

Prüfbericht-Nr.: <i>Test report no.:</i>	CN24PF66 002	Auftrags-Nr.: <i>Order no.:</i>	326034570	Seite 1 von 108 Page 1 of 108
Kunden-Referenz-Nr.: <i>Client reference no.:</i>	2496578	Auftragsdatum: <i>Order date:</i>	26/06/2024	
Auftraggeber: <i>Client:</i>	Sany Silicon Energy (Zhuzhou) Co., Ltd. Room 518-50, Building 1, Longxin International, No.255, Tongxia Road, Tongtangwan Street, Shifeng District, Zhuzhou City, 412005, Hunan Province, P.R. China			
Prüfgegenstand: <i>Test item:</i>	Photovoltaic (PV) module			
Bezeichnung / Typ-Nr.: <i>Identification / Type no.:</i>	See module type designation on page 3			
Auftrags-Inhalt: <i>Order content:</i>	Design qualification and type approval of photovoltaic (PV) modules			
Prüfgrundlage: <i>Test specification:</i>	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			
Wareneingangsdatum: <i>Date of sample receipt:</i>	27/12/2023; 23/05/2024			
Prüfmuster-Nr.: <i>Test sample no.:</i>	See clause 6			
Prüfzeitraum: <i>Testing period:</i>	06/01/2023 - 30/06/2024			
Ort der Prüfung: <i>Place of testing:</i>	Refer to page 5			
Prüflaboratorium: <i>Testing laboratory:</i>	TÜV Rheinland (Shanghai) Co., Ltd.			
Prüfergebnis*: <i>Test result*:</i>	Pass			
geprüft von: <i>tested by:</i>	X 	genehmigt von: <i>authorized by:</i>	X 	
Datum: <i>Date:</i>	08/07/2024	Ausstellungsdatum: <i>Issue date:</i>	08/07/2024	
Stellung / Position:	Project Engineer	Stellung / Position:	Authorizer	
Sonstiges / <i>Other:</i>	<ul style="list-style-type: none"> - Introduce to new model types as listed in section 1 based on previously approved model types. - Extension to alternative materials and modifications. - Refer to page 4-5 and Constructional Data Form (CDF) CN24PF66 002 for more details. 			
Zustand des Prüfgegenstandes bei Anlieferung: <i>Condition of the test item at delivery:</i>	Prüfmuster vollständig und unbeschädigt <i>Test item complete and undamaged</i>			
* 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
<p>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. <i>This test report only relates to the a. m. 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.</i></p>				

Prüfbericht-Nr.: CN24PF66 002
Test report no.:

Seite 2 von 108
Page 2 of 108

Anmerkungen
Remarks

- | | |
|----------|--|
| 1 | <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> |
| 2 | <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: go.tuv.com/digital-signature</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: go.tuv.com/digital-signature</i></p> |
| 3 | <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> |
| 4 | <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> |

Prüfbericht-Nr.: CN24PF66 002
Test report no.:

Seite 3 von 108
Page 3 of 108

Produktbeschreibung
Product description

I	General										
1	<p>Module type designation New model types: Max. System Voltage: up to 1500 VDC (Voc at STC): With cut of mono c-Si cells: (Under STC) SYMN108TBDBxxx (xxx=415-440, in steps of 5, 108 cells) SYMN156R02TBDxxx (xxx=655-675, in steps of 5, 156 cells) With cut of mono c-Si cells: (Under BNPI) SYMN108TBDBxxx (xxx=457-484, 108 cells) SYMN156R02TBDxxx (xxx=721-743, 156 cells)</p> <p>Approved model types: Max. System Voltage: up to 1500 VDC (Voc at STC): With cut of mono c-Si cells: (Under STC) SYMN156TBDxxx (xxx=615-635, in steps of 5, 156 cells) SYMN144TBDxxx (xxx=555-585, in steps of 5, 144 cells) SYMN120TBDxxx (xxx=455-485, in steps of 5, 120 cells) SYMN108TBDxxx (xxx=415-440, in steps of 5, 108 cells) SYMN144R01TBDxxx (xxx=590-620, in steps of 5, 144 cells) SYMN120R01TBDxxx (xxx=490-520, in steps of 5, 120 cells) SYMN108R01TBDxxx (xxx=440-470, in steps of 5, 108 cells) With cut of mono c-Si cells: (Under BNPI) SYMN156TBDxxx (xxx=677-699, 156 cells) SYMN144TBDxxx (xxx=611-644, 144 cells) SYMN120TBDxxx (xxx=501-534, 120 cells) SYMN108TBDxxx (xxx=457-484, 108 cells) SYMN144R01TBDxxx (xxx=649-682, 144 cells) SYMN120R01TBDxxx (xxx=539-572, 120 cells) SYMN108R01TBDxxx (xxx=484-517, 108 cells)</p> <p>xxx represents output power in Wp</p>										
2	<p>Used materials</p> <p>See Constructional Data Form (CDF) no. CN24PF66 002</p>										
3	<p>Address(es) of the manufacturing site(s)</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 / Inspection 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 / Inspection 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 / Inspection date	CN23RWL8 002 / 13/05/2024										

Prüfbericht-Nr.: CN24PF66 002
Test report no.:

Seite 4 von 108
Page 4 of 108

Produktbeschreibung
Product description

4

Summary of test results

All of the required tests of the standards IEC 61215 / EN 61215 and IEC 61730 / EN 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 above mentioned standards, 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 C) were performed according to UL 790.

- Introduce to new model types as listed in section 1 based on previously approved model types. The relevant tests were performed on representative models SYMN108TBDB440 (Median power) (Under STC) / SYMN108TBDB484 (Median power) (Under BNPI) (BOM1) and SYMN156R02TBD655 (Lower power end) (Under STC) / SYMN156R02TBD675 (Higher power end) (Under STC) / SYMN156R02TBD743 (Higher power end) (Under BNPI) (BOM2). The differences are as below:

1. SYMN108TBDBxxx series are for module with 182.2 x 91mm & 182.2 x 91.875mm Topcon solar cells (108 pcs), letter "TBDB" is the same as "TBD" except for the color is black.

2. SYMN156R02TBDxxx series are for module with 191.6 x 91.1mm Topcon solar cells (156 pcs).

- Extension to alternative materials and modifications in below table. The relevant tests were performed on representative models and test results are documented in this test report.

Object	Manufacturer / trademark	Type / model	Technical data / ratings	Representative model for testing
Front cover	Changzhou Almaden Co., Ltd.	Semi-tempered AR coated glass	Thickness [mm]: =1.6±0.16	SYMN108TBDB 440 (Median power) (Under STC) / SYMN108TBDB 484 (Median power) (Under BNPI) (BOM1)
Backside cover	Changzhou Almaden Co., Ltd.	Semi-Tempered back glass	Thickness [mm]: =1.6±0.16 Color: black glaze	
Encapsulation material	Kunshan Tianyang New Materials Co., Ltd.	JCC-105P-T (above cells)	Thickness = 0.45mm±10% gram weight: 410g/m²±10%	
		JCC-105P-T (below cells)	Thickness = 0.45mm±10% gram weight: 410g/m²±10%	
Remark: This encapsulation material can be only used with solar cells SYCN18T16 & SYCN18AT16 from Sany Silicon Energy (Zhuzhou) Co., Ltd.				
Solar cell	Sany Silicon Energy (Zhuzhou) Co., Ltd.	SYCN18AT16	L x W x T [mm]: 191.6 x 91.1 (±0.25) x 0.13 (±0.015) Topcon Mono-Si, 16BB	SYMN156R02TB D655 (Lower power end) (Under STC) / SYMN156R02TB D721 (Lower power end) (Under BNPI) (BOM2) & SYMN156R02TB D675 (Higher power end) (Under STC) / SYMN156R02TB D743 (Higher power end) (Under BNPI) (BOM2).
Remark: This solar cell dimension is extended based on previously approved dimension 182.2 x 95.8mm in test report				

Prüfbericht-Nr.: CN24PF66 002
Test report no.:

Seite 5 von 108
Page 5 of 108

Produktbeschreibung
Product description

No. CN24PF66 001

Frame parts	CHANGSHU DONGNENG SOLAR TECHNOLOGY CO., LTD	Anodized Aluminium Alloy 6005-T6 (black)	H(mm) x W(mm): 30x30mm (long frame) 30x15mm (short frame)	Compare the alternative materials have been approved, the only difference is the color changed. The declaration is in Appendix E for details.
Adhesive (frame)	H.B.Fuller (Suzhou) Advanced Material Co., Ltd.	1527	Color: black	
Potting material	H.B.Fuller (Suzhou) Advanced Material Co., Ltd.	1533	Color: black	

Remark:

1. 1.6mm only used on module types with 108pcs solar cell

This report have to be read in conjunction with Constructional Data Form (CDF) No. CN24PF66 002 and test report No. CN24PF66 001-002.

This test report includes history of reporting and certification, photo documentation 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

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 6 von 108
Page 6 of 108

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

5	Test specification		
	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	

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 7 von 108
Page 7 of 108

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 type="checkbox"/> The modules tested were prototypes of a new design and not taken from a production batch.			
Module type: SYMN108TBDB440 (Median power) (Under STC) / SYMN108TBDB484 (Median power) (Under BNPI) (BOM1)			
Sample no.	Sample SN	Test sequence	Remarks / constructional characteristics (e.g. cell, backsheet, frame type)
1-1	SYMNE253079U 2630	A	Front cover: 1.6mm, Semi-tempered AR coated glass from Changzhou Almaden Co., Ltd. Rear cover: 1.6mm, Semi-Tempered back glass, black glaze, from Changzhou Almaden Co., Ltd. Encapsulation material: JCC-105P-T (between cell and front cover) / JCC-105P-T (between cell and rear cover) from Kunshan Tianyang New Materials Co., Ltd. Solar cell: SYCN18AT16, 191.6mm x 91.1mm (±0.25mm) x 0.13mm (±0.015mm) from Sany Silicon Energy (Zhuzhou) Co., Ltd. Cell connector: Ø0.26mm 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. Frame: 30mm, black , 6005-T6 from CHANGSHU DONGNENG SOLAR TECHNOLOGY CO., LTD Adhesive (frame): 1527 black, from H.B. Fuller (Suzhou) New Material Co., Ltd. Junction box: PV-XT1609Nxyz from Suzhou Xtong Photovoltaic Technologies Co., Ltd. Cable: 62930 IEC 131 1 x 4.0mm ² 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 black, from H.B. Fuller (Suzhou) Advanced Material Co., Ltd. Potting Material in junction box: 1533 black, from H.B. Fuller (Suzhou) Advanced Material Co., Ltd.
1-2	SYMNE253079U 2631	B1	
1-3	SYMNE253079U 2632	C1	
1-4	SYMNE253079U 2633	C2	
1-5	SYMNE253079U 2634	E1	
1-6	SYMNE253079U 2635	E2	
1-7	SYMNE253079U 2636	H	
1-8	SYMNE253079U 2637	M	
1-9	SYMNE253079U 2641	Gf	
1-10	SYMNE253079U 2642	Gb	
1-11	SYMNE253079U 2643	F+G1	
1-12	SYMNE253079U 2644	K1	
1-13	SYMNE253079U 2645	K2	
1-14	SYMNE253079U 2646	K3	
1-15	SYMNE253079U 2647	K4	
1-16	SYMNE253079U 2638	J1	
1-17	SYMNE253079U 2639	J3	

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 8 von 108
Page 8 of 108

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

1-18	240400111D025 51	E1	
1-19	240400111D025 52	E1	
1-20	240400111D025 53	E1	

Module type: SYMN156R02TBD655 (Lower power end) (Under STC) / SYMN156R02TBD721 (Lower power end) (Under BNPI) (BOM2)

Sample no.	Sample SN	Test sequence	Remarks / constructional characteristics (e.g. cell, backsheet, frame type)
2-1	240501102D001 89	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. Solar Cell: SYCN18AT16, 191.6mm x 91.1mm (±0.25) x 0.13mm (±0.015) , Topcon, 16BB 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 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
2-2	240501102D000 01	A	Fluxing agent: SF180 from ASAHI SOLDER TECHNOLOGY(WUXI) CO., LTD 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 ² from QC Solar (Suzhou) Corporation Connector: QC4.10-cds from QC Solar (Suzhou) Corporation 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

Module type: SYMN156R02TBD675 (Higher power end) (Under STC) / SYMN156R02TBD743 (Higher power end) (Under BNPI) (BOM2)

2-3	240501102D001 18	A	Same as above
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Prüfbericht-Nr.: CN24PF66 002

Seite 9 von 108

Test Report No.:

Page 9 of 108

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

2-4	240501102D000 14	A	
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Supplementary information:

See test chart in Appendix A for full test sequences.

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 10 von 108
Page 10 of 108

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

II	IEC/EN 61215-1 and IEC/EN 61730-1 – Requirements for design construction
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7	Requirements for design and construction (Clause 5 of IEC/EN 61215-1 and IEC/EN 61730-1)
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7.1	General (Clause 5.1 of IEC/EN 61730-1)		
	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

7.2	Marking and documentation (Clause 5.2 of IEC/EN 61730-1 and Clause 5 of IEC/EN 61215-1)		
	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
7.2.1	Marking (Clause 5.2.2 of IEC/EN 61730-1 and Clause 5.1 of IEC/EN 61215-1)		
7.2.1.1	General (Clause 5.2.2.1 of IEC/EN 61730-1 and Clause 5.1 of IEC/EN 61215-1)		
	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

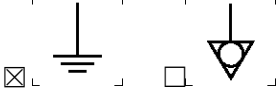
Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 11 von 108
Page 11 of 108

Absatz Clause	Photovoltaic (PV) modules Anforderungen - Prüfungen / Requirements - Tests	Messergebnisse - Bemerkungen Measuring results - Remarks	Ergebnis Result
	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 ϕ_{Isc} Open-circuit voltage bifaciality coefficient ϕ_{Voc} Maximum power bifaciality coefficient ϕ_{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 ² , (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 ² + $\phi \cdot 135W/m^2$)	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)		

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 12 von 108
Page 12 of 108

Absatz Clause	Photovoltaic (PV) modules Anforderungen - Prüfungen / Requirements - Tests	Messergebnisse - Bemerkungen Measuring results - Remarks	Ergebnis Result
	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 ϕ_{Isc} Open-circuit voltage bifaciality coefficient ϕ_{Voc} Maximum power bifaciality coefficient ϕ_{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

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 13 von 108
Page 13 of 108

Absatz Clause	Photovoltaic (PV) modules Anforderungen - Prüfungen / Requirements - Tests	Messergebnisse - Bemerkungen Measuring results - Remarks	Ergebnis Result
	- 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 ² , (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 ² + $\varphi \cdot 135\text{W/m}^2$)	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

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 14 von 108
Page 14 of 108

Absatz Clause	Photovoltaic (PV) modules Anforderungen - Prüfungen / Requirements - Tests	Messergebnisse - Bemerkungen Measuring results - Remarks	Ergebnis Result
	- 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
7.3	Electrical components and insulation (Clause 5.3 of IEC/EN 61730-1)		
7.3.1	Internal wiring (Clause 5.3.2 of IEC/EN 61730-1)		
	Internal wiring has sufficient current carrying capacity for the relevant application.	Verified by MST 14 and MST 26	P
7.3.2	Junction boxes for PV modules (Clause 5.3.5 of IEC/EN 61730-1)		
	Junction boxes for PV modules fulfil the requirements of IEC 62790.	<input checked="" type="checkbox"/> IEC 62790	P
7.3.3	External wiring (Clause 5.3.3 of IEC/EN 61730-1)		
	External wires and cables fulfil the requirements of IEC 62930.	<input checked="" type="checkbox"/> IEC 62930	P
7.3.4	Connectors (Clause 5.3.4 of IEC/EN 61730-1)		
	External DC connectors fulfil the requirements of IEC 62852.	<input checked="" type="checkbox"/> IEC 62852	P
7.3.5	Frontsheets and backsheets (Clause 5.3.6 of IEC/EN 61730-1)		
	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

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 15 von 108
Page 15 of 108

Absatz Clause	Photovoltaic (PV) modules Anforderungen - Prüfungen / Requirements - Tests	Messergebnisse - Bemerkungen Measuring results - Remarks	Ergebnis Result
	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
7.3.6	Insulation barriers (Clause 5.3.7 of IEC/EN 61730-1)		
	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
7.3.7	Electrical connections (Clause 5.3.8 of IEC/EN 61730-1)		
7.3.7.1	General (Clause 5.3.8.1 of IEC/EN 61730-1)		
	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
7.3.7.2	Terminals for external cables and PV connector ribbons (Clause 5.3.8.2 of IEC/EN 61730-1)		
	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
7.3.8	Encapsulant (Clause 5.3.9 of IEC/EN 61730-1)		
	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
7.3.9	Bypass diodes (Clause 5.3.10 of IEC/EN 61730-1)		

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 16 von 108
Page 16 of 108

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

7.4	Mechanical and electromechanical connections (Clause 5.4 of IEC/EN 61730-1)		
7.4.1	General (Clause 5.4.1 of IEC/EN 61730-1)		
	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
7.4.2	Screw connections (Clause 5.4.2 of IEC/EN 61730-1)		
	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

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 17 von 108
Page 17 of 108

Absatz	Photovoltaic (PV) modules	Messergebnisse - Bemerkungen	Ergebnis
Clause	Anforderungen - Prüfungen / Requirements - Tests	Measuring results - Remarks	Result
7.4.3	Rivets (Clause 5.4.3 of IEC/EN 61730-1)		
	Rivets which serve as electrical as well as mechanical connections are locked against loosening.	No rivet is used.	N/A
7.4.4	Thread-cutting screws (Clause 5.4.4 of IEC/EN 61730-1)		
	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
7.4.5	Form / press / tight fit (Clause 5.4.5 of IEC/EN 61730-1)		
	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
7.4.6	Connections by adhesives (Clause 5.4.6 of IEC/EN 61730-1)		
	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
7.4.7	Other connections (Clause 5.4.7 of IEC/EN 61730-1)		
	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

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 18 von 108
Page 18 of 108

Absatz	Photovoltaic (PV) modules	Messergebnisse - Bemerkungen	Ergebnis
Clause	Anforderungen - Prüfungen / Requirements - Tests	Measuring results - Remarks	Result
7.5	Materials (Clause 5.5 of IEC/EN 61730-1)		
7.5.1	Polymeric materials (Clause 5.5.2 of IEC/EN 61730-1)		
7.5.1.1	General (Clause 5.5.2.1 of IEC/EN 61730-1)		
	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
7.5.1.2	Endurance to weathering stress (Clause 5.5.2.2 of IEC/EN 61730-1)		
	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
7.5.1.3	Polymeric materials used as electrical insulation (Clause 5.5.2.3 of IEC/EN 61730-1)		
7.5.1.3.1	General (Clause 5.5.2.3.1 of IEC/EN 61730-1)		
	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
7.5.1.3.2	Endurance to electrical stress (Clause 5.5.2.3.2 of IEC/EN 61730-1)		
	Materials used as electrical insulation are in compliance with the insulation coordination requirements.	See section 7.6.3	P
7.5.1.3.3	Endurance to thermal stress (Clause 5.5.2.3.3 of IEC/EN 61730-1)		

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 19 von 108
Page 19 of 108

Absatz	Photovoltaic (PV) modules	Messergebnisse - Bemerkungen	Ergebnis
Clause	Anforderungen - Prüfungen / Requirements - Tests	Measuring results - Remarks	Result
	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
7.5.1.3.4	Polymeric insulating materials used as external parts (Clause 5.5.2.3.4 of IEC/EN 61730-1)		
	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
7.5.1.3.5	Polymeric insulating used for mechanical functions (Clause 5.5.2.4 of IEC/EN 61730-1)		
	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
7.5.2	Metallic materials (Clause 5.5.3 of IEC/EN 61730-1)		
7.5.2.1	General (Clause 5.5.3.1 of IEC/EN 61730-1)		
	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
7.5.2.2	Current carrying parts (Clause 5.5.3.2 of IEC/EN 61730-1)		
	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
7.5.2.3	Adhesives (Clause 5.5.4 of IEC/EN 61730-1)		
	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

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 20 von 108
Page 20 of 108

Absatz	Photovoltaic (PV) modules	Messergebnisse - Bemerkungen	Ergebnis
Clause	Anforderungen - Prüfungen / Requirements - Tests	Measuring results - Remarks	Result
	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
7.6	Protection against electric shock (Clause 5.6 of IEC/EN 61730-1)		
7.6.1	General (Clause 5.6.1 of IEC/EN 61730-1)		
	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
7.6.2	Protection against accessibility to hazardous live parts (Clause 5.6.2 of IEC/EN 61730-1)		
7.6.2.1	General (Clause 5.6.2.1 of IEC/EN 61730-1)		
	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
7.6.2.2	Protection by means of enclosures and insulation barriers (Clause 5.6.2.2 of IEC/EN 61730-1)		
	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

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 21 von 108
Page 21 of 108

Absatz	Photovoltaic (PV) modules	Messergebnisse - Bemerkungen	Ergebnis
Clause	Anforderungen - Prüfungen / Requirements - Tests	Measuring results - Remarks	Result
	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
7.6.2.3	Protection by means of insulation of live parts (Clause 5.6.2.3 of IEC/EN 61730-1)		
	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
7.6.3	Insulation coordination (Clause 5.6.3 of IEC/EN 61730-1)		
	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
7.6.4	Distance through insulation (Clause 5.6.4 of IEC/EN 61730-1)		
7.6.4.1	General (Clause 5.6.4.1 of IEC/EN 61730-1)		
	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
7.6.4.2	Cemented joints (Clause 5.6.4.2 of IEC/EN 61730-1)		
	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

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 22 von 108
Page 22 of 108

Absatz	Photovoltaic (PV) modules	Messergebnisse - Bemerkungen	Ergebnis
Clause	Anforderungen - Prüfungen / Requirements - Tests	Measuring results - Remarks	Result
	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
7.6.4.3	Insulation in thin layers (Clause 5.6.4.3 of IEC/EN 61730-1)		
	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

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 23 von 108
Page 23 of 108

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

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

Table 1: Design evaluation

Module type: SYMN108TBDB440 (Median power) (Under STC) / SYMN108TBDB484 (Median power) (Under BNPI) (BOM1)

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 ^a	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.

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

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 24 von 108
Page 24 of 108

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

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

Table 2: PV module evaluation MST 01 initial

Module type: SYMN108TBDB440 (Median power) (Under STC) / SYMN108TBDB484 (Median power) (Under BNPI) (BOM1)

Sample no.			1-3, 1-5						
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 ^a	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.

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

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 25 von 108
Page 25 of 108

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

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

Table 3: PV module evaluation MST 01 final

Module type: SYMN108TBDB440 (Median power) (Under STC) / SYMN108TBDB484 (Median power) (Under BNPI) (BOM1)

Sample no.			1-3, 1-5						
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 ^a	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.

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

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 26 von 108
Page 26 of 108

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

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

Table 1: Design evaluation

Module type: SYMN156R02TBD655 (Lower power end) (Under STC) / SYMN156R02TBD721 (Lower power end) (Under BNPI) (BOM2) & SYMN156R02TBD675 (Higher power end) (Under STC) / SYMN156R02TBD743 (Higher power end) (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 ^a	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.

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

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 27 von 108
Page 27 of 108

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

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

Table 2: PV module evaluation MST 01 initial

Module type: SYMN156R02TBD655 (Lower power end) (Under STC) / SYMN156R02TBD721 (Lower power end) (Under BNPI) (BOM2) & SYMN156R02TBD675 (Higher power end) (Under STC) / SYMN156R02TBD743 (Higher power end) (Under BNPI) (BOM2)

Sample no.			2-1						
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 ^a	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.

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

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 28 von 108
Page 28 of 108

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

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

Table 3: PV module evaluation MST 01 final

Module type: SYMN156R02TBD655 (Lower power end) (Under STC) / SYMN156R02TBD721 (Lower power end) (Under BNPI) (BOM2) & SYMN156R02TBD675 (Higher power end) (Under STC) / SYMN156R02TBD743 (Higher power end) (Under BNPI) (BOM2)

Sample no.			2-1						
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 ^a	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.

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

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 29 von 108
Page 29 of 108

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

9	Pass criteria (Clause 7 of IEC 61215-1:2021)		
9.1	Output power and electric circuitry (Clause 7.2 of IEC 61215-1:2021)		
9.1.1	Verification of rated label values (Gate #1) (STC) (Clause 7.2.1 of IEC 61215-1:2021)		
	<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> m_1 [%] = measurement uncertainty of laboratory for P_{\max} m_2 [%] = measurement uncertainty of laboratory for V_{OC} m_3 [%] = measurement uncertainty of laboratory for I_{SC} t_1 [%] = manufacturer's rated lower production tolerance for P_{\max} t_2 [%] = manufacturer's rated upper production tolerance for V_{OC} t_3 [%] = manufacturer's rated upper production tolerance for I_{SC} t_4 [%] = manufacturer's rated upper production tolerance for $P_{\max 4}$ $P_{\max 4}$ = 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 61215-1:2021)		
	<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

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 30 von 108
Page 30 of 108

Absatz	Photovoltaic (PV) modules	Messergebnisse - Bemerkungen	Ergebnis
Clause	Anforderungen - Prüfungen / Requirements - Tests	Measuring results - Remarks	Result
	$I_{SC(BNPI)}(Lab) \cdot \left(1 + \frac{1.65}{2} \frac{ m_3(BNPI) }{100}\right) \leq I_{SC(BNPI)}(NP) \cdot \left(1 + \frac{ t_3(BNPI) }{100}\right)$		
	<p>After stabilization, each individual module that is used for the qualification of low end power classes shall meet:</p> $P_{max(BNPI)}(Lab) \cdot \left(1 - \frac{1.65}{2} \frac{ m_1(BNPI) }{100}\right) \leq P_{max4(BNPI)}(NP) \cdot \left(1 + \frac{ t_4(BNPI) }{100}\right)$	See table "Gate #1 evaluation"	P
	<p> $m_1(BNPI)$ [%] = measurement uncertainty of laboratory for $P_{max(BNPI)}$ $m_2(BNPI)$ [%] = measurement uncertainty of laboratory for $V_{OC(BNPI)}$ $m_3(BNPI)$ [%] = the measurement uncertainty of laboratory for $I_{SC(BNPI)}$ $t_1(BNPI)$ [%] = manufacturer's rated lower production tolerance for $P_{max(BNPI)}$ $t_2(BNPI)$ [%] = manufacturer's rated upper production tolerance for $V_{OC(BNPI)}$ $t_3(BNPI)$ [%] = manufacturer's rated upper production tolerance for $I_{SC(BNPI)}$ $t_4(BNPI)$ [%] = manufacturer's rated upper production tolerance for $P_{max4(BNPI)}$ $P_{max4(BNPI)}$ = maximum rated nameplate power of lowest power class module (under BNPI) NP = name plate </p>		—
9.1.2	Maximum power degradation during type approval testing (Gate #2) (STC) (Clause 7.2.2 of IEC 61215-1:2021)		
	<p>At the end of each test sequence, each test sample shall meet:</p> $P_{max}(Lab_Gate\ 2) \geq 0.95 \times P_{max}(Lab_Gate\ 1) \cdot \left(1 - \frac{r}{100}\right)$	See table "Gate #2 evaluation"	P
	r = reproducibility		—
—	Maximum power degradation during type approval testing (Gate #2) (BNPI) (Clause 7.2.2 of IEC 61215-1:2021)		
	<p>At the end of each test sequence, each test sample shall meet:</p> $P_{max(BNPI)}(Lab_Gate\ 2) \geq 0.95 \times P_{max(BNPI)}(Lab_Gate\ 1) \cdot \left(1 - \frac{r_{(BNPI)}}{100}\right)$	See table "Gate #2 evaluation"	P
	$r_{(BNPI)}$ = reproducibility		—
9.1.3	Electrical circuitry (Clause 7.2.3 of IEC 61215-1:2021)		
	Samples are not permitted to exhibit an open-circuit during the tests.	No open-circuit during tests	P
9.2	Visual defects (Clause 7.3 of IEC 61215-1:2021)		
	There is no visual evidence of a major defect.	No major visual defect	P
9.3	Electrical safety (Clause 7.4 of IEC 61215-1:2021)		
	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: -			

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 31 von 108
Page 31 of 108

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

III	IEC/EN 61215-2 and IEC/EN 61730-2 – Test procedures
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10	Overview of tests and test results <u>Module type: SYMN108TBDB440 (Median power) (Under STC) / SYMN108TBDB484 (Median power) (Under BNPI) (BOM1)</u>
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Initial examination	—	—
Visual inspection (MQT 01 / MST 01)	See table 10.1	P
Insulation test (MQT 03 / MST 16)	See table 10.2	P
Wet leakage current test (MQT 15 / MST 17)	See table 10.3	P
Accessibility test (MST 11)	See table 10.4	P
Continuity test of equipotential bonding (MST 13)	See table 10.5	P
Maximum power determination (MQT 02 / MST 03)	See table 10.6	P
Initial stabilization (MQT 19.1)	See table 10.7	P
Performance at STC and BNPI (MQT 06.1 / MST 03)	See table 10.8	P
Gate #1 evaluation	See table 10.9	P

Sequence A	—	—
Measurement of temperature coefficients (MQT 04)	N/A	N/A
Performance at low irradiance (MQT 07)	N/A	N/A

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

Sequence B2	—	—
Hot-spot endurance test (MQT 09 / MST 22)	See table 10.13	P
Reverse current overload test (MST 26)	N/A	N/A

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

Sequence C	—	—
UV preconditioning test (MQT 10 / MST 54)	See table 10.16	P
Cyclic (dynamic) mechanical load test (MQT 20)	See table 10.17	P
Thermal cycling test (50 cycles) (MQT 11 / MST 51)	See table 10.18	P
Humidity-freeze test (MQT 12 / MST 52)	See table 10.19	P

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 32 von 108
Page 32 of 108

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

Sequence C3	—	—
Retention of junction box on mounting surface (MQT 14.1 / MST 42)	See table 10.20	P

Sequence D	—	—
Thermal cycling test (200 cycles) (MQT 11 / MST 51)	N/A	N/A

Sequence E	—	—
Damp heat test (MQT 13 / MST 53)	See table 10.24	P

Sequence E1	—	—
Retention of junction box on mounting surface (MQT 14.1 / MST 42)	See table 10.25	P
Static mechanical load test (MQT 16 / MST 34)	See table 10.26	P

Sequence E2	—	—
Hail test (MQT 17)	See table 10.27	P

Sequence F	—	—
Materials creep test (MST 37)	See table 10.29	P

Sequence Gf	—	—
Damp heat test (200h) (MST 53)	See table 10.30	P
UV test (front side) (MST 54)	See table 10.31	P
Humidity-freeze test (MST 52)	See table 10.33	P

Sequence Gb	—	—
Damp heat test (200h) (MST 53)	See table 10.30	P
UV test (back side) (MST 54)	See table 10.32	P
Humidity-freeze test (MST 52)	See table 10.33	P

Sequence G1	—	—
Cold conditioning test 1 (MST 55)	See table 10.35	P
Dry heat conditioning test (MST 56)	See table 10.36	P
Humidity-freeze test 1 (MST 52)	See table 10.37	P
Cold conditioning test 2 (MST 55)	See table 10.38	P
Humidity-freeze test 2 (MST 52)	See table 10.39	P

Sequence H	—	—
Impulse voltage test (MST 14)	See table 10.40	P

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 33 von 108
Page 33 of 108

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

Sequence M	—	—
Module breakage test (MST 32)	See table 10.41	P

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

Sequence K	—	—
Potential induced degradation test (MQT 21)	See table 10.43	P

Sequence J	—	—
Fire test (MST 23)	See table 10.44	P

Final measurements	—	—
Final stabilization (MQT 19.2 / MQT 19.3)	See table 10.45	N/A
Maximum power determination (MQT 02 / MST 03)	See table 10.46	P
Performance at STC and BNPI (MQT 06.1 / MST 03)	See table 10.47	P
Gate #2 evaluation	See table 10.48	P
Bypass diode functionality test (MQT 18.2 / MST 07)	See table 10.49	P
Cut susceptibility test (MST 12)	See table 10.50	N/A
Accessibility test (MST 11)	See table 10.51	P
Continuity test of equipotential bonding (MST 13)	See table 10.52	P
Screw connections test (MST 33)	No screw connections	N/A
Durability of markings (MST 05)	See table 10.54	P
Sharp edge test (MST 06)	See table 10.55	P

Component tests	—	—
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.		

Prüfbericht-Nr.: CN24PF66 002

Seite 34 von 108

Test Report No.:

Page 34 of 108

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

10	Overview of tests and test results Module type: SYMN156R02TBD655 (Lower power end) (Under STC) / SYMN156R02TBD721 (Lower power end) (Under BNPI) (BOM2) & SYMN156R02TBD675 (Higher power end) (Under STC) / SYMN156R02TBD743 (Higher power end) (Under BNPI) (BOM2)		
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Initial examination	—	—
Visual inspection (MQT 01 / MST 01)	See table 10.1	P
Insulation test (MQT 03 / MST 16)	See table 10.2	P
Wet leakage current test (MQT 15 / MST 17)	See table 10.3	P
Accessibility test (MST 11)	See table 10.4	P
Continuity test of equipotential bonding (MST 13)	See table 10.5	P
Maximum power determination (MQT 02 / MST 03)	See table 10.6	P
Initial stabilization (MQT 19.1)	See table 10.7	P
Performance at STC and BNPI (MQT 06.1 / MST 03)	See table 10.8	P
Gate #1 evaluation	See table 10.9	P

Sequence A	—	—
Measurement of temperature coefficients (MQT 04)	N/A	N/A
Performance at low irradiance (MQT 07)	N/A	N/A

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

Sequence B2	—	—
Hot-spot endurance test (MQT 09 / MST 22)	N/A	N/A
Reverse current overload test (MST 26)	N/A	N/A

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

Sequence C	—	—
UV preconditioning test (MQT 10 / MST 54)	N/A	N/A
Cyclic (dynamic) mechanical load test (MQT 20)	N/A	N/A
Thermal cycling test (50 cycles) (MQT 11 / MST 51)	N/A	N/A
Humidity-freeze test (MQT 12 / MST 52)	N/A	N/A

Sequence C3	—	—
Retention of junction box on mounting surface (MQT 14.1 / MST 42)	N/A	N/A

Sequence D	—	—
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Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 35 von 108
Page 35 of 108

Absatz Clause	Photovoltaic (PV) modules Anforderungen - Prüfungen / Requirements - Tests	Messergebnisse - Bemerkungen Measuring results - Remarks	Ergebnis Result
Thermal cycling test (200 cycles) (MQT 11 / MST 51)		N/A	N/A
Sequence E		—	—
Damp heat test (MQT 13 / MST 53)		N/A	N/A
Sequence E1		—	—
Retention of junction box on mounting surface (MQT 14.1 / MST 42)		N/A	N/A
Static mechanical load test (MQT 16 / MST 34)		N/A	N/A
Sequence E2		—	—
Hail test (MQT 17)		N/A	N/A
Sequence F		—	—
Materials creep test (MST 37)		N/A	N/A
Sequence Gf		—	—
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
Sequence Gb		—	—
Damp heat test (200h) (MST 53)		N/A	N/A
UV test (back side) (MST 54)		N/A	N/A
Humidity-freeze test (MST 52)		N/A	N/A
Sequence G1		—	—
Cold conditioning test 1 (MST 55)		N/A	N/A
Dry heat conditioning test (MST 56)		N/A	N/A
Humidity-freeze test 1 (MST 52)		N/A	N/A
Cold conditioning test 2 (MST 55)		N/A	N/A
Humidity-freeze test 2 (MST 52)		N/A	N/A
Sequence H		—	—
Impulse voltage test (MST 14)		N/A	N/A
Sequence M		—	—
Module breakage test (MST 32)		N/A	N/A
Sequence I		—	—
Ignitability test (MST 24)		N/A	N/A

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 36 von 108
Page 36 of 108

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

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

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

Final measurements	—	—
Final stabilization (MQT 19.2 / MQT 19.3)	N/A	N/A
Maximum power determination (MQT 02 / MST 03)	N/A	N/A
Performance at STC and BNPI (MQT 06.1 / MST 03)	N/A	N/A
Gate #2 evaluation	N/A	N/A
Bypass diode functionality test (MQT 18.2 / MST 07)	N/A	N/A
Cut susceptibility test (MST 12)	N/A	N/A
Accessibility test (MST 11)	N/A	N/A
Continuity test of equipotential bonding (MST 13)	N/A	N/A
Screw connections test (MST 33)	N/A	N/A
Durability of markings (MST 05)	N/A	N/A
Sharp edge test (MST 06)	N/A	N/A

Component tests	—	—
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.		

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 37 von 108
Page 37 of 108

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

10.1	Visual inspection (initial) – MQT 01 / MST 01		
Test date (dd/mm/yyyy)		30/01/2024 for BOM1 23/05/2024 for BOM2	—
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
1-12		No major visual defects	P
1-13		No major visual defects	P
1-14		No major visual defects	P
1-15		No major visual defects	P
1-16		No major visual defects	P
1-17		No major visual defects	P
1-18		No major visual defects	P
1-19		No major visual defects	P
1-20		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
Supplementary information: N/A			

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

10.2	Insulation test (initial) – MQT 03 / MST 16					
Test date (dd/mm/yyyy)				30/01/2024 for BOM1 23/05/2024 for BOM2		—
Maximum system voltage [V _{DC}]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V _{DC}]				8000		
Insulation resistance measured at [V _{DC}]				1500		
Sample no.	R _{iso} [GΩ]	A [m²]	R _{iso} ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
1-1	7.96	1.95	15.52	-	No	P
1-2	7.84	1.95	15.29	-	No	P
1-3	8.41	1.95	16.40	-	No	P
1-4	9.31	1.95	18.15	-	No	P
1-5	8.97	1.95	17.49	-	No	P
1-6	8.91	1.95	17.37	-	No	P
1-8	8.31	1.95	16.20	-	No	P
1-9	8.22	1.95	16.03	-	No	P
1-10	8.33	1.95	16.24	-	No	P
1-11	8.23	1.95	16.05	-	No	P
1-12	8.34	1.95	16.26	-	No	P
1-13	8.45	1.95	16.48	-	No	P
1-14	8.64	1.95	16.85	-	No	P
1-15	8.12	1.95	15.83	-	No	P
1-18	8.22	1.95	16.04	-	No	P
1-19	8.33	1.95	16.24	-	No	P
1-20	8.44	1.95	16.46	-	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.						

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 39 von 108
Page 39 of 108

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

10.3	Wet leakage current test (initial) – MQT 15 / MST 17			
Test date (dd/mm/yyyy)		30/01/2024 for BOM1 23/05/2024 for BOM2		—
Maximum system voltage [V _{DC}]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V _{DC}]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R _{iso} [MΩ]	A [m²]	R _{iso} ·A [MΩ·m²]	
1-1	4250.0	1.95	8287.50	P
1-2	5010.0	1.95	9769.50	P
1-3	4310.0	1.95	8404.50	P
1-4	5180.0	1.95	10101.00	P
1-5	4340.0	1.95	8463.00	P
1-6	4690.0	1.95	9145.50	P
1-8	4720.0	1.95	9204.00	P
1-9	4310.0	1.95	8404.50	P
1-10	5180.0	1.95	10101.00	P
1-11	4340.0	1.95	8463.00	P
1-12	4690.0	1.95	9145.50	P
1-13	4720.0	1.95	9204.00	P
1-14	5030.0	1.95	9808.50	P
1-15	4600.0	1.95	8970.00	P
1-18	4710.0	1.95	9194.00	P
1-19	5020.0	1.95	9798.50	P
1-20	4610.0	1.95	8980.00	P
Supplementary information: Minimum requirement is 40 MΩ·m².				

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 40 von 108
Page 40 of 108

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

10.4	Accessibility test (initial) – MST 11		
Test date (dd/mm/yyyy)		30/01/2024 for BOM1	—
Applied force [N]		10	
Sample no.	Contact with live electrical part?	R _{iso} [MΩ]	
1-3	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	> 50	P
1-5	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	> 50	P
Supplementary information: The resistance tester can measure up to 50.0 MΩ.			

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 41 von 108
Page 41 of 108

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

10.5	Continuity test of equipotential bonding (initial) – MST 13		
Test date (dd/mm/yyyy)		30/01/2024 for BOM1	—
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]	
1-3	92.3/93.1/94.0	1.23/1.24/1.25	P
1-5	89.8/88.6/91.1	1.20/1.18/1.21	P
1-9	90.6/92.5/91.1	1.21/1.23/1.21	P
1-10	89.1/87.6/92.1	1.21/1.17/1.20	P
1-11	90.5/91.5/90.1	1.20/1.22/1.22	P
1-18	89.0/87.0/92.0	1.20/1.15/1.21	P
1-19	90.4/91.3/90.0	1.21/1.21/1.22	P
1-20	89.0/87.4/92.0	1.20/1.17/1.21	P
Supplementary information: N/A			

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 42 von 108
Page 42 of 108

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

10.6	Initial stabilization – MQT 19.1				
☒ Simulator ☐ Natural sunlight ☐ Other stabilization procedures					
Test date (dd/mm/yyyy)			29/01/2024-02/02/2024 for BOM1 26/05/2024-29/05/2024 for BOM2		—
Irradiance [W/m²]			800 - 1000		
Module temperature [°C]			50		
Sample no.	Test	Integrated irradiation [kWh/m²]	P _{max} [W]	Stabilization [%] *	
1-1	Initial	—	445.3	0.22	P
	Light-soaking 1	5	444.8		
	Light-soaking 2	5	444.3		
1-2	Initial	—	445.5	0.13	P
	Light-soaking 1	5	445.1		
	Light-soaking 2	5	444.9		
1-3	Initial	—	444.1	0.25	P
	Light-soaking 1	5	443.3		
	Light-soaking 2	5	443.0		
1-4	Initial	—	444.9	0.13	P
	Light-soaking 1	5	444.6		
	Light-soaking 2	5	444.3		
1-5	Initial	—	444.7	0.09	P
	Light-soaking 1	5	444.5		
	Light-soaking 2	5	444.3		
1-6	Initial	—	443.2	0.14	P
	Light-soaking 1	5	442.8		
	Light-soaking 2	5	442.6		
1-12	Initial	—	444.6	0.07	P
	Light-soaking 1	5	444.4		
	Light-soaking 2	5	444.3		
1-13	Initial	—	443.1	0.12	P
	Light-soaking 1	5	442.7		
	Light-soaking 2	5	442.5		
1-14	Initial	—	444.6	0.09	P
	Light-soaking 1	5	444.4		
	Light-soaking 2	5	444.2		
1-15	Initial	—	443.1	0.03	P

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 43 von 108
Page 43 of 108

Absatz	Photovoltaic (PV) modules			Messergebnisse - Bemerkungen	Ergebnis
Clause	Anforderungen - Prüfungen / <i>Requirements - Tests</i>			<i>Measuring results - Remarks</i>	<i>Result</i>
	Light-soaking 1	5	442.7		
	Light-soaking 2	5	442.5		
2-1	Initial	—	666.1	0.04	P
	Light-soaking 1	5	665.8		
	Light-soaking 2	5	665.5		
2-2	Initial	—	666.1	0.04	P
	Light-soaking 1	5	665.8		
	Light-soaking 2	5	665.5		
2-3	Initial	—	671.3	0.06	P
	Light-soaking 1	5	671.2		
	Light-soaking 2	5	670.9		
2-4	Initial	—	672.1	0.08	P
	Light-soaking 1	5	671.8		
	Light-soaking 2	5	671.5		

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 61215-2:2021.

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 44 von 108
Page 44 of 108

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

10.7	Maximum power determination (initial) – MST 03		
Test date (dd/mm/yyyy)		02/02/2024 for BOM1	—
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		
1-1	No kinks or other unusual characteristics		P
1-2	No kinks or other unusual characteristics		P
1-3	No kinks or other unusual characteristics		P
1-5	No kinks or other unusual characteristics		P
1-12	No kinks or other unusual characteristics		P
1-13	No kinks or other unusual characteristics		P
1-14	No kinks or other unusual characteristics		P
1-15	No kinks or other unusual characteristics		P
Supplementary information: N/A			

Prüfbericht-Nr.: CN24PF66 002 <i>Test Report No.:</i>		Seite 45 von 108 Page 45 of 108	
Absatz	Photovoltaic (PV) modules	Messergebnisse - Bemerkungen	Ergebnis
<i>Clause</i>	Anforderungen - Prüfungen / <i>Requirements - Tests</i>	<i>Measuring results - Remarks</i>	<i>Result</i>

10.8	Performance at STC (initial) – MQT 06.1
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10.8.1	Performance at STC (initial) (front side) – MQT 06.1						
Test date (dd/mm/yyyy)			02/02/2024 for BOM1 29/05/2024 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 ± 10				
Module temperature [°C]			25 ± 2				
Spectral mismatch			N/A				
Sample no.	P _{max} [W]	V _{mpp} [V]	I _{mpp} [A]	V _{oc} [V]	I _{sc} [A]	FF [%]	
1-1	444.3	33.16	13.397	39.25	14.079	80.4	N/A
1-2	444.9	33.19	13.407	39.27	14.041	80.7	N/A
1-3	443.0	33.18	13.353	39.24	14.013	80.6	N/A
1-4	444.3	33.16	13.399	39.23	14.074	80.5	N/A
1-5	444.3	33.16	13.398	39.23	14.055	80.6	N/A
1-6	442.6	33.23	13.319	39.33	14.065	80.0	N/A
1-12	443.0	33.17	13.351	39.24	14.011	80.6	N/A
1-13	444.2	33.16	13.392	39.23	14.072	80.5	N/A
1-14	444.1	33.17	13.393	39.23	14.051	80.6	N/A
1-15	442.5	33.22	13.312	39.33	14.061	80.0	N/A
1-18	430.6	33.68	12.787	39.61	13.509	80.5	N/A
1-19	431.2	33.67	12.806	39.62	13.610	80.0	N/A
1-20	429.6	33.56	12.800	39.63	13.555	80.0	N/A
2-1	665.5	47.27	14.079	56.18	14.751	80.2	N/A
2-2	665.2	47.23	14.084	56.13	14.749	80.1	N/A
2-3	670.9	47.57	14.103	56.49	14.812	80.3	N/A
2-4	671.5	47.62	14.101	56.57	14.820	80.5	N/A
Supplementary information: The non-illuminated side was covered with non-reflective background and aperture.							

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 46 von 108
Page 46 of 108

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

10.8.2	Performance at STC (initial) (rear side) – MQT 06.1						
Test date (dd/mm/yyyy)			02/02/2024 for BOM1 29/05/2024 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 ± 2				
Spectral mismatch			N/A				
Sample no.	P _{max} [W]	V _{mpp} [V]	I _{mpp} [A]	V _{oc} [V]	I _{sc} [A]	FF [%]	
1-1	331.0	33.14	9.713	39.24	10.982	78.3	N/A
1-2	331.5	33.12	9.720	39.26	10.952	78.4	N/A
1-3	330.0	33.14	9.681	39.23	10.930	78.2	N/A
1-4	331.0	33.15	9.714	39.22	10.978	78.1	N/A
1-5	331.0	33.11	9.714	39.21	10.963	78.6	N/A
1-6	329.7	33.21	9.655	39.32	10.971	78.0	N/A
1-12	330.1	33.13	9.680	39.22	10.932	78.1	N/A
1-13	331.1	33.14	9.713	39.21	10.973	78.0	N/A
1-14	331.1	33.10	9.712	39.20	10.962	78.4	N/A
1-15	329.8	33.20	9.656	39.31	10.974	78.1	N/A
2-1	498.1	47.26	10.540	56.18	11.653	78.1	N/A
2-2	497.9	47.22	10.544	56.13	11.652	78.0	N/A
2-3	500.1	47.55	10.517	56.49	11.701	78.4	N/A
2-4	500.3	47.61	10.508	56.57	11.708	78.2	N/A

Supplementary information: The non-illuminated side was covered with non-reflective background and aperture.

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 47 von 108
Page 47 of 108

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

10.8.3	Bifaciality Coefficients (initial)			
Sample no.	Φ_{isc}	Φ_{Voc}	Φ_{Pmax}	—
1-1	0.78	0.99	0.79	N/A
1-2	0.78	0.99	0.78	N/A
1-3	0.78	0.99	0.78	N/A
1-4	0.78	0.99	0.79	N/A
1-5	0.78	0.99	0.78	N/A
1-6	0.78	0.99	0.78	N/A
1-12	0.78	0.99	0.79	N/A
1-13	0.78	0.99	0.78	N/A
1-14	0.78	0.99	0.78	N/A
1-15	0.78	0.99	0.79	N/A
2-1	0.79	0.99	0.79	N/A
2-2	0.79	0.99	0.78	N/A
2-3	0.79	0.99	0.79	N/A
2-4	0.79	0.99	0.78	N/A
Supplementary information: N/A				

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 48 von 108
Page 48 of 108

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

10.8.4		Performance at BNPI (initial) – MQT 06.1					
Test date (dd/mm/yyyy)			02/02/2024 for BOM1 29/05/2024 for BOM2				—
Test method			<input 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 ± 2				
Spectral mismatch			N/A				
Sample no.	P _{max} [W]	V _{mpp} [V]	I _{mpp} [A]	V _{oc} [V]	I _{sc} [A]	FF [%]	
1-1	487.6	33.18	14.692	39.36	15.477	80.0	N/A
1-2	488.8	33.21	14.723	39.37	15.449	80.4	N/A
1-3	487.2	33.23	14.665	39.38	15.431	80.2	N/A
1-4	487.9	33.21	14.966	39.34	15.456	80.3	N/A
1-5	488.8	33.22	14.713	39.35	15.453	80.4	N/A
1-6	486.9	33.29	14.626	39.44	15.464	79.8	N/A
1-12	487.3	33.21	14.655	39.32	15.421	80.1	N/A
1-13	487.5	33.22	14.956	39.33	15.446	80.2	N/A
1-14	488.5	33.21	14.723	39.31	15.451	80.4	N/A
1-15	486.8	33.27	14.626	39.41	15.464	80.0	N/A
2-1	732.1	47.37	15.455	56.20	16.226	80.1	N/A
2-2	732.6	47.33	15.479	56.19	16.224	80.2	N/A
2-3	737.4	47.67	15.469	56.55	16.293	80.1	N/A
2-4	737.9	47.72	15.463	56.53	16.302	80.3	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 φ employed is the minimum value of φ_{Isc} and φ_{Pmax} as documented in table 10.8.3 for each test sample.

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 49 von 108
Page 49 of 108

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

10.9	Gate #1 evaluation (STC)				
Manufacturer tolerances given on name plate	for P_{\max}	t_1 [%]	± 3.0	—	
	for V_{OC}	t_2 [%]	± 3.0		
	for I_{SC}	t_3 [%]	± 3.0		
	for $P_{\max 4}$	t_4 [%]	± 3.0		
Measurement uncertainty of test laboratory	for P_{\max}	m_1 [%]	± 3.0 (for c-Si)		
	for V_{OC}	m_2 [%]	± 0.9 (for c-Si)		
	for I_{SC}	m_3 [%]	± 2.8 (for c-Si)		

10.9.1	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	444.3	457.63	440.0	426.8	P
1-2	444.9	458.25	440.0	426.8	P
1-3	443.0	456.29	440.0	426.8	P
1-4	444.3	457.63	440.0	426.8	P
1-5	444.3	457.63	440.0	426.8	P
1-6	442.6	455.88	440.0	426.8	P
1-12	443.0	456.29	440.0	426.8	P
1-13	444.2	457.53	440.0	426.8	P
1-14	444.1	457.42	440.0	426.8	P
1-15	442.5	455.78	440.0	426.8	P
2-1	665.5	685.47	655.0	635.4	P
2-2	665.2	685.16	655.0	635.4	P
2-3	670.9	691.03	675.0	654.8	P
2-4	671.5	691.65	675.0	654.8	P

Supplementary information:

Pass criteria follow requirements of section 7.2.1 of IEC 61215-1:2021.

$P_{max,meas,m1}$ = 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

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 50 von 108
Page 50 of 108

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

10.9.2	Evaluation of output power for average of all modules (STC)			
Module type	$P_{\max, \text{meas, avg}}$ [W]	$P_{\max, \text{meas, avg, m1}}$ [W]	$P_{\max, \text{NP}}$ [W]	—
SYMN108TBDB440 (Median power) (Under STC) (BOM1)	443.7	457.0	440.0	P
SYMN156R02TBD655 (Lower power end) (Under STC) (BOM2)	665.4	685.4	655.0	P
SYMN156R02TBD675 (Higher power end) (Under STC) (BOM2)	671.2	691.3	675.0	
Supplementary information: Pass criteria follow requirements of section 7.2.1 of IEC 61215-1:2021. $P_{\max, \text{meas, avg, m1}}$ = Arithmetic average of meas. max. STC power taking positive measurement uncertainty into account				

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 51 von 108
Page 51 of 108

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

10.9.3	Evaluation of open-circuit voltage for each module (STC)				
Sample no.	$V_{oc, meas}$ [V]	$V_{oc, meas, m2}$ [V]	$V_{oc, NP}$ [V]	$V_{oc, NP, t2}$ [V]	—
1-1	39.25	39.60	39.74	40.93	P
1-2	39.27	39.62	39.74	40.93	P
1-3	39.24	39.59	39.74	40.93	P
1-4	39.23	39.58	39.74	40.93	P
1-5	39.23	39.58	39.74	40.93	P
1-6	39.33	39.68	39.74	40.93	P
1-12	39.24	39.59	39.74	40.93	P
1-13	39.23	39.58	39.74	40.93	P
1-14	39.23	39.58	39.74	40.93	P
1-15	39.33	39.68	39.74	40.93	P
2-1	56.18	56.69	55.19	56.85	P
2-2	56.13	56.64	55.19	56.85	P
2-3	56.49	57.00	58.12	59.86	P
2-4	56.57	57.08	58.12	59.86	P

Supplementary information:

Pass criteria follow requirements of section 7.2.1 of IEC 61215-1:2021.

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

$V_{oc, NP, t2}$ = Nominal open-circuit voltage taking positive rated production tolerance into account

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 52 von 108
Page 52 of 108

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

10.9.4	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	14.079	14.473	13.670	14.080	P
1-2	14.041	14.434	13.670	14.080	P
1-3	14.013	14.405	13.670	14.080	P
1-4	14.074	14.468	13.670	14.080	P
1-5	14.055	14.449	13.670	14.080	P
1-6	14.065	14.459	13.670	14.080	P
1-12	14.011	14.403	13.670	14.080	P
1-13	14.072	14.466	13.670	14.080	P
1-14	14.051	14.444	13.670	14.080	P
1-15	14.061	14.455	13.670	14.080	P
2-1	14.751	15.054	14.620	15.059	P
2-2	14.749	15.052	14.620	15.059	P
2-3	14.812	15.227	14.860	15.306	P
2-4	14.820	15.235	14.860	15.306	P

Supplementary information:

Pass criteria follow requirements of section 7.2.1 of IEC 61215-1:2021.

$I_{sc, meas, m3}$ = 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

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 53 von 108
Page 53 of 108

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

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

10.9.6	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	487.6	502.2	484.0	469.5	P
1-2	488.8	503.5	484.0	469.5	P
1-3	487.2	501.8	484.0	469.5	P
1-4	487.9	502.5	484.0	469.5	P
1-5	488.8	503.5	484.0	469.5	P
1-6	486.9	501.5	484.0	469.5	P
1-12	487.3	501.9	484.0	469.5	P
1-13	487.5	502.1	484.0	469.5	P
1-14	488.5	503.2	484.0	469.5	P
1-15	486.8	501.4	484.0	469.5	P
2-1	732.1	754.1	721.0	699.4	P
2-2	732.6	754.6	721.0	699.4	P
2-3	737.4	759.5	743.0	720.7	P
2-4	737.9	760.0	743.0	720.7	P

Supplementary information:

Pass criteria follow requirements of section 7.2.1 of IEC 61215-1:2021.

$P_{\max(\text{BNPI}),\text{meas},m1(\text{BNPI})}$ = 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

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 54 von 108
Page 54 of 108

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

10.9.7	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]	—
SYMN108TBDB484 (Median power) (Under BNPI) (BOM1)	487.7	502.3	484.0	P
SYMN156R02TBD721 (Lower power end) (Under BNPI) (BOM2)	732.4	754.4	721.0	P
SYMN156R02TBD743 (Higher power end) (Under BNPI) (BOM2)	737.7	759.8	743.0	
Supplementary information:				
Pass criteria follow requirements of section 7.2.1 of IEC 61215-1:2021.				
$P_{\max,\text{meas,avg,m1}}$ = Arithmetic average of meas. max. BNPI power taking positive measurement uncertainty into account				

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 55 von 108
Page 55 of 108

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

10.9.8	Evaluation of open-circuit voltage for each module (BNPI)				
Sample no.	$V_{oc(BNPI),meas}$ [V]	$V_{oc(BNPI),meas,m2(BNPI)}$ [V]	$V_{oc(BNPI),NP}$ [V]	$V_{oc(BNPI),NP,l2(BNPI)}$ [V]	—
1-1	39.36	39.71	39.74	40.93	P
1-2	39.37	39.72	39.74	40.93	P
1-3	39.38	39.73	39.74	40.93	P
1-4	39.34	39.69	39.74	40.93	P
1-5	39.35	39.70	39.74	40.93	P
1-6	39.44	39.79	39.74	40.93	P
1-12	39.32	39.67	39.74	40.93	P
1-13	39.33	39.68	39.74	40.93	P
1-14	39.31	39.66	39.74	40.93	P
1-15	39.41	39.76	39.74	40.93	P
2-1	56.20	56.71	55.91	57.59	P
2-2	56.19	56.70	55.91	57.59	P
2-3	56.55	57.06	58.12	59.86	P
2-4	56.53	57.04	58.12	59.86	P

Supplementary information:

Pass criteria follow requirements of section 7.2.1 of IEC 61215-1:2021.

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

$V_{oc(BNPI),NP,l2(BNPI)}$ = Nominal open-circuit voltage taking positive rated production tolerance into account

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 56 von 108
Page 56 of 108

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

10.9.9	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	15.377	15.410	15.040	15.491	P
1-2	15.349	15.482	15.040	15.491	P
1-3	15.331	15.463	15.040	15.491	P
1-4	15.356	15.489	15.040	15.491	P
1-5	15.353	15.486	15.040	15.491	P
1-6	15.364	15.487	15.040	15.491	P
1-12	15.321	15.453	15.040	15.491	P
1-13	15.346	15.478	15.040	15.491	P
1-14	15.351	15.484	15.040	15.491	P
1-15	15.364	15.490	15.040	15.491	P
2-1	16.226	16.550	16.080	16.562	P
2-2	16.224	16.558	16.080	16.562	P
2-3	16.293	16.749	16.350	16.841	P
2-4	16.302	16.758	16.350	16.841	P

Supplementary information:

Pass criteria follow requirements of section 7.2.1 of IEC 61215-1:2021.

$I_{sc(BNPI),meas,m3(BNPI)}$ = 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

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 57 von 108
Page 57 of 108

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

10.11	Performance at low irradiance – MQT 07
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10.11.1	Performance at low irradiance (front side)						
Test date (dd/mm/yyyy)			02/02/2024 for BOM1				—
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 ± 20 corrected to 200				
Module temperature [°C]			25 ± 2 corrected to 25				
Sample no.	P _{max} [W]	V _{mpp} [V]	I _{mpp} [A]	V _{oc} [V]	I _{sc} [A]	FF [%]	
1-1	86.8	31.79	2.731	37.06	2.851	80.4	
Supplementary information: The non-illuminated side was covered with non-reflective background and aperture.							

10.11.2	Performance at low irradiance (rear side)						
Test date (dd/mm/yyyy)			02/02/2024 for BOM1				—
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 ± 20 corrected to 200				
Module temperature [°C]			25 ± 2 corrected to 25				
Sample no.	P _{max} [W]	V _{mpp} [V]	I _{mpp} [A]	V _{oc} [V]	I _{sc} [A]	FF [%]	
1-1	65.3	32.15	2.032	36.44	2.268	79.0	
Supplementary information: The non-illuminated side was covered with non-reflective background and aperture.							

10.11.3	Bifaciality Coefficients at low irradiance			
Sample no.	Φ_{ISC}	Φ_{Voc}	Φ_{Pmax}	—
1-1	0.75	0.98	0.79	—
Supplementary information: N/A				

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 58 von 108
Page 58 of 108

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

10.13	Hot-spot endurance test (WBT) – MQT 09 / MST 22				
Test date (dd/mm/yyyy)		03/02/2024-05/02/2024			—
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]		43.5			
Cell of complete module with highest shunt resistance shaded					
Maximum measured cell temperature [°C]		182.0			
Shading rate [%]		50.0			
1 st worst case cell of complete module with lowest shunt resistance shaded					
Maximum measured cell temperature [°C]		181.0			
Shading rate [%]		60.0			
2 nd worst case cell of complete module with lowest shunt resistance shaded					
Maximum measured cell temperature [°C]		178.0			
Shading rate [%]		50.0			
Cell adjacent to module edge with lowest shunt resistance shaded					
Maximum measured cell temperature [°C]		185.0			
Shading rate [%]		60.0			
Supplementary information: The exposure was performed under aBSI which is equal to 1000W/m ² + φ•300W/m ² .					

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 59 von 108
Page 59 of 108

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

10.13.1	Visual inspection after Hot-spot endurance test – MQT 01 / MST 01		
Test date (dd/mm/yyyy)		05/02/2024	—
Sample no.	Requirement	Nature and position of findings	
1-2	No major visual defects	No major visual defects	P
Supplementary information: N/A			

10.13.2	Insulation test after Hot-spot endurance test – MQT 03 / MST 16					
Test date (dd/mm/yyyy)				05/02/2024		—
Maximum system voltage [V _{DC}]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V _{DC}]				8000		
Insulation resistance measured at [V _{DC}]				1500		
Sample no.	R _{iso} [GΩ]	A [m²]	R _{iso} •A [GΩ•m²]	Dielectric breakdown		
				Yes (description)	No	
1-2	8.41	1.95	16.40	-	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.						

10.13.3	Wet leakage current test after Hot-spot endurance test – MQT 15 / MST 17			
Test date (dd/mm/yyyy)		05/02/2024		—
Maximum system voltage [V _{DC}]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V _{DC}]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R _{iso} [MΩ]	A [m²]	R _{iso} ·A [MΩ·m²]	
1-2	4260.0	1.95	8307.0	P
Supplementary information: Minimum requirement is 40 MΩ·m².				

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

10.13.4	Maximum power determination after Hot-spot endurance test – MQT 02 / MST 03						
Test date (dd/mm/yyyy)			05/02/2024				—
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 _{max} [W]	V _{mpp} [V]	I _{mpp} [A]	V _{oc} [V]	I _{sc} [A]	FF [%]	P
1-2	443.9	33.12	13.307	39.17	13.941	80.5	
Supplementary information: N/A							

10.13.5	Bypass diode functionality test after Hot-spot endurance test – MQT 18.2 / MST 07			
Test date (dd/mm/yyyy)		05/02/2024		—
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
Supplementary information: This test verifies that the sample shows the electrical characteristics of a functional photovoltaic device.				

Prüfbericht-Nr.: CN24PF66 002

Seite 61 von 108

Test Report No.:

Page 61 of 108

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

10.16 UV preconditioning test – MQT 10 / MST 54

Test date (dd/mm/yyyy)		07/02/2024-10/02/2024		—
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.	—			N/A
1-3	—			
1-4	—			

Supplementary information: For bifacial modules, UV preconditioning test shall be performed on both front side and rear side.

10.16.1 Visual inspection after UV preconditioning test – MQT 01 / MST 01

Test date (dd/mm/yyyy)	10/02/2024		—
Sample no.	Requirement	Nature and position of findings	
1-3	No major visual defects	No major visual defects	P
1-4		No major visual defects	P

Supplementary information: N/A

10.16.2 Insulation test after UV preconditioning test – MQT 03 / MST 16

Test date (dd/mm/yyyy)				10/02/2024		—
Maximum system voltage [V _{DC}]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V _{DC}]				8000		
Insulation resistance measured at [V _{DC}]				1500		
Sample no.	R _{iso} [GΩ]	A [m²]	R _{iso} ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
1-3	8.72	1.95	17.00	-	No	P
1-4	8.28	1.95	16.15	-	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.

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 62 von 108
Page 62 of 108

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

10.16.3	Wet leakage current test after UV preconditioning test – MQT 15 / MST 17			
Test date (dd/mm/yyyy)		10/02/2024		—
Maximum system voltage [V _{DC}]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V _{DC}]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R _{iso} [MΩ]	A [m²]	R _{iso} ·A [MΩ·m²]	
1-3	4140.0	1.95	8073.0	P
1-4	4290.0	1.95	8365.5	P
Supplementary information: Minimum requirement is 40 MΩ·m².				

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

10.17	Cyclic (dynamic) mechanical load test – MQT 20		
Test date (dd/mm/yyyy)		20/02/2024	—
Mechanical pressure load applied [Pa]		1000	
Mechanical tensile load applied [Pa]		1000	
Total number of cycles		1000	
Frequency of cycles [cycles/minute]		7	
Mounting method		Mounting holes. screws and rails	
Sample no.	Open circuits (yes/no)		
1-3	No		P
1-4	No		P
Supplementary information: N/A			

10.17.1	Visual inspection after Cyclic (dynamic) mechanical load test – MQT 01		
Test date (dd/mm/yyyy)		20/02/2024	—
Sample no.	Requirement	Nature and position of findings	
1-3	No major visual defects	No major visual defects	P
1-4		No major visual defects	P
Supplementary information: N/A			

10.17.2	Insulation test after Cyclic (dynamic) mechanical load test – MQT 03					
Test date (dd/mm/yyyy)				20/02/2024		—
Maximum system voltage [V _{DC}]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V _{DC}]				8000		
Insulation resistance measured at [V _{DC}]				1500		
Sample no.	R _{iso} [GΩ]	A [m²]	R _{iso} ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
1-3	8.74	1.95	17.04	-	No	P
1-4	8.81	1.95	17.18	-	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.						

Prüfbericht-Nr.: CN24PF66 002

Seite 64 von 108

Test Report No.:

Page 64 of 108

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

10.17.3	Wet leakage current test after Cyclic (dynamic) mechanical load test – MQT 15			
Test date (dd/mm/yyyy)		20/02/2024		—
Maximum system voltage [V _{DC}]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V _{DC}]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R _{iso} [MΩ]	A [m²]	R _{iso} ·A [MΩ·m²]	
1-3	4430.0	1.95	8638.5	P
1-4	4550.0	1.95	8872.5	P
Supplementary information: Minimum requirement is 40 MΩ·m².				

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 65 von 108
Page 65 of 108

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

10.18	Thermal cycling test (50 cycles) – MQT 11 / MST 51		
Test date (dd/mm/yyyy)		21/02/2024-01/03/2024	—
Total number of cycles		50	
Actual dwell duration at high and low temperatures		Minimum 10 min / Minimum 10 min	
Sample no.	Open circuits (yes/no)		
1-3	No		P
1-4	No		P
Supplementary information: A single 5N weight was attached to the electrical termination leads / junction box. I _{mpp} (aBSI) (aBSI equals to 1000W/m ² + ϕ•300W/m ²) was applied.			

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

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

10.18.2	Insulation test after Thermal cycling test (50 cycles) – MQT 03 / MST 16					
Test date (dd/mm/yyyy)				01/03/2024		—
Maximum system voltage [V _{DC}]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V _{DC}]				8000		
Insulation resistance measured at [V _{DC}]				1500		
Sample no.	R _{iso} [GΩ]	A [m²]	R _{iso} ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
1-3	8.46	1.95	16.50	-	No	P
1-4	8.22	1.95	16.03	-	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.						

10.18.3	Wet leakage current test after Thermal cycling test (50 cycles) – MQT 15 / MST 17			
Test date (dd/mm/yyyy)		01/03/2024		—
Maximum system voltage [V _{DC}]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V _{DC}]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R _{iso} [MΩ]	A [m²]	R _{iso} ·A [MΩ·m²]	
1-3	4330.0	1.95	8443.5	P
1-4	4220.0	1.95	8229.0	P
Supplementary information: Minimum requirement is 40 MΩ·m².				

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

10.19	Humidity-freeze test – MQT 12 / MST 52		
Test date (dd/mm/yyyy)		04/03/2024-13/03/2024	—
Total number of cycles		50	
Sample no.	Open circuits (yes/no)		
1-3	No		P
1-4	No		P
Supplementary information: N/A			

10.19.1	Visual inspection after Humidity-freeze test – MQT 01 / MST 01		
Test date (dd/mm/yyyy)		13/03/2024	—
Sample no.	Requirement	Nature and position of findings	
1-3	No major visual defects	No major visual defects	P
1-4		No major visual defects	P
Supplementary information: N/A			

10.19.2	Insulation test after Humidity-freeze test – MQT 03 / MST 16					
Test date (dd/mm/yyyy)				13/03/2024		—
Maximum system voltage [V _{DC}]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V _{DC}]				8000		
Insulation resistance measured at [V _{DC}]				1500		
Sample no.	R _{iso} [GΩ]	A [m²]	R _{iso} ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
1-3	8.24	1.95	16.07	-	No	P
1-4	8.52	1.95	16.61	-	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 $A \leq 0.1 \text{ m}^2$.

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 68 von 108
Page 68 of 108

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

10.19.3	Wet leakage current test after Humidity-freeze test – MQT 15 / MST 17			
Test date (dd/mm/yyyy)		13/03/2024		—
Maximum system voltage [V _{DC}]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V _{DC}]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R _{iso} [MΩ]	A [m²]	R _{iso} ·A [MΩ·m²]	
1-3	4440.0	1.95	8658.0	P
1-4	4320.0	1.95	8424.0	P
Supplementary information: Minimum requirement is 40 MΩ·m².				

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

10.20	Retention of junction box on mounting surface – MQT 14.1 / MST 42		
Test date (dd/mm/yyyy)		13/03/2024	
Sample no.		1-3	
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: -			

10.20.1	Visual inspection after Retention of junction box on mounting surface – MQT 01 / MST 01		
Test date (dd/mm/yyyy)		13/03/2024	—
Sample no.	Requirement	Nature and position of findings	
1-3	No major visual defects	No major visual defects	P
Supplementary information: -			

10.20.2	Insulation test after Retention of junction box on mounting surface – MQT 03 / MST 16					
Test date (dd/mm/yyyy)				13/03/2024		—
Maximum system voltage [V _{DC}]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V _{DC}]				8000		
Insulation resistance measured at [V _{DC}]				1500		
Sample no.	R _{iso} [GΩ]	A [m²]	R _{iso} ·A [GΩ·m²]	Dielectric breakdown		P
				Yes (description)	No	
1-3	8.19	1.95	15.97	-	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.						

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 70 von 108
Page 70 of 108

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

10.20.3	Wet leakage current test after Retention of junction box on mounting surface – MQT 15 / MST 17			
Test date (dd/mm/yyyy)		13/03/2024		—
Maximum system voltage [V _{DC}]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V _{DC}]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R _{iso} [MΩ]	A [m²]	R _{iso} ·A [MΩ·m²]	P
1-3	4870.0	1.95	9496.5	
Supplementary information: Minimum requirement is 40 MΩ·m².				

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 71 von 108
Page 71 of 108

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

10.23	Damp heat test – MQT 13 / MST 53		
Test date (dd/mm/yyyy)		13/03/2024-25/04/2024	—
Total duration [h]		1000	
Sample no.	—		
1-5	—		N/A
1-6	—		N/A
Supplementary information: A single 5N weight was attached to the electrical termination leads / junction box.			

10.23.1	Visual inspection after Damp heat test – MQT 01 / MST 01		
Test date (dd/mm/yyyy)		25/04/2024	—
Sample no.	Requirement	Nature and position of findings	
1-5	No major visual defects	No major visual defects	P
1-6		No major visual defects	P
Supplementary information: N/A			

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

10.23.2	Insulation test after Damp heat test – MQT 03 / MST 16					
Test date (dd/mm/yyyy)				25/04/2024		—
Maximum system voltage [V _{DC}]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V _{DC}]				8000		
Insulation resistance measured at [V _{DC}]				1500		
Sample no.	R _{iso} [GΩ]	A [m²]	R _{iso} ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
1-5	8.25	1.95	16.09	-	No	P
1-6	8.22	1.95	16.03	-	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.						

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 73 von 108
Page 73 of 108

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

10.23.3	Wet leakage current test after Damp heat test – MQT 15 / MST 17		
Test date (dd/mm/yyyy)	25/04/2024		
Maximum system voltage [V _{DC}]	1500		
Cemented joints?	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V _{DC}]	1500		
Solution resistivity [$\Omega \cdot \text{cm}$]	≤ 3500		
Solution temperature [°C]	22 \pm 2		
Sample no.	R _{iso} [M Ω]	A [m ²]	R _{iso} ·A [M $\Omega \cdot \text{m}^2$]
1-5	3880.0	1.95	7566.0
1-6	4080.0	1.95	7956.0
Supplementary information: Minimum requirement is 40 M $\Omega \cdot \text{m}^2$.			

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

10.24	Retention of junction box on mounting surface – MQT 14.1 / MST 42			
Test date (dd/mm/yyyy)		25/04/2024		—
Sample no.		1-5		
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				

10.24.1	Visual inspection after Retention of junction box on mounting surface – MQT 01 / MST 01		
Test date (dd/mm/yyyy)		25/04/2024 for BOM1 21/03/2024 for BOM2	—
Sample no.	Requirement	Nature and position of findings	
1-5	No major visual defects	No major visual defects	
Supplementary information: N/A			

10.24.2	Insulation test after Retention of junction box on mounting surface – MQT 03 / MST 16					
Test date (dd/mm/yyyy)				25/04/2024		—
Maximum system voltage [V _{DC}]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V _{DC}]				10800		
Insulation resistance measured at [V _{DC}]				2025		
Sample no.	R _{iso} [GΩ]	A [m²]	R _{iso} ·A [GΩ·m²]	Dielectric breakdown		P
				Yes (description)	No	
1-5	8.22	1.95	16.03	-	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.						

Prüfbericht-Nr.: CN24PF66 002

Seite 75 von 108

Test Report No.:

Page 75 of 108

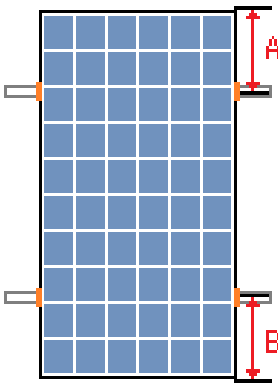
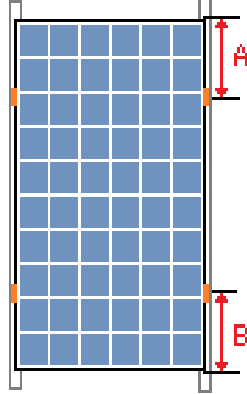
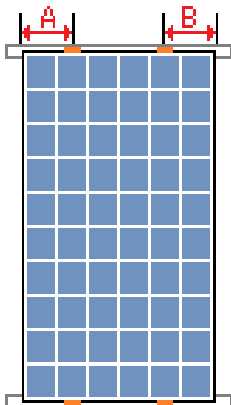
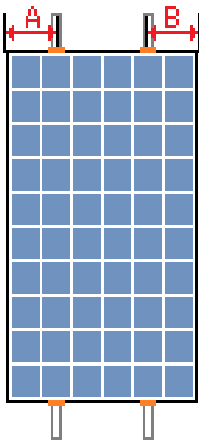
Absatz	Photovoltaic (PV) modules	Messergebnisse - Bemerkungen	Ergebnis
Clause	Anforderungen - Prüfungen / Requirements - Tests	Measuring results - Remarks	Result

10.24.3	Wet leakage current test after Retention of junction box on mounting surface – MQT 15 / MST 17			
Test date (dd/mm/yyyy)		25/04/2024		—
Maximum system voltage [V _{DC}]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V _{DC}]		2025		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R _{iso} [MΩ]	A [m²]	R _{iso} ·A [MΩ·m²]	P
1-5	4390.0	1.95	8560.5	
Supplementary information:				
Minimum requirement is 40 MΩ·m².				

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 76 von 108
Page 76 of 108

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

10.25	Static mechanical load test – MQT 16 / MST 34		
Test date (dd/mm/yyyy)	28/04/2024 for 1-5 11/06/2024 for 1-18,1-19,1-20		
Load direction applied	Positive (downward)	Negative (upward)	
Design load [Pa]	3600	1600	
Safety factor γ_m	1.5	1.5	
Test load [Pa]	5400	2400	
Mounting method	For 1-5 & 1-18: 4 Clamps and 2 rails on long frame side (Variant 1, A=390.5mm) For 1-19: 4 Clamps and 2 rails on short frame side (Variant 4, A=100mm) For 1-20: 4 Clamps and 2 rails on the corner of frame side (Variant 4, A=0mm)		—
Test configuration	Variant 1	Variant 2	
			
	Variant 3	Variant 4	
			
Sample no.	Open circuits (yes/no)		—
1-5	No		P

Prüfbericht-Nr.: CN24PF66 002

Seite 77 von 108

Test Report No.:

Page 77 of 108

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

1-18	No	P
1-19	No	P
1-20	No	P

Supplementary information: See photos in appendix.

Load was applied pneumatically. The coverage ratio of automated system (discrete-point application) is 10%.
For 1-5 & 1-18: 4 Clamps and 2 rails on long frame side (Variant 1, A=390.5mm) and Test load [Pa] is 5400 Positive / 5400 Negative.

For 1-19: 4 Clamps and 2 rails on short frame side (Variant 4, A=100mm) and Test load [Pa] is 1600 Positive / 1600 Negative.

For 1-20: 4 Clamps and 2 rails on the corner of frame side (Variant 4, A=0mm) and Test load [Pa] is 1600 Positive / 1600 Negative.

10.25.1	Visual inspection after Static mechanical load test – MQT 01 / MST 01
---------	---

Test date (dd/mm/yyyy)		28/04/2024 for 1-5 11/06/2024 for 1-18,1-19,1-20	—
Sample no.	Requirement	Nature and position of findings	
1-5	No major visual defects	No major visual defects	P
1-18	No major visual defects	No major visual defects	P
1-19	No major visual defects	No major visual defects	P
1-20	No major visual defects	No major visual defects	P

Supplementary information: N/A

10.25.2	Insulation test after Static mechanical load test – MQT 03 / MST 16
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Test date (dd/mm/yyyy)				28/04/2024 for 1-5 11/06/2024 for 1-18,1-19,1-20		—
Maximum system voltage [V _{DC}]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V _{DC}]				8000		
Insulation resistance measured at [V _{DC}]				1500		
Sample no.	R _{iso} [GΩ]	A [m²]	R _{iso} •A [GΩ•m²]	Dielectric breakdown		
				Yes (description)	No	
1-5	8.32	1.95	16.22	-	No	P
1-18	7.59	1.95	14.80	-	No	P
1-19	8.22	1.95	16.03	-	No	P
1-20	7.39	1.95	14.41	-	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.

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 78 von 108
Page 78 of 108

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

10.25.3	Wet leakage current test after Static mechanical load test – MQT 15 / MST 17			
Test date (dd/mm/yyyy)		28/04/2024 for 1-5 11/06/2024 for 1-18,1-19,1-20		—
Maximum system voltage [V _{DC}]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V _{DC}]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R _{iso} [MΩ]	A [m²]	R _{iso} ·A [MΩ·m²]	
1-5	4350.0	1.95	8482.5	P
1-18	4220.0	1.95	8229.0	P
1-19	4150.0	1.95	8092.5	P
1-20	4120.0	1.95	8034.0	P
Supplementary information: Minimum requirement is 40 MΩ·m².				

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

10.26	Hail test – MQT 17		
Test date (dd/mm/yyyy)		25/04/2024	—
Ice ball diameter [mm]		35	
Ice ball mass [g]		10.54 ± 5 %	
Ice ball velocity [m/s]		23 ± 5 %	
Number of impact locations		11	
Sample no.	—		N/A
1-6	—		
Supplementary information: N/A			

10.26.1	Visual inspection after Hail test – MQT 01		
Test date (dd/mm/yyyy)		25/04/2024	—
Sample no.	Requirement	Nature and position of findings	
1-6	No major visual defects	No major visual defects	P
Supplementary information: N/A			

10.26.2	Insulation test after Hail test – MQT 03					
Test date (dd/mm/yyyy)				25/04/2024		—
Maximum system voltage [V _{DC}]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V _{DC}]				8000		
Insulation resistance measured at [V _{DC}]				1500		
Sample no.	R _{iso} [GΩ]	A [m²]	R _{iso} ·A [GΩ·m²]	Dielectric breakdown		P
				Yes (description)	No	
1-6	12.40	1.95	24.18	-	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.						

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 80 von 108
Page 80 of 108

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

10.26.3	Wet leakage current test after Hail test – MQT 15			
Test date (dd/mm/yyyy)		25/04/2024		—
Maximum system voltage [V _{DC}]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V _{DC}]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R _{iso} [MΩ]	A [m²]	R _{iso} ·A [MΩ·m²]	P
1-6	4530.0	1.95	8833.5	
Supplementary information: Minimum requirement is 40 MΩ·m².				

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

10.39	Impulse voltage test – MST 14		
Test date (dd/mm/yyyy)		28/02/2024	—
Maximum system voltage [V]		1500	
Rated impulse voltage [V]		16000	
Impulse test voltage [V]		19680	
Lab altitude [m]		4	
Sample no.	Test results		
1-8	No evidence of dielectric breakdown or surface tracking observed		P
Supplementary information: N/A			

10.39.1	Visual inspection after Impulse voltage test – MST 01		
Test date (dd/mm/yyyy)		28/02/2024	—
Sample no.	Requirement	Nature and position of findings	
1-8	No major visual defects	No major visual defects	P
Supplementary information: Test sample was covered with conductive foil.			

10.39.2	Insulation test after Impulse voltage test – MST 16					
Test date (dd/mm/yyyy)				28/02/2024		—
Maximum system voltage [V _{DC}]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V _{DC}]				8000		
Insulation resistance measured at [V _{DC}]				1500		
Sample no.	R _{iso} [GΩ]	A [m²]	R _{iso} •A [GΩ•m²]	Dielectric breakdown		
				Yes (description)	No	
1-8	13.10	1.95	25.55	-	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.						

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 82 von 108
Page 82 of 108

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

10.40	Module breakage test – MST 32		
Test date (dd/mm/yyyy)		05/03/2024	—
Weight of impactor [kg]		45.5 ± 0.5	
Drop height [mm]		300	
Mounting technique used		Rails and clamps	
Sample no.	Test results		P
1-7	<input checked="" type="checkbox"/>	No breakage occurred	
	<input type="checkbox"/>	PV module separated from the mounting structure or from the framing	
	<input type="checkbox"/>	Breakage occurred, but no shear or opening large enough for a 76 mm diameter sphere to pass freely has developed and no particles larger than 65 cm² have been ejected from the sample.	
Supplementary information: N/A			

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 83 von 108
Page 83 of 108

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

10.43	Fire test – MST 23 (acc. to UL 790)			
10.43.1	Spread of flame test			
Test date (dd/mm/yyyy)		25/04/2024		—
Sample no.		1-16		
Fire class test specification		C		
Test results				
Did any portion of the module blow off or fall off the test deck in the form of flaming / glowing brands?		<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	P
Did any portion of the roof desk fall away in the form of glowing particles?		<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	
Was the flame spread beyond 1.82m for Class A, 2.40m for Class B or 3.96m for Class C?		<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	
Was there a significant lateral spread-of-flame from the path directly exposed to the test flame?		<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	
Supplementary information: Short module edges were mounted end-to-end.				

10.43.2	Burning brand test		
Test date (dd/mm/yyyy)	25/04/2024	—	
Sample no.	1-17		
Fire class test specification	C		
Test results			
Did any portion of the module blow off or fall off the test deck in the form of flaming / glowing brands?	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	P
Did any portion of the roof desk fall away in the form of glowing particles?	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	
Did the brand burn a hole through the roof covering or through any part of the module?	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	
Did any sustained flaming of the module occur?	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	
Supplementary information: N/A			

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 84 von 108
Page 84 of 108

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

10.45	Maximum power determination (final) – MST 03		
Test date (dd/mm/yyyy)		28/04/2024	—
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		
1-3	No kinks or other unusual characteristics		P
1-5	No kinks or other unusual characteristics		P
1-12	No kinks or other unusual characteristics		P
1-13	No kinks or other unusual characteristics		P
1-14	No kinks or other unusual characteristics		P
1-15	No kinks or other unusual characteristics		P
Supplementary information: N/A			

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

10.46	Performance at STC (final) – MQT 06.1						
Test date (dd/mm/yyyy)	15/03/2024 for 1-2 16/03/2024 for 1-3,1-4 28/04/2024 for 1-5 02/04/2024 for 1-6 04/03/2024 for 1-12~1-15 11/06/2024 for 1-18,1-19,1-20						
Test method	<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight						
Ambient temperature [°C]	25 ± 2						
Irradiance [W/m²]	1000 ± 10						
Module temperature [°C]	25 ± 2						
Spectral mismatch	N/A						
Sample no.	P _{max} [W]	V _{mpp} [V]	I _{mp} [A]	V _{oc} [V]	I _{sc} [A]	FF [%]	Degradation [%]
1-3	442.4	33.12	13.328	39.20	14.044	80.3	-0.13
1-4	443.0	33.15	13.338	39.22	14.006	80.6	-0.28
1-5	441.1	33.14	13.284	39.19	13.978	80.5	-0.71
1-6	442.4	33.12	13.330	39.18	14.039	80.4	-0.04
1-12	441.0	33.12	13.315	39.21	14.012	80.3	-0.45
1-13	442.0	33.13	13.347	39.21	14.071	80.2	-0.50
1-14	442.3	33.12	13.348	39.21	14.041	80.1	-0.41
1-15	441.5	33.19	13.302	39.22	14.051	80.2	-0.23
1-18	426.3	33.45	12.747	39.55	13.502	79.8	-0.99
1-19	425.2	33.40	12.731	39.54	13.484	79.8	-1.03
1-20	428.2	33.42	12.813	39.58	13.486	80.2	-0.69
Supplementary information: Negative degradation means power loss.							

Prüfbericht-Nr.: CN24PF66 002

Seite 86 von 108

Test Report No.:

Page 86 of 108

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

10.46	Performance at STC (final) – MQT 06.1
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10.46.1	Bifaciality Coefficients (final)			
Sample no.	Φ_{isc}	Φ_{Voc}	Φ_{Pmax}	—
1-3	0.91	1.00	0.92	—
1-4	0.91	1.00	0.92	—
1-5	0.91	1.00	0.91	—
1-6	0.91	1.00	0.91	—
1-12	0.91	1.00	0.91	—
1-13	0.91	1.00	0.91	—
1-14	0.91	1.00	0.91	—
1-15	0.91	1.00	0.91	—
Supplementary information: N/A				

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

10.46.2	Performance at BNPI (final) – MQT 06.1							
Test date (dd/mm/yyyy)				15/03/2024 for 1-2 16/03/2024 for 1-3,1-4 28/04/2024 for 1-5 02/04/2024 for 1-6 04/03/2024 for 1-12~1-15 11/06/2024 for 1-18,1-19,1-20				—
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 ± 2				
Spectral mismatch				N/A				
Sample no.	P _{max} [W]	V _{mpp} [V]	I _{mpp} [A]	V _{oc} [V]	I _{sc} [A]	FF [%]	Degra- dation [%]	
1-3	485.5	33.33	14.570	39.36	15.405	80.0	-0.35	P
1-4	486.2	33.31	14.870	39.32	15.430	80.1	-0.33	P
1-5	487.1	33.32	14.618	39.33	15.427	80.2	-0.34	P
1-6	485.2	33.39	14.532	39.43	15.438	79.6	-0.32	P
1-12	483.5	33.31	14.515	39.33	15.425	80.1	-0.78	P
1-13	483.2	33.30	14.511	39.31	15.420	80.2	-0.88	P
1-14	484.1	33.30	14.538	39.32	15.437	80.0	-0.90	P
1-15	482.2	33.32	14.472	39.41	15.418	79.8	-0.94	P

Supplementary information:

Negative degradation means power loss.

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 ϕ employed for 1-17,1-18,1-19,1-20,2-17,2-18,2-19,2-20 is the minimum value of ϕ_{ISC} and ϕ_{Pmax} as documented in table 10.46.1 for each test sample. The bifaciality coefficient ϕ employed for other samples is the minimum value of ϕ_{ISC} and ϕ_{Pmax} as documented in table 10.8.3 for each test sample.

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 88 von 108
Page 88 of 108

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

10.47	Gate #2 evaluation		
Reproducibility r for P_{\max} [%]		0.8	—

10.47.1	Evaluation of output power for each module			
Sample no.	P _{max,meas,Gate #1} [W]	P _{max,meas,Gate #1,r} [W]	P _{max,meas,Gate #2} [W]	—
1-3	443.0	417.5	442.4	P
1-4	444.3	418.7	443.0	P
1-5	444.3	418.7	441.1	P
1-6	442.6	417.1	442.4	P
1-12	443.0	417.5	441.0	P
1-13	444.2	418.6	442.0	P
1-14	444.1	418.5	442.3	P
1-15	442.5	417.0	441.5	P
1-18	430.6	405.8	426.3	P
1-19	431.2	406.4	425.2	P
1-20	429.6	404.9	428.2	P

Supplementary information:

Pass criteria follow requirements of section 7.2.1 of IEC 61215-1:2021.

$P_{\max, \text{meas, Gate \#1}}$ = 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

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 89 von 108
Page 89 of 108

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

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

10.47.1	Evaluation of output power for each module			
Sample no.	P _{max(BNPI),meas,Gate #1(BNPI)} [W]	P _{max(BNPI),meas,Gate #1,r(BNPI)} [W]	P _{max(BNPI),meas,Gate #2(BNPI)} [W]	—
1-3	487.2	459.1	485.5	P
1-4	487.9	459.8	486.2	P
1-5	488.8	460.6	487.1	P
1-6	486.9	458.9	485.2	P
1-12	487.3	459.2	483.5	P
1-13	487.5	459.4	483.2	P
1-14	488.5	460.4	484.1	P
1-15	486.8	458.8	482.2	P

Supplementary information:

Pass criteria follow requirements of section 7.2.1 of IEC 61215-1:2021.

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

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

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

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 90 von 108
Page 90 of 108

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

10.48	Bypass diode functionality test (final) – MQT 18.2 / MST 07			
Test date (dd/mm/yyyy)		15/03/2024 for 1-2 16/03/2024 for 1-3,1-4 28/04/2024 for 1-5 02/04/2024 for 1-6 04/04/2024 for 1-12~1-15		—
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
1-5	working properly	working properly	working properly	P
1-6	working properly	working properly	working properly	P
1-12	working properly	working properly	working properly	P
1-13	working properly	working properly	working properly	P
1-14	working properly	working properly	working properly	P
1-15	working properly	working properly	working properly	P
Supplementary information:				
This test verifies that the sample shows the electrical characteristics of a functional photovoltaic device.				

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 91 von 108
Page 91 of 108

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

10.50	Accessibility test (final) – MST 11		
Test date (dd/mm/yyyy)		16/03/2024 for 1-3 28/04/2024 for 1-4	—
Applied force [N]		10	
Sample no.	Contact with live electrical part?	R _{iso} [MΩ]	
1-3	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	≥60	P
1-5	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	≥60	P
Supplementary information: The resistance tester can measure up to 60.0 MΩ.			

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 92 von 108
Page 92 of 108

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

10.51	Continuity test of equipotential bonding (final) – MST 13		
Test date (dd/mm/yyyy)		16/03/2024 for 1-3 28/04/2024 for 1-5, 1-18~1-20	—
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]	
1-3	94.2/97.9/89.5	1.26/1.31/1.19	P
1-5	92.9/101.4/106.2	1.24/1.35/1.42	P
1-7	95.1/88.6/92.0	1.27/1.18/1.23	P
1-18	92.6/93.8/92.5	1.23/1.25/1.23	P
1-19	92.4/103.2/106.0	1.23/1.38/1.41	P
1-20	92.4/90.8/91.5	1.23/1.21/1.22	P
Supplementary information: N/A			

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 93 von 108
Page 93 of 108

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

10.53	Durability of markings – MST 05		
Test date (dd/mm/yyyy)	15/03/2024 for 1-2 16/03/2024 for 1-3,1-4 28/04/2024 for 1-5 02/04/2024 for 1-6	—	
Duration of rubbing with water [s]	15		
Duration of rubbing with petroleum spirits [s]	15		
Sample no.	Comments		
1-1	The marking is legible; the marking plate is not removable and without curling.	P	
1-2	The marking is legible; the marking plate is not removable and without curling.	P	
1-3	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	
1-5	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	
Supplementary information: N/A			

Prüfbericht-Nr.: CN24PF66 002
Test Report No.:

Seite 94 von 108
Page 94 of 108

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

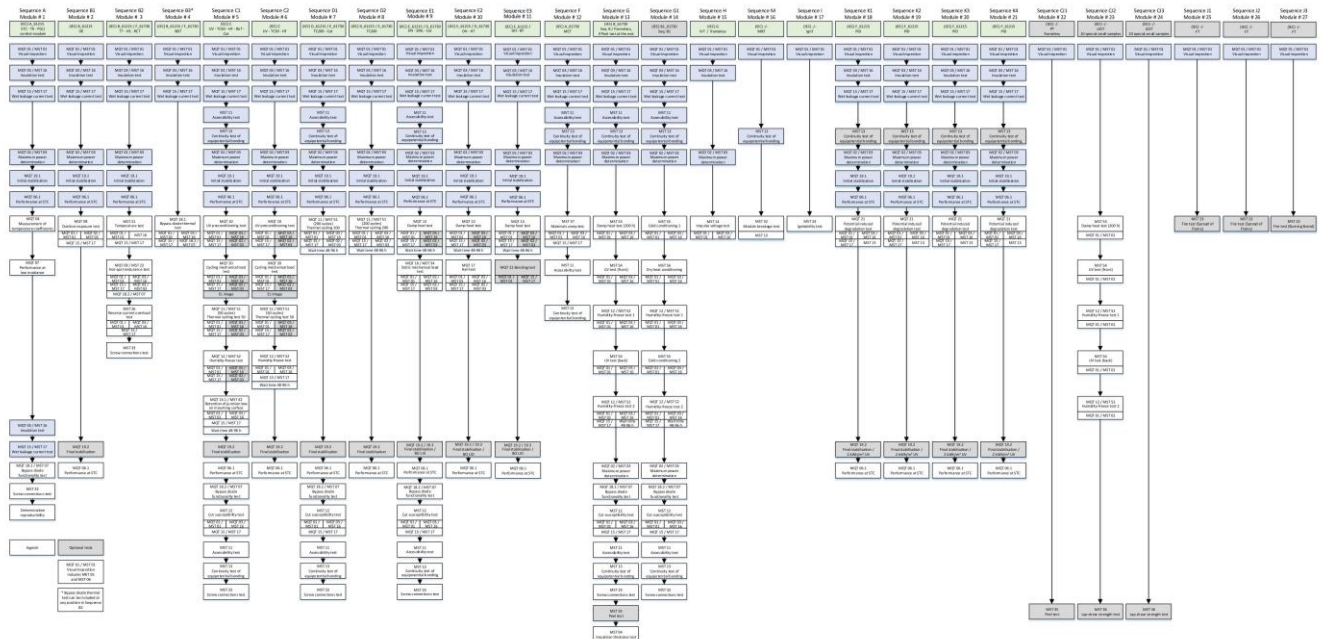
10.54	Sharp edge test – MST 06		
Test date (dd/mm/yyyy)		15/03/2024 for 1-2 16/03/2024 for 1-3,1-4 28/04/2024 for 1-5 02/04/2024 for 1-6	—
Sample no.	Comments		
1-1	The accessible PV module surfaces are smooth and free from sharp edges.		P
1-2	The accessible PV module surfaces are smooth and free from sharp edges.		P
1-3	The accessible PV module surfaces are smooth and free from sharp edges.		P
1-4	The accessible PV module surfaces are smooth and free from sharp edges.		P
1-5	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
Supplementary information: N/A			

ANLAGE zum Prüfbericht-Nr.: CN24PF66 002
APPENDIX to test report no.:

Seite 95 von 108
Page 95 of 108

ZUSATZ-DOKUMENTATION
ADDITIONAL DOCUMENTATION

Appendix A: Test charts



DISCLAIMER

These test sequences were compiled following the requirements as defined in the International Electrotechnical Commission standards IEC 61215:2021 and IEC 61730:2016.

TÜV Rheinland Energy GmbH (TRE) endeavors to ensure that the information provided in these test sequences are correct and up-to-date. Nevertheless, errors and ambiguities cannot be completely excluded. TRE does therefore not warrant the up-to-dateness, correctness, completeness or quality of the provided information.

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Publication or distribution of the test sequences to third parties is not permissible.

ANLAGE zum Prüfbericht-Nr.: CN24PF66 002
APPENDIX to test report no.:

Seite 96 von 108
Page 96 of 108

ZUSATZ-DOKUMENTATION
ADDITIONAL DOCUMENTATION

Appendix B: Abbreviations used in the report

STC	Standard Test Conditions
P_{max}	Maximum power
I_{mpp}	Maximum power point current
V_{mpp}	Maximum power point voltage
I_{sc}	Short circuit current
V_{oc}	Open circuit voltage
FF	Fill factor
α	Current temperature coefficient
β	Voltage temperature coefficient
γ	Power temperature coefficient
S	Series connection
SP	Series-parallel connection
PS	Parallel-series connection
R_{iso}	Electrical insulation resistance
A	Module area
BNPI	Bifacial nameplate irradiance
BSI	Bifacial stress irradiance
G_{BNPI}	Equivalent bifacial nameplate irradiance
aBSI	Applied bifacial stress irradiance
φ	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.
φ_{Pmax}	Maximum power bifaciality coefficient
φ_{Voc}	Open-circuit voltage bifaciality coefficient
φ_{Isc}	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.

ANLAGE zum Prüfbericht-Nr.: CN24PF66 002
APPENDIX to test report no.:

Seite 97 von 108
Page 97 of 108

ZUSATZ-DOKUMENTATION
ADDITIONAL DOCUMENTATION

Appendix C: History of reporting and certification

Project no.	Report no.	Certificate no.	Date of issue	Remarks
326022609	CN24PF66 001	PV 50631004 0001	16/05/2024	Basic project

ANLAGE zum Prüfbericht-Nr.: CN24PF66 002
APPENDIX to test report no.:

Seite 98 von 108
Page 98 of 108

FOTO-DOKUMENTATION
PHOTO DOCUMENTATION

Appendix D: Photos

Module type: SYMN108TBDB440 (Median power) (Under STC) / SYMN108TBDB484 (Median power) (Under BNPI) (BOM1)

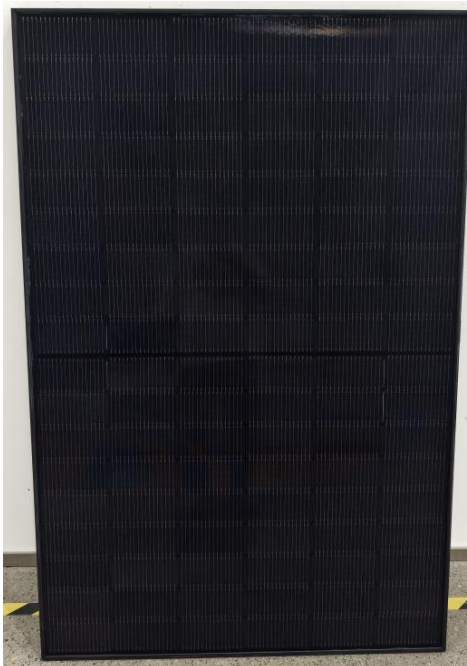


Fig. 1: front view of test sample



Fig. 2: rear view of test sample

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 PHOTO DOCUMENTATION

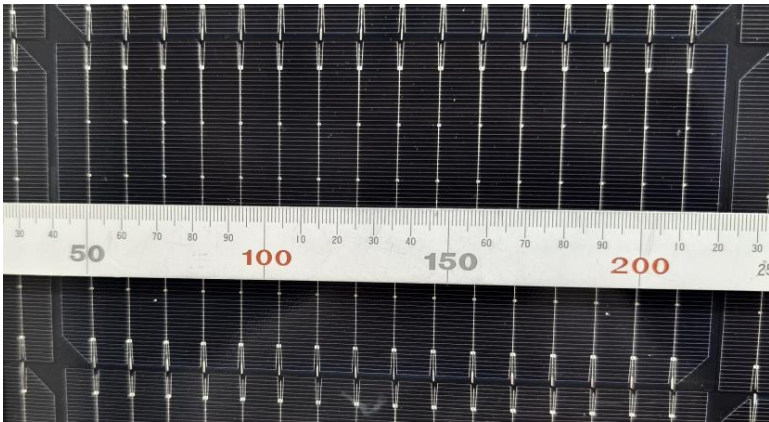


Fig. 3: detail view of solar cell



PV MODULE
 Sany Silicon Energy (Zhuzhou) Co., LTD
 Sany Energy Equipment Industrial Park,
 No.320 Qingshui Road, Shifeng District,
 Zhuzhou City, Hunan Province 412005
 China
<https://www.sanyglobal.com/product/>

SYMN10ETBD8-440	STC	BNP1	BSI
Test conditions	440W	484W	
Max. power (Pmax)	+3%		
Max. power tolerance			
Voltage at max. power (Vmpp)	33.72V		
Current at max. power (Impp)	13.04A		
Open-circuit voltage (Voc)	39.74V±3%	39.74V±3%	
Short-circuit current (Isc)	13.67A±3%	15.09A±3%	16.41A±3%
The following coefficients measured at STC according to IEC TS 60904-1-2, Bifaciality: $\phi_{Pmax} \geq 5\%$, $\phi_{Isc} \geq 5\%$, $\phi_{Voc} \geq 5\%$			

Module(T95)(max)(°C)	70
Design Load (Pa)	+3600/1600
Series Fuse Rating	30A
Maximum system voltage	1500V/DC
operating temperature range	40°C ~ +85°C
protect rage	II
module wiprotectheight	21.0(kg)
module size	1722×1134×30(mm)
STC	1000W/m², AM1.5, 25°C
BNP1	from 1000W/m², near 135W/m²
Connector	Refer to manual


 **warning**
 Only the professionals can install and maintain the components Be careful of the dangerous high DC voltage when connecting the components Never damage or scratch the back of the assembly
 Certified in accordance with IEC 61215:2021 and IEC 61730:2016
 MADE IN CHINA

Fig. 4: detail view of type label

ANLAGE zum Prüfbericht-Nr.: CN24PF66 002
APPENDIX to test report no.:

Seite 100 von 108
Page 100 of 108

FOTO-DOKUMENTATION
PHOTO DOCUMENTATION



Fig. 5: detail view of closed junction box



Fig. 6: detail view of connector

ANLAGE zum Prüfbericht-Nr.: CN24PF66 002
APPENDIX to test report no.:

Seite 101 von 108
Page 101 of 108

FOTO-DOKUMENTATION
PHOTO DOCUMENTATION



Fig. 7: detail view of cable

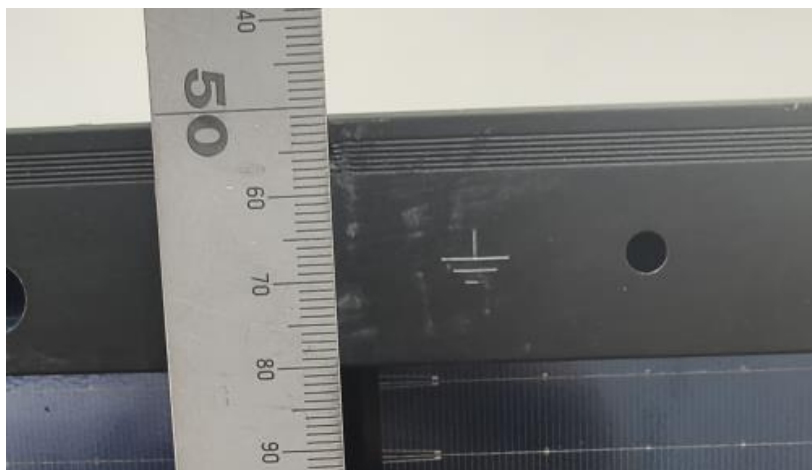


Fig. 8: detail view of equipotential bonding hole and symbol

ANLAGE zum Prüfbericht-Nr.: CN24PF66 002
APPENDIX to test report no.:

Seite 102 von 108
Page 102 of 108

FOTO-DOKUMENTATION
PHOTO DOCUMENTATION



Fig. 9: detail view of frame corner



Fig. 10: view of mechanical load mounting

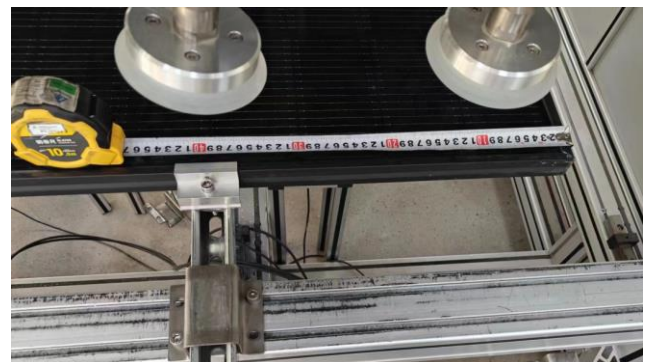


Fig. 11: detail view of mounting method

ANLAGE zum Prüfbericht-Nr.: CN24PF66 002
APPENDIX to test report no.:

Seite 103 von 108
Page 103 of 108

FOTO-DOKUMENTATION
PHOTO DOCUMENTATION



Fig. 12: view of mechanical load mounting

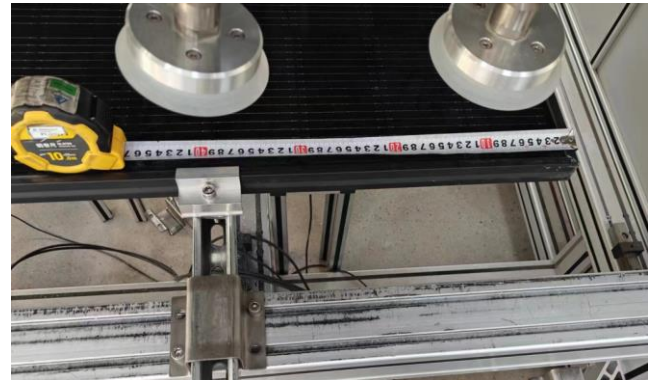


Fig. 13: detail view of mounting method



Fig. 14: view of mechanical load mounting

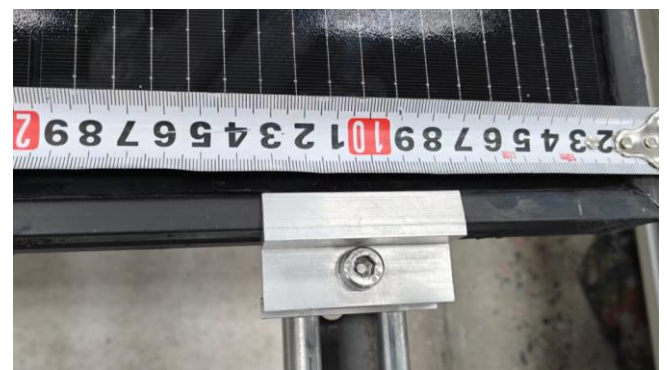


Fig. 15: detail view of mounting method



Fig. 16: view of mechanical load mounting



Fig. 17: detail view of mounting method

ANLAGE zum Prüfbericht-Nr.: CN24PF66 002
APPENDIX to test report no.:

Seite 104 von 108
Page 104 of 108

FOTO-DOKUMENTATION
PHOTO DOCUMENTATION

Module type: SYMN156R02TBD655 (Lower power end) (Under STC) / SYMN156R02TBD721 (Lower power end) (Under BNPI) (BOM2) & SYMN156R02TBD675 (Higher power end) (Under STC) / SYMN156R02TBD743 (Higher power end) (Under BNPI) (BOM2)



Fig. 18: front view of test sample



Fig. 19: rear view of test sample

ANLAGE zum Prüfbericht-Nr.: CN24PF66 002
APPENDIX to test report no.:

Seite 105 von 108
Page 105 of 108

FOTO-DOKUMENTATION
PHOTO DOCUMENTATION

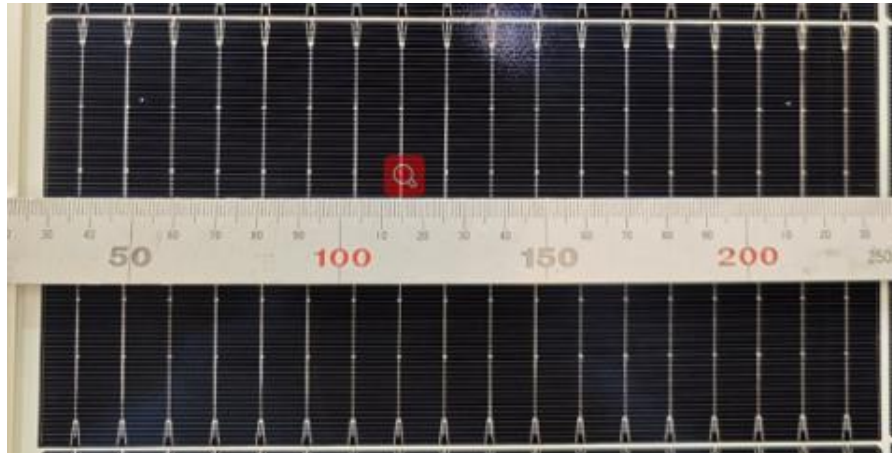


Fig. 20: detail view of solar cell







   	PV MODULE Sany Silicon Energy (Zhuzhou) Co., LTD Sany Energy Equipment Industrial Park, No.320 Qingshui Road, Shifeng District, Zhuzhou City, Hunan Province 412005 China https://www.sanyglobal.com/product/	SYM156R02TBD 655 Test conditions STC BNPI BSI Max. power (Pmax) 655W 721W Max. power tolerance +3% Voltage at max. power(Vmpp) 46.88V Current at max. power(Imp) 13.97A Open-circuit voltage(Voc) 55.91V±3% 55.91V±3% Short-circuit current(Isc) 14.82A±3% 16.08±3% 17.53±3% The following coefficients measured at STC according to IEC TS 60904-1-2: Bifaciality: qPmax80%±5%, qIsco80%±5%, qVoc98%±1%	Module(T08)(max)(°C) 70 Design Load (Pa) +3600/1600 Series Fuse Rating 30A Maximum system voltage 1500VDC operating temperature range 40°C ~ +85°C protect rage II module wprotecttight 36.2(kg) module size 2485×1192×33(mm) STC 1000W/m², AM1.5, 25°C BNPI front 1000W/m², rear 135W/m² Connector Refer to manual	 warning Only the professionals can install and maintain the components Be careful of the dangerous high DC voltage when connecting the components Never damage or scratch the back of the assembly Certified in accordance with IEC 61215:2021 and IEC 61730:2016 MADE IN CHINA
	PV MODULE Sany Silicon Energy (Zhuzhou) Co., LTD Sany Energy Equipment Industrial Park, No.320 Qingshui Road, Shifeng District, Zhuzhou City, Hunan Province 412005 China https://www.sanyglobal.com/product/	SYM156R02TBD 675 Test conditions STC BNPI BSI Max. power (Pmax) 675W 743W Max. power tolerance +3% Voltage at max. power(Vmpp) 46.13V Current at max. power(Imp) 14.21A Open-circuit voltage(Voc) 58.12V±3% 58.12V±3% Short-circuit current(Isc) 14.86A±3% 16.35±3% 17.82±3% The following coefficients measured at STC according to IEC TS 60904-1-2: Bifaciality: qPmax80%±5%, qIsco80%±5%, qVoc98%±1%	Module(T08)(max)(°C) 70 Design Load (Pa) +3600/1600 Series Fuse Rating 30A Maximum system voltage 1500VDC operating temperature range 40°C ~ +85°C protect rage II module wprotecttight 36.2(kg) module size 2485×1192×33(mm) STC 1000W/m², AM1.5, 25°C BNPI front 1000W/m², rear 135W/m² Connector Refer to manual	 warning Only the professionals can install and maintain the components Be careful of the dangerous high DC voltage when connecting the components Never damage or scratch the back of the assembly Certified in accordance with IEC 61215:2016 and IEC 61730:2016 MADE IN CHINA

Fig. 21: detail view of type label

ANLAGE zum Prüfbericht-Nr.: CN24PF66 002
APPENDIX to test report no.:

Seite 106 von 108
Page 106 of 108

FOTO-DOKUMENTATION
PHOTO DOCUMENTATION



Fig. 22: detail view of closed junction box



Fig. 23: detail view of connector

ANLAGE zum Prüfbericht-Nr.: CN24PF66 002
APPENDIX to test report no.:

Seite 107 von 108
Page 107 of 108

FOTO-DOKUMENTATION
PHOTO DOCUMENTATION



Fig. 24: detail view of cable

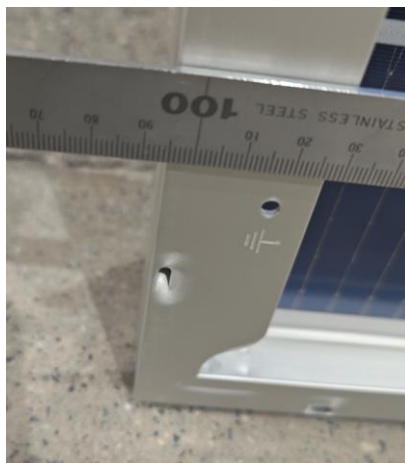


Fig. 25: detail view of equipotential bonding hole and symbol

ANLAGE zum Prüfbericht-Nr.: CN24PF66 002
APPENDIX to test report no.:

Seite 108 von 108
Page 108 of 108

FOTO-DOKUMENTATION
PHOTO DOCUMENTATION



Fig. 26: detail view of frame corner