International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

IJIEMR Transactions, online available on 09 August 2017. Link :

http://www.ijiemr.org/downloads.php?vol=Volume-6&issue=ISSUE-5

Title:- Design of Adaptive Power Oscillation Damping controller by STATCOM with Energy Storage

Page Numbers:- 78 - 83

Paper Authors

[1]LAXMI NARASIMHA, [2]SHAIK YAKOB

Dept of EEE Sana engineering college kodad

USE THIS BARCODE TO ACCESS YOUR ONLINE PAPER

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

Design of Adaptive Power Oscillation Damping controller by STATCOM with Energy Storage

[1]LAXMI NARASIMHA, [2]SHAIK YAKOB

[1]PG Scholar Dept of EEE Sana engineering college kodad.

[2]Assistant Professor Dept of EEE Sana engineering college kodad.

Abstract
This paper describes an approach to design adaptive power oscillation damping controller of an energy storage type a static synchronous compensator is advanced FACT device, which controls both active and reactive power at PCC in the power system. To maintain power system stability damping of low frequency power oscillations are essential, which are measured by using a signal estimation technique based on modified recursive least square algorithm. During the disturbances the proposed method productive by increasing the damping of the system at the different frequencies, system parameter uncertainties and various connection points of static synchronous compensator. i.e.,STATCOM. Paper discuss anatomy of an influence of active and reactive power injection of power system, which will carried out using two machine model and damping controller design. This controlling method optimizes performance of active and reactive power injection at different connection points of STATCOM with energy storage will be derived using simplified model. The result of the study show that, the proposed control strategy provides effective power oscillation damping regardless of the connection point of the device and the system variables uncertainties will be verified through power system simulation.

INDEX TERMS - Energy Storage, FACTS, Low frequency oscillations, STATCOM, E-STATCOM, RLS-algorithm

1.INTRODUCTION

In recent years, the electric power system has grown in size and complexities with more number of inter connections to mitigate the increase in the electric power demand. So, the construction of new long distance, large power transmission lines are difficult due to economical, social and environmental problems. On the basis of the above back ground many FACT technologies have been developed. Furthermore, as a typical FACT devices, staticsynchronous compensator(STATCOM) has been developed and put in operation at distribution level to mitigate power quality and maintain voltage, power oscillation damping at transmission level by reactive power control[1]-[2].With recent advances in energy storage technology by equipping the STATCOM with an energy storage system connected to dc link of the converter has now become feasible for steady state voltage control and elimination of power system disturbances[5]. Wind energy and other distributed generation will provide a smooth easy way for more energy storage into power system and auxiliary stability enhancement function is possible from the energy sources [6]. Due to the interaction

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

among the system components the low frequency electro mechanical oscillations appear in a power system. These oscillations usually in the range of 0.2Hz to 2.5Hz. In this regard, FACT controllers both shunt and series configuration have been widely used to improve the system stability means damping of those low frequency oscillations [1]. In the particular case of shunt connected FACTS controllers (SVC &STATCOM), First swing stability and power oscillation damping can be provided by changing the voltage at the point of common coupling(PCC)using reactive power injection; But one drawback of the shunt controllers for this kind of applications is that PCC voltage must be regulated within the specific limits(typically between ±10% of the rated voltage) and this reduces the amount of damping provided by the compensator.

Active power injection used temporarily during transient and this injected active power affects the PCC voltage angle without varying the voltage magnitude significantly. In the past, power system stabilizers are recognized as an efficient and economical method to damp out oscillations. Where cascade of wash out and lead-lag filter links are used to generate the control input signals. This type of control is effective only at the point where the design of filter links is optimized and also is speed response is limited by the frequency of electromechanical oscillations. In recent years, as new solutions FACTS controllers with energy storage are used for power system stability enhancement has been discussed in [4]-[6]. This control strategy optimizes the injection of active and reactive power to provide uniform damping at various locations in the power system. This is achieved using modified recursive least square algorithm as described in [9],[10] will be used to estimate required control signals from locally measured signals. Finally, effectiveness of proposed control method will be validated via simulation and better controlling achieved through fuzzy controller.

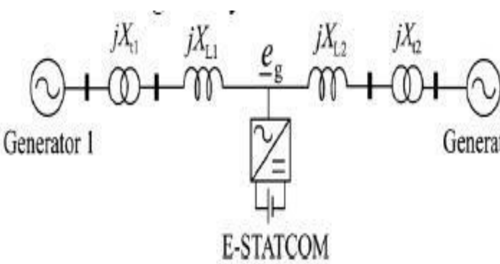


Fig.1.Simplified two-machine system with E-STATCOM

II. MODELLING OF SYSTEM FOR CONTROLLER DESIGN

A Simplified two-machine system with E-STATCOM is used to study the impact of the E-STATCOM on the power system dynamics. This two-machine system approximates an aggregate model of two area power system, where each area represented by a synchronous generators. Synchronous generators are modeled as voltage sources of constant magnitude ( ) and with their corresponding rotor angles ( ) behind a transient reactance ( ). The transmission system contains two transformers and they are represented by their equivalent leakage reactances ( ) and transmission line is represented with equivalent reactance ( )as shown in fig.3. For simple analysis losses in the transmission system are neglected. Initially overall damping in the system is zero when mechanical damping in the generators is neglected. For analysis purpose, the electrical connection point of the converter

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

along transmission line is represented by the parameter „a" is expressed as
Here (1)
The control strategy of E-STATCOM consists of two control loops. They are Outer control loop and Inner control loop. The outer control loop which can be POD controller ac voltage or ac voltage or dc-link voltage. It will sets the reference current for the inner current controller. The measured signal ( ) depends on the type of outer control loop. The control algorithm is executed in dq-reference frame. Where PLL phased locked loop)[7]is used to trace the voltage angle from the grid voltage vector . Synchronizing the PLL with the grid voltage vector , The injected currents of d-q components ( ) control the injected active and reactive power respectively. The superscript„*"denotes the correspondi -ng reference signal. The outer control loop is assumed as POD controller and details description is presented in section 3. Initially, we assume that the injected active and reactive powers in the steady state are zero. In the designing of cascade controller, the speed of outer control loop is typically selected to be much slower than the inner control loop to guarantee the stability. That is the current controller should be considered as infinitely fast when designing the outer control loop. Therefore, E-STATCOM can be modeled as a controlled ideal current source, as represented in the equivalent circuit in fig.3.

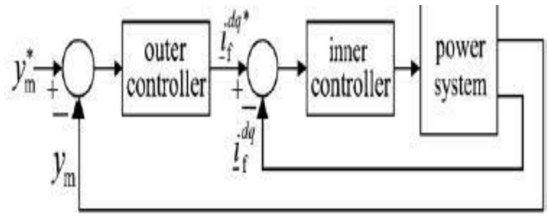


Fig.2.Block diagram for the control of E-STATCOM

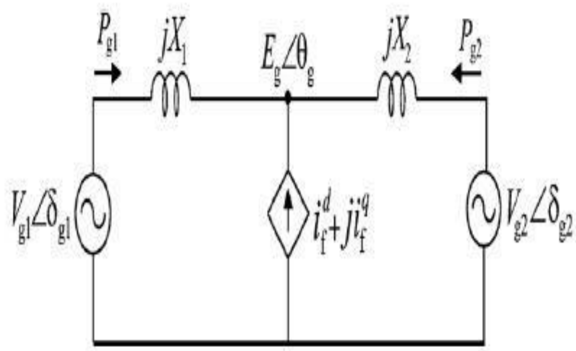


Fig.3.Equivqlent circuit for the two machine system with E-STATCOM

The level of power oscillation damping provided by the converter depends on injected current .The modulate the active power output from the generators. The change in active and reactive power output from the generators due to injected active and reactive power from the E-STATCOM,

III. DESIGN OF POD CONTROLLER

The derivation of POD controller from locally measured signals as shown in this section.

A. Derivation of control input signals

Considering fig.1.the active power output from the each generator is change in proportion to the change in its speed to provide damping [3].From the above equations, the change in active power output from the generators depends on the location of converter "a", as well as on the amount of injected active and reactive power .From

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

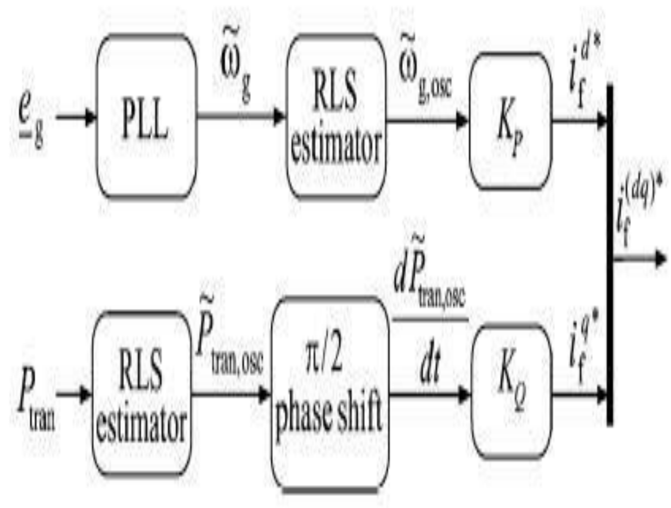
equation (2)the effect of the reactive power injection depends on the magnitude and direction of transmitted power from the generators. Using equivalent system in fig.3.a control input signals are derived that contains the information on the speed variation of the generators. When the E-STATCOM is not injecting any current, the variations in the locally measured signals and at different connection points of E-STATCOM

III. DESIGN OF POD CONTROLLER

The derivation of POD controller from locally measured signals as shown in this section.

A. Derivation of control input signals

Considering fig.1.the active power output from the each generator is change in proportion to the change in its speed to provide damping [3].From the above equations, the change in active power output from the generators depends on the location of converter "a", as well as on the amount of injected active and reactive power .From equation (2)the effect of the reactive power injection depends on the magnitude and direction of transmitted power from the generators. Using equivalent system in fig.3.a control input signals are derived that contains the information on the speed variation of the generators. When the E-STATCOM is not injecting any current, the variations in the locally measured signals and at different connection points of E-STATCOM



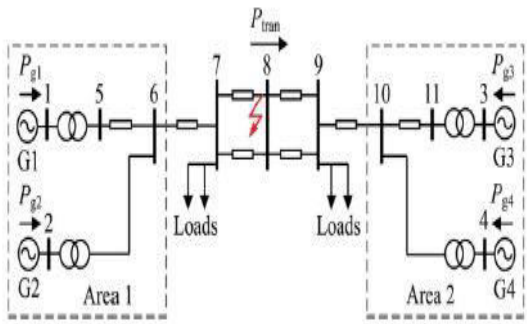
IV.SYSTEM STABILITY ANALYSIS

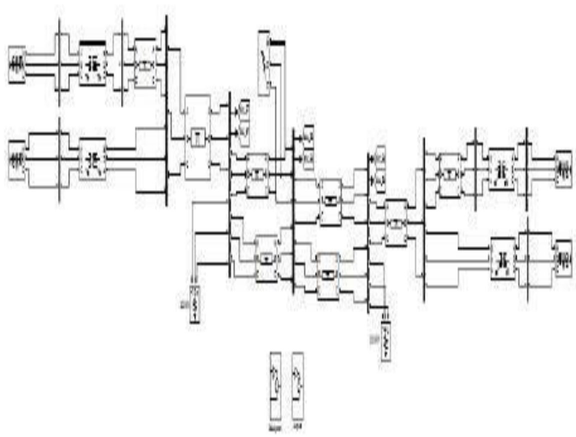
In this section mathematical model of the system in fig.3. is developed to examine the performance of the POD controller using active and reactive power injection.

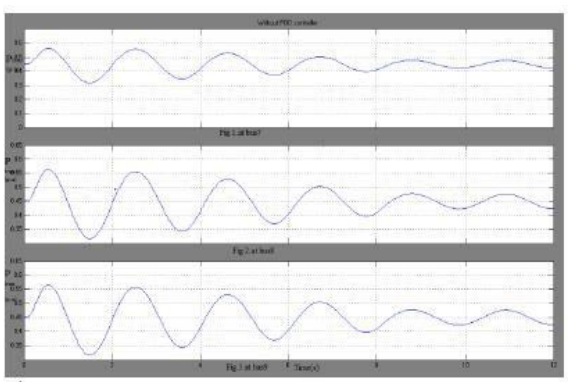
V.SIMULATION RESULTS

The implemented system is rated 20/230kV, 900 MVA, total series reactance of 1.665 p.u. =400 MW and inertia constants .Leakage reactance of transformers 0.15 p.u. and transient impedance of generators 0.3 p.u. By creating a three phase fault at transmission line and E-STATCOM is connected at various points and simulation results were carried out by using simulink/MATLAB software. The simulation results for both PI and Fuzzy controller are discussed in this section.

International Journal for Innovative
Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org







VI. CONCLUSION

With the POD controller structure the performance of the E-STATCOM following the fault at three different locations, This low oscillation frequency highlights the importance of the adopted estimation method, since the classical approaches based on filters would require low bandwidth, resulting in a reduction in the estimation speed. The small-signal analysis for two-machine system, when moving closer to the generator units, a better damping is achieved by active power injection. With respect to reactive power injection, maximum damping action is provided when the E-STATCOM is connected close to the electrical midpoint of the line and the level of damping decreases when moving away from it. Because of a good choice of signals for controlling both active and reactive power injection, effective power oscillation damping is provided by the E-STATCOM irrespective of its location in the line. Instead of PI controller, the fuzzy logic controller then the performance of the system increases, Transients decreases and the stability of the system increases and also to improve the power quality.

VII. REFERENCES

1.N.G. Hingorani and L. Gyugyi, Understanding FACTS. Concepts and Technology of Flexible AC Transmission Systems. NewYork,NY, USA: IEEE, 2000.
2. P.S. Bimbhra, Power Electronics, 4th Edition,22nd Reprint:2011, New A.S Offset Press
3. G. Cao, Z. Y. Dong, Y. Wang, P. Zhang, and Y. T. Oh, “VSC based STATCOM controller for damping multi-mode oscillations,” in Proc. *IEEE Power and Energy Soc. General Meeting—Conversion and Delivery of Electrical Energy in the 21st Century*, Jul. 2008, pp. 1–8.
4.Z.Yang, C. Shen, L. Zhang, M. L. Crow, and S. Atcitty, “Integration of a STATCOM and battery energy storage,” *IEEE Trans. Power Syst.*, vol.16, no. 2, pp. 254–260, May 2001.

5. A.Arulampalam, J. B.Ekanayake, and N. Jenkins, "Application study of a STATCOM with energy storage," *Proc. Inst. Electr. Eng.—Gener., Transm. and Distrib.*, vol. 150, pp. 373–384, July 2003.
6.K. Kobayashi, M. Goto, K. Wu, Y. Yokomizu, and T. Matsumura,"Power system stability improvement by energy storage type STATCOM," in *Proc. IEEE Power Tech Conf.*, Bologna, Italy, Jun. 2003, vol. 2, DOI 10.1109/PTC.2003.1304302
7.V. Kaura and V. Blasko, "Operation of a phase locked loop system under distorted utility conditions," *IEEE Trans. Ind. Appl.*, vol. 33, no. 1, pp. 58– 63, Jan./Feb. 1997
8.R. Q. Machado, S. Buso, and J. A.Pomilio, "A line-interactive single phase to three-phase converter system,"