

## Chapter 4 Engine Electronic Control System

### 4.1 Attentions

#### 4.1.1 Common maintenance precautions

All the failures in electronic control system sensors, actuators, control circuits, ECM and other components will have some impact on the operation of the engine. Because the ECM has fault self-diagnostic capabilities, the computer tester can be connected to the ECM for troubleshooting to identify the cause of the fault in the electronic control system by reading the fault code or data flow. However, in most cases, this method can only determine the approximate scope of the fault. To determine the specific location of the fault, you must further follow the circuit diagram, test method, test procedure, standard value and other technical information in the “Maintenance Manual” to investigate and confirm.

In order to improve the reliability of the engine electronic control system work, most of the system components are structurally designed to be sealed, indecomposable, damaged and can not be repaired. The main task of electronic control system maintenance is to find faulty parts of the system, and replace the faulty parts.

When servicing the electronic control system, the following precautions must be taken to avoid damage to the ECM or control components.

1. Only use automotive-specific diagnostic tools to inspect electronic control systems (such as digital multimeter, automotive oscilloscope, and vehicle diagnostic).
2. Please use JAC genuine parts for maintenance work, otherwise the system will not work properly.
3. Only unleaded petrol can be used during maintenance and use.

4. Please follow the standardized maintenance diagnostic procedures for maintenance work.

5. It is forbidden to disassemble and disassemble the components of the system during the maintenance process.

6. When handling electronic components (electronic control modules, sensors, etc.) during maintenance, be very careful not to drop them.

7. Establish an awareness of environmental protection and effectively treat waste generated during maintenance.

8. Do not remove or plug in the ECM's harness plug when the ignition switch is on, to prevent the inductive components in the electronic control system from generating induced voltage during the power-off or power-on instant, causing damage to the ECM.

9. The ECM harness connector should be securely connected, or the ECM may be damaged.

10. When disassembling the battery or using an external battery to jump start, the ignition switch must be turned off before the folding or bridging operation can be performed. Pay special attention to the battery that can not be connected reversed.

11. When the battery connector is not tightened, please do not start the engine. Also do not remove the battery cable while the engine is running. Otherwise it will make the engine charging voltage too large, damaging the electronic control system components.

12. When turning the engine to check the cylinder compression pressure, please cut off the injector power or unplug all the injector harness connector to prevent the fuel injected into the exhaust without examination, resulting in three-way catalytic converter damage.

13. When the ignition system is inspected , the spark detection shall be carried out only if necessary , and the time shall be as short as possible , otherwise a large amount of unburned gasoline will enter the exhaust pipe and damage the three-way catalyst converter.

14. Never allow the ECM temperature to exceed 80°C during hot-state

simulations of faults and other maintenance operations that may cause temperature rise.

15. The supply pressure is very high in EFI system, and all fuel lines are using high pressure fuel pipe. Even if the engine is not running, the oil path maintains a high fuel pressure. Therefore, do not disassemble the oil pipe easily during maintenance. When the fuel system needs to be repaired, release the oil pressure before releasing the oil pipe.

16. Removal of tubing and replacement of fuel filters should be carried out by professional maintenance personnel in well-ventilated areas.

17. The electric fuel pump must be cut off when it is removed from the fuel tank, so as to avoid the electric spark in the disassembly operation and cause fire. Fuel pumps are not allowed to run in dry or in water, otherwise their service life will be reduced. In addition, the fuel pump negative and positive poles can not be connected wrongly.

18. Prohibit the use of piercing wire skin to detect the input and output components of the electrical signal.

#### 4.1.2 Common diagnostic tool

- ① Tool name: electrical system diagnostic instrument

Functions: read/clear the fault code of the electrical spraying system, observe the data flow, test the action of parts, etc.

- ② Tool name: digital multimeter

Function: check the voltage, current, resistance and other characteristic parameters in the electro spray system.

- ③ Tool name: Vacuum gauge

Function: Check the pressure condition in the air inlet manifold.

- ④ Tool name: Cylinder pressure gauge

Function: Check the cylinder pressure of each cylinder

- ⑤ Tool name: Fuel pressure gauge

Function: Check the pressure condition of fuel system, judge the working condition of the fuel pump and fuel pressure regulator in the fuel system.

### 4.1.3 Engine OBD System Cautions

The Electronic Control Module (ECM) comes with an on-board diagnostic system that lights up when warning a driver of a malfunction caused by the aging exhaust system.

- Before performing any repair or inspection work, please turn the ignition switch OFF and disconnect the battery negative terminal. Open or short circuits in associated switches, sensors, and solenoid valves will cause the fault indicator to light up.

- After work, be sure to connect and reliably lock the connector. Loose (unlocked) connectors may open the circuit and cause the fault indicator to light. (Make sure no dirt such as water, grease and other dirt on the connector, and the connector pins are without bending, fracture, etc.)

- After work, be sure to arrange and fix the harnesses correctly. If the bracket interferes with the harness, it may cause a short circuit or an open circuit, causing the fault lamp to light up.

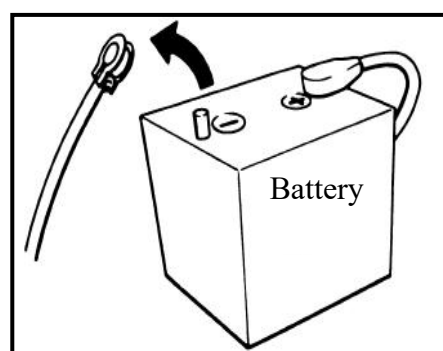
- After work, make sure the rubber hose is connected. If the rubber hose is not connected properly, the failure indicator light may be turned on due to the failure of EVAP system and fuel injection system.

- Before returning the vehicle to the customer, be sure to clear the historical fault information in the ECM (repair has been completed).

- Be sure to use 12V battery as the power source.

- Do not disconnect the battery while the engine is running.

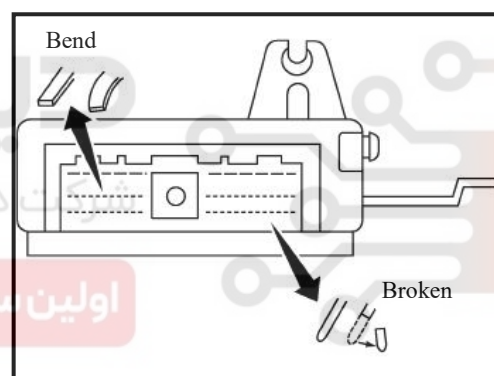
- Before connecting or disconnecting ECM wiring harness connector, turn





ignition switch to "OFF" position, and disconnect the battery negative terminal. Or it may damage ECM, because even the ignition switch is in "OFF" position, the battery still supply power to ECM.

- Before removing the parts, turn the ignition switch OFF and disconnect the negative battery terminal.
- Do not disassemble the ECM.
- When connecting the ECM harness connector, push the lever to the bottom to lock the ECM securely.
- When inserting the pin connector into the ECU or removing it from the ECU, be careful not to damage the pin port (bend or broken). Before connecting the pin connector, make sure the ECM pin port is not bent or broken.



- Securely connect the ECM harness connector. Poor connection can cause very high (ripple) voltage on the coil and capacitor, causing damage to the ECM.
- Keep the engine electronic control system components and harness dry.
- Even a small leak in the air intake system can cause serious malfunctions, so do not easily replace the air intake pressure sensor.
- Do not shake the camshaft position sensor or crankshaft position sensor.
- Read the error code to ensure that there is no error code after the repair is completed.
- When measuring the ECM with a circuit tester, do not contact the two gauges together (the probe is inadvertently touched, resulting in a short circuit and damage to the ECM power transistor).
- Do not use the fuel pump when there is no fuel in the fuel pipe.

- Ensure that fuel lines are installed as standard.
- Do not step on the accelerator pedal during start-up.
- Do not immediately increase the engine speed after starting.
- Do not accelerate before the engine is shut down (prevent the turbocharger from being damaged due to its failure to continue lubrication).

# دیجیتال خودرو

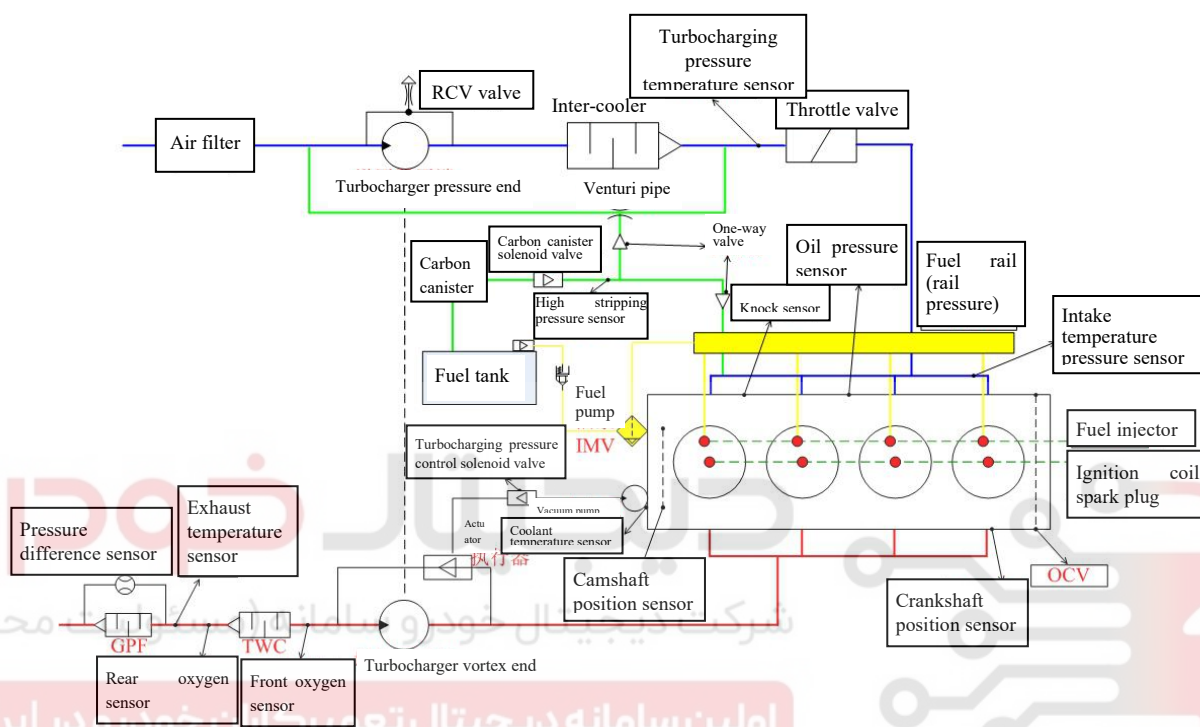
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## 4.2 Structure Principle and Maintenance of the Engine Control System

### 4.2.1 System description



*The picture shows the control system diagram, such as sensor location and physical discrepancies, please prevail in kind.*

### 4.2.2 Electronic control system components

Engine electronic control system is installed in the engine (or connected with the engine) of the various electronic control devices, its role is to control the operation of the engine system for the engine has good power, fuel economy and emissions.

Engine electronic control system can be divided by its components into three parts: sensors, ECM and actuator . ECU is the control center of the engine electronic control system. Various sensors on the engine electronic control, measure the engine speed, throttle valve opening degree, coolant temperature, intake air temperature and other parameters, and according to ECM set procedures for analysis to determine and

calculate, and then issue to control the work of the engine system according to the calculation results of the fuel injector, ignition coil, OCV valve, actuators and other instructions.

Control system control has been extended to the engine fuel injection system, ignition system, intake system, exhaust system and other systems. Therefore, according to its control function, the control system can be divided into fuel control system, ignition control system, intake control system, emission control system, fault self-diagnosis system, electronic coolant pump control, crankcase ventilation system and so on.

#### **a. Fuel injection control system**

The main function of the fuel injection control system is to control the fuel injection quantity to control

the fuel mixture concentration of the engine, which is one of the main control functions of the engine electronic control system.

The fuel enters into the fuel low pressure fuel path through the pump pressing, and then enters the fuel rail through the high pressure pump pressing, forming the high pressure fuel path. ECM calculates relative fuel injection amount according to intake air mass, also amend the quantitative fuel according to air-fuel ratio, precisely controls the injection pressure, injection time and injection phase. The fuel injection control of GDI engine is more complex than that of traditional MPI engine. ECM will select different fuel injection modes according to the engine load, so as to realize the control of fuel injection time and times.

#### **b. Ignition control system**

The ignition system consists of ignition switch, ECU and ignition coil,

The sensors related to ignition control include crankshaft position sensor, inlet temperature and pressure sensor, water temperature sensor, throttle position sensor and so on.

The main function of the ignition system is to control working of ignition coil, thus to control ignition advance angle of engine, which is one of the main control functions of the engine electronic control system. According to the engine speed,

throttle opening, coolant temperature, inlet temperature pressure, knock sensor and other operating conditions measured by various sensors, ECM calculates and selects the ignition angle which is most suitable for the current working condition, which make it have high fuel economy and power performance, reduce emission pollution and prevent detonation.

The ignition advance angle is determined and controlled by ECU according to the signals of various sensors.

Closing angle is the angle that the crankshaft or camshaft turns on during the current conduction of the ignition coil. Closing angle control also known as ignition coil electrification time control. For inductive energy storage type ignition system, the induction voltage produced by the ignition coil depends on the current of the primary coil passing through the coil at the moment of breaking. The higher the current value of the primary coil, the higher the inductive voltage of the ignition coil. Because of the inductive effect of the coil, under the condition of constant supply voltage, the current flowing through the coil increases exponentially at the beginning of the primary coil conduction, and it takes a certain time before the saturation current can be reached. When the closing angle remains constant, the time of primary current conduction will decrease with the increase of engine speed. In order to meet the requirements of ignition voltage and ignition energy of gasoline engine, the closing angle of ignition system is automatically controlled by ECM according to engine speed. When engine speed increases, the closing angle will be increased appropriately to ensure that the primary coil has enough conduction time, so that the current of the primary coil can reach or approach the saturation current at the moment of disconnection, rising the inductive voltage. On the contrary, when engine speed is reduced, ECM will properly reduce the closing angle, so as to prevent the primary coil from overheating and excessive power consumption due to the excessive conduction time of the primary coil current.

### c. Air intake control system

Air intake control system consists of air filter, turbocharger, throttle valve, intake manifold and related pipe.

Air intake control system is to achieve idle control, variable valve control, electronic throttle control, turbocharger control and other tasks through the control of air intake, so as to improve the stability of engine idling operation, or improve engine power, reduce fuel consumption and emission pollution.

Idle speed control: the electronic control system has the function of automatic control of engine idling speed. Through engine working temperature, load and other factors measured by various sensors, to determine the optimal idle speed. And through electronic throttle, the intake amount of idle speed when automatically controlled idling, achieve the purpose of controlling idling speed. So that the engine has stable idle speed under various conditions, to prevent idle speed instability or stall, and as far as possible to reduce idle fuel consumption and emissions pollution.

Electronic throttle control: in the engine with electronic throttle valve, ECM measures operating condition of accelerator pedal according to various sensors, also calculates and confirms optimum opening degree of throttle valve according to engine speed, vehicle speed and other factors, control opening degree of throttle valve by electronic throttle valve actuator, and ensure the best fuel economy and improve safety and comfort. In addition, the electronic control system of gasoline engine can realize traction control and cruise control through electronic throttle valve.

Variable valve control: in engine with variable valve, ECU calculates and confirms the optimal phase of valve distribution according to operating conditions measured by various sensors. Through timing control of solenoid valve and other actuators, change opening and closing time of intake and exhaust valve, so that the phase of engine valve and valve overlap angle change with the change of engine speed and load, and keep the best at all times. Thus, the engine has good fuel economy, power performance and running stability at any speed and load, and reduces emission pollution.

#### **d. Emission control system**

In order to reduce emission pollution of engine, a lot of devices specially used to reduce the emission pollution are set up on the electronic control gasoline engine. The work of these devices is controlled by the emission control system. It mainly includes

fuel vapor recovery control and fuel injection closed loop control, so that these devices can give full play to emission reduction function without affecting the normal operation of the engine, so as to ensure that the emission level of the engine meets the requirements of the national emission regulations.

#### **e. Electronic water pump control**

Electronic pumps mainly provide coolant input to the intercooler and turbocharger. The intercooler and turbocharger are connected in parallel to the electronic coolant pump system, and then in series with electronic coolant pump and cooling radiator to form the entire electronic coolant pump cooling system. The coolant pump cooling capacity is the maximum between the turbocharger and the intercooler according to the actual requirements.

The control strategy of electronic pump is mainly to consider the closed-loop control of inlet air temperature and select the control range according to engine working conditions. When ECM judges that cooling is not needed, electronic coolant pump only needs to ensure cooling demand for turbocharger, which is good for emissions.

The closed-loop control is used when the operating condition enters the intake air temperature, and the target value of the control is set to the intake air temperature of the intake manifold.

#### **f. Crankcase ventilation control system**

The function of fuel vapor recovery device is to recover the gasoline vapor from the gasoline tank of vehicle to engine intake pipe, so that it can burn into the engine cylinder with the fresh mixture, and prevent gasoline vapor from being discharged into the atmosphere to pollute the environment.

The fuel vapor recovery unit consists of activated carbon canister, solenoid valve, one-way valve and corresponding steam pipe and vacuum hose.

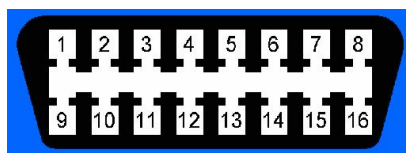
### **4.2.3 Vehicle diagnostic system**

#### **1. Instruction**



On-board Diagnostic System (OBD) is a diagnosis system integrated in engine control system which can monitor the fault parts and the main function state of engine which affect the exhaust gas emission.

The system uses CAN communication, equipped with a standard 16-pin fault diagnosis connector (refer to the figure below), by decoder according to the relevant standards design to read the relevant data.



Standard diagnostic connector diagram

Fault diagnosis socket has four terminals connected with the engine ECM, of which terminals 4 and 5 for the ground,

Terminal 16 is connected to the positive terminal of the battery. Data terminals 6 and 14 are used for data transmission. They are CAN High and CAN Low, respectively, of the high-speed CAN bus.

## 2. function introduction

The main functions of the diagnostic system are monitoring functions, memory fault codes and warning functions, fail-safe functions and data output functions.

### (1) Monitoring function

The target of the diagnosis system monitoring is the various sensors in the engine electronic control system, actuator and the control process of the electronic control system. The fault self-diagnosis system continuously monitors the signal of the electronic control system during the running of the vehicle, when a signal exceeds the preset range value, and the phenomenon does not disappear in a certain period of time. The fault self-diagnosis system determines that the corresponding circuit or component of the signal has failed.

OBD can detect almost any emission degradation failure, such as misfire caused by old spark plug - failure indicator warning will alert the driver.

a. The components (sensors and drives) used for diagnostics and controllers with input or output relationships are primarily tested for component circuits and

include the rationality of sensor input values.

b. System detection for the diagnosis of systemic faults such as fire, catalytic converter degradation, cooling system failure, etc.

c. Control component detection, data hardware failure, communication failure, and memory memory status for diagnostic and control components.

(2) Store fault code and warning function. Once the fault self-diagnosis system detects a fault in the electronic control system, it immediately lights the fault warning light above the dashboard to remind the driver to promptly send the vehicle to the repair shop for inspection and maintenance, so as to avoid any further damage.

The fault self-diagnosis system also detects that the fault is stored in the memory of the ECM as a fault code. As long as the car battery is not removed, the detected fault code will always be stored in the ECM. During maintenance, the inspector can read out the fault code stored in the ECM by using a certain method to provide an accurate basis for finding the fault location.

(3) Failure protection function. According to the different monitoring object, the fault self-diagnosis system will take different failure protection measures when finding fault.

(4) Data storage output function. The cells that store data in ECM are ROM and RAM, respectively, memory ROM stored in the program is based on accurate calculation and a large number of experimental data, the inherent program in the engine work, constantly with the acquisition of the signals of each sensor to compare and calculate, to achieve the control of the engine.

In the automotive electronic control system circuit has a dedicated diagnostic socket, as long as the car ECM decoder and this diagnostic socket connection, you can access the automotive ECM storage unit, read out the stored fault code.

In addition, the fault self-diagnosis system can also output the data flow reflecting the working condition of the automobile electronic control system by diagnosing the outlet outward.

### 3. Fault light description and control strategy

1) Engine fault indicator light (MIL): instructions required for emissions-related

components or system failures, MIL is generally a light that can be displayed on the dashboard in compliance with regulatory standards.

2) The activation of the Mil led follows the following principles:

- ① Ignition switch is in the "ON" state (non-start), MIL continues to light.
- ② 3 seconds after the engine starts, if there is no fault request in the fault memory to turn on the MIL, the MIL goes off.
- ③ There is a fault in the memory required to light the MIL request, or outside the ECM has a MIL request, MIL are lit.
- ④ When there is a flashing MIL request outside the ECM, or there is a blinking MIL request due to a fire or there is a fault request in the memory that flashes MIL, the MIL flashes at 1Hz.

3) Fault indicator light (SVS): for indication related to vehicle fault.

4) In different modes, situation that SVS lamp works:

- ① In normal mode, and the fault memory is empty. Turn the ignition switch to the ON state, ECU immediately initialized, from initialize, SVS light is off for 4 seconds. If it starts in these 4 seconds, the SVS will immediately go out when the engine speed is found.

② In normal mode, the fault memory has been fault. Turn the ignition switch to the ON state, SVS light is continuously on. After starting, if the failure in memory fault requires SVS light in failure mode, the SVS lamp will be on in the subsequent driving cycle; If the failure in the fault memory does not require the SVS in failure mode to light, then the SVS lamp will light after finding the engine speed.

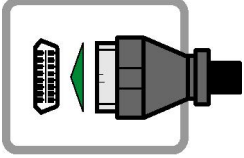
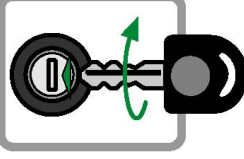
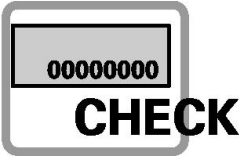
③ Flashing mode with failed memory empty. If the ECU monitors the SVS lamp in flashing mode, EPC will blink to show the fault corresponding fault code in the faulty memory. From turning the ignition switch to ON, the SVS lasts for 4 seconds, then after 1 seconds, the SVS flashes at 2 Hertz to indicate no fault until the engine starts and finds the speed.

④ In flashing mode, the fault memory has failed. If the ECU monitors the SVS lamp in flashing mode, EPC will blink to show the fault corresponding fault code in the faulty memory.

#### 4. Troubleshooting steps

1) For vehicles with OBD function, troubleshooting is generally followed by the following steps:

**OBD Troubleshooting Steps Table**

|                                                                                     |                                                                                                                                                                                                                                        |
|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | <p>1. Connect the diagnostic test equipment to the diagnostic connector and switch on the diagnostic test equipment.</p>                                                                                                               |
|    | <p>2. Connect the ignition switch.</p>                                                                                                                                                                                                 |
|   | <p>3. Read fault related information (fault code, frozen frame, etc.); check workshop manual to confirm fault parts and types; making maintenance plan according to fault related information and experience.</p>                      |
|  | <p>4. Troubleshooting.</p>                                                                                                                                                                                                             |
|  | <p>5. To clear the fault memory, the proper operation of the vehicle and the operation mode must meet the conditions of the corresponding fault diagnosis; Read the fault information to confirm that the fault has been excluded.</p> |

#### 2) Fault diagnosis common detection and diagnostic equipment

Compared with the mechanical system, the automobile electronic control system has a fundamentally different overhaul mode. It is necessary to rely on the electronic equipment and use the information of the self-diagnosis system to diagnose the fault.

The common equipment for overhaul of electronic control system includes automobile computer tester and digital multimeter.

Connect the data cable of the computer detector to the diagnostic outlet on the car to connect with the automotive ECM, accessing to the ECM memory of the fault diagnosis data, including fault code, data flow and so on, so as to understand the auto fault diagnosis system monitoring results and the work of the electronic control system, to provide a basis for quick troubleshooting. In addition, it can carry out the action test and so on.

#### (1) Read and Clear fault codes

By connecting the car's computer detector with the fault diagnosis seat on the car, it is easy to read the fault code stored in the ECM.

The car's computer diagnostic device displays both the fault and its meaning on the screen. By reading the fault codes, maintenance personnel can find out the short circuit, open circuit and other faults of most sensors and their control circuits in the automotive electronic control system.



After troubleshooting, the computer tester can send instructions to the car electronic control system to eliminate ECM stored fault code to turn off the the fault warning light.

#### (2) Read data stream

The car computer tester is connected with the electronic control system to read the running status of the ECM and the instantaneous data of various input and output electric signals (such as the signal of each sensor, the calculation result of the ECM, the control mode, The control signal issued by each actuator, etc.). The computer tester can display these values on the screen of the tester in the form of a data sheet so as to make the whole control system work at a glance. Maintenance personnel can judge whether the system is working normally according to the changes of various

data or compare the values of various signals with the standard values under specific working conditions so as to accurately determine the type and location of the fault.

### (3) Action test

The motion test is to issue a work instruction to the ECM of the automotive electronic control system through the computer tester to drive or stop the work of some actuators to detect the working condition of the actuator and find the faulty actuator or control circuit.

In addition to these basic functions above, the car computer tester also has to read the car computer and make the basic settings.

### 5. ECU common control system fault code and instruction

Multifunction indicating light (MIL) and fault service light (SVS) on principle: in the setting of diagnosis calibration, different fault type settings will have different time and method of lighting fault lamp and fault repair lamp. According to whether the fault has an effect on the emission and the severity of the emission, the fault type is classified into A, B, C, E, Z class, the definition of the fault lamp and the lighting rules of the fault lamp and the fault maintenance lamp as follows:

#### 1) Emission related types:

Class A: once a failure occurs. The system lights will lit MIL indicating light and record the fault code

Class B: The system only lights up the MIL indicating light and records the fault code once in each of the two continuous emission monitoring processes.

Class E: The system only lights up the MIL indicating light and records the fault code once in each of the three continuous emission monitoring processes.

It is required that any faults affecting emission must be diagnosed in three consecutive trips, and the EOBD fault indicator lamp should be lit to record the fault code and the fixed data when the fault occurs.

#### 2) Emission not related types:

Class C: When the fault occurs, the fault code is recorded, but the EOBD fault indicator lamp is not lit.

The SVS lamp can be lit according to the need.



Class Z: Record the fault code when the fault occurs, but do not light any warning lights.

### MT92.1 Common fault code list of ECU control system

| No. | Malfunction Code | Fault code information                                                    | Failure type | Lamp on  |
|-----|------------------|---------------------------------------------------------------------------|--------------|----------|
| 1   | P 0533           | Air conditioning pressure sensor line high voltage                        | C            | Lamp off |
| 2   | P 0532           | Air conditioning pressure sensor line low voltage                         | C            | Lamp off |
| 3   | P 0645           | A/C relay open circuit                                                    | C            | Lamp off |
| 4   | P 0647           | Air conditioning relay short circuit to high voltage                      | C            | Lamp off |
| 5   | P 0646           | Air conditioning relay short circuit to low voltage                       | C            | Lamp off |
| 6   | P 0558           | Brake power vacuum pressure sensor short circuit to high voltage          | C            | Lamp off |
| 7   | P 0557           | Brake power vacuum pressure sensor short-circuit to low voltage           | C            | Lamp off |
| 8   | P 0571           | Brake light malfunction                                                   | C            | Lamp off |
| 9   | P 0504           | Brake switch relativity fault                                             | C            | Lamp off |
| 10  | P 0033           | Turbocharger pressure relief solenoid valve control line disconnection    | A            | MIL      |
| 11  | P 0035           | Turbocharger pressure relief solenoid valve control line high voltage     | A            | MIL      |
| 12  | P 0034           | Turbocharger pressure relief solenoid valve control line low voltage      | A            | MIL      |
| 13  | P 0243           | Turbocharger exhaust gas bypass solenoid valve control line disconnection | A            | MIL      |
| 14  | P 0246           | Turbocharger exhaust gas bypass solenoid valve control line high voltage  | A            | MIL      |
| 15  | P 0245           | Turbocharger exhaust gas bypass solenoid valve control line low voltage   | A            | MIL      |
| 16  | P 0234           | Turbocharger (main pipe) turbo pressure too high                          | B            | MIL      |
| 17  | P 1234           | Turbocharger (manifold pipe) turbo pressure too high                      | B            | MIL      |
| 18  | P 0299           | Turbocharger turbo pressure not enough                                    | B            | MIL      |
| 19  | P 0340           | Camshaft position sensor circuit no signal                                | B            | MIL      |
| 20  | P 0341           | Camshaft position sensor line signal interference                         | B            | MIL      |
| 21  | P 0118           | Coolant temperature sensor circuit high voltage                           | B            | MIL      |
| 22  | P 0117           | Coolant temperature sensor circuit low voltage                            | B            | MIL      |
| 23  | P 0116           | Coolant temperature sensor signal clamp                                   | B            | MIL      |
| 24  | P 1116           | When starting, coolant temperature too high                               | B            | MIL      |
| 25  | P 0119           | In low temperature environment, coolant temperature is abnormal           | B            | MIL      |



| No. | Malfunction Code | Fault code information                                           | Failure type | Lamp on  |
|-----|------------------|------------------------------------------------------------------|--------------|----------|
| 26  | P 0482           | PWM fan control circuit fault - open circuit                     | C            | SVS      |
| 27  | P 0696           | PWM fan control circuit high voltage                             | C            | SVS      |
| 28  | P 0695           | PWM fan control circuit low voltage                              | C            | SVS      |
| 29  | P 2600           | Cooling water pump control circuit open circuit.                 | A            | MIL      |
| 30  | P 2603           | Cooling water pump control circuit short circuit to high voltage | A            | MIL      |
| 31  | P 2602           | Cooling water pump control circuit short circuit to low voltage  | A            | MIL      |
| 32  | P 0115           | Coolant temperature sensor signal change not reach to expect     | B            | MIL      |
| 33  | P 1602           | ECM processor analog-digital conversion fault                    | A            | MIL      |
| 34  | P 060D           | ECM processor fault                                              | A            | MIL      |
| 35  | P 060A           | ECM processor fault                                              | A            | MIL      |
| 36  | P 160A           | ECM processor fault                                              | A            | MIL      |
| 37  | P 060C           | ECM processor fault                                              | A            | MIL      |
| 38  | P 0641           | ETC reference voltage A# amplitude                               | A            | MIL      |
| 39  | P 0651           | ETC reference voltage B# amplitude                               | A            | MIL      |
| 40  | P 0606           | ECM processor fault                                              | A            | MIL      |
| 41  | P 0807           | Clutch sensor short circuit to low voltage                       | B            | MIL      |
| 42  | P 0808           | Clutch sensor short circuit to high voltage                      | B            | MIL      |
| 43  | P 0831           | Clutch top switch circuit short circuit to low voltage           | B            | MIL      |
| 44  | P 0832           | Clutch top switch circuit short circuit to high voltage          | B            | MIL      |
| 45  | P 0336           | Crankshaft position sensor circuit signal interfere              | B            | MIL      |
| 46  | P 0335           | Crankshaft position sensor circuit no signal                     | A            | MIL      |
| 47  | P 0564           | Cruise control input line fault                                  | C            | Lamp off |
| 48  | P 056C           | Cruise "Cancel" button signal interference                       | C            | Lamp off |
| 49  | P 1570           | Cruise "Cancel" button signal embedded                           | C            | Lamp off |
| 50  | P 0565           | Cruise "On/Off" button signal interference                       | C            | Lamp off |
| 51  | P 0566           | Cruise "On/Off" button signal embedded                           | C            | Lamp off |
| 52  | P 0567           | Cruise "Resume/Accel" button signal interference                 | C            | Lamp off |
| 53  | P 0570           | Cruise "Resume/Accel" button signal embeded                      | C            | Lamp off |
| 54  | P 0568           | Cruise "Set/Coast" button signal interference                    | C            | Lamp off |
| 55  | P 0569           | Cruise "Set/Coast" button signal embeded                         | C            | Lamp off |
| 56  | P 065B           | Intelligent generator line failure                               | C            | Lamp off |
| 57  | P 065C           | Intelligent generator mechanical error                           | C            | Lamp off |
| 58  | P 0687           | Main relay circuit high voltage                                  | A            | MIL      |
| 59  | P 0351           | Ignition coil "A" disconnects (1 cylinder)                       | A            | MIL      |
| 60  | P 2301           | Ignition coil "A" short circuit to high voltage (1               | A            | MIL      |

| No. | Malfunction Code | Fault code information                                                    | Failure type | Lamp on |
|-----|------------------|---------------------------------------------------------------------------|--------------|---------|
|     |                  | cylinder)                                                                 |              |         |
| 61  | P 2300           | Ignition coil "A" short circuit to low voltage (1 cylinder)               | A            | MIL     |
| 62  | P 0352           | Ignition coil "B" disconnects (3 cylinder)                                | A            | MIL     |
| 63  | P 2304           | Ignition coil "B" short circuit to high voltage (3 cylinder)              | A            | MIL     |
| 64  | P 2303           | Ignition coil "B" short circuit to low voltage (3 cylinder)               | A            | MIL     |
| 65  | P 0353           | Ignition coil "C" disconnects (4 cylinder)                                | A            | MIL     |
| 66  | P 2307           | Ignition coil "C" short circuit to high voltage (4 cylinder)              | A            | MIL     |
| 67  | P 2306           | Ignition coil "C" short circuit to low voltage (4 cylinder)               | A            | MIL     |
| 68  | P 0354           | Ignition coil "D" disconnects (2 cylinder)                                | A            | MIL     |
| 69  | P 2310           | Ignition coil "D" short circuit to high voltage (2 cylinder)              | A            | MIL     |
| 70  | P 2309           | Ignition coil "D" short circuit to low voltage (2 cylinder)               | A            | MIL     |
| 71  | P 0068           | Electronic throttle valve air flow fault                                  | A            | MIL     |
| 72  | P 2138           | Electronic accelerator pedal position sensor 1#, 2# circuit related fault | A            | MIL     |
| 73  | P 2123           | Electronic accelerator pedal position sensor 1# circuit high voltage      | A            | MIL     |
| 74  | P 2122           | Electronic accelerator pedal position sensor 1# circuit low voltage       | A            | MIL     |
| 75  | P 2128           | Electronic accelerator pedal position sensor 2# circuit high voltage      | A            | MIL     |
| 76  | P 2127           | Electronic accelerator pedal position sensor 2# circuit low voltage       | A            | MIL     |
| 77  | P 2104           | Engine forced idling                                                      | A            | MIL     |
| 78  | P 2105           | Engine forced stop                                                        | A            | MIL     |
| 79  | P 2106           | Engine function limited                                                   | A            | MIL     |
| 80  | P 2110           | Engine power is limited                                                   | A            | MIL     |
| 81  | P 1516           | ETC drive steady state diagnosis fault                                    | A            | MIL     |
| 82  | P 2101           | ETC drive dynamic diagnosis fault                                         | A            | MIL     |
| 83  | P 0123           | Electronic throttle valve position sensor 1# circuit high voltage         | A            | MIL     |
| 84  | P 0122           | Electronic throttle valve position sensor 1# circuit low voltage          | A            | MIL     |
| 85  | P 0223           | Electronic throttle valve position sensor 2# circuit high voltage         | A            | MIL     |
| 86  | P 0222           | Electronic throttle valve position sensor 2# circuit low voltage          | A            | MIL     |

| No. | Malfunction Code | Fault code information                                                 | Failure type | Lamp on |
|-----|------------------|------------------------------------------------------------------------|--------------|---------|
| 87  | P 2135           | Electronic throttle valve position sensor 1#, 2# circuit related fault | B            | MIL     |
| 88  | P 2119           | Electronic throttle valve return fault                                 | B            | MIL     |
| 89  | P 0604           | ECM RAM fault                                                          | A            | MIL     |
| 90  | P 1604           | ECM RAM stack fault                                                    | A            | MIL     |
| 91  | P 0601           | ECM ROM verify fault                                                   | A            | MIL     |
| 92  | P 0193           | Fuel pressure sensor circuit high voltage                              | A            | MIL     |
| 93  | P 0192           | Fuel pressure sensor circuit low voltage                               | A            | MIL     |
| 94  | P 0191           | Fuel pressure sensor reading value fault                               | B            | MIL     |
| 95  | P 0088           | Fuel pressure too high                                                 | B            | MIL     |
| 96  | P 0087           | Fuel pressure is too low                                               | B            | MIL     |
| 97  | P 0627           | Fuel pump relay open circuit                                           | A            | MIL     |
| 98  | P 0629           | Fuel pump relay short circuit to high voltage                          | A            | MIL     |
| 99  | P 0628           | Fuel pump relay short circuit to low voltage                           | A            | MIL     |
| 100 | P 3262           | 1st cylinder fuel injector high end short circuit to high voltage      | A            | MIL     |
| 101 | P 3261           | 1st cylinder fuel injector high end short circuit to low voltage       | A            | MIL     |
| 102 | P 0201           | 1st cylinder fuel injector low end open circuit                        | A            | MIL     |
| 103 | P 0262           | 1st cylinder fuel injector low end short circuit to high voltage       | A            | MIL     |
| 104 | P 0261           | 1st cylinder fuel injector low end short circuit to low voltage        | A            | MIL     |
| 105 | P 3265           | 2nd cylinder fuel injector high end short circuit to high voltage      | A            | MIL     |
| 106 | P 3264           | 2nd cylinder fuel injector high end short circuit to low voltage       | A            | MIL     |
| 107 | P 0202           | 2nd cylinder fuel injector low end open circuit                        | A            | MIL     |
| 108 | P 0265           | 2nd cylinder fuel injector low end short circuit to high voltage       | A            | MIL     |
| 109 | P 0264           | 2nd cylinder fuel injector low end short circuit to low voltage        | A            | MIL     |
| 110 | P 3268           | 3rd cylinder fuel injector high end short circuit to high voltage      | A            | MIL     |
| 111 | P 3267           | 3rd cylinder fuel injector high end short circuit to low voltage       | A            | MIL     |
| 112 | P 0203           | 3rd cylinder fuel injector low end open circuit                        | A            | MIL     |
| 113 | P 0268           | 3rd cylinder fuel injector low end short circuit to high voltage       | A            | MIL     |

| No. | Malfunction Code | Fault code information                                               | Failure type | Lamp on |
|-----|------------------|----------------------------------------------------------------------|--------------|---------|
| 114 | P 0267           | 3rd cylinder fuel injector low end short circuit to low voltage      | A            | MIL     |
| 115 | P 3271           | 4th cylinder fuel injector high end short circuit to high voltage    | A            | MIL     |
| 116 | P 3270           | 4th cylinder fuel injector high end short circuit to low voltage     | A            | MIL     |
| 117 | P 0204           | 4th cylinder fuel injector low end open circuit                      | A            | MIL     |
| 118 | P 0271           | 4th cylinder fuel injector low end short circuit to high voltage     | A            | MIL     |
| 119 | P 0270           | 4th cylinder fuel injector low end short circuit to low voltage      | A            | MIL     |
| 120 | P 0092           | High pressure fuel pump control valve coil high end current too low  | A            | MIL     |
| 121 | P 0091           | High pressure fuel pump control valve coil high end current too high | A            | MIL     |
| 122 | P 2294           | High pressure fuel pump control valve coil low end open circuit      | A            | MIL     |
| 123 | P 2296           | High pressure fuel pump control valve coil low end current too high  | A            | MIL     |
| 124 | P 2295           | High pressure fuel pump control valve coil low end current too low   | A            | MIL     |
| 125 | P 05BC           | Start-Stop switch signal clamp                                       | B            | MIL     |
| 126 | P 0507           | Idling engine speed too high                                         | B            | MIL     |
| 127 | P 0506           | Idling engine speed too low                                          | B            | MIL     |
| 128 | P 2230           | Atmosphere pressure sensor signal fault                              | B            | MIL     |
| 129 | P 2229           | Atmosphere pressure sensor circuit high voltage                      | A            | MIL     |
| 130 | P 2228           | Atmosphere pressure sensor circuit low voltage                       | A            | MIL     |
| 131 | P 0109           | Intake pressure sensor signal fault                                  | B            | MIL     |
| 132 | P 0108           | Intake pressure sensor circuit high voltage                          | A            | MIL     |
| 133 | P 0107           | Intake pressure sensor circuit low voltage                           | A            | MIL     |
| 134 | P 3105           | When engine starting, intake pressure sensor signal embedded         | B            | MIL     |
| 135 | P 025E           | Turbocharged pressure sensor signal fault                            | B            | MIL     |
| 136 | P 0238           | Boost pressure sensor line high voltage                              | A            | MIL     |
| 137 | P 0237           | Boost pressure sensor circuit low voltage                            | A            | MIL     |
| 138 | P 0099           | Air inlet manifold temperature sensor signal fault                   | B            | MIL     |
| 139 | P 0098           | Air inlet manifold temperature sensor circuit high voltage           | A            | MIL     |
| 140 | P 0097           | Air inlet manifold temperature sensor circuit low voltage            | A            | MIL     |

| No. | Malfunction Code | Fault code information                                                     | Failure type | Lamp on  |
|-----|------------------|----------------------------------------------------------------------------|--------------|----------|
| 141 | P 0114           | Turbocharging air inlet temperature sensor signal fault                    | B            | MIL      |
| 142 | P 0113           | Turbocharging air inlet temperature sensor circuit high voltage            | A            | MIL      |
| 143 | P 0112           | Boosted intake air temperature sensor line low voltage                     | A            | MIL      |
| 144 | P 2081           | GPF temperature sensor signal fault                                        | B            | MIL      |
| 145 | P 0546           | GPF temperature sensor circuit high voltage                                | A            | MIL      |
| 146 | P 0545           | GPF temperature sensor circuit low voltage                                 | A            | MIL      |
| 147 | P 0074           | Environment temperature sensor signal fault                                | B            | MIL      |
| 148 | P 0073           | Environment temperature sensor circuit high voltage                        | A            | MIL      |
| 149 | P 0072           | Environment temperature sensor circuit low voltage                         | A            | MIL      |
| 150 | P 0325           | Knock sensor failure                                                       | B            | MIL      |
| 151 | P 0324           | Knock control system failure                                               | B            | MIL      |
| 152 | U 012D           | Communication loss between ECU and intelligent generator                   | C            | Lamp off |
| 153 | U 0028           | LIN communication fault                                                    | C            | Lamp off |
| 154 | P 023A           | Turbo-charging Inter-cooling water pump fault                              | C            | Lamp off |
| 155 | U 019F           | LIN communication fault of turbo-charging Inter-cooling water pump and ECM | C            | Lamp off |
| 156 | P 2610           | LPC fault                                                                  | B            | MIL      |
| 157 | P 1610           | LPC fault                                                                  | B            | MIL      |
| 158 | P 0523           | Oil pressure sensor circuit high voltage                                   | A            | MIL      |
| 159 | P 0522           | Oil pressure sensor circuit low voltage                                    | A            | MIL      |
| 160 | P 06DA           | Oil pressure control end open circuit                                      | A            | MIL      |
| 161 | P 06DC           | Oil pressure control end high voltage                                      | A            | MIL      |
| 162 | P 06DB           | Oil pressure control end low voltage                                       | A            | MIL      |
| 163 | P 0615           | Starter relay 1 open circuit                                               | C            | Lamp off |
| 164 | P 0617           | Starter motor relay 1 high voltage                                         | C            | Lamp off |
| 165 | P 0616           | Starter motor relay 1 low voltage                                          | C            | Lamp off |
| 166 | P 0852           | N gear switch is stuck in non-N gear position                              | B            | MIL      |
| 167 | P 0851           | N gear switch is stuck in N gear position                                  | B            | MIL      |
| 168 | P 06E9           | Starter damage                                                             | C            | Lamp off |
| 169 | P 1615           | Start relays open                                                          | C            | Lamp off |
| 170 | P 1616           | Start relay bonding                                                        | C            | Lamp off |
| 171 | P 1515           | The starter state input is disconnected                                    | C            | Lamp off |
| 172 | P 0602           | ECU programming error (Software version does not match)                    | A            | MIL      |
| 173 | P 0015           | Exhaust VCP Camshaft phase error is large                                  | B            | MIL      |
| 174 | P 0014           | Air exhaust VCP phase response lag                                         | B            | MIL      |

| No. | Malfunction Code | Fault code information                                                                             | Failure type | Lamp on  |
|-----|------------------|----------------------------------------------------------------------------------------------------|--------------|----------|
| 175 | P 0017           | Exhaust VCP camshaft tooth learning deviation exceed range                                         | B            | MIL      |
| 176 | P 0366           | Exhaust VCP target wheel—CAM sensor fault                                                          | B            | MIL      |
| 177 | P 0027           | Exhaust VCP hydraulic pressure control valve vised                                                 | B            | MIL      |
| 178 | P 0012           | Air inlet VCP camshaft phase error is large                                                        | B            | MIL      |
| 179 | P 0011           | Air inlet VCP phase response lag                                                                   | B            | MIL      |
| 180 | P 0016           | Intake VCP camshaft tooth learning deviation exceed range                                          | B            | MIL      |
| 181 | P 1341           | Intake VCP target wheel diagnosis fault                                                            | B            | MIL      |
| 182 | P 0026           | Intake VCP hydraulic pressure control valve vised                                                  | B            | MIL      |
| 183 | P 1340           | Intake VCP camshaft position sensor state diagnosis                                                | B            | MIL      |
| 184 | P 0078           | Exhaust VCP hydraulic pressure control valve coil disconnection                                    | A            | MIL      |
| 185 | P 0080           | Exhaust VCP hydraulic pressure control valve coil high voltage                                     | A            | MIL      |
| 186 | P 0079           | Exhaust VCP hydraulic pressure control valve coil low voltage                                      | A            | MIL      |
| 187 | P 0075           | Intake VCP hydraulic pressure control valve coil disconnection                                     | A            | MIL      |
| 188 | P 0077           | Intake VCP hydraulic pressure control valve coil high voltage                                      | A            | MIL      |
| 189 | P 0076           | Intake VCP hydraulic pressure control valve coil low voltage                                       | A            | MIL      |
| 190 | P 0630           | VIN code not written or incorrect                                                                  | C            | Lamp off |
| 191 | P 0563           | System voltage is high                                                                             | B            | MIL      |
| 192 | P 0562           | System voltage is low                                                                              | B            | MIL      |
| 193 | P 0500           | Vehicle speed sensor failure                                                                       | B            | MIL      |
| 194 | P 226D           | GPF missing                                                                                        | B            | MIL      |
| 195 | P 24A4           | GPF blocked                                                                                        | B            | MIL      |
| 196 | P 2456           | GPF pressure difference sensor signal fault                                                        | B            | MIL      |
| 197 | P 2462           | GPF pressure sensor signal fault                                                                   | B            | MIL      |
| 198 | U 1031           | GPF pressure difference sensor communication fault                                                 | B            | MIL      |
| 199 | P 1452           | GPF pressure difference sensor fault                                                               | B            | MIL      |
| 200 | U 1041           | GPF pressure sensor communication fault                                                            | B            | MIL      |
| 201 | P 145E           | GPF pressure sensor failure                                                                        | B            | MIL      |
| 202 | U 0001           | CAN communication failure                                                                          | A            | MIL      |
| 203 | U 0073           | CAN bus off                                                                                        | A            | MIL      |
| 204 | U 0146           | ECM and GW gateway communication lost (include oil level and environment temperature communication | A            | MIL      |

| No. | Malfunction Code | Fault code information                                             | Failure type | Lamp on  |
|-----|------------------|--------------------------------------------------------------------|--------------|----------|
|     |                  | diagnosis)                                                         |              |          |
| 205 | U 0151           | Communication loss between ECM and ACU airbag controller           | C            | Lamp off |
| 206 | U 0121           | Communication loss between ECU and ABS control module              | C            | SVS      |
| 207 | U 0122           | Communication loss between ECM and TCS                             | C            | SVS      |
| 208 | P 0633           | The anti-theft alarm failed to learn                               | C            | Lamp off |
| 209 | U 0426           | Anti-theft device authentication failed                            | C            | Lamp off |
| 210 | U 1167           | Anti-theft device is not responding                                | C            | Lamp off |
| 211 | P 1397           | Wheel speed sensor no signal                                       | B            | MIL      |
| 212 | P 1396           | Wheel speed sensor signal reasonability failure                    | B            | MIL      |
| 213 | P 2195           | Front oxygen sensor too thin                                       | B            | MIL      |
| 214 | P 3130           | Front oxygen sensor PC-pin open circuit                            | B            | MIL      |
| 215 | P 1130           | Front oxygen sensor RC-pin open circuit                            | B            | MIL      |
| 216 | P 1130           | Front oxygen sensor RC-pin open circuit                            | B            | MIL      |
| 217 | P 0130           | Front oxygen sensor COM-pin open circuit                           | B            | MIL      |
| 218 | P 0132           | Front oxygen sensor short circuit to high voltage                  | B            | MIL      |
| 219 | P 0131           | Front oxygen sensor short circuit to grounding                     | B            | MIL      |
| 220 | P 2A01           | Rear oxygen sensor decelerating and breaking response too slowly   | B            | MIL      |
| 221 | P 2A01           | Rear oxygen sensor dense thin-thick response time is too slow      | B            | MIL      |
| 222 | P 2270           | Excessive thin when rear oxygen accelerating and concentrating     | B            | MIL      |
| 223 | P 2271           | Excessive thick when rear oxygen decelerating and cutting off fuel | B            | MIL      |
| 224 | P 0136           | Rear oxygen sensor open circuit                                    | B            | MIL      |
| 225 | P 0138           | Rear oxygen sensor short circuit to high voltage                   | B            | MIL      |
| 226 | P 0137           | Rear oxygen sensor short circuit to low voltage                    | B            | MIL      |
| 227 | P 2A00           | Front oxygen sensor getting into working too slowly                | B            | MIL      |
| 228 | P 2A00           | Front oxygen sensor can't be activated                             | B            | MIL      |
| 229 | P 00D1           | Front oxygen sensor heating circuit current too small              | B            | MIL      |
| 230 | P 00D2           | Rear oxygen sensor heating circuit current too small               | B            | MIL      |
| 231 | P 0134           | Rear oxygen sensor response times too less                         | B            | MIL      |
| 232 | P 1133           | Front oxygen sensor responds too slowly                            | B            | MIL      |
| 233 | P 0133           | Front oxygen sensor responds too slowly                            | B            | MIL      |
| 234 | P 0030           | Front oxygen sensor heater open circuit                            | A            | MIL      |
| 235 | P 0032           | Front oxygen sensor heater short circuit to high voltage           | A            | MIL      |



| No. | Malfunction Code | Fault code information                                                                 | Failure type | Lamp on |
|-----|------------------|----------------------------------------------------------------------------------------|--------------|---------|
| 236 | P 0031           | Front oxygen sensor heater short circuit to low voltage                                | A            | MIL     |
| 237 | P 0036           | Rear oxygen sensor heater open circuit                                                 | A            | MIL     |
| 238 | P 0038           | Rear oxygen sensor heater short circuit to high voltage                                | A            | MIL     |
| 239 | P 0037           | Rear oxygen sensor heater short circuit to low voltage                                 | A            | MIL     |
| 240 | P 2187           | Idle fuel system is too thin                                                           | B            | MIL     |
| 241 | P 2188           | Idle fuel system is too thick                                                          | B            | MIL     |
| 242 | P 0171           | Non-idle fuel system is too thin                                                       | B            | MIL     |
| 243 | P 2096           | Rear oxygen correction excessive thin                                                  | B            | MIL     |
| 244 | P 2097           | Rear oxygen correction excessive thick                                                 | B            | MIL     |
| 245 | P 0172           | Non-idle fuel system is too thick                                                      | B            | MIL     |
| 246 | P 0301           | 1st cylinder miss fire                                                                 | B            | MIL     |
| 247 | P 0302           | 2nd cylinder miss fire                                                                 | B            | MIL     |
| 248 | P 0303           | 3rd cylinder miss fire                                                                 | B            | MIL     |
| 249 | P 0304           | 4th cylinder miss fire                                                                 | B            | MIL     |
| 250 | P 0300           | Single cylinder or multi-cylinder miss fire                                            | B            | MIL     |
| 251 | P 050B           | Cold starting ignition timing deviation is large                                       | B            | MIL     |
| 252 | P 0315           | 58 tooth gear wheel error not learning                                                 | C            | MIL     |
| 253 | P 0148           | Several injection execution error when cold starting                                   | B            | MIL     |
| 254 | P 0442           | Fuel evaporation system small leakage                                                  | B            | MIL     |
| 255 | P 2279           | There is leakage in air inlet system                                                   | A            | MIL     |
| 256 | P 0496           | High load desorption pipeline flow monitoring                                          | A            | MIL     |
| 257 | P 240C           | Drive type inflator pump heating circuit short circuit to high voltage                 | A            | MIL     |
| 258 | P 240B           | Drive type inflator pump heating circuit short circuit to low voltage                  | A            | MIL     |
| 259 | P 240A           | Drive type inflator pump heating circuit open circuit                                  | A            | MIL     |
| 260 | P 24BF           | Drive type inflator pump switching valve control circuit short circuit to high voltage | A            | MIL     |
| 261 | P 24BE           | Drive type inflator pump switching valve control circuit short circuit to low voltage  | A            | MIL     |
| 262 | P 24BD           | Drive type inflator pump switching valve control circuit open circuit                  | A            | MIL     |
| 263 | P 2402           | Drive type inflator pump control circuit short circuit to high voltage                 | A            | MIL     |
| 264 | P 2401           | Drive type inflator pump control circuit short circuit to low voltage                  | A            | MIL     |
| 265 | P 2400           | Drive type inflator pump control circuit open circuit                                  | A            | MIL     |
| 266 | P 0444           | Carbon canister electromagnetic valve open circuit                                     | B            | MIL     |

| No. | Malfunction Code | Fault code information                                                            | Failure type | Lamp on |
|-----|------------------|-----------------------------------------------------------------------------------|--------------|---------|
| 267 | P 0459           | Carbon canister electromagnetic valve short circuit to high voltage               | B            | MIL     |
| 268 | P 0458           | Carbon canister electromagnetic valve short circuit to low voltage                | B            | MIL     |
| 269 | P 0463           | Fuel position sensor #1 circuit high voltage                                      | B            | MIL     |
| 270 | P 0462           | Fuel position sensor #1 circuit low voltage                                       | B            | MIL     |
| 271 | P 24D8           | Fuel evaporation system high desorption pipe pressure sensor circuit high voltage | A            | MIL     |
| 272 | P 24D7           | Fuel evaporation system high desorption pipe pressure sensor circuit low voltage  | A            | MIL     |
| 273 | P 0420           | Catalytic converter is too inefficient                                            | A            | MIL     |

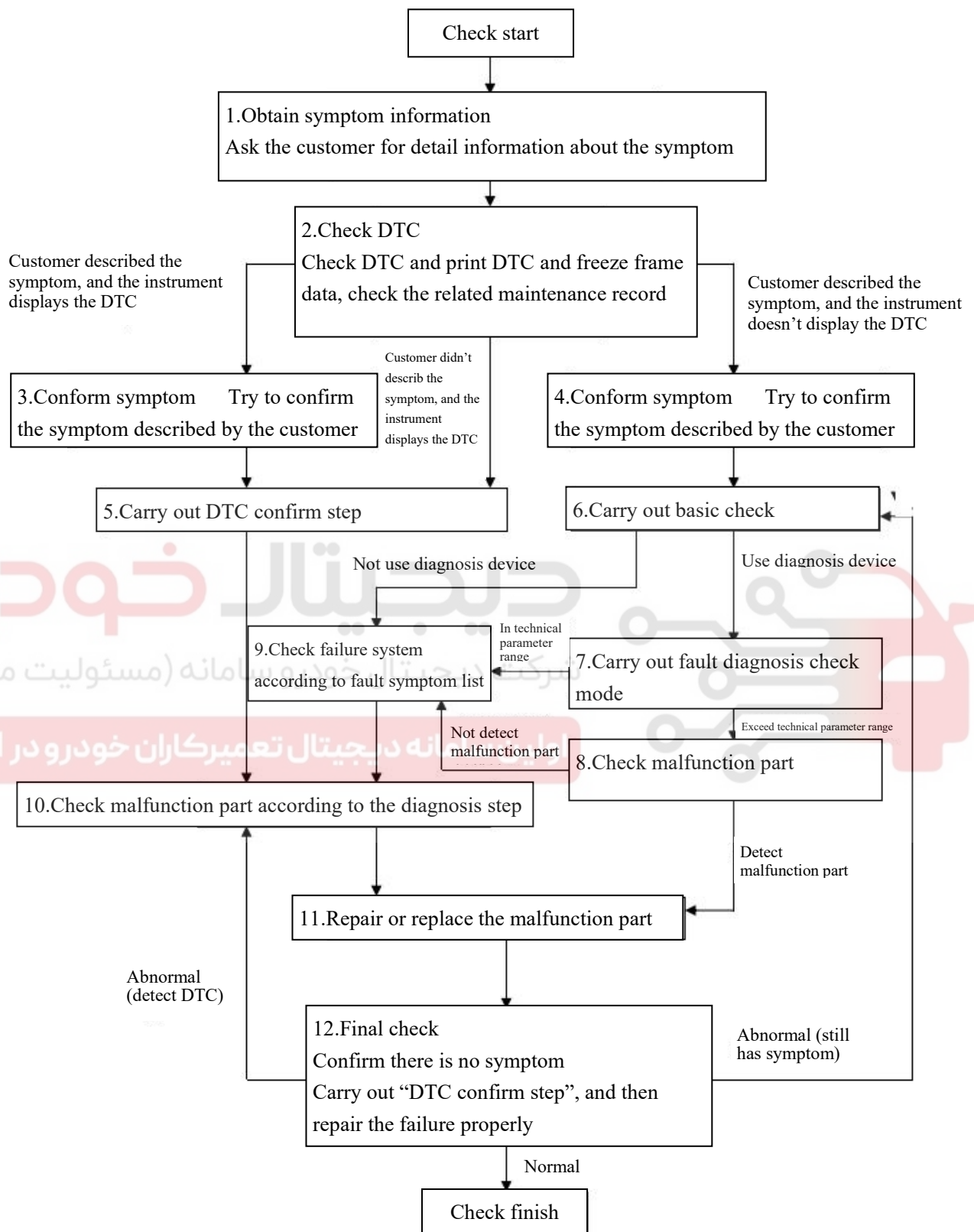
# دیجیتال خودرو

شرکت دیجیتال خودرو سامانه (مسئولیت محدود)

اولین سامانه دیجیتال تعمیرکاران خودرو در ایران



## Faults diagnosis flowchart



Attention:

■ **Before disassembling and installing any components, read the fault code first and then disconnect the negative terminal of the battery.**

- *Turn off the ignition switch before disconnecting the wiring harness from the battery terminal. If the battery wiring harness is disconnected while the engine is working or the ignition switch is turned on, ECM will be damaged.*
- *The wire harness between the ECM and the sensor shall be shielded by an earth wire connected to the body to prevent the ignition system interference and radio interference. If the shielding harness fails, the harness must be replaced.*
- *When checking the charging status of the generator, do not disconnect the positive electrode of the battery to prevent ECM damage.*
- *When charging the battery with an external charger, disconnect the battery connection to prevent damage to ECM.*

دیجیتال خودرو

شرکت دیجیتال خودرو سامانه (مسئولیت محدود)

اولین سامانه دیجیتال تعمیرکاران خودرو در ایران



## 4.3 Structure Principle and Maintenance of the Engine

### Electric Components

The electronic components covered in this section mainly include sensors, actuators and ECM. This section mainly describes the working principle of electronic components, structure, circuits and related maintenance.

The sensor's basic circuit generally has 3 wirings of power, signal and ground. Some sensors do not need a power supply, or the power circuit is built into the ECM, so that they only have the signal and ground two wirings. If they use the shell of iron, there may be only one link to the ECM signal line, so that the circuit is very simple, and some sensors circuit is very complex. The complexity of the sensor circuit depends on the type and structure principle of the sensor, the main sensors in the engine electronic control system are switch type, resistor type, pulse type, voltage type and so on.

Switch-type sensor is a simple structure sensor, usually has two terminals. Its circuit has the iron-and power-type two, of which the iron-type circuit is the end of the switch to the grounding, and the power-type circuit switch to the end of the power supply.

Resistive sensor is the most widely used sensor in electronic control system. Its structure has variable resistor type, potentiometer, etc., generally using the principle of DC circuit partial pressure to generate electrical signals. In order to ensure the accuracy of the signal, the ECM provides a constant size of the reference voltage as its operating voltage (generally 5V).

Variable resistance sensor has 2 terminals, generally the iron-type circuits, the end of which is the signal end, the other end of the iron-end; the potentiometer sensor has 3 terminals, respectively, the power supply end, signal end, and the iron end.

Pulse sensor has a variety of principles and structural forms, such as the electromagnetic using electromagnetic induction principle, photoelectric using photoelectric principle, hall-style using Hall-effect, and the magnetic resistance type

using principle of reluctance, etc., the circuit is very complex.

The voltage sensor usually uses the electrochemical principle and the piezoelectric effect to change the measured parameters into electromotive force. Most voltage sensors do not require operating power.

Electronic control system actuators are mainly solenoid valves, motors, relays, transistor switching circuits, lights and so on. Actuator circuit is usually relatively simple. It is generally only the power and ground wiring. The ECM uses ground control for most actuators. The power source for this actuator comes from the battery and the ground wire to the ECM.

#### 4.3.1 Temperature pressure sensor



Figure 4-1 Intake temperature/pressure sensor



Figure 4-2 Turbocharging pressure temperature sensor

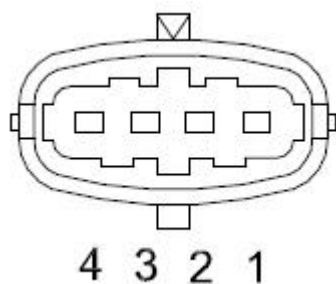


Figure 4-3 Intake temperature/pressure sensor pin

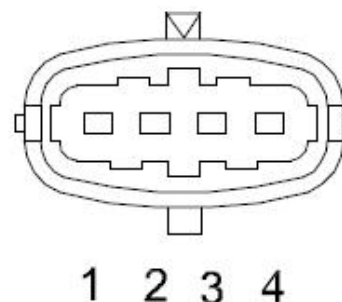


Figure 4-4 Turbocharging pressure temperature sensor pin

##### 1. Overview

The intake manifold absolute pressure and temperature sensor is one of the main components that characterizes the actual intake state of the engine when the engine is

running, and then characterizes the engine operating conditions and load conditions.

## 2. Working principle

Pressure and temperature sensors combine the functionality of a pressure sensor with the functionality of a temperature sensor.

The pressure sensor section (MAP) uses the principle of piezoelectric technology and is designed to produce an output signal that is proportional to the input pressure when pressure is sensed. Pressure level directly characterizes the current engine load and working conditions. It has a decisive influence on the status of the engine management system output control.

The core temperature sensing element of the temperature sensor consists of a semiconductor thermistor with negative temperature coefficient characteristics. The temperature characteristics is that the negative temperature coefficient (NTC) thermistor output resistance decreases; when the temperature decreases, the thermistor resistance increases.

Engine Electronic Control Module (ECM) provides the engine inlet temperature sensor with 5V DC signal and measures the voltage drop through its own circuit, and the engine management system will be based on this voltage signal to determine the actual working state of the engine.

Air intake temperature has direct influence on the status of the engine management system output control. High air intake temperature will lead to the increase of engine knock tendency, and the fuel supply and ignition timing of the engine may need to be corrected and compensated due to the different air intake temperature.

## 3. Installation position





Figure 4-5 Turbocharging pressure temperature sensor    Figure 4-6 Intake temperature/pressure sensor

The turbocharging pressure temperature sensor is installed on the turbocharging pressure connection pipe and before the electronic throttle valve; the air intake temperature/pressure sensor is installed after the steady pressure chamber cooler.

#### 4. Technical characteristics of the parameters

① Pressure signal reference value of air intake temperature/pressure sensor

Intake pressure 60Kpa—1.08V      Intake pressure 30Kpa—0.52V

② Pressure signal reference value of turbocharger pressure temperature sensor

Intake pressure 60Kpa—0.80V      Intake pressure 30Kpa—0.41V

③ Terminal definition:

Turbocharger pressure temperature sensor (For pins, refer to figure 4-4)

Pin 1: Ground

Pin 2: Temperature signal

Pin 3: Power + 5V

Pin 4: Pressure signal

Air inlet temperature/pressure sensor (For pins, refer to figure 4-3)

Pin 1: output voltage (pressure)

Pin 2: input voltage

Pin 3: Output voltage (temperature)

Pin 4: Ground

#### 5. Installation precautions

① Turbocharging pressure Temperature sensor bolt tightening torque: (4 ~ 5) N.m

② Air inlet temperature/pressure sensor bolt tightening torque: (10±1) N.m

③ Prohibit brutal disassembly.

#### 6. Failure phenomenon and judgment

- General Fault Cause: The internal circuit of the sensor is disconnected, head freezing or the dirt accumulates, and the air inlet pipe leaks that causes the incorrect signal.

- Symptom: After a fault occurs, the fuel injection function of the ECM of the engine will be abnormal. If the air mixture is too rich or too thin, the engine will not run normally or accelerates idly, intake pipe return fire during running, and the exhaust pipe will emit black smoke and so on.

- Maintenance Note: Do not open the sensor.

- Inspection methods:

1) Exterior inspection

Check whether the sensor harness connector is well connected, solid and reliable. Whether sensor is installed loosely or fallen off. Whether the appearance is good, and confirm that there is no impact marks. Check if the sensor detection hole is blocked.

2) Circuit detection

① Turn the ignition switch off and unplug the sensor end harness terminal.

② Turn the ignition switch on and measure the terminals of the sensor harness

connector separately with a digital multimeter.

a. Sensor power supply terminals should be measured as 5V reference voltage.

If the voltage value does not match, it indicates that the control circuit or ECM has faulty, and it should be further tested.

b. When the sensor terminal is measured, the negative resistance between the battery and the battery should be less than  $3\Omega$ , if abnormal, the ground line should be repaired.

③ If the above check is not normal, turn off the ignition switch, unplug the harness ECM connector, check the wiring harness between the sensor connector and the ECM connector for the existence of disconnection, and the line phenomenon.

### 4.3.2 Coolant temperature sensor

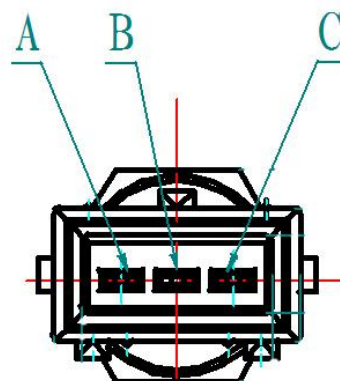


Figure 4-7 Coolant temperature sensor

Figure 4-8 Coolant temperature sensor pin

#### 1. Overview

Engine coolant temperature sensor detects engine coolant temperature and transmits signal to ECM for start-up, idling, normal operation, injection timing and fuel injection pulse width control, while ECU provides water temperature signal to instrument by CAN, for instrument water temperature display.

#### 2. Working principle

The sensor is a negative temperature coefficient (NTC) thermistor, its resistance decreases along with the increasing of coolant temperature. Due to resistance change, the sensor signal voltage changes with it. Signal voltage is inverse with the coolant temperature.

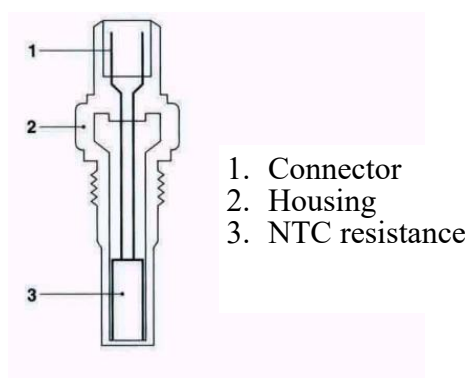


Figure 4-9 Coolant temperature sensor inner principle

#### 3. Installation position

Coolant temperature is installed in the rear part of the engine, blow the vacuum pump and beside the blower water inlet steel tube.

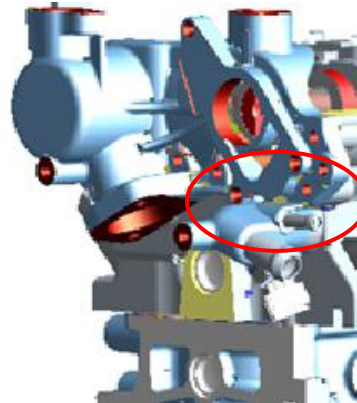


Figure 4-10 Coolant temperature sensor installation position

#### 4. Technical characteristics of the parameters

##### ① Resistance value ( $\Omega$ )

| Computer path resistance (A-C) |                                  |
|--------------------------------|----------------------------------|
| Temperature                    | Standard resistance ( $\Omega$ ) |
| -10                            | 16120                            |
| 25                             | 2795                             |
| 85                             | 283                              |
| 115                            | 115.7                            |

##### ② Pin definition (refer to figure 4-8):

Pin A: Output coolant temperature signal

Pin C: Ground

Pin B: Spare

#### 5. Installation precautions

##### ③ Tightening torque: (11~30) N.m

④ Use KESAIXIN 1243 thread sealant or equivalent sealant products to seal the thread.

#### 6. Failure phenomenon and judgment

General fault reasons: Short circuit, open circuit, the output signal voltage and the standard value does not meet.

Symptom: When the water temperature sensor fails, it will affect the concentration of the mixture. When the temperature signal sent to ECM by the water temperature sensor is lower than the actual temperature of the engine, it will lead to excessive mixing gas, exhaust black smoke, hot car idling instability, etc. when the water temperature sensor to the ECM water temperature signal is higher than the actual engine water temperature, will lead to mixed gas is too thin, cold start difficult, cold car idling instability and other failures. When the water temperature sensor is short circuit or break circuit, ECM fault self-diagnosis circuit will detect this fault, make the engine fault warning light, and ECM will start the failure protection function.

Maintenance note: after the installation is complete, check for leaks in idle speed.

Inspection methods:

1) Exterior inspection

Check whether the sensor harness connector is well connected, solid and reliable.

Whether the appearance is good, and confirm that there is no impact marks.

2) Circuit detection

① Turn the ignition switch off and unplug the sensor end harness terminal.

② Turn the ignition switch on and measure the terminals of the sensor harness connector separately with a digital multimeter.

A. Sensor power supply terminals should be measured as 5V reference voltage.

If the voltage value does not match, it indicates that the control circuit or ECM has faulty, and it should be further tested.

B. When the sensor terminal is measured, the negative resistance between the battery and the battery should be less than  $3\Omega$ , if abnormal, the ground line should be repaired.

3) Performance testing

Unplug the sensor harness connector and remove the sensor. Place the sensor in water, measure the resistance between the sensor terminals at different temperatures when heating, if it is not corresponding to the standard value, the sensor should be replaced.

### 4.3.3 Electronic throttle valve



Figure 4-11 Electronic throttle valve

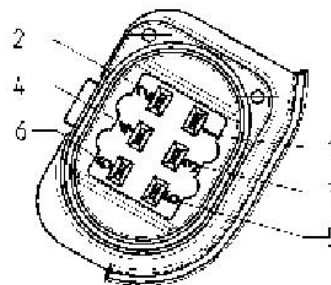


Figure 4-12 Electronic throttle valve pin

#### 1. Overview

Electronic throttle valve assembly is one of the main components of intake control management system in modern engine management system. It directly controls the total intake of the engine, and then controls the engine speed and output power.

The throttle position sensor is mounted on the throttle body to detect the opening of the throttle and its changes, so that the ECM can determine the load rate of the engine and whether it is in special conditions such as idle speed, full load, rapid acceleration, and rapid deceleration. It provides reference for its fuel injection control, ignition control, idle speed control, emission control, etc., to meet the requirements of different engine operating conditions.

#### 2. Working principle

Electronic throttle valve include drive motors, drive gear mechanisms, necessary mechanical transmission components and more powerful special throttle valve position sensors.

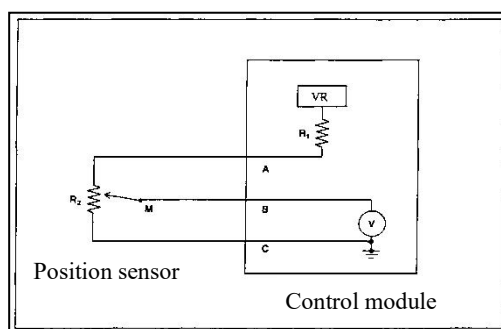


Figure 4-13 Electronic throttle valve position sensor principle

Throttle valve motor can be under the control of ECM in different directions, through the deceleration gear drive throttle valve shaft, making the throttle valve open or closed, while driving the throttle valve position sensor rotor rotation, converting the throttle valve position to electrical signals to the ECM. The return spring allows the throttle valve to close to the initial position when the current of the motor in the throttle valve is cut off (e.g. the ignition switch is closed), at which point the throttle valve is kept to a smaller opening.

Throttle motor is a kind of DC motor with high sensitivity and low power consumption. Its two terminals are connected to ECM. Each terminal is controlled by two transistor switching circuits in the ECM, one of which can provide power to the terminal, the other transistor can make the terminal grounding. The ECM changes the current direction of the throttle motor by controlling the on or off of the two triode switching circuits of each terminal to achieve the purpose of controlling the direction of rotation of the throttle motor. The ECM controls the triode switching circuit at the power supply end so that the current applied to the throttle motor is a pulse current of a fixed frequency, and the purpose of applying the throttle motor current is achieved by changing the point-to-space ratio of the pulse current.

The system is provided with a double output throttle valve position sensor, and a throttle valve position sensor increases with the opening of the throttle valve body. The output voltage signal of another throttle valve position sensor decreases with the increase of throttle valve opening. The two signals of throttle valve position sensor can not only let the ECM know the throttle valve opening, but also help ECM to monitor the fault of the sensor.

The ECM continuously compares the sum of the two signals during the engine operation. If it does not meet the standard, it determines that the sensor is faulty and immediately enters the fail-safe mode.

### **3. Installation position**

The throttle valve is between the intake manifold and the pressurized pressure connecting pipe.

### **4. Technical characteristics of the parameters**

① Throttle valve opening degree

Low machine stoppage position: sensor 1- 9.2~10.8%



Sensor 2- 89.2~90.8%

High machine stoppage position: sensor 1- about 91%

Sensor 2- about 9%

## ② Pin definition (refer to figure 4-12)

The control circuit of the electronic throttle valve is composed of the control circuit of the throttle valve motor and the control circuit of the throttle valve position sensor. Figure 4-12 shows the terminals of the electronic throttle valve used by the 1.5TGDI engine, which have 6 terminals, all connected to the ECM. Among them, pin 3 and pin 5 are the terminals of the throttle valve motor, pin 2 is the positive pole of the power supply of the position sensor, pin 5 is the negative pole of the power supply of the position sensor, pin 1 is the output signal of the position sensor 1, and pin 2 is the output signal of the position sensor 2.

## 5. Installation precautions

Tightening torque:  $(10 \pm 1)$  N.m

Rude operations are prohibited, damage to the casing and associated sensors.

## 6. Failure phenomenon and judgment

General fault cause: The potentiometer in the sensor is open or shorted, the motor can not normally open or close because of the fault, the throttle valve has too much carbon deposit, and the control function of ECM is abnormal.

Fault phenomenon: Throttle valve failure will cause that the engine idling operation not normal (such as idle speed too high or too low, idling unstable, idling easily flameout) or engine acceleration is not normal (such as the acceleration of the engine shaking, acceleration response delay, etc.), sometimes it can lead to the engine in the process of intermittent jitter and other phenomena.

Maintenance attention: after re-installation, be sure to self-learning.

Throttle valve self-learning:

1) Throttle valve self-learning conditions:

- a. Accelerator pedal open degree to zero, do not step on throttle pedal;
- b. There is no related faults in throttle valve body;
- c. Battery voltage  $> 10V$ ;
- d. Temperature in intake manifold more than  $5.25^{\circ}C$ ;

e. Engine coolant temperature in  $5.25 \sim 100^{\circ}\text{C}$ ;

f. Vehicle speed must be 0.

2) Self-learning operation:

(1) Engine electronic control module power off for 5 minutes;

(2) Turn ignition switch to KEY-ON. Do not have any other operation (start or step on the throttle etc.)

(3) The self-learning condition of the throttle valve is ensured that the throttle valve self-learning time is more than 10s;

(4) Turn ignition switch to KEY-OFF;

(5) Start the engine to check if the idle speed is balanced.

### 7. Inspection methods:

Visual inspection:

Check whether the sensor wiring harness plugs are connected well, solid and reliable; whether the sensor installation is loose or off; whether the appearance is good. Make sure there is no impact traces. Slide valves to check whether the rotation is smooth, with or without catching phenomenon. Check whether there is too much carbon deposit in throttle valve.

Circuit detection:

① Turn the ignition switch off and unplug the sensor end harness terminal.

② Open the ignition switch, measure the position sensor harness connector terminals with a digital multimeter

③ Sensor power supply terminals should be measured as 5V reference voltage.

If the voltage value does not match, it indicates that the control circuit or ECM has faulty, and it should be further tested.

④ When the sensor terminal is measured, the negative resistance between the battery and the battery should be less than  $3\Omega$ , if abnormal, the ground line should be repaired.

Position sensor resistance detection:

Sensor resistance can be detected with an electronic multimeter. Inspection methods are as follows:

① Turn the ignition switch off and unplug the sensor end harness terminal.

② Use a multimeter to measure the total resistance of the potentiometer on the sensor harness socket. If it is open circuit, short circuit or the resistance does not meet the standard, then the potentiometer is faulty.

③ Measure the resistance of the potentiometer sliding contact to the ground terminal. The resistance should change smoothly with the opening or closing of throttle valve, otherwise the potentiometer is faulty.

Position sensor performance testing:

Test the position sensor performance by measuring the output signal voltage in working condition. Inspection methods are as follows:

- ① Turn on the ignition switch, but do not start the engine;
- ② Keep the throttle valve at a different opening, while measuring the signal voltage changes with the voltage meter on the sensor signal output wire; the resistance value should be able to increase with the opening increased.

#### 4.3.4 Crankshaft position sensor

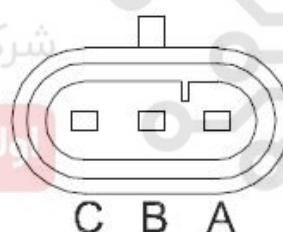


Figure 4-14 Crankshaft position sensor      Figure 4-15 Crankshaft position sensor pin

##### 1. Overview

Crankshaft position sensor signal is to test the relative position of crankshaft speed and crankshaft. The target wheel of the crankshaft is designed as 60-2 rectangular gear with evenly spaced teeth. The missing gear signal helps the system determine the relative position of the crankshaft.

##### 2. Working principle

This sensor is used in non-distributor applications in conjunction with the pulse disk induction sensor to provide the ECU with crankshaft phase information, that is, to distinguish the crankshaft compression top dead center and exhaust top dead center.

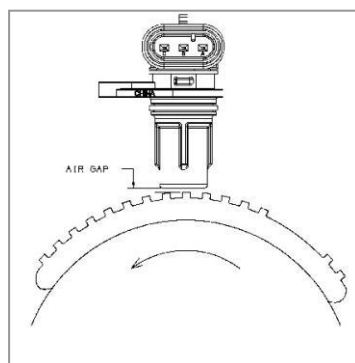


Figure 4-16 Schematic diagram of crankshaft position sensor and signal wheel

Hall sensor is made on the principle of Hall effect. The Hall effect means that if a magnetic field is applied to an electrically charged Hall semiconductor and the direction of the magnetic field is perpendicular to the current, a potential difference will occur between the two ends of the Hall semiconductor perpendicular to the direction of the current and the magnetic field, resulting in a tiny voltage.

### 3. Installation position

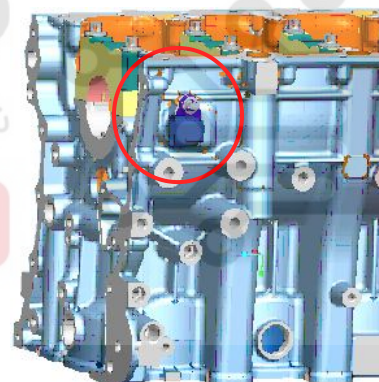


Figure 4-17 Crankshaft position sensor installation position

### 4. Technical characteristics of the parameters

- ③ Output voltage (high voltage):  $4.75 \sim 5.25 \text{ V}$ .
- ④ Output voltage (low voltage):  $0$ .
- ⑤ Working gap:  $0.5 \sim 1.5 \text{ mm}$ .
- ⑥ Supply voltage from ECM:  $4.75 \sim 5.25 \text{ V}$ .
- ⑦ Pin definition (refer to figure 4-15): A-Output, B-Grounding, C-Power supply

### 5. Installation precautions

Tightening torque of tightening bolt:  $8.4 \pm 0.6 \text{ N.m}$ .

When installing, ensure the working gap is  $0.5 \sim 1.5 \text{ mm}$ .

## 6. Failure phenomenon and judgment

General fault reasons:

Sensor internal components are damaged or internal circuit is open or short circuit, which can not generate a signal.

The external circuit of the sensor is open or shorted.

Sensor installation location is incorrect, and the gap between the rotor is too large, resulting in the output signal abnormal.

Symptom: lack of motivation, unable to start.

Maintenance attention: after re-installation, be sure to do gear signal self-learning.

Gear signal self-learning:

- (1) Turn the ignition switch to ON position;
- (2) Start the engine, and observe the engine fault light;
- (3) Use vehicle diagnosis device to get in engine ECU system, get in function interface, select "action test" function, select "offline test" - "gear signal learning";
- (4) After get into operation interface, operate according to the prompt.
- (5) Start the engine to check if the idle speed is balanced.

Inspection methods:

Exterior inspection

✓ Check whether the sensor harness connector is well connected, solid and reliable. Whether the distance between the Hall element and the signal wheel meets the standard requirements, whether there is dirt or iron between them, if so, they should be removed.

✓ Circuit detect: The hall sensor must be able to produce a signal when the power is in normal condition, so please check its power circuit and the ground circuit first.

- ① Turn the ignition switch off and unplug the sensor end harness terminal.
- ② Turn the ignition switch on and measure the terminals of the sensor harness connector separately with a digital multimeter.

✓ Sensor power supply terminals should be measured as 4.5~5V reference voltage. If the voltage value does not match, it indicates that the control circuit or ECM has faulty, and it should be further tested.

✓ When the sensor terminal is measured, the negative resistance between the battery and the battery should be less than  $3\Omega$ , if abnormal, the ground line should be repaired.

③ If the above check is not normal, turn off the ignition switch, unplug the harness ECM connector, check the wiring harness between the sensor connector and the ECM connector for the existence of disconnection, and the line phenomenon.

### 4.3.5 Camshaft position sensor



Figure 4-18 Camshaft position sensor

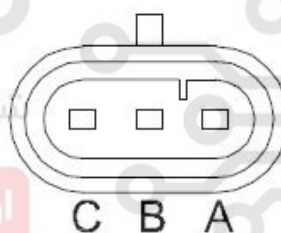
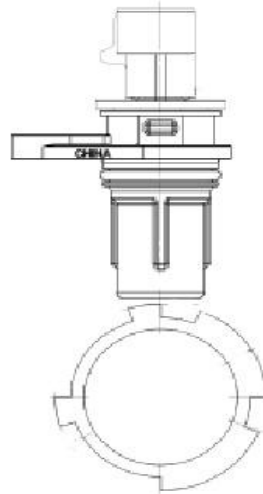


Figure 4-19 Camshaft position sensor pin

#### 1. Overview

The camshaft position sensor can timely and accurately detect the relative rotation angle position of the engine camshaft during the engine operation, and provide it to the engine electronic control module (ECM) in the form of electrical signals. So that the engine electronic control module combined with the crankshaft position signal as the crankshaft position sensor input, correctly determine the moment of each cylinder engine phase, make the system in accordance with the provisions of the engine working sequence control fuel injection and ignition sequence, thus can be more precise control of the combustion process of engine, reduce harmful emissions from combustion. The camshaft position sensor is helpful to realize the optimal control of ignition and injection timing of each cylinder.





4-20 Crankshaft sensor principle

## 2. Working principle

Refer to chapter 3.4.2

## 3. Installation position

Because the intake and exhaust adopt VVT technology, the intake and exhaust camshafts are equipped with corresponding position sensor. Installed on rear end of the engine.



Figure 4-21 Camshaft position sensor installation position

## 4. Technical characteristics of the parameters

- Output voltage (high voltage): 4.75~5.25 V.
- Output voltage (low voltage): 0.
- Working gap: 0.5~1.5 mm.
- Supply voltage from ECM: 4.75 ~ 5.25 V.
- Pin definition (refer to figure 4-19): A-Output, B-Grounding, C-Power



supply

### 5. Installation precautions

- Tightening torque of tightening bolt:  $8.4 \pm 0.6$  N.m.
- When installing, ensure the working gap is  $0.5 \sim 1.5$  mm.

### 6. Failure phenomenon and judgment

General fault reasons:

- ① Sensor internal components are damaged or internal circuit is open or short circuit, which can not generate a signal.
- ② The sensor external circuit is open or short circuit.
- ③ Sensor installation location is incorrect, and the gap between the rotor is too large, resulting in the output signal abnormal.

Failure phenomenon: If the camshaft position sensor is input error signal, it can not inject fuel in order, which is easy to cause engine flameout, idling instability and acceleration weakness.

Detection method:

#### 1) Exterior inspection

Check whether the sensor harness connector is well connected, solid and reliable. Whether the distance between the Hall element and the signal wheel meets the standard requirements, whether there is dirt or iron between them, if so, they should be removed.

2) Circuit detect: The hall sensor must be able to produce a signal when the power is in normal condition, so please check its power circuit and the ground circuit first.

- ① Turn the ignition switch off and unplug the sensor end harness terminal.
- ② Turn the ignition switch on and measure the terminals of the sensor harness connector separately with a digital multimeter.

✓ Sensor power supply terminals should be measured as  $4.5 \sim 5$  V reference voltage. If the voltage value does not match, it indicates that the control circuit or ECM has faulty, and it should be further tested.

✓ When the sensor terminal is measured, the negative resistance between the battery and the battery should be less than  $3\Omega$ , if abnormal, the ground line should be repaired.

③ If the above check is not normal, turn off the ignition switch, unplug the harness ECM connector, check the wiring harness between the sensor connector and the ECM connector for the existence of disconnection, and the line phenomenon.

### 4.3.6 Front oxygen sensor



Figure 4-22 Front oxygen sensor

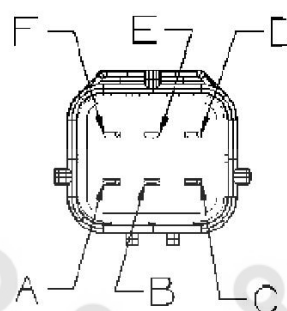


Figure 4-23 Front oxygen sensor pin

#### 1. Overview

The oxygen sensor is used in the configuration of modern engine management system to detect the oxygen content in the combustion exhaust gas from the automobile engine, so as to determine the actual state of the engine real time fuel supply air mixing ratio. The electronic control module is fed back to the engine electronic control module through the electrical response signal produced by itself, which is an important basis for the closed-loop fuel correction compensation control of the fuel management system of the system.

Different from the situation that the front oxygen sensor used by other JAC gasoline engines can only detect the theoretical air-fuel ratio, the wide-area oxygen sensor can continuously detect the air-fuel ratio in the rarefied combustion zone, which makes it possible for ECM to realize the feedback control of fuel injection in the non-theoretical air-fuel ratio zone.

## 2. Working principle

The wide - domain oxygen sensor is developed on the basis of the common oxygen sensor. Zirconia has the property that when there is a difference in oxygen concentration between its inner and outer surfaces, the oxygen ions will move from the side with high concentration to the side with low concentration, thus generating electromotive force. If electromotive force is applied to zirconia, oxygen ion movement will be caused. At this point, the oxygen molecules will gain electrons on the cathode and form oxygen ions, which will move to the anode under the action of an electromotive force, discharge at the anode, and become oxygen molecules. Oxygen is then pumped from the cathode of the electrode to the anode through a solid electrolyte called zirconia. The applied voltage is called pump voltage and the resulting current is called pump current.

In the process of oxygen pump, the pump with the size of the pump current voltage,

but the increase of the pump voltage caused by the increase of the pump current gradually decreases

, and when the pump current reaches a certain value, there will be no longer pump current increases with the increase of the pump voltage or change the

phenomenon of small, namely the saturated state, the current is called the limit current. The oxygen concentration

in the exhaust gas can be measured by the limit current, so that the mixture concentration signal

can be obtained throughout the rarefied combustion zone.

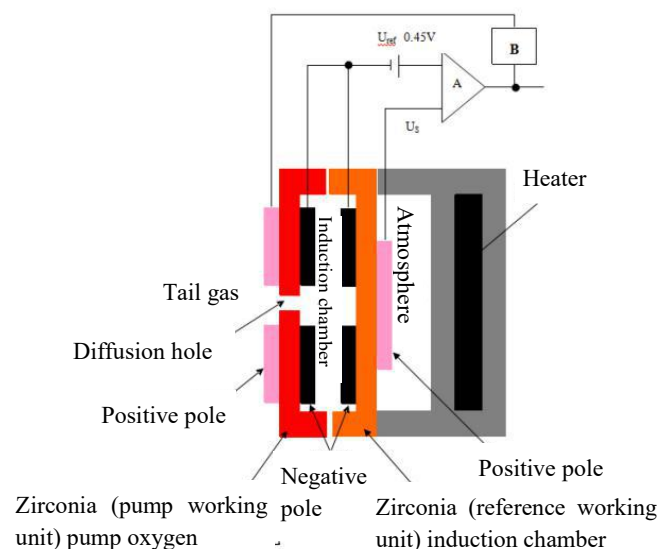


Figure 4-24 Oxygen sensor principle

### 3. Installation position

The front oxygen sensor is mounted on the front end of the catalyst.

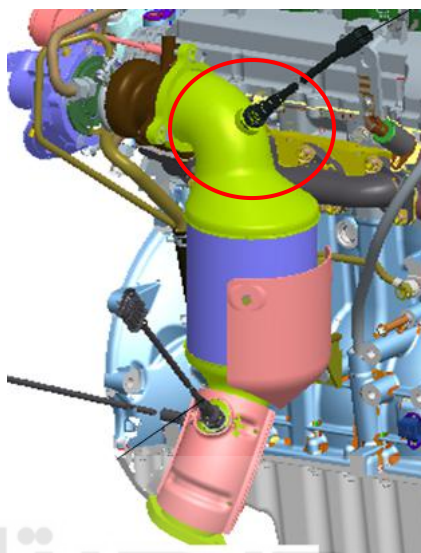


Figure 4-25 Front oxygen sensor installation position

### 4. Technical characteristics of the parameters

- Pin definition (refer to figure 4-33)

|                            |                                |                          |
|----------------------------|--------------------------------|--------------------------|
| A-Pump working unit signal | B-Revised resistance grounding | C-Heater                 |
| D-Heater +                 | E-Pump working unit grounding  | F-Reference working unit |

- Heater resistance: about  $3.5\Omega$ .

### 5. Installation precautions

- Tightening torque:  $(40\sim60)$  N.m
- It is forbidden to drop oxygen sensor or collide with hard surface.
- It is forbidden to give big knock to the engine after installing oxygen sensors.
- Carbon dioxide, silicone oil, engine oil, lead, paint, or other organic contaminants, which are released from the engine, are forbidden to pollute the sensor.
- Do not pull the wire when installing.
- Do not knot, pinch, or otherwise damage the sensor harness wire.
- Do not use grease, detergent or other impurities on the connector

### 6. Failure phenomenon and judgment

Common failure reasons: oxygen sensor poisoning, surface area carbon deposit, oxygen sensor internal circuit breakage, heater failure and so on.

Fault phenomenon: once the oxygen sensor and its connecting line malfunction, it will not only make the emission exceed the standard, but also worsen the working condition sometimes, cause the idle speed to be unstable or flameout, exhaust pipe to emit black smoke and so on.

Maintenance attention: pay attention to the installation of wire harness, and not close to the heat source.

Detection method:

1) Measure resistance of oxygen sensor heater

Turn ignition switch to “OFF”, disconnect wiring harness connector of oxygen sensor, use multimeter to measure resistance between B, C terminal of oxygen sensor. The resistance should accord with standard value (about  $3.5\Omega$ ).

2) Check voltage of oxygen sensor heater

Turn on the ignition switch and test the heating power supply voltage of the sensor with a multimeter. The standard value should be 12V.

① Check whether the connection of several wires on the sensor is good, whether there is short-circuit, open-circuit phenomenon.

② Check extrinsic feature of oxygen sensor visually.

Brown red: lead poisoning

Grayish white: normal

Black: carbon

deposition

### 4.3.7 Rear oxygen sensor



Figure 4-26 Rear oxygen sensor

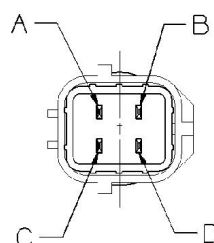


Figure 4-27 Rear oxygen sensor pin

#### 1. Overview

The function of the rear oxygen sensor is to detect the working state of the

catalytic converter, which is mainly compared with the voltage of the front oxygen sensor to determine whether the catalyst is invalid or not.

## 2. Working principle

The oxygen sensor uses zirconia solid electrolyte, ceramic system to form a test tube, also known as zirconium tube, zirconium tube on both sides of the sintered porous platinum (Pt) electrode, zirconium tube inner surface and atmospheric communication. When the external surface is in contact with the exhaust gas, at a certain temperature, the oxygen concentration on both sides is different, resulting in potential difference. When the air-fuel ratio is relatively low (concentrated mixture), the oxygen in the exhaust gas is less, so the oxygen ions on the outside of the ceramic tube are less, forming a high potential. When the air-fuel ratio is relatively high (lean mixture), the difference in the concentration of oxygen ions inside and outside is small, and the potential is low. Oxygen sensors can only fully reflect their characteristics when a certain temperature is guaranteed, so the heater is installed.

## 3. Installation position

The rear oxygen sensor is mounted at the rear end of the catalyst.

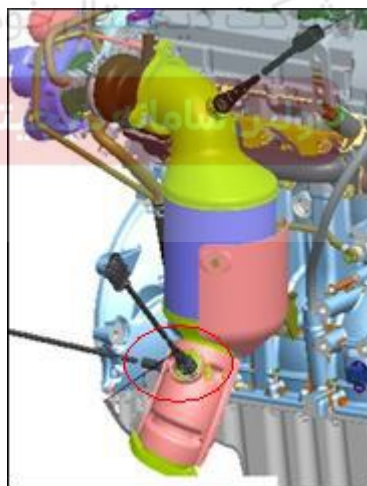


Figure 4-28 Rear oxygen sensor installation position

## 4. Technical characteristics of the parameters

### ■ Pin definition (refer to figure 4-27)

A- Signal output    B- Signal grounding    C- Heating end+    D- Heating end-

### ■ Heater resistance: about $9.6\Omega$ .

## 5. Installation precautions

Refer to chapter 4.3.6.5



## 6. Failure phenomenon and judgment

Common failure reasons: oxygen sensor poisoning, surface area carbon deposit, oxygen sensor internal circuit breakage, heater failure and so on.

Maintenance attention: pay attention to the installation of wire harness, and not close to the heat source.

Detection method:

### ① Measure resistance of oxygen sensor heater

Turn ignition switch to “OFF”, disconnect wiring harness connector of oxygen sensor, use multimeter to measure resistance between pin-B and pin-C of oxygen sensor, its resistance should accord with the standard (about  $9.6\Omega$ ).

### ② Check voltage of oxygen sensor heater

Turn on the ignition switch and test the heating power supply voltage of the sensor with a multimeter. The standard value should be 12V.

### ③ Check whether the connection of several wires on the sensor is good, whether there is short-circuit, open-circuit, etc.

## 4.3.8 Fuel injector

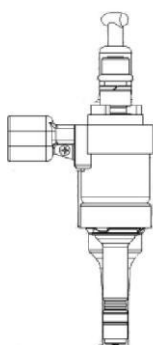


Figure 4-29 Fuel injector

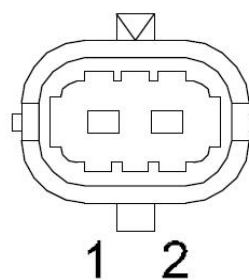


Figure 4-30 Fuel injector pin

### 1. Overview

Electrical control fuel injector is the key component in the fuel system. It accepts the fuel injection pulse signal sent by the ECU to open and close, accurately controls the fuel injection volume, and requires very high machining accuracy. In order to realize the combustion of GDI engine, a new type of fast response electromagnetic



injector is adopted.

## 2. Working principle

The fuel injector is essentially a solenoid valve. When there is no current, the needle valve is in the lowest position and the fuel injection hole is blocked. Therefore, the fuel is injected into the nozzle from the high-pressure fuel chamber. When the current passes through the coil, a magnetic field force is formed. The amount of fuel injection is related to fuel pressure and nozzle shape.

## 3. Installation position

Install it on the fuel rail.



Figure 4-31 Fuel injector installation position

## 4. Technical characteristics of the parameters

- Pin definition (refer to figure 4-30)

- Coil resistance: about  $1.3\Omega$

## 5. Installation precautions

- The installation of the oil injector is done by hand. It is forbidden to hit the oil injector with hammer or other tools.
- When disassembling and reinstalling the injector, the o-ring must be replaced and the sealing surface of the injector must not be damaged;
- The supporting washer of the O-ring shall not be removed from the injector. During installation, avoid damaging the fuel inlet, O-ring, support ring, orifice plate and electrical plug of the injector. If damaged, do not use.
- When the invalid parts are disassembled, the fuel injector clamp should be removed first, and then the fuel injector should be pulled out from the fuel injector pedestal.
- After disassembly, the injector seat should be cleaned to avoid pollution.

## 6. Failure phenomenon and judgment

General fault reason: The carbon deposits of the fuel injector result in leakage or poor injection conditions, and the solenoid coil is damaged and cannot work. The injector leaks oil.

Failure symptom: engine power down, idling shaking, starting difficult or even no start. Engine oil consumption is high, engine exhaust black smoke when serious.

Inspection methods

1) Electromagnetic coil detection

The electromagnetic coil resistance is measured with multimeter, about  $1.3\Omega$  resistance.

2) Visual inspection:

Check whether or not the fuel injector has carbon deposition and other phenomena.

3) Control signal detection

Connect the positive and negative poles of the light-emitting diode test lamp to the power line and the ECM connection line of the fuel injector respectively. When the engine is running, the light-emitting diode test lamp should be shining. If it is not shining, it indicates that the control circuit of the fuel injector is malfunctioning, and the control circuit should be further overhauled. If there is an electric pulse in the control circuit during measurement but the injector does not spray oil, that means the injector is faulty.

4) Control circuit detection

① Repair of fuel injector power supply circuit

Turn on the ignition switch and unplug the fuel injector wire bundle. The power ends supply voltage should be 12V. Otherwise, it indicates that the power circuit of the fuel injector is broken, and it should further check whether or not the power fuse is burnt out, the main relay of the electric control system of the engine is faulty. If the fuse and relay are normal, there is open circuit in the circuit from fuel injector to main relay, please repair.

② Repair of fuel injector to ECM circuit

If the fuel injector does not spray oil under the normal condition of the power circuit, check whether the line from the fuel injector to ECM is broken. When checking, the ignition switch should be closed first, the wire bundle plugs of each fuel injector should be removed, and the circuit between each fuel injector and ECM

should be measured with a multimeter according to the circuit diagram. If there is open circuit in the circuit from fuel injector to ECM, please repair.

#### 4.3.9 Knock sensor



Figure 4-32 Knock sensor

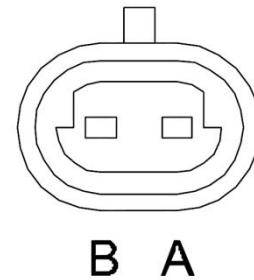


Figure 4-33 Knock sensor terminal

##### 1. Overview

The function of knock sensor is to detect whether the ignition process of mixed gas in the cylinder produces deflative combustion, and ECM provides the basis for timing feedback of ignition.

##### 2. Working principle

This sensor uses piezoelectric effect to convert mechanical vibration generated during detonation into signal voltage. Resonance phenomenon occurs when the vibration frequency of knock is consistent with the natural frequency of piezoelectric effect sensor itself. At this time, the sensor will output a very high detonation signal voltage to the ECU, which will timely modify the ignition time to avoid the generation of detonation.

##### 3. Installation position

Installed between the 2nd and 3rd cylinder.

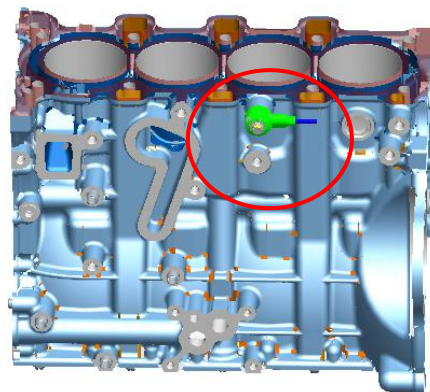


Figure 4-34 Knock sensor installation position

#### 4. Technical characteristics of the parameters

- Pin definition (refer to figure 4-33)

A- connect to ECU 39# pin

B- connect to ECU 40# pin

#### 5. Installation precautions

- Bolt tightening torque:  $(22.5 \pm 2.5) \text{ N} \cdot \text{m}$
- Be careful not to allow a variety of liquids such as oil, coolant, brake fluid, water and other thing long time contact with the sensor.
- Keep the installation surface clean.

#### 6. Failure phenomenon and judgment

General fault reason: The knock sensor is damaged, there are the short circuit, broken circuit, fastening bolts are not tightened as required.

Fault phenomenon: noise and engine power weakening.

Inspection methods

##### 1. Exterior inspection

Check whether or not the fastening bolts are tightened as required, whether or not there is any sundries on the sensor and cylinder joint surface.

##### 2. Circuit check

Close the ignition switch, unplug the wire harness plug of the knock sensor, and check whether or not there is short circuit or open circuit between the signal wire and ECM terminals by comparing the circuit diagram. If abnormal, it should be repaired.

##### 3. Performance check

Disconnect the cord plug of the detonation sensor and tap with a small hammer

on the cylinder body of the detonation sensor attachment, At the same time measure the voltages between the signal output end and the iron end of the sensor with the millivolt of the digital multimeter. If the voltage is generated during tapping, that means the sensor is good, otherwise it should be replaced.

#### 4.3.10 OCV valve



Figure 4-35 OCV valve

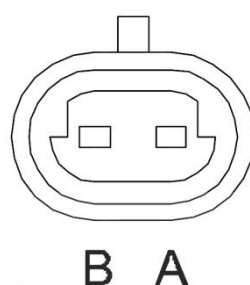


Figure 4-36 OCV valve pin

##### 1. Overview

The continuous variable cam phase regulator is used to change the timing of the valve distribution mechanism. It can continuously adjust the phase relationship between camshaft and crankshaft according to the requirements of the control system. Thus, the engine has good fuel economy, power performance, running stability and emission reduction under any working conditions.

Engine with variable valve mechanism, its valve timing is no longer fixed. According to engine speed, load and other operating parameters, ECM calculates the optimal target valve timing under this condition, and controls the timing regulator through valve timing control valve. By changing the relative angle between camshaft and timing sprocket, the phase of valve distribution is advanced or delayed. At the same time, the ECM monitors the actual displacement between the camshaft and the timing sprocket through the camshaft position sensor, determines the actual valve timing at this time, and makes feedback adjustment to the control of the valve timing control valve to achieve the goal of precise control of the valve timing.

## 2. Working principle

The OCV valve is a two-way movable pulse width control solenoid valve that is controlled by the ECM to control the oil path to the timing regulator. Pressure oil from the main oil channel of the engine lubrication system enters the control valve from the intake hole in the sleeve.

When the ECM controls the movement of the spool by controlling the magnitude of the pulse electric signal applied to the electromagnetic coil, the pressurized oil enters the different oil chambers of the valve timing regulator, and the oil pressure difference causes the valve timing adjuster to rotate and change with the camshaft. Relative position. When the ECM detects that the actual valve timing is equal to the target valve timing, the pulse signal applied to the electromagnetic coil is controlled to an intermediate value, and the spool valve is in the middle of the sleeve, so that the valve timing adjuster The oil pressure in the advance oil chamber and the retard oil chamber are equal, and the valve timing adjuster maintains the relative angles of the cam shaft and the timing sprocket.

## 3. Installation position

Both inlet and exhaust camshaft adopt VVT technology, corresponding to the two OCV valves, both at the front end of the camshaft.

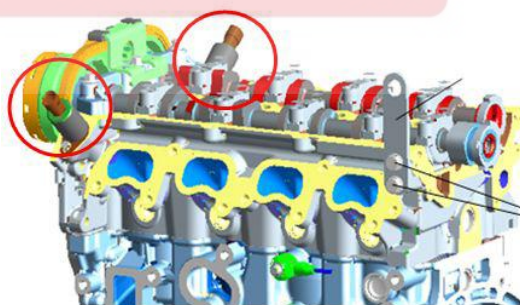


Figure 4-37 OCV valve installation position

## 4. Technical characteristics of the parameters

### ■ Pin definition (refer to figure 4-36)

Intake phase control valve: A-power supply, B-connect to ECU 58# pin

Exhaust phase control valve: A-power supply, B-connect to ECU 44# pin

### ■ Coil resistance: about 8Ω

## 5. Installation precautions



- OCV tighten bolt tightening torque:  $(6\pm1)\text{N.m}$ .
- During installation, apply a proper amount of lubricating oil on the o-ring of OCV before installing OCV.

### 6. Failure phenomenon and judgment

General failure reasons: electromagnetic coil short circuit or open circuit, valve core stuck and so on.

Fault phenomenon: when the valve timing control system fails, the actual valve timing will not match the target valve timing of ECM, which will affect its power performance and emission performance.

Detection method:

- ✓ Measure the solenoid coil resistance

Use multimeter to measure the resistance between the two terminals of the OCV, it is  $8\Omega$ .

### 4.3.11 Carbon canister solenoid valve



Figure 4-38 Charcoal canister solenoid valve

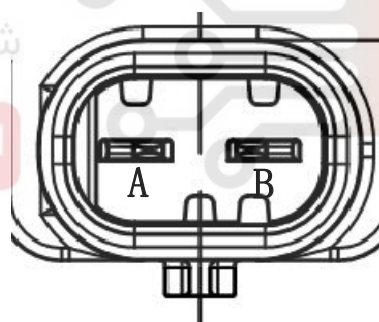


Figure 4-39 Charcoal canister solenoid valve pin

### 1. Overview

The gasoline vapor produced in the fuel tank is piped into the activated carbon canister, which can absorb the gasoline molecules in the gasoline vapor. Another outlet hose above the carbon canister is connected with the carbon canister solenoid valve, which is used to control the on and off of the pipeline. After the solenoid valve, there are low desorption pipeline and high desorption pipeline. The low desorption pipeline is connected to the engine inlet pipe. When the engine works at low speed and low load, the boost pressure is not high and the inlet pipe is in negative pressure



state. After the solenoid valve is opened, the oil vapor can be sucked into the inlet pipe through the low desorption pipeline. The high desorption line is connected to a venturi line. When the engine works at high speed and high load, the boost pressure is high, and the inlet pipe is in positive pressure state. The low desorption line cannot work. At this point, the high pressure air flow after medium cooling is used to suck the oil vapor into the air filter inlet line through the venturi pipe.

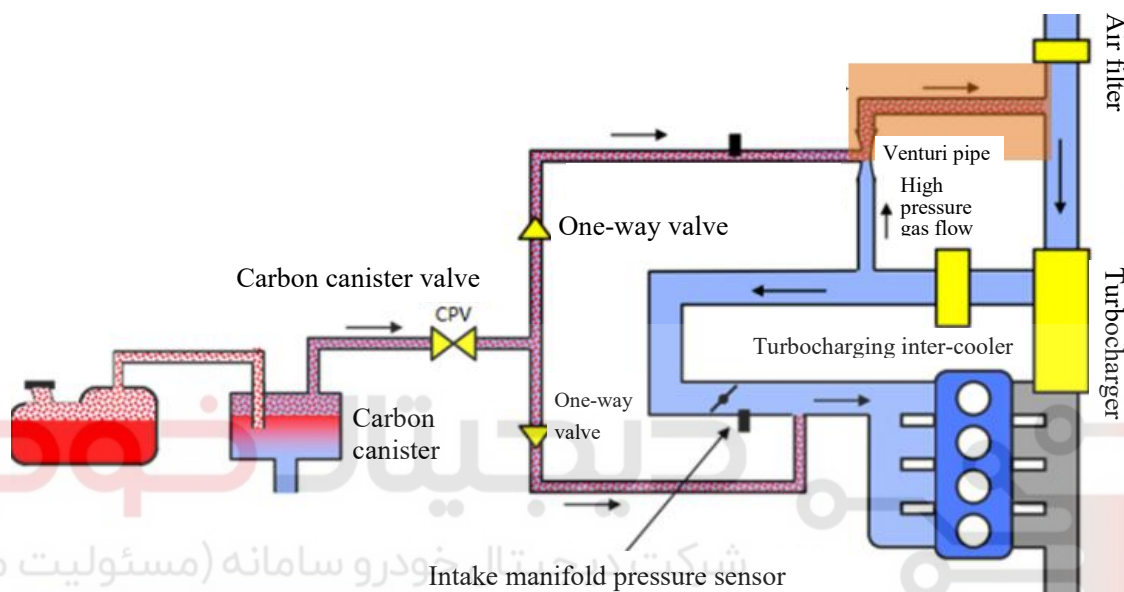


Figure 4-40 Breathing system schematic

## 2. Working principle

Carbon canister valve consists of electromagnetic coil, armature and valve, and there is strainer in the inlet port. The flow rate of the carbon canister control valve is related to the duty cycle of the ECU pulse to the carbon canister control valve on the one hand, and to the pressure difference between the inlet and outlet of the carbon tank control valve on the other hand. When there is no electrical pulse, the carbon canister control valve closes. When the engine stops or idles, ECM causes the solenoid valve to close, at this time the fuel vapor evaporating from the fuel tank is absorbed by the carbon canister. When the engine is running at medium to high speed, ECM makes the solenoid valve open and stores in the activated carbon canister and suck into the engine through the hose. At this time, the engine intake volume is large, a small amount of fuel vapor will not affect mixture concentration.

## 3. Installation position

Install on the intake manifold

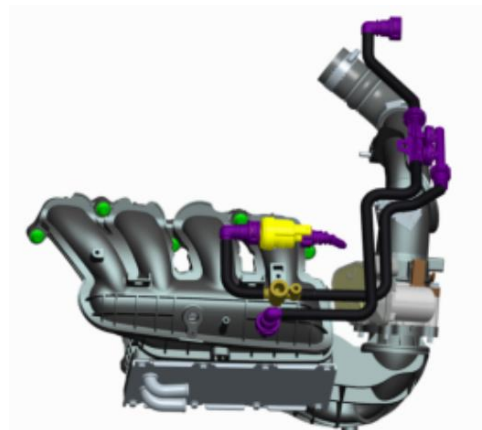


Figure 4-44 Carbon canister solenoid valve installation position

#### 4. Technical characteristics of the parameters

- Pin definition (refer to figure 4-96)

A- Signal pin: connect to ECU 14# pin      B- power supply

- Coil resistance:  $(16 \pm 2) \Omega$  resistance value when at 20°C

#### 5. Installation precautions

- Pay attention to the direction of installation.

#### 6. Failure phenomenon and judgment

General fault reason: The solenoid valve is not working normally, it is closed

continuously, the solenoid valve is often opened, and the solenoid valve is blocked.

fault phenomenon: The first is the failure, that is, the fuel vapor in the fuel tank cannot be recovered, there is a fuel smell in the car during the summer driving; Second, the work is abnormal, such as when the fuel vapor recovery work in the engine idle speed, results in too much mixture or influence the engine idle speed stability.

Detection method:

- 1) Measure the resistance

Use a multimeter to measure the resistance between the two terminals of the OCV, it is  $(16 \pm 2) \Omega$  resistance value when at 20°C

- 2) Performance check

Unplug the solenoid valve harness and blow the air into the solenoid valve. The solenoid valve should not be ventilated. Connect the 12V power supply to the two terminals of the solenoid valve and blow the air into the solenoid valve. The solenoid valve should be ventilated. If there is any abnormality, it indicates that the solenoid

valve is out of order.

### 4.3.12 Ignition coil



Figure 4-45 Ignition coil

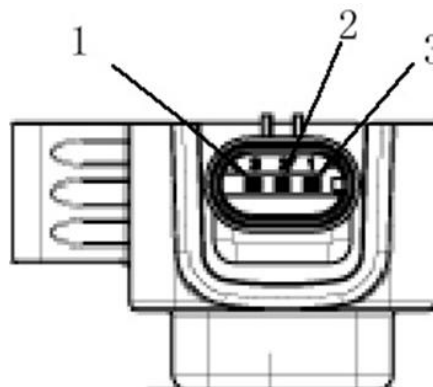


Figure 4-46 Ignition coil pin

#### 1. Overview

This engine adopts the independent electric control ignition system, the secondary coil of the ignition coil is directly connected with the spark plug. In this ignition system, each ignition coil is connected with ECM to calculate the ignition advance angle according to the signals of various sensors, and the piston positions of each cylinder are measured according to the crankshaft position sensor. According to the working order of each cylinder, the ignition signal is sent out to each ignition coil in turn. According to the ignition signal of ECM, the ignition coil of each cylinder controls the conduction and disconnection of the primary winding current of each ignition coil, so that the secondary high voltage is generated, which is directly sent to the spark plug for ignition.

The ignition coil consists of two sets of coils, primary coils and secondary coils, the main function of which is to turn the low voltage of the vehicle into high voltage.

#### 2. Working principle

Ignition coil consists of primary winding resistance, secondary winding and iron core, shell, etc. When some primary resistance grounding is connected, the primary resistance is charged. As soon as the ECU cuts off the

primary

winding circuit, the charging stops and a high voltage is induced in the secondary winding to discharge the spark plug.

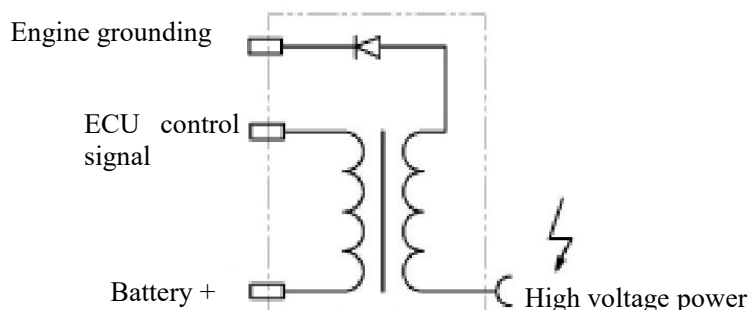


Figure 4-47 Ignition coil principle

### 3. Installation position

Installed on the engine cylinder head guard.

### 4. Technical characteristics of the parameters

■ Pin definition (refer to figure 4-46):

1. GND

2. ECU control signal:

1st cylinder ignition coil corresponding to ECU 4# pin;

2nd cylinder ignition coil corresponding to ECU 5# pin;

3rd cylinder ignition coil corresponding to ECU 20# pin;

4th cylinder ignition coil corresponding to ECU 3# pin;

3. Power supply

### 5. Installation precautions

- When installing ignition coil, hammers and other tools are prohibited.
- Ignition coil bolt tightening torque:  $(10 \pm 1) \text{ N} \cdot \text{m}$
- Be sure to disconnect the battery negative electrode before installation and disassembly.

### 6. Failure phenomenon and judgment

General fault reasons: short circuit or open circuit inside the coil, leakage of the coil, cracks in the shell, insufficient ignition energy caused by the aging of the coil, and breakdown of the coil;

Fault phenomenon: ignition coil failure causes spark plug no fire or fire weak, cause engine work difficult to start, can not start or shake.

Check method: When there is a failure of individual cylinders to ignite, the ignition coil can be exchanged to determine the cause of component damage. If all cylinders do not ignite, the cause of failure should be in the control circuit, sensor or ECM, and it is unlikely that all ignition coils will be damaged at the same time. Therefore, as long as the control circuit is detected, the fault range can be determined.

#### 1) Control circuit detection

Disconnect wire harness plug of the ignition coil, turn on the ignition switch, and the measuring power supply terminal shall be 12V battery voltage. If is 0V, indicating that the power circuit failure, should be further overhaul.

Measure grounding terminal of wiring harness connector, resistance between it and negative electrode of the battery should be less than  $3\Omega$ . If abnormal, it should be repaired.

Measure the signal terminal of the wire harness plug with a light emitting diode test lamp. When starting the engine, the test lights should flicker, otherwise the ECM does not send a ignition signal to the ignition coil. The crankshaft position sensor may be malfunctioning, or the ECM may not work and should be further overhauled.

#### 2) Performance check

Remove the ignition coil, attach the spark plug and make it grounding. Start the engine and check whether there is high pressure spark in the spark plug electrode.

### 4.3.13 Spark plug



Figure 4-48 Spark plug

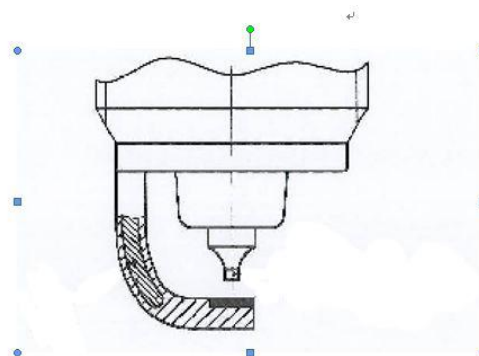


Figure 4-49 Spark plug electrode

#### 1. Overview

The role of the spark plug is to send the ignition coil to the pulse high voltage discharge, to break through the air between the two electrodes of the spark plug, and to produce an electric spark to ignite the mixed gas in the cylinder.

## 2. Working principle

The main parts of spark plug are insulator, shell, connection screw and electrode. Spark plug electrode consists of center electrode and side electrode, and the spark gap is between them. The high voltage current from the ignition coil passes through the central electrode and then discharges at the bottom end of the discharge gap.

## 3. Technical characteristics of the parameters

- Ignition clearance: 0.7~0.8 mm

## 4. Installation precautions

- During installation, hammers and other tools are prohibited
- Spark plug tightening torque:  $(25 \sim 30) \text{ N.m}$
- *It is strictly prohibited that excessive torque will easily lead to spark plug*

*damage and thread damage*

## 5. Failure phenomenon and judgment

General failure reasons: spark plug ablation and so on.

Fault phenomenon: it is difficult to start and shake.

Inspection methods:

- 1) Observe color:

Normal working spark plug, its insulator skirt is russet and relatively clean. If the spark plug shows the following symptoms, it indicates that the engine or spark plug is not working properly.

① Spark plug electrode melts and the body is white. This indicates that the high temperature in the cylinder causes spark plug ablation, which may be due to excessive carbon accumulation in the cylinder, too small valve clearance, too late ignition time, and too thin and damaged spark plug sealing ring. The spark plug failed to tighten according to the required torque, engine heat dissipation and so on.

② Spark plug electrodes become round and insulator scarring. The reason is that the ignition time is too early, the octane number of gasoline is too low, and the heat value of spark plug is too high.



③ The top of the spark plug insulator is broken. This shows that the engine detonation combustion, instantaneous high pressure shock wave will break the insulator. The reason is that the ignition time is too early, the octane number of gasoline is low, the combustion chamber is serious carbon deposit and the temperature is too high.

④ The top of the spark plug insulator has gray and black stripes. This shows that the spark plug has cracked and leaked gas.

⑤ There are oily deposits between the tip of the spark plug insulator and the electrode. This indicates that the lubricating oil has entered the cylinder to participate in combustion. If only individual spark plugs have deposits, it is due to failure of single cylinder valve oil seal etc. If all spark plugs have carbon deposition, a systematic lubrication system and crankcase ventilation device will be considered.

⑥ There are black deposits between the tip of the spark plug insulator and the electrode. This indicates that the mixture does not burn well, mainly because the mixture is too dense, leaving the black soot layer on the spark plug.

⑦ There are gray deposits between the top of the spark plug insulator and the electrode, which is usually due to the gasoline quality does not meet the requirements, gasoline additives after combustion products, this type of sediment will reduce the spark plug ignition performance.

⑧ The flame-plug insulator skirt and electrode are moist and oily. This means that high voltage wire of the cylinder has no power supply or weak electric energy.

## 2) Spark-over test:

Unscrew the spark plug and install it on the ignition coil so that the housing of the spark plug is grounded with the cylinder head, turn on the ignition switch, and use the starting device to turn the engine to see if the spark plug is jumping. Generally speaking, as long as the spark plug jumps out, the spark is blue-white or purple-white, and a "beep" sound at the same time as a flashover, indicating that the spark plug has a strong jump.

## 3) Measuring electrode gap:

The electrode gap of spark plug was measured with thick gauge or circular gauge, the standard value of 0.7 ~ 0.8 mm.



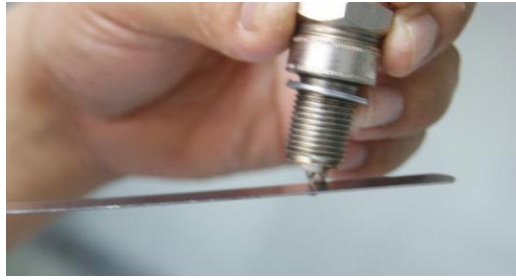


Figure 4-50 Spark plug clearance measurement

#### 4.3.14 High pressure fuel pump



Figure 4-51 High pressure fuel pump

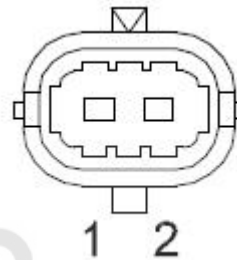


Figure 4-52 Fuel pump pin

##### 1. Overview

GDI engine fuel system is divided into three parts: low pressure fuel path, high pressure fuel path and lubricating fuel path. Compared with the traditional MPI engine, there is an additional set of high-pressure fuel path. GDI high pressure fuel pipeline consists of high pressure fuel pump, high pressure fuel pipe, high pressure fuel rail and fuel injector.

The GDI high pressure pump is single plunger pump that feeds high pressure quantitative fuel to the high pressure rail assembly through plunger motion.

##### 2. Working principle

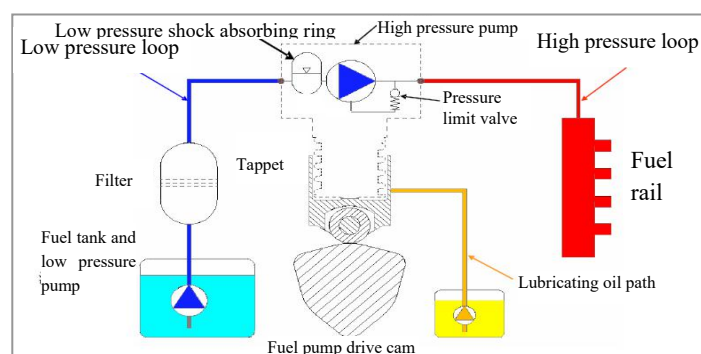


Figure 4-53 Injection pump working principle

The GDI high pressure pump is driven by the cam, which is driven by the oil pump on the camshaft through a roller cylinder, which pushes the plunger of the high pressure pump back and forth. Engine control module input signal to control the valve to do, in order to control the flow.

### 3. Installation position

Installed on rear end of the cylinder head.

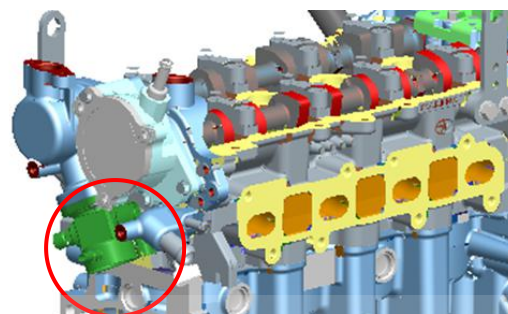


Figure 4-54 Fuel pump installation position

### 4. Technical characteristics of the parameters

- Pin definition (refer to figure 4-52)
  - ✓ Connect to ECM 48# pin
  - ✓ Connect to ECM 46# pin
- Resistance between the pins:  $1.2\Omega$  (@23°C)

- Safety valve opening pressure: 200 bar

### 5. Installation precautions

■ Check the high pressure fuel pump O-shape ring, if the O-shape is damaged, please replace it.

- Note: Max installation torque is not more than 300N.

### 6. Failure phenomenon and judgment

Symptom: power shortage, the engine no start, oil leakage.

General failure reason: Inner oil path blocked, plunger damage, sealing ring damage, etc.

Detection method:

- 1) Measure the resistance between the pins.
- 2) Check whether the connection seal is well.

### 4.3.15 Variable displacement oil pump



Figure 4-55 Variable displacement oil pump

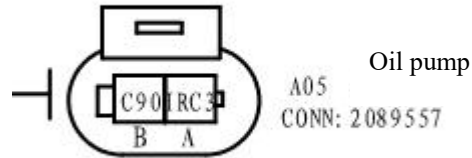


Figure 4-56 Pin

#### 1. Overview

The variable displacement oil pump is variable displacement vane pump. The eccentricity between the pump and the rotor can be changed through the sliding of the external adjusting ring, and then the displacement of the vane pump can be changed.

#### 2. Working principle

Variable oil pump for the vane type variable displacement pump, its main variable displacement process by the main oil hydraulic feedback control, lead the main oil oil and reduction pressure zone, when the interval pressure generated by the torque is more than provide pre-tightening torque spring swing, the eccentric annulus started around the swing swing pin clockwise, the oil pump is less eccentricity, thus reducing emissions technology requirements.

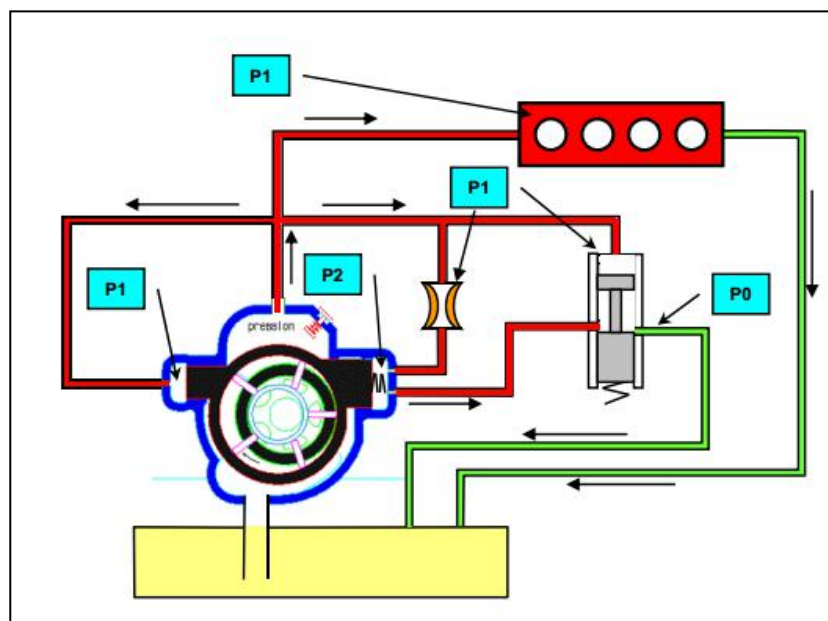


Figure 4-57 Principle diagram

### 3. Installation position

Installed on the cylinder body, below the timing chain.

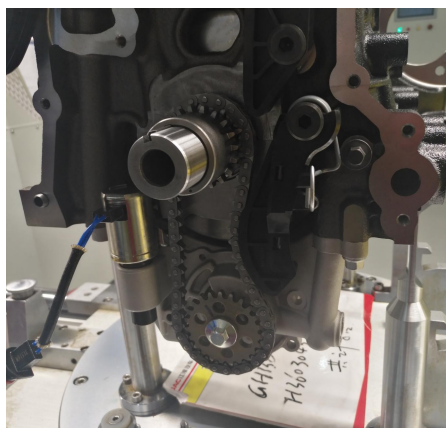


Figure 4-58 Oil pump installation position

### 4. Technical characteristics of the parameters

1. Pump speed 825rpm, oil outlet pressure **1.64bar**, flow **>11 L/min**
2. Opening valve opening pressure: **8bar±0.5bar**

Safety valve cut-off pressure: **10bar**

3. Total weight: about 1.8kg
4. End surface clearance: **0.03mm~0.08mm**

#### 5. Solenoid valve

- 1) Coil resistance: **7.9Ω±0.4 @40°C**
- 2) Strainer “P” port 150um
- 3) Working temperature: -40°C ~ 150°C
- 4) Voltage range: **10 VDC~16 VDC**
6. Strainer specification: GFW1/0.5(plain weave)GB/T5330

7. When fastening the chain bolts, use special fixture to fix the chain without following rotation and damage. Tightening torque (35±5)N·m.

[illegible]

**60 way Engine Connector Layout (1xx)**

**94 way Vehicle Connector Layout (2xx)**

## 1. Overview

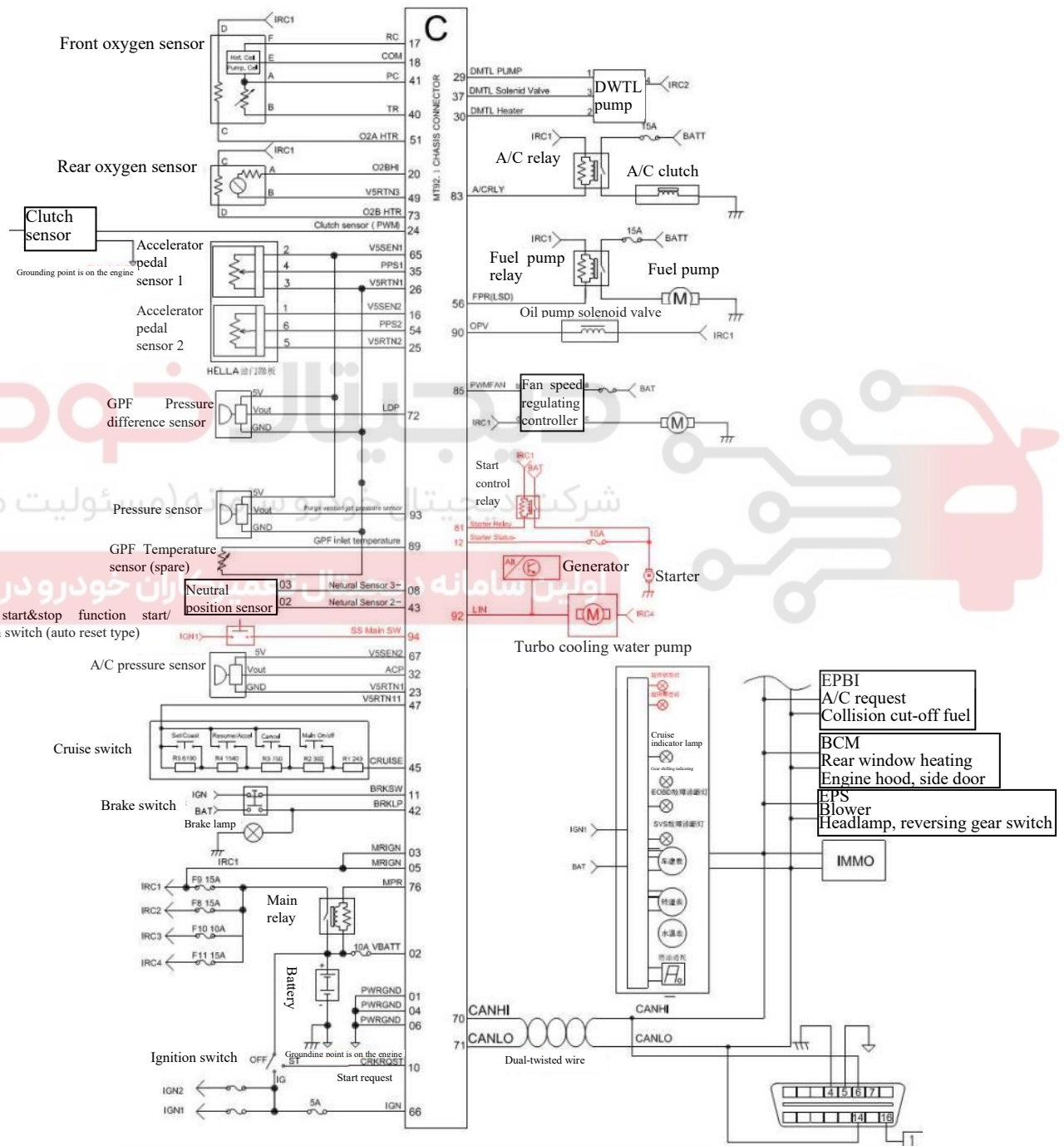
- ① Receive signals from various sensors to obtain engine operating parameters and provide the basis for the control of engine systems.
- ② According to the various operating parameters of the engine provided by the sensor, according to the set program and control strategy, the control signals are output to the actuators such as the injector and the ignition coil to realize the control of each system of the engine.
- ③ Monitor sensors, control circuits, actuators and other signals of the electronic control system. When the signal is abnormal, light up the fault warning lamp to issue an alarm in time. At the same time, store the fault code in the memory of ECU, and start failure protection function to maintain the engine operation. In addition, the maintainer can trigger self-diagnosis function of ECM through specific steps, and read the fault code and data

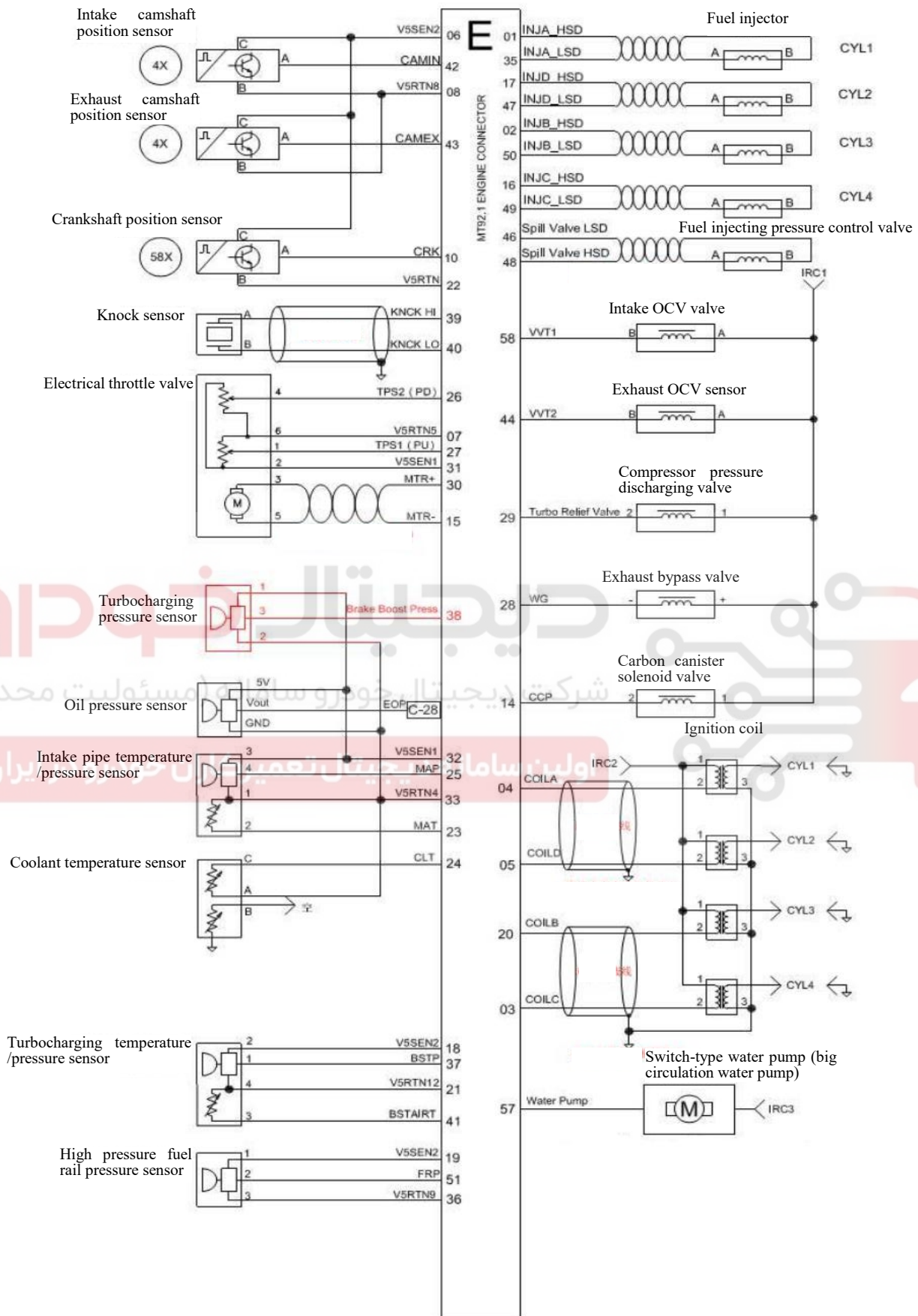


stream stored by ECU through the fault diagnosis connector, which can provide the basis for fault diagnosis.

Besides, ECM also has the function of controlling the power supply of the electronic control system and providing stable reference voltage for some sensors.

## 2、Electrical circuit schematic







## 4.4 Engine Control System Fault Diagnosis Process

### 4.4.1 Electronic control system common failure and main causes

#### 1. ECM failure

Under normal circumstances, ECM has a good reliability, and will not fail in normal use. Most failures of ECM are by not properly used or caused by improper maintenance. Main reasons of ECM failure are the following:

- ① The ECM power circuit is faulty, causing ECM not to work.
- ② Unplug the ECM harness connector while the power is on, causing ECM damage due to momentary high voltage.
- ③ The operation due to water or damp, resulting in ECM internal circuit short circuit or electronic components damaged; or the plug in the terminal is poor contact because of the oxidation.
- ④ The ECM interior is damaged. When the ECM is completely out of service due to damage and power failure, the engine failure warning light on the instrument platform won't light up when the ignition switch is turned on. The engine cannot start because it is not ignited and sprayed with oil.
- ⑤ If there is some damage to the control program of ECM or some of its input and output circuits are damaged, some of the functions of the electronic control system will be abnormal. For example, individual cylinders will not inject fuel and idling automatic control will fail.

#### 2. Sensor failure

Sensor failures are in the following forms.

- ① Internal sensor failures, such as the internal circuit open circuit, short circuit or internal components aging, damage and other failures.
- ② External sensor control circuit failure, such as the sensor power circuit, ground circuit, the signal circuit of the short circuit, open circuit and so on.
- ③ Sporadic failures internal or external the sensor, such as poor contact of

internal components or plugs, and occasional malfunctions at work.

When the sensor internal or external circuit is open or short circuit fault, the sensor signal value will exceed the normal range, this failure is easily measured by ECM self-diagnostic system. The ECM immediately lights the engine fault warning light on the dash and notes the fault code in memory and starts fail-safe control to maintain the engine running.

When the sensor internal components have aging damage, the signal value, although not beyond the normal range, does not meet with the actual parameters detected. This failure is sometimes not detected by ECM self-diagnostic system and fails to initiate fail-safe control, which can result in abnormal engine operation.

### 3. Actuator failure

Actuators containing both electronic components and mechanical parts inside, is the most prone to failure components in electronic control system. When an actuator fails, the ECM control commands will not be executed properly, causing the engine to malfunction. Common causes of failure are the following:

- ① The electronic components in the actuator are damaged or the internal circuit is short-circuit, open-circuit or other hardware failure.
- ② The mechanical parts in the actuator can not work normally due to wear and jamming.
- ③ Aging and other reasons in the electronic components or mechanical parts in actuator lead to slow response.
- ④ Actuator internal electronic components exist virtual connection or mechanical parts exist with the abnormal gap; the actuator occasionally malfunctions due to temperature or other external factors.

### 4. Control circuit failure

The abnormal control circuit between ECM and sensor, actuator, power supply and iron can also make the sensors, actuators and ECM of the electronic control system not work properly, and cause various faults of the engine. The main reasons of the common control circuit fault are as follows.

- ① Power fuse due to bad contact, overload fuse and other reasons causes the

system power circuit failure.

② The grounding wire of a sensor, actuator, or ECM is poorly pitched, resulting in failures of sensor, actuator, or ECM abnormal operation.

③ The connector in the control circuit has been disassembled for many times, causing the plug or terminal to loosen or the terminal to enter.

④ Connecting wire aging, internal fracture or skin rupture, resulting in open circuit or short circuit fault.

#### 4.4.2 Electronic control system common fault diagnose

##### 1. Engine can not start

When ignition switch is ON, the starter can drive engine to turn normally, but can not start, and there is no sign of starting vehicle. Then it must be at least one of ignition control system, fuel control systems or ECM in engine electronic control system is completely disabled. If starting engine, starter can drive engine to normal rotation, and there is a slight sign of starting vehicle, but can not start. It indicates that although function of ignition system, fuel control system and control system is abnormal, but it is not completely functional. The reasons for this failure are that the high pressure spark is too weak or the ignition time is not correct, the mixture is too thin, the mixture is too thick, and the cylinder pressure is too low. The reasons for the failure of engine can't start are usually the followings.

- ① The fuel pump does not work.
- ② Fuel injector does not work.
- ③ Ignition system does not ignite.
- ④ Fuel pressure is too low.
- ⑤ Ignition advance angle is incorrect.
- ⑥ High voltage spark is too weak.
- ⑦ Injector leaks oil.
- ⑧ ECM does not work.

**Check Steps:**

✓ To failure of engine can not start, generally should first check fuel storage situation of fuel tank. Turn on ignition switch, if there is no fuel in the tank, should be refueling.

✓ Read fault code, according to the fault code to find the corresponding fault cause. However, the fault code shown is not necessarily related to the failure of engine can't start, and may be accidental failure in the engine's previous process. The main components that may affect starting are crankshaft position sensor, coolant temperature sensor, inlet temperature pressure sensor and so on.

✓ Check ignition system. If engine does not ignite, engine can not also start. Therefore, ignition system should be checked whether there is failure before further inspection. Refer to this chapter <3.12 ignition coil> to check the ignition.

● If there is no high-pressure spark, ignition system has failure. Before looking up failure position, you can do the engine fault self-diagnosis to check if there is any fault code. The fault diagnosis system of electric control system of gasoline engine can usually detect the fault of crankshaft position sensor and ignition coil related to ignition control. If there is fault code, the fault position can be found according to the displayed fault code. If there is no fault code, the ignition coil, crankshaft positioner and ignition control circuit in the ignition system should be checked separately.

● If there are high pressure sparks, further check whether the strength of high pressure sparks is normal. If high pressure sparks are too weak, consider replacing ignition coils.

✓ Check whether fuel pump is working properly. Make electric fuel pump run artificially (temporarily supply it with a specified voltage). You should be able to hear the sound of fuel pump running or to feel the pressure pulsation of fuel when you hold the inlet pipe with your hand.

If fuel pump does not work, check the fuse, relay and fuel pump control circuit. If circuit is normal, then there is failure in fuel pump, should replace it.

✓ Check whether fuel injector injects fuel.

✓ Check fuel pressure. The standard value should be around 500KPa.

- ✓ Check spark plug. If spark plug surface carbon deposition or abnormal gap, there will be ignition weak or even no spark, causing engine to be hard to start.
- ✓ If there is a large amount of wet gasoline on the surface of spark plug, there is a "choking" phenomenon in cylinder, which will also cause engine to fail to start. For this, remove all spark plugs and bake them, then let all the gasoline in the cylinder evaporate, and then install spark plug and start again. If there is "choking fuel" phenomenon, please remove the fuel injector, and check if there is leakage in the fuel injector.

## 2. Engine hard to start

Engine starting difficulty refers to engine can drive engine to rotate in normal speed, there is obvious sign of vehicle starting, but can not start; or need to start several times; or need starter to drive for a long time before engine can start; or start after flameout, unable to normal running. Main reason for hard starting are in the followings.

1. The fuel pressure is too low, making the mixture too thin when starting.
2. Coolant temperature sensor failure, resulting in the mixture is too thin or too thick.
3. The injector leaks oil, resulting in bad spray atomization
4. Fuel injector is blocked, making the fuel injection amount is less or no, leading to the difficulty of starting.
5. Ignition timing is abnormal or poor performance of spark plug or ignition coil in ignition system.
6. There is failure in ECM starting control circuit.
7. The pressure of the cylinder is too low. The combustible mixture in the cylinder has poor combustion conditions and is not easy to fire.

### Check Steps:

The following steps can be followed for the diagnosis of engine difficult starting faults.

- ✓ Read fault code, check fault code related components.

✓ Check whether there is leaking in intake system. Check carefully to see if the relevant intake pipe is broken, the coupling clamps are loose, and the crankcase ventilation system hose is well connected.

✓ Check whether idling related component is working properly.

✓ Check fuel pressure, if the pressure is too low, check if fuel pump is working properly or the gasoline filter is blocked.

✓ Check if the mixture is too thick during starting (black smoke, sharp unburned gasoline, etc.). If the mixture is too thick, check the fuel pressure, coolant temperature sensor, intake pressure sensor, etc.

✓ If the mixture is normal, focus on the ignition system. Remove spark plug, check whether there is aging, serious carbon deposition or spark plug gap is too large in spark plug, these conditions may affect the starting performance. Check ignition control circuit to see if there are open circuit, short circuit and so on. Do fire test, if necessary.

✓ Check the cylinder pressure. If the cylinder pressure is lower than 0.8Mpa, the engine should be disassembled and inspected for mechanical failure.

✓ If the above all normal, change a new engine ECM to try. If there is any improvement, it indicates that the original ECM malfunction, should be replaced.

### 3. Engine idling unstable

If engine starts normally, its idle speed is unstable, the engine has obvious jitter and miss fire easily, regardless of whether it is cold or warm. This phenomenon is usually caused by the following points.

✓ Turbocharger working not well.

✓ Fuel pressure is too low.

✓ Poor atomization, oil leakage or blockage of the injector;

✓ Spark plug working not well.

✓ Intake temperature pressure related sensor failure.

✓ Carbon canister respiratory system works at idle speed.

✓ Cylinder pressure is too low or cylinder pressure difference is too large.

### Check Steps



- ① Read fault code and repair according to the fault code.
- ② Check whether there is air leakage or pipe connections are connected properly in air intake system.
- ③ Check whether there is stuck, carbon deposits, oil or excessive dust when throttle valve working.
- ④ Do cylinder breaking test, cut off one cylinder one by one in idle speed , and check whether engine speed drop is equal. If engine speed of some cylinder is basically unchanged when the cylinder is broken, it indicates that the cylinder is not working well or not work. Check whether there is fault in cylinder ignition coil, spark plug or fuel injector, and whether there are faults in the related control circuit. Check cylinder pressure, if the cylinder pressure is abnormal, further check the valve clearance, cylinder wear and valve sealing.
- ⑤ Check fuel pressure, if abnormal please check the oil pump and related fuel lines.
- ⑥ Check air inlet temperature pressure sensor signal. If not normal, proceed to the next step.

#### 4. Idling engine speed too high

Electric control system can let engine run in a faster speed when vehicle is cold, and let engine returned to normal idle speed when vehicle is warm. If engine still keeps high idle speed after warming vehicle, that is, the idle speed is too high, it usually has the following reasons.

- ③ Throttle failure or air leakage in intake pipe.
- ④ Accelerator pedal failure.
- ⑤ Coolant temperature sensor fault
- ⑥ Carbon canister solenoid valve failure

#### Check Steps

- ✓ Read fault code and repair according to the fault code.
- ✓ Check whether there is stuck, carbon deposits in electronic throttle valve.
- ✓ Check coolant temperature sensor. Read engine ECM data stream by fault diagnosis device. Analyze coolant temperature sensor signal, and analyze

the difference between coolant temperature and actual coolant temperature. If the difference is too large, the fault of coolant temperature sensor is more likely. Disconnect coolant temperature sensor connector to measure resistance, refer to the standard in this chapter <3.2 coolant temperature sensor>, if not up to standard, replace coolant temperature sensor.

✓ When A/C switch is ON, if engine speed does not change, it indicates that the idle speed control system has a control, check whether the relevant vehicle control signal is normal.

✓ Tighten hose connected to intake manifold, if engine speed decreases, it indicates that there is air leakage in the crankcase ventilation system or the carbon canister respiratory system, so the pipeline and solenoid valve of carbon canister should be further checked.

### 5. Idling engine speed fluctuating too much

If engine speed fluctuates continuously during idling, it may be engine fuel system, ignition system or electronic throttle valve related failure. It can be considered from the following points.

- 1) Poor atomization or blockage of the injector;
- 2) Spark plug bad ignition.
- 3) Incorrect coolant temperature sensor signal.
- 4) Oxygen sensor failure.
- 5) Electronic throttle valve or other control circuit failure.

### Check Steps

- ① Read fault code Pay special attention to coolant temperature sensor, inlet temperature pressure sensor, oxygen sensor.
- ② Electronic throttle valve related fault If there are fault codes, check the corresponding sensors, actuators and their control circuits.
- ③ Disconnect each cylinder high-voltage wire or fuel injector wiring harness connector one by one during idling, check whether the engine cylinders work evenly. If engine speed drop is not obvious when disconnecting some cylinder high voltage wire or fuel injector wiring harness connector, it indicates the cylinder work normally,

should check spark plug, high voltage wire and fuel injector.

④ Measure resistance of coolant temperature sensor at different temperatures, and check whether accord with the standard value. If abnormal, coolant temperature sensor should be replaced.

⑤ Check inlet temperature pressure sensor. If abnormal, it should be replaced.

⑥ Check electronic throttle valve fault.

## 6. Easy to miss fire when idling

Main reasons for engine easy to be off when idling are the followings.

① Ignition system is not working properly, it is easy to miss fire during engine running.

② Fuel system works abnormally, such as low fuel pressure, abnormal fuel pump working, fuel injector blockage, and so on.

③ Idle speed instability or idling engine speed too low;

④ Electronic throttle valve fault

⑤ Bad contact in wiring harness connector of control system circuit, power is suddenly cut off while driving.

## Check Steps

① Read fault code Check related parts according to fault code.

② Check whether there is lack power during driving, such as acceleration weakness, acceleration slow reaction; check fuel pressure, such as abnormal fuel pressure, check fuel system related components.

③ If idle speed is too low or unstable, or even engine turns off during idling when A/C is on, check whether there is failure in A/C switch, or whether there is open circuit or short circuit in ECM connecting circuit.

④ If all the above checks are normal, we should check whether there is bad contact in engine grounding wire or all wiring harness connectors in ECU control system.

## 7. Power not enough

Lack power means that vehicle accelerates slow, accelerator pedal is still insufficient, rotating speed is not high or clamping slope is weak, etc. Main reasons

for the failure include the following points.

- ① Air filter blocked or inlet system pipe connection loosen.
- ② Electronic throttle valve fault.
- ③ Fuel pressure is too low.
- ④ Poor atomization or blockage of the injector;
- ⑤ Coolant temperature sensor fault
- ⑥ Temperature pressure related sensor failure
- ⑦ Improper ignition or high pressure spark too weak.
- ⑧ Abnormal cylinder pressure.

#### Check Steps

✓ Check whether there is blockage in air filter, whether air intake system connection is normal. If abnormal, should be handled.

✓ Read fault code, check fault code related components. Sensors and actuators that affect dynamic include coolant temperature sensor, inlet temperature pressure related sensor, spark plug, fuel injector, ignition coil, etc.

✓ Check spark plug and ignition coil.

✓ Check ignition timing.

✓ Check fuel pressure. If pressure is too low, should further check fuel pump, high pressure fuel pump and fuel line and so on.

✓ Check fuel injector. See if there are serious problems such as carbon deposition.

✓ Measure cylinder pressure. If the cylinder pressure is too low, please go to further operation.

### 4.4.3 Electronic control system common fault code analysis

#### Diagnosis by fault code

##### 1. Instruction

1) The following overhaul would be carried out only it has been confirmed as the current steady-state failure , otherwise will cause the diagnosis to be wrong.

2) The following "multimeter" occasion refers to the the digital multimeter; prohibit the use of pointer multimeter on the electronic control system line inspection.

3) check vehicles with anti-theft system, if ECM replacement occurs in "next steps", pay attention to matching after ECM replacement.

4) If the fault code shows that the voltage of a circuit is too low, it means the circuit may be shorted or open to ground. If the fault code shows that a circuit voltage is too high, it means that the circuit may have a short circuit to the power supply. If the fault code shows a circuit fault, it means there may be a circuit break in the circuit or there are multiple line faults.

## 2. Fault diagnosing assist

1) If the fault code can not be cleared, the fault is a steady-state fault; if it is an occasional fault, check the harness connector for looseness.

2) In the overhaul process, do not neglect the impact of car maintenance, cylinder pressure, mechanical ignition timing and so on to the system.

3) Replace the ECM and carry out the test.

■ If fault code can be cleared at this time, the failure position is in ECM. If fault code is still unable to be cleared at this time, then replace the original ECM, the process is repeated, and the maintenance work is carried out again.

## 3. Fault code diagnosis

■ Related ECM pins mentioned below refer to actual wiring harness diagram.

**Fault code 1: Inlet & exhaust VCP part and system (include OCV valve, CAM sensor) fault**

### 1. Fault code instruction

|            |       |                                                      |
|------------|-------|------------------------------------------------------|
| Fault Code | P0011 | Air inlet VCP phase response lag                     |
| Fault Code | P0012 | Air inlet VCP camshaft phase error is large          |
| Fault Code | P0014 | Air exhaust VCP phase response lag                   |
| Fault Code | P0015 | Exhaust VCP Camshaft phase error is large            |
| Fault Code | P0016 | Inlet VCP camshaft learning deviation exceed range   |
| Fault Code | P0017 | Exhaust VCP camshaft learning deviation exceed range |

|            |       |                                                                               |
|------------|-------|-------------------------------------------------------------------------------|
| Fault Code | P0026 | Intake VCP hydraulic pressure control valve vised                             |
| Fault Code | P0027 | Exhaust VCP hydraulic pressure control valve vised                            |
| Fault Code | P0076 | Intake VCP hydraulic pressure control valve coil low voltage or open circuit  |
| Fault Code | P0077 | Intake VCP hydraulic pressure control valve coil high voltage                 |
| Fault Code | P0079 | Exhaust VCP hydraulic pressure control valve coil low voltage or open circuit |
| Fault Code | P0080 | Exhaust VCP hydraulic pressure control valve coil high voltage                |
| Fault Code | P0341 | Intake VCP target wheel diagnosis fault                                       |
| Fault Code | P0340 | Intake VCP camshaft position sensor state diagnosis                           |
| Fault Code | P0366 | Exhaust VCP target wheel diagnosis fault                                      |

Intake and exhaust camshaft position actuator is connected to intake camshaft valve and operated by hydraulic, hydraulic pressure is supplied by engine oil pump, to change intake angle of camshaft relative to VVT actuator. Main relay supplies working power supply for intake VVT electromagnetic valve, ECM controls grounding by pulse-width modulation signal. Thus, control engine oil flow rate flowing into camshaft position actuator. Oil pressure makes camshaft position actuator fixed in front of camshaft work, and make camshaft rotate. Intake camshaft position actuator can change cam working angle to 50° for the most.

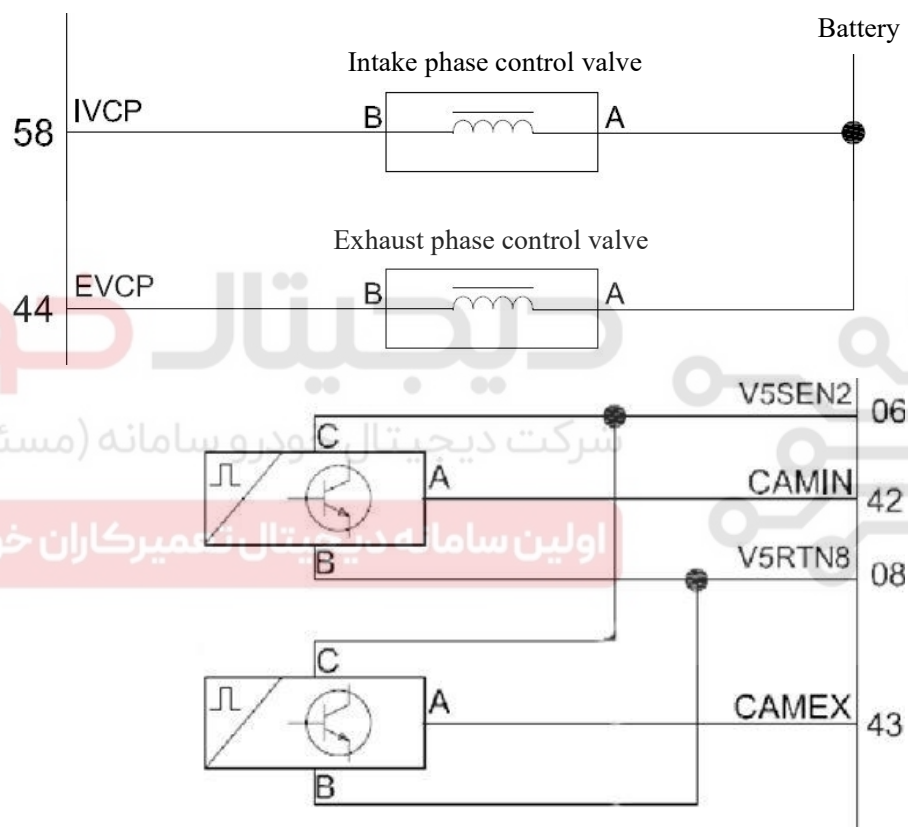
When ECM detecting there is much difference between VVT actual angle and target angle or not in target position, it may has P0011, P0012, P0014, P0015, P0016, P0017, P0026 or P0027 fault code.

ECM controls electromagnetic valve internal grounding through wiring harness connector. There is feedback circuit in ECM, engine ECM confirms whether is open circuit, short circuit to grounding or short circuit to voltage through monitored feedback signal. If engine ECM detecting control circuit voltage in pre-set range when control circuit instruct cut-off, it has P0076, P0077, P0079, P0080 fault code.



Camshaft position (CMP) sensor is to detect camshaft position, and associated with crankshaft position, and can make engine ECM confirm injector to inject to which cylinder. Engine ECM also uses camshaft position sensor output information to confirm camshaft position relative to crankshaft, thus to control phase position adjustment of camshaft and carry out emergency operation. When ECM detecting engine running but not received camshaft position sensor or detected signal not accord with calibration, it may have P0341, P0340 and P0366 fault code.

## 2. Circuit Diagram



## 3. Fault code fault part and solutions

|                                                            |                                  |                                    |
|------------------------------------------------------------|----------------------------------|------------------------------------|
| Fault Code                                                 | P0011                            | Air inlet VCP phase response lag   |
| Fault Code                                                 | P0014                            | Air exhaust VCP phase response lag |
| Invalid protection mode                                    | No                               |                                    |
| Possible causes                                            | Referred failure troubleshooting |                                    |
| 1. Connectors are not plugged in                           | 1. Connect the connector again   |                                    |
| 2. Variable timing control signal circuit has open circuit | 2. Repair wire harness           |                                    |
|                                                            | 3. Repair wire harness           |                                    |

|                                                                       |                             |
|-----------------------------------------------------------------------|-----------------------------|
| 3. Variable timing control signal circuit has short circuit to ground | 4. Repair wire harness      |
| 4. Main relay circuit fault                                           | 5. Replace the sensor       |
| 5. Sensor damaged                                                     | 6. Replace the ECM          |
| 6. Failure of timing control signal input interface on ECM            | 7. Install the timing again |
| 7. Valve timing fault                                                 |                             |

|                                                                                                                                                                               |       |                                                                                                                              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------------------------------------------------------------------------------------------------------------------------|
| Fault Code                                                                                                                                                                    | P0012 | Air inlet VCP camshaft phase error is large                                                                                  |
| Fault Code                                                                                                                                                                    | P0015 | Exhaust VCP Camshaft phase error is large                                                                                    |
| Fault Code                                                                                                                                                                    | P0016 | Intake VCP camshaft tooth learning deviation exceed range                                                                    |
| Fault Code                                                                                                                                                                    | P0017 | Exhaust VCP camshaft learning deviation exceed range                                                                         |
| Fault Code                                                                                                                                                                    | P0026 | Intake VCP hydraulic pressure control valve vised                                                                            |
| Fault Code                                                                                                                                                                    | P0027 | Exhaust VCP hydraulic pressure control valve vised                                                                           |
| Invalid protection mode                                                                                                                                                       | No    |                                                                                                                              |
| Possible causes                                                                                                                                                               |       | Referred failure troubleshooting                                                                                             |
| 1. Valve timing fault (timing fault, timing chain jump tooth or chain lengthen)<br>2. VVT control valve strainer blocked<br>3. Valve timing regulator fault<br>4. ECM failure |       | 1. Check the timing gear and chain<br>2. Replace VVT oil strainer<br>3. Replace valve timing regulator<br>4. Replace the ECM |

|            |       |                                                                              |
|------------|-------|------------------------------------------------------------------------------|
| Fault Code | P0076 | Intake VCP hydraulic pressure control valve coil low voltage or open circuit |
| Fault Code | P0077 | Intake VCP hydraulic pressure control valve coil high voltage                |
| Fault Code | P0079 | Exhaust VCP hydraulic pressure control valve coil                            |

|                                                                                                                                                                                                             |              |                                                                                                                                                                                                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                             |              | low voltage or open circuit                                                                                                                                                                                    |
| Fault Code                                                                                                                                                                                                  | P0080        | Exhaust VCP hydraulic pressure control valve coil high voltage                                                                                                                                                 |
| Invalid protection mode                                                                                                                                                                                     | VCP not work |                                                                                                                                                                                                                |
| Possible causes                                                                                                                                                                                             |              | Referred failure troubleshooting                                                                                                                                                                               |
| 1. Control valve circuit open circuit<br>2. Control valve circuit short circuit to power supply<br>3. Control valve circuit short circuit to grounding<br>4. Control valve internal damage<br>5. ECM damage |              | a. Check whether there is open circuit or short circuit in control valve circuit<br>b. Detect control valve according to the chapter 4.3.10. If abnormal, please<br>c. Replace control valve<br>d. Replace ECM |

|                                                                                                                                                  |                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|--------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Fault Code                                                                                                                                       | P0341                             | Intake VCP target wheel diagnosis fault                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Fault Code                                                                                                                                       | P0340                             | Intake VCP camshaft position sensor state diagnosis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Fault Code                                                                                                                                       | P0366                             | Exhaust VCP target wheel diagnosis fault                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Invalid protection mode                                                                                                                          | VCP not work, quit ignition angle |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Possible causes                                                                                                                                  |                                   | Referred failure troubleshooting                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 1. Sensor circuit failure<br>2. Sensor installation failure<br>3. Sensor failure<br>4. Signal wheel failure<br>5. ECM failure<br>6. Timing fault |                                   | Check whether sensor is installed correctly, clearance is normal<br><br>Check whether there is loosening or bad contact in sensor wiring harness connector<br><br>Turn ignition switch to "OFF", disconnect sensor wiring harness connector, turn ignition switch to "ON", measure voltage of power supply terminal to grounding (standard valve: power supply terminal - 4.5 ~ 5.5V; others are 0, if there is voltage, circuit has short circuit to power supply fault). Measure resistance of terminal to grounding, in which, standard value of grounding terminal to grounding is less than 3Ω; if too large, there is virtual connection in |

|  |                                                                                                                                                                                                                                                                                                                                                                |
|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>connection part or grounding point; if other terminals resistance too small, there is short circuit to grounding fault in circuit.</p> <p>Measure continuity of each terminal of sensor wiring harness connector and ECM connector, check whether there is open circuit.</p> <p>Check whether ECM power supply circuit and grounding circuit is normal.</p> |
|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## Fault 2: Oxygen sensor heating fault

### 1. Fault code instruction

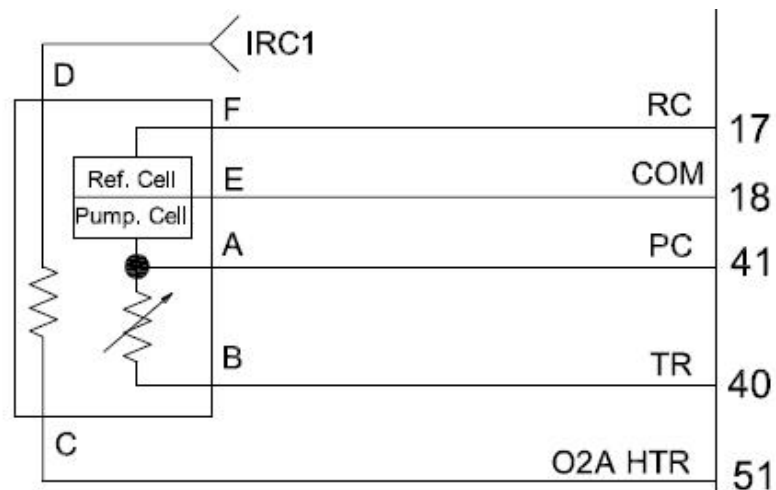
|            |       |                                                          |
|------------|-------|----------------------------------------------------------|
| Fault Code | P0031 | Front oxygen sensor heater short circuit to low voltage  |
| Fault Code | P0032 | Front oxygen sensor heater short circuit to high voltage |
| Fault Code | P0037 | Rear oxygen sensor heater short circuit to low voltage   |
| Fault Code | P0038 | Rear oxygen sensor heater short circuit to high voltage  |

Front oxygen sensor is used to fuel correction control. Front oxygen sensor can work normally only when getting to a certain temperature, thus there are heating components that heat sensor inside each heating type oxygen sensor. ECM controls heating component to work, thus can make system to get into closed loop mode more earlier, let control module calculate air-fuel ratio more earlier. Engine control module instruct heater to be connected or closed, make heating type oxygen sensor keep in specified working temperature.

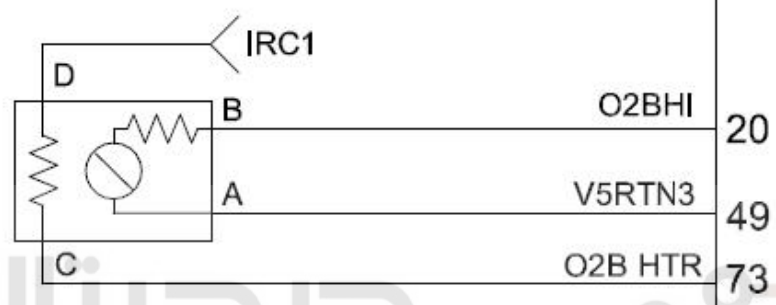
Rear oxygen sensor is used to monitor working state of three-way catalytic converter. Rear oxygen sensor detects oxygen content in exhausting gas, and compare with front oxygen sensor signal, to judge whether three-way catalytic converter is working normally. Rear oxygen sensor also needs heating components to heat sensor.

### 2. Circuit Diagram

Heating type wide-area  
linear front oxygen  
sensor



Heating type rear  
oxygen sensor



### 3. Fault code fault part and solutions

|                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                          |
|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|
| Fault Code                                            | P0031                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Front oxygen sensor heater short circuit to low voltage  |
| Fault Code                                            | P0032                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Front oxygen sensor heater short circuit to high voltage |
| Fault Code                                            | P0037                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Rear oxygen sensor heater short circuit to low voltage   |
| Fault Code                                            | P0038                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Rear oxygen sensor heater short circuit to high voltage  |
| Inspection strategy                                   | Hardware circuit check                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                          |
| Possible causes                                       | Referred failure troubleshooting                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                          |
| Sensor circuit failure<br>Sensor fault<br>ECM failure | <ol style="list-style-type: none"> <li>1. Check whether there is the following conditions that affecting the performance of heating sensor: a) exhaust system blocking or leaking; b) there is water in heating type sensor connector; c) engine running in high temperature, whether exhaust pipe is too red.</li> <li>2. Check the oxygen sensor heater resistance</li> <li>3. Check voltage of power supply</li> <li>4. Check the continuity of the rear oxygen sensor heater</li> </ol> |                                                          |

|  |                                                                                                                         |
|--|-------------------------------------------------------------------------------------------------------------------------|
|  | control terminal                                                                                                        |
|  | 5. Check whether ECM power supply circuit and grounding circuit is normal, if not normal, deal with the fault location. |

### Fault 3: Electronic throttle valve fault

#### 1. Fault code instruction

|            |       |                                          |
|------------|-------|------------------------------------------|
| Fault Code | P0068 | Electronic throttle valve air flow fault |
|------------|-------|------------------------------------------|

Intake manifold absolute pressure (MAP) sensor measures the pressure changes of intake manifold caused by the change of engine load, intake manifold vacuum and rotational speed, and converts these changes into voltage output engine control module (ECM). ECM determines the air volume according to intake pressure and inlet temperature and compares it with the predicted throttle position air flow rate. If ECM detects that the actual air flow is not consistent with the desired air flow rate based on throttle position sensor, DTC P0068 fault will be set.

|            |       |                                                                   |
|------------|-------|-------------------------------------------------------------------|
| Fault Code | P0122 | Electronic throttle valve position sensor 1# circuit low voltage  |
| Fault Code | P0123 | Electronic throttle valve position sensor 1# circuit high voltage |
| Fault Code | P0222 | Electronic throttle valve position sensor 2# circuit low voltage  |
| Fault Code | P0223 | Electronic throttle valve position sensor 2# circuit high voltage |

Electronic throttle valve consists of two position sensors: position sensor 1 and position sensor 2, corresponding to which the two position signals TPS1 / TPS 2 are transported to ECM, refer to chapter 4.3.2.

If a sensor signal is lost, but ECM is still able to receive TPS2 sensor signal normally, then ECU controls engine into "limp home" mode. In this case, engine response to pedal changes is much slower, when driving, you will obviously feel that engine power output is weaker, but still able to drive.

When the TPS signal is grounded, disconnected or shorted to the power supply, the signal is not normal. After the ECM detects this signal, it may report the relevant fault code.



|            |       |                                    |
|------------|-------|------------------------------------|
| Fault Code | P0641 | ETC reference voltage A# amplitude |
| Fault Code | P0651 | ETC reference voltage B# amplitude |

Because ETC uses two throttle position sensors, the 5V reference voltage and the low reference voltage required for normal operation are shared through A and F terminals of the ETC harness connector. If any of the lines fail, the P0641 or P0651 related fault codes will be reported.

|            |       |                                                                        |
|------------|-------|------------------------------------------------------------------------|
| Fault Code | P2135 | Electronic throttle valve position sensor 1#, 2# circuit related fault |
|------------|-------|------------------------------------------------------------------------|

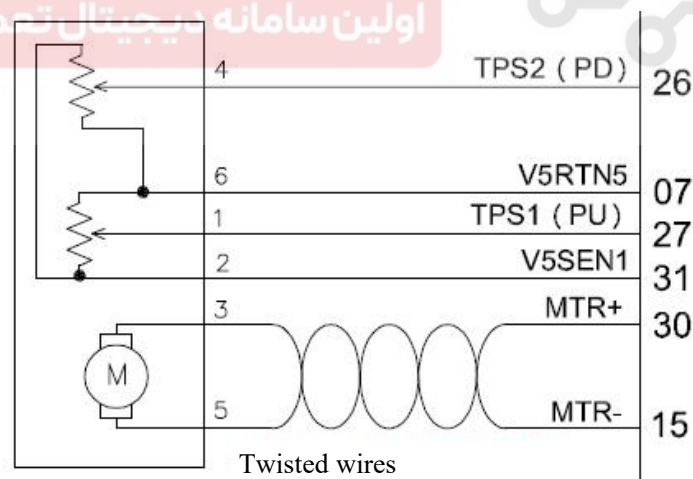
ECM compares input signals of TPS1 sensor with TPS2 sensor. The two input signals add up to 5v at any time. The fault may be reported if ECM detects that the addition of TPS1 and TPS2 signals is quite different from the theoretical value.

|            |       |                                        |
|------------|-------|----------------------------------------|
| Fault Code | P2119 | Electronic throttle valve return fault |
|------------|-------|----------------------------------------|

The electronic throttle stays at the initial angle after the ignition switch is closed. If the throttle is always closed after the ignition switch is closed, the fault code may be recorded. Maybe also there is engine difficult to start and other trouble phenomena.

## 2. Circuit Diagram

Electrical throttle valve



## 3. Fault code fault part and solutions

|            |       |                                                                   |
|------------|-------|-------------------------------------------------------------------|
| Fault Code | P0122 | Electronic throttle valve position sensor 1# circuit low voltage  |
| Fault Code | P0123 | Electronic throttle valve position sensor 1# circuit high voltage |

|                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                   |
|--------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|
| Fault Code                                                                                             | P0222                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Electronic throttle valve position sensor 2# circuit low voltage  |
| Fault Code                                                                                             | P0223                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Electronic throttle valve position sensor 2# circuit high voltage |
| Invalid protection mode                                                                                | If the single TPS fails, the system uses an uninvalidated TPS signal value, and the power output weakens. If the two signals fail at the same time, the system enters engine power management mode and reports the failure of P2106/P2110, VCP not work.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                   |
| Possible causes                                                                                        | Referred failure troubleshooting                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                   |
| 1. Electronic throttle valve failure<br>2. Electronic throttle valve circuit failure<br>3. ECM failure | <p>Turn ignition switch to "OFF", disconnect ETC wiring harness connector and ECM wiring harness connector, and detect conduction of wiring harness between sensor connector and ECM connector. See if there is open circuit in wiring harness;</p> <p>Turn ignition switch to "OFF", disconnect ETC wire harness connector, turn ignition switch to "ON", use multimeter to measure voltage of each terminal of wire harness connector. Normally, power supply terminal and signal terminal have 5V voltage, and grounding terminal is 0V. If there is voltage, the line may be open circuit or short-circuited to high voltage; measure resistance between grounding terminal and battery negative electrode, in normal condition, the resistance should be less than <math>3\Omega</math>. If it is too large, there is virtual connection in connection or grounding point.</p> <p>Refer to 4.3.3 &lt;electronic throttle valve&gt;, check throttle valve circuit, including the conduction and</p> |                                                                   |

|  |                                                                                                                                                 |
|--|-------------------------------------------------------------------------------------------------------------------------------------------------|
|  | power supply condition.<br>Check whether ECM power supply circuit and grounding circuit is normal, if not normal, deal with the fault location. |
|--|-------------------------------------------------------------------------------------------------------------------------------------------------|

|                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                    |
|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| Fault Code                                                                    | P0641                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ETC reference voltage A# amplitude |
| Fault Code                                                                    | P0651                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ETC reference voltage B# amplitude |
| Possible failure part                                                         | Referred failure troubleshooting                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                    |
| 1. Electronic throttle valve<br>2. Electronic throttle valve circuit<br>3.ECM | Turn ignition switch to "OFF", disconnect ETC wire harness connector, turn ignition switch to "ON", measure voltage between power supply terminal and the reliable grounding, the normal value is 4.5-5.5V; measure resistance between grounding terminal and battery negative electrode, the normal value is less than 3Ω. If the resistance is too large, it may be the virtual connection at the junction. Check ECM power supply voltage and grounding circuit |                                    |

|                                                                               |                                                            |                                                                        |
|-------------------------------------------------------------------------------|------------------------------------------------------------|------------------------------------------------------------------------|
| Fault Code                                                                    | P2135                                                      | Electronic throttle valve position sensor 1#, 2# circuit related fault |
| Possible failure part                                                         | Referred failure troubleshooting                           |                                                                        |
| 1. Electronic throttle valve<br>2. Electronic throttle valve circuit<br>3.ECM | Check for possible malfunctions refer to information above |                                                                        |

#### Fault 4: Temperature pressure sensor failure

##### 1. Fault code instruction

|            |       |                                                        |
|------------|-------|--------------------------------------------------------|
| Fault Code | P0072 | Environment temperature sensor circuit low voltage     |
| Fault Code | P0073 | Environment temperature sensor circuit high voltage or |

|  |  |              |
|--|--|--------------|
|  |  | open circuit |
|--|--|--------------|

Environment temperature is installed on the air filter box, and it is used to check the initial intake temperature.

|            |       |                                                                |
|------------|-------|----------------------------------------------------------------|
| Fault Code | P0107 | Intake pressure sensor circuit low voltage or open circuit     |
| Fault Code | P0108 | Intake pressure sensor circuit high voltage                    |
| Fault Code | P0112 | Intake temperature sensor circuit low voltage                  |
| Fault Code | P0113 | Intake temperature sensor circuit high voltage or open circuit |

Intake manifold absolute pressure (MAP) sensor detects pressure change in intake manifold. The pressure changes according to engine load. MAP sensor circuit consists of 5V reference voltage circuit, low reference voltage circuit and sensor signal circuit. Refer to part 2 <Circuit Diagram>

When the absolute pressure of intake manifold is low, the signal voltage detected by ECM should be lower, for example, during idle or deceleration. When the absolute pressure of intake manifold is higher, the signal voltage detected by ECM should be higher, for example, when ignition switch is "ON" and engine is closed, or when throttle valve is fully open.

Both fault codes are detected by circuit, when exceeds lower limit, report P0107; when exceeds upper limit, report P0108. This fault is caused by the sensor signal wire broken or short circuit to power supply and grounding.

There is a signal circuit and a ECM internal grounding circuit in intake temperature pressure sensor. Intake temperature pressure sensor is used to measure air temperature entering into engine. When temperature is cold, the sensor resistance is higher; when the air temperature rises, the sensor resistance decreases. ECM will detect the voltage calibration of the signal circuit of intake temperature pressure sensor. With the decrease of resistance value of the sensor, the voltage of the signal circuit of intake temperature pressure sensor detected by ECM is also reduced.

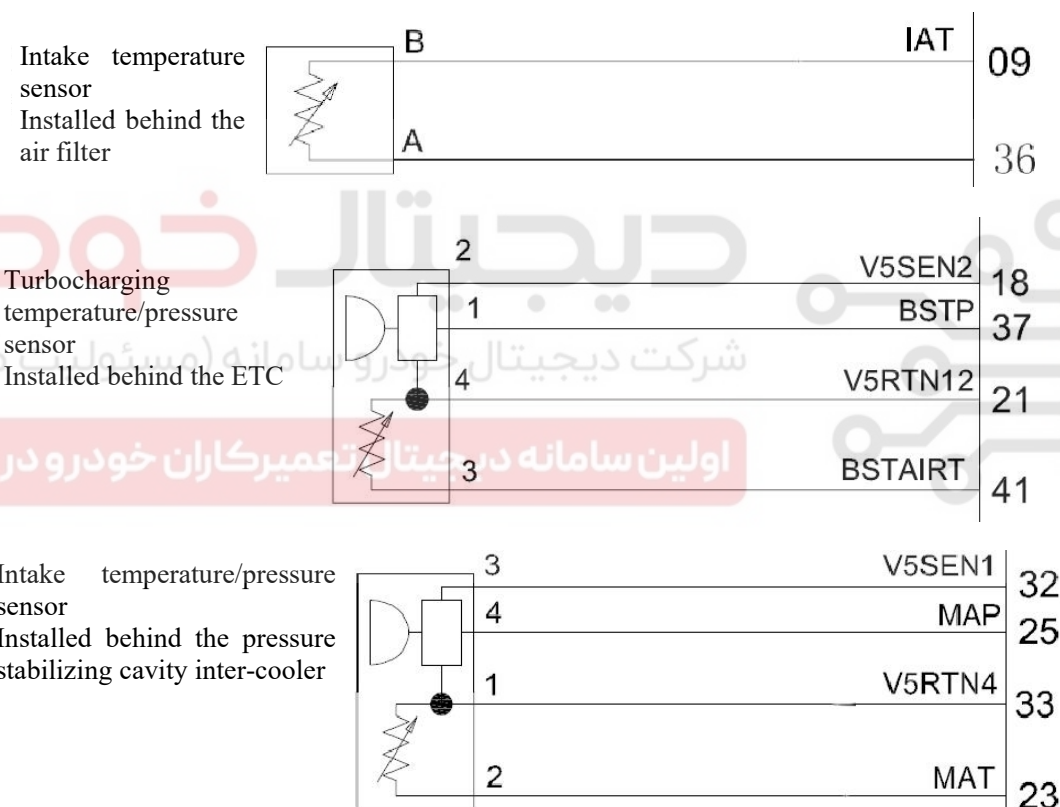
Both P0112 and P0113 detect the voltage value of the signal circuit, when exceed the upper limit, it reports P0113; when exceeds the lower limit, it reports P0112. The two

fault codes are mostly caused by short circuit or open circuit.

|            |       |                                                                |
|------------|-------|----------------------------------------------------------------|
| Fault Code | P0237 | Turbocharging pressure sensor line low voltage or open circuit |
| Fault Code | P0238 | Boost pressure sensor line high voltage                        |
| Fault Code | P0234 | Turbo overcharge                                               |
| Fault Code | P0299 | Turbocharging is insufficient                                  |

Turbo pressure/pressure sensor, is installed on the turbo charging connecting pipe in front of the ETC.

## 2. Circuit Diagram



## 3. Fault code fault part and solutions

|                                                 |       |                                                                                            |  |
|-------------------------------------------------|-------|--------------------------------------------------------------------------------------------|--|
| Fault Code                                      | P0107 | Intake pressure sensor circuit low voltage or open circuit                                 |  |
| Fault Code                                      | P0108 | Intake pressure sensor circuit high voltage                                                |  |
| Possible causes                                 |       | Referred failure troubleshooting                                                           |  |
| Connectors are not plugged in                   |       | Check if there are any the following cases: a) sensor casing is damaged, b) sensor seal is |  |
| Wire harness pressure signal line open circuit  |       |                                                                                            |  |
| Wire harness pressure signal line short circuit |       |                                                                                            |  |

|                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| to grounding<br>5V reference voltage circuit open circuit<br>Sensor signal grounding open circuit<br>Wire harness 5V reference voltage and reference ground line is reversed (this fault may cause damage to sensor)<br>Sensor damaged<br>Failure of MAP signal input interface on ECM | damaged, c) sensor is loose or sensor is not properly installed, d) sensor pipe is blocked<br>Turn ignition switch to "ON", refer to part 3 in this chapter to detect sensor and its circuit;<br>Check whether ECM power supply circuit and grounding circuit is normal. |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|
| Fault Code                                                                                                                                                                                                                                                                                                                                                                                                | P0112                                                                                                                                                                                                                                                                                                                                                                                                                                            | Intake temperature sensor circuit low voltage                  |
| Fault Code                                                                                                                                                                                                                                                                                                                                                                                                | P0113                                                                                                                                                                                                                                                                                                                                                                                                                                            | Intake temperature sensor circuit high voltage or open circuit |
| Inspection strategy                                                                                                                                                                                                                                                                                                                                                                                       | Hardware circuit check                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                |
| Possible causes                                                                                                                                                                                                                                                                                                                                                                                           | Referred failure troubleshooting                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                |
| Connectors are not plugged in<br>Wire harness pressure signal line open circuit<br>Wire harness pressure signal line short circuit to grounding<br>5V reference voltage circuit open circuit<br>Sensor signal grounding open circuit<br>Misalignment of power supply line and grounding wire (this failure may result in sensor damage)<br>Sensor damaged<br>Failure of MAP signal input interface on ECM | 1. Check if there are any the following cases: a) sensor casing is damaged, b) sensor seal is damaged, c) sensor is loose or sensor is not properly installed, d) sensor pipe is blocked<br>2. Turn ignition switch to "ON", refer to part 3 in this chapter to detect sensor and its circuit;<br>3. Check whether ECM power supply circuit and grounding circuit is normal.<br>4. If replace ECM, you must have relevant self-learning in time. |                                                                |



### Fault code 5: Coolant temperature sensor failure

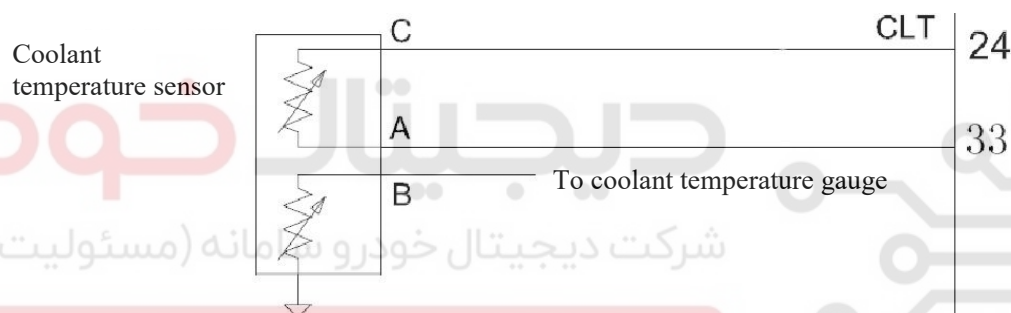
#### 1. Fault code instruction

|            |       |                                                                 |
|------------|-------|-----------------------------------------------------------------|
| Fault Code | P0117 | Coolant temperature sensor circuit low voltage                  |
| Fault Code | P0118 | Coolant temperature sensor circuit high voltage or open circuit |

These two fault codes are judged by detecting the signal voltage in idle condition, most of them are caused by the short circuit or open circuit of coolant temperature sensor.

In the event of failure, coolant temperature will default to a calibrable value varying with running time.

#### 2. Circuit Diagram



#### 3. Fault code fault part and solutions

|                                         |                                                                                                                                                                                     |                                                                 |
|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| Fault Code                              | P0117                                                                                                                                                                               | Coolant temperature sensor circuit low voltage                  |
| Fault Code                              | P0118                                                                                                                                                                               | Coolant temperature sensor circuit high voltage or open circuit |
| Invalid protection mode                 | The system calculates coolant temperature according to inlet temperature of Key_On and engine running time. When there is current failure, the fan is opened at high and low speed. |                                                                 |
| Possible causes                         | Referred failure troubleshooting                                                                                                                                                    |                                                                 |
| 1. Connectors are not plugged in        | 1. Check whether there is corrosion in engine coolant temperature sensor or leakage in engine coolant sensor                                                                        |                                                                 |
| 2. Temperature signal wire open circuit | 2. Turn ignition switch to "OFF", disconnect coolant temperature sensor connector, and check its sensor resistance with reference to third part of this chapter                     |                                                                 |
| 3. Sensor signal                        |                                                                                                                                                                                     |                                                                 |

|                        |                                                                                                                                                                                                              |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| grounding open circuit | 3. Turn ignition switch to "OFF", disconnect coolant temperature sensor connector, use multimeter to measure its wiring conductivity, check whether there is open circuit, short circuit or other phenomena. |
| 4. Sensor damaged      | 4. Check whether ECM power supply circuit and grounding circuit is normal.                                                                                                                                   |

### Fault 6: Oxygen sensor failure

#### 1. Fault code instruction

|            |       |                                                   |
|------------|-------|---------------------------------------------------|
| Fault Code | P0131 | Front oxygen sensor short circuit to low voltage  |
| Fault Code | P0132 | Front oxygen sensor short circuit to high voltage |
| Fault Code | P0133 | front oxygen sensor responds slowly               |
| Fault Code | P0134 | Front oxygen sensor open circuit                  |
| Fault Code | P0137 | Rear oxygen sensor short circuit to low voltage   |
| Fault Code | P0138 | Rear oxygen sensor short circuit to high voltage  |
| Fault Code | P0140 | Rear oxygen sensor open circuit                   |

After vehicle start, the control module works in open loop mode

P0131 and P0132 are judged by detecting whether the signal voltage of oxygen sensor is too high or too low in cold state

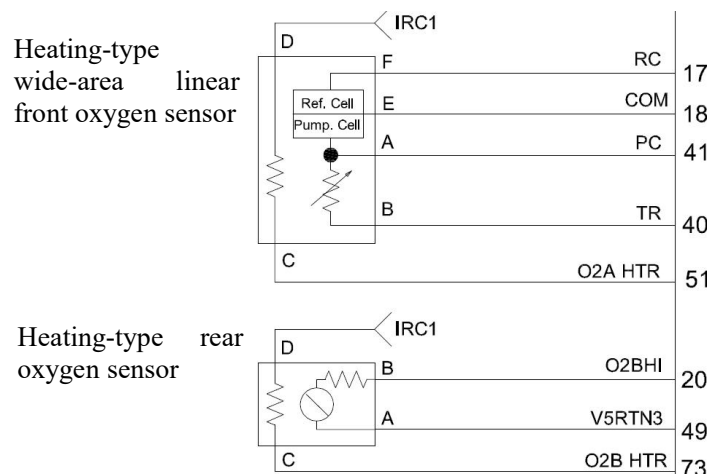
P0134 is judged by detecting whether the signal is open circuit and whether oxygen sensor is high temperature and high resistance.

When detecting engine is hot, the response time to the change in oxygen concentration in the exhaust exceeds the value set by the system, it may report the P0133 fault code.

P0131 and P0132 are judged by detecting whether the signal voltage of oxygen sensor is too high or too low in cold state

P0140 is judged by detecting whether the signal is open circuit and whether oxygen sensor is high temperature and high resistance.

#### 2. Circuit Diagram



### 3. Fault code fault part and solutions

|                                         |                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                   |
|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|
| Fault Code                              | P0131                                                                                                                                                                                                                                                                                                                                                                                                             | Front oxygen sensor short circuit to low voltage  |
| Fault Code                              | P0132                                                                                                                                                                                                                                                                                                                                                                                                             | Front oxygen sensor short circuit to high voltage |
| Fault Code                              | P0134                                                                                                                                                                                                                                                                                                                                                                                                             | Front oxygen sensor open circuit                  |
| Invalid protection mode                 | The system uses fuel open-loop control                                                                                                                                                                                                                                                                                                                                                                            |                                                   |
| Possible causes                         | Referred failure troubleshooting                                                                                                                                                                                                                                                                                                                                                                                  |                                                   |
| 1. Connectors are not plugged in        | 1. After starting engine and warm vehicle, observe output voltage of oxygen sensor and data flow should be in the range of 0.6 ~ 0.7V<br>2. Check appearance of three-way catalytic converter (whether there are signs of overheating at high temperature, lack of gasket, etc.), check whether the appearance of exhaust pipe is in good condition.<br>3. Check whether circuit is open circuit or short circuit |                                                   |
| 2. Temperature signal wire open circuit |                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                   |
| 3. Sensor grounding wire open circuit   |                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                   |
| 4. Sensor damaged                       |                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                   |

|                         |       |                                                  |
|-------------------------|-------|--------------------------------------------------|
| Fault Code              | P0137 | Rear oxygen sensor short circuit to low voltage  |
| Fault Code              | P0138 | Rear oxygen sensor short circuit to high voltage |
| Fault Code              | P0140 | Rear oxygen sensor open circuit                  |
| Invalid protection mode |       |                                                  |

| Possible causes                         | Referred failure troubleshooting                                                                                                                                                                            |
|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Connectors are not plugged in        | 1. After starting engine and warm vehicle, observe output voltage of oxygen sensor and data flow should be in the range of 0.6 ~ 0.7V                                                                       |
| 2. Temperature signal wire open circuit | 2. Check appearance of three-way catalytic converter (whether there are signs of overheating at high temperature, lack of gasket, etc.), check whether the appearance of exhaust pipe is in good condition. |
| 3. Sensor signal grounding open circuit | 3. Check whether circuit is open circuit or short circuit                                                                                                                                                   |
| 4. Sensor damaged                       |                                                                                                                                                                                                             |
| 5. Exhaust system sealing not well      |                                                                                                                                                                                                             |

#### Fault code 7: Fuel system too thick or too thin failure

##### 1. Fault code instruction

|            |       |                                                |
|------------|-------|------------------------------------------------|
| Fault Code | P0171 | Non-idle fuel system is too thin               |
| Fault Code | P0172 | Non-idle fuel system is too thick              |
|            |       | Excessive thick when front oxygen decelerating |
| Fault Code | P1167 | and cutting off fuel                           |
|            |       | Excessive thin when front oxygen accelerating  |
| Fault Code | P1171 | and concentrating                              |
| Fault Code | P2187 | Idle fuel system is too thin                   |
| Fault Code | P2188 | Idle fuel system is too thick                  |

The closed-loop air-fuel ratio measurement system controlled by ECM can achieve the optimal coordination among operating performance, fuel economy and emission control. In closed loop mode, engine control module monitors signal voltage of heating oxygen sensor and adjusts fuel supply according to the signal voltage. The change in fuel supply will change the long-term and short-term fuel adjustment values. Short-term fuel regulation will change rapidly in response to the signal voltage of the heated oxygen sensor. These changes will slightly regulating engine fuel supplying. Long-term fuel regulation is a rough adjustment of fuel supply to return to the central

value of short-term fuel regulation and to restore control of short-term fuel regulation. The ideal fuel adjustment value is about 0%. The positive fuel regulation value indicates that engine control module is adding fuel to compensate for the over dilution of the mixture, while the negative fuel regulation value indicates that the engine control module is reducing the fuel quantity to compensate for the over concentration of the mixture.

The fault codes are judged by detecting fuel correction , when ECM detects that signal voltage of oxygen sensor is higher than 0.55V when engine enters the deceleration oil - breaking condition, or when ECM detects that signal voltage of oxygen sensor is lower than 0.35V when signal voltage of oxygen sensor is higher than 0.35V, and the duration is greater than 12s, the above fault code may be reported .

## 2. Circuit Diagram

Refer to oxygen sensor

## 3. Fault code fault part and solutions

|                                 |                                                                                                                                                                                 |                                                                     |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| Fault Code                      | P0171                                                                                                                                                                           | Non-idle fuel system is too thin                                    |
| Fault Code                      | P0172                                                                                                                                                                           | Non-idle fuel system is too thick                                   |
| Fault Code                      | P1167                                                                                                                                                                           | Excessive thick when front oxygen decelerating and cutting off fuel |
| Fault Code                      | P1171                                                                                                                                                                           | Excessive thin when front oxygen accelerating and concentrating     |
| Fault Code                      | P2187                                                                                                                                                                           | Idle fuel system is too thin                                        |
| Fault Code                      | P2188                                                                                                                                                                           | Idle fuel system is too thick                                       |
| Possible failure part           | Referred failure troubleshooting                                                                                                                                                |                                                                     |
| 1. Fuel injector does not work. | Turn ignition switch to "OFF", connect diagnosis device, start vehicle, and check intake pressure data flow and intake pressure sensor according to the part 3 in this chapter. |                                                                     |
| 2. There is leakage in inlet    |                                                                                                                                                                                 |                                                                     |
|                                 | 2. Start vehicle, check opening degree of throttle valve refer to                                                                                                               |                                                                     |

|                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| system                                  | third part of this chapter, and if abnormal, check the sensor                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 3. Front oxygen sensor works abnormally | <p>3. Observe data flow of front oxygen sensor refer to third part of this chapter, and detect it if it is abnormal</p> <p>4. Start vehicle, warm engine, use diagnostic device to observe if long-term fuel correction parameters are normal</p> <p>5. Check leakage condition, including intake manifold, throttle valve, fuel injector and crankcase ventilation system</p> <p>6. Check fuel system, including fuel injectors, fuel pumps and other fuel system lines, etc.</p> <p>7. Check whether there is collapses or blockages in intake pipes</p> |

### Fault code 8: Fuel pump relay failure

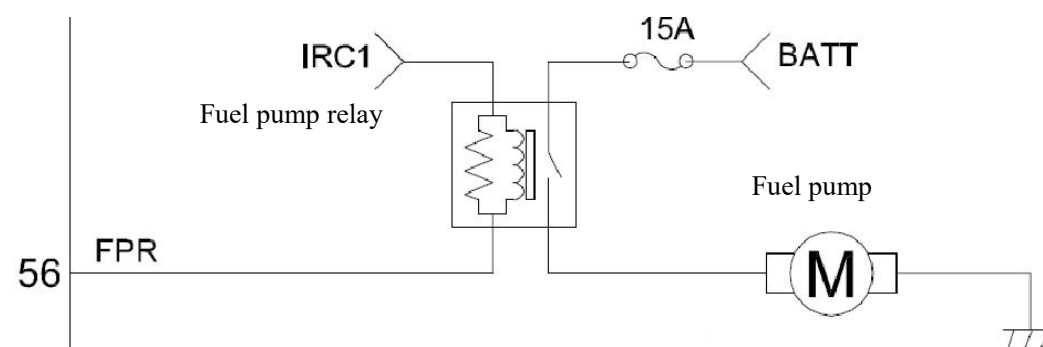
#### 1. Fault code instruction

|            |       |                       |
|------------|-------|-----------------------|
| Fault Code | P0230 | Fuel pump relay fault |
|------------|-------|-----------------------|

Working power supply of oil pump relay coil is supplied by ECM, ECM controls actuation of relay. There is a detection circuit inside ECM, ECM determines whether control circuit is open circuit, short circuit to grounding or short circuit to voltage by monitoring the feedback voltage.

This fault code may be reported when ignition switch is ON , the opening time is greater than the system set threshold , the fuel pump relay voltage is too high or too low.

#### 2. Circuit Diagram



#### 3. Fault code fault part and solutions



|                            |                                                                                                                                                                                                                 |                       |
|----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Fault Code                 | P0230                                                                                                                                                                                                           | Fuel pump relay fault |
| Possible failure part      | Referred failure troubleshooting                                                                                                                                                                                |                       |
| 1. Relay circuit damaged   | 1. Check if fuel pump fuse is good.<br>2. Check fuel pump fuse circuit, repair fuel pump circuit to ground short circuit fault<br>3. Check supply terminal voltage of fuel pump relay, standard value: 11 ~ 14V |                       |
| 2. Fuel pump relay failure | 4. Check resistance between grounding terminal of fuel pump relay and grounding point, standard value: less than 1Ω                                                                                             |                       |
| 3. ECM damage              | 5. Check conductivity of relay terminals and ECU terminals<br>6. Check whether ECU power supply circuit and grounding circuit is normal.<br>7. Check if fuel pump fuse is good.                                 |                       |

### Fault code 9: Fuel injector wire failure

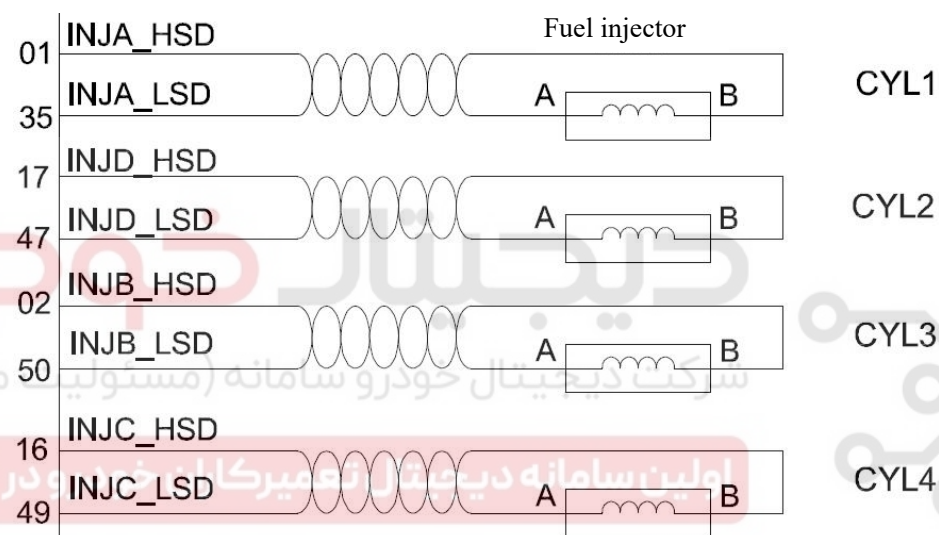
#### 1. Fault code instruction

|            |       |                                                                                    |
|------------|-------|------------------------------------------------------------------------------------|
| Fault Code | P0261 | 1 <sup>st</sup> cylinder fuel injector circuit low end current too low             |
| Fault Code | P0262 | 1 <sup>st</sup> cylinder fuel injector circuit low end current too high            |
| Fault Code | P0264 | 2 <sup>nd</sup> cylinder fuel injector circuit low end current too low             |
| Fault Code | P0265 | 2 <sup>nd</sup> cylinder fuel injector circuit low end current too high            |
| Fault Code | P0267 | 3 <sup>rd</sup> cylinder fuel injector circuit low end current too low             |
| Fault Code | P0268 | 3 <sup>rd</sup> cylinder fuel injector circuit low end current too high            |
| Fault Code | P0270 | 4 <sup>th</sup> cylinder fuel injector circuit low end current too low             |
| Fault Code | P0271 | 4 <sup>th</sup> cylinder fuel injector circuit low end current too high            |
| Fault Code | P2147 | Fuel injector power supply circuit A high end (1st, 4th cylinder) current too high |
| Fault Code | P2148 | Fuel injector power supply circuit A high end (1st, 4th cylinder) current too low  |

|            |       |                                                                                    |
|------------|-------|------------------------------------------------------------------------------------|
| Fault Code | P2149 | Fuel injector power supply circuit A high end (2nd, 3rd cylinder) current too high |
| Fault Code | P2150 | Fuel injector power supply circuit A high end (2nd, 3rd cylinder) current too low  |

The working voltage of fuel injector is provided by the main relay, ECM provides internal grounding. ECM monitors the state of each driving circuit. If ECM detects incorrect voltage corresponding to the instruction state of drive circuit, fault diagnosis code for the control circuit of fuel injector will be set up.

## 2. Circuit Diagram



## 3. Fault code fault part and solutions

|            |       |                                                                                    |
|------------|-------|------------------------------------------------------------------------------------|
| Fault Code | P0261 | 1 <sup>st</sup> cylinder fuel injector circuit low voltage fault                   |
| Fault Code | P0262 | 1 <sup>st</sup> cylinder fuel injector circuit high voltage fault                  |
| Fault Code | P0264 | 2 <sup>nd</sup> cylinder fuel injector circuit low voltage fault                   |
| Fault Code | P0265 | 2 <sup>nd</sup> cylinder fuel injector circuit high voltage fault                  |
| Fault Code | P0267 | 3 <sup>rd</sup> cylinder fuel injector circuit low voltage fault                   |
| Fault Code | P0268 | 3 <sup>rd</sup> cylinder fuel injector circuit high voltage fault                  |
| Fault Code | P0270 | 4 <sup>th</sup> cylinder fuel injector circuit low voltage fault                   |
| Fault Code | P0271 | 4 <sup>th</sup> cylinder fuel injector circuit high voltage fault                  |
| Fault Code | P2147 | Fuel injector power supply circuit A high end (1st, 4th cylinder) current too high |

|                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                    |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| Fault Code                | P2148                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Fuel injector power supply circuit A high end (1st, 4th cylinder) current too low  |
| Fault Code                | P2149                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Fuel injector power supply circuit A high end (2nd, 3rd cylinder) current too high |
| Fault Code                | P2150                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Fuel injector power supply circuit A high end (2nd, 3rd cylinder) current too low  |
| Possible failure part     | Referred failure troubleshooting                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                    |
| 1. Sensor circuit damaged | 1. Check whether there is damage, bad contact, ageing or looseness in fuel injector wiring harness connector<br>2. Disconnect fuel injector wiring harness connector and measure resistance between two terminals according to the part 3 in this chapter.<br>3. According to the part 3 in this chapter, turn ignition switch "ON", disconnect fuel injector wire harness connector, and measure the voltage between power supply terminal and the reliable grounding, standard value: 11-14V<br>4. Refer to the relevant part of third part of this chapter, turn ignition switch to "ON", disconnect fuel injector wiring harness connector, and connect the light emitting diode test lamp to the two terminals of the fuel injector wiring harness, start engine to see if the test lights flicker normally<br>5. Trouble shooting failure of power supply circuit of fuel injector<br>6. Check whether ECU power supply circuit and grounding circuit is normal. |                                                                                    |
| 2. Fuel injector damage   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                    |
| 3. ECM damage             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                    |

### Fault code 10: Miss fire failure

#### 1. Fault code instruction

|            |       |                                             |
|------------|-------|---------------------------------------------|
| Fault Code | P0300 | Single cylinder or multi-cylinder miss fire |
|------------|-------|---------------------------------------------|

Ignition control system is mainly composed of sensors, ECM and actuators.

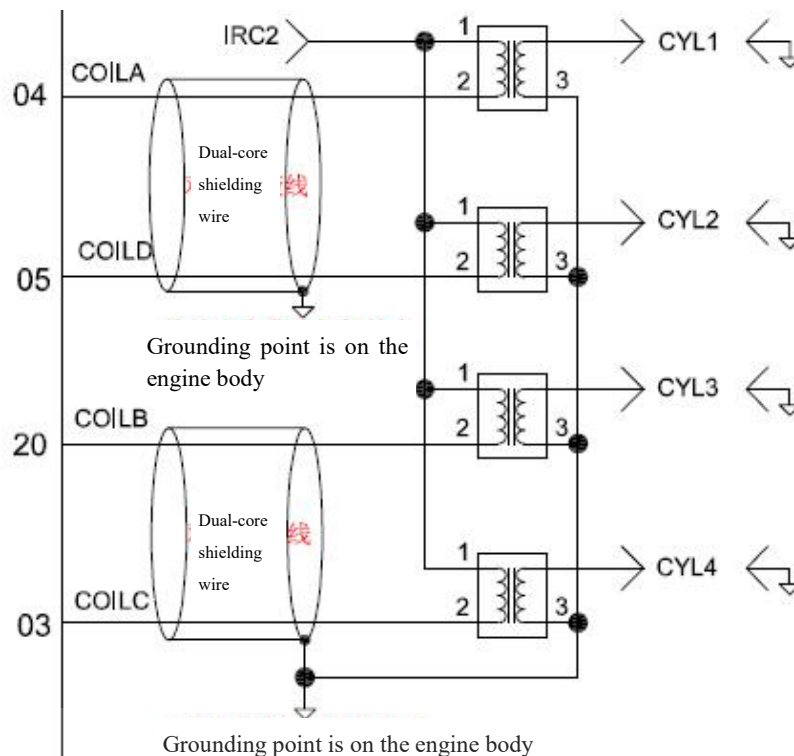
The sensors related to ignition control include crankshaft position sensor, inlet pressure temperature sensor, coolant temperature sensor, throttle valve position sensor and so on. The optimal ignition advance angle of engine at different speeds and loads is stored in the memory of ECM in advance. In actual running of engine, measure engine load and engine speed signal according to intake pressure temperature sensor and crankshaft position sensor, read ignition advance angle in corresponding working condition from RAM, and then measure engine other running parameters according to coolant temperature sensor and throttle valve position sensor, correct the selected ignition advance angle, thus to ensure optimal ignition advance angle in any running condition.

ECM uses information from crankshaft position sensor and camshaft position sensor to judge whether engine miss fire. If some cylinder works abnormally, ECM can monitor changes of crankshaft rotational speed. It is by monitoring the change of crankshaft rotation speed in the process of work that which cylinder is miss fire can be calculated. If there is miss fire, the uncombustion combustible mixture in cylinder is discharged from exhaust system, and finally consumed in three-way catalytic converter, which will cause the converter to overheat and damage three-way catalytic converter seriously.

In steady working condition, when ECM detected fluctuation amplitude of crankshaft rotation velocity exceeds the threshold set by the system, there is no emergency control scheme when the fire level is low, and only fault code and data stream are recorded. When the fire level is too high, it is forced to enter the open loop control condition of fuel oil, and the learning of oxygen dressing is prohibited.

## 2. Circuit Diagram

Ignition system



### 3. Fault code fault part and solutions

| Fault Code                                                           | P0300                                                                                                                                                                                                                               | Single cylinder or multi-cylinder miss fire |
|----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|
| Invalid protection mode                                              | Damaged fire fault of catalytic converter, the system uses fuel open loop control, and under certain working conditions, the fault lamp flashes.                                                                                    |                                             |
| Possible failure part                                                | Referred failure troubleshooting                                                                                                                                                                                                    |                                             |
| 1. Looseness or poor contact of fuel injector wire harness connector | Check whether there is damage, bad contact, ageing or looseness in wiring harness connector                                                                                                                                         |                                             |
| 2. Breathing hose crack or loosen                                    | Check whether there is incorrect connection or leakage phenomenon in carbon canister solenoid valve connecting pipe, crankcase ventilation system, air intake system.                                                               |                                             |
| 3. Ignition system                                                   | Check spark plug refer to the relevant part of third part of this chapter, mainly including spark plug clearance, whether there is electrode ablation, damage, or whether there is wet part in spark plug skirt and electrode, etc. |                                             |
| 4. Fuel injector                                                     |                                                                                                                                                                                                                                     |                                             |
| 5. Fuel pressure                                                     |                                                                                                                                                                                                                                     |                                             |
| 6. Air inlet pressure sensor                                         |                                                                                                                                                                                                                                     |                                             |
| 7. Coolant temperature sensor                                        |                                                                                                                                                                                                                                     |                                             |

|                               |                                                                                   |
|-------------------------------|-----------------------------------------------------------------------------------|
| 8. Cylinder pressure          | Check arcing condition of spark plug.                                             |
| 9. Valve clearance and timing | Check cylinder pressure                                                           |
| 10. EVAP                      | Check whether ignition coil, injector or ECM connecting wiring harness is correct |
| 11. Air inlet system          | Check whether valve clearance and valve timing is correct                         |
| 12. Exhaust system clog       | Refer to DTC 2 to check inlet temperature pressure sensor                         |
|                               | Check whether ECM power supply circuit and grounding circuit is normal.           |

**Note:**

If control system stores faults other than miss fire faults, these faults should be eliminated first.

If vehicle has been tested for a long period of time but the fault stores a fault diagnosis code associated with miss fire, the failure may have been caused by the following reasons:

The fuel tank is overfull and the fuel enters the evaporative emission control system, causing the mixture to be too dense and resulting in miss fire.

Improper use of fuel may lead to poor combustion and lead to miss fire.

Smouldering of spark plug caused ignition failure and lead to miss fire.

**Fault code 11: Knock sensor failure****1. Fault code instruction**

|            |       |                              |
|------------|-------|------------------------------|
| Fault Code | P0324 | Knock control system failure |
| Fault Code | P0325 | Knock sensor failure         |

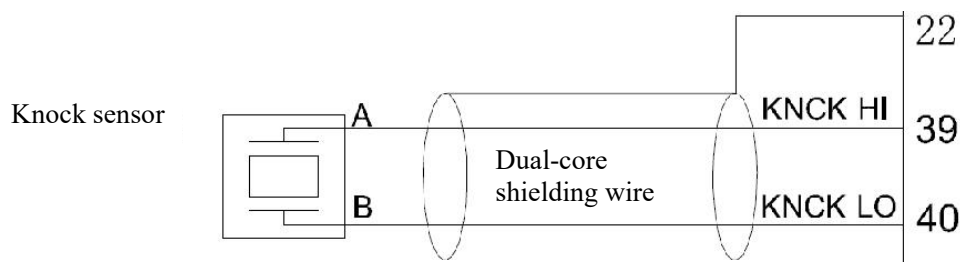
The feedback signal of knock sensor to ECM can make the control of ignition timing of ECM reach the most ideal state, and ignition system achieve the best performance, and also to prevent engine from being damaged by knock. The AC signal voltage generated by knock sensor varies with the vibration of engine. Engine control module



regulates spark timing according to the amplitude and frequency of knock sensor signal.

At a certain load state, any terminal of the signal line may report a knock control system failure.

## 2. Circuit Diagram



## 3. Fault code fault part and solutions

|                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                              |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| Fault Code                | P0324                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Knock control system failure |
| Fault Code                | P0325                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Knock sensor failure         |
| Invalid protection mode   | Quit ignition coil                                                                                                                                                                                                                                                                                                                                                                                                                                          |                              |
| Possible failure part     | Referred failure troubleshooting                                                                                                                                                                                                                                                                                                                                                                                                                            |                              |
| 1. Sensor circuit damaged | Check whether there is physical damage in sensor, whether there is correct installation, burrs, flashes and foreign objects on the mounting surface.<br>Disconnect sensor wire harness connector and detect knock sensor according to the part 3 in this chapter<br>Measure conductive of sensor and ECM connecting wiring harness, check whether there is open circuit and short circuit condition<br>Check ECM power supply voltage and grounding circuit |                              |
| 2. Sensor damaged         |                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                              |
| 3. ECM damage             |                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                              |

## Fault code 12: Crankshaft position sensor failure

### 1. Fault code instruction

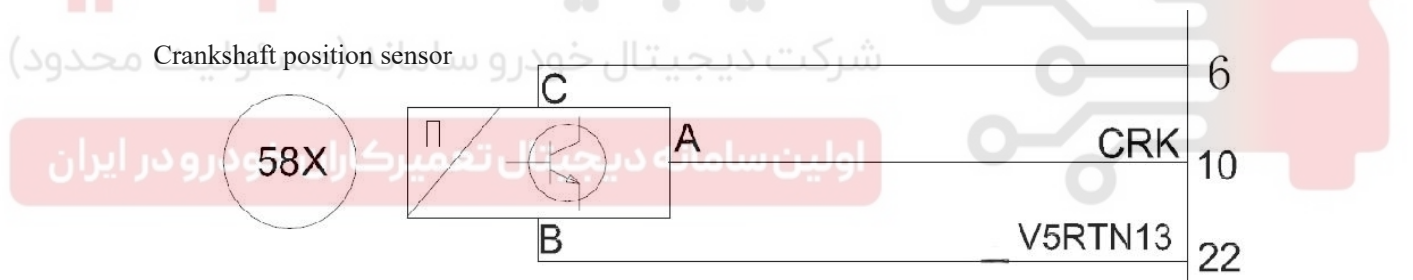
|            |       |                                              |
|------------|-------|----------------------------------------------|
| Fault Code | P0335 | Crankshaft position sensor circuit no signal |
|------------|-------|----------------------------------------------|

|            |       |                                                     |
|------------|-------|-----------------------------------------------------|
| Fault Code | P0336 | Crankshaft position sensor circuit signal interfere |
| Fault Code | P1336 | 58 tooth gear wheel error not learning              |

Crankshaft position sensor signal tells ECM the current crankshaft speed and position. The crankshaft position sensor produces an alternating voltage signal with different amplitudes and frequencies depending on the crankshaft speed. Work with a fixed 58x variable-reluctance rotor on the crankshaft. According to input signal of crankshaft position sensor and camshaft position sensor, ECM can calculate ignition timing, fuel injection timing and knock ignition control. Crankshaft position sensors are also used to detect fire deficiency.

During starting, crankshaft position sensor is disconnected, short-circuited to the ground, and may report P0335 fault when the power supply is short-circuited. When clearance between crankshaft position sensor and signal gear ring is too large or too small, the actual number of teeth identified by the system is not equal to 58 teeth.

## 2. Circuit Diagram



## 3. Fault code fault part and solutions

|                         |                                                                                                                                                 |                                                     |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|
| Fault Code              | P0335                                                                                                                                           | Crankshaft position sensor circuit no signal        |
| Fault Code              | P0336                                                                                                                                           | Crankshaft position sensor circuit signal interfere |
| Invalid protection mode | P0335-Engine can't start<br>P0336-quit ignition angel, VCP not work                                                                             |                                                     |
| Possible failure part   | Referred failure troubleshooting                                                                                                                |                                                     |
| 1. Sensor circuit       | Check whether there is loosening or bad contact in sensor wiring harness connector, whether sensor installation is right or clearance is right. |                                                     |
| 2. Sensor               |                                                                                                                                                 |                                                     |
| 3.ECM                   |                                                                                                                                                 |                                                     |
| 4. Sensor signal wheel  | Measure open circuit and short circuit condition of wiring                                                                                      |                                                     |

|  |                                                                                                                                                                                                                                           |
|--|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | harness of sensor and ECM<br>Refer to detecting sensor in third part of the chapter<br>Check whether there is damage or lack in signal wheel tooth, whether installation is right<br>Check ECM power supply circuit and grounding circuit |
|--|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                   |
|--------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|
| Fault Code                                                         | P0340                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Camshaft position sensor circuit no signal        |
| Fault Code                                                         | P0341                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Camshaft position sensor line signal interference |
| Possible failure part                                              | Referred failure troubleshooting                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                   |
| 1. Sensor circuit<br>2. Sensor<br>3. ECM<br>4. Sensor signal wheel | Check whether there is loosening or bad contact in sensor wiring harness connector, whether sensor installation is right or clearance is right.<br>Measure open circuit and short circuit condition of wiring harness of sensor and ECM<br>Refer to detecting sensor in third part of the chapter<br>Check whether there is damage or lack in signal wheel tooth, whether installation is right<br>Check ECM power supply circuit and grounding circuit |                                                   |

### Fault code 13: Ignition coil failure

#### 1. Fault code instruction

|            |       |                                                |
|------------|-------|------------------------------------------------|
| Fault Code | P0351 | 1 <sup>st</sup> cylinder ignition coil failure |
| Fault Code | P0352 | 2 <sup>nd</sup> cylinder ignition coil failure |
| Fault Code | P0353 | 3 <sup>rd</sup> cylinder ignition coil failure |
| Fault Code | P0353 | 3 <sup>rd</sup> cylinder ignition coil failure |

In idle condition, ignition coil control terminal is disconnected, connected with ground or voltage, and the fault code is reported. The cylinder of the fault code will stop injecting, because the cylinder will cause the engine speed to fluctuate.

#### 2. Circuit Diagram

Refer to fault code 10

### 3. Fault code fault part and solutions

|                          |                                                                                             |                                                |
|--------------------------|---------------------------------------------------------------------------------------------|------------------------------------------------|
| Fault Code               | P0351                                                                                       | 1 <sup>st</sup> cylinder ignition coil failure |
| Fault Code               | P0352                                                                                       | 2 <sup>st</sup> cylinder ignition coil failure |
| Fault Code               | P0353                                                                                       | 3 <sup>st</sup> cylinder ignition coil failure |
| Fault Code               | P0353                                                                                       | 3 <sup>st</sup> cylinder ignition coil failure |
| Invalid protection mode  | Long time failure, report miss fire fault code P0300                                        |                                                |
| Possible failure part    | Referred failure troubleshooting                                                            |                                                |
| 1. Ignition coil circuit | Check whether there is loosening or bad contact in ignition coil wiring harness connector   |                                                |
| 2. Ignition coil         | Measure open circuit and short circuit condition of wiring harness of ignition coil and ECM |                                                |
| 3. ECM                   | Refer to the third part of this chapter to detect the ignition coil                         |                                                |
|                          | Check ECM power supply circuit and grounding circuit                                        |                                                |

### Fault code 14: Catalytic converter fault

#### 1. Fault code instruction

|            |       |                                        |
|------------|-------|----------------------------------------|
| Fault Code | P0420 | Catalytic converter is too inefficient |
|------------|-------|----------------------------------------|

ECM uses two oxygen sensors installed in front of and behind the three-way catalytic converter to monitor conversion efficiency. ECM uses front oxygen sensor to control air-fuel ratio and monitors the oxygen content of the unpurified exhaust gas at the same time. The oxygen content of the purified gas is transmitted to ECM by the voltage signal of rear oxygen sensor. ECM calculates whether catalytic converter is in normal working condition by comparing the signals of front and rear oxygen sensor.

#### 2. Circuit Diagram

Refer to fault code 6

#### 3. Fault code fault part and solutions

|                                  |                                                                                              |                                        |
|----------------------------------|----------------------------------------------------------------------------------------------|----------------------------------------|
| Fault Code                       | P0420                                                                                        | Catalytic converter is too inefficient |
| Possible failure part            | Referred failure troubleshooting                                                             |                                        |
| 1. Front oxygen sensor           | Check whether there is loosening or bad contact in sensor wiring harness connector           |                                        |
| 2. Rear oxygen sensor            | Check output voltage of front and rear oxygen sensor according to the part 3 in this chapter |                                        |
| 3. Three-way catalytic converter | Refer to the part 3 in this chapter to check oxygen sensor                                   |                                        |
| 4. Exhaust gas leaking           | Check whether exhaust gas leaking                                                            |                                        |

### Fault code 15: Carbon canister solenoid valve failure

#### 1. Fault code instruction

|            |       |                                                                                    |
|------------|-------|------------------------------------------------------------------------------------|
| Fault Code | P0458 | Carbon canister electromagnetic valve short circuit to low voltage or open circuit |
| Fault Code | P0459 | Carbon canister electromagnetic valve short circuit to high voltage                |

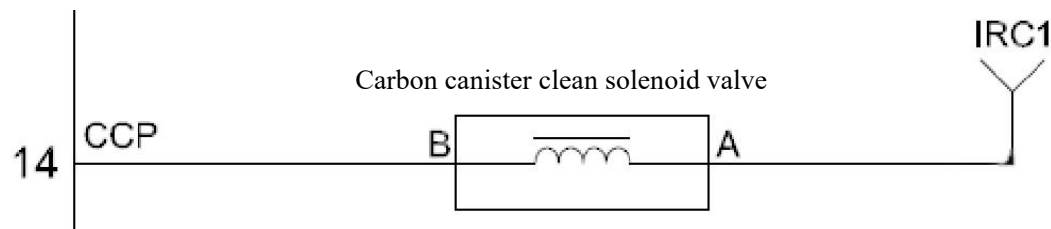
The function of solenoid valve is to inhale adsorbed fuel vapor from carbon canister into intake manifold by opening and closing the intake passage. The opening of solenoid valve in carbon canister is controlled by duty cycle signal. The circuit is composed of:

Working voltage: battery passes through main relay to A terminal of solenoid valve harness connector of carbon canister

ECM control circuit: carbon canister solenoid valve harness connector B terminal is connected to ECM pin-14. There is a drive circuit to control the solenoid valve grounding inside ECM. There is feedback circuit in ECM, engine ECM confirms whether is open circuit, short circuit to grounding or short circuit to voltage through monitored feedback signal.

Carbon canister solenoid valve is grounded or disconnected, P0458 fault code may be reported. Control terminal of carbon canister solenoid valve is short circuit to power supply, may report this fault code.

## 2. Circuit Diagram



## 3. Fault code fault part and solutions

|                                   |                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                    |
|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| Fault Code                        | P0458                                                                                                                                                                                                                                                                                                                                                                                                      | Carbon canister electromagnetic valve short circuit to low voltage or open circuit |
| Fault Code                        | P0459                                                                                                                                                                                                                                                                                                                                                                                                      | Carbon canister electromagnetic valve short circuit to high voltage                |
| Possible failure part             | Referred failure troubleshooting                                                                                                                                                                                                                                                                                                                                                                           |                                                                                    |
| 1. Carbon canister solenoid valve | Connect fault diagnosis device, disconnect solenoid valve from activated carbon canister to vacuum tube of activated carbon tank, start engine, open diagnostic device, and enter "action test" to control related of carbon canister solenoid valve. Open solenoid valve of carbon canister with diagnostic device, cover vacuum interface of solenoid valve with finger, check whether there is suction. |                                                                                    |
| 2. Solenoid valve                 | Check whether there is open circuit or short circuit in connection between ECM and solenoid valve wiring harness.                                                                                                                                                                                                                                                                                          |                                                                                    |
| 3. ECM                            | Switch ignition switch to "OFF", disconnect wire harness connector, and measure resistance between the two terminals of the solenoid valve, standard value is $(22.5 \pm 1.5) \Omega$ .                                                                                                                                                                                                                    |                                                                                    |
|                                   | Check ECM power supply circuit and grounding circuit                                                                                                                                                                                                                                                                                                                                                       |                                                                                    |

**Fault 16: Fan fault**

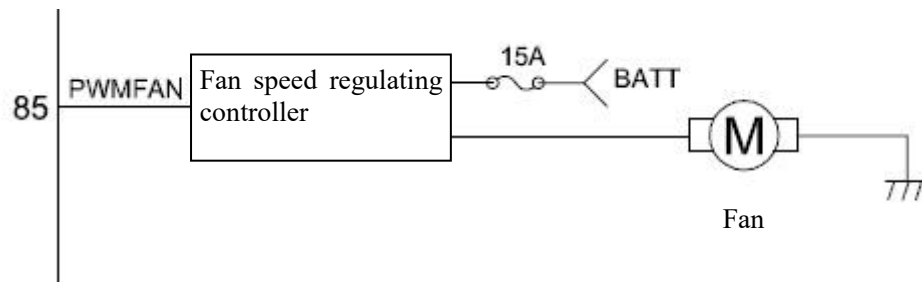
## 1. Fault code instruction

|            |       |                        |
|------------|-------|------------------------|
| Fault Code | P0480 | Low speed fan failure  |
| Fault Code | P0481 | High speed fan failure |



Main relay controller by ECM supplies power supply for cooling fan high/low speed coil. There is a drive circuit to control the relay coil grounding inside ECM. There is feedback circuit in ECM, engine ECM confirms whether is open circuit, short circuit to grounding or short circuit to voltage through monitored feedback signal.

## 2. Circuit Diagram



## 3. Fault code fault part and solutions

|                       |                                                                                                                            |                        |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------|------------------------|
| Fault Code            | P0480                                                                                                                      | Low speed fan failure  |
| Fault Code            | P0481                                                                                                                      | High speed fan failure |
| Possible failure part | Referred failure troubleshooting                                                                                           |                        |
| 1. Relay              | Confirm wiring harness connecting to ECM and cooling fan is normal<br>Check ECM power supply circuit and grounding circuit |                        |
| 2. Relay circuit      |                                                                                                                            |                        |
| 3. ECM                |                                                                                                                            |                        |
| 4. Cooling fan        |                                                                                                                            |                        |

## Fault 17: Idling fault

### 1. Fault code instruction

|            |       |                              |
|------------|-------|------------------------------|
| Fault Code | P0506 | Idling engine speed too low  |
| Fault Code | P0507 | Idling engine speed too high |

Throttle valve actuator control motor is controlled by engine control module (ECM). The DC motor in the throttle drives the throttle slice inside the throttle valve. ECM calculates and controls engine idle speed according to coolant temperature, speed compensation, deceleration adjustment, air conditioning compensation, voltage compensation.

ECM judges whether idle speed is normal according to current idling speed and offset of target idling speed.

## 2. Circuit Diagram

Refer to fault code 3

## 3. Fault code fault part and solutions

|                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                              |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| Fault Code            | P0506                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Idling engine speed too low  |
| Fault Code            | P0507                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Idling engine speed too high |
| Possible failure part | Referred failure troubleshooting                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                              |
| 1. Throttle valve     | <p>Check whether generator is working properly: use diagnostic device to observe whether voltage parameter of the system is normal</p> <p>Check intake pressure sensor: refer to related part in third part of the chapter</p> <p>Check condition of A/C: when A/C is ON, check idle speed increase, the standard value is about 150 rpm</p> <p>Check intake, exhaust system: check whether there is blockage, leakage, throttle, excessive carbon deposition</p> <p>Check engine mechanical drive, accessory drive: whether generator belt is loose, remove belt, in neutral position, rotate crankshaft to see if there is lag, rotate related belt wheel to see if there is lag</p> <p>Check ECM power supply circuit and grounding circuit</p> |                              |
| 2. Air inlet system   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                              |
| 3. Exhaust system     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                              |
| 4. ECM                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                              |

**Fault code 18: System voltage failure**

## 1. Fault code instruction

|            |       |                                |
|------------|-------|--------------------------------|
| Fault Code | P0562 | The system voltage is too low. |
| Fault Code | P0563 | The system voltage is too high |

Power supply circuit is a kind of power supply circuit that is suitable for power supply circuit of ECM, sensor and actuator, including power supply circuit of ECM, and power supply circuit of sensor.

1) Power supply of ECM is divided into two kinds: one is power supply needed for

normal operation of ECM, which is called working power supply; the other is to turn off the ignition switch so that the memory of ECM can memory fault code and other information for a long time, called a constant power supply.

Working power supply is power supply of battery positive pole through ECM fuse of engine and main relay into ECM. The power supply is also connected to the actuators, sensors or other electrical components of the electronic control system. When ignition switch in ON, working power supply is sent into ECM to make ECM start, and enter into the working state. If circuit fails to provide power supply to ECM, engine will not start and run, and ECM will not be able to establish connection to fault diagnosis instrument to complete the fault diagnosis.

There are two control modes of working power supply, one is ignition switch control and the other is ECM control, the purpose of which is to ensure the conduction of power supply circuit after ignition switch is ON, provide power supply for ECM and other parts of electronic control system; after ignition switch is ON, power supply circuit is cut off by ECM control delay, which makes ECM complete the storage of relevant data.

The following figure shows ECU control of power circuit schematic diagram. When ignition switch is in "ST", battery positive electrode ignition switch is connected to ECM-10 pin, at this time, supply software starting and initializing required power supply for ECM, making it complete system software starting; main relay of ECM control circuit to start to work, electromagnetic coil of main relay provide power supply, making relay switch contacts are closed, and making battery power supply enter into ECM (3#, 5# and 76# terminal), as the main working power supply, When ignition switch in "IG", battery positive electrode enters into ECM 10# pin, as ignition signal.

The constant power circuit is power supply that is directly applied to the ECM after battery passing positive fuse without ignition switch, such as the ECM 2# pin as shown in figure below. Its function is to turn off ignition switch so that the working power of ECM is cut off, so that ECM RAM still has power to save the fault code, fuel correction factor and other data stored in RAM. Without this power supply, as

3) Power supply circuit of actuator There are also two kinds of actuator of electronic control systems, one is to use the 12V voltage of vehicle battery directly, the other is to use provided by ECM.

3) Power supply circuit of actuator There are also two kinds of actuator of electronic control systems, one is to use the 12V voltage of vehicle battery directly, the other is to use provided by ECM.

2. Circuit Diagram



## 3. Fault code fault part and solutions

|                             |                                                                                                                                        |                              |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| Fault Code                  | P0506                                                                                                                                  | Idling engine speed too low  |
| Fault Code                  | P0507                                                                                                                                  | Idling engine speed too high |
| Possible failure part       | Referred failure troubleshooting                                                                                                       |                              |
| 1. ECM power supply circuit | Check the related fuse<br>Check ECM power supply voltage<br>Check whether the related wiring harness of power supply circuit is normal |                              |
| 2. Generator                | Check charging system: battery voltage 11-14V, charging voltage 11-15V, check whether charging system related wiring harness is normal |                              |
| 3. ECM                      | Check ECM power supply circuit and grounding circuit                                                                                   |                              |

**Fault 19: Electronic accelerator pedal fault**

## 1. Fault code instruction

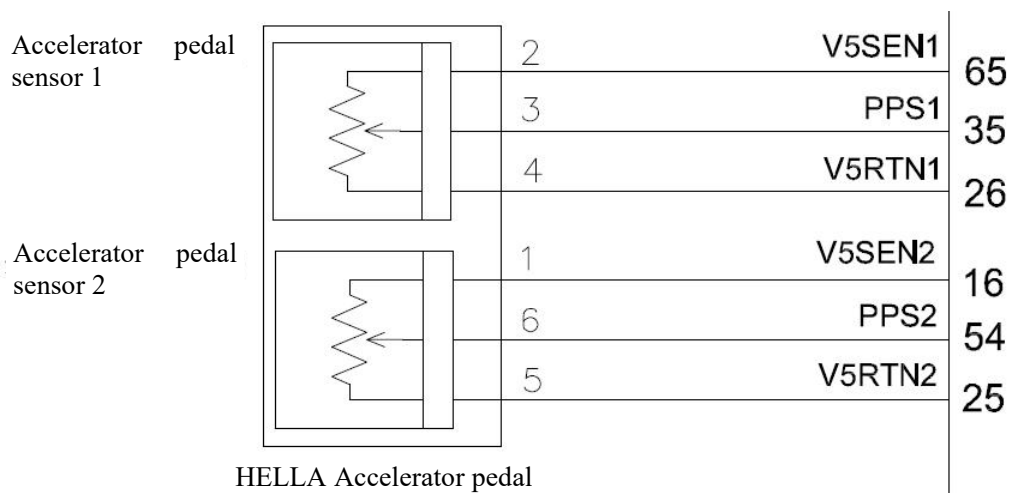
|            |       |                                                                      |
|------------|-------|----------------------------------------------------------------------|
| Fault Code | P2122 | Electronic accelerator pedal position sensor 1# circuit low voltage  |
| Fault Code | P2123 | Electronic accelerator pedal position sensor 1# circuit high voltage |
| Fault Code | P2127 | Electronic accelerator pedal position sensor 2# circuit low voltage  |
| Fault Code | P2128 | Electronic accelerator pedal position sensor 2# circuit high voltage |

To ensure system safety, accelerator pedal position sensor uses dual sensor.

|            |       |                                                                           |
|------------|-------|---------------------------------------------------------------------------|
| Fault Code | P2138 | Electronic accelerator pedal position sensor 1#, 2# circuit related fault |
|------------|-------|---------------------------------------------------------------------------|

ECM compares input signal of APP1 sensor to input signal of APP2 sensor, input signal of APP1 is almost twice of APP2 in any condition. If ECM detects input signal of APP1 and APP2 not satisfy the rule, it will report fault code.

## 2. Circuit Diagram



## 3. Fault code fault part and solutions

|                                                                           |                                                                                                                                                                                                                                                                                                                                          |                                                                      |
|---------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|
| Fault Code                                                                | P2122                                                                                                                                                                                                                                                                                                                                    | Electronic accelerator pedal position sensor 1# circuit low voltage  |
| Fault Code                                                                | P2123                                                                                                                                                                                                                                                                                                                                    | Electronic accelerator pedal position sensor 1# circuit high voltage |
| Fault Code                                                                | P2127                                                                                                                                                                                                                                                                                                                                    | Electronic accelerator pedal position sensor 2# circuit low voltage  |
| Fault Code                                                                | P2128                                                                                                                                                                                                                                                                                                                                    | Electronic accelerator pedal position sensor 2# circuit high voltage |
| Possible failure part                                                     | Referred failure troubleshooting                                                                                                                                                                                                                                                                                                         |                                                                      |
| 1. Accelerator pedal<br>2. Electronic accelerator pedal circuit<br>3. ECM | Check the related fuse<br>Check ECM power supply voltage<br>Check whether the related wiring harness of power supply circuit is normal<br>Check charging system: battery voltage 11-14V, charging voltage 11-15V, check whether charging system related wiring harness is normal<br>Check ECM power supply circuit and grounding circuit |                                                                      |

## Fault 20: Engine power, function limited fault



## 1. Fault code instruction

|            |       |                         |
|------------|-------|-------------------------|
| Fault Code | P2104 | Engine forced idling    |
| Fault Code | P2105 | Engine forced missfire  |
| Fault Code | P2106 | Engine function limited |
| Fault Code | P2110 | Engine power management |

When intake amount control of intake system or throttle valve has failure, ETC system can't use throttle valve to control engine power reliably. ECM will have relative fault code, and engine gets into protection mode at the same time.

When engine in idling state, accelerator pedal position sensor signal 1 and signal 2 both cut-off at the same time, or short circuit to GND or 5V at the same time, it may be P2104 fault code.

When engine in idling state, accelerator pedal position sensor signal 1 and signal 2 both cut-off at the same time, and exist relative fault code, may be P2106, engine gets into limit running state.

When engine in idling state, throttle valve position sensor signal 1 and signal 2 both cut-off at the same time, and exist relative fault code, may be P2110, meanwhile, opening degree of throttle valve will keep in default state.

## 2. Circuit Diagram

Refer to the throttle valve, accelerator position sensor

## 3. Fault code fault part and solutions

|                                                   |       |                                                                                                           |
|---------------------------------------------------|-------|-----------------------------------------------------------------------------------------------------------|
| Fault Code                                        | P2104 | Engine forced idling                                                                                      |
| Fault Code                                        | P2105 | Engine forced missfire                                                                                    |
| Fault Code                                        | P2106 | Engine function limited                                                                                   |
| Fault Code                                        | P2110 | Engine power management                                                                                   |
| Possible failure part                             |       | Referred failure troubleshooting                                                                          |
| 1. Electronic accelerator pedal and its circuit   |       | Remove fault code except the above fault code<br><br>Check ECM power supply voltage and grounding circuit |
| 2. Throttle valve position sensor and its circuit |       |                                                                                                           |
| 3.ECM                                             |       |                                                                                                           |

**Fault code 21: ECU processor fault**

## 1. Fault code instruction

|            |       |                                                        |
|------------|-------|--------------------------------------------------------|
| Fault Code | P0601 | ROM error                                              |
| Fault Code | P0602 | ECM programming error(Software version does not match) |
| Fault Code | P0606 | ECM processor fault                                    |
| Fault Code | P060A | ECM processor fault                                    |
| Fault Code | P1516 | ETC drive second order diagnosis fault                 |
| Fault Code | P2101 | ETC drive steady state diagnosis fault                 |

## 2. Fault code fault part and solutions

|                       |                                                                                                       |                                                        |
|-----------------------|-------------------------------------------------------------------------------------------------------|--------------------------------------------------------|
| Fault Code            | P0601                                                                                                 | ROM error                                              |
| Fault Code            | P0602                                                                                                 | ECM programming error(Software version does not match) |
| Fault Code            | P0606                                                                                                 | ECM processor fault                                    |
| Fault Code            | P060A                                                                                                 | ECM processor fault                                    |
| Fault Code            | P1516                                                                                                 | ETC drive second order diagnosis fault                 |
| Fault Code            | P2101                                                                                                 | ETC drive steady state diagnosis fault                 |
| Possible failure part | Referred failure troubleshooting                                                                      |                                                        |
| ECM                   | Remove fault code except the above fault code<br>Check ECM power supply voltage and grounding circuit |                                                        |