A SINGLE SWITCH NON-ISOLATED TRANSFORMERLESS DC-DC BUCK BOOST CONVERTER

P.Manikandan , Asst Prof, S.Deepak Bharath, K.Bikash Khati, Devareddy Pavan Krishna

Prathyusha Engineering College
manikandan.eee@prathyusha.edu.in, deepakbharaths@gmail.com, lovelybiki11@gmail.com, pavan.d369@gmail.com

ABSTRACT:

A Transformerless buck–boost dc–dc converter is proposed in this paper.
The presented converter voltage gain is higher than that of the conventional boost, buck–boost, CUK, SEPIC, and ZETA converters, and high voltage can be obtained with a suitable duty cycle. In this converter, only one power switch is utilized. The voltage stress across the power switch is low. Hence, the low on-state resistance of the power switch can be selected to decrease conduction loss of the switch and improve efficiency. The presented converter has simple structure, therefore, the control of the proposed converter will be easy.

I. INTRODUCTION

In recent years, environmental troubles, such as climate change and global warming by
Increased emissions of carbon dioxide,are very important.
The Cuk converter (pronounced Chook; sometimes incorrectly spelled Cuk, Cuk or Cuk) is a type of DC/DC converter that has an output voltage magnitude that is either greater than or less than the input voltage magnitude.
The single-ended primary inductor converter (SEPIC) is a type of DC/DC converter allowing the electrical potential (voltage) at its output to be greater than, less than, or equal to that at its input.
Concepts in an isolated zeta converter is principle of operation and design in CCM.
The power factor of an AC electric power system is defined as the ratio of the real power flowing to the load to the apparent power in the circuit, and is a dimensionless number.
A hybrid fuel cell power system was proposed on published April 1, 2009 by Ke Jin, Xinbo Ruan,Mengxiong yang.It consists of a fuel cell, an isolated unidirectional converter, a bidirectional converter, an inverter, and a battery. A power management control scheme, which controls the bidirectional converter operating under buck, boost, or shutdown mode according to the operation condition of the fuel cell and battery, so that the battery can be charged or discharged.

A new single switch buck-boost type dc-dc converter was proposed on October 4-6, 2009, by M.Delshad and H.Farzanehfard. This converter consists of flyback and forward transformers and only one switch in primary side and one diode in secondary side of transformers. this converter operates in both buck and boost modes. Both on and off switch states and controlled by PWM signal,which akes the control circuits easy and cheap. This converter operates over a wide input voltage range, this converter can be employed as a power factor correction.

High efficiency two switch tri-state buck-boost power factor correction converer with fast dynamic response and low-inductor current ripple was proposed on on 4th October 2012 by Mingzhi, Fei zhang and Jian ping.To mitigate the stress on the switch component,this independently controlled two switch buck-boost converter is used.this,two switch buck-boost PFC converter can also work in PCCM mode,with three operating stages in each switching cycle.

Double deck buck-boost converter with soft switching operation was proposed on 2015 by erfan mali and Behrooz vahidi.This was constructed of two identical buck-boost converters working in parallel. The converter units are connected to each other by an inductor as a bridge.This inductor plays an important role in the soft switching operation.

II. Circuit:

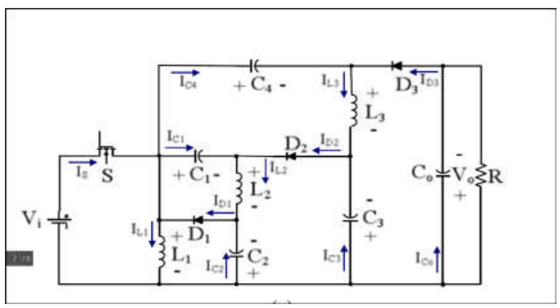

Fig 1.Proposed System

There are two modes of operation with this circuit. They are:

III. Buck operation

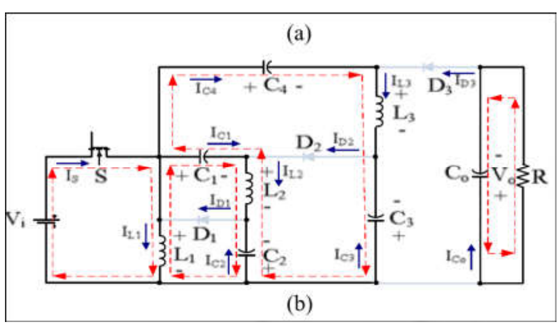

Fig 2. Operation in buck mode

IV. Boost operation

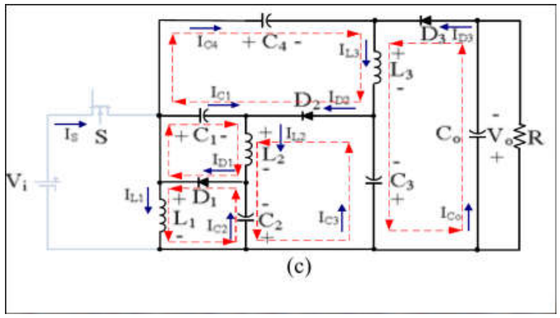

Fig 3. Operation in boost mode

V. Operating principle

The proposed converter is shown. This converter consists one power switch S, three diodes D1 , D2 , and D3 , three inductors L1 , L2 , and L3 , five capacitors C1 , C2 , C3 , C4 , and Co and load R.
For simplicity of the analysis of the operating principles, the following assumptions are considered.
1) The capacitors of the presented converter are large enough, hence the voltage across capacitors are assumed to be constant.
2) The main switch of the proposed converter is treated as ideal and the parasitic capacitor of the main switch is neglected.
The presented converter can be operated in both the continuous conduction mode (CCM) and the discontinuous conduction mode (DCM). The CCM can be divided into two operation modes.

VI. Buck mode:

During this time interval as
shown, the switch S is turned ON and the
diodes D1 , D2 , and D3 are turned OFF. The inductors L1 ,L2 , and L3 are magnetized linearly. The capacitors C1 and C4 are charged by the capacitors C2 and C3.

VII. Boost mode:

The equivalent circuit is shown in Fig. 1(c). During this time interval, the switch S is turned off and the diodes D1 , D2 , and D3 are turned on. The inductors L1 , L2 , and L3 are demagnetized linearly.The capacitor C2 is charged by the inductor L1and the capacitor C3 is charged by the inductors L1 andL2 and the capacitors C1 and C4 are discharged.

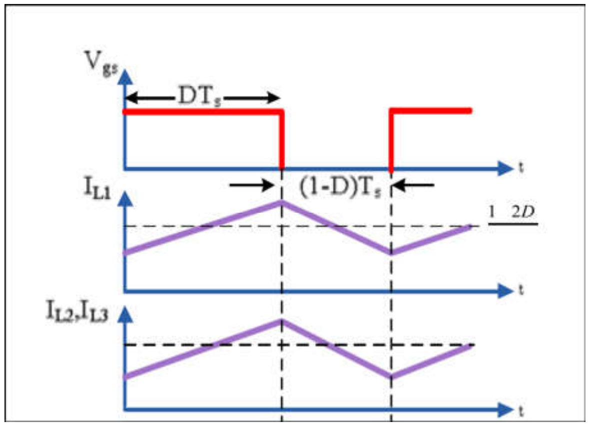

Fig 4. Waveform 1

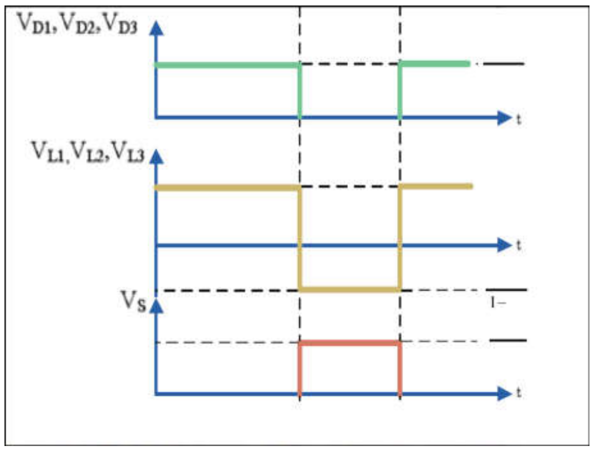

Fig 5. Waveform 2

Some typical waveforms of the proposed converter are shown in these fig 4 & 5.

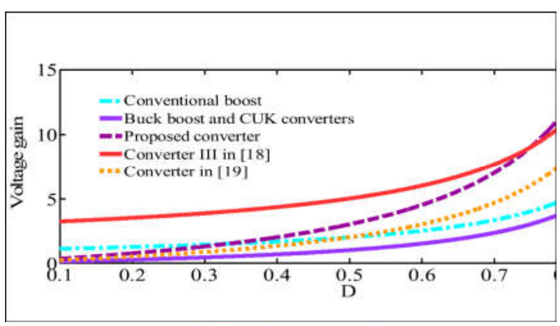

Fig 6. Curves of voltage gain

Curves of voltage gain comparison of proposed converter and other converters at CCM operation.

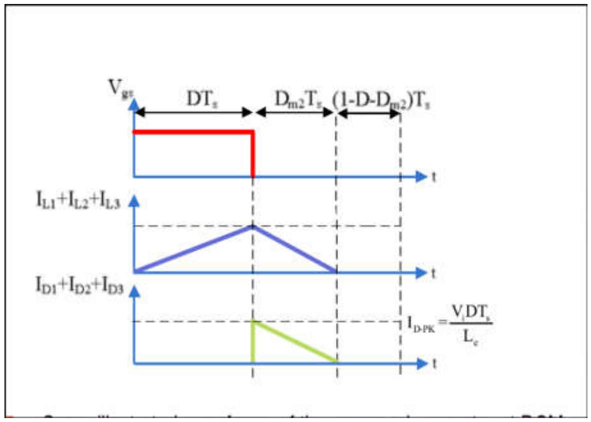

Fig 7. DCM operation

Some illustrated waveforms of the proposed converter at DCM operation.

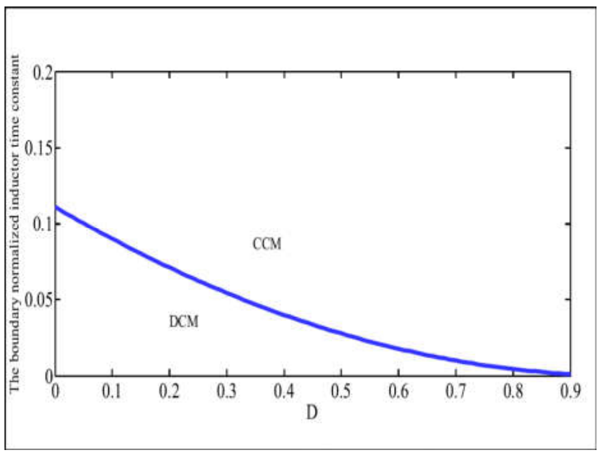

Fig 8. Duty cycle

Boundary normalized inductor time constant versus duty cycle.

The operation modes in DCM can be divided into three modes. The first mode in DCM is the same as the first mode in CCM. In the second mode, the diodes currents are decreasing and in the third mode the diodes D1 , D2 , and D3 currents will be zero and the diodes and switch will turn OFF. The equivalent circuit and the typical waveform in third mode are shown in Figs. 4 and 5. In this mode, the inductors L1 , L2 , and L3 currents will be constant; therefore, the voltage of the inductors L1 , L2 , and L3 will be zero.

In this mode, the voltage transfer gain of the CCM is equal to the voltage transfer gain of the DCM.

The proposed structure uses higher number of elements. But, the total device of the other converters is higher comparing to their gains and voltage stresses. Based on the low voltage stress of the proposed converter, the efficiency of the proposed converter is higher comparing to its gain. the voltage ripple of the capacitor C1 is represented by ΔVC1 . The voltage ripple on capacitor C1 created from the current that flows through the ESR is signified by ΔVC1,ESR and the voltage ripple of capacitor C1 created from the charging and discharging is indicated by ΔVC1,cap.

In this converter, the voltage stress across the active components,such as switch and diodes, is lesser than output voltage.The proposed converter is tested in the buck and boost states operation. The proposed converter is operated in CCM operation mode. In the buck state operation, the output voltage waveform is shown.

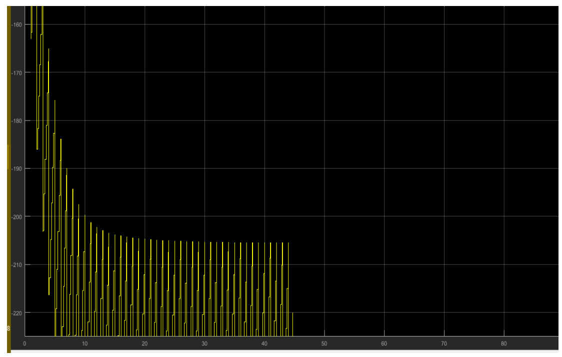

Fig 9. Output Voltage Waveform

The output voltage is equal to 10 V. The inductors L1 , L2 , and L3 currents waveforms are shown. the average values of inductors L1 , L2 , and L3 currents are equal to 0.45, 0.24, and 0.24 A, respectively, which closely
agree with the experimental results. The voltages of diodes D2 and D3 waveforms are not shown since the diodes waveforms are similar to diode D1 voltage waveform. The voltage of diode D1 waveform is shown in Fig.15(e). The voltage of the switch
S is shown. In the boost state operation, the output voltage is shown. The output voltage is equal to 42V and the output power is equal to 135 W. The inductors L1 ,L2 , and L3 currents waveforms are shown. the average values
of inductors L1 , L2 , and L3 currents are equal to 15.4, 3.2, and 3.2 A, respectively, which closely agree with the experimental results. The voltage of the diode D1 is shown. The voltage across switch S is shown. Fig. shows the output voltage changing with ramping up. Fig. shows the curve of presented buck–boost converter efficiency versus output
power. The maximum efficiency is appropriately 97.3%. The full-load efficiency is around 95.2%. Fig.18 shows the curves of efficiency of the proposed converter versus load current.

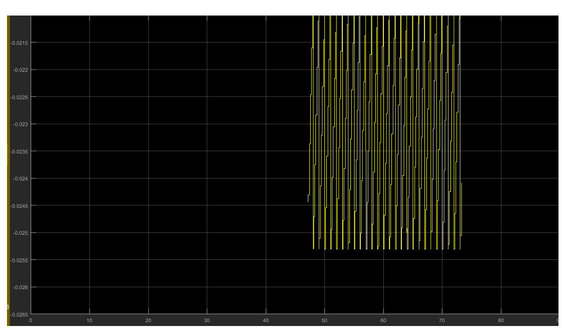

Fig 10.Output Current

VIII. APPLICATIONS:

1. Efficiency increases.
2. No of switches reduced so switching losses will be reduced by using LC
3. It clears the ripples and produce the pure DC output.

IX. CONCLUSION

In this paper, a single switch transformer less buck–boost dc–dc converter was presented. The structure of the presented buck–boost converter is simple. In the proposed converter, only one main switch is utilized, which decreases the conduction loss of power switch and improves efficiency. The voltage stress across the power switch is low and switch with low on-state resistance can be selected. The step-up voltage gain of the proposed buck–boost converter is higher than that of the classic boost, buck–boost, CUK, SEPIC, and ZETA converters. The proposed converter has simple structure; therefore, the control of the presented converter will be easy. The buck–boost converters is utilized in many applications like gadgets such, as mobile phones and notebooks, fuel-cell systems, car electronic devices, and LED drivers. Finally, the experimental results were provided to verify the feasibility of the proposed converter.

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