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Power Factor Correction Using Step-Up Chopper Fed to a DC Motor Drive

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ABSTRACT

With the expanding interest for power from the ac line and more stringent cutoff points for power quality, power factor correction is extraordinary consideration as of late. An assortment of circuit topologies and control strategies has been created for the PFC application. While the discontinuous conduction mode (DCM) converters for example, boost and fly back converters are appropriate for low power applications. Continuous conduction mode (CCM) support converters with normal current mode, hysteresis control are absolute for some medium and high power applications. To eliminate these issues a few converter topologies utilizing proper semiconductor devices and control plans have been proposed. This examination is to find a minimal effort, small size, effective ac to dc converter to meet the UPS. In the proposed circuit, the power factor is enhanced by utilizing boost dc to dc converter. It eliminates the utilization of active switch and control circuit for PFC, which brings about higher efficiency. A Matlab/Simulink based model is introduced to get the results. At last a DC motor load is connected and simulation results are presented.

KEYWORDS: *AC-DC Converter, Power Factor Correction, Step-up Chopper, etc.*

I. Introduction

Switched mode Power Factor Corrected (PFC) AC-DC converters with high response and power consistency are being utilized as front end rectifiers for many uses. The converters are either buck or boost topologies. The buck type topology gives variable DC voltage, which is much lower than the input voltage magnitude. But when the instantaneous input voltage is beneath the DC voltage, the current drops to zero that outcome in huge increment in input current THD. Indeed, even with input filter the buck converters give just restricted change in input current quality.

On other hand the boost type converter dependably creates the voltage higher than the input voltage magnitude. The boost inductor with desired choice keeps up consistent input current with great wave shape. This lead the converter control to keep up close to unity power factor, low input current THD and great voltage regulation. The two stage scheme brings about high power factor and quick response output voltage by utilizing two controllers and improved power stages. The principle disadvantages of this plan are its moderately higher cost and bigger size came about because of its complicated power stage topology and control circuits, especially in low power applications. Keeping in mind the end goal to lessen the cost, the single stage approach, which coordinates the PFC stage with a dc/dc converter into one phase, is produced.

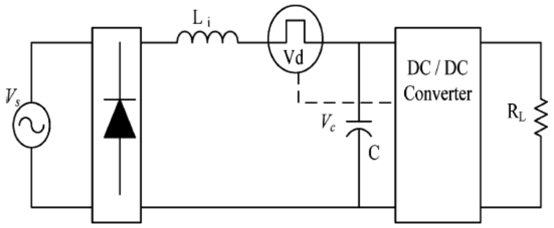

Figure 1 Circuit Diagram of Rectifier with Power Factor Correction

These incorporated single-stage power factor correction (PFC) converters for the most part utilize a boost converter to accomplish PFC with discontinuous current mode (DCM) operation. Normally, the DCM operation gives a lower total harmonic distortion (THD) of the input current related with the continuous current mode (CCM). In any case, the CCM operation yields somewhat higher efficiency compared with the DCM operation.

A point by point audit of the single stage PFC converters is exhibited in closed loop control. For the most part, single stage PFC converters meet the governing requirements with respect to the input current harmonics, yet they don't enhance the power factor and diminish the THD as much as their ordinary two-stage partner. In this paper, another procedure of quasi-active PFC is proposed. In fig1. PFC cell is shaped by interfacing the energy buffer (LB) and an auxiliary winding (L3) coupled to the transformer of the dc/dc cell, between the input rectifier and the low-frequency filter capacitor utilized as a part of ordinary power converter. Since the dc/dc cell is worked at high frequency, the auxiliary winding produces a high frequency pulsating source with the end that the input current conduction angle is essentially extended furthermore the input current harmonics is reduced.

II. Active Power Factor Correction Circuit

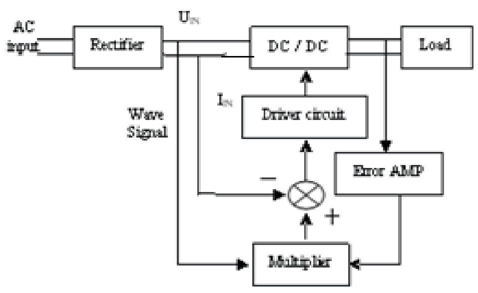

Figure 2 Basic Operating Principle of Active Power Factor Correction Circuit

The above Fig.2 demonstrates the working standard of APFC circuit comprises of rectifier, DC/DC converter, driver circuit, error amplifier and multiplier.

APFC is implying that the rectifier voltage which the input alter current (short for AC) signal is changed over direct current (short for DC) voltage through the bridge diode is changed into the current signal by DC to DC converter and the best possible control techniques. The current wave which can auto track the DC voltage wave is changed with a sine wave, and get an unchanged dc output voltage.

Circuit Topology of Active Power Factor Correction:

By using rectifier as a input, after rectification alternate current will get sinusoidal voltage waveform signal as the input current IC reducing PFC reference waveform and at that point by simulation on time-multiplier operations, will get as the consequence of current waveform reference, and the esteem of the present value and the actual sampling comparison, in the wake of driving circuit to control signal produced by the driver circuit i.e.; DC/DC output current and output voltage.

The fundamental circuit topology is typically carried out with DC to DC converter and is comprised of buck, boost-buck, fly back and boost circuit. Buck circuit is infrequently used because of the huge noise and poor filtering. Boost-buck circuit is complex in nature. Fly back circuit is typically utilized as a part of low power application. Last one is a basic current control circuit in view of the high PF esteem, the low aggregate total harmonic distortion and the high efficiency. The peak current of boost APFC is about equivalent to the input current. The magnitude of the peak voltage of boost APFC is higher than the grid side voltage.

III. Closed Loop Control of Power Factor Correction Circuit

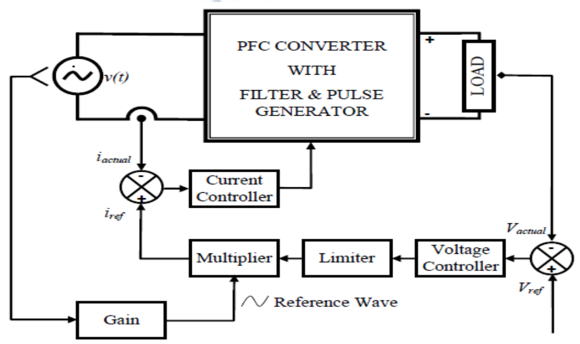

Figure 3 Closed Loop Control for PFC

The above Figure.3 demonstrates the closed loop control for PFC ac dc converter comprises of various component. The general outline of the closed loop control of PFC converter is appeared in Fig.3 The goal is to manage the power flow and meet the UPD input performance , for example, output voltage direction ≤ 2%, input control consider ≥ 0.95, input current distortion THD ≤ 5%. The output voltage is controlled by the external voltage control loop. The input power factor and current wave shape are controlled by the internal current loop. Both controller are picked as PI sort compensator and spoken to by the transfer function Gc(s)=Kp(1+1/Ti s). Where Kp and Ti are relative pick up and necessary time steady separately. The output voltage is controlled utilizing voltage error (Verror) acquired by looking at the measured genuine output voltage (Vactual) and sought reference voltage (Vref). The Verror is prepared by the voltage PI-controller whose output is the coverted current magnitude and limited to most extreme esteem.It is multiplied with unity magnitude extent sinewavereference gotten from input voltage. The output of the multiplier is the sought sinusoidal input reference current signal (iref) with greatness magnitude and phase angle. This signal is further prepared by the direct current controller as shown in Fig.4 and creates pulse width adjusted gate pulses such an extent that converter maintains the input execution index.

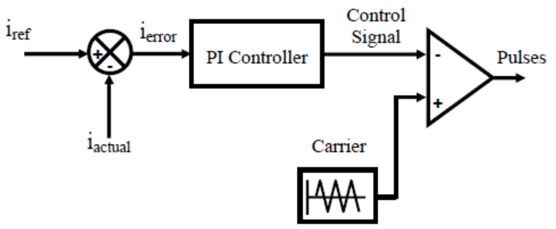

Figure 4 Linear Current Control

The external/voltage loop controller parameter values for Kp furthermore, Ti are intended to keep up steady output voltage independent of disturbances because of progress in load/input voltage. Kp andTi are found from open loop converter output voltage reaction for a step load change [5]. Though the inward/current loop controller values for Kp what's more, Ti are intended to enhance PWM pulses with the end goal that converter operation keeps up inputcurrent close sinusoidal with constrained distortion and power factor close unity.

IV. Matlab/Simulink Model and Simulation Results

In this paper simulation is completed for two cases.

In Case-1: AC to DC transformation without Active Power Factor Correction.

Without Active Power Factor Correction:

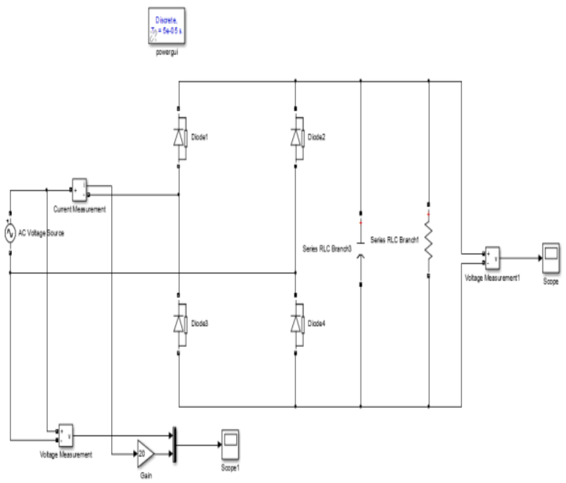

Figure 5 Matlab model without Active Power Factor Correction

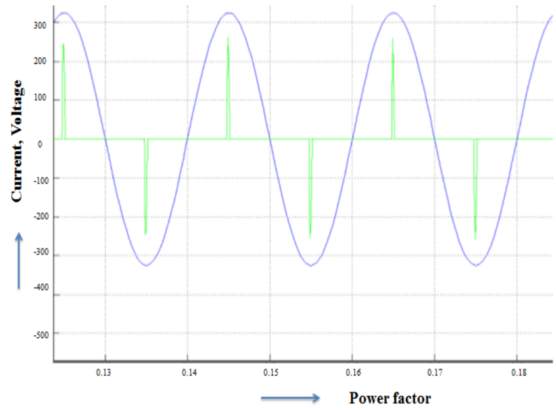

Figure 6 Input Voltage and Current Waveforms

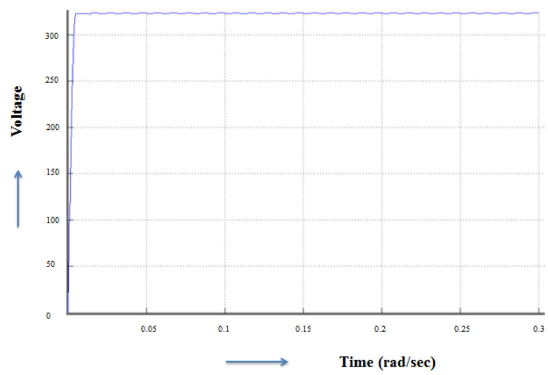

Figure 7 Constant Output Voltage (v) at Load side Waveform

In Case-2: AC to DC transformation with Active Power Factor Correction.

With Active Power Factor Correction:

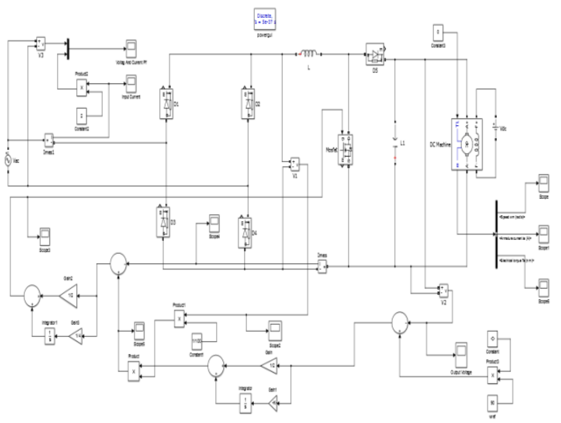

Figure 8 Matlab model with Active Power Factor Correction

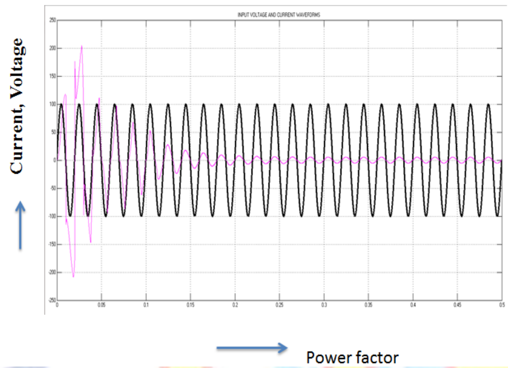

Figure 9 Input Voltage and Current Waveforms

The above waveform shows the AC side Input Voltage and Current in phase with Voltage of Unity Power Factor.

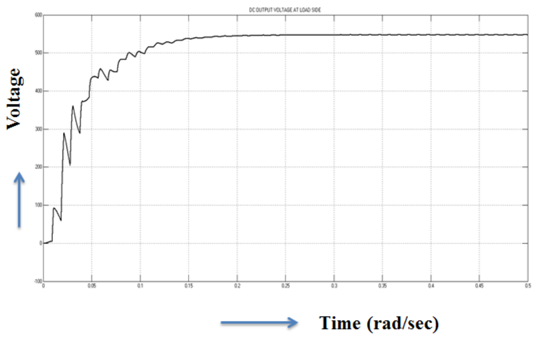

Figure 10 Constant Output Voltage (v) at Load Side Waveform

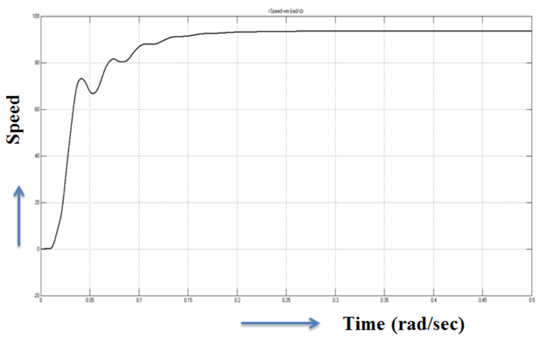

Figure 11 DC Motor Speed (rad/sec) Waveform

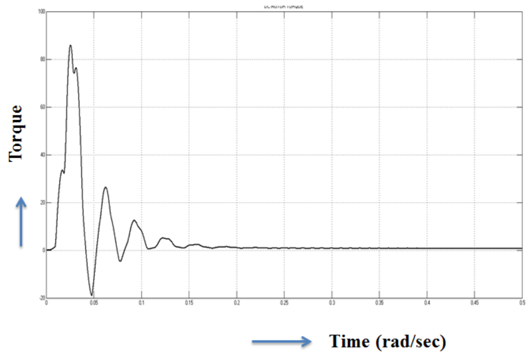

Figure 12 DC Motor Torque (N-m) Waveform

V. CONCLUSION

In this paper, another ac/do converter in view of a quasi-active PFC scheme has been exhibited. The proposed technique creates a current with low harmonic content to meet the standard particulars and additionally high effectiveness. This circuit depends on adding an auxiliary winding to the transformer of a cascade dc/dc DCM fly back converter. The proposed converter is connected to a DC motor drive. At last a Matlab/Simulink based model is created and simulation results are introduced.

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