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Development of a Practical Training Device for Pantograph Debugging and Operating Skills of Chinese Standard EMUs

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Abstract

The high-speed EMUs in our country are developing rapidly, and there is a shortage of EMU-related operations and commissioning personnel. The training of such personnel is still based on theoretical explanations and real car commissioning. On-site debugging of real vehicles requires a lot of space and high cost. The existing debugging test bench has a simple set of failure methods and can only simulate a certain function. Therefore, a training device for EMU debugging operation skills based on PLC and MCGS touch screen is designed. This device can simulate the elevating bow function of the pantograph of the EMU and the situation of different failures in each circuit in a limited space. The faults can be set through the manual switch of the test bench, or the faults can be set in real time through the touch screen, forming a variety of different fault combinations, which are closer to the actual situation. This experimental platform can be used for professional skill training of railway employees and the principle teaching of EMUs, and it has more functions than the existing experimental platform.

Keywords

EMU Pantograph Debugging; PLC; MCGS.

1. Introduction

At present, more than 35,000 kilometers of high-speed railways have been put into operation in China, ranking first in the world. However, the rapid development of EMU technology, but the increase in the number of related technical personnel of the EMU does not match it. Therefore, designing a standardized EMU debugging operation skill device will facilitate the training of railway related practitioners. The pantograph is the link between the EMU and the catenary, the only way for the power source of the EMU, and the foundation of the reliability of the entire EMU. Therefore, the raising and lowering of the pantograph is the key to the operation of the EMU. During the debugging process of the EMU, some faults in the ascending loop, automatic lowering, and pantograph emergency power-off loop are set to form different combinations of faults. The trainees have a more comprehensive understanding of the principle of pantograph, so this set of training equipment for pantograph debugging and operation skills of EMU was designed. [1]

2. Brief introduction of EMU pantograph and its lifting principle

The The pantograph is a device that is installed on the top of the motor car to connect the car and the catenary so that electrical energy enters the high-voltage system of the motor car from the catenary. The main knots of the pantograph are the chassis, dampers, bow raising devices and so on. When the catenary is working, the body current flows from the catenary to the pantograph skateboard, then from the skateboard to the bow head, then enters the underframe along the upper and lower booms, and finally flows into the high-voltage system of the EMU, which is the EMU. Prerequisites are

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provided for the operation. The pantograph lifting device for high-speed EMUs consists of a bow-raising solenoid valve (RPSV), a bow-raising one-way throttle valve, a bow-falling one-way throttle valve, an ADD quick-discharge solenoid valve, a pressure switch one-way throttle, and a fast bow-lowering valve. Solenoid valve (LPSV) and other components. Its control principle block diagram is shown in Figure 1.

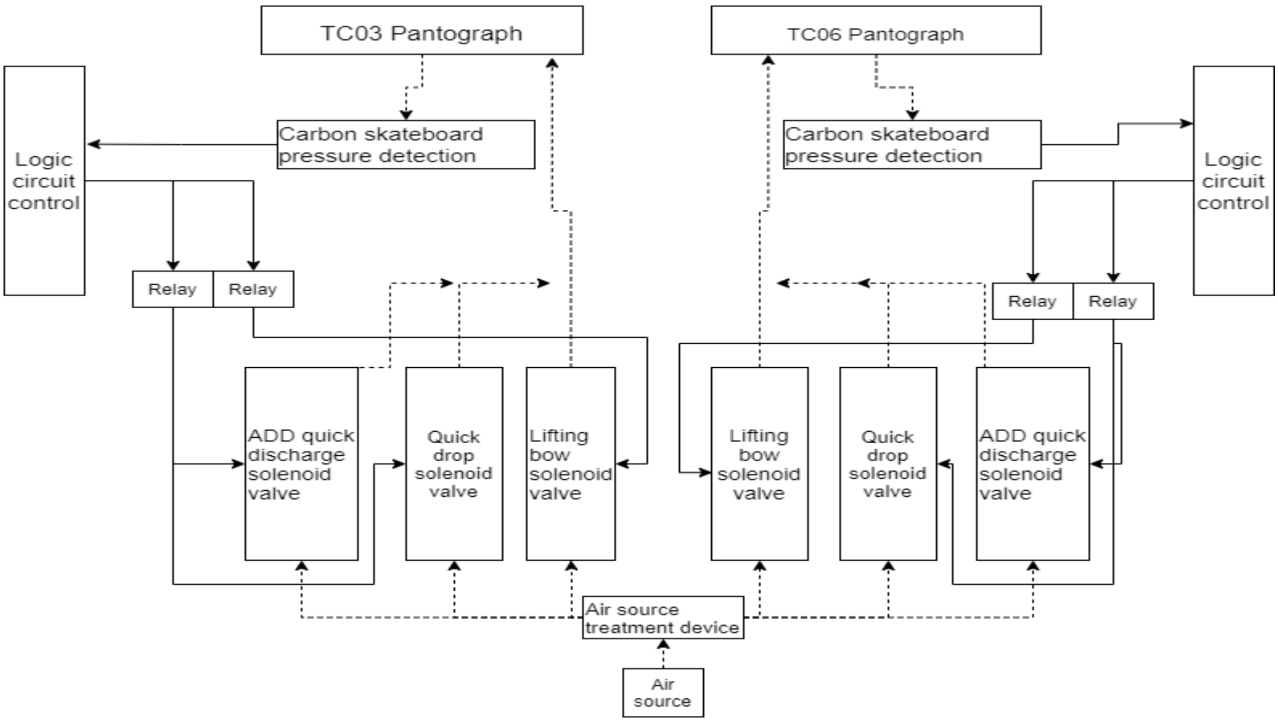

Fig. 1 Block diagram of pantograph lifting control principle

When the driver's cab presses the bow lift switch, the bow lift solenoid valve is energized. At this time, the bow lift one-way throttle valve is used to inflate the airbag to drive the pantograph to lift. At the same time, the ADD quick discharge solenoid valve is normally connected to the carbon slide plate. Inflate until the carbon sliding plate is in normal contact with the contact wire. If no accident occurs, the pantograph will be raised normally and the bow raising operation will end. When the bow is lowered, the solenoid valve is de-energized, and the air in the airbag is discharged to the exhaust port of the solenoid valve through the one-way throttle valve of the lower bow, and the pantograph is slowly lowered under the action of gravity. The pressure air in the pressure switch and the ADD solenoid valve is also discharged at the same time. The bow lowering operation is complete. Under the condition of bow lift, if the carbon slide plate is worn to the limit, the pressure value measured by the air compressor pressure switch does not reach the normal value within the specified delay time, it is considered that the pantograph is faulty, and the ADD quick discharge valve is energized. , Quickly exhaust the air in the airbag, and the pantograph will be lowered quickly to protect the pantograph and contact net from being damaged. The ADD quick-discharge valve can also be linked with the quick-lowering solenoid valve to quickly lower the bow when the power is cut off and the pantograph is hit by a foreign body to prevent the pantograph and catenary from being damaged. [2]

3. Experiment table design and function

Based on the main principle of high-speed EMU pantograph lifting and lowering, the test bench is designed with a fault detection function, which can set faults in various circuits. The test bench is a modular design. When using, the modules used are mounted on the test bench. The invigilator can turn off the switch corresponding to the breakpoint on the side panel or set the breakpoint through the touch screen. Therefore, the pantograph lifting system cannot operate normally. At this time, the trained personnel can perform fault analysis and measurement according to the electrical schematic diagram and the on-site situation, until the fault point is found, and the fault switch can be switched back to the normal state to eliminate the fault. Multiple faults can be set at the same time, and different combinations of faults can be set to increase the difficulty of training. At the same time, the number and location of fault points are displayed on the touch screen in real time. Through these functions, trainees can better understand the principle of pantograph lifting, so that invigilators can invigilate students more conveniently and improve the efficiency of training.

This experimental platform uses a standard operating platform as the basic frame. The pantograph lift control system is composed of 3 independent modules. When in use, the corresponding modules are mounted on the experimental platform, and the pantograph of the EMU can be simulated on one experimental platform. The lifting system has functions such as raising bow and lowering bow, ADD quick discharge and other functions, as well as common failures in different positions and different types of failure combinations. For example, vehicle grounding key circuit failure, emergency power-off circuit failure, bow lift circuit failure, etc. Through training, trainees can master the lifting principle of the pantograph system of EMUs, find and eliminate common faults, and improve their business capabilities. The basic framework of the experimental platform is shown in Figure 2

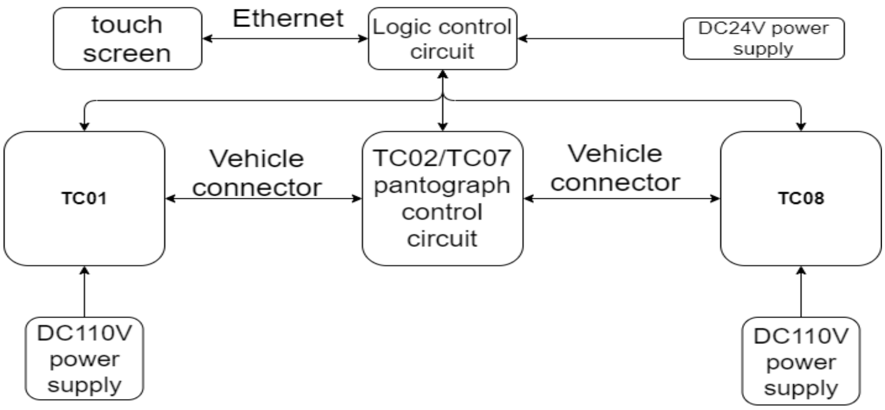

Fig. 2 Experiment table composition

4. Design of control system for experiment platform

The main control system of the experimental platform is controlled by a programmable controller. There are many types of programmable controllers (PLC), mainly Siemens, ABB, Mitsubishi, etc. The input required by this test bench, such as the emergency brake button, the lift bow switch, the driver's cab key, and the breakpoint are all switching values. There are 10 manual switch breakpoints and 10 breakpoints automatically set by the touch screen. The manual switch is set manually by the examiner on the test bench, and the automatic switch of the touch screen is set by the examiner on the touch screen and controlled by the intermediate relay. Since the internal voltage of the EMU is DC110V, and the total number of input/output signal points is actually counted, 15%~20% of the port reserve is increased. A large-scale measurement and control PLC is selected, the controller CPU is a PAG310 controller, and the expansion module uses 20 EIO103 with digital inputs and EIO172 with 15 digital outputs [3].

The breakpoint of this experiment platform is mainly connected to the expansion module. The manual switch on the side panel is a switch input, so it is directly connected to the expansion module EIO103. The breakpoint set by the touch screen is turned on and off by the intermediate relay control circuit, which is a digital quantity. The output is therefore connected to the expansion module EIO172. The programming software is the PLC-config developed by Dagong Computer, which is easy to use, and the programming language is similar to Siemens S7-200 SMART. The development idea of the PLC part is shown in Figure 3.

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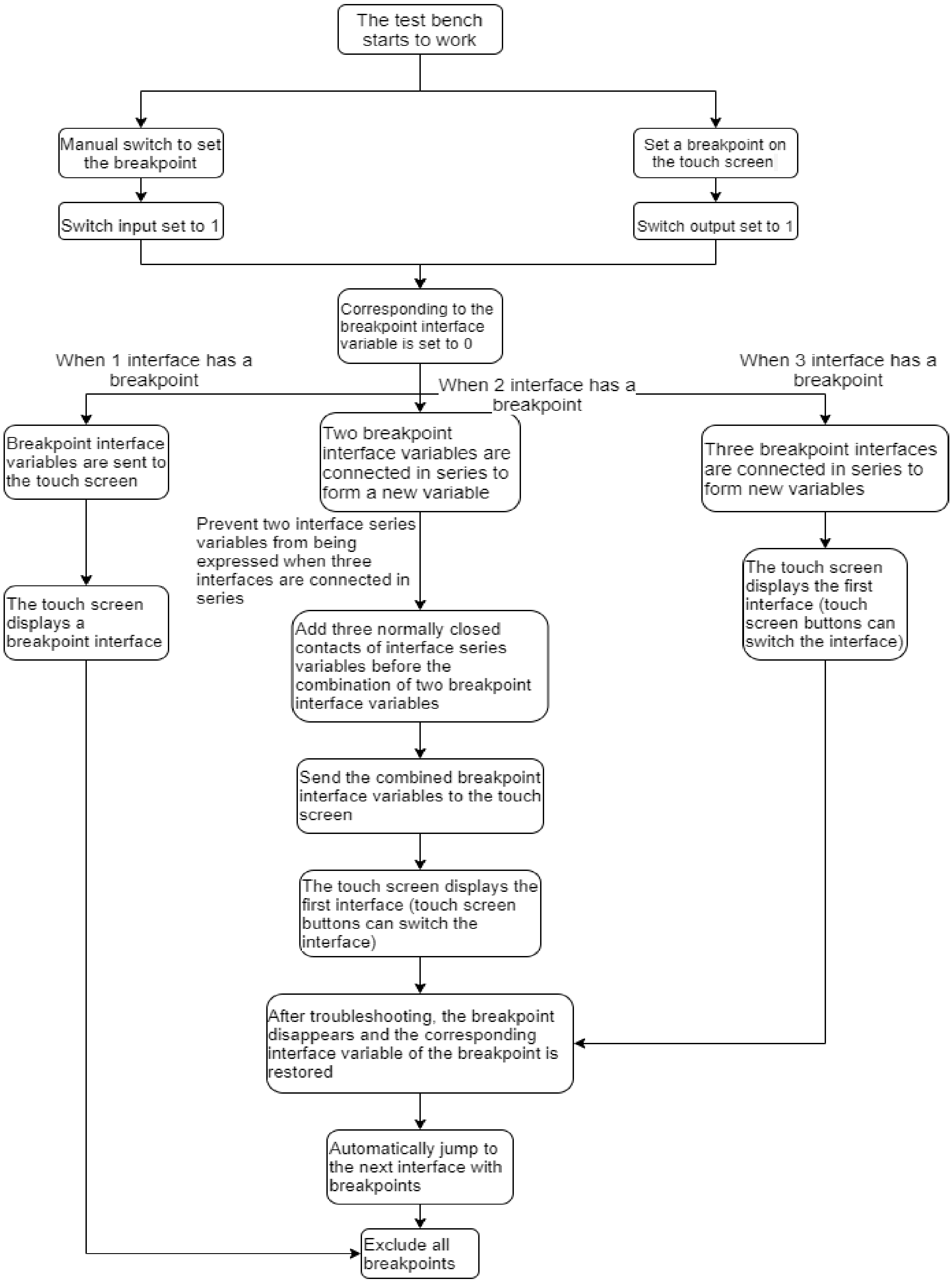

Fig. 3 Part of the development idea of PLC

5. Interface development and demonstration

In order to test the level of candidates more conveniently, observe the breakpoint exclusion in real time, and set new breakpoints, this experimental platform is designed with a human-computer interaction interface. The appearance of the breakpoint will be directly reflected on the touch screen. When the corresponding breakpoint is After troubleshooting, it will automatically jump to the next faulty interface. The touch screen selected by the experimental platform is the Kunlun ON-state MCGS1261Hi touch screen, and the two are connected by Ethernet. The pantograph module has drawn the electrical schematic diagram, and the red error number above is the switch representing the breakpoint. As shown in Figure 4.

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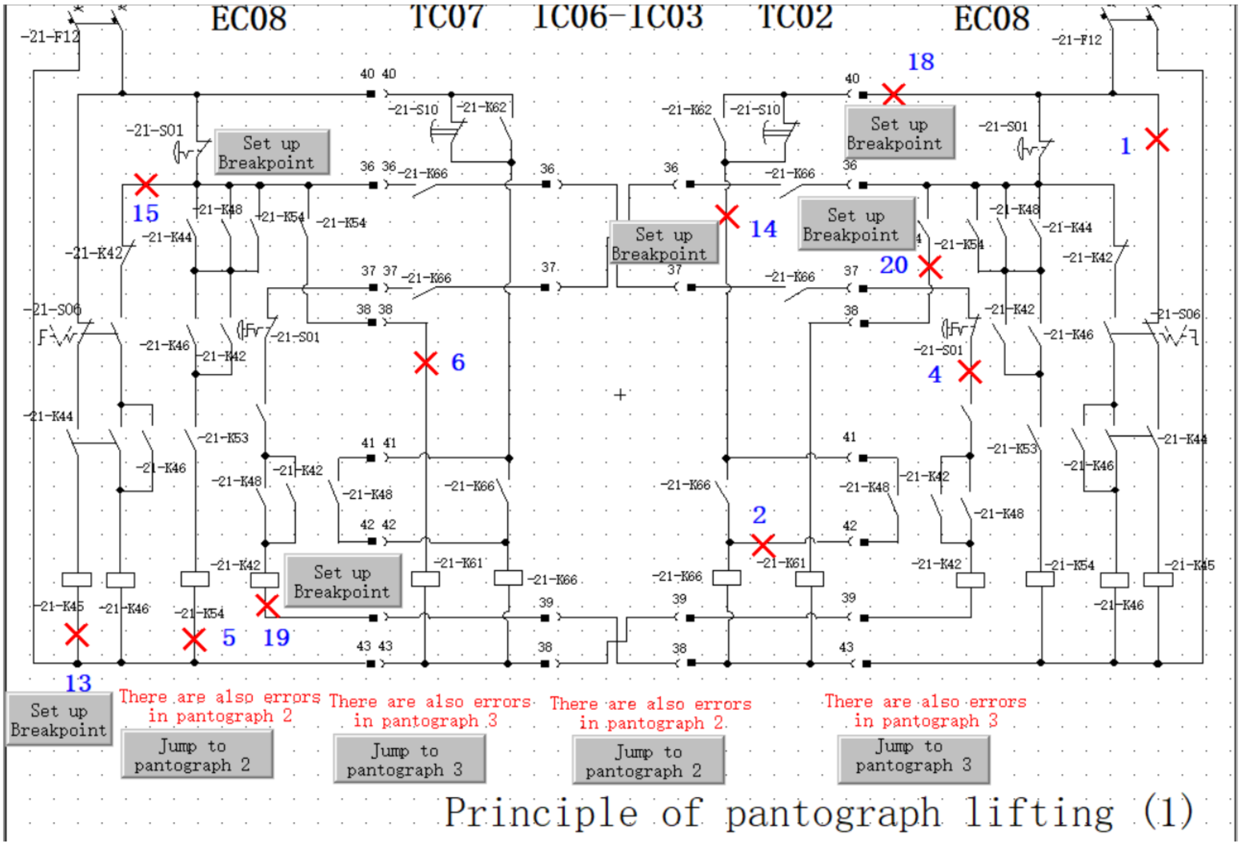

Fig. 4 MCGS circuit schematic interface

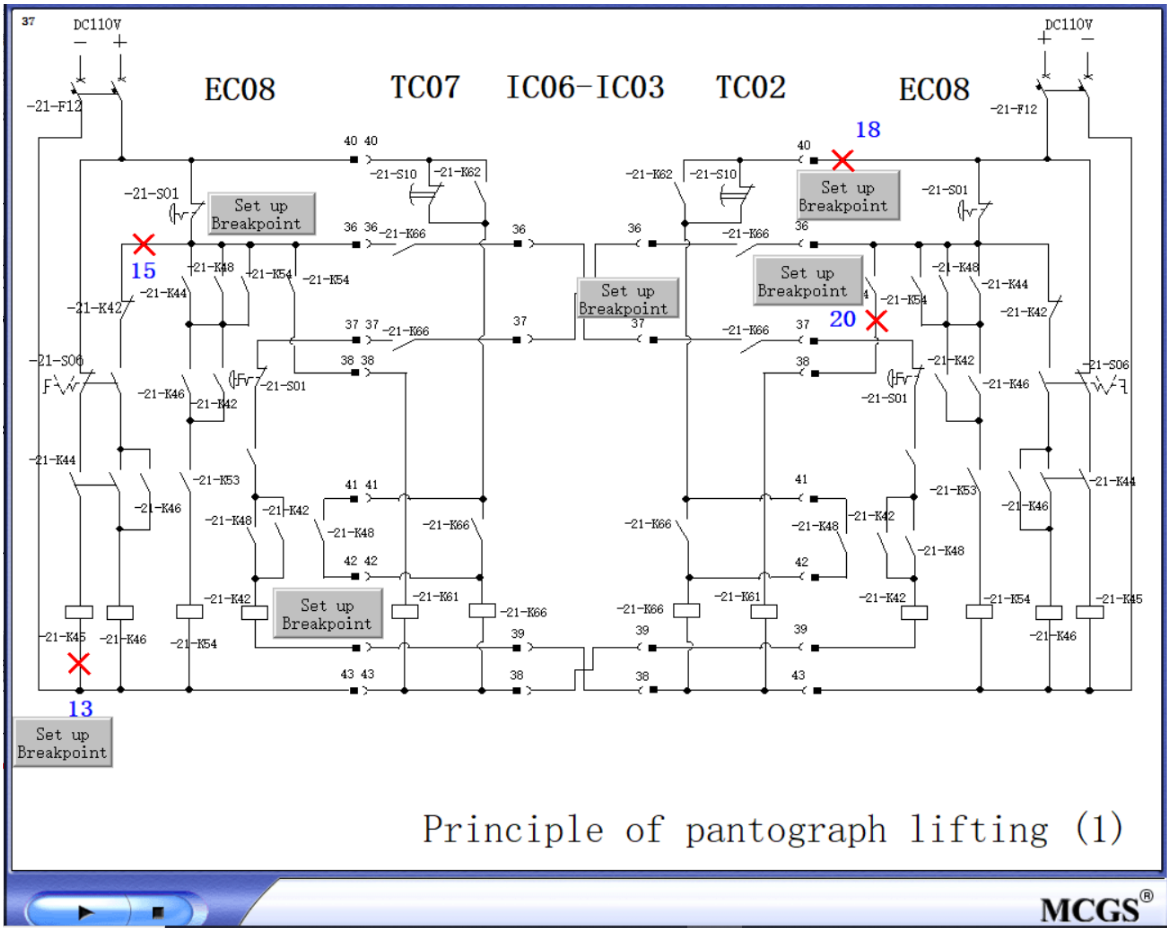

Fig. 5 Running results

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The main control logic of the touch screen of this experiment platform is to use the event strategy line to control the page jump. When a breakpoint occurs, the variable representing the interface with the breakpoint is changed. At this time, the event strategy is triggered by the pantograph interface 1, because at this time only the pantograph interface 1 has a breakpoint, so run the first line of conditions and turn on the receiver. Pantograph interface 1. When the switch representing the breakpoint is turned off, the page where the breakpoint is located will automatically pop up. When there are breakpoints on two or three pages, the words "A certain page also has a breakpoint" and a button will appear on the screen. Just click the button. You can jump to this page. When the candidate successfully eliminates the error, it will automatically jump to the next interface with a breakpoint. The runtime interface is shown in Figure 5. [4]

6. Conclusion

The test bench integrates the main functions of the pantograph of the EMU on a single test bench through a programmable logic controller. It is convenient for the trainees to understand the pantograph of the high-speed EMU in a limited space to raise the bow, lower the bow, and the ADD fast process of lowering the bow, And by setting breakpoints, a variety of fault combinations in actual situations can be simulated to improve the ability of trainees to deal with faults in the field. The experimental platform has the following advantages:

1. The test bench occupies a small space, which saves cost and space compared with the debugging of real cars.

2. The test bench integrates multiple functions. The traditional test bench can only set breakpoints through the side panel switch. This test bench can either manually disconnect the switch through the test bench side panel, or set the breakpoint in real time through the touch screen.

3. The test bench modularizes each loop, and can set multiple breakpoints and multiple different fault combinations, which is closer to the scene.

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