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REVIEW ON NON-ISOLATED DC-DC STEP-UP CONVERTER WITH DIFFERENT VOLTAGE GAIN TECHNIQUES DIFFERENT VOLTAGE GAIN TECHNIQUES

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Abstract: This paper presents a review of non-isolated DC-DC step-up converters with different voltage gain techniques. The research analyses high-boost techniques: interleaved, multilevel, switched inductor, switched capacitor, voltage-lift, and coupled inductor. Additionally, compared with the quantity of passive and active components, voltage gain, voltage stress, switching frequency, efficiency, and power rating Instead of the DC/DC converters, the review of high-boosting methods is the paper's major contribution.

***Index Terms* - Non-isolated; DC/DC converter; step-up techniques; high voltage gain**

I. INTRODUCTION

The converter is a design that uses inductive and capacitive filter elements to switch at high frequencies to produce a DC output of a different voltage from a DC input. The output of a converter, which can perform one or more tasks, can be different from the input. Power converters come in four different varieties: Using a rectifier, the AC-DC converter transforms AC into DC. Using an inverter and the desired frequency and voltage, a DC-AC converter transforms DC to AC. It changes constant current into variable current using a DC-DC converter. Matrix converters are AC-AC converters that convert AC at a particular frequency. A DC-DC converter is a component of electronic equipment that transforms a direct current source from one voltage level to another. It is a particular kind of electric power converter. Power ranges from very low to very high.

It is suggested to use a new coupled inductor-based high-step-up DC-DC converter. The newly presented converter has a number of advantages, including extremely high voltage gain, less voltage stress on the power switches, and constant input current with little ripple. Applications involving renewable energy can use the converter that is being offered. The voltage spike of the active switch is restrained during the turn-off operation by using a clamped circuit. Conduction losses and converter costs can both be decreased by using a switch with a low RDS-on. Additionally, zero-voltage switching (ZVS) for the main and auxiliary switches is achieved using the energy of leaky inductance. This characteristic indicates that the voltage gain can be increased by lowering the coupled inductor's turn ratio. The voltage surge across switches is intended to be absorbed by an active clamp circuit (ACC). Additionally, the ACC encourages the adoption of switches with low on-state resistance to reduce conduction loss and boost efficiency. Leakage inductance is used to generate active switches using zero-voltage switching (ZVS). Consequently, the suggested converter can run at a greater switching frequency. As a result, the power density is raised while the magnetic core's size is decreased. The high-voltage gain converter that is being provided will also have its switching loss minimised without the use of an additional circuit [1].

This study uses a passive multiplier network and the voltage-lift approach to demonstrate a non-isolated interleaved hybrid boost converter. The converter takes a two-phase IBC as input. A voltage-lift capacitor is used to combine the outputs of the two phases. A passive voltage multiplier cell made up of two diodes and two capacitors receives this as input. Before being delivered to the load, the output is filtered through an output diode and capacitor. This converter provides constant input current, low peak overshoot, and good gain at relatively low duty cycles [2].

It is proposed in this paper to develop a novel ZVS interleaved, non-isolated, high step-up boost converter with an active clamping circuit. To obtain a high conversion ratio, the converter uses a switched capacitor and two linked inductors, operating in both forward and flyback modes. On the primary side, interleaving is used to divide the input current, eliminate the current ripple caused by coupled inductors, and lower switch conduction losses. A low-turn ratio can be used to obtain large conversion ratios, which lower the coupled inductor's leakage inductance and copper losses. In order to establish a winding coupling arrangement and maintain the high voltage at the output, the secondary windings of the coupled inductor are linked in series. The active switches and diodes experience less voltage stress. ZVS is achieved for each switch by applying active clamping. All of the diodes' reverse recovery issues are resolved, which further lowers switching losses and results in an effective green power supply [3].

A high gain non-isolated multilevel cascaded boost converter (MCBC) for electric vehicle applications is presented in this paper. The suggested converter combines a multilevel boost converter with a simple cascaded boost converter to increase voltages produced by various sources, including solar energy, fuel cells, and batteries. The high gain boosted voltage is to be given to the multilayer inverter through the multilevel boost converter, which is designed to be used as a dc link. The suggested converter may produce high voltage gain with continuous input current and a substantially higher step-up conversion ratio by only using a single driven semiconductor switch and an inductor [4].

This paper proposes a new boost converter based on a switched-capacitor structure. The proposed SC converter has a large step-up gain with continuous input current. The operating principles and circuit analysis in continuous conduction mode (CCM) and discontinuous mode (DCM) are presented. The parameter selection of the proposed SC converter and a comparison with conventional converters are shown. The main features of the proposed SC converter are the continuous input current, achieving high voltage gain with low voltage and current stress on the power components, no use of a high-frequency transformer, and the easy ability to increase the voltage by adding the SC cell [5].

This research proposes a non-isolated boost dc-dc converter based on the VL approach. The main features of the proposed converter are direct connection of the input inductor and free current ripple, providing high-voltage gain as step-to-step by the simple structure, despite the fact that the PWM method is used to switch two switches that are mutually opposed at a period. The structure of this paper is as follows: First, a detailed explanation of how each suggested converter operates in continuous conduction mode (CCM) and discontinuous conduction mode (DCM) is given. [6].

This paper deals with a hybrid non-isolated active quasi-switched dc-dc converter with a high-boost voltage gain, which is applicable for the high step-up low power applications. By using fewer number of components in circuit topology, the proposed converter can provide higher-gain voltage with a small duty cycle, which can reduce the voltage stress and conduction loss on power switches. In addition, it draws continuous input current, has lower diode voltage stress and lower passive component voltage ratings [7].

These days, industrial applications, including renewable energy systems, frequently use DC/DC converters. An SEPIC (single-ended primary inductance converter) DC-DC converter is frequently employed in battery charger systems and has the ability to operate in either step-up or step-down mode. The modelling and analysis of the SEPIC, both coupled and uncoupled inductors, are presented in this study. The state-space average (SSA) model is developed and constructed in this work using the MATLAB/Simulink environment [8].

A common method that is frequently used in the construction of electronic circuits is the voltage-lift technique. In this paper, voltage lift implementation methods based on SEPIC and Cuk converter prototypes are presented. Thus, a brand-new double-output, mirror-symmetrical DC-DC converter is suggested. It can increase dc-dc voltage from positive to positive and from negative to negative, and it has simple architectures, high power densities, and voltage transfer gains that are all higher than average [9].

A well-known method to raise the converter's voltage gain is voltage lift. High gain can be achieved by combining a switched inductor with the traditional voltage lift technique, but the semiconductor is still under a lot of stress. It is suggested to use a switched inductor, an additional diode, and a capacitor to improve the voltage lift technique. This will greatly increase the voltage-boosting factor and lessen the voltage stress on semiconductor devices. The suggested converter is a non-isolated, transformer-free device. The suggested topology has a common link between the source and load as well as continuous input from the source current. The converter is easy to operate because it can be operated by a single switch [10].

II. VOLTAGE GAIN TECHNIQUES

High step-up Switched capacitors (SCs), voltage multipliers (VM), switched inductors (SL), voltage lift (VL), and converters with multistage or multilevel designs are the primary categories of DC/DC converters used for voltage boosting. These have both advantages and disadvantages in terms of cost, complexity, power density, dependability, and efficiency, depending on the application [11].

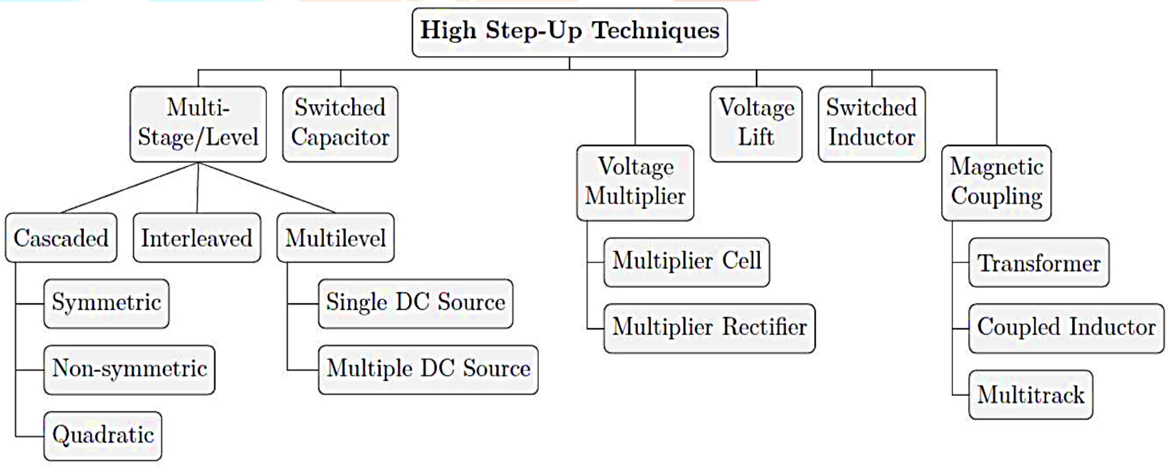

Fig. 1. Classification of High Boosting voltage gain Techniques.

2.1. Coupled Inductor-Based High Voltage Gain DC-DC Converter

The suggested converter has a modest turn ratio and a wide voltage conversion range. This characteristic indicates that the voltage gain can be increased by lowering the coupled inductor's turn ratio. The voltage surge across switches is intended to be absorbed by an active clamp circuit (ACC). Additionally, the ACC encourages the adoption of switches with low on-state resistance to reduce conduction loss and boost efficiency. Leakage inductance is used to generate active switches using zero-voltage switching (ZVS). Consequently, the suggested converter can run at a greater switching frequency. As a result, the power density is raised while the magnetic core's size is decreased. The high-voltage gain converter that is being provided will also have its switching loss minimised without the use of an additional circuit [1].

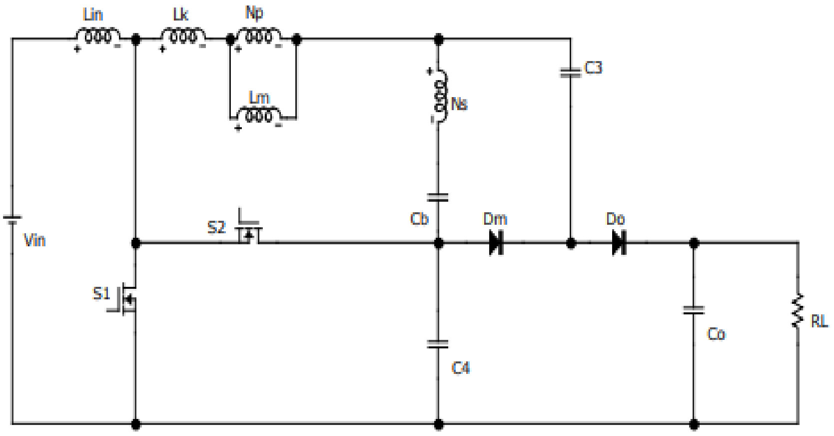

Fig. 2: Circuit diagram of coupled-inductor Boost converter

In order to simplify the steady state analysis of the proposed converter, the ensuing assumptions are considered.

- All components are ideal but the leakage inductance of the coupled inductor is taken into account.
- All capacitors are large enough; thus, their voltages are ripple free.
- The inductors L_{in} and L_m are considered large enough; hence, their current ripple is negligible. The key steady-state waveforms of the proposed high voltage gain DC-DC converter under Continuous Conduction Mode (CCM) for one switching cycle

The theoretical voltage gain of the proposed converter versus duty cycle for different turns ratio of the coupled inductor [1].

$$M = \frac{V_o}{V_{in}} = \frac{2_n - 1}{(n-1)(1-D)}$$

2.2. Interleaved Hybrid Boost Converter

The suggested hybrid boost converter is interleaved. The interleaved input stage and the passive voltage multiplier cell are the two components of the converter. The switches Q_1 and Q_2 and the input inductors L_1 and L_2 together make up the two-phase interleaved input. Through diode D_1, the voltage-lift capacitor lift clamps the output of one phase to the other. The passive voltage multiplier cell is given the output of the interleaved input stage. The network of passive voltage multipliers is made up of the diodes D_2 and D_3 and the capacitors C_1 and C_2. The output is sent to the load by the diode D_{out} and capacitor C_{out} [2].

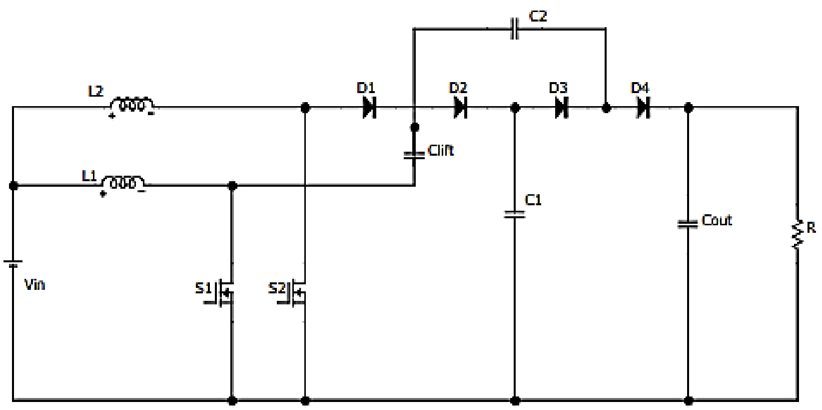

Fig. 3: Circuit diagram of Interleaved Hybrid Boost Converter

Adding the effect of the voltage multiplier cell increases the gain additionally by $\frac{N}{1-D}$,

where N is the number of voltage multiplier cells [2].

$$\frac{V_O}{V_{in}} = \frac{D}{(1-D)^2} + \frac{1}{(1-D)}$$

2.3. Switched-Capacitor-Based High Boost DC-DC converter

The multilevel boost converter and SC structure of the proposed SC non-isolated boost DC-DC converter are shown. One switch, five diodes, one inductor, five capacitors, and a load are used. Comparing the reference voltage, V_{ref}, to the triangle waveform with an amplitude of "1" controls the switch S_o [5].

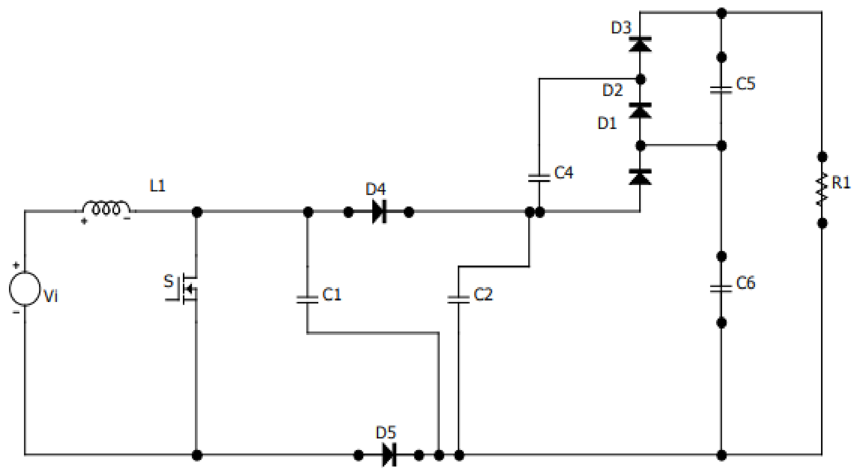

Fig. 4: Circuit diagram of Switched-Capacitor Boost converter

The output voltage and capacitor voltage were determined as:

$$V_o = \frac{3}{1-D}$$

2.4. Voltage-lift technique-based boost converter

Two power switches, S1 and S2, two inductors, three capacitors, and three diodes form the components of the proposed converter.

- Therefore, it follows that the output voltage Vo is constant.
- There are sufficient-sized capacitors. Then, it is assumed that each device's voltage is constant and
- Every switch and diode are perfect [6].

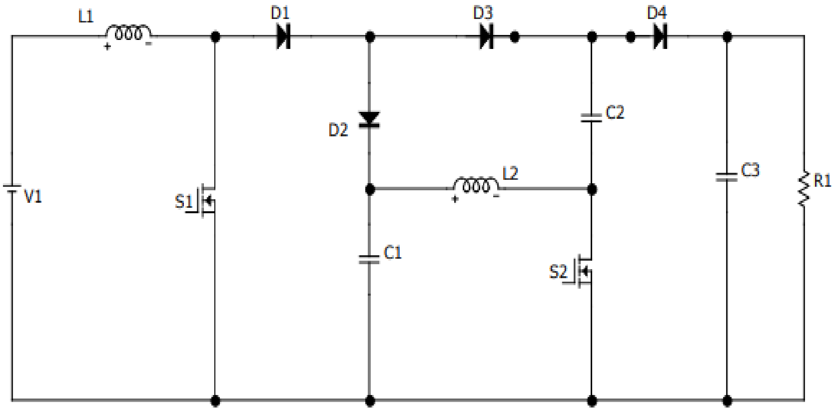

Fig. 5: Circuit diagram of Voltage-lift Boost converter

The accurate voltage gain of Voltage-lift technique-based boost converter

$$V_o = \frac{1 + D}{D(1 - D)}$$

2.5. Active Quasi-Switched DC-DC Converter with High Step-Up Voltage

Both the continuous conduction mode (CCM) and discontinuous conduction mode (DCM) of the proposed converter.

- Switches S1 and S2 are simultaneously switched on and off.
- All of the components are ideal and lossless, and all of the capacitors, inductors, and resistors are linear, time-invariant, and frequency-independent.
- Additionally, all capacitors have capacitance values that are large enough to maintain a constant capacitor voltage [7].

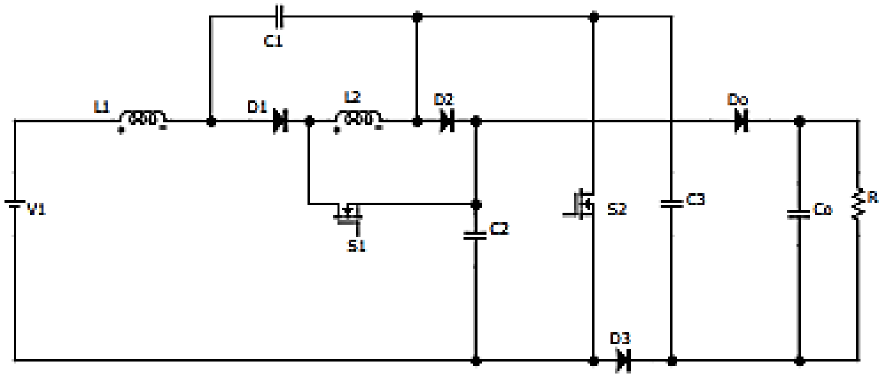

Fig. 6: Circuit diagram of Active Quasi-Switched Boost converter

The proposed converter's output voltage gain in CCM can be calculated as

$$V_o = \frac{2(1 - D)}{1 - 3D + D^2}$$

III. COMPARISON OF STEP-UP VOLTAGE-GAIN TECHNIQUES

	[1]	[2]	[5]	[6]	[7]
No. of. switch	2	2	1	2	2
No. of. diodes	2	4	5	4	4
No. of. inductors	5	2	1	2	2
No. of. capacitors	3	3	4	2	3
Total components	12	11	11	10	11
Input voltage	40	28	25	12	20
Output voltage	400	280	200	95	220
Switching frequency	50kHz	20kHz	20kHz	10kHz	30kHz
Output power	250W	100W	200W	100W	250W
Efficiency	96.5%	90.21%	93%	90%	92.6%

IV. CONCLUSION

The basic drawbacks of power conversion systems are addressed by the introduction of high-boost DC/DC converters. Ideal boost converters that are not separated are preferred because of their low cost, great efficiency, and flexibility. This study evaluates, describes, and categories the benefits and drawbacks of different advanced step-up converters based on voltage boosting methods.
The study divides the high boost approaches into switched inductor, voltage multiplier, voltage lift, switched capacitor, multistage/multilevel, and magnetic coupling. Based on these techniques, coupled-inductor gives better efficiency. The advantages and disadvantages of expenses, complexity, power density, dependability, and efficiency are covered in detail for each area in this study.

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