MODELING AND PERFORMANCE ANALYSIS OF THREE PHASE GRID CONNECTED SOLAR PHOTOVOLTAIC SYSTEM

A THESIS

submitted by

RANJIT SINGH

for the award of the degree

of

MASTER OF SCIENCE

(By Research)

SCHOOL OF COMPUTING AND ELECTRICAL ENGINEERING

INDIAN INSTITUTE OF TECHNOLOGY MANDI

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Declaration by the Research Scholar

This is to certify that the thesis entitled "**MODELING AND PERFORMANCE ANALYSIS OF THREE PAHSE GRID CONNECTED SOLAR PHOTOVOLTAIC SYSTEM**", submitted by me to the Indian Institute of Technology Mandi for the award of the degree of Master of Science by Research is a bonafide record of research work carried out by me under the supervision of **Dr. Bharat Singh Rajpurohit**. The contents of this thesis, in full or in parts, have not been submitted to any other Institute or University for the award of any degree or diploma.

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Signature of Research Scholar

THESIS CERTIFICATE

This is to certify that the thesis titled **MODELING AND PERFORMANCE ANALYSIS OF THREE PHASE GRID CONNECTED SOLAR PHOTOVOLTAIC SYSTEM**, submitted by **Ranjit Singh**, to the Indian Institute of Technology Mandi, for the award of the degree of **Master of Science By Research**, is a bonafide record of the research work done by him under my supervision. The contents of this thesis, in full or in parts, have not been submitted to any other Institute or University for the award of any degree or diploma.

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ABSTRACT

KEYWORDS: *Adaptive Neuro Fuzzy Inference System, DC-DC Converter, Fuzzy Logic Controller, Incremental Conductance, Maximum Perturb and Observe, Power Point Tracking, Solar Photovoltaic System, Switching Losses, Thermal Modeling*

Solar energy has the advantage of no pollution, low maintenance cost, no installation area limitation. Because of non linear relation between the current and the voltage of the photovoltaic cell, it can be observed that there is unique Maximum Power Point (MPP) at a particular environment, and the process to track this point is called as Maximum Power Point Tracking (MPPT). Present work presents a performance analysis of grid connected SPV system for different Maximum Power Point Tracking (MPPT) algorithms. The detailed mathematical model of grid connected three-phase Solar Photovoltaic (SPV) system with parametric model of SPV cell, thermal modeling & switching loss calculation of switching devices are discussed. In the second chapter the performance evaluation has been carried out for Perturb-and-Observe (P&O) and Incremental Conductance (INC) based MPPT algorithms for various outputs of the SPV array, in terms of energy injected to grid, switching losses, junction temperature, sink temperature, and case temperature, for switching in the DC-DC boost converter. The results validated the effectiveness of the MPPT algorithm in increasing SPV output energy, decrease in the switching losses, junction & sink temperature. The simulation results show that INC method is slightly better to P&O method in energy injected to the grid with lower switching losses, junction & sink temperature.

In the third chapter the performance evaluation has been carried out for modified variable step size of the duty cycle of DC-DC boost converter for both algorithms for various outputs of the SPV array, in terms of energy injected to grid, switching losses, junction temperature, sink temperature and case temperature. The results validated the effectiveness of the MPPT algorithms in increasing SPV output energy, improvement of power quality, decrease in the switching losses, junction & sink temperature. The results

show that INC method is slightly better to P&O method in energy injected to the grid with lower switching losses, junction & sink temperature.

In the fourth chapter the performance evaluation has been carried out for the replacement of PI controller by the Fuzzy Logic Controller (FLC) and Adaptive Neuro Fuzzy Inference System (ANFIS) controller. It is found that the ANFIS is more effective as compared to FLC.

The fifth chapter implemented an intelligent control method for the MPPT of a SPV system, this method uses ANFIS instead of conventional INC method. The performance comparison between ANFIS and INC method has been carried out to demonstrate the effectiveness of ANFIS based MPPT to draw much energy with a fast response for variations in working conditions.

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