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TECHNICAL SPECIFICATION

Guidelines for qualifying PV modules, components and materials for operation at high temperatures

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colour inside

Guidelines for qualifying PV modules, components and materials for operation at high temperatures

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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GUIDELINES FOR QUALIFYING PV MODULES, COMPONENTS AND MATERIALS FOR OPERATION AT HIGH TEMPERATURES

FOREWORD

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- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical Specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 63126, which is a Technical Specification, has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

The text of this Technical Specification is based on the following documents:

Draft TS	Report on voting
82/1662/DTS	82/1706A/RVDTS

Full information on the voting for the approval of this Technical Specification can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

The IEC 61215 series, IEC 61730 series, IEC 62790 and IEC 62852 are considered suitable for an environmental temperature range of at least -40 °C to + 40 °C and for modules operating in such conditions that a 98th percentile module operational temperature of 70 °C or less applies. This environmental temperature range encompasses many locations and installation styles in these locations. As an example, it has been determined that thermally unrestricted, or open-rack-style structures, in most cases do not result in 98th percentile module operational temperatures exceeding 70 °C and as such, the originating standards are suitable as written. Module operating temperatures exceeding 70 °C, on the other hand, at the 98th percentile typically will occur with roof-parallel or building-integrated roof top applications in climates with local environmental temperatures that exceed 40 °C.

This document is written for two purposes: to provide modified testing conditions for modules that will be deployed in climates that have a higher environmental air temperature than 40 °C and/or for module installation methods that restrict cooling, resulting in higher operational temperatures than anticipated in the originating standards. This work will also aid in providing an alternative definition of “rack mount” in the context of IEC 61215 series and IEC 61730 series. This term was initially used as a place holder to restrict the scope of PV module type testing for those installation styles that permit open and unrestricted cooling from all surfaces of a PV module. Now that the testing has matured there is a desire to refine definitions for the range of applicability of these standards.

This document is intended to be used as an intermediate step to define high temperature environment use requirements. These requirements are planned to be incorporated into standards in the future. It is not necessarily cost effective for module materials to comply with level 1 or level 2 requirements defined in this document, unless the module temperature is expected to exceed 70 °C at the 98th percentile. Module materials capable of temperature level 1 or temperature level 2 are expected to impose higher expectations of endurance and cost than normal modules.

Component standard IEC 62930 is considered to be adequate for modules operating at high temperatures without modification due to requiring cable to have a 120 °C or greater thermal endurance at a 20 000 h correlation lifetime. Similarly, IEC 62979 is considered adequate for bypass diode thermal runaway determination due to testing temperatures of 90 °C for roof-mounted modules and 75°C for “rack mounted” modules.

Similar to electric cables, IEC 61730-1 requires a RTI, TI, or RTE of 90 °C or larger. A module operating in an environment and installation style resulting in a 98th percentile temperature of 70 °C requires a RTI, TI, or RTE safety factor of +20 °C to establish a 25-year lifetime when the polymer has a minimum activation energy of 46 kJ/mol and the correlation lifetime is 20 000 h. This work applies that safety factor of +20 °C for polymer RTI, TI, or RTE when the 98th percentile operating temperature is above 70 °C.

Finally, data from PV modules in hot climates and modelling were used to understand operating temperatures and resulted in two categories of high temperature operation, temperature level 1 and temperature level 2. These categories are defined within this document and it is relevant to indicate that level 2 temperatures were not found in field data, but may result from insulated substrate modules on pitched roofs facing the sun when ambient air temperature exceeds 40 °C. This may be most consistent with building-integrated PV module roofs and to allow for this possibility, the temperature level 2 category remains in this document.

GUIDELINES FOR QUALIFYING PV MODULES, COMPONENTS AND MATERIALS FOR OPERATION AT HIGH TEMPERATURES

1 Scope

This document defines additional testing requirements for modules deployed under conditions leading to higher module temperature which are beyond the scope of IEC 61215-1 and IEC 61730-1 and the relevant component standards, IEC 62790 and IEC 62852. The testing conditions specified in IEC 61215-2 and IEC 61730-2 (and the relevant component standards IEC 62790 and IEC 62852) assumed that these standards are applicable for module deployment where the 98th percentile temperature (T_{98th}), that is the temperature that a module would be expected to equal or exceed for 175,2 h per year, is less than 70 °C.

NOTE 175,2 h represents 2 % of a total year as some thermal failure modes are a function of time at temperature and not sensitive to day-only or night-only exposure.

This document defines two temperature regimes, temperature level 1 and temperature level 2, which were designed considering deployment in environments with mounting configurations such that the T_{98th} is less than or equal to 80 °C for temperature level 1, and less than or equal to 90 °C for temperature level 2. This document provides recommended additional testing conditions within the IEC 61215 series, IEC 61730 series, IEC 62790 and IEC 62852 for module operation in temperature levels 1 and 2.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of 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 61215-2:2016, *Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 2: Test procedures*

IEC 61730-1, *Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction*

IEC 61730-2, *Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing*

IEC TS 61836, *Solar photovoltaic energy systems – Terms, definitions and symbols*

IEC 62788-1-7, *Measurement procedures for materials used in photovoltaic modules – Part 1-7: Encapsulants – Test procedure of optical durability*

IEC TS 62788-2:2017, *Measurement procedures for materials used in photovoltaic modules – Part 2: Polymeric materials – Frontsheets and backsheets*

IEC TS 62788-7-2, *Measurement procedures for materials used in photovoltaic modules – Part 7-2: Environmental exposures – Accelerated weathering tests of polymeric materials*

IEC 62790, *Junction boxes for photovoltaic modules – Safety requirements and tests*

IEC 62852, *Connectors for DC-application in photovoltaic systems – Safety requirements and tests*

IEC 62930, *Electric cables for photovoltaic systems with a voltage rating of 1,5 kV DC*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TS 61836 apply, as well as the following:

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
environmental temperature
air temperature defined in degrees Celsius for the geographic installation location as measured and documented by meteorological services for this geographic location

Note 1 to entry: The environmental temperature is typically measured 1 m above ground. PV modules deployed closer to the ground may experience higher ambient temperatures than this quoted environmental temperature.

3.2
ambient temperature
average temperature of air or another medium in the vicinity of the equipment

Note 1 to entry: During the measurement of the ambient temperature the measuring instrument/probe should be shielded from draughts and radiant heating.

Note 2 to entry: Ambient temperature is often called operating temperature or operational temperature.

3.3
module operational temperature
temperature representative of the PV module – usually of the junction of the solar cells within the module. This temperature may be measured by means of a temperature sensor or via the equivalent cell temperature technique according to IEC 60904-5

3.4
98th-percentile temperature
when temperature data from a varying temperature process are placed into rank order, the 98th-percentile temperature represents a temperature that is larger than 98 percent of remaining temperatures and is exactly met or exceeded only 2 % of the time

Note 1 to entry: The 98th-percentile temperature is to be determined from data taken at hourly, or more frequent, measurements. For a standard year, the 98th-percentile temperature would be met or exceeded for 175,2 h.

3.5
temperature level 1
is used to categorize test modifications and applies for PV modules whose 98th-percentile temperature falls into the range greater than 70 °C but less than or equal to 80 °C

3.6
temperature level 2
is used to categorize test modifications and applies for PV modules whose 98th-percentile temperature falls into the range greater than 80 °C but less than or equal to 90 °C

4 Modifications to IEC 61215-2

4.1 General

The following tests are based on changes to the test procedures in IEC 61215-2.

Initial and final tests including MQT 19.1 Stabilisation shall be applied without modification.

4.2 Hot-spot endurance test (MQT 09)

MQT 09 of IEC 61215-2:2016 shall be performed by increasing the temperature from (50 ± 10) °C to (60 ± 10) °C for rating modules to temperature level 1 and to (70 ± 10) °C for rating modules to temperature level 2.

NOTE Prolonged product operation under hot spot conditions with temperatures in excess of temperature level 1 or level 2 conditions may lead to premature degradation of module packaging materials.

4.3 UV preconditioning test (MQT 10)

MQT 10 of IEC 61215-2:2016 shall be performed with module temperature sensors reading (70 ± 5) °C for rating modules to temperature level 1 and (80 ± 5) °C for rating modules to temperature level 2. This change only affects the temperature sensor reading from (60 ± 5) °C to the new, higher values.

4.4 Thermal cycling test (MQT 11)

MQT 11 of IEC 61215-2:2016 shall be performed with modification to the temperature setpoints as indicated below leaving the dwell times and temperature ramp rates unchanged.

The upper limit of the temperature cycling shall be increased from (85 ± 2) °C to (95 ± 2) °C for rating modules to temperature level 1 and (105 ± 2) °C for rating modules to temperature level 2.

The upper limit of continuous current flow shall be changed from 80 °C to 90 °C for rating modules to temperature level 1 and 100 °C for rating modules to temperature level 2 and the temperature at which the current flow shall be reduced to less than 1 % of the measured STC peak power current shall be changed from 80 °C to 90 °C for rating modules to temperature level 1 and 100 °C for rating modules to temperature level 2.

Subject the module(s) to cycling between measured module temperatures of (–40 ± 2) °C and (95 ± 2) °C for rating modules to temperature level 1 and (105 ± 2) °C for rating modules to temperature level 2.

4.5 Bypass diode testing (MQT 18)

MQT 18 of IEC 61215-2:2016 shall be performed at higher temperatures and higher current levels using the changes specified below.

In IEC 61215-2 the apparatus shall be capable of heating the module to a temperature of (100 ± 5) °C for rating modules to temperature level 1 and (110 ± 5) °C for rating modules to temperature level 2 rather than just to (90 ± 5) °C.

Additionally, the apparatus shall be capable of applying a current equal to 1,4 times the STC short circuit current of the module under test for rating modules to temperature levels 1 and 2.

V_{D5} shall be measured at (110 ± 5) °C for rating modules to temperature levels 1 and 2 and be added to the least squares fit data.

Change the instructions to “heat the module to (90 ± 5) °C for rating modules to temperature level 1 and (100 ± 5) °C for rating modules to temperature level 2” instead of to (75 ± 5) °C.

Change the instructions to "For rating at temperature level 1 and 2 apply a current to the module equal to 1,15 times the short circuit current (1,15 × I_{sc}) ± 2 % of the module as measured at STC."

Obtain T_J from V_D at T_{amb} = 90 °C for rating modules to temperature level 1 and 100 °C for rating modules to Temperature Level 2 rather than at 75 °C.

Change the instructions to "for rating at temperature levels 1 and 2 increase the applied current to 1,4 times the short-circuit current of the module as measured at STC while maintaining the module temperature at (90 ± 5) °C for rating at temperature level 1 and at (100 ± 5) °C for rating at temperature level 2."

NOTE For additional information regarding the chosen temperature and current levels for MQT 18, see [1] [1].

5 Modifications to IEC 61730

5.1 IEC 61730-1

Most of the tests called out in IEC 61730-1 are found in IEC 61730-2 and are covered in 5.2.

To be considered part of the relied upon insulation (RUI), which is needed for determining the distance through insulation, the RTE (RTI) or TI construction requirement of IEC 61730-1 requires values of at least 90 °C. Similarly, 90 °C is required for "polymeric materials used for mechanical functions". For safety qualification under this guideline, all these materials shall instead be qualified to a minimum 100 °C RTE (RTI) or TI for temperature level 1 modules and a minimum of 110 °C for temperature level 2 modules. All other requirements for the RUI remain as stated in IEC 61730-1.

5.2 IEC 61730-2

5.2.1 General

The following tests shall be conducted similarly to the test procedures in IEC 61730-2, but with modifications as follows.

5.2.2 Hot spot endurance test (MST 22)

This test is equivalent to MQT 09 in IEC 61215-2, so follow the directions given in 4.2 for MQT 09.

NOTE Prolonged product operation under hot spot conditions with temperatures in excess of level 1 or level 2 conditions may lead to premature degradation of module packaging materials.

5.2.3 Bypass diode thermal test (MST 25)

This test is equivalent to MQT 18 in IEC 61215-2, so follow the directions given in 4.5 for MQT 18.

5.2.4 Materials creep test (MST 37)

Temperature level 1 modules shall continue to use (105 ± 5) °C, but for temperature level 2 modules use (110 ± 5) °C.

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1 Numbers in square brackets refer to the Bibliography.

5.2.5 Thermal cycling test (MST 51)

This test is equivalent to MQT 11 in IEC 61215-2, so follow the directions given in 4.4 for MQT 11.

5.2.6 UV test (MST 54)

This test is equivalent to MQT 10 in IEC 61215-2, so follow the directions given in 4.3 for MQT 10.

5.2.7 Dry heat conditioning (MST 56)

Dry heat conditioning applies to pollution degree 1 constructions and temperature level 1 modules shall continue to use (105 ± 5) °C, but for temperature level 2 modules use (110 ± 5) °C.

6 Modifications to component standards

6.1 Polymeric packaging material testing requirements

6.1.1 Test procedures for durability of polymer packaging materials

Polymeric encapsulant materials evaluated to the requirements of IEC 62788-1-7 and intended for use with high temperature modules shall modify the artificial accelerated weathering of temperature level 1 modules to the A4 condition in IEC TS 62788-7-2 and the artificial accelerated weathering of temperature level 2 modules shall be performed at the A5 condition from this document.

6.1.2 Polymeric back sheets and front sheets

Polymeric front sheets and back sheets evaluated to the requirements of IEC TS 62788-2 intended for use with high temperature modules shall comply with the requirements of 4.10.3 of IEC TS 62788-2:2017 with the modification that temperature level 1 modules use the A4 condition in IEC TS 62788-7-2 and temperature level 2 modules use the A5 condition from this document. Following the weathering test in 4.2.4 of IEC TS 62788-2:2017, the pass criteria are:

a) an absolute elongation at break of at least 30 %, and

b) retention of at least 50 % of the initial tensile strength.

6.2 Junction boxes according to IEC 62790

IEC 62790 includes a requirement for junction boxes to be suitable for durable use outside in an ambient temperature range from at least –40 °C to +85 °C. Manufacturers can declare lower and/or upper ambient temperatures outside this range. According to this standard, junction boxes shall withstand such temperatures lower and/or higher than –40 °C to +85 °C when declared.

Junction boxes used for modules with temperature level 1 shall have been qualified according to IEC 62790 for an upper temperature T_{max} of at least 95 °C.

Junction boxes used for modules with temperature level 2 shall have been qualified according to IEC 62790 for an upper temperature T_{max} of at least 105 °C.

6.3 Connectors for DC application in photovoltaic systems according to IEC 62852

IEC 62852 includes a requirement for connectors to be suitable for durable outdoor use in an ambient temperature range from at least –40 °C to +85 °C. IEC 62852 states that connectors shall withstand the upper (ULT) and lower (LLT) values of temperature range as specified by the manufacturer.

Connectors used for modules with temperature level 1 shall have been qualified according to IEC 62852 for an upper limiting temperature ULT of at least 95 °C.

Connectors used for modules with temperature level 2 shall have been qualified according to IEC 62852 for an upper limiting temperature ULT of at least 105 °C.

6.4 Electric cables for photovoltaic systems with a voltage rating of 1,5 kV DC according to IEC 62930

This standard applies without modification.

7 Test modification summary

Table 1 presents the summary test modifications described in Clause 4 through Clause 6.

Table 1 – Test modification summary

Standard	Test Ref	Test Name	Original Requirement $T_{98\%}$ = 70 °C or less	Proposal - Level 1 $T_{98\%}$ > 70 °C to ≤ 80 °C	Proposal - Level 2 $T_{98\%}$ > 80 °C to ≤ 90 °C
module level tests					
IEC 61215	MQT 09	Hot-spot endurance test	(50 ± 10) °C	+10 °C, (60 ± 10) °C	+20 °C, (70 ± 10) °C
	MQT 10	UV preconditioning	(60 ± 5) °C	+10 °C, (70 ± 5) °C	+20 °C, (80 ± 5) °C
	MQT 11	Thermal cycling test	(85 ± 2) °C	+10 °C, (95 ± 2) °C	+20 °C, (105 ± 2) °C
	MQT 18	Bypass diode testing chamber	(75 ± 2) °C	+15 °C, (90 ± 2) °C	+25 °C, (100 ± 2) °C
		Part 1	I_{SC}	1,15 * I_{SC} for diode T	1,15 * I_{SC} for diode T
		Part 2	1,25 * I_{SC}	1,4 * I_{SC} for stress	1,4 * I_{SC} for stress
IEC 61730		RTI/RTE/TI	min RTI 90 °C	min RTI 100°C	min RTI 110 °C
	MST 22	Hot spot endurance	(50 ± 10) °C	+10 °C, (60 ± 10) °C	+20 °C, (70 ± 10) °C
	MST 37	Material creep test	105 °C	no change	110 °C
	MST 51	Thermal cycle	(85 ± 2) °C	+10 °C, (95 ± 2) °C	+20 °C, (105 ± 2) °C
	MST 54	UV test	(60 ± 5) °C	+10 °C, (70 ± 5) °C	+20 °C, (80 ± 5) °C
	MST 56	Dry heat conditioning	105 °C	no change	110 °C
component level tests					
IEC 62788-1-7 (encapsulant, performance)	8	Optical durability encapsulants	IEC TS 62788-7-2 (A3 cond.)	IEC TS 62788-7-2 (A4 cond.)	IEC TS 62788-7-2 (A5 cond.)
IEC TS 62788-2* (backsheet and frontsheet safety)	4.10.3	Weathering (UV) ageing test	IEC TS 62788-7-2 (A3 cond.)	IEC TS 62788-7-2 (A4 cond.)	IEC TS 62788-7-2 (A5 cond.)
IEC 62852		Marking, Upper Limit Temperature (ULT)	no requirement	95 °C	105 °C
IEC 62790		Range of temperature (upper ambient temperature)	no requirement	95 °C	105 °C

* - Following publication of IEC 62788-2-1, this standard will take the place of IEC TS 62788-2 and the test reference will be FBST 09. For backsheets used in BIPV, backside UV exposure is not required. For coloured or black backsheets, IEC TS 62788-2 section 4.10.3.5 recommends a lower chamber temperature for UV exposure, e.g. use A2 instead of A4 for black and A3 instead of A4 for coloured, in order to achieve the target sample temperature. The level 2 weathering condition is under development and may induce failure mechanisms different than in field applications.

8 Reporting

In addition to the reporting requirements of the referenced standard that shall be followed in their entirety, the following information shall be added:

– a statement indicating that the testing modifications according to IEC TS 63126 were followed using level 1 or level 2 criteria (as relevant).

Annex A
(informative)

Determination of temperature level

A.1 General

The purpose of this annex is threefold and provides information on the:

a) modelling method used to obtain temperature estimates for different locations and different PV module mounting styles,
b) 98^{th}-percentile criteria for defining module temperature,
c) guidance on module temperature for several locations.

A.2 Modelling

The test modifications detailed in this document were selected based on modelled photovoltaic module operating temperatures that were generalized into two operating temperature bins, Temperature Level 1 and Temperature Level 2. The modelling included consideration of module basic construction (glass/glass, glass/ polymer, or polymer/ steel) and installation application (open rack, above roof, or insulated backsheet), for typical module dimensions, for worldwide climates based on typical model years. The modelling technique used is described in detail in Annex A of IEC TS 61724-2:2016.

NOTE The same model and background information on its development is also available in SAND2004-3535, August 2004 [2].

The construction style of a PV module can provide an indication of the basic heat transfer coefficient and overall heat capacity. In application, Sandia National Laboratories tested many modules of similar construction and grouped the resulting empirical coefficients together by construction style and application method and reported an average value that was used in this study. This simple temperature model is claimed to be accurate to within ±5 °C at 95 % confidence. Variations may be due to peculiarities of the site, racking, array size, module characteristics or many other factors. The intent here is to provide generally applicable estimates of temperature. The module constructions considered included glass superstrate and glass substrate, (subscript “gg”), glass superstrate and polymer backsheet, (subscript “gp”), and polymer superstrate with a steel substrate, (subscript “ps”). The application methods considered included:

- Open-rack or rack-mounted: as tested, this construction style consists of a module installed on a minimum rack structure consisting of rails bolted to the module frame with open-air circulation on all surfaces and elevated from the ground by approximately 1 m. This modelling application has a subscript of “open”.
- Close-roof: as tested, this construction style had a module mounted parallel to a pitched roof construction. The module was mounted 76 mm to 102 mm from the roof and the pitch of the roof was not fixed as testing was performed on a two-axis tracker. This modelling application has a subscript of “roof”.
- Insulated-backsheet: This constructions style type is the result of severely restricting, or precluding, air flow on the back side of a module. This style is intended to be consistent with building-integrated PV and would be like roof-integrated PV modules, but likely would exceed the actual temperature of vertical building glazing applications such as curtain walls, spandrel glass, or the like. This modelling application has a subscript of “insulated”.

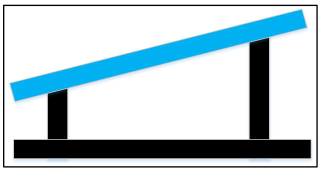
Meteorological data was obtained from TMY-3 [3] and IWEC [4] databases and processed using Python code from PVlib and other online resources to calculate a histogram of temperatures for every location using the Sandia temperature model from which the 98th percentile temperature could be determined. Modules were modelled as being fixed latitude tilt and pointed towards the equator. All temperatures modelled are close to the local maximum based on optimized altitude angles and azimuth angles for the location involved.

A.3 98th-percentile temperatures (T_{98th})

All heat degradation phenomena require time at a temperature to produce a change. The longer the duration of the temperature exposure, or the larger the temperature itself, the higher the degree of damage [5]. This leads to a competing situation where the maximum temperature, defined as the 100th-percentile occurs for too short a duration to be as damaging as the 99th-percentile, but as the percentile decreases, so does the temperature. A second consideration, aside from thermal degradation, is creep of thermoplastic materials that requires an exposure time at temperature to produce change (versus short duration temperature excursions). Consideration of both thermal degradation and creep supported an adoption of the 98th-percentile temperature since it results in a reasonable combination of a cumulative exposure of 175,2 h/year at or above the stated temperature and several days where there are three hours or more contiguous time at or above the stated temperature. The examples below indicate the modelled result for a typical glass-glass module mounted parallel pitch to a roof in Riyadh, Saudi Arabia, Figure A.1 is an overall histogram that provides information of time at temperature. Figure A.2 is specific to the time period from July 28 through September 7 and shows that using the 98th-percentile temperature results in several contiguous days of operation at or above the indicated temperature and that some of these hotter days contain periods of time greater than three hours (represented by four or more dots above the dashed line) at or above the 98th-percentile temperature.

T_{gg} – open

Glass superstrate / glass substrate construction in an open application

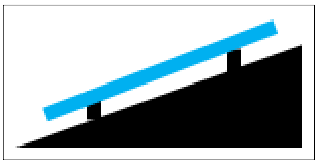


T_{gp} – open

Glass superstrate / polymer backsheet in an open application

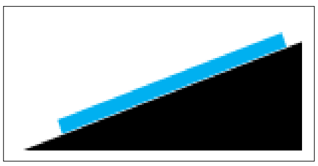
T_{gg} – roof

Glass superstrate / glass substrate construction in an above roof, parallel-pitch application



T_{gp} – insulated

Glass superstrate / polymer backsheet with an insulated backsheet (representative of BIPV)



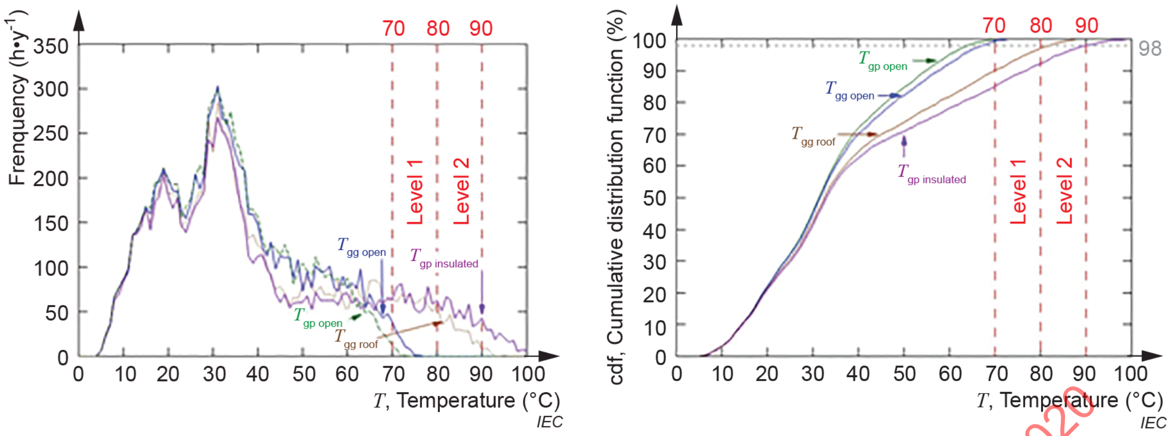


Figure A.1 – Histogram and CDF of module temperature for Riyadh, Saudi Arabia

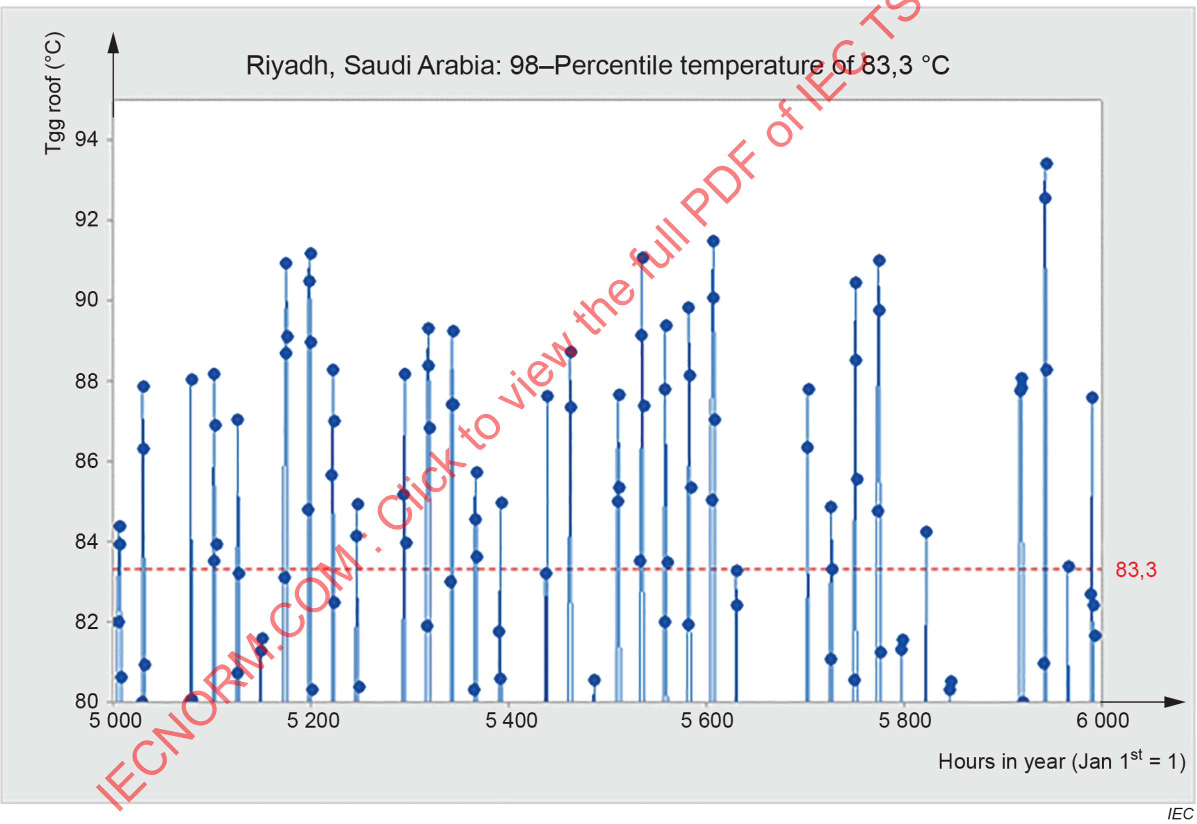


Figure A.2 – Time series from the model for Riyadh

A.4 Guidance on module temperature for several locations

The intent of this clause is to provide the reader with example modelled PV module temperatures, at the 98th-percentile using the above method for locations worldwide. Figure A.3 through Figure A.5 provide the information based on a graphic representation of a mounting method and using colour-coded representations of the resulting operating temperature on a global map using the glass superstrate, polymer backsheet combination T_{gp}. The intent here is to guide the installer as to which locations might require the higher levels of temperature durability. But it is up to the installer to estimate the specifics of the exact microclimate of their arrays. Local variations in geography or installation construction can have significant effects on the module temperature.