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Upfc Power Compensation with Power Generation Smart Grid

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Abstract- The problem of power system to face many problem like as power quality, THD and stabailuty.in modern technology to use of FACT Devices, The FACT Device are many types these paper are present of UPFC power stability device oriented. For recent used many technique to improvement of UPFC performance and reduction of THD. We proposed Machine learning technique like as Fuzzy logic and shunt filter with transformer work as controller to controlling of power transient conditions.

Keywords:- Unified power flow controller (UPFC), Total harmonics distortion (THD)

I. INTRODUCTION

A Power quality problem is an occurrence manifested as a non standard voltage, current or frequency that results in a failure or a mis-operation of end user equipments. Utility distribution networks, sensitive industrial loads and critical commercial operations suffer from various types of outages and service interruptions which can cost significant financial losses. 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 [1]. At present, a wide range of very flexible controllers, which capitalize on newly available power electronics components, are emerging for custom power applications.

Among these, the UPFC and the dynamic voltage restorer are most effective devices, both of them based on the VSC principle. UPFC injects a current and voltage into the system to correct the power quality issues. Comprehensive results are presented to assess the performance of each device as a potential custom power solution [2]. The FACTS (Flexible AC Transmission Systems) technology is a new research area in power engineering. It introduces the modern power electronic technology into traditional ac power systems and significantly enhances power system controllability and transfer limit. In this paper, the unified power flow controller (UPFC) with fuzzy logic control will be used to improve power system dynamic behavior after a system disturbance [3].

II.RESEARCH MOTIVATION

Electricity is a very useful and popular energy form which plays an increasing role in our modern industrialized society. Scarcity of natural resources, the ubiquitous presence of electrical power make it desirable and continuous increase in demand, causing power systems to operate close to their stability and thermal ratings. All the latter mentioned reasons together with the high penetration of Distributed Resources (DR) and higher than ever interest in the quality of delivered energy are the driving forces responsible for extraordinary changes taking place in the electricity supply industry, worldwide. Against this background of rapid changes, the expansion programs for many utilities are being thwarted by variety of environmental and regulatory pressures, that prevent the building of new transmission lines and electricity generating plants, the construction of which is becoming increasingly difficult.

III.POWER FLOW CONTROLLING DEVICES

Power flow is monitored by regulating the parameters of a system, such as voltage magnitudes, line impedances and transmission angle as well. The device that tries to alter the parameters of the system and to monitor the power flow through the transmission line can be treated as Power Flow Controlling Devices (PFCDs) [4, 5].
PFCDs can be classified into the shunt, series as well as combined devices (combination of shunt and series), as represented in figure 1.

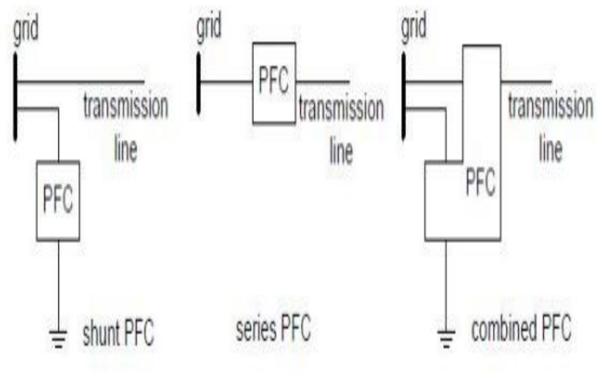

Figure 1 Simplified diagrams of shunt, series and combined devices.

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Shunt device is an equipment which connects the grid and the ground. Shunt devices generate/absorb the reactive power at the point of common coupling, thus it controls the voltage magnitude. As the bus voltage magnitude can only be altered within definite limits, so monitoring the power flow in this approach is restricted. Shunt devices are used for different purposes, such as the voltage support offered by the shunt device at the midpoint of a long transmission line can enhance the power transmission capacity. Another important use of shunt device is to supply reactive power locally, so that the unnecessary reactive power which flows through the transmission line is minimized and thereby the network losses are also decreased. In addition to this, the shunt devices which are placed at consumer side can enhance the power quality, particularly during large demand variations.

IV.BASIC CIRCUIT CONFIGURATION OF UPFC

The advent of advanced power electronics technology has enabled the use of voltage source inverters (VSI) at both the transmission and distribution levels. A stream of VSI based systems such as UPFC, STATCOM and SSSC has made the design of FACTS (Hingorani and Gyugyi 2000) possible. Successful applications of FACTS equipment for power flow control, voltage control and transient stability improvement have been reported in the literature (Nabavi and Iravani 1996, Renz et al 1999, Kannan et al 2004, Eskandar and Shahrokh 2005). In recent years increasing interest has been seen in applying fuzzy theory (Lee 1990) to controller design in many engineering fields. This chapter focuses on the use of UPFC with SFLC (Byung-Jae Choi et al 2000) for the Shunt and Series Inverter of the UPFC for transient stability improvement and voltage control of power system. The principal function of the UPFC is to control the flow of real and reactive power by injecting a voltage in series with the transmission line. The UPFC consists of two solidstate voltage source inverters connected by a common dc link that includes a storage capacitor (shown in Figure4.1).

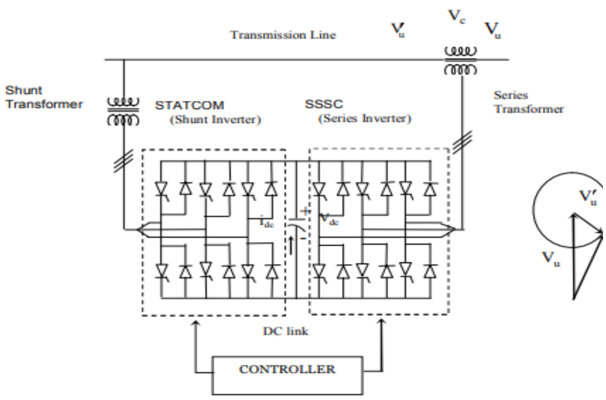

Figure 2 Basic circuit configuration of the UPFC.

The first inverter (shunt inverter) known as a STATCOM (Static Synchronous Compensator) injects an almost sinusoidal current of variable magnitude at the point of connection. The second inverter (series inverter), known as SSSC (Static Synchronous Series Compensator) provides the main functionality of the UPFC by injecting an AC voltage Vc, with a controllable magnitude (0<Vc<Vc max) and phase angle (>0^0 , <360). Thus, the complete configuration operates as an ideal AC to AC power converter in which real power can flow freely in either direction between the AC terminals of the two inverters.

V.PROPOSED METHODE BASED TO DESIGN UPFC

In recent decades, the growing number of power electronics based equipment in both industrial and domestic applications loads causes harmonics in the system and impacts on the power quality of electric supply. At the same time, most of the equipment causing the disturbances is quite sensitive to deviations from the ideal sinusoidal line voltage. Due to the non-ideal characteristics of the voltage source, harmonic currents create voltage distortion. Non-linear loads such as rectifiers, cyclo converters, variable speed drives and arc furnaces, large decaying DC components, asymmetrical loads and other electrical equipment can cause high disturbances in the power supply system. The harmonics generated by the most common non-linear loads effects on amplitude and nature of source current hence the performance of the system. This harmonic distortion problem has traditionally solved with the use of passive filters. However, it has some limitations so passive filters are dropped. And power engineers developed a dynamic and adjustable solution to power quality problems. Such equipment as shown in fig. 5.1 is called an active filter and is able to compensate current and voltage harmonics [6].

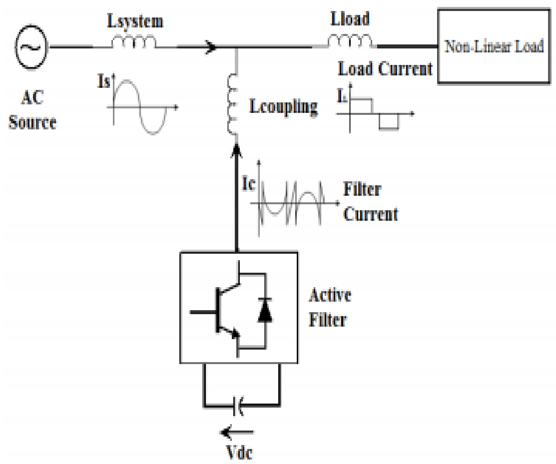

Figure 3 Basic Structure of SAPF.

In recent years, quality of power delivered to industrial, commercial and domestic consumers is an important concern due to rapid rise in the usage of harmonics producing nonlinear loads including adjustable speed drives, power electronics converters, switched mode power supplies, arc furnaces etc. The term quality of power or electric power quality is used to express the purity in voltage and current waveforms. Quality reduction of electric power mainly occurs due to the power line disturbances like sag, swell, notches, unbalance and harmonics, where harmonics is the major power quality problem that is seen in the distribution side of power system network. Harmonics is the term used to express the distortion of voltage and current waveform. Harmonics are injected in to the circuit due to intensive use of nonlinear loads.

These nonlinear load draws short pulses from the source supply and which combines with source impedance resulting in distortion of voltage and current waveform. Overheating, failure of components, interference to communication lines are the major problems associated with harmonics. There are different methods to reduce harmonics in an electric power transmission network including use of line reactors, isolation transformer, phase shifting transformers, passive filter and active power filter. Use of harmonics filters, which are based on the filtering of unwanted frequency component is an effective and commonly used method, But the use of passive filter is limited due to large size, resonance problem and can compensate only fixed value of reactive power.

Limitation of passive filter can be overcome by using active power filters, which may be series active power filter or shunt active power filter. Due to nonlinear loads harmonics mainly occurs in current signal, so in this paper a shunt active power filter is used. Shunt active power filter (SAPF) is a power electronics converter that can inject current having same magnitude and opposite phase with that of original harmonics current. Core of a SAPF is a voltage source inverter (VSI).This VSI can acts as controlled current source and can provide required compensation. Controlling of this VSI is done by using fixed band hysteresis current controller. Synchronous reference frame theory based method is used for producing reference current required for the hysteresis band controller. Simplicity, good static and dynamic performance, reference current generation are independent of source voltage are some of the dominating advantages of SRF theory over other methods of reference current generation. Shunt active power filter is simulated using MATLAB /Simulink under different load conditions and results are compared.

1. Active Filtering Technology:

The first attempt to reduce harmonics without the use of conventional passive filters was made by B. Bird. This design is based on changing the waveform of the current drawn by the load by injecting a third harmonic current, displaced in phase, into the converter itself. With this method however it is impossible to fully eliminate more than one harmonic. The next attempt was made by Ametani, which is based on expanding the current injection method by proposing a technique to eliminate multiple harmonics. According to this theory, an active control circuit could be used to precisely shape the injected current. Ideally, this current would contain harmonic components of opposing phase, thus the harmonics would be neutralized, and only the fundamental component would remain. Despite the promising theoretical concept, Ametani was not successful in producing a practical circuit capable of creating a precise current.

An Active Filter involves the use of one or more active components such as a Voltage Source Inverter which can be controlled in such a way so as to provide the compensating current or voltage to the nonlinear load. In this way, the nonlinear load does not draw the nonsinusoidal components from the source and thus the source becomes free of harmonics. Figure 4.2 shows a shunt active filter system used for providing the harmonic compensation so as to meet IEEE 519 Standard at the point of common coupling. The concept of shunt active filtering was first introduced by Gyugyi and Strycula in 1976[3].Since then several Active Filter topologies have been proposed, some of them are:

- **Shunt Active Filters**
- **Series Active Filters**
- **Hybrid Parallel**

Active Filters These topologies have been discussed in detail in the following chapters. Major Advantage of Active Filter over Passive Filter is that it can be controlled to compensate for harmonics in such a way that THD lower than 5% at the Point of Common Coupling can effectively be achieved. The shunt Active Filter can also be made to act as a damping device in a parallel resonance circuit formed by the passive filter and the power supply system by adopting a lead function in its controller [7].Thus it can prevent harmonic propagation resulting from harmonic resonances. Briefly, Active Filters can be designed to achieve following three goals:

- **Harmonic Compensation**
- **Harmonic Damping**
- **Harmonic Isolation**

2. Shunt active power line conditioner

Shunt active power line conditioner uses power electronics to produce complementary harmonic components that compensates the harmonic components produced by the non-linear load. This harmonic filter consists of a power converter unit and control unit, which controls the harmonic injection of the filter into the ac

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network based on the measured load harmonics. Therefore, this device senses voltage and current harmonics and generates offsetting harmonics to cancel out the superfluous harmonics in the source. There obviously exists a feedback mechanism by virtue of which the source provides clean waveforms for the load. Voltage regulation and power factor control are also normal byproducts of this filter operation. Some of the merits of using active power line conditioner are [8]

- Harmonic reduction
- Reduction of three-phase neutral return current
- Impact minimization upon the distribution transformer
- Power factor improvement
- Voltage regulation Automatically adapts to changes in the ac network and load fluctuation
- Eliminating risk of resonance between filters and network impedance.

3. Shunt active power filter:- The shunt active filter approach is based on the principle of injection of harmonic currents into the ac system, of the same amplitude but opposite in phase to that of the load harmonic currents. Fig.5. 2 shows the active power filter compensation principle, which is controlled in a closed loop manner to actively shape the source current into sinusoid.

Shunt active power topology is most popular topology for current harmonics elimination due to easy implementation and good performance. Shunt active power filter (SAPF) behaves as a three phase controlled current source and it generates compensation current in phase opposition to the harmonics current that depends on the reference current generation [10-13]. It works in a closed loop manner so that it senses the load current variation continuously to generate the required compensation current. Schematic diagram of SAPF is shown in figure 5.2

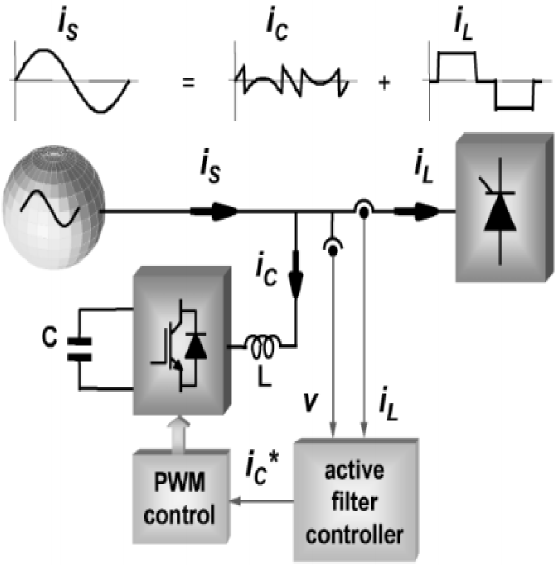

Figure 4 Schematic diagram of shunt active power filter.

Figure shows that SAPF consists of two distinct main blocks

1.Active filter controller (Reference current generation block)

2. Pulse width modulated current controller (PWM controller)

Active filter controller is used for instantaneous monitoring of load current and there by the generation of reference compensating current. Synchronous reference frame theory is the most popular reference current generation method. By using this reference compensating current and source current, gate pulses required for the VSI is generated by PWM controller. PWM controller is responsible for power processing in synthesizing compensation current required for the entire system.

Active filter is classified as series active filter and Shunt active filters. Series filter is consist capacitor and inductor connected in parallel with each other but in series with the load. This types of filter provides high impedance to the harmonics currents and allow to pass them reaching the power supply, but allows the fundamental frequency of 60 Hz current to pass through. But these types of filters have a drawback of carry of full load current. Shunt active filter consist of capacitor and inductor connected in series but parallel with load. This filter provides low impedance path for harmonics current and divert the harmonics to ground. Shunt filter is common and less expensive because they don't have to carry the full load current [3]. Here shunt active power filter is used with voltage source inverter to mitigate the harmonics produced by Non linear load. It injects the compensating harmonics current (in 1800) phase shift to harmonics current) in to the power lines. In these shunt active power filter main theme is to design these filter with synchronous reference frame control theory which is signal processing based. Hysteresis band current controller is used to generate the switching signal to the voltage source inverter [14][13]. The basic diagram for three phase SRF based shunt active filter is shown in fig. 4.2 [14]

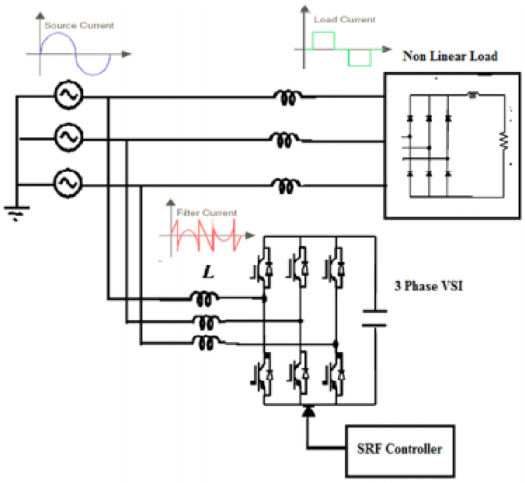

Figure 5. Three Phase SRF based SAPF.

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VI.RESULT AND SIMULATION

The unified power flow controller (UPFC) is a solid-state controller which can be used to control active and reactive power flows in a power transmission line. In this paper, the authors propose a control strategy for UPFC in which they control real power flow through the line, while regulating magnitudes of the voltages at its two ports. They design a controller for this purpose which uses only local measurements. The control strategy is evaluated using digital simulation for a case study.

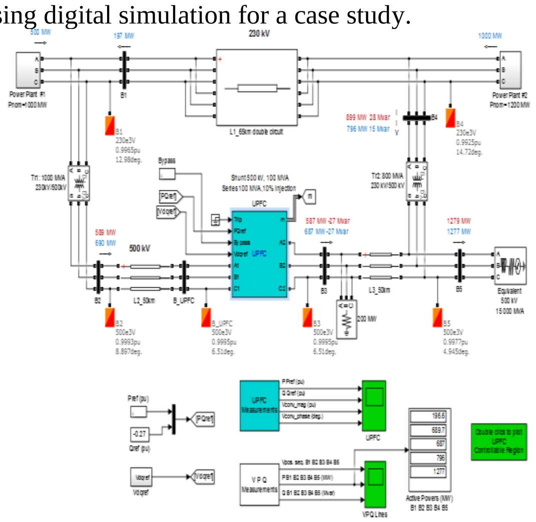

Figure 6 System model UPFC.

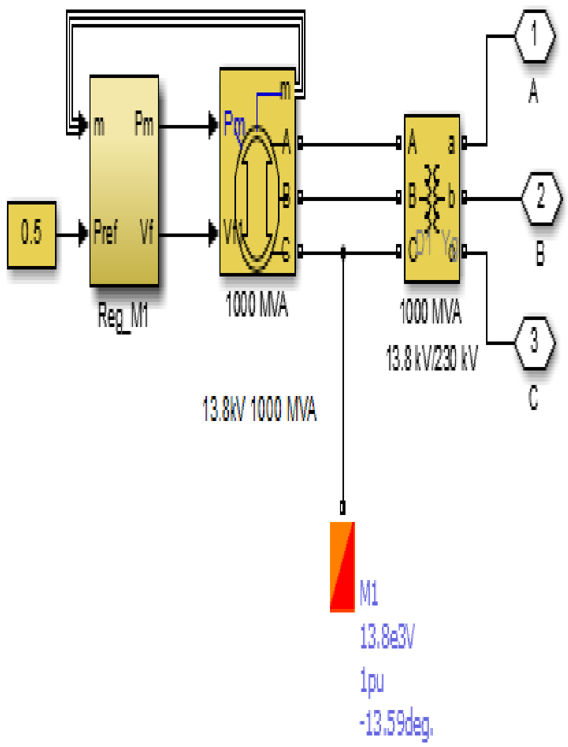

Figure 6.2 Load connected system mode UPFC.

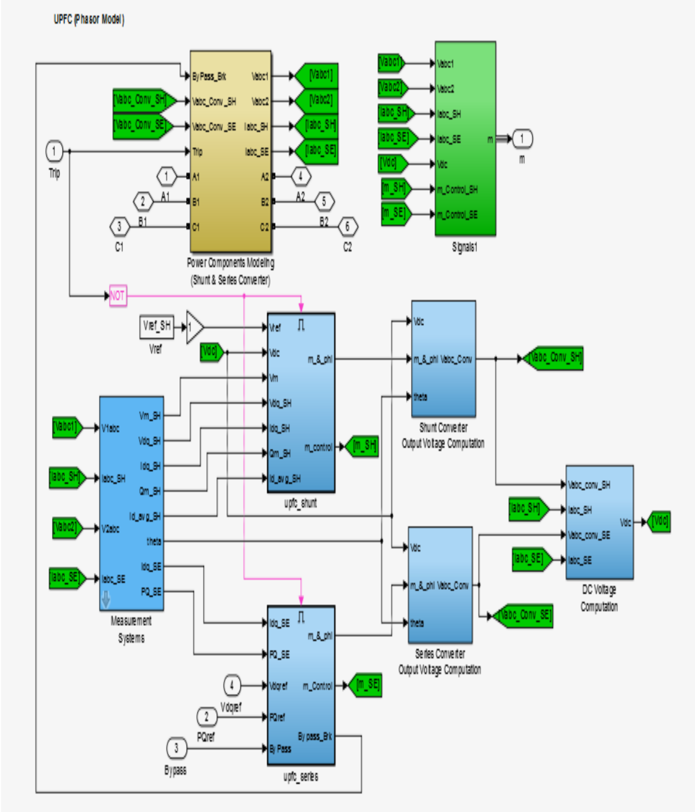

Figure 7 UPFC Controller.

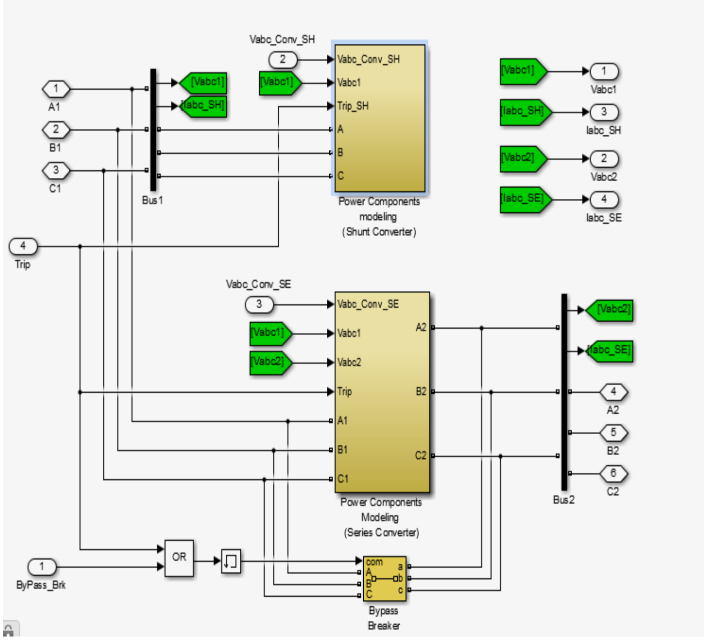

Figure 8 UPFC Controller Series and shunt convertor.

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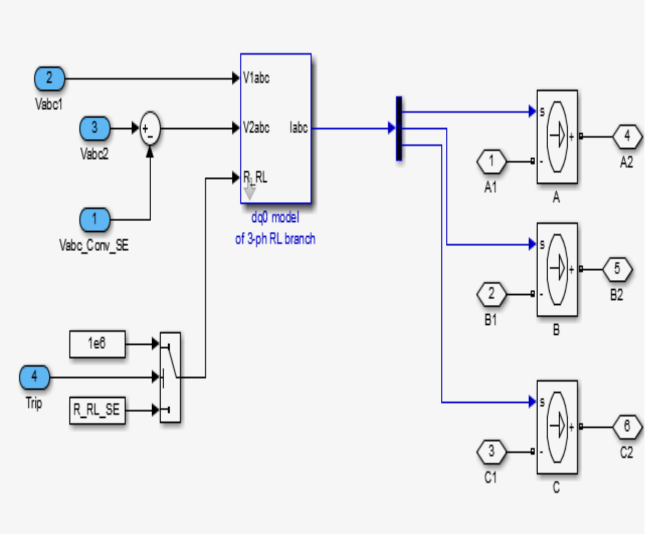

Figure 9 SRF power compensation.

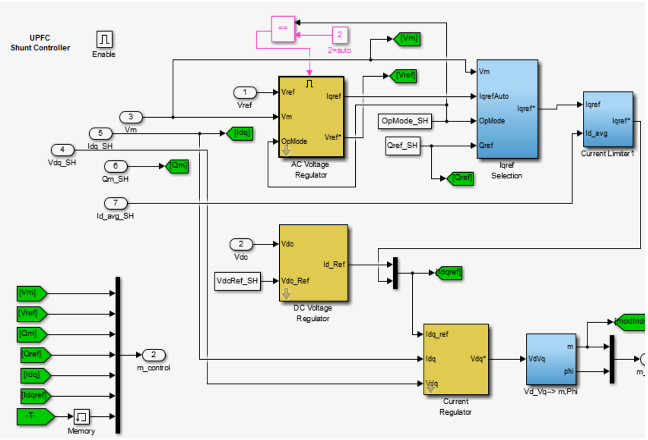

Figure 10 AC and DC power regulators.

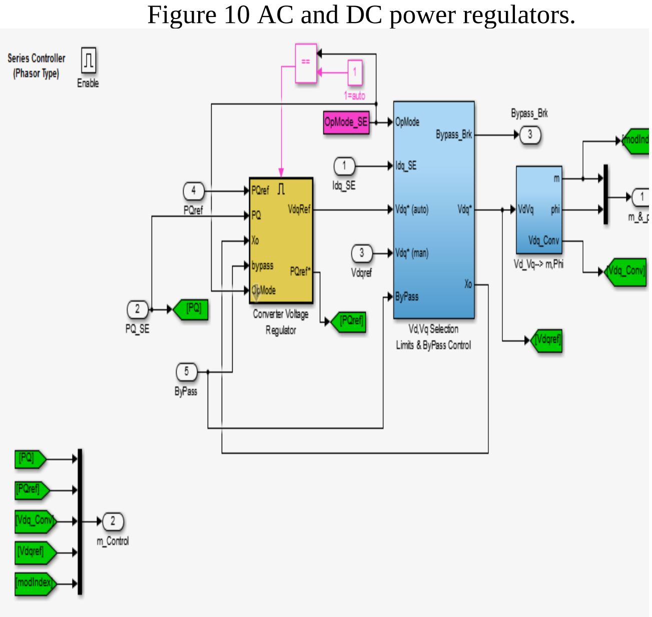

Figure 11 Pulse generators.

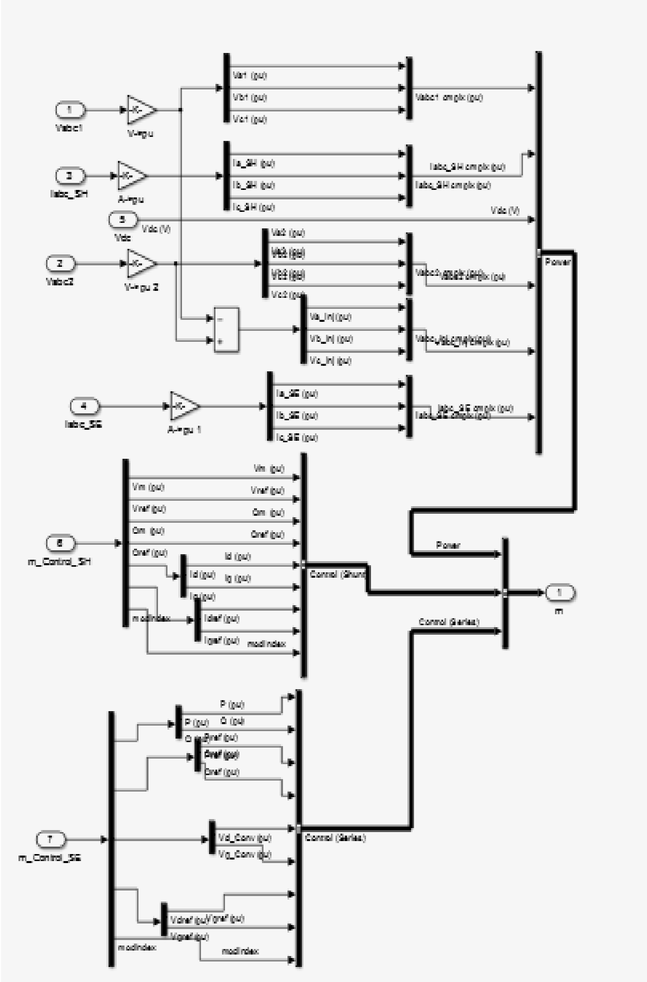

Figure 12 Bus bar connections.

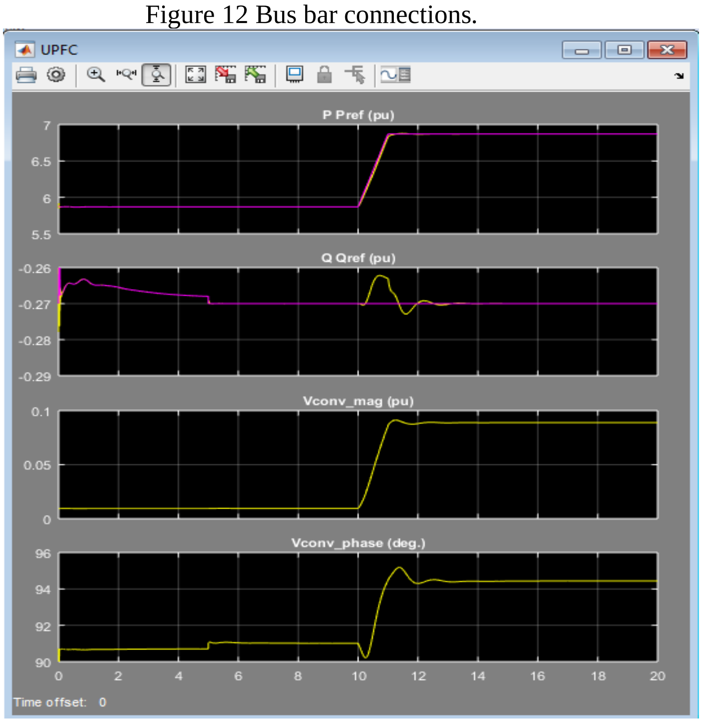

Figure 13 Active power, reactive power, voltage and reference voltage.

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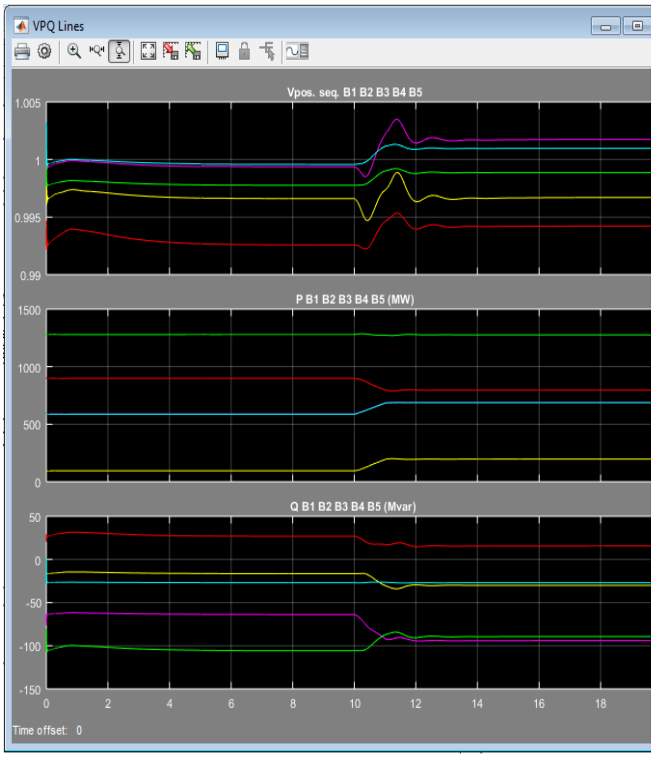

Figure 14 three phase total outcomes.

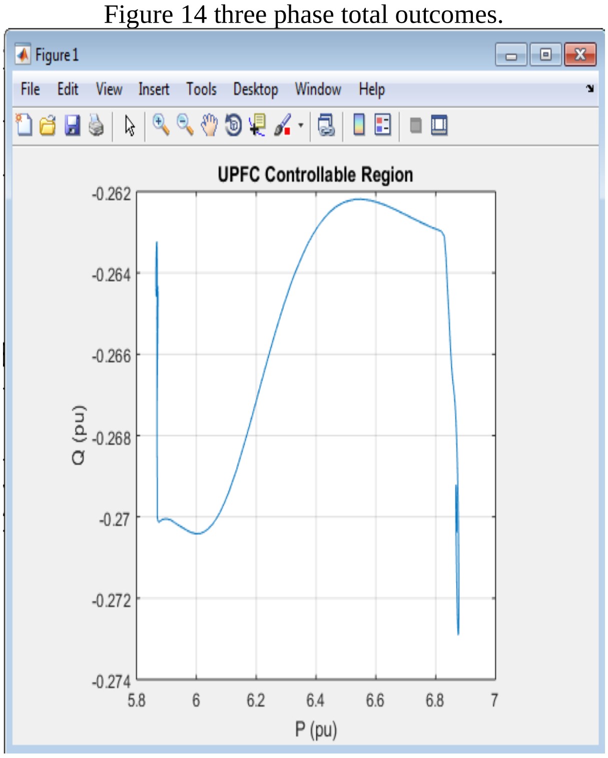

Figure 15 UPFC controllable region.

VII.CONCLUSION AND SCOPE FOR FUTURE WORK

1. MAIN CONCLUSION

The research work presented in the thesis mainly deals with analysis and development of fuzzy and PI voltage controller for self-excited induction generator based on UPFC. The modeling and simulation of SFR-UPFC has been carried out for different types of loads. The MATLAB based model of SFR is developed in q and d stationary reference frame. The SFR develops its terminal voltage with the help of excitations capacitors.

But with application of load, terminal voltage falls down from its rated value. A UPFC based voltage regulator is developed for regulating the SFR voltage in MATLAB. The proposed scheme for maintaining the voltage of SFR constant is simple and easy to implement. The UPFC improves the voltage regulation by injection of compensation currents. The UPFC is design for various loads like linear/ non-linear, balanced/unbalanced. From the simulation result it has been found that the non-linear load injects harmonics in the systems, which are also eliminated by UPFC. Hence it is concluded that UPFC can act as voltage regulator, load balancer and harmonic eliminator. In designing of UPFC, PI and Fuzzy controllers are used and their simulation results are compared. The SFR controller based UPFC gives better dynamic performance. From the simulation result it is also found that the Fuzzy controller has less peak overshoot, fast response and smooth steady state response as compared to conventional PI control. Hence SFR-UPFC with (HY)controller is a good candidate for improving the performance of the regulator.

2.SCOPE FOR FUTURE WORK

The voltage regulations of self-excited induction generator using UPFC have been investigated for various loads (linear/non-linear) with PI and controller for improving the performance of SFR in standalone application. However further research work can be carried out for better operation of SFR. The areas in which further work can be done are as follows

- The SFR-UPFC system can be developed for dynamic load also which increases the flexibility of controller as it can be used for any type of load linear or non-linear, static or dynamic, balanced or unbalanced.
- The UPFC based controller can be developed for three phase SEIG feeding single phase load using controller because controller gives better dynamic response as compared to PI controller.
- Voltage regulation for SFR driven by variable speed prime movers using UPFC can be developed.

- In standalone application using wind energy conversion system, the performance of UPFC based controller may be investigated using maximum power point tracking.

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