Integration of Statcom and Battery Energy Storage System for Dynamic Controlling of Power Oscillatory Damping

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Abstract: **The suggested technique is good at growing the damping from the system in the frequencies of great interest, and in the situation of system parameter uncertainties and also at various connection points from the compensator. This paper handles the style of an adaptive power oscillation damping (POD) controller for any static synchronous compensator (STATCOM) outfitted with energy storage. This is done utilizing a signal estimation technique with different modified recursive least square (RLS) formula, which enables a quick, selective, and adaptive estimation from the low-frequency electromechanical oscillations from in your area measured signals during power system disturbances. First, the research into the impact of active and reactive power injection in to the power system is going to be transported out utilizing a simple two-machine system model. A control strategy that optimizes active and reactive power injection at various connection points from the STATCOM is going to be derived while using simplified model. The potency of the suggested control approach to provide power oscillation damping regardless of the bond reason for the unit as well as in the existence of system parameter uncertainties is going to be verified through simulation and experimental results. Small-signal research into the dynamic performance from the suggested control strategy is going to be transported out.**

Keywords: **Energy Storage; Low-Frequency Oscillation; Power Oscillation Damping (POD); Recursive Least Square (RLS); Static Synchronous Compensator (STATCOM);**

I. INTRODUCTION

A set up of the STATCOM with energy storage has already been based in the U.K. for power flow management and current control. The development of wind energy along with other distributed generation will create more energy storage in to the power system and auxiliary stability enhancement function can be done in the powers. Within the specific situation of shunt connected Details controllers, first swing stability and POD is possible by modulating the current at the purpose of common coupling (PCC) using reactive power injection [1]. However, one disadvantage to the shunt configuration for this sort of applications would be that the PCC current should be controlled within specific limits (typically between 10% from the rated current), which reduces the quantity of damping that may be supplied by the compensator. STATIC synchronous compensator (STATCOM) is really a key device for reinforcement from the stability within an ac power system. This product continues to be applied both at distribution level to mitigate power quality phenomena and also at transmission level for current control and power oscillation damping. The charge of STATCOM with energy storage (named hereafter as E-STATCOM) for power system stability enhancement continues to be discussed within the literature. This sort of control technique is effective limited to the operating point where the style of the filter links is enhanced, and it is speed of fact is restricted to the regularity from the electromechanical oscillations. Within this paper, a control technique for the E-STATCOM when employed for POD is going to be investigated. Finally, the potency of the suggested control strategy is going to be validated via simulation and experimental verification.

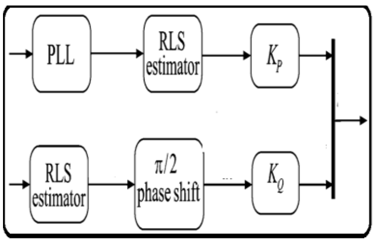

Fig.1.POD Controller

II. PROPOSED DESIGN

A simplified power system model, like the one portrayed, can be used to review the outcome from the E-STATCOM around the power system dynamics. The investigated system approximates an aggregate type of a 2-area power system, where each area is symbolized with a synchronous generator. The synchronous generators are modeled as current causes of constant magnitude and dynamic rotor angles behind a transient reactance [2]. Therefore, the model is suitable to permit a conservative approach from the impact from the E-STATCOM when employed for stability studies. For analysis purpose, the electrical connection reason for the ripper tools across the transmission lines are expressed through the parameter. The charge of the E-STATCOM includes an outer control loop as well as an inner current control loop. The outer control loop, which may be an ac current, electricity-link current or POD controller, sets the reference current for that inner current controller. Within this paper, the outer control loop is assumed to become a POD controller. When making a cascaded controller, the rate of outer control loop is usually selected to become much slower compared to inner someone to guarantee stability [3]. Therefore, the E-STATCOM could be modeled like a controlled ideal current source. The amount of power oscillation damping supplied by the ripper tools depends upon just how much the active output in the generators is modulated through the injected current. Thinking about the simplified two-machine system, the active output from each generator should alternation in proportion towards the alternation in its speed to supply damping. While using equivalent system, a control input signal which contains info on the rate variation from the generators could be derived. Once the E-STATCOM isn't injecting any current, the variation from the in your area measured signals. From the small-signal perspective and underneath the assumption the PCC-current magnitude across the line doesn't change considerably, the needed control input signals could be produced from the PCC-current phase and transmitted active power. The derivative from the PCC-current phase and transmitted active power are generally determined by the rate variation from the generators. This article is exploited within the POD controller design. The derivative from the PCC-current phase and also the transmitted power ought to be believed for manipulating the active and reactive power injection, correspondingly. The purpose of the formula thus remains to estimate the signal components that contain just the low-frequency electromechanical oscillation within the measured signals and. using a PLL with bandwidth much greater compared to frequency of electromechanical oscillations, the derivative from the PCC-current phase could be acquired in the alternation in frequency estimate from the PLL. Therefore, the reduced-frequency electromechanical oscillation component could be extracted from the regularity estimate from the PLL [4]. However, the derivative of transmitted power is believed by removing the reduced-frequency electromechanical oscillation component in the measured signal. Within this paper, this is done by using variable failing to remember factor as described. Once the RLS formula is within steady-condition, its bandwidth is dependent upon the steady-condition failing to remember factor. The investigated control method continues to be derived underneath the assumption of merely one oscillatory frequency component within the input signal. A short this is their explanation suggested formula could be extended for multi-area system with multiple oscillation modes is going to be briefly presented for future reference. Linearizing around a preliminary steady-condition operating point, the little-signal dynamic model of this two-machine system using the E-STATCOM in per unit is developed. With active power injection only, the mix coupling terms lessen the damping because the speed variation from the generators is going to be opposite in the oscillatory frequency. Therefore, the active power injected through the E-STATCOM only at that location is placed to zero through the control formula. When leaving this time for the generator terminals. This improves the damping that may be supplied by active power injection and then the quantity of injected active power is elevated. Using the described control strategy, injected active power is zero at the stage where the result of active power injection on damping is zero. This really is in the electrical midpoint from the line. However, at same position damping by reactive power injection is maximum [5]. Overturn happens at either finish from the generators.

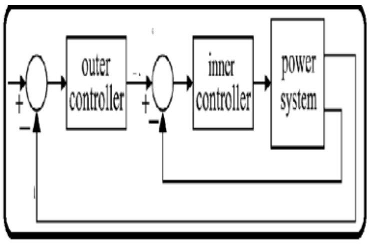

Fig.2.E-STATCOM Framework

III. CONCLUSION

The estimator enables a quick, selective and adaptive estimation of signal components in the power oscillation frequency. An adaptive POD controller by E-STATCOM continues to be coded in this paper. With this, an altered RLS formula has been utilized for estimation from the low-frequency electromechanical oscillation aspects of in your area measured signals during power system disturbances. In addition, while using frequency variation in the E-STATCOM connection point because the input signal for that active power modulation, it's been proven that active power injection is minimized at points during power system where its effect on POD is minimal. The dynamic performance from the POD controller to supply effective damping at various connection points from the E-STATCOM continues to be validated through simulation in addition to experimental verification. This leads to an ideal utilization of the available power source. The sturdiness from the control formula against system parameter changes has additionally been proven through experimental tests.

IV. REFERENCES

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