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Application of Interleaved Bridgeless Boost PFC Converter without Current Sensing

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Abstract- Interleaved bridgeless boost power factor correction (PFC) converter based on predictive control method without any current sensing is presented in this paper. Complicated control strategies including current sensing are used to obtain proper current sharing and current ripple minimization for interleaved type PFC converters which are more suitable than the conventional type PFC converters by virtue of the improving power rating and reducing input current ripple. The proposed predictive control method doesn't need to sample any current signals, only the samplings of the input voltage and the output voltage are required. The input current of the converter is computed based on the input and output voltages according to the switching operations. The duty cycle for next switching is predicted by using reference current signal obtained from the voltage loop compensator, computed input current and converter parameters. A prototype of interleaved bridgeless boost PFC converter controlled by a digital signal processor (DSP) board was established to show the related results.
Index Terms— PFC, DSP, Duty Cycle.

I. INTRODUCTION

High-frequency power-factor correction (PFC) circuits have been an active research topic in power electronics to meet the stringent requirements of power quality since they draw a current nearly proportional to the input voltage from the grid. Due to some advantages such as simple topology and continuous input current, the conventional boost converter operating in continuous conduction mode (CCM) has been widely adopted as a front-end PFC pre regulator among the different alternatives [1], [2]. However, the conventional boost PFC converter always includes three semiconductor voltage drops in the current flow path because of the input full-bridge diode rectifier. Significant conduction losses from this full bridge diode rectifier decrease the converter efficiency, especially at low input voltage. Therefore bridgeless boost topologies were introduced to increase the converter efficiency [3], [4]. By reducing the number of semiconductor devices, the conduction losses are reduced in bridgeless boost topologies. Interleaving operation (the parallel connection of switching converters) of two or more boost converters has been proposed to increase the output power and to reduce the current ripple [5]-[6]. This technique consists of a phase shifting of the control signals of several cells in parallel operating at the same switching frequency. The switching instants are sequentially phase shifted by equal fractions of a switching period.

This arrangement lowers the input current ripple amplitude and raises the effective ripple frequency of the overall converter without increasing switching losses or voltage and current stresses of any component.

II. POWER FACTOR CORRECTION (PFC) TECHNIQUES

A. Power Factor Correction (PFC) Techniques

Power factor correction is a technique by which the degraded power factor of a power system can be improved by use of external equipment. Power factor correction can be classified into two types: passive power factor correction and Active power factor correction In Passive PFC, only passive elements are used with the diode bridge rectifier, to make the line current sinusoidal. By using passive PFC, power factor cannot be increased to a desired value. With increase in the voltage, the PFC components increase in size. In passive power factor correction, the power factor can never be corrected to 1 and the output voltage cannot be controlled as well. In active PFC there is control over the amount of power drawn by a load and power factor is close to unity. Commonly in any active PFC the input current of the load is controlled in order to make the current waveform follow the main voltage waveform closely (i.e. a sine wave). A combination of the reactive elements and some active switches are used to increase the effectiveness of the line current shaping and to obtain controllable output voltage.

B. Boost Converter As Active Power Factor Corrector

Various converter topologies may be utilized for active power factor correction applications. Among these topologies, the boost converter topology (boost PFC topology) is utilized most frequently due to its advantages over other topologies. The main advantage of the boost PFC topology is its continuous input current which can be forced to track the diode bridge rectifier output voltage. In this type of power converter voltage obtained at the output stage is greater than that given at the input. The circuit diagram of a boost converter is shown in Fig.1.

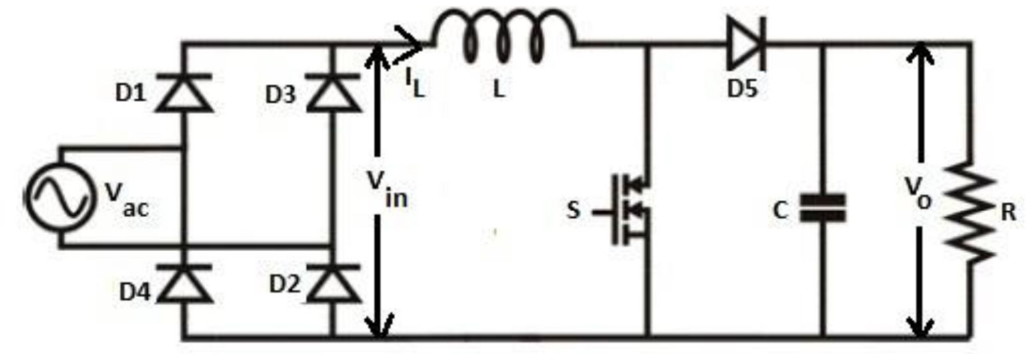


Fig.1. Boost Power Factor Corrector

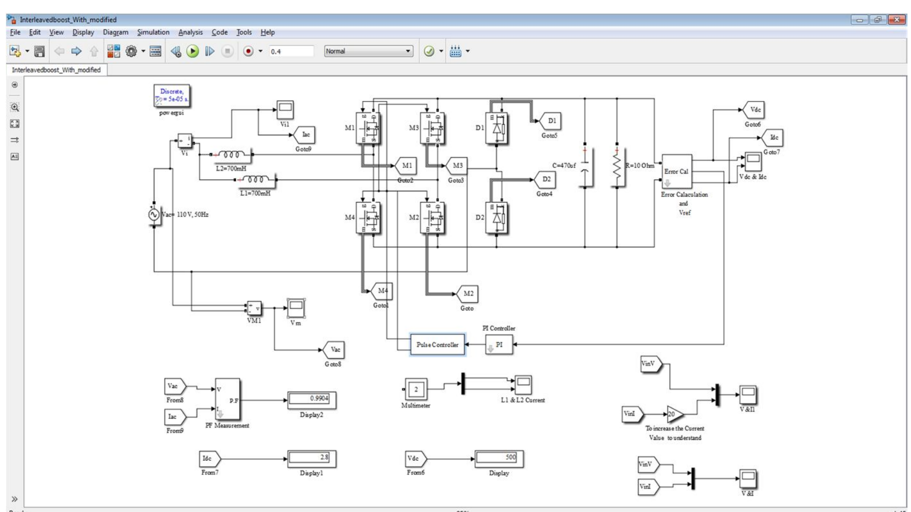
III. WORKING OPERATION

A. Topology and Proposed Control Strategy

The block diagram of the digital controlled interleaved bridgeless boost PFC based on the predicted duty cycle control without any current sensing is shown in Fig.1. Considering the equivalent circuits of the topology for the positive and negative phase of the input voltage, switches of the topology are grouped into positive phase group (*M2* and *M4*) and negative phase group (*M1* and *M3*). The positive phase group operates as boost switches during positive phase of the input voltage. During this period, body diodes of the negative phase group act as the output diodes of the boost cells. In this phase, return current is delivered by *Do2*. When the input voltage is in its negative phase, the opposite condition occurs. Throughout this time, negative phase group operates as the boost switches and the positive phase group body diodes work as the output diodes of the boost cells. Return current is handled by *Do1*.

IV. OUTPUT

A. Simulation Diagram



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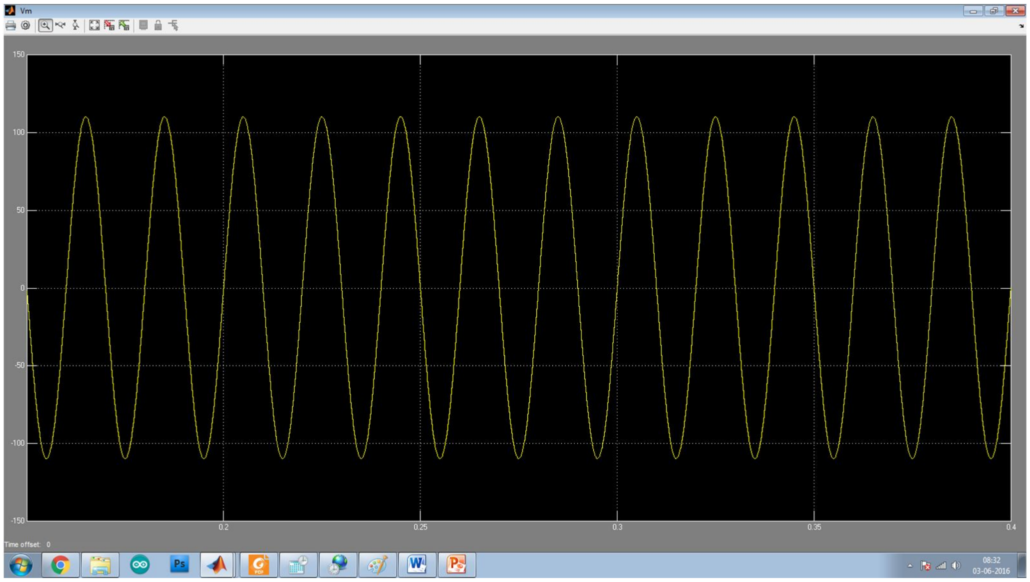
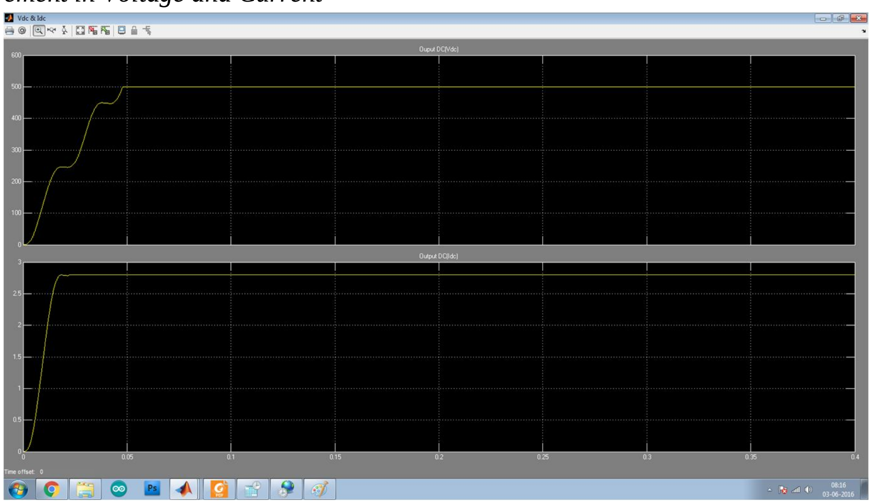
B. Input Waveforms



C. Corresponding Improvement in Voltage and Current



V. CONCLUSION

In the proposed predictive technique there is no need to sample any current signals, only the samplings of the input voltage and the output voltage are required for interleaved bridgeless boost PFC converters. Compared with the traditional control strategies, this control method leaves out the current compensator and complicated signal processing. Simulation and experimental results show that based on the predictive PFC control algorithm, near unity power factor can be achieved under wide load current conditions. In the proposed technique the equal current sharing between two cells of an interleaved bridgeless boost PFC is achieved without measuring or sensing any current of the converter. The results of the proposed study are nearly the same as those of other studies available in the literature. However, eliminating of current sensing and current compensator loop are the main advantages of the proposed technique.In our phase two work we have done several changes so that the voltage and current rating is increased to much extent. We have done the modification in Pi Controller with Pulse Width Value so the corresponding Output Efficiency is increased. In new simulation Power Factor is maintained in Nearby Unity. The Voltage & Current is increased by changing the PI Controller Parameters

VI. ACKNOWLEDGEMENT

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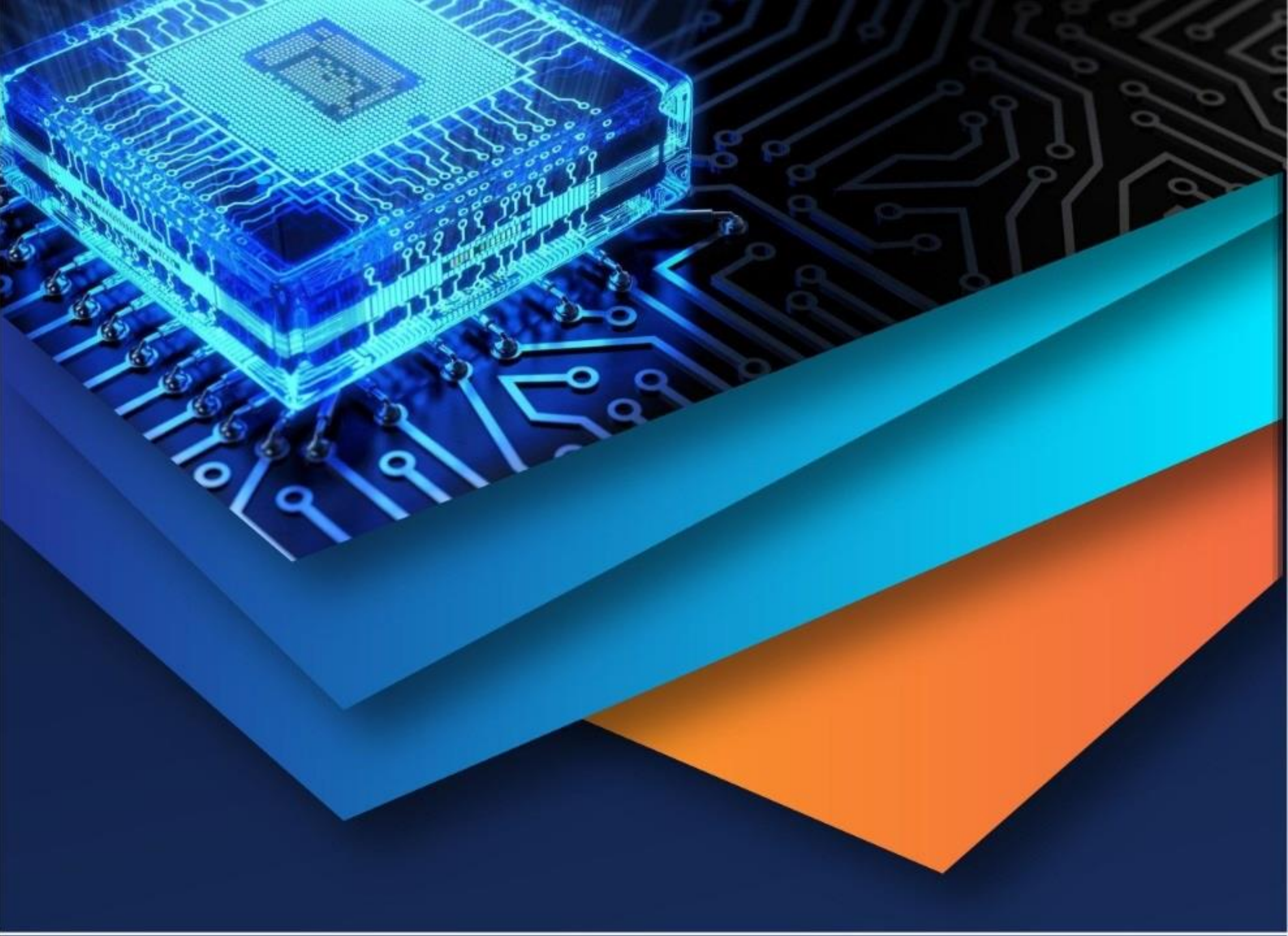

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