Design and analysis of Three-Phase Grid-Connected with Solar PV power based using MPPT Device

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Abstract **- The need for electrical energy is increasing day by day and the surplus electrical energy needed is provided by renewable energy sources (RES). The use of RES is a solution to save fossil fuel reserves for future generations and also protects the environment. Solar energy as RES has several advantages like freely available, pollution free, etc., solar energy is converted into electrical energy using solar photovoltaic (PV) system, it has several advantages and few challenges as well. The voltage generated depends on solar irradiation and operating temperature. The number of PV systems connected to the grid is always increasing and this is leading to various challenges such as voltage quality, power quality, islanding, etc., and these need to be increased. The photovoltaic solar system is used as a distributed generator (DG). These DGs help to meet the additional demand for electricity, improve power quality, reduce distribution losses, etc. The model discussed is designed with Simulink block libraries and made in Matlab/Simulink software. Simulations are run and the results are deliberated and discussed.**

Index Terms **- Solar Cell, MPPT, DC/DC converter, Grid, MATLAB/Simulink.**

1.INTRODUCTION

Many concerns have arisen as a result of the use of fossil fuels as a primary source of energy production. In terms of power generation, India ranks sixth. Thermal power plants produce approximately 65% of India's energy, while hydroelectric plants generate 22%, nuclear power plants generate 3% and other alternative sources such as solar, wind and biomass generate the remaining 10%. India's large coal reserves account for 53.7% of the country's commercial electricity demand. The use of green technology, such as a solar power system, is often used to remove or mitigate such problems. The most serious problem associated with the use of fossil energy is global warming; where rising fossil fuels such as oil and natural gas are used to generate electricity over several decades, results in a number of environmental and health issues.

Photovoltaic power generation based on solar cells that is ready for direct conversion of solar energy to DC Electricity has the potential to be a clean energy source and could be a widely relevant affordable renewable energy source for future energy production. As a result of the development of photovoltaic processing in recent decades, the participation and role of electric utilities in PV has increased significantly. Observations on the DC side of the inverter are necessary, so for measuring and keeping track, MPPT algorithms are used for the highest operating point at each instant. Numerous approaches have been found and discussed in this decade to reduce or eliminate these measurements, system complexity is minimized, and it is more cost-effective. The DC/DC converter controls the total output, while the DC/AC converter synchronizes and feeds the necessary power to the grid in a two-stage topology, it is one of many approaches to a sensor less MPPT algorithm.

However, such strategies require at least one calculation, such as current or voltage on the DC side of the converter, as well as a large number of power switching instruments. Other methods, on the other hand, use a one-stage converter topology, which has the advantage of reducing the number of conversion steps and power switching units. There was a decrease in the number of sensing elements in a stage topology, and on the DC side of the converter, the MPPT algorithms need at least one sensing component, which involves filtering the calculated values to have the DC quantities averaged, requiring more computational power of the controller, and was suggested for the MPPT algorithm.

There are several research works in progress on improving the power quality of photovoltaic systems, such as elimination strategies or harmonic compensation. When the electrical energy generated by the Renewable energy resources are supplied to the grid through the grid-connected inverter, the inverter must provide zero steady-state error, fast response and robustness to disturbances. In addition, the grid-connected inverter must effectively compensate for system imbalance, reactive power and harmonics. Conventionally, simple PI control is used to regulate the grid-connected inverter. Distortion caused by harmonics under the distorted network cannot be properly compensated using the PI controller.

This article presents a grid-connected photovoltaic system and the inverter control strategy, which is based on active and reactive power control using the Park transformation or dq0 transformation in a three-phase grid-connected photovoltaic system. MPPT based controller to DC-AC converter is designed in this article using Disturb and Observe.

2 PHOTOVOLTAIC ARRAY MODELING

We can say that a solar cell is a kind of p-n junction diode that generates the charge carriers when the intensity of an input photon exceeds the band gap of the semiconductor component. Many photovoltaic cells are connected in series and in parallel to form a photovoltaic module and a photovoltaic array is a series or parallel interconnection of modules composed of several photovoltaic cells to achieve the desired power. The model is ideal for scientific conditions because it includes a series and parallel resistance as well as terminal voltage observation.

Control scheme

The idea of the current control simulation is to get the clamping of the active input current Ii(t). This active fixation brings the following advantages to the system:

1. Management of the energy flow between the grid and the photovoltaic solar installation.
2. And the possibility of performing MPPT of photovoltaic panels.

When using the P&O method for MPP tracking in the photovoltaic system and it is noticed that the voltage values vary very little with time, the difference in the intensity of solar irradiation undergoes significant changes. In India, most places do not have significant and large temperature variation during the day. The MPP approach is based on the latest control system and this is achieved by keeping the voltage constant and close to the MPP at the PV terminals. An example is given below for the current properties and voltage properties of a photovoltaic cell for various irradiance values.

3 MODELING

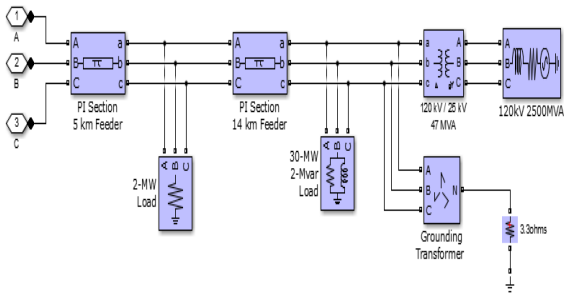

Figure 1 Grid Power Supply with magnitude

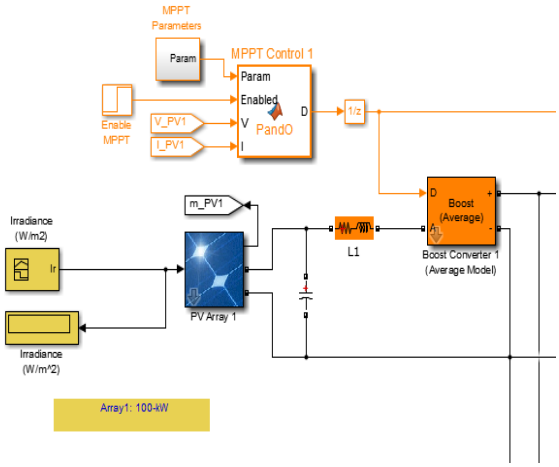

Figure 2 Array 1 with components

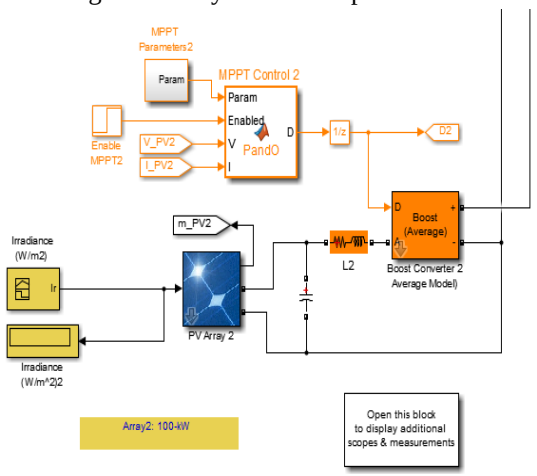

Figure 3 Array 2 with components

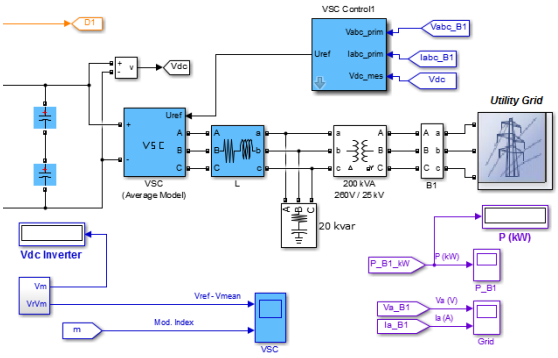

Figure 4 Grid Power Supply with Inverter System

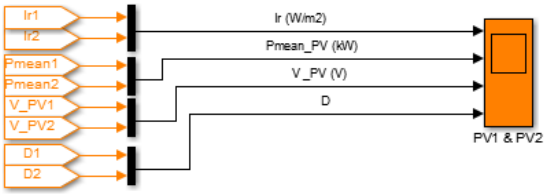

Figure 5 Scope of PV 1 and PV 2

4 RESULTS AND DISCUSSION

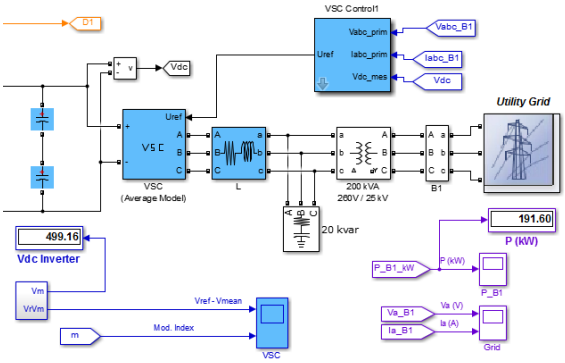

Figure 6 Grid Power Supply with Output Voltage and Power

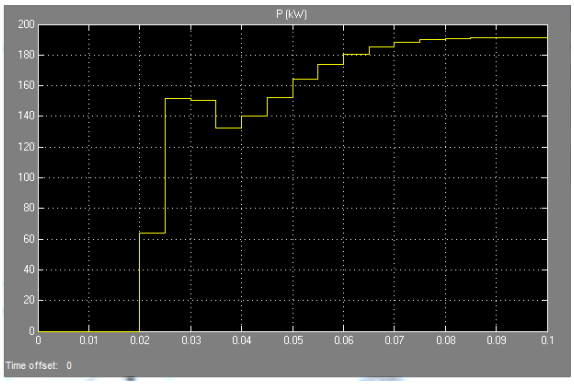

Figure 7 Output Power

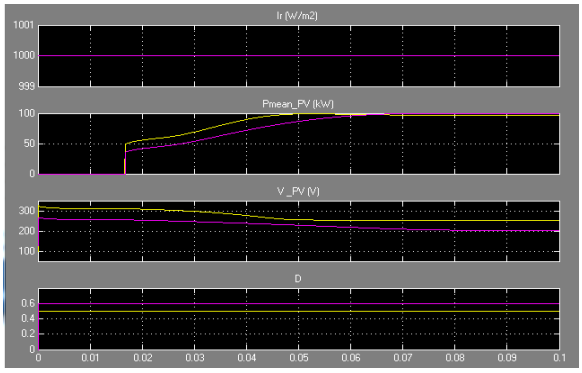

Figure 8 Output of Various Parameter

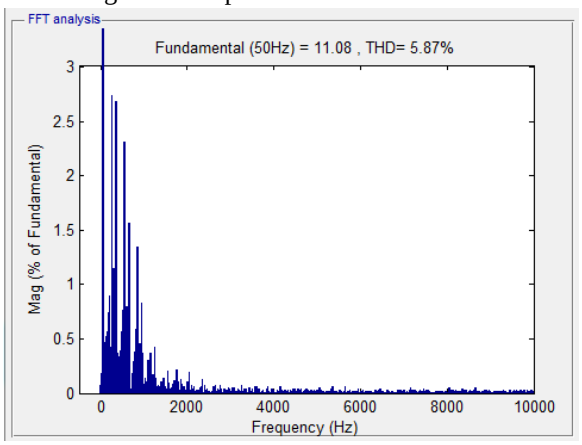

Figure 9 FFT Analysis (Total Harmonic Distortion)

5 CONCLUSION

In this article, the photovoltaic system is modeled, all its elements are modeled, the simulation of the autonomous photovoltaic system and the photovoltaic system connected to the grid is performed. The input parameters are solar insolation of 1000 W/m2 and operating temperature of 25℃. The current voltage at this radiation intensity and the ambient temperature are plotted for both operating modes. The P&O method of maximum power point tracking strategies is used in this work and is simulated. The boost DC/DC converter, inverter, is part of the photovoltaic system. Output Voltage by inverter power supply (499.16 Vdc) and Power is 191.60KW, which is shown in Figure 6.Total Harmonic Distortion(5.87%)is shown in Figure 9.

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