ISSN 2349-7815

International Journal of Recent Research in Electrical and Electronics Engineering (IJRREEE)
Vol. 4, Issue 2, pp: (124-131), Month: April - June 2017, Available at: www.paperpublications.org

Power Factor Corrected Bridgeless Converter Based Improved Power Quality Switched Mode Power Supply

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Abstract: **Many electronic appliances powered up from the utility, utilize the classical method of AC-DC rectification which involves a diode bridge rectifier (DBR) followed by a large electrolytic capacitor. The uncontrolled charging and discharging of this capacitor instigates harmonic rich current being drawn from the utility which goes against the international power quality standard limits. Personal computer (PC) is one of the electronic equipment which is severely affected by power quality problems. 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. It contains a diode bridge rectifier (DBR) with a capacitor filter followed by an isolated DC-DC converter to achieve multiple dc output voltages of different ratings. That result in a highly distorted, high crest factor, periodically dense input current at the single phase ac mains; this violates the limits of international power quality (PQ) standards such as IEC 61000 -3-2 . Employing various power factor corrected (PFC) single-stage and two stage converters effect a perceivable PQ improvement in these SMPSs. Hence from the analysis of different power factor converters a bridgeless buck boost converter is designed and implemented here for near unity power factor.**

Keywords: **Switched mode power supplies(SMPS), Power Factor correction(PFC) Converter, Power Quality, DC-to-DC Converters, AC-DC rectification.**

I. INTRODUCTION

In the present era, computers have become a part of our daily life.A computer power supply normally requires multiple number of DC-DC converters for multiple output with improved power quality.Hence the complexity and cost of the system will be increases.Now a days , switching converters have become very popular .Switching devices are available with very high switching power handling capabilities. It is possible to design switching mode power supplies with higher efficiency 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 ,voltage convertion can be done with higher efficiency using a switching [1].

So now a days SMPS is used as an integrated part of computers.It can convert AC voltage in to multiple output dc voltages to provide power to different parts of the PC. It contains a diode bridge rectifier (DBR) followed by DC-DC converter to achieve multiple DC output voltages of different ratings. The uncontrolled charging and discharging of the filter capacitor result in very low PF and high THD value; this violates the limits of international power quality (PQ) standards such as IEC 610003-2. Further, the neutral current in the distribution system increases if these PCs are used in large numbers which creates serious problems.The main problems are overloading the neutral conductor, noise, de-rating

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of the transformer, voltage distortion etc. To solve this problem , better power quality SMPS that are working with unity power factor are extensively being researched[2]

A variety of circuit topologies have been developed for the PFC .The main features of a good power factor correction circuit are as follows: a well regulated output voltage, isolation between input and output mains, a sinusoidal line current with minimum THD, high efficiency and small size of the components used with reasonable current and voltage ratings[3].The conventional PFC converter is a full-bridge rectifier followed by a boost converte[4]. The converter is widely used, because of its simplicity. Here due the behavior of boost converter, the output voltage is always greater than the input voltage[5]. In many applications, such as low-voltage and low-power supplies, it is required to have the output voltage lower than the input voltage. Thus a buck-type converter is required. The buck converter is rarely used in the PFC application, since as the input current of the buck converter is discontinuous. Besides, the buck PFC converter may lead to increased total harmonic distortion (THD) and reduced power factor (PF)[6]. Therefore, in low power applications buck boost converter is used. The drawbacks of buck-boost converter operating in DCM are high-current stress on semiconductor devices and discontinuous input current, which increases the THD[7].By analysing the derived topologies of buck boost coverters bridgeless buck boost converter is the best one compared with others.This converter can almost satisfy the features of a good PFC converter.

II. OPERATING PRINCIPLE OF BRIDGELESS-CONVERTER-BASED MULTIPLE-OUTPUT SMPS

A buck–boost converter is best suited for computer SMPSs among various converter topologies. A single-phase supply with LC filter is the front end of this circuit and is fed to bridgeless buck boost converter. This provide the required dc link voltage of the VSI. Instead of diode bridge ,two buck–boost converters are used.The two converters are connected in back-to-back so that each takes care of one half cycle of the ac supply. This regulated dc voltage is given to half-bridge VSI for obtaining multiple-output dc voltages. The half-bridge VSI is designed in continuous conduction mode . Here,only one control loop is required to regulate multiple dc voltages.

To eliminate ripples, Single-phase ac supply is fed to two buck–boost converters through an inductor–capacitor filter . During the positive half cycle of the ac supply , the upper buck boost converter is conduct. And during the negative half cycle of the ac supply , the lower buck boost converter is conduct. The upper converter consists of one high-frequency switch Sp, inductor Lp, and two diodes Dp1 and Dp2. Similarly, the lower converter consists of one high-frequency switch Sn, inductor Ln, and two diodes Dn1 and$ Dn2 . The output DC voltage of the buck–boost converter is controlled by using closed-loop control. The output of the buck–boost converter is connected to the half-bridge VSI for obtaining multiple dc voltages. The half-bridge VSI consists of two capacitors C11 and C12, two switches and one high-frequency transformer (HFT). At the secondary side of the HFT, filter inductors L1 L2, L3, and L4 and capacitors C01,C02,C03, and C04 are connected .

A. Operation of Buck–Boost Converter:

According to the positive and negative half cycles of the ac voltage,the switches in the upper and lower buck–boost converters are switched on and off alternately .There are six modes of operations.First three modes are operating under Positive half cycle and the remaining in negative half cycle.

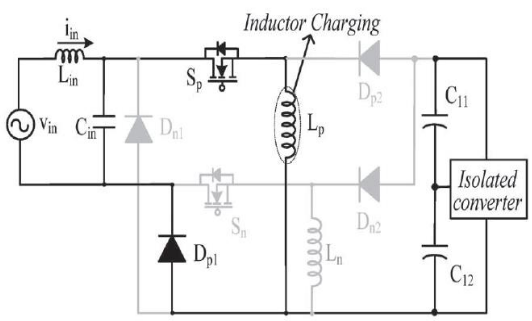

Fig.1: Switch Sp is On

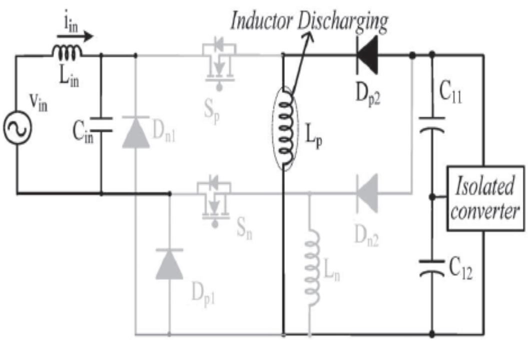

Fig.2: Switch Sp is Off

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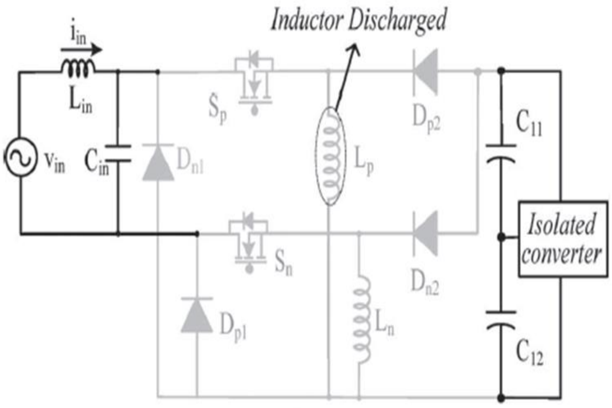

Fig.3: Both switch and diode are off

In In the first state, when the upper switch Sp is on as shown in Fig-1, inductor Lp starts storing energy from the input, and the inductor current increases to the maximum value. Diode Dp1 completes the current flow path in the input side. In the second state, Sp is turned off as shown in fig-2 , and the energy in inductor Lp is transferred to the output, thus reducing its current from maximum value to zero.

In the last state of one switching cycle, neither the switch and nor the diode conducts, and the inductor current remains zero, ensuring DCM operation as shown in fig-3. In the next switching cycle, the same sequence of operation repeats for negative half cycle of the input voltage, the lower buck–boost converter operates, and the same sequence of operation continues.

B. Operation of Half-Bridge VSI:

The operation of the half-bridge VSI in one switching cycle is described in four states. The second and fourth states are similar and occur twice in each switching cycle.

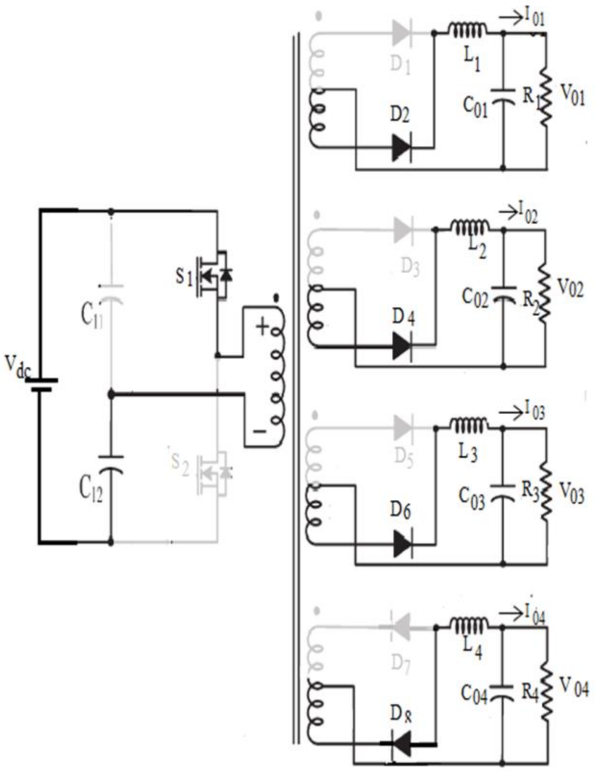

Fig .4. When the switch S1

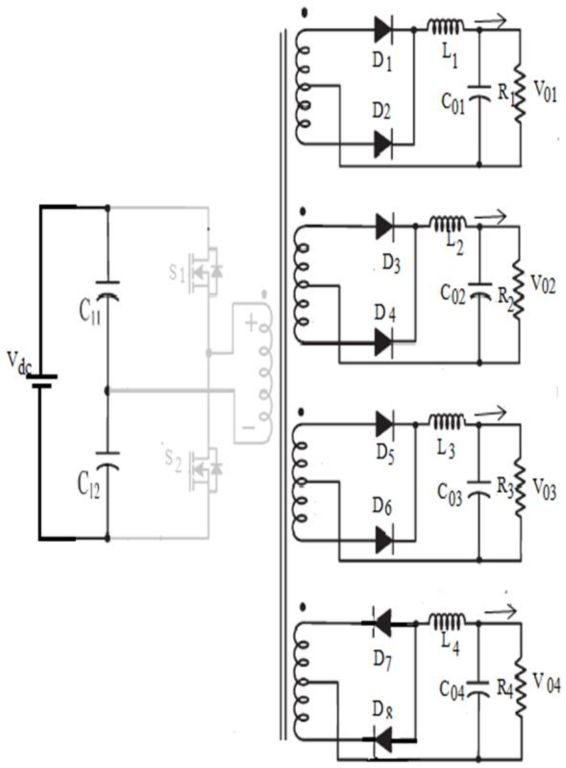

Fig.5. Both switch are off

ISSN 2349-7815

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In the first state of operation, the upper switch S1 is turned on, as shown in fig-4 .When the switch S1 is on, the input current circulates through the primary winding of the HFT to the lower input capacitorC12.Then the secondary windings are energised and the diodes D2, D4D6 , and D8 start conducting. Therefore the inductors associated with the windings start storing energy. Then the inductor currents increase to maximum value, and output filter capacitors discharge through the loads. In the second state of operation , both switches are turned off condition.Therefore the energy stored in the inductors are start to discharging .Then all secondary diodesD1 –D8 freewheel the stored energy until the voltage across the HFT becomes zero. So the, inductor currents iL1, iL2, iL3, and iL4 start decreasing. The circuit operations are shown in fig-5.

In the third state of the switching cycle, the second switch S2 is turned on as shown in fig-5, and the input current flows through upper capacitorC11 and the primary winding. Associated diodes D1, D3, D5and D7 in the secondary windings conduct.

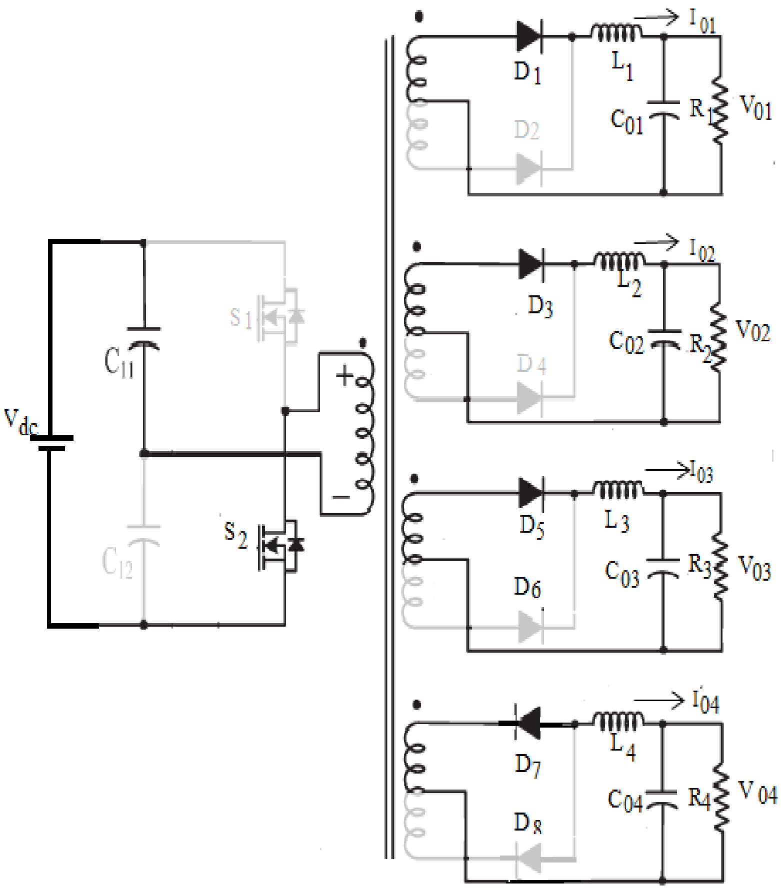

Fig-6 : When the switch S2 is on

Then the inductors L1 , L2, L3, and L4 start storing energy to a maximum value. When the energy stored in the inductors reaches the maximum values, the switch is turned off. In the last state, shown in fig-6, all secondary diodes start conducting, which is similar to the second state. The same operating states repeat in each switching cycle.

III. SIMULATION MODEL AND RESULTS

The closed loop simulink model of the entire system as shown in fig -6 .Here the AC input voltage is first filtered and fed to bridgeless buck boost converter.Then the output is given as the input of half bridge VSI.The output of VSI is four levels of voltages ie,+12V,5V,3V and -12V. This converter is a two stage converter so the voltages can be regulated by independent control loops.The actual output from each converter is compared with its reference voltage and then the error signal can given a controled pulse using PID controller and saturation block.

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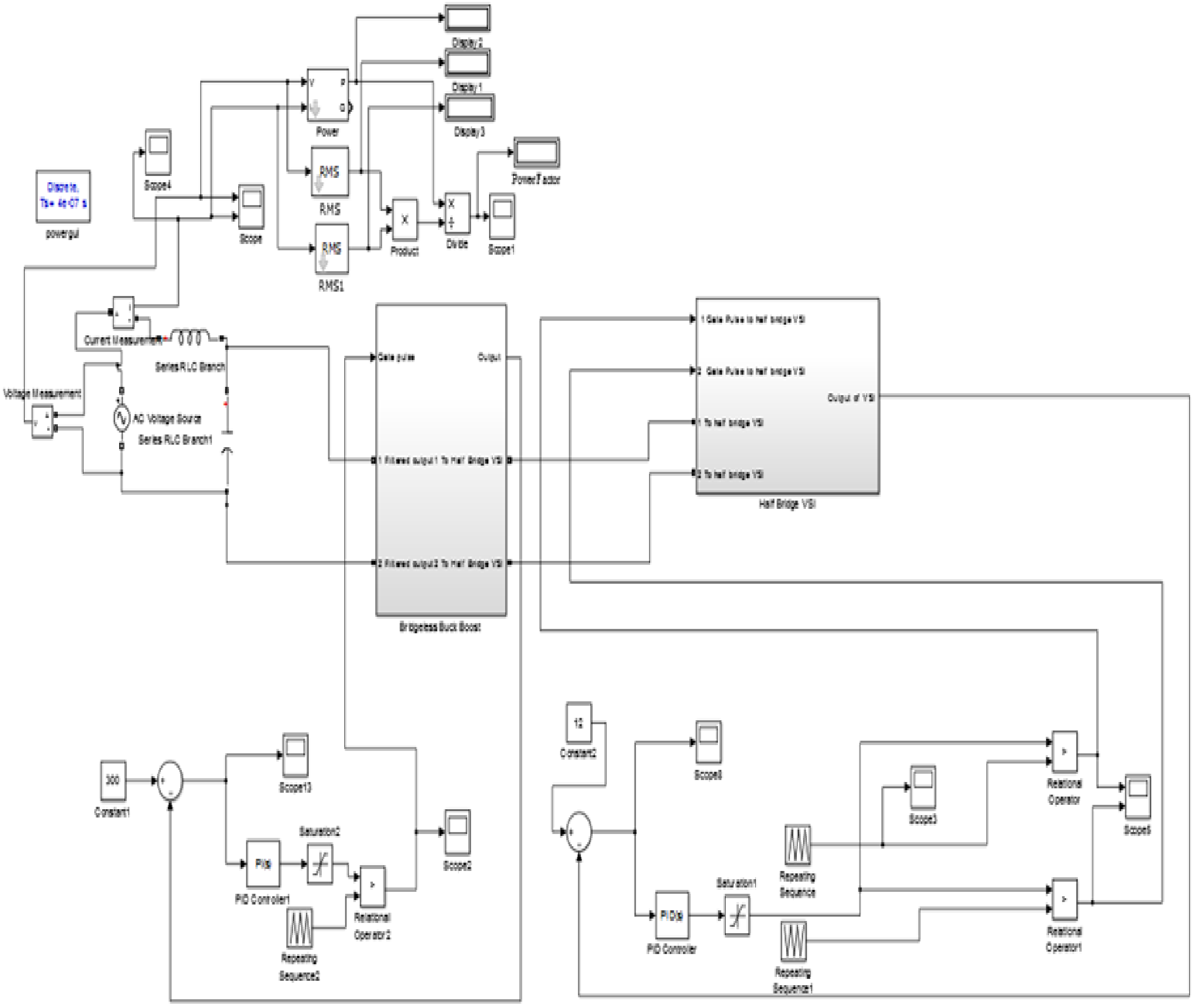

Fig. 6. closed loop simulink model of the proposed system

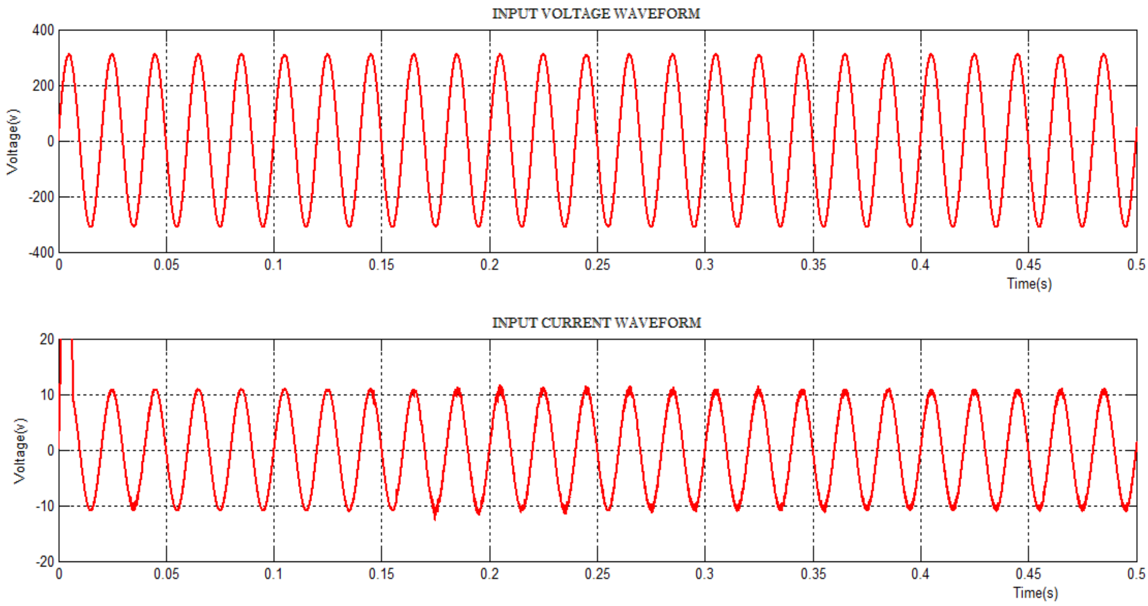

Fig .7 . Input voltage and current waveform of proposed system

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The current waveform of the overall system as shown in fig-7 .Here the waveform having minimum disturbance and high power factor.From the FFT analysis bridgeless buck boost converter with half bridge VSI having minimum THD value (2.81%)

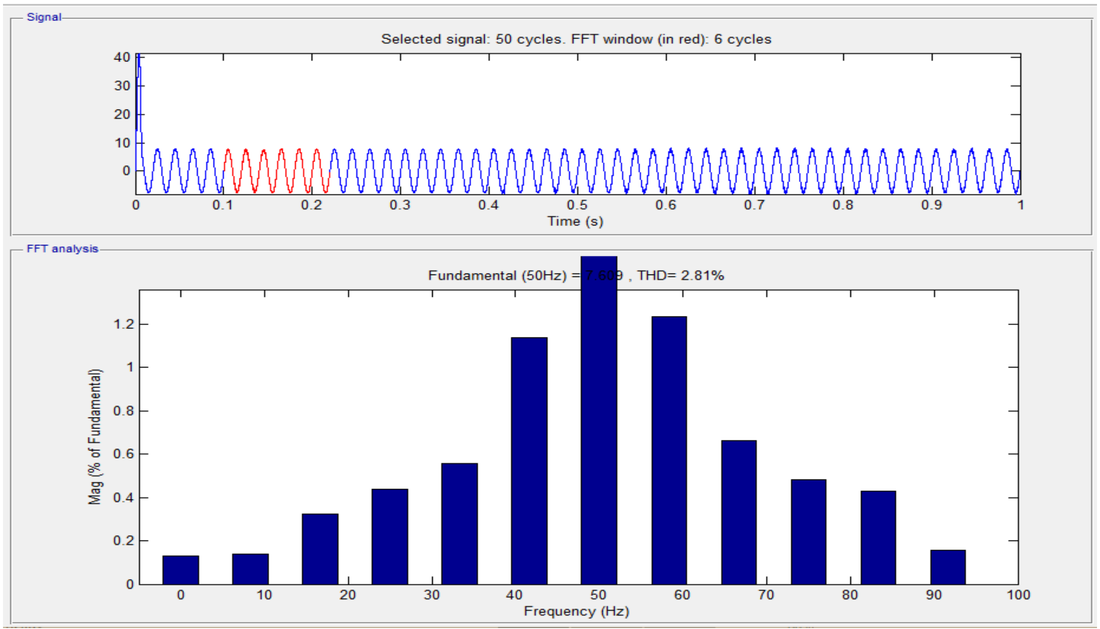

Fig-8: FFT analysis of proposed system

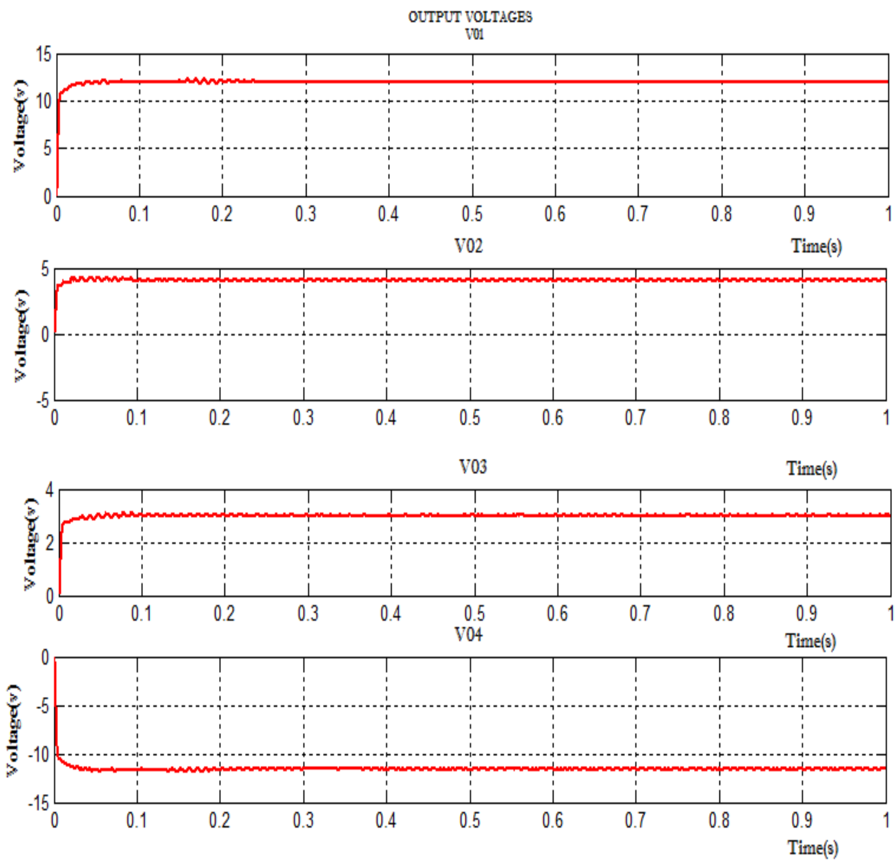

Fig .9 .Output voltages for closed loop bridgeless buck boostConverter

Different levels of output voltages are shown in fig -9.Each output voltage is obtained with minimum ripple content.The different levels of output voltages are +12V,5V,3.3V and -12V.

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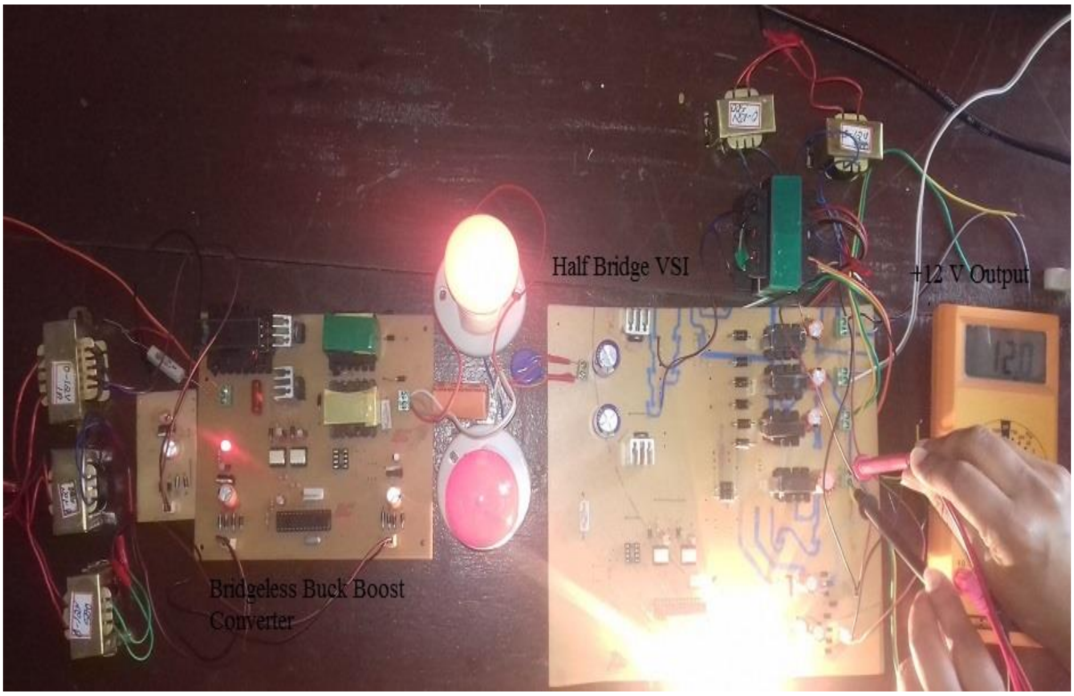

Fig .10. Experimental setup of proposed system

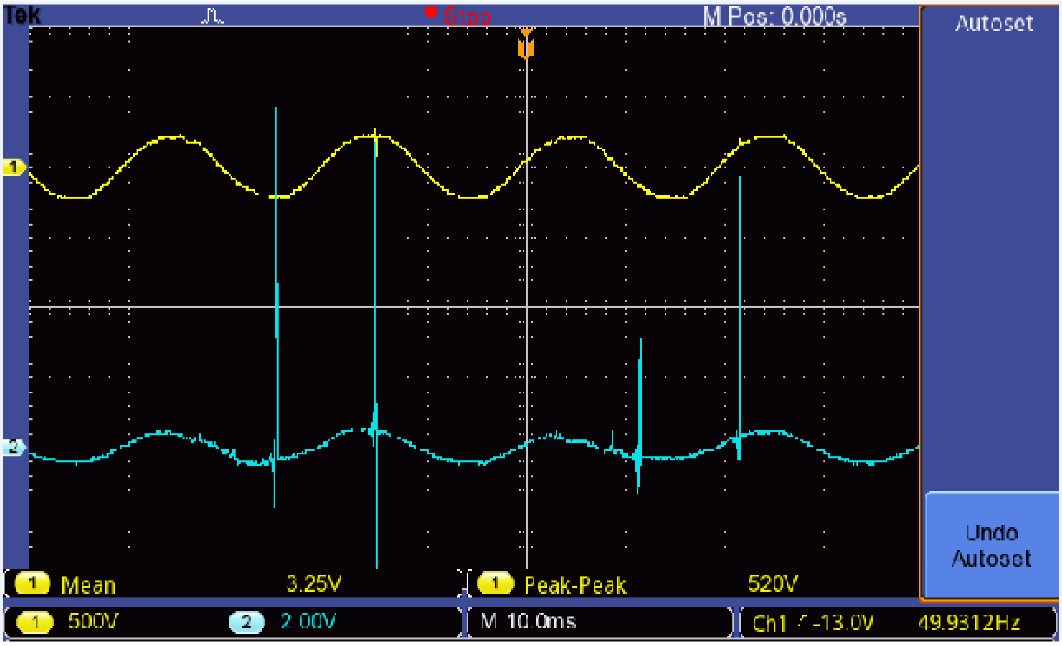

Fig-11: Input bus voltage and current

IV. CONCLUSIONS

A prototype model of two stage bridgeless converter based multiple output SMPS is implemented in hardware to demonstrate its capability to improve the power quality at the utility interface.After a comparative study of different DC to DC converter topologies for power factor correction, a bridgeless buck boost converter has been designed for achieving unity power factor at AC mains.

This converter has been designed with high efficiency, constant outputs and improved power factor with minimum THD value. The performance of the two stage PFC converter is simulated in the MATLAB/SIMULINK environment. This converter can almost satisfy the features of a good PFC converter

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REFERENCES

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

[2] P.J.Moore and I.E.Portugues,The inuence of personal computer processing modes on line current harmonics", IEEE Trans. Power Electron., vol. 25, no.6, pp. 1460-1470, 2010.

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

[4] W. Wei, L. Hongpeng, J. Shigong, and X.Dianguo,(2008). A novel bridgeless buckboost PFC converter", in proc. IEEE PESC, pp. 15-19.

[5] H.Z.Azazi, E. E. EL-Kholy, S.A.Mahmoud and S.S.Shokralla(2010), `Review of Passive and Active Circuits for Power Factor Correction in Single Phase,Low Power AC-DC Converters", Proceedings of the 14th International MiddleEast Power Systems Conference (MEPCON10), Cairo University,Paper ID 154.

[6] K.Matsui et al, `A comparison of various buckboost converters and their application to PFC", in Proc. 28th IEEE IECON,vol. 1, pp. 23802386.

[7] George Chryssis,(2000), High frequency switching power supplies:Theory and design, McGraw-Hill.