

HIRFL-CSR POWER SUPPLY SYSTEM

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Abstract

There are more than 200 power supplies will be employed in CSR power supply system. These power supplies provide DC and pulsed exciting current for all magnets in main ring (CSRm), experiment ring (CSRe), injection line of CSRm and RIB line. Six small-scale prototypes have been designed and made before formal manufacture. One thyristor rectifier pulsed converter was delivered to Lanzhou in January and all measurement has been finished in April. The result is satisfied.

1 INTRODUCTION

The dipole and quadruple supplies in CSRm and CSRe can be operated in two operation modes: synchronization mode and DC mode. In synchronization mode, the repetition cycle is 17 seconds. The rising-time of current pulse is 3 seconds, falling-time is 3 seconds, and flat top is 1 seconds and flat base is 10 seconds. In falling section, magnet output voltage turns to negative. This means energy stored in magnet feedback to mains. Power supply operates as an inverter in this stage. All power converters in CSRm and CSRe system need DC and pulsed output. These power supplies must have high current stability, low current ripple and good dynamic characteristic. The current stability is $\pm 2 \times 10^{-5}$ /8h, ripple is less than 1×10^{-5} , and tracking error is $\pm 2 \times 10^{-4}$. The other power converters need DC mode only. And the current stability and ripple are not so high. So there are several types power converter we can select. Traditional thyristor multi-phase rectifier converter, series-regulator converter and switching mode converter can be considered based on the operation mode, current stability and ripple, dynamo characteristic, output power and so on. For large power supplies, such as dipole magnet and large quadruple magnet power converters, classic 12-phase-shifted thyristor rectifiers will be employed. For middle and small power converters, switching mode power supply is the best choice due to the high efficiency and small size.

2 PROTOTYPES

Our power supply provider never produced pulsed power converters and has poor experiences correspondingly. It is necessary to make a prototype to test the design and obtain experiences before formal manufacture. We select some power supplies in beam line as small-scale prototypes. Three of them are thyristor rectifier type and three are switching mode type. And these prototypes will be designed and manufactured by three different companies. So there are three different designs correspondingly. We hope we can find the best one from them. All parameters of prototypes are same or higher than power supplies in CSRm and CSRe. The prototypes have the same structure as the dipole supplies in CSRm and CSRe. All prototypes are listed here:

Table1 Prototypes of HIRFL-CSR

Prototype	Output	Principle
PS4D01-02	1250A/130V	thyristor
PS4D03-05	510A/190V	thyristor
PSTCAB2-B3	570A/270V	thyristor
PS4Q80-400	340A/30V	switching

The power supply PSTCAB2-B3 was delivered to Lanzhou January and tested in March. The PS4D01-02 has being tested since this May.

3 CIRCUIT DESIGN

Figure1 shows the main circuit of the pulsed thyristor rectifier converter. And figure2 is the block diagram of control loop. The supply is consisted of four sections: 1) SCR 12-phase rectifier; 2) passive filters; 3) active filter; 4) regulator. In fact, thyristor rectifier is composed two series connected 6-phases Rectifier Bridge. After the passive filter, a resonant filter is employed to suppress 600Hz ripple specially.

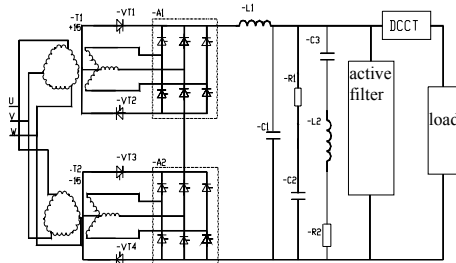


Figure1

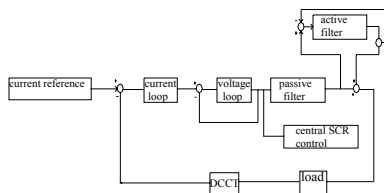


figure 2

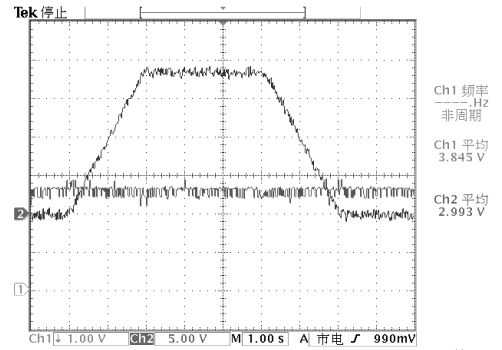
The regulator composes voltage loop and current loop. Voltage loop, the outer loop, is used to suppress the float of mains. So the outer loop need wide bandwidth and fast frequency response. The current loop, the inner loop, needs high gain and narrow bandwidth to attenuate the changes of the load.

4 TEST RESULT AND CONCLUSION

Because this prototype will be operated DC and pulsed mode in future, so DC and pulsed characteristic are tested also. Table2 shows the test result of DC output. Figure3 is the waveform of tracking error. All tested result is in the permitted range. The design is proved successfully.

Table2 DC Characteristic

Parameter		Test result
Long-term stability	570A	9.8×10^{-6}
	200A	3.5×10^{-5}
Current ripple (570A)	100HZ	1.9×10^{-6}
	300HZ	5.6×10^{-7}
	600HZ	6.8×10^{-7}
	900HZ	8.4×10^{-8}
Repetition		7×10^{-5}
Cycle-to-cycle repetition		3.2×10^{-5}



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Figure3

REFERENCE

- [1] E.Tacconi. LEB Ring Magnet Power Supply System Voltage and Current Regulation Design. January 1992.
- [2] J.Lisser and K.Bouwknegt IEEE Transaction on Nuclear Science, Vol.NS-28 NO3, June 1981 High-speed High-precision Programmable Magnet Power Supply For a Wide Range of Magnet Time Constants