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Review of DC-DC Converters for PFC in SMPS

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Abstract: *Switched Mode Power Supply (SMPS) is an integral part of the computer that converts ac to multiple numbers of suitable dc voltages to impart power to different parts of the PC.DC-DC converter is an intermediate stage in the power conversion. Poor power quality, slow dynamic response, high device stress, harmonic rich, periodically dense, peaky, distorted input current are the major problems which are frequently encountered in the conventional switched mode power supplies (SMPSs) . This violates the limits of international power quality (PQ) standards such as IEC 61000-3-2. Using Matlab tool, power factor of different DC-DC converters are analyzed in this paper and a better counterpart is suggested. In this paper Buck, Boost, Buck- Boost, SEPIC Cuk and Zeta converters are analyzed. The performance analysis is done using MATLAB/SIMULINK software. The proposed converters have been designed for achieving an improved power quality operation with low amount of total harmonic distortion (THD) of supply current.*
Keywords: *Switched mode power supplies(SMPS), Power Factor correction(PFC) Converter, Power Quality, DC-to-DC Converters*

I. Introduction

Now a days , switching converters have become very popular due to recent advances in semiconductor technology. Switching devices are available with very high switching speeds and very high power handling capabilities. It is possible to design switching mode power supplies with efficiency greater than 90% with low cost and relatively small size and light weight. In this switching converters power semiconductor devices are used to operate either on-state or the off state .Since either state will lead to low switching voltage or low switching current ,it is possible to convert dc to DC with higher efficiency using a switching regulator. Personal computers (PCs) have become a part of our day to day activities from business to education to infotainment. Switched Mode Power Supply is an integral part of the computer that converts ac to multiple numbers of suitable dc voltages to impart power to different parts of the PC. It contains a diode bridge rectifier with a capacitor filter followed by an isolated DC-DC converter to achieve multiple DC output voltages .The uncontrolled charging and discharging of the capacitor result in a highly distorted, high crest factor at the single phase ac mains[1]; this violates the limits of international power quality (PQ) standards such as IEC 610003-2. So that to solve this problem , improved power quality SMPS that are working with unity power factor are extensively being researched .Now a variety of topologies have been developed for power factor correction application .By analysing the different topologies of PFC converters ,bridgeless buck boost converter is the best one compared with others. This converter can almost satisfy the features of good PFC converters

II. Literature Review

Power factor correction (PFC) converters have been widely used in AC-DC power conversions to achieve high input power factor (PF) and low harmonic distortion Personal computer (PC) is one of the electronic equipment which is severely affected by power quality problems. Switched-mode power supplies (SMPSs) are used for powering up different parts in a personal computer (PC) . Normally, a diode bridge rectifier (DBR) is used at the front end of these SMPS [2]. Due to the presence of DBR causes significant deterioration in the power quality , leading to very low power factor (PF) and high harmonic distortion at the ac mains . Fig 1 shows the diagram of Conventional SMPS. The uncontrolled charging and discharging of the capacitor result in a highly distorted high crest factor, at the single phase ac mains; this violates the limits of international power quality (PQ) standards such as IEC 610003-2. Fig2 shows the input voltage and input current of the Conventional SMPS. The current waveform is very peaky, non sinusoidal, and highly distorted; the PF is around 0.48.Power quality improvement results in better reliability and enhanced efficiency[3]-[4] . PFC circuits are able to achieve high PF and low THD in the input current even at fluctuating input voltages and varying loads. Apart from this, they are also capable of yielding stiffly regulated output DC voltages. In compliance with the harmonic regulations, many power factor corrected AC-DC converters have been proposed.

There are mainly two types of approaches to improve power factor with reduced Total Harmonic Distortion (THD).That is passive and active power factor correction .

The features of the good power factor correction circuit are as follows:

- A well regulated output voltage Isolation between input AC mains and output DC Mains
- A sinusoidal line current with minimum THD that meets the requirements of international standards
- High efficiency by eliminating or reducing the conduction and switching losses
- Small size of the components used with reasonable current and voltage ratings.

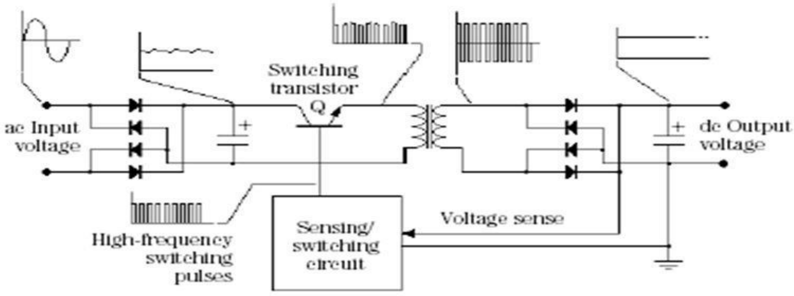

Fig 1 : Conventional SMPS

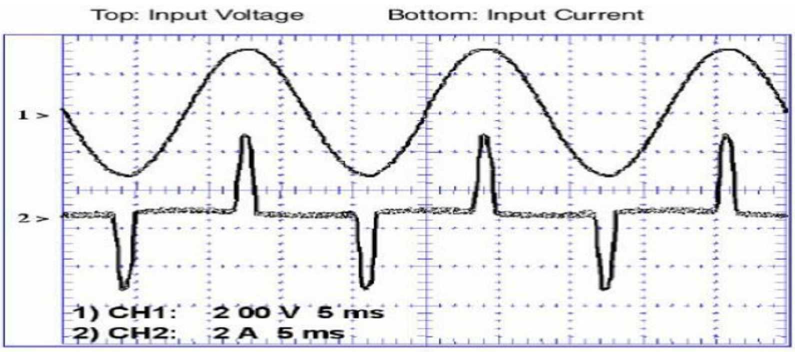

Fig 2 : Conventional SMPS input voltage and input current

So as to satisfy the above features, the converters. should be operated in Continuous Conduction Mode (CCM) and Discontinuous Conduction Mode (DCM). So that to solve this problem , improved power quality SMPS that are working with unity power factor are extensively being researched.Now a variety of topologies have been developed for power factor correction application. The conventional PFC converter is boost converter.Due to this boosting behaviour of the converter output voltage is always greater than input voltage .So it is suitable for high power applications. Thus a buck type converter is reguired for low voltage and low power applications.The buck converter is rarely used in the power factor correction application ,since as the input current of the buck converter is not continuous.And also its having low power factor and high total harmonic distortion . Cuk converters having low voltage stress,improved thermal management, and low conduction losses [5]. However, the component count is increased in these converters,which is not suitable for low-power SMPS applications, By analysing the derived topologies of buck boost converters bridgeless buck boost converter is the best one compared with others.This converter can almost satisfy the features of good PFC converters.

III. Need For Improvement Of Power Factor

In conventional AC rectification ,a highly distorted current is drawn from the mains. That will generate large spectrum of harmonic signals that may interface with other equipment. There are numerous benefits to be gained through power factor correction.

- Reduced demand charges
- Increased load carrying capabilities in existing circuits
- Improved voltage
- Reduced power system losses

Power factor correction is a method of improving power factor and reducing the THD value of input current.Mainly the power factor correction methods are two types.

3.1 PASSIVE PFC

Passive power factor correction typically involves the addition of a line frequency inductor or resistor into the AC line. The effect of the inductor is to squash the current wave shape which resists change in current. The effect of the resistor is to reduce the peak current. The smoother the current wave-shape the less harmonic distortion will be present. This is a very simple solution which has some advantages and some disadvantages. It is not really practical in power supplies above 300 W due to the size of the components required to provide adequate inductance at 50/60 Hz and to keep the resistive losses low enough. This solution is not adequate in lighting, personal computing or colour television applications, but is a viable solution for Class A equipment.

3.2 ACTIVE PFC

The most advanced power factor correction techniques are included in active PFC . In this the PFC converters are normally placed in between the bridge rectifier and the load. The converter output voltage is a DC and it's draws a current that is inphase with the line voltage

IV. Modelling Of Different Converters.

The simulations for the analysis are done in MATLAB software and the models are given below it . Fig 3 Shows the simulation diagram for simple rectifier without PFC converter. Fig 4 to 9 Shows the simulation diagrams of different DC-to-DC converters such as buck boost, buck-boost, SEPIC, cuk and zeta converters .

Input Voltage = 220 V Ac
Switching Frequency = 25kz

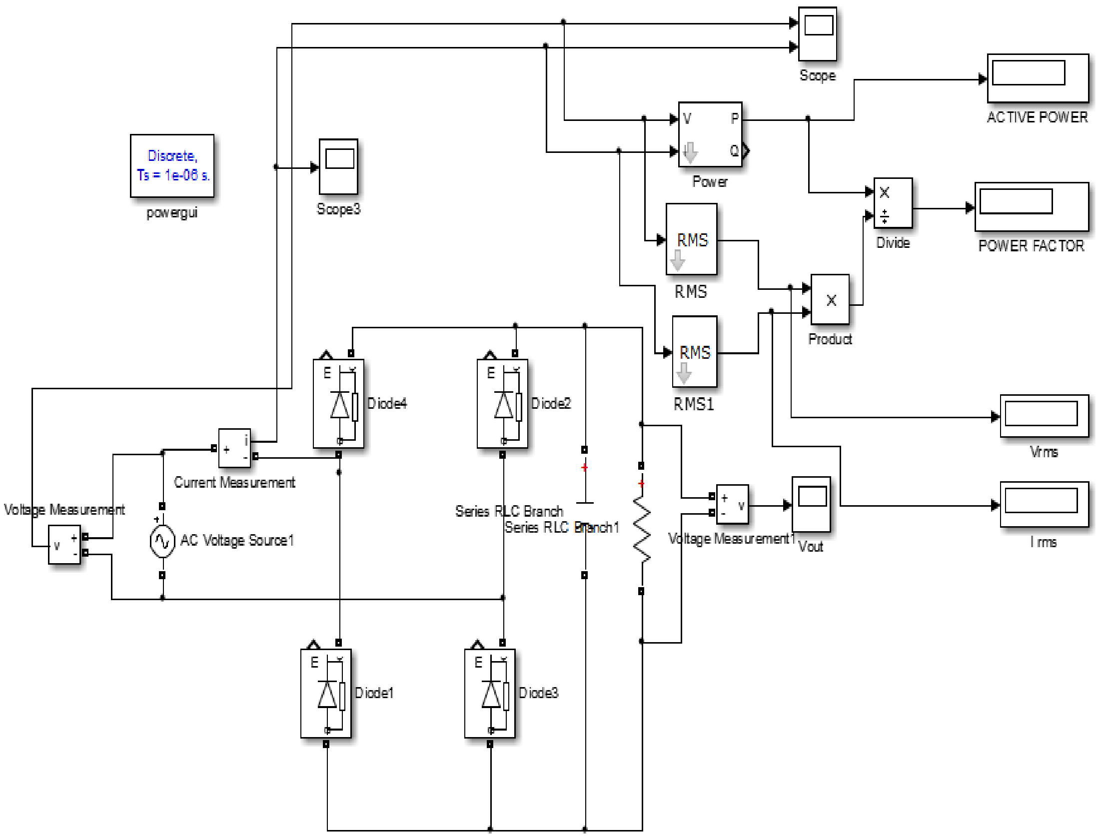

Fig 3. Simulink Model Of Diode Bridge Rectifier

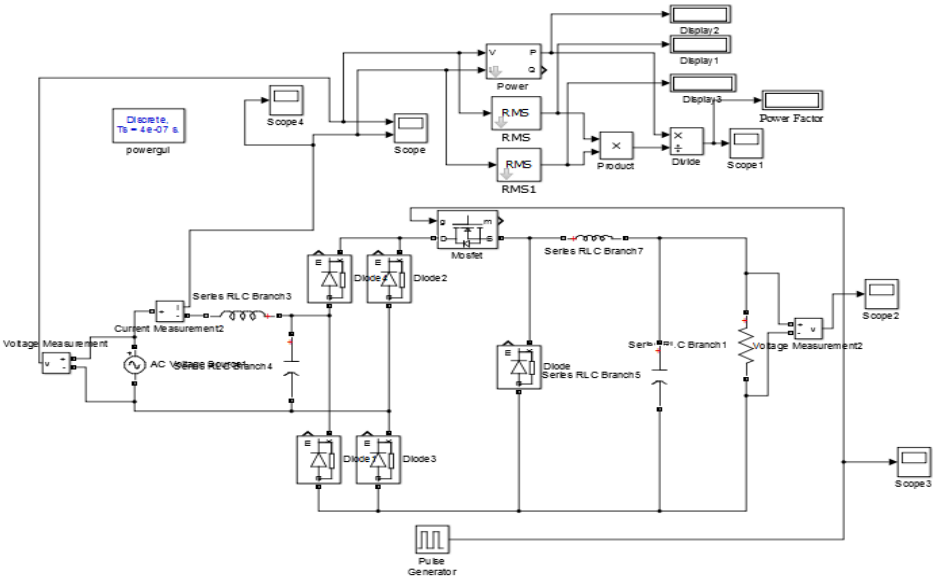

Fig 4. Simulink Model Of buck converter

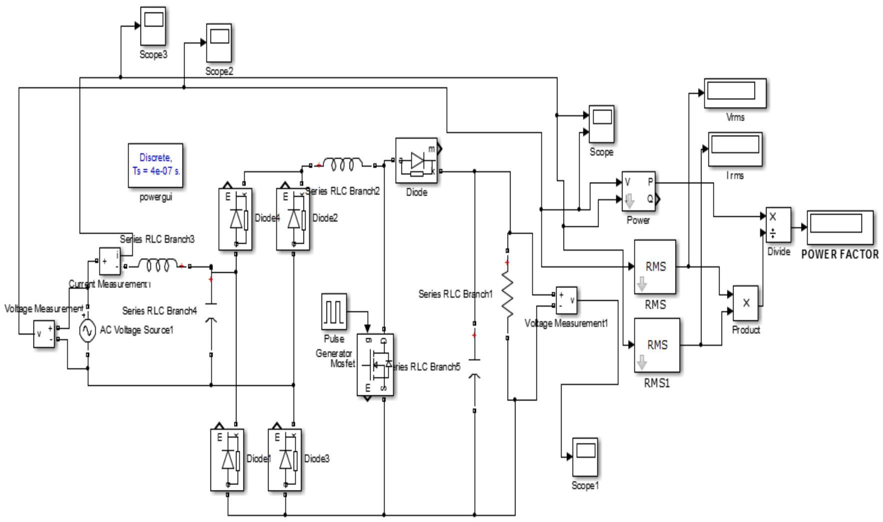

Fig 5. Simulink Model Of boost converter

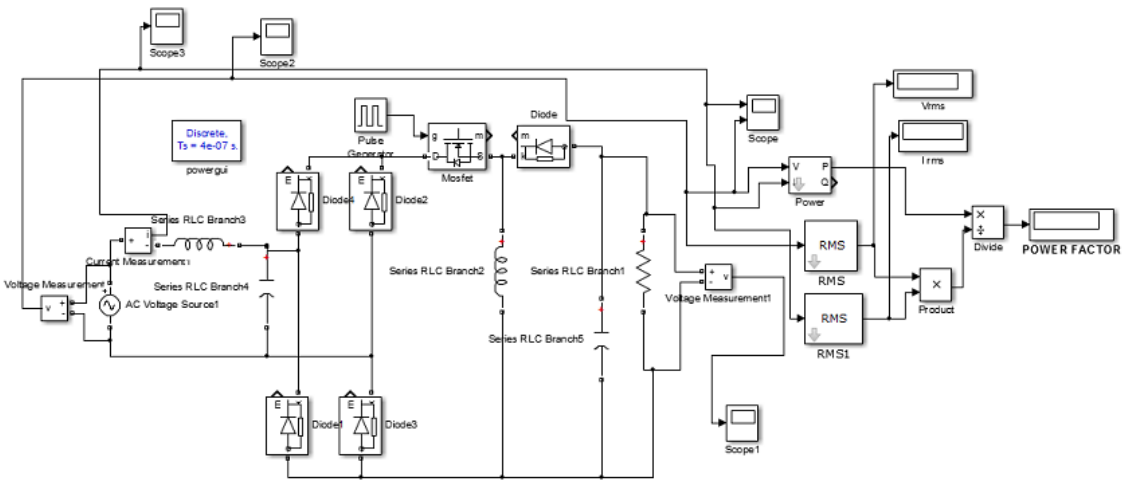

Fig 6. Simulink Model Of buck boost converter

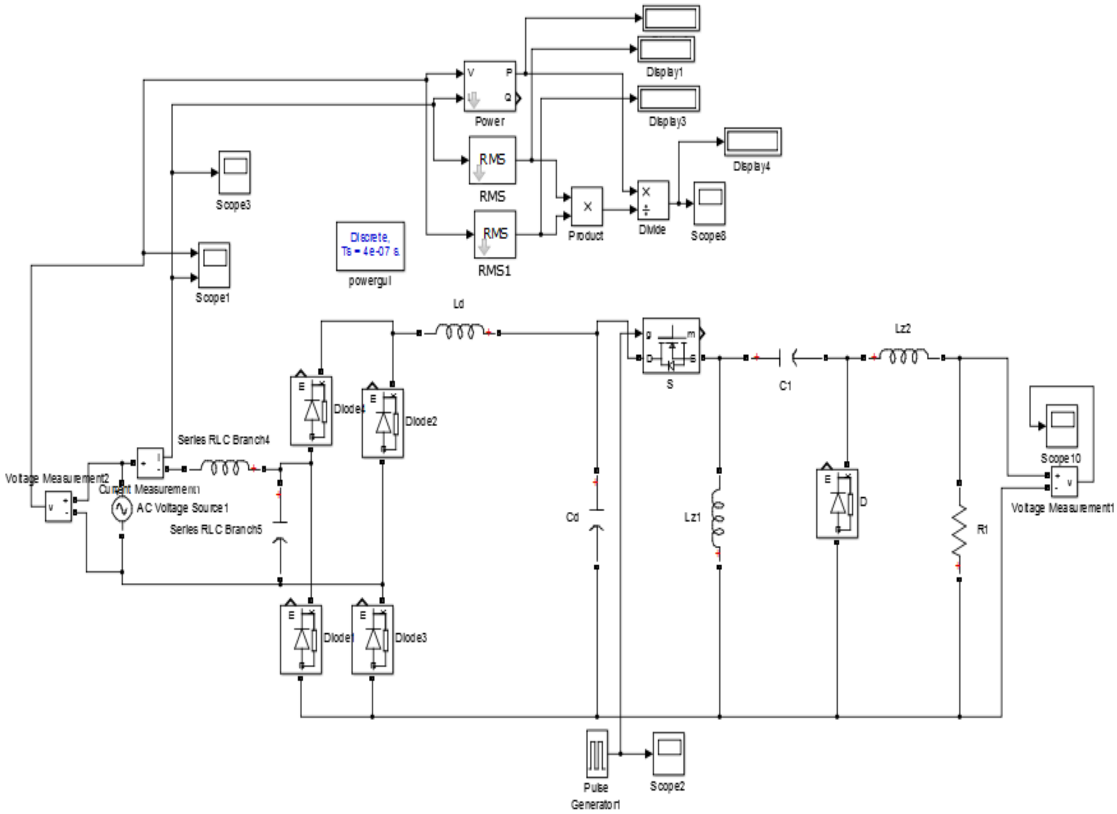

Fig 7. Simulink Model Of zeta converter

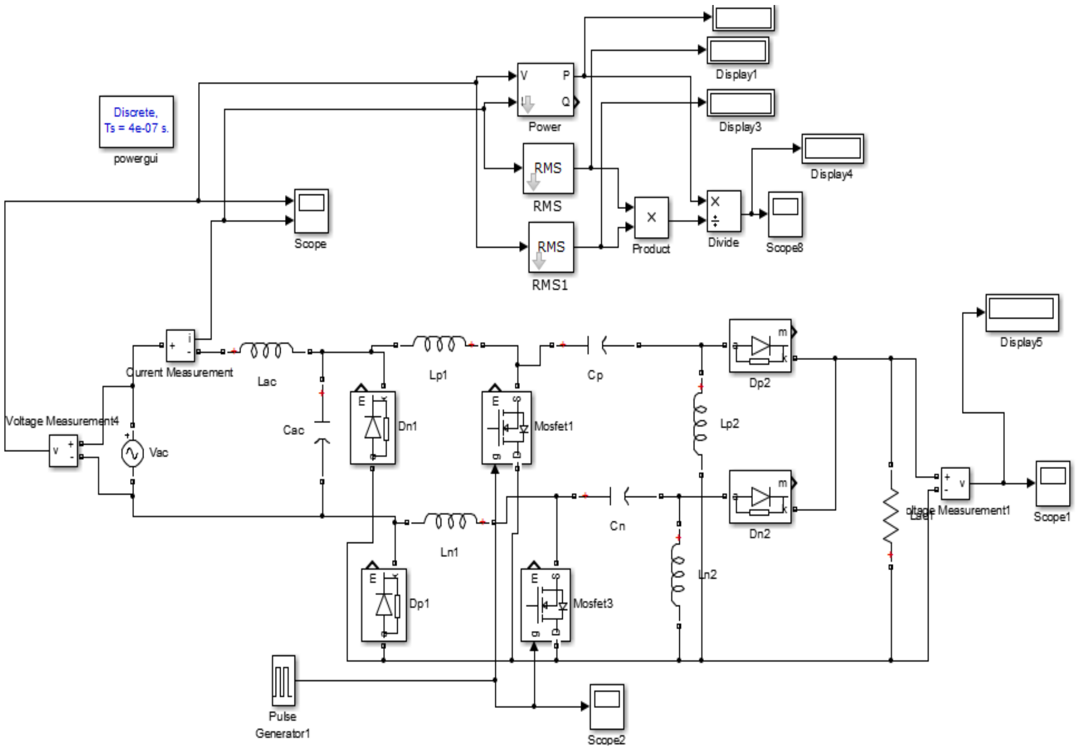

Fig 8. Simulink Model Of Sepic Converter

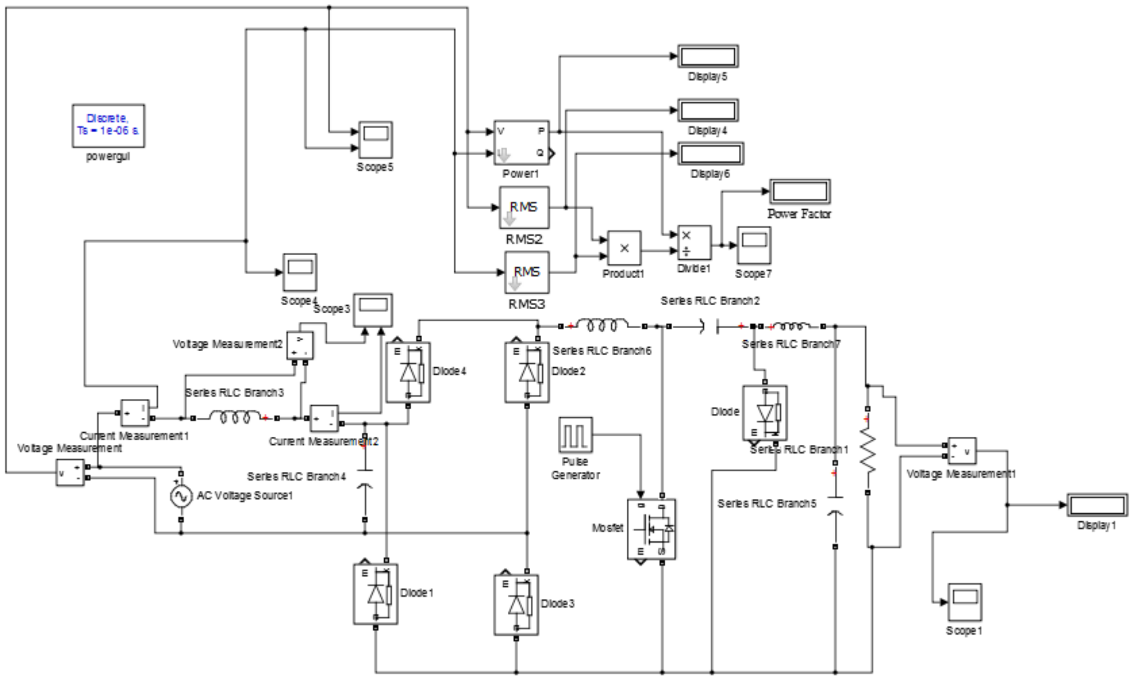

Fig 9. Simulink Model Of Cuk Converter

V. Simulation Results

Fig 9 to 15 shows the THD levels for different PFC converters .

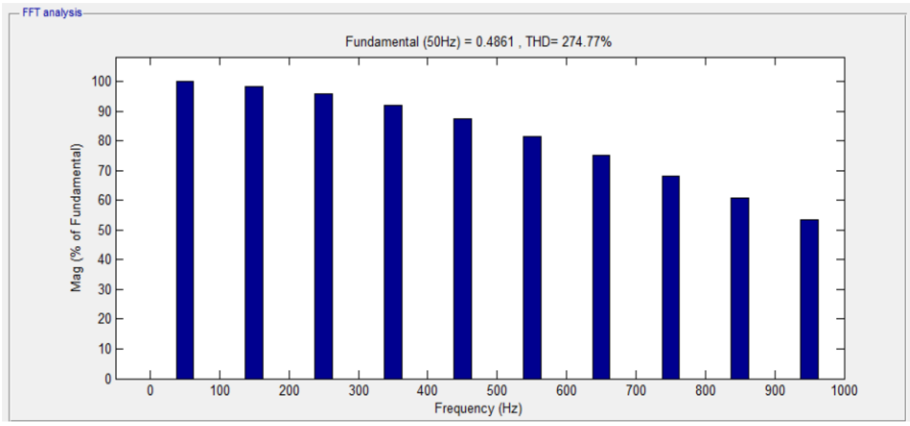

Fig 10. THD of a Diode Bridge Rectifier

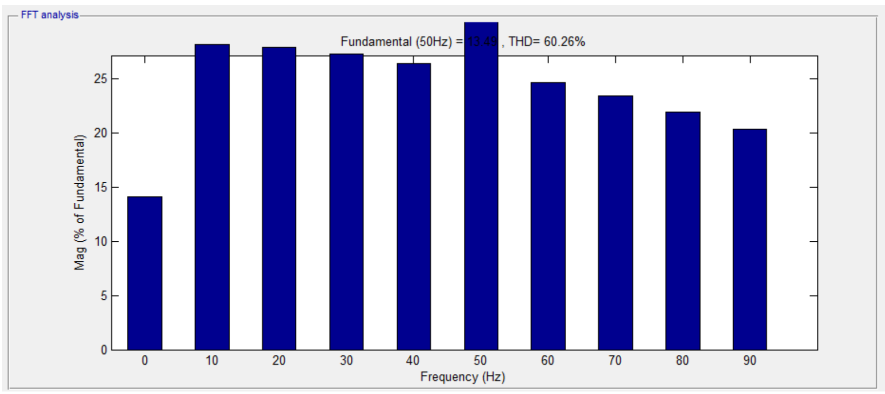

Fig 11 .THD of Buck Converter

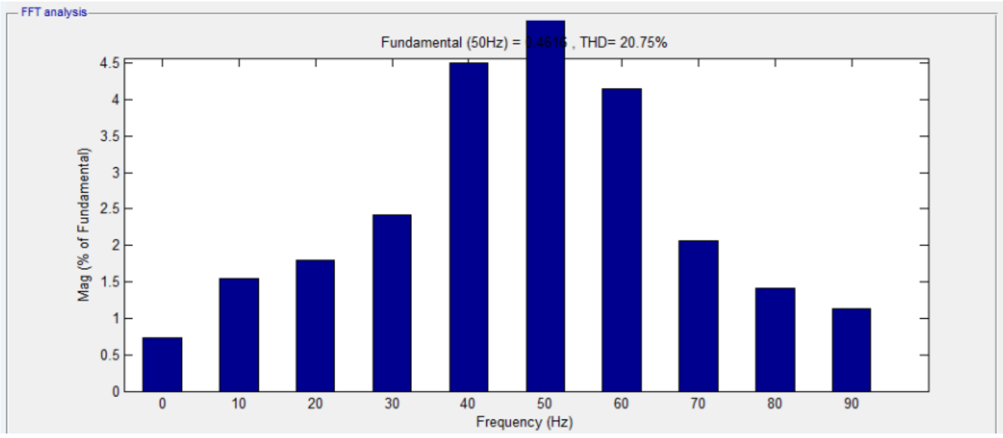

Fig 12. THD of Boost Converter

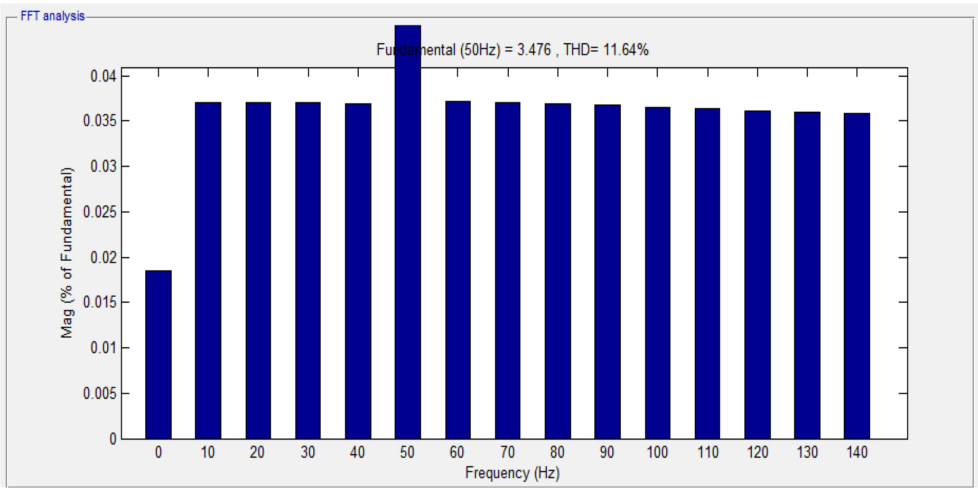

Fig 13. THD of Buck Boost Converter

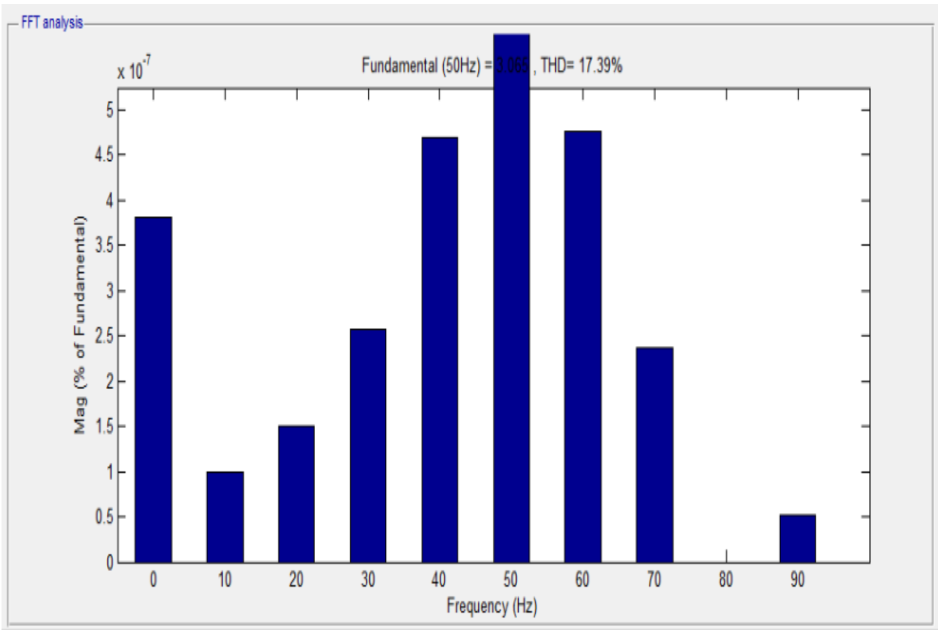

Fig 14. THD of Zeta Converter

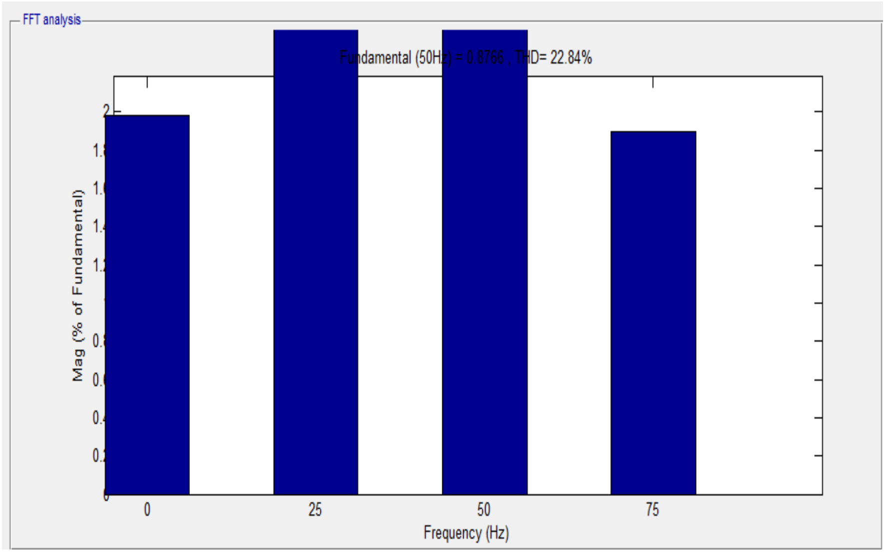

Fig 15. THD of Cuk Converter

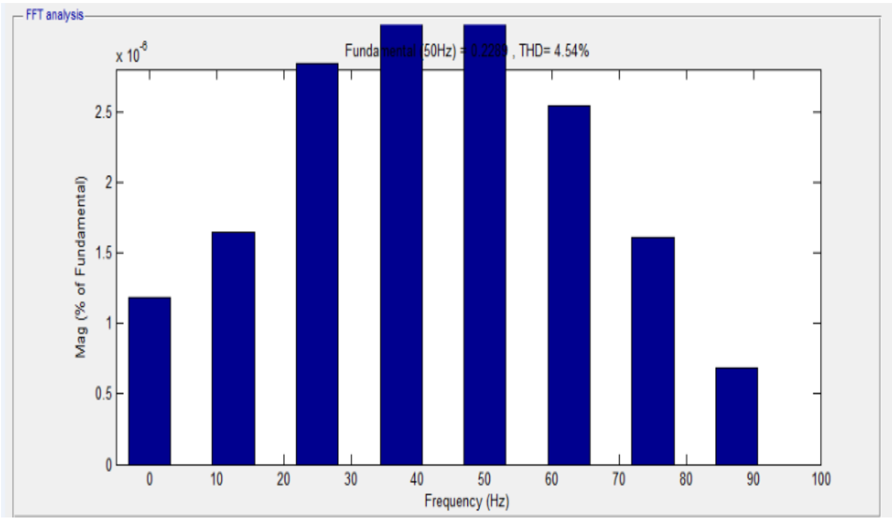

Fig 16. THD of Sepic Converter

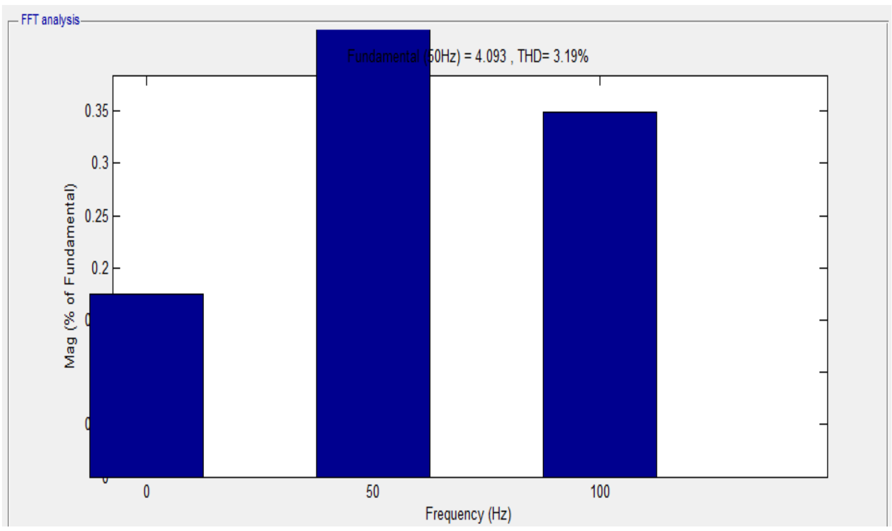

Fig. 17. THD of Bridgeless Buck Boost Converter

Table -1: Comparison of Power factor for different topologies

Converter Topology	Obtained Power Factor	THD(%)
Simple Rectifier	0.34	274.77
Buck	0.78	60.26
Boost	0.89	20.71
Buck –Boost	0.94	11.74
Sepic	0.9768	33.50
Cuk	0.923	22.84
Zeta	0.965	7.90
Bridgeless buck boost	0.99	3.19

Table -1 shows the comparison for power factor and THD for different PFC converters after the analysis .Its clear that Bridgeless Buck Boost, Zeta and Cuk converters have reduced harmonics. And the Power Factor is more near to unity for Bridgeless Buck Boost Converter.

VI. Conclusion

Power Factor Correction in SMPS for computer power supply is discussed in this paper . In general ,different DC- DC converters are proposed for the power factor correction and improving source current harmonics .The comparative study of different converter topologies for active power factor correction has been carried out in this paper. The simulation of different converters are presented with in same simulation parameters and from the comprehensive study , bridgeless buck boost converter has power factor more near to unity with reduced THD level**.**

References

[1]. P. J. Moore and I. E. Portugues, The influence of personal computer processing modes on line current harmonics,IEEE Trans. Power Del., vol. 18, no. 4, pp. 1363–1368, Oct. 2003.

[2]. N. Mohan, T. M. Undeland, and W. P. Robbins, Power Electronics: Converters, Applications and Design. Hoboken, NJ, USA: Wiley 2003.

[3]. B. Singh et al., A review of single-phase improved power quality AC–DC converters, IEEE Trans. Ind. Electron., vol. 50, no. 5, pp. 962–981, Oct. 2003.

[4]. Singh, S. Singh, A. Chandra, and K. Al-Haddad, Comprehensive study of single-phase AC–DC power factor corrected converters with highfrequency isolation," IEEE Trans. Ind. Informat., vol. 7, no. 4, pp. 540– 556, Nov. 2011

[5]. D. S. L. Simonetti, J. Sebastian, F. S. dos Reis, and J. Uceda, Design criteria for SEPIC and Cuk converters as power factor Pre-regulators in discontinuous conduction mode,in Proc. IEEE Ind. Electron. Motion Control Conf., 1992, vol. 1, pp. 283–288.