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# MODELING AND SIMULATION OF PHOTOVOLTAIC MODULE WITH ENHANCED PERTURB AND OBSERVE MPPT ALGORITHM USING MATLAB/SIMULINK

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**ABSTRACT**

Modeling and analysis of photovoltaic (PV) system is substantial for designers of solar power plants to do a yield investigation that precisely predicts the expected output power under changing weather conditions. The model allows the prediction of PV module's behaviour and characteristics based on the mathematical model equivalent circuit using Matlab/Simulink platform under different temperature and solar radiation readings. The second part of this paper proposes an enhancement to the conventional perturb and observe (P&O) maximum power point tracking (MPPT) technique in order to overcome the disadvantages of this method such as oscillation and slow tracking under sudden change of atmospheric conditions. The proposed method suggested that utilizing a variable perturbation step size depending on power changes instead of constant step size which is used in conventional P&O algorithm in order to ensure that the solar energy is captured and converted as much as possible. The simulation results are compared with that of traditional P&O to demonstrate the effectiveness of the proposed method

**Keywords:** PV modelling, matlab / simulink, MPPT, perturb and observe MPPT, enhanced P&O.

## INTRODUCTION

Solar energy is available and clean source that has been used to generate electrical power. In the recent years, the total installed capacity of photovoltaic (PV) generation of electrical energy has increased dramatically from 40 to 177 GW in 2010 and 2014, respectively. The fast increasing usage and significance of PV energy is observed because it is uncontaminated, creates less impact to the environment, freely accessible, less maintenance requirement compared to other resources, creates less noise pollution, and easy to expand [1, 2].

The fundamental device of a solar system is the PV cell, which directly converts daylight into electricity. Typically, a PV cell produces voltage around 0.5 to 0.8 depending on the semiconductor type and the developed technology. This amount of voltage is insufficient and cannot be put to use. Therefore, the cells are linked together to consist a PV module which is the smallest unit that can be utilized to generate a useful amount of PV power. The modules can be connected in parallel and/or in series to form the PV array. In order to study electronics converters of the PV system that are used to regulate current and voltage of the load, to control the power flow of grid-connected photovoltaic power plant (PVPP) and primarily to track the maximum power point (MPP) of the module, one initially needs to know how to model the PV device that is attached to the converter. It is obvious that the output characteristics (I-V and P-V) of the PV modules rely on solar irradiation, temperature and the output voltage [3]. However, there is always a unique point on the V-P or V-I curve called the MPP. This point cannot be identified based on those characteristics, but it can be located by MPPT algorithms.

There are a lot of MPPT algorithms that have been utilized through the advancement of PV energy system. The issues of using MPPT to extract the maximum available power from the PV array has been studied and addressed using different algorithms in the literature. For instance, hill climbing (HC), incremental conductance (INC) method, perturb and observe (P&O) algorithm, look-up table method, constant voltage (CV) or constant current (CC). The aforementioned algorithms have been proposed and reported in [4, 5], In addition, there are high-efficiency algorithms such as particle swarm optimization (PSO) [6], fuzzy logic (FL) algorithm [7] and artificial neural network (ANN) algorithm [8]. These current methods have several advantages and drawbacks concerning to oscillations, complexity, speed, the cost and extra hardware.

A P&O MPPT technique is widely used in PV system due to its ease of implementation and small number of measured parameters required. They operate by increasing or decreasing the array voltage using fixed step value. In case PV array voltage perturbed at any direction and yield increases in terms of power value, this indicates that the operating voltage should be further perturbed in the same direction, otherwise the direction of the perturbation must be reversed. The disadvantage of this method is that it loses some amount of available power at steady state operation because of the oscillation at MPP, especially when the insulation and temperature constant or vary slowly [4, 5, 9]. For improving this method and solving its drawback, there are many adaptive techniques such as [1] considering the current instead of voltage perturbation in conventional P&O to operate the PV panel at MPP, [9] improving the P&O based on auto-tuning perturbation step and hysteresis band. In some methods,