

CONSTRUCTION OF SSRF MAGNET POWER SUPPLY SYSTEM

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Abstract

The Shanghai Synchrotron Radiation Facility (SSRF) is a third-generation synchrotron radiation light source under construction. In SSRF, there are 520 sets of magnet power supplies for the storage ring and 163 sets for injector. All of the power supplies are in PWM switched mode with IGBT. A high precision stable output power supply for 40 dipoles rated at 840A/800V with the stability of $\pm 2E-5/8\text{hrs}$ will be used for storage ring. 200 sets of chopper type power supply will be used for exciting main winding of quadrupoles respectively. In booster ring, two sets of dynamic power supply for dipoles and two sets for quadrupoles will run at the biased 2Hz sinusoidal wave. All above power supplies will work with digital power supply controllers designed by PSI. All power supplies are being manufactured at professional power supply companies in China.

POWER SUPPLY CONTROLLER

A control solution of full digital control as Swiss Light Source(SLS) is adopted in large power supplies for dipoles of storage ring and booster. A pair of PSI controller (See Fig.1) are put inside the power supply cabinet as a master to control several analog slaves, to regulate the output current. There is a 60MHz DSP with 32/40 Bit floating point ALU, 8x16 bit electrically isolated AD converters (50ksps), 11 free memory units for 16,384 data points [2]. It can communicate with IOC through a pair of 5MB optical fibers. The main advantage of the full digital control is much better in stability, repeatability, and flexibility. At present, the long term stability for a sample power supply is up to 10ppm.

Additionally, in order to reduce the cost we have managed to develop a home-made power supply controller product. So far the stability is achieved 20ppm and this controller is expected to use in middle and small power supplies in SSRF linac after authentication.

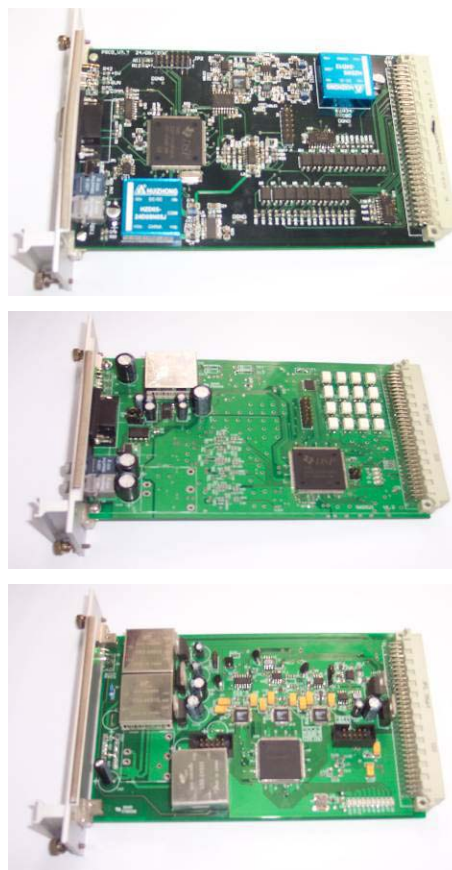


Figure 2: Home-made power supply controllers

LINAC POWER SUPPLY

SSRF is mainly composed of three parts: the 150MeV linac, the 3.5GeV booster and the full energy storage ring. In linac, unipolar power supplies adopted the circuit of chopper, full bridge (or half bridge), and bipolar power supplies adopted the circuit of H-bridge. The medial power supplies above 1kW adopted the full 19" width structure which put inside a standard 3U case. Other small power supplies shared the full 19" width by 2 to 3 units and used the common input DC module [3].

A LEM as a current sensor is adopted for those stability requirement larger than 1000ppm, a DCCT for those stability better than 100ppm, and a resistor for the bipolar power supplies, such as corrector power supplies.

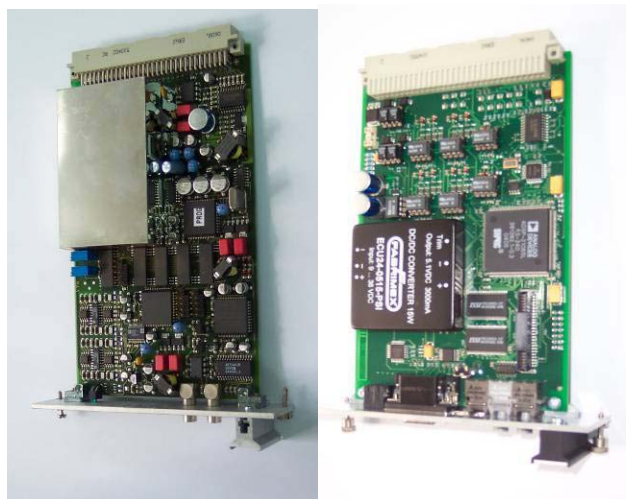


Figure 1: PSI power supply controllers

The home made digital PWM controller can be adopted in linac, which communicate with EPICS via Ethernet and Serial port server.



Figure 3: $\pm 10\text{A}/25\text{V}$ bipolar power supply

BOOSTER POWER SUPPLY

In SSRF booster ring, two sets of dynamic power supply for 48 bending dipoles run at the repetition rate of 2Hz, which are in two quadrants topology with energy recover and rated of 1150A/1000V. A DC/DC booster chopper is staged in series, so that the voltage fluctuation on the power line could be reduced dramatically. A scaled prototype rated 600A/500V was built and tested, the topologic structure of power has been verified as well. A PSI digital PWM controller will be used in the dynamic power supply as a control master with global current feedback loop. Under digital commands from the central control system, PSI controller produces PWM outputs which be converted into analog voltage via a special circuit. This control voltage is then delivered to the analog PWM controllers, which has been designed to manipulate a power module with local feedback loop.



Figure 4: Booster power supply

STORAGE RING POWER SUPPLY

Most magnet power supplies in SSRF storage ring are static. High precision, stability and repeatability are important. The main power supply for 40 dipoles will be an IGBT type converter rated for 800A/840V. The long term stability requirement of this power supply is 20ppm (within 24 hours). Its scaled prototype rated for 400A/840V was built and tested with the stability of $\pm 20\text{ppm}$. The power supply will work with digital power supply controllers designed by PSI.

200 sets of chopper type power supplies are being manufactured to excite the main windings of quadrupoles respectively. Every 5 choppers share a common DC link voltage source. A prototype of power supplies with ratings of 280A/35V for 5 quadrupoles have been built and tested with the output current stability of $\pm 50\text{ppm}$ for 24hrs.

140 sextupoles are divided into 9 groups. A chopper will be employed for the windings of each group in series. The scaled prototype rated of 400A/840V as mention above matches the demand of the sextupole power supplies.



Figure 5: Storage ring power supply

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