

Seminar

Institute for Plasma Research

Title: Design, Analysis, Fabrication & Testing of 100kV, 100mA full wave voltage multiplier (FWVM) modular unit for accelerator power supply

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Date: 29th August 2023 (Tuesday)

Time: 11:00 AM

Venue: Committee Room -1

Abstract

High voltage low current power supply is an essential part of accelerator based neutron sources. Among various technologies, Cockcroft-Walton power supplies are widely used for the development of accelerator power supplies. Apart from this, Cockcroft-Walton power supplies are also used for various biomedical and industrial applications. A 100 kV, 100 mA DC full-wave voltage multiplier (FWVM) modular unit has been developed for the requirement of accelerator power supply and other applications at Institute for Plasma Research (IPR). The design, simulation and analysis of FWVM consist the first part of this research project, whereas the fabrication and testing of FWVM unit is the second part of it.

The 100kV FWVM units can be cascaded over each other and the output voltage up to 500 kV can be achieved for the rated load current up to 100 mA. This 100 kV FWVM unit is fed by 20 kHz high voltage center tapped transformer. There are various factors which affect the output voltage profile when these FWVM units are cascaded to achieve higher voltages. During the design of the voltage multiplier unit, various factors were taken into account, including cascading effects, circuit voltage drops, capacitance de-rating factors, and diode de-rating factors. The capacitance de-rating factors are dependent on frequency, temperature, and operating voltages, while the diode de-rating factors are influenced by temperature, operating frequency, and current. Based on these considerations, two stages of symmetric voltage multiplication have been selected for a 100 kV, 100 mA FWVM unit. The sizing and selection of FWVM unit is carried out using analytical calculations and, performance has been verified by the electrical stimulation. To ensure the performance in cascading condition of FWVM units, cascading of five 100 kV FWVM units is carried out using simulation to achieve 500 kV output voltage at 100 mA load current and performance was analysed. The ground fault scenario has been analysed using the simulation tool. After successful simulation and analysis, the 100kV, 100mA FWVM module is fabricated using single layer ceramic capacitors and high voltage avalanche diodes. The FWVM unit has been fabricated and successfully tested up to 100 kV for 10 mA load current.

Keywords: Full-Wave Voltage Multiplier, Electrostatics, High Voltage Power Supply, Particle Accelerator, HVDC testing, Cockcroft-Walton Circuit, Symmetric Voltage Multiplier.
