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Analysis of Automobile Data Flow

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ABSTRACT

The trend of automobile development is safety, energy saving and environmental protection. Due to the development and application of new technologies such as electronic technology, computer technology and information technology, the electronic control of automobile has made great progress in the control precision, scope, adaptability and intelligence and realized the fully optimized operation of the automobile. Therefore, in the reduction of emissions, reduce fuel consumption, improve safety and comfort and many other aspects of electronic control technology has obvious advantages. This is bound to require a large number of sensors in the car. These miniature sensors are small enough to enable a wide range of new features, high-volume and high-precision production, low cost and easy to form large-scale and multi-function arrays that make them ideal for automotive applications.

KEYWORDS: data flow ECU diagnostic instrument sensor actuator

Introduction

The rapid development of automotive electronics, the application of the growing, especially microcomputer, network technology for the development of automotive electronics has brought a fundamental change. Contemporary car repair is not a simple mechanical maintenance but mechanical and electronic as one of the maintenance. While the maintenance of electronic control components more abstract, the vehicle maintenance technology put forward new challenges. Is a lot of maintenance personnel and stop, feel mysterious. Car oscilloscope and automotive diagnostic apparatus came into being for the car maintenance personnel to quickly determine the failure of automotive electronic equipment provides a powerful tool. The setting of the test of the electronic device becomes very simple and the signal waveform of the electronic component and the read data stream can be directly observed without any setting and adjustment. For the majority of maintenance personnel analysis of the vehicle sensors, actuators, signal waveform and data flow analysis provides a convenient.

1. Car data flow understanding

1.1. The concept of data flow

Automotive data flow refers to the electronic control unit (ECU) and sensor and actuator communication data parameters, it is through the diagnostic interface which is read by the special diagnostic data, and with time and conditions change. Data transmission as the team line up, one by one through the data line flow to the diagnostic apparatus.

The data stream memorized by the Automotive Electronic Control Unit (ECU) truly reflects the operating voltage and status of the sensors and actuators, providing the basis for vehicle fault diagnosis, which can only be read by a dedicated diagnostic instrument. The car data stream can be used as the input and output data of the automobile ECU, so that the maintenance personnel can understand the working condition of the vehicle at any time, and diagnose the fault of the vehicle in time.

The car data stream can detect the working status of each sensor, and detect the working status of the car, through the data stream can also set the car running data.

1.2. Classification of data flow parameters

According to the data flow on the detector display in different ways, the data parameters can be divided into two types: Numerical parameters and state parameters. Numerical parameters are a certain unit, a certain range of parameters and it usually reflects the electronic control device in the work of the various parts of the working voltage, pressure, temperature, time and speed. The state parameters are those that have only two operating states such as on or off, closed or disconnected, high or low, yes or no and it usually indicates the working condition of the components such as switches and solenoid valves in the electronic control unit.

According to the ECU control principle, the data parameters are divided into input parameters and output parameters. Input parameter refers to the sensor or switch signal input to the ECU of the various parameters. The input parameter can be a numeric parameter or a status parameter. The output parameter is an output command sent by the ECU to each actuator. Most of the output parameters are state parameters, and a few are numerical parameters.

The parameters in the data stream can be classified according to the individual systems of the vehicle and the engine, and the analysis methods for the parameters of the different types or different systems are different. In the electronic control device fault diagnosis, it should also be several different types or different system parameters for comprehensive control analysis. Different manufacturers and different models of the car, the electronic control device data flow parameters of the name and content are not exactly the same.

We have to explore is the data of each sensor, that is, how to understand the causal relationship between the various data.

In-depth understanding of the understanding of the relationship between the data of the engine is the premise of the engine work process to have a comprehensive understanding. First of all, we will be the engine of the entire process is divided into three parts: the engine front, midrange and engine back-end, as shown in Figure 4.

Engine front: by a variety of sensors (except oxygen sensor), actuators, intake system, fuel system composed of these parts.

Engine end: the engine mechanical body, ignition system components.

Engine back end: consists of an exhaust system, a catalytic converter, and an oxygen sensor (or air-fuel ratio sensor) that detects oxygen concentration in the exhaust gas.

We all understand that the engine's core problem is air, around the air into the cylinder, the computer through the crankshaft position sensor to provide the engine speed, air flow sensor intake signal to determine the basic fuel injection time, and the basic ignition advance angle. Then, the basic fuel injection time is corrected in accordance with the signals of the remaining sensors, such as the coolant temperature sensor, the intake air temperature sensor, the throttle position sensor (or the accelerator pedal position sensor to achieve the purpose of accurate control The At the same time, in the case of a good fuel system, the engine ECU instructs the injector to perform a certain pulse width opening operation to inject fuel into the intake manifold and mix with the air and into the cylinder.

In the middle of the engine, in the mechanical part is good, the cylinder seal is good, the valve mechanism is working properly, into the cylinder of air and fuel mixture, at the right moment, the work of the secondary spark ignition, Work power, output power.

At the rear end of the engine, the combustion chamber in the cylinder is completed and the exhaust gas is formed into the exhaust pipe which contains a variety of gas components, but more important is O2, HC, CO, CO2, NOX and other waste gas. At this time, the device in the exhaust pipe on the oxygen sensor began to use. As the front into the cylinder of the mixture, it is the engine ECU according to a variety of sensors to obtain the data. After the calculation of the theoretical fuel injection, this fuel injection volume does not match the actual intake rate and ECU itself do not know. If you make an analogy, we can make the engine ECU fuel injection instructions that is similar to the weather forecast behavior which is a predictive, subjective behavior and engine ECU unilateral behavior. The oxygen system in the exhaust system is the role of monitoring and monitoring.

Oxygen sensor according to the number of oxygen atoms in the exhaust, and the oxygen content of the atmosphere to compare, to get the mixture is thin or thick report.

In order to understand the common input parameters of the car, the car is now common types of sensors, installation location and use summarized in the following table.

The main sensor type, installation location and use

Sensor Type	Mounting Position	Use
Coolant temperature sensor	Coolant temperature on the cooling waterway	Coolant temperature measurement

Air temperature sensor	The inlet air temperature is measured on the intake manifold	
	Inlet air temperature measurement	
EGR temperature sensor	EGR intake airway measurement	EGR cycle gas temperature and EGR work
Crankshaft position sensor	Crankshaft front detection	Crank angle position, measuring the engine speed
Detonation sensor	On the machine	engine block detection of deflagration signal, enter the ECU
Oxygen transfer sensor	Oxygen sensor exhaust pipe, ternary catalytic converter	Control air-fuel ratio
Brake master cylinder pressure sensor	Lower part of main cylinder	Detection of the main cylinder output pressure
Raindrop sensor	The engine compartment	Detection of rainfall and controls the speed of the wiper
Speed sensor		
Output shaft or combination instrument	Measurement of vehicle speed	
Throttle position sensor	Throttle body connected with the throttle	Determination of the engine conditions, control the fuel injection pulse width

2. To get the car data flow method

Automotive electronic control system test methods are divided into: communication computer diagnosis and online circuit analysis of two. The former is through the car's computer diagnostic seat to communicate between the computer and the diagnostic device to complete the test work, while the latter is the analyzer probe connected to the sensor and the actuator circuit for online testing. Two different test methods, the use of equipment is also different, the former mainly used in the domestic commonly known as 'decoder' of the car computer diagnostic apparatus which mainly uses the commonly used as 'engine analyzer' car circuit analyzer.

2.1. Computer communication

Special diagnostic apparatus

In addition to reading, decoding, data scanning and other functions, it also has a sensor input signal and the actuator output signal parameter correction experiment, computer control system parameter adjustment, system matching And calibration and anti-theft password settings and other professional features. Dedicated diagnostic equipment is specially designed for automobile manufacturers to test equipment for its special maintenance station. It has the advantages of strong specialty and perfect test function. It is the necessary equipment for automobile repair factory.

General Diagnostic Instrument

The main functions of the general diagnostic instrument are: identification of the control module version, fault code reading and erasing, dynamic data parameter display, sensor and part of the actuator function test and adjustment, some special parameters of the set, maintenance information and fault diagnosis Tips and road record records. General diagnostic equipment can test the type of more wide range of adaptations, it is known as general-purpose equipment, but it is compared with the dedicated diagnostic instrument which cannot complete some special features and itis the inadequacies of most common instruments.

The dynamic data display function of the general diagnostic instrument and the special diagnostic instrument can analyze the running parameters of the control system (up to hundreds) and also observe the dynamic control process of the computer. Therefore, it has a diagnostic function from the computer's internal analysis process, which is the primary means of data analysis.

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2.2. Circuit online measurement methods

Circuit on-line measurement method is through the control module circuit on-line detection (mainly refers to the computer's external connection circuit), the control module input and output of the electrical signal directly to the circuit analyzer measurement. Circuit analyzers are generally two: one is a car multimeter. One is the car oscilloscope.

Auto multimeter is also a digital multi-purpose instrument its shape and working principle and pocket digital multimeter almost no difference which only to add a few car-specific function files (such as DWELL block, TACHO block).

In addition to the car multimeter with a mini digital multimeter function, it also has a dedicated vehicle test function. It can measure the AC voltage and current, DC voltage and current, resistance, frequency, capacitance, duty cycle, temperature, closing angle and speed. There are some new features such as automatic power off, automatic conversion range, analog bar graph display, peak hold , reading (data lock) and battery test (low voltage prompt).

To achieve certain functions (such as measuring temperature, speed), the car multimeter is also equipped with a set of accessories, such as thermocouple adapter, thermocouple probe, inductive pickup and AC / DC induction current clamp and so on.

The car multimeter should have the following functions:

(1) Measure the AC and DC voltage. Taking into account the allowable range of voltage and the possible overload, the motor multimeter should measure more than 40V voltage, but the measurement range cannot be too large, otherwise the accuracy of the reading decreased.

(2) Measuring resistance. Auto multimeter should be able to measure 1MΩ resistance, the measurement range is more convenient to use.

(3) Measure the current. Auto multimeter should be able to measure more than 10A current, the measurement range is small, then the use of inconvenient.

(4) Memory maximum and minimum values. This function is used to check for an instantaneous failure of a circuit.

(5) Analog bar display. This function is used to observe continuously changing data.

(6) Measure the bandwidth ratio of the pulse waveform and the closing angle of the primary current of the ignition coil. This function is used to detect the working condition of the injector, idling stabilization control valve, EGR solenoid valve and ignition system.

(7) Measure the speed.

(8) Output pulse signal. This function is used to detect faults in the non-distributor ignition system.

(9) Measure the frequency of the electrical signal output by the sensor.

(10) Measure the performance of the diode.

(11) To measure high current. When the current sensor (Hall sensor) is configured, a large current can be detected.

(12) Measure the temperature. After the temperature sensor is configured, the coolant temperature, the exhaust temperature and the intake air temperature can be detected.

Auto oscilloscope is a professional instrument that expresses the dynamic change of electrical parameters in the circuit by means of waveform display. It can display the electrical parameters of the circuit continuously. It is a professional instrument to analyze the change of electrical signal on the complex circuit. Automotive oscilloscope usually with two or more test channels, while multi-channel electrical signal synchronization display, with high-speed dynamic analysis of the relationship between the advantages of the signal. Usually the car oscilloscope with a test menu, the use of no need to use ordinary oscilloscope as cumbersome to set, just point to test the sensor or actuator menu can automatically enter the measurement. The electronic storage oscilloscope also has a continuous memory and playback function, easy to capture intermittent failure. But also through a certain software and PC connection, the collected data for storage, printing and reproduction.

Engine comprehensive performance detector

2.3. Component simulation mode

Component simulation mode measurement is through the signal simulator instead of the sensor to the control module to send the analog sensor signal, and control the corresponding parameters of the module to analyze the comparison of measurement. There are two types of signal simulators: one is a single signal simulator; the other is a synchronous signal simulator.

The single signal simulator is a single channel signal generator. It can only output a signal to simulate a sensor dynamic change signal. The main signal has variable voltage signal 0 ~ 15V, variable AC-DC frequency signal 0 ~ 10Hz, variable resistance signal is good or bad, the other is to use variable analog signal to dynamically analyze the module control system response and then analyze the control module And the work of the system.

Synchronous signal simulator is a two-channel signal generator. It is mainly used to generate signals with relevant logic relations, such as crank angle and camshaft sensor synchronization signal, to simulate the engine operating conditions, to complete the engine is not rotating in the case of dynamic control of the corresponding module data analysis experiments. Synchronization signal simulator also has two functions: The comparison of the sensor to compare the quality of good or bad. Analysis of computer control system response data parameters.

3. Long common sensor waveform

3.1. Air flow sensor

Close all ancillary electrical equipment, start the engine, and make it idle operation, idle speed, check the idle air flow meter voltage output signal. To do the acceleration and deceleration test, there should be a similar figure in the waveform appears.

Usually the output voltage does not exceed 0.5V at idle, when the throttle is fully open when not more than 5V, full deceleration and return to the idle voltage, air flow increases when the output voltage increases, the air flow decreases when the output voltage decreases. And when the air flow is stable, it corresponds to a certain stable waveform reference value. When the output voltage and air flow does not meet, we generally from the waveform will clearly find the problem, while the engine will also be significantly affected.

3.2. Intake pressure sensor

Open the ignition switch, but do not start the engine, with a manual vacuum pump to the inlet pressure sensor to impose different degrees of vacuum, while observing the oscilloscope waveform display (pictured).

Determine the decision parameters: amplitude, frequency, shape and other deterministic scales are consistent, repeatable, correct, that is, the amplitude close to 5V, the frequency changes with the vacuum, shape (square wave) remains unchanged;

It is determined that the sensor can send the correct frequency signal in comparison with the service manual under the conditions of a given vacuum.

The amplitude of the waveform should be a pulse of 5V, and the shape is correct, the waveform is stable, the rectangle is correct and the rising edge is vertical. The frequency and the corresponding vacuum should correspond to the values given in the maintenance data.

Possible failures and deviation of parameter values are mainly incorrect frequency values, shorter pulse width, undue spikes, and so on.

3.3. Coolant temperature sensor

With the previous section intake air temperature sensor, but it should be noted that when using the oscilloscope to collect waveform, the time axis of the index should be 60S / P.

Refer to the manufacturer's specification manual for accurate reference to the corresponding voltage range of the sensor. Usually cold when the sensor voltage should be between 3 ~ 5V (full cold), and then with the engine running gradually reduced to run the normal temperature of about 1V. The key to the determination of this DC signal is the voltage amplitude. At any given temperature, the good sensor must produce a stable feedback signal.

When the engine coolant temperature sensor circuit is open, the voltage waveform will appear up to the reference voltage (500)

When the engine coolant temperature sensor is shorted to ground, a spike (0V) is generated that goes down to the ground voltage.

Shortening the time base scan speed to 200ms / D or less, it is helpful to catch intermittent faults.

3.4. Throttle position sensor

Open the ignition switch, the engine does not run, slowly let the throttle from the idle position to full open, and back to the throttle closed. Repeated several times, the action is slow, see the reference waveform in the picture.

Read the manufacturer's maintenance manual to get the exact throttle position sensor voltage range. There should be no breakpoint on the waveform, or a large twist on the ground tip, with particular attention to the waveforms in the first 1/4 throttle movement, since this is usually the most commonly used sensor carbon film potentiometer Part, so the first 1/8 to 1/3 of the carbon film is often the first wear, so that the waveform appears abnormal output signal.

3.5. Knock sensor

On the engine load, see the oscilloscope display.

The peak voltage (peak height or amplitude) and frequency (the number of vibrations) of the waveform will vary with the load and speed of the engine, as well as the ignition of the engine (in advance), the combustion temperature and the exhaust gas recirculation. Normal or not, its amplitude and frequency will also change.

3.6. Speed sensor

Raise the drive wheel to simulate the conditions for driving. It is also possible to lengthen the test line of the car oscilloscope and test it on the road.

4. Automotive data flow analysis method

4.1. Numerical analysis

Numerical analysis is the numerical analysis of the data and the range of numerical changes, and numerical changes, such as speed, speed and computer reading and the actual value of the difference.

When the control system is running, the control module will continue to receive the input signals from each sensor at regular intervals and issue control commands to the individual actuators. The operating status of some actuators is also

based on the feedback signals of the corresponding sensors. Correction. We can use the diagnostic instrument to read the values of these signal parameters to be analyzed.

The control of the cooling fan in the Honda Accord is not the temperature control switch installed on the radiator, but the engine control module receives the coolant temperature signal of the coolant temperature sensor to determine the temperature change of the coolant. When the specified temperature is reached, Control the temperature relay connected to the fan work. A Honda Accord 2.3 sedan, the engine starting time is not long, the cooling fan that work, then feel only 40 to 50 degrees Celsius. The original maintenance personnel cannot find the real cause of the failure, had to change the fan control circuit, with a manual switch manual control. According to the car circuit diagram, you can determine the car's fan is controlled by the computer, so connected to the detector, no fault code exists, but the observation data, the computer read the coolant temperature is 115 degrees Celsius. According to the design of the car, the engine electric fan operating point of 91 ~ 95 degrees Celsius (switch A low speed) and 103 ~ 109 degrees Celsius (switch B high speed). So, you can determine the computer on the fan control circuit is normal, the problem is that the computer to get the temperature signal is not correct, it may be due to coolant temperature sensor, harness plug or computer itself is faulty. Check the sensor found that the resistance is not correct, after the replacement of all normal. Why is there no fault code? This is because the car in the fault code set, only the provisions of the open (reading value is generally below -35 degrees Celsius) and short circuit (reading is generally above 120 degrees Celsius) state and cannot determine whether the sensor temperature value is the actual temperature value, Of course, it is impossible to give a fault code. From this example it can be seen, attention should be paid to the relationship between the measured value and the actual value of a certain physical quantity, whether through the diagnostic apparatus or direct measurement, the value obtained and the actual value difference should not be (due to different means of measurement), otherwise There may be a problem with the measured value.

4.2. Time analysis method

The computer in the analysis of certain data parameters, not only to consider the value of the sensor, but also to determine the corresponding rate to get the best results.

For example, the signal of the oxygen sensor not only requires a change in the signal voltage, but also the frequency of the change of the signal voltage in a certain period of time to more than a certain number of times (such as some vehicles require more than 6 to 10 times / s), when less than this value, It will produce a fault code, said the oxygen sensor response is too slow. With the fault code is a better solution, but when the number does not exceed the limit, and slow response, and will not produce a fault code. At this time do not carefully experience, may not feel a trace of fault symptoms. It should be connected to the instrument to observe the oxygen sensor data changes in the state to determine the sensor is good or bad. For the use of OBD-II system before and after the catalytic converter oxygen sensor signal change frequency is not the same. Usually the post-oxygen sensor's signal change frequency should be at least half of the pre-oxygen sensor, otherwise the catalytic conversion efficiency may have been reduced.

4.3. Causal analysis

Causal analysis is an analysis of the interrelated data response and response speed.

In the control of each system, many parameters are causally related. If the computer gets an input, it is sure to give the next output based on this input. When you think there is a problem with a process, you can observe these parameters together to determine where the fault is.

In the automatic air conditioning system, usually when the air conditioning selector switch is pressed, the switch is not directly connected to the air conditioning compressor clutch, but the switch signal as an air conditioning request after the air conditioning selection signal is sent to the engine control module, the engine control module After receiving this signal, check whether to meet the set conditions, if satisfied, it will be like a compressor relay issued a control command, connected to the relay, so that the compressor work, so when the air conditioner does not work, you can observe the air conditioner switch After the air conditioning request (selection), air conditioning allowable, air conditioning relays and other parameters of the state changes to determine the fault point.

4.4. Association analysis method

The computer's judgment of the fault is based on the signal of several related sensors. When it is found that the relationship between them is unreasonable, one or several fault codes are given, or a signal is unreasonable. At this point do not easily determine the sensor is bad, need to be based on the relationship between them to do further inspection, has been the correct conclusion.

Example Honda Accord sedan sometimes gives the throttle position sensor signal is not correct, but no matter what method to check, the sensor and its settings are no problem. If you can carefully observe the speed signal (with the

instrument or the oscilloscope), you will find the speed signal is not correct, replace the crankshaft on the crankshaft position sensor, troubleshooting. The reason is that the computer receives the incorrect speed signal at this time, and cannot determine whether the speed signal is correct (due to no comparison), but compare the throttle position sensor signal at this time, that its signal and the received error speed signal Does not match, so give the throttle position sensor fault code.

4.5. Comparative analysis

The comparative analysis is the analysis of the same data set for the same vehicle and the system under the same conditions.

In many cases, there is not enough detailed technical information and detailed standard data, cannot be a very good judgment of a device is good or bad. At this time with the same type of vehicle or similar system data to be compared. Of course, in the repair, many people will use the replacement experiment to judge, this is a simple method, but should pay attention to the first to do some basic diagnosis. In the basic to determine the fault trend, and then replace the device is suspected to have problems, not a change on the change for that, the result may be for all the devices, still did not find the problem. Another note is that the device used for replacement must be confirmed to be good, not necessarily new, because the new is not necessarily good, this is the basic principle of the replacement experiment.

Therefore, in the modern vehicle testing and maintenance process, the data flow from the help of more and more, the technical staff have gradually recognized the importance of data flow.

The engine control system data stream is the most comprehensive and inclusive part of all the data in the car, and all systems in Hyundai are inextricably linked to the engine system. At the same time, the engine control system is also the most complex and changing Therefore, it is clear that the definition of the data flow of the engine control system is the key to solving the engine failure.

References:

1. Lu Zhixiong. Car data flow analysis diagram. Electronics Industry Press
2. Tan Benzhong. Automotive waveform and data flow analysis. Machinery Industry Press
3. Wang Yin. Automotive sensor use and maintenance. Golden Shield Press
4. Yao Meihong. The latest car sensor test data. Liaoning Science and Technology Press
5. Song Nianji. How to detect the car sensor. Electric Power Press
6. Song Fuchang. Automotive sensor identification and detection diagram. Electronic Industry Press
7. Lu Zhioxiong. Automotive sensor dynamic and static analysis. People's Communications Press