AUTOMATIC POWER FACTOR CORRECTION BY BOOST CONVERTOR

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ABSTRACT

For regulated outputs, most industrial applications require AC-DC conversion followed by SMPS converters. Power Factor Correction (PFC) converters with a boost type front end are used to achieve a sinusoidal input current that is in phase with the input sinusoidal voltage while keeping the output voltage constant. In AC-DC conversion, power factor is important because for the same amount of active power transfer, there are two different power factors. To maximize the active power pulled from the supply mains, the system's power factor must be kept near to unity. A combination of rectifier and Boost converter is employed in this study to achieve this. The outputs of voltage and current sensors were connected to Arduino, and the power factor was obtained by calculating the real and perceived power.

Keyword: - *Rectifier, Boost converter, Average Current Mode Control, Continuous Conduction Mode Control, Power Factor Correction , Power Factor.*

1. INTRODUCTION:

Industry is often supplied by an AC source, although end equipment may require a dc supply. There is requirement for installing large amount of rectifier unit or front-end AC to DC conversion in specific application. Implementing the front-end conversion is less costly than the back-end conversion but the challenge is maintaining a unity power factor (PF) to optimize the useful power transfer from the source. The reason for the purpose of the unity power factor is to make the circuit appear fully resistive in order to cut cost of used reactive power [1].
The deciding element (PF) is determined by dividing real power by apparent power.

P F = Real Power / Apparent Power

The load characteristics, such as resistive, inductive or capacitive are represented by the determining factor value, which ranges from 0 to 1[2].

They're employed in switched mode power supply (SMPS) circuits to smooth down pulsating AC current, keep the current and voltage inputs waveform in phase and boost the determining factor. For tight regulation and harmonic free operation, a high-power factor is required. For the transportable application of the switched mode power supply. A good PF distribution site invites great reliability, compactness and a smaller form factor [1], [3].

Correction of the active power factor (PFC) approach or the passive PFC approach can be put to use to create a PFC circuit. To smooth out the current waveform, passive approaches use a combination of inductors and capacitors. Although the passive approach is typically less expensive than the active approach, it is difficult to optimize for universal line operation and requires a big, heavy inductor to meet Total Harmonic Distortion (THD) standards [4].

The passive method is usually a low-power, fixed-voltage solution. There are two types of active PFC approach: Peak current mode control (PCMC) and average current mode control (ACMC) are two terms for the same thing (PCMC).Controlling the peak current mode works by comparing the current waveform of the inductor to the present program level. Due to its low gain, the present loop is unable to compensate for the decencies'. By including a high gain integrating current, the current average mode control approach overcomes these issues. With a high degree of precision, average current tracks the current program. This is especially significant in pre-regulators with a high-power factor. Any circuit branch can be detected and controlled using the average current mode method. With buck and fly back topologies, it can correctly control input current, and boost and fly back topologies can accurately control the current output [5].

The continuous current as well as the fact that the current waveform may be modified to track the desired waveform are two of the numerous advantages of a boost converter, as a result it is commonly utilized in the discipline of PFC [6].

Boost converter, are used in PFC, step- up power supplies, photovoltaic inverters and power supply front end [7].

The boost converter has three modes of operation: Continuous Conduction Mode (CCM), Discontinuous Conduction Mode (DCM) and Critical Conduction Mode (CrCM). DCM's functioning appears to the comparable in comparison to CrCM because it can operate at a constant frequency; DCM has disadvantage having the greatest peak current when compare to CrCM and also CCM, with no performance advantage over CrCM. As a result, because CrCM is more prevalent practice design than DCM. In comparison to CrCM requires a larger filter inductor. While low HF core loss, low HF winding loss, and a constant value over the working range are the primary design issues for a CrCM inductor, the CCM mode inductor takes a different approach. The CCM's full load inductor current ripple power factor correction is normally intended to be between 20 and 40% of the average input current. This has number of benefits: A trapezoidal waveform has lower peak current and a lower RMS current factor than a triangle waveform, which reduces device conduction losses. Losses due to turn-offs are significant are reduced since the maximum current is switched off at a lower value [8].

The current flowing through the inductor follows the sinusoidal wave continuously in CCM operation, as a result, there is no double peak current penalty, making it ideal for high-power applications [9].

1.1 BLOCK DIAGRAM:

Rectifier:

The diode rectifier block converts the AC input voltage to an unregulated DC voltage. A diode-bridge rectifier is used to alleviate voltage strains across the switches. By putting the capacitor across the rectifier's output, the ripple in the output is decreased.

Boost Converter:

The current in the boost inductor builds with a slope of by connecting across the input voltage during turn-on, and the inductor stores energy during this time. The Boost inductor current declines with a slope of during Turnoff, and the inductor distributes energy during this time by connecting across the input and output through a diode. The average voltage across an inductor during one switching cycle should be zero, according to the Volt-Sec balancing principle.

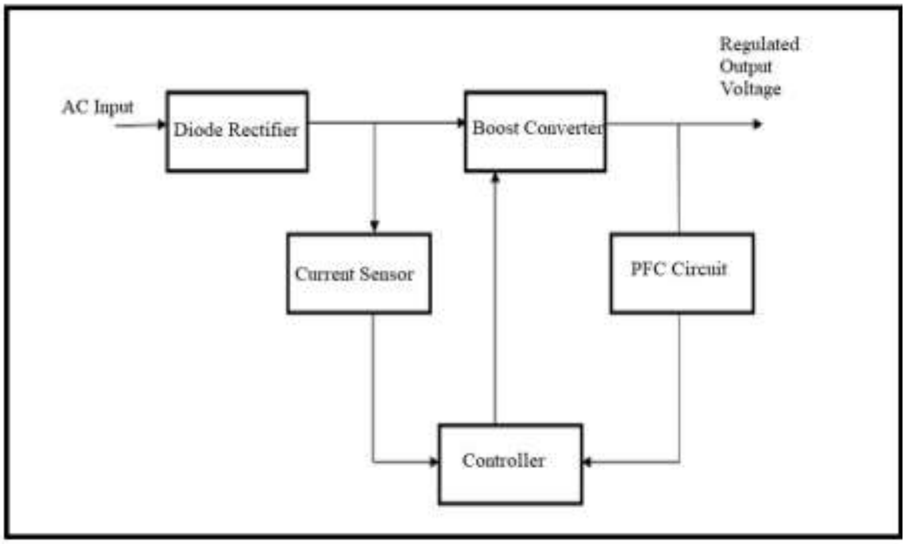

Fig. - Block Diagram of Converter with Active PFC Circuit

Arduino:

Many single board computers (SBCs) are available, including Arduino, Raspberry Pi, PIC, and others. Arduino was chosen above the other SBCs because of its capabilities and affordable cost. Arduino's programming was written in a simplified C language, and it has its own circuitry board for input and output interfacing. It may also function as a serial monitor when linked to a PC via serial connection. This function can be quite useful because it can display results or sensor values without the requirement for a connection to an output display, such as an LCD. We used the Arduino UNO Rev 3 in this study, which includes 6 analogue pins, 14 digital pins, 32 kB of memory, and a clock speed of 16 MHz

Current Sensor:

It has two main functions: it controls the duty cycle of the switch by measuring the input current and it limits the peak current through the boost inductor. An extremely low-value current sense resistor is utilized, and the current is proportional to the voltage across the resistor. The Hall Effect sensor and transformer are two more techniques to measure current, but they significantly increase the converter's size and cost. The sense resistor should be chosen with greater precision.

PFC Circuit:

To boost the power factor to unity, a power factor correction (PFC) circuit lowers supply current distortion and provides a current waveform that is close to a basic sine wave. PF = Cos φ when the phase difference between AC voltage and current is. If the current waveform has a lot of distortion compared to a sine wave, the power factor will be much below 1.0. Harmonic current must be reduced to make the power factor closer to 1.

4. CONCLUSIONS

The investigation of power factor adjustment using a boost converter is presented in this paper: When compared to ac to dc PFC, the suggested PFC has lower power device requires, resulting in lower cost, improved efficiency, and reduced electromagnetic interference. The interest in power factor correction circuits has grown as a result of new suggestions and future standards; an evaluation of the most intriguing solutions for single phase and low power applications is conducted.

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