Specification

Ignition System

Ignition Coil

Item	Specification
Primary Coil Resistance (Ω)	0.62 ± 10 [20°C (68°F)]
Secondary Coil Resistance (kΩ)	7.0 ± 15 [20°C (68°F)]

Spark plug

Item	Specification
Type	FXU16HR11
Gap	1.0 ~1.1 mm (0.0394 ~ 0.0433 in.)

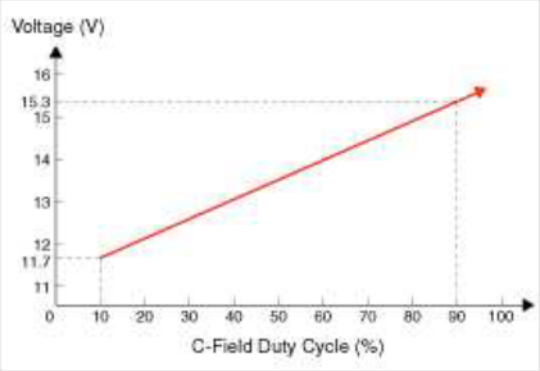
Condenser

Item	Specification
Capacitance (uF)	0.47 [1KHz]
Insulation resistance (MΩ)	1,000 [DC 500 V/1 Min]

Charging System

Alternator

Item		Specification
Rated voltage		13.5V, 130A
Speed in use		1,000 ~ 18,000 rpm
Voltage regulator		IC Regulator built-in type
Regulator Setting Voltage	External mode	Refer to below graph
	Internal mode	14.55 ± 0.3V
Temperature Gradient	External mode	0 ± 3 mV / °C
	Internal mode	-3.5 ± 2mV / °C



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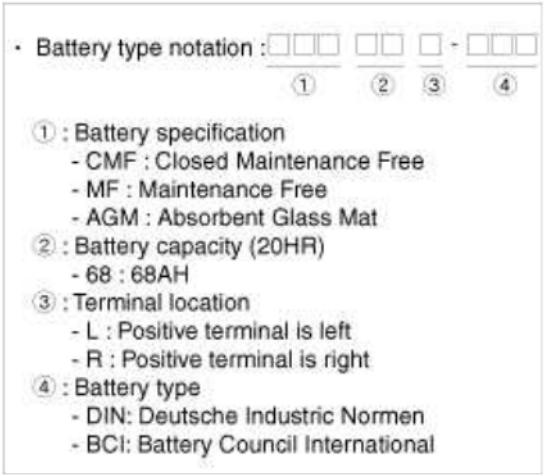
Regulator Setting Voltage (External mode)

Battery

Item	Specification
Model type	CMF68L-BCI
Capacity [20HR/5HR] (AH)	68 / 54
Cold Cranking Amperage (A)	600 (SAE) / 480 (EN)
Reserve Capacity (Min)	110

Information

- Model type description



- Cold Cranking Ampere (CCA): Cold Cranking Amps is a rating used in the battery industry to define a battery's ability to start an engine in cold temperatures.
  - The rating is the number of amps a new, fully charged battery can deliver at -18 °C(-0.4 °F) for 30 seconds, whi maintaining a voltage of at least 7.2 volts for a 12 volt battery.
  - The higher the CCA rating, the greater the starting power of the battery.
- RESERVE CAPACITY (RC) : Reserve Capacity is a battery industry rating, defining a battery's ability to powe vehicle with an inoperative alternator or fan belt.
  - The rating is the number of minutes a battery at 26.7 °C(80 °F) can be discharged at 25 amps and maintain a voltage of 10.5 volts for a 12 volt battery.
  - The higher the reserve rating, the longer your vehicle can operate should your alternator or fan belt fail.

Starting System

Starter

Item		Specification
Rated voltage		12 V, 1.2 kW
The number of pinion teeth		11
Performance [No-load, 11 V]	Ampere	Max. 70 A
	Speed	Min. 2,400 rpm

Tightening Torques

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Item	N.m	kgf.m	lb-ft
Ignition coil installation bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Spark plug installation	14.7 ~ 24.5	1.5 ~ 2.5	10.9 ~ 18.1
Condenser & Hanger bracket installation bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Alternator installation bolt	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
Battery (+) terminal installation nut	7.8 ~ 9.8	0.8 ~ 1.0	5.2 ~ 8.7
Battery (-) terminal installation nut	4.0 ~ 6.0	0.4 ~ 0.6	2.9 ~ 4.3
Battery mounting bracket installation bolt	8.8 ~ 13.7	0.9 ~1.4	6.5 ~ 10.1
Battery tray installation bolt	8.8 ~ 13.7	0.9 ~1.4	6.5 ~ 10.1
Battery sensor cable installation bolt	10.8 ~ 13.7	1.1 ~ 1.4	8.0 ~ 10.1
Starter installation bolt	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0

Engine Electrical System

Special Service Tools

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

Engine Electrical System

Troubleshooting

Ignition System

Symptom	Suspect Area	Remedy
Engine will not start or is hard to start (Cranks 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

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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	If light turns off, 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	If light turns off, replace voltage regulator or alternator
	Wiring	Repair or replace wiring
Overcharge	Electronic voltage regulator	If light turns off, 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	If light turns off, 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 motor 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 motor faulty	Replace
Starter keeps running	Starter motor faulty	Replace
	Ignition switch	Replace

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Starter spins but engine will not crank	Short in wiring	Repair or replace wiring
	Pinion gear teeth broken or starter motor	Replace
	Ring gear teeth broken	Replace fly wheel or torque conve

Engine Electrical System

Description

Ignition timing is controlled by the electronic control ignition timing system.
The standard reference ignition timing data for the engine operating conditions are pre-pro grammed in the memory o ECM (Engine Control Module).
The engine operating conditions (speed, load, warm-up condition, etc.) are detected by the various sensors. Based o 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

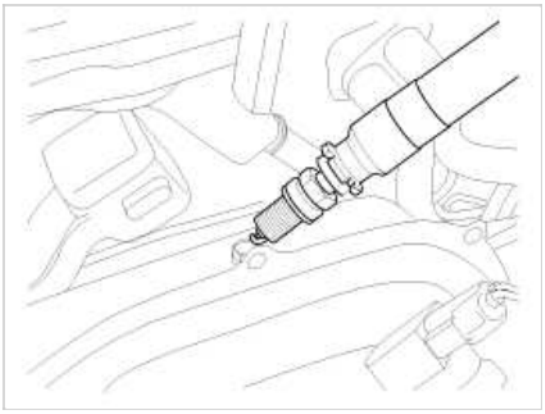
On-vehicle Inspection

Inspect ignition coil assembly and Perform spark test

1. Check for DTCs.

> **NOTICE**
> - If a DTC is present, perform troubleshooting in accordance with the procedure for that DTC. (Refer to DTC guide)

2. Check if sparks occur.
   (1) Remove the engine cover.
   (2) Remove the ignition coils.
   (3) Using a spark plug wrench, remove the spark plugs.
   (4) Disconnect the injector extension connectors.
   (5) Ground the spark plug to the engine.

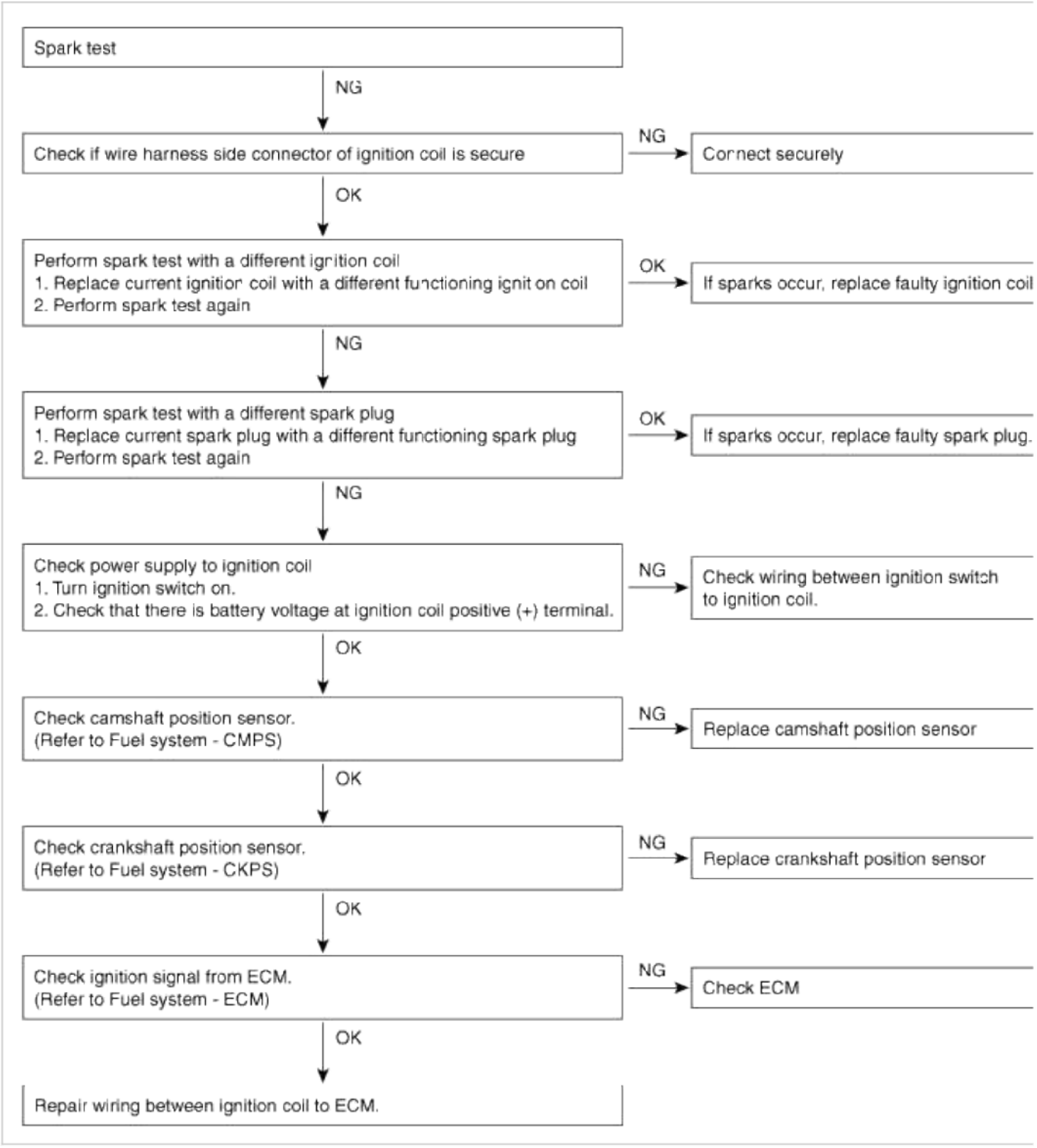


   (6) Check if sparks occur at each spark plug while engine is being cranked.

> **NOTICE**
> - Do not crank the engine for more then 5 seonds.

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3. If sparks do not occur, perform the following test.



4. Using a spark plug wrench, install spark plugs.
5. Install the ignition coils.

Engine Electrical System

Description

An ignition coil is an induction coil in an engine's ignition system which transforms the battery's low voltage to the high voltage needed to create an electric spark in the spark plugs to ignite the fuel. Coils have an internal resistor while oth rely on a resistor wire or an external resistor to limit the current flowing into the coil from the battery 12 V supply.

Engine Electrical System

Specification

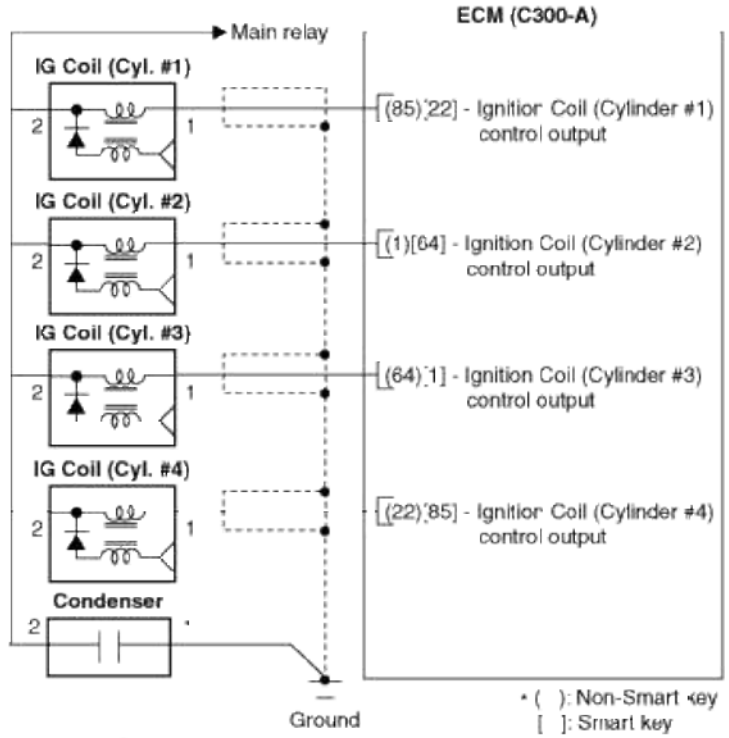
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Item	Specification
Primary Coil Resistance (Ω)	0.62 ± 10 [20°C (68°F)]
Secondary Coil Resistance (kΩ)	7.0 ± 15 [20°C (68°F)]

Engine Electrical System

Circuit Diagram

[Circuit Diagram]



[Connection Information]

Ignition Coil #1 (C318-1)

Terminal	Connected to	Function
1	ECM C300-A (85)[22]	Ignition Coil #1 control
2	Main relay	Battery power (B+)

Ignition Coil #2 (C318-2)

Terminal	Connected to	Function
1	ECM C300-A (1)[64]	Ignition Coil #2 control
2	Main relay	Battery power (B+)

Ignition Coil #3 (C318-3)

Terminal	Connected to	Function
1	ECM C300-A (64)[1]	Ignition Coil #3 control
2	Main relay	Battery power (B+)

Ignition Coil #4 (C318-4)

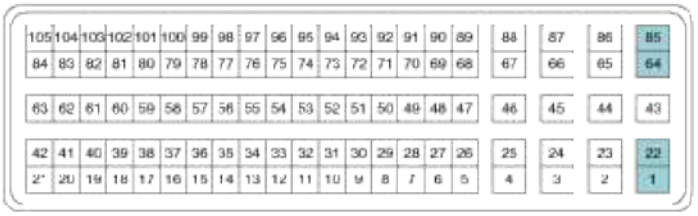
Terminal	Connected to	Function
1	ECM C300-A (22)[85]	Ignition Coil #4 control
2	Main relay	Battery power (B+)

* ( ): Non-Smart key
[ ]: Smart key

[Harness Connector]



C118-1,2,3,4
Ignition Coil #1,2,3,4



C300-A
ECM

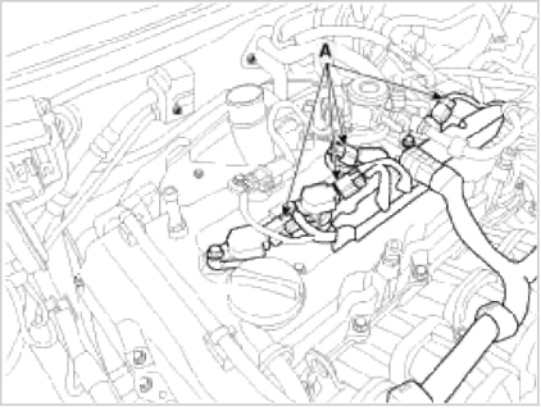
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Engine Electrical System

Removal

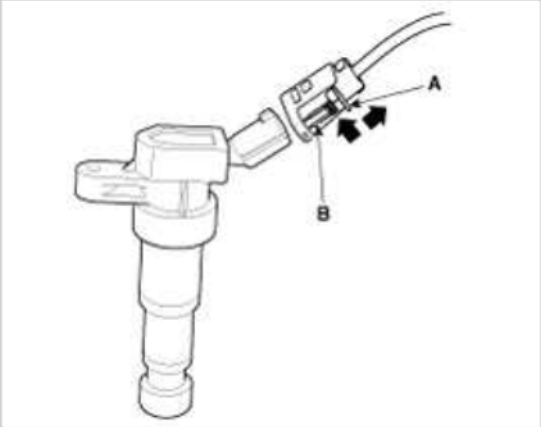
1. Disconnect the battery nagative terminal.
2. Remove the engine cover.

3. Disconnect the ignition coil connector (A).

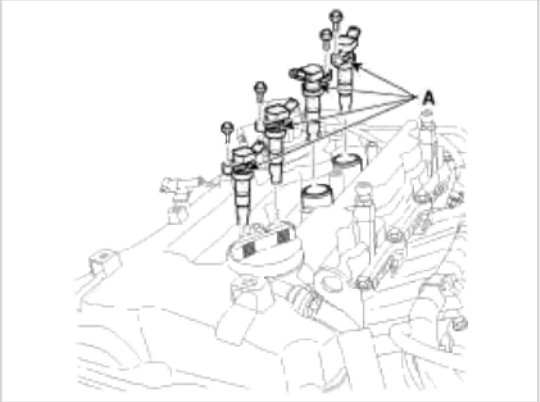


NOTICE

- When removing the ignition coil connector, pull the lock pin (A) and push the clip (B).



4. Remove the ignition coil (A).



Installation

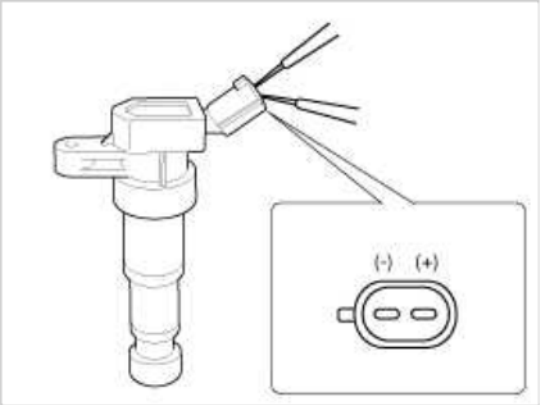
1. Install in the reverse order of removal.

Ignition coil installation bolts:
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 Ib-ft)

Inspection

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

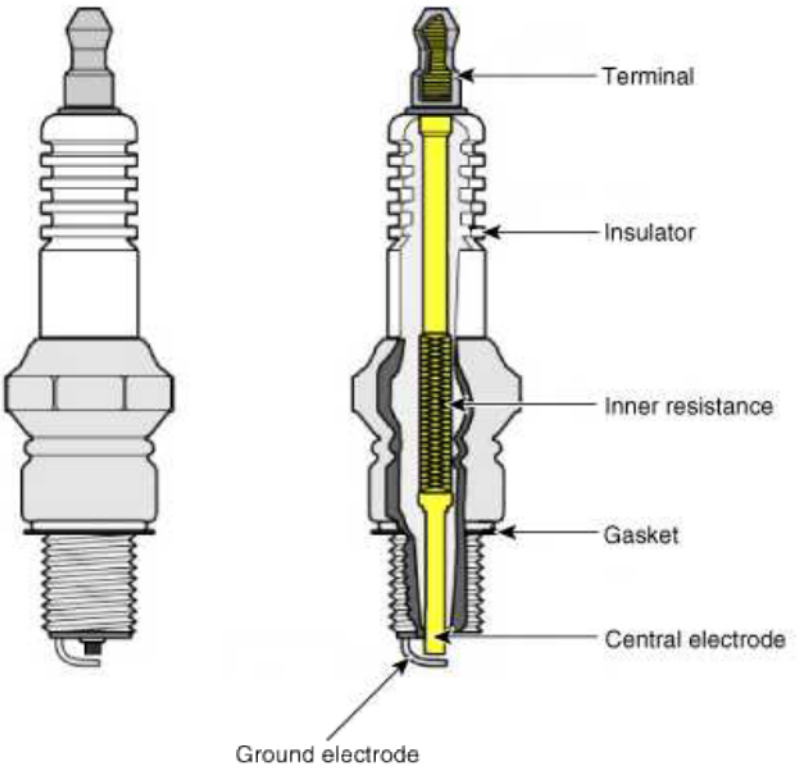


Standard value: 0.62Ω ± 10%

Engine Electrical System

Description

A spark plug is a device for delivering electric current from an ignition system to the combustion chamber of a spark-ignition engine to ignite the compressed fuel/air mixture therein by means of an electric spark, while containing combus pressure within the engine. A spark plug has a metal threaded shell, electrically isolated from a central electrode by a porcelain insulator.



Engine Electrical System

Specification

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Item	Specification
Type	FXU16HR11
Gap	1.0 ~1.1 mm (0.0394 ~ 0.0433 in.)

Engine Electrical System

Inspection

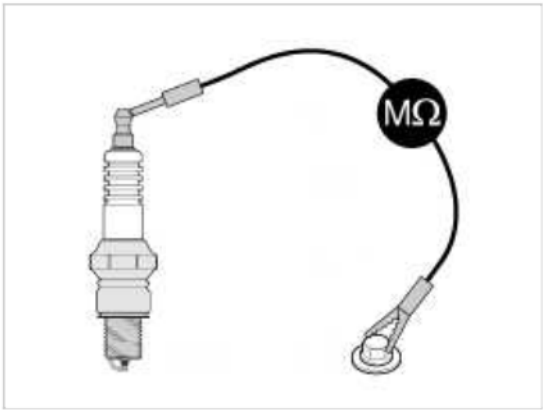
[On vehicle inspection]

1. Accelerate the engine to about 3,000 rpm 3 times or more.
2. Remove the spark plug.
3. Check the spark plug visually.
   If the electrode is dry, the spark plug is normal.
   If the electrode is wet, check the damage and electrode gap as below.

[Component Inspection]

1. Check the spark plug for any damage on its thread and insulator.
   If there is damage, replace the spark plug.
2. Check the electrode. Measure the insulation resistance with an ohmmeter.
   If the resistance is less than the specified value, adjust the electrode gap.

Specification: 10 MΩ or more



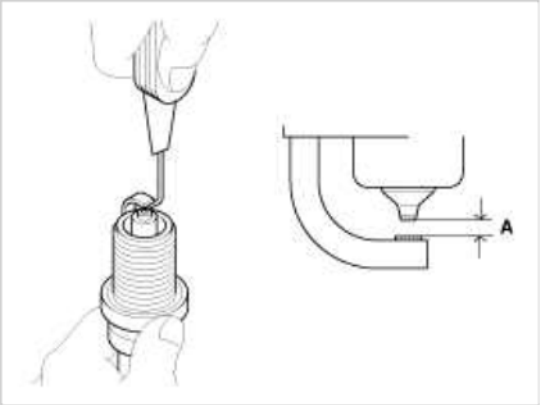
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3. Check the spark plug electrode gap.
   If the gap is greater than the maximum, replace the spark plug.

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

NOTICE

- If adjusting the gap of a new spark plug, bend only the base of the ground electrode. Do not touch the tip.
  Never attempt to adjust the gap on a used plug.

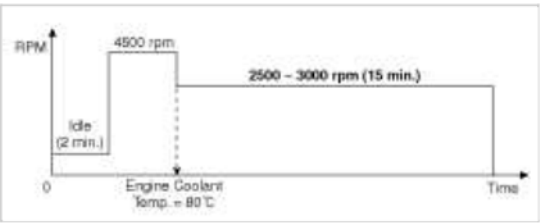


Cleaning

The combustion temporarily becomes unstable, due to the aged fuel and the carbon deposits accumulated on the spa plug(s) after long-term storage.

[1st Method]

1. Start the engine and keep the engine running at idle for 2 minutes.
2. Step on the accelerator pedal and hold it steady at 4500 rpm with the shift lever in N position to warm up the en until the temperature of the engine coolant reaches 80°C.
3. Keep the engine running at 2500~3000 rpm in the N position for 15 minutes.



[2nd Method]

NOTICE

- The 2nd method should be performed only if the 1st method fails (the misfire-related codes recur).

1. Start the engine and keep the engine running at idle for 2 minutes.

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2. Drive the vehicle for over 20 minutes, keeping the engine speed above 3500 rpm.

NOTICE

- If equipped with manual transaxle, shift the gear properly for keeping the engine speed above 3500 rpm.



Removal

1. Remove the ignition coil.
   (Refer to Ignition System - "Ignition Coil")
2. Using a spark plug wrench, remove the spark plug (A).

NOTICE

- Be careful that no contaminates enter into spark plug holes.



Installation

1. Install in the reverse order of removal.

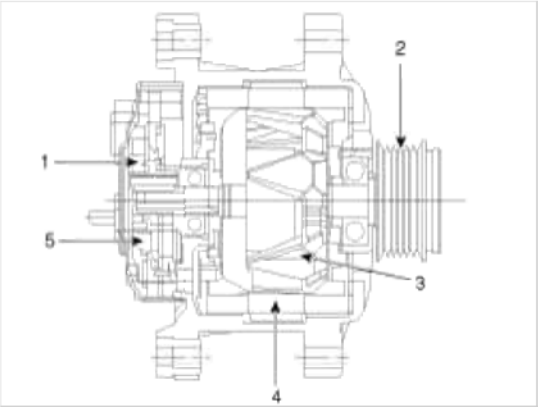
Tightening torque:
14.7 ~ 24.5 N.m (1.5 ~ 2.5 kgf.m, 10.8 ~ 18.0 Ib-ft)

Engine Electrical System

Description

The charging system included a battery, an alternator with a built-in regulator, and the charging indicator light and wir
The Alternator has eight 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 alternator is regulated by the battery voltage detection system. The main components of the alternator are the rot
stator, rectifier, capacitor brushes, bearings and V-ribbed belt pulley. The brush holder contains a built-in electronic
voltage regulator.

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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-charg 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 consum an electric power form a battery.
The system conducts charging control when decelerating a vehicle. Vehicle increases an alternator load and charges a battery.

Engine Electrical System

On-vehicle Inpection

Information

- First of all, check for DTCs. If a DTC is present, perform troubleshooting in accordance with the procedure for t DTC. (Refer to DTC guide)

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.

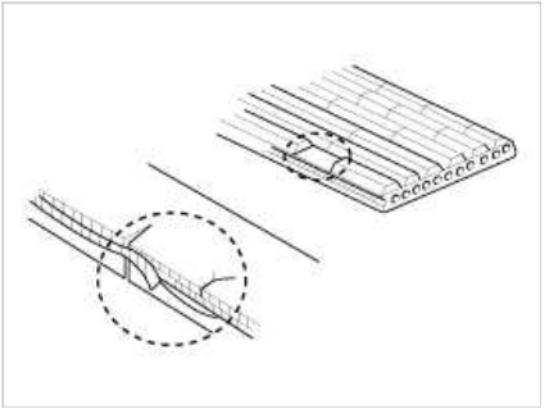
[General Inspection]

1. Check The Battery Terminals And Fuses
   (1) Check that the battery terminals are not loose or corroded.
   (2) Check the fuses for continuity.

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2. Inspect Drive Belt
   (1) 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.



3. Drive belt tension measurement and adjustment
   (Refer to Engine Mechanical System - "Drive Belt")
4. 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.
5. 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. Check that the light is lit.
   If the light does not go off as specified, troubleshoot the discharge light circuit.

[Electrical Specified Value Inspection]

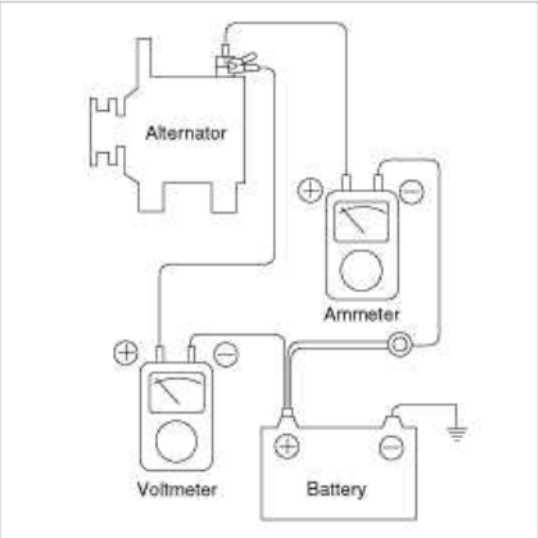
1. Voltage Drop Test Of Alternator Output Wire
   This test determines whether or not the wiring between the alternator "B" terminal and the battery (+) terminal is g
   by the voltage drop method.

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(1) Preparation

A. Turn the ignition switch to "OFF".

B. Disconnect the output wire from the alternator "B" terminal. Connect the (+) lead wire of ammeter to the "] 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.



(2) Test

A. Start the engine.

B. 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.

(3) Result

A. The voltmeter may indicate the standard value.

Standard value : 0.2V max

B. If the value of the voltmeter is higher than expected (above 0.2V max.), poor wiring is suspected. In this c check th e 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.

C. Upon completion of the test, set the engine speed at idle.
Turn off the headlamps, blower motor and the ignition switch.

2. Output Current Test

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

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(1) Preparation

A. 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 i 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".

B. Turn off the ignition switch.

C. Disconnect the battery ground cable.

D. Disconnect the alternator output wire from the alternator "B" terminal.

E. Connect a DC ammeter (0 to 150A) in series between the "B" terminal and the disconnected output wire. sure to connect the (-) lead wire of the ammeter to the disconnected output wire.

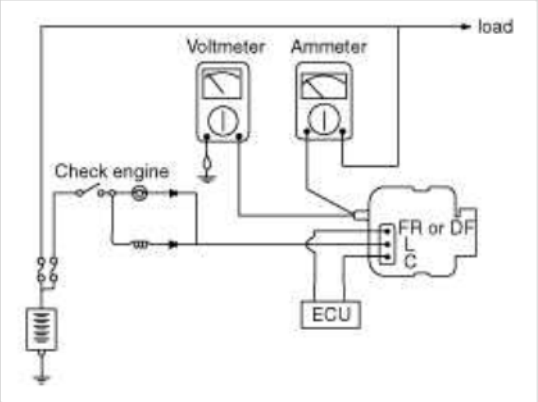
NOTICE

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

F. 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.

G. Attach an engine tachometer and connect the battery ground cable.

H. Leave the engine hood open.



(2) Test

A. Check to see that the voltmeter reads as the same value as the battery voltage. If the voltmeter reads 0V, the open circuit in the wire between alternator "B" terminal and battery (+) terminal or poor grounding is suspected.

B. Start the engine and turn on the headlamps.

C. Set the headlamps to high beam and the heater blower switch to HIGH, quickly increase the engine speed 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.

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(3) Result

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

Limit value : 60% of the voltage rate

NOTICE

- 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 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.

B. Upon completion of the output current test, lower the engine speed to idle and turn off the ignition switch.

C. Disconnect the battery ground cable.

D. Remove the ammeter and voltmeter and the engine tachometer.

E. Connect the alternator output wire to the alternator "B" terminal.

F. Connect the battery ground cable.

3. Regulated Voltage Test

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

(1) Preparation

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

B. Turn ignition switch to "OFF".

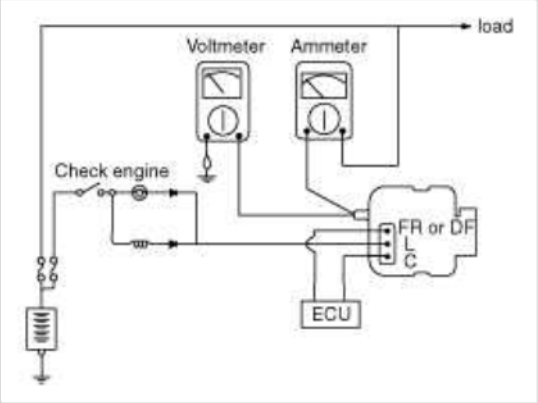
C. Disconnect the battery ground cable.

D. Connect a digital voltmeter between the "B" terminal of the alternator and ground. Connect the (+) lead of voltmeter to the "B" terminal of the alternator. Connect the (-) lead to good ground or the battery (-) termi

E. Disconnect the alternator output wire from the alternator "B" terminal.

F. 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.

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



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(2) Test

A. 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 tl battery (-) terminal.

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

C. 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

(3) Result

A. If the voltmeter reading dosen't agree with the standard value, the voltage regulator or the alternator is faul

B. Upon completion of the test, reduce the engine speed to idle, and turn off the ignition switch.

C. Disconnect the battery ground cable.

D. Remove the voltmeter and ammeter and the engine tachometer.

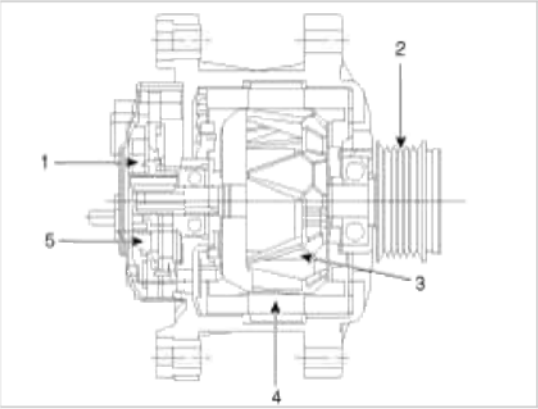
E. Connect the alternator output wire to the alternator "B" terminal.

F. Connect the battery ground cable.

Engine Electrical System

Description

The Alternator has eight 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 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. Overrun Alternator Pully (OAP)
3. Rotor
4. Stator
5. Rectifier

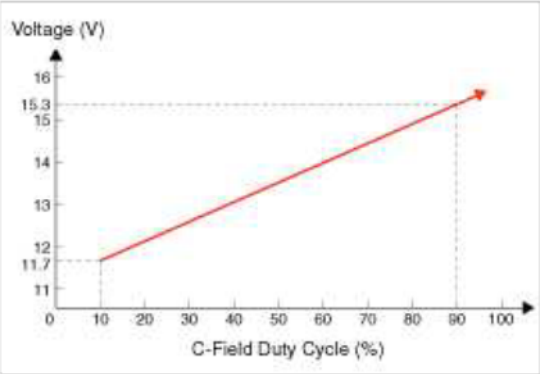
Engine Electrical System

Specification

Alternator

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Item		Specification
Rated voltage		13.5V, 130A
Speed in use		1,000 ~ 18,000 rpm
Voltage regulator		IC Regulator built-in type
Regulator Setting Voltage	External mode	Refer to below graph
	Internal mode	14.55 ± 0.3V
Temperature Gradient	External mode	0 ± 3 mV / °C
	Internal mode	-3.5 ± 2mV / °C

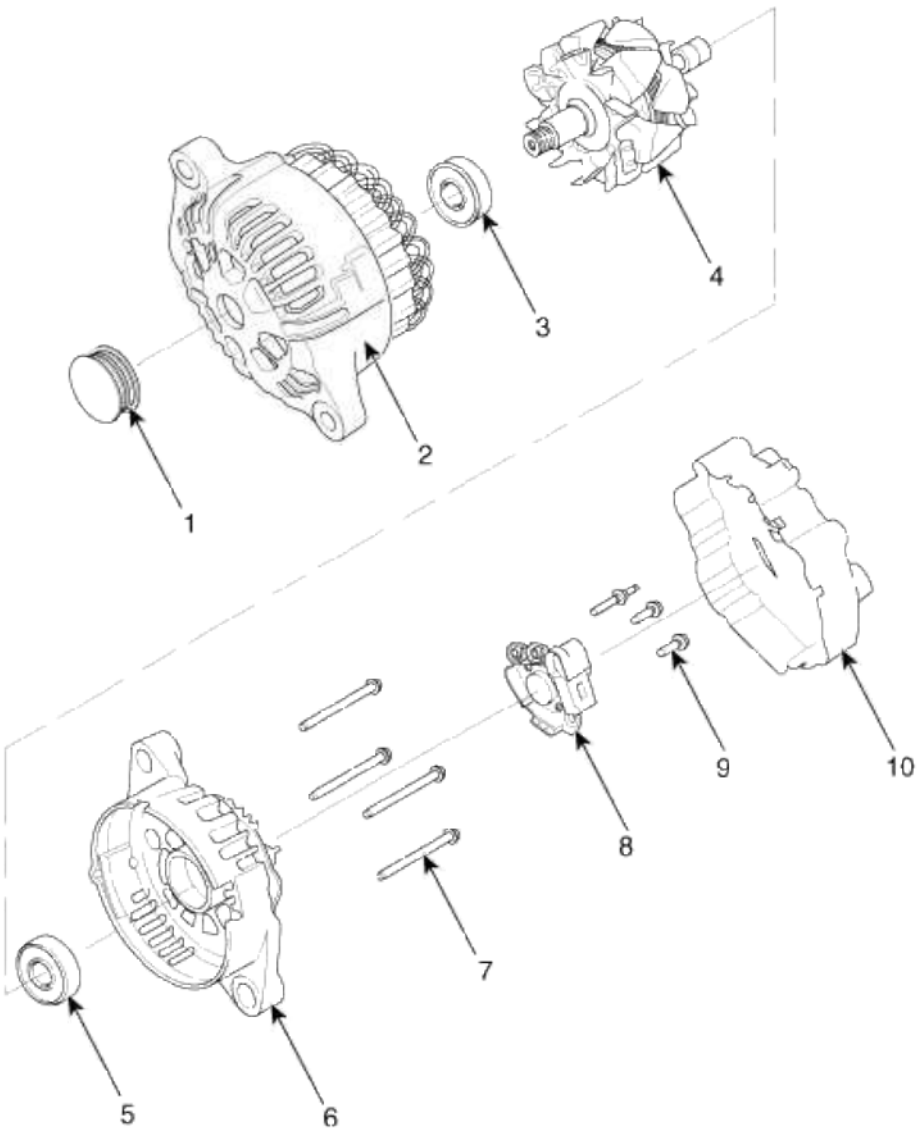


Regulator Setting Voltage (External mode)

Engine Electrical System

Components

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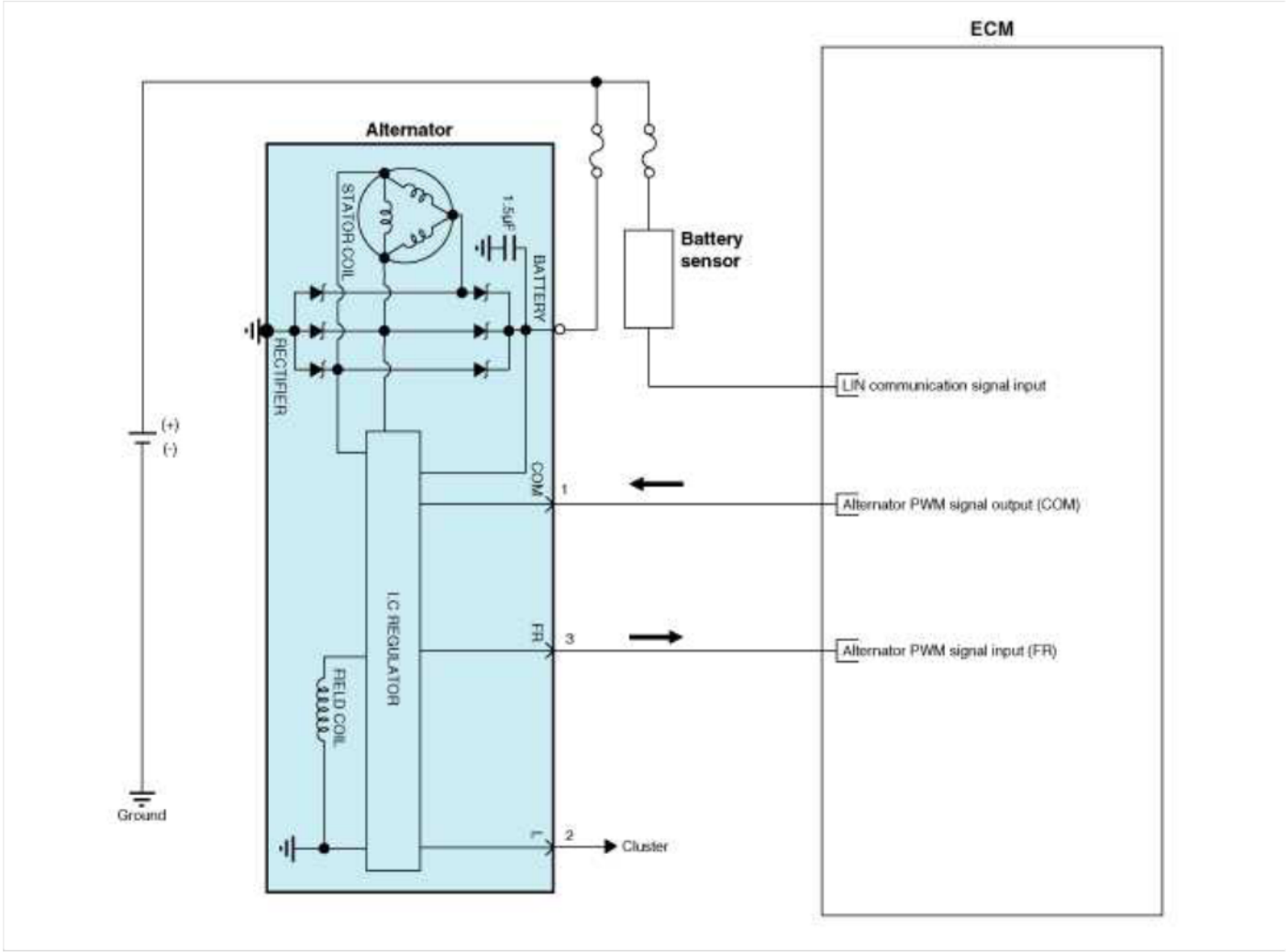


1. Overrun Alternator Pully (OAP) 2. Front bracket 3. Front bearing 4. Rotor 5. Rear bearing	6. Rear bracket 7. Through bolt 8. Regulator assembly 9. Regulator bolt 10. Rear cover

Engine Electrical System

Circuit Diagram

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Information

- **COM signal** - When controlling the voltage generated, the ECM sends the target voltage data to the alternator v a PWM signal.(High voltage: 4V or higher, low voltage: 2V or lower)
- **FR signal** - The transistor activation signal inside the alternator monitors the voltage generated by the alternator t control the excitation current before it sends the FR signal to the ECM. (At certain RPM/electric loads, the FR d can remain static. However, more often, the RPM, electric load, target voltage, etc. are always changing in the vehicle, so the FR must also change constantly)
- **L signal** - Turns on the battery warning lamp on the dashboard when the battery charging system malfunctions. (Conditions for turning on the lamp - overcharge, over discharge, a field coil blown inside the alternator)
- **B+ terminal** - The output voltage from the generator travels to the battery via the B+ terminal.

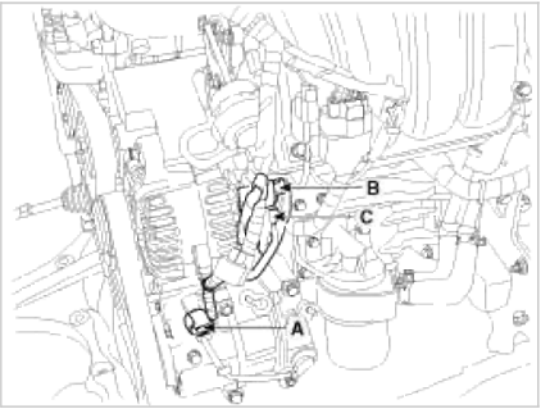
Engine Electrical System

Removal

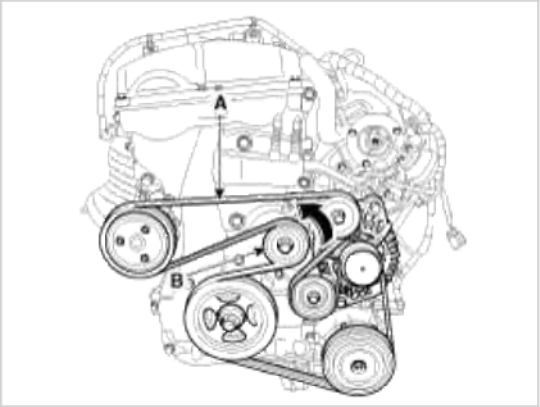
1. Disconnect the battery negative terminal.

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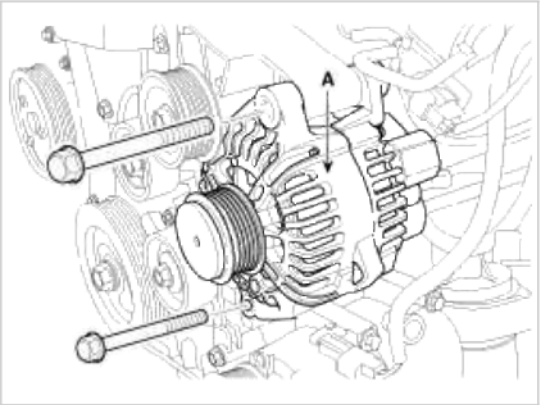
2. Disconnect the air compressor connector (A) and the alternator connector (B), and remove the cable from altern "B" terminal (C).



3. Remove the drive belt (A) after turning the drive belt tensioner (B) counter clockwise.



4. Full out the through bolt and then remove the alternator (A).



Installation

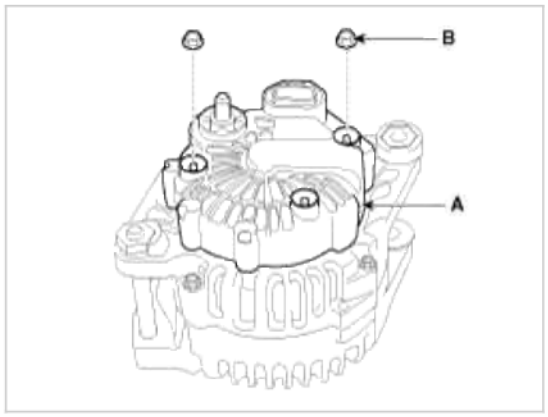
1. Install in the reverse order of removal.
2. Adjust the alternator belt tension after installation.
   (Refer to Engine Mechanical System - "Drive Belt")

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

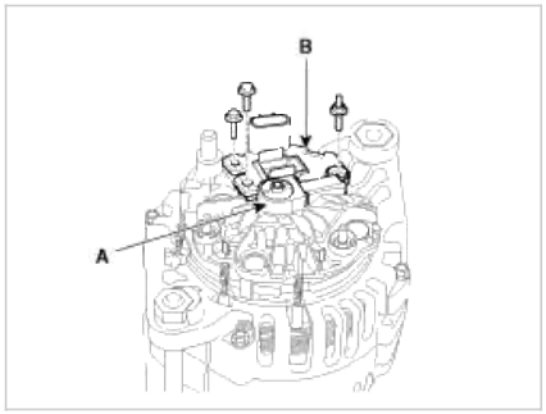
Disassembly

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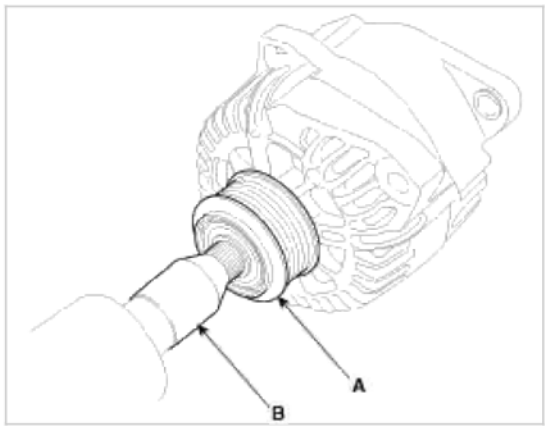
1. Remove the alternator cover (A) using a screw driver after loosening the nuts (B).



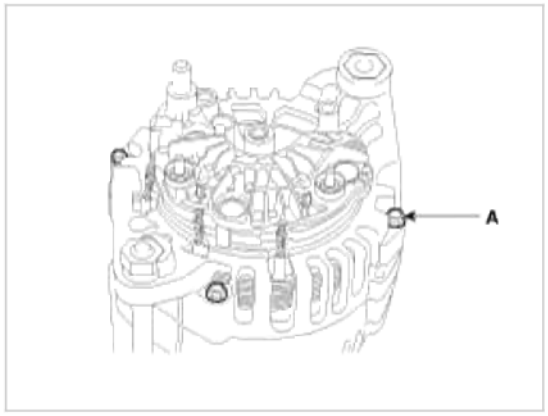
2. Remove the slip ring guide (A) and then loosen the mounting bolts and disconnect the brush holder assembly (B).



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

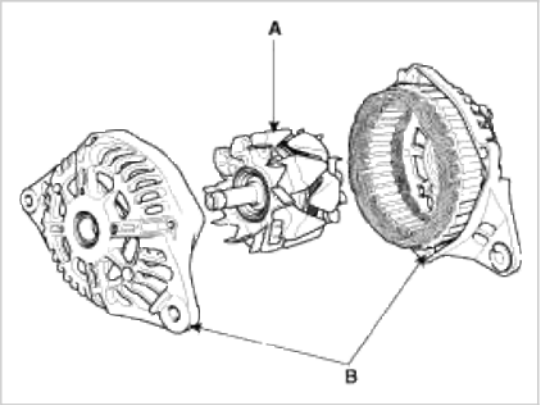


4. Loosen the 4 through bolts (A).



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



6. Reassembly is the reverse order of disassembly.

Reassembly

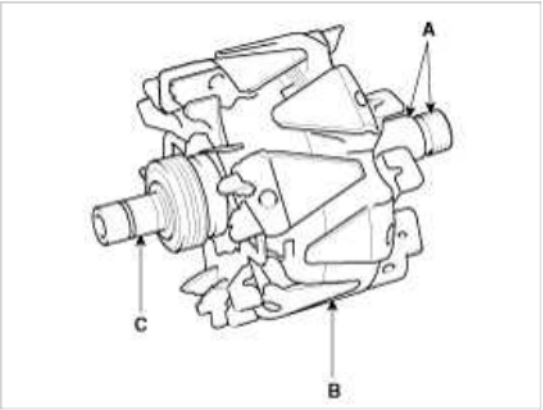
1. Reassemble in the reverse order of disassembly.

> **NOTICE**
>
> • When reassembling OAD pulley, replace with new OAD cap.

Inspection

[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.

[Stator]

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



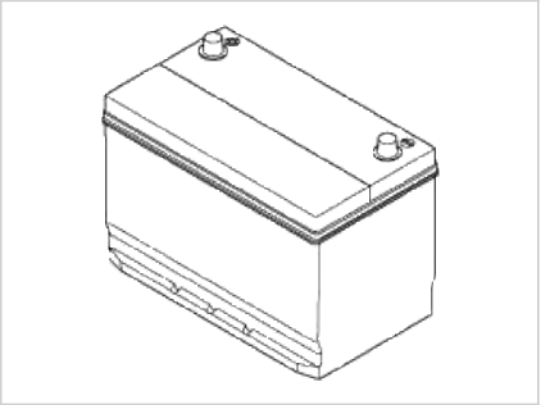
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2. Check that there is no continuity between each lead and the coil core.
3. If the coil fails either continuity check, replace the alternator.

Engine Electrical System

Description

1. The MF(Maintenance Free) battery is, as the name implies, totally maintenance free and has no removable batter cell caps.
2. The MF(Maintenance Free) battery does not require water replenishment for the repair.
3. The battery is completely sealed, except for small vent holes in the cover.



Information

- After disconnecting then reconnecting the battery negative cable, reset some parts that require the reset procedu (Refer to Body Electrical System – "General Information")

Engine Electrical System

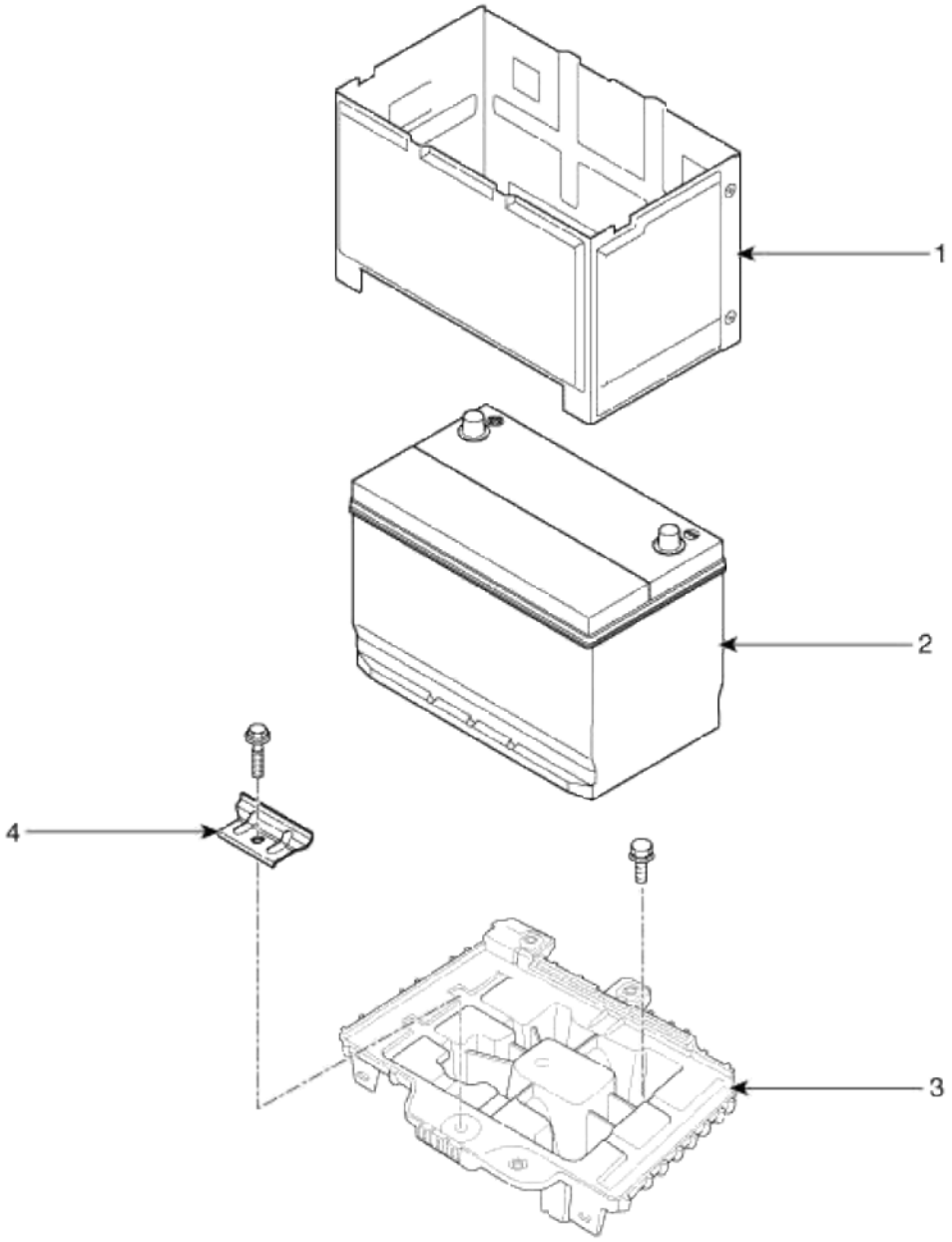
Specification

Item	Specification
Model type	CMF68L-BCI
Capacity [20HR/5HR] (AH)	68 / 54
Cold Cranking Amperage (A)	600 (SAE) / 480 (EN)
Reserve Capacity (Min)	110

Engine Electrical System

Components

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1. Battery insulation pad 2. Battery	3. Battery tray 4. Battery mounting bracket

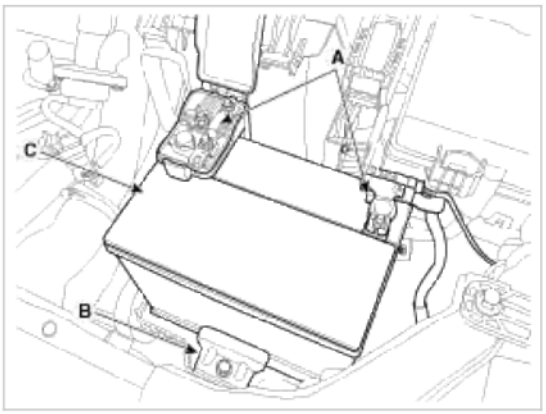
Engine Electrical System

Removal

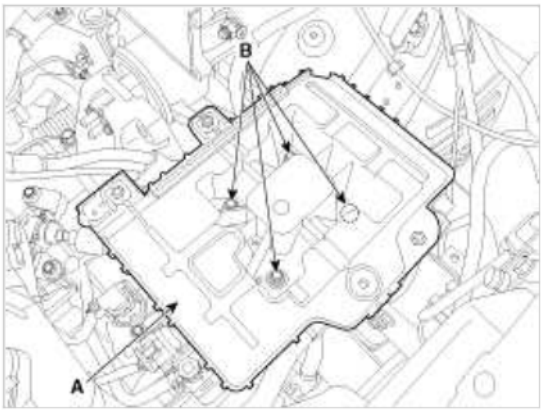
1. Disconnect the battery (-) terminal and (+) terminal (A).

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2. Remove the battery mounting bracket (B) and the insulation pad and then remove the battery (C).



3. Remove the air cleaner.
   (Refer to Engine Mechanical System - "Air Cleaner")
4. Remove the battery tray (A) after removing the bolts (B).



Installation

1. Install in the reverse order of removal.

Battery (-)terminal installation nut:
4.0 ~ 6.0 N.m (0.4 ~ 0.6 kgf.m, 3.0 ~ 4.4 lb-ft)
Battery (+)terminal installation nut:
7.8 ~ 9.8 N.m (0.8 ~ 1.0 kgf.m, 5.8 ~ 7.2 lb-ft)
Battery mounting bracket installation bolt:
8.8 ~ 13.7 N.m (0.9 ~ 1.4 kgf.m, 6.5 ~ 10.1 Ib-ft)
Battery tray installation bolts:
8.8 ~ 13.7 N.m (0.9 ~ 1.4 kgf.m, 6.5 ~ 10.1 Ib-ft)

NOTICE

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

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.

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3. Wait a few minutes until the vehicle's electrical systems go to sleep mode.

NOTICE

- For an accurate measurement of a vehicle parasitic current, all electriacl 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.

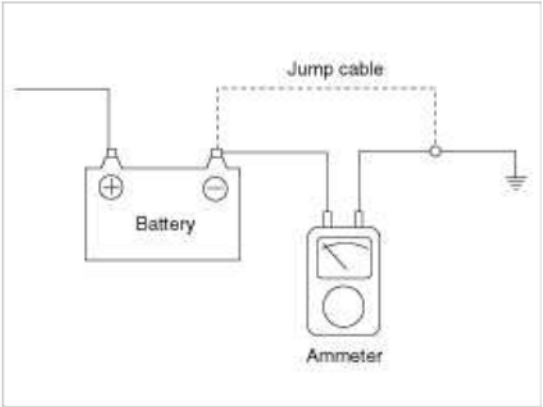
4. Connect an ammeter in series between the battery (-) terminal and the ground cable, and then disconnect the clan from the battery (-) terminal slowly.

NOTICE

- 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. Reconnect the suspected parasitic current draw circuit fuse only and search for suspected unit by removing a compoconnected with the circuit one by one until the parasitic draw drops below limit value.

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

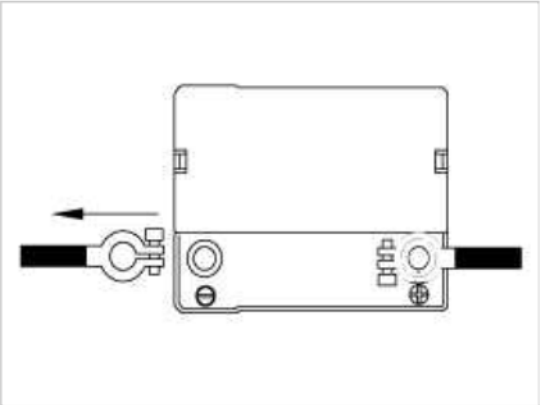
Cleaning

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

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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.



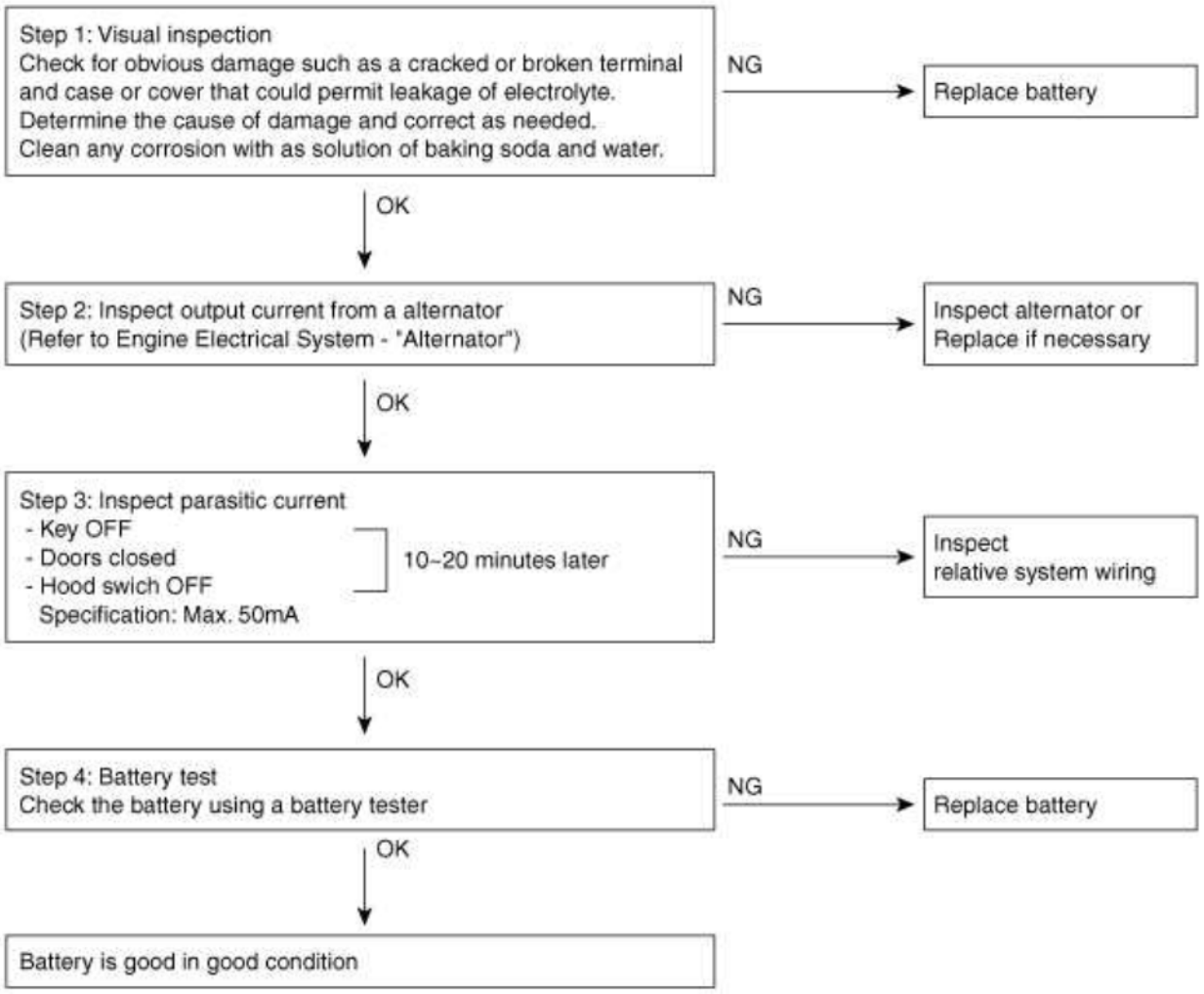
4. Inspect the battery tray for damage caused by the loss of electrolyte. If acid damage is present, it will be necessar clean the area with a solution of clean warm water and baking soda. Scrub the area with a stiff brush and wipe of with a cloth moistened with baking soda and water.
5. Clean the top 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 p .
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

Troubleshooting

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Engine Electrical System

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.



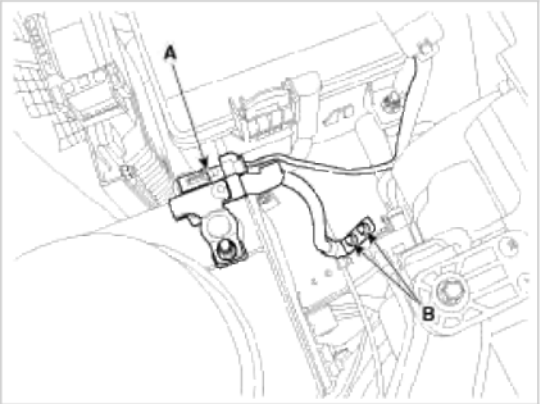
Engine Electrical System

Removal

1. Disconnect the battery negative (-) cable.

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2. Disconnect the battery sensor connector (A).
3. Remove the battery negative (-) cable after removing the bolts (B).



Installation

1. Install in the reverse order of removal.

Battery sensor cable installation bolt:
10.8 ~ 13.7 N.m (1.1 ~ 1.4 kgf.m, 8.0 ~ 10.1 lb-ft)
Battery (-) terminal l tightening nut:
4.0 ~ 6.0 N.m (0.4 ~ 0.6 kgf.m, 2.9 ~ 4.3 lb-ft)

NOTICE

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

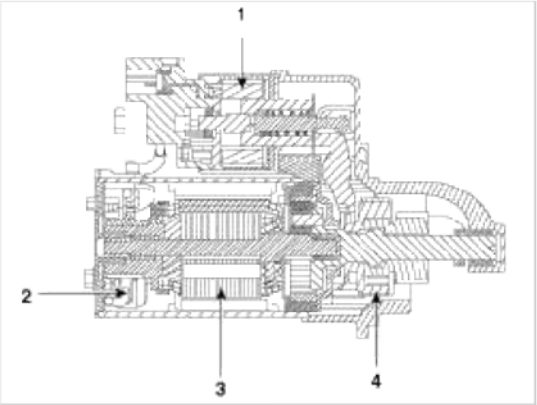
1. When replacing the battery, it should be same one (type, capacity and brand) that is originally installed on your vehicle. If a battery of a different type is replaced, the battery sensor may recognize the battery to be abnormal.
2. When installing the ground cable on the negative post of battery, tighten the clamp with specified torque. 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.

Engine Electrical System

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 pin gear overruns.

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1. Solenoid
2. Brush assembly
3. Armature
4. Over runing clutch

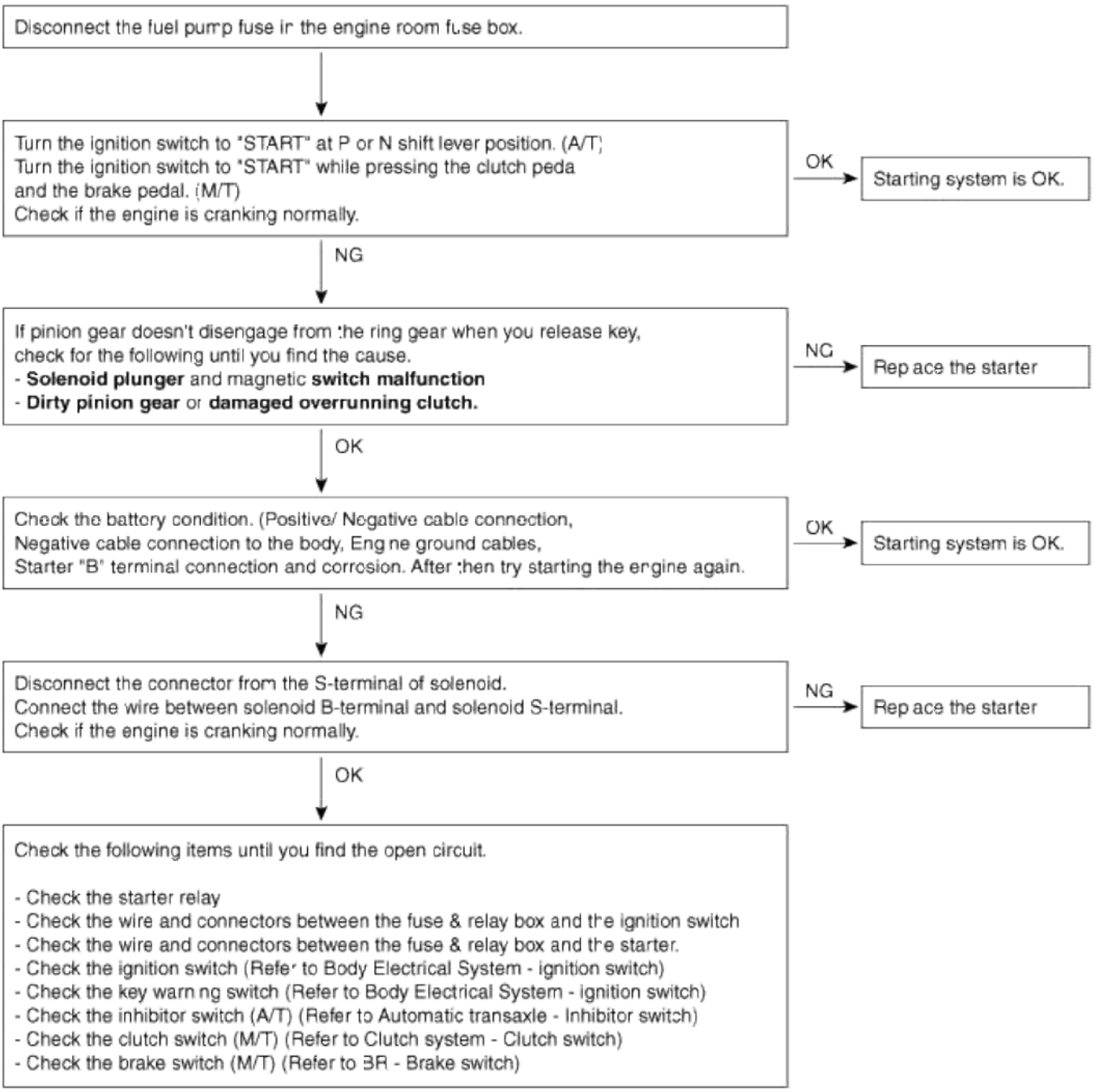
Engine Electrical System

Troubleshooting

NOTICE

- The battery must be in good condition and fully charged for this troubleshooting.

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Engine Electrical System

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.

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Engine Electrical System

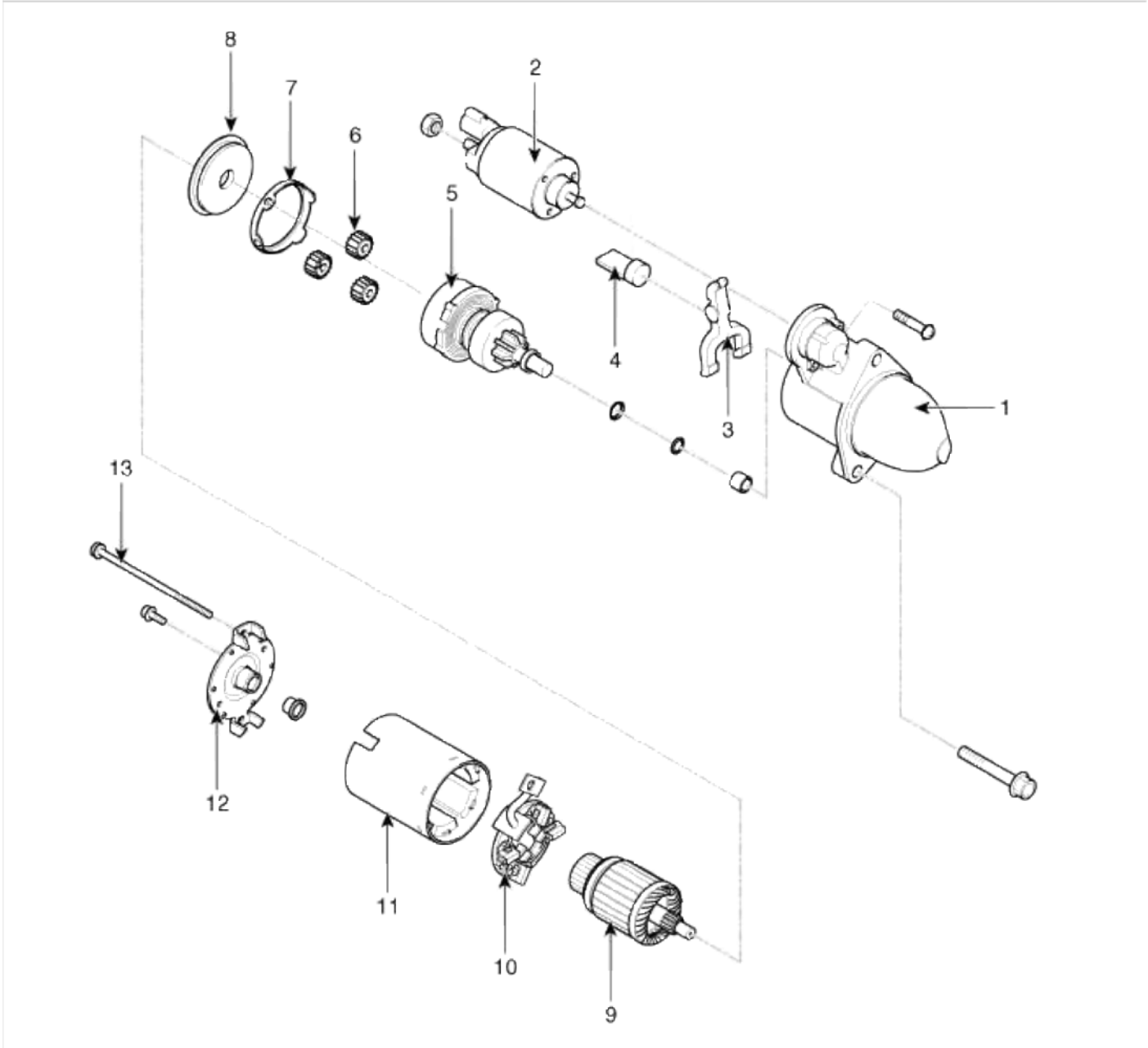
Specification

Starter

Item		Specification
Rated voltage		12 V, 1.2 kW
The number of pinion teeth		11
Performance [No-load, 11 V]	Ampere	Max. 70 A
	Speed	Min. 2,400 rpm

Engine Electrical System

Components

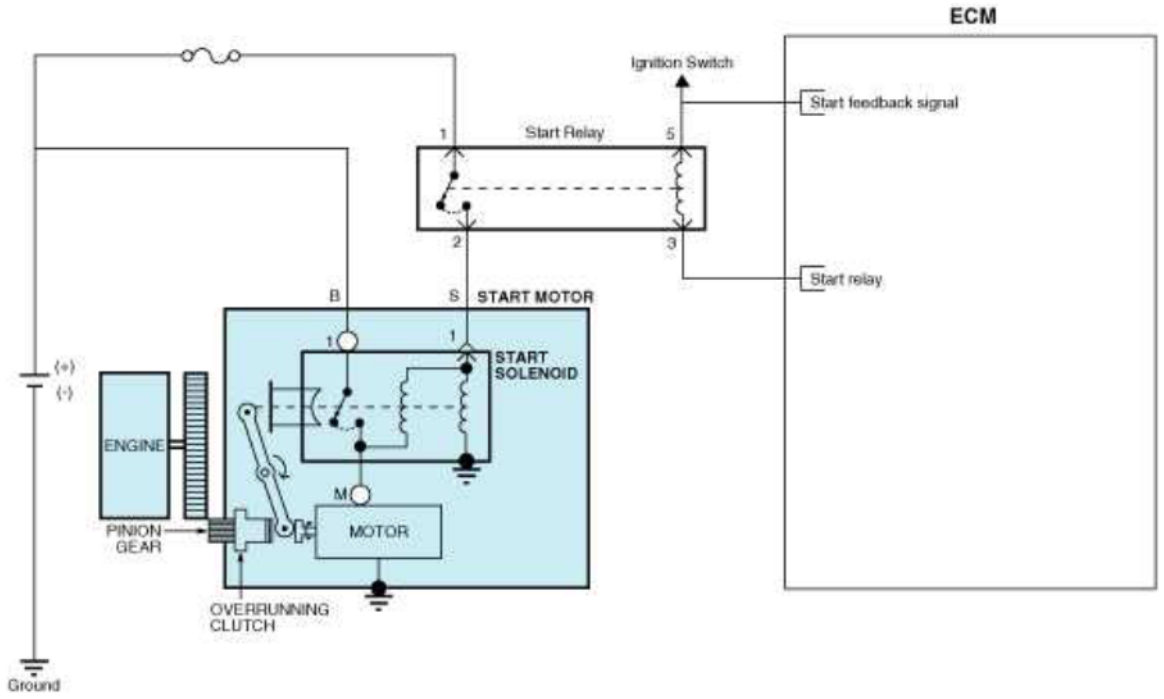


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1. Front housing 2. Starter solenoid assembly 3. Lever 4. Lever packing 5. Planet shaft assembly 6. Planetary gear assembly 7. Packing	8. Shield 9. Amature assembly 10. Brush holder assembly 11. Yoke assembly 12. Rear housing 13. Through bolt

Engine Electrical System

Circuit Diagram



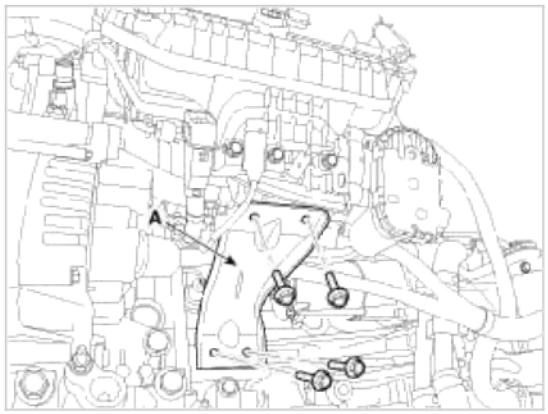
Engine Electrical System

Removal

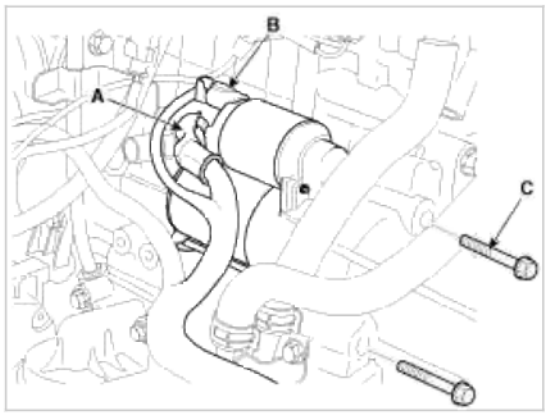
1. Disconnect the battery negative terminal.
2. Remove the air duct and air cleaner assembly.
   (Refer to Engine Mechanical System - "Air Cleaner")
3. Remove the ETC module.
   (Refer to Fuel System - "ETC")

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4. Remove the intake manifold stay (A).



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



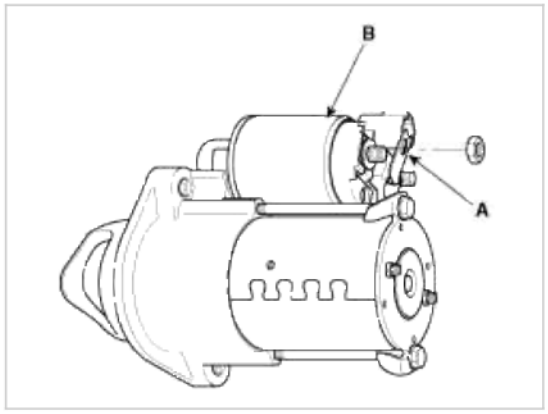
Installation

1. Install in the reverse order of removal.

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

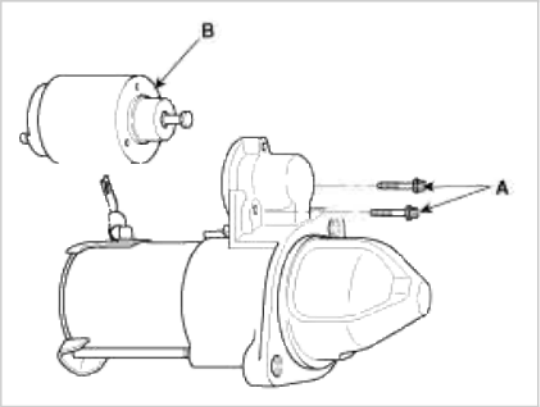
Disassembly

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

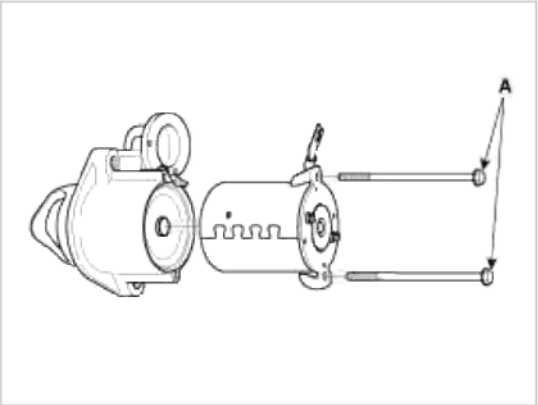


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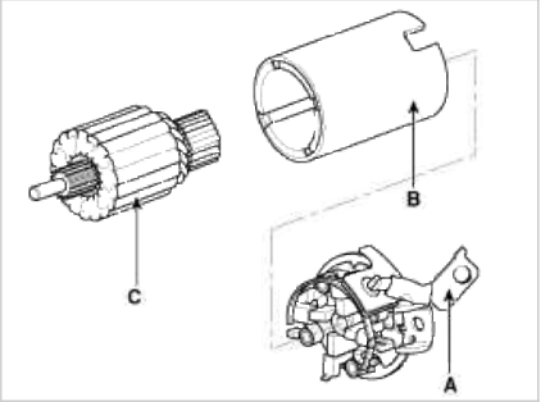
2. After loosening the screws (A), detach the magnet switch assembly (B).



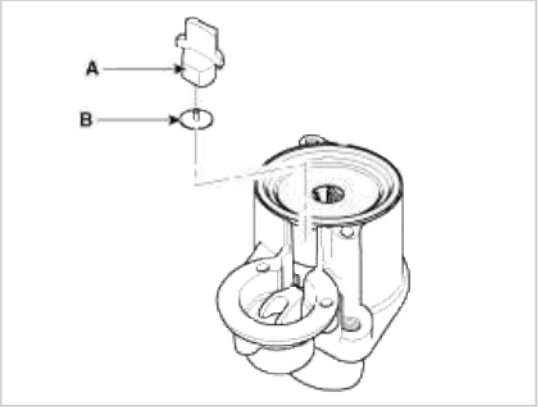
3. Loosen the through bolts (A).



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

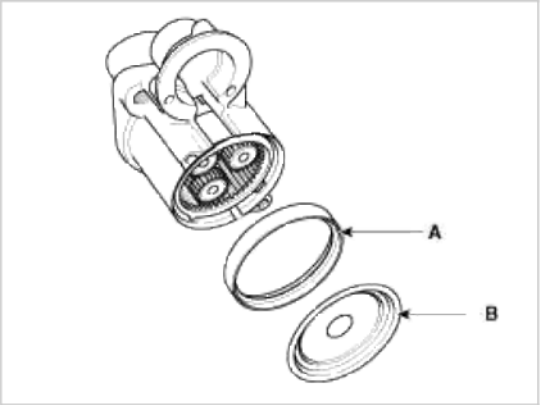


5. Remove the lever plate (B) and lever packing (A).

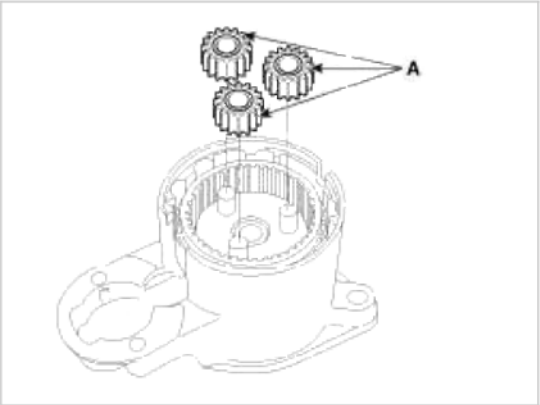


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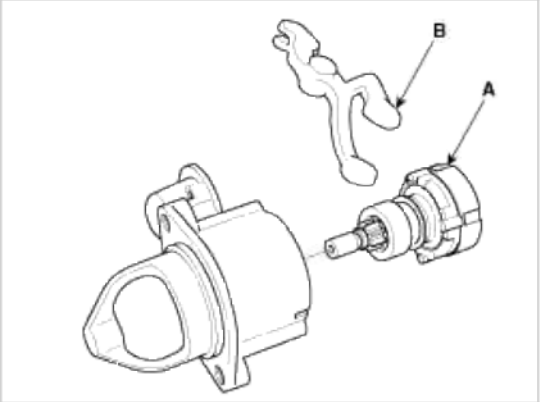
6. Remove the packing (A) and shield (B).



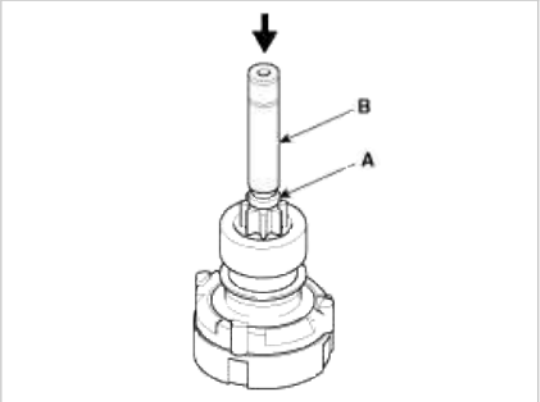
7. Disconnect the planet gear (A).



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

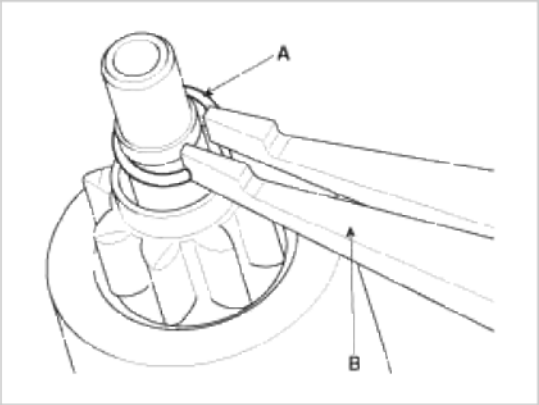


9. Press the stopper (A) using a socket (B).

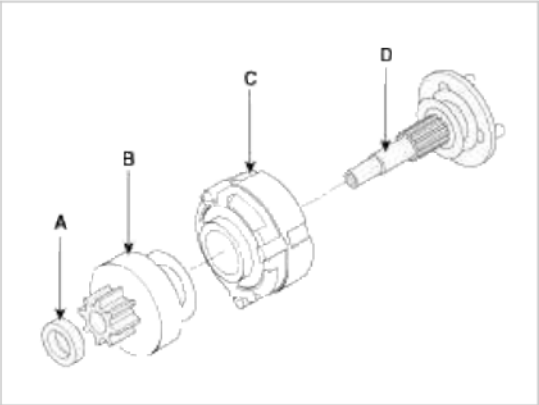


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10. After removing the stop ring (A) using stop ring pliers (B).

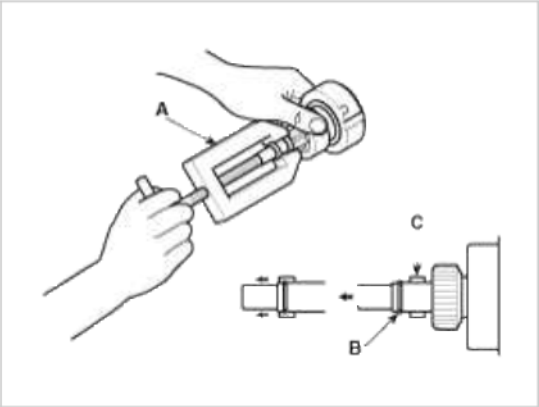


11. Disconnect the stopper (A), overrunning clutch (B), internal gear (C), planet shaft (D) and/or gasket sheet (E).



12. Reassembly is the reverse of disassembly.

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



Reassembly

1. Reassemble in the reverse order of disassembly.

Inspection

Starter Solenoid Inspection

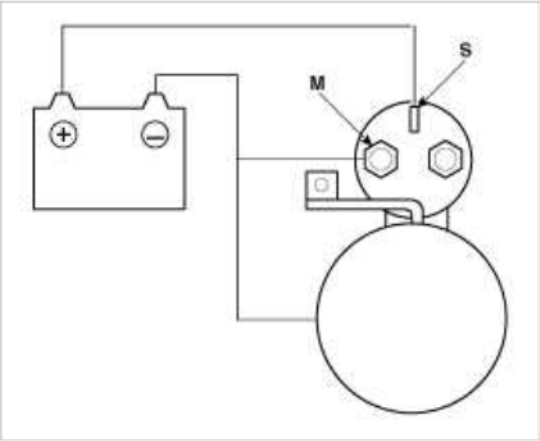
1. Disconnect the lead wire from the M-terminal of solenoid switch.

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2. Connect the battery as shown. If the starter pinion pops out, it is working properly.

NOTICE

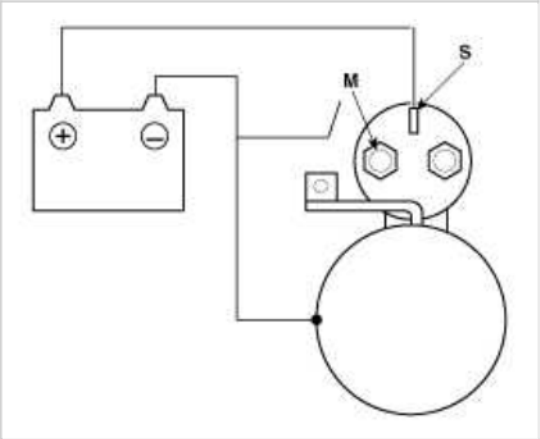
- To avoid damaging the starter, do not leave the battery connected for more than 10 seconds.



3. Disconnect the battery from the M terminal.
   If the pinion does not retract, the hold-in coil is working properly.

NOTICE

- To avoid damaging the starter, do not leave the battery connected for more than 10 seconds.

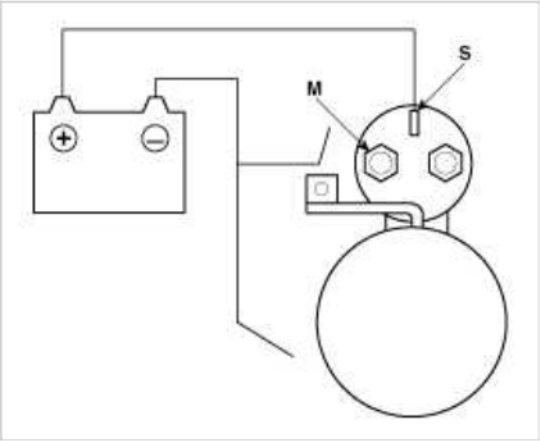


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4. Disconnect the battery also from the body. If the pinion retracts immediately, it is working properly.

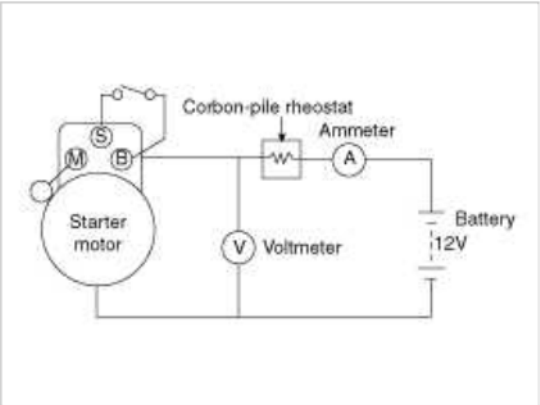
NOTICE

- To avoid damaging the starter, do not leave the battery connected for more than 10 seconds.



Free Running Inspection

1. Place the starter motor in a vise equipped with soft jaws and connect a fully-charged 12-volt battery to starter mo as follows.
2. Connect a test ammeter (150-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 free

Items	Current (Max.)	Speed (Min.)
Non-ISG type	95 A	2,400 rpm

Armature

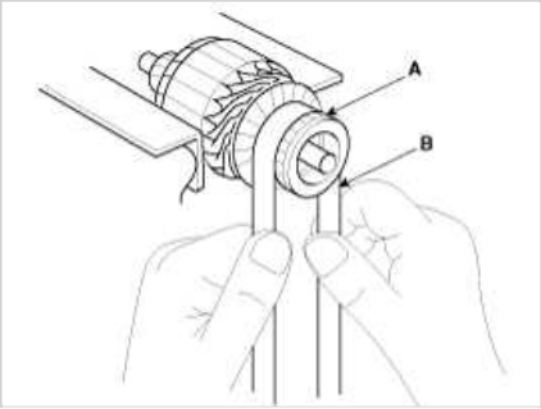
1. Remove the starter.
2. Disassemble the starter as shown at the beginning of this procedure.

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3. Inspect the armature for wear or damage from contact with the permanent magnet. If there is wear or damage, replace the armature.

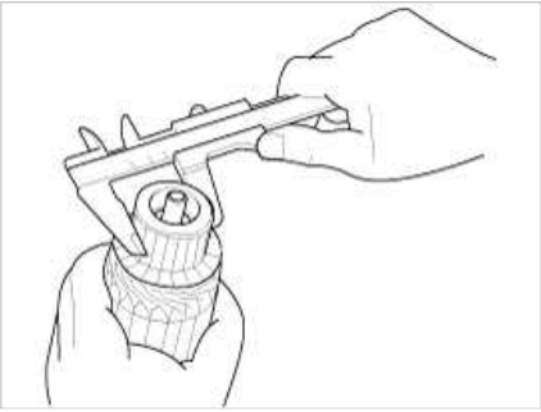


4. Check the commutator (A) surface. If the surface is dirty or burnt, resurface with emery cloth or a lathe within the following specifications, or recondition with #500 or #600 sandpaper (B).



5. Check the commutator diameter. If the diameter is below the service limit, replace the armature.

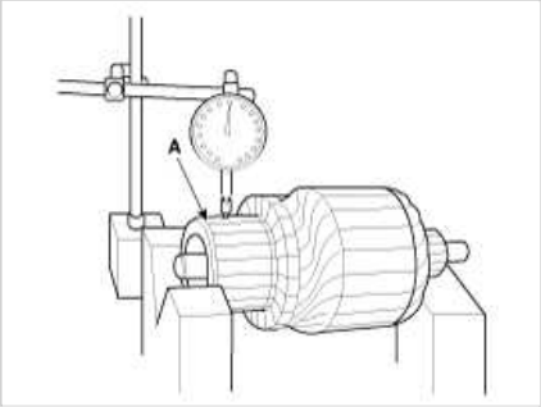
Commutator diameter
Standard (New) : 29.4 mm (1.1575 in)
Service limit : 28.8 mm (1.1339 in)



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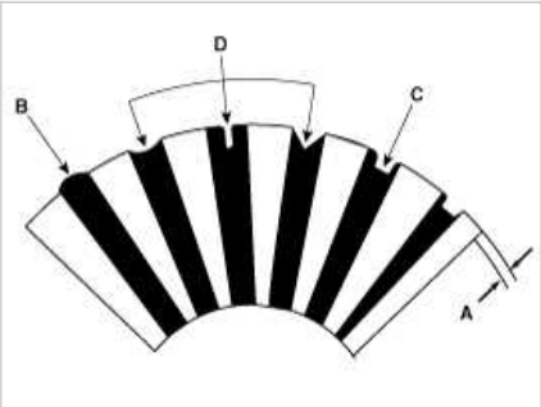
6. Measure the commutator (A) runout.
   A. If the commutator runout is within the service limit, check the commutator for carbon dust or brass chips betw the segments.
   B. If the commutator run out is not within the service limit, replace the armature.

Commutator runout
Standard (New) : 0.05mm (0.0020in.) max
Service limit : 0.10mm (0.0039in.) max



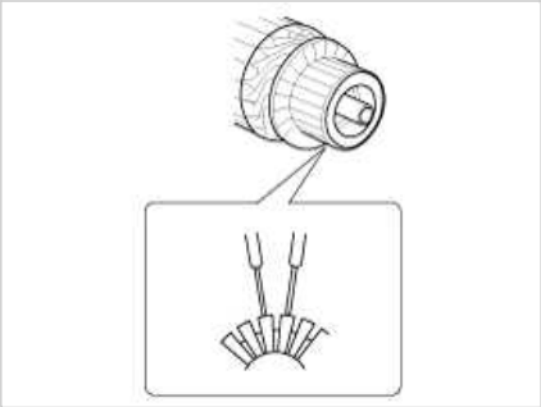
7. Check the mica depth (A). If the mica is too high (B), undercut the mica with a hacksaw blade to the proper dept Cut away all the mica (C) between the commutator segments. The undercut should not be too shallow, too narro or v-shaped (D).

Commutator mica depth
Standard (New) : 0.5 mm (0.0197 in.)
Limit : 0.2mm (0.0079 in.)

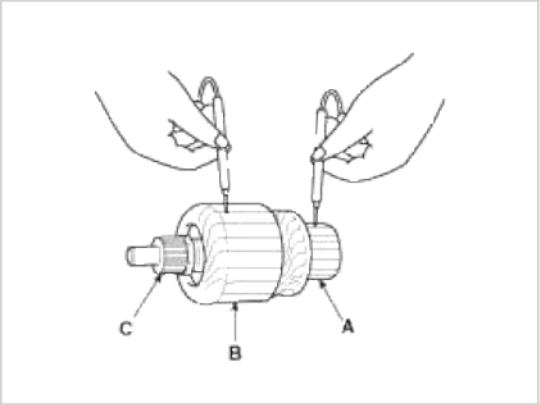


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8. Check for continuity between the segments of the commutator. If an open circuit exists between any segments, replace the armature.



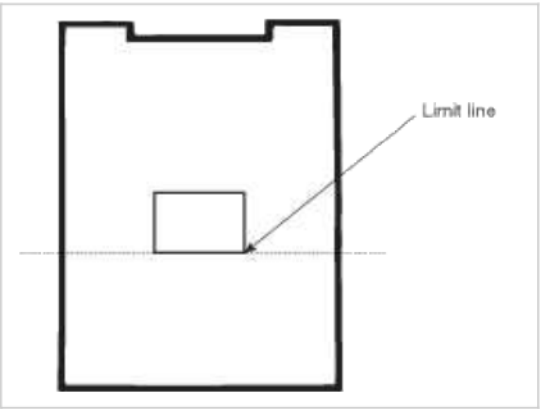
9. Check with an ohmmeter that no continuity exists between the commutator (A) and armature coil core (B), and between the commutator and armature shaft (C). If continuity exists, replace the armature.



Starter Brush

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

Bruch length
Standard : 12.3 mm (0.4843 in)
Service linit : 5.5 mm (0.2165 in)



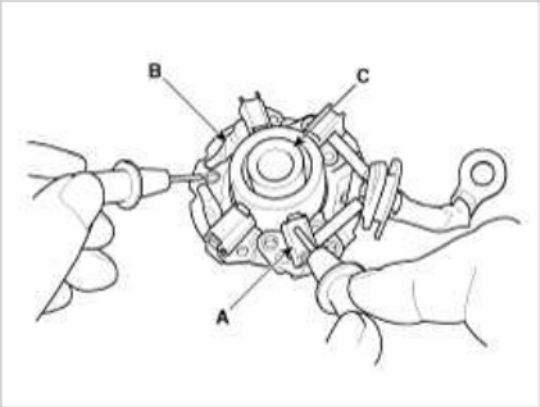
NOTICE

- To seat new brushes, slip a strip of #500 or #600 sandpaper, with the grit side up, between the commutator and each brush, and smoothly rotate the armature. The contact surface of the brushes will be sanded to the same contour as the commutator.

Starter Brush Holder

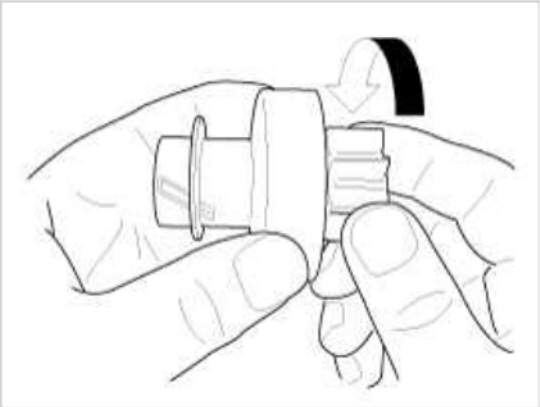
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1. Check that there is no continuity between the (+) brush holder (A) and (-) plate (B).
   If there is continuity, replace the brush holder assembly.



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 of it locks in bot 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 sol-vent 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.

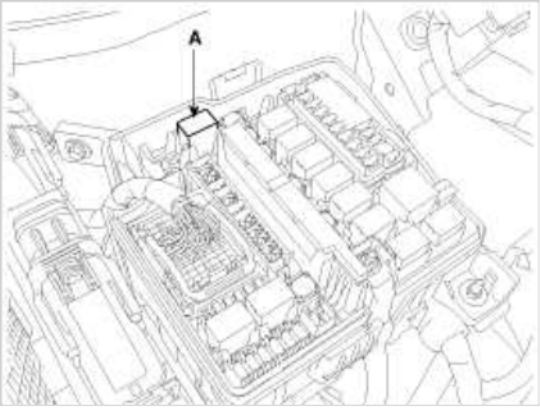
Engine Electrical System

Inspection

1. Disconnect the battery negative terminal.
2. Remove the fuse box cover.

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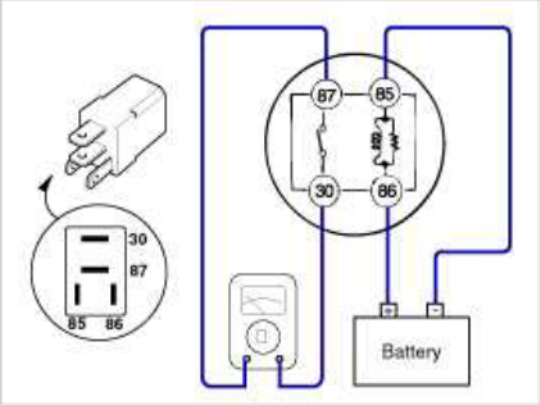
3. Remove the starter relay(A).



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

Terminal	Continuity
30 - 87	NO
85 - 86	YES

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

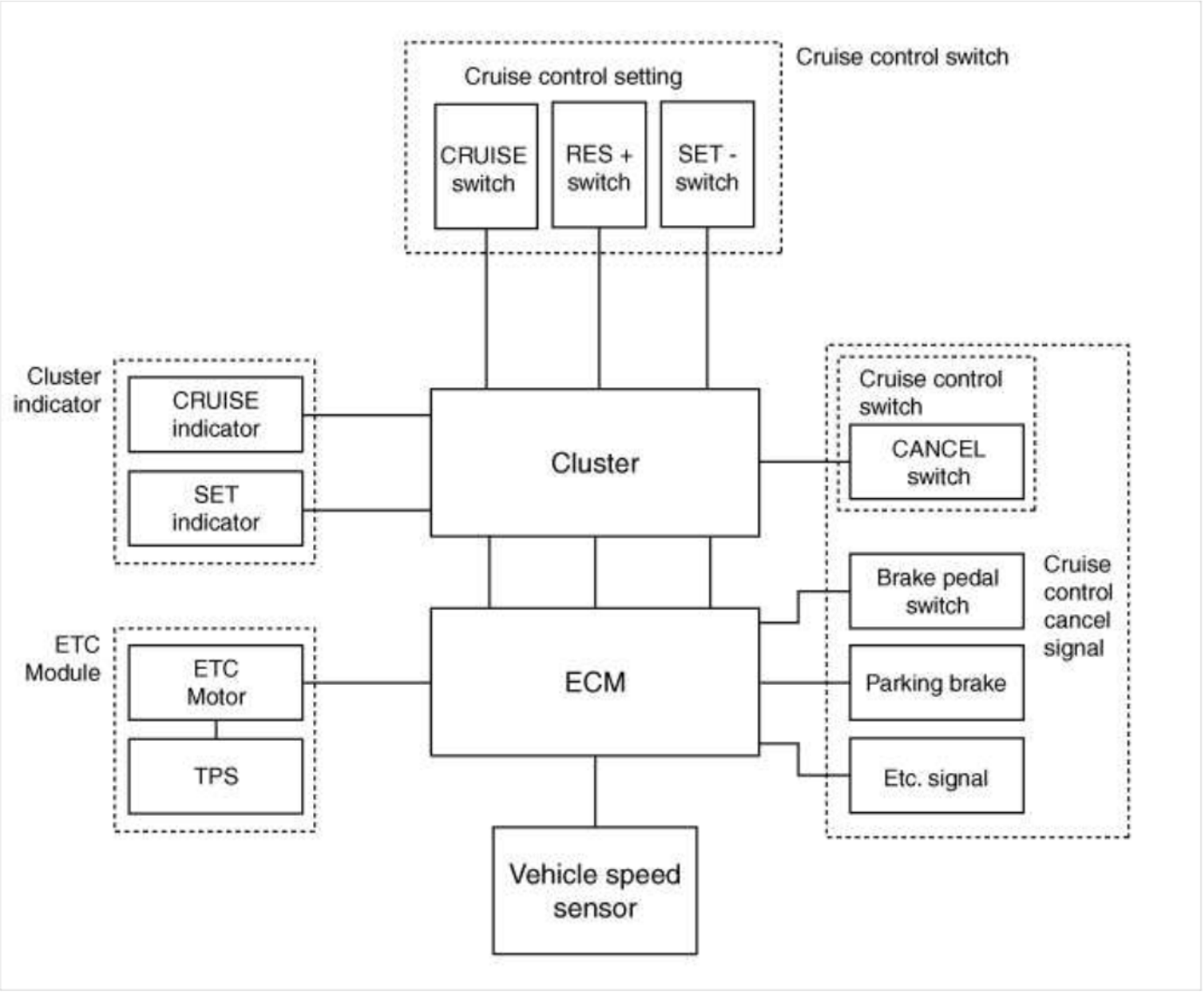


6. If there is no continuity, replace the starter relay.
7. Install the starter relay.
8. Install the fuse box cover.

Engine Electrical System

System Block Diagram

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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 switch is ON (Built into cluste
Cruise Control switches	ON/OFF switch	Switch for automatic speed control power supply.
	RES+ switch	Controls automatic speed control functions by Resume/Accel switch (Set/Coast switch)
	SET- switch	
Cancel switches	Cancel switch	Sends cancel signals to ECM.
	Brake-pedal switch	
	Transaxle range switch (A/T)	
ETC motor		Regulates the throttle valve to the set opening by ECM.

* ETC System : Electronic Throttle Control System

Engine Electrical System

Cruise Control

The cruise control system is engaged by the cruise "ON/OFF" main switch located on right of steering wheel column.

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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 (25m
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 or 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" m 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 instrume 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 2.0km/h (1.2mph) or 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/+" sw 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 2.0km/h (1.2mph) or 1.6km/h (1.0mph).

Cancel switch (CANCEL)

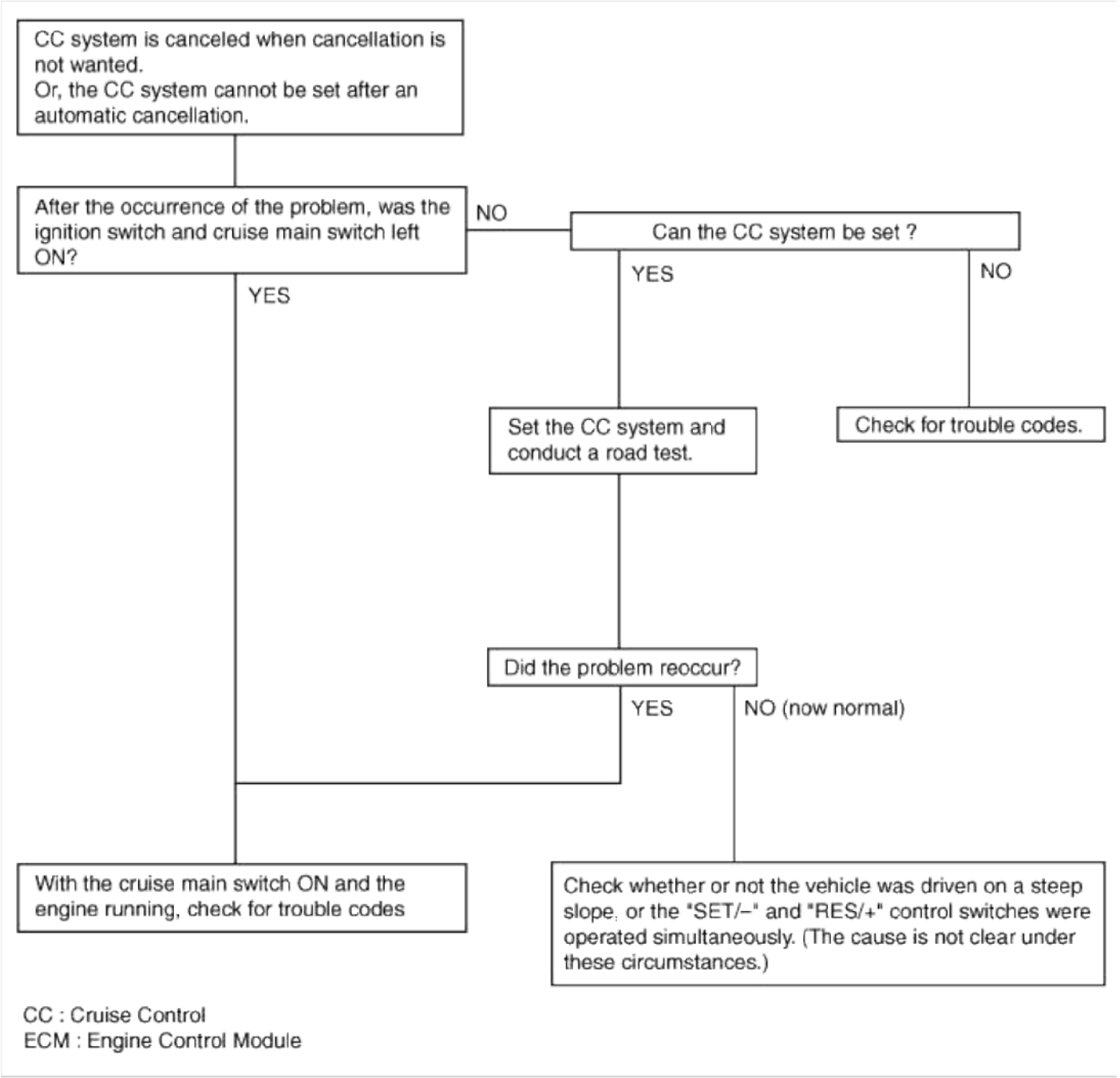
The cruise control system is temporarily disengaged by pushing the "CANCEL" switch.
Cruise speed canceled by this switch can be recovered by pushing the "RES/+" switch.

Engine Electrical System

Trouble Symptom Charts

Trouble Symptom 1

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CC : Cruise Control
ECM : Engine Control Module

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 t brake pedal switch
	Malfunction of the ECM signals	Check input and output signals ECM

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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 replac the "SET/–" switch
	Malfunction of the ECM signals	Check input and output signa 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 repl 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 part
	Malfunction of the ECM signals	Check input and output signals at ECM

Trouble Symptom 8

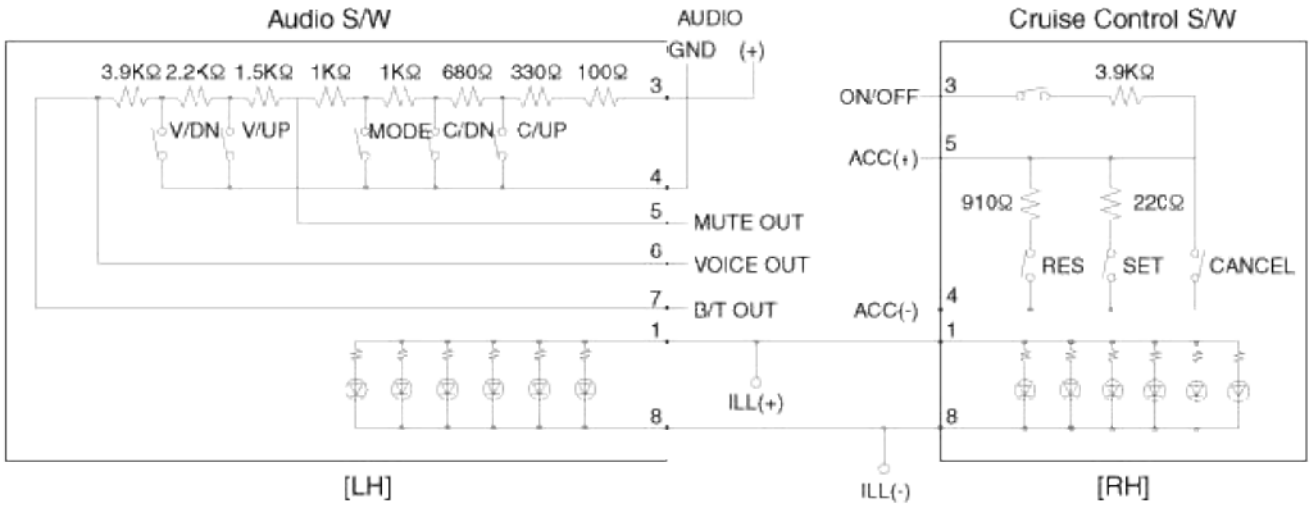
Trouble symptom	Probable cause	Remedy
The cruise main switch indicator lamp does not illuminate (But CC system is normal)	Damaged or disconnected bulb of cruise main switch indicator lamp	Repair the harness o replace the part.
	Harness damaged or disconnected	

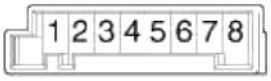
Engine Electrical System

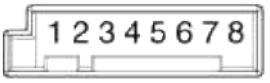
Circuit Diagram

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[Audio + Cruise Control]



Audio S/W Connector	
	
No	Connector
1	ILL (+)
2	-
3	AUDIO (+)
4	AUDIO (-)
5	MUTE OUT
6	VOICE OUT
7	B/T OUT
8	ILL (-)

Cruise Control S/w Connector	
	
No	Connector
1	ILL (+)
2	-
3	ACC ON/OFF
4	ACC (-)
5	ACC (+)
6	-
7	-
8	ILL (-)

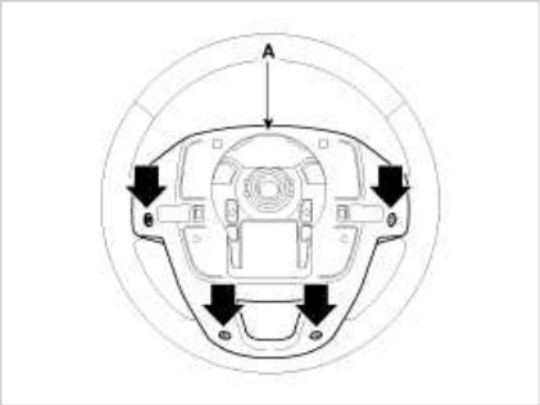
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Engine Electrical System

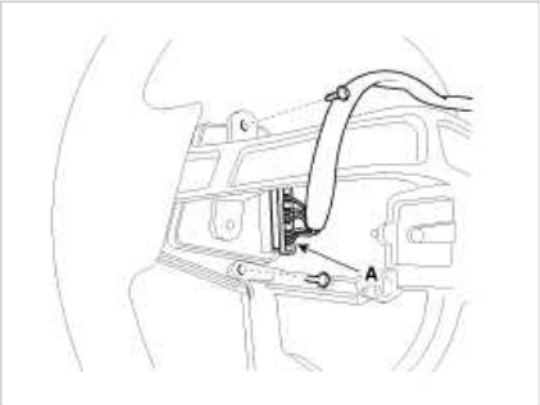
Removal

1. Disconnect the battery (-) terminal.
2. Remove the air-bag module from the steering wheel. (Refer to RT group)

3. Loosen the 4 screws for remove steering wheel rear cover (A).



4. Disconnect the cruise control switch connector (A).



5. Remove the cruise control switch (A).



Installation

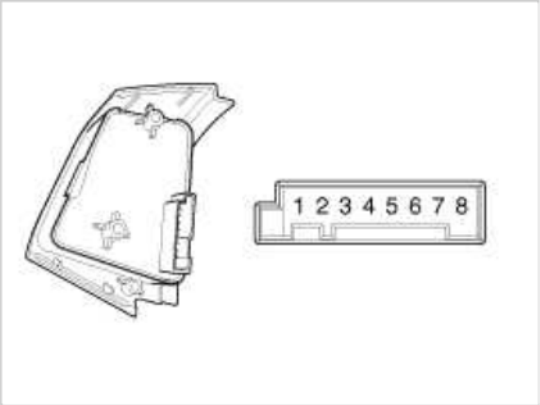
1. Install in the reverse order of removal.

Inspection

Measuring Resistance

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



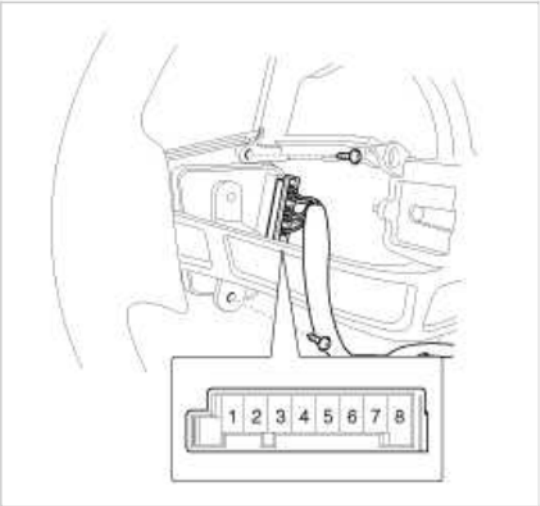
2. Measure resistance between terminals on the control switch when each function switch is ON (switch is depresse

Function switch	Terminal	Resistance
CANCEL	4-5	0Ω
SET/–	4-5	220Ω
RES/+	4-5	910Ω
ON/OFF	3-5	3900Ω

3. If not within specification, replace switch.

Measuring Voltage

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



2. Measure voltage between terminals on the harness side connector when each function switch is ON (switch is depressed).

Function switch	Terminal	Voltage
CANCEL	4-5	0V ~ 0.22V
SET/–	4-5	1.28V ~ 1.77V
RES/+	4-5	2.78V ~ 3.22V
ON/OFF	3-5	-

3. If not within specification, replace switch.38

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