MODELING, SIMULATION AND FAULT DIAGNOSIS IN A MICROGRID

By

Eng. Atef Mohamed Abd El Razek Mansour

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
ELECTRICAL POWER AND MACHINES ENGINEERING

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2016

MODELING, SIMULATION AND FAULT DIAGNOSIS IN A MICROGRID

By

Eng. Atef Mohamed Abd El Razek Mansour

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
ELECTRICAL POWER AND MACHINES ENGINEERING

Under the Supervision of

Prof. Dr. Essam Aboul Zahab

……………………………….

Electrical Power and Machines Department
Faculty of Engineering, Cairo University

Dr. Khaled Nagdy Faris

……………………………….

Power Electronics and Energy Conversion
Department, Electronics Research Institute

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2016

MODELING, SIMULATION AND FAULT DIAGNOSIS IN A MICROGRID

By

Eng. Atef Mohamed Abd El Razek Mansour

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
ELECTRICAL POWER AND MACHINES ENGINEERING

Approved by the
Examining Committee:

Prof. Dr. Essam Aboul Zahab Electrical power and machines department Faculty of Engineering-Cairo University	Thesis Main Advisor ……………………
Prof. Dr. Hosam Kamal Youssef Electrical power and machines department, Faculty of Engineering-Cairo University	Internal Examiner ……………………
Prof. Dr. Mohsen Taha El-hagry Power electronics and energy conversion department, Electronics Research Institute	External Examiner ……………………

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2016

Engineer: Atef Mohamed Abd El Razek Mansour
Date of Birth : 19 / 6 / 1986
Nationality : Egyptian
E-mail : atef_mohamed52@yahoo.com
Phone. : 01152538330
Address : Tahway- Ashmoon- Menofia

Registration Date : 1/ 10 /2010
Awarding Date : / / 2016
Degree : Master of science
Department : Electrical power and machines engineering

Supervisors : Prof. Dr. Essam Mohamed Aboul zahab
Dr. Khaled Nagdy Faris

Examiners : Prof. Dr. Hosam Kamal Youssef
Prof. Dr. Mohsen Taha El-hagry
Prof. Dr. Essam Mohamed Aboul zahab

Title of Thesis : **MODELING, SIMULATION AND FAULT DIAGNOSIS IN A MICROGRID**

Key Words: Photovoltaic and Microgrid, Fault diagnosis, Maximum Power Point Tracking, Energy Management Controller.

Summary : A modeling of the PV is introduced to study its electrical characteristics under normal and at faulty conditions such as short circuit and partial shadow faults. Also a proposed intelligent fault detection and diagnosis technique based on fuzzy logic is introduced. A microgrid system composed of PV source, energy storage systems and DC load; is modeled by using Matlab/Simulink simulation tools. A proposed modified perturb and observe algorithm is introduced to track the maximum power point. The proposed method is compared with fuzzy logic maximum power point tracking. The simulation results show that the two algorithms are nearly the same. Also a proposed energy management controller for the adopted microgrid is introduced to control the power sharing among the power source, the energy storage systems and the load. This controller has the ability to select the suitable energy storage element to be charged or discharged according to the environmental conditions and the load power demand. The proposed controller stabilizes the output voltage at the reference voltage also decreases the voltage change during the transient periods. An experimental study on a lab scale is executed to verify some of the simulation results of the proposed maximum power point tracking algorithm.

Acknowledgement

No one but Allah, the most greatest, deserves all our thanks as he gave us the faith, the patience, and the power to complete this work successfully.

First of all, I would like to thank my advisor, Prof. Dr. Essam Aboul Zahab, for giving me continuous help, patience, understanding, willingness throughout the period of the research and the opportunity to research under his guidance and supervision.

I would like also to express my sincere gratitude to my advisor, Dr. Khaled Nagdy for his guidance, encouragement, remarkable patience and caring support during my finishing this thesis.

Also I am grateful to Pof. Dr. Mohsen Taha Elhagry for his valuable guidance and his insightful suggestions throughout this work.

Also I am really indebted for the Electronic Research Institute for providing all the resources required to carry out this thesis.

Also, I would like to thank all my friends in the department of power electronics and energy conversion for their always encouragement and support.

Last but not least I would like to thank all my family; my father, my mother, my brothers “Ahmed and Abdullah”, my wife , my daughter “Shahd”, and my son “Mohamed” for their support and encouragement and patience during my studying. I am indebted to all of them forever for all that they have done for me.

Table of contents

List of Tables

List of figures

List of abbreviations

CAESS	Compressed Air Energy Storage Systems
DC	Direct current
EMC	Energy Management Controller
ESS	Energy Storage Systems
IGBT	Insulated Gate Bipolar Transistor
L-ion	Lithium Ion
MPP	Maximum power Point
MPPT	Maximum Power Point Tracking
NaBr	Sodium Bromine
NaS	Sodium Sulfur
NiCd	Nickel Cadmium
NiMH	Nickel Metal Hydride
Pb-Acid	Lead Acid Battery
PHES	Pumped Hydro Energy Storage
P&O	Perturb and Observe
PV	Photovoltaic
PWM	Pulse Width Modulation
rpm	Revolution Per Minute
SC	Supercapacitor
SMES	Superconducting magnetic energy storage