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RESEARCH ARTICLE

MODELLING AND ANALYSIS OF SEPIC INTEGRATED INVERTER FOR PV GENERATION

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ABSTRACT

The grid inverter plays a vital role in new energy development and utilization. By improving its energy efficiency and the crisis in transfer of power advances the structure for photovoltaic (PV) grid inverter with good performance can be achieved. The inverter control system has its high speed and flexibility. The source harmonic current is remarkably reduced. The SEPIC converter allows a range of dc voltage to be adjusted to maintain a constant voltage output. The simulation model of the photovoltaic generation is established based on MATLAB/SIMULINK.

INTRODUCTION

The most common attention of alternative energies is solar energy .There are two types of technology that employed solar energy namely solar thermal and solar cell. A PV cell (solar cell) converts the sunlight into the electrical energy by the photovoltaic effect. Energy from PV modules offers several advantages such as requirement of little maintenance and no environmental pollution. Recently PV systems, solar powered water pumping systems, grid connected PV systems ,solar cells photovoltaic (PV) devices, and storage battery sources produce low voltage , so a dc-dc boost converter is generally required to adapt the voltage level for the grid-connected inverter. This dc-dc converter, in addition to boosting, also regulates the inverter input voltage and sometimes isolates the low and high voltage circuits. The system is made up of one or more solar PV panels, an AC or DC power converter that holds the solar c for the other components. Photovoltaic modules or solar panels. A photovoltaic array is a linked assembly of PV modules. Most PV array use an inverter to convert the dc power produced by the modules into alternating current. The modules in a PV array are connected in series to obtain the desired the voltage. The purpose of this paper is to develop the necessary models of the various subsystems of a SEPIC converter-based PV power plant and to use such models in simulation studies to learn the impacts of PV variability and intermittency on the power system and in managing variability problems with energy storage.

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The conventional stand-alone photovoltaic systems have the advantages of simple system configuration and control scheme. However, in order to draw maximum power from PV arrays and store excess energy battery banks are required in these systems. For high power systems, they will increase system cost and weight, and narrow the application areas. According to the photovoltaic array mathematical model, a PV grid inverter simulation model based on MATLAB is established. Many simulation software packages like PV-Spice, PV – Design and PV-cad exist. Despite the inevitability of modelling to proper understanding of PV systems, with few exceptions, utility simulation tools lack standard-library models for PV systems.

Existing System

The main elements that can be included in a system of photovoltaic conversion are photovoltaic modules, converters utility grid loads DC and AC, inverters. It is an arrangement used in PV standby power supply units; it is called grid connected system without a battery backup. Although systems with battery backup confront the issue of reliability of the grid supply but it is more complicated and more expensive PV cell directly converts the solar irradiance into electricity in the form of DC when sunlight interacts with semiconductor materials in the PV cells. The cells are connected in series and in parallel combinations in order to form and array with desired voltage and power levels, solar cells are combined to obtain the voltage and current desired. Photovoltaic systems have developed into a mature technology used for mainstream electricity generation.

However, they introduce numerous negative impacts into the electrical networks. As the capacity of PV systems is growing significantly, the impact of PV modules on utility grids cannot be ignored. Grid connected PV systems can cause problems on the grid, such as injecting more harmonics or reducing the stability. This problem can be solve when a large-scale PV module is connected to the grid. Current harmonics produced voltage distortions, current distortions and cause unsatisfactory operation of power systems. Inverters also introduce harmonics into the system in the presence of non-linear loads, during DC to AC conversion. Harmonic currents introduce voltage drop and result in distortion of supply voltage.

Proposed System

The system is mainly composed of the former stage of DC-DC converter, intermediate DC bus and the level of DC-AC inverter. The DC-DC converter boosts the DC voltage. First, sample the photovoltaic cells output voltage and current are computed, the collected signals based on improved conductivity incremental control algorithm. And then control the switch state of the DC booster circuit to realize maximum power. The oscillation phenomenon, which exists near the maximum exists near the maximum power point, was improved at a great extent, so to the efficiency of photovoltaic cells generate electricity. The inverter control system has an advantage in its high speed and flexibility by applying advanced control algorithm. Inverter technology is the key technology of photovoltaic power grid. As the interface device between solar cells and the power grid inverter play a vital role in the new energy development and utilization, affecting the economics and reliability of the photovoltaic (PV) grid generation system directly. Having improved the traditional control algorithm, we put forward a new design scheme of the model, upon which the experiment of the maximum power point tracking and photovoltaic (PV) grid inverter simulation is realized.

Characteristics of Solar

Array

A photovoltaic system uses one or more solar modules or solar panels to convert solar energy to electrical energy. Basically, its components include solar panels, mechanical and electrical connections and means of modifying the electrical output we get.

Photovoltaic cell

Solar cells are the building blocks of PV array. These are made up of semiconductor materials like silicon etc. A thin semiconductor wafer is specially treated to form an electric field; positive on a side and negative on the other electrons are knocked loose from the atoms of the semiconductor material when light strikes upon them. In an electrical circuit is made attaching a conductor to the both sides of the semiconductor, electrons flow will start causing an electric current. It can be circular or square in construction. It is made up of various semiconductor materials. But mono-crystalline silicon and polycrystalline silicon are mainly used for commercial use

Photovoltaic module

The voltage generated by a single solar cell is very low around 0.5v. So a number of solar cells are connected both in series and parallel connections to achieve the desired output.

In case of partial shading, diodes may be needed to avoid reverse current in the array .Good ventilation behind the solar panels are provided to avoid the possibility of less efficiency at high temperatures.

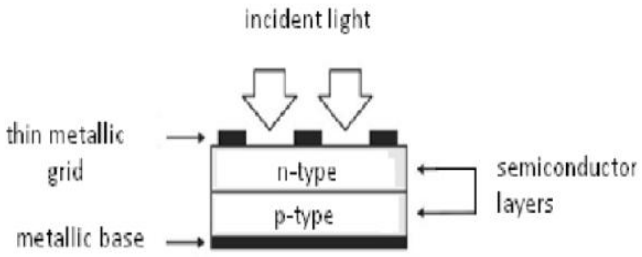

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Fig 1. Photovoltaic cell

Photovoltaic array

The power produced by a single photovoltaic module is not sufficient to meet the power demands for most of the practical purposes. PV array can use inverters to convert the dc output into ac output and use it for motors, lighting and other loads.

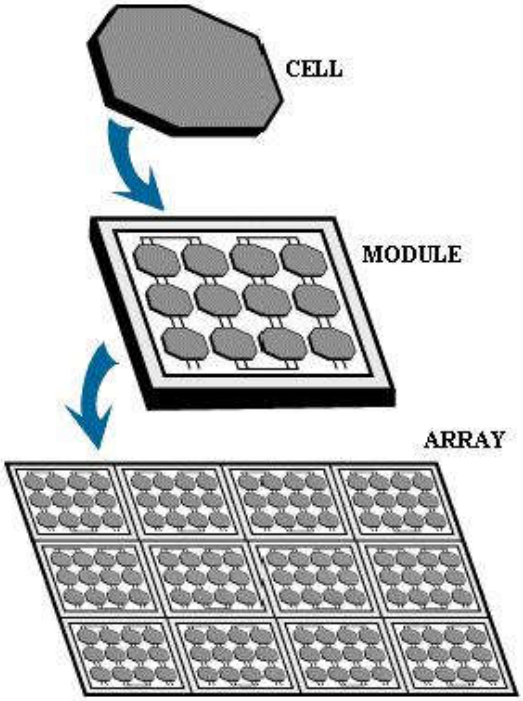

Fig. 2. Photovoltaic array

The modules are connected in series for more voltage rating and then in parallel to meet the current specifications.

Working of Pv Cell

The basic principle of photo electric effect is most important one in the modern world. Photoelectric effect can be defined as a phenomenon in which an electron gets injected from the conduction band as a consequence of absorption of the sunlight of certain wavelength by the matter. So, the photovoltaic cell when sunlight strikes its surface, some portion of the solar energy is absorbed in the semiconductor material. If absorbed energy is greater than the band gap energy of the semiconductor, the electrons from the valance band jumps to the conduction band. By these pair of hole electrons are created in the illuminated region of the semiconductor.

The electrons thus created in the conduction band are now free to move. These free electrons are forced to move in a particular direction by the action of electric field present in the PV cell. These flowing electrons constitutes current and can be draw for external use by connecting metal plate on top and bottom of PV cell. This current and voltage created because of it built.

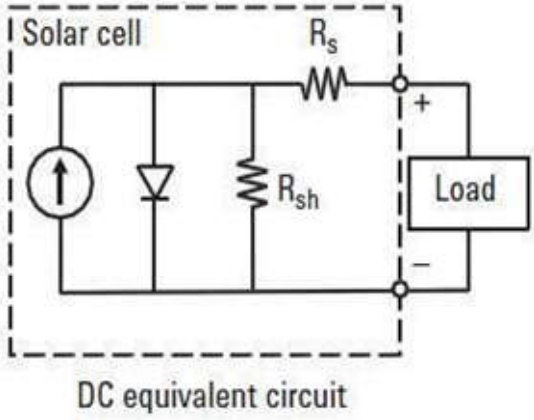

Fig. 3.Working of PV cell

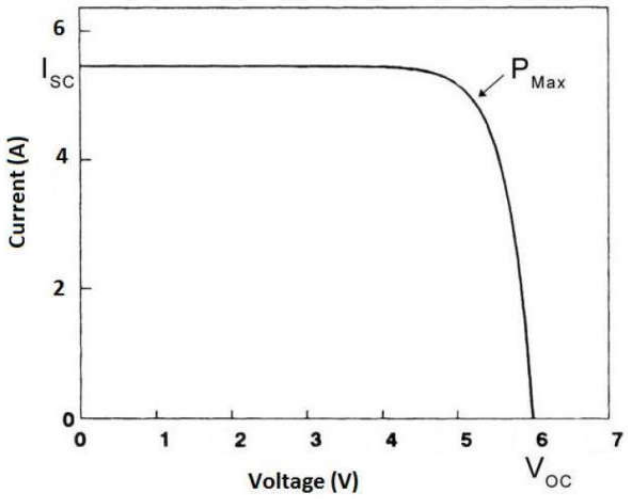

Fig. 4. I-V characteristics of a solar panel

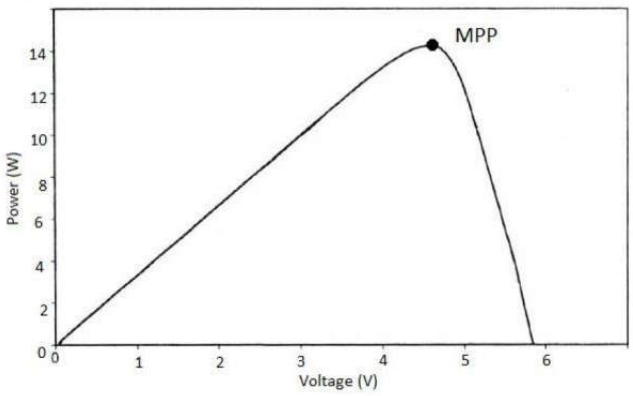

Fig. 5. P-V characteristics of a solar panel

Sepic Converter

The Circuit can run best with a steady and specific input. Controlling the input to specific sub-circuits is crucial for fulfilling design Requirements.

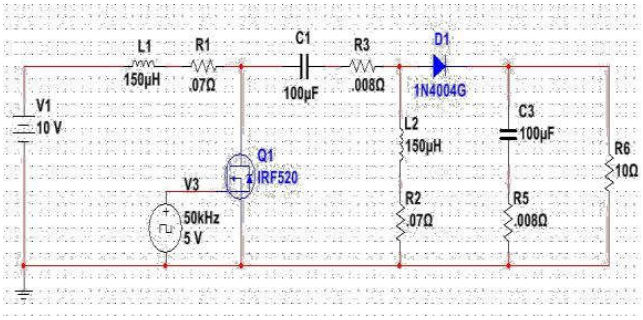

Fig. 6. SEPIC converter

Requirements Diodes and voltage bridges are useful for reducing voltage by a set amount, but can be inefficient. Voltage regulators can be used to provide a reference voltage. The most efficient method of regulating voltage through a circuit is with a dc-dc converter. There are 5 main types of dc-dc converters. Buck converters can only reduce voltage, boost converters can only increase voltage, and buck-boost, buck and SEPIC converters can increase or decrease the voltage. on the components this can result in device failure or overheating. SEPIC converters solve both of these problems.

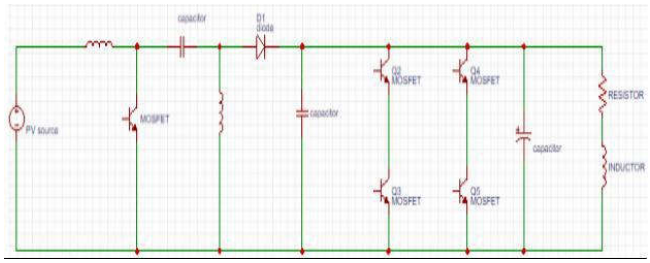

Fig. 7. Circuit diagram for SEPIC integrated inverter

Simulation Design

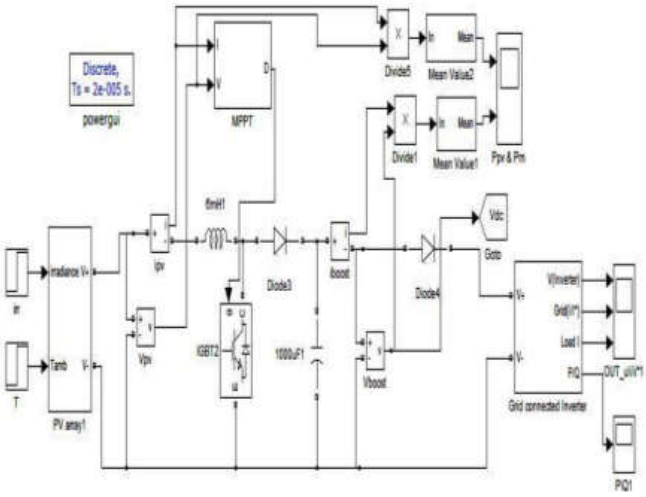

Fig. 8. Simulation model

Sometimes the desired output voltage will be in the range of input voltage. When this is the case it is usually best to use a converter that can decrease or increase the voltage .Buck-boost converters can be cheaper because they only require a single inductor and a capacitor. However, converter suffers from a high amount of input current ripple. This ripple can create harmonics; in many applications these harmonics necessitate using a large capacitor or an LC filter.

This often makes the buck-boost expensive another issue that can complicate the usage of buck-boost converters is the fact that they can invert the voltage. Buck converters solve both of these problems by using an extra capacitor and inductor. However, both buck and buck-boost converter operation because large amounts of electrical stress. The Photovoltaic grid connected inverter methods have 500 PV cells in series an thousand in parallel and other temperature of 300k light intensity 1000w/m2, grid voltage 220 volt , 50Hz, intermediate dc bus voltage 450volt simulation time is 0.4sec ,use PV array model for simulation. The grid current remains same frequency and phase as grid voltage power factor is equal to the photovoltaic array output power.

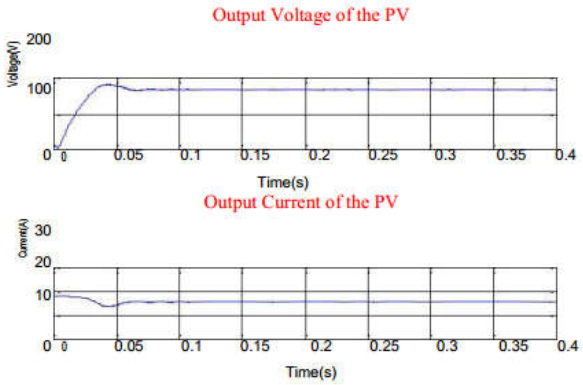

Fig. 9. Output waveform of PV

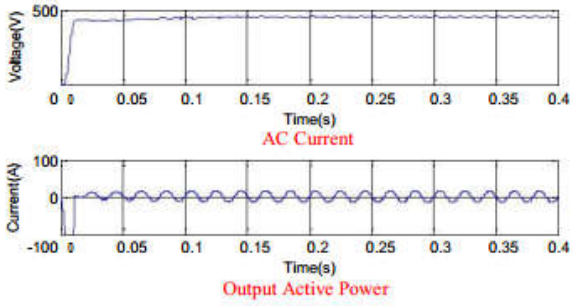

Fig 10: Inverter output waveforms

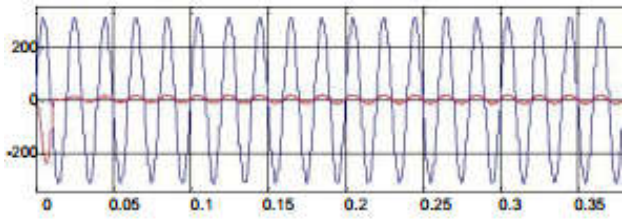

Fig. 11. output voltage and current

Conclusion

The mathematical model of the SEPIC converter connected to inverter fed to grid is demonstrated using SIMULINK/MATLAB. The PV array voltage and current is also shown. The method shows that the improved PWM inverter control method can make the voltage and current waveform of the grid tend to sine wave effectively and quickly, the power factor almost reach one. The simulation results indicate that the system is stable and it has good performance. Still can achieve better result with reactive and active power control with suitable topology of inverter with reduction of harmonic content.

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