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High Voltage DC Generation using Marx Generator

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ABSTRACT: We have attempted to provide a complete and evaluative coverage of the project entitled "IMPULSE GENERATOR". It has created a readable, understandable introduction to what the project is. As you flip across the pages of this project, you will find that it is structured in a systematic manner so as to decide the protection and the bearing capacity of power equipment against lightning strikes. The intent is to present a precise picture without getting lost in finer points. Beginning with a general introduction to the project subject we have tried to understand the depth of it in quiet a brief manner and with a simplistic approach. Our aim is to generate high voltage to test the strength of electric power equipment against lightning and switching surges.

KEYWORDS: Marx generator, Spark Gaps, High Voltage Pulses, MOSFET, IC 555, FlybackTransformer, Lead acid battery

I. INTRODUCTION

An impulse generator is an electrical apparatus which produces very short high-voltage or high-current surges. Such devices can be classified into two types: impulse voltage generators and impulse current generators. High impulse voltages are used to test the strength of electric power equipment against lightning and switching surges. High impulse currents are needed not only for tests on equipment such as lightning arresters and fuses but also for many other technical applications such as lasers, thermonuclear fusion, and plasma devices. One form is the Marx generator, named after Erwin Otto Marx, who first proposed it in 1923. This consists of multiple capacitors that are first charged in parallel through charging resistors as by a high-voltage, direct current source and then connected in series and discharged through a test object by a simultaneous spark-over of the spark gaps. The impulse current generator comprises many capacitors that are also charged in parallel by a high-voltage, low-current, direct-current source, but it is discharged in parallel through resistances, inductances, and a test object by a spark gap. Impulse Voltage Generators are designed to generate impulse voltages that simulate lightning strikes and switching surges. The complete test system consists of a charging rectifier, impulse stages according to the "Marx Circuit". The high-voltage generator drives a power MOSFET based on oscillation, which converts dc to ac. A high-frequency transformer with high turns ratio is used to increase the voltage. In addition, the system uses the battery as dc power supply. Thus, it reduces cost and simplifies system structure.

II. RELATED WORK

A Marx generator is an electrical circuit first described by Erwin Otto Marx in 1924. Its purpose is to generate a high-voltage pulse from a low-voltage DC supply. Marx generators are used in high-energy physics experiments, as well as to simulate the effects of lightning on power-line gear and aviation equipment.[1]

III. METHODOLOGY

BLOCK DIAGRAM

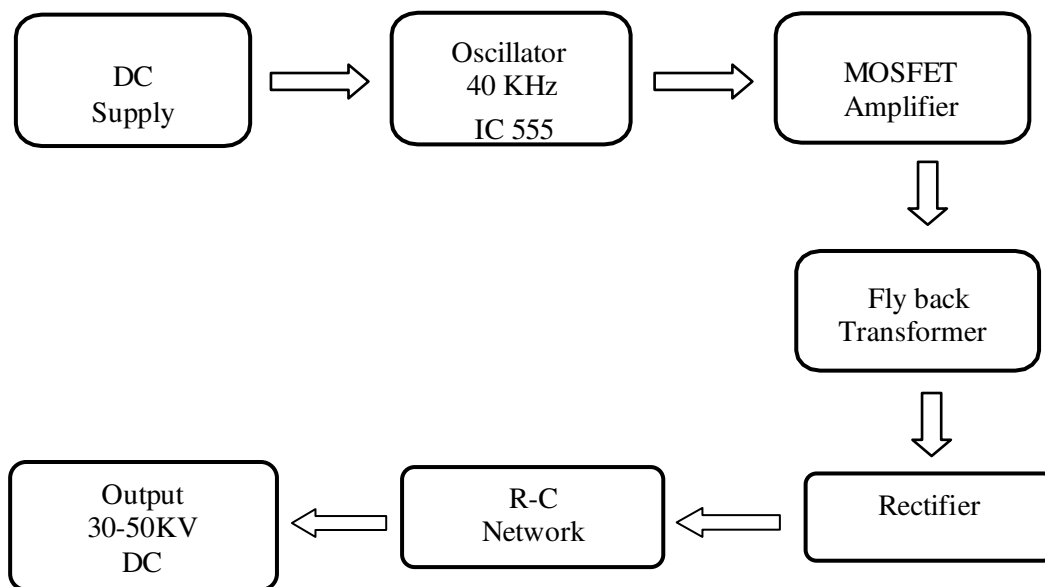


Fig (a). Block Diagram

WORKING: -

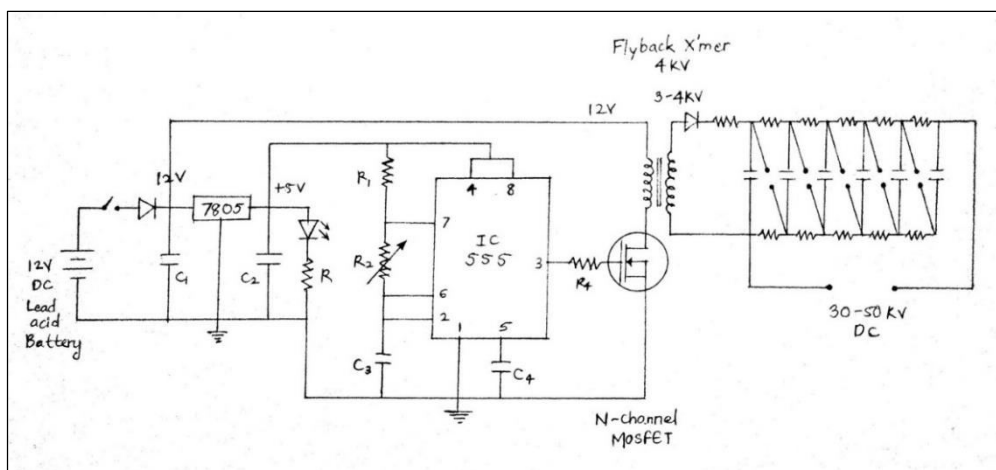
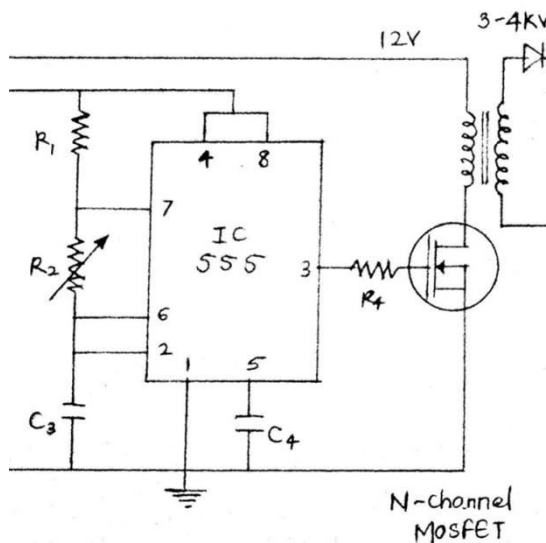
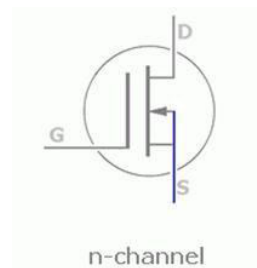


Fig (b). Circuit Diagram

Oscillator circuit

The 555 timer IC in an Astable mode to produce a very stable 555 Oscillator circuit for generating highly accurate free running waveforms whose output frequency can be adjusted by means of an externally connected RC tank circuit consisting of just two resistors and a capacitor.

**Fig (c). IC 555 Timer Circuit****Fig (d). n – channel MOSFET**

The 555 Oscillator is another type of relaxation oscillator for generating stabilized square wave output waveforms of either a fixed frequency of up to 500 kHz or of varying duty cycles from 50 to 100% [1].

In the 555 Oscillator circuit above, pin 2 and pin 6 are connected together allowing the circuit to re-trigger itself on each and every cycle allowing it to operate as a free running oscillator. During each cycle capacitor, C charges up through both timing resistors, R1 and R2 but discharges itself only through resistor, R2 as the other side of R2 is connected to the *discharge* terminal, pin 7[5]. Then the capacitor charges up to $\frac{2}{3}V_{cc}$ (the upper comparator limit) which is determined by the $0.693(R1+R2)C$ combination and discharges itself down to $\frac{1}{3}V_{cc}$ (the lower comparator limit) determined by the $0.693(R2 \cdot C)$ combination. This results in an output waveform whose voltage level is approximately equal to $V_{cc} - 1.5V$ and whose output "ON" and "OFF" time periods are determined by the capacitor and resistors combinations.

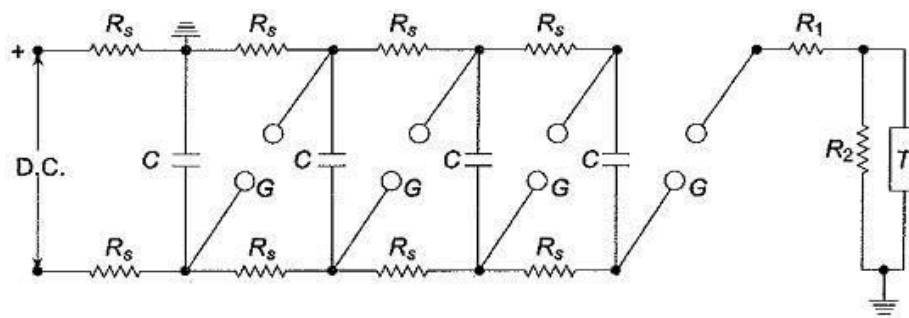
MARX GENERATOR: -

A Marx Generator is an electrical circuit consisting of capacitors, resistors, and spark gaps arranged in a ladder structure capable of producing high voltage impulses (which result in sparks) by first charging the capacitors in parallel and then discharging them in series.

The circuit generates a high-voltage pulse by charging a number of capacitors in parallel, then suddenly connecting them in series. See the circuit above. At first, n capacitors (C) are charged in parallel to a voltage V_C by a DC power supply through the resistors (R_C). [6] The spark gaps used as switches have the voltage V_C across them, but the gaps have a breakdown voltage greater than V_C , so they all behave as open circuits while the capacitors charge. The last gap isolates the output of the generator from the load; without that gap, the load would prevent the capacitors from charging. To create the output pulse, the first spark gap is caused to break down (triggered); the breakdown effectively shorts the gap, placing the first two capacitors in series, applying a voltage of about $2V_C$ across the second spark gap [7]. Consequently, the second gap breaks down to add the third capacitor to the "stack", and the process continues to sequentially break down all of the gaps. This process of the spark gaps connecting the capacitors in series to create the high voltage is called erection. The last gap connects the output of the series "stack" of capacitors to the load. Ideally,

the output voltage will be nV_C , the number of capacitors times the charging voltage, but in practice the value is less[5]. Note that none of the charging resistors R_c are subjected to more than the charging voltage even when the capacitors have been erected. The charge available is limited to the charge on the capacitors, so the output is a brief pulse as the capacitors discharge through the load [3]. At some point, the spark gaps stop conducting, and the low-voltage supply begins charging the capacitors again.

From fig(a), the generator capacitance C_1 is to be first charged and then discharged into the wave shaping circuits. A single capacitor C_1 may be used for voltages up to 200 kV. Beyond this voltage, a single capacitor and its charging unit may be too costly, and the size becomes very large. The cost and size of the impulse generator increases at a rate of the square or cube of the voltage rating. Hence, for producing very high voltages, a bank of capacitors are charged in parallel and then discharged in series. The arrangement for charging the capacitors in parallel and then connecting them in series for discharging was originally proposed by Man [2]. Nowadays modified Marx circuits are used for the Multistage Impulse Generator Circuit. The schematic diagram of Marx circuit arrangement for Multistage Impulse Generator Circuit and its modification are shown in figure respectively. Usually, the charging resistance R_s is chosen to limit the charging current to about 50 to 100 mA, and the generator capacitance C is chosen such that the product CR_s is about 10 s to 1 min. The gap spacing is chosen such that the breakdown voltage of the gap G is greater than the charging voltage V . Thus, all the capacitance are charged to the voltage V in about 1 minute.



Fig(e). Multistage Impulse Generator Circuit

IV. EXPERIMENTAL RESULTS

This project is designed to develop a circuit to deliver the o/p around triple to that of the i/p voltage based on the principle of Marx generator [4]. This project generates high-voltage pulses using multiple capacitors in parallel to charge during the on time, and then connected in series to develop a high voltage during the off time. When the i/p voltage is applied around 12v volts DC, then the o/p will be around 33kv AC.

Simulation result:

Fig (g). Waveform of 11 stage Marx Generator

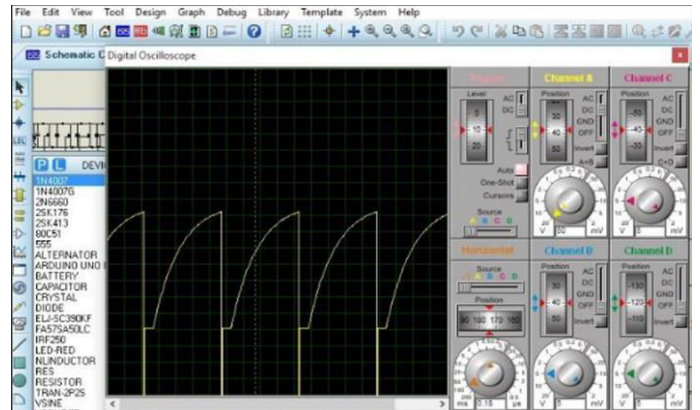
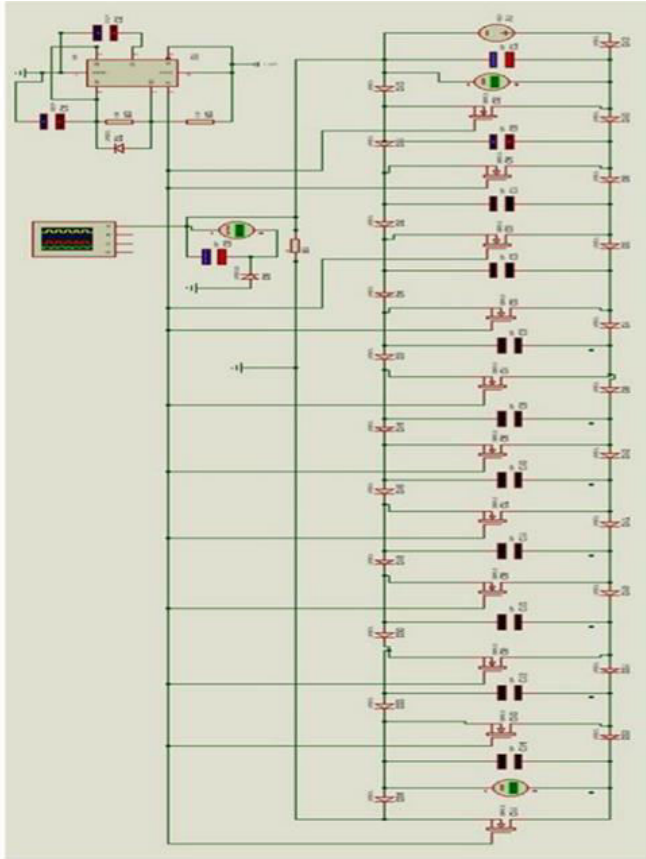


FIG (F). SIMULATION OF 555 TIMER CIRCUIT

V. CONCLUSION

So, we conclude that by using Marx generator we can study high voltage test. Using combination of RC network, we can generate High Voltage. Therefore, by using Marx Generator we can also perform High voltage test in small scale laboratories.

FUTURE SCOPE

Pulse Power sources are widely used in various experimental studies and researches for the generator of intense electron beams used

1. To generate high power microwaves
2. Flash X-rays
3. Pulsed power systems also find application in surface flashover study of insulators
4. Study of Radiations in Antennas
5. It is used in modelling technique has been carried out for high voltage switch using CST Microwave studio.

REFERENCES

1. [HTTPS://EN.WIKIPEDIA.ORG/WIKI/MARX_GENERATOR#:~:TEXT=A%20MARX%20GENERATOR%20IS%20AN, LINE%20GEAR%20AND%20AVIATION%20EQUIPMENT.](https://en.wikipedia.org/wiki/Marx_generator#:~:text=A%20Marx%20generator%20is%20an, line%20gear%20and%20aviation%20equipment.)
2. MARX GENERATOR". ECSE.RPI.EDU. (ED. EXPLAINS THE FIBERCON 2020 PULSER EXPERIMENTED WITHIN THE



RPI PLASMA DYNAMICS LABORATORY)

3. Jochen Kronjaeger, "Marx generator". Jochen's High Voltage Page, 2003.
4. Jim Lux, "Marx Generators", High Voltage Experimenter's Handbook, 3 May 1998.
5. "The 'Quick & Dirty' Marx generator". Mike's Electric Stuff, May 2003.
6. <https://hvtechnologies.com/hv-equipment/test-bay-equipment/impulse-generators>
7. <https://www.electrical4u.com/high-voltage-testing/>



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