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Modelling of Statcom based d-q Reference Control Algorithm for Distribution System

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ABSTRACT: This paper is all about the Statcom device, a shunt compensation device connected with a three wire power systems in parallel with the equipment responsible for the main source of generating power quality problems or having issues to comply with grid code and energy efficiency requirements. The main target of this project is to achieve the grid code compliance by resolving power quality issues and providing the required services. A transmission system of length 200Km has been implied with the statcom device. This paper describes an advanced approach for power quality enhancement and mostly flicker problems. The basis of this device is a voltage source converter connected in series with some type of reactance like power transformer and allows to control power flow without any real power flow. The whole model is being designed and simulated by using Matlab Simulink software to analyse the outputs.

KEYWORDS: Statcom Static Synchronous Compensator, Phase control, Active power compensation, Power quality, Facts Devices.

I.INTRODUCTION

A Flexible AC Transmission System (FACTS) device provides reactive power to the grid enhancing controllability and improving the performance of the transmission system. Among the family of converter-based FACTS devices, Static Synchronous Compensator (STATCOM) is a reliable device and has been installed in many countries around the world. The usual interest of a STATCOM device is to control transmission voltage by reactive power shunt compensation. However, these devices can be used for various applications depending on the control functions implemented some authors have analysed the benefits of using STATCOM to mitigate voltage fluctuations and Sub-Synchronous Resonance (SSR) [1]

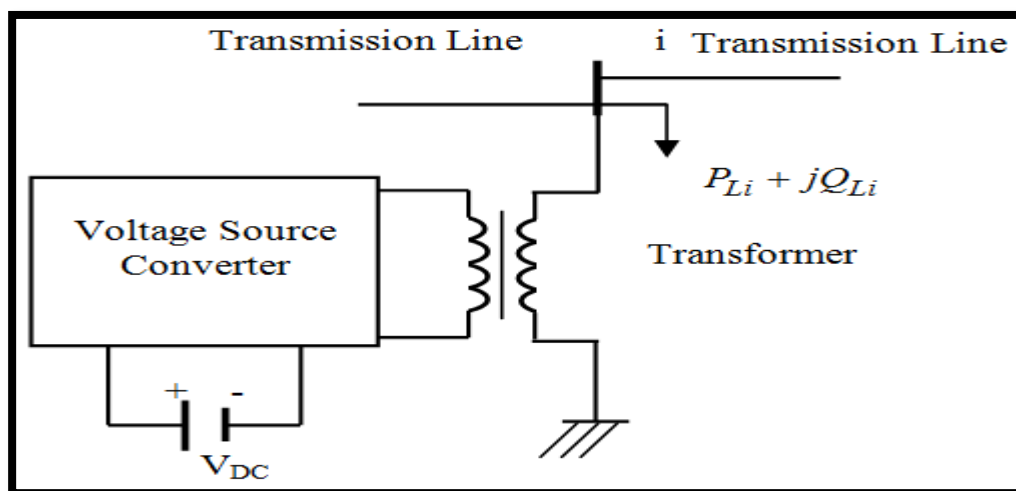


Fig. 1 Schematic Diagram of Statcom

II. CONTROL SYSTEM ALGORITHM

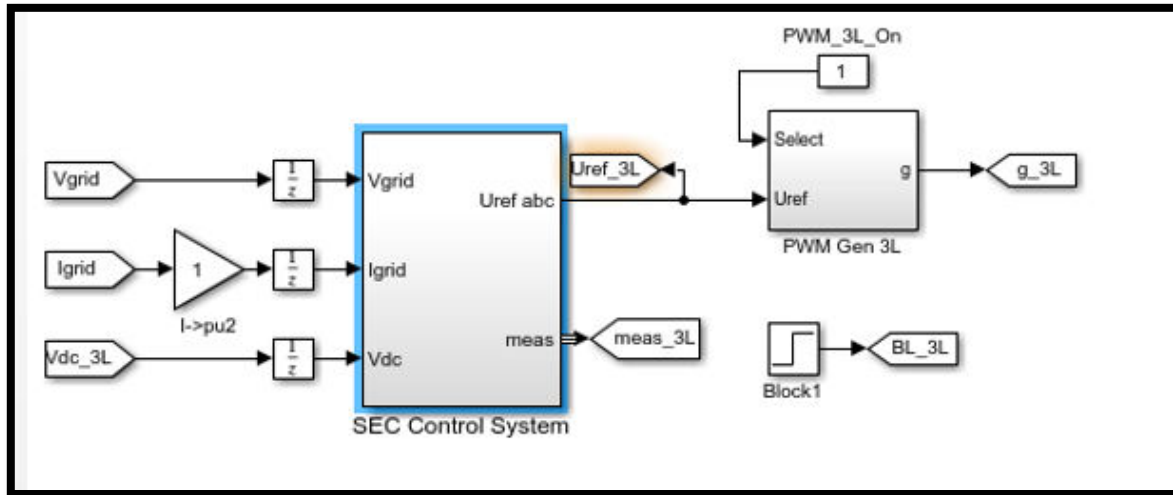


Fig. 2 Schematic Diagram of Statcom

A Statcom solution system is been installed in the transmission grids that provides grid operator with reactive power compensation and improved range of operational voltage with a faster response time. A shunt connected Statcom system is able to generate capacitive or inductive output current independent of the AC system voltage.

STATCOM allows voltage stabilization, improvement of power factor and dynamic control at the point of connection to industrial load using reactive power compensation. This is not enough in situations when a variable load is connected to the grid and produces voltage fluctuations. In this case, using additional active power compensation is required because the voltage drop is caused by reactive and active power consumption too [2]

$$\Delta \hat{U}_{ph} = \hat{Z}\hat{I} = (R + jX) \frac{P \mp jQ}{\sqrt{3}U} = \frac{RP \pm XQ}{\sqrt{3}U} + j \frac{XP \mp RQ}{\sqrt{3}U} \dots\dots\dots (1)$$

Equation (1) has upper sign “+” in real part for inductive and bottom “-” for capacitive load character. We can see from this formula that voltage drop cannot be eliminated just by compensating reactive power. However, using active power injection can eliminate small fast voltage disturbances during variable load operation. Such disturbances are the main cause of flicker in transmission and distribution grids.

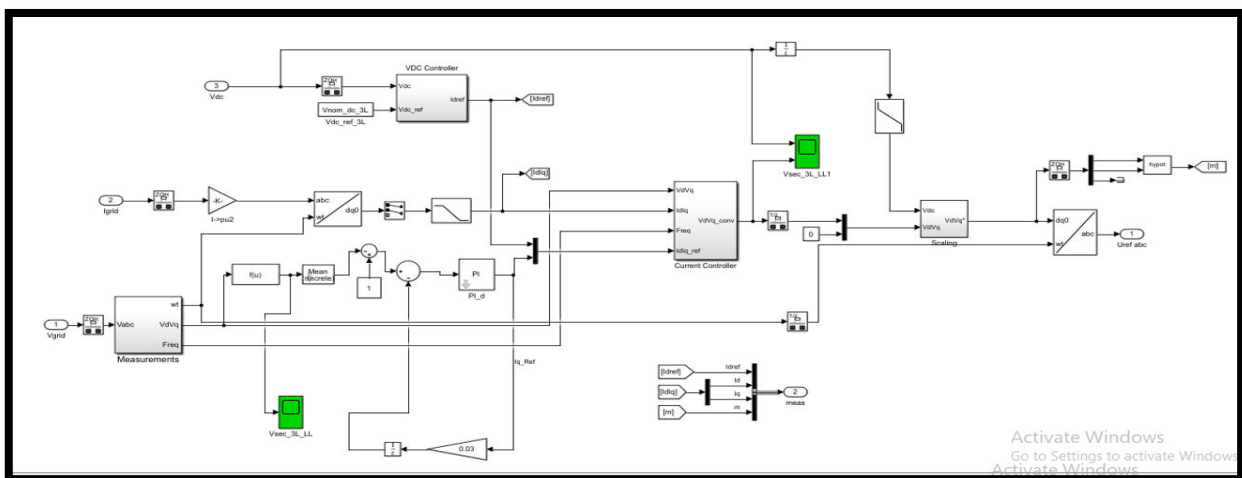


Fig. 3 Schematic Diagram of Statcom

III. ASSUMPTION AND MODEL DESCRIPTION

Statcom designed has different components with different roles in the model, Voltage source converter is used to convert the DC input voltage to AC output voltage, a PWM inverters using insulated IGBT uses PWM pulse width modulation technique to produce sinusoidal waveform from a dc voltage source with a typical chopping frequency of few kHz, the IGBT based VSC uses a fixed DC voltage and varies its output AC voltage by changing modulation index of modulator. DC capacitor is used to supply a constant DC voltage to the voltage source converter. Transformer is connected between the output of VSC and power system. Transformer acts as a coupler and neutralizes the square wave produced by VSC. Harmonic filter also connected that attenuates harmonics and high frequency components due to VSC.

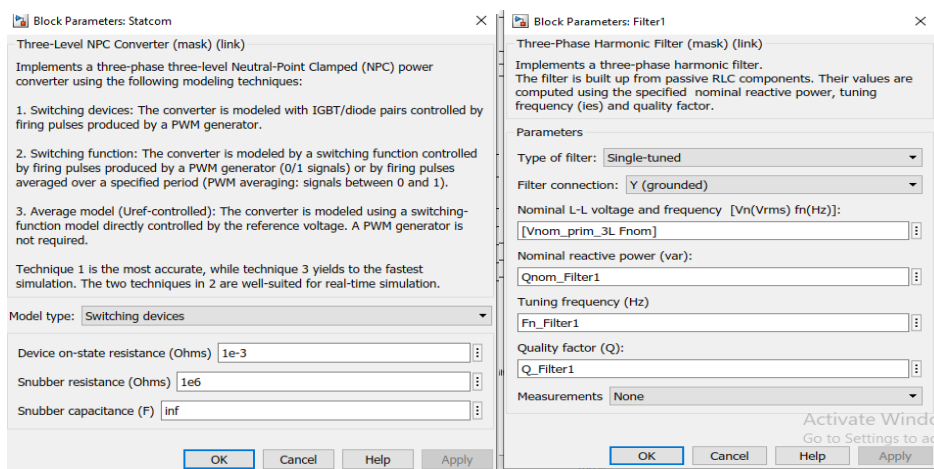


Fig. 4 Statcom and three phase harmonic filters parameters

IV. RESULT AND DISCUSSION

The output waveform of the designed model has been recorded for voltages, currents and other parameters in the output ports of the Statcom. The first graph shows the three phase line to line voltage. The second graph shows the DC link capacitor voltages which is almost constant for the supply to voltage source converter. Third graph shows the three phase grid voltage and current, fourth graph shows active and reactive power of the system.

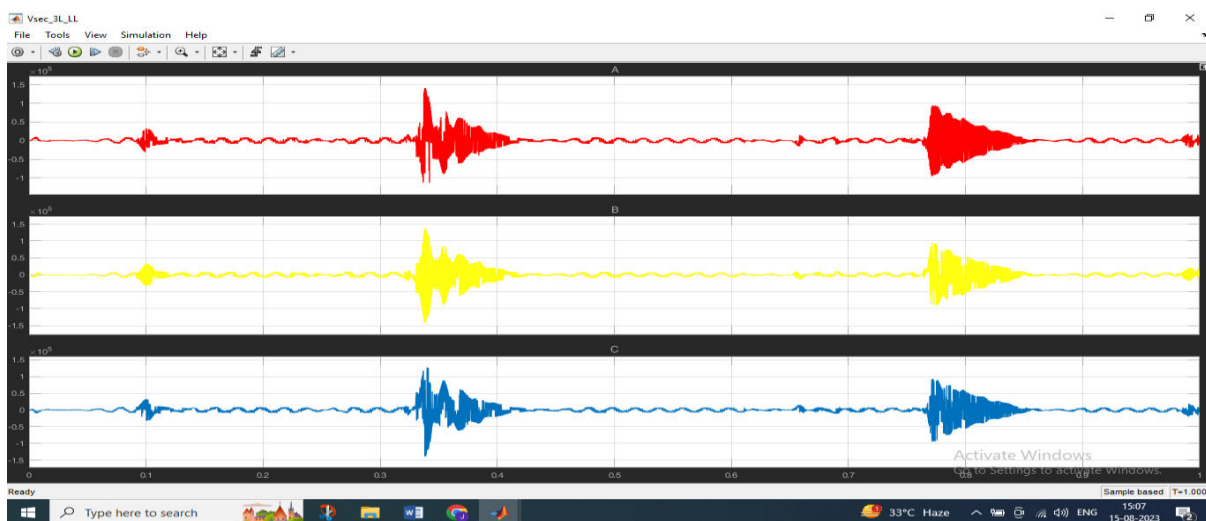


Fig. 5 Three Phase Line to Line Voltage



Fig. 6 DC link Capacitance voltage



Fig. 7 Three Phase Grid Voltage Vgrid and Grid Current Igrid



Fig. 8 P&Q Active and Reactive power of the grid

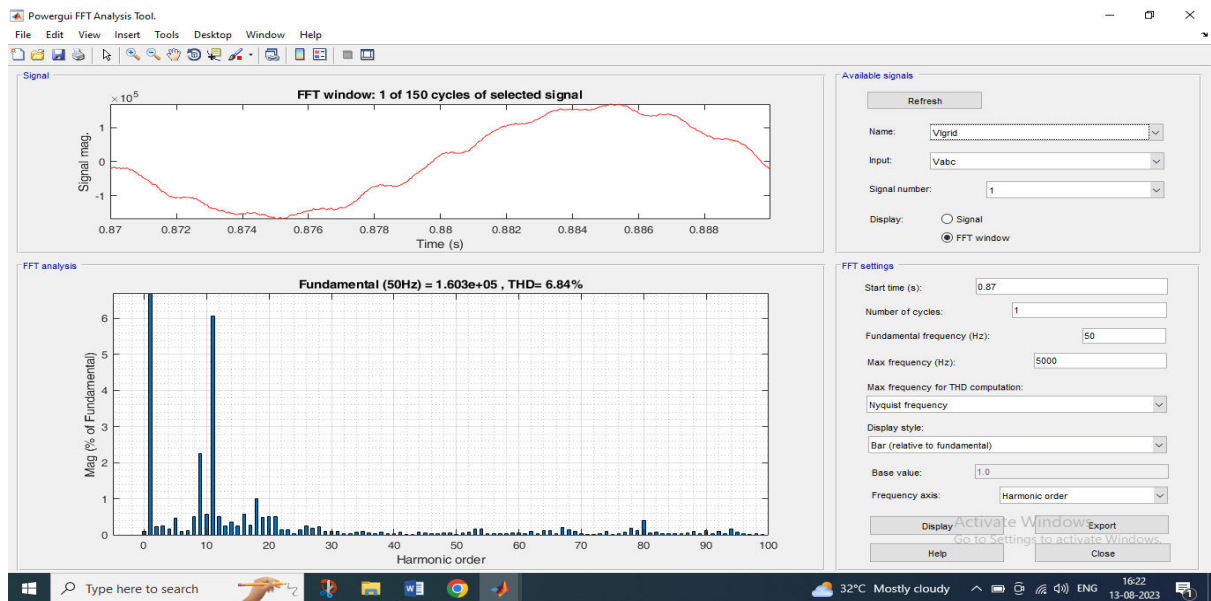


Fig. 9 THD of grid voltage

V.CONCLUSION

In this paper three level VSC based STATCOM imposed in parallel to the transmission line in a distribution system for checking the effects in voltage waveforms. The results are showing that the value of THD in voltage of grid near by 6 % which is in the specified limit decided by IEEE. After implementation of device in the transmission system some flickers in voltage, current, active and reactive power has been arrived as the statcom is also having some limitations and after a certain limit the absorption and transfer of reactive power is limited to certain extent. Simulation results shows the effectiveness of the proposed control strategy to control the Statcom in a secure mode and provides the desired output in the transmission system.

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