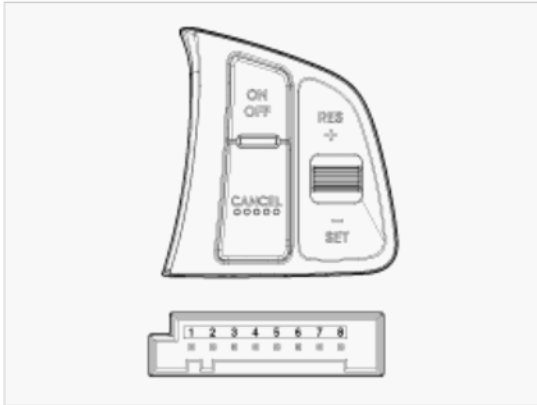
Be careful not to damage the hook when removing the switch.

7. Installation is the reverse of removal.

Inspection

Measuring Resistance

1. Disconnect the cruise control switch connector from the control switch.



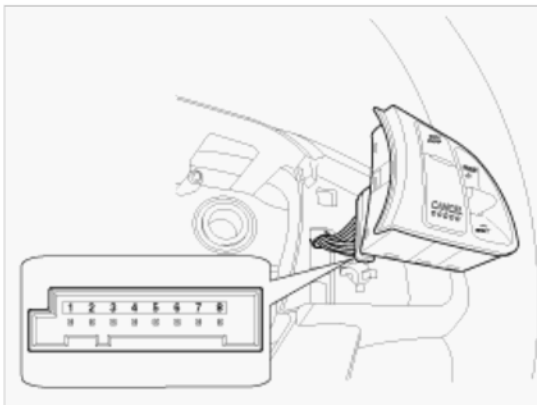
2. Measure resistance between terminals on the control switch when each function switch is ON (switch is depressed).

Function switch	Terminal	Resistance
CANCEL	2 - 7	$180\Omega \pm 5\%$
SET/-	2 - 7	$330\Omega \pm 5\%$
RES/+	2 - 7	$550\Omega \pm 5\%$
ON/OFF	2 - 7	$880\Omega \pm 5\%$

3. If not within specification, replace switch.

Measuring Voltage

1. Connect the cruise control switch connector to the control switch.



2. With ignition switch ON, measure voltage between terminals on the harness side connector when each function switch is ON (switch is depressed).

Function switch	Terminal	Voltage
CANCEL	2 - 7	0.67 ~ 0.86V

SET/-	2 - 7	1.10 ~ 1.39V
RES/+	2 - 7	1.59 ~ 1.97V
ON/OFF	2 - 7	2.13 ~ 2.56V

3. If not within specification, inspect the control switch resistance. The measuring resistance value is not within specification, replace the switch and measure the voltage again.
4. If resistance is OK but, measuring voltage is not within specification, inspect the wiring harness and connectors between the switch and the instrument cluster .