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Adding IEC 61215-2016 Ed and Bifacial Testing according to IEC 60904-1-2

IEC 61215 and IEC 61646 have been harmonized to cover both C-Si and Thin Film Technologies under IEC 61215:2016. The current SB1 Guidelines (7th Ed) still refer to IEC 61646 which has a 43kWh/m² generic Light soaking requirement for thinfilm (regardless of which technology) which is already an obsolete standard. IEC 61215 is broken further to cover technology specific requirements such as varying Lightsoak levels accordingly:

IEC 61215-1-1: c-Si 5 kWh/m²
IEC 61215-1-2: Cd Te 20 kWh/m²
IEC 61215-1-3: a-Si 43 kWh/m²
IEC 61215-1-4: CIGS 10 kWh/m²

There is also a new standard for Bifacial released in 2019, IEC 60904-1-2. The current SB1 guideline does not have any differentiation in the testing methods between Monofacial and Bifacial technologies.

I have marked up the existing SB1 Guidelines Appendix B.A attached to provide some information on how these standards can be applied as a reference for future SB1 Guideline revision.

Additional submitted attachment is included below.

Proposed Changes to SB1 Guidelines for California's Solar Electric Incentive Programs 7th Ed (Addition of IEC 61215:2016 and Bifacial Module Testing)

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Appendix B: Criteria for Testing and Certification Before Adding Equipment to the Energy Commission's Eligible Equipment Lists

A. Photovoltaic Modules

I. Monofacial Modules

All flat-plate PV modules shall have certification conducted by a NRTL to an American National Standard for safety. Before January 1, 2020, safety certification to either UL 61730 (Parts 1 and 2) or UL 1703 will be accepted as proof of compliance as of the effective date of these guidelines. Starting January 1, 2020, only safety certification to UL 61730 will be accepted.

Before January 1, 2022, the Energy Commission will accept safety certification from a NRTL with either UL 1703 or UL 61730 in its scope of recognition. Starting January 1, 2022, the Energy Commission will accept safety certification only from a NRTL with UL 61730 in its scope of recognition.

For incentive eligibility, a unique model number shall be required for each PV module that has a different power rating. Manufacturers may distinguish multiple PV modules at a given power rating by using additional unique model numbers. For incentive eligibility, each unique model number shall be explicitly identified on the certification documentation.

Additional testing shall be conducted to specific subsections of IEC Standard 61215, *Crystalline silicon terrestrial photovoltaic (PV) modules - Design qualification and type approval* (second edition, April 2005 or first edition, March 2016) or IEC Standard 61646, *Thin-film terrestrial photovoltaic (PV) modules - Design qualification and type approval* (second edition, May 2008), except as specified in Note 3 of Table B.1 below. The additional testing shall be conducted by a laboratory with accreditation to ISO/IEC 17025 from an accreditation body that has signed the ILAC MRA and with an accreditation scope that includes IEC 61215:2005, IEC 61215-2:2016 and/or IEC 61646:2008.

IEC Standard 61215:2005 Sections

5. Preconditioning

10.2 Maximum Power Determination

10.4 Measurement of Temperature Coefficients

10.5 Measurement of Nominal Operating Cell Temperature (NOCT)

10.6 Performance at Standard Test Conditions (STC) and NOCT

10.7 Performance at Low Irradiance

IEC Standard 61646:2008 Sections

10.2 Maximum Power Determination

10.4 Measurement of Temperature Coefficients

10.5 Measurement of NOCT

10.6 Performance at STC and NOCT

10.7 Performance at Low Irradiance

10.19 Light-Soaking

IEC Standard 61215-2:2016 Sections
 MQT 19 Initial Stabilization
 MQT 02 Maximum Power Determination
 MQT 04 Measurement of Temperature Coefficients
 MQT 05 Measurement of Nominal Module Operating Temperature
 MQT 06 Performance at Standard Test Conditions (STC) and NMOT
 MQT 07 Performance at Low Irradiance

Manufacturers providing certification to UL 61730 as proof of safety certification shall comply with the provisions of UL 61730-2, Annex DVA, by sampling production modules as defined. For manufacturers electing to use UL 1703 (as allowed in Chapter III, Section A), the factory measured maximum power of each production module, as specified in UL 1703, Section 44.1, and the lower bound of the manufacturer's stated tolerance range, under UL 1703, Section 48.2, shall be no less than 95 percent of the maximum power reported to the Energy Commission.

The performance data and information in Table B.1 shall be submitted to the Energy Commission in a test report issued by the laboratory that completed the testing. These data may be made public. For multiple model numbers, data may be grouped together as described in Section A.2 below.

Table B.1 Module Performance Testing (Monofacial)

Table B.1: Module Performance Parameter Testing

Parameter	Symbol	Units	Notes
Maximum Power	P_{max}	Watts	1, 5
Voltage at Maximum Power	V_{pmax}	Volts	1, 5
Current at Maximum Power	I_{pmax}	Amps	1, 5
Open Circuit Voltage	V_{oc}	Volts	1, 5
Short Circuit Current	I_{sc}	Amps	1, 5
Nominal Operating Cell Temperature	NOCT	°C	3
Temperature Coefficients	β_{Voc} (at V_{oc}) α_{Isc} (at I_{sc}) γ_{Pmax} (at P_{max})	%/°C	2
Voltage at Maximum Power and Low Irradiance	$V_{pmax,low}$	Volts	4
Current at Maximum Power and Low Irradiance	$I_{pmax,low}$	Amps	4
Voltage at Maximum Power and NOCT	$V_{pmax,NOCT}$	Volts	5
Current at Maximum Power and NOCT	$I_{pmax,NOCT}$	Amps	5

Notes:

- 1) Values shall be measured at standard test conditions after preconditioning according to IEC Standard 61215:2005, Section 5, or after light-soaking according to IEC Standard 61646:2008, Section 10.19. Modules may be light-soaked by the manufacturer prior to submitting the modules to a testing laboratory. The testing laboratory shall verify the module stabilization in accordance with IEC Standard 61646:2008, Section 10.19.
- 2) Values shall be measured and calculated according to IEC 61215:2005 and IEC 61646:2008, Section 10.4.
- 3) Values shall be measured in accordance with IEC 61215:2005 and IEC 61646:2008, Section 10.5. For BIPV modules, the measurements shall be made using the mounting specified below.
- 4) Values shall be measured at low irradiance according to IEC 61215:2005 and IEC 61646:2008, Section 10.7.
- 5) Values shall be measured at STC and NOCT according to IEC 61215:2005 and IEC 61646:2008, Section 10.6.

II. Bifacial Modules

For Bifacial Modules, tests specified in Appendix B.A shall be performed in accordance to IEC TS 60904-1-2, *Photovoltaic devices – Part 1-2: Measurement of current-voltage characteristics of bifacial photovoltaic (PV) devices*

1. Maximum Power Determination- Two measurements shall be reported applying single side or double side illumination at BSTC and at elevated irradiance BNPI
 - a. BSTC: 25 °C, 1000 W/m² on module front (no rearside irradiation)
 - b. BNPI: 25 °C, 1000 W/m² on the module front (no rearside irradiation) and 135 W/m² on the module rear (no frontside irradiation), applying Bifacial Coefficient φ (see 3.d)
2. Calculation of Bifaciality Coefficients
 - a. $\varphi_{P_{max}} = P_{maxr} / P_{maxf}$
 - b. $\varphi_{I_{sc}} = I_{scr} / I_{scf}$
 - c. $\varphi_{V_{oc}} = V_{ocr} / V_{ocf}$
 - d. $\varphi = \text{Min} (\varphi_{P_{max}}, \varphi_{I_{sc}})$

Where r= rear and f=front

3. Measurement of Temperature Coefficients – same as clause MQT 04 but with frontside irradiation only (rearside is covered)
4. Measurement of NOCT/NMOT – same as clause 10.5 of IEC 61215:2005 or MQT 05 of IEC 61215-2:2016
5. Performance at Low Irradiance – measured at 25 °C, 200 W/m² on module front (no rearside irradiation)
6. Performance at NOCT/NMOT – measured at NOCT/NMOT Temperature, 800 W/m² on module front (no rearside irradiation)

Table B.2 Bifacial Module Performance Parameter Testing

Parameter	Symbol	Units	Notes
Maximum Power at BSTC	P _{max}	Watts	1,2
Voltage at Maximum Power at BSTC	V _{pmax}	Volts	1,2
Current at Maximum Power at BSTC	I _{pmax}	Amps	1,2
Open Circuit Voltage Voc Volts at BSTC	Voc	Volts	1,2
Short Circuit Current Isc Amps at BSTC	Isc	Amps	1,2
Maximum Power at BNPI	P _{max}	Watts	1
Voltage at Maximum Power at BNPI	V _{pmax}	Volts	1
Current at Maximum Power at BNPI	I _{pmax}	Amps	1
Open Circuit Voltage Voc Volts at BNPI	Voc	Volts	1
Short Circuit Current Isc Amps at BNPI	Isc	Amps	1
Nominal Operating Cell Temperature NOCT or Nominal Module Operating Temperature (NMOT)	NOCT/NMOT	°C	N/A
Temperature Coefficients	β_{Voc} (at Voc) α_{Isc} (at Isc) γ_{Pmax} (at Pmax)	%/°C	2
Bifaciality Coefficients	$\phi_{Pmax} = P_{maxr} / P_{maxf}$ $\phi_{Isc} = I_{scr} / I_{scf}$ $\phi_{Voc} = V_{ocr} / V_{ocf}$ $\phi = \text{Min} (\phi_{Pmax}, \phi_{Isc})$	N/A	1
Voltage at Maximum Power and Low Irradiance	V _{pmax, low}	Volts	1,2
Current at Maximum Power and Low Irradiance	I _{pmax, low}	Amps	1,2
Voltage at Maximum Power and NOCT	V _{pmax, NOCT/NMOT}	Volts	1,2
Current at Maximum Power and NOCT	I _{pmax, NOCT/NMOT}	Amps	1,2
<p>Notes:</p> <ol style="list-style-type: none"> Values shall be measured at Preconditioning of IEC 61215:2005 Section 5 or Initial Stabilization of IEC 61215-2 Section MQT 19 Values shall be measured without rearside irradiation by using baffles and/or back-cover screen 			