Journal of Theoretical and Applied Information Technology

www.jatit.org

IMPLEMENATION OF SOFT SWITCHED CONVERTERS FOR HIGH POWER APPLICATION

M.KARPAGAM [*], Dr. N.DEVARAJAN[#]

*Research scholar, Government College of Technology, Coimbatore
[#]Professor, Government College of Technology, Coimbatore
E-mail: karpagam.sathish@gmail.com , profdevarajan@yahoo.com

ABSTRACT

This paper deals with the performance comparison of compound active clamping boost converter with the two inductor boost converter. The simulation is carried out on the open loop systems of compound active clamping and two inductor boost converters and is verified with the hardware results. The simulation results closely agree with the hardware results.

Keywords: *DC DC converter, boost converter, open loop, closed loop*

I. INTRODUCTION

BOOST converters are normally used to step up the voltage for various types of DC loads. There are various types of boost converters and are also classified depending upon the voltage level we boost. All the boost converters exhibit better performance characteristics. One important reason to exhibit better performance is having a natural power factor correction in the circuit. This is essential in order to have the circuit to comply with the standards specified by the international organizations. Power factor correction is included so that it will reduce the harmonics in the line current; increase the efficiency of the system and its capacity. Power factor correction in the circuit can be obtained by many methods including average current control [1], peak current control [2], hysteretic control [3], and non-linear carrier control [4]. There are many more methods of power factor improvement of which only few are considered here.

Boost converter itself has its own configurations. This paper discusses the performance of a boost converter with compound active clamping (CAC) that will reduce the loss caused by the diode reverse recovery with the two inductor boost converter. The compound active clamping boost converter reduces the loss caused by the diode reverse recovery characteristics. The two inductor boost converter is employed to increase input to output voltage conversion ratios. The important feature that makes the boost converter to be employed in many areas is its capability of input current shaping. The zero voltage transition technique is being employed here in order to avoid the switching losses that are available in the circuit.

The operation of boost converter employing compound active clamping with active filter is not presented by Feng&Dehong. This work deals with comparison of PFC converter with active clamping along with the two inductor boost converter. In the present work, an attempt is made to compare the performance characteristics of boost converter system with active clamping with the two-inductor boost converter.

II. COMPOUND ACTIVE CLAMPING (CAC) BOOST CONVERTER

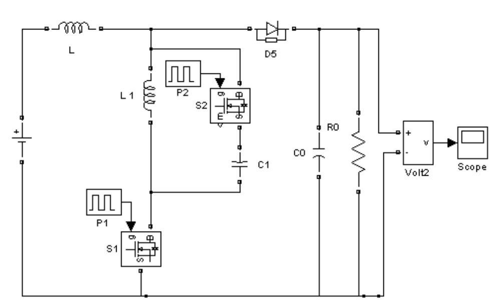


Fig. 1. Compound active-clamping boost PFC converter.

The circuit of CAC boost converter is shown in Fig1.The inductor L is the boost inductor. The inductor L_1 and capacitor C_c are used for soft switching of S_2. The duty cycle of $S_1$is adjusted to get the required output voltage. When $S_1$is turned on, the energy is stored in the inductor L. When $S_1$is turned off, the energy in the inductor is supplied to the capacitor C_0.

The boost converter circuit consists of a bridge rectifier to rectify the AC supply, two inductors L and L_1, two switches S_1 and S_2, comparator to compare the output with the reference wave.

The AC supply that is fed to the circuit is rectified using a bridge rectifier. Inductors L and L_1 are connected to the bridge rectifier and along with that switch S_1 is also connected. During initial operation, switch S_1 is on, the inductors L and L_1 store energy. Switch S_2 is connected in parallel with the inductor L_1 and it acts as an auxiliary switch. During the next stage switch S_1 is off and voltage across L_1 will appear across the load.

The compound active claming boost converter exhibits certain characteristics such as boosting up the voltage, improving the power factor, zero voltage transition thereby reducing the switching losses, and avoiding the voltage stress on the diode with the help of clamping capacitor C1.

III.TWO INDUCTOR BOOST CONVERTER (TIBC)

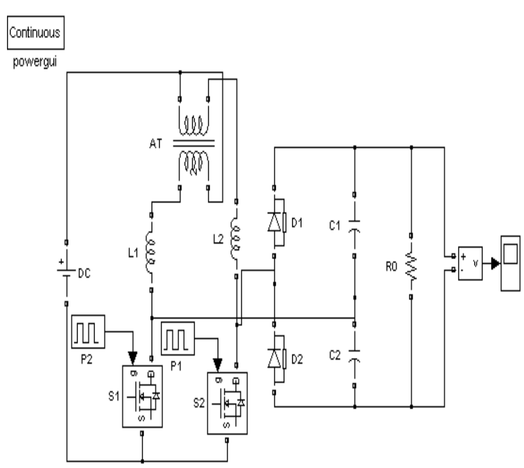


Fig2.Two inductor boost converter

The circuit of two-inductor boost converter is shown in the Fig2. This two-inductor boost converter is chosen for high input to output voltage conversion applications.

The input side of the two inductor boost converter consists of two switches S1 an S2, two boost inductors L1 and L2, and auxiliary transformer ATR. The output side of the circuit consists of boost rectifiers D1 and D2 and output filter capacitors C1 and C2 connected across load R_0.

The operation of the circuit can be explained through various time periods. During mode 1 the switch S_1 is closed. This makes the circuit complete, causing the flow of current. Therefore the current through the inductor L_2 forward bias the diode D_2, switch S_2 remains open. The current through L_2 forward biases D_2 thereby the inductor discharges the energy stored in it.

During mode 2 both the switches S_1 and S_2 are turned ON. The current flow through the inductors L_1 and L_2 increase at an equal rate. The capacitors C_1 and C_2 discharge their stored energy because the diodesD_1 and D_2 are reverse biased. As a result the input part of the circuit is decoupled from the output part.

During the mode 3, the switch $S_1$is turned ON and the inductor which is charged in mode 2 discharges through capacitor C_1.During mode 4 the circuit repeats the operation as in mode 2.

III.SIMULATION RESULTS

a)CAC Boost Converter

The open loop controlled CAC boost converter circuit is shown in Fig1. The input consists of an AC source and therefore rectified and fed to the converter. It is simulated using MATLAB Simulink and the results are presented. The input voltage waveform is shown in Fig3. The waveform displays a steady AC source voltage. This input is fed to the rectifier thus being capable of feeding it to the converter so that it may boost up the voltage.

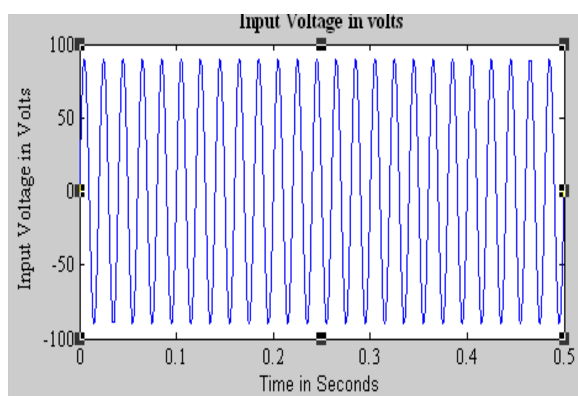


Fig3.Input voltage waveform

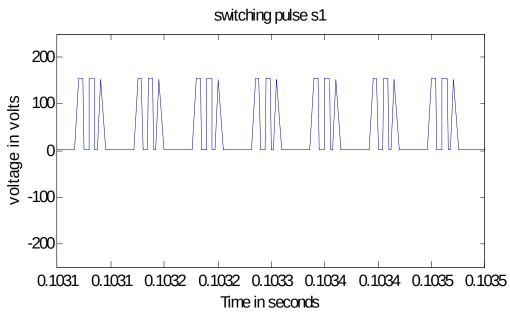


Fig 4. Driving Pulse for S_1

The above waveform displays the switching pulse fed to the switch S_1 of the compound active clamping circuit.

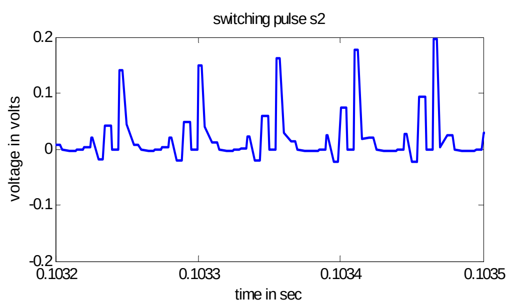


Fig 5 Driving Pulse for S_2

The above waveform displays the switching pulse fed to the switch S_2 of the compound active clamping circuit. The above two switching pulses serve to turn on and turn off the switch thereby maintaining the active clamping which reduces the voltage stresses of the switches.

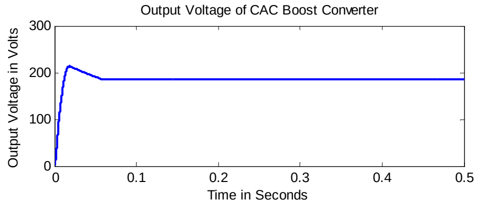


Fig6.Output voltage of CAC boost converter

The output voltage of open loop system is shown in Fig6. From the output it can be seen that the output voltage is boosted from the input voltage level.

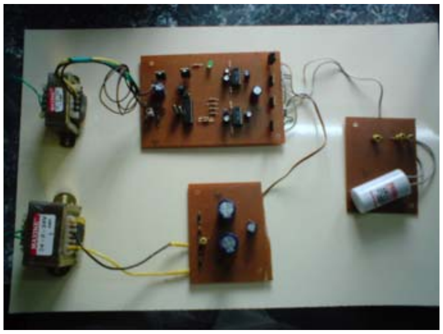
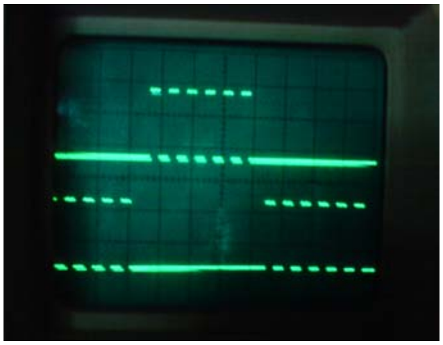
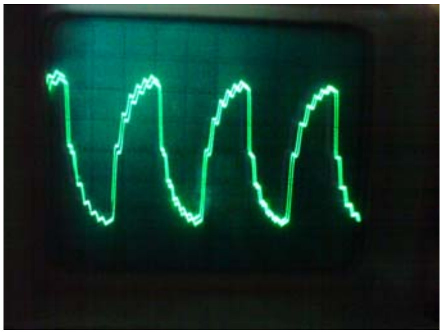


Fig.7a).CAC Hardware



b) Pulse Waveforms

c) Output Voltage



d)Capacitor Voltage

b)Two Inductor Boost Converter (TIBC)

The two inductor boost converter is shown in Fig2. Various waveforms associated with the converter are shown below.

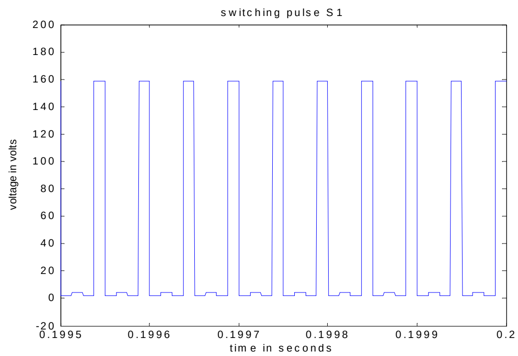


Fig8. Switching pulse for Switch S1

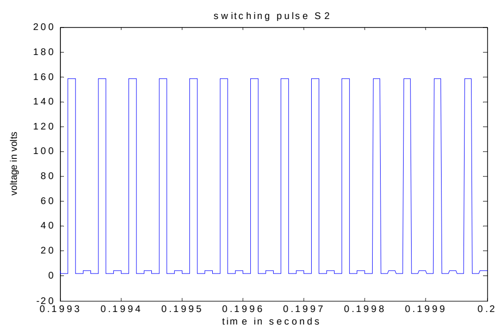


Fig 9Switching pulse for Switch S2

The above graphs indicate the pulse waveforms of the two switches that are present in the circuit. The switches are two in number inorder to increase the input to output voltage conversion and also high current.

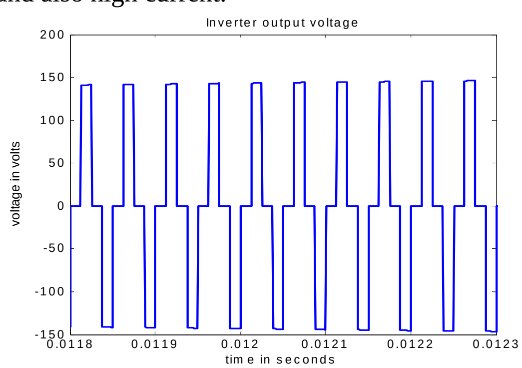


Fig10. Inverter Output Voltage

The output voltage from the stage I of the two inductor boost converter circuit is shown in Fig10. The input to the circuit is DC and the stage I of the circuit converts it into AC. The waveform assumes significance here because the AC is transferred from the stage I of the circuit to the stage II of the circuit without the help of a transformer, achieving better output voltage regulation. The outptut volatge of the two inductor circuit is shown in Fig11.

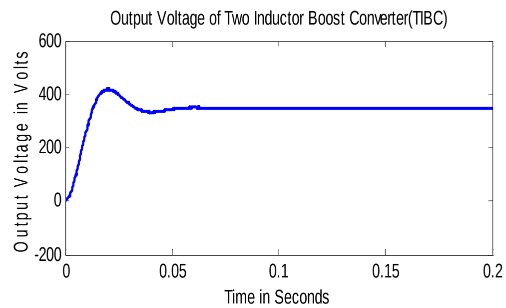
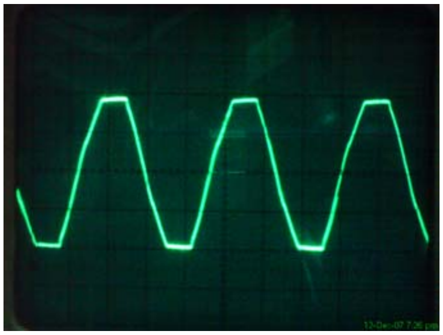
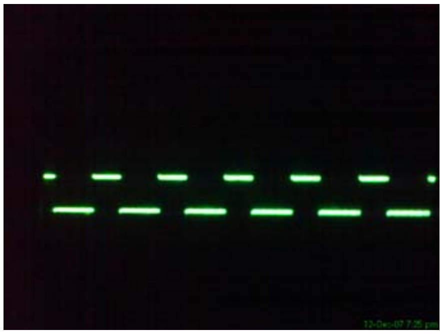


Fig11.Output Voltage(across load)

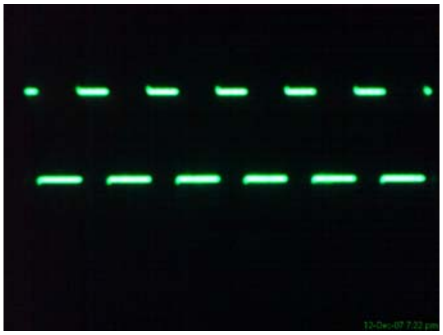
Fig12.a)Two Inductor Hardware



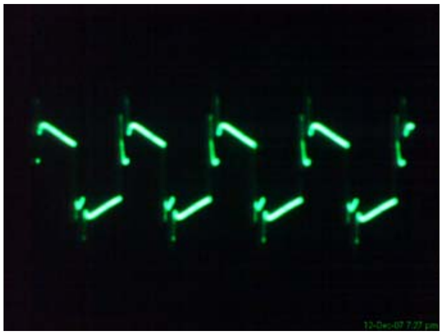
b)Input Waveform



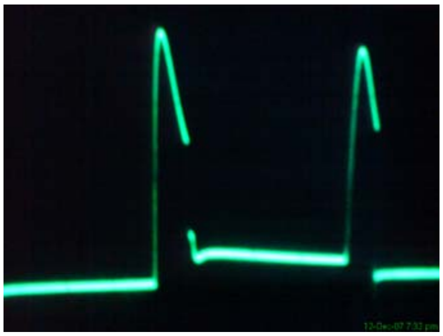
c)Pulse To Switch 1



d)Pulse To Switch 2



e)Drain To Source Voltage(Switch S1)



f)Drain To Source Voltage(Switch S1)

IV. PERFORMANCE EVALUATION OF CAC ACTIVE CLAMPING BOOST CONVERTER ITH TWO INDUCTOR BOOST CONVERTER

The performance of the Compound Active Clamping (CAC) boost converter with two inductor boost convert is analyzed in this section.

The performance of the CAC boost converter and two inductor boost converter is predicted with input voltage ranging from 46V to 52V. Results obtained are summarized in table I. from the table we can infer that the output voltage level of two inductor boost converter is better compared to CAC boost converter. The graph is plotted (Fig 12) between the input voltage and the output voltage of the two configuration of the converters.

Table I

S.No	Input Voltage (V)	Output Voltage (V)	
		CAC	**TWO L**
1.	46	164.3	307.4
2.	48	171.4	320.8
3.	50	178.6	334.2
4.	52	185.8	347.6

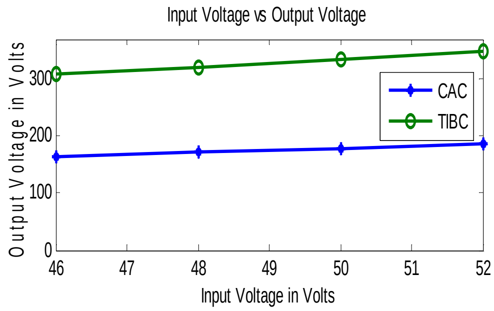


Fig12.Input Voltage Vs Output Voltage

The performance of the CAC boost converter and two inductor boost converter is predicted with input voltage ranging from 46V to 52V. Results obtained are summarized in table II. The inference from the table is that the two inductor boost converter has higher output power compared to CAC boost converter. This is also plotted through MATLAB plot commands.

Table II

S.No	Input Voltage (V)	Output power (watts)	
		CAC	TWO L
1.	46	449.8	1574
2.	48	489.9	1715
3.	50	531.8	1861
4.	52	575.4	2014

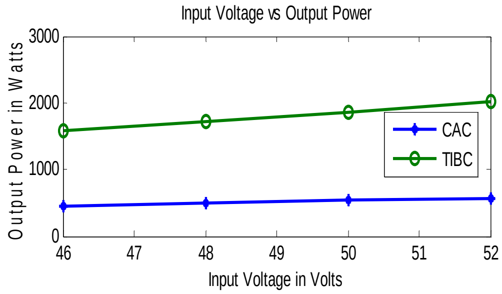


Fig13.Input Voltage Vs Output Power

The performance of the CAC boost converter and two inductor boost converter is predicted with input voltage ranging from 46V to 52V. Results obtained are summarized in table III.

TableIII

S.No	Input Voltage (V)	Input power (watts)	
		CAC	TWO L
1.	46	506.1	1934
2.	48	551.2	2107
3.	50	598.2	2286
4.	52	647.1	2476

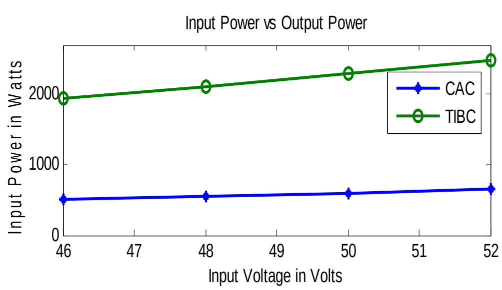


Fig14.Input Voltage Vs Input Power

V. CONCLUSION

A comparison of two configurations of the boost converter is presented. The performance of the two converters is compared through simulation experiments. The two inductor boost converter has better voltage regulation over a wide with constant frequency control which is emphasized through tabulation and by the graphs.

VI. REFERENCES

[1]. Bo Feng and Dehong Xu, "1-kW PFC converter with Compound Active Clamping", *IEEE Trans. Power Electron.*, vol. 20, pp. 324–331, March 2005.

[2]. P.C.Todd, "UC 3854 controlled power factor correction circuit design"U-134 Unitrode Application Note, pp3.269-3.288.

[3]. R.Redl and BP.Erisman, "Reducing distortion in peak current controlled Boost power factor correctors", in Proc.Applied Power Electronics Conf.expo.1994, pp.576-583.

[4]. J.Spangler and A.Behera, "A comparison between hysteretic and fixed frequency Boost converters used for power factor correction" in Proc.Applied Power Electronics Conf.expo.1993, pp.281-286.

[5]. R.Zane and D.Maksimovic, "Non linear carrier control for high power factor rectifiers based upon up-down switching converters", *IEEE Trans. Power Electron.*, vol. 13, pp. 213-221, March 1998.

[6]. J. Sebastian, M. Jaureguizar, and J. Uceda, "An overview of power factor correction in single-phase offline power supply systems," in *Proc. IEEE IECON'94 Conf.*, 1994, pp. 1688–1693.

[7]. G. Hua, C. S. Leu, Y. Jiang, and F. C. Y. Lee, "Novel zero-voltage transition PWM converters," *IEEE Trans. Power Electron.*, vol. 9, pp.213–219, Mar. 1994.

[8]. .S. Y. R. Hui, K. W. E. Cheng, and S. R. N. Prakash, "A fully soft-switched extended-period quasi resonant power-factor correction circuit," *IEEE Trans. Power Electron.*, vol. 12, pp. 922–930, Sept. 1997.

[9]. C. M. Liaw and T. H. Cheng, "A soft-switching mode rectifier with power factor correction and high frequency transformer link," *IEEE Trans. Power Electron.*, vol. 15, pp. 644–654, July 2000.

[10]. M. O. Eissa, S. B. Leeb, G. C. Verghese, and A. M. Stankovic, "Fast controller for an unity-power-factor rectifier," *IEEE Trans. Power Electron.*, vol. 11, pp. 1–6, Jan. 1996.

[11]. G. Spiazzi, P. Mattavelli, and L. Rossetto, "Power Factor Preregulator with improved response" IEEE *Trans. Power Electron.*, vol.12,pp. 343–349, Mar. 1997.

BIOGRAPHY

M.Karpagam has obtained her B.E. degree from Bharathiyar University and M.E. from Anna University in 2003 and 2005 respectively. She has a teaching experience of 5 years. Presently she is a research scholar at Government College of Technology. Her research areas include embedded controllers and boost converters.

Dr.N.Devarajan obtained his Ph.D. degree in the area of control engineering from Bharathiyar University. He has 25 years of teaching experience. Presently he is working as an Professor at Government College of Technology, Coimbatore. He has published about 37 research papers in international journals. His research areas include power quality and power electronic controllers.