ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

An ISO 3297: 2007 Certified Organization   Vol. 5, Special Issue 3, March 2016

National Conference on Recent Advances in Electrical & Electronics Engineering (NCREEE'16)

Organized by

Dept. of EEE, Mar Baselios Institute of Technology & Science (MBITS), Kothamangalam, Kerala-686693, India

On 17th & 18th March 2016

High Step-Up Converter with Voltage Multiplier

Alwin Mamachan[1], Minu Joseph[2], Ponni Poulose[3], Ponnu Poulose[4], Shiju Ramachandran[5]

UG Students ,Dept. of EEE, MBITS, Nellimattom, Kothamangalam, India [1,2,3,4]

Assistant Professor, Dept. of EEE, MBITS, Nellimattom, Kothamangalam, India [5]

ABSTRACT: The voltage multiplier module is composed of a conventional boost converter and coupled inductors. An extra conventional boost converter is integrated into the first phase to achieve a considerably higher voltage conversion ratio. The two-phase configuration not only reduces the current stress through each power switch, but also constrains the input current ripple, which decreases the conduction losses of metal–oxide–semiconductor field-effect transistors (MOSFETs).The proposed converter functions as an active clamp circuit, which alleviates large voltage spikes acrossthe power switches. Thus, the low-voltage-rated MOSFETs can be adopted for reductions of conduction losses and cost. Efficiency improves because the energy stored in leakage inductances is recycled to the output terminal.

KEYWORDS:Boost–flyback converter, High step-up, Diode bridge rectifier, Passive filter, Photovoltaic system, Voltage multiplier module.

I.INTRODUCTION

Renewable sources of energy are increasingly valued worldwide because of energy shortage and environmentalcontamination. Among renewable energy systems, photovoltaic systems are expected to play an important role in future energy production[2]-[4]. 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. The voltage multiplier module, an asymmetrical interleaved high step-up converter obtains high stepup gain without operating at an extreme duty ratio[1]. The high step-up converter performs importantly among the system because the system requires a sufficiently high step-up conversion.In existing system have 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 [5]-[7].The main goal of this project is to high step-up conversion without an extreme duty ratio and number of turns ratios through the voltage multiplier module.

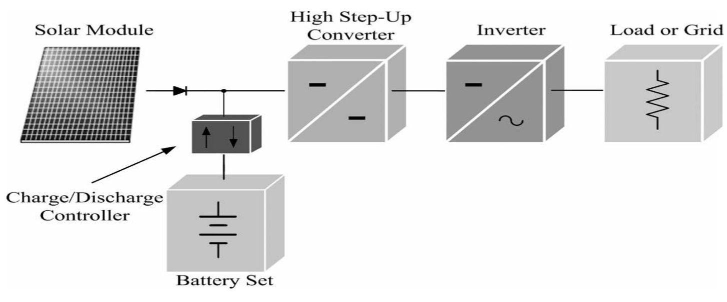


Fig.1.Typical Photovolatic System

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

An ISO 3297: 2007 Certified Organization *Vol. 5, Special Issue 3, March 2016*

National Conference on Recent Advances in Electrical & Electronics Engineering (NCREEE'16)

Organized by

Dept. of EEE, Mar Baselios Institute of Technology & Science (MBITS), Kothamangalam, Kerala-686693, India

On 17th & 18th March 2016

The conventional step-up converters with a single switch are unsuitable for high-power applications given an input large current ripple, which increases conduction losses. The current study also presents an asymmetrical interleaved converter for a high step-up and high-power application. Modifying a boost–flyback converter, shown in Fig. 2(a), is one of the simple approaches to achieving high step-up gain; this gain is realized via a coupled inductor. 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 typeIt 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.

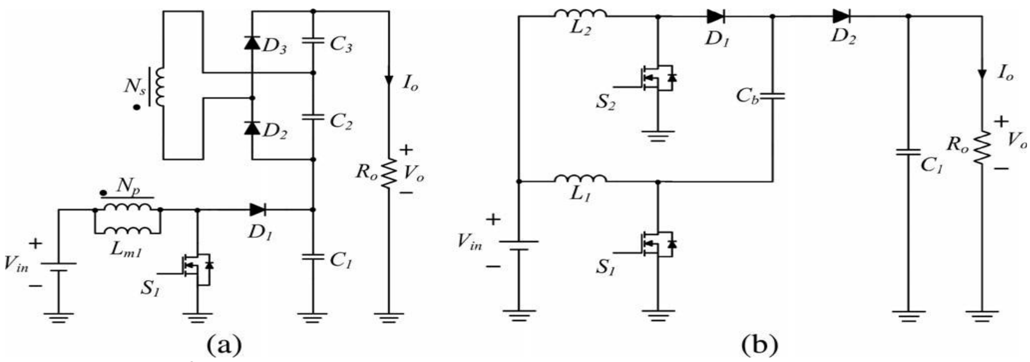


Fig. 2. (a)Intergratedflyback-boost converter structure (b) Interleaved boost converter with a voltage lift capacitorstructure

II. OPERATING PRINCIPLE DESCRIPTION

The proposed high step-up converter with voltage multiplier module is shown in Fig. 3(a). 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 coupling references of the inductorsare denoted by " ." and " ∗" in Fig. 3.

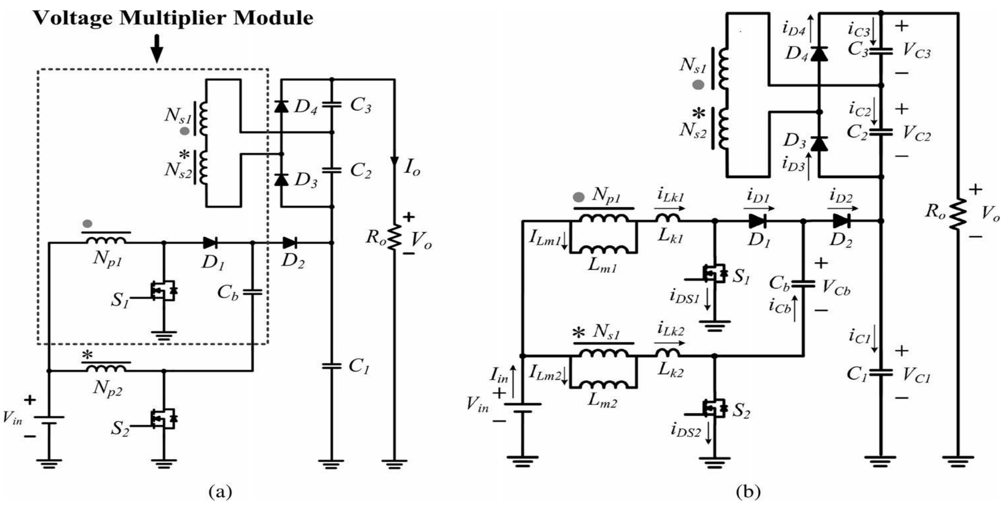


Fig. 3. (a) Proposed step-up converter with a voltage multiplier module.(b) Equivalent circuit of the the proposed converter

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

An ISO 3297: 2007 Certified Organization Vol. 5, Special Issue 3, March 2016

National Conference on Recent Advances in Electrical & Electronics Engineering (NCREEE'16)

Organized by

Dept. of EEE, Mar Baselios Institute of Technology & Science (MBITS), Kothamangalam, Kerala-686693, India

On 17th & 18th March 2016

The equivalent circuit of the proposed converter is shown in Fig. 3(b), where L_{m1} and L_{m2} are the magnetizing inductors, L_{k1} and L_{k2} represent the leakage inductors, S_1 and S_2denote the power switches, C_b is the voltage-lift capacitor, and n is defined as a turns ratio N_s /N_P.Theproposed converter operates in continuous conduction mode (CCM), and the duty cycles of the power switches during steady operation are interleavedwith a 180^0phase shift; the duty cycles are greater than 0.5. The key steady waveforms in one switching period of the proposed converter contain six modes, which are depicted in Fig. 4, shows the topological stages of the circuit.it can be explained by using six modes of operation

Mode 1$^{[t0,t1]}$: 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 .

Mode 2$^{[t1,t2]}$: At t= t_1 , the power switch $S_2$is switched OFF, there by turning ON diodes D_2 and D_4. The energy thatmagnetizing 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_b via diode D_2, thereby extending the voltage on C_1.

Mode 3$^{[t2,t3]}$:At t = t_2, diode D_2automatically 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.

Mode 4$^{[t3,t4]}$: At t = t_3, the power switch $S_2$is switched ON and all the diodes are turned OFF. The operating states ofmodes 1 and 4 are similar.

Mode 5$^{[t4,t5]}$: At t = t_4 , the power switch $S_1$is switched OFF, which turns ON diodes D_1 and D_3. The energy stored inmagnetizing inductor L_{m1} is transferred to the secondary side charging the output filter capacitor C_2. The input voltage source and magnetizing inductor L_{m1} release energy to voltage-lift capacitor $C_b$via diode D_1, which stores extra energy in C_b.

Mode 6$^{[t5,t6]}$: 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 C_b. Magnetizing inductor L_{m1} transfers energy to the secondary side charging the output filter capacitor C_2 via diode D_2 until t_0.

The transient characteristics of circuitry are disregarded to simplify the circuit performance analysis of the proposed converter in CCM mode.the voltage V_{cb}can be derived from

$$V_{cb} = \frac{1}{(1-D)} V_{in}$$

The voltage gain of the proposed converter is,

$$\frac{V_0}{V_{in}} = \frac{2n+2}{(1-D)}$$

The Voltage stress can be derived from

$$V_{d1} = V_{c1} = \frac{2}{(1-D)} V_{in}$$

$$V_{d2} = V_{c1} - V_{cb} = \frac{1}{(1-D)} V_{in}$$

The voltage stresses on diodes D_1 and $D_2$are close on power switches S_1 and S_2.The voltage stress on diode D_1 is larger,it accounts for only half of output voltage V_0 at a turns ratio n of 1.The voltage stresses on diodes D_3 and D_4both equal the V_{c2} plus V_{C3} , which can be derived from $V_{d3} = V_{d4} = \frac{2n}{(1-D)} V_{in}$

The voltage stresses on diodes D_3 and $D_4$is related to output voltages V_O and turns ratio n can be expressed as

$$V_{d3} = V_{d4} = V_o - \frac{2}{(1-D)} V_{in}$$

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

An ISO 3297: 2007 Certified Organization *Vol. 5, Special Issue 3, March 2016*

National Conference on Recent Advances in Electrical & Electronics Engineering (NCREEE'16)

Organized by

Dept. of EEE, Mar Baselios Institute of Technology & Science (MBITS), Kothamangalam, Kerala-686693, India

On 17th & 18th March 2016

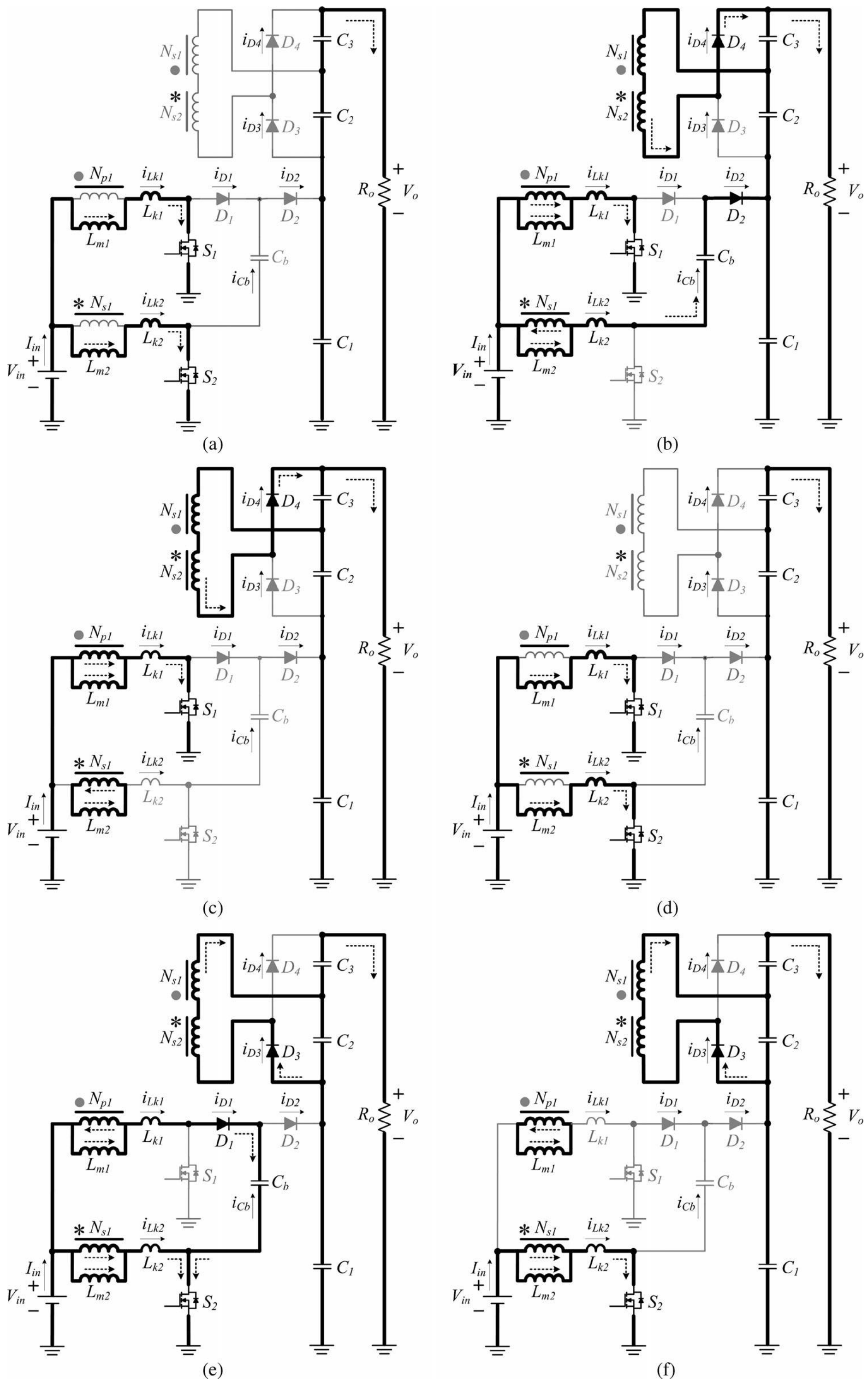


Fig..4.Operating modes of proposed converter (a)Mode 1 [to,t1] (b)Mode 2[t1,t2] (c)Mode 3[t2,t3] (d)Mode 4[t3,t4] (e)Mode 5[t4,t5] (f)Mode 6[t5,t6].

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

An ISO 3297: 2007 Certified Organization | Vol. 5, Special Issue 3, March 2016

National Conference on Recent Advances in Electrical & Electronics Engineering (NCREEE'16)

Organized by

Dept. of EEE, Mar Baselios Institute of Technology & Science (MBITS), Kothamangalam, Kerala-686693, India

On 17th & 18th March 2016

III.SIMULATION &RESULTS

The simulation of the proposed high step-up converter was done on the MATLAB software with Turns ratio 'n' is chosen as1 with a 40-V input voltage, 380-V output voltage to reduce the cost, volume and conduction loss of the winding.The duty cycle is nearly equal to 0.26. The switching frequency is 40KHz and the corresponding component parameters are listed in table 1.To obtain extra voltage gain through the voltage- lift capacitor and reduces the input current ripple, which is suitable for high power applications.The leakage energy is recycled and send to the output terminal through capacitor C_b. The high efficiency are achieved by the low voltage rated and low on-state resistance MOSFET can be selected.

CONVERTER COMPONENTS AND PARAMETERS

components	Symbols	parameters
Magnetizing inductance	Lm1 , Lm2	133mH
Leakage inductances	Lk1 , Lk2	1.6mH
Turns ratio	N(Ns/Np)	1
Power switches	S1 , S2	IRFP4227
Diodes	D1 , D3 , D4	FCF06A-40
	D2	BYQ28E-200
Capacitors	Cb , C2 , C3	220 mF
	C1	470 mF

TABLE 1

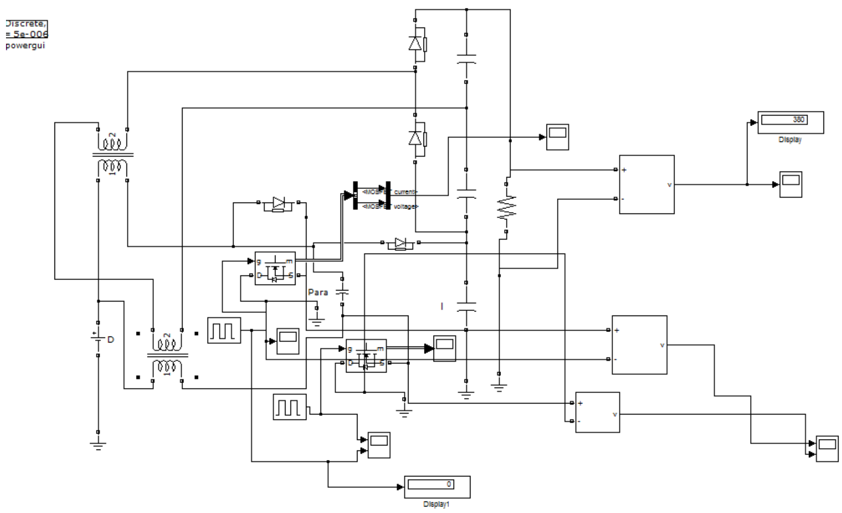


Fig.5. Simulation Diagram

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

An ISO 3297: 2007 Certified Organization Vol. 5, Special Issue 3, March 2016

National Conference on Recent Advances in Electrical & Electronics Engineering (NCREEE'16)

Organized by

Dept. of EEE, Mar Baselios Institute of Technology & Science (MBITS), Kothamangalam, Kerala-686693, India

On 17th & 18th March 2016

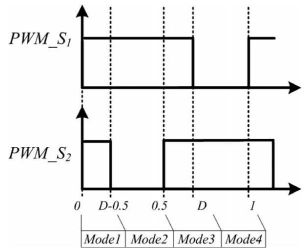


Fig. 6. PWM signal of S_1 and S_2

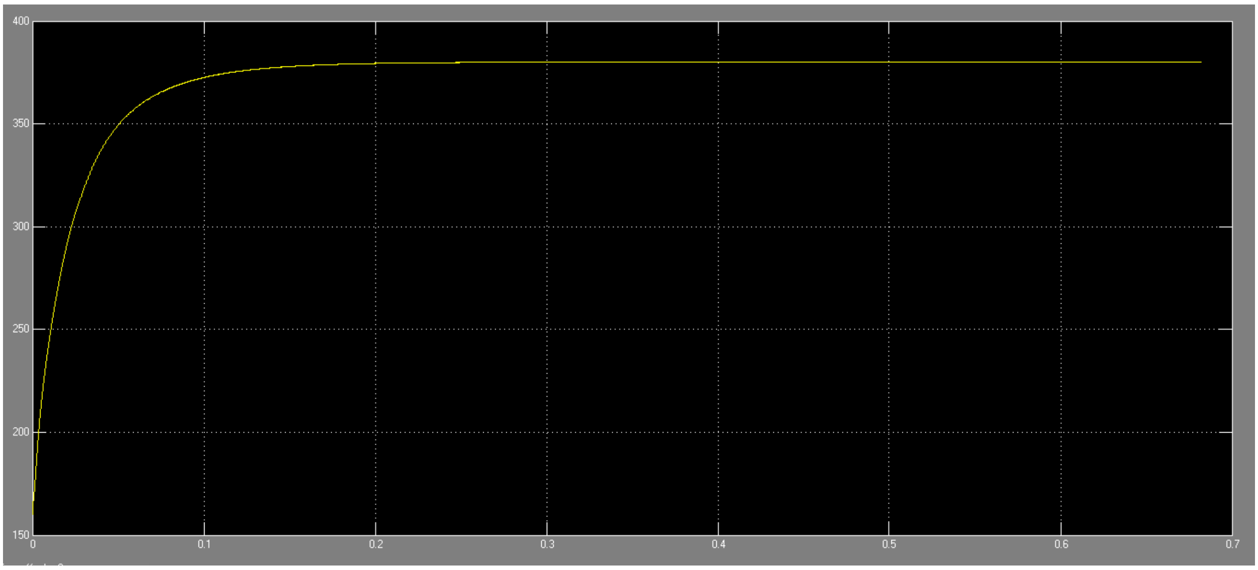


Fig. 7. Output voltage waveform

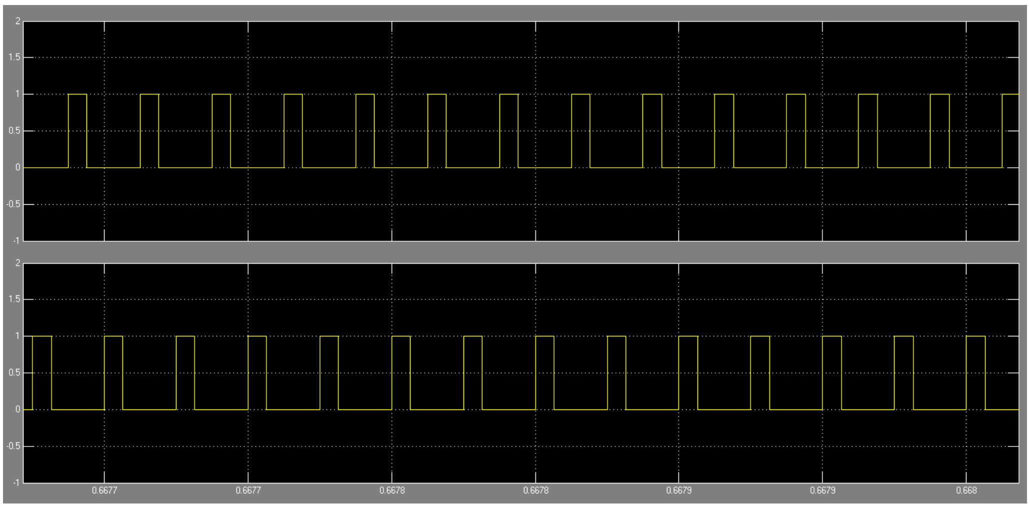


Fig. 8.Switching Pulses (D= 0.26)

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

An ISO 3297: 2007 Certified Organization *Vol. 5, Special Issue 3, March 2016*

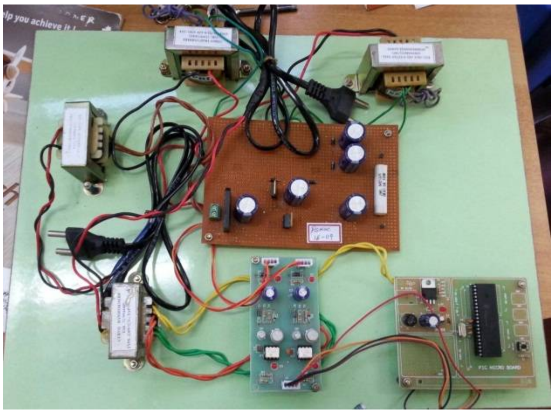
National Conference on Recent Advances in Electrical & Electronics Engineering (NCREEE'16)

Organized by

Dept. of EEE, Mar Baselios Institute of Technology & Science (MBITS), Kothamangalam, Kerala-686693, India

On 17th & 18th March 2016

IV. HARDWARE



VI.CONCLUSION

This paper has presented the topological principles, steady state analysis, and simulation of proposedconverter.The interleaved PWM scheme reduces the currents that pass through each power switch and constrained the input current ripple by approximately 6%.The leakage energy is recycled through capacitor C_b, is the output terminal.The voltage stresses over the power switches are restricted and are much lower than the output voltage and is about 380V. The proposed converter is suitable for PV systems or other renewable energy applications that need high step-up high-power energy conversion.

REFERENCES

[1] W. Li and X. He, "An interleaved winding-coupled boost converter with passive lossless clamp circuits," *IEEE Trans. Power Electron.*, vol. 22, no. 4, pp. 1499–1507, Jul. 2007.

[2] J. T. Bialasiewicz, "Renewable energy systems with photovoltaic power generators: Operation and modeling," *IEEE Trans. Ind. Electron.*, vol. 55, no. 7, pp. 2752–2758, Jul. 2008.

[3] H. Tao, J. L. Duarte, and M. A. M. Hendrix, "Line-interactive UPS using a fuel cell as the primary source," *IEEE Trans. Ind. Electron.*, vol. 55, no. 8, pp. 3012–3021, Aug. 2008

[4] G. K.Andersen, C.Klumpner, S. B. Kjaer, and F. Blaabjerg, "A newgreen power inverter for fuel cells," in *Proc. IEEE 33rd Annu. Power Electron.Spec. Conf.*, 2002, pp. 727–733.

[5] K. C. Tseng and T. J. Liang, "Novel high-efficiency step-up converter," *IEE Proc. Elect. Power Appl*, vol. 151, no. 2, pp. 182–190, Mar. 2004.

[6] T. J. Liang and K. C. Tseng, "Analysis of integrated boost–flyback step-up converter," *IEE Proc. Elect. Power Appl.*, vol. 152, no. 2, pp. 217–225, Mar. 2005.

[7] J. W. Baek,M. H. Ryoo, T. J. Kim, D. W. Yoo, and J. S. Kim, "High boost converter using voltage multiplier," in *Proc. 31st Annu. Conf. IEEE Ind.Electron. Soc.*, May 2005, pp. 567–572.