Intercomparison of PV module lab’s test methodology in Swiss and Finnish PV labs

Comparison of Solar Simulators for PV-Devices; Differences in Spectral Mismatch Factors and Uncertainties

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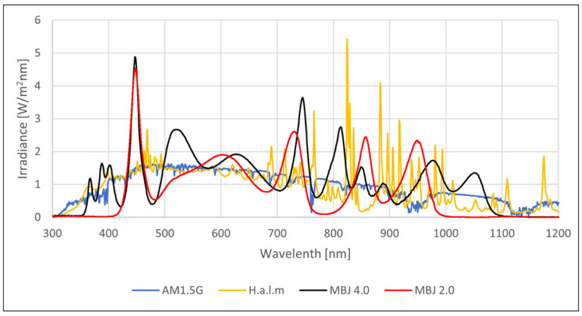
Introduction: Key data figure for any PV-device is it’s IV-curve to predict its performance in the destined work environment. The IV-curve can be influenced by external factors like the irradiance of the incoming illumination, the operating temperature of the device, e.g., outside temperature, humidity, wind etc. and the spectrum of the incoming illumination. This leads to the desire to design an artificial test environment where these factors can be controlled and kept at uniform levels for every measurement, to create a basis for comparison of different PV-devices. This is done using solar simulators. This thesis compares three different solar simulators. Located at the New Energy Research Center Turku are a Xenon long pulse solar simulator and a LED long pulse solar simulator and at the laboratory of the SPF Institut für Solartechnik Rapperswil there is another LED long pulse solar simulator which is evaluated.

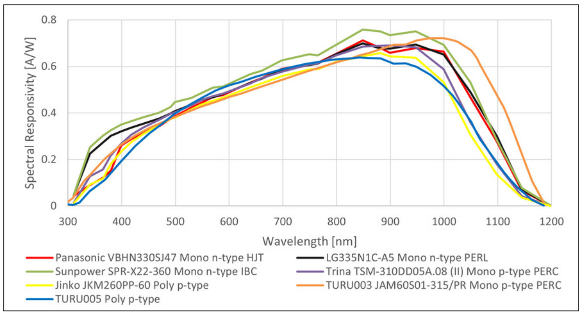
Approach: The following goals were set in order to compare these systems: • Setup and calibration of the spectrometer.• Measurement of the spectral irradiance of the NERC Xenon solar simulator and the LED solar simulator.• Comparing and interpreting the values gained from the spectral irradiance measurements. Also incorporating the irradiance spectrum values from the LED solar simulator supplied by the SPF Rapperswil.• Calculation of the spectral mismatch correction factors and spectral mismatch related uncertainty using the known spectral response of a number of PV-Modules.• Calculation of the combined uncertainty of a solar simulator.• Comparison and interpretation of the values gained from the SMM and uncertainty calculations.

Result: The original goal of measuring the device specific irradiance spectrum was not reached due to problems encountered with the digital trigger unit of the spectrometer. However, the whole process for conducting the measurement been fully prepared, including the necessary data and parameters.
The SMM-values gained enable a good look at the differences between these different solar simulators and the influence an irradiance spectrum which matches the reference spectrum more closely has on the SMM-calculation. The comparison of an LED and a Xenon based solar simulator show how closely SMM-results can match each other despite using completely different light sources and amounts of light sources. The uncertainty values calculated for all of the different solar simulators show the influence the irradiance spectrum uncertainty has on these combined uncertainties. Due to these uncertainty values all being estimated, the differences between the solar simulators are quite small, mostly the result of the different total bandwidth length the light sources cover and not of the spectra. This shows that even though a class A+ solar simulator may be used for a PV-Module performance measurement, it may have a higher total uncertainty than a class A solar simulator, simply because of the difference in bandwidth they cover. It has been proven that the small differences between the SMM-uncertainties of different PV-Module combinations used in a solar simulator have no influence on the total uncertainty. The average of these uncertainties can be used and doesn't need to be changed for every PV-Module performance measurement which is done. As long as the spectral response curve of the device under test falls somewhere in between the ones used for the SMM-calculations.

Irradiance Spectra of the MBJ2.0, MBJ4.0 and H.a.l.m solar simulators and reference solar irradiance spectrum AM1.5G.
Own presentment



Spectral Response of PV-modules used for SMM-calculation.
Own presentment



Excerpt of Table containing calculated SMM-factors and related Uncertainties.
Own presentment

MBJ 4.0				
Name PV-Device under Test PV-Reference Device under Test Irradiance Reference Irradiance	SMM	Usmm (k=2)	Usmm	Date
PV-DUT: LG335N1C-A5 Mono n-type PERL PV-Ref: Panasonic VBHN330SJ47 Mono n-type HJT DUT:MBJ 4.0 Ref:AM1.5G	0.9939	1.2931%	0.6466%	20.12.2022
PV-DUT: Sunpower SPR-X22-360 Mono n-type IBC PV-Ref: Panasonic VBHN330SJ47 Mono n-type HJT DUT:MBJ 4.0 Ref:AM1.5G	0.9948	1.2931%	0.6465%	20.12.2022

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Subject Area
Electric solar technology

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