A.1: Magnet Power Supplies for CUTE-FEL Beamline and Photocathode Gun based Linac

A 10 MeV eight-cell S-band PWT linac structure is being developed at BP&FEL Laboratory, RRCAT Indore and a photocathode gun and PWT linac is being set up for laser driven pico second accelerator for an ultrafast time-resolved spectrometer to study the radiation-induced chemical reactions at Radiation and Photochemistry Division, BARC, Mumbai. DC current-controlled magnet power supplies (29 nos.) are developed for these applications. Required output current stability is ±1000 ppm for all the supplies. Although, terminal specifications are different for all magnets, required power supplies are grouped into three ranges, namely, 12 A/3 V, 12 A/5 V and 12 A/26 V.

Fig. A.1.1: Power supply card and sub-rack.

Despite the advantages of simplicity and ruggedness of transistor series pass scheme, high-frequency switching mode power supply (SMPS) is preferred for size, weight and efficiency. Among a large number of SMPS topologies, two-switch forward converter is chosen since the topology is simple, rugged, tested and proven. The power supply is equipped with two-loop feedback control scheme, output-current limiting capacity , over current protection and is capable of being operated from local fascia panel or in remote mode from central computer interface via a 25-pin sub-D connector provided on the fascia plate.

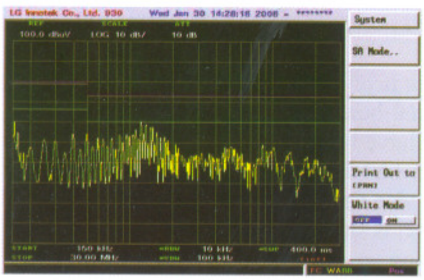


Fig. A.1.2: Conducted EMI of the power supply rack along with CISPR-11 limit lines.

Each power supply is standardized on a 6U card. Five such power supplies are housed in one 6U, 19-inch sub-rack. Photographs in Fig. A.1.1 show a power supply card and a sub-rack. All power supply cards were subjected to 48 hour heat run test at maximum rating. Long term stability of output current was tested to be well within the specified limits. Conducted electromagnetic interference (EMI) was measured and pre-compliance was achieved with CISPR-11 norms as shown in Fig. A.1.2.

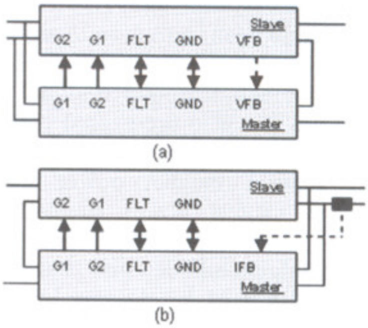
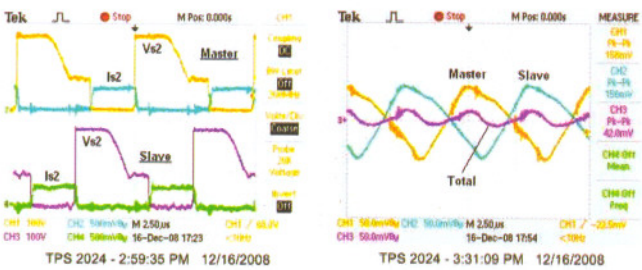


Fig. A.1.3: (a) IPOS, and, (b) ISOP configuration of power supply boards.

Power supply boards are easily configurable in input-series, output-parallel (ISOP) configuration (to increase total output current) and in input-parallel, output-series (IPOS) configuration (to increase total output voltage) or combined configuration simply by setting few jumper selectors provided in the control circuit on the board. Fig. A.1.3 schematically illustrates these configurations. One of the boards is configured as the master and the other boards are configured as the slaves. The overall power supply architecture can be controlled from the master board. Additionally, it is possible to reduce input and output ripple by crossing the gate pulse connections of the boards.



(a) (b)

Fig. A1.4.: (a) Switch voltage and current waveforms,(b) ripple reduction in IPOS configuration.

The waveform pairs in Fig. A.1.4(a) (switch voltage and current) demonstrate inherent phase-shifted and balanced operation in IPOS configuration. High-frequency ripple in the total output voltage is significantly less than the ripple in the output of individual power supply [see Fig. A.1.4(b)].

Reported by :
Mangesh Borage (mbb@rrcat.gov.in) and Sunil Tiwari