

# Power Quality Enhancement Using Hybrid Active Power Filter

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**Abstract**— Most of the pollution issues created in power systems are due to the non-linear characteristics and fast switching of power electronic equipment. Power quality issues are becoming stronger because sensitive equipment will be more sensitive for market competition reasons, equipment will continue polluting the system more and more due to cost increase caused by the built-in compensation and sometimes for the lack of enforced regulations. In general, passive filters are used for compensating voltage harmonics, but these passive filters doesn't gives good compensation features and have various demerits like limited compensation characteristics, high transient response, etc. Modern power electronics devices like active power filter and comprehensive simulation study of relay give the idea of power quality improvement. Generally, in electrical parallel circuits voltage is constant and current is variable parameter, so by using parallel active filter provided variable currents in system and mainly series active filters are used for voltage and power quality improvement and reducing the harmonic content in load voltage. In this paper, FFT analysis is done with help of series active power filter. The results show that proper tune active power filter provides best outputs for the imaginary power compensation and power factor developments. Additionally, the proposed series active filter is used for compensating voltage sag, voltage swell and voltage unbalanced issues in a three-phase distribution system without use of additional devices. The performance of proposed series-active power filter is verified under various voltage related PQ issues by using Matlab-Simulink tool, results are presented.

**Keywords**—Active power filters, harmonics, hybrid filters, Power quality.

## INTRODUCTION

Electric power quality may be defined as a measure of how well electric power service can be utilized by customers. Power Quality problem is an occurrence manifested as a nonstandard voltage, current or frequency that results in a failure or a mis-operation of end user equipment. To compensate harmonics conventional Passive Filters are used for specific number of harmonics. To compress total harmonic content Active Power Filters are used. For all types of power quality solutions at the distribution system voltage level FACTS also called as Custom Power Devices are introduced to improve Power Quality.[1,2,3,4]

### POWER QUALITY

Power quality is certainly a major concern in the present era; it becomes of especially important with the introduction sophisticated devices, whose performance is very sensitive to the quality of power supply.[5]

Modern industrial processes are based on a large amount of electronic devices such as programmable logic controllers and adjustable speed drives. Electronic devices are very sensitive to disturbances and thus industrial loads become less tolerant to power quality problems.

Power Quality (PQ) has become an important issue since many loads at various distribution ends like adjustable speed drives, process industries, printers, domestic utilities; computers, microprocessor based equipment's etc. have become intolerant to voltage fluctuations, harmonic content and interruptions. Power Quality (PQ) mainly deals with issues like maintaining a fixed voltage at the Point of

Common Coupling (PCC) for various distribution voltage levels irrespective of voltage fluctuations, maintaining near unity power factor power drawn from the supply, blocking of voltage and current unbalance from passing upwards from various distribution levels, reduction of voltage and current harmonics in the system and suppression of excessive supply neutral current.[6,7,8]

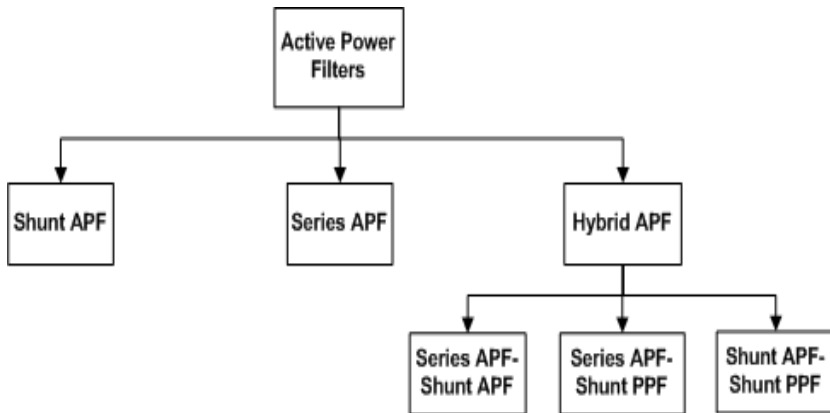
Recently, the importance of power quality issues has increased due to various reasons. First of all, there have been changes in the nature of electrical loads. On one hand, the characteristics of load have become more complex due to the increased use of power electronic equipment, which results in a deviation of voltage and current from its sinusoidal waveform.[13,14]

### ANALYSIS OF FFT

Fourier analysis is a mathematical tool which can be used to break down a signal into its various magnitude components. Then, it is possible to predict the effect of particular signal from the previous knowledge of its individual component. Hence this method works for fault domain identification accurately. Fast Fourier Transform is presented in this chapter for identification of fault in power distribution system accurately.

The function FFT in Matlab is a powerful tool which works even with noisy signals. When the FFT algorithm is applied to each supply phase it is possible to obtain the magnitude and phase of each of the frequency components of the supply waveform

## POWER FILTERS



The different filters present in the literature are classified into three basic types. They are Active Filters and Passive Filters and Hybrid filter. Each type has its own sub classification.

Figure 1: Shows compensation devices

## PROPOSED CONCEPT

In earlier days around 20th century there are so many drawbacks for passive filter, so we can reduce these drawbacks by study on active power filter. The Active filter costing a lot of money than the Passive filter, but these are having superior position, so it can alternatively remove the broadband harmonics at the source side. Compensating current is introduced through PAF and from other side compensating voltage is introduced through SAPF by through a combined parallel filter and series filter and through transformer. The use of semiconductors where we can take in some switching equipment's like thyristors, diodes and rectifiers had randomly increased. So, by these switching equipment's and other nonlinear loads the power quality decreases gradually. whenever there is greater in nonlinear loads, we require additional amount of complex steps to overcome the power quality degradation.

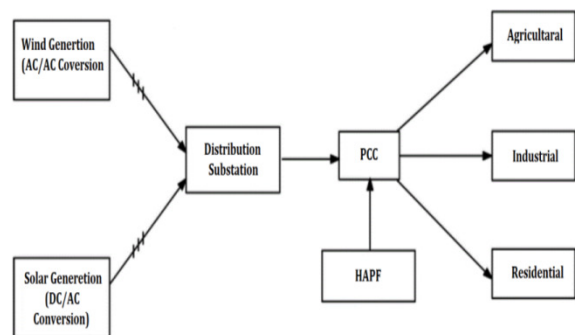
Typical uses include:-

- Math and computation
- Algorithm development
- Data acquisition
- Modeling, simulation, and prototyping
- Data analysis, exploration, and visualization
  - Scientific and engineering graphics

## SYSTEM CONFIGURATION

Harmonics and Reactive Power is reduced by employing an PAPP, by an idea of generalized p-q theory. To Calculate these limitations, a new developed p-q theory is derived. Whenever gain is multiplied to the system to develop compensating voltage then it is also becoming additional disadvantage to generalized p-q theory and this p-q theory is controlled by the value of current, so no need to be multiplied gain to the system. Some attempts are needed to attain the current by using instantaneous power and reactive power .

## LOCATION OF HAPF



A Voltage source inverter (VSI) is nearly equal as the SAPF . To neutralize the voltage harmonics on load side we have to introduce compensating voltage to the supply. So, by this APF produces the distortions which is opposite to the source.

Figure2: Shows single line diagram of test system

## MATLAB/SIMULATION RESULTS

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical

## CONTROL STRATEGY

On this control strategy major have sine wave generator and producing its switching signals. The citation voltage depends on two parameters, those are initial crest value of the basic term of the source voltage and unit sine vectors in phase to source voltages

. This Citation signals are produced by through at most sine wave generator and its constant amplitude to produce signals to it. The use of PLL circuits is to producing major voltages to it. This way ciliated voltage is produced it has sinusoidal and regardless of mains. This citation voltage and identified load voltage are specified to hysteresis controller for producing the switching signals for the inverter. By providing series

transformers, variable voltage inserted due to switching operation the produced output voltage has nature is sinusoidal

load voltage.

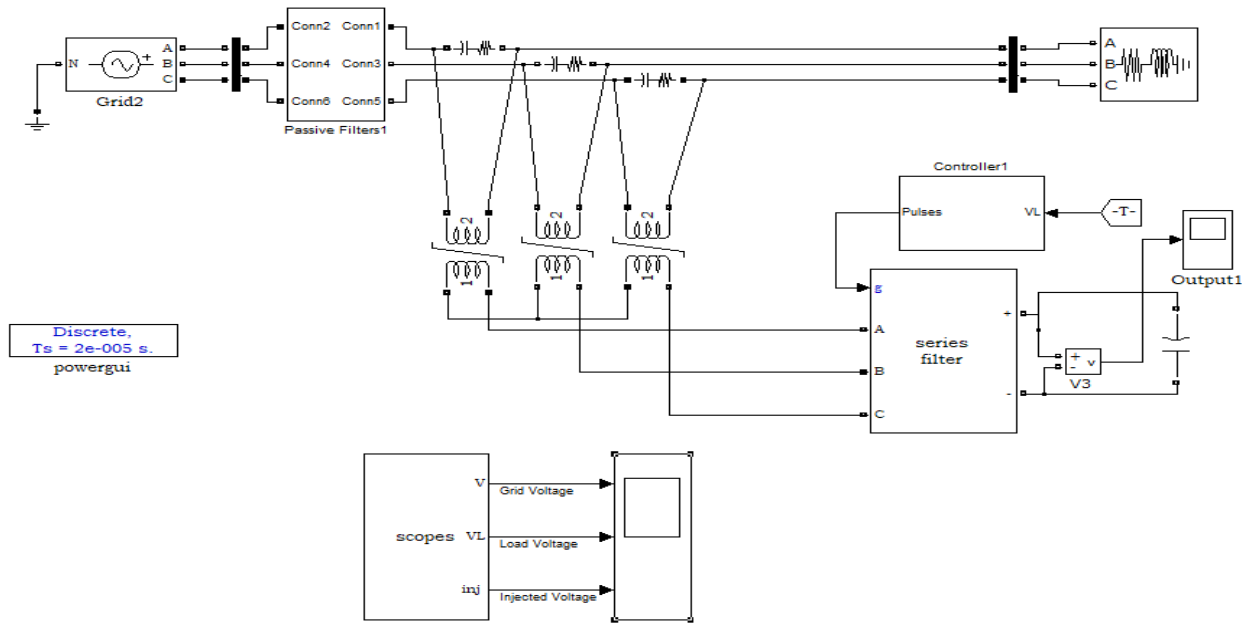


Figure 3: Simulation Diagram of Hybrid Active Power Filter

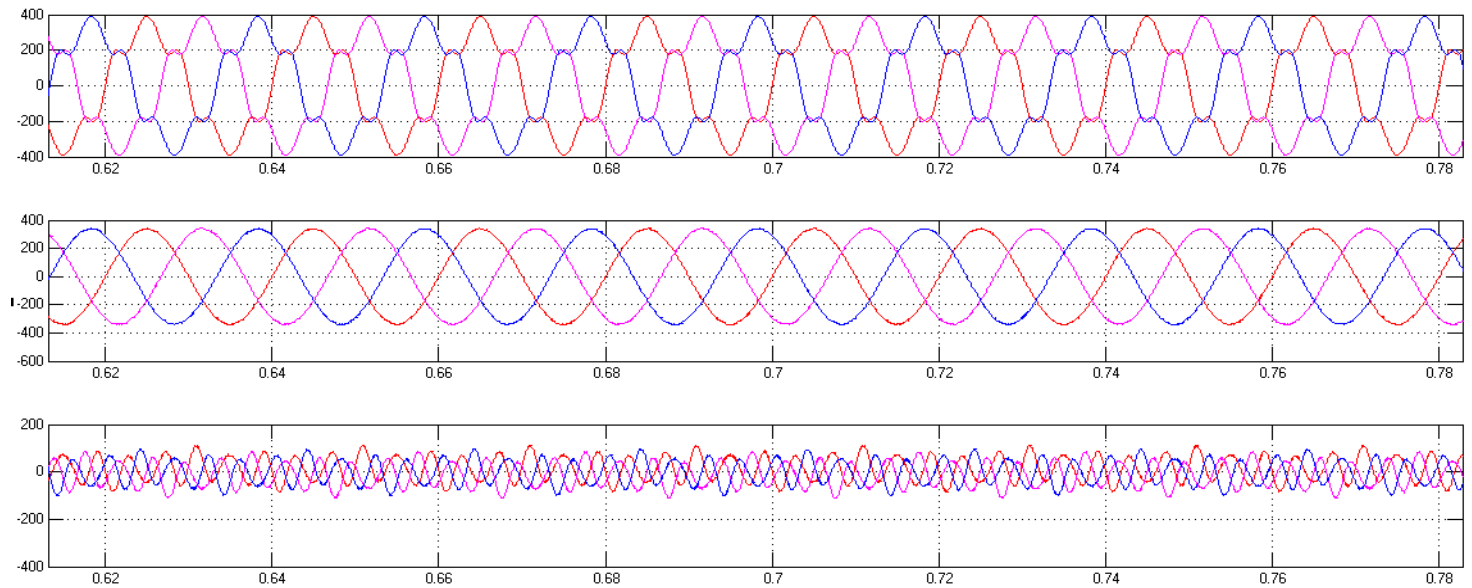


Figure 4: Shows Results for Grid voltage ,load voltage and injected voltage

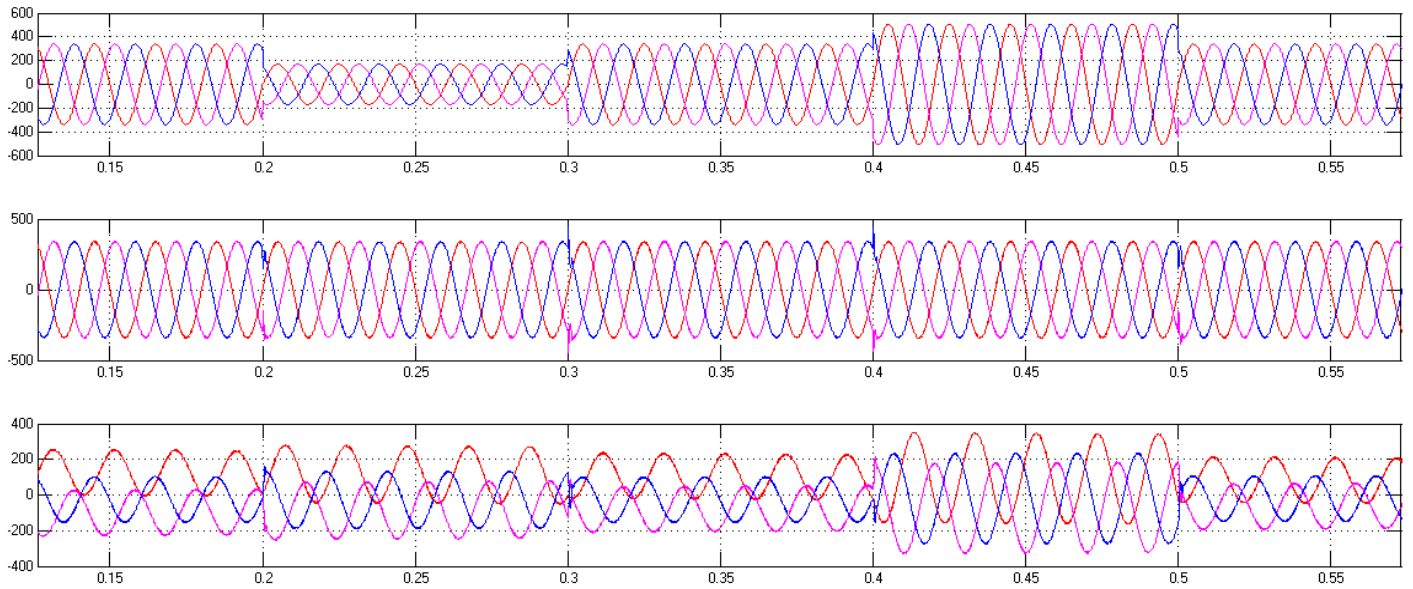


Figure5: Shows Results for 3 phase sag and swell conditions with HAPF voltage

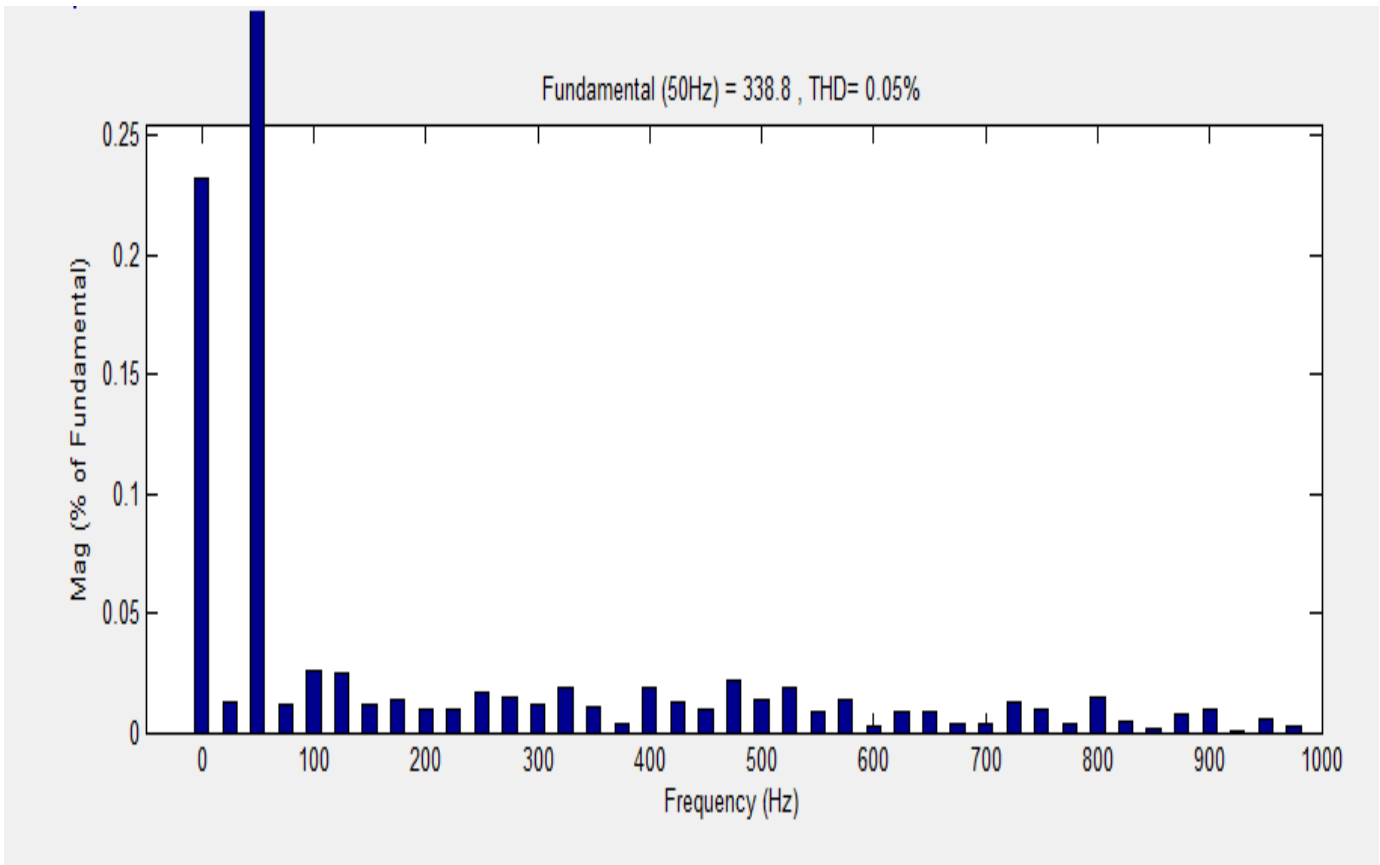


Figure 6: Shows the results for Harmonics

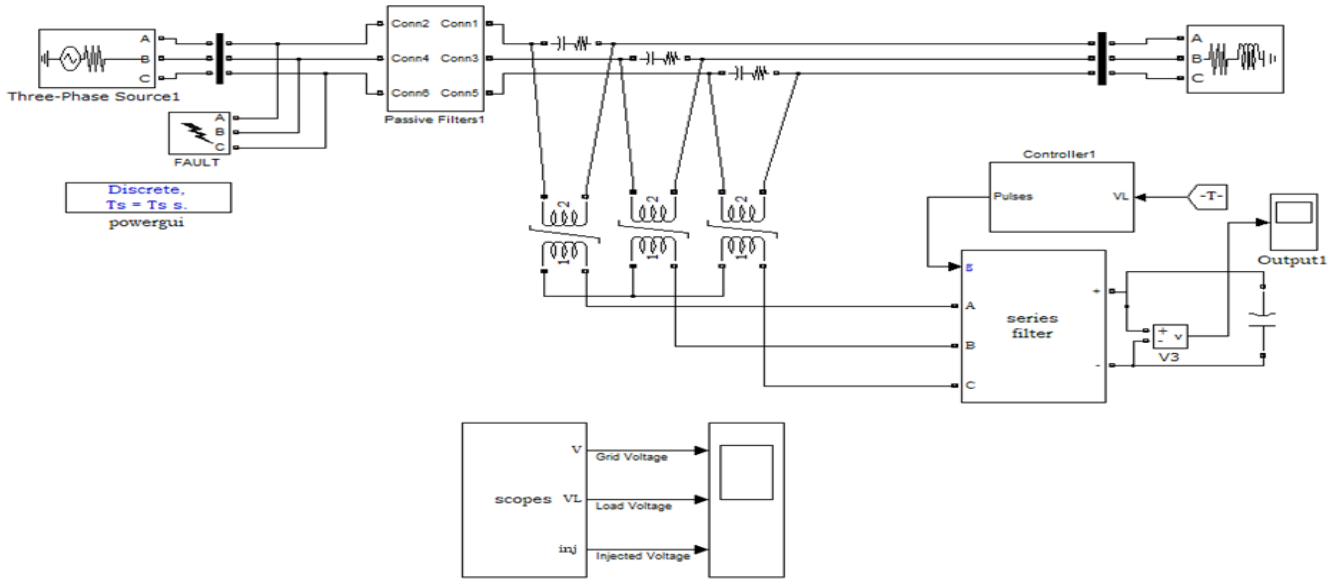


Figure. 7: Simulation diagram of APF at different fault conditions

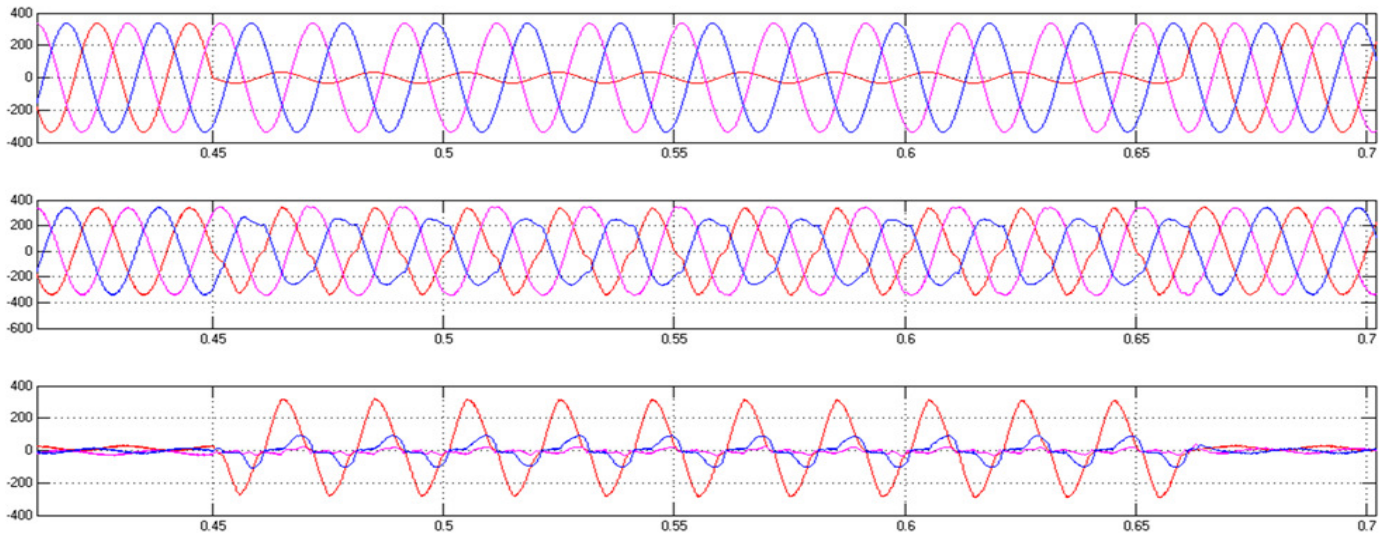
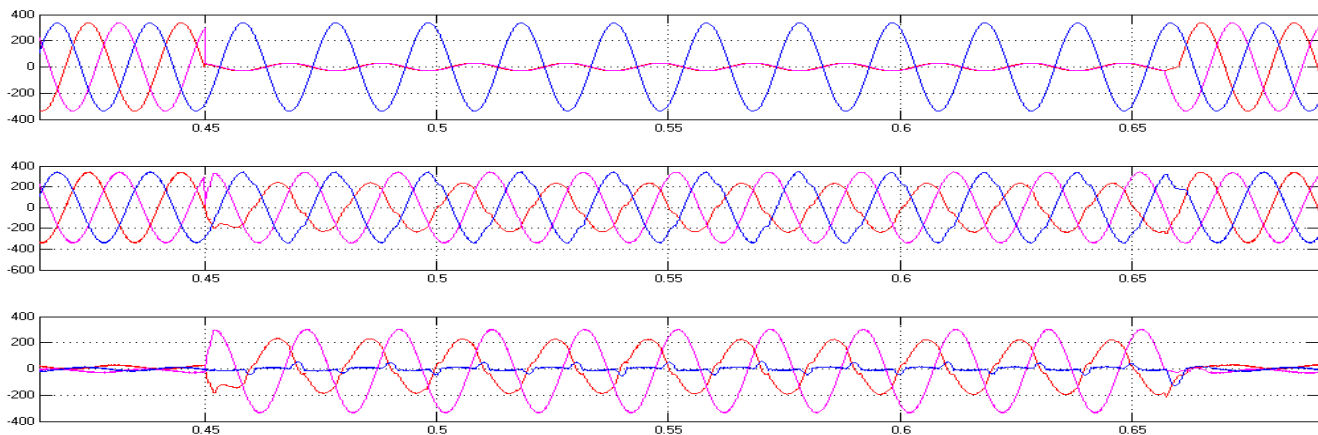
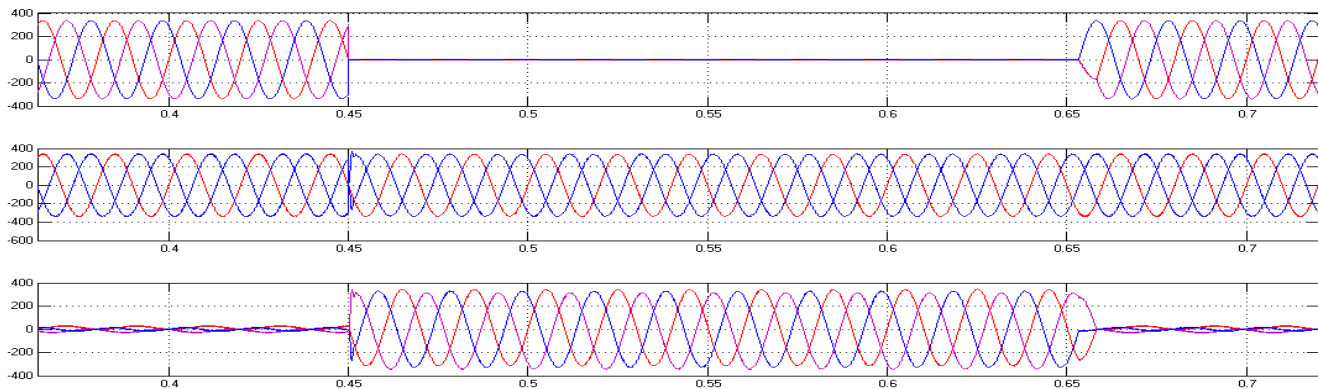


Figure. 8: Shows results for single line to ground fault



**Figure 9: Shows results for double line to ground faults**



**Figure 10: Shows results for triple line to ground faults**

**CONCLUSION:**

By observing the source voltage and load voltage of FFT analysis results shows that harmonics are reduced by using series active filter and observing Fast Fourier Transform (FFT) voltage analysis the percentage THD values contain in load voltage are reduces. So its conclude that series active filters provided better quality power improvements.

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Modern power electronics devices like active power filter and comprehensive simulation study of relay give the idea of power quality improvement. Generally, in electrical parallel

circuits voltage is constant and current is variable parameter, so by using parallel active filter provided variable currents in system and mainly series active filters are used for voltage and power quality improvement and reducing the harmonic content in load voltage.

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