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DESIGN AND SIMULATION OF FUSED LUO CONVERTER

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ABSTRACT

Among the available renewable energy resources, the wind and photo voltaic energy is being widely utilized because of their abundance and sustainability to generate electricity. In this paper, a new hybrid integrated topology, fed by AC supply and solar energy system is configured using Positive output Luo converter and negative output Luo converter. This configuration allows the two sources to supply the load separately or simultaneously together (Hybrid) depending on the availability of the energy sources. The main purpose of this hybrid is to meet our daily demand effectively and to get an uninterrupted power supply. By combining these two intermittent sources, the system's power transfer efficiency and reliability can be improved significantly. Due to the inherent nature of this multi input converter, additional filters are not necessary to filter out high frequency harmonics and hence an enhanced output voltage with less ripples is obtained. Simulation results are given to highlight the merits of the proposed circuit.

Keywords: Luo converter, fused, simulation.

INTRODUCTION

DC–DC converters are widely used in computer hardware and industrial applications, such as traction motor control in electric automobiles, marine hoists, forklift trucks and mine haulers.[1] In recent years, DC–DC conversion technology has been developed to achieve high efficiency, high power density and simple topology[2]. Series DC–DC Luo converters have been successfully implemented with the voltage-lift technique [3], which results in good performance such as high voltage transfer gain (VTG) and low ripple voltage and current. In a hybrid system, when a source is unavailable or insufficient to meet the load demand, the other energy source can compensate for the difference in load. Several hybrid wind/PV power systems with MPPT control have been proposed and discussed in works. Most of the systems in literature use a separate DC/DC boost converter connected in parallel in the rectifier stage to perform the MPPT control for each of the renewable energy power sources. A simpler multi- input structure has been suggested earlier by combining the sources from the DC-end. The structures proposed were a fusion of the buck and buck-boost converter [4], Cuk and Buck converters [5,6]. The systems in literature require passive input filters to remove the high frequency current harmonics injected into wind turbine generators.

FUSED CUK SEPIC CONVERTER

Our existing system consists of an alternative dual-input converter circuit for hybrid solar/wind energy systems. It is a fusion of the Cuk and SEPIC converters and the block diagram is shown in the fig.1, where one of the input is connected to the PV array and the other input is connected to the output of the generator. The fusion is achieved by rearranging the two existing diodes from each converter and sharing the output inductor of the Cuk by the SEPIC converter. This configuration allows each converter to operate individually in the event that one source is unavailable. The converters have step up/down capabilities which provide more design with flexibility in the system if duty ratio is utilized to perform MPPT control [7].

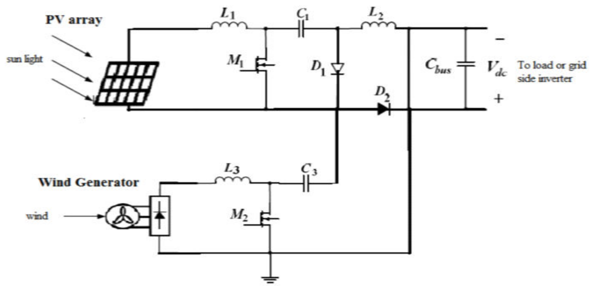

Figure-1. Fused Cuk Sepic converter.

FUSED LUO CONVERTER

The proposed system is a fusion of Positive output Luo converter and Negative output Luo converter. The CUK and SEPIC converters are replaced by Positive output Luo converter and Negative output Luo converter respectively. The proposed hybrid energy system is shown in the fig. 2. This configuration allows the two sources to supply the load separately (PV/ACsupply) or simultaneously together (Hybrid) depending on the availability of the energy sources. The main purpose of this hybrid is to meet our daily demand effectively and to get an uninterrupted power supply. By combining these two intermittent sources, the system's power transfer efficiency and reliability can be improved significantly. For the same value of duty cycle, the values of inductance and capacitance are less for Fused Luo converter than the fused cuk sepic converter which reduces the overall cost and size of the converter.

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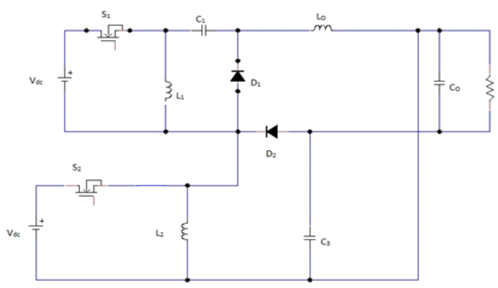

Figure-2. Multi Input Luo Converter.

POSITIVE OUTPUT LUO CONVERTER

The circuit diagram of elementary positive output Luo converter is shown in fig.1. The converter consists of a positive Luo-pump and a low-pass filter -, and lift circuit [8].

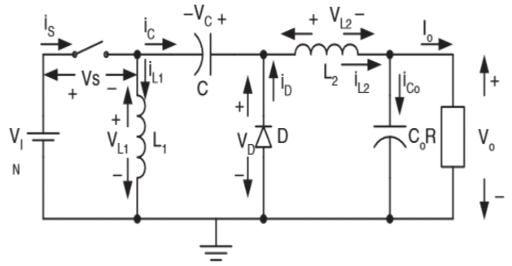

Figure-3. Positve output Luo converter.

$$V_o = \frac{K}{1-K} V_1 \quad (1)$$

$$I_o = \frac{1-K}{K} I_1 \quad (2)$$

$$\Delta i_{L1} = \frac{KTV_1}{L_1} \quad (3)$$

$$\Delta i_{L2} = \frac{KTV_1}{L_2} \quad (4)$$

$$C_O = \Delta Q / \Delta V_O \quad (5)$$

$$\Delta V_C = \frac{1-K}{C} T I_1 \quad (6)$$

NEGATIVE OUTPUT LUO CONVERTER

The circuit diagram of elementary negative output Luo converter is shown in fig.4.The pump inductor L absorbs energy from the source during switch-on, and transfers the stored energy to capacitor C during switch-off [8].

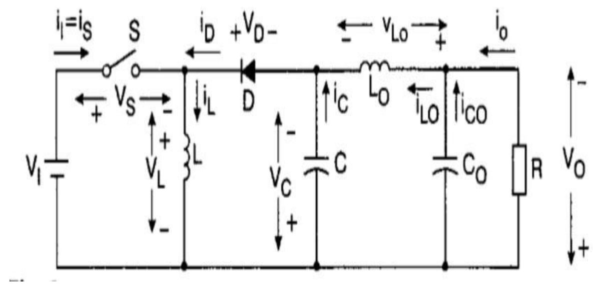

Figure-4. Negative output Luo converter.

$$V_o = \frac{K}{1-K} V_1 \quad (7)$$

$$I_o = \frac{1-K}{K} I_1 \quad (8)$$

$$\Delta i_L = \frac{KTV_1}{L} \quad (9)$$

$$\Delta V_C = \frac{K}{C} T I_O \quad (10)$$

$$\Delta i_{LO} = \frac{K}{8f^2 C L_o} I_O \quad (11)$$

$$\Delta V_{CO} = \frac{K}{64 f^3 C L_O C_O} I_O \quad (12)$$

MODES OF OPERATION

Mode-1: S1 on, S2 on

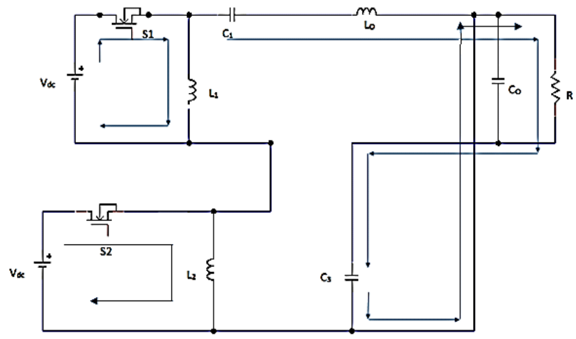

Figure-5. Mode I.

In this mode both the switches S1 and S2 are turned ON. The Input current flows through the switch S_1 and inductor L_1. Hence the inductor L_1 is charged. Similarly inductor L_2 is also charged through the switch S_2. Meanwhile the capacitor C_1 and inductor L_o discharges through the load.

Mode-2: S1 on, S2 off

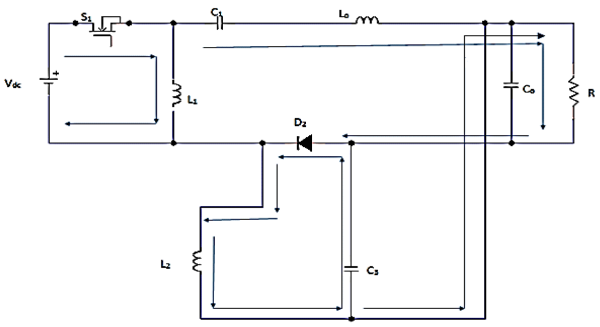

Figure-6. Mode II.

In this mode switch S_1 turned ON while switch S_2 is turned OFF. The Inductor L_1 is charged through the switch S_1 while inductor L_2 discharges through the diode D_2 due to which the capacitor C_3 is charged. The capacitors C_o, C_1 and the inductor L_o discharges through the load R.

Mode-3: S1 off, S2 on

In this mode switch S_2 turned ON while switch S_1 is turned OFF. Here the inductor L_2 discharges through the diode D_2 and charges the capacitor C_2. Meanwhile the capacitor C_1 and the inductor L_2 is charged through the switch S_2 and the inductor L_o and the capacitor C_o discharges through the load R.

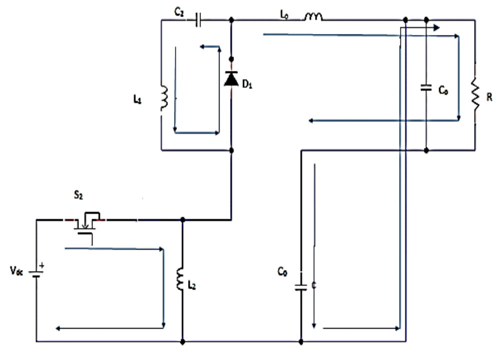

Figure-7. Mode III.

Mode-4: S1 off, S2 off

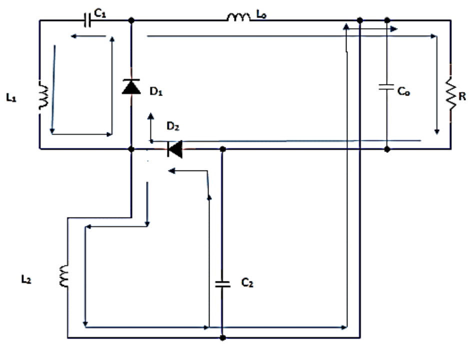

Figure-8. Mode IV.

In this mode both the switches S_1 and S_2 are turned off. Here the inductor1 discharges through the diode D_1 due to which the capacitor C_1 is charged. Similarly the inductor L_2 also discharges through C_2 and D_2.Meanwhile the inductor Lo discharges and the current flows through the load R.

Table-1. Component ratings.
For V_{in} =12 V, Switching Frequency f =25KHz, Duty Cycle K=75%, R_o =10Ω.

Converter	L_1	L_2	L_O	C_1	C_2	C_O
Fused Cuk Sepic converter	10 mH	1.6 mH	10 mH	0.1 mF	0.15 mF	0.15 mF
Fused Luo converter	6 mH	6 mH	3 mH	20 µF	60 µF	0.5 µF

Table-2. Tabulation of V_O and I_O.
For V_{in} =12 V, Switching Frequency f =25KHz, Duty Cycle K=75%, R_o =10Ω.

Converter	Output voltage (V_O)	Output current (I_O)
Fused cuk sepic converter	66.24 V	6.62 A
Fused luo converter	-66.24 V	-6.62 A

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SIMULATION RESULTS

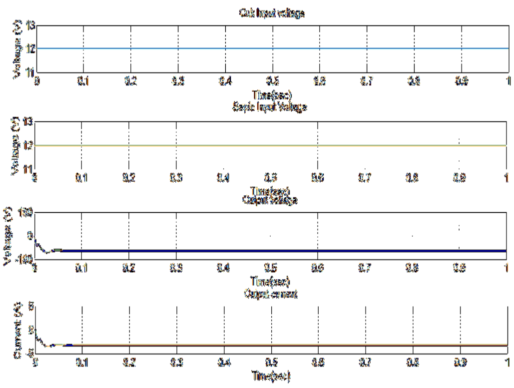

Figure-9. Fused Cuk Sepic converter.

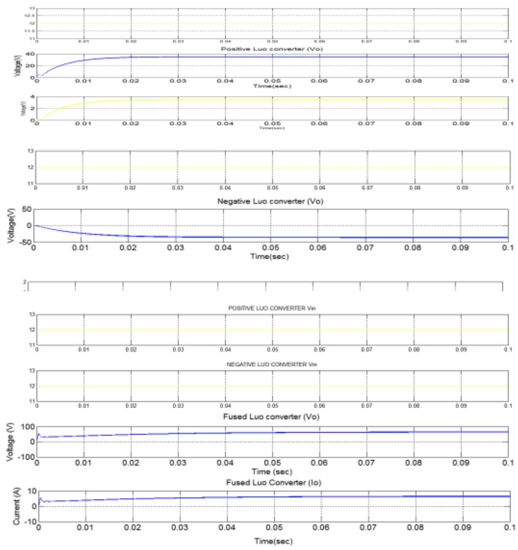

Figure-10. Fused LUO converter.

CONCLUSIONS

Thus a new hybrid integrated topology, fed by two DC sources is configured using Positive output Luo converter and negative output Luo converter. This configuration allows the two sources to supply the load separately or simultaneously together (Hybrid) depending on the availability of the energy sources. The main purpose of this hybrid is to meet our daily demand effectively and to get an uninterrupted power supply. By combining these two intermittent sources, the system's power transfer efficiency and reliability is improved significantly. Due to the inherent nature of this fused Luo converter, additional filters are not necessary to filter out high frequency harmonics and hence an enhanced output voltage with less ripples is obtained. For the same value of duty cycle, the values of inductance and capacitance are less for Fused Luo converter than the fused cuk sepic converter which reduces the overall cost and size of the converter.

REFERENCES

[1] Mohan, N., Undeland, T.M., and Robbins, W.P.: "Power electronics: converters, applications and design" (John Willey and Sons, Inc, 2004, 3rd edn.)

[2] Massey, R.P., and Snyder, E.C.: "High-voltage single-ended DC-DC converter". IEEE Power Electronics Specialists Conf., Record 1977, June 1977, pp. 156–159

[3] Luo, F.L., and Ye, H.: "Advanced DC-DC converters" (CRC Press, Boca Raton, FL, USA, 2004)

[4] Chen et al., "Multi-Input Inverter for Grid-Connected Hybrid PV/Wind Power System", IEEE Transactions on Power Electronics, vol. 22, May 2007.

[5] Y. C. Liu, and Y. M. Chen, "A Systematic Approach to Synthesizing Multiple-Input DC/DC Converters," IEEE Trans. Power Electron. vol. 24, No. 1, pp. 116-127, January 2009.

[6] Y. Li, X. Ruan, D. Yang, F. Liu and C. K. Tse, "Synthesis of Multiple- Input DC/DC Converters," IEEE Trans. Power Electron., vol. 25, no. 9, pp. 2372-2385, September 2010.

[7] Teena Jacob,Arun S "Modelling of Hybrid Wind and photovoltaic Energy System using a new converter Topology" Electrical and Electronics Engineering: An International Journal (EEEIJ) Vol.1, No.2, 2012

[8] M. Chilambarasan, M. Ramesh Babu, R. Sujatha, "Design And Simulation of LUO Converter Topologies For Photovoltaic Applications", International Journal of Applied Engineering Research ISSN 0973-4562 Volume 9, Number 23 (2014) pp. 21553-21560.