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# A NOVEL WIND ENERGY BASED COORDINATED ACTIVE POWER SHARING UNIFIED POWER QUALITY CONDITIONER

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## ABSTRACT

This Paper presents A Novel Wind Energy Based Coordinated Active Power Sharing Unified Power Quality Conditioner. With the advancement of technology, the dependency on the electrical energy has been increased greatly. To meet the increased energy demand renewable energy sources (RES) like solar, wind, biomass etc. will be integrated to the distribution system directly. On the load side we are using more and more non-linear loads which also cause power quality issues in the system. Hence it is necessary to mitigate the power quality (PQ) issues in the distribution system in the presence of renewable energy source. This paper deals with the mitigation of power quality issues in the presence of unified power quality conditioner (UPQC).

Normally, the UPQCs are used to mitigate both voltage and current power quality problems. However, these UPQCs are also used for delivering active power in addition to its power quality improvement by integrating distributed generation (DG) at the DC link of back to back connected converters. But, only the shunt converters are used to carry the whole active power from the DG sources and the series converters are used to handle only voltage related power quality problems. So, the shunt converter is loaded heavily and the series converter is kept idle in steady state cases. The more dependency on the shunt converter also reduces the reliability of the total system. This proposed control strategy is used to carry active power through both series converter and shunt converter even at the steady state conditions. The proposed method improves the utilization of the converters and also the reliability of the system.

The effectiveness of the proposed control strategy is demonstrated by comparing with the conventional control algorithm, where only the shunt converter is used to carry active power. The proposed system is validated by performing SIMULATION in Matlab software.

## I.INTRODUCTION

Wind energy is one in every of the most to be had and utile kinds of renewable energy. Among the several renewable strength belongings, wind energy has emerged due to the truth the maximum capability deliver of wattage, and is economically energetic with the conventional belongings. Since then there has been associate diploma developing plan to assemble wind driven turbines to be used in secluded companies with minor sources in the form of water electricity or coal strength, and at places that cannot be expeditiously linked to public provide networks. Another reason for the worldwide trouble in developing wind technology plants is that the quick developing call for energy and additionally the ensuing depletion of fossil fuels, mainly, coal and oil, whose reserves square diploma constrained.

Generation of electricity from renewable belongings has superior substantially. Utilizing of wind strength as a renewable deliver to get power has superior especially rapid and hundreds of enterprise wind producing devices square degree currently accessible in the marketplace. The rate of producing power from wind has fallen really 90% since the Eighties. Wind may be a variable and random deliver of power. All sorts of machines, i.E., DC, synchronous, induction, searching on the scale of the gadget are acquainted with convert this shape of energy to electricity. The growth of wind power for wattage generation had been given beautify as quickly as, within the early a long term of the twentieth century, aviation instrumentality resulted in accomplice diploma expanded acceptive of the forces working on blades moving through air. This resulted inside the development of turbine with 2 or three blades.

One of the most attention-grabbing systems of power conditioner is two consecutive associated dc/ac virtually managed converters. During this example, looking on the control situation, the converters may additionally have sincerely wonderful reimbursement features. For instance, they'll function as active series and shunt filters to compensate on the identical time load current harmonics and provide voltage fluctuations. During this example, the instrumentality is called unified power quality conditioner (UPQC).

An active shunt filter can be a suitable tool for current-based compensation. It will compensate cutting-edge harmonics and reactive strength. The active series filter is often used for voltage harmonics and voltage sags and swells compensation. The UPQC, that has 2 inverters that share one DC hyperlink electric tool, will compensate the voltage sag and swell, the harmonic contemporary-day and voltage and manage the potential go with the go with the flow and voltage balance.

In this paper we are using wind energy as a supply of energy for UPQC and battery energy storage system (BESS) is established at the dc link of again to once more related converters with the purpose of voltage regulation.

**1.1 OBJECTIVE OF THE THESIS:**

A new coordinated active power management strategy has been projected to share the active power between the shunt and series converters of the UPQC for top Power Generation victimisation Wind Turbines. This projected management strategy has been compared with the traditional management strategy of the UPQC by victimisation hardware-in-the-loop experimental results.

By using HIL consequences, The overall potential of causing the active power through the series device has been incontestable. This management rule reduces the burden on the shunt device and conjointly refines powerful duty of spectacular synchro.

## II. LITERATURE SURVEY

A survey has been done from relevant papers is as follows, This situation presents effect of UPQC on wind energy conversion system (WECS) through showing its active filter behavior due to the nature affiliation of the each power controllers that appear as if same structure with the conventional power convertors of Double fed induction generator (DFIG) .This paper has pictured a review paper for economical system for unified power quality conditioner that makes it gettable to cut back the voltage fluctuations like sag and swell conditions, further as current and voltage harmonics mitigation in wind energy conversion system.

In some papers, performance of the custom power devices are analysed, which is connected with the point of common coupling during wind fluctuation. Amongst all the continuous upholster woodwind instrument will be which spectacular important natural resource consisting of vigor extra point system of rules. In general, energy is obtained by harnessing the wind at no price.Power quality is that the live of ideal power provide system. Unreliable nature of wind influence the matter of power quality in grid interconnected system.

when powerful woodwind world power will be feeding prospering so sensational facility urogenital, the it prompts spectacular great power wholesomeness containing core router. Most common power quality issues are voltage sag, voltage Swell, harmonics, frequency changes and reactive power problem. In order to keep away from the above-mentioned major power visual aspect complications tradition superpower units have a tendency to be victimised. Such unremarkably victimized evidence transmitters will be SVC, STATCOM along with UPQC. These devices are connected at purpose of common coupling with battery energy system to cut back the facility quality drawback. This paper clearly reviews the varied power quality problems and moreover because the role of FACTS devices in resolution these problems.

In other case an increased generation of wind power gives high potential support to meet out the power demand. Supply of wind generation into associate degree electrical grid affects the facility quality. The presence of the turbine in grid system owes to the facility quality problems like active /reactive power variation, voltage sag/swell and harmonics. In this projected theme, UPQC is connected to a transmission line to mitigate the power quality issues. The UPQC management theme for the grid connected wind energy generation system for power quality improvement is simulated exploitation MATLAB/SIMULINK in installation block set.

This paper mainly focuses on economical system of unified power quality conditioner that creates it attainable to cut back the voltage fluctuations like sag and swell conditions, as well as current and voltage harmonics mitigation in wind energy conversion system. The UPQC which can be used at the PCC for improving power quality is modeled and simulated using proposed control technique and the performance is compared by applying it to a wind energy conversion system with UPQC and with traditional power device. The assistance containing of MATLAB/SIMULINK habitat slashing items consisting of spectacular DFIG and UPQC are going to be progressed.

## III.POWER QUALITY AND ITS ISSUES

Power quality determines powerful intensity of electric great power up to drinker waiting game. synchronism of powerful electromotive force radio frequency as well as part permits avionics that one may function of their projected properness devoid of sizable lack of underachievement or liveliness. Powerful term is employed that one may explain electric superpower which steers plus electric load & sensational loads skill so function pleasantly.Without the suitable power, an electrical device may failure, fail impulsively or not operate at all. There are several ways in which electric power can be of poor quality and several new causes of such poor quality power.
The different classifications for Power quality issues, each using a specific property to categorize the problem.

## POWER QUALITY ISSUES:

Voltage sag or voltage dip, Short interruptions, Long interruptions, Voltage spike, Voltage swell, Harmonic distortion, Voltage fluctuation, Noise, Voltage unbalance

## IV.PULSE WIDTH MODULATION

Pulse Width Modulation (PWM) uses digital signals to manage power applications, still as being fairly simple to convert back to analog with a minimum of hardware.

Analog systems, such as linear power supplies, tend to generate a lot of heat since they are basically variable resistors carrying a lot of current. Digital systems don't generally generate as much heat. Almost all the warmth generated by a Switching device is throughout the transition (which is finished quickly), while the device is neither on nor off, but in between. This is because power follows the following formula:

**P = E I, or Watts = Voltage X Current**

If either voltage or current is near zero then power will be near zero. PWM takes full advantage of this fact.

PWM will have several of the characteristics of Associate in Nursing analog system, in that the digital signal can be free wheeling. PWM doesn't need to capture information, though there ar exceptions to the current with higher end controllers.

### 4.1DUTY CYCLE

One of the parameters of any sq. wave is duty cycle. Most square waves are 50%, this is the norm when discussing them, but they don't have to be symmetrical.
The ON time are often varied utterly between signal being off to being totally on, 0% to 100%, and all ranges between.
Shown below square measure samples of a 10%, 50%, and 90% duty cycle.
While the frequency is that the same for every, this is not a requirement.

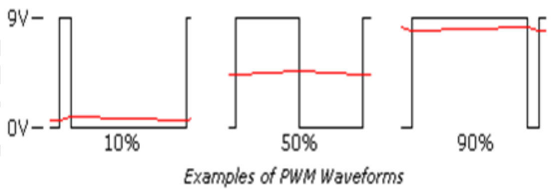


Figure.1.PWM Waveforms

## V.UNIFIED POWER QUALITY CONDITIONER

The Unified Power Quality Conditioner is a tradition power device that is engaged in the distribution system to diminish the disturbances that have an effect on the performance of sensitive and/or critical load. It is a type of hybrid APF and is the only versatile device which can mitigate several power quality problems related with voltage and current simultaneously therefore is multi functioning devices that compensate varied voltage disturbances of the power supply, to correct voltage fluctuations and to forestall harmonic load current from entering the power system.

UPQC has shunt & series compensation capabilities for harmonics, reactive power, voltage disturbances, and power flow control. Normally a UPQC consists of two voltage source converters with a typical DC link designed in single phase, three phase three wire, or three phase four wire configurations. One converter is connected in series through a transformer between the source & the critical load at the PCC and operates as a voltage

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source inverter (VSI). The other converter is connected in shunt at the PCC through a transformer and operates as a current source inverter.

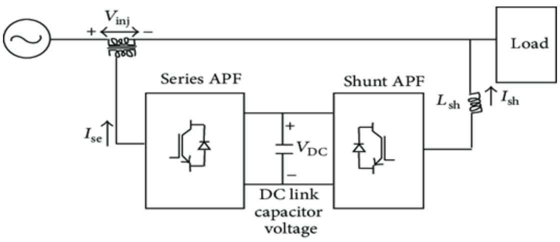


Figure.2. UPQC general block diagram

The main purpose of a UPQC is to compensate for supply voltage power quality issues, such as, sags, swells, unbalance, flicker, harmonics, and for load current power quality problems, such as, harmonics, unbalance, reactive current, and neutral current.

**CONTROL SCHEME**

The Unified Power Quality Conditioner having two types of controllers one is shunt UPQC controller it is responsible to determine the compensating current references for PWM control of the UPQC shunt converter. Another one is series UPQC controller it is responsible to determine the compensating voltage references for PWM series converter.

**Shunt upqc controller**

The shunt UPQC controller is connect with the shunt transformer in transmission line, it is used for determine the compensating current references for PWM control of the UPQC shunt converter. It is used as the current minimization algorithm.

**Current minimization algorithm**

It determines the instantaneous compensating current references, which should be synthesized by the shunt PWM converter of the UPQC. It has the same kernel as the Generalized Fryze Currents methods widely used. The inputs of the controller are the load currents $i_{a1},i_{b1},i_{c1}$ the control voltages $V_{a1},V_{b1},V_{c1}$ determined by the $V_{+1}$detector, and the DC voltage regulator signal Gloss .

Since the shunt active filter of the UPQC compensates the difference between the calculated active current and the measured load current, it is possible to guarantee that the compensated currents $I_{as},I_{bs},I_{cs}$ drawn from the network are always sinusoidal, balanced and in phase with the positive sequence system voltages.

**VI.WIND POWER**

The terms "wind energy" and "wind power" both describe the process by which the wind is used to generate mechanical power or electricity. Wind turbines convert the kinetic energy from the wind into mechanical power. This mechanical power can be used for specific tasks (such as grinding grain or pumping water) or a generator can convert this mechanical power into electricity.

A wind turbine turns energy in the wind into electricity using the aerodynamic force created by the rotor blades, which work similarly to an airplane wing or helicopter rotor blade. When the wind flows across the blade, the air pressure on one side of the blade decreases. The difference in air pressure across the two sides of the blade creates both lift and drag. The force of the lift is stronger than the drag and this causes the rotor to spin. The rotor is connected to the generator, either directly (if it's a direct drive turbine) or through a shaft and a series of gears (a gearbox) that speed up the rotation and allow for a physically smaller generator. This translation of aerodynamic force to rotation of a generator creates electricity.

**THE INSIDE OF A WIND TURBINE**

Wind turbines harness the power of the wind and use it to generate electricity. Simply stated, wind turbines work the opposite of a fan. Instead of using electricity to make wind—like a fan—wind turbines use wind to make electricity. The wind turns the blades, which in turn spins a generator to create electricity. The detailed view of the inside of a wind turbine, its components, and their functionality are as follows

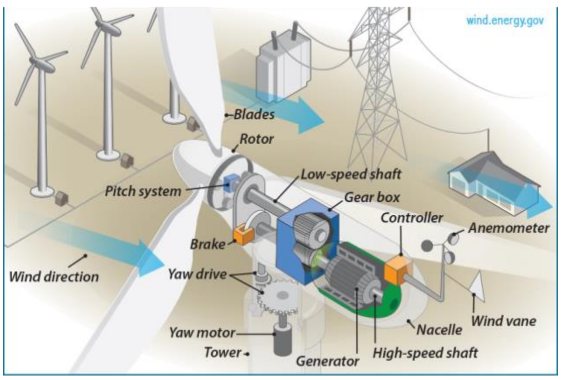


Figure.3..Inside of a wind turbine

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## VII.MATLAB SIMULATION RESULTS

The co-ordinated active power sharing between each series and shunt converters of the UPQC are by experimentation valid by mistreatment the simulation results. This UPQC-P is taken into account as a standard topology for the comparison. In UPQC-P, the voltage sag and swell are paid by mistreatment active power. The performance of the planned and traditional management algorithms are compared for various conditions like voltage sag, voltage swell, modification asynchronous convertor power reference and alter in metric weight unit power. Figures below show the dynamic performance comparison between the planned and also the typical management algorithms. Here within the results, solely ‘a’ section is recorded out of 3 phases, that ar denoted by adding ‘a’ within the subscript of the notations. ends up in the take a look at ar recorded in terms of grid voltage (Vga), load voltage (Vla), series convertor voltage (Vsea), DC link voltage (Vdc), active power from the grid (Pg), series convertor active power (Pse), shunt convertor active power (Psh) and metric weight unit active power (Pdg).

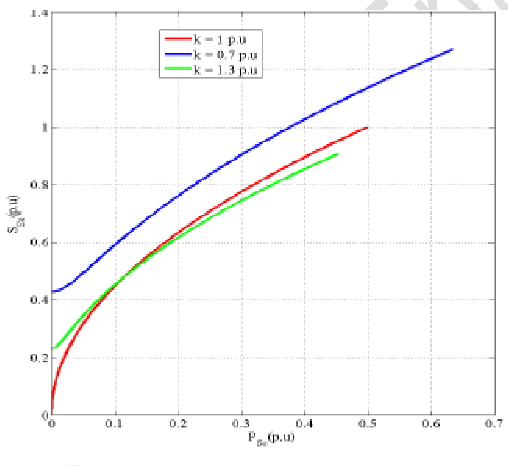


Figure.4.Variation of the series convertor apparent power with the variation in the active power injection for various grid voltages.

**Simulation Diagram:**

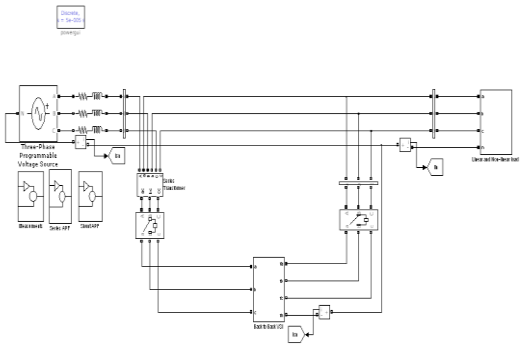

Figure.5.Matlab Simulation Circuit.

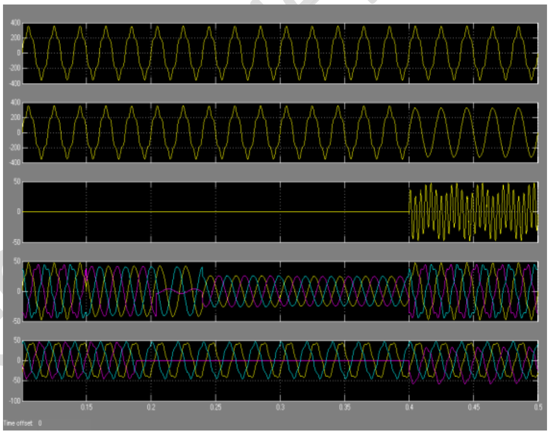

Figure.6.Response of UPQC for the compensation of customer generated harmonics.

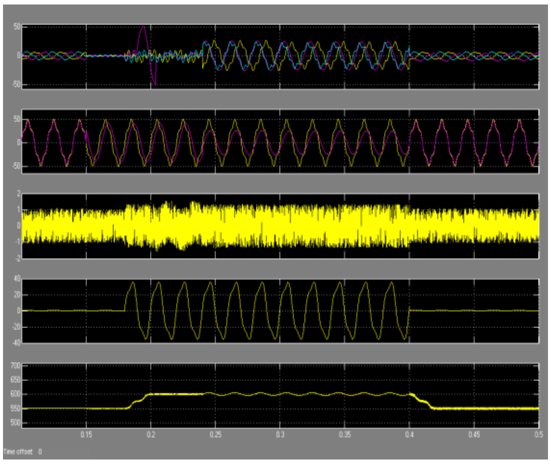

Figure.7.Dynamic Response of UPQC for the compensation of customer generated harmonics only (from t=0.1 s to t=0.15 s), total source current harmonics only (from t=0.15 s to t= 0.24 s), total source current harmonics and negative sequence components only (from t=0.24 s to t= 0.32 s), total source current harmonics, negative sequence

components and reactive power compensation (from t=0.32s to t= 0.50 s).

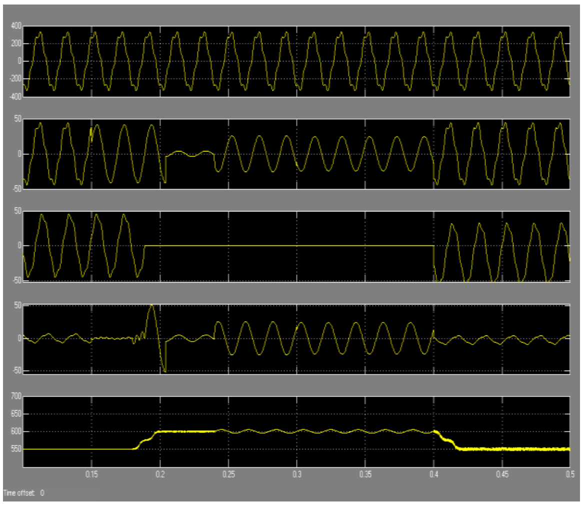

Figure.8.Source voltage (Vsb),source current(isb),load current( ilb ),Compensator current( icb) and DC link voltage (Vdc )

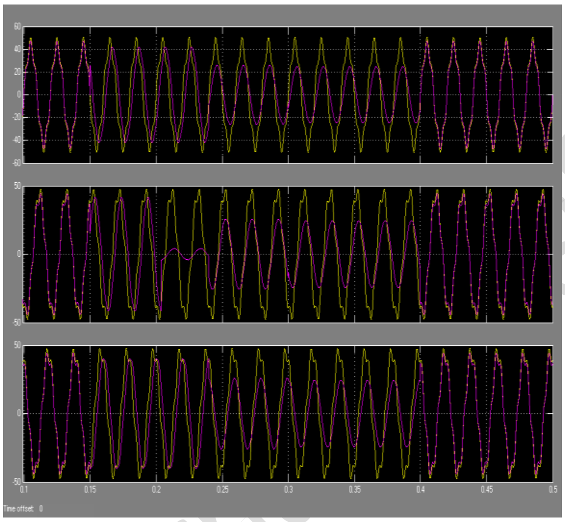

Figure.9.Source voltage and source current in phase ‘a’(Vsa, I sa), source voltage and source current in phase ‘b’(Vsb, isb) and source voltage and source current in-phase ‘c’(Vsc, I sc) and DC link voltage( Vdc)for customer generated harmonics only, total source current harmonics compensation, total source currents harmonics and negative sequence component compensation and total source currents harmonics, negative sequence component compensation and reactive power compensation, respectively.

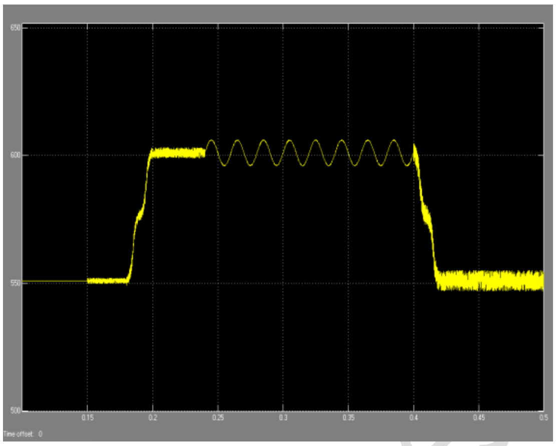

Figure.10.$V_{dc}$

### 7.2 UPQC EXTENSION (wind):

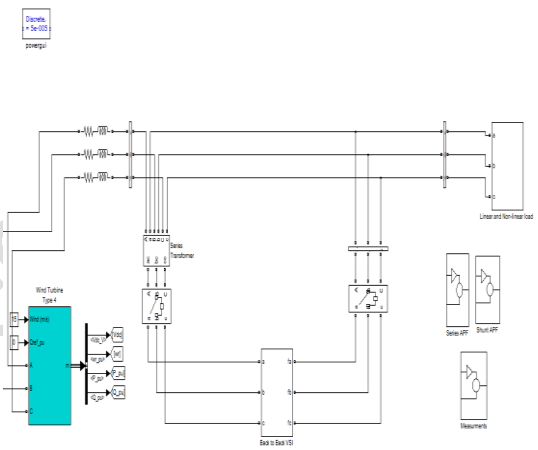

Figure.11.Matlab Extension circuit (Wind Energy)

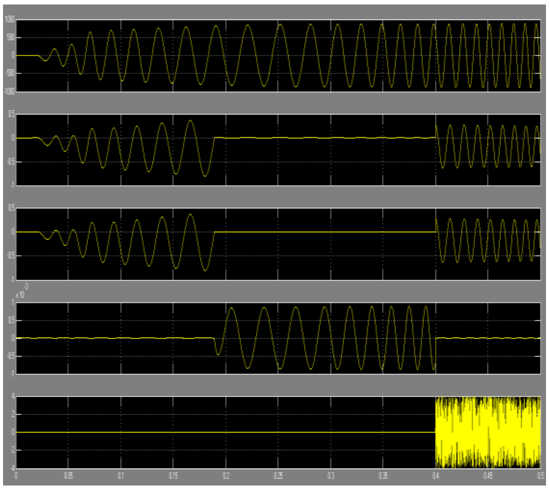

Figure.12.Source voltage (vsb),source current(isb),load current(ilb),Compensator current(icb) and DC link voltage (Vdc )

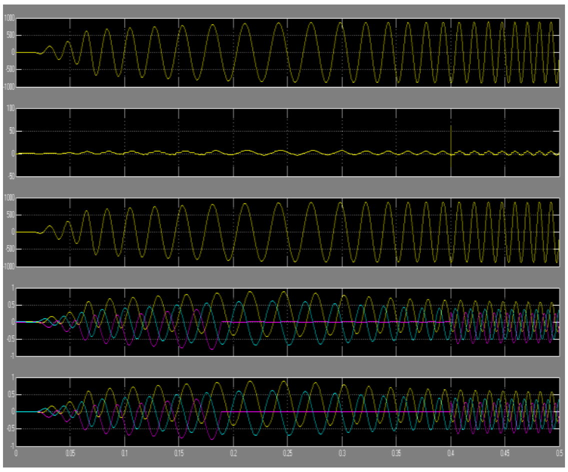

Figure.13..Dynamic response of UPQC for the compensation of customer generated harmonics.

## VIII. CONCLUSION

The work given above lies within the scope of the seek for new solutions for the improvement of the power quality within the electrical supply network. The parallel active filter aimed to complete the harmonic, reactive and unbalanced interference currents. The active filter series its objective was the compensation of the harmonic disturbing voltage, and of the voltage sags and Swells. Finally, the UPQC) was projected as a general answer of the compensation of all the disturbances because of voltage or/and current

A replacement coordinated active power management strategy has been planned to share the active power between the shunt and series converters of the UPQC for prime power generation mistreatment wind turbines. This planned management strategy has been compared with the standard management strategy of the UPQC by mistreatment hardware-in-the-loop experimental results. By mistreatment HIL results, the potential of causing the active power through the series convertor has been incontestable . This management algorithmic program reduces the burden on the shunt convertor and additionally improves the dependability of the system.

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