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A Study on STATCOM and SVC in Power Transmission System

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ABSTRACT

This paper presents an in-depth investigation of the effect of the Static Var Compensator SVC and the Static Synchronous Compensator STATCOM on the power system dynamic performance theoretically and by exact digital simulation. A 48-pulse Gate Turn-off GTO dc-ac converter model is designed to represent the operation of the STATCOM within a power transmission system. The main considerations of the SVC and STATCOM precariousness dissected and another Automatic Gain Controller AGC proposed to guarantee the steady activity of the SVC and STATCOM for various sorts of burden. The recommended SVC and its area will upgrade the transmission capacity of the line and tackle the issue of the normal over-burden in 2010. The got results have been contrasted and those results when a static compensator (ST ATCOM) is utilized to improve the voltage profile of a similar transmission line. The stacking rise rate has been considered 14.35% yearly. The line-to-Iine voltages at various burden transports with-and without FACTS regulators have been delineated.

Keywords: VSC, CSI, STATCOM, FACTS, SVC, Voltage Stabilization, Reactive Compensation, Power Quality Issues, PQ Devices.

INTRODUCTION

Due to expanding power interest and intricacy in activity and design, using current electrical power gadgets turns out to be significantly more troublesome and imposing. Voltage flimsiness is practically the most concentrated on issue in power systems as one of the significant reasons for voltage shakiness in the power system is receptive power limit and expanding responsive burden. Giving adequate receptive power to the fitting transport upgrades voltage insecurity issues. As there is a between association of huge territorial power systems and the fast improvement of power system, the cutting edge systems turns into an all the more enormous nonlinear unique system, including enormous limit units, additional high voltage, significant distance transmission, complex dispersion organization and weighty burden interest. Especially the kind of cool burden and modern burdens which is more inductive will retain additional responsive power from the system during framework flaws, further decay the system voltage security, even lead to huge region power outage, and truly impact the transient dependability of the power systems. By reason of that, there is a need to repay the expected responsive power during the framework flaws and dynamic help the system voltage turns into a significant concerned subject where Facts gadgets come as arrangement. In this paper STATCOM and SVC has been examined The coming of FACTS systems is leading to another group of power electronic hardware for controlling and streamlining the unique presentation of power system, e.g., STATCOM, SSSC, and UPFC. The utilization of voltage-source inverter (VSI) has been generally acknowledged as the up and coming age of adaptable receptive power pay to supplant other customary VAR pay, for example, the Thyristor-Switched Capacitor (TSC) and thyristor controlled reactor (TCR). As a significant individual from the FACTS regulators' family, Static Synchronous Compensator (STATCOM) has been at the focal point of consideration and the subject of dynamic examination for a long time. STATCOM is a shunt-associated gadget that is utilized to give responsive power pay to a transmission line. Adaptable rotating current transmission system (FACTS) regulators are intended to work on the presentation of power systems and increment the power move capacity. Improvement of the bandwidth up to 40-half can be accomplished by utilizing a FACTS gadget. Realities regulators enjoy a few benefits, for example, power-stream control; voltage

solidness and control; loadability upgrade; improvement of transient strength and power wavering damping in svc [1].

This paper proposes and carries out SVC and STATCOM models to further develop control modules in DIgSILENT, which are associated with IEEE 14-transport standard power system, confirming the legitimacy of SVC and STATCOM models while checking its impact on power system [2].

Static Synchronous Compensator STATCOM

The essential STATCOM model comprises of a stage down transformer with spillage reactance Xt, a three-stage GTO Voltage Source Inverter VSI, and a dc side capacitor. The air conditioner voltage distinction across this transformer spillage reactance produces responsive power trade between the STATCOM and the power system at the mark of point of interaction [3].

The voltage controlled to further develop the voltage profile of the interconnected power system, which is the essential obligation of the STATCOM. An optional damping capability added to the STATCOM for upgrading power system dynamic security. The STATCOM fundamental capability is to manage key transport voltage size by progressively retaining or producing receptive power to the air conditioner lattice organization, similar to a thyristor static compensator. This responsive power move is finished through the spillage reactance of the coupling transformer by involving an optional transformer voltage in stage with the essential voltage (network-side). This voltage is given by a voltagesource Pulse Width Modulation PWM inverter and is dependably in quadrature to the STATCOM current. Voltage Source Converter VSC that produces a three-ease voltage from a dc capacitor in synchronism with the transmission line voltage and is associated with it by a coupling transformer by controlling the greatness of the STATCOM voltage, the receptive power trade between the STATCOM and the transmission line and thus how much shunt pay can be controlled. The activity and control basics of the STATCOM have been widely talked about [4].

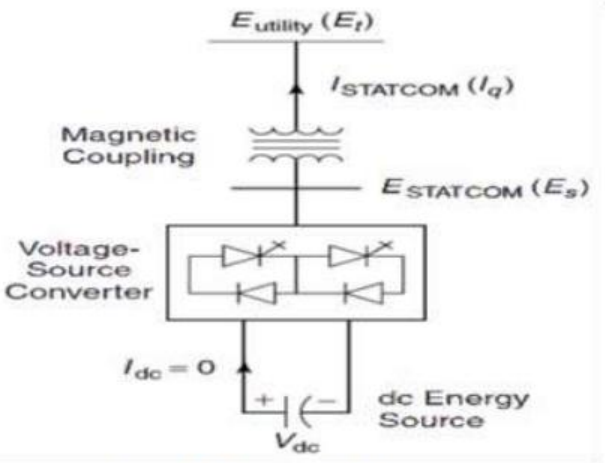

Fig1. Block diagram of STATCOM [2]

Static Var Compensator (SVC)

The SVC has been widely used in power system are well known to further develop power system properties, for example, steadystate security limits, voltage guideline and var pay, dynamic over-voltage and under voltage control, and clammy power system motions for both voltage guideline and dynamic soundness upgrade [5].

The variety of responsive power is performed by exchanging three-stage capacitor banks and inductor banks associated on the optional side of a coupling transformer. Every capacitor bank is turned here and there by three Thyristor Switched Capacitor or TSC. Reactors are either turned on-off (Thyristor Switched Reactor or TSR) or stage controlled (Thyristor Controlled Reactor or TCR). The control system in comprises of; voltage controller that utilizes the voltage mistake to decide the SVC susceptance BSVC expected to keep the system voltage steady. A conveyance unit that decides the TSC's (and in the end Tsr's) that should be exchanged in and out, and registers the terminating point α of Tcr's. A synchronizing system utilizing a Phase Locked Loop PLL synchronized on the optional voltages and a heartbeat generator that send suitable heartbeats to the thyristors [6].

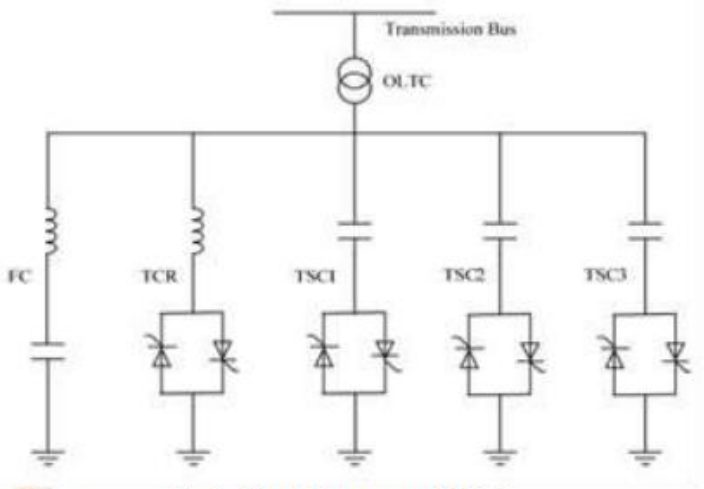

Fig2. Block Diagram of SVC

RESPONSE TIME OF STATCOM vs SVC

During power system transient process the duration of fault is 0.1 second, which shows that the reaction season of the gadget decides straightforwardly the transient help capacity of the remuneration gadget. As the SVC is made by the exchanging gadgets with TCR/TSC are half-controlled thyristor and can't be switched off just when current zero-crossing happens, so there is a control delay. Connected with change season of the gear, the reaction season of SVC really depends on a few cycles. In the mean time the exchanging gadget utilized in STATCOM are made out of full-controlled gadget IGBT/GTO with high exchanging recurrence, so control delay is practically disregarded, the reaction time still up in the air by the intrinsic time steady of the gadget (for the most part a couple of milliseconds). Accordingly , he whole reaction season of STATCOM is just a single recurrence cycle, some of the time even ups to just half recurrence cycle. So we infer that the reaction season of STATCOM is superior to the one of SVC [7].

LITERATURE REVIEW

In this paper, the unique activity of novel control plot for both Static Synchronous Compensator (STATCOM) and Static Synchronous Series Compensator (SSSC) in light of another full model containing a 48-beat Gate Turn-Off thyristor voltage source converter for joined receptive power pay and voltage adjustment of the electric lattice network is examined. The advanced reenactment of the STATCOM and SSSC inside the power system is acted in the MATLAB/Simulink climate utilizing the Power System Blockset (PSB). Two novel regulators for the STATCOM and SSSC are proposed in this paper in light of a decoupled current control technique. The proposed decoupled regulators for the 48-beat voltage source converter STATCOM showed high productivity for receptive power remuneration and voltage guideline with the system exposed to stack unsettling influences like exchanging various sorts of burdens. The exhibition of the Auxiliary Tracking control with PWM exchanging procedure in smothering any wavering and damping the homeless people that might show up during the progress from capacitive to inductive method of activity contrasted and the decoupled current control system are depicted in this

paper.. A total computerized reproduction concentrate on utilizing the full 48-beat GTO-SSSC gadget model for an example test power system is likewise introduced in this paper. The advanced reenactment is acted in the MATLAB/Simulink programming climate utilizing the PSB. The essential structure block of the SSSC gadget is similar outpouring of converters framing the 48-beat GTO converter whose total advanced recreation model was carried out utilizing MATLAB/Simulink. The control procedures execute decoupled current control and helper following control in light of a heartbeat width balance changing method to guarantee quick controllability, least oscillatory way of behaving, and least inborn stage locked circle time delay as well as system unsteadiness diminished influence because of a powerless interconnected ac system [8].

In the paper, a staggered D-STATCOM setup comprising of a three level voltage source converter, a DC energy capacity gadget, a coupling transformer and related control circuits is presented. The control depends on sinusoidal PWM and just requires the estimation of the RMS voltage at the heap point. The legitimacy and adequacy of the proposed power conditioner has been shown through PSCAD/EMTDC reenactment device utilized for its demonstrating and reproduction. Broad reenactment are additionally completed to check the prevalence of staggered D-STATCOM with two level D-STATCOM. By this remarkable construction of the staggered Voltage Source Converter (VSC) permits it to arrive at high voltages with low music without the utilization of transformers or series-associated, synchronized exchanging gadgets. It is seen that for expanded number of levels of VSC the result voltage and current waveforms moves toward a sinusoidal nature with least music. With the assistance of this Comparison of staggered D-STATCOM with two-level DSTATCOM finds that the staggered VSC is liked over the generally involved two-level VSC for high power applications from the point of view of consonant parts, %THD in voltage and current, proficiency, DC connect voltage and inverter exchanging recurrence. The productivity, % THD in voltage and current for different degrees of D-STATCOM are assessed and views as the quantity of level expands, the THD of the result voltage and current reductions. The three-level VSC shows max effectiveness, with diminished upsides of %THD in voltage and current. This custom power regulator might track down application in mechanized ventures with basic burdens [9-11].

This paper introduced an original double circle current decoupled regulator plot for the 48-beat GTO based voltage source converter utilized as a STATCOM for giving the voltage guideline and responsive remuneration of the power system. The decoupled regulator conspire depends on a decoupled current system utilizing direct and quadrature part of STATCOM current. The presentation of this regulator is assessed by ±100 MVAR STATCOM plot associated with the 230-kV matrix. Responsive power remuneration and voltage guideline is approved for burden and system trips in both the capacitive and inductive methods of activity. The regulator is displayed utilizing simulink and the STATCOM or power matrix is reenacted utilizing MATLAB/SIMULINK by utilizing power system block-set. The unique recreation results have shown the excellent of the 48 heartbeat STATCOM for responsive power remuneration and voltage guideline while the system exposed to aggravations like exchanging various sorts of burdens. The full 48 heartbeat model can be used in different Facts gadget concentrates, for example, Active Power Filters and new mixture adjustment geographies [12-15].

In this paper, a clever twofold circle control system of current feed-forward in addition to twofold PI circle for changing transmission line genuine power is proposed. Transport bar voltage external circle control system takes on voltage hang control which comprises of PI guideline and scaling factors of hang trademark. An ongoing feed-forward control is brought into twofold circle de-coupled control system of dc capacitor voltage guideline. Planning cycle of control system is talked about momentarily in this paper. The exploratory outcomes on a15-KVA lab scale hardware and furthermore reenactment results for a contextual investigation demonstrate that dc capacitor voltage and transport bar voltage can be controlled proficiently, and demonstrated that the control plan and regulator configuration are practical and successful. Essentially we know that the Static Synchronous Compensator (STATCOM) in view of voltage source converter is perhaps of the most utilized Fact gadget.. The proposed novel twofold circle control system, including current regulator, dc-connect capacitor voltage regulator, feed-forward regulator and transport bar voltage regulator are planned freely and momentarily introduced in this paper. The trial and reproduced results demonstrates that the dc-connect capacitor voltage and transport bar voltage is controlled proficiently, and the system has great dynamic and stable exhibitions and furthermore check that ongoing feed-forward in addition to twofold PI circle is a reasonable control plan and regulator configuration is exact and compelling [16-19].

RESULTS AND DISCUSSION

To look at the transient voltage soundness improvement exhibitions of SVC and STATCOM gadgets, two situations are viewed as in a 14-transport test system. In the principal situation, a three-stage cut off that happens in the transport 14 while in the subsequent situation, the line blackout case that happens between transport 9 and transport 14 are considered. In the two situations, the heap of transport 14 was expanded by half and 100 percent while the exhibitions of SVC and STATCOM gadgets were looked at. The control model of SVC is picked Type 1 model made sense of in Section 3.A, concerning STATCOM the ongoing infusion model is utilized.

In this review, as a proposed arrangement both transient voltage dependability improving and to increment strength edge of the system, shunt FACTS regulator that are SVC a STATCOM regulators are added, demonstrated in DIgSILENT, tried and contrasted with show the impact of these regulators on the different solidness edges under stacking conditions . The IEEE 14 transport was concentrated on utilizing the DIgSILENT program to get the system P-V bends and perform time area to concentrate on the overall execution of the system. SVC, STATCOM regulators were likewise added to the system. Assuming the power system impedance diminishes (solid system), the system is more steady, albeit the reaction is more slow than that of the frail system. Concentrating on more successfully STATCOM regulator model. Obviously utilized of enhancement calculations in deciding the coefficients of PI boundaries will improved results as execution of regulators the system reactance Xeq, is a piece of the criticism circle and it is urgent to take note of that Xeq differs as burdens are added to or dismissed from the power system or when a transmission line or generator blackout happens. The computerized recreation results are responsive power of the SVC in MVAR, susptance of the SVC Bsvc in pu, and terminal voltage VB2 in pu are examined, for two cases [20-23].

The STATCOM is associated with the power system at t=0.1s while the two burdens are in the system and at t=0.4s, load #1 is dismissed. The reenactments results for Iq, Vdc and VB2 alongside the aftereffects of a similar system without the AGC, to approve the upside of the AGC. The voltage controller is stabilized after a few oscillations, and the STATCOM dc capacitor and B2 bus voltages are stabilized, while the system without the AGC is still oscillating at the end of the simulation. As expected, the AGC does not affect the STATCOM when there is no oscillation in Iq [24].

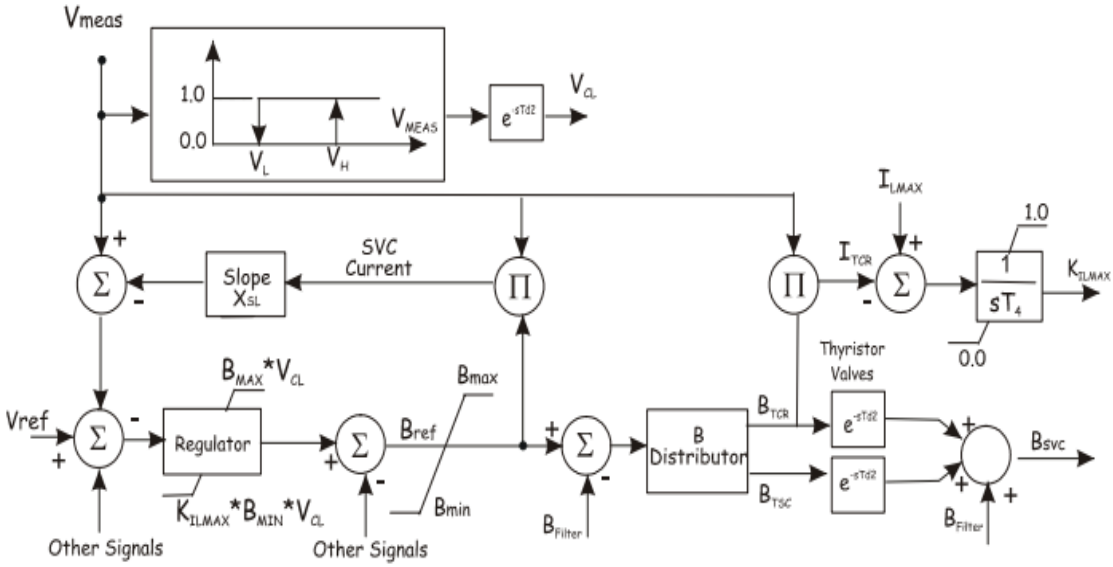

Fig. 3. SVC model for dynamic studies

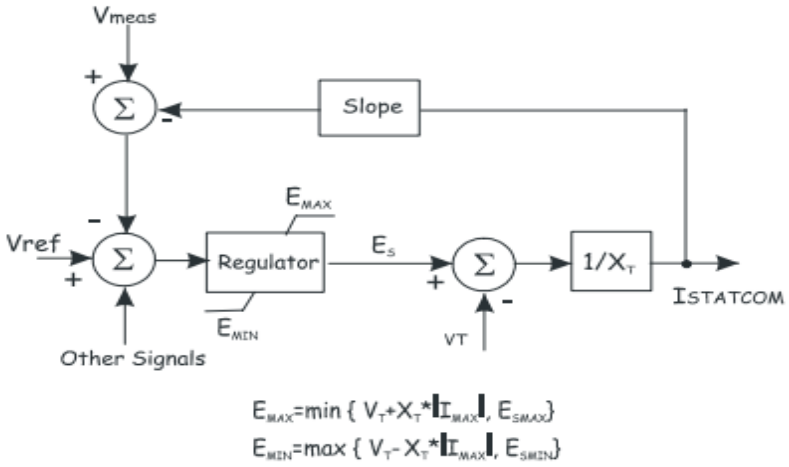

Fig. 4. STATCOM model for dynamic studies

CONCLUSION

In this paper, a revision of past literature published on the various control strategies of STATCOM is presented. By doing so we have found that with the advancement of power electronics converters, the power engineers find various opportunities to develop the control strategy so that harmonics are reduced as possible. The consequences of the review show that SVC and STATCOM are more useful in voltage recuperation when little and enormous aggravations of step load expanding and like weighty stacking. A few focuses coming about because of this paper could be the reason for future investigations; The STATCOM CIGRE model and has not been impacted. In this manner, the generally speaking shut circle gain and the security edge of the SVC are enormously impacted by Xeq, or system strength. In the event that the impedance of the power system increments (frail system), how much voltage change because of the SVC responsive current increments and the general system watches out for unsteadiness. We can also see that a multilevel cascaded multi-pulse STATCOM have found great applications in today power system .There is a great scope for power quality researchers for developing fast adaptive controllers for STATCOM.

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