SQRE4T15B STARTING SYSTEM

GENERAL INFORMATION

Overview

Description

1 - Ignition Starting Switch	2 - Engine Compartment Fuse and Relay Box
3 - Battery	4 - Starter

Starting system consists of battery, ignition 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 runs normally.

Operation

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

1. Control mechanism (solenoid switch): controls engagement and disengagement between starter drive gear and engine flywheel gear and switches on/off the DC circuit; Also the solenoid switch has function of additional resistance of short circuit ignition coil when starting.
2. 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.
3. DC motor: converts electrical energy from battery into electromagnetic moment.

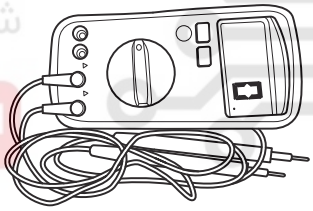
Specifications

Torque Specifications

Description	Torque (N·m)
Starter Power Cable Nut	13 ± 2
Starter Fixing Bolt	45 ± 5

Tool

General Tool

Digital Multimeter	 002

DIAGNOSIS & TESTING

Diagnosis Content

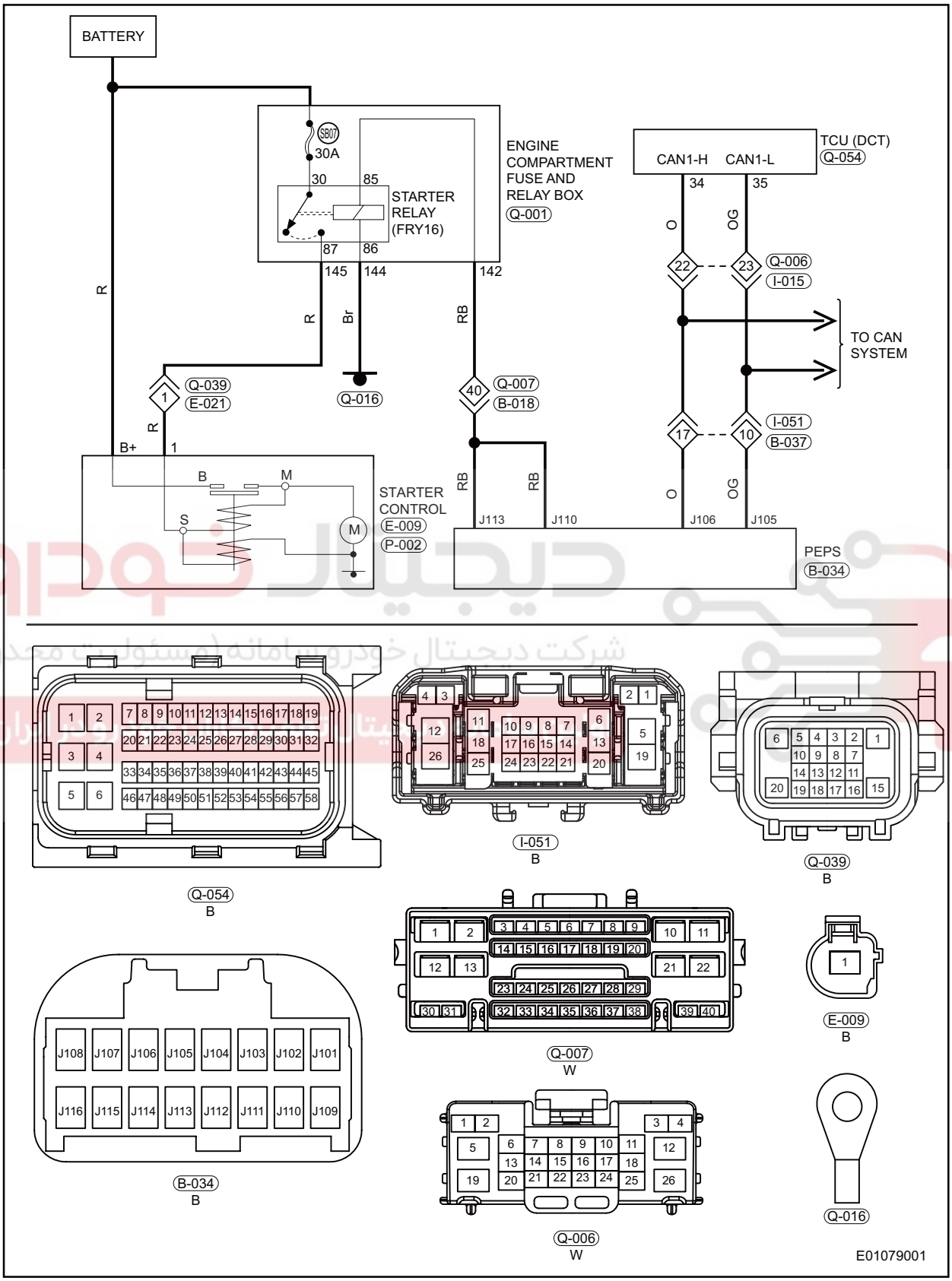
Problem Symptoms Table

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.

Symptom	Suspected Area
When ignition switch is turned to START, solenoid switch makes a "clanking" sound and engine cannot start	Battery (depleted)
	Starter (solenoid switch)
Starter does not run	Battery (depleted)
	Fuse
	Relay
	Starting system wire harness
	Starting switch
	Starter
	ECU
Starter runs weakly	Battery (depleted)
	Starter
Starter is racing	Starter (incorrect installation, internal fault)
	Flywheel ring gear (gear teeth broken)

Starting Circuit Diagram

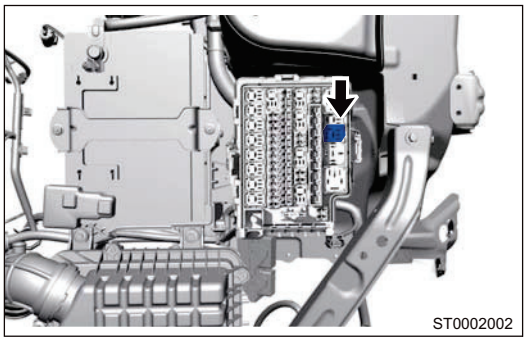


On-vehicle Inspection

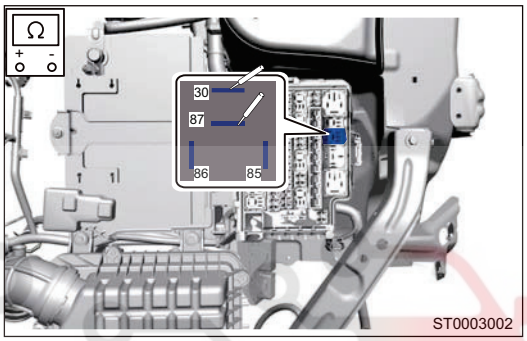
Starter Relay

1. Check the starter relay.

   (a) Remove the starter relay from engine compartment fuse and relay box.



   (b) Using a digital multimeter, measure starter relay resistance.



Multimeter Connection	Specified Condition
30 - 87	No continuity
30 - 87	Continuity (battery voltage is applied between terminals 85 and 86)

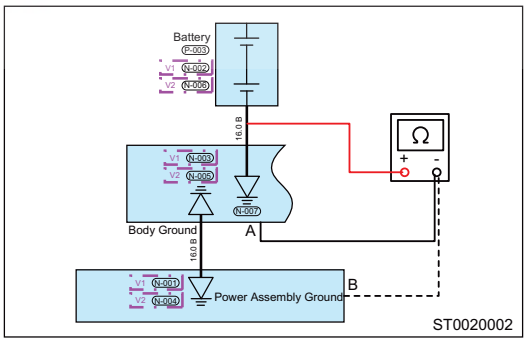
Hint:
If result is not as specified, replace the starter relay.

Ground Inspection

1. Power assembly ground and body ground inspection.

   (a) Check the power and body ground wire fixing bolts for looseness, and the ground parts should be in good contact with no heat or burnt smell.

   (b) Using ohm band of digital multimeter, one test lead is connected to the negative cable, and the other test lead is connected to the body ground or power assembly ground. The resistance measured at A is $\leqslant$ 0.3Ω, and the resistance measured at B is $\leqslant$ 1Ω. , the values at A and B cannot differ greatly. If it does not meet the requirements, check the body ground and power assembly ground cable.



Precautions for Starting System

1. Before starting engine, shift transmission to P/N, neutral position (MT), and apply parking brake while depressing clutch pedal.
2. Make sure that battery is fully charged to reduce repeat operating time of starter.
3. Do not start engine for more than 5 seconds each time, repeated starting interval should not be less than 10 - 15 seconds, and consecutive starting is not allowed for more than 3 times.
4. If starter cannot stop, turn off ignition switch immediately, or remove the negative battery cable to find the problem.
5. Check the starter circuit frequently to make sure that each wire of starting system is connected securely and in good insulation.
6. Generally, perform maintainable service for starter when servicing the vehicle. Also, maintenance interval can be shortened or extended depending on actual conditions.
7. Remove the negative battery cable before removing starter.

ON-VEHICLE SERVICE

Starter Assembly

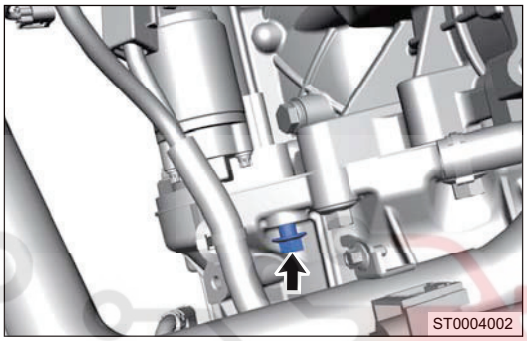
Removal

Warning/Caution/Hint

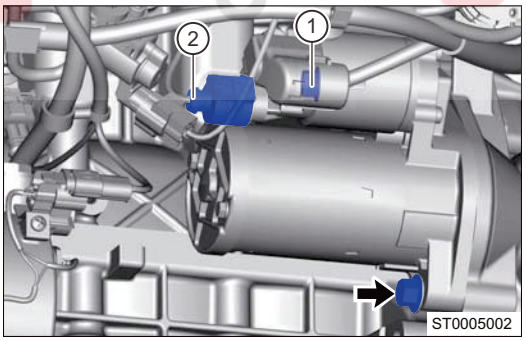
Caution:

- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the air filter assembly (<Blue>See page 10-8).
4. Remove the engine lower protector assembly.
5. Remove starter assembly.
   (a) Remove the fixing bolt (arrow) between starter assembly and transmission housing assembly.
   Tightening torque
   45 ± 5 N·m



   (b) Remove positive cable fixing nut (1) from starter.
   Tightening torque
   13 ± 2 N·m
   (c) Disconnect the starter connector (2).
   (d) Remove the fixing bolt (arrow) between starter assembly and transmission housing assembly.
   Tightening torque
   45 ± 5 N·m

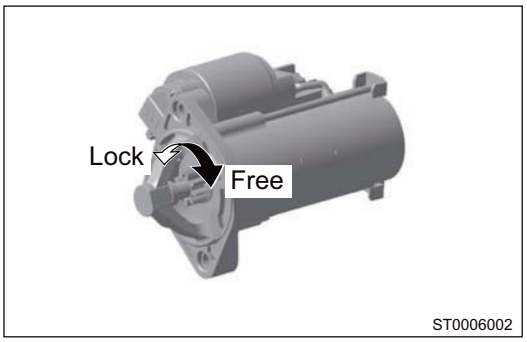


   (e) Remove starter assembly.

Inspection

1. Check the starter clutch.

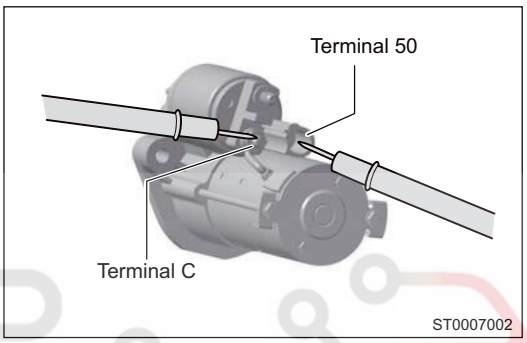
   (a) Rotate the clutch pinion gear clockwise to check that it can turn freely. Rotate the clutch pinion gear counterclockwise to check that it locks. If result is not as specified, replace the starter.



2. Check the starter solenoid switch.

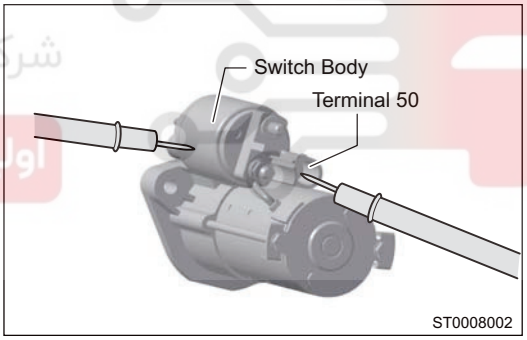
   (a) Check the pull-in coil.

   - Measure the resistance between terminal 50 and terminal C.
   - Standard resistance should be below 2 Ω.
     If the resistance is abnormal, replace the starter assembly.



   (b) Check the hold-in coil.

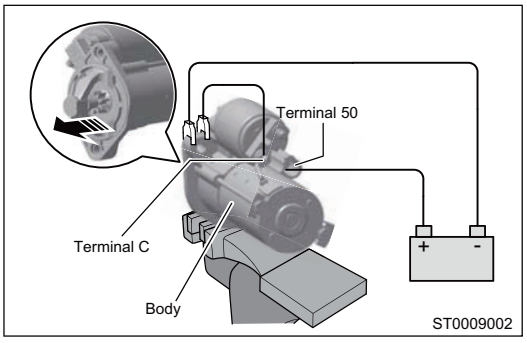
   - Measure the resistance between terminal 50 and starter solenoid switch body.
   - Standard resistance should be below 2 Ω.
     If the resistance is abnormal, replace the starter assembly.



3. 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 table. The jaws of vise should be covered by aluminum sheet or brass plate; otherwise, the starter assembly will be easily damaged when clamping it.

   (a) 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.

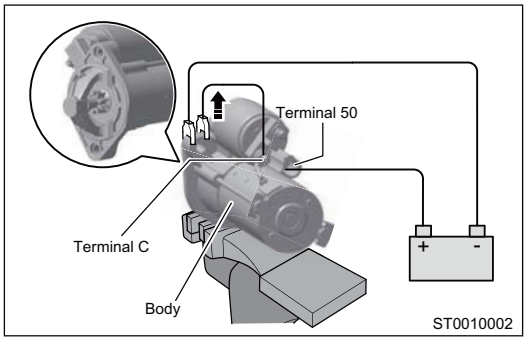


If starter clutch pinion does not move, replace the starter assembly.

(b) Perform hold-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.

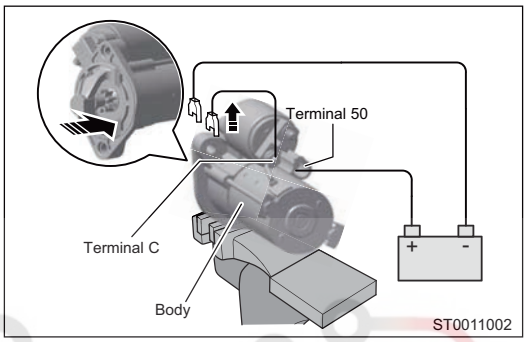
  Check if starter clutch pinion keeps sticking out. If starter clutch pinion moves inward, replace the starter assembly.



(c) Check if starter clutch pinion returns back.

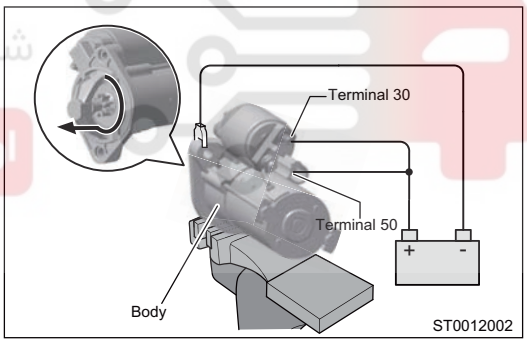
- Disconnect the negative battery cable from starter body. Check that starter clutch pinion returns back.

  If starter clutch pinion does not return back, replace the starter assembly.



(d) 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. Check that starter rotates smoothly when the starter clutch pinion moves outward.



Caution:

- 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. Installation is in the reverse order of removal.

Ignition Starting Switch

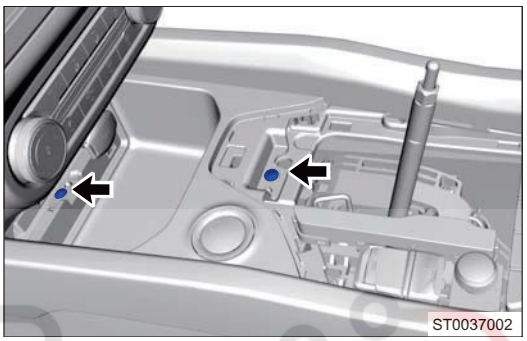
Removal

Warning/Caution/Hint

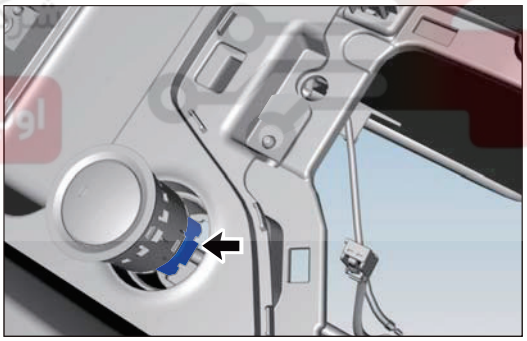
Caution:

- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent interior from being scratched during removal and installation.

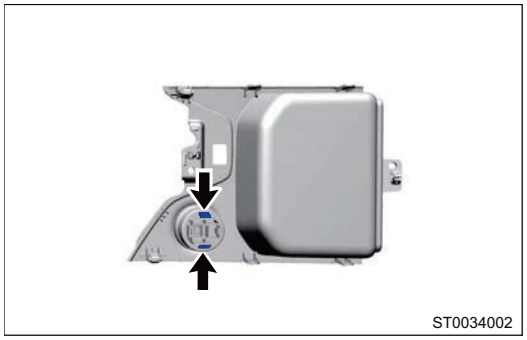
1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove outlet power panel.
4. Remove shift panel.
5. Remove central storage box.
   (a) Remove 2 fixing screws (arrow) from central storage box.



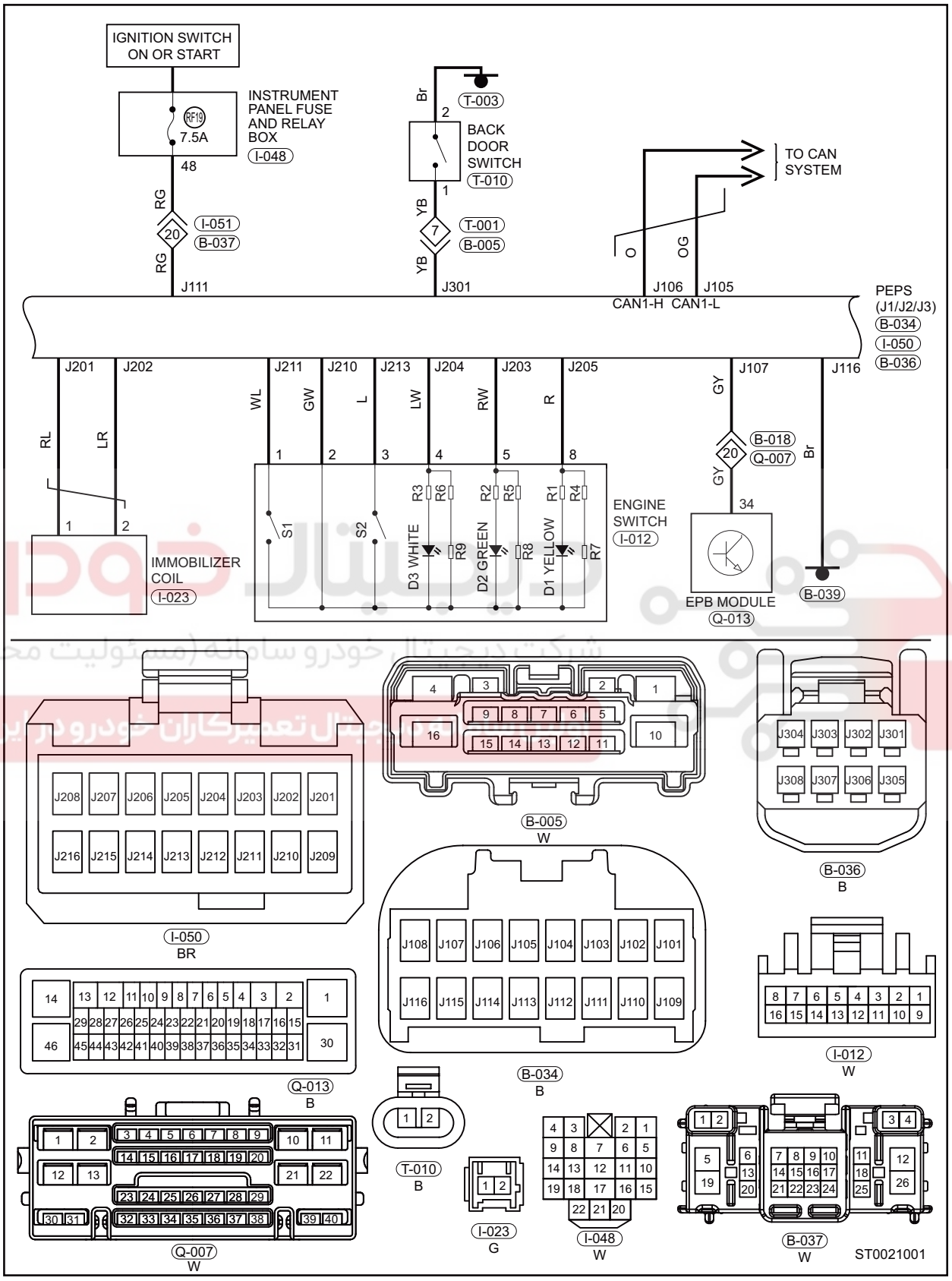
   (b) Using a plastic crow plate, carefully remove central storage box.
6. Remove the ignition starting switch.
   (a) Disconnect the ignition starting switch connector (arrow).



   (b) Push fixing clips on both sides of starting switch in direction of arrows and remove starting switch assembly.



Starting Switch Circuit Diagram



Inspection

1. Check for continuity of ignition starting switch.
   (a) Using a digital multimeter, check the continuity of ignition starting switch according to the table below.

Multimeter Connection	Switch Condition	Specified Condition
Terminal 1 - Terminal 2	Not pressed	No continuity
Terminal 3 - Terminal 2	Not pressed	No continuity
Terminal 1 - Terminal 2	Pushed	Continuity
Terminal 3 - Terminal 2	Pushed	Continuity

   If measure result is not as specified, replace the ignition starting switch.

2. Check the ignition starting switch indicator.
   (a) Press the ignition starting switch, observe if switch indicator illuminates normally.
   Hint:
   - If the positive (+) lead and negative (-) lead are incorrectly connected, the ignition starting switch indicator will not illuminate.
   - If the battery voltage is too low, the ignition starting switch indicator will not illuminate.

Multimeter Connection	Specified Condition
Battery positive (+) → Terminal 4 Battery negative (-) → Terminal 2	White (not illuminate)
Battery positive (+) → Terminal 5 Battery negative (-) → Terminal 2	Green
Battery positive (+) → Terminal 8 Battery negative (-) → Terminal 2	Yellow

   If measure result is not as specified, replace the ignition starting switch.

Installation

1. Installation is in the reverse order of removal.

SQRE4T15B CHARGING SYSTEM

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GENERAL INFORMATION

Overview

Description

1 - Alternator Assembly	2 - Battery Assembly
3 - Engine Compartment Fuse and Relay Box	4 - ECU

Alternator is a key component of the charging system. It is a device that converts mechanical energy into electrical energy and generates DC voltage through a rectifying circuit, as one of main power sources of the vehicle. The alternator operates as a complete assembly. If alternator fails for any reason, the entire unit must be replaced.

Operation

- Alternator is a silicon rectifying alternator, which mainly consists of rotor, stator and rectifier.
- When direct current flows to rotor winding, rotor claws energize magnetic field to produce alternating induced electromotive force. The stator 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. 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.

Specifications

Torque Specifications

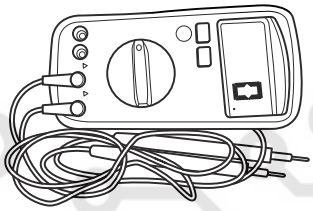
Description	Torque (N·m)
Battery Pressure Plate Fixing Bolt	5 ± 1
Battery Tray Fixing Bolt	25 ± 4
Alternator Output Cable Fixing Nut	13 ± 2
Alternator Fixing Bolt	40 + 5
Alternator Bracket Fixing Nut	20 + 5
Idler Pulley Fixing Bolt	50 + 5

Battery Specification

Engine Type	Type	Specifications
SQRE4T15B	Common Lead-acid Battery	12V 70Ah/60Ah 480A

Tools

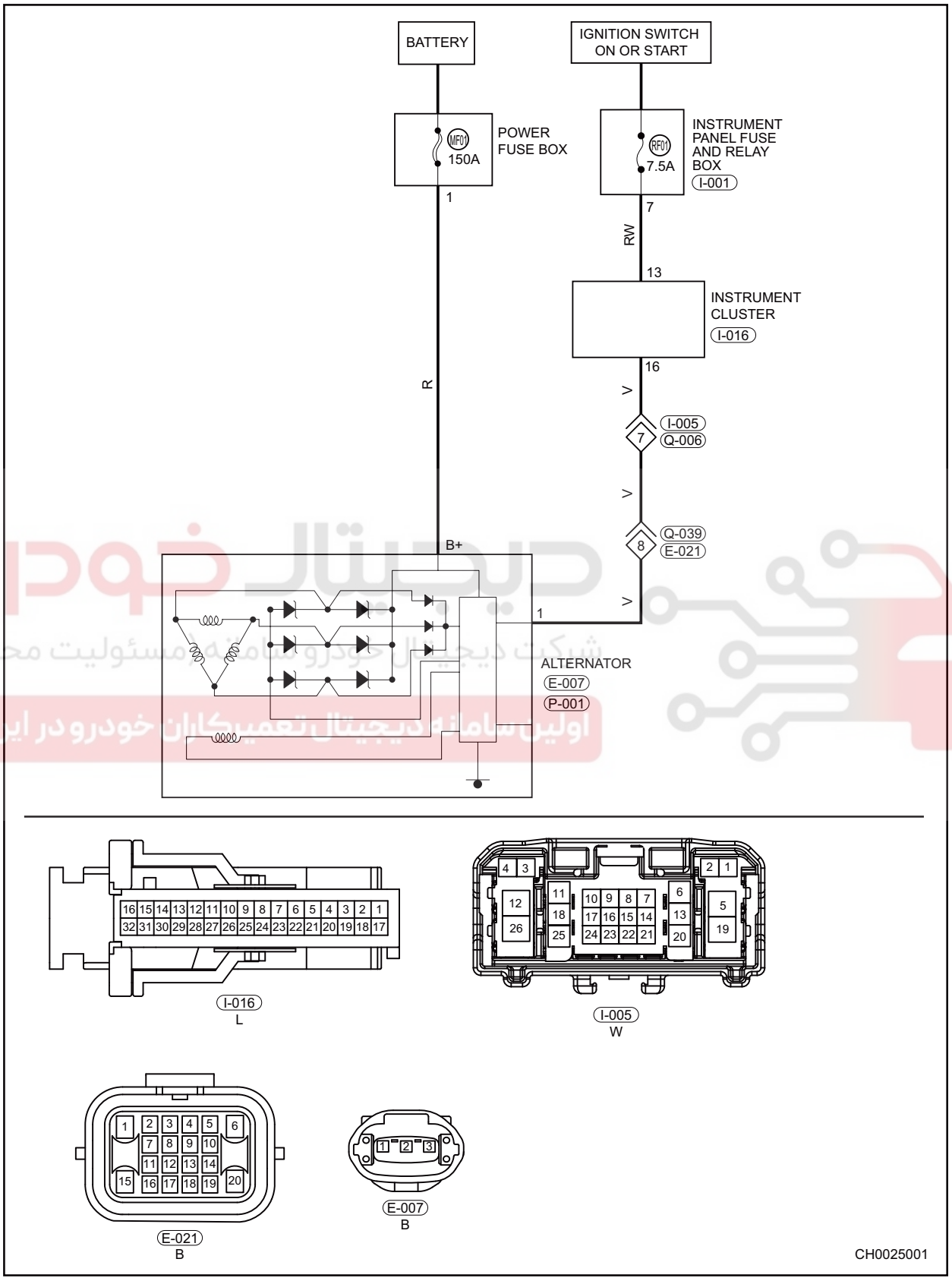
General Tool

Digital Multimeter	 002

Special Tool

Battery Tester	 090

Charging Circuit



DIAGNOSIS & TESTING

Diagnosis Content

Diagnosis Specification for Alternator Malfunction

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.

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 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°， adjust 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 13.8V, the alternator operates normally. It may be LIN communication malfunction. Please check the LIN communication setting in ECU. 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 LIN communication is normal with an oscilloscope or other test software.

Charging indicator flashes (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 voltage is 0, it indicates that the excitation coil circuit is open. Check the excitation coil circuit; if the voltage is equal to battery voltage, it indicates that excitation coil circuit is normal and there may be alternator malfunction. Replace the alternator.

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.

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 baring failure or poor rotor dynamic balance which causing abnormal noise. 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.

Battery External Normal Malfunction

1. Housing is cracked
   (a) 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.
2. Electrode is loose
   (a) 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.
3. Connecting part of electrode is corroded or burnt
   (a) The cause is that anti-corrosive solvent is not applied when installing battery. You can apply vaseline oil after cleaning up. If the electrode is seriously corroded or burnt, replace it with a new one.
4. Battery swells
   (a) Check if the generated electricity is normal and if the charging voltage is too high.
   (b) The causes are that battery is aging and resistance is excessively high. It is necessary to replace the battery.

On-vehicle Inspection

Charging System Charging Voltage Inspection

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
   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.
   Load test condition:
   - Set headlight to high beam;
   - Turn on blower and adjust blower speed to the highest.
   - Turn on the "A/C" switch.

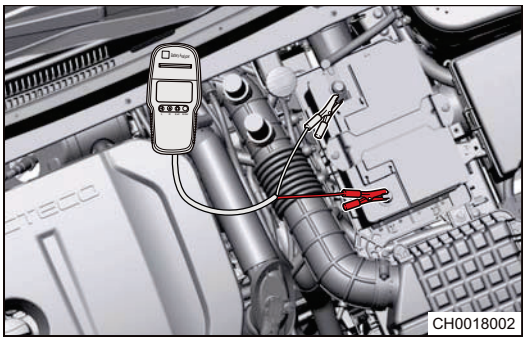
   Standard voltage: 13.5 V - 14.8 V
   If result is not as specified, replace the alternator.

Usage of Battery Tester

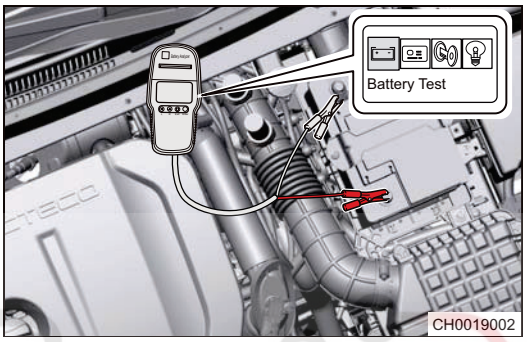
1. Check the battery with battery tester to gain the condition of battery. Replace or charge as necessary.

   (a) Connect the tester to battery.

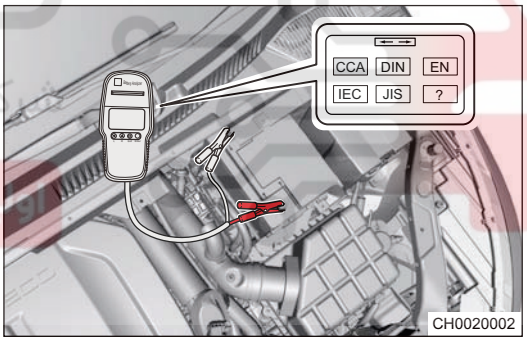
   Caution:
   - Connect red tube clamp to battery positive terminal while black tube clamp to battery negative terminal.

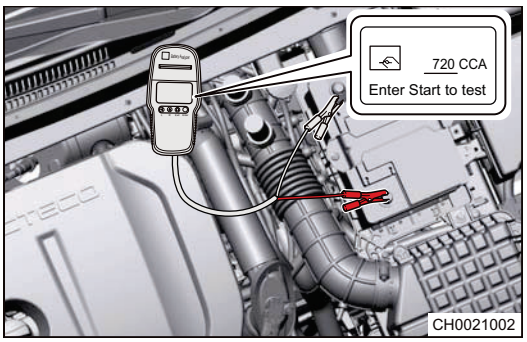


   (b) Operate tester to select "Battery Test"and click "OK".

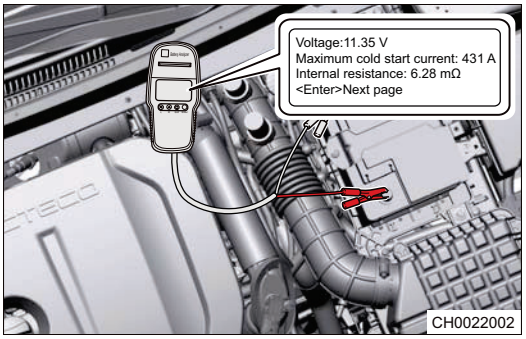


   (c) Select "CCA" and click "OK".



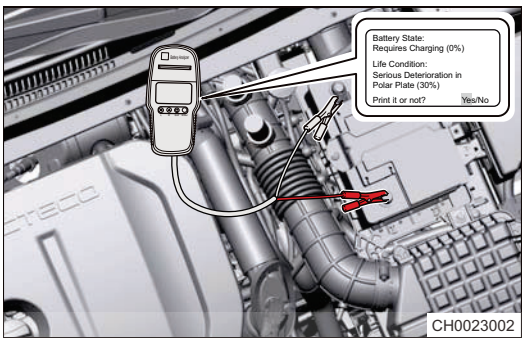


(d) Operate "Left/Right" button on tester to adjust and set the battery capacity (such as 720CCA, this value indicates the battery low temperature starting performance) and click "Enter".



(e) The battery condition is displayed on tester.

Hint:
Recharge or replace battery according to the tested data.



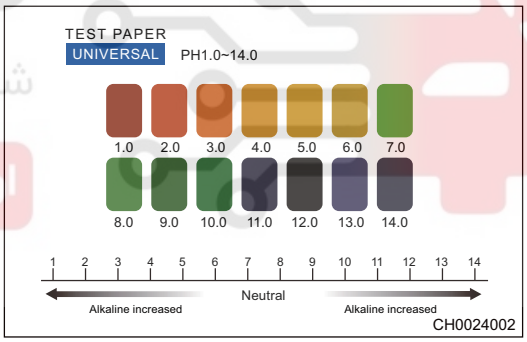
Battery Fluid Leakage Test

1. Test method

(a) PH paper is used for judgment.

PH paper model definition:

PH 1 - 14



2. Judgment method

(a) Take a piece of PH 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 paper. Then compare it with the color bar to judge the PH value.

(b) If the PH value is less than 7, it is an acidic liquid, which indicates battery leakage.

(c) 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.

ON-VEHICLE SERVICE

Battery

On-vehicle Inspection

1. Check that battery terminals are not loose or corroded. If battery terminals are corroded, clean them.
2. Check battery for damage, deformation or leakage. If damage, deformation or leakage is found, replaced the battery.
   Check battery voltage.
   (a) Turn ENGINE START STOP switch to ON, and turn it off 20 to 30 seconds after turning on headlight. Release the surface charge on battery. Measure battery voltage with a digital multimeter.
   Rated Voltage
   12 V - 13 V

Battery Charging Method

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).
- Charging with constant current: charging I: 0.05C
  When continue to charge with constant current for 3 to 5 hours after the voltage reaches 16 V.

Caution:

- Battery on vehicles equipped with blue drive configuration can only use the method of charging with constant voltage.

Battery Handling/ Warning Description and Safety Specification

1. Following the related specifications on appliances connected with battery, in repair manual and owner's manual.
2. There is risk of corrosiveness (burns).
   Battery acid is highly corrosive, so it is necessary to wear protective gloves and goggles when working.
   Do not dump the battery, because acid may spill from vent hole.
3. 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.
4. Wear eye protective mask/glasses.
5. Never allow the children approaching acid and battery.
6. Recycle the battery.
   Deliver the used battery to designated recycling site.
7. Never throw the used battery into household garbage.
8. There is risk of explosion.

Removal

Warning/Caution/Hint

Caution:

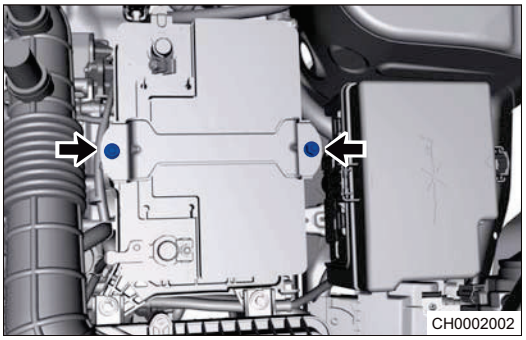
- Be sure to wear necessary safety equipment to prevent accidents when repairing.

- Try to prevent body paint surface from being scratched during removal and installation.

1. Turn off all electrical equipment and the ignition switch.
2. Remove the battery assembly

(a) Loosen 2 fixing bolts (arrow) from battery pressure plate, and remove battery pressure plate.

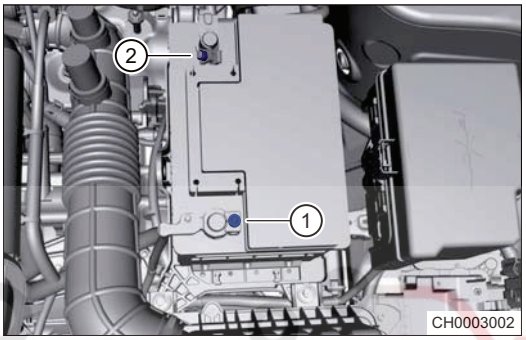
Tightening torque
5 ± 1 N·m



(b) Loosen the locking nuts of positive and negative battery cables, and remove the positive (+) and negative (-) battery cables (1) (2).

Tightening torque
7 ± 1 N·m

Hint:
When removing the positive battery cable, pay attention to just loosen the locking nuts without removing them, so as to prevent the "T" position at bottom of stud from deforming when tightening the nuts.



(c) Remove the battery assembly.

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

Installation

Warning/Caution/Hint

Caution:
- Replace battery with a new one which conforms to the specifications.
- Used battery contains sulfuric acid and lead, so never discard it at will. Please dispose of it at a qualified local waste treatment station.

1. Installation is in the reverse order of removal.

Battery Tray

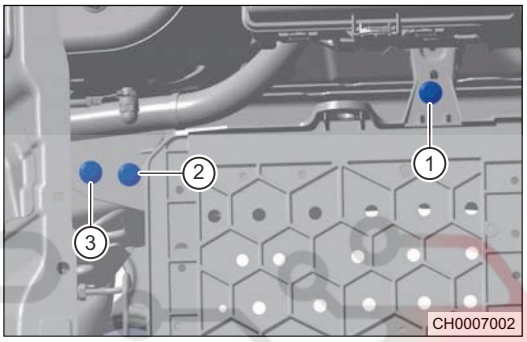
Removal

Warning/Caution/Hint

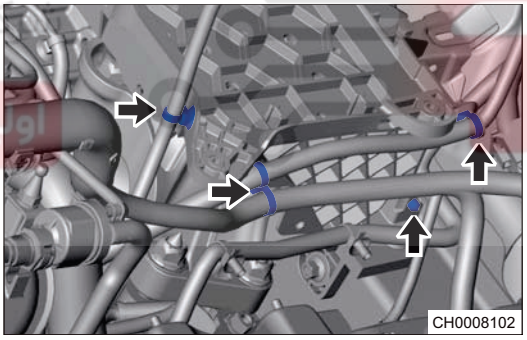
Caution:

- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

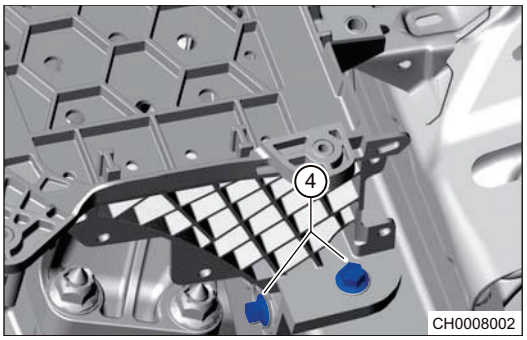
1. Turn off all electrical equipment and the ignition switch.
2. Remove the battery assembly
3. Remove the air filter assembly (<Blue>See page 10-8).
4. Remove the battery tray
   (a) Remove the battery tray fixing bolt (1).
   Tightening torque
   9 ± 1 N·m
   (b) Remove the battery tray fixing bolt (2) and (3).
   Tightening torque
   25 ± 4 N·m



   (c) Remove 5 wire harness fixing clips (arrow) from battery tray.



   (d) Remove the battery tray fixing bolt (4).
   Tightening torque
   25 ± 4 N·m



   (e) Remove the battery tray.

Installation

1. Installation is in the reverse order of removal.

Alternator

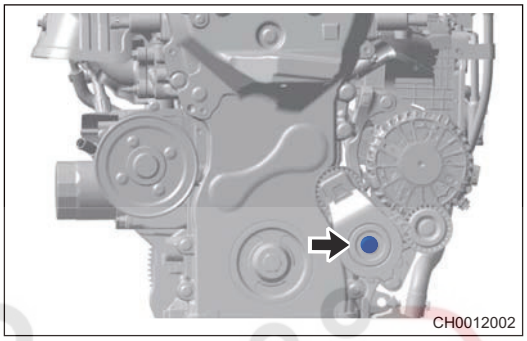
Removal

Warning/Caution/Hint

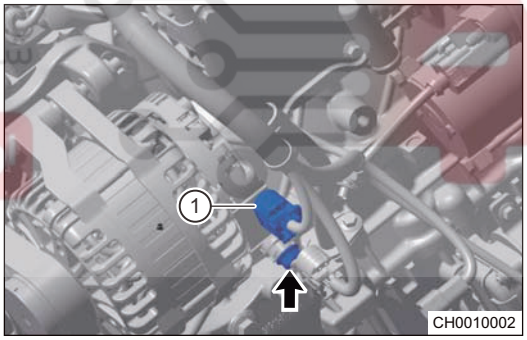
Caution:

- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

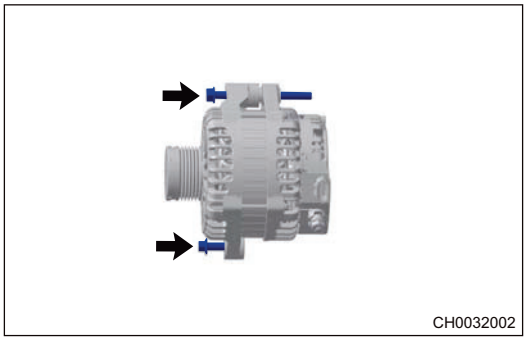
1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover.
4. Move away the accessory drive belt.
5. Remove the alternator assembly.
   (a) Remove the tensioner assembly (arrow).
   Tightening torque
   50 + 5 N·m



   (b) Disconnect the alternator connector (1).
   (c) Open output end protective cap, remove fixing nut (arrow) and remove output cable.
   Tightening torque
   20 ± 2 N·m

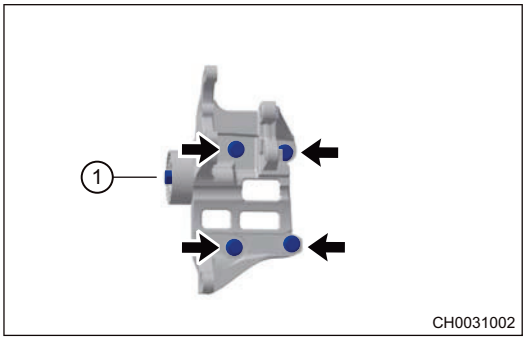


   (d) Remove 2 fixing bolts (arrow) from alternator.
   Tightening torque
   20 + 5 N·m



   (e) Remove the alternator.
6. Remove the alternator mounting bracket.
   (a) Remove the idler pulley assembly (1).
   Tightening torque
   50 + 5 N·m

(b) Remove 4 fixing bolts (arrow) from alternator mounting bracket.
Tightening torque
40 + 5 N·m



(c) Remove the alternator mounting bracket.

Installation

1. Installation is in the reverse order of removal.
2. Inspection
   (a) Start the engine.
   Caution:
   • If battery warning light comes on, charging system may have a malfunction.
   (b) When engine is running, use digital multimeter to check the output voltage of alternator and record it.
   (c) If the voltage is between 13.5 - 14.8 V, the alternator is normal.