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Voltage Source Converter (VSC) Control of Grid Connected PV System

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Abstract—*This Paper investigates about the control of the grid connected PV system using the voltage source converter (VSC) the output voltage from the boost converter is controlled and regulated by VSC using pulse width modulation (PWM) Technique. This three level VSC regulates the DC bus voltage and keeps the power factor at unity. At last the results are presented using the matlab simulink, which tells about the practicality of the system.*

1. INTRODUCTION

Nowadays solar energy is an important source of electricity production due to plenty of energy emitted by sun we can convert the energy of the solar rays into electricity using the photovoltaic system. This source of energy results in quality of energy cost effectiveness and flexibility. The DC to AC converter used in the Grid connected PV system results in the optimum transfer of energy from DC to AC Side. The output from the DC to DC boost converter is converted into the AC voltage by means of appropriate switching signals, which is further given to electric utility grid and loads after passing through a filter and step up transformer[1,2].

2. PV GRID CONNECTED SYSTEM

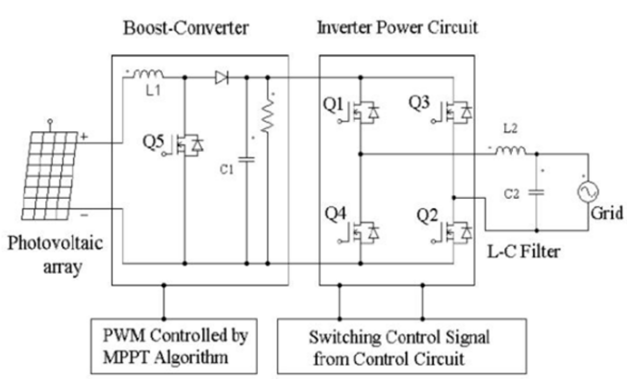

Fig. 1: Block diagram of two-stage grid-connected PV system[3]

Grid interconnection of photovoltaic power generation system has the advantage of more effective utilization of generated power. However, the technical requirements from the utility power system grid side and PV system side need to be satisfied, to ensure the safety of PV installer and the reliability of utility grid. Grid interconnection of PV system ids accomplished through the inverted which converts the DC power generated from the PV modules to AC power used for ordinary Power Supply for electrical equipments. Inverter system is therefore very important for Grid connected PV systems[3,4,5].

To meet with the requirements up-to-date technologies of Power electronics are applied for PV inverters. By means of High frequency switching of semiconductor devices with PWM (Pulse width Modulation) technologies, high efficiency conversion with high power factor and low harmonic distortion power can be generated.

Conditions for grid interfacing:

The conditions for proper interfacing or synchronizing the SPV system with a grid are discussed below:

1. Phase sequence matching- Phase sequence of SPV system with conventional grid should be meshed, otherwise synchronization is not possible.
2. Frequency matching- Frequency of the SPV system should be same as grid. Generally grid is of 50 Hz frequency
3. Voltage Matching- Voltage level of both systems should be same.

3. CONTROL OF DC TO AC CONVERTER AND NETWORK INTERFACE

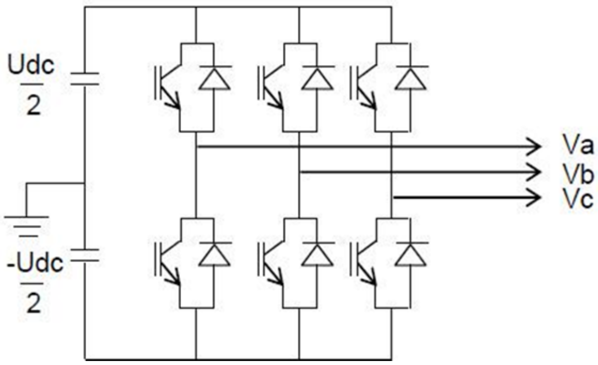

Fig. 2: Inverter Structure[7]

We use a three- phase three –level system using IGBT switches to connect the inverter to the network. The IGBT Semiconductor is used due to its smaller size and reduced switching losses as compared to other power electronics devices. Here the PWM technique provides the control of the output voltage. The DC bus voltage is regulated by three level VSC and it also keeps power factor at unity. It uses the control system which further consists of two control loops. One is external control loop and another is internal control loop. The DC link voltage is regulated by external control loop whereas the active and reactive current components are regulated by an internal control loop. To control the current of inverter of each phase we use PI compensator.

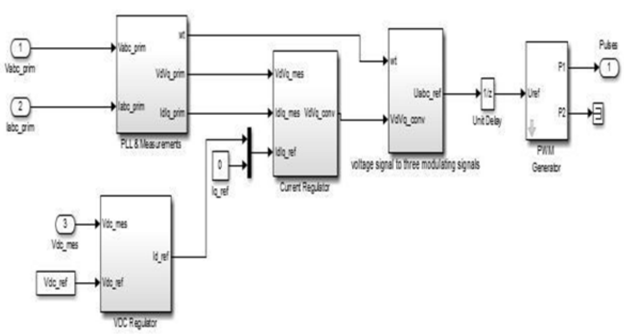

Fig. 3: Simulation Model of VSC Controller

I_d current reference is the output of the external control loop and I_q current is set to zero in order to maintain power factor at unity.

V_d and V_q voltages are outputs of the current loop, which are converted to three modulating signals. These modulating signals are used by three – level PWM pulse generator.

The synchronization control over the grid voltages is achieved by the three-phase locked loop (PLL). It applies inverse transformation on the phase voltages of the network. Here the regulation of the voltage is the outcome of absorbing or supplying active power to the network[6,7,8].

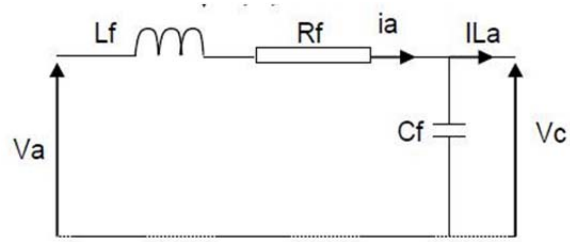

Fig. 4: Low Pass Second order LC Filter[8]

High frequency Harmonics generated by the inverter are filtered using a low pass LC filter.

4. SIMULATION RESULTS

After the boost converter increases voltage from natural voltage to the boosted voltage , a three-level three-phase VSC converts the boosted voltage to the subsequent AC voltage and keeps the power factor at unity. The Harmonics produced by the VSC is filtered using the LC filter. The utility grid model consists of 25 kv distribution feeder and 120 kv equivalent transmission system. Following figures shows the results of simulation of models using the VSC and its multilevel control and the grid voltage and current in the steady state of the system.

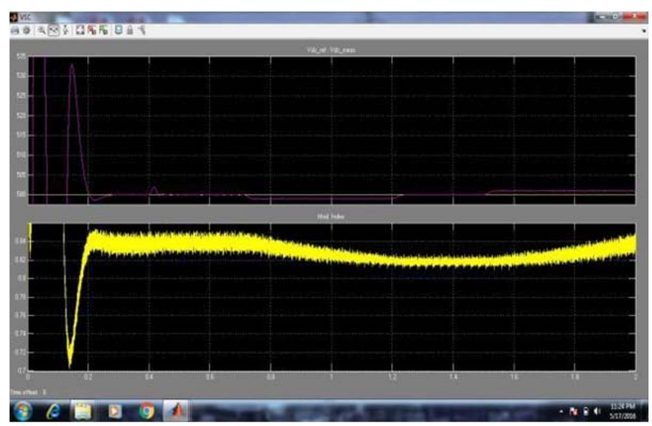

Fig. 5: Voltage and Modulation Index curves

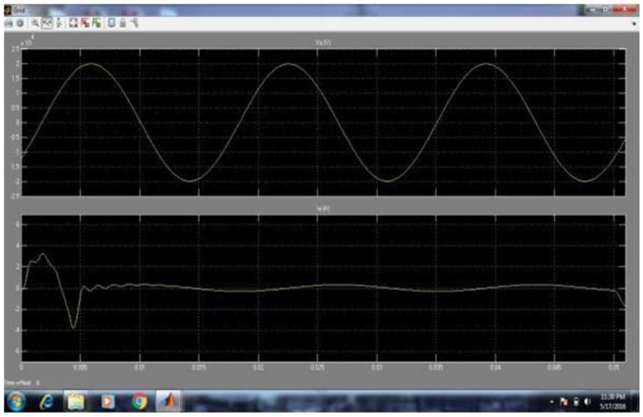

Fig. 6: Grid Voltage and Grid Current curves

5. CONCLUSION

This Paper has presented the Voltage Source Converter Control of Grid Connected PV system, which is used for the regulation of DC link Voltage and keeps the power factor at unity. The simulation results confirmed the validity of the proposed power allocation and control.

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