UNIVERSITI TEKNOLOGI MARA

SINGLE-PHASE SINGLE STAGE STRING INVERTER FOR A GRID CONNECTED PHOTOVOLTAIC SYSTEM WITH INTEGRATED PERTURB AND OBSERVE – FUZZY LOGIC CONTROL MPPT TECHNIQUE

SITI ZALIHA BINTI MOHAMMAD NOOR

Thesis submitted in fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Electrical Engineering)

Faculty of Electrical Engineering

November 2018

CONFIRMATION BY PANEL OF EXAMINERS

I certify that a Panel of Examiners has met on 26th June 2018 to conduct the final examination of Siti Zaliha Binti Mohammad Noor on her **Doctor of Philosophy** thesis entitled "Single-Phase Single Stage String Inverter For A Grid Connected Photovoltaic System With Integrated Perturb and Observe-Fuzzy Logic Control MPPT Technique" in accordance with Universiti Teknologi MARA Act 1976 (Akta 173). The Panel of Examiner's recommends that the student be awarded the relevant degree. The Panel of Examiners was as follows:

Mohd Tarmizi Ali, PhD
Associate Professor
Faculty of Electrical Engineering
Universiti Teknologi MARA
(Chairman)

Mohammad Nawawi Seroji, PhD
Associate Professor
Faculty of Electrical Engineering
Universiti Teknologi MARA
(Internal Examiner)

Saad Mekhilef, PhD
Professor
Department of Electrical Engineering, Faculty of Engineering
University of Malaya
(External Examiner)

Pham Thi Thuy Linh, PhD
Associate Professor
Electric Power University
Tan Minh, Soc Son, Hanoi, Vietnam
(External Examiner)

PROF SR TS DR HJ ABDUL HADI HAJI NAWAWI
Dean
Institute of Graduates Studies
Universiti Teknologi MARA
Date : 30 October 2018

AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student	:	Siti Zaliha Binti Mohammad Noor
Student I.D. No.	:	2012477802
Programme	:	Doctoral of Philosophy – EE990
Faculty	:	Electrical Engineering
Thesis Title	:	Single-Phase Single Stage String Inverter For A Grid Connected Photovoltaic System With Integrated Perturb and Observe – Fuzzy Logic Control MPPT Technique
Signature of Student	:	.....
Date	:	November 2018

ABSTRACT

This thesis presents a design of Single-phase Single stage String Inverter for Grid Connected Photovoltaic (PV) system. The proposed system use Integrated Perturb and Observe (P&O) - Fuzzy Logic Control (FLC) as a Maximum Power Point Tracking (MPPT) technique. Previous works on single-phase single stage inverter comes with various types of circuit configuration and switching techniques incorporating with MPPT. However, each topology has their advantages and disadvantages and also has their own circuit limitation. Therefore, the proposed single stage converter is designed to reduce number of power switching components with higher power conversion efficiency. The new control scheme of MPPT and Pulse Width Modulation (PWM) control technique implemented on one power circuit (single stage) without boosted DC-link is introduced. The prototype inverter is tested mainly with 340Wp PV capacity system using two series of STP170s-24/Ac PV modules. The Maximum Power Point Tracking (MPPT) is achieved by changing the modulation index and the phase angle of the inverter's output voltage. This new intelligent controlling based MPPT algorithm is implemented by combining advantages of Perturb and Observe (P&O) and Fuzzy Logic Control (FLC). The inverter switching frequency is set at 25kHz and IGBTs are used as power switching devices with full-bridge configuration. The simulation model is developed and analysed using Matlab/Simulink and Mathcad software. The simulation and experimental results are evaluated under steady state and dynamic operation. The performance of the developed string inverter is also evaluated with standard features as required by international standard. In summary, the proposed inverter complies with IEC 61727 for low THD which is less than 5% at rated output and has fast Maximum Power Point (MPP) tracking which is less than 1s. In addition, the inverter has fast turn-off response during loss of utility which is less than 2s. These finding show new control technique is capable to perform effectively on PV system without DC to DC converter or any complex design of new inverter topology.

TABLE OF CONTENTS