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# STATCOM Communication, SSSC, and the UPFC Technology Controller Dynamic Performance

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**Abstract:** The paper researches the powerful activity of both static simultaneous compensator (STATCOM) and static coordinated series compensator (SSSC) in view of another full model containing a 48-beat door switch off thyristor voltage source converter for joined responsive power pay and voltage adjustment of the electrical matrix net work. The total computerized reproduction of the STATCOM and SSSC inside the power framework is acted in the MATLAB/reenactment climate utilizing the power framework block set (PSB).The STATCOM conspire and the electrical matrix network are displayed by unambiguous electrical blocks from the power framework block set, while the control framework is demonstrated involving simulink. Two regulators for the STATCOM and SSSC are introduced in this paper in view of a decoupled with voltage and flow control methodology. The presentation of both STATCOM and SSSC plans associated with the 500-kv framework are assessed. The proposed to guarantee the steady activity of the STATCOM under different burden conditions. it is shown that stage locked loop(PLL) innate deferral significantly affects dynamic activity of SSSC and new assistant controller is proposed to improve the unique exhibition of the SSSC. the proposed control plans are approved by advanced recreation.

**Key Word:** Stage Locked Loop(PLL), helper controller, GateTurn-Off unique execution, static coordinated series compensator (SSSC), static simultaneous compensator (STATCOM),voltage adjustment, 48-beat converter.

## 1. Introduction

The GTO thyristors empower the plan of the strong state shunt receptive pay and dynamic sifting gear in view of exchanging convertor innovation. These power quality gadgets (PQ Gadgets) are power electronic converters associated in equal or in series with transmission lines, and the activity is constrained by advanced regulators. The cooperation between these remunerating gadgets and the lattice network is ideally concentrated on by advanced recreation. Adaptable exchanging current transmission frameworks (Realities) gadgets are typically utilized for quick powerful control of voltage, impedance, and stage point of high-voltage ac lines. Realities gadgets gave vital advantages to further developed transmission framework power stream the executives through better usage of existing transmission resources, expanded transmission framework security and dependability as well as accessibility, expanded dynamic and transient lattice strength, and expanded power quality for delicate businesses (e.g., micro processor produce). The coming of Realities frameworks is leading to another group of force electronic hardware for controlling and advancing the elements gear for controlling and enhancing the unique exhibition of force framework, 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 traditional VAR pay, for example, the thyristor-exchanged capacitor (TSC) and thyristor controlled reactor (TCR). This paper bargains clever an original fountain staggered converter model, which is a 48-beat (three levels) source converter. The voltage source converter depicted in this paper is a consonant killed, 48-beat GTO converter.

It comprises of four three stage, three-level inverters and four stage - moving transformers. In the 48-beat voltage source converter, the dc transport Vdc is associated with the four three-stage inverters. The four voltage produced by the inverters are applied to auxiliary windings of four crisscross stage moving transformers associated in Y or Δ .The four transformer essential windings are associated in series, and the converter beat designs are stage moved with the goal that

the four voltage basic parts aggregate in Stage on the essential side.

## 2. Dynamic Execution of the Stat com

The STATCOM gadget activity can be outlined by the phasor graphs displayed in Fig. 1. At the point when the auxiliary voltage (Versus) is lower than the network framework transport voltage (VB), the STATCOM behaves like an inductance retaining receptive power from the matrix transport. At the point when the optional voltage (Versus) is higher than the transport voltage (VB), the STATCOM behaves like a capacitor creating responsive capacity to the network transport. In consistent state activity and because of inverter misfortunes, the transport voltage (VB) consistently drives the inverter ac voltage by a tiny point to supply the expected little dynamic influence misfortunes.

## 3. Digital Reenactment STATCOM Model

An original complete model utilizing the 48-beat computerized recreation of the STATCOM inside a power framework is introduced in this paper. The advanced recreation is performed utilizing the MATLAB/Simulink programming climate and the Power Framework Block set (PSB). The essential structure block of the STATCOM is the full 48-beat converter-overflow executed utilizing the MATLAB/Simulink programming it was displayed in the Fig.2. The control interaction depends on an original decoupled current control system utilizing both the direct and quadrature current parts of the STATCOM. The activity of the full STATCOM model is completely concentrated on in both capacitive and inductive modes in a power transmission framework and burden journey. The utilization of full 48-beat STATCOM model is more exact than existing low-request or practical models.

Two 24-beat GTO-converters, stage moved by 7.5 º from one another, can give the full 48-beat converter activity. Utilizing an even shift measure, the 7.5 º are given in the accompanying manner: stage shift twisting with - - - 3.75º on the two coupling transformers of one 24-beat converter and +3.75º on the other two transformers of the subsequent 24-beat converter. The terminating beats need a stage shift of +3.75º, separately.

The 48-beat converter model contains four indistinguishable 12-beat GTO converters interlinked by four 12-beat transformers with stage moved windings. Fig. 3 portrays the schematic graph of the 48-beat Versus GTO converter model. The transformer associations and the important terminating beat rationales to get this last 48-beat activity are demonstrated.

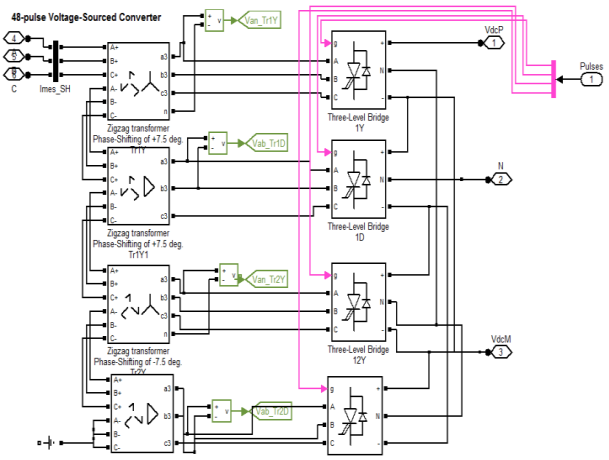


*Fig.1Forty-eight- pulse GTO's voltages ource converter.*

**A. Current Control Mode Activity:**

The new decoupled control framework depends on a full d-q decoupled current control methodology utilizing both direct and quadrature current parts of the STATCOM ac current. The decoupled control framework is carried out stage locked circle (PLL) synchronizes as displayed in Fig. 8. An on the positive grouping part of the three stage terminal voltage at

PST:7.5° Important to wipe out the 24 - beat sounds

3.75 ° Important to wipe out the 48 - beat sounds

All out 11.25° winding turn rate 1: tan(11.25 °) Drive: 7.5 ° Important to dispense with the 24-heartbeat sounds 3.75° Important to take out the 48 - beat sounds. Complete 5° point of interaction Transport 2. The result of the PLL is the point () that used to quantify the immediate hub and quadrature hub part of the air conditioner three-stage voltage and current. To upgrade the powerful exhibition of the full 48-beat STATCOM gadget model, a valuable controller circle is added utilizing the dc capacitor voltage. The dc side capacitor voltage charge is picked as the pace of the variety of this dc voltage. Consequently, for a proper chose brief time frame stretch , the variety in the Vdc size is estimated, and any fast change in this dc voltage is estimated and in the event that this change is more prominent than a predetermined edge k , the beneficial circle is enacted. The principal idea is to distinguish any quick variety in the dc capacitor voltage.

The methodology of a strengthening damping controller is to address the stage point of the STATCOM gadget voltage , regarding the positive or negative indication of this variety. If , the dc capacitor is charging extremely quick. This happens when the STATCOM converter voltage fall behind the air conditioner framework voltage; along these lines, the

converter retains a modest quantity of genuine power from the air conditioner framework to make up for any interior misfortunes and keep the capacitor voltage at the ideal level. The equivalent procedure can be utilized to increment or lessening the capacitor voltage and, in this manner, the adequacy of the converter yield voltage to control the Var age or retention. This strengthening circle lessens swell substance in charging or releasing the capacitor and works on quick controllability of the STATCOM.

## 4. Digital Recreation Model of SSSC

A total computerized recreation concentrate on utilizing the full 48-beat GTO-SSSC gadget model for an example test power framework is introduced in this paper. The computerized recreation is acted in the MATLAB/Simulink programming climate utilizing the PSB. The essential structure block of the SSSC gadget is similar fountain of converters shaping the 48-beat GTO converter whose total computerized reenactment model was executed utilizing MATLAB/Simulink. This new full SSSC gadget compensator can be more exact in giving completely controllable remunerating voltage over a predetermined indistinguishable capacitive and inductive reach, freely of the greatness of the line current, and better address practical superior power quality diminished music.

**A.POWER Framework DESRIPTION:**

The test framework is a straightforward power framework 500-kV network lattice outfitted with the SSSC and its clever regulator, which associated in series with the transmission framework. Demonstrating the SSSC compensator, including the power organization and its regulator in MATLAB/Simulink climate, requires utilizing ―electric blocks‖ from the power framework block set and control blocks from thr Simulink library. A Mvar SSSC gadget is associated with the 500-kV framework organization. Fig. 5 shows the single line graph that addresses the SSSC and the 500/33-kV framework organization.

The taking care of organization is addressed by an its comparable The venin (transport B1) where the voltage source is a 500 kV with 10 000 MVA impede with an opposition of 0.1 p.u. what's more, a comparable reactance of 0.3 p.u. followed by the 500-kV outspread transmission framework associated with transport B2. The full framework boundaries are given in supplement. The SSSC Realities gadget comprises fundamentally of the 48-beat GTO-voltage source converter model that is associated in series with the transmission line at Transport B1 by the coupling transformer T1. The dc interface voltage V dc is given by capacitor C, which is accused of a functioning power taken straightforwardly from the air conditioner organization. The clever full 48-beat GTO-VSC model outcomes in less consonant twisting than other 6-, 12-, and 24-beat converters or utilitarian models typically used to address SSSC gadget activity.

**B. Control Plan for the 48-beat SSSC**

The control framework for the SSSC gadget is displayed in Fig. 7. The fundamental synchronization signal is the stage point of the transmission line current. The SSSC identical impedance Xs is estimated as the proportion of the q-pivot voltage of the SSSC gadget Veq to the greatness of transmission line current . This identical embedded or same (positive/negative) impedance is then contrasted and the reference level of the pay impedance (S ).

## 5. Results of Recreation:

**Different Control Strategies for STATCOM and SSSC:**

A mix of SHUNT regulator and SERIES regulator activity is fills in as a bound together power stream regulator (UPFC) is utilized to control the power stream in a 500 kV transmission framework. The SSSC and STATCOM situated at the left finish of the 75-km line L2, between the 500 kV transports B1 and B2, is utilized to control the dynamic and responsive powers moving through transport B2 while controlling voltage at transport B1. It comprises of two 100-MVA, three-level, 48-beat GTO-based converters, one associated in shunt at transport B1 and one associated in series between transports B1 and B2. The shunt and series converters can trade power through a DC transport. The series converter can infuse a limit of 10% of ostensible line-to-ground voltage (28.87 kV) in series with line L2.

**These sets of converters can be worked in three modes:**

Bound together Power Stream Regulator (UPFC) mode, when the shunt and series converters are interconnected through the DC transport. At the point when the distinction switches between the DC transports of the shunt and series converter are opened, two extra modes are accessible: Shunt converter working as a Static Coordinated Compensator (STATCOM) controlling voltage at transport B1Series converter working as a Static Simultaneous Series Capacitor (SSSC) controlling infused voltage, while keeping infused voltage in quadrature with current.

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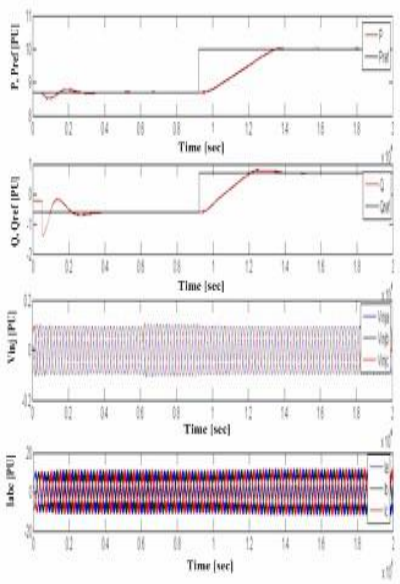
**Power control in UPFC mode:**

The GUI permits you to pick the activity mode (consolidated SSSC and STATCOM, STATCOM or SSSC) as well as the Pref/Qref reference powers or potentially Vref reference voltage settings . Likewise, to notice the powerful reaction of the control framework, the GUI permits you to determine a stage change of any reference esteem at a particular time. The reference dynamic and receptive powers are determined in the last two lines of the GUI menu. At first, Pref= +8.7 pu/100MVA (+870 MW) and Qref=-0.6 pu/100MVA (- 60 Mvar). At t=0.25 sec Pref is changed to +10 pu (+1000MW). Then, at that point, at t=0.5 sec, Qref is changed to +0.7 pu (+70 Mvar). The reference voltage of the shunt converter (determined in the second line of the GUI) will be kept consistent at Vref=1 pu during the entire recreation (Step Time=0.3*100> Reenactment stop time (0.8 sec). At the point when the UPFC is in power control mode, the progressions in STATCOM reference responsive power and in SSSC infused voltage (determined separately in first and third line _

Run the reenactment for 0.8 sec. See on follows 1 and 2 of the degree the varieties of P and Q. After a transient period enduring roughly 0.15 sec, the consistent state is reached (P=+8.7 pu; Q=-0.6 pu). Then P and Q are inclined to the new settings (P=+10 pu Q=+0.7 pu). See on follows 3 and 4 the subsequent changes in P Q on the three transmission lines. The presentation of the shunt and series converters can be noticed separately on the STATCOM and SSSC scopes. In the event that you zoom on the main hint of the STATCOM scope, you can notice the 48-step voltage waveform Versus created on the auxiliary side of the shunt converter transformers (yellow follow) superimposed with the essential voltage Vp (fuchsia) and the essential current Ip (cyan).




## 6. Conclusion

The paper presents a clever full 48-beat GTO voltage source converter of STATCOM and SSSC Realities gadgets. These full clear computerized models are approved for voltage adjustment receptive pay and progressively power stream control utilizing three novel decoupled current control techniques. The control procedures carry out 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 framework shakiness decreased influence because of a feeble interconnected ac framework.

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