ISSN No: 2348-4845
International Journal & Magazine of Engineering,
Technology, Management and Research
A Peer Reviewed Open Access International Journal

Improved Power Quality for the Harmonic Sensitive Loads by Using as New IUPQC Device

Ankita Dilip Tarpe
M.Tech,
Department of EPS,
Jawaharlal Nehru Institute of Technology (JNIT).

Ch.Satyanarayana
Associate Professor,
Department of Power Engineer,
Jawaharlal Nehru Institute of Technology (JNIT).

Abstract:

Unified Power Quality Conditioner (UPQC) for harmonic elimination and simultaneouscompensation ofvoltage and current, which improves the power quality offeredfor other harmonic sensitive loads. UPQC consist of combinedseries active power filter that compensates voltage harmonics ofthe power supply, and shunt active power filter thatcompensates harmonic currents of a non-linear load. In thispaper a new control algorithm for the UPQC system isoptimized and simplified without transformer voltage, load andfilter current measurement, so that system performance isimproved. The proposed control technique has been evaluatedand tested underdynamical and steady state load conditions Thesimulation result is verified using MATLAB/SIMULINK.

Index Terms: Active filters, control design, power line conditioning,unified power quality conditioner (UPQC).

I.INTRODUCTION:

The usage of power quality conditioner in the distributionsystem network has increased during the past years due to thesteady increase of nonlinear loads connected totheelectricalgrid. Because it drains current with high harmonic content,the nonlinear loads distorts the voltage sourced by the utilitygrid, it directly affects the behavior of other more sensitiveloads to this kind of distortion.By using power quality conditioner it is possible toguaranteesinusoidal, with low harmonic distortion, balancedand regulated voltages to the load and at the same time todrain from the utility grid undistorted currents, even if thegrid voltage and the load current have harmonic contents. The unified power quality conditioners present a topologyconsisted by two different filters, the series active filter andthe parallel active filter. The parallel active filter is usuallycurrent controlled, which is responsible forcompensating theharmonic current of the load, while the series active filter isvoltage controlled, which is responsible for compensating thegrid voltage distortion [15]. In this case, the voltage and thecurrent the filters must compensate have harmonic contentswhose reference must also have harmonic contents, and thesereferences are obtained through complex methods.Dias [6] presented a control technique with sinusoidalreferences in order to find a solution for the complexitythatis the reference generation for these conditioners.

Thereference generation works well but the leakage impedanceof the connection transformer interferes in the voltage compensation generated by the series filter, since it isappliedto the distribution system network.The article presented by Moran [7] in 1989, shows a dualsingle-phase CSI line voltage conditioner where series activefilter is current controlled and the parallel active filter isvoltage controlled. In this way, the signals to be controlledare sinusoidal and therefore the references are alsosinusoidal. Some authors have applied this idea inUninterruptablePower Supplies (UPS) [8-9], while others inUnified Power Quality Conditioners (UPQC) [10], the latteris highlighted by the work of Aredes [11], who presents athree-phase unified power quality conditioner designated byhim iUPQC. The advantage of the iUPQC is that it worksonly with sinusoidal references, although the control useduses the p-q

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

theory which makes the unified power qualityconditioner control complex, because it is necessary todetermine in real time the positive sequence components ofthe voltages and of the currents.

II.DUAL UPQC:

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. 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 the 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 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 which is derived from transfer function for both series and shunt active filters.

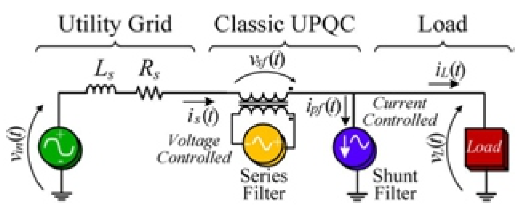

Fig. 1. Conventional UPQC.

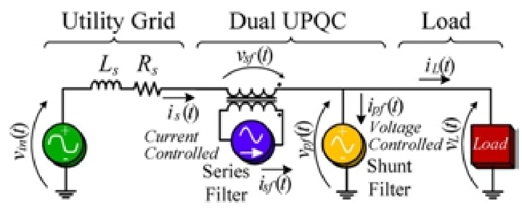

Fig. 2. Dual UPQC (iUPQC).

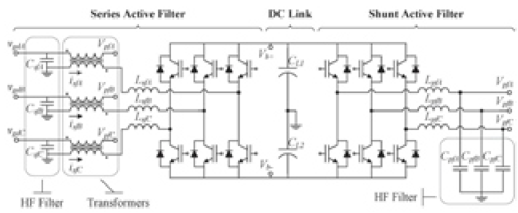

Fig. 3. Power circuit of the iUPQC.

III. PROPOSED CONTROL SCHEME:

The proposed iUPQC control structure in an ABC reference frame based control, where the SAF and PAF are controlled in an independent way, shown in Fig. 3. In the proposed control scheme, the power calculation and harmonic extraction are not needed since the harmonics, unbalances, disturbances, and displacement should be compensated. The Series Active Filter (SAF) has a current loop in order to ensure a sinusoidal grid current synchronized with the grid voltage. The PAF has a voltage loop in order to ensure a balanced regulated load voltage with low harmonic distortion.

These control loops are independent from each other since they act independently in each active filter. The dc link voltage control is made in the SAF, where the voltage loop determines the amplitude reference for the current loop, in the same mode of the power factor converter control schemes. The sinusoidal references for both SAF and PAF controls are generated by a digital signal processor, which ensure the grid voltage synchronism using a phase locked loop.

III.SAF CONTROL:

The SAF control scheme consists of three identical grid current loops and two voltage loops. The current loops are responsible for tracking the reference to each grid input phase in order to control the grid current independently. One voltage loop is responsible for regulating the dc link voltage, and the other is responsible for avoiding the unbalance between the dc link capacitors shown in the Fig.4.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

The total dc voltage control loop has a low-frequency response and determines the reference amplitude for the current loops. Thus, when the load increases, overcoming the input grid current, the dc link supplies momentarily the active power consumption, resulting in a decrease of its voltage. This voltage controller acts to increase the grid current reference, aiming to restore the dc link voltage. In the same way, when the load decreases, the voltage controller decreases the grid current reference to regulate the dc link voltage. Considering the three phase input current, sinusoidal and balanced, the voltage loop transfer function is obtained through the method of power balance analysis.

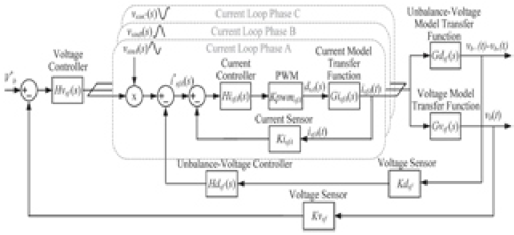

Fig 4. Control block diagram of the SAF controller.

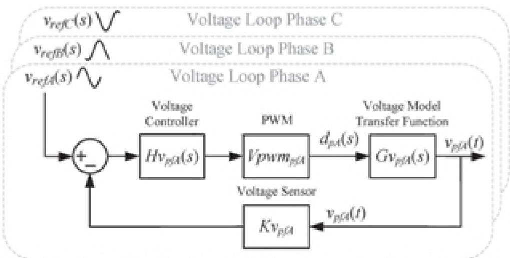

Fig.5. Control block diagram of the PAF voltage loop.

V. PAF CONTROL:

The PAF control scheme is formed by three identical load voltage feedback loops, except for the 1200 phase displacements from the references of each other. The voltage loops are responsible for tracking the sinusoidal voltage reference for each load output phase in order to control the load voltages independently shown in Fig. 5.

The voltage loop transfer function is obtained through the analysis of the single-phase equivalent circuit shown in Fig. 5. The dynamic model is obtained through the circuit analysis using average values related to the switching period. Through small signal analysis by using Laplace transformation.

VI SIMULATION RESULATS:

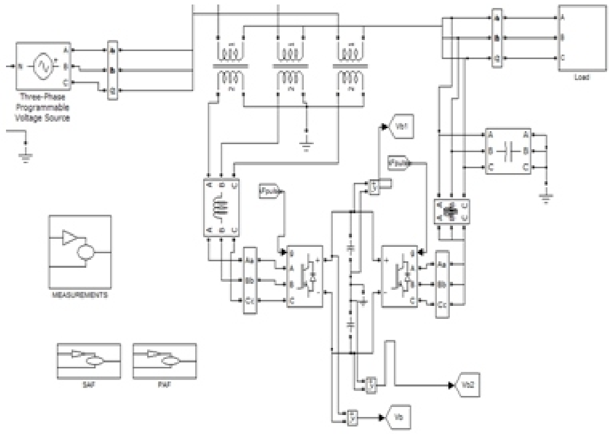

Fig.6. Mat lab Simulation Circuit

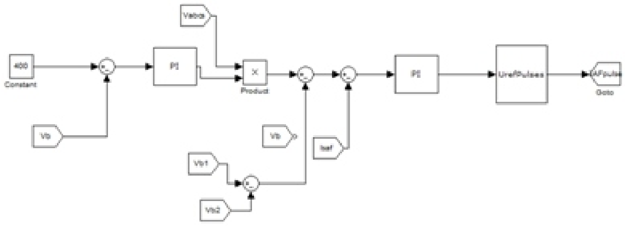

Fig.7. Mat lab SAF CONTROL

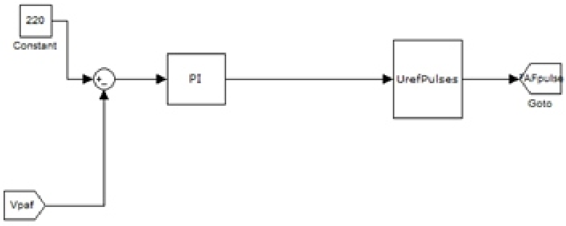

Fig.8. Mat lab PAF CONTROL

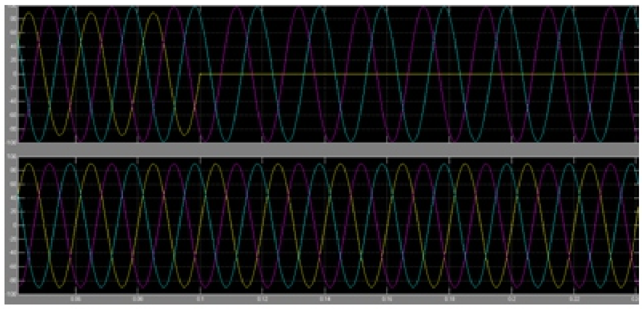

Fig..9 Source voltages and load voltages

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

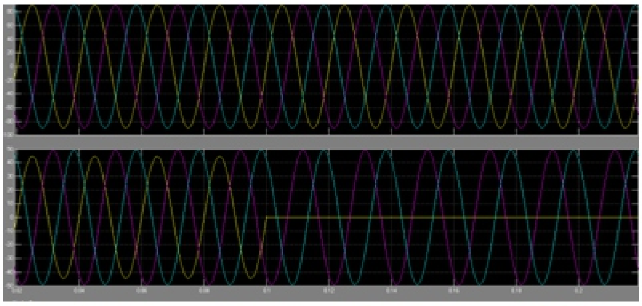

Fig.10 Load voltages (100 V/div and 10 ms/div) and source currents (5 A/div and 10 ms/div).

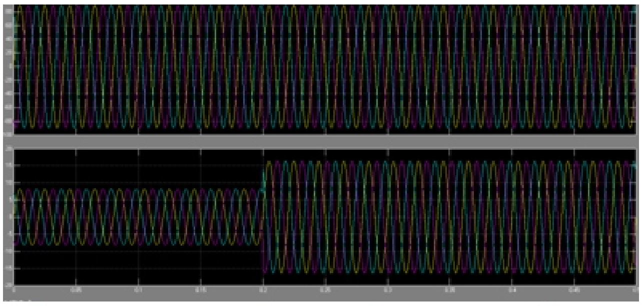

Fig 11 Load voltages (100 V/div and 5 ms/div) and load currents (5 A/div and 5 ms/div) during a load step from 50% to 100%.

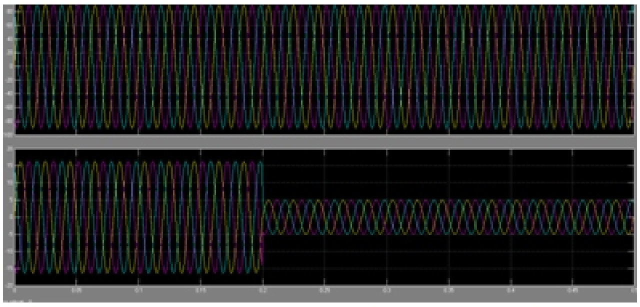

Fig 12 Load voltages (100 V/div and 5 ms/div) and load currents (5 A/div and 5 ms/div) during a load step from 100% to 50%.

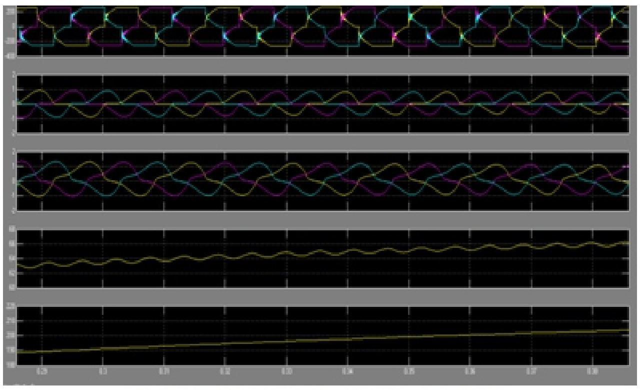

Fig 13.Vsaf, Isaf, Ipaf, Vb1, Vb2

VII. CONCLUSION:

The proposed iUPQC confirms that the ABC reference frame based control works very well and that it was able to compensate the nonlinear load currents and also ensure the sinusoidal voltage for the load in all three phases. The control also had a great performance during the load steps and voltage disturbances at the source. The main advantage of the proposed control in relation to other proposed schemes were the utilization of sinusoidal references for both series and shunt active filter controls without the need for complex calculations or coordinate transformations.

REFERENCES:

[1] A. Jindal, A. Ghosh, and A. Joshi, Jan. 2007, "Interline unified power quality conditioner", IEEE Trans. Power Del., vol. 22, no. 1, pp. 364– 372.

[2] B. Han, B. Bae, S. Baek, and G. Jang, Jul. 2006, "New configuration of UPQC for medium voltage application", IEEE Trans. Power Del., vol. 21, no. 3, pp. 1438–1444.

[3] F. Pottker de Souza and I. Barbi, Jan 2000, "Single-phase active power filters for distributed power factor correction", in IEEE PESC/IEEE Power Electron. Spec. Conf., 2000, vol. 1, pp. 500–505.

[4] G. Li, F. Ma, S. Choi, and X. Zhang, May 2012, "Control strategy of a cross phase connected unified power quality conditioner", IET Power Electron., vol. 5, no. 5, pp. 600–608.

[5] H. Fujita and H. Akagi, Mar. 1998, "The unified power quality conditioner: The integration of series and shunt-active filters", IEEE Trans. Power Electron., vol. 13, no. 2, pp. 315–322.

[6] I. Axente, J. Ganesh, M. Basu, M. Conlon, and K. Gaughan, Jun. 2010, "A 12-kVA DSP controlled laboratory prototype UPQC capable of mitigating unbalance in source voltage and load current", IEEE Trans. Power Electron., vol. 25, no. 6, pp. 1471–1479.

[7] I. Axente, M. Basu, M. Conlon, and K. Gaughan, Jul. 2010, "Protection of unified power quality conditioner against the load side short circuits", IET Power Electron., vol. 3, no. 4, pp. 542–551.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

[8] J. Munoz et al., Oct. 2012, "Design of a discrete-time linear control strategy for a multicell UPQC", IEEE Trans. Ind. Electron., vol. 59, no. 10, pp. 3797– 3807.

[9] K. Karanki, G. Geddada, M. Mishra, and B. Kumar, Sep. 2013, "A modified three phase four wire UPQC topology with reduced dc-link voltage rating", IEEE Trans. Ind. Electron., vol. 60, no. 9, pp. 3555–3566.

AUTHORS DETAILS:

Ankita Dilip Tarpe Received B.E degree from G.H.RAISONI college of engineering & technology, AMRAVATI, Medak, Maharashtra in 2013. And currently pursuing M.Tech in Electrical power system at JAWAHARLAL NEHRU INSTITUTE OF TECHNOLOGY, Ibrahimpatnam, hyderabad, Telangana.
CH SATYANARAYANA

Ch Satyanarayana Obtained his B.Tech (EEE) from-SINDHURA COLLEGE OF ENGINEERING & TECHNOLOGY in 2006, M.Tech.(Power Engineer) from SCIENT INSTITUTE OF TECHNOLOGY in 2012.He worked as Asst. Prof. Tudi Ram Reddy Institute of Technology & Sciences .He has been working as a Associate Professor in dept. of EEE at Jawaharlal Nehru Institute of Technology. He Stood First at Mandal level in S.S.C. His areas of interest Power Systems-1, ElectricalCircuits, NetworkTheory, ControlSystems, ElectricalMeasurements, Electrical Distribution Systems.He is having 8 years teaching experience.