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# Enhancement of Dynamic Stability of Multi-machine System with FACT Devices

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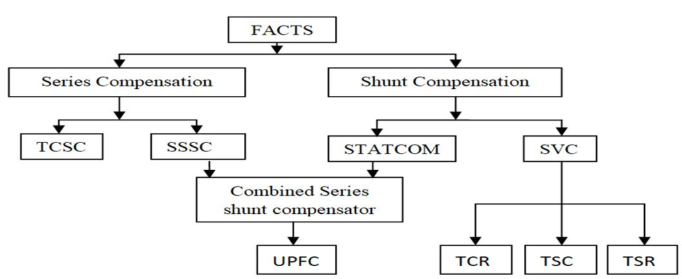
***Abstract: This paper presents the enhancement of dynamic stability of Multi Machine with the help of FACT devices. If there is lack of damping torque in power system then it can lead to fluctuations and instability. For the solution to this problem, power system stabilizers (PSSs) have been widely used to improve power system stability. Where due to few drawbacks of the conventional PSSs, the need for finding a better substitution still remains. In this paper, the application of a Flexible AC Transmission(FACT Devices) is used to improve dynamic stability of a multi machine. Based upon the modal analysis and singular value analysis, the dynamic voltage stability analysis is carried out. The proposed approach has the advantages of the classical static voltage stability analysis and the modern multi-variable feedback control theory. The values and vectors are calculated for frequencies corresponding to the critical system modes. This proposed method is also applicable to very large systems.***
***Keywords: Flexible AC Transmission System (FACTS), Static Series Synchronous Compensator (SSSC), Thyristor Controlled Series Capacitor (TCSC), Static Synchronous Compensator (STATCOM), dynamic stability enhancement, multi-machine electric power system.***

## I. INTRODUCTION

The high-power electronics industry has made flexible alternating current transmission system (FACTS) devices viable and attractive for utility applications. FACTS devices are effective in controlling the parameters of the power system and also in damping power system oscillations. Recently new types of FACTS devices have been invented that can be used to increase power system operation flexibility and controllability, enhance system stability, and achieve better utilization of existing power systems [1]. Therefore the voltage difference along the reactance between the STATCOM and the transmission network produces active and reactive power exchanges. A STATCOM is used for the dynamic compensation of power systems to provide voltage support [2–6].
The aspects of Thyristor Controlled Series Capacitor (TCSC) is used to schedule line power and damp system oscillation in a single machine Infinite Bus (SMIB) system was analyzed in [7]. The voltage and angle stability of Static Synchronous Compensator (STATCOM) is studied in [8]. The impact of static synchronous series compensator (SSSC) control mode on the small signal and transient stability of a single machine infinite bus was established in [9]. The dynamic behavior of source convertor based FACTS devices for simulation studied was discussed in [10].
This paper is organized as follows: Following the introduction, the classification of FACTS Devices is described in section 2. After that in section 3, the block diagram of Multi-Machine. Where in section 4 power system stability is discussed. In section 5 we have mentioned about system modeling along with the simulation diagram an graph. Finally, brief conclusions are deduced in section 6.

## II. CLASSIFICATION




Classification of FACTS Devices[11]

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### A. Series compensation

It is defined as insertion of reactive power elements into transmission lines and provides the following benefits: Reduces line voltage drops. Limits load-dependent voltage drops. Influences load flow in parallel transmission lines.

### B. Shunt compensation

This method is used to improve the power factor. Whenever an inductive load is connected to the transmission line, power factor lags because of lagging load current. To compensate, a shunt capacitor is connected which draws current leading the source voltage.

### C. Thyristor Controlled Series Capacitor (TCSC)

A capacitive reactor compensator which consists of series capacitor bank shunted by a thyristor controlled reactor in order to provide a smooth variable series capacitive reactor.

### D. Static Series Synchronous Compensator (SSSC)

Static Series Synchronous Compensator is operated without an external electric energy source as a series compensator. It's output voltage is an quadrature with and controllable independently of, the line current for the purpose of increasing or decreasing the overall reactive voltage drop across the line and controlling the transmission power.

### E. Static Synchronous Compensator (STATCOM)

It is operated as shunt connected devices whose capacitive or inductive output current current can be controlled independent of the ac system voltage.

### F. Static Var Compensator (SVC)

A shunt connected static VAR absorber whose output is adjusted to exchange capacitive or inductive current so as to control specific parameter of electrical power system.

### G. Unified Power Flow Controller (UPFC)

A combination of static synchronous compensator (STATCOM) and Static series compensator (SSSC) connected via DC link to pass flow of real power between the series output terminal of SSSC and shunt output terminal of STATCOM.

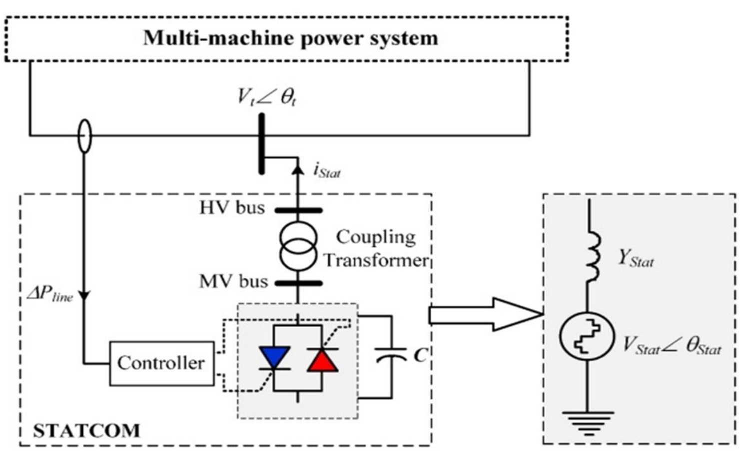
### H. Thyristor Controlled Reactor (TCR)

It is a reactance connected in series with a bidirectional thyristor valve. The thyristor valve is phase-controlled, which allows the value of delivered reactive power to be adjusted to meet varying system conditions. Thyristor-controlled reactors can be used for limiting voltage rises on lightly loaded transmission lines.

### I. Thyristor Switched Capacitor (TSC)

It is a type of equipment used for compensating reactive power in electrical power systems. It consists of a power capacitor connected in series with a bidirectional thyristor valve and, usually, a current limiting reactor (inductor).

## III. BLOCK DIAGRAM OF MULTIMACHINE



## IV. POWER SYSTEM STABILITY

It is mainly concerned with the production of electrical power and its transmission from the sending end to the receiving end as per consumer requirements, incurring a minimum amount of losses. The power at the consumer end often changes due to the variation of load or due to disturbances induced within the length of transmission line. For this reason, the term power system stability is of utmost importance in this field. It is used to define the ability of the of the system to bring back its operation to steady state condition within a minimum possible time after having undergone any transience or disturbance in the line. It may be classified into three categories.

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

## V. SYSTEM MODELLING

### *A. Two Area System with STATCOM connected*

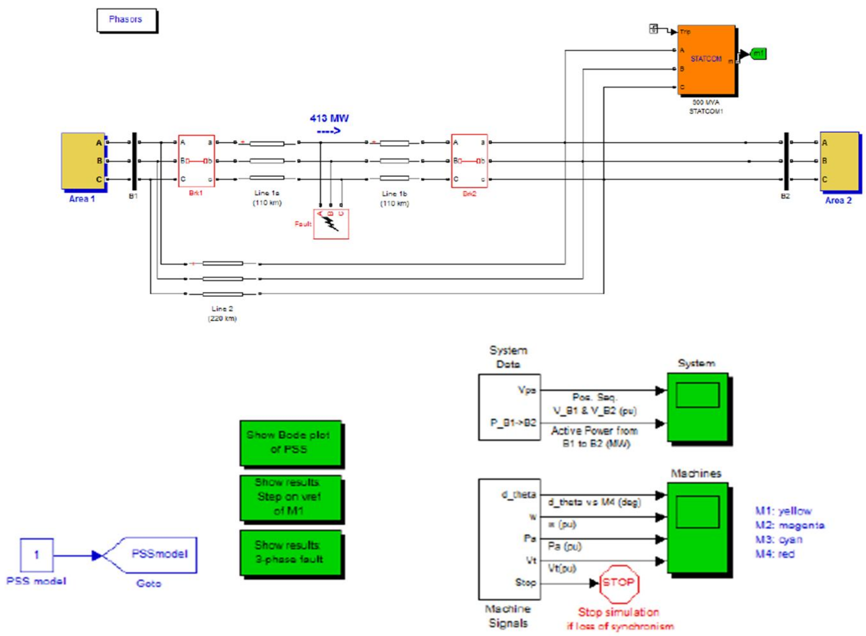
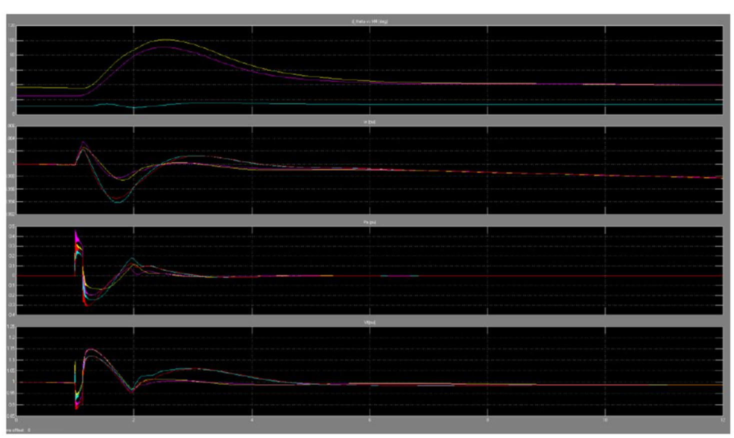



Figure 3 Two Area Systems with STATCOM connected



Graph 1 Rotor Angle, Power, Terminal Voltage Vs. time

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*B. Two Area System with SSSC connected*

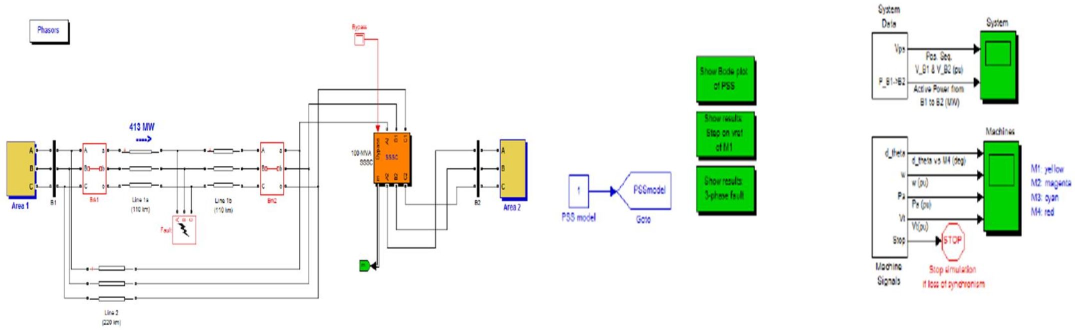
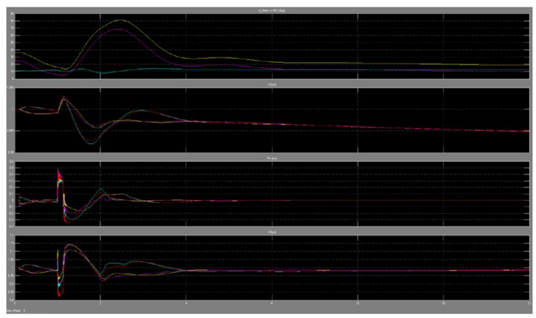


Figure 4 Two Area Systems with SSSC connected



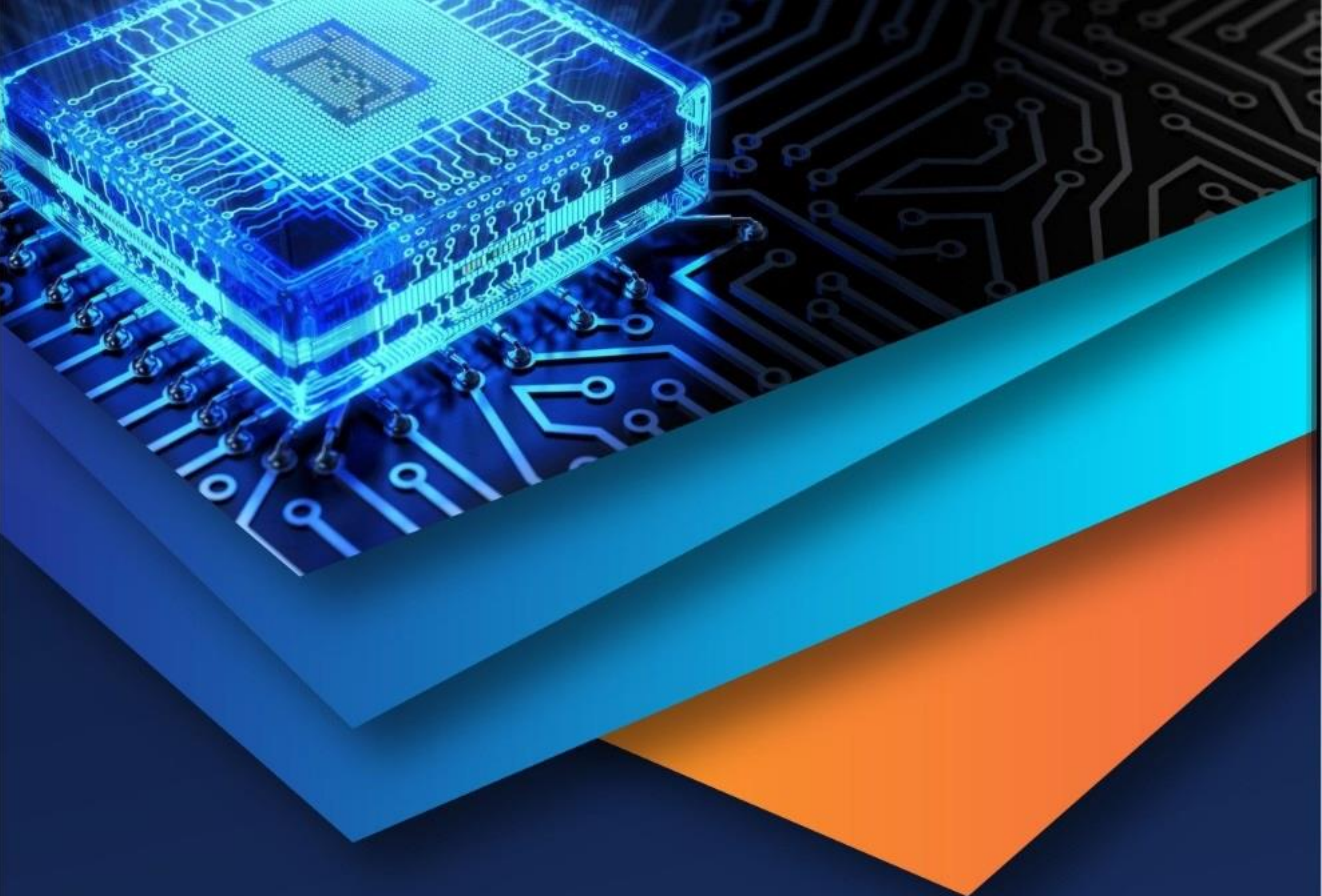
Graph 2 Rotor Angle, Power, Terminal Voltage Vs. time

## VI. CONCLUSION

We have analyzed the different type of FACTS devises. In our analysis we have conclude with that the different FACTS devises are beneficial to power system network where a fault occur in the system. The power electronics controller act quite fast and hence regulate voltage and power flow during steady sate and dynamic condition. We conclude that STATCOM give better performance than SVC in shunt connected FACTS controller, and SSSC give fast performance than other in series connected FACTS device. And critical clearing time for TCSC is minimum. We guaranteed that the use of FACTS controller in future is going to be increased.

## REFERANCES

[1] N.G. Hingorani, L. Gyugyi, Understanding FACTS, New York, IEEE Press, pp. 157–235, 2000.
[2] M.N. Slepchenkov, K.M. Smedley, J. Wen, “Hexagram-converter-based STATCOM for voltage support in fixedspeed wind turbine generation systems”, IEEE Transactions on Industrial Electronics, Vol. 58, pp. 1120–1131,2011.
[3] K. Li, L. Liu, Z. Wang, B. Wei, “Strategies and operating point optimization of STATCOM control for voltage unbalance mitigation in three-phase three-wire systems”, IEEE Transactions on Power Delivery, Vol. 22, pp. 413–422, 2007.
[4] B. Singh, S.S. Murthy, S. Gupta, “Analysis and design of STATCOM-based voltage regulator for self-excited induction generators”, IEEE Transactions on Energy Conversion, Vol. 19, pp. 783–790, 2004.
[5] N.A. Laha, cani, D. Aouzellag, B. Mendil, “Static compensator for maintaining voltage stability of wind farm integration to a distribution network”, Renewable Energy, Vol. 35, pp. 2476–2482, 2010.
[6] A. Valderr´abano, J.M. Ramirez, “DStatCom regulation by a fuzzy segmented PI controller”, Electric Power Systems Research, Vol. 80, pp. 707–715, 2010.
[7] Nelson Martins, Herminio J.C.P. Pinto, John J.Paserba, Using a tcsc for line power scheduling and system oscillation damping- small signal and transient stability studies, IEEE Power Engineering Society Winter Meeting, 2(2), pp. 1455–1461, 2000.
[8] Claudio A. Canizares, Massimo Pozzi, Sandro Corsi, Edvina Uzunovic, Statcom modeling for voltage and angle stability studies, Electric Power & Energy Systems, 25(6), pp.431-441, 2003.
[9] M.S.Castro, H.M.Ayres, V.F.da Costa, L.C.P.da Silva, Impacts of the SSSC control modes on small-signal and transient stability of a power system, Electric Power Systems Research, 77(1), pp.1–9, 2007.
[10] W.Freitas and A.Morelato, A generalized current injection approach for modeling of FACTS in power system dynamic simulation, IEEE Seventh International Conf. ACDC Power Transmission, pp.175–180, 2001.
[11] Youssef A. Mobarak, Rabigh, SVC, Statcom, and Transmission Line Rating Enhancments on Induction Generator Driven by Wind Turbine. International Journal of Electrical Engineering & Technology, **3**(1), 2012, pp. 326–343.



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