A NEW TRANSFORMER LESS BUCK–BOOST CONVERTER WITH POSITIVE OUTPUT VOLTAGE

K DEEPTHI 1*, K KRISHNA REDDY 2*

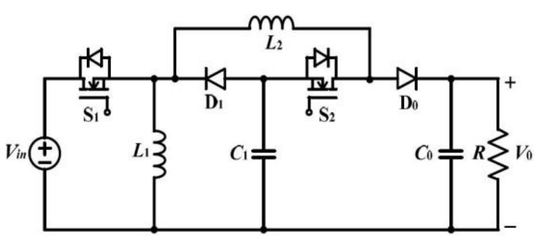
1. *II. M.Tech , Dept of EEE, AM Reddy Memorial College of Engineering & Technology, Petlurivaripalem.*
2. *Asst. Prof, Dept. of EEE, AM Reddy Memorial College of Engineering & Technology, Petlurivaripalem.*

ABSTRACT A new transformer less buck–boost converter with simple structure is proposed in this study. Compared with the traditional buck–boost converter, the proposed buck–boost converter's voltage gain is squared times of the former's and its output voltage polarity is positive. These advantages enable it to work in a wider range of positive output. The two power switches of the proposed buck–boost converter operate synchronously. In the continuous conduction mode (CCM), two inductors are magnetized and two capacitors are discharged during the switch-on period, while two inductors are demagnetized and two capacitor are charged during the switch-off period. The power electronics simulator (PSIM) and the circuit experiments are provided to validate the effectiveness of the proposed buck–boost converter.

INTRODUCTION

AS is well known, switching-mode power supply is the core of modern power conversion technology, which is widely used in electric power, communication system, house hold appliance, industrial device, railway, aviation, and many other fields [1], [2]. As the basis of switching-mode power supply, converter topologies attract a great deal of attention and many converter topologies have been proposed. Buck converter and boost converter have the simple structure and high efficiency. However, due to the limited voltage gain, their applications are restricted when the low or high output voltage are needed [3]. Luo converters can obtain high voltage gain by employing the voltage lift technique, but the topological complexity, cost, volume, and losses increase at the same time[4]–[6]. Interleaved converters can achieve high step-up or step down conversion ratio with low-voltage stress, while their operating mode, converter structure, and control strategy are complicated [7]–[10]. Quadratic converters can achieve the voltage gain of cascade converters with fewer switches; however, the efficiency of these converters are low [11], [12]. Additionally, some switched networks are added into the basic converters to obtain the high-voltage step-up or step-down gain, at the price of complicating construction and increasing cost [13]–[20].Compared with the above-mentioned converter topologies which can only step-up or step-down voltage, the voltage bucking/boosting converters, which can regulate output voltage under wider range of input voltage or load variations, are popular with the applications such as portable electronic devices, car electronic devices, and so on. The traditional buck–boost converter with simple structure and high efficiency, as we all known, has the drawbacks such as limited voltage gain, negative output voltage, and floating power switch, mean while discontinuous input and output currents. The other three basic non isolated converters: 1) Cuk converter; 2) Sepic converter; and 3) Zeta converter, which also have the peculiarity of step-up and step-down voltage, have been provided. However, the limits of the voltage gain along with other disadvantages in Cuk,Sepic, and Zeta converters are also non ignorable. The quadratic buck–boost converter, proposed by Maksim ovic and Cuk in, has one common-ground power switch; meanwhile, it can achieve the voltage gain $D2/(1 - D)2$. However, due to the diodes D1 and D2 clamp the output voltage to the input voltage while the duty cycle is bigger than 0.5, so that this converter can only work in step-down mode. By combining KY converter and the traditional synchronously rectified buck converter, Hwuand Peng proposed a new buck–boost converter which can realize the continuous output current, positive output voltage, continuous conduction mode (CCM) operation all the time, and no right-half plane zero. Unfortunately, its voltage gain of two multiplies the duty cycle ($2D$) is not sufficiently high or low in the situation where the converter needs to operate in a wide range of output voltage. Moreover, based on the Cuk converter, a new buck–boost converter, which has the low output voltage ripple, minimal radio frequency interference, and one common-ground power switch. However, as a seventh-order circuit, the converter has complex construction, and both its input terminal and output terminal do not share the same ground. Besides, the voltage gain is still limited. In a boost–buck cascade converter, aggregating two separated converters with current source and current sink, is applied for the thermoelectric generator. Nevertheless, the voltage gain of this cascade converter is also constrained.Especially, in order to obtain high-voltage step-up or step down gain, these converters must be operating under extremely high or low duty cycle, and this point is too hard to realize due to the practical constraints. Hence, exploring new topology of buck–boost converter to overcome the drawbacks of the conventional ones for satisfying the increasingly requirements in industrial applications is very important and valuable.

TRANSFORMERLESS BUCK-BOOST CONVERTER WITH POSITIVE OUTPUT VOLTAGE AND FEEDBACK



A new transformerless buck-boost converter is obtained by inserting an additional switched network into the traditional buck-boost converter. The main merit of the proposed buck- boost converter is that its voltage gain is quadratic of the traditional buck-boost converter so that it can operate in a wide range of output voltage, that is, the proposed buck-boost converter can achieve high or low voltage gain without extreme duty cycle. Moreover, the output voltage of this new transformerless buck-boost converter is common-ground with the input voltage, and its polarity is positive.

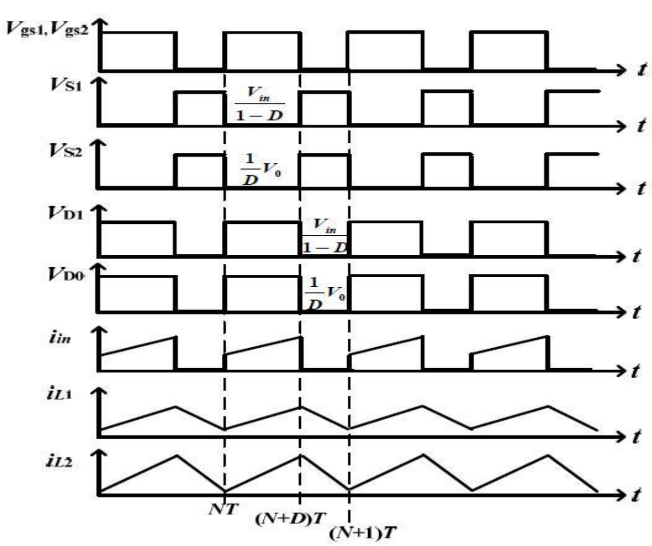
a) Converter Structure

The circuit configuration of the new transformerless buck- boost converter is shown in fig-1. It consists of two power switches (S1 and S2), two diodes (D1 and DO), two inductors (L1 and L2), two capacitors (C1 and Co), and one resistive load R. Power switches S1 and S2 are controlled synchronously. According to the state of the power switches and diodes, some typical time-domain waveforms for this new transformerless buck-boost converter operating in CCM are displayed in fig- 2, and the possible operation states for the proposed buck-boost converter are shown in figures 3 and 4. Figure 3, it denotes that the power switches S1 and S2 are turned on whereas the diodes D1 and DO do not conduct. Consequently, both the inductor L1 and the inductor L2 are magnetized, and both the charge pump capacitor C1 and the output capacitor CO are discharged. Figure 4, it describes that the power switches S1 and S2 are turned off while the diodes D1 and DO conduct for its forward biased voltage. Hence both the inductor L1 and the inductor L2 are demagnetized, and both the charge pump capacitor C1 and the output capacitor CO are charged.

b)Operating Principles

As shown in fig-2, there are two modes, that is, mode 1 and mode 2, in the new transformerless buck-boost converter

when it operates in CCM operation. Mode 1 between time interval (NT<t<(N+D)T). Mode 2 between time interval ((N+D)T<t<(N+1)T).

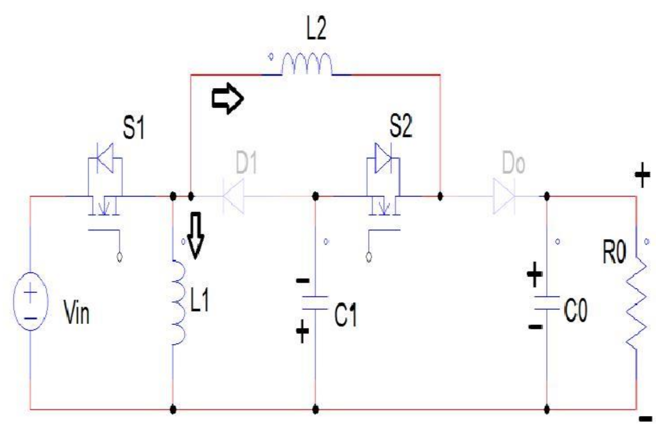


- *Mode 1(NT<t<(N+D)T)*

Mode 1 is during the time interval (NT<t<(N+D)T). During this time interval, the switches S1 and S2 are turned on, while D1 and DO are reverse biased. From fig-3, it is seen that L1 is magnetized from the input voltage Vin while L2 is magnetized from the input voltage Vin and the charge pump capacitor C1. Also, the output energy is supplied from the output capacitor CO. Thus, the corresponding equations can be established as,

VL1= Vin... (1)

VL2= Vin + VC1................................ (2)



CONCLUSION

This paper has proposed a new transformer less buck–boost converter as a fourth-order circuit, which realizes the optimization between the topology construction and the voltage gain to overcome the drawbacks of the traditional buck–boost converter. The operating principles, steady-state analyses, small signal modeling, and comparisons with other converters are presented.

From the theoretical analyses, the PSIM simulations, and the circuit experiments, it is proved that the new transformer less buck–boost converter possesses the merits such as high step-up/step-down voltage gain, positive output voltage, simple construction, and simple control strategy. Hence, the proposed buck–boost converter is suitable for the industrial applications requiring high step-up or step-down voltage gain.

REFERENCES

[1] W. H. Li and X. N. He, "Review of non-isolated high step-up DC/DCconverters in photovoltaic grid-connectedapplications," IEEE Trans. Ind.Electron., vol. 58, no. 4, pp. 1239–1250, Apr. 2011.

[2] C. T. Pan and C. M. Lai, "A high-efficiency high step-up converter withlow switch voltage stress for fuel-cell system applications," IEEE Trans.Ind. Electron., vol. 57, no. 6, pp. 1998–2006, Jun. 2010.

[3] T. F. Wu and Y. K. Chen, "Modeling PWM DC–DC converters outof basic converter units," IEEE Trans. Power Electron., vol. 13, no. 5,pp. 870–881, Sep. 1998.

[4] F. L. Luo, "Six self-lift DC–DC converters, voltage lift technique," IEEETrans. Ind. Electron., vol. 48, no. 6, pp. 1268–1272, Dec. 2001.

[5] F. L. Luo and H. Ye, "Positive output cascade boost converters," Proc.Inst. Elect. Eng. Elect. Power Appl., vol. 151, no. 5, pp. 590–606, Sep.2004.