Ain Shams University
Faculty of Engineering
Electric Power and Machine Department

Investigation of Operational Problems in Photovoltaic Systems

M.Sc. thesis
by:

Eng. Nader Ezzat Abdallah Tawfik

A thesis submitted to the Faculty of Engineering –Ain Shams University in partial fulfillments of the requirements for the M.Sc. degree in Electrical Power and Machines Engineering

Supervised by:

Prof. Dr. Hamdy Saleh Khalil El-Goharey

Prof. Dr. Somaya Afifi Mohamed Shehata

Assist. Prof. Dr. Walid Atef Omran

Electric Power and Machine Department
Faculty of Engineering, Ain Shams University

Cairo 2015

Approval sheet

For the M.Sc. Thesis:

Investigation of Operational Problems in Photovoltaic Systems

By:

Eng. Nader Ezzat Abdallah Tawfik

A thesis submitted to the Faculty of Engineering-Ain Shams University in partial fulfillments of the requirements for the M.Sc. degree in Electrical Power and Machines Engineering

Approved by:

Examiners Committee

Name, Title, and Affiliation	Signature
1. Prof. Dr. Said Wahsh Prof. of Power Electronics Electronics Research Institute	
2. Prof. Dr. M.A.L. Badr Electrical Power and Machines Dept. Faculty of Engineering Ain Shams University	
3. Prof. Dr. Hamdy S. K. El-Goharey Electrical Power and Machines Dept. Faculty of Engineering Ain Shams University	

Statement

This thesis is submitted to Ain Shams University in Partial Fulfillment of the requirements for M.Sc. degree in Electrical Engineering.

The included work in this thesis has been carried out by the author at the Electrical Power and Machines Department, Ain Shams University. No part of this thesis has been submitted for a degree or a qualification at any other university or institution.

Name: Nader Ezzat Abdallah Tawfik
Signature:
Date:

Acknowledgment

I would like to express my sincere gratitude to my Supervisor, Dr. Walid A. Omran for his valuable guidance, encouragement and support throughout my Master's study. I was honored by working under his supervision. I would like also to thank Prof. Dr. Hamdy S. K. El-Goharey for his great help, assistance and valuable comments. I would like to thank Prof. Dr. Somaya A. M. Shehata for her guidance and assistance during my master study.

I would like to express my deep appreciation to my family for their endless love and support.

My deep thanks to my friends and my colleagues for their great encouragement.

Abstract

Photovoltaic (PV) systems are gaining more attention worldwide. These systems are relatively expensive, and thus, they must be operated efficiently in order to obtain the maximum possible output. However, to achieve this task, the performance of these systems under different operating conditions should be thoroughly investigated. A thorough review of modeling PV modules from a commercial datasheet is presented. Detailed mathematical equations are presented from a cell to module to array. Hence, a developed model in Matlab/Simulink environment is presented. The model is then validated by comparing the I-V characteristics from datasheet to the simulated model results.

In this research, three array configurations are considered in simulation analyses, these are: series-parallel (SP), bridge-linked (BL), and total-cross-tied (TCT).

One of the most dominant factors that affect the generation of electricity from PV systems is the shading of PV arrays. Therefore, this thesis aims to investigate the problem of partial shading on different array configurations in order to identify the configuration that is comparatively less susceptible to shading problems. Moreover, the thesis attempts to provide guidelines that can help in predicting the expected number of peaks in the power-voltage curves for different array configurations under partial shading conditions. This can be of great benefit for the purpose of tracking the maximum power point under partial shading conditions.

This thesis also investigates the impact of dust on PV arrays which is very important especially in desert regions like Egypt. This factor is examined to investigate the deterioration of PV modules performance by different amounts of sand dust particles. The results show an obvious reduction in MPP especially in the large amounts of sands on PV modules. For inclined planes, the results show similar effects to the partial shading conditions.

The results obtained are shown in figures and tables. These results are discussed and explained in details.

Keywords— Array configurations, partial shading, sand dust, modeling, photovoltaic array modelling

List of Contents

List of Figures