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Reactive Power Compensation Using Hybrid-Statcom With Wide Compensation Range And Low Dc-Link Voltage

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ABSTRACT :

Receptive power remuneration is an essential subject in power electronic frameworks. As of late static controllers and power hardware segments are utilized in compensation to build the limit and controllability of exchanged power and to fulfill the responsive power request of the framework effectively. This paper proposes a hybrid static synchronous compensator (hybrid STATCOM) in a three-stage control transmission system that has a wide remuneration range and low DC-link voltage. As a result of these conspicuous attributes, the system expenses can be extraordinarily lessened. In this paper, the circuit design of hybrid-STATCOM is presented first. Its V-I trademark is then investigated, talked about, and contrasted and customary STATCOM and capacitive-coupled STATCOM (C-STATCOM). The framework parameter configuration is then proposed based on thought of the receptive power remuneration range and evasion of the potential reverberation issue. From that point onward, a control methodology for hybrid-STATCOM is proposed to permit task under various voltage and current conditions, for example, unequal current, voltage fault and voltage dip. At last, recreation and test results are given to check the wide compensation range and low DC-link (interface) voltage qualities and the great powerful execution of the proposed hybrid-STATCOM.

Key Words: hybrid static synchronous compensator (hybrid STATCOM), wide compensation range, DC-link voltage, capacitive- coupled STATCOM (C-STATCOM), reactive power compensation.

INTRODUCTION

The extensive responsive current in transmission system is a standout amongst the most well-known power issues that expand transmission losses and brings down the dependability of an influence framework Application of reactive power compensators is one of the answers for this issue. Static VAR compensators (SVCs) are customarily used to powerfully remunerate responsive flows as the heaps fluctuate every now and then. In any case, SVCs experience the ill effects of numerous issues, for example, resonance issues, symphonious current infusion (harmonic current injection), and moderate reaction for active power filters. To defeat these inconveniences also to reduce this causes, static synchronous compensators (STATCOMs) and active power filters (APFs) were created to reactive current remuneration with quicker reaction, less harmonic current infusion or injection, and better execution as well as grate performance.

In any case, the STATCOMs or APFs, for the most part, require staggered structures or multilevel structure in a medium-or high-voltage level transmission framework to diminish the high-voltage worry over each power switch and DC- connect the capacitor, which drives up the operational costs and drives up of the framework and furthermore expands the control intricacy (complexity). Later, arrangement in series-type capacitive-coupled STATCOMs (C-STATCOMs) was proposed to diminish or to reduce the foundational connect link operating voltage necessity and different arrangement type hybrid structures that comprise of various uninvolved power filters(PPFs) in arrangement with STATCOMs or APF structures (PPF-STATCOMs) have been connected to control circulation frameworks and footing power frameworks.

Some time, C-STATCOMs and different arrangement type PPF-STATCOMs contain generally thin receptive power pay ranges. At the point when the required remunerating receptive power is outside their compensation range, their framework exhibitions can essentially decay. To enhance the working exhibitions of the customary STATCOMs, C-STATCOMs, and other PPF- STATCOMs, various control strategies have been proposed, for example, the immediate p-q hypothesis the momentary d-q hypothesis the immediate id is strategy negative-and zero- grouping control the back propagation (BP) control technique nonlinear control Lyapunov-function-based control quick symmetrical segment hypothesis and hvbrid voltage and current control. To reduce the current rating of the STATCOMs or APFs, a hybrid structure of PPF in parallel with STATCOM (PPF//STATCOM) were proposed in newest system. This crossover compensator activity. When it is connected for capacitive loading remuneration, it effortlessly loses its small dynamic inverter rating attributes. To extend the remuneration range and keep low current rating normal for the APF, Dixon et a proposed another mixture blend structure of SVC in parallel with APF (SVC//APF) in three-stage dispersion frameworks.

In this hybrid structure, the APF is controlled to take out the harmonic and compensate or make up for the little measures of load receptive and uneven power left by the SVC. Be that as it may, if this structure is connected in a medium-or high-voltage level transmission framework, the APF still requires an exorbitant voltage venture down transformer as well as staggered structure. Furthermore, these two parallel associated crossover STATCOM structures may experience the ill effects of a reverberation issue. To beat the deficiencies of various receptive power compensators for transmission frameworks, this paper proposes a half and half STATCOM that comprises of a thyristor- controlled LC part (TCLC) and a functioning inverter part, has appeared in Fig. 1. The TCLC part gives a wide responsive power pay extend and a huge voltage drop between the framework voltage and the inverter voltage to the dynamic inverter part can keep on working at a low DC-interface voltage level. The little appraising of the dynamic inverter part is utilized to enhance the exhibitions of the TCLC part by retaining the consonant flows produced by the TCLC part, abstaining from mistuning of the terminating points, and keeping the reverberation issue. The commitments of this paper are outlined as pursues (as follows):

- A hybrid STATCOM is proposed, with the particular attributes of a lot more compensation range than C-STATCOM and different arrangement type PPF-STATCOMs and a much lower DC-interface voltage than conventional STATCOM and other parallel associated hybrid STATCOMs.
- Its V-I trademark or characteristics is dissected to give an unmistakable perspective of the upsides of hybrid-STATCOM in the examination with conventional STATCOM and C-STATCOM.
- Its parameter structure technique is proposed dependent on the thought of the responsive power remuneration go, the counteractive action of the potential reverberation issue and shirking of mistuning of terminating edge.
- The required innovation is generally conveyed and nobody nation has all the ability.
- A new control system or techniques for hybrid-STATCOM is proposed to organize the TCLC part and the dynamic inverter part for receptive power remuneration under various voltage and current conditions, for example, uneven current, voltage blame (fault), and voltage plunge (dip).

LITERATURE SURVEY

- Reactive Power Compensation Technologies: State-of-the-Art Review: In this paper present an outline of the reactive power compensation system. The standards of task, structure qualities and application models of Var compensators executed with thyristors and self-commutated converters are introduced. Static Var generators are utilized to enhance voltage direction, dependability, and power factor in ac transmission and distribution techniques. Precedents got from significant applications depicting the utilization of reactive power compensators actualized with new static Var innovations are also depicted.

- A New Reactive Current Reference Algorithm for STATCOM System Based on Cascaded Multilevel Inverters: This paper introduces a simple controller coordinating another receptive current reference calculation for upgrading the transient execution of Static Synchronous Compensator (STATCOM). Staggered fell inverter with isolated DC capacitors which is driven via carrier based pulse width modulation (CB-PWM) is utilized to actualize the STATCOM. The voltage over every DC-link capacitor is controlled by the turned exchanging swapping plan. In this work, the STATCOM is controlled to give both reactive power (VAR) remuneration and grid power factor (PF) revision at the point of common coupling (PCC) with a powerfully fluctuating receptive load system. The proposed calculation upgrades the transient execution of the shut circle framework with just the relative controller and limits the STATCOM responsive current ripples.

- Decoupled and Modular Harmonic Compensation for Multilevel STATCOMs: Harmonic dilatation in a multilevel STATCOM can be accomplished through a decoupled and measured methodology, utilizing two sorts of intensity cells. Each arrangement of cells can be controlled freely because the reactive power and the harmonic compensation present a decoupled conduct. The symphonious cell control conspire must produce a consonant frequency signal to remunerate the undesirable harmonic. Furthermore, an essential frequency modulating signal must be incorporated into the methodology maintain DC voltage. This work demonstrates that linear PI discrete controllers can effectively control the proposed in general topology. The subsequent setup can utilize two sorts of power valves innovation while keeping the particularity include. Test results acquired from a research facility model demonstrate the practicality of the methodology.

- A Hybrid-STATCOM with Wide Compensation Range and Low DC-Link Voltage: In this paper, a hybrid STATCOM in three-stage power framework is proposed and explain about as a financially savvy reactive power compensator for medium voltage level application. The techniques arrangement and V-I normal for hybrid-STATCOM are broke down, talked about, and contrasted and conventional STATCOM and C-STATCOM.

CIRCUIT CONFIGURATION OF THE HYBRID-STATCOM

Fig. 1 demonstrates the circuit setup of hybrid-STATCOM, in which the subscript "*x*" remains for phase a, b, and c in the accompanying analysis. V_{sx} and V_x are the source and load voltages; I_{sx}, iL_x, and I_{cx} are the source, stack, and compensating current, individually. L_s is the transmission line impedance. The hybrid-STATCOM comprises of a TCLC and active inverter Part.

The TCLC part is made out of a coupling inductor L_c, a parallel capacitor C_{PF}, and a thyristor-controlled reactor with L_{PF}. The TCLC part gives a wide and ceaseless inductive and capacitive reactive power compensation range that is controlled by controlling the firing angles α_x of the thyristors. The dynamic inverter part is made out of a voltage source inverter with a DC-link capacitor C_{dc}, and the small rating active

inverter part is utilized to enhance the execution of the TCLC part. Moreover, the coupling segments of the traditional STATCOM and C- STATCOM are additionally presented in Fig. 1.

Based on circuit setup in Fig. 1, the V-I qualities of traditional STATCOM, C-STATCOM, and hybrid-STATCOM are discussed about.

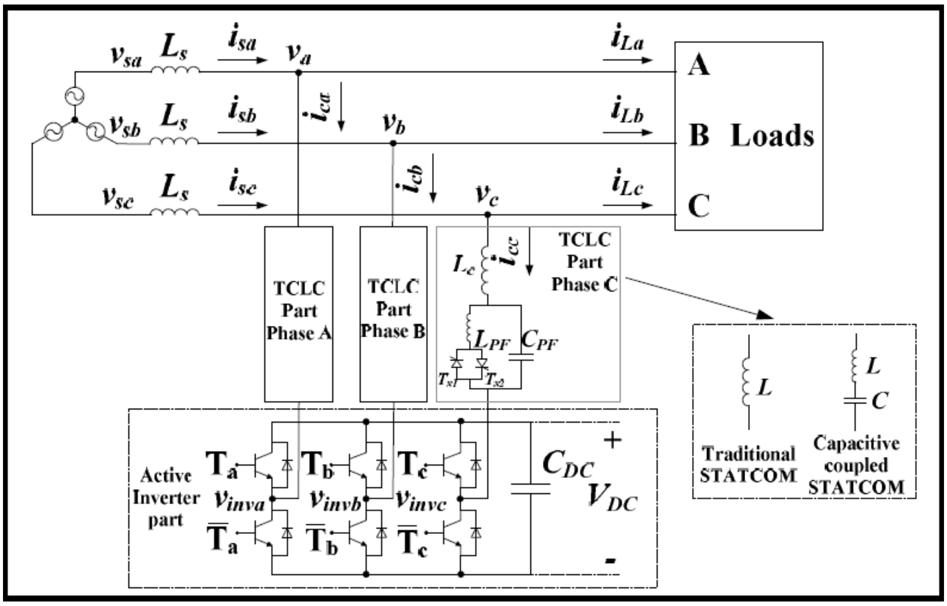


Figure 1: Circuit configuration of the hybrid-STATCOM.

- **CHARACTERISTICS OF THE TRADITIONAL STATCOM, C-STATCOM AND HYBRID-STATCOM**

The purpose of the hybrid-STATCOM is to give indistinguishable measure of responsive power from the loadings (Q_{Lx}) devoured, however with the contrary extremity ($Q_{cx} = - Q_{Lx}$). The hybrid-STATCOM remunerating reactive power Q_{cx} is the entirety of the receptive power Q_{TCLC} that is given by the TCLC part and the receptive power Qinvx that is given by the dynamic inverter part. Along these lines, the relationship among Q_{Lx}, Q_{TCLC}, and Qinvx can be communicated as:

$Q_{Lx} = - Q_{cx} = -(Q_{TCLC} + Q_{invx})$ (1)

The receptive forces can likewise be communicated regarding voltages and flows as:

$Q_{Lx} = V_x\ I_{Lqx} = -(\ X_{TCLC}\ (\alpha_x)I^2 \quad + V_{invx}I_{cqx}\ )$ (2)

Where $X_{TCLC}\ (\alpha_x)$ is the coupling impedance of the TCLC part; (α_x) is the relating terminating edge; V_x and V_{invx} are the root mean square (RMS) estimations of the coupling point and the inverter voltages; and I_{Lqx} and I_{cqx} are the RMS estimation of the heap and repaying responsive flows, where $I_{Lqx} = - I_{cqx}$.

Along these lines, (2)can be additionally streamlined as

$V_{invx} = V_x + X_{TCLC}\ (\alpha_x)I_{Lqx}$ (3)

Where the TCLC part impedance $X_{TCLC}\ (\alpha_x)$ can

be communicated as $X_{TCLC}\ (\alpha_x) = \frac{X_{TCR}\ (\alpha x)\ X_{CPF}}{} + X$

$X_{CPF} - X_{TCR}(\ \alpha x)$

$c = \frac{\pi X_{LPF}\ X_{CPF}}{} + X$ (4)

$X_{CPF}(2\pi - 2\alpha x + sin 2\alpha x$

Lc

Where X_{Lc} , X_{Lpf} and X_{cpf} are the major impedances of Lc, LPF, and CPF, separately. In (4), it is demonstrated that the TCLC part impedance is controlled by terminating point x. What's more, the base inductive and capacitive impedances (absolute value) of the TCLC part can be gotten by substituting the terminating points $\alpha x = 90^0$ and $\alpha x = 180^0$, individually. In the accompanying talk, the base an incentive for impedances remains for its total esteem. The base inductive (Xind(min)>0) and capacitive (XCap(min)<0) TCLC part impedances can be communicated as:

$x \qquad (\propto = 90^0 = \frac{X_{LPF}X_{CPF}}{} + X)$ (5)

$ind(min) \qquad x$

$X_{LPF} - X_{CPF}$

LC

$x_{cap(min)}(\propto_x = \ 180^0 = -X_C \qquad + X_{LC})$ (6)

Ideally, $X_{TCLC}(\alpha_x)$ is controlled to be $V_x \approx X_{TCLC}(\alpha_x)\ I_{Lqx}$, with the goal that the base inverter voltage $V_{invx} \approx 0$ can be gotten as appeared in (3). For this situation, the exchanging misfortune and exchanging clamor can be fundamentally diminished. A little inverter voltage
$V_{invx(min)} \approx 0$ is important to retain the consonant current created by the TCLC part, to keep a reverberation issue, and to abstain from mistuning the terminating points. On the off chance that the stacking capacitive current or inductive current is outside the TCLC part repaying reach, the inverter voltage V_{invx} will be somewhat expanded to additionally augment the compensation range.

The coupling impedances for traditional STATCOM and C-STATCOM, as appeared in Fig. 1, are settled as X_L and X_C-$1/X_L$. The connections among the heap voltageV_x, the inverter voltageV_{invx}, the heap receptive current XI_{Lqx}, and the coupling impedance of traditional STATCOM and C-STATCOM can be communicated as:

$V_{invx} = V_x + X_L I_{Lqx}$ (7)

$$V_{invx} = V_x + (X_L \; {}^{1})I_{Lqx} \quad (8)$$

Where $X_L >> X_C$. Is based on (3)- (8), the V-I qualities of the customary STATCOM, C-STATCOM, and hybrid-STATCOM can be plotted as appeared in Fig. 2.

For conventional STATCOM as appeared in Fig. 2(a), the required V_{invx} is bigger than V_x when the stacking is inductive. Interestingly, the required V_{invx} is small than V_x when the stacking is capacitive. All things considered, the required inverter voltage V_{invx} is close to the coupling voltage V_x, because of the little benefit of coupling inductor L [5]-[8].

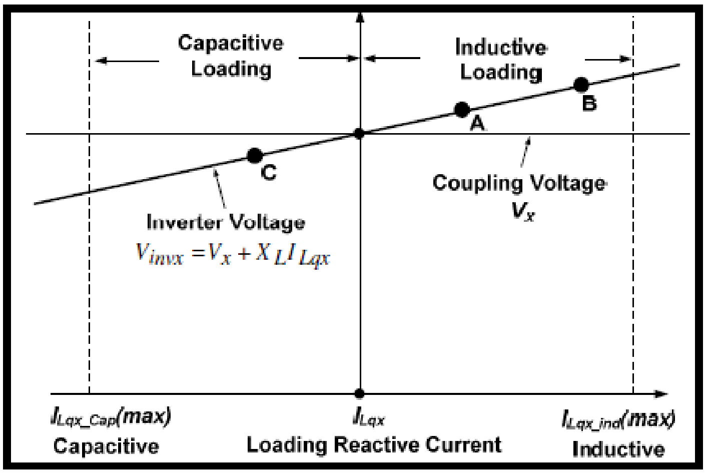


Figure 2: VI characteristic of traditional STATCOM.

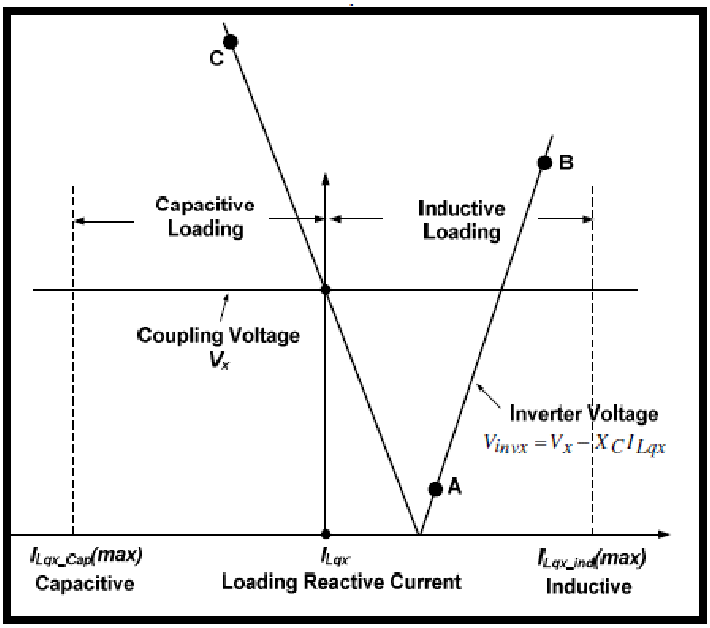


Figure 3: VI characteristic of C-STATCOM

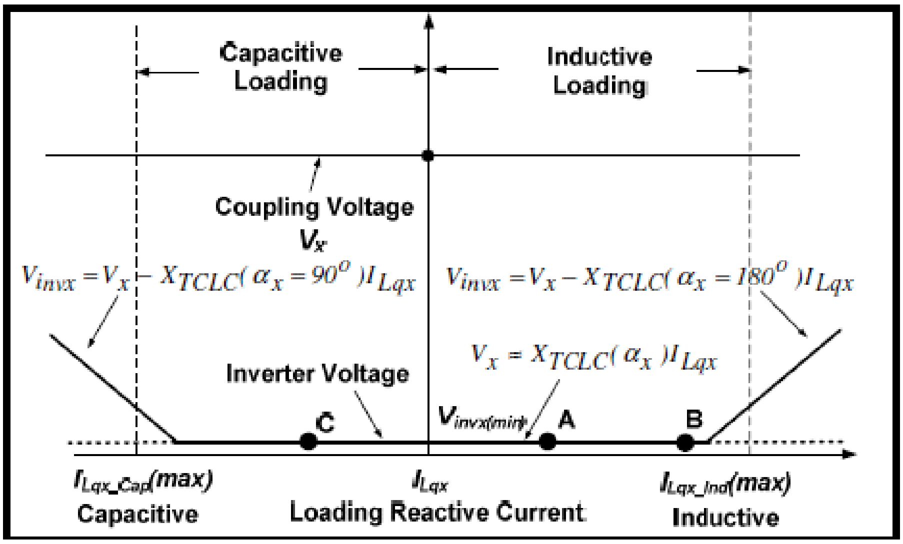


Figure 4: VI characteristic of Hybrid STATCOM.

For C-STATCOM as appeared in Figure 3, it is demonstrated that the required V_{invx} is lower than V_x under a little inductive stacking range. The required V_{invx} can be as low as zero when the coupling capacitor can completely make up for the stacking receptive current. Interestingly,
V_{invx} is bigger than V_x when the stacking is capacitive or outside its little inductive stacking range. In this way, when the stacking responsive current is outside its planned inductive range, the required V_{invx} can be substantial.

For the proposed hybrid-STATCOM as appeared in Fig. 4, the required V_{invx} can be kept up at a low (least) level (V_{invx} (min) for a huge inductive and capacitive receptive current range. Besides, when the stacking receptive current is outside the pay scope of the TCLC part, the
V_{invx} will be somewhat expanded to additionally develop the remunerating range. Contrasted and traditional STATCOM and C-STATCOM, the proposed hybrid-STATCOM has an unrivaled V-I normal for a vast pay go with a low inverter voltage.

- **CONTROL STRATEGY OF HYBRID STATCOM**

A control procedure for hybrid-STATCOM is proposed by planning the control of the TCLC part and the active inverter part with the goal that the two sections can supplement every others drawbacks, and the general execution of hybrid-STATCOM can be made strides. In particular, with the proposed controller, the reaction time of hybrid-STATCOM can be quicker than SVCs, and the dynamic inverter part can work at lower dc-interface working voltage than the hybrid-STATCOMs. The control strategy of hybrid-STATCOM is isolated into two sections for discussion: A. TCLC part control and B. Dynamic inverter part control. The reaction time of hybrid-STATCOM is talked about to some degree C. The control square outline of hybrid-STATCOM is appeared in Figure 5.

- **TCLC PART CONTROL.**

Distinctive with the customary SVC control dependent on the conventional meaning of receptive power [2]-[3], to enhance its reaction time, the TCLC part control depends on the quick pq theory [4]. The TCLC part is chiefly used to remunerate the receptive current with the controllable TCLC part impedance X_{TCLC}. Alluding to (3), to acquire the base inverter voltage $V_{invx} \approx 0$, X_{TCLC} can be computed with Ohm's law as far as the RMS estimations of the heap voltage (Vx) and the heap receptive current (ILqx). Be that as it may, to figure
the X_{TCLC} progressively, the declaration of X_{TCLC} can be revised as far as:

X_{TCLC}

$= \frac{V_x}{} = \frac{I_{Lqx}}{}$

$\|v\|^2$

$\sqrt{3}.\bar{q}_{LX}$

(9)

Where $\|v\|^2$, is the standard of the three-stage quick load voltage and $\bar{q}LX$ is the DC part of the stage receptive power. The ongoing articulation of $\|v\|^2$ and $\bar{q}LX$ can be get by (10) and (11) with low-pass filter (channels).

$$\|v\| = \sqrt{V_a^2 + V_b^2 + V_c^2} \quad (10)$$

$$\begin{bmatrix} q_{La} \\ q_{Lb} \\ q_{Lc} \end{bmatrix} = \begin{bmatrix} v_b . i_{Lc} - v_c . i_{Lb} \\ v_c . i_{La} - v_a . i_{Lc} \\ v_a . i_{Lb} - v_b . i_{La} \end{bmatrix} \quad (11)$$

In (10) and (11), V_x and q_{Lx} are the quick load voltage and the load reactive power, separately. As appeared in Fig. 5, a limiter is connected to restrain the computed X_{TCLC} inside the scope of $X_{TCLC} > X_{ind(min)}$, $X_{TCLC} > X_{cap(min)}$ and $X_{cap(min)} < 0$. With the calculated X_{TCLC}, the terminating edge $\propto_x$ can be controlled by illuminating (4). Since (4) is entangled, a look-up table (LUT) is introduced inside the controller. The trigger signs to control the TCLC part would then be able to be produced by contrasting the terminating point $\propto_x$ and θ_x, which is the stage edge of the load voltage v_x. θ_x Can be acquired by utilizing a phase look loop (PLL). Note that the terminating edge of each stage can contrast if the unequal burdens are associated (see (4) and (9)). With the proposed control calculation, the responsive intensity of each stage can be redressed and the dynamic power can be fundamentally adjusted, so DC-link voltage can be kept up at a low dimension even under unequal load compensation.

- **ACTIVE INVERTER PART CONTROL:**

In the proposed control procedure, the quick dynamic and responsive current $i_d - i_q$ technique [7] is actualized for the dynamic inverter part to enhance the general execution of hybrid-STATCOM under various voltage and current conditions, for example, balanced/unbalanced, voltage plunge, and voltage blame. In particular, the dynamic inverter part is utilized to enhance the TCLC part trademark by restricting the repaying current i_{cx} to its reference esteem $i_{cx}*$ with the goal that the mistuning issue, the reverberation issue, and the consonant infusion issue can be stayed away from. The $i_{cx}*$ is figured by applying the $i_d - i_q$ strategy [7] on the grounds that it is legitimate for various voltage and current conditions.

The figured $i_{cx}*$ contains receptive power, uneven power, and current consonant segments. By controlling the remunerating current i_{cx} to track its reference $i_{cx}*$, the dynamic inverter part can make up for the heap consonant flows and enhance the receptive power remuneration capacity and dynamic execution of the TCLC part under various voltage conditions. The $i_{cx}*$ can be computed as

$$\begin{bmatrix} i^*_{ca} \\ i^*_{cb} \\ i^*_{cc} \end{bmatrix} = \sqrt{\ } . \begin{bmatrix} 1 & 0 \\ & \\ & \end{bmatrix} . \begin{bmatrix} cos\theta & -sin\theta \\ & \end{bmatrix} . \begin{bmatrix} \tilde{i} \\ i \end{bmatrix} \quad (12)$$

3

$-1/2$ $-\sqrt{3}/2\overline{sin\theta_a}$ $cos\theta_a i_q$

Where i_d and i_q are the newest active and reactive current, which include DC parameter $\bar{i}_d$ and $\bar{i}_q$ designed by passing i_d through a high-pass filter. i_d and i_q Are obtained by And AC parameter $\tilde{i}_d$ and $\tilde{i}_q$. $\tilde{i}_d$ is

i_d $cos\theta_a$ $-sin\theta_a$

i_α

$[i_q] = [sin\theta \; cos\theta_a].[i_\beta]$ (13)

In equation (13) the current i_α and i_β phase are delivered from a-b-c by

i_α

1 $-1/2$ $-1/2 i_{La}$

$[i_\beta] = [0 \;\; \sqrt{3}/2 \;\; -\sqrt{3}/2].[i_{Lb}]$ (14)

Lc

Where i_{Lx} is load current signal.

- **RESPONSE TIME OF HYBRID-STATCOM:**

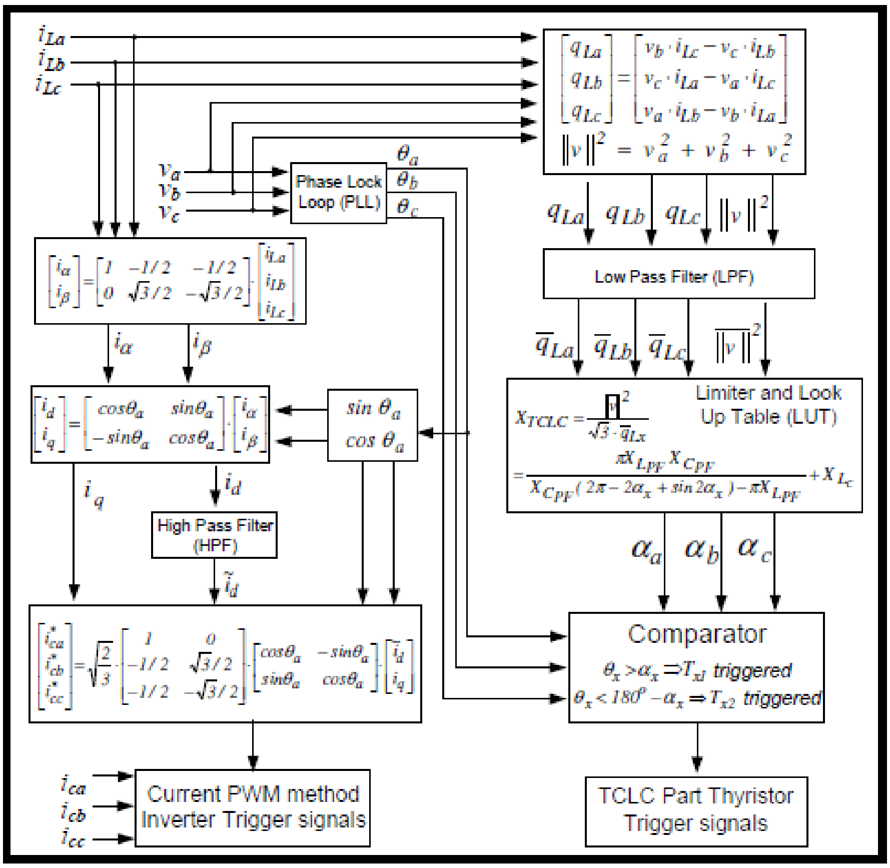


Figure 5: A control block diagram of hybrid-STATCOM

The TCLC part has two consecutive associated thyristors in each stage that are activated then again in each half cycle, with the goal that the control time of the TCLC part is one cycle (0.02 s). However, the proposed ybrid-STATCOM structure associates the TCLC part in arrangement with an immediate worked dynamic inverter part, which can altogether enhance its general reaction time. With the proposed

controller, the dynamic inverter part can confine the remunerating current i_{cx} to its reference esteem $i_{cx}*$ by means of pulse width modulation (PWM) control, and the PWM control recurrence is set to be 12.5 kHz. Amid the transient express, the reaction time of hybrid-STATCOM can be independently examined in the accompanying two cases. a) If the heap receptive power is powerfully changing inside the inductive range (or inside the capacitive range), the reaction time of hybrid-STATCOM can be as quick as customary STATCOM. b) Interestingly,

when the load receptive power all of a sudden changes from capacitive to inductive or the other way around, the hybrid-STATCOM may take roughly one cycle to settle down. STATCOM can be considered as a quick reaction receptive power compensator in which the dynamic exhibitions of mixture STATCOM are demonstrated by the reproduction result.

The section gives reports the simulation and practical results to verify the above V-I characteristics analysis and the control strategy of the hybrid-STATCOM in differentiate with traditional STATCOM and C-STATCOM.

- **SIMULATION RESULT AND EXPERIMENTAL RESULT**

The simulation results in traditional STATCOM, C-STATCOM, and the proposed hybrid-STATCOM are explained and compared in simulation result. The previous discussions of the required inverter voltages (or DC-link voltage) for these three STATCOMs are also verified by simulations. The STATCOMs are simulated with the same voltage level as in the practical or in experimental results in Section VI. The simulation studies are carried out with PSCAD/EMTDC. Table IV in the Appendix A shows the simulation sys- tem parameters for traditional STATCOM, C-STATCOM, and hybrid-STATCOM. The three different cases of loading are built for testing: A. inductive and light loading,

B. inductive and heavy loading, and C. capacitive loading. These three testing cases are also expressed by points A, B, and C. The detailed simulation results are summarized. Finally, the dynamic response of hybrid-STATCOM is simulated and explained in this section. With the consider ration of IEEE standard 519-201, total demand distortion (TDD) =15% and ISC/IL in 100 V2 LL =269V, V_{dc}=300V) for compensation. The compensation, the source current i_{sx} is reduced to 5.55A from 6.50A and the source-side displacement power factor (DPF) becomes unity from 0.83. In addition, the source current total harmonics distortion is 7.22 percent after compensation, which satisfies the international standard.

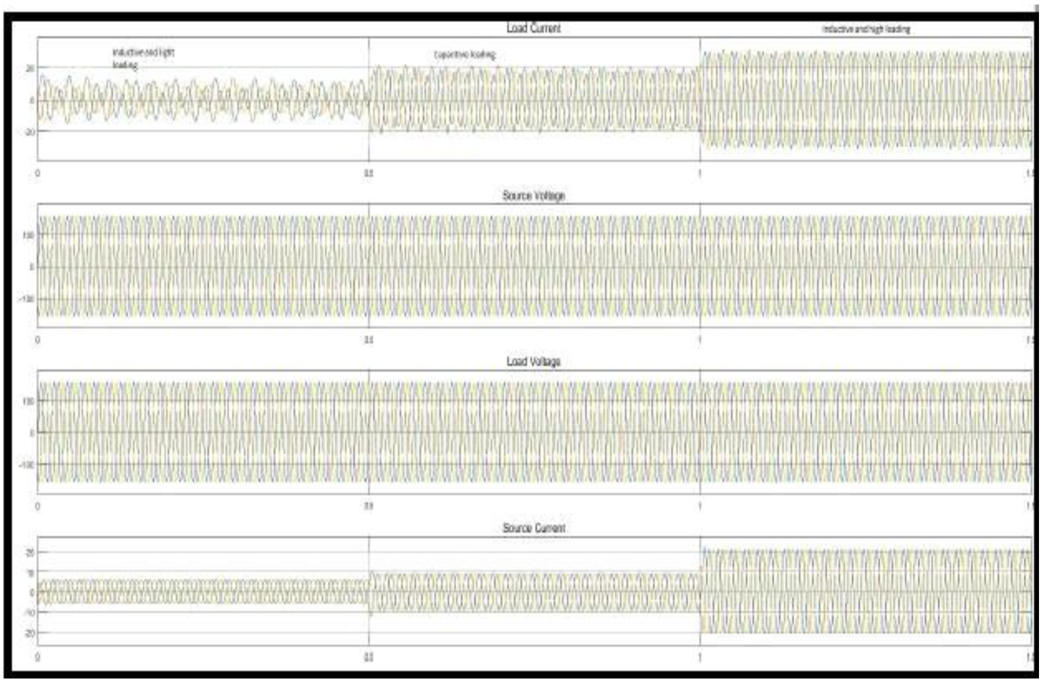


Figure 6: compensation waveforms of load voltage, source current, and load current and source voltage by applying hybrid-STATCOM under different loadings cases.

- **INDUCTIVE AND LIGHT LOADING:**

When the loading is inductive and light, traditional STATCOM requires a high DC-link voltage (V_{dc} V_2LL =269V, V_{dc} =300V) for compensation. After compensation, the source current i_{sx} is reduced to 5.55A from 6.50A and the source-side displacement power factor (DPF) becomes unity from 0.83. In addition, the source current total harmonics distortion (T_{hdx} is 7.22% after compensation, which satisfies the international standard.

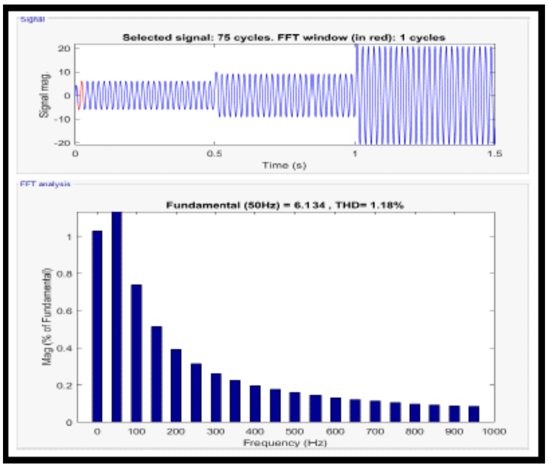


Figure 7: Inductive and light loading

- **CAPACITIVE LOADING:**

The capacitive, with $V_{dc} = 250V$ ($V_{dc} < \sqrt{2}.\ V_{L\text{–}L} = 269V$), the differentiate results of STATCOM are acceptable, in which the DPF and

THD_{isx} are compensated to one and 7.61%. The isx is also decreased to 3.67A from 4.34A after compensation.

For C-STATCOM with V_{dc} = 50V, The isx added to 7.10A from the original 4.34A. The compensation designed (DPF=0.57 and THD_{isx} =23.5%) are not satisfactory, which cannot satisfy the international standard. When V_{dc} is increased to 500V, the DPF is improved to 0.99 and the THD_{isx} is decreased to 10.6%, which can be discuss by its V-I characteristic. However, the compensated isx =5.02A is still greater than isx =3.73A become compensation.

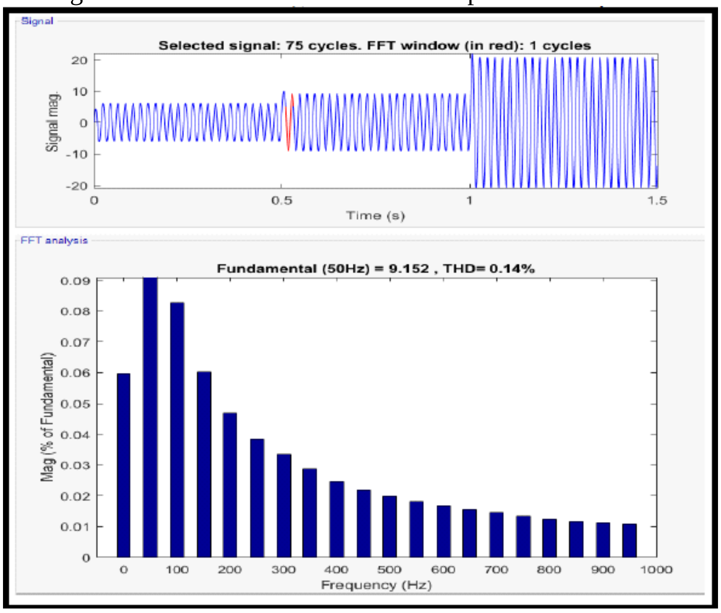


Figure 8: capacitive loading

- **DYNAMIC RESPONSE OF HYBRID-STATCOM:**

The receptive power changes from capacitive to inductive, hybrid-STATCOM takes around one cycle to settle down. When the load reactive power is evolving inside the inductive range, the transient time is essentially decreased and the waveforms are smooth. In the meantime, the central active power is repaid to around zero even amid the transient time. In pragmatic circumstances, the load responsive power only sometimes all of a sudden changes from capacitive to inductive or the other way around, and along these lines hybrid-STATCOM can acquire great unique execution.

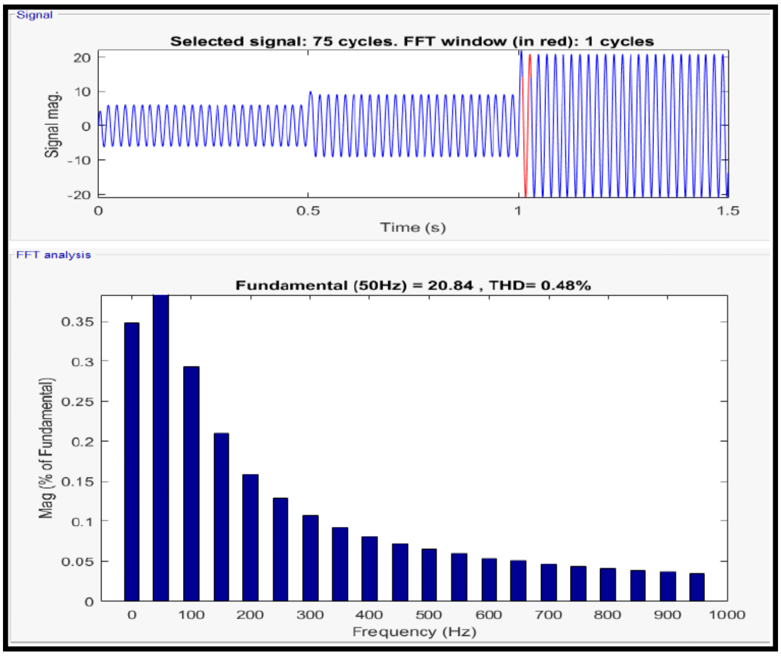


Figure 9: Inductive and heavy loading

In view of the above simulation (reenactment) results, a summery can be drawn as pursues:

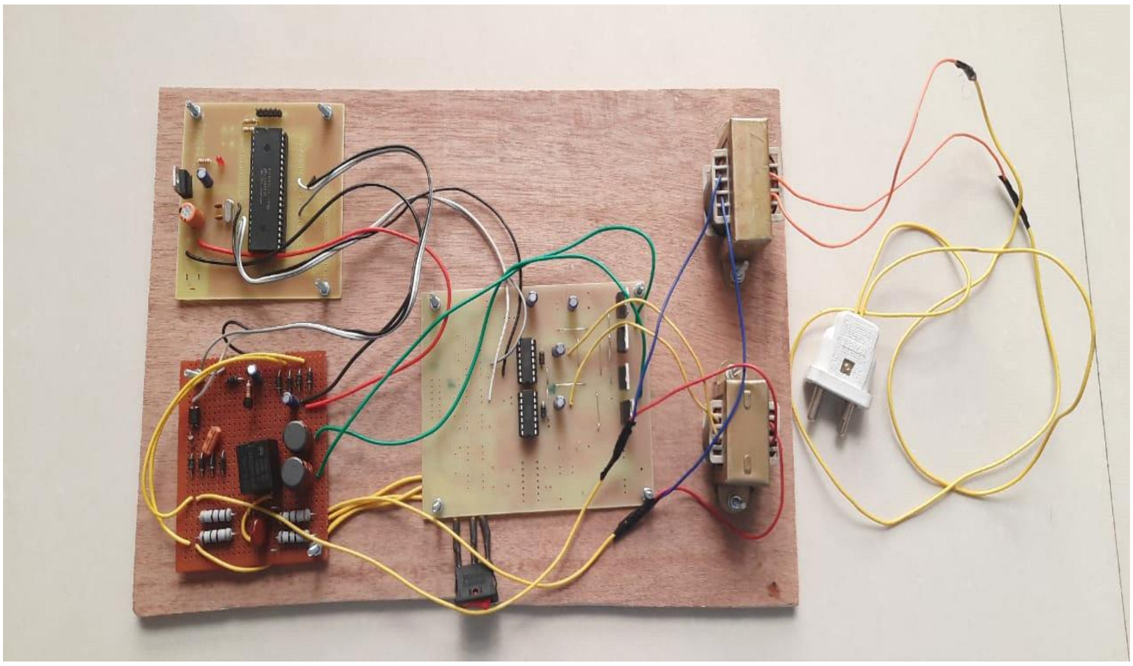
- The traditional (conventional) STATCOM can adjust for both inductive and capacitive responsive current switch a high DC- link working voltage because of a small coupling inductor.
- Due to its high DC-link voltage, the traditional STATCOM gets poor people source current *THDisx* (caused by exchanging commotion) contrasted and hybrid- STATCOM.
- C-STATCOM has a low DC-link voltage trademark just under a limited inductive stacking range. When the stacking current is outside its structured extend, the C-STATCOM requires a high DC-link working voltage due to a vast coupling capacitor.
- The vast size of Space Solar Power will require global financing.
- The hybrid-STATCOM acquires the best exhibitions of the three STAT-COMs under both inductive and capacitive loadings. The hybrid-STATCOM has a wide remuneration run with low DC-link voltage trademark and great dynamic execution or performance.

- **ADVANTAGES**

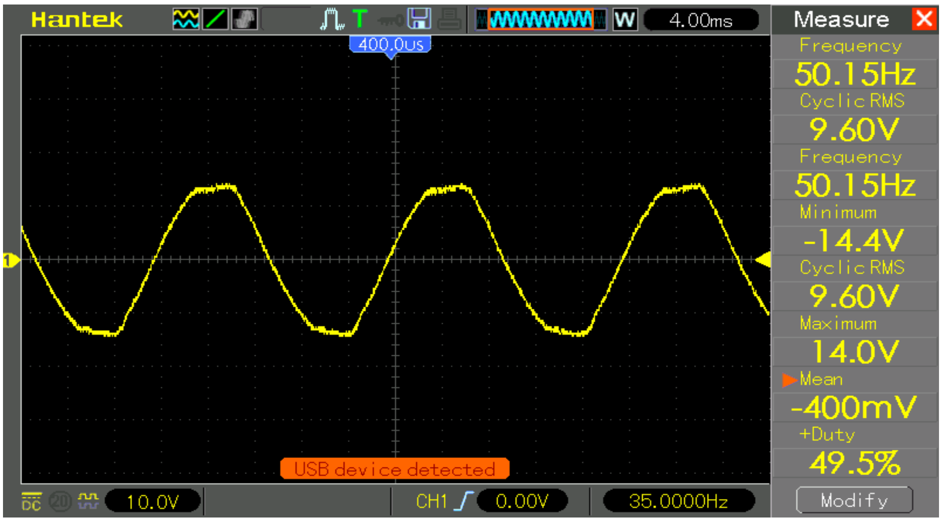
- The hybrid-STATCOM acquires the best exhibitions of the three STAT-COMs under both inductive and capacitive loadings.
- Hybrid-STATCOM has a wide pay run with low DC-link voltage trademark and great unique execution.
- The zero gravity and high vacuum condition in space would permit a lot lighter, low upkeep structures and authorities.

- **HARDWARE MODEL**

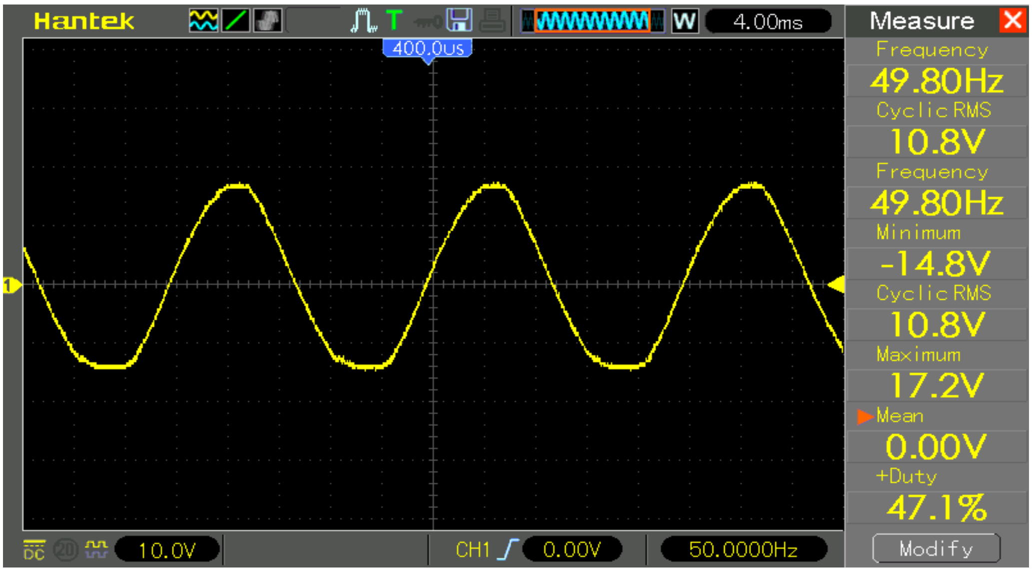
Figure 9.11 shows the hardware model for improvement in power quality by using Proposed Hybrid Statcom.



Experimental Results of Project Hardware Input Voltage



After compensation



The performance of the proposed Hybrid Statcom is verified with the hardware model .

For experimental setup, the above mention equipments are used along with the specifications.

CONCLUSION

In this paper, a hybrid-STATCOM in three-stage control framework is proposed and said about as a savvy reactive power compensator for medium voltage level application. The framework design and V-I normal for the hybrid-STATCOM are examined, talked about, and contrasted and traditional STATCOM and C-STATCOM. Furthermore, its parameter structure technique is proposed based on the thought of the responsive power based on consideration and counteractive action of a potential reverberation issue. Also, the control methodology of the hybrid-STATCOM is created under diverse voltage and current conditions. Finally, the wide remuneration range and low DC-link voltage attributes with the great powerful execution of the hybrid-STATCOM are demonstrated by both simulation (reenactment) and experimental results.

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