Oscillations Damping in multi-machine System by the using of Unified Power Flow Controller-UPFC

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Abstract

Unified Power Flow Controller (UPFC) is most important device which used to help in damping out the oscillations which present in the system. UPFC device is the most flexible FACTS equipments. UPFC execute the combined functions of the controlled reactor (TCR), static synchronous compensator (STATCOM), thyristor controlled reactor (TCR), thyristor switched capacitor (TSC). By using this device the phase angle regulator offers the flexibility for the dynamic and static operation of the power network. In the transmission line all the electrical variable can be controlled by the FACTS device. By the use of FACTS we can control various applications concerned of the power system, like power flow scheduling; power oscillations damping and enhancing the transient stability. We are present here the studies & result on FACTS devic & their impact of oscillations on power system.

In the FACTS device one important tool UPFC device which have capability to control independent true power & active power . By use of this device reliability & quality of supply of system can be improvised.

Various types of oscillations as consequence & interaction of its component in power system. Worldwide the most common oscillations that is observed is electromechanically oscillations in power system. Oscillations may occurs because of many reason such as change of load, disturbances in network , fault in the system etc. Here we studied about smooth power flow control, transient stability and how to enhancement it, stability of small disturbance for small time & improvement and oscillation damping in the system. In the family of FACTS device UPFC have flexible characteristics.

Index Terms—*UPFC model, oscillations of three phase fault, stability of system.*

1. INTRODUCTION

Now a days FACTS device are more useful for smooth power flow in the system or we can say to control damped in power system. In this necessary precaution are taken for oscillations because it may lead to partial or totally interruption in the supply or power system. Stabilizer is a tool which is used for damp out or control the oscillations. To controls damping & ensure the stability of the system PSS tuned carefully. In proper tuned PSS can cancel the damping which produced by the system. Excitation of rotor speed or signal change as the rotor speed may change in output with speed. In the power system instability is major issue. To improve steady state stability & dynamic stability appropriate devices were used that's come from FACTS family. In FACTS family UPFC have capability to damp out oscillations in power system and improve system transient stability.

2. UPFC PRINCIPLE

From the concept point of view UPFC have a generalized synchronous voltage source (SVS). The UPFC is the most versatile FACTS controller developed so far, with all encompassing capabilities of voltage regulation, series compensation, and phase shifting. The series converter is controlled to inject a phasor voltage of magnitude *Vpq*, which is series with the line, that can be varied from 0 to *Vpq* max. However , the phase angle of *Vpq* can be independently varied from 0^0 to $360^{0.}$ In UPFC device process, the series converter exchanges both real power and reactive power with 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 .The real power can be exchange by the UPFC device gives by one of the buses as shown in Figure. 1

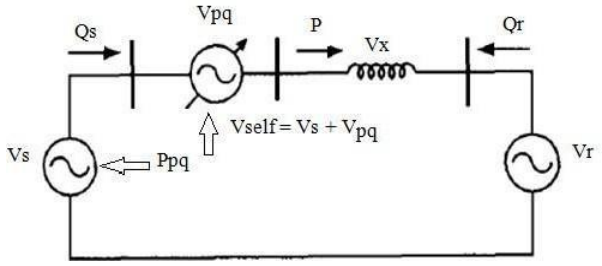

Fig -1: Representations of UPFC in a two machine system.

3. BASIC CONFIGURATION OF UPFC

Two voltage source converters (VSC) as shown in figure-1 are connected in UPFC. VSC are connected back-to-back as shown in figure. These converters are connected via a common dc link which is provide dc storage capacitor.

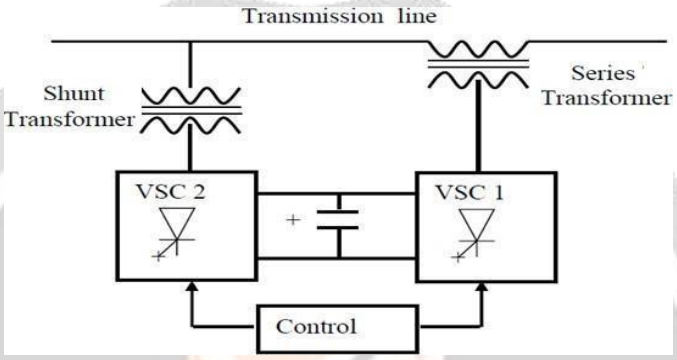

Fig -2: Basic configuration of UPFC

So this system working as ideal AC to AC power converter in that active power can be smoothly flow in any of the direction in between two converters terminals, so that each converter can freely generate (or absorb) imaginary (reactive) power at the output terminal. If converter 1 desired some controlled reactive power it can also generate or absorb. So for line it is provide freely reactive compensation for shunt.

4. SYSTEM MODEL UNDER STUDY

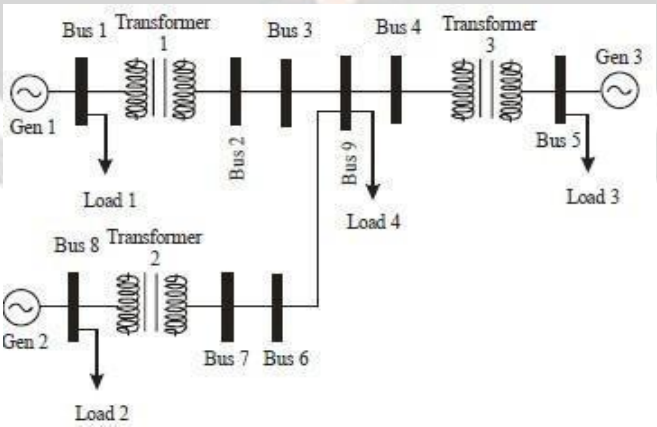

Fig-3: A system model without the controllers

In this system we take four loads name load1 to load 4, three generators name gen 1 to3, & buses one to nine it contains. This models are made with & without Controller as shown in figure. In this figure generator no 1 connected to the bus no 1, generator no 2 connect to bus no 8 and generator no 3 connect to bus no 5. For transmitting power for step up & step down we are connected transformer no 1, 2 & 3 are connected to the near by generator buses. As we know that power system nature nonlinear. So that for analysis purpose we create mathematics model in simulating for MATLAB software.

5. DEVELOPMENT OF THE SIMULINK MODEL

Simulink model of multi machine system facts based device is developed here with & without controller. In the Fig. show below 3

simulation models of the 3-generator & 9-bus system install with UPFC device controllers. First one connected between 2nd and 3rd bus. Other second one is connected between 6th and 7th bus. If fault occurs near generators no 1, 2 & 3 places. Three phase line to line to line to ground (LLLG) that is symmetrical fault occurs near the generator for short time 200ms. We are taking here from the 1st cycle to the 10th cycle as showing in the model with UPFC device controller in all 1 to 3 cases. It is complete in order to see the effectiveness of incorporated controller model & when fault occurs with model & without controller when the fault occurs.

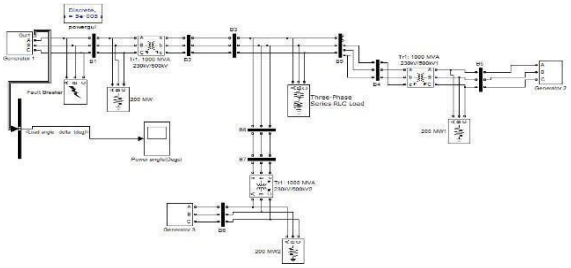

Fig-4: System with 3-phase fault at generator 1 withoutcontroller circuit

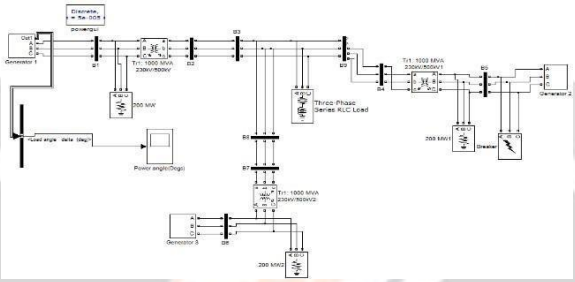

Fig-5: System with 3-phase fault at generator 2 withoutcontroller circuit

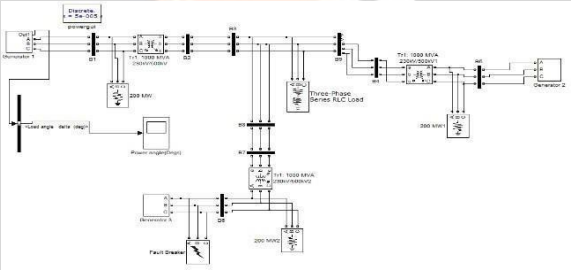

Fig-6: System with 3-phase fault at generator 3 without controller simulation Circuit

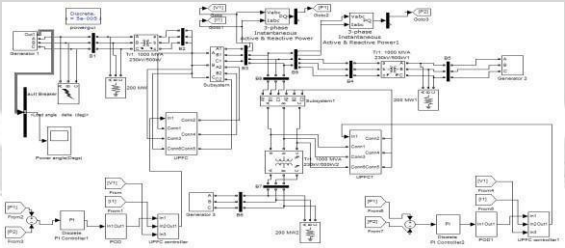

Fig-7: System with 3-phase fault at generator 1 with PI controller simulation circuit

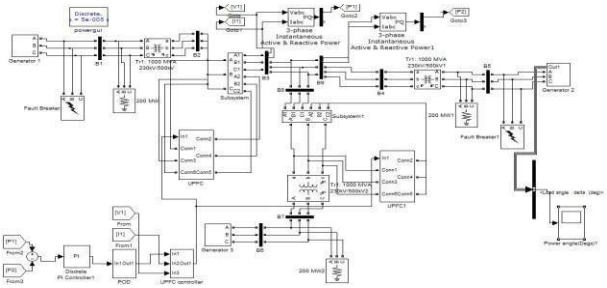

Fig-8: System with 3-phase fault at generator 2 with PI controller simulation circuit

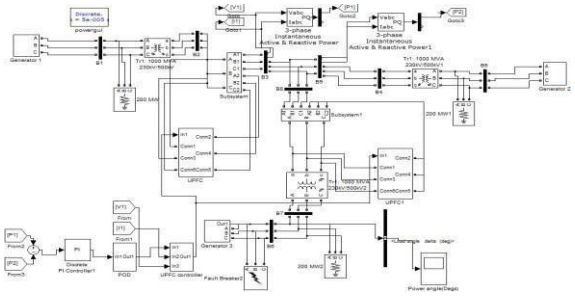

Fig-9: System with 3-phase fault at generator 3 with PI controller simulation circuit

6. SIMULATION RESULTS

Here we are showing the result of System of three phase fault with & without controllers. We are Consider 3 machine & 9 bus system

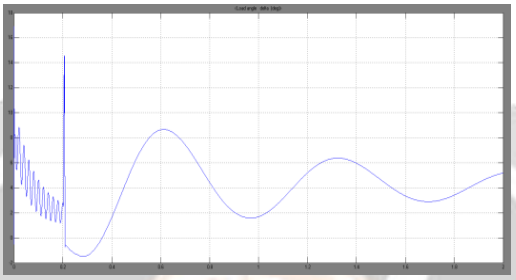

Fig No-10: power angle v/s time with 3-phase fault at generator 1 without controller Simulation result

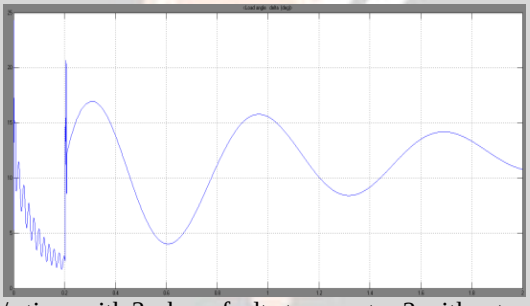

Fig No-11: power angle v/s time with 3-phase fault at generator 2 without controller Simulation result

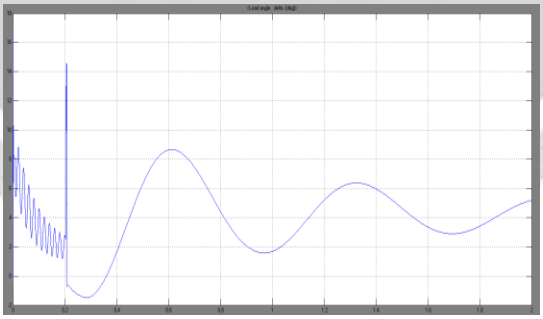

Fig No-12: power angle v/s time with 3-phase fault at generator 3 without controller Simulation result

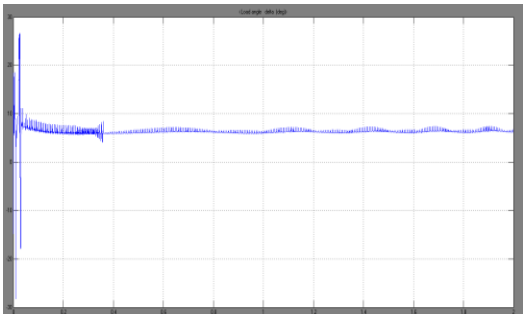

Fig No-13: power angle v/s time with 3-phase fault at generator 1 with PI controller Simulationresult

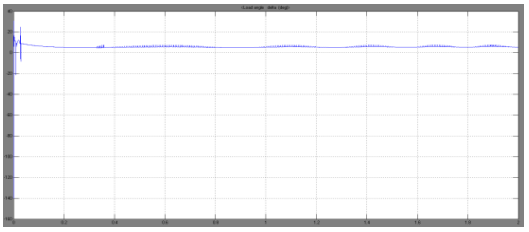

Fig No-14: power angle v/s time with 3-phase fault at generator 2 with PI controller Simulation result

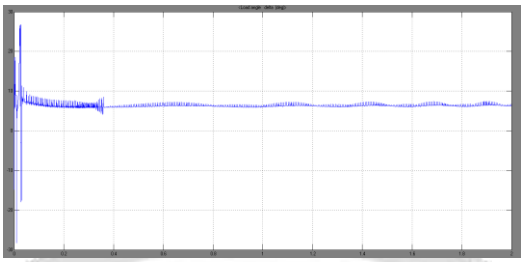

Fig No-15: opower angle v/s time with 3-phase fault at generator 3 with PI controller Simulation result

CONCLUSION

As we are using UPFC device result of that are very effectively control the power system oscillations. In this paper we show the result of upfc that show the stability of power system . We Introduce three phase fault to create oscillations in transmission line. To damp out power system oscillations time requirement is reduced when used UPFC device. When three fault occurs in transmission line result are shown in above figure. So we can say UPFC device is capable to damp oscillation which occurs in transmission line.

REFERENCES

[1] K.R. Padiyar , K. Uma Rao, "Modeling and Control of UPFC for Transient Stability", *Elsevier Journal of Electrical Power EnergySystems*, N0. 21, pp. 1- 11, 1999.

[2] Z. Huaang, Y.X. Ni, C. M. She, F. F. Wu, S. Chen, and B.Zhang, "Application of Unified Power Flaw controller in interconnected Power Systems modeling, interface, control, strategy, and case study", IEEE Trans. On Power Systems. Vol.15, No.2, pp. 817- 824, May 2000.

[3] L. Gyugi, "Unified Power flow concept forflexible AC transmission systems", *IEEProc.*, Vol. 139, No. 4, pp. 323–332, 1992.

[4] M. Noroozian, L. Angquist, M. Ghandari, and G. Anderson, "Use of UPFC for optimal power flow control", *IEEE Trans. on PowerSystems*, Vol. 12, No. 4, pp. 1629–1634,1997.

[5] Hingorani N G, GyugyiL(2000). Understanding FACTS, IEEE Press, pp., 323-387.

[6] Narain G. Hingorani, Laszlo Gyugyi "Understanding FACTS: Conceptsand Technology of Flexible AC Transmission Systems", *Power electronics sponsored byEngineers*, Inc. 3 Park Avenue, New York, NY 10016-5997, 2000.

[7] V.K.Chandrakar, A.G.Kothari, "RBFN Based UPFC for Improving transient stability Performance", *WSEAS Transactions onPower Systems*, Issue 1 , Vol. 2 , pp.1-6 ,Jan2007.

[8] S. Kannan, S. Jayaram, M. M. A. Salama, "Real and Reactive Power Coordination for a Unified Power Flow Controller", *IEEETransactions on Power Systems*, Vol. 19, Issue 3, pp. 1454 – 1461, 2004.

[9] LijunCai, IstvanErlich, "Fuzzy coordination of FACTS controllers for damping power system oscillations", Proc. Of the Int. Symp. On Modern Electronic Power Systems, Wroclaw, pp. 251-256, Sept. 11-13, 2002.

[10] R.P Kalyani, G.K. Venayagamoorthy, M. Crow, "Neuroidentification of system parameters for the shunt & series branch control of UPFC", *Power EngineeringSociety General Meeting, 2003*, IEEE Vol. 4, 13-17 Jul. 2003.

[11] P. K. Dash, S. Mishra, and G. Panda, "Damping Multi-modal Power System Oscillation Using a Hybrid Fuzzy Controller for Series Connected FACTS Devices", *IEEETrans. on Power Systems*, Vol. 15, No. 4, pp. 1360–1366, Nov. 2000.