Middle-East Journal of Scientific Research 24 (3): 548-551, 2016
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2016.24.03.23066

# A Novel Buck-Boost-based for Single Phase Inverter Applicable for Photovoltaic Based Electric Vehicle

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**Abstract:** Recently, many types of power boost converters have been introduced. To minimize the harmonic of the AC output voltage, different switching schemes such as PWM topology are usually applied. In this paper a novel DC-AC power converter is presented with almost a typical sinusoidal output waveform from two Buck-Boost converters. A typical inverting circuit is then applied with a switching frequency that is equal to that of the output voltage. The associated total harmonic distortion is less than 10%. Such design is attractive for photovoltaic applications in which the input DC source is varying and where maximum power point tracking algorithms takes place.

**Key words:** Buck converter · Inverter · Sinusoidal

## INTRODUCTION

Nowadays, by development in power electronic fields, there is a good attention to dc–dc converters In order to achieve a proper design and control, it is necessary to have an exact model of converter. By modeling the dc–dc converters, the operation of converter in different operational modes can be investigated in both transient and steady states. High accuracy and low response time are major features of a good modeling [1-6]. Boosting the input voltage is widely used to get the desired output which can be done by many ways but the main way is by either converting the input voltage from DC to AC by rectifiers then a transformer can be used or boosting the DC voltage by DC-DC booster then an inverter can be used then a transformer can be used if needed. The first way has some drawbacks in high boosting by making the transformer to larger which mean high cost and high losses, but in the other way less losses obtained to thesame output. Traditional DC-AC converters have a main problem which is the total harmonic distortion because of the square shape of the signal so a better way is used in this paper by boosting the input voltage to half sinusoidal waveform as in Fig (1) in this case a lower total harmonic distortion can be obtained with the same output voltage. Fig.1 shows the input dc voltage in (a) and the output voltage of the buck-boost converter which can be noticed that it

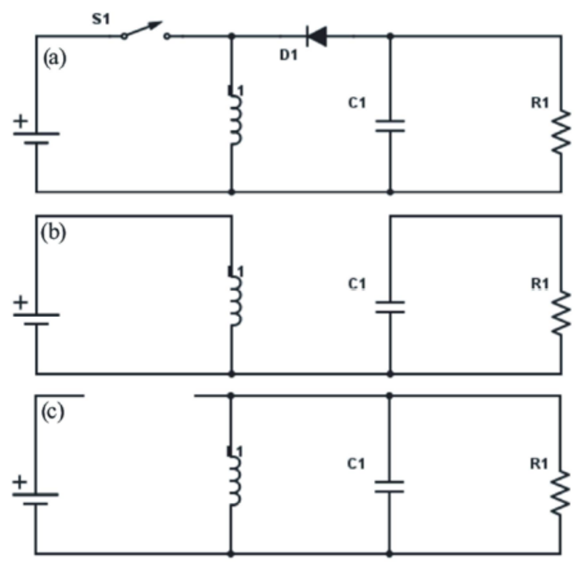


Fig. 1: (a) input voltage (b) output voltage of the buck-boost converter (c) output voltage of the inverter.

is in shape of half sinusoidal waveform in (b) and the output voltage of the half inverter with shape of sinusoidal waveform in (c). Different PWM topologies have been introduced recently [7-8] but the problem of total harmonic distortion can't be eliminated so we used the proposed topology of sinusoidal waveform output to minimize the total harmonic distortion. PWM topology can be used to minimize the THD by adding PWM

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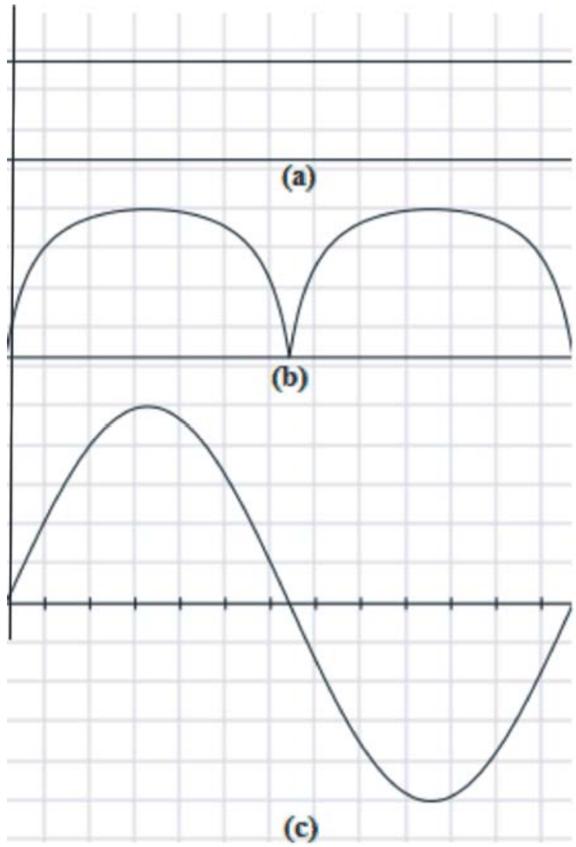


Fig. 2: General Schematic diagram of Buck-Boost Converter

technique to the switches of the inverter. In this paper a proposed Buck-Boost converter is introduced to generate a half sinusoidal signal contains of two Buck-Boosts, one generate a positive half sinusoidal and the other generate negative sinusoidal signal and a study on the relation between the output voltage with the capacitance and inductance of the Buck-Boost and see the relation between the duty cycle and the output voltage.

**Operation Analysis:** Traditional Buck-Boost inverter has been used in this paper as shown in figure in this paper to get a positive half sinusoidal signal as shown in Fig. (2).

In Fig (2-a) the general schematic diagram of the buck- boost converter and in Fig (2-b) the schematic diagram of case S1 is closed, in this case the voltage source will charge the inductor with specific current which depend on the duty cycle of S1 and the capacitor provides the load with the needed voltage, in Fig (2-c) schematic diagram of the buck-boostFigure 2. General Schematic diagram of Buck-Boost Converter converter in case of S1 is open, in this case the inductor will charge the capacitor with voltage equals to L di/dt of the inductor and provides the load with power. The output voltage of the. According to [3] –[4] the output voltage depends on the duty cycle of S1 so this converter can work as buck to reduce to output voltage under the input voltage or as booster which means increasing the output voltage greater than the input voltage. By using the following equation:

$$V_o = \frac{D}{1-D} Vi \quad (1)$$

$$D = \frac{V_o}{V_o + Vi} \quad (2)$$

where V□ is the output voltage and Vi is the input voltage and D is the duty cycle. From (1) we can obtain that the converter can work as buck converter when 0 < D <0.5 and work as boost converter when 0.5 < D < 1. To obtain an output of sinusoidal we can modify (2) by making V0 a function of sin which is a function of wt :

$$D = \frac{|Vp\sin(wt)|}{|Vp\sin(wt)| + Vi} \quad (3)$$

From (3) we can notice that D will varies with the time so it starts with zero value and be in its peak then goes to zero again, by having the absolute value of sine the value will be in positive all the time. The proposed circuit of buck-boost has two buck-boost converter one of them to get a positive half sinusoidal waveform and the other to get negative sinusoidal waveform, and inverter of two switches has been used to obtain the sinusoidal waveform. Fig. (3) Show two ways to obtain an output of sinusoidal waveform, (a) shows that we can done that by having one buck-boost converter with a half sinusoidal output and an inverter is connected to the buck-boost by making the duty of the buck-boost converter varies from zero to maximum then to zero then to maximum and so on in this case an inverter of four switches need to be used to invert the second half sine of the output of the buck-boost converter and that can be done by making the switches working in the principle of Bi-polar inverter but without and PWM techniques by just making the switches work for the half period of a full sinusoidal then it changes to the other side to obtain the negative side of the waveform for the same period this way need a continuous controlling for the switch of the buck-boost which causes high losses also it can damage the switch since it works continuously so other way has been

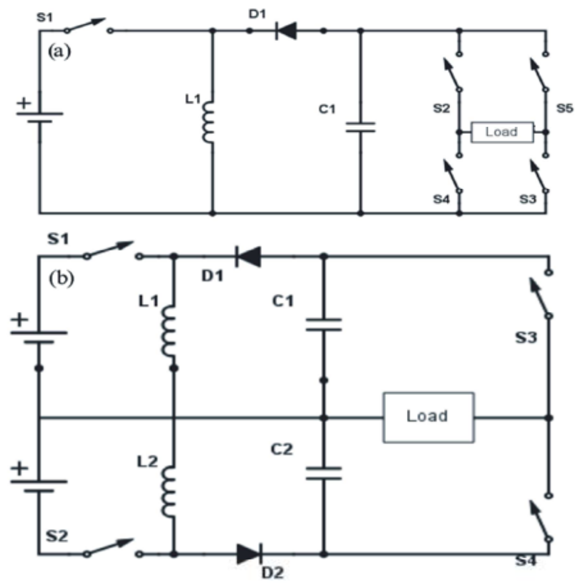


Fig. 3: (a) Schematic diagram of the traditional buck-boost converter (b) Proposed Buck-boost converter.

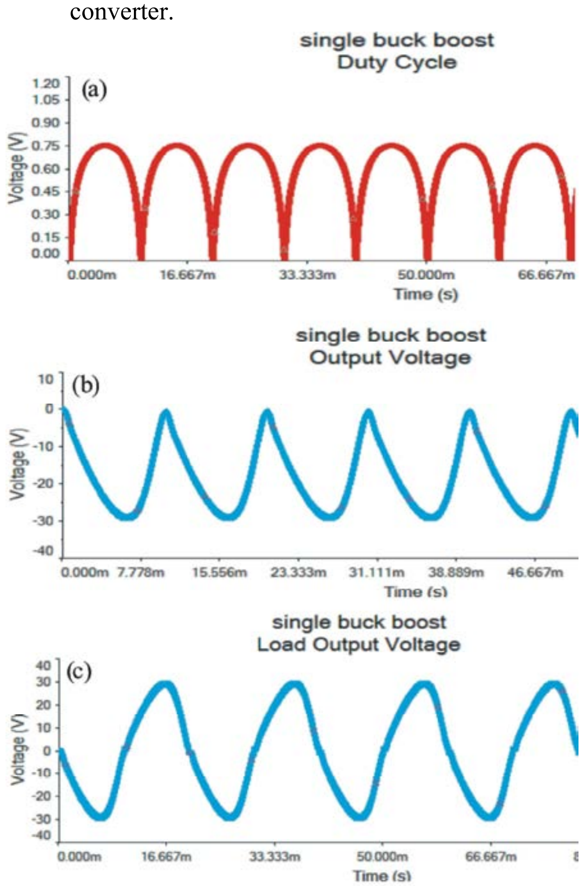


Fig. 4: (a) Duty Cycle Values varying with time (b) output voltage of the traditional buck-boost converter (c) Output voltage of the inverter

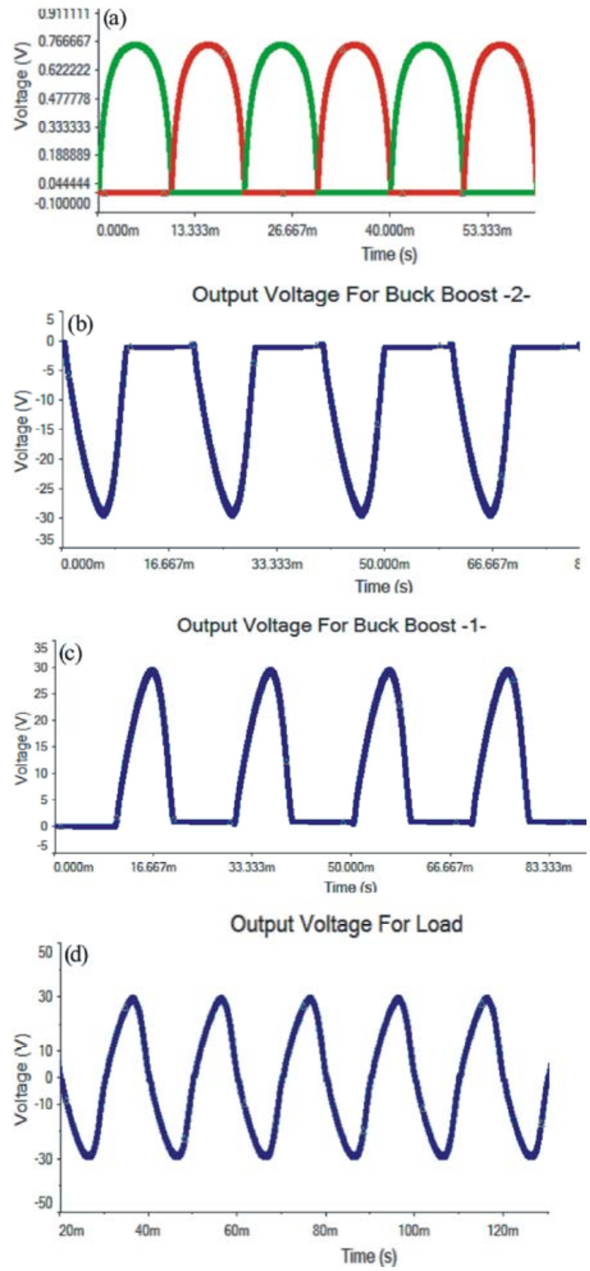


Fig. 5: (a)output voltage of the upper buck-boost converter (b) output voltage of the lower buck-boost converter (c)duty cycle through time for upper buck boost in green and for lower buck boost in red(d) voltage of the load.

introduced by having two buck-boost inverter on of them generates the positive side for half period of a full sinusoidal then it turns off and the other buck-boost converter work generates the negative side of the waveform for the second half of the full sinusoidal waveform the circuit of this method is shown in Fig. (3-b)

**Simulation and Results:** The introduced Buck-Boost converters have been simulated in National Instrument (Multisim) for sinusoidal output with minimum total harmonic distortion without the need of PWM techniques. DC source of 10 volts with buck-boost converter and according to [11] so for the maximum duty cycle L=1.2mH and C=3.75µF with resistive load 100Ω, the desired output was 30 volts. We can obtain this desired voltage by D=0.75 so that D will varies from zero to 0.75 then to zero then stay zero for (π) then return to rise until reach the maximum value and so on.

In the proposed buck-boost converter THD has been reduced to less than 10% which is better than in traditional buck-boost converter which has 40% THD for the operation, if the capacitor decreased less than the specified capacitance the output voltage will have high ripple because of the discharge of the capacitor which means higher total harmonic distortion percentage, in case the capacitor has been increased more than the specified capacitance the voltage across the capacitor will not decrease with the decreasing of the duty cycle and it will not reach the zero voltage so that the output voltage will have sudden change from a specific voltage to the negative side directly so the total harmonic distortion will be increased, in the other side if the inductance decreased the inductor current ripple will increase which leads to higher THD but in case if the inductance has been increased more than the specified inductance it will work in DCM so that the energy supplied to the capacitor will stop flowing in specific time which leads to sudden change in the voltage.

## CONCLUSION

The proposed Buck-Boost converter has a big advantage of boosting the input voltage and also reduces the total harmonic distortion better than using PWM techniques. In the proposed Buck-Boost converter two switches have been used which mean lower losses also the switch of the buck-boost will have a half period rest instead of working continuously, the proposed Buck-Boost converter has a unique advantage for the traditional Buck-Boost converter which the proposed converter eliminate the chance of having a short circuit in the inverter which may occur in the traditional Buck-Boost converter in the four leg inverter, the proposed Buck-Boost converter has lower THD output voltage which has been reduced less than 10% which was around 40% in the traditional buck-boost converter so that the total efficiency of the circuit will be increased more than the traditional Buck-Boost converter. Generally if we have a DC input voltage and we need to boost it to an AC voltage load it is better to use a DC-DC converter then we can use an inverter connected to load.

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