E.5: FPGA controlled bipolar power supply with integrated human machine interface

A FPGA controlled bipolar power supply rated at ±15 A / ±50 V has been designed and developed for magnetic characterization of the Indus accelerator magnets having wide range of time constants by the Accelerator Ramping Power Converter Section. Figure E.5.1 shows photograph of the power supply.

Fig. E.5.1: FPGA controlled bipolar power supply with HMI

The power stage of the power supply has an uncontrolled rectifier stage followed by an H-Bridge four quadrant converter switching at 50 kHz. The power supply has a FPGA based digital control with 64-bit floating-point architecture and HMI interface. Figure E.5.2 shows screenshot of the HMI panels.

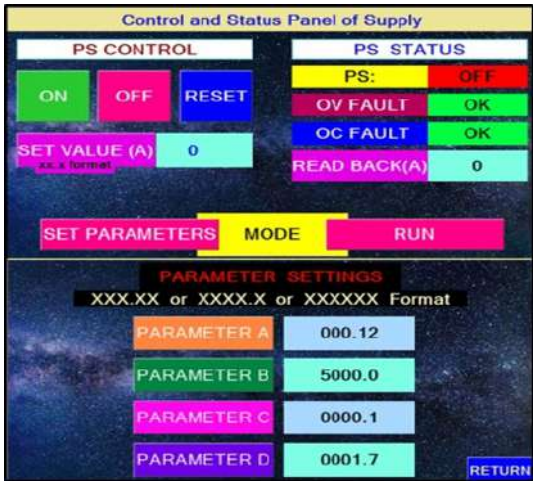

Fig. E.5.2: HMI control panels

The digital control has the provision to independently tune the control loop gains with a resolution of 0.01. This enables the power supply to adapt and cater to varying magnet loads of different time constants and provide exceptional control over system accuracy and response. This feature of power supply significantly eases the characterization of the magnets over the analog controlled power supplies, wherein the controller gains have to be physically adjusted by changing components on the PCBs. There is a provision to set these gains, monitor and control the power supply operation through a touch screen interface. Overcurrent and overvoltage protections have been implemented and a provision for an additional interlock is also provided in case any need arises during the operation. A custom software, GUI as shown in Fig. E.5.3, is also developed to compute the gain parameters for the power supply as per the magnet load parameters.

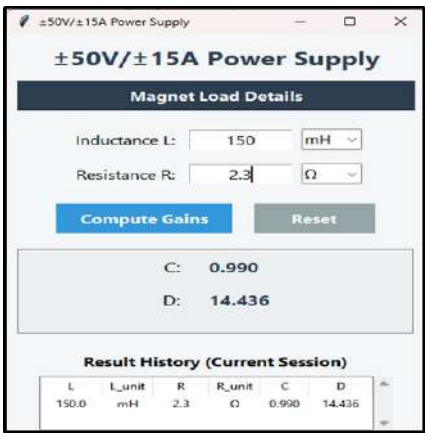

Fig. E.5.3: GUI of software for controller gains

The power supply was tested with different loads with time constants varying up to 4 times. Figure E.5.4 shows the stability data of the power supply, with a load time constant of 0.4 s, showcasing nearly ±25 PPM stability over 7 hours of operation.

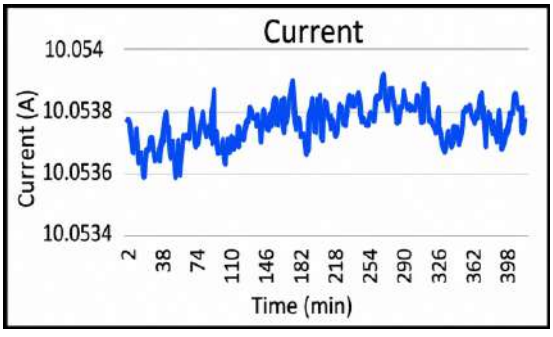

Fig. E.5.4: Load current stability over 7 hours

This power converter has been deployed at AMTD, RRCAT, Indore. Its modular, floating-point-based architecture is scalable to higher power levels and serves as a robust platform for future digitally controlled power systems being developed for the next generation particle accelerator at RRCAT.

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