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# Comparative analysis of high voltage generation using Cockcroft-Walton voltage multiplier

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**Abstract -** *This paper proposes high voltage DC generation using Cock-croft Walton multiplier circuit. Cockcroft-Walton voltage multiplier circuit provides suitable high DC voltage source from a low input voltage i.e. 230V AC supply. It is constructed by ladder network of diodes and capacitors. The output increases as we increases as we the number of stages. The simulation of Cockcroft-Walton multiplier circuit is done in MATLAB software. The result hopefully can fulfill the theory of the Cockcroft-Walton multiplier circuit.*

***Key Words: Cockcroft-Walton voltage multiplier, High Voltage***

## 1. INTRODUCTION

There are many uses of high DC voltage. High voltage DC power supplies have widely applied to industries, science, medicine, military such as test equipments, x-rays systems, dust filtering, insulating test and electrostatic coating. For stepping up of voltage step up transformer is commonly used. The output of secondary of step up transformer increases the voltage and decreases the current and losses, this is for AC system. In DC system it is not possible due to constant current. Therefore for DC system for stepping up of voltage Voltage multipliers and voltage doublers are used. Cock croft Walton voltage multiplier is a popular option among high voltage DC application.

This circuit was first discovered by Henrich Greinacher in 1919 but the circuit got named after the British and Irish physist John Douglas Cockcroft and Earnest Thomson Walton who used this circuit design to power the particle accelerator in 1932. The Cockcroft-Walton multipliers has many advantages. By using only diodes and capacitors, these voltage multipliers can step up relatively low voltages to extremely high values, while at the same time being far lighter and cheaper. The biggest advantage of such circuit is that the voltage across each stage of this cascade voltage multiplier is only equal to twice the peak input voltage, so it has the advantage of requiring relatively low cost components and being easy to insulate. One can also tap the output from any stage, like a multi-tapped transformer.

### 1.1 Cockcroft-Walton voltage multiplier circuit

The cock croft Walton voltage multiplier is an electric circuit that generates a high DC voltage from a low voltage AC source. Cockcroft voltage multiplier circuit is constructed by the ladder network of diode and capacitor to generate high voltages. It provides the advantages of High voltage ratio low voltage stress on diodes and capacitors, compactness and cost efficiency.

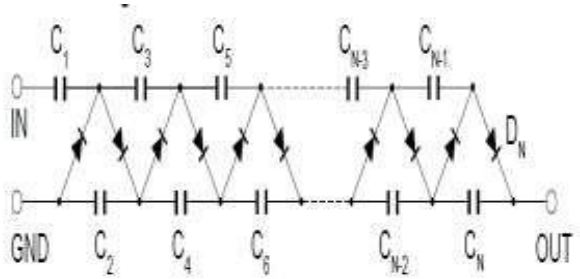


Fig.1-Multistage Cockcroft-Walton Voltage Multiplier Circuit

### 1.2 WORKING OF COCK-CROFT WALTON CIRCUIT

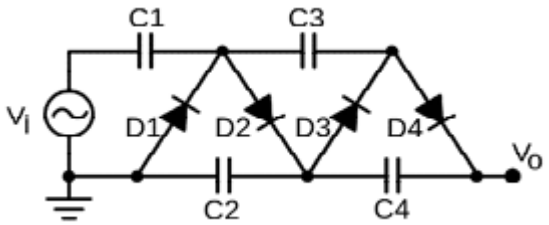


Fig.2 Two stage Cockcroft Walton voltage multiplier

- During the negative half cycle, D1 is in forward bias and D2 is in reverse bias so capacitor C1 is charged through diode D1 to Vmax.
- During positive half cycle D2 is in forward bias and D1 is reverse bias so that Vmax add arithmetically exiting potential C1 , thus capacitor C2 is charged through diode D2 to 2Vmax.
- Again negative half cycle, C3 is charged 2Vmax through diode D3.
- Again positive half cycle , C4 is charge diode to 4Vmax

- The voltage across the column of capacitors consisting of C1, C3 keeps on oscillating as supply voltage alternates. Therefore, this column is known as oscillating column. However, the voltage across C2, C4 remains constant and it is known as smoothening column. Therefore voltage across all the capacitor is 2Vmax except for C1 where it is Vmax only. The total output voltage will be2nVmax where n is the number of stages. The equal stress of elements (diodes and capacitors) used is very helpful and promotes a modular design of such generators.

## 2. MATLAB MODEL

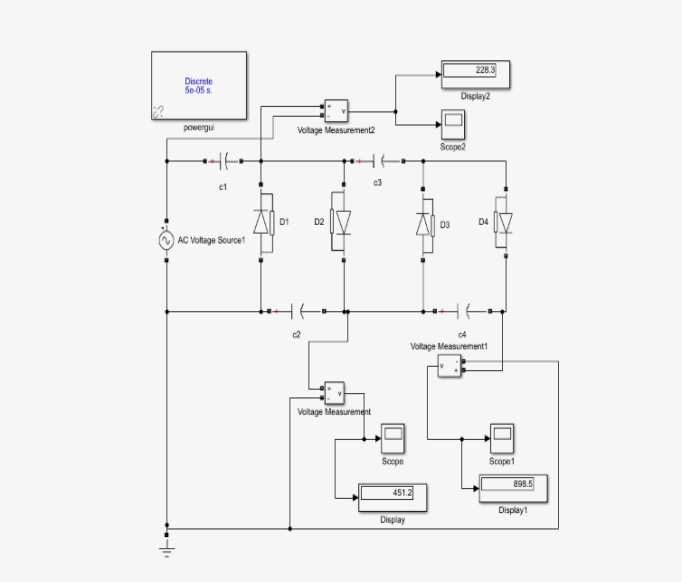


Fig.3- Two stage Cockcroft-Walton circuit MATLAB model.

Fig 4. Output waveform for 1st stage

Fig.5 Output waveform for 2nd stage

**Table-1:** Comparison of Simulated and Experimentally obtained Results

| Input Voltage (V) | Stage | Expected Result | Simulated Result |
|---|---|---|---|
| 230V | 1<br>2 | 460V<br>920V | 451.2V<br>898.5V |

**Table-2:** Circuit parameter for simulation and hardware

| Parameter | Value |
|---|---|
| Capacitors | 100μf |
| Diode | 1N5408 |

## 3. HARDWARE CIRCUIT

The hardware circuit of three stage Cockcroft-Walton voltage multiplier circuit is as shown in the fig.4. Each stage consists of two diodes and four capacitors. The diodes used are 1N5408, 3A, 1000V and the capacitors used are of 100uf, 450V. Here two capacitors are connected in series to have effective capacitance of 50uf, 900V in each stage.

Fig.4 Hardware setup Cockcroft-Walton voltage multiplier circuit

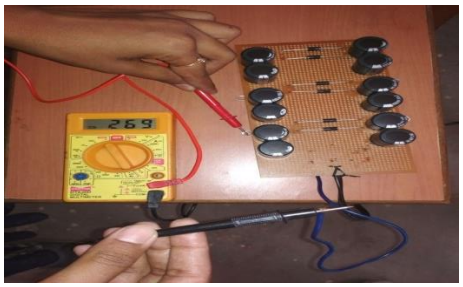

Fig 4.1 Input to CW voltage multiplier circuit

Fig 4.2 First stage output (484v)

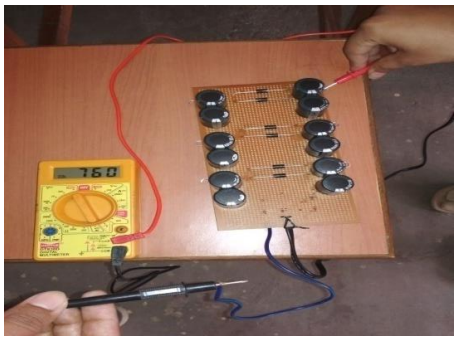

Fig 4.3 Second stage output (760v)

## 4. COMPARISON OF OUTPUT OF SIMULATED AND

| Stage | Expected Result | Simulated Result | Observed Result |
|---|---|---|---|
| 1 | 460V | 451.2 | 484V |
| 2 | 920V | 898.5V | 760V |

## HARDWARE MODEL

## 5. CONCLUSION

The following conclusions can be made from this work-

1. Simulated and observed results get matched with the expected result.

2. As we increase number of stages output also get increased. Different magnitude of high voltage can be tapped from different stages.

3. Construction of whole circuit is simple, small and robust in nature.

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