National Journal of Multidisciplinary Research and Development
ISSN: 2455-9040; Impact Factor: RJIF 5.22
Received: 03-07-2019; Accepted: 05-08-2019
www.nationaljournals.com
Volume 4; Issue 4; October 2019; Page No. 07-10

Damping of inter area oscillations using power system stabilizer and unified power flow controller

Indreshwar Prasad Srivastava
Assistant Professor, Department of Electrical Engineering, MITRC Alwar, Rajasthan, India

Abstract
Oscillation occurs in power system as a result of conditions such as faults or sudden changes in load or generation. These are harmful to the operations of the system since they affect power system stability and the flow of optimal power through it. These oscillations does not generally damp out in tie-lines by its own even the tripping of these lines can't result in damping of these oscillations, unless some controls are applied to the system. Local and inter area mode of oscillations have conventionally been controlled by the use of Power System Stabilizers (PSS). However FACTS (Flexible alternating current transmission systems) controllers such as UPFC (Unified power flow controller) have sufficient strength as an alternatives to PSS. In addition to steady state solutions such as voltage control at bus and power flow control in transmission line, an additional benefit of FACTS controllers is that they can control power system oscillations in transmission system. These oscillations can damage generators, increases line losses and damage of power system components.
The main aim of this thesis is to damp inter-area power system oscillations by the use of UPFC (Unified power flow controller). The approach proposed is a general nonlinear method for multiple FACTS controllers for damping power system oscillations in a power system. UPFC controllers can be used for fast damping of inter-area oscillations in both two-area and multi-area power systems.By using a UPFC the oscillation introduced by the faults, the rotor angle and speed deviations can be damped out quickly than a system without a UPFC. In multi area system with more than one FACTS controller are analysed during faults and also the response of these controllers in such conditions can be analysed.

Keywords: Inter area oscillations, PSS, UPFC, FACTS, simulink

1. Introduction

Modern bulk power systems cover large geographic areas, and have a large number of load buses and generators. Additionally, available generating plants are often not situated near load centers and power must consequently be transmitted over long distances. To meet the load and electric market demands, new lines should be added to the system, but due to environmental reasons, the installation of electric power trans-mission lines must often be restricted. Hence, the utilities are forced to rely on already existing infra-structure instead of building new transmission lines. Due to the expansion of loads in power systems and increasing the power system interconnections, the economic drivers encourage loading the transmission lines near their limits [1].

There are two types of modes in the power system oscillations: local modes and inter-area modes. Local modes are associated with the swinging of one generator against the rest of the system. In the inter-area modes, generators in one area swing against the generators of the other area.

Oscillations can be rank in four major classes

1. Local oscillations: These oscillations actuate among a unit and the rest of the generating network, and therefore in the rest of the power system. Their frequency range lies between 0.8Hz to 4.0Hz.
2. Interplant oscillations: These oscillations occur between two electrically close generation plants. Frequency range of these type of oscillations can vary from 1Hz to 2Hz.
3. Inter area oscillations: These oscillations usually produce among two major groups of generation plants. Frequencies are lies in a range of 0.1Hz to 0.8Hz.
4. Global oscillation: Oscillations created in common in-phase of all generators as initiate on an isolated network. The frequency varies generally below 0.2Hz.The system events cause the creation of Inter-Area oscillations, which are connects with a scantily damped power network [2].

These oscillations are unwanted to effect in instability of operation in power system network. To damp such kind of electromechanical oscillations, conventionally power system stabilizers are utilized on generator excitation control system. A PSS (Power System Stabilizer) can be significant as an extra block of ma generator excitation control, which utilize to enhance the overall performance of power system dynamics, particularly for obstructing the electromechanical oscillations. Therefore, the PSS utilizes the auxiliary stabilizing signals such as terminal voltage, generator speed, and frequency or power to alter the input signal of the voltage regulator. This scheme is very productive for enhancing small signal stability capability in a power system network PSS are commonly deployed via the excitation system of generator to boost up the stability of power system, which has been turn into more complex shape in recent year. However, the control of PSS may be unproductive to suppress the oscillations in case of two-area power system which is to be connecting via long weak line. The key feature of PSS is to establish modulating signal acting by the excitation system to improve rotor oscillation damping. Even though power system stabilizer is the main damping control, but it has a drawback that during in various operating condition, this device may not generate sufficient damping particularly to inter-area mode and thus, there is an escalating significance in using FACTS device UPFC to support in damping of these oscillations and to enhance the voltage profile. Unified Power Flow Controller (UPFC) is most advance member of FACTS, which can manage power system parameters such as voltage magnitude, impedance of line and phase angle simultaneously. Therefore, this device (UPFC) used not only for power flow control, but also for power system stabilizing control. Different researchers use this device for different scenarios. UPFC carry out the task of a shunt reactive current injection for controlling the bus voltage and power flow can be control in transmission line by injecting series reactive voltage [3].

Freely flow in either direction between the two-ac branches. Each converter can independently generate or absorb reactive power at the ac output terminals. The controller provides the gating signals to the converter valves to provide the desired series voltages and simultaneously drawing the necessary shunt currents, In order to provide the required series injected voltage, the inverter requires a dc source with regenerative capabilities. The possible solution is to use the shunt inverter to support the dc bus voltage [4].

The UPFC can perform the function of Statcom and SSSC and phase angle regulator. Besides that the UPFC also provides an additional flexibility by combining some of the function above. Lastly the UPFC also can reduce the value of the reactive power and it will optimum the real power flow through the transmission line [5].

The Unified Power Flow Controller (UPFC) was proposed first time for real turn-off time control and dynamic compensation of ac transmission systems. The Unified Power Flow Controller is consists of two switching converters, which are considered as voltage sourced inverters using gate thyristor valves, as illustrated in Fig.2.1 These inverters, labeled "VSC1" and "VSC2" in the figure are operated with a common dc link provided by a dc storage capacitor. With this arrangement the ac power converter in which the real power can freely flow in either direction between the ac terminals of the two inverters and each inverter can independently generate as well as absorb the reactive power at its own ac output termina [6].

Since the series converter of the UPFC can inject a voltage with variable magnitude and phase angle it can exchange real power with the transmission line with the help of series transformer. Thus the shunt branch is required for compensate (from the system for any real power drawn/supplied by the series branch and the losses. when the power balance is not maintained, at that situation the capacitor cannot remain at a constant voltage. Shunt branch also can independently exchange reactive power with the system [7].

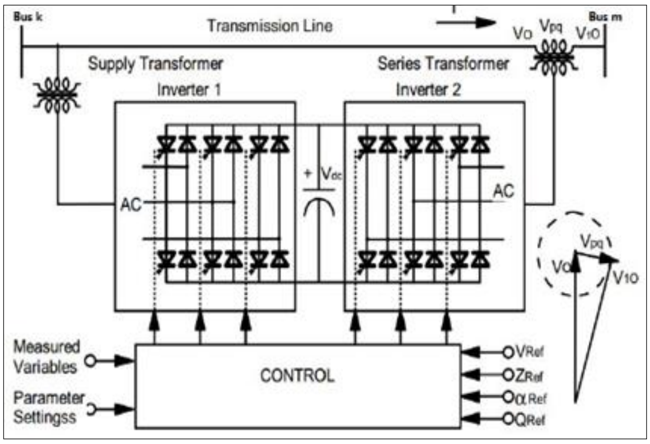

Fig 1: Connection

Diagram of UPFC with Transmission Line

3. Simulinlk Models

3.1 Simulink Model for two area system for Power System Stabilizer (PSS) connected in transmission line.

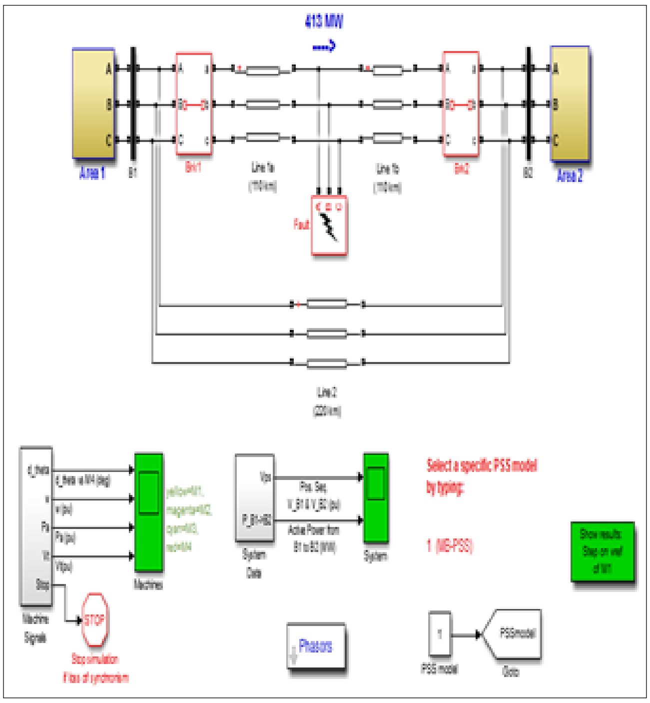

Fig 2: Simulink Model for two area system when Power System Stabilizer (PSS).

3.2 Simulink Model for two area system for UPFC connected in transmission line.

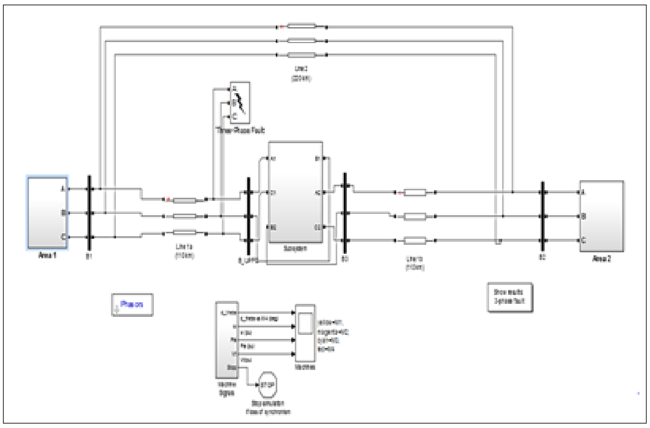

Fig 3: Simulink Model for two area system for UPFC connected in transmission line

3.3 Simulink model for two area system with UPFC for controllable region

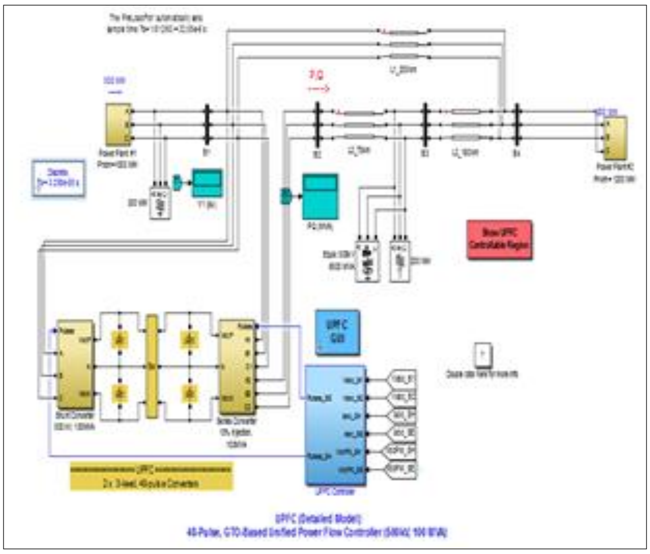

Fig 4: Simulink model for two area system with UPFC for controllable region.

4. Results

4.1 Simulation result for two area system with PSS.

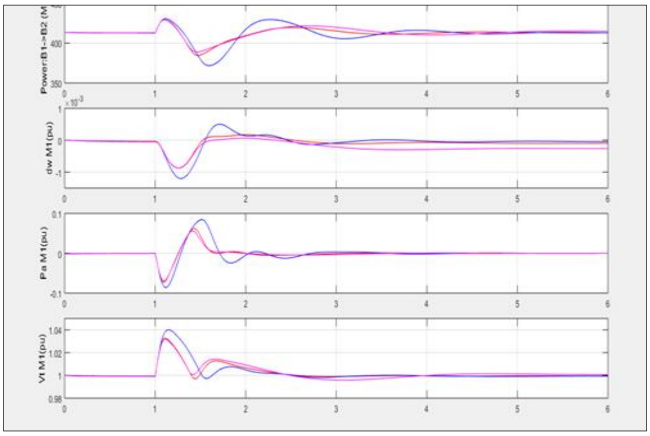

Fig 5: Results for damped oscillations when PSS is connected in two area system.

4.2 Simulation result for two area system with UPFC.

Fig 4.3 shows the result for damped oscillations when UPFC is connected in two area system.

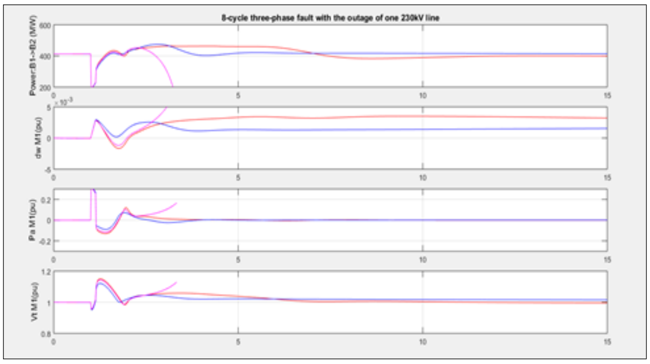

Fig 5: Results for damped oscillations when UPFC is connected in two area system.

4.3 Simulation result for two area system for controllable region with UPFC.

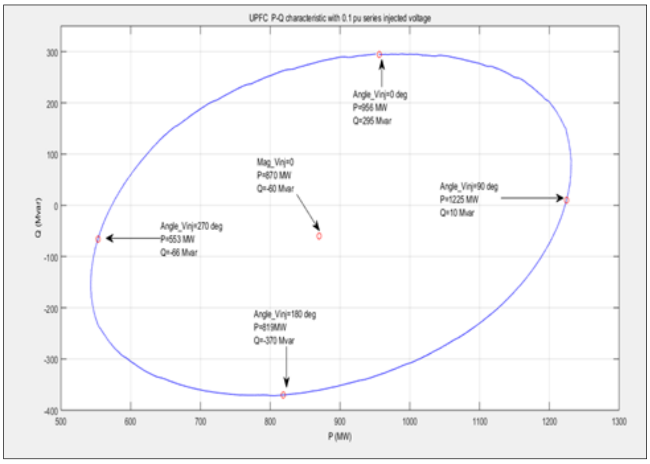

Fig 6: Results for controllable region when UPFC is connected in two area system.

5. Conclusion

The two area power system was used to analyse the role of UPFC for damping the oscillations. It was observed that the results with UPFC, and PSS show satisfactory performance as compared with only PSS. Thus it can be concluded that for effective damping of power system oscillations, Different kinds of electromechanical oscillation and capability of power system stabilizer (PSS) in local oscillation damping and inefficient to low frequency inter area oscillation damping of two area connected by tie line have been discussed. An efficient scheme with UPFC based controllers for damping power system oscillations has been applied. After testing four different scenarios it has been concluded that, the mutual operation of Power System Stabilizer and UPFC not only reduces the system oscillations but also overcome the oscillations, which exist in the reactive power, real power and phase voltage. The performance of the device (UPFC) analyzed by inducing the single phase to ground fault in the transmission line. The simulation results reveals that the oscillation occurs after inducing the fault are successfully and efficiently overcome by incorporating the both of PSS and UPFC simultaneously in transmission system.

6. References

1. Uhlen K, Pálsson M, Time TR, Gjerde JO. Raising Stability Limits in the Nordic Power Transmission System, 14th Power Systems Computation Conference (PSCC'02), Sevilla, 2002.
2. Kundur P. Power System Stability and Control, McGraw Hill, New York, 1994.
3. Prabha Kundur. Power System Stability & Control, Tata Mcgraw Hill, 2006.
4. Padiytar KR. FACTS Controllers in Power Transmission and Distribution, New Age International, 2010.
5. Gyugyi L, Hingorani NG. Understanding FACTS: concepts and technology of flexible AC transmission system, IEEE Press, New York, 1999.
6. Molinas M, Suul JA, Undeland T. Low Voltage Ride Through of Wind Farms With Cage Generators: STATCOM versus SVC, IEEE Transactions on Power Electronics. 2008; 23:3.
7. Gyugyi FL, Schauder CD, Torgenon SL, Edris A. The Unified Power Flow Controller: A new approach to Power Transmission Control", IEEE Trans. On Power Delivery. 1995; 10(2):1088-1097.
8. Internet Materials, SCI HUB, Matlab Library files.