iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** I **Month of publication:** January 2020

DOI: http://doi.org/10.22214/ijraset.2020.1015

A High Power Factor Switched Mode Power Supplied using Full-Bridge Converter

Mayank Vyas[1], Parvez Vasovala[2], Dhaval Dave[3], Vibhuti Patel[4]
[1, 2, 3]Lecturer, Department of Electrical Engineering, Parul University, Limda
[4]Lecturer, Department of Electronics & Communication Engineering, Parul University, Limda

***Abstract:** In this era due to Power electronics revolution, people have very efficient tools to solve problems of having DC voltage to power the Electronics Devices. Every new electronic product requires converting input voltage 230V AC power to some fixed DC voltage for powering the electronics circuit or devices. Switching regulators (SMPS) are becoming an essential part of many electronic systems due to miniaturization and energy efficiency. Conventional power supplies, however, draw currents that are highly non-sinusoidal and out of phase with input voltage, thus display a low power factor and higher total harmonic distortion (THD), which causes power quality problems. In This work presents two stage AC-DC and DC-DC power converter using single-phase isolated Full bridge converter with inherent power factor correction (PFC) method for switched mode power supply (SMPS).The advantages of the proposed methodology are its simple control strategy, reduction in complexity of system, low input line current harmonics. The effect of load variation on SMPS is also studied in order to demonstrate the effectiveness of converter for the complete range of load conditions.*

***Keywords:** Dc to dc converter, dc to ac converter, SMPS etc.*

I. INTRODUCTION

An S.M.P.S. can be a complicated circuit as can be seen from the block diagram shown in Fig. 1. (This configuration a 50 Hz mains input supply is used.) The ac supply is first rectified, and then filtered by the input reservoir capacitor to produce a rough dc input supply. This level could be fluctuate widely due to variations in the mains. In addition the capacitance of the input has to be large to hold the supply in case of a severe droop in the mains. (The S.M.P.S. can also be configured to operate from any suitable dc input, in this case the supply is called a dc to dc converter.), The unregulated dc is put directly to the central block of the supply, the high frequency power switching section. Fast switching power devices as MOSFETs and Bipolar are driven on and off, and switch the input voltage across the primary of the power transformer.

The drive pulses are normal fix frequency (20 to 200 kHz) and variable duty cycle. The voltage pulse of suitable magnitude and duty ratio appears on the Transformer secondary. This voltage pulse train is rectified, and smoothed by the output filter, which is either a capacitor /inductor arrangement, depending upon the topology used. This transfer of power has to be out with the lowest losses possible, to maintain efficiency.

Thus, Design of the magnetic components, and selection of the correct power semiconductors is critical Regulation of the output to provide a stabilized dc supply is carried out by the control / feedback block. Generally, most S.M.P.S. systems operate a fixed frequency pulse width modulation, where the duration of the on time of the drive to the power switch is varied on a cycle by cycle basis. This changes in the input supply and output load. The output voltage is compared to a desire reference supply, and the incorrect voltage produced by the comparator is used by dedicated control logic to terminate the drive pulse to the main power switch/switches at the correct instance.

Correctly designed, that provide a very stable dc output supply. It is that delays in the control loop are kept to a minimum, otherwise stability problems would occur. Very high speed components must be selected for the loop. In the transformer-coupled supplies, in order to keep the isolation barrier intact, some type of electronic isolation is required in the feedback. It is usually achieved by using a small pulse transformer or an opto -isolator, hence adding to the component count. In most applications, the S.M.P.S. topology contains a power transformer.

This are provides isolation, voltage scaling via the turns ratio, and the ability to provide multiple outputs. There is non-isolated topologies (without transformers) such as the buck and the boost converters, where the power processing is achieved by inductive energy transfer alone. All of complex arrangements are based on these non-isolated types.

Basic Switched Mode Supply Circuit

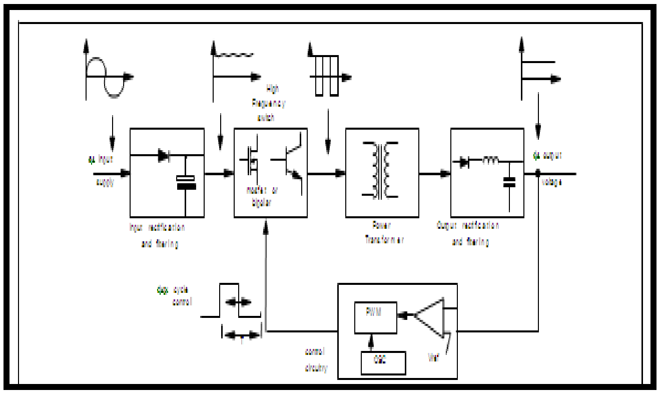


Figure 1. Non-Isolated Converter

The majority of the topologies used in today's converters are all derived from the following three non-isolated versions called the buck, the boost and the buck-boost. These is the simple system possible, and have the lowest component count, requiring only one inductor, capacitor, transistor and diode to generate their single output. If there are isolation in between the input and output is required, a transformer must be included before the converter.

A. *Transformers in S.M.P.S. Converters*

The non-isolated types have very limited uses, such as dc-dc regulators only capable of producing a single output. The output range is limited by the input & duty cycle. The addition of a transformer removes most of these constraints and provides a converter with the following advantages:-

1) Input to output isolation is provided. This is normally always necessary for 220/110v mains applications, where a degree of safety is provided for the outputs.
2) The transformer turns ratio will be selected to provide outputs widely different from the input and non-isolated versions are limited to a range of approximately 5 times. By selecting the correct turn's ratio, the duty cycle of the converter can also be optimized and the peak currents flowing minimized. The polarity of each output is dependent upon the polarity of the secondary w.r.t the primary.
3) Different outputs are very easily obtained, simply by adding more secondary windings to the transformer. There are some disadvantages with transformers, such as their additional size, weight and power loss.

The isolated converters to be covered are split in to two main categories, called asymmetrical and symmetrical converters, depending upon how the transformer is operated.

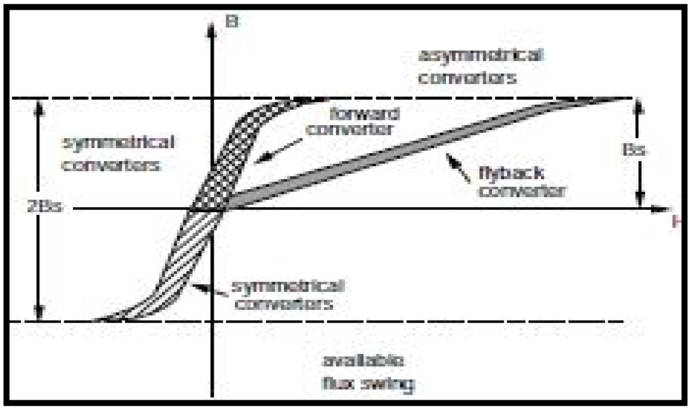


Figure 2 Comparative core usage of asymmetrical and symmetrical converters.

In asymmetrical converters the magnetic operating point on transformer is always in first quadrant i.e. the flux and the magnetic field never changes sign. The core reset each cycle to avoid saturation, meaning that only half of the usable flux is ever exploited. This can be seen in Fig.2, which shows the operating mode of each converter. The fly back and forward converter are both asymmetrical types.

The diagram also indicates that the fly back converter is operated at a lower permeability (B/H) and lower inductance than the others. This is because the fly back transformer actually stores all of the energy before dumping into the load, hence an air gap is required to store this energy and avoid core saturation. The air gap has the effect of reducing the overall permeability of the core.

In the symmetrical converters always require an even number of transistor switches, the full available flux swing in both quadrants of the B / H loop is used, thus utilizing the core much more effectively. Symmetrical converters will produce more power than their asymmetrical cousins. The three major symmetrical topologies used in practice are the push-pull, the half-bridge and the full bridge types**.** Below Table outlines the typical maximum output power available from each topology using present day technologies.

Converter Topology	Typical max output power
FLYBACK	200W
FORWARD	300W
FLYBACK	400W
PUSH PULL	500W
HALF BRIDGE	1000W
FULL BRIDGE	<1000W

Different types of converter topologies

B. Design and Analysis of the Single-phase Full bridge Converter Module

For the design and analysis of the full-bridge converter, all the switches considered ideal. The output inductor current is continuous in switching period. In the previous section, the full-bridge converter has two intervals of operation in each half cycle. To operate at CCM, the current should not reach zero at the end of Interval 1. Fig. shows the circuit of a full-bridge converter. The converter operates in two intervals in one half cycle. In Interval 1, S1, and S4 are on. In Interval 2, all the four switches are off. The two intervals of operation are explained in detail below.

1) Interval 1: To<t<DTs

In this interval, two diagonal switches, S1 and S4, are on and are providing energy to the load through a high frequency transformer and two diodes. For this purpose, the circuit model is considered Fig., the following equations can be derived:

Vp=Vd (1)

$$V_{s1} = (N_{s1}/N_p)V_d; V_{s2} = (N_{s2}/N_p)V_d \quad (2)$$

The voltage across the output inductor is represented by Lo. VL is given by:

$$V_L = (N_{s1}/N_p)V_d - V_{dc} \quad (3)$$

where Vp is the voltage across the primary winding of the high frequency transformer; Vs1 and Vs2 are the voltages across the secondary windings of the high frequency transformer, respectively; Vd is the input dc voltage for the full bridge converter; VL is the voltage across the output inductor Lo; and Vdc is the dc output voltage across the load. Np, Ns1, and Ns2 are the number of turns of the primary winding and secondary windings of the high frequency transformer.

The rate of rise of the inductor current iLo is given by:

$$\frac{di_{Lo}}{dt} = \frac{V_L}{L_o} = \frac{(N_{s1}/N_p)V_d - V_{dc}}{L_o} \quad (4)$$

The change in the inductor current during the on period is expressed as:

$$(\Delta i_L)_{ON} = \frac{(n V_d - V_{dc})}{L}(\Delta t)_{ON} \quad (5)$$

$$(\Delta i_L)_{ON} = \frac{(n V_d - V_{dc})}{L_o}DT_S \quad (6)$$

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 8 Issue I, Jan 2020- Available at www.ijraset.com

2) *Interval 2:* DTs <t< Ts/2

In this interval, all switches are off during the period DTs < t < (Ts/2), and the load current flows through the diodes. The equivalent circuit can be drawn as in Fig. The rate of change of output inductor current is given by

$$\frac{di_{Lo}}{dt} = \frac{-V_{dc}}{L_o} \quad (7)$$

C. *Operation Intervals of full-Bridge Converter*

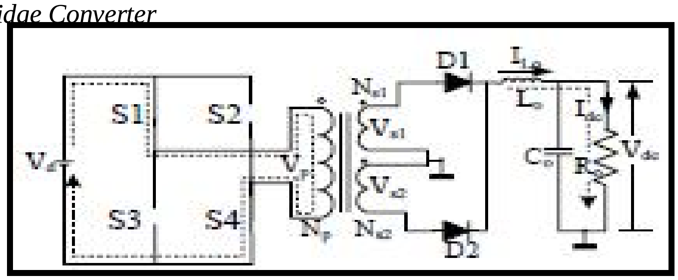


Figure 3 Interval-1

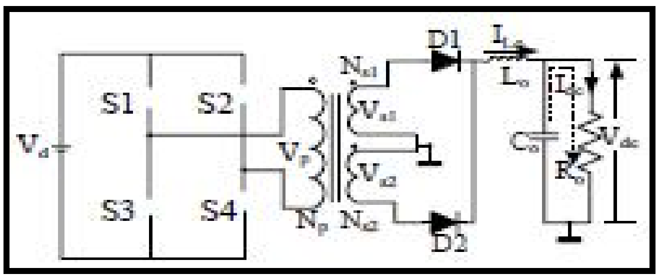


Figure 4 Interval-2

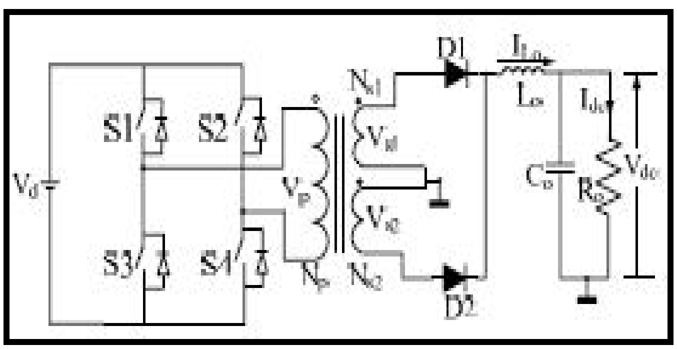


Figure 5 Schematic for the analysis of a single-phase module full-bridge converter fed by constant dc source.

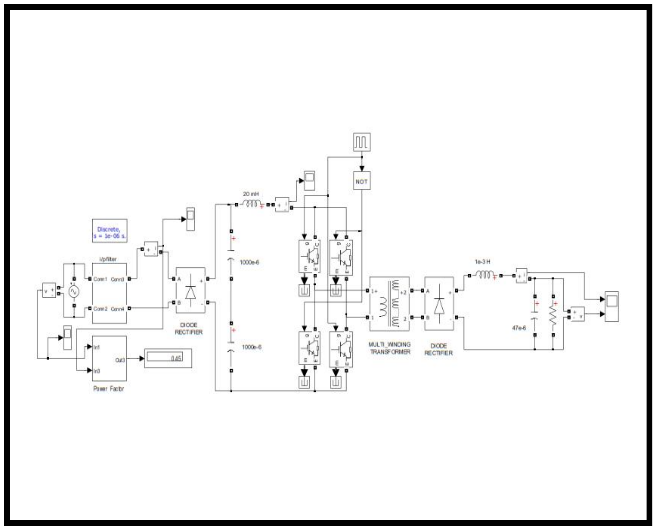
The inductor value Lo can be calculated for a given value of its ripple current. During the period the inductor current increases linearly as expressed by:

$$(\Delta i_L)_{ON} = \frac{(n V_d - V_{dc})}{L_o}(\Delta t)_{ON} \quad (8)$$

$$I_{Lo,\,max} - I_{Lo,\,min} = \frac{(n V_d - V_{dc})}{L_o} T_{ON} \quad (9)$$

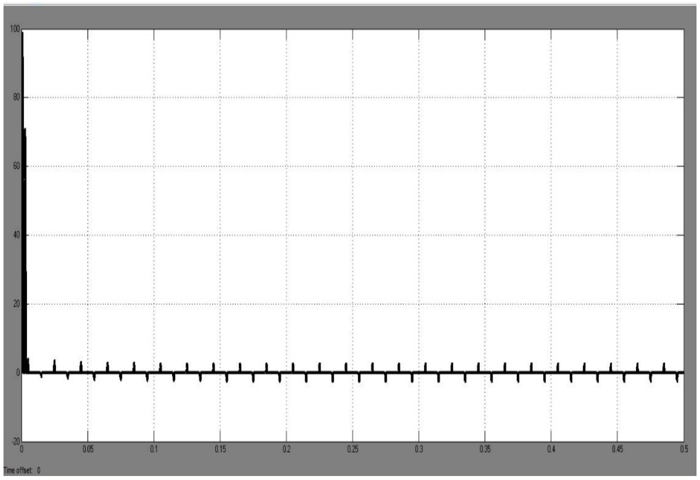
$$(\Delta i_L)_{ripple} = \frac{(n V_d - V_{dc})}{L_o} T_{ON} \quad (10)$$

D. Simulation for Propose Work

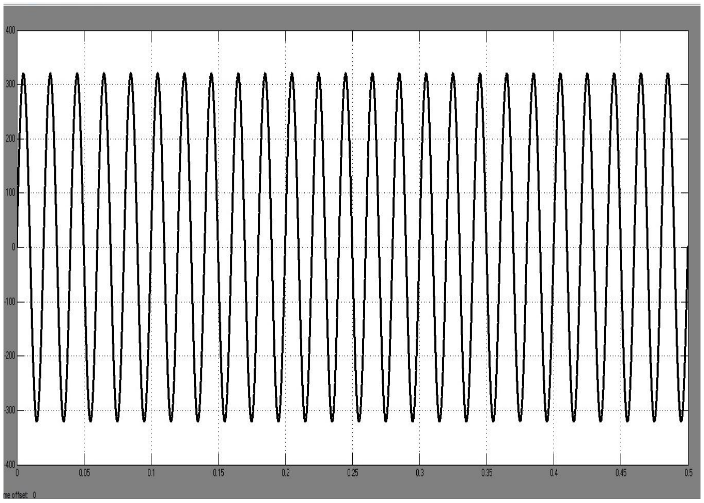


Simulation for SMPS with full bridge converter with R-Load

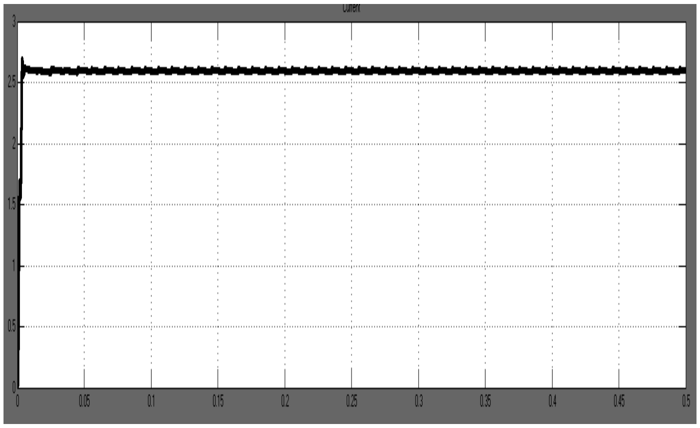
E. Simulation Result and Waveform



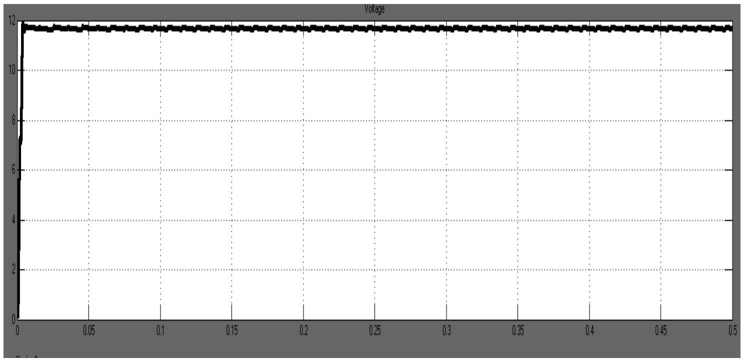
Input Current waveform for SMPS



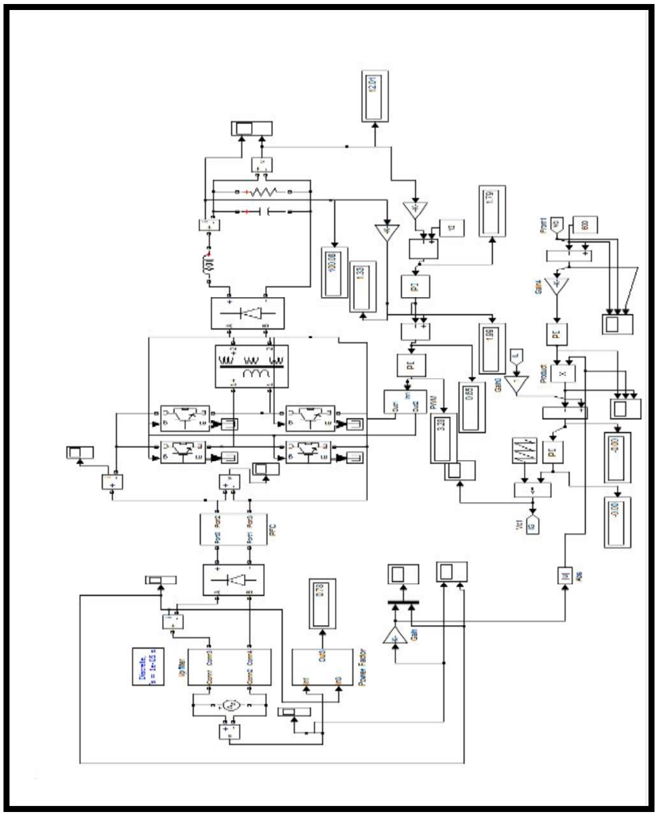
Input Voltage waveform for SMPS



Out-put Current waveform for SMPS

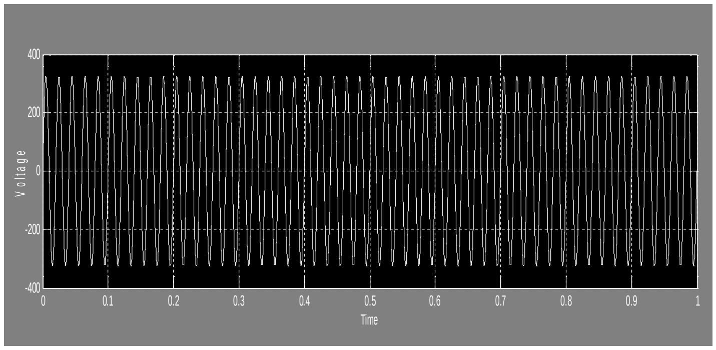


Out-put Voltage waveform for SMPS

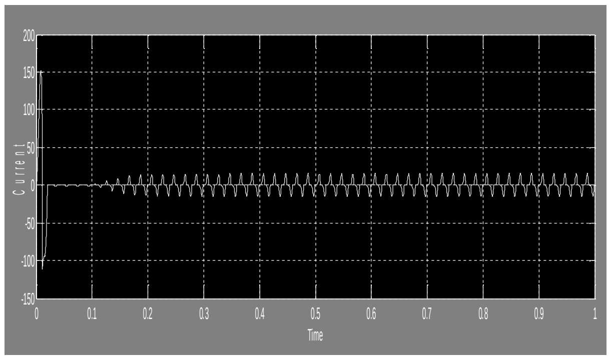


Close-loop Simulation for SMPS with full bridge converter with R Load

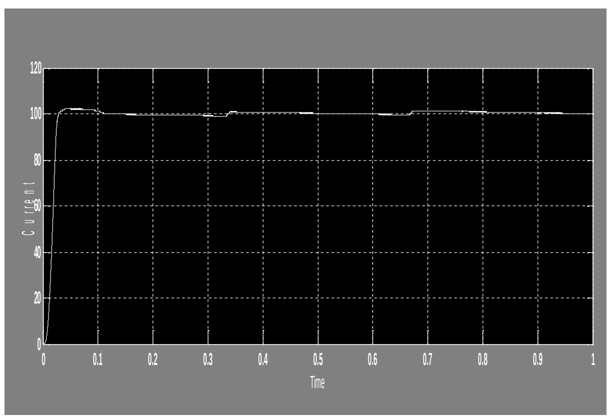
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 8 Issue I, Jan 2020- Available at www.ijraset.com



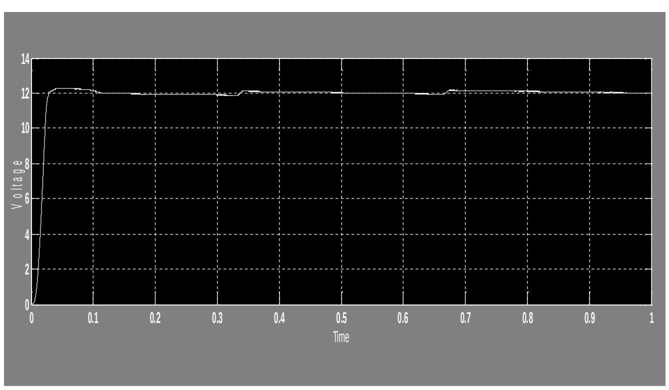
Input Voltage waveform for SMPS



Input Current waveform for SMPS



Out-put Current waveform for SMPS



Out-put Voltage waveform for SMPS

Different types of Load Connected with SMPS

Connecting Linear Load	Power Factor	Voltage (Volt)	Current (Amp)
R(resistor)	0.82	12	100
L(inductor)	0.81	12	120
R-L	0.79	12	100

II. CONCLUSION

A fast transient response to a step load changes is very essential in a switch mode power supply. This thesis presents a thorough literature review of control methods to improve transient response in switch mode power supply (SMPS). The transient response can be improved by means of feedback control method. A simulation study on these feedback control methods has been done using MATLAB Simulink. It is found that the CMC helps the SMPS for a faster transient response compared to the VMC.

The advantages of the proposed methodology are its simple control strategy, reduction in complexity of system, low input line current harmonics. The effect of load variation on SMPS is also studied in order to demonstrate the effectiveness of converter for the complete range of load conditions. The various simulated and comparative result is also presented in this work.

REFERENCES

[1] Philips MOSFET Selection Guide for S.M.P.S.by M.J.Humphreys. Philips Power Semiconductor Applications group, Hazel Grove.
[2] Switch Mode Power Conversion - Basic theory and design by K.Kit.Sum. [Published by Marcel Dekker inc.1984]
[3] Sanjay L. Kurume, Praveen M. Patel, Vend H. Patil, "A Comparative Study and Analysis of Power Factor Control Techniques" International Journal of Computer Science & Emerging Technologies [E-ISSN: 2044-6004] Volume 1, Issue 4, December 2010
[4] Mr. D. Lenine1, Dr.Ch. Sai Babu2, "Comparison between Variable Switching Frequency and Timer Controller with Constant Switching Frequency Techniques for PFC Converter" International Journal of Computer and Electrical Engineering, Vol. 1, No. 2, June 2009
[5] R.Balamurugan Senior Member, IEEE Dr.G.Gurusamy Senior Member, IEEE, "Harmonic Optimization by Single Phase Improved Power Quality AC-DC Power Factor Corrected Converters2010 International Journal of Computer Applications [0975 – 8887]
[6] Supratim Basu and Math H. J. Bollen, Fellow, IEEE, '' A Novel Commpon Power Factor Correction Scheme for Homes And Offices" IEEE TRANSACTIONS ON POWER DELIVERY, VOL. 20, NO. 3, JULY 2005
[7] B. Bryant, M.K. Kazimierczuk, "Voltage Loop of Boost PWM DC-DC Converters with Peak Current-Mode Control", Circuits and Systems IEEE Transactions, Vol. 53 Issue 1, pp. 99-105, 2006.
[8] L. Rossetto, G. Spiazzi, P. Tenti, "Control Techniques for Power Factor Correction Converters", Application notes, Department of Electrical Engineering, Department of Electronics and Informatics, University of Padova, Via Gradenigo, Italy, pp. 1-9, 1994.
[9] S. Buso, S. Fasolo, L. Malesani, P. Mattavelli, "A Dead-Beat Adaptive Hysteresis Current Control", IEEE Trans. Ind. Appl., Vol. 36, Issue 4, pp. 1174-1180, Jul./Aug. 2000.
[10] J.W. Kimball, P.T. Krein, Y. Chen, "Hysteresis and Delta Modulation Control of Converters using Sensorless Current Mode", IEEE Trans. Power Electron., Vol. 21, Issue 4, pp. 1154-1158, Jul. 2006.
[11] N.A. Rahim, J. Selvaraj, C. Krismadinata, "Hysteresis Current Control and Sensorless MPPT for Grid-Connected Photovoltaic Systems", Proc. IEEE ISIE, pp. 572-577, 2007.
[12] Electromagnetic Compatibility (EMC), "Limits for Harmonic Current Emissions (Equipment input current ≤16A per phase)", IEC Standard IEC 61000-3-2, 3 (2) 2009.
[13] M.H. Rashid, "Power Electronics Handbook: Devices, Circuits, and Applications", Academic Press, Vol. 19, pp. 525-530, 2006.
[14] Direct Single-stage Power Converter with Power Factor Improvement for Switched Mode Power Supply, Journal of Electrical Engineering and Technology 5(3):468-476 · September 2010 with 740Reads DOI: 10.5370/JEET.2010.5.3.468
[15] Direct Single-stage Power Converter with Power Factor Improvement for Switched Mode Power Supply, Journal of Electrical Engineering & Technology Vol. 5, No. 3, pp. 468~476, 2010
[16] Design and Implementation of High Frequency Isolated AC-DC Converter for Switched Mode Power Supplies, December 2014 with 1,123 Reads DOI: 10.1109/NPSC.2014.7103804 Conference: Eighteenth National Power Systems Conference (NPSC), 2014., At IIT Guwahati