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Enhancement of Power Quality in Distribution System using UPQC

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Abstract - *In this paper The recent developments in communications, digital electronics, and control system have rapidly increased the number of sensitive loads that require ideal sinusoidal supply voltage for their proper operation. So it became necessary to include some sort of compensation in order to meet limits proposed by standards. Here Unified power quality Conditioner (UPQC) has been used to overcome the power quality problem. UPQC which is a combination of back to back connected series and shunt APFs through a common DC link voltage, the two APFs function differently. Now a days our power system is facing many power quality issues. The various reasons for these power quality problems are voltage fluctuations, harmonics, transients and reactive power demands. All these power quality problems are due to changing trend of our power demand. This paper proposes a unified power quality conditioner (UPQC), The results are analyzed using MATLAB Simulink software. The results are analyzed using MATLAB Simulink software.*

Key Words: Power Quality, UPQC, Power Distribution system etc.

1. INTRODUCTION

Today only continuous power supply is not the need of time. Rather maintaining the quality of supply of power is a major issue these days. Power quality engineers are concerned about keeping the supply purely sinusoidal and at acceptable frequency but the same is not fulfilled due to the use of non linear loads, implementation of power electronics. Unified power quality conditioner (UPQC), distribution static synchronous compensator (DSTATCOM) and dynamic voltage restorer (DVR) etc. are many custom power devices. These devices are connected in series or in shunt or in a combination of both. Active power filters (APF's) are of two types: series active power filters (APF's) and shunt active power filters (APF's).

As the supply voltage gets distorted it leads to mal-operation of protection, control, and the metering equipment. So the necessity for maintenance of the power quality standards arises and to achieve a voltage that will be purely sinusoidal, the use of compensation technique is very much important. Many consumers are also there whose need of power quality is high than what provided by the electrical networks. So it's very much essential to obtain a higher quality of electrical power.

Custom power devices and FACTS devices are used widely in order to overcome these problems and in order to assure a high and better power quality. Custom power devices refer to the power electronic controllers used in the distribution systems to get a higher level of power quality. They act as power conditioning equipment that helps in mitigating the distorted voltage and current. DVR, DSTATCOM, active filters etc. are utilized as a part of request to enhance the quality of voltage and current to a better standard.

Unified Power Quality Conditioner (UPQC) is a very effective step in improving these power quality problems. It is a combination of parallel-Active Power Filter and Series-Active power Filter. Both of these filters are associated through the same dc link. Parallel active filter is connected parallel with the load. It helps in compensating the harmonic current flowing through the load, compensates reactive power demand of the load and helps in maintenance of a constant dc link voltage. On the other hand, series active power filter is connected in series with the utility voltage by the help of series transformer and helps in maintenance of a sinusoidal the load voltage. So as a whole it helps in a simultaneous compensation of the delivered load voltage and source side currents.

2. DISTRIBUTION SYSTEM

The distribution substation is the interconnection element between the distribution system and the upstream power delivery system. At the substation the step-down (HV/MV) transformer reduces the sub transmission voltage level to an appropriate value for primary distribution lines. Different protection, switching, and measurement equipment is installed at the substation to ensure a safe operation. The primary distribution lines spread across the consumption area served by the substation, these primary distributions lines are also known as feeders. One or more lateral lines (or laterals) branch from distribution feeders and extend until they reach the step-down (MV/LV) distribution transformers, which are responsible for performing the final voltage reduction in order to obtain a voltage level adequate for customer use (e.g. 400 and 230 V). The secondary distribution lines operating at a low-voltage level transport the energy to the customer's interconnection point; these lines are usually one-phase but there can also exist three-phase circuits.

3. POWER QUALITY AND ITS EFFECT ON DISTRIBUTION SYSTEM

The As indicated by the IEEE principles, Power quality can be characterized as the technique for grounding and

supplying sensitive equipment with power so as to get a reasonable and agreeable performance of the equipment .Overall power quality represents a blend of quality of the current and voltage. Voltage quality at the point of connection is governed by the network operator whereas the quality of current at the connection point is governed by the client's load.

The guidelines for measurement of power quality of distribution system are developed by The International Electro-Technical Commission (IEC) in coordination with the Technical Committee-88. This commission explained the methodologies for measuring the power quality characteristics of a distribution system [16]..

Perfect power quality means that the voltage is continuous and sinusoidal having a constant amplitude and frequency. Power quality can be expressed in terms of physical characteristics and properties of electricity. It is most often described in terms of voltage, frequency and interruptions. The quality of the voltage must fulfill requirements stipulated in national and international standards. In these standards, voltage disturbances are subdivided into voltage variations, flicker, transients and harmonic distortion [17]. Fig. 1 shows a classification of different power quality phenomena.

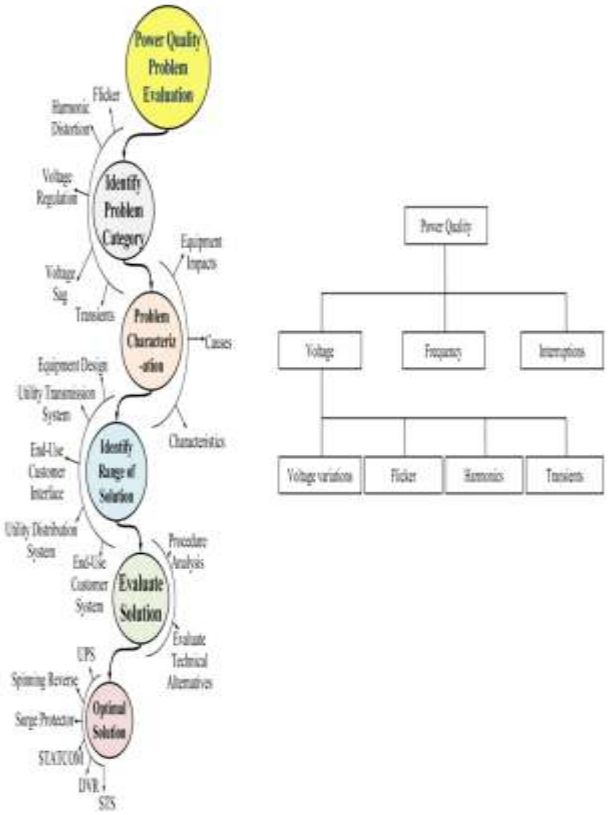

Figure.1: Flow diagram for evaluation of power quality problems, solution of a problem comes through a process starting with identification of the problem category.

4. UPQC

In order to compensate the current related problems such as load unbalance compensation, reactive power compensation , current harmonic filter shunt active power filters(APF) are used and to compensate voltage related problems such as voltage sag, voltage swell, harmonics etc series active power filters(APF) are used. Unified power quality conditioner (UPQC) aims at integrating both shunt and series active power filters (APF) through a common dc link capacitor. Construction wise both unified power quality conditioner (UPQC) and unified power flow controller(UPFC) both are similar. Unified power quality conditioner (UPQC) aims at conditioning the power supply by eliminating the disturbances that adversely affect the performance of the load in power system. Unified power quality conditioner (UPQC) is used to improve the quality of power on power distribution system at the point of installation.

- The nature, magnitude and duration of the PQ event
- The frequency of the event
- The sensitivity of the component to the event
- The location of the equipment within the customer's installations
- The age of the component

The loss of the power supply causes operational hassle to the consumer and monetary losses for the consumer and the utility. In the industrial production unit, the cost of unsupplied energy due to an outage is much higher than the cost of the supplied energy that is supplied when it is needed.

4.1. UPQC Configuration

The main components of UPQC are the following:

- Shunt Inverter
- Series Inverter
- LC filter
- Transformer
- Coupler etc.

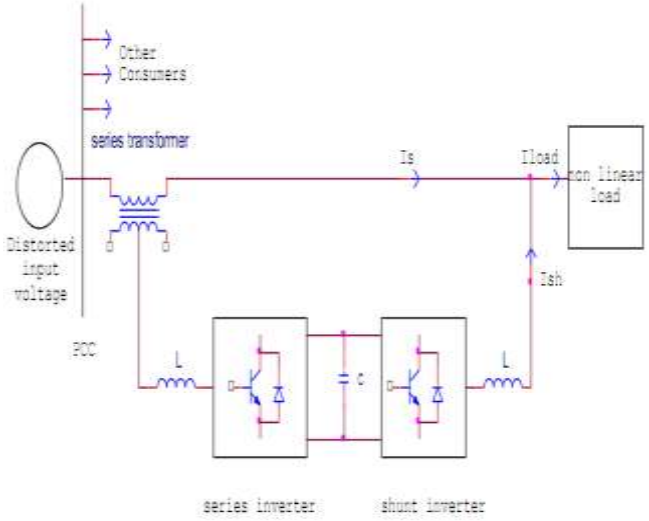

Figure.2: Basic block diagram of UPQC

4.2. UPQC Controlling Technique

Various control techniques have been used for the control of harmonics in voltage and current by using UPQC. Here mainly two methodology has been described i.e. the unit vector template generation technique and the Synchronous reference frame and PQ theory

- *UNIT VECTOR TEMPLATE GNERATION*
- *SYNCHRONOUS REFERENCE FRAME AND P-Q CONTROL OF UPQC*

For household customers, voltage sag might cause regular disturbances and hamper the tempo of completing the normal work. The Voltage sag is measured by the magnitude of voltage drop and its duration. Different devices have different sensitivity towards voltage sags and are described by their individual voltage tolerance curves. When voltage sag occurs, the voltage available at the equipment terminal is lower than the nominal voltage.

5. MATLAB MODEL AND RESULT:

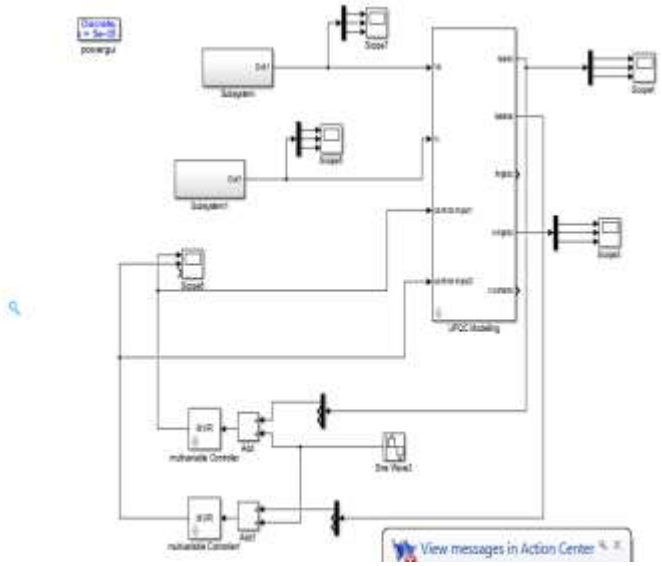

Figure.3: Simulink Model of UPQC For Distribution System

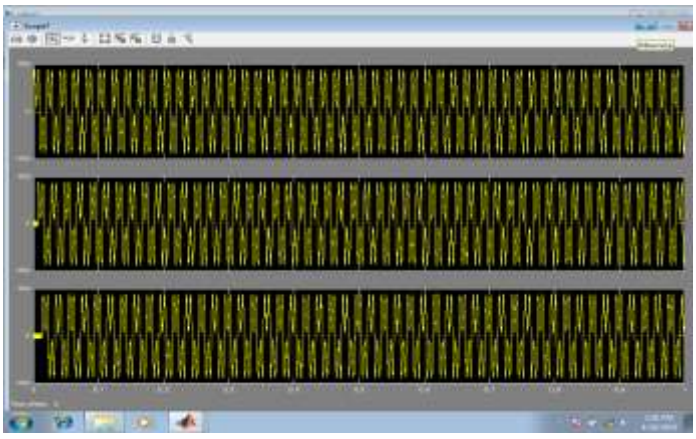

Figure.4: 3- phase input wave form

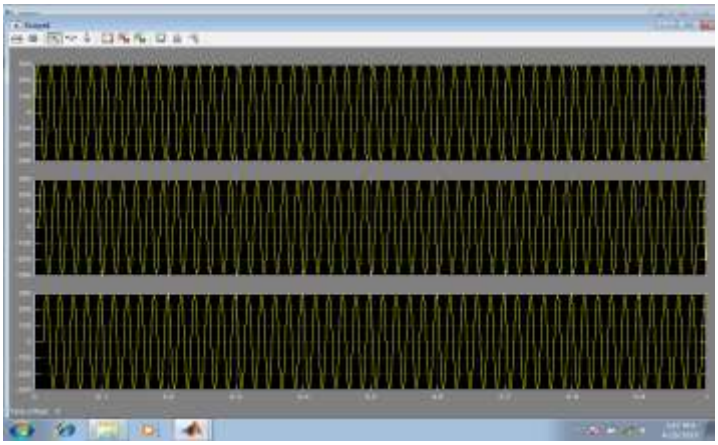

Figure.5: 3- phase output wave form

6. CONCLUSION:

A simplified control of UPQC that is relies on generation of unit vector templates and another method based on synchronous reference frame, P-Q control technique has been given for UPQC. Both of these methodologies provides effective solution for the improvement of power quality, solving the problems related with the power quality and helps in mitigation of voltage and current harmonics. Simulation of a Simulink based model has been done. From the simulation results it can be inferred that the current harmonics that are caused by non-linear load can be compensated very effectively by using proposed synchronous reference frame control method.

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