



Photovoltaic System with Step Up Converter

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Abstract- A novel step up converter which is proposed for a front end photovoltaic power system. Through a voltage multiplier module in which an asymmetrical interleaved step up converter usually high step up gain without which act as a function at an extreme duty ratio. The voltage multiplier module which is create of a conventional boost converter and coupled inductors. An extra conventional boost converter is combine into the first phase to achieve a considerably higher voltage conversion ratio. The two phase configuration not only decreases the current stress through each power switch but also force to do some thing the input current ripple, in which decreases the conduction losses of MOSFETs. The proposed step up converter functions as an active clamp circuit which moderate large voltage spikes across the power switches. So, the low-voltage rated MOSFETs which can be adopted for reduces of conduction losses and also cost. Efficiency improves because the energy which is stored in leakage inductances is energized to the output terminal. Finally, the prototype circuit which with a 40V input voltage, 380V output is operated to verify its performance. The highest efficiency of the step up converter is 96.8%.

Keywords: Step up converter, photovoltaic system, voltage multiplier module, MPPT model, PWM converter.

I. INTRODUCTION

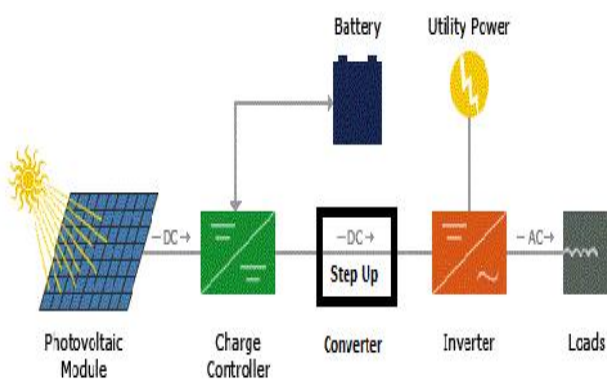


Fig. 1 Typical photovoltaic system

A photovoltaic system also known as solar PV power system or simply PV system which is a power system designed to supply usable solar power by means of photovoltaics. PV system consists of an arrangement of several components which are as including solar panels to absorb and convert sunlight into electricity and a solar inverter to change the electric current from DC to AC, as well as having mounting cabling and other electrical accessories to set up a working system. But the output voltage of PV system is very low so to get large output a step up converter are using here to boost the output voltage with voltage multiplier [1] [2]. The typical PV system is shown in above figure. It use a solar tracking system to improve the system's overall performance and also include an integrated battery solution. A solar array which is only encompasses the ensemble of solar panels and the visible part of the PV system also does not include all the other hardware, often summarized as balance of system PV systems convert light directly into electricity and which should not be confused with other technologies such as concentrated solar power or solar thermal or used for heating and cooling [6].

II. PROPOSED TOPOLOGY

In this paper, an asymmetrical interleaved high step-up converter that combines the advantages of the aforementioned converters is proposed in which combined the advantages of both. In the voltage multiplier module of the proposed converter as the turns ratio of coupled inductors can be designed to extend voltage gain and a voltage lift capacitor offers an extra voltage conversion ratio[1]. The step up converter performs importantly among the system because the system requires a sufficiently step up conversion. Theoretically, conventional step up converters such as the boost converter and fly back converter, cannot achieve a high step-up conversion with high efficiency because of the resistances of elements or leakage inductance. Thus, a modified boost fly back converter was proposed, and many converters that use the coupled inductor for a considerably high voltage conversion ratio were also proposed.

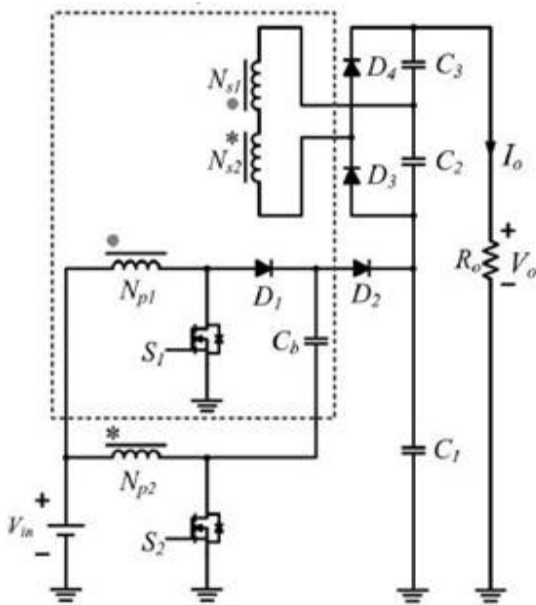


Fig. 2 Step up converter

The proposed high step-up converter with voltage multiplier module is shown in Figure. A conventional boost converter and two coupled inductors are located in the voltage multiplier module, which is stacked on a boost converter to form an asymmetrical interleaved structure. Primary windings of the coupled inductors with N_p turns are employed to decrease input current ripple, and secondary windings of the coupled inductors with N_s turns are connected in series to extend voltage gain. The turns ratios of the coupled inductors are the same.

The Figure number 2 shows the circuit configuration of the proposed an asymmetrical interleaved converter with voltage multiplier cell. The voltage multiplier module of the proposed converter is composed of coupled inductor, the conventional boost converter and a voltage-lift capacitor. This capacitor offers an extra voltage conversion ratio. The leakage energy of the coupled inductor is recycled to the output capacitors the turns ratio of coupled inductors can be designed to enlarge voltage gain. The number of multiplier can be adjusted to get a desired duty ratio; a higher boost rate is easily obtained from the voltage multiplier. The coupling coefficient of the coupled inductor is denoted [5].

III. OPERATING PRINCIPLE

The switching period can be subdivided in to six modes of operation. The modes 1-3 are same as modes 4-6. So the first three modes are explained here. To make the circuit operation simpler, some assumptions are made the transformer leakage inductances are negligible The magnetizing inductances L_{m1} and L_{m2} are identical. The

phase shift between two switches are 180° The proposed converter operates in continuous conduction mode.

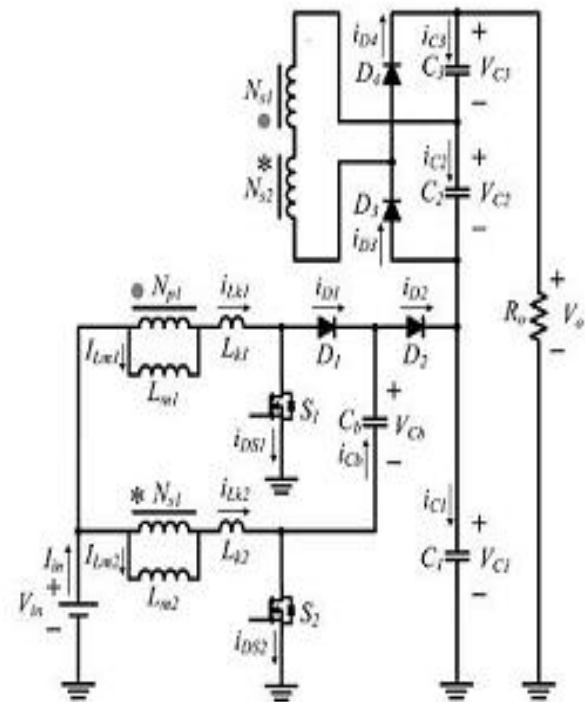


Fig.3 Operating modes of converter

A. Mode I

At $t=t_0$, the power switches S_1 and S_2 are both turned ON. All of the diodes are reversed-biased. Magnetizing inductors L_{m1} and L_{m2} as well as leakage inductors L_{k1} and L_{k2} are linearly charged by the input voltage source V_{in} .

B. Mode II

At $t=t_1$, the power switch S_2 is switched OFF, thereby turning ON diodes D_2 and D_4 . The energy that magnetizing inductor L_{m2} has stored is transferred to the secondary side charging the output filter capacitor C_3 . The input voltage source, magnetizing inductor L_{m2} , leakage inductor L_{k2} , and voltage-lift capacitor C_b release energy to the output filter capacitor C_1 via diode D_2 , thereby extending the voltage on C_1 .

C. Mode III

At $t=t_2$, diode D_2 automatically switches OFF because the total energy of leakage inductor L_{k2} has been completely released to the output filter capacitor C_1 . Magnetizing inductor L_{m2} transfers energy to the secondary side charging the output filter capacitor C_3 via diode D_4 until t_3 .

D. Mode IV

At $t=t_3$, the power switch S_2 is turned ON and all the diodes are turned OFF. Now all the diodes are reversed-biased and the Magnetizing inductors L_{m1} and L_{m2} as well as leakage inductors L_{k1} and L_{k2} are linearly charged by the input voltage source V_{in} .

E. Mode V

At $t=t_4$, the power switch S_1 is turned OFF, therefore diodes D_1 and D_3 are turned ON. Now the energy stored in the magnetizing inductor L_{m1} is transferred to the secondary side and it charges the output filter capacitor C_2 . The input voltage source and the energy stored in the magnetizing inductor L_{m1} is completely released to the voltage-lift capacitor C_b through the diode D_1 , which supplies extra energy to C_b .

F. Mode VI

At $t=t_5$, the diode D_1 is automatically turns OFF because the entire energy stored in the leakage inductor L_{k1} is totally released to voltage-lift capacitor C_b . Now the magnetizing inductor L_{m1} transfers energy to the secondary side and it charges the output filter capacitor C_2 through the diode D_3 until t_0 .

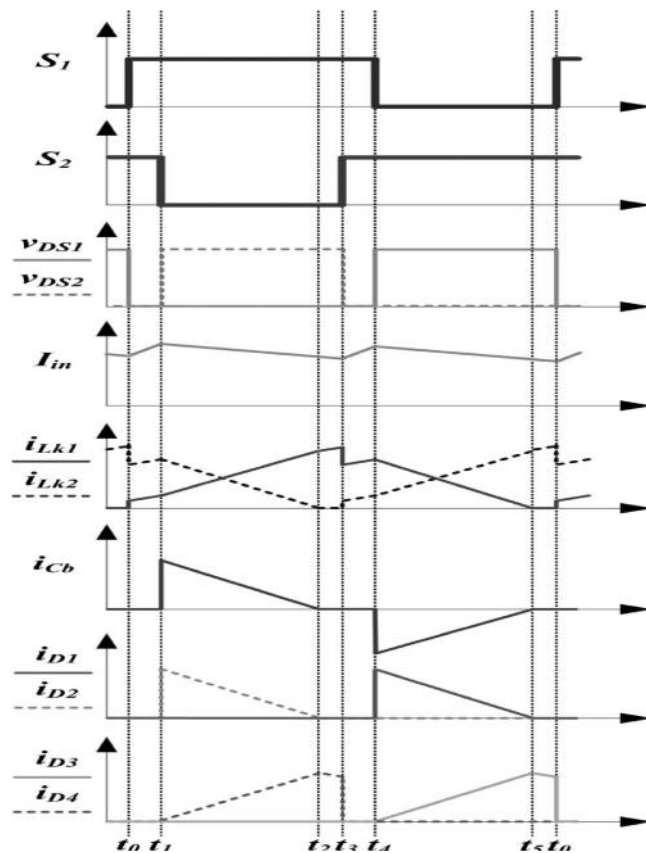


Fig.4 Steady waveforms of the proposed converter at CCM.

Above figure 4 shows the steady waveforms for step up converter at its different operating modes which is at continuous conduction mode.

V. DESIGN AND EXPERIMENTAL RESULTS

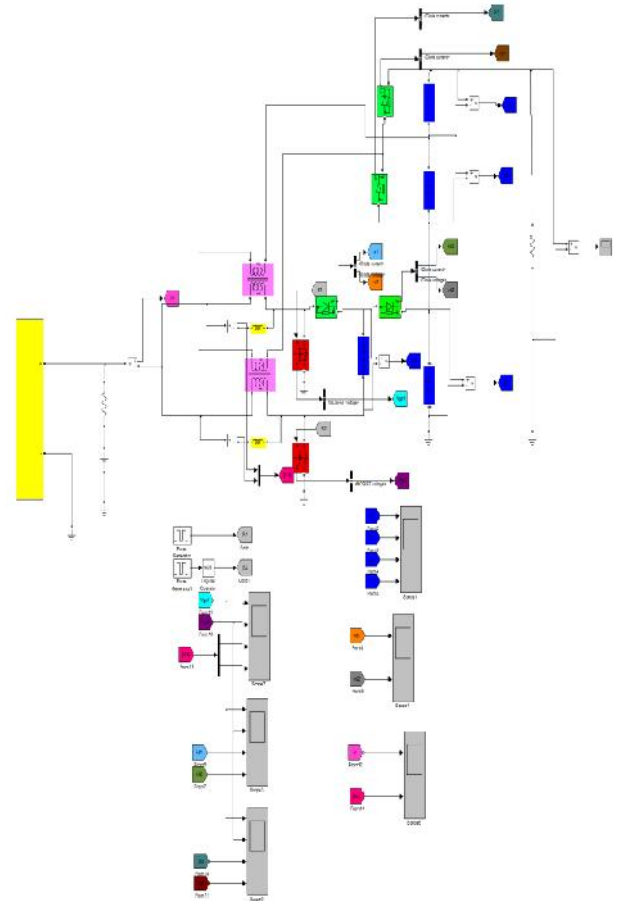


Fig. 5 Matlab simulation model for step up converter

COMPONENTS	SYMBOLS	PARAMETERS
Magnetizing Inductances	L_{m1}, L_{m2}	133 μH
Leakage Inductances	L_{k1}, L_{k2}	1.6 H
Turns Ratio	$N(N_s/N_p)$	1
Power Switches	S_1, S_2	IRFP4227
Diodes	D_1, D_2, D_3, D_4	FCF06A-40
Capacitors	C_b, C_1, C_2, C_3	220 μF

Table 1 Parameters and symbols

Figure number 5 shows the matlab simulation model for step up converter with voltage multiplier module for photovoltaic power system. In the above table the parameters and symbols of proposed step up converter

are given. Its simulation waveform are given in following figure

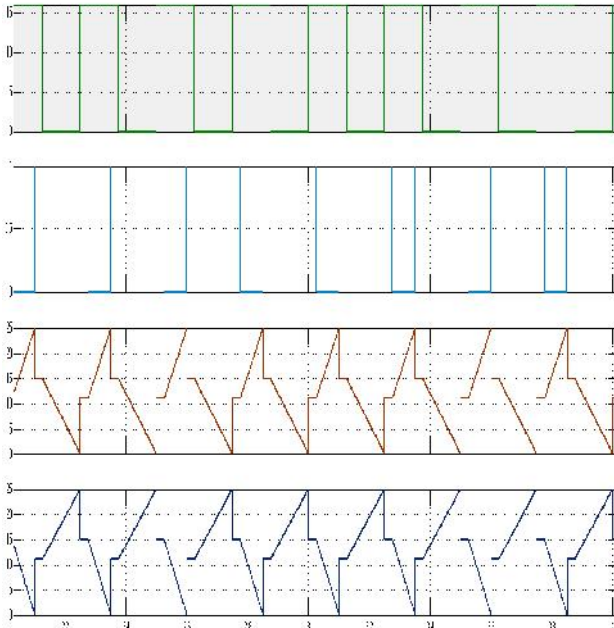


Fig. 6 Voltage and current waveforms for Vgs1, Vgs2, ILK1, ILK2

Figure 6 illustrates the measured waveforms of voltages at switch S1 (Vgs1) and switch S2 (Vgs2) and current at Leakage inductances Lk1 and Lk2.

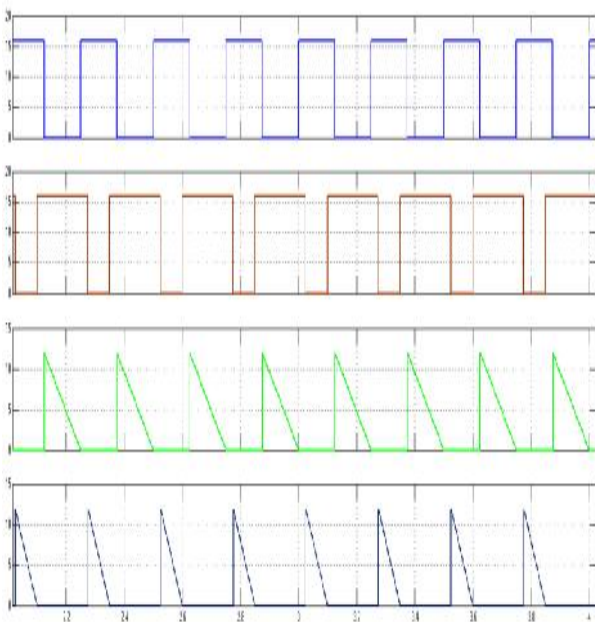


Fig. 7 Voltage and current waveforms for Vgs1, Vgs2, Id1, Id2

Figure 7 shows the waveforms for voltages at switch S1 (Vgs1) and switch S2 (Vgs2) and current at diodes D1 & D2.

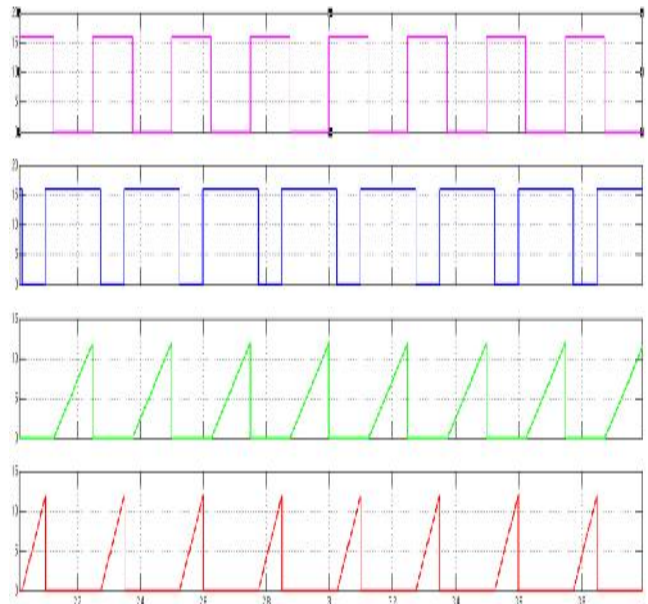


Fig. 9 Voltage and current waveforms for Vgs1, Vgs2, Id3, Id4

Figure 9 depicts the voltage and current waveforms at the Swith S1 , S2 and Current at diodes D3 and diode D4.

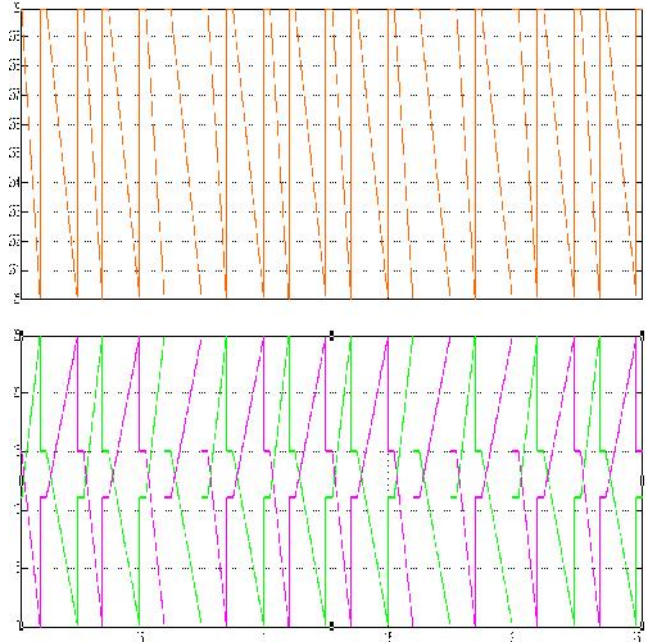


Fig. 10 Results for current waveforms for Iin, Ilk

Above figure 10 dispalys the current waveforms for input current Iin and current at leakage inductances Lk1 and Lk2.

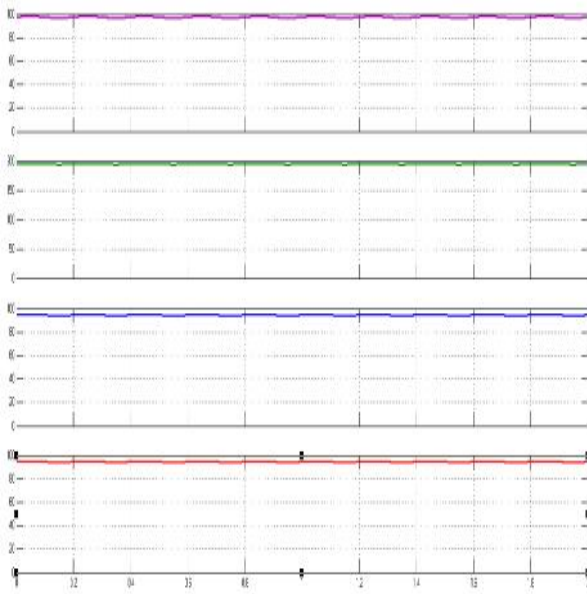


Fig. 11 Results for output voltages Vcb, Vc1, Vc2, Vc3

Figure shows the waveforms for output voltages at four capacitors Cb, C1, C2 and C3. By addition of these output voltages we get the output voltage of step up converter.

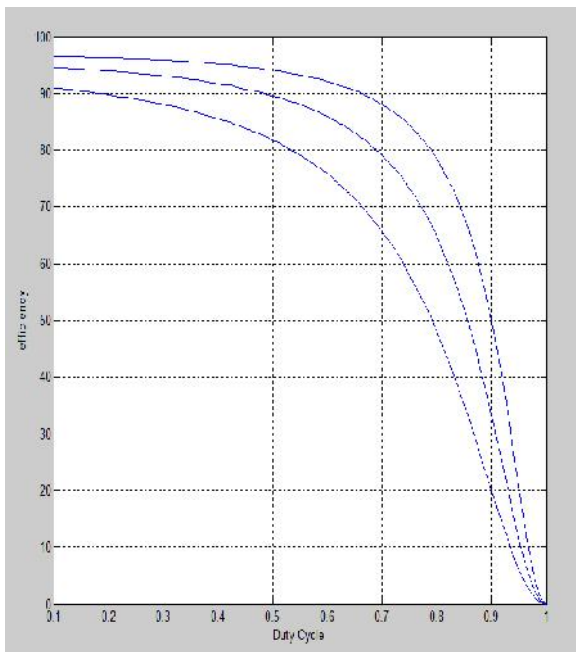


Fig. 12 Efficiency versus duty cycle.

Figure 12 plots the waveform for efficiency versus duty cycle of the proposed converter which shows the maximum efficiency is 96 %.

The output voltage of step up converter is the sum of all the voltages across the capacitors which is shown in

figure number 18. So the output voltage is 380V. The figure shows the efficiency of proposed step up converter.

VI. CONCLUSION

This paper has presented the topological principles steady state analysis and experimental results for a proposed step up converter. The proposed step up converter has been successfully implemented in an efficiently high step up conversion. The experimental results which indicate that leakage energy is recycled through capacitor Cb to the output terminal. The voltage stresses over the power switches are restricted and are much lower than the output voltage (380 V). These switches, conducted to low voltage rated and low on-state resistance MOSFET, can be selected. Furthermore, the full-load efficiency is 96.8% at Thus, the proposed converter is suitable for PV systems or other renewable energy applications that need high step up high-power energy conversion. The simulation results by using MATLAB Simulink proved the validity of the theoretical analysis and the feasibility of the proposed step up converter.

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BIOGRAPHIES



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