Hardware Realization of Prototype of Impulse Voltage Generator

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Abstract: Marx turbines may generate high-voltage pulses via multiple, equivalent tiers operating at a fraction of the full output voltage. Each Marx degree comprises a high-voltage transfer and network-forming condenser or pulse. Without the application of a step-up transformer, which limits instances of pulse upward thrust and reduces tool performance. Marx turbines exist in close, tight lifelines, and such switches are normally spark gaps, so they produce low repetition charges. Creating inexpensive, long-lived, resilient, high-voltage Marx mills which have a tendency to pulse heavily repeated charges is enhanced by the availability of small, high voltage, high dv/dt, and fast turn-on strong state switches. Fashionable impulse waveforms can be utilized in testing the electrical equipment's capability because they are similar to lightning strokes. The most popular and commonly used technique for generating high-voltage pulses is the Marx generator. During the ON time, a 555 timer generates pulses that make the capacitors rate in parallel. With the help of MOSFETs, capacitors are connected in series during the pulses ' OFF time. Finally, the voltage is boosted to about eleven times the supply voltage by a combination of capacitors employed in the collection. The best output was over 4KV DC, for which the input of 400V was utilized.

Keywords: *High Voltage Generation, Marx Generator, and Over Voltage Trigger.*

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I. INTRODUCTION

One device for producing an over pulse is The Marx generator. The function of this device will be guided by the following idea Having been charged by electric power today, the condenser in a parallel connection is finished in a collection of different switching devices. Therefore, the output voltage increases proportionally according to the quantity of connected capacitors. From the initial discharge, the generator will commence its operation while charging the capacitor. All chargers have to operate Almost at the same time, under the conditions of overvoltage for special discharges, triggering an avalanche connection towards the charged capacitor. Marx generators output pulses between tens of kilovolts to ten million volts in voltage. The Marx generator can create tens of kilovolts to ten million volts of the pulse. The frequency of the generator's pulse depends on its pulse capacity and can range from a pulse per hour to several tens of hertz. The losses in the capacitors, the spark gaps, and the burden resistance constitute the total losses in the discharge mode. Marx's high-voltage pulse generator was applied in a range of medical research experiments and technical operations. Certain units utilize generators rather than advanced turbines. Stable-nation devices are increasingly suited for pulsed electricity applications with the development of stable-state electronics. They may provide the pulsed power systems with their long life, high repetition charge, and compactness and reliability. The growth of generators of pulsed power Strong-nation devices eleiminate barriers related to conventional additives and offer the promise of mass industrial use of pulsed electricity technology. Still, solid-kingdom switching devices available today are rated for only a few kilovolts and consist of steel oxide semiconductor field impact transistors (MOSFETs). It was earlier using spark gaps as switches, but it would be possible to replace them with electronic switches consisting of MOSFETs and resistors since diodes would be employed in converting the isolator. Thus, the traditional Marx generator was limited in its lifespan as well as its repetition rate. The modern Marx generator

II. METHODOLOGY

Method The Impulse Voltage Generator approach is used to produce standardized high-voltage transient waveforms for testing the dielectric strength of electrical power equipment. This study deals with designing, testing, and analyzing an impulse voltage generator to produce a 1.2/50 µs waveform according to IEC and IEEE standards. The impulse voltage generator mimics over voltages caused by lightning discharges and switching in high-voltage transmission systems.

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A. Design and Working Principle

The impulse voltage generator is implemented with the Marx circuit configuration to generate extremely high voltage impulses. The generator includes multiple capacitors, spark gaps, resistors, and inductors arranged to achieve maximum output voltage on discharge. During charging, the capacitors are charged in parallel from a DC power supply. In the discharge phase, the spark gaps simultaneously or in triggered sequence break down and make the capacitors switch over in series. This switch-over multiplies the voltage on the test object. The Marx generator permits modular assembly, in which every stage is a capacitor and spark gap. The multiplication factor of the output voltage is set by the number of stages. Compactness, scalability, and controlled laboratory safety are provided by the design.

B. Charging and Triggering Mechanism

The capacitors are charged to a predetermined voltage level using high-value charging resistors to limit the charging current and avoid early firing. After charging the capacitors, a triggering pulse is sent to the first spark gap. This leads to a cascading breakdown of all the spark gaps, thus producing a synchronized discharge of the capacitors. A triggered spark gap gives greater control over the triggering of the impulse, so that the discharge will only happen when the required voltage level is achieved. This is essential for repeatability and accuracy during testing.

C. Wave-shaping Network and Output Waveform

The shape of the impulse waveform is determined by a network of inductors and resistors in both the front and tail sections. The front inductor and resistor determine the rise time of the impulse, and the tail resistor determines the fall time. By adjusting these components, a typical 1.2 µs rise time and 50 µs fall time waveform is obtained. This waveform is used to test the test object to mimic actual overvoltage conditions. The wave-shaping elements are chosen by theoretical design and validated with simulation tools before actual implementation. This ensures waveform compliance to standards and shields the test equipment from overstress.

D. Measurement and Data Analysis

The generated impulse voltage is measured using a capacitive or resistive voltage divider to a digital oscilloscope. The divider provides safe scaling of the high voltage to a level that is measurable. The waveform is captured by the oscilloscope, and peak voltage, rise time, and fall time are measured.

These readings are then compared to theoretical values to ensure the generator's performance. Adjustments to the wave-shaping network are made in the event of deviations. The data are applied to determine the insulation strength of the test object under high-voltage impulse stress

III. MODELING AND ANALYSIS

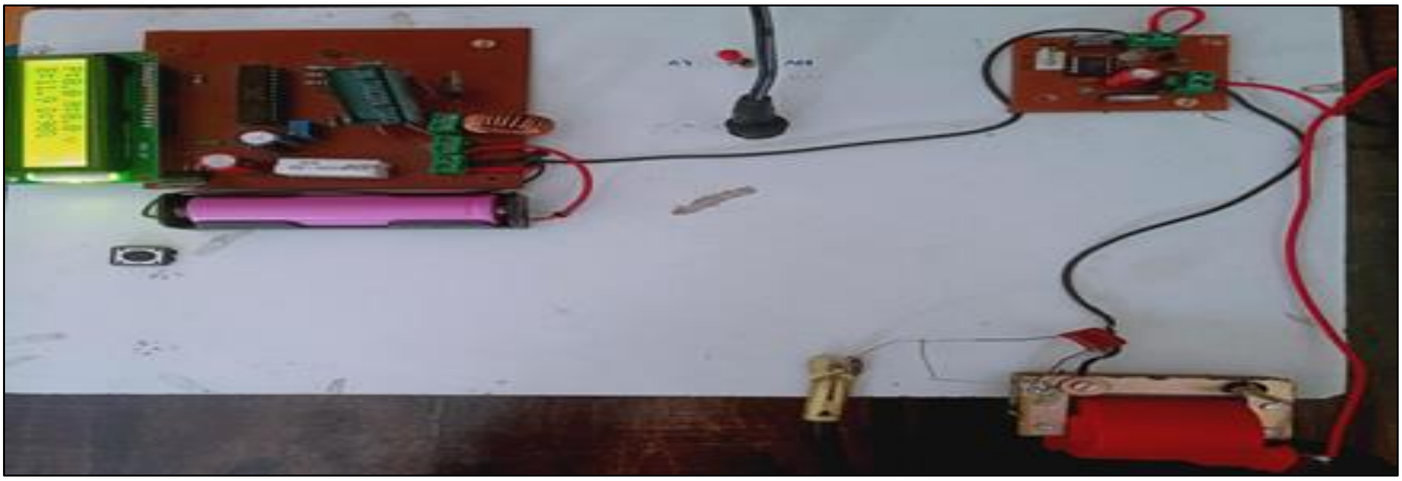

Fig 1 Modeling and Analysis

- *Dc Voltage Source:*

Here in simulation 24V DC voltage battery is utilized for input voltage and 12V supplied to 555 timer.

- *Capacitor:*

An apparatus that stores electric power in an electric field is a capacitor. The two terminals are by no means a passive digital feature. By connecting the capacitors in parallel and within the circuit's group of capacitors, the circuit generates the high-voltage pulse. Typically, a group of "N" capacitors is charged in parallel to the voltage. During the process, when all the capacitors are being charged, the circuit acts as an open circuit**.**

- *Diode (1N4007):*

A diode is an electronic device through which a cutting-edge float is provided in a single direction. Presently, we always adhere to the anode-to-cathode direction. As has been shown above, a light gray bar may be employed as a marker of the cathode terminal. The 1N4007 diode has the highest current sporting capacity of 1A, and it will withstand peaks to 30A. As a result, this can be utilized in circuits which can be constructed at less than 1A. Presently, the reverse is 5µA, which is negligible. Strength dissipation of this diode is 3W.

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- *MOSFET:*

Metal-oxide-semiconductor Field-effect transistors (MOSFETs, MOS-FETs, or MOS). FETs are subject-effect transistors. (FETs with an insulated gate) where the conductivity of the device is controlled by the voltage. It is utilized for switching or Amplification of a signal. Electronic indicators can be switched or amplified using the ability to trade conductivity with the amount of applied voltage. MOSFET 2N660 and electricity MOSFET FA57SA50LC was used in this work.

- *Irf540 MOSFET:*

IRF540 is an N-Channel-powered MOSFET employed for extremely fast switching operations and for amplification processes. It is an enhancement mode device. It is employed for numerous applications in everyday life. For instance, switching regulators, relay drivers, switching converters, motor drivers, high-speed power switching drivers etc.

- *555 Timer:*

A critical part of electronic tasks is the 555timer integrated circuit. Whether a basic project with a single 8-bit microcontroller and accessories or a sophisticated one with gadgets on chips (SoCs), the timer is at stake. These are used as flip-flop details between different programs, oscillators, and time delays. Figure10. The IC555The original 555 timer package contains an eight-pin mini dual-in-line bundle (DIP-eight) of 25 transistors, 2 diodes, and 15 resistors on a silicon chip. Variations involve integrating several chips onto one board.

- *Fly Back Transformer:*

A fly back transformer can create sparks since it steps up the voltage, producing high-voltage output that can arc over an air gap. These transformers are often used in vintage CRTs and TVs to store energy in the core's magnetic field and then discharge it through the secondary winding, creating a high voltage. The high-voltage output combined with an air gap is likely to result in sparking.

- *Resistor (Load):*

Any electrical load or device that primarily transforms electrical energy into heat and maintains a constant current and voltage is known as a resistive load. Examples of such devices are electric heaters and incandescent bulbs.

IV. RESULTS AND DISCUSSION

This project illustrates the construction of a small and inexpensive impulse voltage generator that boosts a 12V DC supply to an approximately 2 kV impulse output. The circuit employs capacitive energy storage and a flyback transformer to produce high-voltage impulses for testing insulation material and spark gap characteristics. The design emphasizes safe operation, small size, and efficienc

V. CONCLUSION

A strong kingdom Marx generator is more compacted with ease in controlling the heartbeat width as compared to classical spark hole transfer. In this type of Marx generator, we have alternating classical resistor and spark hole circuits into the diode and MOSFET circuit. Thus, by utilizing the usage of this diode and MOSFET, we can reduce the operation time of the Marx generator and, besides, the performance of the generator will boom. And on the input side of the robust nation Max generator, we've positioned the boost converter to switch the input voltage from 24 volts to four hundred volts, so, through that, we will also be able to reduce the range of the Marx generator, so the cost of the generator will be minimized, and moreover, in the future, if any fault appears, then we can simply find the location of it.

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