International Journal for Modern Trends in Science and Technology
Volume: 03, Issue No: 07, July 2017
ISSN: 2455-3778
http://www.ijmtst.com

A High Step Up DC-DC Converter for Photovoltaic Applications

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To Cite this Article
K.Bhavya and B.Sushma, "A High Step Up DC-DC Converter for Photovoltaic Applications", *International Journal for Modern Trends in Science and Technology*, Vol. 03, Issue 07, July 2017, pp. 90-92.

ABSTRACT

Now-a-days renewable energy sources like wind energy and PV arrays have more demand due to shortage of power. But the energy generated by theses sources is at low level which is not sufficient to meet the requirements of load demand. To meet the load demand high voltage gain converter is proposed in this paper. This converter employs a floating active switch to isolate energy from the PV panel when the ac module is off. With various turns-ratios of a coupled inductor, this converter attains a high voltage-conversion ratio. The operating principles and steady-state analyses for continuous, discontinuous and boundary conduction modes are described. The relationship between the voltage ratio and the duty cycle of the proposed converter is analysed. The simulation is carried out in MATLAB/Simulink Software.

KEYWORDS: *DC-DC Converter, High Voltage gain, Step up converter*

I. INTRODUCTION

Nowadays, renewable energy sources such as photovoltaic (PV) arrays and wind turbine generators, have received increasingly attentions due to energy shortage and environmental contamination. Such renewable energy systems typically generate low voltage output. Photovoltaic (PV) power-generation systems have become more important and prevalent in distribution generation systems. A conventional centralized PV array is a serial connection of numerous panels to obtain higher dc-link voltage for main electricity through a dc–ac inverter. But there is a partial shadow on some panels, he system's energy yield becomes significantly reduced.

An ac module is a micro inverter configured on the rear bezel of a PV panel. This alternative solution not only reduces the loss by shadow effect, but also provides flexible installation options to the users. The power capacity range of a single PV panel is about 100 W to 300 W and the maximum power point (MPP) voltage range is from 15 V to 40 V which will be the input voltage of the ac module in cases with lower input voltage. In order to low voltage up to higher level, a conventional boost converter is commonly used because of its simple structure and control. Unfortunately, it cannot achieve a high step up conversion with high efficiency due to the extreme duty cycle operating limitations.

A number of modified high step-up converter topologies have been proposed in order to increase the voltage conversion ratio. The modified SEPIC converter with the combination of an auto transformer and the coupled inductors is introduced to photovoltaic application in order to increase the voltage gain of the converter. But by connecting a high step-up dc–dc converter in the front of the inverter improves power-conversion efficiency and provides a stable dc link to the inverter. In this paper a converter is proposed which employs a floating active switch to isolate energy from the PV panel when the ac module is OFF. The Different operating modes are explained in detail.

II. Proposed High step up DC-DC converter

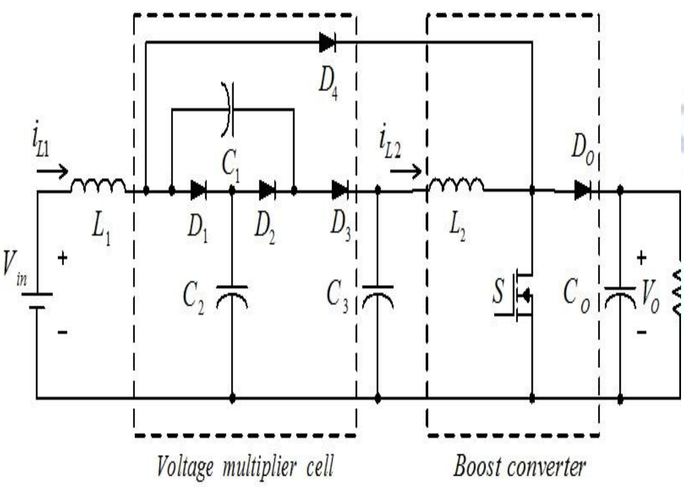

Figure 1: Proposed DC-DC converter configuration

The proposed converter configuration is as shown in figure 1. It consists of voltage multiplier and conventional boost converter. These two are connected by a DC link capacitor C_3. This converter consists of an input inductor L_1, output diode D_0, output filter capacitor C_0 and inductor L_2. The voltage multiplier consists of two capacitors C_1 and C_2 and three diodes D_1,D_2 and D_3.

The operation of the converter during one switching period can be basically divided into four modes. The operating principle of the proposed converter can be described briefly as follows:

Mode 1: The switch S and the diode D_3 are turned on. The remaining diodes are all off. V_{in} and C_1 deliver energy to L_1 and L_2. Thus, during this operation mode both i_{L1} and i_{L2} increase linearly to store energy in L_1 and L_2 respectively. The capacitor C3 is charged. The output power is supplied from capacitor C_0Units.

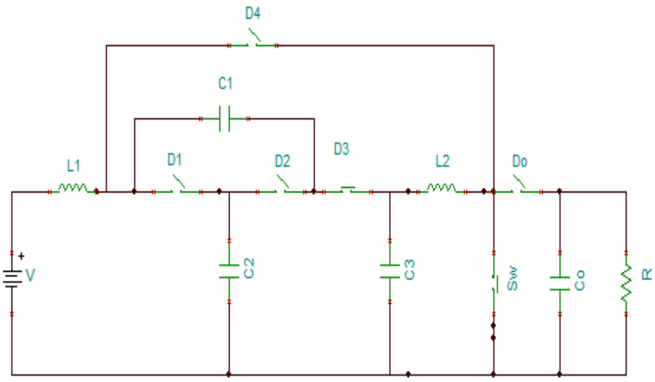

Figure 2: Mode 1 equivalent circuit

B. **Mode 2:** The switch *S* remains conducting and diode D_3 is off. The diodes D_1, D_4 and D_0 remain reversely biased but D_2 is forward biased. The energy stored in C_3 is released through L_2. The capacitors C_1 and C_2 are now in charging and discharging stages, respectively.

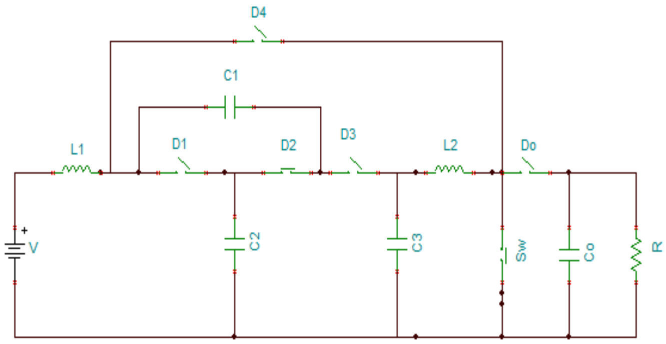

Figure 3: Mode 2 equivalent circuit

C. **Mode 3:** The switch *S* is turned off but D_2 becomes reversely biased. The diodes D_1, D_3 and D_0 are in forward biased state. The inductor L_1 releases energy to C_2 while C_1 delivers energy to L_2 through D_3. In addition, the output filter capacitor C_0 is supplied from the energy stored in L_2 through D_0.

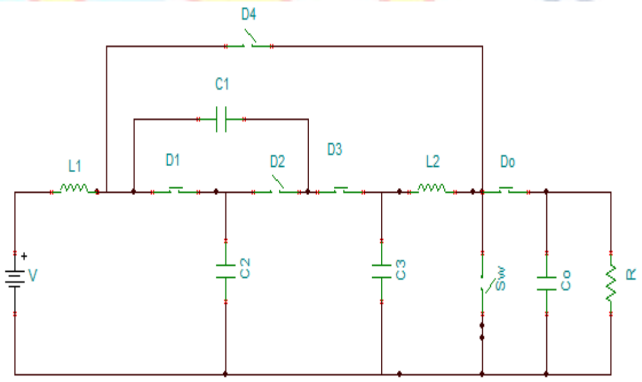

Figure 4: Mode 3 equivalent circuit

D. **Mode 4:** The switch *S* is still in turned-off state and D_1 becomes reversely biased. The diodes D_3 and D_0 remain in forward-biased state. The energy stored in L_1 and C_1 is transferred the boost converter side charging the output capacitor filter C_0 via diodes D_3 and D_0.

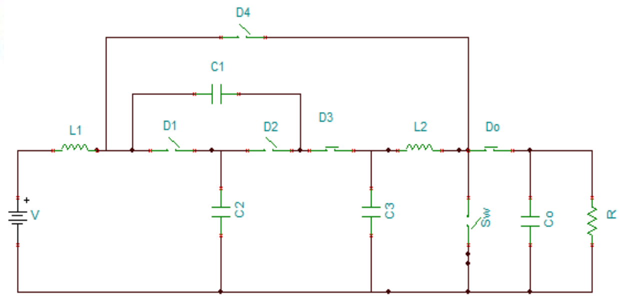

Figure 5: Mode 4 equivalent circuit

III. SIMULATION RESULTS

Figure 6 shows the MATLAB simulation results of the proposed converter with R-load.

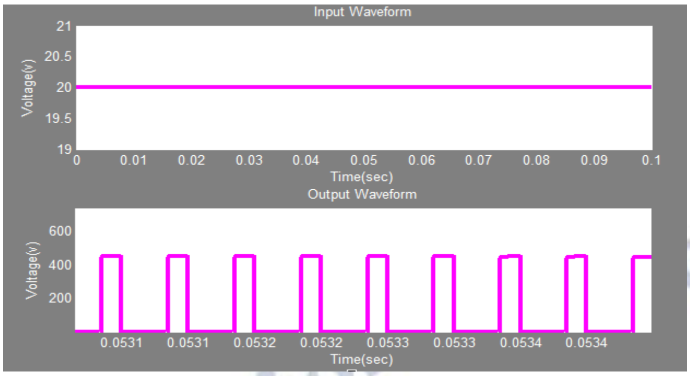

Figure 6. Input and output waveforms across R load

Figure 7 shows the MATLAB simulation results of the proposed converter with RL-load.

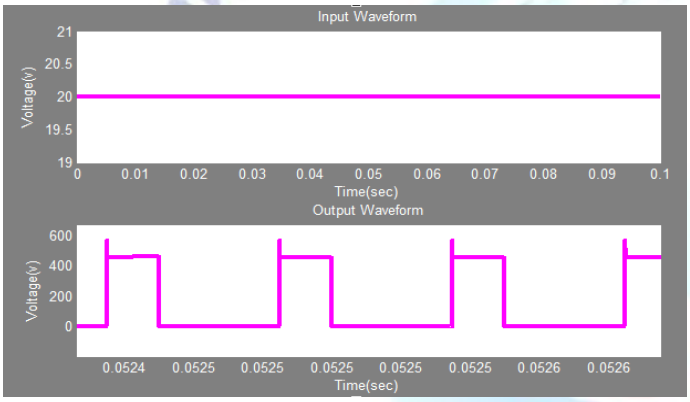

Figure 7. Input and output waveforms

Figure 8 shows the MATLAB simulation results of the proposed converter using PV cell

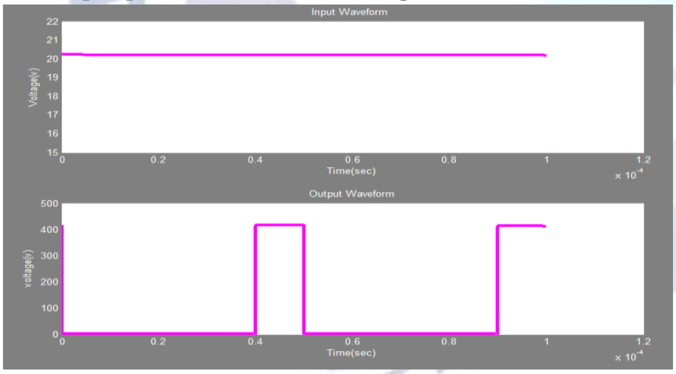

Figure 8. Input and output waveforms of Proposed Converter using PV cell

IV. CONCLUSION

This paper has presented a high step-up dc-dc converter, which can step-up a low input voltage to a high level without an extremely large duty cycle. Thus, the proposed converter is suitable for photovoltaic system applications or other renewable energy applications that need high step-up voltage conversion ratio. The proposed converter topology is based on the incorporation of the voltage multiplier module and the conventional boost converter in order to achieve a high voltage gain. The operation principle and steady analysis as well as a comparison with other boost converters are presented.

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