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# Performance Evaluation of PWM Based CSI Active Filter and Passive Filters

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**ABSTRACT**: The aim of this project is to simulate CSI based active power filters to Non-linear load for improving power quality. THD is used as measuring index for comparing performances of these filters. These filters can reduce harmonic in supply current. When a non-linear load is connected to an AC supply it produces a quasi square waveform which contains harmonic current. Thus, active filters injects harmonic currents and changes quasi-square waveform to sinusoidal current. In this work, SVM based the voltage source shunt active filters and passive filters are compared. The circuits are simulated using MATLAB simulink. Harmonic distortion is found to be lowest in the case of VSI filter.

## I. INTRODUCTION

The growing number of power electronics base equipment has produced an important impact on the quality of electric power supply.[1-3] Both high power industrial loads and domestic loads cause harmonics in the network voltages. At the same time, much of the equipments causing the disturbances is quite sensitive to deviations from the ideal sinusoidal line voltage. Therefore, power quality problems may originate in the system or may be caused by the consumer itself.

Consumers that are becoming increasingly aware of the power quality issues and being more informed about the consequences of harmonics, interruptions, sags, switching transients, etc. Motivated by deregulation, they are challenging the energy suppliers to improve the quality of the power delivered.[4-6]

The technology of active power filter has been developed during the past two decades reaching maturity for harmonics compensation, reactive power, voltage balance in ac power networks. All active power filters are developed with PWM inverters (current source or voltage source inverters). The current fed PWM inverter bridge structure behaves as a sinusoidal current source to meet the harmonic current requirement of the non-linear load. It has a self supported dc capacitor that ensures the continuous circulation of the dc current. They present good reliability and require higher values of parallel capacitor filters at the ac terminals to remove unwanted current harmonics. However, they cannot be used in multilevel or multistep diodes configurations to allow compensation in higher power ratings.

The other converters used in active power filters topologies is the voltage-source PWM inverter. This converter is more convenient for active power filtering applications since it is lighter, cheaper, expandable to multilevel and multistep versions, to improve its performance for high power rating compensation with lower switching frequencies. The PWM voltage source inverter has to be connected to the ac mains through the coupling reactors. An electrolytic capacitor keeps a dc voltage constant and ripple free.[7-8]

## II. ACTIVE FILTERS

An active filter is basically a power electronic converter incorporating energy-storage components. In theory, the active filter can perform various firnctions. depending on the configuration of active filter, to improve the power quality of an electrical system. For example, a so-called shunt active filter can inject harmonic currents into a system at the point of common coupling to cancel the current distortion of the supply. Other forms of active filters also exist such as a series active filter and a unified active filter. Two main types of converters can be used as an active filter, -. namely voltage-source inverter (VSI) and current-source inverter (CSI).[9]

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A. Current-Source Active Power Filter

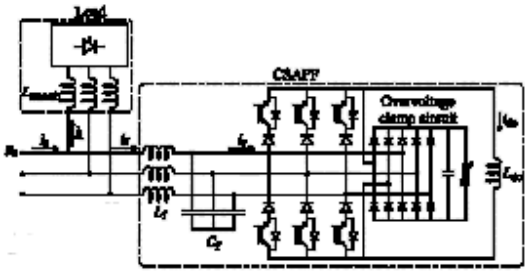

Fig Current source shunt active filter

The current-source active filter [Fig.] PWM bridge is built with six controllable unidirectional switches. Fig. shows the antiparallel diodes of the commercial IGBT power modules. Because of these and the very low reverse voltage blocking capability of the IGBTs, additional diodes have to be connected in series with the transistors. Instead of the series connection the use of the RB–IGBTs discussed previously would also be possible. Although the lifetime of the dc coil is not limited as was that of the electrolytic capacitor in the VSAPF, the coil is a bulky and heavy component. The VSI type is more commonly used, since it is less bulky, cheaper anc expandable as coinpaied to the CSI type.[10-11]

B. Modulation of a Current-Source PWM Bridge

The current-source PWM bridge Fig. modulates unidirectional dc current. The bridge is controlled so that one of the upper switches and one of the lower switches are in on-state at a time. This results in six possible active vectors and three zero vectors . The zero vectors mean that although the dc current continues to flow, this is not circulating through the mains. This is done by short-circuiting the dc link coil by turning on both the upper and the lower switch in a phase. Fig. presents the active and zero vectors together with the corresponding switching combinations. In the so-called halfwave symmetrical space-vector modulationtechnique [5] applied, the current reference vector is realized on average during a modulation period. This is done using two active switching vectors and one of the zero vectors. The active vectors applied are adjacent to the reference vector and the zero vector is chosen so that one of the switches in the bridge is always in on-state during the half of the carrier period . This way the switching losses can be reduced. As in the modulation of the voltage-source bridge, the new switching times are calculated every . Fig. illustrates the switching sequence when the reference vector lies in sector I.[12]

## III. PASSIVE HARMONIC FILTERS

Passive harmonic filters work on the principle of electrical resonance in tuned circuits which is useful in mitigating harmonic orders corresponding to a particular frequency. The concept is that at resonant frequency the tuned RLC circuit considered to be the passive filter provides a least resistance path for the harmonic current to flow out of the system that feeds the loads. Thus it reduces harmonics in the system. [13]The impedance offered by the filters is minimum and purely influenced only by the resistive nature of the circuit at resonance conditions. Thus maximum current corresponding to the harmonic order is filtered out from the path that feeds the loads.

| FILTER TYPE | VALUES |
|---|---|
| Double tuned filter 3rd & 5th Harmonics | L=5mH, C=225e-6 F and 81.057 F |
| High pass filter | R=100 ohms. C=31.58e-6F |
| Single tuned filter (7th harmonics) | L=5mH, C=41.356e-6F |

## IV. SIMULATION RESULTS

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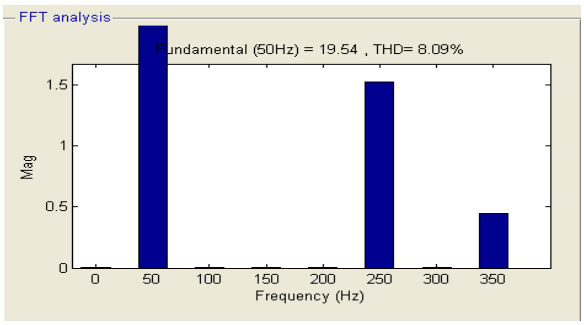
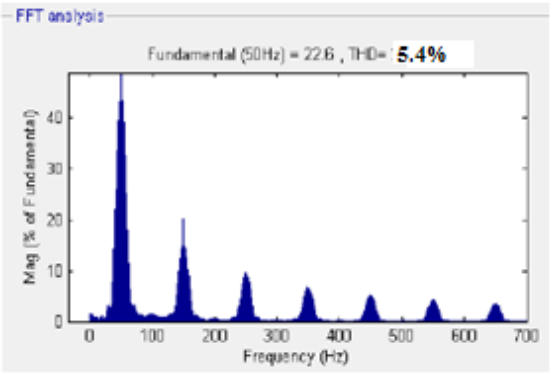
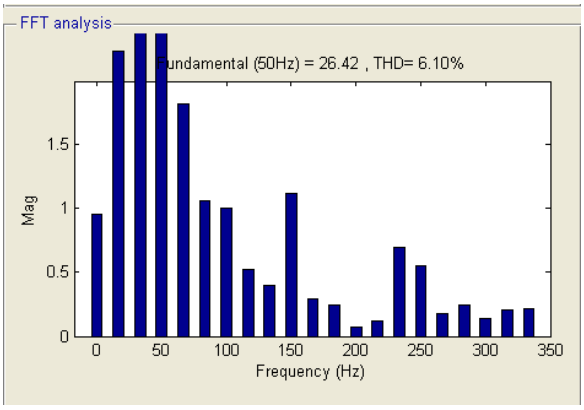



FFT Analysis without filter

The above shown fig represents the FFT Analysis without filter. The THD content is found to be 8.09% which should be reduced to obtain an undistorted waveform, for this purpose we use shunt active filters.




The THD content is found to be 8.09% in passive filters.




FFT Analysis with CSI SVM filter

The fig represents the FFT Analysis with CSI PWM filter and found that the THD content is reduced to 6.10%. Thus the THD content is reduced with the use of PWM based CSI filter than the use of passive filters

## V.CONCLUSION AND SCOPE FOR FUTRE WORK

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**CONCLUSION**:

Highly inductive load is connected at the output of the rectifier. The A.C current drawn by the rectifier is Non-linear as shown in fig 6.a. The current drawn is quasi-sinusoidal current, thus the load acts as a Non-linear load. The harmonic distortion is found to be 24.68%.

The THD content is found to be 8.09% which should be reduced to obtain an undistorted waveform, for this purpose we use shunt active filters.

The THD content is found to be 8.09% in passive filters.

THD content is reduced to 6.10%. Thus the THD content is reduced with the use of PWM based CSI filter than the use of passive filters and hence it is widely used in industrial applications.

**FUTURE WORK:**

The following work can be imposed on the topic done

- To simulate VSI fed active filter using PWM technique.

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