Harmonic Emission of Grid Connected Back To Back Arrangement of Rectifiers in Distribution Networks

S. Phani Venkata Ramana, K. Anitha Reddy, K. Deepthi, K. Chetaswi

Abstract: ***Emission of Harmonics plays a potent role in distribution systems. The intention of this paper to inspect the harmonic level by the implementation of UPQC (Unified Power Quality Conditioner) at distribution system level. This system offers indirect power quality (PQ) pay of the voltage and also the supply current. The harmonic performance of small grid with respect to different power electronics and grid parameters. Latest studies suggest that the UPQC has high efficiency and better Power quality. This system is very simple and uncomplicated. The equipments used in this system always monitors the harmonic level on the source side by considering the voltage magnitude and supply current. By employing this system, the THD value is very low, injected voltages or currents gets nearer to sinusoidal. The execution of the planned system is simulated in MATLAB/Simulink surrounding***

Keywords: Power Quality, UPQC, Active power filter, Sinusoidal, Harmonic content.

I. INTRODUCTION

Most of the ac loads consumes reactive power (Q), which is a prominent cause for poor power quality (PQ) problems. [1][2]. For a steady power system the generating side should produce sufficient power to meet the consumers demand. Distribution system is the one which mainly connected to consumer's side commonly, so the effect of power quality problems will be very high at distribution side. Generally power quality problems are like voltage swell, sag, flickers; harmonics forms the cause for electrical distribution network failures [3]. Among the above the effect of harmonics will be very severe at distribution side due to vast usage of non linear loads. Implementation of Unified power quality controller (UPQC) at DS (Distribution Side) control the level of harmonics to very low quantity and keeps the load safe and work efficiently. UPQC is most effective and powerful electronics device for heavy (high) loads and sensitive to line voltage and line current disruptions. [4][5] UPQC Based Power Quality Improvement in Distribution System Connected with PV Arrays).

This paper proposes a system for along power quality conditioner (UPQC) topology that infuses streams & voltages at lower THD values into utility framework association by the implementation of technique of synchronous reference frame theory

1.Introduction
2.Upqc System Configuration and Control Mechanism
3.Proposed model

II. UPQC CONFIGURATION AND CONTROL MECHANISM

Unified Power quality Conditioner (UPQC) is a combination of series and shunt active power filters which are connected back to back, where series active power filter is arranged in series with transmission or distribution line to mitigate the voltage distortions and imbalances present on source side and the load voltage balanced ,regulated and sinusoidal and shunt active power filters are arranged in

parallel with transmission or distribution line to mitigate harmonics in load current and make the source current free from distortions and imbalances and make the source current sinusoidal. These two active power filters are connected back to back with a dc link capacitor in case of 1-phase,3-phase3-wire,3-phase 4-wire configurations. The configuration of UPQC includes series active filter, shunt active filter, dc link capacitor, series transformers, low and high pass filters.[7]

The normal principle of a shunt APF is that it develops a current (I) which is equal and inverse in polarity to the Harmonic current drawn by load and implants it to the point of common coupling (PCC), thereby forcing the main source current to be pure sine wave. By that both harmonic and reactive currents are then nullified at source end and the result is balanced sine current. [8][9] Synchronous frame theory helps us in eliminating number of controllers in case of three phase system and forms the benefit in easy controlling of steady state errors. The SRF theory can also be termed as d-q theory. The main concept of this theory relies on Parks Transformations for transforming the 3- · voltage (V) and current(I) into synchronous rotating frame.

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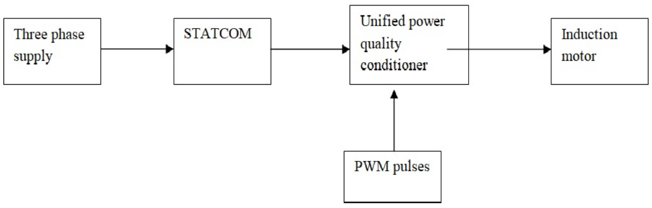
The P and Q components of 3- ・ system are generally represented as direct (d) and quadrature (q) components.[10][11]

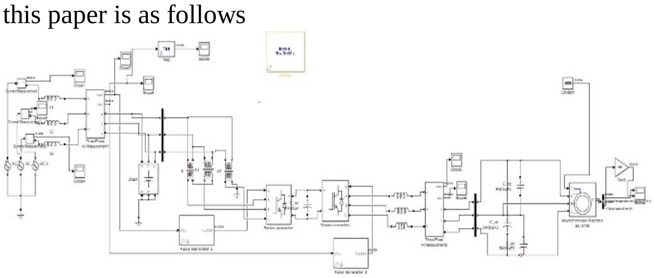
The block diagram of the system that is represented in this paper is as follows



The system contains of a three-phase supply followed by a static compensator then a unified power quality conditioner (UPQC) which is in series with the transformers and then by a specified load (the load considered in this paper is an Induction motor)

III. PROPOSED MODEL AND ITS WORKING

This paper mainly concentrates on the level of harmonics which are on the source side such that the amount of power from the source side to load side should be reliable. Many experiments and researches have done by installing different types of controllers in different ways and obtained results and amount of THD have been calculated on Distribution side. This paper presents the SIMULINK model of the distribution network with Unified Power Quality Conditioner (UPQC) as main controller. The control strategy used for generation of gating pulses for series and shunt filters which are arranged back to back with a dc link capacitor in between them is Synchronous Reference Frame Theory (SRFT)[12].The MATLAB/Simulink model of distribution side represented in this paper is as follows



This system comprises of a 3 phase source where phase displacement was arranged as 1200 each, then followed by inductors which can be treated as the transmission lines then a static compensator device connected in parallel to adjust the inductive (L) or capacitive (C) current so as to maintain the specific parameters connected with the network. It can be helpful in reducing losses, active power fluctuation mitigation and improvement of transfer capcity. This variable compensator is a combination of three separate variable capacitors connected in parallel to form one single capacitor of high value. Each phase is connected with a linear transformer in series combination.

The transformers are connected in ・ - ・ arrangement. Then a block of unified power quality conditioner is connected with a combo of both shunt and series filter a dc link capacitor is arranged in between these filters. [13]

The control strategy for obtaining triggering pulses is based on SRF theory which implements the concept of parks transformation and inverse transformation. The values of voltage and current obtained from the 3-∅ source was considered as the value with the harmonics and a value was pre-determined within the pwm generator with SRF theory installed in it. Once the value reaches the pwm generator the obtained value will be compared with the pre-determined value and if there is difference in its waveform then the gating pulses will be supplied to series active filter which comes into action and will regularize obtained value to the predetermined value. By using the park's transformation, the phase variables will be decoupled from 3-∅ to 2-∅ normally. By this the three-phase source current is first categorized and changed into (**α-β-0**) two phase stationary frame

The working equations of this model to obtain the process of decoupling the three phase currents to two phase currents is as follows

$$\begin{bmatrix} T_{dq} \end{bmatrix} = 2/3 \begin{bmatrix} \cos Ø_d & \cos (Ø_d-2\pi/3) & \cos (Ø_d+2\pi/3) \\ -\sin Ø_d & \sin (Ø_d-2\pi/3) & \sin (Ø_d+2\pi/3) \\ 0.5 & 0.5 & 0.5 \end{bmatrix} \quad \ldots (1)$$

Then the values of 2-∅ will be transmitted through the dc link capacitor to reach the shunt active filter. The shunt active filter was already arranged inverse parks transformation which converts input 2-∅ values into 3-∅ values. The parks inverse transformation was characterized by eqn 2

$$\begin{bmatrix} T_{dq} \end{bmatrix}^{-1} = \begin{bmatrix} \cos Ø_d & -\sin Ø_d & 1 \\ \cos (Ø_d-2\pi/3) & -\sin (Ø_d-2\pi/3) & 1 \\ \cos (Ø_d+2\pi/3) & -\sin (Ø_d+2\pi/3) & 1 \end{bmatrix}$$

The gating pulses to the shunt filter is also supplied in the same way as stated for series filter concept. The value of current obtained from 3-∅ source will be cross checked with the predetermined value and if there is a difference then triggering pulses will be supplied. The filtered values was then sent to load. A capacitor bank Δ connected was installed in middle of load and UPQC circuit to rectify the problems related to the power factor on load side. The experimental results are obtained by using MATLAB/SIMULINK model. The results are as follows

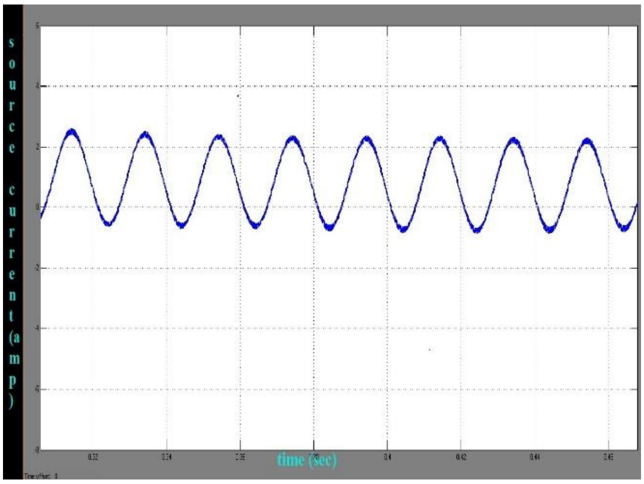


Fig.1 wave form of the source current [Source current vs Time]

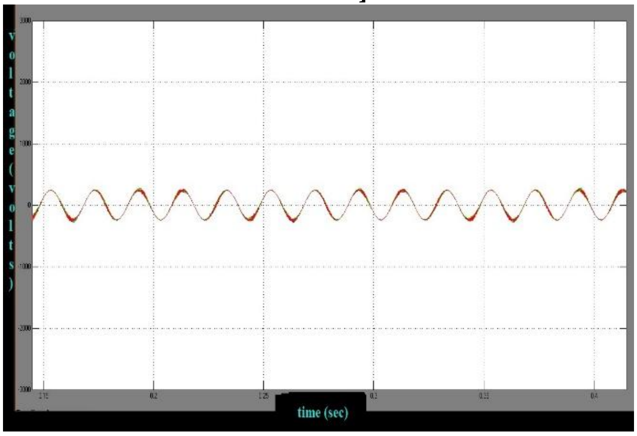


Fig.2 wave form of the UPQC output voltage [voltage vs time]

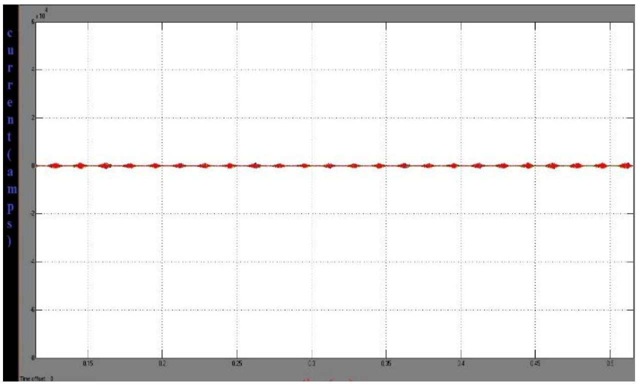


Fig.3 wave form of the UPQC output current [current vs time]

From the experimental results the amount of THD was around 9%, where as compared to many controllers the value of THD is very low and the obtained wave form also resembles the sine wave to most of the extent.

S. No	CONTENT	THD
1	Amount of Harmonic Emission with Diode Rectifier and P-I Controller	29%
2	Amount of Harmonic mission with IGBT based back to back arranged rectifiers	9%

IV. CONCLUSION

This paper is mainly based on the harmonic reduction at distribution side by considering cost, complexity of the model, power transfer capability, and reliability as the factors. By installing the unified power quality conditioner system performance is increased and the obtained waveform is resembling the sine wave. By the reduction of harmonic content, the power quality issues can be controlled to the larger extent.

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