Shunt Active Power Filtering based on the p-q Theory Control

(Full text in English)

Kelthoum Hachani[1], Djillali Mahi[1], Abdellah Kouzou[2]

[1]Laboratory for Analysis and Control of Energy Systems and Electrical Systems, LACoSERE, Laghouat University, Algeria

[2]Laboratory for Industrial diagnosis, Faculty of Science and Technology, Djelfa University, Algeria

Abstract

This paper presents the main performance constraints of the pq theory for Shunt Active Power filter (SAPF) control application, under the objective to ensure the compensation of the undesired harmonic component currents, and the unbalanced three phase current generated by non-linear load, in addition to improve the power factor in the source current. The behaviors of the voltage and current components in the Dc-link is also considered. The main drawbacks of the p-q control theory when the power source voltages are distorted and unbalanced are also discussed. On the other hand the use of the pq theory to compensate specific or partial powers components is addressed. To clarify the main constraints and drawback of the application of the p-q theory, simulation results for different cases are shown.

Keywords: Shunt Active Power filter, the p-q theory, power factor

Received: 17 May 2017

To cite this article:

Hachani Kelthoum,Mahi Djillali,Kouzou Abdellah, “Shunt Active Power Filtering based on the p-q Theory Control”, in *Electrotehnica, Electronica, Automatica (EEA)*, 2017, vol. 65, no. 3, pp. 85-89, ISSN 1582-5175.

1. Introduction

Nowdays, the widespread increase of non-linear loads, significant amounts of harmonic currents are being injected into power systems. Harmonic currents flow through the power system impedance can cause, voltage distortion at the harmonic currents' frequencies. The existence of current and voltage harmonics in power systems increases the losses in the lines, decreases the power factor, and also can cause timing errors in sensitive electronic equipments. The use of grid connected with power electronic converters to improve power quality in power distribution systems represents the best solution, in terms of the performance and the stability, eliminating of harmonic distortion, correcting the power factor, balancing of loads, and voltage regulation [3].

Passive filters have been used as a solution to overcome harmonic current problems, but they present several disadvantage, namely; they only filter out the frequencies they have been previously tuned for, their operation cannot be limited to a certain load, resonances can be occured due to the interaction between the passive filters and other loads, with unpredictable results. To overcome these disadvantages, recent efforts have been put into the development of active power filters (APFs) [4][10][11][19], which have two types: the shunt type and the series type, or both acting together, the APF is inverter of current or of voltage based on MLI or hysteresis, connected in parallel by the output filter L, LC, LCL (Figure 1).

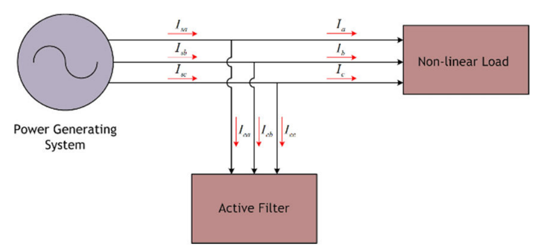

Figure 1. Basic structure of Shunt Active Power Filter

An equal disruptive current was injected in the system to those absorbed by the nonlinear load with opposite direction with theme. The ARF limits the spread of high frequency components, in which both current harmonics and power filter compensated. To do that, many command strategies have been utilized such as the PQ theory (instantaneous puissance), the SRF (Synchronous Reference Frame), algorithm of synchronized detection, algorithm of Fryze-Buchloz-Depenbrock (FBD), a method of Fourier, and a method of generalizing the sinusoidal of Fryze. This paper mainly focuses on some drawbacks of the p-q theory with the unbalanced source voltage [1][7][12][13][20].

2. The p-q Theory

This theory is based on the calculations of the instantaneous values of power, the powers corresponding to the harmonic currents is maintained. It is necessary to filter the DC components corresponding to the fundamental component. It can be achieved by using a high-pass or low-pass filter. The low-pass is utilized due to its lower harmonic content. Also, using the Algebraic transformation of “Edite Clark” to transform three-phase systems of currents and voltages