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Transformer Less High DC–DC Converter Based on Cockcroft Voltage Multiplier for Photovoltaic Application

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Abstract: The proposed Cockcroft Walton voltage multiplier DC-DC converter produces high dc voltage without using the step up transformer. The output of the dc converter has minimum ripple, high voltage gain and continuous current across the switches and diode. The input voltage is less and produce more output voltage using the CW voltage multiplier. The proposed method operates has high switching frequency and produce high voltage. The Cock Croft Walton voltage multiplier has three stages in the proposed circuit. The photovoltaic based DC-DC converter and the inverter has designed. The high voltage is generated and verified in MATLAB Simulink Software.

Key words: Cockcroft Walton (CW), PhotoVoltaic (PV), inverter, DC-DC converter, voltage, output

INTRODUCTION

In recent years there is increase in the use of renewable energy because it produces more output at the source side. The proposed system use the photovoltaic as the source and it is feed into the Cockcroft Walton voltage multiplier (Bhaskar *et al*., 2016). The proposed converter has transformer less high voltage gain converter. The DC-DC converter has n stage and produce high gain and continuous current in the output of the inverter (Muller and Kimball, 2016). The current-fed PV based converter incorporated high boost voltage or coupled inductors which focused on increasing the efficiency and decrease the voltage stress and reach the desired output voltage at the output of the converter (Cornea *et al*., 2017). In parallel or series connected passive devices and the variety of converters supplied not only increase the voltage and also they designed in simple and structure will be complex (Nguyen *et al*., 2016). The voltage is increased and has steady output at the dc voltage and the harmonics will be reduced compared to the conventional converter. In this study described that the PV inverter topology it is a high efficiency topology (Bavitra *et al*., 2015). Firefly algorithm is presented in this study in this algorithm used to generate the reactive power (Kannan *et al*., 2015).

MATERIALS AND METHODS

The photovoltaic converts sunlight into electricity. The PV power depends on the type of the semiconductor material and also the radiation and temperature. The proposed block diagram of cockcroft Walton voltage multiplier based PV system is shown in Fig 1. The single diode PV Model is shown in Fig. 2. The specifications of PV Model is shown in Table 1. V-I characteristic of PV module are given as:

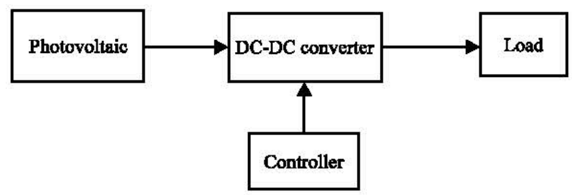

Fig. 1: Proposed block diagram

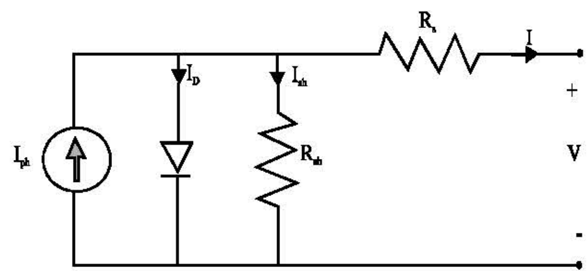

Fig. 2: Single diode PV model

$$I = I_i - I_0 \left(e \frac{q(V+IR_s)}{nKT} - 1 \right)$$

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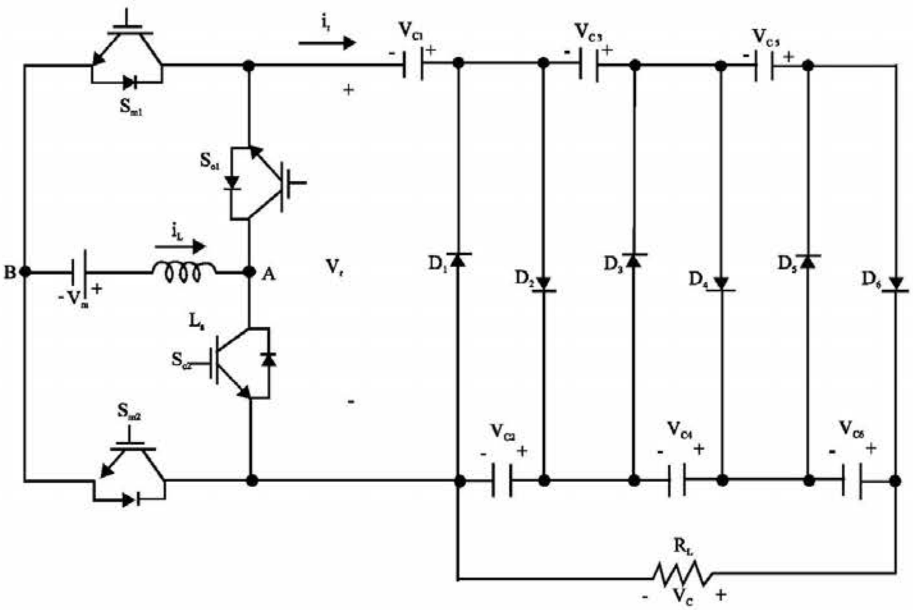

Fig. 3: Cockcroft Walton voltage multiplier

Table 1: Specifications of PV Model

Parameters	Values
Temperature (T)	25 (K)
Irradiance (sec)	400 (W/m^2)
Maximum voltage (V_m)	54.2 (V)
Current at Max power (I_m)	23.25 (A)
Open circuit voltage (V_{oc})	66 (V)
Short circuit current (I_{sc})	25.44 (A)

Where:

I_i = Photo voltaic current
I_0 = Diode saturation current
R_s = Series current = charge of electrons
K = Constant = temperature
n = Number of PV module

The proposed Cockcroft Walton voltage multiplier is shown in Fig. 3. The control topology has different frequencies and the size of the passive elements and produce the desired output and improve the performance of the converter.

RESULTS AND DISCUSSION

The proposed PV based Cockcroft voltage multiplier was simulated and the output waveforms are obtained using MATLAB. The PV voltage and current is shown in Fig 4. The voltage across the Cockcroft Walton first stage is shown in Fig. 5. The second stage of Cockcroft Walton is shown in Fig. 6. The third stage of Cockcroft voltage is shown in Fig. 7.The output voltage across the converter is shown in Fig. 8.

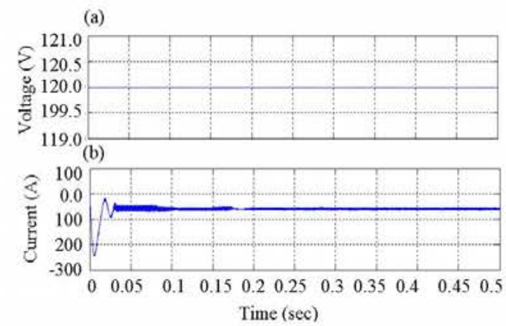

Fig. 4: PV voltage and current waveform

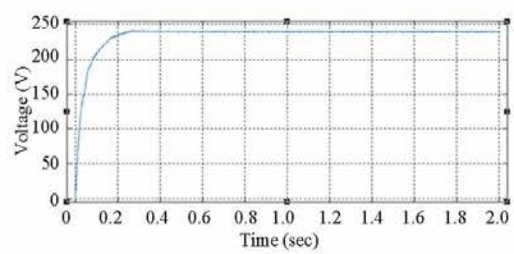

Fig. 5: First stage of CW converter across the capacitor voltage (VC_1)

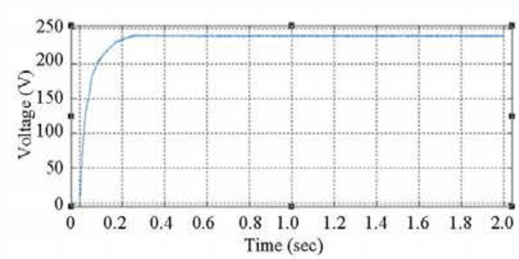

Fig. 6: Second stage of CW voltage multiplier (VC_2)

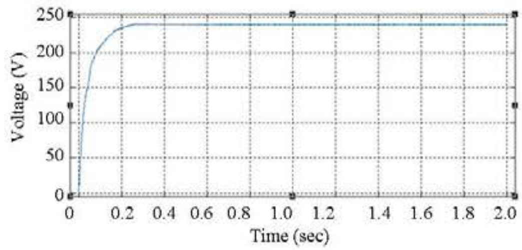

Fig. 7: Third stage of CW voltage multiplier

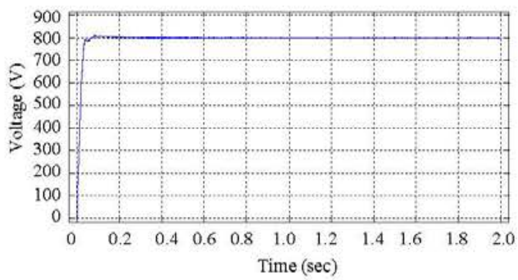

Fig. 8: Output voltage of the proposed converter

CONCLUSION

The proposed Cockcroft Walton voltage multiplier has three stages and produces the more boosting ratio and also produces continuous current with less ripple. The gain of the CW voltage multiplier without using transformer is increased compared to the conventional converter. The voltage of the converter and the results are verified.

RECOMMENDATION

In future the converter has analyze the steady state and to improve the voltage and size of the passive device.

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