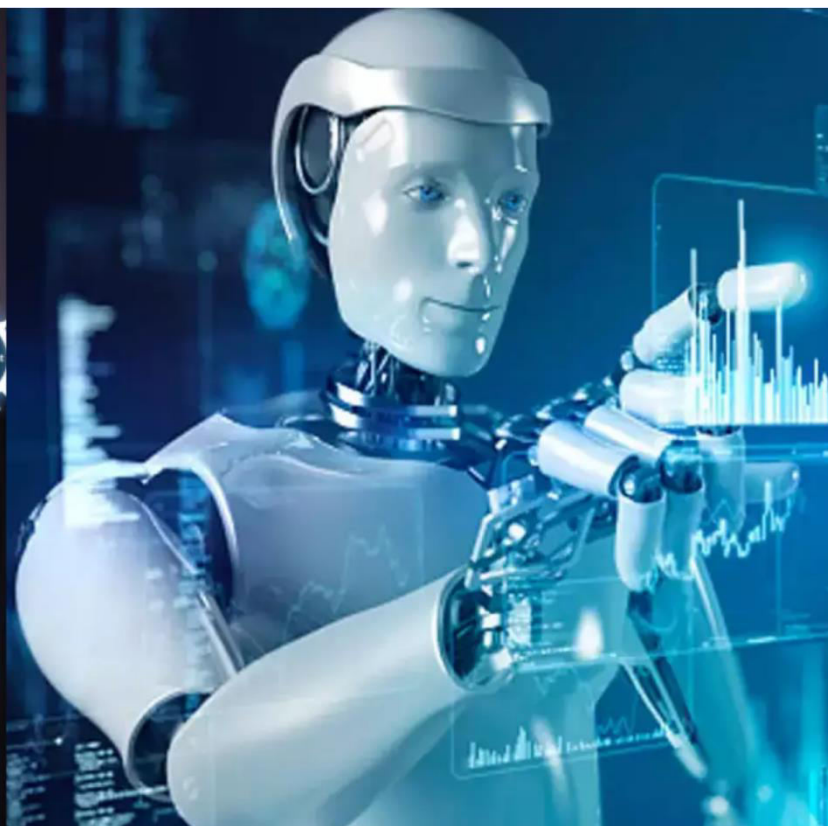




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Stability Improvement of Multi Machine Infinite Bus System by Facts Devices

Deepshikha Soni¹, Chitransh Tiwari², Hemant Kumar Barle³, Ankit Meshram⁴

M.Tech Scholar, Department of EE, RSR, Rungta College of Engineering & Tech., Bhilai, C.G, India¹

Assistant Professor, Department of EE, RSR, Rungta College of Engineering & Tech., Bhilai, C.G, India²

M.Tech Scholar, Department of EE, RSR, Rungta College of Engineering & Tech., Bhilai, C.G, India³

M.Tech Scholar, Department of EE, RSR, Rungta College of Engineering & Tech., Bhilai, C.G, India⁴

ABSTRACT: In power system of long transmission lines the generating units connected to infinite bus the maintenance of stability is one of the most important concern. In infinite bus the concept is that the power system can absorb or supply any amount of power without affecting its voltage and frequency. In a single machine infinite bus system the ability of generator to remain synchronized with this infinite bus is the main concern of stability. Stabilizers play a vital role in maintaining stability by counteracting disturbances and oscillations. Facts controllers are used to enhance power transmission capability of the existing transmission lines. The static VAR compensator is a FACTS controller used to stabilize the voltage profile of the system. This paper presents a multi machine connected to infinite bus with a SVC connected at the midpoint of transmission line. This model is design to analyse dynamic stability during faults, evaluate the impacts of SVC Facts devices on voltage and reactive power stability and loss of synchronism under stressed condition

KEYWORDS: FACTS Flexible AC transmission system, PSS Power System Stabiliser, SVC Static VAR Compensator.

I. INTRODUCTION

The power system stabilizer can conquer the electromechanical oscillation and improve the power system stability with the help of its additional excitation mechanism. For more economical and consistent generation and transmission of electric energy, the electric power systems become larger and larger, which covers a vast area and include many synchronous generators, transmission lines, loads and variety of controllers. The stability of the power system is the ability to extend restoring forces equal to or greater than the disturbing forces to sustain the state of equilibrium. Power industries are updated to provide effective utilization to more consumers at lower prices and better power efficiency. The complexity of the power systems has been increasing as they become inter-connected. Load demand also increases linearly with the increase in users. Since stability phenomenon limits the transfer capability of the system, there is a need to confirm stability and reliability of the power system due to economic reasons. With these conditions, authorities and researchers were continually tasked to find simple, effective and economical strategy of achieving stabilization of the power system, which is considered of highest priority. Thus, because of the importance of the stability of the power systems, stabilizing control techniques have been used for the single-machine power system with the help of intelligent methods. The optimal sequential design for single-machine power systems is very essential. As a result, serious consideration is now being given on the concern of stabilization control. In recent times, the utilization of optimization techniques becomes possible to deal with control signals in power system. [1]

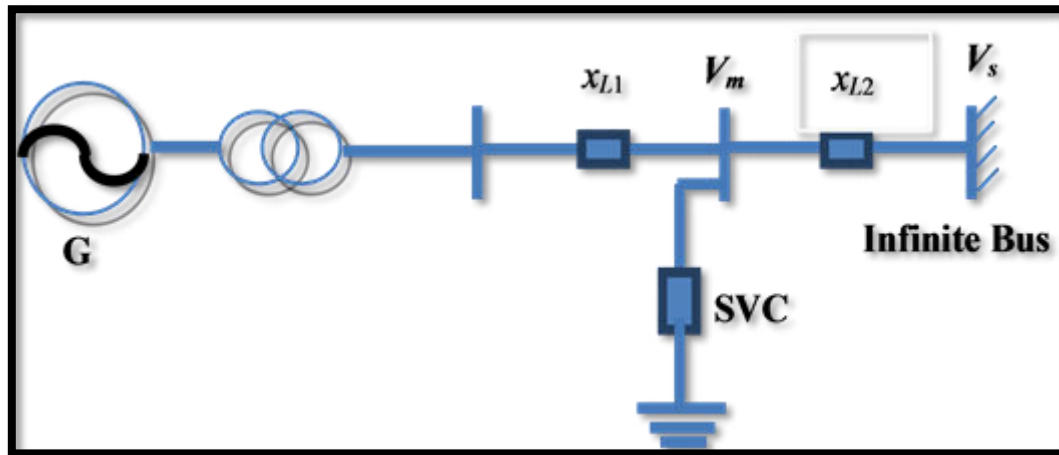


Fig. 1 Single machine infinite bus system with SVC

A machine connected to an infinite bus represents a typical power system stability problem where a synchronous generator (SG) is connected to a very large grid (infinite bus) via a transmission line. In such a setup, the infinite bus has constant voltage and frequency. The generator's performance, especially its stability, depends on its ability to maintain synchronism with the grid during disturbances.

A Static VAR Compensator (SVC) is a FACTS (Flexible AC Transmission System) device used to provide fast-acting reactive power compensation. It helps in voltage regulation, improving transient and dynamic stability, and enhancing power transfer capability.

When a synchronous generator is connected to an infinite bus, the system may suffer from:

- **Transient instability** due to sudden disturbances (e.g., short circuits, load changes).
- **Voltage instability** due to insufficient reactive power support.
- **Poor damping of oscillations** in rotor angle (swinging).

The main components used in the Matlab simulation are 4 generators with turbine and regulators along with the four major buses and interconnected transmission lines. The loads placed at different buses like after each generator. Two Facts device SVC static VAR compensator has been placed at suitable locations. A fault breaker for testing system stability. A power system stabiliser to enhance damping. The measurement blocks for the measurement of various parameters like rotor speed, angle.

The stator voltage equations in per-unit (p.u.) are:

$$V_d = R_s I_d + \frac{d\psi_d}{dt} - \omega \psi_q$$

$$V_q = R_s I_q + \frac{d\psi_q}{dt} - \omega \psi_d$$

Flux linkages are expressed as

$$\psi_d = L_d I_d + \psi_f$$

$$\psi_q = L_q I_q$$

- └ L_d, L_q :synchronous inductances in d and q axis
- └ ψ_{fd} : flux linkage due to rotor field winding (present only in d-axis)

Simplified stator voltage equations

$$V_d = R_s I_d + L_d \frac{di_d}{dt} + \frac{d\psi_{fd}}{dt} - \omega L_q i_q$$

$$V_s = R_s I_q + L_q \frac{di_q}{dt} + \omega (L_d i_d + \psi_{fd})$$

The fault breaker has been placed to test the stability parameters and fault switching time of 5 to 5.1 seconds and after simulation with the faults the impact of SVC and PSS can be seen in the below results.

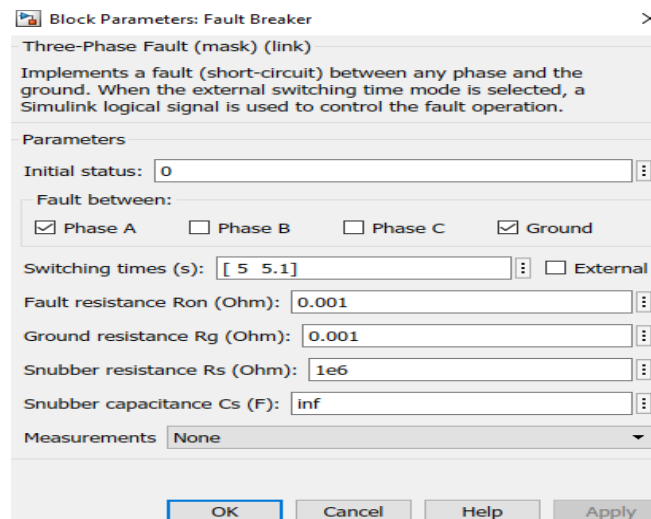


Fig. 2 Fault breaker parameters

II. RESULT AND DISCUSSION

The output waveform of the designed model after simulation in which detailed model and phasor model has been compared, after the three phase fault occurs and by the use of SVC and PSS the stability improvement has been studied in this work.

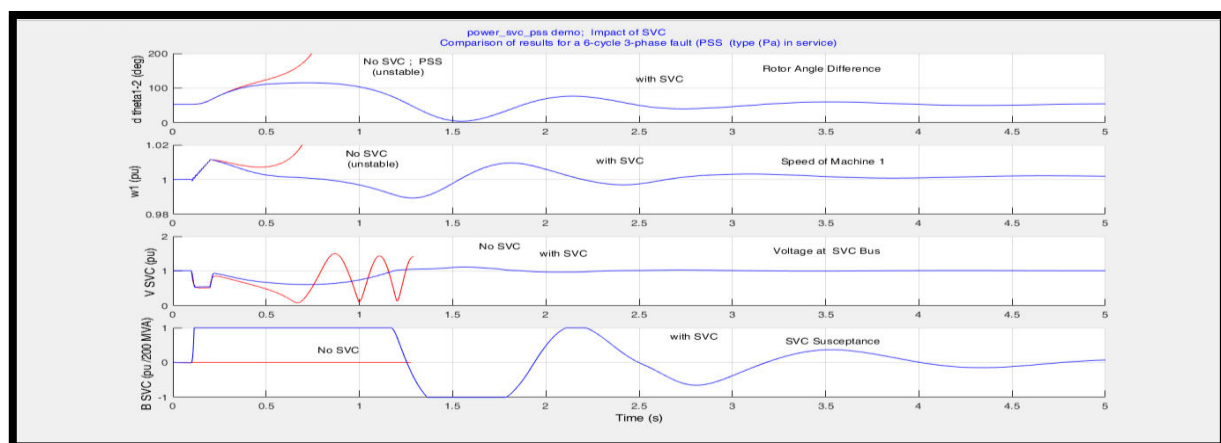


Fig. 3 Impact of SVC on three phase fault

In the above graph the first one shows about the angular difference between two machines and as the rotor angle diverges at the time of 1.2 seconds with no SVC we can see the loss of synchronism and system became unstable. In the case with SVC we can see that the rotor angle oscillates and stabilizes and system remains stable. Second graph shows the rotor speed in per unit and speed diverges due to rotor instability and machine becomes unstable. With SVC speed stabilizes and system remains stable. Third graph shows the voltage at bus where SVC is connected voltage is better regulated and stabilize quickly with SVC.

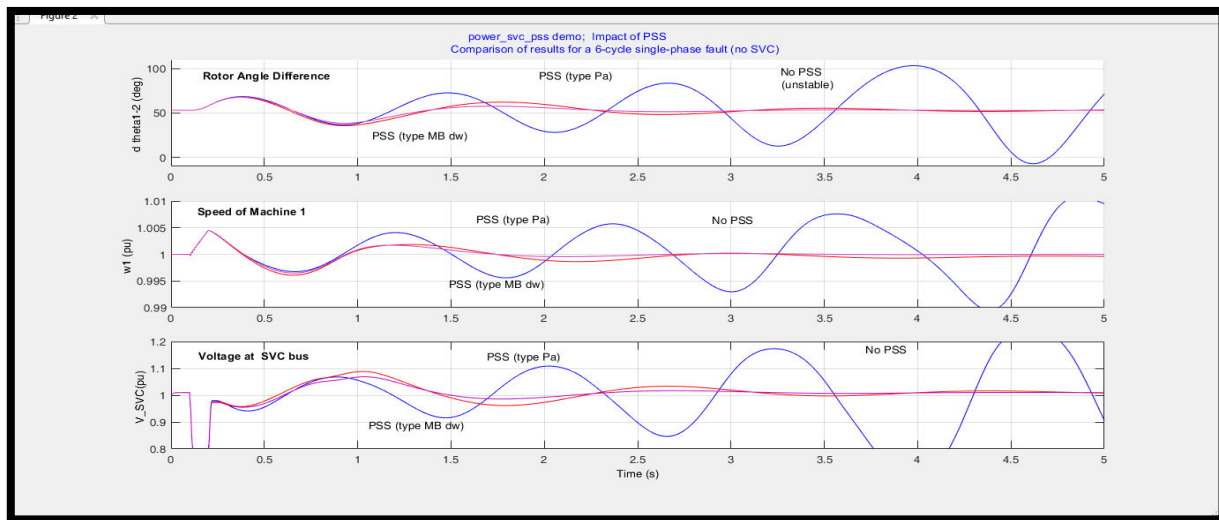


Fig. 4 Impact of PSS on three phase fault

Rotor angle shows increasing undamped oscillations indicating instability. Two types of PSS has been used and both PSS shows stable rotor angle response with well damped oscillations. Machine speed is controlled with slight deviation and return to nominal speed. Similarly voltage profile is smoother and stable with both the PSS.

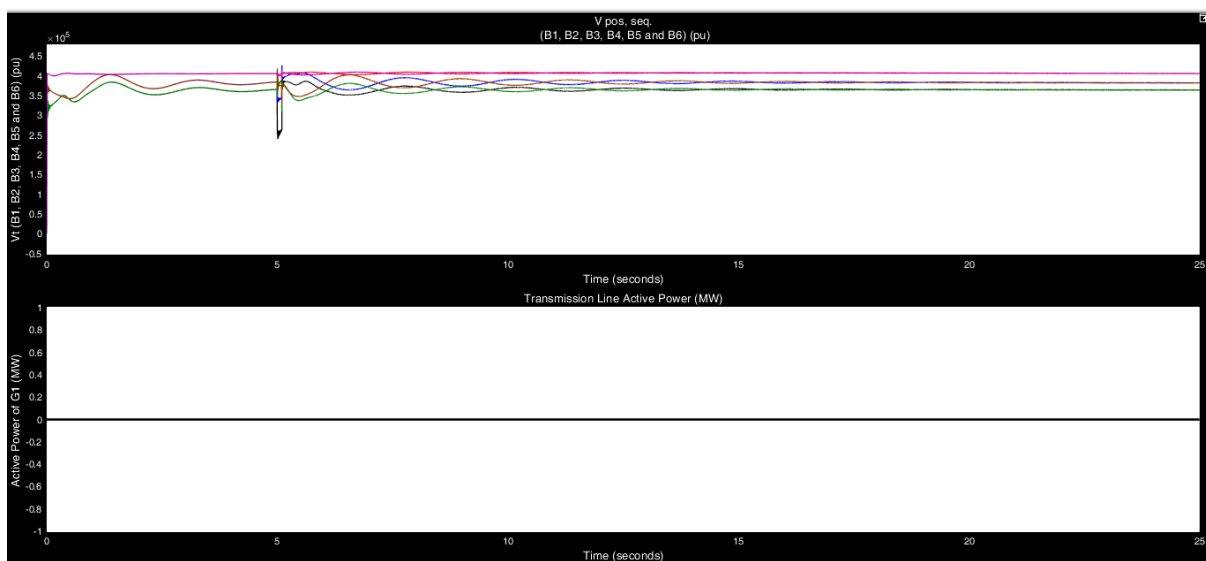


Fig. 5 PV Measurements

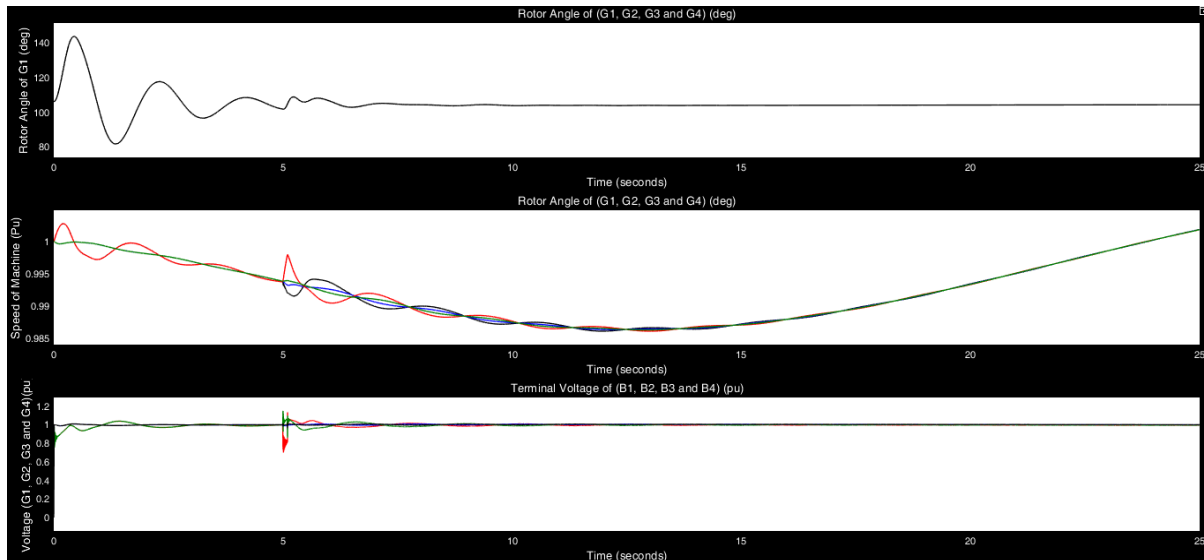


Fig. 6 Machine Signals

III. CONCLUSION

In this work a Simulink model showing the analysis of power system stability when multi generators connected to an infinite bus system and after the occurrence of fault. The Facts controller devices like SVC and PSS also connected at the mid point of the system. The response of the system analyses after the fault occurs and comparative study has been done in the system with SVC and without SVC similarly with PSS and without PSS. Even without SVC the system response can be maintain stable with the help of PSS but if SVC plus PSS is used in the system the system will give the best performance. This devices can significantly improve the transient and dynamic stability after faults by damping rotor angle oscillations, regulating generator speed, indirectly stabilizing voltage.

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