Research and Development of Off-line Detection System for Electric Vehicle

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Abstract: With the development and popularization of electric vehicles, it is of great significance to study the off-line detection equipment of pure electric vehicles. This paper first analyzes the principle and scheme of the test system, and then designs the test system. Finally, through the verification of the test system, it is proved that it can read and clear the fault code, and speed up the detection speed of the electric vehicle, which not only ensures the quality of the product, but also is conducive to the rapid maintenance of the maintenance personnel.

Keywords: Off-line detection system, Electric vehicle, Development

1. Introduction
As we all know, fossil fuel will bring serious pollution. With the increase of people's awareness of environmental protection, countries have invested in the research and development of electric vehicles to replace the traditional fossil fuel vehicles that will bring pollution. In addition, many advantages of electric vehicles, such as: no pollution, low noise, and high energy efficiency, make electric vehicles become the current research hotspot[1], as well as the future trend of automobile development. With more and more functions of automobile, and more and more parts related to electrical appliances, higher requirements are brought to its quality and reliability. Especially for pure electric vehicles, the reliability of electrical components is directly related to the safety of the whole vehicle. Therefore, the vehicle must be tested before being offline to ensure the reliability of all components. From the above analysis, it can be seen that the research and development of the electric vehicle offline detection system has important practical significance[2].

2. Principle analysis and scheme design of test system

2.1. Function of detection system
In the process of vehicle detection, first of all, the system software should complete the processing of detection signals, display and store detection results in time[3], and be able to manage user
information by classification. Based on the working principle of each electronic component and the control logic of the wingman, to analyze the function of the offline detection system, and finally determine its functional requirements. Generally speaking, the design principles of the test system mainly include the following aspects as shown in Figure 1.

![Figure 1. Design principles of the test system](image)

2.2. Offline detection signal classification
The offline detection system first analyzes the status and fault of each node controller according to the CAN bus message. Send the signal through the upper computer, and then display the loop signal on the upper computer. The whole vehicle network topology is shown in Figure 2.

![Figure 2. Vehicle network topology](image)

2.3. Hardware connection mode
The test system is connected to the vehicle body CAN bus to process the useful information of the vehicle body high-speed and low-speed CAN bus and realize the vehicle body status detection. The hardware connection mode is shown in Figure 3.
2.4. Overall design of offline detection system
The vehicle offline detection system uses the computer as the control centre to detect the harness, components and network of the whole vehicle. The ECU unit communicates through the CAN bus to save and transmit the test results. The design structure of the detection system is shown in Figure 4.

3. Design of the offline test system

3.1. Hardware system design of the whole system
The system hardware includes two parts: the internal hardware design and the lower computer hardware design. The main function of the lower computer is signal simulation and acquisition, and its hardware is connected with the vehicle harness[4]. The internal hardware of the system box mainly supplies power for the industrial computer, the lower computer board and the vehicle electrical appliances through the DC power supply.

The equipment will be connected to the whole vehicle can line of the vehicle, communicate with the VCU of the vehicle for diagnosis, follow the model configuration and basic test requirements, realize the vehicle offline test project, and have some expansion capabilities of vehicle type test project.

3.2. CAN communication circuit design
The data and information between the upper computer and the lower computer or between the upper
computer and the electrical appliances to be tested are transmitted through the CAN bus, so the design of the CAN communication circuit must be stable and reliable, with strong anti-interference ability. Through the bus receiving function, receiving the indicator signal, component data signal and diagnosis signal converted from the low-speed CAN bus on the high-speed CAN line, monitoring programs of various monitoring systems can be designed.

3.3. Design of the test software
The test software carries out vehicle diagnosis based on UDS protocol, and the acquisition of vehicle parameters data is realized through UDS data communication[5]. The final counting method realizes on-line diagnosis and analysis of vehicles. The mechanism of UDS diagnosis communication is simple. VCU collects or diagnosis tool sends request message and replies response message after receiving the request. At the same time, the diagnosis protocol specifies the format between request and response and the processing mode of request and response. UDS defined function unit diagnosis services mainly include data transmission, storage data transmission and remote activation routines.

4. Test system integration and verification
In the system integration test, first of all, it need to test the normality of the board communication, send the switch value through the upper computer, and transfer the CAN bus to the lower computer to test whether the corresponding relay changes. Then connect the corresponding switch value to the corresponding channel of the board and measure each channel. Similarly, the test analog board and the power board are connected with the switch board. It can be seen from the collected data of each board channel that each channel of the board is working normally to realize the hardware requirements of the offline detection system.

The test content of the upper computer test system includes automatic test and manual test of the hard line test. The off-line detection system of pure electric vehicle can detect the system failure in real time in the off-line detection of the whole vehicle, and display it in a visual form in the graphical interface. The system automatically receives the information on the CAN bus of the whole vehicle or the fault information uploaded from the lower computer, which is displayed in the upper computer in real time. The CAN bus signal can be easily collected in the fault bar, and the detection result can be displayed in the interface in real time through the analysis of can signal.

5. Conclusions
In this paper, the physical layer protocol and software protocol between the upper computer and the lower computer of the detection system are designed, and through the analysis of the principle and the overall scheme design of the off-line detection system of the electric vehicle, the overall scheme of the off-line detection equipment is obtained. The test system can read and clear the fault code, and speed up the detection speed of electric vehicles, which is to ensure the product quality is conducive to the rapid maintenance of maintenance personnel.

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