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 selfdiagnosis 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.

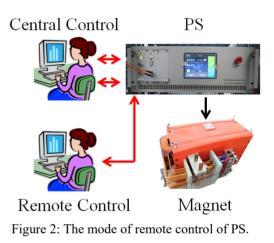
The reliable operation of the accelerator power system is important for the long-term effective operation of the entire accelerator. The use of multi-module parallel technology to achieve a reduction in power failure rate, to achieve high reliability of the power system operation is an ideal choice for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

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							m/OPI/BPR_N							
						BPR M	ain Pow	er Supj	ply Mo	onit	or			
NAME			STA'	TUS Ow/Off	DESIMOIN	SETPOINT	CURRENT	NAMI	Б		STA A/N	TUS Ow/Off	DESIMOIN	SETPOI
R3OWBT	KNOB	R	N		-3.753	-3.753	-3.772	R11Q01	KNOB	R	N		41.878	41.578
R2OQ02	KNOB	R	N	ON	49.254	48.354	40.259	R11Q02	KNOB	R	N	ON	54.312	54,312
R2OQ03	KNOB	R	N	ON	299.259	299.259	239.356	R11Q03	KNOB	R	N	ON	31.595	31.595
R2OQ04	KNOB	R	N		95.167	95.167	95.163	R11Q04	KNOB	R	N	ON	45.292	48.282
R2OQ05	KNOB	R	N	ON	82.438	82.438	82.441	R11Q05	KNOB	R	N	ON	77.230	77.230
R2OQ06	KNOB	R	N		111.289	111.289	111.297	R11Q06	KNOB	R	N	ON	125.534	125.53
R2OQ07	KNOB	R	N		82.984	82.994	\$2.974	R11Q07	KNOB	R	N	ON	93.875	93.875
R2OQ08	KNOB	R	N	ON	95.659	95.659	98.683	R11Q08	KNOB	R	N	ON	129.786	129.78
R2OQ09	KNOB	R	N		114.288	114.289	114.279	R1IQ09	KNOB	R	N	ON	130.424	138.42
R2OQ10	KNOB	R	N		105.505	105.505	105.503	R11Q10	KNOB	R	N	ON	126.418	126.41
R20Q11	KNOB	R	N		115.715	115.715	115.726	R11Q11	KNOB	R	N	ON	124.272	124.27
R2OQ12	KNOB	R	N		105.402	105.602	105.595	R1IQ12	KNOB	R	N	ON	141.450	141.45
R20Q13	KNOB	R	N		\$7.302	87.382	\$7.309	R11Q13	KNOB	R	N	ON	112.756	112.75
R20Q14	KNOB	R	N		116.404	116.404	116.425	R11Q14	KNOB	R	N	ON	126.893	126.893
R2OQ15	KNOB	R	N		37.664	37.664	37.668	R11Q15	KNOB	R	N	ON	38.319	30.319
R2OQ16	KNOB	R	N		67.113	67.113	67.109	R1IQ16	KNOB	R	N	ON	85.959	\$5.959
R20Q17	KNOB	R	N	ON	3\$3.776	383.776	353.523	R11Q17	KNOB	R	N	ON	94.928	94.928
R230MB	KNOB	R	N	ON	\$10.923	\$10.933	810.549	R14IMB	KNOB	R	N	ON	\$73.508	\$73.50
R30Q17	KNOB	R	N		378.557	378.557	378.536	R4IQ17	KNOB	R	N		95.662	95.442

Figure 1: Power system control interface of BEPCII.



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.

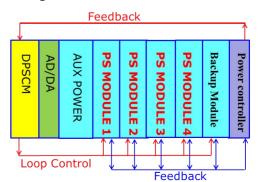
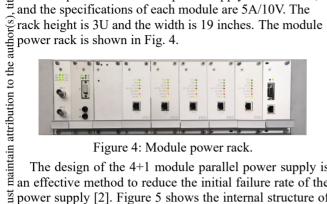


Figure 3: Structure diagram of multi-module.

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and I The block diagram includes FPGA-based digital power 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 of the 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



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 work 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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本控 **开机**

地址设定

子网掩码 255.255.0.0

电源设计

設定 319

余款沿台

电源 设定电流值

PW1

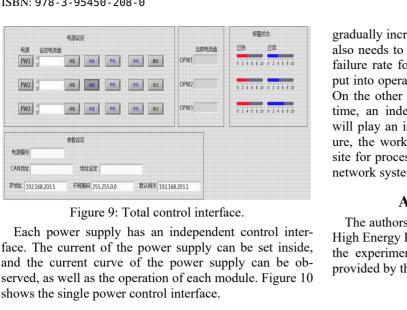
PW2

PW3

电源编号

CANthat

IP地址 192.168.203.5



直流源状态	類位	给定电	3流	8 R.#85			
电源电流输出的	 曲线						曲线 0 🔨
10-							
-5-							
-10-							
-10-	10 15 20	25 30 35	40 45 50 时间	55 60 65	70 75 80	85 90	95 10
横块1	io is io is io	· 25 30 35			70 75 80	85 90	95 10
横块1			at la			85 90	95 10
· · · · · · · · · · · · · · · · · · ·	模块2	模块 3	时间 模块 4	模块 5 0.000000 开关状态 5		85 90	95 10
0 s 模块1 0.00000 ^{开关状态 1}	楼块2 0.00000	模块 3	时间 模块 4	模块 5 0.00000 开关状态 5		85 90	95 10
0 5 模块1 0.00000 开关状态 1 正成状态 1	楼块2 0.00000 开关状态 2 在域状态 2	模块 3	时间 使快 4 0.00000 开关状态 4 在线状态 4	模块 5 0.000000 开关状态 5		85 90	95 10
0 5 模块1 0.00000 开关状态 1 在成状态 1	模块2 0.00000 开关状态 2 在线状态 2	模块 3 0.00000 开关状态 3 在线状态 3	町周 使決4 0.00000 开矢状志4 正統状志4	機块 5 0.00000 开关状态 5 在16代表 5		85 90	95 10
0 5 模块1 0.00000 开关状态 1 在成状态 1	模块2 0.00000 开关状态 2 在线状态 2 智密 2	模块 3 0.00000 开关状态 3 正确的 在线状态 3 面面 容易 3	时间 使快 4 0.00000 开关状态 4 在线状态 4	模块 5 0.00000 开关状态 5		83 90	95 10
0 5 模块1 0.00000 开关状态 1 在场状态 1	模块2 0.00000 开关状态 2 在线状态 2	模块 3 0.00000 开关状态 3 在线状态 3	町周 使決4 0.00000 开矢状志4 正統状志4	機块 5 0.00000 开关状态 5 在16代表 5		83 90	95 10

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

状态监控	故障和维修	多记录
ON OFF AL	FAULT	
电源电流		
电源电压		
	参数设定	
电源编号		
CAN地址	地址设定	
	子网掩码 255.255.0.0	默认网关 192.168.203.1

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

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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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- [3] W5500 Datasheet (PDF), http://pdf1.alldatasheet.com/datasheet.pdf/view/ 554784/ETC2/W5500.html
- [4] STM32F103CBT6 Datasheet (PDF), http://pdf1.alldatasheet.com/datasheetpdf/view/499695/STMICROELECTRONICS/STM32F103CBT6 .html