General Information

Specifications

Ignition System

Items			Specification	
			Theta-II 2.0/2.4	Gamma 1.6 GDI
Ignition coil	Primary resistance		0.62 ± 10 % (Ω)	0.75 ± 15 % (Ω)
	Secondary resistance		7.0 ± 15 % (kΩ)	5.9 (kΩ)
Spark plugs	Unleaded	Type	LFR5A-11	SILZKR6B10
		Gap	1.0 ~ 1.1 mm (0.0394 ~ 0.0433 in.)	0.9 ~ 1.0 mm (0.0354 ~ 0.0394 in.)
	Leaded	Type	LFR5A	-
		Gap	0.8 ~ 0.9 mm (0.0315 ~ 0.0354 in.)	

Starting System

Items			Specification					
			R2.0	Theta-II 2.0/2.4	Gamma 1.6 GDI		U-II 1.7	
					Non-ISG	ISG	Non-ISG	ISG
Starter	Rated voltage		12 V, 2.0kW	12V, 1.2kW	12V, 1.2Kw	12V, 1.3kW	12V, 1.7Kw	12V, 1.8Kw
	No. of pinion teeth		11		8	9	11	13
	No-load characteristics	Voltage	11V		11V	12V	11.5V	
		Ampere	125A , MAX	90A, MAX	95A, MAX	95A, MAX	85A, MAX	100A, MAX
		Speed	3,320rpm, MIN	2,600rpm, MIN	2,500rpm, MIN	3,500rpm, MIN	2,550rpm, MIN	2,390rpm, MIN

Charging System

Items			Specification				
			R 2.0	Theta-II 2.0	Theta-II 2.4	Gamma 1.6 GDI	U-II 1.7
Alternator (A-MS)	Rate voltage		13.5V, 150A	13.5V, 110A			13.5V, 130A
	Speed in use		1,000 ~ 18,000 rpm				
	Voltage regulator		IC Regulator built-in type				
	Regulator setting voltage	External mode	ECU control				
		Internal mode	VALEO: 14.1 ± 0.3V DENSO: 14.5 ± 0.3V	14.4 ± 0.1V		14.1 ± 0.3V	14.55 ± 0.3V
	Temperature compensation	External mode	ECU control				
		Internal mode	VALEO: -3.5 ± 2mV/°C DENSO: -4.4 ± 4mV/°C	-3.5 ± 2mV/°C			
Alternator (Non-AMS)	Rate voltage		13.5V, 150A	13.5V, 110A		-	
	Speed in use		1,000 ~ 18,000 rpm				
	Voltage regulator		IC Regulator built-in type				
	Regulator setting voltage		14.55 ± 0.2V	14.55 ± 0.2V			
	Temperature compensation		-7 ± 2mV/°C	-3.5 ± 1mV/°C			
Battery (Non-ISG)	Type		72-30FR	48-23GL	56-26FL	48-23GL	72-30FR
	Cold cranking amperage [at -18°C (-0.4°F)]		720A	550A	600A	550A	720A
	Reserve capacity		160 min.	92 min.	113 min.	92 min.	160 min.
	Specific gravity [at 25°C(77°F)]		1.280 ± 0.01				
Battery (ISG)	Type		-			56-28GL (A-GM)	64-31GL (A-GM)
	Cold cranking amperage [at -18°C (-0.4°F)]					760A	800A
	Reserve capacity					120 min	155 min
	Specific gravity [at 25°C(77°F)]					1.310 ± 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˚C(80.1˚F).**

NOTICE

- Battery type notation : MF 48 - 23 G L
  ① ② ③ ④ ⑤

① : Battery type
- MF : Maintenance Free

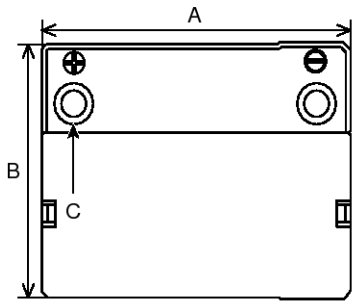
② : Battery capacity (5HR)
- 48 : 48AH

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

SVGE10111L



SXMEE9103L

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

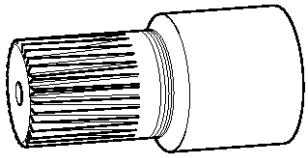
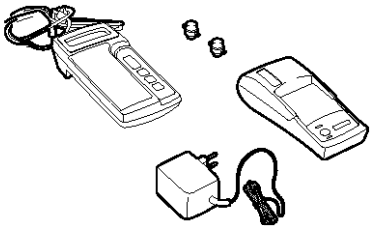
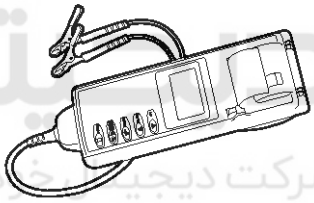
Charging System

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	Disconnect the voltage regulator to see if light turns off. 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	Disconnect the voltage regulator or alternator to see if light turns off. If light turns off, replace voltage regulator.
	Wiring	Repair or replace wiring
Overcharge	Electronic voltage regulator	Disconnect the voltage regulator to see if light turns off. 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	Disconnect the voltage regulator or alternator to see if light turns off. If light turns off, replace voltage regulator.
	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 TR 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	Replace
	Ignition switch	Replace
Starter spins but engine will not crank	Short in wiring	Repair wiring
	Pinion gear teeth broken or starter motor	Replace
	Ring gear teeth broken	Replace fly wheel or torque converter

Reference Service Tools

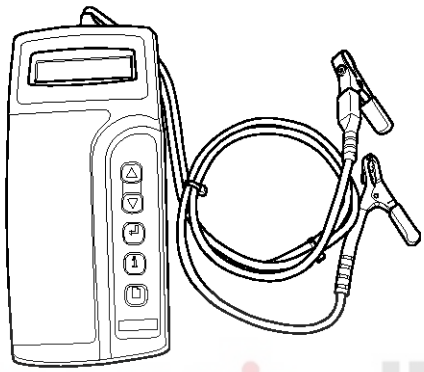
Tool (Number and name)	Illustration	Use
Alternator pulley remover wrench (09373-27000)	 EBDD700A	Removal and installation of alternator pulley
Micro-570 Battery checker	 LBLG001A	- Check the battery condition - Check the charging and starting system
MDX-670P Battery checker	 SMDE11029D	- Check the battery condition - Check the charging and starting system

The Micro 570 Analyzer

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

⚠CAUTION

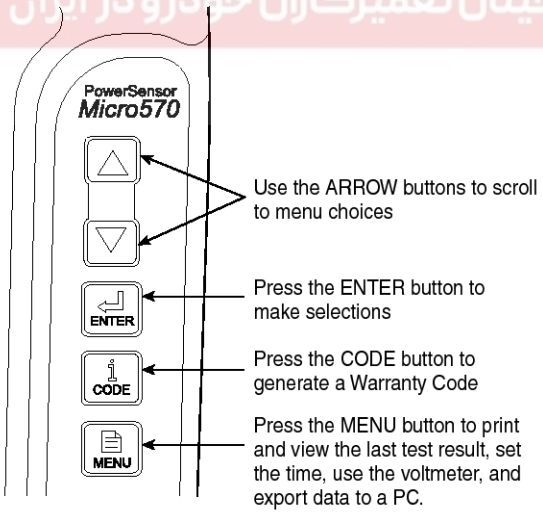
Because of the possibility of personal injury, always use extreme caution and appropriate eye protection when working with batteries.



EBKD001A

Keypad

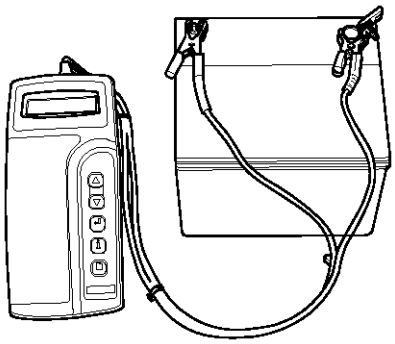
The Micro 570 button on the key pad provide the following functions :



LBGE012A

Battery Test Procedure

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

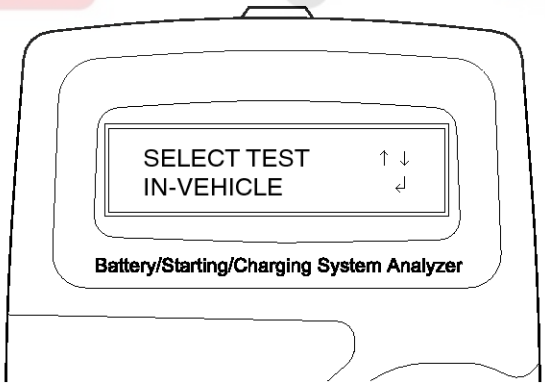


EBKD001C

⚠CAUTION

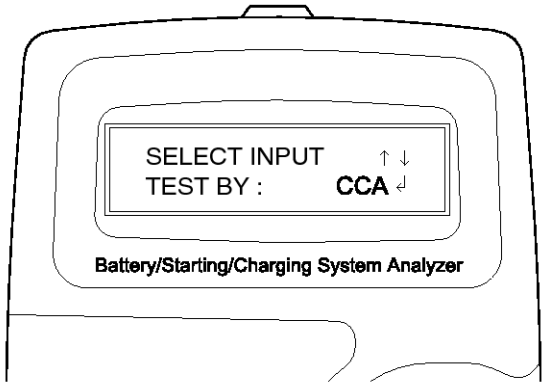
Connect clamps securely. If "CHECK CONNECTION" message is displayed on the screen, reconnect clamps securely.

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



SXMEE9129D

3. Select CCA and press the ENTER button.

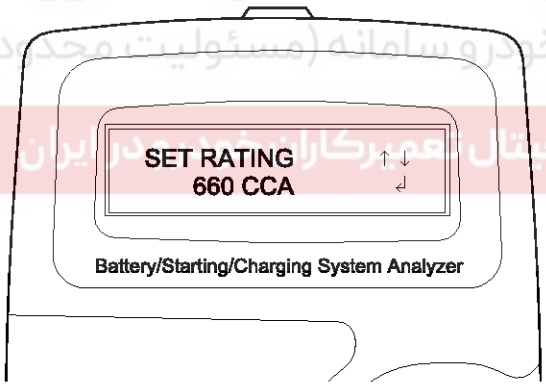


SXMEE9130D

NOTICE

CCA : Cold cranking amps, is an SAE specification for cranking batteried at -0.4˚F (-18˚C).

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

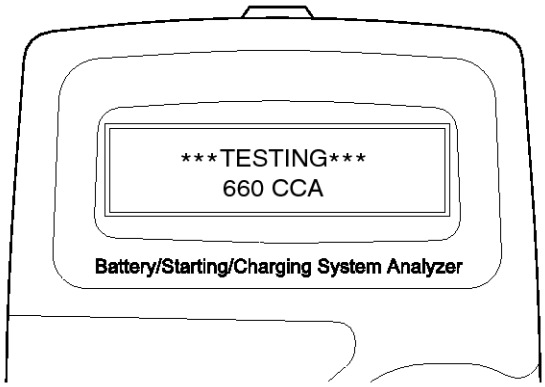


EBKD001F

NOTICE

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

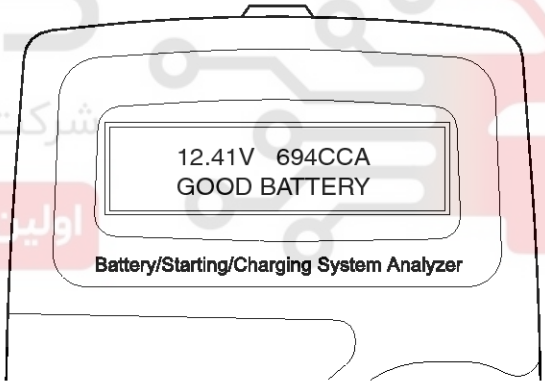
5. The tester will conduct battery test.



SXMEE9131D

6. The tester displays battery test results including voltage and battery ratings.

   Refer to the following table and take the appropriate action as recommended by the Micro 570.



SXMEE9132D

Battery Test Results

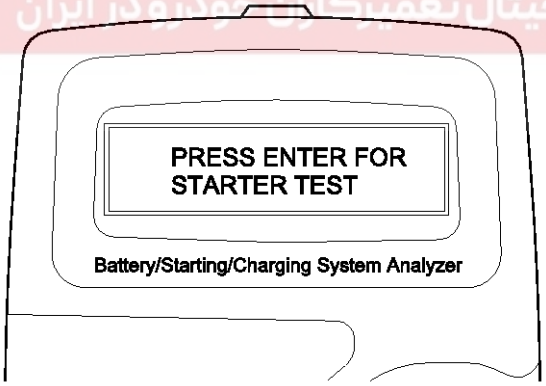
Result On Printer	Remedy
GOOD BATTERY	No action is required.
GOOD RECHARGE	Battery is in a good state. - Recharge the battery and use. (Battery may be charged by running the engine at idle for 20 minutes.)
CHARGE & RETEST	Battery is not charged properly. - Charge and test the battery again. (Failure to charge the battery fully may read incorrect measurement value.)
REPLACE BATTERY	Replace battery and recheck the charging system. - Improper connection between battery and vehicle cables may cause "REPLACE BATTERY". Retest the battery after removing cables and connecting the tester to the battery terminal directly prior to replacing the battery.
BAD CELL-REPLACE	Charge and retest the battery. - If the Micro 570 recommends "REPLACE BATTERY", replace the battery and recheck the charging system.

WARNING

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

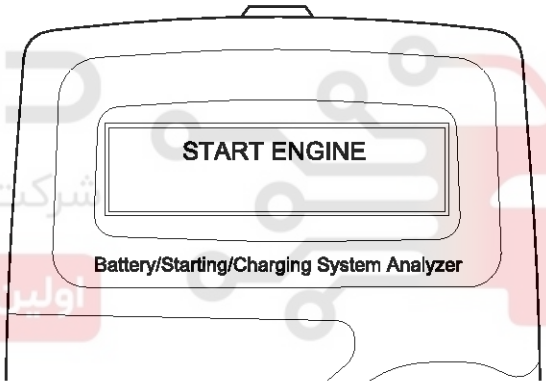
Starter Test Procedure

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



EBKD001H

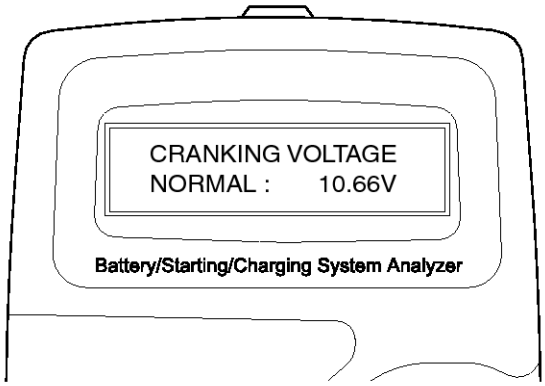
8. Start the engine.



EBKD001I

9. Cranking voltage and starter test results will be displayed on the screen.

   Refer to the following table and take the appropriate action as recommended by the Micro 570.



SXMEE9133D

Starter Test Results

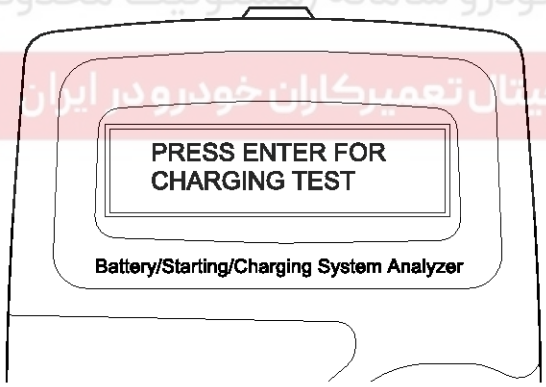
Result On Printer	Remedy
CRANKING VOLTAGE NORMAL	System shows a normal starter draw.
CRANKING VOLTAGE LOW	Cranking voltage is lower than normal level. - Check starter.
CHARGE BATTERY	The state of battery charge is too low to test. - Charge the battery and retest.
REPLACE BATTERY	Replace battery. - If the vehicle is not started though the battery condition of "GOOD BATTERY" is displayed, check wiring for open circuit, battery cable connection, starter and repair or replace as necessary. - If the engine does crank, check fuel system.

NOTICE

When testing the vehicle with old diesel engines, the test result will not be favorable if the glow plug is not heated. Conduct the test after warming up the engine for 5 minutes.

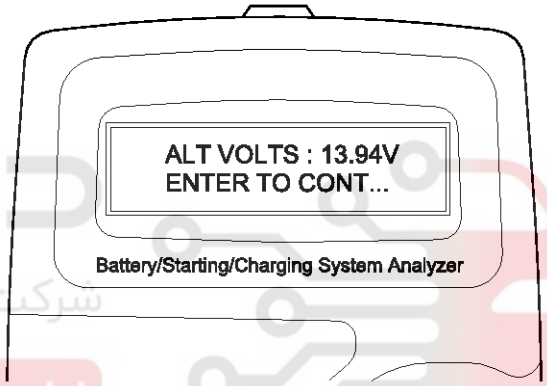
Charging System Test Procedure

10. Press ENTER to begin charging system test.



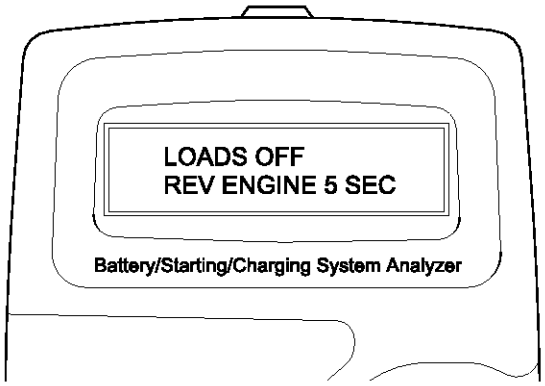
EBKD001K

11. The tester displays the actual voltage of alternator.
    Press ENTER to continue.

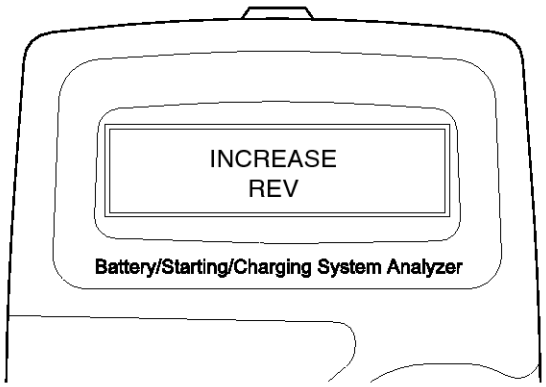


EBKD001L

12. Turn off all electrical load and rev engine for 5 seconds with pressing the accelerator pedal. (Follow the instructions on the screen)



EBKD001M



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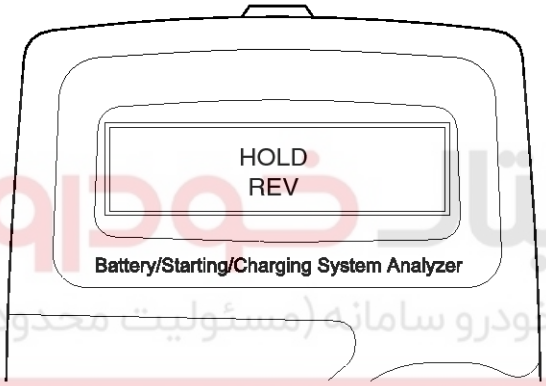
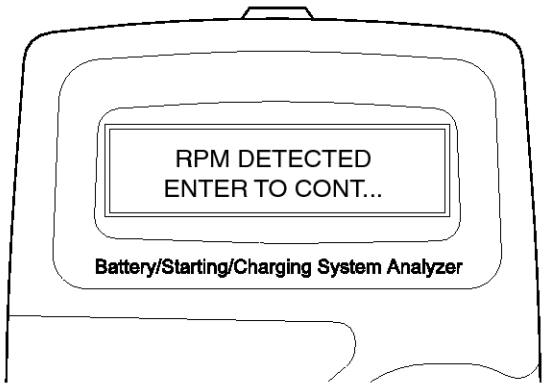


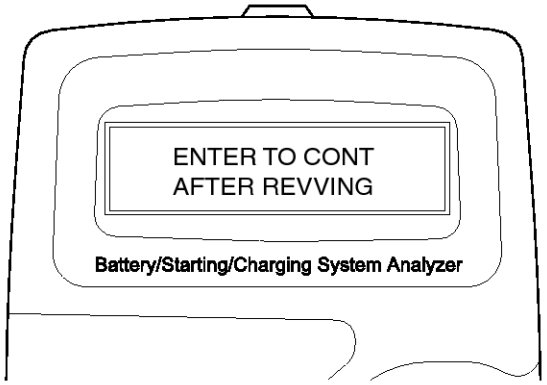
SXMEE9135D

13. The message that engine RPM is detected will be displayed on the screen. Press ENTER to continue.



SXMEE9136D

14. If the engine RPM is not detected, press ENTER after revving engine.



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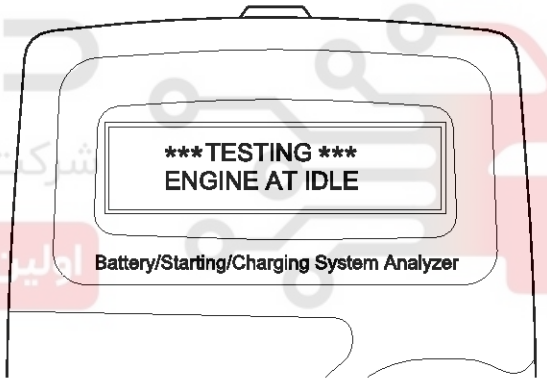
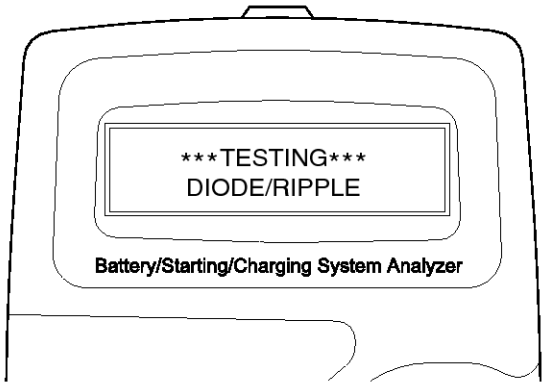
15. The tester will conduct charging system test during loads off.

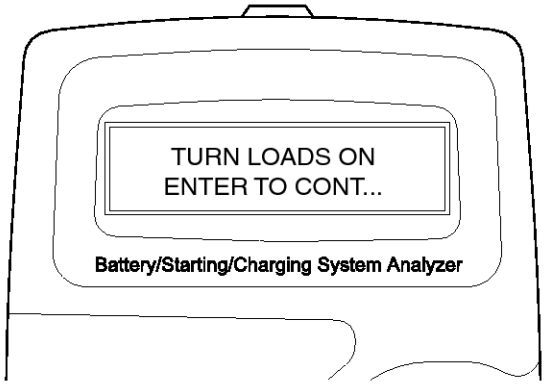


EBKD001O



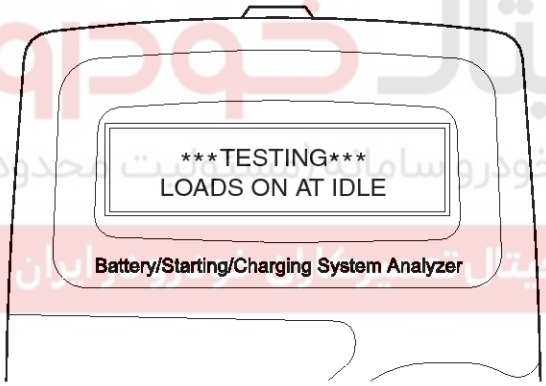
SXMEE9138D

16. Turn on electrical loads (air conditioner, lamps, audio and etc). Press ENTER to continue.



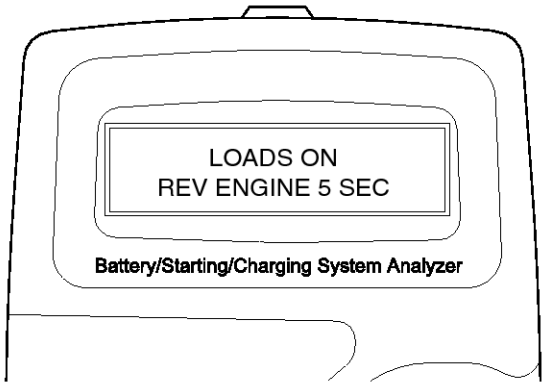
SXMEE9139D

17. The tester will conduct charging system test during loads on.



SXMEE9140D

18. Rev engine for 5 seconds with pressing the accelerator pedal. (Follow the instructions on the screen)



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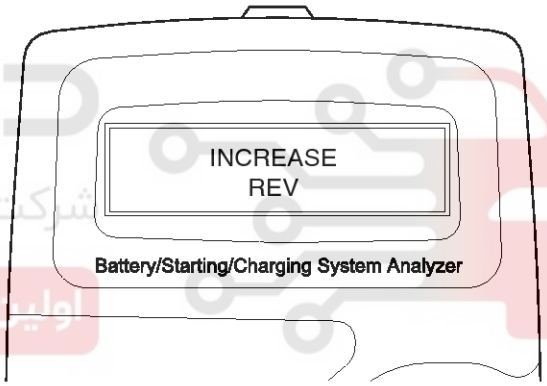
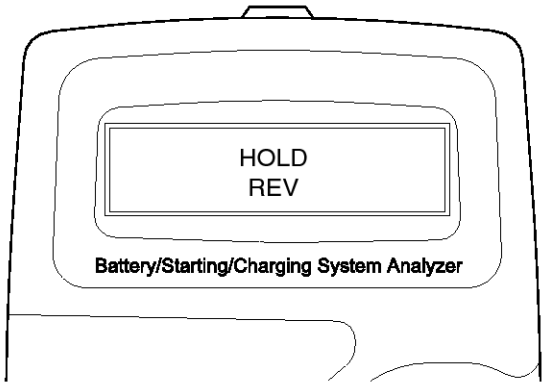
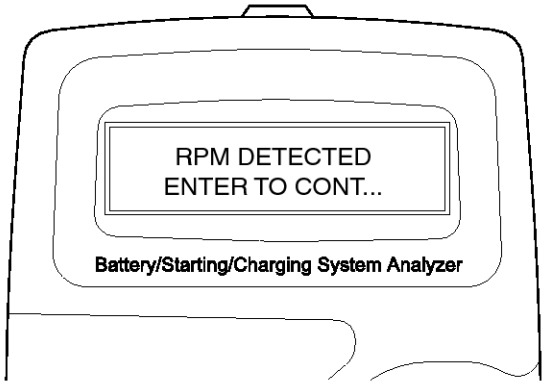


SXMEE9142D



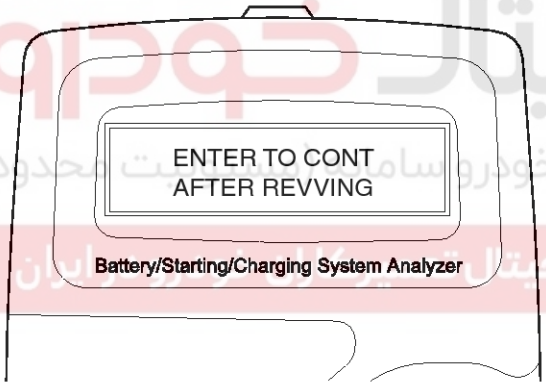
SXMEE9143D

19. The message that engine RPM is detected will be displayed on the screen. Press ENTER to continue.



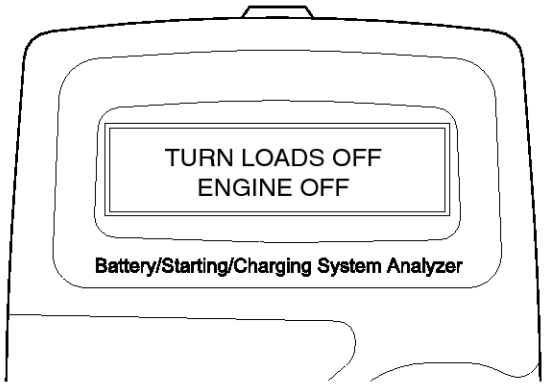
SXMEE9144D

20. If the engine RPM is not detected, press ENTER after revving engine.



SXMEE9145D

21. Turn off electrical loads (air conditioner, lamps, audio and etc). Turn the engine off.



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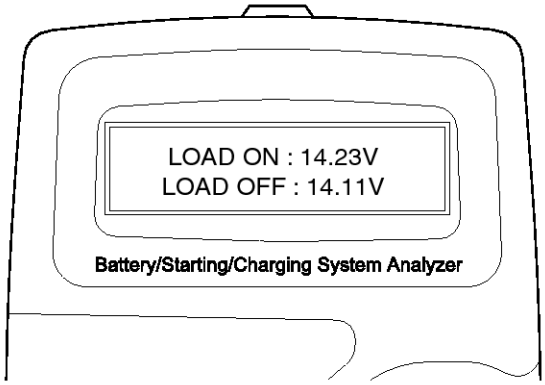
22. Charging voltage and charging system test results will be displayed on the screen.

Shut off engine end disconnect the tester clamps from the battery. Refer to the following table and take the appropriate action as recommended by the Micro 570.



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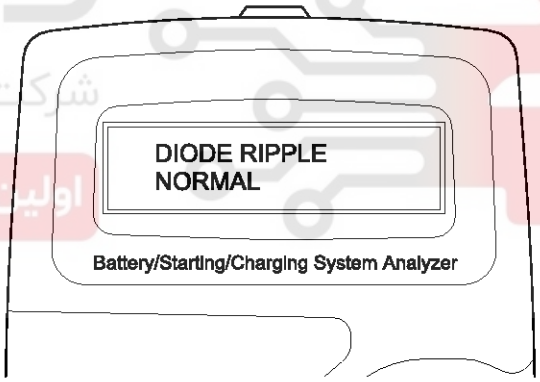

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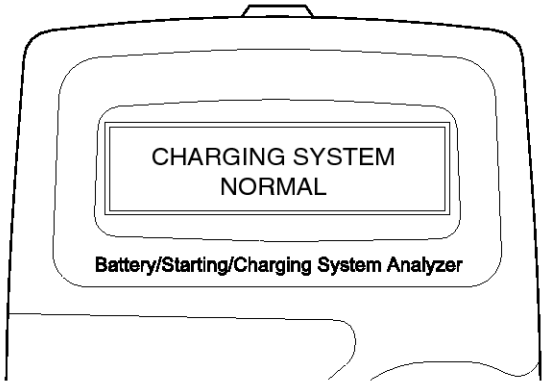


SXMEE9148D

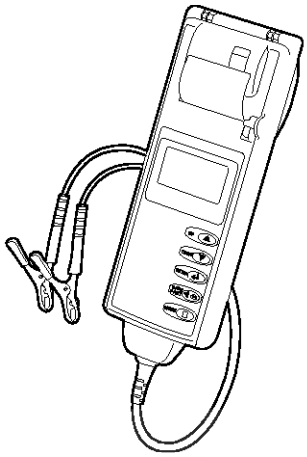
Charging System Test Results

Result On Printer	Remedy
CHARGING SYSTEM NORMAL / DIODE RIPPLE NORMAL	Charging system is normal.
NO CHARGING VOLTAGE	Alternator does not supply charging current to battery. - Check belts, connection between alternator and battery and replace belts or cable or alternator as necessary.
LOW CHARGING VOLTAGE	Alternator does not supply charging current to battery and electrical load to system fully. - Check belts and alternator and replace as necessary.
HIGH CHARGING VOLTAGE	The voltage from alternator to battery is higher than normal limit during voltage regulating. - Check connection and ground and replace regulator as necessary. - Check electrolyte level in the battery.
EXCESS RIPPLE DETECTED	One or more diodes in the alternator is not functioning properly. - Check alternator mounting and belts and replace as necessary.

The MDX-670P Analyzer

The MDX-670P battery conductance and electrical system analyzer tests batteries as well as starting and charging systems for vehicle.

It displays the test results in seconds and features a built-in printer to provide a copy of the results.



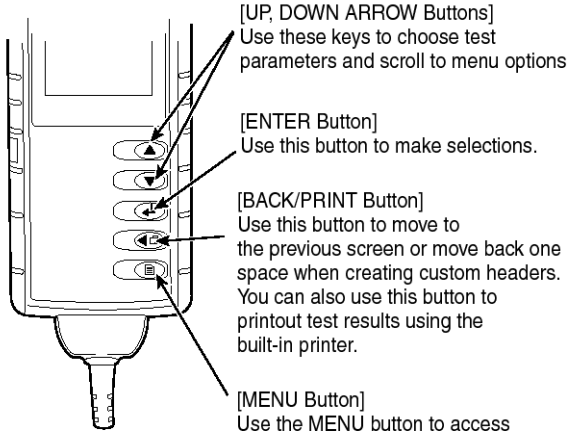
SMDE11001D

CAUTION

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

NOTICE

When testing the vehicle with old diesel engines, the test result will not be favorable if the glow plug is not heated. Conduct the test after warming up the engine for 5 minutes.



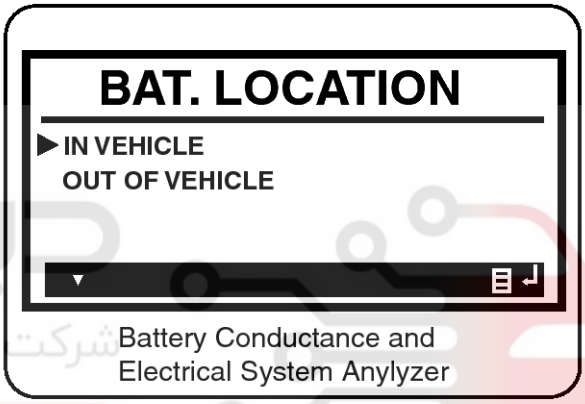
SSLEE1050L

1. Connect the red clamp to the positive (+) terminal and the black clamp to the negative (–) terminal.

   NOTICE

   For a proper connection, rock the clamps back and forth. The tester re¬quires that both sides of each clamp be firmly connected before testing. A poor connection will produce a CHECK CONNECTION or WIGGLE CLAMPS message. If the message appears, clean the terminals and reconnect the clamps.

2. Scroll to and select IN VEHICLE or OUT OF VEHICLE for a battery not connected to a vehicle.

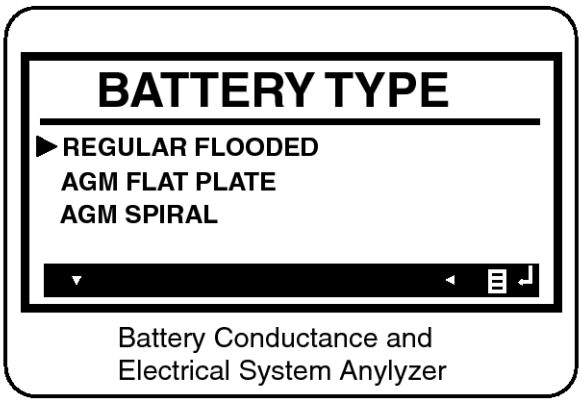


SMDE11004D

NOTICE

Following an IN VEHICLE test you will be prompted to test the starting and charging systems.

3. Scroll to and select REGULAR FLOODED, AGM FLAT PLATE, or AGM SPIRAL where applicable.



SMDE11005D

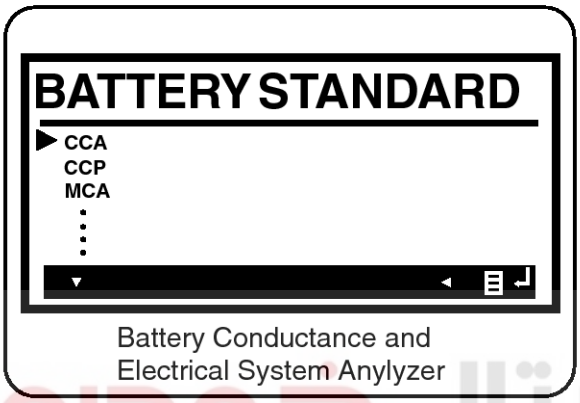
NOTICE

If the vehicle equipped with ISG function, select the AGM FLAT PLATE.

4. Scroll to and select the battery's rating system.

NOTICE

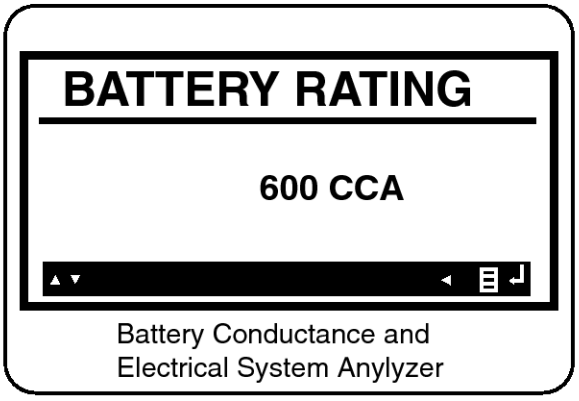
Mostly, the CCA value is marked on the battery label, but sometimes marked EN or SEA value. Select one of them.



SMDE11006D

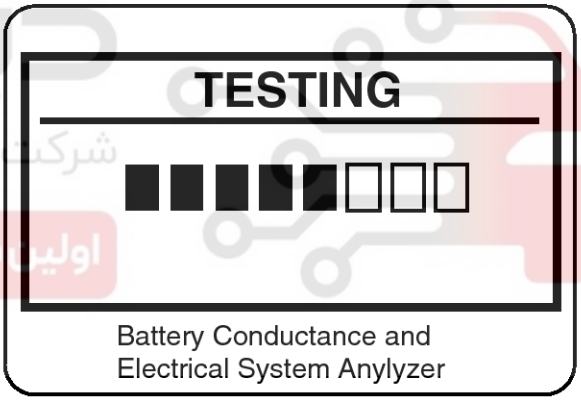
- CCA: Cold Cranking Amps, as specified by SAE. The most common rating for cranking batteries at 0 ºF (–17.8 ºC).
- EN: Europe-Norm
- SEA: Society of Automotive Engineers, the European labeling of CCA

5. Set the selected rating value displayed on the screen to the value marked on the battery label by pressing up and down arrow buttons.



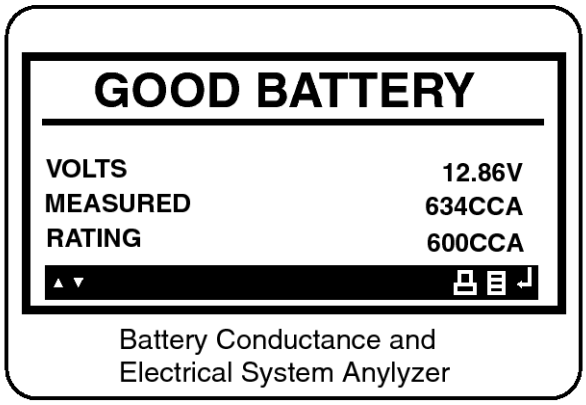
SMDE11007D

6. Press ENTER to start test.



SMDE11008D

7. After several seconds the tester displays the decision on the battery's condition and the measured voltage. The tester also displays your selected battery rating and the rating units.



SMDE11009D

Result On Printer	Remedy
GOOD BATTERY	No action is required.
GOOD RECHARGE	Battery is in a good state.Recharge the battery and use. (Battery may be charged by running the engine at idle for 20 minutes.)
CHARGE & RETEST	Battery is not charged properly. - Charge and test the battery again. (Failure to charge the battery fully may read incorrect measurement value.)
REPLACE BATTERY	Replace battery and recheck the charging system. - Improper connection between battery and vehicle cables may cause "REPLACE BATTERY", retest the battery after removing cables and connecting the tester to the battery terminal directly prior to replacing the battery.
BAD CELLREPLACE	Charge and retest the battery. - If recommends "REPLACE BATTERY", replace the battery and recheck the charging system.

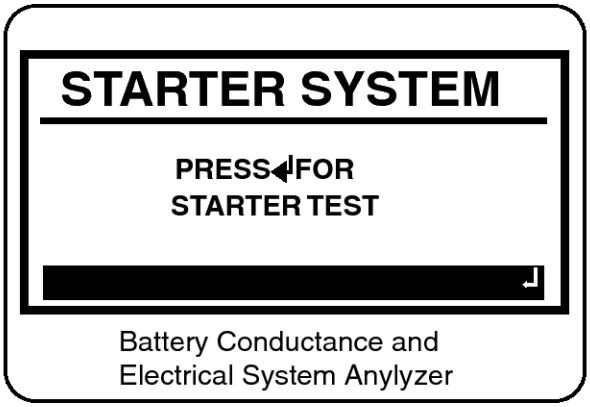
NOTICE

For an in-vehicle test, the display alternates between the test results and the message "PRESS FOR STARTER TEST.

NOTICE

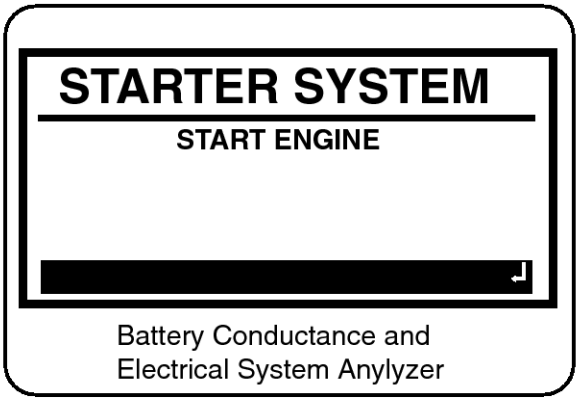
Before starting the test, inspect the alternator drive belt. A belt that is glazed or worn, or lacks the proper tension, will prevent the engine from achieving the rpm levels needed for the test.

8. Press the ENTER button to proceed with the starter test.



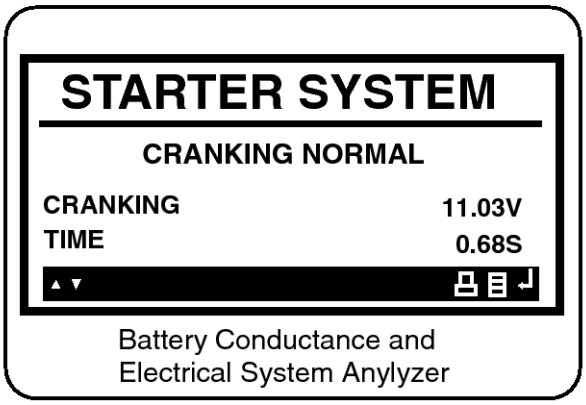
SMDE11010D

9. Start the engine when prompted.



SMDE11011D

10. The tester displays the decision on the starter system, cranking voltage, and cranking time in milliseconds.



SMDE11012D

Starter Test Results

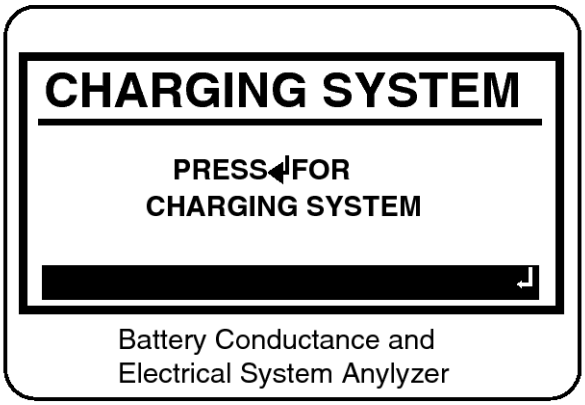
Result On Printer	Remedy
CRANKING VOLTAGE NORMAL	System shows a normal starter draw.
CRANKING VOLTAGE LOW	Cranking voltage is lower than normal level. - Check starter.
CHARGE BATTERY	The state of battery charge is too low to test. - Charge the battery and retest.
REPLACE BATTERY	Replace battery. - If the vehicle is not started though the battery condition of "GOOD BATTERY" is displayed, check wiring for open circuit, battery cable connection, starter and repair or replace as necessary. - If the engine does crank, check fuel system.

NOTICE

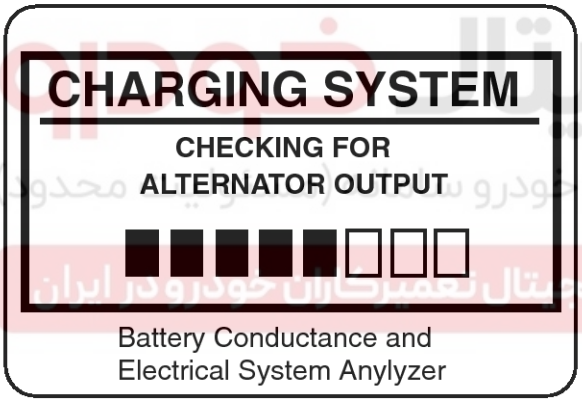
For an in-vehicle test, the display alternates between the test results and the message "PRESS FOR CHARGING TEST.

Step 3: Charging System Test

11. Press the ENTER button to proceed with the charging test.

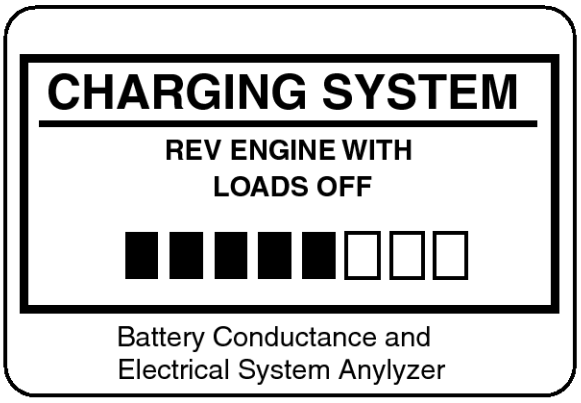


SMDE11013D



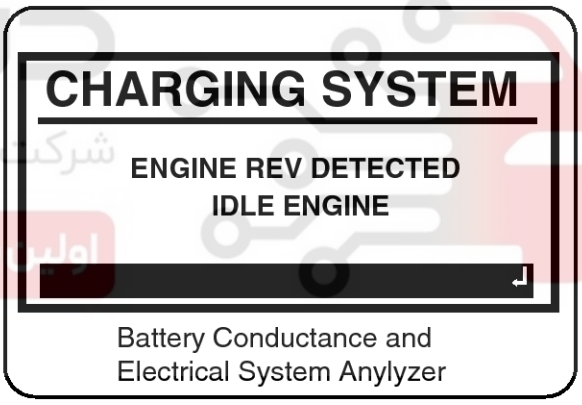
SMDE11014D

12. Rev the engine with loads off. (Following the on-screen prompts)



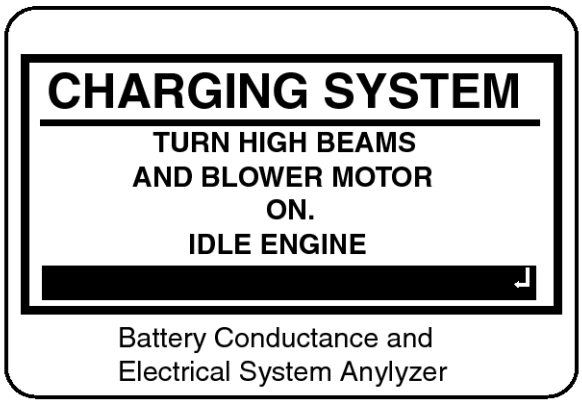
SMDE11015D

13. The message that engine RPM is detected will be displayed on the screen, idle the engine.



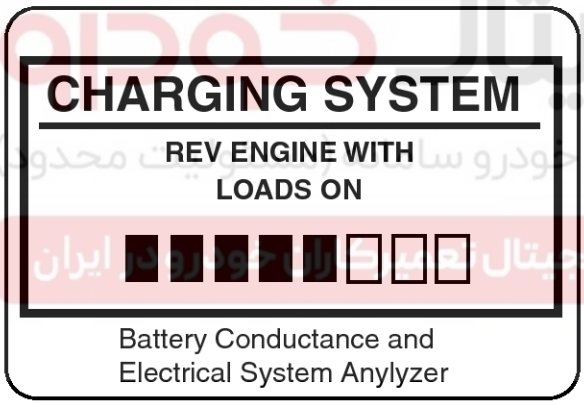
SMDE11016D

14. Turn on electrical loads (air conditioner, lamps, audio and etc). Press ENTER to continue.



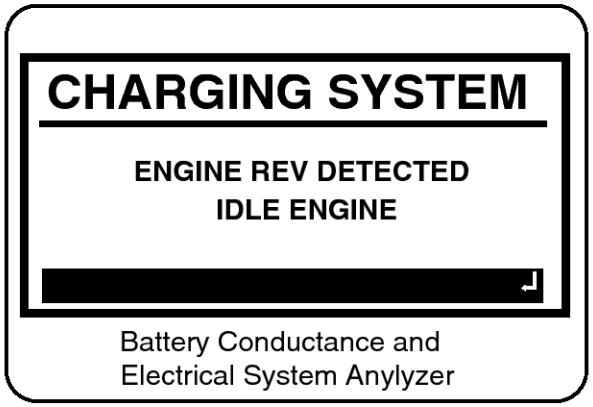
SMDE11017D

15. Turn on electrical loads (air conditioner, lamps, audio and etc). Press ENTER to continue.



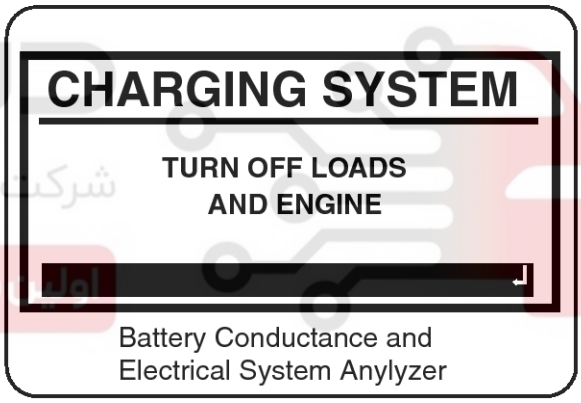
SMDE11018D

16. The message that engine RPM is detected will be displayed on the screen, idle the engine.



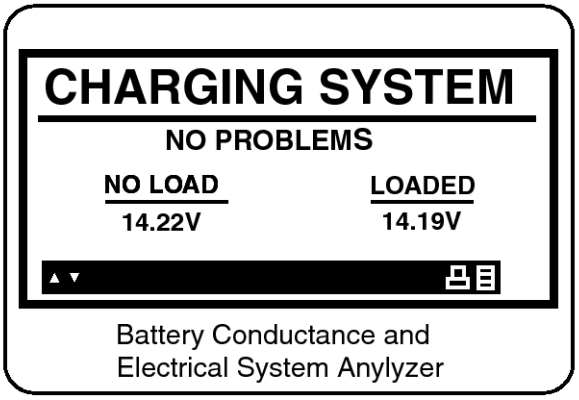
SMDE11019D

17. Turn off loads and engine.



SMDE11020D

18. The Charging System decision is displayed at the end of the procedure.



SMDE11021D

Result On Printer	Remedy
NO PROBLEMS	System is showing normal output from the alternator.
NO OUTPUT	No alternator output detected. - Check all connections to and from the alternator, especially the connection to the battery. If the connection is loose or heavily corroded, clean or replace the cable and retest. - If the belts and connections are in good working condition, replace the alternator. (Older vehicles use external voltage regulators, which may require only replacement of the voltage regulator.)
LOW OUTPUT	Alternator does not supply charging current to battery and electrical load to system fully. - Check belts and alternator and replace as necessary.
HIGH OUTPUT	The voltage from alternator to battery is higher than normal limit during voltage regulating. - Check connection and ground and replace regulator as necessary. - Check electrolyte level in the battery.
EXCESSIVE RIPPLE	The voltage from alternator to battery is higher than normal limit during voltage regulating. - Check alternator mounting and belts and replace as necessary.
CHARGE BATTERY	The starter voltage is low and the battery is discharged. Fully charge the battery and repeat the starter system test.
REPLACE BATTERY	Battery must be replaced before the starting system can be tested.

19. Press the BACK/PRINT button to print the test results or MENU to return to the Options Menu.

Ignition System

Descrition (Theta-II 2.0/2.4, Gamma 1.6 GDI)

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).

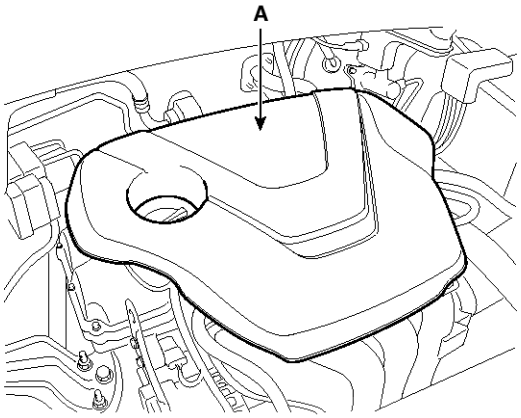
The engine operating conditions (speed, load, warm-up condition, etc.) are detected by the various sensors. Based on these sensor signals and the ignition timing data, signals to interrupt the primary current are sent to the ECM. The ignition coil is activated, and timing is controlled.

On-vehicle Inspection

Spark Test

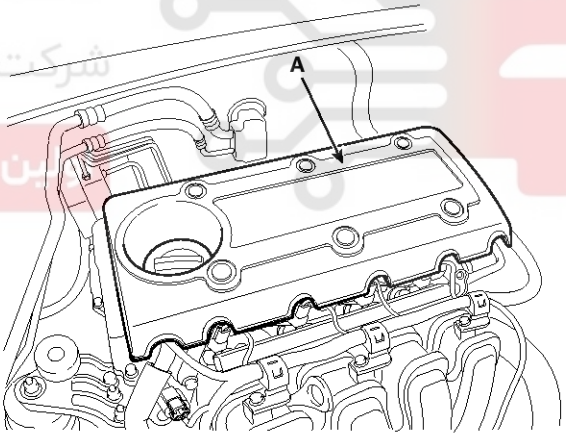
1. Remove the engine cover (A).

[Gamma]



SSLM11001L

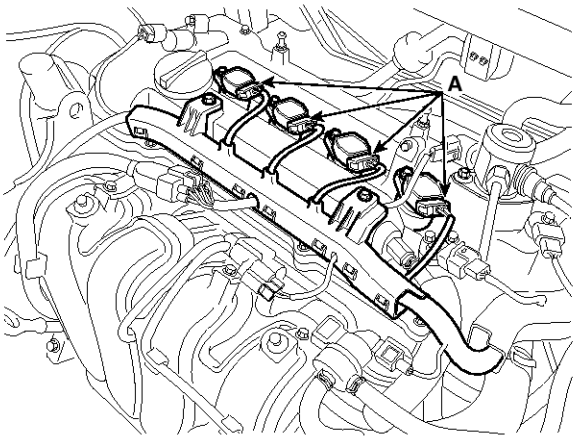
[Theta-II]



SSLM10004D

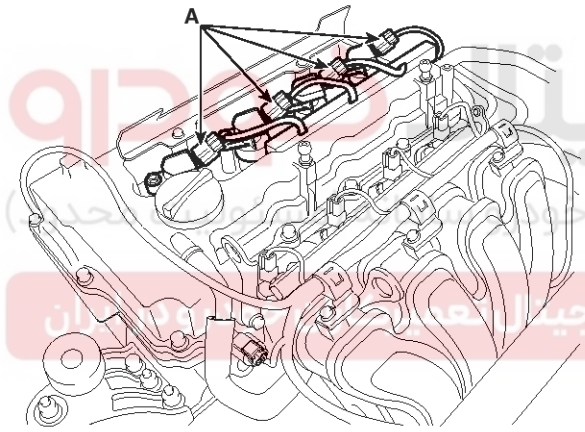
2. Remove the ignition coil connectors (A).

[Gamma]



SSLEE1105L

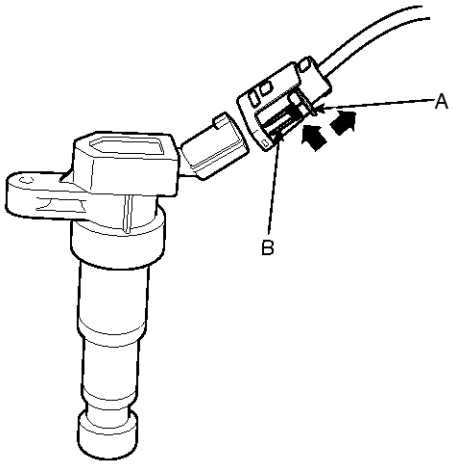
[Theta-II]



SSLE10105D

NOTICE

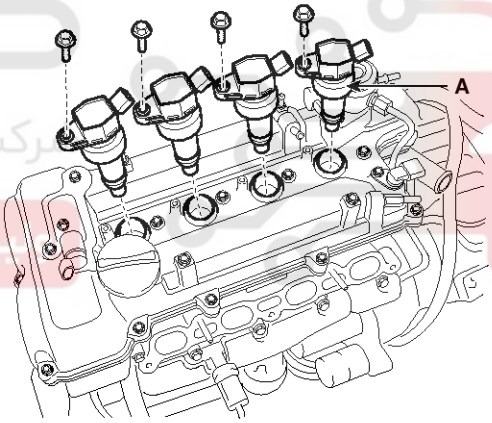
When removing the ignition coil connector, pull the lock pin (A) and push the clip (B).



STQEE9001D

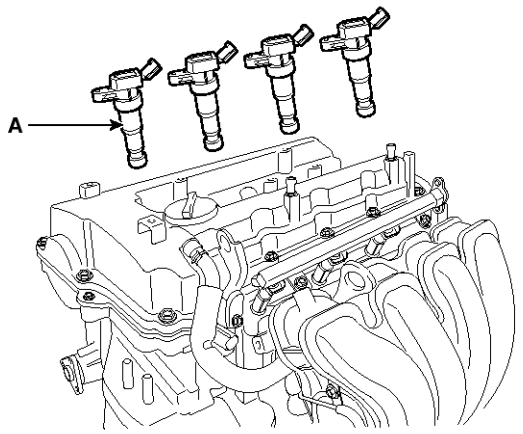
3. Remove the ignition coils (A).

[Gamma]



SMDEE1012D

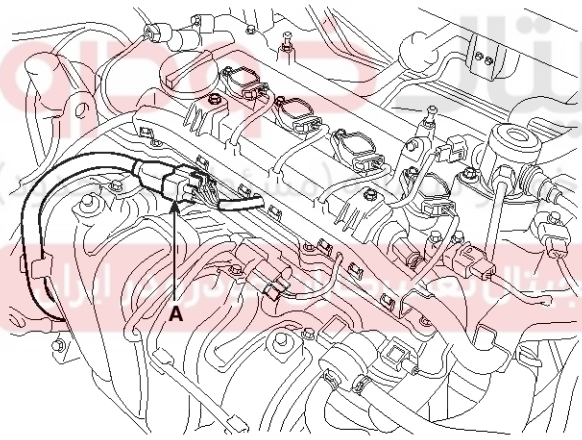
[Theta-II]



SSLM10002D

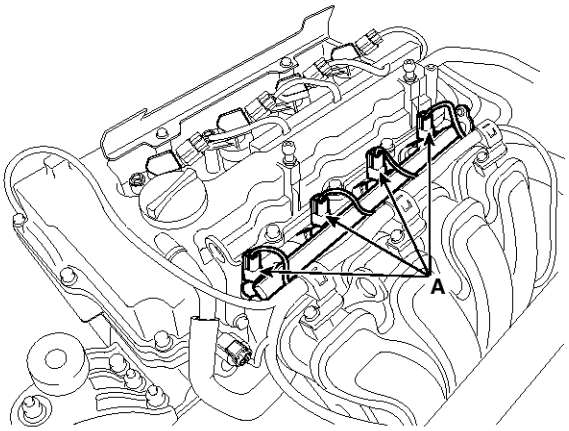
4. Disconnect the injector connector or extension connector (A).

[Gamma]



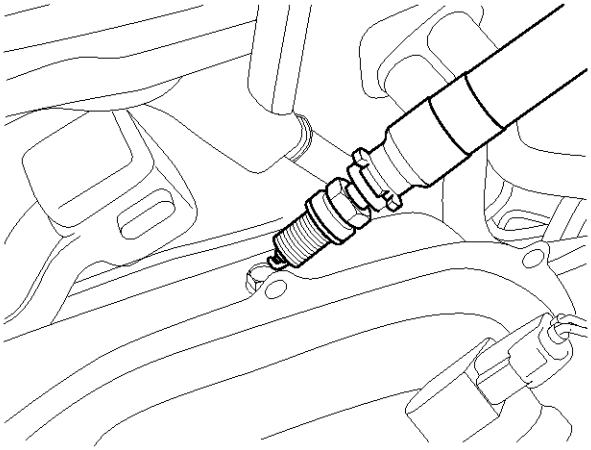
SSLEE1106L

[Theta-II]



SSLM10130D

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



SHDEE6003D

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

NOTICE

To prevent fuel being injected from injectors while the engine is being cranked, disconnect the fuel pump connector.

Crank the engine for no more than 5 ~ 10 seconds.

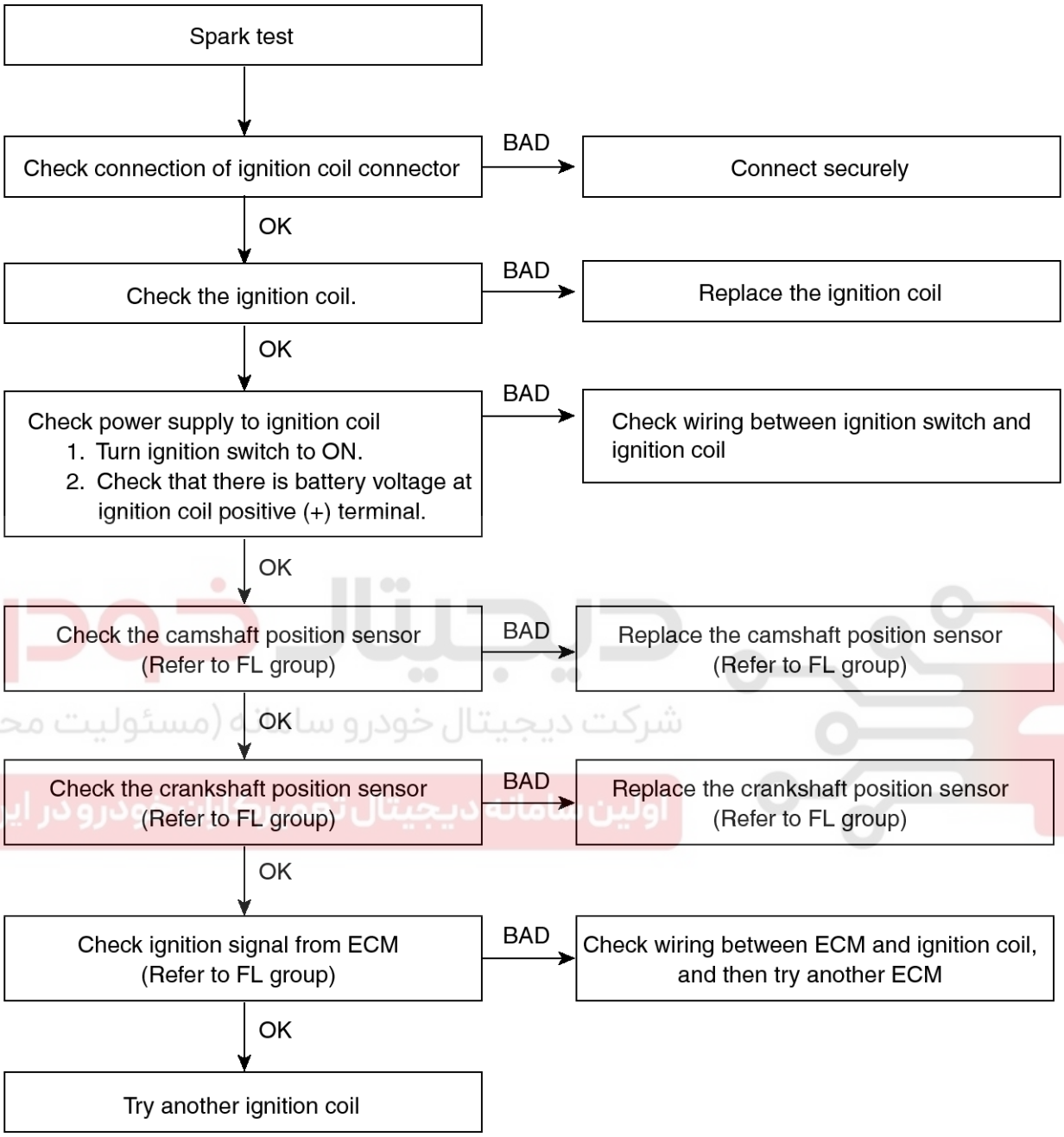
9. Inspect all the spark plugs.
10. Using a spark plug socket, install the spark plug.
11. Install the ignition coil.

Tightening torque :
Gamma 1.6 GDI :
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)
Theta-II 2.0/2.4 :
3.9 ~ 5.9 N.m (0.4 ~ 0.6 kgf.m, 2.9 ~ 4.3 lb-ft)

NOTICE

When inserting ignition coil into the cylinder head cover for spark plug to be inserting ignition coil, the sealing cap of ignition coil must be mated totally with inner side of cylinder head.

12. Reconnect the ignition coil connectors.

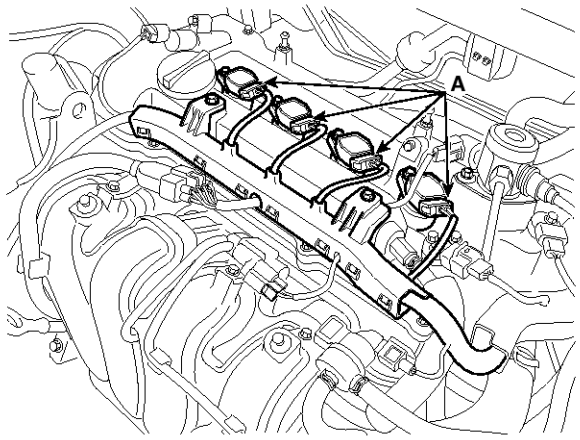


SBHEE9020L

Inspect Spark Plug

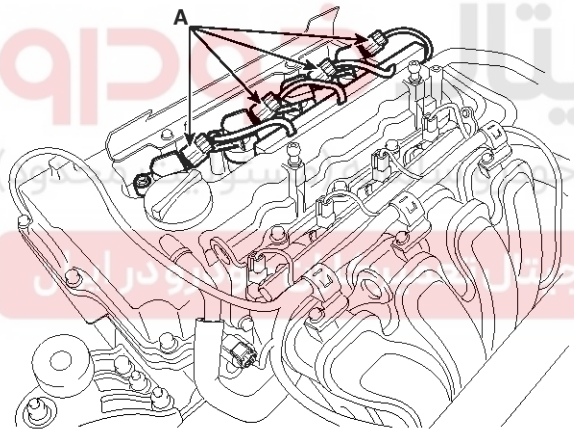
1. Remove the ignition coil connectors (A).

[Gamma]



SSLEE1105L

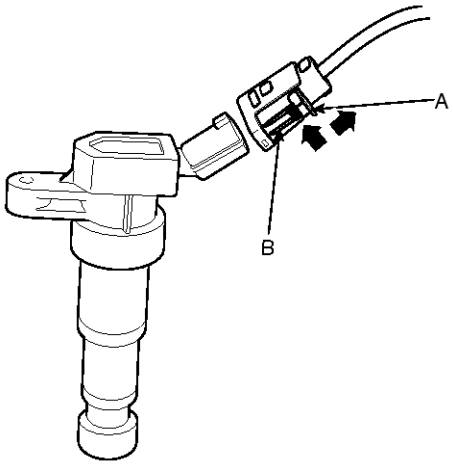
[Theta-II]



SSLE10105D

NOTICE

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

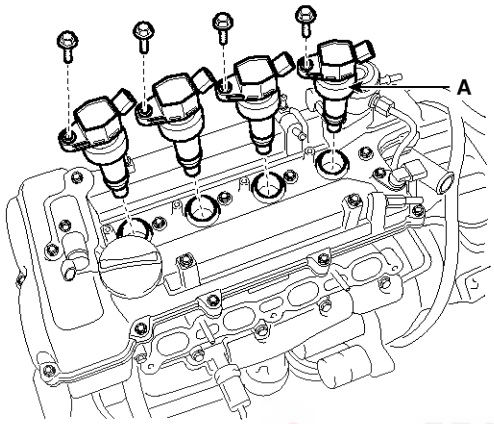


STQEE9001D

2. Remove the ignition coils (A).

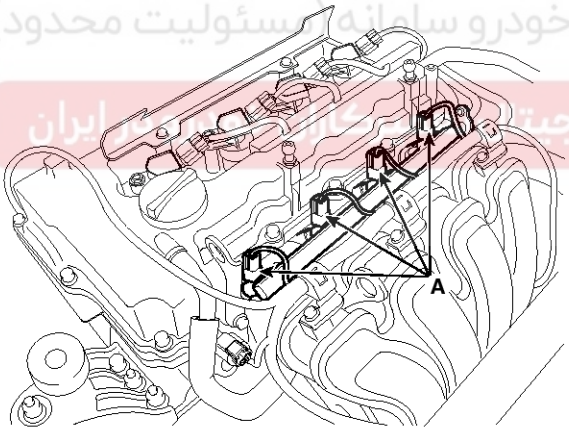
Tightening torque :
Gamma 1.6 GDI :
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)
Theta-II 2.0/2.4 :
3.9 ~ 5.9 N.m (0.4 ~ 0.6 kgf.m, 2.9 ~ 4.3 lb-ft)

[Gamma]



SMDEE1012D

[Theta-II]

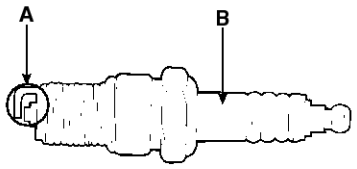


SSLM10130D

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

⚠CAUTION
Be careful that no contaminates enter through the spark plug holes.

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



EBKD002K

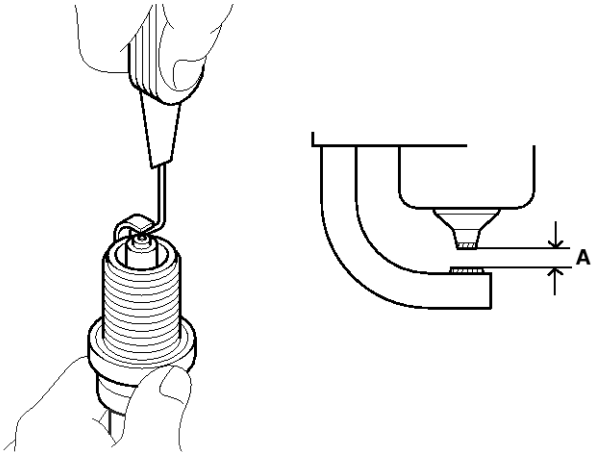
Inspection Of Electrodes

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

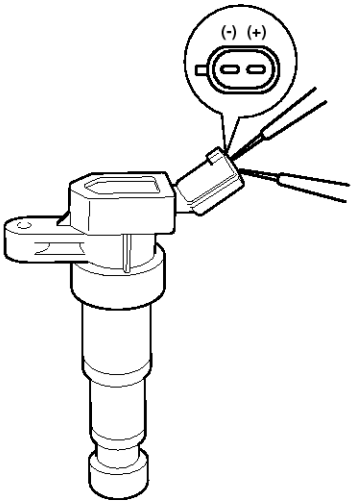
Theta-II 2.0/2.4
Unleaded : 1.0 ~ 1.1 mm (0.0394 ~ 0.0433 in.)
Leaded : 0.8 ~ 0.9 mm (0.0315 ~ 0.0354 in.)
Gamma 1.6 GDI : 0.9 ~ 1.0 mm (0.0354 ~ 0.0394 in.)



SSLEE1100L

Inspect Ignition Coil

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



SUNEE9001N

Standard value:

Theta-II 2.0/2.4 : 0.62Ω ± 10%
Gamma 1.6 GDI : 0.75Ω ± 15%

Charging System

Description

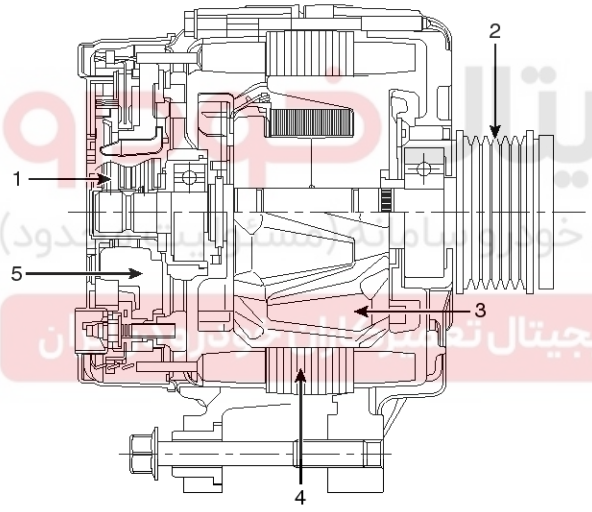
The charging system includes a battery, an alternator with a built-in regulator, and the charging indicator light and wire.

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

DC current appears at alternator "B" terminal. The charging voltage of this alternator is regulated by the battery voltage detection system (or ECM - with AMS).

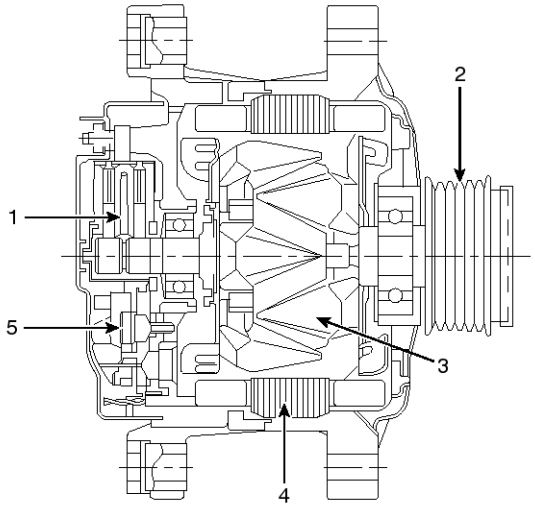
The main components of the alternator are the rotor, stator, rectifier, capacitor, brushes, bearings and V-ribbed belt pulley (or OAD : Overrunning Alternator Decoupler). The brush holder contains a built-in electronic voltage regulator.

[R2.0]



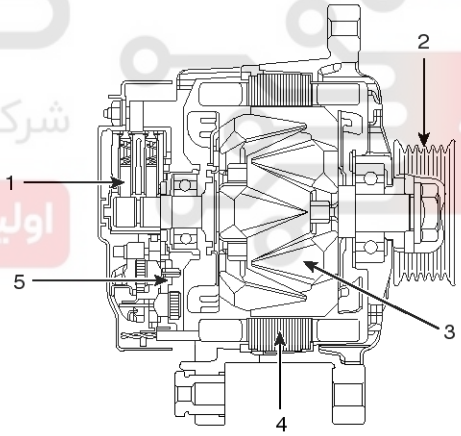
SSLEE0005D

[Theta-II 2.0/2.4]



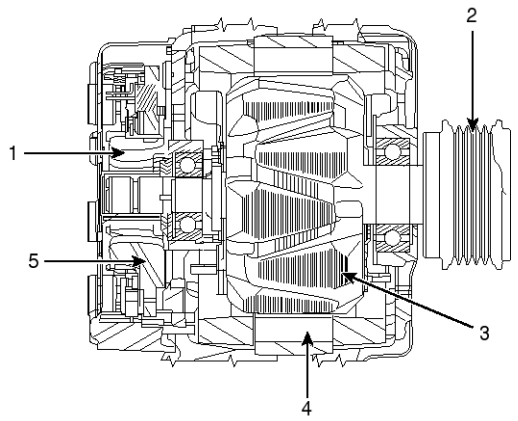
SSLEE0006D

[Gamma 1.6 GDI]



SSLE11001L

[U-II 1.7]



SSLEE1003L

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

Alternator Management System (AMS)

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 lowers the charging rate when accelerating. Lowering the charging rate will allow more engine power for accelerating.

The system increases the charging rate when decelerating. The system uses the unused power of the decelerating engine and increases the charging rate.

On-vehicle Inspection

⚠CAUTION

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

Check Battery Voltage

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

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

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

Check The Battery Terminals And Fuses

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

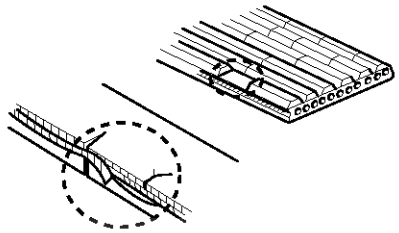
Inspect Drive Belt

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

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

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.



EBKD004B

Drive belt tension measurement and adjustment

Belt tension measurement (Gamma 1.6 GDI)

Measure the belt tension using a mechanical tension gauge or a sonic tension meter.

Tension

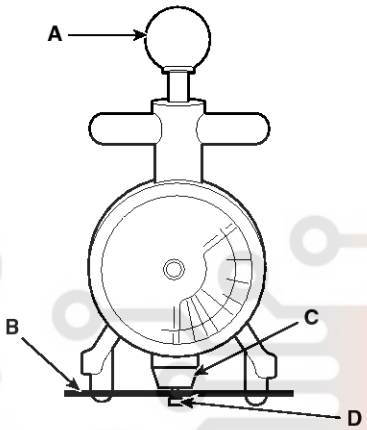
New belt: 882.6 ~ 980.7N (90 ~ 100kg, 198.4 ~ 220.5lb)
Used belt: 637.4 ~ 735.5N (65 ~ 75kg, 143.3 ~ 165.3lb)

CAUTION

- **If the engine has run for 5 minutes or more, the belt tension must be adjusted as a used belt.**
- **When installing the V-ribbed belt, all grooves on the pulley should be covered with belt ribs.**
- **A loose belt causes slip noise.**
- **Too tight belt cause bearing of alternator and water pump to damage.**

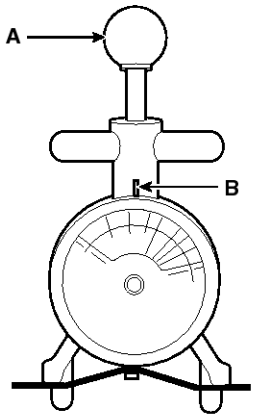
Using a mechanical tension gauge (BT-33-73F, BTG-2 type)

1. While pressing the handle (A) of the gauge, insert the belt (B) between pulley and pulley (or idler) into the gap between spindle (C) and hook (D).



STDEE0002D

2. After releasing the handle (A), read a value on the dial pointed by the indicator (B).



STDEE0212D

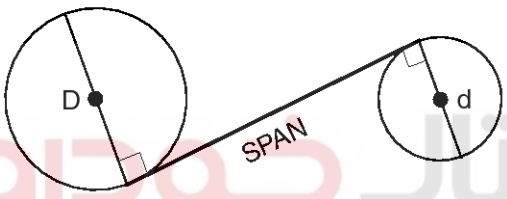
Using a sonic tension meter (U-505/507 type)

1. Input the belt specifications into the tension meter.

Belt type	Location of measurement	Input data		
		M (Mass, g/m.rib)	W (Width, rib)	S (Span, mm)
With A/C	Crankshaft pulley to A/C compressor pulley	013.4	006.0	178.9
Without A/C	Idler to alternator pulley	013.4	006.0	Actual measurement value

NOTICE

Measurement of S (Span) : Caculate average value after measuring the distance 3~4 times.



STDEE0213D

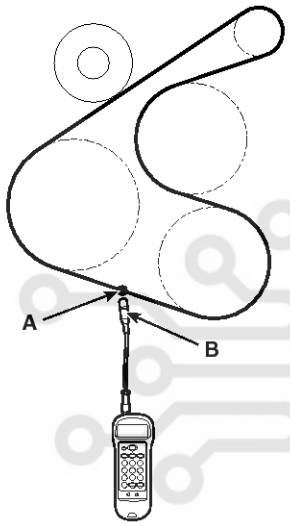
D : Idler

d : Alternator pulley

STDEE0003D

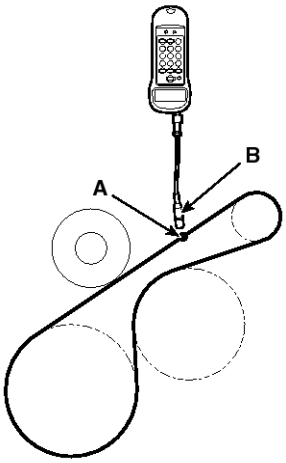
2. Locate the micro phone (B) close to the center of belt span (A) and bounce the belt by finger 2~3 times. Read a value on the display.

[With A/C]



STDEE0215D

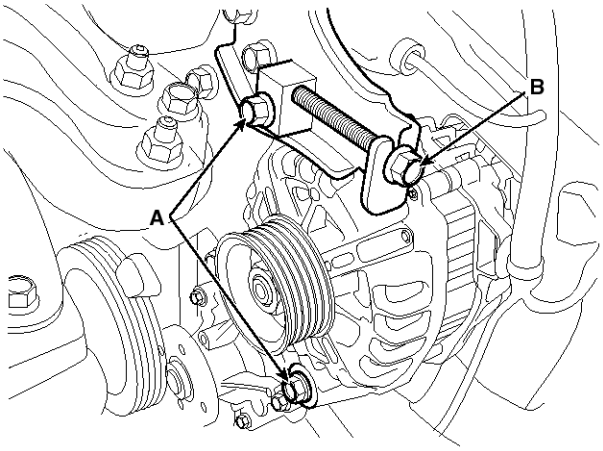
[Without A/C]



STDEE0216D

If adjustment is necessary:

1. Loosen the mounting bolts (A).
2. Tighten the adjusting bolt(B) clockwise in loose tension ; loosen the bolt counterclockwise in high tension.



SMDE11025D

3. Recheck tension of the belt.
4. After adjusting tension, tighten the through bolts.

Tightening torque

12mm (0.47in) bolt : 19.6 ~ 26.5 Nm (2.0 ~ 2.7 kgf.m, 14.5 ~ 19.5 lb-ft)
14mm (0.55in) bolt : 29.4 ~ 41.2 Nm (3.0 ~ 4.2 kgf.m, 21.7 ~ 30.4 lb-ft)

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. Check that the light is lit.

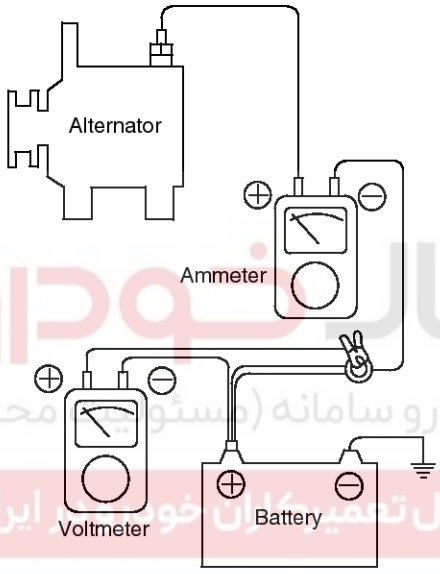
   If the light does not go off as specified, troubleshoot the discharge light circuit.

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.



SVGE10020L

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.

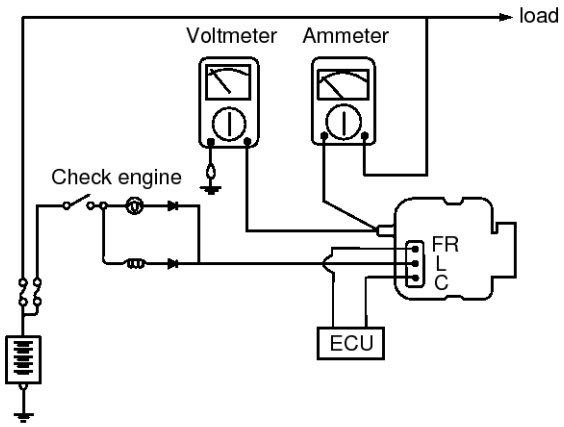
   Check the tension of the alternator drive belt. The belt tension check method is described in the section "Inspect drive belt".
2. Turn off the ignition switch.
3. Disconnect the battery ground cable.
4. Disconnect the alternator output wire from the alternator "B" terminal.
5. Connect a DC ammeter (0 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.

   NOTICE

   Tighten each connection securely, as a heavy current will flow. Do not rely on clips.
6. Connect a voltmeter (0 to 20V) between the "B" terminal and ground. Connect the (+) lead wire to the alternator "B" terminal and (-) lead wire to a good ground.
7. Attach an engine tachometer and connect the battery ground cable.

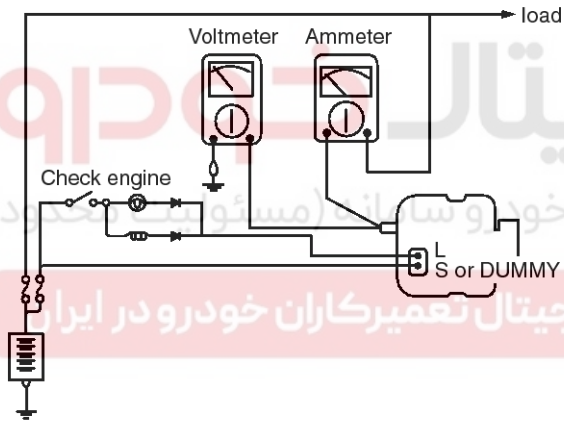
8. Leave the engine hood open.

[AMS]



SVGE20100L

[Non-AMS]



EBRF020A

Test

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

NOTICE

After the engine start up, the charging current quickly drops.

Therefore, the above operation must be done quickly to read the maximum current value correctly.

Result

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

Limit value : 60% of the voltage rate

NOTICE

- *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

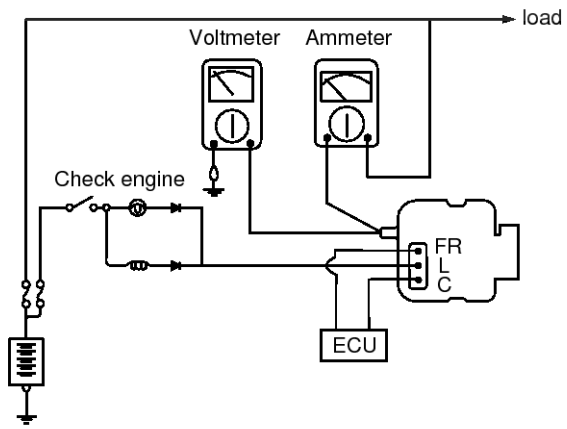
1. Prior to the test, check the following items and correct if necessary.

   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.

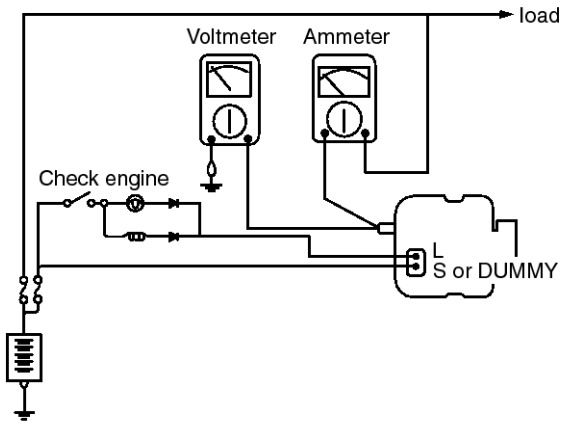
   Connect the (-) lead wire of the ammeter to the disconnected output wire.
7. Attach the engine tachometer and connect the battery ground cable.

[AMS]



SVGE20100L

[Non-AMS]



EBRF020A

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

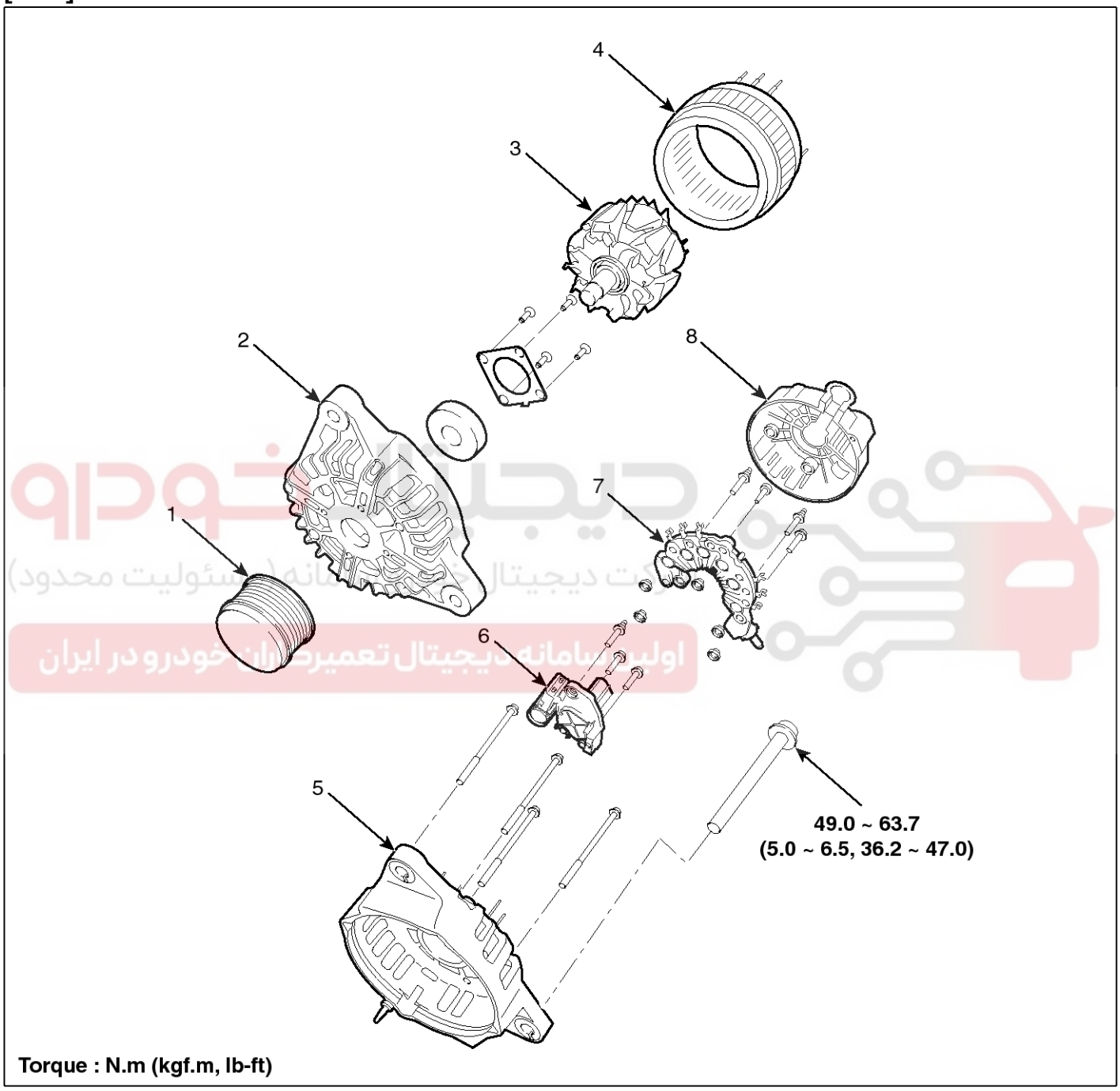
Result

1. If the voltmeter reading dosen't agree with the standard value, the voltage requlator 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.

Alternator

Components

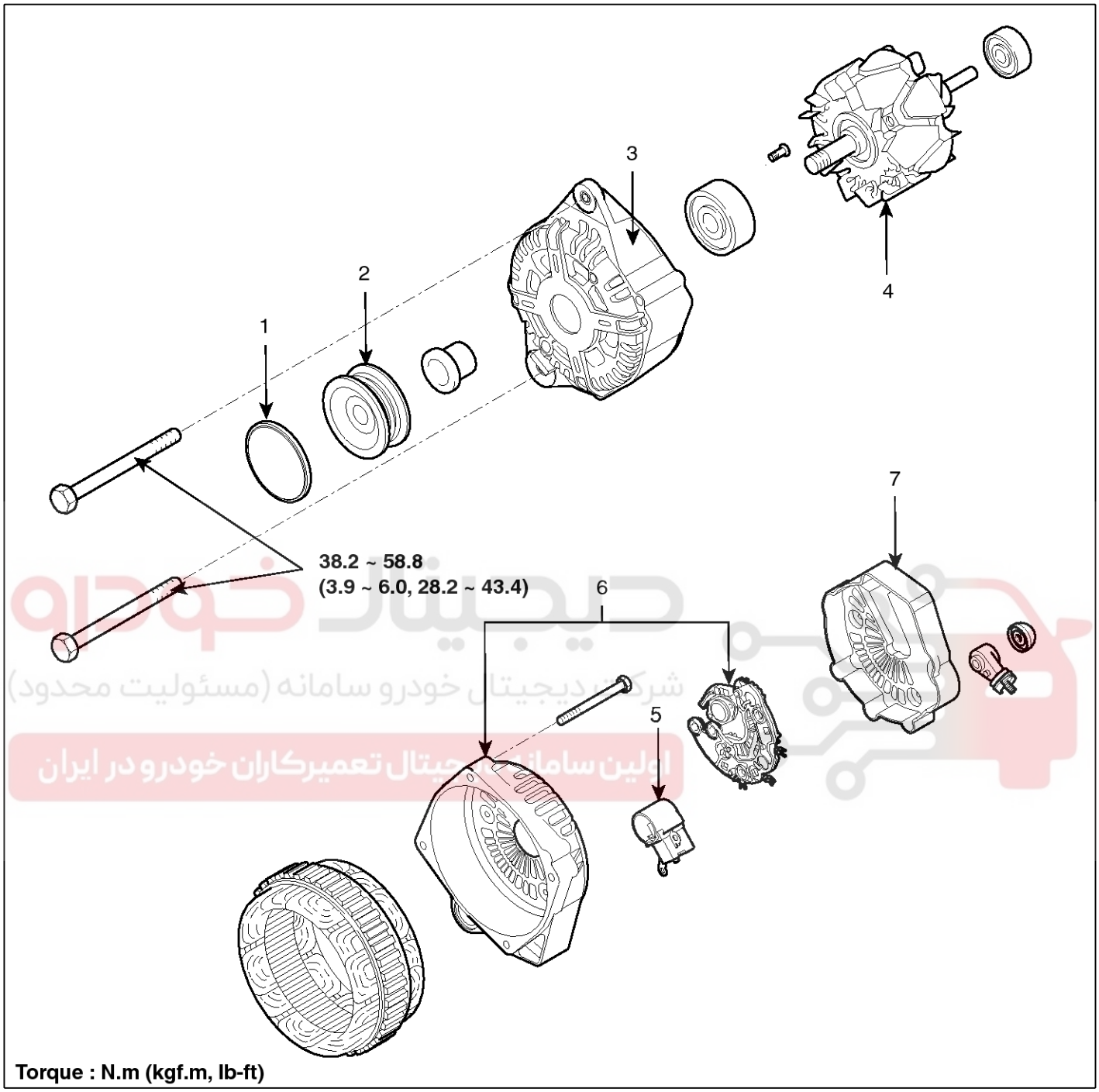
[R2.0]



SXMEE9151L

1. Overrunning alternator pulley(OAP)
2. Front housing
3. Rotor assembly
4. Stator
5. Rear housing
6. Regulator assembly
7. Rectifier assembly
8. Rear cover

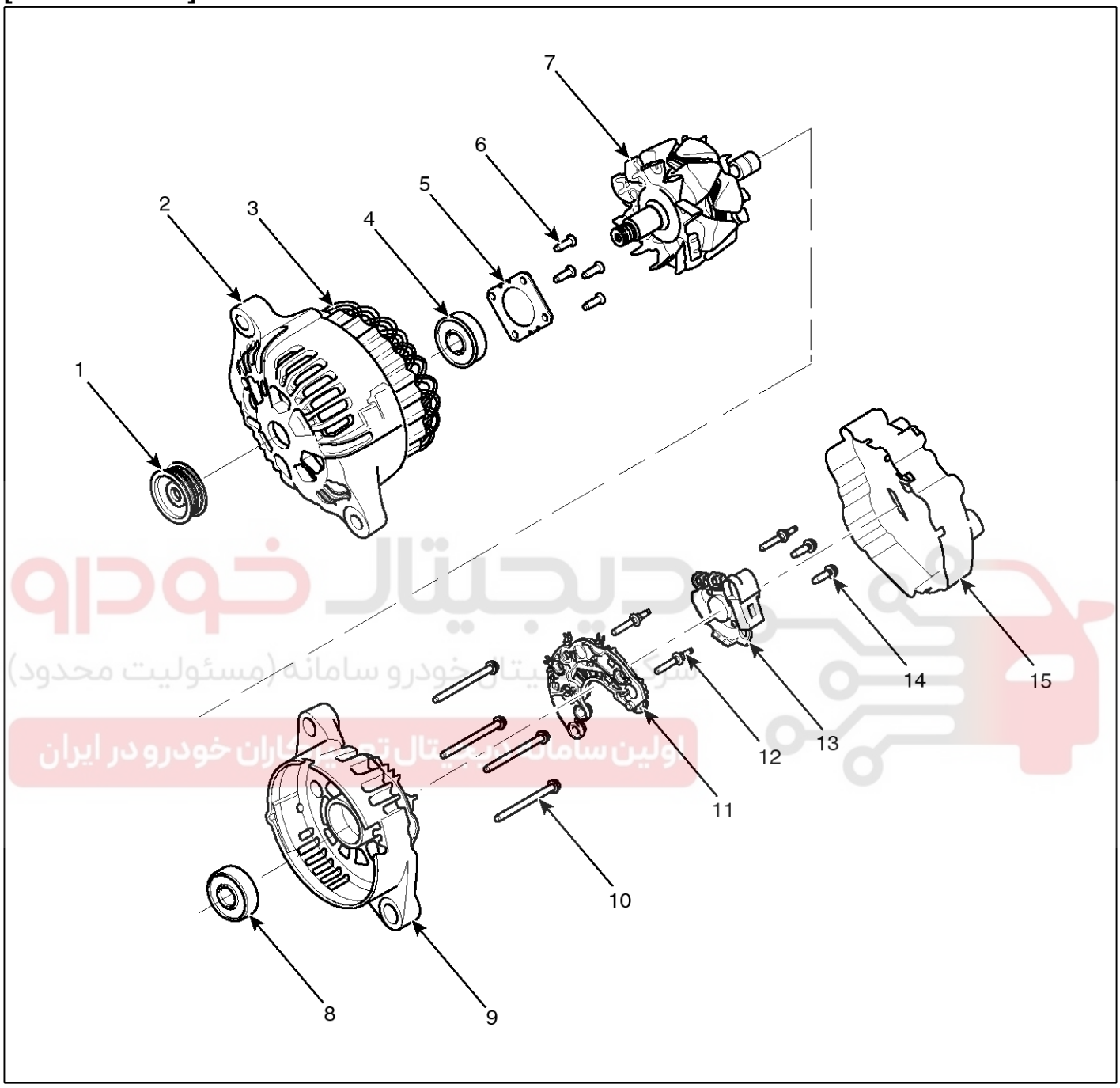
[U-II 1.7]



SSLEE1005L

1. OAD (Overrunning Alternator Decoupler) cap
2. OAD (Overrunning Alternator Decoupler) pully
3. Front housing complete
4. Rotor assembly
5. Regulator
6. Rectifier assembly
7. Cover

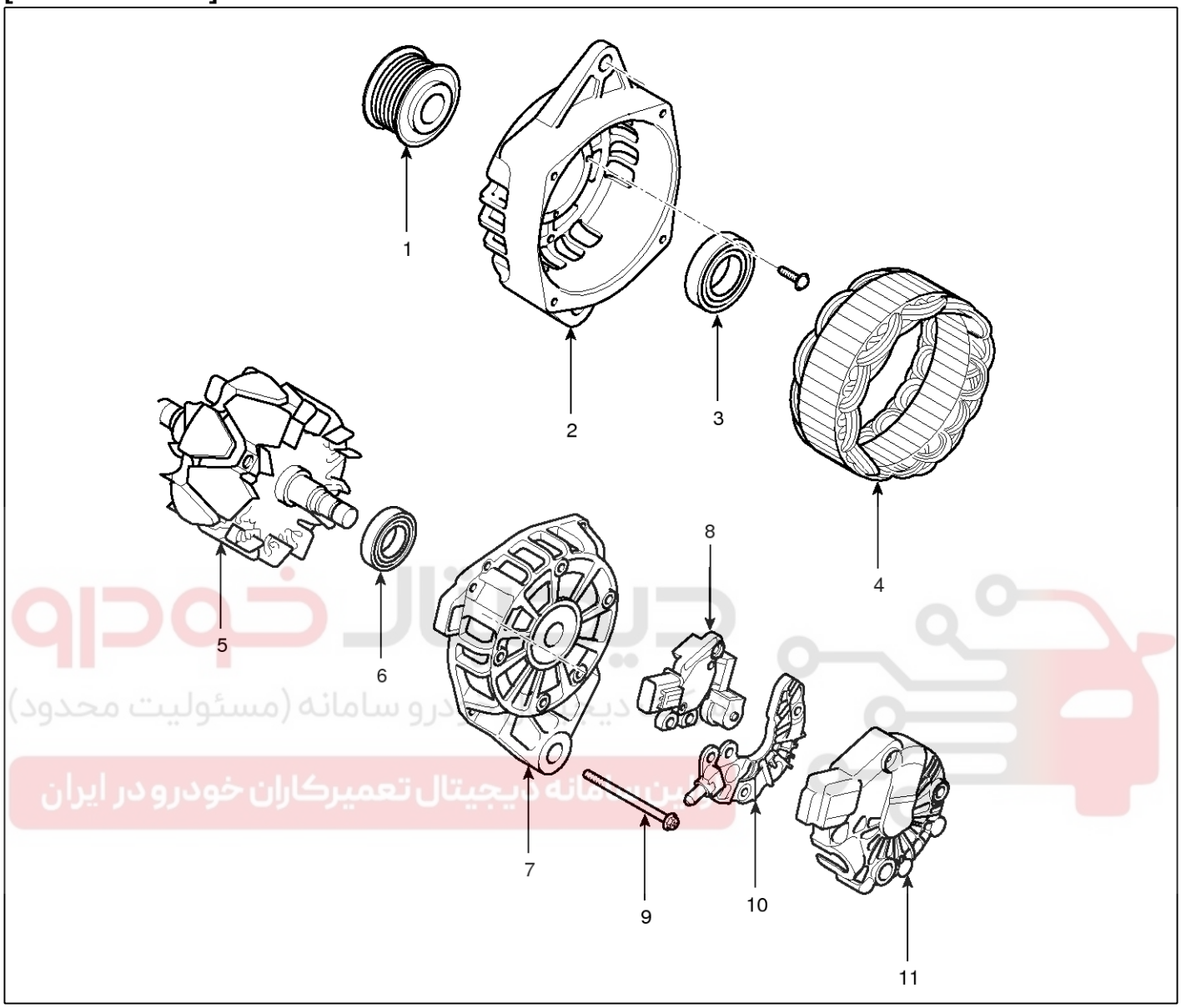
[Theta-II 2.0/2.4]



SVGEE0107D

1. Pulley
2. Front housing
3. Stator
4. Front bearing
5. Bearing retainer
6. Bearing retainer bolt
7. Rotor
8. Rear bearing
9. Rear housing
10. Through bolt
11. Rectifier
12. Rectifier bolt
13. Regulator assembly
14. Regulator bolt
15. Rear cover

[Gamma 1.6 GDI]



SSLEE1101L

1. Pulley
2. Front housing
3. Front bearing
4. Stator
5. Rotor
6. Rear bearing
7. Rear housing
8. Regulator assembly
9. Through bolt
10. Rectifier assembly
11. Rear cover

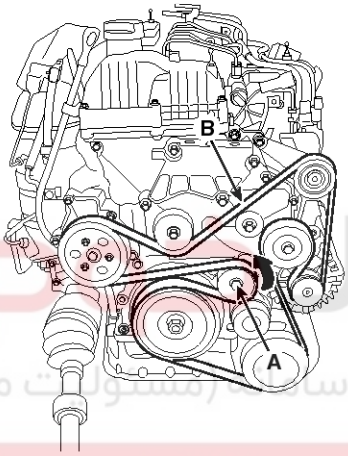
Removal and installation

[R2.0]

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 (without battery sensor):
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
(-) terminal (with battery sensor):
4.0 ~ 6.0N.m (0.4 ~ 0.6kgf.m, 3.0 ~ 4.4lb-ft)

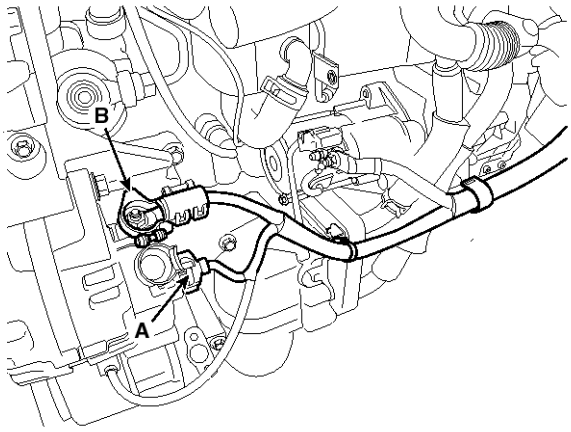
2. Remove the drive belt (B) after turning the drive belt tensioner (A) counterclockwise.



SSLEE0101D

3. Remove the under cover. (Refer to EM group)
4. Loosen the A/C compressor mounting bolt and then disconnect the A/C compressor. (Refer to HA group)
5. Disconnect the alternator connector(A), and remove the cable(B) from alternator "B" terminal.

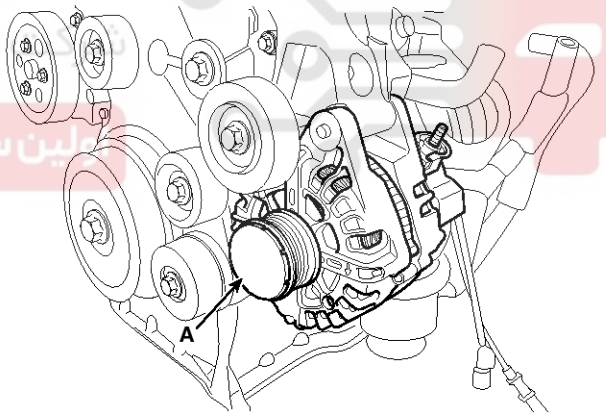
Tightening torque :
9.8 ~ 14.7N.m (1.0 ~ 1.5kgf.m, 7.2 ~ 10.8lb-ft)



SLMEE0004D

6. Remove the alternator (A).

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

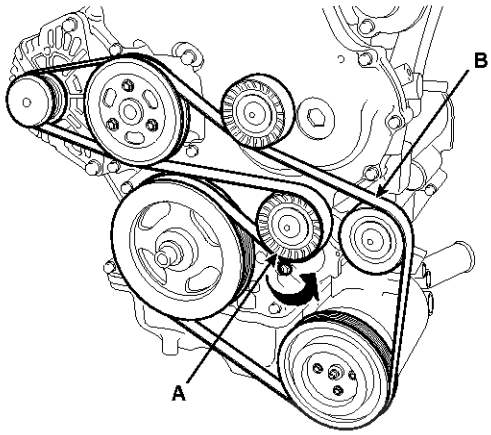


SLMEM0065D

7. Installation is the reverse order of removal.

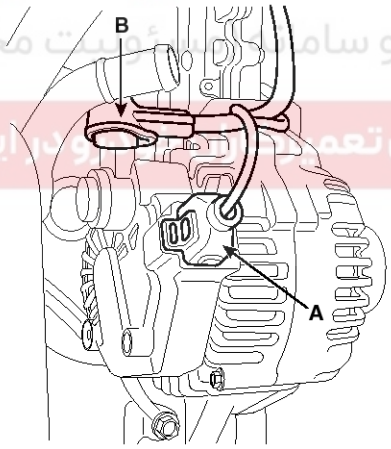
[U-II 1.7]

1. Disconnect the battery negative terminal first, then the positive terminal.
2. Using the hexagon wrench, turn the tensioner (A) counterclockwise and loosen. Then remove the drive belt (B).



SUNEM1114L

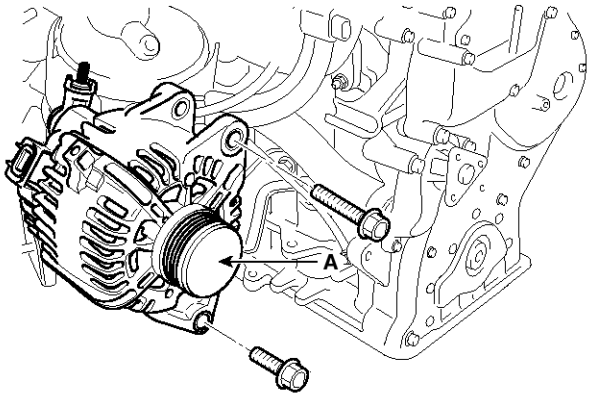
3. Disconnect the alternator connector(A), and remove the cable(B) from alternator "B" terminal.



LCGF119A

4. Remove the under cover. (Refer to EM group)
5. Remove the RH front wheel. (Refer to SS group)
6. Disconnect the RH front strut assembly. (Refer to SS group)
7. Remove the alternator(A).

Tightening torque :
38.2 ~ 58.8N.m (3.9 ~ 6.0kgf.m, 28.2 ~ 43.4lbf.ft)



SYNEM0033L

8. Installation is the reverse order of removal.

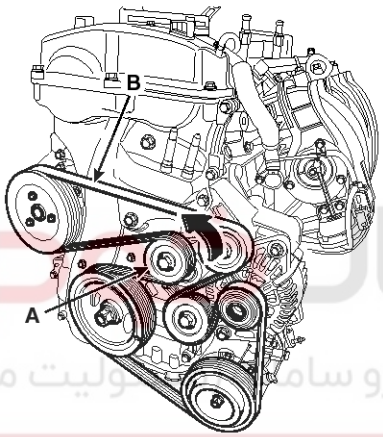
[Theta-II 2.0/2.4]

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 (without battery sensor):
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
(-) terminal (with battery sensor):
4.0 ~ 6.0N.m (0.4 ~ 0.6kgf.m, 3.0 ~ 4.4lb-ft)

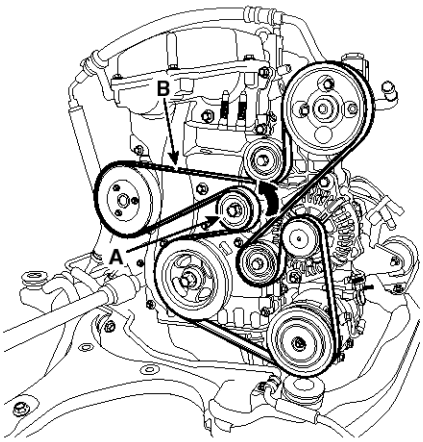
2. Remove the drive belt (B) after turning the drive belt tensioner (A) counterclockwise.

[MDPS]



SSLM10022D

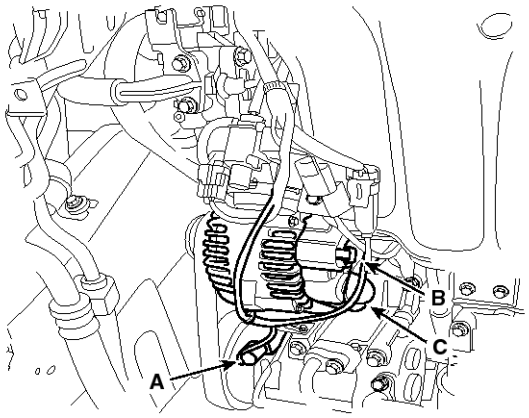
[HPS]



SVGEM0153D

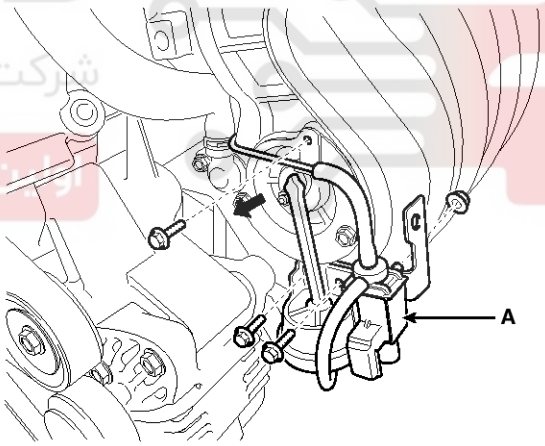
3. Disconnect the A/C compressor switch connector (A), the alternator connector (B), and the cable (C) from alternator "B" terminal.

Tightening torque :
9.8 ~ 14.7N.m (1.0 ~ 1.5kgf.m, 7.2 ~ 10.8lb-ft)



SVGEE0109D

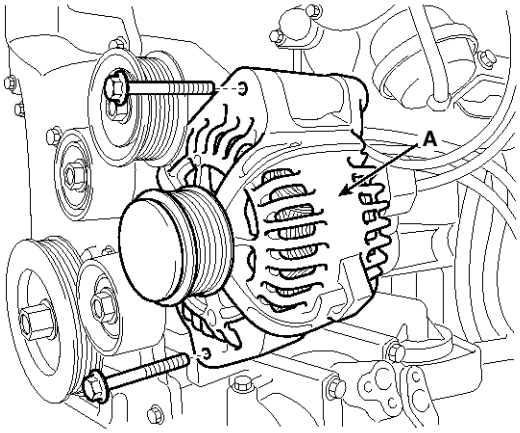
4. Remove the VIS(Variable intake system) actuator/valve (A) from the intake manifold.



SSLE10001D

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)



SSLE10002D

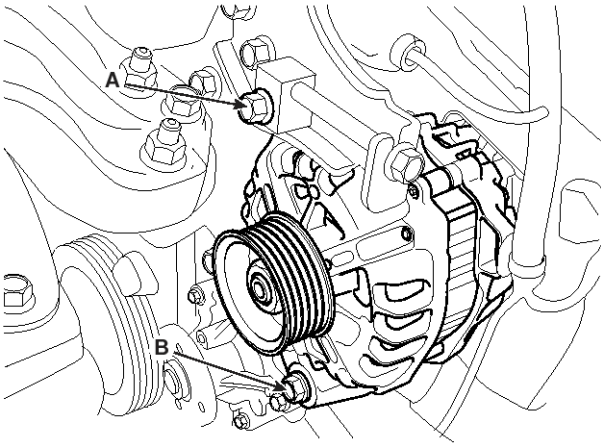
6. Installation is the reverse order of removal.

[Gamma 1.6 GDI]

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

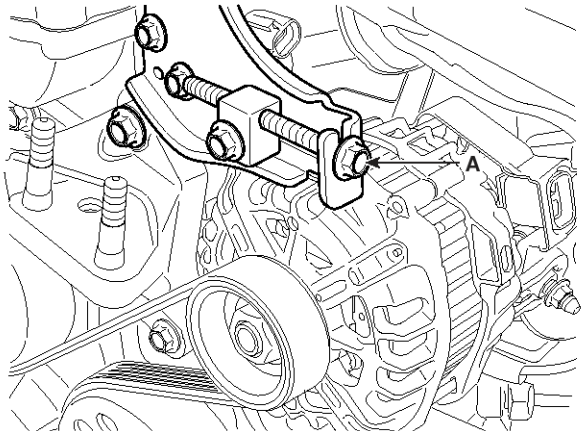
Tightening torque :
(+) terminal :
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
(-) terminal (without battery sensor):
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
(-) terminal (with battery sensor):
4.0 ~ 6.0N.m (0.4 ~ 0.6kgf.m, 3.0 ~ 4.4lb-ft)

2. Remove the drive belt.
   1) Loosen the through bolt (A,B).



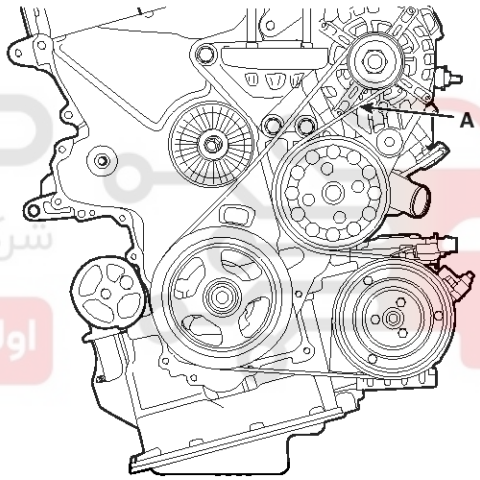
SMDM11033D

   2) Loosen the tension by turning the tension adjusting bolt (A).



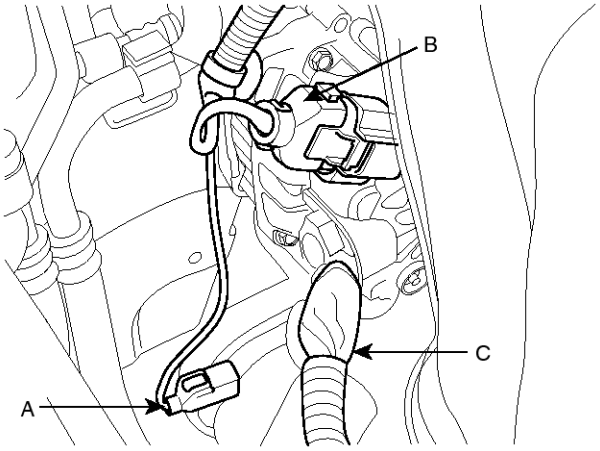
SMDM11030D

   3) Remove the drive belt (A).



SRBEM1034C

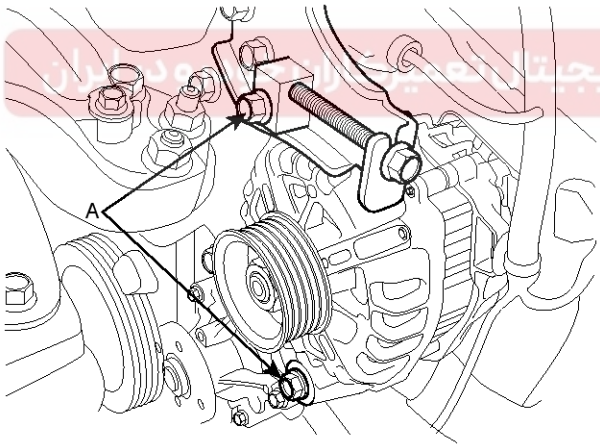
3. Disconnect the air compressor connector(A) and the alternator connector (B), and remove the cable (C) from alternator "B" terminal.



SHDEE6004D

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

Tightening torque :
19.6~26.5 Nm (2.0~2.7 kgf.m, 14.5~19.5 lb-ft)-12mm bolt
29.4~41.2 Nm (3.0~4.2 kgf.m, 21.7~30.4 lb-ft)-14mm bolt



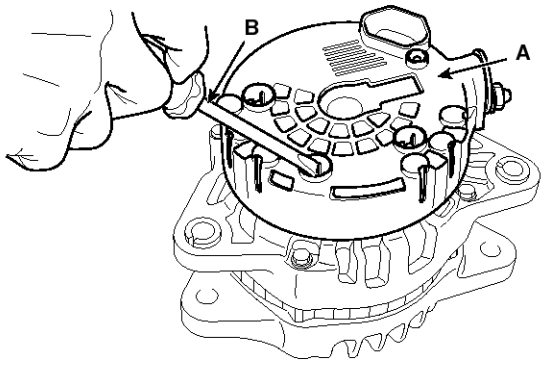
SHDEE6005D

5. Installation is the reverse order of removal.
6. Adjust the alternator belt tension after installation.

Disassembly

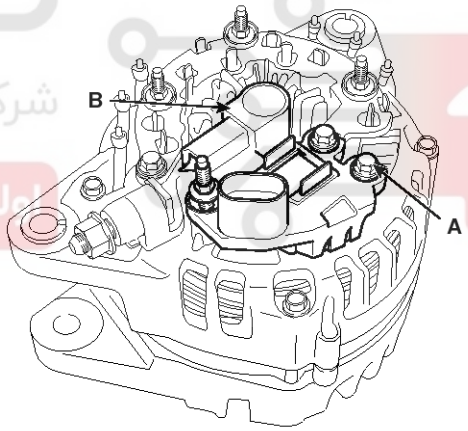
[R2.0]

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



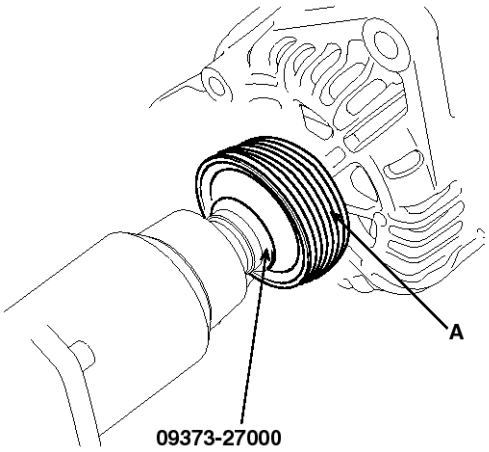
SXMEE9001D

2. Loosen the mounting bolts (A) and remove the regulator assembly (B).



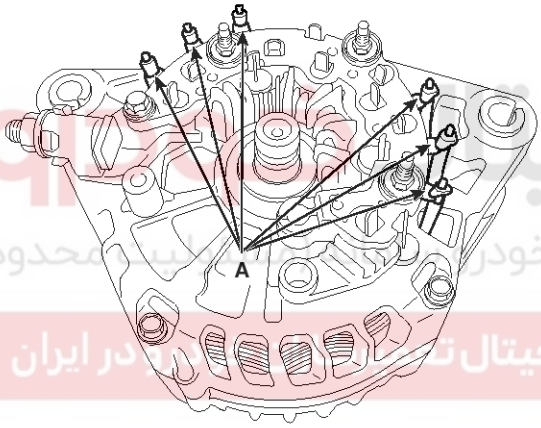
SXMEE9002D

3. Remove the pulley(A) using the special tool.



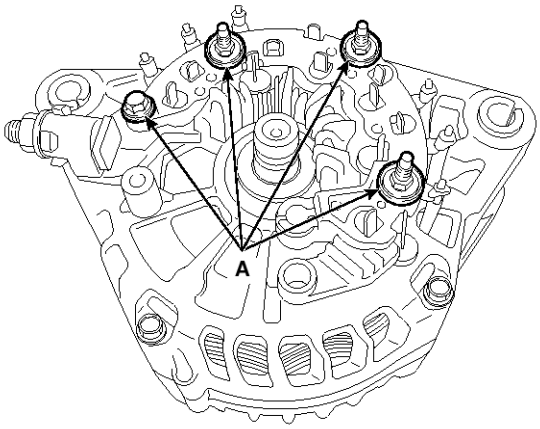
SHDEB6002D

4. Unsolder the stator leads (A).



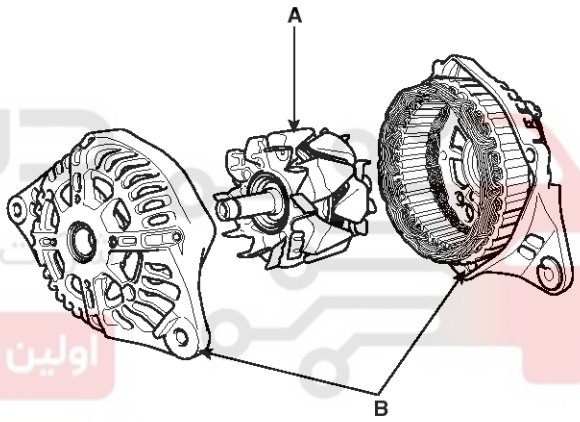
SXMEE9003D

5. Loosen the through bolts (A).



SXMEE9106D

6. Disconnect the rotor (A) and housing (B).

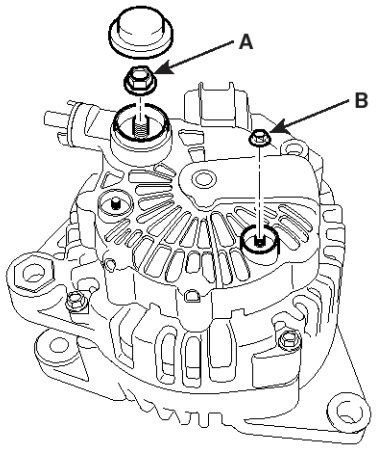


SUNEE6006D

7. Reassembly is the reverse order of disassembly.

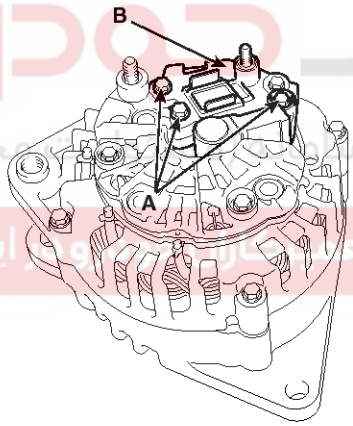
[U-II 1.7]

1. Remove the alternator cover after loosening the B terminal mounting nut(A) and rear cover nut(B).



LCGF120A

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

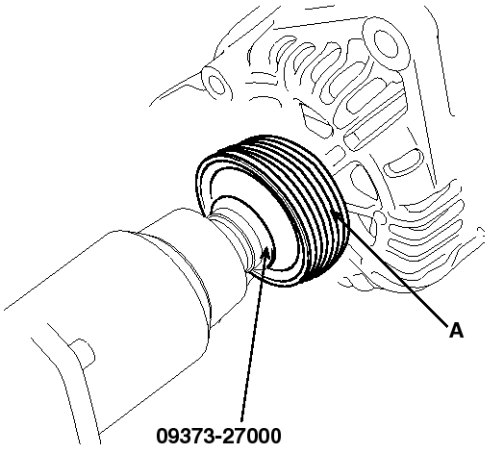


SYNEE0002L

3. Remove the OAD(Overrunning Alternator Decoupler) cap.

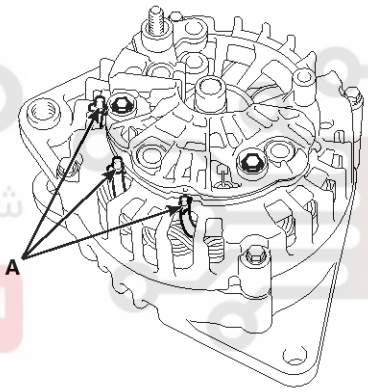
NOTICE
When installing, replace with new OAD cap.

4. Remove the OAD(Overrunning Alternator Decoupler) pulley(A) using the special tool.



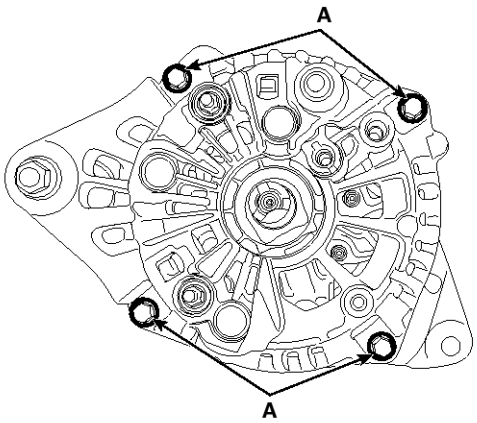
SHDEB6002D

5. Unsolder the 3 stator leads(A).



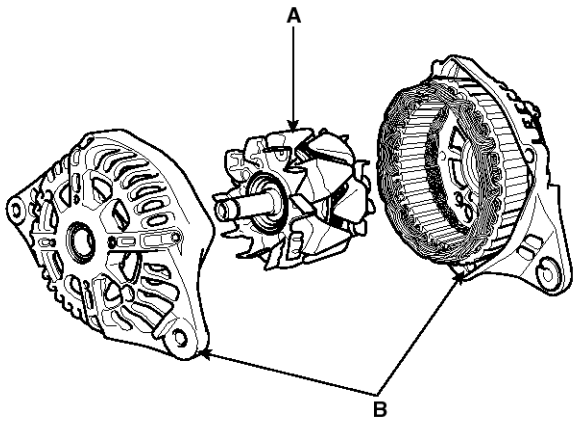
SYNEE0003L

6. Loosen the 4 through bolts(A).



SUNEE6005D

7. Disconnect the rotor(A) and bracket(B).

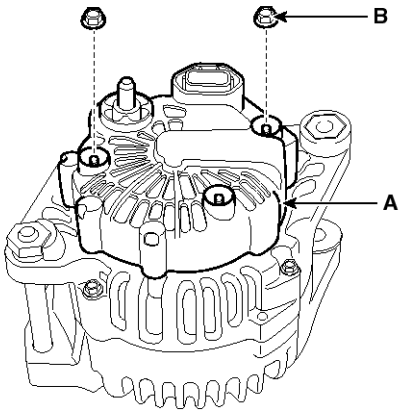


SUNEE6006D

8. Reassembly is the reverse order of disassembly.

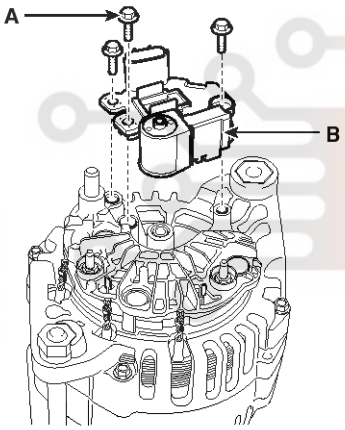
[Theta-II 2.0/2.4]

1. Loosen the nuts (B) and then remove the cover (A).



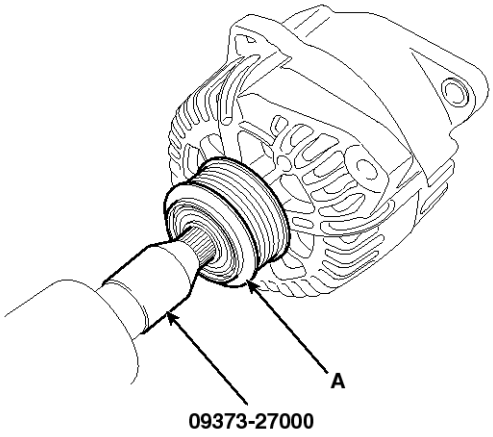
SYFEE0201N

2. Loosen the mounting bolts (A) and remove the regulator assembly (B).



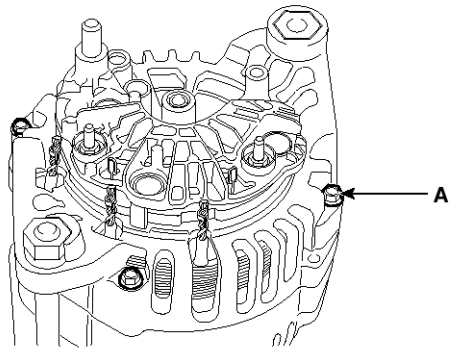
SYFEE0001N

3. Using the SST (09373-27000), remove the pulley (A).



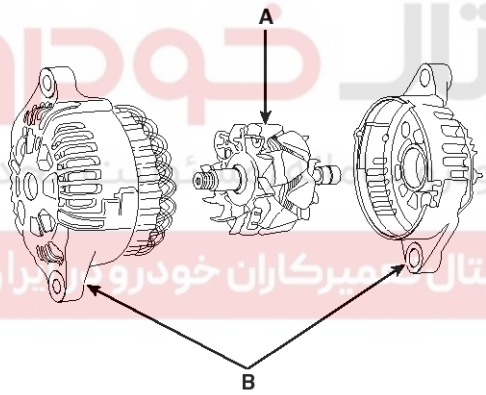
SSLEE0102D

4. Loosen the 4 through bolts (A) and then remove the rear housing with the rectifier by loosen the clamping wires.



SYFEE0110D

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

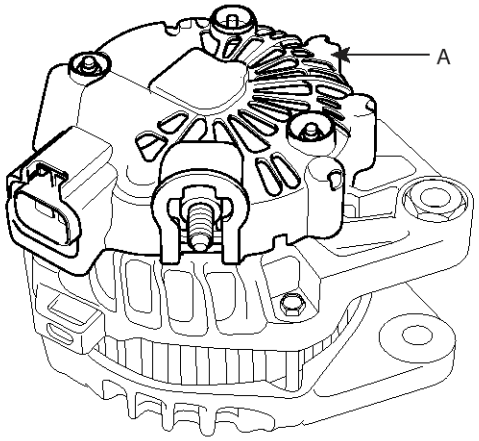


SVGE10021D

6. Reassembly is the reverse order of disassembly.

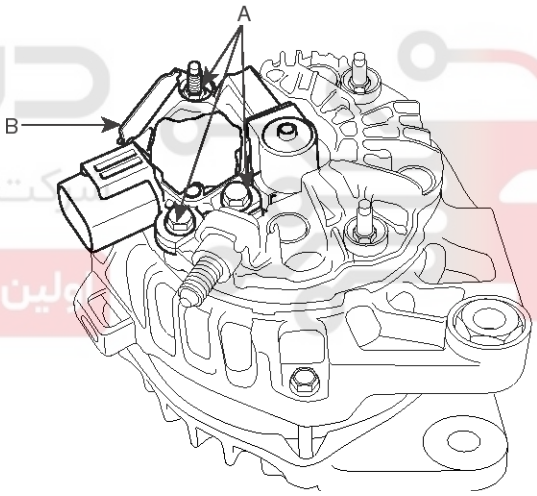
[Gamma 1.6 GDI]

1. Remove the alternator cover(A).



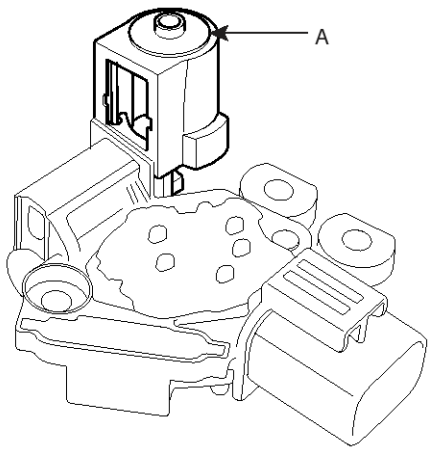
SHDEE6006D

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



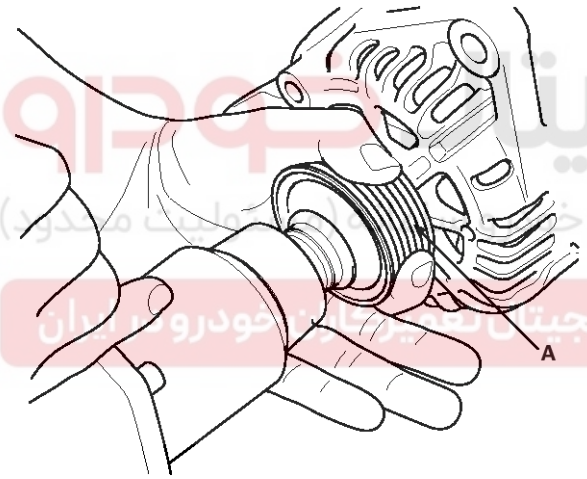
SHDEE6007D

3. Remove the slip ring guide(A).



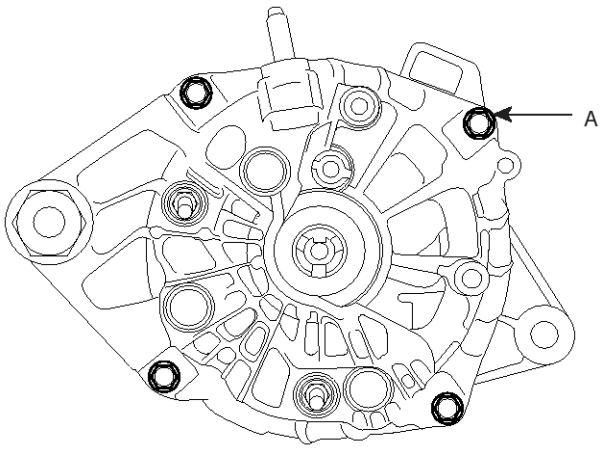
SHDEE6008D

4. Remove the nut and pulley(A).



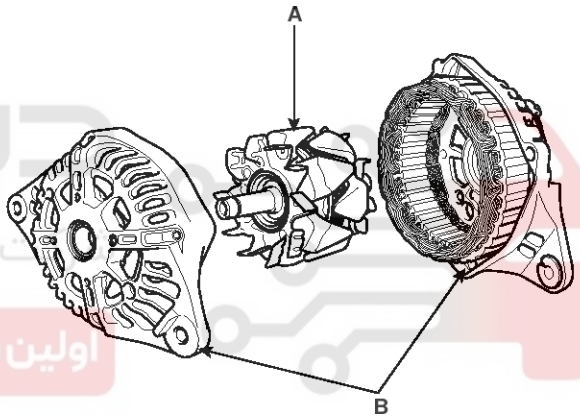
EBKD301D

5. Loosen the 4 through bolts(A).



SHDEE6009D

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



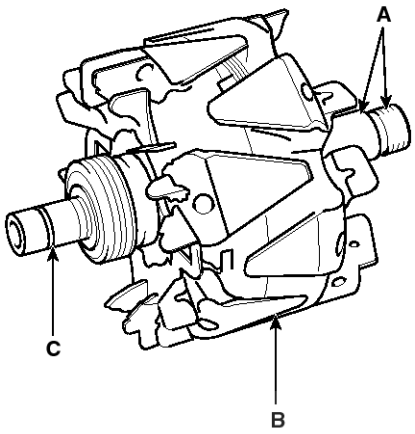
EBKD301G

7. Reassembly is the reverse 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).

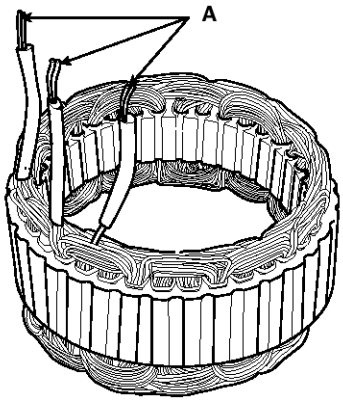


STDEE9109D

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).



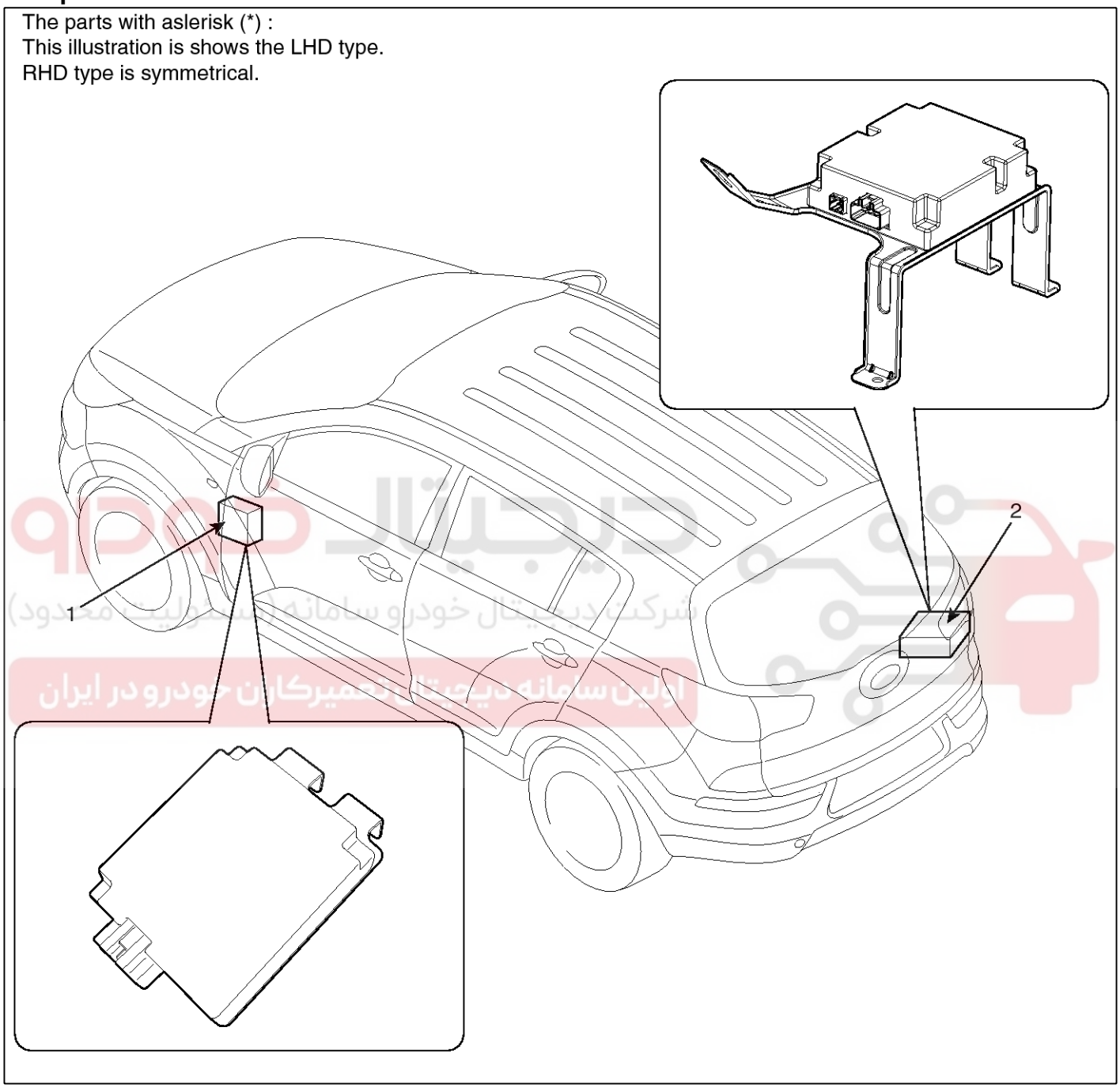
STDEE9110D

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.

DC DC converter

Component Location

The parts with aslerisk (*) :
This illustration is shows the LHD type.
RHD type is symmetrical.



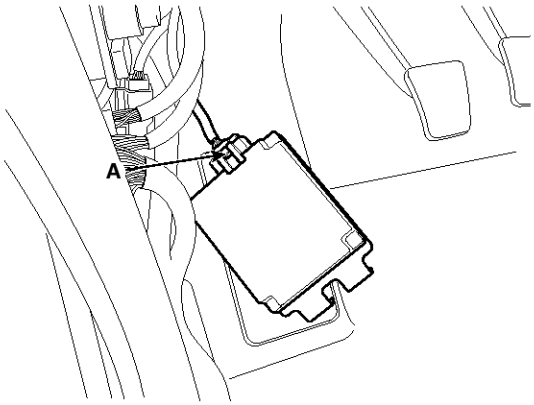
SSLEE1107L

1. DC/DC converter (Head unit)*
2. DC/DC converter (External amplifier)

Replacement

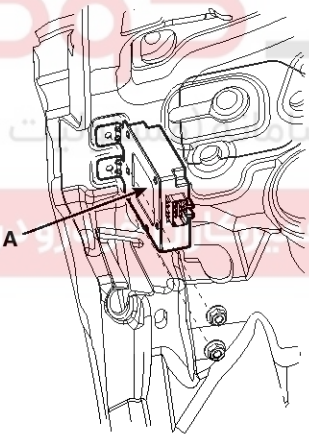
[Head unit]

1. Disconnect the battery negative terminal.
2. Disconnect the DC/DC converter connector (A).



SSLEE1108L

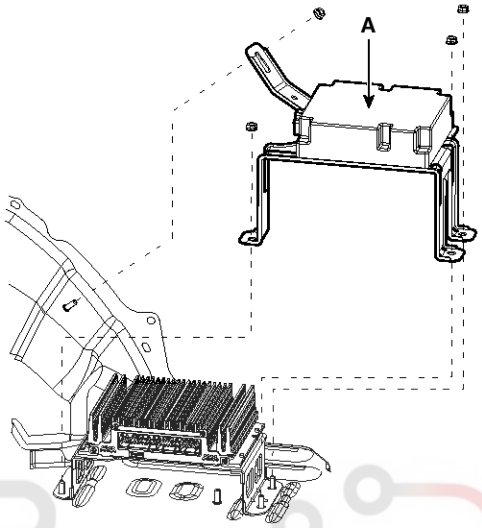
3. Remove the DC/DC converter (A).



SSLEE1109L

[External amplifier]

1. Disconnect the battery negative terminal.
2. Remove the right luggage side trim.
   (Refer to the BD group - "Interior trim")
3. Disconnect the DC/DC converter connector.
4. Remove the DC/DC converter (A).

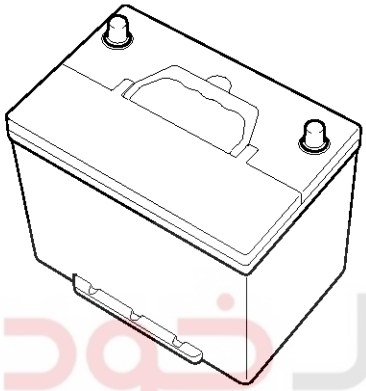


SSLEE1110L

Battery

Description

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



SSLE10106D

NOTICE

After disconnecting then reconnecting the batterynegative cable, reset some parts that require thereset procedures. (Refer to BE group . GeneralInformation)

[ISG Type]

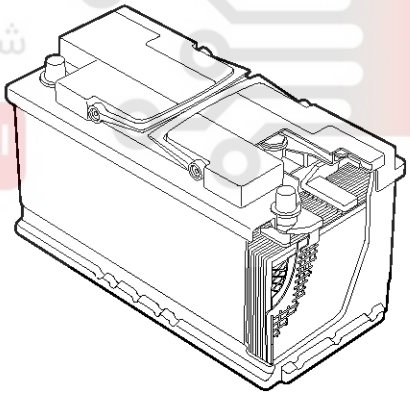
AGM battery is used for especially heavy load on the vehicle network depending on equipment and requirements. AGM stands for Absorbent Glass Material Battery; that is absorbent glass fibre fleece. AGM batteries are fitted in models with electrical loads/consumers which have a high energy demand.

The constantly increasing energy demand of modern vehicle electrical systems calls for ever more powerful battery solutions.

The power consumption is considerable even when the vehicle is parked.

The somewhat higher price compared with a battery of similar size is fully balanced by the following benefits:

- Significantly longer service life
- Increased starting reliability at low temperatures
- 100 % freedom from maintenance
- Low risk in event of an accident (reduced risk to the environment)



SEDEE9001L

Recharging [ISG Type]

Check the battery condition

The battery condition cannot be determined solely on the basis of the battery charge state. If there is a suspicion of a damaged battery, check the battery condition whit battery tester and investigate the cause by means of the test module. With a low battery charge state, recharge the battery.

Recharging the AGM battery

The battery may be charged using the battery chargers at a constant charge voltage of 14.8V.

If possible, the battery temperature during charging should be between 20℃ and 30℃.

Only chargers with voltage clamping (IU or WU curve) may be used or chargers with IUoU curve which have a trickle.

IU or WU charging technique
Optimized charging voltage for IU or WU: 14.7V (at 20˚C ~ 30˚C) about 24 hours
Min. charging voltage at 20˚C: 14.4V
Max. charging voltage at 20˚C: 14.8V
10% of capacity is recommended as charging current (e.g. 60Ah : 10 = 6,0A charging current).

WARNING

Do not charge the AGM battery with>15.2V. No quick-charging routines.

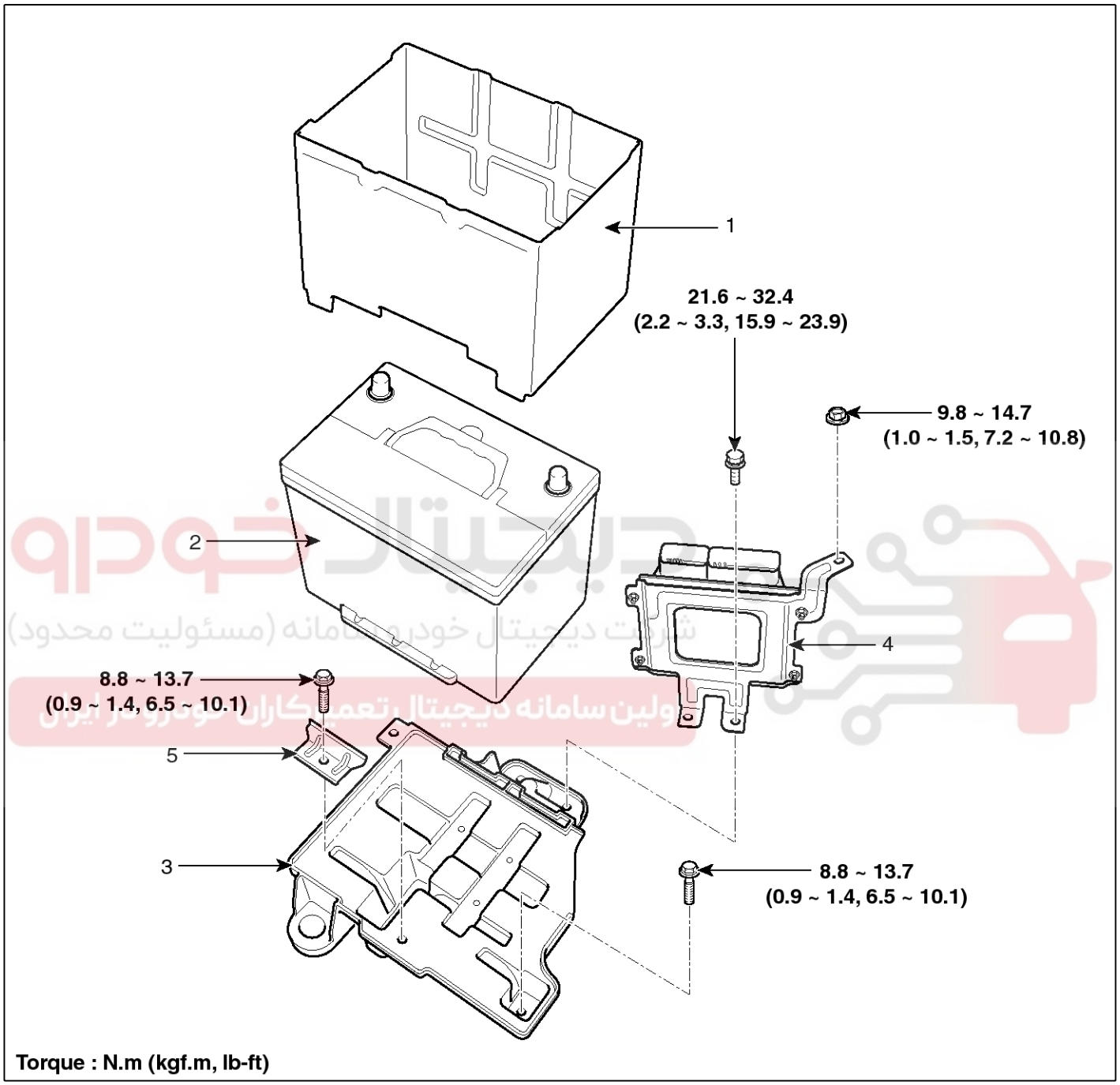
CAUTION

If the battery is charged directly at the battery terminals on vehicles with battery sensor, misinterpretations of battery condition and under certain circumstances also unwanted Check Control messages or fault memory entire can occur.

After recharging finished, let the battery stand for over 10 hours with normal temperature for battery stabilization.

Components

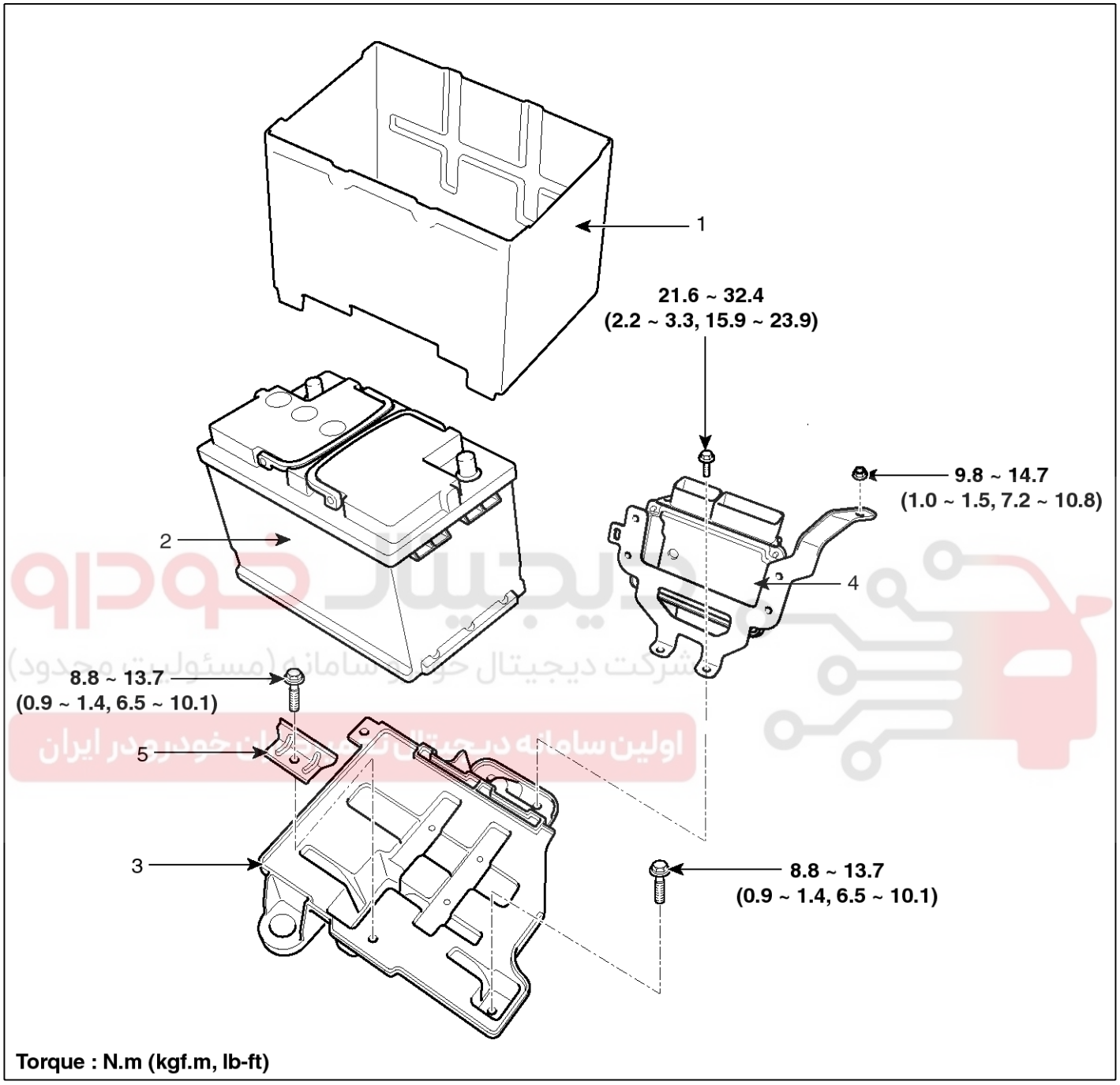
[Non-ISG Type]



SSLE10004N

1. Battery insulation pad
2. Battery
3. Battery tray
4. ECM & bracket assembly
5. Battery mounting bracket

[ISG Type]



SELE11001L

1. Battery insulation pad
2. Battery
3. Battery tray
4. ECM & bracket assembly
5. Battery mounting bracket

Removal and Installation

1. Remove the battery.
   1) Disconnect the battery negative terminal (A).

Tightening torque:
Without battery sensor :
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
With battery sensor :
4.0 ~ 6.0N.m (0.4 ~ 0.6kgf.m, 3.0 ~ 4.4lb-ft)

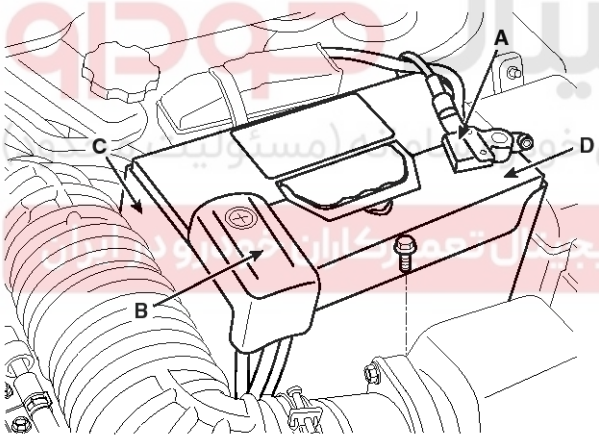
   2) Disconnect the battery positive terminal (B).

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

   3) Remove the battery insulation pad (C).
   4) Remove the battery mounting bracket, and the battery (D).

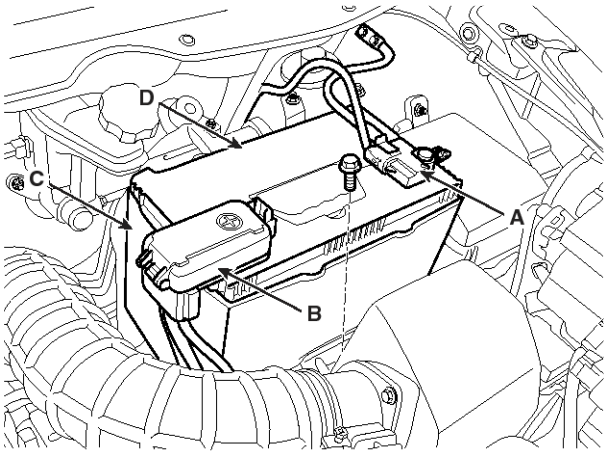
Tightening torque :
Bracket bolt: 8.8 ~ 13.7 N.m (0.9 ~ 1.4 kgf.m, 6.5 ~ 10.1 lb-ft)

[R2.0]



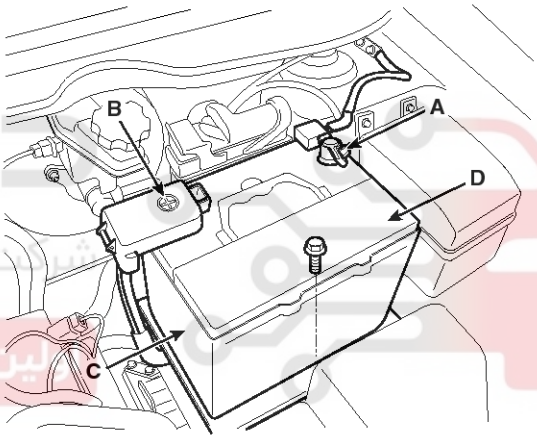
SSLE10107D

[U-II 1.7]



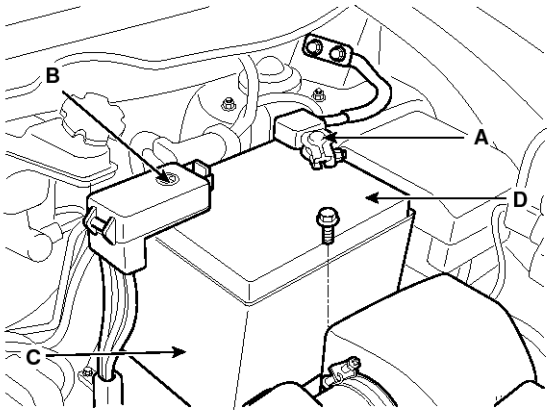
SSLEE1004L

[Theta-II 2.0/2.4]



SSLE10108D

[Gamma 1.6 GDI]



SSLEE1103L

2. Remove the air duct and air cleaner assembly. (Refer to EM group).

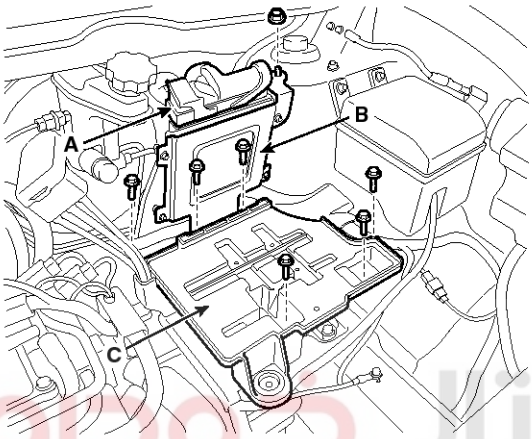
3. Remove the ECM (B) and the battery tray (C) after disconnecting the ECM connector (A).

Tightening torque

ECM bracket nut : 9.8 ~ 14.7N.m (1.0 ~ 1.5kgf.m, 7.2 ~ 10.8lb-ft)

ECM bracket bolts : 21.6 ~ 32.4N.m (2.2 ~ 3.3kgf.m, 15.9 ~ 23.9lb-ft)

Battery tray bolts : 8.8 ~ 13.7N.m (0.9 ~ 1.4kgf.m, 6.5 ~ 10.1lb-ft)



SSLM10008D

4. Installation is the reverse order of removal.

CAUTION

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

CAUTION

- **ISG (Idle stop & go) system equipped vehicle always use the AGM battery only. If flooded battery has installed, this can potentially lead to engine electrical trouble or ISG system error.**
- **Replace same capacity of the AGM battery.**

NOTICE

Ensure an AGM battery is fitted.

In all cases, an AGM battery must be installed and registered in the vehicle for the ISG function to work perfectly.

The vehicle with the new battery must be placed in the ignition switch OFF and door closed, hood switch OFF state for at least 4 hours.

ISG system's stabilization may take 4 hours after new battery installation.

ISG function is operates about 4 hours later and 2 times cranking by user.

But first 25 times, the ISG function can operates regardless of ISG system stability for ISG function operating check.

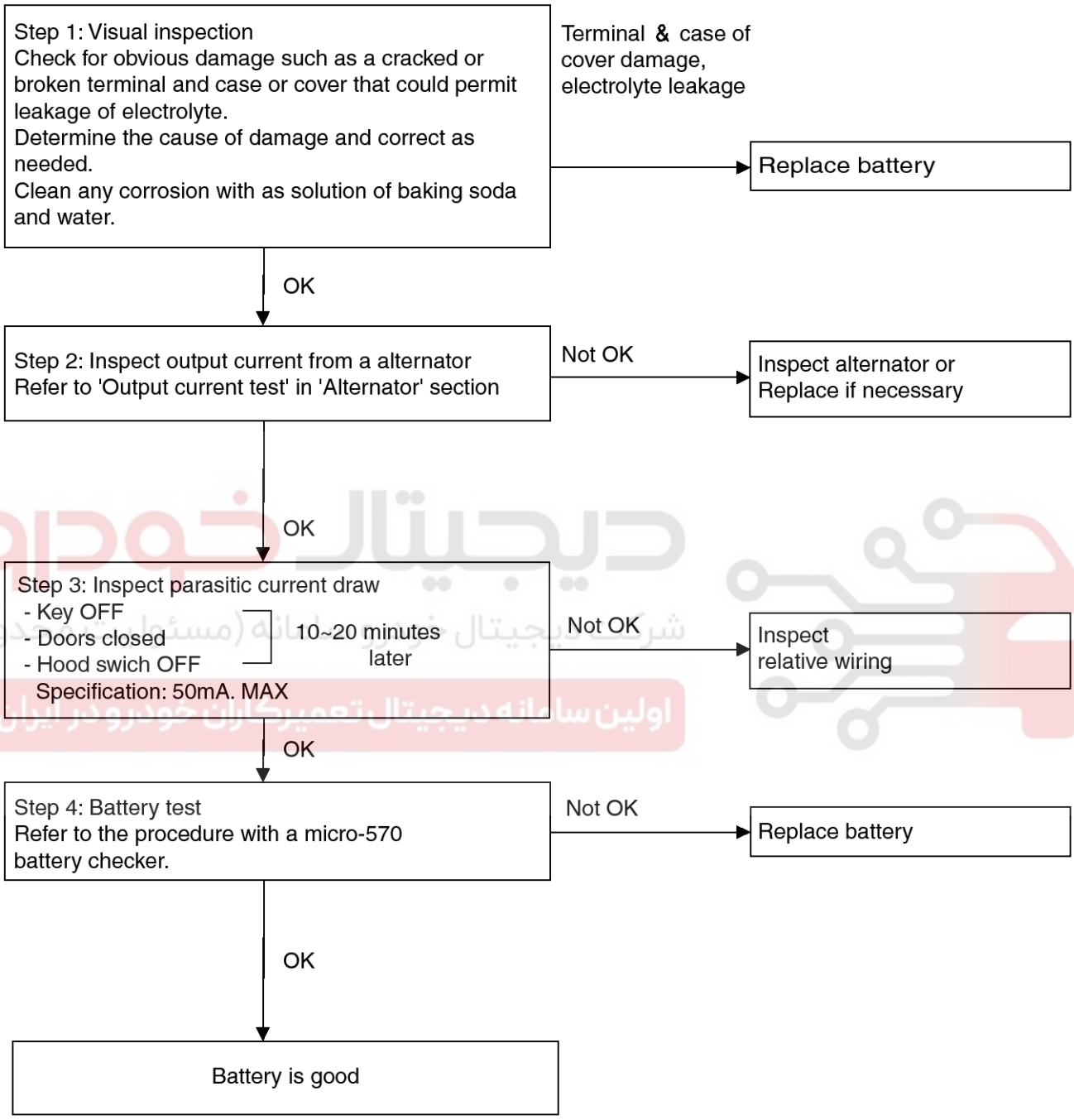
WARNING

Do not open the AGM battery.

The AGM battery must not be opened under any circumstances as the introduction of oxygen from the air will cause the battery to lose its chemical equilibrium and rendered non-operational.

Inspection

Battery Diagnostic Flow



SXMEE9150L

Vehicle parasitic current inspection

1. Turn all the 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.

   NOTICE

   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.

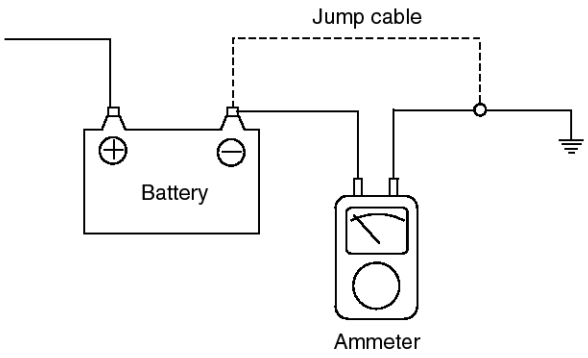
   To prevent the battery from being reset during the inspection,

   a. Connect a jump cable between the battery (-) terminal and the ground cable.

   b. Disconnect the ground cable from the battery (-) terminal.

   c. Connect an ammeter between the battery (-) terminal and the ground cable.

   d. After disconnecting the jump cable, read the current value of the ammeter.



SVQEE0002L

5. Read the current value of the ammeter.
   - 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.
   - Reconnect the suspected parasitic current draw circuit fuse only and search for suspected unit by removing a component connected with the circuit one by one until the parasitic draw drops below limit value.

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

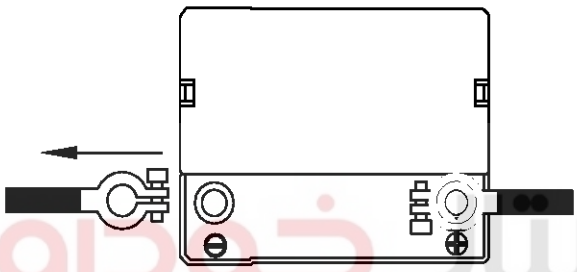
Cleaning

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



EBJD008B

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

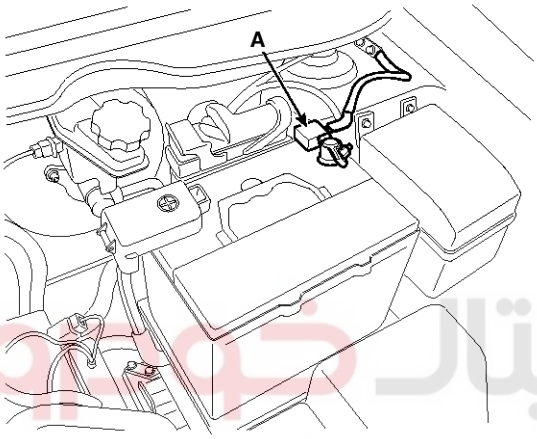
When batteries are being charged, an explosive gas forms beneath the cover of each cell. Do not smoke near batteries being charged or which have recently been charged. Do not break live circuit at the terminals of batteries being charged.

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

Battery Sensor

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 (A) 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.



SSLE10005D

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)

NOTICE

It takes a few hours for a new battery sensor to detect the battery state correctly.

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 that the SOC (State of charge) of battery is displayed on GDS properly.*

CAUTION

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

- **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.**
- **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.**
- **When recharging the battery, ground the negative terminal of the booster battery to the vehicle body.**

Starting System

Description

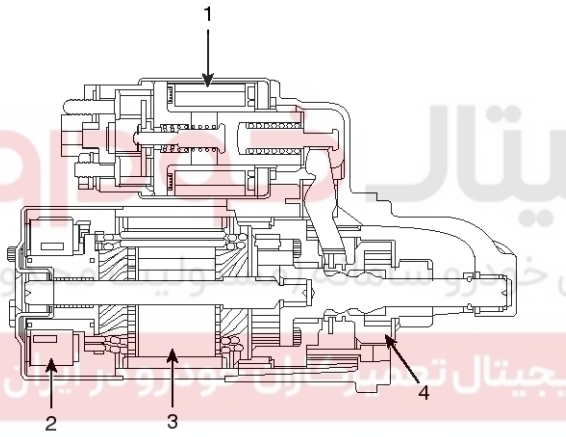
The starting system includes the battery, starter, solenoid switch, ignition switch, inhibitor switch (A/T), ignition lock switch, connection wires and the battery cable.

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

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

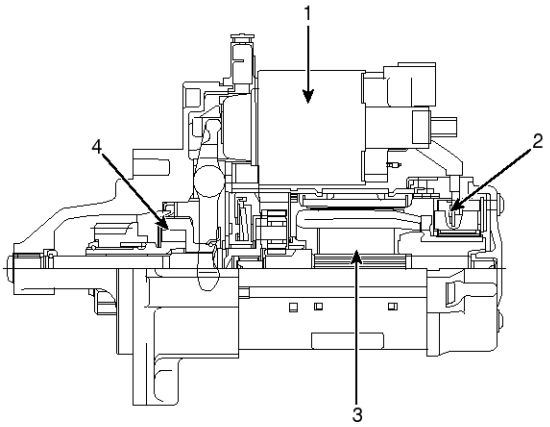
The contacts close and the starter motor cranks. In order to prevent damage caused by excessive rotation of the starter armature when the engine starts, the clutch pinion gear overruns.

[R2.0]



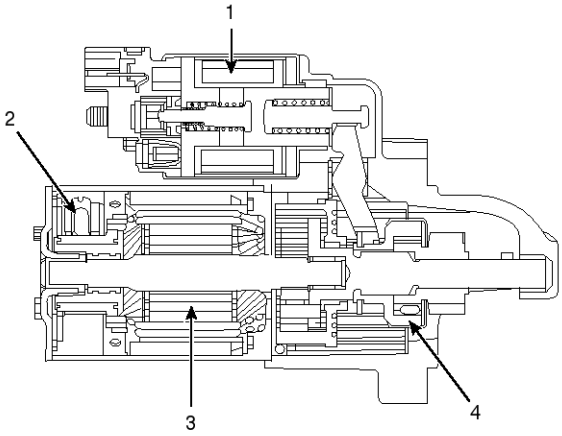
SSLE10109D

[U-II 1.7 (ISG Type)]



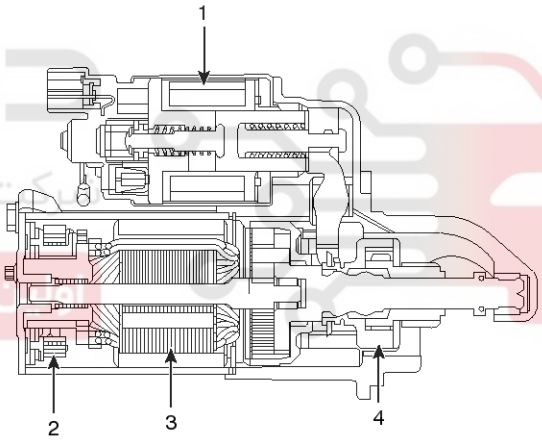
SSLEE1001L

[U-II 1.7 (Non-ISG Type)]



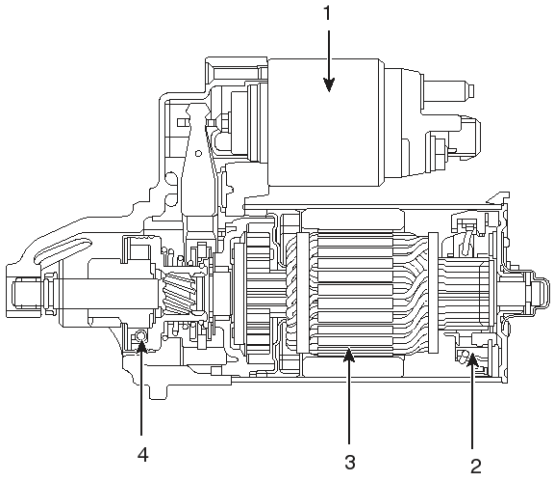
SSLEE1002L

[Theta-II 2.0/2.4]



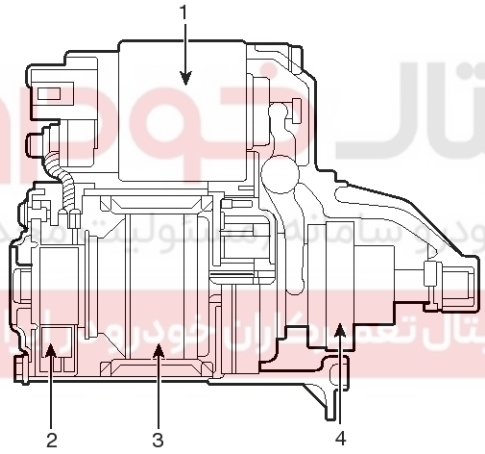
SSLEE0007D

[Gamma 1.6 GDI (ISG Type)]



SSLE11002L

[Gamma 1.6 GDI (Non-ISG Type)]



SSLEE1104L

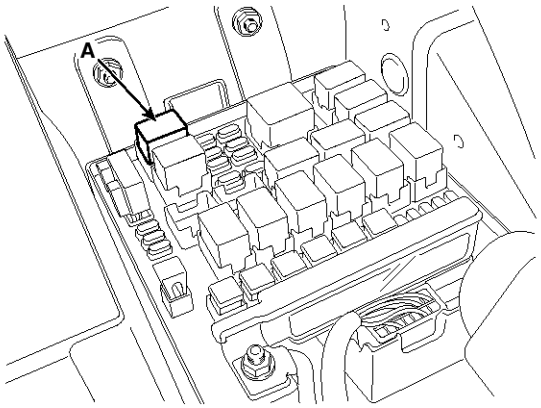
1. Solenoid
2. Brush
3. Armature
4. Overrun clutch

Troubleshooting Starter Circuit

NOTICE

The battery must be in good condition and fully charged.

1. Remove the fuel pump relay (A) from the fuse box.



SSLE10113D

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.

   - Solenoid plunger and switch malfunction.
   - 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 the engine normally, 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.

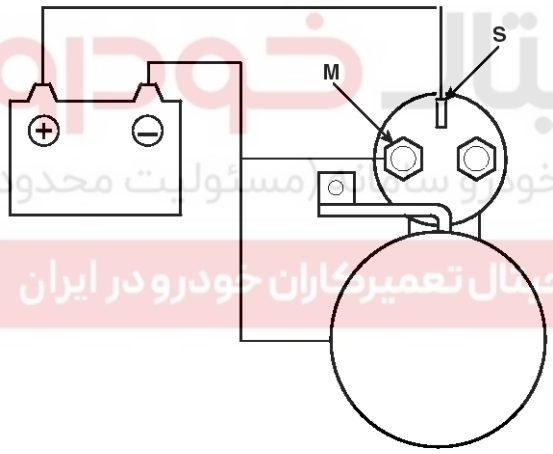
   If the starter cranks the engine, go to next step.

   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.
   - 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.
   - Check the ignition switch (Refer to ignition system in BE Group).
   - Check the transaxle range switch connector or ignition lock switch connector.
   - Inspect the starter relay.

Starter Solenoid Test

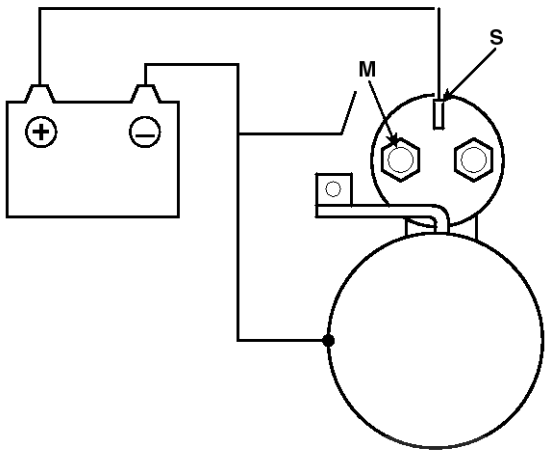
1. Disconnect the field coil wire from the M-terminal of solenoid switch.
2. Connect the battery as shown. If the starter pinion pops out (engages), it is working properly. To avoid damaging the starter, do not leave the battery connected for more than 10 seconds.



KBSE203D

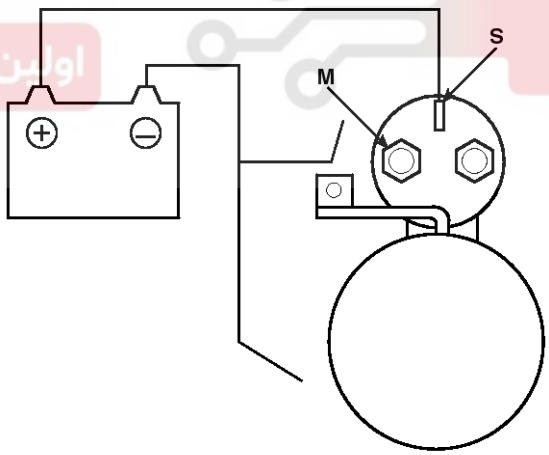
3. Disconnect the battery from the M terminal.

   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.



KBSE203E

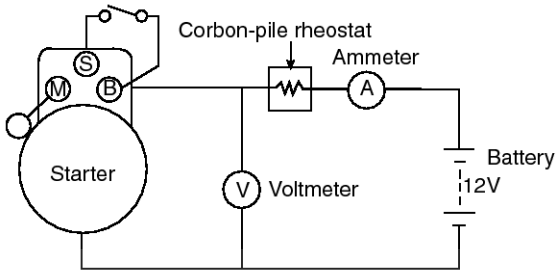
4. Disconnect the battery also from the body. If the pinion retracts immediately, it is working properly. To avoid damaging the starter, do not leave the battery connected for more than 10 seconds.



KBSE203F

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.



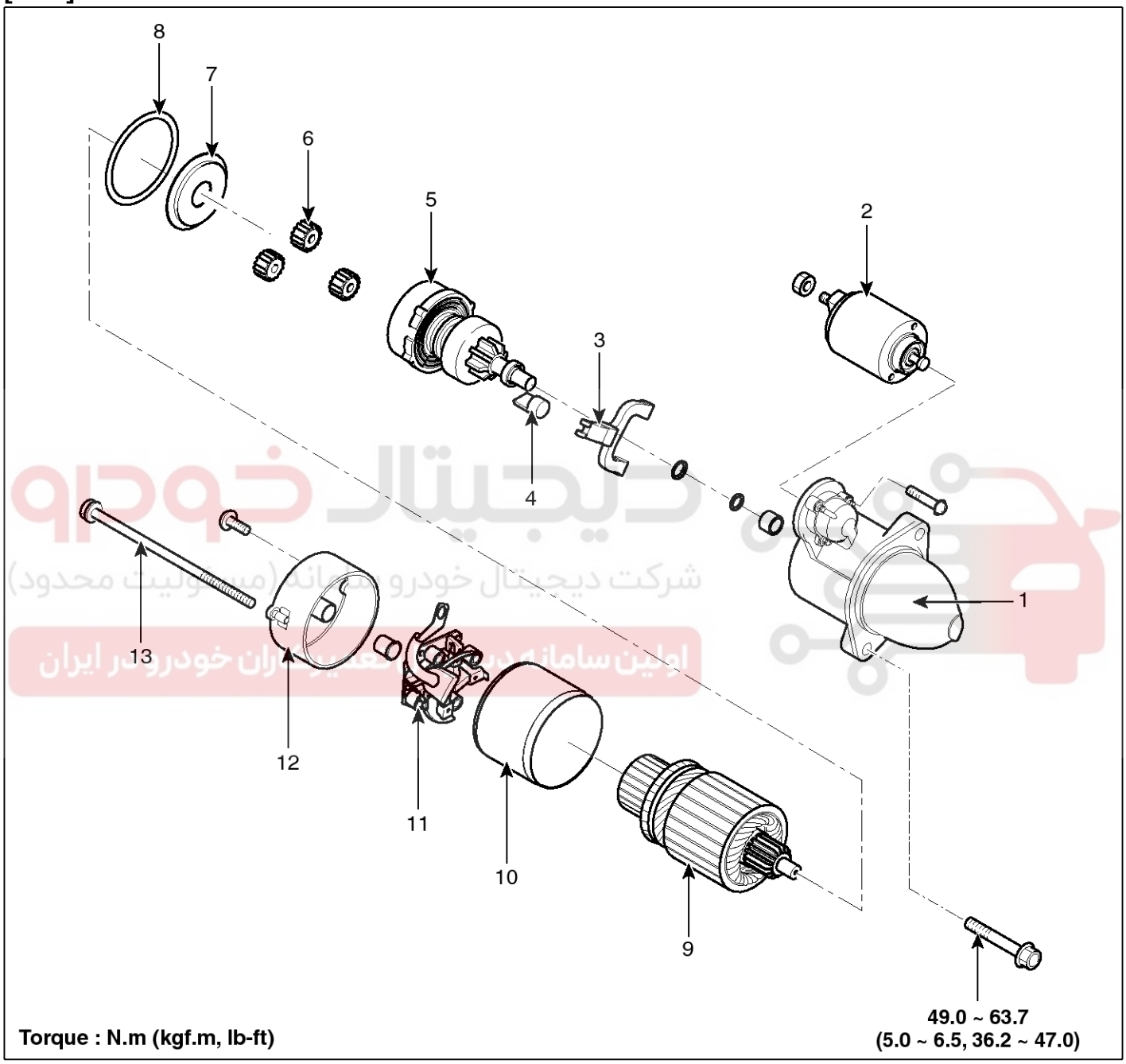
BBGE005A

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.

Max. Current :
R2.0 : 125A
U-II 1.7 (Non-ISG) : 85A
U-II 1.7 (ISG) : 100A
Theta II 2.0/2.4 : 90A
Gamma 1.6 GDI (Non-ISG) : 95A
Gamma 1.6 GDI (ISG) : 95A
Min. Speed :
R2.0 : 3,320 rpm
U-II 1.7 (Non-ISG) : 2,550 rpm
U-II 1.7 (ISG) : 2,390 rpm
Theta II 2.0/2.4 : 2,600 rpm
Gamma 1.6 GDI (Non-ISG) : 2,500rpm
Gamma 1.6 GDI (ISG) : 3,500rpm

Starter

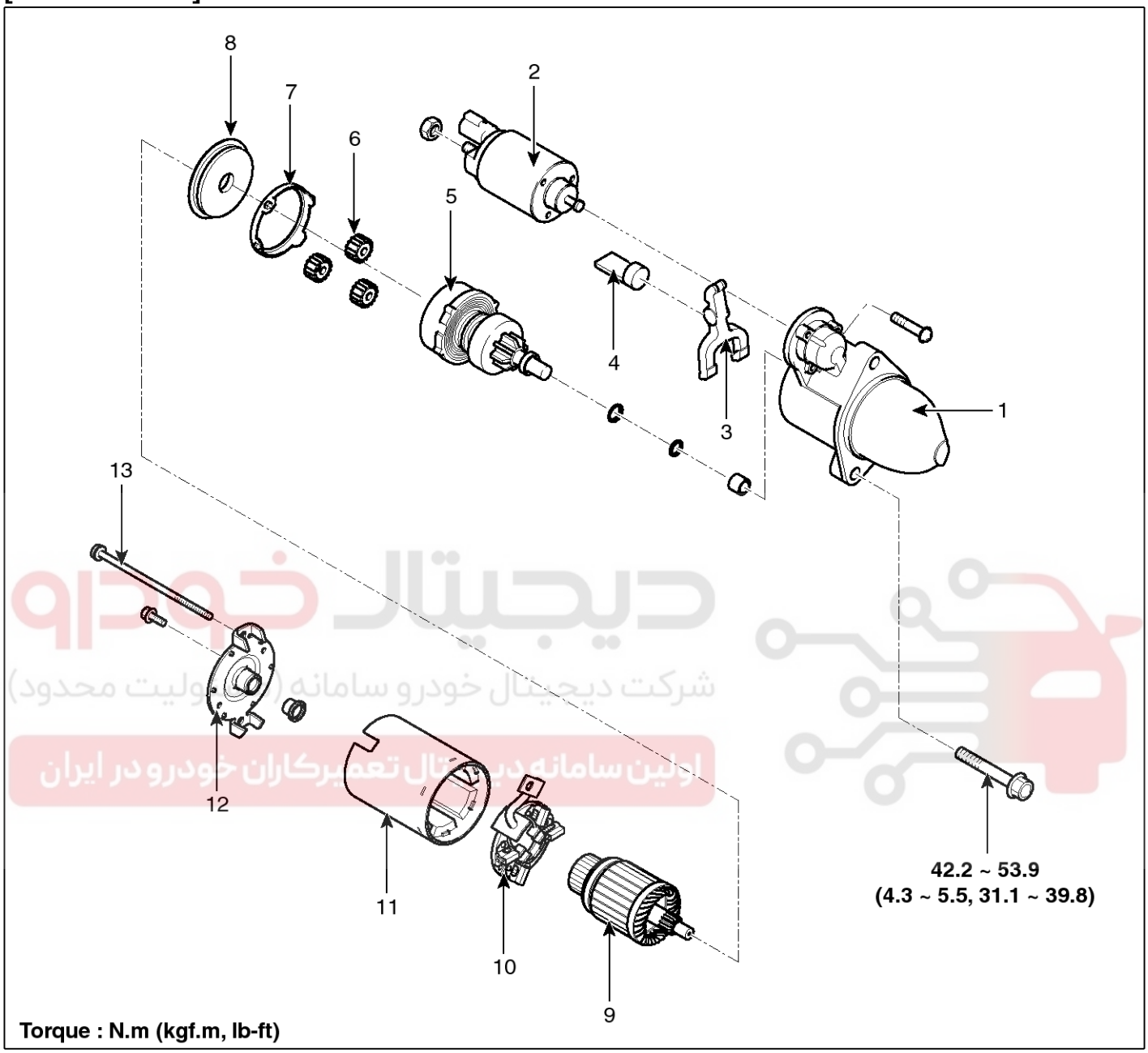
Components
[R2.0]



SSLEE0001L

1. Front bracket
2. Magnet switch assembly
3. Lever
4. Lever packing
5. Planet shaft assembly
6. Planetary gear assembly
7. Shield
8. Gasket
9. Amature assembly
10. Yoke assembly
11. Brush holder assembly
12. Rear bracket
13. Through bolt

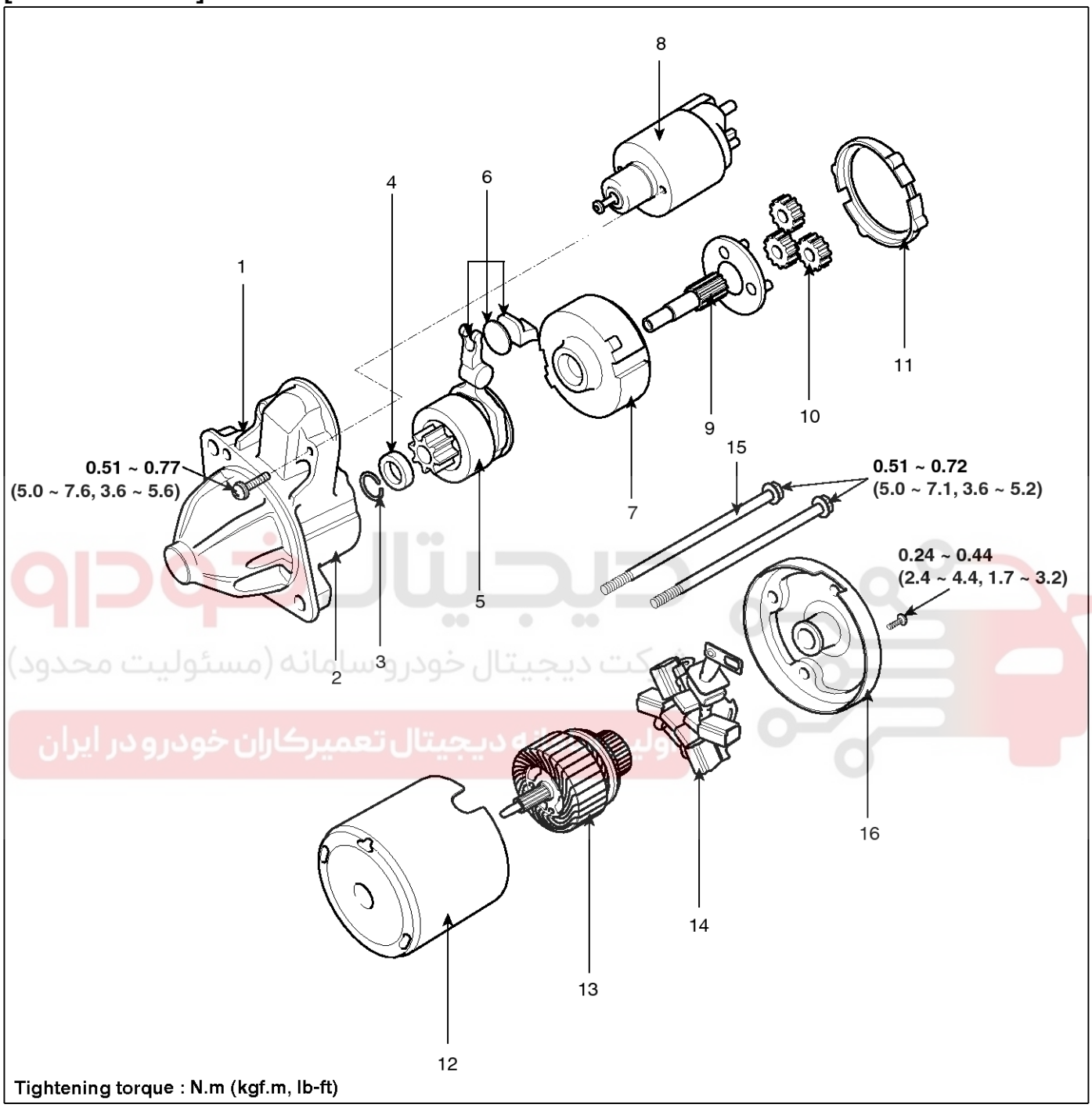
[Theta-II 2.0/2.4]



SSLE10115N

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

[Gamma 1.6 GDI]



SEDEE9101L

1. Screw
2. Front bracket
3. Stop ring
4. Snap ring
5. Overrun clutch
6. Lever set
7. Internal gear
8. Solenoid
9. Shaft assy gear
10. Planetary gear
11. Packing
12. Yoke assembly
13. Armature
14. Brush holder
15. Through bolts
16. Rear bracket

Removal and Installation

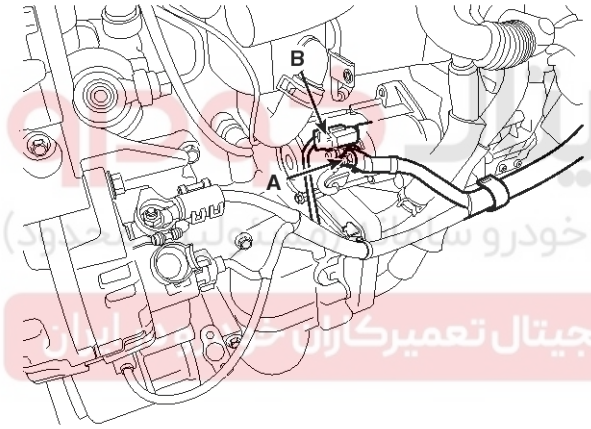
[R2.0]

1. Disconnect the battery negative cable.

Tightening torque:
Without battery sensor :
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
With battery sensor :
4.0 ~ 6.0N.m (0.4 ~ 0.6kgf.m, 3.0 ~ 4.4lb-ft)

2. Remove the air duct and air cleaner assembly. (Refer to EM group)
3. Remove the under cover. (Refer to EM group)
4. Disconnect the starter cable (A) from the B terminal on the solenoid then disconnect the connector (B) from the S terminal.

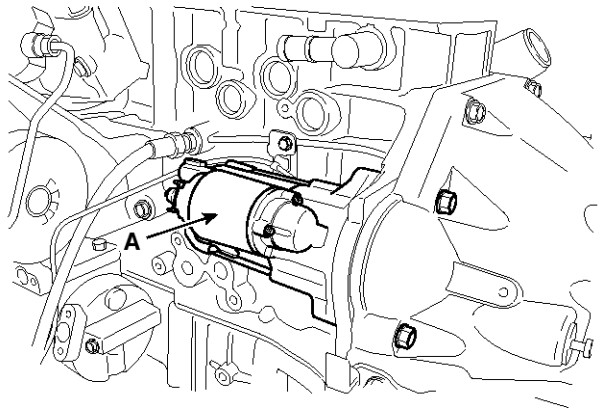
Tighting torque :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



SLMEE0010D

5. Remove the bolts holding the starter, then remove the starter.

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



SLMEE0011D

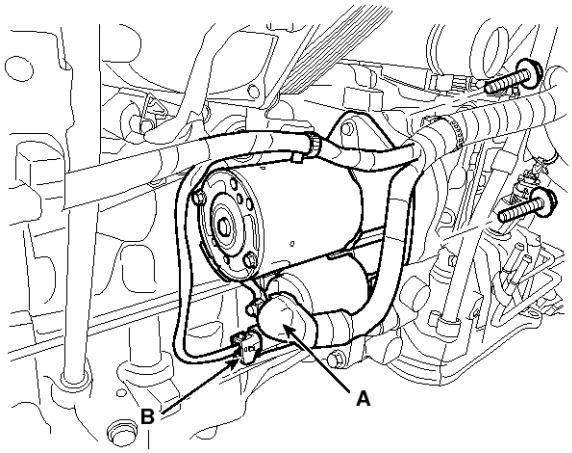
6. Installation is the reverse of removal.

[U-II 1.7]

1. Disconnect the battery negative terminal.

Tightening torque:
Without battery sensor :
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
With battery sensor :
4.0 ~ 6.0N.m (0.4 ~ 0.6kgf.m, 3.0 ~ 4.4lb-ft)

2. Remove the under cover. (Refer to EM group)
3. Disconnect the starter cable(A) from the B terminal on the solenoid then disconnect the connector(B) from the S terminal.



SRBEE1001D

4. Remove the 2 bolts holding the starter, then remove the starter.

Tighting torque :
38.2 ~ 58.8 Nm (3.9 ~ 6.0 kgf.m, 28.2 ~ 43.4 lb-ft)

5. Installation is the reverse of removal.

CAUTION
Do not disassemble the starter.

If it seems to be the problem of starter, inspect the 'starter circuit', 'starter solenoid test' and 'free running test' first(refer the troubleshooting in this group), and then replace the starter assembly.

[Theta-II 2.0/2.4]

1. Disconnect the battery negative cable.

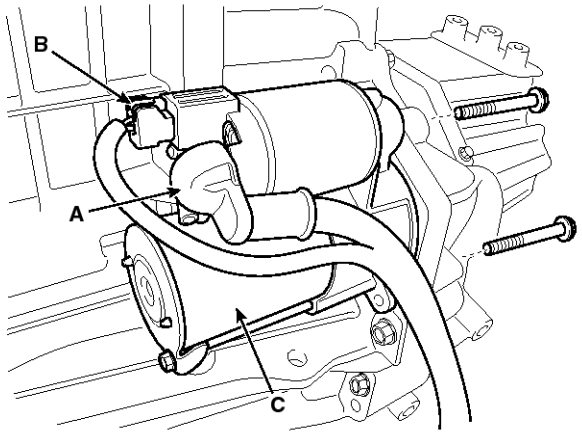
Tightening torque:
Without battery sensor :
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
With battery sensor :
4.0 ~ 6.0N.m (0.4 ~ 0.6kgf.m, 3.0 ~ 4.4lb-ft)

2. Disconnect the starter cable (A) from the B terminal on the solenoid, then disconnect the connector (B) from the S terminal.

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

3. Remove the 2 bolts holding the starter, then remove the starter (C).

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



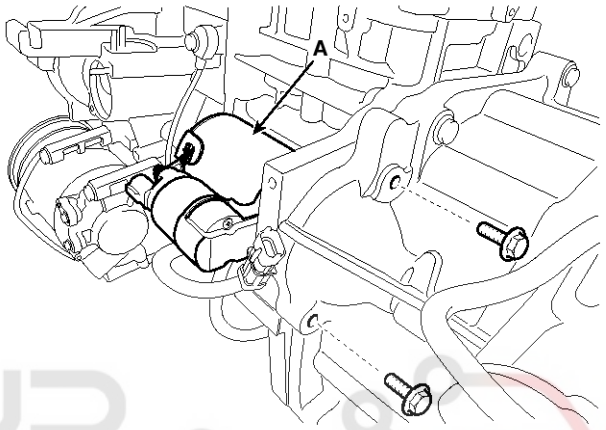
SSLE10003D

4. Installation is the reverse of removal.

[Gamma 1.6 GDI]

1. Disconnect the battery negative terminal.
2. Disconnect the starter cable from the B terminal on the solenoid then disconnect the connector from the S terminal.
3. Remove the 2 bolts holding the starter, then remove the starter (A).

Tighting torque :
42.2 ~ 53.9 Nm (4.3 ~ 5.5 kgf.m, 31.1 ~ 39.8 lb-ft)



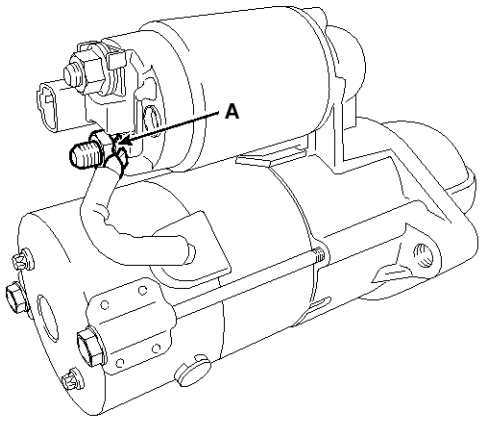
SMDEE1001D

4. Installation is the reverse of removal.

Disassembly

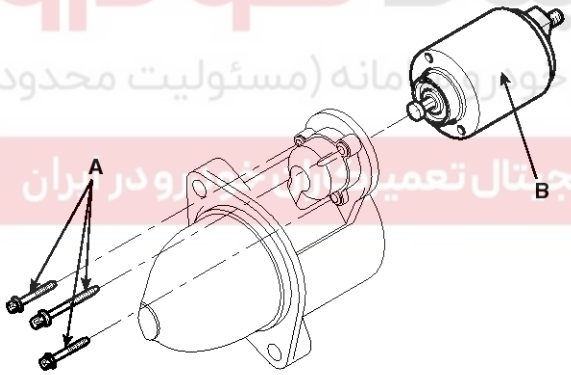
[R2.0]

1. Disconnect the M-terminal (A) on the starter solenoid assembly (B).



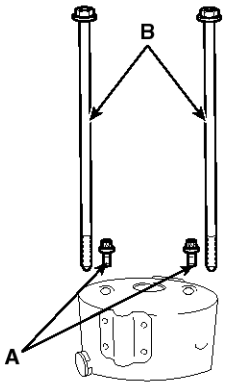
SXMEE9006D

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



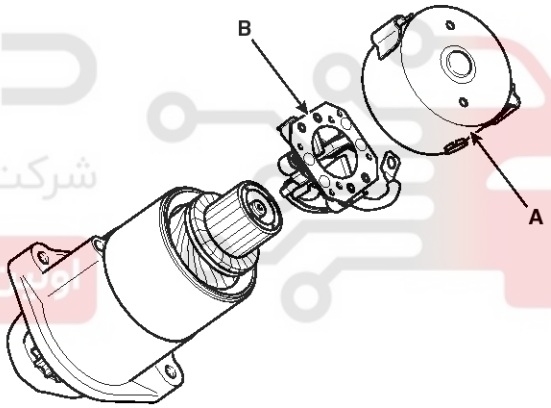
SSLEE0103D

3. Loosen the brush holder mounting screw (A) and through bolts (B).



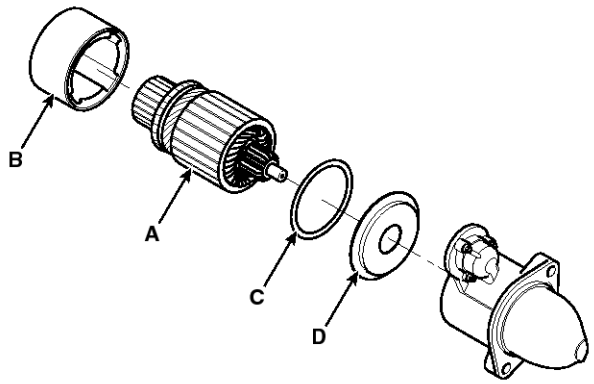
SSLEE0104D

4. Remove the rear bracket (A) and brush holder assembly (B).



SSLEE0002D

5. Remove the amature (A), yoke (B), gasket (C) and shield (D).

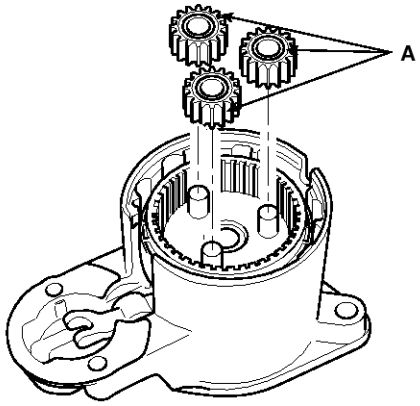


SSLEE0003D

6. Remove the lever packing (A).

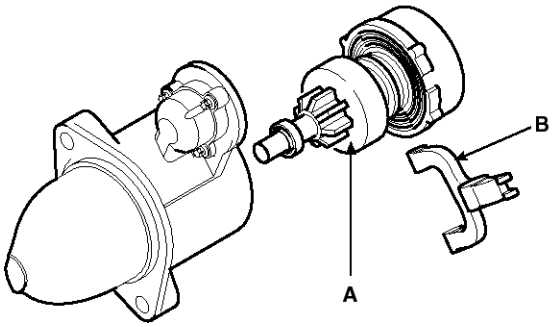
SVIE19104D

7. Disconnect the planet gear (A).



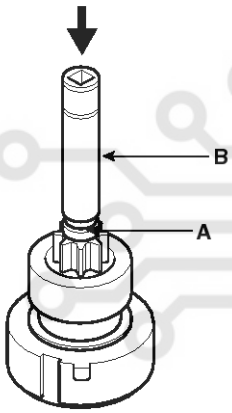
EBKD011I

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



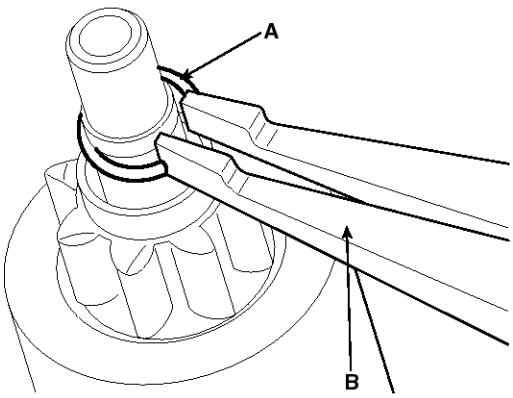
SXMEE9120D

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



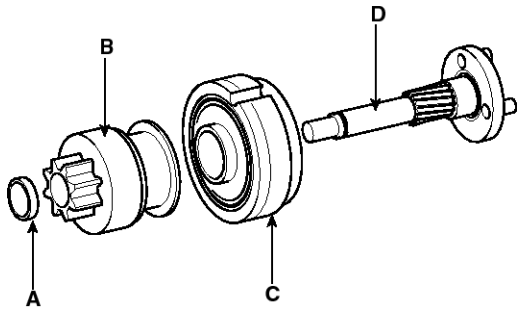
EBKD011K

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



EBKD011L

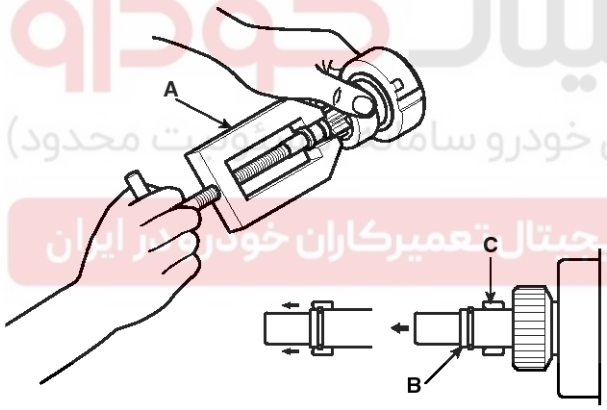
11. Disconnect the stopper (A), overrunning clutch (B), internal gear (C) and planet shaft (D).



LBGF024A

NOTICE

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

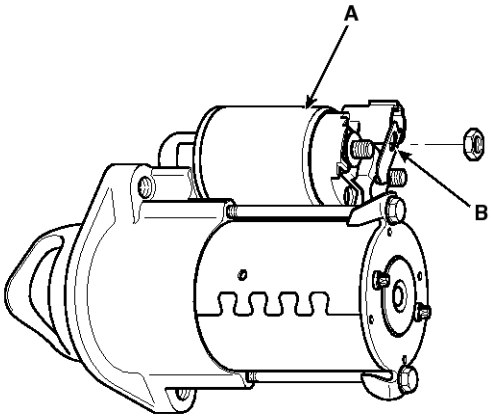


LBGF025A

12. Reassembly is the reverse of disassembly.

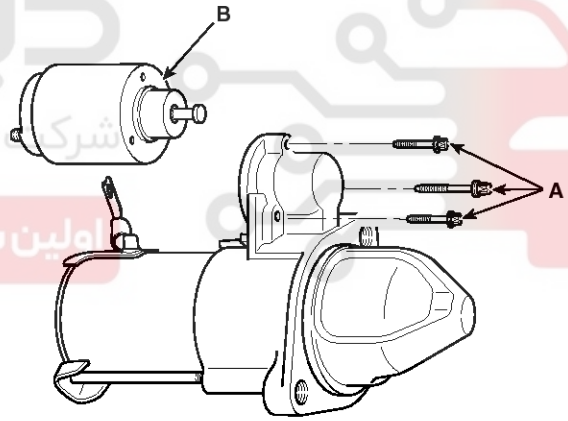
[Theta-II 2.0/2.4]

1. Disconnect the M-terminal (B) on the starter solenoid assembly (A).



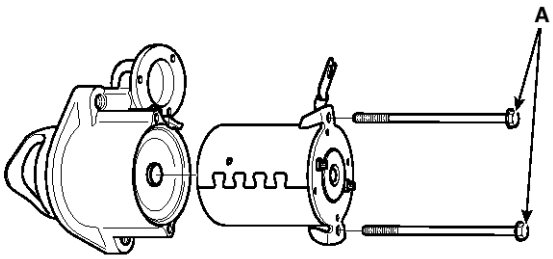
SYFEE0005N

2. After loosening the screws (A), detach the starter solenoid assembly (B).



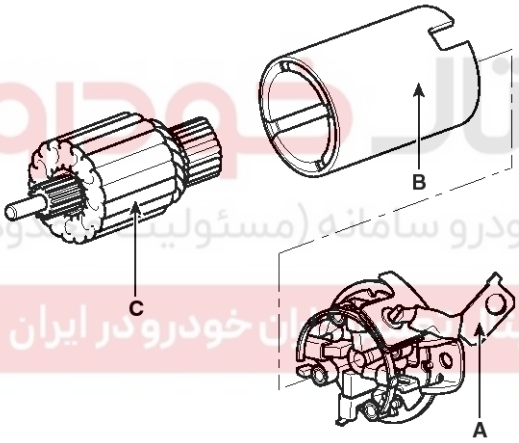
SYFEE0006N

3. Loosen the through bolts (A).



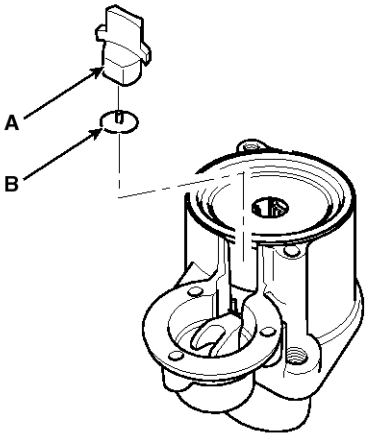
SYFEE0007N

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



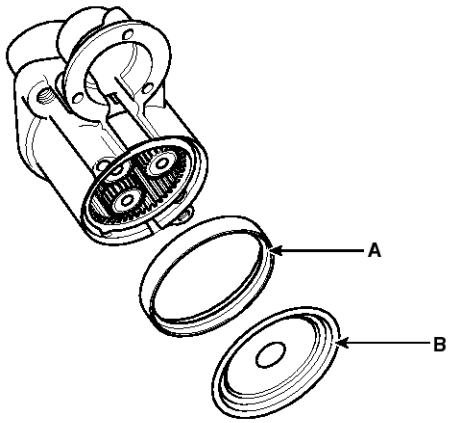
SYFEE0008N

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



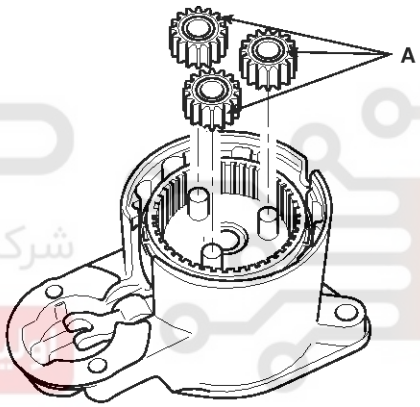
SYFEE0009N

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



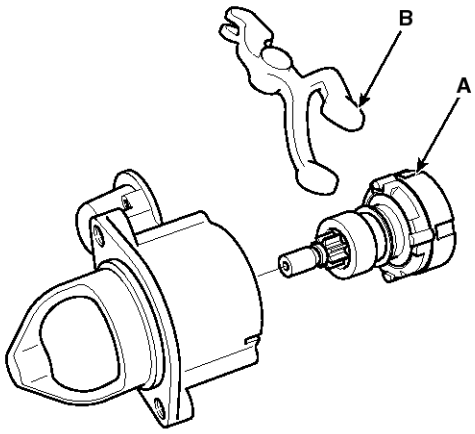
SYFEE0010N

7. Disconnect the planet gear (A).



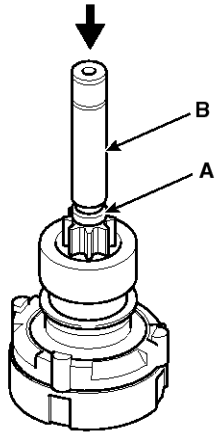
EBKD011I

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



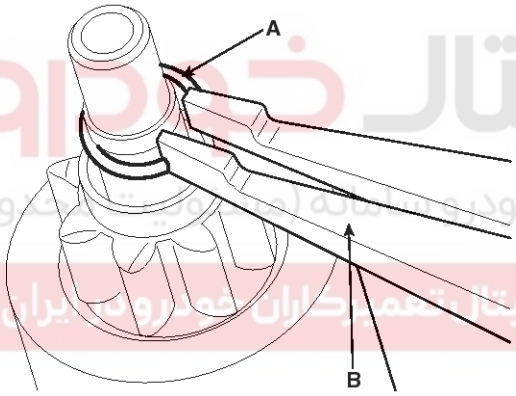
SYFEE0011N

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



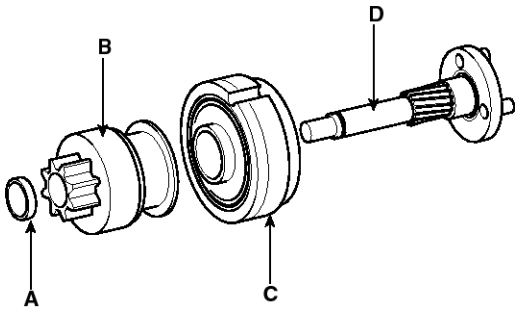
SYFEE0012N

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



EBKD011L

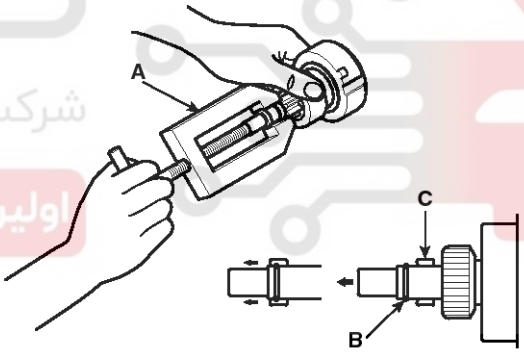
11. Disconnect the stopper (A), overrunning clutch (B), internal gear (C) and planet shaft (D).



EBKD011M

NOTICE

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

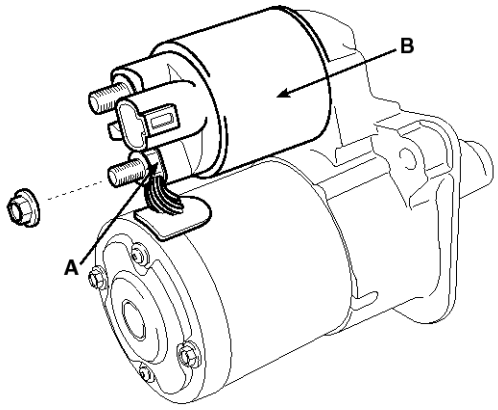


EBKD011O

12. Reassembly is the reverse of disassembly.

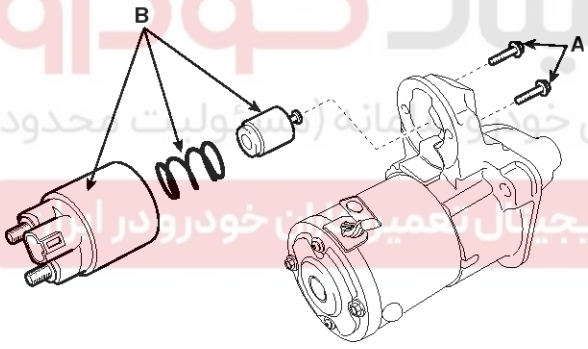
[Gamma 1.6 GDI]

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



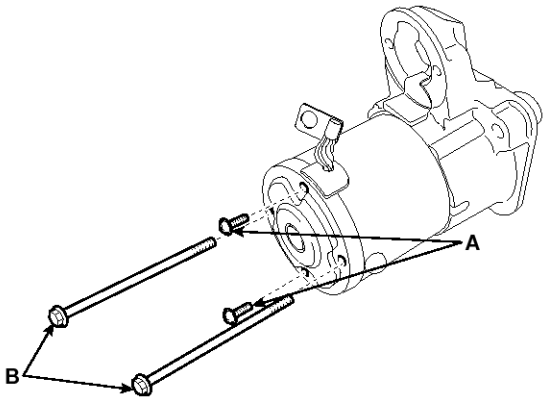
SEDEE7004L

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



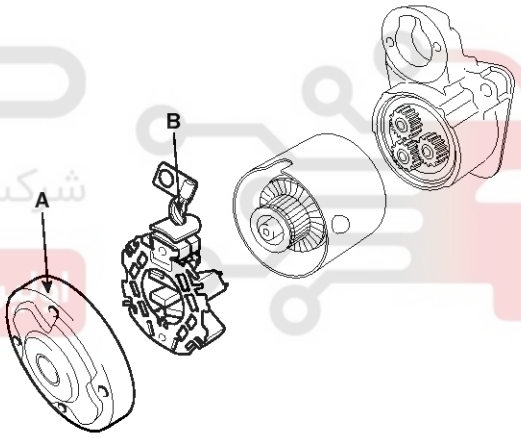
SEDEE7005L

3. Loosen the brush holder mounting screw (A) and through bolts (B).



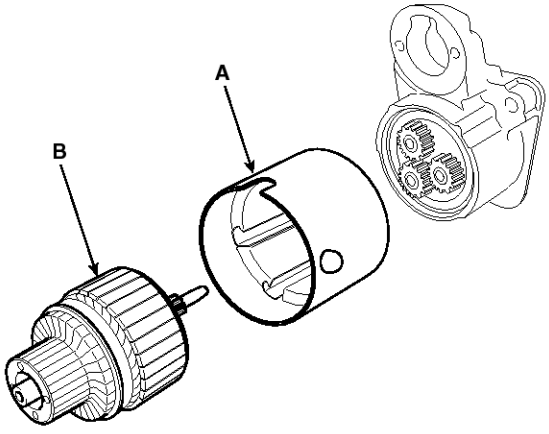
SEDEE7006L

4. Remove the rear bracket (A) and brush holder assembly (B).



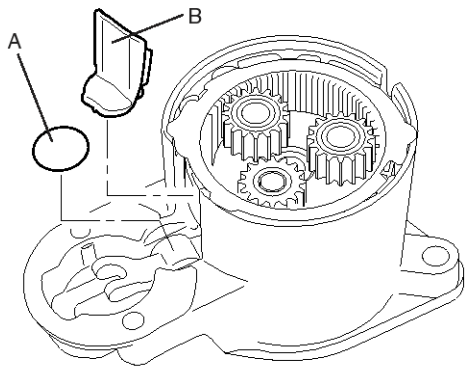
SEDEE7007L

5. Remove the yoke (A) and armature (B).



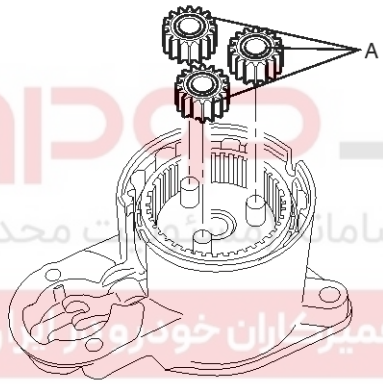
SEDEE7008L

6. Remove the, lever plate (A) and packing (B).



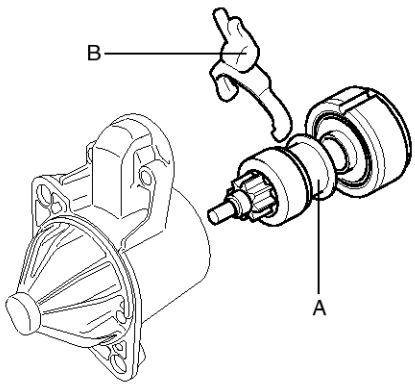
SHDEA6023D

7. Disconnect the planetary gear(A).



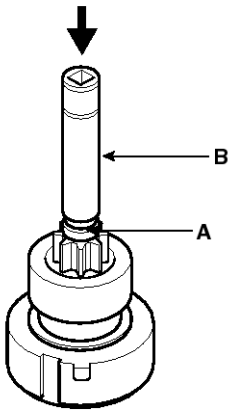
SHDEA6024D

8. Remove the overrunning clutch (A) and lever (B).



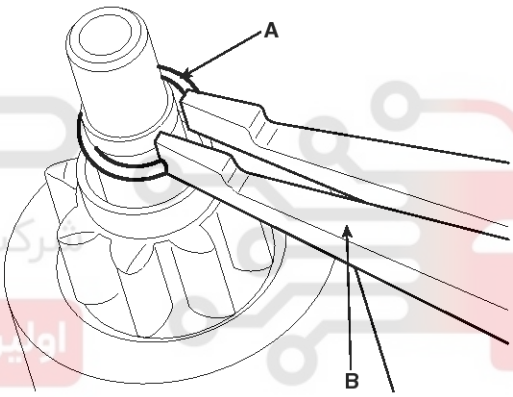
SHDEA6025D

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



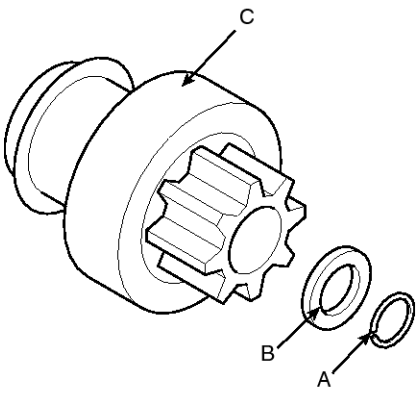
EBKD011K

10. Remove the stop ring (A) using stop ring pliers (B).



EBKD011L

11. Remove the stop ring (A), stopper (B), overrunning clutch (C).

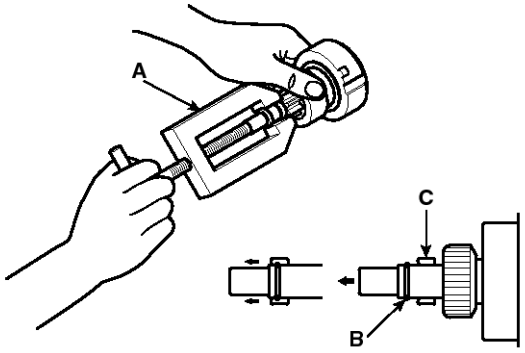


SEDEE7018L

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).

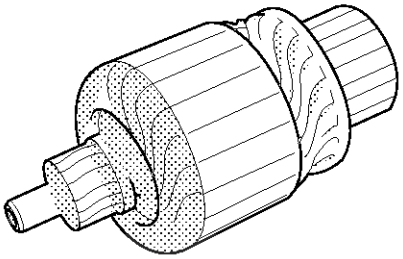


EBKD011O

Inspection

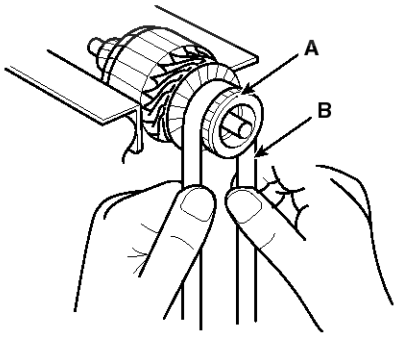
Armature Inspection And Test

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.



EBKD012A

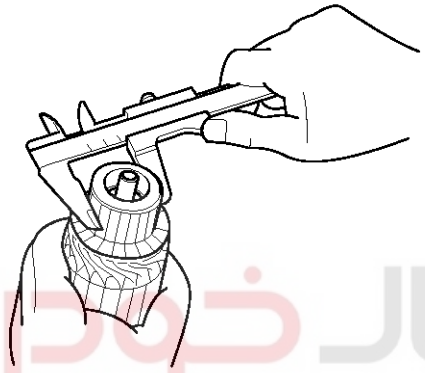
4. Check the commutator (A) surface. If the surface is dirty or burnt, resurface with emery cloth or a lathe within the following specifications, or recondition with #500 or #600 sandpaper (B).



EBKD012B

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

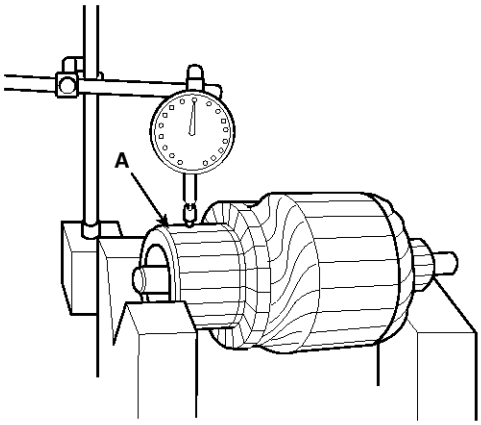
Commutator diameter
Standard (New)
R2.0 : 33.0 mm (1.2992 in)
Theta II 2.0/2.4 : 27.0 mm (1.0630 in)
Gamma 1.6 GDI : 29.4 mm (1.1575 in)
Service limit
R2.0 : 32.8 mm (1.2913 in)
Theta II 2.0/2.4 : 26.0 mm (1.0236 in)
Gamma 1.6 GDI : 28.8 mm (1.1339 in)



EBKD012C

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

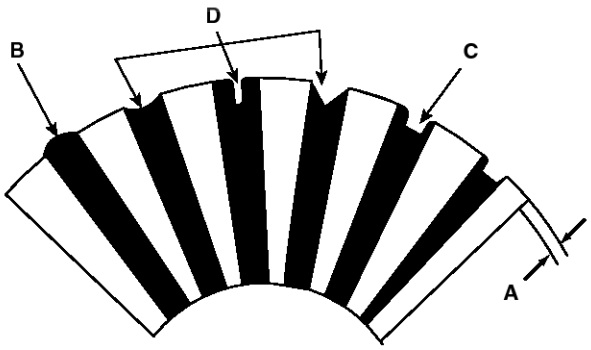
Commutator runout
Standard (New)
R2.0 : 0.05mm (0.0020in.) max
Theta II 2.0/2.4 : 0.05mm (0.0020in.) max
Gamma 1.6 GDI : 0.05mm (0.0020in.) max
Service limit
R2.0 : 0.08mm (0.0031in.) max
Theta II 2.0/2.4 : 0.08mm (0.0031in.) max
Gamma 1.6 GDI : 0.08mm (0.0031in.) max



EBKD012D

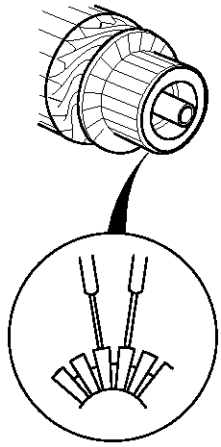
7. Check the mica depth (A). If the mica is too high (B), undercut the mica with a hacksaw blade to the proper depth. Cut away all the mica (C) between the commutator segments. The undercut should not be too shallow, too narrow, or v-shaped (D).

Commutator mica depth
Standard (New)
R2.0 : 0.5mm (0.0197in.)
Theta II 2.0/2.4 : 0.8mm (0.0315in.)
Gamma 1.6 GDI : 0.5mm (0.0197in.)
Limit
R2.0 : 0.2mm (0.0079 in.)
Theta II 2.0/2.4 : 0.2mm (0.0079 in.)
Gamma 1.6 GDI : 0.2mm (0.0079 in.)



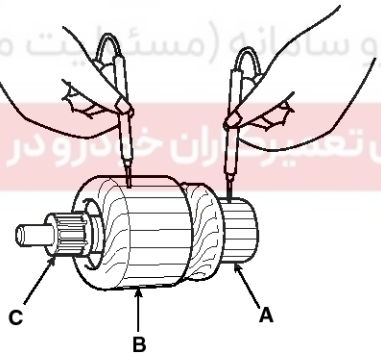
LBGF030A

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



LBGF031A

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.



EBKD012G

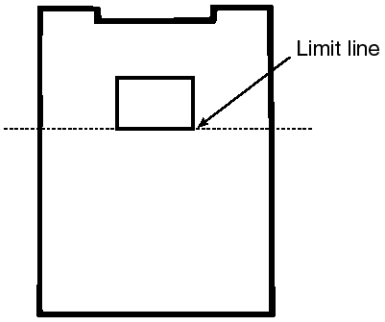
Inspect Starter Brush

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

Bruch length

Standard : 12.3 mm (0.4843 in)

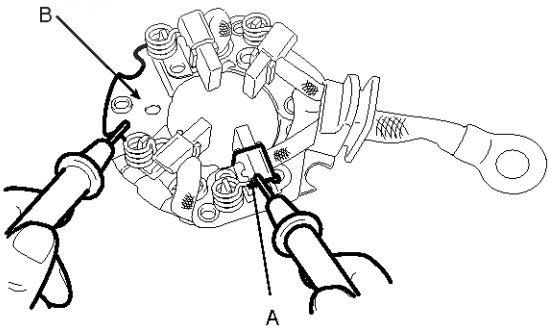
Service limit : 5.5 mm (0.2165 in)



SVGE10019L

Starter Brush Holder Test [R2.0]

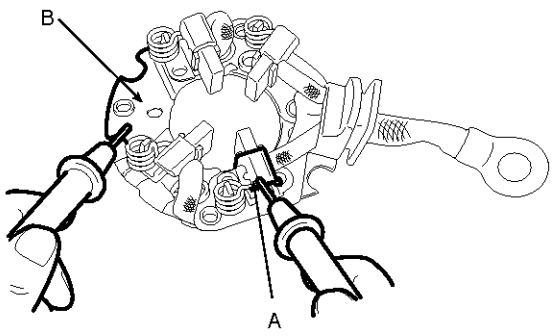
Make sure there is no continuity between the (+) brush holder (A) and (-) plate (B). If there is continuity, replace the brush holder assembly.



EBBD330A

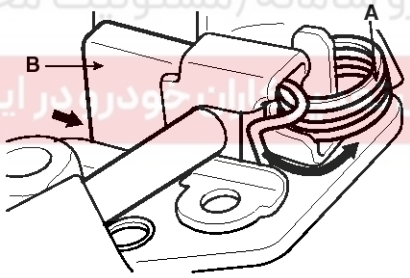
[Theta II 2.0/2.4, Gamma 1.6 GDI]

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



EBBD330A

2. Pry back each brush spring (A) with a screwdriver, then position the brush (B) about halfway out of its holder, and release the spring to hold it there.

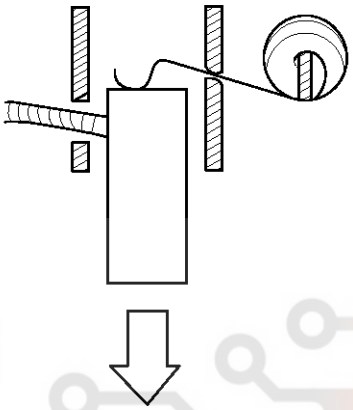


EBKD012K

3. Install the armature in the housing, and install the brush holder. Next, pry back each brush spring again, and push the brush down until it seats against the commutator, then release the spring against the end of the brush.

NOTICE

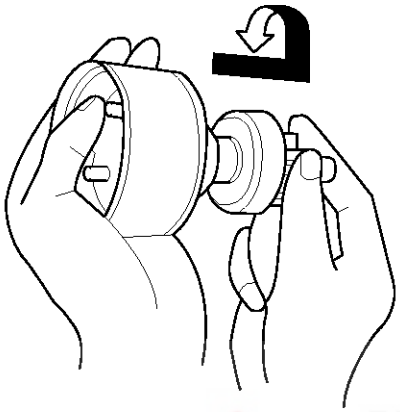
To seat new brushes, slip a strip of #500 or #600 sandpaper, with the grit side up, between the commutator and each brush, and smoothly rotate the armature. The contact surface of the brushes will be sanded to the same contour as the commutator.



EBKD012I

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.



EBKD012J

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.

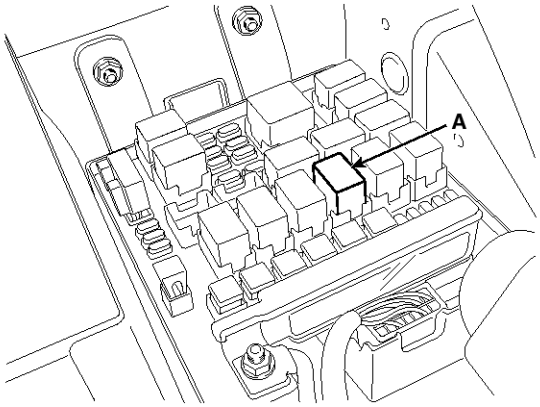
Cleaning

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.

Starter Relay

Inspection

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

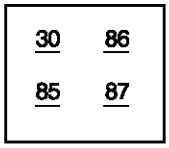


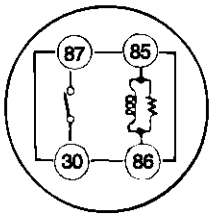
SSLE10114D

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

Terminal	Continuity
30 - 87	NO
85 - 86	YES

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





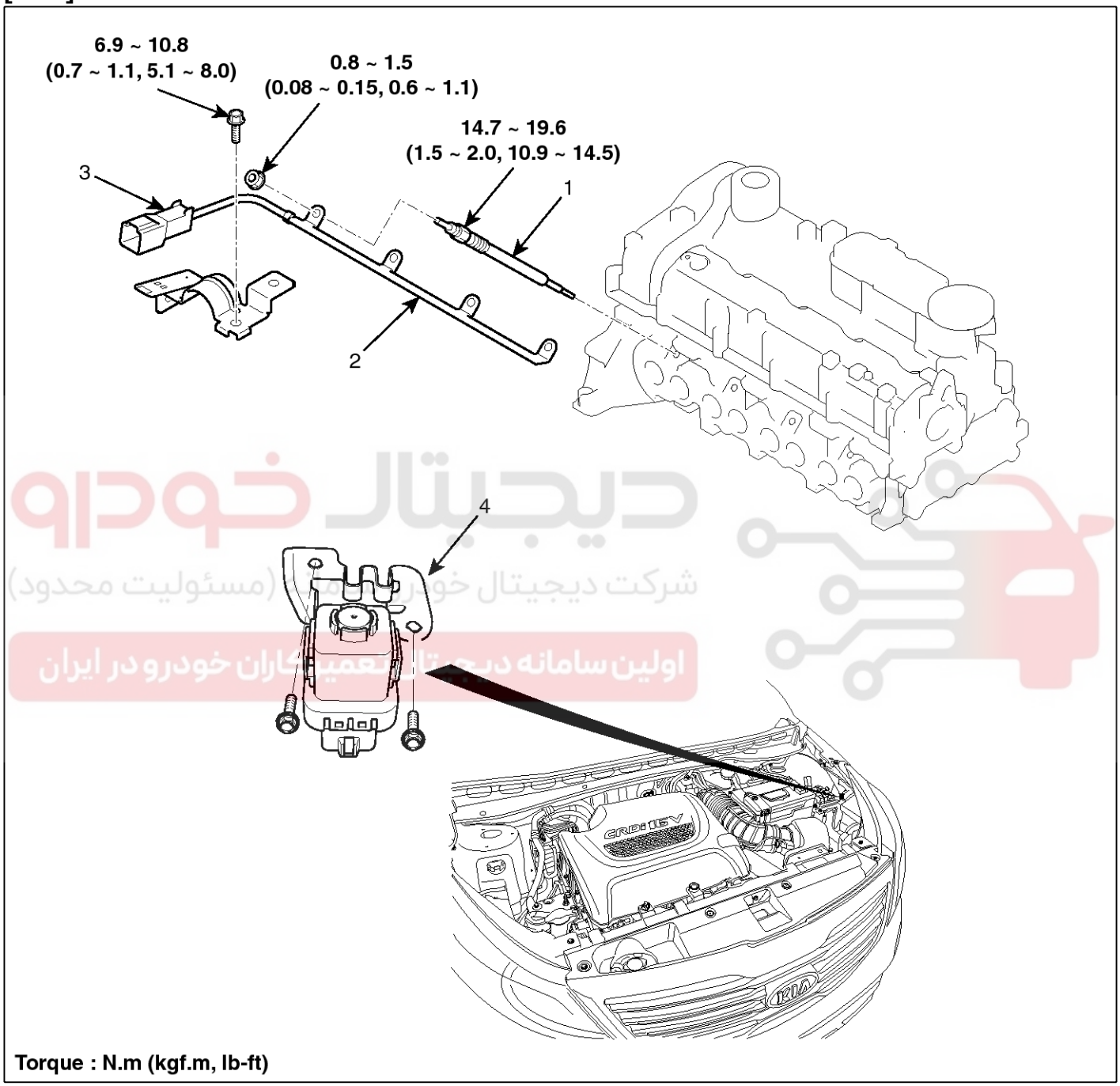
LDAD510B

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

Preheating System

Components

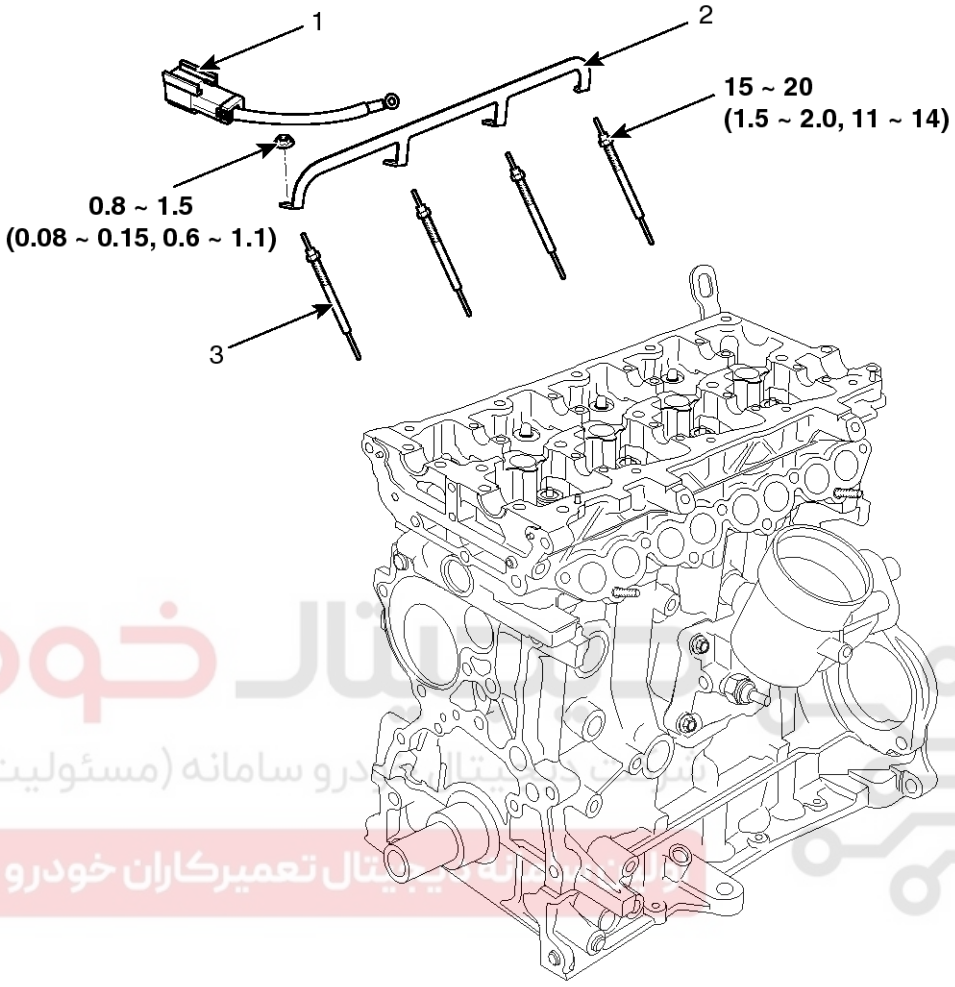
[R2.0]



SSLE10110L

1. Glow plug
2. Glow plug plate
3. Glow plug connector
4. Glow plug relay

[U-II 1.7]



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

SEDE29005L

1. Glow plug connector
2. Glow plug plate
3. Glow plug

Inspection

[R2.0]

Preheating System

Conditions before inspection :

Battery voltage : 12V

Cooling water temperature : Below 30℃ (86˚F)

(Disconnect the water temperature sensor connector).

CAUTION

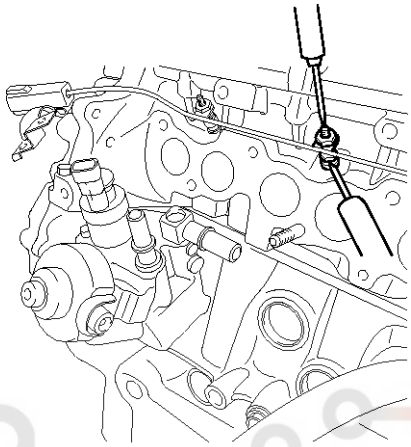
Reconnect the water temperature sensor connector after inspection.

1. Connect voltmeter between glow plug plate and plug body (ground).
2. Check indicated value on voltmeter with ignition switch ON.
3. Check that preheat indication lamp lights for about 6 seconds and indicates battery voltage (about 9V or over) for about 20 seconds immediately after ignition switch is turned on. [At cooling water temperature 20˚C (68.0˚F)]

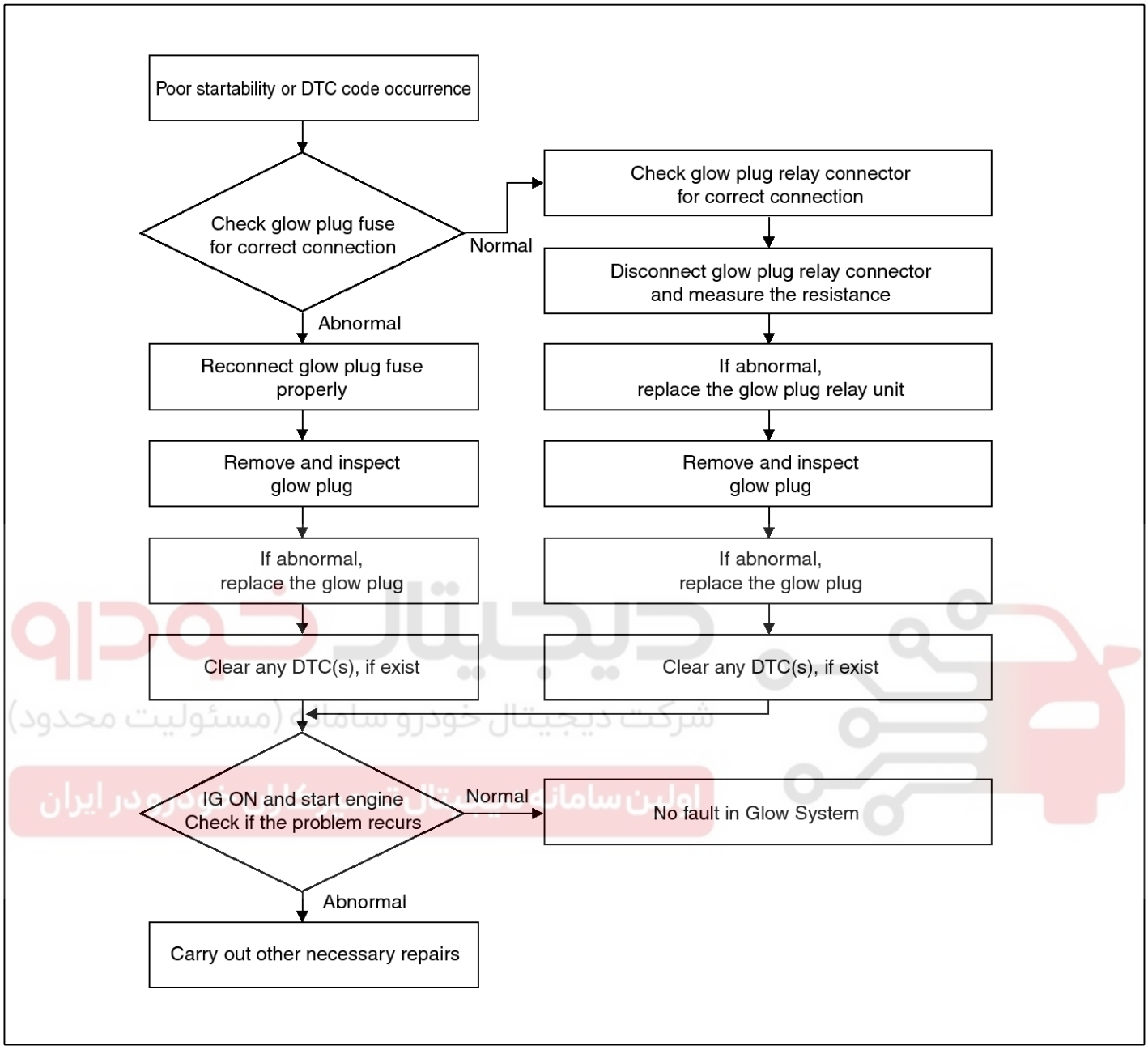
NOTICE

Continuity time varies depending upon cooling water temperature.

4. After checking 3, set ignition switch at START position.
5. The system is normal if battery voltage (about 9V or over) is generated for about 6 seconds during engine cranking and after start operation. [at cooling water temperature 20˚C (68.0˚F)]
6. When the voltage or continuity time is not normal, check the terminal voltage in glow control unit, and single parts.



SXMEE9009D



SSLE10121L

Glow Plug

CAUTION

- **Never connect glow plug directly to car battery to test the heating performance of the glow plug. It causes damage to the glow plug.**
- **Before removing glow plug to inspect it, be sure to check that glow plug fuse (in the engine compartment fuse & relay box) is properly connected in place. If starting the engine with the glow plug fuse improperly connected, it causes damage to the glow plug.**

NOTICE

Be sure to check that the engine coolant temperature is below 30˚C prior to inspection. If the coolant temperature is above 30˚C, incorrect resistance of the glow plug may be measured.

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

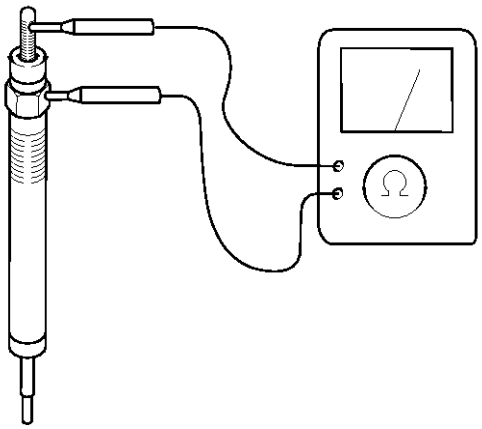
Standard value
Ceramic : 0.31Ω
Metal : 0.35Ω

State	Resistance
Short	Below 100mΩ
Open	Over 1Ω

CAUTION

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

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



SSLE10116D

Glow Plug Relay

CAUTION

- **The vehicle with NHTC glow plugs (ceramic heating element, beige insulator) should be equipped with black glow plug relay unit.**
- **The vehicle with AQGS glow plugs (metal coil heating element, black insulator) should be equipped with gray glow lug relay unit.**

1. Remove the glow plug relay after disconnecting it from wire harness.
2. Check open / short at each point of the glow plug relay by using multi meter (1MΩ range).
   1) Check open / short between terminals 87 and 31.

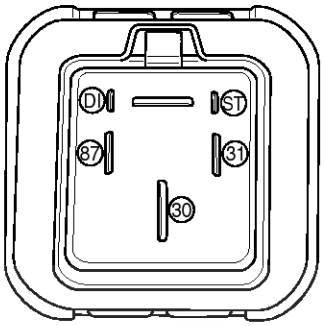
State	Open / short criteria	Remedy
Short / Open	Out the range of 350kΩ ± 30%	Change the glow plug relay
Not Short / Open	In the range of 350kΩ ± 30%	Go to next step

   2) Check open / short between terminals G and 30.
      - Connect (+) rod to 30 terminal and (-) rod to G terminal.

State	Open / short criteria	Remedy
Short / Open	Out the range of 100kΩ ± 30%	Change the glow plug relay
Not Short / Open	In the range of 100kΩ ± 30%	Go to next step

- Connect (+) rod to G terminal and (-) rod to 30 terminal.

State	Open / short criteria	Remedy
Short / Open	Out the range of 100kΩ ± 30%	Change the glow plug relay
Not Short / Open	In the range of 100kΩ ± 30%	o.k



SXMEE9123L

3. Install the glow plug relay and then connect wiring harness to it.

[U-II 1.7]

Preheating System

Conditions before inspection :

Battery voltage : 12V

Cooling water temperature : Below 30℃ (86˚F)

(Disconnect the water temperature sensor connector).

⚠CAUTION

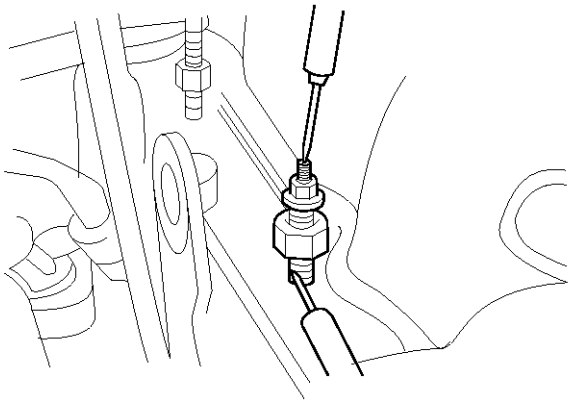
Reconnect the water temperature sensor connector after inspection.

1. Connect voltmeter between glow plug plate and plug body (ground).
2. Check indicated value on voltmeter with ignition switch ON.
3. Check that preheat indication lamp lights for about 6 seconds and indicates battery voltage (about 9V or over) for about 36 seconds immediately after ignition switch is turned on. [At cooling water temperature 20˚C (68.0˚F)]

NOTICE

Continuity time varies depending upon cooling water temperature.

4. After checking 3, set ignition switch at START position.
5. The system is normal if battery voltage (about 9V or over) is generated for about 6 seconds during engine cranking and after start operation. [at cooling water temperature 20˚C (68.0˚F)]
6. When the voltage or continuity time is not normal, check the terminal voltage in glow control unit, and single parts.



EBKD300O

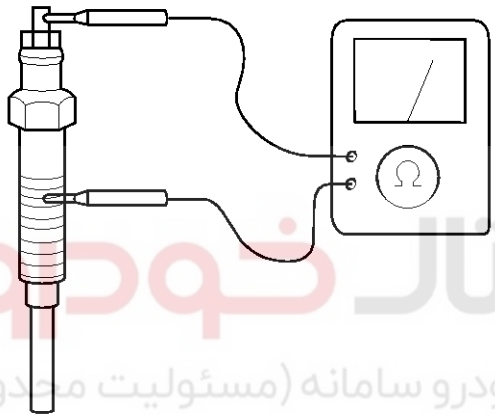
Glow Plug

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

Standard value :
Non-Ceramic : 0.45 ± 0.1Ω
Ceramic : 0.8Ω

⚠CAUTION
Remove oil from plug before measuring as glowplug resistance is very small.

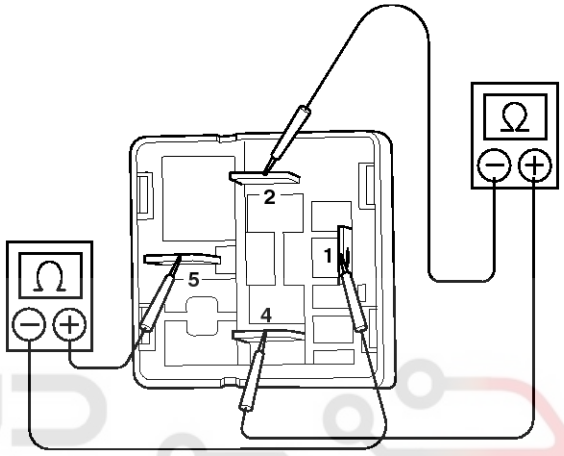
2. Check for rust on glow plug plate.
3. Check glow plug for damage.



EBKD300P

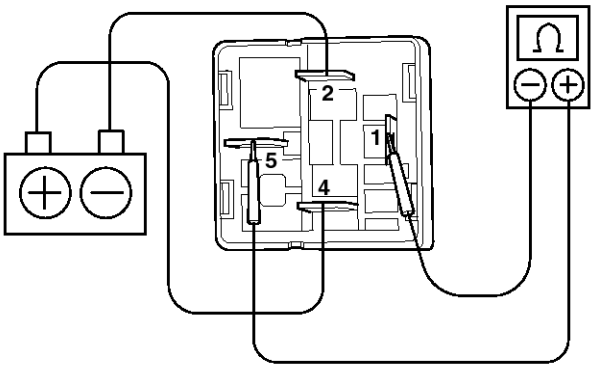
Glow Plug Relay

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



LBGF035A

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

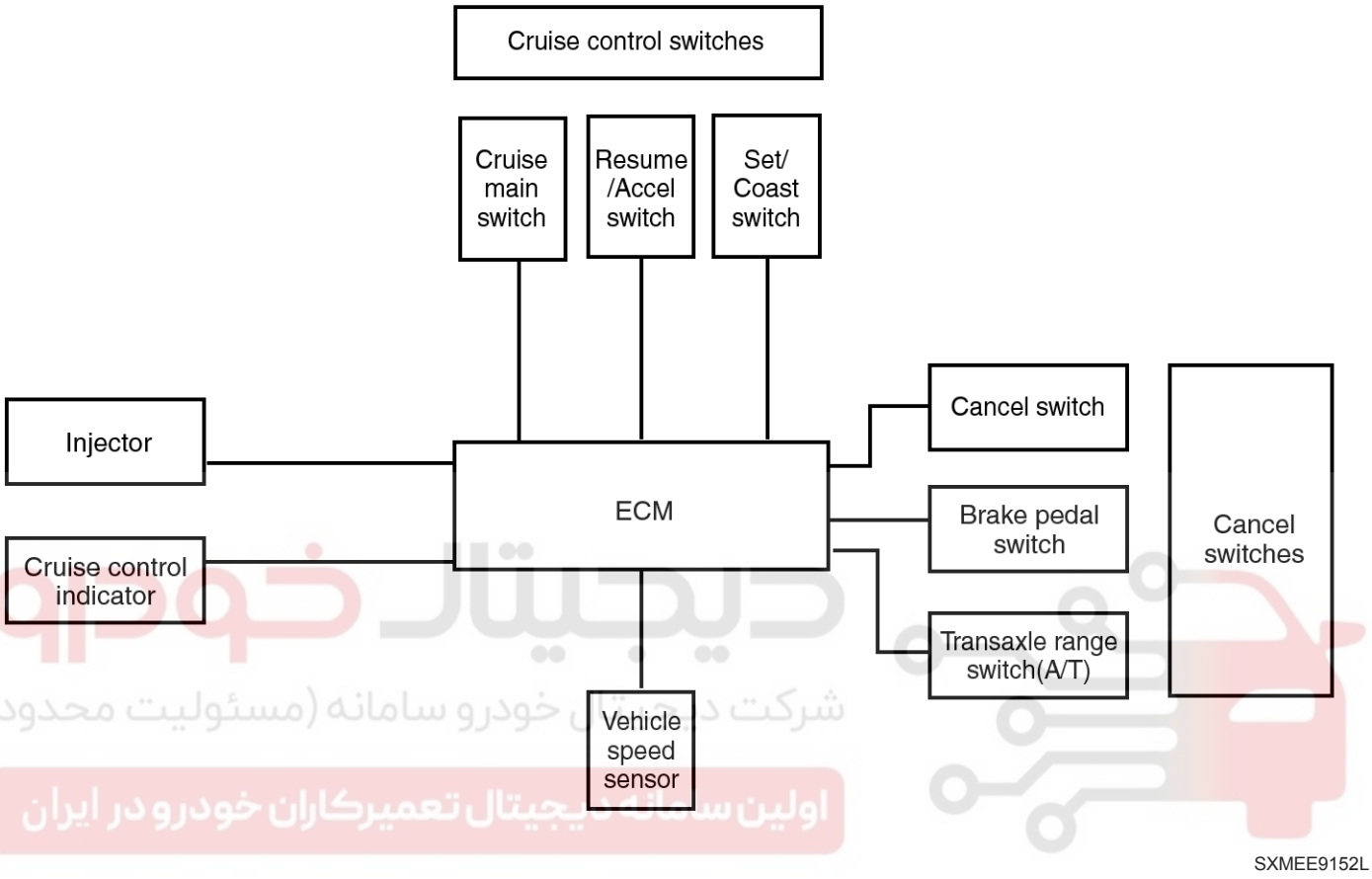


LBGF036A

4. Install the glow plug relay.

Cruise Control System

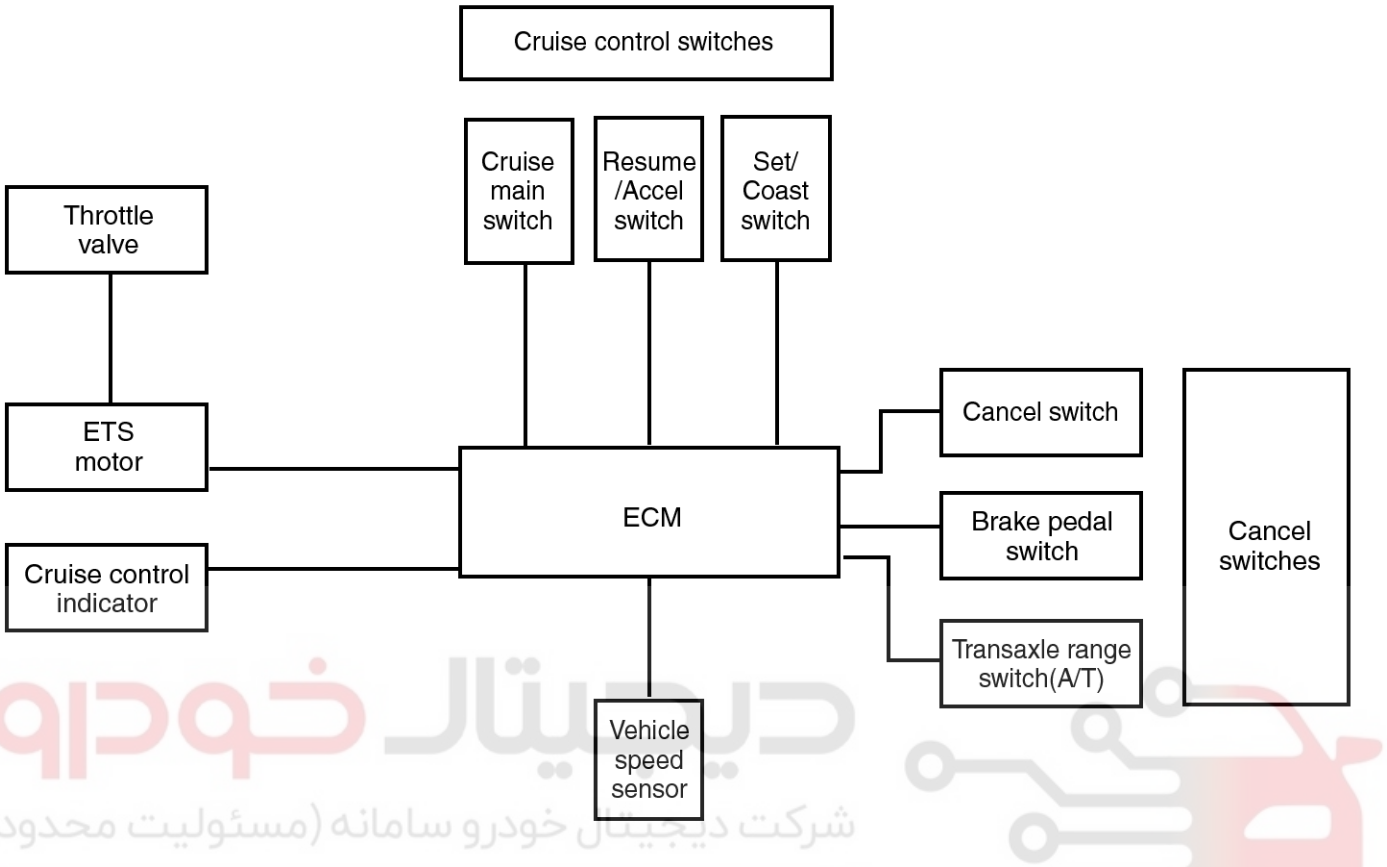
System Block Diagram
[R2.0, U-II 1.7]



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	Cruise main 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)	
Injector		Controls the fuel injection quantity by ECM signal.

[Theta II 2.0/2.4, Gamma 1.6 GDI]



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

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 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/+" 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 2.0km/h (1.2mph) or 1.6km/h (1.0mph).

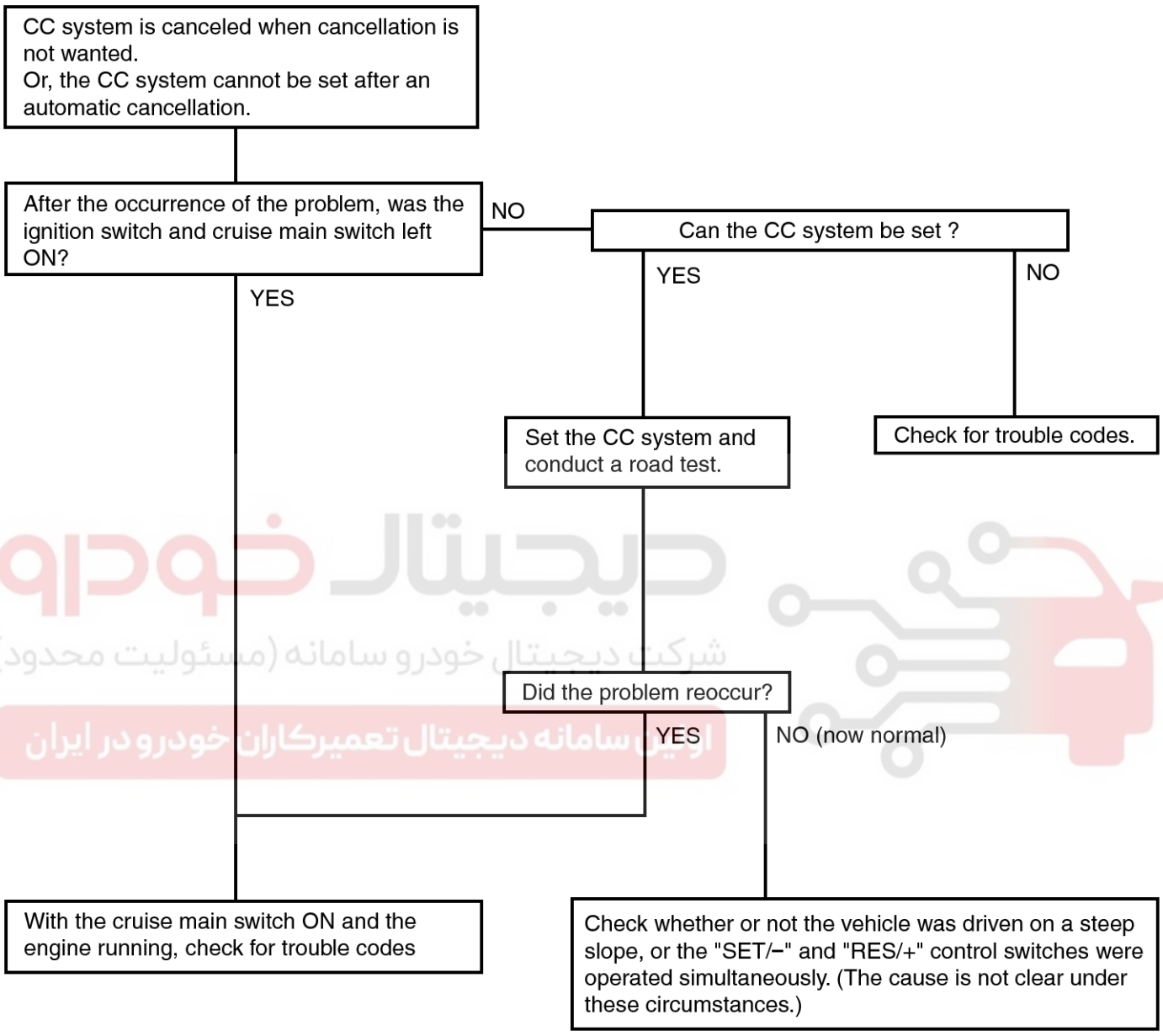
Cancel switch (CANCEL)

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.

Trouble Symptom Charts

Trouble Symptom 1



CC : Cruise Control
ECM : Engine Control Module

SVIE19143L

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

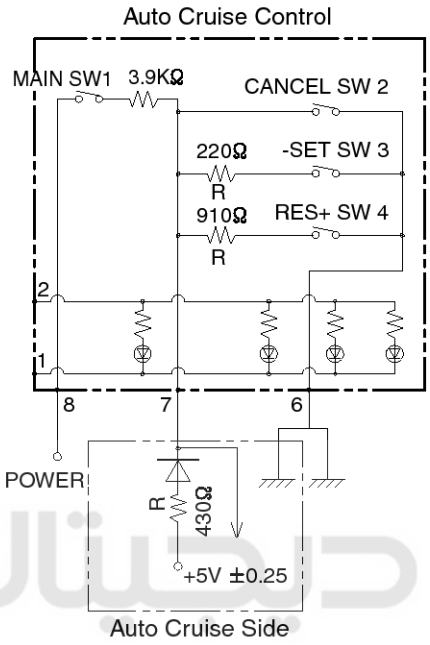
Trouble Symptom 8

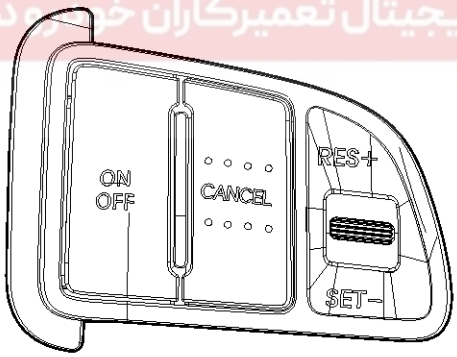
Trouble symptom	Probable cause	Remedy
The cruise main switch indicator lamp does not illuminate (But CC system is normal)	Damaged or disconnected bulb of cruise main switch indicator lamp	Repair the harness or replace the part.
	Harness damaged or disconnected	

Cruise Control Switch

Circuit Diagram

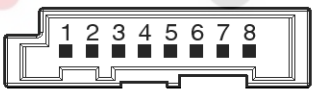
[Auto Cruise Control]





[RH]

Connector RH



No	Connector
1	ILL (-)
2	ILL (+)
3	-
4	-
5	-
6	ACC GND
7	ACC signal
8	ACC power

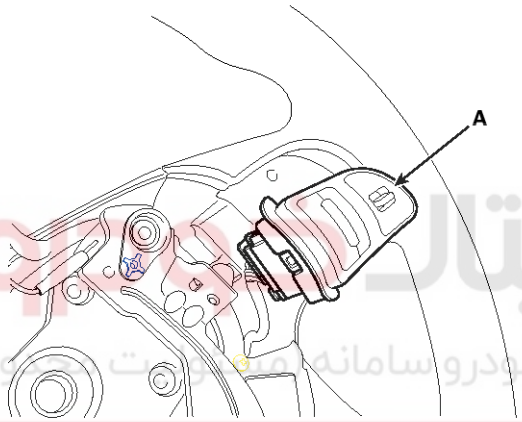
SSLE10118N

Removal and Installation

1. Disconnect the battery (-) terminal.

Tightening torque:
Without battery sensor :
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
With battery sensor :
4.0 ~ 6.0N.m (0.4 ~ 0.6kgf.m, 3.0 ~ 4.4lb-ft)

2. Remove the air-bag module from the steering wheel. (Refer to RT group)
3. Remove the steering wheel. (Refer to ST group)
4. Remove the cruise control switch (A) after unfastening the 2 screws and disconnecting the switch connector.



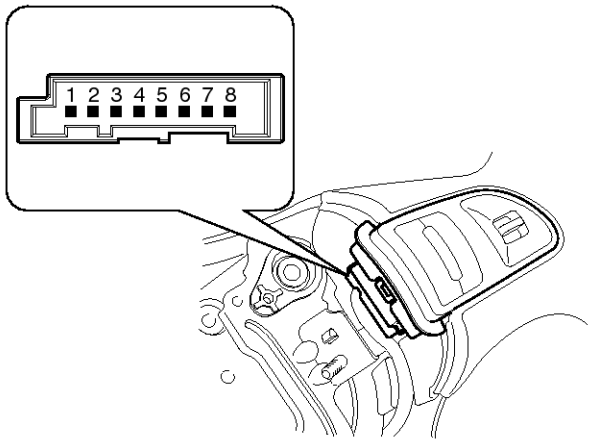
SSLE10119N

5. Installation is reverse order of removal.

Inspection

Measuring Resistance

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



SSLE10120N

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

Function switch	Terminal	Resistance
CANCEL	6 - 7	0Ω ± 5%
SET/–	6 - 7	220Ω ± 5%
RES/+	6 - 7	910Ω ± 5%
ON/OFF	7 - 8	3900Ω ± 5%

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	6 - 7	0.0 ± 0.22V
SET/–	6 - 7	1.5 ± 0.22V
RES/+	6 - 7	3.0 ± 0.22V
ON/OFF	7 - 8	-

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 ECM.