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PIC controller based power factor improvement and harmonic reduction by using single-phase active power filter: a case study and prototype

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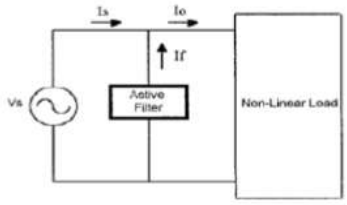
ABSTRACT

In This paper presents a technique for single phase power factor correction of non-linear loads employing an active power filter. The current control strategy is the same used in the boost pre-regulator, which is the average current mode technique. The project will focus on the design methodology and the analysis of the control strategy which allows the compensation of harmonics and phase displacement of the input current, for single and multiple non-linear and linear loads. Experimental results of an active filter controlling a 200W to 1KW rectifier with a capacitive filter, a 58OW multiple load, which consists of a rectifier with a capacitive filter are presented. "In the last years the use of electronic equipment has been increasing rapidly. This equipment draws The current from the AC mains has harmonic components, which leads to low power factor, low efficiency, interference in some instruments and communication equipment by the EMI, overtaxed electrical-distribution systems, overheated transformers and electromagnetic fields. A classical solution is the use of passive filters to suppress harmonics in power systems. However, passive filters have many disadvantages, such as large size, resonance, and fixed compensation characteristics. Therefore, it does not provide a complete solution. The most usual single phase non-linear load is the frontend rectifier followed by a bulk capacitor, which draws current from the input during its charging. The boost pre-regulator is used to reduce the harmonic contents and improves the power factor. The boost pre-regulator has some disadvantage because it cannot be used in equipment already in service, and it is applied only to one kind of non-linear load which is the front end rectifier followed by a bulk capacitor. A very interesting solution is the use of a single-phase active power filter, which is connected in parallel with then on-linear loads. The active power filters concept uses in power electronics to produce harmonic components which cancel the harmonic components from the non-linear loads. It can limit harmonics to acceptable levels and can adapt itself in case of harmonic component alteration or even changes in then on-linear loads types. Usually the technique used to control the single-phase active filter senses the non-linear load current and calculates its harmonics. This project will focus on the design and the control strategy for a shunt single-phase active power.

Keywords: *Controller, control strategy, Harmonic reduction, power factor, active power filter.*

1. INTRODUCTION

Now days the electronics equipment uses increasing very faslty this equipment produces the high harmonics with very low power factor in distribution network in Electrical system so our project objective is to improve the power factor up to the unity level by adding shunt capacitor to the main line of distribution network and another objective is to design prototype circuit for proposed system and simulate active filter circuit with the help of mat lab software and verify both the results of Hardware and Simulation this are the objective of my project because in industries and college network loads are mostly inductive so require to improve the power factor by improving the power factor we can avoid the penalty charges from the government.

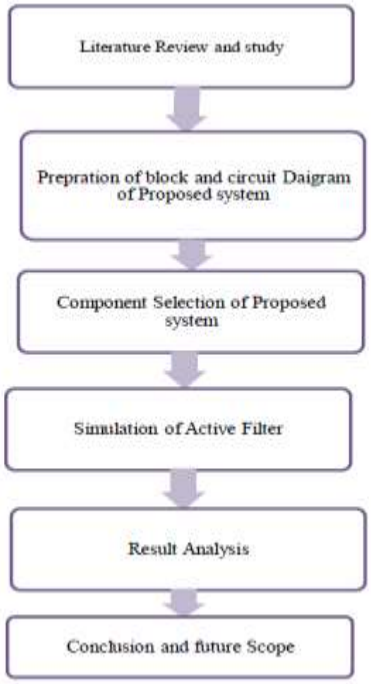


This is the basic Block diagram of shunt active filter with nonlinear load figure show voltages source, active filter and nonlinear load with the help of active filter we can cancel the harmonics from nonlinear load and improve the power factor

2. OBJECTIVE OF THE PAPER

- To improve the power factor up to unity for distribution network by adding shunt Capacitor to the Network.
- To Design Prototype circuit for proposed system.
- Simulation of Active Filter.
- To verify results of simulation and implemented Hardware

3. METHODOLOGY OF THE PROJECT



4. LITERATURE REVIEW

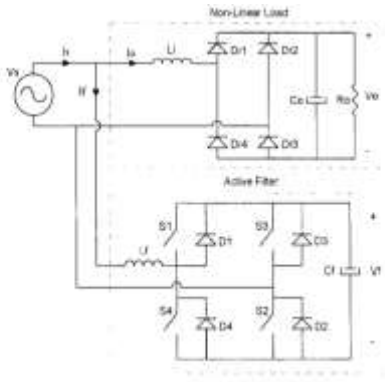
Review of the Literature Shows That the Different Research Papers on Power Factor Improvement Harmonic Reduction By Using Active Filter And Simulation Related This Section Presents The Overview Of The Research Work. The Single Phase Power Factor Correction Of Non Linear Load By Using The Active Filter [1] And It Explained Design Methodology And Simple Control Strategy With Help Of This Author Get High Power Factor In This Paper The Active Power Filter Has Maintained Sinusoidal Supply Current In Phase With The Supply Voltage And Gives Unity Power Factor Of The Supply For The Steady State And Transient Condition [2] Also He Used Control Technique For Harmonic Reduction. The current harmonics cancel by the shunt active filter and passive power filter and improve the power factor by connecting both shunt and passive filter improved power and improve the performance of APF **[3]** in this paper author used reference current for d –q transformation.

The medium and high power network single phase or three phase networks not possible to reduce the harmonics the paper address the of active filtering in low power single phase and medium and high power three phase network **[4]** the presented result obtained active filter prototype shows the both in static and dynamic operation. In this paper author implemented sine multiplication theory by using microcontroller by this method he achieved high power factor **[5]** finally active filter compensate grouped load and microcontroller is used and validates the analysis The full bridge voltage source inverter (VSI) controlled AC load current through sensor **[6]** also he presented prototype system and also he simulate the prototype system so in this paper author carried out simulation and hardware implementation of single phase active filter. The author elaborates **[7]** shunt active filter allow the compensation of current harmonics and unbalanced together with power factor correction gives the better solutions than the conventional approach also d –q theory was used to implement the control algorithm. In this paper initially the active filter mitigate the voltage sag and swells of the circuit then it is compensate the harmonics current in the line current [8] in this paper filter model compensate harmonics mitigate the voltage sag and swells and correct the power factor near to unity A single phase ac to dc converter using

modified series –parallel resonance converter with active filter was presented by using this converter with APF improved power factor.[9] Also he was minimize the harmonic current and decreases the switch peak current with decrease in load thus the converter has part load efficiency Author found the d –q theory is applicable for single phase and three phase system by this system was improved the power factor with help of active filter but total harmonic distortion (THD) was increased. [12] Also he explained DSP controller DSP controller gives good result for power factor improvement

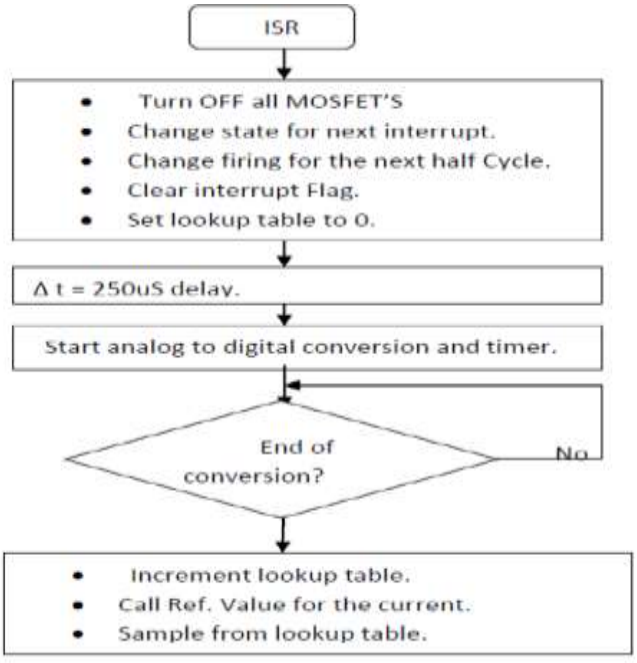
5. BLOCK DIAGRAM DESCRIPTION

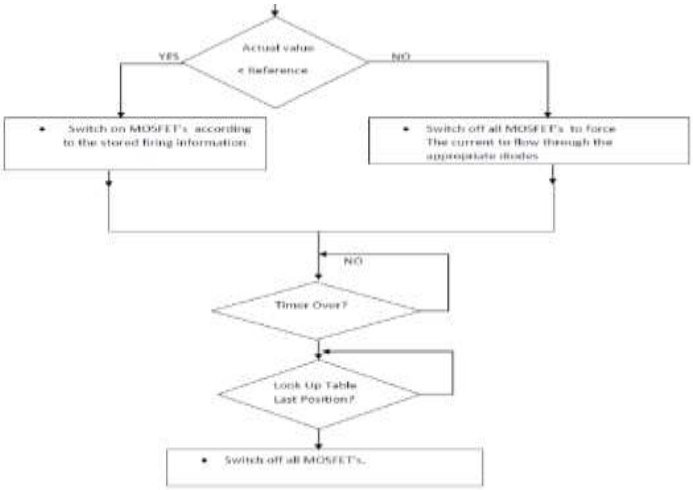
The diagrammatic representation of block diagram is as given below. This figure shows MOSFET with capacitor are connected with main line with parallel. By using boost Regulator to compensate harmonics components and improves the P.F The active filter is cancelling and reducing the harmonics components from Non-linear loads. In this block diagram CT PT is used for measurement of current and voltages the Isolation and driver section are measure signals in the presence of a high common mode voltage by providing electrical isolation and an electrical safety barrier. In this project we use PIC Controller. The PIC18F4620 is used for control strategy. From the Block diagram the Regulated power supply circuit with the help of a rectifier it converts AC into DC. From the LCD we can see the result. From the block diagram we implemented the main hardware the schematic of the hardware is as given below in these hardware shows the different electrical block like Bridge rectifier circuit with filter capacitor as Non-linear load, Active filters using MOSFET for triggering purposes, CT/PT for signal conditioning. For voltage and current measurement, Isolation and driver section for MOSFET, ZCD ref block, PIC Controller, Source transformer, boost inductor, Regulated power supply."



In this figure 4 diode bridge rectifiers with capacitor are called as nonlinear load and MOSFET with capacitor are called as active filter this filter circuit connected with parallel to the main line this circuit can cancel the harmonic components and improve the power factor

6. FLOW CHART FOR APF



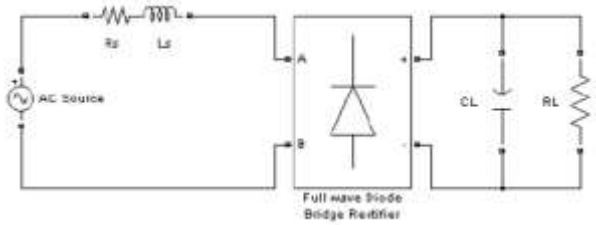


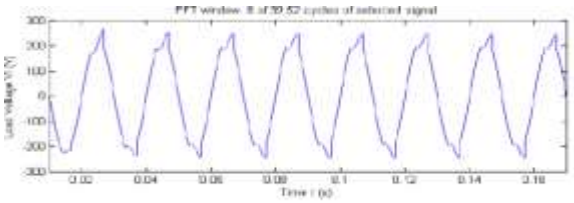
From the above flow chat first off all turn all MOSFET then change condition for after that break off after that modify the firing used for the next short phase the clear break off standard set search for table to 0 set delta t =250 delay then start analog to digital conversion and timer then end of the conversion the after that block is addition search for table and identify the ref. Value for a current and sample from lookup table now take up actual value Ref. If yes then switch on all MOSFET according to the store firing in order if no switch off all MOSFET to force the current to flow through the appropriate diode after time then lookup the table last position then finally switch off all MOSFET"

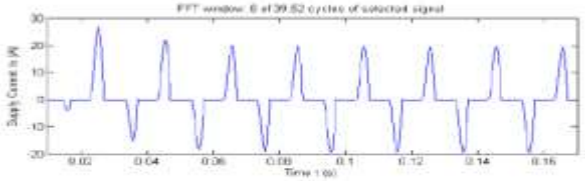
Simulation of Active filter

Mat lab is nothing but Matrix lab which consists of following commands we can do the program, simulation very quickly as compared to other software in the electrical field. It is very power full tool for electrical circuit simulation. In this project with this software I have done active filter simulation

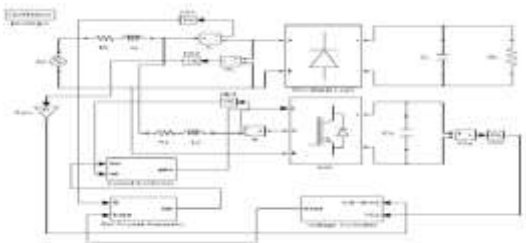
Simulation for without active filter

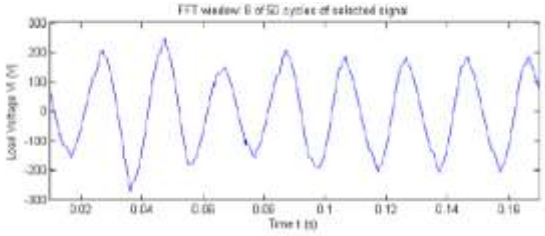


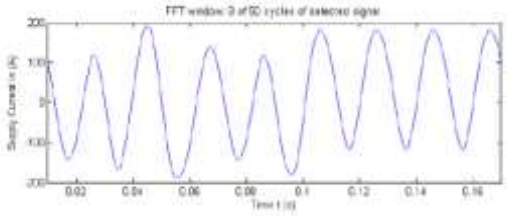




Simulation for Active filter







Result of APF Simulation

Sr.no	Parameter	Without APF	With APF
1	Voltage (V)	230V	230V
2	Current (I)	20A	200A
3	Voltage (V) Harmonics	10.6	3.39
4	Current (I) Harmonics	92.78	1.71

7. CONCLUSION

In this project would be obtainable a design method of an active filter and its new control loops strategy. By observe all aspects of the power factor it is clear that power factor is the generally important part for the utility Company as well as for the consumer Utility Company clear from the power losses while the consumer frees from low power factor penalty charges. By installing shunt capacitors into the circuit the Power Factor is improved and the value becomes nearer to unity and PIC controller gives very good Result for power factor Improvement

8. FUTURE SCOPE

For additional development we can introduce predictive control strategy in which the active filtering approach can be utilized so as to further decrease the current ripples and switching losses the switches can be made to be work under soft-switching condition. Also we can use DSP.

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