International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 01 | Jan 2022 www.irjet.net p-ISSN: 2395-0072

5 kW Three-Channel CCM PFC Controller

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Abstract - *Power Element (PF) is a proportion of how a load draws power from the source. A leading or lagging power factor makes energy be moved to and fro between the heap and the source and just a piece of the energy is utilized for performing genuine work. Loads that draw a non-sinusoidal current from the source, cause mutilation of the source voltage waveform and lead to execution debasement of other gear associated on the line. Administrative norms force limits on the nature of current waveforms attracted by gear request to restrict the degrees of consonant flows. A few dynamic and uninvolved techniques can be utilized to shape the current attracted by power supplies to accomplish consistence with the administrative principles.*

This report clarifies power factor rectification (PFC), the related terms that are habitually utilized. The Constant Conduction Mode (CCM) help PFC geography is an ideal answer for power factor remedy over an exceptionally wide scope of force levels. The CCM support geography is examined exhaustively. Working current waveforms are introduced and part determination models are examined.

***Key Words*: *Continuous Conduction Mode (CCM), Power Factor Correction (PFC), Power Factor (PF),* Total Harmonics Distortion (THD), volt-amp (VA).**

1.INTRODUCTION

At the point when the responsive power is high, the AC source should supply an enormous evident ability to assist the activity of the heap which results in higher RMS current. High responsive power not just requests a higher source ability to help the heap, yet additionally brings about higher transmission misfortunes. For an unadulterated sinusoidal voltage and current waveform, PF is the cosine of the stage point between the voltage and current phasors.

$$PF = \frac{Average\ Power\ or\ Real\ Power}{Apparent\ power}$$

$$= \frac{P}{S} = \frac{V \times I \times \cos\varphi}{V \times I} = \cos\varphi$$

Table 1.1 Classification of Equipment According to

Category	Type
Class A	• Balanced three-phase equipment • Household appliances, excluding equipment identified by Class D • Tools excluding portable tools • Dimmers for incandescent lamps • Audio equipment • Everything else that is not classified as B, C or D
Class B	• Portable tools • Arc welding equipment which is not professional equipment
Class C	• Lighting equipment
Class D	• Personal computers and monitors • Television receivers • Note: Equipment must have power level 75 W up to and not exceeding 600W

IEC610000-3-2.

It is Class D gear's which really Draws DC Voltages From our AC Source Which makes greatest Twisting the Source voltage waveform. Circuit Graph of Such Loads is displayed underneath. It comprises of Rectifier Which Redresses AC Voltage into throbbing DC. After that throbbing DC is handled through a Channel to diminish the waves and afterward at last through a DC-DC converter to change the voltage appropriately.

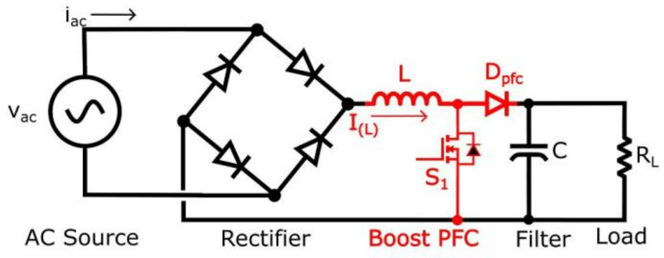


Fig. 1.1 Class D load Supply Circuit

2. AC-DC Rectifiers

A rectifier is an electrical gadget that interprets substituting flow (AC), which inconsistently turns around bearing, to coordinate flow (DC), which streams in just single heading. The cycle is known as amendment, since it "smooths" the course of current.

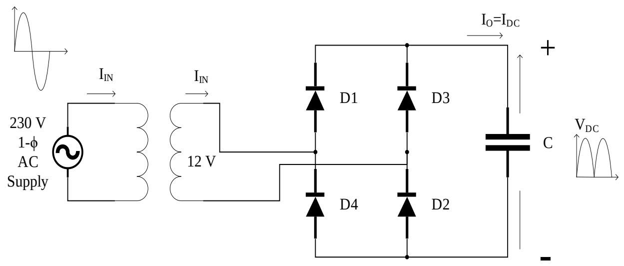


Fig. 1.1. A Single-Phase Full Bridge Rectifier Circuit

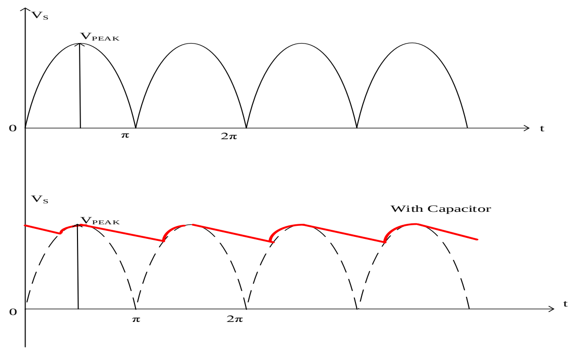


Fig. 1.2 Input and Output Voltages of Rectifier

3. Boost DC-DC Converter

The boost DC-DC converter is utilized to "step up" an info voltage to some more elevated level, needed by a heap. This sole capacity is achieved by putting away energy in an inductor and delivering it to the heap at a higher voltage. Additionally, a shut circle help converter is intended to comprehend the guideline and close circle activity which can be stretched out for PFC application.

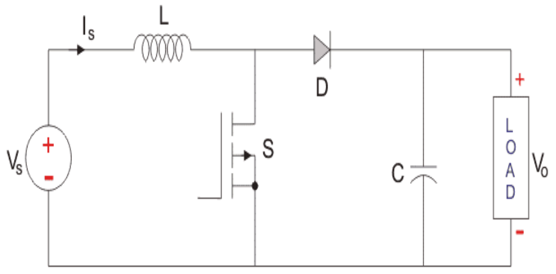


Fig. 1.1 The Boost DC-DC Converter

3.1 The boost converter has the following advantages

This converter is skilled to move forward the voltage at lower most part sum conceivable.

The current at input is nonstop which is exceptionally vital for sources like PV or battery.

The switch utilized as of now has the shared belief through the source which makes the drive circuit and control circuit arranging simpler.

The consistent information current makes it simple to channel and experience electromagnetic obstruction (EMI) necessities.

3.2 The boost converter has the following disadvantages:

The result capacitor required is enormous to diminish swell voltage as current in yield is throbbing.

The pay of input circle is troublesome and it has slow reaction due to presence of right half zero in nonstop conduction mode (CCM) help converter.

The result and information have no partition makes it basic in numerous applications like the power supply of entryway driver of force semiconductors.

4. Power Factor Correction

Power factor correction shapes the input current of off-line power supplies to maximize the real power available from the mains. Ideally, the electrical appliance should present a load that emulates a pure resistor, in which case the reactive power drawn by the device is zero.

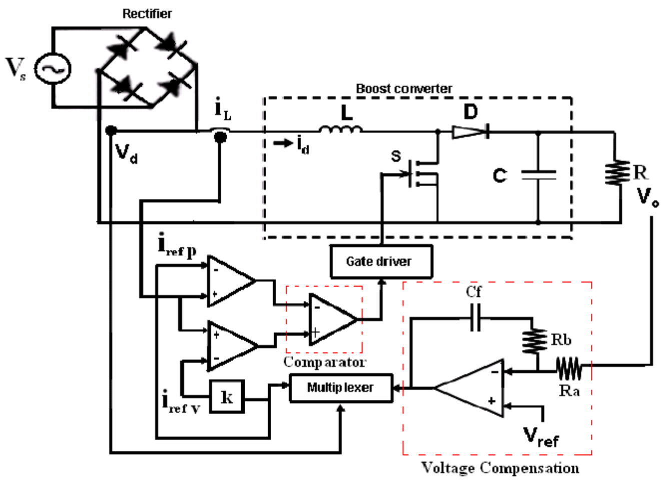
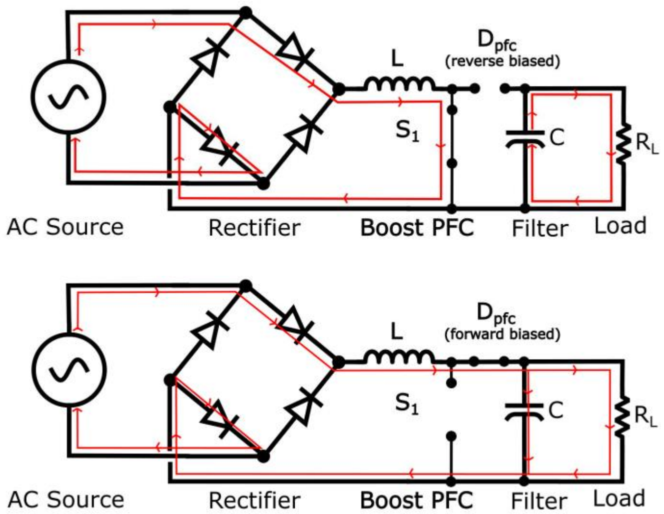


Fig. 2.1.1 Basic Structure of PFC which uses Average Current Mode Control



The cycling between the two states is done at a high frequency that is at least in the tens of kHz, but is often an order of magnitude (or even more) higher than that. The cycling back and forth between states is done rapidly and in a manner that both maintains a constant output voltage and controls the average inductor current (and subsequently the average AC current).

5. Simulink Model

By using MATLAB/SMULINK we throw more clarity in understanding the harmonic behavior of the system. This chapter is divided into three parts for the three different system.

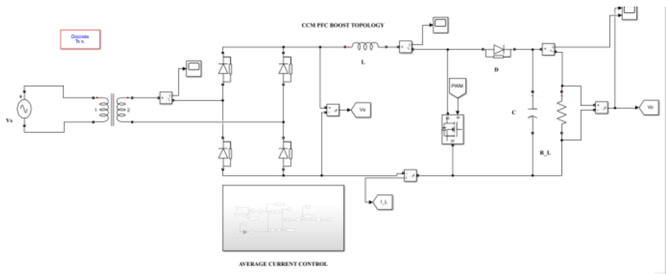


Fig 5.1: CCM PFC Boost Converter

The parameter for the closed loop boost converter is shown below:

Parameters

- Input voltage V_S = 12 V DC.
- Output Voltage V_O = 24 V DC.
- Output Current I_O = 1 A.
- Switching Frequency f_{SW} = 25 kHz.
- Load = Variable 50 Ω rheostat.
- η = Efficiency of the circuit.
- **STM32F407VGT** microcontroller for generating the closed loop PWM.

5.1 Control Technique

The average current mode control is used and its Simulink diagram is shown below:

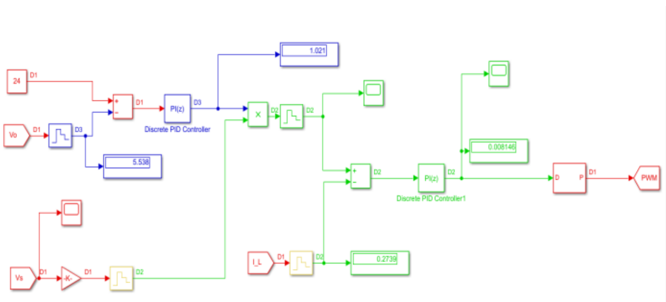


Fig 5.1.1 Average Current Control Technique

5.2 Results

The results for the above Simulink model are shown below:

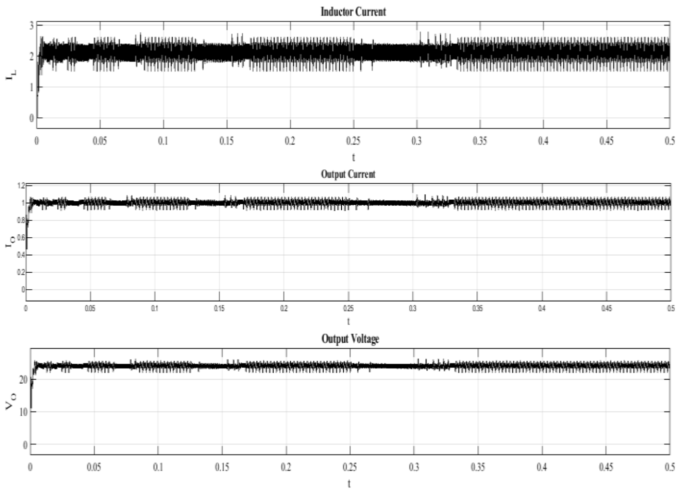


Fig 5.2.1 Output Waveforms of Closed Loop Boost Converter

6. CONCLUSIONS

This report has introduced AC/DC help type converter for PFC applications. Without utilizing any committed converter, one converter can be utilized to kill the consonant current produced by the other non-direct burden. With the assistance of recreation study, it very well may be presumed that, this setup eliminates practically all lower request music, consequently with this arrangement we can accomplish power factor closer to solidarity, THD under 15%. Trial results show that power variable can be improved and huge decrease in THD.

The Lift PFC converter is taken (since it enjoys huge benefits as talked about in section 3) with appropriate exchanging control procedure. There are assortment of control strategies, among which any one strategy can be utilized in PFC application. By and large, for any control methodology for PFC, two essential input repaying circles are required. A voltage input repaying circle is utilized as the external circle to keep the transport voltage to a decent DC (predefined reference) esteem. An inward circle, known as current circle is to control the inductor current to a particular level and to shape the inductor current with the mean to be just about as the same as conceivable to the corrected information DC voltage keeping nearly solidarity PF

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