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Implementation of Three levels Boost DC-DC Converter for High Gain Photovoltaic Application

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Abstract: The centre commitment in this proposal is scientific, reproduction and trial examination of a DC-DC multilevel Boost converter (MBC). MBC is gotten from the ordinary Boost converter by including 2N-1 capacitors, 2N-1 diodes, with on driven switch and one inductor without changing the primary conventional Boost converter, to get N levels of yield voltage. The proposed topology is a non-isolated circuit worked at high exchanging frequency. As an outcome the extent of inductor and capacitor and also swell crosswise over it decreases. The structure of the circuit is multimodular to change over low information dc voltage to high yield dc voltage with low appraising gadgets at low Duty cycle. This denotes the circuit more appropriate for different applications as Photovoltaic (PV) framework, energy component and so on. The open loop and shut loop examination of the converter is finished. A point by point scientific investigation to choose reasonable estimation of Inductor and capacitor to meet yield necessity is given. Non-direct powerful examination of full request MBC, diminished request MBC and little flag displaying of the converter is introduced. To confirm the scientific outcomes, reproductions are done in Matlab Simulink.

Keywords: Cascaded boost, Multilevel Boost, Modified cascaded boost, quadratic boost with voltage multiplier cell, Modified LUO converter.

I.INTRODUCTION

The requests of venture up control transformation are ceaselessly expanding in applications like autos and sustainable power source frameworks. In most sustainable power source frameworks like sun based and energy component, the voltage got is low and must be fundamentally ventured up for important use. Routinely, interleaved and fell lift converters were utilized to acquire the required high voltage pick up [1]-[4]. In spite of the fact that falling of lift converters accomplished the required pick up, it brought about incremental cost and multifaceted nature of the control circuit. Further, these topologies have innate issues of high swell current and generally higher misfortunes which limit activity at high proficiency and high pick up.

Disconnected topologies utilize transformers or coupled inductors with required swings proportion to accomplish the required voltage pick up [5]-[8]. High turns proportion isn't favoured because of high spillage at the auxiliary which cause expanded exchanging misfortunes at the yield. These topologies experience the ill effects of restricted exchanging recurrence, expanded transformer misfortunes, expanded voltage worry over the gadget and are cumbersome.

Fig.1 shows about the Block diagram of High gain non-isolated DC-DC Converters that work without a transformer yet are as yet appropriate for lattice association are fundamental for enhancing framework effectiveness. In [9] and [10], coupled inductors and exchanged capacitors were utilized to get the required high transformation

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proportion. These topologies gave the required voltage pick up by utilizing more parts and complex attractive components. Because of these reasons, such converters are not broadly utilized as a part of training.

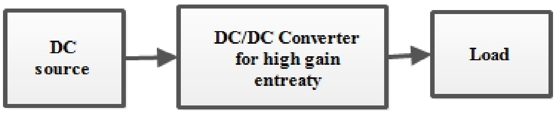

Fig.1 Block diagram of High gain non-isolated DC-DC Converters

The topologies proposed in [11] accomplished the required pick up by utilizing voltage multiplier cells (VMCs) and coupled inductors with VMCs. The switch worry in these topologies was near portion of the yield voltage. In a delicate exchanged multi-yield converter utilizing an attractive enhancer is displayed. To diminish the gadget stresses, exchanged inductor and exchanged capacitor based topologies were proposed in [7]. Be that as it may, the utilization of exchanged inductor and exchanged capacitor structure brought about moderately diminished proficiency.

Non-isolated DC-DC converters are common and of lower cost, they are used in most negative ground application in vehicles for various DC powered appliances and equipment. However they have one big disadvantage in the electrical connection between the input and output which offers little or no protection to the load for any high electrical voltage, current and etc. occurs on the input side. They also have less noise filtering blockage and isolated converter is that it will protects load sensitive, the output of the converter is characterised by either positive or negative polarity, and it has stupendous noise interference capability. In case of non-isolated converter, electrical barrier is absent in it.

II. EXECUTION AND CIRCUIT PARAMETERS OUTLINE OF HIGH PICK UP CONVERTERS

Non-isolated DC/DC converters are typical and of lower cost, they are used as a piece of most negative ground application in vehicles for various DC controlled contraptions and equipment [5]. Regardless they have one noteworthy disadvantage in the electrical association between the info and yield which offers by zero security to the stack for any high electrical voltage, current et cetera occurs on the input side and have less noise isolating blockage.

A. Multilevel Boost Converter.

The Multilevel Boost Converter topology comprises of the ordinary boost converter and voltage doubler stages to give a high voltage pick up. The topology which utilizes single switch with just a single inductor, (2N-1) diodes and (2N-1) capacitors and fig 4 shows the three level multilevel boost converter. In this topology, every device blocks just a single voltage level. The principle point of this topology is continuous input current, extensive pick up without high Duty cycle or transformer, measured quality and utilization of devices with low voltage rating.

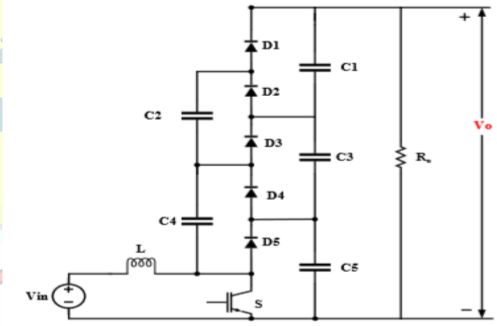

Fig .4 Multilevel boost converter for 3 level

This is used as a DC link in application required with the unidirectional current flow and self-balancing such as PV or fuel cell generation system with multilevel boost converter and fig 4a and 4b shows the operating modes of MBC for two level.

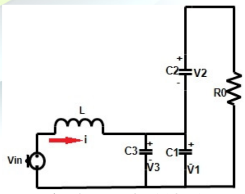

Fig.4a Mode 1(ON)

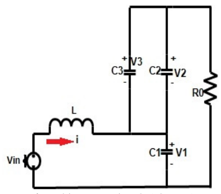

Fig.4b Mode 2(OFF)

The main benefits of multilevel boost converter are

- Continuous input current.
- A big conversion ratio without extreme duty cycle.
- Allow high switching frequency.
- Transformer-less.

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- It provides several self-balancing voltage level and only one driven switch, which makes it ideal for feeding a diode clamped multilevel inverter.
- It can be built in a module way and more level can be added without changing the main circuit.

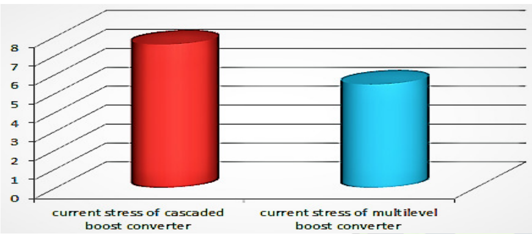

Fig.5 Comparison of current stress with cascaded and multilevel boost Converter

The proposed circuit is based on the multilevel converter principle, were each device which arrests only one voltage level achieving high voltage converter with the high voltage devices in MBC and fig 5 shows the comparison of cascaded and multilevel boost converter

Differential equations relating the state variables are when switch is ON.

$$\frac{di_L}{dt} = \frac{V_s}{L} \qquad 22$$

$$\frac{dv_1}{dt} = -\frac{V_1}{R(C_1+C_3)} - \frac{V_2}{R(C_1+C_3)} \qquad 23$$

$$\frac{dv_2}{dt} = -\frac{V_1}{RC_2} - \frac{V_2}{RC_2} \qquad 24$$

$$\frac{dv_3}{dt} = -\frac{V_1}{R(C_1+C_3)} - \frac{V_2}{R(C_1+C_3)} \qquad 25$$

Differential equations relating the state variables are when switch is OFF.

$$\frac{di_L}{dt} = -\frac{V_1}{L} - \frac{V_s}{L} \qquad 26$$

$$\frac{dv_1}{dt} = \frac{i}{C_1} - \frac{V_1}{RC_1} - \frac{V_2}{RC_1} \qquad 27$$

$$\frac{dv_2}{dt} = -\frac{V_1}{R(C_1+C_2)} - \frac{V_2}{R(C_1+C_2)} \qquad 28$$

$$\frac{dv_3}{dt} == -\frac{V_1}{R(C_2+C_3)} - \frac{V_2}{R(C_2+C_3)} \qquad 29$$

Critical inductor value and capacitor value for Multilevel boost converter is given by

$$L_c = \frac{(1-D)*(V_o-N*V_s)*R}{2*N*f_s*V_o} \qquad 30$$

$$C_c = \frac{N*((1-D)*(V_o-N*V_s)*R}{2(I_a*R)} \qquad 31$$

B. To find the efficiency of the proposed converter.

The actual efficiency of MBC converter is obtained considering all power loss calculations across all components and table 1 shows the parameter analysis for cascaded boost converter and three level multilevel boost converter.

For loss less converter system,

$$V_S \times I_S = V_O \times I_O \qquad 32$$

$$\eta = \frac{\text{output power}}{\text{Input power}}$$

$$\eta \times \text{Input power} = \text{output power} \qquad 33$$

$$\eta \times V_S \times I_S = V_O \times I_O$$

$$\eta = V_o(1-D)/N*V_s$$

34

Power losses of MBC,

$$P_{Switch} = V_{switch} * I_{Switch,avg} + R_{switch}*(I^2_{switch,rms}) \qquad 35$$

$$P_{Inductor} = R_L * I_{RMS}^2$$

36

$$P_{Diode} = R_d * I_o^2 + V_F * I_o$$

37

The actual efficiency of converter written below.

$$\eta = \frac{P_{in} - (P_{switch} + P_{inductor} + (2N-1) \times P_{diode})}{P_{in}} \qquad 38$$

C. Applications of MBC Converter

The proposed converter is expected to be much more dominating in the following areas are

a. Motor drive
b. Hybrid electric vehicle
c. Multilevel inverters (MLI)
d. uninterruptible power supply (UPS)
e. High voltage DC (HVDC)
f. Magnetic traction

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g. Renewable energy sources
h. Automotive applications.

TABLE I
Performance analysis of CBC vs MBC

PARAMETERS	CASCADED BOOST CONVERTER	MULTILEVEL BOOST CONVERTER
Number of switches used	1	1
Switch Utilization Factor(SUF)	Low	Moderate
Diode Utilization Factor(DUF)	Moderate	Moderate
Efficiency	Moderate	High

III. SIMULATION CIRCUIT WITH RESULTS

Fig 6 and 7 shows an open and closed loop three level boost converter. Simulation is carried out in Matlab Simulink. To validate the simulation results and Simulation results carried with the parameters shown in Table II

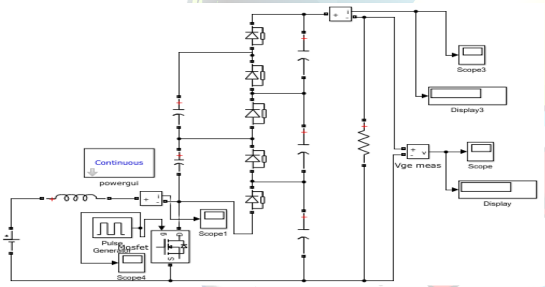

Fig 6. Open loop simulation circuit of three level MBC

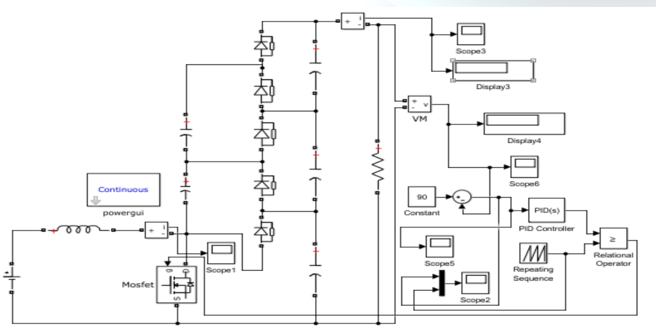

Fig 7. Closed loop simulation circuit of three level MBC

Table II
Three level boost converter model specifications

PARAMETERS	MULTILEVEL BOOST CONVERTER
Input Voltage	15V
Output Voltage	88.5
Duty Cycle (D)	50%
Load Resistance (R_o)	400Ω
Inductor L	2 mH
Capacitors	100 µF
Switching Frequency	10KHz

Fig 8 and Fig 9 denotes the output voltage and inductor current respectively. Fig 10 and Fig 1 1 embodies the voltage across capacitor 5 and sum of voltage across capacitor5 and capacitor3.

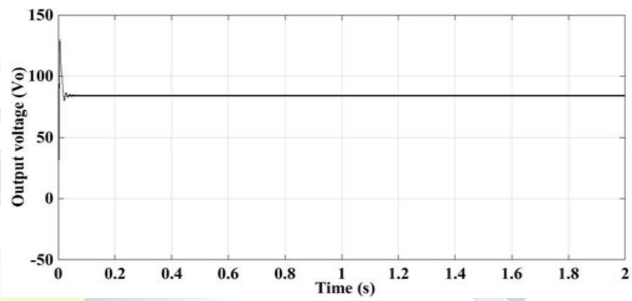

Fig.8 Simulation of output voltage waveform for three level Boost converter

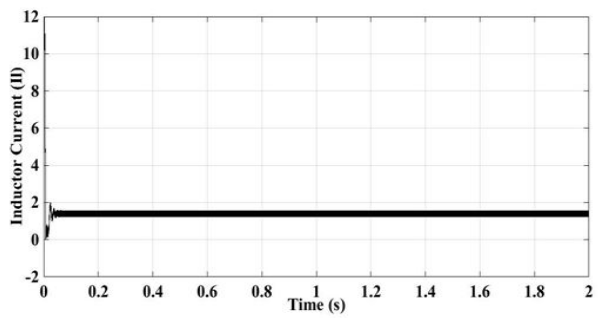

Fig.9 Simulation of inductor current waveform for three level Boost converter

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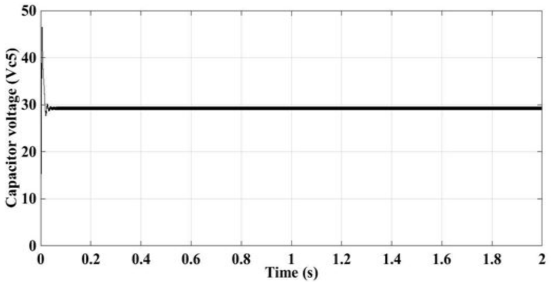

Fig.10 Simulation of capacitor voltage (Vc5) waveform for three level Boost converter

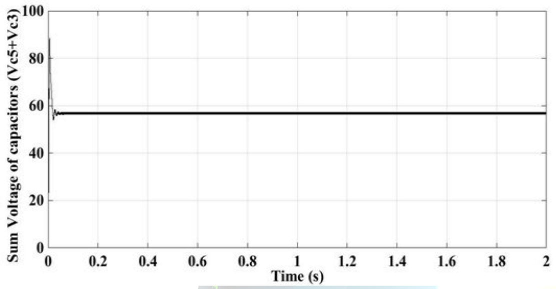

Fig.11 Simulation of sum of the capacitor voltage (Vc5+Vc3) waveform for three levels Boost converter

IV. CONCLUSION

Multilevel dc-dc boost converter is resultant from conventional boost converter evenhanded by adding (2N-1) capacitors, (2N-1) diodes to obtain N level output voltage. At this point the conventional topology ruins unaffected. Multilevel converter output voltage is in excess of conventional boost converter is justified with the mathematical, simulation effects. Systematic design of inductor and capacitor for three level boost converters is offered. The continuous conduction mode of inductor current is experienced. Advanced gain can be accomplished at truncated duty cycle compared to conventional one. Another important advantage of the converter is that no external circuitry is needed to balance the capacitor voltage. The converter activates at high switching frequency to encounter less space constraint. Ripple in the inductor current and capacitor voltage is scrutinized using MATLAB SIMULINK. It is appropriate for several uses likes PV system, fuel cell system, traction system, HVDC system and so on.

FUTURE SCOPE OF WORK

Power demand is increasing day by day. To meet the demands conventional energy sources are not sufficient because of environmental concern. We need to depend on renewable energy sources. It is well known from the literature that the processing of power from renewable energy sources is a challenging issue. It is observed and synthesized from the thesis work that the proposed converter can extend its contribution to solve the issue.

REFERENCES

[1]R. D. Middlebrook, “Transformerless dc-to-dc converters with large conversion ratios,”*IEEE Trans. Power Electron.*, vol. 3, no. 4, pp. 484–488, 1988.

[2]D. Maksimovic and S. Cuk, “Switching Converters with Wide DC Conversion Range,”*IEEE Trans. Power Electron.*, vol. 6, no. 1, pp. 151–157, 1991.

[3]D. Zhou, A. Pietkiewicz, and S. Cuk, “A Three-Switch High-Voltage Converter,” vol.14, no. 1, pp. 177–183, 1999.

[4] B. Axelrod, Y. Berkovich, and A. Ioinovici, “Switched-capacitor/switched-inductor structures for getting transformerless hybrid DC-DC PWM converters,” *IEEE Trans. Circuits Syst. I Regul. Pap.*, vol. 55, no. 2, pp. 687–696, 2008.

[5] J. C. Rosas-Caro, J. M. Ramirez, F. Z. Peng, and A. Valderrabano, “A DC–DC multilevel boost converter,” *IET Power Electron.*, vol. 3, no. 1, p. 129, 2010.

[6] M. Mousa, M. E. Ahmed, and M. Orabi, “New converter circuitry for high voltage applications using switched inductor multilevel converter,” *INTELEC, Int. Telecommun. Energy Conf.*, 2011.

[7] B. W. Williams, “Unified synthesis of tapped-inductor DC-to-DC converters,” *IEEE Trans. Power Electron.*, vol. 29, no. 10, pp. 5370–5383, 2014.

[8] M. Kasper, D. Bortis, and J. W. Kolar, “Classification and comparative evaluation of PV panel-integrated DC-DC converter concepts,” *IEEE Trans. Power Electron.*, vol. 29, no. 5, pp. 2511–2526, 2014.

[9] M. Bella, F. Prieto, S. P. Litrán, J. Manuel, and E. Gómez, “New Single Input Multiple Output Converter Topologies,” no. June, pp. 6–20, 2016.

[10] M. Mousa and M. Hilmy, “Optimum Design for Multilevel Boost Converter,” *Middle East*, pp. 734–739, 2010.

[11] T. Eichhorn, “Boost Converter Efficiency Through Accurate Calculations,” *Power Electron.*, vol. September, pp. 30–35, 2008.

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