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A NEW SINGLE STAGE THREE LEVEL ISOLATED PFC CONVERTER FOR LOW POWER APPLICATIONS

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Abstract- Majority of electronic appliances used today is operated only through dc power supplies and this requires ac-dc conversion. For such ac-dc conversion, the research focuses on single stage multi-level topologies because of their low cost. This paper proposes a new single stage three level ac/dc PFC converters for low power applications such as SMPS, laptop adapters, smart TV power supply systems, etc., With this proposed converter, the input current shaping and output voltage regulation can be achieved with the help of microcontroller based soft switching technique and it does not require any additional switches. Through this soft switching technique, the inverter switches are turned on under zero current and zero voltage in discontinuous conduction mode operation. Due to the flexible dc-link voltage, high power factor can be achieved with regulated dc output. A 300W/110V prototype is designed and developed for the proof of concept, which shows the power factor is in the range of 0.96 to 0.99.

Keywords: PFC Converter, Soft switching, PIC Microcontroller.

I. INTRODUCTION

In recent years, the usage of electronic equipment is increasing rapidly in daily life to fulfil consumers and industrial needs. All these electronic equipment uses power supplies which requires power electronic systems and devices. These devices produce poor power factor, harmonic current and pollute the electricity network. A load with poor power factor draws more current than with high power factor for the same amount of useful power transferred. Also a load with power factor of 1.0 result in the most efficient loading of the supply and the load with a power factor of 0.5 will result in much higher losses in the supply system. Therefore, engineers design all the electronic devices to meet the design on power factor standards. Alternatively, most of the power supplies consist of ac/dc converter element based on diode or thyristor rectifier circuit and requirement for more number of switches**.** This project is to increase the effective utilization of ac power from the grid by achieving high power factor for ac-dc converters. Also this approach does not require additional semiconductor switches and control devices, but permits cheaper and smaller active components.

II. NEED FOR POWER FACTOR CORRECTION

Conventional AC rectification is very inefficient process, resulting in waveform distortion of the current drawn from the mains. This produces a large spectrum of harmonic signals that may interfere with other equipment. These rectifier circuits will lead to main harmonic distortion and power factor issues. Line-frequency diode rectifiers convert AC voltage to DC voltage in an uncontrolled way. At higher power levels (200 to 500 watts and higher) severe interference with other electronic equipment may become apparent due to these harmonics sent into the power utility line. Another problem is that the power utility line cabling, the installation and the distribution transformer, must all be designed to withstand these peak current values resulting in higher electricity costs for any electricity utility company. Power Factor Correction enables the equipment to maximize the active power and minimize the reactive power draw from the AC outlet.

1.1 PFC APPROACH

For the effective utilization of power supply by the equipment, different power factor correction topologies are handled. The following topologies are integrated in the proposed system.

a. Active PFC approach
b. Single stage PFC topology

(a) Active PFC approach

An active PFC technique is the use of power electronic devices to change the waveform of current drawn by a load to improve the power factor. Some types of active PFC are buck, boost, buck-boost and synchronous condenser. Active PFC can be single-stage or multi-stage. Many power supplies with active PFC can automatically adjust to operate on AC power from about 100V to 230V.This feature is particularly welcome in power supplies for laptops. In active power factor correction techniques approach, switched mode power supply (SMPS) technique is used to shape the input current in phase with the input voltage. Thus, the power factor can reach up to unity. By the introduction of regulation norms IEC 1000-3-2 active power factor correction technique is used now a day.

(b) Single stage PFC topology

A single-stage scheme combines the PFC circuit and dc/dc power conversion circuit into one stage. A number of single-stage circuits have been reported in recent years. Although for a single-stage PFC converter attenuation of input-current harmonics is not as good as for the two-stage approach. But it meets the requirements of IEC1000-3-2 norms. It is cost effective and compact with respect to two stage approach. Also it is simplified in structure and more efficient in low to medium power applications.

III. EXISTING SYSTEM

In this system, a front-end AC-DC PFC converter is operated with a switching frequency in the order of few kHz with wide-band gap devices, to shape the input current close to sinusoidal waveform in phase with the grid voltage. The secondary ac/dc stage uses a center-tapped transformer and full wave rectification process as shown in Fig.1. This becomes a major drop in the peak efficiency. Since, the use of full wave rectifier leads to the half of the output power. Also the existing methodology uses a predefined pulse width to drive the switches. Hence, this system does not suitable for the varying loads. However, this topology concentrates on improving the power factor and output voltage regulation.

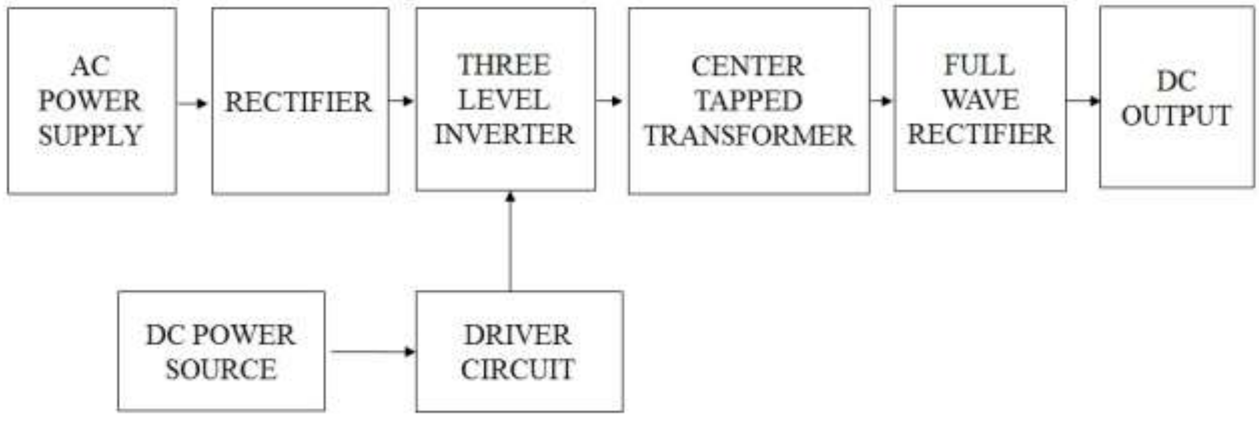

Figure 1. Block Diagram

IV. PROPOSED SYSTEM

The proposed system deals with the design and implementation of new single stage three level PFC converter which is shown in Fig 2. The MOSFET inverter, dc-link capacitor and boost inductor act as PFC circuit as well as boost converter. The inverter switches are driven by the TLP250 driver IC and also it uses 12V/24V universal DC supply input to the MOSFET switched inverter. As the load increases, the current drawn from the grid will be high. This in turn varies the phase angle between the voltage and the current. Hence, the proposed converter uses same number of switches as in three-level isolated DC-DC converter, and achieves high PF operation with only changing the switching scheme. Only a diode-bridge and a boost inductor are added to the dc-dc stage.

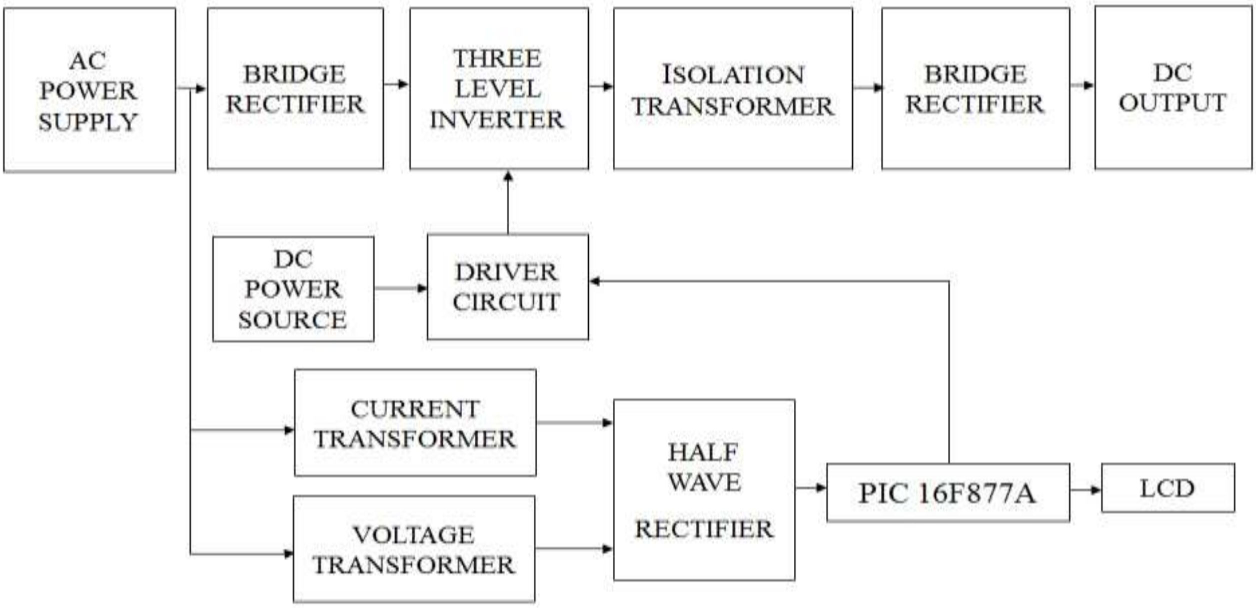

Figure 2. Block diagram

V. WORKING

The working of single stage three level PFC converter is based on the microcontroller. The microcontroller uses the voltage parameter and current parameter separately from the input transformer and the current transformer. These parameters are used for PF calculation as well as in comparison with reference to drive the gate of MOSFET switches in accordance with the TLP250 driver circuit. When a current drawn by the load is high, the MOSFET switch provides the necessary current to the load by drawing the current in phase with the voltage from the grid. The switches S2 and S3 are turned on under zero current in discontinuous conduction mode and S1 and S4 under zero voltage switching and to keep the switching losses as low as possible. In addition to this, a dead time is inserted in between these two switches to avoid short circuit. The TLP250 has a function that it increases only the amplitude of the pulse width and it does not change the duty cycle of the pulse width. Therefore, if the need for change in duty cycle arises then it can be changed only through the microcontroller. However, the output of the inverter is three level and boosted voltage of 110V is achieved by the effective utilization of boost inductor.

VI. SIMULATION RESULT

The simulation result in Fig 3 shows the motor load speed, armature current and torque when connected with the PFC converter.

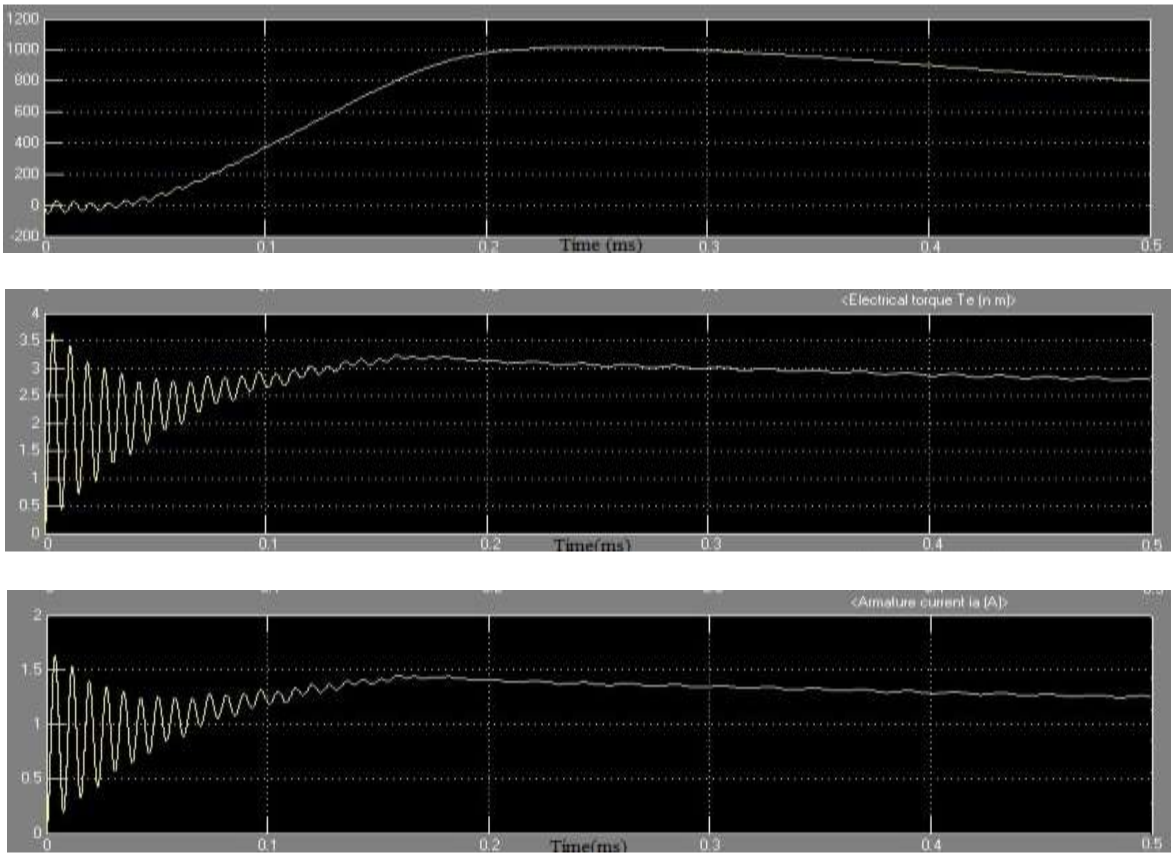

Figure 3. Speed, torque and armature current of motor load

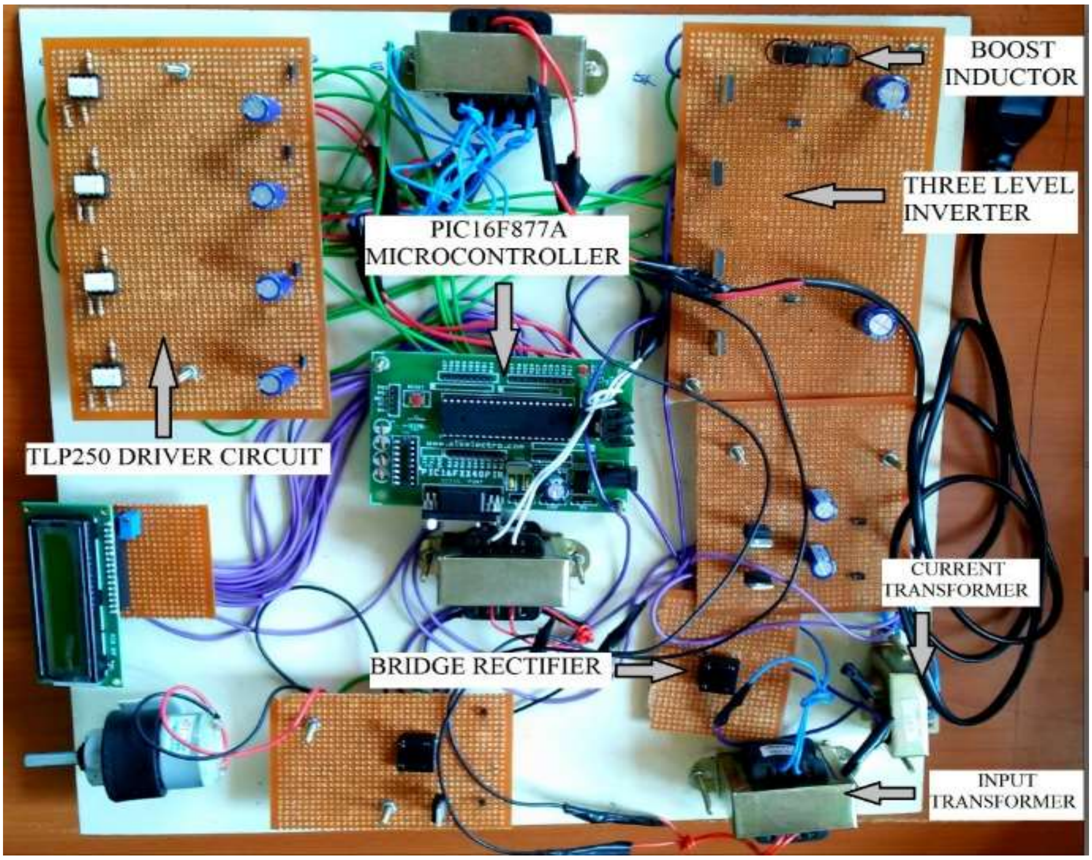

Figure 4. Working Hardware Prototype

VII. CONCLUSION

Thus, a three-level single-stage PFC ac/dc converter is proposed for low-power applications. The proposed converter exhibits high PF with less number of switches/diodes, operated at constant duty ratio. A PFC inductor and a diode bridge are added to the conventional three-level isolated dc/dc converter, while the switching scheme is modified to be compatible with single-stage operation. The input current ripple frequency is twice of the switching frequency contributing to using smaller PFC inductor. The results of the analyses show that less than 265 V line voltage, the PF can be increased to 0.99 from 0.88.

REFERENCE

1. Serkan Dusmez, Xiong Li and Bilal Akin, “A fully integrated three-level isolated single stage PFC converter,” *IEEE Trans. Power Electron.*, vol. 30, no. 4, Apr. 2015.
2. L. Rosseto and S. Buso, “Digitally-controlled single-phase single-stage ac/dc PWM converter,” *IEEE Trans. Power Electron.*, vol. 18, no. 1, pp. 326–333, Jan. 2003
3. D. D. C. Lu,H.H.C. Iu, and V. Pjevalica, “A single-stage AC/DC converter with high power factor, regulated bus voltage, and output voltage,” *IEEE Trans. Power Electron.*, vol. 23, no. 1, pp. 218–228, Jan. 2008.
4. J. R. Morrison and M. G. Egan, “A new modulation strategy for a buck boost input AC/DC converter,” *IEEE Trans. Power Electron.*, vol. 16, no. 1, pp. 34–45, Jan. 2001.
5. H. Ma, Y. Ji, and Y. Xu, “Design and analysis of single-stage power factor correction converter with a feedback winding,” IEEE Trans. Power Electron., vol. 25, no. 6, pp. 1460–1470, Jun. 2010.
6. H.Wang, S.Dusmez, and A.Khaligh, “Design and analysis of a full bridge LLC based PEV charger optimized for wide battery voltage range,” IEEE Trans. Veh. Technol., vol. 63, no. 4, pp. 1603–1613, May 2014.