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High Efficient DC-DC Converter with Low-Input Ripple

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Abstract— The depletion of fossil fuel reserves and increased energy demand led to search of renewable energy resources. There are various renewable sources are available. Among these, the solar PV is most commonly used. In this paper a high efficient converter has been deliberated. There are two stages of conversion. In first stage, large conversion ratio with low potential stress on converter switch is accomplished. In second stage, the conversion rate of the converter is further improved with reduced conduction losses. A cuk regulator integrated through Boost and SEPIC converter based topology has been presented. The design parameters of proposed switched mode regulator topology has discussed and results are verified with MATLAB simulation.

Key words: Boost, Cuk, SEPIC converter, high voltage ratio, one switch regulator.

I. INTRODUCTION

The conventional sources (fossil fuel) creates more pollution into an environment. It will emits the CO2 and leads greenhouse effects. So, the usage of non-conventional energy sources such as Air (wind), Solar PV are increased. The energy gathered from sun has been used in power industry because of its cleanness and cost effectiveness when compare to other non-conventional sources [1]. The solar photovoltaic (PV) power generation system is extensively used in grid-connected and off-grid applications [2].Solar PV systems is used for low power electrical generation. The PV output voltage is constrained to low DC voltage levels, typically with an open circuit voltage that is limited to 1500V per string for safety considerations [3]. The solar power is fluctuated due to whether changes and a controller is used to track the maximum power during day time. The lower DC voltages of PV system is regulated to utilizable value by using a suitable converter. Conventional boost converter is the first converter is designed with high conversion ratio [4]. The power semiconductor device is used in conventional boost converter. But, the switch undergoes high dv/dt stress and the potential gain also less. Hence, the rating of switch is increased to reduce stress on it. High conduction loss is occurred in the converter system due to an increased switching rate. Hence, new isolated switched mode regulator topology is utilized with transformer connection. It leads the low switching frequency, switches are turned on/off at high voltage& current and the transformer core also gets saturated. The static voltage gain is increased by coupling the inductors with conventional converter. A new configuration of regulator is introduced by integrating two converters in order to get high static voltage gain. In [5] Boost-cuk integrated converter topology is presented with PV generator. An integrated double stage dc-dc converter is presented in this paper. At first stage the boost converter is combined with SEPIC. A newly integrated converter is combined with cuk regulator at stage two. The proposed converter topology reduces the switch potential stress and also provides better voltage conversion ratio with single MOSFET switch. This proposed converter topology is designed and the results are analyzed using MATLAB simulation.

II. PROPOSED SYSTEM

This paper presents a converter which helps to improve the static voltage gain and efficiency. This proposed converter contains both DC-DC and DC-AC conversion stage.

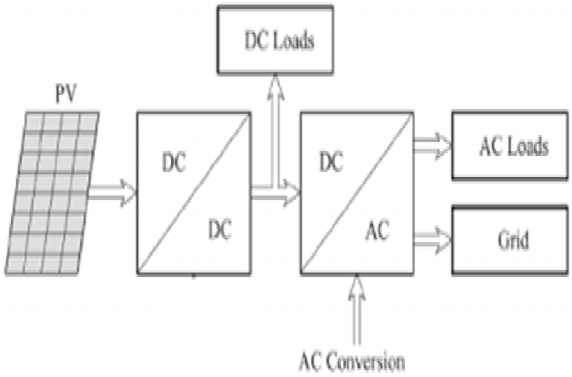

Fig. 1 Block Diagram of proposed an integrated Converter Topology

A hybrid design of cuk and integrated boost & SEPIC converter is proposed. In fig.1 the proposed converter block diagram is shown.

The transfer function of an integrated boost and SEPIC converter is represented in (1).

$$V_{out}=2/(1-\delta)\ V_{in} \quad (1)$$

The transfer function of conventional cuk converter is represented in (2),

$$V_{out}=\delta/(1-\delta)\ V_{in} \quad ..(2)$$

Addition of (1) & (2) gives the output voltage of newly proposed converter.

$$V_o=2/(1-\delta)\ V_{in}+\delta/(1-\delta)\ V_{in}$$

$$V_o=(2+\delta)/(1-\delta)V_{in}\ldots \quad ..(3)$$

Equation (3) represents the voltage equation of the integrated conventional boost-sepic&cuk converter topology.Fig.2 represents the entire proposed system circuit diagram.

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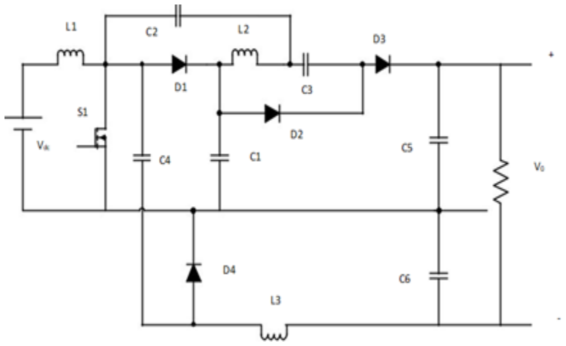

Fig.2 Circuit Diagram of the converter topology

This system consists of single switch and parasitic elements. Two assumptions are taken to analyze an integrated regulator system. MOSFET to be considered as lossless and the above mentioned system is operated in Continuous Conduction Mode. There are two modes of operation, first one is switch ON mode and the switch is in OFF state in second mode.

III. DEVELOPMENT OF CONVERTER

In Equivalent circuit of proposed topology, the diode D1, D3 and D4 is in blocking state due to reversal voltage polarity of capacitor and inductors. The energy is stored in an inductors L1, L2 & L3 and current which is flowing through it increases simultaneously. In mode2 switch is in OFF state, the three inductors named L1, L2 and L3discharges and current through them starts decreasing. The diodes D1, D3 and D4 are forward biased simultaneously to make them to ON state and frame the loop for above mentioned currents which flowing through an inductor.

The inductors L1 and L2 both are coupled together and it is assumed that L1= L2.The equation4, 5 represents the formula for calculating L1 (L2) and L3.

$$L1 = \frac{\delta . V_{in}}{\Delta I_{L1}} Ts\text{-} \quad (4)$$

$$L3 = \frac{(1-\delta)V_{out}}{\Delta I_{L3}} Ts \quad .. (5)$$

The following equations represents the capacitor calculation.

$$C = \frac{V_{out} . \delta}{\Delta V_{Cs} R_L} Ts \quad .(6)$$

IV. SIMULINK MODEL AND RESULTS ANALYSIS

The proposed converter has developed using MATLAB to verify its effectiveness. Fig.3 shows the MATLAB/SIMULINK model of an integrated regulator which presented above.

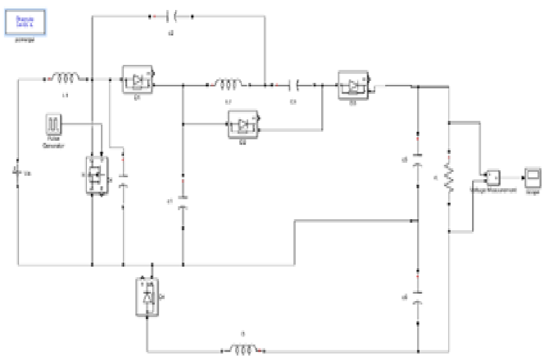
Fig.3 Simulink Model of Proposed Converter

Fig.3 displays the Simulink model of combined boost, cuk and SEPIC converter topology. The effectiveness is demonstrated through simulation results. It is seen to be the results are better than the other converters.

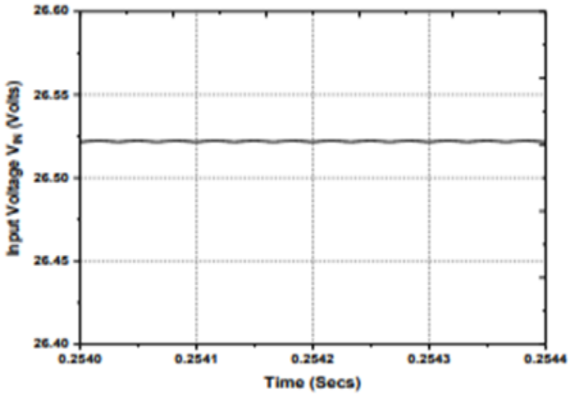

Fig.4 Input Waveforms of proposed system

The performance of combined boost, cuk and sepic topology is identified with the input and output waveforms. The input and load waveforms are shown in fig.4 &5. Input voltage is around 26V and output is around 400V. The power semiconductor switches requirement has been reduced to 1 in this proposed system. Then losses which arise during ON and OFF time of switch is reduced to low level. The performance of the system is improved and the converter design is simple. The conversion ratio is also improved with low-ripple on input side.

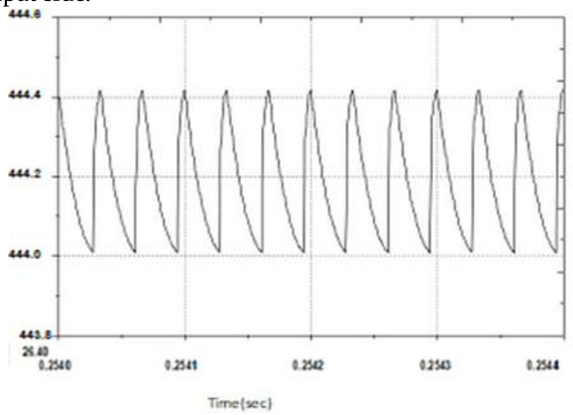

Fig.5 Output Waveforms of combined converter

V. CONCLUSION

A new integrated/combined converter topology for renewable application is discussed. It has less number of MOSFET as switch and reduces conduction losses. The ripple at input side of the entire system is low by selecting the inductor with appropriate values. This has been achieved by combining the conventional boost regulator with cuk-sepic converter. The conversion values also increased to get high load voltage. Finally, the proposed system has better efficiency than the other step up converters used in solar PV based applications. The performance improvement in the proposed converter system is verified by the Simulink model and the results obtained.

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