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Power Quality Improvement Using Shunt Active Power Filter

Diksha Rani Singh
Electrical and Electronics Engineering Department, NIIST, Bhopal, India
Sourabh Gupta
Electrical and Electronics Engineering Faculty, NIIST, Bhopal, India

Abstract:
Shunt Active Power Filter are known to compensate the reactive and harmonic currents drawn by the Non-linear load so as to make supply current sinusoidal and have been explored for executing different power conditioning functions simultaneously, along with harmonic elimination. Many different methods can be used to control active power filters, whereby the reference current method forms a very crucial role in determining the active filter performance. The reference current can be calculated by pq transformation. In this paper, used hysteresis current controller for removing of current harmonics is presented. The system was tested and modelled using MATLAB/Simulink.0

Key words: *Current harmonics, Hysteresis Controller, Non –Linear Load, PQ Theory, Shunt active Filter, Simulink Model*

1. Introduction

With use of power converters and other non-linear loads in industry as well as in domestic it is observed that it deteriorates the power systems voltage and current waveforms. Static power converters such as single phase and three phase rectifiers, thyristor converters and large number of power electronic equipment are nonlinear loads which generate considerable disturbances in the ac mains. Due to this, the electric system is hard to measure and anticipate and the effects are harmful to other loads. For overcome of this disadvantages shunt active filters are used which allow the compensation of current harmonics, unbalance, together with power factor correction, and can be a much better solution than the conventional approach like passive filters. In this case the shunt active power filter operates as a current source produces harmonics currents having opposite phase than those harmonics currents produced by non-linear loads. The development of a shunt active filter is proposed, with a control system based on the p-q theory.

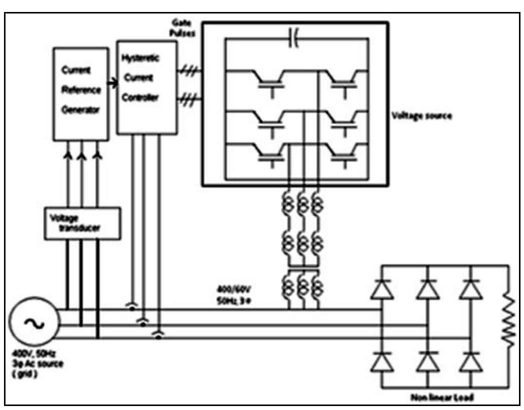

Figure 1: Schematic diagram of Active Filter connecting with Non Linear Load

2. Reference Current Signal Generation for Shunt Active Power Filter

Shunt active power filter with control strategy Instantaneous reactive power (p-q) theory is used to control of shunt active power filter. The p-q theory, or "Instantaneous Power Theory", was developed by *Akagi et al* in 1983, with the objective of applying it to the control of active power filters. Initially, it was developed only for three-phase systems without neutral wire, being later worked by *Watanabe* and *Aredes* for three-phase four wires power systems. This theory is based on time-domain. Another important characteristic of this theory is the simplicity of the calculations, which involves only algebraic calculation (exception done to the need of separating the mean and alternated values of the calculated power components). The p-q theory implements a transformation from a stationary reference system in a-b-c coordinates, to a system with coordinate's α-β-0. It corresponds to an algebraic transformation, known as Clarke transformation, which are shown in the block diagram, where coordinates α-β are orthogonal to each other, and coordinate 0 corresponds to the zero-sequence component. The zero sequence component calculated here differs from the one obtained by the symmetrical components transformation.

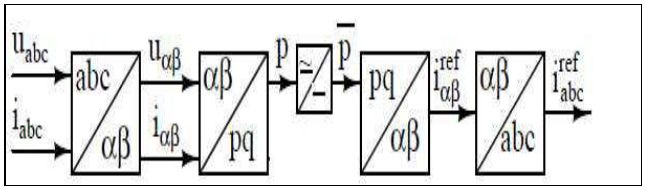

Figure 2: Block diagram of the IRPT

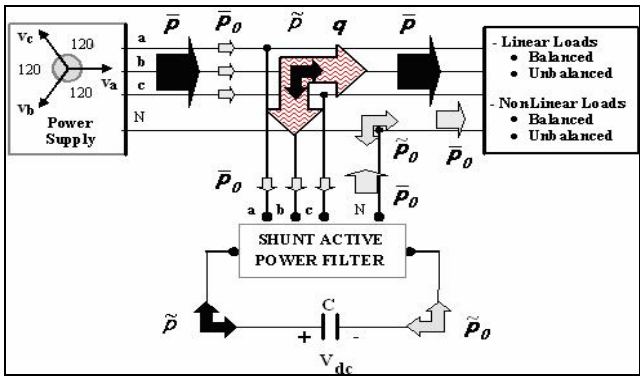

Figure 3: p-q theory power components in a generic three phase power system with shunt active filter

3. Simulation

The simulation diagram with a shunt Active Power Filter is shown in Figure. The diagram consists of hysteresis controller circuit.

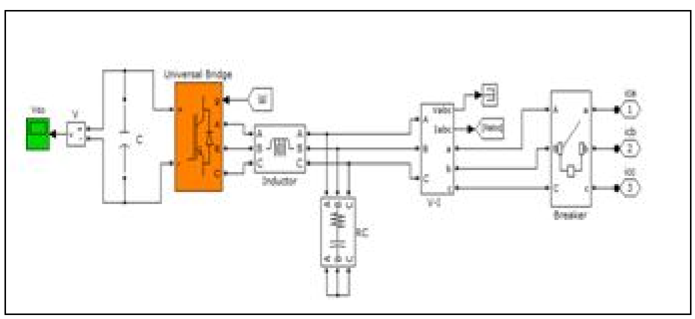

Figure 4: Simulink Model of Instanteneous Power Theory

The p-q theory calculations are done in the shunt active power filter controller block. The controller allows, in a systematic way, and according to the received information, to verify the needing of compensation currents by the active filter. The controller receives the information of phase voltages, load currents and DC voltage and proceeds to the calculations of the p-q theory values, generating, or not, the necessary reference compensation currents, which are injected into the power system.

4. Simulation Results

The *Matlab/Simulink* simulation tool was used to develop a model that allowed the simulation and testing of the p-q theory calculations, which were implemented in the controller of the shunt active power filter for three3phases, four wire systems. For the simulation of the active filter operation, with different type of loads, it was always used a balanced and sinusoidal three-phase voltages system, as can be observed in Figure.

Waveform of load voltage & current with reference of time

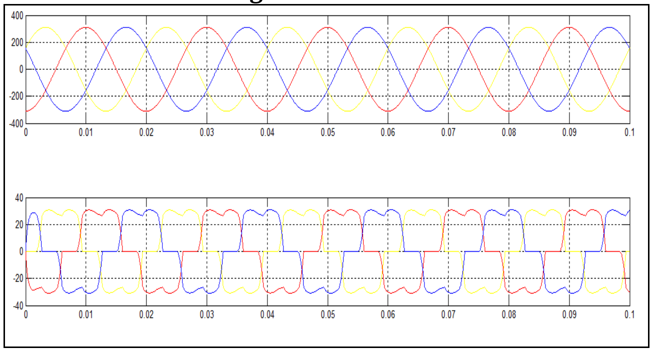

Figure 5

Harmonics current waveform with respect to time

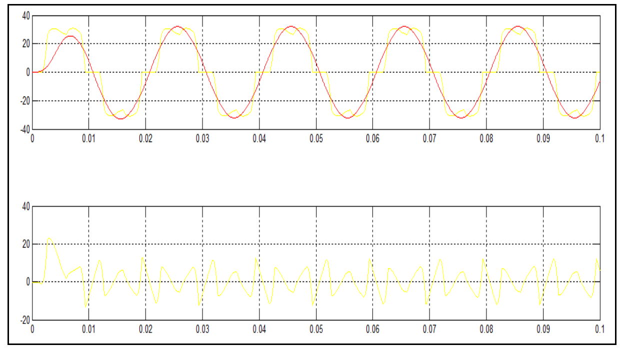

Figure 6

5. Conclusion

The proposed method provides an efficient method of achieving better THD and control of active power filter dealing with harmonic and reactive current compensation. The control of an active power filter using Hysteresis a controller is simulated in MATLAB/Simulink. The total harmonic distortions were observed to be more for shunt active power without controller than with controller. The simulation results shows that the shunt active filter with Hysteresis controller gives better result for all type of loads. Using Hysteresis controller THD is considerably reduced, and the power factor gets improved.

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