Step Up DC-DC Converter with High Voltage Gain Using Switched-Inductor Techniques

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***Abstract-* The high-voltage gain converter is widely employed in many industry applications, such as photovoltaic systems, fuel cell systems, electric vehicles, and high-intensity discharge lamps. This paper a novel single-switch high step-up non isolated dc–dc converter integrating coupled inductor with extended voltage doubler cell and diode–capacitor techniques. The proposed converter achieves extremely large voltage conversion ratio with appropriate duty cycle and reduction of voltage stress on the power devices. Moreover, the energy stored in leakage inductance of coupled inductor is efficiently recycled to the output, and the voltage doubler cell also operates as a regenerative clamping circuit, alleviating the problem of potential resonance between the leakage inductance and the junction capacitor of output diode. These characteristics make it possible to design a compact circuit with high static gain and high efficiency for industry applications. The hardware design is implemented by PIC16F877A controller circuit.**

***Index Terms-* Coupled inductor, dc–dc, diode–capacitor, high voltage gain, low voltage stress, MATLAB..**

I. INTRODUCTION

To achieve a high conversion ratio without operating at extremely high duty ratio Many boost converters based on a coupled inductor or tapped inductor provide solutions to achieve a high voltage gain, and low voltage stress on the active switch without the penalty of high duty ratio. However, the leakage inductor of the transformer may not only cause high voltage spikes on the power device, but also induce energy losses. In order to improve aforementioned problems, a resistor–capacitor–diode snubber can be used, but the leakage inductor energy is dissipated. Although active clamped techniques can release high voltage spikes and reduces switching losses an additional active switch leads to complex structures and control. In these applications, a classical boost converter is normally used, but the voltage stress of the main switch is equal to the high output voltage; hence, a high-voltage rating switch with high on-resistance should be used, generating high conduction. In addition, an extremely high duty cycle will results in large conduction losses on the power device and serious reverse recovery problems. As a result, the conventional boost converter would not be acceptable for realizing high step-up voltage gain ($V_{out} \geq 8*V_{in}$) along with high efficiency. Many non-isolated topologies have been researched to achieve a high conversion ratio and avoid operating at extremely high-duty cycle.

II. OPERATIONAL PRINCIPLE OF THE PROPOSED CONVERTER

Fig. 1 shows the circuit structure of the proposed converter, which consists of an active switch Q, an input inductor L1 and a coupled inductor T1, diodesD1, D2, and DO, a storage energy capacitor C1 and a output capacitor CO, a clamped circuit including diode D3 and capacitor C2, an extended voltage doubler cell comprising regeneration diode Dr and capacitor C3, and the secondary side of the coupled inductor.

The simplified equivalent circuit of the proposed converter is shown in Fig.2The dual-winding coupled inductor is modeled as an ideal transformer with a turn ratio N (n2 /n1), a parallel magnetizing inductance Lm, and primary and secondary leakage inductance Lk1 and Lk2. In order to simplify the circuit analysis of the converter. In order to simplify the circuit analysis of the converter, some assumptions are as follows:

1. The input inductance L1 is assumed to be large enough so that iL1 is continuous; every capacitor is sufficiently large, and the voltage across each capacitor is considered to be constant during one switching period

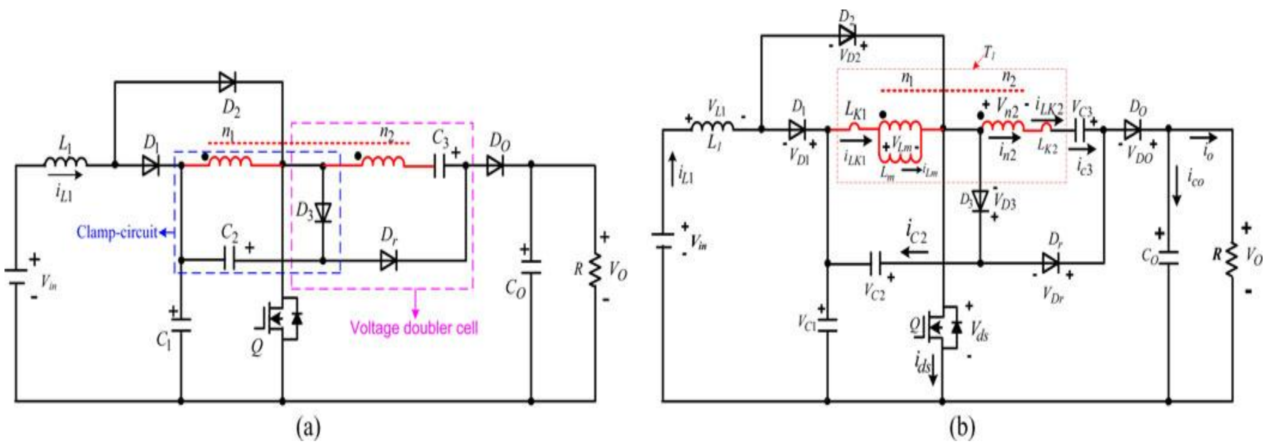


Figure 1: Circuit structure of proposed converter

Figure 2: Equivalent circuit of proposed high gain

III. SIMULATION OF PROPOSED SCHEME

A model for the proposed scheme was designed using MATLAB/SIMULINK software as shown in fig.3 and fig.4.The data of the QAB based SST used for simulation is given in table-1.

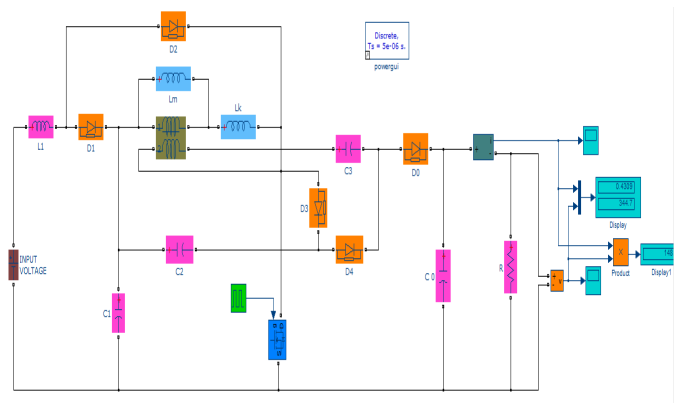
Table I: Parameters

Description	Values
Maximum output power	500W
Maximum output voltage	18-36V
Output voltage Vo	380V
Power MOSFET	FQP34N20
Switching Frequency	40 KHz
C1(Capacitor)	470µF/100V
C0(Capacitor)	470µF/600V
C2(Capacitor)	47µF/100V
C3(Capacitor)	47µF/250V
Diodes(D1/D2/D3)	20ETF02
Input inductance	L1 60µH
Magnetizing inductance	Lm 200µH

Simulation is done for both open loop system and closed loop system conditions, from the results it was that it provides various voltage conditions.

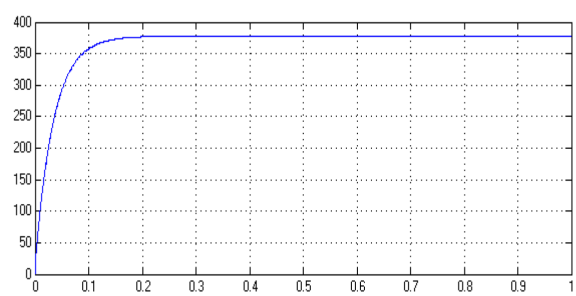
IV. RESULTS AND DISCUSSIONS

A simulation design open loop system as shown in Fig.4 is implemented in MATLAB SIMULINK with the help of coupled inductor, switches and diodes we get desired output voltage level (Fig.3)



DC –DC converter

Figure 3: Open loop circuit the proposed system

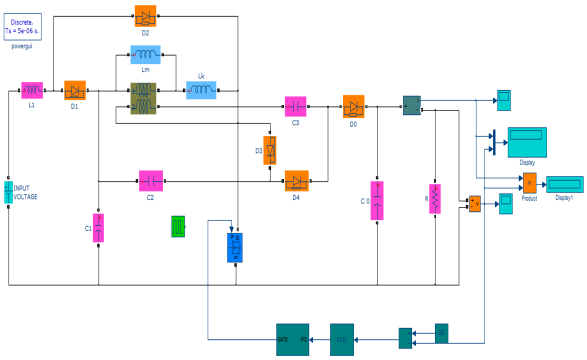


Case 1: Open loop Converter Output Voltage

Figure 4: open loop circuit output

Figure.4shows the open loop circuit output waveform for the proposed scheme. Here the output voltage is 380V.

A simulation design closed loop system as shown in Fig.5 is implemented in MATLAB SIMULINK with the help of coupled inductor, switches and diodes we



get desired output voltage level (Fig.6)

Figure 5: Closed loop circuit the proposed system

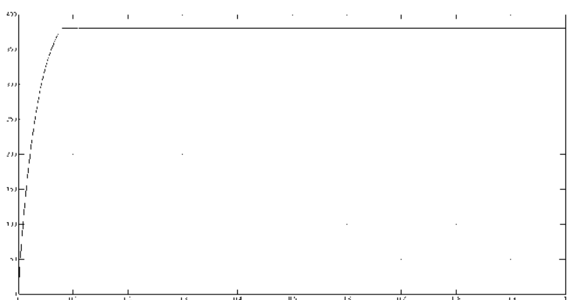


Figure 6: closed loop circuit output

V.CONCULUSIONS

This paper has non-isolated high step-up industry applications, a novel high-voltage gain converter is introduced in this paper, which combines a quadratic boost converter with coupled inductor and diode–capacitor techniques.

A clamped-capacitor circuit is connected to the primary side of the coupled inductor, the voltage stress of the active switch is reduced greatly and the clamped capacitor also transfers the primary leakage energy to the output.

At the same time, a diode-capacitor circuit is integrated with the secondary winding for further extending the voltage gain greatly.

Furthermore, the energy of secondary leakage inductor can be recycled and the turned off voltage spikes on the main switch are suppressed.

In addition, compared with some active clamp or three-level counterparts, only one MOSFET is required to simplify the circuit configuration and improve the system reliability, and the proposed converter maintains the advantage of continuous input current.

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