Maximum Power Extraction in PV Systems using MPPT Techniques

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Abstract - *An In this paper MPPT technique are used for extraction of maximum power from PV system. Solar is main source of non conventional energy since wind energy is also the form of solar energy. Solar energy is converted into electrical energy by the help of Photo Voltaic system. Solar panels collect the sun's energy and convert it to electrical energy. Unfortunately, the sun is not consistent throughout the day due to cloud cover and the sun's angle relative to the position of the solar panel. In addition, the intensity of the sun varies according to season and geographical location. Furthermore the characteristic curve of a solar cell exhibits a nonlinear voltage-current relationship. Therefore, a controller named the maximum power point tracker (MPPT) is an essential part of a photovoltaic (PV) system, to find automatically the maximum power operating point at all environmental conditions and then force the PV system to operate at this point (MPP), to ensure the optimal use of the available solar energy.*

Key Words: Solar Energy, PV cells, Maximum Power Point Techniques, etc

1. INTRODUCTION

Photovoltaic (PV) power generation has received significant attention from scientists over the last few years to help reduce the environmental pollution inherently associated with traditional electric generators. The economic convenience of PV generation is directly connected to the cost of the cells and the amount of energy that the arrays are capable of supplying over their life. The former is influenced mainly by the price of the feedstock for the PV industry and the improvement of fabrication technologies. The latter is connected to the efficiency of the power conversion system, which is normally necessary when PV arrays are used for power generation. At the present state of the art, the control algorithms used for the maximization of the power extracted from PV arrays are widely known as maximum power point tracking (MPPT) algorithms. [1]

These power conditioners guarantee that PV arrays operate close to their point of maximum efficiency under any weather conditions. This is particularly important for variable irradiation levels, because the efficiency of the PV modules is very low when the operating point is far from the maximum power point. In the last few years, several MPPT techniques have been developed to maintain the PV arrays operating at their MPPs and have been proposed in the literature; examples are the Perturb and Observe (P&O) method, the Incremental Conductance (IC) method, the Artificial Neural Network method, the Fuzzy Logic method. It became clear that perturb and observe (P&O) technique was widely used for its ease of implementation. This paper present an adaptive perturb and observe MPPT for a photovoltaic module connected to the buck-boost converter (DC-DC converter)[2,3].The DC-DC converter is able to draw maximum power from the PV module for a given solar radiation level and environment temperature by adjusting the duty cycle of DC -DC converter.

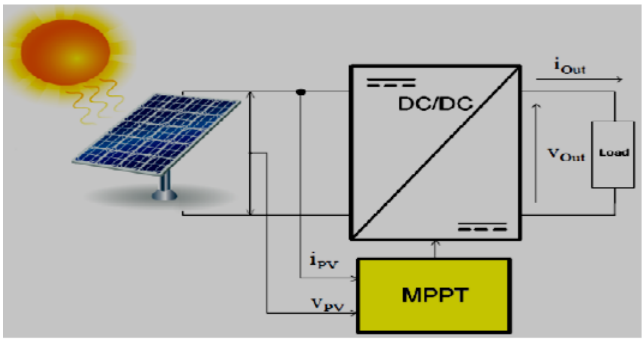

Figure 1: Module and dc/ dc converter with MPPT

1.1 PV System

Before Photovoltaic cells convert the sunlight into electricity directly [12], two categories of PV cells are used in most of today's commercial PV modules: crystalline silicon and thin film. The crystalline silicon category, called first-generation PV, includes monocrystalline and multi-crystalline PV cells, which are the most efficient of the mainstream PV technologies. These cells produce electricity via crystalline silicon semiconductor material derived from highly refined poly silicon feedstock. Monocrystalline cells, made of single silicon crystals, are more efficient than multi crystalline cells but are more expensive to manufacture [13]. The thin-film category, called second-generation PV, includes PV cells that produce electricity via extremely thin layers of semiconductor material made of amorphous silicon (a-Si), copper indium diselenide (CIS), copper indium gallium diselenide (CIGS), or cadmium telluride (CdTe).

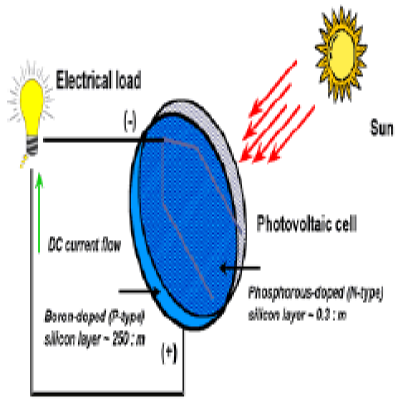

Figure 2: Working of Photovoltaic cell

PV cells are made of semi-conducting materials similar to those used in computer chips. When these materials absorb sunlight, the solar energy knocks electron loose from their atoms, allowing the electrons to flow through the material to produce electricity [4].

1.2 Materials used in a PV cell

a) **Single-crystal silicon:** Single-gem silicon cells are the most widely recognized in the PV business. The primary method for delivering single-precious stone silicon pertaining to the Czochralski strategy. High immaculateness polycrystalline is dissolved in quartz pot. A solitary gem silicon seed is dunked into this liquid heap of polycrystalline. The seed is brought out gradually from the molten liquid; a solitary precious stone ingot is shaped. The ingots are cut into slim wafers something like two hundred micrometers thick.

b) **Polycrystalline silicon:** Comprising of little grains of single-gem silicon, polycrystalline PV cells are less vitality effective than single-crystalline silicon PV cells. The grain limits in polycrystalline silicon block the stream of electrons and lessen the force yield of the cell. A typical methodology to deliver polycrystalline silicon PV cells is to cut dainty wafers from pieces of cast polycrystalline

2. MPPT Structure

The power delivered by a PV system of one or more photovoltaic cells is dependent on the irradiance, temperature, and the current drawn from the cells. Maximum Power Point Tracking (MPPT) is used to obtain the maximum power from these systems. Such applications as putting power on the grid, charging batteries, or

an electric motor benefit from MPPT. In these applications, the load can demand more power than the PV system can deliver. In this case, a power conversion system is used to maximize the power from the PV system. There are many different approaches to maximizing the power from a PV system, these ranges from using simple voltage relationships to more complex multiple sample based analysis. [6]

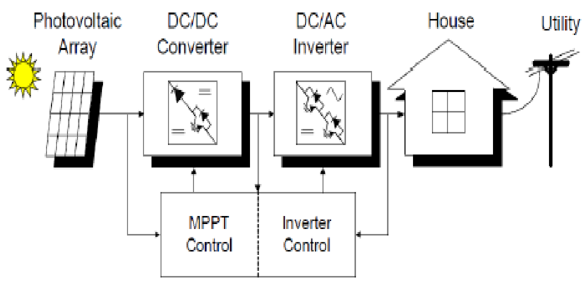

Figure 3: Structure of PV Power System

2.1 MPPT Modes of Operation

- **Continues mode:** This converter works in nonstop mode if the current flowing from the inductor never tumbles to null throughout the commutation. At the point when the switch as shown above in previous page is shut. The current flowing from the inductor climbs straightly. As the diode is converse predisposition by the source voltage V, no current courses from it.
- **Discontinues mode:** In some circumstances, the measure of energy needed is excessively little. For this situation, the current flowing from the inductor tumbles to nothing throughout a piece of time period. The main distinction in the standard depicted is that inductor is totally released at the ending of commutation. This has, be that as it may, some impact on the past mathematical statements. If converter works in relentless state, the energy in the inductor is the same at the start and attending of the cycle (on account of intermittent mode, it is zero). This implies that the normal estimation is zero for inductor voltage. [7-8]

2.2 Types of MPPT Technique

a) Curve-Fitting Technique:
b) Fractional Short-Circuit Current (FSCI) Technique
c) Fractional Open-Circuit Voltage (FOCV) Technique
d) One-Cycle Control (OCC) Technique
e) Hill Climbing/P&O Technique
f) Load Current/Load Voltage Maximization Technique
g) Incremental Conductance (Inc-Cond) Technique
h) Ripple Correlation Control (RCC) Technique [11]

3. Simulink Model and Result Analysis

Fig. 3 shows a complete model of the Solar Photovoltaic system incorporating a boost converter that boosts the voltage from the Maximum Power Point Tracking algorithm (MPPT). The simulation of this model has been done by taking different values of Irradiance and Temperature.

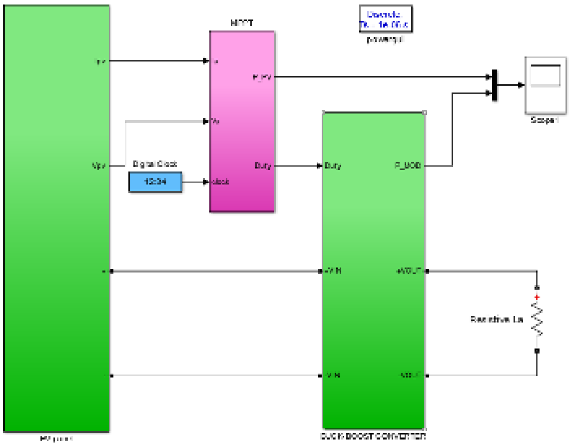

Figure 4: Simulink model of the proposed PV system

The variations of voltage and power with time are shown in the various graphs. The temperature and irradiance are varied and the characteristics curves of voltage and power are plotted with respect to time. From the graphs, it can be seen that as the irradiance is increased, the voltage increases and so there is a change in the output waveform. Thus, a direct effect on the output voltage with respect to the irradiance and temperature can be observed. The temperature when increased the PVG gives a higher output power.

It is observed from the graph that the variations are non-linear and are rather exponential. The outputs as obtained are shown in Figure 5.

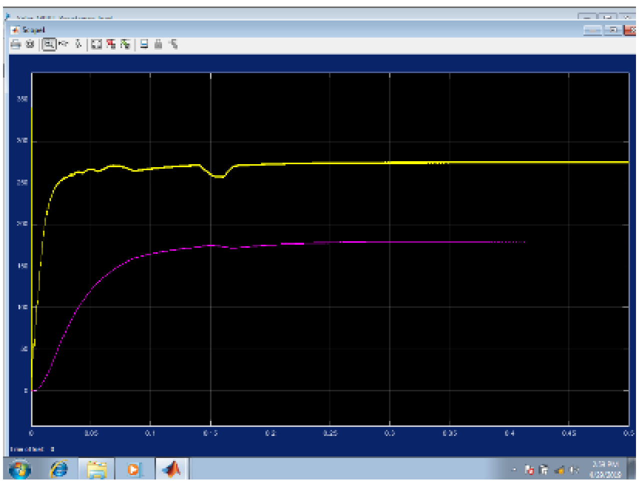

Figure 5: Simulink result

4. Conclusion

P&O MPPT method is implemented with MATLAB-SIMULINK for simulation. The MPPT method simulated is able to improve the dynamic and steady state performance of the PV system simultaneously. Through simulation it is observed that the system completes the maximum power point tracking successfully despite of fluctuations. When the external environment changes suddenly the system can track the maximum power point quickly. Both buck and buck-boost converters have succeeded to track the MPP but, buck converter is much more effective specially in suppressing the oscillations produced due the use of P&O technique.

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