High Precision Power Supply SCE Model 450

This family of high precision power supplies was custom developed for **Brookhaven National Laboratory** to power superconducting Corrector and Control Magnets for the **Relativistic Heavy Ion Collider (RHIC)**. Six hundred and fifty units are located around the two mile ring.

These power supplies are actually controlled current sources which are remotely programmed to deliver specified currents through the superconducting magnet coils. Time and temperature stability specs are very tight -.05% repeatability and stability over 12 hours and 20 ppm temperature stability at full current. Output noise is also exceptionally low 5 mvpp. Additionally, during beam formation and shutdown, magnet current is ramped up and down. However, because of the very low resistance associated with these magnets - it is only the lead-in cable resistance during ramp down, the voltage across the magnet reverses polarity and the magnet actually delivers power to the supply. Thus the supply must be capable of **4 quadrant** operation, while keeping current under very tight control at all times.

The SCE model 450, the first unit delivered, consists of a full bridge resonant phase controlled converter whose variable output feeds a bridge output circuit that performs polarity switching and fine-grain control. A new current sensor was developed based on flux gate magnetometer techniques that features much better stability and less noise than traditional current shunts - these power supplies can be set to within **milliamps** of commanded current at the **50 Amp** level.

The unit features full protection, error detection and reporting, start-up sequencing, etc., all under microprocessor control. In addition, a special over-voltage circuit called 'Quench Protection' (necessary only with superconducting magnets) is incorporated.

Major Specifications
Model 450

Output:

Voltage	-20 to +20 VDC
Current	-50 to +50 Amps
Control	Analog: 5 Amps/Volt
Linearity/Repeatability	.05% control voltage to output current
Absolute Accuracy	.5%, .1% typical
Stability	20ppm/ºC, 50 ppm/12 hours
Output Noise, Common Mode	10MVPP/1MHz BW
Output Noise, Normal Mode	5 MVPP/1MHz BW
2nd and 4th Quadrant Operation	2V Max, internally settable

Switching Frequency	100KHz ±10%, front panel adjustable
Input Power:	
Voltage	208VAC ± 15%, 60 HZ, 3
Maximum	1400W
Input Power Factor	>85% at 700 watts or more! Better than 90% at full load
Remote Inputs:	
Standby	TTL Levels
Off	TTL Levels
Operate	TTL Levels
Contactor Enable	TTL Levels
Analog Outputs:	
Output Voltage (Chassis Reference)	1V/2V ± .2%
Current (Chassis Reference)	1V/5 Amp ± .1%
Setpoint (Chassis Reference)	1V/1V ± .1%
Error:	1V=10 mV error
Operating Modes:	
Current Mode	1Volt = 5 Amps
Voltage Mode	1Volt = 2 Amps
Front Panel Adjustments & Testpoints:	
Overcurrent	30% - 100%, full output
Overvoltage (quench)	1V to 20V
Quench Delay	V/sec
Heatsink Temperature	10 mV/°C

The model 450 performed so well that the family was expanded to include the 150 Amp (Model 440) and 300 Amp (Model 470).

The circuitry for the 440 and 470 is very similar to the 450, except control circuitry for the large supplies is modularized and relocated to removable VME cards.

The Model 440 (150 Amp) consists of a single off-line converter coupled with a larger (compared to the 450) bridge output section.

The Model 470 consists of two Model 440 power sections (converter and bridge output modules) stacked on the control electronics card cage. The technique is readily expandable to higher power levels.