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RESEARCH ON MODULE DESIGN AND NETWORK MANAGEMENT OF ACCELERATOR POWER SUPPLY SYSTEM*

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Abstract

Accelerator power supply system is a very special system. Many factors such as high number of power supplies, uninterrupted operation and unreasonable design lead to high failure rate, long maintenance time and the discovery of the fault is not timely, which bring a lot of unnecessary troubles to the operator. In this paper, a networked control method for accelerator power supply is studied, and the power supply parallel connection technology is used to maximize the trouble-free time of the power supply and increase the redundancy performance of the power supply. With independent networked control, the accelerator power supply system becomes a whole, no longer relying solely on the control of the accelerator control system, but in a network system with self-diagnosis and self-healing. Through the monitoring and management of the upper computer, the power supply system will be work stable, and the function of remote operation and remote repair of the power supply is realized finally. This is a research direction for the operation of large accelerator power supply systems in the future.

INTRODUCTION

The BEPCII accelerator power system is controlled by a central control room. The remote power-on, remote shutdown, and current setting of the power supply can only be done by the central control room. When the power supply encounter minor problems and needs to be restored, The staff calls the power system personnel to come to repair or replace the backup power supply, which will delay the operation of the entire collider. The power system control interface of BEPCII is shown in Fig. 1.

The reliable operation of the accelerator power system is important for the long-term effective operation of the entire accelerator. The use of multi-module parallel technology to achieve a reduction in power failure rate, to achieve high reliability of the power system operation is an ideal choice for accelerator power. The mode of remote control of PS is shown in Fig. 2.

In addition to the reliability of the power supply itself, there is a need for improvement in the management of the power system. For example, a remote power control system helps to recover from failures quickly. If the power system owner can replace the backup power supply through a remote system, the recovery time will be reduced.

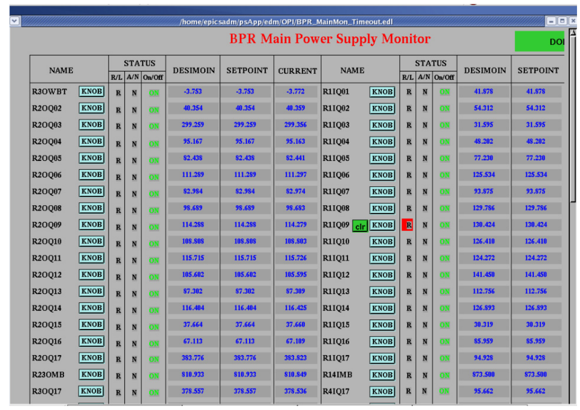

Figure 1: Power system control interface of BEPCII.

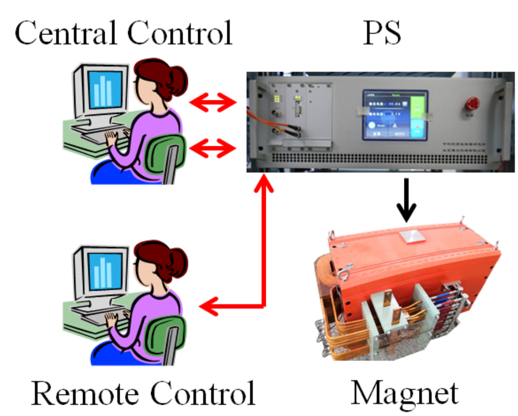

Figure 2: The mode of remote control of PS.

MULTI-MODULE DESIGN

The design of the 4+1 module parallel power supply is an effective method to reduce the initial failure rate of the power supply. The structure diagram of multi-module is shown in Fig. 3.

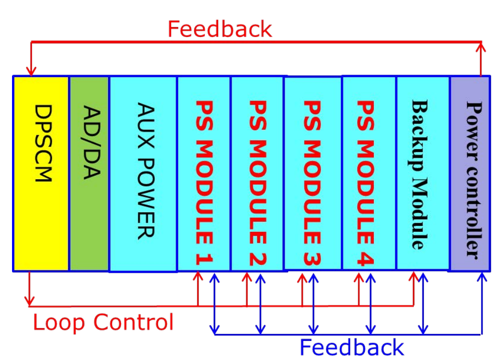

Figure 3: Structure diagram of multi-module.

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The block diagram includes FPGA-based digital power controller and an AD/DA board. There are a total of 4 module power supplies and one backup power supply. In addition, there is a DSP-based control panel for connecting the computer to the power supply for remote control of the power supply [1].

The actual power supply is made according to the block diagram of the parallel module. Adopt 5 modules in parallel. The specifications of the power supply are 20A/10V, and the specifications of each module are 5A/10V. The rack height is 3U and the width is 19 inches. The module power rack is shown in Fig. 4.

Figure 4: Module power rack.

The design of the 4+1 module parallel power supply is an effective method to reduce the initial failure rate of the power supply [2]. Figure 5 shows the internal structure of the power supply rack. There are 5 power supplies and a DSP-based digital controller.

Figure 5: Internal structure of the power supply.

The power supply design adopts a plug-in design scheme, which uses the backplane to supply power and use a group of DC sources together. The module is designed with an average current and each module can be put in and out. The control of each module is controlled by the DSP and the temperature can be measured. Figure 6 shows the printed circuit board of the module

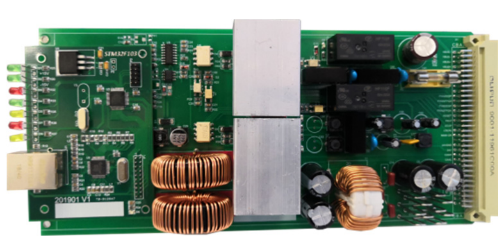

Figure 6: Printed circuit board of module.

The module power supply communicates with the DSP power controller through the CAN bus to transmit the control parameters of the power module. The module fault information and status are displayed on the front panel. The module has a separate external interface for expansion of module functions and modification of redundant power supply related addresses. The module controller uses the STM32F103 ARM processor to communicate with the debug computer via Ethernet. Figure 7 shows the controller of the module.

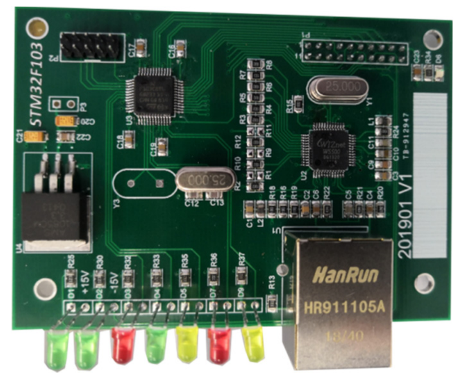

Figure 7: Controller of the module.

POWER MANAGEMENT DESIGN

In order to realize the network control of the power supply, three module power supplies were produced. Connect to the local power control system via a separate power remote control interface. Figure 8 shows the structure of three module power supplies.

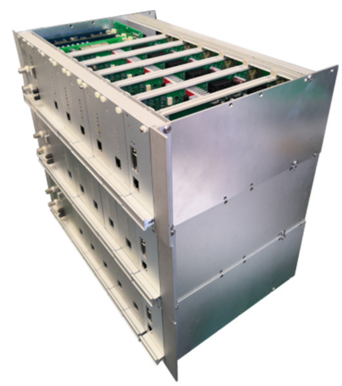

Figure 8: Three power supplies.

A simple power remote control interface was designed using LabView software. Three power control information is included in the interface. The interface also contains settings for IP address information for Ethernet communication [3]. Figure 9 shows the total control interface. In the interface, each power supply can be turned on and off, the current value of each power supply is set, and the power supply current value is displayed to display the core temperature of the power supply. Figure 9 show the total control interface of three modules power supply.

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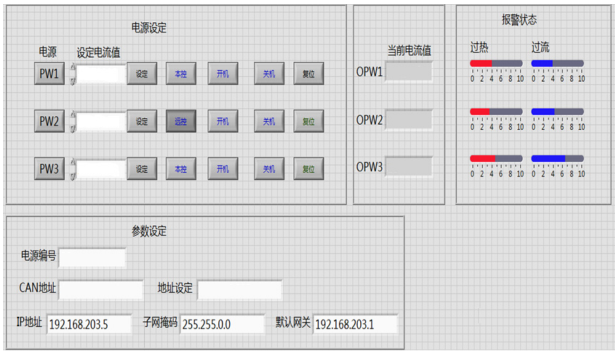

Figure 9: Total control interface.

Each power supply has an independent control interface. The current of the power supply can be set inside, and the current curve of the power supply can be observed, as well as the operation of each module. Figure 10 shows the single power control interface.

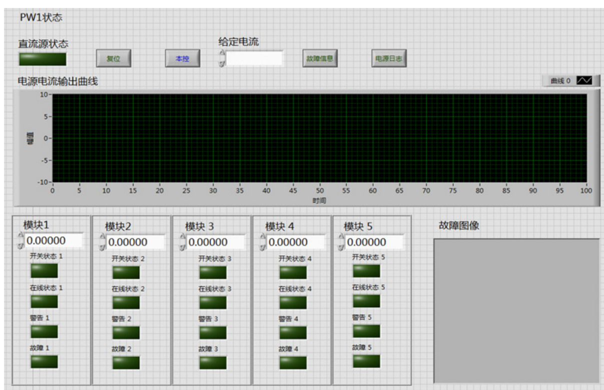

Figure 10: Single power control interface.

Each module power supply can be debugged and information read and address set via the STM32 control card installed on it [4]. And the previous maintenance record of this module can also be displayed through the interface. Figure 11 shows the module power debugging interface

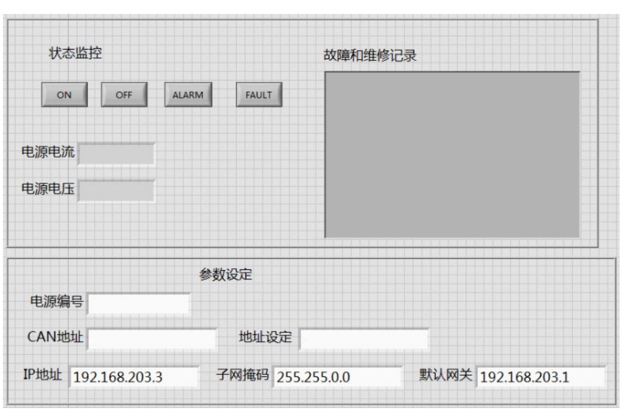

Figure 11: Module power debugging interface.

CONCLUSION

The effect of the parallel module power supply on reducing the initial power failure rate is obvious. Moreover, the initial failure rate is low, and the late failure rate is gradually increasing. Therefore, the module power supply also needs to be maintained frequently to maintain a low failure rate for a long time. The standby module can be put into operation quickly in the event of a power failure. On the other hand, in order to reduce the fault recovery time, an independent power remote monitoring system will play an important role. In the event of a power failure, the worker generally does not need to come to the site for processing, and the power is restored through the network system, which shortens the fault repair time.

ACKNOWLEDGEMENT

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