HARDWARE IMPLEMENTATION OF BRIDGELESS PFC BOOST CONVERTER FED DC DRIVE

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ABSTRACT

To meet the challenges of ever-increasing power densities of today’s AC/DC power supplies, designers are continuously looking for opportunities to maximize the power-supply efficiency, minimize its component count, and reduce the size of components. Bridgeless PFC is one of the options to meet these new requirements. The Bridgeless circuit is analyzed, simulated and fabricated with motor load. The efficiency of this System is high with less conduction loss, power factor correction, reduced common mode noise, less switching loss and reduced thermal effect. Experimental results based on prototype are obtained to show the performance of the controller.

I INTRODUCTION

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. As the amount of equipment using conventional diode rectifiers increases, harmonic input currents are becoming a problem. Harmonic current limits are recommended by the IEC standards (IEC 555). In an effort to meet these requirements, power-factor correction techniques to reduce harmonic current are becoming very important. Furthermore, it is desirable to have minimal size, high efficiency, and low electromagnetic interference. Some topologies have been introduced to meet the requirements. A bridgeless input power factor boost converter has been introduced over the potential for higher efficiency to meet increasing demands for power savings, especially in switch-mode power supply applications. Higher efficiency can be achieved by using the bridgeless boost topology. The circuit has advantages like reduced conduction loss, reduced harmonics and improved power factor. As a
high efficiency topology, bridgeless PFC attracts widespread attention, and the research is mainly focused on topology. In the arisen bridgeless Boost PFC topologies, Figure.01 is almost the best choice in medium-to-high power applications. The Literature [1]-[3] deals with the Bridge and their control circuits. The discussion of new methods is in [4]. The problem of line frequency due to instability of PFC is in [5]. To overcome the harmonics and to improve the efficiency of the system were discussed in [6]-[7]. The basic of Bridgeless system is in [8]. In above literature survey the paper does not deals with simulation and experimental analysis of Bridgeless PFC converter fed DC drive. In this paper, the hardware details controller based bridgeless converters are presented.

II Basic Bridgeless PFC boost converter

In the bridgeless PFC configuration Figure.01, current flows through only one diode with the Power MOS providing the return path. The operation can be analyzed in two stages: operation as the boost converter and the operation for return path for the AC input signal. When the AC input voltage goes positive, the gate of S1 is driven high and current flows from the input through the inductor, storing energy. When S1 turns off, energy in the inductor is released as current flows through D1, through the load and returns through the body diode of S2. During the-off time, the current through the inductor L (i.e., during this time the inductor discharges its energy) flows in to the boost diode D1 and close the circuit through the load. During the negative half cycle circuit operation is mirrored as shown in S2 turns on, current flows through the inductor, storing energy. When S2 turns off, energy is released as current flows through D2, through the load and back to the mains through the body diode of S1back to the input mains. 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 benefit of lower power dissipation when current flows through the Power MOSFETs during the return phase. Thus, in each half line cycle, one of
the MOSFET operates as active switch and the other one operates as a diode, both the MOSFETs can be driven by the same signal [8]. The difference between the bridgeless PFC and conventional PFC is bridgeless PFC inductor current only goes through two semiconductor devices, but inductor current goes through three semiconductor devices for the conventional PFC circuit. The bridgeless PFC uses one MOSFET body diode to replace the two slow diodes of the bridge PFC [8]. Since both the circuits operates as a boost DC/DC converter; the switching loss should be the same. Thus the efficiency improvement relies on the conduction loss difference between the two slow diodes and the body diode of the MOSFET [7]. Besides, comparing with the conventional PFC, the bridgeless PFC not only reduces conduction loss, but also reduces the total components count.

### III BRIDGELESS CONVERTER FED DC DRIVE

Converter-controlled electrical machine drives are very important in modern industrial applications. The drive system efficiency is high because the converter operates in switching mode using power semiconductor devices. The primary control variable of the machine may be torque, speed, or position, or the converter can operate as a solid-state starter of the machine. The recent evolution of high-frequency power semiconductor devices and high-density and economical microelectronic chips, coupled with converter and control technology developments, is providing a tremendous boost in the applications of drives. The speed of a DC motor can be controlled by controlling the DC voltage across its armature terminals. The machine can be a permanent magnet or wound field type. The wound field type permits variation and reversal of field and is normally preferred in large power machines. In this paper Bridgeless PFC converter is used to control the DC drive under no load and load conditions.

### IV SIMULATION RESULTS

The computer simulation of proposed converter is done using Matlab/Simulink and the results are presented. Bridgeless PFC rectifier fed DC drive is shown in Figure.02. The controlled switch implemented is the power MOSFET with its inherently slow body diode. Simulated input voltage and current waveforms of bridgeless PFC boost rectifier are shown in Figure.03, respectively. The power factor is improved and the measured value is 0.9982. The corresponding output voltage is boosted to 400 volts as shown in Figure.04. The drive is operated under two conditions. One at no load and another at loaded condition. The speed of armature is above 1000 rpm under no load condition and it gets reduced when it is operated at load condition. The results are shown in Figure.05, and Figure.06. The speed torque curve of the DC motor is shown in
Figure.07. The curve indicates that the speed decreases with increase in load torque.

Figure 02 Bridgeless converter fed drive

Figure 03 Input Current and Voltage
V EXPERIMENTAL RESULTS

Laboratory model of Bridgeless PFC boost converter fed DC motor is fabricated and tested. The experimental results are obtained and they are presented here. The top view of fabricated Bridgeless PFC boost converter fed DC motor is shown in Figure .08. The rating of motor is 50 watts, 48 volt and 1 amp. It can be view that the fabrication consist of inductance at the source side to improve the PF. The oscillogram of voltage across MOSFET 1& 2 are shown in Figure .09. These are input pulse given to the MOSFET to turn ON and OFF. The output of the boost converter is shown in Figure.10. It is measured as 400 volts. The motor run at 1000 rpm during torque equal to 1N-M. The motor rotation is shown in Figure.11.
VI CONCLUSION

Bridgeless PFC Converter fed DC drive is modeled and simulated using Matlab. The simulation studies indicate that the power factor is nearly unity by employing the Bridgeless boost converter. Here, an attempt is made to find the performance of Bridgeless PFC boost converter fed DC drive. This converter has advantages like reduced hardware, high performance and improved power factor. The speed torque curve indicates the mechanical characteristic of DC drive. Smooth speed control is possible with this bridgeless converter. The experimental results closely agree with the simulation results.
REFERENCES


Authors

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