L.9: Development of control system for Table Top Terra-watt laser

A distributed supervisory control system has been developed for a single beam, single shot Table Top Terra-watt (TTT) laser in Laser Plasma Division, RRCAT. The TTT laser consists of a Master Oscillator followed by several stages of optical amplifiers. These amplifiers are pumped by flash-lamps, which in turn are excited by dumping of high energy stored in capacitor banks. The capacitor banks are charged by high voltage (~5kV) constant current charging power supplies.

The control system has PC as a main controller and there are number of control modules which are directly interfaced with Capacitor charging Flash Lamp Power Supply. PC provides a LabVIEW based intuitive Graphical User Interface (GUI) for the user.

A microcontroller based intelligent control module has been developed which consists of a 16-bit programmable delay generator and analog and digital interface to control and monitor one capacitor charging flash lamp power supply. The TTT laser has nine operational laser amplifier power supplies. Thus the control system has nine control modules. Each control module provides one 12-bit set point reference voltage to charge the capacitor bank. It has a provision for monitoring eight capacitor banks simultaneously with 12-bit resolution. Block diagram of TTT Intelligent control module is shown in Fig.L.9.1.

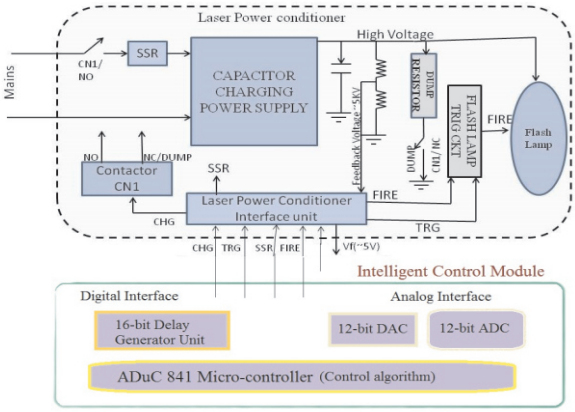

Fig. L.9.1: Block diagram of TTT Intelligent control module.

Each control module has three digital signals to issue a command for initiating charging of capacitor bank, trigger circuit activation command and a fire command to discharge flash lamp. A CPLD based 16-bit programmable delay generator unit with 1 µs resolution provides a delayed fire pulse for synchronizing the laser amplifiers.

Digital on/off control algorithm has been developed to precisely control charging of the capacitor bank voltage within +/- 10V band. A hybrid digital control algorithm (proportional & on/off) to avoid overshoot during charging has been developed for Regenerative laser amplifier since precise control of capacitor bank voltage (1% or better) was required. This will reduce shot to shot fluctuation in laser energy. The embedded control software has been developed using real time framework.

The photograph of the TTT control system is shown in Fig.L.9.2. This control system has various safety features like detection of capacitor over charging, detection of capacitor short, monitoring residual voltage on capacitor bank, etc. if the residual voltage is above pre-set threshold then an alarm is generated and further operation of power supply will be prevented. A distributed architecture of the control modules is based on RS-485 network. This highly scalable architecture has flexibility to accommodate additional power supplies with slight modification in control software.

Fig. L.9.2: Photograph of the TTT control system.

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