A Comparative Analysis for Transient Stability Improvement Using Power System Stabilizer and Static VAR Compensator

Ajay Chaudhary[1], Ram Avtar Jaswal[2]

[1]*M.tech Student, U.I.E.T kuk (Haryana)*

[2]*U.I.E.T Kuk (Haryana), Department of Electrical Engineering U.I.E.T, Kurukshetra*

Abstract: The objective of this paper is to compare the performance of a conventional power system stabilizer and Static VAR compensator to improve the transient stability of multi machine power system. Power system stabilizer is a conventional method which is used to make the system oscillation free. The performance of this system is now compared with one of FACTS devices used Static VAR compensator Transient stability is one of the most important stability of the power system. The loss of Transient stability is due to overloading of some of the lines (or due to sever line fault) as a consequence of tripping off of the other lines after fault or heavy loss of loads. The proposed work includes (WSCC) 3-machine 9-bus system incorporated with Power system stabilizer and Static VAR compensator respectively controller using Matlab. The simulated SVC shows how the oscillations are damped out with PSS and SVC controller. Performance of both PSS and SVC are compared.

Keywords: FACTS devices, Transient Stability, SVC, PSS, Multi Machine

1. INTRODUCTION

A power system is an interconnected network with components converting mechanical energy continuously into electrical form and transporting the electrical energy from generating sources to loads. Most if not all of the world's electric power supply systems are widely interconnected, involving connections inside utilities own territories which extend to inter utility interconnections and then to inter-regional and international connections. With such an interconnected large system there is a problem of stability [2]. Whenever there is a fault then the power system result in the oscillation of rotor. Power system stability may be broadly defined as that property of a power system that enables it to remain in a state of operating equilibrium under normal operating conditions and to regain an acceptable state of equilibrium after being subjected to a disturbance.

2. CONCEPT OF TRANSIENT STABILITY

Transient stability is the ability of the power system to maintain synchronism when subjected to a severe transient disturbance. The resulting system response involves large excursions of generator rotor angles and is influenced by the non-linear power-angle relationship. Stability depends on both

The initial operating state of the system and the severity of the disturbance[6]. Usually, the system is altered so that the post-disturbance steady-state operation differs from that prior to the disturbance.

In large power systems, transient instability may not always occur as first swing instability, it could be the result of several modes of oscillations causing large excursions of rotor angle beyond the first swing. Capacity during the fault condition. Transient stability limit is the maximum power which can be transmitted during the transient state. Transient stability is important from the point of Transient stability limits the available transfer view of maintaining system security. In other words, incidence of a fault should not lead to tripping of generating unit due to loss of synchronism and the possibility of a cascaded outage leading to system black out

3. TRANSIENT STABILITY IMPROVEMENT CONTROLLER

The loss of transient stability in a power system is due to overloading of some of the lines (or due to severe line faults), as a consequence of tripping off of the other lines after faults or heavy loss of loads[3]. By means of rapid and flexible control over the ac transmission parameters and network topology, FACTS technology can facilitate power control, enhance the power transfer capacity, decrease the line losses, increase power system damping and improve the stability and security of the power system.

After having adopted FACTS devices, the operating point of the power system in steady state can be altered to improve the transient stability significantly. This can be done correctly changing the pattern of power flow. Flexible AC Transmission Systems (FACTS) is alternating current transmission systems incorporating high power electronics based and other static controllers with an aim to build flexibility in the system in order to enhance controllability and increase power transfer capability.

4. POWER SYSTEM STABILIZER

The generating units in a power system are equipped voltage regulator. VR action has a detrimental impact upon stability, perhaps more properly steady state stability of power system. Oscillations of small magnitude and low frequency often persisted for long periods of time and in some cases presented limitations on power transfer capability. Power system stabilizers (PSS) were developed to aid in damping these oscillations via modulations of excitation system of generators. The action of a PSS is to extend the angular stability limits of a power system by providing supplemental damping to the oscillation of synchronous machine rotors through the generator excitation. These oscillations of concern typically occur in 0.2 to 2.5 Hz and insufficient damping of these oscillations may limit the ability to transmit power. To provide damping, these stabilizers must produce a component of electrical torque on the rotor which is in phase with speed variations This supplementary control is very beneficial during line outages and large power transfers. However, power system instabilities can arise in certain circumstances due to negative damping effects of the PSS on the rotor. The reason for this is that PSSs are tuned around a steady-state operating point; their damping effect is only valid for small excursions around this operating point. During severe disturbances, a PSS may actually cause the generator under its control to lose synchronism in an attempt to control its excitation field. The function of PSS is to sense shaft speed or frequency deviations, to condition the signal thus obtained and then feed it into the VR as supplementary input. It includes a reset stage, two lead lag stages and a limiter.

Power system stabilizers (PSS) are used to generate supplementary control signals for the excitation system in order to damp the low frequency power system oscillations. The traditional solution to this problem is application of conventional power system stabilizer (CPSS). Power system stabilizers (PSS) were developed to aid in damping these oscillations via modulations of excitation system of generators. The action of a PSS is to extend the angular stability limits of a power system by providing supplemental damping to the oscillation of synchronous.

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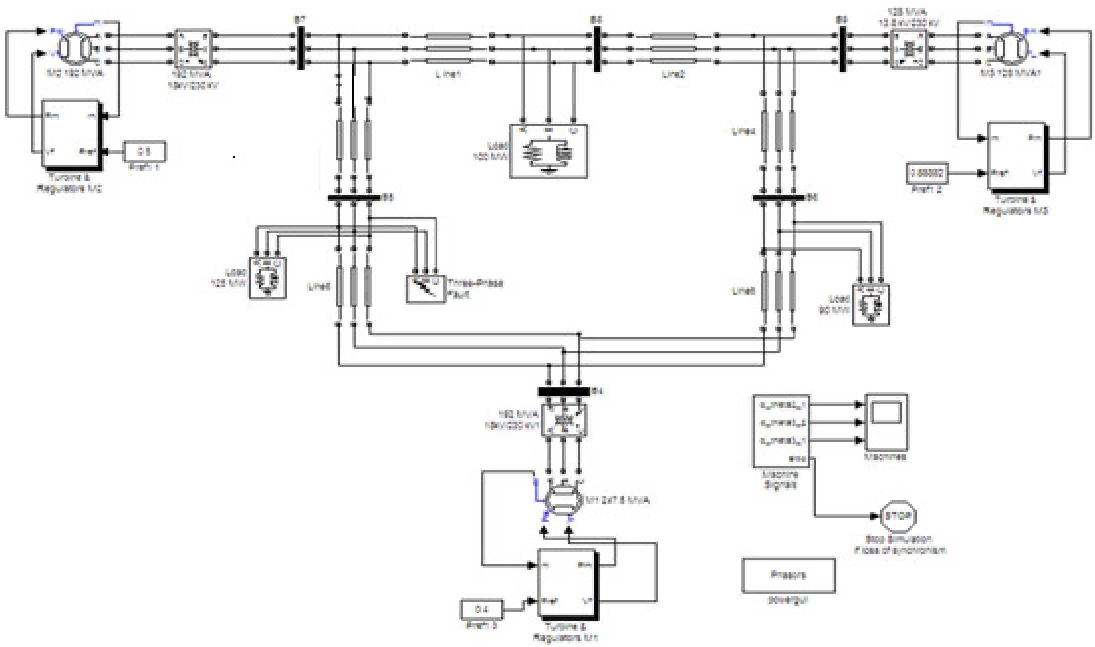
5. STATIC VAR COMPENSATOR

Static VAR compensator is one of the FACTS devices. It is used as supplementary controller to improve the transient stability and Power oscillation damping of the system. Static VAR compensator is a shunt connected compensator which can deliver or absorb VAR at the point of connection. It is a combination of Static compensator and mechanically switched capacitor and rector whose operation is coordinated. The emphases in a Static VAR system is on coordination

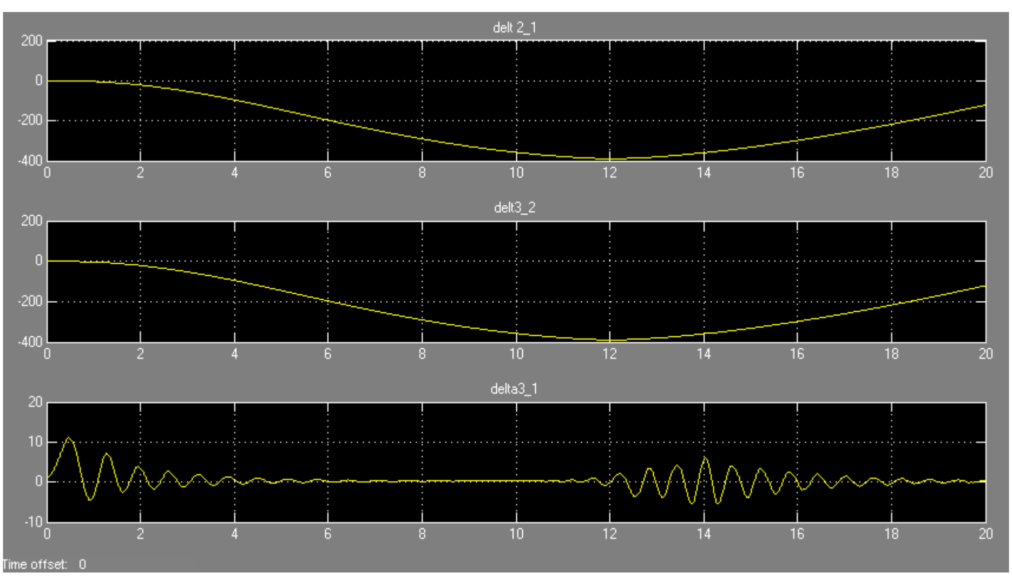
6. CASE STUDIES

The model used for simulation work is a 3 machine 9 bus system. In this model the three machine are connected in parallel such that they maintain a synchronization with each other. If there is a fault then there is a rotor angle deviation, which can be showed with the help of waveforms.



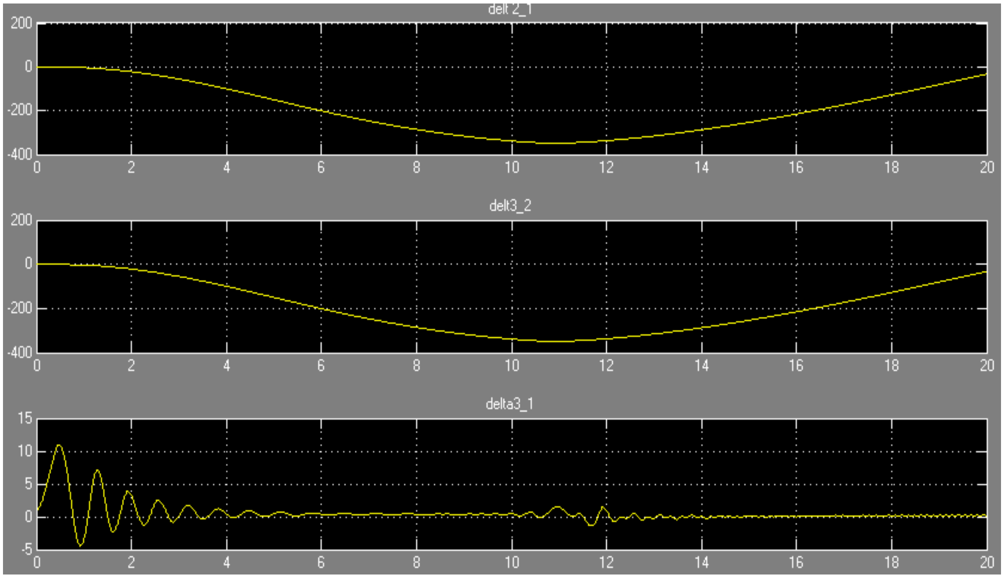
WSCC 3 machine 9 bus system

6.1.1 When Fault Occur between Bus 9 and 4



Variation of angular position delta2_1, delta3_2, delta1_3

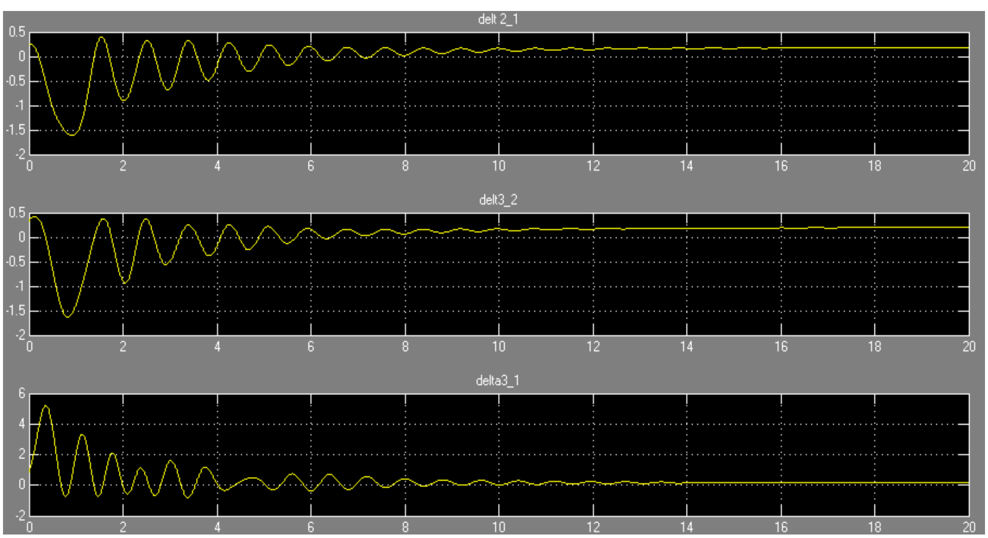
6.2.2 When PSS is connected Between Bus 7 and 4



Variation of angular position delta2_1, delta3_2, delta1_3

From the above two cases it is clear that when a fault occur then it will result in oscillation. In the second fig when PSS is connected in the system then it will result in damped out of oscillation. But as we see that oscillation are not fully damped out.

6.2.3 When SVC is connected Between Bus 7 and 4



Variation of angular position delta2_1, delta3_2, delta1_3

7. CONCLUSION

In this paper fault on multi machine system with power system stabilizer and Static VAR compensator has been studied. The simulation result shows that PSS can remove only the small oscillation produced. If large oscillation occurs then it is not able to remove it completely There are some limitations with conventional power system stabilizer. But when SVC is connected it shows better result in removing out the oscillations at the first swing. Hence we concluded that SVC shows better performance as compared to power system stabilizer.

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