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Dynamic Stability Enhancement of Power System network using FACTS Devices

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ABSTRACT:Modern Power Transmission networks are becoming increasingly stressed due to increasing demand of electricity and also restrictions on building new transmission system. Decreasing power system stability is one of the big problems of such a stressed on system following a disturbance. Flexible ac transmission system (FACTS) devices are found to be very effective and useful in a transmission network for better utilization of its existing facilities without loss of the stability. The static synchronous compensator (STATCOM) and Static Var Compensator (SVC) are the shunt devices of the flexible AC transmission systems (FACTS) family. When system voltage is minimum, STATCOM generates reactive power and when system voltage is high that's time STATECOM absorb reactive power while Static Var Compensation is recover the loss of stability at the time of fault in the power system.

KEYWORDS: Flexible AC Transmission Systems (FACTS), FACTS Controllers, SVC, TCSC, SSSC, STATCOM, Power Systems, Power System Stability, Oscillatory Stability, Small Signal Stability, Transient Stability, Voltage Stability.

I.INTRODUCTION

The available power generating plants are often located at distant locations for economic, environmental and safety reasons. For instance, it becomes cheaper to install a thermal power station at pit-head instead of transporting coal to load centers. Hydro power is generally available in remote areas and a nuclear plant may be located at a place away from urban areas. Additionally, modern power systems are highly interconnected. Sharing of generation reserves, exploiting load diversity and economy gained from the use of large efficient units without sacrificing reliability are the advantages of interconnection. Thus power must consequently be transmitted over long distances. To meet the load and electric market demands, new lines should be added to the system, butdue to environmental reasons, the installation of electric power transmission lines are often restricted.
The power system may be thought of as a nonlinearsystem with many lightly damped electromechanical modes of oscillation. The three modes ofelectromechanical oscillations are:

- Local plant mode oscillations
- Inter-area mode oscillations
- Torsional modes between rotating plant

In local mode, one generator swings against the rest of the system at 1.0 to 2.0 Hz. The impact of the oscillation is localized to the generator and the line connecting it to the grid.
Inter-area mode of oscillations is observed over a large part of the network. It involves two coherent groups of generators swinging against each other at 1Hz or less. This complex phenomenon involves many parts of the system with highly non-linear dynamic behavior.
Torsional mode oscillations is associated with a turbine generator shaft system in the frequency range of 10-45 Hz. Usually these modes are excited when a multi-stage turbine generator is joint to the grid system through a series compensated line.
If the damping of these modes becomes too short, it can impose severe constraints on the system "s operation. It is thus important to be able to determine the nature of those modes, find stability limits and in many cases use controls to prevent instability. The poorly damped low frequency electromechanical oscillations come due to inadequate damping torque in some generators, causing both local-mode oscillations and inter-area oscillations (0.2 Hz to 2.5 Hz) [1], [2].
The traditional approach employs power system.

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The traditional approach employs power system stabilizers (PSS) on generator excitation control systems in order to damp those oscillations. PSSs are effective but they are usually designed for damping local modes. In large power systems, they may not provide enough damping for inter-area modes. So, more efficient substitutes are needed other than PSS.

II.REVIEW OF LITERATURE

FACTS Controllers

FACTS are defined as “a power electronic based device and other static equipment that provide control of one or more AC transmission system parameters to increase controllability and enhance power transfer capability. Generally, FACTS controllers can be divided into four categories [7].

1) Series Controller
2) Shunt Controller
3) Combined series-series Controller
4) Combined series-shunt Controller

Table 1: Comparison among FACTS Controllers

Name	Type	Controller Used	Purpose
SVC	Shunt	Thyristor	Voltage Control
SSSC	Series	GTO	Power Flow Control
STATCOM	Shunt	GTO	Voltage Control
UPFC	Shunt and Series	GTO	Voltage and Power Flow Control
TCSC	Series	Thyristor	Power Flow Control
TCPAR	Shunt and series	Thyristor	Power Flow Control

In the 1980s, the Electric Power Research Institute (EPRI) formulated the vision of the FACTS in which various power-electronics based controllers regulate power flow and transmission voltage, and they reduce dynamic disturbances. Generally, the main objectives of FACTS are to enhance the useable transmission capacity of lines and control power flow over designated transmission routes.

Table.2 Performance Analysis of FACTS devices [13]

	Load Flow	**Voltage Stability**	**Transient Stability**
SVC	☆	☆ ☆ ☆	☆
TCSC	☆ ☆	☆	☆ ☆
STATCOM	☆	☆ ☆ ☆	☆ ☆
SSSC	☆ ☆ ☆	☆	☆ ☆
UPFC	☆ ☆ ☆	☆ ☆ ☆	☆ ☆

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III.POWER SYSTEM STABILITY

Stability is nothing but ability of power system to remain in synchronism when different fault occur in power system circuit such as symmetrical and unsymmetrical fault.
Power system stability is divided into three categories.

A. Rotor Angle Stability
B. Voltage Stability
C. Frequency Stability

A. Rotor Angle Stability

Rotor angle stability is the ability of synchronous machines of an interconnected power network to remain in synchronism after being subjected to a fault or disturbance. It depends on the ability to maintain equilibrium between electromagnetic torque and mechanical torque of each synchronous machine in the network. Instability that may result occurs in the form of enhancing angular swings of some generators leading to their loss of synchronism with other synchronous generator.
The rotor angle stability problem involves the study of the electromechanical oscillations inherent in power systems. For convenience in analysis and for obtaining useful insight into the nature of stability problems, it is useful to characterize rotor angle stability in terms of the following two subcategories: Small-disturbance (or small signal) rotor angle stability is concerned with the ability of the power system to maintain synchronism under small disturbances. The disturbances are considered to be small that linearization of system equations is permissible for purposes of analysis [14].

B. Voltage Stability

Voltage stability is the ability of a power system network to maintain steady state voltages at all buses in the system when after being subjected to a disturbance from a given starting operating condition.
It depends on the ability to maintain equilibrium between load demand and load supply from the power system network. Instability that may result occurs in the form of a progressive raise or fall of voltages of some buses. A possible outcome of voltage instability is loss of load in an area, or may be tripping of transmission lines and other elements by their protective systems leading to cascading outages. Loss of synchronism of some generators may result from these outages or from operating conditions that violate field current limit [15].

C. Frequency Stability

Frequency stability is the ability of a power system network to sustain steady frequency following a severe system upset or fall resulting in a significant imbalance between sending end to load end. It depends on the ability to restore equilibrium between system generation and load premises, with smallest unintentional loss of load. Instability that may result in the form of sustained frequency swings leading to tripping of generating units and/or loads.

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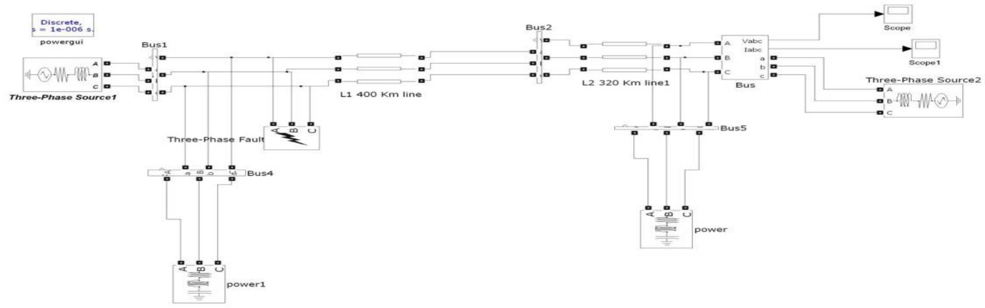
IV.SYSTEM MODELLING

Two Area System with Three Phase Fault

Fig no.1 Two Area System during Three Phase Fault



Graph no.1 Difference of two rotor angles with time during three phase fault

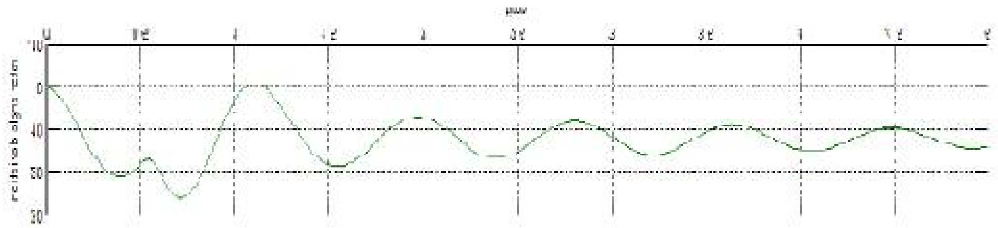
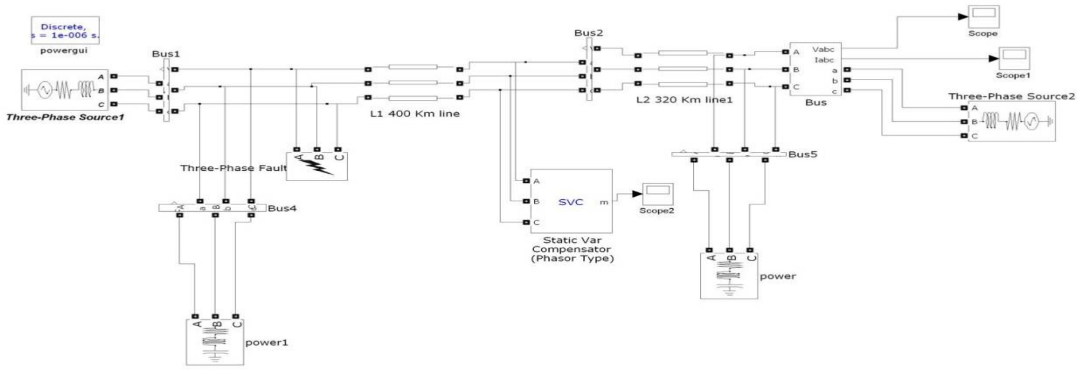


Fig no.2 Two Area System installed with SVC



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Graph no.2 Difference of two rotor angles with time installed with SVC

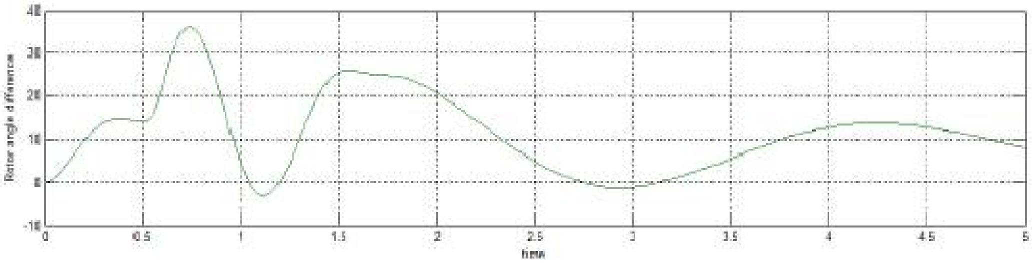
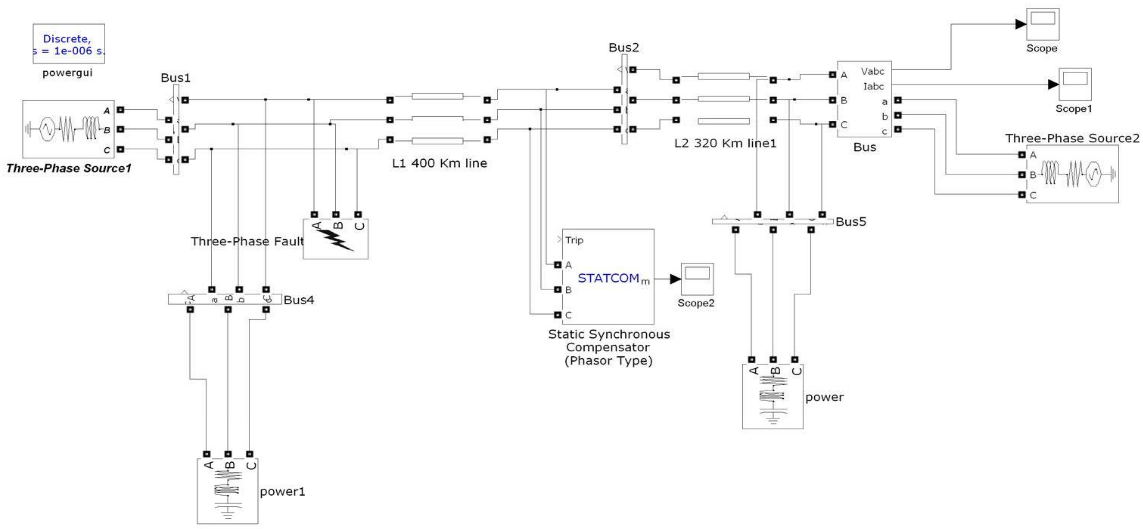
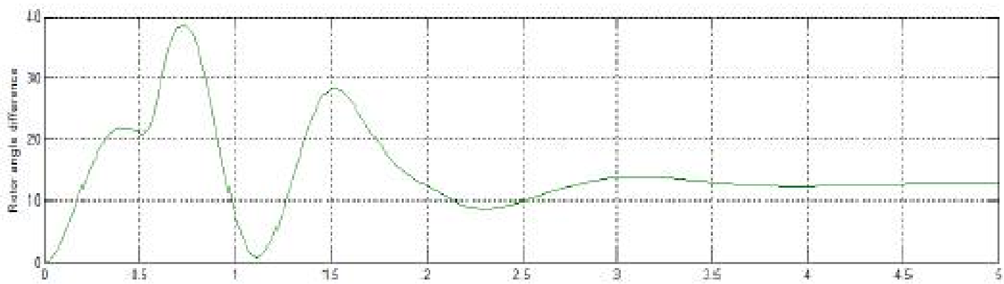


Fig no.3 Two Area System installed with STATCOM



Graph no.3Difference of two rotor angles with time installed with STATCOM and PSS



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V.CONCLUSION

In the above fig no 1 three phase fault occur in power system And Rotor verses time graph is indicated. In fig no 2 FACTS controller Device SVC is connected at the time of fault and again rotor verses time graph is indicated in the result. In fig no. 3 FACTS controller Device STATCOM is connected at the time of fault and again rotor verses time graph is indicated in the result. The post setting time of SVC is 4sec, while post settling time of STATCOM is 2.8 sec From above graph of result ,the comparative study indicate that STATCOM is more Reliable than SVC in stability enhancement of power system at the time of fault.

REFERENCES

[1] Kundur, P., “Power system stability and control”, McGraw-Hill, N.Y., 1994.K.
[2] Rogers, G., “Power system oscillations”, Kluwer Academic Publishers, USA, 2000.
[3] Hingorani, N. G., “Flexible AC transmission”, IEEE
[4] Gyugyi, L., “Dynamic compensation of AC transmission lines by solid-state synchronous voltage sources”, IEEE Transactions on Power Delivery, vol.9, no. 2, pp. 904-911,1994.
[5] Byerly, R. T., Poznaniak, D. T., Taylor, E. R., “Static reactive compensation for power transmission system”, IEEE Transactions on Power Apparatus and Systems, vol. 101, no. 10, pp. 3997–4005, 1982.
[6] Hammad, A. E., “Analysis of power system stability enhancement by static VAR compensators”, IEEE Transactions on Power Systems, vol. 1, no. 4, pp. 222–227, 1986.
[7] Hingorani, N. G., &Gyugyi, L. (2000). Understanding FACTS: concepts and technology offlexible AC transmission systems (Vol. 1). M. El-Hawary (Ed.). New York: IEEE press.
[8] Yong Hua Song, Allan T. Johns, “Flexible AC Transmission Systems (FACTS)”, London, UK: IEE Press, 1999.
[9] Hanson, D. J., Woodhouse, M. L., Horwill, C., Monkhouse, D. R., Osborne, M. M., “STATCOM: a new era of reactive compensation”, Power Engineering Journal,pp.151–160,2002.
[10] Wang, H. F., Li, H., Chen, H., “Application of cell immune response modeling to power system voltage control by STATCOM”, IEE Proceedings on Generation Transmission and Distribution, vol. 149, no. 1, pp. 102–107, 2002.
[11] Abido, M. A., “Analysis and assessment of STATCOMbased damping stabilizers for power system stability enhancement”, Electric Power Systems Research, vol. 73, no. 2, pp. 177–185, 2005.
[12] Haque, M. H., “Use of energy function to evaluate the additional damping provided by a STATCOM”, Electric Power Systems Research, vol. 72, no. 2, pp. 195–202, 2004.
[13] Erinmez, I. A., Foss, A. M., “Static Synchronous Compensator (STATCOM)”, Working Group 14.19, CIGRE Study Committee 14, DocumentNo.144, 1999.
[14] P. Kundur, Power System Stability and Control. New York: McGrawHill, 1994.
[15] C. W. Taylor, Power System Voltage Stability. New York: McGraw Hill, 1994