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Multistage Impulse Voltage Generator

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Abstract:- The project is designed to generate High impulse voltage using Multistage or Marx generator principle and combination of Cockcroft Walton voltage multiplier circuit by using multi stage resistor and capacitor stacks. Principle is to generate a high impulse voltage pulse using a number of capacitors in parallel to charge up during the on time and then connected or discharged in series to develop higher impulse voltage during the off period or negative cycle. This principle or aim is used to generate impulse voltages in the range of KV's in real-time for testing the insulation and capability withstanding impulse voltage of the electrical appliances like transformers and the insulation of the power carrying lines. This project contains the combination with Cockcroft voltage multiplier circuit for the generation of the high dc voltage for input source for Marx generator. This project is practical and highly feasible in economic point of view, and has an advantage of researching and testing equipments for higher ratings and development.

Keywords- Cockcroft Walton Voltage Multiplier, Flyback Transformer ,EHT Coil, Marx Generator

I. INTRODUCTION

Multistage Impulse Voltage generator is used in high power equipment testing and also in the experimental transmission line and aviation object's. The basic principle of the Multistage impulse voltage generator is the charging x number of capacitors in parallel & discharge them in series stack. MIVG's consist of a N number of stack where each stack consists of N number of components and each stack consists of two resisters and capacitors connected with protective device for testing operator.

In this system operation of the capacitor discharges from the MIVG, the form of the impulse is controlled by external impedance at the output of the MIVG. When the voltage gets higher it is hard to get sensible resistors with low freeloading inductance that will also survive the full impulse voltage or surge. The usual cure for this is to comprise the wave shaping resistors in the MIVG.

In the combination of this project the MIVG requires HVDC supply unit so we had used the Cockcroft-Walton Voltage multiplier circuit The CWVM is a device which converts sine wave (AC)power from a low voltage level to a high voltage DC. It is combined of a voltage multiplier steps system of capacitors and diodes which produces high voltages. This method eliminates the necessity for the weighty core and the bunch of insulation. Using only capacitors and diodes, these CWVM can step up relatively low voltages to high voltage, while at the same time being faraway lighter and economical and efficient than transformers.

From this ideas my project can be extensively used in the High Voltage Manufacturing industries and also for Research and Development of Central organization because the time and craftsmanship is the highest priority hence our system would help industries and workers to save time and attain all the mean with high efficiency and less efforts .

1.1 Need of Impulse Voltage Generation

In daily maintenance or routine test performed for HV equipment like transformer, various instrument and also for protective devices so multistage impulse voltage generator is used to test the withstand capacity of either switching surge or lightning surge occurs on instrument or also load imbalance stroke occurs on insulated module.

1. Testing of transformers and the insulation of the power carrying lines.
2. Di-electric test under dry and wet conditions and pollution on equipments.
3. Energizing the experimental transmission line.
4. Specially used for testing to know the withstand capacity against the lightning surge or switching surge occurs.

1.1.1 What is Impulse Voltage ?

A unidirectional voltage that rapidly rises to a peak value and then drops to zero at more or less rapidly. Also known as pulse voltage.

1.1.2 What is feature of Impulse Voltage Generator ?

The MIVG can be used in also of the following two modes selected by routine switching:
(a) Manual operation. (b) Computer operation.

The physical operation mode allows you to select random test items for the Alternating current, Direct Current, or impulse voltage test from the Manual change over switch to generate the desired set voltage.

The HVDC power supply for charging MIVG can be set linearly by constant current charging in increment of stimulating voltage, providing extremely exact voltage values.

The generator uses compensation circuit, the constant voltage can be stabled without reducing after charging the generator, completed until it is fully discharged.

The generator is provided with a HVDC supply, so that the difference in output remains inside 0.005% even if the load varies from 0 to 100% at an input voltage of 100 VAC [+/-]10%. The DC withstand voltage test can therefore yield extremely accurate reading.

The safety device is provided with an over-current relay, so that it turn off and earths the high voltage circuit instantaneously if the load is short-circuited.

1.1.3 Components of Impulse Voltage Generator ?

The component is divided in two sections:

Components for Marx Generator:-
- High Voltage Metal Glazed Resistor.
- High Voltage Film Capacitor.
- High Voltage Spark Gaps.
- Test Specimen.
- Fuse.

Components for Cockcroft Walton Voltage Multiplier:-
- High Voltage Film Capacitor.
- Semi-Conductor Diode.
- Frequency Oscillator.
- Fuse/Circuit Breaker.
- High Voltage Spark Gaps.

2.1 What is Marx Generator?

A Marx generator is a simple high impulse voltage generator which has various technical uses, ranging from insulation and lightning safety testing to fusion research. It is based on slow, parallel charging Stack level of capacitors, which are then quickly discharged in series, usually by means of spark-gaps. Due to extraordinary power handling capabilities of spark gaps, Marx generators are able of providing pulses of peak powers along with multi-megavolt voltages.

The circuit generates a high-voltage pulse by charging x number of capacitors in parallel, then abruptly discharging them in series. At first, n capacitors(C) are charged in parallel to a voltage V by a high voltage DC power supply through the resistors (RC). The spark gaps used as switches have the voltage V across them, but the gaps have a breakdown voltage greater than V, so they all behave as open circuits while the capacitors charge.

Spark gap isolates the output of the originator 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 be triggered then breakdown effectively shorts the gap, placing the first two capacitors in series.

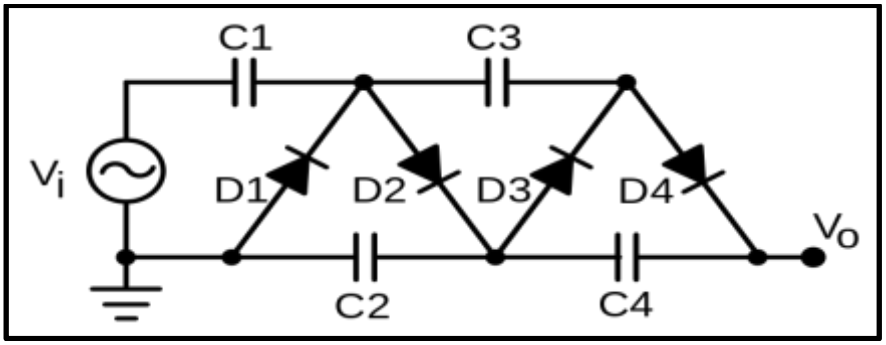
Accordingly, the second gap breaks down to add the third capacitor to the "stack", and the process continues to consecutively break down all of the spark gaps. The last gap connects the output of the series "stack" of capacitors to the load. Ideally, the output voltage will be nV, the number of capacitors times the charging voltage, but in practice the value is less. Note that none of the charging resistors R care subjected to more than the charging voltage even when the capacitors have been erected.

2.2 What is Cockcroft Walton Voltage Multiplier?

The Cockcroft–Walton (CW) generator, or Voltage Doublers is an electric circuit that generates a high DC voltage from a low voltage AC or pulsing DC input.

The CWVM is made up of a voltage multiplier stack or steps network of capacitors and diodes to generate high d.c voltages. Contrasting transformers, this method eliminates the necessity for the more amount of core and the massiveness of insulation required. Using only stack of capacitors and diodes, these voltage multipliers can step-up the low voltages to extremely high dc voltage, while it is being far lighter and cheaper and efficient than transformers.

The wide benefit is that the voltage across each stage of the stack is equal to only double the peak input voltage in a half-wave rectifier. In a full-wave rectifier it is thrice times the input voltage. It has benefit due to comparatively low cost components and it is also easy to insulate. One can also tap the output from any stage, like a multi-tapped transformer.



Circuit Diagram of Cockcroft Walton Voltage Multiplier

When the input voltage Vi reaches its negative peak −Vp, current flows through diode D1 to charge capacitor C1 to a voltage of Vp. When Vi reverses polarity and reaches its positive peak +Vp, so it added to the capacitor (V) to produce a voltage of (2Vp) on C1s right hand plate. Since D1 is reverse-biased, current flows from C1 through diode D2, charging capacitor C2 to a voltage of 2Vp.When Vi reverses polarity again, current from C2 flows through diode D3, charging capacitor C3 also to a voltage of 2Vp.When Vi reverses polarity again, current from C3 flows through diode D4, charging capacitor C4 also to a voltage of 2Vp. With every transform in input polarity, current flows in the "stack" of capacitors through the diodes, until they are all charged. second instant the rest of capacitors are charged to a voltage of 2Vp, except for C1, which has charged to Vp. The key to the voltage multiplication is that, while the capacitors are charged in parallel, they are connected to the load in series. Since C2 and C4 are in series between the output and ground, the total output voltage (under no-load conditions) is Vo = 4Vp.

2.3 What is Flyback Transformer Unit ?

The flyback transformer unit is used for controlling the straight movement of the electron light or beam in a (CRT). Flyback transformer is not fed with a signal of the same wave shape as required output current. A suitable side effect of such a transformer is the substantial energy that is available in magnetic circuit.

EHT coil can be designed with extra windings used to provide power operate other parts of the equipment. For operational very high voltages are easily obtained using few turns of winding is rectified and can provide the high voltage acceleration. EHT coil can be used for many applications such as transformer to produce high voltages and just use the device as, a efficient means of producing a wide range of lower voltages using a transformer much smaller.

The transformer can be equipped with extra windings to generate high voltage pulse induced in EHT coil when the magnetic field induced as the input switch is turned off.

There is significant energy stored in the magnetic field and coupling it out via extra windings helps it to disintegrate quickly, and avoids the voltage flash over .

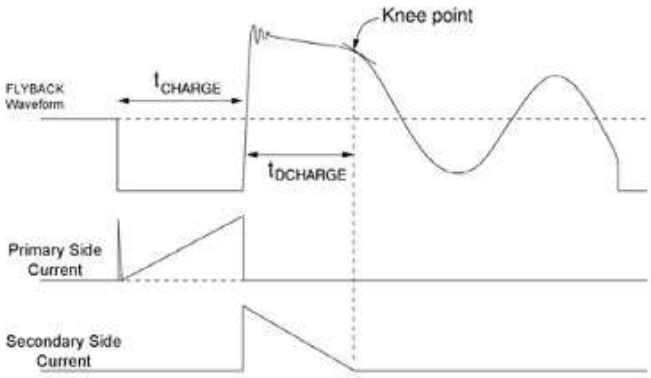
The high voltage stokes or pulses from the flyback transformer windings is converted to D.C by half wave rectifier. There is no point in using a full wave design as there are no corresponding pulses of opposite polarity.

In the operating condition switch is turned off, the current in the primary winding becomes zero. The energy stored in magnetic core is induced in the secondary as the magnetic field in the core collapses.

The voltage in the output winding rises very quickly (usually less than a micro-second) until it is limited by the load conditions. Once the voltage reaches such level as to allow the secondary current to flow, then the current in the secondary winding begins to flow in the form of a descending ramp.

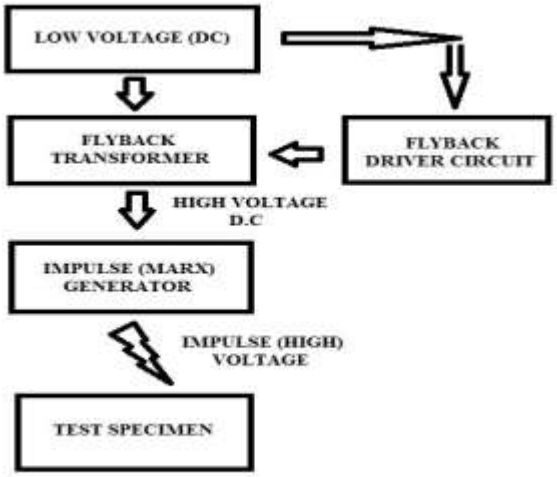
The operating cycle can be repeated if the secondary winding current is allowed to discharge completely to zero (no energy stored in the core) then it is said that the transformer works in discontinuous mode(DCM).

Some of the energy is always stored in the core or in winding(and the current waveforms look trapezoidal rather than triangular) then this is continuous mode (CCM). This terminology is used especially in power supply transformers.



EHT COIL (FLY-BACK TRANSFORMER OUTPUT WAVEFORM)

2.4 Block Diagram:-



2.5 Application & Uses:-

I. Testing of transformers and the insulation of the power carrying lines.
II. Testing of high-voltage components and aircraft instrumentation to simulate the type of power surge that might result from a lightning strike.
III. Di-electric test under dry and wet conditions and pollution on equipments.
IV. Energizing the experimental transmission line.
V. Specially used for Aerospace Industry to examine Lightning pulses of surge outer skin of Jet Aircraft and Passenger Planes

REFERENCES

[1] IEEE Xplore, "Marx Generator using power Mosfets," *IEEE Xplore on Marx Generator*, Pulsed Power Conference June 28 2009 pages- 408-410.
[2] IEEE Xplore, "Solid State Marx Generator," *IEEE Xplore on Marx Generator*, Power Modulator Symposium 2006 May 14-18 pages- 314-317.
[3] Reference Book on High Voltage Engineering: For Marx Generator by**:-** M. S. Naidu, V. Kamaraju.
[4] Reference Book on High Voltage Engineering:- Introduction to High Voltage Engineering for Marx Generator by:- Subir R. Ray.
[5] Reference Book on High Voltage Engineering:- For Cockcroft Walton Voltage Multiplier by:- C. L. Wadhva.