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Improvement of Power quality by Employing Dual Unified power Quality Conditioner

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Abstract:

This paper presents a simplified control technique for a dual three-phase topology of a unified power quality onditioneri UPQC. The iUPQC is composed of two active filters, a series active filter and a shunt active filter (parallel active filter), used to eliminate harmonics and unbalances. Different from a conventional UPQC, the iUPQC has the series filter controlled as a sinusoidal current source and the shunt filter controlled as a sinusoidal voltage source. Therefore, the pulse width modulation (PWM) controls of the iUPQC deal with a well-known frequency spectrum, since it is controlled using voltage and current sinusoidal references, different from the conventional UPQC that is controlled using nonsinusoidal references. In this paper, the proposed design control, power flow analysis, and experimental results of the developed prototype are presented.

Keywords: Active Filters, Control Design, Power Line Conditioning, Unified Power Quality Conditioner (UPQC).

1. INTRODUCTION

The usage of power quality conditioners in the distribution system network has increased during the past years due to the steady increase of nonlinear loads connected to the electrical grid. The current drained by nonlinear loads has a high harmonic content, distorting the voltage at the utility grid and consequently affecting the operation of critical loads. By using a unified power quality conditioner (UPQC) [1]– [32], it is possible to ensure a regulated voltage for the loads, balanced and with low harmonic distortion and at the same time draining undistorted currents from the utility grid, even if the grid voltage and the load current have harmonic contents. The UPQC consists of two active filters, the series active filter (SAF) and the shunt or parallel active filter (PAF) [1], [2]. The PAF is usually controlled as a nonsinusoidal current source, which is responsible for compensating the harmonic current of the load, while the SAF is controlled as a nonsinusoidal voltage source, which is responsible for compensating the grid voltage. Both of them have a control reference with harmonic contents, and usually, these references might be obtained through complex methods control technique to both shunt and SAFs which uses sinusoidal references without the need of harmonic extraction, in order to decrease the complexity of the reference generation of the UPQC [31], [33].

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An interesting alternative for power quality conditioners was proposed in [34] and was called line voltage regulator/ conditioner. This conditioner consists of two single-phase current source inverters where the SAF is controlled by a current loop and the PAF is controlled by a voltage loop. In this way, both grid current and load voltage are sinusoidal, and therefore, their references are also sinusoidal. Some authors have applied this concept, using voltage source inverters in uninterruptable power supplies this concept is called "dual topology of unified power quality conditioner" (iUPQC), and the control schemes use the p−q theory, requiring determination in real time of the positive sequence components of the voltages and the currents. The aim of this paper is to propose a simplified control technique for a dual three-phase topology of a unified power quality conditioner (iUPQC) to be used in the utility grid connection.The proposed control scheme is developed in ABC reference frame and allows the use of classical control theory without the need for coordinate transformers and digital control implementation. The references to both SAF and PAFs are sinusoidal, dispensing the harmonic extraction of the grid current and load voltage.

2. RELATED WORK

The conventional UPQC structure is composed of a SAF and a PAF, as shown in Fig. 1. In this configuration, the SAF works as a voltage source in order to compensate the grid distortion, unbalances, and disturbances like sags, swells, and flicker. Therefore, the voltage compensated by the SAF is composed of a fundamental content and the harmonics. The PAF works as a current source, and it is responsible for compensating the unbalances, displacement, and harmonics of the load current, ensuring a sinusoidal grid current.

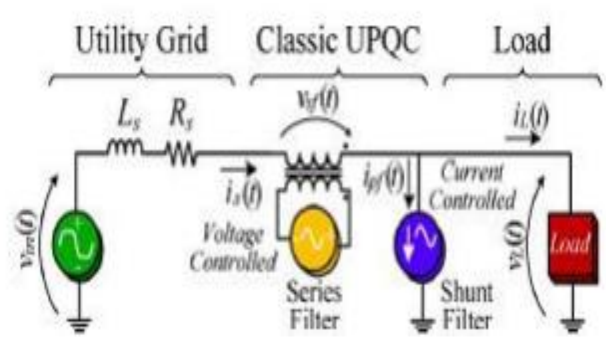

Fig.1.UPQC

The series filter connection to the utility grid is made through a transformer, while the shunt filter is usually connected directly to the load, mainly in low- voltage grid applications. The conventional UPQC has the following drawbacks: complex harmonic extraction of the grid voltage and the load involving complex calculations, voltage and current references with harmonic contents requiring a high bandwidth control, and the leakage inductance of the series connection transformer affecting the voltage compensation generated by the series filter. In order to minimize these drawbacks, the iUPQC is investigated in this paper, and its scheme is shown in Fig. 2. The scheme of the iUPQC is very similar to the conventional UPQC, using an association of the SAF and PAF, diverging only from the way the series and shunt filters are controlled. In the iUPQC, the SAF works as a current source, which imposes a sinusoidal input current synchronized with

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the grid voltage. The PAF works as a voltage source imposing sinusoidal load voltage synchronized with the grid voltage. In this way, the iUPQC control uses sinusoidal references for both active filters. This is a major point to observe related to the classic topology since the only request of sinusoidal reference generation is that it must be synchronized with the grid voltage. The SAF acts as high impedance for the current harmonics and indirectly compensates the harmonics, unbalances, and disturbances of the grid voltage since the connection transformer voltages are equal to the difference between the grid voltage and the load voltage. In the same way, the PAF indirectly compensates the unbalances, displacement, and harmonics of the grid current, providing a low-impedance path for the harmonic load current.

3. PROPOSED SYSTEM

In the distribution system grid, the operation of power quality conditioner has increased during the past few years due to the constant increase of nonlinear loads linked to the electrical network. It is feasible to ensure a modulated voltage for the loads, balanced and with low harmonic distortion and at the same time leaving undistorted current from the utility grid by employing a Dual topology of unified power quality conditioner. The Dual UPQC incorporates of two active filters the shunt active filter and the series active filter. The Dual UPQC(iUPQC) is combination of two active filters, a series active filter and a shunt active filter (parallel active filter), used to terminate harmonics and unbalances.

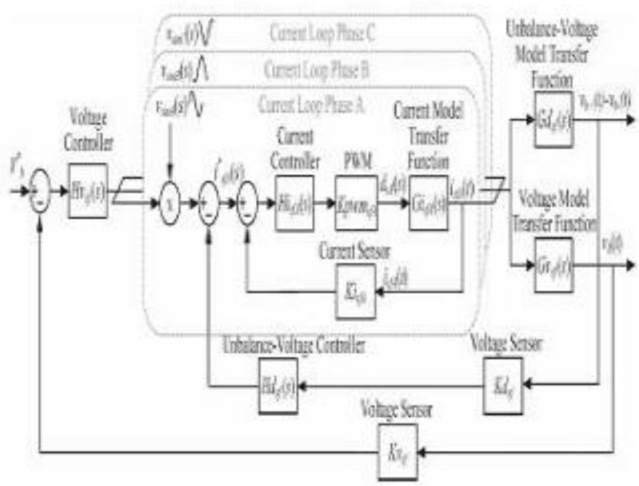

Fig.2.Controller

Divergent from a conventional UPQC, the iUPQC has the series filter managed as Classical UPQC arrangement is collected of a SAF and a PAF, as shown in Fig.2. In this topology, the SAF works as voltage source in way to compensate the grid distortion, unbalances, and disturbances like sags, swells, and flicker. Consequently, the voltage compensated by the Series active filter is composed of a major content and the harmonics. The PAF acts as a current source and it is responsible for reimbursing the displacement, unbalances ,and harmonics of the load current, make sure a sinusoidal grid current. The scheme of the iUPQC is much related to the conventional UPQC, using an association of the PAF and SAF, differing only from the way the shunt and series filters are controlled. In the iUPQC, the SAF works as a current source, which inflicts a sinusoidal input current synchronized with the grid voltage. In iUPQC, the SAF act as a current source, which deliver to a sinusoidal input current synchronized with the network voltage. The PAF works such as voltage source dignifying sinusoidal load voltage synchronized with the network voltage. Therefore, the pulse width modulation (PWM) controls of the iUPQC deal with a well-known frequency spectrum, since it is controlled by using voltage and current sinusoidal references for both active filters.The SAF acts as high impedance for the current harmonics and indirectly compensates the harmonics, Unbalances, and interference of the network voltage since the connection transformer voltages is equal to the distinction between the grid voltage and the load voltage. Similarly, the PAF indirectly compensate the unbalances, displacement, and harmonics of the network current, provision of a low- impedance path for the harmonic load current. By employing Dual UPQC we can separate the complex harmonic extraction of the grid voltage a sinusoidal current source and the shunt filter constrained as a sinusoidal voltage source. Thus, the pulse width modulation controls of the iUPQC deal with a well-known frequency spectrum, since it is supervised employing voltage and current sinusoidal references, divergent from the conventional UPQC that is Controlled employing non sinusoidal references.This paper presents a Fuzzy based controller for dual topology of the Interline Unified Power Quality Conditioner (iUPQC) for power quality improvement by considering sudden load changes.

4. ANALYSIS

In the present control scheme, the power computation and harmonic extraction are not needed since the harmonics, unbalances, disturbances, displacement should be recompensed. The SAF has a current loop in order to certify a sinusoidal grid current synchronized with the network voltage.

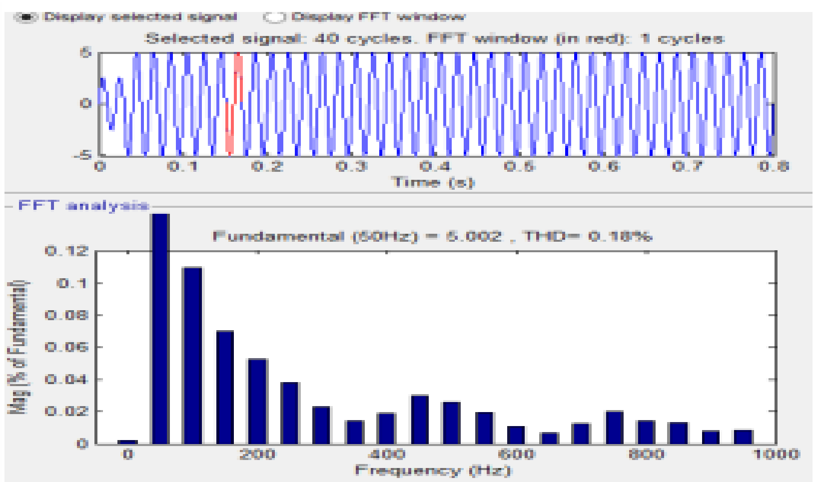

Fig.3.Varience Analyse

The PAF has a voltage loop in order to verify a balanced modulated load voltage with low harmonic deformation. These control loops are self-determining from each other since they act independently in each active filter. A P.I Controller is a feedback control loop that calculates an error signal by taking the difference between the output of a system, which in this case is the power being drawn from the battery, and the set point. The set point is the level at which we'd like to have our system running, ideally we'd like our system to be running near max power (990W) without causing the limiter to engage.It is important to point out that due the the complexity of the electronic components within the circuit path(i.e ESC, power limiter, and motor) I was not able to accurately create model (transfer function) for the system. Having a transfer function would have allowed me to simulate the system in a software package such as MATLAB/Simulink and assist me in finding the right proportional and integral constant parameters for the controller. Unfortunately, due to the lack of a model, the parameters were obtained via a trial and error format.

CONCLUSION

The results obtained with the iUPQC able to compensate the nonlinear load currents and also certain the sinusoidal voltage for the load in all three phases. The control also had a great operation during the load steps and voltage disturbances at the source. The main advantages of this initiate control in relation to the other proposed schemes were the utilization of sinusoidal references for both series and shunt active filter controls without the requirement of complicated calculations or coordinate transformations. By the use of Dual UPQC, it can confirm that current source linear with respect to nonlinear load, Constant load voltage; this model Eliminates harmonic load voltage. By using fuzzy logic controller instead of PI controller in the control scheme , we can see the improvement in total harmonic distortion.

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