International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 06 | June - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

DESIGN OF MULTI-PORT DC-DC CONVERTER

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Abstract-Integrating Energy sources to have a sustainable energy supply is an important aspect to handle the significant loads. Multiport power converters are used to connect various types of energy sources and loads. The key advantages of multi-input converters lie in their capability to interface with multiple input sources such as solar panels, wind turbines, batteries, and grid power, thereby optimizing energy utilization and enhancing system reliability. In the paper, a new configuration of single switch Dual– Input Single-Output (DISO) DC-DC converter is proposed. This paper presents an overview of multi-input converters, focusing on their design, operation, and applications in renewable energy integration Multiport converter reduces the system size and cost by reducing the number of components. The proposed converter is verified in MATLAB/ Simulink and validated with simulation results.

Key Words*:** ***Dul-input single-output converter (DISO), switch, and Multiport converter.

1.INTRODUCTION

Renewable energy sources have seen a surge in demand for electric vehicles (EVs), auxiliary power, and grid-connected applications over the last decade. Multiport DC–DC converters are required in these applications for hybridizing energy sources, which reduces the number of components, complexity, and cost of the system. Multi-input DC-DC converters are essential components in modern power systems, enabling the integration of multiple energy sources and enhancing system reliability and efficiency. Unlike traditional single-input converters, multi-input converters can handle input power from various sources such as solar panels, batteries, fuel cells[1]-[2].

Multiple-input converters (MICs) has the tremendous performance over conventional solutions that employ multiple single converters:

1) MICs has a compact in size and a lower cost because of sharing the reactive components and active power switches.

2) Higher power density.

3) MICs avoid the complex communication among multiple different power sources due to the unified power management with centralized control.

4) improve the dynamic performance. Therefore, MICs are an excellent candidate for EVs and grid connected applications which is economic and good development prospects.

Therefore, multi-input converters (MICs) are a good choice for grid-connected systems, renewable energy sources (RESs), and EV applications.

Mostly, the non-isolated MICs are proposed based on the structure of the boost or buck dc–dc converters. The two independent voltage sources are successfully integrated by using the time multiplexing scheme and reduced device count which results, reduction in cost, size and power losses. However, in this configuration the output voltage is still negative. Based upon a time-sharing concept a MIC can operate in different modes of operation, such as boost, buck and buck–boost mode; nevertheless, only one input power source is allowed to deliver energy at a time. Over a decade, few topologies are developed which pulled the attention towards hybridizing the energy sources with high voltage gain and effective energy storage system for EVs and renewable energy source applications. These topologies are greatly impacted on part count, associated control scheme and size. The energy sources are operated individually or simultaneously with a proper time delay between them and it may be difficult to get a wide range of duty cycle operation.

2.PROPOSED TOPOLOGY AND MODES OF OPERATION

The two-input converter proposed in this paper is shown in the Figure1. There are two input sources V1, V2 , and two inductors L1 and L2 and the diodes are taken as D1, D2 and D3. In this a single switch is used. Also, there is output capacitor C0. The input1 is taken as Solar PV Array and input2 is taken as battery.

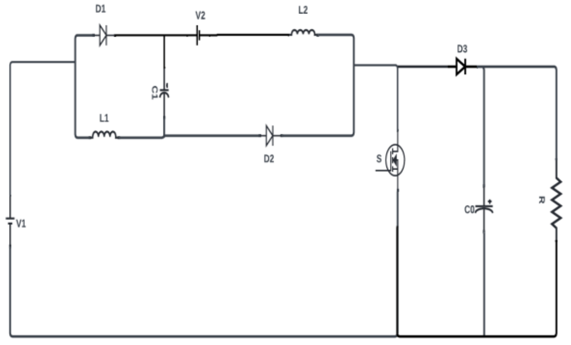


Fig. I. The proposed converter configuration

A. Mode 1

Figure2(a) represents the first operating stage of the converter. Here, the switch S is on. The diode D1, D2 are on and D3 is off. The inductors L1 and L2 are charged.

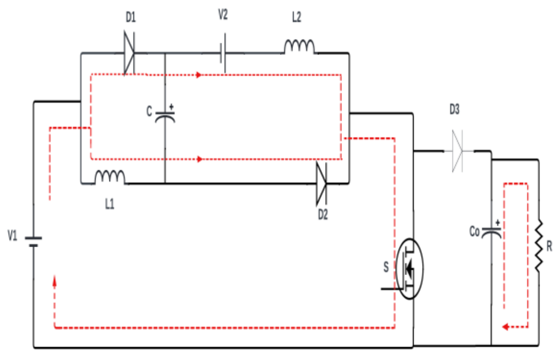


Fig. 2(a). Equivalent circuit diagram of the proposed topology for mode1.

B. MODE 2

Figure2(b) represents the second operating stage of the converter. Here, the switch S is off. The diode D1, D2 are off and D3 is on.

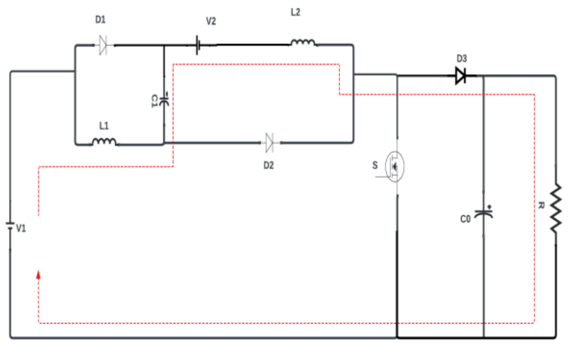


Fig. 2(b). Equivalent circuit diagram of the proposed topology for mode2.

3. ANALYSIS OF THE PROPOSED CONVERTER

Analysis of the proposed converter in steady state is presented in this section and expression for output voltage is derived.

When switch S is turned on (mode 1), and the diode d1, d2 are on.

$$VL1 = V1$$

$$VL2 = V1 + V2$$

$$VC1 = V1$$

When switches S is turned off (in mode 2), and D3 is turned on.

$$V1 - VL1 - VL2 + V2 + VC1 - Vo = 0$$

$$VL1 = VL2$$

Applying volt-second balance equation,

$$V1D + (V1 + V2)\,D + (V1 + V2 + VC1 - Vo)\,(1-D) = 0$$

$$V_o = \frac{(2V1 + V2)}{(1-D)}$$

IV. PARAMETERS DESIGN

Inductor:

The inductance value depends on maximum inductor voltage (V), ripple current (ΔIL), switching frequency (Fs) and duty ratio (D) for charging to maximum voltage. Thus, the inductance is given by the equation:

$$V = L\frac{di}{dt}$$

$$L = \frac{V_{in}DT}{\Delta I_L}$$

$$L = \frac{V_{in}D}{\Delta I_L * fs}$$

Capacitor:

The equation above given the critical value of output capacitance. The value of switched capacitor Co and C1 will be equal Where I1 is the input current and ΔVo is the ripple voltage across capacitor Co or C1.

$$I = C\frac{dv}{dt}$$

$$Co = \frac{IoDT}{\Delta Vo}$$

$$C1= \frac{Vc1D}{\Delta Vo * fs * R}$$

V.PARAMETERS SPECIFICATIONS

SI. NO.	PARAMETERS	VALUES
1.	Power rating	100W
2.	Switching frequency	10kHZ
3.	Input voltage(V_1,V_2)	36V,10V
4.	Output voltage	190V
5.	Inductors L1 and L2	31.6mH
6.	Capacitors , Co	5mF
7.	Load Resistance R_L	360Ω

VI. SIMULATION AND RESULTS

The proposed configuration performance and operation are studied through extensive simulations in MATLAB\Simulink environment. The simulation study is carried out at a different set of voltages. The parameter details are presented in Table. I. It is tested at V1 = 36V, V2 = 10 V, and switching frequency is considered as 10 kHz. The corresponding, simulation results of output voltage (V0) is shown in Fig. 3 respectively.

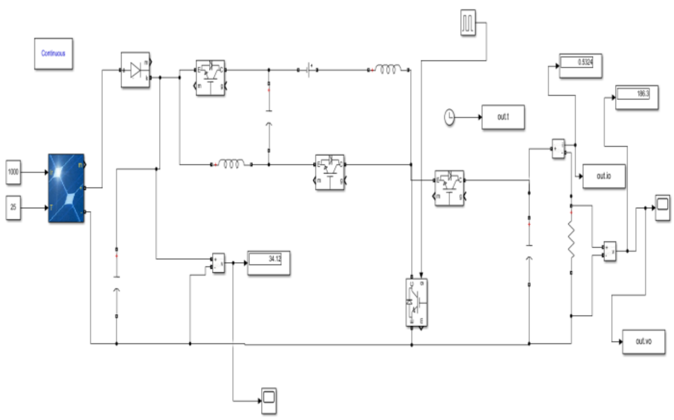
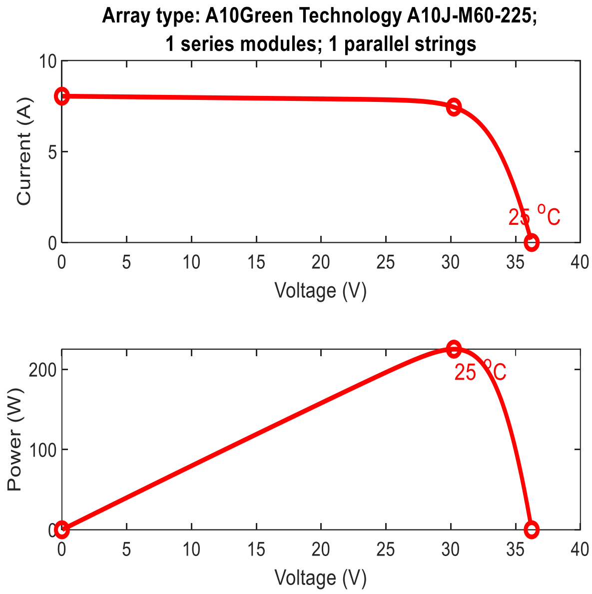


Fig. 3. Simulink model of proposed converter



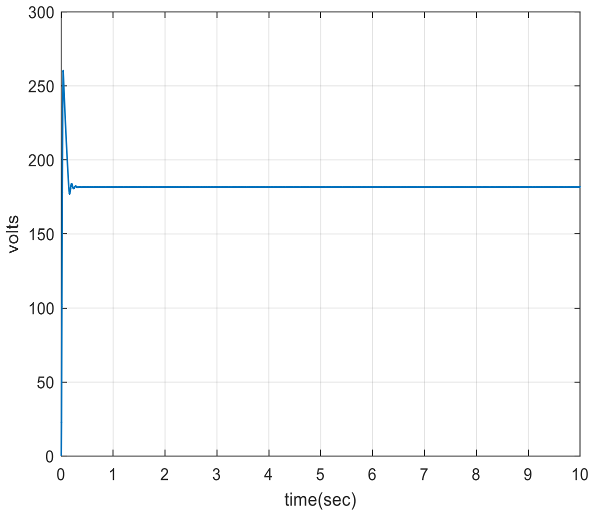


Fig.4 Simulated output voltage of proposed converter

VII. CONCLUSION

A new DISO converter structure with reduced switches is presented in this paper. The operating principle and modes of operation have been explained in detail. The proposed configuration has a simple structure and low complexity. The key features of the proposed converter are, it uses a simple gate-driving pattern, designed to improve the energy source utilization and output voltage. The proposed configuration can be operated at a different set of input voltages and without duty cycle constraints. The simulation tests validate the effectiveness of the proposed converter.

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