UL 4730

STANDARD FOR SAFETY

Nameplate, Datasheet, and Sampling Requirements of Photovoltaic Modules

UL Standard for Safety for Nameplate, Datasheet, and Sampling Requirements of Photovoltaic Modules, UL 4730

First Edition, Dated July 14, 2017

SUMMARY OF TOPICS

This revision of UL 4730 dated December 6, 2021 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The requirements are substantially in accordance with Proposal(s) on this subject dated September 24, 2021.

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Standard for Nameplate, Datasheet, and Sampling Requirements of Photovoltaic Modules

First Edition

July 14, 2017

This ANSI/UL Standard for Safety consists of the First Edition including revisions through December 6, 2021.

The most recent designation of ANSI/UL 4730 as a Reaffirmed American National Standard (ANS) occurred on December 3, 2021. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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APPENDIX A Sample Size (n) Determination (informative)

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1 Scope

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

1.2 This standard identifies five rating conditions under which the performance parameters of PV modules shall be reported.

1.3 This standard identifies a statistical method to determine the number of samples required for the power rating measurements.

1.4 The samples shall be drawn at random without regard to their quality as defined in the Standard for sampling procedures and tables for inspection by attributes, ANSI/ASQ Z1.4.

1.5 The power rating measurements shall be performed.

1.6 This standard requires that the nameplate on the PV module carry the minimum required information identified in this standard.

1.7 This standard requires that the datasheet supplied by PV module manufacturers carry the minimum required information identified in this standard.

1.8 Every model/type nameplate rating shall be tested to this standard. If any single model has multiple power bins, then the lowest and highest power bins of the model shall be tested as a minimum.

1.9 This standard does not specify annual sampling frequency.

1.10 This standard does not apply to concentrator PV modules.

2 Normative References

2.1 The following documents, in whole or in part, are normatively referenced in this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61215-1:2016, *Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 1: Test requirements*

IEC 61215-2:2016, *Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 2: Test procedures*

IEC 61853-1:2011, *Photovoltaic (PV) module performance testing and energy rating – Part 1: Irradiance and temperature performance measurements and power rating*

IEC TS 62941:2016, *Terrestrial photovoltaic (PV) modules – Guideline for increased confidence in PV module design qualification and type approval*

ANSI/ASQ Z1.4:2008, *Sampling Procedures and Tables for Inspection by Attributes*

3 General

3.1 All modules shall be stabilized following method MQT 19.1 from IEC 61215-2:2016 (for technology specific requirements see sub-parts of IEC 61215-1:2016). After stabilization the modules shall be

measured in accordance with MQT 6.1 (P_{max}(Lab)). After the stabilization procedure all modules must be within the power rating of the name plate (P_{max}(NP)) including stated measurement uncertainty $m1$. Therefore, the following criteria shall be met:

P_{max} Verification:

Each individual module shall meet the following criterion:

$$P_{\max}(Lab)\cdot\left(1+\frac{|m_1|\,[\%]}{100}\right)\geq P_{\max}(NP)\cdot\left(1-\frac{|t_1|\,[\%]}{100}\right)$$

where

P_{max} (Lab) is the measured maximum STC power of each module in the stabilized state;

P_{max} (NP) is the maximum rated nameplate power of each module without tolerances;

m_1 is the measurement uncertainty in % of laboratory for P_{max} (expanded combined uncertainty (k=2), ISO/IEC Guide 98-3);

t_1 is the manufacturer's rated lower production tolerance in % for P_{max}.

For $\overline{P}_{max}$ (Lab), the following criterion shall apply:

$$\overline{P}_{\max}(Lab)\cdot\left(1+\frac{|m_1|\,[\%]}{100}\right)\geq P_{\max}(NP)$$

where

$\overline{P}_{max}$ (Lab) is the arithmetic average of the measured maximum STC power of the modules in stabilized condition.

For multiple bins of power classes this formula has to be applied to each power class under investigation.

V_{oc} Verification:

Each individual module shall meet the following criterion:

$$V_{\mathrm{oc}}(Lab)\cdot\left(1+\frac{|m_2|\,[\%]}{100}\right)\leq V_{\mathrm{oc}}(NP)\cdot\left(1+\frac{|t_2|\,[\%]}{100}\right)$$

where

V_{oc} (Lab) is the measured maximum V_{oc} of each module in the stabilized state;

V_{oc} (NP) is the maximum rated nameplate V_{oc} of each module without tolerances;

m_2 is the measurement uncertainty in % of laboratory for V_{oc};

t_2 is the manufacturer's rated upper production tolerance in % for V_{oc}.

I_{sc} Verification:

Each individual module shall meet the following criterion:

$$I_{sc}(Lab)\cdot\left(1+\frac{|m_3|\,[\%]}{100}\right)\le I_{sc}(NP)\cdot\left(1+\frac{|t_3|\,[\%]}{100}\right)$$

where

I_{sc} (Lab) is the measured maximum I_{sc} of each module in the stabilized state;

I_{sc} (NP) is the maximum rated nameplate I_{sc} of each module without tolerances;

m_3 is the measurement uncertainty in % of laboratory for I_{sc};

t_3 is the manufacturer's rated upper production tolerance in % for I_{sc}.

A systematic variation to either higher or lower output power will be stated in the final report.

3.2 In addition, a minimum of one module (more modules may be required as dictated by the purchaser or user) closest to the nominal rated power shall be measured at the other four rating conditions given in the Standard for Photovoltaic module performance testing and energy rating, IEC 61853-1, (NOCT, LIC, HTC, and LTC). All five rating conditions are presented in Table 3.1. The nameplate on the individual PV modules shall carry the minimum information identified in Nameplate, Section 4. Similarly, the datasheet and installation manual supplied by the PV module manufacturer shall carry the minimum information identified in Datasheet, Section 5. The number of samples used to calculate the measured average power shall be determined using the method identified in Sampling, Section 6.

Table 3.1
Five Rating Conditions as Required by IEC 61853-1

Abbreviation	Description	Irradiance (W/m^2)	Module Temperature (°C)	Spectrum
HTC	High temperature conditions	1000	75	AM 1.5
STC	Standard test conditions	1000	25	AM 1.5
NMOT	Nominal module operating temperature conditions	800	NMOT (data from a certification body supplied by manufacturer)	AM 1.5
LTC	Low temperature conditions	500	15	AM 1.5
LIC	Low irradiance conditions	200	25	AM 1.5
Note: The measurements at non-STC conditions may be done according to manufacturer procedure as long as it is consistent with the intent, test procedure and requirements of IEC 61853-1 standard.				

4 Nameplate

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

a) Name and logo of original manufacturer or supplier,

b) Type designation and serial number,

c) Maximum system voltage,

d) Rated nominal power (P_{max}) at STC (1000 W/m^2, 25°C cell temperature, and air mass [AM] 1.5 global spectrum),

e) Maximum negative production tolerance (- % or ± %) of P_{max} at STC, and

f) Rated nominal 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.

5 Datasheet

5.1 The datasheet and installation manual supplied by the PV module manufacturer shall carry the following minimum information:

a) All the nameplate information identified in Nameplate, Section 4,

b) Temperature coefficients (%/°C) of V_{oc}, I_{sc}, and P_{max} at STC,

c) Performance data for at least one module closest to the nominal rated power measured at the five rating conditions given in the Standard for Photovoltaic module performance testing and energy rating, IEC 61853-1, and shown in Table 3.1. In addition, the uncertainty of measured value at each test condition shown in Table 3.1, and the uncertainty value of the measured STC data shall appear on the datasheet.

d) The independently measured average power, P_{max} (Lab), from the measured power of all the individual modules, P_{max} (Lab), shall be included in the datasheet. Note: The number of modules (n in Table 6.1) included in the calculation should be continually updated as more batches (or production lines) are manufactured and shipped by the manufacturer.

e) The methodology about how the manufacturer established the nominal rating shall be included - starting with the initial number of modules tested and then how the manufacturer continues to increase the number of modules as more batches are tested and shipped. Suppose the initial number of modules (n1) tested from the first batch (or production line) yields a nominal rating of P1. As more batches (or production lines) are tested and shipped, different pair (Pi, ni) should be obtained for each batch i. The best estimator of the mean rated nominal power for m batches is the grand average of (P1+P2+P3+...+Pm)/m. The standard deviation obtained from all the modules from the m batches shall be used to determine the standard deviation shown in Table 6.1.

f) The measurement uncertainty at STC along with calibration traceability chain for the measuring equipment and calibrated modules used in the production line by the manufacturer, and

g) A statement declaring that the overall performance requirements of the standard including PV-specific QMS per IEC TS 62941:2016 are met and that the test modules were stabilized before the lab measurements by preconditioning the test samples according to IEC 61215 standard series.

6 Sampling

6.1 The samples shall be drawn at random without regard to their quality as defined in the Standard for sampling procedures and tables for inspection by attributes, ANSI/ASQ Z1.4. P_{max} (Lab) is the independently measured average power of “1-to-100” samples (n). The exact number of samples “n” to be used is to be determined based on the ratio between the percent production tolerance “t%” and the percent standard deviation “σ%” of 30 (thirty) samples provided by the manufacturer from a production batch/lot or batches/lots based on the accepted inspection level and sampling procedure per ANSI/ASQ Z1.4. Table 6.1 identifies the required number of samples (n) depending on the production tolerance and