APPLICATION OF UPQC FOR POWER QUALITY IMPROVEMENT IN DISTRIBUTION SYSTEM

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ABSTRACT:
The power system network is the combination of complex networks, in which many generating units and load centers are interconnected together through long transmission and distribution lines. Customers distribution networks, significant commercial operations and susceptible industrial loads all suffer from various types of outages and interruptions which can lead to considerable financial loss, loss of manufacturing of idle work forces etc. Now a day due the changing trends and reformation of power systems, the end users are concentrating on the quality and reliability of power supply at the load points. A power quality problem is an incidental claim as an irregular voltage, current or frequency that results in a failure of end use equipments. With shifting this trend towards distributed and isolated generation, the issue of power quality will take new magnitude. The concept of customaries power will be introduced to distribution network for the improvement of System performance. The motto then lies, in this work, is to clarify the major concerns in the area and from there to recommend measuring of the enhancement of power quality, by considering the economic capability and technical cost. The Unified power quality conditioner (UPQC) is an efficient traditional power electronics device for the improvement of power quality because of its quick response, high consistency and insignificant value. A Unified power quality conditioner is used to suppress misrepresentation, unstable voltage and current situation. It is capably accomplishes of defending perceptive loads against the voltage turbulence. UPQC uses two converters that are connected to a common DC link with energy storage condenser. The main components of UPQC are series &shunt converters, capacitors, low pass and high pass filters, series and shunt transformers

Keywords: UPQC, Power Quality, faults, DSTATCOM, PI Controller.

INTRODUCTION

In present years, Electrical Power system engineers are mainly concerned on the power quality of the utility systems. In industries, Electrical Machine uses electronic based Controllers which are very sensitive to unstable voltage and will be off. If the supply voltage is decreased it mis-operates due harmonic distortion in the supply voltage. Most of the load equipments utilize the electronic based switching devices which contribute week network voltage quality. The electrical energy market competition in electrical supply has shaped greater commercial alertness of the issues of power quality while equipment is willingly available to measure the quality of the voltage waveform and so quantify the problem. With advanced technology, the association of the world economy has analyzed globally and the income limits of many activities are likely to be decreased. The augmented compassion of the huge mainstream of processes like (industrial and residential services) to power quality problems turned to the availability of electric power with quality a critical factor competitively in every sector. The continuous process of services to industry and the information technology are most significant areas. Due to interruption, a vast amount of economic losses may happen, with the consequential loss of production and competition. Many pains have been taken by utilities to complete consumer obligation, some customers require a higher level of power quality than the level provided by existing networks. This implies that some actions must be taken so that upper levels of Power Quality can be obtained. The FACTS devices and tradition power electronics devices are introduced to power system for the improvement of power quality of the electrical power system. DVR, D-STATCOM, ACTIVE power FILTERs and UPQC etc. are few devices which are used to improve the quality of voltage and current. With the support of such devices we can accomplish for the reduction of power quality issues related. Though all devices can improve the power quality, but in this paper it is

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focused on UPQC, because it is a device which consists of both DVR and D-STATCOM, Previously it was connected in series and then in parallel to protect the sensitive load from all disturbances.

Scope of work

This paper proposes the MATLAB SIMULINK model of unified power quality conditioner (UPQC), which is used for the enhancement of power quality at allocation level. The major objectives are summarized as follows:

- UPQC model Study
- Investigating the presentation of Unified Power Quality Conditioner (UPQC) using the proportional integral control for field oriented control motor.
- Investigating the recital of Unified Power Quality Conditioner (UPQC) using the proportional integral for ASD load under different faults.

Power Quality

Power quality has dissimilar meanings to different people. [1]. A high range power quality issues are connected with distribution power systems lines which are based on time factor; such as long period, short period and other instability All electrical devices are liable to failure or break down when expose to one or more power quality issues

The main purpose for concerning with power quality (PQ) issues is as follows:

- Consumer's devices become more susceptible to PQ due to many microprocessor based controls.
- Outsized computer systems in many businesses facilities.
- Power electronics equipments are used for enhancing system stability for operation and improve their efficiency.
- Uninterrupted progress of high presentation of equipments: Such equipments are more susceptible to power instability.

The end users demand is to get high quality power. Some essential initiations for power quality (PQ) are constant frequency, pure sinusoidal wave shape, constant rms value, symmetrical three-phases, and limited THD.

Requirement of power quality:

There is an increase of power quality demand due to the following reasons [3]:

1. At present days loads are being connected through microprocessor and microcontroller based controls and modern power electronic devices are more sensitive to power quality change than the equipments used in the past.

2. the demand for increased power system efficiency results in continue to increase the devices efficiency, adjustable-speed motor drives etc. The shunt capacitors are used for power factor correction and to reduce losses. These results in the increase of harmonic level in power systems and many consumers concerned about the future impact on system capabilities.

3. End users have an increased alertness of power feature issues. End Users are becoming better informer about the power quality issues such as interruptions, sags, and switching transients etc. and are challenging the utilities to improve the quality of power delivered.

4. Most of the networks are interconnected together. Incorporated processing means, the failure of any component that has more important

Consequences: Sparks produced due to loose connections in wiring. [3].

(i)Voltage Sag: Means drop or dip in the supply voltage which decreases the rms value of line voltage by15 to 95% of the nominal supply voltage. The time of a sag is 1/2 cycle to one cycle or 1 minute. The carouses for the occurrence of sags are, starting of High HP motors and faults in the utility systems.

Issues of power quality

Short Duration Voltage Variation, Long Duration Voltage Variation, Transients, Voltage Fluctuations, Voltage Imbalances, Waveform Distortions, Harmonics, Electrical Noises, Notching

Customerized power devices

The maximum use of automatic equipments, such as variable speed drives, logic controllers, switches of power supplies, arc furnaces, and fluorescent lamps are very more sensible to disruption than the previous consumable devices and minimum automated produced systems. Though the power production in country is more reliable, but the distribution systems are not so

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perfect. The customers require reliability and good quality power in their premises, with the deregulation of the energy market and awareness regarding the power quality among them. Power quality is the major problem which is becoming important to end users of all levels. In many processes like manufacturing of semiconductors or operation of food processing plants, a batch of a particular product can be affected by a small amount of voltage dip for a very short time. Even the small dips are enough to create connections to drives and drop the voltage. There may be other usages which are very much active to to power problems, like medical hospitals, food processing plants, control of air traffic etc. are other data processing and service lines which need clear and undisrupted power. Therefore in such situation where customers highly demand the good power quality, hence the power quality reaches with high significance. Thus the factors mentioned will point out the issues come across by the industry power users and understand the awareness of consumers about good quality of power by which it has efficiently becomes very important to supply the customers with reliable and high quality power so that the development of custom power has been achieved so much of widespread attention nowadays.

Table 1: Protection and Power Quality index

Index	Description	Examples
		Equipment Immunity Indices
I	High immunity	Motors, transformers, incandescent lighting, heating loads, electromechanical relays
II	Moderate immunity	Electronic ballasts, solid-state relays, programmable logic controllers, adjustable speed drives
III	Low immunity	Signal, communication and data processing equipment, electronic medical equipment
		Power Quality Indices
I	Low power quality problems	Service entrance switchboard, lighting power distribution panel
II	Moderate power quality problems	HVAC power panels
III	High power quality problems	Panels supplying adjustable speed drives, elevators, large motors

Commonly used customerised power devices

There are several types of Custom Power electronics devices, such as Unified power quality conditioner (UPQC)[22], Surge Arresters, Static Electronic Tap Changers (SETC),(SA), Uninterruptible Power Supplies (UPS), Super conducting Magnetic Energy Systems (SMES), Solid State Fault Current Limiter (SSFCL), Solid-State Transfer Switches (SSTS), Active Power Filters (APF, Static VAR Compensator (SVC), Distribution Static synchronous Compensators (DSTATCOM), Battery Energy Storage Systems (BESS), Dynamic Voltage Restorer (DVR), Distribution Series Capacitors (DSC) the classification of custom power devices can be done into two major techniques, one is network configuring type and the other is mitigating type. The network configuring type devices change the configuration of the power system network for power quality improvement. SSCL (Solid State Current Limiter), SSCB (Solid State Circuit Breaker) and SSTS (Solid State Transfer Switch) are the examples of this category. The other types of devices are used for the purpose of active filtering; electrical load equalizing, correction of power factor andregulation of voltage etc. The device which includes in this group are DSTATCOM (Distribution Static compensator), DVR (Dynamic voltage restorer) and Unified power quality conditioner (UPQC) etc. The DSTATCOM is connected in parallel with the power system line and the DVR is connected in series to inject a voltage to compensate the line voltage. UPQC is the combination of DSTATCOM and DVR. And It injects series voltage and shunt current to the power system line [16,19]. Even though there are several methods to compensate the voltage sag & swell, but the application of custom power electronics device is to be considered as the most efficient to serve for various purposes. The term Custom Power means to use the power electronic controllers in a distribution system for dealing with different power quality issues. It is sure that consumers may get better quality and reliability of power supply that may include a single or the combination of the specifications like no power disruption, minimum phase imbalance, minimum harmonic disruption in voltage at load, minimum fluctuation / flicker at the load voltage, acceptable magnitude of fluctuation, and time period of maximum and minimum voltages within definite limit and poor power factor of the load without considerable effect on the terminal voltage.

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Importance of specialized UPQC

Every Power electronics device has its own advantages and disadvantages. But The UPQC is the most powerful electronics device for high loads and very sensitive to line voltage and load current disruptions. The most effective type of device is to be considered as the Unified Power Quality Conditioner (UPQC). There are many reasons as why the UPQC is selected over the others. UPQC is more flexible than any single Converter/inverter based device. It can alternately correct for the imbalance and disruption in the supply voltage and current where as other devices either correct the current or the voltage distortion only. Hence the purpose of two devices at a time will be served by UPQC alone.

Unified Power Quality Conditioner (UPQC)

The major parts of a UPQC are series power converter, shunt power converter, capacitors, low-pass & high-pass passive filters, series and shunt transformers etc.

1. Series converter is a voltage-source converter connected in series with the AC supply line and acts as a line voltage source to compensate voltage disruptions. It is used to minimize line voltage fluctuations from the load supply voltage and feeds to shunt branch of the device to consume current harmonics produced by unbalance load. The pulse-width modulation (SPWM) is used to Control the series converter output voltage. The gate pulses which required for converter are produced by comparing the fundamental voltage and reference signal voltage with a high-frequency triangular waveform.

2. Shunt converter is a voltage-source converter (VSC) which is connected in parallel with the same AC supply line and acts as a current source to eliminate current disruption and mitigates the reactive current of in the load circuit, and enhances the load power factor. It also acts as DC-link voltage regulator for the reduction of the DC capacitor rating. The resultant current of shunt converter can be setterate by the application of dynamic hysteresis band (DHB) on the basis of the status semiconductor switches control so that resultant current follows the reference signal and remains in predicted hysteresis band (PHB).

3. The DC capacitor bank connected between Midpoint-to-ground is divided into two parts, which are arranged in series together. The neutral point's secondary transformer is connected to the DC link midpoint directly. Since both three-phase transformers are connected in Y/Yo form, therefore the zero-sequence voltage will appear in primary winding of transformer which is connected in series to mitigate the zero-sequence voltage of the supply power system. There would not be any zero-sequence current flow in the primary side of both transformers. This assures the balancing of system current when the voltage disturbance occurs.

4. The Low-pass filter (LPF) is made use to to get high attenuation in high frequency components at the output side of series converter which are produced by high-frequency switching mode.

5. High-pass filter (HPF) can applied at the output of shunt converter to consume the ripples produced while in current switching mode .

6. Series and shunt transformers are used to inject the mitigating voltages and currents for the purpose of electrically seperation of UPQC converters. The UPQC is very useful for steady-state analysis and dynamically control of series and shunt active and reactive power mitigation at fundamental as well as harmonic frequencies. Any how the UPQC is concerned about the good quality load voltage and the line current at the point of its application, but it does not enhance the quality of power for entire power system unit.

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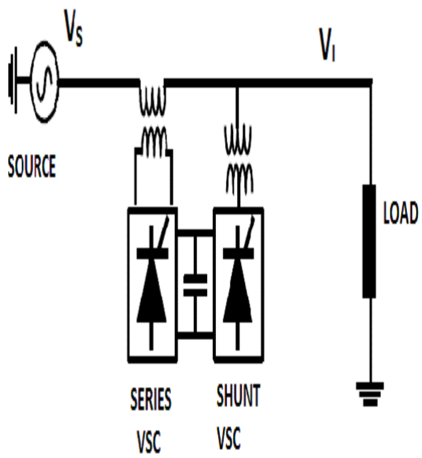

Figure 1: Block diagram of UPQC

Equivalent circuit of UPQC

In this circuit, [27] Voltage Source (VS) represents the voltage at power supply. VSR represents the series Active Power Filter (APF) for voltage mitigation, VL shows the load voltage and ISh stands for Current of shunt Active Power Filter (APF) and VSR is for mitigation purpose. The negative phase sequence and harmonic components may occur due to voltage Distortion. The source voltage in Figure 4.2 can be written as: Vs + Vsr = VL To get a balanced sinusoidal load and line voltage with fixed amplitude V, the output voltages of the Series-APF should be given by; Vsr = (V – V1p) sin $(\omega t+\theta 1P)$ – VLn (t) - $V(t)\infty K$=2 ,where, V1P: Positive sequence voltage amplitude fundamental Frequency

$\theta 1$: initial phase of voltage for positive sequence

V1n: negative sequence component. The shunt-APF acts as a controlled current source and its output components should handle harmonics, reactive components and negative-sequence components in order to mitigate the quantities of load current, when the output current of shunt APF *ish* is kept equal to the load component as shown in the following equation:

iL = I1p cos$(\omega t+\theta 1P)$sinφ1P + iLn+ $iLK\infty K$=2 (4.3) $\phi 1P$ =φ1P - $\theta 1P$ (4.4), where, φ1P:

Initial phase current for positive sequence is seen from the above equations which contains the harmonic components, reactive components but negative sequence current doesnot flow into the power source. Thus the source current will be free of harmonics and is achieved as pure sinusoidal, it has the same phase angle as the phase voltage has at theterminal of load

iS = iL – iSh = I1p sin$(\omega t-\theta 1P)$cosφ1P (4.55)

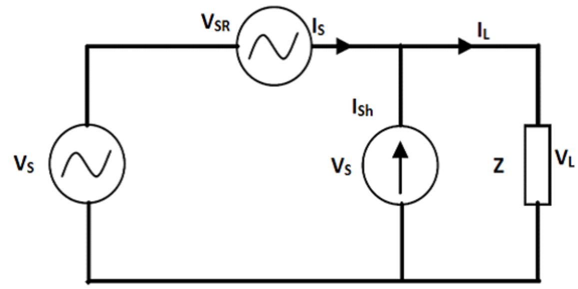

Figure 2: equivalent circuit for UPQC

Configurations of UPQC

There are two ways of connecting the UPQC unit to the terminal voltage (Vt) at PCC:

- Right-shunt UPQC (figure4.3.1), where the shunt compensator (ic) ia placed at the right side of the series compensator (Vc).
- Left-shunt UPQC (figure4.3.2), where the shunt compensator (ic) is placed at the left side of the series compensator (Vc).

These two structures which will have the similar features; however the overall characteristics of the right shunt UPQC are superior (e.g. operation at zero) power injection/consumption mode, which achieves the unity power factor at load terminals, and full reactive power mitigation) [1].

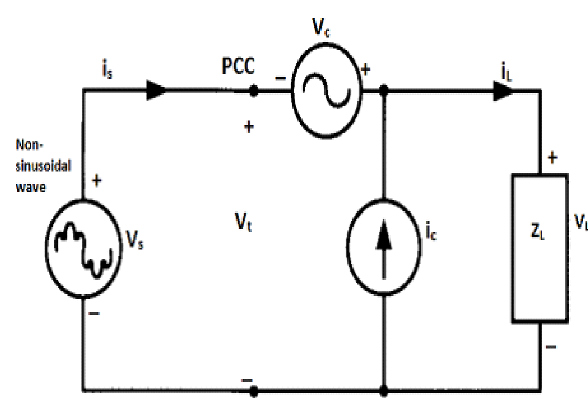

Figure 3: Right shunt UPQC compensation configuration

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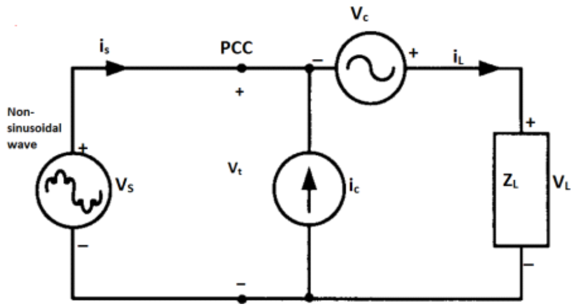

Figure 4: Left shunt UPQC compensation configuration

Functions performed by UPQC

- Convert the feeder (system) current into balanced sinusoids through the shunt compensator.
- Convert the load voltage VL to balanced sinusoids through the series compensator.
- Ensure zero real power injection (and/or absorption) by the compensators.
- Supply reactive power to the load (Q compensation).

Control strategy

A controller is required to control the working of UPQC whenever there is any fault in the line then the pi controller can be used. In the case of DVR control, voltage across the load is sensed and passed through a device called sequence analyzer. The peak value of the real voltage is compared with reference voltage (Vref).Pulse width modulation (PWM) control system is used for energizing the inverter, so as to develop a three phase sinusoidal supply voltage across the load. Chopping frequency is in the required range of the order of KHz. The PI controller controls The IGBT inverter in order to maintain 1p.u. voltage at the load side. The difference between the Vref and Vin. Is the actuating input signal of PI controller In the case of STATCOM control, load current is first sensed and allowed to pass through a device as sequence analyzer. The peak value of true current is compared with reference current (Iref).Pulse width modulation (PWM) controls the inverter switching operation for generation of a three phase sinusoidal current for the connected load. Chopping frequency is in the range of some kHz. The IGBT inverter is controlled with PI-lead controller in order to maintain 1p.u. current at the load. PI-lead controller input is an actuating signal which is the difference between the Iref and Iin.

PI - Controller

A PI-Lead controller is actually a proportionate gainer which is in parallel with an integrator; both the devices are in series with a lead controller. The proportionate gainer shows the fast error response and the integrator activates the system for steady-state error. PI controller is one of the essential devices especially in industry as it is the simplest to design. [26]

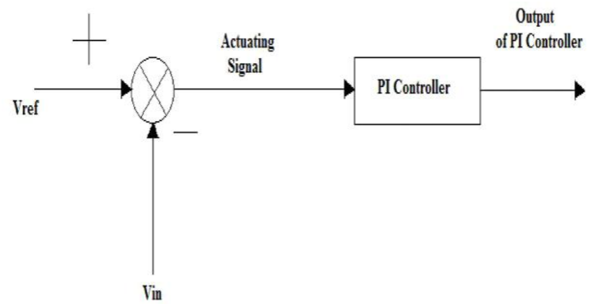

Figure 5: PI controller

Proportionate Gainer (PG) is the Proportional controller in which the output changes based upon how long work sequence is from sequential target. The resultant error is multiplied by a negative (-) proportional constant (P), and added to the total current output. P represents the band limit on which a controller output is proportional to the error of the particular system. For many applications Proportional + Integral control will be satisfactory with good stability and at the desired set point.

Advantages:

- To eliminate the offset, should be adjusted and reach a constant value when error becomes zero:

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- The integral mode will modify the bias value until the error becomes zero and eliminate offset
- The action is not immediate until the integral becomes significant. Also, the integral mode tends the system to be more oscillatory, even unstable. Advantages are Fast action, eliminate the offset.

Disadvantage:

- Are Oscillatory or unstable with integral control, one more parameter to tune.

Test system single line diagram of UPQC

It is observed from the vast literature Survey of UPQC that, the area of power quality and custom electronics power devices plays an important role in power system network. UPQC is one of the custom power device used in distribution system for the improvement of power quality. Various types of controllers such as fuzzy logic controller, hysteresis controller, PI-lead controller, and PID-controller are some reportedly seen in the literature survey to mitigate several PQ issues. In this work, PI controller is used for controlling the UPQC. In this system, the generating unit is of 13kV, 50 Hz. Test System employed to carry out the simulations concerning the UPQC Actuation. The output from generating unit or existing supply line is connected to the primary of the three phase transformer. Further two feeders of medium voltage line (11kV) each are run parallel to each other. In one of the feeders UPQC is connected and other feeder is kept as it is. For this system ASD load is considered and different fault conditions LL, LLG and LLLG are tested on this system. PI controller is used for the control section.

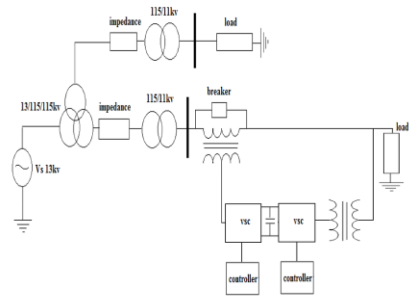

Figure 6: Circuit Model of UPQC Test System

Simulation results

- Distribution network having adjustable speed drive load i.e. field oriented induction motor.
- In this work, the role of Unified power quality conditioner for power quality improvement of following distribution networks is carried out
- Distribution network having field oriented control induction motor as load during fault condition

Parameters

The test system for field oriented control induction motor load and the Simulation model of UPQC using PI controller and field oriented control induction motor as load is shown in Fig.5.1. The System parameters are listed in Table 5.1

Results

An ideal three-phase sinusoidal supply voltage is applied to the non-linear load (Field oriented control Induction motor drive) injecting current and voltage harmonics into the system. Figure 5.2 shows load current in three-phase before compensation Figure 5.3 shows THD level for uncompensated load current. Figure 5.4(a) shows the load current for compensated system Figure 5.4(b) shows THD level for compensated load current. Figure5.5(a) shows load voltage in three-phase before compensation Figure 5.5(b) shows THD level for uncompensated load voltage. Figure 5.7(a) shows the load voltage for compensated system Figure 5.6(b) shows THD level for compensated load voltage. The Total

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Harmonic Distortion (THD) for load current which was 23.14% in Figure5.3(b) before compensation and effectively reduces to 4.87 % in Fig. 5.4(b) after compensation using PI controller. Shunt inverter is able to reduce the harmonics entering into the system. The Total Harmonic Distortion (THD) for load voltage which was 13.58% in Fig.5.5(b) before compensation and effectively reduces to 7.85 % in Fig.5.6(b) after compensation using PI controller. The voltage compensation is small because system consists of transformers which are already doing compensation for voltage.

Three different fault conditions are considered for the test system as shown in Figure-5.1. Test System consist of Adjustable speed drive that is field oriented control induction motor and the controller used is a proportional integral controller. The faults that occur in the system are tested. It may be LG fault which will occur with LLG and LLLG fault also occurs rarely in the concerned system. The three different fault conditions are single line to ground, double line to ground and three phase line to ground. The results for each fault conditions are shown in the graphs.

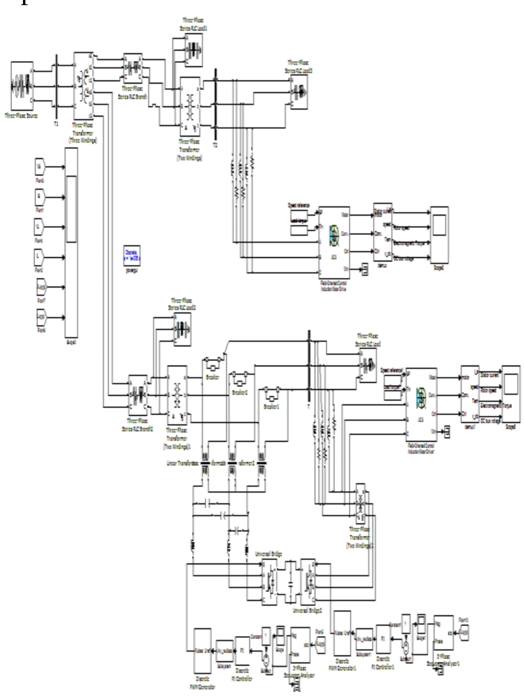

Figure 7: MATLAB Simulink model of UPQC

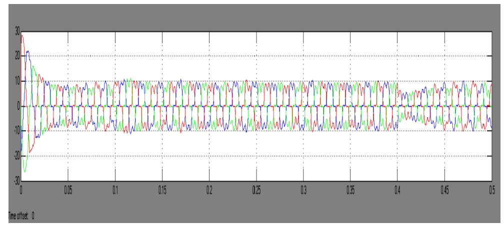

Figure 8: Current waveform without UPQC

Table 5.1: System Parameters for field oriented control induction motor load

S. No.	System Quantities	Standards
1	Source	3-phase, 13kV, 50Hz
2	Inverter parameters	IGBT based, 3-arm, 6-Pulse, Carrier Frequency=1080 Hz, Sample Time=5 μs
3	PI controller	K_P=0.5, K_i=1000 for series control K_p=0.5, K_i=1000 for shunt control, Sample time=50 μs
4	RL load	Active power = 1kW, Inductive Reactive Power=400 VAR
5	Motor load	Voltage V_{rms}=11kV, Frequency 50 Hz
6	Transformer1	Y/Δ/Δ 13/115/115kV
7	Transformer2	Δ/Y 115/11kV

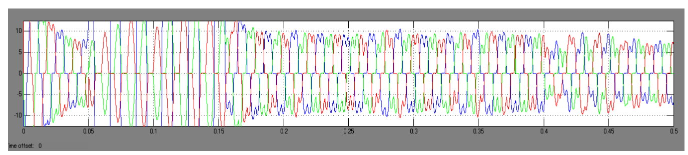

Figure 9: voltage waveform without UPQC

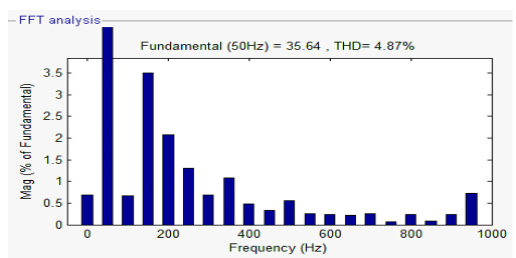

Figure 10: Total harmonic distortion with UPQC for current

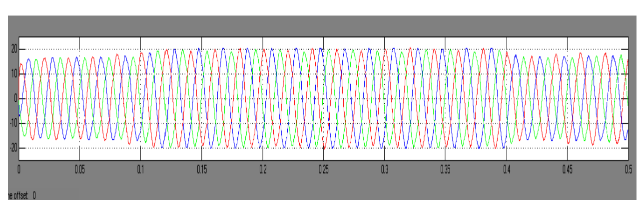

Figure 11: Voltage waveform without UPQC

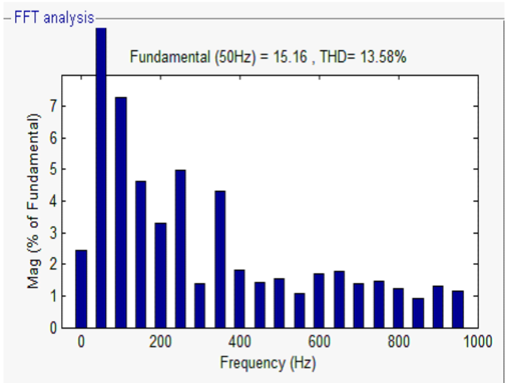

Figure 12: Total harmonic distortions without UPQC for voltage

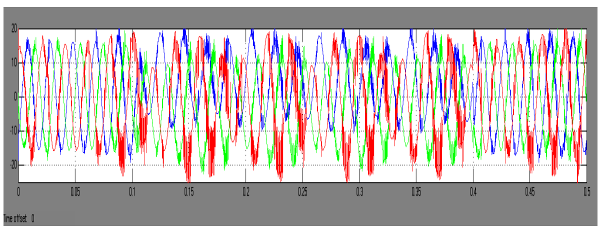

Figure 13: Voltage waveform with UPQC

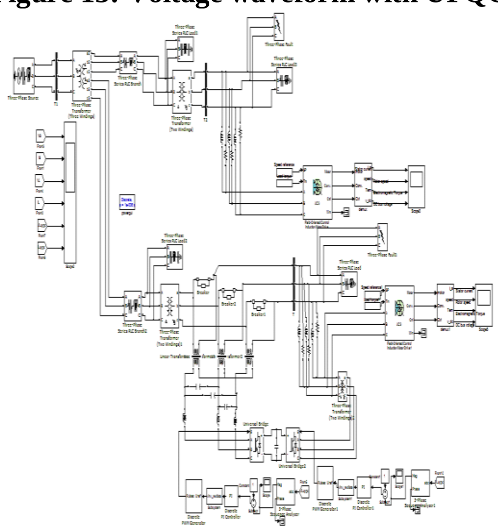

Figure 14: MATLAB Simulink model of UPQC using field oriented control induction motor drive during fault conditions

Single Line to Ground Fault Condition

A line to ground fault is considered for both the feeders. Here the fault resistance is 0.002 ohm and the ground resistance is 0.002 ohm. The fault is created for the duration of 0.06s to 0.16s. The output waveform for the load voltage without compensation is shown in Figure-5.10 and with compensation is shown in Figure-5.15. The output waveform for the load current without compensation is shown in Figure-5.20 and current with compensation is shown in Figure-5.21

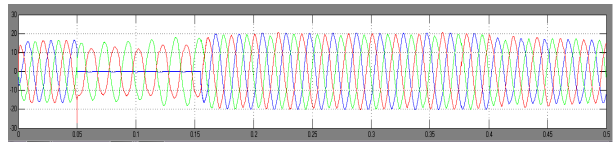

Figure 15: Voltage waveform without UPQC during LG fault

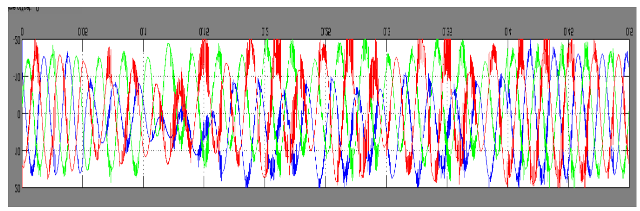

Figure 16: Voltage waveform with UPQC during LG fault

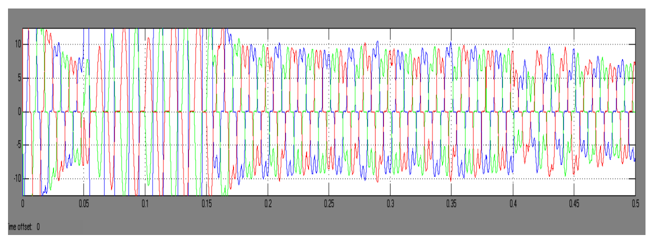

Figure 17: Current waveform without UPQC during LG fault

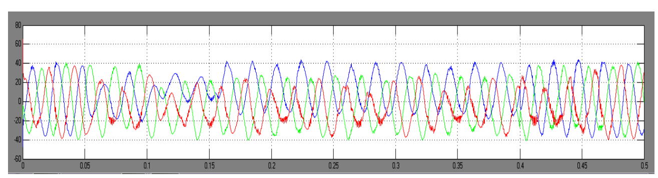

Figure 18: Current waveform with UPQC during LG fault

In this it is clear from the output wave shapes that the voltage in the particular phase, where the fault is created will be decreasing and current will be increasing during the fault period in the unmitigated line/ feeder. Hence the unbalancing in the system where UPQC is connected is reduced clearly.

Double Line to Ground Fault Condition

A double line to ground fault is considered for both the lines/feeders. In this the fault resistance

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is 0.0015 ohm and the ground resistance is 0.0015 ohm. The fault is created for the period of 0.07s to 0.18s. The output waveform for the load voltage without compensation is shown in Figure-5.14and with compensation is shown in Figure-5.15. The output waveform for the load current without compensation is shown in Figure-5.16 and compensation is shown in Figure-5.17.

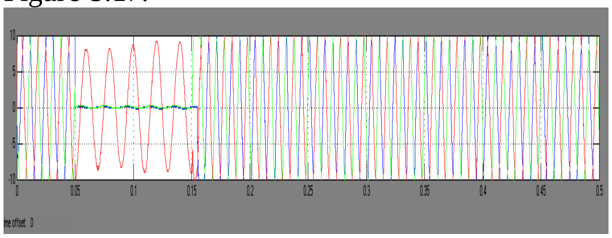

Figure 19: Voltage waveform without UPQC during LLG fault

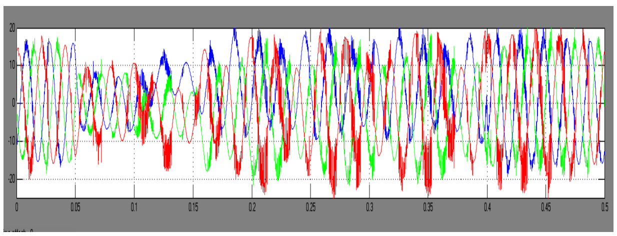

Figure 20: Voltage waveform with UPQC during LLG fault

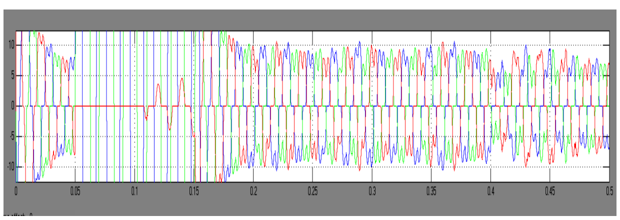

Figure 21: Current waveform without UPQC during LLG fault

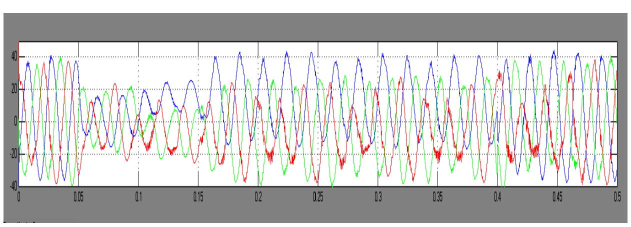

Figure 22: Current waveform with UPQC during LLG fault

In this it is clear from the output wave shapes that the voltage in the phase where fault is created is decreasing and current in the phase where fault is created is increasing during the fault period in the unmitigated lines/feeder. Hence the unbalancing in the system where UPQC is connected is reduced clearly.

Three Phase Line to Ground Fault Condition

A three phase line to ground fault is considered for both the lines/feeders. In this the fault resistance is 0.0016 ohm and the ground resistance is 0.0016 ohm. The fault is created for the period of 0.06s to 0.16s. The output waveform for the load voltage without compensation is shown in Figure-5.18 and with compensation is shown in Figure-5.19. The output waveform for the load current without compensation is shown in Figure-5.20 and compensation is shown in Figure-521.

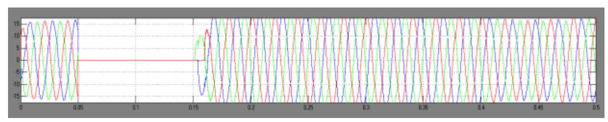

Figure 23: Voltage waveform without UPQC during LLLG fault

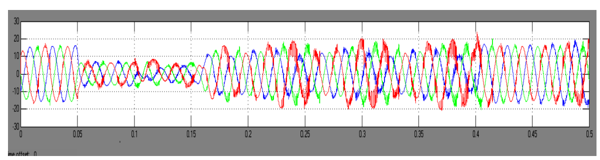

Figure 24: Voltage waveform with UPQC during LLLG fault

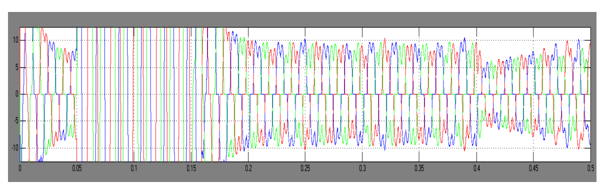

Figure 25: Current waveform without UPQC during LLLG fault

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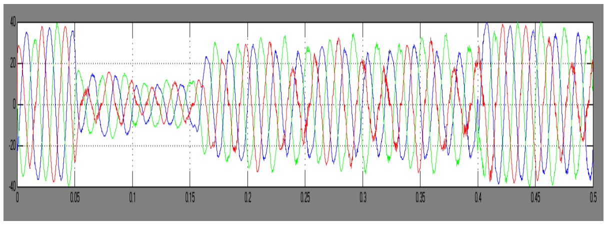

Figure 26: Current waveform with UPQC during LLLG fault

In this it is clear from the output wave shapes that the voltage in that phase where fault is created is decreasing and current in the phase where fault w created will be increasing during the fault period in the unmitigated line/feeder. Hence the unbalancing in the system where UPQC is connected is reduced clearly.

CONCLUSIONS

The main objectives of this work is to reduce the disruption occurring in case of the harmonics produced in the loads connected to distribution networks bu using the custom power electronics devices. There will be high improvement in the power quality of the system. In order to protect critical loads from more harmonics in voltage and current of the distribted network, the UPQC is reccomended in the form of series connected voltage-source converter called as Dynamic Voltage Restorer and shunt connected voltage-source converter called as D-statcom. UPQC gives the optimal solution for the mitigatrion of voltage and current harmonics as well the other PQ issues. The power simulink/ MATLAB are used to carry out simulation work on unified power quality conditioner (UPQC) and also for the controlling techniques results of the proportional integral controller (PIC). It adjusts the speed of the drive which is used as a mechanical load. Hence the UPQC is considered to be an efficient solution to power quality issues. Unified power quality conditioner (UPQC) is capable of reducing the level of third harmonic distortion (THD) in the networks which are connected to the harmonics producing loads. All types of faults such as LG, LLG, LLLG also mitigated by using UPQC.

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