International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 13
September 2016

Energy Storage by Static Synchronous Compensator with Power Oscillation Damping Controller

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Abstract—This paper offers with the design of an adaptive power oscillation damping (POD) controller for a static synchronous compensator (STATCOM) prepared with Energy storage. That is performed utilizing a signal estimation system based on a modified recursive least square (RLS) algorithm, which allows a quick, selective, and adaptive estimation of the low-frequency electro-mechanical oscillations from locally measured indicators for the period of power system disturbances. The proposed approach is amazing in increasing the damping of the process at the frequencies of interest, additionally within the case of procedure parameter uncertainties and at quite a lot of connection points of the compensator. First, the evaluation of the impact of active and reactive power injection into the power system will likely be implemented making use of a simple two-computing device method model. A manipulate process that optimizes active and reactive vigour injection at various connection points of the STATCOM will likely be derived utilizing the simplified model. Small-signal evaluation of the dynamic performance of the proposed manage approach might be applied. The effectiveness of the proposed control system to furnish power oscillation damping regardless of the connection factor of the device and within the presence of method parameter uncertainties shall be tested by means of simulation..

Index Terms— *Energy storage, low-frequency oscillation, power oscillation damping (POD), recursive least square (RLS), static synchronous compensator (STATCOM).*

I. INTRODUCTION

Static synchronous compensator (STATCOM) is a key gadget for reinforcement of the soundness in an ac vigor system. This gadget has been utilized both at distribution level to mitigate vigour high-quality phenomena and at transmission degree for voltage manipulate and vigour oscillation damping (POD). Although most of the time used for reactive power injection best, by way of equipping the STATCOM with an vigor storage related to the dc-link of the converter, a more bendy manipulate of the transmission process will also be completed. An installation of a STATCOM with Energy storage is already observed in the U.K. For power flow management and voltage manipulate. The introduction of wind energy and other disbursed generation will pave the best way for more energy storage into the energy method and auxiliary steadiness enhancement perform is viable from the power sources [7]. Considering that injection of lively power is used temporarily throughout transient, incorporating the stability enhancement perform in systems the place lively vigor injection is particularly used for other purposes [8] could be appealing.

Low-frequency electromechanical oscillations (mostly in the range of zero.2 to 2 Hz) are fashioned in the energy system and are a cause for trouble concerning comfortable method operation, especially in a weak transmission system [9]. On this regard, tips controllers, each

p-ISSN: 2348-6848
e-ISSN: 2348-795X
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in shunt and sequence configuration, were widely used to increase steadiness of the power system [1]. Within the designated case of shunt linked details controllers [STATCOM and static var compensator (SVC)], first swing steadiness and POD can also be executed by using modulating the voltage on the factor of common coupling (PCC) utilising reactive energy injection. Nevertheless, one problem of the shunt con figuration for this type of purposes is that the p.C.Voltage must be regulated inside certain limits (traditionally between 10% of the rated voltage), and this reduces the quantity of damping that may be supplied by using the compensator. Additionally, the amount of injected reactive vigor needed to modulate the percentvoltage depends upon the short circuit impedance of the grid obvious at the connection point. Injection of energetic vigor, on the other hand, impacts the %voltage attitude (transmission strains are comfortably reactive) without varying the voltage magnitude tremendously.

The control of STATCOM with energy storage (named right here-after as E-STATCOM) for energy process balance enhancement has been mentioned in the literature. Nonetheless, the influence of the vicinity of the E-STATCOM on its dynamic performance is more often than not treated. When active vigor injection is used for POD, the vicinity of the E-STATCOM has a huge influence on its dynamic efficiency. Additionally, the common control method of the device for POD to be had within the literature is just like the one utilized for vigour procedure stabilizer (PSS), the place a sequence of wash-out and lead-lag filter links are used to generate the manage enter alerts. This form of manipulate strategy is amazing handiest on the working factor where the design of the filter hyperlinks is optimized, and its speed of response is confined by the frequency of the electromechanical oscillations.

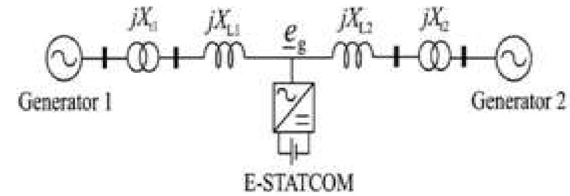

Fig. 1. Simplified two-machine system with E-STATCOM

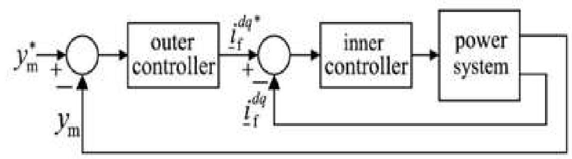

Fig. 2. Block diagram of the control of E-STATCOM

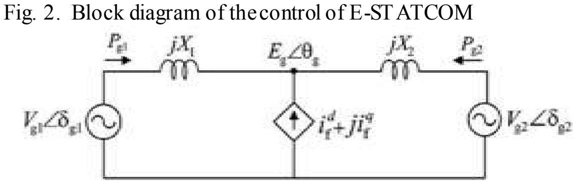
Fig. 3. Equivalent circuit for two-machine system with E-STATCOM.

II. EXISTING SYSTEM

In this regard, FACTS controllers, both in shunt and series configuration, have been widely used to enhance stability of the power system. In the specific case of shunt connected FACTS controllers [STATCOM and static var compensator (SVC)], first swing stability and POD can be achieved by modulating the voltage at the point of common coupling (PCC) using reactive power injection. However, one drawback of the shunt configuration for this kind of applications is that the PCC voltage must be regulated within specific limits (typically between 10% of the rated voltage), and this reduces the amount of damping that can be provided by the compensator. Moreover, the amount of injected reactive power needed to modulate the PCC voltage depends on the short circuit impedance of the grid seen at the connection point. Injection of active power, on the other hand, affects the PCC-voltage angle (transmission lines are effectively reactive) without varying the voltage magnitude significantly.

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III. PROPOSED SYSTEM

A simplified power system model, such as the one depicted in Fig. 1, is used to study the impact of the E-STATCOM on the power system dynamics. The investigated system approximates an aggregate model of a two-area power system, where each area is represented by a synchronous generator. In this paper, a control strategy for the E-STATCOM when used for POD will be investigated, the control strategy optimizes the injection of active and reactive power to provide uniform damping at various locations in the power system. It will be shown that the implemented control algorithm is robust against system parameter uncertainties. For this, a modified recursive least square (RLS)-based estimation algorithm as described and will be used to extract the required control signals from locally measured signals. Finally, the effectiveness of the proposed control strategy will be validated via simulation results.

• Develop a generic signal estimation algorithm based on a Recursive Least Square (RLS) algorithm with variable forgetting factor. An RLS algorithm with variable forgetting factor and frequency adaptation is implemented. This enables a fast and selective estimation of different frequency components.

• Develop an adaptive POD controller using RLS algorithm with variable forgetting factor for E-STATCOM. A POD controller is designed to adapt to system parameter changes and stability enhancement is provided irrespective of the connection point of the E-STATCOM with minimum active power injection.

SIMULATION RESULTS

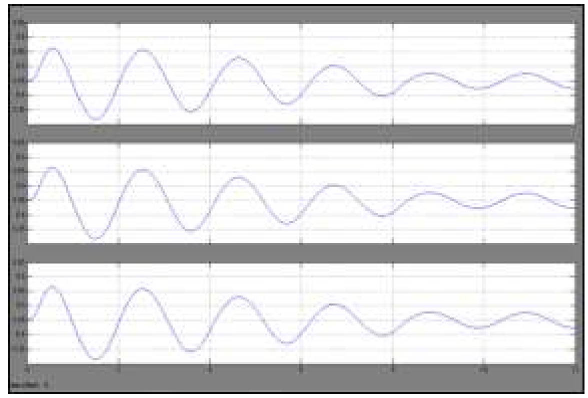

Fig 4: Measured transmitted active power output following a three-phase fault with E-STATCOM Without POD controller.

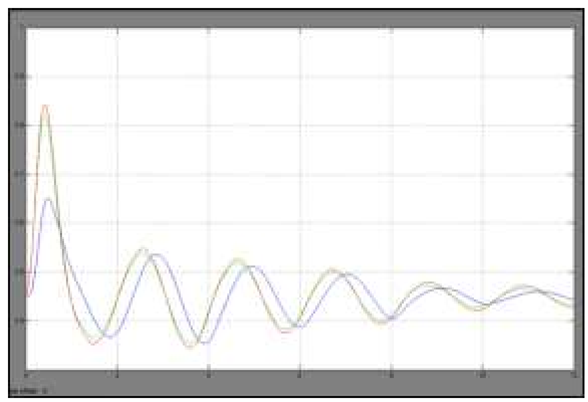

Fig 5: Measured transmitted active power output following a three-phase fault with E-STATCOM connected at bus 7.

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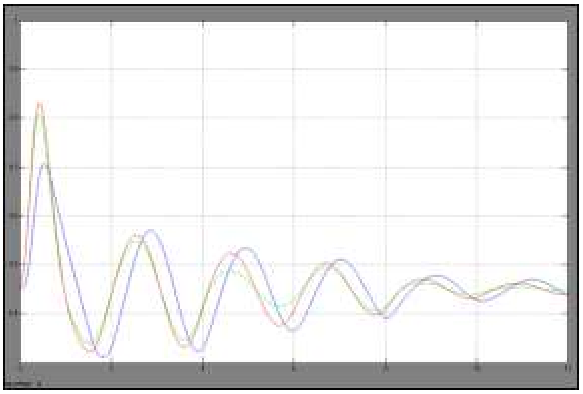

Fig 6: Measured transmitted active power output following a three-phase fault with E-STATCOM connected at bus 8.

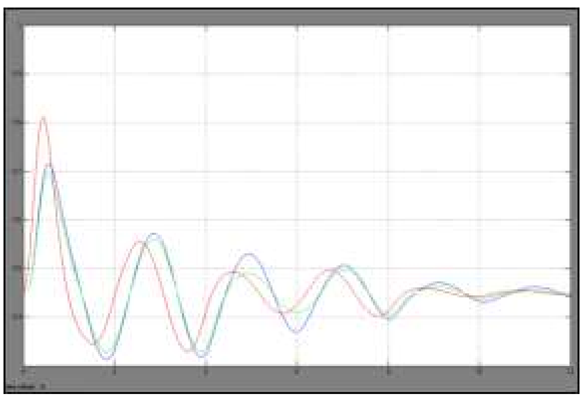

Fig 7: Measured transmitted active power output following a three-phase fault with E-STATCOM connected at bus 9.

IV. CONCLUSION

In this chapter, control of E-STATCOM for power system stability enhancement is shown using a simplified two machine power system model. The control input signals for active and reactive power injection are derived using the signal estimation technique described in Chapter 4. The robustness of the control algorithm against system parameter uncertainties has been investigated through simulation. By using the frequency estimate of the Phase Locked Loop (PLL) to control injection of active power for POD, injection of active power is minimized at locations in the power system where its effect is negligible. When both active and reactive power injection for POD and TSE is used with the control strategy as described, it is shown that stability enhancement can be achieved at different connection points of the E-STATCOM in the transmission line..

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