Damping of Oscillations in multimachine Integrated Power System using Unified Power Flow Controller-UPFC

[1]Poonam G Umap, [2]P.P. Jagtap

[1]Mtech Student, [2]Assistant Professor
Department of Electrical Engineering,
G. H. Raisoni College of Engineering, Nagpur

***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 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 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.

***IndexTerms*—UPFC model, stability, three phase fault oscillations.**

1. INTRODUCTION

In recent few years FACTS devices have been employed to damp power system. 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 provides 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. UPFC is able to damp oscillations in power system and improve transient stability in the system.

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

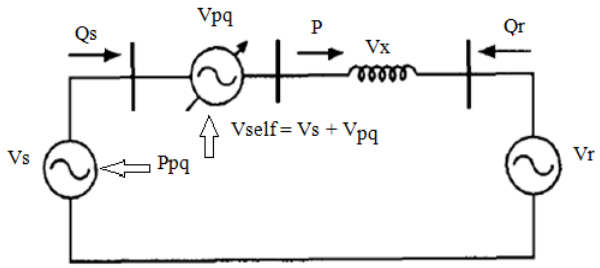

Fig -1: Represenation of UPFC in a two machine power system.

3. BASIC CONFIGURATION OF UPFC

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

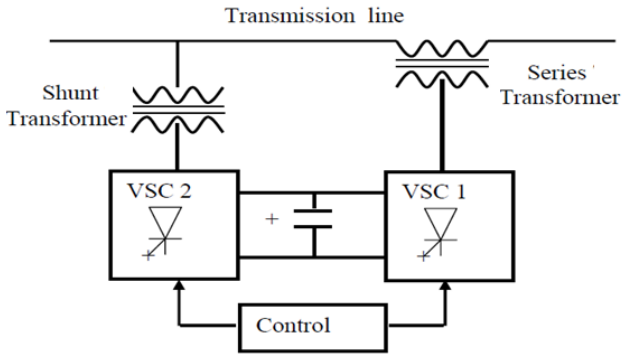

Fig -2: Basic configuration of UPFC

"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. Therefore provide independent shunt reactive compensation for the line.

4. SYSTEM MODEL UNDER STUDY

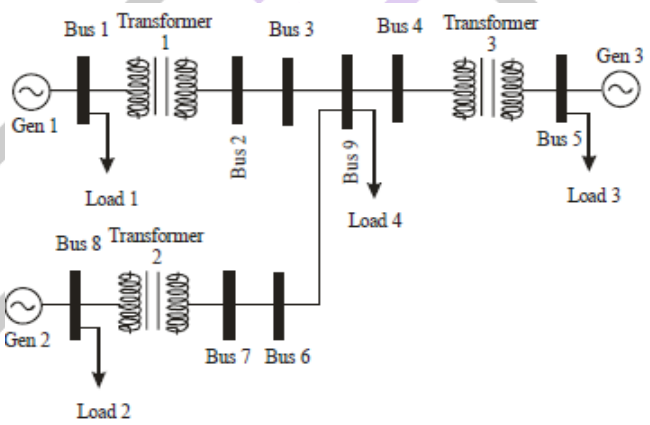

Fig-3: A systemmodel without the controllers

The system model is developed containing three generators, four loads and nine buses. The models are developed without and with controllers as shown in Figs 1 and 2 respectively. The generator 1 is connected to the bus 1, generator 2 to bus 8 and generator 3 to bus 5. The transformers 1, 2 and 3 are placed near the generator buses for transmitting power either by stepping up or stepping down. As the power system is nonlinear in nature, there is a requirement of mathematical model for modeling and simulating in Matlab/Simulink software.

5. DEVELOPMENT OF THE SIMULINK MODEL

The development of the Simulink model for the multi-machine FACTS based power system with and without the controller.The Fig. show the 3 simulation models of the 3-generator, 9-bus system installed with UPFC controllers first one between 2nd and the 3rd bus and second one is at 6th and 7th bus when the fault takes place near generators 1, 2 & 3. The 3 phase to ground symmetrical fault is created near the generators for 200 ms. from the first cycle to the tenth cycle like in the model with the controller in all the 3 cases. This is done in order to compare the effectiveness of the incorporated controller in the model when the fault takes place with the model without the controller when the fault takes place.

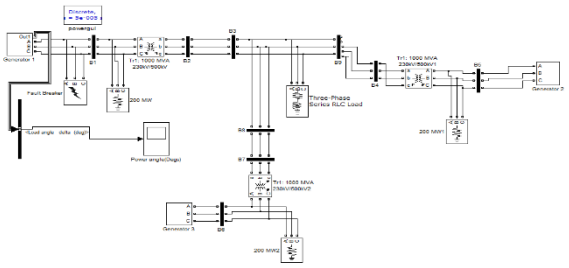

Fig-4: System with 3-phase fault at generator 1 without controller

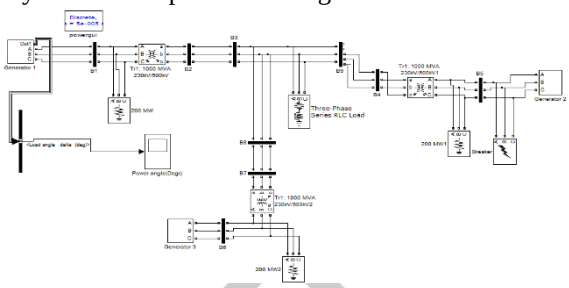

Fig-5: System with 3-phase fault at generator 2 without controller

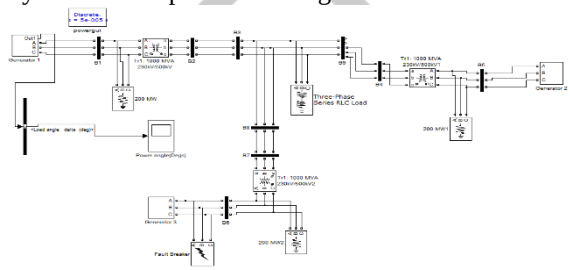

Fig-6: System with 3-phase fault at generator 3 without controller

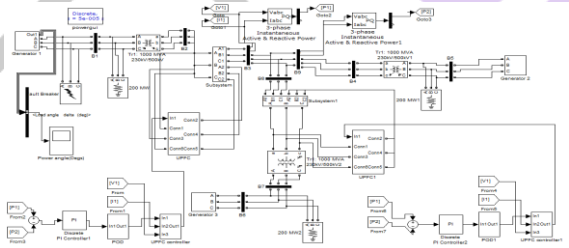

Fig-7: System with 3-phase fault at generator 1 with PI controller.

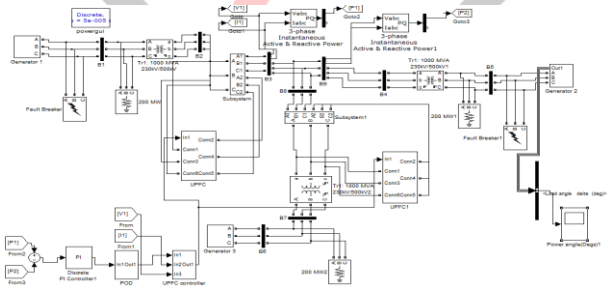

Fig-8: System with 3-phase fault at generator 2 with PI controller

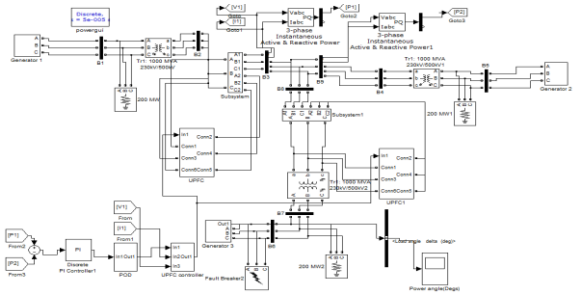

Fig-9: System with 3-phase fault at generator 3 with PI controller

6. SIMULATION RESULTS

System with 3-phase fault without and with controllers Consider three machine nine bus system

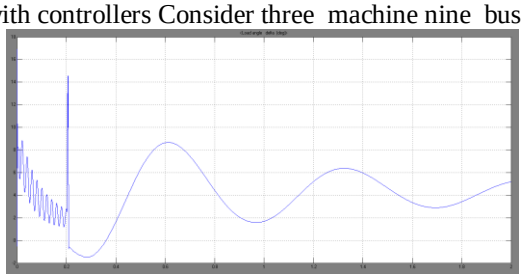

Fig-10: Simulation result of power angle v/s time with 3-phase fault at generator 1 without controller

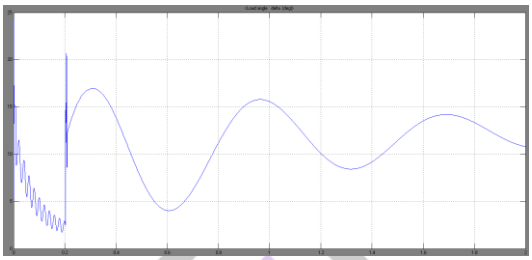

Fig-11: Simulation result of power angle v/s time with 3-phase fault at generator 2 without controller

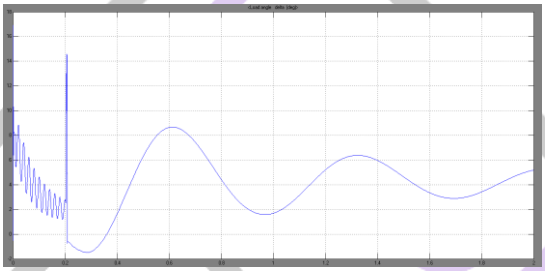

Fig-12: Simulation result of power angle v/s time with 3-phase fault at generator 3 without controller

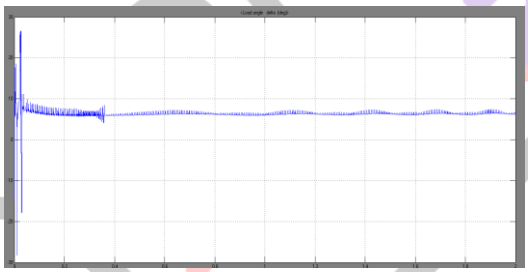

Fig-13: Simulation result of power angle v/s time with 3-phase fault at generator 1 with PI controller

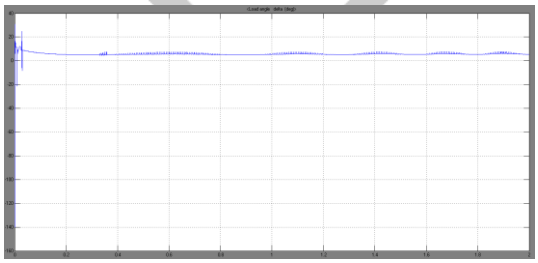

Fig-14: Simulation result of power angle v/s time with 3-phase fault at generator 2 with PI controller

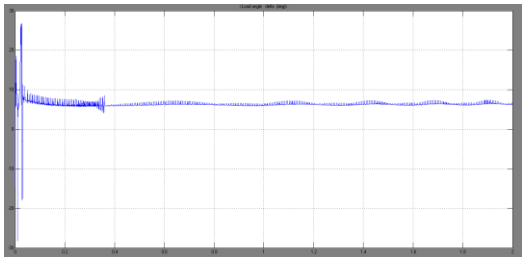

Fig-15: Simulation result of power angle v/s time with 3-phase fault at generator 3 with PI controller

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 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 fault both in a transmission line.

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