
ENGINE

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11.1 STARTING AND CHARGING SYSTEM

1 Warning and Precaution

1.1 Warning

Be sure to observe the following instructions before repairing, to prevent property damage, personal injury or even death:

- (1) Battery acid is highly corrosive, so it is necessary to wear protective gloves and goggles when working.
- (2) Do not dump the battery, because acid may spill from vent hole.
- (3) Never throw the used battery into household garbage. There is risk of explosion.

1.2 Precaution

In order to avoid dangerous operation and damage to the vehicle, always follow the instructions below before repair:

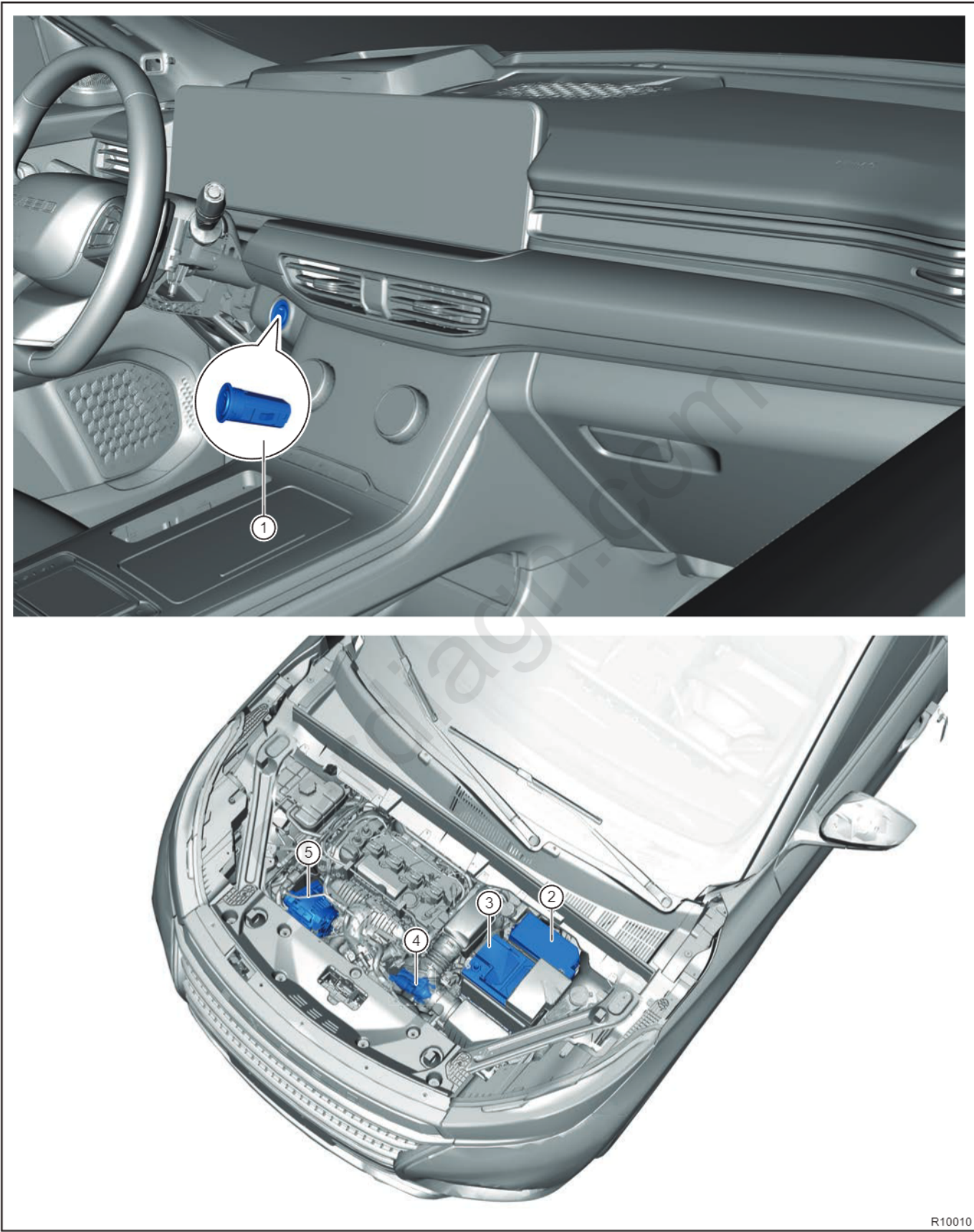
- (1) Deliver the used battery to designated recycling site.
- (2) Never allow the children approaching acid and battery.

2 System Overview

2.1 System Description

Starting system consists of battery, starting switch and starter, etc. Starting system converts electrical energy from battery into mechanical energy, allowing engine to crank initially, and disconnects power transmission between starter and engine when engine starts successfully. Charging system is consist of battery, alternator and charging state indicator device. Alternator is the main power supply component while vehicle is operating. It is used to supply power to all the electric equipment (except for the starting system) and charge the battery. Since alternator is rotated through drive belt which is driven by the engine, voltage will changes depending on engine speed. To meet electric device power supply and battery charging requirements, voltage regulator is equipped in charging system (inside alternator). The voltage regulator maintains voltage output stability of alternator by adjusting exciting current in alternator while engine speed and load is changing. Charging state indicator is used to show the charging system operation and indicate whether the battery is in a charging or discharging state.

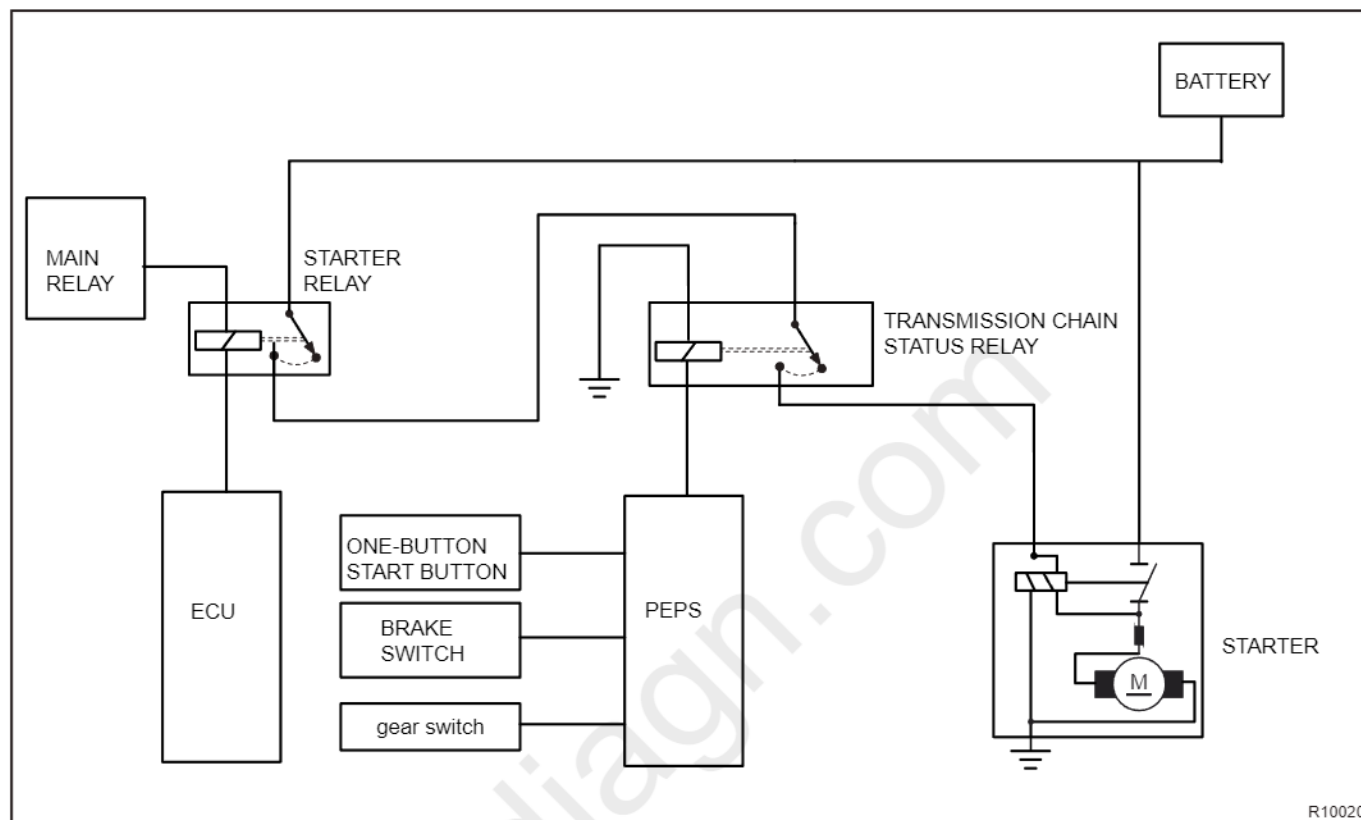
2.2 System Components Diagram



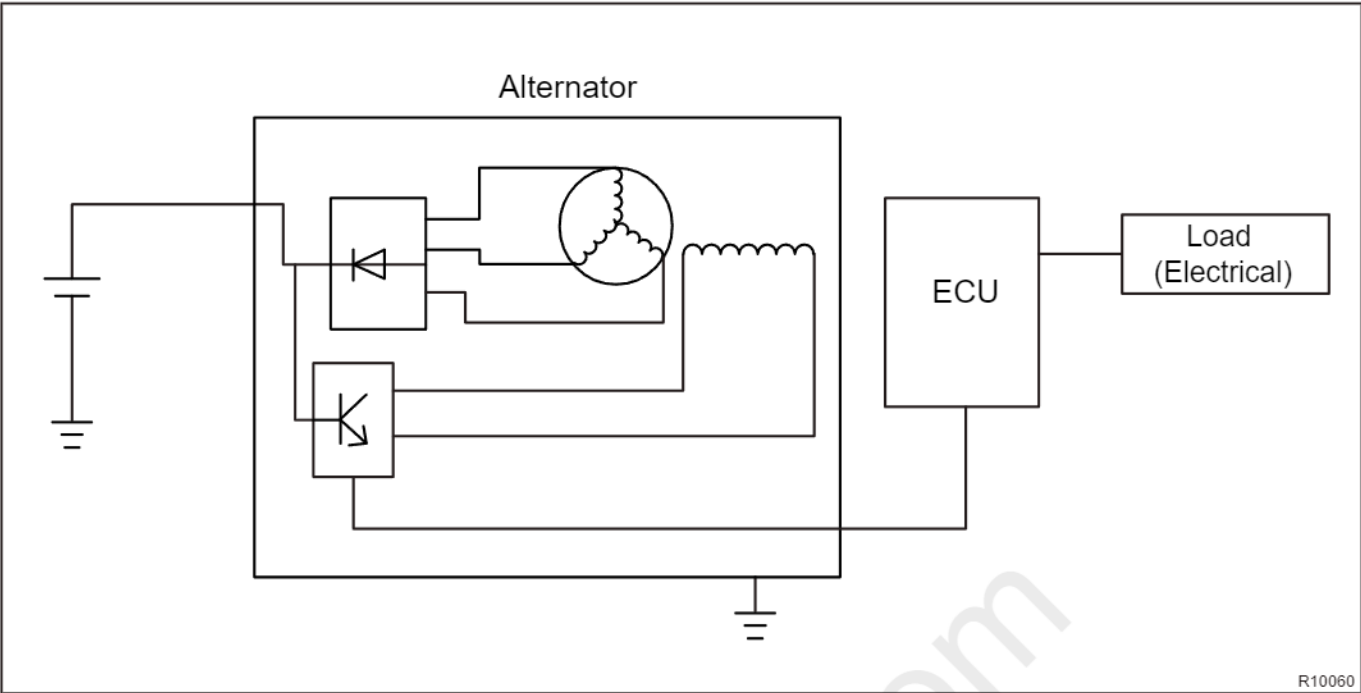
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1	ENGINE START STOP Switch	4	Starter Assembly
2	Engine Compartment Fuse and Relay Box	5	Alternator Assembly
3	Battery Assembly		

2.3 System Schematic Diagram



When battery voltage is normal starting voltage and transmission is in P position, press ENGINE START STOP switch while depressing brake pedal. When PEPS receives signal, it controls the starter relay to engage, then the starter runs normally.



Three-phase alternating current generated by alternator is converted to direct current from alternating current by rectifier, and direct current is transmitted to the vehicle electrical system and battery.

3 Component Operation Description

3.1 Battery Assembly

■ Main Function

When starting the engine, it is responsible for providing the working current required by the starter; When engine is running, it can help alternator to supply power to electric device; When engine is stationary, it can supply power to electric device separately; Moreover, battery is a large capacity capacitor which protects vehicle electrical device.

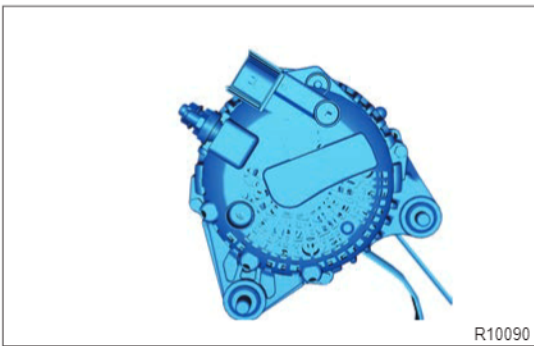
■ Specifications

Description	Specifications
Battery	12V 70Ah

3.2 Alternator Assembly

■ Main Function

Alternator is a silicon rectifying alternator, which mainly consists of rotor, stator and rectifier.
When excitation direct current flows to rotor winding, rotor winding establishes a magnetic field and magnetizes the rotor claw poles, forming the corresponding poles.
The three-phase stator coil is installed on the outside of rotor, which is secured together with the front and rear end covers of alternator.
When the rotor of the generator is rotated by the drive belt, the magnetic pole lines cut the stator winding, causing a change in the magnetic flux in the stator winding, and an alternating induced electromotive force is generated in the stator winding, thereby generating alternating current. The generated three-phase alternating current is converted to direct current by rectifier, and direct current is transmitted to the vehicle electrical system and battery by further adjusting by regulator.



3.3 Starter Assembly

■ Main Function

Starter consists of three parts: control mechanism, drive train mechanism and DC motor.

Control mechanism (solenoid switch): Controls engagement and disengagement between starter drive gear and engine flywheel gear and switches on/off the DC circuit.

Drive train mechanism: When engine starts, it engages starter drive gear with flywheel gear ring and transmits starter torque to the engine crankshaft; after engine starts, drive gear will automatically disengage from the flywheel gear, so that engine cannot drive starter at high speed, avoiding damage to the starter.

DC motor: Converts electrical energy from battery into electromagnetic moment.



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4 Special Tool and Equipment

4.1 General Tool

Tool Name	Tool Drawing
Digital Multimeter	 S00002

4.2 Special Tool

Tool Name	Tool Drawing
Battery Tester	 S00064

5 DIAGNOSIS & TESTING

5.1 Problem Symptoms Table

Hint:

Use symptoms table below to help determine cause of problem. Check each suspected area in sequence. Repair, replace or adjust faulty components as necessary.
Starting and Charging system

Symptom	Possible Cause
Housing is cracked	Housing cracked is the most serious and destructive malfunction. When vehicle is subjected to strong vibration, lead acid battery overheating, too high pressure or electrolyte frozen expansion, the housing of lead acid battery will be damaged. For such malfunction, replacing battery is the sole way for treatment.
Electrode is loose	The cause of loosen electrode is that excessive force is applied during removal and installation of wire harness and inspection of contact. It is necessary to replace the battery assembly.
Connecting part of electrode is corroded or burnt	Check if the generated electricity is normal and if the charging voltage is too high.
Battery swells	The causes are that battery is aging and resistance is excessively high. It is necessary to replace the battery.

5.2 Common Trouble Diagnosis

Operation Content	Operation Description
Appearance inspection: Confirm if there is any washer fluid, coolant, oil, sludge and other foreign matters adhered.	If the washer fluid, coolant, oil enters rotor slip ring, brush holder, it will cause oxidization to alternator rotor slip ring and poor contact to brush, resulting in charging light remaining on or flashing.
Turn over the center of alternator belt by hand and observe if the max. turning angle is over 90°.	Loose belt will cause low alternator speed, resulting in low electric energy production or failing to generate energy; if the angle is over 90°, check the belt tension.
Measure battery voltage with a multimeter.	Confirm if the battery is depleted (more than 12 V). If so, unplug the generator excitation coil connector and retest the battery voltage (more than 12 V). If such condition still exists, charge the battery.
Confirm if there is any looseness, short circuit, dirt on alternator B+, excitation end, battery pile line and ground line and also confirm if the connectors are connected firmly.	Confirm if the wire harness is connected normally. Poor contact will cause that the alternator voltage is high, the indicator light doesn't come on, remains on or flashes. If there is any looseness, please tighten it firmly.

Charging indicator light remains on (do not generate electricity or power is low, vehicle cannot start, etc.)

Operation Content	Operation Description
Unplug the alternator connector, start the engine and depress the accelerator (engine speed is above 1500rpm), turn off the vehicle load, measure B+ voltage to ground with multimeter and observe 2-3 minutes.	If B+ voltage is about 13.8 V, the alternator is normal. If B+ voltage is the battery voltage, it indicates alternator malfunction. Replace the alternator.
If the alternator operates normally, reconnect the alternator connector, start the engine and keep it idling, turn on some electrical load on vehicle, such as A/C, headlight, etc. Meanwhile, depress the accelerator pedal or decelerate the vehicle. Measure B+ voltage to ground with multimeter and observe 2 - 3 minutes.	When vehicle load or speed changes, the alternator normal voltage should change within 10.6 - 16 V. If the charging indicator remains on, check if communication is normal with an oscilloscope or other test software.

Charging indicator (unstable electricity generation)	
Operation Content	Operation Description
Start the engine and keep it idling, remove alternator excitation coil and observe if the meter indicator flashes.	If the light flashes, it indicates that some excitation coil has outer leakage and intermittently ground. Check the circuit malfunction.
Indicator does not come on during self-check	
Operation Content	Operation Description
Turn ENGINE START STOP switch to "ON" position, remove the engine excitation coil and measure the alternator excitation coil terminal voltage to ground with multimeter.	If the light flashes, it indicates that some excitation coil has outer leakage and intermittently ground. Check the circuit malfunction.
Adjusting voltage is high (headlight and other electrical appliances used on vehicle are burnt out)	
Operation Content	Operation Description
Start the engine and keep it idling, measure B+ voltage to ground with multimeter and observe 2 - 3 minutes to check if the max. value exceeds 16 V.	If so, it indicates that the regulator in alternator is damaged which causes voltage out of control. Replace the alternator.
Instrument indicator or headlight dims and then goes off during vehicle driving (fail to generate energy, low electric energy production)	
Operation Content	Operation Description
Start the engine and keep it idling for 5 minutes (turn off the electrical appliances with large power, test with light load as possible), measure the alternator B+ voltage.	If the measured voltage is 13 V - 14.8 V, the alternator is normal; if not, the alternator is abnormal. Replace the alternator.
Abnormal noise occurs in alternator	
Operation Content	Operation Description
Check if the alternator mounting bolt is installed in place and tightened with specified torque.	Improper installation of bolt will cause pulley jumps as alternator operate, resulting in abnormal noise. Tighten the bolt.
Remove the alternator belt, rotate the pulley by hand. Listen and observe near the motor if there is any abnormal noise during alternator rotation.	Excessive belt tension or dirt in alternator will cause alternator bearing failure or poor rotor dynamic balance which causing abnormal noise. Replace the alternator.

6 ON-VEHICLE SERVICE

6.1 Battery Assembly

■ Check Charging System Voltage

Warning

- Following the related specifications on appliances connected with battery, in repair manual and owner's manual.
- Battery acid is highly corrosive, so it is necessary to wear protective gloves and goggles when working.
- Keep away from open fire, spark, light devices without protective measures and no smoking. Never generate any sparks when operating cable/wire and electrical devices. Avoid short circuit in battery.
- Wear eye protective mask/glasses.
- Never allow the children approaching acid and battery.
- Deliver the used battery to designated recycling site. Never throw the used battery into household garbage.

- (1) Leave vehicle under no load test condition and idle the engine. Measure battery voltage with a digital multimeter.

Standard voltage: 13.5 V - 14.8 V

Hint:

If result is not as specified, replace the alternator.

- (2) Leave vehicle under load test condition and idle the engine. Measure battery voltage with a digital multimeter.

- 1) Set headlight to high beam.
- 2) Turn on blower and adjust blower speed to the highest.
- 3) Turn on the "A/C" switch.

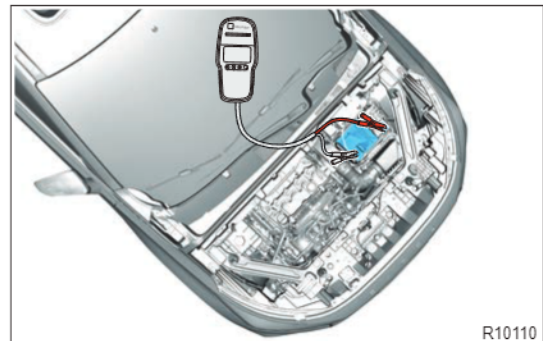
Standard voltage: 13.2 V - 14.8 V

■ Usage of Battery Tester

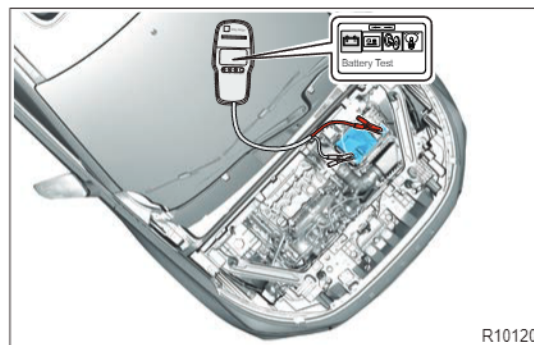
- (1) Connect the battery tester to battery.

Hint:

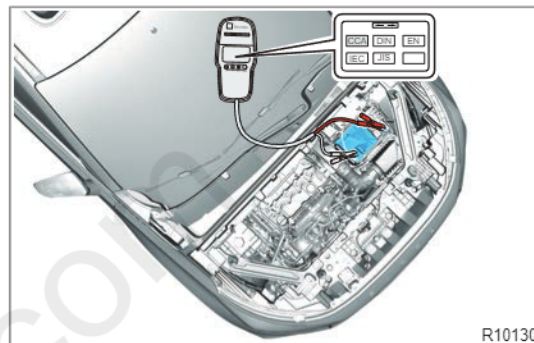
Connect red tube clamp to battery positive terminal while black tube clamp to battery negative terminal.



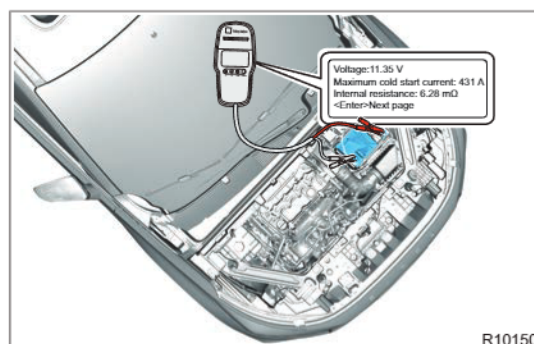
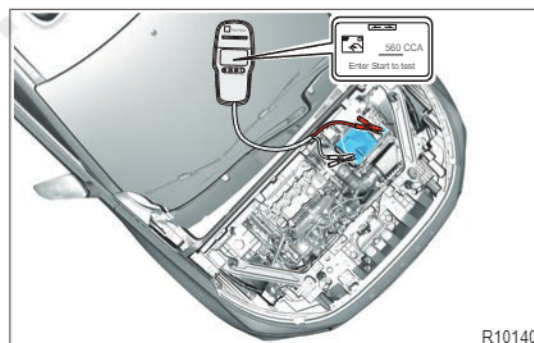
- (2) Operate tester to select "Battery Test" and click "Enter" .



- (3) Select "CCA" and click "Enter" .



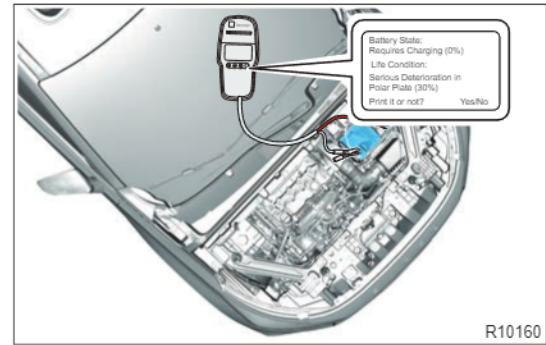
- (4) Operate "L and R" on tester to adjust and set the battery capacity (such as 560CCA, this value indicates the battery low temperature starting performance) and click "Enter" .



- (5) The battery condition is displayed on tester.

Hint:

Recharge or replace battery according to the tested data.

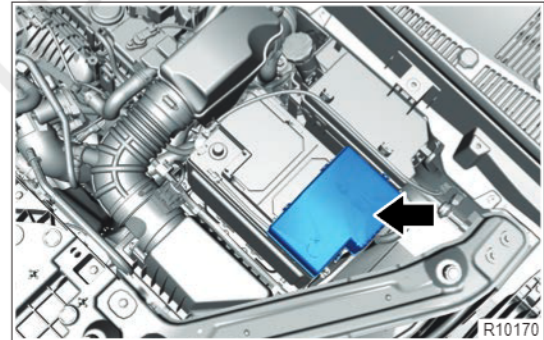


■ Removal

⚠ Warning

- **Be sure to wear safety equipment to prevent accidents, when removing battery assembly.**
- **Appropriate force should be applied, when removing battery assembly. Be careful not to operate roughly.**

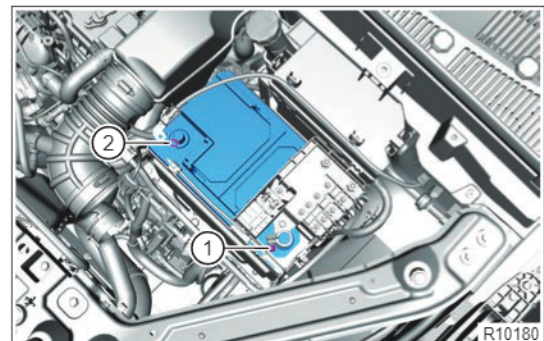
- (1) Turn off all electrical equipment and ENGINE START STOP switch.
- (2) Remove the engine compartment trim cover assembly.
- (3) Remove engine compartment fuse and relay box upper cover.



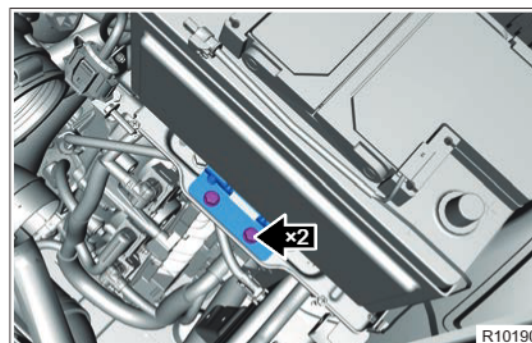
- (4) Remove the air filter assembly.
- (5) Loosen the locking nuts of positive and negative battery terminals, and remove the positive and negative battery cables (1) (2).

Hint:

When removing the battery positive and negative battery terminals, remove negative terminal before positive terminal.



- (6) Remove 2 fixing bolts and battery pressure plate.



- (7) Remove the battery assembly from protective cover carefully.

⚠ Caution

- When removing battery, be careful to prevent metal tools from contacting both electrodes of battery at the same time or touching the positive electrode and vehicle body.

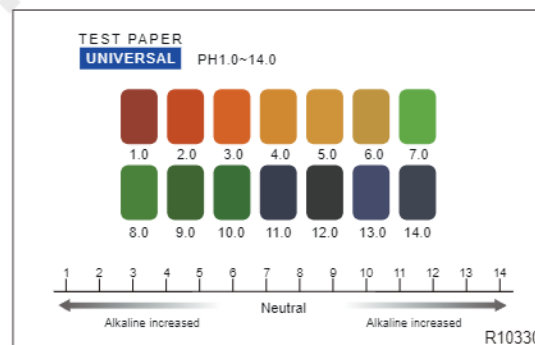
■ Battery Fluid Leakage Test

- (1) PH test paper is used for judgment.

Hint:

Test paper model: PH 1 - 14.

- (2) Take a piece of PH test paper (never allow it contacting with other fluid before test) to wipe the leaking area, so as to make the fluid adhere on the PH test paper. Then compare it with the color bar to judge the PH value.
- (3) If the PH value is less than 7, it is an acidic liquid, which indicates battery leakage.
- (4) If the PH value is 7 or higher, it is non-acidic liquid (- neutral or alkaline) which indicates “Petroleum jelly” fluid or other fluids leakage on battery surface.



■ Battery (Off-Vehicle) Charging

- (1) Because the battery has the characteristic of self-discharging, even if the battery is not in use, it is necessary to perform regular charging maintenance. When the discharging ratio for battery capacity is lower than 50%, the capacity cannot restore to 100% if charging with small current while the battery temperature increases and the plate active material will fall off easily if charging with large current, affecting the performance and life of battery.
- Charging with constant voltage: Voltage is limited at 14.40 V. During charging, make sure the charger is connected to the maximum charging current so as to get the preset voltage value (14.40 V) according to the current battery status and temperature. After the voltage reaches the limiting value, the charging current will drop gradually until it closes to 0 A (maintain the condition charging current).

■ Battery (On-vehicle) External Power Supply Charging

- (1) If battery external power supply charging is necessary, it's important to keep external charger is properly connected. If charging process is not correct, the sensor cannot recognize the charging current, and SOC value cannot be calculated correctly. Positive clamp of external charging device must clamp positive terminal of battery, and negative clamp must be ground instead of negative terminal of battery. Battery sensor only properly balances the charge when there is a continuous current through it.

■ Installation

⚠ Caution

- Replace battery with a new one which conforms to the specifications.
- During installation, make sure the directions of positive and negative terminals are correct.
- Used battery contains sulfuric acid and lead, so never discard it at will. Please dispose of it at a qualified local waste treatment station.
- When installing the battery positive and negative battery terminals, install negative terminal before positive terminal.

(1) Place the battery into battery tray carefully.

(2) Install 2 fixing bolts to battery pressure plate.

Torque: $10 \pm 1 \text{ N}\cdot\text{m}$

(3) Install and tighten battery positive and negative battery terminals.

Torque: $5 \pm 1 \text{ N}\cdot\text{m}$

(4) Install the air filter assembly.

(5) Install engine compartment fuse and relay box upper cover.

(6) Install the engine compartment trim cover assembly.

6.2 Battery Tray

■ Removal

⚠ Warning

- Be sure to wear safety equipment to prevent accidents, when removing battery tray.
- Appropriate force should be applied, when removing battery tray. Be careful not to operate roughly.

(1) Turn off all electrical equipment and ENGINE START STOP switch.

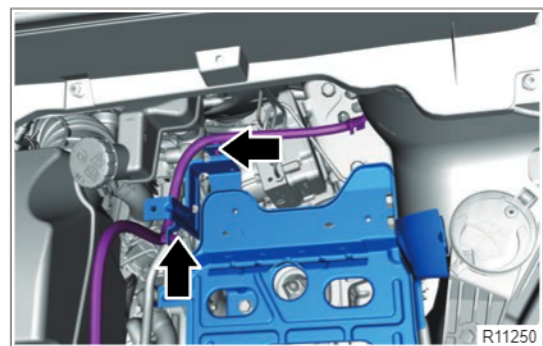
(2) Remove the engine compartment trim cover assembly.

(3) Remove the air filter assembly.

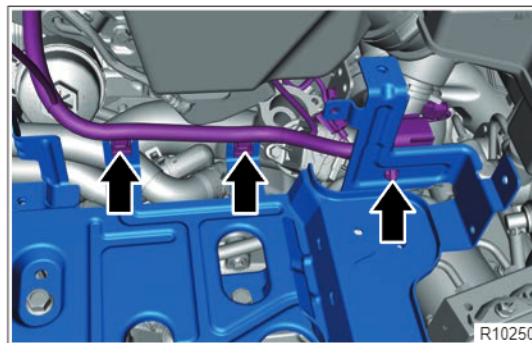
(4) Remove the battery assembly.

(5) Remove engine compartment fuse and relay box assembly.

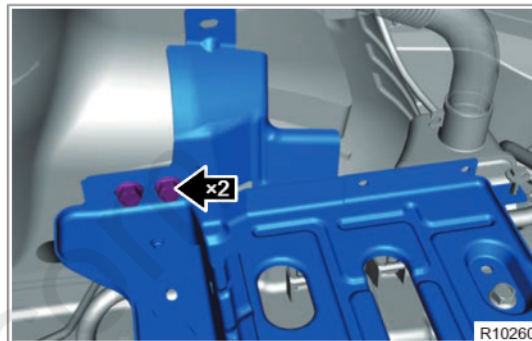
(6) Disconnect fixing clip from negative battery wire harness.



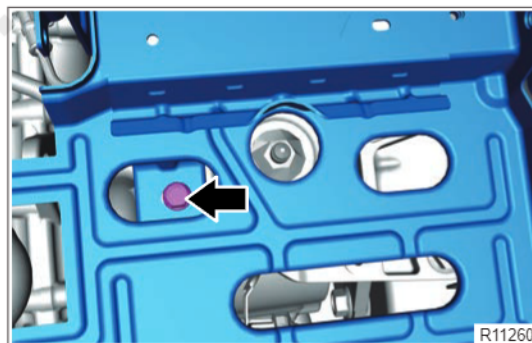
- (7) Disconnect fixing clip from engine electronic injection wire harness.



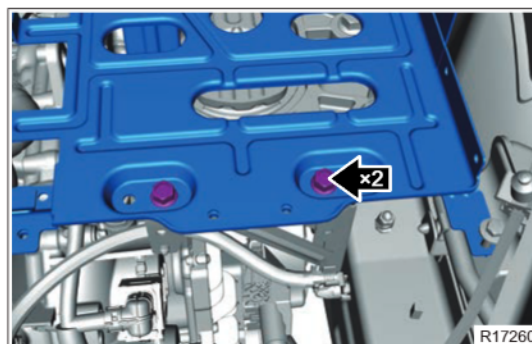
- (8) Remove 2 fixing bolts between battery tray and body.



- (9) Remove 1 fixing bolt between battery tray and left mounting cushion assembly.

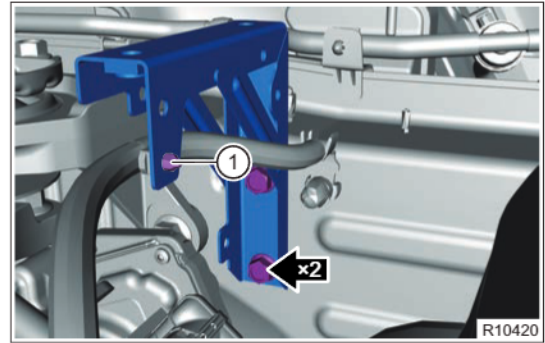


- (10) Remove 2 fixing bolts between battery tray and battery tray bracket.



- (11) Remove the battery tray assembly.

- (12) Remove 2 fixing bolts from battery tray mounting bracket and detach wire harness fixing clip (1).



- (13) Remove the battery tray mounting bracket.

■ Installation

- (1) Install 2 fixing bolts to battery tray bracket.

Torque: $20 \pm 2 \text{ N}\cdot\text{m}$

- (2) Install 5 fixing bolts to battery tray.

Torque: $20 \pm 2 \text{ N}\cdot\text{m}$

- (3) Secure engine electronic injection wire harness.
 (4) Secure the negative battery cable.
 (5) Install engine compartment fuse and relay box assembly.
 (6) Install the battery assembly.
 (7) Install the air filter assembly.
 (8) Install the engine compartment trim cover assembly.

6.3 Alternator Assembly

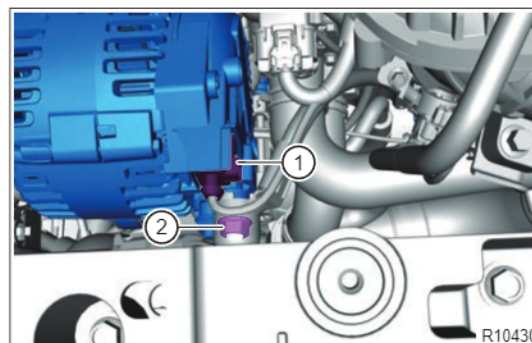
■ Removal

⚠ Warning

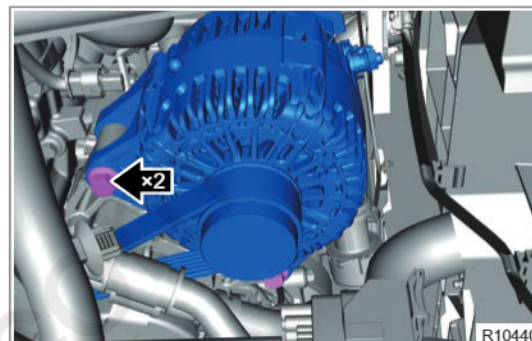
- When removing alternator assembly, be sure to wear safety equipment to prevent accidents.
- Appropriate force should be applied, when removing alternator assembly. Be careful not to operate roughly.

- (1) Turn off all electrical equipment and ENGINE START STOP switch.
 (2) Remove the engine compartment trim cover assembly.
 (3) Disconnect the negative battery cable.
 (4) Remove the engine trim cover.
 (5) Remove the engine accessory belt.

- (6) Disconnect the alternator assembly connector (1) and remove alternator positive cable harness fixing nut (2).



- (7) Remove 2 fixing bolts from alternator assembly.



- (8) Remove the alternator assembly carefully.

■ Installation

- (1) Install 2 fixing bolts to alternator assembly.

Torque: 40 + 5 N·m

⚠ Caution

- After alternator bolt is tightened, visually check for clearance between two sliding sleeves as well as between module sliding sleeve and the module. If clearance exists, it meets the installation requirement.

- (2) Install alternator positive wire harness port and secure the nut.

Torque: 13 ± 2 N·m

- (3) Connect alternator assembly connector.
 (4) Install the alternator accessory belt.
 (5) Install the engine compartment trim cover.

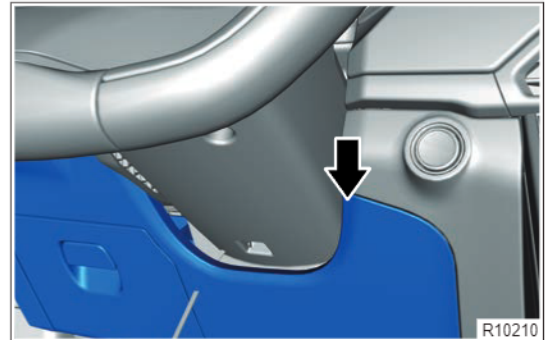
6.4 ENGINE START STOP Switch

■ Removal

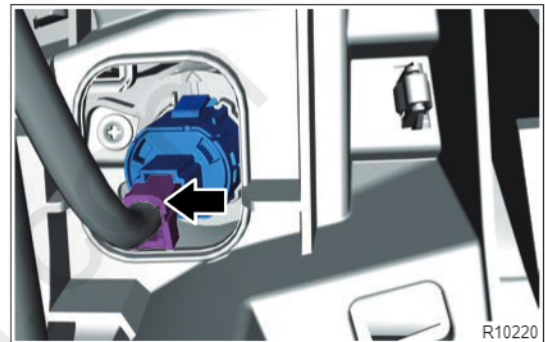
⚠ Warning

- Be sure to wear necessary safety equipment to prevent accidents, when removing ENGINE START STOP switch.
- Try to prevent interior protector from being scratched during removal and installation.

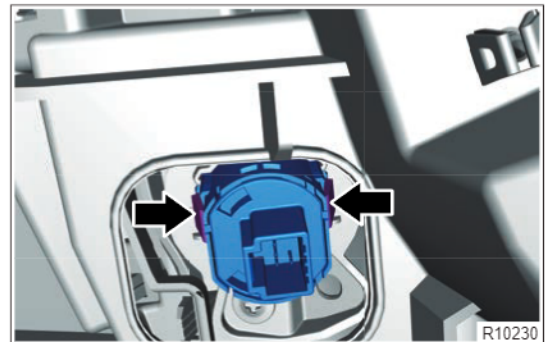
- (1) Turn off all electrical equipment and ENGINE START STOP switch.
- (2) Disconnect the negative battery cable.
- (3) Using an interior crow plate, remove the lower left protector body assembly.



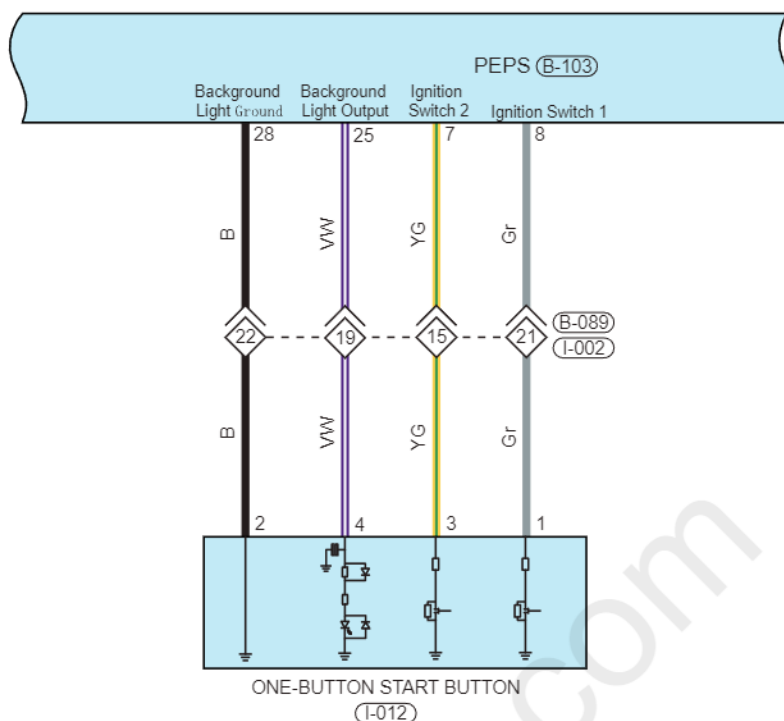
- (4) Disconnect ENGINE START STOP switch connector.



- (5) Press/Push fixing clips on both sides of ENGINE START STOP switch and remove ENGINE START STOP switch assembly.



■ Inspection



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- (1) Using a digital multimeter, check the continuity of ENGINE START STOP switch according to the table below.

Multimeter Connection	Switch Condition	Specified Condition
Terminal 6 - Terminal 8	Not pressed	No continuity
Terminal 4 - Terminal 8	Not pressed	No continuity
Terminal 6 - Terminal 8	Pushed	Continuity
Terminal 4 - Terminal 8	Pushed	Continuity

⚠ Caution

- If measure result is not as specified, replace the **ENGINE START STOP** switch assembly.

■ Installation

- Install ENGINE START STOP switch to lower center protector body.
- Connect ENGINE START STOP switch connector.
- Install the lower left protector body assembly.

6.5 Starter Assembly

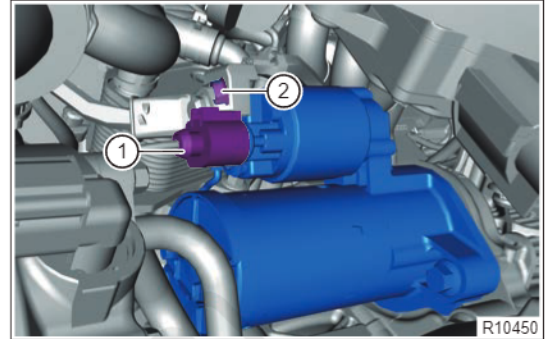
■ Removal

⚠ Warning

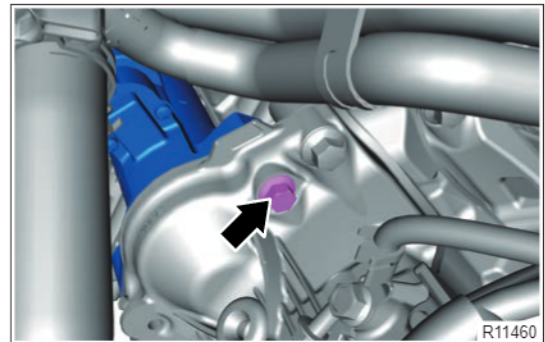
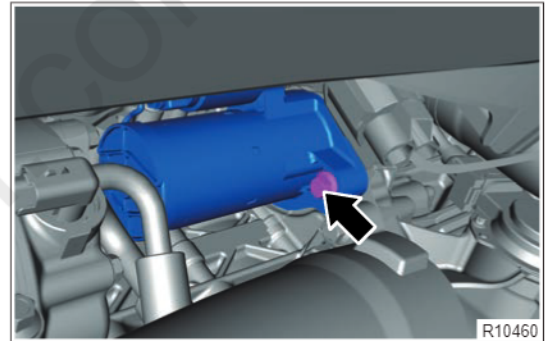
- Be sure to wear safety equipment to prevent accidents, when removing starter assembly.
- Appropriate force should be applied, when removing starter assembly. Be careful not to operate roughly.

- (1) Turn off all electrical equipment and ENGINE START STOP switch.
- (2) Disconnect the negative battery cable.
- (3) Remove the air filter assembly.
- (4) Remove the intercooler inlet pipe II assembly.
- (5) Remove the engine lower protector assembly.
- (6) Remove the intercooler outlet pipe II assembly.

- (7) Disconnect the starter assembly connector (1) and remove positive cable fixing nut (2).



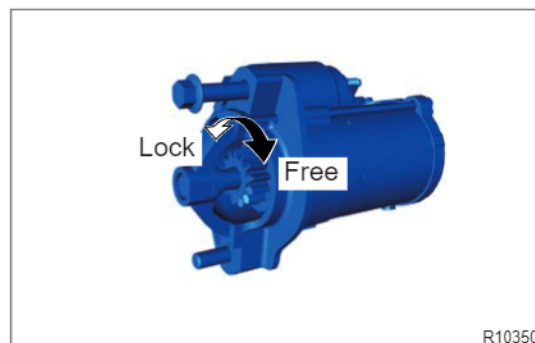
- (8) Remove 2 set bolts between starter assembly and transmission case.



- (9) Remove the starter assembly carefully.

■ Check the starter clutch

- (1) Rotate the clutch pinion gear clockwise to check that it rotates freely. Rotate the clutch pinion gear counterclockwise to check that it locks. If result is not as specified, replace the starter.

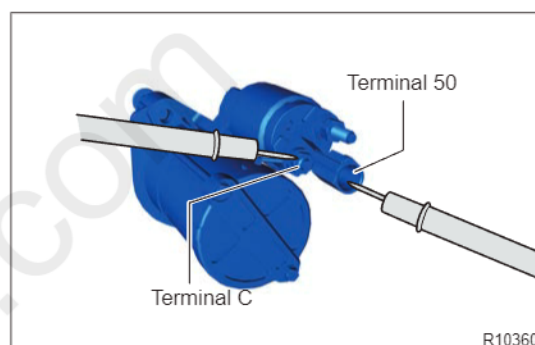


■ Check the pull-in coil

- (1) Measure the resistance between terminal 50 and terminal C.

Hint:

Standard resistance should be below 2Ω . If the resistance is abnormal, replace the starter assembly.



■ Check the starter assembly

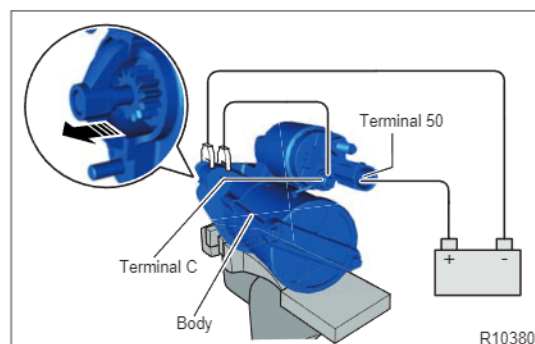
⚠ Caution

- These measurements must be performed within 3 to 5 seconds to avoid coil burnout.
- Place the starter assembly onto a vise. The jaws of vise should be covered by aluminum sheet or brass plate; otherwise, the starter assembly will be easily damaged when clamping it.

- (1) Perform pull-in test.
 - Remove the nut and disconnect the field coil lead from terminal C.
 - As shown in illustration, connect battery to solenoid switch, and check that starter clutch pinion sticks out normally.

Hint:

If starter clutch pinion does not move, replace the starter assembly.

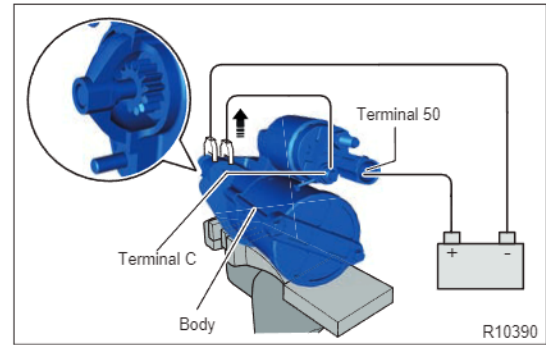


(2) Perform pull-in test.

- Keep the starter clutch pinion sticking out and the connection condition of battery mentioned above, and disconnect the negative battery cable from terminal C.
- Check if starter clutch pinion keeps sticking out.

Hint:

If starter clutch pinion moves inward, replace the starter assembly.

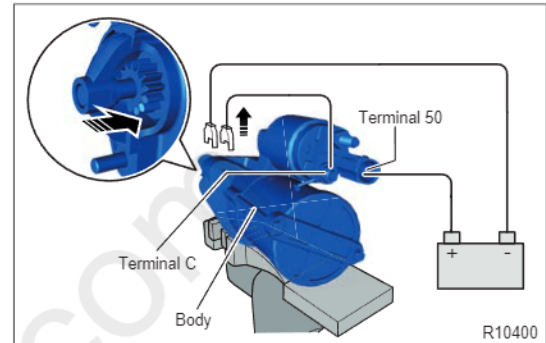


(3) Check if starter clutch pinion returns back.

- Disconnect negative battery cable from starter body and check that starter clutch pinion returns back.

Hint:

If starter clutch pinion moves inward, replace the starter assembly.

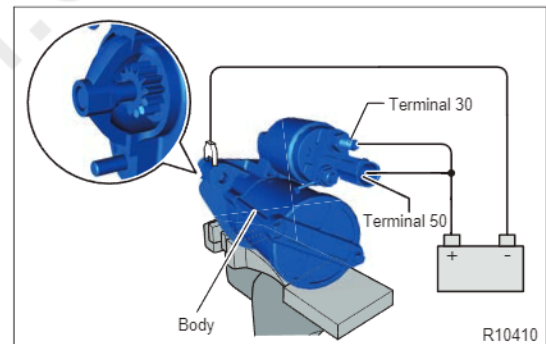


(4) Check if starter rotates smoothly.

- Connect the field coil lead to terminal C, and tighten it with a nut.
- As shown in illustration, connect battery to starter; And check that starter rotates smoothly when the starter clutch pinion moves outward.

Hint:

The lead to be connected should avoid the pinion side to prevent lead stuck as pinion rotates. If result is not as specified, replace the starter assembly.



■ Installation

- (1) Align starter with the corresponding holes on transmission, install 2 bolts and tighten it in order after pre-tightening 2-3 teeth with hand.

Torque: 40 + 5 N·m

- (2) Install positive wire harness port and secure the nut.

Torque: 13 ± 2 N·m

- (3) Connect starter assembly connector.
- (4) Install intercooler intake pipe II assembly.
- (5) Install the air filter assembly.
- (6) Install engine lower protector assembly.
- (7) Install intercooler outlet pipe II assembly.