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### Enhancement of power quality using UPQC by ANN controller

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#### ABSTRACT

This paper proposes Design and analysis of ANN based unified power quality controller (UPQC) for power quality improvement. The UPQC is the combination of shunt and series APF. The series APFs are used to compensate voltage related problems and the shunt APFs are used to compensate current related problems. The unified power quality conditioner (UPQC) integrates both shunt and series APFs through a common DC link capacitor. The UPQC is employed in power transmission system, and the primary objective of UPQC is to control the flow of power at, fundamental frequency. Whereas the UPQC is employed in a power transmission system. It controls distortion due to harmonics and unbalance in voltage in addition to control of flow of power at the fundamental frequency. In this work, the conventional controller has been replaced by an ANN (Artificial Neural Network). The ANN has been used in APFs in place of conventional controller for improving the dynamic performance. The results obtained through the ANN are good in terms of dynamic response. Simulations are verified by using of MATLAB/Simulink.

**Index Terms:** Artificial neural network (ANN), Current Source Inverter (CSI), Proportional integral (PI), Unified power- quality conditioner (UPQC), Voltage Source Inverter (VSI).

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#### INTRODUCTION

The term electric power quality (PQ) is generally used to assess and to maintain the good quality of power at the level of generation, transmission, distribution, and utilization of AC electrical power [1][2]. Since the pollution of electric power supply systems is much astringent at the utilization level, it is paramount to study at the terminals of end users in distribution systems. There are a number of reasons for the pollution of the AC supply systems, including natural ones such as lightning, flashover, equipment failure, and faults and coerced ones such as voltage distortions and notches. A number of customer's equipment withal pollute the supply system as they draw non sinusoidal current and depart as on linear loads. Therefore, power quality is quantified in

terms of voltage, current, or frequency deviation of the supply system, which may result in failure or mal-operation of customer's equipment. Typically, some power quality quandaries cognate to the voltage at the point of prevalent coupling (PCC) where sundry loads are connected are the presence of voltage harmonics, surge, spikes, notches, sag/dip, swell, unbalance, fluctuations, glitches, flickers, outages, and so on. These quandaries are present in the supply system due to sundry perturbances in the system or due to the presence of sundry non linear loads such as furnaces, uninterruptible power supplies (UPSs), and adjustable speed drives (ASDs). However, some power quality quandaries cognate to the current drawn from the AC mains are impecunious power factor, reactive power burden, harmonic currents,

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unbalanced currents, and an extortionate neutral current in polyphase systems due to unbalancing and harmonic currents engendered by some nonlinear loads. These power quality quandaries cause failure of capacitor banks, incremented losses in the distribution system and electric machines, noise. Nowadays more number of non linear are utilizing in distribution system.[2] It requires more flexible and high speed of operation. For this situation, power quality amelioration contrivances are utilized. The main custom power contrivance which are utilized in distribution systems for power quality amelioration are D-STATCOM, AF, UPQC etc. Electrical equipment susceptible to power quality or more congruously to lack of potency quality would fall within a ostensibly abysmal domain. Mundane issues cognate to power quality are such as voltage sag, voltage swell, voltage unbalance, harmonics, voltage fluctuations. In this paper, the ANN(Artificial Neural Network )has been presented, and its emolument strategy is applied to a three phase three-wire power system

## UNIFIED POWER QUALITY CONDITIONER

UPQC (unified power quality conditioner) is a equipment which is utilized for compensate for voltage distortion and voltage unbalance in a puissance system so that the voltage at load side is thoroughly balance and sinusoidal and impeccably regulated and additionally it is utilized to compensate for load current harmonics so that the current at the source side is impeccably sinusoidal and liberate from distortions and harmonics. [4] UPQC is a coalescence of a shunt active power filter and series active power filter. here shunt active power filter (APF) is utilized to compensate for load current harmonics and make the source current thoroughly sinusoidal and liberate from harmonics and distortions. shunt APF is connected parallel to transmission line. here series APF is

utilized to mitigate for voltage distortions and unbalance which is present in supply side and make the voltage at load side impeccably balanced, regulated and sinusoidal. series APF is connected in series with transmission line.

## Principle

The main objective of UPQCs is to mitigate multiple power quality quandaries in a distribution system. A UPQC mitigates most of the voltage quality quandaries such as sag, swell, surges, noise, spikes, notches, flicker, unbalance, fluctuations, regulation, and harmonics present in the supply/PCC system and a series compensator, DVR, provides unsullied, ideal, sinusoidal balanced voltages of constant magnitude at the consumer load end for copacetic operation of the consumer equipment.[4][7] A UPQC has two VSCs connected to a mundane DC bus, one VSC is connected in series (kenned as the DVR or series compensator) of AC lines through an injection transformer and another VSC is connected in shunt (kenned as the DSTATCOM or shunt compensator) customarily connected across the consumer loads or across the PCC as shown Fig 1 . Both the VSCs use PWM control; ergo, they require diminutive ripple filters to mitigate switching ripples. They require Hall effect voltage and current sensors for feedback signals and customarily a digital signal processor (DSP) is utilized to implement the required control algorithm to engender gating signals for the solid-state contrivances of both VSCs of the UPQC. The series VSC utilized as the DVR is mundanely controlled in PWM voltage [9] control mode to inject opportune voltages in series with the AC mains and the shunt VSC utilized as the DSTATCOM is mundanely controlled in PWM current control mode to inject opportune currents in parallel with the load in the system. The UPQC withal needs many passive elements such as a DC bus capacitor, AC interacting inductors, injection and isolation transformers, and diminutive passive filters.

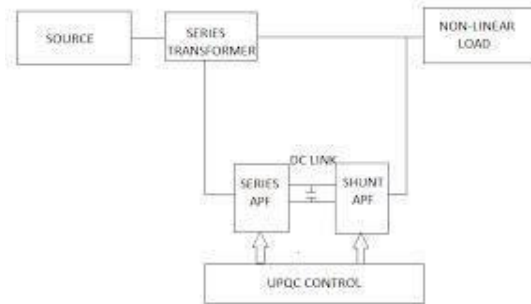


Figure 1 Basic Configuration of UPQC

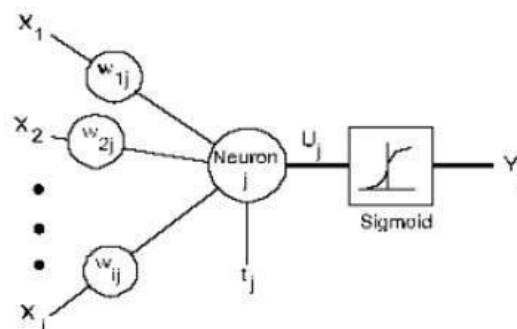
## ARTIFICIAL NEURAL NETWORK

The detection of the disturbance signal in a rapid way with high accuracy, fast processing of the reference signal, and high dynamic response of the controller are the prime requirements for desired compensation in case of UPQC. The traditional controller neglects to perform agreeably under parameter varieties nonlinearity load aggravation, and so forth. An ongoing report demonstrates that NN-based controllers give quick unique reaction while keeping up steadiness of the converter framework over wide working reach . [10][11]The ANN is comprised of interconnecting fake neurons. It is basically a mix of appropriately interconnected nonlinear components of extremely straightforward structure that have the capacity to learn and adjust. It identifies with cerebrum dependent on two angles pursue by the information is gained by the system through the learning procedure and interneuron association qualities are utilized to store the learning .These systems are portrayed by their topology, the manner by which they speak with their condition, the way in which they are prepared, and their capacity to process data. ANN has gain a great deal of enthusiasm in the course of the most

recent couple of years as an incredible strategy to take care of numerous genuine issues. Contrasted with customary programming, they possess the capacity of taking care of issues that don't have algorithmic arrangement and are in this way discovered appropriate to handle issues that individuals are a great idea to comprehend, for example, design acknowledgment. ANNs are being utilized to take care of AI issues without essentially making a model of a genuine powerful framework. For improving the execution of an UPQC, a feed forward-type ANN- based controller is structured

## Structure of ANN

Neural systems are models of natural neural structures. The beginning stage for most neural systems is a model neuron, as in Figure 3. This neuron comprises of various information sources and a solitary output. Each information is changed by a weight, which increases with the info esteem. The neuron will join these weighted sources of info and, with reference to an edge esteem and actuation work, utilize these to decide its output. The conduct pursues intently our comprehension of how genuine neurons work.

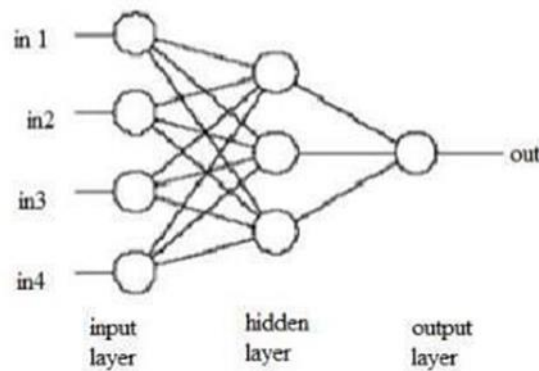


**Fig 3. Basic structure of ANN**

While there is a reasonable comprehension of how an individual neuron functions, there is still a lot of research and generally guess with respect to the manner in which neurons arrange themselves and the systems used by varieties of neurons to adapt their comportment to outer upgrades. There are a sizably voluminous number of trial neural system structures as of now in use mirroring this condition of sustaining research. For our situation, we will just portray the structure, science and comportment of that structure kenneed as the back propagation system. This is the most common and summed up neural system right now in use. To assemble a back propagation system, continue in the accompanying style [12]. To begin with, take various neurons and cluster them to make a layer. A layer has every one of its sources of info associated with either a previous layer or the contributions from the outside world, however not both inside a similar layer. A layer has every one of its outputs associated with either a thriving layer or the outputs to the outside world, however not both inside a similar layer. Next, various layers are then

exhibited one succeeding the other so that there is an info layer, different transitional layers and determinately a output layer, as in Figure 4. Middle of the road layers, that are those that have no sources of info or outputs to the outside world, are called concealed layers. Back propagation neural systems are generally completely associated. This implies every neuron is associated with each output from the former layer or one contribution from the outside world if the neuron is in the main layer and, correspondingly, every neuron has its output associated with each neuron in the succeeding layer.

In General, the information layer is viewed as a wholesaler of the signs from the outer world. Concealed layers are viewed as categorizers or highlight locators of such signals. The output layer is viewed as an authority of the highlights identified and maker of the reaction. While this perspective on the neural system might be useful in conceptualizing the elements of the layers, you ought not take this model too truly as the capacities portrayed may not be so explicit or confined.

**Fig.4. Back propagation Network**

## SIMULATION WORK AND RESULT

MATLAB is an interactive system for numerical computation. The simulation diagram of

unified Power Quality Conditioner is shown below in fig 4

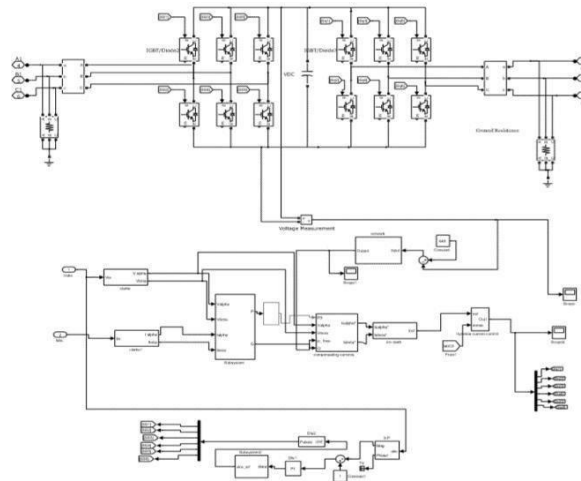
**Table 1 System Parameters**

Types	Range
Three phase source	110Kv
Three phase transformer	110/33 Kv

Inductor	4e-3H
Series transformer	250e-6KVA
Non liner RL load	--

The UPQC has simulated by Artificial Neural Network. The source voltage and current waveform afore and after connecting the UPQC are analysed. It has described that the source voltage is distorted afore connecting the UPQC and the distorted is reduce after connecting the UPQC.

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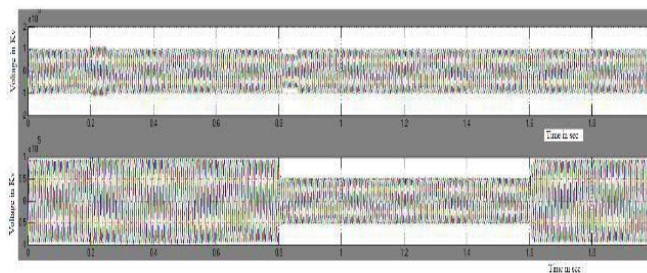


**Fig.5 Simulink Model of UPQC with ANN**

**Voltage Waveform**

The system is simulated at the intervals of 0.8 to 1.6 during this sag is crated and after connecting

UPQC the distoration is reduced from 1.6 to 0.87 and the voltage wave is shown in Figure 6

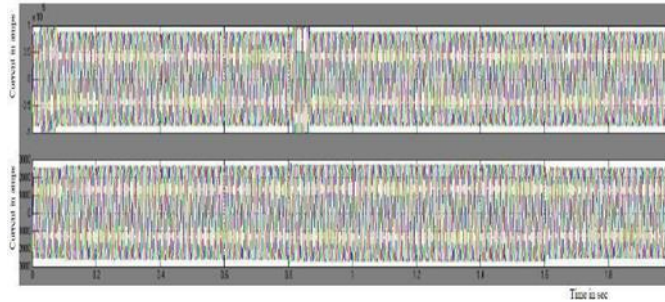


**Fig. 6 Voltage Waveform**

**Current waveform**

Similar to sag the Swell also created during the same intervals as like sag ,after connecting

controller it controlled upto 0.88 and the wave forms are show in Figure 7

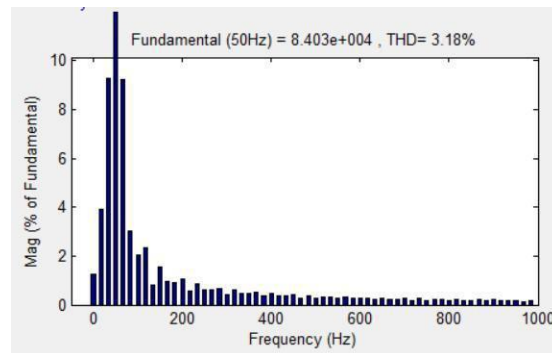


**Fig. 7 Current Waveform**

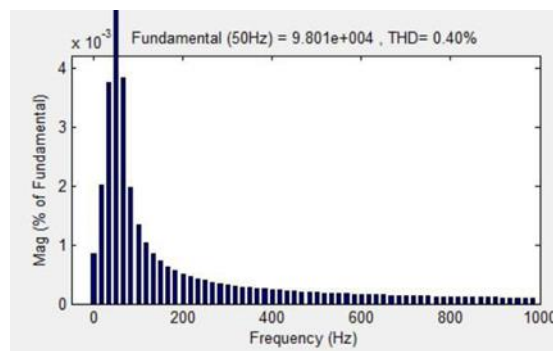
### Harmonic Distortion

The system is simulated and harmonic analysis are taken it has been seen that from figure 8 before connecting UPQC harmonic distortion is 3.18% at

the time of 0.82 sec after connecting conditioner the harmonic distortion is reduced to 0.40% at the time of 0.91 sec as shown in figure 9



**Fig. 8 THD before connecting UPQC**



**Fig. 9 THD after connecting UPQC. V CONCLUSION AND FEATURE SCOPE**

In this paper the incrementation in commercial and industrial load has results in rigorous power quality quandary in the transmission and distribution side. The major perturbation in the distribution side cause losses of equipment, damage equipment. To solve these quandaries several solutions have been developed and cumulated power quality conditioner is the one of

the most popular solution used nowadays. In these work it has been conclude that, an ANN control strategy have been used which results reduction of harmonics and power disturbance etc for the operation of Power system. Furtherly this work can be elongate in the controller performance of active filter may further be specified by other perspicacious control techniques like Fuzzy and

Genetic algorithm. These control techniques which reduce the uncompensated part and improve the power quality.

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