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Design of Test System of Engineering Vehicle Electronic Equipments Based on PC104 Bus

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Abstract

In order to quickly solve the problem of performance test and fault diagnosis of the engineering vehicle electronic equipments, this paper designed a test system of engineering vehicle electronic equipments based on PC104 bus, and emphatically discussed the achievement method of hardware and software. Experiments showed that test system was fast, accurate and easy to use.

1. Introduction

Along with rapid development of technology, engineering vehicle electronic equipments develop toward the direction of digitalization, integration, automation and intelligent [1]. PC104 is the industrial control bus which is designed specifically for embedded control. It inherits the advantage of open bus structure of IBM-PC, so it is fully compatible with IBM-PC. Meanwhile, it can meet the special requirements of embedded control such as small size, low power consumption, high reliability, convenient programming and so on. It adopts a modular structure that is easy to be expanded and installed in the fastening stack manner [2]. Because engineering vehicle electronic equipments become more and more integrated, the difficulty of test continue to increase. Therefore, we adopt PC104 bus to design test system.

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2. System components

Test system is mainly used to test and locate rapidly problems of Engineering vehicle electronic equipments such as main box, GPS positioning and orientation system, PLC control box and power distribution box and so on. Problems can be located to replaceable unit, so it can help equipment maintenance person repair them rapidly. Figure1 shows test system structure which is composed of PC104 module, adjustment module, test interface, test cable.

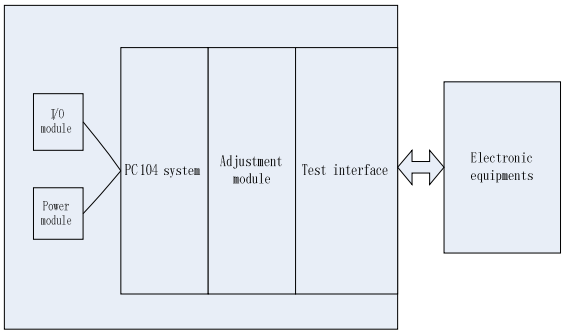

Fig. 1 Test system structure

3. Design of hardware

3.1 Overall plan

The hardware circuit of test system is controlled and managed by PC104 computer integrated circuit, which is composed of a AC/DC power supply circuit, keyboard-display circuit, simulation switch quantity instruction I/O circuit, simulation quantity instruction I/O circuit, simulation engineering vehicle high/low direction angle circuit, simulation engineering vehicle tilt angle circuit and communication circuit. As shown in Figure 2.

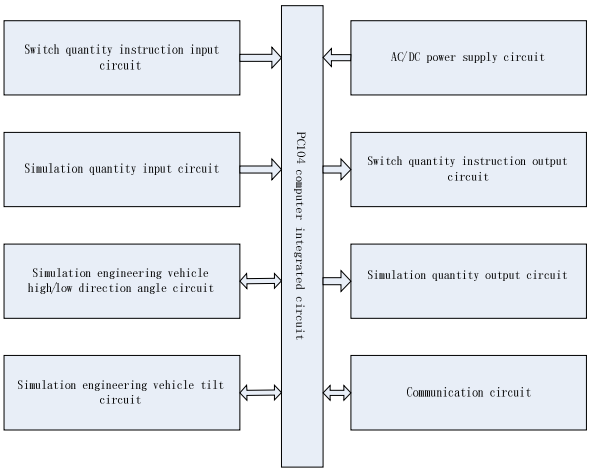

Fig. 2 Test system circuit

1) PC104 computer integrated circuit

PC104 computer integrated circuit using embedded low power consumption CPU module is in charge of coordination of the test system and analysis and processing of signal, at the same time there are many peripherals such as serial port, I/O port, A/D port, D/A port and so on.

2) Keyboard-display circuit

Keyboard-display circuit is used to input user test command and display data, of which the design adopts a wide-temperature screen and a thin film switch.

3) AC/DC power supply circuit

In order to ensure the test system being used conveniently in the open, the power supply system of test system uses AC/DC power supply circuit [3], which can supply either 220V AC power, or 28V DC power, it provides 28V, 15V or 5V DC voltage through the internal conversion module in AC/DC power supply circuit, therefore ensure the test system work normally. As shown in Figure 3 below.

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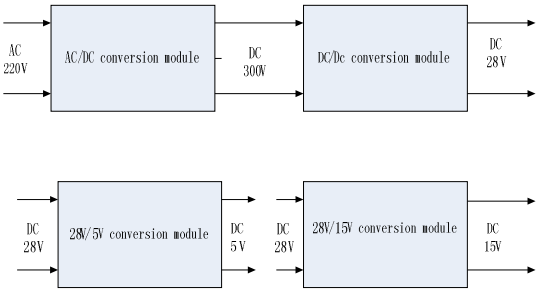

Fig. 3 AC/DC conversion

4) Switch quantity instruction output circuit

Because there are so many kinds of switch quantity input instruction to measured box, we use mult-technique and there is a total of 38 simulations switch quantity output instruction. Because the highest voltage of them is 28V but the maximum output voltage of I/O port of PC104 computer is 5V, here we use MC1413 integrated circuit [4] as voltage conversion circuit to ensure that it can match with the highest one. About the process of the measured box switch quantity input instruction, we solve it through the computer software programming.

5) Switch quantity instruction input circuit

Facing the simulation switch quantity output instruction of the measured body, we also used mult-technique and there is a total of 24 switch quantity input instruction. Because the highest voltage of them is 28V but maximum input voltage of PC104 computer I/O port is 5V, here we use the resistor divider form as voltage conversion circuit to ensure that it can match with the high voltage of measured body. For the process of measured box switch quantity output instruction, we also solve it through the computer software programming.

6) Simulation quantity output circuit

The simulation quantity output circuit is designed to test engineering vehicle distribution box servo drive circuit.It simulate the measured servo drive circuit work through using 5V simulation signal which is supplied by computer D/A as the simulation quantity input instrument of servo drive circuit.

7) Simulation quantity input circuit

Simulation quantity input circuit is also designed for engineering vehicle servo drive circuit, it send simulation quantity instrument coming from the simulation quantity output circuit to the detected servo drive circuit, in order to generate servo drive circuit high/low direction output signals. These signals access simulation quantity input circuit and is sent to the computer A/D channel through the resistor divider to judge whether the high/low direction servo drive circuit is normal.

8) Simulation engineering vehicle high/low direction angle circuit

Simulation engineering vehicle height direction angle circuit is used to test the change of high/low direction angle of vehicle when it is working. It adopts 4 DRDC module which convert the data into analog signals of resolver, in order to simulate the vehicle high/low direction angle.

9) Simulation engineering vehicle tilt circuit

Simulation engineering vehicle tilt circuit also adopts DRDC module, which convert the data into the analog signal of inclinometer which measure engineering vehicle longitudinal and transverse slope angle for simulation the analog signal of inclinometer, in order to ensure that main box can be operated in the allowed range of tilt angles when it is working. In addition, it also can detect the main box angle conversion circuit.

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10) Communication circuit

Communication circuit [5] communicates with the GPS through the computer's RS232 port. During the working time, test system may be seen as the one which test communication between the GPS and the main box.

3.2 Selection of hardware equipment

According to hardware and the actual demand of A/D, D/A, serial port module and DIO module, we select the CDM1261 computer and peripheral circuit plug board which contains all resources needed. In addition, the CDM1261 computer also supports EL640.400-C3 wide-temperature screen.

3.3 Design of test system interface

In order to protect system security and prevent cable from inserting wrong, test system interface panel adopts different interface design. There are 10 kind of interfaces in test system which are designed respectively for the main box, distribution box, PLC box, GPS, power supply input and printer output.

3.4 Design of test system connection

Because there are many interfaces in test system and it can only be connected with only one interface when working, therefore, the cable bifurcation method achieve the connection between the detection system and the measured box. Among them,No.1 and No.2 cable connect the host machine box; No. 3 and No. 4 cable connect PLC box; No.5 cable connect an electrical distribution box; No. 6 and No. 7 cable connect GPS box; No. 8 cable is 220V AC input cable; No. 9 cable is 28V DC input cable; No. 10 cable is connected with the printer.

4. **Design of software**

The software programming of this system based on BC++ 3.1 integrated development environment use hierarchical and modular system which combine the functional modules of test, board hardware driving modules and maintenance database. The software is clear, portable and open and it is easy to upgrade. At the same time the software has many functions, such as the man-machine interaction, equipment testing, fault analysis and record keeping and print. The Software structure is as shown in Figure 4 below.

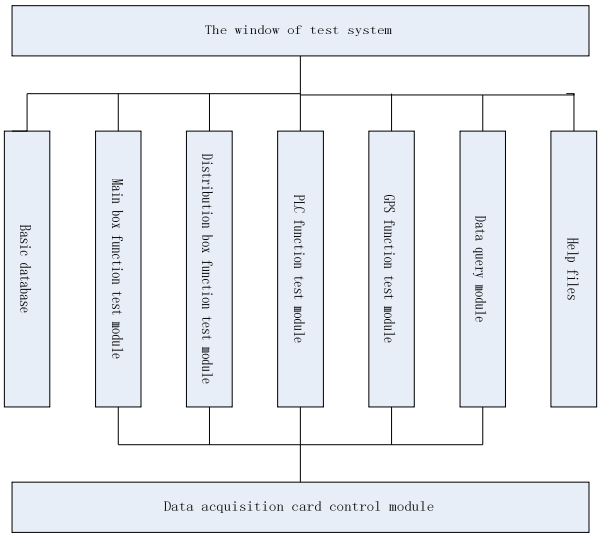

Fig. 4 Software structure

4.1 Basic database

Basic database is mainly used to save basic standard data coming from test .they are designed to notepads in order to save switch quantity instruction conveniently which is need in logical test and the simulation instruction of input and output signal. Each module calls a corresponding data file during testing time in order to judge whether the results are right.

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4.2 Main box function test module

The test module works through simulation quantity I/O interface circuit and communication circuit. It tests to find whether the working conditions are normal according to the logic process of main box.

4.3 Distribution box function test module

The test module works through analog I/O interface circuit. It tests to find whether the working conditions are normal according to the logic process of the distribution box.

4.4 PLC function test module

The test module works through simulation I/O interface circuit. It tests to find whether the working conditions are normal according to the logic process of the PLC.

4.5 GPS function test module

The test module works through the influence of the communication circuit on GPS [6]. It tests to find whether the working conditions are normal according to analysis of the testing data.

4.6 Data query module

System save the test result of each batch of data in order to it can be visited and printed.

4.7 Data acquisition card control module

The test module is used to achieve input and output of switch quantity and simulation quantity and communication interface code, which can be called by other test modules.

5. Experiment and results

In order to verify the system performance and maneuverability, we take experiment on a particular engineering vehicle .Test procedure as follows in Figure 5.

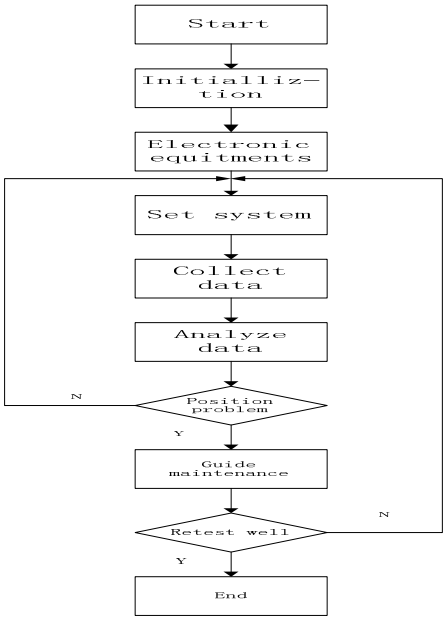

Fig. 5 Test procedure

The experimental results are as shown in Table 1.

Table 1 The experimental results

Program	Technical parameters and requirements	results
Function	Whether it can be used to test electronic equipment and problem can be located to independent unit.	Yes
Performance	Preparation time：≤ 5 min	3’22”
	Function conversion time：≤ 10 min	8’16”
	Test time：≤ 3 min	2’48”
	Withdraw time：≤10 min	5’01”
	Continuous working time：≥ 3h	6h
	Whether it is stable, complete, friendly, simple	Yes

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6. Conclusion

This paper introduced the test system design of electronic equipment of engineering vehicle based on PC104 bus. Hardware design made full use of PC104 bus technology, digital simulation technology and signal processing technology, and software design used hierarchical and modular system which combined the functional modules of test, board hardware driving modules and maintenance database. Proved by experiments, the system was stable, complete, friendly, simply and the main technical indicators and performance reached the application requirements. It could successfully help the engineering vehicle repair units and individuals solve test problem.

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