Research Paper | Engineering

Simulation of Shunt Active Power Filter for Three Phase AC-DC Converter

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ABSTRACT *Nowadays, the active filter is a viable solution for controlling harmonics levels in industrial non linear load. This paper present a study and simulation of a three phase shunt active power filter. The control of shunt active power filter is based on the p-q theory is briefly explained and generate the compensating current for each phase. The proposed active power filter is employed to reduce the current Total Harmonic Distortion (THD) drawn by the non- linear load and compensate the reactive power. Simulation of a shunt active power filter is done in PSIM software. Simulation results have been obtained, FFT analysis of source current and load current is also presented and Total harmonic distortion of source current is calculated before and after compensation and THD of the source current after compensation is below 5% which is in permissible limit imposed by IEEE-519 standard.*

KEYWORDS : p-q theory, PWM control, Reactive power compensation, Shunt active power filter, Total harmonic distortion(THD)

1. INTRODUCTION

The non linear load is growing rapidly because of the proliferation of power electronics equipment and which causes power quality problem in the power system. Harmonic current are drawn by the nonlinear load results in the distortion of the current waveform as well as voltage waveform at the point of common coupling (PCC)[1]. Both distorted current and voltage may cause malfunction for end-user equipment especially. Harmonics are reduced the efficiency and life span of the electrical equipments connected at the PCC. Usually harmonics are suppressed by the LC filter which is also known as a passive filter, which eliminate current harmonics when it is connected in parallel with the load. But the passive filter has disadvantages of large size, series and parallel resonance, fixed compensation and so on. Active filters(AF) are more superior than passive filters in case of a variable load[2-5].

Different topologies are available for compensate the harmonics such as passive filter, active filter, and hybrid filter. The performance of an active filter mainly depends on the reference current generation strategy. Several papers have studied and compared the performances of filter with different reference current generation technique. Generally the reference current generation technique is classified into two categories (i) frequency domain method and (ii) time domain method. In this, the instantaneous reactive power theory (p-q theory) in time domain is more popular and required less calculations[1][6].

2. ACTIVE FILTER

Fig. 1 shows block diagram of shunt active power filter. In this three phase diode bridge rectifier with resistive loading is considering as non linear load on three phase ac supply Non linear load draws non-sinusoidal currents from supply.

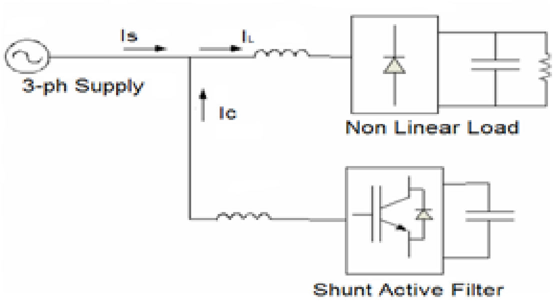

Fig. 1. Block Diagram of Shunt Active Power Filter

Active power filter is use the switch mode power converter to perform the harmonic current elimination. Shunt active filter is generally use to suppress the harmonic currents and compensate reactive power simultaneously. The shunt active power filters are considered as a current source parallel with the nonlinear load. The power converter of active filter is controlled to generate a compensation current, which is equal and opposite to the harmonic current[7-10].

A voltage source inverter in which IGBT is use as a switch and capacitor on DC bus is implemented as a shunt active power filter. The main function of active filter is to compensate harmonics and reactive power and to eliminate the unwanted effects of non linear load on source current[11][12].

3. FLOW CHART FOR P-Q THEORY

Implementation of the p-q Theory is simple using the DSP processor. Steps for implementing the p-q Theory for shunt active filter is shown in Fig. 2.

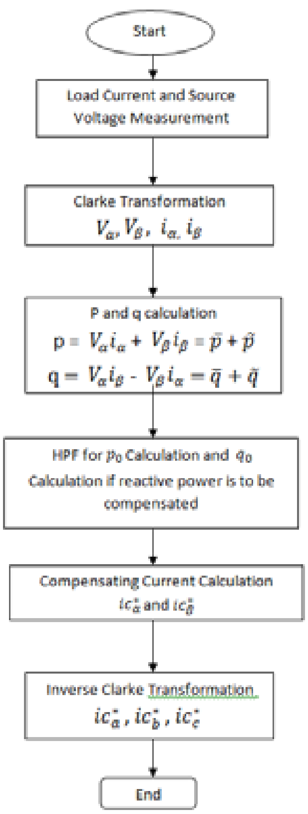

Fig. 2. Flow Chart of Calculating Reference Harmonic Compensation Current using p-q Theory

4. SIMULATION RESULT

Fig. 3 shows the simulation diagram for shunt active power filter based on p-q theory.

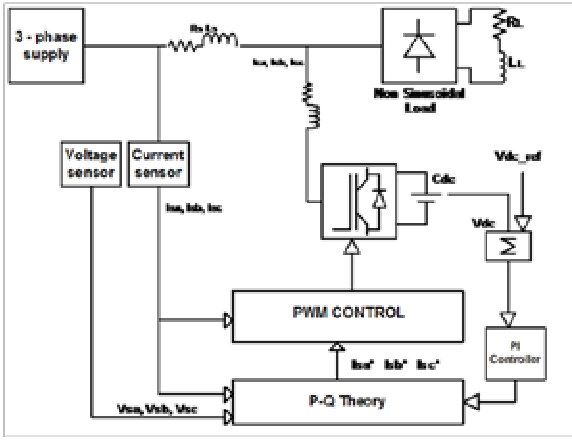

Fig. 3. Simulation Diagram for Shunt Active Power Filter based on p-q Theory

Simulation parameters are given below,

1) Supply Voltage and Frequency : 400V (L-L) and 50 Hz
2) Source Resistance and Source Inductance : 0.5 ohm and 0.1 mH
3) C_{dc} = 2200 uF
4) Switching Frequency : 10 kHz
5) DC Load : R_{dc} = 0.5 ohm, L_{dc} = 0.3 mH
6)

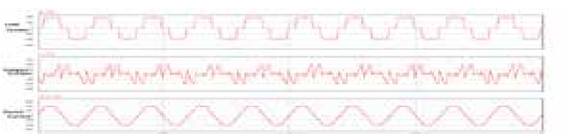

Fig. 4. Load Current, Compensating Current, and Source Current

Simulation result shown in Fig. 4, Load current, Compensating current which is supplied by active power filter and source current waveform. THD of Load current is 24% whereas after compensation THD of Source current is 4.92% which is in permissible limit specified in standards in IEEE-519.

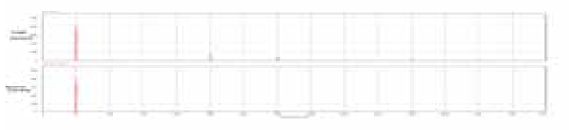

Fig. 5. FFT analysis of Load Current and Source Current

Simulation result in Fig.5 shows the FFT analysis of Load current and Source Current. In Load current FFT, there is a 5^{th} , 7^{th} , 11^{th} and 13^{th} order harmonics are present, after compensation provide by shunt active power filter Source current FFT shows only fundamental component is present and all other harmonics are removed.

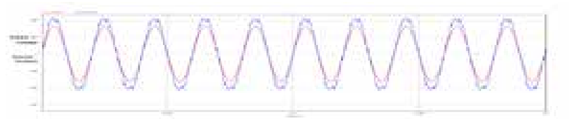

Fig. 6. Supply Voltage and Source Current after compensation

Simulation result in Fig.6 shows the supply voltage and source current and result shows that the power factor is improved by the use of active filter and power factor is 0.99 with Non linear load.

5. CONCLUSION :

The active power filter is very effective and flexible solution compare to passive filter, because passive filter is tuned for only one or single frequency whereas the active filter is suitable for all frequencies. In this paper simulation of a three phase shunt active power filter based on p-q theory in PSIM simulator is presented.

The simulation result shows that the total harmonic distortion (THD) of Load Current without active filter is 24%. Shunt Active Filter supplied compensation current and so source current THD after compensation is 4.92% which is in permissible limit specified in standards in IEEE-519. Here also present the FFT analysis so one can get idea about the order of harmonic present in source current without the active filter and with active filter.

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