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GRID CONNECTED SMART PHOTOVOLTAIC SYSTEM

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ABSTRACT

Solar photovoltaic energy conversion has gained much attention nowadays. The performance of solar photovoltaic system mainly depends on the solar radiation falling on the panel surface. Shading across the panel surface is the main cause for the degradation of its performance. It was found that due to 25% shading the reduction in short circuit current and maximum power output was respectively 40.72% and 41.40%. Similarly, the reduction in short circuit current and maximum power output was 60.86% and 61.80%, respectively. This paper work on PV Systems with intelligent grid control and It solves the problem of shading to the available PV modules which is sensitive to the existing central inverter system topology by proposing a PV system which is more efficient and reliable. This thesis is focused on the design of the PV-grid connected inverter power stage that supports the PV system under shading

Keywords: *Photovoltaic; shading; Smart PV system, centralized inverter, string inverter.*

I. INTRODUCTION

Photovoltaic (PV) power supplied to the utility grid is gaining more and more visibility, while the world's power demand is increasing. Solid-state inverters have been shown to be the enabling technology for putting PV systems into the grid [1]. Integration of PV power generation systems in the grid plays an important role in securing the electric power supply in an environmentally-friendly manner [2]. Grid-connected PV System comprises of PV panel, a DC/AC converter that capably connected to the grid. This system is used for power generation in places or sites accessed by the electric utility grid. If the PV system AC power is greater than the owner's needs, the inverter sends the surplus to the utility grid for use by others. The utility provides AC power to the owner at night and during times when the owner's requirements exceed the capability of the PV system [3]. Depending on the application and requirements PV system can either be a standalone or hybrid system. The concept of smart grid is introduced in PV systems [4] depend on different ways of power utilization in the future. A smart grid construction with more strength and higher efficiency in power utilization is on schedule worldwide.

Due to a large amount of new technologies and service will be raised, updated or replaced in smart grid from traditional power grid, a framework of the whole smart grid structure become necessary for the huge costly deployment, as well as the characteristics and functionalities. Smart Grid is a large and complicated concept which is still holding debate on its definition because of the expected emphasis addressed by each participant

Grid –Connected Inverters Technology

There are different technologies and topologies available for grid connected PV systems which are categorized based on the number of power stages. In PV plants applications, various technological concepts are used for connecting the PV array to the utility grid. Each technology has its advantage and/or disadvantages compared to other, interns of efficiency and maximum power point tracking.

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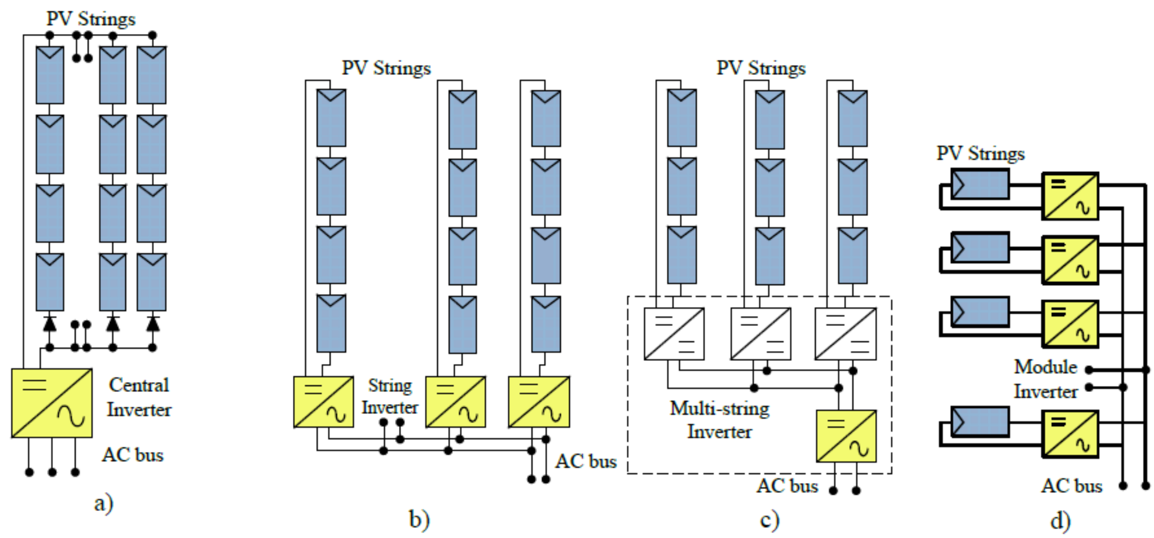


Figure 1: PV grid connected systems configurations a).Central Inverters; b). String Inverters; c).Multi-String Inverters; d). Module inverters [3]

Problem Formulation and Identification

PV system is among the centralized inverter system topologies connected from single PV array resulted from parallel connected strings. Although the solar façade is south facing, effects of occasional shading have had to be minimized to maximize electricity generation [5]. Plant-oriented configuration has observed to be one of the most popular PV grid-connected system's architectures due to its simplicity and low cost per peak kilowatt, and assumes a single PV array formed by parallel connection of strings which is linked to the grid through a single central inverter. The DC power extraction is carried out by the inverter input stage which is generally driven by a maximum power point tracking (MPPT) algorithm in charge to ensure the PV array operates at its maximum power point regardless of the environmental (irradiance and temperature) conditions explained in [6] [7].

Partially shaded of the PV array by clouds or by surrounding obstacles such as nearby buildings and trees, has been the major source of power losses in such architecture. These losses are mainly due to PV module failure or the electrical configuration of the PV array, in particular to the hardwired series connection of PV modules in each string since a partially shaded module limits the string current where it is connected, thus reducing the maximum available dc power of the PV array . It is also stated in the literatures [6] [7], one of the strategies to improve DC power from a partially shaded solar array is to modify the power processing architecture. This approach improves the energy efficiency and the reliability of the PV system. The strategy is based on a previous association of the available PV modules in several independent PV arrays.

Each PV array is formed by the PV modules operating under similar environmental conditions to reduce the current limitation on the strings. In addition, the dc power is improved by a modified power processing architecture which shares out the maximum DC power extraction task among as many power processors as independent PV arrays.

II. DISCUSSION AND SIMULATION

The circuitry design of the partial shading PV module detailed in Fig.2 is implemented in Simulink. MATLAB Simulink controls the circuits. Simulink controls the output voltage of the inverter by SPWM generated from the inverter controller. The general idea is to present the whole PV-Grid system together as real and visible system in a Simulink environment. In the control system there are function blocks for converting the inverter output to RMS value. It also gives the frequency at each time the simulation is running up to when 50Hz grid frequency is attained.

The three phase grid is shown and one phase is taken to compare with the inverter outputs as well for switching signal generation

Output waveforms of the inverter in Fig.3 shows at the Simulink scope stable response of the grid voltage and output current.

Figure 4 shows during shading of the PV panel the maximum power is extracted from the panel.

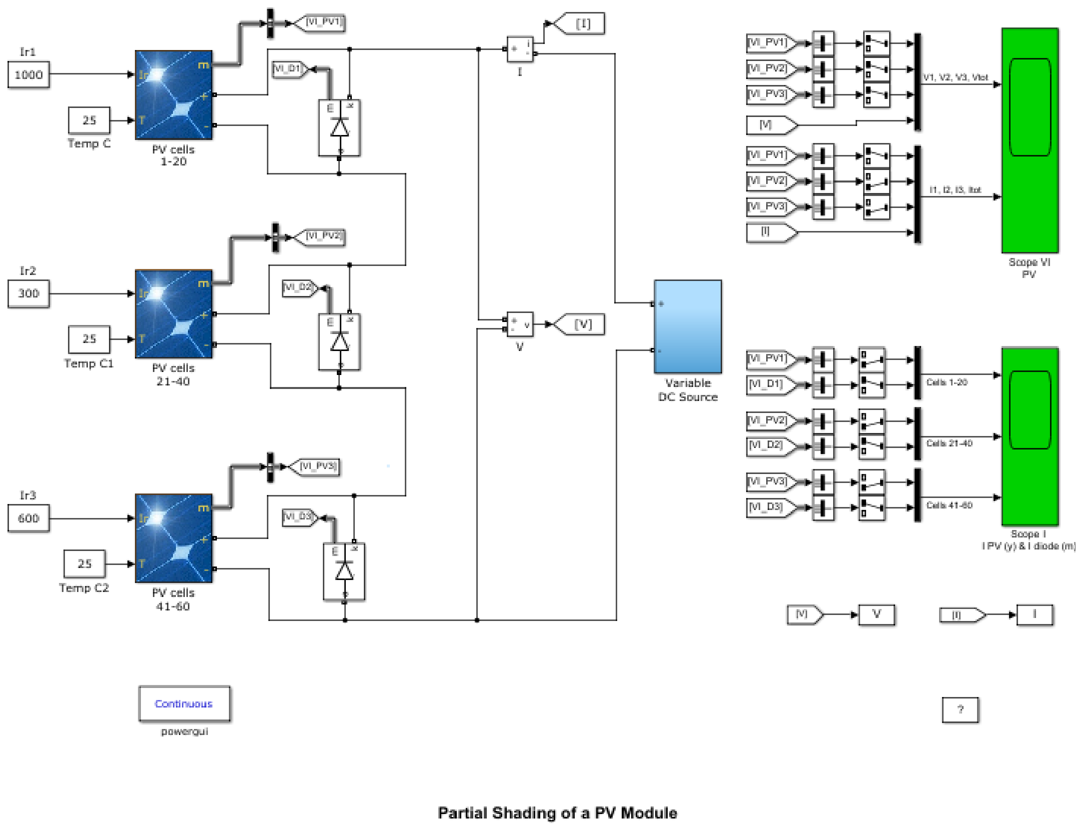
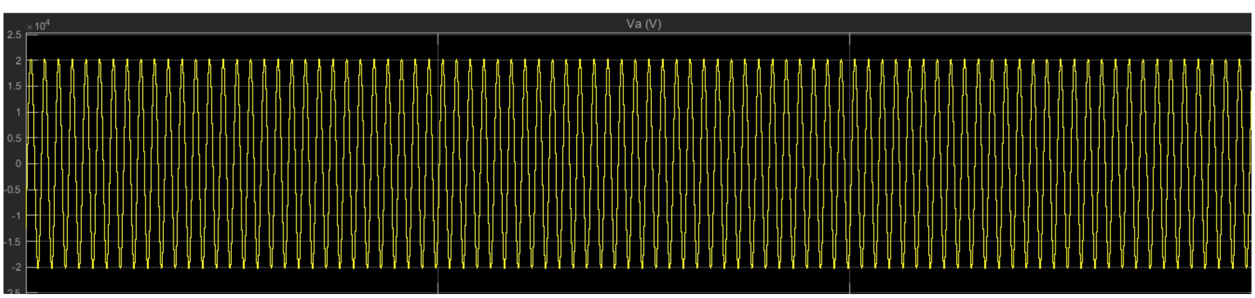
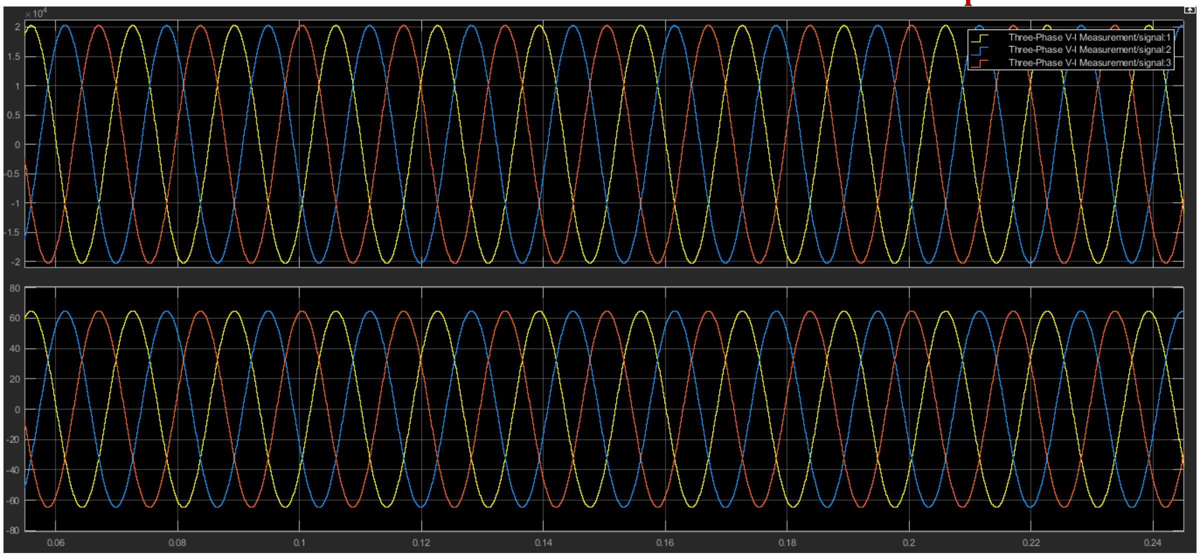


Figure 2: partial shading PV module



a) Filtered Inverter output voltage



b) Grid side output voltage and current

Figure 3: output waveform of the inverter and grid

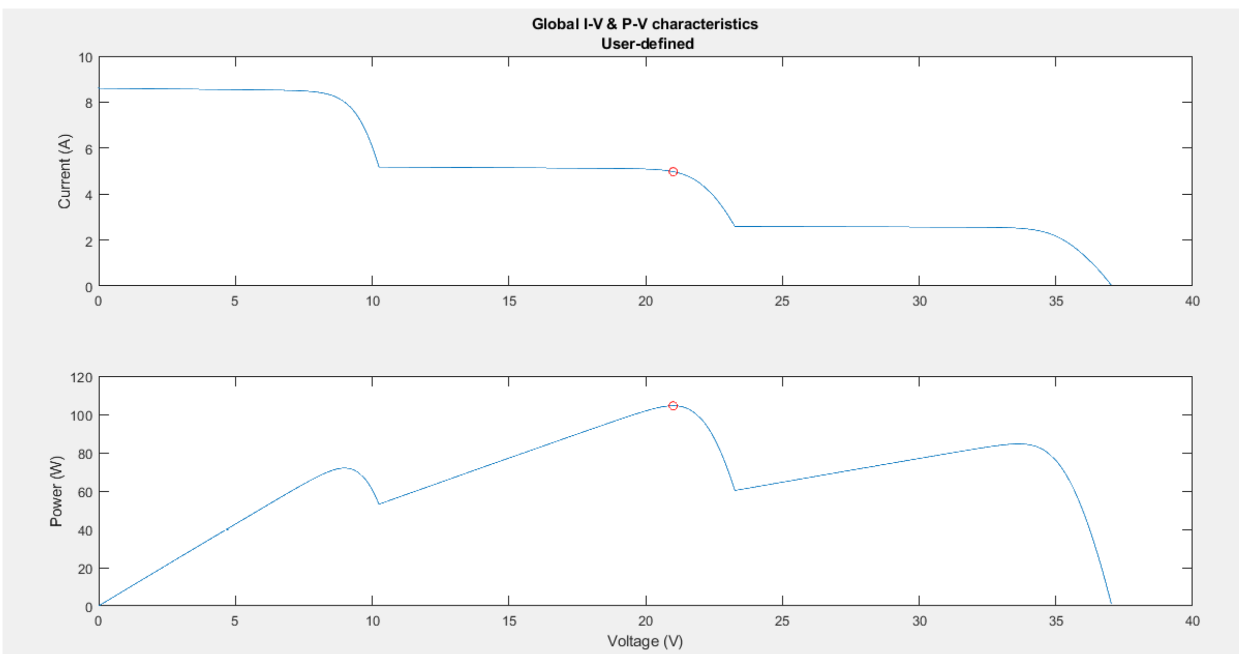


Figure 4: maximum power is extracted during shading

III. CONCLUSION

PV system model with different irradiance level for representing shading effect has been proposed in this thesis. The system is very useful for academic purposes and researches. The string of the proposed PV system can easily be integrated with other renewable energy sources available. Each inverter of the system is independent and therefore the supply of electricity will be available all the time regardless of whether one inverter fails. Thus this system is available and reliable.

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