

Designing and Simulation of Multilevel STATCOM on Cascaded Topology

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Abstract - This paper presents a simple technique to represent investigation of power system for compensation of reactive power with the help of cascaded H-bridge inverter. Whenever we consider any system which is used to calculate the instantaneous reactive power a control methodology has to be designed for such type of the system. To control the multilevel inverter, the selected switching techniques play an important role for this. The simulation result of MATLAB/Simulink has been proposed to verify such model. The STATCOM is one of the facts devices which very well represent the cascaded multilevel strategy. We have to use PWM for STATCOM for active power filter and for enhancing transient stability

Index Terms, MULTILEVEL INVERTER, PWM, STATCOM

I. INTRODUCTION

Since the use of power sources increases day by day demand for the low cost the energy also inverters as far the load increases the devices are more prove to the fluctuation which causes a high change in the state. The STATCOM using voltage source inverters has been accepted as a competitive alternative to the conventional static VAR's using thyristor-controlled reactors. By handling and controlling the reactive power, a STATCOM can stabilize the power system, the interaction while lies between the AC system voltage and the inverter composed voltage provides the control. When two voltage are synchronized with each other the active as well as the reactive power are zero. The main objective of this converter is to provide an AC output waveform for DC power supply. A bidirectional current conducting switch may also be used for enhanced flexibility and functional improvements. There are various converter configurations available for both single and three phase applications:-The single phase half bridge is a one-leg converter consisting of two switching elements. The H- bridge VSC is most popular for single phase applications because with the same DC input voltage the output of the full bridge is twice that of the half bridge. Numerous mechanical applications have started to require high power as of late. Some machines in the ventures anyway require medium or high power for their activity. Utilizing a powerful hotspot for every single mechanical load may end up being valuable to a few engines requiring high power while it might harm alternate burdens. Inverters are utilized for some applications, as in circumstances where low voltage DC sources must be changed over with the goal that gadgets can keep running off of AC control. The staggered inverter has been presented since 1975 as an option in high power and medium voltage situations. The staggered inverter resembles an inverter and it is utilized for modern applications as an option in high power and medium voltage circumstances. The staggered inverter comprises of a few switches. In the staggered inverter the gate plan switches edges are critical. Multilevel inverter goes up to high exchanging voltage by methods for a progression of voltage steps, every one of which is rely upon the rating of intensity gadgets separately. For staggered inverter, a few topologies are ordered in two gatherings relying upon the quantity of autonomous dc source. The most well known working topologies are diode clipped (NPC), flying capacitor (FC) and course H- connect (CHB). A NPC inverter is fundamentally made out of two ordinary two-level voltage source inverter stacked over the other with some minor adjustments. The FC topology is some path like the NPC with contrast that the clamping diodes are supplanted by flying capacitors. CHBs inverters are characterized by arrangement association of at least two single-stage H- connect inverters. Basic exchanging recurrence and high exchanging recurrence PWM strategies are utilized to work the staggered inverters. It has bring down exchanging misfortune and higher productivity. In the CHB MLI, each dimension requires a different dc source and for every dc source a PV cell or battery is to be associated. The thyristor-controlled reactor (TCR), thyristor exchanged capacitors (TSC), static compensator (STATCOM), static VAR compensators (SVR), static synchronous arrangement compensators (SSSC). Static synchronous compensator is a solid responsive power controller contrasted with customary VAR compensators. Multilevel inverter innovation has risen as of late as an essential option in the territory of high-control medium- voltage vitality control. Staggered converters present numerous favorable circumstances when contrasted and traditional two-level converters, for example, ability to work in high-voltage levels, littler semiconductors gadgets and higher number of voltage levels in the yield voltage. Also, staggered topology likewise displays a lower complete symphonious bending (THD) and permits a decrease of exchanging recurrence [4,5]. Consequently, the utilization of staggered topologies joined with power quality conditioners, for example, Static Synchronous Compensator (STATCOM) [5,6], can enhance control quality and effectiveness in appropriation frameworks [7]. A few staggered topologies have been accounted for in the most recent decade [8,9]. The Neutral Point Clamped Converter (NPC) is the most develop innovation among all accessible staggered topologies. There are two converter topologies that may contend with the NPC:

the Flying Capacitor Converter (FC), and the Symmetric or Asymmetric Cascade H Bridge Converter (CHB) there are a considerable amount of adjustment strategies, however portion move adjustment has utilized in this paper. CHB inverters may likewise extend the number of yield voltage arranges easily with the guide of developing the amount of H-spans cells. This paper gives a STATCOM a PI controller focused eleven stage CHB staggered inverter for the present consonant, voltage glint and receptive force alleviation of the nonlinear load.

II. MULTILEVEL INVERTER TOPOLOGIES

There are various multilevel inverter topology that has been incorporated with DSTATCOM for energy requirements. These are

(a) Diode clamped multilevel inverter (b) Flying capacitors multilevel inverters (c) Cascaded H bridge multilevel inverter.

The table below shows the comparison of all three multilevel inverters and why we have used the cascaded H-bridge inverter only. This comparison is based on the voltages on each stage, number of output levels and number of switches.

The STATCOM can be utilized in various power levels relying upon the applications. There are fundamentally three-primary regions for the STATCOM application on the premise of various power levels as To actualize the STATCOMs at medium and high power level, high power converter is required that much of the time surpasses the power taking care of ability of a straightforward two dimension converter without 2 Multilevel Converter Topologies for STATCOMs device arrangement/parallel association. Ordinarily, for such high power applications and for boosting up the DC transport voltage past the voltage rating of an individual switch, the two dimension converter needs to utilize arrangement associated gadgets. So also, for this situation, the arrangement associated low appraising gadgets go about as a solitary switch like one of the switches appeared in Fig. 2.1. Nonetheless, because of the diverse dispersing times of semiconductor gadgets, the accompanying issues must be all around considered so as to maintain a strategic distance from voltage-sharing issues among the switches. The electrical and warm qualities of the semiconductor gadgets in a similar change should be matched. The synchronization of the exchanging is extremely troublesome and may result in voltage unbalance between the gadgets. Extra consideration is required for the killing procedure of the switch, just as for its entryway flows. Because of these restrictions, power dissemination amid conduction and exchanging is with the end goal that the exchanging recurrence is seriously constrained. This causes a moderate framework reaction and massive yield channel circuits. Expansive snubber circuit parameters are additionally required to remunerate transient voltage unbalance and to accomplish static voltage adjusting. It might likewise prompt all the more exchanging misfortunes and moderately longer exchanging time. In spite of the fact that the blocking voltage of the switch in the two-level converter is expanded, a stage up transformer is as yet required for coupling to the transmission systems. In addition, additional endeavors are expected to coordinate the symphonious models at the two-level converter outputs Another conceivable method for accomplishing such high power necessity is to utilize attractive transformer coupled multi-beat converters [5]. Customary attractive coupled multi-beat converters regularly orchestrate the staircase voltage wave by changing transformer turns proportion with convoluted crisscross associations. For instance, a regular 48-beat converter comprises of eight 6-beat converters associated together through eight crisscross game plan transformers utilizing the symphonious crossing out system, or associated through Wye/Delta and Delta/Delta association transformers and utilizing modern control plans, so as to decrease symphonious twisting and to achieve high voltage. The patent of Unified Power Flow Controller (UPFC) [13] demonstrates that the shunt-side and the arrangement side of the UPFC are based on eight, 2-level, three-stage connects VSCs. A powerful converter course of action is at that point accomplished by combining the voltage waveform utilizing entangled crisscross transformer associations with guarantee that the Total Harmonic Distortion (THD) guidelines are at long last met. In 1995, the first ± 100 MVA STATCOM was introduced at the Sullivan substation of Tennessee Valley Authority (TVA) in northeastern Tennessee [14]. This unit is basically used to control 161 kV transport amid the everyday stack cycle to lessen the activity of the tap changer of a 1.2 GVA-161 kV/500 kV transformer. Its 48-beat power converter comprises of eight two-level VSCs with complex-interface attractive circuits. Since this is a two-level VSC, an arrangement association of five of door kill (GTO) thyristors is utilized as a principle switch. The control conspire utilized in this STATCOM is a 60 Hz staircase. Due to the moderate exchanging rate of the GTOs, the terminating points of the yield waveform are settled; along these lines, the plentifulness of each yield waveform is constrained by trading dynamic intensity of the DC-interface capacitor with the power lattice. Since it started working, a few feeble purposes of the TVA-STATCOM framework have been brought up A portion of these powerless focuses were because of the utilization of arrangement associated exchanging gadgets as talked about above. Taking input from the encounters of this installation, in the AEP UPFC establishment, Inez region, eastern Kentucky, USA, the VSCs were intended to make utilization of three-level design rather than a two dimension utilized prior in

the TVA STATCOM venture. Be that as it may, this structure still utilized the multi-beat course of action. The confinements with this multi- heartbeat game plan with attractive transformer coupling strategy are:

- (i) They are pricey,
- (ii) Create around 50 % of the complete misfortunes of the framework,
- (iii) involve up to 40 % of the all-out framework's land, (iv) cause troubles in charge because of DC polarizing what's more, flood overvoltage issues coming about because of immersion of the transformers in transient states and
- (v) Are inclined to disappointment. In this manner, the capacitor voltage union technique is liked to attractive coupling strategy for accomplishing higher rating converters. An alluring option in contrast to the above talked about topologies and latest improvement in the field of high power converters is the staggered converter.

III. CASCADED H-BRIDGE MULTILEVEL INVERTER:

Below a DC power source is converted to an H-bridge inverter. These inverter has no of switches numbering that it can has four switches. These four switches can produce different combinations. In connection to it each phase of the cascaded inverter which require that it should transfer the power. The cascading means connecting inverter in series or in parallel. The salient features of the multilevel state cascaded inverter is that (a)It can work at very low distortion that means with great output voltage.(b)It can be able to draw the input current with very low total harmonic distortion.(c)They can operate at a very high frequency. To design the cascaded H-bridge we have IGBT/DIODE has been used as a power semiconductor switches in each H-bridge network.

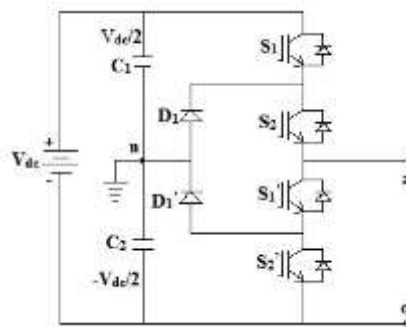


Fig 1 Cascaded h-bridge multilevel inverter

There are numerous routes in which electric power can be of low quality and some more reasons for such low quality power. With the expanding utilizations of nonlinear and electronically exchanged gadgets in dissemination frameworks and enterprises, Power quality (PQ) issues, for example, music, gleam, and irregularity have turned out to be not kidding concerns. Likewise Lighting strikes on transmission lines, exchanging of capacitor banks, and different system flaws can likewise cause PQ issues, for example, homeless people, voltage droop and interference Voltage- source converter (VSC)-based custom power (CP) gadgets are progressively being utilized in custom power applications to relieve these PQ issues in power dispersion frameworks. A shunt converter (otherwise called the shunt dynamic channel) can make up for contortion and unbalance in a heap with the goal that a reasonable sinusoidal current moves through the feeder. An arrangement converter (otherwise called the dynamic voltage) can make up for voltage list and twisting in the supply side voltage with the goal that the voltage over a touchy load is superbly regulated. Control procedures assume a fundamental job in the general execution of the power conditioner. Momentary power hypothesis is commonly wanted to create reference signals for the shunt converter. An expanded strategy dependent on momentary responsive power hypothesis in a pivoting reference outline is utilized to smother the music and to address the power factor in. Fluffy rationale is used to control the pay flows of the shunt converter

IV. METHODOLOGY:-

STATCOM is a regulating device used on alternating current electricity transmission network. It is based on a power electronics voltage source converter and can act as either a source of sink of reactive AC power to an electricity network. If connected to a source of power it can also provide active AC power. It is a member of the FACTS family of devices and the standard configuration of STATCOM is shown in figure 1 and standard configuration and schematic diagram of DVR is shown

in fig 2 and 3 respectively. One of the main reasons for installing an SVC or STATCOM in transmission networks is to increase the power transfer capability where limited by post-contingency voltage criteria or under voltage loss of load probability. Determining the optimum mix of dynamic and switched compensation is a challenge. Control systems are designed to keep the normal operating point within the middle of the SVC or STATCOM dynamic range. The voltage-sourced inverter (VSC) is the basic electronic part of a STATCOM, which the dc voltage into a frequency, and the phase. There are different methods to realize a voltage-sourced converter for power utility application. Based on harmonics and loss considerations, pulse width modulation (PWM) or multiple converters are used. Inherently, STATCOMs have symmetrical rating with respect to inductive and capacitive reactive power for asymmetric rating. Balance method decides the exchanging capacity of a converter. The tweak strategy must ensure that the produced voltage at the yield of the converter is like the desired voltage however much as could reasonably be expected. The test is to stretch out conventional tweak strategies to the staggered case, where the vast number of cells gives distinctive choices to regulate the converter. Every regulation methodology centers around the improvement of some converter highlights for example, exchanging misfortune decrease, uniform exchanging misfortune dispersion, enhancing consonant exhibitions, normal mode voltage minimization, least computational expense, and so on. The most widely recognized tweak systems for staggered converters. The principal exchanging modulators, give an exchanging capacity with the end goal that every cell has just a single compensation for every central cycle. The exchanging capacity with multicarrier PWM are decided dependent on examination among transporters and a reference flag. Cross breed PWM is a blend of crucial and transporter based tweak. Space Vector Modulation (SVM) considers all the conceivable exchanging states and select the best mixes in each control cycle to produce a yield voltage with equivalent volt/second as the reference esteem. Detail portrayal of each modulator is given in this segment. It is additionally worth referencing that the exchanging directions for the converter are not constantly decided by a committed balance arrange; rather, they can be dictated by an immediate result of the general converter controller. Hysteresis current controller

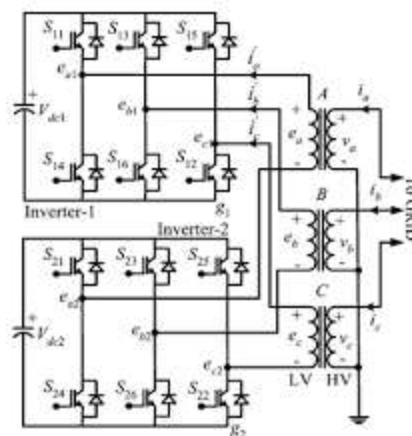


Fig 2 Generalized Diagram

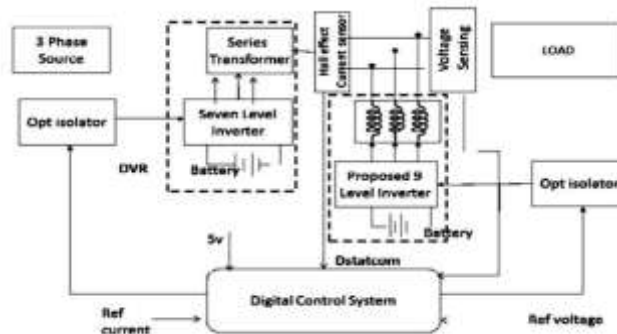


Fig 3 Proposed Diagram of the project

V. Conclusions

This project has managed the control and regulation of Cascaded H-Bridge (CHB) converters for STATCOM applications. With spotlight on the star and delta association of the stage legs that comprise the converter, the framework execution under adjusted and lopsided activity have been examined, attempting to feature the focal points yet additionally the difficulties and conceivable entanglements that this sort of topology presents for STATCOM applications. After an initial review of the principle staggered converter topologies that are accessible in the present market, the general control structure for the CHB-STATCOM has been portrayed in Guidelines for tuning of the distinctive control circles have been exhibited and the dynamic execution of the framework has been tried through recreations. It has been featured that in real usage, because of the unavoidable deviations from perfect conditions, the Stage Shifted Modulations (PS-PWM) method experiences a non-uniform power circulation among the distinctive cells that comprise the stage legs of the converter, prompting the requirement for extra control circles to ensure that the diverse DC-capacitor voltages don't separate from the reference esteem. The examination of this wonder is done in where it has been demonstrated that the non-uniform dynamic power appropriation is because of the connection between the bearer side-band sounds of the cell voltage and the base-band music of the current (when low-exchanging recurrence for the individual cells is chosen), just as poor abrogation of the transporter side-band music (chiefly in the event of high- exchanging recurrence determination).

Hypothetical examination demonstrates that by appropriate determination of the recurrence regulation ratio, an all the more even power conveyance among the diverse cells of a similar stage leg can be achieved. This choice permits to reduce the adjustment activity required from the individual adjusting controller and in this way to upgrade the general framework security. Another method for the individual DC-connect voltage adjusting talked about in Chapter 4 is the cells arranging calculation. In any case, it has been appeared the two strategies are not ready to give appropriate individual adjusting when the CHB-STATCOM isn't trading current with the network (here signified as zero-current mode). This condition is particularly basic for the star-associated CHB- STATCOM, because of the absence of a shut way for the current, (for example, in the delta design) to trade vitality

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