IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

BATTERY OPERATED MULTISTAGE HIGH VOLTGAE GENERATION BY COCKCROFT-WALTON MULTIPLIER

Nikhil M. Waghamare [*], Rahul P. Argelwar, Amol Thakare, Sneha Urkude

[*] Electrical Engineering(E&P), Amravati University,India.

ABSTRACT

In this section describes the details of high voltage DC power supply whose output voltage is upto 1 KV. In this study, we review the major aspects of the design of voltage multiplier circuits and constructed a prototype power supply based on design and implementation of the hardware. In this study 8 stage Cockcroft-Walton Multiplier Circuit is used for the generation of high voltage by using battery operated as compare to 230V, 50HZ AC supply system. The battery operated syetm is a beauty of the whole system. A prototype was designed and experimental result was tested and demonstrate was purpose.

Keywords: Battery; Cockcroft-Walton Multiplier; High Voltage;

INTRODUCTION

There are some advantages of the Cockcroft-Walton multiplier circuit they are simple in design only the cascading of the diode and capacitor, transformer scheme are neglected therfore cost and size of the circuit is small and because of the used of the battery this particular circuit easy to portable and easy to handling, this is the main advantage of the circuit. DC voltages are widely used in scientific research work and in the industry level the main application of the DC high voltage is in test on cables with a relatively large capacitance, which takes a very large current if it is tested with AC voltages and also there are several application of the Cockcroft-Walton Multiplier circuit in the scientific instrument, TV sets and CRTs, Oscilloscope, x-ray and photomultiplier tubes are used in nuclear industry for detection of radiation [3]. Battery operated method is more advantageous than the ac power source because, battery operating system is portable and if ac supply is not available at that place battery operated scheme is more preferable.

VOLTAGE MULTIPLIER

There are several method for stepping up voltage transformer are used only in AC system for stepping up and down the voltage. But in DC transformer method is not applicable because of this voltage multiplier circuit is used for generation or stepping up high voltage by number of stages. And this is the easy way for achieving High Voltage in DC power system. Voltage multipliers are used to generation of the high voltage where low current system. The output voltage of a voltage multiplier circuit may be several times greater than the input voltage. Because of this reason, voltage multipliers are used only in special applications where the load is constant and has high impedance or where input voltage stability is not critical. Voltage multipliers may be classified as voltage doubler, tripler or quadrupler. The classification depends on the ratio of the output voltage to the input voltage. For example, a voltage multiplier that increases the peak input voltage twice is called a voltage doubler. And if the number of stage increase then peak to peak current is also increase and that system called as Cockcroft-Walton Multiplier cicuit.

COCKCROFT-WALTON MULTIPLIER CIRCUIT

Voltage multipliers are circuits typically consisting cascading of diodes and capacitors, although there are variations using resistors and spark gaps. The multiplier designed to take in an AC input or DC input with a certain amplitude and output a higher peak to peak voltage in DC system.

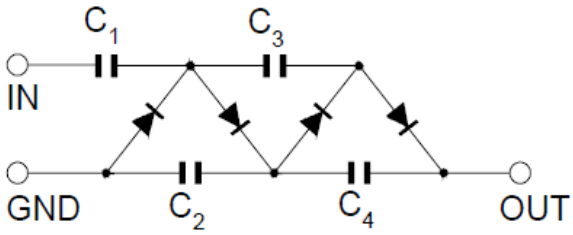

Fig-1: Cockcroft-Walton Multiplier Circuit

In figure shows the typical Cockcroft-Walton Multiplier circuit. There are number of capacitor and Diode are connected in cascading circuit. Consider operation of two stages Cockcroft-Walton multiplier is shown in figure1.

1) When Vs is negative, then Capacitor C1 charges through Diode D1 to Vmax.
2) When Vs is positive, then Vmax add arithmetically existing potential C1, thus C2 charges to 2Vmax through D2.
3) Again Vs is negative, C3 charge 2Vmax through Diode D3.
4) Again Vs is positive, Capacitor C4 charge Diode D4 to 4Vmax.
Therefor output of multiplier = Vmax * N

Where,
N = Number of stages [3].

In this way if the number of stages of the Cockcroft-Walton Multiplier circuit is increases then output is also increases and in this way obtained high peak to peak Voltage.

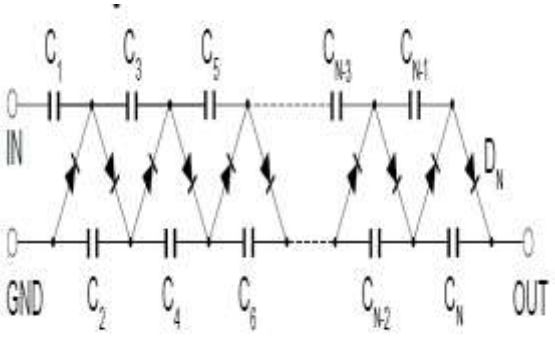

Fig-2:Multistage Cockcroft-Walton Multiplier Circuit

The well-known CW voltage multiplier is made by joining a number of diode–capacitor ladder stages with each stage containing two capacitors and two diodes. Theoretically, an *n*-stage CW voltage multiplier dc output voltage is equal to the value of 2*n* times of the magnitude of the ac voltage source under no-load condition. Due to non ideal characteristics of the circuit components the dc output voltage is practically less than the theoretic value. Some drawback of CW multiplier is, under heavy-load condition, the CW multiplier intrinsically presents not only poor output voltage regulation but also high output ripple with line frequency.

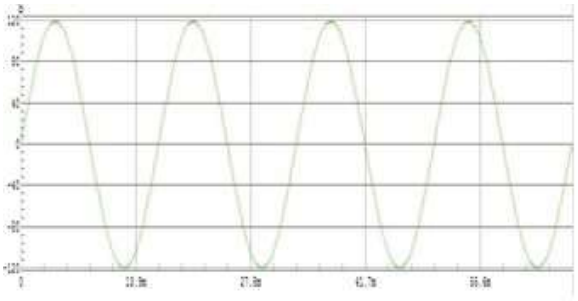

*Fig-3: **Input of the capacitor and Diode***

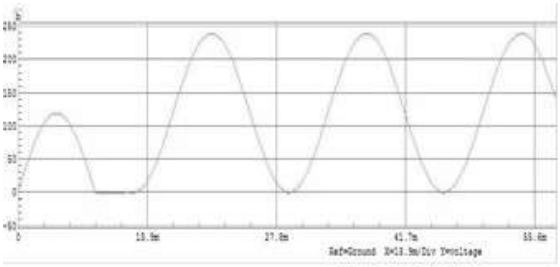

*Fig-4:**output of the capacitor and Diode***

In figure 3 and 4 shows the matlab simulation of the voltage of the capacitor and diode. From, this two figure it will be conclude that Output voltage increased.

DESIGN AND TEST SETUP

In our previous work design and setup High voltage generation by using AC supply. But there are some difficulty faces. In some area there are problem of electricity. Hence In this work setup Battery operated High Voltage generation By using Cockcroft-Walton Multiplier. This circuit is everywhere to applicable if there is problem of electricity or not. In this work instead of the AC supply we used small rating of the battery.

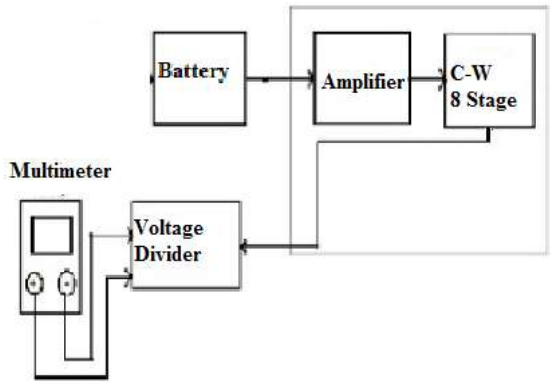

Fig-5: Block Diagram of test setup

Fig-5: Output of the first stage

In figure 5 shows that experimental setup and in that Battery are used for the supply if the Cockcroft-Walton Multiplier circuit. Because of 230V AC supply neglecting rectified circuit also neglected. And direct battery output connected to the Amplifire circuit for amplified the DC voltage. A voltage divider is used for dividation of voltage with a very high resistance. The two main components are used in the setup as shown.in figure 5. They are amplifier and 8 stages voltage multiplier. Amplifier is used to amplify the DC input signal and 8 stages Cockcroft-Walton multiplier is used to step up DC voltage into a high voltage at 1KV or 1000 Volt from Battery. Voltage adjuster are used to adjust the voltage and amplifier end for supplying to the Cockcroft-Walton multiplier circuit. The operation of a multiplier is to be effectively multiply the peak to peak voltage by number of stages and convert into high voltage. The voltage at the 1st stage of multiplication is 120V DC. The voltage at the 8th stage of multiplication is 960VDC. In theoretical consideration these values were somewhat reduced because of losses in the diodes, capacitances and leakage currents of the diodes, component tolerances of the diodes and capacitors, etc. The voltage divider in which high value of resistance are use. In the actual prototyped circuit, we used 10 Mohm resistors because of availability in the experiment [1]. Components are used in prototype model Capacitor and Diode in cascade network, and operational amplifier (741).

In theoretically at first stages output is 120 peak to peak voltage and at the end of 8 stages the peak to peak voltages is 960 volt. Developed high voltage D.C. Power supply based on Cockcroft-Walton voltage multiplier circuit. And Figure 6 shows that the matlab simulation of the output of the fiest stage in Cockcroft-Walton Multiplier. This circuit is a unique circuit

CAPACITOR AND DIODE SELECTION

Capacitor selection - The size of capacitors used in multiplier circuits is directly proportional to the frequency of the input signal. Capacitors used in off-line, 60 Hz applications are usually in the range of 1.0 to 250 µF while those used in higher frequency applications, say 10 kHz, are typically in the range of 0.02 to 0.06 µF. In practice, it is usually easier, and less costly, to use the same large capacitance value for all capacitors, both “AC” and “DC” type. The overall capacitive reactance of the circuit must be considered, however, to determine the largest permissible value.

For selection of diode, parameter must be consider. When the maximum reverse voltage across a diode that is known as peak inverse voltage. This peak reverse voltage are available in each diode therefor for selection of diode rating which is 2 * Vmax for a safety purpose.

CONCLUSION

Battery operated Cockcroft-Walton multiplier is design and compare with the 230 V, 50Hz AC Supply. This system is more advantageous than AC supply because of the this system is portable and it is applicable where, AC supply is provided or not. This system give high reliability and less cost. This small circuit give High output voltage. This multiplier circuit is useful for a scientific instrument, TV sets and CRTs, Oscilloscope, x-ray and photomultiplier tubes and field testing of HV cables.

ACKNOWLEDGEMENTS

In this work supported by professor Rahul P. Argelwar sir Dept. of Electrical Engineering (E&P),Amravati University, India.

REFERENCES

[1] D. F. Spencer, R. Aryaeinejad, E. L. Reber," Using the Cockcroft-Walton Voltage Multiplier Design in Handheld Devices*", INEEL/CON-01-01424 PREPRINT* October 2001.

[2] C. K. Dwivedi ,M. B. Daigavane," Multi-purpose low cost DC high voltage generator (60 kV output), using Cockcroft-Walton voltage multiplier circuit‖, *International Journal of Science and Technology Education Research* Vol. 2(7), pp. 109 - 119, July 2011.

[3] Nikhil M. Waghamare, Rahul P. Argelwar."High voltage generation by using Cockcroft-Walton multiplier", *International Journal of Science, Engineering and Technology Research (IJSETR), Volume 4, Issue 2, February 2015*,pp.256-259.

[4] C.L.Wadhwa,―High Voltage Engineering‖.New Age International Publication. pp. 56-63 .

[5] Naidu MS, Kamaraju V (2004),‖High Voltage Engineering‖, Third Edn. McGraw- Hill Company Ltd. pp. 146-156

[6] Nileena P. Subhash, Ajmal K.A, K. Punnagai Selvi," A High Step-Up Converter Using Transformerless Cockcroft-Walton Voltage Multiplier for a PV System,‖ *International Conference on Engineering Technology and Science-(ICETS'14)*

Author Biblography

Nikhil M. Waghamare, (Age:23) was born in Nagpur (Maharashtra). He is pursuing B.E. degree in Electrical Engineering (E&P), From Amravati university, India. he has 6 month experience in SEE-Tech solution Nagpur.

Rahul P. Argelwar, (Age:24) was born in Nagpur (Maharashtra). He received B.E. degree in 2011 from KDKCE Nagpur University, MTech (Pursuing) from PCE, RTM Nagpur University and he has 3 Year experience.

Amol R. Thakare, (Age:24) was born in Nagpur (Maharashtra).He is pursuing B.E. degree in Electrical Engineering (E&P), From Amravati university, India.

Sneha B. Urkude, (Age:22) was born in Nagpur (Maharashtra).He is pursuing B.E. degree in Electrical Engineering (E&P), From Amravati university, India.