Solar America Board for Codes and Standards

Photovoltaic Module Power Rating per IEC 61853-1 Standard:

A Study Under Natural Sunlight

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Study Report Overview

This study report from the Solar America Board for Codes and Standards (Solar ABCs) provides the results from two rounds of outdoor measurement testing, which were conducted as specified in the International Electrotechnical Commission (IEC) power and energy rating standard, IEC 61853-1, *Irradiance and Temperature Performance Measurements and Power Rating.*

The five objectives of this study report were to:

- identify measurement repeatability issues with a non-standardized test setup,
- standardize the measurement setup,
- verify the device linearity per IEC 60904-10,
- generate the power (Pmax) matrix per IEC 61853-1, and validate four different current-voltage (I-V) translation/interpolation techniques of IEC 60891 and the National Renewable Energy Laboratory Method (NREL Method).

The full report provides complete test results and provides the major conclusions drawn from these test results.

Why the Report is Important

Manufacturers typically rate PV modules at standard test conditions (STC). The STC rating involves only one temperature (25°C), one irradiance (1000 W/m^2), and one sunlight spectrum (AM [air mass] 1.5G [global]). However, the actual energy production of field installed photovoltaic (PV) modules is a result of a range of operating temperatures, irradiances, and sunlight spectra. Therefore, characterizing PV modules at different conditions of temperature and irradiance can provide a more comprehensive rating to predict the power and energy values of field-installed modules.

Issue

Recognizing this issue, the IEC Technical Committee 82 Working Group 2 (TC82/WG2) has been developing an appropriate power and energy rating standard, IEC 61853, for more than 15 years. This IEC 61853 standard titled *Photovoltaic Module Performance Testing and Energy Rating* consists of four parts:

- **IEC 61853-1**: *Irradiance and Temperature Performance Measurements and Power Rating,*
- **IEC 61853-2**: *Spectral response, incidence angle, and module operating temperature measurements,*
- **IEC 61853-3**: *Energy rating of PV modules,* and
- **IEC 61853-4**: *Standard days.*

Standardization of the outdoor measurement techniques for repeatable performance values over time is extremely important for the successful implementation of the IEC 61853-1 standard. This report addresses the performance repeatability issues and current-voltage curve translation issues associated with implementation of the IEC 61853-1 standard for four different PV module technologies.

Solar America Board for Codes and Standards Conclusions

Below are the major conclusions corresponding to the five objectives of this study report:

- Repeatable power rating measurements at various irradiance levels under natural sunlight within an acceptable deviation limit of 2 % could not be achieved when uncalibrated mesh screens were placed directly (0-inch distance) on the test module and reference cell.
- A standardized measurement setup was established with reference cells kept outside the calibrated mesh screens, which were placed at a 2-inch distance above the test modules.
- The linearity requirements of open-circuit voltage, short-circuit current, and maximum power versus temperature are met by all four test technologies. Similarly, the linearity requirement of open-circuit voltage versus the logarithm of irradiance is also met in most instances by all four test technologies. For the short-circuit current versus irradiance, the devices met the linearity requirement (2 % deviation limit) for irradiance levels above 200 W/m^2, but they showed a higher deviation for the irradiance levels below 200 W/m^2. This higher deviation was later attributed to minor experimental errors.
- The required 23-element P_{max} matrix of IEC 61853-1 was successfully generated for all four module technologies using the four translation/interpolation procedures of IEC 60891 and the NREL Method. Unless the data processing personnel pay extreme attention or commercial test laboratories automate the data processing, the translation procedures are more prone to human error than the interpolation procedures. However, the translation procedures would work well if multiple narrow irradiance ranges are used with individual sets of correction values for each narrow irradiance range or multiple sets of correction values are used for a single wide irradiance range.
- An extensive validation analysis of the four translation/interpolation procedures, at both narrow and wide irradiance ranges, indicates that all the four procedures are accurate within an average error of 3 % and a root mean square error (RMSE) of 4.5 %.

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Download the full report: www.solarabcs.org/Ratingper61853

About Solar America Board for Codes and Standards

The Solar America Board for Codes and Standards (Solar ABCs) is a collaborative effort among experts to formally gather and prioritize input from the broad spectrum of solar photovoltaic stakeholders including policy makers, manufacturers, installers, and consumers resulting in coordinated recommendations to codes and standards making bodies for existing and new solar technologies. The U.S. Department of Energy funds Solar ABCs as part of its commitment to facilitate widespread adoption of safe, reliable, and cost-effective solar technologies. For more information, visit the Solar ABCs website: www.solarabcs.org

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