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# Development of Transformer Less Cockcroft Walton voltage Multiplier for Improved Voltage Gain

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***Abstract*** *: In generally to get high dc output voltage we are using voltage multipliers, DC-AC-DC inverters with step-up transformer due to using of transformers the size, cost and high ripples are present in output voltage and current. The Cockcroft–Walton (CW) generator, or multiplier, which is an electronic circuit it generates a high DC voltage from a low level input voltage AC or pulsing DC. Today Cockcroft-Walton (CW) circuits are still used in particle accelerators, and also in many electronic devices where high voltages require. In our research physics laboratories, High Voltage laboratories High Voltage Testing of Cables and Capacitors, The outline of the report deals with Generation of High voltage Using Three Stage Transformer less Cockcroft Walton Voltage Multiplier Circuit.*

***Keywords****: Cockcroft–Walton, Operating mode, DC*
*Voltage*

## 1. Transformer less Cockcroft Walton circuit

The proposed converter supplied by a low-level dc source, such as battery, PV module, or fuel cells. The proposed converter (Cockcroft–Walton (CW) generator, or multiplier) consists of one inductor Ls(boost inductor), four switches (Sm1, Sm2, Sc1, and Sc2) the rating of all switches are same as well as voltage stress across each switches are same, and one n-stage CW voltage multiplier The four switches are divided into two groups Sm1 (Sc1) and Sm2(Sc2) which operate in complementary mode, and they are operating under two different frequencies of Sm1 and Sc1 are defined as fsm and fsc, respectively. For convenience, fsm is denoted as modulation frequency, and fsc is denoted as alternating frequency. The both fsm and fsc frequencies should be as high as possible so that we can use smaller inductor and capacitors in this circuit. In this paper, fsm (=60 kHz) is set much higher than fsc (=1 kHz), and the output voltage is regulated by controlling by the duty cycle of Sm1 and Sm2, while the output voltage ripple can be adjusted by fsc. As shown in Fig.1, the well-known CW voltage multiplier is constructed by a cascade of stages with each stage containing six capacitors (C1, C2, C3, C4, C5, C6,) and six diodes (D1, D2, D3, D4, D5, D6,). In an n-stage CW voltage multiplier, there are N (= 2n) capacitors and N diodes n=3 (3-stage)

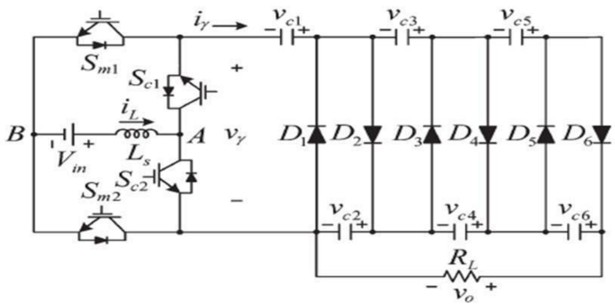


Figure 1 Transformer less Cockcroft-Walton voltage multiplier

## 2. Operations of proposed system

The operation of 3-stage Cockcroft-Walton (CW) Voltage Multiplier is divided to four mode operations.

### 2.1 Operating mode 1

Sm1 and Sc1 Switches are turned on, and Sm2, Sc2 Switches turn off, and all diodes are turned off. The boost inductor is get charged by the Vin which is may be fuel cell solar cell or other source, the even group capacitors C6, C4, and C2 are discharged and give supply to the load, the odd-group capacitors C5, C3, and C1 are not in conduction.

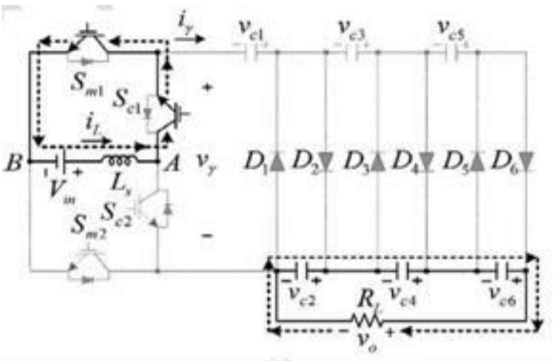


Figure 2 Operating Mode 1

## 2.2Operating Mode 2

Sm2 and Sc1 Switches are turned on, Sm1 and Sc2 Switches are turned off, the current iγ is positive. The boost inductor (Ls) and input Vin dc source are in series the boosted energy transfer to the CW voltage multiplier through different even diodes. In mode 2-A, diode D6 is conducting; the even-group capacitors C6, C4, and C2 are get charged, and the odd-group capacitors C5, C3, and C1 are discharged by iγ. In mode 2- B, diode D4 is conducting. Thus, C4 and C2 are get charged, C3 and C1 are discharged by iγ, C6 supplies load current, and C5 is floating. In mode 2-C, diode D2 is conducting. Thus, C2 is charged, C is discharged by iγ, C6 and C4 supply load current, and C5 andC3 are not in conduction.

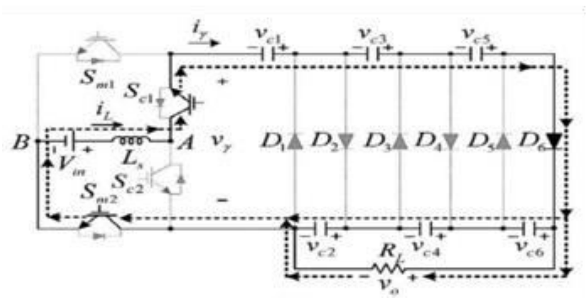


Figure .3 Operating Mode 2

## 2.3Operating Mode 3

Sm2 and Sc2 Switches are turned on, and Sm1, Sc1, and all CW diodes are turned off. The boost inductor Ls is get charged by the Vin dc source, the even group capacitors C6, C4, and C2 supply the load current, and the odd-group capacitors C5, C3, and C1 are not in conduction.

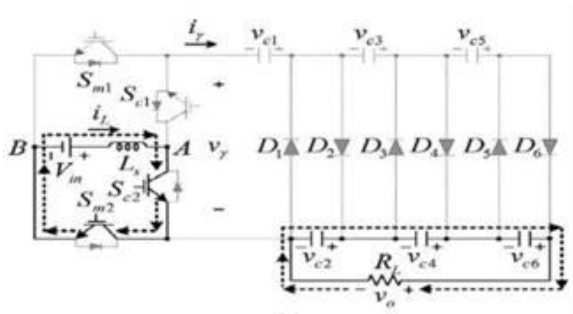


Figure 4 Operating Mode 3

## 2.4 Operating Mode 4

Sm1 and Sc2 Switches are turned on, Sm2 and Sc1 Switches are turned off, and the current iγ is negative. The boost inductor Ls and input Vin dc source are in series the boosted voltage is “-Vγ” transfer energy to the CW voltage multiplier through odd diodes. In mode 4-A, diode D5 is conducting. Thus, the even-group capacitors, except C6 which supplies load current, are discharged, and the odd-group capacitors C5, C3, and C1 are charged by iγ. In mode- 4-B, D3 is conducting. Thus, C2 is discharged, C3 and C1 are charged by iγ, C6 and C4 supply load current, and C5 is not in conduction. In mode-4-C, D1 is conducting. Thus, C1 is charged by iγ, all even capacitors supply load current, and C5 and C3 are not in conduction.

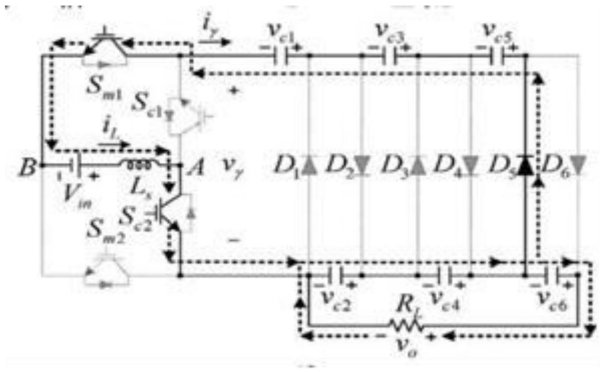


Figure 5 Operating Mode 4

## 3. Simulation of Cockcroft Walton Circuit

Obtained simulated results are presented for the closed loop analysis of 3-stage Cock-craft Walton (CW) voltage multiplier

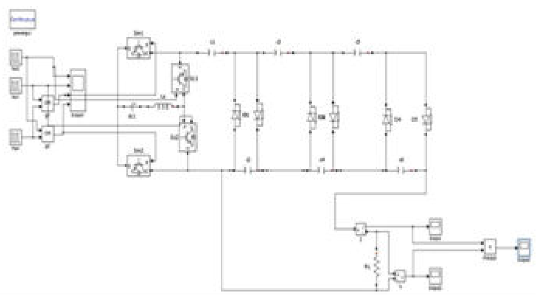

Figure 6 simulations of 3 stages transform less cock-craft Walton

## 4. Output of transformer less Cockcroft Walton voltage multiplier

### 4.1Output current

- The output current characteristics of the proposed transformer less Cockcroft Walton voltage multiplier is represented in Figure 7

- From figure7, it is seen that the current gets gradually decreased from higher value to a lower value, because of increasing voltage.

- The value of current is low, which is the required thing.

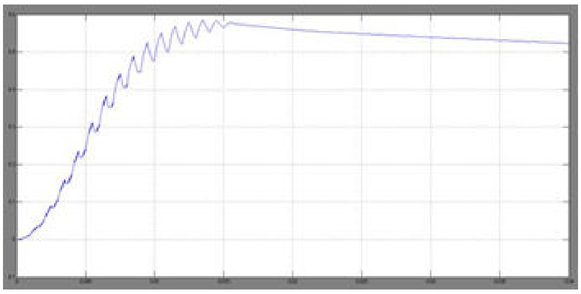

Figure 7 Output Current

### 4.2 Output Voltage

- The output voltage characteristics of the proposed transformer less Cockcroft Walton voltage multiplier is represented in Figure 8.
- From figure 8, it is seen that the voltage gets increased from lower value to a higher value.
- Were the input voltage is 48V and the output is more than 500V

- The value of voltage is high, which is the required thing

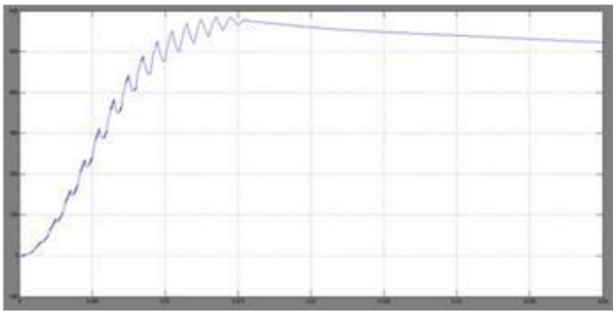

Figure 8 Output Voltage

### 4.3 Output power

- The output power characteristics of the proposed transformer less Cockcroft Walton voltage multiplier is represented in Figure 9
- From figure, it is seen that the current gets gradually increased.
- The value of output power is 250W.

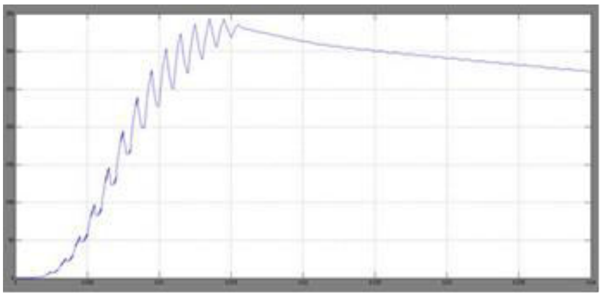

Figure 9 Output power

### 4.4 Analysis

- These are simulated results obtained for the 3-stage Cockcroft-Walton (CW) voltage multiplier.

- The input voltage for Cockcroft-Walton (CW) generator is 48V, Output voltage is 500V, and output current is 0.5Amp.

- Output power is 250W.

- The output voltage range can be increased by adding the number of stages, for every stage we have to connect the two more capacitors and two more diodes.

## 5. Conclusion

A high step-up dc-dc converter based on the Cockcroft-Walton (CW) voltage multiplier without using a transformer has been presented to obtain a high voltage gain. Since the voltage stress on the active switches, diodes, and capacitors is not affected by increasing the number of cascaded stages, power components with the same voltage ratings can be selected. The Control strategy employs two independent frequencies, one is operates at high frequency to minimize the size of the inductor(Ls) while the other one operates at relatively low frequency according to the desired output voltage ripple. Finally, the simulation and experimental results proved the validity of theoretical analysis and the feasibility of the proposed converter. In future we can increase number of n-stages the high dc output voltage can be converted to AC voltage.

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