IJSEAT International Journal of Science Engineering and Advance Technology

Photovoltaic System with Step Up Converter

[1] Bhushan S. Chaudhari, [2]M. Mujtahid Ansari, [3]Nilesh S. Mahajan
1. Research Scholar,Electrical Engineering Dept, SSBT‘s COET, Jalgaon (MS),India.
2. Assistant Professor, Electrical Engineering Dept, SSBT‘s COET, Jalgaon (MS), India.
3. Assistant Professor, Electrical Engineering Dept, SSBT‘s COET, Jalgaon (MS), India.
1.bhushansc1989@gmail.com , 2. mujtahidansari@gmail.com, 3. nilesh17_mahajan@rediffmail.com

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

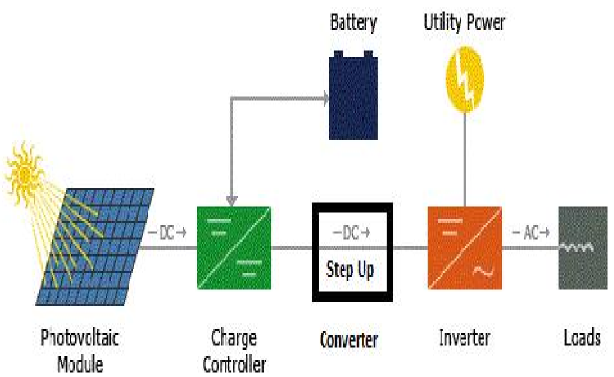

Fig. 1 Typical photovoltaic system

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.

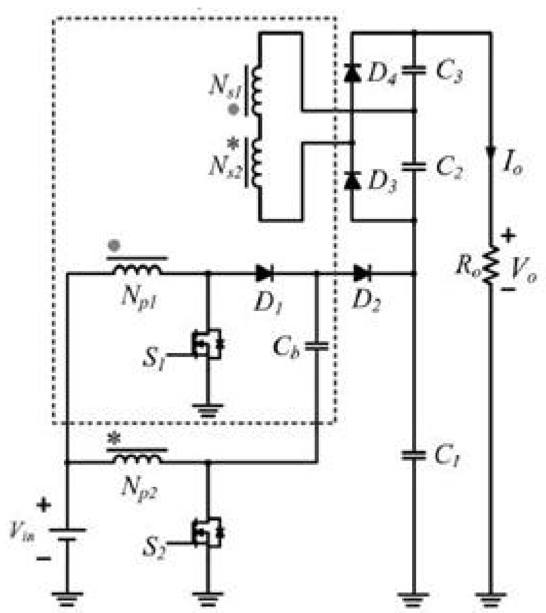

Fig. 2 Step up converter

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 Np turns are employed to decrease input current ripple, and secondary windings of the coupled inductors with Ns 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 Lm1 and Lm2 are identical. The phase shift between two switches are 1800The proposed converter operates in continuous conduction mode.

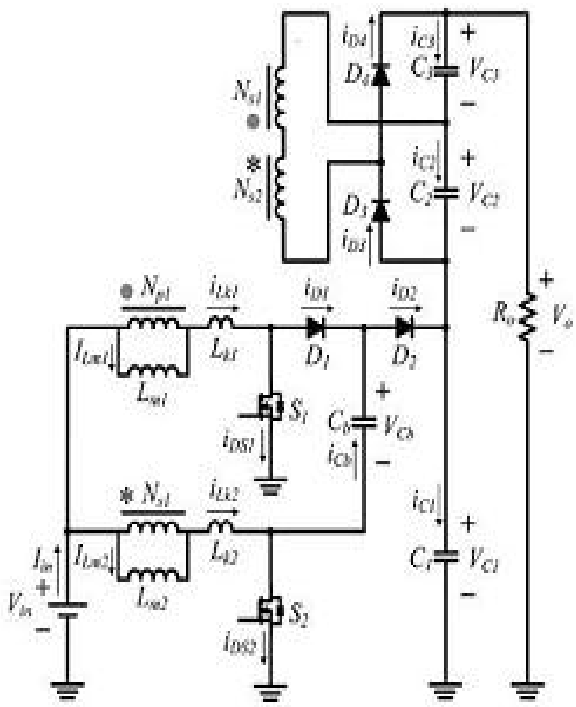

Fig.3 Operating modes of converter

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 *Lm*1 and *Lm*2 as well as leakage inductors *Lk*1 and *Lk*2 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 *Lm*2 has stored is transferred to the secondary side charging the output filter capacitor *C*3 . The input voltage source, magnetizing inductor *Lm*2 , leakage inductor *Lk*2 , and voltage-lift capacitor *Cb* 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 *Lk*2 has been completely released to the output filter capacitor *C*1. Magnetizing inductor*Lm*2 transfers energy to the secondary side charging the output filter capacitor *C*3 via diode *D*4 until *t*3 .

D. *Mode IV*

At $t=t3$, the power switch $S2$ is turned ON and all the diodes are turned OFF. Now all the diodes are reversed-biased and the Magnetizing inductors $Lm1$ and $Lm2$ as well as leakage inductors $Lk1$ and $Lk2$ are linearly charged by the input voltage source Vin.

E. *Mode V*

At $t=t4$, the power switch $S1$ is turned OFF, therefore diodes $D1$ and $D3$ are turned ON. Now the energy stored in the magnetizing inductor $Lm1$ is transferred to the secondary side and it charges the output filter capacitor $C2$. The input voltage source and the energy stored in the magnetizing inductor $Lm1$ is completely released to the voltage-lift capacitor Cb through the diode $D1$, which supplies extra energy to Cb.

F. *Mode VI*

At $t=t5$, the diode $D1$ is automatically turns OFF because the entire energy stored in the leakage inductor $Lk1$ is totally released to voltage-lift capacitor Cb. Now the magnetizing inductor $Lm1$ transfers energy to the secondary side and it charges the output filter capacitor $C2$ through the diode $D3$ until $t0$.

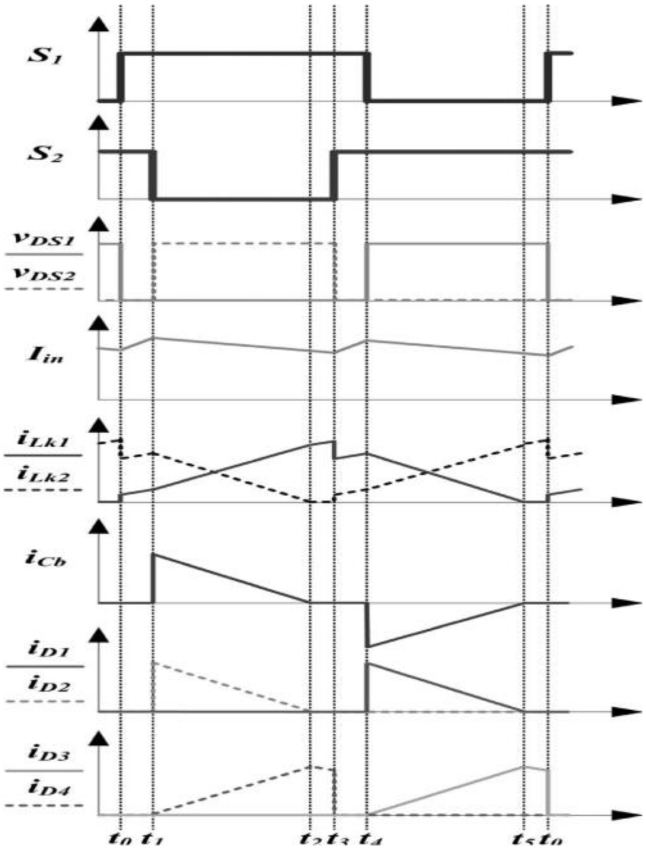

Fig..4 Steady waveforms of the proposed converter at CCM.

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

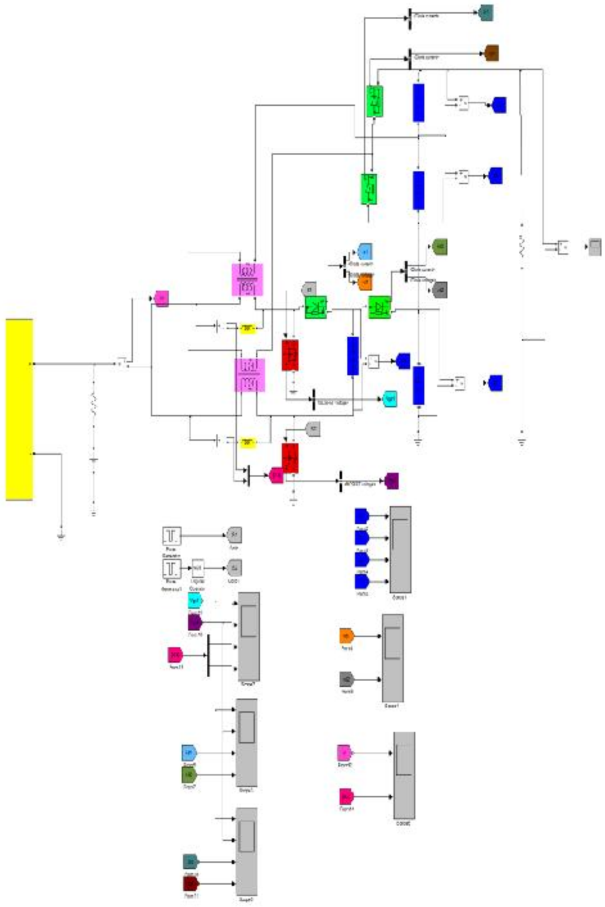

Fig. 5 Matlab simulation model for step up converter

COMPONENTS	SYMBOLS	PARAMETERS
Magnetizing Inductances	Lm1, Lm2	133 uH
Leakage Inductances	Lk1, Lk2	1.6 H
Turns Ratio	N(Ns/Np)	1
Power Switches	S1, S2	IRFP4227
Diodes	D1, D2, D3, D4	FCF06A-40
Capacitors	Cb, C1, C2, C3	220 uF

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

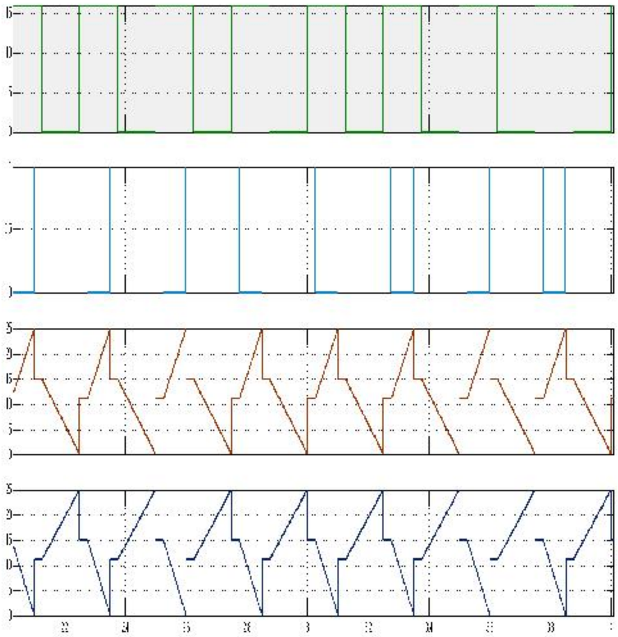

Fig. 6 Voltage and current waveforms for Vgs1, Vgs2, ILK1, ILK2

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

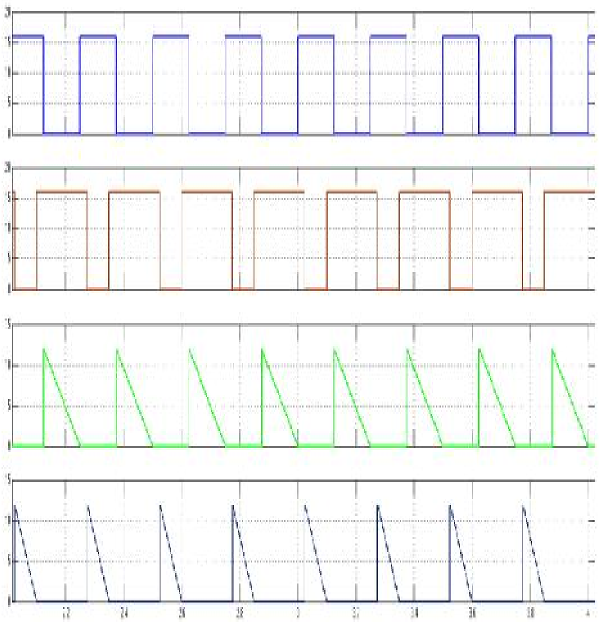

Fig. 7 Voltage and current waveforms for Vgs1, Vgs2, Id1, Id2

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

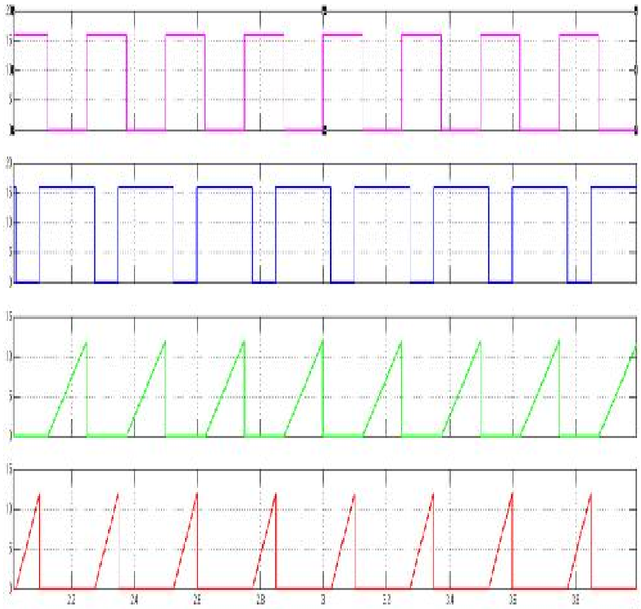

Fig. 9 Voltage and current waveforms for Vgs1, Vgs2, Id3, Id4

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

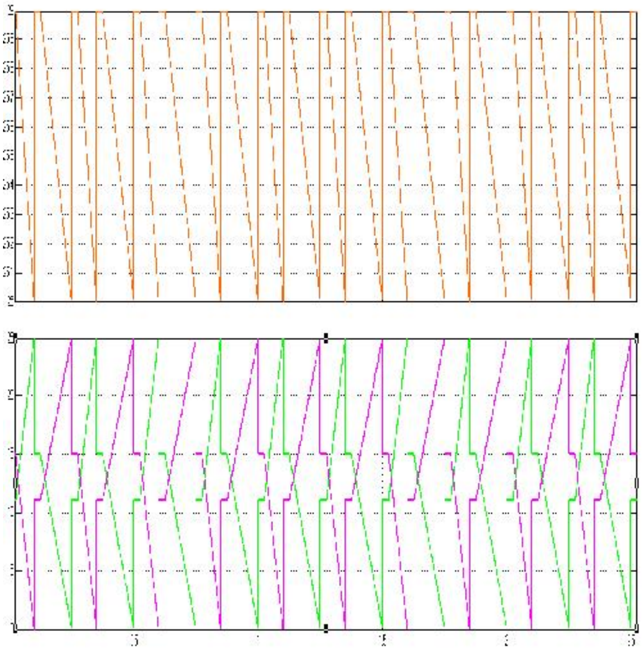

Fig. 10 Results for current waveforms for Iin, Ilk

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

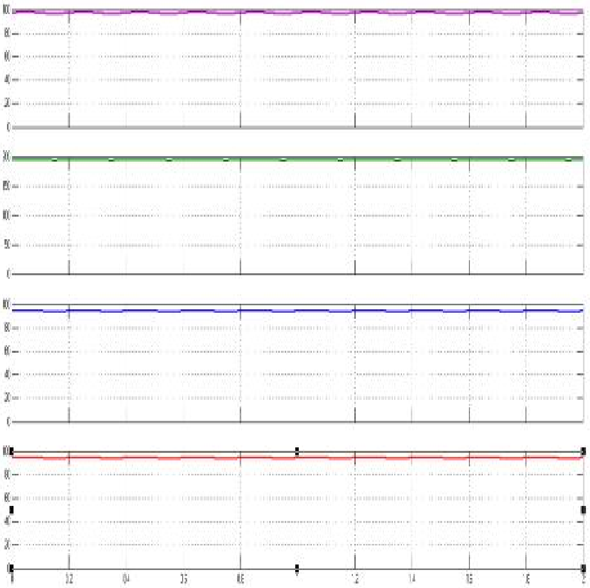

Fig. 11 Results for output voltages Vcb, Vc1, Vc2, Vc3

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.

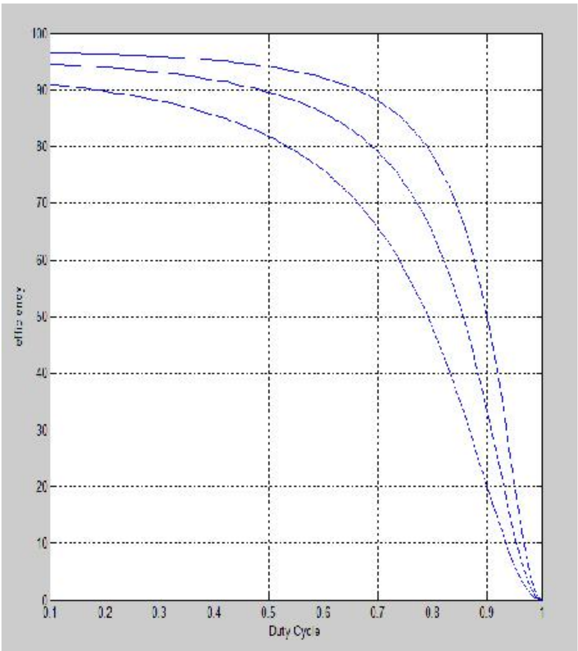

Fig. 12 Efficiency versus duty cycle.

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.

REFERENCES

[1] Kuo-Ching Tseng, Chi-Chih Huang, and Wei-Tuan Shih “A High Step-Up Converter With Voltage Multiplier Module For a Photovoltaic Power System” IEEE Transactions On Power Electronics, Vol. 28. No. 6, June 2013. 3047.

[2] Bhushan S. Chaudhari, M.M. Ansari, N.S. Mahajan, “A Review Of Step Up Converter With Voltage Multiplier For Photovoltaic Power System” , International Journal of Innovative Research in Advanced Engineering (IJIRAE), Issue 11, Volume 2 (November 2015), ISSN: 2349-2163.

[3] Yen-Mo Chen, Alex Q. Huang, Xunwei Yu, “A High Step-Up Three-Port DC–DC Converter for Stand-Alone PV/Battery Power Systems”, IEEE Transactions On Power Electronics, Vol. 28, No. 11, 0885-8993, November 2013.

[4] Vincent W. Ng, Seth R. Sanders, “A High-Efficiency Wide-Input-Voltage Range Switched Capacitor Point-of-Load DC–DC Converter”, IEEE Transactions On Power Electronics, Vol. 28, No. 9, 0885-8993, September 2013.

[5] Chung-Chuan Hou, , Chih-Chung Shih, Po-Tai Cheng, Ahmet M. Hava, “Common-Mode Voltage Reduction Pulsewidth Modulation Techniques for Three-Phase Grid-Connected Converters”, IEEE Transactions On Power Electronics, Vol. 28, No. 4, 0885-8993, April 2013.

[6] Bin Gu, Jason Dominic, Jih-Sheng Lai, Zheng Zhao, Chuang Liu, “High Boost Ratio Hybrid Transformer DC–DC Converter for Photovoltaic Module Applications”, IEEE Transactions On Power Electronics, Vol. 28, No. 4, 0885-8993, April 2013.

[7] Shih-Jen Cheng, Yu-Kang Lo, Huang-Jen Chiu, Shu-Wei Kuo, "High-Efficiency Digital-Controlled Interleaved Power Converter for High-Power PEM Fuel-Cell Applications", IEEE Transactions On Industrial Electronics, Vol. 60, No. 2, 0278-0046, February 2013.
[8] Rong-Jong Wai, Kun-Huai Jheng, "High-Efficiency Single-Input Multiple-Output DC–DC Converter", IEEE Transactions On Power Electronics, Vol. 28, No. 2, 0885-8993, February 2013.
[9] Fellipe S. Garcia, Jose Antenor Pomilio, Giorgio Spiazzi, "Modeling and Control Design of the Interleaved Double Dual Boost Converter", IEEE Transactions On Industrial Electronics, Vol. 60, No. 8, 0278-0046, August 2013.
[10] Hongrae Kim, Babak Parkhideh, Tim D. Bongers, Heng Gao, "Reconfigurable Solar Converter: A Single-Stage Power Conversion PV-Battery System", IEEE Transactions On Power Electronics, Vol. 28, No. 8, 0885-8993, August 2013.
[11] Jia-Min Shen, Hurng-Liahng Jou, Jinn-Chang Wu, "Novel Transformerless Grid-Connected Power Converter With Negative Grounding for Photovoltaic Generation System", IEEE Transactions On Power Electronics, Vol. 27, No. 4, 0885-8993, April 2012.
[12] Wuhua Li, Jianguo Xiao, Yi Zhao, Xiangning He, "PWM Plus Phase Angle Shift (PPAS) Control Scheme for Combined Multiport DC/DC Converters", IEEE Transactions On Power Electronics, Vol. 27, No. 3, 0885-8993, March 2012.
[13] J.S.Anu Rahavi, T.Kanagapriya, Dr.R.Seyezhai, "Design and Analysis of Interleaved Boost Converter for Renewable Energy Source", International Conference on Computing, Electronics and Electrical Technologies, IEEE, 978-1-4673-0210-4112, 2012 .
[14] Juan Manuel Carrasco, Leopoldo Garcia Franquelo, Jan T. Bialasiewicz, Eduardo Galván, Ramón C. Portillo Guisado, , Ma. Ángeles Martín Prats, José Ignacio León, and Narciso Moreno-Alfonso, "Power-Electronic Systems for the Grid Integration of Renewable Energy Sources: A Survey", IEEE Transactions On Industrial Electronics, Vol. 53, No. 4, 0278-0046, August 2006.
[15] Y. Xiong, X. Cheng, Z. J. Shen, C. Mi, H. Wu, and V. Garg, "A Prognostic and Warning System for Power Electronic Modules in Electric, Hybrid, and Fuel Cell Vehicles", IEEE Transactions, 1-4244-0365-0/06, 2006.

BIOGRAPHIES

Mr. Bhushan S. Chaudhari received the B.E. Electrical from Government College of Engineering, Jalgaon, in 2013, and pursing M.E. from S.S.B.T.'s College Of Engineering and Technology, Jalgaon. He has published one paper in international journal.

M. Mujtahid Ansari received his B.E.(Electrical Engg) and M.E.(Electrical Power System) from the S.G.B.University, Amravati, India in year 1996 and 2009 respectively . He is member of IE, ISTE and IACSIT. He has joined SSBT's College of Engineering and Technology, Jalgaon in the year 2000 where he is working as Assistant Professor in Electrical Engineering Department. He has published six papers in international journal and one text book. He was chairman Board of studies in Electrical Engineering and Instrumentation Engineering under the faculty of Engineering and Technology, North Maharashtra University, Jalgaon (MS) India.

Nilesh S. Mahajan had completed his M. E. in Electrical Power Systems from Government College of Engineering, Aurangabad. He is working as an Assistant Professor in the Department of Electrical Engineering in SSBT's College of Engineering & Technology, Bambhori, Jalgaon. He has published three papers in international journal.