02-Engine

Start system

Technical specifications

General specifications

Name	Specification
Commutator ring gear runout	
Commutator diameter	
Starter brush length	

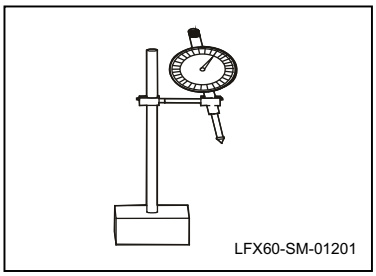
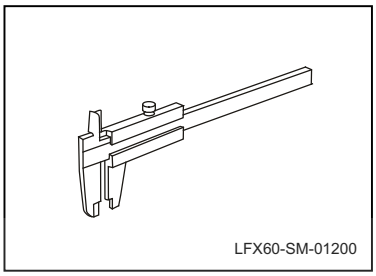
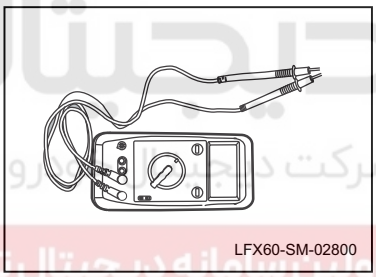
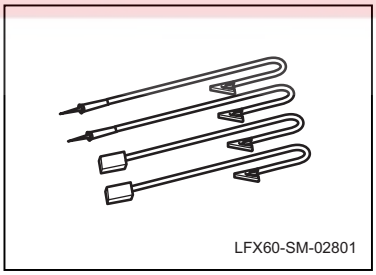
Precautions

Precautions

1. No matter the engine is running or not, when the ignition switch is turned on, do not enable any components in the system such as any cable of the battery, fuel injector, fuel pump, ignition system wire, electronic control unit (ECU) wire, etc.
2. When the engine is difficult to start, the starting time once cannot be too long (generally not greater than 5s), and the other start should be made 15s later. It will not only allow the battery electrolyte to penetrate into the inner layers of the electrode plates, so that the battery potential can be restored to facilitate the engine start, but also it can avoid that the starter is damaged due to overheating after long-time continuous operation.
3. Be careful not to damage the insulating parts when disassembling the starter.
4. Do not use the starter to drive the car, so as to avoid damage to the starter due to excessive load.
5. Release the ignition switch in time after the engine starts, and let the ignition switch automatically return to the ignition gear, so as to avoid the wear when starting the electric motor and one-way clutch after the starter idles at high speed for a long time.
6. Do not turn the ignition switch to the starting gear when the engine is running, so as to avoid the fact that the driving gear of starter collides with the flywheel gear ring of engine.
7. The performance testing time of the starter in maintenance shall not exceed 5s to avoid damage to the starter.

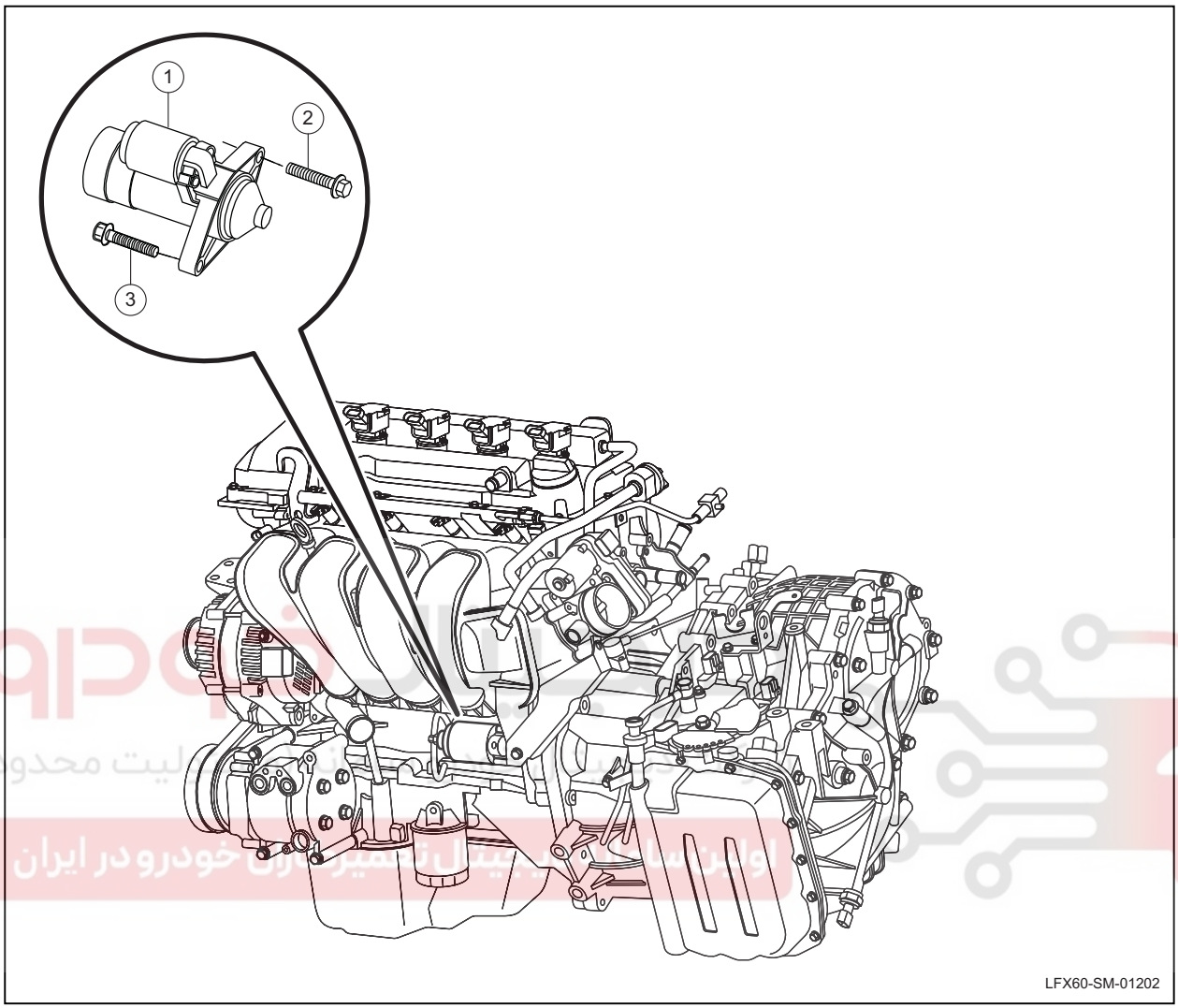
Preparation

General and special tools

No.	Tool name	Tool figure	Tool code	Remarks
1	Dial gauge	 LFX60-SM-01201	-	Measure the starting commutator gear ring runout
2	Calipers	 LFX60-SM-01200	-	Measure the diameter and length
3	Digital universal meter	 LFX60-SM-02800	-	Measure the voltage and resistance
4	Conductor assembly	 LFX60-SM-02801	-	Testing circuit

Structure and installation location

Component Location Plan



No.	Part Name
1	Starter assembly
2	Starter mounting bolt

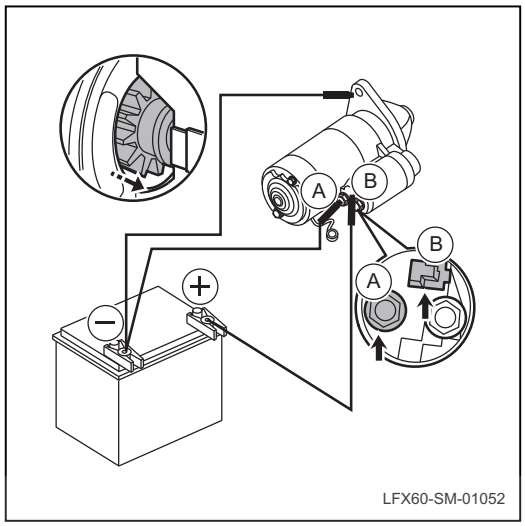
No.	Part Name
3	Starter mounting bolt

General Inspection

Starter detection

Testing

1. Check the starter assembly.

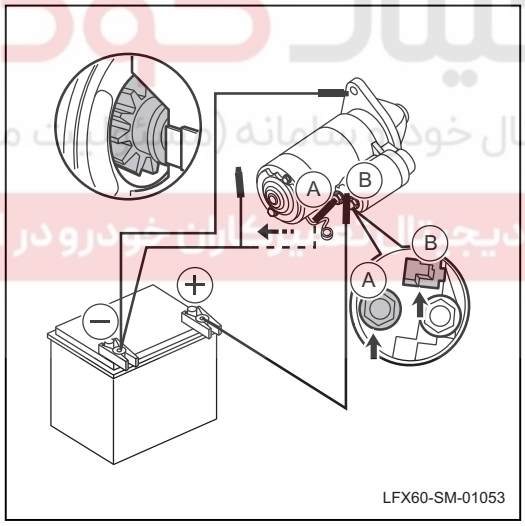


LFX60-SM-01052

Note:

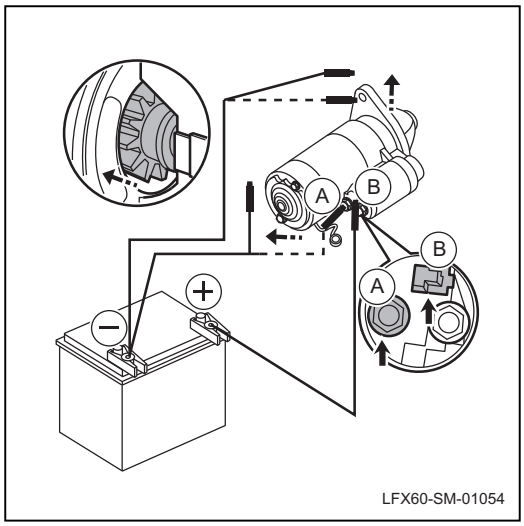
- **To prevent the starter from running, disconnect the field coil lead from terminal A.**
- **Complete the following tests within 3 to 5 s.**

(a). As shown, connect the battery to the two terminals A and B of the starter, and check if the clutch pinion is moving outward. If the clutch pinion does not run or move outward, replace the electromagnetic starter switch assembly.



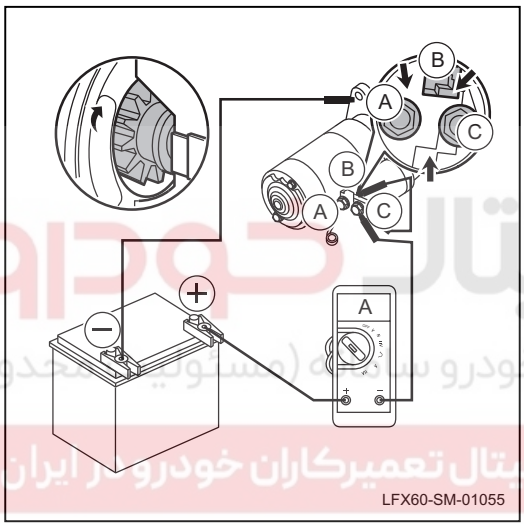
LFX60-SM-01053

(b). As shown, disconnect the terminal A lead and check that the clutch pinion can remain in place (no inward movement).



LFX60-SM-01054

(c). As shown, disconnect the terminal A lead and D lead, and check if the clutch pinion can return (inward movement).



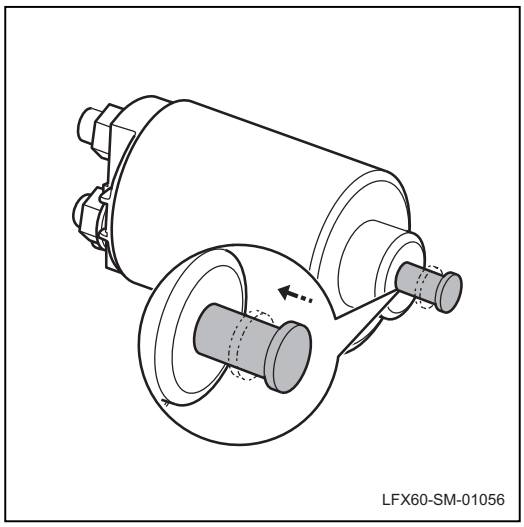
LFX60-SM-01055

(d). As shown, perform no load test on the starter, and observe and record the current value (using the multimeter's current mode).

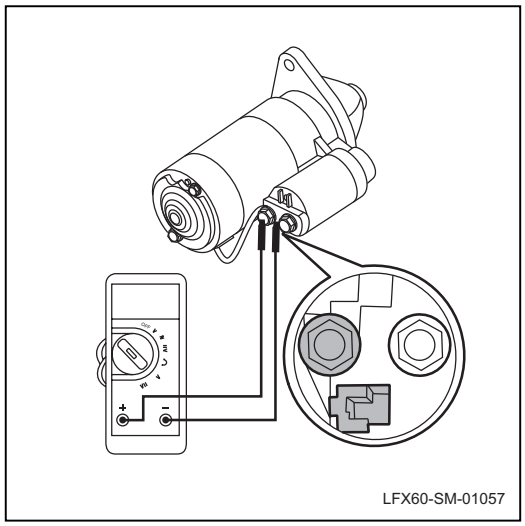
Note:

- **Use a vise to hold the starter caught by the aluminum plate or the cloth.**
- **When the battery voltage is below 11.5V, the current value should be <90A; replace the starter if the current value does not meet the requirements.**

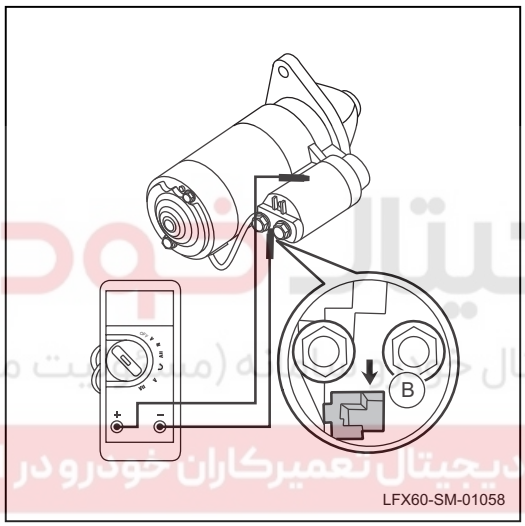
2. Check the starter magnetic switch.


LFX60-SM-01056

(a). As shown, push the core in, and check if the core can quickly return; if not, replace the magnetic switch assembly.

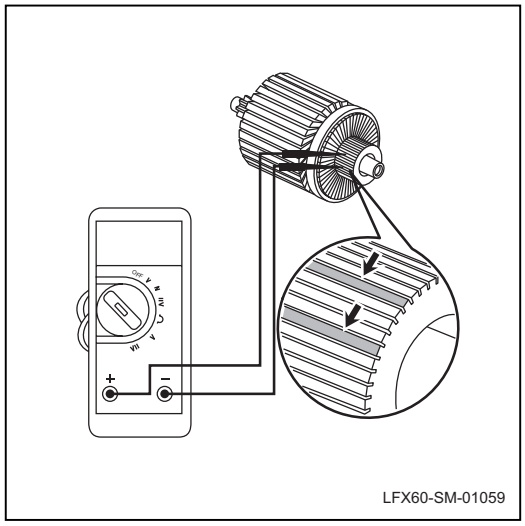


(b). As shown, use the multimeter's ohm mode to measure the resistance between terminals A and B; replace the magnetic switch if it does not meet the requirements.
Resistance: <1Ω

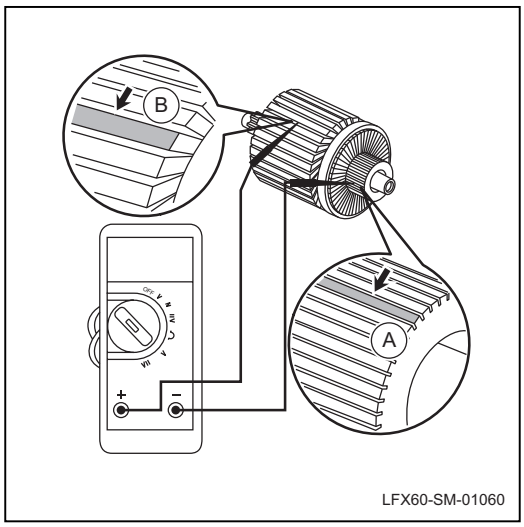


(c). As shown, use the multimeter's ohm mode to measure the resistance between terminal B and housing; replace the magnetic switch if it does not meet the requirements.
Resistance:<2Ω

3. Check the armature coil.



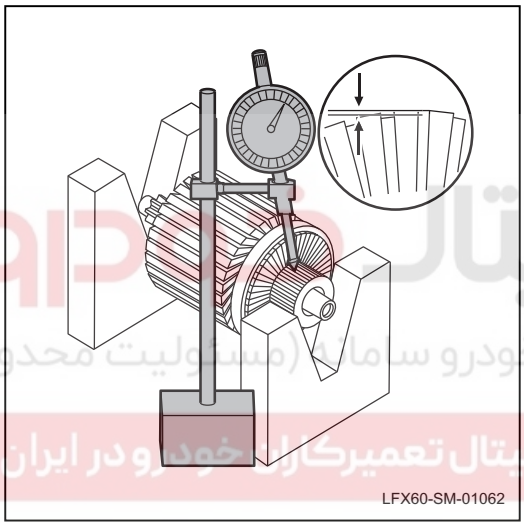
(a). As shown, use the multimeter's ohm mode to check if any two commutation bars are conductive; if not, replace the armature winding.



LFX60-SM-01060

(b). Test the commutator in the Ohm gear of multimeter, as shown in the figure to check if the commutator (as shown in Figure A) and armature core (as shown in Figure B) are conductive; if conductive, replace the armature winding.

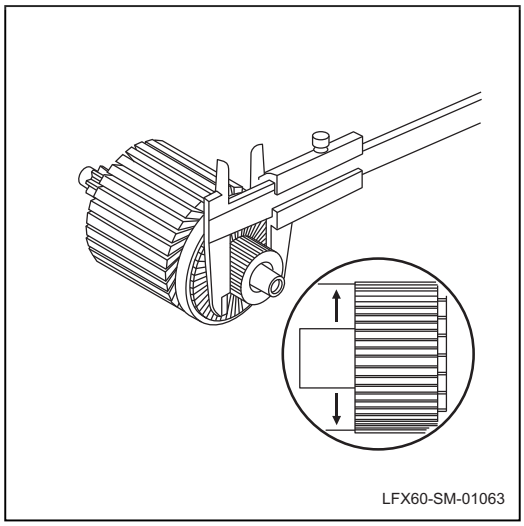
4. Check the commutator.


LFX60-SM-01062

(a). Check the surface of the commutator for contamination and burns; if yes, polish with a sandpaper.

(b). Put the commutator on the V-shaped block, and check the commutator gear ring with a dial indicator; if the difference is greater than the maximum value, repair it or replace it if necessary.

Maximum gear ring difference: 0.05mm

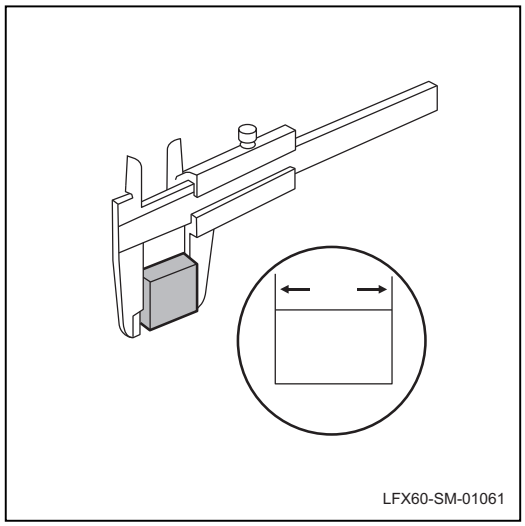

LFX60-SM-01063

(c). Use the vernier caliper to measure the diameter of the commutator, and replace the armature if the diameter is less than the minimum.

Standard Diameter:30mm

Minimum diameter:29mm

5. Check the starter brush.



(a). Use the vernier caliper to check the length of the brush. If the length is less than the minimum, replace the brush. Replace the brush carrier and the starter yoke assembly, if necessary.
Standard Diameter:15.5mm
Minimum diameter:10mm

Operating Principle

System Overview

The start-up system consists of a battery, a start-up switch, a starter and related lines, all of which are connected by wires. When the start signal is received, and the power supply is supplied to the starter's electromagnetic switch; the electromagnetic switch coil generates a magnetic field to drive the plunger and gear transmission rod, then the pinion gets engaged with the engine's flywheel gear ring; finally, the electromagnetic switch is closed, and the engine starts. After the engine is started, the pinion will overrun the clutch protection armature, to avoid that the flywheel drives the pinion driving armature, until the switch is disconnected, and then the return spring will make the pinion to return its original position.

Starter

The starter consists of stator assembly, armature assembly, overdrive clutch assembly, electromagnetic switch assembly, front shell, rear shell, brush carrier and transmission rod.

Diagnostic Information and Procedures

Diagnosis Instructions

Before starting to diagnose a fault in the startup system, familiarize yourself with the operating principle of the startup system, and then start the system diagnostics, which helps to determine the correct troubleshooting steps in the event of a failure. More importantly, this also helps to determine whether the customer's situation belongs to normal operation.

Any troubleshooting of the start-up system should begin with the start-up system check, so as to instruct the service personnel to take the next logical step to troubleshoot. Comprehend and correctly use the diagnostic flow chart to shorten the diagnosis time and avoid the misjudgement.

General equipment

Digital universal meter
Diagnostic equipment of vehicle

Visual Inspection

1. Confirm the customer's question.
2. Visually check for obvious signs of mechanical or electrical damage.

Visual inspection table

Mechanical	Electrical
• One-touch start switch • Lgnition switch • Starter • Flyweight disk	• Fuse • Harness or plug • Battery • Engine compartment fuse box • PEPS

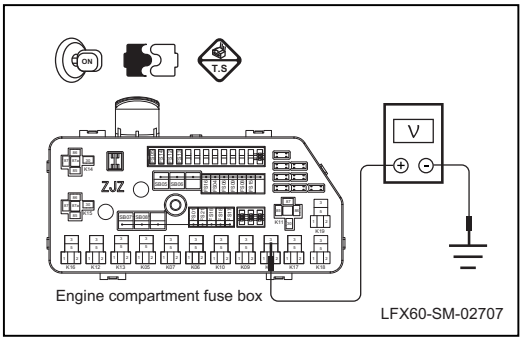
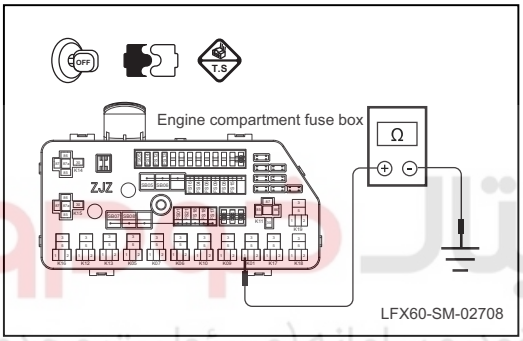
3. Check the system lines easy to see or can be seen.
4. If the observed or proposed problem is obvious and its cause is identified, rectify the cause before proceeding with next step.
5. If for the problem, there are no obvious findings, then confirm the fault and refer to the symptom table.

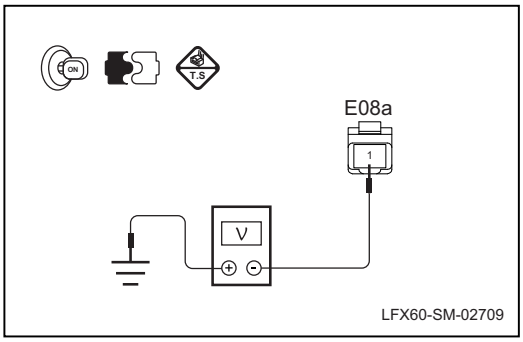
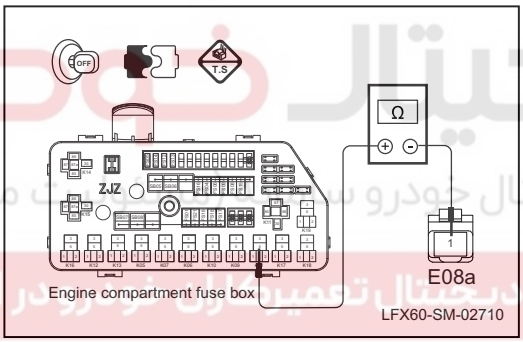
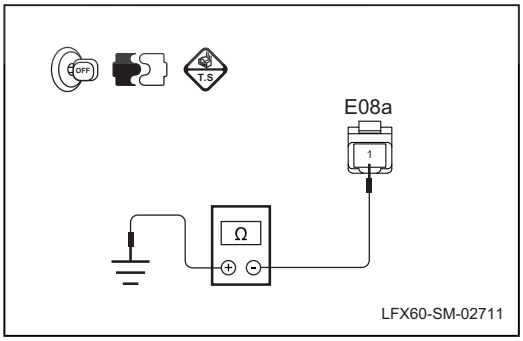
List of fault symptoms

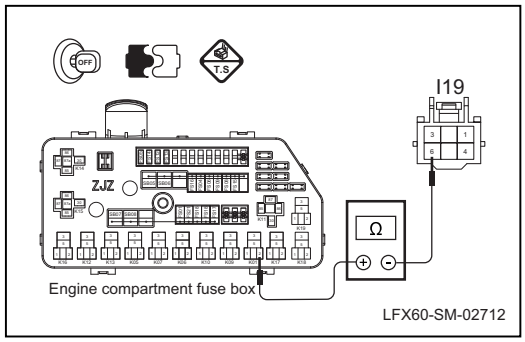
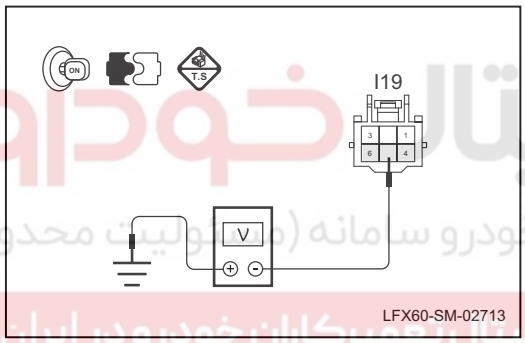
Symptom	Possible point of failure	Recommended Measures
The starter can not be operated	• Fuse	**Refer to: Diagnostic process for starter failing to work**
	• Battery	
	• Harness or plug	
	• Engine compartment fuse box	
	• Dashboard fuse box	
	• Ignition switch/one-touch start switch	
	• Starter	
	• PEPSECU	
The starter can not stop running	• Starter relay	**Refer to:Diagnostic process for starter failing to stop running**
	• Harness or plug	
	• Engine compartment fuse box	
	• Ignition switch/one-touch start switch	
	• PEPSECU	
The starter is working but the engine is not working	• Starter	• Repair or replace the starter **Refer to: Replacement of starter**
	• Flywheel	• Repair or replace the flywheel **Refer to: Replacement of flywheel**
The starter is running slowly	• Battery voltage low	• Charge or replace the battery. **Reference: Replacement of the battery**
	• Engine accessories	• Repair the booster pump and other accessories; replace, if necessary.
	• Starter	• Repair or replace the starter **Refer to: Replacement of starter**
Abnormal start-up noise	• Starter fasteners get loose	• Reinstall the starter fasteners
	• Flywheel fasteners get loose	• Reinstall the flywheel fasteners
	• Starter	• Repair or replace the starter **Refer to: Replacement of starter**
	• Flywheel	• Repair or replace the flywheel **Refer to: Replacement of flywheel**

Diagnostic process for starter failing to work

Test condition	Details/results/measures
1. General inspection.	
	A. Check whether the battery positive and negative harness connection is loose. B. Check the starter positive terminal harness and harness plug for looseness. Is it OK after checking? →**Yes** To step 2. →**No** Repair the fault position.
2. Check the battery voltage.	
	A. Measure the battery voltage with a multimeter. **Standard value:11 ~ 14V** Is the voltage normal? →**Yes** To step 3. →**No** Charge or replace the battery. **Refer to: Replacement of battery**
3. Check the fuse.	
	A. Check the fuse starting relay fuse FS01 and starting switch fuse SB03. **Fuse rated capacity: FS01 (15A), SB03 (30A)** Is it OK after checking? →**Yes** To step 4. →**No** Replace the fuse.
4 Check the K01 starter relay.	
	A. Operate the ignition switch to turn the power to OFF state. B. Remove the engine compartment fuse box K01 starter relay. C. Replace the K01 starter relay and check whether the starting operation is normal. Is the starter running normal? →**Yes** Replace the K01 starter relay. →**No** To step 5.

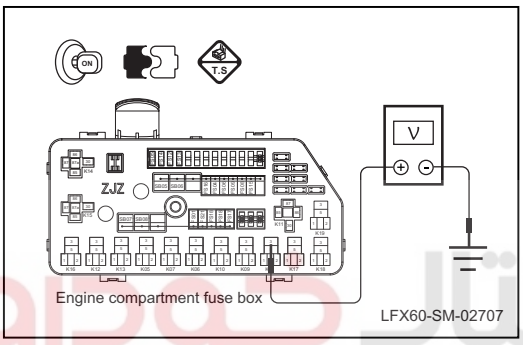
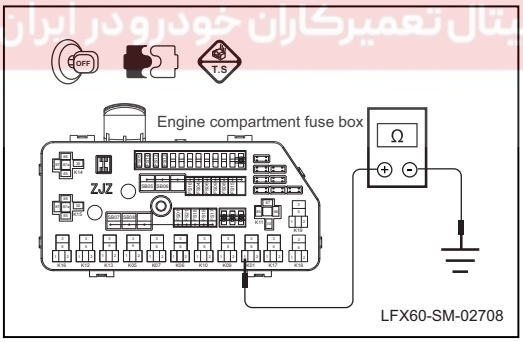
Test condition	Details/results/measures
5. Check the K01 starter relay power line.	
	A. Operate the ignition switch to turn the power to OFF state. B. Remove the engine compartment fuse box K01 starter relay. C. Measure the voltage between the engine compartment fuse box K01 starter relay terminal 3 and the fixed ground point with the multimeter. **Standard value:11 ~ 14V** Is the voltage normal? **→Yes** To step 6. **→No** Check the K01 starting relay power line; if necessary, replace the electrical box of engine compartment.
6. Check the K01 starter relay ground line.	
	A. Operate the ignition switch to turn the power to OFF state. B. Remove the engine compartment fuse box K01 starter relay. C. Measure the resistance between the engine compartment fuse box K01 starter relay terminal 1 and the fixed ground point with the multimeter. **Standard value:Less than 5Ω** Is the resistance normal? **→Yes** To step 6. **→No** Repair the K01 starter relay ground line fault and replace the harness if necessary.
7. Check the starter power line.	
	A. Check whether the start power line is loose. B. Measure the voltage between the starter power line and fixed ground point with the multimeter. **Standard value:11 ~ 14V** Is the voltage normal? **→Yes** To step 8. **→No** Repair the starter power line fault and replace the harness if necessary.

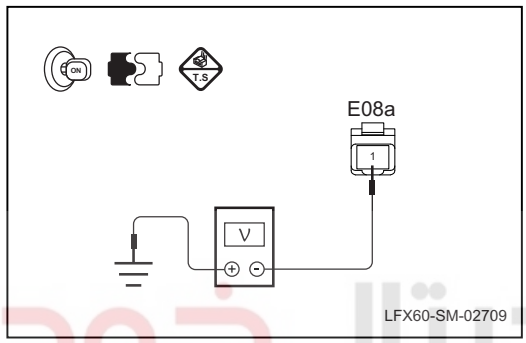
Test condition	Details/results/measures
8. Check the starter relay input voltage.	
	A. Operate the ignition switch to turn the power to OFF state. B. Disconnect the battery negative connector. C. Disconnect the starter harness plug E08a. D. Connect the battery negative terminal. E. Start the engine, and use a multimeter to measure the voltage between terminal 1 of the starter harness plug E08a and the reliable ground point. **Standard value:11 ~ 14V** Is the voltage normal? **→Yes** To step 9. **→No** To step 10.
9. Check the starter.	
	A. Replace the starter. **Refer to: Replacement of starter** Confirm that the fault has been ruled out.
10. Check the starter relay input voltage line.	
 	A. Operate the ignition switch to turn the power to OFF state. B. Disconnect the battery negative connector. C. Remove the engine compartment fuse box K01 starter relay. D. Disconnect the starter harness plug E08a. E. Measure the resistance between the engine compartment fuse box K01 starter relay terminal 5 and the starter harness plug E08a terminal 1 with the multimeter. **Standard value:Less than 5Ω** F. Measure the resistance between the starter harness plug E08a terminal 1 and the fixed ground point with the multimeter. **Standard value:10MΩ or higher** Is the resistance normal? **→Yes** To step 11. **→No** Repair the starter relay input voltage line fault and replace the harness if necessary.

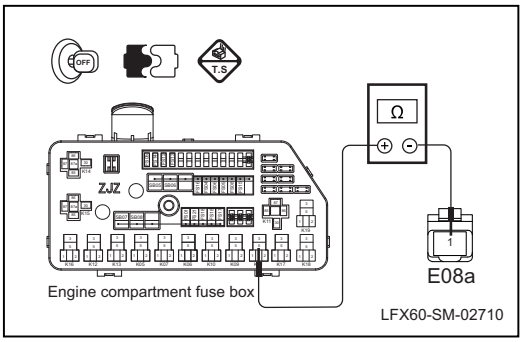
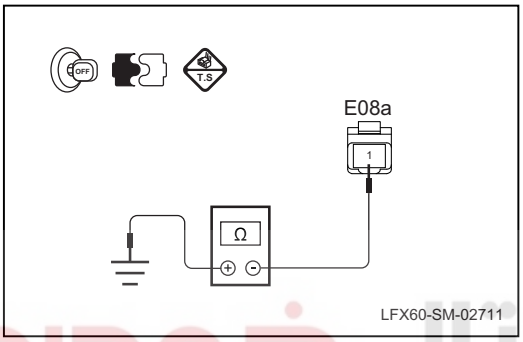
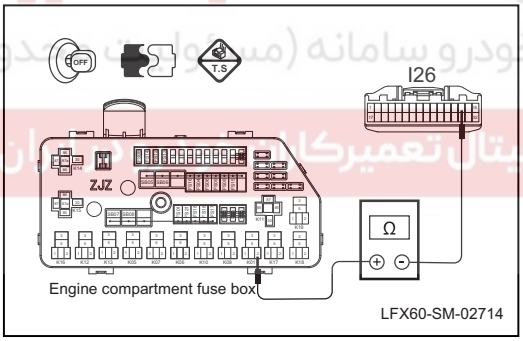
Test condition	Details/results/measures
11. Check the K01 starter relay control line.	
	A. Operate the ignition switch to turn the power to OFF state. B. Disconnect the battery negative connector. C. Remove the engine compartment fuse box K01 starter relay. D. Disconnect the harness plug I19 of the ignition switch. E. Use a multimeter to measure the resistance between the terminal 2 of K01 starting relay in the engine compartment electrical box / terminal 4 of ignition switch harness plug I19 and the reliable ground point. **Standard value:Less than 5Ω** Is the resistance normal? **→Yes** To step 12. **→No** Repair the K01 starter relay control line fault and replace the harness if necessary.
12. Check the power supply for ignition switch.	
	A. Operate the ignition switch to turn the power to OFF state. B. Disconnect the battery negative connector. C. Disconnect the ignition switch harness plug I19. D. Connect the battery negative terminal. E. Operate the ignition switch to turn the power to ON state. F. Measure the voltage between the ignition switch harness plug I19 terminal 5 and fixed ground point with the multimeter. **Standard value:11 ~ 14 V** Is the voltage normal? **→Yes** To step 13. **→No** Repair the ignition switch start power line fault and replace the dashboard fuse box if necessary.
13. Check the ignition switch.	
	A. Replace the ignition switch. **Refer to: Replacement of ignition switch** Confirm that the fault has been ruled out.

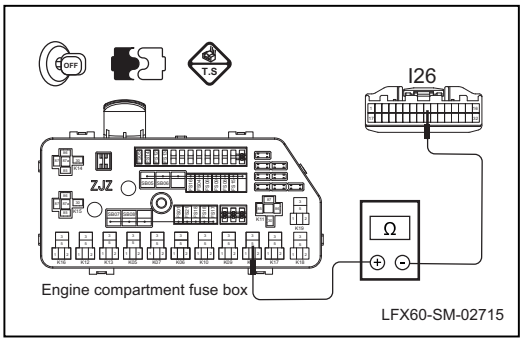
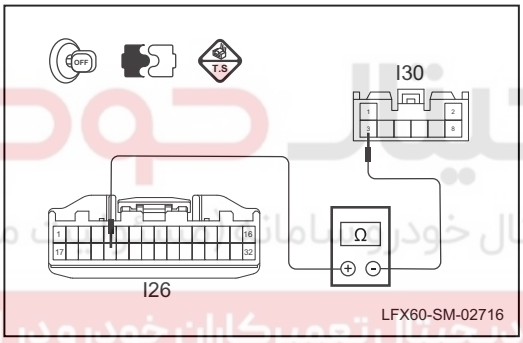
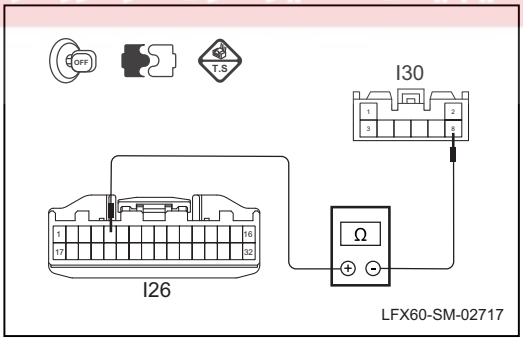
Diagnostic process for starter failing to run (one-button start)

Test condition	Details/results/measures
1. Check the PEPS system DTC.	
	A. Operate the ignition switch to turn the power to OFF and connect the diagnostic meter. B. Operate the ignition switch to turn the power to ON, turn on the diagnostic meter - use the latest software version. C. Read PEPS DTC. Is there PEPS DTC? →**Yes** **Refer to: Diagnostic trouble code (DTC) list. Perform DTC diagnostic procedure.** →**No** To step 2.
2. General inspection.	
	A. Check whether the battery positive and negative harness connection is loose. B. Check the starter positive terminal harness and harness plug for looseness. Is it OK after checking? →**Yes** To step 3. →**No** Repair the fault position.
3. Check the battery voltage.	
	A. Measure the battery voltage with a multimeter. **Standard value:11 ~ 14V** Is the voltage normal? →**Yes** To step 4. →**No** Charge or replace the battery. **Refer to: Replacement of battery**
4. Check the fuse.	
	A. Check the fuse FS01 of K01 starter relay. **Fuse rated capacity: 15A** Is it OK after checking? →**Yes** To step 5. →**No** Replace the fuse.

Test condition	Details/results/measures
5. Check the K01 starter relay.	
	A. Operate the ignition switch to turn the power to OFF state. B. Remove the engine compartment fuse box K01 starter relay. C. Replace the K01 starter relay and check whether the starting operation is normal. Is the starter running normal? →**Yes** Replace the K01 starter relay. →**No** To step 6.
6. Check the K01 starter relay power line.	
	A. Operate the ignition switch to turn the power to OFF state. B. Remove the engine compartment fuse box K01 starter relay. C. Measure the voltage between the engine compartment fuse box K01 starter relay terminal 3 and the fixed ground point with the multimeter. **Standard value:11 ~ 14V** Is the voltage normal? →**Yes** To step 7. →**No** Check the K01 starting relay power line; if necessary, replace the electrical box of engine compartment.
7. Check the K01 starter relay ground line.	
	A. Operate the ignition switch to turn the power to OFF state. B. Remove the engine compartment fuse box K01 starter relay. C. Measure the resistance between the engine compartment fuse box K01 starter relay terminal 1 and the fixed ground point with the multimeter. **Standard value:Less than 5Ω** Is the resistance normal? →**Yes** To step 8. →**No** Repair the K01 starter relay ground line fault and replace the harness if necessary.

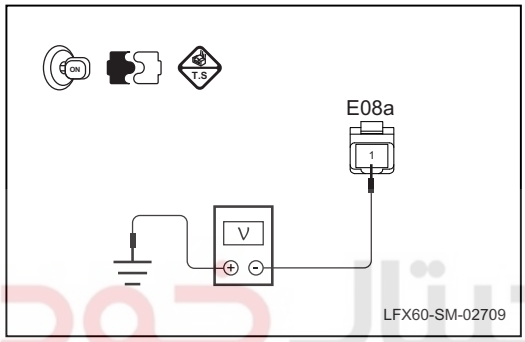
Test condition	Details/results/measures
8. Check the starter power line.	
	A. Check whether the start power line is loose. B. Measure the voltage between the starter power line and fixed ground point with the multimeter. **Standard value:11 ~ 14V** Is the voltage normal? →**Yes** To step 9. →**No** Repair the starter power line fault and replace the harness if necessary.
9. Check the starter relay input voltage.	
	A. Operate the ignition switch to turn the power to OFF state. B. Disconnect the battery negative connector. C. Disconnect the starter harness plug E08a. D. Start the engine, and use a multimeter to measure the voltage between terminal 1 of the starter harness plug E08a and the reliable ground point. **Standard value:11 ~ 14V** Is the voltage normal? →**Yes** To step 10. →**No** To step 11.
10. Check the starter.	
	A. Replace the starter. **Refer to: Replace the starter.** Confirm that the fault has been ruled out.

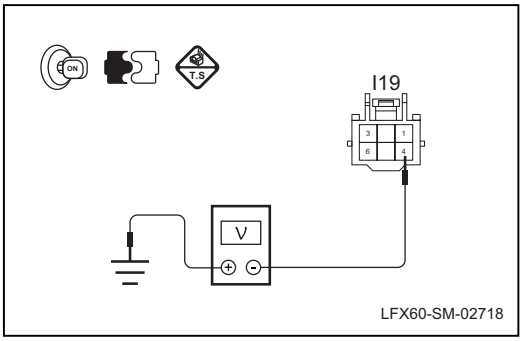
Test condition	Details/results/measures
11. Check the starter relay input voltage line.	
 	A. Operate the ignition switch to turn the power to OFF state. B. Disconnect the battery negative connector. C. Remove the engine compartment fuse box K01 starter relay. D. Disconnect the starter harness plug E08a. E. Measure the resistance between the engine compartment fuse box K01 starter relay terminal 5 and the starter harness plug E08a terminal 1 with the multimeter. **Standard value:Less than 5Ω** F. Measure the resistance between the starter harness plug E08a terminal 1 and the fixed ground point with the multimeter. **Standard value:10MΩ or higher** Is the resistance normal? **→Yes** To step 12. **→No** Repair the starter relay input voltage line fault and replace the harness if necessary.
12. Check the K01 starter relay control line.	
	A. Operate the ignition switch to turn the power to OFF state. B. Disconnect the battery negative connector. C. Remove the engine compartment fuse box K01 starter relay. D. Disconnect the PEPS ECU harness plug I26. E. Use a multimeter to measure the resistance between the terminal 2 of K01 starting relay in the engine compartment electrical box / terminal 14 of PEPSECU harness plug I26 and the reliable ground point. **Standard value:Less than 5Ω** Is the resistance normal? **→Yes** To step 13. **→No** Repair the K01 starter relay control line fault and replace the harness if necessary.

Test condition	Details/results/measures
13. Check the start signal feedback line.	
	A. Operate the ignition switch to turn the power to OFF state. B. Disconnect the battery negative connector. C. Remove the engine compartment fuse box K01 starter relay. D. Disconnect the PEPS ECU harness plug I26. E. Use a multimeter to measure the resistance between the terminal 5 of K01 starting relay in the engine compartment electrical box / terminal 9 of PEPSECU harness plug I26 and the reliable ground point. **Standard value:Less than 5Ω** Is the resistance normal? **→Yes** To step 14. **→No** Repair the K01 starter relay control line fault and replace the harness if necessary.
14. Check the signal line of one-button start switch.	
 	A. Operate the ignition switch to turn the power to OFF state. B. Disconnect the battery negative connector. C. Disconnect the harness plug of one-button start switch. D. Disconnect the PEPS ECU harness plug I26. E. Use a multimeter to measure the resistance between the terminal 3 of harness plug I30 of one-button start switch and the terminal 21 of PEPSECU harness plug I26. **Standard value:Less than 5Ω** F. Use a multimeter to measure the resistance between the terminal 8 of harness plug I30 of one-button start switch and the terminal 5 of PEPSECU harness plug I26. **Standard value:Less than 5Ω** Is the resistance normal? **→Yes** To step 15. **→No** Repair the ignition switch start power line fault and replace the dashboard fuse box if necessary.
15. Check the one-touch start switch.	
	A. Replace the one-touch start switch. **Refer to: Replacement of one-touch start switch** Is the troubleshooting successful? **→Yes** Replace the one-touch start switch. **→No** To step 16.

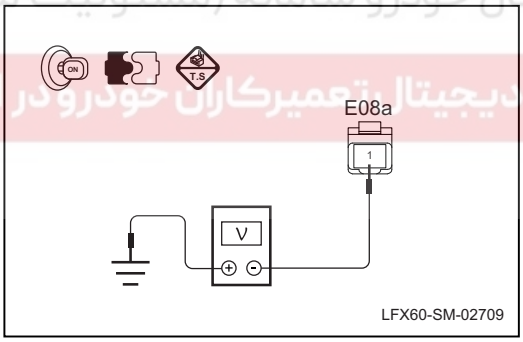
Test condition	Details/results/measures
16. Check the PEPS ECU.	
	A. Replace the PEPS ECU. **Refer to: Replacement of PEPS ECU** Confirm that the fault has been ruled out.

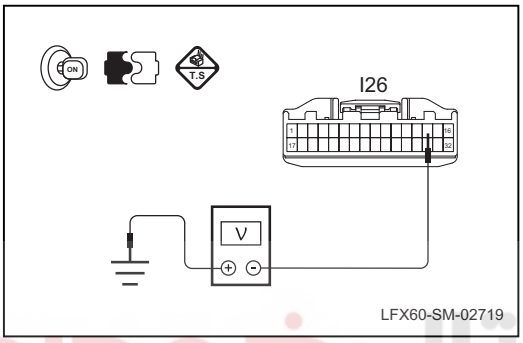
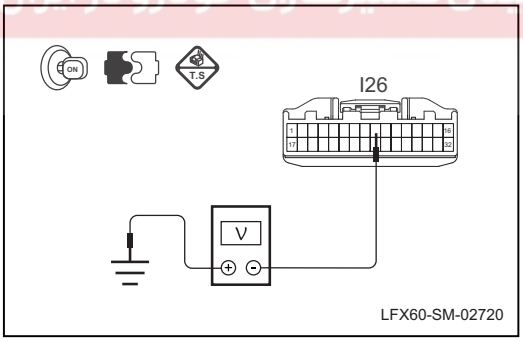
Diagnostic process for starter failing to stop running

Test condition	Details/results/measures
1. Check the K01 starter relay.	
	A. Remove the engine compartment fuse box K01 starter relay. B. Operate the ignition switch to turn the power to ON state. Is the starter running stopped? →**Yes** To step 4. →**No** To step 2.
2. Check the starter relay line.	
	A. Operate the ignition switch to turn the power to OFF state. B. Disconnect the battery negative connector. C. Disconnect the starter harness plug E08a. D. Connect the battery negative terminal. E. Operate the ignition switch to turn the power to ON state. F. Measure the voltage between the starter harness plug E08a terminal 1 and the fixed ground point with the multimeter. **Standard value:0V** Is the voltage normal? →**Yes** To step 3. →**No** Repair the starter relay line fault and replace the harness if necessary.
3. Check the starter.	
	A. Replace the starter. **Refer to: Replacement of starter** Confirm that the fault has been ruled out.
4. Replace the K01 starter relay.	
	A. Operate the ignition switch to turn the power to OFF state. B. Replace the engine compartment fuse box K01 starter relay. Is the troubleshooting successful? →**Yes** Replace the K01 starter relay. →**No** To step 5.

Test condition	Details/results/measures
5. Check the K01 starter relay control line.	
	A. Operate the ignition switch to turn the power to OFF state. B. Disconnect the battery negative connector. C. Disconnect the ignition switch harness plug I19. D. Connect the battery negative terminal. E. Operate the ignition switch to turn the power to ON state. F. Measure the voltage between the ignition switch harness plug I19 terminal 4 and fixed ground point with the multimeter. **Standard value:0V** Is the voltage normal? →**Yes** To step 6. →**No** Check the K01 starting relay control line; if necessary, replace the electrical box of engine compartment.
6. Check the ignition switch.	
	A. Replace the ignition switch. **Refer to: Replacement of ignition switch** Confirm that the fault has been ruled out.

Diagnostic process for starter failing to stop running (one-button start)

Test condition	Details/results/measures
1. Check the PEPS system DTC.	
	A. Switch off the ignition switch; switch on the ignition switch to connect the automobile diagnosis device. B. Operate the ignition switch to turn the power to ON, turn on the diagnostic meter - use the latest software version. C. Read PEPS DTC. Is there PEPS DTC? →**Yes** **Refer to: Diagnostic trouble code (DTC) list. Perform DTC diagnostic procedure.** →**No** To step 2.
2. Check the K01 starter relay.	
	A. Remove the engine compartment fuse box K01 starter relay. B. Operate the ignition switch to turn the power to ON state. Is the starter running stopped? →**Yes** To step 5. →**No** To step 3.
3. Check the starter relay line.	
	A. Operate the ignition switch to turn the power to OFF state. B. Disconnect the battery negative connector. C. Disconnect the starter harness plug E08a. D. Connect the battery negative terminal. E. Operate the ignition switch to turn the power to ON state. F. Measure the voltage between the starter harness plug E08a terminal 1 and the fixed ground point with the multimeter. **Standard value:0V** Is the voltage normal? →**Yes** To step 4. →**No** Repair the starter relay line fault and replace the harness if necessary.
4. Check the starter.	
	A. Replace the starter. **Refer to: Replacement of starter** Confirm that the fault has been ruled out.

Test condition	Details/results/measures
5. Replace the K01 starter relay.	
	A. Operate the ignition switch to turn the power to OFF state. B. Replace the engine compartment fuse box K01 starter relay. Is the troubleshooting successful? →**Yes** Replace the K01 starter relay. →**No** To step 6.
6. Check the K01 starter relay control line.	
	A. Operate the ignition switch to turn the power to OFF state. B. Disconnect the battery negative connector. C. Disconnect the PEPSECU harness plug 126. D. Connect the battery negative terminal. E. Operate the ignition switch to turn the power to ON state. F. Use a multimeter to measure the voltage between terminal 14 of PEPSECU harness plug 126 and the reliable ground point. **Standard value:0V** Is the voltage normal? →**Yes** To step 7. →**No** Check the K01 starting relay control line; if necessary, replace the electrical box of engine compartment.
7. Check the start signal feedback line.	
	A. Operate the ignition switch to turn the power to OFF state. B. Disconnect the battery negative connector. C. Disconnect the PEPSECU harness plug 126. D. Connect the battery negative terminal. E. Operate the ignition switch to turn the power to ON state. F. Use a multimeter to measure the voltage between terminal 9 of PEPSECU harness plug 126 and the reliable ground point. **Standard value:0V** Is the voltage normal? →**Yes** To step 8. →**No** Check the start signal feedback line for fault; and replace, if necessary.

Test condition	Details/results/measures
8. Check the one-touch start switch.	
	A. Replace the one-touch start switch. Is the troubleshooting successful? →**Yes** Replace the one-touch start switch. →**No** To step 9.
9. Check the PEPS ECU.	
	A. Replace the PEPS ECU. **Refer to: Replacement of PEPS ECU** Confirm that the fault has been ruled out.

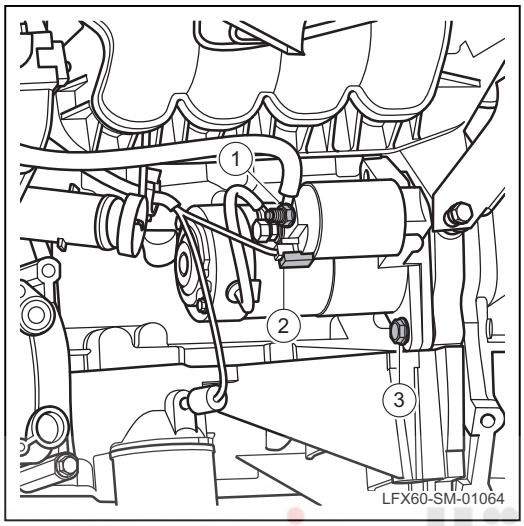
Removal and Installation

Replacement of starter

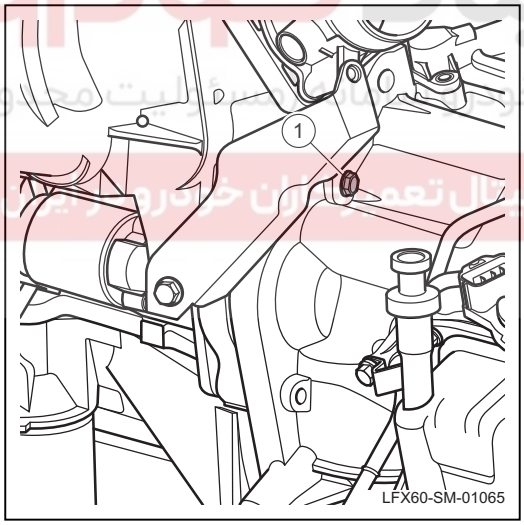
Removal

1. Disassemble the starter.

(a). Disconnect the battery negative terminal.



(b). Remove the starter's power supply fixing bolt 1.
(c). Disconnect the starter harness plug 2.
(d). Remove the starter fixing bolt 3.



(e). Remove the upper fixing bolts on the starter and take the starter assembly.

Installation

1. Install the starter.

(a). The installation sequence is the reverse of the disassembly order.