OPTIMIZATION OF A STANDALONE PHOTOVOLTAIC SYSTEM USING INTELLIGENT TECHNIQUES

BY

Eng. Mohamed Mostafa Ahmed El Sotouhy

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

OPTIMIZATION OF A STANDALONE PHOTOVOLTAIC SYSTEM USING INTELLIGENT TECHNIQUES

BY

Eng. Mohamed Mostafa Ahmed El Sotouhy

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

Prof. Dr. Aziza Mahmoud Zaki

…………………………………….

Power Electronics and Energy Conversion
Department, Electronics Research Institute

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2016

OPTIMIZATION OF A STANDALONE PHOTOVOLTAIC SYSTEM USING INTELLIGENT TECHNIQUES

BY

Eng. Mohamed Mostafa Ahmed El Sotouhy

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. Aziza Mahmoud Zaki Power Electronics and Energy Conversion Department, Electronics Research Institute	Member …………………….
Prof. Dr. Adel D. Shaltout Electrical power and machines department, Faculty of Engineering-Cairo University	Internal Examiner ……………………
Prof. Dr. Ahmed A. Sattar Electrical power and machines department, Faculty of Engineering-Ain-Shams University	External Examiner ……………………

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2016

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, Prof. Dr. Aziza Mahmoud Zaki for her guidance, encouragement, remarkable patience and caring support during my finishing this thesis.

Also I am really indebted for the Electronics 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 continuous encouragement and support.

Last but not least I would like to thank all my family; my father, my mother, my brothers “Abdel Azim ,Yahiya, and Rehab”, my wife , my daughter “Dalia”, and my son “Mostafa” for their support and encouragement and patience during my study. I am indebted to all of them forever for all they have done for me.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

AI	Artificial Intelligent
ANNs	Artificial Neural Networks
AC	Alternative Current
ADC	Analog to Digital Converter
A/D	Analog to Digital
BLDCM	Brushless Direct Current Motor
BLDC	Brushless Direct Current
CCM	Continuous Conduction Mode
COG	Center Of Gravity algorithm
CO2	Carbon dioxide
DAC	Digital to Analog Converter
D/A	Digital to Analog
DCM	Discontinuous Conduction Mode
DC	Direct Current
DOD	Depth of Discharge
DSP	Digital Signal Processing
EMF	Electromotive Force
FL	Fuzzy Logic
IC	Intermittent Charging
INC-CON	Incremental Conductance
IM	Induction Motor
Km	Kilo-meters

KCL	Kirchhoff's Current Law
KVL	Kirchhoff's Voltage Law
L-ion	Lithium Ion
LRC	Load Starting current
LRT	Load Starting Torque
MPP	Maximum Power Point
MPPT	Maximum Power Point Tracking
NiCad	Nickel Cadmium
NiMH	Nickel Metal Hydride
PMBLDC	Permanent Magnet Brushless DC Motor
PMDC	Permanent Magnet Direct Current
PV	Photovoltaic
Pb-S	Lead Acid
PWM	Pulse Width Modulation
P&O	Perturb and Observe
rpm	Revolution Per Minute
SRM	Switched Reluctance Motors
SEPIC	Single-Ended Primary Inductor Converter
SOC	State of Charge
$\mathbf{T_R}$	Rated Torque
$\mathbf{T_P}$	Peak Torque
UN	United Nations
VRLA	Valve Regulated Lead Acid