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Unified Power Quality Conditioner (UPQC) For Harmonic Reduction Using Hysteresis Current Control

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Abstract:
The problem of voltage ride through capability of fixed speed wind generation as a result of voltage sags is examined by means of a simulation study. The role of a Unified Power Quality Conditioner (UPQC), which provides both shunt and series compensation, in enhancing the ride through capability is investigated under both full and partial voltage restoration. The results are analyzed and presented using matlab/simulink software. The problem of voltage ride through capability of fixed speed wind generation as a result of voltage sags is examined by means of a simulation study. The role of a Unified Power Quality Conditioner (UPQC), which provides both shunt and series compensation, in enhancing the ride through capability is investigated under both full and partial voltage restoration. Results of a study to identify the minimum rating requirements to ensure stability are presented.

Keywords:
Hysterisis current control, UPQC, Voltage sag,

Introduction:

Power quality is the set of limits of electrical properties that allows electrical system to function in proper manner without significant loss of performance. Like flexible ac transmission system, the term custom power use for distribution system. Just as facts improve the reliability and quality of power transmission system, the custom power enhances the quality and reliability of power that is delivered to customers [1][8]. The main causes of a poor power quality are harmonic currents, poor power factor, supply voltage variations, etc.

In recent years the demand for the quality of electric power has been increased rapidly. Power quality problems have received a great attention nowadays because of their impacts on both utilities and customers. Voltage sag, swell, momentary interruption, under voltages, over voltages, noise and harmonics are the most common power quality disturbances [2]. There are many custom power devices. The devices either connected in shunt or in series or a combination of both. The devices include D-STATCOM, DVR and UPQC etc.One of the most common power quality problems today is voltage dips. A voltage dip is a short time event during which a reduction in R.M.S voltage magnitude occurs. Despite a short duration, a small deviation from the nominal voltage can result in serious disturbances.

A voltage dip is caused by a fault in the utility system, a fault within the customer’s facility or a large increase of the load current, like starting a motor or transformer energizing. Unified power quality conditioner (UPQC) is one of the best custom power device used to compensate both source and load side problems [3][9]. It consists of shunt and series converters connected back to back to a common dc link. It can perform the functions of both DSTATCOM and DVR. In this paper a fuzzy logic controller is used to compensate voltage sag and it is compared with neural network based controller.

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The addition of energy storage through an appropriate interface to the power custom device leads to a more flexible integrated controller. The ability of the UPQC-ESS to supply effectively active power allows expanding its compensating actions [16]. Various types of advanced energy storage technologies can be incorporated into the dc bus of the UPQC, namely superconducting magnetic energy storage (SMES), ultra-capacitor energy storage (aka super-capacitor energy storage - UCES/SCES respectively) and flywheel energy storage (FES), among others. However, ultra-capacitors (UC) have distinct potential advantages for energy storage which make them almost unbeatable in many applications [4][10].

II. UPQC SYSTEM WITH CONTROL METHODS:

UPQC mainly includes three parts: the series active power filters, shunt active power filters and energy storage capacitors.

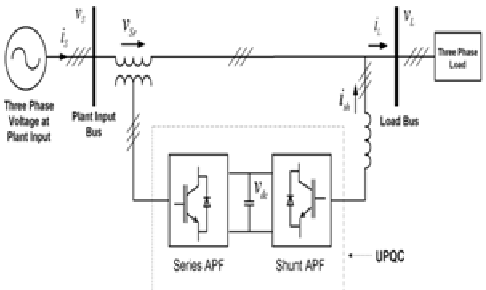

Figure 1. Topology of upqc

The series and shunt active power filter couples together through the DC-link energy storage capacitors. Series APF connected to the grid and load by coupling transformer is mainly used to adjust the load voltage amplitude and compensate the power supply voltage sag in the controlled voltage source mode. Shunt active filter connected to the load is used to compensate load currents [5][13].

III. Hystersis Control:

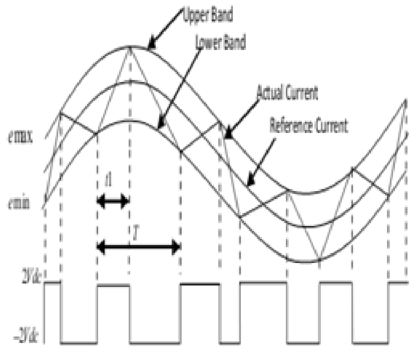

Fig:3 Waveform of Hysteresis current controller

A hysteresis current controller is implemented with a closed loop control system and waveforms are shown in Fig 4.4. An error signal exceeds the upper limit of the hysteresis band, the upper switch of the inverter arm is turned off and the lower switch is turned on. As a result, the current starts decaying [14]. If the error crosses the lower limit of the hysteresis band, the lower switch of the inverter arm is turned off and the upper switch is turned on. As a result, the current gets back into the hysteresis band [6][11]. The minimum and maximum values of the error signal are e_{min} and e_{max} respectively. The range of the error signal e_{max} - e_{min} directly controls the amount of ripple in the output current from the VSI.

VI. DESIGN OF UPQC USING MATLAB SIMULATION

Simlink Model of a System with UPQC

SIMLINK model of system with UPQC is shown in below figure. The simulation results show that the input voltage harmonics and the current harmonics caused by non-linear load can be compensated very effectively by using proposed control strategy. The total harmonic distortion value also decreased when compared to system without UPQC [7][12].

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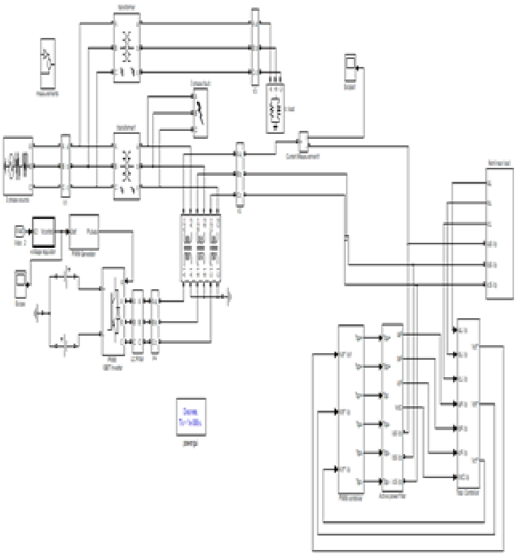


Fig.6.15: Simlink model of system with UPQC

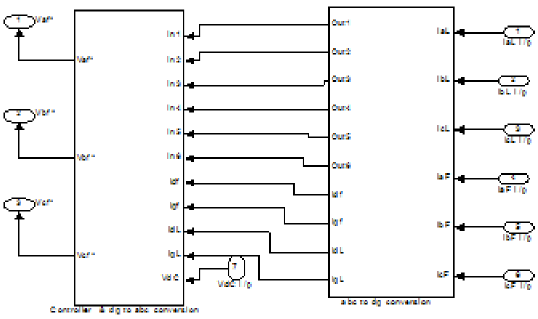
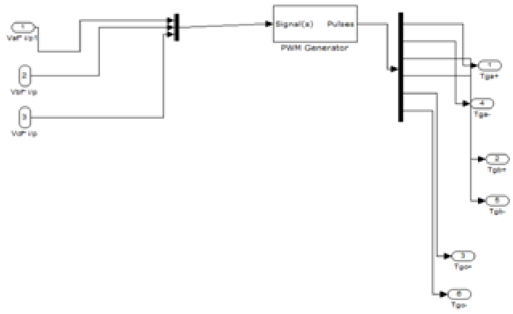


Fig .6.2 Simulink Model for conversions and for producing reference waves V_{af}, V_{bf}, V_{cf}.

Fig.6.2 is a simulink model consists of two subsystems one is abc to dq transformation Subsystem another one is dq to abc transformation and also having current controllers. Here transformation is doing for sake of simplicity and easy of calculations for designing the controller to the analytical model of Active Power Filter [13][15].



Simulink Model for PWM control of APF for Gating pulses

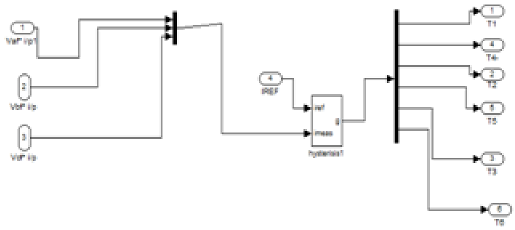
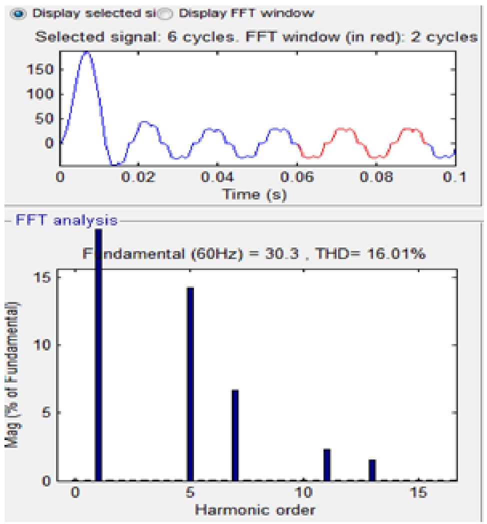


Fig .6.5 Simulink Model for hystesis control of APF for Gating pulses



THD without compensation

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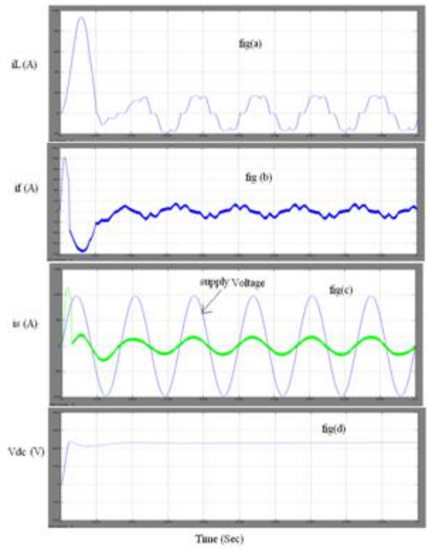
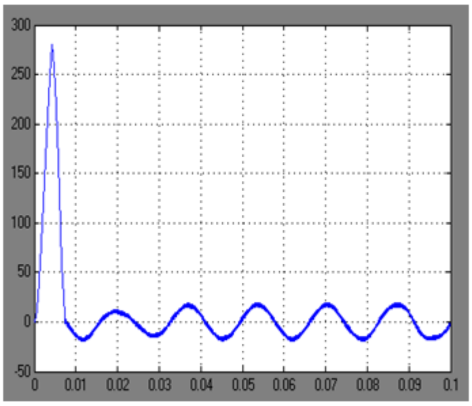
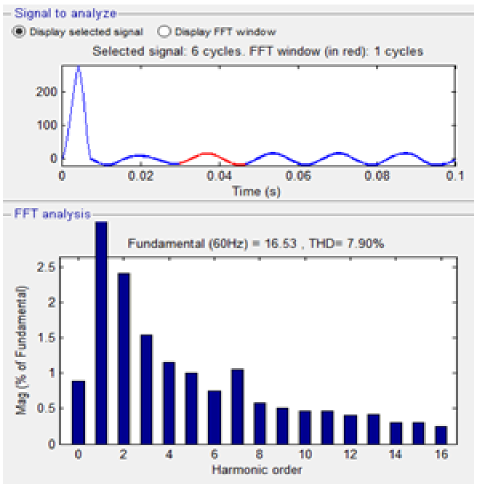


Fig.6.22(a) Distorted load current ia_L



Source voltage with compensation



THD with compensation

CONCLUSION:

A Power quality problem is an occurrence manifested as a nonstandard voltage, current or frequency that results in a failure or a misoperation of end use Equipments. Utility distribution networks, sensitive industrial loads, and critical commercial operations all suffer from various types of outages and service interruptions which can cost significant financial 1oss per incident based on process down-time, lost production, idle work forces, and other factors. With the restructuring of Power Systems and with shifting trend towards distributed and dispersed Generation, the issue of Power Quality is going to take newer dimensions. The aim therefore, in this work, is to identify the prominent concerns in the area and thereby to recommend measures that can enhance the quality of the power, keeping in mind their economic viability and technical repercussions. So the studies are presented in this to mitigate the above problems by the utility of custom power devices such as Unified power Quality Conditioner is used to compensate the voltage sag and swell cases and it also improves the power factor. The control strategy is based on unit vector templates which are given to hysteresis controller to reduce the voltage variations. Simulation results carried out by the MATLAB/SIMULINK shows that the proposed method to inject the required voltage which is based on a control system based on dqo technique for sag and swell conditions is presented.

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