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Single Stage PFC AC –DC Converter using Pi Controller

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Abstract: The steady growth in the use of electronic equipment has become a major problem based on the harmonic of the line current. Its negative effects on the feeding system are recognized as healthy. Thus, in three-phase systems, the amount of neutral current increases and becomes the cause of the overheating of transformers and induction motors, as well as the terrible conditions of the voltage waveforms in the system. There are numerous international standards to limit the harmonic content, caused by line currents of the equipment coupled to the electrical distribution networks. As a result, a reduction in line current harmonics or power factor correction - PFC is vitally important. This idea is the inspiration for this research effort. The goal is to improve the power factor almost with the minimum total harmonic distortion (THD). There are two types of PFC. 1) Passive PFC, 2) Active PFC. For this thesis, the small passive EMI PFC (LC) and the active converter Boost converter are presented with an appropriate switching control. Several conventional and non-linear control schemes are analyzed for switching the Boost PFC converter, which is the key to achieving a power factor almost equal to the unit with a minimum percentage of THD. There are some important conventional control techniques that are implemented for thesis work, which are; 1) Maximum current control 2) Average current control 3) PI control. Also for a better dynamic response and a wide range of high frequency, non-linear regulators; 1) Controller for dynamic evolution and 2) Controller for scroll mode. For each case, the input power factor is closed to the unit and the waveform of the line current is observed as a sine wave with a percentage of THD within the tolerated limit.

I. INTRODUCTION

The daily increase in consumers of electronic products and the existence of rigid grinding circuits within electronic devices dominate the cause of harmonic distortion of the network. Some forms of AC to DC power are used in the construction of most modern electrical and electronic equipment, and for each power semicirculator these supplies take current impulses. Considering that for a single device (a domestic television, for example) the amount of reactive power extracted can be small, but in mass, it can be 100 or more TVs that use reactive power from the same feed phase causing a significant amount of flow of reactive current and therefore generation of harmonics. Advances in electronic converters of reduced weight and size and, at the same time, the performance and function of these converters, preferably for industrial, commercial and residential use.

This reactive current can not be identified because it is the national tariff counter and results in the loss of income due to the lack of correspondence between the developed power and the power used. Different ways are provided by different phases and creates a three-phase imbalance within a housing scheme. Through the neutral line of the star configuration, the unbalanced current flows and causes the heating and combustion of the conductor, in extreme cases. Furthermore, the waveform of the supply voltage is distorted due to the reactive current, whereby an EMC problem occurs for a device sensitive to said voltage distortion. In addition, it has accumulated additional losses and dielectric stresses in capacitors and cables due to the harmonic content and, therefore, an increase in the currents in the windings of machines and transformers and noise in various products and the elimination of rotary premature failure fuse and safety modules .

Since in the present situation, the increase and growth in the use of equipment such as computers, laptops, telecommunications, biomedical equipment and uninterruptible power supplies is uncontrollable and also determines power consumption and small power densities.

Industry or the market calls for the reduction of energy sources with a higher power density at a reasonable value. Therefore, it is mandatory to provide additional energy at lower costs and dimensions for telecommunications and IT applications. To solve these

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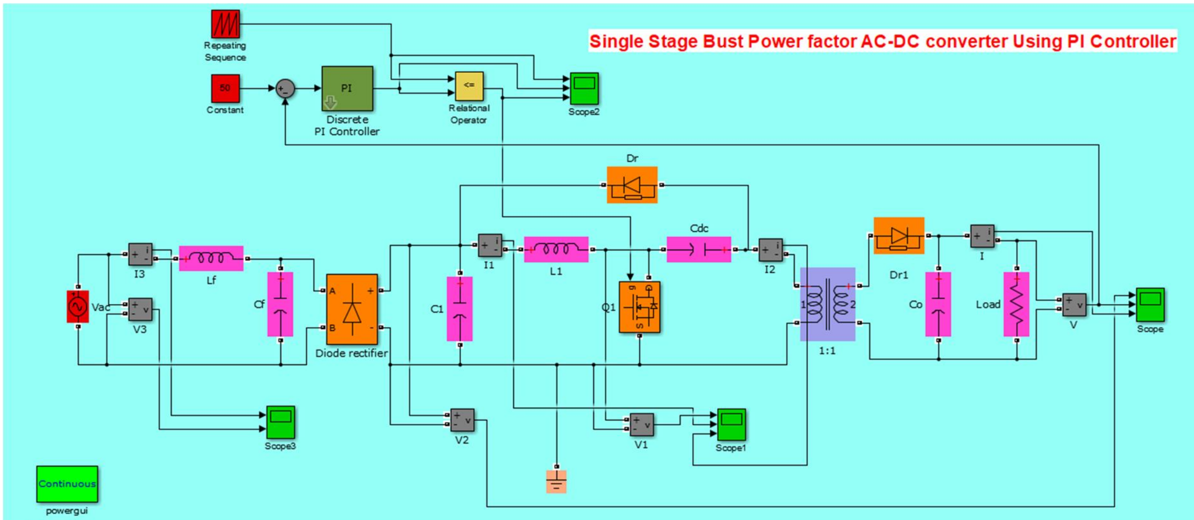
problems, you want to support the distributed energy system (DPS). Therefore, DPS has expanded from a normal access using isolated DC-DC converters to the construction of bus converters midway with non-isolated.



A. *Nonlinear Loads and Its Effect*

The distortion normal electric current waveform due to the nonlinear loads creates harmonics in AC distribution systems. Nonlinear loads arise for variable resistance i.e. resistance varies for each sine wave of the applied voltage, causing in a series of positive and negative pulses, . In AC-DC system, the connected equipment to the DPS desires some kind of power conditioning, rectification in general, which creates a non-sinusoidal line current because of the non-linear input characteristic.

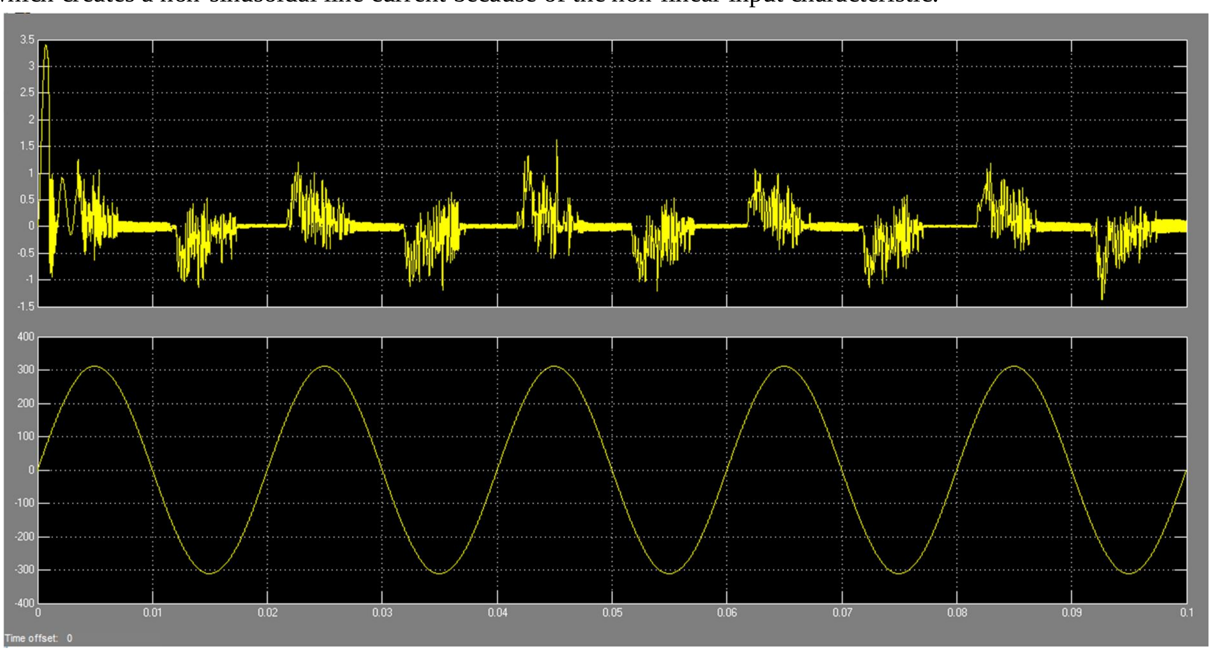


Figure: Scope output 1

B. *Harmonic Mitigation*

Realistically, completely eliminating the harmonics would be very demanding and too expensive. The understanding of the choices and the relative costs to balance the actual harmonic load in contradiction with the cost of the solution is the vital factor. For the minimization of the actual harmonic loads there are numbers of selections offered, but they should be deliberately studied due to the combined consumption and the use of extra copper, increasing the increase in deficiencies.

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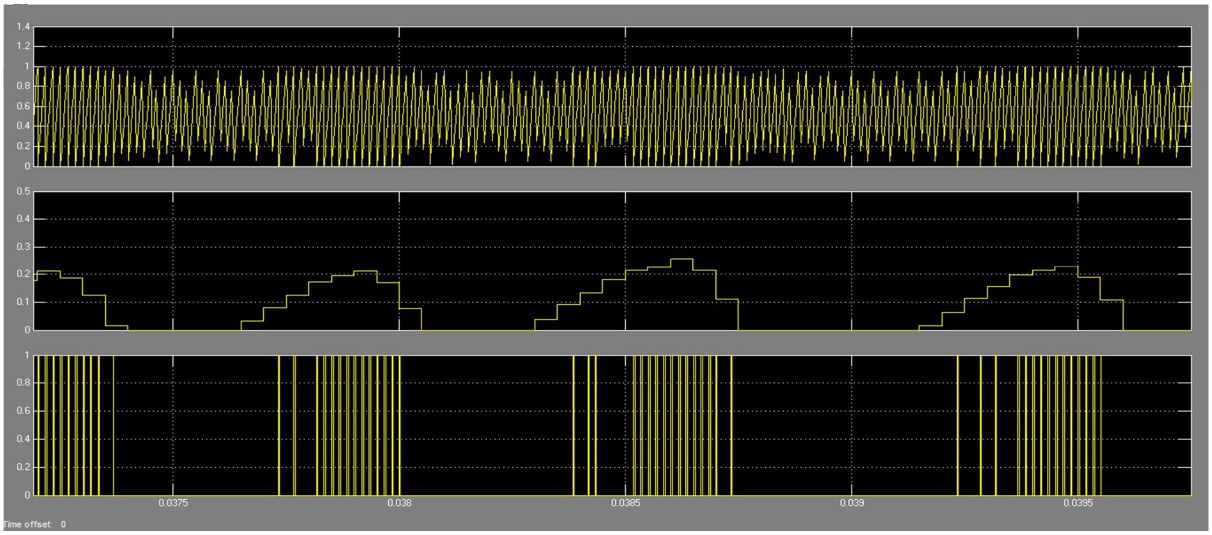

Figure: Scope output 2

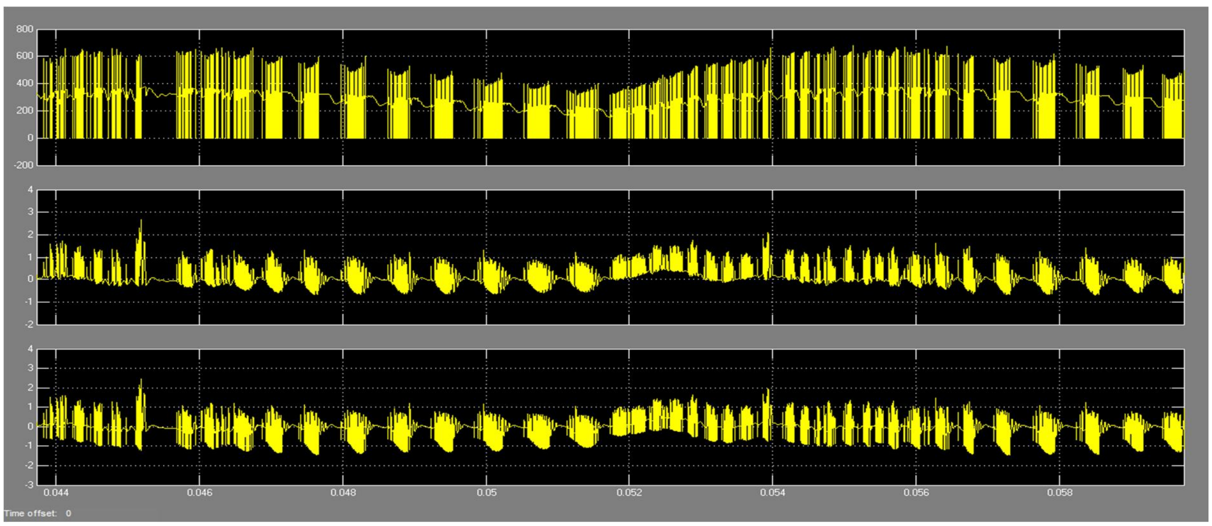

Figure: Scope output 3

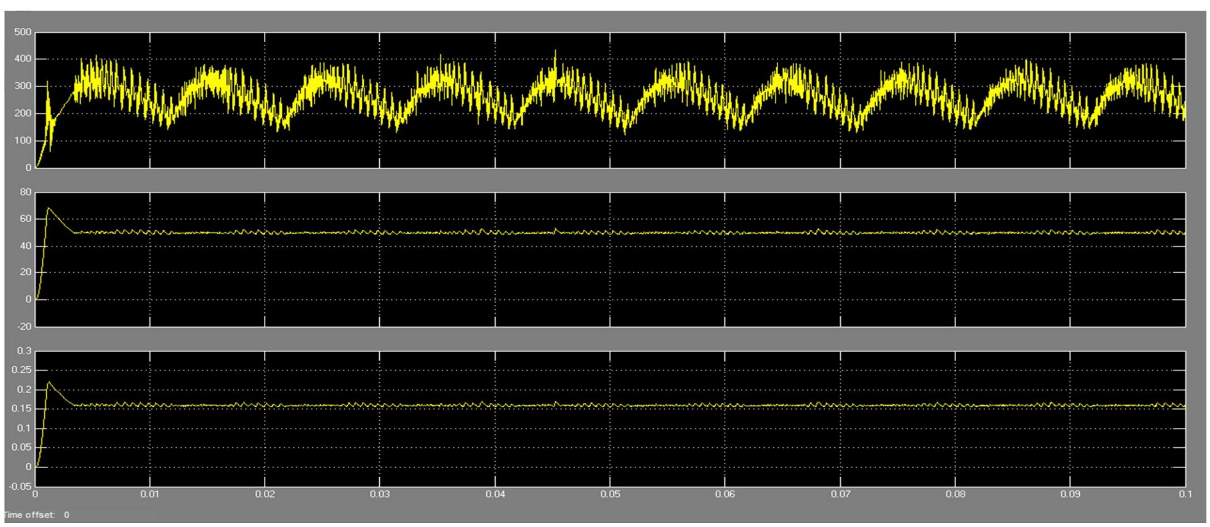

Figure: Scope output 4

C. Advantages of the high power factor

1) Voltage distortion is lower.
2) All power is active.
3) Small current RMS.
4) More loads can be supplied.

D. Advantages of circuits with PFC

1) The cost reduction factor such as electrical loads (SMPS, electronic ballast or other electrical load) becomes much simpler.
2) Due to the lower RMS current with PFC, it allows the use of small and very economical network rectifiers for the electric load manufacturer.
3) The input voltage for the DC electric load becomes stable and regulated. In fact, the AC-DC system becomes functional on extended range power due to the PFC.

II. CONCLUSION

The minimization of line current harmonics is essential to comply with the standard that determines an increase in the degree of use of the power of the network. This is discussed as the PFC (Power Factor Correction) in general.

PFC is a technique to counteract unwanted effects of electrical loads that create a power factor (PF) of less than 1.

There are technical numbers for PFC. Based on the electrical selection element to filter the harmonics and obtain almost an input power factor, the PFC technique is classified in the "active" and "passive" PFC method.

The "passive PFC circuit" uses low-frequency filter components to reduce harmonics. Furthermore, in this technique the power factor can not be significantly improved and the output voltage can not be controlled. The active switches are used in association with the reactive element for "active PFC approach" to improve the line current shape and to obtain a controllable output voltage. This DC-DC converter is used and is operated at high frequency to model the waveform of the most sinusoidal possible line current.

In the "Active PFC approach", the Boost PFC converter is taken (as it has significant advantages as discussed in Chapter I) with an appropriate switching control strategy. There are various methods of control, including any method that can be used in the PFC application. In general, for any control strategy for PFC, two basic feedback compensation circuits are required. A voltage feedback compensation loop is used as an Outer Ring to maintain the bus voltage on a fixed DC value (default reference). An internal loop, known as current loop, is to control the current of the inductor at a specific level and to model the inductor current with the objective of being as similar as possible to the DC input voltage rectified by keeping almost the PF unit. PFC power supplies with control loop implementation are used to achieve a stable system with tolerable dynamic behavior regardless of the system load conditions. Using some conventional control methodologies and some non-linear control techniques, the non-sinusoidal input current is converted into sinusoidal with improved THD and their advantages and limitations based on constraints are discussed.

Some conventional control schemes are taken;

1) Peak current control
2) Control of the average current
3) PI control

Some non-linear control schemes are taken;

1) Control of dynamic evolution
2) Sliding mode control

The almost unit power factor with tolerated THD percentage of the input line current is observed for the Boost PFC converter operating in the control methods described above.with constant load R, operating with different control schemes. Meanwhile, for the operation controlled by PI and the Boost PFC converter controlled in sliding mode with variable R-L-E-Load over time, the power factor and the THD obtained are analyzed.

A. Future Purpose

For this work, the Boost PFC converter with different controllers is realized with the help of MATLAB / Simulation, which can be analyzed in real time on the simulator for the consideration of practical applications. Furthermore, hardware implementation can be practically performed with a proper control technique. Switching losses can be considered and a suitable smooth switching technique can be introduced. Some special optimization techniques can be used to guarantee a very high dynamic stability and a very wide and stable operating range.

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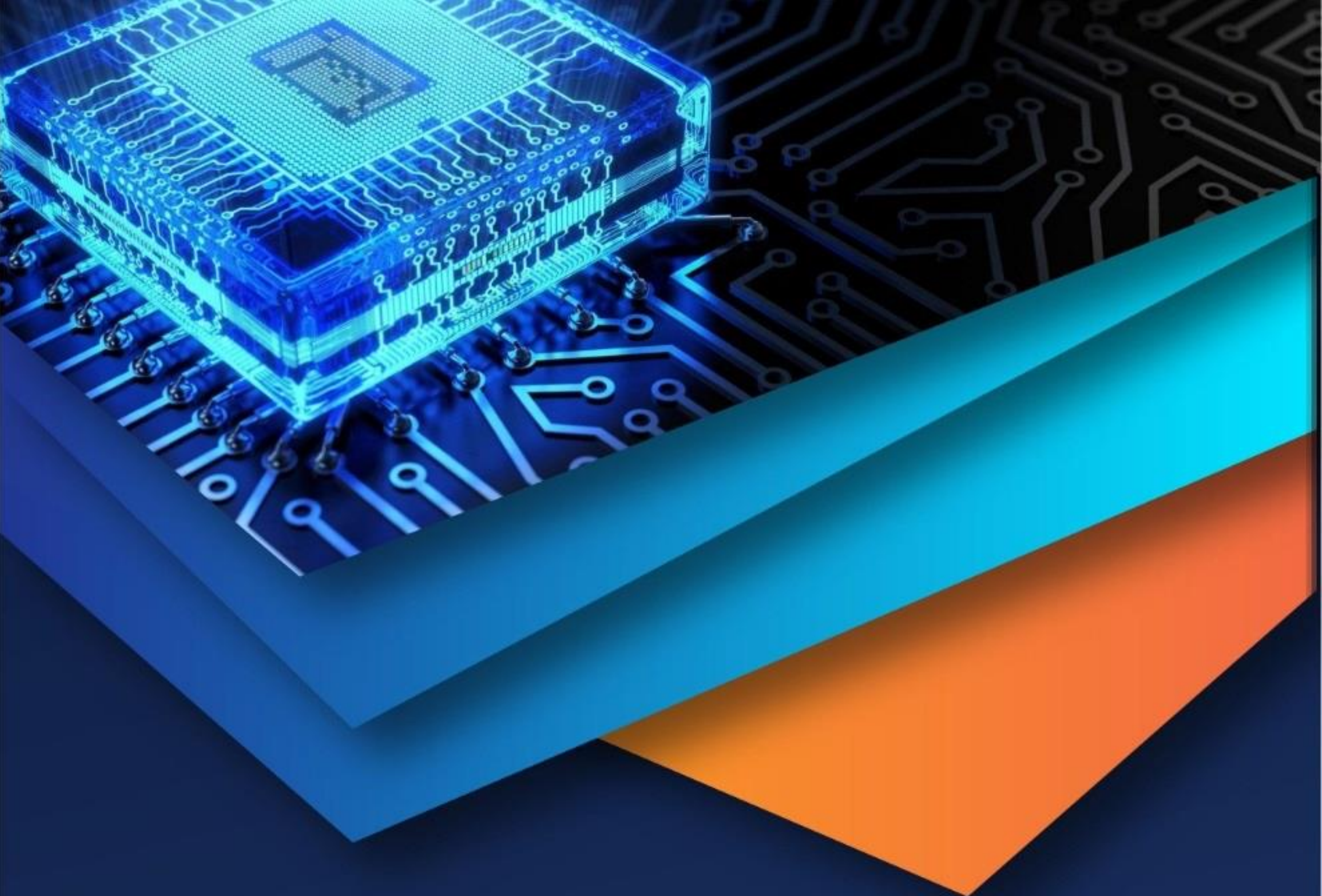

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