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Solid-State Unipolar Marx Generator for Water Treatment Process

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Abstract: *Marx Generator can generate a high voltage pulse from low voltage dc supply using identical stages that operate at a fraction of the total output voltage. They are used in high energy physics experiments, as well as to simulate the effects of lighting on power line gear and aviation equipment. Each stage includes a capacitor or pulse forming network and a high voltage switch. Typically, these switches are spark gaps resulting in Impulse Generator with low repetition rates and limited lifetimes. The development of economical, compact, high voltage, high di/dt and fast turn-on solid state switches made it easy to build economical, long lifetime, high voltage Impulse Generators capable of high pulse repetition rates.It is a clever way of charging a number of capacitors in parallel , then discharging them in series. Pulse Electric Field (PEF) can be effectively used in water treatment applications. In this Paper, High Voltage Impulse Generator is presented for treating water via application of PEF.*

Keywords **-** *Converter, Pulse Generator, Gate driver circuit, Impulse Generator, Pulse Electric Field.*

I. Introduction

Rapid discharge of stored energy in short interval as electrical pulses into a load produces big quantity of instant power. The traits of pulse as rise time, fall time, pulse width, repetition charge, a voltage and strength tier varies with unique applications. High voltage pulsed electricity have extensive variety of programs in exclusive fields like industrial, scientific, agricultural, environmental, Medical etc. The essential precept of Marx Generator is that the capacitors are charged in parallel as much as its input DC voltage stage. Those capacitors are then related in series the use of switches to produce an excessive voltage pulse throughout the burden technology. With the improvement of solid state electronics, solid-state devices have become more and more appropriate for pulsed power application. They might offer the pulsed energy systems with compactness, reliability, excessive repetition fee, and lengthy existence time. The rising of pulsed electricity generators the usage of solid-state gadgets gets rid of barriers of traditional additives, and promises pulsed strength era to be extensively utilized in business packages.

For High voltage output, circuit requires high voltage DC input. This can be employed by using DC-DC converters. Intended circuit uses a Boost Converter for supplying 60V input.

Simulation model of proposed Circuit has been developed along with its output. Simulation output shows effectiveness of proposed circuit.

Being a Power Device, use of MOSFET (Metal Oxide Field Effect Transistor) has been extensively increased. MOSFETs require almost no input current to control the load current which makes them more resistive at the gate terminal, because of the isolation layer between the gate and the channel. MOSFET devices are widely used for switching and amplifying electronic signals in electronic devices, typically for high noise applications. Also it is low voltage high frequency power switch which fits in our specifications.

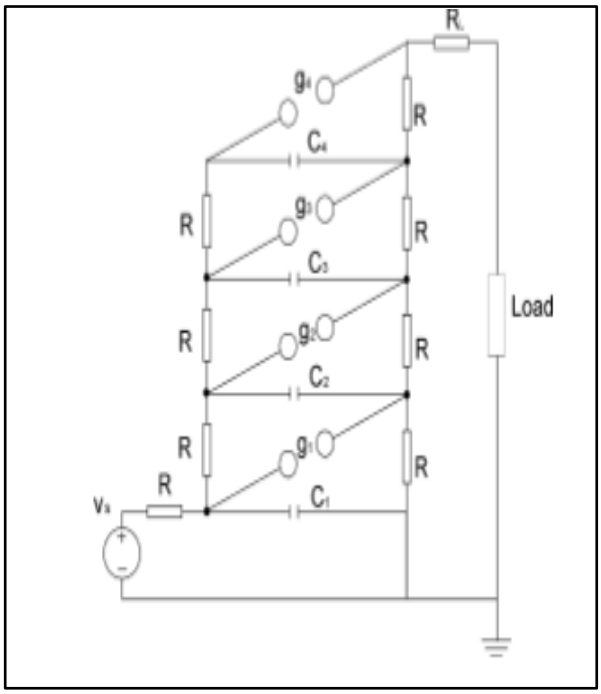

Fig 1. Conventional Marx Generator using Spark Gap

II. Circuit Topology

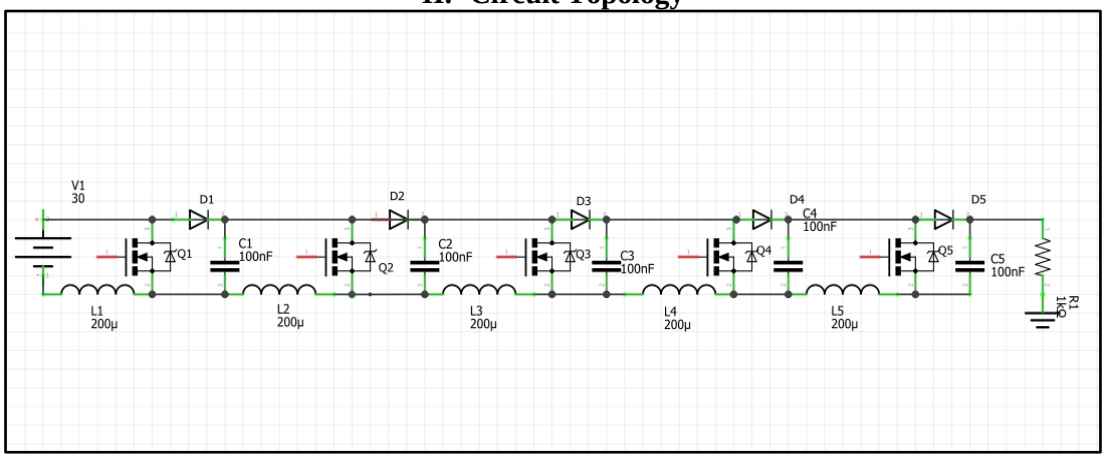

Fig 2. Proposed Impulse Generator using MOSFETs in Fritzing software.

Above circuit shows basic circuit of Impulse generator using MOSFETs. General operation way is, First capacitors are charged in parallel then discharged in series. This generates high voltage impulse wave across load (output). MOSFETs are fed with gate pulses at equal instants and they act as switches. Inductor provides a opposition while switches are acted.

Operation Principle

The basic operations of the proposed circuit can be divided into to three modes. The first mode is from the time after charging to the turn-on of switches. The second mode is when switches are turned on. The third one is the capacitor charging mode.

Mode 1) At beginning, there is no current moving the circuit. The voltage of capacitors is maintained at the input voltage level, and diodes and switches are turned off. Therefore, the voltage applied to overall components is the input voltage. Thus, it does not need high voltage isolation.

Mode 2) All switches are turned on at this time and capacitors are connected in series. The output voltage is applied to the load and is in proportion to the sum of voltage of the series-connected capacitors. At this time, the terminal of the load side has high voltage potential. There it needs to be isolated between the low voltage side and the output side during the pulse period. Therefore, isolation voltage can be lowered compared to high dc voltage isolation.

Mode 3) After the switches are turned off, the capacitors are charged to the input voltage level through the path of input, inductors and diodes.

These three modes are explained on the basis of the assumption that all parameters are ideal. However ,in a circuit, time delay of the driving signal can result in difference among switch voltage levels. Fortunately, this problem is naturally solved by the proposed circuit structure where the equivalent series connected capacitor and diode are in parallel with the switch to provide voltage clamp so as to prevent switch over voltages.

Boost converters are used to raise the voltage to the desired voltage level. The boost converter here is used to boost the input which eventually results in a output level raised.

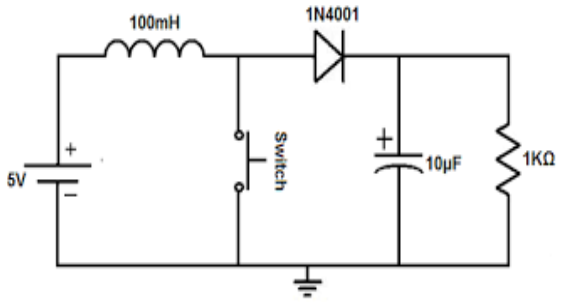

Fig 3. Boost converter

III. Circuit Topology

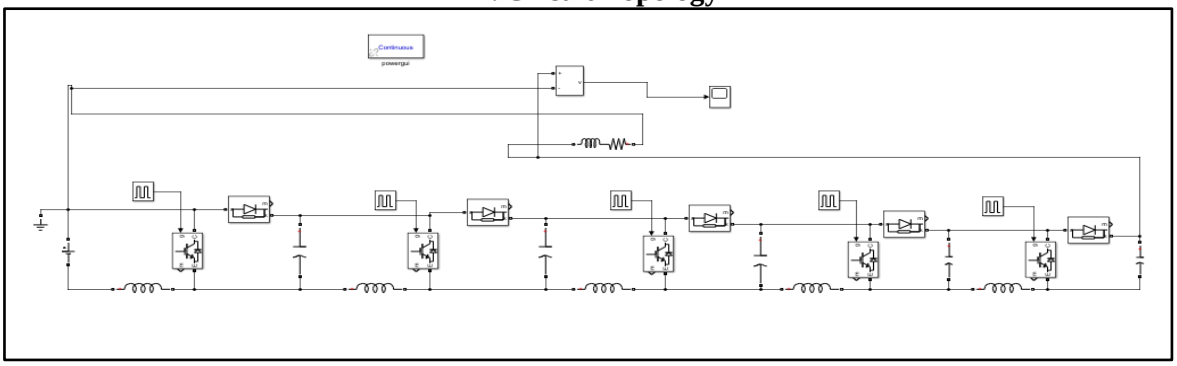

Fig 4. Circuit diagram of Marx Generator using IGBT in Matlab software.

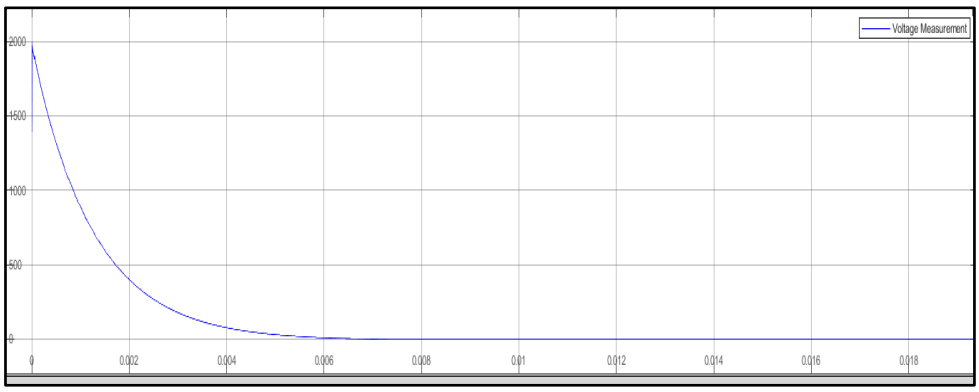

Fig 5. Simulated output waveform

IV. Conclusion

This paper described the operating principle of a solid state impulse generator along with the simulated results. Due to technological advancements in power electronics, the proposed circuit has advantages over the conventional circuit. This paper also describes the simulation study for the proposed generator carried out on 2000V, 50 micro seconds pulse width. A scaled down prototype is implemented and tested. The simulation results validate the experimental results.

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