# EXPERIMENTAL RESULTS OF BRIDGELESS PFC BOOST CONVERTER

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Abstract: This paper deals with the simulation and implementation of a bridgeless PFC boost converter. The Bridgeless PFC Boost Converter Circuit is analyzed, simulated and implemented. The circuit has advantages like reduced harmonics and improved power factor. Higher efficiency can be achieved by using the bridgeless boost topology. Near unity power factor is obtained by using Bridgeless PFC boost PFC Converter. The laboratory model is implemented and the experimental results are obtained. These experimental results are correlated with the simulation result.

Keywords - Power Factor Correction, rectifier, Bridgeless converter, Simulink, Microcontroller.

## 1. INTRODUCTION

In recent years, there have been increasing demands for high power factor and low total harmonic distortion (THD) in the current drawn from the utility. Recently, in an effort to improve the efficiency of the front-end PFC rectifiers, many power supply manufacturers and some semiconductor companies have started looking into bridgeless PFC circuit topologies. Generally, the bridgeless PFC topologies, also referred to as dual boost PFC rectifiers, may reduce the conduction loss by reducing the number of semiconductor components in the line current path. So far, a number of bridgeless PFC boost rectifier implementations and their variations have been proposed. The conduction losses are reduced by reducing the number of semiconductor devices that conduct current from the source to the load. However, the output diodes operated in high voltage have severe reverse-recovery problems due to high diode forward current and high output voltage. As the switching frequency increases, the large reverse-recovery currents of the output diodes affect the switches in the form of additional turn-on losses and also produce electromagnetic interference (EMI) noises. To overcome these problems, various active and passive snubber approaches have been proposed for the bridgeless boost rectifier. The active snubber technique has been applied to the bridgeless boost rectifier to reduce the diode reverse-recovery problems. All of them employ an auxiliary switch to form an auxiliary circuit that is used to control the di/dt rate of the output diode currents and to create soft-switching conditions for the switching devices. The passive snubber approaches are also presented for the bridgeless boost rectifier to reduce the complexity and cost of the circuits. In this paper, a systematic review and hardware of the bridgeless PFC boost rectifier implementations that have received the most attention are presented.

## 2. BRIDGELESS PFC CONFIGURATION

The conventional boost topology is the most efficient for PFC applications. It uses a dedicated diode bridge to rectify the AC input voltage to DC, which is then followed by the boost section. This

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approach is good for a low to medium power range. As the power level increases, the diode bridge begins to become an important part of the application and it is necessary for the designer to deal with the problem of how to dissipate the heat in limited surface area. The dissipated power is important from an efficiency point of view. The bridgeless configuration topology presented in this paper avoids the need for the rectifier input bridge yet maintains the classic boost topology. This is easily done by making use of the intrinsic body diode connected between drain and source of Power MOS switches.

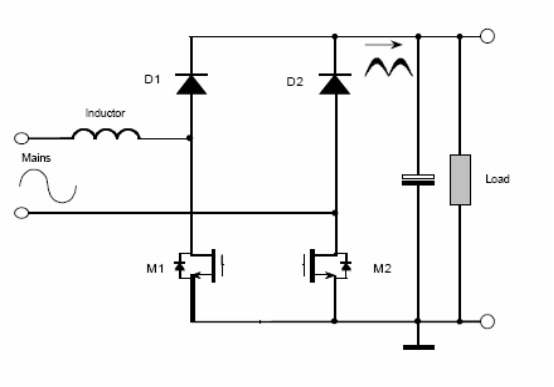


Fig.1. Bridgeless PFC circuit

A simplified schematic of the bridgeless PFC configuration is shown in Fig 1.The circuit shown from a functional point of view is similar to the common boost converter. In the traditional topology, current flows through two of the bridge diodes in series. In the bridgeless PFC configuration, current flows through only one diode with the Power MOS providing the return path. To analyze the circuit operation, it is necessary to separate it into two sections. The first section operates as the boost stage and the second section operates as the return path for the AC input signal. When the AC input voltage goes positive, the gate of M1 is driven high and current flows from the input through the inductor, storing energy. When M1 turns off, energy in the inductor is released as current flows through D1, through the load and returns through the body diode of M2 back to the input mains. During the-off time, the current throws the inductor L (that during this time discharges its energy), flows in to the boost diode D1 and the load.

During the negative half cycle, circuit operation is mirrored. M2 turns on, current flows through the inductor, storing energy. When M2 turns off, energy is released as current flows through D2, through the load and back to the mains through the body diode of M1. Note that the two Power MOSFETs are driven synchronously. It doesn't matter whether the sections are performing as an active boost or as a path for the current to return. In either case there is a benefit of low power dissipation when current flows through the Power MOSFETs during the return phase.

## 3. CHALLENGES OF BRIDGELESS PFC CIRCUIT

As shown in Figure 1, the bridgeless PFC circuit doesn't have an input diode bridge and the boost inductor is located on the AC side. Since the output and input of the circuit have no direct connection, the bridgeless circuit has several issues of input voltage sensing, current sensing and EMI noise. The voltage sensing and current sensing issues are related to the control of bridgeless PFC circuit. For the conventional PFC circuit, several kinds of different control methods have been developed, such as the average current mode control, peak current mode control, and one cycle control. The average current mode control is the most popular control method because of its high performance and easy to understand: the controller multiplies input voltage signal with the voltage loop output voltage to generate the current reference while the current loop controls the inductor average current to follow the current reference. As for the One Cycle Control, the controller uses the voltage loop output voltage and inductor peak current to calculate the duty cycle of each switching cycle. Since the duty cycle meets the requirement of the boost circuit input and output voltage relationship, the inductor current peak current automatically follows the input voltage shape. Thus the power factor correction function is achieved. The above literature does not deal with implementation of PFC bridgeless circuit using Atmel microcontroller circuit. This paper presents the implementation using embedded controller.

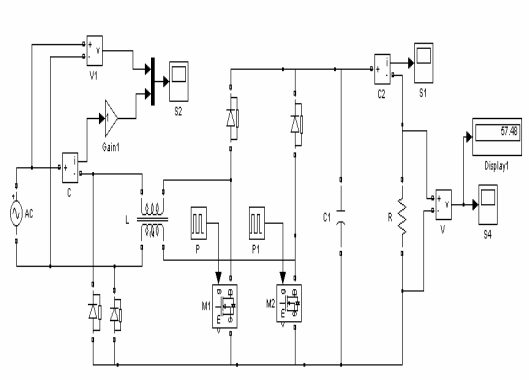


Fig.2. Simulation of Bridgeless PFC circuit

## 4. SIMULATION RESULTS

Bridgeless PFC boost converter is simulated using Mat lab Simulink and it is shown in Fig 2. The circuit consists of an AC source with inductance. Due to the effect of source inductance, the power factor is improved at the AC side. The bridgeless circuit is formed with two diodes and two Mosfets. The purpose of the capacitor in the circuit is to eliminate the ripple content in the DC

output. In the conventional methods the AC input voltage and current are not in phase.

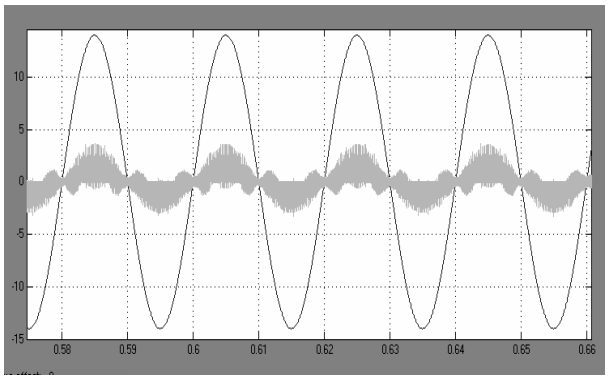

Fig.3. AC Input voltage and current

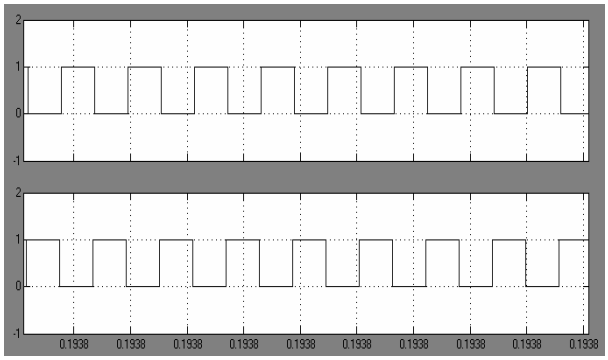

Fig.4. Pulse waveform of MOSFETS 1 & 2

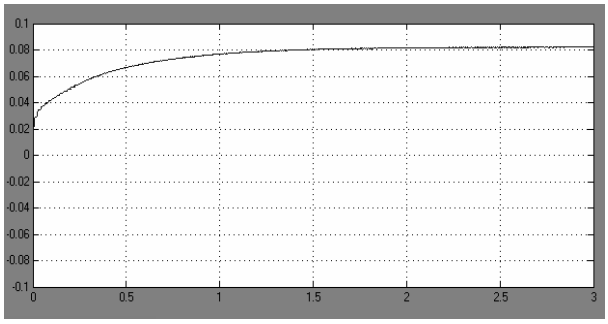

Fig.5.a. Output Current

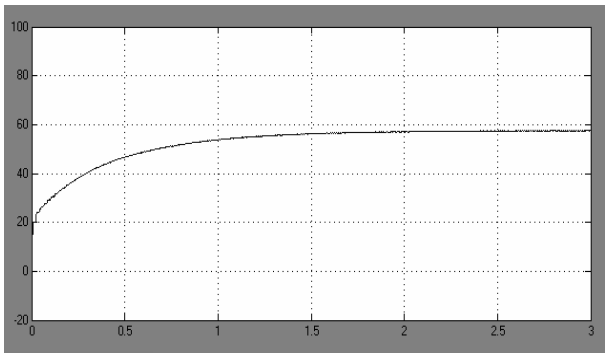

Fig.5.b. Output Voltage

On the schematics, it is assumed that a controlled switch is implemented as the power MOSFET with its inherently slow body diode. AC input voltage and current are shown in Fig 3. It can be seen that the current and voltage are almost in phase. The value observed is 0.9999. Therefore the power factor is corrected. Distortion of current is due to switching and it can be easily eliminated using filter circuit. The driving pulse of MOSFETs 1 & 2 is shown in Fig 4. Output current is shown in Fig 5.a. Output voltage is shown in Fig. 5.b. From the output waveform it is clear that the voltage is boosted to 57.8 volts. The model is developed and it is used successfully for simulation. The simulation studies indicate that the power factor is nearly unity by employing the modified boost converter.

## 5. EXPERIMENTAL RESULTS

Laboratory model of Boost converter is fabricated and tested. The experimental results are obtained and they are presented here. The top view of fabricated Bridgeless PFC boost converter is shown in Fig 6.a. It can be viewed that the fabrication consists of inductance at the source side to improve the PF. The oscillogram of voltage across MOSFET 1& 2 is shown in Fig 6.b. These are input pulses given to the MOSFET to turn ON and OFF. The input to the boost converter is shown in Fig. 7. This is an AC input which is stepped down to 10 Volt. The output voltage is a DC boosted voltage. It is measured as 57.8 volts. The output of the boost converter is shown in Fig. 8.

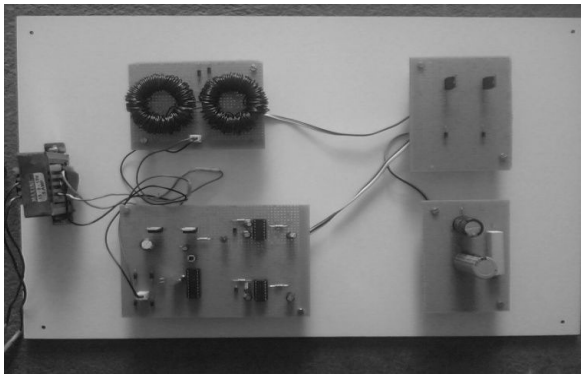

Fig.6.a. Hardware of the Boost Converter

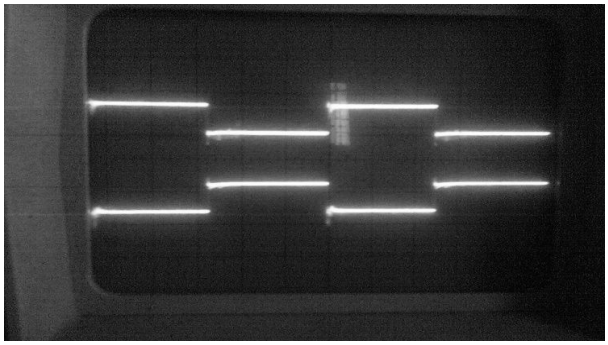

Fig.6.b. Voltage across MOSFETS 1 & 2


Fig.7. Input to the Boost converter

## 6. CONCLUSION

The bridgeless boost PFC Converter is analyzed, simulated and fabricated. Models are developed using Matlab and they are used successfully for simulation. From the simulation results, it is observed that best power factor can be obtained by using bridgeless boost PFC converter. The laboratory model for boost converter is implemented. The experimental results are presented in this paper. The experimental results closely agree with the simulation results.

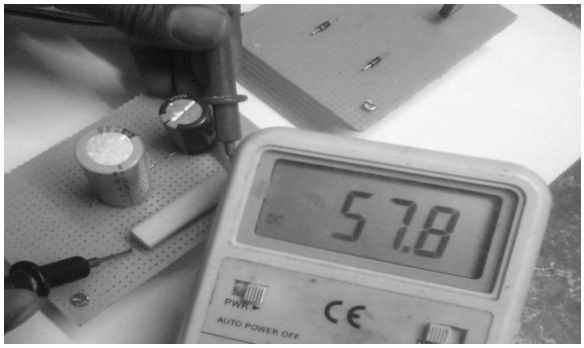


Fig 8: Output of the Boost converter

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