UNIVERSITI TEKNOLOGI MARA

DETERMINATION OF NOMINAL OPERATING CELL TEMPERATURE FOR PHOTOVOLTAIC MODULES IN TROPICAL MALAYSIA

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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.

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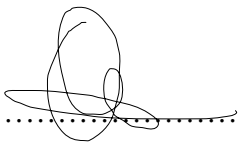
Signature of Student	:	 ……..
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ABSTRACT

Photovoltaic (PV) modules are sent by manufacturers for testing to numerous testing laboratories in the world particularly the renowned ones to get international certifications. One of the tests is Nominal Operating Cell Temperature (NOCT) determination which will act as thermal characteristics of a specific design of PV module under actual outdoor condition. However, the present specified outdoor test conditions designated as Standard Reference Environment (SRE) in IEC61215 is not possible in tropical Malaysia as ambient temperature of 20 °C is not achievable. New modified SRE is needed for an NOCT test to be conducted in Malaysia and will consequently formulate new NOCT mathematical model. Numerous studies have been conducted in investigating SRE in NOCT testing and consequently NOCT values. Nevertheless, very few studies were conducted under tropical region particularly Malaysia. This study presented the evaluation of SRE ambient parameters of solar irradiance (SI), ambient temperature (AT) and wind speed (WS), developed and verified a new SRE, developed and verified new revised NOCT model which finally determined the NOCT values for monocrystalline, polycrystalline and copper indium selenium thin film PV modules under tropical Malaysia climate condition. This was achieved through field testing and meticulous analytical techniques of statistical and mathematical. One year field data of five minutes interval was analysed for SRE evaluation and development, meanwhile a month field data of five seconds interval was analysed for NOCT testing. All testing procedures and equipment specifications were based on international standard of IEC 61215, IEC 61646 and IEC 61724. The SRE ambient parameters of SI, AT and WS median were found to be 294 W/m^2, 31°C and 1 m/s respectively. The median SI was very much lower than the current SI of 800 W/m^2 stated in the IEC standard. Thus, a new SRE was developed for NOCT testing dedicated for tropical Malaysia by acquiring the corresponding value of AT at SI of 800 W/m^2. As a result, the new developed SRE ambient parameters that suits tropical Malaysia are SI of 800 W/m^2, AT of 31°C and WS of 1 m/s. Modifying the existing SRE consequently formulated new NOCT model. The accuracy of the modified NOCT model has outperformed the existing NOCT model by 2 % on average via percentage error, root mean square error and mean average percentage error analysis. Finally, the NOCT values of monocrystalline, polycrystalline and thin film PV modules are 55 ^{o}C, 57 ^{o}C and 59 ^{o}C respectively. Thus, this study has succeeded in determining NOCT values for tropical Malaysia which are significantly higher than the value of present NOCT. Results of this study can provide significant input to IEC 61215 and IEC 61646 committee to address revision and modification of SRE and NOCT model. Furthermore, the NOCT values obtained will be an outdoor thermal reference that can be used by PV system designers, integrators and researchers in tropical Malaysia.

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