REDUCTION OF RIPPLE IN OUTPUT CURRENT OF SOFT-SWITCHING STEP-UP CONVERTER BY USING A SINGLE SWITCH SEPIC CONVERTER

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ABSTRACT:

Here SEPIC converter is introduced at the output of the soft-switching step-up converter. The offered converter lowers the ripple content and also a good step up gain is achieved. The offered converter is designed based on KY converter, which is a voltage boosting converter. Thus it has the added features like non pulsating output current, clamped switch voltage stress, to voltage at the input and it has a quick transient response. Here in the offered converter an additional ZVS (zero-voltage-switching) is achieved for the power switches by using an auxiliary circuit. Therefore it reduces the losses during switching operation and there is an improvement in the system efficiency. In addition the content of ripple of the filter inductor current is cancelled by using this auxiliary circuit. Thus the offered converter achieves a reduction of ripple in current at the output. With the analysis of the offered converter in the MATLAB software, the analysis of the steady state and the principle of operation are given in detailed, graphically with all the characterizes of operating elements of this circuit topology.

Keywords: SEPIC converter, KY converter, MATLAB.

I.INTRODUCTION

The demand for the portable and convenient power systems is increasing nowadays. These portable and convenient power systems would be handier if they fulfill the requirements such as small output ripple, small size, compactness, light weight and so on. These portable and convenient power systems are needed sometimes to boost the voltage at the input to an adequately and constant high level. But it should consider the ripple in the voltage at the output seriously [1].

To lower the ripples in the voltage there are distinctive solutions. One way is implementing operation at high-frequency. But however this method brings a low efficiency in the system operation due to hard operation of switches there will be a large switching loss. Another way is implementing large LC filters at the output voltage. However this implementation enlarges the weight and size of the system. A step-up converter with soft-switching implemented is shown in the Fig. 1.1. This has properties of KY converter. Features like quick transient response, clamped switch voltage stress at the input voltage and lower pulsating current at the output. Additionally, the implemented converter has features like soft-switching and with a reduced ripple current of inductor. Here it uses the auxiliary circuit which consists of a capacitor and serial inductor. Thus improving the efficiency of system by decreasing the losses during the switching operation and negates the filter inductor ripple component effectively.

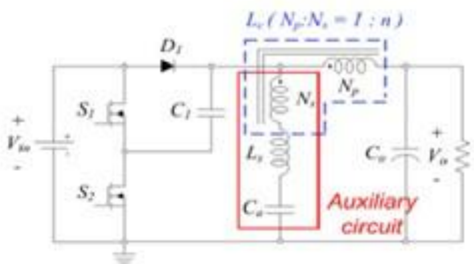


Fig. 1. Circuit diagram of soft-switching step-up KY converter

The integration of this convertor with improved version of SEPIC (Single-Ended Primary Inductance Converter) is implemented. Thus, it get a high step-up gain operating with a lower voltage at input and higher input voltage operation is provided with a low step-up gain. By implementing this SEPIC convertor reduces the total number of components which also reduces the losses during switching operations. It also has an improved efficiency, higher voltage gain and an improved reliable system operation.

The improved SEPIC converter implementing adapting techniques of voltage multiplier is shown in Fig. 1.2.

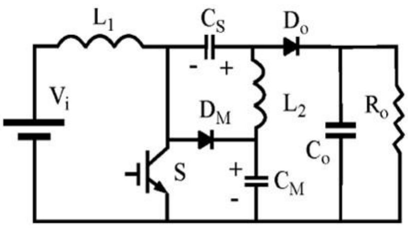


Fig 2. Modified SEPIC converter

II. LITERATURE SURVEY

Why the SEPIC converter is to be implemented

Actually, in order to achieve high conversion ratio of voltage, with high efficiency, high gain enhancement techniques were implemented previously. A dc-dc converter is the most proficient strategy for managing voltage in a circuit. There are 5 fundamental sorts of dc-dc converters. It can reduce voltage by Buck converters. Whereas it can step-up voltage by Boost converters. Here the Cuk, buck-boost and SEPIC converters can increment or Step-down the voltage.

The Buck Converter:

The buck converter is a usually operated as a part of circuits that reduces the voltage level from the voltage at the input as indicated by the necessity. It has the benefits of simplicity and ease. Figure 3 demonstrates a buck converter the operation of this converter begins when the switch is OFF. When the switch is shut, the current moves through the inductor gradually at first, later building after some time. When the switch is shut the inductor pulls current by the diode, and this implies the voltage at the output of the inductors is less than it initially was. This is the extremely fundamental rule of operation of the buck circuit.

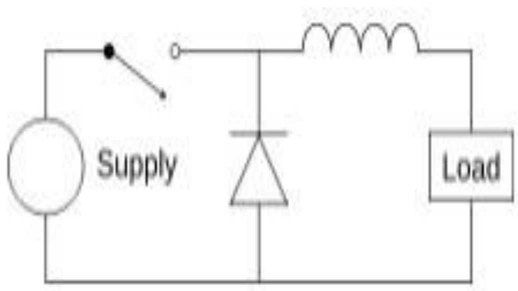


Figure 3 : BUCK Converter

The Boost Converter:

A boost converter is a power converter. Here in this converter its DC voltage at output more prominent than its DC voltage at its input. It's a class of SMPS (switching mode control supply) having not less than two switches of semi-conductors, which are a transistor and a diode. And no less than one component of energy storage. Filters which are made of capacitors are typically added to the converter output to decrease ripple at the output voltage. A boost converter occasionally called as "step-up" converter because it steps up the input voltage. Meanwhile power (P = VI) must be saved, the current at output is lower than the current at the source.

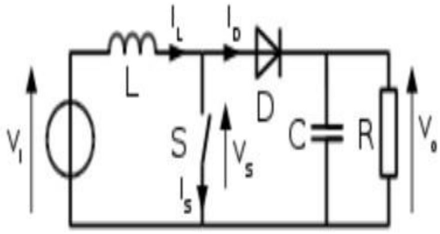


Figure 4 : BOOST Converter

BUCK-BOOST Converter

The buck-boost converter is another fundamental switched mode converter. The output can be higher than the voltage at input or lower, for the buck-boost converter. Presumption made about the operation of this circuit is same as it was for the past converter circuits.

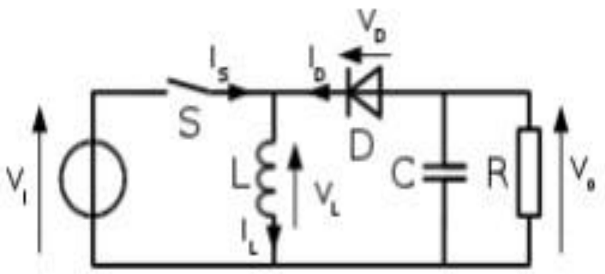


Figure 5: BUCK-BOOST Converter

The CUK Converter:

The Cuk converter is utilized for getting the voltage at output with various extremities. That implies output voltage size can be either bigger or smaller when compared to the input, and there is an inversion of polarity on the output. . For the dc supply, the inductor on the input side acts like a filter, to avoid vast harmonic current. Distinct from the past converter topologies where transfer of energy exchange is related with the inductor. Energy exchange for the cuk converter relies upon the capacitor C1.

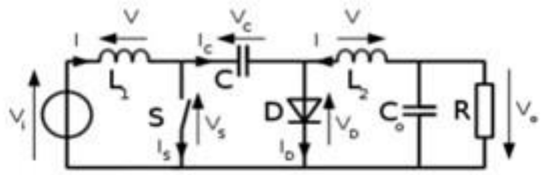


Figure 6: CUK Converter

The proposed SEPIC converter:

The SEPIC (single-ended primary inductor converter) converter is a kind of DC/DC converter permitting the voltage at its output to be higher than, not exactly, or equivalent to that at its input. The output of the SEPIC for the control transistor is handled by the duty cycle.A SEPIC is basically a boost converter took after by a buck-boost converter, in this way it is like a customary buck-boost converter, however have benefits of having non-inverter output here there is same or similar polarity of the output voltage as that of the input voltage, utilizing a series capacitor for coupling energy. Here the energy is coupled from the input to the output, and being prepared to do genuine shutdown: when the switch is Off, its output voltage drops to 0 V, following a genuinely heavy transient dump of charge. SEPIC converter is helpful in applications where a battery voltage can be underneath or above that of the controller's expected output.

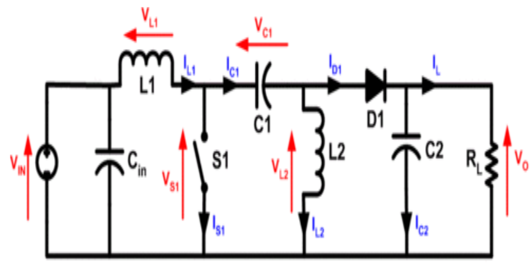


Figure 7: SEPIC Converter

In spite of the fact that the boost converter for the most part has higher proficiency than the SEPIC, be that as it may, it is appropriate for situations where the battery voltage is higher than the PV module voltage. The buck–boost highlight of the SEPIC broadens the applications.

Features \ Converters	Buck-boost	Cuk	Positive Buck-boost [13]	SEPIC	Flyback
Output voltage Polarity	Invert	Invert	Non-invert	Non-invert	Non-invert
Input current	Pulsating	Nonpulsating	Depends on operation mode	Nonpulsating	Pulsating
Switch drive	Floated	Floated	One floated One grounded	Grounded	Grounded
Efficiency	Low	Medium	High with only one stage is active	Medium	Low
Cost	Medium due to float drive	Medium due to additional block capacitor	High due to an additional switch and diode, a more complex drive circuit	Medium due to additional block capacitor	Low due to grounded switch and no block capacitor

Table 1. Comparison table of different converters

II-I PROBLEMS IDENTIFICATION:

To reduce voltage ripples, it can use large LC filters but, this enlarges the system size and weight. It can also adopt high frequency operation, but it brings low efficiency, due to high switching losses.

Interleaving technique can also be adopted like several converters are connected in parallel , but it increases number of components which leads to increases in its size and weight .By increasing the number of components It also increases the total cost of the system and also the control of the system becomes complex.

From past strategies problems identified in every technique are less voltage gain, more segment stress, poor productivity, high voltage ripple, and more circuit complexity. Here executing the SEPIC converter is presented for a soft- switching step-up converter based on KY converter model to tackle above recognized issues.

III. OUTPUT RESULTS

Design of Soft-switching KY converter module.

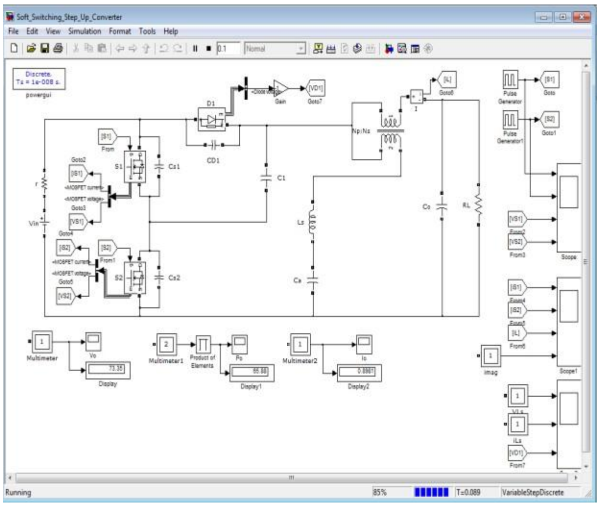


Fig. 8. Design of Soft-switching step-up converter model in Simulink software of MATLAB

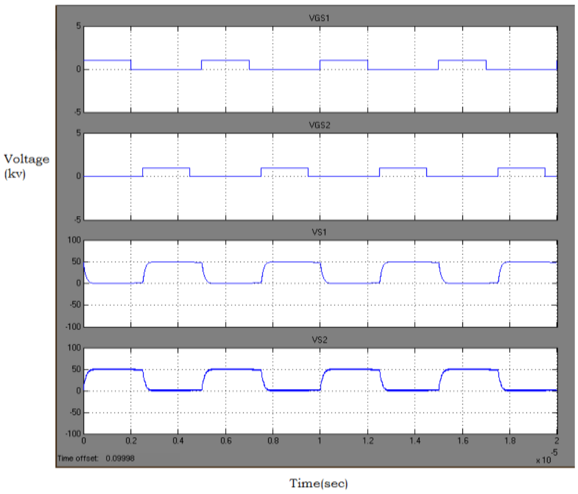
For the voltage of output inductance Lm, by applying the volt-second balance it gives

$$M = Vo/Vin = 1 + D$$

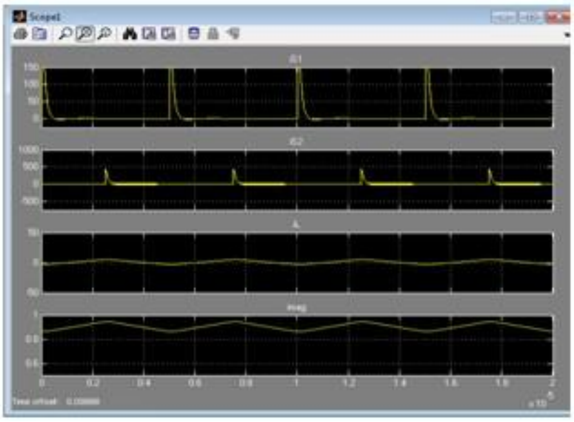
The output Io is given by

$$Io = iL(avg)$$
$$= iLm(avg) + ip(avg)$$
$$= iLm(avg) + niLs(avg)$$

Output waveforms:



Output waveforms of the proposed module of scope



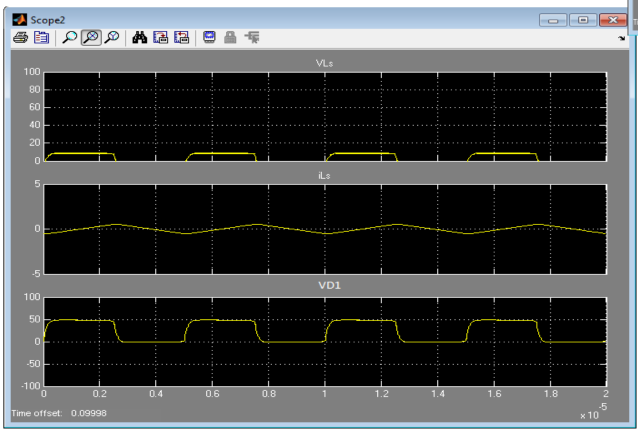
Output waveforms of the proposed module of scope1

Since here the inductor current iLs(avg) should be zero, the current at output Io can be given as

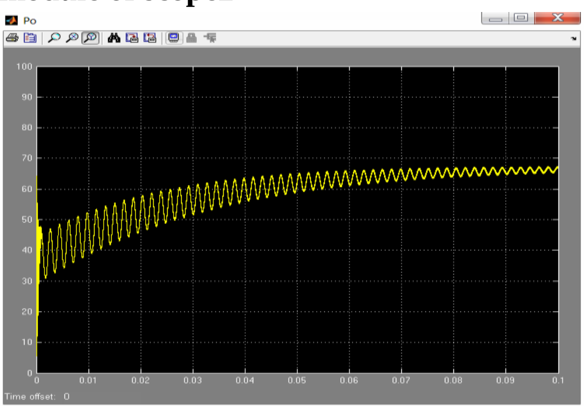
$$I_o = i_{Lm(avg)}$$

The average magnetizing current iLm(avg) is give by

$$i_{Lm(avg)} = (I_{Lm(max)} + I_{Lm(min)})/2$$

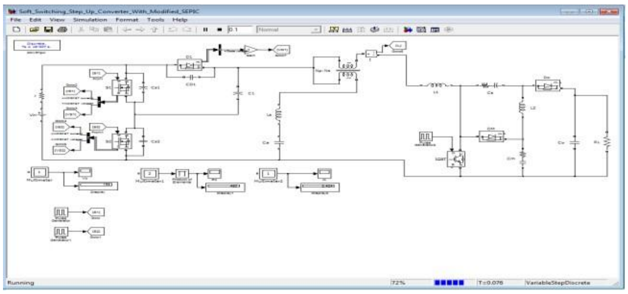


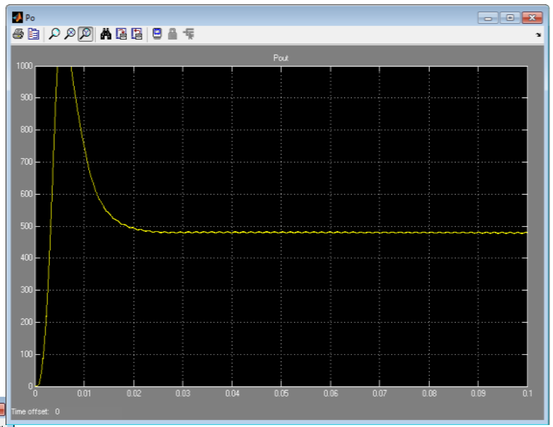
Output waveforms of the proposed module of scope2



Output Power of the Soft-switching step-up converter

Design of Soft-switching KY converter module with Modified SEPIC Converter





Output Current waveform of the Soft-switching step-up converter with modified SEPIC converter

CONCLUSION

A modified SEPIC converter at the output of the soft-switching step-up converter further reduces the ripple content of the output current and also a high voltage gain can be achieved. It gets a high voltage conversion ratio. Here the complexity of the circuit is reduced by the use of voltage boosting converter based on KY converter, which leads to reduction in number of components, thus reducing size and cost. By using the auxiliary circuit, the "zero voltage switching (ZVS)" is achieved, that significantly reduces the losses during the switching operation and the ripple at the output filter inductor current is cancelled irrespective of the load conditions. It improves the system efficiency by reducing the system losses.

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