
ENGINE

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7.1 IGNITION 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) It is prohibited to use short circuit spark test to test ignition function during repair, otherwise it may damage the module.
- (2) During using, do not remove ignition coil from spark plug with bare hands with power on, and do not contact the metal part and rubber guide rod directly, to avoid electric shock.
- (3) Make sure that ground wire of ignition coil assembly is short to the nearest GND separately from ECU and other electrical device to reduce signal interfere as possible.
- (4) Ensure that connector or wire harness has no damage; the wire harness connector is connected correctly. Ensure that wire harness and connector have no short circuit or poor contact.

1.2 Precaution

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

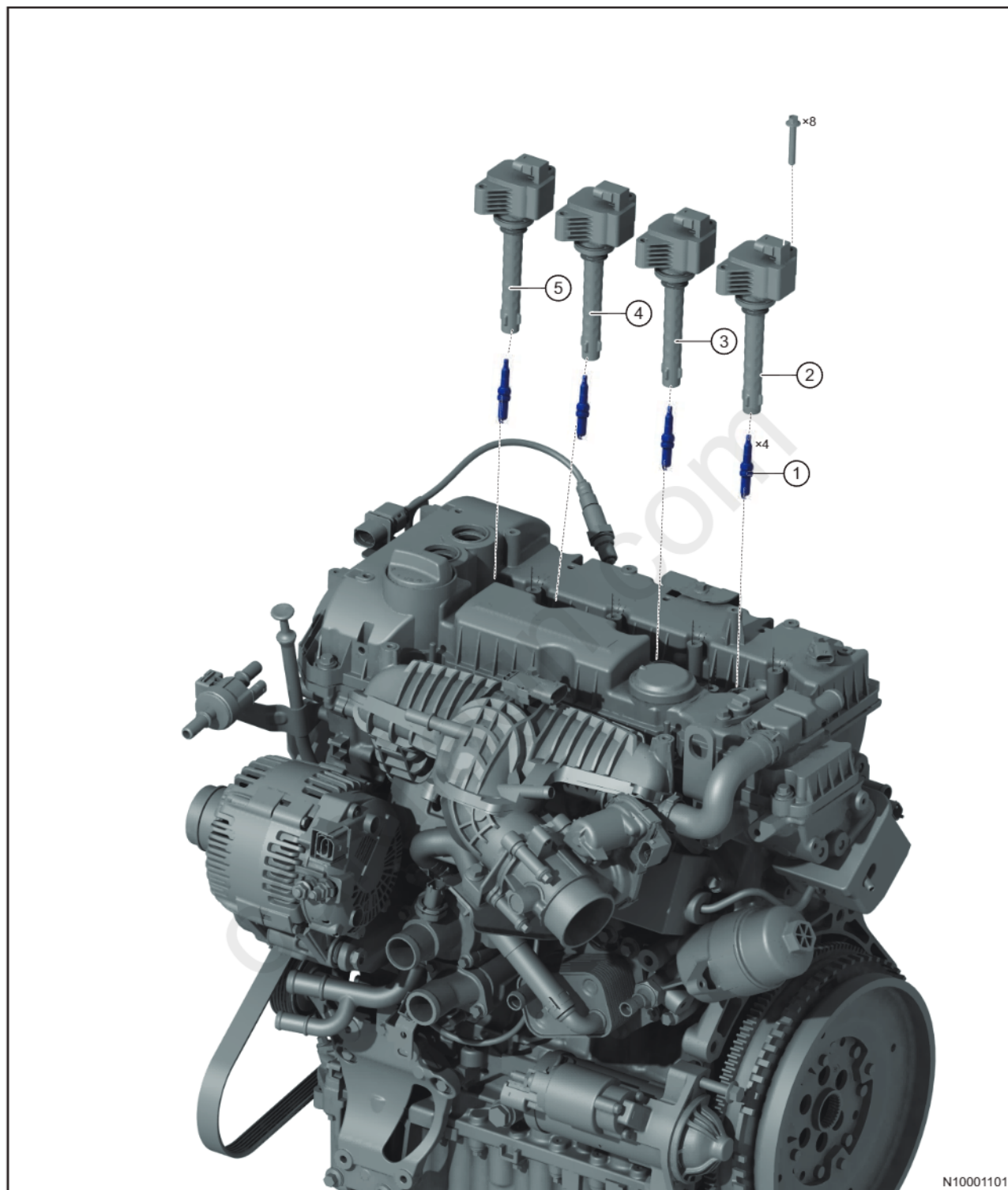
- (1) DO NOT remove the spark plugs when engine is hot; failure to do this may cause damage to the spark plug thread holes on cylinder head.
- (2) When installing spark plug and ignition coil, check if there is impurities in cylinder head mounting holes, and if the inner wall is smooth.
- (3) Do not make paint mark on spark plug assembly ceramic body. If there is paint or other organic mark, it is necessary to clean. Never apply grease such as lubricant and anti-rust oil etc. on spark plug assembly. If so, it is required to clean it.
- (4) Before removal, remove the dirt and foreign matter around ignition coil and ignition coil mounting hole to prevent them from dropping into cylinders.
- (5) After removing or when replacing ignition coil, do not place ignition coil on the ground or other dusty places, otherwise, dust or foreign matter may enter rubber guide and lead to ignition coil failure.
- (6) When replacing spark plug, remove and install ignition coil carefully. Do not rotate ignition coil (avoid scratching rubber guide).
- (7) Do not separate ignition coil rubber guide and ignition coil body. If so, it may cause the decrease of seal performance and fuel gas enter and corrode inner structure when reinstalling.

2 System Overview

2.1 System Description

Ignition system mainly consists of sensors, engine control module, ignition coils (integrated drive module can not be disassembled), spark plugs, etc. Ignition coil integrated drive module uses 4-line coil-on-plug system, and has over current and overtime protection function. The secondary (secondary high-voltage terminal) of each ignition coil is connected to spark plugs in engine cylinder respectively via high-voltage damping anti-interference rubber connecting rod. Ignition coil primary (original low-voltage terminal) is controlled by the internal integrated drive module via the pulse signal command issued by the engine control module (working state: power on, power off). Engine control module receives the top dead center position of each cylinder piston via camshaft position sensor, and uses the speed sensor signal to issue pulse drive command; correct ignition advance angle according to knock sensor signal; make ignition system operate normally.

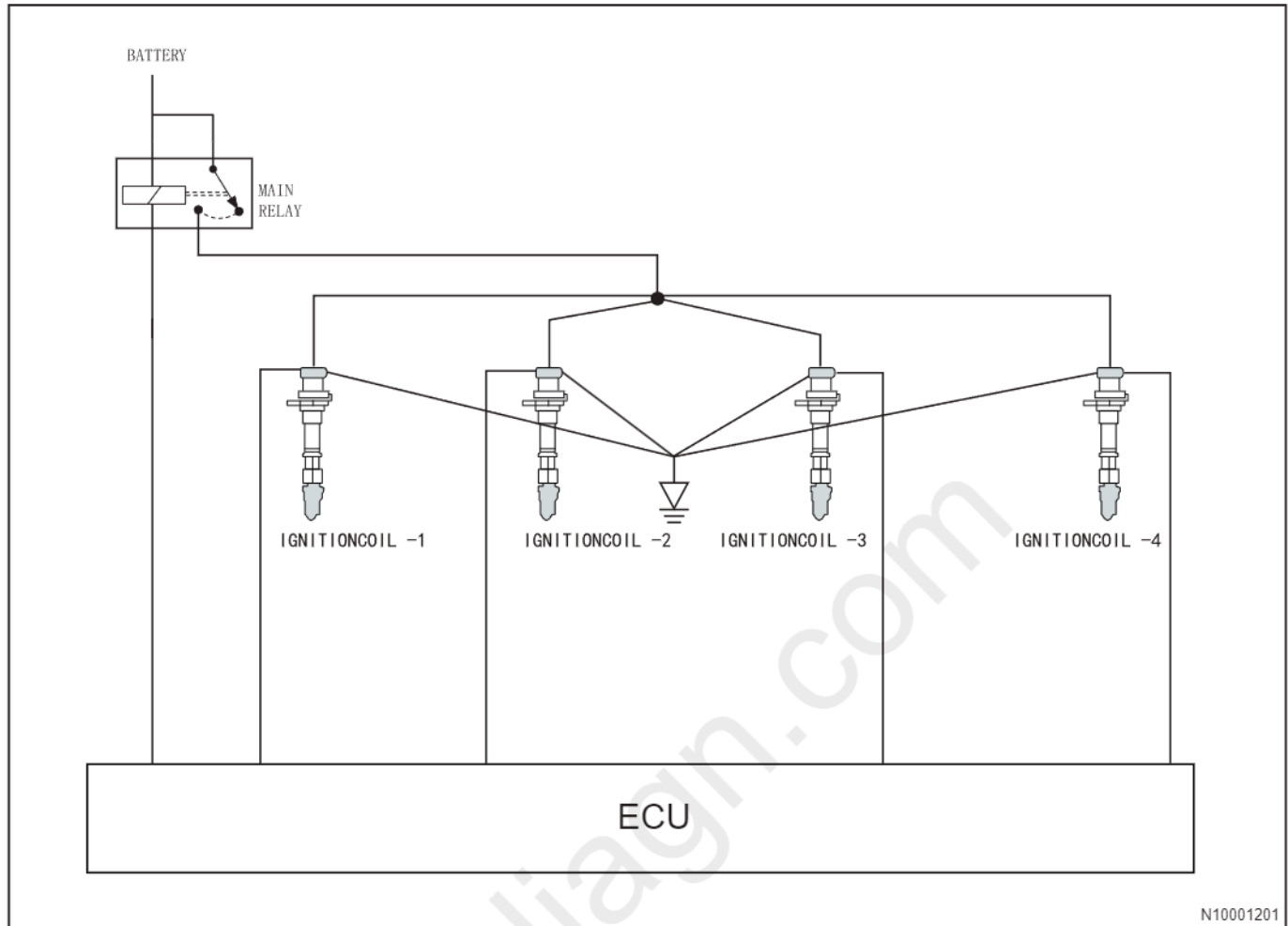
2.2 System Components Diagram



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1	Spark Plug	4	Cylinder 2 Ignition Coil Assembly
2	Cylinder 4 Ignition Coil Assembly	5	Cylinder 1 Ignition Coil Assembly
3	Cylinder 3 Ignition Coil Assembly		

2.3 System Schematic Diagram



3 Component Operation Description

3.1 Ignition Coil

■ Main Function

Ignition coil consists of primary winding, secondary winding, integrated module, iron core and housing etc. When the ground circuit of a primary winding is on, this primary winding starts charging (magnetizing). When ECU cut off pulse signal (high level to low level) circuit, charging (magnetizing) is terminated. At this time, high voltage will be induced in the secondary winding by the magnetic field coupling. In the process of passing the spark plug circuit, the spark plug will discharge (ignition).

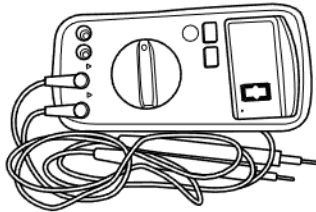
3.2 Spark Plug

■ Main Function

Spark plug consists of wired nut, insulator ceramic body, wired screw, central electrode, side electrode (the side electrode is weld to case) and case. The high-voltage current passes through the center electrode of the spark plug to the side electrode, which forms a circuit. In this process, the high-voltage current break through the air to produce sparks, that is, ignite the combustible mixture in the cylinder.

4 Special Tool and Equipment

4.1 General Tool

Tool Name	Tool Drawing
Digital Multimeter	 S00002

5 Fasteners Torque List

5.1 Torque Specifications

Description	Torque (N·m)
Spark Plug	20 ± 3
Ignition Coil Fixing Bolt	8 ± 3

6 DIAGNOSIS & TESTING

6.1 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.
Ignition System

Symptom	Possible Cause
Stall	Ignition coil
	Camshaft position sensor
	Spark plug
	Intake camshaft phaser control valve
	Exhaust camshaft phaser control valve
	Wire harness
	ECU
Knock	Ignition coil
	Knock sensor
	ECU
Difficult to start	Battery
	Ignition coil
	Spark plug

Symptom	Possible Cause
	Engine speed sensor
Engine hesitation, power drop, unstable performance	Ignition coil
	Intake camshaft phaser control valve
	Exhaust camshaft phaser control valve
	Engine speed sensor
	Spark plug
	Camshaft position sensor
	ECU

6.2 Spark Plug Common Problems

■ Normal

Spark plug porcelain small end is between white and yellowish, gray or brownish. Air-fuel ratio and ignition time are normal, there is no misfire, and cold-start enriching function is normal.

■ Carbon Accumulation

A layer of velvety black charcoal smoke attaches on the insulator small end, electrode and spark plug body		
Cause	Result	Treatment
Mixture is excessively rich due to improper adjustment of air fuel mixture.	Poor starting ability	Check air filter and adjust air-fuel ratio and cold starting system.
Traveling distance of vehicle is too short, engine temperature is low, and combustion is incomplete.		
Fuel quality is poor or fuel deteriorates, fuel is abnormal.		
Spark plug type is incorrect.		

■ Oil Dirt

A layer of black oily charcoal smoke and dirt attach on the insulator small end, electrode and spark plug body		
Cause	Result	Treatment
Piston ring has bad elasticity or is worn excessively, and oil breaks into combustion chamber.	Difficult to start	Check and repair engine, or replace spark plug.
Excessive matching clearance between piston skirt and cylinder wall causes oil breaking and air leakage.		
Air leakage occurs due to incorrect installation of piston ring in direction of inside and outside tangent angle, causing oil breaking into combustion chamber.		
Excessive clearance occurs between valve stem and valve guide due to excessive wear, or valve guide oil seal fails, causing oil leakage.		

A layer of black oily charcoal smoke and dirt attach on the insulator small end, electrode and spark plug body

Oil level is too high and oil breaks into combustion chamber.

■ Lead Deposits

Brownish yellow enamels or greenish deposits exist on the insulator small end

Cause	Result	Treatment
The fuel additive contains lead, when engine runs under high load conditions with throttle partially opened for a long time, enamel is formed.	Causing misfire	Replace spark plug.

■ Red Deposits

There are severe red brown deposits on insulator skirt and electrodes, and clear radial discharge traces can be seen on the surface of insulator small end

Cause	Result	Treatment
In the unleaded gasoline, Mn-based anti-riot agent MMT is used instead of lead tetraethyl, the oxide of Mn after combustion adheres on the surface of insulator and electrode.	At high temperature, these deposits are easily conductive, resulting in flashover on insulator skirt surface, unstable combustion, high engine speed, and jitter under heavy load conditions.	Use qualified fuel, replace spark plug.

7 ON-VEHICLE SERVICE

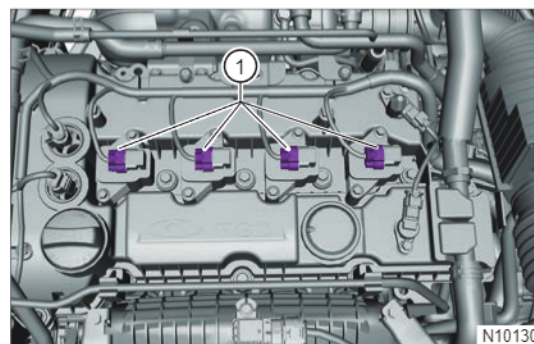
7.1 Ignition Coil Assembly

■ Removal

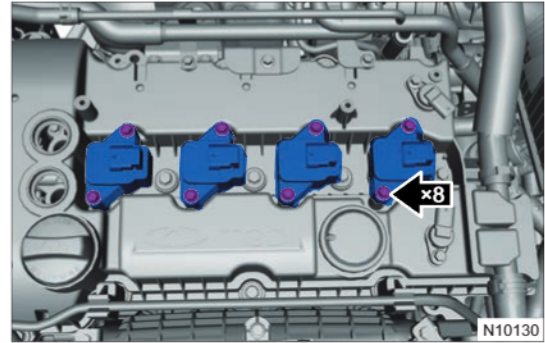
⚠ Warning

- Appropriate force should be applied, when removing ignition coil assembly. Be careful not to operate roughly.
- It is prohibited to use short circuit spark test to test ignition function during repair, otherwise it may damage the module.
- During using, do not remove ignition coil from spark plug with bare hands with power on, and do not contact the metal part and rubber guide rod directly, to avoid electric shock.

- (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) Disconnect the ignition coil connectors (1), and move away the wire harness from ignition coil.



- (6) Remove 8 fixing bolts from ignition coil assembly.



- (7) Remove the ignition coil assembly.

⚠ Caution

- After removing ignition coil, do not place ignition coil on the ground or other dusty places, otherwise, dust or foreign matter may enter rubber guide and torsion ignition coil failure.
- Remove ignition coil carefully. Do not rotate ignition coil (avoid scratching rubber guide).
- Do not separate ignition coil rubber guide and ignition coil body. If so, it may cause the decrease of seal performance and air oil enter and corrode inner structure when reinstalling.

■ Inspection

⚠ Caution

- It is prohibited to use short circuit spark test to test ignition coil performance, otherwise it may cause damage to electronic controller.
- During inspection, do not remove ignition coil from spark plug with bare hands with power on, and do not contact the metal part and rubber guide rod directly, to avoid electric shock.

Terminal	Terminal Definition
1	Power supply
2	Ground
3	Ground
4	Pulse drive signal

- (1) Use a digital multimeter to measure if ignition coil power supply/ground is normal.
- (2) Use LED test light to measure the pulse drive signal of ignition coil and observe if LED test light flashes.
- (3) The ignition coil assembly can be exchanged for each cylinder to judge if the ignition coil assembly is in good condition.

■ Installation

⚠ Caution

- Make sure that ground wire of ignition coil assembly is short to the nearest GND separately from ECU and other electrical device to reduce signal interfere as possible.
- Ignition coil assembly rubber guide rod end is applied with specified grease of its self, which can help in assembly of ignition coil assembly and spark plug assembly. Do not remove it arbitrarily.
- Make sure that the connection of ignition coil high-voltage output terminal and spark plug is reliable, or it may cause high-voltage leakage, resulting in poor ignition.
- Before installation, check the mounting hole of cylinder head spark plug, and no impurities can be brought in during assembly.
- Install the ignition coil into cylinder head cover mounting hole and press it to close to mounting boss on cylinder head cover. Never turn ignition coil to left/right after pressing and do not tap ignition coil with a hammer etc.
- To prevent accidental scratches to ignition coil assembly, do not allow sharp edge to contact with rubber guide rod under ignition coil assembly during installation.

- (1) Install 8 fixing bolts on ignition coil assembly.

Torque: $8 \pm 3 \text{ N}\cdot\text{m}$

- (2) Connect the ignition coil assembly connector.
- (3) Install the engine trim cover.
- (4) Install the engine compartment trim cover assembly.

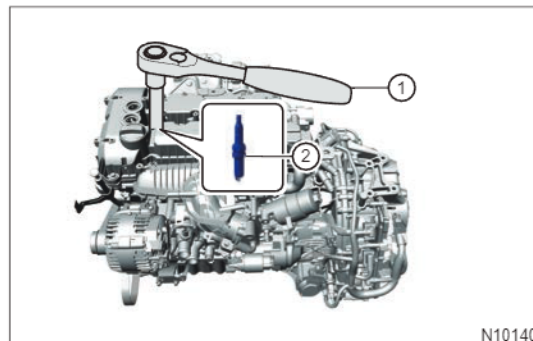
7.2 Spark Plug Assembly

■ Removal

⚠ Warning

- Be sure to wear necessary safety equipment to prevent accidents, when removing spark plug.
- Appropriate force should be applied when removing spark plug. Be careful not to operate roughly.
- DO NOT remove the spark plugs when engine is hot; failure to do this may cause damage to the spark plug thread holes on cylinder head.
- Before removal, remove the dirt and foreign matter around spark plug holes to prevent them from dropping into cylinders.

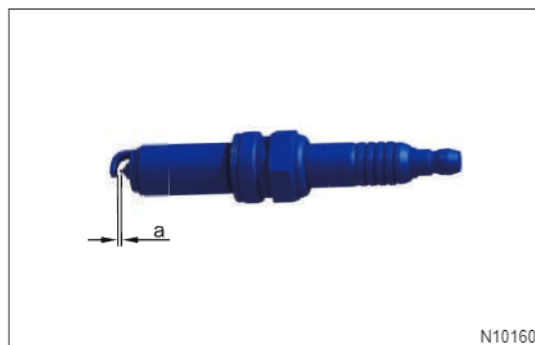
- (1) Turn off all electrical equipment and ENGINE START STOP switch.
- (2) Remove the engine compartment trim cover assembly.
- (3) Disconnect the negative battery cable.
- (4) Remove the engine trim cover.
- (5) Remove the ignition coil assembly.
- (6) Using a special spark plug socket ratchet wrench (1), loosen the spark plug.
- (7) Remove the spark plug (2).



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■ Inspection

- (1) Check the spark plug gap a: 0.7 - 0.8 mm
 - It is not necessary to adjust the gap.



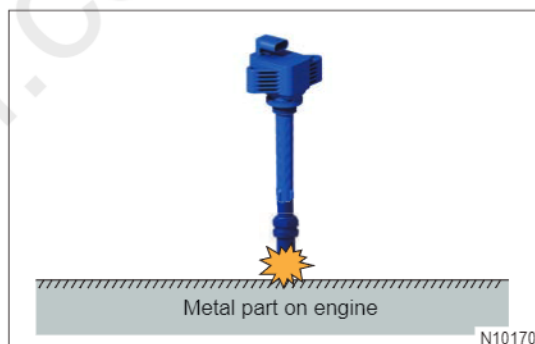
■ Spark Jump Test Method

- (1) Remove the spark plug from engine and connect it to ignition coil, put the spark plug case 5 - 7 mm away from engine body and start vehicle to check the spark jump.

⚠ Warning

- **Always disconnect the injector circuit before test to avoid injection during spark jump test.**

- (2) If there is a thick spark with blue-white color and popping occurs between spark plug and engine body and also spark generated between center electrode and side electrode, that indicates ignition system is normal.



- (3) If the spark is red and short or there is no spark, check ignition coil wire and ECU.

■ Installation

⚠ Caution

- Check the spark plug type to confirm if it is suitable.
- Check if there is impurities in cylinder head mounting holes, the inner wall is smooth.
- Do not make paint mark on spark plug assembly ceramic body. If there is paint or other organic mark, it is necessary to clean. Never apply grease such as lubricant and anti-rust oil on spark plug assembly. If so, it is required to clean it.
- Please install spark plug with a special spark plug socket, and never damage the normal spark plug gap.
- Avoid to install the spark plug from higher position from mounting hole during installation to prevent spark plug side electrode gap from damaging, resulting in poor ignition.
- Always tighten the spark plug according to specified torque using a torque wrench when installing it.

- (1) Install 4 spark plugs respectively into the cylinder head mounting holes for pre-tightening tighten, and then retighten the spark plugs with a torque wrench.

Torque: $20 \pm 3 \text{ N}\cdot\text{m}$

- (2) Install the ignition coil assembly.
- (3) Install the engine trim cover.
- (4) Install the engine compartment trim cover assembly.

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