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DESIGN OF HIGH GAIN DC-DC STEP UP CONVERTER

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Abstract – *An interleaved boost converter with a bi-fold Dickson voltage multiplier suitable for interfacing low-voltage renewable energy sources to high-voltage distribution buses and other applications that require a high-voltage-gain conversion ratio. The proposed converter was constructed from two stages: an interleaved boost stage, which contains two inductors operated by two low-side active switches, and a voltage multiplier cell (VMC) stage, which mainly consists of diodes and capacitors to increase the overall voltage gain. It offers a high voltage gain ratio with low voltage stress on the semiconductor switches as well as the passive component. Moreover, the required inductance that ensures operation in the continuous conduction mode (CCM) is lower than the one in the conventional interleaved boost converter. The distinction of the proposed converter is that the inductors currents are equal, regardless of the number of VMCs. Equal sharing of interleaved boost-stage currents reduces the conduction loss in the active switches as well as the inductors and thus improves the overall efficiency.*

Key Words: interleaved boost converter, bi-fold Dickson VMC, switched capacitors, coupled inductors

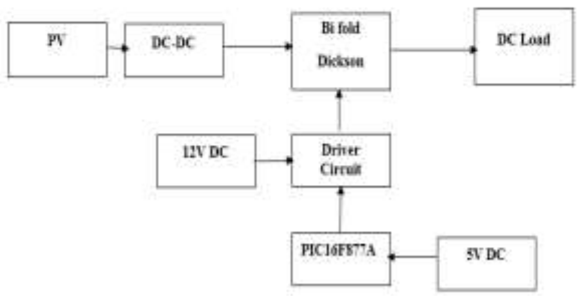
I.INTRODUCTION

In recent years, many novel high step-up converters have been developed. Despite these advances, high step-up single-switch converters are unsuitable to operate at heavy load given a large input current ripple, which increases conduction losses. The conventional interleaved boost converter is an excellent candidate for high-power applications and power factor correction. Unfortunately, the step-up gain is limited, and the voltage stresses on semiconductor components are equal to output voltage. Hence, based on the aforementioned considerations, modifying a conventional interleaved boost converter for high step-up and high-power application is a suitable approach. To integrate switched capacitors into an interleaved boost converter may make voltage gain reduplicate, but no employment of coupled inductors causes the step-up voltage gain to be limited. Oppositely, to integrate only coupled inductors into an interleaved boost converter may make voltage gain higher and adjustable, but no employment of switched capacitors causes the step-up voltage gain to be ordinary. Thus, the synchronous employment of coupled inductors and switched capacitors is a better concept; moreover, high step-up gain, high efficiency, and low voltage stress are achieved even for high-power applications.

A. The Working of the project

The proposed converter consists of an interleaved boost stage and a bi-fold Dickson multiplier cell stage. The interleaved stage consists of two inductors connected to the input source and switched by two low-side active switches. The function of the interleaved boost stage is to store energy and release it to the bi-fold Dickson VMC capacitors. The proposed converter has three modes of operations: mode 1, where both switches are ON; mode 2, where switch 1 is ON and switch 2 is OFF; and mode 3, where switch 1 is OFF and switch 2 is ON.. There is a 180◦ phase shift between the active switches' gate signals. This topology, can work with both active switches open and without violating voltage second balance across input inductors. However, opening both active switches creates several drawbacks to the interleaved topology, such as a reduction in the voltage gain and an imbalance between capacitor voltage. Therefore, it is not beneficial to use this topology for a duty cycle less than 50%. To conduct the analysis, a few assumptions are considered: 1) All components of the proposed converter are ideal; 2) The capacitors are large enough that the voltage ripples can be neglected; 3) The converter operates in the steady state; 4) The duty cycles are symmetrical and greater than 50%, and the converter is fed by a single voltage source. Nonetheless, the voltage gain ratio of the proposed converter will be summarized for cases where the duty cycles are asymmetrical and for cases where the converter is fed by two independent voltage sources.

Block Diagram



II. LITERATURE SURVEY

"General derivation law of non-isolated high-step-up interleaved converters with built-in transformer," W. Li, W. Li, X. He, D. Xu, and B. Wu IEEE Trans. Ind. Electron., vol. 59, no. 3, pp. 1650–1661, Mar. 2012.

First, the limitations of the conventional interleaved boost converters in high-step-up and high-output-voltage applications are addressed in this paper. Then, a general derivation law of the non-isolated converters from their isolated counterparts is proposed and studied to give a universal solution for high-performance topology deduction. By employing the direct energy transfer concept, a family of non-isolated high-step-up interleaved boost converters is originated to make the turns ratio of a built-in transformer as another design freedom for the voltage gain extension. The derived converters have the advantages of large voltage conversion ratio, low power switch voltage stress, small input current ripple, and zero-voltage-switching soft-switching performance. The steady-state operation of the derived converter is analyzed, and the circuit performance is summarized to explore its advantages in the high-step-up, high-output-voltage, and large-current conversion systems. Finally, a 1-kW prototype with 40-V input and 380-V output voltages is implemented and tested to show the effectiveness of the derived converters. One of the main contributions of this paper is that a clear picture is made on the universal derivation law to generate high-step-up and high-performance dc/dc converters.

"Interleaved high step-up ZVT converter with built-in transformer voltage doubler cell for distributed PV generation system," W. Li, X. Xiang, C. Li, W. Li, and X. He, IEEE Trans. Ind. Electron., vol. 28, no. 1, pp. 300–313, Jan. 2013

The concept of built-in transformer voltage doubler cell is derived to generate an improved interleaved high step-up converter for distributed photovoltaic generation applications. The proposed built-in transformer voltage doubler cell is composed of three transformer windings, two voltage doubler diodes, and two voltage doubler capacitors. The voltage doubler capacitors are charged and discharged alternatively to double the voltage gain. The switch duty cycle and the transformer turns ratio can be employed as two controllable freedoms to lift the voltage ratio flexibly. The power device voltage stress can also be reduced to improve the circuit performance. Furthermore, the active clamp scheme is adopted to recycle the leakage energy, absorb the switch turn-off voltage spikes, and achieve zero-voltage switching (ZVS) operation for all active switches. Meanwhile, the diode reverse-recovery problem is alleviated by the leakage inductance of the built-in transformer.

III. Existing System

In recent years, many novel high step-up converters have been developed. Despite these advances, high step-up single-switch converters are unsuitable to operate at heavy load given a large input current ripple, which increases conduction losses. The conventional interleaved boost converter is an excellent candidate for high-power applications and power factor correction. Unfortunately, the step-up gain is limited, and the voltage stresses on semiconductor components are equal to output voltage. Hence, based on the aforementioned considerations, modifying a conventional interleaved boost converter for high step-up and high-power application is a suitable approach.

To integrate switched capacitors into an interleaved boost converter may make voltage gain reduplicate, but no employment of coupled inductors causes the step-up voltage gain to be limited. Oppositely, to integrate only coupled inductors into an interleaved boost converter may make voltage gain higher and adjustable, but no employment of switched capacitors causes the step-up voltage gain to be ordinary. Thus, the synchronous employment of coupled inductors and switched capacitors is a better concept; moreover, high step-up gain, high efficiency, and low voltage stress are achieved even for high-power applications.

B. DRAWBACKS

- Poor voltage gain.
- Current ripples will be more in the output which decreases the renewable source lifetime.
- Conduction loss will be more.

IV. Proposed system

The proposed converter is a conventional interleaved boost converter integrated with a dual voltage multiplier module, and the voltage multiplier module is composed of switched capacitors and coupled inductors. The coupled inductors can be designed to extend step-up gain, and the switched capacitors offer extra voltage conversion ratio. In addition, when one of the switches turns off, the energy stored in the magnetizing inductor will transfer via three respective paths; thus, the current distribution not only decreases the conduction losses by lower effective current but also makes currents through some diodes decrease to zero before they turn off, which alleviate diode reverse recovery losses

C. THE PROPOSED TOPOLOGY INTRODUCTION AND THEORY OF OPERATION

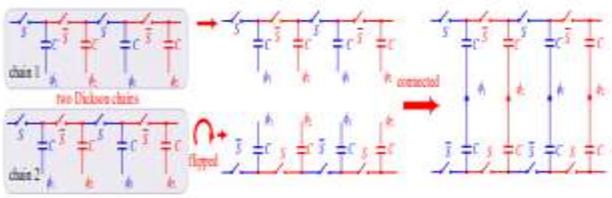


Fig. 2. The construction of a bi-fold Dickson cell. The BD cell is constructed using two conventional Dickson cells, and one of the cells is rotated by 180°. Then, they are connected so that a single VMC stage consists of two complementary switches and two capacitors.

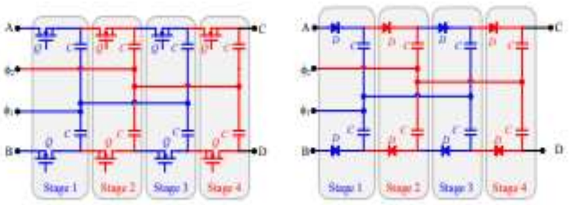


Fig. 3. Implementation of a bi-fold Dickson switched capacitor (left) and a bi-fold voltage multiplier cell (right) with $N = 4$.

The proposed converter is a conventional interleaved boost converter integrated with a bi-fold Dickson cell and the Dickson voltage multiplier module is composed of switched capacitors and coupled inductors. The coupled inductors can be designed to extend step-up gain, and the switched capacitors offer extra voltage conversion ratio. Alternative step-up dc-dc converters without step-up transformers and coupled inductors were presented.

D. ADVANTAGES

- The proposed converter is characterized by low input current ripple and low conduction losses, which increases
- The lifetime of renewable energy sources and makes it suitable for high-power applications.
- The converter achieves the high step-up gain that renewable energy systems require.

V. CONCLUSIONS

A high gain, current-fed, CW multiplier is presented and analyzed in this project. The CW multiplier structure limits the voltage stresses over the individual stages. This allows components with the same voltage ratings for all of the stage components, regardless of the number of stages or the output voltage of the converter. All equations required to design a practical implementation of the converter are presented in this paper. An equation describing the non-ideal output voltage of the converter based on the load, component parameters and duty ratios is given as well. This equation can be used to evaluate the overall performance of the converter and identify the maximum allowable duty ratio range.

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