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Analysis of Different Modifications in SEPIC Converter with Snubber Circuits

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Abstract- This paper summarizes the analysis of different modifications in SEPIC converter with snubber circuits. There are different snubber circuits used in dc-dc converters for the protection purpose. The main purpose of snubber circuit is to provide protection against the di/dt and dv/dt at the time of switching of power semiconductor devices. The snubber circuit is generally the combination of active and passive components and mostly passive snubber circuits are used for the protection purpose of power semiconductor devices. The proposed snubber circuit consists of the combination of inductors, capacitors and diodes which provides better output than other snubber circuits used in SEPIC converter. The analysis is done on the basis of output voltages of different converters at different duty cycles. The results show that proposed converter provides better output than others providing higher static gain. The duty cycles are controlled with the help of pulse generator using MATLAB simulink.
Keywords – SEPIC converter, Dc-dc converter, Snubber circuit, MATLAB Simulink.

I. INTRODUCTION

Dc-dc converters provide variable dc supply which can be used in regulated switched mode dc power supplies or in different dc motor drive applications. There are different dc-dc converters used for several years for different applications. Some applications require high voltages while some require low voltages. Different methods are used to increase the efficiency and gain of dc-dc converters. Different dc-dc converters are studied to improve the power quality in machines, power systems etc. [1]. Different regulators are used for enhancing the power factor so that efficiency is very high. Different modifications have been applied in SEPIC for this purpose [2-7]. Dc-dc converters can be used in different lighting systems to increase the efficiency [8]. Different multiplier techniques have been used for better power factor so that SEPIC converters can be used in different applications [9-11]. Synchronous converters are used for high efficiency at low input voltage [12]. Two or more converters can be integrated with each other to increase the gain of converter system [13]. Snubber circuits are best suitable option for these improvements. There are many types of snubbers like as RCD snubber, CD snubber, LCD snubber etc. which are used in different converters.

II. SNUBBER CIRCUIT BASED SEPIC CONVERTERS

There are different modifications done in ordinary SEPIC converter for the improvement of static gain. The simulink models of different topologies obtaining high static gain and high efficiency in SEPIC converter are as follows:

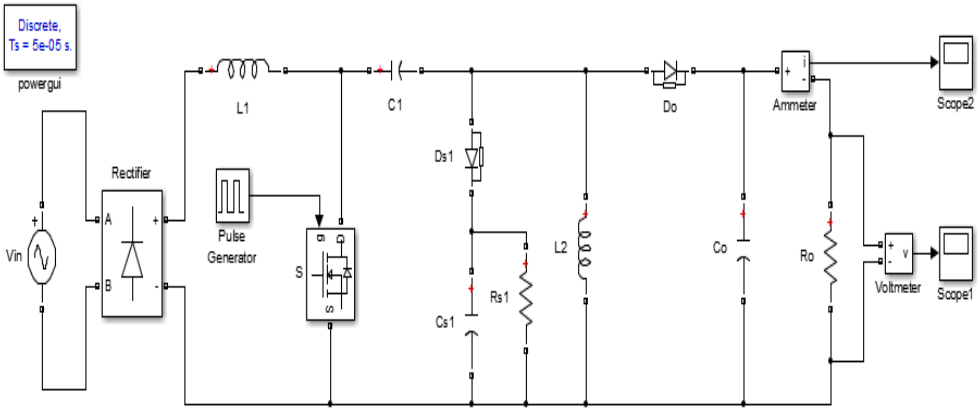

Figure. 1 Simulink model of RCD snubber based SEPIC

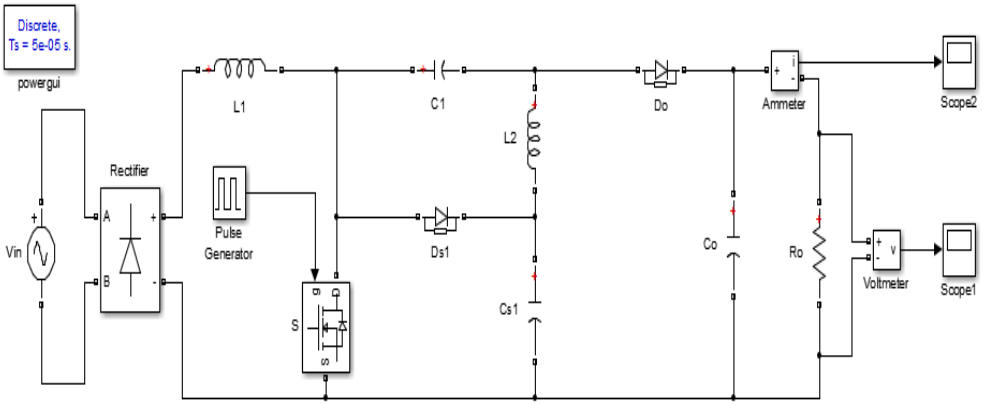

Figure. 2 Simulink model of CD snubber based SEPIC

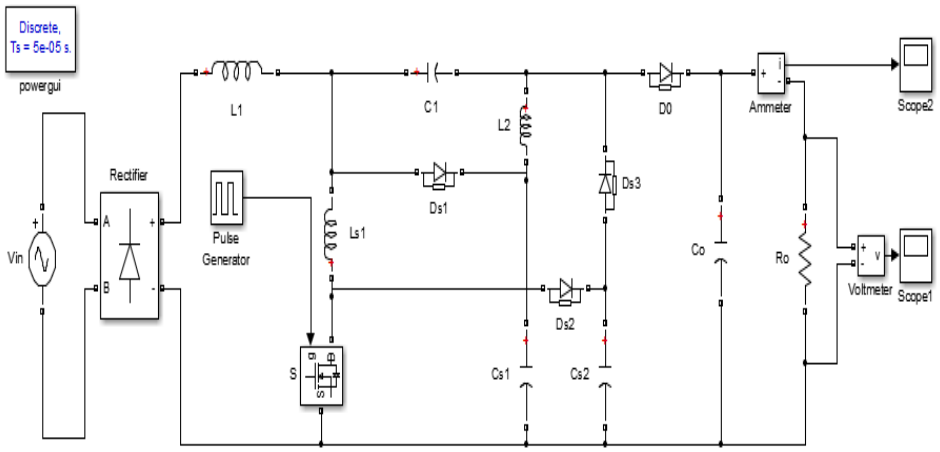

Figure. 3 Simulink model of LCD Snubber based SEPIC

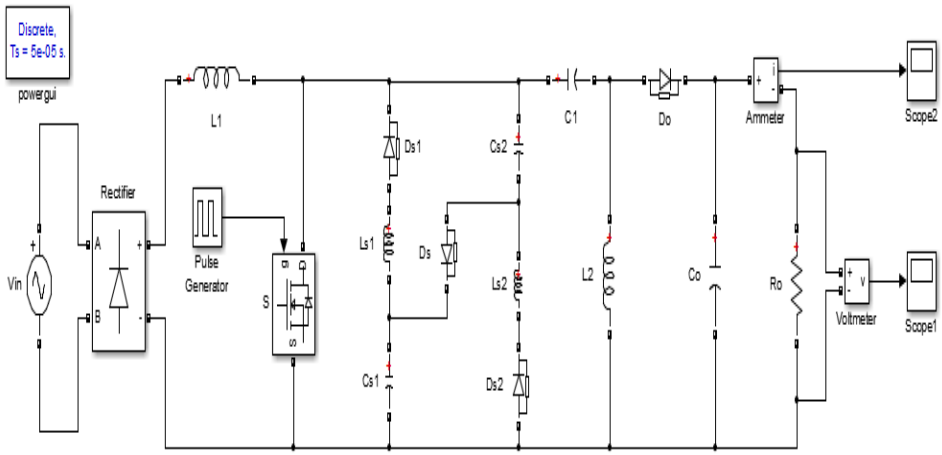

Figure. 4 Simulink model of proposed LCDD snubber based SEPIC

III. SIMULATED RESULTS AND DISCUSSION

The different simulink models of SEPIC converter with different snubber circuits are simulated and different results are observed. The various waveforms for the output voltages of these converters are obtained with different duty cycles. These waveforms are as follows:

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3.1. For 20% Duty Cycle-

The output voltages observed of different snubber circuit based SEPIC converters for 20% Duty Cycle are as follows:

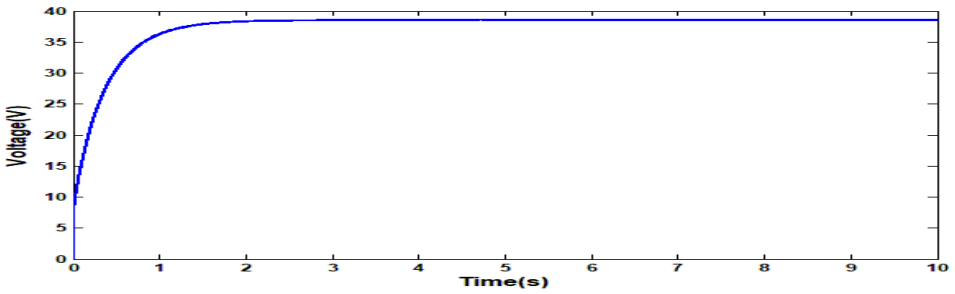

Figure. 5 Output of RCD Snubber based SEPIC

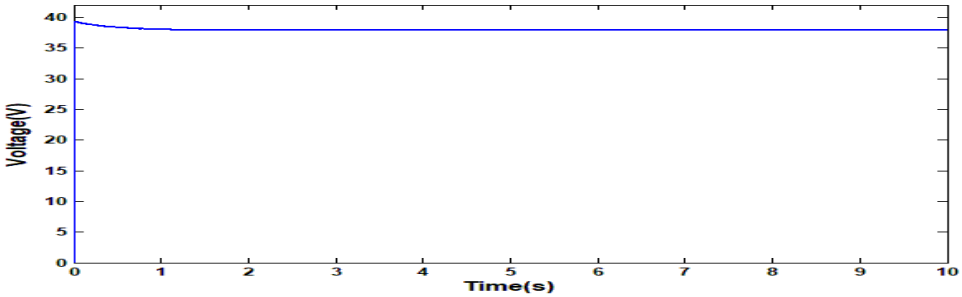

Figure. 6 Output of CD Snubber based SEPIC

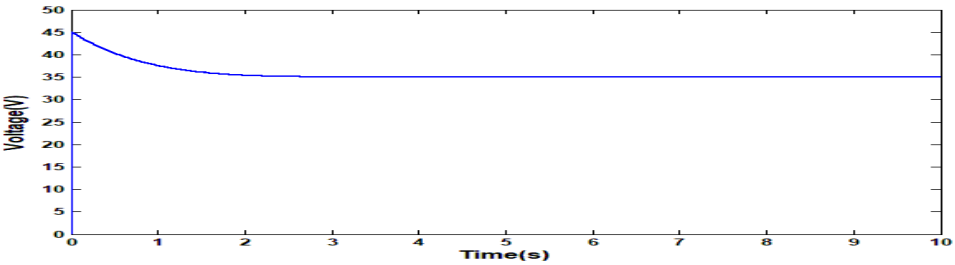

Figure. 7 Output of LCD Snubber based SEPIC

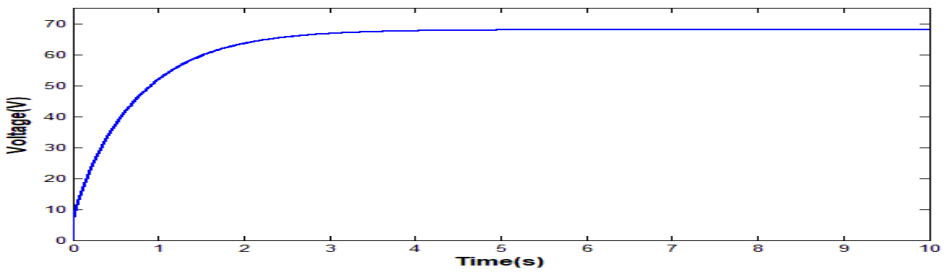

Figure. 8 Output of proposed LCDD Snubber based SEPIC

3.2. For 40% Duty Cycle-

The output voltages observed of different snubber circuit based SEPIC converters for 40% Duty Cycle are as follows:

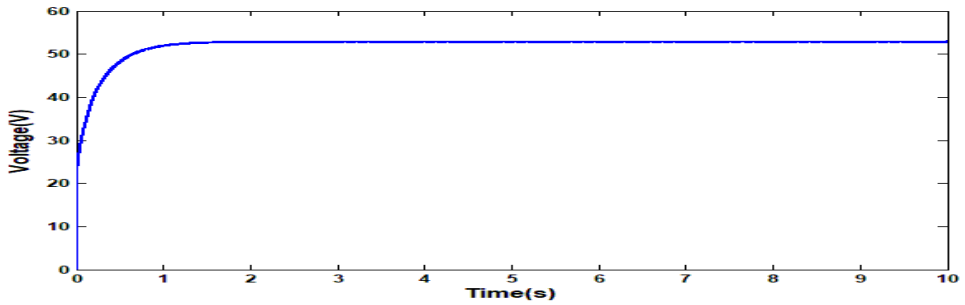

Figure. 9 Output of RCD Snubber based SEPIC

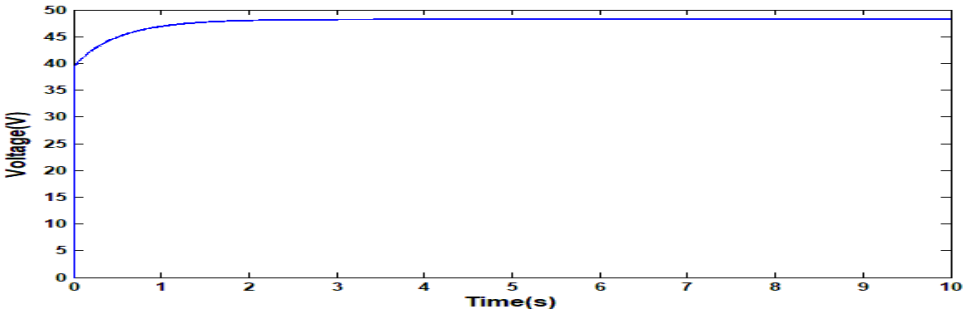

Figure. 10 Output of CD Snubber based SEPIC

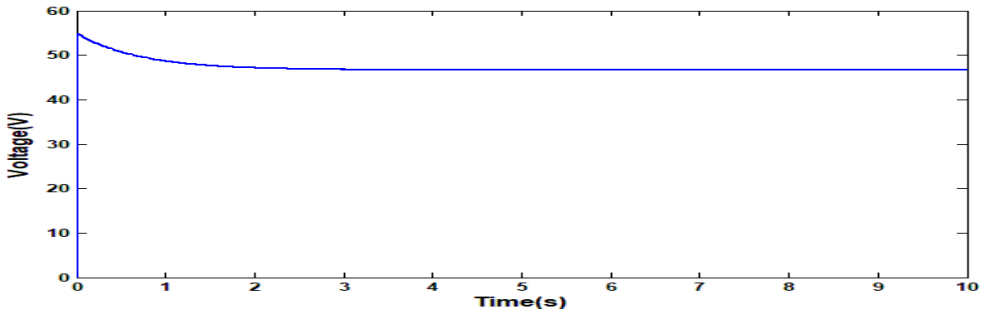

Figure. 11 Output of LCD Snubber based SEPIC

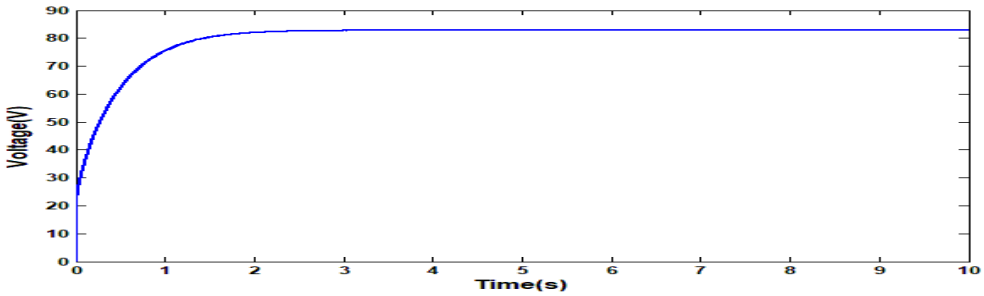

Figure. 12 Output of proposed LCDD Snubber based SEPIC

3.3. For 50% Duty Cycle-

The output voltages observed of different snubber circuit based SEPIC converters for 50% Duty Cycle are as follows:

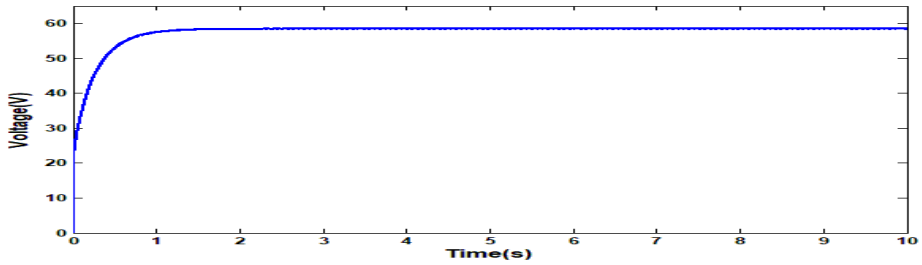

Figure. 13 Output of RCD Snubber based SEPIC

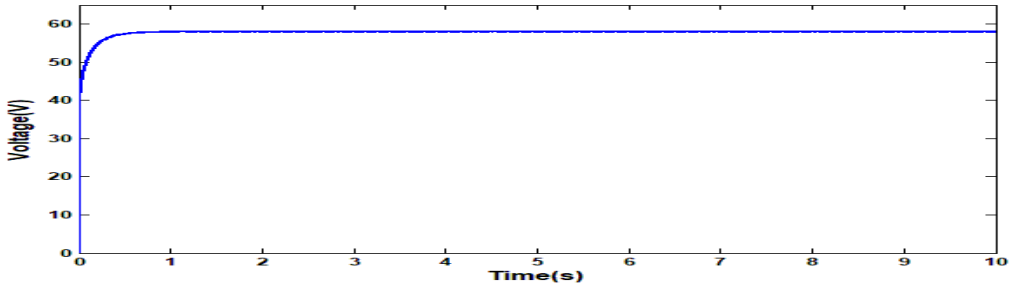

Figure. 14 Output of CD Snubber based SEPIC

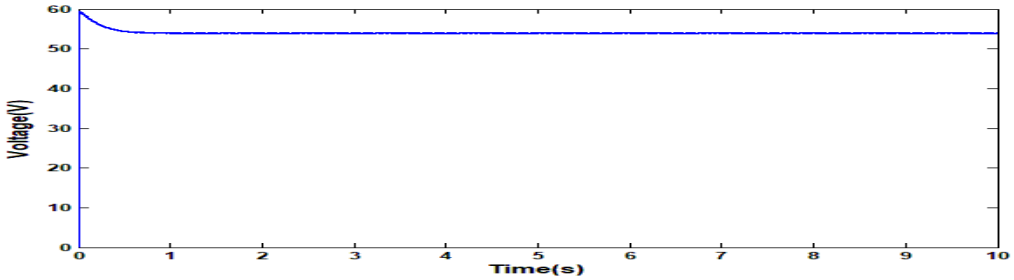

Figure. 15 Output of LCD Snubber based SEPIC

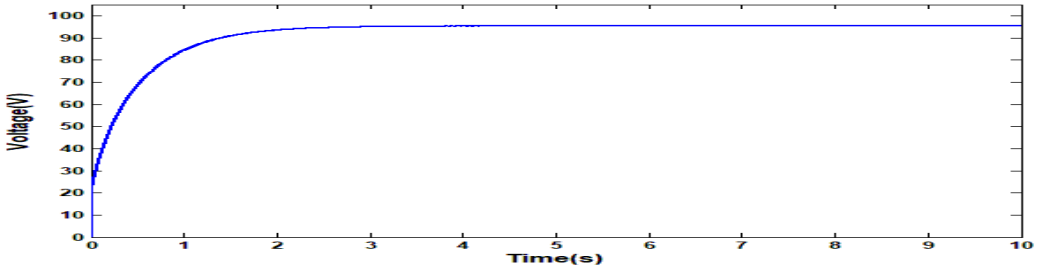

Figure. 16 Output of proposed LCDD Snubber based SEPIC

3.4. For 60% Duty Cycle-

The output voltages observed of different snubber circuit based SEPIC converters for 60% Duty Cycle are as follows:

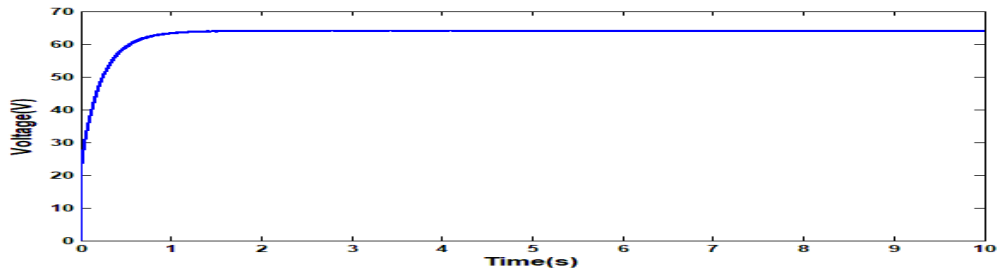

Figure. 17 Output of RCD Snubber based SEPIC

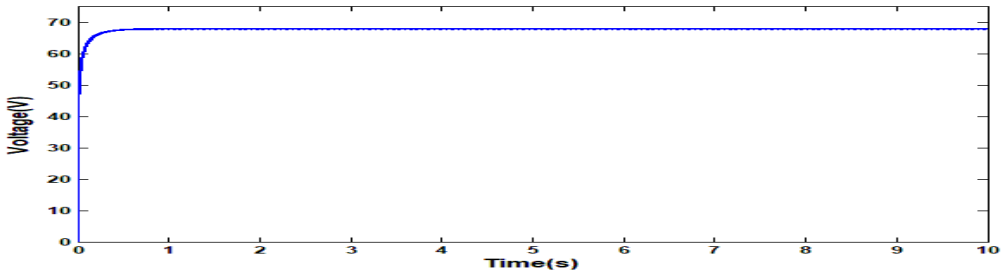

Figure. 18 Output of CD Snubber based SEPIC

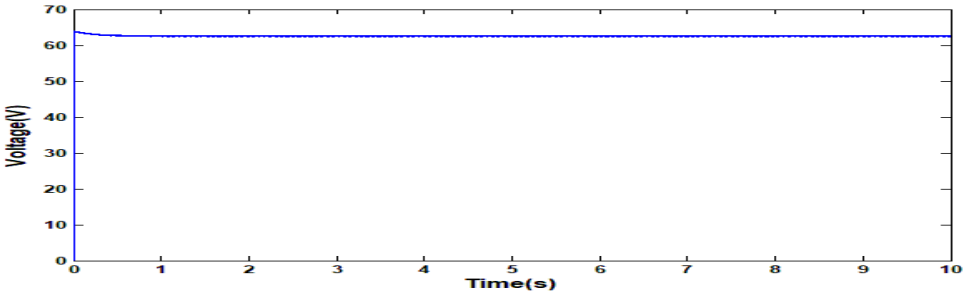

Figure. 19 Output of LCD Snubber based SEPIC

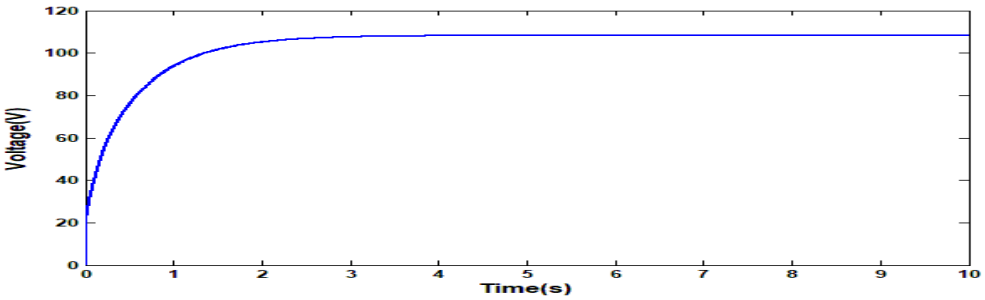

Figure. 20 Output of proposed LCDD Snubber based SEPIC

2.5. For 80% Duty Cycle-

The output voltages observed of different snubber circuit based SEPIC converters for 80% Duty Cycle are as follows:

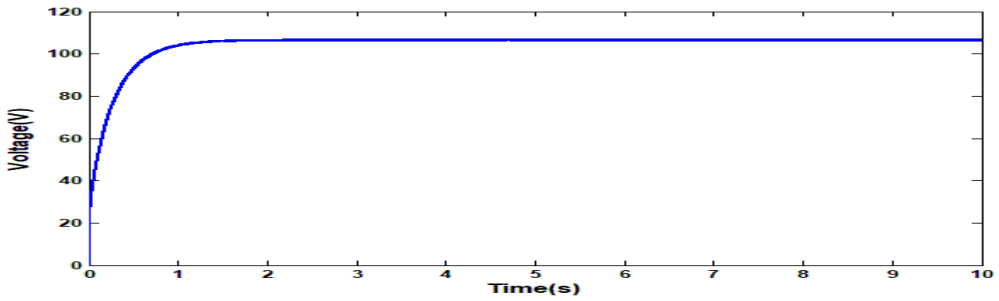

Figure. 21 Output of RCD Snubber based SEPIC

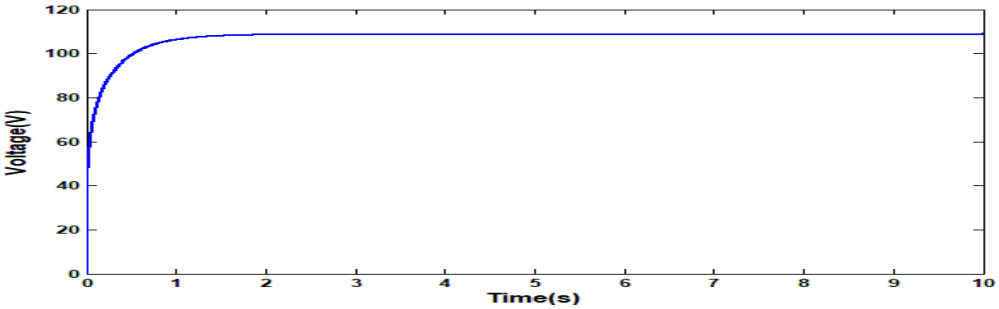

Figure. 22 Output of CD Snubber based SEPIC

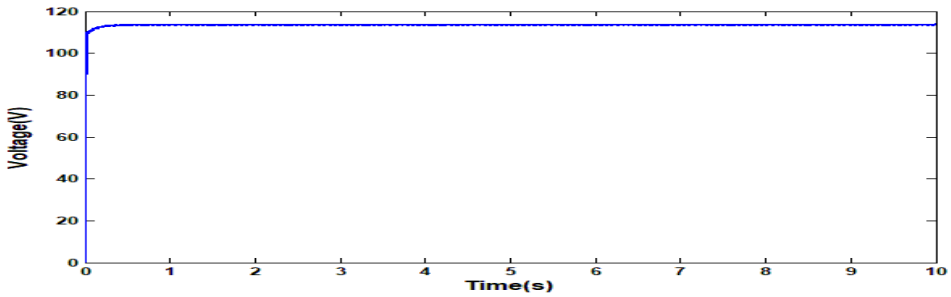

Figure. 23 Output of LCD Snubber based SEPIC

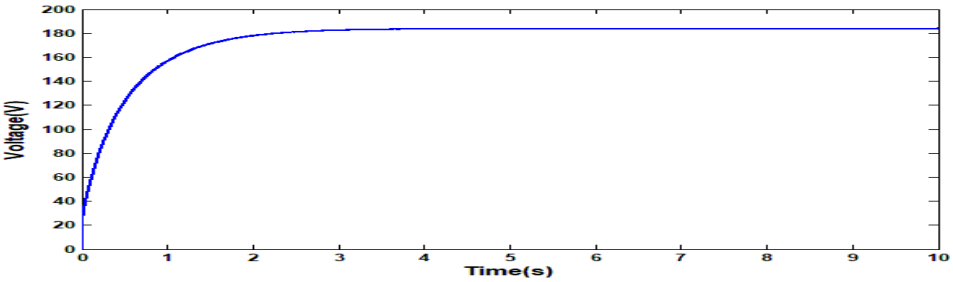

Figure. 24 Output of proposed LCDD Snubber based SEPIC

3.6 Comparison of Results

The result comparison of output voltages of these converters is shown in Table 1.

Table 1. Comparison between different converters

S.No.	Duty Cycle (%)	Output Voltage (V)			
		RCD snubber	CD snubber	LCD snubber	Proposed LCD snubber
1	20	38	37	35	68
2	40	53	48	46	83
3	50	59	58	54	95

4	60	64	68	63	108
5	80	107	109	113	184

The graph showing the comparison between different converters is shown below:

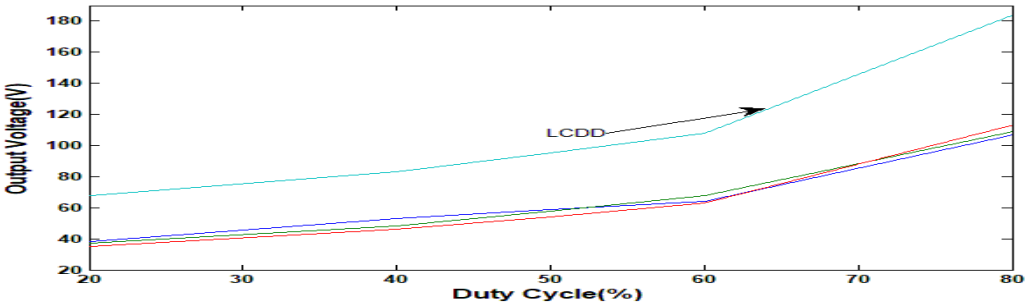

Figure. 25 Comparison between different converters

IV. CONCLUSION

The analysis of different modifications in SEPIC converter with snubber circuits has been done. SEPIC converters are widely used in various industrial and commercial applications. These converters provide variable dc voltage as per our requirements. These converters provide comfortable and flexible operation of the system. SEPIC converter based products operate from batteries which benefits most from the wide ranging step up and down operating modes of the SEPIC topology. It is clear that a properly designed snubber circuit will enhance the circuit operation providing high static gain with higher switching frequency. The behavior of the different converters has been analyzed here which is done by using MATLAB simulink. Therefore, we can say that SEPIC converter with proposed snubber circuit is more efficient than the other snubber circuits based SEPIC converter as output voltage of proposed LCDD snubber based SEPIC converter is more than the output voltage of the other snubber circuits based SEPIC converters. Thus high static gain SEPIC converter is obtained with the help of proposed LCDD snubber circuit.

V. REFERENCE

[1] B. Singh and S. Singh, Single-phase power factor controller topologies for permanent magnet brushless DC motor drives, IET Power Electronics, vol. 3, no. 2, pp. 147-175, 2010.
[2] C. G. Bianchin, R. Gules, A. A. Badin and E. F. R. Romaneli, High-Power-Factor Rectifier Using the Modified SEPIC Converter Operating in Discontinuous Conduction Mode, IEEE Transactions on Power Electronics, vol. 30, no. 8, pp. 4349-4364, 2015.
[3] G. Tibola, E. Lemmen and J. L. Duarte, Passive regenerative snubber cell applied to isolated DCM SEPIC converter, IEEE 8th International Power Electronics and Motion Control Conference (IPEMC-ECCE Asia), Hefei, pp. 2779-2786, 2016.
[4] I. Burgardt, E. Agostini, C. H. I. Font and C. B. Nascimento, A SEPIC-energy-regenerative-snubber with linear current regulator for power LEDs, 11th IEEE/IAS International Conference on Industry Applications, Juiz de Fora, pp. 1-6, 2014.
[5] V. A. Bonfa, P. J. M. Menegaz, J. L. F. Vieira and D. S. L. Simonetti, Multiple alternatives of regenerative snubber applied to SEPIC and Cuk converters, 28th Annual Conference of the Industrial Electronics Society, pp. 123-128, 2002.
[6] S. W. Lee and H. L. Do, Isolated SEPIC DC-DC Converter with Ripple-Free Input Current and Lossless Snubber, IEEE Transactions on Industrial Electronics, Vol. 65, No. 2, pp: 1254–1262, 2018.
[7] W. Mcmurray, Selection of snubbers and clamps to optimize the design of transistor switching converters, IEEE Power Electronics Specialists Conference, San Diego, CA, USA, pp. 62-74, 1979.
[8] M. Ali, M. Orabi, M. E. Ahmed and A. El-Aroudi, Design consideration of modified SEPIC converter for LED lamp driver, 2nd International Symposium on Power Electronics for Distributed Generation Systems, Hefei, China, pp. 394-399, 2010.
[9] P. F. de Melo, R. Gules, E. F. R. Romaneli and R. C. Annunziato, A Modified SEPIC Converter for High-Power-Factor Rectifier and Universal Input Voltage Applications, IEEE Transactions on Power Electronics, vol. 25, no. 2, pp. 310-321, 2010.

[10] Jingquan Chen and Chin Chang, Analysis and design of SEPIC converter in boundary conduction mode for universal-line power factor correction applications, IEEE 32nd Annual Power Electronics Specialists Conference, Vancouver, BC, pp. 742-747, 2001.
[11] A. M. Al Gabri, A. A. Fardoun and E. H. Ismail, Bridgeless PFC-Modified SEPIC Rectifier with Extended Gain for Universal Input Voltage Applications, IEEE Transactions on Power Electronics, vol. 30, no. 8, pp. 4272-4282, 2015.
[12] K. Panda and K. Aroul, A Novel Technique to Reduce the Switching Losses in a Synchronous Buck Converter, International Conference on Power Electronic, Drives and Energy Systems, New Delhi, pp. 1-5, 2006.
[13] K. B. Park, G. W. Moon and M. J. Youn, Non-isolated High Step-up Boost Converter Integrated with SEPIC Converter, IEEE Transactions on Power Electronics, vol. 25, no. 9, pp. 2266-2275, 2010.