International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 06, June-2021

Modelling of High Gain DC-DC Converter

Dilip Kumar Arya
M.Tech, (Dept. of Electrical Engineering)
Integral University
Lucknow India

M.A. Malick
Professor, (Dept. of Electrical Engineering)
Integral University
Lucknow India

***Abstract*— This paper discusses about modelling of high-gain DC to DC converter with the reduction in voltage stress, which is used in place of regular step up converters. Regular step up converter doesn't stand at high gain due to heavy voltage stress. Here we can use the solar energy, wind energy as a source for the step up converter. Proposed converter works at very high voltage gain compared to the existing topologies such as the twice boost converter and conventional boost converter. The main advantage of the proposed boost converter over the conventional boost converter is that it provides very high voltage gain at lower duty ratio and has better efficiency at higher loads as compared to another similar kind of converters. The converter design and comparison with previous boost converter have been discussed in detail with supporting simulations using MATLAB/SIMULINK.**

Keywords: High voltage gain, DC-DC converter, duty ratio

I. INTRODUCTION

In ancient ages, people used to depend upon the Sun only, the most powerful energy supplier on the Earth. Then they used to learn about the use of fire and a positive vibe came to their mind towards the invention of some dependable source of energy. Electricity, being discovered by Benjamin Franklin in the 18th century has opened the eyes of the then Scientists and Researchers for the best future source of energy [1]. The increasing dependency on electricity requires more amount of electricity generation by combustion of fossil fuels by putting a great impact on the green house effect and global warming. Modern technology makes the use of renewable energy sources (RES) to become an alternative of the combustion engines for power generation as the cost and the environmental issues are concerned without any harmful emission [2-3]. Few of these sources include solar, fuel cell, wind energy etc [4-5]. These renewable sources needs power conditioning using power electronic converter [6-8]. Photovoltaic (PV) based system is most popular among various sources of renewable [8-11].But the output of PV cells are very low so need a isolated/ non isolated DC-DC converter, which step up the low input DC voltage into higher output voltage. Transformer based isolated topologies suffer from limited switching frequency, increased transformer losses, increased voltage stress across the device and are bulky[11-14]. So the non isolated DC-DC boost converters required with reduced switch voltage stress technique for providing a high voltage gain without extreme duty cycle and the use of transformer link and hence the system cost is reduced [14-17]. Proposed converter works with low voltage stress, high voltage gain, and also provide higher efficiency triple boosting in input voltage.

II. MODELLING OF DC-DC CONVERTER

One of most important applications of the high gain DC-DC converter is renewable energy generation. The gain of multilevel converter is depends upon the duty cycle of gate pulse. When convectional converter operation is designed into given boost converter operation, only changes the output voltage and voltage gain. The block diagram of the high gain DC-DC Converter is shown in Figure 1. The high gain Boost DC-DC Converter contains only one button (MOSFET), so it has only two operating modes. During start-up mode, the button is turned on and diode D5 is not working. During the second operating mode, the button is in OFF mode and the D5 diode is ON mode. Diode D5 acts as freewheeling condition.

i. Case-1 (When Switch ON)

During the switch S is in ON condition and diode D1 to D4 are conducting, and D5 works in reversed biased. The switch S is conducting for an interval of DT, where D is the duty ratio and T is the time period of the switching signal. The voltage across the inductors during this mode of operation can be obtained by applying KVL as shown in circuit and the equations are as follows:

$$V_{L1} = -V_{L2} \quad (1)$$
$$V_{L2}=V_{in} \quad (2)$$
$$V_{L3}=V_{in} \quad (3)$$
$$V_{C1}=-V_{C2}=V_{in} \quad (4)$$

Now combine equation no. (1), (2), (3) and (4)

$$V_{L1}=V_{L2}=V_{L3}=V_{C1}=-V_{C2}=V_{in} \quad (5)$$

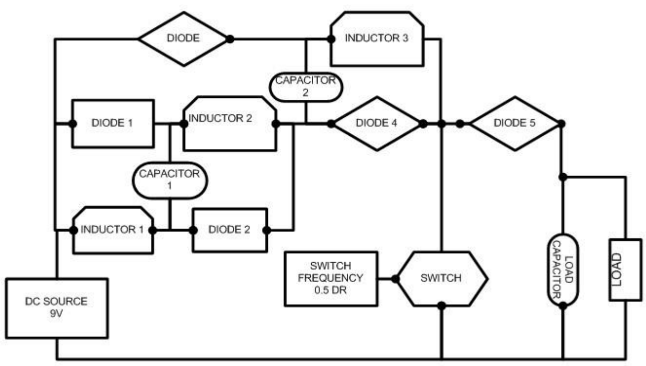

Fig 1 block diagram of proposed high gain converter.

ii. Case 2 (When Switch OFF)

During the second Condition the switch is in OFF condition, diode D1 to D4 are in reverse biased and D5 is conducting. The voltage across inductor L1, L2, and L3 are the same. If their inductance values are the same as they are in series and the same current is following through them. The voltage across the inductors during this condition of operation can be obtained by applying KVL .

III. SIMULATION RESULTS

Proposed converter simulate with the help of MATLAB/Simulink software. Then find the output voltage (53.08V), voltage across inductor L3 and current at output capacitor C3 graph in fig 2 and 3.

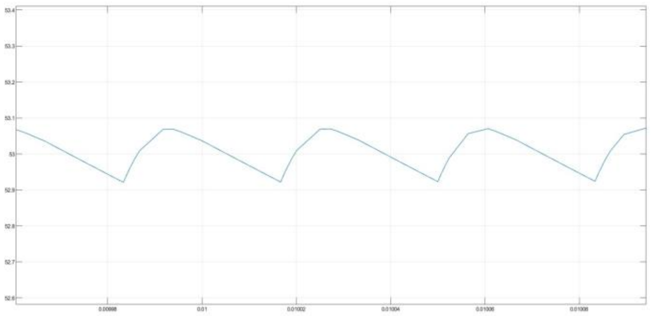

Fig 2.Output waveform of converter during 0.50 duty ratio

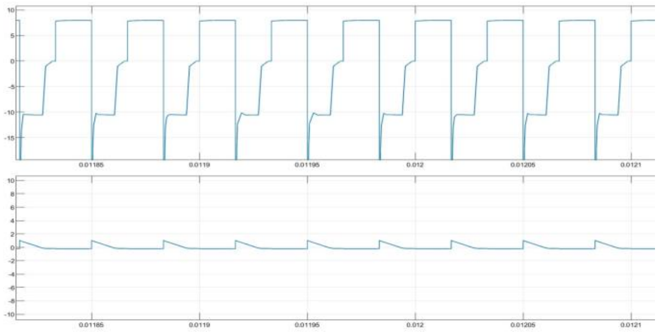

Fig 3.Output waveform input voltage VL3, IC3 during 0.50 duty ratio

IV. COMPARISON WITH OTHER CONVERTERS

Proposed converter is compared with the other high output voltage gain converters discussing as

1. According to given two tier high gain converter the given output voltage 33.5 V is lower then the proposed model at 0.5 lower duty cycle. There are using two switches for boost output voltage which increases voltage stress and decrease overall efficiency.

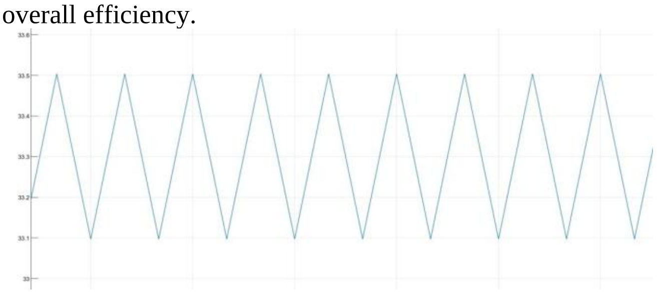

Fig 4.Output waveform of converter during 0.50 duty ratio

2. This double boost high gain converter the given output voltage 24.54V is lower then the proposed model at 0.5 duty cycle. There are also using two switches for boost output voltage which increases voltage stress. So the overall efficiency is also lower then proposed triple boost converter.

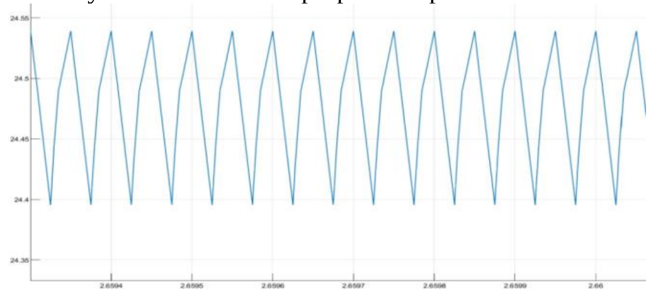

Fig 5.Output waveform of double boost converter during 0.50 duty ratio

V. CONCLUSION

In this paper you are tripling the DC-DC power converter proposed. The proposed converter is built from a single switch with a 0.5 duty ratio. The output voltage in the case of a proposed DC-DC converter is higher in terms of low performance compared to other parameters presented in Figure 2. For most converters, the loss is much higher in duty ratios, so similarly the output voltage, the proposed converter will work preferably as it will provide the same benefit as the minimum duty rate. Key advantages such as (a) high power gain (b) Smooth and continuous (non-ripple) drawing current from input (c) Flexible structure that provides the required maximum power gain while extracting smooth energy from the source. These key features prove that the proposed high profit converter is the ideal way to integrate a PV input source into standard grid, electric vehicles and other applications.

REFRENCES

[1] Sawa M., Fantuzzi A., Bombelli, P.et al. Electricity generation from digitally printed cyanobacteria . Nat Commun 8 1327 (2017).

[2] Ahamad, I., Asim, M., Sarkar, P. R., & Khan, F. A. (2016). Comparison of conventional PFC boost converter and bridgeless PFC boost converter. *Int J Innov Res Electr Electron Instrum Control Eng*, *4*(5).

[3] M. Shahabuddin, M. Asim and A. Sarwar, "Parameter Extraction of a Solar PV Cell Using Projectile Search Algorithm," *2020 International Conference on Advances in Computing, Communication & Materials (ICACCM)*, 2020, pp. 357-361, doi: 10.1109/ICACCM50413.2020.9213005.

[4] Dang Bang Viet; Lembeye, Y. ;Ferrieux, J.P, Barbaroux, J. ;Avenas, Y., “New high power- high ratio non isolated DC-DC boost converter for fuel cell Applications” Power Electronics Specialists conference, 2006. PESC’06. 37th IEEE.

[5] Ahmad J, Zaid M, Sarwar A, Lin C-H, Asim M, Yadav RK, Tariq M, Satpathi K, Alamri B. A New High-Gain DC-DC Converter with Continuous Input Current for DC Microgrid Applications. *Energies*. 2021; 14(9):2629. https://doi.org/10.3390/en14092629

[6] Forouzesh M, Siwakoti YP, Gorji SA, Blaabjerg F, Lehman B. Step-up DC–DC converters: a comprehensive review of voltage-boosting techniques, topologies, and applications. IEEE Trans Power Electron. 2017;32(12):9143-9178.

[7] Asim, M., Riyaz, A., Tiwari, S., & Verma, A. (2018). Performance evaluation of fuzzy controller for boost converter with active PFC. Journal of Intelligent & Fuzzy Systems, (Preprint), 1-8.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 06, June-2021

[8] Asim, M., Mallick, M. A., Malik, A., & Saaqib, M. (2015). Modelling and simulation of 5 parameter model of solar cell. *International Journal of Electronics, Electrical and Computational System*, *4*..

[9] Sri Revathi B, Mahalingam P. Non-isolated high gain DC–DC converter with low device stress and input current ripple. IET Power Electron. 2018;11(15):2553-2562.

[10] Liu L, Li D, Yao L. A family of non-isolated transformerless high step-up DC-DC converters. Int Trans Electr Energy Syst. 2019;29(4):1-34.

[11] Raghav, R., Raza, A., & Asim, M. (2015). Distributed Power Flow Controller-An Improvement Of Unified Power Flow Controller. *Development*, *2*(5).

[12] Heena Parveen, Mohammed Asim, , Isarar Ahamad, “Efficiency Analysis of Bridgeless PFC Boost Converter” International journal for scientific research and development, vol. 04, issue 01,2016..

[13] Zhengxin Liu, Jiuyu Du * and Boyang Yu. State Key Laboratory of Automotive Safety and Energy, Tsinghua University, Beijing ,China World Electric Vehicle Journal 2020, 11, 64.

[14] Rafeeq Ahmed, Mohd Asim, Safwan Zubair Khan and Bharat Singh, "Green Iot-Issues and Challenges", *2nd International Conference on Advanced Computing and Software Engineering (ICACSE-2019)*.

[15] Milad Nemati, Seyed Hossein Hosseini, Mohammad Bagher Bannae Sharifian, Mehran Sabahi. *IET Power Electron.*, 2020, Vol. 13 Iss. 12, pp. 2589-2597© The Institution of Engineering and Technology 2020.

[16] Liu L, Li D, Yao L. A family of non-isolated transformerless high step-up DC-DC converters. Int Trans Electr Energy Syst. 2019;29(4): 1-34.

[17] Maalandish M, Hosseini SH, Jalilzadeh T, Vosoughi N. High step-up DC-DC converter using one switch and lower losses for photovoltaic applications. IET Power Electron. 2018;11(13):2081–2092.