AN EXPERIMENTAL DESIGN TO IMPROVE POWER QUALITY ON STATCOM

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ABSTRACT

The execution of force frameworks diminishes with the size, the stacking and the unpredictability of the systems. This is identified with issues with burden stream, force motions and voltage quality. Such issues are even extended by the altering scenarios coming about because of deregulation of the electrical force markets, where contractual force streams do no more accompany the starting plan criteria of the existing system design. Extra issues can come up if there should arise an occurrence of huge framework interconnections, particularly when the joining AC connections are feeble. Realities apparatuses, in any case, give the indispensable characteristics to evade specialized issues in the force frameworks and they expand the transmission productivity. This paper displays a study on the configuration of a shunt associated FACTS apparatus (STATCOM) and explores the requisition of this gadget to control voltage motion and to moist out the wavering in electric force framework. STATCOM is one of the key shunt controllers in adaptable substituting current transmission framework (FACTS) to control the transmission line voltage and might be utilized to improve the burden capacity of transmission line and expand the voltage soundness edge. In this paper, the proposed shunt controller dependent upon the voltage source converter topology as it is traditionally acknowledged by VSC that can create controllable current straightforwardly at its yield terminal. The execution and conduct of this shunt controller is tried in 3-machine 9-transport framework and in addition the execution is contrasted in the test framework and without STATCOM at three cases in Matlab/simulink. Recreation results demonstrate that the demonstrated shunt controller is competent to enhance the Power quality altogether.

Keywords: Quality, Power, STATCOM, Transmission.
I. INTRODUCTION

The customary consistent state steadiness studies and Transient strength considers the animated force stream P and force point \( \partial \) and ordinarily expect steady getting and sending end transport voltage. The mechanical force flow Q and voltage fall throughout substantial current stream is dismissed. This approach couldn't clarify the some power outages in USA, Europe, Japan and so forth. Throughout the last quarter of the twentieth century. The power outages were because of voltage downfall. Throughout voltage crumple, the transport voltage begins falling and thus force exchange P through the transmission line begins lessening bringing about extreme voltage downfall and misfortune of framework steadiness of whole system. That is the reason voltage steadiness studies have appropriated more consideration and have obtained an imperative place in force framework Studies. Voltage crumple phenomena occur where reactive force administration is inadequate.

The provision of force hardware in the electric force transmission assumes a vital part to make the framework more solid, controllable and proficient. Because of deregulation, natural enactments and cost of development, it is coming to be progressively challenging to fabricate new transmission lines. Consequently it is vital to completely use the limits of the existing transmission framework. The adaptable AC Transmission framework (FACTS) has turned into a famous answer for our large/over amplified force transmission & appropriation framework. Certainties mechanisms are turned out to be extremely viable in utilizing the full transmission limit while expanding power framework solidness, transmission proficiency and administering power quality and unwavering quality of Force framework. These units are predominantly dependent upon either voltage source converter (VSC) or Current Source Converter (CSC) also have quick reaction time. As a paramount part of FACTS mechanisms family, STATCOM has been at the inside of consideration and the subject of dynamic research for numerous years.

STATCOM is a shunt joined mechanism that is utilized to furnish reactive power recompense to a transmission line. This controller can either retain or infuse reactive force whose capacitive or inductive current might be regulated autonomous of the AC line voltage. Hence, STATCOM can improve the transmission line stack capacity by enlarging the MW edge and enhances the swaying of voltage homeless people through effective regulation of the transmission line voltage at the purpose of association. This paper arrangements with the demonstrating of a SPWM based STATCOM with a PID controller actualized on a 3- machine 9-transport test framework. The unit is associated with a burden transport with a converter transformer. The displaying of shunt controller and testing is mimicked in the earth. The controller is spoken to as square chart that introduces reasonable electronic model of shunt controller. PID controller is utilized to control the present infusion at the association focus by differing the wanted parameters, one is Modulation file (AM) and an alternate is force edge (\( \partial \)). Essentially there are four circle tuning strategies for a PID controller; those are manual tuning, Ziegler-Nichols, programming Tools and Cohencoon strategy. Firstly, Ziegler-Nichols strategy is picked for circle tuning and afterward manual tuning is connected to the PID controller by experimentation strategy to take its execution at ideal level. Truth be told, there are four distinctive control techniques for a STATCOM controller, steer control, decoupling control, cross control and grid control. The immediate control technique is utilized here to control the yield of shunt associated FACTS device.

II. FUNDAMENTAL DESIGNING AND STANDARD OPERATION

Fundamentally, shunt joined FACTS mechanism might be acknowledged by either a VSC or a CSC. Anyway the VSC topology is favoured in light of the fact that CSC topology is more intricate than VSC in both force and control circuits. In CSC, for example GTO (Gate Turn off Thyristor) is
utilized; a diode must be put in arrangement with each of the switches. This just about copies the conduction misfortunes contrasted and the instance of VSC. The DC join vigor space component in CSC topology is inductor where as that in VSC topology is a capacitor. Therefore, the effectiveness of a CSC is relied upon to be lower than that of a VSC. The displayed STATCOM utilizing VSC topology is, no doubt utilized within the test framework to supply reactive power to expand the transmittable power and to make it more perfect with the overall load request. Consequently, the shunt joined FACTS unit ought to have the ability to minimize the line over voltage under light load condition and support voltage levels under overwhelming load condition. Two VSC innovations could be utilized for the VSC. One of them, VSC is built with Igbt/gto-based SPWM inverters. This sort of inverter uses sinusoidal Pulse-Width Modulation (SPWM) system to blend a sinusoidal waveform from a DC voltage source with a regular hacking recurrence of a couple of kilohertz. Consonant voltages are drop by uniting channels at the AC side of the VSC.

This sort of VSC utilization a DC join voltage Vdc. Yield voltage is changed by updating the regulation rule file of the SPWM modulator. Accordingly tweak record must be fluctuated for regulating the reactive power infusion to the transmission line. In an alternate sort VSC is built with GTO-based square-wave inverters and uncommon interconnection transformers. Ordinarily four three-level inverters are utilized to raise a 48-stage voltage waveform. Uncommon interconnection transformers are utilized to kill sounds held in the square waves produced by distinctive inverters. In this sort of VSC, the key part of yield voltage is relative to the voltage Vdc. Thusly Vdc must be fluctuated for regulating the reactive force the shunt controller is similar to a present source, which draws from or infuses present into the framework at the purpose of association. The shunt controller may be variable impedance, variable source or a mixture of these. Variable shunt impedance associated with the line voltage makes a variable current stream and subsequently speaks to infusion of present into the line. Provided the infused current is in stage quadrature with the line voltage, the shunt controller just supplies or devours reactive force. The point when framework voltage is low, the STATCOM produces reactive force (STATCOM capacitive). The point when framework voltage is high, it retains reactive force (STATCOM inductive). The variety of reactive force is performed by method of a VSC associated on the auxiliary side of a coupling transformer. The VSC utilization constrained commutated force electronic mechanisms (Gtos, Igbts or Igcts) to integratea voltage V2 from a DC voltage source. Any viable stage relationship will include taking care of genuine power moreover. Along these lines, the shunt controller is accordingly a great approach to control the voltage at and around the purpose of association through infusion of reactive current (heading or slacking) alone or a mixture of dynamic and reactive present for a more adequate voltage control and damping of voltage progress.

The true power (P) and

\[ P = \frac{E.V}{X} \sin\delta \]

Reactive forces (Q) are given by:

\[ Q = \frac{E^3}{X} - \frac{E \cdot V}{X} \cos\delta \]
E is the line voltage of transmission line. V is the produced voltage of VSC. X is the equal reactance of interconnection transformer and channels and δ is the stage edge of E as for V. In consistent state operation, the voltage V produced by the VSC is in stage with E (δ=0), so just reactive force is streaming (P=0). In the event that V is lower than E, Q is streaming from E to V (STATCOM is engrossing reactive force). On the opposite, if V is higher than E, Q is spilling out of V to E (STATCOM is producing reactive force). Since we are utilizing here a VSC dependent upon SPWM inverters thus tweak file is fluctuated for regulating the reactive power infusion to the transmission line. A capacitor is joined on the DC side of the VSC demonstrations as a DC voltage source. In consistent state the voltage V must be stage moved marginally behind E keeping in mind the end goal to repay for transformer and VSC misfortunes and to keep the capacitor charged.

Fig. 2 shows a development of STATCOM using one interconnection transformer and three Gto/diode based twofold arm H-spans. Every H-scaffold is joined with the every stage of the optional of interconnection transformer. Transformer essential is joined with the transmission line. Expectedly, shunt controllers are built of three stage converters or inverters. Anyway it is conceivable to supplant the three stage converter with three single stage converters. The three stage converter developed with three single stage converter prepares less exchanging swells than the accepted three stage converter. In this way, three stage converter developed with three single stage converters is utilized. T1, T2 and T3 speak to the transformer curls of stage A, B and C separately that shape a three stage transformer optional joined with shunt on verter. A capacitor (C) which goes
about as a voltage source is utilized. The definitive circuit graph of every Gto/diode span (B1, B2 and B3) is demonstrated in fig.2. Every H- connect comprises of four GTO and four diodes where the GTO and diode are joined in against parallel. Thus, four diverse control beats are instructed to control each of scaffolds. In this manner to apply terminating beats to three separate connects legitimately, add up to twelve separate beats are needed for regulating the shunt converter.

III. PROPOSED CONTROL SCHEME

STATCOM might be regulated in voltage control mode and Voltage control mode. The control utilized as a part of this recreation is AC voltage control mode. Primarily, the control is isolated into two parts. One is for edge request and an alternate is for the request of balance file. The shunt converter is worked in such a path as to request this DC terminal power from the line keeping the voltage over the space capacitor Vdc consistent. Thus, as per comparison 1, the plot is requested in such a path, to the point that the net true power consumed from the line by this shunt FACTS unit is equivalent to the misfortunes of the converters and the transformer just. The remaining limit of this shunt converter might be utilized to trade reactive power with the line so to give VAR payment at the association focus. The reactive power as per comparison 2 is electronically given by the shunt converter and the animated force is transmitted to the DC terminals. The shunt converter reactive current is immediately managed to look after the transmission line voltage at the purpose of association with a reference worth. The line voltage and Dc connect voltage crosswise over capacitor are measured to compute the measure of reactive power to control the line voltage and subsequently the adjustment list is differed in such a path as to compute reactive force might be infused at the purpose of association and in this way the shunt FACTS apparatus goes about as a voltage controller. The SPWM terminating beats to the Gtos are gotten by thinking about the PWM bearer indicator and the reference sine wave. The adequacy of reference sine wave is 1 Volt and recurrence is 50 Hz which is comparable to framework working recurrence. The bearer recurrence is situated at 1.5Khz which is 30 times the framework working recurrence.

The stage lock circle (PLL) assumes an essential part in synchronizing the exchanging to the framework voltage and bolt to the stage at crucial recurrence.

The converter is comprised of 12 GTO with extra parts. The controller controls the terminating beats from G1 to G12 which are sinusoidal beat width regulated indicators. The accompanying figure shows the piece outline of control method to create one and only beat width regulated sign and 11 indicators might be created correspondingly.
IV. RESULT ANALYSIS

Simulation Setup

Fig 4 shows the 3 machine 9 bus test system for simulation. The test system includes machines, transmission lines and loads at different buses. The modelled FACTS device (STATCOM, 300 MVA) is installed at Bus-9. Two types of large loads (Load-1 & Load-2) are also connected at bus-9. Power is flowing to Bus-9 by TL1 and TL2.

Simulation Result

At beginning (t=0.0 s), Load-1 and Load-2 is associated with the Bus-9 and drawing tremendous force. Yet for any explanation for why (it is possible that manual or assurance) transmission line Tl1 is separated from the framework at t=0.4 second. Reenactment begins at t=0 second and closes at t=1 second. Waveforms Scales are zoomed with the goal that the voltage motions could be seen obviously. Fig 5 shows the voltages of Bus-9 in for every unit (p.u) when STATCOM is not being used. The robust line speaks to the voltage in p.u when demonstrated STATCOM is joined with the transport. As it is instituted at Bus-9 the voltage is regulated at that transport effectively.

Fig.4: STATCOM connected to the 3 machine 9 bus test System

Fig.5: voltage at bus-9 Transmission line
Fig. 6 shows the infused reactive power to the Bus-9 to control the voltage and genuine power attracted by the STATCOM to keep the DC join voltage (Vdc) over the capacitor consistent in light of the fact that the DC voltage has a tendency to change throughout operation. In relentless state the voltage V must be stage moved marginally behind E with a specific end goal to remunerate for transformer and VSC misfortunes and to keep the capacitor charged. The regulation file is solicited to change because of create or retain the needed measure of reactive force. To support the transmission line voltage at Bus-9 the tweak record is regulated by PID controller which is demonstrated in Fig 7.

CONCLUSION

In reenactment, most noticeably bad occasions are acknowledged to look at the execution of demonstrated shunt joined FACTS gadget. The recreation comes about show that the displayed STATCOM is skilled enough to control the transmission line voltage motion as well as the same shunt controller might be utilized as a part of VAR control mode. Vdc is controlled by regulating legitimate stage shift and transmission voltage is managed by changing the regulation file. Two single data and single yield (SISO) shut circle frameworks are utilized. The reaction of controller is exceptionally quick because of apply regulate control system. The reenactment comes about additionally demonstrate that the shunt apparatus with proposed exchanging plan capacities effectively as the continuous voltage controller and it enhances the dynamic strength with an extensive variety of control the reactive force. The extent of voltage swaying in reenactment and different figures are zoomed along y hub to watch the swaying unmistakably regardless the motions are extremely low. Three single stage converters are utilized instead of three stage converter to diminish exchanging swells.
REFERENCES