ZVS based SEPIC Converter Fed DC Motor using PIC Microcontroller

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Abstract— *This paper presents the advantage of SEPIC(Single Ended Primary Inductance Converter) over non-isolated DC-DC converter. It is widely used in Aerospace, Telecommunication, UPS, Photovoltaic cell. The main advantage of SEPIC is to reduce the switching losses. Zero Voltage Switching (ZVS) is applied to the SEPIC converter and its efficiency is increased. Hardware result is compared with the simulation using MATLAB .The output of the SEPIC remains constant. The input of the SEPIC converter is 12V and the output obtained is 70V.*

Keywords— Zero Voltage Switching; Bidirectional Power Flow; DC Motor; SEPIC Converter; PIC Microcontroller

I. INTRODUCTION

Power electronics converter are utilized for the operation of bidirectional power flow which is needed in industrial applications. Bidirectional power flow is operated in both the non-isolated and isolated converter. Non isolated DC-DC converter is suitable for high voltage operation with some modification such as SEPIC converter operation. The soft switching is used in half bridge bidirectional DC-DC converter. The loss occurs due to operation of the switches used in the circuit. In SEPIC converter only two switches are used ,and so the efficiency can be increased by eliminating the loss occurring in the circuit. The value of the capacitor is large, so they are free from the distortion output and output voltage is constant. The performance of the non- isolated DC-DC converter is limited to low and medium voltage operation.

The conventional hard switching converter suffers from efficiency degradation problem. MOSFET and IGBT are used as the power switching devices in the SEPIC converter. The half bridge low voltage MOSFET and high voltage IGBT using ZVS technical and isolate operation are carried the low and medium application this same function is carried out in the non isolated active clamping circuit is carried out. MOSFET are used as switching devices in converters. This loss occurs during on condition .This reduces the losses and improves the efficiency

II. OPERATING PRINCIPLE

Fig.1 shows the block diagram of SEPIC converter. The input A.C supply is given to the circuit. To rectify the ripple content using passive filter. After reducing the ripple content the current is flowing to the boost rectifier and the SEPIC converter .The input voltage is boosted and rectified from A.C supply into D.C .The D.C output produced is not pure D.C. So the filter like C filter, LC filter Pi filter and RC filter, here C filter is efficient for the SEPIC converter at the same time output is produced. The power supply is given to the MOSFET driver circuit and by the PIC microcontroller PWM pulses are produced in order to obtain the better output pulses. The capacitor is designed and kept in the output side of the D.C motor. SEPIC provides an additional step up ratio. The combination of a boost and SEPIC converter is called as the SIB(SEPIC Intergrated Boost Converter).

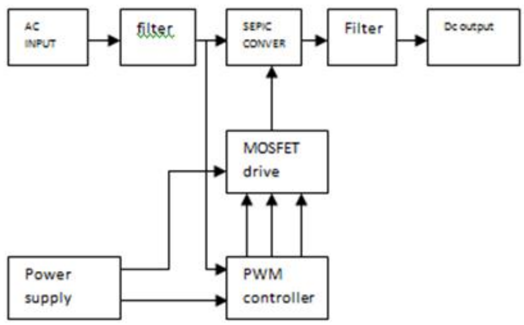

Fig. 1: Block diagram of SEPIC converter

A. *Assumption*

1) Output Voltage is kept Constant.
2) Transformer is modeled as a magnetizing Inductor Lm, a leakage inductor L and an ideal transformer with a turn ratio n.
3) The Converter Component sis ideal.
4) The capacitor C0 and c1 are large.

The output voltage is less than input voltage to produce the Buck voltage

$$\mathrm{Vo} = \mathrm{Vin}\ \delta \qquad (1)$$

Vo =output voltage
Vin=input voltage
From equation 1 output voltage < input voltage

The SEPIC converter is said to be operating in conduction mode. They can be operated in both the continous and discontinuous mode. The output voltage may be greater than, lesser than or equal to the input voltage in the SEPIC converter can be varied by the duty cycle of the control transistor.

$$\mathrm{Vo} = \frac{\mathrm{Vin}}{(1-\delta)} \qquad (2)$$

From equation 2 output voltage >input voltage

$$\mathrm{Ton} = \frac{\mathrm{L\Delta I}}{\mathrm{Vc}} \qquad (3)$$

ΔI=Ripple current in amps

$$\mathrm{Vc} = \mathrm{Vin} - \mathrm{Vo} \qquad (4)$$

V_c=Capacitor Voltage
L_c=Capacitor Current
I_I=Load Current
E=Energy

$$\mathrm{Ic(t)} = -c\,\frac{\mathrm{dVc(t)}}{\mathrm{dt}} \qquad (5)$$

The open loop voltage conversion ratio V_o/V_{in} in the discontinuous mode if the load resistance is greater than the critical resistance

$$\frac{Von}{Vin} = \frac{1 \pm \sqrt{1+(4\mathrm{D\ Lc/L(1-D)2}}}{2} \qquad (6)$$

L_c=critical resistance

The efficiency of this converter disregarding fluctuation of the output and the input voltage

$$\eta = \frac{Po}{Pon} = \frac{Vo}{Vin} \qquad (7)$$

Eenergy stored in the magnetic field

$$E = \frac{1}{2LI^2} \qquad (8)$$

The inductance and capacitance can be found by using this formula

$$L = Vo\delta/f\Delta I \qquad (9)$$

$$C = \delta/2fR \qquad (10)$$

The additional step up ratio is boosted in the SEPIC converter with distributed voltage stresses on the devices. This is called as the SIB converter. It is the combination of a boost converter and a SEPIC converter with common boost inductors and switches

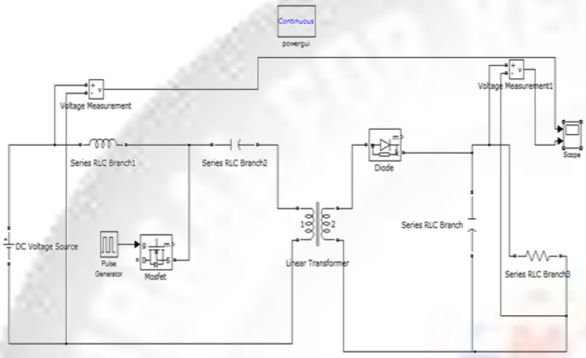

Fig. 2: SEPIC DC-DC Converter

III. Simulation Result

SEPIC converter is simulated with DC motor ,which operates in open loop.The efficiency of the SEPIC converter obtained is 95% which has the efficiency more than the non isolated DC-DC converter. The SEPIC converter is simulated with the MAT LAB version10A.The input Voltage is 15V and the output voltage obtained is 75V.The SIB converter can be implemented by using passive filter and get the output Voltage.

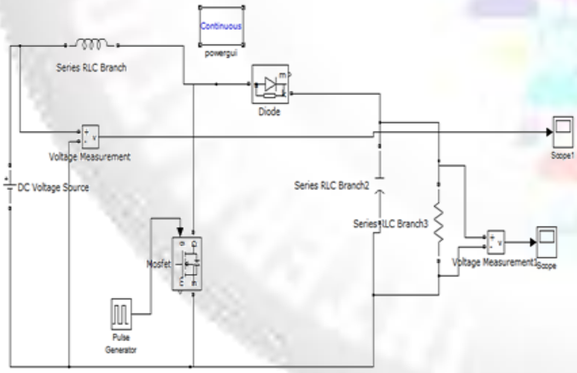

Fig. 3: Non - isolated DC-DC converter

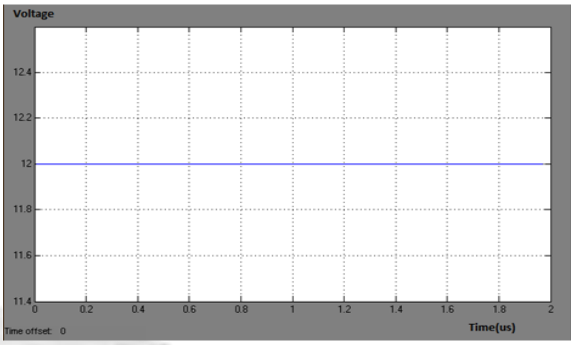

Fig. 4: Input voltage waveform

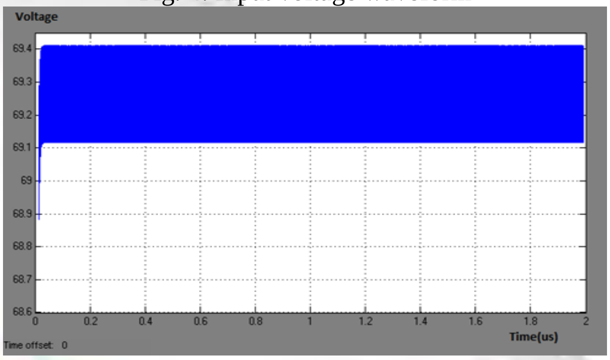

Fig .5: Input voltage waveform

Filter	Π	LC	C
VO	24.01v	21.459v	23.87v
Ripple voltage	0.016	0.12	0.16
%Efficiency	89%	87%	86%

Table 1: Open loop ripple in passive filters non isolated dc-dc converter

Input voltage	Non- Isolated Efficiency	SEPIC converter Efficiency
20	85-23%	87.5%
24	86.6%	89.5%
28	88.45%	91.4%
32	89.34%	95.8%

Table 2: Boost mode efficiency of nonisolated and SEPIC converter

Filters	Parameters	Load Distribution With Motor	Load Distribution (Without Motor)
	Input voltage	12V	12V
	Output Voltage	110V	110V
Filters	THD	30%	31%
	Efficiency	91.67%	91.67%
LC filter	Input voltage	12V	12V
	Output voltage	45V	110V
	THD	23%	22%
	Efficiency	87.5%	91.01%
π filter	Input voltage	12V	12V
	Output voltage	75V	45V
	THD	26%	43%
	Efficiency	82.5%	87.5%
RC filters	Input voltage	12V	12V
	Output voltage	115V	100V
	THD	30%	30%
	Efficiency	95.83%	83-34%

Table 3 Open loop in passive filters for sepic dc- dc converter

IV. SIMULATION PARAMETER

Non-Isolated	Vi = 12 v	V0=52 v	L= 12.5μ H	C=70 μH	Fs=55 Khz	RL=100 Ω
SEPIC Converter	Vi = 12 v	V0=75 v	L= 12.5μ H	C=70 μH	Fs=55 Khz	RL=100 Ω

Table 4: Simulation Parameter

V. CONCLUSION

By the simulation results, the efficiency of the SEPIC converter with RC filter is 95.28% which gives greater efficiency than a conventional converter. Therefore the SEPIC converter is used in high voltage application where in the efficiency can be achieved. It maintain the continuous input current voltage stress on the switch. The SEPIC converter is separated without the snubber circuits,so the efficiency is gradullay increased by this SEPIC converter technique.

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