

# Development of High Voltage Pulse Power Supply for Microwave Tube Applications

Subhash Kumar Ram<sup>1\*</sup>, Anand Abhishek<sup>1</sup>, P. K. Pedapati<sup>1</sup>, B. K. Verma<sup>1</sup>, A. K. Dhakar<sup>1</sup>, Rahul Varma<sup>1</sup>

<sup>1</sup>Power Electronics Group

<sup>1</sup>CSIR-Central Electronics Engineering Research Institute  
Pilani (Rajasthan)-333031, India

\*Corresponding author email: skr@ceeri.res.in

**Abstract** - This paper describes about the design and development of high voltage DC pulse power supply for high power applications. The system has variety of features such as independent control of Pulse Repetition Frequency (PRF), Pulse Duration ( $T_{on}$ ) and pulse amplitude. PC based wireless module with Graphical User Interface (GUI) having variable/controlled PRF (10Hz-1kHz) and  $T_{on}$  (10-100 $\mu$ s) module has been developed for pulse generation. Two sets of -25kV, 10A pulse power supplies are connected in series to achieve -50kV, 10A pulse output voltage. High voltage DC pulse power supply is used for the characterization of high power microwave tube and testing applications. To verify the proposed design, simulation and experimental results on resistive load are presented in this paper.

**Keywords** – Graphical user interface, high voltage pulse power supply, HF transformer, microwave tube devices, pulse switching modules.

## I. INTRODUCTION

The design and development of high voltage DC pulse power supply for microwave tubes (MWT) devices has become very important in recent years due to special requirements of the MWT devices. DC pulse power supply for MWT devices need special design, development and control approach. The frequently used topology for high voltage pulse power generation is based on Pulse Forming Network (PFN) approach. The main drawback of PFN based topology are: output pulse width is load dependant and it is used for only low power applications. High voltage switching using solid state devices directly is reported in some applications. But due to complexity in design, control and voltage balancing across solid state devices its uses are very limited for high power applications [1]. The Cockcroft-Walton generator, or multiplier to generate high DC voltage from a low voltage AC or pulsing DC input is also reported for low power applications [2].

The proposed high voltage pulse power supply system consist pulse switching modules connected in series to generate high voltage, high power output pulse, which is a reliable and robust technique for high power applications. Continuous output pulse voltage variation up to 50kV with Pulse Repetition Frequency (PRF): 10Hz to 1 kHz and Pulse Duration ( $T_{on}$ ): 10 $\mu$ s to 100  $\mu$ s has been achieved, with satisfactorily good output over the entire working range. Special pulse generation and control module with utmost precision in PRF and  $T_{on}$  control has been incorporated in the system.

## II. SYSTEM DESCRIPTIONS

The Block diagram of high voltage pulse power supply is shown in the figure. The basic topology of the block diagram consists of capacitor bank, single phase high frequency square wave inverter, high frequency step up transformer, single phase bridge rectifier, pulse switching modules, pulse generation and control modules.

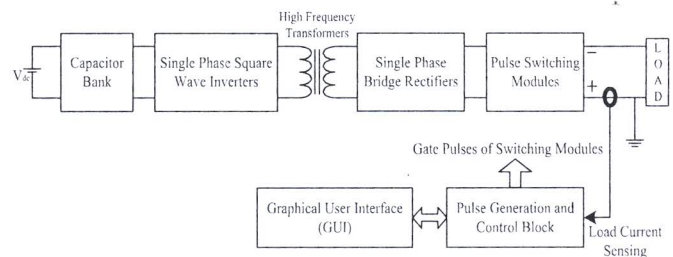


Fig. 1. Block diagram of high voltage pulse power supply

The rectified DC voltage is regulated through capacitor bank at the input side of square wave inverter. Single phase high frequency H-bridge inverter is used for square wave inversion of regulated DC input. High frequency step-up transformer to increase the voltage at required level and providing isolation, rectifier, capacitor to convert and regulate the high voltage transformer output to DC voltage level. Pulse switching modules switches the input regulated DC voltage at required pulse width and pulse repetition rate to generate pulse output voltage. PC based wireless Xbee module with Graphical User Interface (GUI) having variable Pulse Repetition Frequency (PRF) and Pulse Duration ( $T_{on}$ ) is developed for pulse generation.

Pulse switching module uses high voltage IGBT to switch the voltage and a high voltage diode for free-wheeling the power in the inductive load and also to clamp the IGBT voltage to the input DC voltage. Each pulse switching module has isolated gate drive power supply. Gate control signal is provided through optical fibre cable. Total twenty such modules are connected to form high voltage pulse power supply. Output pulse amplitude is varied by controlling DC bus voltage at the input of square wave inverter. Pulse repetition frequency and pulse width is controlled wirelessly through Xbee module. Overcurrent protection is also incorporated in the systems and it can be seen on the GUI.

