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0302 UAES Engine Management System

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1 General Information

1.1 Overview

Engine SQR477F applies the M7-Motronic engine management system to control the closed-loop control unit, the sequential fuel injection, the distributorless group direct ignition and the three-way catalytic converter aftertreatment.

The MT80 engine management system mainly consists of three parts: electronic control module (ECM), sensor and actuator. The sensor is used to detect the physical signals (temperature, pressure, speed, etc.) of the vehicle, convert them to voltage signals and send them to the ECM. The ECM calculates and analyzes the electric signal data input by the sensor according to the preset program after receiving them, and then sends the corresponding control command to the power drive circuit. The power drive circuit will drive each actuator to perform according to the command, thus enabling the engine to run efficiently and smoothly.

The fault diagnosis system of the engine electronic control module (ECM) is used to monitor every sensor and controller in the system randomly. If detecting and confirming a fault signal, it will store the relevant fault code and activate the "Limp Home" function to run the engine. If detecting that the fault has been eliminated, it will reactivate the normal engine function.

Functions of the engine management system

Intake air pressure/temperature sensor control:

1. Engine torque output control
2. Sequential fuel injection closed-loop control
3. Ignition timing and emission control
4. Knock control
5. Idling control
6. A/C control
7. Cooling fan control
8. Carbon canister solenoid valve control
9. System self-diagnosis
10. ECM anti-theft control
11. Built-in ignition drive module of ECM, distributorless group direct ignition

Features of ECM in the engine management system

1. ECM developed by the high-end market
2. Latest electronic hardware technology
3. 16-bit CPU, 40MHz clock frequency and 768k cache
4. New modularized software and hardware structure with high portability
5. Meeting the Euro IV emission standards and the EOBD (European On-Board Diagnostics) technology

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1.2 System functions

Calculation of air flow by engine aerothermodynamics

The ECM calculates the air flow and air mass entering the cylinder via signals of the intake air pressure/temperature sensor, and then corrects the injection volume to make the air-fuel ratio meet the requirements of various conditions.

Torque control

The ECM estimates the current torque output required by the engine according to signals of the accelerator pedal position sensor, and controls the engine torque output via sensor information.

Measurement of crankshaft position and engine speed

The ECM determines the crankshaft position and the engine speed according to signals from the 58X ring gear, and accurately controls the engine ignition and the injection timing.

Determination of working sequence of engine cylinders

The ECM recognizes the top dead center of one cylinder via the camshaft position sensor, so as to determine the working sequence of engine cylinders.

Fuel control

There are two modes of fuel control: closed-loop fuel control and open-loop fuel control. The closed-loop fuel control can accurately regulate engine's air-fuel ratio, thus effectively controlling emissions. The open-loop fuel control is applied when the engine is starting or warming up or the oxygen sensor is malfunctioning.

Ignition control

The ignition control system of the engine applies group control.

Knock control

When a knocking is detected by the knock sensor, the system will calculate the ignition advance angle that needs to be delayed or advanced according to the current condition and knock intensity, and adjusts it to the proper ignition angle, thus avoiding or reducing knocking.

Emission control

The three-way catalytic converter can convert the engine exhaust into harmless gas and discharge it to the air. When the engine reaches the normal temperature after warming up, the ECM will activate the closed-loop fuel control to correct the air-fuel ratio, thus realizing the optimum conversion efficiency of the three-way catalytic converter.

Three-way catalytic converter protection

The engine management system has the function to protect the three-way catalytic converter. The ECM estimates the temperature of the three-way catalytic converter according to engine's operation. When it is estimated that the exhaust temperature will exceed converter's maximum permissible temperature for a long time, the ECM will automatically activate the function of three-way catalytic converter protection to keep it at a normal temperature.

System voltage protection

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When the charging system malfunction causes an excessive system voltage, the engine electronic control system will activate the protection program to limit the engine speed, thus avoiding damage to ECM and battery.

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1.3 System control logic

Start control

When starting the engine, special calculation method shall be taken to control the air intake, injection volume and ignition timing. Before starting the engine, the throttle is closed; the air in the intake manifold is static; the internal pressure of the intake manifold equals the atmospheric pressure; and the idling regulator uses the initial fixed parameter.

Soon after the engine starts, the control signal of the injection timing is the initial pulse signal. The fuel injection volume increases gradually with the temperature increase of the engine, causing the oil film to form on the intake manifold and cylinder walls. Before the engine reaches a certain speed, a rich mixture will be used in the cylinder.

When the engine reaches a certain speed and temperature, the system will gradually reduce the injection volume and use a flammable lean mixture. When the engine starts, the ignition advance angle will also be adjusted according to the engine's operation and will change with the engine temperature, intake temperature and engine speed.

Warming up and heating control of the three-way catalytic converter

When the engine starts from cold, the air intake, injection volume and ignition timing will accord with the starting mode. The high torque of the engine will be compensated though increasing the injection volume and adopting fixed ignition timing, until the engine reaches a certain temperature. After the engine starts normally, the three-way catalytic converter is required to be warmed up quickly to reach the operating temperature, thus reducing the exhaust emissions significantly. Therefore, the engine electronic control system will delay the ignition advance angle properly, and use the high-temperature exhaust to heat the three-way catalytic converter.

Fuel cut-off control when accelerating/decelerating

When accelerating, a small portion of fuel injected into the intake manifold by the injector can not reach the cylinder in time for combustion, thus forming a layer of oil film on the intake manifold wall. With the increase of engine load and injection volume, the oil film in the intake manifold will get more and more. When the throttle opening increases, some injected fuel will be absorbed by the oil film. Therefore, the injection volume must be increased to compensate the concentration of the mixture, preventing the flammable mixture from becoming lean when accelerating. In addition, when the throttle opening and the engine load decrease, the fuel on the intake manifold wall will be released to the cylinder. So the injection volume shall be reduced when decelerating.

When decelerating, the power at the flywheel provided by the engine is negative. In this case, the injector is cut off to reduce the fuel consumption and exhaust emission, especially to protect the three-way catalytic converter.

When the engine speed reduces to a speed higher than the idling speed, the injection system will start injecting fuel again. In fact, the engine electronic control system program will provide fuel again to keep the engine running according to the changes of engine temperature and engine speed, thus preventing the engine speed from becoming lower than the specified value. When the injection system provides fuel again, the system will use the initial pulse control signal to supply fuel and forms oil film on the intake manifold wall, enabling the engine to smoothly shift to the normal idling operation.

Idling control

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When idling, the engine does not provide torque to the flywheel. To ensure the steady running of the engine at an idling speed as low as possible, the closed-loop idling control system must maintain the balance between the torque and engine power. Certain power is generated to meet the needs for various loads, such as the load needed to overcome the internal friction of engine crankshaft and valve train.

The closed-loop idling control of the M7 system determines the engine torque output needed to maintain the idling speed under certain operation conditions. The torque output increases when the engine speed decreases, and decreases when the engine speed increases. The system will increases the engine torque to respond to the new "interference factor", such as switching on the air conditioner compressor or shifting by automatic transaxle. When the engine temperature is low, the torque will also be increased to overcome the friction of internal parts and maintain the idling speed. All of the torque output requirements will be calculated by the torque input adaptor so as to obtain the corresponding air intake, air-fuel ratio and ignition timing.

λ closed-loop control

The three-way catalytic converter can efficiently reduce 98% of harmful elements in the exhaust, such as HC, CO and NO_x, and converts them to water, CO_2 and N_2. However, the three-way catalytic converter can reach the above efficiency only when the engine excess air factor λ is approximately 1. The purpose of the λ closed-loop control is to ensure that the mixture concentration is within the range.

The λ closed-loop control system works only when equipped with the oxygen sensor. The oxygen sensor is installed on the three-way catalytic converter and can detect the oxygen content in the exhaust at any time. When the mixture is lean ($\lambda > 1$), the oxygen sensor will output the signal voltage of about 100 mV to BCM. When the mixture is rich ($\lambda < 1$), the oxygen sensor will output the signal voltage of about 800 mV. When the engine is running, the signal voltage of the oxygen sensor may vary between 100 mV and 800 mV; and the closed-loop control will correct the injection volume and control the exhaust emissions according to the signal voltage.

Evaporation and emission control

Due to the outside temperature and heat produced by the fuel pump, the fuel in the fuel tank will be heated and generate fuel vapor. The fuel vapor is not allowed to be discharged to the atmosphere directly. It is collected and stored in the activated carbon canister by the guide tube, and sent to the engine for combustion at a proper time. The ECM controls the carbon canister solenoid valve so as to control the fuel vapor volume entering the cylinder, which is performed only under the closed-loop control.

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1.4 Product specifications

Torque specifications

Item	Data (N•m)
Crankshaft position sensor	8±2
Camshaft position sensor	8±2
Knock sensor	20±5
Intake air pressure/temperature sensor	6±1
Throttle position sensor	2±0.5
Coolant temperature sensor	22±2
Ignition coil	6±1
Oxygen sensor	45±5
Idling stepper motor	7±1

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1.5 Failures of engine management system input and output devices

No.	Component	Symptoms	Maintenance recommendations
1	Crankshaft position sensor	• Engine start failure • Frequent engine flameout • Sporadic flameout • Maximum engine speed of less than 3800 rpm	Replace the crankshaft position sensor
2	Camshaft position sensor	• Engine start failure • Maximum engine speed of less than 4000 rpm • Increased fuel consumption	Replace the camshaft position sensor
3	Knock sensor	• Knocking when accelerating • Incorrect ignition timing • Increased fuel consumption • Inadequate engine power	Replace the knock sensor
4	Intake air pressure/temperature sensor	• High fuel consumption • Frequent engine flameout • Rough idling • Poor engine performance	Replace the intake air pressure/temperature sensor
5	Throttle position sensor	• Engine flameout when accelerating • Increased fuel consumption • Engine flameout at high speed	Replace the throttle position sensor
6	Coolant temperature sensor	• Engine start difficulty • Rough idling • Disabled cooling fan • Poor engine performance • Incorrect ignition timing	Replace the coolant temperature sensor
7	Oxygen sensor	• Improper air-fuel ratio and high exhaust emission • High fuel consumption	Replace the oxygen sensor
8	A/C pressure switch	• Excessive cooling temperature and poor cooling effect when the A/C is on	Replace the A/C pressure switch

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No.	Component	Symptoms	Maintenance recommendations
		• Disabled magnetic clutch relay when the A/C is on	
9	Power steering switch	• Engine vibration when turning the steering wheel at idling • Disabled engine compensation and frequent flameout when idling	Replace the power steering switch
10	Brake lamp switch	• Unsmooth fueling • Vehicle hesitation	Replace the brake lamp switch
11	Idling stepper motor	• Excessive engine start time • Engine starts only when the accelerator pedal is depressed • Engine flameout when idling • High idling speed • No idling speed	Clean and replace the idling stepper motor
12	Ignition coil	• Engine start failure • Inadequate engine power and disabled acceleration • Incomplete combustion • Unstable engine operation	Replace the ignition coil
13	Carbon canister solenoid valve	• Poor idling • Incorrect air-fuel ratio	Replace the carbon canister solenoid valve
14	Injector	• Engine start failure or difficulty • Unstable engine operation and vibration • Frequent engine flameout • Black smoke in emissions • Inadequate engine power and disabled acceleration	Replace the injector
15	Fuel pump	• Engine start failure • Inadequate engine power and disabled acceleration • Engine start difficulty • Poor acceleration	Replace the fuel pump

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No.	Component	Symptoms	Maintenance recommendations
16	Cooling fan	• Excessive engine coolant temperature • Intermittent operation of the air conditioner • Low engine coolant temperature	Replace the cooling fan

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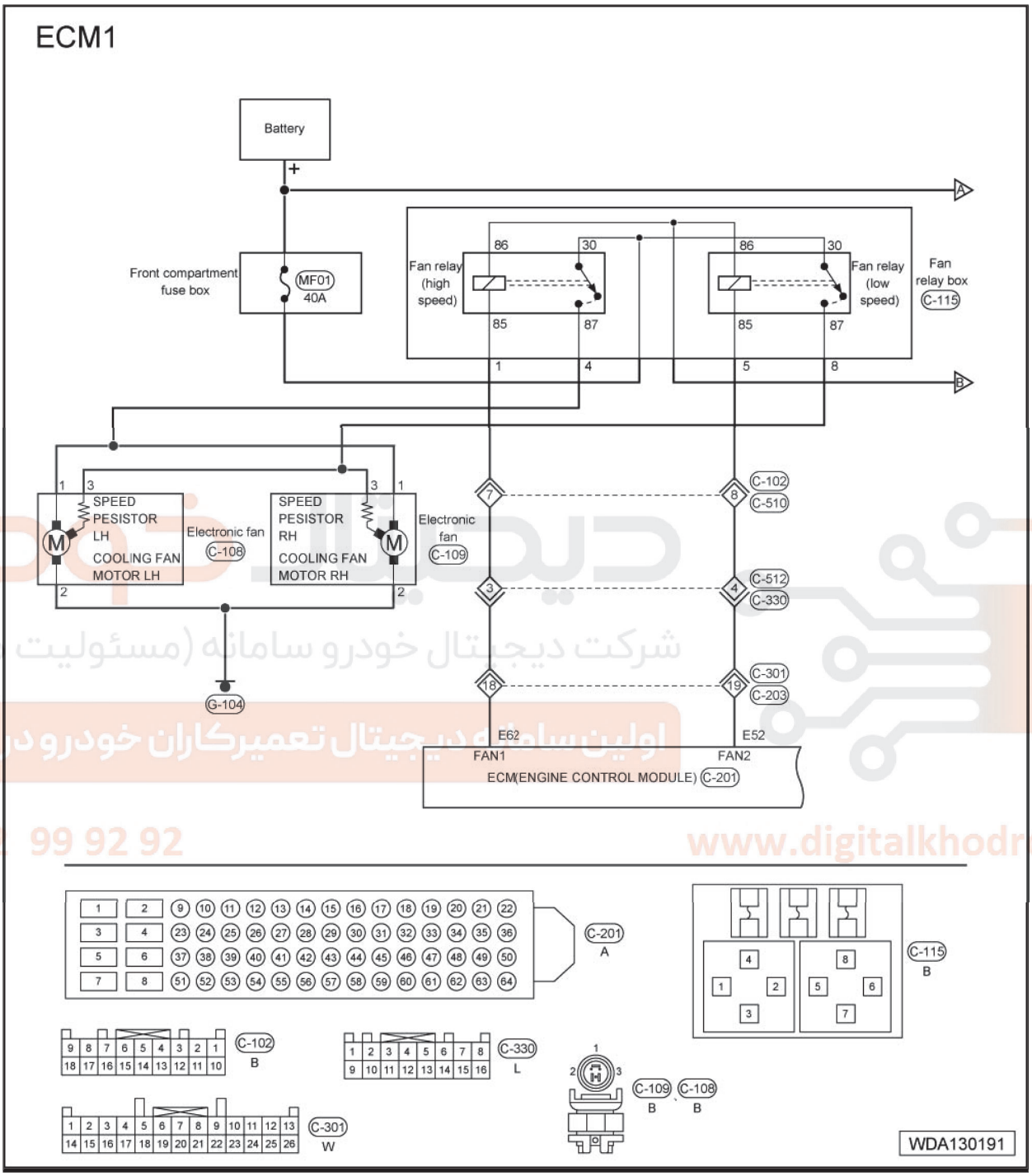
1.6 Circuit diagram of UAES engine management system

Engine circuit diagram (page 1)



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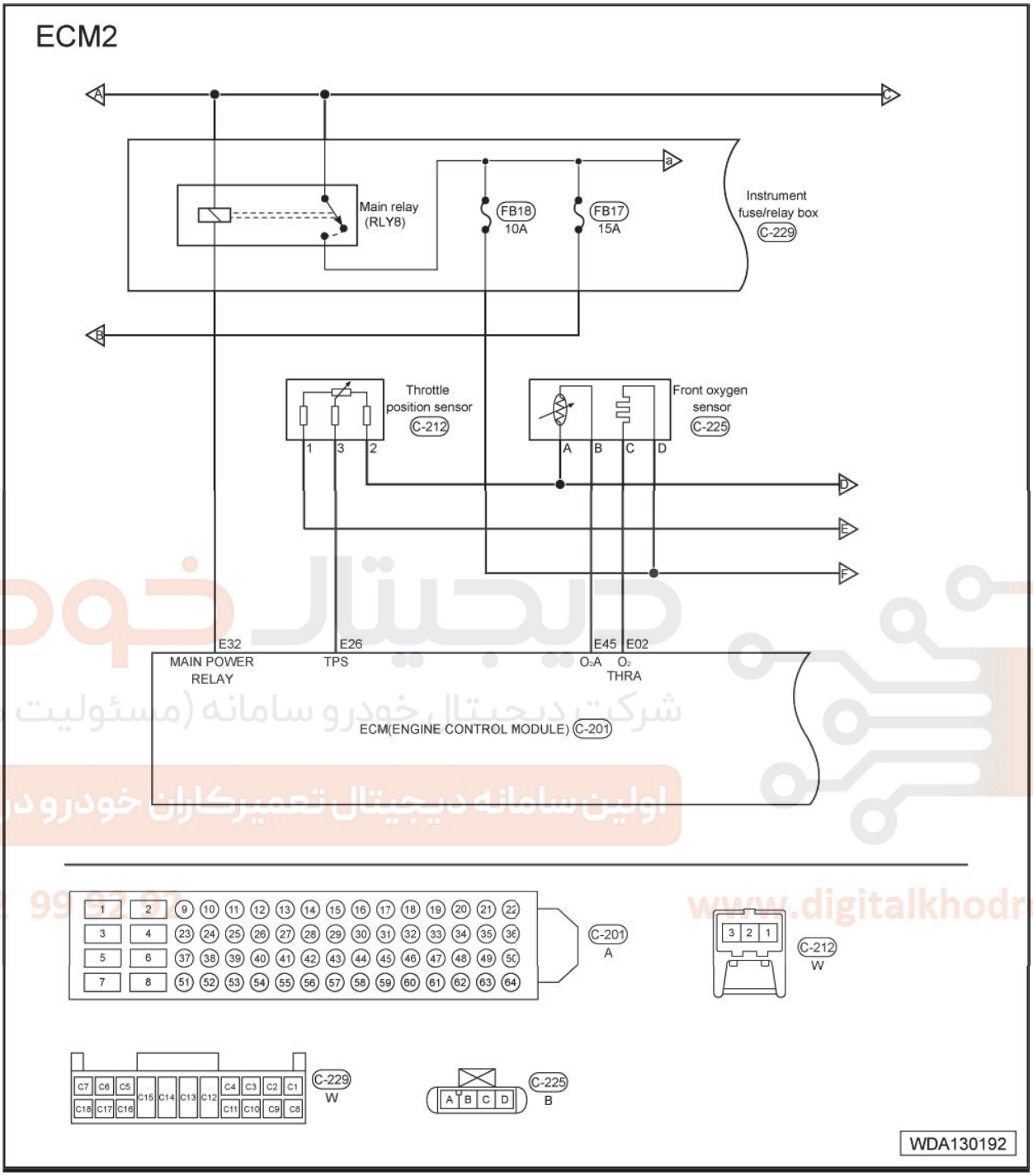
Engine circuit diagram (page 2)



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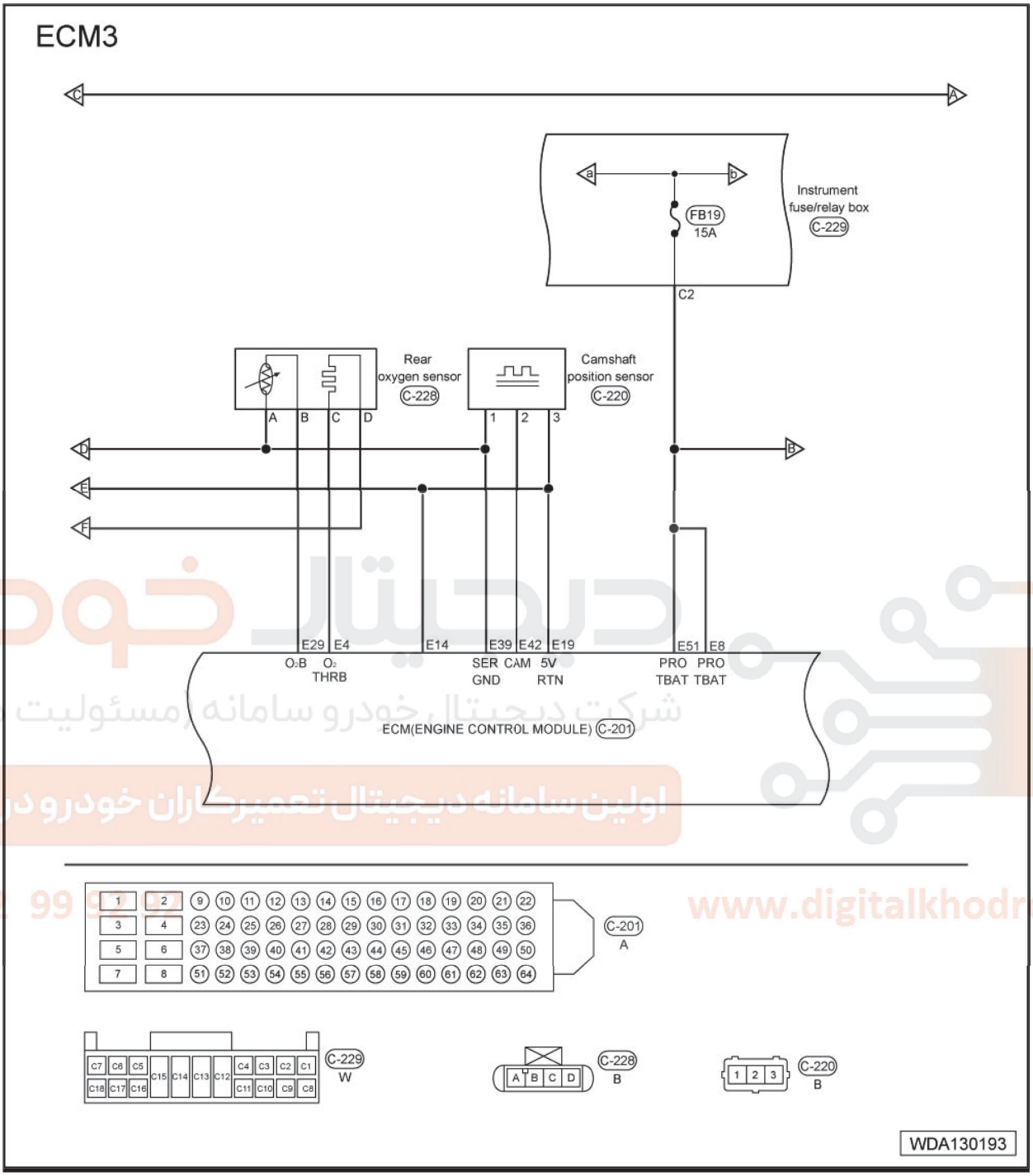
Engine circuit diagram (page 3)



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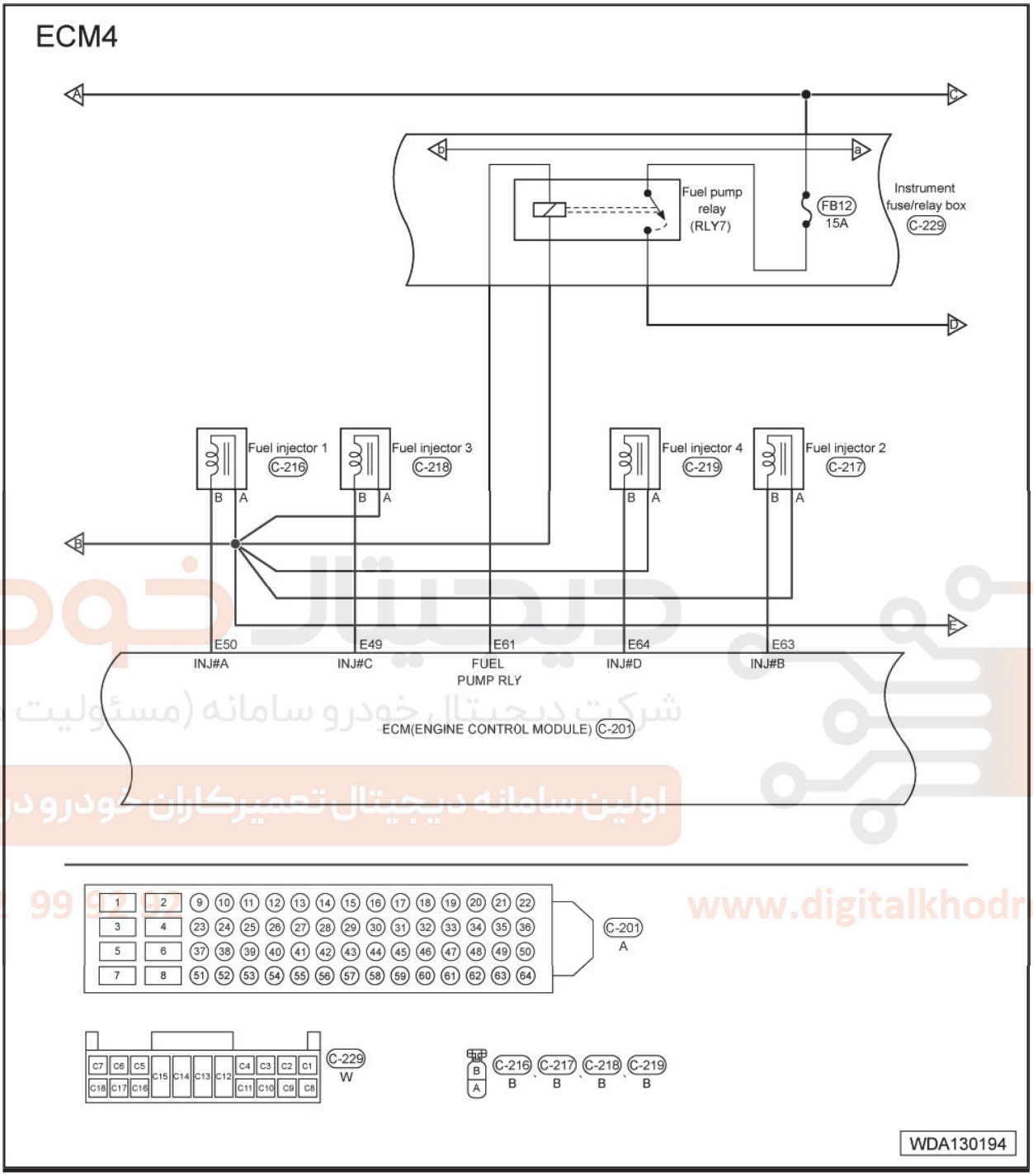
Engine circuit diagram (page 4)



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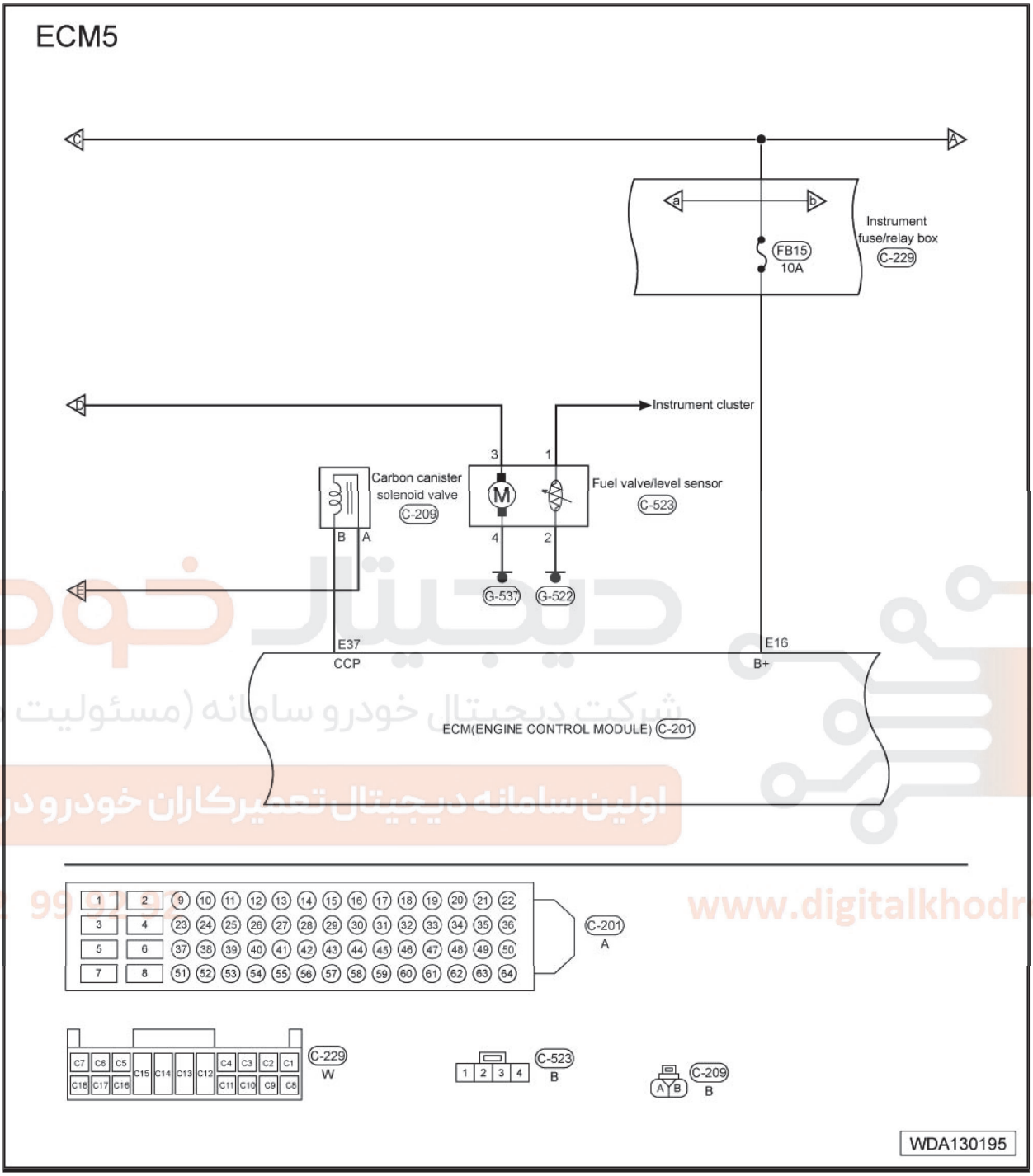
Engine circuit diagram (page 5)



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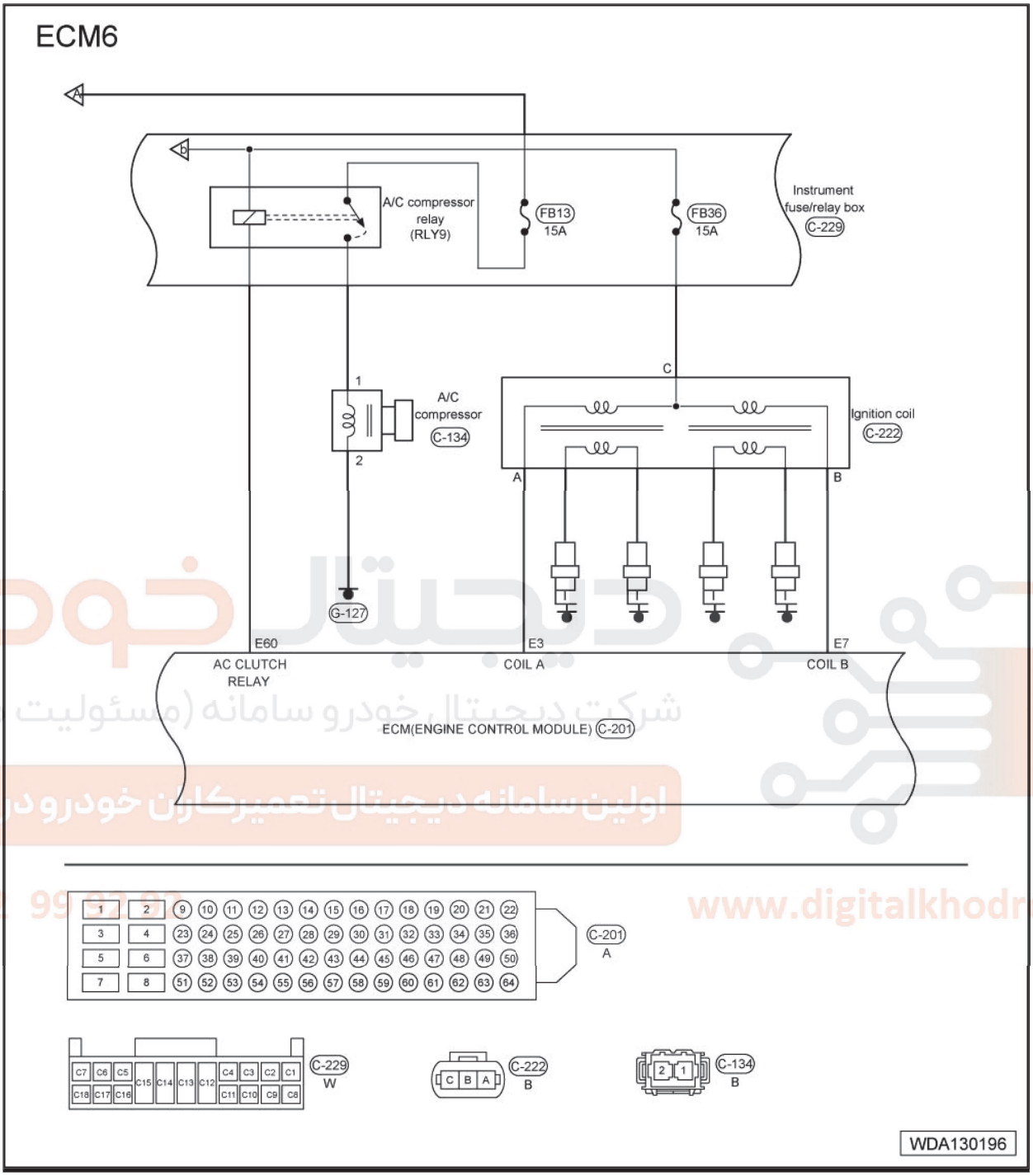
Engine circuit diagram (page 6)



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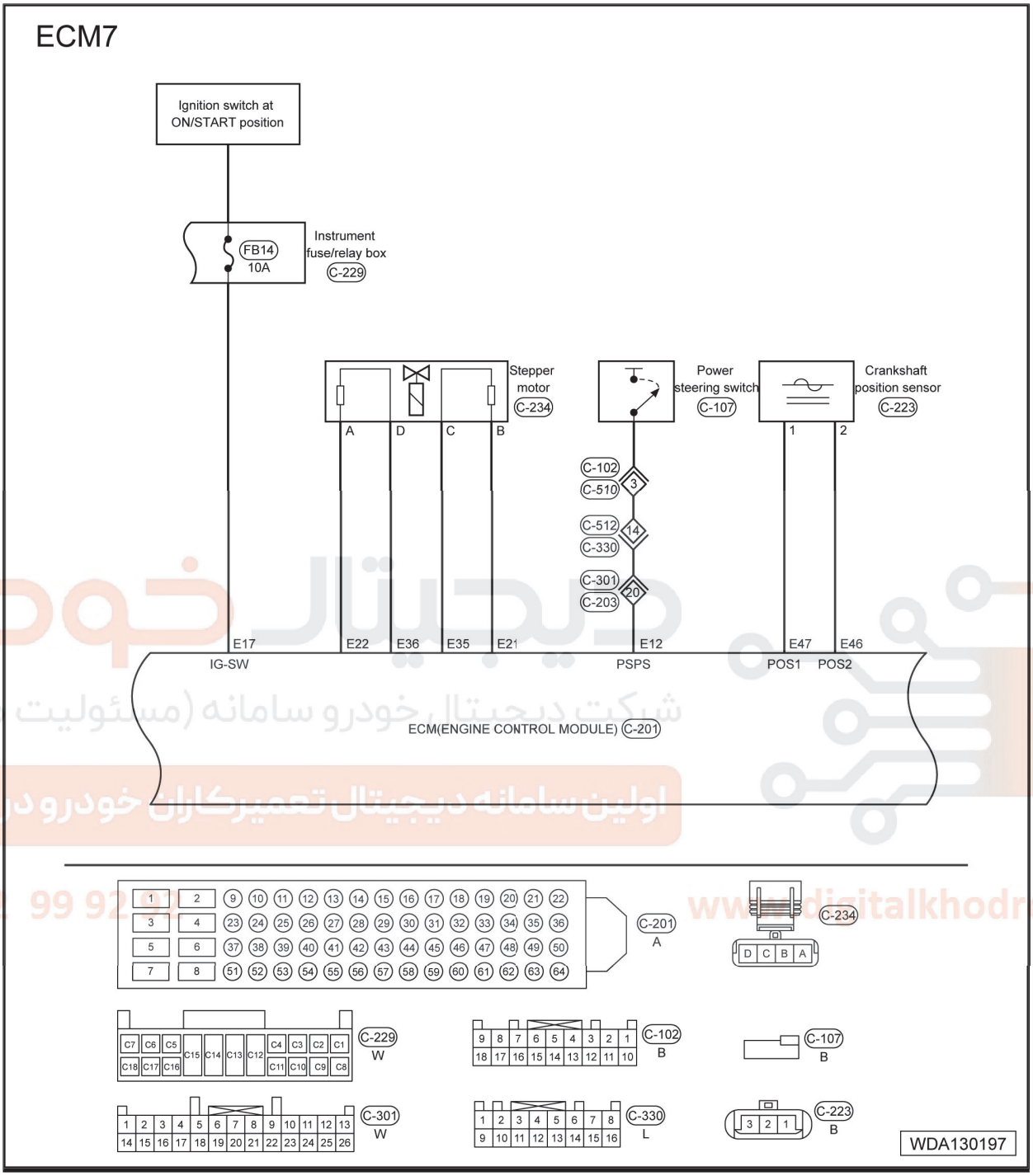
Engine circuit diagram (page 7)



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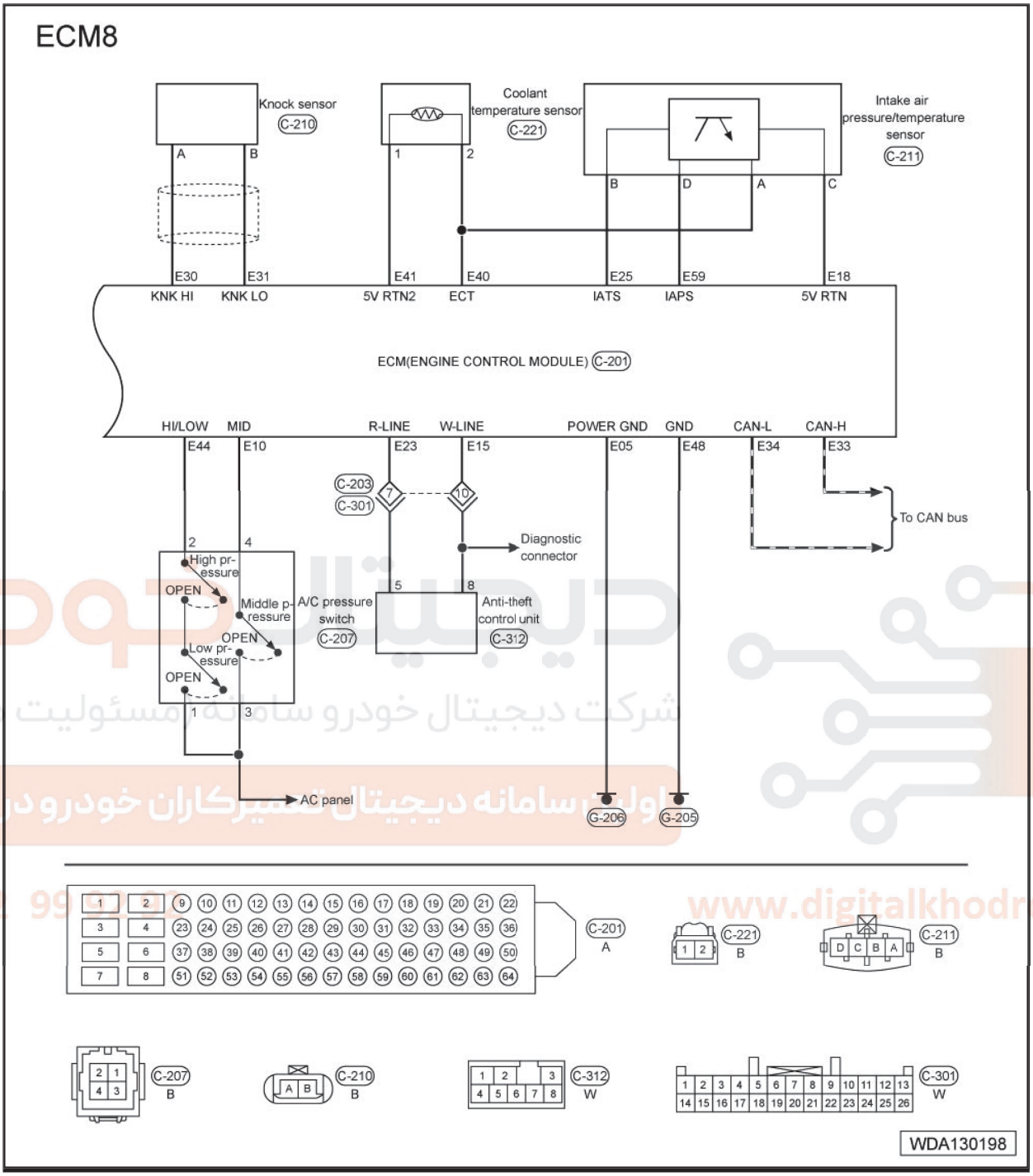
Engine circuit diagram (page 8)



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2 Diagnosis and Inspection

2.1 Diagnosis and troubleshooting of sporadic faults

Diagnosis and inspection of sporadic DTC faults

If the sporadic DTC faults occur, please check the following items:

- Check if the connector of the DTC-related actuator or sensor is properly installed.
- Check the connector pins of the actuator or sensor for leakage and corrosion.
- Check the leads for bending or squeezing.
- Check the sensor for dirt or damage.
- Check if the routing of wire harness is correct and proper.

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2.2 Checking earth connection

A good earth connection is prerequisite for ensuring the normal operation of the circuit. If the earth terminal of the circuit is always exposed to the wet and dusty environment, the metal of the earth terminal will corrode and affect the circuit smoothness, thus causing various electrical system malfunctions. As the control circuit is very sensitive, the loosened or corroded wires may significantly affect the transmission of various signals in the electronic control circuit. Therefore, please note the followings when inspecting:

- Replace the earth bolts or nuts.
- Check the earth terminal and coil for corrosion.
- Clean and polish the earth terminal and coil when necessary to ensure good contact.
- Check if there is any accessory interfering with the earth circuit.

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2.3 Self-learning process of the idling stepper motor

If the following occurs, please perform self-learning on the idling stepper motor:

1. Remove the battery and disconnect the battery negative terminal.
2. Replace the engine control module.
3. Replace or clean the idling stepper motor.

Conditions of stepper motor self-learning:

1. The battery voltage is within the normal range.
2. The engine stops.
3. The throttle is fully closed.
4. The engine has no fault and fault code.
5. The engine performance is normal.

Methods of idling stepper motor self-learning:

1. Do not start the engine immediately after switching on the ignition switch. Wait for 5 seconds and then start the engine. If poor idling is detected at this time, repeat the above procedures until the engine idles steadily.

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2.4 DTC diagnosis list

No.	Fault code	Description
1	P0016	Crankshaft position-camshaft position correlation
2	P0030	Front oxygen sensor heater control circuit open circuit
3	P0031	Front oxygen sensor heater control circuit short to ground
4	P0032	Front oxygen sensor heater control circuit short to power
5	P0036	Rear oxygen sensor heater control circuit open circuit
6	P0037	Rear oxygen sensor heater control circuit short to ground
7	P0038	Rear oxygen sensor heater control circuit short to power
8	P0053	Improper front oxygen sensor heater resistance
9	P0054	Improper rear oxygen sensor heater resistance
10	P0105	No signal change in the intake air pressure sensor (frozen)
11	P0106	Improper intake air pressure sensor
12	P0107	Intake air pressure sensor short to ground
13	P0108	Intake air pressure sensor short to power
14	P0112	Intake air temperature sensor signal low input
15	P0113	Intake air temperature sensor signal high input
16	P0116	Improper engine coolant temperature sensor
17	P0117	Engine coolant temperature sensor circuit low input
18	P0118	Engine coolant temperature sensor circuit high input
19	P0122	Throttle position sensor circuit low input
20	P0123	Throttle position sensor circuit high input
21	P0130	Improper front oxygen sensor signal
22	P0131	Front oxygen sensor signal low voltage
23	P0132	Front oxygen sensor signal high voltage
24	P0133	Front oxygen sensor slow response

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No.	Fault code	Description
25	P0134	Front oxygen sensor circuit signal failure
26	P0136	Improper rear oxygen sensor signal
27	P0137	Rear oxygen sensor signal low voltage
28	P0138	Rear oxygen sensor signal high voltage
29	P0140	Rear oxygen sensor circuit signal failure
30	P0170	Improper fuel trim
31	P0171	Fuel trim too lean
32	P0172	Fuel trim too rich
33	P0201	Cylinder 1- injector control circuit open circuit
34	P0202	Cylinder 2- injector control circuit open circuit
35	P0203	Cylinder 3- injector control circuit open circuit
36	P0204	Cylinder 4- injector control circuit open circuit
37	P0261	Cylinder 1- injector control circuit short to ground
38	P0262	Cylinder 1- injector control circuit short to power
39	P0264	Cylinder 2- injector control circuit short to ground
40	P0265	Cylinder 2- injector control circuit short to power
41	P0267	Cylinder 3- injector control circuit short to ground
42	P0268	Cylinder 3- injector control circuit short to power
43	P0270	Cylinder 4- injector circuit short to ground
44	P0271	Cylinder 4- injector control circuit short to power
45	P0300	Random/Multiple cylinder misfire
46	P0301	Cylinder 1 misfire
47	P0302	Cylinder 2 misfire
48	P0303	Cylinder 3 misfire
49	P0304	Cylinder 4 misfire
50	P0317	Rough road sensor signal lost
51	P0321	Crankshaft TDC signal failure
52	P0322	Speed sensor signal failure
53	P0327	Knock sensor signal circuit low input

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No.	Fault code	Description
54	P0328	Knock sensor signal circuit high input
55	P0340	Improper camshaft position sensor
56	P0341	Camshaft position sensor poor contact
57	P0342	Camshaft position sensor short to ground
58	P0343	Camshaft position sensor short to power
59	P0420	Catalyst system efficiency below threshold
60	P0444	Carbon canister valve control circuit open circuit
61	P0458	Carbon canister valve control circuit low input
62	P0459	Carbon canister valve control circuit high input
63	P0480	Cooling fan relay control circuit failure (low speed)
64	P0481	Cooling fan relay control circuit failure (high speed)
65	P0501	Improper vehicle speed sensor
66	P0506	Idling control system RPM lower than expected
67	P0507	Idling control system RPM higher than expected
68	P0508	Idling stepper motor drive pin short to ground
69	P0509	Idling stepper motor drive pin short to power
70	P0511	Idling stepper motor drive pin failures
71	P0560	Improper system voltage signal
72	P0562	System voltage low
73	P0563	System voltage high
74	P0602	Control module programming error
75	P0627	Fuel pump relay control circuit open circuit
76	P0628	Fuel pump relay control circuit short to ground
77	P0629	Fuel pump relay control circuit short to power
78	P0645	A/C compressor relay control circuit open circuit
79	P0646	A/C compressor relay control circuit short to ground

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No.	Fault code	Description
80	P0647	A/C compressor relay control circuit short to power
81	P0691	Cooling fan relay control circuit short to ground (low speed)
82	P0692	Cooling fan relay control circuit short to power (low speed)
83	P0693	Cooling fan relay control circuit short to ground (high speed)
84	P0694	Cooling fan relay control circuit short to power (high speed)
85	P1610	ECM defective
86	P1611	Security code reception error
87	P1612	Challenge request failure
88	P1613	IMMO code request failure
89	P1614	Transponder check error
90	P2177	System too lean (off idle)
91	P2178	System too rich (off idle)
92	P2195	Front oxygen sensor slow response
93	P2196	Front oxygen sensor slow response
94	P2270	Rear oxygen sensor slow response
95	P2271	Rear oxygen sensor slow response
96	U0001	CAN communication diagnosis
97	U0101	Lost communication of ECM and TCU control module
98	U0121	Lost communication of ECM and ABS control module
99	U0140	Lost communication of ECM and BCM control module
100	U0155	Abnormal communication of ECM and IPC (Instrument Panel Control) control module

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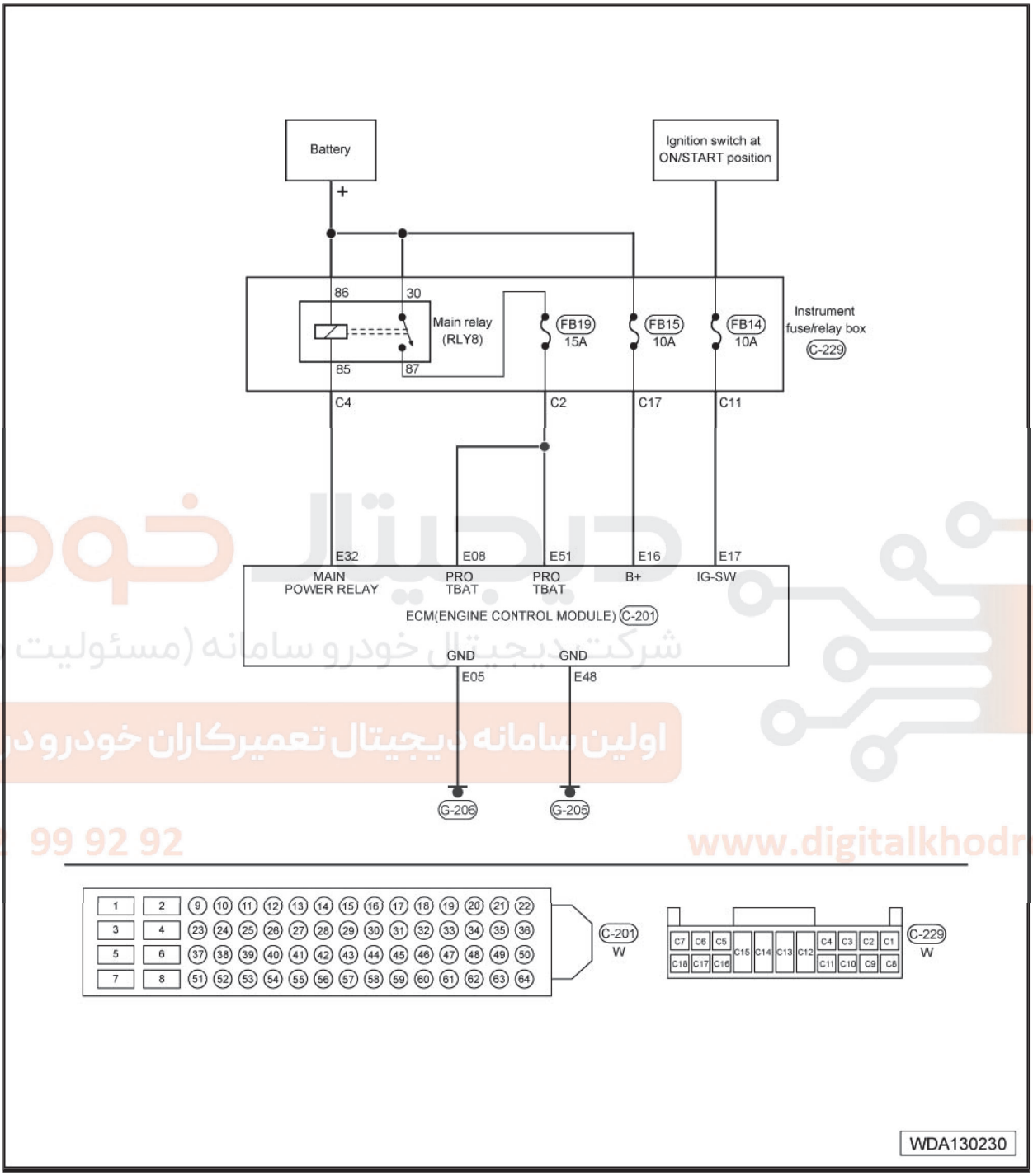
2.5 Testing the ECM power and ground circuit

2.5.1 Testing the ECM power circuit



Testing the ECM power circuit value

ECM pin No.	Function	Condition	Value (DC voltage range)
E16	Providing power constantly	The ignition switch in the LOCK, ON and START position	Battery voltage

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ECM pin No.	Function	Condition	Value (DC voltage range)
E17	Providing power to the ignition switch in the ON position	The ignition switch in the ON position	Battery voltage

DTC test procedures:

Please confirm that the battery voltage is normal before performing the following procedures.

- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.
- If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

Diagnosis procedures:

1. Check if the ECM power supply fuses FB15 (10A) and FB14 (10A) are normal.
   - If yes, go to step 2.
   - If not, replace the defective fuse. ■

2. Check if the lead between the battery positive pole and FB15 (10A) fuse pin has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 3.

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3. Check if the lead between the ignition switch and FB14 (10A) fuse pin has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 4.

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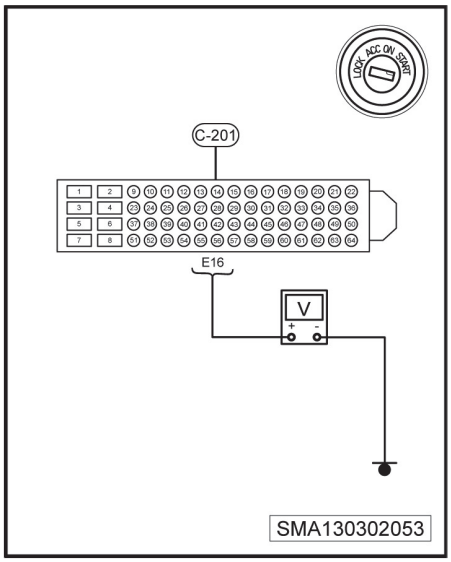
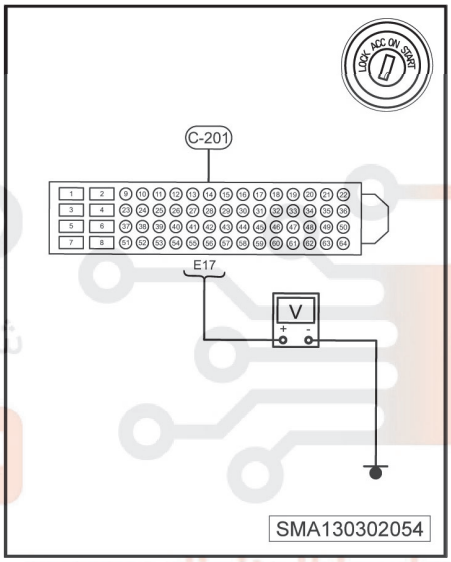
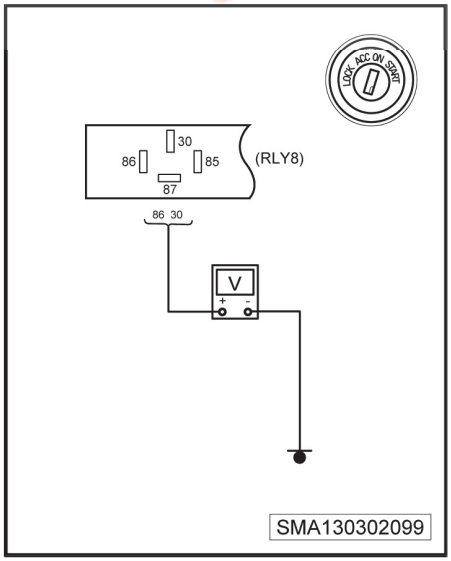
4. Turn the ignition switch to the ON position, disconnect the ECM connector C-201 and check if the voltage at the pin E16 of C-201 is battery voltage.
   - If yes, go to step 5.
   - If not, the lead between the ECM connector and the fuse/relay box fails. ■



5. Turn the ignition switch to the ON position, disconnect the ECM connector C-201 and check if the voltage at the pin E17 of C-201 is battery voltage.
   - If yes, go to step 6.
   - If not, the lead between the ECM connector and the fuse/relay box fails. ■



6. Pull out the main relay (RLY8), and check if the voltage between the relay connectors 86 and 30 is battery voltage.
   - If yes, go to step 7.
   - If not, the lead between the fuse/relay box and the battery positive terminal or the fuse/relay box fails. ■



7. Pull out the main relay (RLY8) and check if the relay is normal.

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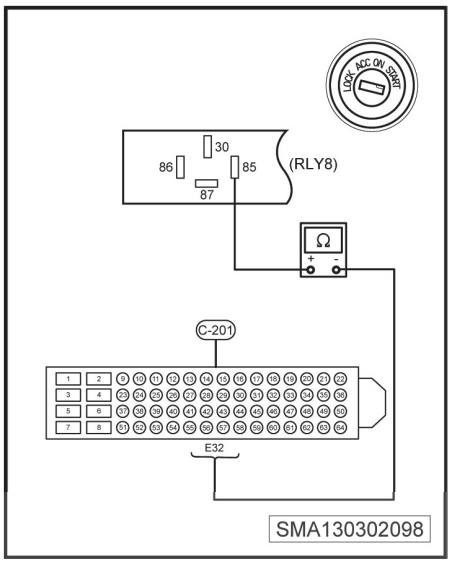
- If yes, go to step 8.
- If not, the main relay fails and please replace it.

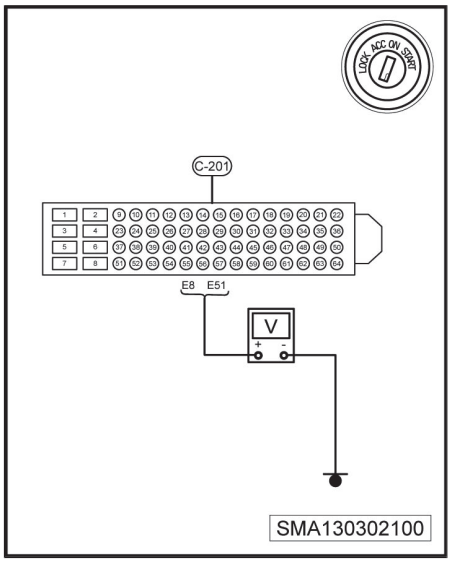
8. Pull out the main relay (RLY8) and check if the lead between the main relay pin 85 and the pin E32 of the ECM connector C-201 has short or open circuit.
   - If yes, repair the defective lead.
   - If not, go to step 9.



9. Check if the ECM power fuse FB19 (15A) is normal.
   - If yes, go to step 10.
   - If not, replace the fuse FB19 (15A).

10. Pull out the main relay (RLY8) and FB19 (15A). Check if the circuit between the relay pin 87 and pin FB19 is conducted.
    - If yes, go to step 11.
    - If not, the fuse/relay box fails.

11. Disconnect the ECM connector C-201 and pull out the main relay (RLY8). Short-circuit the main relay pins 30 and 87 with the short connector, and check if the voltage between the pins E8 and E51 of C-201 is battery voltage.
    - If yes, go to step 12.
    - If not, repair the defective lead.



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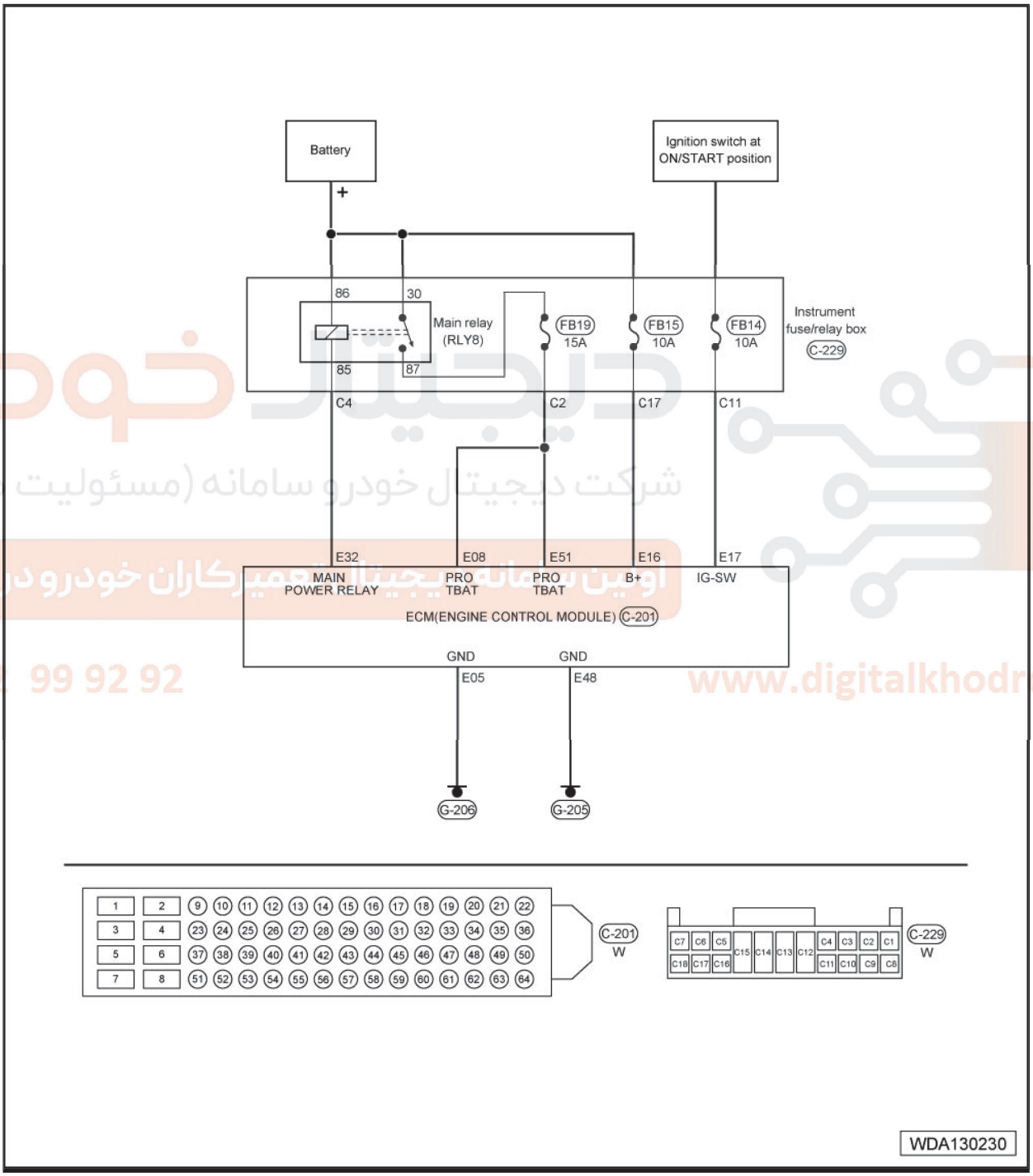
12. Replace the ECM control module, carry out the function test again, and read the fault code to verify if it exists or not.
    - If yes, locate fault causes from other symptoms.
    - If not, the fault has been rectified. ■

2.5.2 Testing the ECM ground circuit



DTC test procedures:

Please confirm that the battery voltage is normal before performing the following procedures.

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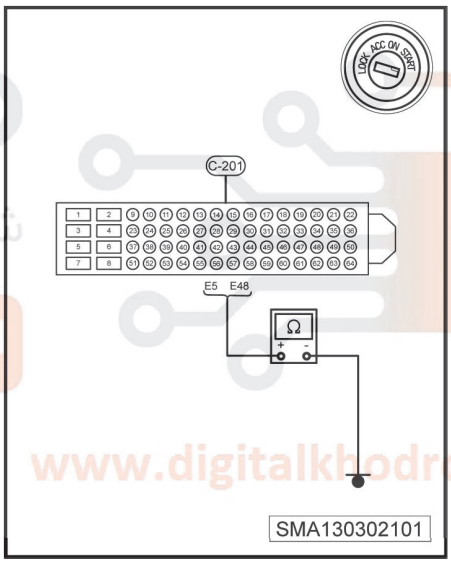
- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.
- If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

Diagnosis procedures:

1. Disconnect the battery negative terminal, and pull out the ECM connector C-201. Check if the circuit between the pins E05 and E48 of C-201 and the battery negative terminal is conducted.
   - If yes, diagnosis ends. ■
   - If not, go to step 2.

2. Remove the battery ground points G206 and G205 to check if the lead between the pins E5 and E48 of C-201 and the ground point has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 3.



3. Check if the ground points has oxide and corrosion.
   - If yes, clean the ECM ground points. ■
   - If not, go to step 4.

4. Replace the ECM control module, carry out the function test again, and read the fault code to verify if it exists or not.
   - If yes, locate fault causes from other symptoms.
   - If not, the fault has been rectified. ■

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2.6 DTC diagnosis procedures

2.6.1 P0016 Crankshaft position-camshaft position correlation

Fault code definition and fault causes

DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
P0016	Crankshaft position-camshaft position correlation	Engine running	Crankshaft position-camshaft position correlation	• Improper installation position • Failure of the drive gear and belt

DTC test procedures:

Please confirm that the battery voltage is normal before performing the following procedures.

- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Start the engine, and make it reach normal operating temperature.
- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.
- If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

Diagnosis procedures:

Note

- Please verify again if the DTC and its symptoms are present after fault is rectified.

1. Check if the timing belts are installed correctly.
   - If yes, go to step 2.
   - If not, reinstall the timing belts. ■

2. Check if the camshaft signal gear and the camshaft woodruff key are normal.
   - If yes, go to step 3.
   - If not, replace the camshaft and woodruff key. ■

3. Check if the crankshaft woodruff key exists.
   - If yes, go to step 4.
   - If not, install the woodruff key and reinstall the timing belt. ■

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4. Replace the ECM control module, carry out the function test again, and read the fault code to verify if it exists or not.
   - If yes, locate fault causes from other symptoms.
   - If not, the fault has been rectified. ■

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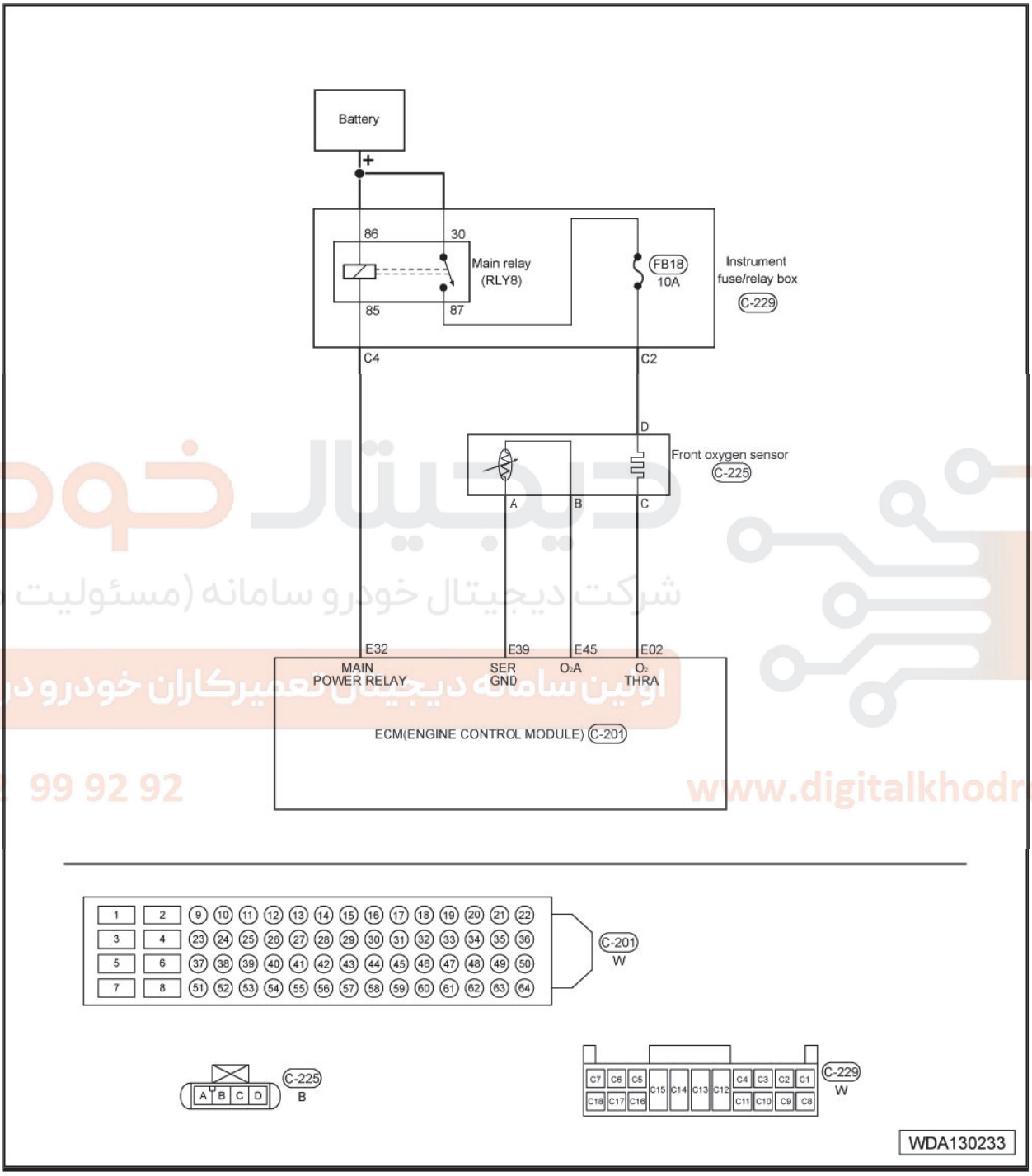
2.6.2 P0030 Front oxygen sensor heater control circuit open circuit

P0031 Front oxygen sensor heater control circuit short to ground
P0032 Front oxygen sensor heater control circuit short to power
P0053 Improper front oxygen sensor heater resistance



Fault code definition and fault causes

DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
P0030	Front oxygen sensor heater control circuit open circuit	The ignition switch in the ON or START position	The oxygen sensor connecting wiring harness open circuit	• Failure of the front oxygen sensor

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DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
				• Failure of the wiring harness (open circuit) • Failure of the fuse • Failure of the engine control module
P0031	Front oxygen sensor heater control circuit short to ground	The ignition switch in the ON or START position	The oxygen sensor connecting wiring harness short circuit	• Failure of the front oxygen sensor • Failure of the wiring harness (short circuit) • Failure of the fuse • Failure of the engine control module
P0032	Front oxygen sensor heater control circuit short to power	The ignition switch in the ON or START position	The oxygen sensor connecting wiring harness short to power	• Failure of the front oxygen sensor • Failure of the wiring harness (short circuit) • Failure of the fuse • Failure of the engine control module
P0053	Improper front oxygen sensor heater resistance	The ignition switch in the ON or START position	The oxygen sensor connecting wiring harness heater resistor short/open circuit	• Failure of the front oxygen sensor • Failure of the wiring harness (short/open circuit) • Failure of the fuse • Failure of the engine control module

DTC test procedures:

Please confirm that the battery voltage is normal before performing the following procedures.

- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Start the engine, and make it reach normal operating temperature.

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- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.
- If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

Diagnosis procedures:

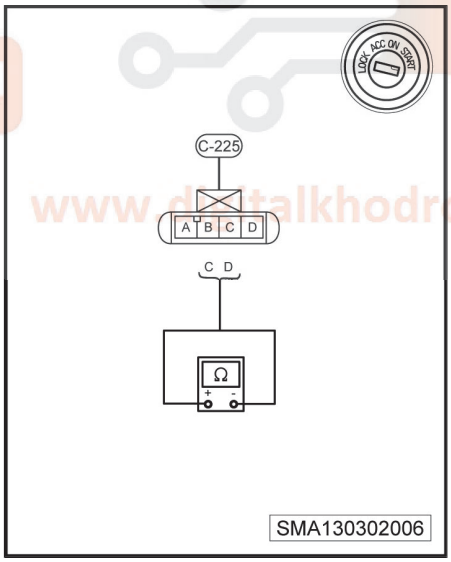
Note

- Please verify again if the DTC and its symptoms are present after fault is rectified.

1. Check if the front oxygen sensor connector is corrosive, tainted or loose and if the wiring harness is damaged.
   - If yes, the connector/wiring harness fails and please repair it. ■
   - If not, go to step 2.

2. Check if the power fuse FB18 (10A) of the front oxygen sensor heater resistor is damaged.
   - If yes, the fuse fails and please replace it. ■
   - If not, go to step 3.

3. Turn the ignition switch to the LOCK position, disconnect the front oxygen sensor connector C－225 and check if the resistance between the pins C and D of C－225 is 7 Ω to 11 Ω.
   - If yes, go to step 4.
   - If not, the front oxygen sensor heater fails and please replace it. ■



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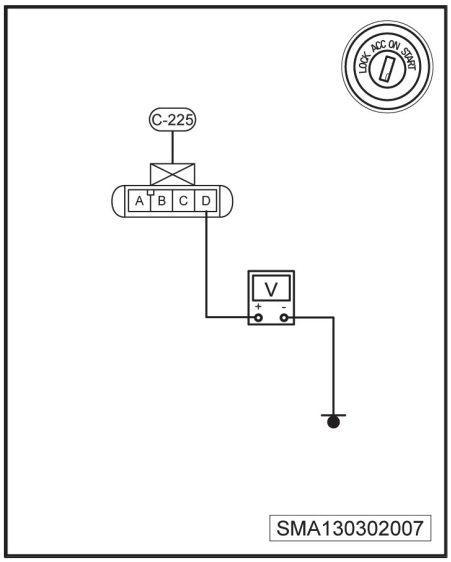
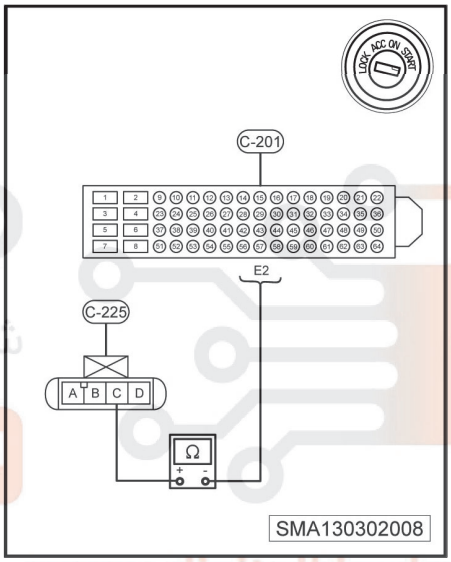
4. Turn the ignition switch to the ON position, check if the voltage at the pin D of C－225 is battery voltage.
   - If yes, go to step 5.
   - If not, the lead between the pin D of C-225 and the front compartment fuse box FB18 fails and please repair it. ■



5. Turn the ignition switch to the LOCK position, disconnect the ECM connector C-201 and check if the lead between the pin C of C－225 and E2 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 6.



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6. Replace the ECM control module, carry out the function test again, and read the fault code to verify if it exists or not.
   - If yes, locate fault causes from other symptoms.
   - If not, the fault has been rectified. ■

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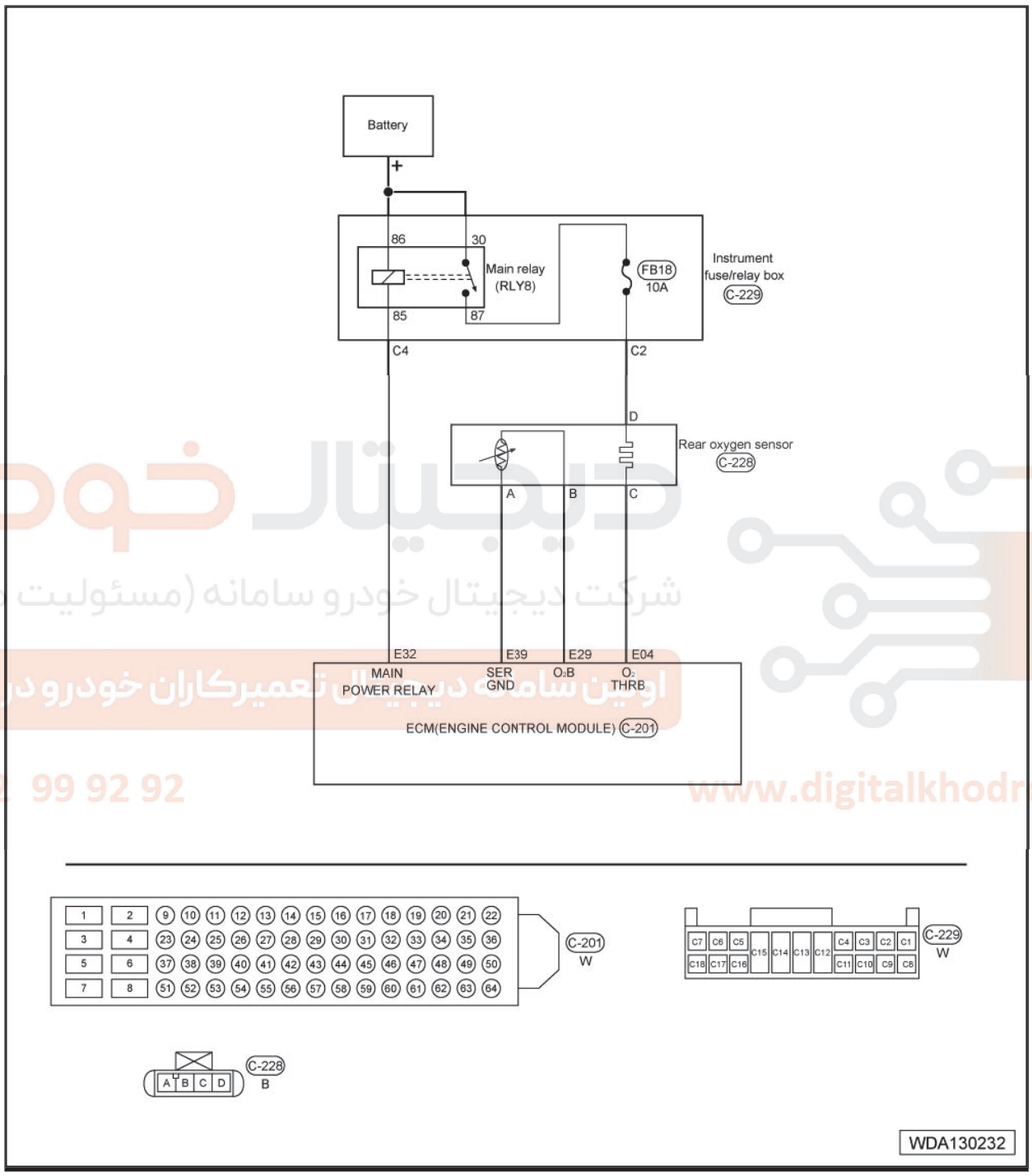
2.6.3 P0036 Rear oxygen sensor heater control circuit open circuit

P0037 Rear oxygen sensor heater control circuit short to ground
P0038 Rear oxygen sensor heater control circuit short to power
P0054 Improper rear oxygen sensor heater resistance



Fault code definition and fault causes

DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
P0036	Rear oxygen sensor heater control circuit open circuit	The ignition switch in the ON or START position	The oxygen sensor open circuit	• Failure of the rear oxygen sensor

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DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
				• Failure of the rear oxygen sensor circuit • Failure of the engine control module
P0037	Rear oxygen sensor heater control circuit short to ground	The ignition switch in the ON or START position	The connecting wiring harness of the oxygen sensor short to ground	• Failure of the rear oxygen sensor • Failure of the rear oxygen sensor circuit • Failure of the engine control module
P0038	Rear oxygen sensor heater control circuit short to power	The ignition switch in the ON or START position	The connecting wiring harness of the oxygen sensor short to power	• Failure of the rear oxygen sensor • Failure of the rear oxygen sensor circuit • Failure of the engine control module
P0054	Improper rear oxygen sensor heater resistance	The ignition switch in the ON or START position	The connecting wiring harness of the oxygen sensor heater resistor short/open circuit	• Failure of the rear oxygen sensor • Failure of the rear oxygen sensor circuit • Failure of the engine control module

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DTC test procedures:

Please confirm that the battery voltage is normal before performing the following procedures.

- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Start the engine, and make it reach normal operating temperature.
- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.
- If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

Diagnosis procedures:

Note

- Please verify again if the DTC and its symptoms are present after fault is rectified.

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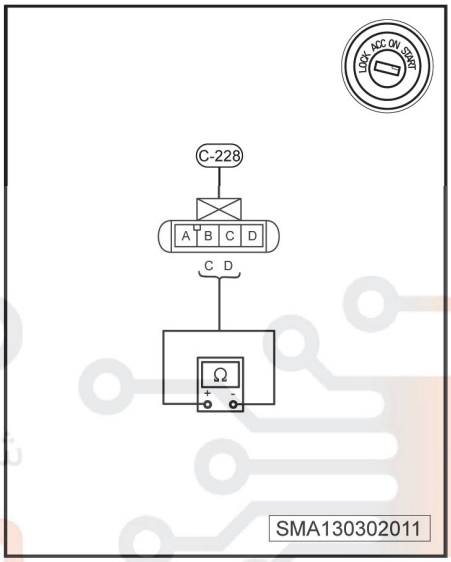
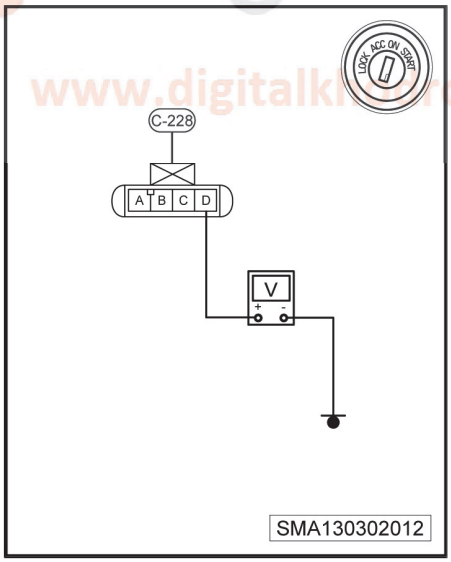
1. Check if the rear oxygen sensor connector is corrosive, tainted or loose and if the wiring harness is damaged.
   - If yes, the connector/wiring harness fails and please repair or replace it. ■
   - If not, go to step 2.

2. Check if the power fuse FB18 (10A) of the rear oxygen sensor heater resistor is damaged.
   - If yes, the fuse fails and please replace it. ■
   - If not, go to step 3.

3. Turn the ignition switch to the LOCK position, disconnect the rear oxygen sensor connector C-228 and check if the resistance between the pins C and D of C-228 is 7 Ω to 11 Ω.
   - If yes, go to step 4.
   - If not, the rear oxygen sensor heater fails and please replace it. ■



4. Turn the ignition switch to the ON position, check if the voltage at the pin D of C-228 is battery voltage.
   - If yes, go to step 5.
   - If not, the lead between the pin D of C-228 and the front compartment fuse box FB18 fails and please repair it. ■



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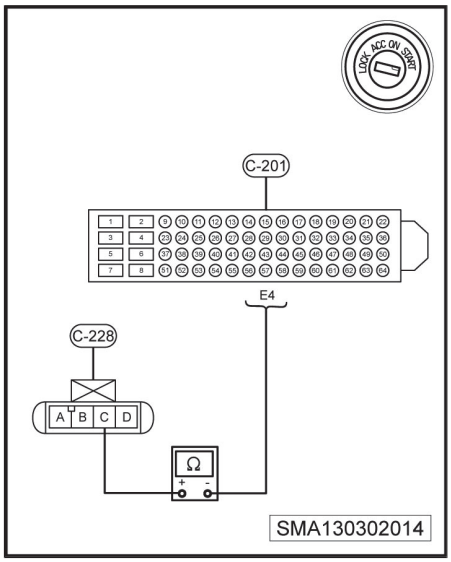
5. Turn the ignition switch to the LOCK position, disconnect the ECM connector C-201 and check if the lead between the pin C of C-228 and the pin E4 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 6.



6. Replace the ECM control module, carry out the function test again, and read the fault code to verify if it exists or not.
   - If yes, locate fault causes from other symptoms.
   - If not, the fault has been rectified. ■

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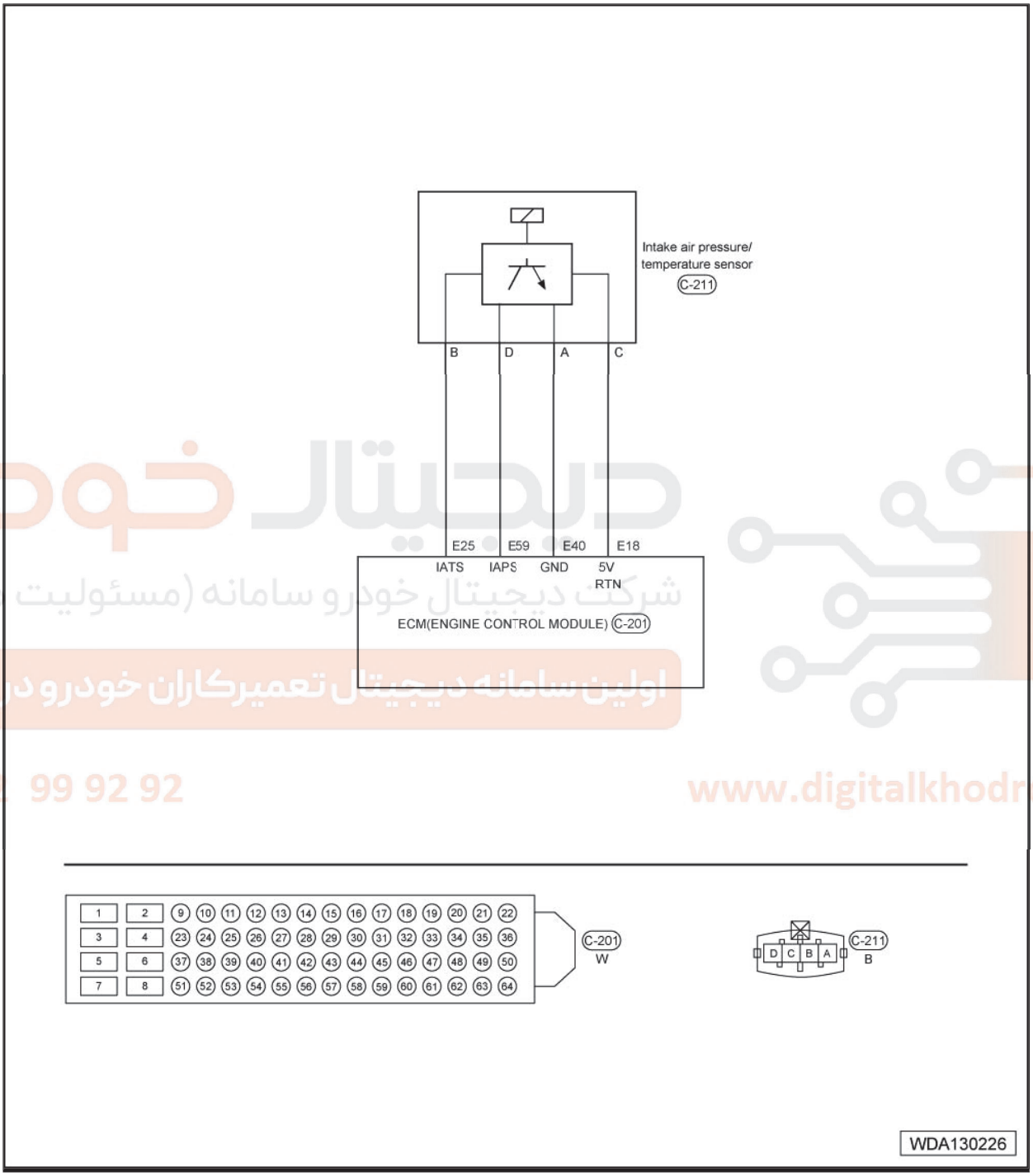
2.6.4 P0105 No signal change in the intake air pressure sensor (frozen)

P0106 Improper intake air pressure sensor
P0107 Intake air pressure sensor short to ground
P0108 Intake air pressure sensor short to power



Fault code definition and fault causes

DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
P0105	No signal change in the intake air	Engine running normally	No signal in the intake air pressure	• Failure of the intake air pressure sensor

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DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
	pressure sensor (frozen)		sensor detected by the ECM	• Failure of the intake air pressure sensor circuit • Failure of the engine control module
P0106	Improper intake air pressure sensor	Engine running normally	Improper intake air pressure sensor	• Failure of the intake air pressure sensor • Failure of the intake air pressure sensor circuit • Failure of the engine control module
P0107	Intake air pressure sensor short to ground	Engine running normally	Intake air pressure sensor short to ground	• Failure of the intake air pressure sensor • Failure of the intake air pressure sensor circuit • Failure of the engine control module
P0108	Intake air pressure sensor short to power	Engine running normally	Intake air pressure sensor short to power	• Failure of the intake air pressure sensor • Failure of the intake air pressure sensor circuit • Failure of the engine control module

DTC test procedures:

Please confirm that the battery voltage is normal before performing the following procedures.

- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Start the engine, and make it reach normal operating temperature.
- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.

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If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

Diagnosis procedures:

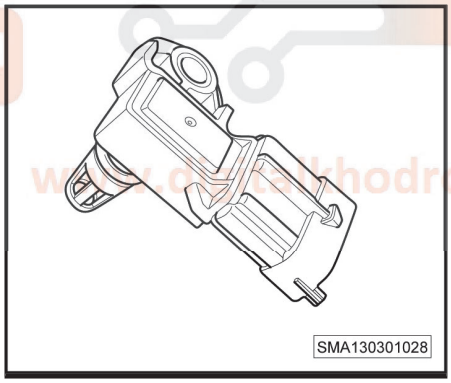
Note

- Please verify again if the DTC and its symptoms are present after fault is rectified.

1. Turn the ignition switch to the ON position, connect the diagnostic device and check if the "intake air pressure data flow" severely deviates from the ambient pressure for about 101 kpa (in which the actual value is relevant to the atmospheric pressure).
   - If yes, the intake air pressure sensor fails and please repair or replace it. ■
   - If not, go to step 2.

2. Disconnect the intake air pressure/temperature sensor connector and check if the connector pin is corrosive, tainted or loose. And check if the wiring harness is damaged.
   - If yes, the connector/wiring harness fails and please repair or replace it. ■
   - If not, go to step 3.

3. Remove the intake air pressure/temperature sensor and check if the sensor has any dust or other foreign matters on it.
   - If yes, clean or replace the intake air pressure/temperature sensor. ■
   - If not, go to step 4.



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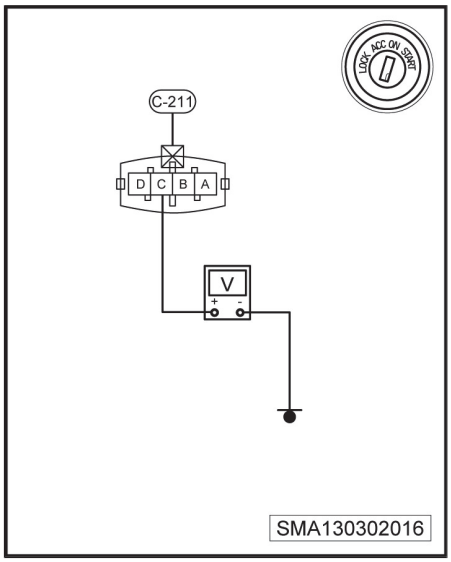
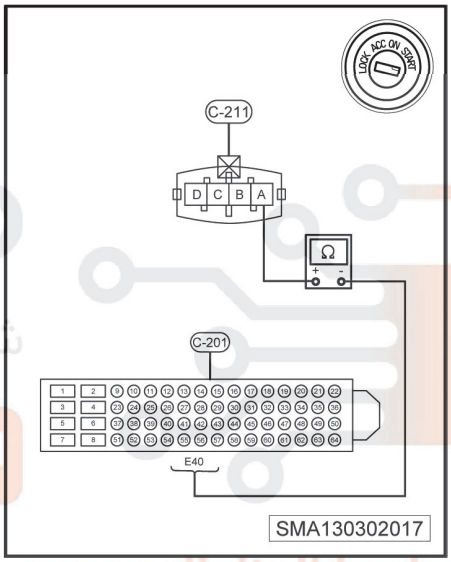
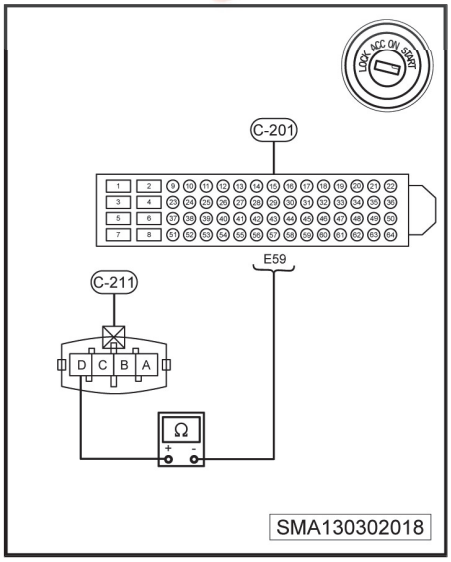
4. Turn the ignition switch to the ON position, disconnect the intake air pressure/temperature sensor connector C-211 and check if the voltage at the pin C of C-211 is 5 V.
   - If yes, go to step 5.
   - If not, the lead between the pin C of C-211 and the pin E18 of C-201 fails and please repair it. ■



5. Turn the ignition switch to the LOCK position, disconnect the ECM connector C-201 and intake air pressure/temperature sensor connector C-211, and check if the circuit between the pin A of C-211 and the pin E40 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 6.



6. Turn the ignition switch to the LOCK position, check if the circuit between the pin D of C-211 and the pin E59 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 7.



7. Replace the ECM control module, carry out the function test again, and read the fault code to verify if it exists or not.

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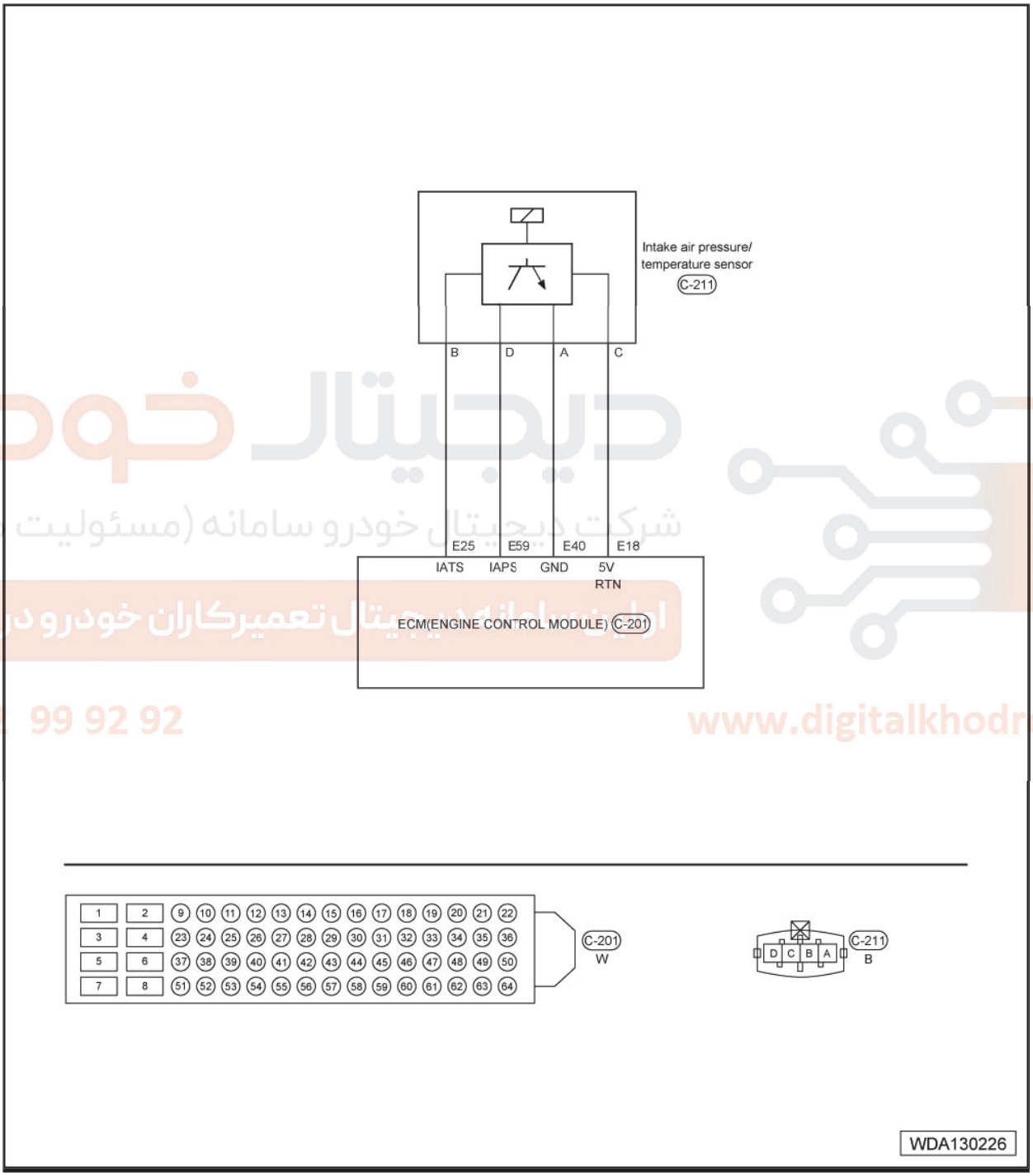
- If yes, locate fault causes from other symptoms.
- If not, the fault has been rectified. ■

2.6.5 P0112 Intake air temperature sensor signal low input
P0113 Intake air temperature sensor signal high input



Fault code definition and fault causes

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DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
P0112	Intake air temperature sensor signal low input	Engine running normally	The intake air temperature sensor signal pin opposite to ECM end short to ground	• Failure of the intake air pressure sensor • Failure of the intake air temperature sensor circuit • Failure of the engine control module
P0113	Intake air temperature sensor signal high input	Engine running normally	The intake air temperature sensor signal pin opposite to ECM end short to power or internal circuit damaged	• Failure of the intake air pressure sensor • Failure of the intake air temperature sensor circuit • Failure of the engine control module

DTC test procedures:

Please confirm that the battery voltage is normal before performing the following procedures.

- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Start the engine, and make it reach normal operating temperature.
- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.
- If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

Diagnosis procedures:

Note

- Please verify again if the DTC and its symptoms are present after fault is rectified.

1. Disconnect the intake air pressure/temperature sensor connector and check if the connector pin is corrosive, tainted or loose. And check if the wiring harness is damaged.
   - If yes, the connector/wiring harness fails and please repair or replace it. ■
   - If not, go to step 2.

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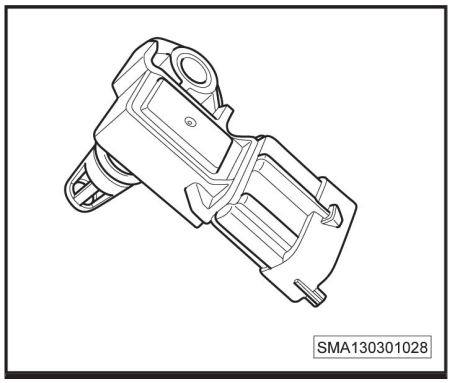
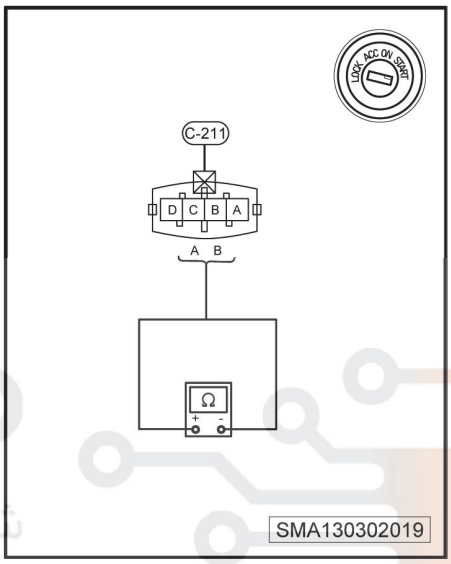
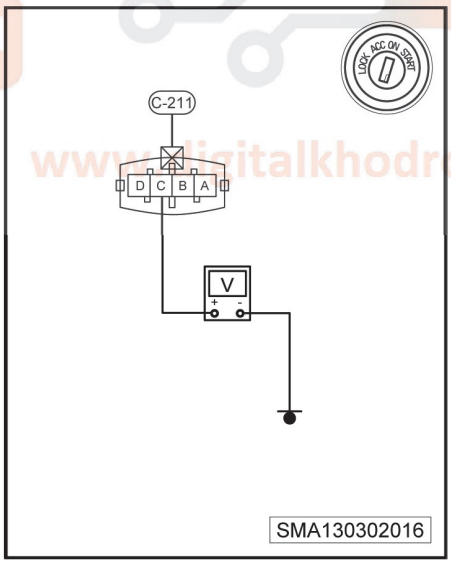
2. Remove the intake air pressure/temperature sensor and check if the sensor has any dust or other foreign matters on it.
   - If yes, clean or replace the intake air pressure/temperature sensor. ■
   - If not, go to step 3.



3. Turn the ignition switch to the LOCK position, disconnect the intake air pressure/temperature sensor connector C－211 and check if the resistance between the pins A and B of C－211 is normal (the rated resistance is 2.5 KΩ ± 5% at 20℃).
   - If yes, go to step 4.
   - If not, the intake air pressure/temperature sensor fails and please repair or replace it. ■



4. Turn the ignition switch to the ON position, disconnect the intake air pressure/temperature sensor connector C-211 and check if the voltage at the pin C of C-211 is 5 V.
   - If yes, go to step 5.
   - If not, the lead between the pin C of C-211 and the pin E18 of C-201 fails and please repair it. ■



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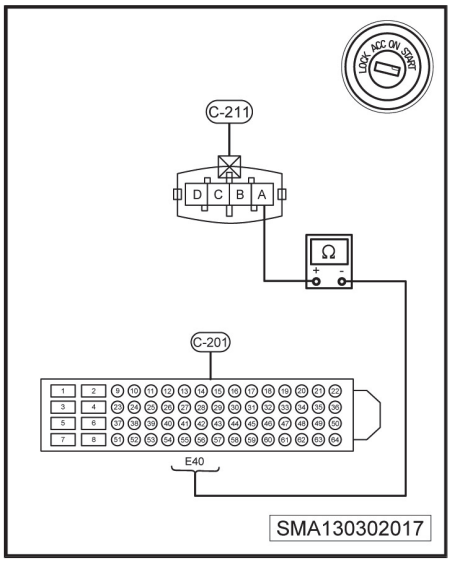
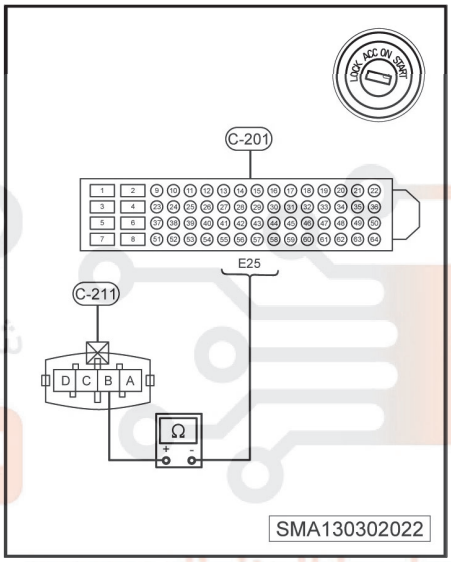
5. Turn the ignition switch to the LOCK position, disconnect the ECM connector C-201 and intake air pressure/temperature sensor connector C-211, and check if the lead between the pin A of C-211 and the pin E40 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 6.



6. Turn the ignition switch to the LOCK position, check if the lead between the pin C of C-211 and the pin E25 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 7.



7. Replace the ECM control module, carry out the function test again, and read the fault code to verify if it exists or not.
   - If yes, locate fault causes from other symptoms.
   - If not, the fault has been rectified. ■

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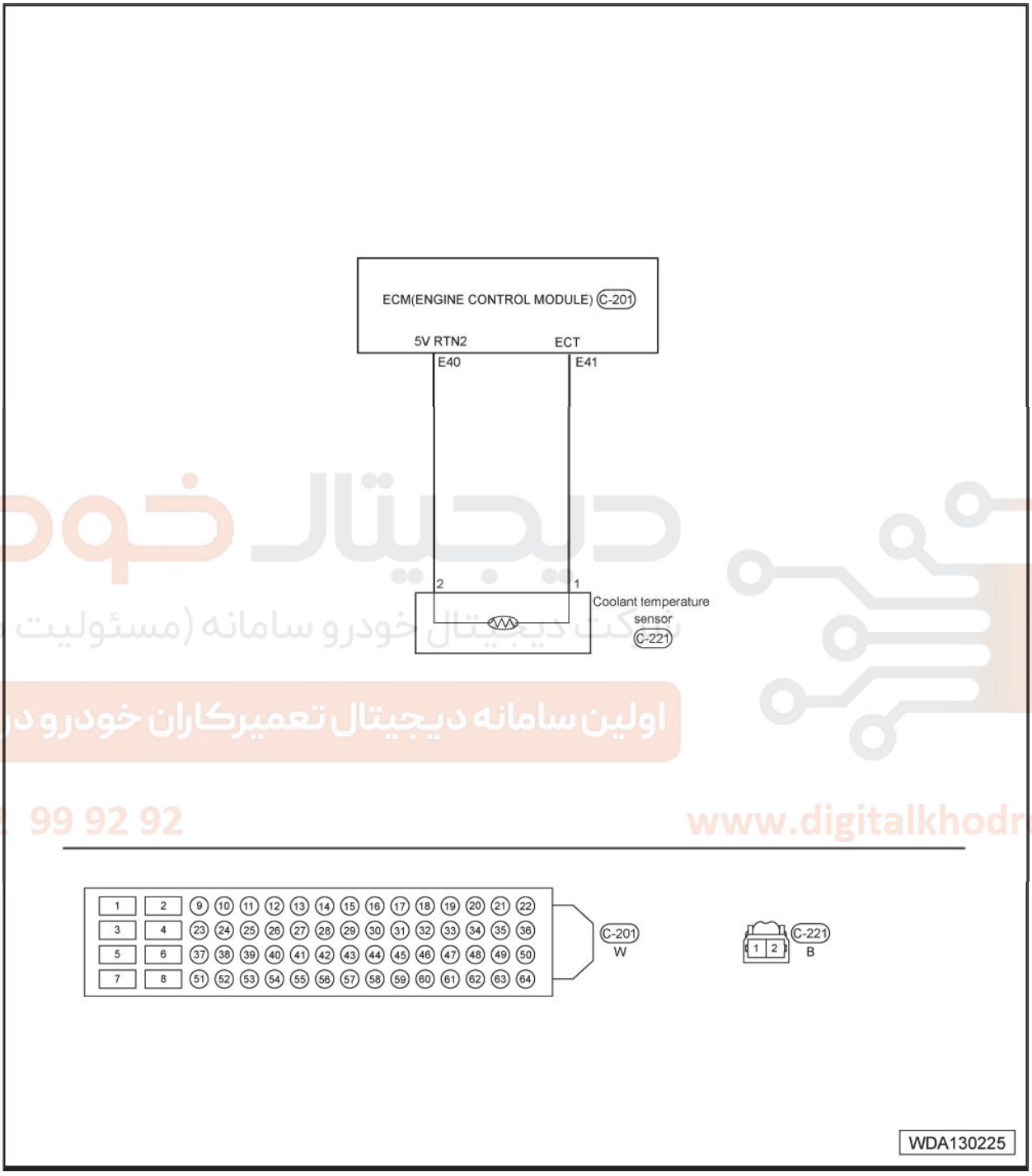
2.6.6 P0116 Improper engine coolant temperature sensor

P0117 Engine coolant temperature sensor circuit low input
P0118 Engine coolant temperature sensor circuit high input



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Fault code definition and fault causes

DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
P0116	Improper engine coolant temperature sensor	Engine running normally	Improper engine coolant temperature sensor	• Failure of the coolant temperature sensor

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DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
				• Failure of the coolant temperature sensor circuit • Failure of the engine control module
P0117	Engine coolant temperature sensor circuit low input	Engine running normally	Coolant temperature sensor short or open circuit	• Failure of the coolant temperature sensor • Failure of the coolant temperature sensor circuit • Failure of the engine control module
P0118	Engine coolant temperature sensor circuit high input	Engine running normally	Coolant temperature sensor signal short to power or internal circuit damaged	• Failure of the coolant temperature sensor • Failure of the coolant temperature sensor circuit • Failure of the engine control module

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DTC test procedures:

Please confirm that the battery voltage is normal before performing the following procedures.

- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Start the engine, and make it reach normal operating temperature.
- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.

  If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

Diagnosis procedures:

Note

- Please verify again if the DTC and its symptoms are present after fault is rectified.

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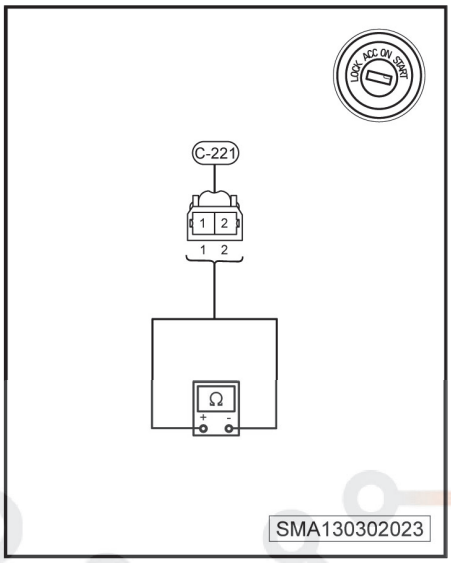
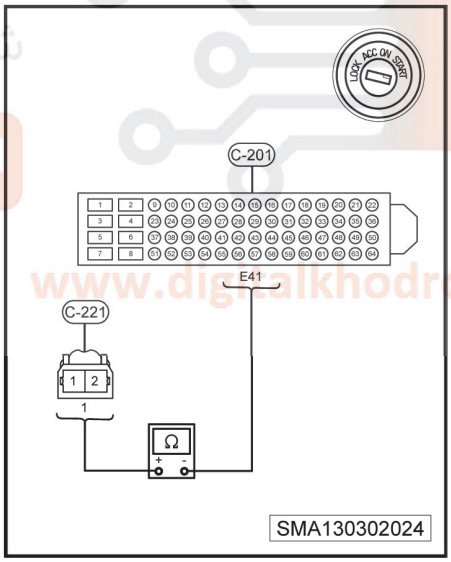
1. Check if the engine coolant temperature sensor connector is corrosive, tainted or loose. And check if the wiring harness is damaged.
   - If yes, the connector/wiring harness fails and please repair or replace it. ■
   - If not, go to step 2.

2. Turn the ignition switch to the LOCK position, disconnect the coolant temperature sensor connector C-221 and check if the resistance between the pins 1 and 2 of C-221 is normal (the rated resistance is 2.5 KΩ ± 5% at 20℃).
   - If yes, go to step 3.
   - If not, the coolant temperature sensor fails and please replace it. ■



3. Turn the ignition switch to the LOCK position, disconnect the ECM connector C-201 and coolant temperature sensor connector C-221, and check if the lead between the pin E41 of C-201 and the pin 1 of C-221 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 4.



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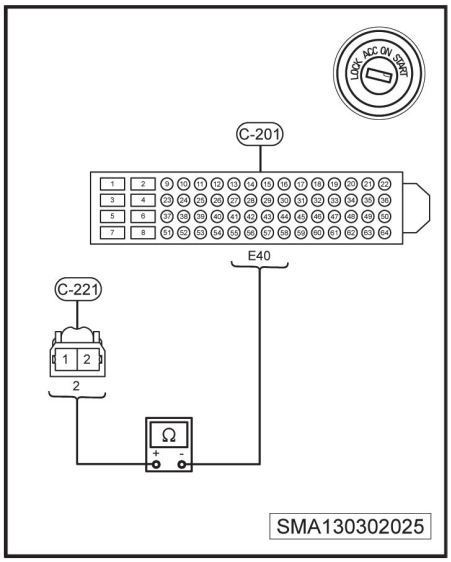
4. Turn the ignition switch to the LOCK position, check if the lead between the pin E40 of C-201 and the pin 2 of C-221 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 5.



5. Replace the ECM control module, carry out the function test again, and read the fault code to verify if it exists or not.
   - If yes, locate fault causes from other symptoms.
   - If not, the fault has been rectified. ■

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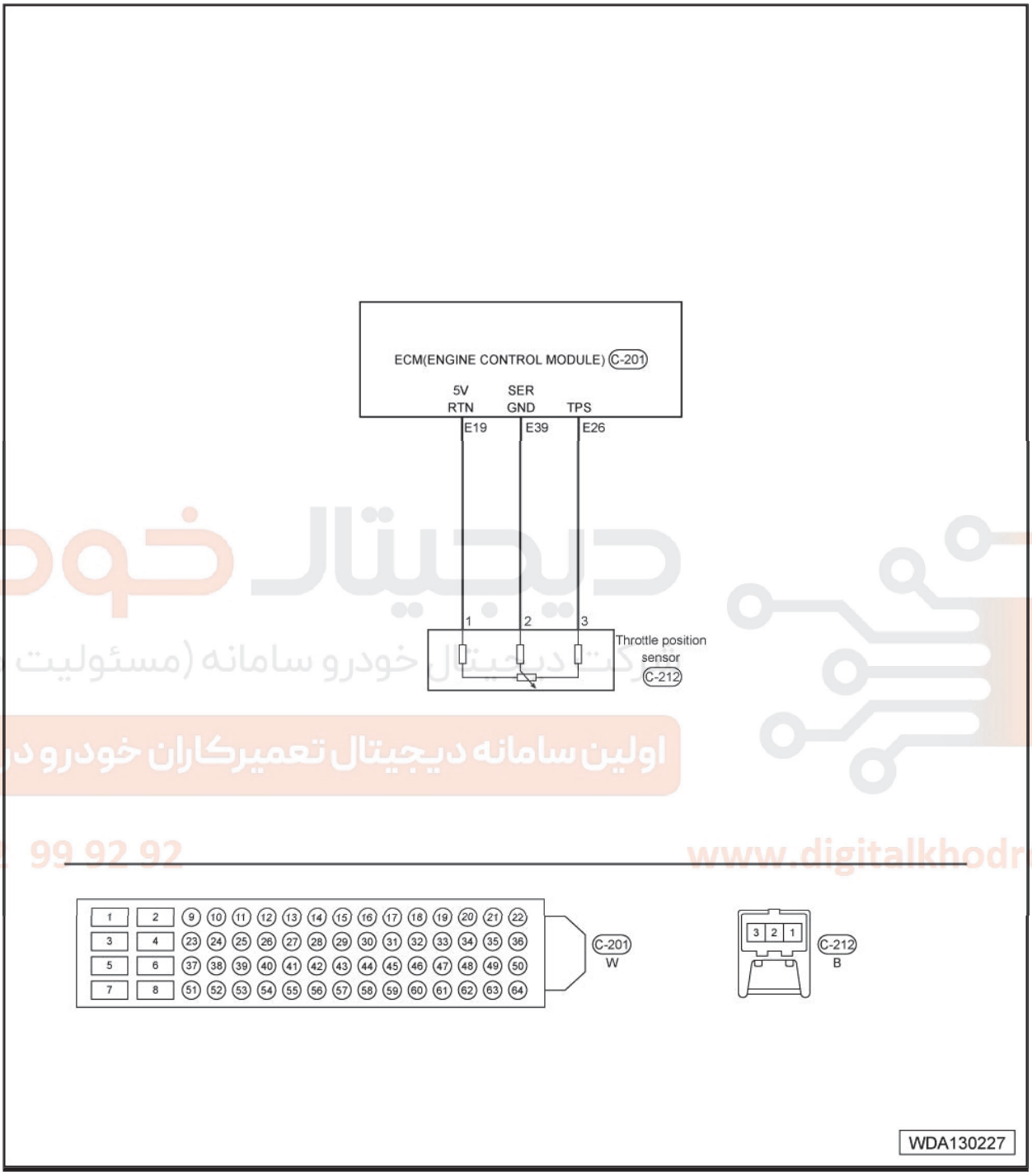
2.6.7 P0122 Throttle position sensor circuit low input

P0123 Throttle position sensor circuit high input



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Fault code definition and fault causes

DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
P0122	Throttle position sensor circuit low input	The ignition switch in the ON or START position	Failure of the throttle position sensor detected by the ECM	• Failure of the throttle position sensor

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DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
				• Failure of the throttle position sensor circuit • Failure of the engine control module
P0123	Throttle position sensor circuit high input	The ignition switch in the ON or START position	Failure of the throttle position sensor detected by the ECM	• Failure of the throttle position sensor • Failure of the throttle position sensor circuit • Failure of the engine control module

DTC test procedures:

Please confirm that the battery voltage is normal before performing the following procedures.

- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.

  If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

Diagnosis procedures:

Note

- Please verify again if the DTC and its symptoms are present after fault is rectified.

1. Check if the throttle position sensor connector is corrosive, tainted or loose. And check if the wiring harness is damaged.
   - If yes, the connector/wiring harness fails and please repair or replace it. ■
   - If not, go to step 2.

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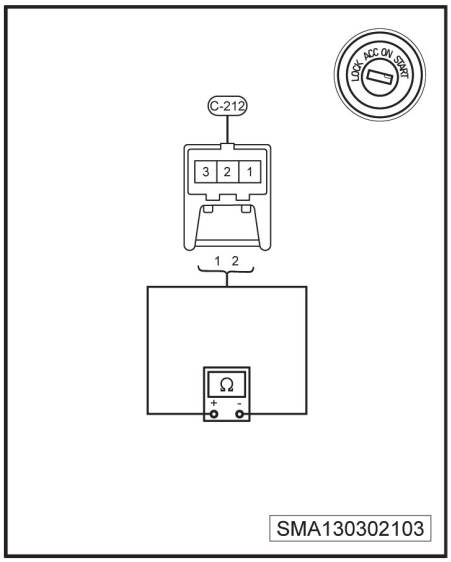
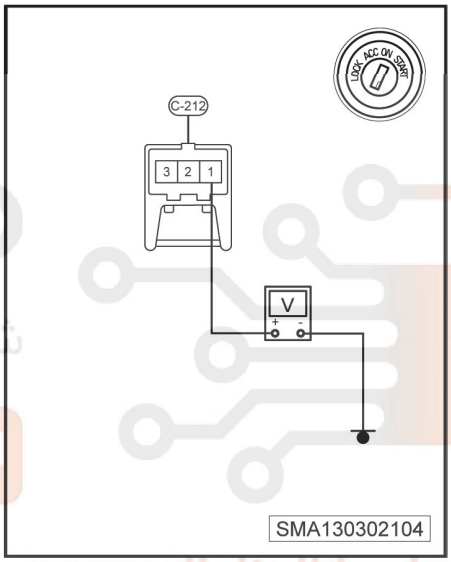
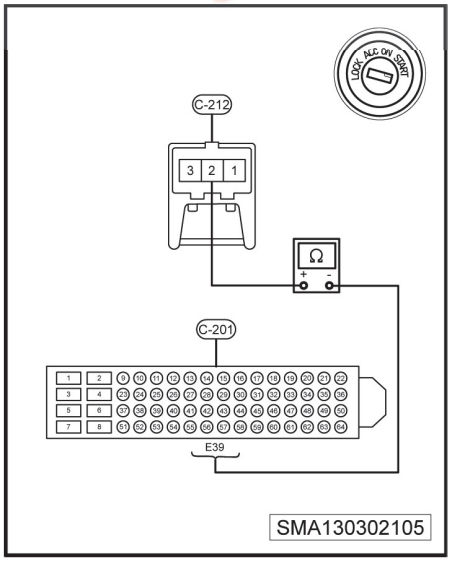
2. Turn the ignition switch to the LOCK position, disconnect the throttle position sensor connector C-212 and check if the resistance between the pins 1 and 2 of C-212 is 2 KΩ ± 20%.
   - If yes, go to step 3.
   - If not, the throttle position sensor fails and please replace it. ■



3. Turn the ignition switch to the ON position, disconnect the throttle position sensor connector C-212 and check if the voltage at the pin 1 of C-212 is 5 V.
   - If yes, go to step 4.
   - If not, the lead between the pin 1 of C-212 and the pin E19 of C-201 fails and please repair it. ■



4. Turn the ignition switch to the LOCK position, disconnect the throttle position sensor connector C-212 and ECM connector C-201, and check if the lead between the pin 2 of C-212 and the pin E39 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 5.



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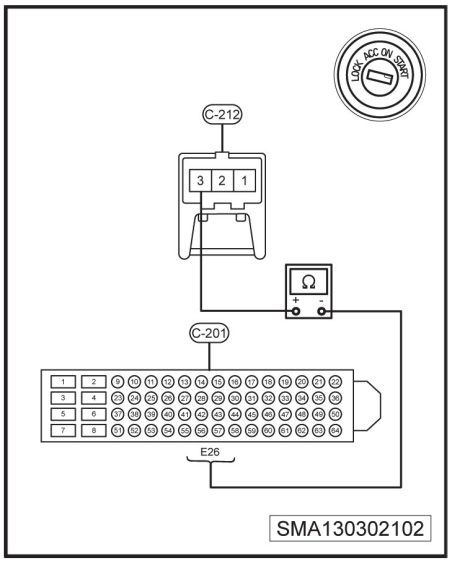
5. Turn the ignition switch to the LOCK position, check if the lead between the pin 3 of C-212 and the pin E26 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 6.



6. Replace the ECM control module, carry out the function test again, and read the fault code to verify if it exists or not.
   - If yes, locate fault causes from other symptoms.
   - If not, the fault has been rectified. ■

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2.6.8 P0201 Cylinder 1 - injector control circuit open circuit

P0202 Cylinder 2 - injector control circuit open circuit
P0203 Cylinder 3 - injector control circuit open circuit
P0204 Cylinder 4 - injector control circuit open circuit
P0261 Cylinder 1 - injector control circuit short to ground
P0262 Cylinder 1 - injector control circuit short to power
P0264 Cylinder 2 - injector control circuit short to ground
P0265 Cylinder 2 - injector control circuit short to power
P0267 Cylinder 3 - injector control circuit short to ground
P0268 Cylinder 3 - injector control circuit short to power
P0270 Cylinder 4 - injector control circuit short to ground
P0271 Cylinder 4 - injector control circuit short to power

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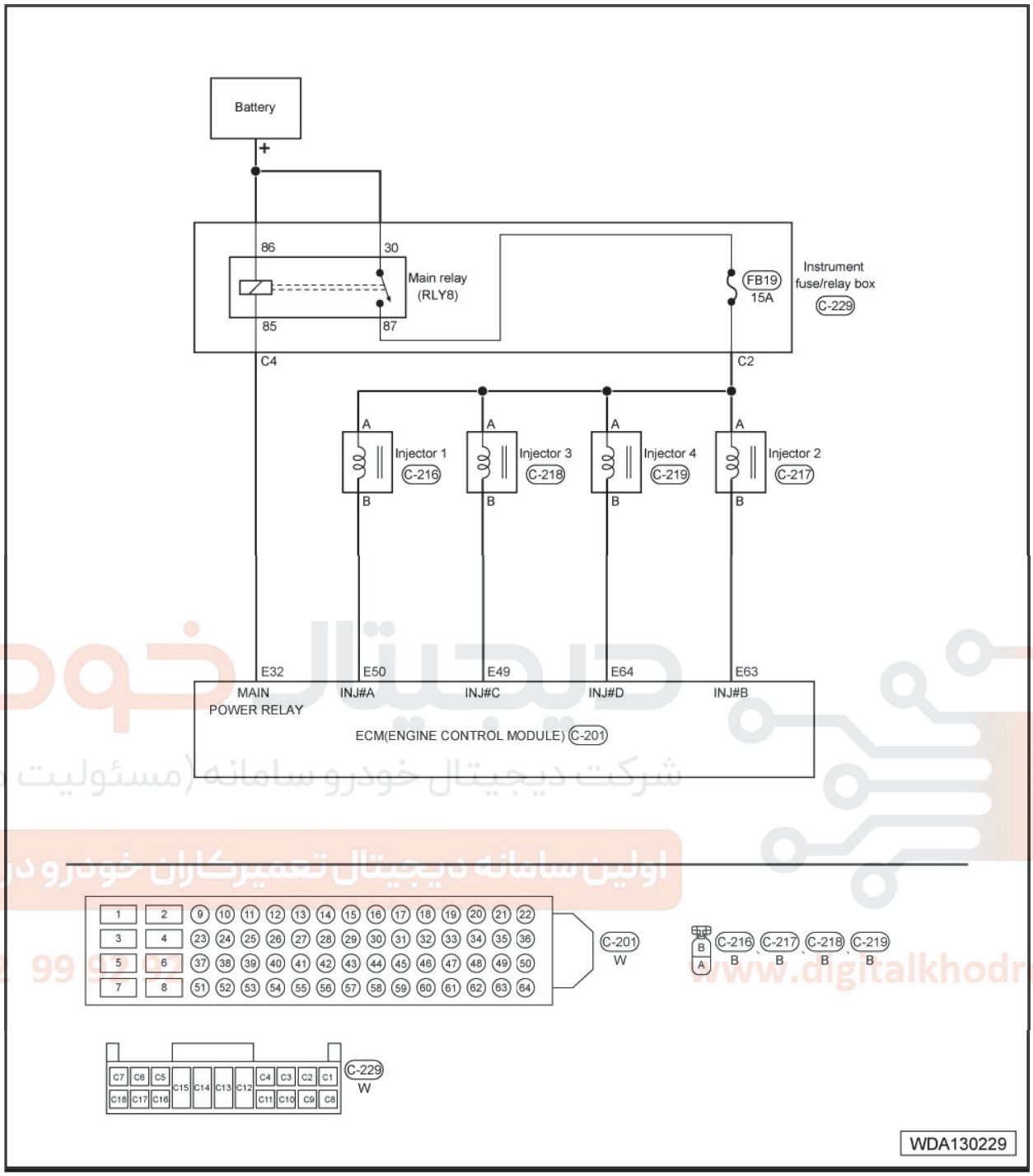

Fault code definition and fault causes

DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
P0201	Cylinder 1 - injector control circuit open circuit	Engine running	Injector circuit short to ground	• Failure of the injector • Failure of the injector circuit • Failure of the engine control module

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DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
P0202	Cylinder 2 - injector control circuit open circuit	Engine running	Injector circuit short to ground	• Failure of the injector • Failure of the injector circuit • Failure of the engine control module
P0203	Cylinder 3 - injector control circuit open circuit	Engine running	Injector circuit short to ground	• Failure of the injector • Failure of the injector circuit • Failure of the engine control module
P0204	Cylinder 4 - injector control circuit open circuit	Engine running	Injector circuit short to ground	• Failure of the injector • Failure of the injector circuit • Failure of the engine control module
P0261	Cylinder 1 - injector control circuit short to ground	Engine running	Injector circuit short to ground	• Failure of the injector • Failure of the injector circuit • Failure of the engine control module
P0262	Cylinder 1 - injector control circuit short to power	Engine running	Injector circuit short to ground	• Failure of the injector • Failure of the injector circuit • Failure of the engine control module
P0264	Cylinder 2 - injector control circuit short to ground	Engine running	Injector circuit short to ground	• Failure of the injector • Failure of the injector circuit • Failure of the engine control module
P0265	Cylinder 2 - injector control circuit short to power	Engine running	Injector circuit short to ground	• Failure of the injector • Failure of the injector circuit • Failure of the engine control module

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DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
P0267	Cylinder 3 - injector control circuit short to ground	Engine running	Injector circuit short to ground	• Failure of the injector • Failure of the injector circuit • Failure of the engine control module
P0268	Cylinder 3 - injector control circuit short to power	Engine running	Injector circuit short to ground	• Failure of the injector • Failure of the injector circuit • Failure of the engine control module
P0270	Cylinder 4 - injector control circuit short to ground	Engine running	Injector circuit short to ground	• Failure of the injector • Failure of the injector circuit • Failure of the engine control module
P0271	Cylinder 4 - injector control circuit short to power	Engine running	Injector circuit short to ground	• Failure of the injector • Failure of the injector circuit • Failure of the engine control module

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DTC test procedures:

Please confirm that the battery voltage is normal before performing the following procedures.

- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Start the engine, wait until its natural flameout.
- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.

  If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

Diagnosis procedures:

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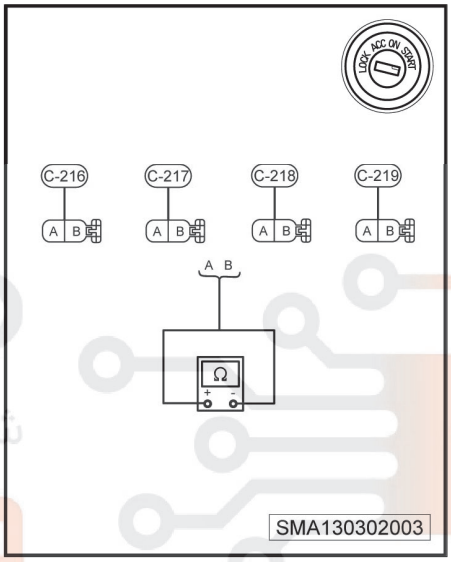
Note

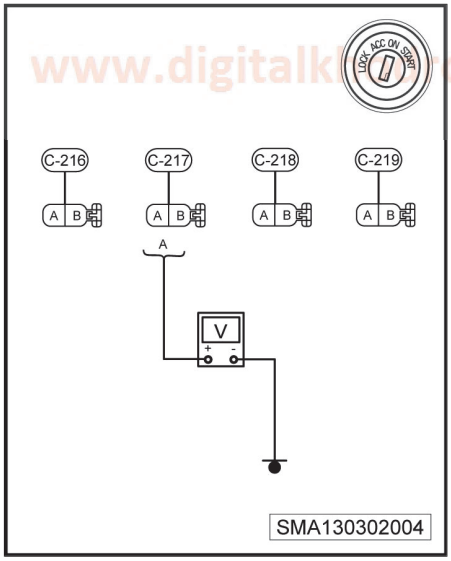
- Please verify again if the DTC and its symptoms are present after fault is rectified.
- The control principles and modes of the four injectors are the same. Therefore, cylinder 1 injector is given as an example to check the faults.

1. Check if the injector connector is corrosive, tainted or loose and if the wiring harness is damaged.
   - If yes, the connector/wiring harness fails and please repair or replace it. ■
   - If not, go to step 2.

2. Turn the ignition switch to the LOCK position, disconnect the cylinder 1 injector connector C-216 and check if the resistance between the pins A and B of C-216 is normal. (The rated resistance is 11 Ω ~ 16 Ω at 20℃)
   - If yes, go to step 3.
   - If not, the injector fails and please replace it. ■



3. Turn the ignition switch to the ON position, disconnect the cylinder 1 injector connector C-216 and check if the voltage at the pin A of C-216 is battery voltage.
   - If yes, go to step 4.
   - If not, the lead between the pin A of C-216 and the front compartment fuse box FB19 fails and please repair it. ■



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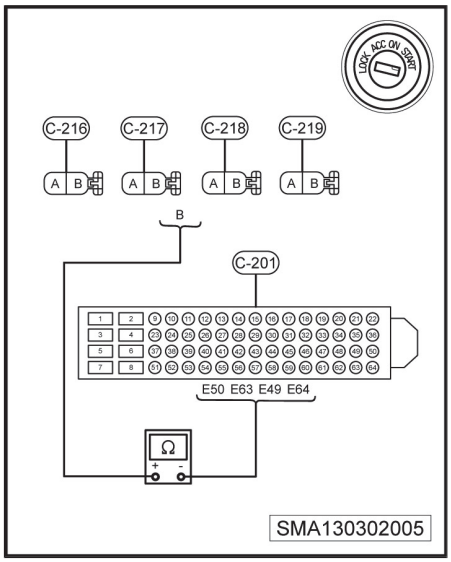
4. Turn the ignition switch to the LOCK position, disconnect the ECM connector C-201 and the cylinder 1 injector connector C-216, and check if the lead between the pin B of C-216 and the pin E50 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 5.



5. Replace the ECM control module, carry out the function test again, and read the fault code to verify if it exists or not.
   - If yes, locate fault causes from other symptoms.
   - If not, the fault has been rectified. ■

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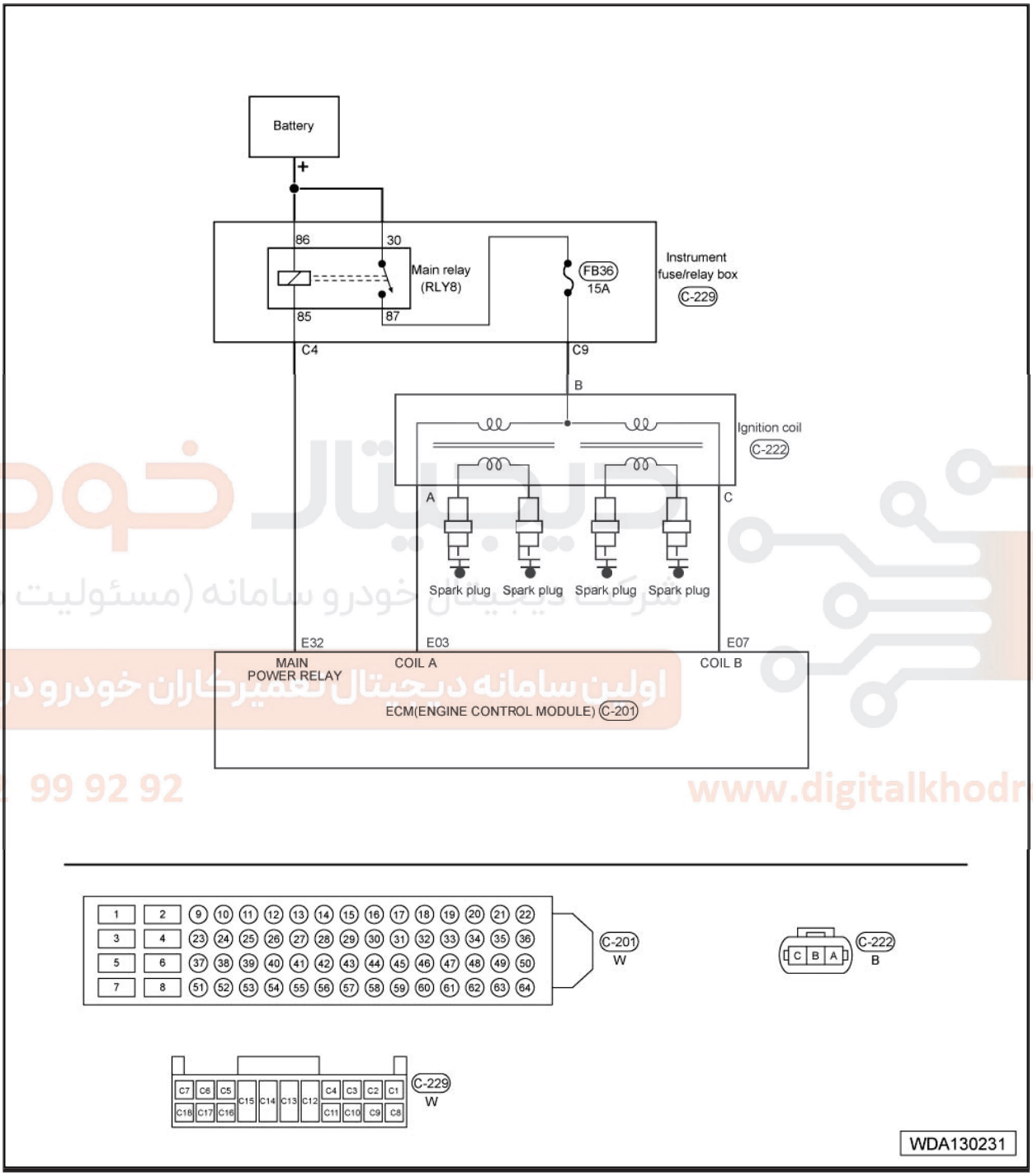
2.6.9 P0301 Cylinder 1 misfire

P0302 Cylinder 2 misfire
P0303 Cylinder 3 misfire
P0304 Cylinder 4 misfire



Fault code definition and fault causes

DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
P0301	Cylinder 1 misfire	Engine running normally	Cylinder 1 misfire detected by the diagnostic device	• Failure of the ignition coil

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DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
				• Failure of the spark plug or ignition cable • Failure of the ignition coil circuit • Failure of the engine control module
P0302	Cylinder 2 misfire	Engine running normally	Cylinder 2 misfire detected by the diagnostic device	• Failure of the ignition coil • Failure of the spark plug or ignition cable • Failure of the ignition coil circuit • Failure of the engine control module
P0303	Cylinder 3 misfire	Engine running normally	Cylinder 3 misfire detected by the diagnostic device	• Failure of the ignition coil • Failure of the spark plug or ignition cable • Failure of the ignition coil circuit • Failure of the engine control module
P03041	Cylinder 4 misfire	Engine running normally	Cylinder 4 misfire detected by the diagnostic device	• Failure of the ignition coil • Failure of the spark plug or ignition cable • Failure of the ignition coil circuit • Failure of the engine control module

DTC test procedures:

Please confirm that the battery voltage is normal before performing the following procedures.

- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Start the engine, and make it reach normal operating temperature.
- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.

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If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

Diagnosis procedures:

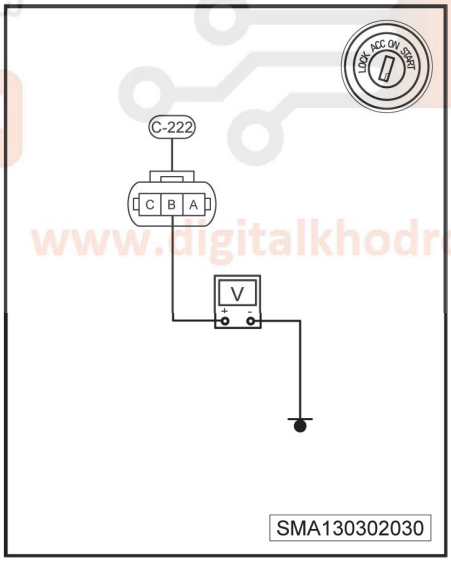
Note

- Please verify again if the DTC and its symptoms are present after fault is rectified.

1. Check if the ignition coil connector is loose or disengaged. And check if the wiring harness has leakage of electricity or is damaged.
   - If yes, the connector/wiring harness fails and please repair or replace it. ■
   - If not, go to step 2.

2. Pull out the ignition cable of each cylinder successively. Connect the spark plug, ground the spark plug housing, start the engine and check if there is blue and white high-pressure fire.
   - If yes, go to step 3.
   - If not, the spark plug or the ignition cable fails and please replace it. ■

3. Turn the ignition switch to the ON position, disconnect the ignition coil connector C-222 and check if the pin B of C-222 is battery voltage.
   - If yes, go to step 4.
   - If not, the lead between the pin B of C-222 and the front compartment fuse box FB36 fails and please repair it. ■



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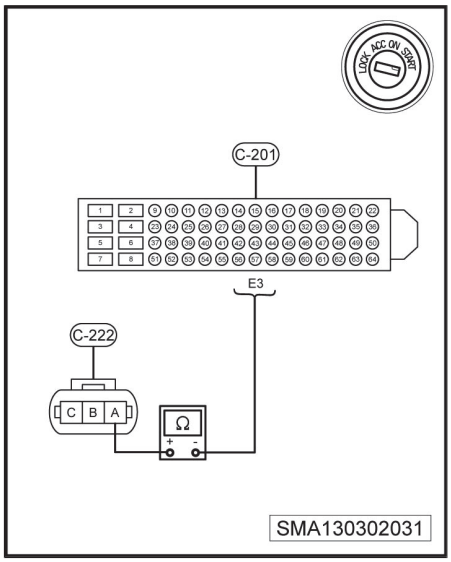
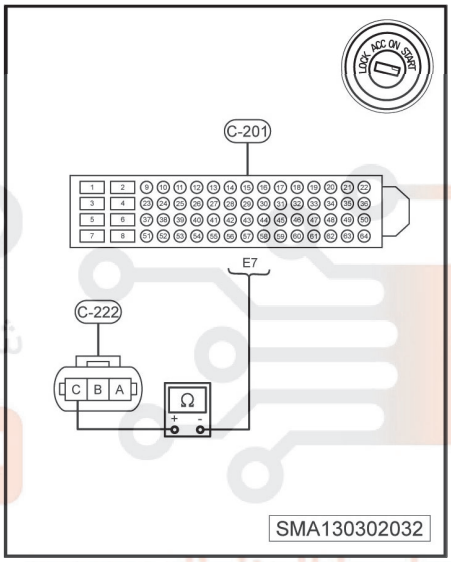
4. Turn the ignition switch to the LOCK position, disconnect the ECM connector C-201 and the ignition coil connector C-222, and check if the lead between the pin A of C-222 and the pin E3 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 5.



5. Turn the ignition switch to the LOCK position, check if the lead between the pin C of C-222 and the pin E7 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 6.



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6. Check if the ignition coil itself fails.
   - If yes, the ignition coil fails and please replace it. ■
   - If not, go to step 7.

7. Replace the ECM control module, carry out the function test again, and read the fault code to verify if it exists or not.
   - If yes, locate fault causes from other symptoms.
   - If not, the fault has been rectified. ■

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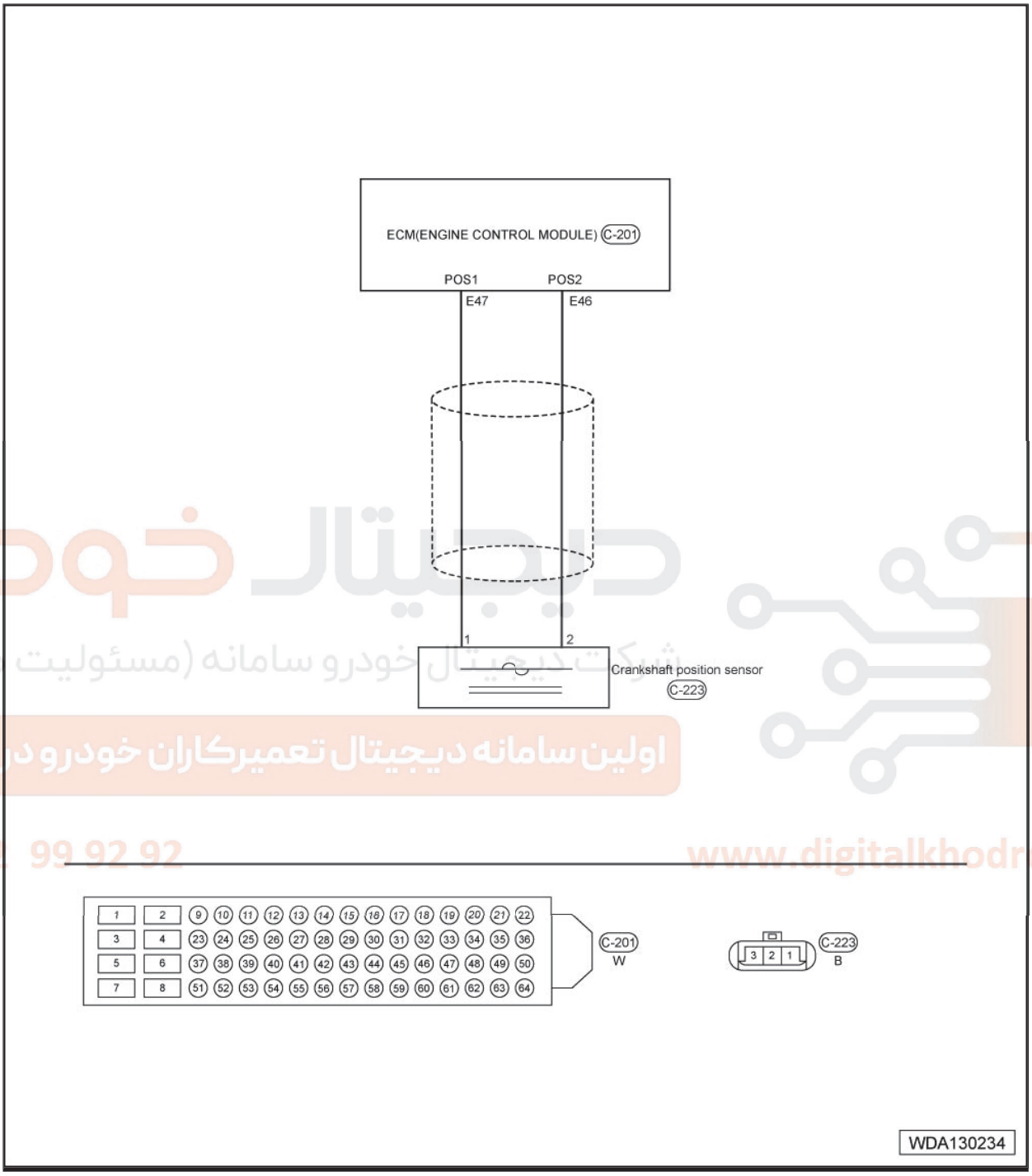
2.6.10 P0321 Crankshaft TDC signal failure

P0322 Crankshaft position sensor signal failure



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Fault code definition and fault causes

DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
P0321	Crankshaft TDC signal failure	Engine starting	Failure of the crankshaft position sensor detected by the ECM	• Failure of the crankshaft position sensor • Failure of the crankshaft

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DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
				position sensor circuit • Failure of the engine control module
P0322	Failure of the crankshaft position sensor signal	Engine starting	Failure of the crankshaft position sensor detected by the ECM	• Failure of the crankshaft position sensor • Failure of the crankshaft position sensor circuit • Failure of the engine control module

DTC test procedures:

Please confirm that the battery voltage is normal before performing the following procedures.

- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Start the engine, and make it reach normal operating temperature.
- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.

  If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

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Diagnosis procedures:

Note

- Please verify again if the DTC and its symptoms are present after fault is rectified.

1. Check if the crankshaft position sensor connector is corrosive, tainted or loose and if the wiring harness is damaged.
   - If yes, the connector/wiring harness fails and please repair or replace it. ■
   - If not, go to step 2.

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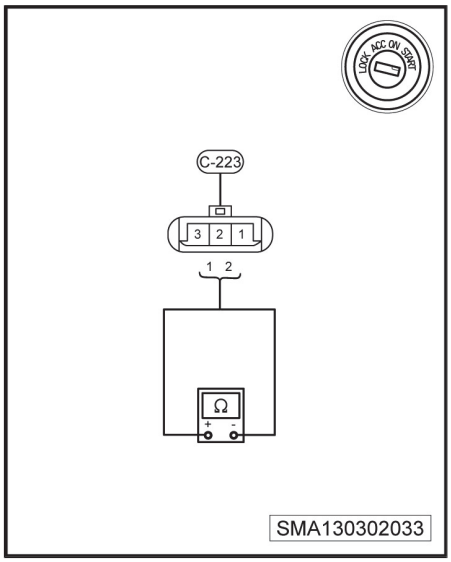
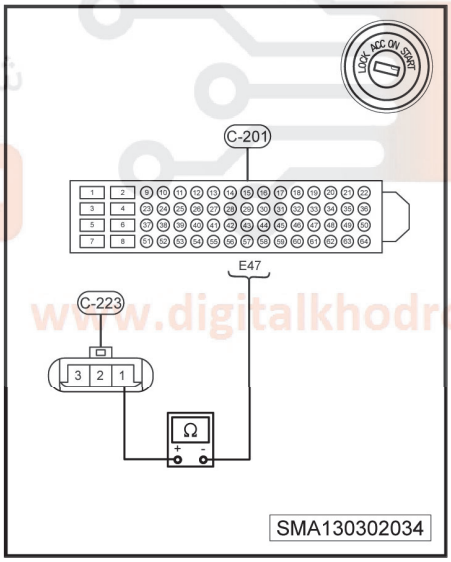
2. Turn the ignition switch to the LOCK position, disconnect the crankshaft position sensor connector C-223 and check if the resistance between the pins 1 and 2 of C-223 is normal. (The rated resistance is 860 Ω ± 20% at 23℃)
   - If yes, go to step 3.
   - If not, the crankshaft position sensor fails and please replace it. ■



3. Check if the crankshaft position sensor is stained with foreign matters and damaged.
   - If yes, the crankshaft position sensor fails and please clear or replace it. ■
   - If not, go to step 4.

4. Turn the ignition switch to the LOCK position, disconnect the ECM connector C-201 and the crankshaft position sensor connector C-223, and check if the lead between the pin 1 of C-223 and the pin E47 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 5.



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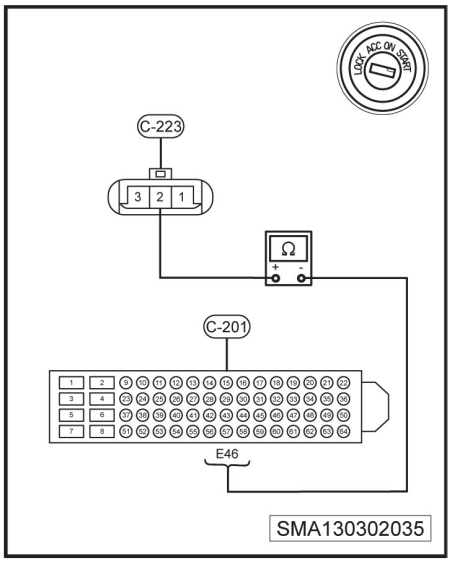
5. Turn the ignition switch to the LOCK position, check if the lead between the pin 2 of C-223 and the pin E46 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 6.



6. Replace the ECM control module, carry out the function test again, and read the fault code to verify if it exists or not.
   - If yes, locate fault causes from other symptoms.
   - If not, the fault has been rectified. ■

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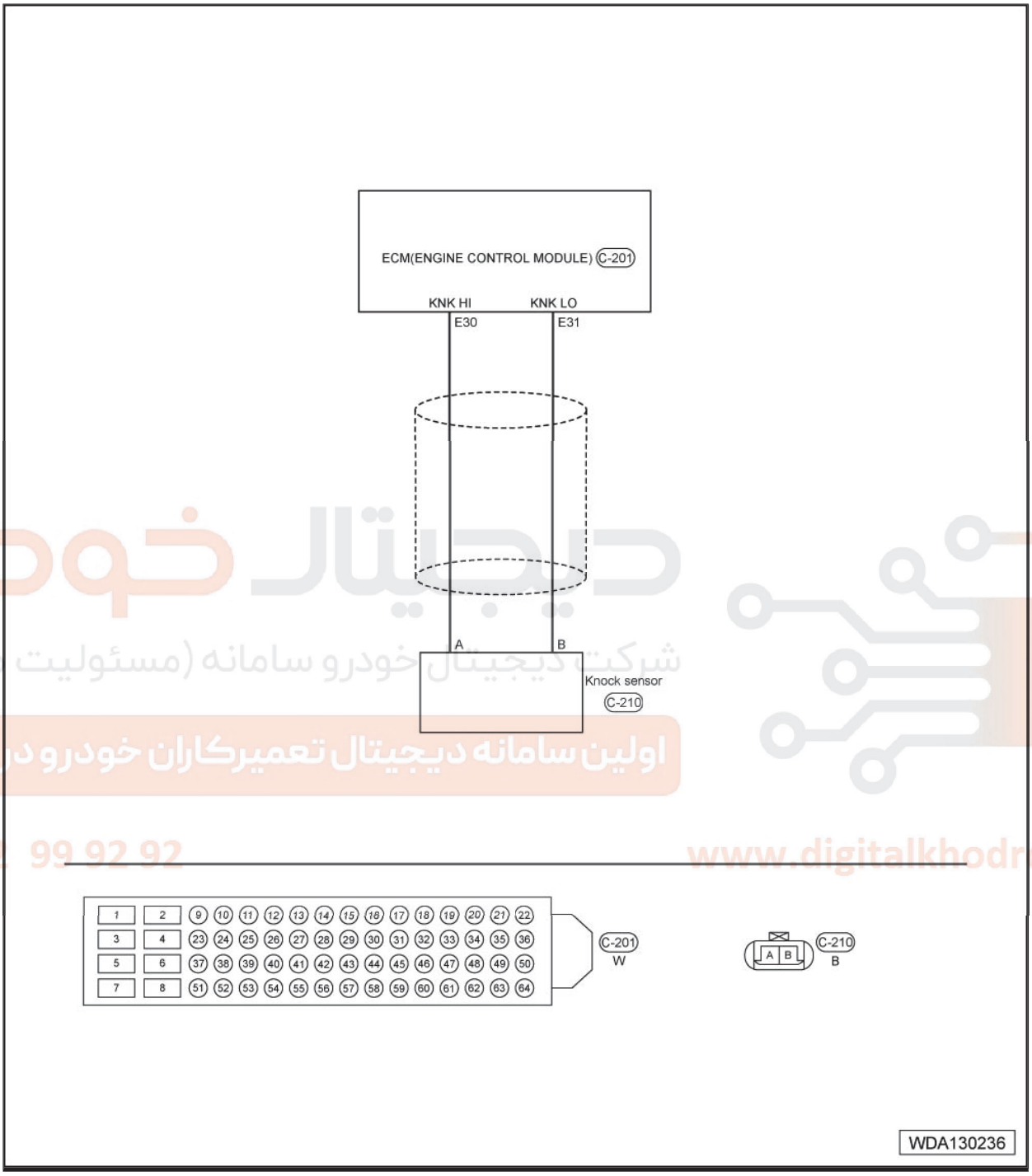
2.6.11 P0327 Knock sensor signal circuit low input
P0328 Knock sensor signal circuit high input



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Fault code definition and fault causes

DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
P0327	Knock sensor signal circuit low input	Engine running	Knock sensor signal circuit low input	• Failure of the knock sensor • Failure of the knock sensor circuit

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DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
				• Failure of the engine control module
P0328	Knock sensor signal circuit high input	Engine running	Knock sensor signal circuit high input	• Failure of the knock sensor • Failure of the knock sensor circuit • Failure of the engine control module

DTC test procedures:

Please confirm that the battery voltage is normal before performing the following procedures.

- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Start the engine, and make it reach normal operating temperature.
- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.

  If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

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Diagnosis procedures:

Note

- Please verify again if the DTC and its symptoms are present after fault is rectified.

1. Check if the knock sensor connector is corrosive, tainted or loose. And check if the wiring harness is subject to electromagnetic interference etc..
   - If yes, the connector/wiring harness fails and please repair or replace it. ■
   - If not, go to step 2.

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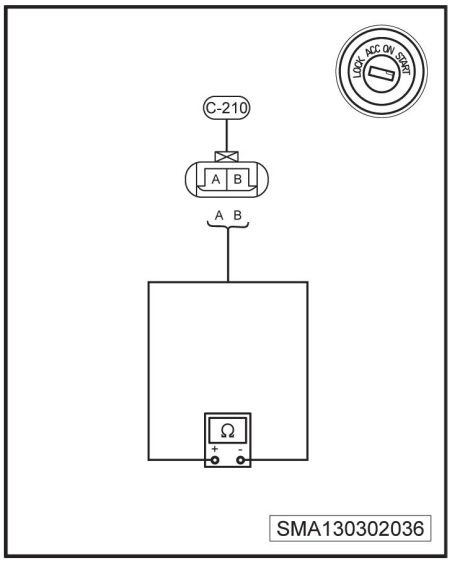
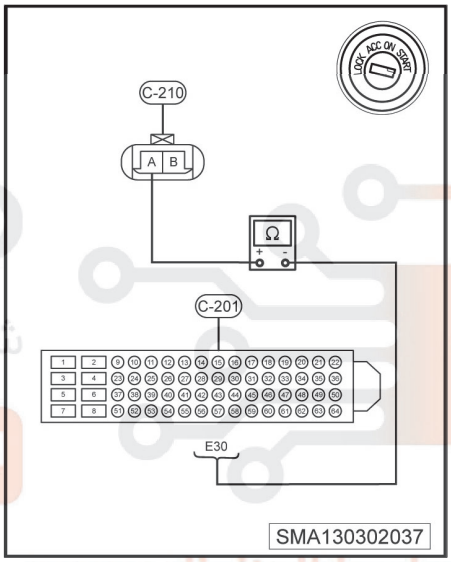
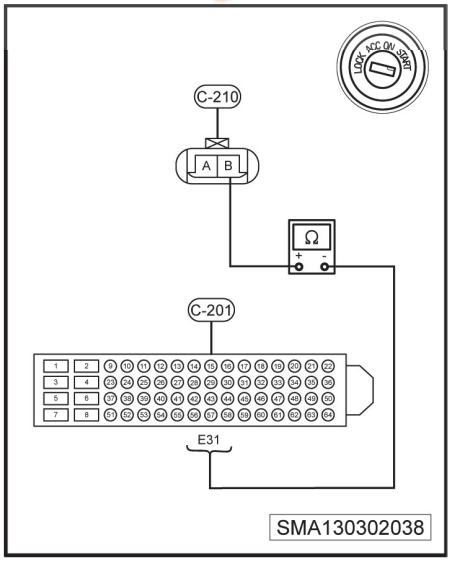
2. Turn the ignition switch to the LOCK position, disconnect the knock sensor connector C-210 and check if the resistance between the two pins of the knock sensor is greater than 1 MΩ.
   - If yes, go to step 3.
   - If not, the knock sensor fails and please replace it. ■



3. Turn the ignition switch to the LOCK position, disconnect the ECM connector C-201 and the knock sensor connector C-210, and check if the lead between the pin A of C-210 and the pin E30 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 4.



4. Turn the ignition switch to the LOCK position, check if the lead between the pin B of C-210 and the pin E31 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 5.



5. Replace the ECM control module, carry out the function test again, and read the fault code to verify if it exists or not.

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- If yes, locate fault causes from other symptoms.
- If not, the fault has been rectified. ■

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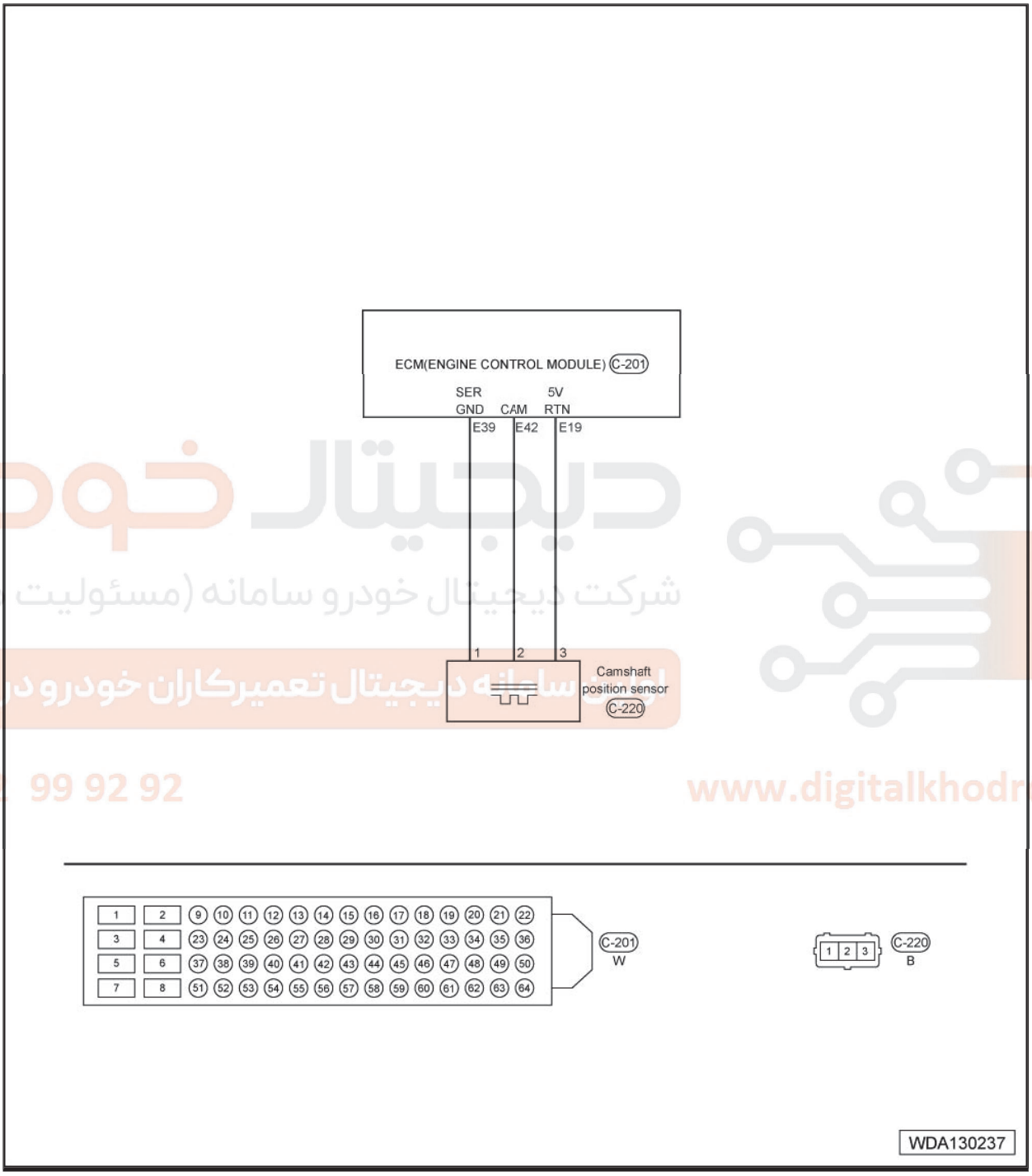
2.6.12 P0340 Improper camshaft position sensor

P0341 Camshaft position sensor poor contact
P0342 Camshaft position sensor short to ground
P0343 Camshaft position sensor short to power



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Fault code definition and fault causes

DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
P0340	Improper camshaft position sensor	The ignition switch in the ON position	Improper camshaft position sensor	• Improper timing belt position

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DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
P0341	Camshaft position sensor poor contact	The ignition switch in the ON position	Camshaft position sensor unstable signal	• Failure of the camshaft position sensor • Failure of the camshaft position sensor circuit • Failure of the engine control module
P0342	Camshaft position sensor short to ground	The ignition switch in the ON position	Camshaft position sensor wiring harness short to ground	• Failure of the camshaft position sensor • Failure of the camshaft position sensor circuit • Failure of the engine control module
P0343	Camshaft position sensor short to power	The ignition switch in the ON position	Camshaft position sensor wiring harness short to power	• Failure of the camshaft position sensor • Failure of the camshaft position sensor circuit • Failure of the engine control module

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DTC test procedures:

Please confirm that the battery voltage is normal before performing the following procedures.

- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Start the engine, and make it reach normal operating temperature.
- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.

  If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

Diagnosis procedures:

Note

- Please verify again if the DTC and its symptoms are present after fault is rectified.

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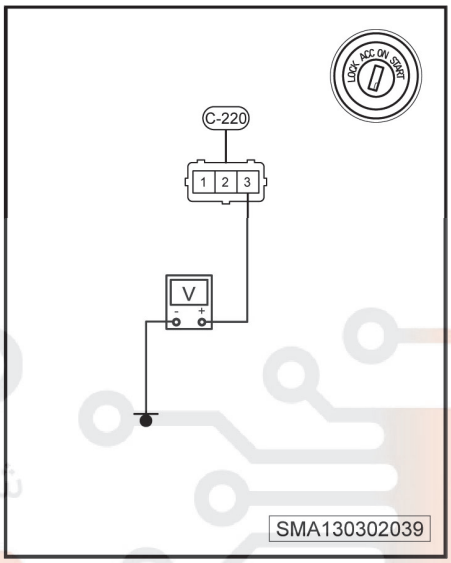
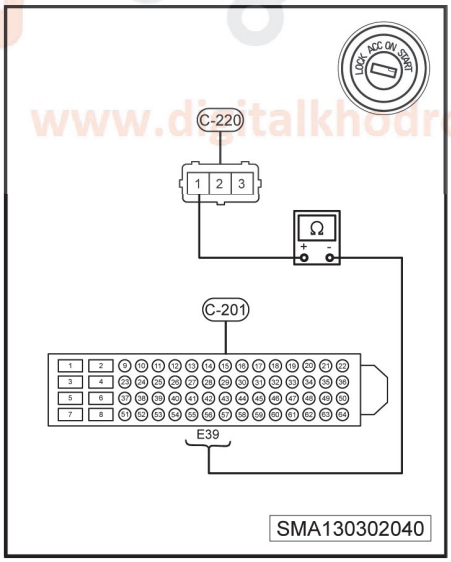
1. Check if the camshaft position sensor connector is corrosive, tainted or loose and if the wiring harness is damaged.
   - If yes, the connector/wiring harness fails and please repair or replace it. ■
   - If not, go to step 2.

2. Check if the timing belts are installed correctly.
   - If yes, go to step 3.
   - If not, reinstall the timing belts. ■

3. Turn the ignition switch to the ON position, disconnect the camshaft position sensor connector C-220 and check if the pin 3 of C-220 is 5 V.
   - If yes, go to step 4.
   - If not, the lead between the pin 3 of C-220 and the pin E19 of ECM C-201 fails and please repair it. ■



4. Turn the ignition switch to the LOCK position, disconnect the camshaft position sensor connector C-220 and the ECM connector C-201, and check if the lead between the pin 1 of C-220 and the pin E39 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 5.



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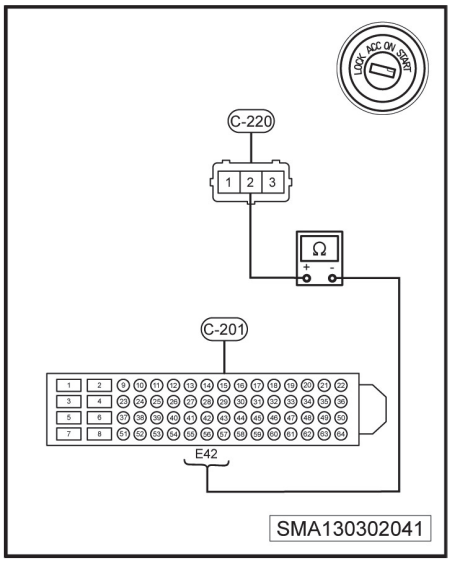
5. Turn the ignition switch to the LOCK position, check if the lead between the pin 2 of C-220 and the pin E42 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 6.



6. Replace the ECM control module, carry out the function test again, and read the fault code to verify if it exists or not.
   - If yes, locate fault causes from other symptoms.
   - If not, the fault has been rectified. ■

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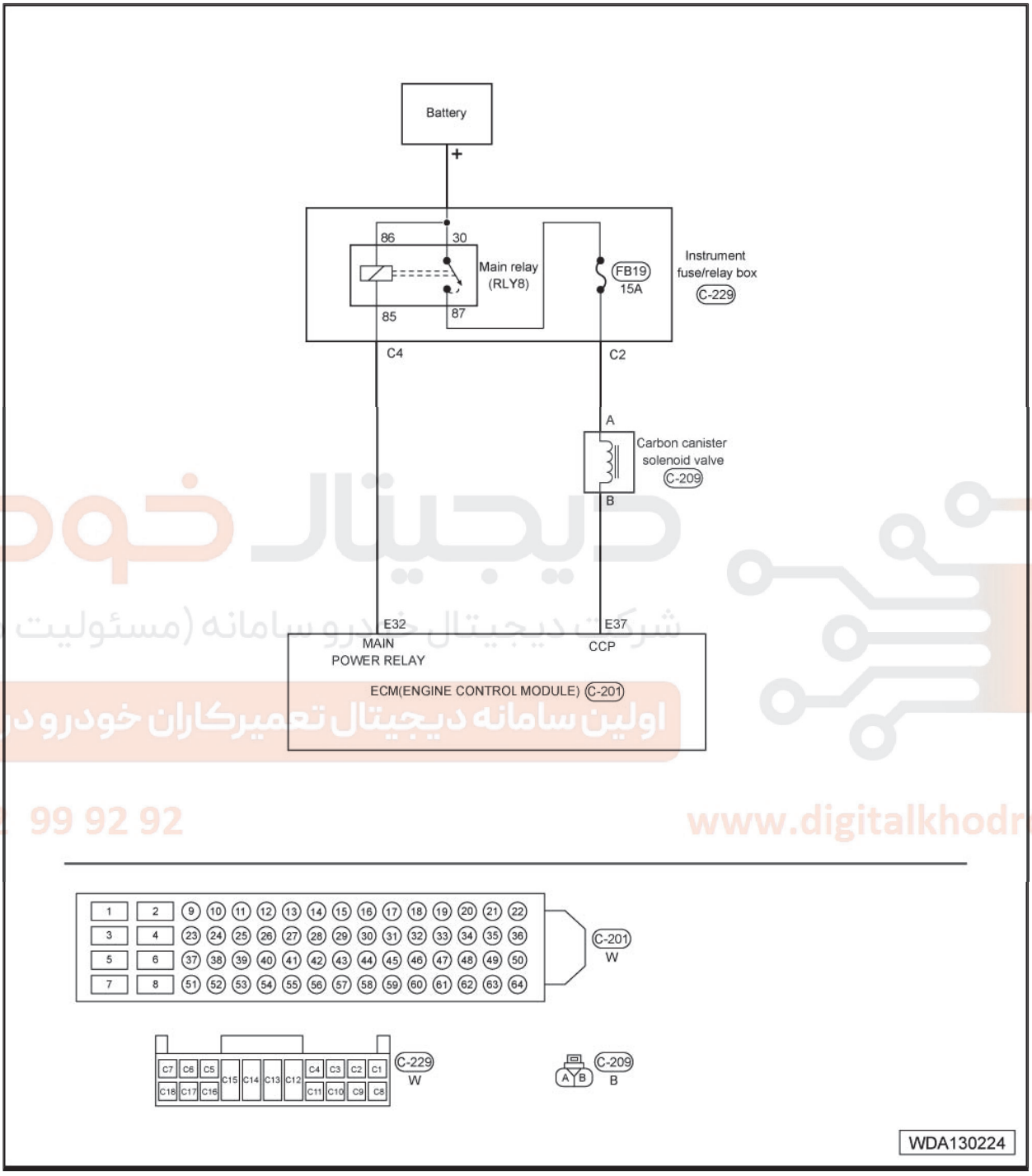
2.6.13 P0444 Carbon canister solenoid valve control circuit open circuit

P0458 Carbon canister solenoid valve control circuit low input

P0459 Carbon canister solenoid valve control circuit high input



Fault code definition and fault causes

DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
P0444	Carbon canister solenoid valve control circuit open circuit	Engine running	Carbon canister solenoid valve wiring harness open circuit	• Failure of the carbon canister solenoid valve

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DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
				• Failure of the carbon canister solenoid valve circuit • Failure of the engine control module
P0458	Carbon canister solenoid valve control circuit low input	Engine running	The carbon canister solenoid valve wiring harness short to ground	• Failure of the carbon canister solenoid valve • Failure of the carbon canister solenoid valve circuit • Failure of the engine control module
P0459	Carbon canister valve control circuit high input	Engine running	The carbon canister solenoid valve wiring harness short to power	• Failure of the carbon canister solenoid valve • Failure of the carbon canister solenoid valve circuit • Failure of the engine control module

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DTC test procedures:

Please confirm that the battery voltage is normal before performing the following procedures.

- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Start the engine, and make it reach normal operating temperature.
- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.

  If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

Diagnosis procedures:

Note

- Please verify again if the DTC and its symptoms are present after fault is rectified.

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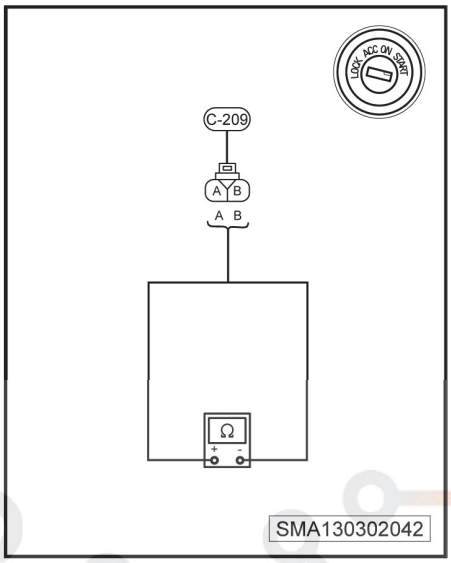
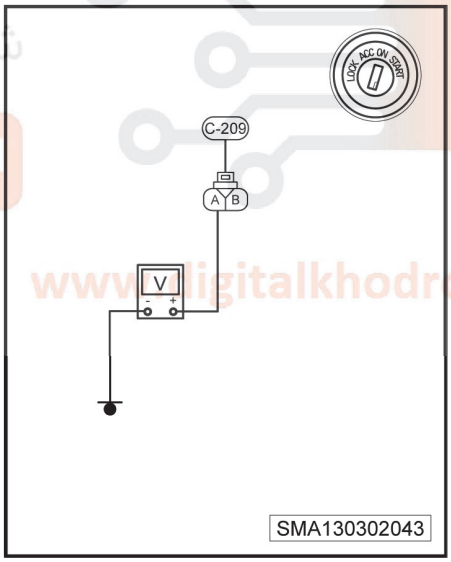
1. Check if the carbon canister solenoid valve connector is corrosive, tainted or loose and if the wiring harness is damaged.
   - If yes, the connector/wiring harness fails and please repair or replace it. ■
   - If not, go to step 2.

2. Turn the ignition switch to the LOCK position, disconnect the carbon canister solenoid valve connector C-209 and check if the resistance between the pins A and B of C-209 is normal. (The normal resistance in normal temperature is 26 Ω ± 4 Ω).
   - If yes, go to step 3.
   - If not, the carbon canister solenoid valve fails and please replace it. ■



3. Turn the ignition switch to the ON position and check if the voltage at the pin A of C-209 is battery voltage.
   - If yes, go to step 4.
   - If not, the lead between the pin A of C-209 and the front compartment fuse box FB19 fails and please repair it. ■



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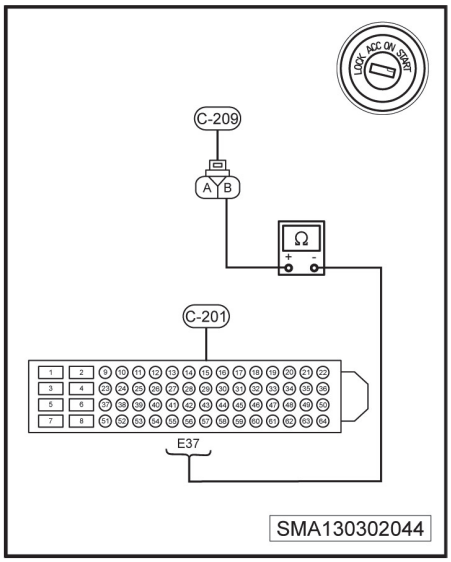
4. Turn the ignition switch to the LOCK position, disconnect the ECM connector C-201 and check if the lead between the pin B of C-209 and the pin E37 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 5.



5. Replace the ECM control module, carry out the function test again, and read the fault code to verify if it exists or not.
   - If yes, locate fault causes from other symptoms.
   - If not, the fault has been rectified. ■

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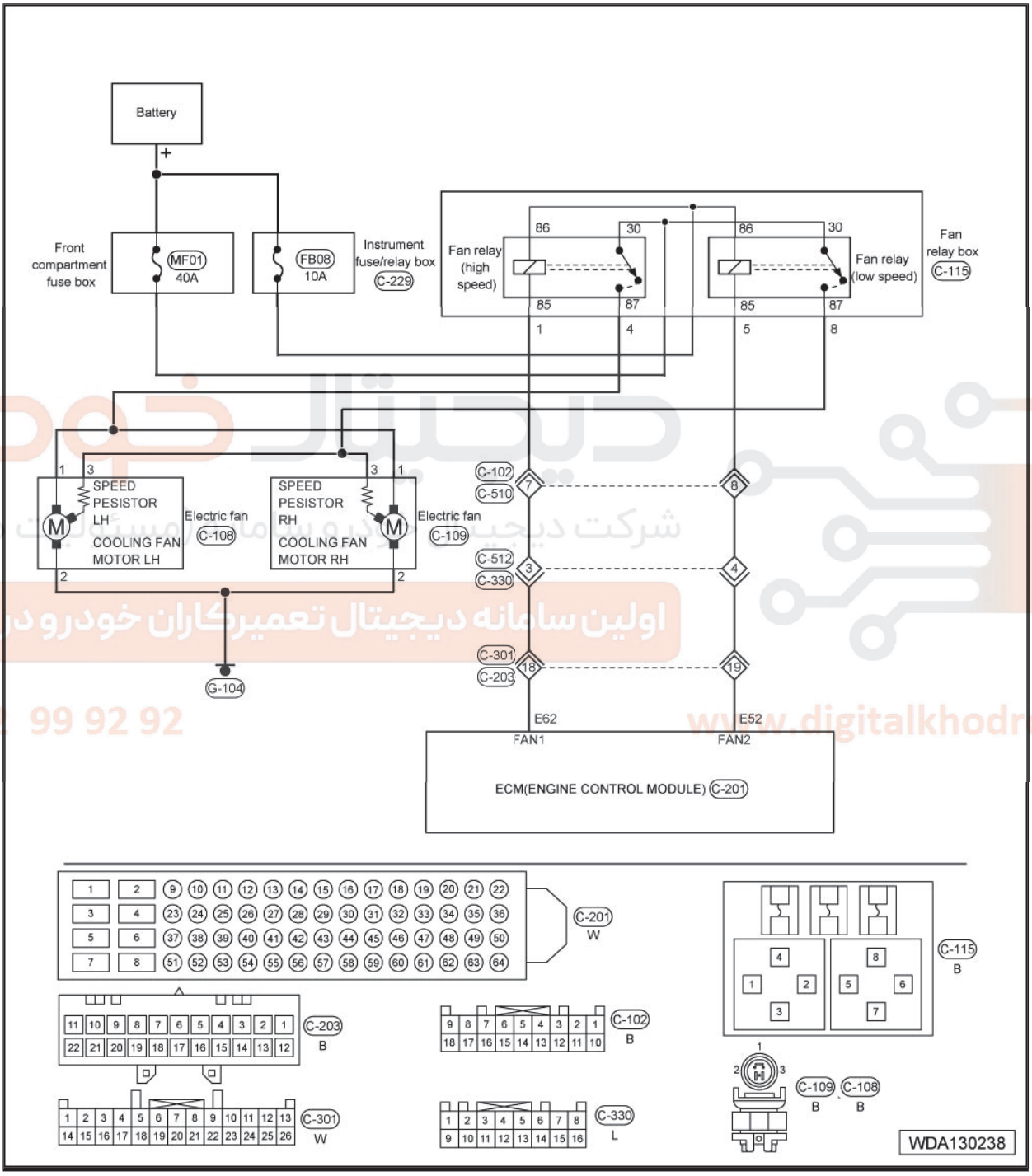
2.6.14 P0480 Cooling fan relay control circuit failure (low speed)

P0481 Cooling fan relay control circuit failure (high speed)
P0691 Cooling fan relay control circuit short to ground (low speed)
P0692 Cooling fan relay control circuit short to power (low speed)
P0693 Cooling fan relay control circuit short to ground (high speed)
P0694 Cooling fan relay control circuit short to power (high speed)



Fault code definition and fault causes

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DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
P0480	Cooling fan relay control circuit failure (low speed)	The engine running normally with the coolant temperature more than 95℃	The relay wiring harness open circuit	• Failure of the relay • Failure of the relay control circuit • Failure of the engine control module
P0691	Cooling fan relay control circuit short to ground (low speed)	The engine running normally with the coolant temperature more than 95℃	The relay wiring harness short to ground	• Failure of the relay • Failure of the relay control circuit • Failure of the engine control module
P0692	Cooling fan relay control circuit short to power (low speed)	The engine running normally with the coolant temperature more than 95℃	The relay wiring harness short to power	• Failure of the relay • Failure of the relay control circuit • Failure of the engine control module
P0481	Cooling fan relay control circuit failure (high speed)	The engine running normally with the coolant temperature more than 99℃	The relay wiring harness open circuit	• Failure of the relay • Failure of the relay control circuit • Failure of the engine control module
P0693	Cooling fan relay control circuit short to ground (high speed)	The engine running normally with the coolant temperature more than 99℃	The relay wiring harness short to ground	• Failure of the relay • Failure of the relay control circuit • Failure of the engine control module
P0694	Cooling fan relay control circuit short to power (high speed)	The engine running normally with the coolant temperature more than 99℃	The relay wiring harness short to power	• Failure of the relay • Failure of the relay control circuit • Failure of the engine control module

DTC test procedures:

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Please confirm that the battery voltage is normal before performing the following procedures.

- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Start the engine, and make it reach normal operating temperature.
- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.

  If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

Diagnosis procedures:

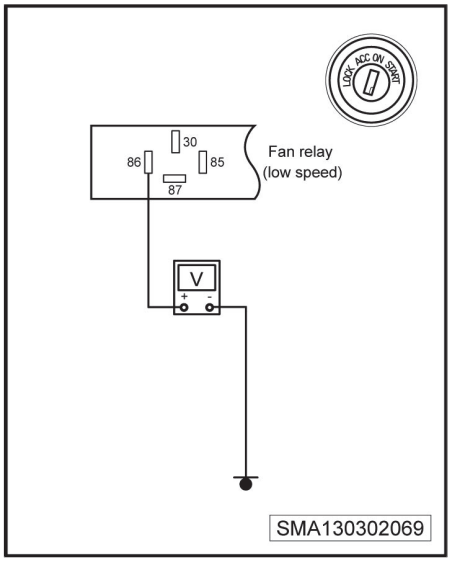
Note

- Please verify again if the DTC and its symptoms are present after fault is rectified.

1. Check if the cooling fan fuses FB17 (15A) and MFO1 (40A) are normal.
   - If yes, go to step 2.
   - If not, the fuse FB17 or MFO1 fails and please replace it. ■

2. Pull out the low speed cooling fan relay and check if the resistance value of the relay coil is normal. Lever out the relay housing to check if the closed contact is normal.
   - If yes, go to step 3.
   - If not, the low speed cooling fan relay fails and please repair it. ■

3. Pull out the low speed cooling fan relay to check if the voltage of its pin 86 is battery voltage.
   - If yes, go to step 4.
   - If not, the lead between the fuse FB17 and the low speed cooling fan relay pin 86 fails and please repair it. ■



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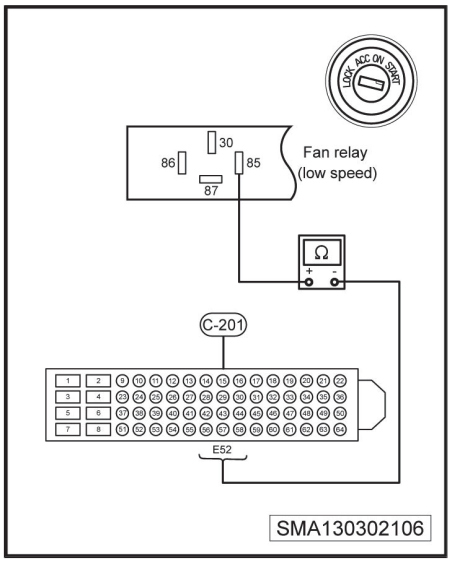
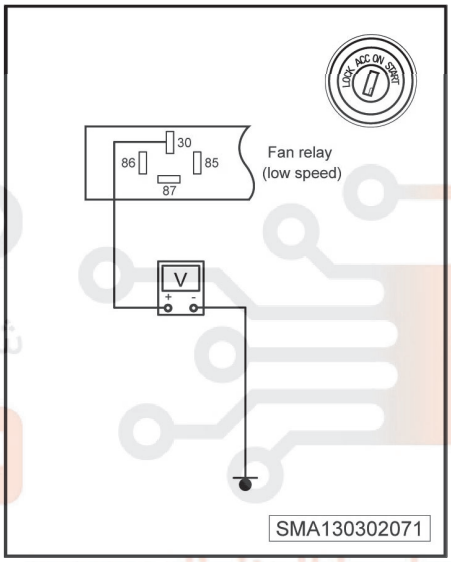
4. Pull out the low speed cooling fan relay, disconnect the ECM connector C-202 and check if the lead between the pin 85 of the low speed cooling fan relay and the pin E52 of C-202 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 5.



5. Pull out the low speed cooling fan relay to check if the voltage of its pin 30 is battery voltage.
   - If yes, go to step 6.
   - If not, the lead between the fuse MFO1 and the low speed cooling fan relay pin 30 fails and please repair it. ■



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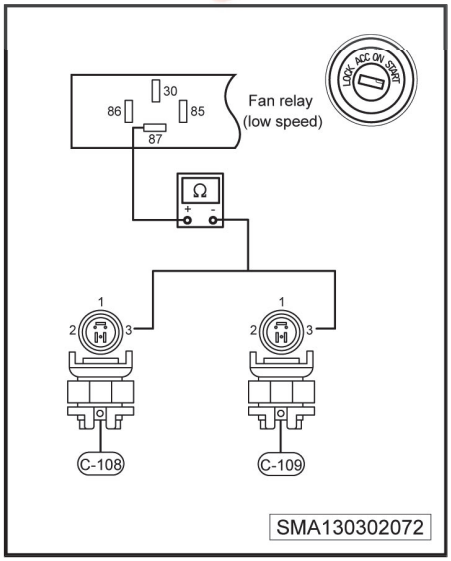
6. Pull out the low speed cooling fan relay, disconnect the cooling fan connectors C-108 and C-109, and check if the lead between the pin 87 of the low speed cooling fan relay and the pins 3 of C-108 and 3 of C-109 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 7.



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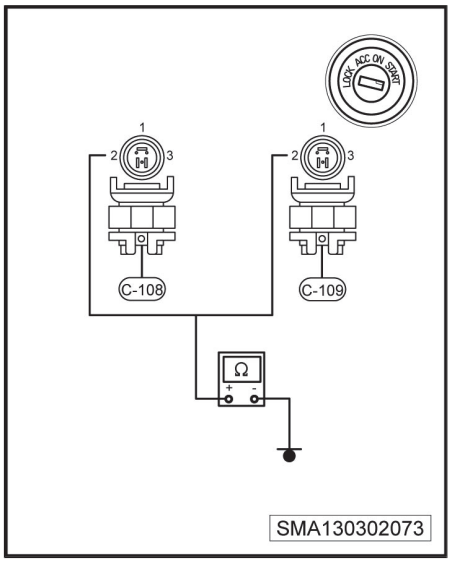
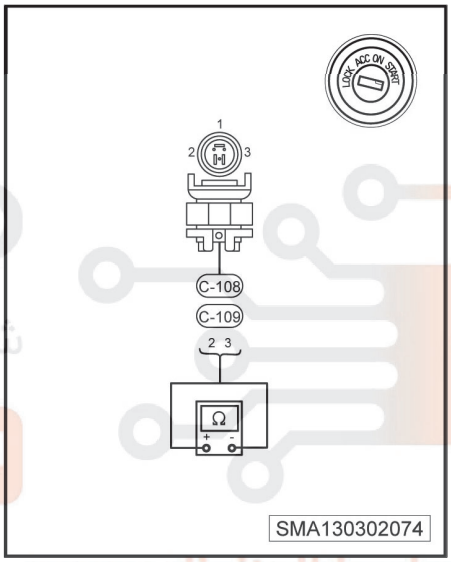
7. Disconnect the cooling fan connectors C-108 and C-109 and check if the lead between the ground point and the pins 2 of C-108 and 2 of C-109 is normal.
   - If yes, go to step 8.
   - If not, the lead between the ground point and the pins 2 of C-108 and 2 of C-109 fails and please repair it. ■



8. Disconnect the cooling fan connectors C-108 and C-109 and check if the resistance value between the pins 2 and 3 of C-108 or the pins 2 and 3 of C-109 is normal. (The measured value is about 0.8 Ω.)
   - If yes, go to step 9.
   - If not, the cooling fan fails and please repair it. ■



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9. Pull out the high speed cooling fan relay and check if the resistance value of the relay coil is normal. Lever out the relay housing to check if the contact switch is normal.
   - If yes, go to step 10.
   - If not, the high speed cooling fan relay fails and please repair it. ■

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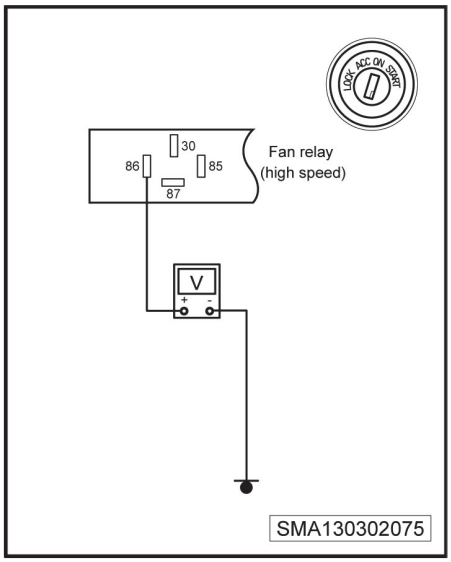
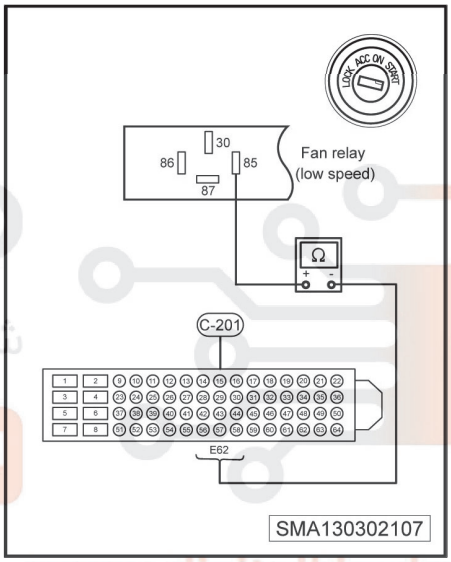
10. Pull out the low speed cooling fan relay to check if the voltage of its pin 86 is battery voltage.

- If yes, go to step 11.
- If not, the lead between the fuse FB17 and the high speed cooling fan relay pin 86 fails and please repair it. ■



11. Pull out the high speed cooling fan relay, disconnect the ECM connector C-202 and check if the lead between the pin 85 of the high speed cooling fan relay and the pin E52 of C-202 has short or open circuit.

- If yes, repair the defective lead. ■
- If not, go to step 12.



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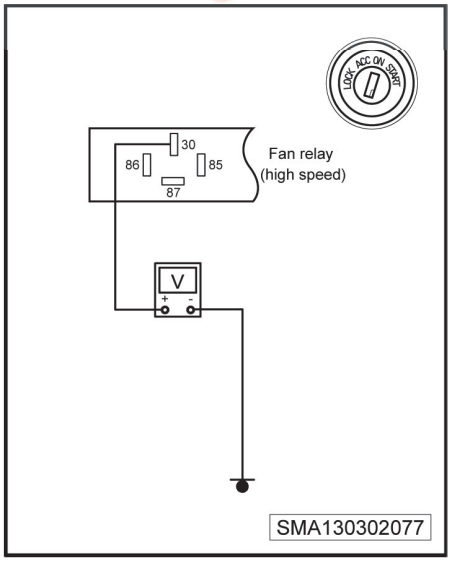
12. Pull out the low speed cooling fan relay to check if the voltage of its pin 30 is battery voltage.

- If yes, go to step 13.
- If not, the lead between the fuse MFO1 and the high speed cooling fan relay pin 30 fails and please repair it. ■



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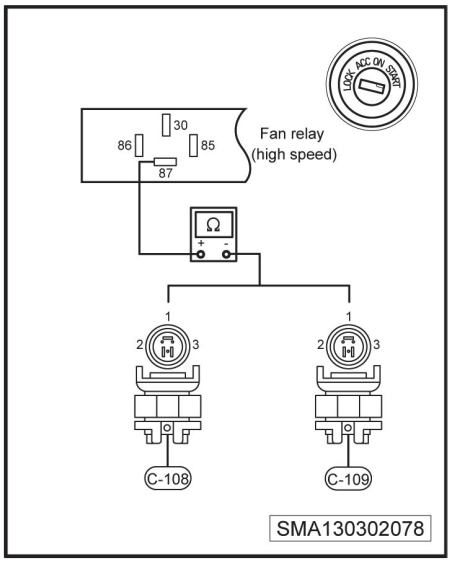
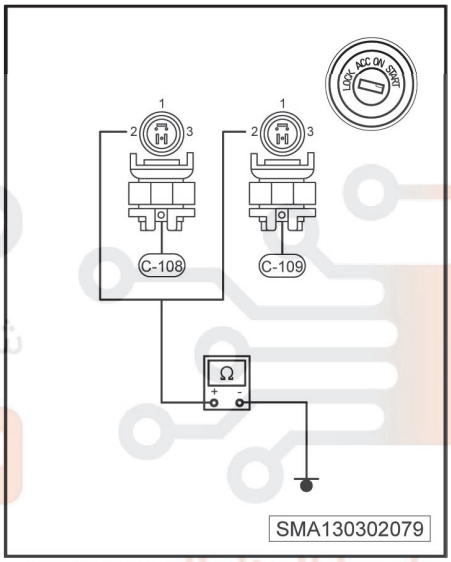
13. Pull out the high speed cooling fan relay, disconnect the cooling fan connectors C-108 and C-109, and check if the lead between the pin 87 of the high speed cooling fan relay and the pins 1 of C-108 and 1 of C-109 has short or open circuit.

- If yes, repair the defective lead. ■
- If not, go to step 14.



14. Disconnect the cooling fan connectors C-108 and C-109 and check if the lead between the ground point and the pins 2 of C-108 and 2 of C-109 is normal.

- If yes, the lead between the ground point and the pins 2 of C-108 and 2 of C-109 fails and please repair it. ■
- If not, go to step 15.



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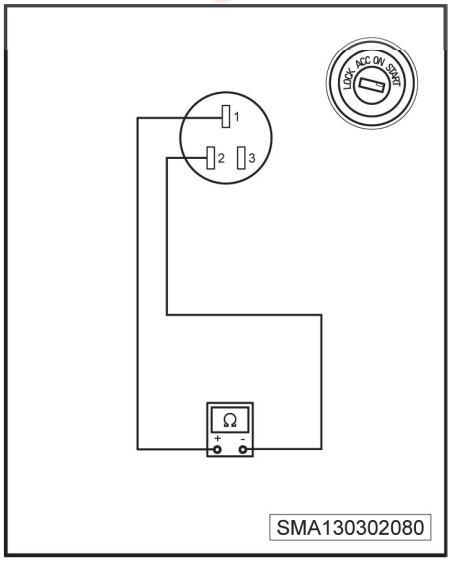
15. Disconnect the cooling fan connectors C-108 and C-109 and check if the resistance value between the pins 2 and 1 of C-108 or the pins 2 and 1 of C-109 is normal.

- If yes, go to step 16.
- If not, the cooling fan fails and please repair it. ■



16. Replace the ECM control module, carry out the function test again, and read the fault code to verify if it exists or not.

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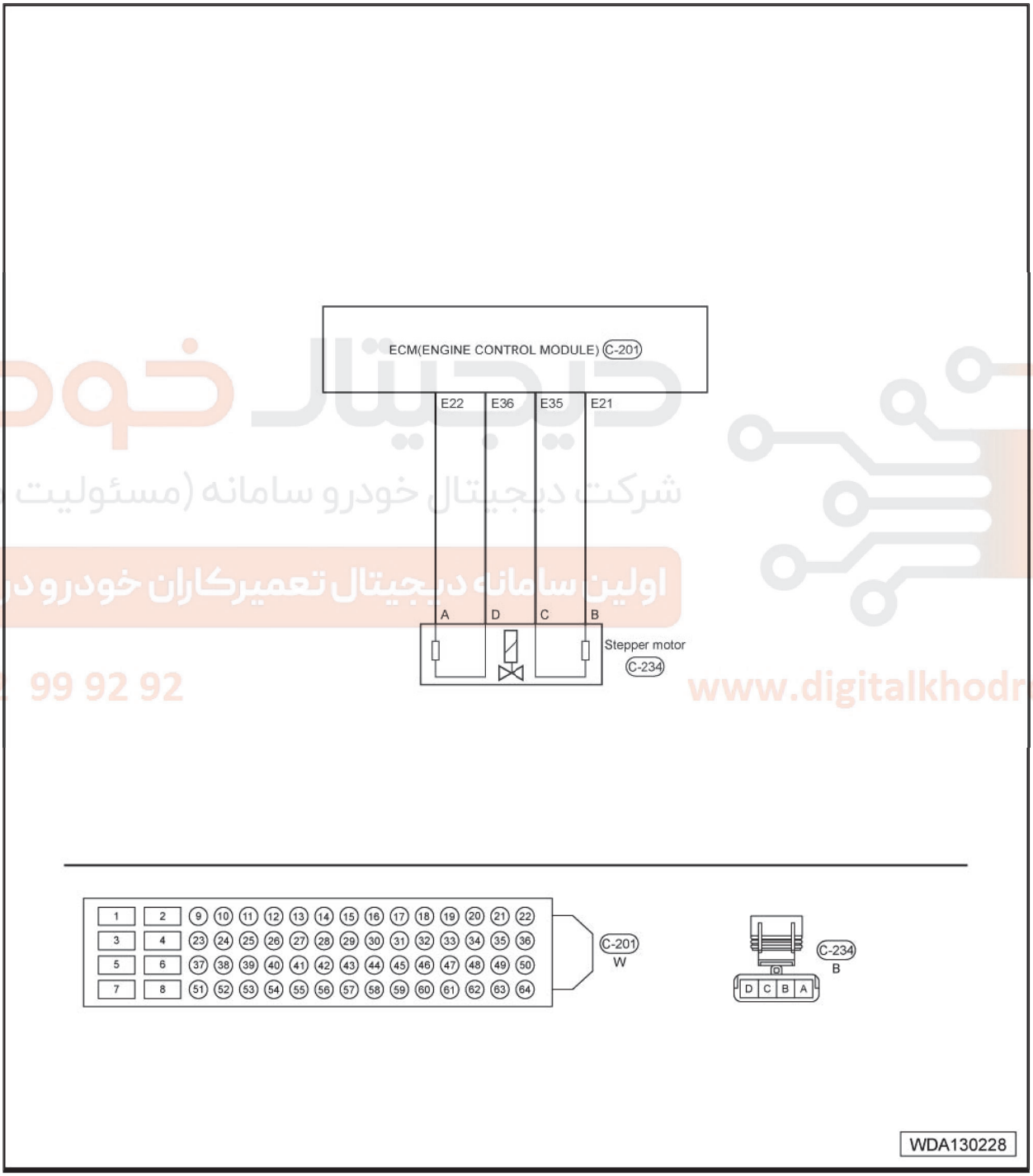
- If yes, locate fault causes from other symptoms.
- If not, the fault has been rectified. ■

2.6.15 P0508 Idling stepper motor control circuit short to ground

P0509 Idling stepper motor control circuit short to power
P0511 Idling stepper motor control circuit failures



Fault code definition and fault causes

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DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
P0508	Idling stepper motor control circuit short to ground	Engine idle running	Idling stepper motor wiring harness short to ground	• Failure of the idling stepper motor • Failure of the idling stepper motor circuit • Failure of the engine control module
P0509	Idling stepper motor control circuit short to power	Engine idle running	Idling stepper motor wiring harness short to power	• Failure of the idling stepper motor • Failure of the idling stepper motor circuit • Failure of the engine control module
P0511	Idling stepper motor control circuit failures	Engine idle running	Failures of the idling stepper motor detected by the ECM	• Failure of the idling stepper motor • Failure of the idling stepper motor circuit • Failure of the engine control module

DTC test procedures:

Please confirm that the battery voltage is normal before performing the following procedures.

- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Start the engine, and make it reach normal operating temperature.
- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.

  If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

Diagnosis procedures:

Note

- Please verify again if the DTC and its symptoms are present after fault is rectified.

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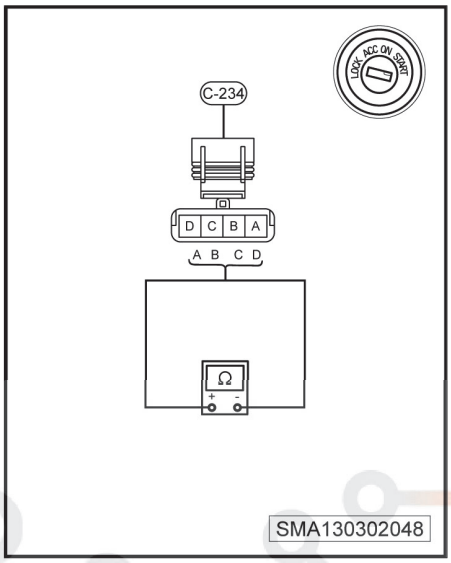
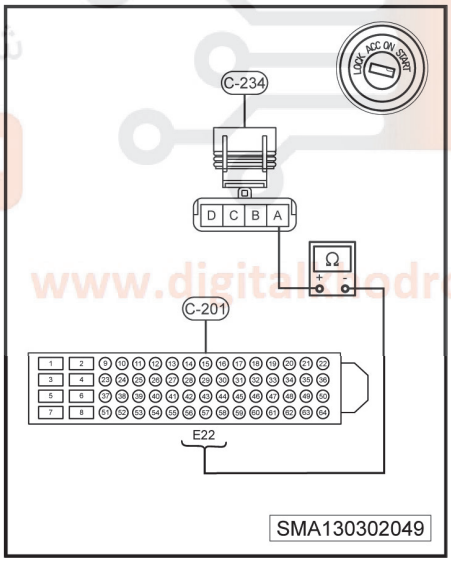
1. Check if the idling stepper motor connector is corrosive, tainted or loose. And check if the wiring harness is damaged.
   - If yes, the connector/wiring harness fails and please repair or replace it. ■
   - If not, go to step 2.

2. Turn the ignition switch to the LOCK position, disconnect the idling stepper motor connector C-234 and respectively check if the resistance value between the pins A and D of C-234 or the pins B and C of C-234 is normal. (The rated resistance value is 53±5.3 Ω at 27℃.)
   - If yes, go to step 3.
   - If not, the idling stepper motor fails and please replace it. ■



3. Turn the ignition switch to the LOCK position, disconnect the ECM connector C-201 and the idling stepper motor connector C-234 and check if the lead between the pin A of C-234 and the pin E22 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 4.



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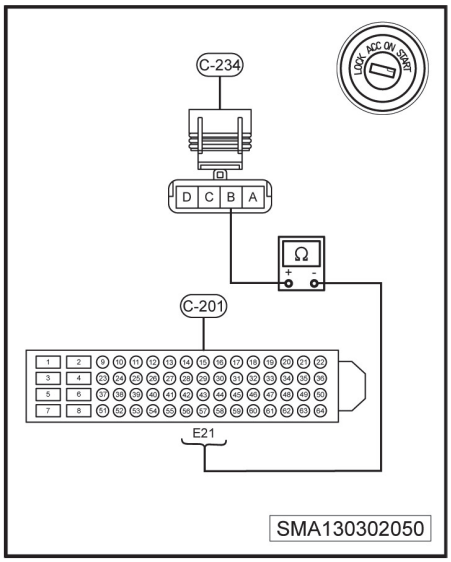
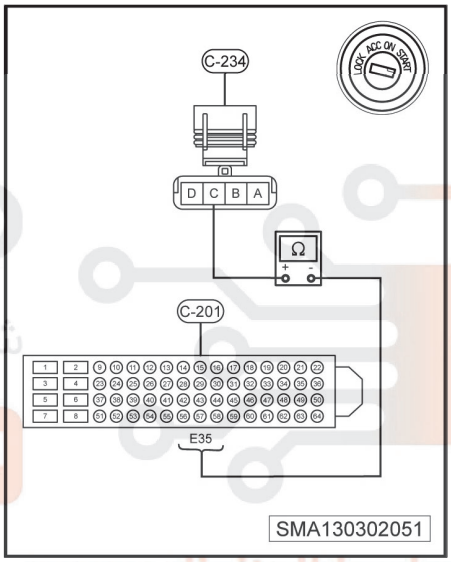
4. Turn the ignition switch to the LOCK position, check if the lead between the pin B of C-234 and the pin E21 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 5.



5. Turn the ignition switch to the LOCK position, check if the lead between the pin C of C-234 and the pin E35 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 6.



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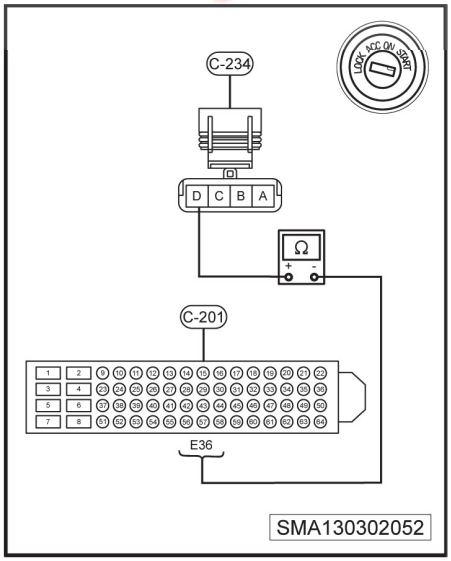
6. Turn the ignition switch to the LOCK position, check if the lead between the pin D of C-234 and the pin E36 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 7.



7. Replace the ECM control module, carry out the function test again, and read the fault code to verify if it exists or not.

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- If yes, locate fault causes from other symptoms.
- If not, the fault has been rectified. ■

2.6.16 P0560 Improper system voltage signal

P0562 System voltage low
P0563 System voltage high

Fault code definition and fault causes

DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
P0560	Improper system voltage signal	Engine running	System voltage unstable	• Failure of the battery • Failure of the generator • Failure of the engine control module
P0562	System voltage low	Engine running	System voltage lower than 9.5 V	• Failure of the battery • Failure of the generator • Failure of the engine control module
P0563	System voltage high	Engine running	System voltage higher than 16 V	• Failure of the battery • Failure of the generator • Failure of the engine control module

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DTC test procedures:

Please confirm that the battery voltage is normal before performing the following procedures.

- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Start the engine, and make it reach normal operating temperature.
- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.

  If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

Diagnosis procedures:

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Note

- Please verify again if the DTC and its symptoms are present after fault is rectified.

1. Check if the battery/generator connector is corrosive, tainted or loose. And check if the wiring harness is damaged.
   - If yes, the connector/wiring harness fails and please repair or replace it. ■
   - If not, go to step 2.

2. Check if the generated energy of the generator is in the normal range.
   - If yes, go to step 3.
   - If not, the generator fails and please replace it. ■

3. Check if the battery is normal.
   - If yes, go to step 4.
   - If not, the battery fails and please replace it. ■

4. Replace the ECM control module, carry out the function test again, and read the fault code to verify if it exists or not.
   - If yes, locate fault causes from other symptoms.
   - If not, the fault has been rectified. ■

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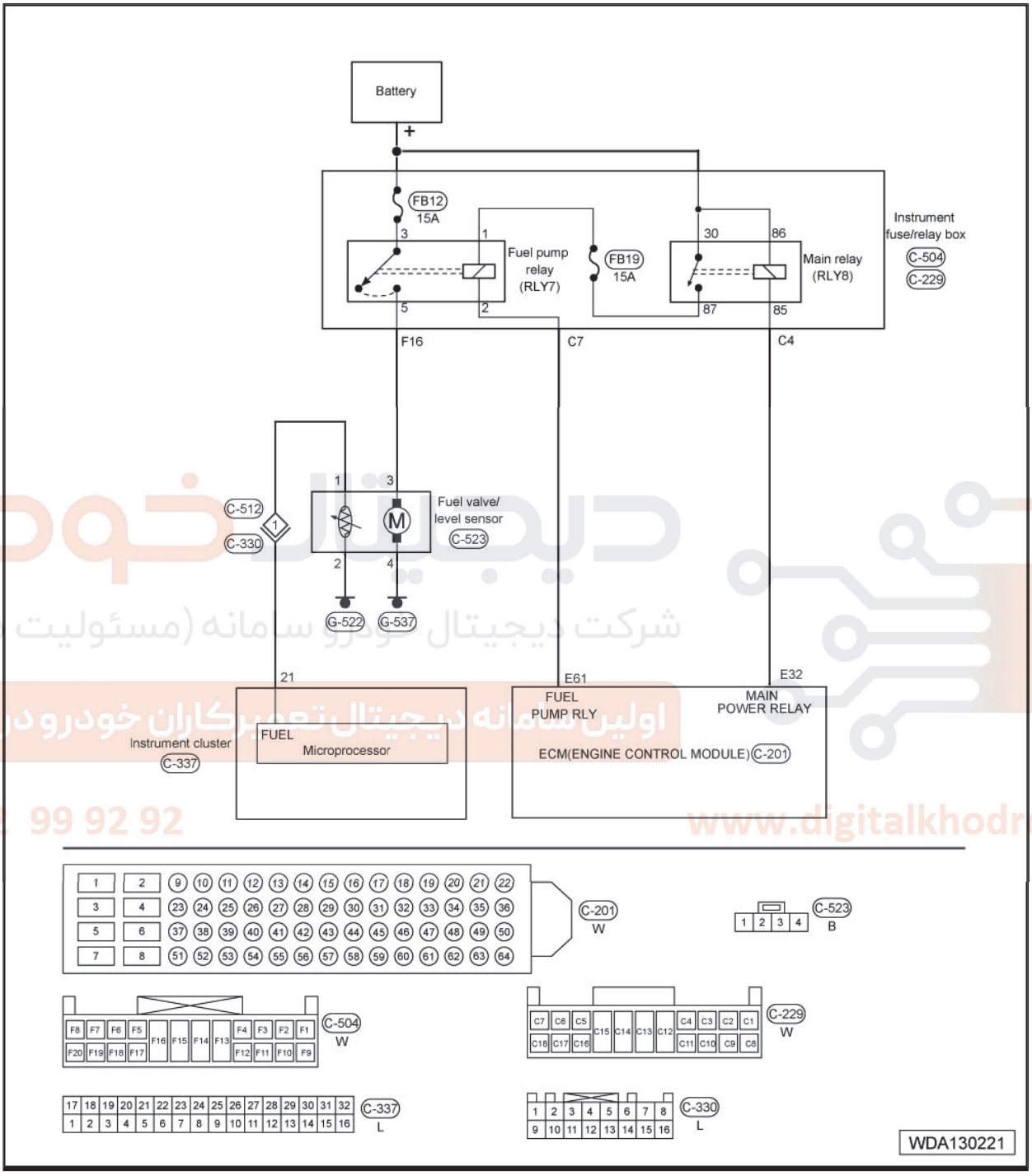
2.6.17 P0627 Fuel pump relay control circuit open circuit

P0628 Fuel pump relay control circuit short to ground

P0629 Fuel pump relay control circuit short to power



Fault code definition and fault causes

DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
P0627	Fuel pump relay control circuit open circuit	The ignition switch in the ON position	Fuel pump relay control circuit open circuit	• Failure of the relay

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DTC	DTC definition	DTC detection condition	DTC triggering condition	Possible causes
				• Failure of the relay control circuit • Failure of the engine control module
P0628	Fuel pump relay control circuit short to ground	The ignition switch in the ON position	Fuel pump relay control circuit short to ground	• Failure of the relay • Failure of the relay control circuit • Failure of the engine control module
P0629	Fuel pump relay control circuit short to power	The ignition switch in the ON position	Fuel pump relay control circuit short to power	• Failure of the relay • Failure of the relay control circuit • Failure of the engine control module

DTC test procedures:

Please confirm that the battery voltage is normal before performing the following procedures.

- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.

  If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

Diagnosis procedures:

Note

- Please verify again if the DTC and its symptoms are present after fault is rectified.

1. Check if the fuel pump relay RLY7 fails.
   - If yes, the relay fails and please replace it. ■
   - If not, go to step 2.

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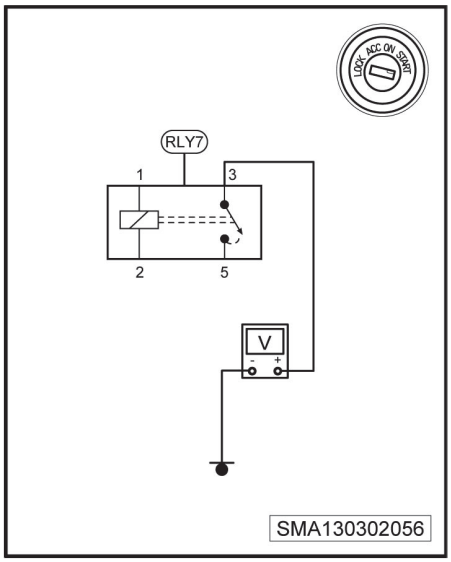
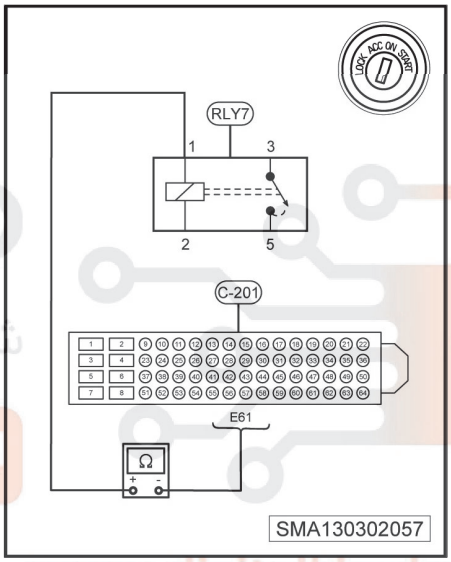
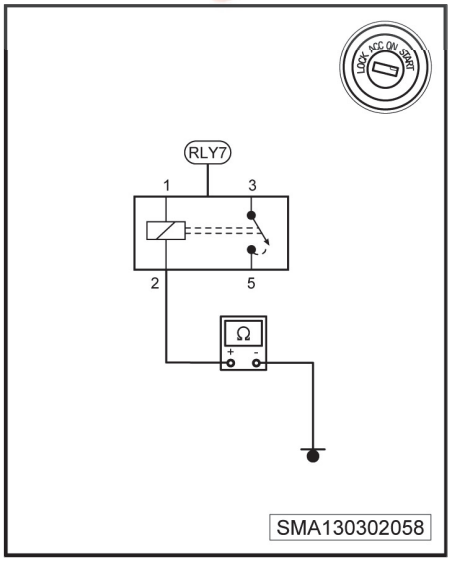
2. Turn the ignition switch to the LOCK position and check if the voltage at the pin 3 of the fuel pump relay is the battery voltage.
   - If yes, go to step 3.
   - If not, the lead between the pin 3 of the fuel pump relay and the front compartment fuse box FB12 fails and please repair it. ■



3. Turn the ignition switch to the LOCK position, disconnect the ECM connector C-201, pull out the fuel pump relay RLY7 and check if the lead between the pin E61 of C-201 and the pin 1 of RLY7 has short or open circuit.
   - If yes, the lead between the pin E61 of C-201 and the pin 1 of the RLY7 fails and please repair it. ■
   - If not, go to step 4.



4. Turn the ignition switch to the LOCK position and check if the lead between the pin 2 of the fuel pump relay and the ground point of G-205 has short or open circuit.
   - If yes, the lead between the pin 2 of the fuel pump relay and the ground point of G-205 fails and please repair it. ■
   - If not, go to step 5.



5. Turn the ignition switch to the LOCK position and check if the ground point of G-205 is corrosive or bad grounded.

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- If yes, repair the G-205 ground point. ■
- If not, go to step 6.

6. Replace the ECM control module, carry out the function test again, and read the fault code to verify if it exists or not.
   - If yes, locate fault causes from other symptoms.
   - If not, the fault has been rectified. ■

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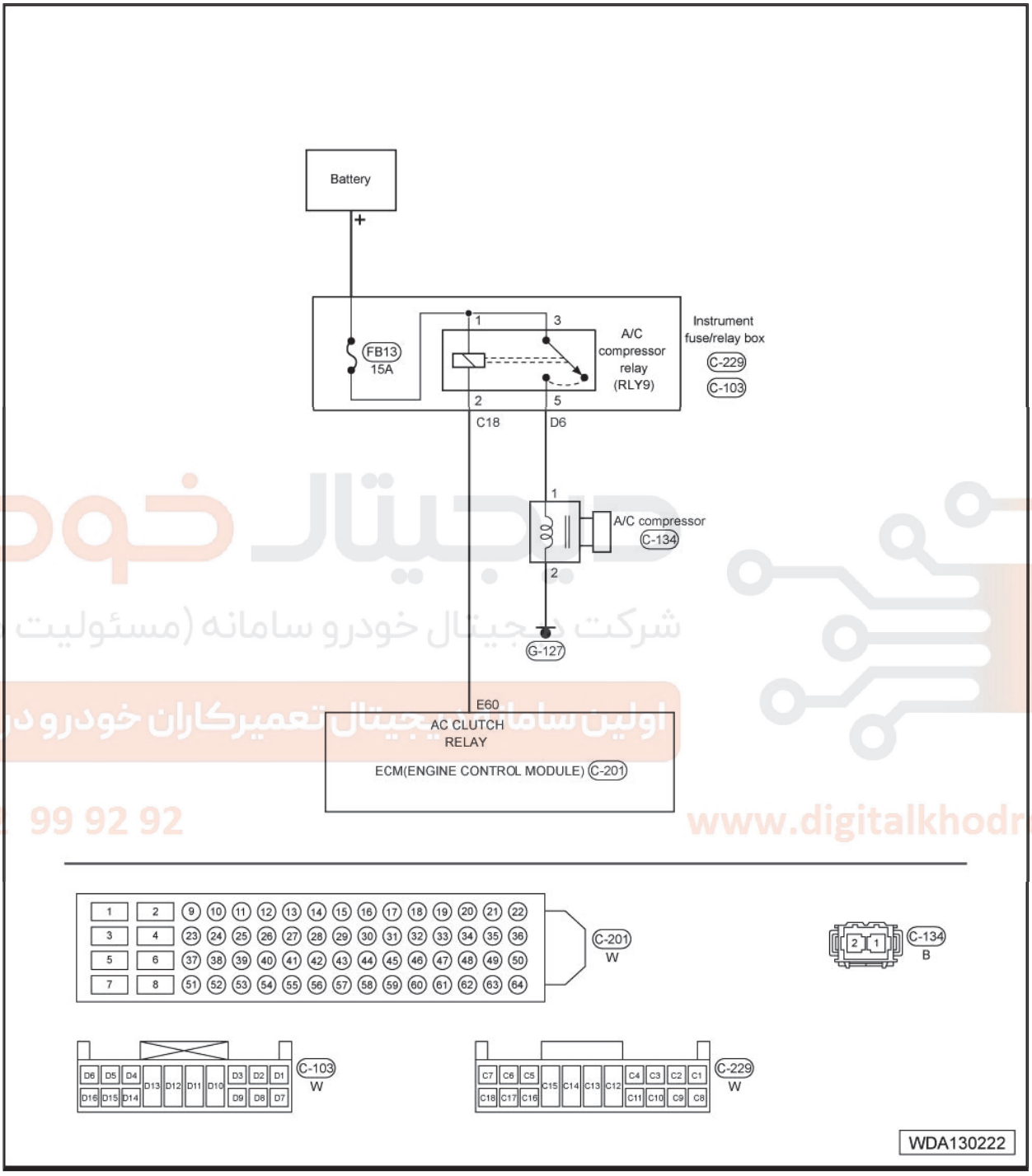
2.6.18 P0645 A/C compressor relay control circuit open circuit

P0646 A/C compressor relay control circuit short to ground
P0647 A/C compressor relay control circuit short to power



Fault code definition and fault causes

DTC	DTC definition	DTC test condition	DTC triggering condition	Possible causes
P0645	A/C compressor relay control circuit open circuit	Engine running normally with the A/C button on	Relay connecting wiring harness open circuit	• Failure of the relay

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DTC	DTC definition	DTC test condition	DTC triggering condition	Possible causes
				• Failure of the relay control circuit • Failure of the engine control module
P0646	A/C compressor relay control circuit short to ground	Engine running normally with the A/C button on	Relay connecting wiring harness short to ground	• Failure of the relay • Failure of the relay control circuit • Failure of the engine control module
P0647	A/C compressor relay control circuit short to power	Engine running normally with the A/C button on	Relay connecting wiring harness short to power	• Failure of the relay • Failure of the relay control circuit • Failure of the engine control module

DTC test procedures:

Please confirm that the battery voltage is normal before performing the following procedures.

- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Start the engine, and make it reach normal operating temperature, then turn on air conditioner.
- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.

  If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

Diagnostic procedures:

Note

- Please verify again if the DTC and its symptoms are present after fault is rectified.

1. Check if the A/C clutch relay fuse FB13 is faulty.
   - If yes, replace the failed fuse. ■
   - If not, go to step 2.
2. Check if the A/C relay RLY9 is faulty.

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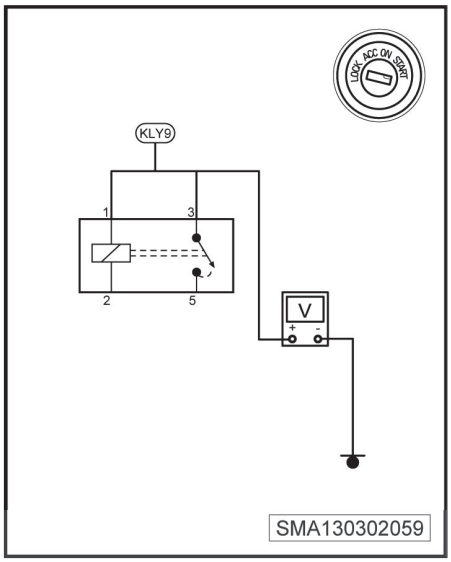
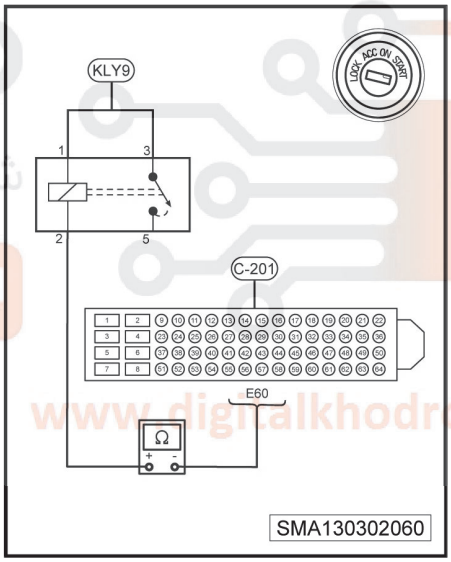
- If yes, replace the relay. ■
- If not, go to step 3.

3. Turn the ignition switch to the ON position, pull out the A/C relay (RLY9), and check if the voltage between the pins 1 and 3 of the A/C relay is the battery voltage.
   - If yes, go to step 4.
   - If not, the lead between the pins 1 and 3 of the A/C relay (RLY9) and the front compartment fuse box FB13 fails and please repair the defective lead. ■



4. Turn the ignition switch to the LOCK position, pull out the A/C relay (RLY9), and disconnect the ECM connector C-201, and check if the lead between the pin E60 of C-201 and the pin 2 of the A/C relay (RLY9) has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 5.



5. Replace the ECM, carry out the function test again, and read the fault code to verify if it exists or not.
   - If yes, find the fault cause from other symptoms.
   - If not, the fault has been rectified. ■

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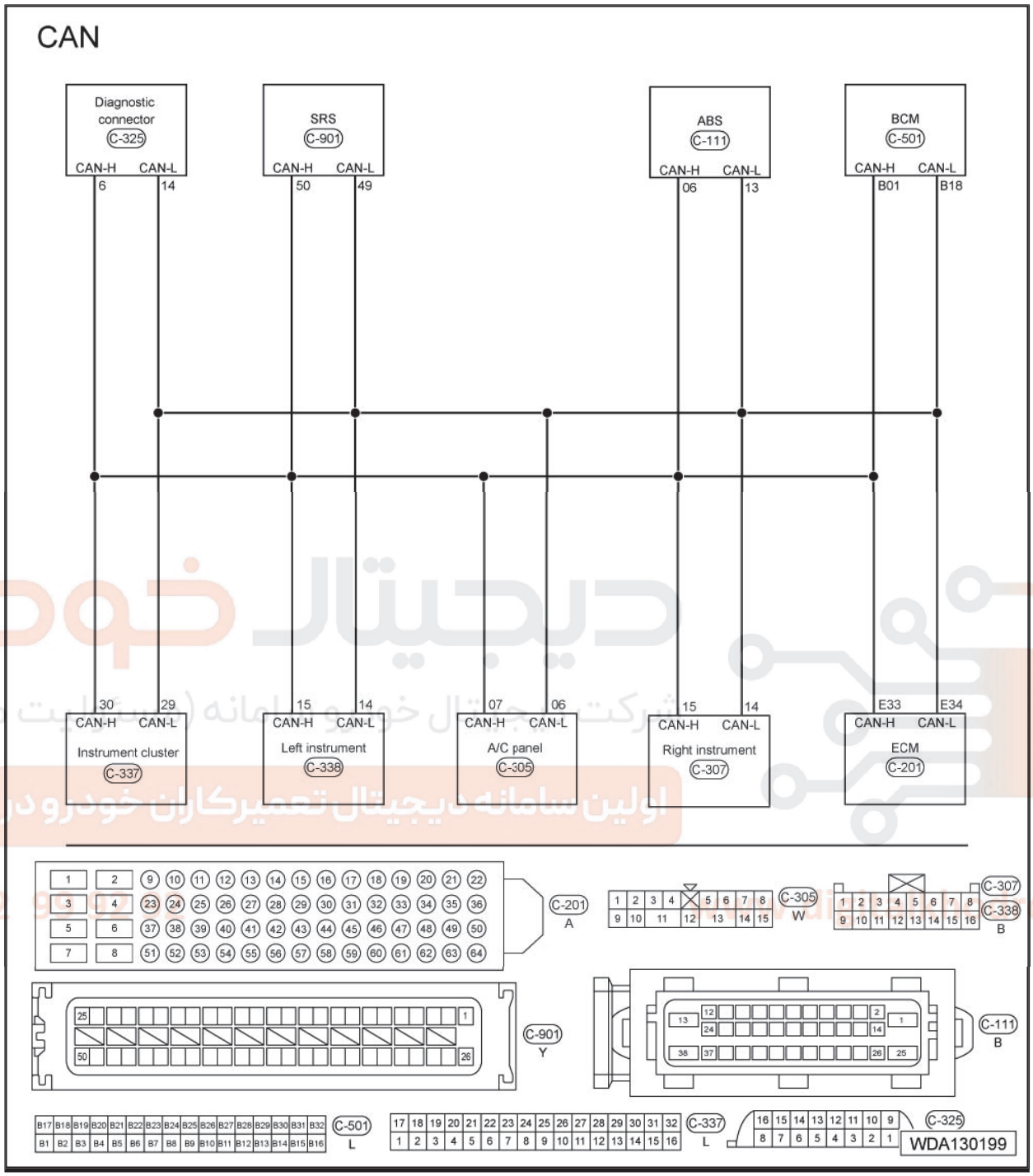
2.6.19 U0001 CAN communication diagnosis



Fault code definition and fault causes

DTC	DTC definition	DTC test condition	DTC triggering condition	Possible causes
U0001	CAN communication diagnosis	The ignition switch in the ON position	The diagnostic device cannot communicate with ECM control module	• Failure of the wiring harness short/open circuit • Failure of the ECM

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DTC test procedures:

Please confirm that the battery voltage is normal before performing the following procedures.

- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.

  If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

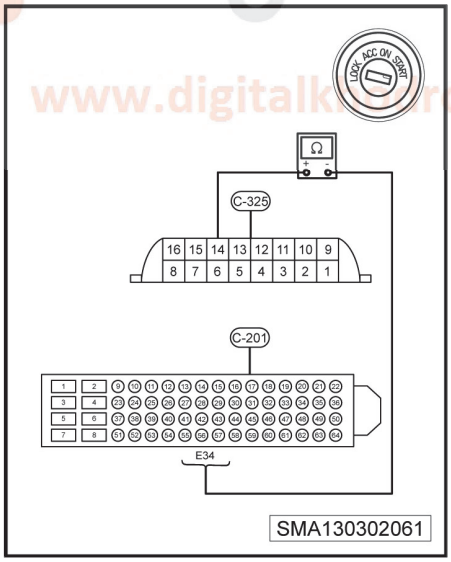
Diagnostic procedures:

Note

- Please verify again if the DTC and its symptoms are present after fault is rectified.

1. Check if the ECM control module pin/connector is corrosive, tainted and loose. Check if the wiring harness is interfered.
   - If yes, the connector/wiring harness fails and please repair or replace the connector/wiring harness. ■
   - If not, go to step 2.

2. Turn the ignition switch to the LOCK position, disconnect the ECM connector C-201, and check if the lead between the pin 14 of the diagnostic connector and the pin E34 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 3.



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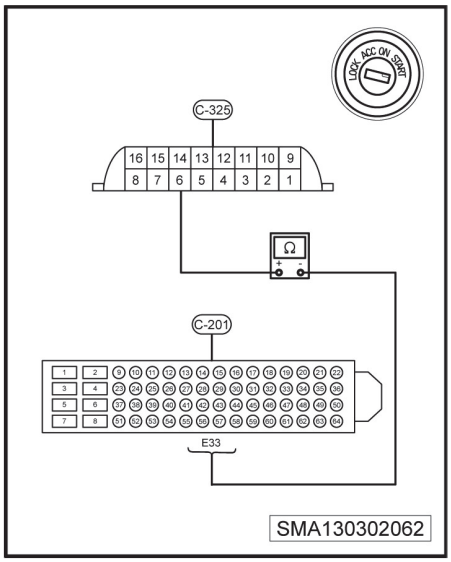
3. Turn the ignition switch to the LOCK position, and check if the lead between the pin 6 of the diagnostic connector and the pin E33 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 4.



4. Replace the ECM, carry out the function test again, and read the fault code to verify if it exists or not.
   - If yes, find the fault cause from other symptoms.
   - If not, the fault has been rectified. ■

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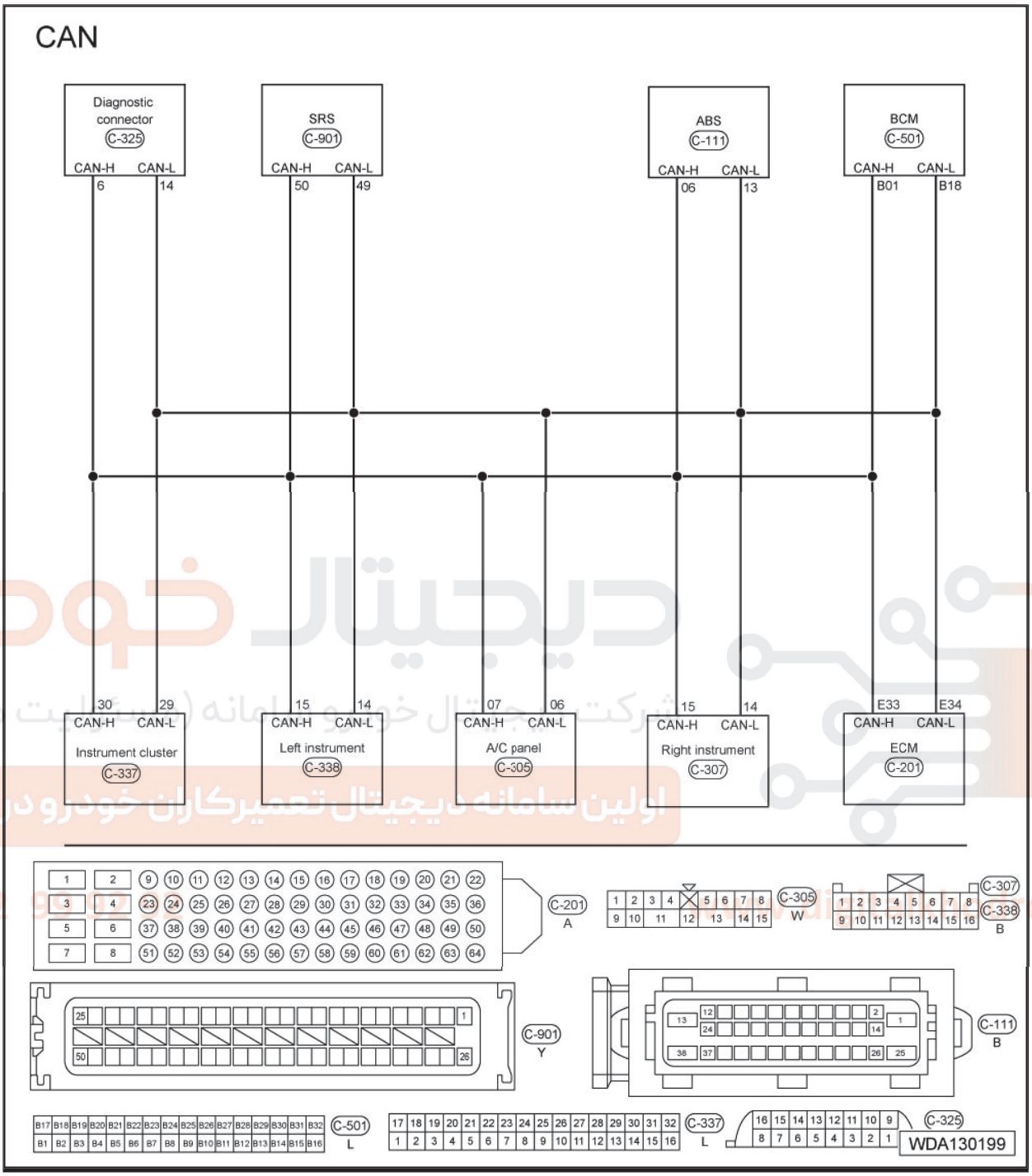
2.6.20 U0121 Lost communication of ECM and ABS control module



Fault code definition and fault causes

DTC	DTC definition	DTC test condition	DTC triggering condition	Possible causes
U0121	Lost communication of ECM and ABS control module	The ignition switch in the ON position	The diagnostic device cannot communicate with ECM control module	• Failure of the wiring harness (open/short circuit) • Failure of the ABS control unit

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DTC	DTC definition	DTC test condition	DTC triggering condition	Possible causes
				• Failure of the ECM

DTC test procedures:

Please confirm that the battery voltage is normal before performing the following procedures.

- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.

  If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

Diagnostic procedures:

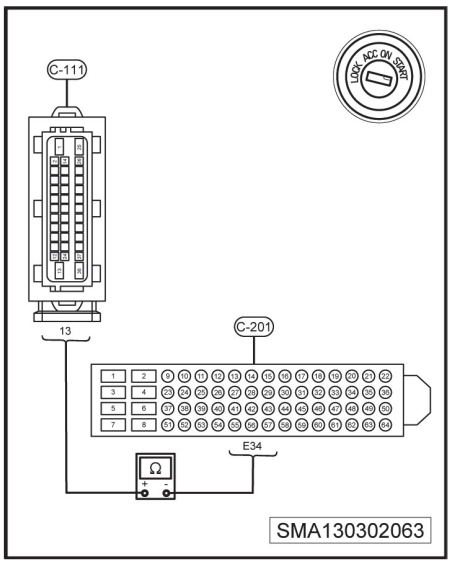
Note

- Please verify again if the DTC and its symptoms are present after fault is rectified.

03

1. Check if the ABS control unit pin/connector is corrosive, tainted and loose. Check if the wiring harness is interfered.
   - If yes, the connector/wiring harness fails and please repair or replace the connector/wiring harness. ■
   - If not, go to step 2.

2. Turn the ignition switch to the LOCK position, disconnect the ECM connector C-201 and ABS control unit connector C-111, and check if the lead between the pin 13 of C-111 and the pin E34 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 3.



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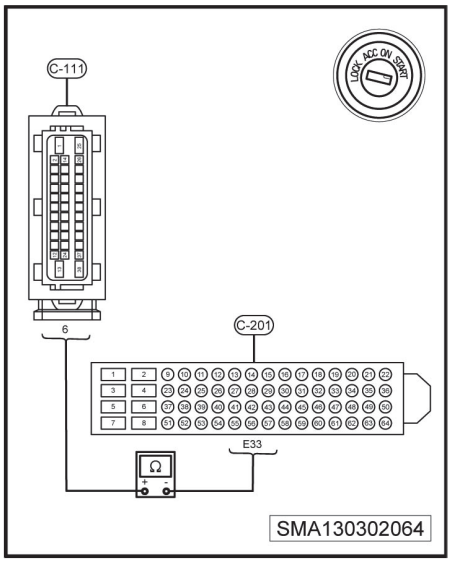
3. Turn the ignition switch to the LOCK position, and check if the lead between the pin 6 of C-111 and the pin E33 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 4.



4. Turn the ignition switch to the ON position, communicate with another control unit module with the diagnostic device, and check if this system can be normally communicated with.
   - If yes, go to step 5.
   - If not, the ABS control unit fails and please replace it. ■

5. Replace the ECM, carry out the function test again, and read the fault code to verify if it exists or not.
   - If yes, find the fault cause from other symptoms.
   - If not, the fault has been rectified. ■

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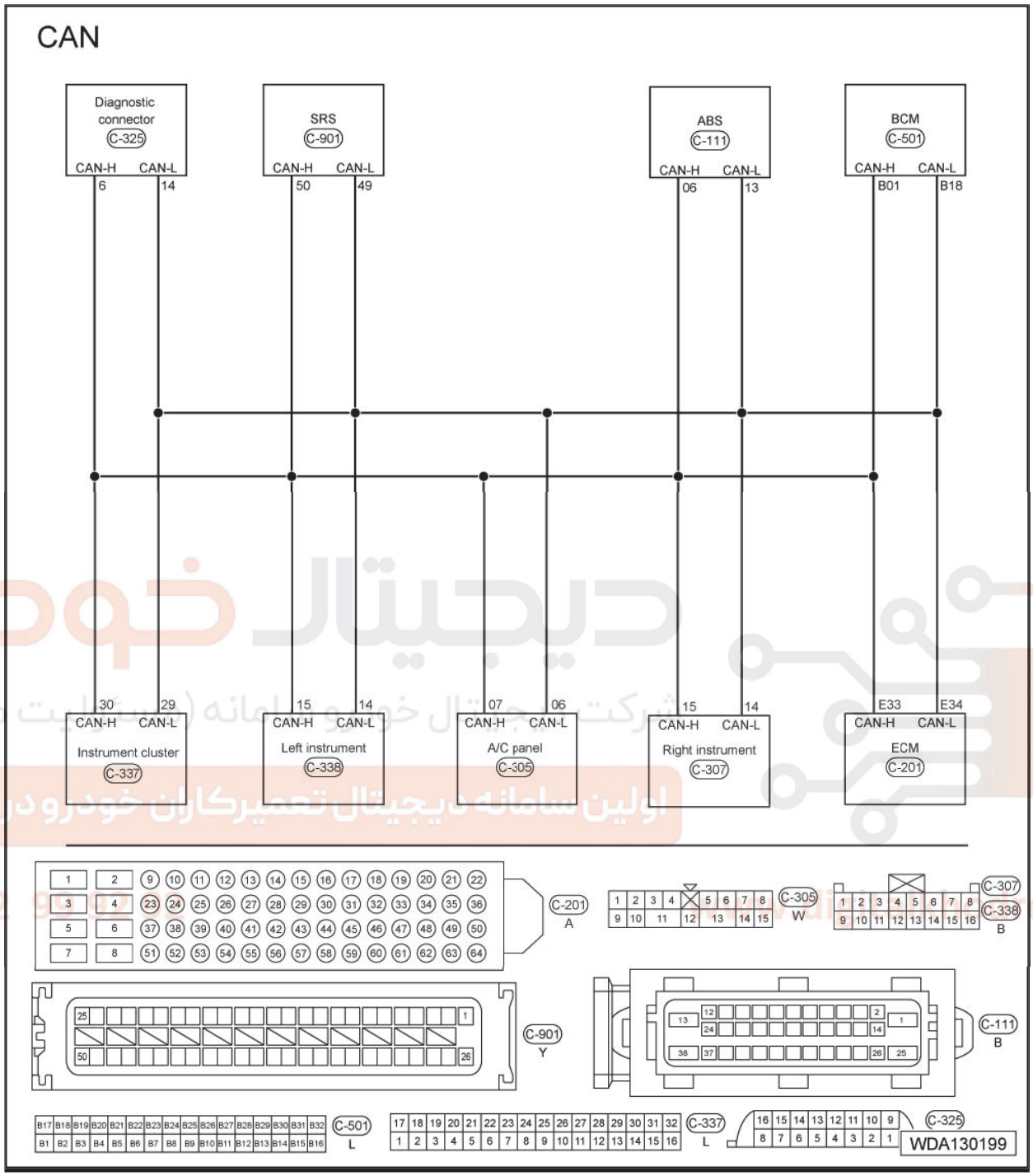
2.6.21 U0140 Lost communication of ECM and BCM control module



Fault code definition and fault causes

DTC	DTC definition	DTC test condition	DTC triggering condition	Possible causes
U0140	Lost communication of ECM and BCM control module	The ignition switch in the ON position	The diagnostic device cannot communicate with ECM control module	• Failure of the wiring harness (open/short circuit) • Failure of the BCM

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DTC	DTC definition	DTC test condition	DTC triggering condition	Possible causes
				• Failure of the ECM

DTC test procedures:

Please confirm that the battery voltage is normal before performing the following procedures.

- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.

  If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

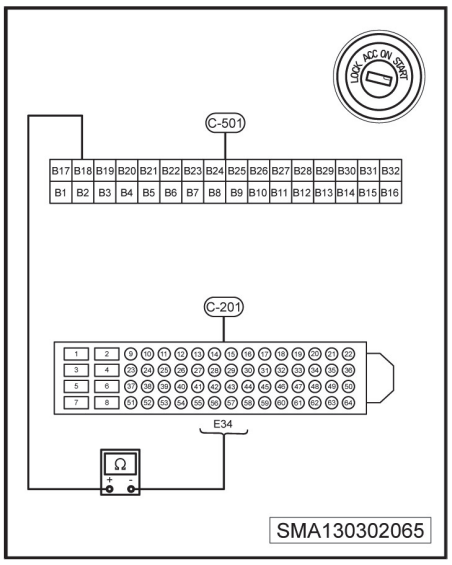
Diagnostic procedures:

Note

- Please verify again if the DTC and its symptoms are present after fault is rectified.

1. Check if the BCM control module pin/connector is corrosive, tainted and loose. Check if the wiring harness is interfered.
   - If yes, the connector/wiring harness fails and please repair or replace the connector/wiring harness. ■
   - If not, go to step 2.

2. Turn the ignition switch to the LOCK position, disconnect the BCM connector C-501 and the ECM connector C-201, and check if the lead between the pin B18 of C-501 and the pin E34 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 3.



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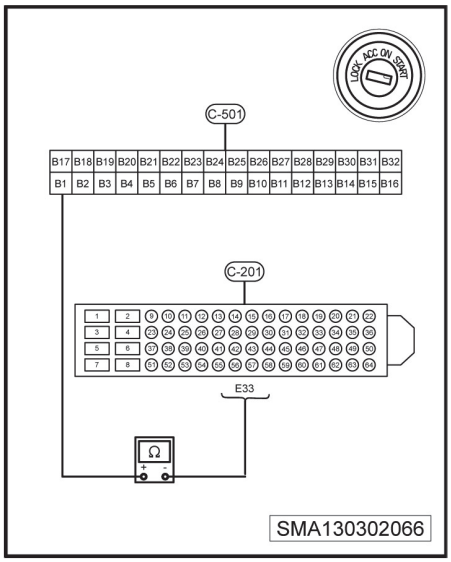
3. Turn the ignition switch to the LOCK position, and check if the lead between the pin B1 of C-501 and the pin E33 of C-201 has short or open circuit.
   - If yes, go to step 4.
   - If not, check if the lead between the pin B1 of the BCM control module and the pin E33 of the ECM control module has short or open circuit. And repair or replace the defective lead. ■



4. Turn the ignition switch to the ON position, communicate with another control unit module with the diagnostic device, and check if this system can be normally communicated with.
   - If yes, go to step 5.
   - If not, the BCM control module fails and please replace it. ■
5. Replace the ECM, carry out the function test again, and read the fault code to verify if it exists or not.
   - If yes, find the fault cause from other symptoms.
   - If not, the fault has been rectified. ■

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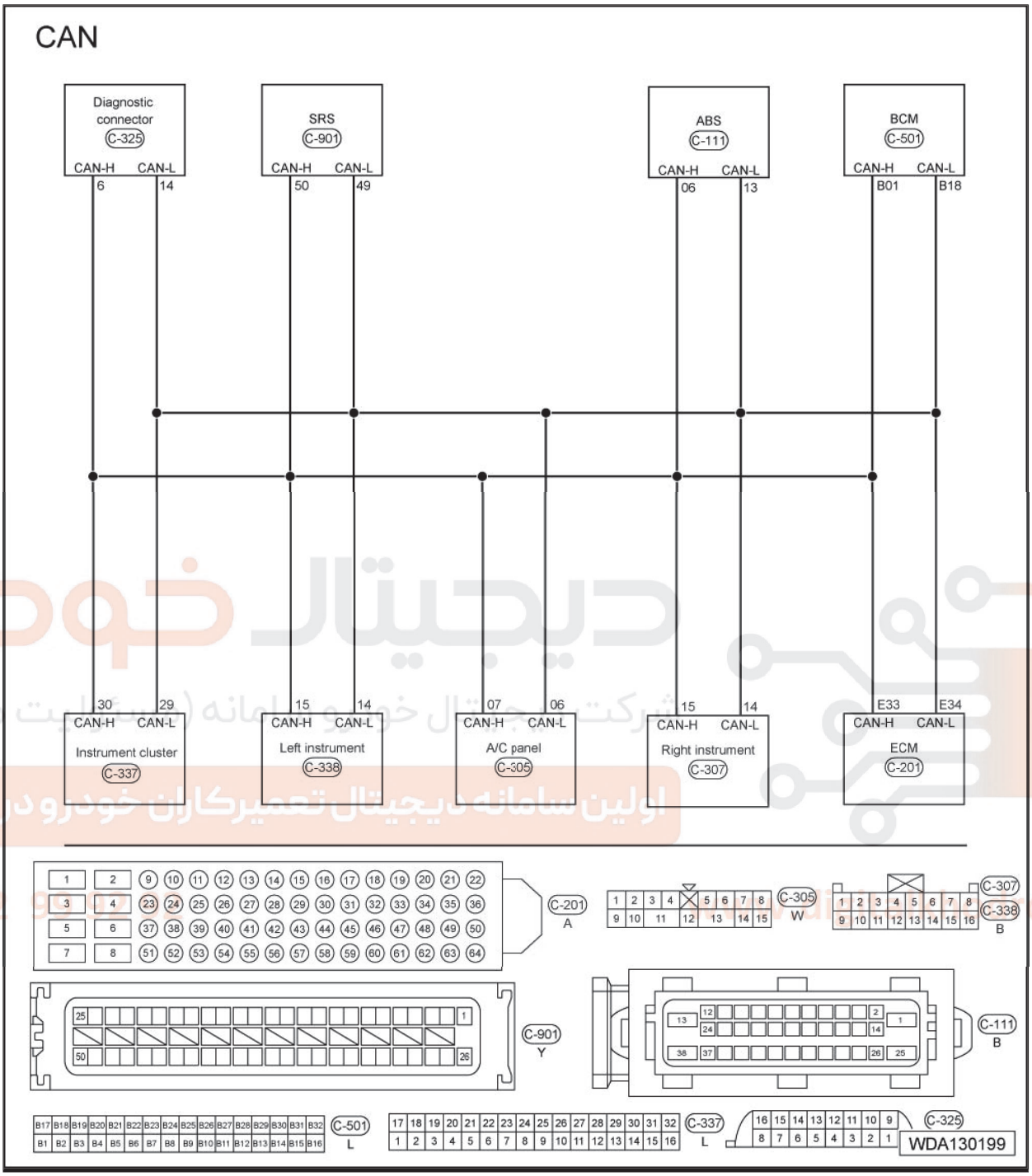
2.6.22 U0155 Abnormal communication of ECM and IPC control module



Fault code definition and fault causes

DTC	DTC definition	DTC test condition	DTC triggering condition	Possible causes
U0155	Abnormal communication of ECM and IPC control module	The ignition switch in the ON position	The diagnostic device cannot communicate with IPC control unit module	• Failure of the wiring harness (open/short circuit) • Failure of the IPC control unit

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DTC	DTC definition	DTC test condition	DTC triggering condition	Possible causes
				• Failure of the ECM

DTC test procedures:

Please confirm that the battery voltage is normal before performing the following procedures.

- Turn off the ignition switch.
- Connect the X-431 diagnostic device to the DLC and perform the test with the updated software.
- Turn on the ignition switch.
- Measure and clear the DTC with the diagnostic device.
- Turn off the ignition switch and turn it on again after 3 to 5 seconds.
- Measure the DTC with the diagnostic device.
- If a DTC is detected, it indicates that the vehicle is faulty, please perform corresponding diagnostic procedures.

  If no DTC is detected, it indicates that the previously detected faults are sporadic. (Please refer to the chapters on the sporadic DTC and check faults)

Diagnostic procedures:

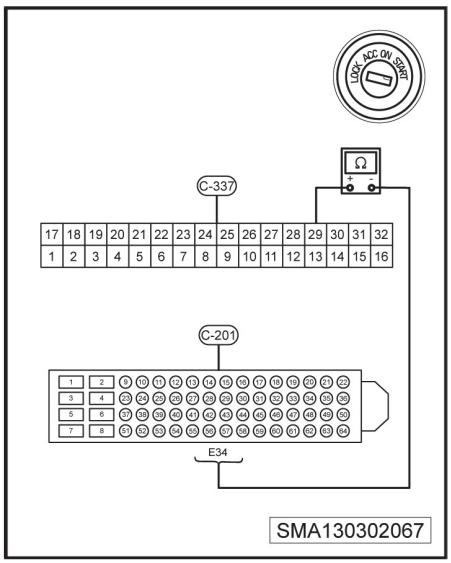
Note

- Please verify again if the DTC and its symptoms are present after fault is rectified.

03

1. Check if the IPC instrument panel control module pin/connector is corrosive, tainted and loose. Check if the wiring harness is interfered.
   - If yes, the connector/wiring harness fails and please repair or replace the connector/wiring harness. ■
   - If not, go to step 2.

2. Turn the ignition switch to the LOCK position, disconnect the ECM connector C-201 and IPC instrument panel connector C-337, and check if the lead between the pin 29 of C-337 and the pin E34 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 3.



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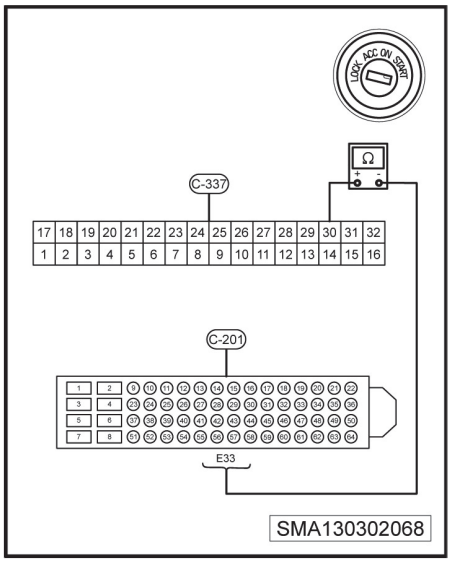
3. Turn the ignition switch to the LOCK position, and check if the lead between the pin 30 of C-337 and the pin E33 of C-201 has short or open circuit.
   - If yes, repair the defective lead. ■
   - If not, go to step 4.



4. Turn the ignition switch to the ON position, communicate with another control unit module with the diagnostic device, and check if this system can be normally communicated with.
   - If yes, go to step 5.
   - if not, the IPC control unit fails and please replace it. ■

5. Replace the ECM, carry out the function test again, and read the fault code to verify if it exists or not.
   - If yes, find the fault cause from other symptoms.
   - If not, the fault has been rectified. ■

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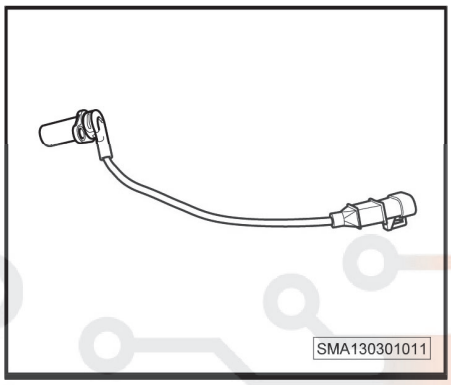
3 Engine Electronic Control System Sensor

3.1 Crankshaft position sensor

3.1.1 Overview

Crankshaft position sensor output signal is the most important signal to ECM, which works together with the camshaft position sensor to determine the basic ignition timing. This sensor is an electromagnetic induction sensor, and works together with the gear ring 58X on the flywheel. When the crankshaft is rotating, the crest and tooth space of the gear ring 58X pass through the sensor with different distances. The sensor senses changes in reluctance, this alternating reluctance results in an alternating output signal, and the gap location on the gear ring 58X corresponds to the engine top dead center position. At the top dead center of the first cylinder, the sensor aims at the negative-edge of the 20th tooth of the gear ring 58X, and ECM uses this signal to determine crankshaft rotation position and speed.



3.1.2 Technical data

Performance

Item	Value
Coil resistance	860±86 Ω
Coil inductance	370±60 mH
Gear ring clearance for 58SX	0.8～1.2 mm

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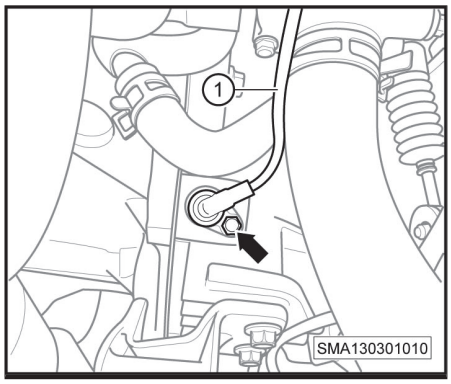
3.1.3 Removing and installing the crankshaft position sensor

Removal



1. Switch off all electrical equipment and the ignition switch, and pull out the key.
2. Disconnect the battery negative terminal.
3. Disconnect the crankshaft position sensor connector, unscrew the fixing bolt (-arrow-), and remove the crankshaft position sensor (-1-).

Installation

Installation shall follow the reverse sequence of the removal procedure. Please pay attention to the following notes:

- Visually check for oil stain, scrap iron or other foreign matter on the sensor, if detected, clean it.
- During installation, first apply lubricant on the sensor O-ring to prevent the O-ring damage during installation.

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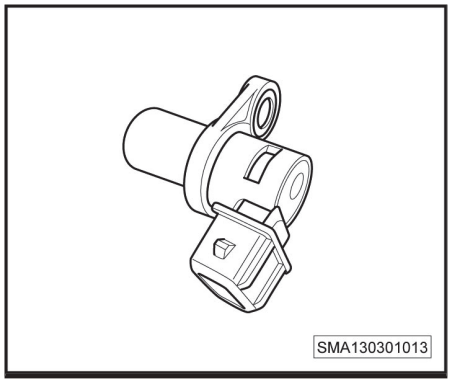
3.2 Camshaft position sensor

3.2.1 Overview



Camshaft position sensor adopts Hall effect, whose integrated circuit is in front of one permanent magnet pole. When the camshaft is driving the signal wheel to rotate, tooth profile variety causes changes in the strength of the magnetic field lines, with voltage signal output.

Camshaft position sensor provides the phase information of the camshaft to ECM, this information is integrated with that from the crankshaft position sensor to determine each cylinder stroke in engine's working cycle.

With the camshaft turning one circle, according to Hall effect the sensor produces a series of electromagnetic pulses. After getting this information, ECM synthetically calculates the ignition timing, at the same time controls the fuel injector to eject fuel into the right cylinder. As an auxiliary sensor, the camshaft position sensor has a great impact on engine emissions.

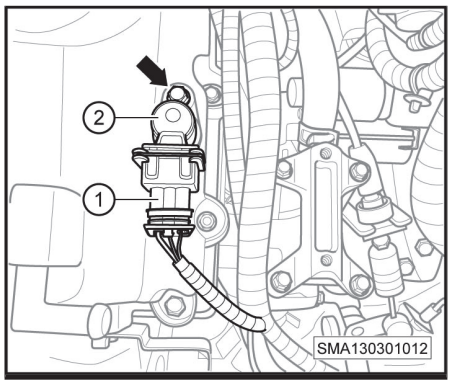
3.2.2 Technical data

Performance

Item	Value
Operating voltage	4.5～1.3 V
Operating clearance	0.8～1.2 mm

3.2.3 Removing and installing the camshaft position sensor

Removal



1. Switch off all electrical equipment and the ignition switch, and pull out the key.
2. Disconnect the battery negative terminal.
3. Disconnect the camshaft position sensor connector (-1-).
4. Unscrew the fixing bolt (-arrow-), and remove the camshaft position sensor (-2-).

Installation

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Installation shall follow the reverse sequence of the removal procedure. Please pay attention to the following notes:

- Visually check for oil stain, scrap iron or other foreign matter on the sensor, if detected, clean it.
- During installation, first apply lubricant on the sensor O-ring to prevent the O-ring damage during installation.

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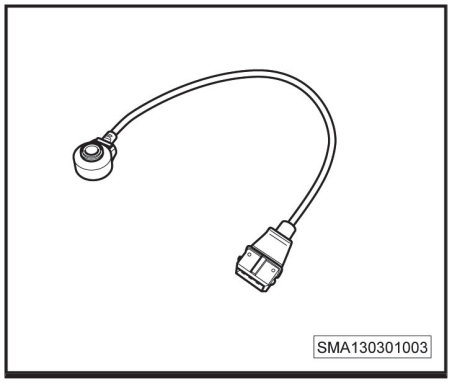
3.3 Knock sensor

3.3.1 Overview



Knock sensor is used to monitor the gas mixture combustion status and the knocking trend in the engine combustion chamber, and provides knocking signal to ECM, to facilitate ECM's better control of ignition advance angle.

Knock sensor is a vibration acceleration sensor, which produces an output voltage according to the engine mechanical vibration. If the engine produces knocking, ECM will receive knocking signal, filter non-knocking signals and calculate. The engine position in the working cycle is determined through the camshaft and crankshaft position sensor signal, ECM thus calculates which cylinder produces knocking, and the ignition advance angle of this cylinder will be delayed until the knocking phenomenon disappears. Then the ignition advance angle will be advanced again until the ignition advance angle is at the best location in the condition.

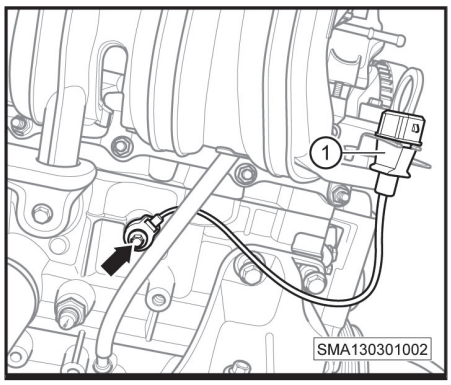
3.3.2 Technical data

Performance

Frequency response range	Resistance	Capacitance
3～18 KHz	More than 1 MΩ	1150±200 pF

3.3.3 Removing and installing the knock sensor

Removal



1. Switch off all electrical equipment and the ignition switch, and pull out the key.
2. Disconnect the battery negative terminal.
3. Disengage the knock sensor connector (-1-) from the bracket, unscrew the fixing bolt (-arrow-), and remove the knock sensor.

Installation

1. Check the mounting surface flatness, perpendicularity, and surface finish.
2. During installation, make sure that the metal part at the sensor bottom have full contact with the engine

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cylinder block, and the washer cannot be used between the sensor and the engine cylinder block.

3. Tightening torque of the bolt: 20±5 Nm.

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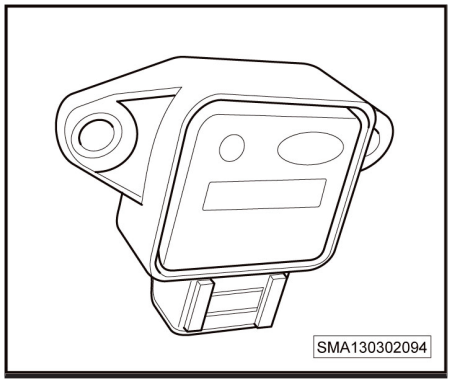
3.4 Throttle position sensor

3.4.1 Throttle position sensor

Throttle position sensor transforms the throttle opening (engine load) into the electric signal as ECM input, ECM determines the engine condition (such as idling speed, high load, etc.) according to the signal voltage and controls the fuel injection volume on the basis of different conditions.



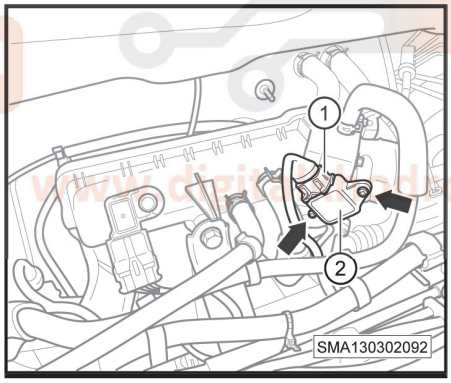
3.4.2 Technical data

Item	Data
Appropriate temperature of operating condition	- 40℃～125℃
Total resistance	2.0±0.4 KΩ
Sliding contact arm protection resistance (sliding contact arm at zero, pins 2-3)	Minimum 710 Ω, maximum 1380 Ω

3.4.3 Removing and installing the throttle position sensor

Removal

1. Switch off all electrical equipment and the ignition switch, and pull out the key.
2. Disconnect the battery negative terminal.
3. Remove the air filter assembly.=> refer to page 239
4. Disconnect the throttle position sensor connector (-1-), unscrew the fixing bolts (-arrow-), and remove the throttle position sensor (-2-).



Installation

Installation shall follow the reverse sequence of the removal procedure. Please pay attention to the following notes:

Considering the leakage at the throttle shaft seal after long time running, it is recommended to install the throttle shaft with at least 30 degrees deflection over the vertical direction.

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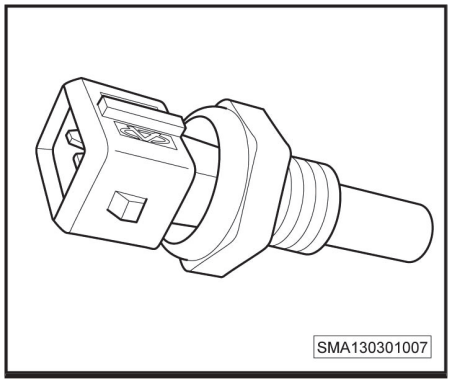
3.5 Coolant temperature sensor

3.5.1 Overview

Coolant temperature sensor provides coolant temperature information to the engine electronic control module. ECM controls engine start, idling speed, ignition timing of normal running, fuel injection pulse width according to coolant temperature signal. After the signal is processed by ECM, it will be transmitted to the instrument through CAN data communication lines to be used by the coolant temperature gauge. Therefore, if the coolant temperature gauge in the instrument is not accurate, in addition to the instrument, coolant temperature sensor and relevant lines, the proper working of ECM should also be considered.



3.5.2 Technical data

Coolant temperature sensor

Condition	Value
Operating voltage	5VDC
Operating temperature	- 30～130℃
Rated resistance at 20 ℃	2.5 KΩ±5%

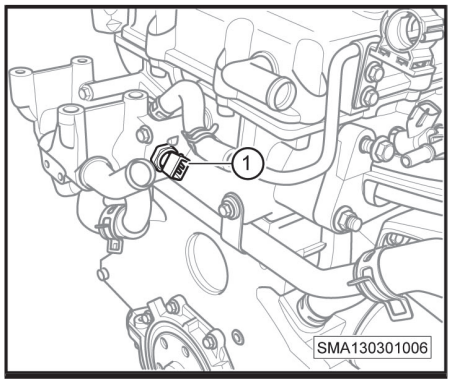
Voltage reference

Condition	Value (voltage)
The sensor voltage at 59℃ (coolant temperature)	1.89 V
The sensor voltage at 78℃ (coolant temperature)	1.25 V
The sensor voltage at 90℃ (coolant temperature)	0.94 V

3.5.3 Removing and installing the coolant temperature sensor

Removal

1. Switch off all electrical equipment and the ignition switch, and pull out the key.
2. Disconnect the battery negative terminal.
3. Disconnect the coolant temperature sensor connector, and unscrew the coolant temperature sensor (-1-).



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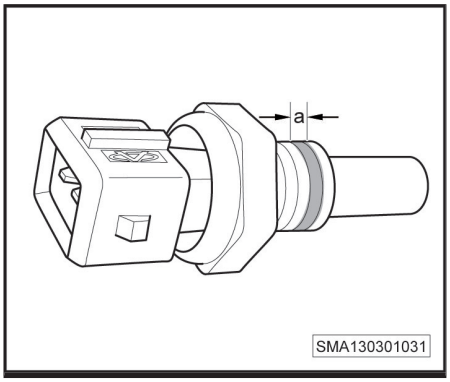
Installation

Installation shall follow the reverse sequence of the removal procedure. Please pay attention to the following notes:

- As shown in the figure, apply the sealant in the area a before the installation of the coolant temperature sensor.
- Tightening torque of the coolant temperature sensor: 20～25 Nm.



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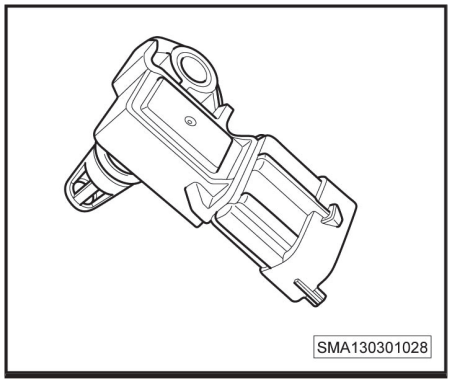
3.6 Intake air pressure/temperature sensor

3.6.1 Overview

The intake air pressure/temperature sensor measures the intake manifold absolute pressure and temperature changes behind the throttle according to the engine load, convert them to voltage signals and send them to ECM. ECM corrects the fuel injection volume according to the voltage signals.



3.6.2 Technical data

Performance

Intake air pressure sensor

Item	Data
Operating voltage	5 V
Operating current	Maximum 12 mA
Pressure testing range	20～115 kPa

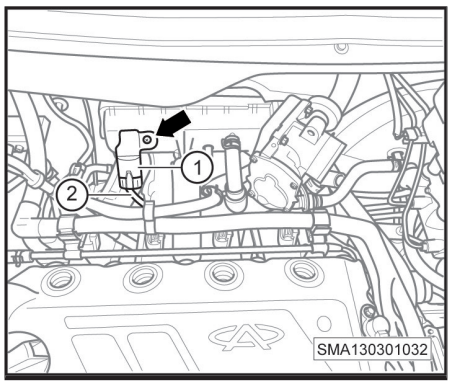
Intake air temperature sensor

Item	Data
Operating voltage	5 V
Operating current	Maximum 12 mA
Temperature testing range	-40～125℃
Rated resistance at 20℃	2.5 kΩ ± 5%

3.6.3 Removing and installing the intake air pressure/temperature sensor

Removal

1. Switch off all electrical equipment and the ignition switch, and pull out the key.
2. Disconnect the battery negative terminal.
3. Disconnect the connector (-2-), and unscrew the fixing bolt (-arrow-).
4. Remove the intake air pressure/temperature sensor (-1-).



Installation

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Installation shall follow the reverse sequence of the removal procedure. Please pay attention to the following notes:

- Visually check for oil stain, scrap iron or other foreign matter on the sensor, if detected, clean it.
- During installation, first apply lubricant on the sensor O-ring to prevent the O-ring damage during installation.

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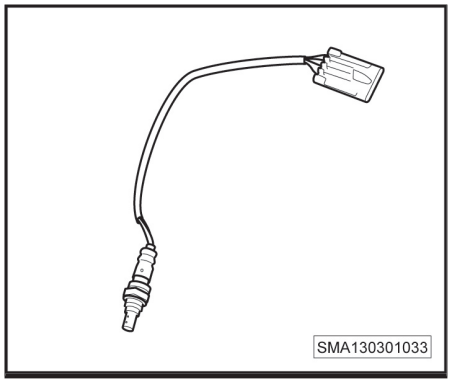
3.7 Oxygen sensor

3.7.1 Overview

Front oxygen sensor



The front oxygen sensor is used to detect the oxygen content in the engine exhaust emissions and convert this information to voltage signal and send it to ECM. ECM can use this information to realize the fuel-quantitative closed-loop control, making the three main toxic elements in the engine exhaust hydrocarbon (HC), carbon monoxide (CO) and nitrogen oxides (NOX) able to be transformed and purified furthest in the three-way catalytic converter.

Rear oxygen sensor

The rear oxygen sensor is used to monitor the oxygen content of emissions after the three-way catalytic converter. The detected signals of the front and rear oxygen sensors are compared by ECM to monitor the efficiency of the catalytic converter. When the catalytic converter works inefficiently or is damaged and the signals of the rear oxygen sensor detected by ECM varies considerably, the engine warning light will light up and the oxygen sensor failure will also occur. At this moment, ECM may even take restrictive driving measures to protect the environment.

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3.7.2 Technical data

Performance

Temperature	260℃	450℃	595℃
Rich-oxygen output voltage (mV)	＞800	＞800	＞750
Lean-oxygen output voltage (mV)	＜200	＜200	＜150
Response time from lean to rich (ms)	＜75	＜75	＜50
Response time from rich to lean (ms)	＜150	＜125	＜90
Internal resistance (Ω)	＜100 K		

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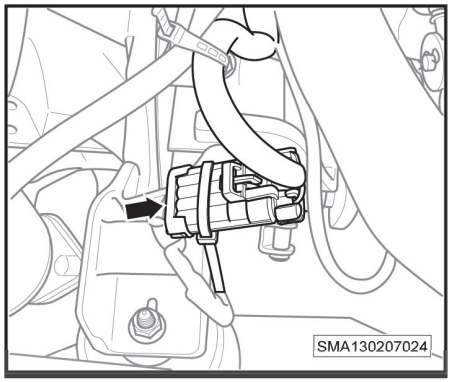
3.7.3 Removing and installing the oxygen sensor

Note

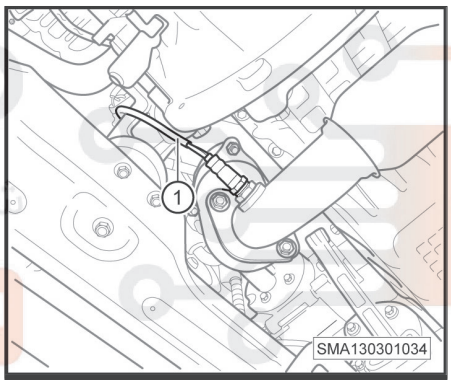
- The removal and installation procedures of the rear oxygen sensor are the same as that of the front oxygen sensor. Here only the removal and installation of the rear oxygen sensor is described.
- The exhaust pipe can only be removed after it has cooled down.

Removal

1. Switch off all electrical equipment and the ignition switch, and pull out the key.
2. Disconnect the battery negative terminal.
3. Disconnect the oxygen sensor connector (-arrow-).



4. Unscrew the oxygen sensor (-1-).



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Installation

Installation shall follow the reverse sequence of the removal procedure. Please pay attention to the following notes:

- The oxygen sensor generally uses zirconia (ZrO2, a ceramic material) as the sensor element. Do not knock it with a wrench or other hard object to avoid damage, because the ceramic is hard and brittle. The oxygen sensor impacted cannot be used any more. Tightening torque of the oxygen sensor is 40 to 60 Nm.

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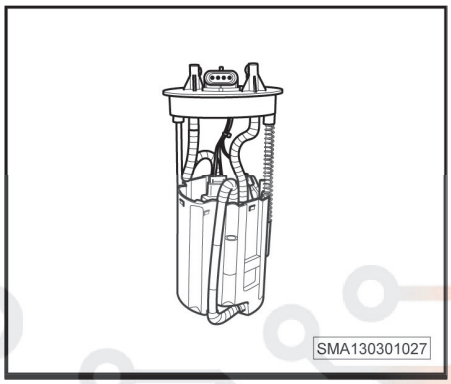
4 Engine Electronic Control System Actuator

4.1 Fuel pump

4.1.1 Overview

After the ignition switch is turned on, ECM controls the fuel pump to work for 2 to 5 seconds, to establish an appropriate starting fuel pressure, suck the fuel out of the tank, and then into the fuel pipe. At this time if the engine does not start, ECM will cut off the fuel pump control circuit, stopping the fuel pump. If the engine starts and continues running, ECM will control normal running of the fuel pump.



Note

- The fuel temperature has a great impact on the performance of the fuel pump. When the fuel pump has run for a long time in high temperature condition, if the fuel temperature is higher than a certain value, the fuel pressure of the pump will quickly descend; therefore, when the hot engine cannot start, please carefully check the fuel pump operating performance in high temperature condition.

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4.1.2 Technical data

Output pressure	>350 KPa	Operating voltage	8-16 V
Maintenance pressure	≈24 KPa	Overvoltage protection	-13.5~26 V
Output flow	>10 g/s	Fuel-free running	<60 seconds

4.1.3 Removing and installing the fuel pump

The removal and installation of the fuel pump (refer to the Engine Mechanism)=> refer to page 206

4.1.4 Checking the fuel pump

Methods:

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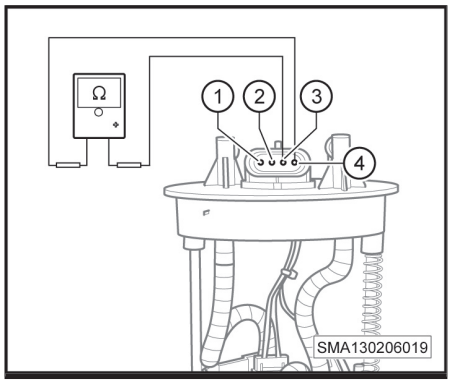
1. Disconnect the connector, turn the digital multimeter to the "ohm" position, respectively connect the two probes to the two pins of the fuel pump, and measure the internal resistance, not zero or infinity (i.e. non-short, non-open circuit state).
2. Connect the connector, connect the fuel pressure gauge onto the fuel inlet pipe, start the engine, and observe if the fuel pump is running. If not, check if the voltage of the pin "+" at the battery level; if running, check if the fuel pressure is about 400 kPa in idling condition. Press the accelerator pedal until the engine speed reaches 2500 rpm, and observe if at this time the fuel pressure is about 400 kPa.



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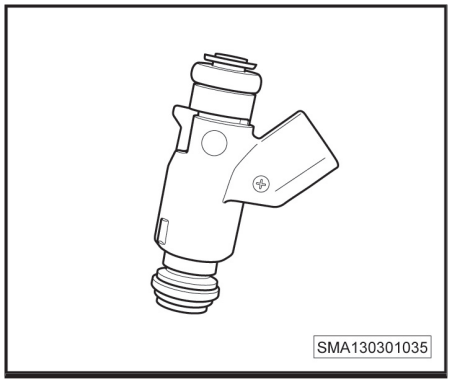
4.2 Fuel injector

4.2.1 Overview

Function:

The fuel injector jets fuel within the specified time according to ECM's instructions, to provide atomized fuel to the engine. It stores high-pressure fuel and eliminates the resonance caused by the pumping of the fuel pump to keep the stable fuel pressure.



4.2.2 Technical data

Item	Data
Coil resistance	12±0.4 Ω
Minimum operating voltage	4.5 V
Operating temperature	−40−130℃

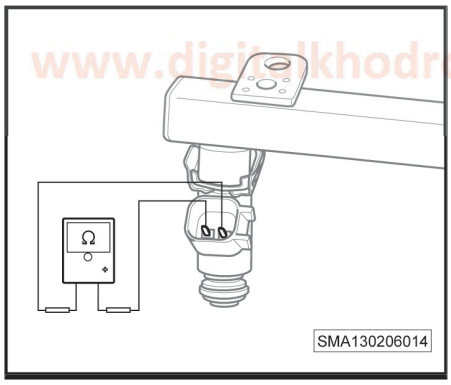
4.2.3 Removing and installing the fuel injector

The removal and installation of the fuel injector (refer to the Engine Mechanism)=> refer to page 213

4.2.4 Checking the fuel injector

Methods:

Turn the digital multimeter to the "ohm" position, and respectively connect the two probes to the two pins of the fuel injector. The rated resistance is 11-16 Ω at 20℃.



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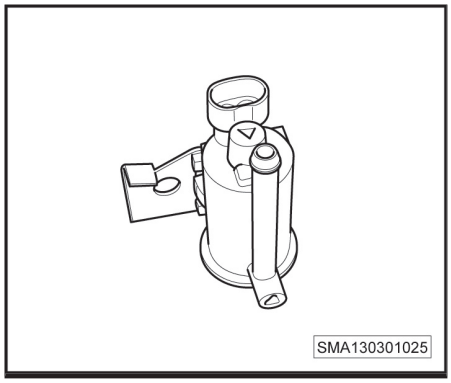
4.3 Activated carbon canister solenoid valve

4.3.1 Overview

The carbon canister control valve is controlled through electrical pulse duration and frequency (i.e. duty cycle) synthetically calculated by ECM according to engine load, engine temperature, speed and a series of signals. Gasoline vapor in the carbon canister will leak in the case of excessive accumulation, causing environmental pollution. Therefore, the carbon canister solenoid valve is used to open the solenoid valve at the right time, in order to make the gasoline vapor fully mixed with air and then into the intake manifold for combustion.



4.3.2 Technical data

Performance

Rated operating voltage	12 V	Operating temperature	140－120℃
Operating voltage range	8－16 V	Coil resistance	19－22 Ω
Limit voltage	25 V	Coil inductance	12－15 mH

4.3.3 Removing and installing the carbon canister solenoid valve

Note

- Before removal, mark at the inlet and outlet pipes to avoid confusion.

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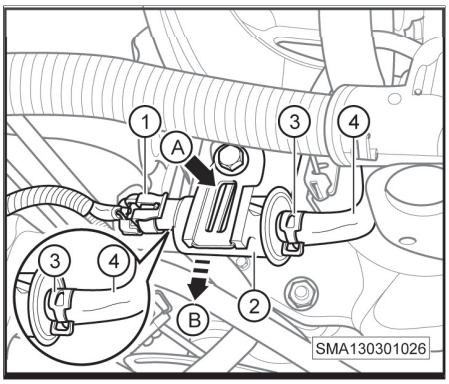
Removal

1. Switch off all electrical equipment and the ignition switch, and pull out the key.
2. Disconnect the battery negative terminal.
3. Disconnect the connector (-1-), loosen the clamp (-3-), and pull out the inlet and outlet hose (-4-).
4. Lever out the clip (-arrow A-), and remove the carbon canister solenoid valve (-2-) from the bracket in the (-arrow B-) direction.



Installation

- Installation shall follow the reverse sequence of the removal procedure.

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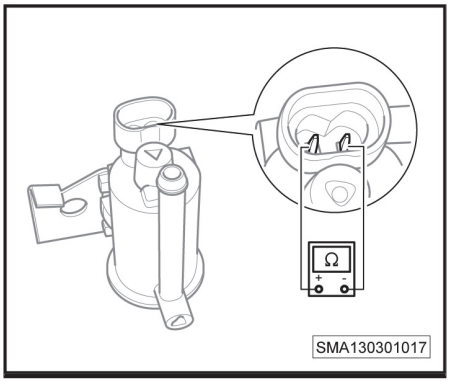
4.3.4 Checking the activated carbon canister solenoid valve

Inspection

Turn the digital multimeter to the "ohm" position, and respectively connect the two probes to the two pins of the activated carbon canister solenoid valve. The rated resistance is 21±1 Ω at 20℃.



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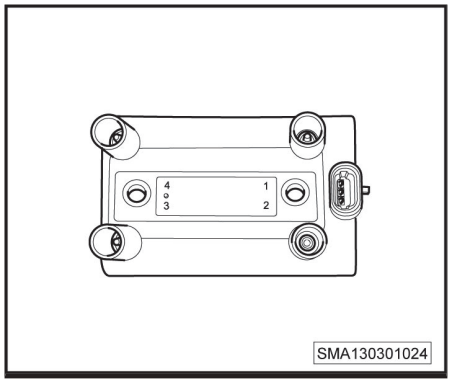
4.4 Ignition coil

4.4.1 Overview

The ignition coil transforms low voltage of the primary winding to high voltage of the secondary winding, and the high voltage produces spark through the electrode discharge of the spark plug, to detonate the flammable gas mixture within the cylinder.

The ignition coil consists of two primary windings, two secondary windings and iron core, shell and so on. When a primary winding is connected to the ground, this primary winding is charged. Once ECM cuts off the primary winding circuit, the charging stops, at this time the secondary winding induces a high voltage, to make the spark plug electrode discharge.



4.4.2 Technical data

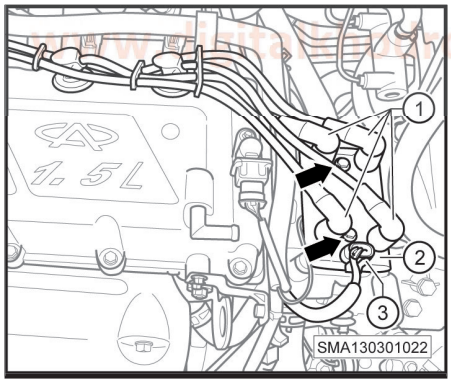
Performance

Primary resistance	0.5±0.05 Ω	Secondary inductance	17.5±1.2 H
Secondary resistance	9840±980 Ω	Power-off current peak	9.5 A
Primary inductance	2.75±0.25 mH	Secondary output voltage	34 KV

4.4.3 Removing and installing the ignition coil

Removal

1. Switch off all electrical equipment and the ignition switch, and pull out the key.
2. Disconnect the battery negative terminal.
3. Disconnect the ignition coil connector (-3-), and pull out the ignition cable (-1-).
4. Unscrew the fixing bolts (-arrow-), and remove the ignition coil (-2-).



Installation

- Installation shall follow the reverse sequence of the removal procedure.

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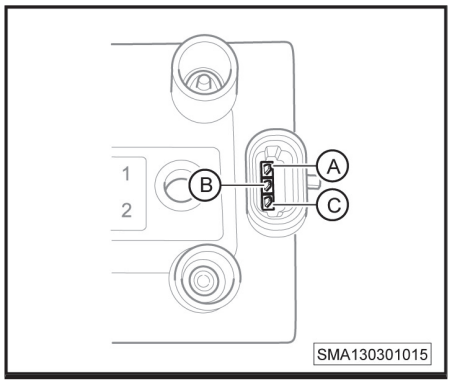
4.4.4 Checking the ignition coil

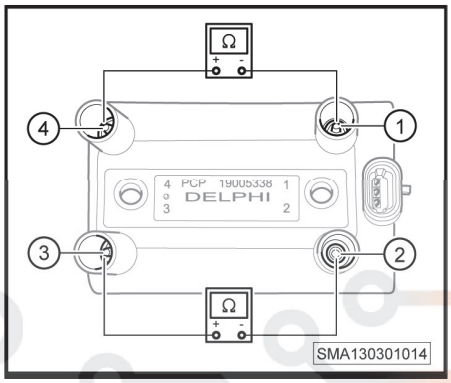
Methods:

1. Turn the digital multimeter to the "ohm" position, and respectively measure the pins 1 and 2, 2 and 3 with the two probes. The resistance is 0.42-0.58 Ω at 20℃;



Methods:

2. Turn the digital multimeter to the "ohm" position, and respectively measure the pins 1 and 4, 2 and 3 with the two probes. The secondary winding resistance is 11.2-14.8 kΩ at 20℃.



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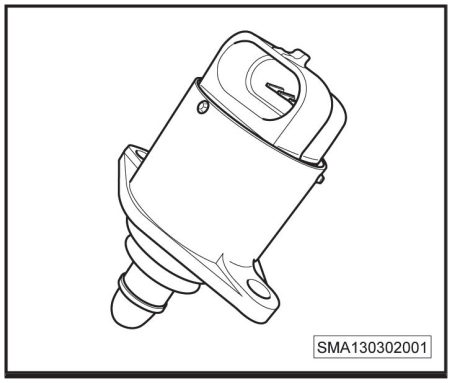
4.5 Idling stepper motor

4.5.1 Overview

The idling stepper motor is mainly used for engine idling control. In idling condition, the main valve plate of the mechanical throttle body is closed, and the air flows into the intake manifold through the air bypass of the throttle body. The engine control module controls the position of the stepper motor adjuster in the air bypass via controlling its moving steps, and thus controls the engine's air input, making the engine achieve the best in idling condition.



4.5.2 Technical data

Performance

Primary resistance	0.5±0.05 Ω	Secondary inductance	17.5±1.2 H
Secondary resistance	9840±980 Ω	Power-off current peak	9.5 A
Primary inductance	2.75±0.25 mH	Secondary output voltage	34 KV

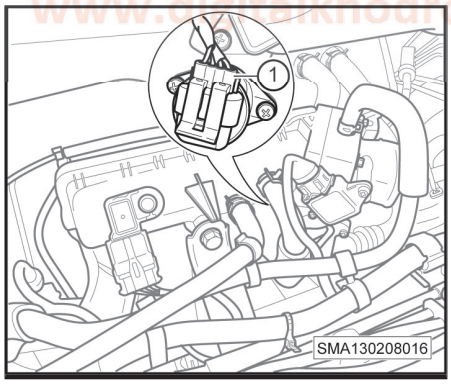
4.5.3 Removing and installing the idling stepper motor

Caution

- Do not push and pull the idling stepper motor valve when cleaning the idling stepper motor.

Removal

1. Switch off all electrical equipment and the ignition switch, and pull out the key.
2. Disconnect the battery negative terminal.
3. Disconnect the idling stepper motor connector (-1-).



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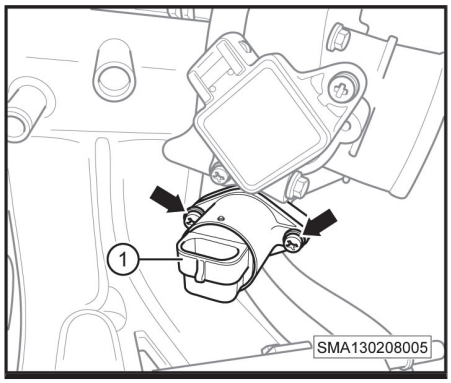
4. Unscrew the fixing bolts (-arrow-) and remove the idling stepper motor (-1-).



Installation

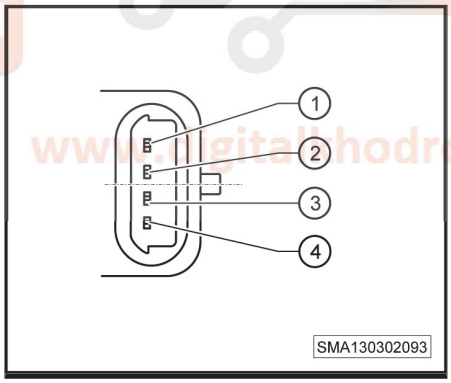
Installation shall follow the reverse sequence of the removal procedure. Please pay attention to the following notes:

1. Replace the throttle seal ring. Remove the dust on the working surface of the idling stepper motor and the carbon deposit on the throttle seat.
2. Replace the O-ring of the idling stepper motor.
3. After cleaning the idling stepper motor, you shall take the adaptation and learning procedure.

4.5.4 Checking the idling stepper motor

Methods:

1. Turn the digital multimeter to the "ohm" position, and respectively connect the two probes to the pins AD, BC of the idling stepper motor. The rated resistance is 53±5.3 Ω at 27℃.



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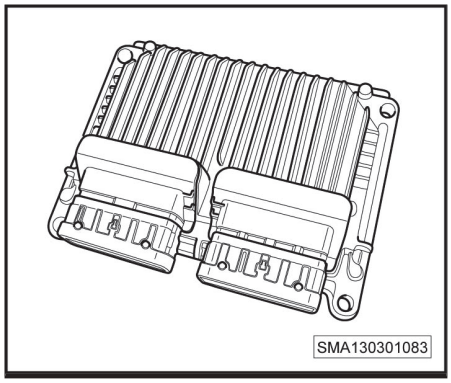
4.6 Engine control module

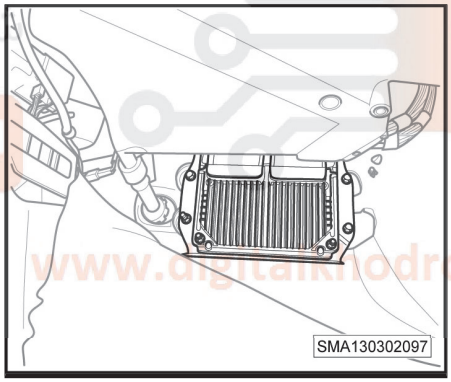
4.6.1 Overview

The engine control system function consists of electronic fuel injection control, electronic ignition control, idling control, exhaust emission control, fail-safe, self-diagnosis system, data communication system, anti-theft system and etc.. The engine control module is the core of the engine electronic fuel injection system, which calculates the required fuel injection volume (injection pulse width) for combustion in the cylinder according to the sensor feedback signal and the signals of various conditions, and opens the fuel injector at the right injection timing, jets appropriate amount of fuel into the intake pipe to form the flammable gas mixture with the best air-fuel ratio, and keeps the engine in good running condition through the harmonious working of the fuel injector, ignition coil and a series of actuators.



4.6.2 Installation location

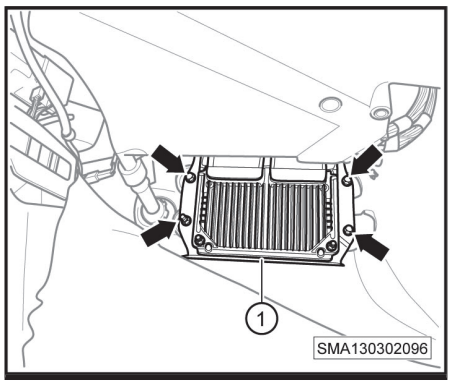
Engine control module is installed on the front passenger side, below the evaporation tank assembly.



4.6.3 Removing and installing the engine control module

Removal

1. Switch off all electrical equipment and the ignition switch, and pull out the key.
2. Disconnect the battery negative terminal.
3. Remove the front right A pillar lower trim, and open the front passenger's side carpet.
4. Unscrew the fixing bolts (-arrow-). Take out the engine control module and the bracket (-1-).



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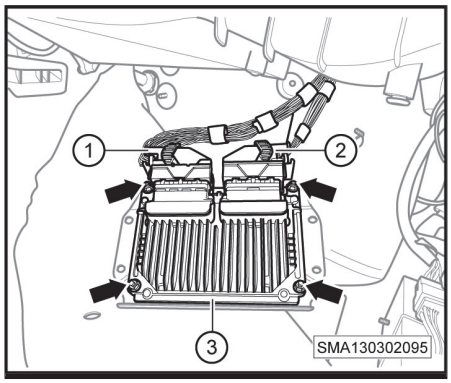
5. Disconnect the engine control module connectors (-1-) and (-2-), and unscrew the fixing bolts (-arrow-). Take out the engine control module (-3-).



Installation

Installation shall follow the reverse sequence of the removal procedure. Please pay attention to the following notes:

- **1**The engine control module must be adapted during the replacement or removal of the anti-theft control unit.
- **2**The anti-theft control unit must be adapted during the replacement of the engine control module.

4.6.4 Adapting the engine control module

Note

- The engine control module must be adapted with the anti-theft system control unit during the replacement of new engine control module.

Preconditions

- The battery voltage is within the normal range.
- There is no fault in the anti-theft system.
- There is no fault in the engine electronic control system actuators and sensors.
- It has been confirmed that the new engine control module model matches the anti-theft control system.

Preconditions

1. Turn off the ignition switch, and replace the engine control module.
2. Insert the key into the ignition lock and turn to the ON position.
3. Connect X-431.
4. Select the menu "Anti-theft control"→"Enter code"→"Enter the security code".
5. Select the menu "Anti-theft control"→"Anti-theft control adaption"→"Read from the anti-theft control to the engine control module " to adapt the engine control module with the anti-theft control.

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5 Symptom Diagnosis and Inspection

5.1 Diagnosis processes of the inspection according to the symptoms

Preliminary inspection:

1. Check if the battery voltage is normal.
2. Check if the engine malfunction indicator works properly.
3. Check if there is any fault record with the diagnostic device.
4. Check if the fault symptoms complained by the owner exists, and confirm its occurrence conditions (like on steep road, on smooth road, in accelerated motion, or at constant speed etc.)

Visual check:

1. Check the fuel pipe for leakage.
2. Check for fracture, kink, and correct connection of the vacuum tube.
3. Check for blockage, air leakage, crushing or damage of the intake pipe.
4. Check for rupture, aging, correct ignition sequence of the high-voltage wire in the ignition system.
5. Check the wiring harness grounding area for cleanness and firmness.
6. Check loose or poor contact of each sensor and actuator connector.

Note

- If any symptom above exists, first carry out maintenance work for that symptom, or it will affect the following fault diagnosis and maintenance work.

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5.2 Diagnostic tips

1. Check if there is any fault record in the engine.
2. Check if the symptom described by the customer exists.
3. The influence of the vehicle maintenance condition, cylinder pressure, mechanical ignition timing, fuel situation and etc. on the system cannot be ignored in the inspection process.
4. If there is any fault difficult to troubleshoot in the repair process, you can replace ECM first for testing.

If now the fault symptom disappears, there is fault in ECM. If the symptom still exists, find fault causes from other symptoms.

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5.3 Symptom diagnosis and inspection list

Symptoms
1. Engine failure or low engine speed when started
2. Engine idling with start failure when started
3. Warm start difficulty
4. Cold start difficulty
5. Disabled acceleration and poor performance
6. Engine idling vibration
7. Normal speed but difficult to start all the time
8. Normal start but unstable idling speed all the time
9. Normal start but unstable idling speed during warming up
10. Unstable engine idling speed or even flameout when the throttle is released after acceleration
11. Normal start but excessive idling speed
12. Slow response in acceleration
13. Normal start but unstable idling speed after warming up

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5.4 Symptom diagnosis and inspection

5.4.1 Engine failure or low engine speed when started

Possible causes:

1. Failure of the battery
2. Failure of the starter
3. Failure of the wiring harness
4. Mechanical failure of the engine

Diagnostic procedures

Note

- If the starter operates slowly, first check if the battery voltage is normal.

1. Check the voltage between the two battery terminals with a digital multimeter, and check if the battery voltage is normal when starting the engine.
   - If yes, go to step 2.
   - If not, the battery fails and please replace the battery. ■

2. Start the engine to run the starter, and check if the grounding between the battery and the engine is hot.
   - If yes, the engine grounding is poor and please repair it. ■
   - If not, go to step 3.

3. Remove the starter relay and the relay housing, and check the relay pull-in point for corrosion and burning.
   - If yes, the relay fails and please replace it. ■
   - If not, go to step 4.

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4. Disassemble the starter to mainly check the starter brush for excessive wear, the rotor coil for short circuit and the bearing for damage.
   - If yes, the starter fails and please replace it. ■
   - If not, go to step 5.

5. Check if the resistance of the internal mechanical parts of the engine is excessive that results in abnormal or null operation of the starter.
   - If yes, the mechanical part of the engine fails and please repair it. ■
   - If not, go to step 6.

6. Check if the power supply and grounding of the engine control module is normal.
   - If yes, find the fault cause from other symptoms.
   - If not, inspect the corresponding lines of the engine control module. ■

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5.4.2 Engine idling with start failure when started

Possible causes:

1. Failure of the idling stepper motor
2. Failure of the fuel system
3. Failure of the crankshaft position sensor
4. Failure of the ignition system
5. Mechanical failure of the engine

Diagnostic procedures

1. Turn the ignition switch to the ON position. Check if there is any fault record with the diagnostic device.
   - If yes, refer to the corresponding diagnostic procedures of the fault codes for troubleshooting based on the fault information. ■
   - If not, go to step 2.

2. Press the accelerator pedal to slightly open the throttle. Start the engine and check if the engine is successfully starting.
   - If yes, the idling stepper motor fails and please clean or replace it. ■
   - If not, go to step 3.

3. Connect the fuel pressure gauge to the common rail, start the engine and check if the fuel system pressure is normal.
   - If yes, go to step 4.
   - If not, the fuel system fails and please inspect it. ■

4. Pull out the ignition cable of each cylinder successively. Connect the spark plug, ground the spark plug housing, start the engine, and check if there is blue and white high-pressure fire.
   - If yes, go to step 5.
   - If not, the ignition system fails and please inspect it. ■

5. Disconnect the power supply fuse of the fuel pump, unscrew all spark plugs from the cylinders, connect an engine cylinder pressure gauge and check if the pressure of each cylinder is normal.
   - If yes, the mechanical part of the engine fails and please repair it. ■
   - If not, go to step 6.

6. Start the engine and check if the "crankshaft position sensor waveform" is normal with an oscilloscope.
   - If yes, go to step 7.
   - If not, the crankshaft position sensor fails and please replace it. ■

7. Check if the power supply and grounding of the engine control module is normal.
   - If yes, find the fault cause from other symptoms.
   - If not, inspect the corresponding lines of the engine control module. ■

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5.4.3 Warm start difficulty

Possible causes:

1. Failure of the idling stepper motor
2. Failure of the coolant temperature sensor
3. Failure of the ignition system
4. Failure of the fuel system

Diagnostic procedures

1. Turn the ignition switch to the ON position. Check if there is any fault record with the diagnostic device.
   - If yes, refer to the corresponding diagnostic procedures of the fault codes for troubleshooting based on the fault information. ■
   - If not, go to step 2.

2. Check if the failure occurs when the fuel is filled.
   - If yes, clean the fuel system and replace the fuel. ■
   - If not, go to step 3.

3. Check if the reading of the "coolant temperature sensor data flow" is normal with a vehicle diagnostic device.
   - If yes, go to step 4.
   - If not, the coolant temperature sensor fails and please replace it. ■

4. Press the accelerator pedal to slightly open the throttle. Start the engine and check if the engine is successfully starting.
   - If yes, the idling stepper motor fails and please clean or replace it. ■
   - If not, go to step 5.

5. Check if the model and clearance of the spark plug of each cylinder are up to specifications.
   - If yes, go to step 6.
   - If not, replace the spark plug. ■

6. Pull out the ignition cable of each cylinder successively. Connect the spark plug, ground the spark plug housing, start the engine, and check if there is blue and white high-pressure fire.
   - If yes, go to step 7.
   - If not, the ignition system fails and please inspect it. ■

7. Connect the fuel pressure gauge to the common rail, start the engine and check if the fuel system pressure is normal.
   - If yes, go to step 8.
   - If not, the fuel system fails and please inspect it. ■

8. Check if the power supply and grounding of the engine control module is normal.
   - If yes, find the fault cause from other symptoms.
   - If not, inspect the corresponding lines of the engine control module. ■

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5.4.4 Cold start difficulty

Possible causes:

1. Failure of the idling stepper motor
2. Failure of the fuel system
3. Failure of the fuel injector
4. Failure of the ignition system
5. Failure of the coolant temperature sensor

Diagnostic procedures

1. Turn the ignition switch to the ON position. Check if there is any fault record with the diagnostic device.
   - If yes, refer to the corresponding diagnostic procedures of the fault codes for troubleshooting based on the fault information. ■
   - If not, go to step 2.

2. Press the accelerator pedal to slightly open the throttle. Start the engine and check if the engine is successfully starting.
   - If yes, the idling stepper motor fails and please clean or replace it. ■
   - If not, go to step 3.

3. Check if the reading of the "coolant temperature sensor data flow" is normal with a diagnostic device.
   - If yes, go to step 4.
   - If not, the coolant temperature sensor fails and please replace it. ■

4. Connect the fuel pressure gauge to the common rail. Start the engine for seconds before turning it off, and check if the fuel system pressure is dropping.
   - If yes, go to step 5.
   - If not, go to step 8.

5. Visually check the fuel pipe for leakage.
   - If yes, go to step 6.
   - If not, the fuel pipe is leaking and please replace it. ■

6. Disassemble the fuel injector, install it to the injector tester for pressure leak test, and check if the injector leaks.
   - If yes, the injector fails and please replace it. ■
   - If not, go to step 7.

7. Connect the fuel pressure gauge to the common rail. Start the engine for seconds before turning it off, and check if the fuel system pressure is dropping.
   - If yes, the fuel pump fails and please replace it. ■
   - If not, go to step 8.

8. Pull out the ignition cable of each cylinder successively. Connect the spark plug, ground the spark plug housing, start the engine, and check if there is blue and white high-pressure fire.

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- If yes, go to step 9.
- If not, the ignition system fails and please inspect it. ■

9. Check if the power supply and grounding of the engine control module is normal.
   - If yes, find the fault cause from other symptoms.
   - If not, inspect the corresponding lines of the engine control module. ■

5.4.5 Disabled acceleration and poor performance

Possible causes:

1. Improper adjustment of the throttle cable
2. Failure of the air intake system
3. Failure of the exhaust system
4. Failure of the ignition coil
5. Failure of the fuel system
6. Failure of ignition timing

Diagnostic procedures

1. Turn the ignition switch to the ON position. Check if there is any fault record with the diagnostic device.
   - If yes, refer to the corresponding diagnostic procedures of the fault codes for troubleshooting based on the fault information. ■
   - If not, go to step 2.

2. Check if the throttle cable is loose.
   - If yes, adjust the throttle cable. ■
   - If not, go to step 3.

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3. Disassemble the air filter and check the air filter element for blockage.
   - If yes, replace the air filter element. ■
   - If not, go to step 4.

4. Start the engine and check if the exhaust pipe is smooth.
   - If yes, go to step 5.
   - If not, the three-way catalytic converter is blocked and please replace it. Besides, replace the fuel and clean the fuel system. ■

5. Pull out the ignition cable of each cylinder successively. Connect the spark plug, ground the spark plug housing, start the engine, and check if there is blue and white high-pressure fire.
   - If yes, go to step 6.
   - If not, the ignition system fails and please inspect it. ■

6. Connect the fuel pressure gauge to the common rail, start the engine and check if the fuel system pressure is normal.
   - If yes, go to step 7.

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- If not, the fuel system fails and please inspect it. ■

7. Disassemble the timing belt upper guard and check if the timing belt is installed properly.
   - If yes, go to step 8.
   - If not, disassemble the timing belt and reinstall it. ■

8. Check if the reading of the "intake air pressure/temperature sensor data flow" is normal with a diagnostic device.
   - If yes, go to step 9.
   - If not, the intake air pressure/temperature sensor fails and please replace it. ■

9. Check if the power supply and grounding of the engine control module is normal.
   - If yes, find the fault cause from other symptoms.
   - If not, inspect the corresponding lines of the engine control module. ■

5.4.6 Engine idling vibration

Possible causes:

1. Failure of the idling stepper motor
2. Failure of the air intake system
3. Failure of the ignition coil
4. Failure of the fuel system
5. Mechanical failure of the engine

Diagnostic procedures

1. Turn the ignition switch to the ON position. Check if there is any fault record with the diagnostic device.
   - If yes, refer to the corresponding diagnostic procedures of the fault codes for troubleshooting based on the fault information. ■
   - If not, go to step 2.

2. Disassemble the idling stepper motor and throttle, clean the idling stepper motor and throttle, and recheck if the fault still exists.
   - If yes, the idling stepper motor and throttle are too dirty. ■
   - If not, go to step 3.

3. Disassemble the air filter and check the air filter element for blockage.
   - If yes, replace the air filter element. ■
   - If not, go to step 4.

4. Start the engine and check if the exhaust pipe is smooth.
   - If yes, go to step 5.
   - If not, the three-way catalytic converter is blocked and please replace it. Besides, replace the fuel and clean the fuel system. ■

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5. Pull out the ignition cable of each cylinder successively. Connect the spark plug, ground the spark plug housing, start the engine, and check if there is blue and white high-pressure fire.
   - If yes, go to step 6.
   - If not, the ignition system fails and please inspect it. ■

6. Connect the fuel pressure gauge to the common rail, start the engine and check if the fuel system pressure is normal.
   - If yes, go to step 7.
   - If not, the fuel system fails and please inspect it. ■

7. Disassemble the timing belt upper guard and check if the timing belt is installed properly.
   - If yes, go to step 8.
   - If not, disassemble the timing belt and reinstall it. ■

8. Check if the reading of the "intake air pressure/temperature sensor data flow" is normal with a diagnostic device.
   - If yes, go to step 9.
   - If not, the intake air pressure/temperature sensor fails and please replace it. ■

9. Disconnect the power supply fuse of the fuel pump, unscrew all spark plugs from the cylinders, connect an engine cylinder pressure gauge and check if the pressure of each cylinder is normal.
   - If yes, go to step 10.
   - If not, the mechanical part of the engine fails and please repair it. ■

10. Check if the power supply and grounding of the engine control module is normal.
    - If yes, find the fault cause from other symptoms.
    - If not, inspect the corresponding lines of the engine control module. ■

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5.4.7 Normal speed but difficult to start all the time

Possible causes:

1. Failure of the idling stepper motor
2. Failure of the air intake system
3. Failure of the ignition system
4. Failure of the fuel system
5. Failure of the coolant temperature sensor
6. Failure of the intake air pressure/temperature sensor
7. Failure of the fuel injector
8. Mechanical failure of the engine

Diagnostic procedures

1. Turn the ignition switch to the ON position. Check if there is any fault record with the diagnostic device.
   - If yes, refer to the corresponding diagnostic procedures of the fault codes for troubleshooting based on the fault information. ■

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- If not, go to step 2.

2. Press the accelerator pedal to slightly open the throttle. Start the engine and check if the engine is successfully starting.
   - If yes, the idling stepper motor fails and please clean or replace it. ■
   - If not, go to step 3.

3. Disassemble the air filter and check the air filter element for blockage.
   - If yes, replace the air filter element. ■
   - If not, go to step 4.

4. Pull out the ignition cable of each cylinder successively. Connect the spark plug, ground the spark plug housing, start the engine, and check if there is blue and white high-pressure fire.
   - If yes, go to step 5.
   - If not, the ignition system fails and please inspect it. ■

5. Connect the fuel pressure gauge to the common rail, start the engine and check if the fuel system pressure is normal.
   - If yes, go to step 6.
   - If not, the fuel system fails and please inspect it. ■

6. Disassemble the fuel injector, install it to the injector tester for pressure leak test, and check if the injector leaks.
   - If yes, go to step 7.
   - If not, the injector fails and please replace it. ■

7. Disassemble the timing belt upper guard and check if the timing belt is installed properly.
   - If yes, go to step 8.
   - If not, disassemble the timing belt and reinstall it. ■

8. Remove the air filter assembly and check if the throttle panel is too dirty.
   - If yes, clean the throttle. ■
   - If not, go to step 9.

9. Check if the reading of the "coolant temperature sensor data flow" is normal with a diagnostic device.
   - If yes, go to step 10.
   - If not, the coolant temperature sensor fails and please replace it. ■

10. Check if the reading of the "intake air pressure/temperature sensor data flow" is normal with a diagnostic device.
    - If yes, go to step 11.
    - If not, the intake air pressure/temperature sensor fails and please replace it. ■

11. Disconnect the power supply fuse of the fuel pump, unscrew all spark plugs from the cylinders, connect an engine cylinder pressure gauge and check if the pressure of each cylinder is normal.

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- If yes, go to step 12.
- If not, the mechanical part of the engine fails and please repair it. ■

12. Check if the power supply and grounding of the engine control module is normal.
    - If yes, find the fault cause from other symptoms.
    - If not, inspect the corresponding lines of the engine control module. ■

5.4.8 Normal start but unstable idling speed all the time

Possible causes:

1. Failure of the idling stepper motor
2. Failure resulting from bad fuel quality
3. Failure of the fuel injector
4. Failure of the spark plug
5. Failure of the air intake system
6. Failure of ignition timing
7. Mechanical failure of the engine

Diagnostic procedures

1. Turn the ignition switch to the ON position. Check if there is any fault record with the diagnostic device.
    - If yes, refer to the corresponding diagnostic procedures of the fault codes for troubleshooting based on the fault information. ■
    - If not, go to step 2.

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2. Check if the failure occurs when the fuel is filled.
    - If yes, clean the fuel system and replace the fuel. ■
    - If not, go to step 3.

3. Disassemble the idling stepper motor and check if the idling stepper motor and the throttle are too dirty.
    - If yes, clean the idling stepper motor. ■
    - If not, go to step 4.

4. Check if the model and clearance of the spark plug of each cylinder are up to specifications.
    - If yes, go to step 5.
    - If not, adjust or replace the spark plug. ■

5. Pull out the ignition cable of each cylinder successively. Connect the spark plug, ground the spark plug housing, start the engine, and check if there is blue and white high-pressure fire.
    - If yes, go to step 6.
    - If not, the ignition system fails and please inspect it. ■

6. Connect the fuel pressure gauge to the common rail, start the engine and check if the fuel system pressure is normal.
    - If yes, go to step 7.

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- If not, the fuel system fails and please inspect it. ■

7. Disassemble the fuel injector, install it to the injector tester for pressure leak test, and check if the injector leaks.
   - If yes, go to step 8.
   - If not, the injector fails and please replace it. ■

8. Check if the reading of the "coolant temperature sensor data flow" is normal with a diagnostic device.
   - If yes, go to step 9.
   - If not, the coolant temperature sensor fails and please replace it. ■

9. Check if the reading of the "intake air pressure/temperature sensor data flow" is normal with a diagnostic device.
   - If yes, go to step 10.
   - If not, the intake air pressure/temperature sensor fails and please replace it. ■

10. Disconnect the power supply fuse of the fuel pump, unscrew all spark plugs from the cylinders, connect an engine cylinder pressure gauge and check if the pressure of each cylinder is normal.
    - If yes, go to step 11.
    - If not, the mechanical part of the engine fails and please repair it. ■

11. Check if the failure occurs when the fuel is filled.
    - If yes, clean the fuel system and replace the fuel. ■
    - If not, go to step 12.

12. Check if the power supply and grounding of the engine control module is normal.
    - If yes, find the fault cause from other symptoms.
    - If not, inspect the corresponding lines of the engine control module. ■

5.4.9 Normal start but unstable idling speed during warming up

Possible causes:

1. Failure of the idling stepper motor
2. Failure of the throttle
3. Failure of the coolant temperature sensor
4. Failure of the spark plug
5. Failure of the fuel injector
6. Failure of the air intake system
7. Failure of ignition timing
8. Failure resulting from bad fuel quality
9. Mechanical failure of the engine

Diagnostic procedures

1. Turn the ignition switch to the ON position. Check if there is any fault record with the diagnostic device.

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- If yes, refer to the corresponding diagnostic procedures of the fault codes for troubleshooting based on the fault information.
- If not, go to step 2.

2. Remove the air filter assembly and check if the throttle panel is too dirty.
   - If yes, clean the throttle.
   - If not, go to step 3.

3. Disassemble the idling stepper motor and check if it is too dirty.
   - If yes, clean the idling stepper motor.
   - If not, go to step 4.

4. Check if the reading of the "coolant temperature sensor data flow" is normal with a diagnostic device.
   - If yes, go to step 5.
   - If not, the coolant temperature sensor fails and please replace it.

5. Check if the model and clearance of the spark plug of each cylinder are up to specifications.
   - If yes, go to step 6.
   - If not, adjust or replace the spark plug.

6. Pull out the ignition cable of each cylinder successively. Connect the spark plug, ground the spark plug housing, start the engine, and check if there is blue and white high-pressure fire.
   - If yes, go to step 7.
   - If not, the ignition system fails and please inspect it.

7. Disassemble the fuel injector, install it to the injector tester for pressure leak test, and check if the injector leaks.
   - If yes, go to step 8.
   - If not, the injector fails and please replace it.

8. Check the air intake system pipe for leakage.
   - If yes, repair or replace the leaking pipe.
   - If not, go to step 9.

9. Disassemble the timing belt upper guard and check if the timing belt is installed properly.
   - If yes, go to step 10.
   - If not, disassemble the timing belt and reinstall it.

10. Check if the failure occurs when the fuel is filled.
    - If yes, clean the fuel system and replace the fuel.
    - If not, go to step 11.

11. Check if the power supply and grounding of the engine control module is normal.
    - If yes, find the fault cause from other symptoms.

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- If not, inspect the corresponding lines of the engine control module. ■

5.4.10 Unstable engine idling speed or even flameout when the throttle is released after acceleration

Possible causes:

1. Failure of the idling stepper motor
2. Failure of the air intake system
3. Failure of the spark plug
4. Failure of the ignition
5. Failure of the fuel injector
6. Failure of ignition timing
7. Failure resulting from bad fuel quality

Diagnostic procedures

1. Turn the ignition switch to the ON position. Check if there is any fault record with the diagnostic device.
   - If yes, refer to the corresponding diagnostic procedures of the fault codes for troubleshooting based on the fault information. ■
   - If not, go to step 2.

2. Check if the failure occurs when the fuel is filled.
   - If yes, clean the fuel system and replace the fuel. ■
   - If not, go to step 3.

3. Disassemble the idling stepper motor and check if it is too dirty.
   - If yes, clean or replace the idling stepper motor. ■
   - If not, go to step 4.

4. Disassemble the air filter and check the air filter element for blockage.
   - If yes, replace the air filter element. ■
   - If not, go to step 5.

5. Remove the air filter assembly and check if the throttle plate is too dirty.
   - If yes, clean the throttle. ■
   - If not, go to step 6.

6. Check the air intake system pipe for leakage.
   - If yes, repair or replace the leaking pipe. ■
   - If not, go to step 7.

7. Disassemble the timing belt upper guard and check if the timing belt is installed properly.
   - If yes, go to step 8.
   - If not, disassemble the timing belt and reinstall it. ■

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8. Check if the power supply and grounding of the engine control module is normal.
   - If yes, find the fault cause from other symptoms.
   - If not, inspect the corresponding lines of the engine control module. ■

5.4.11 Normal start but excessive idling speed

Possible causes:

1. Improper adjustment of the throttle cable
2. Failure of the idling stepper motor
3. Failure of the throttle
4. Failure of the air intake system
5. Failure of the coolant temperature sensor

Diagnostic procedures

1. Turn the ignition switch to the ON position. Check if there is any fault record with the diagnostic device.
   - If yes, refer to the corresponding diagnostic procedures of the fault codes for troubleshooting based on the fault information. ■
   - If not, go to step 2.

2. Check if the throttle cable is tight.
   - If yes, readjust the throttle cable. ■
   - If not, go to step 3.

3. Disassemble the idling stepper motor and check if it is too dirty or blocked.
   - If yes, clean the idling stepper motor. ■
   - If not, go to step 4.

4. Check if there is any carbon deposit in the throttle plate.
   - If yes, clean the throttle. ■
   - If not, go to step 5.

5. Start the engine and check the intake manifold for leakage at idling.
   - If yes, repair or replace the leaking pipe. ■
   - If not, go to step 6.

6. Start the engine and connect the diagnostic device to check if the reading of the "coolant temperature sensor data flow" is normal.
   - If yes, go to step 7.
   - If not, the coolant temperature sensor fails and please replace it. ■

7. Make sure that the A/C switch is in the OFF position, turn the ignition switch to the ON position and check if the reading of the "A/C switch" is in the ON position with a diagnostic device.
   - If yes, the A/C circuit fails. ■

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- If not, go to step 8.

8. Check if the power steering switch is connected without steering.
   - If yes, the power steering switch fails and please replace it. ■
   - If not, go to step 9.

9. Check if the power supply and grounding of the engine control module is normal.
   - If yes, find the fault cause from other symptoms.
   - If not, inspect the corresponding lines of the engine control module. ■

5.4.12 Slow response in acceleration

Possible causes:

1. Improper adjustment of the throttle cable
2. Failure of the exhaust system
3. Failure of the air intake system
4. Failure of the coolant temperature sensor
5. Failure of the intake air pressure/temperature sensor
6. Failure of ignition timing
7. Failure of the fuel system

Diagnostic procedures

1. Turn the ignition switch to the ON position. Check if there is any fault record with the diagnostic device.
   - If yes, refer to the corresponding diagnostic procedures of the fault codes for troubleshooting based on the fault information. ■
   - If not, go to step 2.

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2. Check if the throttle cable is tight.
   - If yes, readjust the throttle cable. ■
   - If not, go to step 3.

3. Start the engine and check if the exhaust pipe is smooth.
   - If yes, go to step 4.
   - If not, the three-way catalytic converter is blocked and please replace it. Besides, check the fuel quality. ■

4. Disassemble the air filter and check the air filter element for blockage.
   - If yes, replace the air filter element. ■
   - If not, go to step 5.

5. Connect the fuel pressure gauge to the common rail, start the engine and check if the fuel system pressure is normal in each condition.
   - If yes, go to step 6.
   - If not, the fuel system fails and please inspect it. ■

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6. Start the engine, connect the diagnostic device and check if the reading of the "coolant temperature sensor data flow" is normal.
   - If yes, go to step 7.
   - If not, the coolant temperature sensor fails and please replace it. ■

7. Start the engine, connect the diagnostic device and check if the reading of the "intake air pressure/temperature sensor data flow" is normal.
   - If yes, go to step 8.
   - If not, the intake air pressure/temperature sensor fails and please replace it. ■

8. Disassemble the timing belt upper guard and check if the valve timing is correct.
   - If yes, go to step 9.
   - If not, reinstall the timing belt. ■

9. Check if the power supply and grounding of the engine control module is normal.
   - If yes, find the fault cause from other symptoms.
   - If not, inspect the corresponding lines of the engine control module. ■

5.4.13 Normal start but unstable idling speed after warming up

Possible causes:

1. Failure of the idling stepper motor
2. Failure of the air intake system
3. Failure of the fuel system
4. Failure of the coolant temperature sensor
5. Failure of the intake air pressure/temperature sensor

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Diagnostic procedures

1. Turn the ignition switch to the ON position. Check if there is any fault record with the diagnostic device.
   - If yes, refer to the corresponding diagnostic procedures of the fault codes for troubleshooting based on the fault information. ■
   - If not, go to step 2.

2. Disassemble the air filter assembly and check if there is carbon deposit around the throttle plate.
   - If yes, clean the throttle. ■
   - If not, go to step 3.

3. Disassemble the idling stepper motor and check if it is too dirty or blocked.
   - If yes, clean the idling stepper motor. ■
   - If not, go to step 4.

4. Connect the fuel pressure gauge to the common rail, start the engine and check if the fuel system pressure is normal in each condition.
   - If yes, go to step 5.

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- If not, the fuel system fails and please inspect it. ■

5. Disassemble the fuel injector, install it to the injector tester for pressure leak test, and check if the injector leaks.
   - If yes, the injector fails and please replace it. ■
   - If not, go to step 6.

6. Start the engine and connect the diagnostic device and check if the reading of the "coolant temperature sensor data flow" is normal.
   - If yes, go to step 7.
   - If not, the coolant temperature sensor fails and please replace it. ■

7. Start the engine, connect the diagnostic device and check if the reading of the "intake air pressure/temperature sensor data flow" is normal.
   - If yes, go to step 8.
   - If not, the intake air pressure/temperature sensor fails and please replace it. ■

8. Check if the power supply and grounding of the engine control module is normal.
   - If yes, find the fault cause from other symptoms.
   - If not, inspect the corresponding lines of the engine control module. ■

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6 Ignition Control System

6.1 General Information

6.1.1 Overview

- The ignition system is used to ignite the flammable gas mixture of the corresponding cylinder sequentially as per the reasonable orders of ignition timing in order to maintain the normal operation of the engine.
- The ignition control system consists of the following components:

  a. Engine control module (ECM)
  b. Ignition coil
  c. Spark plug
  d. Ignition cable
  e. Camshaft position (CMP) sensor
  f. Crankshaft position (CKP) sensor

6.1.2 Product specifications

Torque specifications

Component	Tightening torque (N.m)
Spark plug	30±3
Ignition coil fixing bolt	6±1

Spark plug

Item	Data
Model	FR7DTC
Standard electrode clearance	0.7±0.1 mm

Ignition cable resistance

Item	Resistance (KΩ)
No. 1 cylinder ignition cable	7.5～11.2
No. 2 cylinder ignition cable	5.8～9.3
No. 3 cylinder ignition cable	4.2～7.7
No. 4 cylinder ignition cable	4～7.5

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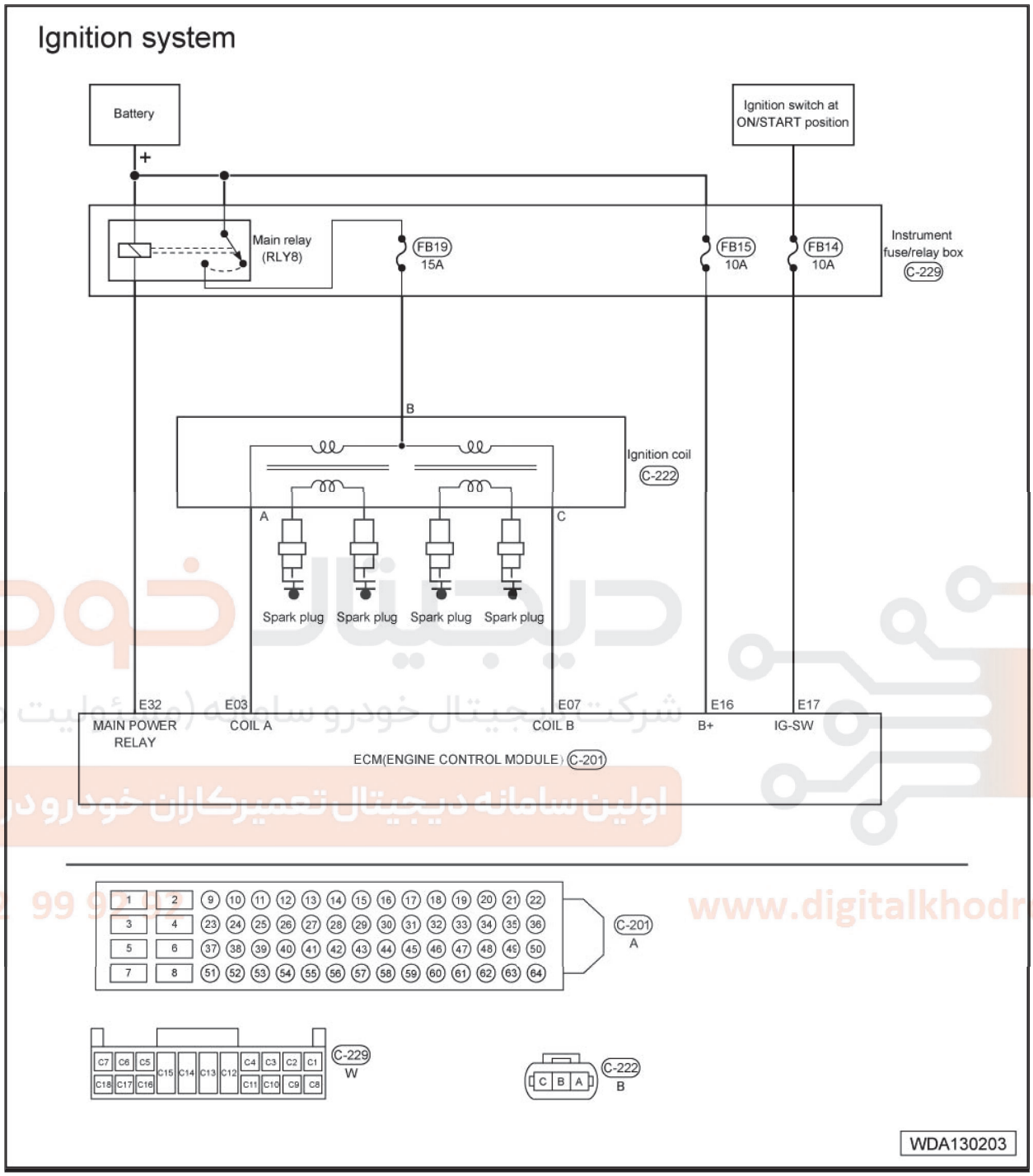
6.1.3 Ignition system circuit diagram



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6.2 Diagnosis and inspection

6.2.1 Ignition system troubleshooting

Symptoms	Possible causes	Maintenance recommendations
Engine idling vibration and disabled acceleration	Excessive spark plug electrode clearance	Replace the spark plug
	Failure of the spark plug	Replace the spark plug
	Weak ignition coil arcing	Replace the ignition coil
	Excessive ignition cable resistance	Replace the ignition cable
	Ignition cable open circuit	Replace the ignition cable

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6.3 Spark plug

6.3.1 Removing and installing the spark plug

Caution

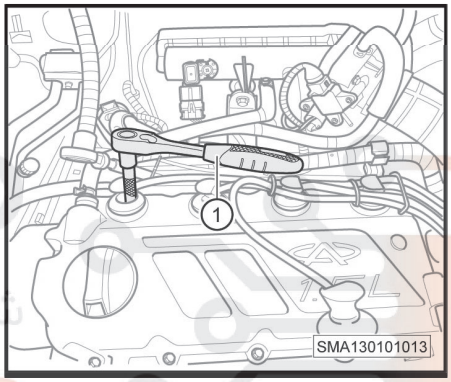
- Do not remove the spark plug when the engine is hot; otherwise, it may cause damage to the spark plug threaded hole on the cylinder head.

Note

- Remove the spark plug wires in sequence and mark their positions individually to avoid incorrect installation.
- Remove dust and impurities around the spark plug hole before removal to prevent them from falling into the cylinder.

Removal

1. Turn off the ignition switch and wait until the engine cools down.
2. Pull out the ignition cable.
3. Unscrew the spark plug with a special spark plug socket wrench (-1-).

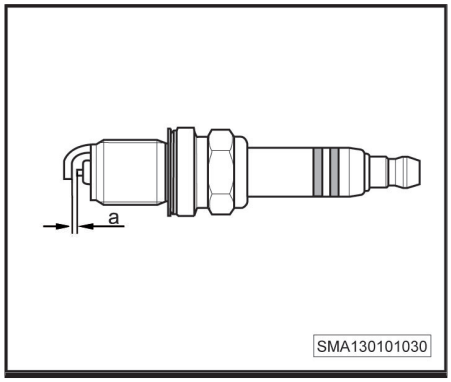


Installation

Note

- Check the spark plug type to see if it is applicable.
- During installation, use the special socket for installation to avoid the plug knocking against the cylinder wall and breaking the normal spark plug electrode clearance.

1. During installation, manually screw the spark plug into the cylinder head until it cannot be turned, and tighten it with a torque wrench with the specified torque.
   - Tightening torque of the spark plug: 30±3 N•m
2. Check the spark plug for clearance and the related data before installation.



Spark plug	Value
Standard electrode clearance	0.7±0.1 mm
Type	FR7DTC

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Spark plug	Value
Recommended replacement interval	Every 30000 Km or 18 months

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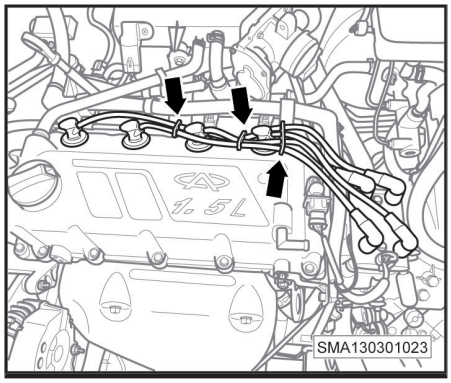
6.4 Ignition cable

6.4.1 Removing and installing the ignition cable

Removal

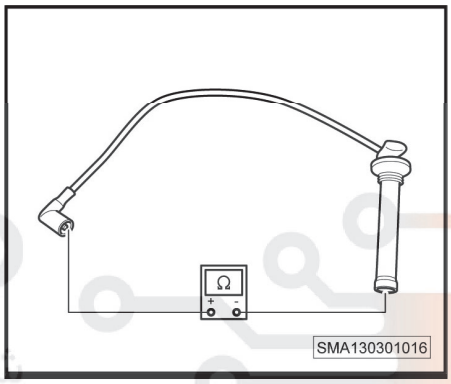
1. Switch off all electrical equipment and the ignition switch, and pull out the key.
2. Remove the retaining clips of the ignition cable (-arrow-) and pull out the big end of the ignition cable sequentially from the spark plug and the small end of the ignition cable sequentially from the ignition coil to remove the ignition cable.



Installation

Installation shall follow the reverse sequence of the removal procedure. Please pay attention to the following notes:

1. Note the location for installation of the ignition cable.
2. Check if the resistance of the ignition cable is normal. Measure the resistance of the ignition cable at both ends as shown in the diagram.



- Standard resistance of No. 1 cylinder ignition cable: 7.5～11.2 (Ω)
- Standard resistance of No. 2 cylinder ignition cable: 5.8～9.3 (KΩ)
- Standard resistance of No. 3 cylinder ignition cable: 4.2～7.7 (KΩ)
- Standard resistance of No. 4 cylinder ignition cable: 4～7.5 (KΩ)

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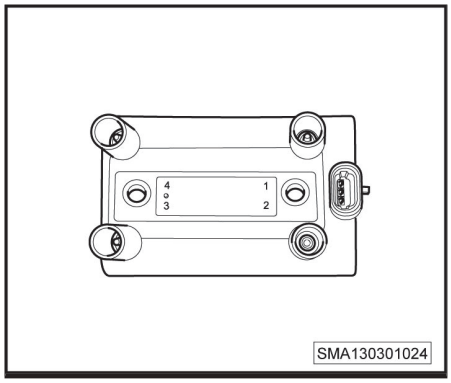
6.5 Ignition coil

6.5.1 Overview

The ignition coil transforms low voltage of the primary winding to high voltage of the secondary winding, and the high voltage produces spark through the electrode discharge of the spark plug, to ignite the flammable gas mixture within the cylinder.

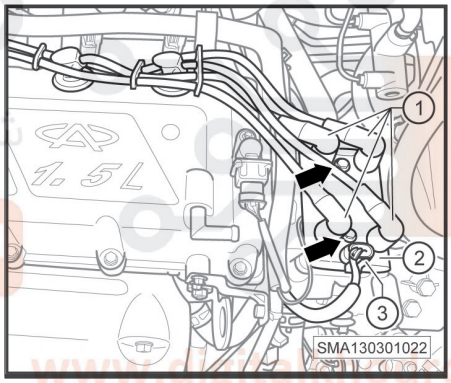


The ignition coil consists of two primary windings, two secondary windings and iron core, shell and so on. When a primary winding is connected to the ground, this primary winding is charged. Once the ECM cuts off the primary winding circuit, the charging stops, at this time the secondary winding induces a high voltage, to make the spark plug electrode discharge.

6.5.2 Removing and installing the ignition coil

Removal

1. Switch off all electrical equipment and the ignition switch, and pull out the key.
2. Disconnect the battery negative terminal.
3. Pull out the ignition cable connector (-1-).
4. Disconnect the ignition coil connector (-3-).
5. Unscrew the bolts (-arrow-) and remove the ignition coil (-2-).



Installation

Installation shall follow the reverse sequence of the removal procedure. Please pay attention to the following notes:

a. The ignition cable shall be installed as per the "-1-3-4-2-" ignition sequence.

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7 Fuel Vapor Emission Control System

7.1 General information

7.1.1 Overview

- The fuel vapor emission control system recovers and burns the fuel vapor so as to prevent the fuel vapor in the fuel tank from being discharged into the atmosphere.
- The activated carbon canister plays an important role in the fuel vapor emission control system. The activated carbon canister is used to absorb and filter the moisture and fuel vapor. The fuel vapor enters the top of the activated carbon canister through the pipe while fresh air goes to the bottom of the activated carbon canister. After engine flameout, the fuel vapor and fresh air are stored in the activated carbon canister and when the activated carbon canister solenoid valve opens, the fuel vapor will go to the intake manifold for combustion.

7.1.2 Product specifications

Torque specifications

Item	Torque (N.m)
Activated carbon canister solenoid valve mounting bracket	18±2
Activated carbon canister assembly	7±2

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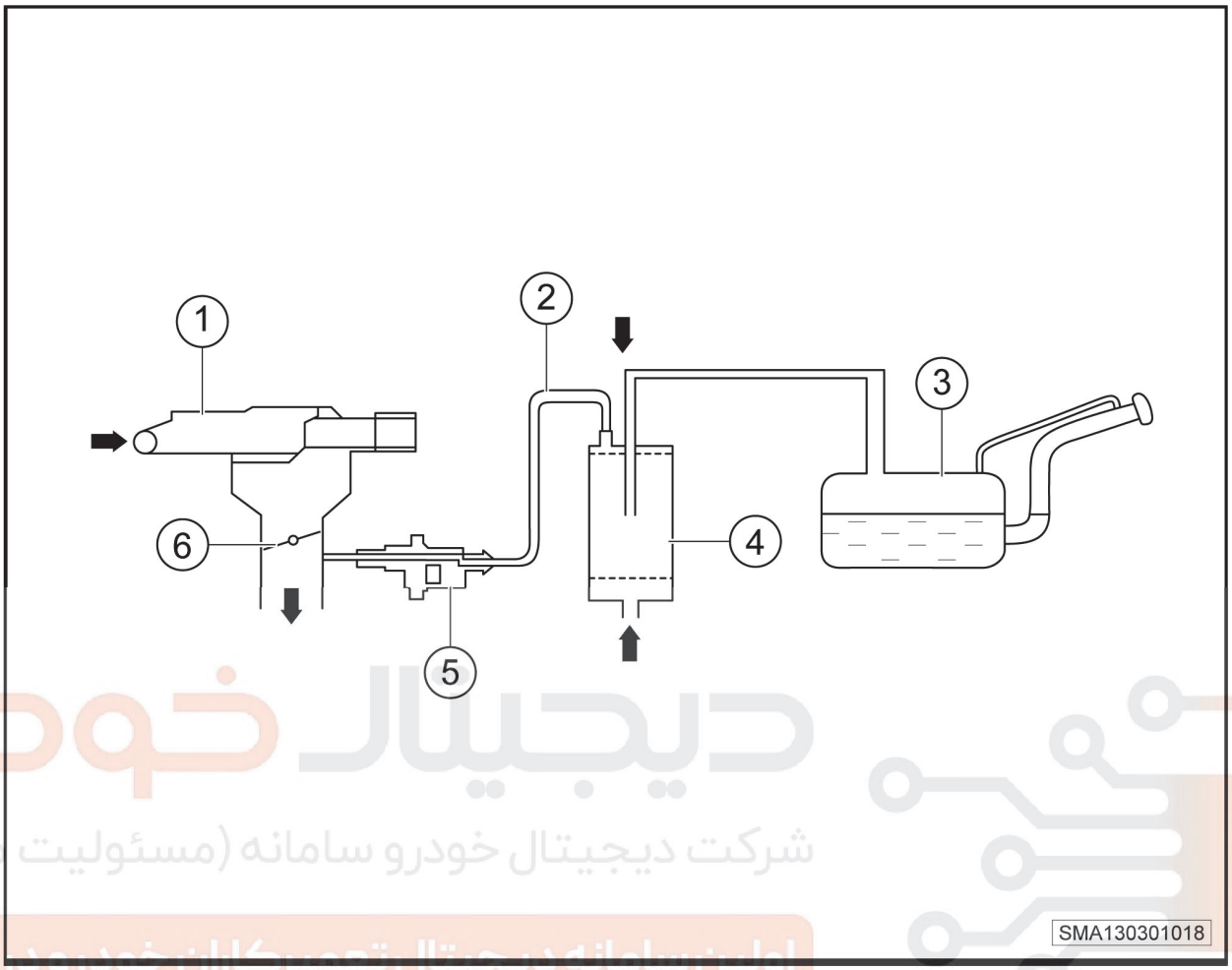
7.1.3 The fuel vapor emission control system assembly drawing



1. Air filter	2. Activated carbon canister outlet hose
3. Fuel tank	4. Activated carbon canister
5. Activated carbon canister solenoid valve	6. Throttle

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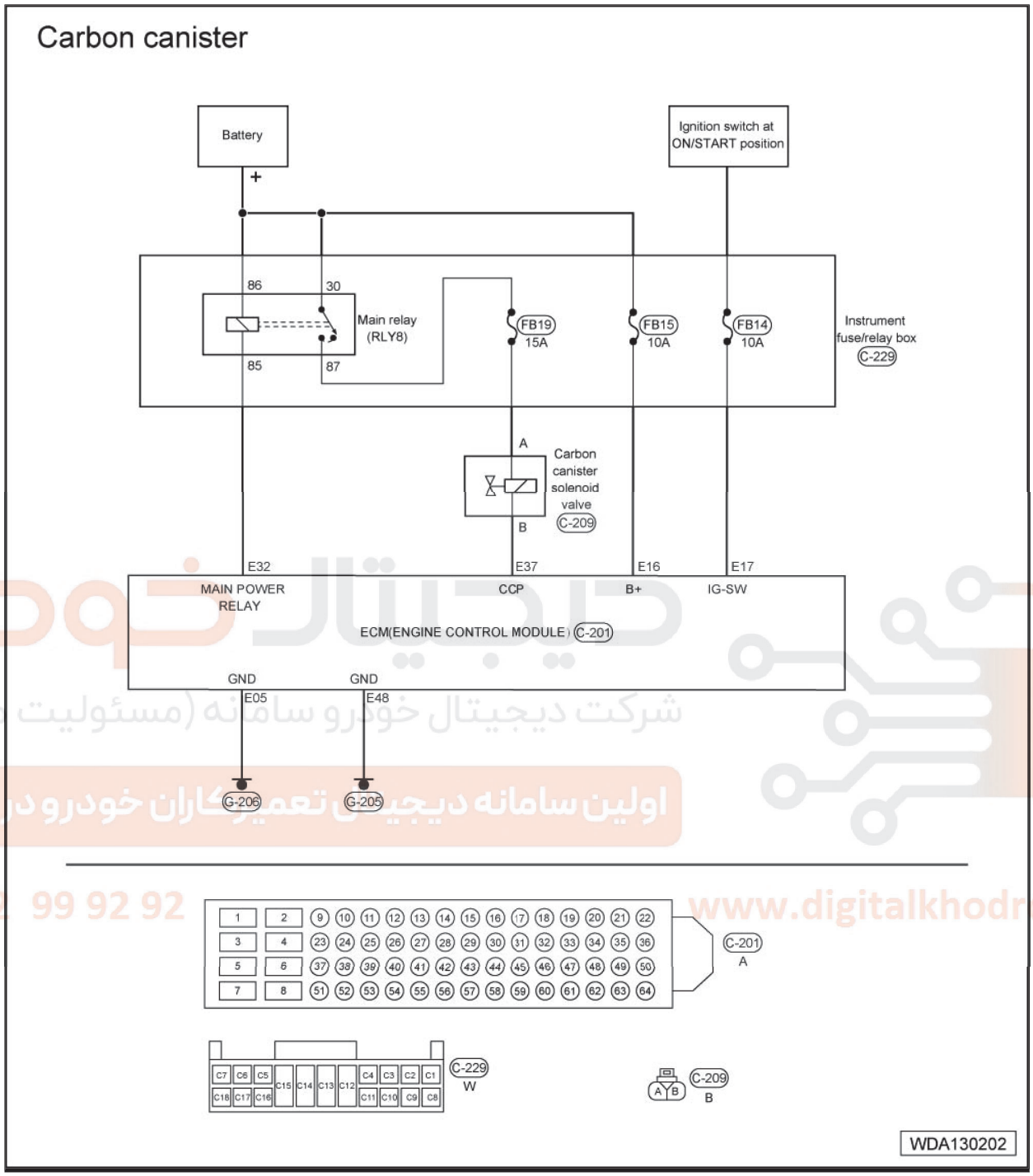
7.1.4 Fuel vapor emission control system circuit diagram



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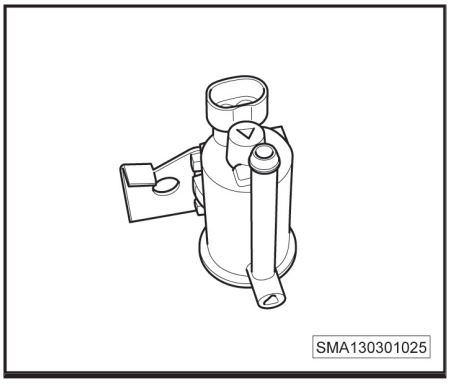
7.2 Activated carbon canister solenoid valve

7.2.1 Overview

The opening and closing of the activated carbon canister solenoid valve is controlled through electrical pulse duty cycle synthetically calculated by the ECM according to engine load, engine temperature, speed and a series of signals.



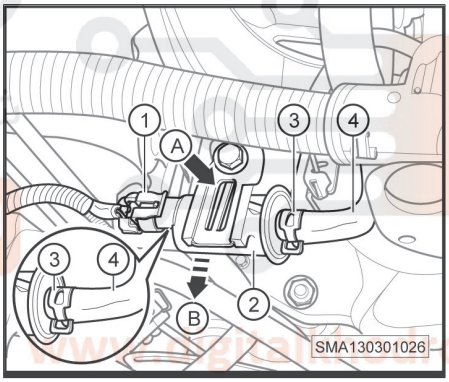
7.2.2 Removing and installing the activated carbon canister solenoid valve

Note

- Before removal, mark at the inlet and outlet pipes to avoid confusion.

Removal

1. Switch off all electrical equipment and the ignition switch, and pull out the key.
2. Disconnect the battery negative terminal.
3. Disconnect the carbon canister solenoid valve connector (-1-), loosen the clamp (-3-), and pull out the inlet and outlet hose (-4-).
4. Lever out the clip (-arrow A-) and remove the carbon canister solenoid valve (-2-) in the (-arrow B-) direction.

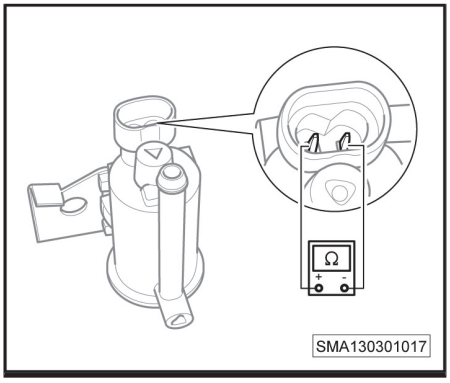


Installation

- Installation shall follow the reverse sequence of the removal procedure.

7.2.3 Checking the activated carbon canister solenoid valve

1. Remove the activated carbon canister solenoid valve.
2. Turn the digital multimeter to the "ohm" position, and respectively connect the two probes to the two pins of the activated carbon canister solenoid valve. The rated resistance is 21±1 Ω at 20℃.



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7.3 Activated carbon canister

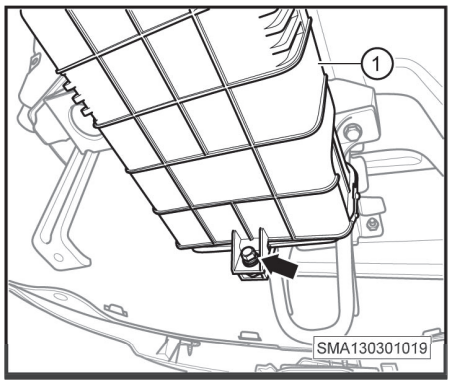
7.3.1 Overview

- The activated carbon canister is filled with the activated carbon which is used to absorb, filter and store the fuel vapor.

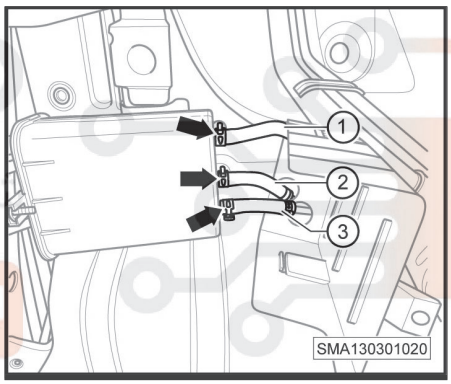
7.3.2 Removing and installing the activated carbon canister

Removal

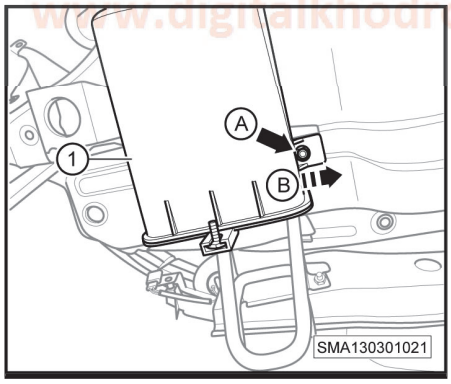
1. Unscrew the nut (-arrow-) and loosen the cover (-1-).



2. Loosen the clamps (-arrow-) and loosen the hoses (-1-, -2- and -3-).



3. Unscrew the bolt (-arrow A-), loosen the body clip in the (-arrow B-) direction, and take out the activated carbon canister (-1-).



Installation

Installation shall follow the reverse sequence of the removal procedure.

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