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STATCOM Controlled Scheme for Grid Connected Wind Energy System for Power Quality Improvement

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Abstract: *This paper deal with the controlling circuit of the STATCOM and simulation of the STATCOM for power quality improvement at the point of common coupling for the grid connected wind energy system. Basically STATCOM is a three phase voltage source inverter having the capacitance on dc link and connected at the point of common coupling. The controlling scheme approach of the STATCOM is based on injecting the current in to the grid using bang-bang controller. The controller uses a "hysteresis current controlled" technique. The controller gives the correct switching signals for STATCOM operation. The FACTS Device–Static Compensator (STATCOM) control scheme for the grid connected wind energy generation system to improve the power quality is simulated using MATLAB/SIMULINK in power system block set.*

1. INTRODUCTION

When we integrate a wind turbine in to the grid it causes the power quality issues. The main power quality issues are voltage flicker and harmonics. In the fixed -speed wind turbine operation, all the fluctuation in the wind speed are transmitted in the mechanical torque and electrical power so wind turbine produces a continuous variable output power.

To mitigate the voltage variation and improve the power quality issues a power electronics based fact device STATCOM is connected at the point of common coupling. Basically STATCOM is a three phase voltage source inverter having the capacitance on dc link and connected at the point of common coupling.

1.1 STATCOM

Static synchronous compensator (STATCOM) is defined with the three operational components

1) Static
2) Synchronous
3) Compensator

Static stands for solid state switching device. Synchronous stands for analogous to an ideal synchronous machine with 3 sinusoidal phase voltages at fundamental frequency compensator stands for reactive power compensation.

2. BASIC OPERATING PRINCIPLE OF STATCOM

The basic operating principle of STATCOM is similar to the synchronous machine. The synchronous machine will provide lagging current when under exited and leading current when over exited. Similarly if the output voltage of the voltage source converter is greater than the system voltage the STATCOM will act as a capacitor and generate reactive power i.e it provide leading current to the system. If the output voltage of the voltage source converter is less than the system voltage then the STATCOM act as a inductor and absorb reactive power.

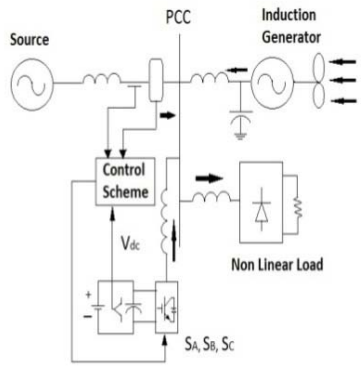

Fig. 1: Grid connected system for power quality improvement

3. CONTROLLING CIRCUIT OF THE STATCOM

The controlling scheme of the STATCOM based on injecting the current in to the grid using "bang-bang controller". The controller equipped with the unit

template vector and hysteresis current controlled technique.

3.1 UNIT VECTOR TEMPLATE

Forunit vector template two control loop is used.

1) *Phase Locked Loop (PLL)*
2) *DC voltage control loop*

PLL is used to generate Synchronizing angle for three phases. Firstly we obtain synchronizing angle through PLL and then we generate three phase unity sinusoidal reference source current.

V_A^* = sin θ

V_B^* = sin $(\theta - 120^o)$

V_C^* = sin $(\theta + 120^o)$

The objective of dc voltage control loop is to determine the reference source current (I_m).The reference source current(I_m) decided by the output of PI controller as shown in Fig 3. Given below.

3.2 HYSTERESIS CURRENT CONTROLLER

In hysteresis current controller the reference three phase current are compared with the three phase grid current and error signal is applied to hysteresis current controller in order to generate switching pulses for IGBTS in inverter.

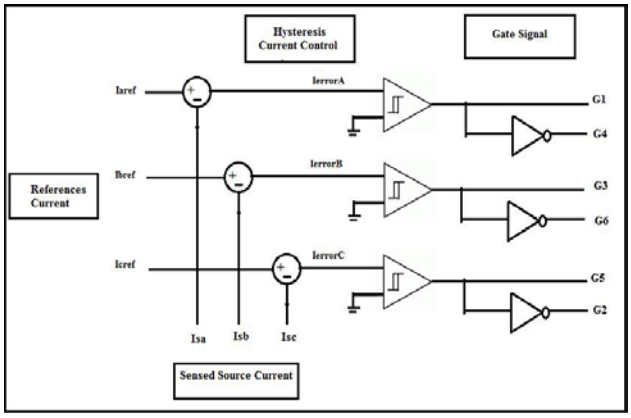

Fig. 2: Hystersis Current Controller

The reference three phase current are:

$$I_{aref}^* = I_m . V_a^*$$

$$I_{bref}^* = I_m . V_b^*$$

$$I_{cref}^* = I_m . V_c^*$$

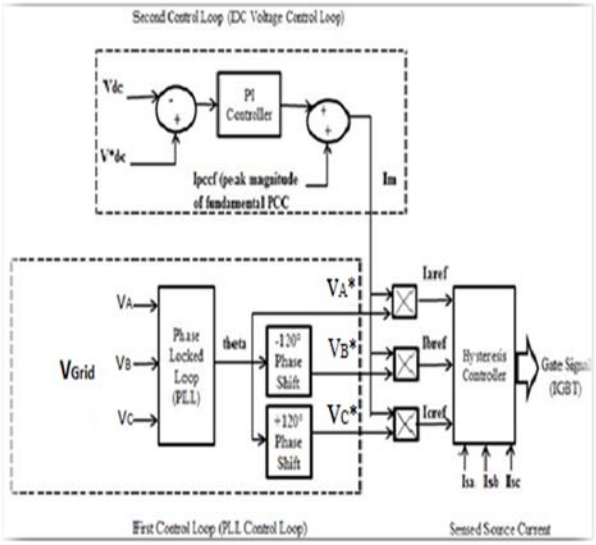

Fig. 3: STATCOM Controller

4. SIMULATION OF THE CONTROLLING CIRCUIT OF THE STATCOM

The simulation diagram of the Controlling circuit of the STATCOM is shown in Fig 4 and the output waveforms of the PWM is shown in Fig 5.

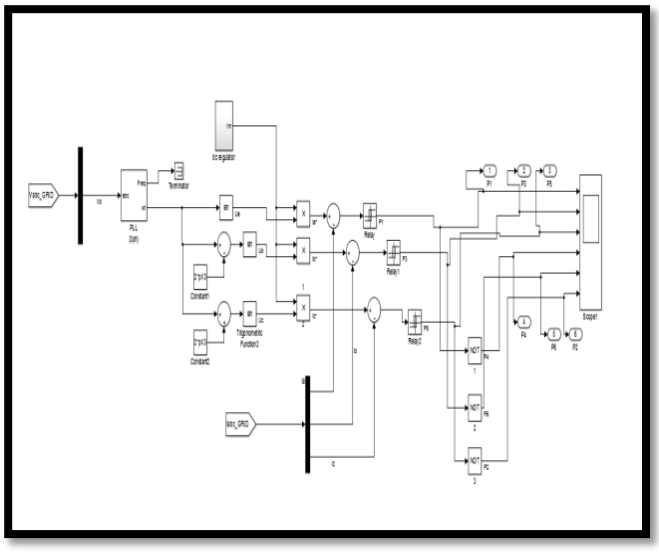

Fig. 4: Simulink of the controlling circuit of STATCOM

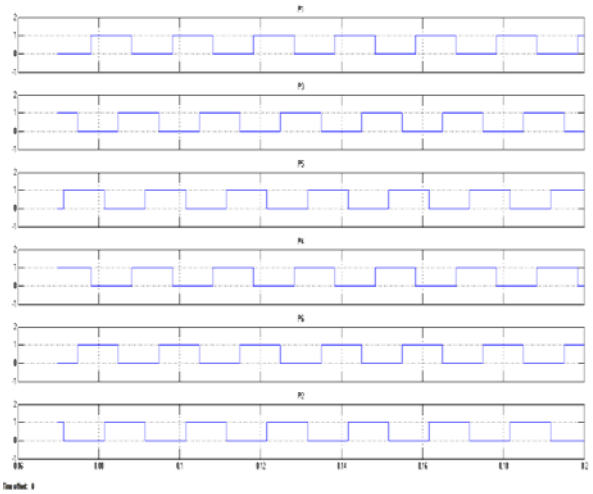

Fig. 5: Output of the controlling circuit

The Voltage source converter simulation diagram is shown in Fig.6 and its output of phase V_{ab} is shown in Fig.7.

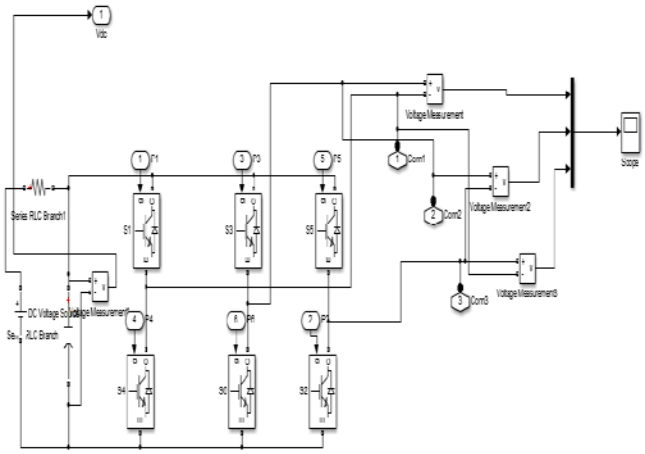

Fig. 6: Voltage Source Converter

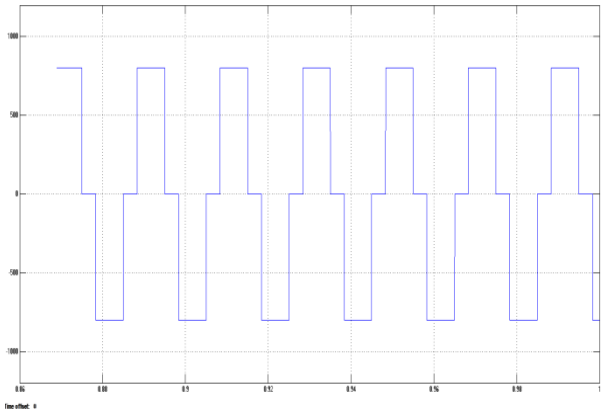

Fig. 7: Output Voltage Waveform of the inverter

5. CONCLUSION

This paper presents the controlling circuit and the STATCOM for power quality improvement for grid connected wind energy system. Modelling and simulation has been analysed using MATLAB/ SIMULINK. This paper introduced PLL and hysteresis current controller for 6-pulse STATCOM to compensate power quality issues due to wind turbine and non linear load.

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