ENG460 ENGINEERING THESIS FINAL REPORT

PV Array Simulator Performance Evaluation

Joshua Yong Ern, CHAN

2011

A report submitted to the School of Engineering and Energy, Murdoch University in partial fulfilment of the requirements for the degree of Bachelor of Engineering.

Declaration

I declare that this thesis is my own account of research and contains as its main content work which has not previously been submitted for a degree at any tertiary institution.

…….

Joshua Chan

18/11/2011

Academic Supervisor endorsement pro forma

This is to be signed by your academic supervisor and attached to each report submitted for the thesis.

I am satisfied with the progress of this thesis project and that the attached report is an accurate reflection of the work undertaken

Signed:

Date:

Abstract

This dissertation evaluates the performance of a 25kW PV Array Simulator based on a design from Prof. Heinrich Haberlin and his staff from the PV laboratory of the Berne University of Applied Sciences, in Burgdorf, Switzerland. The simulator was set up and is operated by ResLab, based at Murdoch University. The device has a power rating of 25kW, an open circuit voltage of up to 750V, and a short circuit current of up to 40A. The design and concept of the simulator replicates the operations of an actual PV array. Incorporated in its controls are eight IV curves of different fill factors that were configured to portray different cell technologies. The development of such a test device was initiated when PV applications such as inverters required a device that could repeatedly produce consistent testing conditions, as well as a platform that could perform precise MPPT measurements.

First the study goes into understanding the control options of the simulator in terms of its IV curve production abilities. The initial familiarization stage was conducted with technical manuals and a brief session with Andrew Ruscoe who was involved in the development of the simulator. Through that and further research, it was comprehended that the *Main Control,* which is the control responsible for all IV curve generations, is designed electronically to follow the single diode model circuit of the PV array. A mathematical aspect has been included in the thesis to confirm the operation of *Main Control*. Designers of the simulator expanded on this theory by utilising individual sets of diode strings with different configurations, which developed certain fill factors when a voltage is applied.

Operation of the PV Array Simulator commenced after the understanding of the controls was established. The eight IV curves of varying fill factors were captured and observed. As part of the study, the curves were classified against the three most common cell technologies. The performance of the simulator was evaluated using different test conditions to observe its stability. It was proven through these tests, as well as documentations from past tests that the simulator was very stable even when it was made to operate at its threshold limit.

As the varying fill factors were obtained by the different configuration of diode strings, a study was focused on developing a basis or pattern associated with the formation of different classifications of diodes in series. The diode strings found in the simulator were replicated and reverse engineered.

Acknowledgements

I would like to sincerely acknowledge and thank the following Murdoch staff:

Associate Professor Graeme R Cole, my supervisor for his continuous guidance and inspiration

Dr Martina Calais, my associate supervisor for her constructive feedback and assistance.

Andrew Ruscoe, who took the time to help me with the familiarization of the simulator.

Will Stirling and Jeff Laava, for the constant technical support.

And my family and friends who have supported and encouraged me throughout my degree.

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Acronyms

CSB – Current Source Block.

FAULT – This depicts an over-heating or fuse failure condition of the CSB.

FPU – Field Point Unit.

LIMIT – This would appear as the current output is limited during a fault due to an excessive voltage drop over the CSB.

LTspice – Design simulation tools for electrical circuits.

MPPT – Maximum power point tracking

PV – Photovoltaic

RESLab – Renewable Energy Systems Test Centre.

Symbols

HV_{IN} – The DC input voltage to the PV array simulator. This voltage is supplied from the DC genset.

HV_{OUT} –The DC output voltage of the PV array simulator. This voltage supplies the DUT.

I_D – Current across the diode.

I_{ph} – Current derived from solar radiance.

I_{SC} – The short circuit current of the IV curve that is simulated by the PV array simulator.

V_{CSCS} – The current source control signal. This is the signal that is fed through the CSBs.

V_{OC} – The open circuit voltage of the IV curve that is simulated by the PV array simulator.