

## International Journal of Innovative Research in Science, Engineering and Technology

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# Voltage Regulation of Interleaved Boost Converter for Power Distribution of Solar Power Source

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**ABSTRACT:** Renewable Energy Sources (RES) have proved to be most suitable for power generation and transmission. Solar PV cell is the most widely used among other renewable energies. The main advantage of this cell include longer life and less maintenance. A novel high-step-up Interleaved Converter with a built-in transformer and a voltage-multiplier circuit is used to raise the voltage gain of the presented converter and to lower the voltage stresses on the power devices. This project proposes Interleaved Boost Converter (IBC) uses high step-up conversion feature for stepping up the low input voltage to high output voltage. Other features are high circuit efficiency and low input-current ripple. Output voltage obtained may vary due to many factors hence it has to be regulated for constant output. Closed loop topology helps to regulate the voltage and provide constant output. This project also includes the comparison of open loop and closed loop topology for the detailed study of voltage regulation.

**KEYWORDS:** Renewable Energy Sources, Interleaved Boost Converter.

### I. INTRODUCTION

For overcoming energy-shortage and environmental-contamination issues, renewable and alternative power sources that feature cleanliness and sustainability play an important role in the world, and have begun to be employed worldwide for environment protection. The voltage levels of renewable and alternative power sources, such as photovoltaic cells and fuel cells, are generally low. Thus, high-step- up DC-DC converters have been widely utilized in such renewable energy systems in order to boost their voltage. The high step-up DC-DC converter can convert low levels of input voltage from renewable sources into high levels of output voltages which are then fed into a DC load or a DC-AC inverter for supplying AC sources with an AC load. Hence, the high-step- up DC-DC converter with high efficiency is essential in such power-conversion systems[1].

The substantial increase of research and development work in the area of PhotoVoltaic (PV) systems have made the PV power generators a feasible alternative energy resource that complements other energy sources in hybrid energy systems. The trend of fast increase of the PV energy use is related to the increasing efficiency of solar cells as well as the improvements of manufacturing technology of solar panels. The PV generators can either be grid connected (operate in distributed generation systems) or can operate in stand-alone (autonomous) systems. With the development of distributed generation systems, the renewable electricity from PV sources became a resource of energy in great demand[3].

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## II. PROPOSED SYSTEM

Today, interleaved boost converters are widely applied in fuel cell, solar panels, and battery sources for boosting a very low voltage to an appropriate voltage for the alternating current (ac) inverters or front-end applications. The proposed interleaved boost converter not only lengthens the lifetime of the renewable power source by reducing the input-current ripple but also achieves high step-up conversion. In addition, the voltage stress of the main switches is lowered due to the lossless passive-clamp circuit. Hence, large voltage spikes across the main switches are alleviated and the efficiency is improved[1].

On the other hand, the built-in transformer does not deal with large DC magnetizing current, and the voltage gain can be extended by increasing the turns ratio of the built-in transformer without an air gap; thus, the volume of core is smaller and the coupling coefficient as well as the circuit efficiency is higher. This paper proposes a novel high-step-up interleaved boost converter that not only utilizes the clamp capacitors but also integrates the secondary winding of the built-in transformer; thus, high step-up voltage gain of the presented converter and lower voltage stresses of the power devices are achieved.

The interleaved boost converter with features of high step-up conversion, high circuit efficiency, and low input-current ripple, which can lengthen the life time of the input source, is suitable for distributed generation using renewable and alternative power sources. The conventional interleaved boost converter is an outstanding for high-power requirements and power factor correction. In addition, windings of the built-in transformer can be designed to extend the step-up gain, and two diodes and two capacitors in the proposed converter. act as an active clamp circuit in order to lower voltage stress on the main switches; thus, low-voltage-rated semiconductor devices (such as power MOSFETs and diodes) can be adopted in the presented converter[10][5].

### CHARACTERISTICS

The key characteristics of the proposed converter are listed as follows:

- Lowering the input-current ripple and reducing the conduction losses results in an increased lifetime of the power sources and makes the presented converter suitable for renewable and alternative energy applications.
- The converter is capable of achieving high step-up gain easily.
- By recycling the leakage energy, the voltage stresses of clamp diodes are alleviated and the circuit efficiency is improved.
- The voltage stresses on the semiconductor components are substantially lower than the output voltage.

Compared with existing converter, the proposed high step-up converter decreases the power switch count and achieves similarly high circuit efficiency without soft-switching function and active clamp circuit. Moreover, the proposed converter has features of cost-effectiveness and relatively low input current ripple.

### CIRCUIT DIAGRAM

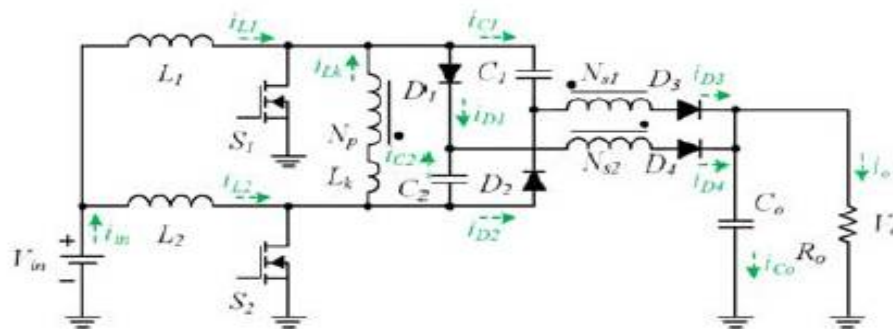


Fig. 1 High step-up interleaved boost converters

The proposed high-step-up interleaved boost converter is shown in Fig. 1, where  $L_1$  and  $L_2$  are the energy storage inductors;  $S_1$  and  $S_2$  denote the power switches;  $C_1$  and  $C_2$  are the clamp capacitors;  $C_o$  is the output capacitor;  $D_1$  and  $D_2$

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are the clamp diodes, and  $D_3$  and  $D_4$  are the rectified diodes. The built-in transformer consists of a primary winding  $N_p$ , a secondary winding  $N_{s1}$ , a third winding  $N_{s2}$  and a leakage inductor  $L_k$ [1].

## III.SIMULATION MODEL

### CLOSED LOOP CONTROL OF PROPOSED SYSTEM

The proposed converter eliminates the limitations of the conventional converters and they have the advantages like interleaving structure, non-isolated structure and soft switching scheme. Due to soft switched scheme, the current stress and voltage stress are eliminated and hence reduced switch losses. Interleaving structure guarantees equal current sharing and hence reduced component size. Non-isolated structure reduces the circuit size and complexity. A closed loop control method is adopted to overcome the voltage drift problem. To regulate the output of the converter, closed loop control is used. In order to obtain load regulation, a PI (Proportional Integral) controller is added to get the desired output voltage. Here the output voltage is given as input to the (Pulse Width Modulation) PWM generator, which in turn gives the pulses to the switches in the circuit as depicted in Fig 2 Open loop simulink circuit as shown in Fig 3 is simulated with an input voltage of 48V. Variation of input may deviate the desired output voltage. This variation is regulated using closed loop circuit as shown in Fig 4 Control block diagram of closed loop circuit is shown in Fig 5.

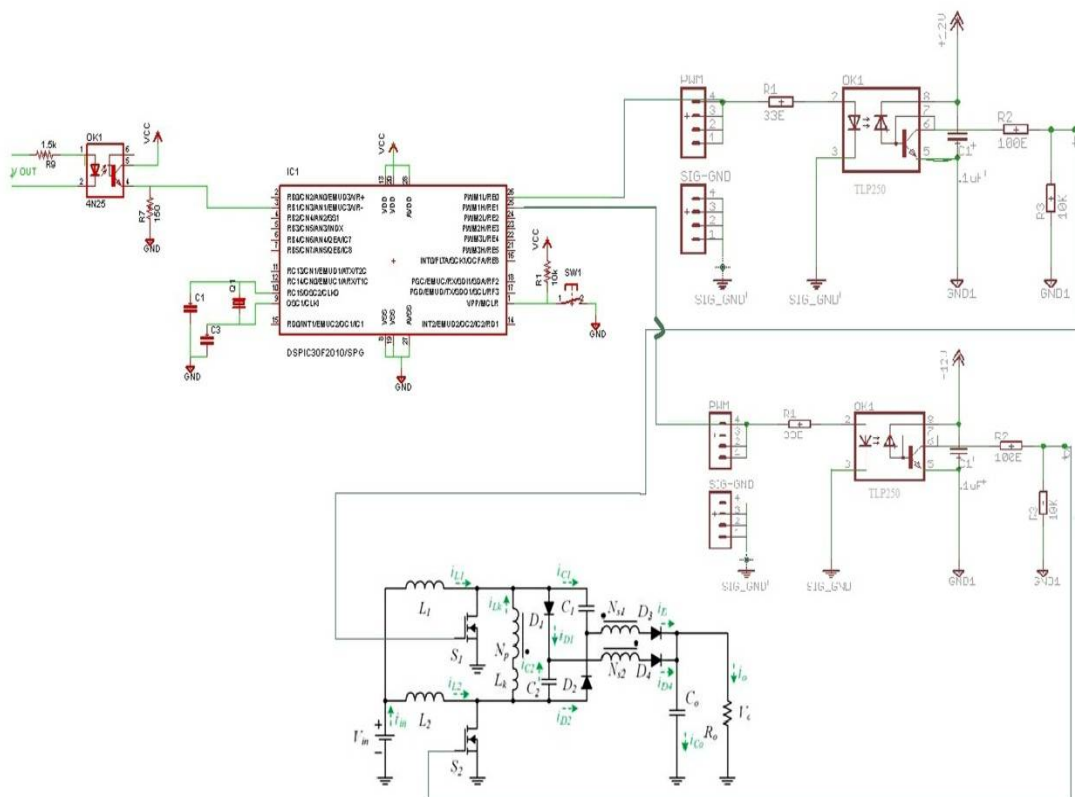


Fig. 2 Schematic diagram of proposed system

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## OPEN LOOP SIMULINK CIRCUIT

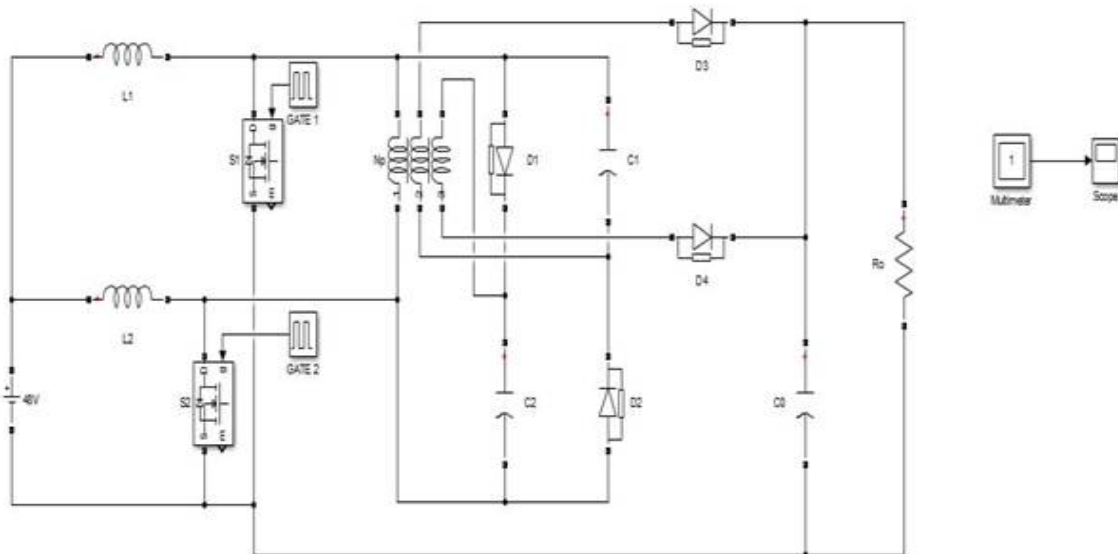


Fig. 3 Open loop circuit

## CLOSED LOOP SIMULINK CIRCUIT

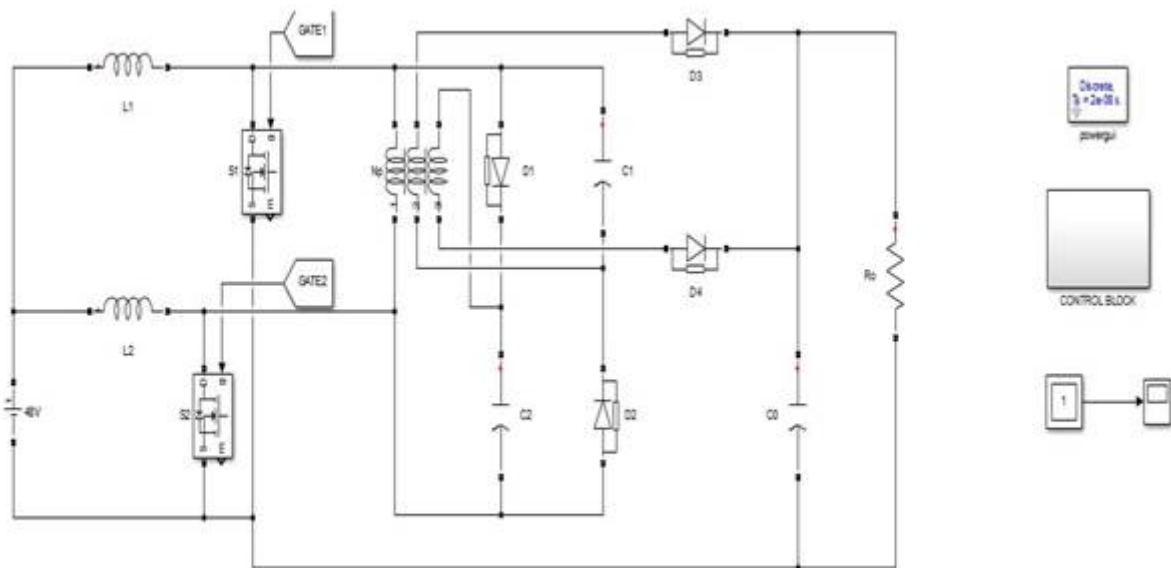


Fig. 4 Closed loop circuit

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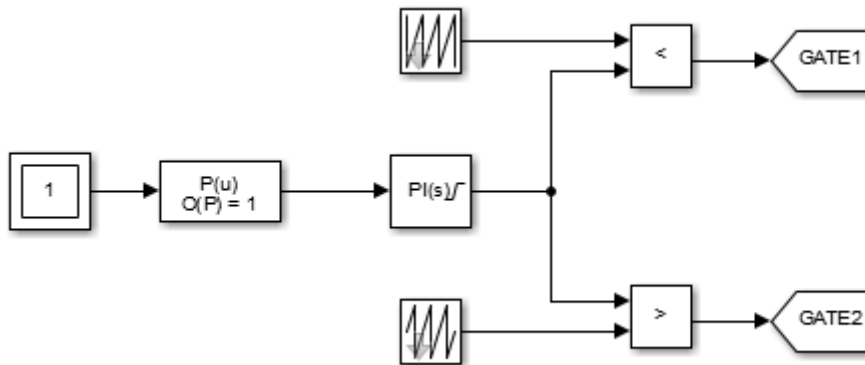


Fig. 5 Control block diagram

## IV. SIMULATION RESULTS

Circuit diagram is drawn using MATLAB and output is obtained as shown below. Input voltage is set to 48V as shown in Fig 6. Output voltage of 380V is obtained after simulation of open loop circuit as in Fig 7 and output current is obtained as shown in Fig 8. Closed loop circuit is compared with open loop circuit by giving a different input voltages 45V. The Resultant output voltage obtained in open loop drastically came down as shown in Fig.9 whereas in closed loop circuit output voltage obtained is the same 380V as shown in Fig.10. Hence voltage is regulated using closed loop control which is more efficient than open loop.

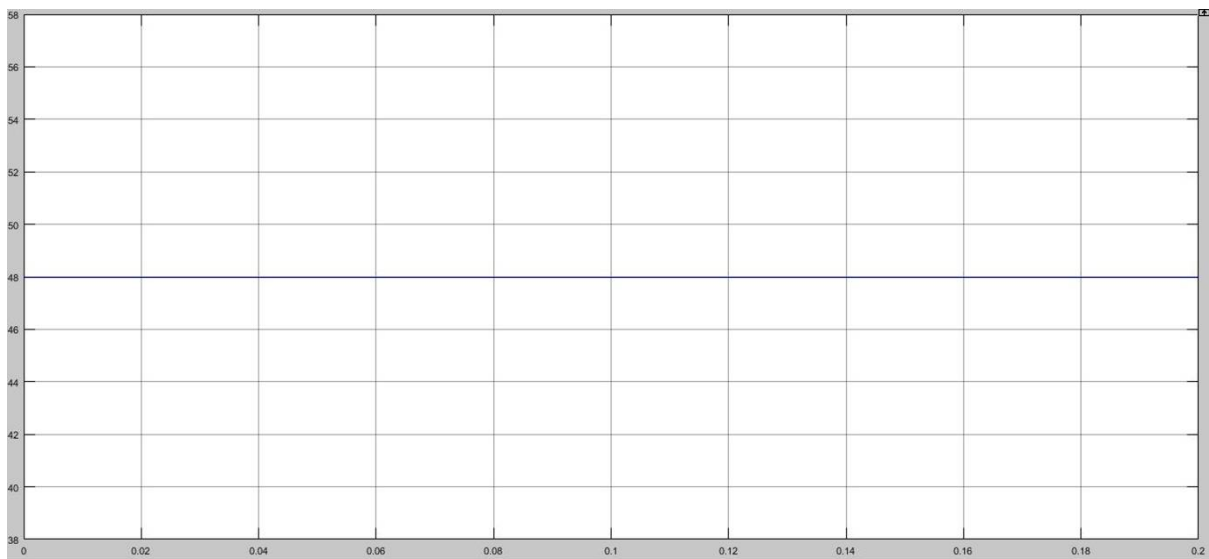


Fig. 6 Input voltage

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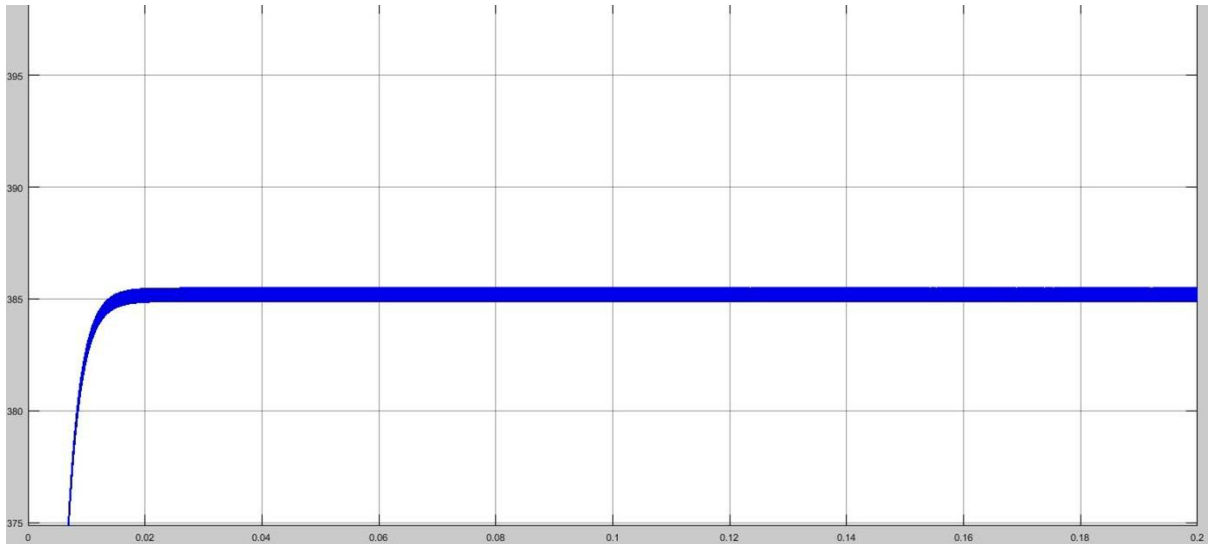


Fig. 7 Output voltage of open loop circuit with 48Vof input

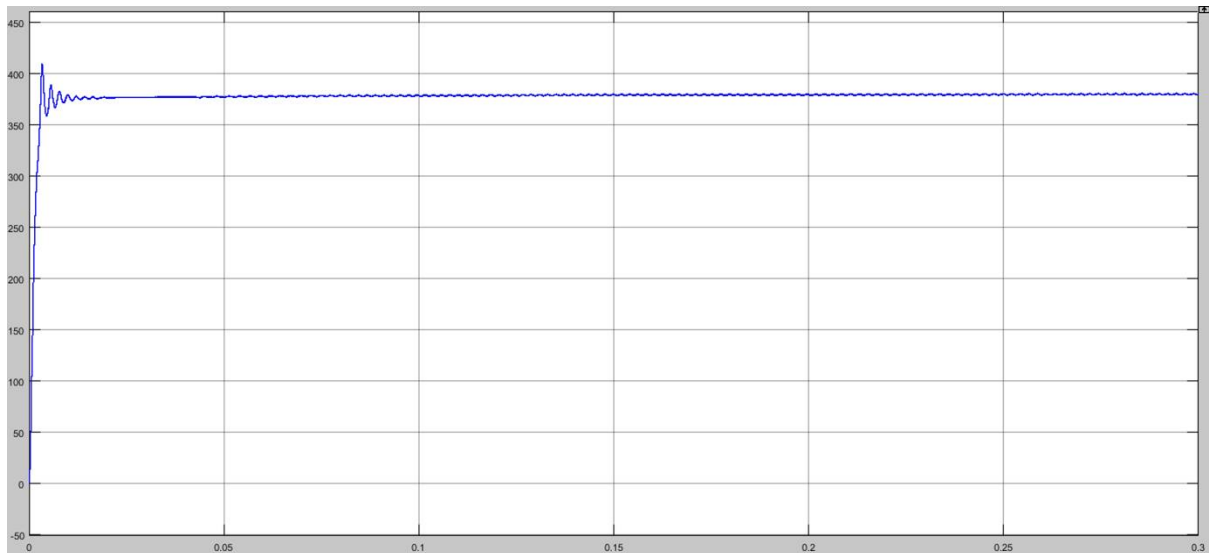


Fig. 8 Output voltage of closed loop control with 48Vof input

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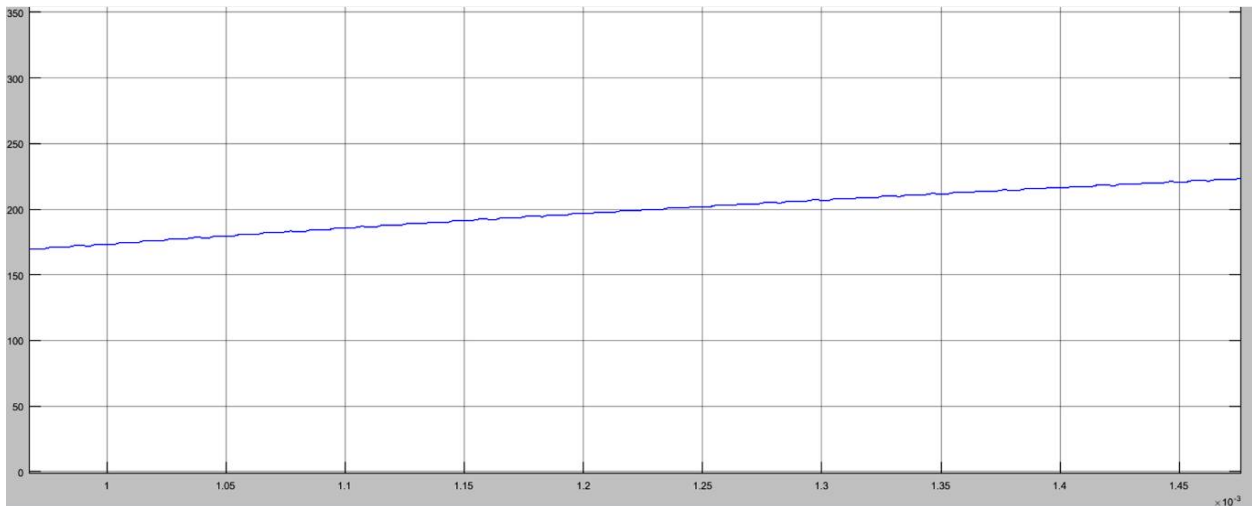


Fig. 9 Output voltage of open loop circuit with 45V of input

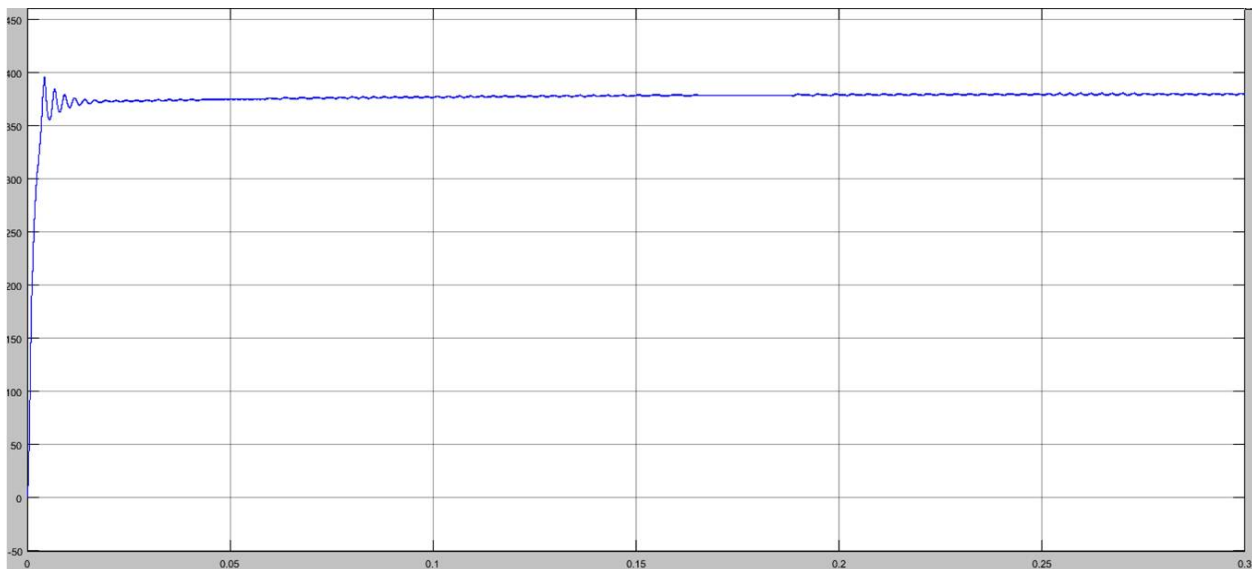


Fig. 10 Output voltage of closed loop control with 45V of input

## V. CONCLUSION

This project has proposed a high-step-up interleaved boost converter for distributed generation using renewable and alternative power sources. Analysis of operational modes, open loop and closed loop circuits has been developed and tested. The interleaved structure inside the presented converter reduces the input-current ripple and distributes the current through each component. In addition, the lossless passive-clamp circuit recycles the leakage energy and constrains voltage spikes across power switches. Moreover, it has been recorded that ripple reduction at the input and output is greater in closed loop voltage mode when compared to open loop operation. Higher stability levels are

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attained using closed loop voltage control. Voltage regulation is also obtained using closed loop topology. Hence, closed loop voltage control of interleaved boost converter proves to be a suitable topology for photovoltaic applications

## REFERENCES

- [1] Kuo-Ching Tseng, Chun-An Cheng, *Member, IEEE*, and Chun-Tse Chen “High Step-Up Interleaved Boost Converter for Distributed Generation Using Renewable and Alternative Power Sources” 2168-6777 (c) 2016 *IEEE*
- [2] Tamal Biswas, G K Panda, P K Saha, S Das, “Design of PWM-Based Sliding-Mode Control of Boost Converter with Improved Performance”, *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*, Vol. 4, Issue 2, February 2015.
- [3] Nithya Subramanian, R. Srinivasan, Dr.R.Seyezhai, Pridhivi Prasanth\* & R.R. Subhesh Investigation of Closed Loop Control for Interleaved Boost Converter with Ripple Cancellation Network for Photovoltaic Applications *I.J. Information Technology and Computer Science*, 2015, 09, 66-7
- [4] Farag. S. Alarag; Ahmed. S. Ashur, ‘ Analysis and Simulation of Interleaved Boost Converter for Automotive Applications’, *International Journal of Engineering and Innovation Technology*, volume 2, issue 11, May 2013.
- [5] Yu Gu, Donglai Zhang “Interleaved Boost Converter with Ripple Cancellation Network”, *IEEE Journal*, volume, pp.3860 - 3869, (2013).
- [6] Robert S. Balog, Philip T. Krein, “Coupled- Inductor Filter: A Basic Filter Building Block”, *IEEE Journal*, volume, pp. 537 – 546 , (2013).
- [7] Sathya, P.; Natarajan, R., ‘Design and Implementation of 12/24V Closed loop Boost Converter for Solar Powered LED lighting system, *International Journal of Engineering Science & Technology*, volume 5 issue 2, February 2013.
- [8] S. M. Chen, T. J. Liang, L. S. Yang, and J. F. Chen, “A safety enhanced, high step-up dc-dc converter for ac photovoltaic module application” *IEEE Trans. Power Electron.*, vol 27, no. 4, pp.1809-1817, Apr 2012
- [9] K. B. Park, G. W. Moon, and M. J. Youn, “High step-up boost converter integrated with a transformer-assisted auxiliary circuit employing quasi-resonant operation,” *IEEE Trans. Power Electron.*, vol. 27, no. 4, pp. 1974– 1984, Apr. 2012.
- [10] G. Spiazzi, P. Mattavelli, and A. Costabeber, “High step-up ratio flyback converter with active clamp and voltage multiplier,” *IEEE Trans. Power Electron.*, vol. 26, no. 11, pp. 3205–3214, Nov. 2011.
- [11] S. V. Araujo, R. P. Torrico-Bascope, and J. V. Torrico- Bascope, “Highly efficient high step-up converter for fuel-cell power processing based on three-state commutation cell,” *IEEE Trans. Ind. Electron.*, vol. 57, no. 6, pp. 1987–1997, Jun. 2010
- [12] J. M. Carrasco, L. G. Franquelo, J. T. Bialasiewicz, E. Galván, R. C. Portillo, M. Á. Martín Prats, J. E. León, and N. Moreno-Alfonso, “Power-electronic systems for the grid integration of renewable energy sources: A survey,” *IEEE Trans. Ind. Electron.*, vol. 53, no. 4, pp. 1002–1016, Aug. 2006