

Non-Isolated Boost Converter Integrated with SEPIC for High Step up Conversion Ratio

Bhagyalakshmi K R ¹, Naveen J ²

PG Scholar, Department of Electrical and Electronics Engineering, NMAM Institute of Technology, Nitte, India ¹

Assistant Professor, Department of Electrical and Electronics Engineering, NMAM Institute of Technology, Nitte,
India²

ABSTRACT: Many of the applications make use of DC-DC converters without isolation. Some of the converters provide high step up ratio but the trade off has to be made between high conversion ratio and efficiency. Making use of coupled inductor can help to improve high conversion ratio but leads in decrease of efficiency mainly due to leakage inductance. This is because of parasitic resistance causing degradation of step up ratio. To obtain high step up ratio in a non-isolated system, combination of boost converter such as SEPIC is done. Thus integrating boost converter with SEPIC, high step up ratio and improved efficiency is obtained.

KEYWORDS: Boost converter, SEPIC(Single Ended Primary Inductance Converter)

I. INTRODUCTION

Many of the applications require very high step up ratio. This may include many of the industrial applications such as high intensity discharge lamps, uninterruptible power supply, telecommunication industry etc. Some of the DC-DC converters may provide good step up gain but with the penalty of extreme duty ratio. DC-DC converters when combined with the coupled inductor can provide high voltage gain but there will be degradation of efficiency mainly due to the losses associated with the leakage inductance. The recycling of this leakage energy is possible by the converters with the active clamps but the complexity increases. There are two factors that has to be considered for a good efficiency of the converter, that is very high input current and another factor is high output voltage. Large input current is mainly because of the low input voltage. So to reduce conduction loss low voltage rated switches with low R_{ds-on} should be selected. Unfortunately for the switch to sustain high output voltage has to have high R_{ds-on}. Another factor is the severe reverse recovery problem. This high R_{ds-on} and the reverse recovery problem limits the output power. One of the best way to overcome this problem is by cascading the boost converter. Even though cascading the converter will provide high step up ratio there are major drawbacks. They are increase in complexity mainly because of two sets of switches, controllers, components etc. Thus instead of going for non-isolation converter or cascade converter, converters with coupled inductors such as flyback or SEPIC converter can be chosen[3]-[4].

Most of the applications makes use of the non-isolated high step up conversion technique. In all such applications, boost converters[2] are generally used and it has many advantages like simple structure, continuous input current,etc. but providing high step up ratio and high efficiency is difficult at once. This is mainly because of the parasitic resistance, which is the main reason causing the degradation in the stepping up ratio and efficiency as the duty ratio gets increased. Moreover in case of the high output voltage applications, there will be a severe reverse recovery problem mainly because of the high voltage rated diode. There by making use of snubber circuit. Thus a basic boost converter would not be acceptable for high step up applications. In order to obtain high step up ratio in a non-isolated system, a boost converter combined with an isolated converter acting as a series output model can be employed. Selecting the best converter for the series output model has got many advantages like high step up capability, flexibility in design, distribution in voltage stress etc. The best option for series output model is the SEPIC converter. The block diagram of boost converter integrated with SEPIC is as shown in figure 1.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 9, May 2016

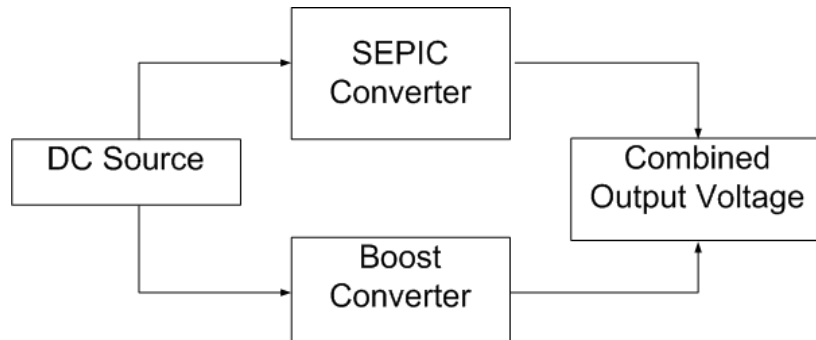


Figure 1 Block diagram

Both the converters will be provided with the single source. Single switch will be driving both the converters. .Output of both the converters will be combined and taken at the load end. The complete circuit of boost converter integrated with SEPIC is as shown in figure 2.

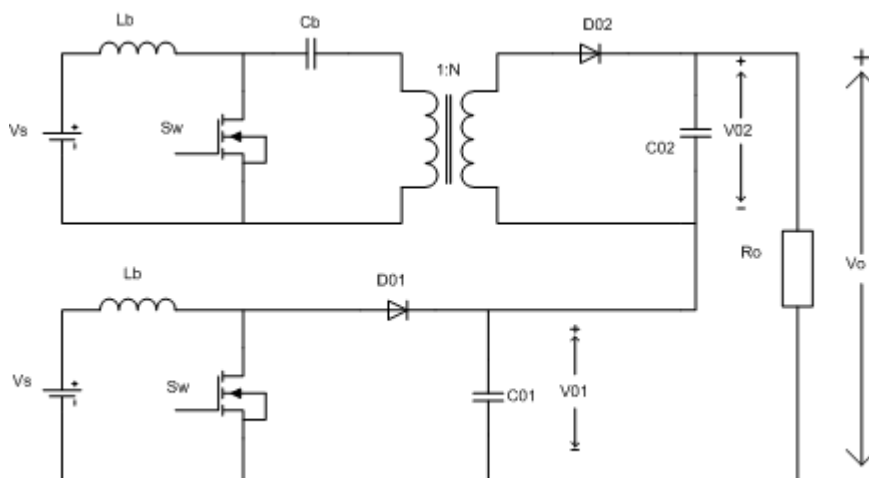


Figure 2. Boost and SEPIC Converter

As can be seen in figure 2 the switch S_w and boost inductor L_b is shared by both converters. Thus leading to the reduced structure in the model which is as shown in figure 3.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 9, May 2016

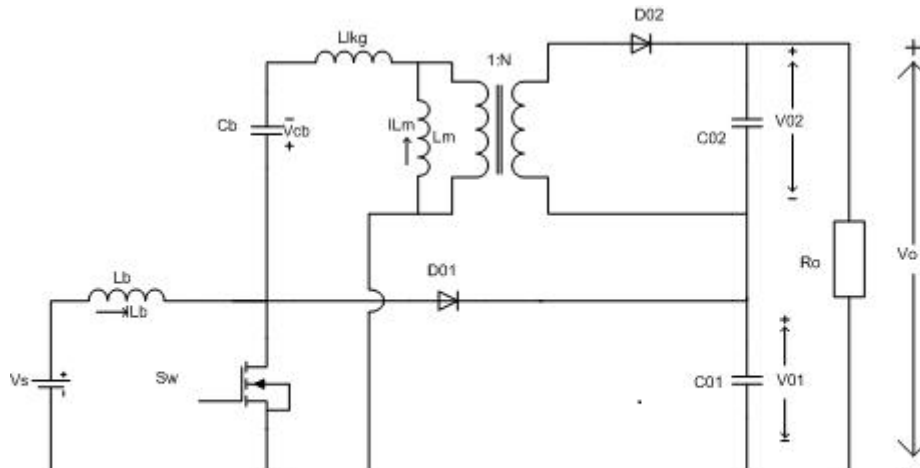


Figure 3 Boost integrated with SEPIC Converter

II. SYSTEM DESIGN

The transformer T is modelled as an ideal transformer with magnetising inductance L_m , leakage inductance L_{lk} with certain number of turns ratio N_1 and N_2 as primary and secondary number of turns. The input voltage is V_s , complete converter output voltage is V_o , V_{01} and V_{02} being the output of boost and SEPIC converter respectively. The basic operation of proposed converter with common boosting inductor and a switch will be the combined operation of boost and SEPIC converter. When the switch S_w is turned ON, the diodes D_{01} and D_{02} of boost and SEPIC converters respectively will be reverse biased. No output voltage will be appearing across the resistor. The voltage across the boosting inductor will be the supply voltage V_s and the current keeps increasing linearly. When the switch S_w is switched OFF both the diodes D_{01} and D_{02} will be forward biased. The charge stored in the boost inductor L_b will be discharged through the diodes. The output voltage of integrated boost and SEPIC converter is obtained which is the sum of individual converters. The capacitors C_{01} and C_{02} acts as a filtering capacitor which reduces the ripple. The system is designed[5] for a input voltage $V_s=12V$, output voltage $V_o=120V$, output power $P_o=20W$, switching frequency $F_s=60KHz$.

Table 1:Experimental Parameters

Part	Value
Input voltage V_s	12V
Output voltage V_o	120V
Output power P_o	20W
Switching frequency F_s	60KHz
Boosting inductance L_b	542.16 μ H
Transformer turns ratio	1:10
Transformer magnetizing inductance L_m	271.08 μ H
Transformer leakage inductance L_{lk}	10% of L_m
Balance capacitance C_b	3.125 μ F

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 9, May 2016

III. SIMULATION

The converter is designed and is simulated using MATLAB. The system is designed by assuming that output power is equal to input power. The simulation of proposed converter is done where the output of 120V with a current of 0.16A is obtained. The circuit shown in figure 4 is the converter design in MATLAB. In the simulation all the components are considered to be ideal. The magnetizing inductance is considered in the internal parameter of the linear transformer and the leakage inductance is considered as 10% that of the magnetising inductance.

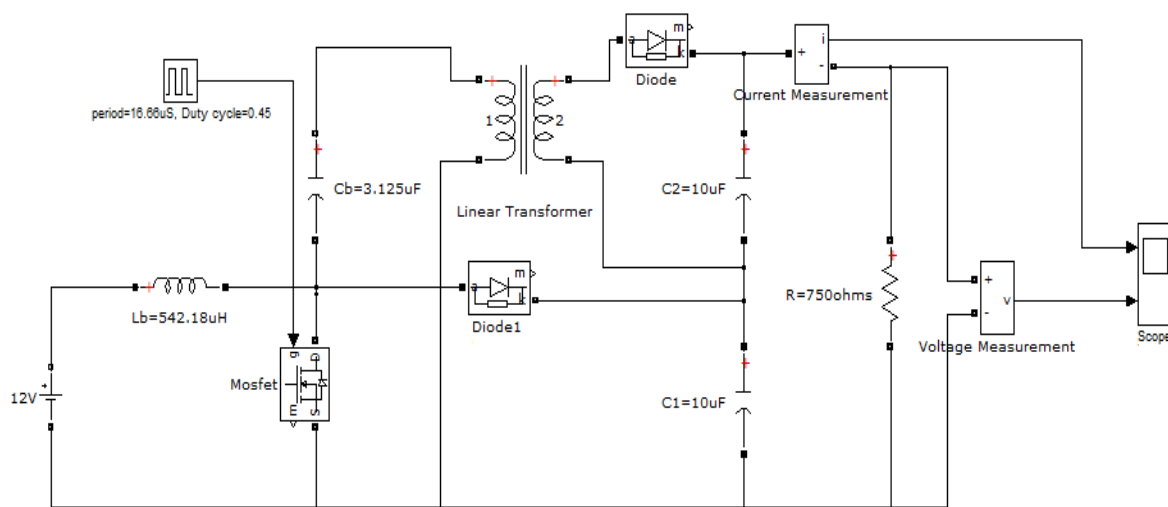


Figure 4 Simulated model of the converter

The simulated output waveform of both output voltage and current is as shown in figure 5 and figure 6 respectively. The voltage waveform shows that the input has got boosted up to ten times of that of input voltage. This is the combination of both Boost converter and SEPIC converter output voltage.

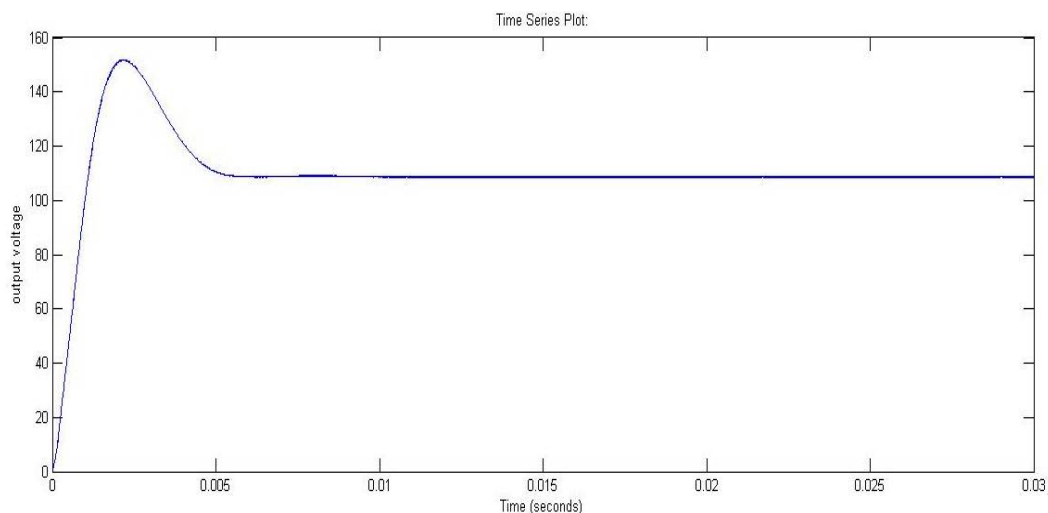


Figure 4 Output voltage of 120V

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 9, May 2016

Similarly the current of 0.15A flows through the load thus matches the input power with the output power. Matching with the input power gets related to the efficiency of the converter as the efficiency is the ratio of output power to input power.

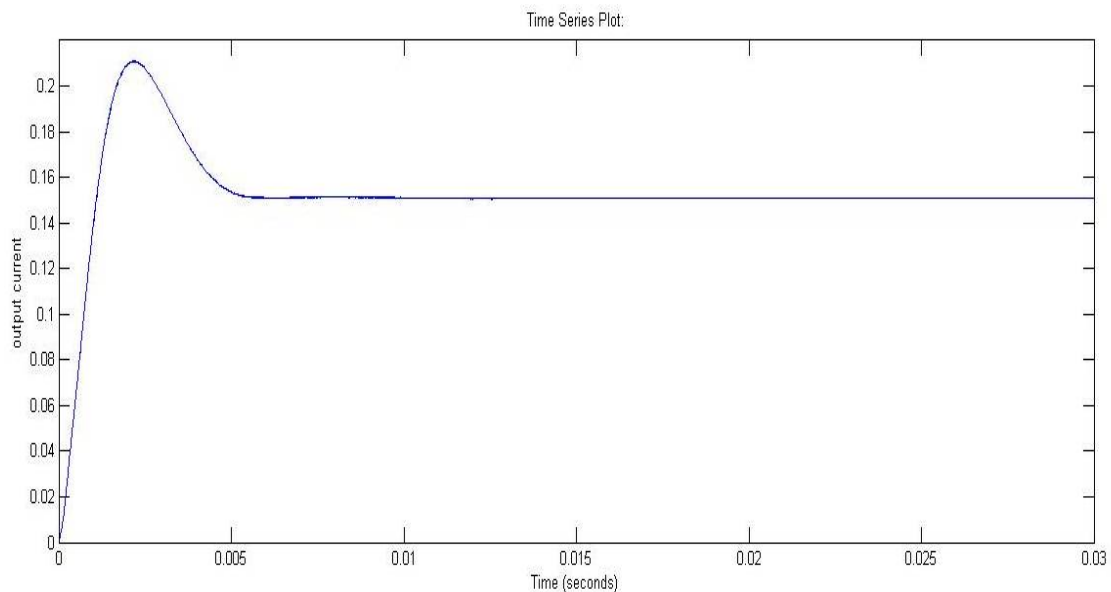


Figure 5 Output current of 0.166A

IV. CONCLUSION

With the duty ratio of 45% the high step up conversion ratio of the converter is achieved. The input of 12V is stepped up to a higher voltage ratio of 120V . With reduced duty ratio, the efficiency of the converter also increases.

REFERENCES

- [1] Ki-Bum Park, Gun-Woo Moon, Myung-Joong Young, "Non-Isolated high step up boost converter integrated with SEPIC converter", IEEE Trans. Power Electron., vol.25, no.9, September 2010.
- [2] Ned Mohan, Tore M. Undeland, Willaim P. Robbins, "Power Electronics converters, Applications and Design", second edition, John Wiley and sons, 1995.
- [3] Q. Zhao and F. C. Lee, "High-efficiency, high step-up dc-dc converters", IEEE Trans. Power Electron., vol. 18, no. 1, pp. 6573, Jan. 2003.
- [4] T.-F. Wu, Y.-S. Lai, J.-C. Hung, and Y.-M. Chen, "Boost converter with coupled inductors and buck-boost type of active clamp", IEEE Trans. Ind. Electron., vol. 55, no. 1, pp. 154162, Jan. 2008.
- [5] Daniel W. Hart, "Power Electronics", McGraw-Hill Publications, 2010.