Modelling and Analysis of Grid Connected PV System

Nikhil Kumar Singh, Dr.Vinod Kumar Singh, Ashish Kumar Singhal

Abstract— **In this paper a grid-connected photovoltaic (PV) system is introduced along with under varying load condition. Based on this, a number of schemes are introduced. Increasing demand and investment in renewable energy give rise to greater development of high penetration solar energy. Compared to the nonrenewable energy resources, photovoltaic (PV) system is an important phenomenon that uses the solar energy to produce electricity [1, 2]. It is considered as an important renewable energy that has a great potential and development of solar power are increasingly fast compared to its counterparts of renewable energies. Such systems can be either stand-alone system or utility grid connected.**

Index Terms— **Matlab/ Simulink, Maximum Power Point Techniques (MPPT)**

I. Introduction

In the last few years, the demand for renewable energy has increased significantly due to the disadvantages of conventional fossil fuels and greenhouse gas effect. Among various types of renewable energy resources [1-2] , solar energy and wind energy have become the most promising and attractive because of advancement in power electronic technique for production of electricity. Photovoltaic (PV) sources are used recently in many applications because they have the advantage of being maintenance free and pollution free.[3-5] In the past few years, solar energy demand has grown consistently due to the following facts:

1) Increasing efficiency of solar cells
2) Manufacturing technology improvement
3) Economies of scale.

The high uses of PV technology was induced by continuous increase of energy price generated in coal, diesel and gas power plant. PV systems have been required to reduce costs in order to complete the demand of population and compete on energy market but on the same time to provide reliability. Usually reliability of a PV system is associated with inverter topology and the main components.

At the same time, more PV modules have been attached in series and will be connected to utility grid in many countries. The largest PV power plant is more than 100MW all over the world. But, the output of PV arrays is significantly influenced by solar irradiation and weather. More importantly, high initial cost and limited life time of PV panels make it harder to extract as much power from them as possible. Therefore, maximum power point tracking (MPPT) algorithms should be implemented in DC/DC converter to achieve maximum power efficiency of PV arrays. Several algorithms have been developed to achieve MPPT technique [6-9].The fast expansion and development of PV system into the lower parts of grid raised several concerns for grid reinforcement. This is the reason; grid Operators had to impose strict operational rules in order to keep the LV grid under control and to harmonize the behavior of all distributed generators connected to it in terms of accuracy, efficiency and prices.

The disadvantage of solar energy is that PV solar power generation depended on weather. Thus, the battery energy storage is necessary to help get a stable and reliable output from PV generation system for varying loads and improve both steady and dynamic behaviors of the entire PV generation system. The project presents detailed modelling of the grid-connected PV/Battery hybrid generation system components, in Simulink / MATLAB software. There are multiple ways to attach PV arrays with the power grid. The topology of a multi string three-stage PV module with an inverter and converters are developed in this project report, which is more suitable for medium power applications. However, the output of solar PV arrays varies due to change of solar irradiation in different fields and change in weather. Therefore, the maximum power point tracking (MPPT) algorithm is implemented in converter to ensure PV arrays to operate at maximum power point.

II. PROBLEMS OF GRID CONNECTED PV SYSTEM WITH INVERTER

The increased number of grid connected PV system with the use of inverters gave rise a lot of problems concerning the stability, efficiency and safety of grids. The main problems are:

Voltage Rise Problem

The integration of large amounts of PV system in the LV network increases generation of active power leading to increase in the rise of voltage along the feeders. At the moment the voltage rise does not exceed the 2% limit imposed by old grid code but now a days this limit has been increased by 3%.

50.2 Hz Problem

When the grid frequency reaches and exceeds 50.2 Hz an immediate shutdown is required from the grid connected generators to avoid risks which can appear in operation of network. If power deviation is higher than the predefined power of primary control, the system will not be able to stabilize and control the grid frequency. To overcome this problem we should use the frequency dependent active power control.

Increased Harmonics

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As PV system leads to an increase in harmonic content at the connection point. Each PV system connected to utility grid injects harmonics. More PV systems are connected the more harmonic content will increase. If one or more non linear loads are present, the total harmonic distortion can increase above allowable limit [5,6].

Increased Voltage Unbalance

The features of installed PV system such as their location and power generation capacity can lead to an increase in the voltage unbalance. This effect most the power quality in the LV residential networks due to random location of PV installation and their single phase grid connection. The voltage of three phases is different because the PV systems are installed randomly along the feeders and with various ratings. When the difference in amplitude between these phases is high then voltage unbalance increases.

Anti-islanding

Islanding happens when the PV generator is disconnected from the grid, but continues to supply power locally. The islanding problem mainly occurs in Low Voltage (LV) Networks, Therefore it is recommended for the generation units to disconnect the power supply within a narrow frequency band such as 49 to 51 Hz.

III. MATLAB SIMULATION RESULTS

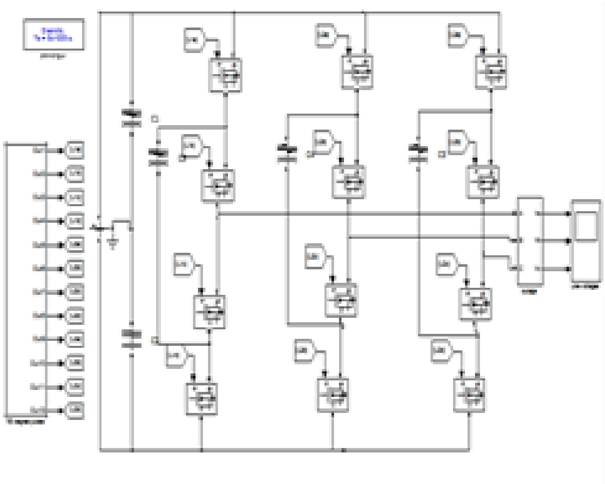

Fig.1: Complete Model of grid connected PV system

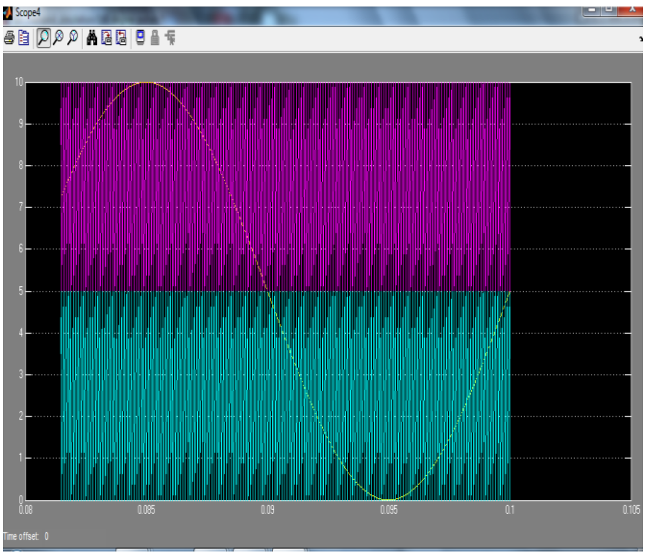

Fig.2: Input Signal-1

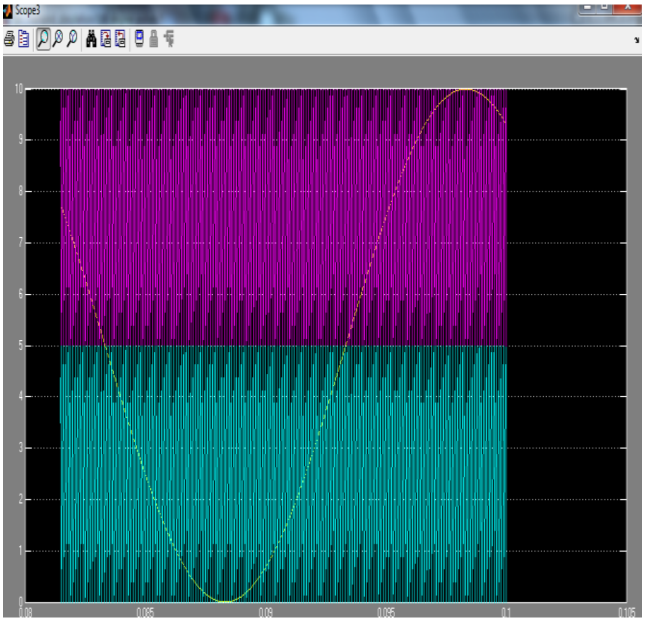

Fig.3: Input Signal-2

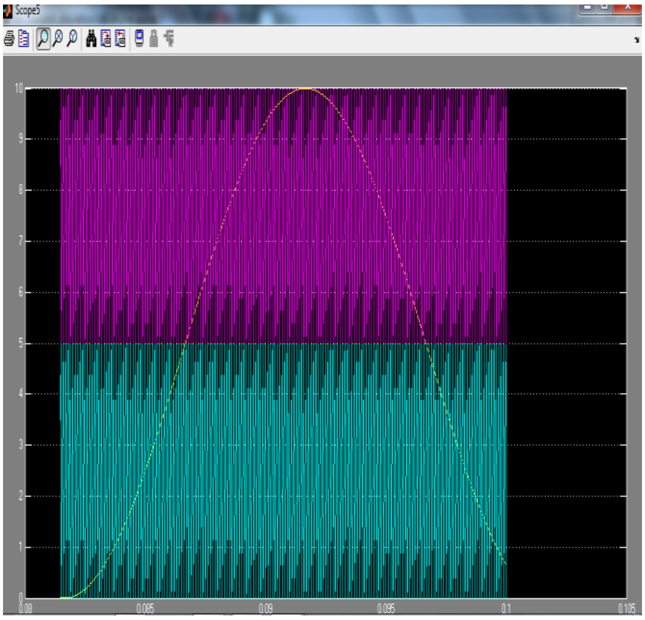

Fig.4: Input Signal-3

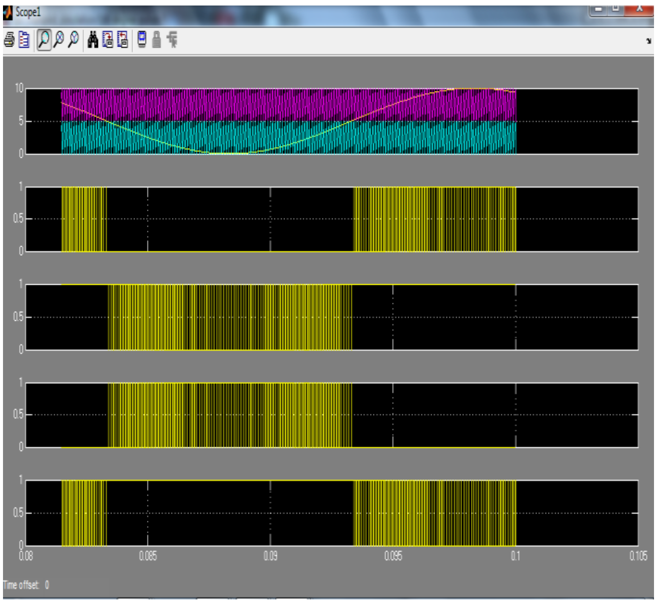

Fig.6: Input Signal with 120 degrees phase delay

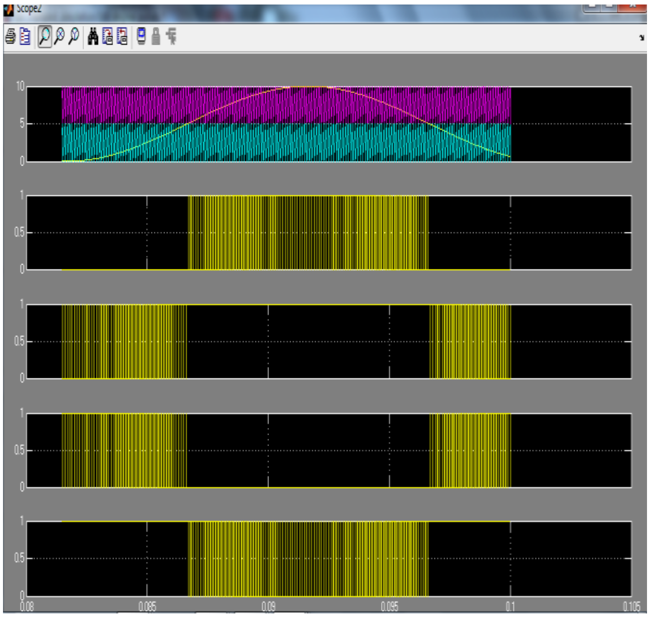

Fig.5: Input Signal with 240 degrees phase delay

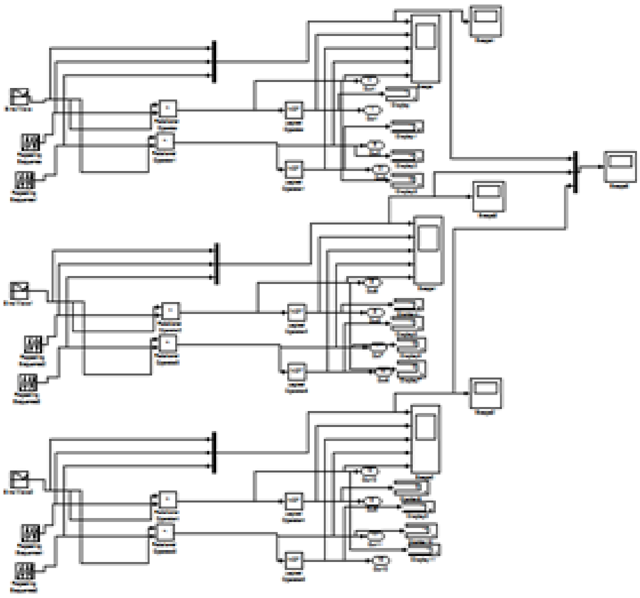

Fig.10: PWM 180 degree pulse

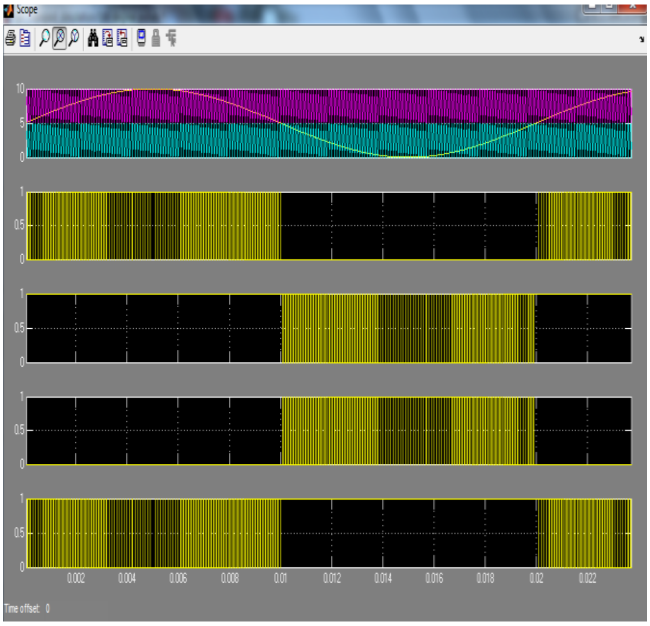

Fig.7: Input Signal with 0 degree phase delay

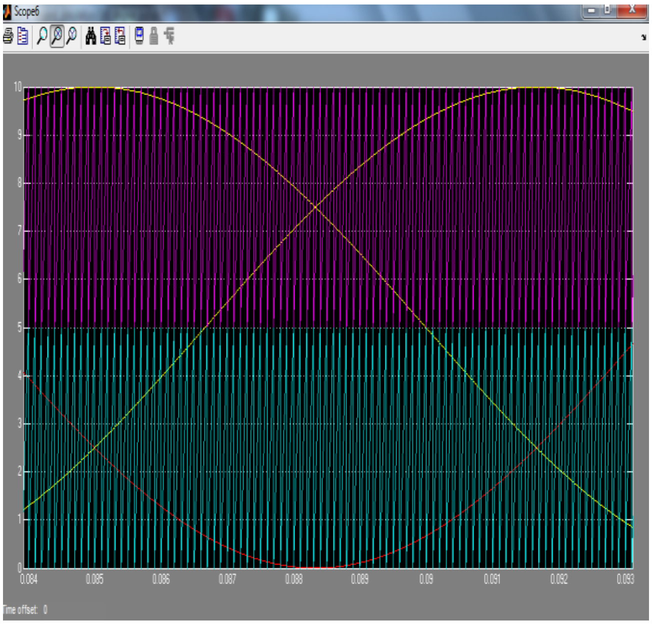

Fig.9: Complete PWM Signal

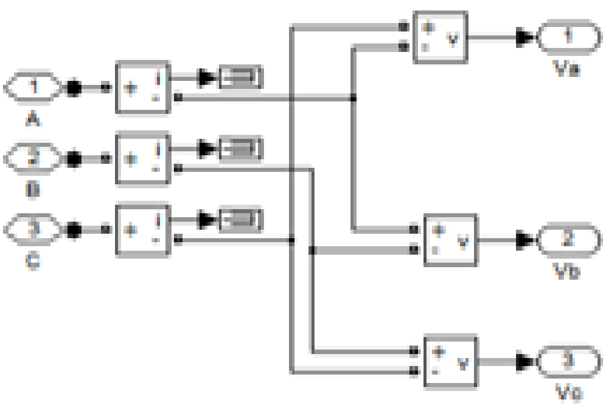

Fig.8: Current measurement and Voltage Measurement

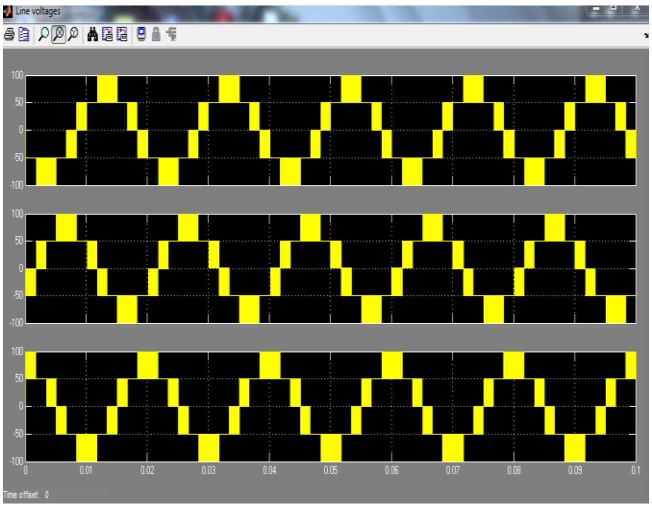

Fig.11: Final Sine wave form

IV. CONCLUSION

This study presents a single-phase five-level Photo-Voltaic (PV) inverter topology for grid-connected application. The photovoltaic models, operation of suggested inverter topology, control system calculations, modulation technique and results of simulation were analyzed. The control system methods are created in MATLAB version. The FUZZY - PI current controller was produce low harmonic distortion and improved sudden step response compare to PI current controller. The grid current is nearly sine wave and the power factor also near unity. Further, in the system will be applied to real time application [4, 5].

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