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Improvement of Power System Oscillation by using Coordinated Control Plan for PSS and STATCOM Devices

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ABSTRACT
This thesis work introduces the control of the coordinates of PSS and STATCOM to damp the inter-field oscillations of the multi-machine system. In previous eras, PSS was used as a local controller in multi-machine systems to dampen such oscillations between fields. Reactive FACTS devices, such as synchronous static compensators (STATCOM) are taken into account and evaluated for their design of a damping controller. STATCOM is a reactive power compensator based on a voltage source converter that uses electronic power devices with stop capacity as switching devices. Its main function is to support the voltage of the bus from which it is connected to the system by providing a quick response to the delivery or absorption of reactive power. In order to dampen the power oscillations, the power oscillation damping function (POD) must be used, in which its output is summed with the voltage reference at the input of STATCOM.

***KEYWORDS:** POD, Inter-area oscillation, Power System Stabilizer, FACTS, STATCOM*

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I. INTRODUCTION

Due to the ever increasing demand for electricity, power supply systems work very close to their stability limit. The continuous increase in load is also a kind of disturbance. In this case, modern power supply systems are more likely to reach stressful conditions than in the past. Under such conditions, the occurrence of errors and eventualities can lead to vibrations with negative or poor damping, which have dangerous effects on the power grid. With the increasing power requirements of this modern era, negatively damped low frequency vibrations between zones or poorly damped vibrations are becoming a major problem for network engineers.

The conventional method of damping or decaying these types of intermediate range vibrations for a negative or low damping ratio uses a conventional method. In this conventional method, we used a power system stabilizer (PSS) on each generator, and the control signal for this PSS is a separate generator signal called the local signal. However, this type of controller may not always be able to dampen such vibrations between zones because there is no global observation.

Due to technological advances in power electronics, the trend is increasing to use FACTS devices in power supply systems for both transmission and distribution levels. When FACTS and WASM (Wide Area System Monitoring and Control System) technologies are used together, they can help improve the stability performance of power systems. In this study, the STATCOM, a FACTS controller connected in the shunt and based on a variable reactive current, is used to control the current flow of the connecting line between two zones of an electrical study system.

II. OBJECTIVES OF THE RESEARCH

The main objective of this research includes the following prospects:

A. Design a STATCOM FACTS device based power system stabilizer to damped out the inter-area oscillations and improves the power system stability.
B. Develop a multi-machine SIMULINK models for the Kundur two-area four-machine power systems with STATCOM FACTS device to validate the expected results.

III. LIMITATIONS OF THE RESEARCH

The following are the limitations of the research.

A. Out of various FACTS devices only STATCOM used in this research work.
B. Optimized location of FACTS devices and Feedback signal for FACTS controller not taken in this work

Test system used as a Kundur's two-area four machine power system.

1. Small-Signal Model Of Power System

The small signal models for electrical components used in this article are illustrated in the following sections. The algebraic and differential equations represent the statics and dynamics of electrical systems.

1.1. STATCOM

A synchronous static compensator (STATCOM) is a controllable source for reactive power compensation by modifying the VSC voltage and current waveforms to generate or absorb reactive power. It is a shunt which is connected to the busbar at points on the electrical network for voltage regulation.

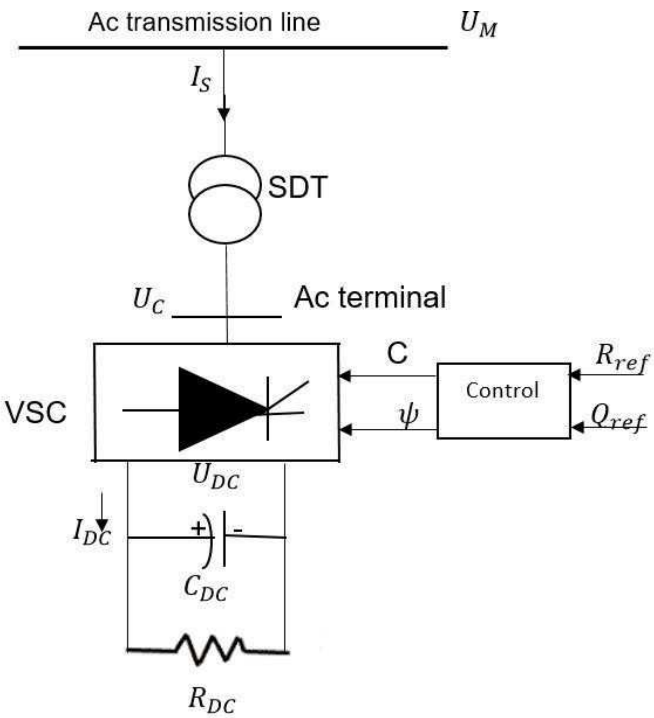

Figure 1: Circuit diagram of STATCOM

1.2. FACTS POD Controller Design

Supplementary control action applied to FACTS devices to increase the system damping is called Power Oscillation Damping (POD). Since FACTS controllers are located in transmission systems, local input signals are always preferred, usually the active or reactive power flow through FACTS device or FACTS terminal voltages. Fig. -2 shows the considered closed-loop system where G(s) represents the power system including FACTS devices and H(s) FACTS POD controller.

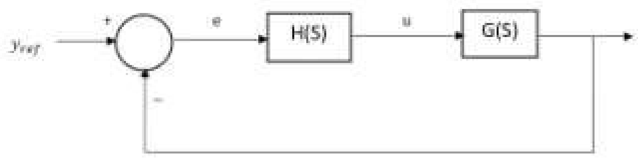

Figure 2: Closed Loop System With POD Control

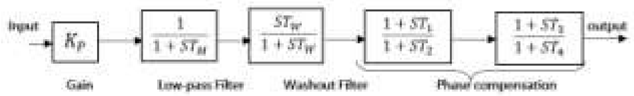

Figure 3: Block diagram of pod controller

The POD controller consists of an amplification block, a wash-out and low-pass filters and mc stages of lead-lag blocks are as shown in Figure 3.

IV. Simulation Results of Proposed Controller

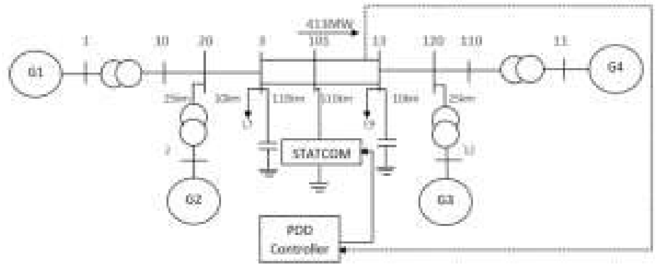

Figure 4: Two-area four-machine interconnected power system with STATCOM

The single line diagram of study power system with proposed controller as shown in figure-4. The STATCOM-POD controller is installed in shunt connected with the transmission line B-101 and B-13. This system consists of two symmetrical areas connected by two parallel tie-line of length 220 km and 230 kv. Each area is equipped with two identical round rotor generators rated 20 kv/900 MVA. All four generators have identical parameters, except inertia coefficient (H), which are H=6.5s for Gen-1 and Gen-2 in area-1 and H=6.175 s for Gen-3 and Gen-4 in area-2.

To perform the dynamic analysis of the closed loop test system for Kundur two area four machine system as shownin figure-4, a small pulse with magnitude of 5% as a disturbance was applied to the generator G1 for 12 cycles. Thesimulation time was of 30 seconds. Then the response of tie-line active power flow from area-1 to area-2, rotor speed, rotor speed deviation , are examined by considering the test system with LPSS and STATCOM-POD controller.

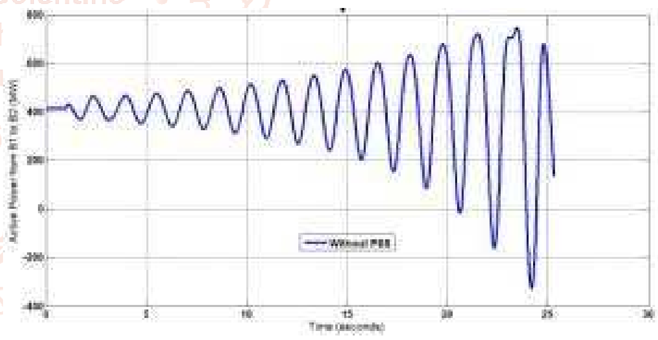

Figure 5: Tie-line active power flow without any controller

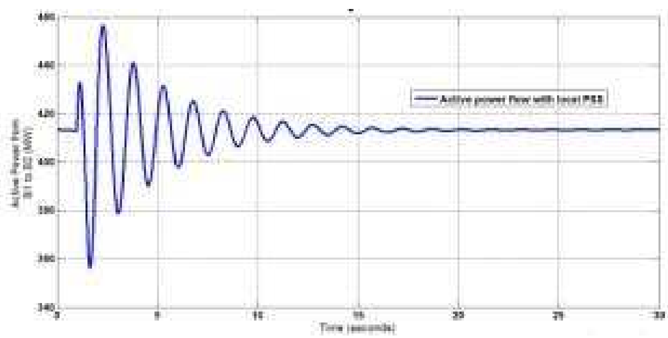

Figure 6: Tie-line active power flow with local PSS

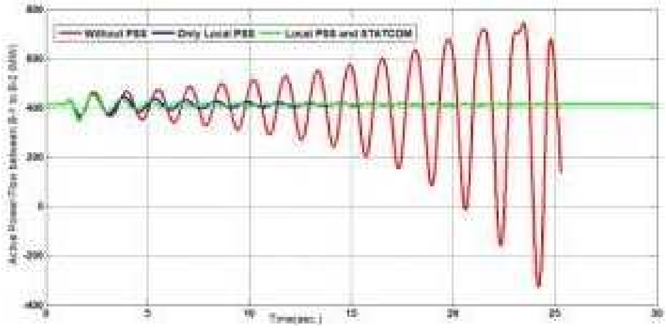

Figure 7: Tie-line active power flow with STATCOM-POD and Local PSS

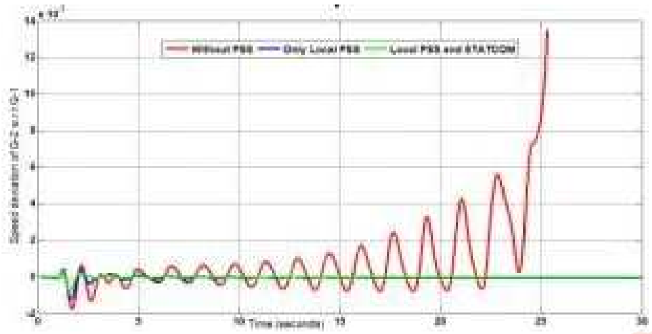

Figure 8: Speed deviation of G-2 w.r.t G-1 with STATCOM-POD and local PSS

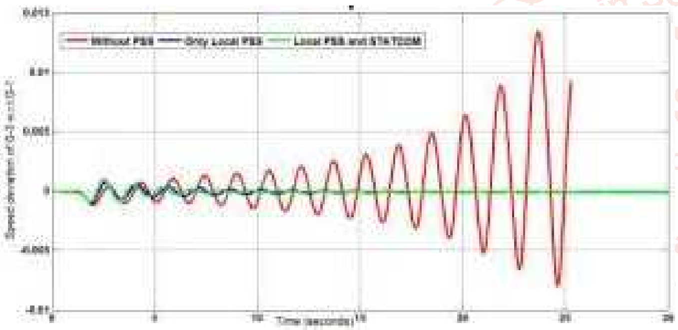

Figure 9: Speed deviation of G-3 w.r.t G-1 with STATCOM-POD and local PSS

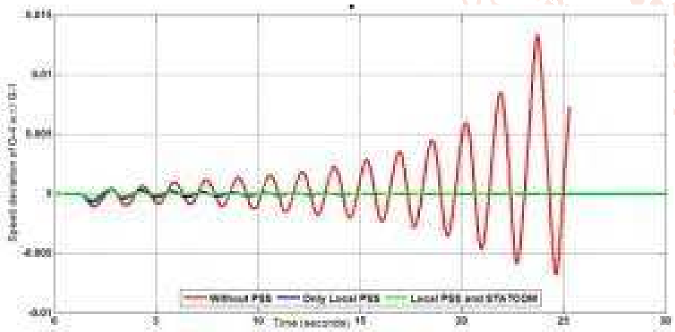

Figure 10: Speed deviation of G-4 w.r.t G-1 with STATCOM-POD and local PSS

V. CONCLUSION

In this article, the researchers developed a FACTS damping controller to dampen vibrations between the zones of a large power system using the STATCOM POD controller. Some simulation results are performed to verify the efficiency of the proposed controller for small disturbances. The results of the simulation show that the proposed control effectively dampens the vibrations between the zones

References

[1] K. Sebaa, M. Boudour, "Robust power system stabilizers design using multi objective genetic algorithm," IEEE Power Engineering Society General Meeting, Jun. 2007, pp. 1– 7.

[2] Kundur P., Power System Stability and Control. New York: McGraw- Hill, 1994.

[3] Aboul-Ela M. E., Sallam A. A., Mccalley J. D., and Fouad A. A.,"Damping controller design for power system oscillations using global signals," IEEE Trans. Power Syst., vol. 11, no. 2, pp. 767–773, May 1996.

[4] Majumder R., Chaudhuri B., Pal B. C., and Zhong Q. C., "A unifiedSmith predictor approach for power system damping control design using remote signals," IEEE Trans. Control Syst. Technol., vol. 13, no.6, pp. 1063–1068, Nov. 2005.

[5] Pal, B.C. "Robust Damping Control of Inter-Area Oscillations in Power System with Super-conducting Magnetic Energy Storage Devices ," PhD thesis, Imperial college of Science Technology and Medicine, Department of Electrical & Electronics Engineering.

[6] Paserba J., 'Analysis and Control of Power System Oscillation' CIGRE special publication 2007, Technical Brochure 111.

[7] Kamwa, R. Grondin and Y. Hebert, "Wide-area measurement based stabilizing control of large power system-a decentralized/hierarchical approach," IEEE Transaction on Power Systems, vol. 16, no. 1, pp. 136-153, Feb. 2001.

[8] Kamwa, L. Gérin Lajoie, "State-space system identification-toward MIMO models for modal analysis and optimization of bulk power systems," IEEE Trans. on Power Systems, vol. 15, no. 1, pp. 326-335, Feb. 2000.

[9] C. W. Taylor, D. C. Erickson, K. E. Martin, R. E. Wilson and V. Venkatasubramanian, "WACS-wide area stability and voltage control system: R & D and Online Demonstartion," Proceedings of IEEE, vol. 93, no. 5, pp. 892-906, May 2005.

[10] J. F. Hauer, W. A. Mittelstadt, R. Adapa, W. H. Litzenberger, and M. K. Donnelly, "Chapter 11: Power System Dynamics and Stability. Section 8: Direct Analysis of Wide Area Dynamics," CRC Electric Power Engineering Handbook (L. L. Grigsby ed.), CRC Press, and IEEE press, Boca Raton, FL, 2001, pp. 11-82 through 11-120.

[11] N. Martins, A. A. Barbosa, J. C. R. Feraz, M. G. dos Santos, A. L. B. Bergarno, C. S. Yung, V. R. Oliveria, N. J. P. Macedo, "Retuning the stabilizers for the North-South Brazilian Interconnection," IEEE PES summer Meeting, Vol.1, pp. 58-67, 18-22 July 1999.

[12] H. Breulmann, E. Grebe, M. Lösing, W. Winter, R. Witzmann, P. Dupuis, M. P. Houry, T. Margotin, J. Zerenyi, J. Dudzik, J. Machowski, L. Martin, J. M. Rodriguez, E. Urretavizcaya, "Analysis and Damping of Inter-Area Oscillations in the UCTE/CENTREL Power System," CIGRE, pp. 38-113, Paris, 2000.

[13] U. S.-Canada Power System Outage Task Force, Final Report on the August 14, 2003 Blackout in the United States and Canada (on line): http://www.pserc.wisc.edu/BlackoutFinal-Web.pd

[14] CERC report on, "Grid Disturbance on 30th July 2012 and Grid Disturbance on 31st July 2012"CERC Order in Petition No. 167/ Suo-Motu/2012 dated 1st Aug 2012.