



AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Electrical power and Machines Engineering Department

Development of battery charge controller for renewable energy systems

A Thesis

Submitted in partial fulfillment of the requirements of the degree of
Master of Science in Electrical Engineering

Submitted by

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B.Sc. of Electrical Engineering
AIN SHAMS July 2000

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STATEMENT

This dissertation is submitted to Faculty of Engineering, AIN SHAMS University for the degree of Master of Science in Electrical Engineering (Electrical power and Machines Engineering). The author carried out the work included in this thesis at Electrical power and Machines Engineering Department, Faculty of Engineering, AIN SHAMS University, Cairo, Egypt. No part of this thesis was submitted for a degree or a qualification at any other university or institution.

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ABSTRACT

Batteries are the power tank of renewable energy power systems. They play the role of power supply when the renewable energy power sources are not available. This thesis demonstrates the development of a new battery charge controller for renewable energy systems. A comprehensive review of the conventional controllers is conducted to collect their contributions, advantages, and disadvantages for comparison and validation.

The new controller designed based on a novel maximum power point tracking (MPPT) technique. The new MPPT technique utilizes a smart algorithm and is optimized using the genetic neural algorithm. In addition, the proposed controller utilizes a multistage charging algorithm in order to minimizing the charging time.

The components of photovoltaic generator system are introduced and mathematically modeled including the control and optimization methods. The charge controllers design aspects, functions, and charging control methods are discussed. Consequently, the new controller is modeled based on complete mathematical models.

In order to determine the performance parameters and evaluate the validity and efficiency of the new controller, a complete PV system is modeled and simulated using MATLAB/SIMULINK. Moreover, a complete experimental prototype is implemented. The simulation and experimental results are compared for validation and clarification. They strongly agree on that, under all test conditions, the new controller tracks the target maximum power point (MPP) more faster than the traditional methods. In addition, it can tracks successfully the global maximum power point (GMPP) in all partial shading conditions. Moreover, the charging time is significantly reduced.

The thesis is divided into six chapters organized as follows:

Chapter One introduces the components of a general photovoltaic system. Moreover, it reviews the recent publications and contributions in the scope of maximum power point tracking and charging control methods for renewable energy systems. In addition, it lists the thesis objectives and outlines.

Chapter Two covers the mathematical model of general photovoltaic systems and the control and optimization methods.

Chapter Three demonstrates the theory, design aspects, and control methods of the battery charge controllers.

Chapter Four shows the complete modeling, simulation, and validation of the proposed system.

Chapter Five presents a complete experimental version for the proposed system including all test cases and validation.

Chapter Six concludes the work and states the recommendations for future work.

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Table of Contents

List of figures	III
List of tables	IX
List of symbols	X
List of abbreviations	XII
Chapter 1 Introduction	1
1.1. General	1
1.2. Photovoltaic (PV)	1
1.3. DC-DC converter	2
1.4. Battery charging controller	3
1.5. Literature survey	3
1.6. Thesis objectives and outlines	6
1.7. Summary	7
Chapter 2 Photovoltaic Systems	8
2.1. Introduction	8
2.2. PV modeling	8
2.2.1. Variation of Solar Irradiation (G)	9
2.2.2. Variation of ambient Temperature (T)	10
2.3. PV Control methods	11
2.3.1. Constant voltage method (CV)	11
2.3.2. Short current pulse method (SC)	11
2.3.3. Open circuit method	11
2.3.4. Perturb and Observe Methods (P&O)	12
2.3.5. Incremental Conductance Methods (IC)	12
2.4. PV optimization methods	13
2.4.1. Neural network optimization techniques:	13
2.5. Effects of Partial Shading on PV Array Characteristics	16
2.6. Summary	18
Chapter 3 Battery charge controllers	19
3.1. Introduction	19
3.2. The functions of Battery charge controllers.	19
3.3. Charge controllers basics and theory	19
3.3.1. Voltage regulation set point (VR)	19
3.3.2. Low-Voltage load disconnect set point (LVD)	19
3.3.3. Voltage regulation hysteresis (VRH)	20
3.3.4. Low voltage disconnect hysteresis (LVDH)	20
3.4. Charging control methods	20
3.4.1. Shunt Controller	20
3.4.2. Shunt-Interrupting controller	21
3.4.3. Shunt-Linear controller	21
3.4.4. Series Controller	21
3.4.5. Series-Interrupting controller	22
3.4.6. Series-Interrupting, 2-step, Constant-Current controller	22
3.4.7. Series-Interrupting, 2-Step, Dual Set Point controller	22
3.4.8. Series-Linear, Constant-Voltage controller	23

Table of Contents

3.4.9. Series-Interrupting, Pulse Width Modulated (PWM) controller	23
3.4.10. MPPT charge controller	23
3.5. Battery charging control algorithms	23
3.6. Battery charge controller structure	24
3.7. Summary	25
Chapter 4 Modeling and simulation	26
4.1. Introduction	26
4.2. System description	26
4.3. System structure and components	26
4.3.1. The PV model	27
4.3.2. The DC-DC converter model	27
4.3.3. The inverter model	27
4.3.4. The MPPT controller	27
4.3.5. The proposed new MPPT technique	27
4.3.6. Optimization of the new MPPT method using the genetic neural network	28
4.3.7. PI controller model	31
4.3.8. The battery model and charging algorithm.	31
4.4. System operation	32
4.5. Test cases and results	32
4.5.1. Test case I, temperature and irradiance are fixed	32
4.5.2. Test case II, temperature and/or irradiance are changing with time	35
4.5.3. Test case III, the new MPPT test	37
4.5.4. Validation	40
4.6. Summary	41
Chapter 5 System implementation	42
5.1. Introduction	42
5.2. System description and operation	42
5.3. System hardware structure	43
5.3.1. The Power Circuit of the charge controller	44
5.3.2. The Control Circuit	45
5.3.3. The sensor circuit board	46
5.3.4 Computer serial interface board	47
5.4. I-V and P-V characteristics of the PV module	49
5.5. System software	52
5.6. Experiment results	53
5.6.1. Test case I, fixed temperature, and irradiance	53
5.6.2. Test case II, varying temperature, and/or irradiance with time	55
5.6.3. Test case III, the case of partial shading	56
5.6.4. Test case IV, the new MPPT test	58
5.6.5. Charging Process test	62
5.7. Validation	63
5.8. Summary	64

Table of Contents

Chapter 6 Conclusions, Recommendation,	65
6.1. Conclusion and recommendation	65
6.2. Future work	66
References	67
Extracted Paper	71
Appendix A	72
Appendix B	88

List of Figures

List of figures

Fig. 1.1. Solar cells are connected in parallel and in series.	1
Fig. 1.2. Modules are connected in parallel and in series.	2
Fig. 1.3. The Buck DC-DC converter.	2
Fig. 1.4. The Boost DC-DC converter.	2
Fig. 1.5. The Buck-Boost DC-DC converter.	3
Fig. 2.1. Equivalent circuit model of PV Cell.	8
Fig. 2.2. Power -Voltage and Current-Voltage curve of a solar cell at given T and G.	9
Fig. 2.3. I-V characteristics of a PV module at various irradiance, constant temperature.	10
Fig. 2.4. I-V characteristics of a PV module at various temperature, constant irradiance.	10
Fig. 2.5. CV block diagram.	11
Fig. 2.6 SC block diagram.	11
Fig. 2.7. OV block diagram.	12
Fig. 2.8. P&O block diagram.	12
Fig. 2.9. ICb block diagram.	13
Fig. 2.10. MPPT methods comparison regarding cost and efficiency.	13
Fig. 2.11. Search techniques classification.	14
Fig. 2.12. GA reproduction cycle and stages.	15
Fig. 2.13. GA Crossover.	15
Fig. 2.14. GA mutation.	16
Fig. 2.15. The shading effects on solar cells.	17
Fig. 2.16. I-V characteristic of PV array under partial shading condition.	17

List of Figures

Fig 2.17. P-V characteristic of PV array under partial shading condition.	17
Fig. 3.1. The charge controller set points.	20
Fig. 3.2. The shunt charge controller.	21
Fig. 3.3. The series charge controller.	22
Fig. 3.4. The MPPT charge controller.	23
Fig. 3.5. Three stages charging process (CCCV).	24
Fig. 3.6. The MPPT charge controller block diagram.	24
Fig. 4.1. Complete system model Block diagram.	26
Fig. 4.2. Flowchart of the new MPPT method.	28
Fig. 4.3. GA interfaces with MPPT.	29
Fig. 4.4. Chart of the GA reproduction cycle and stages.	30
Fig. 4.5. MPP location changed with irradiance change.	30
Fig. 4.6. PI controller model.	31
Fig. 4.7. The battery model.	31
Fig. 4.8. The PV current of GA controller based, PI controller based and Traditional MPPT.	32
Fig. 4.9. The PV Voltage of GA controller based, PI controller based and Traditional MPPT.	33
Fig. 4.10. The PV power of GA controller based, PI controller based and Traditional MPPT.	33
Fig. 4.11. The PV power of GA controller based, PI controller based and Traditional MPPT through the first 10 samples.	33
Fig. 4.12. The inverter output before and after LC filter is applied.	34
Fig. 4.13. The line to line three phase output voltage.	34
Fig. 4.14. PV current changes due to irradiance change of Traditional MPPT, GA controller based MPPT and PI controller based MPPT.	35
Fig. 4.15. PV voltage changes due to irradiance change of Traditional MPPT, GA controller based MPPT and PI controller based MPPT.	35

List of Figures

Fig. 4.16. PV power changes due to irradiance change of Traditional MPPT, GA controller based MPPT and PI controller based MPPT.	35
Fig. 4.17. PV power changes due to irradiance change in a period of one sample.	36
Fig. 4.18. P-V curve changes due to irradiance change of Traditional MPPT, GA controller based MPPT and PI controller based MPPT.	36
Fig. 4.19. I-V curve changes due to irradiance change of Traditional MPPT, GA controller based MPPT and PI controller based MPPT.	36
Fig. 4.20. The voltage of the new MPPT technique compared to the traditional MPPT techniques.	37
Fig. 4.21. The first 100 samples of the voltage of the new MPPT technique versus the traditional MPPT techniques.	37
Fig. 4.22. Current curve of the new MPPT technique versus the traditional MPPT techniques.	38
Fig. 4.23. The first 100 samples of the current curve of the new MPPT technique compared to the traditional MPPT techniques.	38
Fig. 4.24. The Power curve of the new MPPT technique compared to the traditional MPPT technique.	38
Fig. 4.25. The first 100 samples of the power curve of the new MPPT technique versus the traditional MPPT techniques.	39
Fig. 4.26. Efficiency of the new MPPT technique versus the traditional techniques.	39
Fig. 4.27. The first 100 samples of efficiency of the new MPPT technique compared to the traditional MPPT techniques.	39
Fig. 4.28. The P-V curve of the new MPPT technique compared to the traditional technique.	40
Fig. 5.1. The charger controller block diagram.	42
Fig. 5.2. Charging characteristic.	43
Fig. 5.3. Circuit block diagram of the charge controller.	43
Fig. 5.4. The power circuit of the proposed controller.	45
Fig. 5.5. The prototype board of the control circuit.	45
Fig. 5.6. The circuit diagram of the sensor board.	46
Fig. 5.7. The circuit diagram of the battery current sensor board.	46
Fig. 5.8. The calibration test of the sensor circuit board.	47
Fig. 5.9. The voltage divider circuit.	47

List of Figures

Fig. 5.10. The serial interface circuit diagram.	48
Fig. 5.11. The output signals at different position.	48
Fig. 5.12. The proposed controller prototype.	49
Fig. 5.13. The I-V characteristic curves at fixed temperature and different irradiance.	50
Fig. 5.14. The I-V characteristic curves at fixed irradiance and different temperature.	50
Fig. 5.15. The P-V characteristic curves at fixed irradiance and different temperature.	51
Fig. 5.16. The P-V characteristic curves at fixed temperature and different irradiance.	51
Fig. 5.17. The software flowchart of the proposed controller.	52
Fig. 5.18. The PV current of MPPT versus the current of MPPT optimized by GA.	53
Fig. 5.19. The PV voltage of MPPT versus the voltage of MPPT optimized by GA.	54
Fig. 5.20. The PV power of MPPT versus the power of MPPT optimized by GA.	54
Fig. 5.21. The PV power curve when irradiance changes from 1000 Wm ² to 750 Wm ² .	55
Fig. 5.22. The PV current curve in partial shading case for MPPT and GA based MPPT controller.	56
Fig. 5.23. The PV voltage curve in partial shading case for MPPT and GA based MPPT controller.	57
Fig. 5.24. The PV power curve in partial shading case for MPPT and GA based MPPT controller.	57
Fig. 5.25. The P-V curve in partial shading case for MPPT and GA based MPPT controller.	58
Fig. 5.26. The PV current curve of the new MPPT versus the traditional MPPT.	58
Fig. 5.27. The PV voltage curve of the new MPPT versus the traditional MPPT.	59
Fig. 5.28. The PV power curve of the new MPPT versus the traditional MPPT.	59
Fig. 5.29. The PV efficiency curve of the new MPPT versus the traditional MPPT.	60
Fig. 5.30. The first 10 seconds of the PV current curve of the new MPPT versus the traditional MPPT.	60
Fig. 5.31. The first 10 seconds of the PV voltage curve of the new MPPT versus the traditional MPPT.	61