Mathematical Modeling of different Photovoltaic Modules

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Abstract— This paper presents a mathematical model for solar Photovoltaic (PV) cells and compares their performance to an existing model in renewable energy research center (RERC) at the University of Anbar-Iraq. The model is able to simulate both the I-V characteristics curves and the P-V characteristics curves and it is used to study different parameters variations that can affect on the PV array performance including operating temperature and solar irradiance level. The results of the PV characteristics curves are compared to the curves provided by Kyocera PV and Solara PV model datasheets. The results are extracted and simulated using the Matlab software. One-diode equivalent circuit is employed in order to investigate I-V and P-V characteristics of a typical 54 W and 100W solar modules. The simulation results will be used as a reference to compare the performance of both models under a dusty weather and also for comparing their performances by using the solar module simulator in our future work.

Index Terms— PV, MPP, Solara, Kyocera, I-V, P-V, RERC-Anbar.

1 Introduction

In the recent years, the problems of the environmental pollution or the exhausted energy are apprehended about the utilization of the energy. In order to solve these problems, the clean energy is utilized positively such as photovoltaic (PV) generation system [1], wind power generation system, geothermal and so on. This research will be concentrated on the analysis of PV generation system, which is most utilized as a new energy source. In case of actual utilization of a PV panel, the output voltage of a PV panel is fluctuated sharply depend on the weather and load conditions. So, the control of the PV output using the power converter is needed for the improvement in the stability of the system. Up to now, various control methods were proposed. In order to confirm the effectiveness of each proposed method, the characteristics must be compared under the same weather and load conditions. However, due to the evaluation of these control methods with real experiment equipment, the preparation of the plural same specification is necessary. As a result, the economical burden must be high. So, economical point of view, simulation analysis is more effective. However, more detailed model of a solar cell must be analyzed using simulation analysis method. Consequently, more cheapness and actual simulation analysis technique must be important and required to solve of above the problems.

In [2], numerical simulations with use of equivalent diode model applied for the analysis of Cu (In,Ga)Se2 (CI(G)S) thin-film solar cells are presented. Presented examples show results of using developed program and effect of chosen model on resulting module performance parameters. It was shown which model seems to be more reliable for Cu (In,Ga)Se2 thin film solar cells, including analysis of the approximation errors.

In [3], the authors developed a photovoltaic simulation system with maximum power point tracking (MPPT) function using Matlab/Simulink software in order to simulate, evaluate and predict the behaviors of the real photovoltaic system. A model of the most important component in the photovoltaic system, the solar module, was the first model to have been established. The characteristics of the established solar module model were simulated and compared with those of the original field test data under different temperature and irradiance conditions. After that, a model of a photovoltaic system with maximum power point tracker, which was developed using DC-DC buck-boost converter with the perturbation and observation method, was also established and simulated. According to comparisons of the simulation results, the I-V curves of the established solar module model could closely match those of the original field test data, and the model of the photovoltaic system that was built can track the maximum power point of the system successfully and accurately under arbitrary temperature and irradiance conditions.

A New Technique for Photovoltaic Module Performance was introduced in [4]. The modeling method and the proposed circuit model are useful for power electronic designers who need a simple, fast, accurate, and easy-to-use modeling method to simulate the PV systems. The parameters extraction and the model evaluation was demonstrated using Matlab and Excel link as a new technique to facilitate input/output data of solar module simulink model such as weather conditions and solar module parameters. One-diode equivalent circuit is employed in order to investigate I-V and P-V characteristics of a typical Kyocera and Solara PV solar modules.

In this paper, the PV generation system using real data

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