International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 07 | July 2022 www.irjet.net p-ISSN: 2395-0072

Review on Different Time Domain Controlling Technique for UPQC

Bhumika A. Akade[1], Dr. Vasant M. Jape[2]

[1]Student, Electrical Engineering Department, Govt. College of Engineering, Amravati, India
[2]professor, Electrical Engineering Department, Govt. College of Engineering, Amravati, India

---***---

Abstract - *Supply experts have gained more worried in recent years about the quality of the electrical power. A variety of electrical, electronic, and power electronic devices are used in industrial application in today's power systems. Due to the nonlinear nature of the majority of electronic equipment, harmonics will be done concurrently and will have an impression on the sensitive loads that will be carried by the system. Unified Power Quality Conditioner (UPQC), one of the many compensating devices, aims to integrate series-active and voltage differential power filters into a power distribution network to lessen any type of voltage and current perturbations and power factor correction so that better power quality is made publicly available at the point of connection. This study presents a comprehensive overview of the control methods for the unified power quality conditioner (UPQC) in order to make sure optimal UPQC operation.*

Key Words:- **Voltage Sag, power quality, harmonics, UPQC, control strategies.**

1. INTRODUCTION

Keeping the quality of electric electricity within reasonable bounds has always been difficult. Poor power quality has negative repercussions, which are discussed[1]. Generally speaking, low power quality can lead to increased power losses, unusual and unwelcome device behaviour, interference with surrounding communication lines, and other problems. As a result of the growing usage of power electronic-based technologies, which produce harmonic voltages and currents as well as more reactive current, the power system is now under additional stress. The term active power filter (APF) is frequently used when discussing how to improve the quality of electric power. This article concentrates on a single power quality condition (UPQC).

The effectiveness of the power conditioner as a whole is significantly influenced by the control method. The three main conditions for achieving the appropriate compensation are quick and accurate disturbance signal detection, quick processing of the reference signal, and strong dynamic response of the controller. creation of sensible switching. The control strategy of the UPQC is determined by the pattern or gating signal in relation to the command compensating signal. Numerous theories and methods have been presented or put into operation over the years since the main function is the derivation of the reference signal from the observed distorted signal. Either the frequency domain or the time domain applies to these. For the purpose of determining the reference variables, adjustments of the powers hypotheses have been made. Controlling UPQC's power filters is necessary to ensure optimal operation. Different topologies have been developed to regulate them.

2 Basic Structure of UPQC

The distribution system uses the Unified Power Quality Conditioner, a bespoke power device, to reduce disturbances that impair the performance of sensitive and/or important loads. It is a hybrid APF type and the only versatile device that can mitigate multiple power quality issues related to voltage and current at the same time. As a result, it performs multiple functions by compensating for different power supply voltage disturbances, reducing voltage fluctuations, and preventing harmonic load current from entering the power system. A single-phase UPQC's system configuration is shown in Fig. 1. A shared DC bus connects two IGBT-based Voltage Source Converters (VSC), one in series and one in shunt, to create the Unified Power Quality Conditioner (UPQC). The load is linked in parallel with the shunt converter. It supports the load and supply harmonic currents with VAR. Voltage compensation is provided by the series converter linked in series with the load. By eliminating load current harmonics and adjusting the input power factor, UPQC enhances power quality.

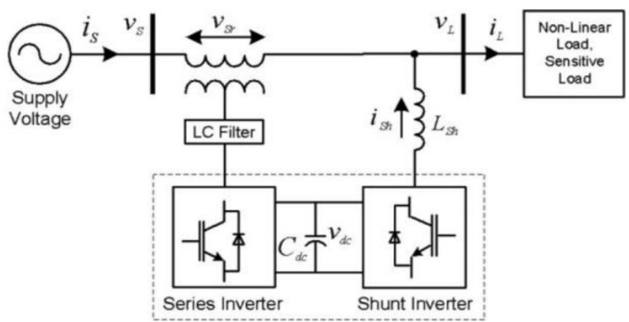

Figure 1 UPQC general block diagram

Series and shunt power converters, DC capacitors, low-pass and high-pass passive filters, and series and shunt transformers are the primary elements of a UPQC.

3 Controlling technique

The most important role in any power electronics-based system is played by controlling approaches. A given system's behaviour and desired operation are determined by the control technique. A UPQC system's performance exclusively depends on its control algorithm. In order to achieve the desired performance, the UPQC control strategy decides the switching instants of the inverter switches by determining the reference signals (current and voltage). In this study, a number of control mechanisms are thoroughly reviewed.

The following list of time domain control methods is utilised for UPQC:

3.1 Instantaneous active & reactive power or 3phase pq theory

3.2 Synchronous reference frame or 3phase dq theory (SRF)

3.3 Unit Vector Template Generation (UVTG)

3.4 One Cycle Control (OCC)

3.5 H∞-based model matching control

3.6 Model Predictive Control (MPC)

3.7 deadbeat Control

3.8 Artificial Neural Network (ANN) technique

3.9 Feed forward & feedback theory

3.10 Multi Output AD Aptive LINear Approach (MO-ADAL)

4. Instantaneous active & reactive power or 3phase pq theory

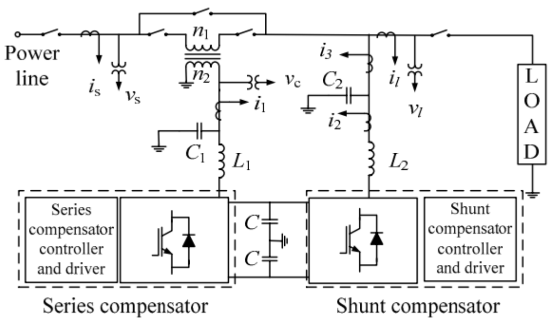

Figure 2 Circuit configuration of the proposed UPQC

The most important role in any power electronics-based system is played by controlling approaches. A given system's behaviour and desired operation are determined by the control technique. A UPQC system's performance exclusively depends on its control algorithm. In order to achieve the desired performance, the UPQC control strategy decides the switching instants of the inverter switches by determining the reference signals (current and voltage). In this study, a number of control mechanisms are thoroughly reviewed.

5. Synchronous reference frame or 3phase dq theory (SRF)

The synchronous reference frame method, often known as the three phase dq theory, is one of the most popular time-domain control techniques for UPQC among the theories discussed. With this technique, the fundamental and harmonic values are separated by moving the voltage and current signals from the ABC frame to a synchronously rotating frame (dq theory). The current independent of the source voltage is the focus of the d-q theory. The intriguing aspect of this theory is that distorted voltage or current (dq theory) fundamentally consists of dc quantities.TAn LPF or a high-pass filter can be used to retrieve these amounts with ease (HPF). Signal filtering in the reference frame is insensitive to any phase shift faults caused by LPF because of the dc signal extraction. However, the dynamic performance of the controller might be impacted by the cutoff frequency of this LPF or HPF [1,2].

6. Unit Vector Template Generation (UVTG)

A phaselocked loop (PLL) is used in the unit vector template generation (UVTG) approach, a straightforward controller scheme for UPQC, to produce unit vector templates for single- and three-phase systems.

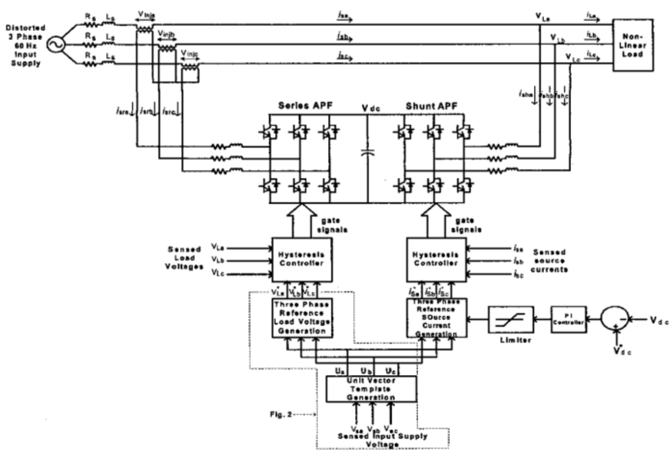

Figure 3 Overall Control Circuit Configuration of UPQC

On the other hand, an analogous technique for detecting current and voltage perturbations has been provided by Khoor and Machmoum .A frequency synchronizer is not required for this technique, unlike the pole shift control technique for UPQC. In this discrete-time control method, the open-loop poles are drastically shifted toward the origin to select the closed-loop poles.

7. One Cycle Control (OCC)

A controller based on the one cycle control (OCC) of switching converters can likewise be created for the UPQC. To force the controlled variables to satisfy the control target in each switching cycle, the OCC controller often employs an integrator with a reset capability.

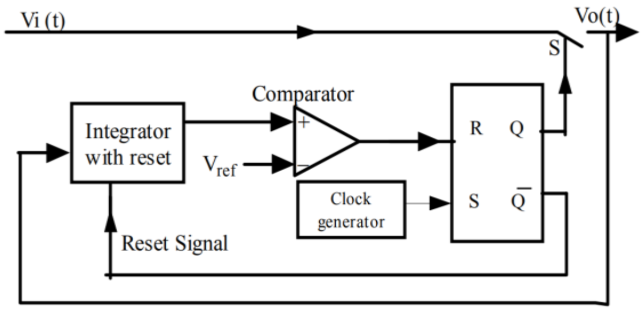

Figure 4 Principle block diagram of One Cycle Control

High precision and quick responsiveness are benefits of the OCC. According to authors, the series inverter of the UPQC is not used to its full potential during regular working conditions.

8. Control method based on h8

This approach is based on the h8 optimal power quality controller, which is designed using the h8 standard control of matching system. By examining the fundamental causes of the coupling effect between the UPQC series unit and shunt unit, a simple and effective coordinated control strategy for the UPQC series unit and shunt unit has been developed. The coupling effect between the UPQC series unit and shunt unit is completely eliminated by adding the appropriate voltage corrective link directly to the UPQC series unit and shunt unit, respectively. [7]

This tactic is used in conjunction with a waveform tracking control technique based on power quality model matching technology called h8 to execute the coordinated control between UPQC series units and shunt units. According to the experimental findings, the method is capable of removing the steady-state phase shift and amplitude attenuation of the voltage tracking compensation of the series unit and the current tracking compensation of the shunt unit for UPQC. Finally, UPQC achieves unified power quality multi-function control. By implementing a UPQC, the distribution network will transform into a perfect source of pure energy with high dependability and premium quality for power consumers, and those with pollution sources will qualify as distribution system customers. [7]

9. Model Predictive Control (MPC)

This tactic is used in conjunction with a waveform tracking control technique based on power quality model matching technology called h8 to execute the coordinated control between UPQC series units and shunt units. According to the experimental findings, the method is capable of removing the steady-state phase shift and amplitude attenuation of the voltage tracking compensation of the series unit and the current tracking compensation of the shunt unit for UPQC. Finally, UPQC achieves unified power quality multi-function control. By implementing a UPQC, the distribution network will transform into a perfect source of pure energy with high dependability and premium quality for power consumers, and those with pollution sources will qualify as distribution system customers.[7]

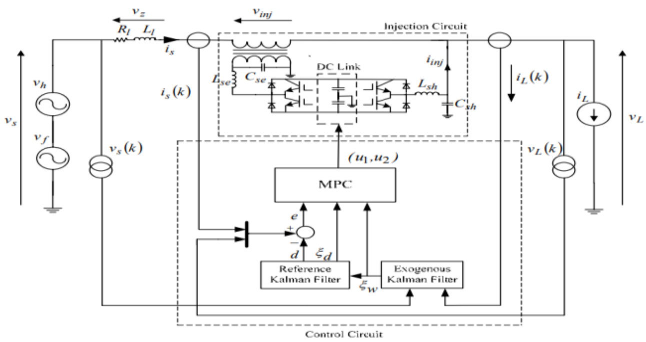

Figure 5 System block diagram of MPC-controlled UPQC with Kalman filters

By reducing the tracking error, the MPC controller will regulate the load voltage and source current to the appropriate references. Power factor correction on the supply side is also possible if the projection of onto is used as the reference for the track. Through simulation tests, it has been demonstrated that all voltage sags, swells, and load fluctuations may be rejected by the MPC controller, demonstrating the effectiveness of the UPQC with the MPC and Kalman filters.

10. Deadbeat Control

A approach based on deadbeat control that treats the UPQC inverter combination as a single unit has been proposed by Kamran and Habetler [8]. One single multi-input, multi-output system can be used to model the entire system. As a result, the individually operated converters' control performance is enhanced, and/or the energy storage between converters is decreased. The system is capable of quick dynamic response and great accuracy in steady state.

11. Artificial Neural Network (ANN) technique

Another model that employs the ANN technique is likewise capable of successfully managing a multi-input multi-output control system [9], [10], and [11]. In order to create the controller for the UPQC and correct various voltage and/or current-related issues, the ANN technique can be used. Banaei and Hosseini proposed using a feed-forward ANN approach to separate the harmonics contents in the nonlinear load. The time-domain and frequency-domain methods have some limits and shortcomings. A wavelet analysis technique, a tool for fault detection, localization, and classification of various power system transients, is suggested by some researchers as a solution to these issues. The wavelet transform can represent a time-varying signal in terms of frequency component by employing multi resolution analysis.

12. **Feed forward & feedback theory**

A model-based coordinated control is proposed for the UPQC by R. Rajasree and S. Premalatha. It is an FF/FB control that tries to directly adjust the supply current and load voltage to the required waveforms to prevent distortion. Additionally taken into account is the coupling impact between series and shunt filters. In theory, the FF control can produce zero steady-state error in the absence of any modelling mistake.

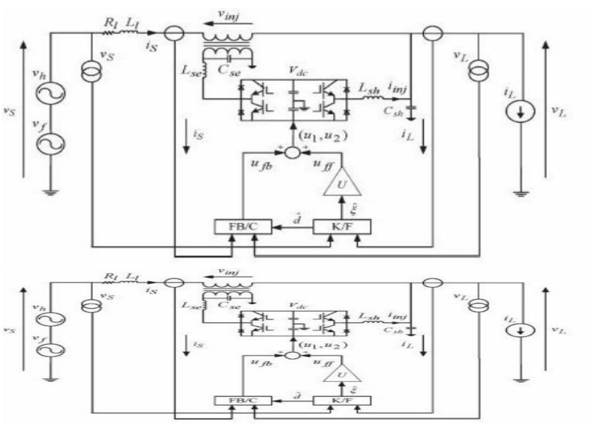

Figure 5 Overall configuration of Unified Power Quality Conditioner (UPQC)

13. Multi Output AD Aptive LINear Approach (MO-ADALINE)

Control algorithms based on the MO-ADALINE technique have been proposed by H.A. Shayanfar S.M.T. Bathaee and have been assembled in MATLAB programme using M-File. SAF of the UPQC has adjusted for voltage harmonics, and PAF of the UPQC has compensated for current harmonics. Based on the findings, the suggested technique is able to produce pure sinusoidal source current and load voltage as well as effectively compensate for source reactive power. Before compensation, the total harmonic distortion of the load voltage was 0.17, and it was virtually zero after compensation. Additionally, the source current's total harmonic distortion before compensation was 0.12, and it decreased to virtually zero after compensation.

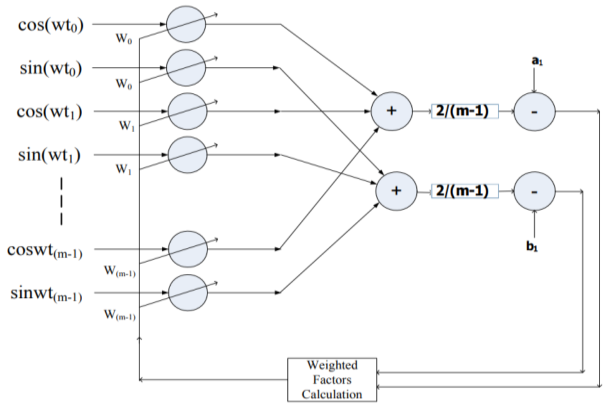

Figure 3. Block diagram of the proposed MO-ADALINE approach

14. CONCLUSION

In order to improve the quality of the electric power at the distribution level, a thorough evaluation of the control mechanisms for UPQC based on time domain is done in this work.

REFERENCES

[1] V. Khadkikar, A.Chandra and B.N.Singh, "Generalized single-phase p-q theory for active power filtering: Simulation and DSP based experimental investigation," IET Power Electron., vol. 2, no. 1, pp. 67- 78, Jan. 2009.

[2] J.Correa, F.Farret and M.Simoes, "Application of a modified single phase P-Q Theory in the control of shunt and series active filters in a 400 Hz micro grid," in Proc. Power Electron. Spec. Conf., pp. 2585-2591 Jun. 16, 2005.

[3] T.Zhili, L.Xun, C.Jian, K.Yong and Z.Yang, "A new control strategy of UPQC in three-phase four-wire system," in Proc. IEEE Power Electron. Spec. Conf., pp. 1060-1065, Jun. 17-21, 2007.

[4] V.Khadkikar, P.Agarwal, A.Chandra, A. Barry, and T. Nguyen, "A simple new control technique for unified power quality conditioner (UPQC)," in Proc. 11th Int. Conf. Harmonics Quality Power, pp. 289-293, Sep. 12-15, 2004.

[5] M.Khoor and M.Machmoum, "Simplified analogical control of a unified power quality conditioner," in Proc. Power Electronics. Spec. Conf., pp. 2565-2570, Jun. 16, 2005.

[6] A.Ghosh, A.K.Jindal and A.Joshi, "Inverter control using output feedback for power compensating devices," in Proc. Convergent Technol. Conf., pp. 48-52 , Oct. 15-17, 2003.

[7] G.G.Zhou, Jun, "Integrated Guidance-Control System Design Based On H8 Control", International Conference On Electrical And Control Engg., 2010.(H8 based)

[8] J.Le,Y.Xie, Z.Zhi and C.Lin, "Anonlinear control strategy for UPQC," in Proc. Int. Conf. Electr. Mach. Syst., pp. 2067-2070, Oct. 17-20, 2008.

[9] [35] J.Le, Y.Xie, Z.Zhi and C.Lin, "A nonlinear control strategy for UPQC," in Proc. Int. Conf. Electr. Mach. Syst., pp. 2067-2070, Oct. 17-20, 2008.

[10] G.S.Kumar, P.H.Vardhana, B.K.Kumar and M. K.Mishra, "Minimization of VA loading of unified power quality conditioner (UPQC)," in Proc. Power Eng., Energy Electr. Drives, pp. 552-557, Mar. 18-20, 2009. INTERNATIONAL JOURNAL of RENEWABLE ENERGY RESEARCH Payal Deshpande et al., Vol.3, No.2, 2013 402

[11] M.R.Banaei and S.H.Hosseini, "Mitigation of current harmonic using adaptive neural network with active power line conditioner," in Proc. IEEE 5th Int. Conf. Power Electron. Motion Control Conf., pp. 1-5, Aug. 14-16, 2006.

[12] R. K. Agarwal, I. Hussain, and B. Singh, "Three-phase single-stage grid tied solar pv ecs using PLL-less fast CTF control technique," IET Power Electronics, vol. 10, no. 2, pp. 178–188, 2017.

[13] Y. Singh, I. Hussain, B. Singh, and S. Mishra, "Single-phase solar gridinterfaced system with active filtering using adaptive linear combiner filter-based control scheme," IET Generation, Transmission Distribution,vol. 11, no. 8, pp. 1976–1984, 2017.

[14] T.-F. Wu, H.-S. Nien, C.-L. Shen, and T.-M. Chen, "A single-phase inverter system for pv power injection and active power filtering with nonlinear inductor consideration," IEEE Trans. Ind. Appl., vol. 41, no. 4, pp. 1075–1083, July 2005.

[15] A. Javadi, A. Hamadi, L. Woodward, and K. Al-Haddad, "Experimental investigation on a hybrid series active power compensator to improve power quality of typical households," IEEE Trans. Ind. Electron., vol. 63, no. 8, pp. 4849–4859, Aug 2016.

[16] A. Javadi, L. Woodward, and K. Al-Haddad, "Real-time implementation of a three-phase thseaf based on vsc and p+r controller to improve power quality of weak distribution systems," IEEE Transactions on Power Electronics, vol. PP, no. 99, pp. 1–1, 2017.

[17] A. M. Rauf and V. Khadkikar, "Integrated photovoltaic and dynamic voltage restorer system configuration," IEEE Transactions on Sustainable Energy, vol. 6, no. 2, pp. 400–410, April 2015.

[18] S. Devassy and B. Singh, "Design and performance analysis of threephase solar pv integrated upqc," in 2016 IEEE 6th International Conference on Power Systems (ICPS), March 2016, pp. 1–6.

[19] K. Palanisamy, D. Kothari, M. K. Mishra, S. Meikandashivam, and I. J. Raglend, "Effective utilization of unified power quality conditioner for interconnecting PV modules with grid using power angle control method," International Journal of Electrical Power and Energy Systems, vol. 48, pp. 131 – 138, 2013.

[20] S. Devassy and B. Singh, "Modified p-q theory based control of solar pv integrated upqc-s," IEEE Trans. Ind. Appl., vol. PP, no. 99, pp. 1–1,2017.

[21] S. K. Khadem, M. Basu, and M. F. Conlon, "Intelligent islanding and seamless reconnection technique for microgrid with upqc," IEEE Journal of Emerging and Selected Topics in Power Electronics, vol. 3, no. 2, pp. 483–492, June 2015.

[22] J. M. Guerrero, P. C. Loh, T. L. Lee, and M. Chandorkar, "Advanced control architectures for intelligent microgrids;part ii: Power quality,energy storage, and ac/dc microgrids," IEEE Transactions on Industrial Electronics, vol. 60, no. 4, pp. 1263–1270, April 2013.

[23] B. Singh and J. Solanki, "A comparison of control algorithms for dstatcom," IEEE Transactions on Industrial Electronics, vol. 56,no. 7, pp. 2738–2745, July 2009.

[24] B. Singh, C. Jain, S. Goel, A. Chandra, and K. Al-Haddad, "A multifunctional grid-tied solar energy conversion system with anf-based control approach," IEEE Transactions on Industry Applications, vol. 52, no. 5,pp. 3663–3672, Sept 2016.