Unified power flow controller for damping oscillations

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Abstract - *Unified Power Flow Controller (UPFC) is used which help in damping out the oscillations present in the system. The UPFC is the most flexible FACTS equipments. UPFC perform the functions of the static synchronous compensator (STATCOM), thyristor controlled reactor (TCR), thyristor switched capacitor (TSC) and the phase angle regulator offering the flexibility for the static and dynamic operation of the power network. It controls all the electrical variables of the transmission network. FACTS devices can have various applications concerned with operation and control of power system, such as scheduling power flow; damping the power oscillations and enhancing transient stability. Presently the studies on FACTS devices and their impact on power system such as control of power flow, transient stability and enhancement, small disturbance stability improvement and oscillation damping is studied.UPFC is the most flexible FACTS device amongst all.*

Key Words: **UPFC model , stability, three phase fault oscillations.**

1.INTRODUCTION

        In recent few years FACTS devices have been employed to damp power system oscillations.
The unified power flow controller (UPFC) which is a second generation FACTS device is having a capability of controlling independently the true and apparent power independently which improves the reliability and quality of the supply.
    Power system contains various modes of oscillations as a consequence of interactions of its components. Electromechanical oscillation has been observed in many power systems worldwide. These oscillations may occurs due to disturbances in the network such as fault in the system, change in load, etc. It is necessary to control these oscillations other it will grow and may lead to total or partial interruption in supply. Traditionally, Power System Stabilizer Device is used for controlling or damping out this oscillation .To provide effective damping and ensure the stability of the system, the PSS should be carefully tuned. A proper tuned PSS acts by cancelling the negative damping produced by the excitation system. It changes the excitation as the rotor speed changes or change in some other signal to produce the change in electrical output in phase with speed. system instability is the major problem in power system . Appropriate FACTS devices were used for improving the

steady state stability and dynamic stability [1-3]. UPFC is able to damp oscillations in power system and improve transient stability in the system [4] .

2. OPERATING PRINCIPLE OF UPFC

        The UPFC is a generalized synchronous voltage source (SVS), represented at the fundamental frequency by voltage *Vpq* phasor with controllable magnitude and angle in series with the transmission line. In this functionally unrestricted operation, which includes voltage and angle regulation, the SVS generally exchanges reactive and real power with the transmission system. Since, as established previously, an SVS is able to generate only the reactive power exchanged, the real power must supplied to it, or absorbed from it, by a suitable power supply . In the UPFC arrangement the real power exchanged is provided by one of the end buses (e.g., the sending-end bus), as indicated in Figure 1.
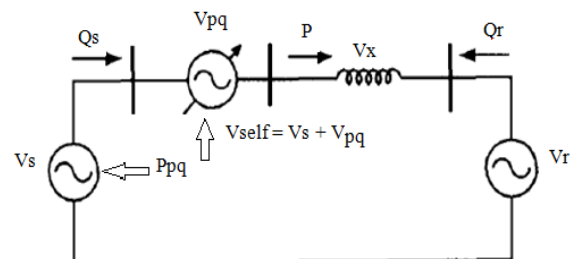
Fig -1: Represenation of UPFC in a two machine power system.

3. BASIC CONFIGURATION OF UPFC

The UPFC consists of two voltage-sourced converters, as shown in Figure.1 These back-to-back converters, labeled
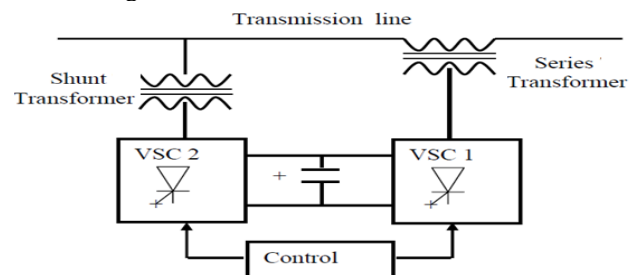
Fig -2: Basic configuration of UPFC

"Converter I" and "Converter 2" in the figure, are operated from a common dc link provided by a dc storage capacitor. This arrangement work as an ideal AC-to-AC power converter in which the real power can freely flow in either direction between the terminals of the two converters, and each converter can independently generate {or absorb) reactive power at its own ac output terminal. converter 1 can also generate or absorb controllable reactive power if it is desired [5] [6].Therefore provide independent shunt reactive compensation for the line.

4. CASE STUDY
4.1 CASE INTRODUCTION

In a 500 kV /230 kV transmission network which is connected in a loop configuration, consists essentially of five buses (B1 to B5) interconnected through transmission lines (L1, L2, L3) and two 500 kV/230 kV transformer banks Tr1 and Tr2. Two power plants located on the 230-kV system generate a total of 1500 MW which is transmitted to a 500 kV 15000-MVA equivalent and to a 200-MW load connected at bus B3. The plant models include a speed regulator, an excitation system as well as a power system stabilizer (PSS). In normal operation, most of the 1200-MW generation capacity of power plant #2 is exported to the 500- kV equivalent through three 400-MVA transformers connected between buses B4 and B5.
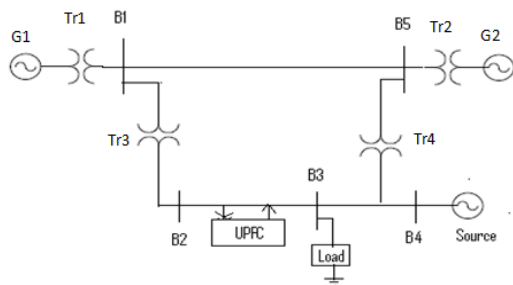

Fig -3: Structure of 2-machines 5-bus system

4.2 CONSIDERATION

Study of effect of unified power flow controller (UPFC)and power system stabilizer without fault and with fault in a multimachine system to damped power system oscillations.

Case 1: Simulation model without upfc without fault.

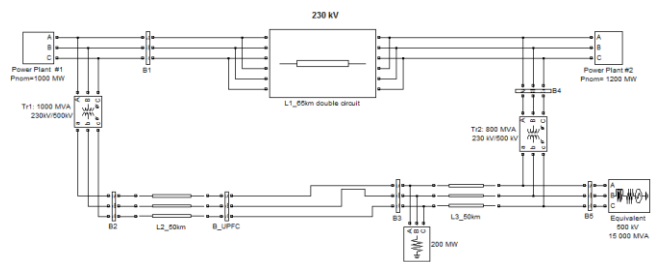This is healthy system without any fault created in it. This is the stable system .

Fig - 4. Two machine five bus system model without UPFC

Case 2: Simulation model without UPFC with three phase fault

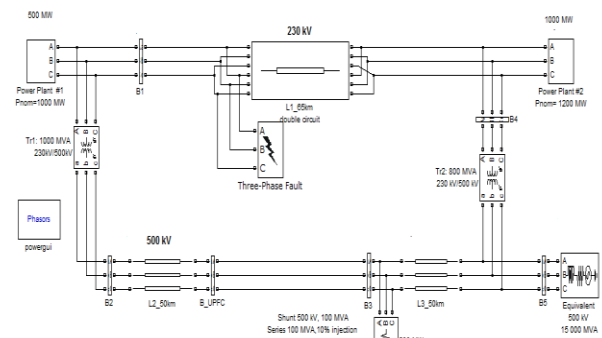In this model UPFC is not connected in the system Three phase fault is created near bus 1.

Fig - 5. Two machine five bus system model without UPFC

Case 3 : Simulation model with UPFC with fault.

In this model UPFC is connected in between bus B2 and B3. three phase fault is created simultaneously near bus B1.Oscillations are observed in bus voltage B1 and power .UPFC plays the role and damped out these oscillations. system will stable within small duration of time.
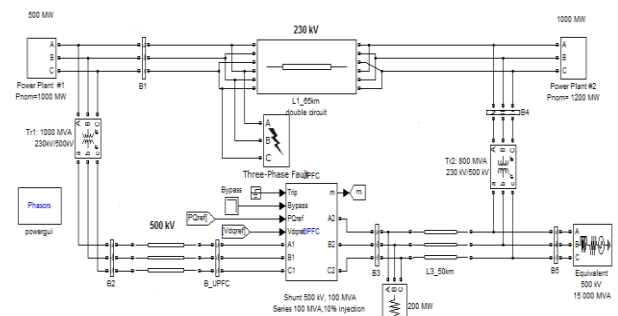

Figure 6. Two machine five bus system model without UPFC

5. SIMULATION AND RESULTS

A. System without fault without UPFC

Consider two machine five bus system without creating any fault the scope will show the results without oscillations. The
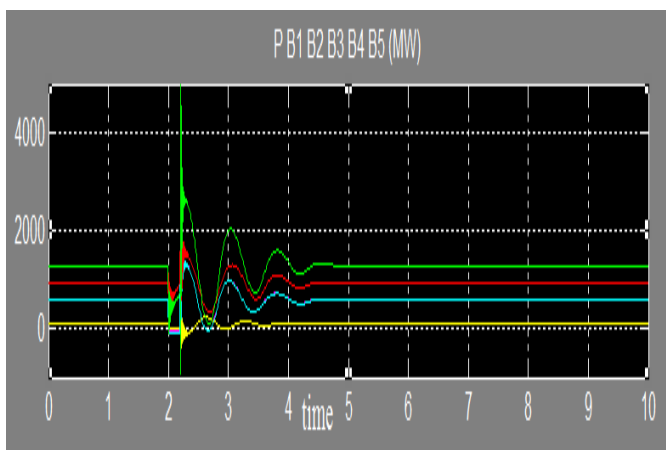
active , reactive power and voltages at different buses will be obtained in scope .results obtained in the scope are straight line without any oscillations.
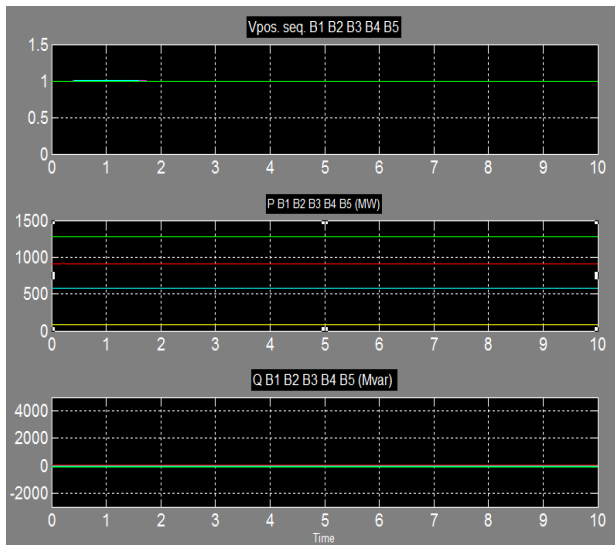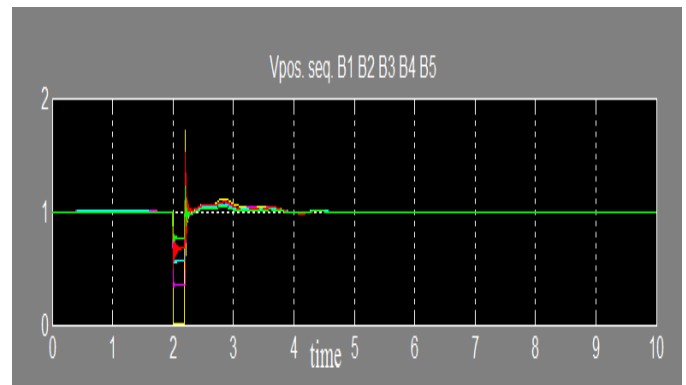

Fig -7: bus active power ,reactive power and bus voltages at different buses without fault.
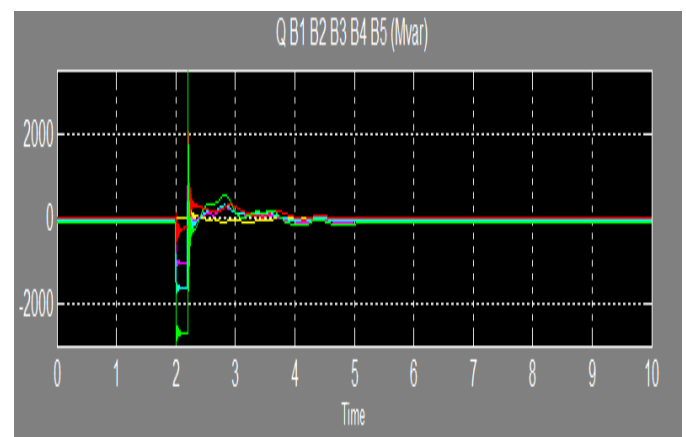
B. Three phase fault (without UPFC)

In two machine five bus system if fault is created near bus B1 then results obtained in the scope is shown in fig7 which shows system is unstable with oscillations in power and voltages.

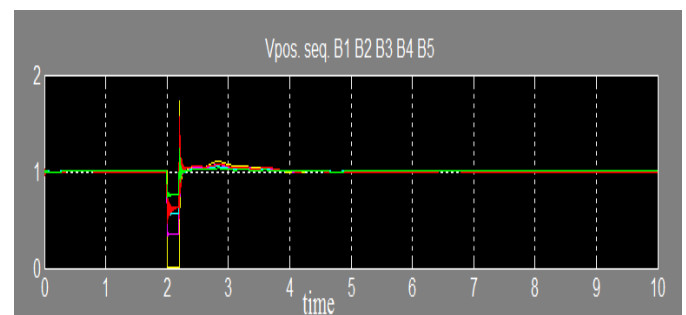**Fig -8**: active power in MW at different buses without UPFC

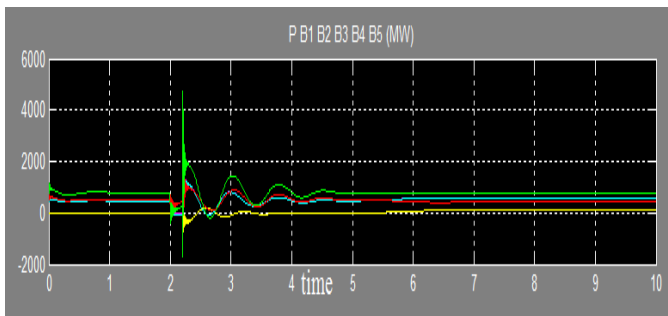**Fig -9**: voltages in p.u. at different buses with UPFC

Fig – 10: Reactive power in Mvar at different buses without UPFC
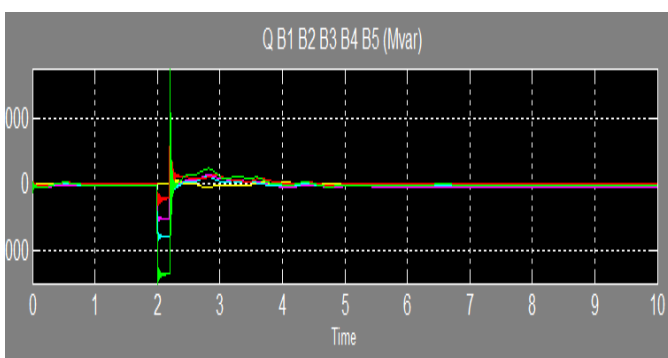
C. Three phase fault (with UPFC)

During the fault if UPFC is applied then voltage becomes stable at 1.2 seconds and power becomes stable at 1.4 seconds.

Fig -11: voltages in p.u. at different buses with UPFC

Fig -10: Active power in MW at different buses with UPFC

Fig – 12 : Reactive power in Mvar at different buses with UPFC

6. CONCLUSION

It is clear from the results that the Unified Power Flow Controller can effectively damp the power system oscillations. This paper presents the effectiveness of the UPFC on power system improving stability. Oscillations are produce by creating three phase and single phase fault in transmission line Time required for damping power system oscillations is reduce when use UPFC and we get stabilize system in small duration of time. Results are shown for both three phase and single phase fault ..UPFC is able to damp oscillations which are created by three phase and single phase fault both in a transmission line

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