

<b>Prüfbericht-Nr.:</b> Test report no.:	<b>CN24PF66 001</b>	<b>Auftrags-Nr.:</b> Order no.:	326022609	Seite 1 von 97 Page 1 of 97
<b>Kunden-Referenz-Nr.:</b> Client reference no.:	2496578	<b>Auftragsdatum:</b> Order date:	14/05/2024	
<b>Auftraggeber:</b> Client:	<b>Sany Silicon Energy (Zhuzhou) Co., Ltd.</b> Room 518-50, Building 1, Longxin International, No.255, Tongxia Road, Tongtangwan Street, Shifeng District, Zhuzhou City, 412005, Hunan Province, P.R. China			
<b>Prüfgegenstand:</b> Test item:	Photovoltaic (PV) module			
<b>Bezeichnung / Typ-Nr.:</b> Identification / Type no.:	See module type designation on page 3			
<b>Auftrags-Inhalt:</b> Order content:	Design qualification and type approval of photovoltaic (PV) modules			
<b>Prüfgrundlage:</b> Test specification:	Photovoltaic (PV) modules IEC 61215-1:2021; IEC 61215-1-1:2021; IEC 61215-2:2021; IEC 61730-1:2016; IEC 61730-2:2016; EN IEC 61215-1:2021; EN IEC 61215-1-1:2021; EN IEC 61215- 2:2021; EN IEC 61730-1:2018; EN IEC 61730-2:2018			
<b>Wareneingangsdatum:</b> Date of sample receipt:	02/01/2024			
<b>Prüfmuster-Nr.:</b> Test sample no.:	See clause 6			
<b>Prüfzeitraum:</b> Testing period:	10/01/2024 - 14/05/2024			
<b>Ort der Prüfung:</b> Place of testing:	Refer to page 5			
<b>Prüflaboratorium:</b> Testing laboratory:	TÜV Rheinland (Shanghai) Co., Ltd.			
<b>Prüfergebnis*:</b> Test result*:	Pass			
<b>geprüft von:</b> tested by:			<b>genehmigt von:</b> authorized by:	
<b>Datum:</b> Date:	15/05/2024	Signed by: Jun Huang	<b>Ausstellungsdatum:</b> Issue date:	15/05/2024
<b>Stellung / Position:</b> Project Engineer		<b>Stellung / Position:</b> Authorizer		
<b>Sonstiges /</b> <b>Other:</b>	- Basic qualification for module types listed on page 3-4. - Refer to page 4-5 and Constructional Data Form (CDF) CN24PF66 001 for more details.			
<b>Zustand des Prüfgegenstandes bei Anlieferung:</b> Condition of the test item at delivery:		Prüfmuster vollständig und unbeschädigt Test item complete and undamaged		
* Legende: P(ass) = entspricht o.g. Prüfgrundlage(n) F(ail) = entspricht nicht o.g. Prüfgrundlage(n) N/A = nicht anwendbar N/T = nicht getestet * Legend: P(ass) = passed a.m. test specification(s) F(ail) = failed a.m. test specification(s) N/A = not applicable N/T = not tested				
Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens. This test report only relates to the above mentioned test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any test mark.				

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**Anmerkungen**  
Remarks

- |          |  |
|----------|--|
| <b>1</b> | <p>Alle eingesetzten Prüfmittel waren zum angegebenen Prüfzeitraum gemäß eines festgelegten Kalibrierungsprogramms unseres Prüfhauses kalibriert. Sie entsprechen den in den Prüfprogrammen hinterlegten Anforderungen. Die Rückverfolgbarkeit der eingesetzten Prüfmittel ist durch die Einhaltung der Regelungen unseres Managementsystems gegeben.</p> <p>Detaillierte Informationen bezüglich Prüfkonditionen, Prüfequipment und Messunsicherheiten sind im Prüflabor vorhanden und können auf Wunsch bereitgestellt werden.</p> <p><i>The equipment used during the specified testing period was calibrated according to our test laboratory calibration program. The equipment fulfils the requirements included in the relevant standards. The traceability of the test equipment used is ensured by compliance with the regulations of our management system. Detailed information regarding test conditions, equipment and measurement uncertainty is available in the test laboratory and could be provided on request.</i></p>  |
| <b>2</b> | <p>Wie vertraglich vereinbart, wurde dieses Dokument nur digital unterzeichnet. Der TÜV Rheinland hat nicht überprüft, welche rechtlichen oder sonstigen diesbezüglichen Anforderungen für dieses Dokument gelten. Diese Überprüfung liegt in der Verantwortung des Benutzers dieses Dokuments. Auf Verlangen des Kunden kann der TÜV Rheinland die Gültigkeit der digitalen Signatur durch ein gesondertes Dokument bestätigen. Diese Anfrage ist an unseren Vertrieb zu richten. Eine Umweltgebühr für einen solchen zusätzlichen Service wird erhoben. Informationen zur Verifizierung der Authentizität unserer Dokumente erhalten Sie auf folgender Webseite: <a href="https://go.tuv.com/digital-signature">go.tuv.com/digital-signature</a></p> <p><i>As contractually agreed, this document has been signed digitally only. TUV Rheinland has not verified and unable to verify which legal or other pertaining requirements are applicable for this document. Such verification is within the responsibility of the user of this document. Upon request by its client, TUV Rheinland can confirm the validity of the digital signature by a separate document. Such request shall be addressed to our Sales department. An environmental fee for such additional service will be charged. For information on verifying the authenticity of our documents, please visit the following website: <a href="https://go.tuv.com/digital-signature">go.tuv.com/digital-signature</a></i></p> |
| <b>3</b> | <p>Prüfklausel mit der Note * wurden an qualifizierte Unterauftragnehmer vergeben und sind unter der jeweiligen Prüfklausel des Berichts beschrieben.</p> <p>Abweichungen von Prüfspezifikation(en) oder Kundenanforderungen sind in der jeweiligen Prüfklausel im Bericht aufgeführt.</p> <p><i>Test clauses with remark of * are subcontracted to qualified subcontractors and described under the respective test clause in the report.</i></p> <p><i>Deviations of testing specification(s) or customer requirements are listed in specific test clause in the report.</i></p>   |
| <b>4</b> | <p>Die Entscheidungsregel für Konformitätserklärungen basierend auf numerischen Messergebnissen in diesem Prüfbericht basiert auf der "Null-Grenzwert-Regel" und der "Einfachen Akzeptanz" gemäß ILAC G8:2019 und IEC Guide 115:2021, es sei denn, in der auf Seite 1 dieses Berichts genannten angewandten Norm ist etwas anderes festgelegt oder vom Kunden gewünscht. Dies bedeutet, dass die Messunsicherheit nicht berücksichtigt wird und daher auch nicht im Prüfbericht angegeben wird. Zu weiteren Informationen bezüglich des Risikos durch diese Entscheidungsregel siehe ILAC G8:2019.</p> <p><i>The decision rule for statements of conformity, based on numerical measurement results, in this test report is based on the "Zero Guard Band Rule" and "Simple Acceptance" in accordance with ILAC G8:2019 and IEC Guide 115:2021, unless otherwise specified in the applied standard mentioned on Page 1 of this report or requested by the customer. This means that measurement uncertainty is not taken in account and hence also not declared in the test report. For additional information to the resulting risk based of this decision rule please refer to ILAC G8:2019.</i></p>   |

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**Produktbeschreibung**  
Product description

<b>I</b>	<b>General</b>										
<b>1</b>	<p><b>Module type designation</b>  <b>Max. System Voltage: up to 1500 VDC (Voc at STC):</b>  <b>With cut of mono c-Si cells: (Under STC)</b>  <b>SYMN156TBDxxx (xxx=615-635, in steps of 5, 156 cells)</b>  <b>SYMN144TBDxxx (xxx=555-585, in steps of 5, 144 cells)</b>  <b>SYMN120TBDxxx (xxx=455-485, in steps of 5, 120 cells)</b>  <b>SYMN108TBDxxx (xxx=415-440, in steps of 5, 108 cells)</b>  <b>SYMN144R01TBDxxx (xxx=590-620, in steps of 5, 144 cells)</b>  <b>SYMN120R01TBDxxx (xxx=490-520, in steps of 5, 120 cells)</b>  <b>SYMN108R01TBDxxx (xxx=440-470, in steps of 5, 108 cells)</b></p> <p><b>With cut of mono c-Si cells: (Under BNPI)</b>  <b>SYMN156TBDxxx (xxx=677-699, 156 cells)</b>  <b>SYMN144TBDxxx (xxx=611-644, 144 cells)</b>  <b>SYMN120TBDxxx (xxx=501-534, 120 cells)</b>  <b>SYMN108TBDxxx (xxx=457-484, 108 cells)</b>  <b>SYMN144R01TBDxxx (xxx=649-682, 144 cells)</b>  <b>SYMN120R01TBDxxx (xxx=539-572, 120 cells)</b>  <b>SYMN108R01TBDxxx (xxx=484-517, 108 cells)</b></p> <p><b>xxx represents output power in Wp</b></p> <p>Refer to Constructional Data Form (CDF) no. CN24PF66 001 for electrical ratings</p>										
<b>2</b>	<p><b>Used materials</b></p> <p>See Constructional Data Form (CDF) no. CN24PF66 001</p>										
<b>3</b>	<p><b>Address(es) of the manufacturing site(s)</b></p> <table border="1"> <tr> <td>Name / Description:</td><td>Sany Silicon Energy (Zhuzhou) Co., Ltd.</td></tr> <tr> <td>Street:</td><td>Sany Energy Equipment Industrial Park, No.320 Qingshui Road, Shifeng District</td></tr> <tr> <td>Postcode / City, Country:</td><td>412005 / Zhuzhou City, Hunan Province, P.R. China</td></tr> <tr> <td>Type of production:</td><td>Crystalline PV-module</td></tr> <tr> <td>Inspection report No.and date</td><td>CN23RWL8 002 / 13/05/2024</td></tr> </table>	Name / Description:	Sany Silicon Energy (Zhuzhou) Co., Ltd.	Street:	Sany Energy Equipment Industrial Park, No.320 Qingshui Road, Shifeng District	Postcode / City, Country:	412005 / Zhuzhou City, Hunan Province, P.R. China	Type of production:	Crystalline PV-module	Inspection report No.and date	CN23RWL8 002 / 13/05/2024
Name / Description:	Sany Silicon Energy (Zhuzhou) Co., Ltd.										
Street:	Sany Energy Equipment Industrial Park, No.320 Qingshui Road, Shifeng District										
Postcode / City, Country:	412005 / Zhuzhou City, Hunan Province, P.R. China										
Type of production:	Crystalline PV-module										
Inspection report No.and date	CN23RWL8 002 / 13/05/2024										

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Anmerkungen  
Remarks

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Summary of test results

All of the required tests of the standards IEC 61215 / EN IEC 61215 and IEC 61730 / EN IEC 61730 were passed according to its regulations of the pass criteria. It is therefore declared, that the photovoltaic modules of the aforementioned types fulfil the requirements of the standards IEC 61215 / EN IEC 61215 and IEC 61730 / EN IEC 61730, and it is recommended that certification should be granted.

The Static mechanical load test (MQT 16) was performed with design load/safety factor:

Positive: 3600Pa/1.5 (downward)

Negative: 1600Pa/1.5 (upward)

- The fire tests (Class A) were performed according to UL 790.

- Basic qualification for new module types as listed in section 1.1

- The tests were performed on model SYMN156TBDxxx (BOM1) (156pcs of ½ cut 182 Topcon solar cell) with bill of materials as listed on page 7 and 8 as representative to cover the others with less cells, the test results were documented within this test report. The module types have been approved based on previous test report No. CN23M7KD 001-007 according to standards IEC 61215: 2016 and IEC 61730: 2016.

The differences are as below:

1. SYMN156TBDxxx series are for module with 182.2 x 91mm & 182.2 x 91.875mm Topcon solar cells (156 pcs).
2. SYMN144TBDxxx series are for module with 182.2 x 91mm & 182.2 x 91.875mm Topcon solar cells (144 pcs).
3. SYMN120TBDxxx series are for module with 182.2 x 91mm & 182.2 x 91.875mm Topcon solar cells (120 pcs).
4. SYMN108TBDxxx series are for module with 182.2 x 91mm & 182.2 x 91.875mm Topcon solar cells (108 pcs).
5. SYMN144R01TBDxxx series are for module with 182.2mm x 95.8mm Topcon solar cells (144 pcs).
6. SYMN120R01TBDxxx series are for module with 182.2mm x 95.8mm Topcon solar cells (120 pcs).
7. SYMN108R01TBDxxx series are for module with 182.2mm x 95.8mm Topcon solar cells (108 pcs).

- Critical material tested within this project are listed as page 7 & 8. The relevant tests were performed on the representative module type SYMN156TBD625 (Under STC) / SYMN156TBD688 (Under BNPI) (BOM1) & SYMN156TBD620 (Under STC) / SYMN156TBD682 (Under BNPI) (BOM2).

- Extension to alternative materials in below table. No additional testing is considered necessary for the following modifications.

Object	Manufacturer / trademark	Type / model	Technical data / ratings	Representative model for testing
Solar cell	Sany Silicon Energy (Zhuzhou) Co., Ltd.	SYCN18T16	N type mono c-Si cell with 16 dotted busbars 182.2mmx91.875mm±0.25mm Thickness=130µm±15µm	Compare the alternative materials have been approved, the only difference is the size changed. The declaration is in Appendix E for details.
Solar cell	Sany Silicon Energy (Zhuzhou) Co., Ltd.	SYCN18AT16	N type mono c-Si cell with 16 dotted busbars 182.2mmx95.8mm±0.25mm Thickness=130µm±15µm	

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*Remarks*

**Remark:**

These solar cells SYCN18T16 & SYCN18AT16 can be only used with encapsulation material EP304 (between front glass and solar cell) & F460PS (between solar cell and back glass) from HANGZHOU FIRST APPLIED MATERIAL CO., LTD and B602M (between front glass and solar cell) & B601HP (between solar cell and back glass) from CHANGZHOU BETTERIAL FILM TECHNOLOGIES CO., LTD.

This report have to be read in conjunction with report CN23M7KD 001-007 and Constructional Data Form (CDF) No. CN24PF66 001.

This test report includes a history of reporting and certification, photo documentation and declaration in the appendix.

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

*Summary of test locations:*

All the tests were performed at TÜV Rheinland (Suzhou) Co., Ltd., which is located at No.14 building and north half of No.10 workshop building, No.525, Yuewang Lingang South Road, Pingqian (Taicang) Modern Industrial Park, Shaxi Town, Taicang City, Jiangsu Province, P.R. China.

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Clause	Anforderungen - Prüfungen / Requirements - Tests	Measuring results - Remarks	Result

<b>5</b>	<b>Test specification</b>		
	IEC 61215-1:2021 Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 1: Test requirements	applicable	—
	IEC 61215-1-1:2021 Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules	applicable	
	IEC 61215-2:2021 Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval - Part 2: Test procedures	applicable	
	IEC 61730-1:2016 Photovoltaic (PV) Module Safety Qualification - Part 1: Requirements for Construction	applicable	
	IEC 61730-2:2016 Photovoltaic (PV) module safety qualification - Part 2: Requirements for testing	applicable	

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Absatz	Photovoltaic (PV) modules	Messergebnisse - Bemerkungen	Ergebnis
Clause	Anforderungen - Prüfungen / Requirements - Tests	Measuring results - Remarks	Result

6	List of test samples		
<input type="checkbox"/> The modules tested were taken at random from a production batch and subjected to manufacturer's normal quality control and inspection for safety testing			
<input checked="" type="checkbox"/> The modules tested were prototypes of a new design and not taken from a production batch.			
Module type: SYMN156TBD625 (Under STC) / SYMN156TBD688 (Under BNPI) (BOM1)			
Sample no.	Sample SN	Test sequence	Remarks / constructional characteristics (e.g. cell, backsheet, frame type)
1-1	2312012090001	A	Front cover: 2.0mm Semi-tempered AR coated glass from Hunan Kibing Solar Technology Co., Ltd. Encapsulation material: EP304 (between glass and cell) / F406PS (between cell and backsheet) from HANGZHOU FIRST APPLIED MATERIAL CO., LTD Rear cover: 2.0mm Semi-Tempered back glass from Hunan Kibing Solar Technology Co., Ltd. Solar Cell: SYCN18T16 from Sany Silicon Energy (Zhuzhou) Co., Ltd. Frame: 30mm, 6005-T6 from Jiangyin Chaoyang Photovoltaic Co., Ltd. Adhesive of frame sealing: 1527 from H.B.Fuller (Suzhou) Advanced Material Co., Ltd. Light redirecting film: BC81 from Wuxi Heyu Renewable Technology Co., Ltd Cell connector: Φ0.26mm Sn60/Pb40 from Suzhou YourBest New-type Materials Co., Ltd. String connector: 6.0mm x 0.3mm, 4.0mm x 0.3mm Sn60/Pb40 from Suzhou YourBest New-type Materials Co., Ltd. Fluxing agent: SF180 from ASAHI SOLDER TECHNOLOGY(WUXI) CO., LTD Fixing Tape: HZ UV-3 from Guangdong Sunrui New Material Co., Ltd. Junction box: PV-XT1609Nxyz from Suzhou Xtong Photovoltaic Technologies Co., Ltd. Cable: 62930 IEC 131 1 x 4.0mm <sup>2</sup> from Suzhou Xtong Photovoltaic Technologies Co., Ltd. Connector: PV-XT101.2 from Suzhou Xtong Photovoltaic Technologies Co., Ltd. Bypass diode: XT4050M-B from Suzhou Xtong Photovoltaic Technologies Co., Ltd. Adhesive of J-Box sealing: 1527 from H.B.Fuller (Suzhou) Advanced Material Co., Ltd. Potting Material in junction box: 1533 from H.B.Fuller (Suzhou) Advanced Material Co., Ltd.
1-2	2312012090003	B2	
1-3	2312012090002	B3	
1-4	2312012090004	C1	
1-5	2312012090005	C2	
1-6	2312012090010	D1	
1-7	2312012090011	D2	
1-8	2312012090012	E1	
1-9	2312012090013	E2	
1-10	2312012090015	F+G1	
1-11*	2312012090020	H	



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Module type: SYMN156TBD620 (Under STC) / SYMN156TBD682 (Under BNPI) (BOM2)			
2-1	2311012100001	A	Front cover: 2.0mm Semi-tempered AR coated glass from CSG HOLDING CO., LTD. Encapsulation material: EP304 (between glass and cell) / F406PS (between cell and backsheet) from HANGZHOU FIRST APPLIED MATERIAL CO., LTD Rear cover: 2.0mm Semi-Tempered mesh glazed back glass from CSG HOLDING CO., LTD.
2-2	2311012100002	B2	Solar Cell: SYCN18T16 from Sany Silicon Energy (Zhuzhou) Co., Ltd. Frame: 30mm, 6005-T6 from CHANGSHU DONGNENG SOLAR TECHNOLOGY CO., LTD Adhesive of frame sealing: HT-8258 from Jiangsu Tianchen New Materials CO., LTD
2-3	2311012100003	C1	Cell connector: Ø0.26mm Sn60/Pb40 from Suzhou bonide Photovoltaic Technology Co., Ltd String connector: 6.0mm x 0.3mm, 4.0mm x 0.3mm Sn60/Pb40 from Suzhou bonide Photovoltaic Technology Co., Ltd Fluxing agent: SF180 from ASAHI SOLDER TECHNOLOGY(WUXI) CO., LTD
2-4	2311012100004	C2	Fixing Tape: HZ UV-100 from Guangdong Sunrui New Material Co., Ltd. Junction box: 3Qxy from QC Solar (Suzhou) Corporation Cable: 62930 IEC 131 1 x 4.0mm <sup>2</sup> from QC Solar (Suzhou) Corporation Connector: QC4.10-cds from QC Solar (Suzhou) Corporation
2-5*	2311012100005	H	Bypass diode: QCM4045 from QC Solar (Suzhou) Corporation Adhesive of J-Box sealing: HT-8258 from Jiangsu Tianchen New Materials CO., LTD Potting Material in junction box: HT-6360 A/B from Jiangsu Tianchen New Materials CO., LTD
Supplementary information: See test chart in Appendix A for full test sequences. *Sample No. 1-11*,2-5* is frameless module for Impulse voltage test (MST 14).			



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<b>II</b>	<b>IEC/EN 61215-1 and IEC/EN 61730-1 – Requirements for design construction</b>
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<b>7</b>	<b>Requirements for design and construction (Clause 5 of IEC/EN 61215-1 and IEC/EN 61730-1)</b>
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<b>7.1</b>	<b>General (Clause 5.1 of IEC/EN 61730-1)</b>		
	Incorporation of a PV module into the final assembly does not require any alteration of the PV module from its originally evaluated form. (It is not provided in subassemblies).	PV modules are completely assembled.	P
	Product shipped from the factory	<input checked="" type="checkbox"/> completely assembled <input type="checkbox"/> as subassemblies	N/A
	Equipotential bonding continuity is not interrupted by installation.	Confirmed by test MST 13.	P
	Any adjustable or movable structural part is provided with a locking device.	No such parts.	N/A
	PV modules do not have accessible burrs, sharp edges or sharp points.	Compliance checked by tests MST 01 and MST 06	P
	Parts are prevented from loosening or turning if this results in a risk of fire, electric shock, or injury to persons.	Compliance checked by tests MST 01	P
	The modules are intended for a maximum operating altitude [meters above sea level] of [m]	≤ 2000 m above sea level	N/A
	Recommended maximum series/parallel module configurations	Available in installation manual	P
	The module has been evaluated for the following Class (IEC 61140):	<input type="checkbox"/> Class 0 <input checked="" type="checkbox"/> Class II <input type="checkbox"/> Class III	N/A

<b>7.2</b>	<b>Marking and documentation (Clause 5.2 of IEC/EN 61730-1 and Clause 5 of IEC/EN 61215-1)</b>		
	Instructions related to safety are in an official language of the country where the equipment is to be installed.	Marking and documentation are written in English.	P
<b>7.2.1</b>	<b>Marking (Clause 5.2.2 of IEC/EN 61730-1 and Clause 5.1 of IEC/EN 61215-1)</b>		
<b>7.2.1.1</b>	<b>General (Clause 5.2.2.1 of IEC/EN 61730-1 and Clause 5.1 of IEC/EN 61215-1)</b>		
	Each PV module includes the following clear and indelible markings:	Compliance checked by tests MST 01 and MST 05	P
	a) Name, registered trade name, or registered trade mark of manufacturer	Marked on type label	P
	b) Type or model number designation	Marked on type label	P
	c) Serial number (unless marked on other part of product)	Marked on type label / Additional label with barcode	P
	d) Date and place of manufacture; alternatively serial number assuring traceability of date and place of manufacture	Traceable from serial number (checked during factory inspection)	P
	e) Polarity of terminals or leads	“+” and “-” indicated on terminal	P

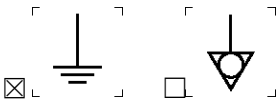
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	f) Maximum system voltage or " $V_{sys}$ "	Marked on type label	P
	g) Class of protection against electrical shock, in accordance with Clause 4 of IEC/EN 61730-1	Marked on type label	P
	h) Voltage at open-circuit or " $V_{oc}$ " including manufacturing tolerances	Marked on type label	P
	i) Current at short-circuit or " $I_{sc}$ " including manufacturing tolerances	Marked on type label	P
	j) Maximum power or " $P_{max}$ " including manufacturing tolerances	Marked on type label	P
	k) Maximum overcurrent protection rating	Marked on type label	P
	l) Short-circuit current bifaciality coefficient $\phi_{Isc}$ Open-circuit voltage bifaciality coefficient $\phi_{Voc}$ Maximum power bifaciality coefficient $\phi_{Pmax}$	Marked on type label	P
	m) Minimum radius of curvature	N/A	N/A
	All electrical data are shown at standard test conditions (STC) (1000 W/m <sup>2</sup> , (25 ± 2) °C, AM 1.5 according to IEC 60904-3).	Marked on type label	P
	Description of measurement of BNPI (AM 1.5, T = 25 °C, Irradiance = 1000W/m <sup>2</sup> + $\phi \cdot 135W/m^2$ )	Marked on type label	P
	PV connectors or wiring are marked with a symbol or/and hint „Do not disconnect under load“. Symbol or/and warning notice is imprinted or labelled close to connector.	Connector fulfill the requirements of IEC 62852. Symbol or warning notice indicated on connector.	P
	For Class II and Class 0 PV modules, the  (IEC 60417-6042: Caution, risk of electric shock) symbol is applied near the PV module electrical connection means.	Electrical hazard symbol indicated on type label	P
	PV modules are marked to indicate the class.	<input checked="" type="checkbox"/> class II:  <input type="checkbox"/> class III  <input type="checkbox"/> class 0: no symbol	P
	PV modules provided with terminals for field wiring rated only for use with copper wire are marked, at or adjacent to the terminals, with the statement "Use copper wire only", "Cu only", or the equivalent.	PV modules provided with terminals for field wiring rated for use with all types of wiring material, do not need to be marked.	N/A
	PV modules provided with terminals for field wiring rated only for use with a different specific wiring material are marked with a similar statement referring to the rated material.	PV modules provided with terminals for field wiring rated for use with all types of wiring material, do not need to be marked.	N/A
7.2.1.2	Symbols (Clause 5.2.2.2 of IEC/EN 61730-1)		
7.2.1.2.1	Equipotential bonding (Clause 5.2.2.2.1 of IEC/EN 61730-1)		

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	A wiring terminal or bonding location for equipotential bonding is identified with:		P
	No other terminal or location is identified in this manner.	Mounting hole may not be used for bonding.	P
7.2.1.2.2	Functional earthing (Clause 5.2.2.2.2 of IEC/EN 61730-1)		
	Field installed functional earthing conductor is identified with the symbol:	No functional earthing.	N/A
7.2.2	Documentation (Clause 5.2.3 of IEC/EN 61730-1 and Clause 5.2 of IEC/EN 61215-1)		
	Documentation concerning electrical and mechanical installation is provided.	Available in data sheet / installation manual	P
	The documentation states the class for protection against electrical shock under which the PV module was qualified and any specific limitations required for that class.	Available in data sheet / installation manual	P
	Environmental conditions to which the module has been qualified are stated.	N/A	N/A
	- concerning temperature range, typically -40 °C to +40 °C.	Available in data sheet / installation manual	P
	- concerning wind/snow load including safety factor.	Available in data sheet / installation manual	P
	The documentation contains the following information:	N/A	N/A
	- Name, registered trade name, or registered trade mark of manufacturer	Available in data sheet / installation manual	P
	- Type or model number designation	Available in data sheet / installation manual	P
	- Maximum system voltage or " $V_{sys}$ "	Available in data sheet / installation manual	P
	- Class for protection against electrical shock, in accordance with Clause 4 of IEC/EN 61730	Available in data sheet / installation manual	P
	- Voltage at open-circuit or " $V_{oc}$ " including manufacturing tolerances	Available in data sheet / installation manual	P
	- Current at short-circuit or " $I_{sc}$ " including manufacturing tolerances	Available in data sheet / installation manual	P
	- Maximum power or " $P_{max}$ " including manufacturing tolerances	Available in data sheet / installation manual	P
	- Short-circuit current bifaciality coefficient $\phi_{Isc}$ Open-circuit voltage bifaciality coefficient $\phi_{Voc}$ Maximum power bifaciality coefficient $\phi_{Pmax}$	Available in data sheet / installation manual	P
	- Minimum radius of curvature	N/A	N/A
	- Maximum overcurrent protection rating (compliance verified by reverse current overload test (MST 26))	Available in data sheet / installation manual	P
	- Recommended maximum series / parallel PV module configurations	Available in data sheet / installation manual	P

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	- Temperature coefficient for maximum output power	Available in data sheet / installation manual	P
	- Temperature coefficient for voltage at open-circuit	Available in data sheet / installation manual	P
	- Temperature coefficient for short-circuit current	Available in data sheet / installation manual	P
	- All electrical data are shown at standard test conditions (1000 W/m <sup>2</sup> , (25 ± 2) °C, AM 1.5 according to IEC 60904-3).	Available in data sheet / installation manual	P
	- Description of measurement of BNPI (AM 1.5, T = 25 °C, Irradiance = 1000W/m <sup>2</sup> + $\varphi \cdot 135W/m^2$ )	Available in data sheet / installation manual	P
	- Performance at low irradiance (MQT 07) is specified.	Available in data sheet / installation manual	P
	Detailed wiring method for electrical installation is included in the documentation, containing	N/A	N/A
	- minimum cable diameters for PV modules intended for field wiring	Available in installation manual	P
	- any limitations on wiring methods and wire management that apply to the PV module junction box	Available in installation manual	P
	- size, type, material, and temperature rating of the conductors to be used	Junction boxes fulfill the requirements of IEC 62790	P
	- type of terminals for field wiring	Junction boxes fulfill the requirements of IEC 62790	P
	- specific PV connector model / types and manufacturer to which the PV module connectors can be mated	Available in installation manual	P
	- bonding to be used (if applicable) including all provided or specified hardware	Available in installation manual	P
	- type and ratings of bypass diode to be used (if applicable) as well as the installation instructions for those diodes (if applicable)	Junction boxes fulfill the requirements of IEC 62790	P
	The documentation includes	N/A	N/A
	- limitations to the mounting situation (e.g. slope, mounting means, cooling).	Available in installation manual	P
	- a statement indicating the fire rating(s)	<input checked="" type="checkbox"/> fire rating(s) and applied standards <input type="checkbox"/> statement that resistance to external fire sources was not evaluated	P
	- a statement indicating the minimum mechanical means for securing the PV module	Available in installation manual	P
	- a statement indicating the maximum altitude the PV module is designed for	≤ 2000 m above sea level Available in installation manual	P
	The documentation for roof mounting includes	N/A	N/A

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	- a statement indicating the minimum mechanical means for securing the PV module	Available in installation manual	P
	- specific parameter(s) when the fire rating is dependent on a specific mounting structure, specific spacing, or specific means of attachment to the roof or structure	Available in installation manual	P
	The documentation includes a statement advising that external or otherwise artificially concentrated sunlight shall not be directed onto the front or back face of the PV module (if not qualified for).	Available in installation manual	P
	Assembly instructions are provided with a product shipped in subassemblies, and are detailed and adequate to the degree required to facilitate complete and safe assembly of the product.	No subassemblies	N/A
	The following or equivalent statement is included: "Under normal conditions, a photovoltaic module is likely to experience conditions that produce higher current and/or voltage than reported at standard test conditions. Accordingly, the values of $I_{sc}$ and $V_{oc}$ marked on this PV module should be multiplied by a factor of 1.25 when determining component voltage ratings, conductor current ratings, and size of controls (e.g. inverter) connected to the PV output." Safety factor may vary acc. to local conditions.	Available in installation manual	P
<b>7.3</b>	<b>Electrical components and insulation (Clause 5.3 of IEC/EN 61730-1)</b>		
<b>7.3.1</b>	<b>Internal wiring (Clause 5.3.2 of IEC/EN 61730-1)</b>		
	Internal wiring has sufficient current carrying capacity for the relevant application.	Verified by MST 14 and MST 26	P
<b>7.3.2</b>	<b>Junction boxes for PV modules (Clause 5.3.5 of IEC/EN 61730-1)</b>		
	Junction boxes for PV modules fulfil the requirements of IEC 62790.	<input checked="" type="checkbox"/> IEC 62790	P
<b>7.3.3</b>	<b>External wiring (Clause 5.3.3 of IEC/EN 61730-1)</b>		
	External wires and cables fulfil the requirements of IEC 62930.	<input checked="" type="checkbox"/> IEC 62930	P
<b>7.3.4</b>	<b>Connectors (Clause 5.3.4 of IEC/EN 61730-1)</b>		
	External DC connectors fulfil the requirements of IEC 62852.	<input checked="" type="checkbox"/> IEC 62852	P
<b>7.3.5</b>	<b>Frontsheets and backsheets (Clause 5.3.6 of IEC/EN 61730-1)</b>		
	Frontsheet:		N/A
	Material of frontsheet:	<input checked="" type="checkbox"/> Glass <input type="checkbox"/> Polymeric material <input type="checkbox"/> Others	N/A
	Thermal index frontsheet (see also Clause 5.5.2.3.3 of IEC/EN 61730-1):	Not applicable for glass frontsheet	N/A

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	Adhesion to encapsulant or glass is appropriate.	Compliance checked by IEC/EN 61730-2 tests listed in this report.	P
	Backsheet:		N/A
	Material of backsheet:	<input checked="" type="checkbox"/> Glass <input type="checkbox"/> Polymeric material <input type="checkbox"/> Others	N/A
	Thermal index backsheet (see also Clause 5.5.2.3.3 of IEC/EN 61730-1):	Not applicable for glass backsheet	N/A
	Adhesion to encapsulant or glass is appropriate.	Compliance checked by IEC/EN 61730-2 tests listed in this report.	P
<b>7.3.6</b>	<b>Insulation barriers (Clause 5.3.7 of IEC/EN 61730-1)</b>		
	Polymeric insulation barrier meets the relevant requirements of Clause 5.5.2 of IEC/EN 61730-1).	See section 7.5.1 Part of IEC 62790 qualification	P
	Barrier is held in place while keeping its required electrical and mechanical properties.	Compliance checked by IEC/EN 61730-2 tests listed in this report.	P
	Removal of barrier is only possible by using a tool.	Tools are necessary for removal of the insulation barrier.	P
<b>7.3.7</b>	<b>Electrical connections (Clause 5.3.8 of IEC/EN 61730-1)</b>		
<b>7.3.7.1</b>	<b>General (Clause 5.3.8.1 of IEC/EN 61730-1)</b>		
	Terminations are so designed, that the contact pressure is not transmitted through insulating material except ceramic, mica or other adequate material.	Compliance checked by MST 01.	P
	Prevention are taken that connections do not become loose, e.g. by using a washer.	Verified by MST 01 / MST 13	P
<b>7.3.7.2</b>	<b>Terminals for external cables and PV connector ribbons (Clause 5.3.8.2 of IEC/EN 61730-1)</b>		
	Terminals for electrical connections are suitable for the type and range of conductor cross-sectional areas according to specification of the manufacturer. They meet the requirements of IEC 62790.	<input checked="" type="checkbox"/> IEC 62790	P
	Insulated terminals are designed in a manner where a possible displacement that may result in a reduction of clearances and creepage distances is prevented.	Insulated terminals are qualified according to the related component standards. Part of IEC 62790 qualification.	P
<b>7.3.8</b>	<b>Encapsulant (Clause 5.3.9 of IEC/EN 61730-1)</b>		
	Thermal properties are sufficient for intended application.	Compliance checked by IEC/EN 61730-2 tests listed in this report.	P
	The insulation properties according to Clause 5.5.2.3 of IEC/EN 61730-1 are met, if applicable.	Compliance checked by IEC/EN 61730-2 tests listed in this report.	P
<b>7.3.9</b>	<b>Bypass diodes (Clause 5.3.10 of IEC/EN 61730-1)</b>		



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	Bypass diodes are rated to withstand the current and voltage for their intended use.	Compliance checked by MST 01, MST 07, MST 22 and MST 25 Datasheet values for bypass diode checked.	P
<b>7.4</b>	<b>Mechanical and electromechanical connections (Clause 5.4 of IEC/EN 61730-1)</b>		
<b>7.4.1</b>	<b>General (Clause 5.4.1 of IEC/EN 61730-1)</b>		
	Type of connection:	<input checked="" type="checkbox"/> Connection within frame <input type="checkbox"/> Mounting interfaces via adhesive <input checked="" type="checkbox"/> Frame to clamp a mounting system <input checked="" type="checkbox"/> Equipotential bonding <input checked="" type="checkbox"/> Attachment of junction box <input type="checkbox"/> Mechanical connections within the laminate	N/A
	Mechanical connections are durable to withstand the thermal, mechanical, and environmental stresses occurring in the application.	Compliance checked by inspection and by MST 13, MST 32, MST 34 and MST 37	P
	Parts intended to be removed are only detachable with the aid of tools.	Tools are necessary for removal.	P
	A tool does not come into contact with the live parts when the lid is removed with it.	Compliance checked by IEC 62790 tests.	P
	No friction occurs between surfaces as the sole means to inhibit the turning or loosening of a part, unless provisions to prevent unintended movement or rotation of the component are given.	No such parts.	N/A
<b>7.4.2</b>	<b>Screw connections (Clause 5.4.2 of IEC/EN 61730-1)</b>		
	Screws and mechanical connections withstand the mechanical stresses occurring in normal use.	No screw is used.	N/A
	Screws are not made of a material which is soft or liable to creep.	No screw is used.	N/A
	Screws used to provide mechanical stability and continuity for equipotential bonding withstand the mechanical stresses occurring in normal use.	No screw is used.	N/A
	At least one screw per electrical-mechanical connection ensures the electrical connection between the metallic components.	No screw is used.	N/A
	Screws used for mechanical and electrical connections with a nominal diameter of less than 3 mm are screwed into metal.	No screw is used.	N/A
	For screws used for mechanical and electrical connections two full threads are engaged into the metal.	No screw is used.	N/A
	Screwed and other fixed connections are in such a way that they do not come loose through torsion, bending stresses, vibration, etc.	No screw is used.	N/A



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<b>7.4.3</b>	<b>Rivets (Clause 5.4.3 of IEC/EN 61730-1)</b>		
	Rivets which serve as electrical as well as mechanical connections are locked against loosening.	No rivet is used.	N/A
<b>7.4.4</b>	<b>Thread-cutting screws (Clause 5.4.4 of IEC/EN 61730-1)</b>		
	Thread-cutting and self-tapping screws are not used for interconnection of current-carrying parts made of a material which is soft or liable to creep.	No thread-cutting screw is used.	N/A
	No thread-forming or thread-cutting (self-tapping) screws (sheet metal screws) are used for the connection of current-carrying parts.	No thread-cutting screw is used.	N/A
	Thread-cutting (self-tapping) screws are not used if they are likely to be operated by the user or installer.	No thread-cutting screw is used.	N/A
	Thread-cutting and thread-forming screws, used to provide continuity for equipotential bonding, are such that it is not necessary to disturb the connection in normal use.	No thread-cutting screw is used.	N/A
	For equipotential bonding one screw is used if two full threads engage the metal.	No thread-cutting screw is used.	N/A
<b>7.4.5</b>	<b>Form / press / tight fit (Clause 5.4.5 of IEC/EN 61730-1)</b>		
	Form/press/tight fits of metallic components which are not separately equipotential bonded are electrically connected.	Compliance checked by inspection and tested by MST 32, MST 34 and MST 13 pre and post the MST 32 and MST 34 tests.	P
<b>7.4.6</b>	<b>Connections by adhesives (Clause 5.4.6 of IEC/EN 61730-1)</b>		
	Connections by adhesive for mounting means are sufficient.	Compliance checked by MST 34, MST 13, MST 32 for mounting adhesives.	P
	Fixing of junction box by adhesive is sufficient.	Compliance checked by MST 42, MST 17 for junction box adhesives.	P
	Adhesion of a polymer relied upon for insulation to another insulating layer is appropriate for the application.	Compliance checked by MST 34, MST 13, MST 32 for adhesives used for mounting means and MST 42, MST 17 for junction box adhesives.	P
	Requirements for adhesive materials are met.	See section 7.5.2.2	P
	Connection by adhesive which is considered as cemented joint fulfills the requirements of Clause 5.6.4.2 of IEC/EN 61730-1.	No cemented joints	N/A
<b>7.4.7</b>	<b>Other connections (Clause 5.4.7 of IEC/EN 61730-1)</b>		
	Other connections (such as welded or soldered) as well as materials and processes to create the connections are appropriate for the application and for the intended use.	Compliance checked by MST 01 and MST 13.	P
	Other connections which are relied upon for equipotential bonding fulfil the requirements of MST 13.	Compliance checked by MST 01 and MST 13.	P

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<b>7.5</b>	<b>Materials (Clause 5.5 of IEC/EN 61730-1)</b>		
<b>7.5.1</b>	<b>Polymeric materials (Clause 5.5.2 of IEC/EN 61730-1)</b>		
<b>7.5.1.1</b>	<b>General (Clause 5.5.2.1 of IEC/EN 61730-1)</b>		
	Polymeric materials are able to durably and safely withstand the electrical, mechanical, thermal, environmental, and corrosive stresses occurring in the application.	Compliance checked by IEC/EN 61730-2 tests listed in this report and other environmental chamber tests including pre- and post-measurements and including assessment of creepages.	P
	Polymeric materials are resistant to electrical and mechanical property degradation.	Compliance checked by MST 37. Compliance checked by all tests including pre- and post-measurements and including assessment of creepages.	P
	Polymeric parts which ensure either the electrical or mechanical safety of the PV module or both, are resistant to electrical and mechanical property degradation. They comply with the requirements of the Materials creep test (MST 37) depending on their constructive function in the PV module.	Compliance checked by MST 37.	P
	Polymeric material used as a part of a cemented joint fulfills additionally the requirements of Clause 5.6.4.2 of IEC/EN 61730-1.	No cemented joints	N/A
<b>7.5.1.2</b>	<b>Endurance to weathering stress (Clause 5.5.2.2 of IEC/EN 61730-1)</b>		
	Polymeric materials of the module and its components are durable to weathering stress.	Components are evaluated according to the relevant requirements in the applicable component standards. Compliance checked by IEC/EN 61730-2 tests listed in this report.	P
<b>7.5.1.3</b>	<b>Polymeric materials used as electrical insulation (Clause 5.5.2.3 of IEC/EN 61730-1)</b>		
<b>7.5.1.3.1</b>	<b>General (Clause 5.5.2.3.1 of IEC/EN 61730-1)</b>		
	Material relied upon for insulation is of adequate thickness, as described in Tables 3 and 4.	Components are evaluated according to the relevant requirement in the applicable component standard.	P
	The temperature limits of materials used as insulation are not less than the maximum measured operating temperature of the specific material in application, as measured during the temperature test (MST 21).	See MST 21	P
<b>7.5.1.3.2</b>	<b>Endurance to electrical stress (Clause 5.5.2.3.2 of IEC/EN 61730-1)</b>		
	Materials used as electrical insulation are in compliance with the insulation coordination requirements.	See section 7.6.3	P
<b>7.5.1.3.3</b>	<b>Endurance to thermal stress (Clause 5.5.2.3.3 of IEC/EN 61730-1)</b>		

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	Materials used as relied upon insulation have a electrical relative thermal endurance, relative thermal index or temperature index (RTE / RTI / TI) appropriate for the application, at least 90°C.	<input checked="" type="checkbox"/> TI <input type="checkbox"/> RTE <input type="checkbox"/> RTI Compliance is checked with temperature test (MST 21).	P
<b>7.5.1.3.4</b>	<b>Polymeric insulating materials used as external parts (Clause 5.5.2.3.4 of IEC/EN 61730-1)</b>		
	External polymeric parts of the PV module whose deterioration could impair the safety meet the following additional requirements:	N/A	N/A
	- Ignitability test (MST 24) in final application (laminated or the PV module)	See section 9.42	P
	- Peel test (MST 35) for proof of cemented joints	No cemented joints	N/A
	- Lap shear strength test (MST 36) for proof of cemented joints	No cemented joints	N/A
<b>7.5.1.3.5</b>	<b>Polymeric insulating used for mechanical functions (Clause 5.5.2.4 of IEC/EN 61730-1)</b>		
	Materials used for mechanical functions have a mechanical relative thermal endurance, relative thermal index or temperature index (RTE / RTI / TI) appropriate for the application, at least 90°C.	<input type="checkbox"/> TI <input type="checkbox"/> RTE <input checked="" type="checkbox"/> RTI Compliance is checked with Temperature test (MST 21).	P
<b>7.5.2</b>	<b>Metallic materials (Clause 5.5.3 of IEC/EN 61730-1)</b>		
<b>7.5.2.1</b>	<b>General (Clause 5.5.3.1 of IEC/EN 61730-1)</b>		
	Metal parts are not in contact to other metal parts having a difference of their electrochemical potentials of more than 600 mV.	Compliance is checked by inspection.	P
	Iron or mild steel is plated, painted, or enamelled for protection against corrosion.	Compliance is checked by inspection.	P
	For iron or mild steel, corrosion protection is at least equivalent to a zinc coating of 0.015 mm thickness, and the manufacturer specified how they demonstrate this.	Compliance is checked by inspection.	P
<b>7.5.2.2</b>	<b>Current carrying parts (Clause 5.5.3.2 of IEC/EN 61730-1)</b>		
	Assessed parts:	N/A	N/A
	Current-carrying parts have sufficient mechanical strength and electrical conductivity.	Compliance checked by IEC/EN 61730-2 tests listed in this report.	P
	Current-carrying materials are protected against corrosion.	N/A	N/A
	The coating for protective coated metal is capable of preventing corrosion according to either one of the listed standards.	N/A	N/A
	Coated metal is not used if the current-carrying parts are stressed by abrasion.	N/A	N/A
<b>7.5.2.3</b>	<b>Adhesives (Clause 5.5.4 of IEC/EN 61730-1)</b>		
	Adhesives are appropriate for the application.	Compliance is checked by relevant tests of IEC 61730-2, including MST 42, MST 34, MST 01, MST 11 and MST 17.	P

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	Adhesives as part of the relied upon electrical insulation meet the requirements of Clause 5.5.2.3.3 of IEC/EN 61730-1.	See section 7.5.1.3.3	P
<b>7.6</b>	<b>Protection against electric shock (Clause 5.6 of IEC/EN 61730-1)</b>		
<b>7.6.1</b>	<b>General (Clause 5.6.1 of IEC/EN 61730-1)</b>		
	Adequate protection against contact with hazardous live parts is provided and poses no risk of electric shock.	See section 7.6.2 - 7.6.4	P
<b>7.6.2</b>	<b>Protection against accessibility to hazardous live parts (Clause 5.6.2 of IEC/EN 61730-1)</b>		
<b>7.6.2.1</b>	<b>General (Clause 5.6.2.1 of IEC/EN 61730-1)</b>		
	Class of module	See safety ratings	N/A
	For Class 0 and Class II modules, adequate protection against accessibility to hazardous live parts (> 35 V DC) is provided.	Compliance is checked by MST 01 and MST 11.	P
	For Class 0 PV modules, accessible metal parts and accessible surfaces as well as live parts of different potential of the same circuit are separated by at least basic insulation.	Table 2 in Clause 5.6.2.3 of IEC/EN 61730-1	N/A
	For Class II PV modules, construction provides separation between accessible parts or accessible surfaces and hazardous live parts by double or reinforced insulation.	Table 2 in Clause 5.6.2.3 of IEC/EN 61730-1	N/A
	For Class II PV modules, live parts of different potential of the same circuit are separated by at least basic insulation.	Table 2 in Clause 5.6.2.3 of IEC/EN 61730-1	N/A
	For Class III PV modules, construction provides separation between accessible parts or accessible surfaces and hazardous live parts by at least functional insulation.	Table 2 in Clause 5.6.2.3 of IEC/EN 61730-1	N/A
	In Class III PV modules live parts of different polarity are separated by at least functional insulation.	Table 2 in Clause 5.6.2.3 of IEC/EN 61730-1	N/A
	Materials used for realizing protection against accessibility of hazardous live parts by means of enclosure, insulation barrier or relied upon insulation comply with the requirements of Clause 5.5.2 of IEC/EN 61730-1 due to their application.	See section 7.5.1	N/A
<b>7.6.2.2</b>	<b>Protection by means of enclosures and insulation barriers (Clause 5.6.2.2 of IEC/EN 61730-1)</b>		
	Enclosures or insulation barriers are designed that, after mounting, the live parts are not accessible.	Encapsulant, glass, backsheet, junction box, cable and connectors acceptably insulate any live parts.	P
	The degree of protection of housing is not impaired by any possible deformation.	Encapsulant, glass, backsheet, junction box, cable and connectors acceptably insulate any live parts.	P
	Parts of enclosures and insulation barriers that provide protection are not removable without the use of a tool.	Tools are necessary for removal.	P

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	Lids which are attached without screws have one or several detectable features, e.g. recesses.	Compliance verified by evaluation of components.	P
	Tools to open the lid do not come into contact with the live parts if lid is removed correctly.	Tools are necessary for removal.	P
	Insulation barriers are held in place and are not affected by influences expected during normal operation. Electrical and mechanical properties do not fall below the minimum acceptable values for the application.	Compliance checked by IEC/EN 61730-2 tests listed in this report.	P
	Parts are prevented from loosening or turning.	No such parts.	N/A
<b>7.6.2.3</b>	<b>Protection by means of insulation of live parts (Clause 5.6.2.3 of IEC/EN 61730-1)</b>		
	An insulation material providing the sole insulation between a live part and an accessible metal part, or between uninsulated live parts not of the same potential, is of adequate thickness and of a material appropriate for the application. For requirements see table 2 in Clause 5.6.2.3 of IEC/EN 61730-1 (7.6.2.1).	Compliance verified by evaluation of materials and components.	P
<b>7.6.3</b>	<b>Insulation coordination (Clause 5.6.3 of IEC/EN 61730-1)</b>		
	Components comply with the requirements for their relevant standards (Clause 5.6.3.1 of IEC/EN 61730-1).	Compliance verified by evaluation of materials and components.	P
	Pollution degree (Clause 5.6.3.2 of IEC/EN 61730-1):	See tables in 7.7	N/A
	Material group (Clause 5.6.3.3 of IEC/EN 61730-1):	See tables in 7.7	N/A
	Clearance and creepage distance (Clause 5.6.3.4 of IEC/EN 61730-1):	See tables in 7.7	N/A
	Derating factor for altitude above 2000 m is considered.	N/A	N/A
<b>7.6.4</b>	<b>Distance through insulation (Clause 5.6.4 of IEC/EN 61730-1)</b>		
<b>7.6.4.1</b>	<b>General (Clause 5.6.4.1 of IEC/EN 61730-1)</b>		
	Polymeric materials for cemented insulation parts and insulation in thin layers withstand environmental, thermal, electrical and mechanical stresses as far as they occur.	See section 7.5	N/A
	Distances through insulation (dti) of solid insulation comply with the minimum distance as required:	N/A	N/A
	System voltage	See safety ratings	N/A
	Distances through insulation (dti)	N/A	N/A
	The insulation fulfils the material classification as given in IEC 60216-1, IEC 60216-2 and IEC 60216-5 (RTE/TI/RTI).	See section 7.3.5	P
<b>7.6.4.2</b>	<b>Cemented joints (Clause 5.6.4.2 of IEC/EN 61730-1)</b>		
	Cemented joints were considered as	<input type="checkbox"/> Edge seal <input type="checkbox"/> Interface between junction box and mounting surface <input type="checkbox"/> Others <input checked="" type="checkbox"/> No cemented joints	N/A

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	Distances along cemented joints comply with the minimum distances as required in table 3:	No cemented joints	N/A
	System voltage	No cemented joints	N/A
	Distance along cemented joints, req./meas. [mm]:	No cemented joints	N/A
	A distance can be considered as cemented joint if following requirements are met:	N/A	N/A
	- Neither cracks nor voids in the insulating compounds have been occurred which either by themselves or in combination reduces the distances through the cemented joint below the required values.	No cemented joints	N/A
	- No breakdown at MST 16 (initial and final tests) with a 1.35 times higher test voltage occurred.	No cemented joints	N/A
	- No breakdown at MST 17 (initial and final tests) with a 1.35 times higher test voltage occurred.	No cemented joints	N/A
	- The electrically insulating adhesive / sealant has a volume resistivity of bigger than $50 \times 10^6 \Omega \text{ cm}$ (dry) / bigger than $10 \times 10^6 \Omega \text{ cm}$ (wet)	No cemented joints	N/A
	- Peel test (MST 35) was passed (rigid / flexible)	No cemented joints	N/A
	- Lap shear strength test (MST 36) was passed (rigid / rigid)	No cemented joints	N/A
<b>7.6.4.3</b>	<b>Insulation in thin layers (Clause 5.6.4.3 of IEC/EN 61730-1)</b>		
	Relied upon insulation in thin layers is applied at	<input type="checkbox"/> Backsheet <input type="checkbox"/> Frontsheet <input type="checkbox"/> Insulation within laminate <input type="checkbox"/> Others <input checked="" type="checkbox"/> N/A	N/A
	Initial construction of insulation in thin layers complies with requirements concerning thickness under consideration of figure 4 as described in table 3 or 4.	Not applicable for glass backsheet	N/A
	Construction of insulation in thin layers complies with requirements concerning RTE/TI/RTI.	Not applicable for glass backsheet	N/A
	Insulation in thin layers provides sufficient dielectric strength:	N/A	N/A
	Test voltage for single-layer sheet and for entire multi-layer sheet providing relied upon insulation (2000V + 4 times system voltage): 8000V	Not applicable for glass backsheet	N/A
	Single-layer sheet as well as entire multi-layer sheet in final application comply with following:	N/A	N/A
	Dielectric strength for basic insulation is provided after Cut susceptibility test (MST 12). Test voltage [V]: (1000V + 2 times system voltage)	Not applicable for glass backsheet	N/A



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**7.7 Clearance and creepage distances (Clause 5.6.3.4 of IEC/EN 61730-1)**

**Table 1: Design evaluation**

**Model types: SYMN156TBD625 (Under STC) / SYMN156TBD688 (Under BNPI) (BOM1) & SYMN156TBD620 (Under STC) / SYMN156TBD682 (Under BNPI) (BOM2)**

Clearance (cl) and creepage distance (cr) at/of/between:	Line of table 3 or 4	Type of insulation	Pollution degree	CTI Material group	Working voltage [V]	Clearance cl [mm]		Creepage cr [mm]	
						Required	Design <sup>a</sup>	Required	Design
Position 1: Shortest distance string connector – module edge	1a	<input type="checkbox"/> Functional <input type="checkbox"/> Basic <input type="checkbox"/> Suppl. <input checked="" type="checkbox"/> Reinforced	<input checked="" type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3	<input checked="" type="checkbox"/> I <input type="checkbox"/> II <input type="checkbox"/> IIIa <input type="checkbox"/> N/A	1500	19.4	12.31±1	10.4	12.31±1
Position 2: Shortest distance cell – module edge	1a	<input type="checkbox"/> Functional <input type="checkbox"/> Basic <input type="checkbox"/> Suppl. <input checked="" type="checkbox"/> Reinforced	<input checked="" type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3	<input checked="" type="checkbox"/> I <input type="checkbox"/> II <input type="checkbox"/> IIIa <input type="checkbox"/> N/A	1500	19.4	12.31±1	10.4	12.31±1
Position 3: Cell to cell	2	<input type="checkbox"/> Functional <input type="checkbox"/> Basic <input type="checkbox"/> Suppl. <input checked="" type="checkbox"/> Reinforced	<input checked="" type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3	<input checked="" type="checkbox"/> I <input type="checkbox"/> II <input type="checkbox"/> IIIa <input type="checkbox"/> N/A	100	0.1	1.7±0.2	0.2	1.7±0.2
Position 4: String to string	2	<input type="checkbox"/> Functional <input type="checkbox"/> Basic <input type="checkbox"/> Suppl. <input checked="" type="checkbox"/> Reinforced	<input checked="" type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3	<input checked="" type="checkbox"/> I <input type="checkbox"/> II <input type="checkbox"/> IIIa <input type="checkbox"/> N/A	100	0.1	1.8±0.2	0.2	1.8±0.2
Position 5: E.g., distance between terminals in JB or between terminal and outer JB enclosure.	3	<input type="checkbox"/> Functional <input type="checkbox"/> Basic <input type="checkbox"/> Suppl. <input checked="" type="checkbox"/> Reinforced	<input checked="" type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3	<input checked="" type="checkbox"/> I <input type="checkbox"/> II <input type="checkbox"/> IIIa <input type="checkbox"/> N/A	100	0.5	N/A*	0.4	N/A*

Supplementary information:

\*The junction box is potted and fulfils the requirements of IEC 62790.

<sup>a</sup> List relevant position and test voltage for each clearance which is verified by Impulse voltage test according to IEC 60664-1.



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**7.7 Clearance and creepage distances (Clause 5.6.3.4 of IEC/EN 61730-1)**

**Table 2: PV module evaluation MST 01 initial**

**Model types: SYMN156TBD625 (Under STC) / SYMN156TBD688 (Under BNPI) (BOM1) & SYMN156TBD620 (Under STC) / SYMN156TBD682 (Under BNPI) (BOM2)**

Sample no.			1-4, 1-6, 1-8, 2-3						
Clearance (cl) and creepage distance (cr) at/of/between:	Line of table 3 or 4	Type of insulation	Pollution degree	CTI Material group	Working voltage [V]	Clearance cl [mm]		Creepage cr [mm]	
						Required	Measured <sup>a</sup>	Required	Measured
Position 1: Shortest distance string connector – module edge	1a	<input type="checkbox"/> Functional <input type="checkbox"/> Basic <input type="checkbox"/> Suppl. <input checked="" type="checkbox"/> Reinforced	<input checked="" type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3	<input checked="" type="checkbox"/> I <input type="checkbox"/> II <input type="checkbox"/> IIIa <input type="checkbox"/> N/A	1500	19.4	12.31	10.4	12.31
Position 2: Shortest distance cell – module edge	1a	<input type="checkbox"/> Functional <input type="checkbox"/> Basic <input type="checkbox"/> Suppl. <input checked="" type="checkbox"/> Reinforced	<input checked="" type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3	<input checked="" type="checkbox"/> I <input type="checkbox"/> II <input type="checkbox"/> IIIa <input type="checkbox"/> N/A	1500	19.4	12.31	10.4	12.31
Position 3: Cell to cell	2	<input type="checkbox"/> Functional <input type="checkbox"/> Basic <input type="checkbox"/> Suppl. <input checked="" type="checkbox"/> Reinforced	<input checked="" type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3	<input checked="" type="checkbox"/> I <input type="checkbox"/> II <input type="checkbox"/> IIIa <input type="checkbox"/> N/A	100	0.1	1.7	0.2	1.7
Position 4: String to string	2	<input type="checkbox"/> Functional <input type="checkbox"/> Basic <input type="checkbox"/> Suppl. <input checked="" type="checkbox"/> Reinforced	<input checked="" type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3	<input checked="" type="checkbox"/> I <input type="checkbox"/> II <input type="checkbox"/> IIIa <input type="checkbox"/> N/A	100	0.1	1.8	0.2	1.8
Position 5: E.g., distance between terminals in JB or between terminal and outer JB enclosure.	3	<input type="checkbox"/> Functional <input type="checkbox"/> Basic <input type="checkbox"/> Suppl. <input checked="" type="checkbox"/> Reinforced	<input checked="" type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3	<input checked="" type="checkbox"/> I <input type="checkbox"/> II <input type="checkbox"/> IIIa <input type="checkbox"/> N/A	100	0.5	N/A*	0.4	N/A*

Supplementary information:

\*The junction box is potted and fulfils the requirements of IEC 62790.

<sup>a</sup> List relevant position and test voltage for each clearance which is verified by Impulse voltage test according to IEC 60664-1.

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**7.7 Clearance and creepage distances (Clause 5.6.3.4 of IEC/EN 61730-1)**

**Table 3: PV module evaluation MST 01 final**

**Model types: SYMN156TBD625 (Under STC) / SYMN156TBD688 (Under BNPI) (BOM1) & SYMN156TBD620 (Under STC) / SYMN156TBD682 (Under BNPI) (BOM2)**

Sample no.			1-4, 1-6, 1-8, 2-3						
Clearance (cl) and creepage distance (cr) at/of/between:	Line of table 3 or 4	Type of insulation	Pollution degree	CTI Material group	Working voltage [V]	Clearance cl [mm]		Creepage cr [mm]	
						Required	Measured <sup>a</sup>	Required	Measured
Position 1: Shortest distance string connector – module edge	1a	<input type="checkbox"/> Functional <input type="checkbox"/> Basic <input type="checkbox"/> Suppl. <input checked="" type="checkbox"/> Reinforced	<input checked="" type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3	<input checked="" type="checkbox"/> I <input type="checkbox"/> II <input type="checkbox"/> IIIa <input type="checkbox"/> N/A	1500	19.4	12.31	10.4	12.31
Position 2: Shortest distance cell – module edge	1a	<input type="checkbox"/> Functional <input type="checkbox"/> Basic <input type="checkbox"/> Suppl. <input checked="" type="checkbox"/> Reinforced	<input checked="" type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3	<input checked="" type="checkbox"/> I <input type="checkbox"/> II <input type="checkbox"/> IIIa <input type="checkbox"/> N/A	1500	19.4	12.31	10.4	12.31
Position 3: Cell to cell	2	<input type="checkbox"/> Functional <input type="checkbox"/> Basic <input type="checkbox"/> Suppl. <input checked="" type="checkbox"/> Reinforced	<input checked="" type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3	<input checked="" type="checkbox"/> I <input type="checkbox"/> II <input type="checkbox"/> IIIa <input type="checkbox"/> N/A	100	0.1	1.7	0.2	1.7
Position 4: String to string	2	<input type="checkbox"/> Functional <input type="checkbox"/> Basic <input type="checkbox"/> Suppl. <input checked="" type="checkbox"/> Reinforced	<input checked="" type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3	<input checked="" type="checkbox"/> I <input type="checkbox"/> II <input type="checkbox"/> IIIa <input type="checkbox"/> N/A	100	0.1	1.8	0.2	1.8
Position 5: E.g., distance between terminals in JB or between terminal and outer JB enclosure.	3	<input type="checkbox"/> Functional <input type="checkbox"/> Basic <input type="checkbox"/> Suppl. <input checked="" type="checkbox"/> Reinforced	<input checked="" type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3	<input checked="" type="checkbox"/> I <input type="checkbox"/> II <input type="checkbox"/> IIIa <input type="checkbox"/> N/A	100	0.5	N/A*	0.4	N/A*

Supplementary information:

\*The junction box is potted and fulfils the requirements of IEC 62790.

<sup>a</sup> List relevant position and test voltage for each clearance which is verified by Impulse voltage test according to IEC 60664-1.

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8	Pass criteria (Clause 7 of IEC/EN 61215-1)		
8.1	Output power and electric circuitry (Clause 7.2 of IEC/EN 61215-1)		
8.1.1	Verification of rated label values (Gate #1) (STC) (Clause 7.2.1 of IEC/EN 61215-1)		
	<p>After stabilization, each individual module shall meet:</p> $P_{\max}(\text{Lab}) \cdot \left(1 + \frac{1.65}{2}  m_1 \right) \geq P_{\max}(\text{NP}) \cdot \left(1 - \frac{ t_1 }{100}\right)$ $P_{\max}(\text{Lab}) \cdot \left(1 + \frac{1.65}{2}  m_1 \right) \geq P_{\max}(\text{NP})$	See table "Gate #1 evaluation"	P
	<p>After stabilization, each individual module shall meet:</p> $V_{\text{OC}}(\text{Lab}) \cdot \left(1 + \frac{1.65}{2}  m_2 \right) \leq V_{\text{OC}}(\text{NP}) \cdot \left(1 + \frac{ t_2 }{100}\right)$	See table "Gate #1 evaluation"	P
	<p>After stabilization, each individual module shall meet:</p> $I_{\text{SC}}(\text{Lab}) \cdot \left(1 + \frac{1.65}{2}  m_3 \right) \leq I_{\text{SC}}(\text{NP}) \cdot \left(1 + \frac{ t_3 }{100}\right)$	See table "Gate #1 evaluation"	P
	<p>After stabilization, each individual module that is used for the qualification of low end power classes shall meet:</p> $P_{\max}(\text{Lab}) \cdot \left(1 - \frac{1.65}{2}  m_1 \right) \leq P_{\max 4}(\text{NP}) \cdot \left(1 + \frac{ t_4 }{100}\right)$	See table "Gate #1 evaluation"	P
	<p> <math>m_1</math> [%] = measurement uncertainty of laboratory for <math>P_{\max}</math>  <math>m_2</math> [%] = measurement uncertainty of laboratory for <math>V_{\text{OC}}</math>  <math>m_3</math> [%] = measurement uncertainty of laboratory for <math>I_{\text{SC}}</math>  <math>t_1</math> [%] = manufacturer's rated lower production tolerance for <math>P_{\max}</math>  <math>t_2</math> [%] = manufacturer's rated upper production tolerance for <math>V_{\text{OC}}</math>  <math>t_3</math> [%] = manufacturer's rated upper production tolerance for <math>I_{\text{SC}}</math>  <math>t_4</math> [%] = manufacturer's rated upper production tolerance for <math>P_{\max 4}</math>  <math>P_{\max 4}</math> = maximum rated nameplate power of lowest power class module  NP = name plate </p>		—
—	Verification of rated label values (Gate #1) (BNPI) (Clause 7.2.1 of IEC/EN 61215-1)		
	<p>After stabilization, each individual module shall meet:</p> $P_{\max}(\text{BNPI})(\text{Lab}) \cdot \left(1 + \frac{1.65}{2}  m_1(\text{BNPI}) \right) \geq P_{\max}(\text{BNPI})(\text{NP}) \cdot \left(1 - \frac{ t_1(\text{BNPI}) }{100}\right)$ $P_{\max}(\text{BNPI})(\text{Lab}) \cdot \left(1 + \frac{1.65}{2}  m_1(\text{BNPI}) \right) \geq P_{\max}(\text{BNPI})(\text{NP})$	See table "Gate #1 evaluation"	P
	<p>After stabilization, each individual module shall meet:</p> $V_{\text{OC}}(\text{BNPI})(\text{Lab}) \cdot \left(1 + \frac{1.65}{2}  m_2(\text{BNPI}) \right) \leq V_{\text{OC}}(\text{BNPI})(\text{NP}) \cdot \left(1 + \frac{ t_2(\text{BNPI}) }{100}\right)$	See table "Gate #1 evaluation"	P
	After stabilization, each individual module shall meet:	See table "Gate #1 evaluation"	P

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	$I_{SC(BNPI)}(Lab) \cdot \left(1 + \frac{\frac{1.65}{2}  m_3(BNPI) }{100}\right) \leq I_{SC(BNPI)}(NP) \cdot \left(1 + \frac{ t_3(BNPI) }{100}\right)$		
	<p>After stabilization, each individual module that is used for the qualification of low end power classes shall meet:</p> $P_{max(BNPI)}(Lab) \cdot \left(1 - \frac{\frac{1.65}{2}  m_1(BNPI) }{100}\right) \leq P_{max4(BNPI)}(NP) \cdot \left(1 + \frac{ t_4(BNPI) }{100}\right)$	See table "Gate #1 evaluation"	P
	<p> <math>m_1(BNPI)</math> [%] = measurement uncertainty of laboratory for <math>P_{max(BNPI)}</math>  <math>m_2(BNPI)</math> [%] = measurement uncertainty of laboratory for <math>V_{OC(BNPI)}</math>  <math>m_3(BNPI)</math> [%] = the measurement uncertainty of laboratory for <math>I_{SC(BNPI)}</math>  <math>t_1(BNPI)</math> [%] = manufacturer's rated lower production tolerance for <math>P_{max(BNPI)}</math>  <math>t_2(BNPI)</math> [%] = manufacturer's rated upper production tolerance for <math>V_{OC(BNPI)}</math>  <math>t_3(BNPI)</math> [%] = manufacturer's rated upper production tolerance for <math>I_{SC(BNPI)}</math>  <math>t_4(BNPI)</math> [%] = manufacturer's rated upper production tolerance for <math>P_{max4(BNPI)}</math>  <math>P_{max4(BNPI)}</math> = maximum rated nameplate power of lowest power class module (under BNPI)  NP = name plate </p>		—
8.1.2	Maximum power degradation during type approval testing (Gate #2) (STC) (Clause 7.2.2 of IEC/EN 61215-1)		
	At the end of each test sequence, each test sample shall meet:	$r = 0.8$	N/A
	$P_{max}(Lab\_Gate\#2) \geq 0.95 \times P_{max}(Lab\_Gate\#1) \cdot \left(1 - \frac{r}{100}\right)$	See table "Gate #2 evaluation"	
	$r$ = reproducibility		—
—	Maximum power degradation during type approval testing (Gate #2) (BNPI) (Clause 7.2.2 of IEC/EN 61215-1)		
	At the end of each test sequence, each test sample shall meet:	$r_{(BNPI)} = 0.8$	N/A
	$P_{max(BNPI)}(Lab\_Gate\#2) \geq 0.95 \times P_{max(BNPI)}(Lab\_Gate\#1) \cdot \left(1 - \frac{r_{(BNPI)}}{100}\right)$	See table "Gate #2 evaluation"	
	$r_{(BNPI)}$ = reproducibility		—
8.1.3	Electrical circuitry (Clause 7.2.3 of IEC/EN 61215-1)		
	Samples are not permitted to exhibit an open-circuit during the tests.	No open-circuit during tests	P
8.2	Visual defects (Clause 7.3 of IEC/EN 61215-1)		
	There is no visual evidence of a major defect.	No major visual defect	P
8.3	Electrical safety (Clause 7.4 of IEC/EN 61215-1)		
	The insulation test (MQT 03) requirements are met at the beginning and the end of each sequence.	See tables below	P
	The wet leakage current test (MQT 15) requirements are met at the beginning and the end of each sequence.	See tables below	P
	Specific requirements of the individual tests are met.	See tables below	P
Supplementary information: N/A			

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<b>III</b>	<b>IEC/EN 61215-2 and IEC/EN 61730-2 – Test procedures</b>
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<b>9</b>	<b>Overview of tests and test results</b> <b><u>Model types: SYMN156TBD625 (Under STC) / SYMN156TBD688 (Under BNPI) (BOM1)</u></b>
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<b>Initial examination</b>	—	—
Visual inspection (MQT 01 / MST 01)	See table 9.1	P
Insulation test (MQT 03 / MST 16)	See table 9.2	P
Wet leakage current test (MQT 15 / MST 17)	See table 9.3	P
Accessibility test (MST 11)	See table 9.4	P
Continuity test of equipotential bonding (MST 13)	See table 9.5	P
Initial stabilization (MQT 19.1)	See table 9.6	P
Maximum power determination (MQT 02 / MST 03)	See table 9.7	P
Performance at STC and BNPI (MQT 06.1 / MST 03)	See table 9.8	N/A
Gate #1 evaluation	See table 9.9	P

<b>Sequence A</b>	—	—
Measurement of temperature coefficients (MQT 04)	N/A	N/A
Performance at low irradiance (MQT 07)	See table 9.11	N/A

<b>Sequence B1</b>	—	—
Outdoor exposure test (MQT 08)	N/A	N/A

<b>Sequence B2</b>	—	—
Temperature test (MST 21)	N/A	N/A
Hot-spot endurance test (MQT 09 / MST 22)	See table 9.14	P
Reverse current overload test (MST 26)	See table 9.15	P

<b>Sequence B3</b>	—	—
Bypass diode thermal test (MQT 18.1 / MST 25)	See table 9.16	P

<b>Sequence C</b>	—	—
UV preconditioning test (MQT 10 / MST 54)	See table 9.17	P
Cyclic (dynamic) mechanical load test (MQT 20)	See table 9.18	P
Thermal cycling test (50 cycles) (MQT 11 / MST 51)	See table 9.19	P
Humidity-freeze test (MQT 12 / MST 52)	See table 9.20	P

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<b>Sequence C1</b>	—	—
Retention of junction box on mounting surface (MQT 14.1 / MST 42)	See table 9.21	P
Test of cord anchorage (MQT 14.2)	See table 9.22 Junction box is approved according to IEC 62790	P

<b>Sequence D</b>	—	—
Thermal cycling test (200 cycles) (MQT 11 / MST 51)	See table 9.23	P

<b>Sequence E</b>	—	—
Damp heat test (MQT 13 / MST 53)	See table 9.24	P

<b>Sequence E1</b>	—	—
Static mechanical load test (MQT 16 / MST 34)	See table 9.25	P

<b>Sequence E2</b>	—	—
Hail test (MQT 17)	See table 9.26	P

<b>Sequence F</b>	—	—
Materials creep test (MST 37)	See table 9.28	P

<b>Sequence G</b>	—	—
Damp heat test (200h) (MST 53)	N/A	N/A
UV test (front side) (MST 54)	N/A	N/A
Humidity-freeze test (MST 52)	N/A	N/A
UV test (back side) (MST 54)	N/A	N/A
Humidity-freeze test (MST 52)	N/A	N/A
Insulation thickness test (MST 04)	N/A	N/A

<b>Sequence G1</b>	—	—
Cold conditioning 1 (MST 55)	N/A	N/A
Dry heat conditioning (MST 56)	N/A	N/A
Humidity-freeze test 1 (MST 52)	N/A	N/A
Cold conditioning 2 (MST 55)	N/A	N/A
Humidity-freeze test 2 (MST 52)	N/A	N/A

<b>Sequence H</b>	—	—
Impulse voltage test (MST 14)	See table 9.40	P

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<b>Sequence M</b>	—	—
Module breakage test (MST 32)	N/A	N/A

<b>Sequence I</b>	—	—
Ignitability test (MST 24)	N/A	N/A

<b>Sequence K</b>	—	—
Potential induced degradation test (MQT 21)	N/A	N/A

<b>Sequence J</b>	—	—
Fire test (MST 23)	N/A	N/A

<b>Final measurements</b>	—	—
Final stabilization (MQT 19.2 / MQT 19.3)	See table 9.45	N/A
Maximum power determination (MQT 02 / MST 03)	See table 9.46	P
Performance at STC and BNPI (MQT 06.1 / MST 03)	See table 9.47	P
Gate #2 evaluation	See table 9.48	P
Bypass diode functionality test (MQT 18.2 / MST 07)	See table 9.49	P
Cut susceptibility test (MST 12)	N/A	N/A
Accessibility test (MST 11)	See table 9.51	P
Continuity test of equipotential bonding (MST 13)	See table 9.52	P
Screw connections test (MST 33)	No screw connections	N/A
Durability of markings (MST 05)	See table 9.54	P
Sharp edge test (MST 06)	See table 9.55	P

<b>Component tests</b>	—	—
Peel test (MST 35)	No cemented joints	N/A
Lap shear strength test (MST 36)	No cemented joints	N/A
Supplementary information: See Appendix A: Test charts for more details.		



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9	<b>Overview of tests and test results</b> <b>Module type: SYMN156TBD620 (Under STC) / SYMN156TBD682 (Under BNPI) (BOM2)</b>		
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<b>Initial examination</b>	—	—
Visual inspection (MQT 01 / MST 01)	See table 9.1	P
Insulation test (MQT 03 / MST 16)	See table 9.2	P
Wet leakage current test (MQT 15 / MST 17)	See table 9.3	P
Accessibility test (MST 11)	See table 9.4	P
Continuity test of equipotential bonding (MST 13)	See table 9.5	P
Initial stabilization (MQT 19.1)	See table 9.6	P
Maximum power determination (MQT 02 / MST 03)	See table 9.7	P
Performance at STC and BNPI (MQT 06.1 / MST 03)	See table 9.8	N/A
Gate #1 evaluation	See table 9.9	P

<b>Sequence A</b>	—	—
Measurement of temperature coefficients (MQT 04)	N/A	N/A
Performance at low irradiance (MQT 07)	See table 9.11	N/A

<b>Sequence B1</b>	—	—
Outdoor exposure test (MQT 08)	N/A	N/A

<b>Sequence B2</b>	—	—
Temperature test (MST 21)	N/A	N/A
Hot-spot endurance test (MQT 09 / MST 22)	See table 9.14	P
Reverse current overload test (MST 26)	See table 9.15	P

<b>Sequence B3</b>	—	—
Bypass diode thermal test (MQT 18.1 / MST 25)	N/A	N/A

<b>Sequence C</b>	—	—
UV preconditioning test (MQT 10 / MST 54)	See table 9.17	P
Cyclic (dynamic) mechanical load test (MQT 20)	See table 9.18	P
Thermal cycling test (50 cycles) (MQT 11 / MST 51)	See table 9.19	P
Humidity-freeze test (MQT 12 / MST 52)	See table 9.20	P

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<b>Sequence C1</b>		—	—
	Retention of junction box on mounting surface (MQT 14.1 / MST 42)	See table 9.21	P
	Test of cord anchorage (MQT 14.2)	See table 9.22 Junction box is approved according to IEC 62790	P
<b>Sequence D</b>		—	—
	Thermal cycling test (200 cycles) (MQT 11 / MST 51)	N/A	N/A
<b>Sequence E</b>		—	—
	Damp heat test (MQT 13 / MST 53)	See table 9.24	P
<b>Sequence E1</b>		—	—
	Static mechanical load test (MQT 16 / MST 34)	N/A	N/A
<b>Sequence E2</b>		—	—
	Hail test (MQT 17)	N/A	N/A
<b>Sequence F</b>		—	—
	Materials creep test (MST 37)	N/A	N/A
<b>Sequence G</b>		—	—
	Damp heat test (200h) (MST 53)	N/A	N/A
	UV test (front side) (MST 54)	N/A	N/A
	Humidity-freeze test (MST 52)	N/A	N/A
	UV test (back side) (MST 54)	N/A	N/A
	Humidity-freeze test (MST 52)	N/A	N/A
	Insulation thickness test (MST 04)	N/A	N/A
<b>Sequence G1</b>		—	—
	Cold conditioning 1 (MST 55)	N/A	N/A
	Dry heat conditioning (MST 56)	N/A	N/A
	Humidity-freeze test 1 (MST 52)	N/A	N/A
	Cold conditioning 2 (MST 55)	N/A	N/A
	Humidity-freeze test 2 (MST 52)	N/A	N/A
<b>Sequence H</b>		—	—
	Impulse voltage test (MST 14)	See table 9.40	P

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<b>Sequence M</b>		—	—
Module breakage test (MST 32)		N/A	N/A
<b>Sequence I</b>		—	—
Ignitability test (MST 24)		N/A	N/A
<b>Sequence K</b>		—	—
Potential induced degradation test (MQT 21)		N/A	N/A
<b>Sequence J</b>		—	—
Fire test (MST 23)		N/A	N/A
<b>Final measurements</b>		—	—
Final stabilization (MQT 19.2 / MQT 19.3)		See table 9.45	N/A
Maximum power determination (MQT 02 / MST 03)		See table 9.46	P
Performance at STC and BNPI (MQT 06.1 / MST 03)		See table 9.47	P
Gate #2 evaluation		See table 9.48	P
Bypass diode functionality test (MQT 18.2 / MST 07)		See table 9.49	P
Cut susceptibility test (MST 12)		N/A	N/A
Accessibility test (MST 11)		See table 9.51	P
Continuity test of equipotential bonding (MST 13)		See table 9.52	P
Screw connections test (MST 33)		No screw connections	N/A
Durability of markings (MST 05)		See table 9.54	P
Sharp edge test (MST 06)		See table 9.55	P
<b>Component tests</b>		—	—
Peel test (MST 35)		No cemented joints	N/A
Lap shear strength test (MST 36)		No cemented joints	N/A
Supplementary information: See Appendix A: Test charts for more details.			

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9.1	Visual inspection (initial) – MQT 01 / MST 01			
Test date (dd/mm/yyyy)		26/01/2024		—
Sample no.	Requirement	Nature and position of initial findings		
1-1	No major visual defects	No major visual defects		P
1-2		No major visual defects		P
1-3		No major visual defects		P
1-4		No major visual defects		P
1-5		No major visual defects		P
1-6		No major visual defects		P
1-7		No major visual defects		P
1-8		No major visual defects		P
1-9		No major visual defects		P
1-10		No major visual defects		P
1-11		No major visual defects		P
2-1		No major visual defects		P
2-2		No major visual defects		P
2-3		No major visual defects		P
2-4		No major visual defects		P
2-5		No major visual defects		P
Supplementary information: N/A				

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9.2	Insulation test (initial) – MQT 03 / MST 16					
Test date (dd/mm/yyyy)				23/02/2024 for BOM1 21/02/2024 for BOM2		—
Maximum system voltage [V <sub>DC</sub> ]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V <sub>DC</sub> ]				8000		
Insulation resistance measured at [V <sub>DC</sub> ]				1500		
Sample no.	R <sub>iso</sub> [GΩ]	A [m²]	R <sub>iso</sub> ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
1-1	7.85	2.80	21.98	-	No	P
1-2	8.61	2.80	24.11	-	No	P
1-3	8.63	2.80	24.16	-	No	P
1-4	8.65	2.80	24.22	-	No	P
1-5	8.63	2.80	24.16	-	No	P
1-6	8.66	2.80	24.25	-	No	P
1-7	8.84	2.80	24.75	-	No	P
1-8	8.93	2.80	25.00	-	No	P
1-9	8.71	2.80	24.39	-	No	P
1-10	7.73	2.80	21.64	-	No	P
1-11	7.69	2.80	21.53	-	No	P
2-1	12.80	2.80	35.84	-	No	P
2-2	13.50	2.80	37.80	-	No	P
2-3	13.30	2.80	37.24	-	No	P
2-4	13.40	2.80	37.52	-	No	P
2-5	14.20	2.80	39.76	-	No	P
Supplementary information: Minimum requirement is 0.04 GΩ·m² for A > 0.1 m² and 0.4 GΩ for A ≤ 0.1 m².						

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9.3	Wet leakage current test (initial) – MQT 15 / MST 17			
Test date (dd/mm/yyyy)		23/02/2024 for BOM1 21/02/2024 for BOM2		—
Maximum system voltage [V <sub>DC</sub> ]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V <sub>DC</sub> ]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R <sub>iso</sub> [MΩ]	A [m²]	R <sub>iso</sub> ·A [MΩ·m²]	
1-1	4110.0	2.80	11508.0	P
1-2	4170.0	2.80	11676.0	P
1-3	4170.0	2.80	11676.0	P
1-4	4190.0	2.80	11732.0	P
1-5	3750.0	2.80	10500.0	P
1-6	3910.0	2.80	10948.0	P
1-7	4790.0	2.80	13412.0	P
1-8	4780.0	2.80	13384.0	P
1-9	4310.0	2.80	12068.0	P
1-10	3580.0	2.80	10024.0	P
2-1	4220.0	2.80	11816.0	P
2-2	3930.0	2.80	11004.0	P
2-3	4190.0	2.80	11732.0	P
2-4	3890.0	2.80	10892.0	P
Supplementary information: Minimum requirement is 40 MΩ·m².				

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9.4	Accessibility test (initial) – MST 11		
Test date (dd/mm/yyyy)		23/02/2024 for 1-4,1-6,1-8,1-10 21/02/2024 for 2-3	—
Applied force [N]		10	
Sample no.	Contact with live electrical part?	R <sub>iso</sub> [MΩ]	
1-4	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	≥60.0	P
1-6	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	≥60.0	P
1-8	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	≥60.0	P
1-10	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	≥60.0	P
2-3	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	≥60.0	P
Supplementary information: The resistance tester can measure up to 60.0 MΩ.			

9.5	Continuity test of equipotential bonding (initial) – MST 13		
Test date (dd/mm/yyyy)		23/02/2024 for 1-4,1-6,1-8,1-10 21/02/2024 for 2-3	—
Maximum overcurrent protection rating [A]		30	
Current applied [A]		75	
Duration of applied current [min]		2	
Location of designated point for equipotential bonding		long side of the frame	
No. of other conductive parts tested		3	
Sample no.	Max. measured voltage [mV]	Max. calculated resistance [mΩ]	
1-4	95.4/95.5/95.5	1.27/1.27/1.27	P
1-6	95.6/95.5/95.6	1.27/1.27/1.27	P
1-8	95.6/95.7/95.6	1.27/1.28/1.27	P
1-10	95.5/95.4/95.5	1.27/1.27/1.27	P
2-3	92.6/93.5/93.7	1.23/1.25/1.25	P
Supplementary information: N/A			



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9.6	Initial stabilization – MQT 19.1				
☒ Simulator   ☐ Natural sunlight   ☐ Other stabilization procedures					
Test date (dd/mm/yyyy)			21/02/2024 - 23/02/2024 for BOM1 18/02/2024 - 21/02/2024 for BOM2		—
Irradiance [W/m²]			800 - 1000		
Module temperature [°C]			50		
Sample no.	Test	Integrated irradiation [kWh/m²]	P <sub>max</sub> [W]	Stabilization [%] *	
1-1	Initial	—	626.8	0.18	P
	Light-soaking 1	5	627.4		
	Light-soaking 2	5	627.9		
1-2	Initial	—	626.0	0.05	P
	Light-soaking 1	5	625.9		
	Light-soaking 2	5	626.2		
1-3	Initial	—	627.0	0.18	P
	Light-soaking 1	5	625.9		
	Light-soaking 2	5	626.1		
1-4	Initial	—	626.9	0.14	P
	Light-soaking 1	5	627.1		
	Light-soaking 2	5	626.2		
1-5	Initial	—	627.9	0.06	P
	Light-soaking 1	5	628.0		
	Light-soaking 2	5	627.6		
1-6	Initial	—	626.3	0.19	P
	Light-soaking 1	5	627.5		
	Light-soaking 2	5	627.5		
1-7	Initial	—	626.7	0.10	P
	Light-soaking 1	5	627.1		
	Light-soaking 2	5	626.5		
1-8	Initial	—	627.4	0.10	P
	Light-soaking 1	5	627.8		
	Light-soaking 2	5	628.0		
1-9	Initial	—	627.9	0.08	P
	Light-soaking 1	5	627.4		
	Light-soaking 2	5	627.7		
2-1	Initial	—	622.0	0.08	P

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	Light-soaking 1	5	621.8		
	Light-soaking 2	5	622.3		
2-2	Initial	—	622.0	0.08	P
	Light-soaking 1	5	621.8		
	Light-soaking 2	5	622.3		
2-3	Initial	—	622.0	0.06	P
	Light-soaking 1	5	621.9		
	Light-soaking 2	5	621.6		
2-4	Initial	—	621.4	0.64	P
	Light-soaking 1	5	621.8		
	Light-soaking 2	5	617.8		
Supplementary information: * Stabilization criterion: $(P_{\text{max}}-P_{\text{min}})/P_{\text{avg}} \leq 1 \%$ for three consecutive measurements. Initial measurement corresponds to MQT 02 of IEC/EN 61215.					

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9.7	Maximum power determination (initial) – MST 03		
Test date (dd/mm/yyyy)		23/02/2024 for BOM1 21/02/2024 for BOM2	—
Irradiance [W/m²]		1000*	
Module temperature [°C]		25 ± 1	
Test method		<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight	
Sample no.	Appearance of initial IV-curve		
1-2	No kinks or other unusual characteristics		P
1-3	No kinks or other unusual characteristics		P
1-4	No kinks or other unusual characteristics		P
1-6	No kinks or other unusual characteristics		P
1-8	No kinks or other unusual characteristics		P
1-10	No kinks or other unusual characteristics		P
1-11	No kinks or other unusual characteristics		P
2-2	No kinks or other unusual characteristics		P
2-3	No kinks or other unusual characteristics		P
2-5	No kinks or other unusual characteristics		P
Supplementary information: N/A			

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9.8	Performance at STC (initial) – MQT 06.1
-----	---

9.8.1	Performance at STC (initial) (front side) – MQT 06.1						
Test date (dd/mm/yyyy)			23/02/2024 for BOM1 21/02/2024 for BOM2				—
Test method			<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight				
Illuminated side			<input checked="" type="checkbox"/> Front side <input type="checkbox"/> Rear side				
Ambient temperature [°C]			25 ± 2				
Irradiance [W/m²]			1000*				
Module temperature [°C]			25 ± 0.2				
Spectral mismatch			N/A				
Sample no.	P <sub>max</sub> [W]	V <sub>mpp</sub> [V]	I <sub>mpp</sub> [A]	V <sub>oc</sub> [V]	I <sub>sc</sub> [A]	FF [%]	
1-1	627.9	48.16	13.038	56.65	13.714	80.8	N/A
1-2	626.2	47.95	13.060	56.54	13.723	80.7	N/A
1-4	626.1	48.07	13.024	56.58	13.718	80.7	N/A
1-5	626.6	48.12	13.022	56.59	13.722	80.7	N/A
1-6	627.6	48.05	13.061	56.62	13.752	80.6	N/A
1-7	627.5	48.08	13.051	56.58	13.729	80.8	N/A
1-8	626.5	47.98	13.058	56.61	13.723	80.6	N/A
1-9	628.0	48.05	13.069	56.59	13.716	80.9	N/A
2-1	621.6	47.91	12.977	56.58	13.657	80.4	N/A
2-2	622.3	48.06	12.948	56.57	13.656	80.6	N/A
2-3	621.6	47.92	12.970	56.58	13.667	80.4	N/A
2-4	617.8	47.78	12.929	56.53	13.677	79.9	N/A

Supplementary information: The non-illuminated side was covered with non-reflective background and aperture.  
\*A pulse solar simulator class AAA conforming to the requirements of IEC 60904-9 is used.

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9.8.2	Performance at STC (initial) (rear side) – MQT 06.1						
Test date (dd/mm/yyyy)			23/02/2024 for BOM1 21/02/2024 for BOM2				—
Test method			<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight				
Illuminated side			<input type="checkbox"/> Front side <input checked="" type="checkbox"/> Rear side				
Ambient temperature [°C]			25 ± 2				
Irradiance [W/m²]			1000*				
Module temperature [°C]			25 ± 0.2				
Spectral mismatch			N/A				
Sample no.	P <sub>max</sub> [W]	V <sub>mpp</sub> [V]	I <sub>mpp</sub> [A]	V <sub>oc</sub> [V]	I <sub>sc</sub> [A]	FF [%]	
1-1	473.5	49.23	9.619	56.18	10.640	79.2	N/A
1-2	476.5	49.03	9.718	56.07	10.735	79.2	N/A
1-4	474.3	49.27	9.627	56.17	10.690	79.0	N/A
1-5	474.3	49.02	9.676	56.14	10.672	79.2	N/A
1-6	474.6	49.30	9.628	56.12	10.744	78.7	N/A
1-7	471.1	49.08	9.598	56.16	10.693	78.4	N/A
1-8	474.8	49.28	9.636	56.15	10.751	78.6	N/A
1-9	473.6	49.20	9.626	56.12	10.508	80.3	N/A
2-1	467.1	48.90	9.551	56.03	10.533	79.1	N/A
2-2	460.2	49.51	9.295	56.05	10.378	79.1	N/A
2-3	463.1	48.92	9.467	56.04	10.459	79.0	N/A
2-4	465.1	48.82	9.528	56.03	10.523	78.9	N/A
Supplementary information: The non-illuminated side was covered with non-reflective background and aperture. *A pulse solar simulator class AAA conforming to the requirements of IEC 60904-9 is used.							

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9.8.3	Bifaciality Coefficients (initial)			
Sample no.	$\Phi_{isc}$	$\Phi_{Voc}$	$\Phi_{Pmax}$	—
1-1	0.7758	0.9917	0.7541	N/A
1-2	0.7823	0.9917	0.7609	N/A
1-4	0.7793	0.9928	0.7575	N/A
1-5	0.7777	0.9920	0.7569	N/A
1-6	0.7813	0.9912	0.7562	N/A
1-7	0.7789	0.9926	0.7508	N/A
1-8	0.7834	0.9919	0.7579	N/A
1-9	0.7661	0.9917	0.7541	N/A
2-1	0.7713	0.9903	0.7514	N/A
2-2	0.7600	0.9908	0.7395	N/A
2-3	0.7653	0.9905	0.7450	N/A
2-4	0.7694	0.9912	0.7528	N/A
Supplementary information: N/A				

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<i>Clause</i>	Anforderungen - Prüfungen / <i>Requirements - Tests</i>	<i>Measuring results - Remarks</i>	<i>Result</i>

9.8.4	Performance at BNPI (initial) – MQT 06.1						
Test date (dd/mm/yyyy)			23/02/2024 for BOM1 21/02/2024 for BOM2				—
Test method			<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight				
Illuminated side			<input checked="" type="checkbox"/> Front side <input type="checkbox"/> Rear side				
Ambient temperature [°C]			25 ± 2				
Irradiance [W/m²]			1000 + $\varphi \cdot 135^*$				
Module temperature [°C]			25 ± 0.2				
Spectral mismatch			N/A				
Sample no.	P <sub>max</sub> [W]	V <sub>mpp</sub> [V]	I <sub>mpp</sub> [A]	V <sub>oc</sub> [V]	I <sub>sc</sub> [A]	FF [%]	
1-1	690.1	48.12	14.340	56.83	15.093	80.5	N/A
1-2	689.1	47.99	14.359	56.73	15.125	80.3	N/A
1-4	689.6	48.03	14.360	56.79	15.108	80.4	N/A
1-5	690.7	47.97	14.401	56.80	15.127	80.4	N/A
1-6	689.8	48.00	14.371	56.75	15.110	80.4	N/A
1-7	687.9	47.97	14.340	56.78	15.082	80.3	N/A
1-8	690.5	48.00	14.387	56.78	15.118	80.4	N/A
1-9	691.1	48.10	14.368	56.78	15.115	80.5	N/A
2-1	683.2	47.90	14.262	56.75	15.020	80.2	N/A
2-2	682.5	47.98	14.225	57.00	15.005	80.2	N/A
2-3	683.0	47.87	14.266	56.73	15.021	80.1	N/A
2-4	683.2	47.86	14.277	56.72	15.045	80.1	N/A
Supplementary information: The non-illuminated side was covered with non-reflective background and aperture. *A pulse solar simulator class AAA conforming to the requirements of IEC 60904-9 is used. The bifaciality coefficient $\varphi$ employed is the minimum value of $\varphi_{isc}$ and $\varphi_{Pmax}$ as documented in table 9.8.3 for each test sample.							



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9.9	Gate #1 evaluation (STC)				
Manufacturer tolerances given on name plate	for $P_{max}$	$t_1$ [%]	$\pm 3.0$	—	
	for $V_{OC}$	$t_2$ [%]	$\pm 3.0$		
	for $I_{SC}$	$t_3$ [%]	$\pm 3.0$		
	for $P_{max4}$	$t_4$ [%]	$\pm 3.0$		
Measurement uncertainty of test laboratory	for $P_{max}$	$m_1$ [%]	$\pm 3.0$ (for c-Si)		
	for $V_{OC}$	$m_2$ [%]	$\pm 0.9$ (for c-Si)		
	for $I_{SC}$	$m_3$ [%]	$\pm 2.8$ (for c-Si)		

9.9.1	Evaluation of output power for each module (STC)				
Sample no.	$P_{max,meas}$ [W]	$P_{max,meas,m1}$ [W]	$P_{max,NP}$ [W]	$P_{max,NP,t1}$ [W]	—
1-1	627.9	643.4	625.0	606.3	P
1-2	626.2	641.7	625.0	606.3	P
1-4	626.1	641.6	625.0	606.3	P
1-5	626.6	642.1	625.0	606.3	P
1-6	627.6	643.1	625.0	606.3	P
1-7	627.5	643.0	625.0	606.3	P
1-8	626.5	642.0	625.0	606.3	P
1-9	628.0	643.5	625.0	606.3	P
2-1	621.6	637.0	625.0	606.3	P
2-2	622.3	637.7	625.0	606.3	P
2-3	621.6	637.0	625.0	606.3	P
2-4	617.8	633.1	625.0	606.3	P

Supplementary information:

Pass criteria follow requirements of section 7.2.1 of IEC/EN 61215-1.

$P_{max,meas,m1}$  = Measured maximum STC power taking positive measurement uncertainty into account

$P_{max,NP,t1}$  = Nominal maximum STC power taking negative rated production tolerance into account

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9.9.2	Evaluation of output power for average of all modules (STC)			
Module type	$P_{\max, \text{meas}, \text{avg}}$ [W]	$P_{\max, \text{meas}, \text{avg}, \text{m1}}$ [W]	$P_{\max, \text{NP}}$ [W]	—
SYMN156TBD625 (BOM1)	627.1	642.6	625.0	P
SYMN156TBD620 (BOM2)	620.8	636.2	620.0	P

Supplementary information:  
Pass criteria follow requirements of section 7.2.1 of IEC/EN 61215-1.  
 $P_{\max, \text{meas}, \text{avg}, \text{m1}}$  = Arithmetic average of meas. max. STC power taking positive measurement uncertainty into account

9.9.3	Evaluation of open-circuit voltage for each module (STC)				
Sample no.	$V_{\text{oc}, \text{meas}}$ [V]	$V_{\text{oc}, \text{meas}, \text{m2}}$ [V]	$V_{\text{oc}, \text{NP}}$ [V]	$V_{\text{oc}, \text{NP}, \text{t2}}$ [V]	—
1-1	56.65	57.07	55.81	57.48	P
1-2	56.54	56.96	55.81	57.48	P
1-4	56.58	57.00	55.81	57.48	P
1-5	56.59	57.01	55.81	57.48	P
1-6	56.62	57.04	55.81	57.48	P
1-7	56.58	57.00	55.81	57.48	P
1-8	56.61	57.03	55.81	57.48	P
1-9	56.59	57.01	55.81	57.48	P
2-1	56.58	57.00	55.67	57.34	P
2-2	56.57	56.99	55.67	57.34	P
2-3	56.58	57.00	55.67	57.34	P
2-4	56.53	56.95	55.67	57.34	P

Supplementary information:  
Pass criteria follow requirements of section 7.2.1 of IEC/EN 61215-1.  
 $V_{\text{oc}, \text{meas}, \text{m2}}$  = Measured open-circuit voltage taking positive measurement uncertainty into account  
 $V_{\text{oc}, \text{NP}, \text{t2}}$  = Nominal open-circuit voltage taking positive rated production tolerance into account

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9.9.4	Evaluation of short-circuit current for each module (STC)				
Sample no.	$I_{sc, meas}$ [A]	$I_{sc, meas, m3}$ [A]	$I_{sc, NP}$ [A]	$I_{sc, NP, t3}$ [A]	—
1-1	13.714	14.031	13.840	14.255	P
1-2	13.723	14.040	13.840	14.255	P
1-4	13.718	14.035	13.840	14.255	P
1-5	13.722	14.039	13.840	14.255	P
1-6	13.752	14.070	13.840	14.255	P
1-7	13.729	14.046	13.840	14.255	P
1-8	13.723	14.040	13.840	14.255	P
1-9	13.716	14.033	13.840	14.255	P
2-1	13.657	13.972	13.780	14.193	P
2-2	13.656	13.971	13.780	14.193	P
2-3	13.667	13.983	13.780	14.193	P
2-4	13.677	13.993	13.780	14.193	P

Supplementary information:

Pass criteria follow requirements of section 7.2.1 of IEC/EN 61215-1.

$I_{sc, meas, m3}$  = Measured short-circuit current taking positive measurement uncertainty into account

$I_{sc, NP, t3}$  = Nominal short-circuit current taking positive rated production tolerance into account

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9.9	Gate #1 evaluation (BNPI)				
Manufacturer tolerances given on name plate	for $P_{\max(\text{BNPI})}$	$t_{1(\text{BNPI})}$ [%]	$\pm 3.0$	—	
	for $V_{\text{OC}(\text{BNPI})}$	$t_{2(\text{BNPI})}$ [%]	$\pm 3.0$		
	for $I_{\text{SC}(\text{BNPI})}$	$t_{3(\text{BNPI})}$ [%]	$\pm 3.0$		
	for $P_{\max 4(\text{BNPI})}$	$t_{4(\text{BNPI})}$ [%]	$\pm 3.0$		
Measurement uncertainty of test laboratory	for $P_{\max(\text{BNPI})}$	$m_{1(\text{BNPI})}$ [%]	$\pm 3.0$ (for c-Si)		
	for $V_{\text{OC}(\text{BNPI})}$	$m_{2(\text{BNPI})}$ [%]	$\pm 0.9$ (for c-Si)		
	for $I_{\text{SC}(\text{BNPI})}$	$m_{3(\text{BNPI})}$ [%]	$\pm 2.8$ (for c-Si)		

9.9.6	Evaluation of output power for each module (BNPI)				
Sample no.	$P_{\max(\text{BNPI}),\text{meas}}$ [W]	$P_{\max(\text{BNPI}),\text{meas},m1(\text{BNPI})}$ [W]	$P_{\max(\text{BNPI}),\text{NP}}$ [W]	$P_{\max(\text{BNPI}),\text{NP},t1(\text{BNPI})}$ [W]	—
1-1	690.1	707.2	688.0	667.4	P
1-2	689.1	706.2	688.0	667.4	P
1-4	689.6	706.7	688.0	667.4	P
1-5	690.7	707.8	688.0	667.4	P
1-6	689.8	706.9	688.0	667.4	P
1-7	687.9	704.9	688.0	667.4	P
1-8	690.5	707.6	688.0	667.4	P
1-9	691.1	708.2	688.0	667.4	P
2-1	683.2	700.1	682.0	661.5	P
2-2	682.5	699.4	682.0	661.5	P
2-3	683.0	699.9	682.0	661.5	P
2-4	683.2	700.1	682.0	661.5	P

Supplementary information:

Pass criteria follow requirements of section 7.2.1 of IEC/EN 61215-1.

$P_{\max(\text{BNPI}),\text{meas},m1(\text{BNPI})}$  = Measured maximum BNPI power taking positive measurement uncertainty into account

$P_{\max(\text{BNPI}),\text{NP},t1(\text{BNPI})}$  = Nominal maximum BNPI power taking negative rated production tolerance into account

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9.9.7	Evaluation of output power for average of all modules (BNPI)			
Module type	$P_{\max(\text{BNPI}),\text{meas,avg}}$ [W]	$P_{\max(\text{BNPI}),\text{meas,avg,m1}(\text{BNPI})}$ [W]	$P_{\max(\text{BNPI}),\text{NP}}$ [W]	—
SYMN156TBD688 (BOM1)	689.9	706.9	688.0	P
SYMN156TBD682 (BOM2)	683.0	699.9	682.0	P

Supplementary information:  
Pass criteria follow requirements of section 7.2.1 of IEC/EN 61215-1.  
 $P_{\max,\text{meas,avg,m1}}$  = Arithmetic average of meas. max. BNPI power taking positive measurement uncertainty into account

9.9.8	Evaluation of open-circuit voltage for each module (BNPI)				
Sample no.	$V_{\text{oc}(\text{BNPI}),\text{meas}}$ [V]	$V_{\text{oc}(\text{BNPI}),\text{meas,m2}(\text{BNPI})}$ [V]	$V_{\text{oc}(\text{BNPI}),\text{NP}}$ [V]	$V_{\text{oc}(\text{BNPI}),\text{NP,i2}(\text{BNPI})}$ [V]	—
1-1	56.83	57.25	55.81	57.48	P
1-2	56.73	57.15	55.81	57.48	P
1-4	56.79	57.21	55.81	57.48	P
1-5	56.80	57.22	55.81	57.48	P
1-6	56.75	57.17	55.81	57.48	P
1-7	56.78	57.20	55.81	57.48	P
1-8	56.78	57.20	55.81	57.48	P
1-9	56.78	57.20	55.81	57.48	P
2-1	56.75	57.17	55.67	57.34	P
2-2	57.00	57.42	55.67	57.34	P
2-3	56.73	57.15	55.67	57.34	P
2-4	56.72	57.14	55.67	57.34	P

Supplementary information:

Pass criteria follow requirements of section 7.2.1 of IEC/EN 61215-1.

$V_{\text{oc}(\text{BNPI}),\text{meas,m2}(\text{BNPI})}$  = Measured open-circuit voltage taking positive measurement uncertainty into account

$V_{\text{oc}(\text{BNPI}),\text{NP,i2}(\text{BNPI})}$  = Nominal open-circuit voltage taking positive rated production tolerance into account

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9.9.9	Evaluation of short-circuit current for each module (BNPI)				
Sample no.	$I_{sc(BNPI),meas} [A]$	$I_{sc(BNPI),meas,m3(BNPI)} [A]$	$I_{sc(BNPI),NP} [A]$	$I_{sc(BNPI),NP,t3(BNPI)} [A]$	—
1-1	15.093	15.442	15.220	15.677	P
1-2	15.125	15.474	15.220	15.677	P
1-4	15.108	15.457	15.220	15.677	P
1-5	15.127	15.476	15.220	15.677	P
1-6	15.110	15.459	15.220	15.677	P
1-7	15.082	15.430	15.220	15.677	P
1-8	15.118	15.467	15.220	15.677	P
1-9	15.115	15.464	15.220	15.677	P
2-1	15.020	15.367	15.160	15.615	P
2-2	15.005	15.352	15.160	15.615	P
2-3	15.021	15.368	15.160	15.615	P
2-4	15.045	15.393	15.160	15.615	P

Supplementary information:

Pass criteria follow requirements of section 7.2.1 of IEC/EN 61215-1.

$I_{sc(BNPI),meas,m3(BNPI)}$  = Measured short-circuit current taking positive measurement uncertainty into account

$I_{sc(BNPI),NP,t3(BNPI)}$  = Nominal short-circuit current taking positive rated production tolerance into account

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9.11	Performance at low irradiance – MQT 07
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9.11.1	Performance at low irradiance (front side)						
Test date (dd/mm/yyyy)			23/02/2024 for 1-1 21/02/2024 for 2-1				—
Test method			<input checked="" type="checkbox"/> indoor		<input type="checkbox"/> outdoor		
Illuminated side			<input checked="" type="checkbox"/> Front side <input type="checkbox"/> Rear side				
Ambient temperature [°C]			25 ± 2				
Irradiance [W/m²]			200*				
Module temperature [°C]			25 ± 0.2				
Sample no.	P <sub>max</sub> [W]	V <sub>mpp</sub> [V]	I <sub>mp</sub> [A]	V <sub>oc</sub> [V]	I <sub>sc</sub> [A]	FF [%]	
1-1	123.3	46.59	2.647	53.74	2.780	82.6	N/A
2-1	122.3	46.06	2.656	53.26	2.768	83.0	N/A
Supplementary information: *A pulse solar simulator class AAA conforming to the requirements of IEC 60904-9 is used. The non-illuminated side was covered with non-reflective background and aperture.							

9.11.2	Performance at low irradiance (rear side)						
Test date (dd/mm/yyyy)			23/02/2024 for 1-1 21/02/2024 for 2-1				—
Test method			<input checked="" type="checkbox"/> indoor		<input type="checkbox"/> outdoor		
Illuminated side			<input type="checkbox"/> Front side <input checked="" type="checkbox"/> Rear side				
Ambient temperature [°C]			25 ± 2				
Irradiance [W/m²]			200*				
Module temperature [°C]			25 ± 0.2				
Sample no.	P <sub>max</sub> [W]	V <sub>mpp</sub> [V]	I <sub>mp</sub> [A]	V <sub>oc</sub> [V]	I <sub>sc</sub> [A]	FF [%]	
1-1	93.4	47.45	1.969	53.47	2.192	79.7	N/A
2-1	93.1	46.79	1.990	52.61	2.213	80.0	N/A
Supplementary information: *A pulse solar simulator class AAA conforming to the requirements of IEC 60904-9 is used. The non-illuminated side was covered with non-reflective background and aperture.							

9.11.3	Bifaciality Coefficients at low irradiance			
Sample no.	$\Phi_{\text{isc}}$	$\Phi_{\text{Voc}}$	$\Phi_{\text{Pmax}}$	—
1-1	0.7885	0.995	0.7575	N/A
2-1	0.7995	0.9878	0.7612	N/A
Supplementary information: N/A				



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9.14	Hot-spot endurance test (WBT) – MQT 09 / MST 22				
Test date (dd/mm/yyyy)		08/05/2024-09/05/2024		—	
Sample no.		1-2			
Cell interconnection circuit		<input type="checkbox"/> S	<input checked="" type="checkbox"/> SP		<input type="checkbox"/> PS
Module temperature at thermal equilibrium [°C]		45.3			
Cell of complete module with highest shunt resistance shaded					
Maximum measured cell temperature [°C]		180.0			
Shading rate [%]		40.0			
1 <sup>st</sup> worst case cell of complete module with lowest shunt resistance shaded					
Maximum measured cell temperature [°C]		175.0			
Shading rate [%]		50.0			
2 <sup>nd</sup> worst case cell of complete module with lowest shunt resistance shaded					
Maximum measured cell temperature [°C]		184.0			
Shading rate [%]		40.0			
Cell adjacent to module edge with lowest shunt resistance shaded					
Maximum measured cell temperature [°C]		169.0			
Shading rate [%]		60.0			
Supplementary information: The exposure was performed under G <sub>BSI</sub> which is equal to 1000W/m <sup>2</sup> + φ•300W/m <sup>2</sup> .					

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9.14	Hot-spot endurance test (WBT) – MQT 09 / MST 22			
Test date (dd/mm/yyyy)		28/03/2024-01/04/2024		
Sample no.		2-2		
Cell interconnection circuit		<input type="checkbox"/> S	<input checked="" type="checkbox"/> SP	<input type="checkbox"/> PS
Module temperature at thermal equilibrium [°C]		55.9		
Cell of complete module with highest shunt resistance shaded				
Maximum measured cell temperature [°C]		170.0		
Shading rate [%]		40.0		
1 <sup>st</sup> worst case cell of complete module with lowest shunt resistance shaded				
Maximum measured cell temperature [°C]		183.0		
Shading rate [%]		60.0		
2 <sup>nd</sup> worst case cell of complete module with lowest shunt resistance shaded				
Maximum measured cell temperature [°C]		175.0		
Shading rate [%]		50.0		
Cell adjacent to module edge with lowest shunt resistance shaded				
Maximum measured cell temperature [°C]		181.0		
Shading rate [%]		50.0		
Supplementary information: The exposure was performed under G <sub>BSI</sub> which is equal to 1000W/m <sup>2</sup> + φ•300W/m <sup>2</sup> .				

9.14.1	Visual inspection after Hot-spot endurance test – MQT 01 / MST 01		
Test date (dd/mm/yyyy)	10/05/2024 for 1-2 08/04/2024 for 2-2		—
Sample no.	Requirement	Nature and position of findings	
1-2	No major visual defects	No major visual defects	P
2-2	No major visual defects	No major visual defects	P
Supplementary information: N/A			

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9.14.2	Insulation test after Hot-spot endurance test – MQT 03 / MST 16					
Test date (dd/mm/yyyy)				10/05/2024 for 1-2 08/04/2024 for 2-2		—
Maximum system voltage [V <sub>DC</sub> ]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V <sub>DC</sub> ]				8000		
Insulation resistance measured at [V <sub>DC</sub> ]				1500		
Sample no.	R <sub>iso</sub> [GΩ]	A [m²]	R <sub>iso</sub> ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
1-2	8.44	2.80	23.63	-	No	P
2-2	12.30	2.80	34.44	-	No	P
Supplementary information: Minimum requirement is 0.04 GΩ·m² for A > 0.1 m² and 0.4 GΩ for A ≤ 0.1 m².						

9.14.3	Wet leakage current test after Hot-spot endurance test – MQT 15 / MST 17			
Test date (dd/mm/yyyy)		10/05/2024 for 1-2 08/04/2024 for 2-2		—
Maximum system voltage [V <sub>DC</sub> ]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V <sub>DC</sub> ]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R <sub>iso</sub> [MΩ]	A [m²]	R <sub>iso</sub> ·A [MΩ·m²]	
1-2	4160.0	2.80	11648.0	P
2-2	3690.0	2.80	10332.0	P
Supplementary information: Minimum requirement is 40 MΩ·m².				

Absatz	<b>Photovoltaic (PV) modules</b>	Messergebnisse - Bemerkungen	Ergebnis
Clause	Anforderungen - Prüfungen / <i>Requirements - Tests</i>	<i>Measuring results - Remarks</i>	<i>Result</i>

9.14.4	Maximum power determination after Hot-spot endurance test – MQT 02 / MST 03						
Test date (dd/mm/yyyy)			10/05/2024 for 1-2 08/04/2024 for 2-2				—
Test method			<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight				
Ambient temperature [°C]			25 ± 2				
Irradiance [W/m²]			1000*				
Module temperature [°C]			25 ± 1				
Sample no.	P <sub>max</sub> [W]	V <sub>mpp</sub> [V]	I <sub>mpp</sub> [A]	V <sub>oc</sub> [V]	I <sub>sc</sub> [A]	FF [%]	
1-2	625.7	48.13	12.999	58.54	13.724	80.6	N/A
2-2	619.9	47.91	12.940	56.36	13.703	80.3	N/A
Supplementary information: *A pulse solar simulator class AAA conforming to the requirements of IEC 60904-9 is used.							

9.14.5	Bypass diode functionality test after Hot-spot endurance test – MQT 18.2 / MST 07			
Test date (dd/mm/yyyy)		10/05/2024 for 1-2 08/04/2024 for 2-2		—
Test method		<input type="checkbox"/> Method A <input checked="" type="checkbox"/> Method B		
Sample no.	Diode 1	Diode 2	Diode 3	
1-2	working properly	working properly	working properly	P
2-2	working properly	working properly	working properly	P
Supplementary information: This test verifies that the sample shows the electrical characteristics of a functional photovoltaic device.				

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9.15	Reverse current overload test – MST 26		
Test date (dd/mm/yyyy)		11/05/2024 for 1-2 10/05/2024 for 2-2	—
Module over-current protection rating [A]		30	
Test current [A]		40.5	
Range of applied voltage [V]		1500	
Test duration [h]		2	
Sample no.	Test results		—
1-2	<input checked="" type="checkbox"/> No flaming of the PV module		P
	<input checked="" type="checkbox"/> No flaming or charring of the tissue paper		
2-2	<input checked="" type="checkbox"/> No flaming of the PV module		P
	<input checked="" type="checkbox"/> No flaming or charring of the tissue paper		
Supplementary information: N/A			

9.15.1	Visual inspection after Reverse current overload test – MST 01		
Test date (dd/mm/yyyy)		11/05/2024 for 1-2 10/05/2024 for 2-2	—
Sample no.	Requirement	Nature and position of findings	
1-2	No major visual defects	No major visual defects	P
2-2	No major visual defects	No major visual defects	P
Supplementary information: N/A			

9.15.2	Insulation test after Reverse current overload test – MST 16					
Test date (dd/mm/yyyy)				11/05/2024 for 1-2 10/05/2024 for 2-2		—
Maximum system voltage [V <sub>DC</sub> ]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V <sub>DC</sub> ]				8000		
Insulation resistance measured at [V <sub>DC</sub> ]				1500		
Sample no.	R <sub>iso</sub> [GΩ]	A [m²]	R <sub>iso</sub> ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
1-2	8.25	2.80	23.10	-	No	P
2-2	11.80	2.80	33.04	-	No	P

Supplementary information:

Minimum requirement is  $0.04 \text{ G}\Omega\cdot\text{m}^2$  for  $A > 0.1 \text{ m}^2$  and  $0.4 \text{ G}\Omega$  for  $A \leq 0.1 \text{ m}^2$ .

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9.15.3	Wet leakage current test after Reverse current overload test – MST 17			
Test date (dd/mm/yyyy)		11/05/2024 for 1-2 10/05/2024 for 2-2		—
Maximum system voltage [V <sub>DC</sub> ]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V <sub>DC</sub> ]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R <sub>iso</sub> [MΩ]	A [m²]	R <sub>iso</sub> ·A [MΩ·m²]	
1-2	4080.0	2.80	11424.0	P
2-2	3810.0	2.80	10668.0	P
Supplementary information: Minimum requirement is 40 MΩ·m².				

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9.16	Bypass diode thermal test – MQT 18.1 / MST 25				
Test date (dd/mm/yyyy)		11/05/2024			—
Sample no.		1-3			
Number of diodes in junction box		3			
Max. permissible junction temperature $T_{Jmax}$ [°C] (according to diode datasheet)		200.0			
Step 1: Determination of $V_D$ versus $T_J$ characteristic					
Temperature of junction box (average) [°C]		30 ± 2	50 ± 2	70 ± 2	90 ± 2
Diode voltage [ $V_D$ ]		0.4675/0.4685/0.4704	0.4453/0.4466/0.4489	0.4270/0.4271/0.4293	0.4085/0.4086/0.4113
Determined $V_D$ versus $T_J$ characteristics					
$V_D = -0.0010 T_J + 0.4957$ (diode 1) $V_D = -0.0010 T_J + 0.4975$ (diode 2) $V_D = -0.0010 T_J + 0.4990$ (diode 3)					
Step 2: Bypass diode thermal test					
—	Diode 1		Diode 2		Diode 3
Module temperature [°C]		75 ± 5	75 ± 5		75 ± 5
Diode current flow applied ( $I_{sc}$ ) [A]		16.769	16.769		16.769
Voltage drop across diode after 1 hour [V]		0.324	0.315		0.333
Calculated junction temperature $T_{Jcalc}$ [°C]		175.8	183.2		168.7
$T_{Jcalc} < T_{Jmax}$ (required for passing the test)?		Yes	Yes		Yes
Diode current flow applied ( $1.25 \cdot I_{sc}$ ) [A]		20.961	20.961		20.961
Diode functional?		Yes	Yes		Yes
Supplementary information: N/A					

9.16.1	Visual inspection after Bypass diode thermal test – MQT 01 / MST 01		
Test date (dd/mm/yyyy)		11/05/2024	—
Sample no.	Requirement	Nature and position of findings	
1-3	No major visual defects	No major visual defects	P
Supplementary information: N/A			



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9.16.2	Insulation test after Bypass diode thermal test – MQT 03 / MST 16					
Test date (dd/mm/yyyy)				11/05/2024		—
Maximum system voltage [V <sub>DC</sub> ]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V <sub>DC</sub> ]				8000		
Insulation resistance measured at [V <sub>DC</sub> ]				1500		
Sample no.	R <sub>iso</sub> [GΩ]	A [m²]	R <sub>iso</sub> ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
1-3	8.29	2.80	23.21	-	No	P
Supplementary information: Minimum requirement is 0.04 GΩ·m² for A > 0.1 m² and 0.4 GΩ for A ≤ 0.1 m².						

9.16.3	Wet leakage current test after Bypass diode thermal test – MQT 15 / MST 17			
Test date (dd/mm/yyyy)		11/05/2024		—
Maximum system voltage [V <sub>DC</sub> ]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V <sub>DC</sub> ]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R <sub>iso</sub> [MΩ]	A [m²]	R <sub>iso</sub> ·A [MΩ·m²]	P
1-3	4080.0	2.80	11424.0	
Supplementary information: Minimum requirement is 40 MΩ·m².				

9.16.4	Bypass diode functionality test after Bypass diode thermal test – MQT 18.2 / MST 07			
Test date (dd/mm/yyyy)		11/05/2024		—
Test method		<input type="checkbox"/> Method A <input checked="" type="checkbox"/> Method B		
Sample no.	Diode 1	Diode 2	Diode 3	
1-3	working properly	working properly	working properly	P
Supplementary information: This test verifies that the sample shows the electrical characteristics of a functional photovoltaic device.				

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9.17	UV preconditioning test – MQT 10 / MST 54			
Test date (dd/mm/yyyy)		24/02/2024- 26/02/2024 for 1-4,1-5 26/02/2024- 01/03/2024 for 2-3,2-4		—
Module temperature [°C]		60 ± 5		
Ratio of UV-B irradiation (280 – 320 nm) [%]		3 - 10		
UV irradiation dose (280 – 400 nm) [kWh/m²]		15		
UV irradiation direction		<input checked="" type="checkbox"/> Front side <input checked="" type="checkbox"/> Rear side		
Operation mode		<input checked="" type="checkbox"/> Short-circuit	<input type="checkbox"/> Open-circuit	
Sample no.	—			
1-4	—			N/A
1-5	—			N/A
2-3	—			N/A
2-4	—			N/A
Supplementary information: UV preconditioning test was performed on both front side and rear side for bifacial modules.				

9.17.1	Visual inspection after UV preconditioning test – MQT 01 / MST 01		
Test date (dd/mm/yyyy)		28/02/2024 for 1-4,1-5 05/03/2024 for 2-3,2-4	—
Sample no.	Requirement	Nature and position of findings	
1-4	No major visual defects	No major visual defects	P
1-5		No major visual defects	P
2-3		No major visual defects	P
2-4		No major visual defects	P
Supplementary information: N/A			

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9.17.2	Insulation test after UV preconditioning test – MQT 03 / MST 16					
Test date (dd/mm/yyyy)				28/02/2024 for 1-4,1-5 05/03/2024 for 2-3,2-4		—
Maximum system voltage [V <sub>DC</sub> ]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V <sub>DC</sub> ]				8000		
Insulation resistance measured at [V <sub>DC</sub> ]				1500		
Sample no.	R <sub>iso</sub> [GΩ]	A [m²]	R <sub>iso</sub> ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
1-4	8.45	2.80	23.66	-	No	P
1-5	8.43	2.80	23.60	-	No	P
2-3	13.10	2.80	36.68	-	No	P
2-4	13.20	2.80	36.96	-	No	P
Supplementary information: Minimum requirement is 0.04 GΩ·m² for A > 0.1 m² and 0.4 GΩ for A ≤ 0.1 m².						

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9.17.3	Wet leakage current test after UV preconditioning test – MQT 15 / MST 17			
Test date (dd/mm/yyyy)		28/02/2024 for 1-4,1-5 05/03/2024 for 2-3,2-4		—
Maximum system voltage [V <sub>DC</sub> ]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V <sub>DC</sub> ]		/1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R <sub>iso</sub> [MΩ]	A [m²]	R <sub>iso</sub> ·A [MΩ·m²]	
1-4	4170.0	2.80	11676.0	P
1-5	3730.0	2.80	10444.0	P
2-3	4170.0	2.80	11676.0	P
2-4	3870.0	2.80	10836.0	P
Supplementary information: Minimum requirement is 40 MΩ·m².				

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9.18	Cyclic (dynamic) mechanical load test – MQT 20		
Test date (dd/mm/yyyy)		19/03/2024 for 1-4,1-5 20/03/2024 for 2-3,2-4	—
Mechanical pressure load applied [Pa]		1000	
Mechanical tensile load applied [Pa]		1000	
Total number of cycles		1000	
Frequency of cycles [cycles/minute]		3	
Mounting method		4 clamps and 2 rails	
Sample no.	Open circuits (yes/no)		
1-4	No		P
1-5	No		P
2-3	No		P
2-4	No		P
Supplementary information: N/A			

9.18.1	Visual inspection after Cyclic (dynamic) mechanical load test – MQT 01		
Test date (dd/mm/yyyy)		21/03/2024	—
Sample no.	Requirement	Nature and position of findings	
1-4	No major visual defects	No major visual defects	P
1-5		No major visual defects	P
2-3		No major visual defects	P
2-4		No major visual defects	P
Supplementary information: N/A			

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9.18.2	Insulation test after Cyclic (dynamic) mechanical load test – MQT 03					
Test date (dd/mm/yyyy)				21/03/2024		—
Maximum system voltage [V <sub>DC</sub> ]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V <sub>DC</sub> ]				8000		
Insulation resistance measured at [V <sub>DC</sub> ]				1500		
Sample no.	R <sub>iso</sub> [GΩ]	A [m²]	R <sub>iso</sub> ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
1-4	8.25	2.80	23.10	-	No	P
2-3	12.90	2.80	36.12	-	No	P
Supplementary information: Minimum requirement is 0.04 GΩ·m² for A > 0.1 m² and 0.4 GΩ for A ≤ 0.1 m².						

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9.18.3	Wet leakage current test after Cyclic (dynamic) mechanical load test – MQT 15			
Test date (dd/mm/yyyy)		21/03/2024		—
Maximum system voltage [V <sub>DC</sub> ]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V <sub>DC</sub> ]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R <sub>iso</sub> [MΩ]	A [m²]	R <sub>iso</sub> ·A [MΩ·m²]	
1-4	4150.0	2.80	11620.0	P
1-5	3710.0	2.80	10388.0	P
2-3	4150.0	2.80	11620.0	P
2-4	3850.0	2.80	10780.0	P
Supplementary information: Minimum requirement is 40 MΩ·m².				



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9.19	Thermal cycling test (50 cycles) – MQT 11 / MST 51		
Test date (dd/mm/yyyy)		22/03/2024 - 31/03/2024	—
Total number of cycles		50	
Actual dwell duration at high and low temperatures		Min. 10 min / Min. 10 min	
Sample no.	Open circuits (yes/no)		
1-4	No		P
1-5	No		P
2-3	No		P
2-4	No		P
Supplementary information: A single 5N weight was attached to the electrical termination leads / junction box. $I_{mpp}(G_{BSI})(G_{BSI} \text{ equals to } 1000W/m^2 + \phi \cdot 300W/m^2)$ was applied.			

9.19.1	Visual inspection after Thermal cycling test (50 cycles) – MQT 01 / MST 01		
Test date (dd/mm/yyyy)		31/03/2024	—
Sample no.	Requirement	Nature and position of findings	
1-4	No major visual defects	No major visual defects	P
1-5		No major visual defects	P
2-3		No major visual defects	P
2-4		No major visual defects	P
Supplementary information: N/A			

9.19.2	Insulation test after Thermal cycling test (50 cycles) – MQT 03 / MST 16					
Test date (dd/mm/yyyy)				31/03/2024		—
Maximum system voltage [V <sub>DC</sub> ]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V <sub>DC</sub> ]				8000		
Insulation resistance measured at [V <sub>DC</sub> ]				1500		
Sample no.	R <sub>iso</sub> [GΩ]	A [m²]	R <sub>iso</sub> ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
1-4	7.21	2.80	20.19	-	No	P
2-3	14.60	2.80	40.88	-	No	P

Supplementary information:

Minimum requirement is  $0.04 \text{ G}\Omega\cdot\text{m}^2$  for  $A > 0.1 \text{ m}^2$  and  $0.4 \text{ G}\Omega$  for  $A \leq 0.1 \text{ m}^2$ .

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9.19.3	Wet leakage current test after Thermal cycling test (50 cycles) – MQT 15 / MST 17			
Test date (dd/mm/yyyy)		31/03/2024		—
Maximum system voltage [V <sub>DC</sub> ]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V <sub>DC</sub> ]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R <sub>iso</sub> [MΩ]	A [m²]	R <sub>iso</sub> ·A [MΩ·m²]	
1-4	4060.0	2.80	11368.0	P
1-5	3810.0	2.80	10668.0	P
2-3	4100.0	2.80	11480.0	P
2-4	4020.0	2.80	11256.0	P
Supplementary information: Minimum requirement is 40 MΩ·m².				

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9.20	Humidity-freeze test – MQT 12 / MST 52		
Test date (dd/mm/yyyy)		01/04/2024 - 11/04/2024	—
Total number of cycles		10	
Sample no.	Open circuits (yes/no)		
1-4	No		P
1-5	No		P
2-3	No		P
2-4	No		P
Supplementary information: N/A			

9.20.1	Visual inspection after Humidity-freeze test – MQT 01 / MST 01		
Test date (dd/mm/yyyy)		11/04/2024	—
Sample no.	Requirement	Nature and position of findings	
1-4	No major visual defects	No major visual defects	P
1-5		No major visual defects	P
2-3		No major visual defects	P
2-4		No major visual defects	P
Supplementary information: N/A			

9.20.2	Insulation test after Humidity-freeze test – MQT 03 / MST 16					
Test date (dd/mm/yyyy)				11/04/2024		—
Maximum system voltage [V <sub>DC</sub> ]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V <sub>DC</sub> ]				8000		
Insulation resistance measured at [V <sub>DC</sub> ]				1500		
Sample no.	R <sub>iso</sub> [GΩ]	A [m²]	R <sub>iso</sub> ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
1-4	8.16	2.80	22.85	-	No	P
1-5	9.24	2.80	25.87	-	No	P
2-3	12.40	2.80	34.72	-	No	P
Supplementary information:						
Minimum requirement is 0.04 GΩ·m² for A > 0.1 m² and 0.4 GΩ for A ≤ 0.1 m².						

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9.20.3	Wet leakage current test after Humidity-freeze test – MQT 15 / MST 17			
Test date (dd/mm/yyyy)		11/04/2024		—
Maximum system voltage [V <sub>DC</sub> ]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V <sub>DC</sub> ]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R <sub>iso</sub> [MΩ]	A [m²]	R <sub>iso</sub> ·A [MΩ·m²]	
1-4	4100.0	2.80	11480.0	P
1-5	3980.0	2.80	11144.0	P
2-3	4100.0	2.80	11480.0	P
2-4	3970.0	2.80	11116.0	P
Supplementary information:				
Minimum requirement is 40 MΩ·m².				

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9.21	Retention of junction box on mounting surface – MQT 14.1 / MST 42		
Test date (dd/mm/yyyy)		19/04/2024 for 1-8 11/04/2024 for 1-4,2-3	—
Sample no.		1-4,1-8,2-3	
Applied force in all directions parallel to the mounting surface and parallel to the module edges [N]		40	
Applied force perpendicular to the mounting surface [N]		40	
Supplementary information: N/A			

9.21.1	Visual inspection after Retention of junction box on mounting surface – MQT 01 / MST 01		
Test date (dd/mm/yyyy)		19/04/2024 for 1-8 11/04/2024 for 1-4,2-3	—
Sample no.	Requirement	Nature and position of findings	
1-4	No major visual defects	No major visual defects	
1-8	No major visual defects	No major visual defects	
2-3	No major visual defects	No major visual defects	P
Supplementary information: N/A			

9.21.2	Insulation test after Retention of junction box on mounting surface – MQT 03 / MST 16					
Test date (dd/mm/yyyy)				19/04/2024 for 1-8 11/04/2024 for 1-4,2-3		—
Maximum system voltage [V <sub>DC</sub> ]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V <sub>DC</sub> ]				8000		
Insulation resistance measured at [V <sub>DC</sub> ]				1500		
Sample no.	R <sub>iso</sub> [GΩ]	A [m²]	R <sub>iso</sub> ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
1-4	7.11	2.80	19.91	-	No	P
1-8	8.45	2.80	23.66	-	No	P
2-3	11.70	2.80	32.76	-	No	P
Supplementary information:						
Minimum requirement is 0.04 GΩ·m² for A > 0.1 m² and 0.4 GΩ for A ≤ 0.1 m².						

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9.21.3	Wet leakage current test after Retention of junction box on mounting surface – MQT 15 / MST 17			
Test date (dd/mm/yyyy)		19/04/2024 for 1-8 11/04/2024 for 1-4,2-3		—
Maximum system voltage [V <sub>DC</sub> ]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V <sub>DC</sub> ]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R <sub>iso</sub> [MΩ]	A [m²]	R <sub>iso</sub> ·A [MΩ·m²]	
1-4	3720.0	2.80	10416.0	P
1-8	4430.0	2.80	12404.0	P
2-3	3930.0	2.80	11004.0	P
Supplementary information: Minimum requirement is 40 MΩ·m².				

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9.23	Thermal cycling test (200 cycles) – MQT 11 / MST 51		
Test date (dd/mm/yyyy)		08/03/2024 - 12/04/2024	—
Total number of cycles		200	
Actual dwell duration at high and low temperatures		Min. 10 min / Min. 10 min	
Sample no.	Open circuits (yes/no)		
1-6	No		P
1-7	No		P
Supplementary information: A single 5N weight was attached to the electrical termination leads / junction box. $I_{\text{mpp}}(G_{\text{BSI}})(G_{\text{BSI}}$ equals to $1000\text{W/m}^2 + \varphi \cdot 300\text{W/m}^2$ ) was applied.			

9.23.1	Visual inspection after Thermal cycling test (200 cycles) – MQT 01 / MST 01		
Test date (dd/mm/yyyy)		12/04/2024	—
Sample no.	Requirement	Nature and position of findings	
1-6	No major visual defects	No major visual defects	
1-7		No major visual defects	
Supplementary information: N/A			

9.23.2		Insulation test after Thermal cycling test (200 cycles) – MQT 03 / MST 16				
Test date (dd/mm/yyyy)				12/04/2024		—
Maximum system voltage [V <sub>DC</sub> ]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V <sub>DC</sub> ]				8000		
Insulation resistance measured at [V <sub>DC</sub> ]				1500		
Sample no.	R <sub>iso</sub> [GΩ]	A [m²]	R <sub>iso</sub> ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
1-6	7.24	2.80	20.27	-	No	P
1-7	14.60	2.80	40.88	-	No	P
Supplementary information:						
Minimum requirement is 0.04 GΩ·m² for A > 0.1 m² and 0.4 GΩ for A ≤ 0.1 m².						

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9.23.3	Wet leakage current test after Thermal cycling test (200 cycles) – MQT 15 / MST 17			
Test date (dd/mm/yyyy)		12/04/2024		—
Maximum system voltage [V <sub>DC</sub> ]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V <sub>DC</sub> ]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R <sub>iso</sub> [MΩ]	A [m²]	R <sub>iso</sub> ·A [MΩ·m²]	
1-6	3810.0	2.80	10668.0	P
1-7	3760.0	2.80	10528.0	P
Supplementary information: Minimum requirement is 40 MΩ·m².				



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9.24	Damp heat test – MQT 13 / MST 53		
Test date (dd/mm/yyyy)		08/03/2024 - 19/04/2024	—
Total duration [h]		1000	
Sample no.	—		
1-8	—		N/A
1-9	—		N/A
Supplementary information: N/A			

9.24.1	Visual inspection after Damp heat test – MQT 01 / MST 01		
Test date (dd/mm/yyyy)		19/04/2024	—
Sample no.	Requirement	Nature and position of findings	
1-8	No major visual defects	No major visual defects	P
1-9		No major visual defects	P
Supplementary information: N/A			

9.24.2		Insulation test after Damp heat test – MQT 03 / MST 16				
Test date (dd/mm/yyyy)				19/04/2024		—
Maximum system voltage [V <sub>DC</sub> ]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V <sub>DC</sub> ]				8000		
Insulation resistance measured at [V <sub>DC</sub> ]				1500		
Sample no.	R <sub>iso</sub> [GΩ]	A [m²]	R <sub>iso</sub> ·A [GΩ·m²]	Dielectric breakdown		P
				Yes (description)	No	
1-8	8.42	2.80	23.58	-	No	
Supplementary information: Minimum requirement is 0.04 GΩ·m² for A > 0.1 m² and 0.4 GΩ for A ≤ 0.1 m².						

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9.24.3	Wet leakage current test after Damp heat test – MQT 15 / MST 17			
Test date (dd/mm/yyyy)		19/04/2024		—
Maximum system voltage [V <sub>DC</sub> ]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V <sub>DC</sub> ]		8000		
Solution resistivity [ $\Omega \cdot \text{cm}$ ]		$\leq 3500$		
Solution temperature [ $^{\circ}\text{C}$ ]		22 $\pm$ 2		
Sample no.	R <sub>iso</sub> [M $\Omega$ ]	A [m <sup>2</sup> ]	R <sub>iso</sub> ·A [M $\Omega \cdot \text{m}^2$ ]	
1-8	4540.0	2.80	12712.0	P
1-9	4280.0	2.80	11984.0	P
Supplementary information: Minimum requirement is 40 M $\Omega \cdot \text{m}^2$ .				

9.24.4	Maximum power determination after Damp heat test – MQT 02 (Optional)						
Test date (dd/mm/yyyy)			19/04/2024				—
Test method			<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight				
Ambient temperature [°C]			25 ± 2				
Irradiance [W/m²]			1000 + $\varphi \cdot 135^*$				
Module temperature [°C]			25 ± 1				
Sample no.	P <sub>max</sub> [W]	V <sub>mpp</sub> [V]	I <sub>mpp</sub> [A]	V <sub>oc</sub> [V]	I <sub>sc</sub> [A]	FF [%]	
1-8	621.6	48.17	12.906	56.60	13.559	81.0	N/A
1-9	622.3	48.11	12.934	56.60	13.550	81.1	N/A

Supplementary information: \*A pulse solar simulator class AAA conforming to the requirements of IEC 60904-9 is used. The bifaciality coefficient  $\phi$  employed is the minimum value of  $\phi_{\text{ISC}}$  and  $\phi_{\text{Pmax}}$  as documented in table 9.8.3 for each test sample.

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9.25	Static mechanical load test – MQT 16 / MST 34			
Test date (dd/mm/yyyy)		11/05/2024		—
Load direction applied		Positive (downward)	Negative (upward)	
Design load [Pa]		3600	1600	
Safety factor $\gamma_m$		1.5	1.5	
Test load [Pa]		5400	2400	
Mounting method		4 clamps and 2 rails		
Sample no.	Open circuits (yes/no)			—
1-8	No			P
Supplementary information:				
Load was applied pneumatically; 1 cycle = 1 hour pressure load + 1 hour tensile load (total 3 cycles)				
1 <sup>st</sup> cycle = 5400Pa + 2400Pa				
2 <sup>nd</sup> cycle = 5400Pa + 2400Pa				
3 <sup>rd</sup> cycle = 5400Pa + 2400Pa				
See photos in Appendix E for detailed mounting method.				

9.25.1	Visual inspection after Static mechanical load test – MQT 01 / MST 01		
Test date (dd/mm/yyyy)		11/05/2024	
Sample no.		Requirement	Nature and position of findings
1-8		No major visual defects	No major visual defects
Supplementary information: N/A			

9.25.2	Insulation test after Static mechanical load test – MQT 03 / MST 16					
Test date (dd/mm/yyyy)				13/05/2024		—
Maximum system voltage [V <sub>DC</sub> ]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V <sub>DC</sub> ]				8000		
Insulation resistance measured at [V <sub>DC</sub> ]				1500		
Sample no.	R <sub>iso</sub> [GΩ]	A [m²]	R <sub>iso</sub> •A [GΩ•m²]	Dielectric breakdown		
				Yes (description)	No	
1-8	8.61	2.80	24.11	-	No	P
Supplementary information:						
Minimum requirement is 0.04 GΩ•m² for A > 0.1 m² and 0.4 GΩ for A ≤ 0.1 m².						

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9.25.3	Wet leakage current test after Static mechanical load test – MQT 15 / MST 17			
Test date (dd/mm/yyyy)		13/05/2024		—
Maximum system voltage [V <sub>DC</sub> ]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V <sub>DC</sub> ]		8000		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R <sub>iso</sub> [MΩ]	A [m²]	R <sub>iso</sub> ·A [MΩ·m²]	P
1-8	4240.0	2.80	11872.0	
Supplementary information: Minimum requirement is 40 MΩ·m².				

—

P

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9.26	Hail test – MQT 17		
Test date (dd/mm/yyyy)		09/05/2024	—
Ice ball diameter [mm]		25	
Ice ball mass [g]		7.53 ± 5 %	
Ice ball velocity [m/s]		23 ± 5 %	
Number of impact locations		11	
Sample no.	—		N/A
1-9	—		
Supplementary information: N/A			

9.26.1	Visual inspection after Hail test – MQT 01		
Test date (dd/mm/yyyy)		10/05/2024	—
Sample no.	Requirement	Nature and position of findings	
1-9	No major visual defects	No major visual defects	P
Supplementary information: N/A			

9.26.2	Insulation test after Hail test – MQT 03					
Test date (dd/mm/yyyy)				10/05/2024		—
Maximum system voltage [V <sub>DC</sub> ]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V <sub>DC</sub> ]				8000		
Insulation resistance measured at [V <sub>DC</sub> ]				1500		
Sample no.	R <sub>iso</sub> [GΩ]	A [m²]	R <sub>iso</sub> ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
1-9	7.86	2.80	22.01	-	No	P

Supplementary information:

Minimum requirement is  $0.04 \text{ G}\Omega\cdot\text{m}^2$  for  $A > 0.1 \text{ m}^2$  and  $0.4 \text{ G}\Omega$  for  $A \leq 0.1 \text{ m}^2$ .

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<b>9.26.3</b>	<b>Wet leakage current test after Hail test – MQT 15</b>		
Test date (dd/mm/yyyy)	10/05/2024		
Maximum system voltage [V <sub>DC</sub> ]	1500		
Cemented joints?	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V <sub>DC</sub> ]	1500		
Solution resistivity [Ω·cm]	≤ 3500		
Solution temperature [°C]	22 ± 2		
Sample no.	R <sub>iso</sub> [MΩ]	A [m²]	R <sub>iso</sub> ·A [MΩ·m²]
1-9	3770.0	2.80	10556.0
Supplementary information: Minimum requirement is 40 MΩ·m².			

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9.28	Materials creep test – MST 37		
Test date (dd/mm/yyyy)		11/03/2024 - 20/03/2024	—
Temperature [°C]		105 ± 5	
Duration [h]		200	
Worst case mounting angle [°]		90	
Sample no.	—		
1-10	—		N/A
Supplementary information: N/A			

9.28.1	Visual inspection after Materials creep test – MST 01		
Test date (dd/mm/yyyy)		20/03/2024	—
Sample no.	Requirement	Nature and position of findings	
1-10	Creepage and clearance distances acc. to IEC/EN 61730-1, Table 3 are met.	No major visual defects	P
Supplementary information: N/A			

9.28.2	Insulation test after Materials creep test – MST 16					
Test date (dd/mm/yyyy)				20/03/2024		—
Maximum system voltage [V <sub>DC</sub> ]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V <sub>DC</sub> ]				8000		
Insulation resistance measured at [V <sub>DC</sub> ]				1500		
Sample no.	R <sub>iso</sub> [GΩ]	A [m²]	R <sub>iso</sub> ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
1-10	7.60	2.80	21.28	-	No	P
Supplementary information: Minimum requirement is 0.04 GΩ·m² for A > 0.1 m² and 0.4 GΩ for A ≤ 0.1 m².						

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9.28.3	Wet leakage current test after Materials creep test – MST 17			
Test date (dd/mm/yyyy)		20/03/2024		—
Maximum system voltage [V <sub>DC</sub> ]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V <sub>DC</sub> ]		8000		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R <sub>iso</sub> [MΩ]	A [m²]	R <sub>iso</sub> ·A [MΩ·m²]	P
1-10	3620.0	2.80	10136.0	
Supplementary information:				
Minimum requirement is 40 MΩ·m².				



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9.40	Impulse voltage test – MST 14		
Test date (dd/mm/yyyy)		14/05/2024 for 1-11 08/04/2024 for 2-5	—
Maximum system voltage [V]		1500	
Rated impulse voltage [V]		19680	
Impulse test voltage [V]		19680	
Lab altitude [m]		4	
Sample no.	Test results		
1-11	No evidence of dielectric breakdown or surface tracking observed		P
2-5	No evidence of dielectric breakdown or surface tracking observed		P
Supplementary information: N/A			

9.40.1	Visual inspection after Impulse voltage test – MST 01		
Test date (dd/mm/yyyy)		14/05/2024 for 1-11 08/04/2024 for 2-5	—
Sample no.	Requirement	Nature and position of findings	
1-11	No major visual defects	No major visual defects	P
2-5	No major visual defects	No major visual defects	P
Supplementary information: Test sample was covered with conductive foil.			

9.40.2	Insulation test after Impulse voltage test – MST 16					
Test date (dd/mm/yyyy)				14/05/2024 for 1-11 08/04/2024 for 2-5		—
Maximum system voltage [V <sub>DC</sub> ]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V <sub>DC</sub> ]				8000		
Insulation resistance measured at [V <sub>DC</sub> ]				1500		
Sample no.	R <sub>iso</sub> [GΩ]	A [m²]	R <sub>iso</sub> ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
1-11	8.71	2.80	24.39	-	No	P
2-5	8.72	2.80	24.40	-	No	P
Supplementary information:						
Minimum requirement is 0.04 GΩ·m² for A > 0.1 m² and 0.4 GΩ for A ≤ 0.1 m².						

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9.46	Maximum power determination (final) – MST 03		
Test date (dd/mm/yyyy)		11/04/2024 for 1-4,1-10,2-3, 13/05/2024 for 1-6,1-8	—
Irradiance [W/m²]		1000*	
Module temperature [°C]		25 ± 1	
Test method		<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight	
Sample no.	Appearance of final IV-curve		
1-4	No kinks or other unusual characteristics		P
1-6	No kinks or other unusual characteristics		P
1-8	No kinks or other unusual characteristics		P
1-10	No kinks or other unusual characteristics		P
2-3	No kinks or other unusual characteristics		P
Supplementary information: *A pulse solar simulator class AAA conforming to the requirements of IEC 60904-9 is used.			

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9.47	Performance at STC (final) – MQT 06.1
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9.47.1	Performance at STC (final) – MQT 06.1							
Test date (dd/mm/yyyy)			13/05/2024 for 1-6,1-7, 1-8, 10/05/2024 for 1-9, 11/04/2024 for others					—
Test method			<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight					
Illuminated side			<input checked="" type="checkbox"/> Front side <input type="checkbox"/> Rear side					
Ambient temperature [°C]			25 ± 2					
Irradiance [W/m²]			1000 ± 10					
Module temperature [°C]			25 ± 0.2					
Spectral mismatch			N/A					
Sample no.	P <sub>max</sub> [W]	V <sub>mpp</sub> [V]	I <sub>mp</sub> [A]	V <sub>oc</sub> [V]	I <sub>sc</sub> [A]	FF [%]	Degradation [%]	
1-4	624.6	48.19	12.962	56.57	13.649	80.9	-0.32	P
1-5	624.6	47.82	13.062	56.58	13.671	80.7	-0.49	P
1-6	620.3	47.31	13.111	56.52	13.669	80.3	-1.15	P
1-7	622.3	47.70	13.047	56.58	13.66	80.5	-0.67	P
1-8	621.6	48.17	12.906	56.60	13.559	81.0	-1.20	P
1-9	622.3	48.11	12.934	56.60	13.550	81.1	-0.86	P
2-3	621.0	48.01	12.935	56.58	13.61	80.6	-0.10	P
2-4	615.3	47.55	12.939	56.14	13.639	80.4	-0.41	P
Supplementary information: Negative degradation means power loss.								

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9.48	Gate #2 evaluation		
Reproducibility $r$ for $P_{\max}$ [%]		0.8	—
Reproducibility $r_{(\text{BNPI})}$ for $P_{\max(\text{BNPI})}$ [%]		0.8	—

9.48.1	Evaluation of output power for each module			
Sample no.	$P_{\max, \text{meas, Gate \#1}}$ [W]	$P_{\max, \text{meas, Gate \#1, r}}$ [W]	$P_{\max, \text{meas, Gate \#2}}$ [W]	—
1-4	626.1	590.0	624.6	P
1-5	626.6	590.5	624.6	P
1-6	627.6	591.5	620.3	P
1-7	627.5	591.4	622.3	P
1-8	626.5	590.4	621.6	P
1-9	628.0	591.8	622.3	P
2-3	621.6	585.8	621.0	P
2-4	617.8	582.2	615.3	P

Supplementary information:

Pass criteria follow requirements of section 7.2.1 of IEC/EN 61215-1.

$P_{\max, \text{meas, Gate \#1}}$  = Measured initial maximum STC power

$P_{\max, \text{meas, Gate \#1, r}}$  = Measured initial maximum STC power taking reproducibility and degradation of 5% into account

$P_{\max, \text{meas, Gate \#2}}$  = Measured final maximum STC power

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9.48.2	Evaluation of output power for each module			
Sample no.	$P_{\max(\text{BNPI}),\text{meas,Gate \#1}(\text{BNPI})}$ [W]	$P_{\max(\text{BNPI}),\text{meas,Gate \#1,r}(\text{BNPI})}$ [W]	$P_{\max(\text{BNPI}),\text{meas,Gate \#2}(\text{BNPI})}$ [W]	—
1-4	689.6	649.9	687.1	P
1-5	690.7	650.9	689.1	P
1-6	689.8	650.1	687.7	P
1-7	687.9	648.3	683.9	P
1-8	690.5	650.7	684.6	P
1-9	691.1	651.3	685.5	P
2-3	683.0	643.7	681.9	P
2-4	683.2	643.8	675.7	P

Supplementary information:

Pass criteria follow requirements of section 7.2.1 of IEC/EN 61215-1.

$P_{\max(\text{BNPI}),\text{meas,Gate \#1}(\text{BNPI})}$  = Measured initial maximum BNPI power

$P_{\max(\text{BNPI}),\text{meas,Gate \#1,r}(\text{BNPI})}$  = Measured initial maximum BNPI power taking reproducibility and degradation of 5% into account

$P_{\max(\text{BNPI}),\text{meas,Gate \#2}(\text{BNPI})}$  = Measured final maximum BNPI power

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Absatz	Photovoltaic (PV) modules	Messergebnisse - Bemerkungen	Ergebnis
Clause	Anforderungen - Prüfungen / Requirements - Tests	Measuring results - Remarks	Result

9.49	Bypass diode functionality test (final) – MQT 18.2 / MST 07			
Test date (dd/mm/yyyy)		11/05/2024 for 1-2, 11/04/2024 for 1-4, 04/05/2024 for 1-6, 13/05/2024 for 1-8, 23/02/2024 for 2-1, 10/05/2024 for 2-2, 21/02/2024 for 1-1,2-3		—
Test method		<input type="checkbox"/> Method A <input checked="" type="checkbox"/> Method B		
Sample no.	Diode 1	Diode 2	Diode 3	
1-1	working properly	working properly	working properly	P
1-2	working properly	working properly	working properly	P
1-3	working properly	working properly	working properly	P
1-4	working properly	working properly	working properly	P
1-6	working properly	working properly	working properly	P
1-8	working properly	working properly	working properly	P
2-1	working properly	working properly	working properly	P
2-2	working properly	working properly	working properly	P
2-3	working properly	working properly	working properly	P
Supplementary information:				
This test verifies that the sample shows the electrical characteristics of a functional photovoltaic device.				

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Absatz	Photovoltaic (PV) modules	Messergebnisse - Bemerkungen	Ergebnis
Clause	Anforderungen - Prüfungen / Requirements - Tests	Measuring results - Remarks	Result

9.51	Accessibility test (final) – MST 11		
Test date (dd/mm/yyyy)		11/04/2024 for 1-4,2-3, 13/05/2024 for 1-8 20/03/2024 for 1-10	—
Applied force [N]		10	
Sample no.	Contact with live electrical part?	R <sub>iso</sub> [MΩ]	
1-4	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	≥60.0	P
1-8	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	≥60.0	P
1-10	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	≥60.0	P
2-3	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	≥60.0	P
Supplementary information: The resistance tester can measure up to 60.0 MΩ.			

9.52	Continuity test of equipotential bonding (final) – MST 13		
Test date (dd/mm/yyyy)		11/04/2024 for 1-4,2-3, 13/05/2024 for 1-8 20/03/2024 for 1-10	—
Maximum overcurrent protection rating [A]		30	
Current applied [A]		75	
Duration of applied current [min]		2	
Location of designated point for equipotential bonding		long side of the frame	
No. of other conductive parts tested		3	
Sample no.	Max. measured voltage [mV]	Max. calculated resistance [mΩ]	
1-4	90.4/89.1/91.2	1.21/1.19/1.22	P
1-8	94.4/92.2/98.1	1.26/1.23/1.31	P
1-10	92.5/93.1/98.0	1.23/1.24/1.31	P
2-3	90.4/88.6/89.1	1.21/1.18/1.19	P
Supplementary information: N/A			



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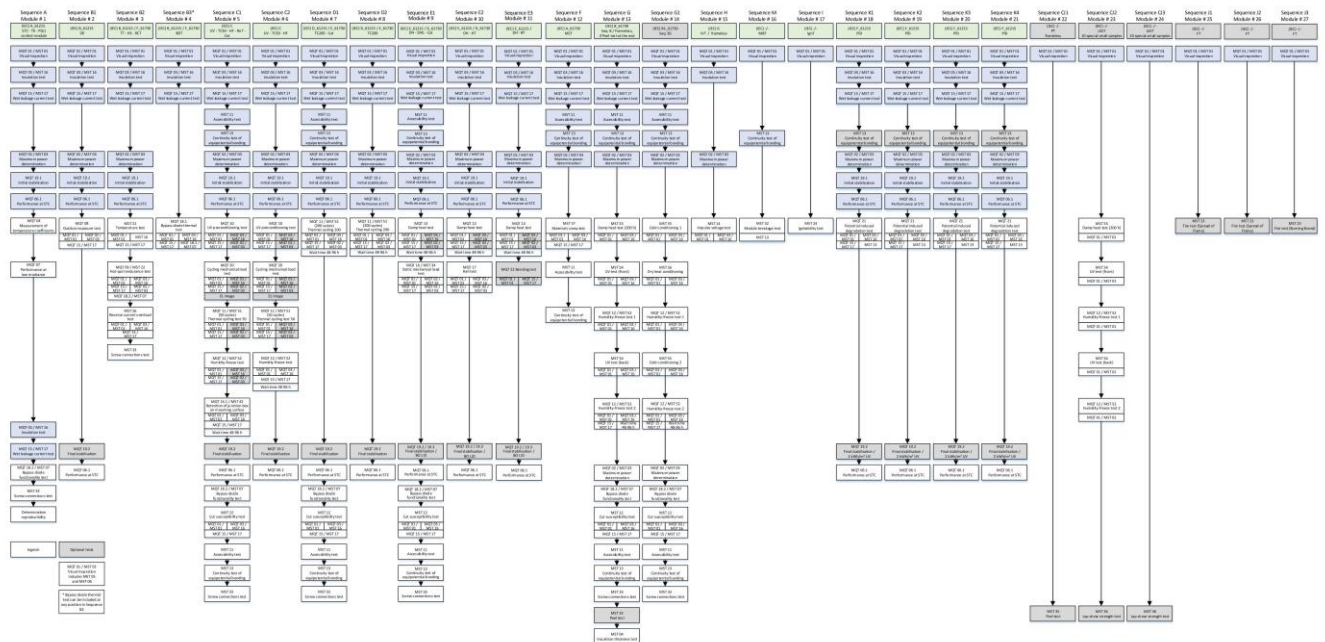
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Absatz	Photovoltaic (PV) modules	Messergebnisse - Bemerkungen	Ergebnis
Clause	Anforderungen - Prüfungen / Requirements - Tests	Measuring results - Remarks	Result

9.54	Durability of markings – MST 05		
Test date (dd/mm/yyyy)		11/05/2024 for 1-2, 11/04/2024 for 1-4, 04/05/2024 for 1-6, 13/05/2024 for 1-8, 10/05/2024 for 2-2, 21/02/2024 for 2-3	—
Duration of rubbing with water [s]		15	
Duration of rubbing with petroleum spirits [s]		15	
Sample no.	Comments		
1-2	The marking is legible; the marking plate is not removable and without curling.		P
1-4	The marking is legible; the marking plate is not removable and without curling.		P
1-6	The marking is legible; the marking plate is not removable and without curling.		P
1-8	The marking is legible; the marking plate is not removable and without curling.		P
2-2	The marking is legible; the marking plate is not removable and without curling.		P
2-3	The marking is legible; the marking plate is not removable and without curling.		P
Supplementary information: N/A			

9.55	Sharp edge test – MST 06		
Test date (dd/mm/yyyy)		11/05/2024 for 1-2, 11/04/2024 for 1-4, 04/05/2024 for 1-6, 13/05/2024 for 1-8, 10/05/2024 for 2-2, 21/02/2024 for 2-3	—
Sample no.	Comments		
1-2	The marking is legible; the marking plate is not removable and without curling.		P
1-4	The accessible PV module surfaces are smooth and free from sharp edges.		P
1-6	The accessible PV module surfaces are smooth and free from sharp edges.		P
1-8	The accessible PV module surfaces are smooth and free from sharp edges.		P
2-2	The accessible PV module surfaces are smooth and free from sharp edges.		P
2-3	The accessible PV module surfaces are smooth and free from sharp edges.		P
Supplementary information: N/A			

## Appendix A: Test charts



These test sequences were compiled following the requirements as defined in the International Electrotechnical Commission standards IEC 61215:2021 and IEC61730:2016.

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**ZUSATZ-DOKUMENTATION**  
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**Appendix B: Abbreviations used in the report**

<b>STC</b>	Standard Test Conditions
<b>P<sub>max</sub></b>	Maximum power
<b>I<sub>mpp</sub></b>	Maximum power point current
<b>V<sub>mpp</sub></b>	Maximum power point voltage
<b>I<sub>sc</sub></b>	Short circuit current
<b>V<sub>oc</sub></b>	Open circuit voltage
<b>FF</b>	Fill factor
<b>α</b>	Current temperature coefficient
<b>β</b>	Voltage temperature coefficient
<b>γ</b>	Power temperature coefficient
<b>S</b>	Series connection
<b>SP</b>	Series-parallel connection
<b>PS</b>	Parallel-series connection
<b>R<sub>iso</sub></b>	Electrical insulation resistance
<b>A</b>	Module area
<b>BNPI</b>	Bifacial nameplate irradiance
<b>BSI</b>	Bifacial stress irradiance
<b>G<sub>BNPI</sub></b>	Equivalent bifacial nameplate irradiance
<b>G<sub>BSI</sub></b>	Equivalent bifacial stress irradiance
<b>φ</b>	Bifaciality refers to the ratios between the main I-V characteristics of the rear side and the front side of a bifacial device, typically at Standard Test Conditions (STC) unless otherwise specified. It is quantified with reference to bifaciality coefficients, namely as φ.
<b>φ<sub>Pmax</sub></b>	Maximum power bifaciality coefficient
<b>φ<sub>Voc</sub></b>	Open-circuit voltage bifaciality coefficient
<b>φ<sub>Isc</sub></b>	Short-circuit current bifaciality coefficient

**Statement of the estimated uncertainty of the test verdicts**

- Electrical performance rating is outside the scope of IEC 61215:2021 qualification testing. The verdicts of performance rating are only related to the test samples that were subjected to the tests. They cannot be generalised to the modules from the series production.
- The calibration to STC was performed with a class AAA solar simulator. The extended measurement uncertainty is:
  - $2\sigma (P_{mpp}) \leq \pm 3.0 \%$
  - $2\sigma (I_{sc}) \leq \pm 2.8 \%$
  - $2\sigma (V_{oc}) \leq \pm 0.9 \%$
- The reproducibility parameter r with the solar simulator is 0.8 %.
- Relative measurements were performed with a flash type solar simulator.

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**Appendix C: History of reporting and certification**

Subject	Module type	Report no.	Certificate no.	Date of issue
N/A	N/A	N/A	N/A	N/A

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**Appendix D: Declaration**

**Statement**

To TUV Rheinland (Shanghai) Co., Ltd.:

Below solar cells have identical anti-reflective coating, metallization, crystallization process, cell thickness et. expect for cell dimension as below for details.

Solar cell 1 SYCN182T16 182.2mmX91mm & 182.2mmX91.875mm 16BB  
Solar cell 2 SYCN18AT16 182.2mmX95.8mm 16BB



Sany Silicon Energy (Zhuzhou) Co., Ltd.

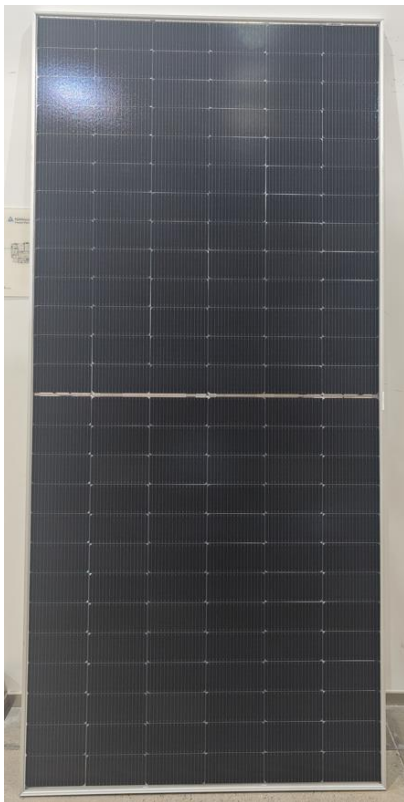
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**FOTO-DOKUMENTATION**  
**PHOTO DOCUMENTATION**

**Appendix E: Photos**

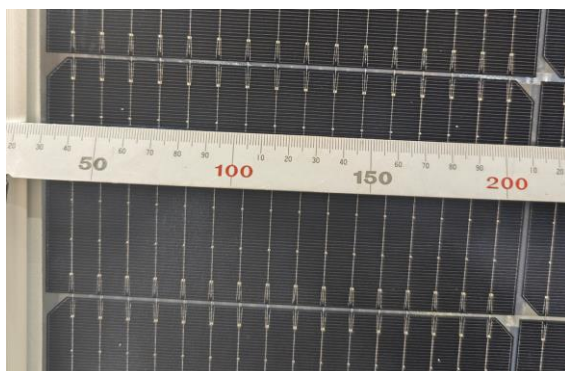
**Module type: SYMN156TBD625 (Under STC) / SYMN156TBD688 (Under BNPI) (BOM1)**



*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*

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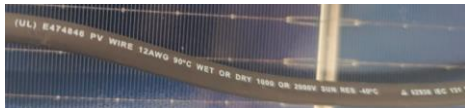
**FOTO-DOKUMENTATION**  
**PHOTO DOCUMENTATION**



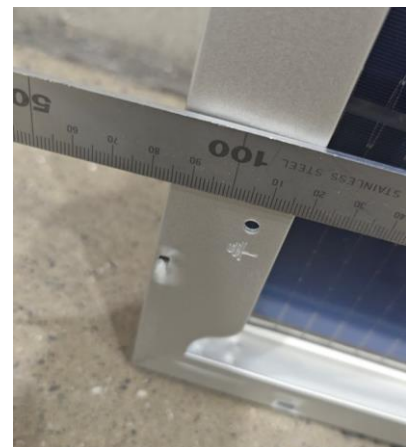
*Fig. 5: detail view of closed junction box*



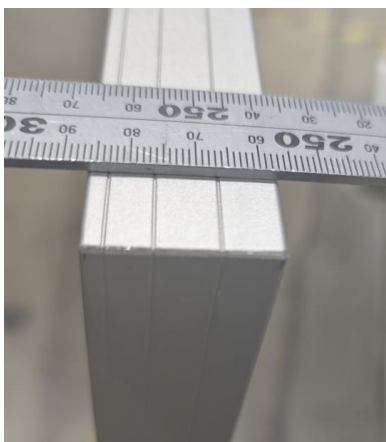
*Fig. 6: detail view of connector*



*Fig. 7: detail view of cable*



*Fig. 8: detail view of equipotential bonding hole and symbol*



*Fig. 9: detail view of frame corner*

N/A

N/A



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**Module type: SYMN156TBD620 (Under STC) / SYMN156TBD682 (Under BNPI) (BOM2)**



Fig. 10: front view of test sample



Fig. 11: rear view of test sample

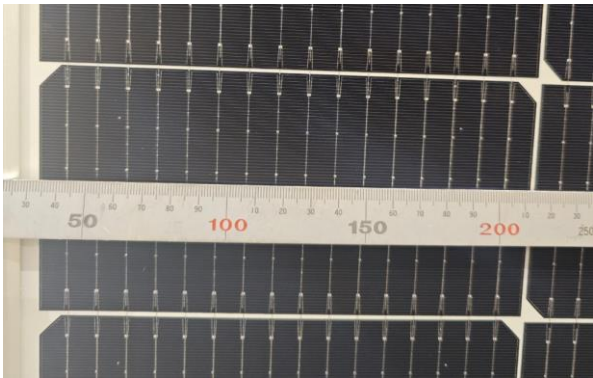


Fig. 12: detail view of solar cell



Fig. 13: detail view of type label



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**PHOTO DOCUMENTATION**



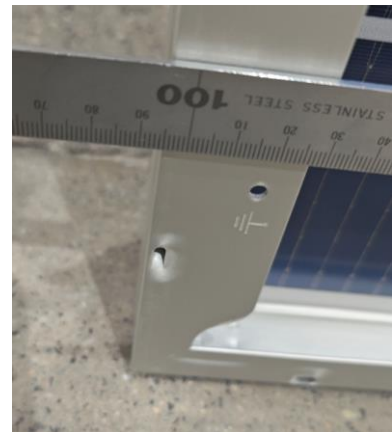
*Fig. 14: detail view of closed junction box*



*Fig. 15: detail view of connector*



*Fig. 16: detail view of cable*



*Fig. 17: detail view of equipotential bonding hole and symbol*



*Fig. 18: detail view of frame corner*

N/A

N/A