A.10: New Power Supplies for Transport Line-1 Quadrupole Magnets in Indus

Transport line-1 (TL-1), installed in Indus complex at RRCAT, is used to transfer electron beam at 20 MeV from microtron to booster synchrotron which ramps up the energy of electron beam to 450 MeV for Indus-1 and to 550 MeV for injection in Indus-2. Six quadrupole magnets are installed in TL-1 which are energised by stable constant current sources. Existing power supplies for quadrupole magnets in TL-1 are based on series pass scheme and are in operation for several years. These are being upgraded with new, compact, efficient and stable power supplies developed at PSIAD. Input to the power supplies is 230 V, 50 Hz ac while the output current and voltage ratings are 5 A and 12 V, respectively with specified output current stability of ±500 ppm.

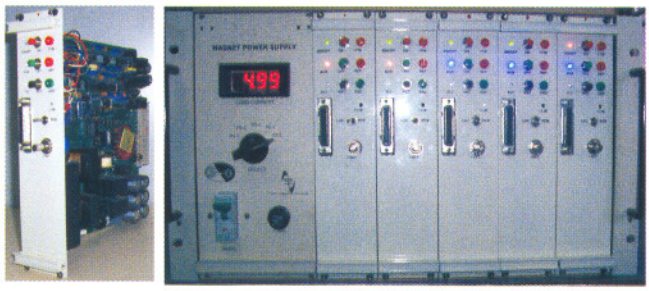

Fig. A.10.1: Power supply card and sub-rack

Switch mode power supplies (SMPS) have an edge over series pass scheme because of its reduced size, lighter weight and better efficiency. Two-switch forward converter topology is chosen amongst various SMPS topologies since it is simple, rugged, tested and proven. The power supplies developed for the present application are an improved version of those developed for CUTE FEL (Ref: RRCAT Newsletter, Vol. 23, Issue 1-2010, pp.-2). In addition to the features incorporated in the CUTE FEL power supplies like output-current-limiting, over-current protection, two-loop based feedback control scheme and remote operation capability [1], some circuit enhancements and layout modifications have been done in these supplies to strive for better performance and standardization of power supply cards for similar future applications.

Layout modifications in supply card include generalization of footprint for magnetic components so as to accommodate various ferrite core geometries (e.g. EE36 and EE42). Similarly, generalized footprint for power devices is provided on PCB to suit various packages (e.g. TO-220 and TO-247). The PCB layout is optimized to accommodate additional input filter capacitors and bigger heatsinks with approximately 50 % more surface area.

In addition to the layout optimization, various enhancements in the circuit design have been carried out. With this, it is possible now to increase the dc link filter capacity by 50 % to further reduce 100 Hz ripple component in the output current. Precision MFR resistors with temperature coefficient of ±15 ppm/°C and ±0.1 % tolerance are used in front-end control circuit to improve output current stability. A common mode choke is added on the output terminals to suppress common mode noise in the output. Grounding on the PCB is further optimized to minimize interference of high-frequency noise in the analog control circuit. The electronics needed for local/remote operation has been redesigned to comply with the existing interface.

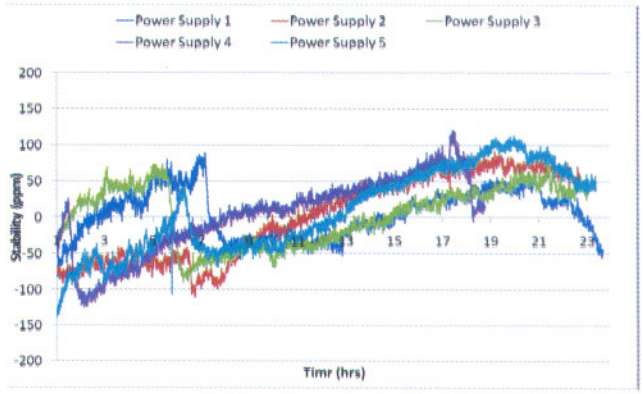

Fig. A.10.2: Output current stability curves of 5 power supply units for 24 hrs of continuous operation

Each power supply is standardized on a 6U card and five such power supplies are housed in one 6U, 19-inch sub-rack. Figure A.10.1 show the photographs of a power supply card and a sub-rack. All power supply cards were subjected to 48 hour heat run test at maximum rating. Figure A.10.2 shows the stability curve of 5 nos. of power supply cards for 24 hours of continuous operation after initial warm-up time of 1 hour. Long term stability of output current is seen to be well within the specified ±500 ppm. Two numbers of TL-1 quadrupole magnet power supply (TL1-QP1 and TL1-QP2) have already been put in actual operation (Fig. A.10.3) and performing satisfactorily.

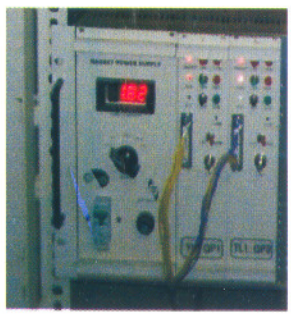

Fig. A.10.3: Photograph of two TL-1 quadrupole magnet power supplies in operation.

Reported by:
Alok Singh (aloksingh@rrcat.gov.in)