TÜV Rheinland PTL LLC

Test Report

Photovoltaic module qualification
according to ANSI/UL1703 – 2014
“Flat-Plate Photovoltaic Modules and Panels”

Certification Report No: 31440031.001

TÜV Rheinland PTL, LLC

February 2015

Testing Certificates 0921-01 & 0921-02

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Test Report No.: *Prüfbericht - Nr.:*	Certification Report No.: 31440031.001
Client **(Customer no. and address):** *Auftraggeber* *(Kunden-Nr. u. Adresse):*	IUSASOL SA de CV (Client No.:804119) Av. Paseo de la Reforma 2608, P.H., Col. Lomas Altas, Del. Miguel Hidalgo, México D.F. C.P. 11950
Test item: *Gegenstand der Prüfung:*	Photovoltaic (PV) Module(s)
Module type designation / family: *Modultypen-Bezeichnung:*	IUSASOL-PV-01-xxx (xxx=235-260) (for details see Constructional Data Form no. CDF 31440031.001)
Order No.: *Auftragsnummer:*	TRM140506, TRM141029
Date of receipt: *Eingangsdatum:*	30Oct2014
Testing Location: *Prüfort:*	**Name & Address of Testing Location:** **TÜV Rheinland PTL, LLC** 2210 S Roosevelt St, Tempe, AZ 85282 Tel.: +1 (480) 966-1700, Fax: +1 (775) 314-6458
Test Specification: *Prüfgrundlage:*	**UL1703 2002 R5:14 "Flat Plate Photovoltaic Modules and Panels "**
Test Result: *Prüfergebnis:*	**Based on the review of the test procedures and results documented in this report, the PV modules tested in this program have met the testing requirements of the above test specification.**

Compiled By: *Erstellt:*			**Reviewed By:** *Kontrolliert:*		
17Feb2015	Bo Li	Bo Li	17Feb2015	Samantha Doshi	Samantha Doshi
Date *Datum*	**Title/Name** *Titel/Name*	**Signature** *Unterschrift*	**Date** *Datum*	**Title/Name** *Titel/Name*	**Signature** *Unterschrift*

Certification Report No.: 31440031.001

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Address(es) of the Manufacturing Site(s)

Client No.:	804120
Name / Description:	IUSASOL S.A. DE C.V.
Street:	Km. 109 Carr. Panamericana Mex-Qro.
Postcode / City:	C.P. 50700 Jocotitlan
Country:	Estado de Mexico
Type of Production:	Photovoltaic (PV) modules
Inspection Report No:	Q0803906.001

Client No.:	
Name / Description:	
Street:	
Postcode / City:	
Country:	
Type of Production:	
Inspection Report No:	

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Certification Report No.: 31440031.001

History of Certification

Revision Number (Project No.)	Revision	Model Name	Reference Report Number	Reference Certificate Number	Certificate Date
0 (TRM140506)	Base	IUSASOL-PV-01-xxx (xxx=235-260)	31440031.001	pending	pending
1 (TRM141029)	Addition of cell, frame	IUSASOL-PV-01-xxx (xxx=235-260)	31440031.001	pending	pending
Supplementary information: None.					

Summary of Test Locations

All tests were performed at TÜV Rheinland PTL in Tempe, Arizona.

Summary of Deviations from the Standard

TÜV Rheinland reserves the right to impose more demanding requirements and select superior tests, which may reflect worst-case scenarios in the interest of product safety liability.

General Report Information

Test Item Particulars	
Accessories and detachable parts included in the evaluation	N/A
Mounting system used	N/A
Other options included	N/A
Possible Test Case Verdicts	
Test case does not apply to the test object	N/A
Test object does meet the requirement	P (Pass)
Test object does not meet the requirement	F (Fail)
Test was not required for this particular program	NR
Abbreviations Used in the Report	
Fill factor	FF
Open circuit voltage	Voc
Short circuit current	Isc
Maximum power voltage	Vmax
Maximum power current	Imax
Maximum power	Pmax
Module Safety Test	MST
Relative Thermal Index	RTI
Standard Test Conditions	STC
Comparative Tracking Index	CTI
Thermal Cycling	TC
Humidity Freeze	HF
Damp Heat	DH

General Remarks

- This report shall not be reproduced, except in full, without the written approval of TÜV Rheinland PTL.
- The test results presented in this report relate only to the item(s) tested.
- "(see remark #)" refers to a remark appended to the report.
- "(see Annex #)" refers to an annex appended to the report.
- "(see appended table)" refers to a table in the test Report.
- Throughout this report a point is used as the decimal separator.

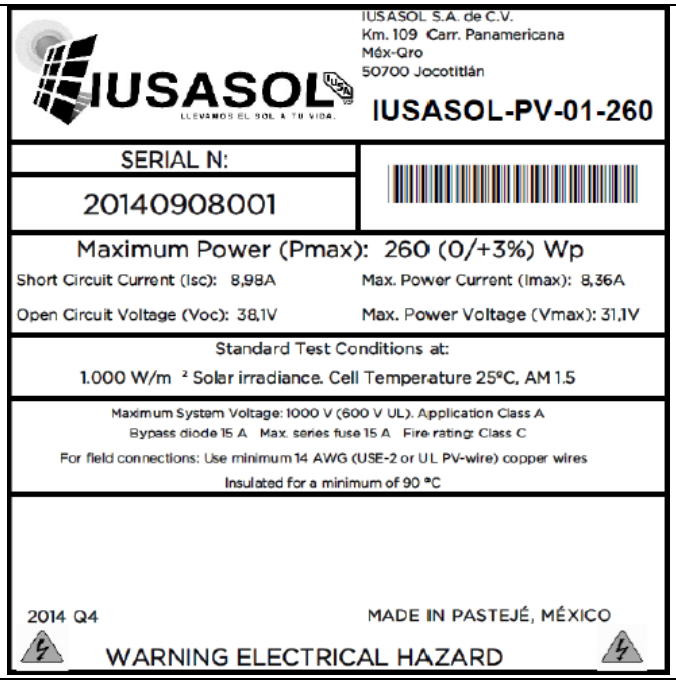
General Product Information

General Information	
Manufacturer	IUSASOL S.A. DE C.V.
Model Number	IUSASOL-PV-01-xxx (xxx=235-260)
Module Technology	Poly Crystalline
Product Electrical Ratings at STC	
Nominal Maximum Power, Pmax (W)	235-260
Nominal Open-circuit Voltage, Voc (V)	37-38.1
Nominal Short-circuit Current, Isc (A)	8.35-8.98
Nominal Maximum Power Voltage, Vmax (V)	30-31.1
Nominal Maximum Power Current, Imax (A)	7.85-8.36
Product Safety Ratings	
Maximum System Operating Voltage (V)	600
Maximum Over-current Protection Rating (A)	15
Safety Application Class	N/A
Fire Safety Class	Type 2

Marking Requirements

Requirement	Comments	Verdict
Name, monogram, or symbol of manufacturer	Verified through visual inspection	P
Type or model number	Verified through visual inspection	P
Isc, Voc, Imax, Vmax, Pmax	Verified through visual inspection	P
Serial number	Verified through visual inspection	P
Polarity of terminals or leads	Verified through visual inspection	P
Maximum system voltage	Verified through visual inspection	P
The date of manufacture	Verified through visual inspection	P
The place of manufacture	Verified through visual inspection	P
Maximum overcurrent protection rating	Verified through visual inspection	P
Application class	N/A	N/A
Fire class	Verified through visual inspection	P

Copy of Nameplate



Supplementary information:
None.

Testing Procedure

Scope of Testing

Sampling
☒ Random sampling from production ☒ The modules tested (modules and laminate) were taken at random from a production batch and subjected to manufacturer's normal quality control and inspection for safety testing. ☐ The modules tested (modules and laminate) were supplied by the manufacturer. ☐ Prototype submitted by client

Program
☒ New module type ☒ Modifications (if yes, please choose the applicable modification according to the Retesting Guideline) Original test report ref. no.: ☒ Change in cell technology ☐ Modification to encapsulation system ☐ Modification to superstrate ☐ Increase in module size ☐ Modification to back sheet / substrate ☒ Modification to frame and / or mounting structure ☐ Modification to junction box / electrical termination ☐ Change in cell interconnect materials or technique ☐ Change in electrical circuit of an identical package ☐ Higher or lower power output (by 10%) in the identical package including size and using the identical cell process ☐ Qualification of a frameless module after the design has received certification as a framed module ☐ Change in bypass diode or number of diodes ☐ Increase in overcurrent protection (series fuse) rating ☐ Change in grounding means ☐ Change of label material or label adhesive ☐ Change or inclusion of use of fixing tape used to hold cells for lamination ☐ Other….
Description of similarity (differences) between the applied model and the previously tested model:

Testing program is base qualification with addition of cell from Bluecell and frame from Consorcio Industrial.
Consorcio Industrial frame has no change of cross section, material, coating and therefore no test is needed for frame change.

Module Group Assignment

Sample ID	Date Received (DD/MM/YYYY)	Serial Number	Type / Model Number	Remarks	Seq. No.
TRM1036	30/10/2014	20141001036	IUSASOL-PV-01-250	No defects	Spare
TRM1054	30/10/2014	20141001054	IUSASOL-PV-01-250	No defects	Spare
TRM1068	30/10/2014	20141001068	IUSASOL-PV-01-250	No defects	Spare
TRM2170	30/10/2014	20141002170	IUSASOL-PV-01-255	No defects	E
TRM2173	30/10/2014	20141002173	IUSASOL-PV-01-255	No defects	Spare
TRM2188	30/10/2014	20141002188	IUSASOL-PV-01-255	No defects	D
TRM2192	30/10/2014	20141002192	IUSASOL-PV-01-255	No defects	B2/H
TRM2267	30/10/2014	20141002267	IUSASOL-PV-01-255	No defects	Spare
TRM3147	30/10/2014	20141003147	IUSASOL-PV-01-255	No defects	C/G
TRM6062*	30/10/2014	20141006062	IUSASOL-PV-01-250	No defects	B1
TRM6386	30/10/2014	20141006386	IUSASOL-PV-01-255	No defects	C/G
TRM6403	30/10/2014	20141006403	IUSASOL-PV-01-255	No defects	B1
TRM6416	30/10/2014	20141006416	IUSASOL-PV-01-255	No defects	B1
TRM6453	30/10/2014	20141006453	IUSASOL-PV-01-255	No defects	D
TRM6474	30/10/2014	20141006474	IUSASOL-PV-01-255	No defects	C/G
TRM7124	30/10/2014	20141007124	IUSASOL-PV-01-255	No defects	D
TRM7125	30/10/2014	20141007125	IUSASOL-PV-01-255	No defects	Spare
TRM5357	30/10/2014	1141007195357	IUSASOL-PV-01-255	No defects	B2/I
TRM4507*	30/10/2014	1141008154507	IUSASOL-PV-01-245	No defects	B2
TRM3252*	30/10/2014	1141008203252	IUSASOL-PV-01-245	No defects	B2
TRM2430*	30/10/2014	1141009002430	IUSASOL-PV-01-245	No defects	B1
TRM1434	30/10/2014	1141009021434	IUSASOL-PV-01-250	No defects	Spare
TRM3421	30/10/2014	1141009033421	IUSASOL-PV-01-250	No defects	Spare
TRM4908	30/10/2014	1141010074908	IUSASOL-PV-01-245	No defects	Spare
Supplementary Information: * samples for qualification by similarity, cell change.					

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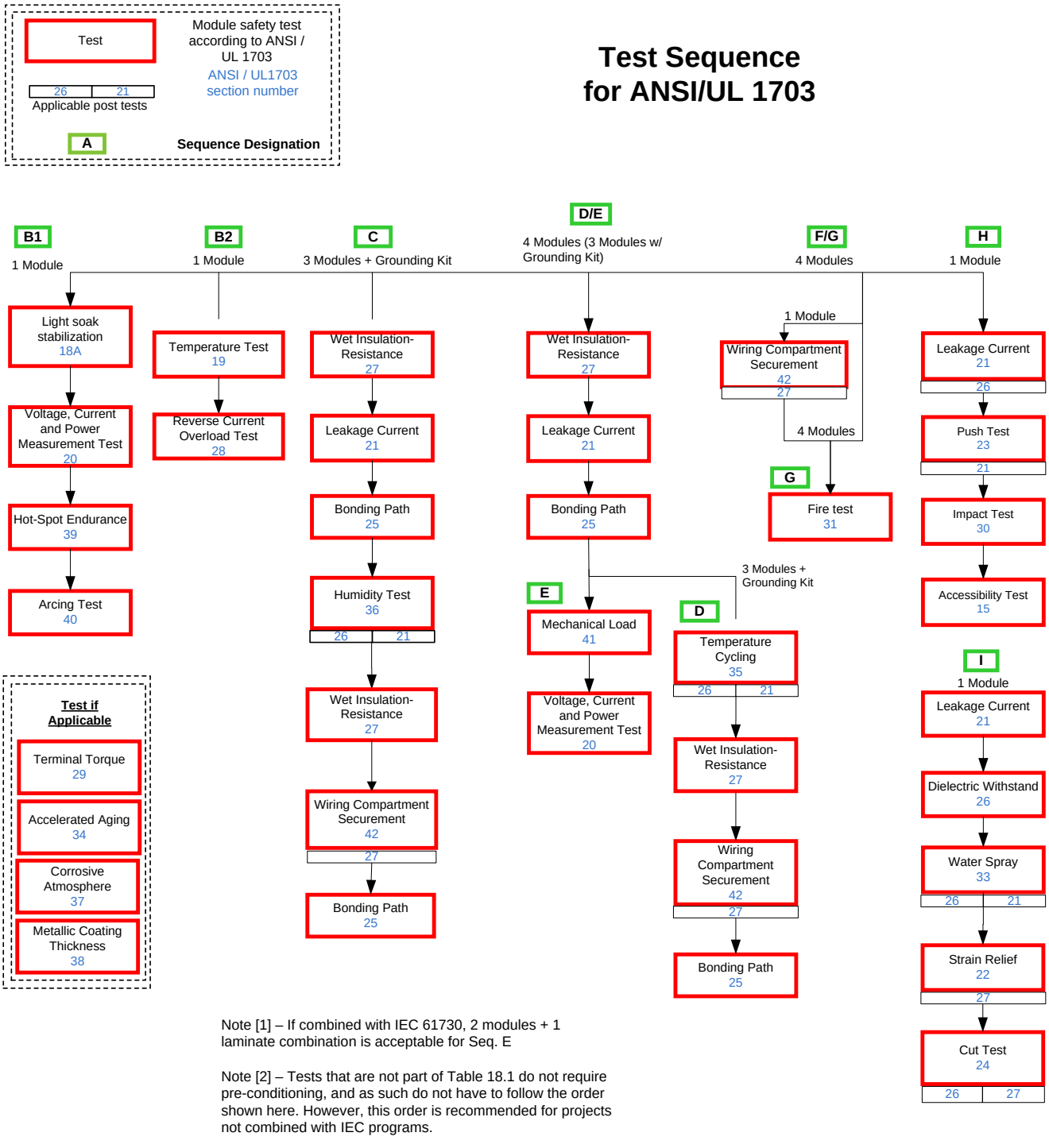
Test Program – Full Qualification

Note: Deviations from test sequence are possible but must be documented.



Note [1] – If combined with IEC 61730, 2 modules + 1 laminate combination is acceptable for Seq. E

Note [2] – Tests that are not part of Table 18.1 do not require pre-conditioning, and as such do not have to follow the order shown here. However, this order is recommended for projects not combined with IEC programs.

Testing Summary

Section No.	Test Name	Test Location	Verdict
19	Temperature Test.....:	TÜV Rheinland PTL	P
20	Voltage, Current, and Power Measurements Test.....:	TÜV Rheinland PTL	P
21	Leakage Current Test (initial) .....:	TÜV Rheinland PTL	P
22	Strain Relief Test.....:	TÜV Rheinland PTL	P
23	Push Test .....:	TÜV Rheinland PTL	P
24	Cut Test .....:	TÜV Rheinland PTL	P
25	Bonding Path Resistance Test.....:	TÜV Rheinland PTL	P
26	Dielectric Voltage Withstand Test (initial) .....:	TÜV Rheinland PTL	P
27	Wet Insulation Resistance Test (initial) .....:	TÜV Rheinland PTL	P
28	Reverse Current Overload Test.....:	TÜV Rheinland PTL	P
29	Terminal Torque Test.....:	TÜV Rheinland PTL	N/A
30	Impact Test .....:	TÜV Rheinland PTL	P
31 / 32	Fire Test & General Information .....:	TÜV Rheinland PTL	P
33	Water Spray Test.....:	TÜV Rheinland PTL	P
35	Temperature Cycling (TC200) Test .....:	TÜV Rheinland PTL	P
36	Humidity (HF10) Test .....:	TÜV Rheinland PTL	P
39	Hot-spot Endurance Test.....:	TÜV Rheinland PTL	P
41	Mechanical Loading Test.....:	TÜV Rheinland PTL	P
42	Wiring Compartment Securement Test.....:	TÜV Rheinland PTL	P
15	Accessibility Test..... .....:	TÜV Rheinland PTL	P

CONSTRUCTIONAL DATA:

Section 6 (General)

Sec.	Description	Tests	Verdict
6.1	A module shall be completely assembled when shipped from the factory. A panel may be completely assembled when shipped from the factory, or may be provided in subassemblies, provided assembly of the panel does not involve any action that is likely to affect compliance with the requirements of this standard. *Exception: An assembly part need not be affixed to the module at the factory.*	**Visual Inspection**	P
6.2	A module or panel assembly bolt, screw, or other part shall not be intended for securing the complete device to the supporting surface or frame.	**Visual Inspection**	P
6.3	Incorporation of a module or panel into the final assembly shall not require any alteration of the module or panel unless specific details describing necessary modification(s) for alternate installation(s) are provided in the installation instructions. If a module or panel must bear a definite relationship to another for the intended installation and operation of the array (for example, to allow connectors to mate), it shall be constructed to permit it to be incorporated into the array in the correct relationship without the need for alteration.	Document Verification **Installation manual**	P
6.4	The construction of a product shall be such that during installation it will **not** be necessary to alter or remove any cover, baffle, insulation, or shield that is required to reduce the likelihood of: a) Excessive temperatures, or b) Unintentional contact with a part that may involve a risk of electric shock. *Exception: A cover of a wiring compartment providing access to a connection means that may involve a risk of electric shock may be removable to allow for the making of electrical connections.*	**Visual Inspection**	P
6.5	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.	**Visual Inspection** Remarks: Latching connectors	P
6.6	Friction between surfaces is not acceptable as the sole means to inhibit the turning or loosening of a part, but a lock washer properly applied is acceptable for this purpose.	**Visual Inspection** Remarks: Latching connectors	P
6.7	An adjustable or movable structural part shall be provided with a locking device to reduce the likelihood of unintentional shifting, if any such shifting may result in a risk of fire, electric shock, or injury to persons.	**Visual Inspection** Remarks: No adjustable components on a flat-plate module.	N/A

6.8	Metals used in locations that may be wet or moist shall not be employed in combinations that could result in deterioration of either metal such that the product would not comply with the requirements in this standard.	**Visual Inspection**	P
6.9	Edges, projections, and corners of photovoltaic modules and panels shall be such as to reduce the risk of injury to persons.	**Visual Inspection** Remarks: Visual inspection covers flat-plate	P
6.10	Whenever a referee measurement is necessary to determine that a part as mentioned in 6.9 is not sufficiently sharp to constitute a risk of injury to persons, the method described in the requirements in the Standard for Tests for Sharpness of Edges on Equipment, UL 1439, is to be employed.	**Visual Inspection** Remarks: Visual inspection covers flat-plate	N/A

Section 7 (Polymeric Materials)

Note 1: Junction Box – if a junction box is UL recognized or meets 2 Pfg1798 by TUV, it meets the requirements of sections 7.1, 7.2 and 7.5.
Note 2: Connector – if a connector is UL listed or meets 2 Pfg1937 by TUV, it meets the requirements of sections 7.1 and 7.2, and 7.5.

Sec.	Description	Tests	Verdict
7.1	A polymeric material system serving as the enclosure of a part involving a risk of fire or electric shock shall comply with the applicable requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, concerning: a) Flammability, b) Ultraviolet light exposure, c) Water exposure and immersion, and d) Hot-wire ignition (HWI). *Exception: The flammability tests prescribed in UL 746C do not apply to the superstrate, encapsulation, and substrate. These materials shall comply with 7.4.*	Document Verification Jbox: PV-JM805A, UL E337337 Connector: PV-JM601, UL E341975	P

7.2	A polymeric material that is in contact with or in close proximity, less than 0.8 mm (1/32 in), to uninsulated live parts shall: a) Have a flammability classification of HB, V-2, V-1, or V-0 determined in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94; b) Have a minimum High-Current Arc Ignition performance level category (PLC) in accordance with the following: **Flammability classification** — **High-current arc ignition, PLC** HB — 1 V-2 — 2 V-1 — 2 V-0 — 3 c) Have a Comparative Tracking Index performance level category (PLC) as determined in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A, and as defined in Table 7.1, when the system voltage rating is 600 V or less; Exception No. 1: The CTI rating is not required when both the material and live part are completely encapsulated by potting materials such that there is no surface upon which tracking may occur, and the potting materials has been evaluated according to UL 746C, Table 6.1, for Electric Strength, Resistance to Electrical Ignition Sources (HAI and HWI), and Thermal Endurance. Exception No. 2: The CTI rating is not required when both the material and live part are completely coasted by a conformal coating that has been evaluated to the requirements of the Standard for Polymeric Materials – Industrial Laminates, Filament Wound Tubing, Vulcanized Fibre, and materials used in Printed Wiring Boards, UL 7546E, Section 22, at the rated thickness such that there is no surface upon which tracking may occur. Exception No. 3: Single component silicone rubber based room temperature vulcanizing (RTV) materials when applied in accordance with Exception No. 2 is considered a suitable conformal coasting without further evaluation	Document Verification Jbox: PV-JM805A, UL E337337 Connector: PV-JM601, UL E341975	P

<table>
<tr>
<td>7.2</td>
<td>
d) Have an Inclined Plane Tracking (ASTM D2303) rating of 1 h using the time to track method at the higher of system voltage or 1000V when the system voltage is in the range of 601-1000V, as specified in Table 7.1; and

Exception No. 1: The 1 hr. rating is not required when both the material and live part are completely encapsulated by a potting material such there is no surface upon which tracking may occur, and the potting material has been evaluated according the UL 746C, Table 6.1, for Electric Strength, Resistance to Electrical Ignition Sources (HAI and HWI), and Thermal Endurance.

Exception No. 2: The 1 hr. rating is not required when both the material and live part are completely coated by a conformal coating that has been evaluated to the requirements of UL 746C, Section 43A, at the rated thickness such that there is no surface upon which tracking may occur.

Exception No. 3: Single component silicone rubber based room temperature vulcanizing (RTV) materials when applied in accordance with Exception No. 2 is considered a suitable conformal coasting without further evaluation.

e) Comply with the requirements for exposure to ultraviolet light as determined in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, when exposed to light during normal operation of the product. Polymeric materials that are exposed to sunlight and are protected by glass, or other transparent medium, shall be tested with an equivalent layer of that medium attenuating the ultraviolet light exposure during the test.

Exception: Encapsulant materials between the substrate and the superstrate are not required to comply with this requirement

Table 7.1: Determination of comparative tracking index performance level category (PLC)
<table>
<tr><th>Voltage</th><th>Creepage distance</th><th>IPT 1 hr rating required</th><th>CTI PLC of 2 or better required</th></tr>
<tr><td>0-30</td><td>Any</td><td>No</td><td>No</td></tr>
<tr><td>> 30-600</td><td>< 12.7 mm</td><td>No</td><td>Yes</td></tr>
<tr><td>> 30-600</td><td>≥ 12.7 mm</td><td>No</td><td>No</td></tr>
<tr><td>> 601 – 1000</td><td>< 16.0 mm</td><td>Yes</td><td>No</td></tr>
<tr><td>> 601 – 1000</td><td>≥ 16.0 mm</td><td>No</td><td>No</td></tr>
<tr><td colspan="4">Note – Voltage is determiend as follows:
Between live parts: the maximum potential difference during normal use.
Between live parts and dead metal parts that may be grounded in service: maximum system voltage.
Between live parts and any surface exposed to contact: maximum system voltage.</td></tr>
</table>
</td>
<td>Document Verification

Jbox: PV-JM805A, UL E337337
Connector: PV-JM601, UL E341975</td>
<td>P</td>
</tr>
</table>

7.3	A polymeric substrate or superstrate shall have a thermal index, both electrical and mechanical, as determined in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B, not less than 90°C (194°F). In addition, the thermal index shall not be less than 20°C (36°F) above the measured operating temperature of the material. All other polymeric materials shall have a thermal index (electrical and mechanical) 20°C above the measured operating temperature. The measured operating temperature is the temperature measured during the open-circuit mode for Temperature Test, Section 19, or the temperature during the short-circuit mode, whichever is greater.	Document Verification Backsheet: Madico HyTek, UL E311012 Lab Test **Temperature test** Remarks: Max. temp. of substrate = 83.54 [°C]. RTI = 105 [°C].	P
7.4	A polymeric material that serves as the outer enclosure for a module or panel that: a) Is intended to be installed in a multi-module or multi-panel system; or b) Has an exposed surface area greater than 10 ft2(0.93 m2) or a single dimension larger than 6 ft. (1.83 m) shall have a flame spread index of 100 or less as determined under the Standard Method of Test for Surface Flammability of Materials Using a Radiant Heat Energy Source, ASTM E162-2001. *Exception No. 1: A material that serves as the outer enclosure for a small cover or box used for electrical connections is not required to have an index of 100 or less.* *Exception No. 2: A material that serves as the outer enclosure for a module or panel complying with 16.1 meets the intent of this requirement.*	Lab Test **Fire Test** Remarks: Successfully completed at TÜVPTL	P
7.5	A barrier or liner 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. The barrier or liner shall be held in place and shall not be adversely affected to the extent that its necessary properties may fall below the minimum acceptable values for the application.	Document Verification Jbox: PV-JM805A, UL E337337 Connector: PV-JM601, UL E341975	P

Section 8 (Current-Carrying Parts and Internal Wiring)

Sec.	Description	Tests	Verdict
8.1	A current-carrying part and wiring shall have the mechanical strength and ampacity necessary for the service.	Lab Test **Reverse Current Overload test** Remarks: Successfully completed at TÜVPTL	P
8.2	A current-carrying part shall be of silver, a copper-base alloy, stainless steel, aluminum, or other material appropriate for the application.	Document Verification Cable: ZHEJIANG JIAMING TIANHEYUAN PHOTOVOLTAIC TECHNOLOGY CO LTD PV wire, UL E343893	P
8.3	Wiring used in a module or panel shall be insulated and acceptable for the purpose, when considered with respect to temperature, voltage, and the conditions of service to which the wiring is likely to be subjected within the equipment.	Document Verification Cable: ZHEJIANG JIAMING TIANHEYUAN PHOTOVOLTAIC TECHNOLOGY CO LTD PV wire, UL E343893	P
8.4	A splice shall be provided with insulation equivalent to that required for the wires involved.	**Visual Inspection** BL: No such design	N/A
8.5	A joint or connection shall be mechanically secure and shall provide electrical contact without strain on connections and terminals. Soldered connections between interconnects and metallizations are considered mechanically secure when held by encapsulation systems.	Lab Test **Strain Relief test** Remarks: Successfully completed at TÜVPTL.	P
8.6	An un-insulated live part, including a terminal, shall be secured to its supporting surface by a method other than friction between surfaces 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 12.1 and 12.2 in the ANSI/UL1703 standard.	**Visual Inspection** BL: No such design	N/A

8.7	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 connection inside the module or panel.	Lab Test **Strain Relief test** Remarks: Successfully completed at TÜVPTL.	P
8.8	The wiring of a module or panel shall be located so that after installation of the product in the intended manner it will not be exposed to the degrading effects of direct sunlight. *Exception: Wiring rated sunlight resistant need not be so located.*	Document Verification **Installation manual**	P

Section 9 (Wireways)

Sec.	Description	Tests	Verdict
9.1	An enclosure for wire shall be smooth and free from sharp edges, burrs, or the like that may damage insulation or conductors.	**Visual Inspection**	P

Section 10 (Connection Means)

Sec.	Description	Tests	Verdict
10.1	In 10.2 /4.5.2 – 10.10 / 4.5.10, connection means are considered to be those to which field-installed wiring is connected when the product is installed. Connection means may be within a wiring compartment, may be connectors outside of a wiring compartment, or may be another means acceptable for the application.		
10.2	A module or panel shall be capable of accommodating at least one of the acceptable wiring systems described in the National Electrical Code, NFPA 70.	Document Verification **Mechanical drawings** **Installation manual**	P
10.3	A module or panel shall be provided with wiring terminals, connectors, or leads to a current-carrying conductors of the load circuit.	**Visual Inspection**	P
10.4	The connection means for a module or panel shall be so located that after installation of the product in the intended manner they will not be exposed to the degrading effects of direct sunlight. *Exception: Connection means rated for use in direct sunlight need not be so located.*	Document Verification **Installation manual**	P
10.5	A lead that is intended to be spliced in the field to a circuit conductor shall not be smaller than No. 18 AWG (0.82 mm^2) and the insulation shall not be less than 1/32 in (0.8 mm) thick.	**Visual Inspection** Remarks: 12 AWG, see picture in appendix.	P
10.6	The free length of a lead for field connection shall be at least 6 in (152 mm).	**Visual Inspection** Remarks: Approx. 850 mm long.	P

Sec.	Description	Tests	Verdict
10.7	A wire-binding screw or stud- and nut-type terminal used to terminate conductors not larger than No. 10 AWG (5.3 mm2) shall comply with the following: a) A threaded screw or stud shall be of nonferrous metal, stainless steel, or plated steel appropriate for the application, shall not have more than 32 threads/in, and shall not be smaller than No. 8 when used to terminate No. 10 or 12 AWG (5.3 or 3.3 mm2) wire; and not smaller than No. 6 when used to terminate No. 14 AWG (2.1 mm2) and smaller wire. A wire-binding screw or stud- and nut-type terminal shall be provided with upturned lugs, a cupped washer, a barrier, or other equivalent means to retain the wire in position. The head of a wire-binding screw used to terminate No. 12 AWG or smaller wire shall have a minimum diameter of 0.275 in (7.0 mm) and the head of a screw used to terminate No. 10 AWG wire shall have a minimum diameter of 0.327 in (8.3 mm). b) A tapped terminal plate shall: 1) Be of nonferrous metal, 2) Not have less than two full screw threads, and 3) Be of metal not less than 0.050 in (1.27 mm) thick when used to terminate No. 10 or 12 AWG wire and not less than 0.030 in (0.76 mm) thick when used to terminate a No. 4) 14 AWG or smaller wire. Unextruded metal for screw threads obtained by extruding a hole shall have a thickness not less than the pitch of the screw thread.	**Visual Inspection** Remarks: Field wiring terminals only, therefore N/A.	N/A
10.8	A connector intended for use on the output wiring of a module or panel only shall comply with: a) the Standard for Component Connectors for Use in Data, Signal, Control and Power Applications, UL 1977, b) Temperature Cycling Test, Section 35, excluding the Wiring Compartment Securement Test and the following Wet Insulation-Resistance Test, and c) Humidity Test, Section 36, excluding the Wiring Compartment Securement Test and the following Wet Insulation-Resistance Test. 10.8 revised October 1, 2003	Document Verification Connector: PV-JM601, UL E341975 Lab Test **TC200** **HF10** Remarks: Successfully completed at TÜVPTL.	P
10.9	A separable multi-pole connector shall be polarized. If two or more separable connectors are provided, they shall be configured or arranged so that the mating connector for one will not be accepted by the other, and vice-versa, if such is an improper connection.	**Visual Inspection** BL: no such part	N/A
10.10	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.	**Visual Inspection** BL: no such part	N/A

Section 11 (Bonding and Grounding)

Sec.	Description	Tests	Verdict
11.1	A module or panel shall have a means for grounding all accessible conductive parts. The grounding means shall comply with the applicable requirements in Connection Means, Section 10. The grounding means shall be bonded to each conductive part of the module or panel that is accessible during normal use. The grounding means shall be described in detail in the installation manual. See Installation and Assembly Instructions, Section 48. *Exception: When the grounding means is a module or panel mounting member intended to contact an array structural member, the module or panel grounding means are not required to comply with the requirements for Connection Means, Section 10.*	**Visual Inspection** Lab Test **Bonding Path Resistance** Remarks: Successfully completed at TÜVPTL.	P
11.1A	**Grounding Terminology.** The term “grounding” encompasses two types of connection to Earth. One connection is a functional or system grounding where one of the circuit conductors (also known as a current-carrying conductor) is connected to a grounding system and then connected to earth. Functional grounding may or may not be implemented in any particular system. The second use of the grounding term refers to protective (earth) or equipment grounding where any exposed metallic conductive surfaces that may become energized (unintentionally) are connected to the grounding system and then connected to earth. The grounding system is composed of the grounding electrode (the actual connection to earth), and the grounding-electrode conductor (between the grounding electrode and a common grounding point). The common grounding point is where the functional/system-grounding conductor (if required) and the equipment/protective grounding conductor(s) (if required) connect to the grounding electrode conductor. The bonding and grounding material discussed in this section pertains only to equipment/protective bonding.		
11.1B	**Factory Bonding.** The process of bonding entails the electrical connection of the exposed conductive pieces of the module frame or other exposed conductive surfaces to create an equipotential conductive surface. The bonding process is carried out in the factory under carefully controlled conditions using methods and hardware that must be identified and remain relatively controlled. These bonding methods and hardware are evaluated through the requirements in this standard. Changes in the hardware used in the bonding process must be revaluated through the tests described in this standard. The overall bonding connections are evaluated through the Bonding path Resistance Test, Section 25.		

Sec.	Description	Tests	Verdict
11.1C	**Field Grounding.** The process of grounding involves the connection of a field-installed conductor or assembly to the exposed conductive parts of a module that connects the exposed conductive parts of a module to earth in a manner prescribed by the National Electrical Code (NEC). The instruction manual provided with each PV module will describe the location and method of making this field installed connection. These connections will, in general, not be made under factory-controlled conditions nor will each and every field connection be evaluated by the Bonding Path Resistance Test, Section 25. Normally, the methods and hardware used to make electrical bonding connections in the factory will not be applicable to field installed grounding connections. Such hardware items may be used in making the grounding connections if, and only if, the hardware is supplied with the PV module and has been evaluated for use as a grounding device/method through the requirements in this standard. Only listed grounding devices may be used to ground PV modules.		
11.1D	**Insulating Coatings.** Clear coatings, anodizing, and the rapid oxidation of aluminum make electrical connections to module frames in the field difficult. In many cases, the clear coating, anodizing, and oxidation film will have to be penetrated or removed and an anti-oxidation compound applied to the bare aluminum surface before a good electrical connection can be made.		
11.2	Routine maintenance of a module or panel 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.	Document Verification **Installation Manual**	P
11.3	Bonding shall be by a positive means, such as clamping, riveting, bolted or screwed connections, or welding, soldering (see 11.5) or brazing. The bonding connection shall penetrate nonconductive coatings, such as paint or vitreous enamel.	Document Verification **Installation Manual**	P
11.4	A bolted or screwed connection that incorporates a star washer under the screwhead or a serrated screwhead may be acceptable for penetrating nonconductive coatings. If the bonding means depends upon screw threads, two or more screws or two full threads of a single screw shall engage the metal.	Document Verification **Installation Manual**	P

Sec.	Description	Tests	Verdict
11.5	All joints in the bonding path shall be mechanically secure independent of any soldering.	**Visual Inspection**	P
11.6	A separate bonding conductor or strap shall: a) Be of copper, copper alloy, or other material acceptable for use as an electrical conductor; b) Be protected from mechanical damage; and c) Not be secured by a removable fastener used for any purpose other than bonding, unless the bonding conductor is unlikely to be omitted after removal and replacement of the fastener.	**Visual Inspection** Lab test **Accessibility test** Remarks: Successfully completed at TÜVPTL.	P
11.7	A ferrous metal part in the grounding path shall be protected against corrosion by metallic or nonmetallic coatings, such as painting, galvanizing, or plating. Stainless steel is acceptable without additional coating.	**Visual Inspection** BL: No such part	N/A
11.8	A metal-to-metal multiple-bearing pin-type hinge is considered to be an acceptable means for bonding.	**Visual Inspection** BL: No such part	N/A
11.9	A terminal of a module or panel (for example, a wire-binding screw, a pressure wire connector, or a nut-on-stud) intended to accommodate an equipment grounding conductor shall be identified by being marked 'G', or ,GROUND',or shall have a green-colored part. No other terminal shall be so identified. Universal grounding symbol, ⏚, is acceptable.	**Visual Inspection**	P
11.10	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 afixed to the module or panel near the terminal.	**Visual Inspection**	P
11.11	If a green-colored part is used to identify the equipment-grounding terminal, it shall be readily visible during and after installation of the equipment-grounding conductor and the portion of the terminal that is green shall not be readily removable from the remainder of the terminal.	**Visual Inspection** BL: No such part	N/A
11.12	The surface of a lead of a module or panel intended for the connection of an equipment-grounding conductor shall be identified by insulation colored green, or green with yellow stripe(s). No other lead shall be so identified.	**Visual Inspection** BL: No such part	N/A

Section 12 (Spacings)

<table>
<tr><th>Sec.</th><th>Description</th><th>Tests</th><th>Verdict</th></tr>
<tr><td>12.1</td><td>The spacings 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 12.1 and 12.2.

Exception: 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.

Table 12.1
Minimum acceptable spacings at wiring terminals
<table><tr><th rowspan="2">Potential involved, V</th><th colspan="2">Through air and over surface</th></tr><tr><th>In</th><th>(mm)</th></tr><tr><td>0 – 50</td><td>1/4</td><td>(6.4)</td></tr><tr><td>51 – 300</td><td>3/8</td><td>(9.5)</td></tr><tr><td>301 – 600</td><td>1/2</td><td>(12.7)</td></tr><tr><td>601 – 1000</td><td>5/8</td><td>(15.9)</td></tr></table>
Table 12.2
Minimum acceptable spacings elsewhere than at wiring terminals
<table><tr><th rowspan="2">Potential involved, V</th><th colspan="2">Through air</th><th colspan="2">Over surface</th></tr><tr><th>In</th><th>(mm)</th><th>In</th><th>(mm)</th></tr><tr><td>0 – 50</td><td>1/16</td><td>(1.6)</td><td>1/16</td><td>(1.6)</td></tr><tr><td>51 – 300</td><td>1/8</td><td>(3.2)</td><td>1/4</td><td>(6.4)</td></tr><tr><td>301 – 600</td><td>1/4</td><td>(6.4)</td><td>3/8</td><td>(9.5)</td></tr><tr><td>601 – 1000</td><td>3/8</td><td>(9.5)</td><td>1/2</td><td>(12.7)</td></tr></table></td><td>Document Verification

Jbox: PV-JM805A, UL E337337
Connector: PV-JM601, UL E341975

Remarks: Minimum measured distance = 13.26 [mm], circuit to long edge.</td><td>P</td></tr>
<tr><td>12.2</td><td>The spacings at a field-wiring terminal are to be measured with and without wire connected to the terminal. The wire is to 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.</td><td>Visual Inspection

Document Verification

Jbox: PV-JM805A, UL E337337
Connector: PV-JM601, UL E341975</td><td>P</td></tr>
<tr><td>12.3</td><td>Surfaces separated by a gap of 0.013 in (0.33 mm) or less are considered to be in contact with each other for the purpose of judging over surface spacings.</td><td></td><td></td></tr>
<tr><td>12.5</td><td>A barrier or liner of electrical grade fiber providing the sole insulation between a live part and an accessible metal part or between uninsulated live parts not of the same potential shall not be less than 0.028 in (0.71 mm) thick. The barrier or liner shall be held in place and shall not be adversely affected to the extent that its necessary properties may fall below the minimum values required for the application.</td><td>Visual Inspection</td><td>N/A</td></tr>
</table>

Section 13 (Wiring Compartments)

Sec.	Description	Tests	Verdict
13.1.2	The internal volume of the wiring compartment shall be in accordance with Table 13.1. The volume shall be calculated for each conductor intended to be installed, including integral conductors of the module or panel. In the space being evaluated for the minimum required volume, no enclosure dimension shall be less than 3/4 in (19.1 mm). The internal volume shall be determined using water as prescribed for the Volume Verification Test in the Standard for Metallic Outlet Boxes, UL 514A. Table 13.1 Volume required per conductor Size of conductor, AWG / Free space within box for each conductor, in³ 18 / 1.50 16 / 1.75 14 / 2.00 12 / 2.25 10 / 2.50 8 / 3.00 6 / 5.00 For SI units: 1 cubic in = 16.4 cm³	Document Verification Jbox: PV-JM805A, UL E337337	P
13.1.3	A wiring compartment shall have provision for accommodating a wiring system employing a raceway or cable.	**Visual Inspection**	N/A
13.1.4	A wiring compartment shall have no more than one opening when the module or panel is shipped from the factory. Tapped holes with screwed-in plugs and knockouts are not considered openings.	**Visual Inspection**	P
13.1.5	Gaskets and seals shall not deteriorate beyond limits during accelerated aging, and shall not be used where they may be subject to flexing during normal operation. See Accelerated Aging Test, Section 34. Wiring Compartment Securement	Document Verification Jbox: PV-JM805A, UL E337337 Lab Test **Wiring Compartment Securement** Remarks: Successfully completed at TÜVPTL.	P
13.1.6	A wiring compartment that is secured to a substrate by means of an adhesive shall comply with Wiring Compartment Securement Test, Section 42.	Lab Test **Wiring Compartment Securement** Remarks: Successfully completed at TÜVPTL.	P

Sec.	Description	Tests	Verdict
13.2.1	A wiring compartment of sheet steel shall have a wall thickness of not less than 0.053 in (1.35 mm) if uncoated, or 0.056 in (1.42 mm) if zinc coated.	**Visual Inspection**	N/A
13.2.2	A wiring compartment of sheet aluminum shall have a wall thickness of not less than 0.0625 in (1.59 mm).	**Visual Inspection**	N/A
13.2.3	A wiring compartment of cast iron, aluminum, brass, or bronze shall have a wall thickness of not less than 3/32 in (2.4 mm).	Document Verification **Data Sheets**	N/A
13.2.4	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 1/4 in (6.4 mm) thick, and shall be tapered unless a conduit end stop is provided.	N/A	N/A
13.2.5	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 3-1/2 nor more than five threads in the metal and the construction shall be such that a conduit bushing can be attached as intended.	N/A	N/A
13.2.6	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 five 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. The throat diameter of an inlet hole shall be within the limits specified in the Standard for Metallic Outlet Boxes, UL 514A.	N/A	N/A
13.2.7	For a nonthreaded opening in a metal wiring compartment intended to accommodate rigid metallic conduit, a flat surface of sufficient area as described in the Standard for Metallic Outlet Boxes, UL 514A, shall be provided around the opening to accept the bearing surfaces of the bushing and lock washer.	N/A	N/A

Sec.	Description	Tests	Verdict
13.3.2	A nonmetallic wiring compartment intended to accommodate nonmetallic conduit shall have: a) One or more unthreaded conduit-connection sockets integral with the compartment that comply with the requirements in the Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers, UL 514C, b) One or more threaded or unthreaded openings for a conduit-connection socket, or c) One or more knockouts that comply with UL 514C.	N/A	N/A
13.3.3	With reference to 13.3.2 (b), a module or panel provided with a nonmetallic wiring compartment having a threaded opening shall be marked in accordance with 47.8.	N/A	N/A
13.3.4	In a nonmetallic compartment, a socket for the connection of nonmetallic conduit shall provide a positive end stop for the conduit; and 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 Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers, UL 514C.	N/A	N/A
13.3.5	A knockout or opening in a nonmetallic wiring compartment intended to accommodate rigid nonmetallic conduit shall comply with the requirements in the Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers, UL 514C.	N/A	N/A

Section 14 (Corrosion Resistance)

Sec.	Description	Tests	Verdict
14.1	Sheet steel having a thickness of 0.12 in (3.05 mm) or more that may be exposed to the weather shall be made corrosion-resistant by one of the following coatings: a) Hot-dipped mill-galvanized sheet steel conforming with the coating designation G60 or A60 in the Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process, ASTM A653/A653M-01, with not less than 40 percent of the zinc on any side, based on the minimum single spot-test requirement in this ASTM specification. The weight of zinc coating may be determined by any method; however, in case of question, the weight of coating shall be established in accordance with the Standard Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles, ASTM A90-81 (1991).	Document Verification **Data Sheets** Remarks: Not sheet steel, therefore N/A	N/A
14.1	b) A zinc coating, other than that provided on hot-dipped mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00041 in (0.010 mm) on each surface with a minimum thickness of 0.00034 in (0.009 mm). The thickness of the coating shall be established by the Metallic Coating Thickness Test, Section 38. c) An organic or inorganic protective coating system on both surfaces, applied after forming. The results of an evaluation of the coating system shall demonstrate that it provides protection at least equivalent to that provided by the zinc coating described in 14.1(a). See Polymeric Materials, Section 7 and Corrosive Atmosphere Test, Section 37. d) Any one of the means specified in 14.2. 14.1 revised October 1, 2003	Document Verification **Data Sheets** Remarks: Not sheet steel, therefore N/A	N/A
14.2	Sheet steel having a thickness of less than 0.12 in (3.05 mm) which may be exposed to the weather shall be made corrosion-resistant by one of the following coatings: a) Hot-dipped, mill-galvanized sheet steel conforming with the coating designation G90 in the Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process, ASTM A653/A653M-01, with not less than 40 percent of the zinc on any side, based on the minimum single spot-test requirement in this ASTM specification. The weight of zinc coating may be determined by any acceptable method; however, in case of question, the weight of coating shall be established in accordance with the Standard Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles, ASTM A90-81 (1991). b) A zinc coating, other than that provided on hot-dipped mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00061 in (0.015 mm) on each surface with a minimum thickness of 0.00054 in (0.014 mm). The thickness of the coating shall be established by the Metallic-Coating Thickness Test, Section 38. An annealed coating shall also comply with 14.5 and 14.6.	Document Verification **Data Sheets** Remarks: Not sheet steel, therefore N/A	N/A

Sec.	Description	Tests	Verdict
14.2	c) A cadmium coating not less than 0.0010 in (0.025 mm) thick on both surfaces. The thickness of the coating shall be established by the Metallic Coating Thickness Test, Section 38. d) A zinc coating conforming with 14.1(a) or 14.1(b) with one coat of outdoor paint. The coating system shall comply with 14.3. e) A cadmium coating not less than 0.00075 in (0.019 mm) thick on both surfaces with one coat of outdoor paint on both surfaces, or not less that 0.00051 in (0.013 mm) thick on both surfaces with two coats of outdoor paint on both surfaces. The thickness of the cadmium coating shall be established by the Metallic Coating Thickness Test, Section 38, and the coating system shall comply with 14.3. 14.2 revised October 1, 2003		
14.3	With reference to 14.2(d) and 14.2(e), the results of an evaluation of the coating system shall demonstrate that it provides protection at least equivalent to that provided by the zinc coating as described (G90) in 14.2(a). See Polymeric Materials, Section 7 and Corrosive Atmosphere Test, Section 37.	Document Verification **Data Sheets** Remarks: Not sheet steel, therefore N/A	N/A
14.4	With reference to 14.1 and 14.2, other finishes, including paints, other metallic finishes, and combinations of the two may be accepted when comparative tests with galvanized sheet steel (without annealing, wiping, or other surface treatment) conforming with 14.1(a) or 14.2 as applicable, indicate they provide equivalent protection. See Corrosive Atmosphere Test, Section 37.	Document Verification **Data Sheets** Remarks: Not sheet steel, therefore N/A	N/A
14.5	An annealed coating on sheet steel that is bent or similarly formed or extruded or rolled at edge of holes after annealing shall additionally be painted in the bent or formed area if the bending or forming process damages the zinc coating. If flaking or cracking of a zinc coating at the outside radius of a bent or formed section is visible at 25 power magnification, the zinc coating is considered damaged.	**Visual Inspection** Document Verification **Data Sheets** Remarks: Not sheet steel, therefore N/A	N/A
14.7	Iron or steel serving as a necessary part of the product but not exposed to the weather shall be plated, painted, or enameled for protection against corrosion.	Document Verification **Data Sheets**	N/A

Section 15 (Accessibility of Uninsulated Live Parts)

Sec.	Description	Tests	Verdict
15.1	An accessible part of a module or panel shall not involve a risk of electric shock. *Exception: A part that is not energized when it is accessible need not comply with this requirement.*	Lab Test **Accessibility test** Remarks: Successfully completed at TÜVPTL.	P
15.2	In determining whether a part is energized, the module or panel is to be evaluated: a) Not connected, and b) Connected in any implied or described acceptable manner. In both cases, the module or panel is to be in the state described in 15.4 and in the environment described in 20.2.	Lab Test **Accessibility test** Remarks: Successfully completed at TÜVPTL.	P
15.3	For voltages and currents between parts of the individual unconnected product, voltage is to be determined in accordance with 20.2. For voltages and currents between parts of the assembly of products, voltage is to be the maximum system voltage, current is to be the available current.	Lab Test **Accessibility test** Remarks: Successfully completed at TÜVPTL.	P
15.5	The probe illustrated in Figure 15.1 shall be applied to any depth that the opening will permit; and shall be rotated or angled before, during, and after insertion through the opening to any position that is necessary to examine the product. The probe shall be applied in any possible configuration; and, if necessary, the configuration shall be changed after insertion through the opening. The probe is to be used as a measuring instrument to judge the accessibility provided by an opening, and not as an instrument to judge the strength of a material; as such, it is to be applied with the minimum force necessary to accurately determine accessibility.	Lab Test **Accessibility test** Remarks: Successfully completed at TÜVPTL.	P

Section 16 (Fire Resistance)

Sec.	Description	Tests	Verdict
16.1	A module or panel intended for stand-off, rack, or direct mounting in combination with a specified roof, or intended for integral mounting shall comply with the fire resistance requirements for a Class A, B, or C roof covering when the module or panel is indicated or implied as being fire rated. For a combination construction, the rating shall be coincident with, or at a lower level than, the rating of the basic roof covering material. The fire resistance shall be determined in accordance with the Standard for Tests for Fire Resistance of Roof Covering Materials, UL 790, as modified by Fire Tests, Section 31.	Lab Test **Fire test** Remarks: Successfully completed at TÜVPTL.	P

Section 17 (Superstrate)

Sec.	Description	Tests	Verdict
17.1	A module or panel superstrate shall comply with at least one of the following: a) The requirements in the Performance Specifications and Methods of Test for Safety Glazing Material Used in Buildings, ANSI Z97.1-1984; or b) The requirements in the Code of Federal Regulations, Title 16 CPSC Part 1201 – Safety Standard for Architectural Glazing Materials; c) The Impact Test, Section 30 *Exception No. 1: Thin-film flexible glazing material having a thickness of 0.01 in (0.254 mm) or less need not comply with this requirement.* *Exception No. 2: Encapsulant that is protected with wire screen or other similar means having openings that will not pass a 1/2-in (12.7-mm) diameter hemispherically tipped probe applied with a force of 1 lb (4.4 N).*	Lab Test **Impact test** Remarks: Successfully completed at TÜVPTL.	P

Section 47 (Marking - Details)

Sec.	Description	Tests	Verdict
47.1	A module or panel shall have a plain, legible, permanent marking that includes: a) The manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product can be identified; b) The model number or the equivalent; c) The electrical ratings – see 46.1; and d) The date or other dating period of manufacture not exceeding any three consecutive months. *Exception No. 1: The manufacturer's identification may be in a traceable code if the product is identified by the brand or trademark owned by a private labeler.* *Exception No. 2: The date of manufacture may be abbreviated; or may be in a nationally accepted conventional code or in a code affirmed by the manufacturer, provided that the code:* *i. Does not repeat in less than 10 years; and* ii. *Does not require reference to the production records of the manufacturer to determine when the product was manufactured.*	**Visual Inspection**	P
47.2	A permanent marking shall be molded, die-stamped, paint-stenciled, stamped, or etched metal that is permanently secured, or indelibly stamped on a pressure-sensitive label secured by adhesive that complies with the Standard for Marking and Labeling Systems, UL 969. Ordinary usage, handling, storage, and the like of the unit shall be considered in determining whether a marking is permanent.	**Visual Inspection**	P
47.3	If a module or panel is manufactured at more than one factory, it shall have a marking indicating its place of manufacture.	**Visual Inspection**	N/A
47.4	The output power wiring terminals, leads, connector, or other connection means of a module or panel shall be identified with one of the following marking statements: ″+″ and ″−″ or ″POS″ and ″NEG″ or ″POSITIVE″ and ″NEGATIVE″	**Visual Inspection**	P

Sec.	Description	Tests	Verdict
47.5	Modules having field-accessible wiring compartments or junction boxes intended for use with field-installed wiring shall comply with the following and 47.6, 47.7, and 47.8. During the temperature test, if the temperature on a field-installed lead or on any part of the wiring compartment that the lead might contact is more than 60°C (140°F), the module or panel shall be marked with the following statement or the equivalent. The marking shall be located at or near the points where field connections will be made, and located so that it will be readily visible during installation. "For field connections, use ___ AWG wires insulated for a minimum of 90°C, rated for wet conditions and resistance to ultra violet radiation (where exposed)".	Lab Test **Temperature test** Remarks: Max. field wire temperature = 68.34 [°C].	P
47.6	If the pressure wire connectors of a module or panel are not acceptable for use with aluminum wire, or if the module or panel manufacturer intends the use of only copper wire, the module or panel shall be marked, at or adjacent to the terminals, with the statement ″Use copper wire only,″ ″CU only,″ or the equivalent. This marking may be combined with the marking required by 47.5.	**Visual inspection**	P
47.7	If the pressure wire connectors of a module or panel are acceptable for accommodating both copper and aluminum wire and if the manufacturer intends such use, the module or panel shall be marked (independent of any marking of the terminal) with the statement ″Use aluminum or copper wire,″ ″AL-CU,″ or the equivalent. This marking may be combined with the marking required by 47.5.	**Visual inspection**	N/A
47.8	In accordance with 13.3.3, a module or panel employing a nonmetallic wiring compartment having a threaded or unthreaded opening shall be marked ″For use with nonmetallic wiring systems only″ or the equivalent.	**Visual inspection**	N/A

Sec.	Description	Tests	Verdict
47.9	A module or panel having accessible bypass diodes that are intended for field servicing shall be marked: a) To indicate the minimum acceptable diode ratings and to indicate the configuration for bypassing, or b) To make reference to a manufacturer's literature where information on diode bypassing can be found. The module or panel manufacturer shall supply this literature with the module or panel. c) Instructions in the module instruction manual describing the diode replacement procedures. *Exception No. 1: Marking or literature is not required when the system DC voltage rating is equal to the limit voltage (V_L) used for the Hot-Spot Endurance Test and the Arcing Test. See 39.2.2 and 40.1.1, respectively.* *Exception No. 2: A module or panel supplied with a bypass diode is not required to be marked when the type, voltage rating, current rating, and configuration of the diode are identified in the installation instructions.*	**Visual inspection**	P
47.10	A module or panel shall be marked relative to the maximum electrical rating of an acceptable overcurrent protective device (for protection against back feed). The statement on the module or panel shall include the following: "Maximum series overcurrent protective device, where require."	**Visual inspection**	P
47.10.1	The ampere rating of the maximum series overcurrent device shall be not less than 1.56 times the rated short-circuit current of the module and the rating shall be rounded up to the next higher available overcurrent device rating. The available ratings are 1-10 amps in one-amp increments, 1.5, 2.5, 3.5, 12 amps, 15 amps, and 20 amps. The rounded up rating of the series overcurrent protective device shall be used in the reverse current tests of 28.1.		
47.11	A module or panel shall be marked relative to its fire resistance rating as a roof covering. A module or panel shall be marked ″Not Fire Rated″ unless it complies with the requirements for fire rating. If a module or panel is fire rated and if its use is so intended by the manufacturer, it shall be marked accordingly, for example, ″Modules mounted freestanding 6 in above a Class B roof constitute a Class C roof.″	**Visual inspection**	P
47.12	A module provided as a part of a panel shall be provided with all of the markings that would be required for its existence as a separate entity.	**Visual inspection**	N/A

Sec.	Description	Tests	Verdict
47.13	A module or panel intended for structural loads greater than 30 lb/ft shall be marked with the intended load in lb/ft^2.	**Visual inspection**.	N/A

Section 48 (Marking - Details)

Sec.	Description	Tests	Verdict
48.1	A module or panel shall be supplied with installation instructions describing the methods of electrical and mechanical installation. The instructions shall include the following in addition to any other information required by this standard: a) The electrical ratings in Table 46.1, b) The following statements: 1. "The fire rating of this module is valid only when mounted in the manner specified in the mechanical mounting instructions." 2. "The module is considered to be in compliance with UL 1703 only when the module is mounted in the manner specified by the mounting instructions below." 3. "A module with exposed conductive parts is considered to be in compliance with UL 1703 only when it is electrically grounded in accordance with the instructions presented below and the requirements of the National electrical Code." 4. "Any module without a frame (laminate) shall not be considered to comply with the requirements of UL 1703 unless the module is mounted with hardware that has been tested and evaluated with the module under this standard or by a field Inspection certifying that the installed module complies with the requirements of UL 1703", and c) A list containing the date of the first edition of these instructions and the dates of any and all subsequent revisions, amendments, and tech notes related to these instructions.	Document Verification **Installation manual**	P

Sec.	Description	Tests	Verdict
48.1.1	The electrical installation instructions shall include a detailed description of the wiring method to be used in accordance with the National Electrical Code. This description shall include: a) The grounding method to be used, and where a specific grounding device is supplied or suggested, the following statements: 1. "Where common grounding hardware (nuts, bolts, star washers, spilt-ring lock washers, flat washers and the like) is used to attach a listed grounding/bonding device, the attachment must be made in conformance with the grounding device manufacturer's instructions" 2. PV modules manufacturers recommending such a method must either 1.) thoroughly detail the attachment means in the module installation instructions or 2.) refer the installer to readily available manufacturer's instructions for the grounding/bonding device. 3. "Common hardware items such as nuts, bolts, star washers, lock washers and the like have not been evaluated for electrical conductivity or for use as a grounding devices and should be used only for maintaining mechanical connections and holding electrical grounding devices in the proper position for electrical conductivity. Such devices, where supplied with the module and evaluated through the requirement in UL 1703, may be used for grounding connections in accordance with the instructions provided with the module." b) For modules with a wiring compartment intended for use with field-installed wiring: 1. The size, type, and temperature rating of the conductors to be used, 2. The maximum rating of any overcurrent protection, if required, 3. The minimum and maximum cable diameters when the wiring method is cable, and 4. Any limitations on wiring methods that apply to the wiring compartment or box.	Document Verification **Installation manual**	P
48.1.2	The mechanical installation instructions for roof mounting shall include: a. A statement indicating the minimum mechanical means to be used for securement of the module or panel to the roof, b) For a non-integral module or panel (See Figure 41.1), a statement that the assembly is to be mounted over a fire resistant roof covering rated for the application, and c) Indication of any slope less than 5 in/ft (127 mm/305 mm) required to maintain a fire class rating.	Document Verification **Installation manual**	P
48.2	The electrical ratings mentioned in 48.1 shall include information indicated in 48.1 and the following statement or the equivalent: "The electrical characteristics are within ±10 percent of the indicated values of I_{SC}, V_{OC}, and P_{max} under standard test conditions (irradiance of 100 mW/cm^2, AM 1.5 spectrum, and a cell temperature of 25°C (77°F))." *Exception: The tolerance may be either smaller than ±10 percent or omitted, provided the values measured during the production line tests– see 44.1– are:* *i. Within a tolerance indicated in the instructions when a smaller tolerance is indicated, or* ii. *The same as the values indicated in the instructions when the tolerance is omitted.*	Document Verification **Installation manual**	P

Sec.	Description	Tests	Verdict
48.3	Installation instructions shall include a statement advising that artificially concentrated sunlight shall not be directed on the module or panel.	Document Verification **Installation manual**	P
48.4	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.	Document Verification **Installation manual**	N/A
48.5	To allow for increased output of a module or panel resulting for certain conditions of use, the installation instructions for a module or panel shall include the following statement or the equivalent: “Under normal conditions, a photovoltaic module is likely to experience conditions that produce more current and/or voltage than reported at the standard test conditions. The requirements of the National Electrical Code (NEC) in Article 690 shall be followed to address these increased outputs. In installations not under the requirements of the NEC, 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 ampacities, overcurrent device ratings, and size of controls connected to the PV output.” For a module or panel containing other than crystalline-silicon cells, the multiplying factor at conditions of an irradiance of 125 mW/cm^2, AM 1.5 spectrum, and a cell temperature of minus 10°C (plus 14°F) for Voc and plus 75°C (167°F) for Isc is to be determined and this factor is to be indicated in the instructions.	Document Verification **Installation manual**	P
48.7	The contents of the instruction manual and subsequent revisions to the instruction manual shall be verified for compliance with this standard by inspection.		

TEST DATA:

Section 18A (Light Soak Stabilization) thin-film module per IEC 61646:2008

Test Results						
Start Date / End Date (DD/MM/YYYY)			N/A		N/A	
Sample ID			N/A			
Light Source			N/A			
Irradiation Applied (kWh/m^2)			N/A			
Test cycle	Avg. Irradiance (W/m^2)	Min. Tmodule (°C)	Min. Tmodule (°C)	Avg. Tmodule (°C)	Pmp* (W)	ΔPmp* (W)
1	N/A	N/A	N/A	N/A	N/A	N/A
2	N/A	N/A	N/A	N/A	N/A	N/A
3	N/A	N/A	N/A	N/A	N/A	N/A
Test Results						
Start Date / End Date (DD/MM/YYYY)			N/A		N/A	
Sample ID			N/A			
Light Source			N/A			
Irradiation Applied (kWh/m^2)			N/A			
Test cycle	Avg. Irradiance (W/m^2)	Min. Tmodule (°C)	Min. Tmodule (°C)	Avg. Tmodule (°C)	Pmp* (W)	ΔPmp* (W)
1	N/A	N/A	N/A	N/A	N/A	N/A
2	N/A	N/A	N/A	N/A	N/A	N/A
3	N/A	N/A	N/A	N/A	N/A	N/A
Test Results						
Start Date / End Date (DD/MM/YYYY)			N/A		N/A	
Sample ID			N/A			
Light Source			N/A			
Irradiation Applied (kWh/m^2)			N/A			
Test cycle	Avg. Irradiance (W/m^2)	Min. Tmodule (°C)	Min. Tmodule (°C)	Avg. Tmodule (°C)	Pmp* (W)	ΔPmp* (W)
1	N/A	N/A	N/A	N/A	N/A	N/A
2	N/A	N/A	N/A	N/A	N/A	N/A
3	N/A	N/A	N/A	N/A	N/A	N/A
Supplementary information: not applicable for poly Crystalline modules.						

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Section 19 (Temperature Test)

Sample ID	TRM2192
Reference solar irradiance (W/m²)	1000
Reference ambient temperature (°C)	40
Module Open-Circuited	Date: (DD/MM/YYYY) 02/01/2015

Measuring Location	Component Temp., T_{obs} (°C)	Normalised Temp., T_{con} (°C)	Component Temp. Limit (°C)	Verdict
Front glass above center cell	10.7	39.94	N/A	N/A
Back sheet behind center cell	42.7	72.01	105	P
J-box inside surface	32.9	62.17	90	P
Ambient air within J-box	32.3	61.59	90	P
Positive terminal	10.2	39.46	90	P
Field wiring	30.9	60.18	90	P
Diode 1	35.4	64.65	200	P
Diode 2	34.6	63.82	200	P
Diode 3	36.5	65.81	200	P

Module Short-Circuited	Date: (DD/MM/YYYY) 02/01/2015

Measuring Location	Component Temp., T_{obs} (°C)	Normalised Temp., T_{con} (°C)	Component Temp. Limit (°C)	Verdict
Front glass above center cell	13.9	45.55	N/A	N/A
Back sheet behind center cell	46.9	78.55	105	P
J-box inside surface	37.1	68.68	90	P
Ambient air within J-box	36.6	68.27	90	P
Positive terminal	18.2	49.87	90	P
Field wiring	34.9	66.57	90	P
Diode 1	40.5	72.17	200	P
Diode 2	39.0	70.63	200	P
Diode 3	42.0	73.59	200	P

Center Cell Shaded 50 % and Module Short-Circuited	Date: (DD/MM/YYYY) 02/01/2015

Measuring Location	Component Temp., T_{obs} (°C)	Normalised Temp., T_{con} (°C)	Component Temp. Limit (°C)	Verdict
Front glass above center cell	11.2	41.29	N/A	N/A
Back sheet behind center cell	53.5	83.54	105	P
J-box inside surface	45.0	75.08	90	P
Ambient air within J-box	39.4	69.45	90	P
Positive terminal	10.7	40.71	90	P
Field wiring	38.3	68.34	90	P
Diode 1	47.9	77.93	200	P
Diode 2	52.7	82.78	200	P
Diode 3	50.1	80.15	200	P
Supplementary information: $T_{con} = T_{obs} + (40°C - T_{AMB})$. Temperature limits are given in table 19.1 of UL 1703.				

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Section 19 (Temperature Test)

Sample ID	TRM3252*
Reference solar irradiance (W/m²)	1000
Reference ambient temperature (°C)	40
Module Open-Circuited	Date: (DD/MM/YYYY) 06/02/2015

Measuring Location	Component Temp., T_{obs} (°C)	Normalised Temp., T_{con} (°C)	Component Temp. Limit (°C)	Verdict
Front glass above center cell	73.8	78.3	N/A	N/A
Back sheet behind center cell	75	79.5	105	P
J-box inside surface	68.8	73.4	90	P
Ambient air within J-box	69.4	74	90	P
Positive terminal	66.9	71.4	90	P
Field wiring	62	66.5	90	P
Diode 1	71.8	76.3	200	P
Diode 2	70.4	74.9	200	P
Diode 3	71.6	76.2	200	P

Module Short-Circuited	Date: (DD/MM/YYYY) 05/02/2015

Measuring Location	Component Temp., T_{obs} (°C)	Normalised Temp., T_{con} (°C)	Component Temp. Limit (°C)	Verdict
Front glass above center cell	77.5	85.2	N/A	N/A
Back sheet behind center cell	78.2	85.9	105	P
J-box inside surface	67.9	75.6	90	P
Ambient air within J-box	70.3	77.9	90	P
Positive terminal	69.6	77.3	90	P
Field wiring	64.2	71.9	90	P
Diode 1	71.3	79	200	P
Diode 2	71.6	79.3	200	P
Diode 3	73.1	80.8	200	P

Center Cell Shaded 50 % and Module Short-Circuited	Date: (DD/MM/YYYY) 06/02/2015

Measuring Location	Component Temp., T_{obs} (°C)	Normalised Temp., T_{con} (°C)	Component Temp. Limit (°C)	Verdict
Front glass above center cell	116.3	118.4	N/A	N/A
Back sheet behind center cell	77.4	79.4	105	P
J-box inside surface	71	73.1	90	P
Ambient air within J-box	72.9	75	90	P
Positive terminal	69.5	71.6	90	P
Field wiring	63.3	65.4	90	P
Diode 1	87.3	89.4	200	P
Diode 2	78.8	80.9	200	P
Diode 3	79.4	81.5	200	P

Supplementary information: $T_{con} = T_{obs} + (40°C – T_{AMB})$. Temperature limits are given in table 19.1 of UL 1703.
* samples for qualification by similarity, cell change.

Section 20 (Voltage and Current Measurement), Unconditioned Sample

Date (DD/MM/YYYY)			10/12/2014			
Sample ID			TRM6416			
Test Results of Maximum Power Determination						
	I_{sc} (A)	V_{oc} (V)	I_{mp} (A)	V_{mp} (V)	FF (%)	P_m (W)
Rated at STC	8.75	37.8	8.17	30.6	75.6	250
Measured at STC	8.95	37.92	8.38	30.74	75.94	257.58
Δ(rated-measured)$_{STC}$	2.25%	0.31%	2.56%	0.47%	0.47%	3.03%
Rated at NOCT	N/A	N/A	N/A	N/A	N/A	N/A
Determined at NOCT*	7.22	35.22	6.67	27.91	73.17	186.21
Δ(rated-determined)$_{NOCT}$	N/A	N/A	N/A	N/A	N/A	N/A
Determined at -20°C	-	43.69	-	-	-	-
Temperature Coefficients	I_{sc} (A/°C)	V_{oc} (V/°C)	I_{max} (A/°C)	V_{max} (V/°C)	FF (%/°C)	P_{max} (W/°C)
	0.00401	-0.12826	-	-	-	-1.18171
Supplementary information: * NOCT = 46.0°C This NOCT value was an estimate.						

Section 20 (Voltage and Current Measurement), Unconditioned Sample

Date (DD/MM/YYYY)			10/12/2014			
Sample ID			TRM6416*			
Test Results of Maximum Power Determination						
	I_{sc} (A)	V_{oc} (V)	I_{mp} (A)	V_{mp} (V)	FF (%)	P_m (W)
Rated at STC	8.75	37.8	8.17	30.6	75.6	250
Measured at STC	8.87	37.69	8.24	30.06	74.12	247.67
Δ(rated-measured)$_{STC}$	1.35%	-0.29%	0.85%	-1.76%	-1.94%	-0.93%
Rated at NOCT	N/A	N/A	N/A	N/A	N/A	N/A
Determined at NOCT*	7.18	35.03	6.59	27.20	71.22	179.14
Δ(rated-determined)$_{NOCT}$	N/A	N/A	N/A	N/A	N/A	N/A
Determined at -20°C	-	43.40	-	-	-	-
Temperature Coefficients	I_{sc} (A/°C)	V_{oc} (V/°C)	I_{max} (A/°C)	V_{max} (V/°C)	FF (%/°C)	P_{max} (W/°C)
	0.00513	-0.12687	-	-	-	-1.13083
Supplementary information: * samples for qualification by similarity, cell change.						

* NOCT = 46.0°C This NOCT value was an estimate.

Section 21 (Leakage Current)

Maximum Allowable (µA)			10								
Applied Voltage (V)			600								
Sample ID	Test Date (DD/MM/YYYY)	Measured Condition	Leakage Current, µA								Verdict
			Polarity 1				Polarity 2				
			frame	top	back	jbox	frame	top	back	jbox	
Test Results, Tmodule = 50 +/- 3°C											
TRM6416	13/01/2015	Uncond.	0.5	0.7	0.1	0.1	0.5	0.7	0.1	0.1	P
TRM2267	13/01/2015	Uncond.	0.2	0.3	0.1	0.1	0.2	0.4	0.1	0.1	P
TRM7125	13/01/2015	Uncond.	0.2	0.5	0.1	0.1	0.2	0.4	0.1	0.1	P
Test Results, Tmodule = 25 +/- 3°C											
TRM6416	13/01/2015	Uncond.	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	P
TRM2267	13/01/2015	Uncond.	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	P
TRM7125	13/01/2015	Uncond.	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	P
TRM7124	22/12/2014	Post TC200	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	P
TRM6453	22/12/2014	Post TC200	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	P
TRM2188	22/12/2014	Post TC200	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	P
TRM6474	12/12/2014	Post HF10	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	P
TRM6386	12/12/2014	Post HF10	0.1	0.5	0.1	0.1	0.1	0.5	0.1	0.1	P
TRM3147	12/12/2014	Post HF10	0.1	0.4	0.1	0.1	0.1	0.4	0.1	0.1	P
TRM2192	22/01/2015	Post Push	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	P
TRM5357	13/01/2015	Post Water Spray	0.9	1.4	0.1	0.3	1.4	1.4	0.1	0.5	P
Supplementary information: None.											

Section 22 (Strain Relief)

Date (DD/MM/YYYY)	30/01/2015	
Sample ID	TRM5357	
Applied Force (N)	89	
Test Duration (min)	1	
Angle of Pull (°)	0°, 90°, -90°	
Test Results		
Damage to lead / cable / mating connectors?	☐ Yes	☒ No
Damage to lead/ cable / connecting means?	☐ Yes	☒ No
Damage to the test sample?	☐ Yes	☒ No
Separation of the mating connectors?	☐ Yes	☒ No
Verdict……:	☒ Pass	☐ Fail
Supplementary information: None.		

Section 23 (Push Test)

Date (DD/MM/YYYY)	16/01/2015							
Sample ID	TRM2192							
Applied Force (N)	89, 17.8							
Test Duration (min)	1							
Test Results								
Surface	Risk of Fire? (arcing likely)		Risk of Electric Shock?		Risk of Injury?		Sect. 21 Requirements Fulfilled?	
Superstrate Center	☐ Yes	☒ No	☐ Yes	☒ No	☐ Yes	☒ No	☒ Yes	☐ No
End	☐ Yes	☒ No	☐ Yes	☒ No	☐ Yes	☒ No	☒ Yes	☐ No
Side	☐ Yes	☒ No	☐ Yes	☒ No	☐ Yes	☒ No	☒ Yes	☐ No
Verdict……:	☒ Pass		☐ Fail					
Supplementary information: None.								

Section 24 (Cut Test)

Sample ID			TRM3147, TRM7124, TRM2170
Applied Force (lbs)			2.0 (907 N)
Velocity (in/s)			4.8-7.2 (121.9-182.9 mm/s)
Date (DD/MM/YYYY)	Surface	Test Results	Verdict
17/12/2014	Substrate*	☒ No visual evidence that the superstrate / substrate was cut	P
		☒ No exposure of active circuitry of the module	
		☒ No risk of electric shock	
15/01/2015	Substrate*	☒ No visual evidence that the superstrate / substrate was cut	P
		☒ No exposure of active circuitry of the module	
		☒ No risk of electric shock	
27/01/2015	Substrate*	☒ No visual evidence that the superstrate / substrate was cut	P
		☒ No exposure of active circuitry of the module	
		☒ No risk of electric shock	
Supplementary information: *Only one cut is required for UL1703.			

Section 25 (Bonding Path Resistance Test)

Maximum series fuse rating (A)			15			
Maximum permissible R (mΩ)			100			
Path 1:Left-side frame to right-side frame ground points						
Sample ID	Date (DD/MM/YYYY)	Testing Stage	Current (A)	Voltage Drop (mV)	Resistance (mΩ)	Verdict
TRM6416	13/01/2015	Initial	30	25.4	0.846	P
TRM2267	13/01/2015	Initial	30	27.8	0.926	P
TRM7125	13/01/2015	Initial	30	21.3	0.71	P
Supplementary information: None.						

Section 26 (Dielectric Voltage Withstand Test)

Applied Voltage (V)			2200		
Minimum requirement of leakage current (μA)			≤ 50 μA		
Sample ID	Date (DD/MM/YYYY)	Tested Condition	Leakage Current (μA)		Verdict
			Polarity 1	Polarity 2	
Test Results, Tmodule = 78 +/- 3°C					
TRM6416	13/01/2015	Uncond.	0.9	0.8	P
TRM2267	13/01/2015	Uncond.	1.3	1.0	P
TRM7125	13/01/2015	Uncond.	0.9	0.7	P
Test Results, Tmodule = 50 +/- 3°C					
TRM7124	22/12/2014	Post TC200	0.9	0.7	P
TRM6453	22/12/2014	Post TC200	0.7	0.5	P
TRM2188	22/12/2014	Post TC200	0.3	0.3	P
Test Results, Tmodule = 25 +/- 3°C					
TRM6416	13/01/2015	Uncond.	0.2	0.2	P
TRM2267	13/01/2015	Uncond.	0.1	0.1	P
TRM7125	13/01/2015	Uncond.	0.1	0.1	P
TRM7124	22/12/2014	Post TC200	0.1	0.1	P
TRM6453	22/12/2014	Post TC200	0.1	0.1	P
TRM2188	22/12/2014	Post TC200	0.1	0.1	P
TRM6474	12/12/2014	Post HF10	0.1	0.2	P
TRM6386	12/12/2014	Post HF10	0.2	0.2	P
TRM3147	12/12/2014	Post HF10	5.7	17.2	P
TRM5357	13/01/2015	Post Water Spray	7.8	4.6	P
Supplementary information: None.					

Section 27 (Wet Insulation-Resistance Test)

Applied Voltage (VDC)	500
Module Area (m^2)	1.65
Minimum Requirement ($M\Omega m^2$)	50
Solution Surface Tension (N/m)	≤0.03
Solution Resistivity (Ωcm)	≤3500
Solution Temperature (°C)	22±3

Sample ID	Date (DD/MM/YYYY)	Tested Condition	Polarity 1		Polarity 2		Verdict
			Leakage Current (μA)	Insulation Resistance (MΩ)	Leakage Current (μA)	Insulation Resistance (MΩ)	
TRM6416	13/01/2015	Uncond	4.7	106.4	4.7	106.4	P
TRM2267	13/01/2015	Uncond	4.6	108.7	4.6	108.7	P
TRM7125	13/01/2015	Uncond	4.6	108.7	4.6	108.7	P
TRM7124	22/12/2014	Post TC200	4.5	111.1	4.6	108.7	P
TRM6453	22/12/2014	Post TC200	4.6	108.7	4.7	106.4	P
TRM2188	22/12/2014	Post TC200	4.6	108.7	4.6	108.7	P
TRM6474	12/12/2014	Post HF10	7.9	63	7.8	64	P
TRM6386	12/12/2014	Post HF10	6.9	72	6.5	77	P
TRM3147	12/12/2014	Post HF10	6.9	72	6.5	77	P
TRM6474	16/12/2014	Post Wiring Compartment	13.8	36.2	13.5	37.0	P
TRM6386	16/12/2014	Post Wiring Compartment	11.6	43.1	11.4	43.9	P
TRM3147	16/12/2014	Post Wiring Compartment	12.6	39.7	13.5	37.0	P
TRM7124	13/01/2015	Post Wiring Compartment	4.4	113.6	4.4	113.6	P
TRM6453	13/01/2015	Post Wiring Compartment	4.4	113.6	4.3	116.3	P
TRM2188	13/01/2015	Post Wiring Compartment	4.1	121.9	4.1	121.9	P
Supplementary information: None.							

Section 28 (Reverse Current Overload Test)

Test Date (DD/MM/YYYY)	14/01/2015, 20/01/2015	
Sample ID	TRM5357, TRM4507*	
Rated Isc (A)	8.86	
Overcurrent Device Rating and Test Current (A)	15, 20.25	
Test duration (hr)	2	
Test results		
Flaming of the module for 15 seconds or more?	☐ Yes	☒ No
Flaming and/or charring of the cheesecloth/tissue paper?	☐ Yes	☒ No
Verdict……:	☒ Pass	☐ Fail

Supplementary information:

UL 1703, §47.10.1: The ampere rating of the maximum series overcurrent device shall be not less than 1.56 times the rated short-circuit current of the module and the rating shall be round up to the next higher available overcurrent device rating. The available ratings are 1-10 amps in one-amp increments, 1.5, 2.5, 3.5, 12 amps, 15 amps, and 20 amps. The rounded up rating of the series overcurrent protective device shall be used in the reverse current tests of UL 1703 §28.1.

Updated May 14th 2012

* samples for qualification by similarity, cell change.

Section 29 (Terminal Torque test)

Date (DD/MM/YYYY)	N/A	
Sample ID	N/A	
Torque (Nm)	N/A	
Screw Size (AWG)	N/A	
Test results		
Damage to the terminal supporting member?	☐ Yes	☐ No
Loss of continuity?	☐ Yes	☐ No
Short-circuiting of electrical circuit to accessible metal?	☐ Yes	☐ No
Verdict……:	☐ Pass	☐ Fail

Supplementary information: There are no screws inside the junction box, therefore this test is not applicable.

Section 30 (Impact Test)

Date (DD/MM/YYYY)	27/01/2015	
Weight of Impactor (g)	535	
Distance of Impactor from module/panel (m)	1.295	
Location of Impact	Near the center of the superstrate	
Surface	Superstrate	
Test results for Tmodule = 25°C		
Sample ID	TRM2192	
Superstrate cracked?	☐ Yes	☒ No
Superstrate cracked, particles < 1 in^2 were released?	☐ Yes	☐ No
Weight of particles (g)		
Live parts accessible?	☐ Yes	☒ No
Verdict……:	☒ Pass	☐ Fail
Test results for Tmodule = 25°C		
Sample ID	TRM2192	
Junction box cracked?	☐ Yes	☒ No
Live parts accessible?	☐ Yes	☒ No
Verdict……:	☒ Pass	☐ Fail
Test results for Tmodule = -35°C		
Sample ID	TRM2192	
Junction box cracked?	☐ Yes	☒ No
Live parts accessible?	☐ Yes	☒ No
Verdict……:	☒ Pass	☐ Fail
Supplementary information: Only for polymeric wiring enclosures is the test to be repeated at -35°C.		

Section 31 (Fire Test)

Spread of Flame		
Date (DD/MM/YYYY)	16/01/2015	
Sample ID	TRM3147, TRM6474	
Fire Resistance Class	Type 2	
Test Results		
Any portion of the module be blown off or fall off the test deck in the form of flaming/glowing brands?	☐ Yes	☒ No
Did any portions of the roof desk fall away in the form of glowing particles?	☐ Yes	☒ No
Was the flame spread beyond 6ft for Class A, 8ft for Class B, or 13ft for Class C?	☐ Yes	☒ No
Was there a significant lateral spread-of-flame from the path directly exposed to the test flame?	☐ Yes	☒ No
Verdict……:	☒ Pass	☐ Fail
Supplementary information: None.		

Burning-Brand		
Date (DD/MM/YYYY)	16/01/2015	
Sample ID	TRM3147	
Fire resistance class	Type 2	
Test Results		
Any portion of the module be blown off or fall off the test deck in the form of flaming/glowing brands?	☐ Yes	☒ No
Did the brand burn a hole through the roof covering or through any part of the module?	☐ Yes	☒ No
Did any portions of the roof desk fall away in the form of glowing particles?	☐ Yes	☒ No
Sustained flaming of the module?	☐ Yes	☒ No
Verdict……:	☒ Pass	☐ Fail
Supplementary information: None.		

Section 33 (Water Spray Test)

Test Date (DD/MM/YYYY)	13/01/2015	
Sample ID	TRM5357	
Mounting Angle (°)	45	
Test Pressure (kPa)	34.5 (5 psi)	
Start Time / End Time	2:48	3:48
Test Results		
Water on uninsulated live parts?	☐ Yes	☒ No
Section 21 requirements fulfilled?	☒ Yes	☐ No
Section 26 requirements fulfilled?	☒ Yes	☐ No
Verdict……:	☒ Pass	☐ Fail

Supplementary information:

UL 1703 §33.8: After exposure, the module or panel is to be examined for evidence of water penetration to and above uninsulated live parts and for evidence of the collection of water in any compartment containing live parts. If drain holes are provided, consideration is to be given to their preventing the water level from reaching uninsulated live parts.

Updated May 14th 2012

Section 34 (Accelerated Aging Test)

Tensile Strength

Sample ID	Test Date (DD/MM/YYYY)	Sample Thickness (mm)	Cross-Sectional Area (m^2)	Force Magnitude at Rupture (MPa)	Tensile Strength (Mpa/m^2)	Verdict
N/A	N/A	N/A	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A

Supplementary information:

Not performed. This test applies to the gasket material used in the junction box. The junction box was dully evaluated as an individual component and is UL Listed under File E337337.

Durometer Hardness

Sample ID	Unconditioned		Conditioned		Change in Durometer (mm)	Verdict
	Test Date (DD/MM/YYYY)	Durometer (mm)	Test Date (DD/MM/YYYY)	Durometer (mm)		
N/A	N/A	N/A	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A

Supplementary information:

Not performed. This test applies to the gasket material used in the junction box. The junction box was dully evaluated as an individual component and is UL Listed under File E337337.

Section 35 (Thermal Cycling 200 Test)

Start Date / End Date	18/11/2014	22/12/2014
Sample ID(s)	TRM2188, TRM7124, TRM6453	
Total Cycles	200	
Test Results		
Open circuits?	☐ Yes	☒ No
Dielectric breakdown to ground?	☐ Yes	☒ No
Verdict……:	☒ Pass	☐ Fail
Supplementary information: None.		

Section 36 (Humidity Freeze 10 Test)

Start Date / End Date	02/12/2014	12/12/2014
Sample ID(s)	TRM3147, TRM6386, TRM6474	
Total Cycles	10	
Test Results		
Open circuits?	☐ Yes	☒ No
Dielectric breakdown to ground?	☐ Yes	☒ No
Verdict……:	☒ Pass	☐ Fail
Supplementary information: None.		

Section 37 (Corrosive Atmosphere Test)

Salt Spray Test

Date (DD/MM/YYYY)	N/A
Solution Salinity (%)	N/A
Solution Temperature (°C)	N/A
Solution pH	N/A
Reference Sample	N/A

Test Results			
Sample ID	Soak Time (hh:mm)	Comparison to Reference Sample	Verdict
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A

Supplementary information:

Not performed. The only metallic structure – the frame – is anodized aluminum. UL 1703-37.1/37.2 states:

"A module constructed of materials such as plastic, stainless steel, or aluminum that are inherently resistant to atmospheric corrosion need not be tested."

Moist Carbon Dioxide/Sulphur Dioxide Test

Date (DD/MM/YYYY)	N/A
Solution Salinity (%)	N/A
Solution Temperature (°C)	N/A
Solution pH	N/A
Reference Sample	N/A

Test Results			
Sample ID	Soak Time (hh:mm)	Comparison to Reference Sample	Verdict
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A

Supplementary information:

Not performed. The only metallic structure – the frame – is anodized aluminum. UL 1703-37.1/37.2 states:

"A module constructed of materials such as plastic, stainless steel, or aluminum that are inherently resistant to atmospheric corrosion need not be tested."

Section 38 (Metallic Coating Thickness Test)

Date (DD/MM/YYYY)		N/A	
Ambient Temperature (°C)		N/A	
Solution Temperature (°C)		N/A	
Coating Type		N/A	
Thickness Factor (mm/s)		N/A	
Test Results			
Sample ID	Position	Test Duration (second)	Thickness of Metallic Coating (mm)
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
Calculated Avg. Thickness of Metallic Coating (mm)		N/A	
Calculated Min. Thickness of Metallic Coating (mm)		N/A	
Verdict……:		☐ Pass	☐ Fail
Supplementary information: Not performed. The only metallic structure – the frame – is anodized aluminum. This method is used for determining the thickness of a zinc or cadmium coating of sheet steel.			

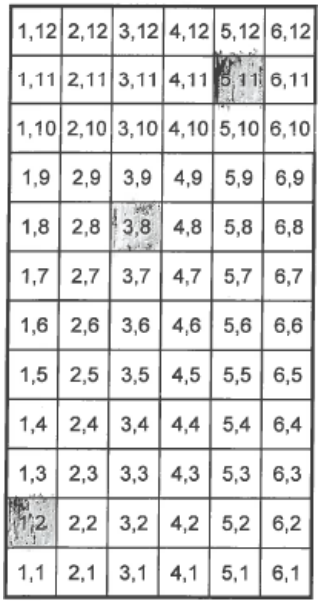
Section 39 (Hot-Spot Endurance Test), crystalline silicon module

Date (DD/MM/YYYY)	30/01/2015 to 08/02/2015		
Sample ID	TRM6403		
Cell Interconnection Circuit	☒ S	☐ SP	☐ SPS
Cell Selection Method	☒ Intrusive	☐ Non-Intrusive	
Hours (Intrusive method only)	100		
Number of series cells per bypass diode	20		
V_{mp} (V)	0.515		
V_L (V)	9.19		
I_L (A)	8.45		
Test Results			
Melted solder?	☐ Yes	☒ No	
Openings in the enclosure?	☐ Yes	☒ No	
Delamination?	☐ Yes	☒ No	
Burn spots on substrate?	☐ Yes	☒ No	
Verdict……:	☒ Pass	☐ Fail	

Supplementary information:

The test module must be subjected to the Dielectric Voltage Withstand and Wet Insulation Resistance tests following the Hotspot test.

Diagram or photo showing the selected cells



Section 39 (Hot-Spot Endurance Test), crystalline silicon module

Date (DD/MM/YYYY)	09/02/2015 to 15/02/2015		
Sample ID	TRM6062*		
Cell Interconnection Circuit	☒ S	☐ SP	☐ SPS
Cell Selection Method	☐ Intrusive	☒ Non-Intrusive	
Hours (Intrusive method only)	100		
Number of series cells per bypass diode	20		
V_{mp} (V)	0.510		
V_L (V)	9.1		
I_L (A)	8.35		
Test Results			
Melted solder?	☐ Yes	☒ No	
Openings in the enclosure?	☐ Yes	☒ No	
Delamination?	☐ Yes	☒ No	
Burn spots on substrate?	☐ Yes	☒ No	
Verdict……:	☒ Pass	☐ Fail	

Supplementary information:

* samples for qualification by similarity, cell change.

The test module must be subjected to the Dielectric Voltage Withstand and Wet Insulation Resistance tests following the Hotspot test.

Diagram or photo showing the selected cells

1,12	2,12	3,12	4,12	5,12	6,12	7,12	8,12	9,12	10,12	11,12	12,12
1,11	2,11	3,11	4,11	5,11	6,11	7,11	8,11	9,11	10,11	11,11	12,11
1,10	2,10	3,10	4,10	5,10	6,10	7,10	8,10	9,10	10,10	11,10	12,10
1,9	2,9	3,9	4,9	5,9	6,9	7,9	8,9	9,9	10,9	11,9	12,9
1,8	2,8	3,8	4,8	5,8	6,8	7,8	8,8	9,8	10,8	11,8	12,8
1,7	2,7	3,7	4,7	5,7	6,7	7,7	8,7	9,7	10,7	11,7	12,7
1,6	2,6	3,6	4,6	5,6	6,6	7,6	8,6	9,6	10,6	11,6	12,6
1,5	2,5	3,5	4,5	5,5	6,5	7,5	8,5	9,5	10,5	11,5	12,5
1,4	2,4	3,4	4,4	5,4	6,4	7,4	8,4	9,4	10,4	11,4	12,4
1,3	2,3	3,3	4,3	5,3	6,3	7,3	8,3	9,3	10,3	11,3	12,3
1,2	2,2	3,2	4,2	5,2	6,2	7,2	8,2	9,2	10,2	11,2	12,2
1,1	2,1	3,1	4,1	5,1	6,1	7,1	8,1	9,1	10,1	11,1	12,1

Section 40 (Arcing Test)

Test Date (DD/MM/YYYY)	10/02/2015	
Sample ID	TRM6403	
Number of cells	60	
Number of bypass diodes	3	
Diode string operating voltage, V_L (V)	9.19	
I_{sc} (A)	8.86	
Determination of required testing based on UL 1703 Figure 40.1	☐ Arc Test Required	☒ No Arc Test Required
Test Duration (minutes)	N/A	
Test Results		
Evidence of flaming/ignition of the module?	☐ Yes	☐ No
Verdict……..:	☐ Pass	☐ Fail
Supplementary information: Not performed. Zone fit for Arc test was in the NO ARC TEST region.		

Section 41 (Mechanical Load Test)

Date (DD/MM/YYYY)			13/01/2015	
Test Duration (minutes)			60	
Allowable Deflection*, D=L/240 (mm)			N/A	
Sample ID	Location	Pressure Load (kg/m^2)	Tensile Load (kg/m^2)	Measured Deflection* (mm)
TRM2170	Superstrate	2400 Pa	N/A	N/A
TRM2170	Substrate	2400 Pa	N/A	N/A
Test Results				
Structural/Mechanical failure?			☐ Yes	☒ No
Open circuit?			☐ Yes	☒ No
Ground fault?			☐ Yes	☒ No
Verdict……..:			☒ Pass	☐ Fail

Supplementary information:
Manufactures design load = 30 (lbf)
45 pounds per square foot = 2155 Pa.
Existing holes in the frame were used for mounting as shown in the photo in Annex 3.
For modules that are intended to be installed as part of a building wall or roof, deflection was measured.

Section 42 (Wiring Compartment Securement Test)

Date (DD/MM/YYYY)	16/12/2014, 05/01/2015, 13/01/2015	
Applied Force (lbf)	35 (155.7 N)	
Test Results for Unconditioned		
Sample ID	TRM2267	
Wiring compartment separated from laminate	☐ Yes	☒ No
Verdict……:	☒ Pass	☐ Fail
Test Results for Post Thermal Cycling		
Sample ID	TRM2188	
Wiring compartment separated from laminate	☐ Yes	☒ No
Section 27 requirements fulfilled	☒ Yes	☐ No
Verdict……:	☒ Pass	☐ Fail
Sample ID	TRM6453	
Wiring compartment separated from laminate	☐ Yes	☒ No
Section 27 requirements fulfilled	☒ Yes	☐ No
Verdict……:	☒ Pass	☐ Fail
Sample ID	TRM7124	
Wiring compartment separated from laminate	☐ Yes	☒ No
Section 27 requirements fulfilled	☒ Yes	☐ No
Verdict……:	☒ Pass	☐ Fail
Test Results for Post Humidity Freeze		
Sample ID	TRM3147	
Wiring compartment separated from laminate	☐ Yes	☒ No
Section 27 requirements fulfilled	☒ Yes	☐ No
Verdict……:	☒ Pass	☐ Fail
Sample ID	TRM6386	
Wiring compartment separated from laminate	☐ Yes	☒ No
Section 27 requirements fulfilled	☒ Yes	☐ No
Verdict……:	☒ Pass	☐ Fail
Sample ID	TRM6474	
Wiring compartment separated from laminate	☐ Yes	☒ No
Section 27 requirements fulfilled	☒ Yes	☐ No
Verdict……:	☒ Pass	☐ Fail
Supplementary information: None.		

Section 15 Accessibility Test

Test Results for Unconditioned			
Date (DD/MM/YYYY)		17/11/2014	
Test Condition		Unconditioned	
Sample ID	Probe Location	Measured Resistance (MΩ)	Verdict
TRM2188	Frame	∞	P
TRM2188	Junction Box	∞	P
TRM2188	Terminations	∞	P
Test Results for Post Impact / Push			
Date (DD/MM/YYYY)		27/01/2015	
Test Condition		Post Impact / Post Push	
Sample ID	Probe Location	Measured Resistance (MΩ)	Verdict
TRM2192	Frame	∞	P
TRM2192	Junction Box	∞	P
TRM2192	Terminations	∞	P
Supplementary information: None.			

ANNEXES

Annex 1: Statement of the Estimated Uncertainty of the Test Verdicts

The total expanded uncertainty of maximum power measurement for this project is estimated to be ±2.68% for operation at STC. This estimate is valid for baseline data obtained on module number TRM6416. This estimate includes statistical uncertainty based on a linear regression procedure as well as an uncertainty propagation analysis based on the instrumentation used during electrical performance measurement. This estimate does not include the spectral mismatch error, if any.

TÜV Rheinland estimates the uncertainty of P_{max} using the procedures outlined in ANSI/NCSL Z540-2-1997, *U.S. Guide to the Expression of Uncertainty in Measurement*, which is identical to ISO/TAG 4/WG 3 1997, *Guide to the Expression of Uncertainty in Measurement*. A coverage factor of has been calculated to yield an uncertainty estimate at the 95% confidence level.

Annex 2: Equipment List

Equipment ID	Equipment Type	Last Cal. Date	Test Date	Next Cal. Date	Test Procedure
A14	Pressure gauge	17/11/2014	13/01/2015	17/11/2015	33
A45	Current shunt	24/01/2014 20/01/2015	13/01/2015, 14/01/2015, 20/01/2015	24/01/2015 20/01/2016	25, 28
A68	Curve tracer	20/06/2014	10/12/2014	20/06/2015	20
A117	Insulation tester	15/09/2014	30/01/2015 to 08/02/2015	15/09/2015	39
A224	Steel ball	09/12/2013	27/01/2015	09/12/2015	30
A225	Weight 10 lbs	11/12/2013	16/12/2014, 05/01/2015, 13/01/2015, 16/01/2015, 30/01/2015	11/12/2015	22. 23, 42
A228	Weight 10 lbs	11/12/2013	16/12/2014, 05/01/2015, 13/01/2015, 16/01/2015, 30/01/2015	11/12/2015	22. 23, 42
A231	Weight 7.5 lbs	11/12/2013	16/12/2014, 05/01/2015, 13/01/2015	11/12/2015	42
A232	Weight 7.5 lbs	11/12/2013	16/12/2014, 05/01/2015, 13/01/2015	11/12/2015	42
A233	Weight 2 lbs	09/12/2013	17/12/2014, 15/01/2015, 16/01/2015	09/12/2015	23, 24
A234	Weight 2 lbs	09/12/2013	16/01/2015, 27/01/2015	09/12/2015	23, 24
A239	Anemometer	25/04/2013	16/01/2015	25/04/2016	31
A241	DMM	15/04/2014	17/11/2014, 13/01/2015	15/04/2015	15, 41
A244	DMM	21/04/2014	13/01/2015, 27/01/2015	21/04/2015	15, 25
A246	DMM	21/04/2014	13/01/2015, 14/01/2015, 20/01/2015	21/04/2015	25, 28
A255	Chamber 4	14/03/2014	02/12/2014 to 12/12/2014	14/03/2015	36
A256	Chamber 5	01/05/2014	18/11/2014 to 02/12/2014	01/05/2015	35
A275	Data Acquisition System	14/02/2013	02/01/2015, 05/02/2015, 06/02/2015	14/02/2015	19
A260	Timer	21/02/2014	27/01/2015	21/02/2015	24, 30
A280	Timer	03/02/2014	12/12/2014, 05/01/2015, 13/01/2015, 15/01/2015	03/02/2015	24, 25, 27, 42
A281	Timer	03/02/2014	16/01/2015	03/02/2015	31
A282	Timer	03/02/2014	13/01/2015, 14/01/2015, 16/01/2015, 20/01/2015	03/02/2015	23, 28, 33
A289	Thermocouple input	27/06/2014	30/01/2015 to 08/02/2015 09/02/2015 to 15/02/2015	27/06/2015	39
A294	Scale	18/09/2013	17/12/2014, 13/01/2015	18/09/2015	24, 41
A310	Probe	23/10/2014	17/11/2014, 27/01/2015	23/10/2015	15

Equipment ID	Equipment Type	Last Cal. Date	Test Date	Next Cal. Date	Test Procedure
A320	Chamber 1	29/02/2014	02/12/2014 to 22/12/2014	29/02/2015	35
A353	Thermometer	03/10/2014	22/12/2014, 13/01/2015, 16/01/2015	03/10/2015	21, 26, 31
A372	Dielectric tester	27/02/2014	12/12/2014, 16/12/2014, 22/12/2014, 13/01/2015, 22/01/2015	27/02/2015	21, 26, 27
A411	Cut tester	NR	17/12/2014, 15/01/2015, 27/01/2015	NR	24
A412	Motor	NR	17/12/2014, 15/01/2015, 27/01/2015	NR	24
A425	Power supply	NR	13/01/2015	NR	25
A803P	Reference cell	25/08/2014	02/01/2015, 05/02/2015, 06/02/2015	25/08/2015	19
A823P	Reference cell	25/08/2014	10/12/2014	25/08/2015	20
A944	Wind sensor	08/04/2014	02/01/2015, 05/02/2015, 06/02/2015	08/04/2015	19
A963	Pressure gauge	17/11/2014	13/01/2015	17/11/2015	33
A964	Pressure gauge	17/11/2014	13/01/2015	17/11/2015	33
A985	Timer	16/04/2014	16/12/2014, 17/12/2014, 13/01/2015	16/04/2015	24, 41, 42
A986	Timer	16/04/2014	30/01/2015	16/04/2015	22
A988	14 gauge Thermocouple	07/01/2015	16/01/2015	07/01/2016	31
A989	14 gauge Thermocouple	07/01/2015	16/01/2015	07/01/2016	31
PS1	Power supply	NR	14/01/2015, 20/01/2015	NR	28
PS17	Power supply	27/05/2014	30/01/2015 to 08/02/2015 09/02/2015 to 15/02/2015	27/05/2015	39
PS18	Power supply	27/05/2014	30/01/2015 to 08/02/2015 09/02/2015 to 15/02/2015	27/05/2015	39
PS19	Power supply	27/05/2014	30/01/2015 to 08/02/2015 09/02/2015 to 15/02/2015	27/05/2015	39
T05	Thermocouple	13/08/2014	02/01/2015	13/08/2015	19
T07	Thermocouple	13/08/2014	30/01/2015 to 08/02/2015 09/02/2015 to 15/02/2015	13/08/2015	39
T61	Thermocouple	13/08/2014	02/01/2015, 05/02/2015, 06/02/2015	13/08/2015	19
T91	Thermocouple	13/08/2014	02/01/2015	13/08/2015	19

Equipment ID	Equipment Type	Last Cal. Date	Test Date	Next Cal. Date	Test Procedure
T92	Thermocouple	13/08/2014	02/01/2015	13/08/2015	19
T134	Thermocouple	13/08/2014	05/02/2015, 06/02/2015	13/08/2015	19
T143	Thermocouple	13/08/2014	02/01/2015	13/08/2015	19
T156	Thermocouple	13/08/2014	05/02/2015, 06/02/2015	13/08/2015	19
T159	Thermocouple	13/08/2014	02/01/2015, 05/02/2015, 06/02/2015	13/08/2015	19
T165	Thermocouple	13/08/2014	22/12/2014	13/08/2015	26
T208	Thermocouple	13/08/2014	05/02/2015, 06/02/2015	13/08/2015	19
T218	Thermocouple	13/08/2014	30/01/2015 to 08/02/2015 09/02/2015 to 15/02/2015	13/08/2015	39
T251	Thermocouple	13/08/2014	05/02/2015, 06/02/2015	13/08/2015	19
T253	Thermocouple	13/08/2014	02/01/2015	13/08/2015	19
T267	Thermocouple	13/08/2014	30/01/2015 to 08/02/2015 09/02/2015 to 15/02/2015	13/08/2015	39
T279	Thermocouple	13/08/2014	05/02/2015, 06/02/2015	13/08/2015	19
T290	Thermocouple	13/08/2014	02/01/2015	13/08/2015	19
T295	Thermocouple	13/08/2014	30/01/2015 to 08/02/2015 09/02/2015 to 15/02/2015	13/08/2015	39
T297	Thermocouple	13/08/2014	05/02/2015, 06/02/2015	13/08/2015	19
T303	Thermocouple	13/08/2014	05/02/2015, 06/02/2015	13/08/2015	19
T310	Thermocouple	13/08/2014	13/01/2015	13/08/2015	21, 26
T313	Thermocouple	13/08/2014	02/01/2015, 05/02/2015, 06/02/2015	13/08/2015	19
T315	Thermocouple	13/08/2014	05/02/2015, 06/02/2015	13/08/2015	19

Annex 3: Photos of Modules

Fig. 1: Front view of test sample

Fig. 2: Rear view of test sample

Fig. 3: Detail view of solar cell

Fig. 4: Detail view of type label

Fig. 5: Detail view of closed junction box

Fig. 6: Detail view of cables

Fig. 7: Detail view of connections

Fig. 8: Detail view of frame corner

Fig. 9: Detail view of grounding mark

Fig. 10: Detail view of serial number label

End of Report