Mitigation of Voltage Sag/Swell Using UPQC

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Abstract: *This Paper deals with unified power quality conditioners ,which aim at the integration of series-shunt active power filter .The main purpose of a UPQC is to compensate for voltage sag/swells,negative sequence current ,harmonics.In the other words, the UPQC has the capability of improving power quality at the point of installation on power distribution systems.*

Keywords : *power quality, AC Voltage,*

1. INTRODUCTION:

A Power Quality problem can be defined as deviation of magnitude and frequency from the ideal sinusoidal waveform. Good power quality is benefit to the operation of electrical equipment, but poor power quality will produce great harm to the power system. Most of the electronic equipments such as personal computers, telecommunication equipments, microprocessor and micro controller, etc are responsible for power quality problems. A Power Quality problem can be defined as deviation of magnitude and frequency from the ideal sinusoidal wave from. Good power quality is benefit to the operation of electrical equipment, but poor power quality will produce great harm to the power system . Harmonics are defined as sinusoidal wave form having a frequency equal to an integer multiple of the power system fundamental frequency. It is a component of a periodic waveform. If the fundamental frequency multiple is not an integer, then we are dealing with inter harmonics. Most of the electronic equipments such as personal computers, telecommunication equipment, microprocessors, and microcontrollers etc; are generally responsible to Power Quality problems. A poor power quality has become a more important issue for both power suppliers and customers. Poor power quality means there is a deviation in the power supply to cause equipment malfunction or may failure.

To solve the power quality problem the power electronic devices such as flexible alternating-current transmission system (FACTS) and custom power devices (DVR) which are used in transmission and distribution control, respectively, should be developed. The impact of transient parameters in majority of transmission lines problems such as sag (voltage dip), swell (over voltage) and interruption, are also considerable.

2. VOLTAGE SAG:

Voltage sags and momentary power interruptions are probably the most important Power Quality problem affecting industrial and large commercial customers. These events are usually associated with a fault at some location in the supplying power system. Interruptions occur when the fault is on the circuit supplying the customer. But voltage sags occur even if the faults happen to be far away from the customer's site. Voltage sags lasting only 4-5 cycles can cause a wide range of sensitive customer equipment to drop out.

3. VOLTAGE SWELL :

A swell is the reverse form of Sag, having an increase in AC Voltage for duration of 0.5 cycles to 1 minute's time. For swells, high-impedance neutral connections, sudden large load reductions, and a single-phase fault on a three phase system are common sources. Swells can cause data errors, light flickering, electrical contact degradation, and semiconductor damage in electronics causing hard server failures. Our power conditioners and UPS Solutions are common solutions for swells. It is important to note that, much like sags, swells may not be apparent until results are seen. Having your power quality devices monitoring and logging your incoming power will help measure these events

4. UNIFIED POWER QUALITY CONDITIONER:

UPQC for harmonic elimination and simultaneous compensation of voltage and current, which improve the Power Quality, offered for other harmonic sensitive loads at the point of common coupling. In almost all of the papers on UPQC, it is shown that the UPQC can be utilized to solve PQ problems simultaneously. Fig. 1 shows a basic system configuration of a general UPQC with series and shunt APFs. The main aim of the series APF is to obtain harmonic isolation between the load and supply. It has the capability of voltage imbalance compensation as well as voltage regulation and harmonic compensation at the utility-consumer PCC. The shunt APF is used to absorb current harmonics, to compensate for reactive power, and to regulate the dc-link voltage between both APFs.

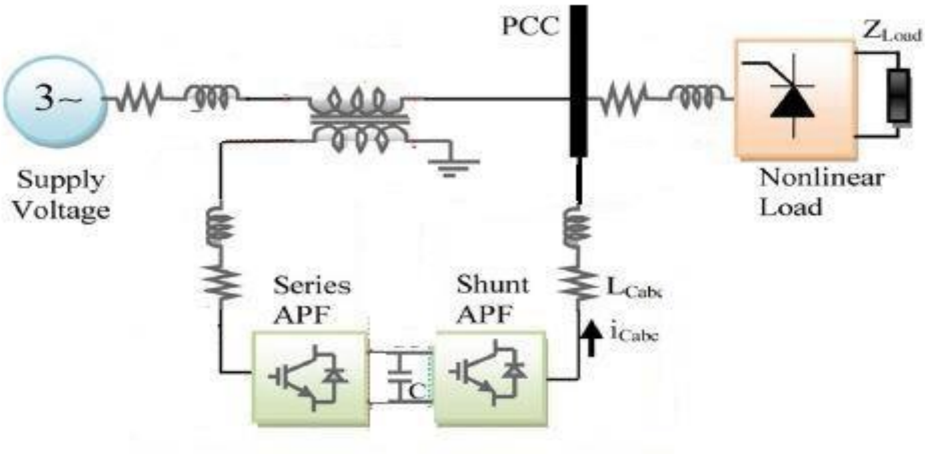
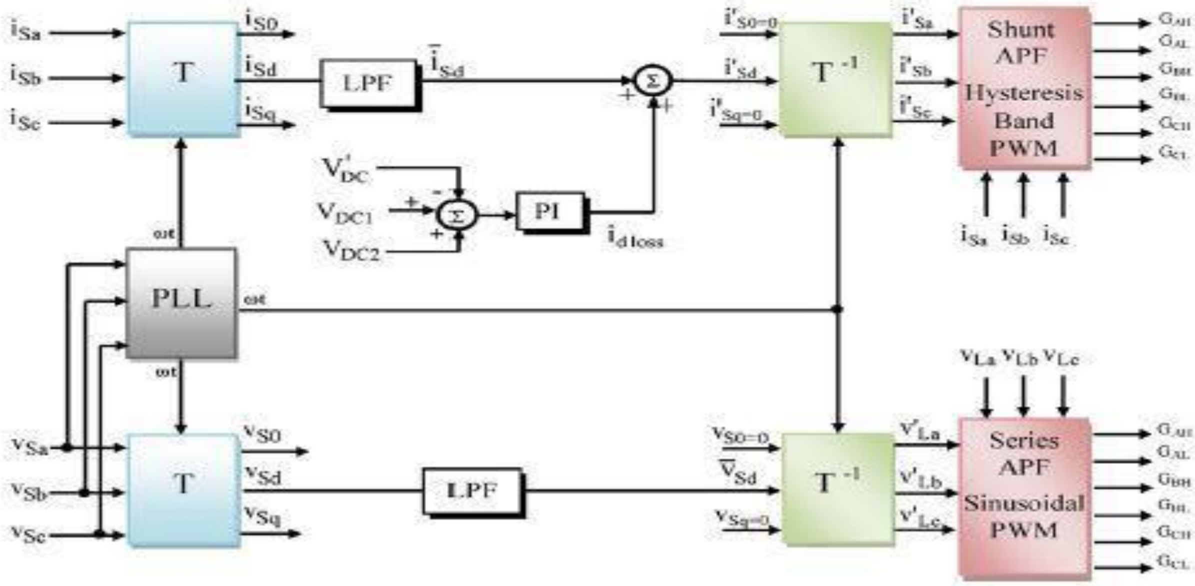


Fig 1 Basic UPQC

5. SYNCHRONOUS REFERENCE FRAME:

The SRF method can be used to extract the harmonics contained in the supply voltages or currents. For current harmonic compensation, the distorted currents are first transferred into two-phase stationary coordinates using $\alpha-\beta$ transformation . After that, the stationary frame quantities are transferred into synchronous rotating frames using cosine and sinus functions from the phase-locked loop . The sinus and cosine functions help to maintain the synchronization with supply voltage and current. Similar to the $p-q$ theory, using filters, the harmonics and fundamental components are separated easily and transferred back to the $a-b-c$ frame as reference signals for the filter. The conventional SRF algorithm is also known as $d-q$ method, and it is based on $a-b-c$ to $d-q-0$ transformation (park transformation).



SRF BASED UPQC CONTROL

6. PARK TRANSFORMATION MATRIX T:

$$T=\sqrt{\frac{2}{3}}\begin{bmatrix} 1/\sqrt{2} & 1/\sqrt{2} & 1/\sqrt{2} \\ \sin(wt) & \sin(wt-2\pi/3) & \sin(wt+2\pi/3) \\ \cos(wt) & \cos(wt-2\pi/3) & \cos(wt+2\pi/3) \end{bmatrix}$$

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

$$\begin{bmatrix} v_{So} \\ v_{Sd} \\ v_{Sq} \end{bmatrix} = T \begin{bmatrix} v_{Sa} \\ v_{Sb} \\ v_{Sc} \end{bmatrix}$$

7. SHUNT CONTROL STRATEGY:

The shunt active power filter is provided the current and the reactive power (if the system need) compensation. It acts as a controlled current generator that compensated the load current to force the source currents drained from the network to be sinusoidal, balanced and in phase with the positive-sequence system voltages.

8. SERIES CONTROL STRATEGY:

The series active power filter is provided the voltage compensation. It generates the compensation voltage that synthesized by the PWM converter and inserted in series with the supply voltage, to force the voltage of PCC to become sinusoidal and balanced.

9. SIMULATION MODEL WITHOUT UPQC:

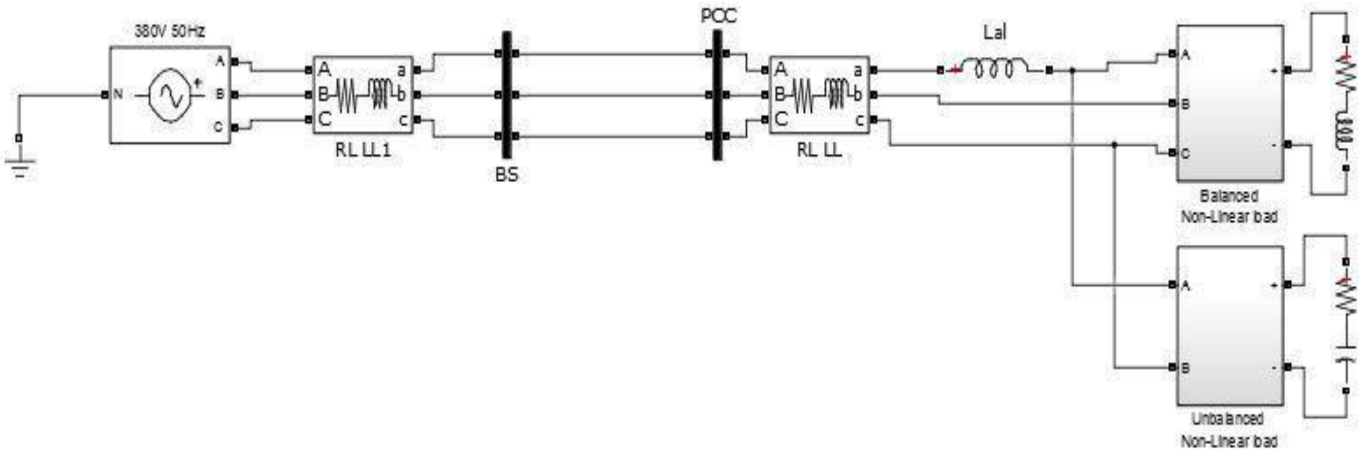


Fig 1. Without UPQC

10. SIMULATION RESULTS:

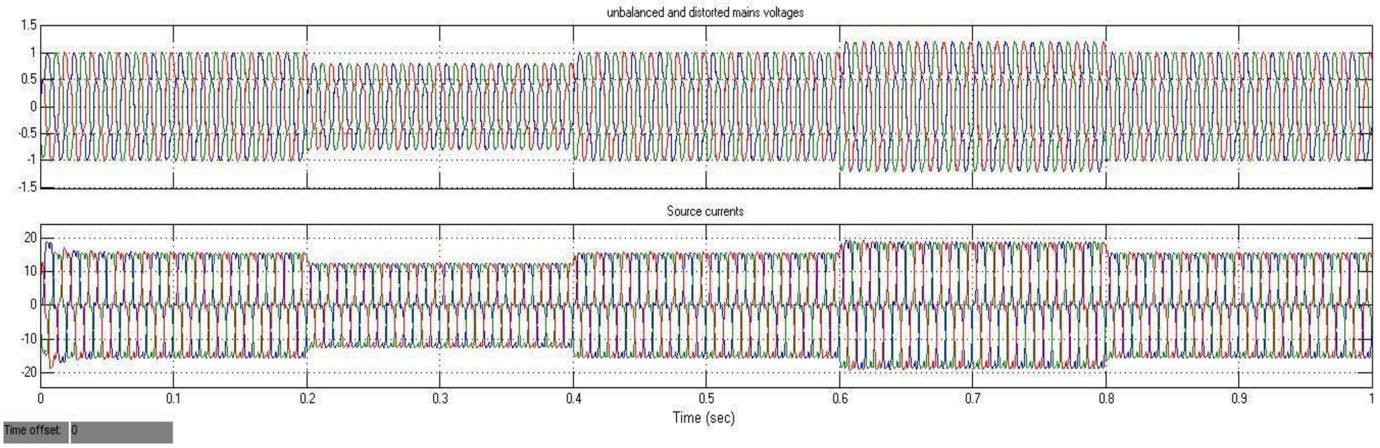


Fig 2. SOURCE VOLTAGE

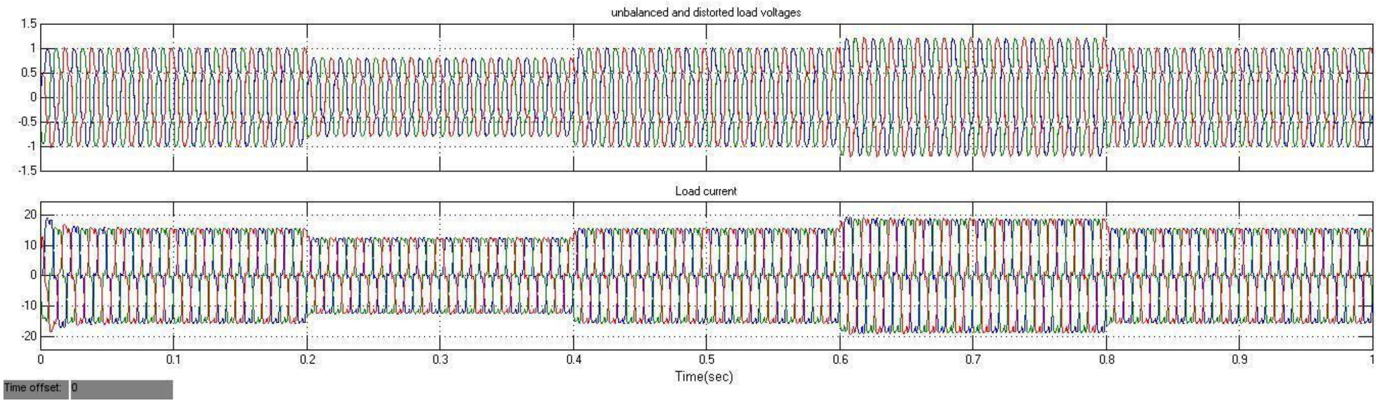


Fig 3. LOAD VOLTAGE

11. SIMULATION MODEL WITH UPQC :

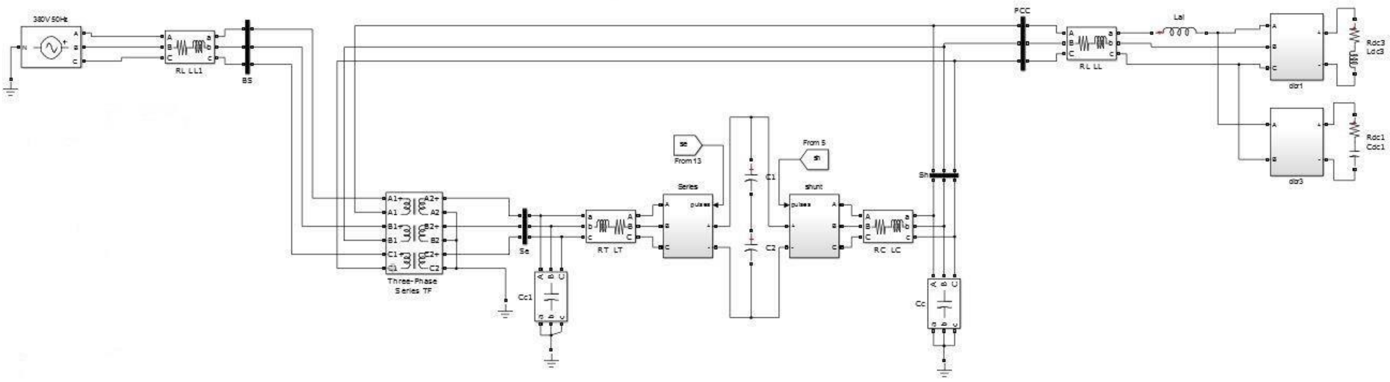


Fig 4. With UPQC

12. SIMULATION RESULT:

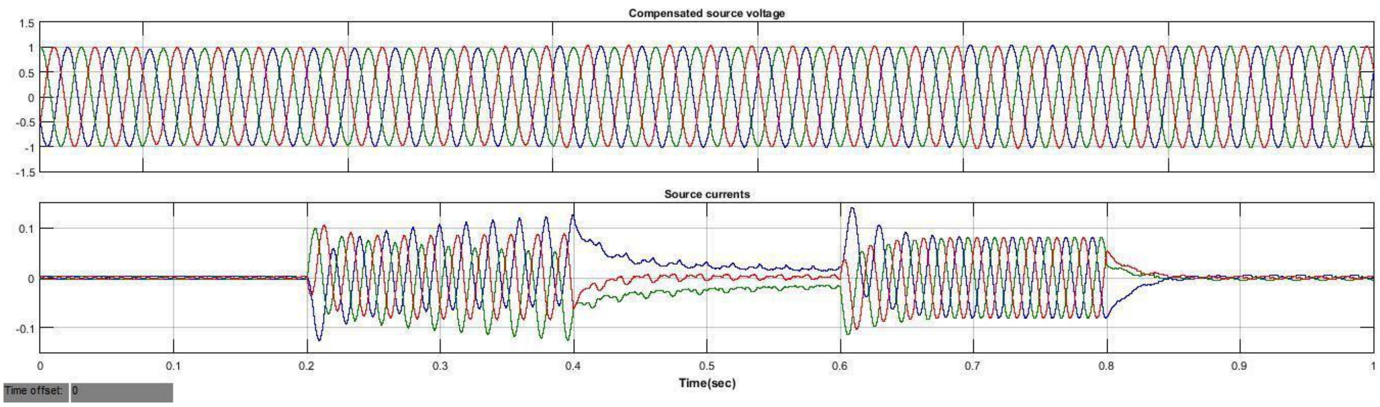


Fig 5. Source voltage

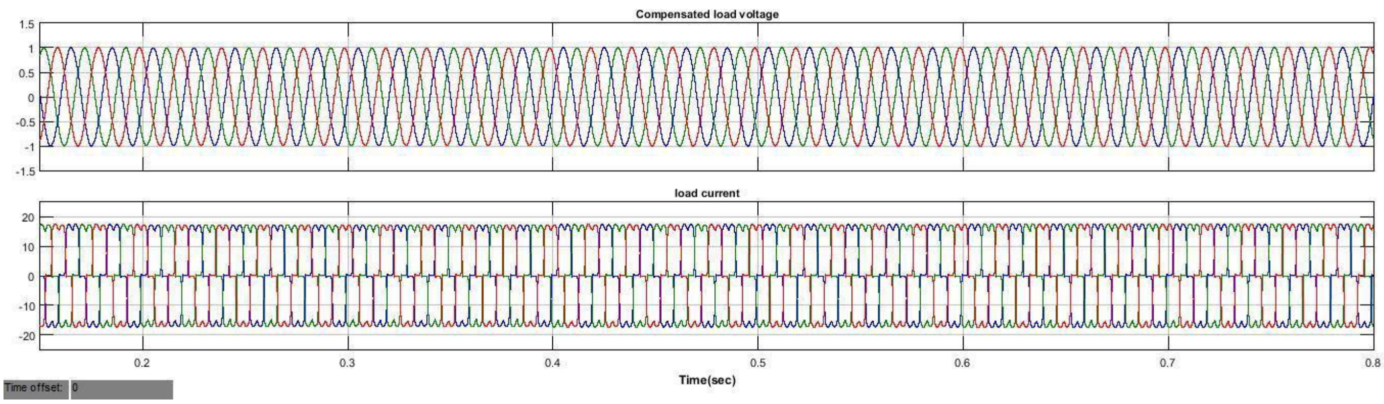


Fig 6.Load voltage

13. CONCLUSION:

The main objective of this paper was to develop the UPQC scheme and its two controllers for the improvement of power quality problem in power distribution system, by eliminating the voltage sag /swell and harmonics. The simulation has been implemented using the SRF control strategy controllers.

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