High Voltage Pulse Generator Using High Voltage Transformer and Marx Generator

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ABSTRACT

The project presents a high voltage pulse generator system based On H.V Transformer. This system comprises mainly of a Marx generator, which is charged to a high voltage by a H.V transformer Generator. To verify the viability of this technology routine, a generator system with 3-stage Marx generator charged by a DC 3.7V-7.4V to 1000KV High Voltage Generator Transformer Boost Inverter Module. The output pulse is designed to be a 200-300 kV and 200 ns FWHM .pulse signal on the load. The experiment platform has been set up The simulation outcome are accordant with the design reason.. This novel system has the characteristics of quite high energy efficiency, accurate control, and the design with less number of spark switches is exercisable for operated at repetition rate.

Keywords:-H.V Transformer Generator, Capacitor Bank.

1. INTRODUCTION

Marx generator have used for pulse power source. In the past they usually perform using spark gap process and had low pulse repetition rate. In modern years Marx generators based on semiconductor switches are Introduced for high pulse repetition rates. But these generators have a low o/p pulse voltage due to the Margin of voltage rating of semiconductor switches. Marx generator (MG) with high repetition rates could be used for solving ecological issues, the electron-beam generation, the microwave generation, and plasma source ion implantation. plasma source ion implantation is an emerging processing for surface treatment of metal and polymer materials. Via that process it is possible to improve surface properties of the materials such as metals, plastics and ceramics. High pulse power technology is to compress the energy in period and volume. The pulse power system with Pulse Forming Line is commonly used. High voltage is charged to Pulse Forming Line , then dismission the energy to the load in an vastly less time (10~100ns). Marx generator and Tesla transformer are always applied singly as the charging part for Pulse Forming Line. In modern years, a compact Marx generator without Pulse Forming Line has been applied to drive low impedance load. A novel H.V pulse generator based on H.V transformer generator and Marx generator is designed. This system has the Features of fully high energy efficiency, accurate control, and the design with less number of spark switches is applicable for operating at repetition rate

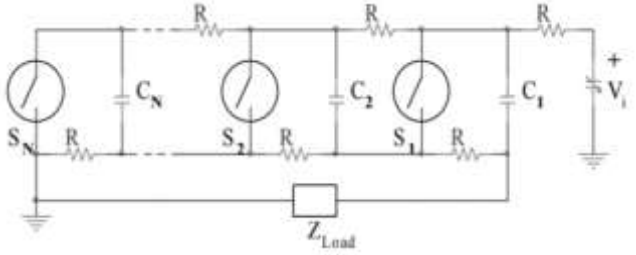


Fig:-1.Typical Marx Generator

The resistors(R) are used in Marx generator to provide for charging the capacitors(C) in charging mode and in discharging (H.V generation) mode. S_n is spark gap switch as the resistance values are

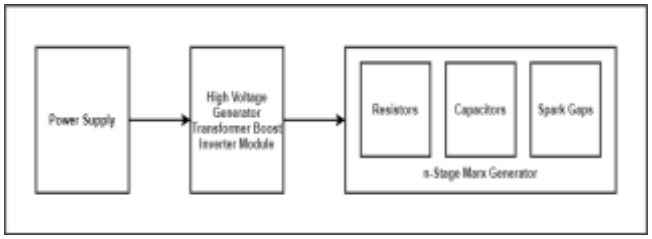
more, the system loss becomes lower. But the more value of resistance means a long charging time and high pulse repetition rate is impossible.

II BACKGROUND

A MARX GENERATOR IS AN ELECTRICAL CIRCUIT FIRST MENTIONED BY E.O MARX IN 1924. ITS MOTIVE IS TO GENERATE A H.V PULSE FROM A LOW-VOLTAGE DC SUPPLY. MARX GENERATOR ARE USED IN HIGH-ENERGY PHYSICS EXPERIMENT AND ALSO SIMULATE THE EFFECTS OF LIGHTNING ON POWER-LINE GEAR AND AVIATION EQUIPMENT.

2. METHODOLOGY

A. Block Diagram of Marx Generator



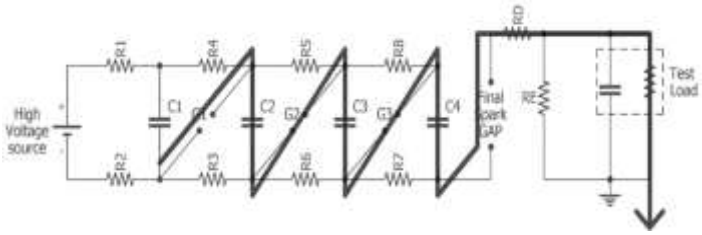
Description Of Block Diagram

To design and develop H.V pulses in the range of 20-220Kv using Marx Generator of various stages and study the optimum number of Resistor-Capacitor-Spark Gap stages with the best performance.

The operating principle of the system is shown in Block Diagram. The close the primary loop of the pulse transformer is control. The energy stored in the low voltage capacitor(C) banks is delivered to the capacitor banks of Marx generator by H.V transformer generator. The capacitors(C) in each stage are charged to a considerably H.V, which reduced the number of the Marx stages and the spark switches. The spark gaps of the Marx generator are closed when the voltage of the capacitor(C) banks reach to the threshold value. As all the stages are connected in series with extremely H.V, the energy stored in the capacitor banks is transferred to load. The H.V transformer generator is give to dc supply to capacitor bank. The design with low number of spark switches is applicable for operate the repetition rate.

B.Marx Generator with Spark Gap

This circuit is specifically used to produced high impulse voltage from a low-voltage power source. The circuit of multiplex impulse generator or commonly called as Marx circuit can be seen in the below.



. The above circuit uses four capacitors(C) (there can be n number of capacitors) that are charged by a H.V source in parallel charging condition by the charge resistors R1 to R8.

During the discharge condition the spark gap which was an open circuit during the charging condition, act as a switch and connects a series path through the capacitor(c) bank and produce a very high impulse voltage across the load.The voltage of the first capacitor needs to be increase sufficiently to break down the spark gap and energize the Marx generator circuit. When this occurs the first spark gap link two capacitor 1 and Capacitor 2. Therefore, the voltage across the 1st capacitor gets double by two voltages of Capacitor 1 and capacitor 2. After, the third spark gap automa breaks down because the voltage across the third spark gap is high enough and it starts to add the third capacitor 3 voltage into the stack & this going on up to the final capacitor(c).Ultimetally, when the final spark gap is reached, the voltage is huge enough to break the last spark gap across the load which has a larger gap amid the spark plugs.

The final o/p voltage across the last gap will be (nVC) where n is the number of capacitors and (VC) is the capacitor charged voltage. but this is real in ideal circuits. The o/p voltage of the Marx Impulse generator circuit will be much low than the

real desired. This last spark point must be have large gap because, without this, the capacitor do not get into a fully charged condition. Sometimes, the discharge is done intentionally. There are various way to discharge the capacitor bank in the Marx generator.

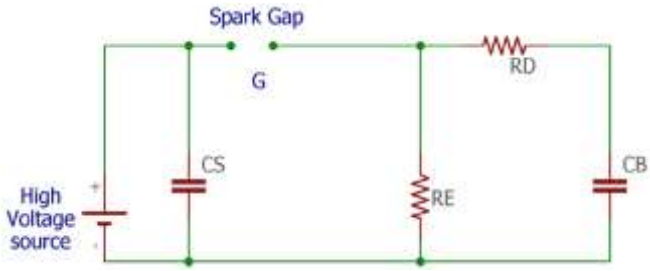
3. OBJECTIVE

1) The Maine objective of our project that we use low voltage Dc to produced high voltage Dc By using High voltage transformer Generator.

4. OVERVIEW

A. Single Stage Impulse Generator

To learn the working of an Impulse generator, let see the circuit diagram of a single-stage impulse generator that is shown in figure.



The above circuit consists of 2 capacitor(C) and 2 resistances(R). The spark (G) is an electrically seperate gap between two electrodes where electrical spark happen. A H.V power source is also shown in the fig. Any impulse generator circuit required rarely one large capacitor(c) that is charged to an suitable voltage level and then discharged by a load. In the circuit, the CS is the charging capacitor. This is a H.V capacitor typically more than a 2kV rating (depends on the output voltage). The CB is the load capacitance that will discharge the charged capacitor(C). The RD and RE control the wave shape. If the above Fig observed sharply, we find that the spark gap has no electrical connection. Then how does load capacitance get the h.v? Here is the trick, the circuit act as an impulse generator (IG). The capacitor (C) is charged until the capacitor charged voltage is enough to cross the spark gap. An electrical impulse generated across the SG and h.v gets transferred the left electrode terminal to the right electrode terminal of the spark gap and thus making it a connected circuit. The response time of the circuit can be controlled by vary the distance between 2 electrodes or changing the capacitors(C) fully charged voltage.

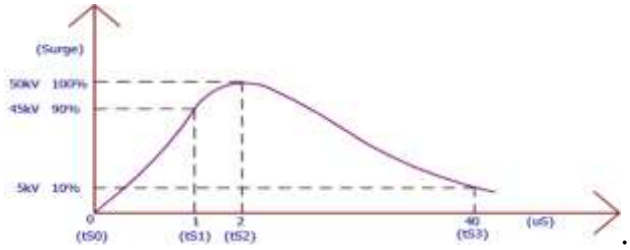
$$v(t) = [V0 / Cb*Rd*(\alpha - \beta)] (e - \alpha t - e - \beta t)$$

Where,

$\alpha = 1 / Rd*Cb$

$\beta = 1 / Re*Cz$

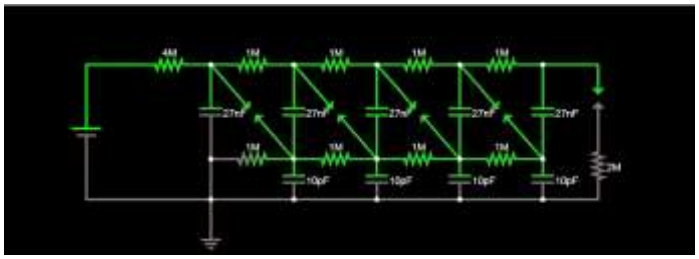
B. Impulse Voltage Waveform



Here we can see, the wave is obtained to its maximum 100 percent peak within 2 uS micro second. This is much rapid, but the H.V is losing its energy with a span of 40uS micro second almost. Therefore, the pulse has a very minor or fast rise period (time) whereas a very slow or long fall time.The time of the pulse is called the wave tail which is defined by the difference between 3rd time stamp ts three(3) and ts zero(0).

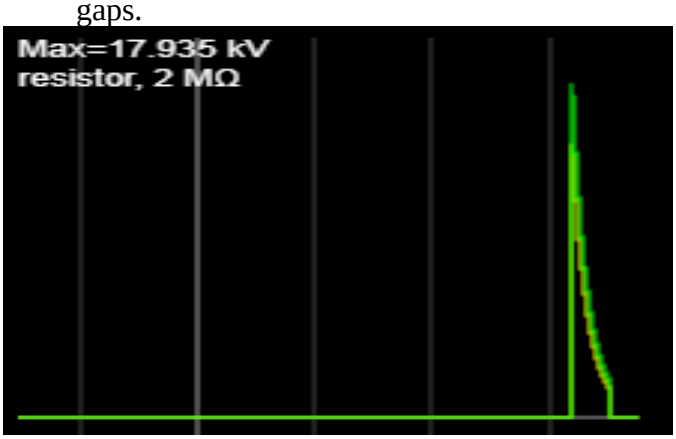
5. RESULT

A. SIMULATION AND RESULT



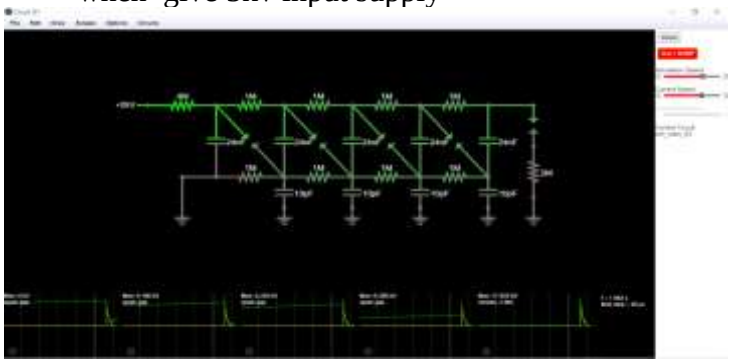
GENERAL LAYOUT OF SYSTEM

1) This is a General layout of System.We Use dc 1M,2M,4M ohm and two types Capacitor use in Circuit.
2) We use H.V Transformer Generator for Supply. 4M ohm resistor used to Prevent the continuous arc forming across the first gap- this is prevent further firing of Marx generator .
3) 1M ohm resistor connect in series and 27nf capacitor parallel.
4) 10 pf capacitor also use to prevent current going to directly ground
5) When supply on we can see the arc in spark gaps.



5KV supply. Various types of resistor use

1) Using simulation we get 17.935kv output when give 5kv input supply



6. CONCLUSION & FUTURE SCOPE

This work proposed a generalized dynamic model for n-stage Marx generators during the charging mode. The obtained model can be used to estimate the generator maximum pulse repetition rate or the maximum duty-cycle. Based on the dynamic model, the developed analysis can estimate the optimum number of stages (n) for a given needed pulse repetition rate and therefore the working voltage of each stage. In future solid-state switches like IGBTs and MOSFETs can be used instead of the conventional methodology.

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