A Novel Design of Luo Boost Converter positive output super lift converter

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Abstract-*In solar energy DC/DC conversion is one of the major requirements that provide a large conversion ratio, high power density and high efficiency. Recently, more widely LUO converter is used. In LUO converter, voltage lift technique is implemented to obtain a high voltage transfer gain. The output voltage of proposed luo converter is increased in geometric progression. In this project, single inductor can be replaced by the two inductor and three diodes, which increases the voltage transfer gain. There is a possible way to further increase the output voltage by adding the additional inductor and capacitor for voltage multipliers without increasing the number of switches. This super lift luo converter can boost the voltage transfer gain in power gain. Simulation and experiment results confirm the advantages of proposed converter.*

Keywords-Inductor, capacitor, voltage lift technique, voltage gain, geometric progression, voltage gain.

I. INTRODUCTION

DC to DC step-up converters are used in many electronic devices. The main requirements for these converters are to provide a large conversion ratio, high power density and high efficiency. Recently, more and more widely used so-called Luo converters [1, 2]. This is because of their universality and relative simplicity. One of the most perspectives in the family of Luo converters is positive output super-lift Luo (POSL) converter [3–5]. In fact, this family includes three types of converters – 'elementary circuit', 'relift circuit' and 'triple-lift circuit'. More extended analysis of POSL in the various modes of operation is presented in [6]. Calculation of the capacitor voltages ripple of these converters is given in [7]. It should be noted that the increase in voltage transfer ratio in all cases is achieved by significantly increase in the number of the passive circuit elements. A new method of increasing the voltage transfer ratio by splitting one of the capacitors of the circuit POSL is presented in [8]. However these schemes require the additional transistor. A similar idea (but without additional transistor) has been proposed in [9]. The DC output voltage thus obtained from the Solar panel is generally low and needs to be converted into higher DC voltage as shown in Fig.1.

Fig1. Block diagram of LUO boost converter

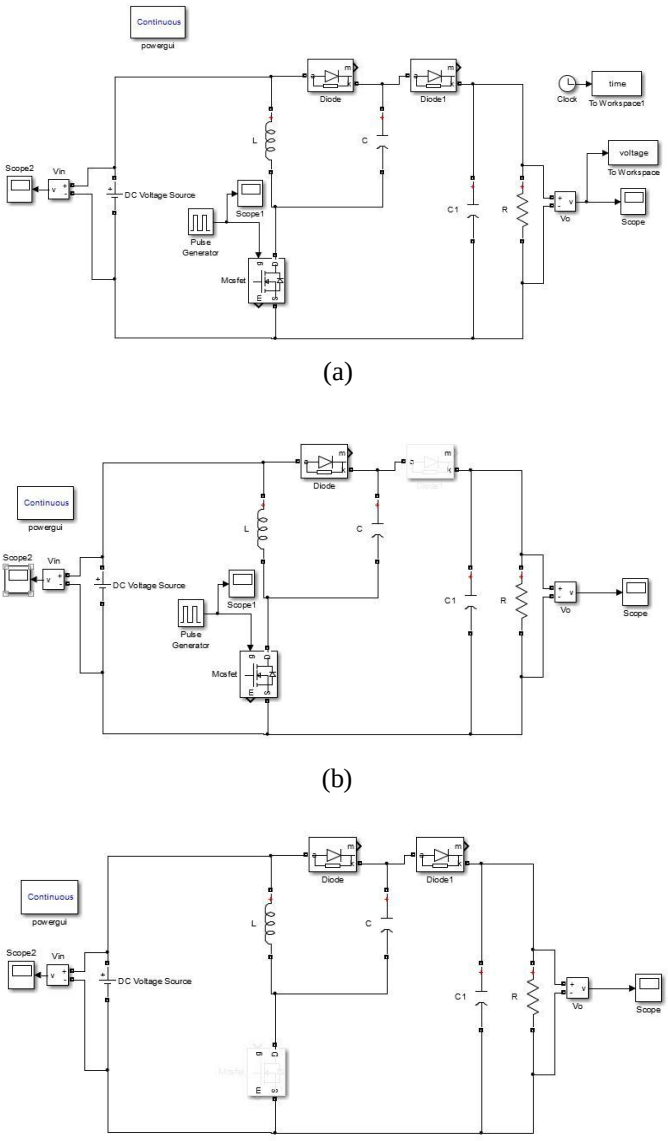
A significant increase in voltage transfer ratio can be achieved by introducing the switched-inductor cells [10]. The switching-inductor cell forms of two inductors and three diodes. During the two base states of the main circuit these two inductors are connected in parallel or in series. The main idea of introducing such cells in various types of DC-DC converters has been summarized in [11, 12]. A significant increase of voltage ratio can be obtained also by using diode capacitor multipliers in combination with DC-DC converters [13, 14]. It is important however to emphasize that all the schemes proposed by the authors include more than one controlled switch. Series of new voltage-lift-type converters formed by combining the voltage-lift converters with switching-inductor cells are presented also in [10]. The paper provides examples of calculation of some of these schemes. These ideas are developed later in [15, 16]. Paper [17] propose to use the analogue resonant controller for the voltage control of a zero-voltage switching quasi-resonant POSL. The sliding mode control of POSL is proposed and investigated in [18]. Applying of switched-inductor cells in DC-DC converters and Z-source inverters has been described in [19–21]. A significant increase of the voltage transfer ratio of the DC-DC converter is achieved by using the coupled inductors [18, 22–24].

This paper provides a detailed analysis of the static and dynamic regimes of the POSL converter combining with the switching-inductor cell. An important advantage of the proposed schemes is the presence of only one controlled switch. The necessary relations for continuous current modes (CCM) and discontinuous current modes (DCM) are obtained. Moreover, proposed the alternative variants of schemes that allow further increasing the voltage transfer ratio.

II.ELEMENTARY CIRCUIT OF POSL CIRCUIT

Elementary Circuit Of Posl Circuit

The elementary circuit along with its equivalent circuits during switch-on and switch-off period is shown in Fig. 2. The voltage across capacitor C is charged to Vin during switch-on period. The current flowing through inductor L is iL1 and increases with input voltage Vin during switch-on period kT as shown in Fig.2.b. The inductor current iL1 decreases with voltage (V o-2Vin) during switch-off period (1-k)*T as shown in Fig.2.c.



(a)

(b)

(c)

Fig 2: Elementary circuit of POSL converter (a) circuit diagram (b) circuit diagram when switch is ON (c) circuit diagram when switch is OFF.

III.ANALYSIS OF POSL AND MODIFIED POSL CONVERTER

A. Analysis of POSL converter.

Therefore the ripple of the inductor current iL1:

$$\Delta i_{L1} = \frac{Vin * D * T}{L1}$$

$$= \frac{Vo - 2Vin(1-D)T}{L1}$$

$$Vo = \left(\frac{2-D}{1-D}\right)$$

The voltage transfer gain:

$$G = \frac{Vo}{Vin} = \left(\frac{2-D}{1-D}\right)$$

T=1/f, and

$$\frac{Vin}{Iin} = \left(\frac{(1-D)^2}{(2-D)^2}\right) * R$$

Therefore, the variation ratio of output voltage Vo

$$\varepsilon = \frac{Vo/_2}{Vo} = \frac{1-D}{2RfC_2}$$

$$G_{dvo}(s) = \frac{Vo(s)}{d(s)}$$

$$= \frac{(2sL.I - D_1V_o + 2R_i.I).\omega_o^2}{S^2 + 2\delta.S + (1 + \left(\frac{2R_i}{R_oD_1^2}\right))D_1^2\omega_o^2}$$

B. Matlab Program For Posl Converter

For the design of POSL converter, we consider a various circuit parameters. Here a mathematical calculations for ripple in inductor current and output voltage inductor current ratio variation and output voltage ratio variation as well as input and output power of POSL converter.

MATLAB PROGRAM FOR POSL CONVERTER

```
clc
clear all
R=80;
f=100e3;
vo=790;
k=0.5;
di=0.1317;
dv=0.0224;
T=1/f
vin=vo*((1-k)/(2-k))
L1=(vin*k)/(di*f)
x=(k*((1-k)^2)*R)/(2*(2-k)*f*L1)
iL1=(di/2)/x
Iin=(2-k)*iL1
C2=(k*vo)/(f*R*dv)
Io=(dv*C2)/((1-k)*T)
y=((dv/2)/vo);
pin=vin*Iin
po=vo*Io
n=po/pin
```

MATLAB PROGRAM OUTPUT

```
T    =  1.0000e-05
vin  =  263.3333
L1   =  0.0100
x    =  0.0033
iL1  =  19.7500
Iin  =  29.6250
C2   =  0.0022
Io   =  9.8750
pin  =  7.8012e+03
po   =  7.8013e+03
n    =  1.0000
```

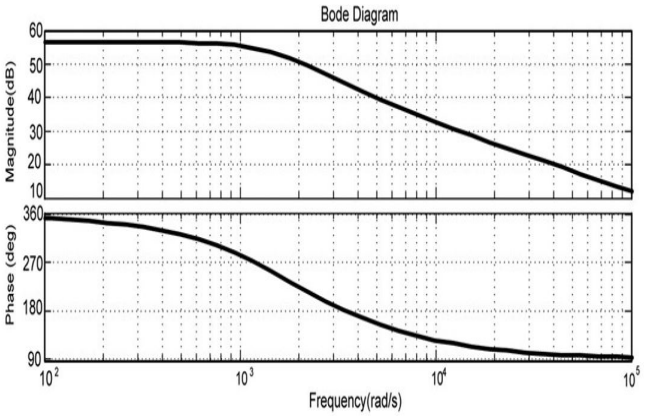


Fig 3.d Bode plot for transfer function.

Table 1 Parameters Used For Simulation

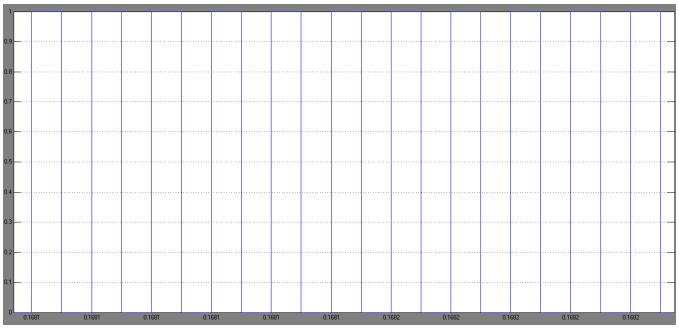
SYMBOL	QUANTITY	POSL CONVERTER VALUE
L1	Inductor 1	10mH
L2	Inductor 2	-
C1=C2	Capacitor	2200µF
Vin	Input voltage	263V
Vout	Output voltage	790V
Iin	Input current	29A
Iout	Output current	10A
Pin	Power input	7.8KW
Pout	Power output	7.8KW

IV.SIMULATION RESULTS

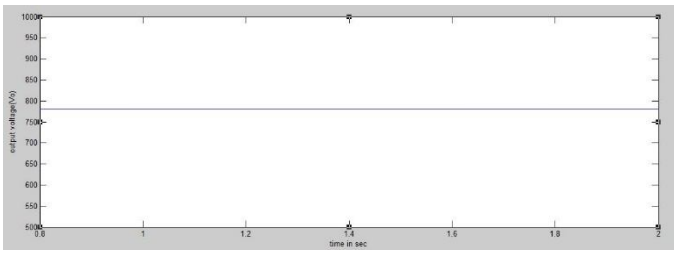
For the simulation purpose, instead of solar panel we used a DC battery. MATLAB software is used to design a POSL converter and modified POSL converter. MATLAB simulation parameters are as follows:

For POSL converter: Vin=263V, L=10mH, C1=C2=2200µF and R=80Ω for k=0.5 and f=100kHz.

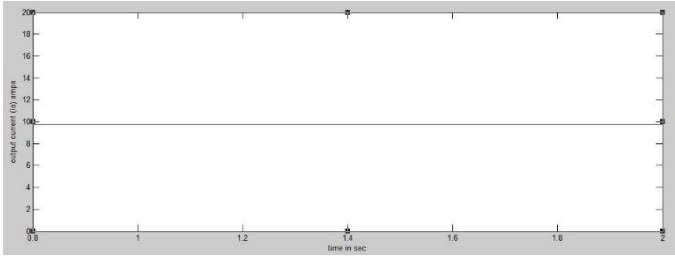
A. Simulation output for POSL converter



(a)



(b)



(c)

Fig 4. (a) Simulation waveform for switching pulse for both POSL and modified POSL converter (b) simulation waveform for output voltage of POSL converter (c) Simulation waveform for output current of POSL converter.

V. CONCLUSION

Positive Output Super lift Converter with has been satisfactorily analyzed and simulated. It chiefly increases output voltage and voltage transfer gain in power circuit. The design and calculations are verified by obtained simulation results and theoretical results. It has been observed that the voltage transfer gain has increased. The circuit parameters can be calculated by using the MATLAB program for various applications. After the DC/AC conversion by solar Inverter, the AC output voltage is obtained.

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