A Solar ABCs **Proposed Standard** on:

Nameplate, Datasheet and Sampling Requirements of Photovoltaic Modules

Prepared by

Govindasamy TamizhMani & Joseph Kuitche
Arizona State University

Alex Mikonowicz
PowerMark Corporation

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About the Author

Dr. (Mani) Govindasamy TamizhMani is the president of TUV Rheinland PTL (Photovoltaic Testing Laboratory) and a professor in the Department of Electronic Systems at Arizona State University. Dr. Mani has been involved in R&D activities related to photovoltaics and fuel cells for over 25 years, and photovoltaic module testing and certification activities for over 10 years. He has been involved in test standards' development activities since 1996. He has served or has been serving as a member of various standards committees including Canadian Standards Council, IEEE, IEC and ASTM. He has taught graduate level courses related to photovoltaics, fuel cells, electrolysis and batteries, has published more than 60 journal and conference papers.

Alex Mikonowicz is a ISO-9001 Consultant on Quality Systems & Photovoltaic Reliability and the Executive Director of PowerMark, Inc. He has 28 years in the Aerospace & Computer industries and 18 years in Photovoltaic's, managing quality organizations at SolarWorld USA, Siemens and Shell Solar Industries, USA. Five times, he was appointed as an examiner for the Malcolm Baldrige National Quality Award. Mr. Mikonowicz is active on the standards committees of the IEC, IEEE, and ASTM, and is the present USA TAG Technical Advisor (TA) for the IEC-TC 82, and votes on the behalf of US for the IEC, TC-82, Photovoltaic Standards. He holds degrees in electrical engineering and business.

Joseph Kuitche is a Ph.D. student at Arizona State University and is the R&D and certification manager of TUV Rheinland PTL. He has taught undergraduate level courses at ASU and has published 3 papers related to statistical reliability prediction of PV modules and several papers related to the performance and qualification testing of PV modules.

Solar America Board for Codes and Standards

The Solar America Board for Codes and Standards (Solar ABCs) provides an effective venue for all solar stakeholders. A collaboration of experts formally gathers and prioritizes input from groups such as policy makers, manufacturers, installers, and large- and small-scale consumers to make balanced recommendations to codes and standards organizations for existing and new solar technologies. The U.S. Department of Energy funds Solar ABCs as part of its commitment to facilitate wide-spread adoption of safe, reliable, and cost-effective solar technologies.

BACKGROUND

Solar ABCs recently (March 2011) developed a recommended policy report entitled "Photovoltaic Module Power Rating Requirements." The purpose of the report was to develop a Solar ABCs power rating policy statement that establishes requirements for the procurement of photovoltaic (PV) modules for consumers, states, and organizations providing incentives for PV systems in the United States. The purpose of this document is to convert the above policy report into a PV module standard with the text format that would be acceptable to the standard developing organizations (SDO) such as IEEE, ASTM or IEC.

The European Community has developed a related standard (EN 50380) titled *"Datasheet and nameplate information for photovoltaic modules."* This EN standard, published in 2003, details the information that must be supplied with a PV module by the manufacturer. The EN standard requires module data (voltage, current, and power at maximum power point, Voc and Isc) at STC, NOCT, and low irradiance conditions as well as temperature coefficients.

The proposed standard by Solar ABCs differs from the EN standard in **three** major view points:

Difference 1: The EN standard requirement can be represented as in the Equation 1 below:

$$(P_{measured} + m) \geq (P_{rated} - t) \qquad [1]$$

where "m" is the measurement uncertainty and "t" is the production tolerance.

The above EN standard requirement allows leniency, for the nameplate rating by the manufacturers, on both sides of the equation: the production tolerance leniency on the right side of the equation and the measurement uncertainty leniency on the left side of the equation. Unfortunately, the measurement uncertainty varies from one lab to another, and one technology to another. Also, the EN standard does not impose any specific lower/upper limit for the production tolerance. The proposed standard by Solar ABCs accounts for these issues of the EN standard.

Difference 2: The EN 50380 standard requires reporting the module data only at 3 test conditions: STC, NOCT and low irradiance. The newly published (January 2011) standard IEC 61853-1 titled "*Photovoltaic Module Performance Testing and Energy Rating"* requires reporting the module data at 23 test conditions. The proposed standard by Solar ABCs recommends the use of the test conditions required by the IEC 61853-1 standard.

Difference 3: The EN 50380 standard does not impose any statistical sampling requirement to select the modules for the independent power rating measurements. The proposed standard by Solar ABCs incorporates a simple statistical sampling method to determine the number of samples required for the power rating measurements by the independent testing organizations.

PROPOSED STANDARD

IEEE/IEC/ASTM Designation: XXXXXX-11

Nameplate, Datasheet and Sampling Requirements of Photovoltaic Modules

1. Scope

1.1 This standard identifies the required information on the production and measurement tolerances of nameplate rating of flatplate photovoltaic (PV) modules.

1.2 This standard identifies twenty-three test conditions under which the performance parameters of PV modules shall be reported.

1.3 This standard identifies a simple statistical method to determine the number of samples required for the power rating measurements by the independent testing organizations.

1.4 This standard requires that the **nameplate** on the PV module carries certain minimum information identified in this standard.

1.5 This standard requires that the **datasheet** supplied by PV module manufacturers carries certain minimum information identified in this standard.

1.6 This standard does not apply to the concentrator PV modules

2. Overall Requirements of the Standard

After accounting for the light induced degradation as per IEC 61215 (crystalline silicon)[1] or IEC61646 (thin film)[2], the measured average power shall be equal to or higher than the nominal nameplate power rating at STC (standard test conditions) and no individual module power shall be more than 3% below nominal. These requirements are represented by the following two equations:

$$P_{\text{measured, average}} \geq P_{\text{rated, nominal}}$$

$$\&$$

$$P_{\text{measured, individual}} \geq (P_{\text{rated, nominal}} - 3\%\ \text{production tolerance})$$

where $P_{\text{measured, average}}$ is the measured average power of “n” samples and $P_{\text{measured, individual}}$ is the measured power of individual samples.

In addition, at least one module closest to the nominal rated power shall be measured at other twenty-two reference conditions given in IEC 61853-1 standard. The nameplate on the individual PV modules shall carry the minimum information identified in section 3 of this standard. Similarly, the datasheet supplied by the PV module manufacturer shall carry the minimum

information identified in section 4 of this standard. The number of samples used to calculate the measured average power shall be determined using the method identified in section 5 of this standard.

3. Nameplate Requirements

The nameplate on the individual PV modules shall carry the following minimum information:

- Name and logo of original manufacturer or supplier
- Type designation and serial number
- Maximum system voltage
- Rated nominal power (P_{max}) at STC
  (Standard Test Condition: 1000 W/m², 25 °C cell temperature and AM 1.5 global spectrum)
- Maximum negative production tolerance (- % or ± %) of P_{max} at STC
- Short circuit current (I_{sc}), Open circuit voltage (V_{oc}), Voltage at maximum power point (V_{max}) and Current at maximum power point (I_{max}) at STC

4. Datasheet Requirments

The datasheet supplied by the PV module manufacturer shall carry the following minimum information:

- All the nameplate information identified in section 3 of this standard
- Name of an acceptable independent ISO 17025 accredited laboratory which measured the test samples
- Temperature coefficients (%/^{o}C) of V_{oc}, I_{sc}, V_{max}, I_{max} and P_{max} at STC
- Performance data for at least one module closest to the nominal rated power shall be measured at twenty-three reference conditions given in IEC 61853-1 standard and shown in Table 1 below.
- Number of samples used by the independent lab to obtain measured average power
- Measured power of all the individual modules used to obtain average power
- The measurement uncertainty of each test sample at STC along with calibration traceability chain for the measuring equipment of the test laboratory and calibrated modules used in the production line by the manufacturer shall be reported.
- A statement from the manufacturer attesting that the test modules were stabilized by the independent test laboratory for the light induced degradation by preconditioning the test samples according to IEC Standard 61215 (crystalline silicon), Section 5, or after light-soaking according to IEC Standard 61646 (thin film), Section 10.19 or other stabilizing methods as recommended by the manufacturer (if they are consistent with outdoor operation).
- A statement from the manufacturer confirming that the sampling requirements identified in section 5 of this standard is met by the independent test laboratory.

Table 1: Twenty-Three Reporting Conditions Required by IEC 61853-1 Standard

P_{max}, I_{sc}, V_{oc}, and V_{max} versus Irradiance and Temperature					
Irradiance (W/m^2)	Spectrum	Module Temperature (°C)			
		15	25	50	75
1100	AM1.5	NA			
1000	AM1.5				
800	AM1.5				
600	AM1.5				
400	AM1.5				NA
200	AM1.5				NA
100	AM1.5			NA	NA

5. Sampling Requirements

The required number of samples (n) for the average is dictated by the standard deviation (σ) of the measured values. A baseline value for σ is calculated from a minimum number of 30 samples. Then this baseline value of σ is used to determine the required number of samples (n) to meet the Policy recommendation. The required number of samples "n" shall be determined using the following method:

- Note down the nameplate rated power (P_0 in watts)
- Measure the individual power of 30 modules
- Calculate the standard deviation (σ in watts) of these 30 modules
- Determine the sample size "n" using the following equation and table

$$n = (z_{\alpha/2} * \sigma / 0.03P_0)^2$$

Confidence level	$z_{\alpha/2}$
90%	1.645
95%	1.96
99%	2.58
99.9%	3.3

If the “n” value is determined to be higher than 30, then the measured average power shall be based on “n” samples. If the “n’ value is determined to be less than 30, then the measured average power shall be based on 30 samples. The “n” value shall be rounded upward. The details on the sample size determination are presented in the appendix. The timeline for module sampling shall be mutually agreed upon between the supplier and customer.

6. References

1) IEC 61215 (2005): Crystalline silicon terrestrial photovoltaic (PV) modules-Design qualification and type approval

2) IEC 61646 (2008): Thin film terrestrial photovoltaic (PV) modules-Design qualification and type approval

3) IEC 61853-1 (2011): Photovoltaic Module Performance Testing and Energy Rating

APPENDIX

Sample size (n) determination

Assume that the measured average power of "n" samples (say, P_r) is to be within +/-3% of the rated nominal value (say, P_0). That is, if one draws a random sample (for example 30 modules) from a production line and compute the average or mean of 30 samples (say, P), then that value (average) shall fall between $0.97P_0$ and $1.03P_0$; with a certain degree of confidence.

We can set our sight on a 95% (2-sigma) or 99% (3-sigma) confidence level for example. So a 95% confidence interval can be computed as:

$P_r \pm 2\sigma_P$
Where
$\sigma_P = \sigma/\sqrt{n}$ = standard error of the mean
σ = standard deviation of the sample drawn (30 samples)
n = sample size

Thus, the half-width confidence interval is given by

$$w = 2^* \sigma/\sqrt{n}$$

More accurately, 95% confidence level <--> $z_{\alpha/2}$-sigma; so

$$w = z_{\alpha/2}^* \sigma/\sqrt{n}$$

where $z_{\alpha/2}$ can be obtained from statistical tables for any confidence level.

The commonly used values of $z_{\alpha/2}$ are shown in the following table.

Confidence level	$z_{\alpha/2}$
90%	1.645
95%	1.96
99%	2.58
99.9%	3.3

If the target half-width is 3% P_0 as stated, then

$$3\%P_0 = z_{\alpha/2}^* \sigma/\sqrt{n}$$

$$n = (z_{\alpha/2}^* \sigma/0.03P_0)^2$$

Note

The value of "σ" is estimated from a prior sample (of size 30 above).
The value of "n" obtained shall be rounded upward
P_r is the average of "n" samples after preconditioning (crystalline silicon) or light-soaking (thin film)