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A GRID CONNECTED PV SYSTEM WITH HYSTERESIS CONTROL ALGORITHM FOR HIGH EFFICIENCY RIPPLE FREE MPPT

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ABSTRACT: ***This project presents a control methodology of three phase grid connected PV system and its control schemes for applications in distributed generation (DG) systems. The system uses a two stage energy conversion topology composed of a DC-DC boost converter and five level-three phase voltage source inverter (VSI). The DC-DC converter is used to extract maximum power from the PV array and boost its output voltage. A maximum power point tracking (MPPT) technique is proposed in which hysteresis algorithm is used, with direct control method in which duty cycle is adjusted to achieve the maximum power point (MPP). The VSI is use for exchange the maximum power extracted by DC-DC converter to AC power by giving the gate pulse from voltage source controller. Simulation results on MATLAB/Simulink software are carried out to confirm the system operation. The Efficiency of MPPT and DC link voltage on the entire PV system is increased.***

Keywords*:* VSI, DG, MPPT, Boost converter, PV Array

1. INTRODUCTION

Fossil fuels and hydropower together with non-commercial fuels such as firewood are considered the main energy resources in Egypt. However, Because of the rising demand in fossil fuel resources and the resulting environmental effects, Egypt's energy strategy aims to enhance the reliance on renewable energy sources, particularly wind and concentrated solar power. Accordingly, the national energy plan aims to achieve 20% of total generated electricity from renewable energy sources by the year 2020 with 12% from wind energy. This expected to be achieved through establishing grid connected wind farms and solar photovoltaic (PV) systems. **:**Solar, wind and hydro are renewable energy sources that are seen as trustworthy alternatives to conventional energy sources such as oil or natural gas. However, the efficiency and the performance of non conventional energy systems are still under development. Consequently, the control structures of the grid tied inverter as an main section for energy conversion and transmission should be improved to meet the requirements for grid interconnection.

Most of renewable energy technology create a DC power output. An inverter is required to convert the DC electric energy from the non conventional energy source into AC electric energy. The inverters are either stand alone or grid tied. In case of grid linked inverter, the inverter output voltage and frequency should be the same as that of the grid voltage and frequency. Accordingly, the control of the inverter should be improved to meet the requirements for grid interconnection. Photovoltaic (PV) energy has developed one of the most widespread sustainable energy sources nowadays. Due to continuous cost decrease and government incentives, the installation of grid-integrated PV system has grown rapidly in the past few years.

The search for renewable energy sources then becomes more and more intense as a prominent alternative for the mitigation of the world energy emergency. Along with the clean and green power sources, the photovoltaic (PV) solar energy comes up as an exciting alternative to improvement the generation of electricity. The transformation efficiency is low and the initial cost is still appreciable, as it is compulsory to use MPPT techniques in order to maximize the extracted energy. Among all the various DG technologies, solar photovoltaic systems are quickly increasing in electricity markets due to the declining cost of PV modules, increasing efficiency of PV cells, manufacturing- technology improvement and economics of scale.

However, the increasing penetration levels of PV systems into the grid have given increase to potential problems connecting to power quality (i.e. low power factor, harmonic distortion, etc.).The grid connected inverter can be divided into two parts: Input side controller and Grid side controller The control goal on the input side controller is to capture maximum power from the input source. However, the control goal on the Grid side controller are to control the power delivered to the grid, ensure high quality of the inject power and Grid synchronization.

MPPT techniques generally known in the literature by using a dc-dc boost converter operating in continuous conduction mode to supply a given load. If this voltage ripple propagates to the PV side, it will deteriorate the MPPT performance and decrease the MPPT efficiency. All the control, MPPT, and grid-current are implemented in the DC-AC stage (inverter) that includes of a three-phase bidirectional power flow PWM

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voltage source inverter (VSI).This is the principal power electronics circuit of a three-phase grid-tied photovoltaic Power System. The MPPT will not be carried out by a DC-DC stage; it will be implementing through the inverter, which is in addition responsible for the grid-current control. And the super capacitor is used to reduce the ripples.

2. EXISTING SYSTEM

In this existing system topology for single phase single level inverter is suggested. This topology uses reduced number of switches compared to conventional topologies. As the number of levels increases, the produced output waveform is staircase wave which approximates a sine wave with more number of steps. Thus the output voltage approaches the desired sinusoidal waveform. The basic idea of a single level converter is to obtain lower operating voltage using a series connection of power semiconductor switches through much lower voltage rating compared to power switches used in conventional inverter. These power switches are controlled in such a way that less number of voltage levels is generated in the output using many dc sources. The rated voltage of the power semiconductor switches depends upon the rating of the input voltage sources to which they are connected and it is much less than the output voltage.

3. PROPOSED SYSTEM

A Grid Connected solar PV system is a kind of electrical inverter that convert direct current electricity from PV module into alternating current(AC). While the PV system is connected to the grid, it can transfer the extra energy to the grid after satisfying the local demand. Although when the system generates less than what is required to maintain the local demand, than extra energy is extracted from the grid. Thus PV solar energy acts as an alternative supply of electricity. The PV system, designed in this work, aims to transfer electrical power from PV panels to the grid. First, a DC-DC Converter is used to increasethe PV voltage to a level higher than the peak of grid voltage. The converter as well as tracks the maximum power point of PV module. There are many algorithms for tracking maximum power point.In this paper hysteresis control method is proposed in MPPT. PV module‘s voltage and power need to sense for tracking maximum power point in this method. Followed by, a voltage source controller based dc-ac inverter (voltage source inverter) is used for implement sinusoidal voltage waveform with matching phase frequency with grid voltage.

4. BLOCK DIAGRAM

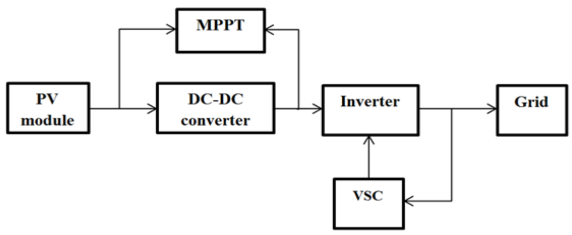

Figure 1: Block Diagram

In this block diagram consists of PV panel, DC-DC Converter circuit, inverter, and MPPT and Hysteresis controller. Input dc supply get from PV panel then its given to the DC to DC converter, then the converter output is given to the inverter circuit the output AC supply is fed into the grid. And the variable DC supply is converted into fixed DC supply by using the converter and the hysteresis controller can be used.VSC controller is used to give the gate pulse to the inverter.

5. SYSTEM DISCRIPTION

The power circuit consists of a 100 KW PV array, DC-DC boost converter, five level – three phase voltage source inverter (VSI).Due to the high reverse recovery loss of the diodes at transformer secondary side the switching frequency is relatively low. To alleviate the loss on the diodes, a resonant operating mode with ZCS condition based on the same topology is proposed. Nonetheless, the dc-link capacitor is still large and the lower switch suffers from hard switching of high peak current. The current-fed full-bridge converters are suitable for high power applications .However, start-up circuits are needed since the duty cycle can never be smaller than 0.5. Active clamp circuits are usually adopted to extend the duty cycle range as well as enable ZVS.DC-DC converter that enables using small film capacitors. A dc-link voltage synchronizing control is applied to reduce the high current stress and consequent loss in the converter. For control schemes, two control circuits are working for grid connected PV system. The first control circuit control the DC-DC converter to extract maximum output power from the PV array.

5.1 MODEL OF PV ARRAY

The basic structure of PV cell is given below

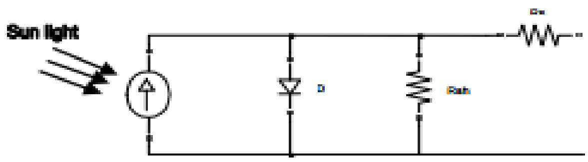

Figure 2: Basic model of PV

Rs = series resistance
Rsh = shunt resistance

So,

$$I - Il - Io\left[e^{(q(V+RsI)\propto kT)} - 1\right] - V + Rsi.Rsh \quad (1)$$

Here,
I = cell output current,
Io = cell reverse saturation current,
α = diode ideality constant,
IL = light generated current .
Open circuit voltage,
Vo = (kT/q) ln[IL/Io]

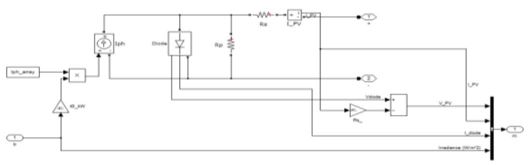

Figure 3. Model of PV module in MATLAB

5.2 CONTROL OF DC-DC BOOST CONVERTER

The photovoltaic array power is certainly a non-linear function of the working array voltage and this utility has a maximum power point (MPP) to a exacting value of voltage. Therefore, photo voltaic systems are frequently prepared with MPP trackers to facilitate utilize electrical rules to track the MPPs under different environmental conditions.

5.3 VOLTAGE SOURCE INVERTER CONTROL

In order to manage three phase voltage source inverters (VSI), there are two control approach: current control and voltage control. The voltage controlled VSI use the phase angle connecting the inverter output voltage and the grid voltage to manage the power flow. The current controlled voltage source inverter, the active and reactive components of the current add into the grid are controlled by means of pulse width modulation (PWM) techniques. A current controller is less susceptible to voltage phase shifts and to alteration in the grid voltage. Moreover, it is quicker in response On the other hand, the voltage control is susceptible to little phase errors and large harmonic currents may arise if the grid voltage is distorted. .The current controller of three phases VSI acting an necessary part in controlling grid connected inverters.

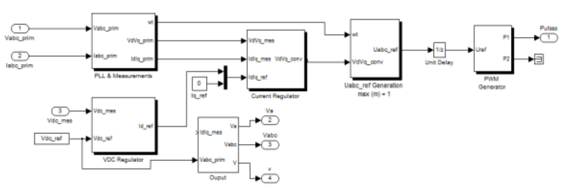

Figure4 VSC main controller

Accordingly, the quality of the be relevant current controller mostly influences the presentation of the inverter system. Many control mechanism have been planned to control the inverter output current that is injected into the utility grid. Among these control mechanisms, three major types of current controller have evolved: hysteresis controller, predictive controller and linear proportional integral (PI) controller. Predictive controller has a very good steady state performance and provides a good dynamic performance. However, its performance is sensitive to system parameters. The hysteresis controller has a quick transient response, non-complex realization and an inherent current safety. However, the hysteresis controller has some disadvantage such as variable switching frequency and high current ripples. These source a reduced current quality and initiate difficulty in the output filter design.

5.4 GRID SYNCHRONIZATION

The inverter output current that is given into the utility network must be synchronized with the grid voltage. The objective the synchronization method is to excerpt the phase angle of the grid voltage. The feedback variables can be changed into a appropriate reference frame using the removed grid angle. Hence, the detection of the grid angle plays an important role in the control of the grid connected inverter. The synchronization algorithms should respond rapidly to changes in the utility grid. Additionally, they should have the ability to reject noise and the higher order harmonics. Several synchronization algorithms have been proposed to extract the phase angle of the grid voltage such as zero crossing detection, and phase locked loop (PLL) nowadays, the most common synchronization algorithm for extracting the phase angle of the grid voltages is the PLL.

6. SIMULATION DIAGRAMI

In this model the PV panel is connected with grid system. Due to the irradiation problems a sufficient power will not obtained.

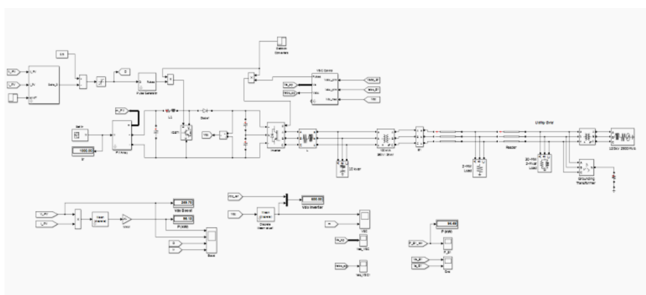

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Figure 5. Simulation Diagram

Implementation of hysteresis algorithm is required to overcome this problem**.** The gate pulse has been generated by connecting a voltage source inverter with the system. The PV system, designed in this work, aims to transfer electrical power from PV module to the grid. Primary, a DC-DC Converter is used to increases the PV voltage to a level higher than the highest of grid voltage. The converter also tracks the maximum power point of PV module.

7. SIMULATION RESULTS

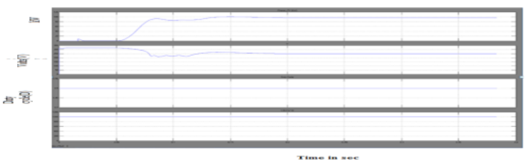

Figure 6. PV Input Power, Voltage, and Irradiation

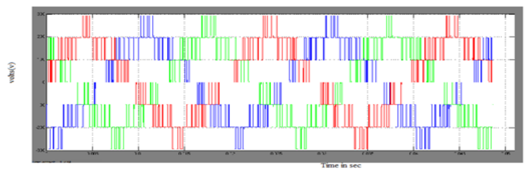

Figure 7.Three phase inverter output voltage

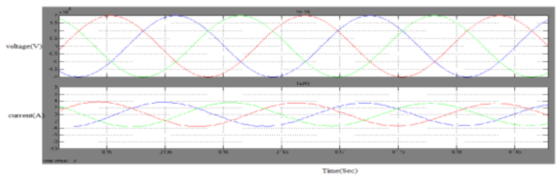

Figure 8. Grid Voltage and Current

8. CONCLUSION AND FUTUREWORK

In this project is grid-tied Multilevel inverter PV system based on dc-dc converters using hysteresis control has been proposed. The contribution of the project is to generate the multilevel power generation. A detailed low-frequency power mitigation control for the Boost converter was proposed based on the dynamic model of the converter. With the proposed using hysteresis controller algorithm, the large low-frequency voltage ripple on the dc-link can be blocked away from the Photo voltaic side. This proposed influence mitigation control can be extended to other boost converter output to the grid. Hysteresis current control MPPT method was also proposed. Fast tracking speed under rapid irradiation change and high MPPT efficiency were realized for the PV system. The future work is simply overcome the drawbacks of the present simulation result. Present work is the generation of high frequency grid level power generation in this output. The future work depends on the enhancement of this power generation. Power factor phenomena is consider as that we go for load change and also the usage of synchronous condenser, adding of capacitor banks, static compensators etc. by increasing the efficiency of the output signal and the reduction of harmonic noise will considered for the future enhancement.

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