Power Quality Improvement by UPQC using AI Technique

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Abstract— Power Quality problems in distribution systems are not new but customer awareness of these problems increased recently. It is very important to maintained the voltage and eliminate the power quality problems because new generation load that uses microprocessor and microcontroller based controls and power electronics devices which are more sensitive to power quality variations. Using UPQC eliminate both series and shunt power quality problems. In this paper I used Neural Network controller to increase the efficiency of UPQC.

Key words: Power Quality, UPQC, Voltage Sag, Voltage Swell, Neural Network

I. INTRODUCTION

Power Quality (PQ) has become an important issue to electricity consumers at all levels of usage. The PQ issue is defined as "Any power problem manifested in voltage, current, or frequency deviations that results in failure of customer equipment." The development of power electronic based equipment has a significant impact on quality of electric power supply. Incresing the use of power electronics based equipment/loads at the distribution system, increase the nonlinear current and degrade electric power quality. The operation of these nonlinear loads/equipment generates harmonics and thus, pollutes the modern distribution system. The quality degradation leads to low power-factor, low efficiency, overheating of transformers and so on. The growing interest in the utilization of renewable energy resources for electric power generation is making the electric power distribution network more susceptible to power quality problems. In such conditions both electric utilities and end users of electric power are increasingly concerned about the quality of electric power. Many efforts have been taken by utilities to fulfil consumer requirement, some consumers require a higher level of power quality than the level provided by modern electric networks. This implies that some measures must be taken so that higher levels of power quality can be obtained.

Active power filters (APF) have been proposed as efficient tools for power quality improvement. There are two types of active power filter, Shunt active power filters and series active power filters. The series connected APF is called DVR (dynamic voltage restorer) which is generally takes care of the voltage based distortions, while shunt connected APF is called DSTATCOM (distributed static compensator) which mitigates current based distortions.

The combination of series and shunt active power filter is called the unified power-quality conditioner (UPQC). UPQC is one of the key custom power device, which compensate the voltage and current based distortion simultaneously. As the UPQC is a combination of back to back connected series and shunt APFs to a common DC link voltage, two APFs have different functions. The series APF suppresses and isolates voltage based distortions, while the shunt APF cancels current-based distortions. At the same time, it improves the power factor by compensating reactive component load current. There are many control strategies to determine the reference values of the voltage and the current, the most common are the instantaneous active and reactive power theory (the p-q theory) proposed by Akagi, symmetrical component transformation, synchronous reference frame theory (SRFT), and UTT etc.

In the present work the instantaneous active and reactive power theory (the p-q theory) based approach is used for the control of UPQC for the mitigation of different power quality problems.

II. UPQC

Unified Power Quality Conditioner (UPQC) is a multifunction power conditioner that can be used to compensate various voltage disturbance of the power supply, to correct voltage fluctuation, and to prevent harmonic load current from entering the power system.

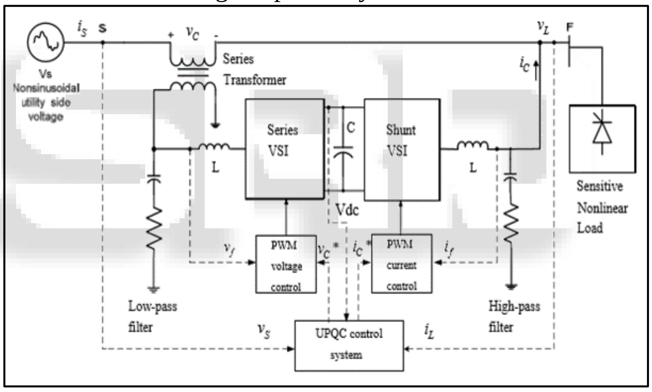

Fig. 1: system configuration of three phase UPQC

A. Series Inverter

It is a voltage-source inverter connected in series with AC line through a series transformer and acts as a voltage source to mitigate voltage distortions. It eliminates supply voltage flickers and imbalances from the load terminal voltage. Control of the series inverter output is performed by using pulse width modulation (PWM). Among the various PWM technique, the hysteresis band PWM is frequently used because of its ease of implementation. Also, besides fast response, the method does not need any knowledge of system parameters.

B. Shunt Inverter

It is a voltage-source inverter connected in shunt with the same AC line which acts to cancel current distortions, compensate reactive current of the load and improve the power factor of the system. It also performs the DC-link voltage regulation, resulting in a significant reduction of the DC capacitor rating. The output current of shunt converter is adjusted using a dynamic hysteresis band by controlling the status of the semiconductor switches such that output current follows the reference signal and remains in a predetermined hysteresis band.

C. DC Link Capacitor

The two VSIs are connected back to back with each other through this capacitor. The voltage across this capacitor provides the self-supporting DC voltage for proper operation of both the inverters. With proper control, the DC link voltage acts as a source of active as well as reactive power and thus eliminates the need of external DC source like battery.

D. Low-Pass Filter

Low pass Filter is used to attenuate high-frequency components of the voltages at the output of the series converter that are generated by high-frequency switching of VSI.

E. Series Transformer

The necessary voltage generated by the series inverter to maintain a pure sinusoidal load voltage and at the desired value is injected in to the line through these series transformers. A suitable turn's ratio is often considered to reduce the current flowing through the series inverter.

III. MODELLING AND RESULT

Neural Network Controller Based UPQC: Neural Network controller based UPQC get improved result when the fault occur in the system.DC link voltage regulator with Neural Network controller shown in figure 3.1.

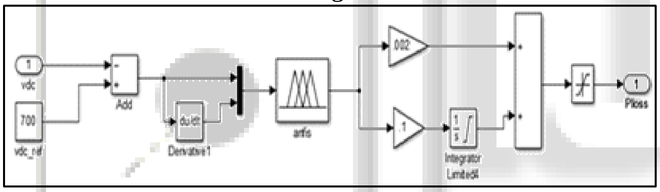

Fig. 2: DC voltage regulator with Neural Network controller

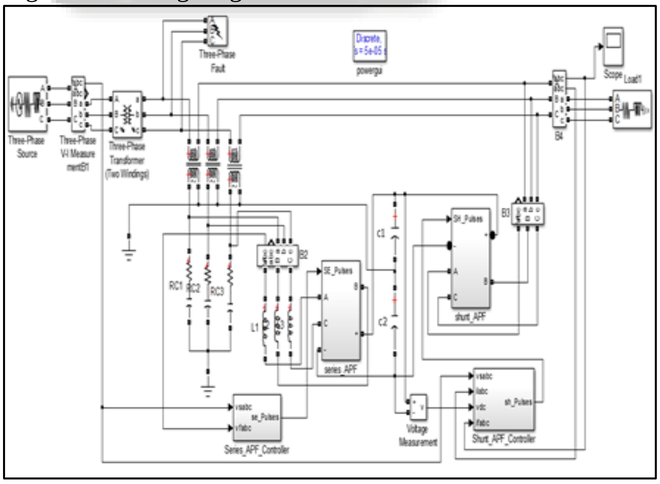

Fig. 3: Simulink model of three phase system with three phase fault

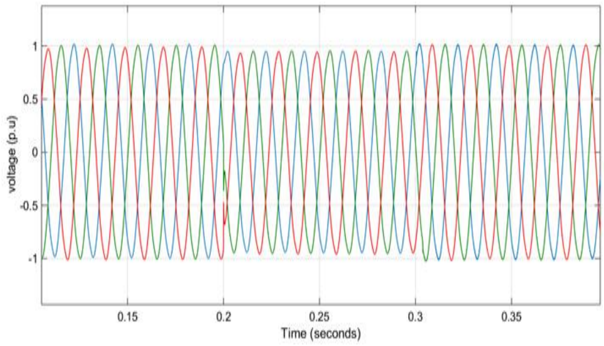

Fig. 4: Three phase voltage sag mitigation waveform by neural network based UPQC

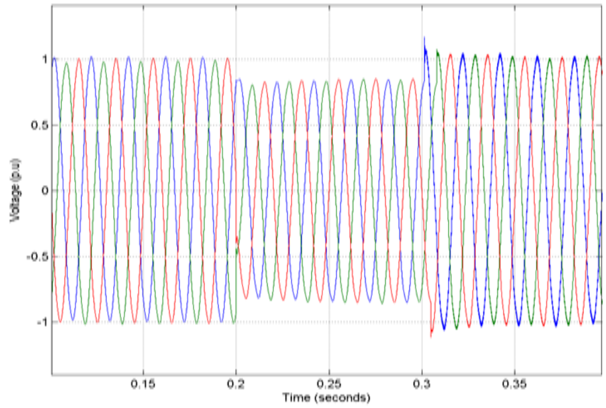

Fig. 5: Three phase voltage sag mitigation waveform with UPQC without neural network

IV. CONCLUSION

I have done the mitigation of voltage sag using UPQC. Mitigation of voltage sag is done using PI as well as neural network controller. Voltage sag at 0.2 to 0.3s with PI based UPQC is 0.85V (p.u) and neural network based UPQC is 0.95V (p.u). Simulation results shows neural network controller based UPQC has effectiveness and improved performance as the PI based UPQC. So the neural network controller is better than the PI controller.

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