International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 07, July - 2017

Design of Fault Diagnosis Training Platform of Electric Drive System for Electric Vehicle

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***Abstract*—With the sustained and rapid development of China's national economy, people's demand for electric vehicles more and more urgent, but the electric vehicle maintenance seriously hampered the promotion and application of electric vehicles. At present, the electric vehicle maintenance process is recognized as a key operational process. In accordance with the structure of electric vehicles, electric drive system for the core part of electric vehicles. In order to avoid non-standard, unskilled maintenance work on the drivers and passengers caused by security risks, in this paper, according to the structure, characteristics and working characteristics of the electric drive system, this paper designs a simulation test bed for the maintenance of electric vehicle electric drive system, the method of fault diagnosis is used to provide fault diagnosis examples, which can effectively improve the efficiency and accuracy of maintenance training, and provide practical application value and reference value for electric vehicle maintenance.**

Keywords — fault diagnosis; electric drive system; training platform

I. INTRODUCTION

With the sustained and rapid development of the national economy, the continuous improvement of urbanization and energy-saving emission reduction needs, electric vehicles in the future travel mode will play an increasingly important role in the next 10-20 years will promote the rapid development of electric vehicle-related industries, a variety of specialized personnel demand increased dramatically[1]. One of the professional maintenance of electric vehicles, electric vehicles and traditional car maintenance is very different, electric vehicles contain high-voltage electrical parts, the maintenance process has a special need. For different fault conditions, the relevant domestic technical staff in the absence of a solid grasp of electric vehicle maintenance work theory of the case, in accordance with the general electrical failure of the fixed mode of processing, so that the electric vehicle parts of the secondary service life is short, high failure rate, serious threat to the driver and passenger safety and other issue[2]. So there is an urgent need for more professional personnel to carry out electric vehicle maintenance and maintenance. Currently, many automotive professional colleges opened some pure electric car-related courses, but a serious lack of qualified teaching related equipment. In order to better train electric vehicle drive motor system maintenance technicians, design electric vehicle electric drive system fault diagnosis training platform has become particularly important.

II. HARDWARE DESIGN OF FAULT DIAGNOSIS TRAINING PLATFORM FOR ELECTRIC VEHICLE ELECTRIC DRIVE SYSTEM

A. *Overall design*

Motor drive controller design is the core of electric vehicle electric drive system fault diagnosis training sets designed. The fault settings into the hardware design and software design process, the hardware failure is mainly used to cut off the relay or connection control[3]. Design and manufacture of experimental training platform are shown in Figure 1.

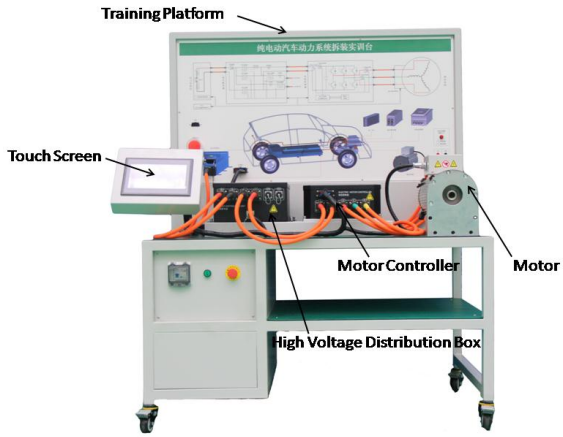

Fig. 1. Electric vehicle drive motor system disassembly and fault diagnosis experimental training bench

B. *Drive motor controller design*

Motor controller hardware circuit is divided into four parts: the main circuit, the control circuit, communication circuit and auxiliary power supply circuit[4]. Motor controller hardware circuit block diagram shown in Figure 2.

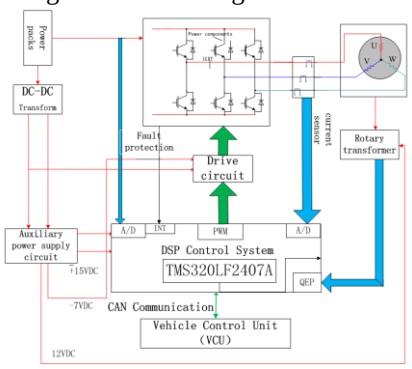

Fig. 2. Motor controller hardware circuit block diagram

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These circuits in the control system, respectively, play a different role, each other with each other, constitute the entire control system. The first is the main circuit, the pure electric vehicle power battery pack to get the DC voltage, after the IPM module consisting of six electronic switches, reverse into three-phase alternating current into asynchronous AC motor. In the control circuit, each sensor will signal the signal will be collected to the VCU, and then through the VCU communication, to obtain the various signals, such as acceleration, deceleration, start, stop, reverse and other command signals, and the three-phase stator current obtained by rotating the transformer, the speed signal, the motor speed and the sampled three-phase stator current are fed into the vector control algorithm of the DSP, resulting in six PWM wave to control the main circuit of the IPM module of the electronic switch closed to achieve the motor speed[5].

The circuit includes: bus voltage, three-phase current, the motor speed sampling circuit, CAN bus communication circuit, DSP peripheral circuit. In order to drive the IGBT to work, it is necessary to add the driving circuit to the main circuit and the control circuit to ensure that the IGBT can work according to the requirements, and can supply the auxiliary power supply circuit from the power battery pack through the DC-DC converter module. It should be noted that the battery and DC-DC modules are not part of the motor controller. The auxiliary power supply circuit provides voltage for the rotary transformers, IPM modules and associated chips in the control system to ensure they are working properly.

C. Design of high voltage distribution box

The For pure electric vehicle current control, the high-voltage distribution box plays a vital role, it acts as an energy dispenser. When the high voltage control box receives the current from the power battery pack, the current part of the motor controller into the part of the air conditioning system to supply power, and some part of the circuit is the charging circuit[6]. The distribution of these currents is controlled by the Vehicle control unit (VCU), when the VCU receives the sensor signal, after a logical analysis, issued a control instruction, the operation of the various actuators, so that part of the circuit connected. High-pressure control box schematic diagram shown in Figure 4.

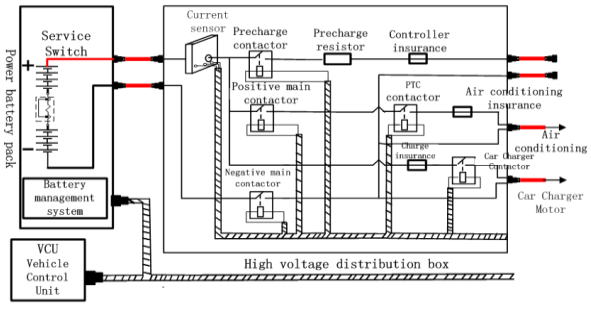

Fig. 3. High-pressure control box schematic diagram

The principle of high-voltage distribution box is not complicated, mainly related to the selection of electronic devices, including DC contactors and insurance.

- Selection of DC contactors
  From the electrical principle design diagram that high-voltage distribution box, contactors and fuses in the entire control circuit plays a significant role, their performance directly affects the performance of the entire car, so their choice is very important.

  DC contactor for DC circuit, mainly used to connect and disconnect the DC circuit, simply it is equivalent to the switch. It has the advantages of high operating frequency, long service life, reliable operation and stable performance compared with ordinary switch. At present, mainstream manufacturers include France's Schneider Electric Company, CROUZET Company, Japan's Omron, the United States TYCO, these companies have excellent reputation in electrical terms. This design uses Tyco TE high voltage DC electric vehicle EV200 series of high voltage DC contactors. The parameters include the control voltage DC12V, current 200A and voltage 500V.

- Choice of fuses
  In Fuses play a very important role in the circuit, the circuit is the most simple and most commonly used protection of electrical appliances, widely used in power supply lines and electrical equipment in the short circuit protection. When using the fuse should be connected to the protected circuit, the circuit is working properly, the melt should not be blown. When the circuit fails to cause the current through the fuse exceeds a certain value, resulting in the heat generated in the melt to melt the melt, thus protecting the circuit and electrical equipment. The fuse in the high-voltage distribution box includes the main fuse, the drive motor controller fuse, the car charger fuse, the electric air conditioning fuse and the DCDC converter fuse. Faults that can be set include the main contact of the DC contactor contact failure and the super gap fault, control the coil short circuit fault and the fault. Fuse failure is a fusing fault[7].

  Integrated voltage, current and fuse time parameters to consider CANl fuse, the specific model and parameters are as follows Table 1:

TABLE I. HIGH-VOLTAGE DISTRIBUTION BOX SELECTED FUSE MODELS AND RATED CURRENT

Fuse Name	Model	Rated Current (A)
Car Charger Fuse	CANl 16A	16A
Electric air conditioning fuse	CANl 16A	16A
DCDC converter fuses	CANl 16A	16A
Drive motor controller fuses	CANl 100 A	100A
Main fuse	CANl 200 A	200A

III. OTHER HARDWARE DESIGN

Other hardware design including touch screen, drive motor and other fault settings function design. As the electric vehicle drive motor limited to space and high pressure restrictions can't be secondary development, need to be redesigned. So the motor used to drive the existing motor, and the internal winding was modified, set up 10 points of failure[10]. Touch screen software design to achieve the main principle of display, fault settings, troubleshooting, troubleshooting examination of the four major functions. Each part of the

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 07, July - 2017

function by means of MCGS configuration software editing implementation, the relevant software design is not described here.

ACKNOWLEDGMENT

This paper designs a complete fault diagnosis training station for the structure, principle and characteristics of the electric vehicle electric drive system, which enriches the single and simple fault diagnosis of the existing electric vehicle fault diagnosis training station. For the maintenance of electric vehicle maintenance workers to provide a better training equipment solutions.

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