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Transformer Less High Voltage Gain Step-Up DC-DC Converter Using Cascode Technique

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Abstract

The objective of this work is to achieve high step-up voltage gain with appropriate duty ratio with the application of cascode technique on buck boost converters for electric energy conversion system. As the available electrical AC voltage cannot be directly fed to electronic power devices, these devices and load require DC Power conversion from AC voltage sources. Conventional boost converters are unable to provide high voltage gains due to the effect of power switches, the impact of the parasitic resistive components and the reverse-recovery problem of the diodes. In this paper high voltage gain step-up (HVGSU) DC-DC converter is proposed, which consists of two integrated buck-boost converters with a single switch. High voltage gain can be achieved using cascode technique without any extreme duty ratio, here the duty ratio of the switch is controlled using PWM technique. The simulation and hardware of the proposed converter is discussed in detail.

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Keywords: Boost converter; cascode technique; dc-dc converter; high voltage gain step-up(HVGSU); PWM *Technique* **;**

1. Introduction

As renewable energy sources offer clean, pollution free and sustainable environment, they are preferred across the world [1]. In future, pollution free electric vehicles by RESs are very much essential for transportation [2]. Generally the voltage obtained from PV cells is less, hence high step up voltage gain DC-DC converters are recommended to meet the necessary voltage levels [1] [3]. For example the operating voltage required in high – intensity discharge lamps used in automobile applications are more than its battery voltage [4] [5]. HVGSU DC-DC

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Converters are also used in applications like UPS, renewable energy conversion and industry testing [6] [7]. Also to obtain low THD and high power factor in boost PFC circuits, it is essential to have a high ac input voltage [8]. In general smooth high voltage gain is not possible due to parasitic components and reverse recovery problems of the diodes. HVGSU can be possible with fly back converter but the leakage inductance of the transformer limits the voltage stress of the switches [9] [10] [11] [12] [3]. The HSUVG not only increases the voltage levels but also efficiency [5]. In literature many solutions are implemented to obtain HV with reduced switches to improve the efficiency, they are described as follows: A novel DC-DC converter topology is proposed which increases the conversion efficiency and reduces the voltage stress on the switches [13] [14]. DC-DC converter with a single switch is proposed which reduces the reverse recovery problems and switching losses [15] [13].Transformer less DC-DC converter with cascode technique is proposed to reduce the voltage and current stresses on the switches [13].Voltage multiplier with interleaved converter is proposed in power management applications such as electric vehicles [1]. DC-DC converter with coupled inductor is proposed to gain high voltage [4]. A soft switching technique in association with PWM and PFC controller is proposed to achieve high efficiency energy conversion with better power factor [16]. Bi directional H-bridge DC-DC converter with DC link avoids the transformers, coupled inductors and switched capacitors [2]. Large capacitor stacks can be eliminated with the use of bidirectional DC-DC converter with SVM technique compared to conventional DC-DC converter with PWM technique. DC-DC converter with MPPT is proposed to obtain a 300v from 10-40v PV cell for HVDC applications [17]. Cost effective single ended converter is proposed with isolation and non isolation configuration to improve the conversion efficiency [3]. This paper proposes a HVGSU DC- DC converter without a transformer by using PWM technique. This configuration is very well goes with grid connected RESs [18][19].

2. High Voltage Gain Cascode Boost Converter

This work proposes a transformer less high step up DC-DC converter with cascode technique. The circuit diagram of the proposed converter is given in Fig 1.

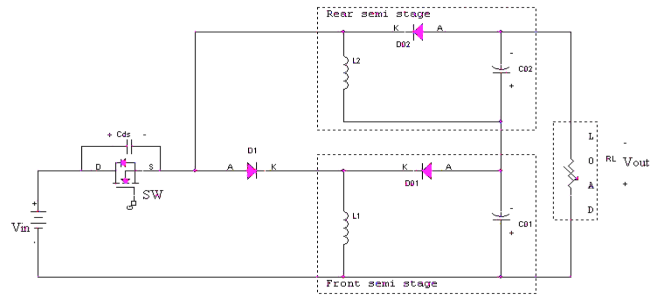

Fig. 1. Circuit diagram of the proposed cascode converter

Table 1: Theoretical calculations of High Voltage Gain step up DC-DC Converter

Vi (V)	I_i (A)	P_i (W)	V_0 (V)	I_o (A)	P_o (W)	$R_L(\Omega)$	η%
24	1.23	29.6	200	0.1	20	2000	67.57
24	2.56	61.4	200	0.2	40	1000	65.15
24	3.53	84.7	200	0.3	60	666.67	70.84
24	4.65	111.6	200	0.4	80	500	71.68
24	5.73	137.6	200	0.5	100	400	72.67

The theoretical results under various load conditions are described in table 1 The conversion efficiency is 72.67% at the full-load condition. At full-load condition the input power is 137.6Watts and output power is 100Watts.

3. Results and Discussion

The output gains of the convention and cascode converters in terms of duty ratio are given in Eqns. (1) and (2).

$$M \text{ (Gain of the Conventional Converter)} = \frac{Vo}{Vin} = \frac{1}{1-D} \quad (1)$$

$$M \text{ (Gain of the cascode boost Converter)} = \frac{Vo}{Vin} = \frac{2D-D^2}{(1-D)^2} \quad (2)$$

It is clear from table 2 that the voltage gain of the proposed converter is larger than the voltage gain of the boost