A Novel High Step-Up Converter with a VoltageMultiplier Module

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Abstract:A novel high step-up converter is proposed for a front end photovoltaic method. By means of a voltage multiplier module, an asymmetrical interleaved extreme step-up converter commonly high step up obtain without act as a function at an high duty ratio. The voltage multiplier module is create of a traditional boost converter and coupled inductors. An additional conventional enhance converter is mix into the primary section to achieve a substantially larger voltage conversion ratio. The two-phase converter not only decreases the current stress by way of each power switch, but additionally force to do anything the enter current ripple, which decreases the conduction losses of metallic–oxide–semiconductor field-effect transistors (MOSFETs). In addition, the proposed converter functions as an active clamp circuit, which moderate tremendous voltage spikes throughout the energy switches. As a result, the low-voltage-rated MOSFETs will also be adopted for reduces of conduction losses and rate. Efficiency improves considering that the power saved in leakage inductances is energized to the output terminal.

KEYWORDS-High Step-up Converter, Voltage Multiplier module, Boost Converter, photovoltaic system.

I. INTRODUCTION

Renewable sources of energy are increasingly valued worldwide because of energy shortage and environmental contamination. Renewable energy systems generate low voltage output and thus, high step-up dc/dc converters are widely employed in many renewable energy applications, including fuel cells,wind power, and photovoltaic systems. Among renewable energy systems, photovoltaic systems are expected to play an important role in future energy production. Such systems transform light energy into electrical energy, and convert low voltage into high voltage via a step-up converter, which can convert energy into electricity using a grid-by-grid inverter or store energy into a battery set. Fig.1 shows a typical photovoltaic system that consists of a solar module, a high step up converter, a charge-discharge controller, a battery set, and an inverter.considerations.

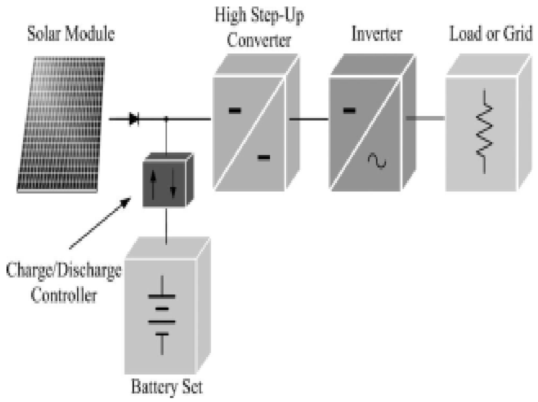

Fig. 1: Typical Photovoltaic System

Conventional step-up converters, such as the boost converter and flyback converter, cannot achieve a high step-up conversion with high efficiency because of the resistances of elements or leakage inductance. Thus, a modified boost–flyback converter was proposed. Modifying a boost–flyback converter, shown in Fig.2(a) is one of the simple approaches to achieving high step-up gain and this gain is realized via a coupled inductor.

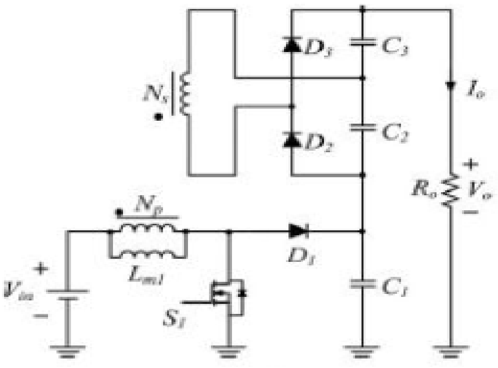

Fig.2(a): Modified boost flyback converter

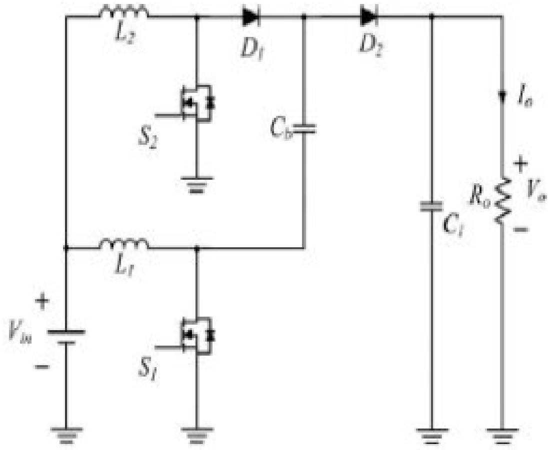

Fig. 2(b): Interleaved boost converter with a voltage-liftcapacitor structure.

The performance of the converter is similar to an active-clamped flyback converter; thus, the leakage energy is recovered to the output terminal. An interleaved boost converter with a voltage-lift capacitor shown in Fig. 2(b) is highly similar to the conventional interleaved type. It obtains extra voltage gain through the voltage-lift capacitor, and reduces the input current ripple, which is suitable for power factor correction (PFC) and high-power applications.

The proposed converter is the integration of voltagemultiplier module with the traditional interleaved boostconverter. Coupled inductors and switched capacitors togetherconstitute the voltage multiplier module. The design of thecoupled inductors can be used to lengthen step-up gain andhigher voltage conversion ratio is furnished through the switchedcapacitors. Additionally, the energy stored within the magnetizinginductor will switch via three respective paths when one ofthe switches turns off and for that reason current distribution decreases.As a result, the conduction losses reduce seeing that of loweffective current. The currents by means of some diodes reduceto zero earlier than they turn off and thus diode reverse restorationlosses are additionally lessen. The target of this paper is todevelop a converter with low switching losses, reducedvoltage and current stress and reduced conduction loss. Theleakage inductance of the isolation transformer, resulting inexcessive voltage spike for the duration of switching transition is a major predicament.The freewheeling current as a result of the leakage inductance willexpand the conduction losses and lower the duty cycle. Aawesome process is to pre charge the leakage inductance andto elevate its present stage as much as that of the present-fed inductor,for this reason lowering their present difference and voltage spikes. Asthe current degree varies with variant in the load, it is intricateto tune the switching timing diagram to match these twocurrents. Accordingly, a passive or an active clamp circuit is required.

II. LITERATURE SURVEY

Conventional step-up converters, such as the boost converter and fly back converter, cannot achieve a highstep-up conversion with high efficiency because of the resistances of elements or leakage inductance. Conventionalstep-up converters with a single switch are unsuitable for high-power applications given an input large current ripple,which increases conduction losses.Thus, numerous interleaved structures and some asymmetrical interleaved structures are extensively used . The currentstudy also presents an asymmetrical interleaved converter for a high step-up and high-power application. Modifying aboost–fly back Converter. One of the simple approaches to achieving high step-up gain; this gain is realized via acoupled inductor. The performance of the converter is similar to an active-clamped fly back converter; thus, the leakageenergy is recovered to the output terminal.

III. PROPOSED SYSTEM

The proposed high step-up converter with voltage multiplier module is shown in Fig. 3(a). A conventionalboost converter and two coupled inductors are located in the voltage multiplier module, which is stacked on a boostconverter to form an asymmetrical interleaved structure. Primary windings of the coupled inductors with Np turns are employed to decrease input current ripple, and secondary windings of the coupled inductors with Ns turns areconnected in series to extend voltage gain. The turns ratios of the coupled inductors are the same. The couplingreferences of the inductors are denoted by "." and "*" in Fig. 3.The equivalent circuit of the proposed converter is shown in Fig. 3(b), where Lm1 and Lm2 are the magnetizinginductors, Lk1 and Lk2 represent the leakage inductors, S1 and S2 denote the power switches, Cb is the voltage-liftcapacitor, and n is defined as a turns ratio Ns /Np.

The proposed converter operates in continuous conduction mode (CCM), and the duty cycles of the powerswitches during steady operation are inter leaved with a 180◦ phase shift; the duty cycles are greater than 0.5. The keysteady waveforms in one switching period of the proposed converter contain six modes, which are depicted in Fig.3shows the topological stages of the circuit.

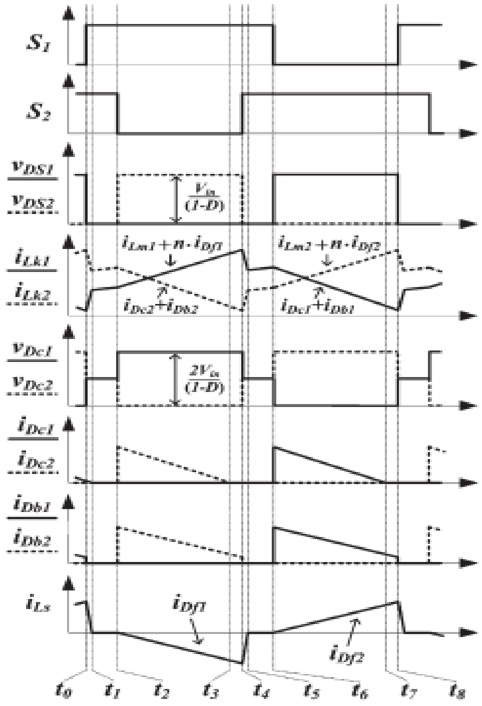

Fig. 3. Steady waveform of the proposed converter in CCM.

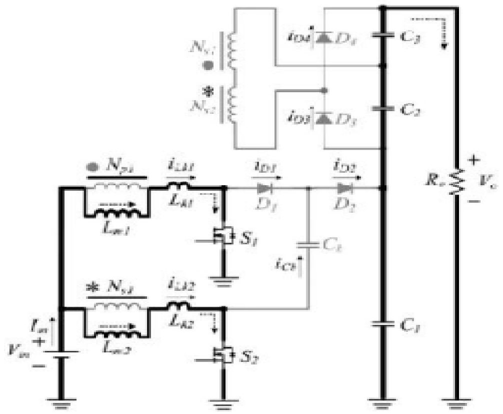

Fig. 4. (a)Mode-1 $[t0, t1]$.

Mode 1 [t0, t1]: At t=t0 , the power switches S1 and S2are both turned ON. All of the diodes arereversed-biased. Magnetizing inductors Lm1 and Lm2as well as leakage inductors Lk1 and Lk2 are linearlycharged by the input voltage source Vin.

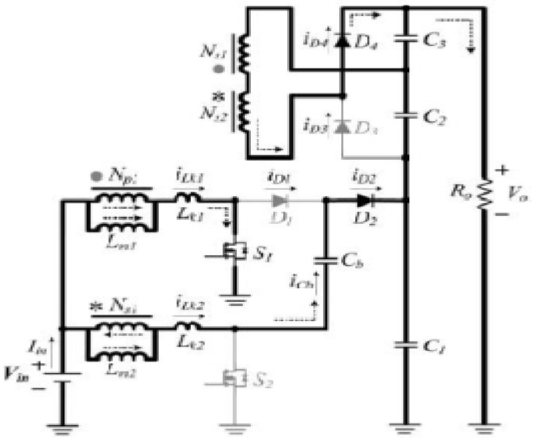

Fig. 4.(b) Mode-2[t1, t2]

Mode 2 [t1, t2]: At t=t1, the power switch S2 isswitched OFF, thereby turning ON diodes D2 and D4.The energy that magnetizing inductor Lm2 has storedis transferred to the secondary side charging the outputfilter capacitor C3. The input voltage source,magnetizing inductor Lm2, leakage inductor Lk2, andvoltage-lift capacitor Cb release energy to the outputfilter capacitor C1 via diode D2, thereby extending thevoltage on C1.

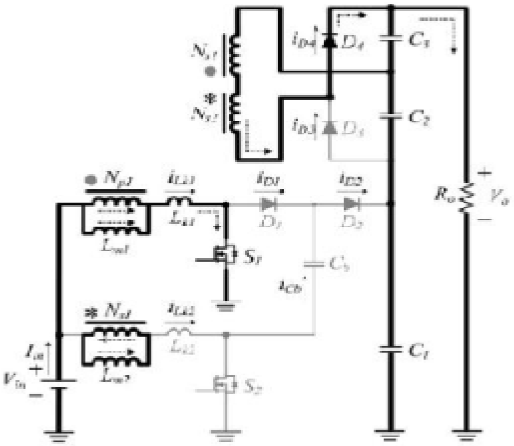

Fig. 4.(c) Mode-3 [t2, t3].

Mode 3 [t2, t3]: At t=t2, diode D2 automaticallyswitches OFF because the total energy of leakageinductor Lk2 has been completely released to the outputfilter capacitor C1. Magnetizing inductor Lm2 transfersenergy to the secondary side charging the output filtercapacitor C3 via diode D4 until t3.

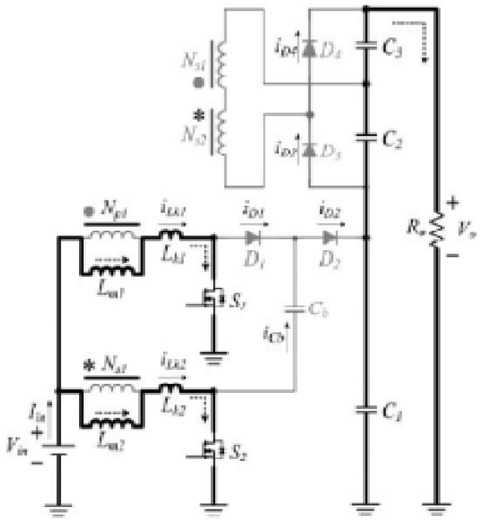

Fig. 4.(d) Mode-4[t3, t4].

Mode 4 [t3, t4]: At t=t3, the power switch S2 is switched ON and all the diodes are turned OFF. The operating states of modes 1 and 4 are similar.

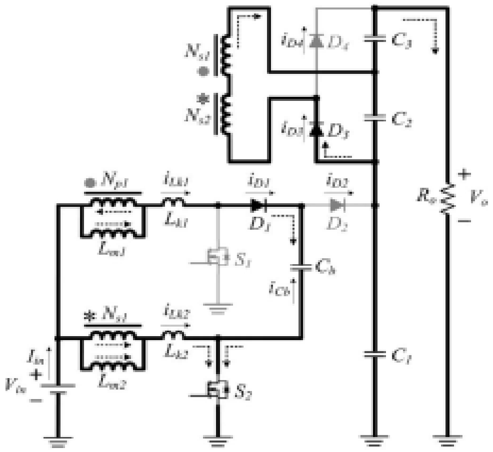

Fig. 4.(e) Mode-5 [t4, t5].

Mode 5: Mode 5 [t4, t5]: At t=t4, the power switch S1 isswitched OFF, which turns ON diodes D1 and D3. Theenergy stored in magnetizing inductor Lm1 istransferred to the secondary side charging the outputfilter capacitor C2. The input voltage source andmagnetizing inductor Lm1 release energy to voltage-liftcapacitor Cb via diode D1, which stores extra energy inCb

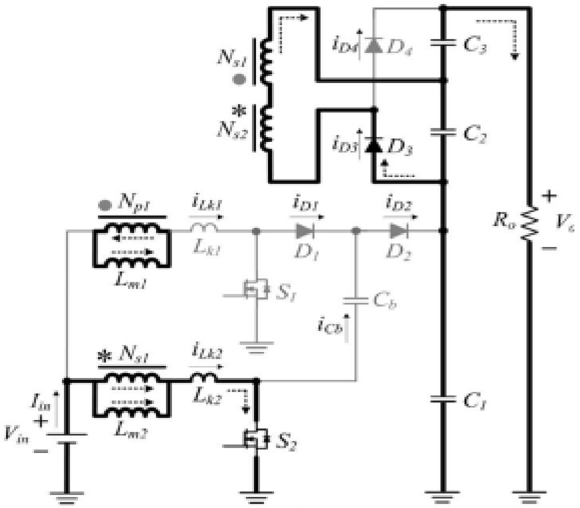

Fig. 4.(f) Mode-6 [t5, t0].

Mode 6 [t5, t0]: At t=t_5 , diode D_1 is automatically turned OFF because the total energy of leakage inductor L_{k1} has been completely released to voltage-lift capacitor Cb. Magnetizing inductor L_{m1} transfers energy to the secondary side charging the output filter capacitor C_2 via diode D_3 until t_0.

IV. SIMULATION RESULTS

The simulation diagram for closed loop operation is shownin Fig-12. The output voltage adjusts to a constant voltage forslight variations in the supply voltage. The simulationparameters are

Input voltage Vin= 12V
Output voltage Vo= 110V
Switching frequency fs=40 kHz
Duty cycle D=0.7
Magnetizing inductors Lm =Lm2 =133 µH
Output capacitor C1=470 µF
Output capacitor C2=C3=220 µF
Clamp capacitors Cc1=Cc2=220 µF
Turns Ratio n=1
Load resistance R=140 Ω

Here the simulation carried by two different cases they are 1) high step-up interleaved converter with a voltage multiplier module 2) PV as input source of proposed converter with inverter module.

Case-1: **High step-up interleaved converter with a voltage multiplier module.**

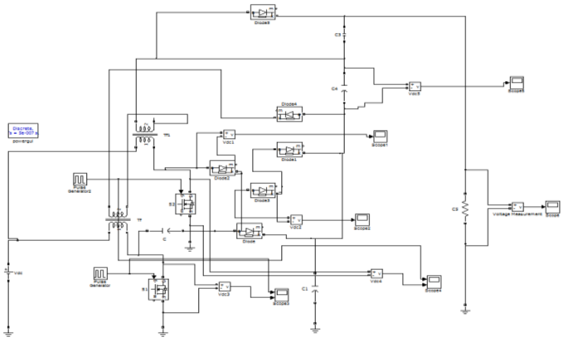

Fig.5.Simulink model of conventional high step-up interleaved converter with a voltage multiplier module

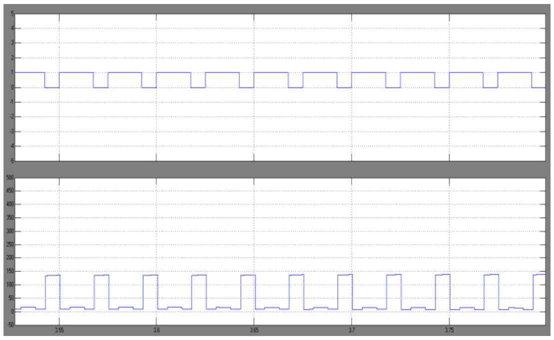

Fig.6. power switch S1 gating pulse and output voltage

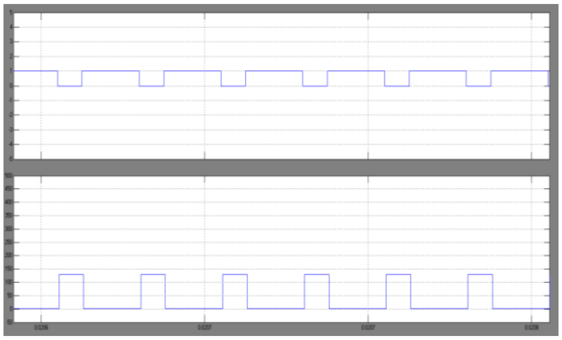

Fig.7.power switch S2 gating pulse and output voltage

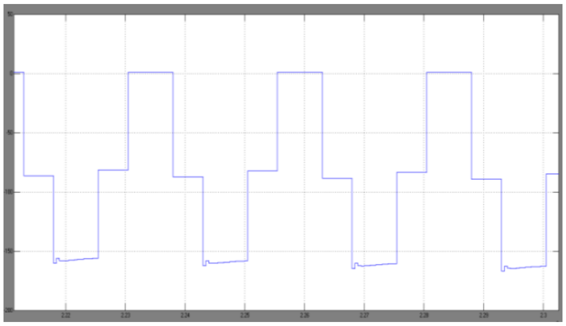

Fig.8. shows the simulated output waveform voltage across switched capacitor

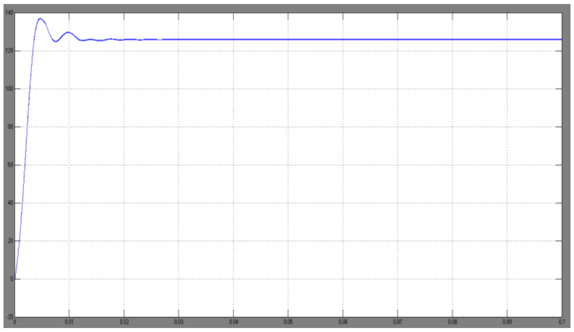

Fig.9 output voltage of clamp diode

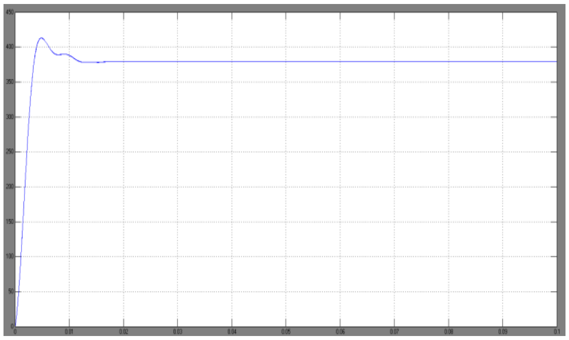

Fig.10 shows the ooutput voltage of conventional high step-up interleaved converter

Case-2 proposed converter with AC load

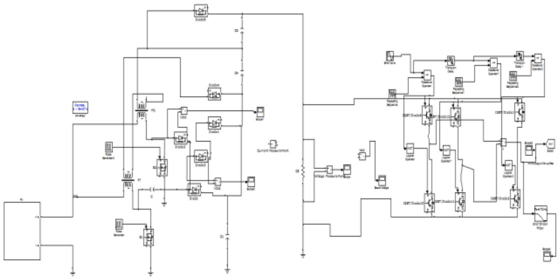

Fig.11. Simulink model of PV as input source of proposed converter with inverter module

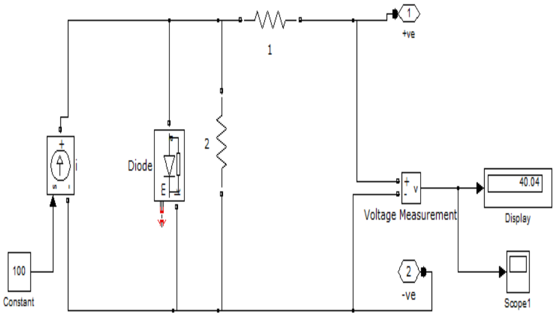

Fig.12 .Simulation model of PV system

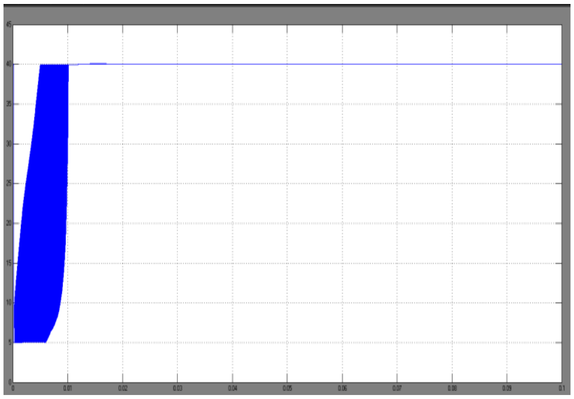

Fig.13. shows simulated PV output voltage

V. CONCLUSION

This paper has presented the topological principles, steady state analysis, and experimental results for aproposed converter. The proposed converter has been successfully implemented in an efficiently high step-upconversion without an extreme duty ratio and a number of turns ratios through the voltage multiplier module andvoltage clamp feature. The interleaved PWM scheme reduces the currents that pass through each power switch andconstrained the input current ripple by approximately 6%. The experimental results indicate that leakage energy isrecycled through capacitor Cb to the output terminal. Meanwhile, the voltage stresses over the power switches arerestricted and are much lower than the output voltage (380 V). These switches, conducted to low voltage rated and lowon-state resistance MOSFET, can be selected.

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