High Gain DC-DC Converter with Voltage Multiplier using Pulse Generation

Neha Agrawal, Mr. Tikeshwar Gajpal, Mr. Ritesh Diwan

***Abstract*— A various number of conventional methods for DC- DC converter are proposed in recent year. This research is based on pulse generation approach for converter design. Photo voltaic (PV) system is used in recent era as a non-conventional system. Where energy or power are generated and consume as required with the conversion of voltage or current. The losses are high during conversion process, so with pulse generation technique the wastage heat in switching element is minimized. The technique gives high gain 8.62 with input Voltage of 40 V, Output Voltage 345 V, and maximum efficiency of 98 %. .**

***Index Terms*— PV system, Pulse generation method, Voltage converter, steps up converter.**

I. INTRODUCTION

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. Renewable energies such as photovoltaic and fuel cells are becoming increasingly important and widely used in distribution systems. However, the maincharacteristics of these energies is the low-output voltage, then a DC–DC converter with large voltage conversion ratio is used to increase the output voltage of the clean energy for the DC interface to the main electricity source through the DC–AC inverter[1]. The proposed technique combination of boost converter with voltage multiplier is stacked on a boost converter configuration in order to achieve a high gain at lower duty ratio. Typical Pulse generation applications are embedded systems, renewable energy systems, fuel cells, mobility applications and uninterrupted power supply (UPS). These applications demand high step-up static gain, high efficiency and reduced weight, volume and cost [2].

II. LITERATURE SURVEY

The surveys of various research papers that have contributed to achieve the high gain from lower output values obtained from renewable energy sources as photovoltaic system and also provide a guideline to work on this field.

The comparison and analysis of various methods used for converter designs is described in the following subsections

Qun Zhao et al. developed a High-Efficiency, High Step-Up DC–DC Converters [1]. They have used Diodes and coupled windings instead of active switches to realize functions similar to those of active clamps. High step-up dc–dc converters not require isolation. Some dc–dc converters are provide high step-up voltage gain, but with the penalty of either an extreme duty ratio or a large amount of circulating energy.

S. Saggini et al. developed a Digital Deadbeat Control Tuning for dc-dc Converters Using Error Correlation. They have proposed a simple tuning algorithm for digital deadbeat control based on error correlation. The authors obtained by inject a square-wave reference input and calculate the correlation of the control error, a gain correction for deadbeat control [2].

Abbas A. Fardoun et al. developed a Ultra Step-Up DC-DC Converter with Reduced Switch. They have proposed a new single-switch non-isolated dc-dc converter with high-voltage transfer gain and reduced semiconductor voltage stress. The author utilize a hybrid switched capacitor technique for providing a high voltage gain without extreme switch duty cycle, the use of a lower voltage and RDS-ON MOSFET switch to reduce cost, switch conduction and turn-on losses. [3]

Li Tianze et al discussed Application and design of solar photovoltaic system. they have analyzed the design of PV system, software and hardware requirement, economic benefit, and basic ideas and steps of the installation and the connection of the system. Solar modules, power electronic equipments (include the charge-discharge controller), the inverter, the test instrumentation and the computer monitoring, and the storage battery or the other energy storage and auxiliary generating plant of the photovoltaic system [4].

Lung-Sheng Yang et al developed a Novel High Step-Up DC-DC Converter with Coupled-Inductor and Voltage-Doubler Circuits. The converter achieves high step-up voltage gain with appropriate duty ratio and low voltage stress on the power switches, and the energy stored in the leakage inductor of the coupled inductor are also recycled to the output [5].

S.DaisonStallonet al developed a High Efficient Module of Boost Converter in PV Module. they used a converter that employs a floating active switch to isolate energy from the PV panel when the ac module is OFF, a high voltage gain converter is essential for the module's grid connection

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through a dc–ac inverter. This design protects installers and users from electrical hazards. They suggested that without extreme duty ratios and the numerous turns-ratios of a coupled inductor, this converter achieves a high step-up voltage-conversion ratio; the leakage inductor energy of the coupled inductor is efficiently recycled to the load [6].

Sheng-Yu Tsenget al. developed A Photovoltaic Power System Using a High Step-up Converter for DC Load Applications. they have used a power system with a high step-up converter for dc load applications. The high step-up converter adopts a boost converter with interleaved mode and a coupled inductor to raise its powering ability and increase its step-up voltage ratio, for increase conversion efficiency, an active clamp circuit is used into the soft-switching to reduce switching losses. Switches in the converter and active clamp circuit were integrated with a synchronous switching technique to reduce circuit complexity and component counts, in a lower cost and smaller volume. A perturb and observe method is adopted for extract the maximum power from photovoltaic (PV) arrays and a microchip associated with PWM IC is also used to implement maximum power point tracking operation, voltage regulation and power management.[7].

Nalini.Net al. developed a Step-Up DC-DC Converter Using Zero-Voltage Switching Boost Integration Technique in PV and All Renewable Battery Systems. They used the non-isolated high step-up DC-DC converter using Zero Voltage Switching (ZVS) Bi-directional Integration Technique (BIT). The DC-DC converter used which integrates PV and battery power for high step up. Coupled inductors were also used to attain the high step up voltage gain and to reduce the voltage stress of input side switches [8].

III. PROPOSED METHODOLOGY

Renewable energy systems generate low voltage output, and thus, high step-up dc/dc converters have been employed in renewable energy photovoltaic (PV) systems. Such systems transform energy from renewable sources 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 dc micro-grid. Thus, a high step-up converter is seen as an important stage in the system because such a system requires a sufficiently high step-up conversion with high efficiency.

The procedure of drawing simulink model consists of following steps:

a) Selecting environment for simulation – continuous
b) Exporting various elements from library

Connection and optimization of connection.

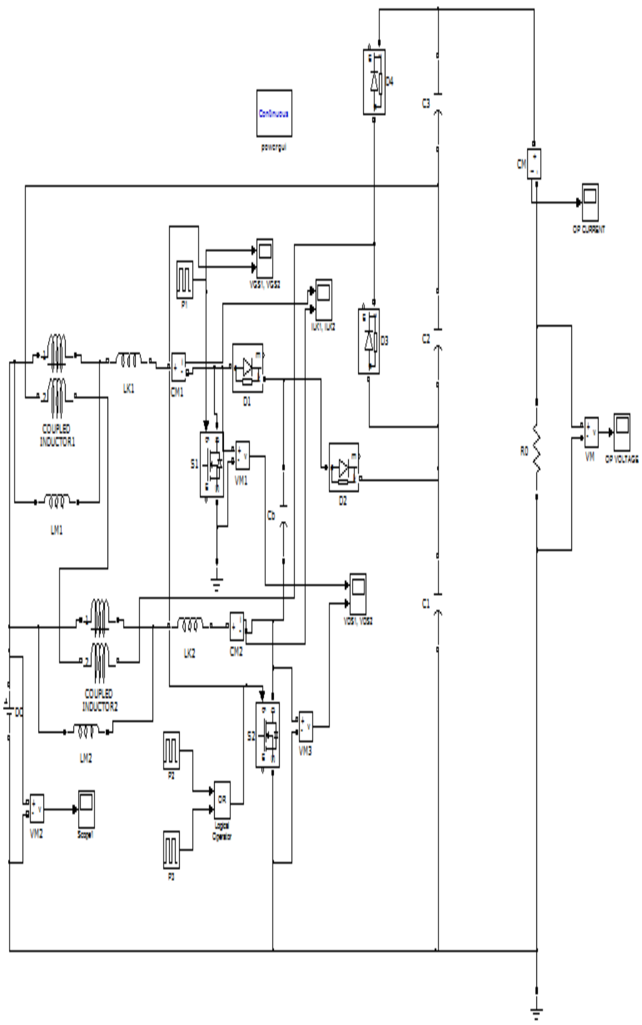

Fig 1.Proposed Simulink Model

IV. RESULTS AND COMPARISONS

The various input output waveforms are obtained from Simulink model. Figure 2 shows the given input voltage that is 40 V DC with respect to time. As the DC is fixed, a horizontal line is seen as the input voltage graph indicating the 40V input voltage.

The iductors placed in the model is for mutual inductance, the current through it is shown in the below graphs, showing the peak value of current is about 14 A from zero.the current wave form is sawtooth in nature varying from zero to maximum in time interval of 1 sec.

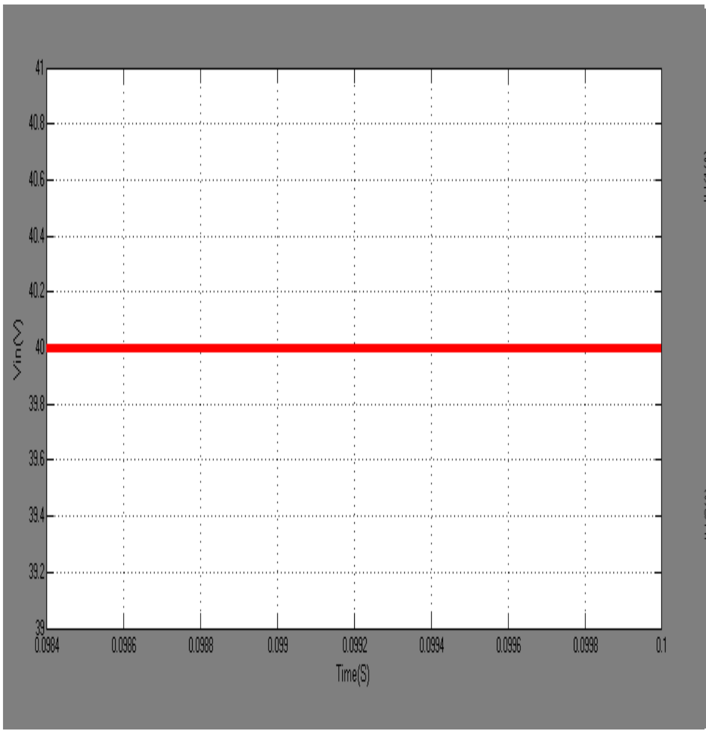

Fig. 2 Input Voltage

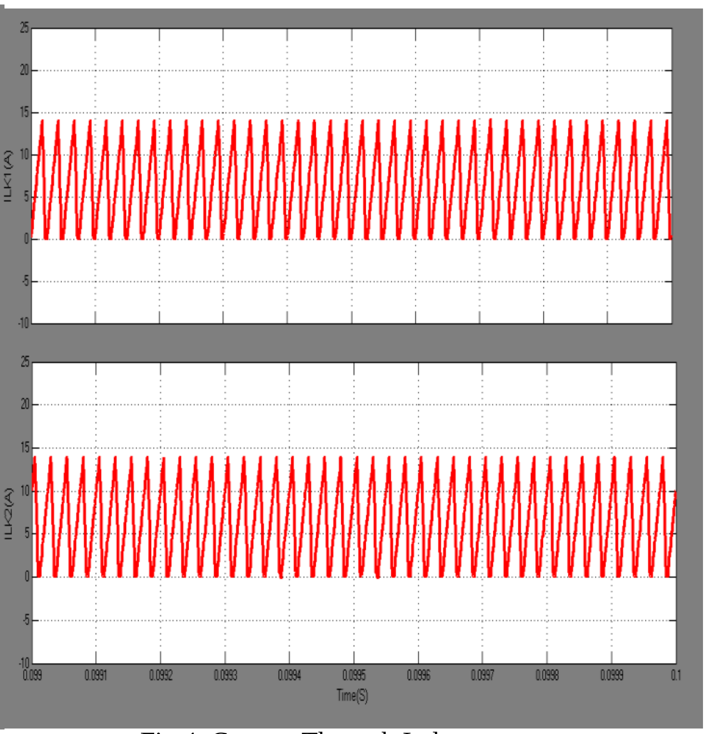

Fig 4. Current Through Inductor

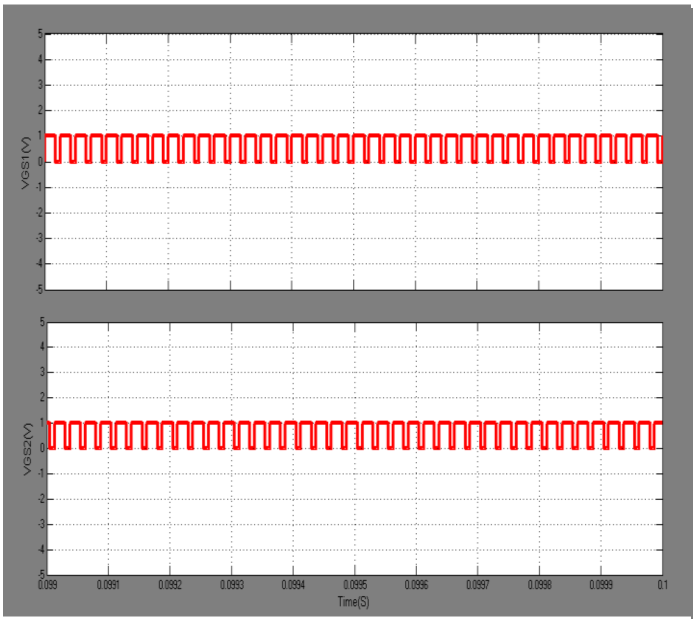

Fig. 3 V_{GS1}, V_{GS2}

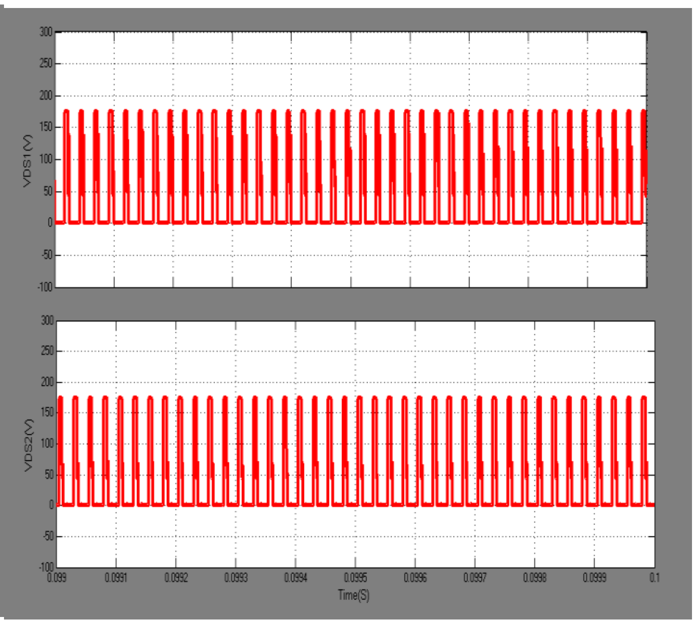

Fig. 5 Voltage across Switches

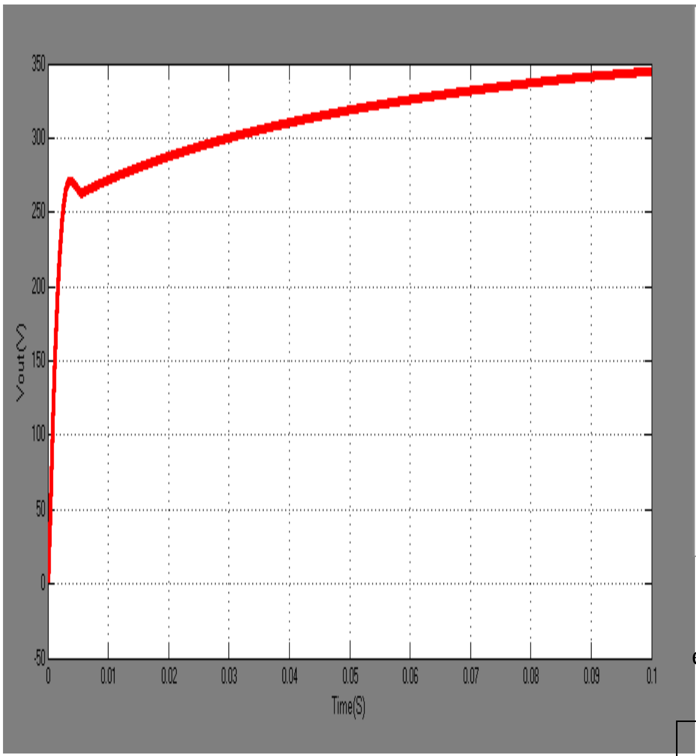

Fig 6. Output Voltage

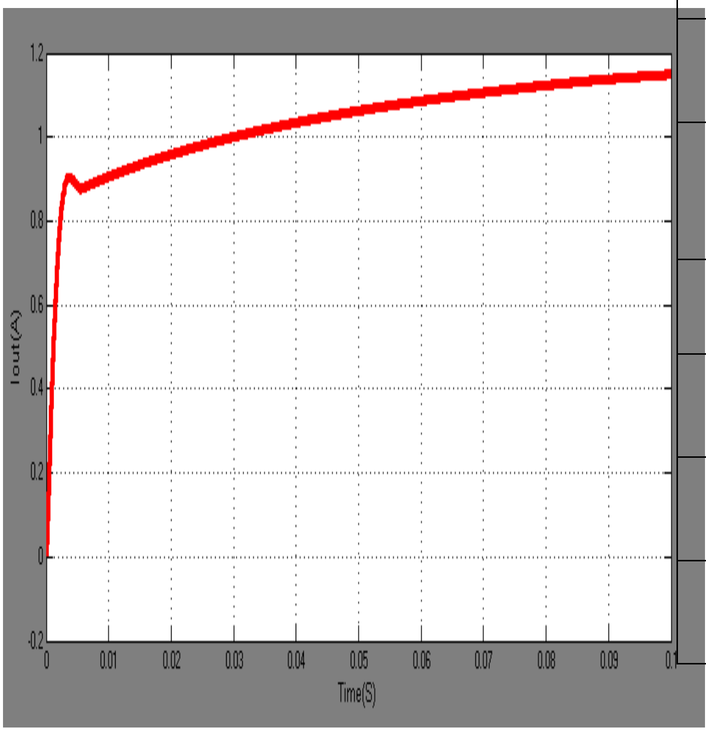

Fig. 7 Output Current

Figure 8 shows the comparison between different technique used by literature. the nature of graphs of proposed system are approximate same with comparison to other literature graphs, so we can conclude from the graphs that the result of proposed system better than the other results which are mentioned on graphs and as a references taken.

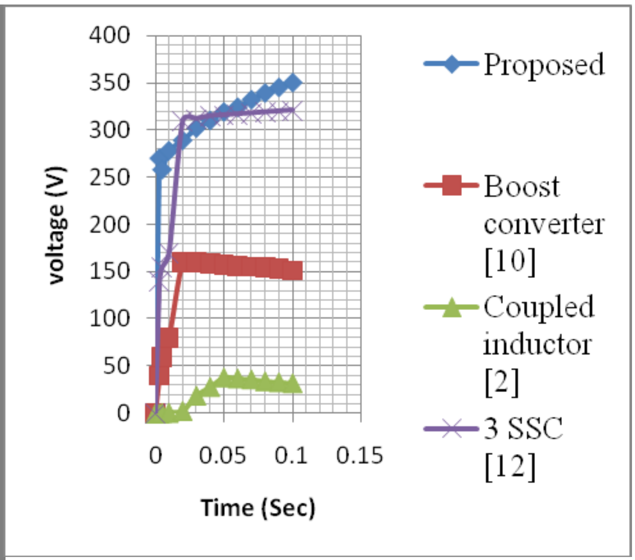

Fig 8. Comparison with different methodologies

Table below shows the various parameter values taken for experiment using different techniques.

Table 5.3: Parameter Values of Different Methods

S. No.	Method	Input (V)	Output (V)	Power (W)	Efficiency (%)
1	Coupled Inductor	40	380	1000	93.1
2	Diode capacitor multiplier	48	384	1470	95.4
3	Boost converter	40	150	-	95.2
4	Buck boost converter	12	143	205	93.2
5	3 state s/w converter	40	390	-	95.6
6	Proposed Method	40	345	396.75	99.1

V. CONCLUSION

In this thesis voltage clamping based high gain DC-DC converter is studied. The various techniques like boost converter, buck-boost converter, 3 state switching have been used for PV systems. The drawback of such technique was high input ripples and maximum efficiency was achieved at extreme duty ratio. The conduction losses switch losses were also the factors affecting the performance of system slightly. The proposed system high step up gain DC-DC converter has analyzed by using voltage multiplier, the model is operating at minimum duty ratio. Also, less input current ripples are seen in the graph, that means it minimize the input current ripple. By implementing voltage multiplier high gain has achieved which was also the drawback of system. It has been observed that the system provide a maximum output value with in small time interval. The proposed converter has successfully implemented an efficient high step-up conversion through the voltage multiplier module. The integration of voltage multiplier with high step up converter increases the voltage conversion ratio and gain. The voltage multipliers are provided with capacitors and diodes in the circuit for converting the input voltage to another high level output. The converter with the voltage multiplier determines the efficiency and performance of the photovoltaic system connected to the system. Also the gain of the system is calculated by the ratio of V_{out} to the V_{in} which is 8.625. Here we can conclude as higher gain is achieved at lower duty ratio of 0.21.

The conduction loss is minimized from MOSFET switches. MOSFET and IGBT structures look very similar, but there is one basic difference—the addition of a p-substrate beneath the n-substrate in the IGBT, This variation is sufficient to produce some clear distinctions as to which device serves which applications better. Certainly, the IGBT is the choice for breakdown voltages above 1000 V, while the MOSFET is for device breakdown voltages below 250 V.

REFERENCES

[1] Qun Zhao, and Fred C. Lee, "High-Efficiency, High Step-Up DC–DC Converters", IEEE Transactions on power electronics, Vol. 18(1), 2003.

[2] S. Saggini, Member, W. Stefanutti, E. Tedeschi, and Paolo Mattavelli, "Digital Deadbeat Control Tuning for dc-dc converters Using Error Correlation", IEEE transactions on power electronics, Vol. 22(4), 2007

[3] Abbas A. Fardoun, and Esam H. Ismail, "Ultra Step-Up DC-DC Converter with Reduced Switch" ICSET, 2008.

[4] Li Tianze, Lu Hengwei, Jiang Chuan, Hou Luan, and Zhang Xia, "Application and design of solar photovoltaic system", 3rd International Photonics &OptoElectronics Meetings (POEM), 2010.

[5] Lung-Sheng Yang, Tsorng-Juu Liang, Hau-Cheng Lee, and Jiann-Fuh Chen, "Novel High Step-Up DC-DC Converter with Coupled-Inductor and Voltage-Doubler Circuits", IEEE Transactions on Industrial Electronics, Vol. 58(9), 2011.

[6] S.DaisonStallon, K.Vinoth Kumar, and S.Suresh Kumar, "High Efficient Module of Boost Converter in PV Module", IJECE, Vol.2, pp. 758-781, 2012.

[7] Sheng-Yu Tseng and Hung-Yuan Wang, "A Photovoltaic Power System Using a High Step-up Converter for DC Load Applications", Energies 6(2), Pp 1068-1100, 2013.

[8] Nalini.N, and Ms.M.SheelaSankari, "Step-Up DC-DC Converters Using Zero-Voltage Switching Boost Integration Technique in PV and All Renewable Battery Systems", International Journal of Innovative Research in Science, Engineering and Technology, Vol. (1)3, 2014

[9] PulipatiMadhuri, and Daravath Ramesh, "Integrated dc-dc converter for high voltage gain", Transactions on advances in power electronics, Pp 327–343, 2015

[10] M. Vignesh, G. Abirami, " High Gain Voltage DC-DC Converter based on Three State Switching Cell for Battery Charging using PV system", IJREE, Vol. 03(01), 2016.

[11] Rafael V. Silva1, Antônio A. A. Freitas, Marcus R. Castro, Fernando L. M. Antunes, and Edilson M. SáJr, "High gain qzs dc/dc converter with coupled inductor", Power Electronics Conference and 1st Southern Power Electronics Conference2015, IEEE 13th Brazilian. 2016