Design Of AC-DC Boost Converter With Power Factor Correction

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ABSTRACT

In the electrical and electronic appliances such as computers, televisions, audio sets etc, Dc power supply source are used because it make the load compatible with its source of power. If there are nonlinear loads then the power factor operation of the system is low. In this paper a bridgeless power factor correction boost converter is implemented which helps the power factor and harmonics content to reduce line currents of the input as compared with the topology of boost converter. Bridgeless power factor correction boost converter eliminates the line voltage bridge rectifier in conventional boost power factor correction converter, so that the conduction loss is decreased.

Keywords: Power factor, Total Harmonic Distortion, Conventional Boost converter, Bridgeless PFC Boost converter, Power Factor Correction.

1. INTRODUCTION:

In the appliances the current with harmonic content and power factor will be unity as the source is Dc power and it has high demand. Most of electrical and electronic appliances such as computers, audio sets, televisions DC power is used for the supply. The block of power electronic converters are uncontrolled diode bridge rectifiers with capacitive filter. Due to the bridge rectifiers of the non-linear condition the current and harmonics are into the utility lines. The bridge rectifiers are high THD, low PF, and low efficiency of the power system. Due to this it causes several problems such as voltage distortion, heating, noises etc. which results in reduced efficiency of the power. The AC supply is supposed to be free from high voltage spikes and current harmonics.

We have Power factor correction techniques are of two types passive and active. In the active power factor are used in majority of the applications. While, passive power factor is used for low power, cost sensitive applications. The continuous-conduction mode (CCM) conventional boost topology has been widely used as a PFC converter because of its high-power capability. In improve the efficiency of the PFC rectifiers, many power supply manufacturers have started which consider the bridgeless power factor correction. The bridgeless PFC, also known as dual boost PFC rectifiers, which helps in the conduction loss by reducing the number of semiconductor components of the line current

2. BOOST CONVERTER

A boost converter also know as step-up converter is a DC-to-DC power converter that steps up voltage while stepping down current from its supply input to its load output. It's a category of switched-mode power supply (SMPS) containing a minimum of two semiconductors, a diode and a transistor and a minimum of one energy storage element i.e., a capacitor, inductor, or the 2 together. To reduce voltage ripple, filters constructed of capacitors (sometimes together with inductors) are commonly added to such a converter's output at load-side filter and input at supply-side filter.
3. CONVENTIONAL PFC BOOST CONVERTER

The conventional input stage for single phase power provides operates by rectifying the ac line voltage and filtering with massive electrolytic capacitors. This method ends up in a distorted input current waveform with huge harmonic content. As a result, the power factor becomes terribly poor. The reduction of input current harmonics and operation at high power issue, close to unity are vital need for good power supply.

The conventional boost topology is that the most generally used topology for power factor correction applications. It consists of a front-end full-bridge diode rectifier followed by the boost convertor. The diode bridge rectifier is to rectify the AC input voltage to DC, that is then given to the boost section. This approach is fine for a low to medium power range applications. For upper power levels, the diode bridge becomes a vital a part of the application and it's necessary to out the matter of heat dissipation in restricted area.

4. BRIDGELESS PFC BOOST CONVERTER

The operation of bridgeless power factor correction boost converter are often divided into four modes. Where, modes I and II comes below positive half of the cycle of input voltage and modes III and IV comes below the negative half of the cycle of input voltage.

1. Positive half cycle: Throughout the positive half of the cycle cycle of the input voltage, the 1st dc/dc boost circuit, LB1-D1–S1 is active through diode D4. Diode D4 connects the ac supply to the output ground. The positive half of the cycle operation are divided into two modes i.e., Mode I and Mode II. At the time of mode I operation, the switch S1 is in on condition. Once switch S1 activates, LB1 inductor stores energy through the trail Vin-LB1-S1-D4. During the operation of mode II , the switch S1 is in off condition. Once switch S1 is deactivated, the energy stored within the LB1 inductor gets discharged and also the current flows through diode D1, load RL, and returns back to the mains through the diode D4.
2. Negative half cycle: Throughout the negative half of the cycle of the input voltage, the second dc/dc boost circuit, LB2- D2-S2 is active through diode D3. Diode D3 connects the ac supply to the output ground. The negative half cycle operation will be divided into two modes i.e., Mode III and Mode IV. At the time of mode III operation, the switch S2 is in ON condition. Once switch S2 activates, the LB2 inductance stores energy through the trail Vin-LB2-S2-D3. During operation of mode IV, the switch S2 is in off condition. Once switch S2 deactivated, the energy stored within the LB2 inductance gets discharged and also the current flows through diode D2, load RL, and returns to the mains through the diode D3.
FIG. 3.3 Mode III operation

FIG. 3.4. Mode IV operation
5. DESIGN, SIMULATION AND RESULTS

5.1 Conventional PFC Boost Rectifier

Figure 4.2 shows the simulated line voltage and line current waveforms of conventional PFC boost rectifier operating at 230-Vrms line voltage and the power factor is 0.8866.

Figure 4.3 FFT analysis of input current waveform
Figure 4.3 shows the FFT analysis of input current waveform. The THD percentage obtained in the simulation is 27.15% i.e., its more than 10%.

5.2. Bridge less PFC Boost Converter

![Fig. 5.1 Simulation of Bridgeless PFC Boost Converter](image)

Figure 5.1. shows the simulation circuit of bridgeless PFC boost converter.

![Fig. 5.2 Input voltage and input current waveform](image)

Figure 5.2. shows the simulated line voltage and line current waveforms of bridgeless PFC boost rectifier operating at 230- Vrms line voltage and power factor is 0.9332.
Figure 5.3 shows the output voltage waveform. FFT analysis of input current waveform. The THD percentage obtained in the simulation is 7.52% i.e., less than 10%.

6. CONCLUSION:

The single-phase Bridgeless PFC Boost Converter is modelled and simulated from the Matlab. The conventional PFC boost converter and the bridgeless PFC boost converter, are comparatively used in the rectifiers to improve the efficiency of the PFC stage by eliminating the diode forward voltage drop in the line-current. The Bridgeless PFC Boost Converter solve the low cost power factor of the AC–DC converters with fast output regulation.

REFERENCES:


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