High Voltage DC Generation Using Dual Channel Marx Generator

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***Abstract*- Marx generators can generate high-voltage pulses using several, similar stages that run at a fraction of the total output voltage without the need for a step-up transformer that limits pulse rise times and decreases device performance. Every stage in Marx involves a network forming condenser or pulse, and a high voltage switch. Such switches are usually spark gaps resulting in low repetition rates and Marx generators Lives tight. Developing economical, compact, high voltage, high di / dt and fast turn-on solid state switches makes it easy to build cost effective, longlived, high voltage Marx generators capable of high pulse repeat rates. Standard impulse waveforms have similar characteristics to those of lightning strikes and can be used to test the strength of electrical equipment. Marx generator is the most popular and widely used method for producing high voltage pulses.**

***Index terms*- Marx Generator, High Voltage Pulses, Transformer, Switches, Spark Gaps, Low repetition rates, High pulse rate, Standard impulse waveforms, Lightning strikes**

1. INTRODUCTION

The Marx generator is a device used to generate a high pulse. The operation of this device shall be based on the following principle:

The condenser connected in parallel is first charged with electrical current and then carried out in series with the various switching devices. This results in an increase in the output voltage in proportion to the number of connected capacitors. When the capacitor is charged, the generator will be started after the first discharge is discharged. Overvoltage at different discharges forces all the chargers to be operated almost simultaneously, which triggers a series of connections to the charged capacitor. The Marx generator can be used to produce tens of kilovolts to ten million volts of pulse.

The pulse rate of the generator depends on the pulse capacity of the generator and constitutes anything for a single pulse per hour to several tens of Hertz.

The total losses in the discharge mode are the losses in the capacitors and the gaps in the spark and the load resistance Marx's high voltage pulse generator in various scientific studies and in the performance of all kinds of technical tasks. In some units the generators operate instead of the current generators.

1.1 BASIC STRUCTURE AND LITERATURE SURVEY

The Marx generator is a type of electrical circuit, the purpose of which is to generate a high-voltage pulse by a number of condensers, which are charged in parallel and then connected in series by spark gap switches.

The Marx generator is a type of electrical circuit first described by Erwin Otto Marx in 1924, the purpose of which is to generate a high-voltage pulse. It is widely used to simulate the effects of lightning during high voltage and aeronautical testing. Sandia National Laboratories use a bank of 36 Marx generators to generate X-rays in their Z Machine. It can also be used as an ignition switch for thermonuclear equipment.

High voltage technology for electrical power generation and transmission systems was introduced at the beginning of the last century. Long before this effort was made to study the lightning characteristics of the indoor lab in order to perform the power system Equipment to protect them from the hazards of lightning strikes. A number of theories on the

formation and generation of lightning have been presented. Efforts have been made since the lightning exploration began to detect the phenomenon of lightning within the laboratory so that the characteristics of the lightning can be studied more precisely and tests on the power system equipment can be carried out. Many authors have presented their work on the generation of lightning impulses in the laboratory. Marx was an important guiding principle for the generation of lightning impulse voltage.

2. NEED AND SCOPE OF PROJECT

The increase in the output voltage depends on the number of stages. Switching devices, i.e. MOSFETS, are replaced by alternative devices. In this circuit, we obtain high voltage and low current so that both voltage and current will increase in the future.

1. As the rate of pulse repetition is higher, the energy from the source is declining and therefore the overall economy can be achieved.
2. The output voltage remains constant where the required energy is significantly reduced.
3. Source rating, capacitor size (rating), IGBT 's current rating and losses reduces the Compaq size of the entire module.
4. By replacing bulky passive components, the voltage efficiency and the pulse repetition rate are higher, and the higher voltage can also be achieved without the use of a pulse transformer.
5. With higher Pulse frequencies, a percent reduction in the voltage of the capacitors can be achieved by less than 10%.

3. REQURIMENT ANALYSIS

3.1 BLOCK DIAGRAM:-

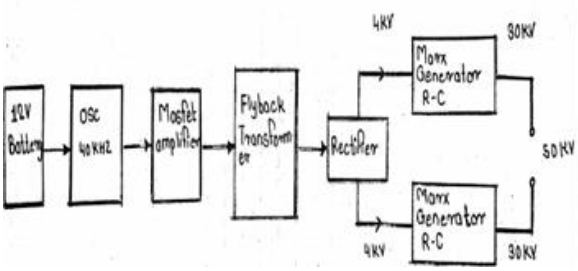

Fig 3.1 Block Diagram of overall circuit.

We use a 12 volt dc battery but in practice we connect two 6 volt batteries in series so we can get a 12 volt dc supply. The output of the battery is given to the oscillator. We use 555 timer IC in this oscillator to generate the power that is given to the MOSFET. MOSFET is basically used to boost the voltage up to 12 volts of the flyback transformer. Flyback Transformer use as rectifier and step up the voltage up to a 4kv witch to the Marx Generator. Channel Marx Generator channel made up of a rc network. There are two channels connected in parallel and the output can be up to 50kv to 60kv.

3.2 CIRCUIT DIAGRAM

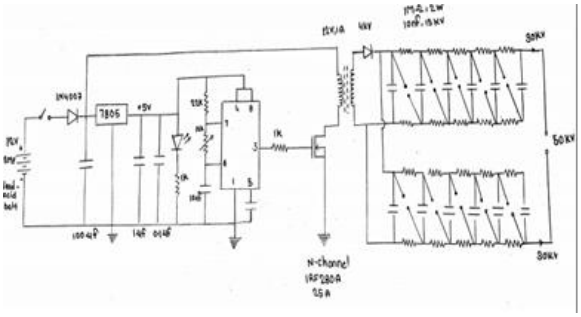

Fig 3.2 Circuit diagram of Marx generator

This is the circuit diagram of the Marx generator. We use 12 volt dc lead acid battery The output of the 12 volt dc battery is given to the oscillator. The oscillator used in this circuit is an astable mode and produces a frequency of 40 kHz. Which produces an ac voltage but requires a regulated 5v DC voltage. We can therefore be regulated 5v dc by means of a voltage regulator 7805.oscillator containing a timer ic 555 different types of resistor and capacitor. Condenser and resistor are used to produce an ac voltage and are delivered to the MOSFET gate terminal due to a flyback transformer requiring 12 voltage. N MOSFET channel is used to amplify the power. The output of MOSFET is given to a fly-back transformer that operates as a step-up transformer and operates at a high frequency of 40kHz. Output of the mosfet is given to the transformer to step up from 12v to 4kv. This 4kv is given through the resistor to the two channels of the Marx generator. There are 2 channels connected in parallel. Each channel consists of 6 stage series or parallel rc network connections with a small spark gap. The first capacitor loads up to 4kv and generates a spark gap between each stage. This spark is going to get short, and at the end of the channel, we 're going to get maximum voltages of the same action in the second channel. And the output of each channel produces 24 kv of voltage. Add voltage

to this two channel and get 48-50 kv on the output side in the form of 3 cm to 5 cm arc.

3.3 DESCRIPTION OF THE SYSTEM

Marx generator is a combination of the RC network that is usually used to amplify the network. Marx generator requires an input supply of 4KV which should be pure DC. This supply is provided by a Fly Back Transformer, which step up the required voltage. Since the output of the transformer is an AC signal, Rectifier is used to convert this AC form to DC and to give the required form to the Marx generator.

The supply to the Flyback Transformer will be isolated separately. We're going to supply 12V battery. The output of the battery is fed to the oscillator to provide oscillation. Since the output of the oscillator is a signal and we need the power, MOSFET is installed. MOSFET amplifies the signal of the oscillator.

4. HARDWARE DETAILS

4.1 Voltage Regulator

All voltage sources cannot provide a fixed output due to circuit fluctuations. The voltage regulators are used to achieve constant and steady output. Integrated circuits used for voltage regulation are referred to as IC voltage regulators. The IC 7805 voltage regulator is actually a member of the 78xx series of IC voltage regulators. It's a fixed linear voltage regulator. The xx present in 78xx represents the value of the fixed output voltage provided by the particular IC. It is a +5V DC regulated power supply for 7805 IC. This IC regulator also adds a heat sink supply The input voltage to this voltage regulator can be up to 35V, and this IC can give a constant 5V for any value of input less than or equal to 35V which is the threshold limit.

4.2 Diode:-

1N4007 is a diode for the PN junction rectifier. These types of diodes only allow the flow of electrical current in one direction. It can therefore be used to convert AC power to DC. 1N 4007 is electrically compatible with other rectifier diodes and can be used instead of any diode belonging to the 1N400X series. 1N-4007 has different real-life applications, e.g. free-wheel diode applications, general purpose power supply rectification, inverters, converters, etc.

4.3 Battery:-

The 12-volt motorcycle battery consists of a plastic case containing six cells. Each cell consists of a set of positive and negative plates immersed in a dilute sulfuric acid solution known as an electrolyte, and each cell has a voltage of around 2.1 volts when fully charged. The six cells are connected together to produce a fully charged battery of approximately 12.6 volts. That's great, but how does the sticking of lead plates to sulfuric acid produce electricity? The battery uses an electrochemical reaction to convert chemical energy to electrical energy. Let's have a look at that. Each cell contains plates resembling tiny square tennis rackets made of either lead antimony or lead calcium A paste of what's referred to as "active material" is then bonded to the plates; sponge lead for the negative plates, and lead dioxide for the positive. This active material is where the chemical reaction with the sulphuric acid takes place when an electrical load is placed across the battery terminals

4.4 IC 555 Timer:-

The IC 555 timer is a single type of chip used in different applications such as oscillator, pulse generation, timer. IC 555 timers can be designed using various electrical and electronic components such as transistors, resistors, diodes and flip flops. The operating range of this IC ranges from 4.5V to 15V DC supply. The functional components of the 555 IC timer include a flip-flop, a voltage divider and a comparator. The main function of this IC is to produce a precise timing pulse. In monostable mode, the delay of this IC is regulated by external components such as a resistor and a capacitor. In the astable mode, both the duty cycle and the frequency are controlled by two external resistors and one capacitor.

4.5 Flyback Transformer:-

The Flyback Transformer is a coupled inductor with a gaped base. During each cycle, when the input voltage is applied to the primary winding, the energy is stored in the core gap. It is then moved to the secondary winding to supply the load with energy. Flyback transformers are used to provide voltage transformation and circuit insulation in flyback

converters. Flyback transformers are the most popular choice for cost-effective, high-efficiency isolated power supply designs of up to approximately 120 watts. They have circuit insulation, the ability for multiple outputs and the probability of positive or negative output voltages. They can also be regulated in a wide range of input voltage and load conditions. Since the energy is stored in the transformer, the flyback topology does not require a separate output filter inductor like the other isolated topologies. This reduces the number of components and simplifies the requirements of the circuit. This article addresses flyback transformers and applications that are ideally suited to them.

5. APPLICATIONS AND FUTURE SCOPE

5.1 It is used to test the sustainability of the outer body of cars and aeroplanes from lightning strikes (as Marx generator is capable of generating real lightning voltage in a safe environment).
5.2 Used in high-rise buildings instead of lightning rod.
5.3 Can be found in the Transmission Line Tower
5.4 Marx Generator is used to provide high-voltage pulses for measuring electrical insulations such as large power transformers or insulators used to support power transmission lines.
5.5 The group of Marx generators is used in X-RAY machines.

6. EXPERIMENTAL PROJECT

6.1 Overall implemented prototype
This is our High voltage DC generation by using Dual channel Marx generator Model in which we get output of 48-50 KV by adding two channels and arc of around 3-5 Cm.

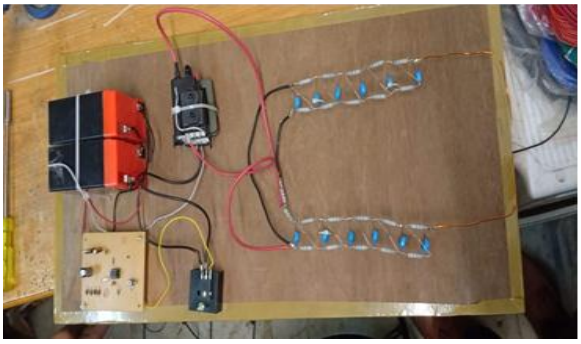

Fig 6.1 Overall project circuit

7. CONCLUSION

From this Project Report, it is observed, analyzed and concluded that:
Marx generators are effective structures for the fast multiplication of voltages. For short pulse generation, Marx is required to operate close to critical damping due to the balance between voltage efficiency and overshoot. The transient wave erection Marx should be used where rapid rise times are critical.

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