TEST REPORT

EN 61215-1

Crystalline silicon terrestrial photovoltaic (PV) modules (PV) modules – Design qualification and type approval

EN 61730-1

Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction

EN 61730-2

Photovoltaic (PV) module safety qualification -- Part 2: Requirements for testing

Report Reference No……..:	AOC250716005S
Tested by (+ signature)…….:	Wanyang Ye
Approved by (+ signature)…….:	Robin Liu
Date of issue……..:	2025-07-16
Contents……..:	72 pages

Testing laboratory

Name……..:	Shenzhen AOCE Electronic Technology Service Co., Ltd
Address……..:	Room 202, 2nd Floor, No.12th Building of Xinhe Tongfuyu Industrial Park, Fuhai Street, Baoan District, Shenzhen, Guangdong, China
Testing location……..:	Same as above

Client

Name……..:	SHANGHAI SUMMIT INTERNATIONAL TRADING CO.,LTD
Address……..:	Room 418, Block 1, No. 1000 zhenchen Road, Baoshan District, Shanghai, China

Test specification Standard……..:	EN IEC 61215-1-2:2021/A1:2022 EN IEC 61730-1:2018+AC:2018; EN IEC 61730-2:2018+AC:2018
Test procedure ……..:	Compliance with EN IEC 61215-1:2021+AC:2021; EN IEC 61730-1:2018+AC:2018; EN IEC 61730-2:2018+AC:2018
Non-standard test method……..:	N/A

Test item Description……..:	ILLUMINATED SIGNS
Trademark……..:	Omoda Jaecoo
Model and/or type reference……..:	900*900, 670*900, 445*900, 220*900, 5520*940, 5520*1860, 500*500*900, 520*520*1860, 900*1860, 670*1860, 445*1820, 220*1820
Manufacturer……..:	SHANGHAI SUMMIT INTERNATIONAL TRADING CO.,LTD
Address……..:	Room 418, Block 1, No. 1000 zhenchen Road, Baoshan District, Shanghai, China
Rating(s)……..:	Input: 120-277 V~, 50/60 Hz, 95 W

Test case verdicts

Test case does not apply to the test object..... : N(.A.)

Test item does meet the requirement..... : P(ass)

Test item does not meet the requirement..... : F(ail)

Testing

Date of receipt of test item ..... : 2025-07-02

Date(s) of performance of test..... : 2025-07-02 – 2025-07-16

General remarks

"This report is not valid as a CB Test Report unless appended to a CB Test Certificate issued by a NCB, in accordance with IECEE 02".

This test report shall not be reproduced except in full without the written approval of the testing laboratory.

The test results presented in this report relate only to the item tested.

"(see remark #)" refers to a remark appended to the report.

"(see appended table)" refers to a table appended to the report.

Throughout this report a comma is used as the decimal separator.

Remark

1. Instructions and equipment marking related to safety is applied in the language that is acceptable in the country in which the equipment is to be sold.
2. All models are similar except appearance and power. All tests were conducted on model 900*900.
3. The product was submitted and tested for use at the manufacturer's recommended ambient temperature (Tma) of 25°C.

Copy of marking plate

Omoda Jaecoo

ILLUMINATED SIGNS
900*900

Input: 120-277 V~, 50/60 Hz, 95 W

Import: XXX
Address: XXX

Manufacturer: SHANGHAI SUMMIT INTERNATIONAL TRADING CO.,LTD

Address: Room 418, Block 1, No. 1000 zhenchen Road, Baoshan District, Shanghai, China

Made in China

EN 61215			
Clause	Requirement Test	Result - Remark	Verdict
4	Marking		P
	Each module shall carry the following clear and indelible markings		P
	– name, monogram or symbol of manufacturer	See marking plate	P
	– type or model number	See marking plate	P
	– serial number	See marking plate	P
	– polarity of terminals or leads (colour coding is permissible)	See marking plate	P
	– maximum system voltage for which the module is suitable	See marking plate	P
	The date and place of manufacture shall be marked on the module or be traceable from the serial number	See marking plate	P
5	Testing		P
	Before beginning the testing, all modules, including the control, shall be exposed to sunlight (either real or simulated) to an irradiation level of $5kWh \cdot m^{-2}$ to $5.5kWh \cdot m^{-2}$ while open-circuited		P
	The modules shall be divided into groups and subjected to the qualification test sequences in Figure 1, carried out in the order laid down. Each box refers to the corresponding subclause in this standard. Test procedures and severities, including initial and final measurements where necessary, are detailed in Clause 10	See clause 10	P
	In carrying out the tests, the tester shall strictly observe the manufacturer's handling, mounting and connection instructions. Tests given in 10.4, 10.5, 10.6 and 10.7 may be omitted if future IEC 61853 has been or is scheduled to be run on this module type		P
	Test conditions are summarized in Table 1	See table 1	P
6	Pass criteria		P
	A module design shall be judged to have passed the qualification tests, and therefore to be IEC type approved, if each test sample meets all the following criteria		P
	a) the degradation of maximum output power does not exceed the prescribed limit after each test nor 8 % after each test sequence		P
	b) no sample has exhibited any open circuit during the tests		P

EN 61215			
Clause	Requirement Test	Result - Remark	Verdict
	c) there is no visual evidence of a major defect, as defined in Clause 7		P
	d) the insulation test requirements are met after the tests		P
	e) the wet leakage current test requirements are met at the beginning and the end of each sequence and after the damp heat test		P
	f) specific requirements of the individual tests are met		P
	If two or more modules do not meet these test criteria, the design shall be deemed not to have met the qualification requirements. Should one module fail any test, another two modules meeting the requirements of Clause 3 shall be subjected to the whole of the relevant test sequence from the beginning. If one or both of these modules also fail, the design shall be deemed not to have met the qualification requirements. If, however, both modules pass the test sequence, the design shall be judged to have met the qualification requirements	All testing samples met the identify requests	P
7	Major visual defects		P
	For the purposes of design qualification and type approval, the following are considered to be major visual defects:		P
	a) broken, cracked, or torn external surfaces, including superstrates, substrates, frames and junction boxes;	No such defects	P
	b) bent or misaligned external surfaces, including superstrates, substrates, frames and junction boxes to the extent that the installation and/or operation of the module would be impaired.	Not be impaired	P
	c) a crack in a cell the propagation of which could remove more than 10 % of that cell's area from the electrical circuit of the module;	No crack in cell	P
	d) bubbles or delaminations forming a continuous path between any part of the electrical circuit and the edge of the module;	No such defects	P
	e) loss of mechanical integrity, to the extent that the installation and/or operation of the module would be impaired.	No such defects	P
8	Report		P

EN 61215			
Clause	Requirement Test	Result - Remark	Verdict
	Following type approval, a certified report of the qualification tests, with measured performance characteristics and details of any failures and re-tests, shall be prepared by the test agency in accordance with ISO/IEC 17025. The report shall contain the detail specification for the module. Each certificate or test report shall include at least the following information:		P
	a) a title;		P
	b) name and address of the test laboratory and location where the tests were carried out;		P
	c) unique identification of the certification or report and of each page;		P
	d) name and address of client, where appropriate;		P
	e) description and identification of the item tested;		P
	f) characterization and condition of the test item;		P
	g) date of receipt of test item and date(s) of test, where appropriate;		P
	h) identification of test method used;		P
	i) reference to sampling procedure, where relevant;		P
	j) any deviations from, additions to or exclusions from the test method, and any other information relevant to a specific tests, such as environmental conditions;		P
	k) measurements, examinations and derived results supported by tables, graphs, sketches and photographs as appropriate including temperature coefficients of short-circuit current, open-circuit voltage and peak power, NOCT, power at NOCT, STC and low irradiance, spectrum of the lamp used for the UV pre-screening test, maximum power loss observed after all of the tests, and any failures observed;		P
	l) a statement of the estimated uncertainty of the test results (where relevant);		P
	m) a signature and title, or equivalent identification of the person(s) accepting responsibility for the content of the certificate or report, and the date of issue;		P
	n) where relevant, a statement to the effect that the results relate only to the items tested;		P
	o) a statement that the certificate or report shall not be reproduced except in full, without the written approval of the laboratory.		P

EN 61215			
Clause	Requirement Test	Result - Remark	Verdict
	A copy of this report shall be kept by the manufacturer for reference purposes.		P
9	Modifications		P
	Any change in the design, materials, components or processing of the module may require a repetition of some or all of the qualification tests to maintain type approval.		P
10	Test procedures		P
10.1	Visual inspection		P
10.1.1	Purpose		P
	To detect any visual defects in the module.	No such defects	P
10.1.2	Procedure		P
	Carefully inspect each module under an illumination of not less than 1 000 lux for the following conditions:		P
	– cracked, bent, misaligned or torn external surfaces;		P
	– broken cells;		P
	– cracked cells;		P
	– faulty interconnections or joints;		P
	– cells touching one another or the frame;		P
	– failure of adhesive bonds;		P
	– bubbles or delaminations forming a continuous path between a cell and the edge of the module;		P
	– tacky surfaces of plastic materials;		P
	– faulty terminations, exposed live electrical parts;		P
	– any other conditions which may affect performance.		P
	Make note of and/or photograph the nature and position of any cracks, bubbles or delaminations, etc. which may worsen and adversely affect the module performance in subsequent tests.	After above tests, no such defects	P
10.1.3	Requirements		P
	Visual conditions other than the major visual defects listed in Clause 7 are acceptable for the purposes of type approval.	See clause 7	P
10.2	Maximum power determination		P
10.2.1	Purpose		P

EN 61215			
Clause	Requirement Test	Result - Remark	Verdict
	To determine the maximum power of the module before and after the various environmental tests. Repeatability of the test is the most important factor.		P
10.2.2	Apparatus		P
	a) A radiant source (natural sunlight or a solar simulator class B or better in accordance with IEC 60904-9).	Solar simulator	P
	b) A PV reference device in accordance with IEC 60904-2 or IEC 60904-6. If a class B simulator is used the reference device shall be a reference module of the same size with the same cell technology (to match spectral response) as the test specimen.		P
	c) A suitable mount for supporting the test specimen and the reference device in a plane normal to the radiant beam		P
	d) A means for monitoring the temperature of the test specimen and the reference device to an accuracy of ±1 °C and repeatability of ±0.5 °C.		P
	e) Equipment for measuring the current of the test specimen and reference device to an accuracy of ±0.2 % of the reading;		P
	f) Equipment for measuring the voltage of the test specimen and reference device to an accuracy of ±0.2 % of the reading		P
10.2.3	Procedure		P

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Clause	Requirement Test	Result - Remark	Verdict
	Determine the current-voltage characteristic of the module in accordance with IEC 60904-1 at a specific set of irradiance and temperature conditions (a recommended range is a cell temperature between 25 °C and 50 °C and an irradiance between 700 W·m–2 and 1 100 W·m–2) using natural sunlight or a class B or better simulator conforming to the requirements of IEC 60904-9. In special circumstances when modules are designed for operation under a different range of conditions, the current-voltage characteristics can be measured using temperature and irradiance levels similar to the expected operating conditions. Temperature and irradiance corrections can be made in accordance with IEC 60891 in order to compare sets of measurements made on the same module before and after environmental tests. However, every effort should be made to assure that peak power measurements are made under similar operating conditions, that is minimize the magnitude of the correction by making all peak power measurements on a particular module at approximately the same temperature and irradiance. Repeatability of the maximum power measurement must be better than ±1 %.	200W	P
10.3	Insulation test	See attached table	P
10.3.1	Purpose		P
10.3.2	Apparatus		P
	a) DC voltage source, with current limitation, capable of applying 500 V or 1 000 V plus twice the maximum system voltage of the module according to 10.3.4 c).	1000Vdc	P
	b) An instrument to measure the insulation resistance.		P
10.3.3	Test conditions		P
	The test shall be made on modules at ambient temperature of the surrounding atmosphere (see IEC 60068-1) and in a relative humidity not exceeding 75 %.	25.3℃, 67.9%	P
10.3.4	Procedure		P
	a) Connect the shorted output terminals of the module to the positive terminal of a d.c. insulation tester with a current limitation.		P

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Clause	Requirement Test	Result - Remark	Verdict
	b) Connect the exposed metal parts of the module to the negative terminal of the tester. If the module has no frame or if the frame is a poor electrical conductor, wrap a conductive foil around the edges and over the back of the module. Connect the foil to the negative terminal of the tester.		P
	b) a PV reference device having a known short-circuit current versus irradiance characteristic determined by calibrating against an absolute radiometer in accordance with IEC 60904-2 or IEC 60904-6;	Isc=11.2A	P
	c) any equipment necessary to change the temperature of the test specimen over the range of interest;	-40 °C - +85°C	P
	d) a suitable mount for supporting the test specimen and the reference device in the same plane normal to the radiant beam;		P
	e) a means for monitoring the temperature of the test specimen and reference device to an accuracy of ±1 °C, and repeatability of ±0.5 °C;		P
	f) equipment for measuring the current of the test specimen and reference device to an accuracy of ±0.2 % of the reading;		P
	g) equipment for measuring the voltage of the test specimen and reference device to an accuracy of ±0.2 % of the reading;		P
10.4.3	Procedure		P
	There are two acceptable procedures for measuring the temperature coefficients.		N
10.4.3.1	Procedure in natural sunlight		N
	a) Measurement in natural sunlight shall only be made when:		N
	– the total irradiance is at least as high as the upper limit of the range of interest;		N
	– the irradiance variation caused by short-term oscillations (clouds, haze, or smoke) is less than ±2 % of the total irradiance as measured by the reference device;		N
	– the wind speed is less than 2 $m \cdot s^{-1}$		N
	b) Mount the reference device co-planar with the test module so that both are normal to the direct solar beam within ±5°. Connect to the necessary instrumentation.		N

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Clause	Requirement Test	Result - Remark	Verdict
	c) If the test module and reference device are equipped with temperature controls, set the controls at the desired level.		N
	d) If temperature controls are not used, shade the specimen and the reference device from the sun and wind until its temperature is uniform within ±1 °C of the ambient air temperature, or allow the test specimen to equilibrate to its stabilized temperature, or cool the test specimen to a point below the required test temperature and then let the module warm up naturally. The reference device should also stabilize within ±1 °C of its equilibrium temperature before proceeding		N
	e) Record the current-voltage characteristic and temperature of the specimen concurrently with recording the short-circuit current and temperature of the reference device at the desired temperatures. If necessary, make the measurements immediately after removing the shade.		N
	f) The irradiance Go shall be calculated in accordance with IEC 60891 from the measured current (Isc) of the PV reference device, and its calibration value at STC (Irc). A correction should be applied to account for the temperature of the reference device Tm using the specified temperature coefficient of the reference device α rc.		N
	g) Adjust the temperature by means of a controller or alternately exposing and shading the test module as required to achieve and maintain the desired temperature. Alternately, the test module may be allowed to warm-up naturally with the data recording procedure of item d) performed periodically during the warm-up.		N
	h) Ensure that the test module and reference device temperature are stabilized and remain constant within ±1 °C and that the irradiance as measured by the reference device remains constant within ±1 % during the recording period for each data set. All data must be taken at 1 000 $W \cdot m^{-2}$ or be translated to that irradiance level.		N
	i) Repeat steps d) through h). Module temperatures shall be such that the range of interest is at least 30 °C and that it is spanned in at least four approximately equal increments. A minimum of three measurements shall be made at each of the test conditions.		N
10.4.3.2	Procedure with a solar simulator		P

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Clause	Requirement Test	Result - Remark	Verdict
	a) Determine the short-circuit current of the module at the desired irradiance at room temperature, in accordance with IEC 60904-1.		P
	b) Mount the test module in the equipment used to change the temperature. Mount the PV reference device within the simulator beam. Connect to the instrumentation.		P
	c) Set the irradiance so that the test module produces the short-circuit current determined in item a). Use the PV reference device to maintain this irradiance setting throughout the test.		P
	d) Heat or cool the module to a temperature of interest. Once the module has reached the desired temperature, measure Isc, Voc and peak power. Change the module temperature in steps of approximately 5 °C over a range of interest of at least 30 °C and repeat the measurements of Isc, Voc and peak power.		P
10.4.3.3	Calculation of temperature coefficients		P
	a) Plot the values of Isc, Voc and Pmax as functions of temperature and construct a least-squares-fit curve through each set of data		P
	b) From the slopes of the least squares fit straight lines for current, voltage and Pmax, calculate α, the temperature coefficient of short circuit current, β, the temperature coefficient of open-circuit voltage, and δ, the temperature coefficient of Pmax, for the module.	α=0.046, β=–0.31	P
10.5	Measurement of nominal operating cell temperature (NOCT)		P
10.5.1	Purpose		P
	To determine the NOCT of the module.		P
10.5.2	Introduction		P
	NOCT is defined as the equilibrium mean solar cell junction temperature within an open- rack mounted module in the following standard reference environment (SRE):		P
	– tilt angle:	46°	P
	– total irradiance:	1000w/m^2	P
	– ambient temperature:	20°C	P
	– wind speed:	50m/s	P
	– electrical load:	Opened circuit	N

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Clause	Requirement Test	Result - Remark	Verdict
	NOCT can be used by the system designer as a guide to the temperature at which a module will operate in the field and it is therefore a useful parameter when comparing the performance of different module designs. However, the actual operating temperature at any particular time is affected by the mounting structure, irradiance, wind speed, ambient temperature, sky temperature and reflections and emissions from the ground and nearby objects. For accurate performance predictions, these factors shall be taken into account.		P
	Two methods for determining NOCT are described.		P
	The first, called "the primary method", is universally applicable to all PV modules. In the case of modules not designed for open-rack mounting, the primary method may be used to determine the equilibrium mean solar cell junction temperature in the SRE, with the module mounted as recommended by the manufacturer.		P
	The second, called "the reference-plate method", is faster but is applicable only to PV modules of the type which respond to changes of ambient temperature (within restricted ranges of wind speed and irradiance) in the same way as the reference plates used in the measurement. Crystalline silicon modules with a glass front and plastic back are in this category. The reference plates are calibrated using the same procedure as in the primary method.		P
10.5.3	Primary method		P
10.5.3.1	Principle		P
	This method is based on gathering actual measured cell temperature data under a range of environmental conditions including the SRE. The data are presented in a way that allows accurate and repeatable interpolation of the NOCT.		P
	The temperature of the solar cell junction (TJ) is primarily a function of the ambient temperature (Tamb), the average wind speed (V) and the total solar irradiance (G) incident on the active surface of the module. The temperature difference (TJ – Tamb) is largely independent of the ambient temperature and is essentially linearly proportional to the irradiance at levels above 400 $W \cdot m^{-2}$. The procedure calls for plotting (TJ – Tamb) against G		P

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Clause	Requirement Test	Result - Remark	Verdict
	or a period when wind conditions are favorable. A preliminary NOCT value is then determined by adding 20 °C to the value of (TJ – Tamb) interpolated at the SRE irradiance of 800 $W \cdot m^{-2}$. Finally, a correction factor, dependent on the average temperature and wind speed during the test period, is added to the preliminary NOCT to correct it to 20 °C and 1 $m \cdot s^{-1}$.		P
10.5.3.2	Apparatus		P
	The following apparatus is required:		P
	a) an open rack to support the test module(s) and pyranometer in the specified manner (see 10.5.3.3). The rack shall be designed to minimize heat conduction from the modules and to interfere as little as possible with the free radiation of heat from their front and back surfaces;		P
	b) a pyranometer, mounted in the plane of the module(s) and within 0.3 m of the test array;		P
	c) instruments to measure wind speed down to 0.25 $m \cdot s^{-1}$ and wind direction, installed approximately 0.7 m above the top of the module(s) and 1,2 m to the east or west;		P
	d) an ambient temperature sensor, with a time constant equal to or less than that of the module(s), installed in a shaded enclosure with good ventilation near the wind sensors;		P
	e) cell temperature sensors, attached by solder or thermally conductive adhesive to the backs of two solar cells near the middle of each test module, or other equipment necessary for IEC-approved measurement of cell temperature;		P
	f) a data acquisition system with temperature measurement accuracy of ±1 °C to record the following parameters within an interval of no more than 5 s:		P
	– irradiance,	1000w/m^2	P
	– ambient temperature,	20°C	P
	– cell temperature,	25°C	P
	– wind speed,	50m/s	P
	– wind direction.	35° of west	P
10.5.3.3	Test module mounting		P
	Tilt angle: the test module(s) shall be positioned so that it (they) is (are) tilted at 45° ± 5° to the horizontal with the front side pointed toward the equator.	46°	P

EN 61215			
Clause	Requirement Test	Result - Remark	Verdict
	Height: the bottom edge of the test module(s) shall be 0.6 m or more above the local horizontal plane or ground level.	0.8m	P
	Configuration: to simulate the thermal boundary conditions of modules installed in an array, the test module(s) shall be mounted within a planar surface that extends at least 0.6 m beyond the module(s) in all directions. For modules designed for free-standing, open-back installations, black aluminum plates or other modules of the same design shall be used to fill out the remaining open area of the planar surface.		P
	Surrounding area: there shall be no obstructions to prevent full irradiance of the test module(s) during the period from 4 h before local solar noon to 4 h after local solar noon. The ground surrounding the module(s) shall not have an abnormally high solar reflectance and shall be flat and level or sloping away from the test fixture in all directions. Grass, other types of vegetation, black asphalt or dirt are acceptable for the local surrounding area.		P
10.5.3.4	Procedure		P
	a) Set up the apparatus with the test module(s), as described in 10.5.3.3. Ensure that the test module(s) are open-circuited.		P
	b) On a suitable, clear, sunny day with little wind, record, as a function of time, the cell temperature, the ambient temperature, the irradiance, wind speed and wind direction.		P
	c) Reject all data taken during the following conditions		P
	– irradiance below 400 $W \cdot m^{-2}$;		P
	– in a 10-min interval after the irradiance varies by more than 10 % from the maximum value to the minimum value recorded during that 10 min period;		P
	– wind speeds outside the range 1 $m \cdot s^{-1}$ ± 0.75 $m \cdot s^{-1}$;		P
	– ambient temperatures outside the range 20 °C ± 15 °C or varying by more than 5 °C from the maximum to the minimum value recorded during one data collection run;		P
	– in a 10-min interval after a wind gust of more than 4 $m \cdot s^{-1}$;		P
	– wind direction within ±20° of east or west.		P

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Clause	Requirement Test	Result - Remark	Verdict
	d) From a minimum of 10 acceptable data points covering an irradiance range of at least 300 $W \cdot m^{-2}$, making sure that data points are from both before and after solar noon, plot (TJ – Tamb) as a function of irradiance. Use regression analysis to fit the data points.		P
	e) Determine the value of (TJ – Tamb) at 800 $W \cdot m–2$ and add 20 °C to give the preliminary value of NOCT		P
	f) Calculate the average ambient temperature, Tamb, and the average wind speed, V, associated with the acceptable data points and determine the appropriate correction factor from Figure 2.		P
	g) Add the correction factor to the preliminary NOCT to correct it to 20 °C and 1 $m \cdot s^{-1}$. This sum is the NOCT of the module.		P
	h) Repeat the entire procedure on two additional days and average the three values of NOCT for each test module.		P
10.5.4	Reference-plate method		P
10.5.4.1	Principle		P
	This method is based on the principle of comparing the temperature of the test module(s) with that of standard reference plates under the same conditions of irradiance, ambient temperature and wind speed. The steady-state temperature of the reference plate in the SRE is determined using the primary method described in 10.5.3.		P
	The NOCT of the test module is obtained by correcting the temperature difference between the test module and the reference plates to the SRE and adding this value to the mean steady-state temperature of the reference plates in the SRE. It has been established that the measured temperature difference is insensitive to fluctuations in irradiance and to small changes in ambient temperature and wind speed.		P
10.5.4.2	Reference plate		P

EN 61215			
Clause	Requirement Test	Result - Remark	Verdict
	The reference plates shall be made of hard aluminum alloy to the dimensions shown in Figure 3. The front surface shall be painted matte black and the back surface gloss white. Means shall be provided for measuring the temperature of the reference plates to the required accuracy. One method employing two thermocouples is shown in Figure 3. One thermocouple is cemented into each branch of the milled groove with thermally conductive and electrically insulating adhesive, after removing any insulation for a distance of 25 mm from the junction. The remainder of the thermocouple wires are finally cemented into the groove with conductive putty.		P
	At least three reference plates shall be made and calibrated, using the primary method described in 10.5.3. The steady-state temperatures so determined shall be within the range 46 °C to 50 °C and shall differ by no more than 1 °C. One of the reference plates shall be kept unused as a control. Before making a NOCT measurement, the steady-state temperatures of the reference plates shall be checked against that of the control plate under the acceptable conditions indicated in item c) of 10.5.3.4 to detect any change in their thermal properties. If the measured temperatures of the reference plates differ by more than 1 °C, the reason for this shall be investigated and necessary corrective action taken before proceeding with the test		P
10.5.4.3	Test site		P
	Select a flat test site with negligible wind disturbance from buildings, trees and topographical features. Non-uniform reflections from the ground and objects behind the test plane shall be avoided.		P
10.5.4.4	Apparatus		P
	The following apparatus is required (see Figure 4).		P
	a) A number of reference plates, as described in 10.5.4.2 (one more than the number of modules to be tested simultaneously).		P
	b) A pyranometer or a PV reference device.		P

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Clause	Requirement Test	Result - Remark	Verdict
	c) An open rack to support the test module(s), reference plates and pyranometer tilted at 45° ± 5° to the horizontal with the front side toward the equator. Each module shall be closely flanked by two reference plates with the lower edge of the module(s) approximately 1 m above the ground. The rack shall be designed to minimize heat conduction from the module(s) and plates and to interfere as little as possible with the free radiation of heat from their front and back surfaces.		P
	d) Instruments to measure wind speed down to 0.25 $m \cdot s^{-1}$ and wind direction, installed approximately 0.7 m above the top of the module(s) and 1,2 m to the east or west, as shown in Figure 4.		P
	e) An ambient temperature sensor with a time constant equal to or less than that of the modules, installed in a shaded enclosure with good ventilation near the wind sensors.		P
	f) Cell temperature sensors, attached by solder or thermally conductive adhesive to the backs of two solar cells near the middle of each module, or other equipment necessary for IEC-approved measurement of cell temperature.		P
	g) A data acquisition system with temperature measurement accuracy of ±1 °C to record the following parameters within an interval of no more than 5 s:		P
	– irradiance;	1000w/m^2	P
	– ambient temperature;	20°C	P
	– cell temperature;	25°C	P
	– wind speed;	50m/s	P
	– wind direction;	35° of west	P
	– reference-plate temperatures.	48°C	P
10.5.4.5	Procedure		P
	a) Set up the apparatus with the test module(s) and reference plates as shown in Figure 4. Ensure that the test module(s) are open-circuited.		P
	b) On a suitable, clear, sunny day with little wind, record, as a function of time, the cell temperature(s) of the test module(s), the reference-plate temperature, irradiance, ambient temperature, wind speed and wind direction.		P
	c) Reject all data taken during, or for 15 min after, the following conditions:		P

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Clause	Requirement Test	Result - Remark	Verdict
	– irradiance below 750 W· m^{-2} or above 850 W· m^{-2};		P
	– irradiance varying by more than ± 40 W· m^{-2} during one data collection run;		P
	– wind speeds above 2 m· s^{-1} that continue for more than 30 s;		P
	– wind speeds below 0.5 m· s^{-1};		P
	– wind direction within ±20° of east or west;		P
	– differences between temperatures of the reference plates greater than 1 °C.		P
	d) For each data point in the selected period, take the mean temperature TP of all the reference plates.		P
	e) For each data point in the selected period and for each test module:		P
10.6	Performance at STC and NOCT		P
10.6.1	Purpose		P
	To determine how the electrical performance of the module varies with load at STC (1 000 W· m^{-2}, 25 °C cell temperature, with the IEC 60904-3 reference solar spectral irradiance distribution) and at NOCT and an irradiance of 800 W· m^{-2}, with the IEC 60904-3 reference solar spectral irradiance distribution		P
10.6.2	Apparatus		P
	a) A radiant source (natural sunlight or a solar simulator class B or better) in accordance with IEC 60904-9.		P
	b) A PV reference device in accordance with IEC 60904-2 or IEC 60904-6. If a class B simulator is used, the reference device shall be a reference module of the same size with the same cell technology to match spectral response.		P
	c) A suitable mount for supporting the test specimen and the reference device in a plane normal to the radiant beam.		P
	d) A means for monitoring the temperature of the test specimen and the reference device to an accuracy of ±1 °C and repeatability of ±0.5 °C.		P
	e) Equipment for measuring the current of the test specimen and reference device to an accuracy of ±0.2 % of the reading.		P

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Clause	Requirement Test	Result - Remark	Verdict
	f) Equipment for measuring the voltage of the test specimen and reference device to an accuracy of ±0.2 % of the reading.		P
	g) Equipment necessary to change the temperature of the test specimen to the NOCT temperature measured in 10.5.		P
10.6.3	Procedure		P
10.6.3.1	STC		P
	Maintain the module at 25 °C and trace its current-voltage characteristic at an irradiance of 1 000 W· m–2 (as measured by a suitable reference device), in accordance with IEC 60904-1, using natural sunlight or a class B or better simulator conforming to the requirements of IEC 60904-9.		P
10.6.3.2	NOCT		P
	Heat the module uniformly to NOCT and trace its current-voltage characteristic at an irradiance of 800 W· m^{-2} (as measured by a suitable reference device), in accordance with IEC 60904-1, using natural sunlight or a class B or better simulator conforming to the requirements of the IEC 60904-9.		P
	If the reference device is not spectrally matched to the test module, use IEC 60904-7 to calculate the spectral mismatch correction.		P
10.7	Performance at low irradiance		P
10.7.1	Purpose		P
	To determine how the electrical performance of the module varies with load at 25 °C and an irradiance of 200 W·m–2 (as measured by a suitable reference device), in accordance with IEC 60904-1 using natural sunlight or a simulator class B or better conforming to the requirements of IEC 60904-9.		P
10.7.2	Apparatus		P
	a) A radiant source (natural sunlight or a solar simulator class B or better) in accordance with IEC 60904-9.		P
	b) Equipment necessary to change the irradiance to 200 W· m^{-2} without affecting the relative spectral irradiance distribution and the spatial uniformity in accordance with IEC 60904-10.		P
	c) A PV reference device in accordance with IEC 60904-2 or IEC 60904-6.		P

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Clause	Requirement Test	Result - Remark	Verdict
	d) A suitable mount for supporting the test specimen and the reference device in a plane normal to the radiant beam.		P
	e) A means for monitoring the temperature of the test specimen and the reference device to an accuracy of ±1 °C and repeatability of ±0.5 °C.		P
	f) Equipment for measuring the current of the test specimen and reference device to an accuracy of ±0.2 % of the reading.		P
	g) Equipment for measuring the voltage of the test specimen and reference device to an accuracy of ±0.2 % of the reading.		P
10.7.3	Procedure		P
	Determine the current-voltage characteristic of the module at 25 °C ± 2 °C and an irradiance of 200 W· m–2 (as measured by a suitable reference device), in accordance with IEC 60904-1 using natural sunlight or a class B or better simulator conforming to the requirements of IEC 60904-9. The irradiance shall be reduced to the specified level by using neutral filters or some other technique, which does not affect the spectral irradiance distribution. (See IEC 60904-10 for guidance on reducing the irradiance without changing the spectral irradiance distribution.)	25°C±2°C 200W/m^2	P
10.8	Outdoor exposure test		P
10.8.1	Purpose		P
	To make a preliminary assessment of the ability of the module to withstand exposure to outdoor conditions and to reveal any synergistic degradation effects which may not be detected by laboratory tests.		P
10.8.2	Apparatus		P
	a) A device capable of measuring solar irradiation, with an uncertainty of less than ±5 %.		P
	b) Means to mount the module, as recommended by the manufacturer, co-planar with the irradiation measuring device.		P
	c) A load sized such that at STC the module will operate near the maximum power point.		P
10.8.3	Procedure		P

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Clause	Requirement Test	Result - Remark	Verdict
	a) Attach the resistive load to the module and mount it outdoors, as recommended by the manufacturer, co-planar with the irradiation monitor. Any hot-spot protective devices recommended by the manufacturer shall be installed before the module is tested.		P
	b) Subject the module to an irradiation totalling 60 $kWh \cdot m^{-2}$, as measured by the monitor, under conditions conforming to general open-air climates, as defined in IEC 60721-2-1.		P
10.8.4	Final measurements		P
	Repeat the tests of 10.1, 10.2 and 10.3.		P
10.8.5	Requirements		P
	The requirements are as follows:		P
	– no evidence of major visual defects, as defined in Clause 7;		P
	– the degradation of maximum output power shall not exceed 5 % of the value measured before the test;		P
	– insulation resistance shall meet the same requirements as for the initial measurements.		P
10.9	Hot-spot endurance test		P
10.9.1	Purpose		P
	The purpose of this test is to determine the ability of the module to withstand hot-spot heating effects, for example solder melting or deterioration of the encapsulation. This defect could be provoked by cracked or mismatched cells, interconnect failures, partial shadowing or soiling.		P
10.9.2	Hot-spot effect		P
	Hot-spot heating occurs in a module when its operating current exceeds the reduced short-circuit current of a shadowed or faulty cell or group of cells within it. When such a condition occurs, the affected cell or group of cells is forced into reverse bias and must dissipate power, which can cause overheating.		P

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Clause	Requirement Test	Result - Remark	Verdict
	Figure 6 illustrates the hot-spot effect in a module of a series string of cells, one of which, cell Y, is partially shadowed. The amount of power dissipated in Y is equal to the product of the module current and the reverse voltage developed across Y. For any irradiance level, maximum power is dissipated in the short-circuit current condition, when the reverse voltage across Y is equal to the voltage generated by the remaining (s – 1) cells in the module. This is shown in Figure 6 by the hatched rectangle constructed at the intersection of the reverse I-V characteristic of Y with the image of the forward I-V characteristic of the (s^{-1}) cells.		P
	Because the reverse characteristics can vary considerably from cell to cell, it is necessary to classify cells as voltage limited (type A) or current limited (type B), according to how the reverse characteristic intersects the “test limit zone” shown in Figure 7.		P
	Figure 6 applies to type A cells. It illustrates that the maximum dissipation in a faulty or shadowed type A cell occurs when the reverse characteristic intersects the image of the (s^{-1}) characteristic at its maximum power point.		P
	In contrast, Figure 8 shows that the maximum dissipation in a type B cell occurs when it is fully shadowed. But it should be noted that, in this case, the dissipated power may be only a fraction of the total power available from the module.		P
10.9.3	Classification of cell interconnection		P
	Solar cells in a PV module are connected in one of the following ways:		P
	Case SP: series-parallel connection, i.e. a parallel connection of p strings, each with s cells in series; see Figure 9;		P
	Case SPS: Series-parallel-series connection, i.e. a series connection of b blocks, where each block consists of a parallel connection of *p* strings, each with s cells in series. See Figure 10.		N
	By-pass diodes, if present, limit the reverse voltage of the enclosed cells and therefore define the part of the circuit to be tested. The maximum internal power dissipation occurs with the module short-circuited.		N
10.9.4	Apparatus		P

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Clause	Requirement Test	Result - Remark	Verdict
	a) Radiant source 1. Steady-state solar simulator or natural sunlight capable of an irradiance of not less than 700 W· m^{-2} with a non-uniformity of not more than ±2 % and a temporal stability within ±5 %.		P
	b) Radiant source 2. Class C steady-state solar simulator (or better) or natural sunlight with an irradiance of 1 000 W· m^{-2} ± 10 %.		N
	c) Module I-V curve tracer.		P
	d) Set of opaque covers for test cell shadowing in 5 % increments.		P
	e) An appropriate temperature detector, if required.		N
10.9.5	Procedure		P
	Any hot-spot protective devices recommended by the manufacturer shall be installed before the module is tested.		P
10.9.5.1	Case S	Not case S	N
	a) Expose the unshadowed module to radiant source 1 at an irradiance of not less than 700 W· m–2. Measure the I-V characteristic and determine the current at maximum power, IMP		N
	b) Short-circuit the module and select a cell by one of the following methods:		N
	1) With the module exposed to radiant source 1 at a stable irradiance of not less than 700 W· m^{-2}, determine the hottest cell using an appropriate temperature detector. (An infrared (IR) camera is recommended).		N
	2) Under the irradiance specified for step a), completely shadow each cell in turn and select the cell or one of the cells which gives the biggest decrease in short-circuit current when shadowed. During this process, the irradiance shall not change by more than ± 5 %.		N
	c) Under the same irradiance (within ±3 %) as used in step a), completely shadow the selected cell and check that the short circuit current (ISC) of the module is less than the peak power current (IMP) of the module, as determined in step a). If this condition does not occur, the condition of maximum power dissipation within a single cell cannot be set. In this case, proceed with the selected cell completely shadowed, omitting step d).		N

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Clause	Requirement Test	Result - Remark	Verdict
	d) Gradually decrease the shadowed area of the selected cell until ISC of the module coincides as closely as possible with IMP. In this condition, the maximum power is dissipated within the selected cell.		N
	e) Expose the module to radiant source 2. Note the value of ISC and keep the module in the condition of maximum power dissipation, re-adjusting the shadow, if necessary, to maintain ISC at the specified level. Under these conditions the module temperature should be 50 °C ± 10 °C.		N
	f) Maintain this condition for a total exposure time of 5 h.		N
10.9.5.2	Case SP		P
	a) Expose the unshadowed module to radiant source 1 at an irradiance of not less than 700 $W \cdot m^{-2}$. Measure the I-V characteristic and determine ISC (*), the short-circuit current corresponding to the condition of maximum hot spot power dissipation, from the following equation, assuming that all strings generate the same current:		P
	b) Short-circuit the module and select a cell by one of the following methods:		P
	1) with the module exposed to radiant source 1 at a stable irradiance of not less than 700 $W \cdot m^{-2}$, determine the hottest cell using an appropriate temperature detector;		P
	2) under the irradiance specified in step a), completely shadow each cell in turn and find the cell which gives the biggest decrease in short-circuit current when shadowed. During this process, the irradiance shall not change by more than ±5 %.		P
	c) Under the same irradiance as in step a) (within ±3 %), check that, with the selected cell fully shadowed, ISC of the module is less than ISC (*), as determined in step a). If this condition does not occur, the condition of maximum power dissipation within a single cell cannot be set. In this case, proceed with the selected cell fully shadowed, omitting step d).		P
	d) Gradually decrease the shadowed area of the selected cell until ISC of the module coincides as closely as possible with ISC (*). In this condition, the maximum power is dissipated within the selected cell.		P

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Clause	Requirement Test	Result - Remark	Verdict
	e) Expose the module to radiant source 2. Note the value of ISC and keep the module in the condition of maximum power dissipation, re-adjusting the shadow, if necessary, to maintain ISC at the specified level. Under these conditions the module temperature should be 50 °C± 10 °C.		P
	f) Maintain this condition for a total exposure time of 5 h.		P
10.9.5.3	Case SPS	Not case SPS	N
	a) Short-circuit the unshadowed module and expose it to radiant source 1 at a stable irradiance of not less than 700 $W \cdot m^{-2}$. Take at random at least 30 % of the cells in the module, fully shadow each cell in turn and measure the temperature at which it stabilizes, using thermal imaging equipment or other appropriate means.		N
	b) Fully shadow the hottest cell found in step a).		N
	c) While continuing to monitor its temperature, gradually decrease the shadowed area and determine the condition in which maximum temperature is achieved.		N
	d) Expose the module to radiant source 2 and keep it in the shadowed condition established in step c). Under these conditions the module temperature should be 50 °C ± 10 °C.		N
	e) Maintain this condition for a total exposure time of 5 h.		N
10.9.6	Final measurements		P
	Repeat the tests of 10.1, 10.2 and 10.3.		P
10.9.7	Requirements		P
	The requirements are as follows:		P
	– no evidence of major visual defects, as defined in Clause 7. If there is evidence of serious damage that does not qualify as a major visual defect, repeat the test on 2 additional cells. If there is no visual damage around either of these two cells the module type passes the hot spot test;		P
	– the degradation of maximum output power shall not exceed 5 % of the value measured before the test;	< 5%	P
	– insulation resistance shall meet the same requirements as for the initial measurements.		P
10.10	UV preconditioning test		P
10.10.1	Purpose		P

EN 61215			
Clause	Requirement Test	Result - Remark	Verdict
	To precondition the module with ultra-violet (UV) radiation before the thermal cycle/ humidity freeze tests to identify those materials and adhesive bonds that are susceptible to UV degradation.		P
10.10.2	Apparatus		P
	a) Equipment to control the temperature of the module while it is irradiated by UV light. The equipment must be capable of maintaining the module temperature at 60 °C ± 5 °C.	58 °C-62 °C	P
	b) Means for measuring and recording the temperature of the module(s) to an accuracy of ±2 °C. The temperature sensors shall be attached to the front or back surface of the module near the middle. If more than one module is tested simultaneously, it will suffice to monitor the temperature of one representative sample.		P
	c) Instrumentation capable of measuring the irradiation of the UV light produced by the UV light source at the test plane of the module(s), within the wavelength ranges of 280 nm to 320 nm and 320 nm to 385 nm with an uncertainly of ±15 %.		P
	d) A UV light source capable of producing UV irradiation with an irradiance uniformity of ±15 % over the test plane of the module(s) with no appreciable irradiance at wavelengths below 280 nm and capable of providing the necessary irradiation in the different spectral regions of interest as defined in 10.10.3.		P
10.10.3	Procedure		P
	a) Using the calibrated radiometer measure the irradiance at the proposed module test plane and assure that at wavelengths between 280 nm and 385 nm it does not exceed 250 $W \cdot m^{-2}$ (i.e. about five times the natural sunlight level) and that it has a uniformity of ±15 % over the test plane.		P
	b) Mount an open-circuited module in the test plane at the location selected in a), normal to the UV irradiance beam. Make sure that the module temperature is 60 °C ± 5 °C.		P
	c) Subject the module(s) to a total UV irradiation of 15 $kWh \cdot m^{-2}$ in the wavelength range between 280 nm and 385 nm, with at least 5 $kWh \cdot m^{-2}$ in the wavelength band between 280 nm and 320 nm, while maintaining the module temperature within the prescribed range.	Performed	P
	d) Means for applying a current equal to the STC peak power current of the module(s) under test.		P

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Clause	Requirement Test	Result - Remark	Verdict
	e) Means for monitoring the flow of current through each module during the test.		P
10.11.3	Procedure		P
	a) Install the module(s) at room temperature in the chamber.		P
	b) Connect the temperature monitoring equipment to the temperature sensor(s). Connect each module to the appropriate current supply by connecting the positive terminal of the module to the positive terminal of the power supply and the second terminal accordingly. During the 200 thermal cycle test set the current flow to the measured STC peak power current within ±2 %. Current flow shall only be maintained when the module temperature is above 25 °C. During the 50 thermal cycle test no current flow is required.		P
	c) Close the chamber and subject the module(s) to cycling between module temperatures of –40 °C ± 2 °C and +85 °C ± 2 °C, in accordance with the profile in Figure 11. The rate of change of temperature between the low and high extremes shall not exceed 100 °C/h and the module temperature shall remain stable at each extreme for a period of at least 10 min. The cycle time shall not exceed 6 h unless the module has such a high heat capacity that a longer cycle is required. The number of cycles shall be as shown in the relevant blocks in Figure 1.		P
	d) Throughout the test, record the module temperature and monitor the current flow through the module(s).		P
10.11.4	Final measurements		P
	After a minimum recovery time of 1 h, repeat the tests of 10.1, 10.2 and 10.3.		P
10.11.5	Requirements		P
	The requirements are as follows:	No below defects	P
	– no interruption of current flow during the test;		P
	– no evidence of major visual defects, as defined in Clause 7;		P
	– the degradation of maximum output power shall not exceed 5 % of the value measured before the test;		P
	– insulation resistance shall meet the same requirements as for the initial measurements.		P
10.12	Humidity-freeze test		P

EN 61215			
Clause	Requirement Test	Result - Remark	Verdict
10.12.1	Purpose		P
	The purpose of this test is to determine the ability of the module to withstand the effects of high temperature and humidity followed by sub-zero temperatures. This is not a thermal shock test		P
10.12.2	Apparatus		P
	a) A climatic chamber with automatic temperature and humidity control, capable of subjecting one or more modules to the humidity-freeze cycle specified in Figure 12.	85%RH, 20h, no RH, 4h, total 10C	P
	b) Means for mounting or supporting the module(s) in the chamber, so as to allow free circulation of the surrounding air. The thermal conduction of the mount or support shall be low, so that, for practical purposes, the module(s) is (are) thermally isolated.		P
	c) Means for measuring and recording the module temperature to an accuracy of ±1 °C. (It is sufficient to monitor the temperature of one representative sample, if more than one module is being tested.)	One module to test	P
10.12.3	Procedure		P
	a) Attach a suitable temperature sensor to the front or back surface of the module(s) near the middle.		P
	b) Install the module(s) at room temperature in the climatic chamber.		P
	c) Connect the temperature monitoring equipment to the temperature sensor(s).		P
	d) After closing the chamber, subject the module(s) to 10 complete cycles in accordance with the profile in Figure 12. The maximum and minimum temperatures shall be within ±2 °C of the specified levels and the relative humidity shall be maintained within ±5 % of the specified value at all temperatures above room temperature.	Performed	P
	e) Throughout the test, record the module temperature.		P
10.12.4	Final measurements		P
	After a recovery time between 2 h and 4 h, repeat the test of 10.3. Repeat the tests of 10.1 and 10.2.		P
10.12.5	Requirements		P
	The requirements are as follows:		P

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Clause	Requirement Test	Result - Remark	Verdict
	– no evidence of major visual defects, as defined in Clause 7;	No defects Complied with Clause 7	P
	– the degradation of maximum output power shall not exceed 5 % of the value measured before the test;	200W	P
	– insulation resistance shall meet the same requirements as for the initial measurements.		P
10.13	Damp-heat test		P
10.13.1	Purpose		P
	To determine the ability of the module to withstand the effects of long-term penetration of humidity.		P
10.13.2	Procedure		P
	The test shall be carried out in accordance with IEC 60068-2-78 with the following provisions:		P
	a) Preconditioning		P
	The module(s), being at room temperature, shall be introduced into the chamber without preconditioning.		P
	b) Severities		P
	The following severities are applied:		P
	Test temperature: 85 °C ± 2 °C	85 °C	P
	Relative humidity: 85 % ± 5 %	85 %	P
	Test duration: 1 000 h	1000h	P
10.13.3	Final measurements		P
	After a recovery time between 2 h and 4 h, repeat the tests of 10.3 and 10.15. Repeat the tests of 10.1 and 10.2.		P
10.13.4	Repeat the tests of 10.1 and 10.2.		P
	The requirements are as follows:	Comply with below requirements	P
	– no evidence of major visual defects, as defined in Clause 7;		P
	– the degradation of maximum output power shall not exceed 5 % of the value measured before the test;		P
	– the insulation test and the wet leakage current test shall meet the same requirements as for the initial measurements.		P
10.14	Robustness of terminations test		P

EN 61215			
Clause	Requirement Test	Result - Remark	Verdict
10.14.1	Purpose		P
	To determine that the terminations and the attachment of the terminations to the body of the module will withstand such stresses as are likely to be applied during normal assembly or handling operations.		P
10.14.2	Types of terminations		P
	Three types of module terminations are considered:		P
	– type A: wire or flying lead		N
	– type B: tags, threaded studs, screws, etc.;		P
	– type C: connector.		N
10.14.3	Procedure		P
	Preconditioning: 1 h at standard atmospheric conditions for measurement and test.		P
10.14.3.1	Type A terminations		N
	Tensile test: as described in IEC 60068-2-21, test Ua, with the following provisions:		N
	– all terminations shall be tested;		N
	– tensile force shall never exceed the module weight.		N
	Bending test: as described in IEC 60068-2-21, test Ub, with the following provisions:		N
	– all terminations shall be tested;		N
	– method 1-10 cycles (1 cycle is 1 bend in each opposite direction).		N
10.14.3.2	Type B terminations		P
	Tensile and bending tests:	Performed	P
	a) for modules with exposed terminals, each termination shall be tested as for type A terminations;		N
	b) if the terminations are enclosed in a protective box, the following procedure shall be applied:	Use protective box	P
	– a cable of the size and type recommended by the module manufacturer, cut to a suitable length, shall be connected to the terminations inside the box using the manufacturer's recommended procedures. The cable shall be taken through the hole of the cable gland, taking care to utilize any cable clamp arrangement provided. The lid of the box shall be securely replaced. The module shall then be tested as for type A terminations.		P

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Clause	Requirement Test	Result - Remark	Verdict
	Torque test: as described in IEC 60068-2-21, test Ud with the following provisions:		P
	– all terminations shall be tested;		P
	– severity		P
	The nuts or screws should be capable of being loosened afterwards unless they are specifically designed for permanent attachment.		P
10.14.3.3	Type C terminations		N
	A cable of the size and type recommended by the module manufacturer, cut to a suitable length, shall be connected to the output end of the connector and the tests for type A terminations shall be carried out.		N
10.14.4	Final measurements		P
	Repeat the tests of 10.1, 10.2 and 10.3.		P
10.14.5	Requirements		P
	The requirements are as follows:	Comply with below requirements	P
	– no evidence of mechanical damage;		P
	– the degradation of maximum output power shall not exceed 5 % of the value measured before the test;		P
	– insulation resistance shall meet the same requirements as for the initial measurements.		P
10.15	Wet leakage current test		P
10.15.1	Purpose		P
	To evaluate the insulation of the module under wet operating conditions and verify that moisture from rain, fog, dew or melted snow does not enter the active parts of the module circuitry, where it might cause corrosion, a ground fault or a safety hazard.		P
10.15.2	Apparatus		P
	a) A shallow trough or tank of sufficient size to enable the module with frame to be placed in the solution in a flat, horizontal position. It shall contain a water/wetting agent solution meeting the following requirements:		P
	Resistivity: 3 500 Ω·cm or less		P
	Surface tension: 0.03 $N \cdot m^{-1}$ or less		P
	Temperature: 22 °C ± 3 °C		P

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Clause	Requirement Test	Result - Remark	Verdict
	The depth of the solution shall be sufficient to cover all surfaces except junction box entries not designed for immersion.		P
	b) Spray equipment containing the same solution.		P
	c) DC voltage source, with current limitation, capable of applying 500 V or the maximum rated system voltage of the module, whichever is more.	1000Vdc	P
	d) Instrument to measure insulation resistance.	Insulation Resistance Meter	P
10.15.3	Procedure		P
	All connections shall be representative of the recommended field wiring installation and precautions shall be taken to ensure that leakage currents do not originate from the instrumentation wiring attached to the module.		P
	a) Immerse the module in the tank of the required solution to a depth sufficient to cover all surfaces except junction box entries not designed for immersion. The cable entries shall be thoroughly sprayed with solution. If the module is provided with a mating connector, the connector should be immersed during the test.		P
	b) Connect the shorted output terminals of the module to the positive terminal of the test equipment. Connect the liquid test solution to the negative terminal of the test equipment using a suitable metallic conductor.		P
	c) Increase the voltage applied by the test equipment at a rate not to exceed 500 $V \cdot s^{-1}$ to 500 V or the maximum system voltage for the module, whichever is greater. Maintain the voltage at this level for 2 min. Then determine the insulation resistance.	1000 Vdc	P
	d) Reduce the applied voltage to zero and short-circuit the terminals of the test equipment to discharge the voltage build-up on the module.		P
10.15.4	Requirements		P
	The requirements are as follows:		P
	– For modules with an area of less than 0.1 m^2 the insulation resistance shall be not less than 400 MΩ.		P
	– For modules with an area larger than 0.1 m^2 the measured insulation resistance times the area of the module shall be not less than 40 $M\Omega \cdot m^2$.	> 100 $M\Omega \cdot m^2$	P
10.16	Mechanical load test		P
10.16.1	Purpose		P

EN 61215			
Clause	Requirement Test	Result - Remark	Verdict
	The purpose of this test is to determine the ability of the module to withstand wind, snow, static or ice loads.		P
10.16.2	Apparatus		P
	a) A rigid test base which enables the modules to be mounted front-side up or front-side down. The test base shall enable the module to deflect freely during the load application.		P
	b) Instrumentation to monitor the electrical continuity of the module during the test.		P
	c) Suitable weights or pressure means that enable the load to be applied in a gradual, uniform manner.		P
10.16.3	Procedure		P
	a) Equip the module so that the electrical continuity of the internal circuit can be monitored continuously during the test.	Installed According to product manual	P
	b) Mount the module on a rigid structure using the method prescribed by the manufacturer. (If there are different possibilities, use the worst one, where the distance between the fixing points is at maximum.)		P
	c) On the front surface, apply gradually a load corresponding to 2 400 Pa, spread uniformly. (This load may be applied pneumatically or by means of weights covering the entire surface. In the latter case, the module shall be mounted horizontally.) Maintain this load for 1 h.	Performed	P
	d) Apply the same procedure on the back surface of the module.		P
	e) Repeat steps c) and d) for a total of three cycles.		P
10.16.4	Final measurements		P
	Repeat the tests of 10.1, 10.2 and 10.3.		P
10.16.5	Requirements		P
	The requirements are as follows:	Comply with below requirements	P
	– no intermittent open-circuit fault detected during the test;		P
	– no evidence of major visual defects, as defined in Clause 7;		P
	– the degradation of maximum output power shall not exceed 5 % of the value measured before the test;		P

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Clause	Requirement Test	Result - Remark	Verdict
	– insulation resistance shall meet the same requirements as for the initial measurements.		P
10.17	Hail test		P
10.17.1	Purpose		P
	To verify that the module is capable of withstanding the impact of hailstones.	Performed	P
10.17.2	Apparatus		P
	a) Moulds of suitable material for casting spherical ice balls of the required diameter. The standard diameter shall be 25 mm but any of the other diameters listed in Table 2 may be specified for special environments.		P
	b) A freezer, controlled at –10 °C ± 5 °C.		P
	c) A storage container for storing the ice balls at a temperature of –4 °C ± 2 °C		P
	d) A launcher capable of propelling an ice ball at the specified velocity, within ±5 %, so as to hit the module within the specified impact location. The path of the ice ball from the launcher to the module may be horizontal, vertical or at any intermediate angle, so long as the test requirements are met.		P
	e) A rigid mount for supporting the test module by the method prescribed by the manufacturer, with the impact surface normal to the path of the projected ice ball.		P
	f) A balance for determining the mass of an ice ball to an accuracy of ±2 %.		P
	g) An instrument for measuring the velocity of the ice ball to an accuracy of ±2 %. The velocity sensor shall be no more than 1 m from the surface of the test module.		P
	As an example, Figure 13 shows in schematic form a suitable apparatus comprising a horizontal pneumatic launcher, a vertical module mount and a velocity meter which measures electronically the time it takes the ice ball to traverse the distance between two light beams. This is only one example as other types of apparatus including slingshots and spring driven testers have been successfully utilized.		P
10.17.3	Procedure		P

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Clause	Requirement Test	Result - Remark	Verdict
	a) Using the moulds and the freezer, make sufficient ice balls of the required size for the test, including some for the preliminary adjustment of the launcher.		P
	b) Examine each one for cracks, size and mass. An acceptable ball shall meet the following criteria:		P
	– no cracks visible to the unaided eye;		P
	– diameter within ±5 % of that required;		P
	– mass within ±5 % of the appropriate nominal value in Table 2.		P
	c) Place the balls in the storage container and leave them there for at least 1 h before use.		P
	d) Ensure that all surfaces of the launcher likely to be in contact with the ice balls are near room temperature.		P
	e) Fire a number of trial shots at a simulated target in accordance with step g) below and adjust the launcher until the velocity of the ice ball, as measured with the velocity sensor in the prescribed position, is within ±5 % of the appropriate hailstone test velocity in Table 2.		P
	f) Install the module at room temperature in the prescribed mount, with the impact surface normal to the path of the ice ball.		P
	g) Take an ice ball from the storage container and place it in the launcher. Take aim at the first impact location specified in Table 3 and fire. The time between the removal of the ice ball from the container and impact on the module shall not exceed 60 s.		P
	h) Inspect the module in the impact area for signs of damage and make a note of any visual effects of the shot. Errors of up to 10 mm from the specified location are acceptable.		P
	i) If the module is undamaged, repeat steps g) and h) for all the other impact locations in Table 3, as illustrated in Figure 14.		P
10.17.4	Final measurements		P
	Repeat the tests of 10.1, 10.2 and 10.3.		P
10.17.5	Requirements		P
	The requirements are as follows:		P
	– no evidence of major visual defects, as defined in Clause 7;		P

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Clause	Requirement Test	Result - Remark	Verdict
	– the degradation of maximum output power shall not exceed 5 % of the value measured before the test;		P
	– insulation resistance shall meet the same requirements as for the initial measurements.		P
10.18	Bypass diode thermal test		P
10.18.1	Purpose		P
	To assess the adequacy of the thermal design and relative long-term reliability of the by-pass diodes used to limit the detrimental effects of module hot-spot susceptibility.	Performed	P
10.18.2	Apparatus		P
	a) Means for heating the module to a temperature of 75 °C ± 5 °C.		P
	b) Means for measuring and recording the temperature of the module(s) to an accuracy of ±1 °C		P
	c) Means for measuring the temperature of any bypass diodes provided with the module. Care should be taken to minimize any alteration of the properties of the diode or its heat transfer path.		P
	d) Means for applying a current equal to 1,25 times the STC short-circuit current of the module under test and means for monitoring the flow of current through the module, throughout the test.		P
10.18.3	Procedure		P
	a) Electrically short any blocking diodes incorporated in the module.		P
	b) Determine the rated STC short-circuit current of the module from its label or instruction sheet.		P
	c) Prepare to measure the temperature of the bypass diodes during the test.		P
	d) Connect wires of the manufacturer’s minimum recommended wire gauge to the output terminals of the module. Follow the manufacturer’s recommendations for wire entry into the wiring compartment and replace the wire compartment cover.		P

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Clause	Requirement Test	Result - Remark	Verdict
	e) Heat the module to 75 °C ± 5 °C. Apply a current to the module equal to the short circuit current of the module as measured at STC ± 2 %. After 1 h measure the temperature of each bypass diode. Using the information provided by the diode manufacturer calculate the junction temperature from the measured case temperature and the power dissipated in the diode using the following formula.	75°C	P
	f) Increase the applied current to 1,25 times the short-circuit current of the module as measured at STC while maintaining the module temperature at 75 °C ± 5 °C. Maintain the current flow for 1 h.		P
	g) Verify that the diode is still operational.		P
10.18.4	Final measurements		P
	Repeat the tests of 10.1, 10.2 and 10.3.		P
10.18.5	Requirements		P
	The requirements are as follows:	Comply with below requirements	P
	– the diode junction temperature as determined in 10.18.3.e) shall not exceed the diode manufacturer's maximum junction temperature rating;		P
	– no evidence of major visual defects, as defined in Clause 7;		P
	– the degradation of maximum output power shall not exceed 5 % of the value measured before the test;		P
	– insulation resistance shall meet the same requirements as for the initial measurements;		P
	– the diode shall still function as a diode after the conclusion of the test.		P

Tables

Table 1-Testing condition

Test	Item	condition
10.1	Visual inspection	See 10.1.2
10.2	Maximum power determination	Comply with IEC 60904-1
10.3	Insulation test	1000V; time:1m'; insulated resistance:≥100MΩ
10.4	Temperature modulus	Comply with IEC 60904-10
10.5	Measurement of nominal operating cell temperature (NOCT)	Total irradiance: 1000W/m^2 Testing temperature: 20℃ Wind speed: 50m/s
10.6	Performance at STC and NOCT	Cell temperature: 25℃ and NOCT Irradiance: 1000 and 800W/m^2
10.7	Performance at low irradiance	Cell temperature: 25℃
10.8	Outdoor exposure test	Irradiance: 200W/m^2
10.9	Hot-spot endurance test	Total irradiance: 60kW·h/m^2
10.10	UV preconditioning test	UV: 280nm～385nm Total rradiance: 15kW·h/m^2
10.11	Hot-circle test	-40℃ to +80℃ 50 and 200 times repeat
10.12	Humidity-freeze test	Humidity: 85% +85℃ to -40℃ 10 times repeat
10.13	Damp-heat test	+85℃; 85% humidity; 1000h
10.14	Robustness of terminations test	Comply IEC 60068-2-21
10.15	Wet leakage current test	See 10.14
10.16	Mechanical load test	2400Pa load; 1h; 2 times repeat
10.17	Hail test	25mm; 23m/s; 11 times strike
10.18	Bypass diode thermal test	75℃ and Isc; 1h 75℃ and 1.25Isc; 1h
END		

EN 61730-1			
Clause	Requirement Test	Result - Remark	Verdict
4	Construction requirements		P
4.1	General requirements		P
4.1.1	All modules shall be able to operate under environmental condition type AB8 according to IEC 60364-5-51		P
4.1.2	A module shall be completely assembled when shipped from the factory, or shall be provided in subassemblies, provided assembly of the product does not involve any action that is likely to affect compliance with the requirements of the IEC 61730 series.		P
4.1.3	An assembly part, such as a terminal compartment cover, need not be affixed to the module at the factory. Incorporation of a module into the final assembly shall not require any alteration of the module from its originally evaluated form, unless specific details describing necessary modification(s) are provided in the installation instructions.		P
4.1.4	If a module must bear a definite relationship to another module for the intended installation and operation (for example, to allow connectors to mate), it shall be constructed to permit incorporation into the final assembly without the need for alteration.		P
4.1.5	The construction of a module shall be such that ground continuity is not interrupted by installation.		P
4.1.6	Parts shall be prevented from loosening or turning if such loosening or turning may result in a risk of fire, electric shock, or injury to persons.		P
4.1.7	Friction between surfaces, such as simple spring pressure, is not acceptable as the sole means to inhibit the turning or loosening of a part.		P
4.1.8	Any adjustable or movable structural part shall be provided with a locking device to reduce the likelihood of unintentional movement, if any such movement may result in a risk of fire, electric shock, or injury to persons.		P
4.2	Metal parts		P
4.2.1	Metals used in locations that are exposed to moisture shall not be employed alone or in combinations that could result in deterioration, such that the product would not comply with the requirements in this standard.		P

EN 61730-1			
Clause	Requirement Test	Result - Remark	Verdict
4.2.2	Iron or mild steel serving as a necessary part of the product but not exposed to the weather shall be plated, painted, or enamelled for protection against corrosion.		P
4.2.3	Simple sheared or cut edges and punched holes are not required to be additionally protected.		P
5	Polymeric materials		P
5.1	General		P
	Polymers are classified into four operational categories:		P
	– polymers serving as an enclosure for live metal parts (such as a junction box);		P
	– polymers serving as a support of live metal parts (such as integrated terminals);		P
	– polymers serving as the outer surface for the module (such as the superstrate or substrate);		P
	– barriers.		P
	Exception: Encapsulation materials are not required to meet these requirements.		
	All polymeric materials shall have a minimum relative thermal index (electrical and mechanical as defined by IEC 60216-5) of 20℃ above the maximum measured operating temperature of said material in application, as measured during the temperature test (IEC 61730-2, MST 21).		P
5.2	Polymers serving as an enclosure for live parts		P
	A polymeric material serving as the enclosure of a part involving a risk of fire or electric shock shall comply with the following requirements:		P
	a) 5-V flammability rating, either by material test or testing in the end-product design (IEC 60695-1-1);		P
	b) 5-V flammability rating, after water immersion and exposure of the end-product (IEC 60695-1-1);		P
	c) ultraviolet radiation resistance (if exposed to direct sunlight in the application), as determined in accordance with ANSI/UL 746C, and		P
	d) a minimum resistance to hot wire ignition rating of 30 (IEC 60695-1-1).		P
5.3	Polymers serving to support live parts		P

EN 61730-1			
Clause	Requirement Test	Result - Remark	Verdict
	A polymeric material serving as the support or insulation of a part involving a risk of fire or electric shock shall:		P
	a) have a flammability classification of HB, V-2, V-1, or V-0 and have a minimum high-current arc ignition rating determined in accordance with IEC 60695-1-1, as shown in Table 1,	V-1 or better	P
	b) have a Comparative Tracking Index (CTI) of 250 V or more, if the system voltage rating is 600 V or less, as determined in accordance with IEC 60112,		N
	c) have an inclined plane tracking rating of 1 h using the time to track method at 2,5 kV according to ASTM D2303, if the maximum system operating voltage rating is in the 601V–1 500V range, and		N
	d) comply with the requirements for exposure to ultraviolet light as determined in accordance with the ANSI/UL 746C if exposed to direct sunlight during normal operation of the product.		N
5.4	Polymers serving as an outer surface		P
5.4.1	A polymeric substrate or superstrate shall have a thermal index, both electrical and mechanical, as determined in accordance with IEC 60216-5 of at least 90℃. In addition, the thermal index shall be at least 20℃ above the maximum measured operating temperature of the material as measured during the temperature test given in IEC 61730-2, MST 21.		P
5.4.2	Polymeric materials that serve as the outer enclosure for a module that (1) is intended to be installed in a multi-module or -panel system or (2) has an exposed surface area greater than 1 m^2 or a single dimension larger than 2 m, shall have a maximum flame spread index of 100 as determined under ASTM E162-02a.		P
5.4.3	If exposed to direct sunlight in the application, the polymeric material shall have been evaluated for ultraviolet (UV) radiation resistance as determined in accordance with ANSI/UL 746C.		P
5.4.4	Polymeric materials intended for use as a superstrate or substrate, without appropriate IEC insulation pre-qualification, shall comply with the requirements of the partial discharge test, IEC 61730-2, MST 15.		P
5.5	Barriers		P

EN 61730-1			
Clause	Requirement Test	Result - Remark	Verdict
	A barrier of polymeric insulating material providing the sole insulation between a live part and an accessible metal part or between uninsulated live parts not of the same potential shall be of adequate thickness and of a material appropriate for the application, as defined by IEC 61140. The barrier or liner shall be held in place and shall not be adversely affected to the extent that its necessary properties fall below the minimum acceptable values for the application.	To meet the requirements	P
5.6	Structural glazing materials		P
	All structural glazing materials used as superstrates or substrates in the construction of modules shall comply with the requirements for safety glazing as described in ANSI Z97.1-93 by material certification or by testing in accordance with MST 32.		P
6	Internal wiring and current-carrying parts		P
	A current-carrying part and wiring shall have the mechanical strength and current-carrying capacity necessary for its application.		P
6.1	Internal wiring		P
6.1.1	Wiring used within a module shall have an insulation rated for a minimum of 90, with a gauge and voltage rating acceptable for the application as defined by the requirements of IEC 60189-2, as applicable.		P
6.1.2	he wiring of a module shall be located so that after installation of the product in the intended manner, the insulation will not be exposed to the degrading effects of direct sunlight.	To meet the requirements	P
	Exception: The requirement does not apply to wiring with insulation rated “sunlight resistant”		N
6.2	Splices		P
	A splice shall be considered acceptable with insulation equivalent to that required for the wiring involved.		P
6.3	Mechanical securement		P
6.3.1	A joint or connection shall be mechanically secure and shall provide electrical contact without strain on connections and terminals. Soldered connections between module interconnections and cell metallizations are considered mechanically secure when held by encapsulation systems.		P

EN 61730-1			
Clause	Requirement Test	Result - Remark	Verdict
6.3.2	An uninsulated live part, including a terminal, shall be secured to its supporting surface so that it will be prevented from turning or shifting in position, if such motion may result in reduction of spacings to less than required in Tables 3 and 4.		P
7	Connections		P
7.1	Field connections – general requirements		P
7.1.1	A module shall be provided with wiring terminals, connectors, or leads to accommodate current-carrying conductors of the load circuit.		P
7.1.2	Field connections shall either be rated for exposure to direct sunlight as defined in Clause 5 or so located that after installation they will not be exposed to the degrading effects of direct sunlight.	To meet the requirements	P
7.2	Field wiring terminals		P
7.2.1	If the module contains a field wiring terminal block, it shall be rated for the appropriate voltage and current for the application and constructed in compliance with the requirements of IEC 60947-1.		P
7.2.2	If the module alternately contains wiring terminals integral to the construction of the terminal enclosure, they shall comply with the following requirements:		P
7.2.2.1	Screws and nuts which clamp external conductors shall have a thread conforming with ISO 261 or ISO 262, or a thread comparable in pitch and mechanical strength (e.g. standard threads). The screws and nuts used for field wiring shall not serve to fix any other component. These connections are also permitted to clamp internal conductors provided that the internal conductors are so arranged that they will not be displaced when fitting the external conductors.		P
7.2.2.2	Terminal screws shall have minimum sizes as shown in Table 2. Stud terminals shall be provided with nuts and washers.		P
7.2.2.3	Terminals shall be so designed that they clamp the conductor between metal surfaces with sufficient contact pressure and without damage to the conductor. Terminals shall be so designed or located that the conductor cannot slip out when the clamping screws or nuts are tightened. Terminals shall be so fixed that, when the means of clamping the conductor is tightened or loosened:		P
	a) the terminal itself does not work loose,		P

EN 61730-1			
Clause	Requirement Test	Result - Remark	Verdict
	b) internal wiring is not subjected to stress,		P
	c) creepage distances and clearances are not reduced below the values specified in Clause 9.		P
7.3	Connectors		P
7.3.1	A connector intended for use in the output circuit of a module shall be rated for the appropriate voltage and current, as per the requirements of the IEC 60130 series. In addition, the connector shall comply with the requirements of Clause 5, with respect to flammability, comparative tracking index and relative thermal index for the support of live parts.		P
7.3.2	Unless a connector is appropriately evaluated for disconnect overload performance, the connector shall be assumed to be suitable for assembly only and not reliable as a disconnect means. See Clause 11.		P
7.3.3	A connector intended for exposure to the outdoor environment shall be enclosed by material which complies with the following:		P
	a) the requirements of Clause 5, with respect to UV resistance,		P
	b) resistance to inclusion of water, as per IEC 60529, equivalent to IP55,		P
	c) the steel ball impact test, per IEC 61721,	No any damage after the test	P
	d) the requirements of the accessibility test, IEC 61730-2, MST 11.		P
7.3.4	Separable multi-pole connectors shall be polarised. If two or more separable connectors are provided, they shall be configured or arranged so that the other and vice-versa will not accept the mating connector for one, if it will result in an improper connection.		P
7.3.5	For a connector incorporating a grounding member, the grounding member shall be the first to make and the last to break contact with the mating connector.		P
7.3.6	Connectors that can be separated without the use of a tool shall not have accessible conductive parts, as determined by 10.2 of IEC 61730-2.		P
7.4	Output lead or cables		P
	Leads extending from the module shall be rated for the appropriate system voltage, ampacity, wet locations, temperature and sunlight resistance.		P

EN 61730-1			
Clause	Requirement Test	Result - Remark	Verdict
8	Bonding and grounding		P
8.1	A module with accessible conductive parts which form a perimeter framing or mounting system, or have a conductive surface area of greater that 10 cm^2 accessible after installation shall have provision for grounding.		P
8.2	Modules rated as safety class II may be provided with provisions for functional grounding. Such grounding means shall be isolated from live parts by reinforced insulation (7.3.2.2 of IEC 61140).		P
8.3	Each exposed conductive part of the module that is accessible during normal use shall be bonded together, as verified by 10.4 of IEC 61730-2.		P
	Exception: If conductive materials are used only as fasteners for installation and separated from the conductive components of the module by both appropriate insulation and spacings, they are not required to be bonded.		P
8.4	Routine maintenance of a module shall not involve breaking or disturbing the bonding path. A bolt, screw, or other part used for bonding purposes within a module or panel shall not be intended for securing the complete device to the supporting surface or frame.		P
8.5	Bonding shall be by a positive means, such as clamping, riveting, bolted or screwed connections, or welding, soldering or brazing. The bonding connection shall penetrate all non-conductive coatings, such as paint, anodised coatings or vitreous enamel.		P
8.6	All joints in the bonding path shall be mechanically secure, independently of any soldering.		P
8.7	If the bonding connection depends upon screw threads, two or more screws or two full threads of a single screw shall engage the metal.		P
8.8	The diameter of the grounding screw or bolt shall be sized appropriately to the gauge of the bonding conductor, as per Table 2.		P
8.9	A ferrous metal part in the grounding path shall be protected against corrosion by metallic or non-metallic coatings, such as painting, galvanising, or plating. Stainless steel is acceptable without additional coating.		P
8.10	A metal-to-metal multiple-bearing pin-type hinge is considered to be an acceptable means for bonding.		P

EN 61730-1			
Clause	Requirement Test	Result - Remark	Verdict
8.11	A wiring terminal or bonding location of a module intended to accommodate a field installed equipment-grounding conductor shall be identified with the appropriate symbol (IEC 60417-5019 (DB:2002-10)) or shall have a green-coloured part. No other terminal or location shall be identified in this manner.		P
8.12	If a marking is used to identify an equipment grounding terminal, it shall be located on or adjacent to the terminal, or on a wiring diagram affixed to the module or panel near the terminal.		P
9	Creepage and clearance distances		P
9.1	The creepage and clearance distances between uninsulated live parts not of the same potential and between a live part and an accessible metal part, shall not be less than the values specified in Tables 3 and 4.		P
	These spacing requirements do not apply to the inherent spacings of a component. Such spacings shall comply with the requirements for the component in question. These distances also do not apply to solid insulation materials. Those insulation properties can be assessed through the tests outlined in IEC 61730-2.		P
9.2	Creepage and clearance distances at field wiring terminals are to be judged on module open-circuit voltage (Voc). If additional unmarked terminals exist in the terminal block, or if wiring terminals are marked specifically for grounding, the creepage and clearance distances will be judged on the basis of the maximum system operating voltage.		P
9.3	The spacings at a field-wiring terminal are to be measured with and without wire connected to the terminal. The wire shall be connected as it would be in actual use. If the terminal will properly accommodate it, and if the product is not marked to restrict its use, the wire is to be one size larger than that required, otherwise, the wire is to be the size required.		P
9.4	Surfaces separated by a gap of 0.4 mm or less are considered to be in contact with each other for the purpose of judging creepage distances.		P
10	Field wiring compartments with covers		P
10.1	General		P

EN 61730-1			
Clause	Requirement Test	Result - Remark	Verdict
	Modules designed for the application of a permanently attached wiring system by an installer in the field shall be provided with an enclosed wiring compartment, which provides protection of the conductors and connections from environmental stress, protection from accessibility to live uninsulated parts and strain relief for the attached wiring system.		P
10.2	Wall thickness		P
	A wiring compartment intended for the attachment of a field-applied permanent wiring system shall provide the minimum wall thickness, based on the material used, as specified in Table 5.		P
10.3	Internal volume		P
	A minimum internal volume for each intended conductor, including integral conductors of the module, shall be provided in a wiring compartment, within ±5 % as given in Table 6.		P
	In the space comprising the minimum required volume, no enclosure dimension shall be less than 20 mm.		P
10.4	Openings	25	P
	All openings shall be provided with appropriate coverings (such as knockouts, plugs, etc.), whose functions comply with the requirements of 5.2.1, the wet leakage test of Subclause 10.20 of IEC 61646 and the accessibility test of Subclause 10.2 of IEC 61730-2, and should only be able to be removed by the use of a tool.		P
10.5	Gaskets and seals		P
	Gaskets and seals shall not deteriorate beyond limits during accelerated ageing, and shall not be used where they may be subject to flexing during normal operation. See accelerated ageing test, IEC 60216-1.		P
10.6	Strain relief		P
	Strain relief shall be provided so that stress on a lead intended for field connection, or otherwise likely to be handled in the field, including a flexible cord, is not transmitted to the electrical connection inside the module. Mechanical securement means which comply with 10.14 of IEC 61215 meet this requirement.		P
10.7	Sharp edges		P

EN 61730-1			
Clause	Requirement Test	Result - Remark	Verdict
10.7.1	The enclosure shall be smooth and free from sharp edges, burrs, or the like that may damage insulation or conductors.	No such defect	P
10.7.2	This requirement also applies to the inner edges of conduit openings and knockouts.		P
10.8	Conduit applications – Metallic		P
10.8.1	A threaded hole in a metal wiring compartment intended for the connection of rigid metal conduit shall be reinforced to provide metal not less than 6,4 mm (1/4 in.) thick, and shall be tapered unless a conduit end stop is provided.		P
10.8.2	If threads for the connection of conduit are tapped all the way through a hole in a compartment wall, or if an equivalent construction is employed, there shall not be less than 3,5 nor more than 5 threads in the metal and the construction shall be such that a conduit bushing can be attached as intended.		P
10.8.3	If threads for the connection of conduit are not tapped all the way through a hole in a compartment wall, there shall not be less than 5 full threads in the metal and there shall be a smooth, rounded inlet hole for the conductors which shall afford protection to the conductors equivalent to that provided by a standard conduit bushing.		P
10.8.4	For a non-threaded opening in a metal wiring compartment intended to accommodate rigid metallic conduit, a flat surface of sufficient area shall be provided around the opening to accept the bearing surfaces of the bushing and lock washer.		P
10.8.5	Conduit shall comply with the Conduit bending test described in Clause 11 of IEC 61730-2, MST 33.		P
10.9	Conduit applications – Non-metallic		P
10.9.1	The sides, end walls, and bottom of a non-metallic wiring enclosure specified for conduit applications shall not have a thickness less than the values specified in Table 7.		P
10.9.2	A non-metallic wiring compartment intended to accommodate non-metallic conduit shall have the following:		P
	a) one or more unthreaded conduit-connection sockets integral with the compartment that comply with the requirements of the conduit system intended;		P

EN 61730-1			
Clause	Requirement Test	Result - Remark	Verdict
	b) one or more threaded or unthreaded openings for a conduit-connection socket, or one or more knockouts that comply with the requirements of IEC 61730-2, MST 44;		P
	c) compliance with Subclause 11.2 of IEC 61730-2, MST 33, if intended for rigid non-metallic conduit. A module which does not comply with MST 33 shall be marked "For use with non-rigid non-metallic conduit only." Modules which comply with MST 33 may be marked "For use with rigid non-metallic conduit".		P
10.9.3	A socket for the connection of non-metallic conduit shall provide a positive end stop for the conduit. The socket diameters, the throat diameter at the entrance to the box, the socket depths, and the wall thickness of the socket shall be within the limits specified in the applicable conduit system.		P
10.9.4	A knockout or opening in a non-metallic wiring compartment intended to accommodate rigid non-metallic conduit shall comply with the dimensional requirements of the applicable conduit system.		P
11	Marking		P
11.1	Each module shall include the following clear and indelible markings:		P
	– name, monogram or symbol of manufacturer;	See the marking label	P
	– type or model number;	See the marking label	P
	– serial number;	See the marking label	P
	– polarity of terminals or leads (colour coding is permissible);	See the marking label	P
	– maximum system voltage for which the module is suitable;	See the marking label	P
	– safety class in accordance with IEC 61140, if applicable.	See the marking label	P
	The date and place of manufacture shall be marked on the module or be traceable from the serial number.		P
11.2	These additional markings shall be applied to either the module or placed into the instruction and installation data (required documents). All electrical data should be shown as relative to standard test conditions (1 000 W/m2 at 25℃):		P
	– voltage at open-circuit;		P
	– current at short-circuit;		P

EN 61730-1			
Clause	Requirement Test	Result - Remark	Verdict
	– maximum over-current protection rating, as verified by IEC 61730-2, MST 26;		P
	– recommended maximum series/parallel module configurations;		P
	- pplication class of product.		P
11.3	Connectors suitable only for field assembly of modules shall be marked “Do not disconnect under load”.		
11.4	For modules with open-circuit voltage in excess of 50 V, and/or modules rated for maximum system voltage in excess of 50 V, a highly visible warning label regarding the shock hazard shall be applied near the means of connection to the module.		P
12	Requirements for supplied documents		P
12.1	A module or panel shall be supplied with installation instructions describing the methods of electrical and mechanical installation and the electrical ratings of the module. The instructions shall state the application class under which the module was qualified and any specific limitations required for that application class.		P
12.2	When the fire rating is dependent on a specific mounting structure, specific spacing, or specific means of attachment to the roof or structure, details of the specific parameter or parameters shall be included in the instructions.		P
12.3	The electrical installation instructions shall include a detailed description of the wiring method to be used. This description shall include:		P
	– the grounding method to be used;		P
	– the size, type, and temperature rating of the conductors to be used;		P
	– recommended maximum series/parallel module configurations;		P
	– the type of overcurrent protection and diode bypassing to be used;		P
	– the minimum cable diameters when the wiring method is cable;		P
	– any limitations on wiring methods that apply to the wiring compartment or box.		P
12.4	The mechanical installation instructions for roof mounting shall include:		P

EN 61730-1			
Clause	Requirement Test	Result - Remark	Verdict
	– a statement indicating the minimum mechanical means for securing the module or panel to the roof;		P
	– for a non-integral module or panel, a statement that the assembly is to be mounted over a fire resistant roof covering rated for the application;		P
	– indication of any slope required for maintaining a fire class rating.		P
12.5	The installation instructions shall include a statement advising that artificially concentrated sunlight shall not be directed on the module or panel.		P
12.6	Assembly instructions shall be provided with a product shipped in subassemblies, and shall be detailed and adequate to the degree required to facilitate total assembly of the product.		P
12.7	To allow for increased output of a module resulting from certain conditions of use, the installation instructions shall include the following statement or the equivalent:		P
	"Under normal conditions, a photovoltaic module is likely to experience conditions that produce more current and/or voltage than reported at standard test conditions. Accordingly, the values of ISC and VOC marked on this module should be multiplied by a factor of 1.25 when determining component voltage ratings, conductor current ratings, fuse sizes, and size of controls connected to the PV output."		P
13	Modifications		P
13.1	Any significant redesign or reconfiguration of the electrical or mechanical elements of a module previously qualified under both this part of IEC 61730 and verified by testing in IEC 61730-2 will require an engineering re-examination in order to determine the effect of those modifications. Based on that re-examination, additional testing under IEC 61730-2 many be deemed necessary.		P
13.2	Guidance on this can be obtained in the blank detail specifications, IEC 62145 (under consideration).		P

EN 61730-2			
Clause	Requirement Test	Result - Remark	Verdict
4	Test categories		P
4.1	General		P
	The following hazards might influence the lifetime and the safety of PV modules. In accordance with these hazards, test procedures and criteria are described. The specific tests to which a module will be subjected will depend on the end use application for which the minimum tests are specified in Clause 5.		P
	Tables 1 to 6 show the origin of the required tests. For some tests, the third column shows for information the origin of the tests, but the appropriate test requirements are given in Clauses 10 and 11. The rest of the tests are based on or identical to IEC 61215/IEC 61646, and references to the relevant Clauses are given in the last two columns. Some of the IEC 61215/IEC 61646-based tests were modified for IEC 61730-2 and are included in Clauses 10 and 11.		P
4.2	Preconditioning tests		P
4.3	General inspection		P
4.4	Electrical shock hazard tests		P
4.5	Fire hazard tests		P
4.6	Mechanical stress tests		P
4.7	Component tests		P
5	Application classes and their necessary test procedures		P
	The specific tests to which a module will be subjected, depending on the application class defined in IEC 61730-1, is described in Table 7. The order in which the tests are carried out shall be in accordance with Figure 1.		P
	Some tests shall be carried out as preconditioning tests.	See clause 10	P
6	Sampling		P

EN 61730-2			
Clause	Requirement Test	Result - Remark	Verdict
	Six modules and a laminate1 (a module without frame) for safety testing (plus spares as desired) and additional modules as required for the fire-test shall be taken at random from a production batch or batches, in accordance with the procedure given in IEC 60410. The modules shall have been manufactured from specified materials and components in accordance with the relevant drawings and process sheets and have been subjected to the manufacturer's normal inspection, quality control and production acceptance procedures. The modules shall be complete in every detail and shall be accompanied by the manufacturer's handling, mounting and connection instructions, including the maximum permissible system voltage.		P
	When the modules to be tested are prototypes of a new design and not from production, this fact shall be noted in the test report (see Clause 7).		P
7	Test report	See above	P
	The results shall be laid down in a test report according to ISO/IEC 17025. The results shall be reported, normally in a test report and shall include all the information requested by the client and necessary to the interpretation of the test and all information required by the method used:		P
	a) a title;		P
	b) name and address of the test laboratory and location where the tests were carried out;		P
	c) unique identification of the certification or report and of each page;		P
	d) name and address of client, where appropriate;		P
	e) description and identification of the item tested;		P
	f) characterization and condition of the test item;		P
	g) date of receipt of test item and date(s) of test, where appropriate;		P
	h) identification of test method used;		P
	i) reference to sampling procedure, where relevant;		P
	j) any deviations from, additions to or exclusions from the test method, and any other information relevant to a specific tests, such as environmental conditions;		P

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Clause	Requirement Test	Result - Remark	Verdict
	k) measurements, examinations and derived results supported by tables, graphs, sketches and photographs as appropriate including maximum systems voltage, safety class, mounting technique and any failures observed;		P
	l) a statement indicating whether the impulse voltage test was performed on module or laminate;		P
	m) a statement of the estimated uncertainty of the test results (where relevant);		P
	n) a signature and title, or equivalent identification of the person(s) accepting responsibility for the content of the certificate or report, and the date of issue;		P
	o) where relevant, a statement to the effect that the results relate only to the items tested;		P
	p) a statement that the certificate or report shall not be reproduced except in full, without the written approval of the laboratory.		P
	A copy of this report shall be kept by the manufacturer for reference purposes.		P
8	Testing		P
	The modules shall be divided into groups and subjected to the safety tests shown in Figure 1, carried out in the order specified. The modules shall be selected such that the preconditioning tests of 4.2 are met. Each box in Figure 1 refers to the corresponding subclause in this part of IEC 61730.		P
	Test procedures and criteria, including initial and final measurements where necessary, are detailed in Clauses 10 and 11. Some tests are identical to tests in IEC 61215/ IEC 61646 and are detailed in Clause 4 instead. In carrying out these tests, the tester shall strictly observe the manufacturer's handling, mounting, and connection instructions.		P
9	Pass criteria		P
	The module product under evaluation shall be judged to have passed the safety qualification test, if the test samples meet all of the criteria of each individual test.		P
	If any module does not meet these test criteria, the module product under evaluation shall be deemed not to have met the safety test requirements.		P

EN 61730-2			
Clause	Requirement Test	Result - Remark	Verdict
10	Test procedures		P
10.1	Visual inspection MST 01		P
10.1.1	Purpose		P
	To detect any visual defects in the module.		P
10.1.2	Procedure		P
	This test is identical with 10.1 from IEC 61215/IEC 61646 with the additional inspection criteria of		P
	– any other conditions which may affect safety;		P
	– markings not consistent with Clause 11 of IEC 61730-1.		P
	Make note of and/or photograph the nature and position of any cracks, bubbles or delaminations, etc. which may worsen and adversely affect the module safety in subsequent tests. Visual conditions other than the major defects listed below are acceptable for the purpose of safety test approval.	No such defects	P
10.1.3	Pass criteria		P
	For the purpose of the safety test approval, the following are considered to be major visual defects:		P
	a) broken, cracked, or torn external surfaces;	No such defects	P
	b) bent or misaligned external surfaces, including superstrates, substrates, frames and junction boxes to the extent that the safety of the module would be impaired;	No such defects	P
	c) bubbles or delaminations forming a continuous path between any part of the electrical circuit and the edge of the module, or which exhibited significant growth during the testing and would, if testing were continued, reach such a condition;		P
	d) evidence of any molten or burned encapsulant, back sheet, diode or active PV component;		N
	e) loss of mechanical integrity to the extent that the safety of the installation and operation of the module would be impaired;		N
	f) markings not complying with Clause 12 of IEC 61730-1.		P
10.2	Accessibility test MST 11		P
10.2.1	Purpose		P
	To determine if uninsulated electrical connections represent a shock hazard to personnel.		P

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Clause	Requirement Test	Result - Remark	Verdict
10.2.2	Apparatus		P
	The apparatus is as follows:		P
	a) A cylindrical test fixture Type 11 according to Figure 7 of IEC 61032.		P
	b) An ohmmeter or continuity tester.		P
10.2.3	Procedure		P
	The procedure is as follows:		P
	a) Mount and wire the test module as recommended by the manufacturer.		P
	b) Attach the ohmmeter or continuity tester to the module electric circuit and to the test fixture.		N
	c) Remove all covers, plugs and connections from the module that can be removed without using a tool.		P
	d) Probe with the test fixture in and around all electrical connectors, plugs, junction boxes and any other areas where the electrical circuit of the module may be accessible.		P
	e) Monitor the ohmmeter or continuity tester during the probing to determine if the test fixture makes electrical contact to the module electric circuitry.		P
10.2.5	Requirements		P
	At no time during the test shall there be less than 1 MΩ resistance between the test fixture and the module electric circuit.		P
10.2.6	Pass criteria		P
	At no time during the test shall the probe contact any live electrical part. This test is performed at the beginning and the end of the sequence according to Figure 1, but also can be used at any time during the test sequence if there is any reason to believe that active electric circuitry has been exposed by one of the other tests.		P
10.3	Cut susceptibility test MST 12		P
10.3.1	Purpose		P
	To determine whether any front and rear surfaces of the module made of polymeric materials are capable of withstanding routine handling during installation and maintenance without exposing personnel to the danger of electric shock. This test is derived from ANSI/UL 1703.		P
10.3.2	Apparatus		P

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Clause	Requirement Test	Result - Remark	Verdict
	A test fixture as shown in Figure 2, designed to draw a defined shaped object, a 0.64 mm ± 0.05 mm thick carbon steel blade (for example the back of a hacksaw blade) over the surface of the module with an applied force of 8.9 N ± 0.5 N.		P
10.3.3	Procedure		P
	The procedure is as follows:		P
	a) Position the module horizontally with the front surface facing upward.		P
	b) The test fixture is to be placed on the surface for 1 min and then drawn across the surface of the module at a speed of (150 ± 30) mm/s.		P
	Repeat the procedure five times in different directions. c) Repeat a) and b) for the rear surface of the module.		P
10.3.4	Final measurements		P
	Repeat MST 01, MST 13, MST 16 and MST 17.		P
10.3.5	Pass criteria		N
	The pass criteria are as follows:		N
	a) No visual evidence that the superstrate or substrate surfaces have been cut, exposing the active circuitry of the module.		N
	b) MST 13, MST 16, MST 17 shall meet the same requirements as for the initial measurements.		N
10.4	Ground continuity test MST 13		P
10.4.1	Purpose		P
	To demonstrate that there is a conductive path between all exposed conductive surfaces of the module, so that the exposed conductive surfaces can be adequately grounded in a PV system. This test is required only if the module has exposed conductive parts such as a metal frame or a metallic junction box.		P
10.4.2	Apparatus		P
	The apparatus is as follows:		P
	a) A constant current supply capable of producing a current that is 2.5 times the maximum over-current protection rating of the module under test. See MST 26.		P
	b) A suitable voltmeter.		P
10.4.3	Procedure		P
	The procedure is as follows:		P

EN 61730-2			
Clause	Requirement Test	Result - Remark	Verdict
	a) Select the manufacturer's designated grounding point and recommended grounding connection. Attach to one terminal of the constant current supply.		P
	b) Select an adjacent (connected) exposed conductive component with the greatest physical displacement from the grounding point, and attach to the other terminal of the current supply.		P
	c) Attach the voltmeter to the two conductive components attached to the current supply in proximity to the current leads.		P
	d) Apply a current 2.5 times ± 10 % of the maximum over-current protection rating of the module for a minimum of 2 min.		P
	e) Measure the applied current and the resultant voltage drop.		P
	f) Reduce the current to zero.		P
	g) Repeat the test on one additional frame component.		P
10.4.5	Pass criteria		P
	The resistance between the selected exposed conductive component and each other conductive component of the module shall be less than 0.1 Ω.		P
10.5	Impulse voltage test MST 14		N
10.5.1	Purpose		N
	To verify the capability of the solid insulation of the module to withstand over-voltages of atmospheric origin. It also covers over-voltages due to switching of low-voltage equipment.		N
10.5.2	Apparatus		N
	The apparatus is as follows:		N
	a) Impulse voltage generator.		N
	b) Oscilloscope.		N
10.5.3	Procedures		N
	For the purposes of test reproducibility, this test is conducted under the conditions of room temperature and relative humidity of less than 75 %. The procedure is as follows:		N
	a) Cover the whole module with a copper foil. Connect the foil to the negative terminal of the impulse voltage generator.		N

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Clause	Requirement Test	Result - Remark	Verdict
	b) Connect the shorted output terminals of the module to the positive terminal of the impulse voltage generator.		N
	Specification of the foil:		N
	1) Thickness copper 0.03 mm to 0.05 mm.		N
	2) Conducting glue (conductivity <1 Ω, measuring area: 625 mm2).		N
	3) Total thickness 0.05 mm to 0.07 mm.		N
	c) With no illumination, apply the surge impulse voltage given in Table 8 with a waveform as shown in Figure 3 by the impulse voltage generator. The waveform of the pulse shall be observed by an oscilloscope and the rise time and the pulse duration shall be checked for each test.		N
	d) Three successive pulses shall be applied.		N
	e) Change the polarity of the terminals of the pulse generator and apply three successive pulses.		N
10.5.5	Pass criteria		N
	The pass criteria are as follows:		N
	a) No evidence of dielectric breakdown or surface tracking of the module is observed during the test.		N
	b) No evidence of major visual defects as defined in 10.1.		N
10.6	Dielectric withstand test MST 16		P
10.6.1	Purpose		P
	To determine whether or not the module is sufficiently well insulated between current carrying parts and the frame or the outside world.		P
	The test shall be made on modules at ambient temperature of the surrounding atmosphere (see IEC 60068-1) and in a relative humidity not exceeding 75 %.		P
10.6.2	Procedure		P
	This test is identical with test 10.3 from IEC 61215/IEC 61646 with test levels depending on the application class and the maximum system voltage.		P
	The maximum test voltage shall be equal to 2 000 V plus four times the maximum system voltage for application-class A and equal to 1 000 V plus two times the maximum system voltage for application-class B.		P

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Clause	Requirement Test	Result - Remark	Verdict
10.6.3	Pass criteria		P
	See IEC 61215/IEC 61646.		P
10.7	Temperature test MST 21		P
10.7.1	Purpose		P
	This temperature test is designed to determine the maximum reference temperatures for various components and materials used to construct the module, in order to establish the suitability of their use.		P
10.7.2	Test conditions		P
	The ambient temperature during the test may be in the range of 20℃ to 55℃.	25℃	P
	The irradiance during the test shall be no less than 700 W/m^2 measured coplanar with the module by a calibrated device with the accuracy to ±5 % in accordance with IEC 60904-2 and IEC 60904-6. All data shall be taken at wind-speeds of less than 1 m/s.		P
10.7.3	Procedure		P
	The module under test shall be mounted on a platform constructed of wood, pressed wood, or plywood, approximately 19 mm thick. The platform is to be painted flat black on the side facing the test sample. The platform shall extend at least 60 cm beyond the module on all sides.		P
	The module under test shall be mounted to the platform in accordance with the manufacturer's installation instructions. If the instructions offer more than one option, the option providing the worst-case shall be used. If no indications have been provided, the test module shall be mounted directly to the platform.		P
	The module component temperatures shall be measured by a calibrated device or system, with an maximum uncertainty of ±2 ℃.		P
	The module is to be operated under both open- and short-circuit conditions, and stabilised temperature data for each test location shall be collected in each condition. Thermal stability has been attained when three successive readings, taken 5 min apart, indicate a change in temperature of less than ±1 ℃.		P

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Clause	Requirement Test	Result - Remark	Verdict
	The measured component temperatures (Tobs) shall be normalised by the addition of the difference between the 40 °C reference ambient and the measured ambient temperature (Tamb) according to the equation Tcon = Tobs + (40 – Tamb) · Tcon is the normalised temperature.		P
	If an unacceptable performance is encountered during the temperature test and the performance is attributed to a test condition that although within the limits specified may be considered more severe than necessary; for example an ambient temperature near the limits allowed, the test may be conducted under conditions closer to the norm.		P
	If the irradiance is other than 1 000 W/m^2, temperatures for more than two irradiance levels with at least 80 W/m2 apart between the levels shall be determined, and a quadratic extrapolation conducted to determine the temperature under 1 000 W/m^2 irradiance.		P
	Typical measurement points include:		P
	• Module superstrate above the centre cell.		P
	• Module substrate below the centre cell.		P
	• Terminal enclosure interior surface.		P
	• Terminal enclosure interior air space.		P
	• Field wiring terminals.		P
	• Insulation of the field wiring leads.		P
	• External connector bodies (if so equipped).		P
	• Diode bodies (if so equipped).		P
10.7.4	Requirements		P
	The requirements are as follows:		P
	a) No measured temperatures exceed any of the temperature limits of surfaces, materials, or components, as described in Table 9; or		P
	b) No creeping, distortion, sagging, charring or similar damage to any part of the module, as indicated in 10.1.		P
10.8	Fire test MST 23		P
10.8.1	Purpose		P

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Clause	Requirement Test	Result - Remark	Verdict
	These requirements establish the fundamental fire resistance of PV modules serving either as roof covering materials or mounted onto a building over an existing roof. These modules may be exposed to fire conditions, and therefore need to indicate their fire-resistance characteristics when exposed to a fire source originating from outside the building on which they are installed. The modules are not required to function after the test.		P
	The fire resistance classes range from Class C (fundamental fire resistance), to Class B to Class A (highest fire resistance). A minimum fire resistance rating of Class C is necessary for any building-mounted module. Certification to a higher level may be considered in order to satisfy specific application requirements.		P
10.8.2	Approach		P
	A PV module used in place of classified roofing material or mounted to or above an existing classified roofing material needs to comply with a single burning brand and spread of flame test, in accordance with the test outlined in Annex A, which are based on ANSI/UL 790. Sufficient samples shall be provided to create a single test assembly for a single spread of flame and a single burning brand test.		N
	Products that comply with these tests are not readily flammable, afford a measurable degree of fire protection to the roof deck, do not slip from position, and are not expected to produce flying brands.		P
10.8.3	Pass criteria		P
	The PV module system shall attain a fire resistance classification by compliance with the stated requirements of Annex A. Compliance with a single burning brand and spread of flame test is required for modules mounted over an existing roof covering. Additional sequential testing, such as that outlined in ANSI/UL 790, is required for modules acting as a roof covering material.		P
10.9	Reverse current overload Test MST 26		P
10.9.1	Purpose		N

EN 61730-2			
Clause	Requirement Test	Result - Remark	Verdict
	Modules contain electrically conductive material, contained in an insulating system. Under reverse current fault conditions, the tabbing and cells of the module are forced to dissipate energy as heat, prior to circuit interruption by an over-current protector installed in the system. This test is intended to determine the acceptability of the risk of ignition or fire from this condition.		N
10.9.2	Procedure		N
	The module under test is to be placed with its superstrate face down onto a 9 mm thick soft pine board, covered by a single layer of white tissue paper.		N
	The back surface of the module shall be covered with a single layer of cheesecloth. The cheesecloth is to be untreated cotton cloth, running 26 m2/kg to 28 m2/kg and have a “thread count” of 32 by 28.		N
	Any blocking diode provided shall be defeated (short-circuited).		N
	The test shall be conducted in an area free of drafts.		N
	The irradiance on the cell area of the module shall be less than 50 W/m2.		N
	A laboratory DC power supply shall be connected to the module with positive output connected to the positive terminal of the module. The reverse tests current (Itest) shall be equal to 135 % of the module’s overcurrent protection rating, as provided by the manufacturer. The test supply current should be limited to the value of Itest, and the test supply voltage shall be increased to cause the reverse current to flow through the module.		N
	The test shall be continued for 2 h, or until ultimate results are known, whichever occurs first.		N
10.9.3	Pass criteria		P
	The pass criteria are as follows:		P
	a) There shall not be flaming of the module, nor flaming or charring of the cheesecloth and tissue paper in contact with the module.		P
	b) MST 17 shall meet the same requirements as for the initial measurements.		P
10.10	Module breakage test MST 32		P
10.10.1	Purpose		P

EN 61730-2			
Clause	Requirement Test	Result - Remark	Verdict
	The purpose of this test is provide confidence that cutting or piercing injuries can be minimized if the module is broken.		P
10.10.2	Background		P
	The test described herein is derived from ANSI Z97.1, Impact test		P
10.10.3	Apparatus		P
	The apparatus is as follows:		P
	a) Impactors shall be leather punching bags of similar shape and size. The bag shall be filled to the required weight using chilled lead shot or pellets (2,5 mm to 3,0 mm in diameter – No. 7½ shot). Figure 4 shows the designs for the impactor bag. The exterior of the bag shall be wrapped with tape as shown in the figures. During testing, the impactor shall be completely covered with a 1.3 cm wide glass filament reinforced pressure sensitive tape. (See Figure 4).		P
	b) A test frame similar to that shown in Figures 5 and 6 shall be provided to minimize movement and deflection during testing. The structure framing and bracing shall be steel channel (approximately C100 mm × 200 mm) or larger and shall have a minimum moment of inertia of approximately 187 cm4. The frame shall be welded or securely bolted at the corners to minimize twisting during impact. It shall also be bolted to the floor to prevent movement during impact testing.		P
	c) When an impactor bag is filled with lead shot, it will weigh approximately 45,5 kg, and will be capable of delivering 542 J of kinetic energy when swung through a 1,2 m vertical drop.		P
10.10.4	Procedure		P
	Mount the module sample so that it is centered and rigid on the test frame using the method described by the manufacturer. The procedure is as follows:		P
	a) At rest, no more than 13 mm from the surface of the module sample and no more than 50 mm from the center of the module sample.		P
	b) Lift the impactor to a drop height of 300 mm from the surface of the module sample, allow the impactor to stabilize, and then release it to strike the module sample.		P

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Clause	Requirement Test	Result - Remark	Verdict
	c) If no breakage occurs, repeat the sequence of b) from a drop height of 450 mm. If still no breakage occurs, repeat from a distance of 1 220 mm.		P
10.10.5	Pass criteria		P
	The module shall be judged to have successfully passed the module breakage test if it meets any one of the following criteria:		P
	a) When breakage occurs, no shear or opening large enough for a 76 mm (3-inch) diameter sphere to pass freely shall develop.		P
	b) When disintegration occurs, the ten largest crack-free particles selected 5 min subsequent to the test shall weigh no more in grams than 16 times the thickness of the sample in millimetres.		N
	c) When breakage occurs, no particles larger than 6,5 cm2 shall be ejected from the sample.		N
	d) The sample does not break.		N
11	Component tests		P
11.1	Partial discharge-test MST 15		P
	The test refers to 4.1.2.4 of IEC 60664-1.		P
11.1.1	Purpose		P
	Polymeric materials intend for use as a superstrate or substrate, without appropriate IEC insulation pre-qualification must comply with the partial discharge test. This test should applied to any polymeric material serving as a superstrate or substrate (see also IEC 61730-1).		N
11.1.2	Preconditioning		N
	It is advisable to perform the partial discharge-test before inserting the reverse side foil into the PV modules.		N
11.1.3	Apparatus		N
	Calibrated charge measuring device or radio interference meter according to IEC 60664-1.		N
11.1.4	Procedure		N
	The procedure is as follows:		N
	a) According to C.2.1 and Clause D.1 of IEC 60664-1, starting from a value below the max. system voltage, up to the point at which partial discharge takes place (inception voltage), the test voltage shall be further increased by 10 %.		N

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Clause	Requirement Test	Result - Remark	Verdict
	b) The voltage shall then be lowered to the point at which the partial discharge extinction voltage is reached.		N
	c) The extinction voltage shall be considered to be reached once the charge intensity has dropped to a value of 1 pC. This voltage shall be measured with an accuracy better than 5 %.		N
	d) The partial discharge extinction voltage may be influenced by environmental conditions. These influences are taken into account by a basic safety factor F1 of 1,2.		N
	e) The hysteresis factor according to 4.1.2.4 of IEC 60664-1 is reduced to 1. The additional safety factor for reinforced insulation F3 = 1.25 is required for safety class A. The initial value of the test voltage is therefore 1.5 UOC (system voltage given by the module manufacturer).		N
	f) Repeat the measurement with 10 test samples.		N
11.1.5	Pass criteria		P
	The solid insulation has passed the test if the mean value minus the standard deviation of the partial discharge extinction voltage is greater than 1,5 times the given maximum system voltage.		P
11.2	Conduit bending test MST 33		P
11.2.1	Purpose		P
	Modules provided with junction boxes intended for attachment of a permanent wiring system using conduit must provide assurance of the ability of the box construction to withstand load forces which may be applied to the conduit during and after installation.		P
11.2.2	Procedure		P
	Two 460-mm lengths of proper trade size conduit with appropriate fitting for the box shall be assembled and installed onto the box on opposing surfaces. For boxes intended for use with non-metallic conduit, the conduit test lengths are to be to welded to the fittings and allowed to dry no less than 24 h prior to assembly.		P
	The test assembly, with the box at the centre, is to be placed on supports as illustrated in Figure 7. The supports are to be separated by a distance of 760 mm plus the distance between the ends of the conduit in the box, to give the required bending moment on the sample under test.		P

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Clause	Requirement Test	Result - Remark	Verdict
	The load specified in Table 10 for the size of conduit used, is to be suspended from the centre of the box for 60 s. During this time, the box and the lengths of conduit shall be rotated through one complete revolution about the major axis of the assembly.		P
11.2.3	Pass criteria		P
	The attachment walls of the module junction box shall not rupture or separate from the conduit.		P
11.3	Terminal box knockout tests MST 44		P
11.3.1	Purpose		P
	Removable hole covers in the walls of module terminal enclosures (knockouts) shall remain in place under nominal force application and also be easily removed for the field application of permanent wiring system components.		P
11.3.2	Condition		P
	A sample of the polymeric terminal box with knockouts will be tested in an “as-received“condition at a 25℃ ambient temperature.		P
	Another sample of the polymeric box is to be conditioned for 5 h in air maintained at ℃±1 °C. The test shall be repeated on the box immediately following this conditioning.		P
11.3.3	Procedure		P
	The knockout shall be easily removed without leaving any sharp edges or causing any damage to the box. The procedure is as follows:		P
	Step 1 – A force of 44,5 N shall be applied to a knockout for 1 min by means of a mandrel, minimum 38 mm long by 6,4 mm diameter, with a flat end. The force is to be applied in a direction perpendicular to the plane of the knockout and at the point most likely to cause movement. Wait 1 h and measure the displacement between the knockouts and the box.		P
	Step 2 – The knockout shall then be removed by means of a screwdriver, used as a chisel. The edge of a screwdriver blade may be run along the inside edge of the resulting opening once only, to remove any fragile tabs remaining along the edge.		P
	Step 3 – Repeat steps 1 and 2 on two additional knockouts.		P
	For a box employing multi-stage knockouts, there shall be no displacement of a larger stage when a smaller stage is removed.		P

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Clause	Requirement Test	Result - Remark	Verdict
11.3.4	Pass criteria		P
	The knockout shall remain in place after the application of the steady force and the clearance between the knockout and the opening shall not be more than 0.75 mm when measured.		P
	The knockout shall be easily removed without leaving any sharp edges or causing any damage to the box.		P

Pictures

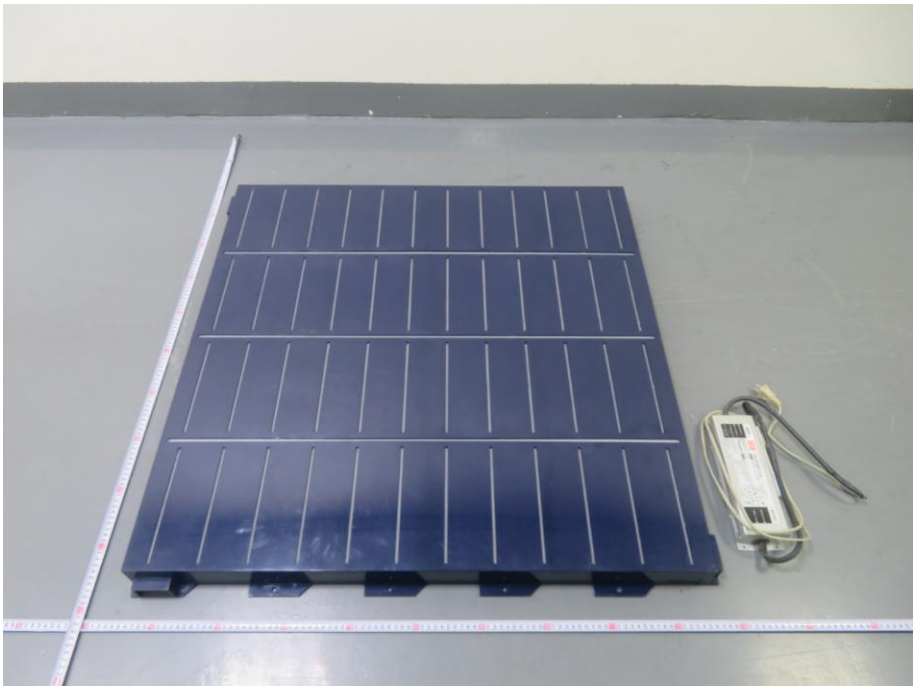

Fig.1

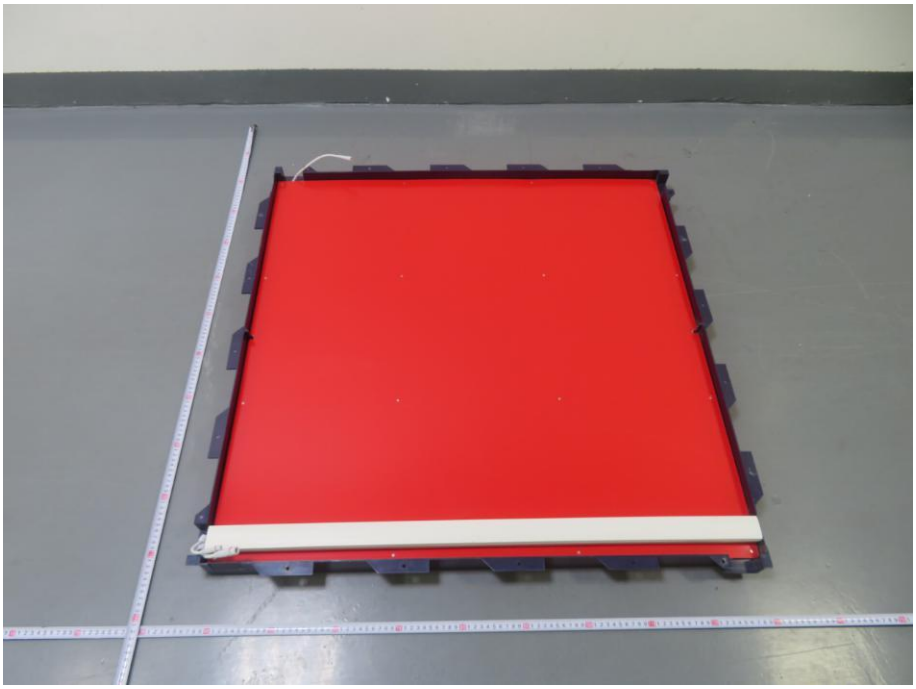

Fig.2

Pictures

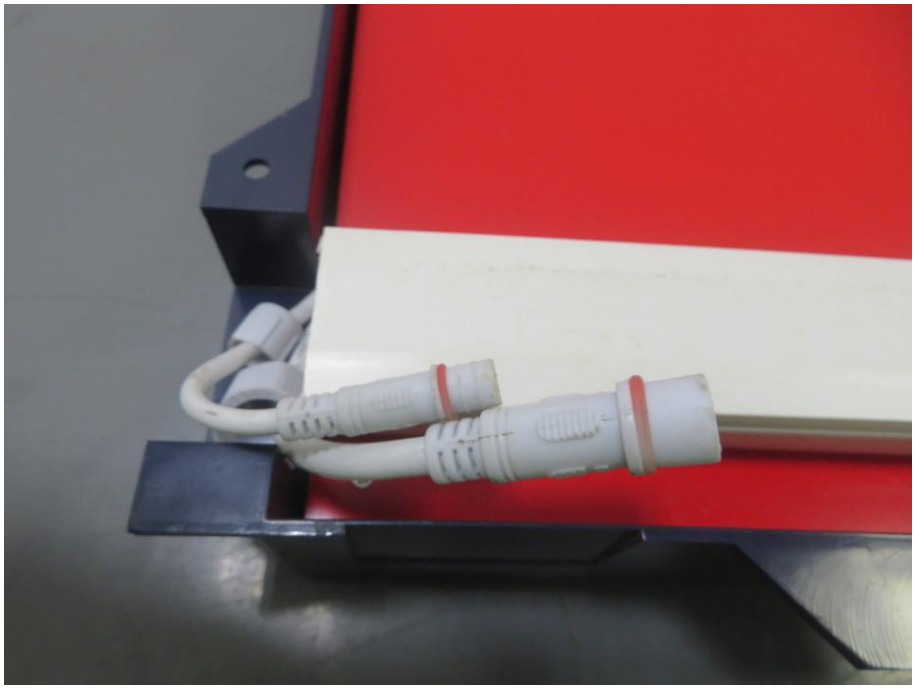

Fig.3

Fig.4

Pictures

Fig.5

********** End of Report **********