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Power Quality Improvement using Unified Power Quality Conditioner

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Abstract-The electricity supply plays an important appearance in the economic development and technology advancement throughout the world. The quality and reliability of power supplies relates closely to the economic growth of a country. The main aim of the utility system is to supply the power to load with proper sinusoidal wave of the voltage and current, with fixed frequency and magnitude with less total harmonic distortion as possible according to *IEEE 519-1992 standard.* Our power system consist of many non-linear loads like electric arc furnaces, power electronic convertors etc. which offer current and voltage harmonics. Also the loads like computers, micro-controllers are sensitive loads; their convenient functioning depends upon the quality of power supplied. However, power quality disturbances such as harmonics, voltage imbalance,sags, swells, flicker etc., create a lot of problems in achieving a reliable and quality power supply. To overcome these problems, power electronics based FACTS devices are used in distribution systems. Reliability of supply and power quality are two most important look of any power delivery system today. For providing reliable and reliable power, proposed UPQC based improvement in Power Quality is the dissertation topic. UPQC is effective in compensation of current, harmonics, reactive power and to improving the power quality of the distribution system.

Keywords:FACTS, UPQC, PQ, PWM, SPWM.

I. Introduction

Now a days competition level is more elevate in industrial sector so all industries are generating mass of production in short duration. This is possible due to using fast response devices. So in most of the industries are used electronic devices, adequate sensitive devices and electronic drives. These are devices very important to disturbances and become less forgiving to power quality problems. It is most importance issue.

Electrical distribution systems should be provide their customers with an uninterrupted energy at tolerated magnitude level and frequency but, in practice, electrical distribution systems widely used the distribution nonlinear loads their impact on the quality of power supplies[1]. As an outcome of the nonlinear loads the cleanliness of the waveform of supplies is lost. So to avoiding such power quality problems and to developed solution is desperate need of the industrial sector and hence in this project is developed new effective solution which helps to mitigate power quality problems [2].

What do we mean power quality? Power quality is the interaction between electrical power and electrical equipment. If electrical equipment operates properly with reliably, we could say that the electrical power is good quality. If the electrical equipment malfunctions, unreliable, we could say that the power quality is poor quality. Power quality is a set of electrical boundaries that grant a example of equipment to function in its design manner without important loss of performance or life expectancy [3]. This definition grasps two things that we interest from an electrical device performance and life expectancy. The Synchronization in voltage frequency and phase grant electrical systems to function in their intended manner without important loss of performance or life [4]. Now days power quality problems are large issue in all over the world in which Deregulation between voltages supplied from the electric power system and end use equipment. Most common power quality problems in electrical power system such as voltage sags, swells, long-duration

overvoltage, transients, voltage unbalance, under voltages interruptions, flickers and harmonics etc. [5,6].

Voltage swell is most severe disturbances to equipment's in the industrial process zone [7]. It is summarized that voltage sags are caused by faults in electrical grids, the starting of large loads such as induction motors or transformer energizing. It is a common reason for failures or malfunctions of power electronics based equipment's that are used widely in modern day power systems. The characteristics of these voltage sags depends on various factors of which the motor rating, rotor structure, the method of starting motor and system's power supply capacity are seen as critical impacts [8]. Utilities and end users can cause voltage sag on transmission and distribution power systems. The transformer failure is an example can be the initiating event that causes a fault on the utility electrical power system that result in voltage sag.These faults link energy from the power system [11]. Voltage sags occurs while the fault is on the utility's electrical power system. As soon as the breaker or reclose clears the fault the voltage returns to normal. Transmission line disturbancescause voltage dips that last about 6 cycles or 0.10 second. Distribution faults last larger than transmission faults while large motor loadscan cause voltage sags on utility's and end user's power systems. If Compare to other power quality problems poignant industrial and commercial end users voltage sags occur most frequently [12].

II. Unified Power Quality Conditioner

Unified Power Quality Conditioner (UPQC) mainly consists of two parameters: (i) Shunt Active Power Filter (Shunt APF) and (ii) Series Active Power Filter (Series APF). UPQC is the integration of shunt and series active power filters, connected back-to-back on the dc side, sharing a common DC capacitor as shown in Fig.1.1. The series component of the UPQC is used to overcome or mitigation of the supply side disturbances such as voltage sags/swells, flicker, voltage unbalance and harmonics. It inserts voltages so as to maintain the load voltages at a desired level with balanced and distortion free. The shunt component is used to overcome or mitigating the current quality problems caused by the consumer such as poor power factor, load harmonic currents, load unbalance etc. It injects currents in the ac system such that the source currents become balanced sinusoidal and in phase with the source voltages.

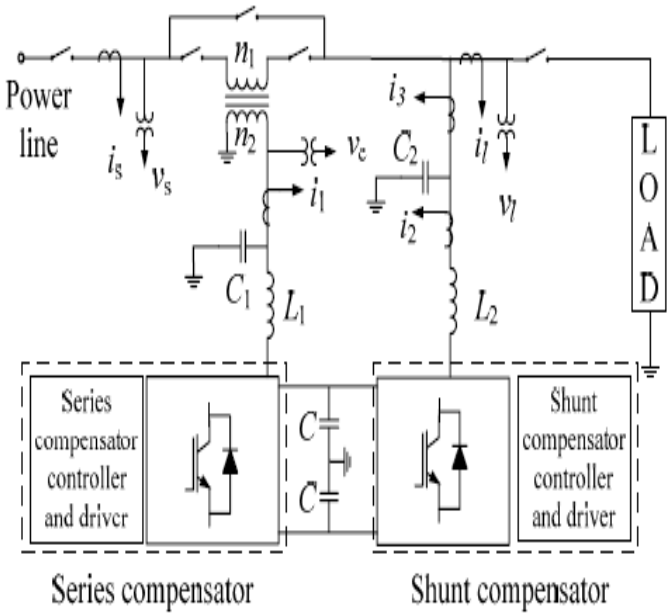

Fig. 1.1 Basic configuration of proposed system

III. Controller of UPQC

A multi-level converter is proposed to increase the converter voltage operation, avoiding the series connection of switching elements. However, the multilevel converter is complicated toform the output voltage and desire an excessive number of back-connection diodes or flying capacitors or cascade converter. A basic structure of multi-level unified power quality conditioner is shown in fig.1.2

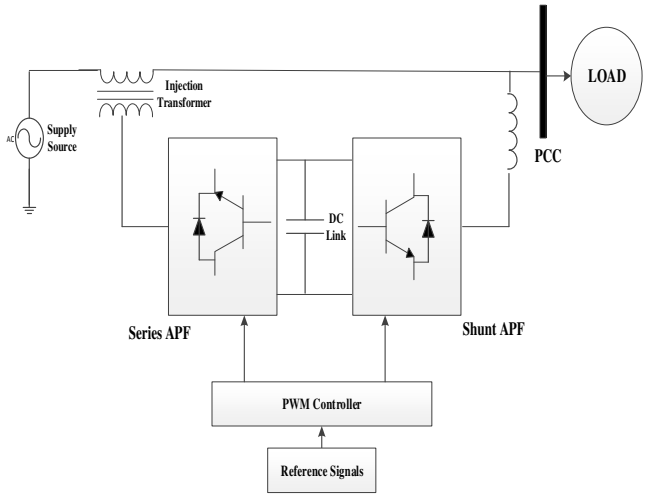

Fig. 1.2 Unified power quality conditioner with controller arrangement

In p-q theory instantaneous active and reactive powers are derive, while, the d-q theory close with current independent of the supply voltage. Both method transform voltage and current from abc frame to stationary reference frame (p-q theory) or synchronously rotating frame (d-q theory) to separate the harmonics and fundamental quantities. In this method the gating signal for semiconductor switches of unified power quality conditioner based on derive compensating commands in terms of voltage or current. Then, these compensating commands are given to pulse width modulation control technique. In this project synchronous reference frame theory are used to abc-dq0 transformation are describe below;

Where the inverse of park's transformation matrix is given by

$$T_{dq0}(wt^{-1}) = \begin{bmatrix} \cos(wt) & \sin(wt) & 1 \\ \cos(wt - \frac{2\pi}{3}) & \sin(wt - \frac{2\pi}{3}) & 1 \\ \cos(wt + \frac{2\pi}{3}) & \sin(wt + \frac{2\pi}{3}) & 1 \end{bmatrix}$$

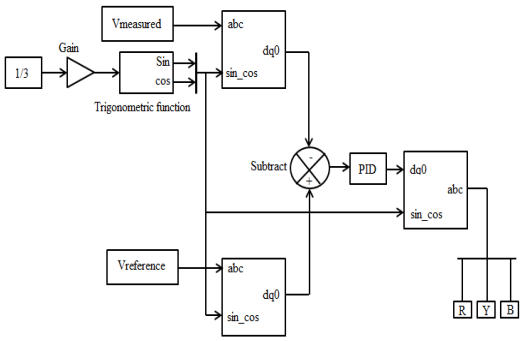

Fig. 1.3 MATLAB/Simulink based block diagram of transformation

Following is composition propose model of insulated gate bipolar transistor based voltage source inverter in matlab Simulink using above concept. The inverter parameter are designed IGBT based, 3-arm, 6-pulse and carrier frequency are 2 kHZ.

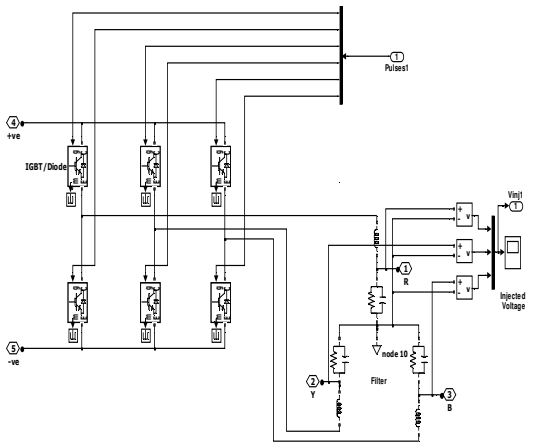

Fig. 1.4 Voltage source inverter in matlab Simulink

Table 1.1 System parameter of unified power quality conditioner

Sr. No.	**System Quantities**	**Standards**
1	Source	3-phase, 33 kV, 50 Hz
2	Source Impedance	R = 4 ohm, L = 1.0001×10^{-6} H Z = 0.1 ohm, wt = 5.730×10^{-4}
3	Inverter Parameter	IGBT Based, 3-arm, 6-pulse, Carrier Frequency = 2 kHz
4	PID Controller	K_P = 0.20, K_i = 0.02, K_d = 0.032
5	Transformer 1	10 MVA, 33 kV,50 Hz
6	Transformer 2	10 MVA, 33 kV/66 kV, 50 Hz
7	Line Impedance	R = 4 ohm, L = 110×10^{-6} Z = 4.00 ohm, wt = 1.575×10^{-3}
8	RL Load	R = 500 ohm, L = 800×10^{-3} H

IV. Performance Analysis

The modeling of UPQC in mat lab environment for electrical network is shown in Fig.4. in which a one feeder of Power transmission and distribution is considered and simulated. The simulation results are performed on basis of that network for the performance of UPQC. The fault is created manually for some period and various results during such conditions are carried out.

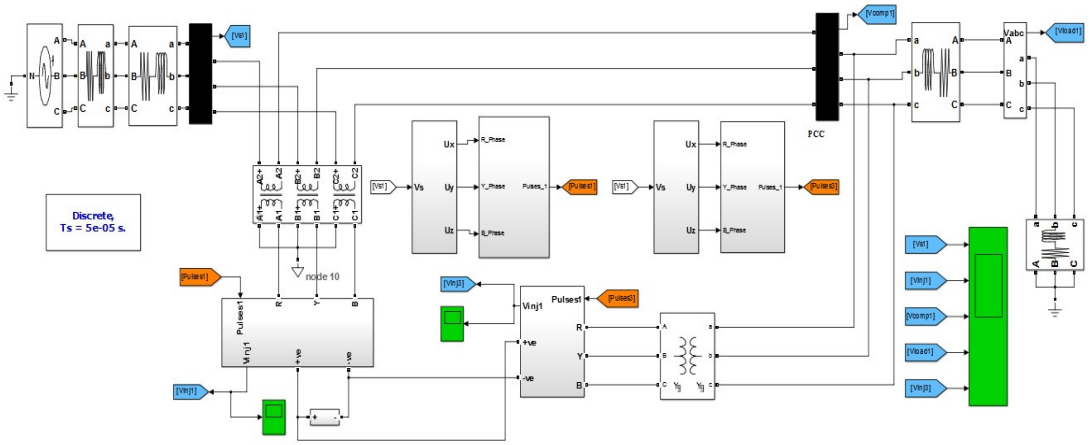

Fig. 1.5 Matlab simulation model of UPQC in transmission network

V. Simulation Result

Following are simulations results of the proposed model of unified power quality conditioner custom power compensation device by using SPWM techniques in MATLAB software. The simulation is carried out and result is analyzed for voltage sag period and rating of the RL load.

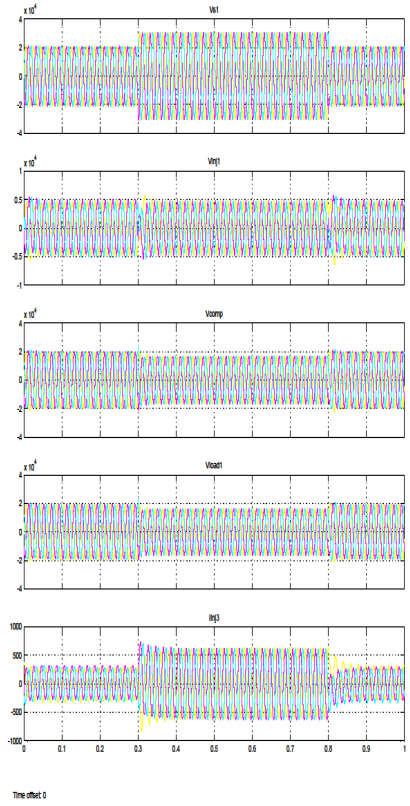

Fig.1.6 Voltage across source side, injected voltage, compensated voltage across load , source.

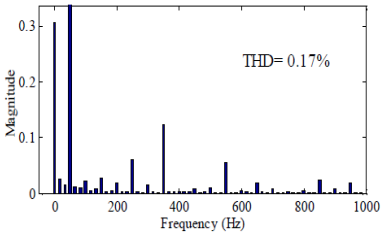

Fig.1.7 Source side voltage THD

VI. Conclusion

The power quality problems in distribution system are not new but customer alertness of these problems recently increased. It is very difficult to maintain electric power quality at sufficient limits. One modern and very bright solution that deals with both load current and supply voltage imperfection is the unified power quality conditioner (UPQC).

The objective of this paper is to improve the power quality in an electrical network using UPQC FACTS device. The simulation is carried out by SPWM control technique. From this paper and simulation results it is clear that the performance in the voltage profile or waveform get improved using UPQC.

References

[1] T. Zhili, L. Xun, C. Jian, K. Yong, 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.

[2] V. Khadkikar, A. Chandra, *"A new control philosophy for a unified power quality conditioner (UPQC) to coordinate load-reactive power demand between shunt and series inverter,"* in IEEE tranc. On power delivery, vol.23, no.4, October 2008.

[3] D. Graovac, V. katic, A. Rufer, *"Power quality compensating using universal power quality conditioning system,"* in IEEE Tranc. Power delivery, vol.8, no.2, pp. 697-703, Apr.1993.

[4] I. Axente, J. Ganesh. M. Basu, M. Conlon, and K. Gaughan, *" A12-KVA DSP-Controlled laboratory prototype UPQC capable of mitigating unbalance in source voltage and load current,"* in IEEE Tranc. On power Electronics, vol.25.no.6, June 2010.

[5] B. Gopal, Pannala Krishna Murthy and G. N. Sreenivas, *" A Review on UPQC for Power Quality Improvement in Distribuation System'',* Global Journal of Researches in Engineering Electrical and Electronics Engineering, Volume 13, Issue 7, Version 1.0, 2013.

[6] Payal Deshpande, Amit Shrivastava and Anula Khare, *"Different Modeling Aspects and Energy System of Unified Power Quality Conditioner (UPQC): An Overview'',* International Journal of Renewable Energy Research'', Vol.3, No. 2, 2013.

[7] Byung-Moon Han, Bo-Hyung Cho, Seung-Ki Sul and Jae-Eon Kim, *" Unified Power Quality Conditioner for Compensating Voltage Interruption'',* Journal of Electrical Engineering and Technology, Vol. 1, No. 4, pp. 503-512, 2006.

[8] Hameed Mohammed Abdul and P.V.Kishore, *"Multi Converter Unified Power-Quality Conditioning for Multi Feeder System'',* International Journal of Engineering Research and Application'', Vol. 2, Issue 1, Jan-Feb 2012, pp. 212-221.

[9] Vinita Vasundhara, Rintu Khanna and Manoj Kumar, *"Improvement of Power Quality by UPQC using Different Intelligent Controls: A Literature Review'',* International Journal of Recent Technology and Engineering, Volume-2, Issue-1, March 2013.

[10] B. Jyothi, B. Jyothsna and Dr. M. Venu Gopal Rao, *"Analysis of Unified Power Quality Conditioner during Voltage Sag and Swell Conditions'',* International Journal of Engineering Science and Advanced Technology, Volume-2, Issue-1, 85-91, Jan-Feb 2012.

[11] Mr. Shaktisinh N. Gohil and Prof. M. V. Makwana, *"A comparative Analysis of UPQC for Power Quality Improvement'',* Journal of Information Knowledge and Research in Electrical Engineering, Volume-02, Issu-02, Nov 12 to Oct 13.

[12] Metin Kesler and Engin Ozdemir " Synchronous-Reference-Frame-Based Control Method for UPQC Under Unbalanced and Distorted Load Conditions'', IEEE Transaction on industrial Electronics, Vol. 58, No.9, Sep.2011.

[13] N. Hari, K. Vijaykumar, S. Dash, "A versatile control scheme for UPQC for power quality improvement," IEEE Conference proceedings of ICETECT 2011.

[14] H. Hingorani, "Introducing Custom Power" IEEE Spectrum, Vol.32, Issue: 6, Page(s): 41-48, June 1995.

[15] G. Siva Kumar, P. HarshaVardhana and B. Kalyan Kumar, "Minimization of VA Loading of Unified Power Quality Conditioner (UPQC)", Conference on POWERENG 2009 Lisbon, Portugal, Page(s): 552 - 557, 2009.
[16] V. Khadkikar, A. Chandra, A.O. Barry and T.D Nguyen, "Conceptual Study of Unified Power Quality Conditioner (UPQC)," IEEE International Symposium on Industrial Electronics, Vol. 2, Page(s): 1088 –1093, 2006.
[17] V. Khadkikar, A. Chandra, A.O. Barry and T.D. Nguyen, "Power quality enhancement utilizing single-phase unified power quality conditioner: digital signal processor-based experimental validation" Conference on Power Electronics, Vol. 4, Page(s): 323 –331, 2011.
[18] A. Mokhtatpour and H.A. Shayanfar "Power Quality Compensation as Well as Power Flow Control Using of Unified Power Quality Conditioner", Asia- Pacific Power and Energy Engineering Conference (APPEEC), Page(s): 1 - 4, 2011.