

SSRF MAGNET POWER SUPPLY SYSTEM

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Abstract

The Shanghai Synchrotron Radiation Facility (SSRF), a third-generation synchrotron radiation light source, has 520 sets of magnet power supplies for the storage ring and 163 sets for the injector. All of the power supplies are in PWM switched mode with IGBT. A high precision DC power supply for 40 dipoles rated at 840A/800V with a stability of $\pm 2 \times 10^{-5}/8h$ is used for the storage ring. The main winding of quadrupoles are excited by 200 sets of chopper type power supplies, respectively. In the booster ring, two sets of dynamic power supply for the dipoles and two sets for quadrupoles run at the biased 2Hz quasi sinusoidal wave. All the power supplies work with digital power supply controllers designed by PSI or SINAP. All power supplies were manufactured at professional power supply companies in China.

POWER SUPPLY CONTROLLER

A control solution of full digital control as Switzerland Light Source (SLS) is adopted in high power supplies for dipoles of the storage ring and booster. A PSI controller mounted in the power supply cabinet works as a master to control several analog slaves, which regulate the output current. The full digital control offers better performance in stability, repeatability and flexibility, with long term stability of power supply for storage ring dipoles of 10 ppm.

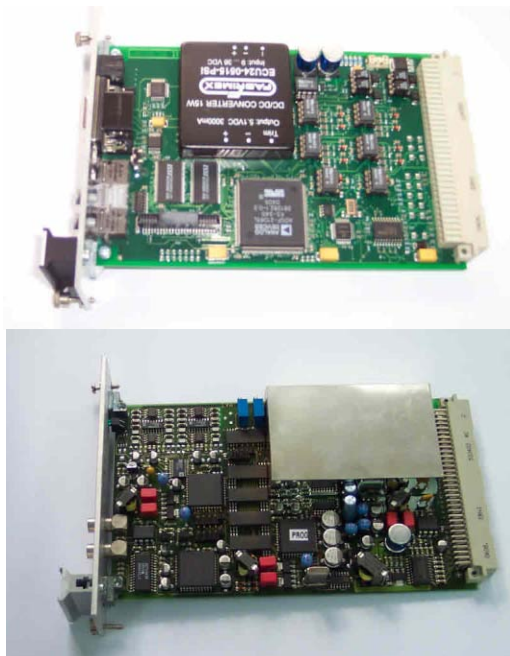


Figure 1: The power supply controller (PSI design)

One cost-effective power supply controller was developed at SINAP, with a stability of up to 20 ppm. They are used in median size and small power supplies in the injector. The controller uses TMS320F2812, which has a clock of 150 MHz with 25 ns time resolution of PWM. Their digital Input and Output ports, electrically isolated from each other, are in 8 bit. The controllers communicate with EPICS via Ethernet and Serial port server by optical fiber, or with local PC by RS232.



Figure 2: The digital power supply controller developed at SINAP

LINAC POWER SUPPLY

SSRF is mainly composed of a 150 MeV linac, a 3.5 GeV booster and a 3.5 GeV Storage ring. The linac has unipolar power supply in topology of chopper or full bridge (half bridge), and bipolar power supply in topology of H bridge. Each of the power supplies is of 1 KW and is placed in a case in a 19" standard cabinet with main

power line. A small power supply is in a structure of common DC link.

An LEM current sensor is adopted in power supplies with stability of better than 1000 ppm, and a DCCT for those with stability of better than 100 ppm. A sampling resistor is used in small bipolar power supplies, such as corrector power supply.

The digital PWM controller communicates with EPICS via Ethernet and serial port server via optical fiber.

BOOSTER POWER SUPPLY

In the booster ring, six sets of dynamic power converter run at the repetition rate of 2 Hz for 48 dipoles, 56 quadrupoles and 46 sextupoles.



Figure 3: The linac power supply



Figure 4: The booster power supply

STORAGE RING POWER SUPPLY

Most magnet power supplies in the storage ring are static. It is important for them to work with higher precision, stability and repeatability. For example, a static power supply for 40 bending dipoles, an IGBT type converter rated at 800A/840V, has a long term stability of is 20 ppm in 24 hours.



Figure 5: Dipole power supply in the storage ring

Two hundred sets of chopper type power supply were designed to excite the main windings of 200 quadrupoles respectively. Every five choppers share a common DC link voltage source. The stability of the output current can be $\pm 2 \times 10^{-5}$ for 24 h.



Figure 6: Quadrupole power supply in the storage ring

The 140 sextupoles are divided into 9 groups. A chopper is employed for the main windings of each group. Therefore there are 9 power supplies for sextupoles

All the power supplies in the storage ring work with the digital power supply controllers designed by PSI.



Figure 7: Sextupole power supplies in the storage ring.

CONCLUSION

So far the power system works well for over half a year. It has been proved that the system with the digital power supply controller is more reliable and flexible, as well as higher accuracy and stability.

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