A Power Frequency Phase Control through STATCOM and improve Transients stability in Power System

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ABSTRACT: Therefore, a fast and accurate estimation algorithm would be a significantly useful tool. In consideration of the composition of the transient signals in the power systems, a new algorithm is proposed for the estimation of the power frequency phasor. Power frequency phasors are widely used in measurement, analysis, control and protection of power systems. When disturbances occur in such systems, power frequency phasors must be estimated quickly to ensure an exact restoration to normal operation. The article presents a hybrid scheme to improve the stability of the multi machine power system. The voltage regulation and the angular stability of the power system are improved with the help of STATCOM. A new standard controller for the STATCOM with a Supplemental Bandwidth Multiple Band Controller is used to improve the power supply voltage profile and to cushion the low frequency oscillation between zones. The selection of the wide area control signals is performed using the sensitivity of the eigenvalues expressed in terms of participation factor. Based on the double matrix pencil method, a unit reference matrix of complex value exponential signals is formed. The estimation of the power frequency phasor is then transformed into a brief multiplication of matrices. Thus, QR decomposition, the calculation of the generalized eigenvalue and the secondary estimate can be avoided and no complex multiplication is introduced. Therefore, the computational efficiency of the proposed method is improved compared to previous estimation techniques. The analytical and experimental investigations show that the proposed algorithm can extract the power frequency phasors with precision, stability and rapidity under the transient of the power system.

KEYWORDS: Fault breaker, ground, turbine regulator, transmission line, transformer, three-phase voltage and current measurement etc.

I. INTRODUCTION

Introduction This section explains the background of the studied topic, the project objectives, the main contributions of this work and the outline of this thesis. The aim of this work is to investigate the applications that are enabled by equipping STATCOMs with energy storage. With energy storage, the devices are able to exchange both active and reactive power, compared to only reactive power without storage. This gives an increased controllability and some additional uses. Furthermore, the studied applications concern power quality improvements which demand fast response times. Hence, uses which utilize slower response times, for example energy trading or deferring of grid reinforcements, are not treated. Additionally, this work examines the impact from dynamic loads on power system performance when compensators with and without energy storage, respectively, are used. In particular, system damping and stability are investigated when the dynamic properties of the loads vary. A simplified dynamic model of a combined system of a dynamic load, a STATCOM (with or without energy storage) and a grid source is investigated. This model shows that dynamic properties of loads can have a large impact on the performance of power systems.

II. STATIC SYNCHRONOUS COMPENSATOR

Specifically, the STATCOM considered in this t thesis is a voltage source inverter that produces from a given input dc voltage a set of three-phase ac output voltages, each of which is in phase 114th: and coupled to the corresponding ac system voltage via a relatively small reactance (which is provided either by an interface reactor or leakage inductance of a coupling transformer). The cic voltage is provided by an energy storage capacitor. The STATCOM is analogous to an ideal synchronous machine which generates a balanced set of their sinusoidal voltages, at the fundament al frequency, with controllable amplitude and phase angle. This ideal machine has no inertia, its response is practically instantaneous, it does not significantly alter the existing system impedance, and it can internally generate reactive (both capacitive and inductive) power.

III. V-I Characteristic of STATCOM

A typical V-I characteristic of STATCOM is depicted in Figure 1 As can be seen, the STATCOM can supply both capacitive and inductive compensation and is able to control its output current over the rated maximum capacitive or inductive range independently and irrespective of the amount of the ac system voltage.

That is, the STATCOM can provide full capacitive reactive power at any system voltage, practically down to zero. Figure 1 also illustrates that the STATCOM has an increased transient rating in both the capacitive and inductive operating regions. The maxi-mum attainable transient over-current in the capacitive region is determined by the maximum current turn-off capability of the inverter switches. In the inductive region, the inverter switches are naturally commutated and therefore the transient current rating is limited by the maximum allowable junction temperature of the inverter switches.

In practice, the semiconductor switches of the inverter are not lossless, and therefore, the energy stored in the dc capacitor would be eventually utilized to meet the interna1 losses of the inverter and the dc capacitor voltage would diminish. However, when the STATCOM is used for reactive power generation, the inverter itself can keep the capacitor charged to the required voltage level. This is accomplished by making the output voltages of the inverter lag the ac system voltages by a small angle.

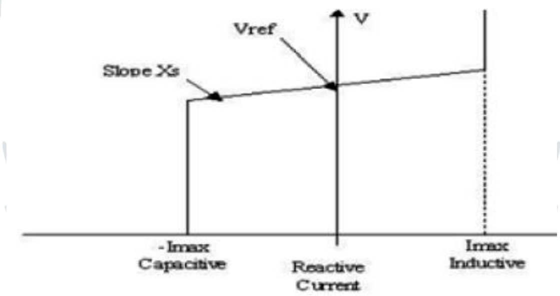


Fig 1. V-I Characteristics of STATCOM

In this way the inverter absorbs a small amount of real power from the ac system to meet its interna1 losses and keep the capacitor voltage at the desired level. The same mechanism can be used to increase or decrease the capacitor voltage, and thereby the amplitude of the output voltage of the inverter, for the purpose of controlling the var generation or absorption. The reactive and real power exchange between the STATCOM and the ac system can be controlled independently of each other and any combination of real power generation or absorption mirth vary generation or absorption is achievable, if the STATCOM is equipped with an energy storage device of suitable capacity, as depicted in Figure 2. With this capability, extremely effective control strategies for modulation of the reactive and real output power can be devised to improve transient and dynamic system stability limits.

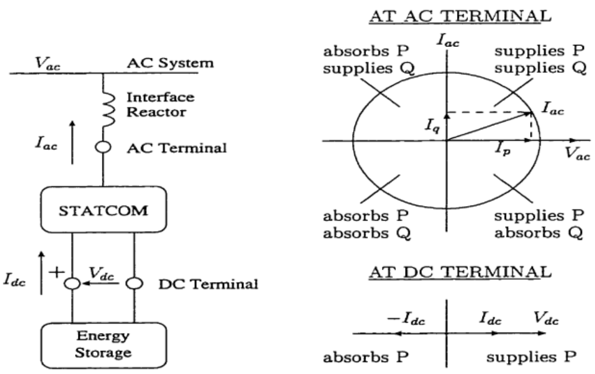


Figure 2: Power exchange between the STATCOM and ac system

IV. MODEL FOR THE STATCOM SMES COMPENSATOR

1. General Concepts:-

In principle, STATCOM is a shunt connected device which injects reactive current into the ac system. Whereas the STATCOM can only absorb/inject reactive power, consequently is limited in the degree of freedom. The addition of SMES allows the STATCOM to inject and/or absorb active and reactive power simultaneously. A functional model of a STATCOM/SMES compensator is shown in Fig 3. This model consists mainly of the STATCOM controller, the SMES coil and the dc-dc chopper is adopted as interface for two devices.

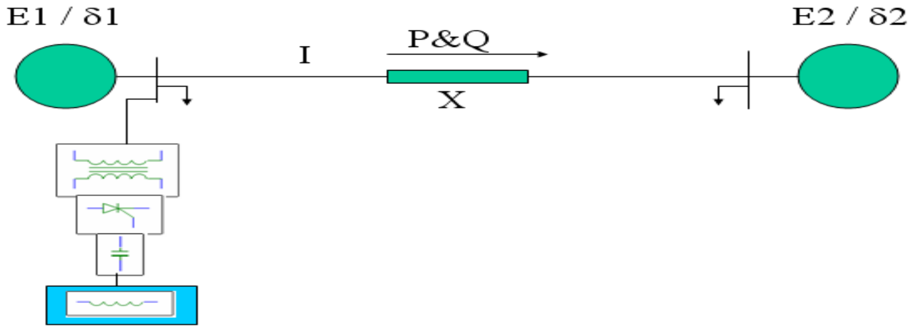
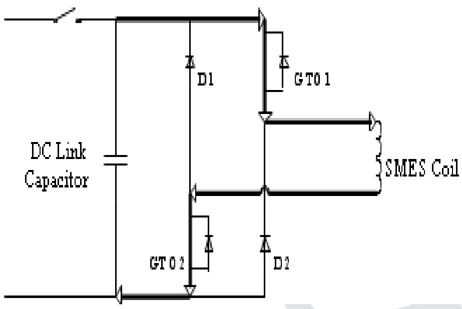


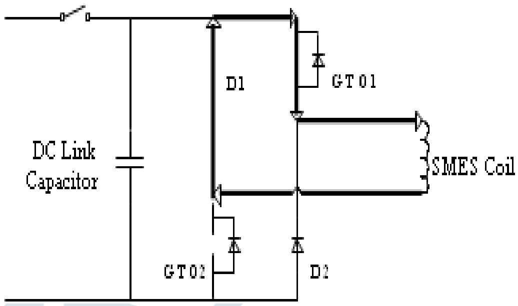
Fig. 3. General model of the proposed STATCOM/SMES compensator

2. The Dc-Dc Chopper Operation in Order to Charge/Discharge SMES Coil

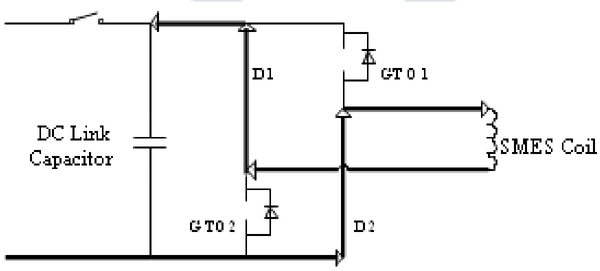
There are three different modes of operation of the SMES coil. The first mode of operation is the charging of the SMES coil. The SMES coil charges relatively fast to its rated current. The second mode is the stand-by mode. In this mode the current in the SMES coil effectively circulates in a closed loop, which can also be called as a freewheeling mode. The third mode is the discharge mode, during which the SMES coil discharges into the dc-link capacitor. The three modes are shown in Fig. 4.



(a) Charging Mode



(b) Freewheeling Mode



(c) Discharging Mode

Fig. 4. (a), (b) and (c), operating modes of SMES dc-dc chopper

3. INCREASE THE BENEFIT OF EXISTING STATCOM BY ADDING WITH REAL POWER INJECTION

The ability to rapidly damp oscillations, respond to sudden changes, dynamic and transient stability, power quality enhancement, correct load voltage profiles with rapid reactive power control and transmission capacity improvement are among the benefits of SMES system. The integration of SMES system into STATCOM can provide independent real and reactive power absorption/injection into/from the grid, leading to a more economical and/or flexible transmission control. The enhanced performance of a combined STATCOM/SMES compensator will have greater appeal to transmission service provides, as shown in Fig. 5. The SMES can be added to a STATCOM to significantly improve the control actions of STATCOM. If a transmission line experiences significant power transfer variations in a short time notice, a STATCOM/SMES compensator can be installed to relieve the loaded transmission line. The traditional STATCOM (without SMES) has only two possible steady state operating modes: inductive (lagging) and capacitive (leading). Although both the STATCOM output voltage magnitude and phase angle can be controlled, they cannot be independently adjusted since the STATCOM has no active power capability. In the case of a STATCOM/SMES compensator, the number of operating modes is extended to four. These modes are namely, inductive with dc charge, inductive with dc discharge, capacitive with dc charge and capacitive with dc discharge, as shown in Fig. 5.

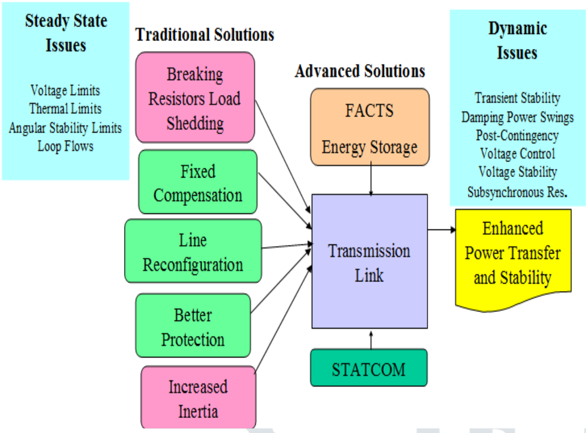


Fig.5 Benefits of STATCOM with SMES

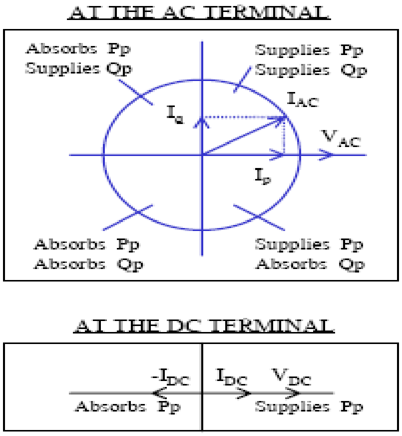


Fig.6 STATCOM/SMES P-Q plane for each operating mode when it is connected to system in parallel

In Fig.6 for the STATCOM, reactive power only operates in the vertical axis only. By addition of SMES, real power compensation can increase operating control of STATCOM. Therefore, by using STATCOM/SMES compensator, real and reactive power can operate anywhere within PQ plane.

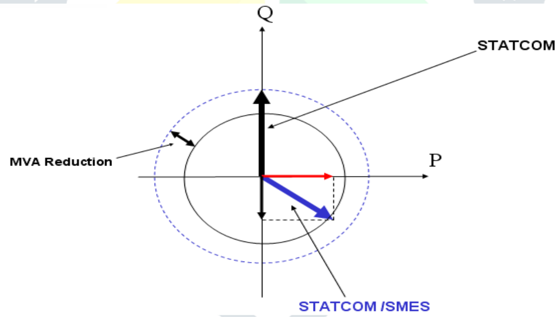


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Fig. 8 Enhances functionality of STATCOM by addition of SMES

An advantage of using the STATCOM/SMES compensator for real power is that the STATCOM has a higher Q rating than P, and the SMES coil will affect only the P rating. P and Q sum orthogonally, so the effect on overall current of combining the SMES and SMES is less when both are used together, as shown in Fig. 9, than if both were used separately. The addition of real power transfer capability does not necessarily result in a large increase in the MVA rating of the converter, since the real power is in quadrature with the reactive power from the converter. The addition of real power capability may improve the performance of the converter enough that the total converter MVA rating could even be reduced.

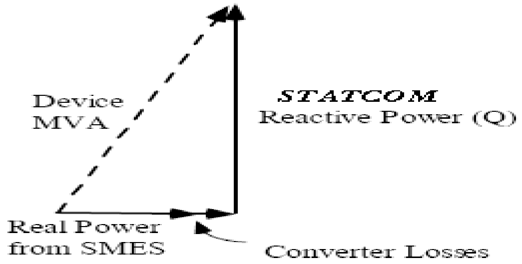


Fig. 9 Orthogonal Addition of SMES Real Power P and STATCOM Reactive Power Q

V. RESULT ANALYSIS

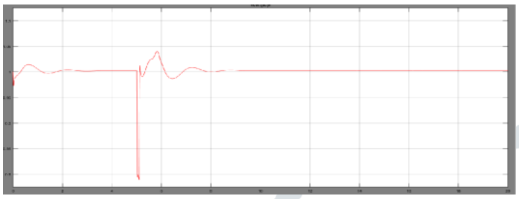


Fig. 10 Voltage magnitude (pu)

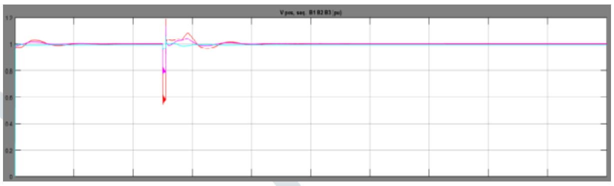


Fig 11 Voltage Sequence B1, B2, B3

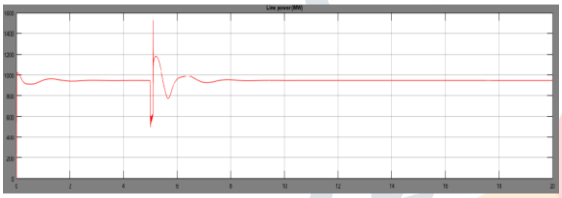


Fig. 12 Shows that the Line Power (Mw)

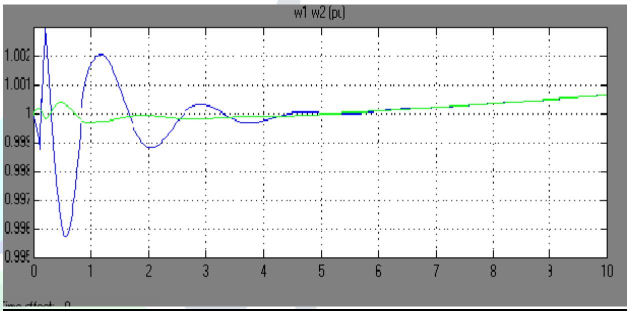


Fig 13 Shown that W1, W2

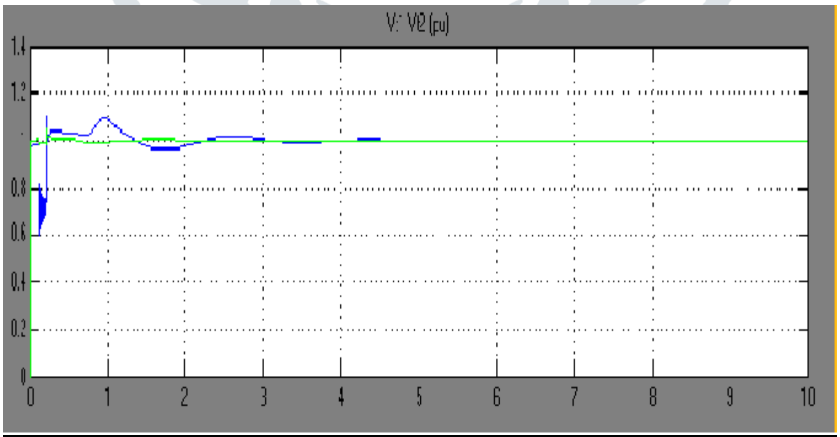
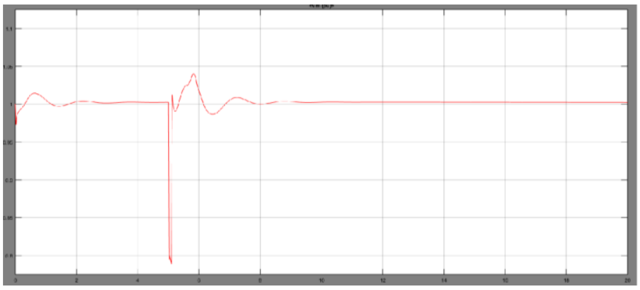
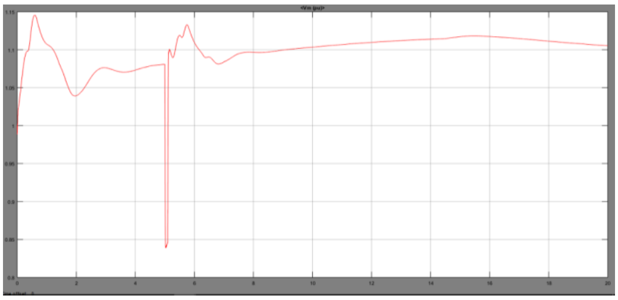


Fig.14 Shows that Vt1, Vt2

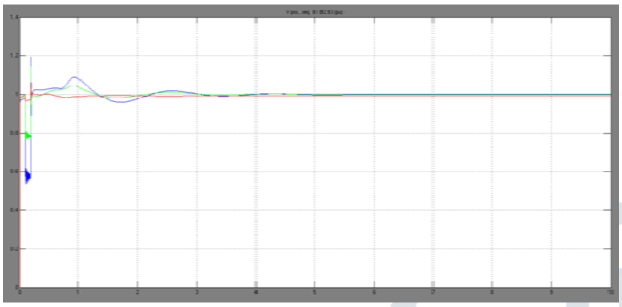
Compression result between Statcom and svc

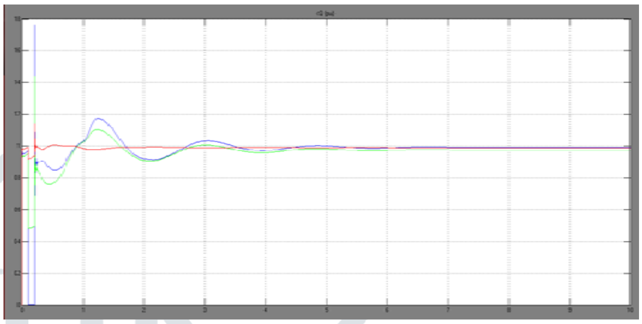
Voltage magnitude (PU)





STATCOM Time (sec) p.u **SVC time (sec) p.u**





Statcom Time sec (PU) **Svc Time sec (PU)**

VI. CONCLUSION:-

1. The STATCOM is compared with pure reactive power compensation, with the STATCOM, which only can control either the magnitude or the phase of the voltage

2. It is not affected by harmonic, Inter harmonic, decaying DC, or damped sinusoidal components.

The thesis has dealt with energy storage equipped STATCOMs for power quality applications, i.e. applications which demand fast response times. Furthermore, the impact of dynamic loads on System performance has been examined.

Applications related to power quality improvements, in which energy storages are necessary, The ability of the STATCOM to completely mitigate a voltage dip, in both magnitude drop and phase jump, is shown by simulations and through simplified explanations. The STATCOM is compared with pure reactive power compensation, i.e. with the STATCOM, which only can control either the magnitude or the phase of the voltage. From this, it is clear that if complete voltage dip mitigation is desired, an energy storage equipped STATCOM is needed with a sufficiently large converter rating and energy storage size. Furthermore, it is described how an STATCOM can be used to quickly balance loads in areas which experience a loss of a single line, hence, entering islanding operation. By consuming or producing power the STATCOM can keep the voltage and frequency within acceptable limits until slower control systems in the islanded system can take action.

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