Prüfbericht-Nr.: *Test report no.:*	**CN24PF66 003**	**Auftrags-Nr.:** *Order no.:*	326018267	Seite 1 von 125 *Page 1 of 125*
Kunden-Referenz-Nr.: *Client reference no.:*	2496578	**Auftragsdatum:** *Order date:*	25/04/2024	
Auftraggeber: *Client:*	**Sany Silicon Energy (Zhuzhou) Co., Ltd.** No.333 Qingxia Road, Tongtangwan Street, Shifeng District, Zhuzhou City, 412005, Hunan Province, P.R. China			
Prüfgegenstand: *Test item:*	Photovoltaic (PV) module			
Bezeichnung / Typ-Nr.: *Identification / Type no.:*	See module type designation on page 3-4			
Auftrags-Inhalt: *Order content:*	Design qualification and type approval of photovoltaic (PV) modules			
Prüfgrundlage: *Test specification:*	Photovoltaic (PV) modules IEC 61215-1:2021; IEC 61215-1-1:2021; IEC 61215-2:2021; IEC 61730-1:2023; IEC 61730-2:2023; 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: *Date of sample receipt:*	05/04/2024
Prüfmuster-Nr.: *Test sample no:*	See clause 6
Prüfzeitraum: *Testing period:*	07/04/2024 - 21/07/2024
Ort der Prüfung: *Place of testing:*	Refer to page 7
Prüflaboratorium: *Testing laboratory:*	TÜV Rheinland (Shanghai) Co., Ltd.
Prüfergebnis*: *Test result*:*	Pass

geprüft von: *tested by:*	X Jun Huang Signed by: Jun Huang	**genehmigt von:** *authorized by:*	X Anderson Ruan Signed by: Anderson Ruan
Datum: *Date:* 20/08/2024		**Ausstellungsdatum:** *Issue date:* 20/08/2024	
Stellung / Position:	Project Engineer	**Stellung** / Position:	Authorizer

Sonstiges /
Other:

- Standard upgrade for module types as listed on page 3-4.
- Change the address of the license holder.
- Change the address of the manufacturer.
- Introduce to new model types as listed in section 1 based on previously approved model t
- Power range extension for previously approved model types as listed in section 1
- Extension to alternative materials and modifications.
- Refer to page 5-7 and Constructional Data Form (CDF) CN24PF66 003 for more details.

Zustand des Prüfgegenstandes bei Anlieferung: *Condition of the test item at delivery:*	Prüfmuster vollständig und unbeschädigt *Test item complete and undamaged*

* Legende:	P(ass) = entspricht o.g. Prüfgrundlage(n)	F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
** Legend:*	*P(ass) = passed a.m. test specification(s)*	*F(ail) = failed a.m. test specification(s)*	*N/A = not applicable*	*N/T = not tested*

Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens.
This test report only relates to the 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.

Anmerkungen
Remarks

1	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. Detaillierte Informationen bezüglich Prüfkonditionen, Prüfequipment und Messunsicherheiten sind im Prüflabor vorhanden und können auf Wunsch bereitgestellt werden. *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.*
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3	Prüfklausel mit der Note * wurden an qualifizierte Unterauftragnehmer vergeben und sind unter der jeweiligen Prüfklausel des Berichts beschrieben. Abweichungen von Prüfspezifikation(en) oder Kundenanforderungen sind in der jeweiligen Prüfklausel im Bericht aufgeführt. *Test clauses with remark of * are subcontracted to qualified subcontractors and descripted under the respective test clause in the report.* *Deviations of testing specification(s) or customer requirements are listed in specific test clause in the report.*
4	Die Entscheidungsregel für Konformitätserklärungen basierend auf numerischen Messergebnisen 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 bezueglich des Risikos durch diese Entscheidungsregel siehe ILAC G8:2019. *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.*

Produktbeschreibung
Product description

I	General
1	**Module type designation** **New model types:** **With cut of mono c-Si cells: (Under STC)** **SYMN108TBDFBxxx (xxx=415-445, in steps of 5, 108 cells)** **SYMN156TBDOxxx (xxx=615-645, in steps of 5, 156 cells)** **SYMN156TBDLxxx (xxx=615-645, in steps of 5, 156 cells)** **With cut of mono c-Si cells: (Under BNPI)** **SYMN108TBDFBxxx (xxx=457-490, 108 cells)** **SYMN156TBDOxxx (xxx=677-710, 156 cells)** **SYMN156TBDLxxx (xxx=677-710, 156 cells)** **Extension power range for below model types:** **With cut of mono c-Si cells: (Under STC)** **SYMN156TBDxxx (xxx=640, 645, 156 cells)** **SYMN144TBDxxx (xxx=590, 595, 144 cells)** **SYMN120TBDxxx (xxx=490, 495, 120 cells)** **SYMN108TBDxxx (xxx=445, 108 cells)** **SYMN108TBDBxxx (xxx=445, 108 cells)** **With cut of mono c-Si cells: (Under BNPI)** **SYMN156TBDxxx (xxx=704, 710, 156 cells)** **SYMN144TBDxxx (xxx=649, 655, 144 cells)** **SYMN120TBDxxx (xxx=539, 545, 120 cells)** **SYMN108TBDxxx (xxx=490, 108 cells)** **SYMN108TBDBxxx (xxx=490, 108 cells)** 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) SYMN108TBDBxxx (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) SYMN156R02TBDxxx (xxx=655-675, in steps of 5, 156 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)

Produktbeschreibung
Product description

	SYMN108TBDxxx (xxx=457-484, 108 cells) SYMN108TBDBxxx (xxx=457-484, 108 cells) SYMN144R01TBDxxx (xxx=649-682, 144 cells) SYMN120R01TBDxxx (xxx=539-572, 120 cells) SYMN108R01TBDxxx (xxx=484-517, 108 cells) SYMN156R02TBDxxx (xxx=721-743, 156 cells) xxx represents output power in Wp
2	**Used materials** See Constructional Data Form (CDF) no. CN24PF66 003
3	**Address(es) of the manufacturing site(s)**

Name / Description:	Sany Silicon Energy (Zhuzhou) Co., Ltd.
Street:	No.333 Qingxia Road, Tongtangwan Street, 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

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 A) were performed according to UL 790.

- Standard upgrade for model types as listed in section 1 from IEC 61215-1:2021; IEC 61215-1-1:2021; IEC 61215-2:2021; IEC 61730-1:2016; IEC 61730-2:2016; EN 61215-1:2021; EN 61215-1-1:2021; EN 61215-2:2021; EN IEC 61730-1:2018; EN IEC 61730-2:2018 to IEC 61215-1:2021; IEC 61215-1-1:2021; IEC 61215-2:2021; IEC 61730-1:2023; IEC 61730-2:2023; EN 61215-1:2021; EN 61215-1-1:2021; EN 61215-2:2021; EN IEC 61730-1:2018; EN IEC 61730-2:2018. The relevant tests were performed on SYMN156TBDO620 and the test result is documented in this test report

- Change the address of license holder from Room 518-50, Building 1, Longxin International, No.255, Tongxia Road, Tongtangwan Street, Shifeng District, Zhuzhou City, 412005 Hunan Province, P.R. China to No.333 Qingxia Road, Tongtangwan Street, Shifeng District, Zhuzhou City, 412005, Hunan Province, P.R. China refer to the declaration is in Appendix E for details.

- Change the address of manufacturer from Sany Energy Equipment Industrial Park, No.320 Qingshui Road, Shifeng District, Zhuzhou City, Hunan Province, 412005 P.R. China to No.333 Qingxia Road, Tongtangwan Street, Shifeng District, Zhuzhou City, 412005, Hunan Province, P.R. China refer to the declaration is in Appendix E for details.

- Introduce to new model types as listed in section 1 based on previously approved model types. The relevant tests were performed on representative models SYMN156TBDO620 (Median power) (Under STC) / SYMN156TBDO682 (Median power) (Under BNPI) (BOM1)

- Power range extension as listed in section 1 based on previously approved model types. The relevant tests were performed on representative models SYMN156TBD645 (Higher power end) (Under STC) / SYMN156TBD710 (Higher power end) (Under BNPI) (BOM2).
  The differences are as below:
  1. SYMN156TBDOxxx series are for module with 182.2 x 91mm & 182.2 x 91.875mm Topcon solar cells (156 pcs), letter “O” means the module used on ocean.
  2. SYMN156TBDLxxx series are for module with 182.2 x 91mm & 182.2 x 91.875mm Topcon solar cells (156 pcs), letter “L” means the module used on lake.
  3. SYMN108TBDFBxxx series are for module with 182.2 x 91mm & 182.2 x 91.875mm Topcon solar cells (108 pcs), letter “FB” means the module with black frame.

- 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	CAIHONG (HEFEI) PHOTOVOLTAIC CO., LTD	Semi-tempered AR coated glass	Thickness [mm]: =2.0±0.2mm	SYMN156TBDO 620 (Median power) (Under STC) / SYMN156TBDO
Backside cover	CAIHONG (HEFEI) PHOTOVOLTAIC CO.,	Semi-Tempered back glass	Thickness [mm]: =2.0±0.2mm	

Produktbeschreibung
Product description

	LTD			682 (Median power) (Under BNPI) (BOM1)
Frame parts	Zhejiang DeYiLong Technology Co., Ltd.	GRPU BK30 (Black)	H(mm) x W(mm): 30x19.95mm (long frame) 30x19.95mm (short frame)	
Adhesive 1 (Junction box 2)	H.B.Fuller (Suzhou) Advanced Material Co., Ltd.	HelioSeal PVS 101	L x W [mm]: 15*15 Color: black	
Adhesive 2 (Junction box 2)	Cybrid Technologies Inc.	SW-4G	Color: black	
Encapsulation material	Jolywood (Jiangsu) Sunwatt Co., Ltd.	JW-EVA01 (above cells)	Thickness = 0.45mm±10% gram weight: 380g/m^2±10%	
		JW-EVA01 (below cells)	Thickness = 0.45mm±10% gram weight: 380g/m^2±10%	
Remark: This encapsulation material can be only used with solar cells SYCN182T1634 & SYCN191T1638 from Sany Silicon Energy (Zhuzhou) Co., Ltd.				
Solar cell	Sany Silicon Energy (Zhuzhou) Co., Ltd.	SYCN182T1634	L x W x T [mm]: 182.2 x 91 (±0.25) x 0.13 (±0.015) 182.2 x 91.875 (±0.25) x 0.13 (±0.015) Topcon Mono-Si, 16BB	Change the name of the solar cell types. The declaration is in Appendix E for details.
	Sany Silicon Energy (Zhuzhou) Co., Ltd.	SYCN191T1638	L x W x T [mm]: 182.2 x 95.8 (±0.25) x 0.13 (±0.015) 191.6 x 91.1 (±0.25) x 0.13 (±0.015) Topcon Mono-Si, 16BB	
Cell connectors 1	Suzhou bonide Photovoltaic Technology Co., Ltd	Sn60Pb40	Dimensions [mm]: Ø= 0.23±0.023mm	Compare the alternative materials have been approved, the only difference is the thickness changed <10%, no additional testing is required.
Cell connectors 2	Jiangsu Xingdarui Optical Power Co., Ltd	Sn60Pb40	Dimensions [mm]: Ø= 0.23±0.023mm	
Cell connectors 3	Changzhou Shengyue metal new material Co., Ltd	Sn60Pb40	Dimensions [mm]: Ø= 0.23±0.023mm	
Cell connectors 4	Suzhou YourBest new-type materials Co., Ltd	Sn60Pb40	Dimensions [mm]: Ø= 0.23±0.023mm	
Encapsulation material 1	HANGZHOU FIRST APPLIED MATERIAL CO., LTD	EP304 (above cells)	Thickness = 0.5mm±10% gram weight: 360g/m^2±10%	Compare the alternative materials have been approved, the only difference is gram weight changed <10%, no additional testing is required.
		F460PS (below cells)	Thickness = 0.5mm±10% gram weight: 380g/m^2±10%	
Encapsulation material 2	CHANGZHOU BETTERIAL FILM TECHNOLOGIES CO., LTD	B602M (above cells)	Thickness = 0.5mm±10% gram weight: 360g/m^2±10%	
		B601HP (below cells)	Thickness = 0.5mm±10% gram weight: 380g/m^2±10%	

This report have to be read in conjunction with Constructional Data Form (CDF) No. CN24PF66 003 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:

Produktbeschreibung
Product description

All the tests were performed at GIGA FORCE(QZ)Testing Technology Co., Ltd., which is located at No.1 Factory Building, No.10 Yincang Road, Qujiang District, Quzhou City, Zhejiang Province, China. Except for the followings tests:
Fire test (MST 23) was performed at China Testing & Certification International Group Co., Ltd., China Photovoltaic Product Test Center, which is located at No.1, South side of Yanmi Road, economic development zone, Miyun District, Beijing, P.R. China

Absatz	**Photovoltaic (PV) modules**	Messergebnisse - Bemerkungen	Ergebnis
Clause	Anforderungen - Prüfungen / *Requirements - Tests*	*Measuring results - Remarks*	*Result*
5	**Test specification**		
	IEC 61215-1:2021; EN 61215-1:2021: Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 1: Test requirements	applicable	—
	IEC 61215-1-1:2021; EN 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; EN 61215-2:2021: Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 2: Test procedures	applicable	
	IEC 61730-1:2023; EN IEC 61730-1:2018: Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction	applicable	
	IEC 61730-2:2023; EN IEC 61730-2:2018: Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing	applicable	

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

6	**List of test samples**

☐ The modules tested were taken at random from a production batch and subjected to manufacturer's normal quality control and inspection for safety testing

☐ The modules tested were prototypes of a new design and not taken from a production batch.

Module type: SYMN156TBDO620 (Under STC) / SYMN156TBDO682 (Under BNPI) (BOM1)

Sample no.	Sample SN	Test sequence	Remarks / constructional characteristics (e.g. cell, backsheet, frame type)
1-1	2403001B2D00001	A+B2	**Front cover: 2.0mm Semi-tempered AR coated glass from Hunan Kibing Solar Technology Co., Ltd.** **Encapsulation material: EP304 (between front glass and cell) / EP304 (between cell and back glass) from HANGZHOU FIRST APPLIED MATERIAL CO., LTD** **Rear cover: 2.0mm Semi-Tempered mesh glazed back glass from Hunan Kibing Solar Technology Co., Ltd.** Solar Cell: SYCN182T1634, 182.2 x 91.875 (±0.25) x 0.13 (±0.015), Topcon,16BB from Sany Silicon Energy (Zhuzhou) Co., Ltd. **Frame: 30mm, GF-R/M,GRPU, black from Zhejiang DeYiLong Technology Co., Ltd.** Adhesive of frame sealing: 1527 from H.B.Fuller (Suzhou) Advanced Material Co., Ltd. Cell connector: Φ0.26mm Sn60/Pb40 from Suzhou YourBest new-type materials Co., Ltd String connector: 6.0mm x 0.3mm, 4.0mm x 0.3mm Sn60/Pb40 from Suzhou YourBest new-type materials Co., Ltd Fluxing agent: AATF9800-MBB from Shenzhen Tongfang Electronic New-Material CO., LTD Fixing Tape: D60F6-2 from SuZhou Rongzhi Electronic Technology 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: SW-4G from Cybrid Technologies Inc. Adhesive of J-Box sealing: HelioSeal PVS 101 from H.B.Fuller (Suzhou) Advanced Material Co., Ltd. Potting Material in junction box: 1533 from H.B.Fuller (Suzhou) Advanced Material Co., Ltd.
1-2	2403001B2D00002	C1	
1-3	240300132D00013	C2	
1-4	2403001B2D00019	E1	
1-5	2403001B2D00022	E2	
1-6	2403001B2D00003	F+G1	
1-7	2403001B2D00025	Gf	
1-8	2403001B2D00028	Gb	
1-9	2403001B2D00016	H	
1-10	2403001B2D00023	M	
1-11	2403001B2D00036	I	
1-12	2403001B2D00008	K1	
1-13	2403001B2D00009	K2	
1-14	2403001B2D00010	K3	
1-15	2403001B2D00015	K4	
1-16	2403001B2D00031	J1	
1-17	2403001B2D00032	J2	
1-18	2403001B2D00036	J3	
Module type: SYMN156TBD645 (STC) / SYMN156TBD710 (BNPI) (BOM2) (Higher power end)			
2-1	240700207D03089	A	Same materials as above
2-2	240700207D02973	A	

—

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

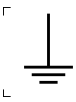
Supplementary information:
See test chart in Appendix A for full test sequences.

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

II	**IEC 61215-1:2021 and IEC 61730-1:2023 – Requirements for design construction**		
7	**Classification, application and intended use (Clause 5 of IEC 61730-1:2023)**		
7.1	**General (Clause 5.1 of IEC 61730-1:2023)**		
	The module has been evaluated for the following Class (IEC 61140):	☐ Class 0 ☒ Class II ☐ Class III	—
7.2	**Rating categories and special applications (Clause 5.2 of IEC 61730-1:2023)**		
	Modules are intended for use in the temperature range -40°C - +70°C ($T_{98\,max}$).		
	PV modules are installed in the following special applications:		—
	Building attached PV (BAPV)	☐ yes ☒ no	—
	Building integrated PV (BIPV)	☐ yes ☒ no	—
	Applications in areas where snow and / or wind load exceeding loads as tested in IEC 61730-2	☐ yes ☒ no	—
	Other (please specify)	☐ yes, as follows: ☒ no	—
8	**Requirements for design and construction (Clause 6 of IEC 61730-1:2023 and Clause 5 of IEC 61215-1:2021)**		
8.1	**General (Clause 6.1 of IEC 61730-1:2023)**		
	Product shipped from the factory as	☒ completely assembled ☐ subassemblies	—
	Incorporation of a PV module into the final assembly does not require any alteration of the PV module from its originally evaluated form.	PV modules are completely assembled.	P
	All methods of PV module mounting and wiring that are specified in the installation instructions are evaluated for compliance with the IEC 61730 series.	Available in installation manual	P
	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 have no accessible burrs, sharp edges, or sharp points.	Compliance checked by tests MST 01 and MST 06	P
	Parts are prevented from loosening or turning.	Compliance checked by tests MST 01	P

Absatz	**Photovoltaic (PV) modules**	Messergebnisse - Bemerkungen	Ergebnis
Clause	Anforderungen - Prüfungen / *Requirements - Tests*	*Measuring results - Remarks*	*Result*
	All electrical data to be reported in the marking or in the documentation accompanying a PV module are given for standard test conditions (1000 W/m^2, 25 °C, spectral irradiance equal to AM1.5 according to IEC TS 61836). For bifacial PV modules, all electrical data are shown as relative to STC, BNPI and aBSI on the front side of the module, plus bifaciality coefficients at STC according to IEC TS 60904-1-2 and IEC 61215-1:2021.	Marked on type label	P
8.2	**Marking and documentation (Clause 6.2 of IEC 61730-1:2023 and Clause 5 of IEC 61215-1:2021)**		
8.2.1	**Marking (Clause 6.2.1 of IEC 61730-1:2023)**		
	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
8.2.1.1	**General / Name plate (Clause 6.2.2.1 of IEC 61730-1:2023 and Clause 5.1 of IEC 61215-1:2021)**		
	Each PV module includes the following clear and indelible markings:	Compliance checked by tests MST 01 and MST 05	—
	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	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
	The manufacturer's identification is in a traceable code if the product is identified by the brand or trademark owned by a private labeler.	Marked on type label	P
	The date of manufacture may be abbreviated; or may be in a nationally accepted conventional code or in a code affirmed by the manufacturer, provided that the code	Marked on type label	P
	- does not repeat in less than 10 years	Marked on type label	P
	- does not require reference to the production records of the manufacturer to determine when the product was manufactured.	Marked on type label	P
	e) Maximum system voltage or "V_{sys}"	Marked on type label	P
	f) Class of protection against electrical shock, in accordance with Clause 5 of IEC 61730-1:2023	Marked on type label	P
	g) Voltage at open-circuit or "V_{oc}" including manufacturing tolerances	N/A	N/A
	h) Current at short-circuit or "I_{sc}" including manufacturing tolerances	Marked on type label	P
	i) Maximum power or "P_{max}" including manufacturing tolerances	Marked on type label	P
	j) For bifacial modules, a clear indication which side is designed as the front side, or if both are designed for prolonged exposure to direct sunlight (> 300 W/m^2).	Maximum series fuse rating indicated	P

Absatz *Clause*	**Photovoltaic (PV) modules** Anforderungen - Prüfungen / *Requirements - Tests*	Messergebnisse - Bemerkungen *Measuring results - Remarks*	Ergebnis *Result*
	k) Short-circuit current bifaciality coefficient φ_{Isc} Open-circuit voltage bifaciality coefficient φ_{Voc} Maximum power bifaciality coefficient φ_{Pmax}	Compliance checked by tests MST 01 and MST 05	P
	l) For flexible modules, the minimum radius of curvature	Marked on type label	P
	m) Positive ("+" or downward) and negative ("−" or upward) design load ratings in pascal (Pa) excluding the test load safety factor, as verified in the static mechanical load test (MST 34)	Marked on type label	P
	n) Maximum overcurrent protection rating	Marked on type label	P
	o) A module temperature rating of 70 °C, (or if tested to IEC TS 63126 Level 1 or Level 2, 80 °C or 90°C)	Marked on type label	P
	p) Connector manufacturer and model used; refer to manual for designated mating connectors	Marked on type label	P
	q) A link (website or QR code) to required documentation if a paper copy of the documentation required is not included with the module	Marked on type label	P
	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
	International symbols are used where applicable.	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.	Symbol, e.g / warning notice indicated on connectors	P
	PV connectors are clearly marked indicating the terminal polarity.	Marked on connectors	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.	☒ class II: ☐ class III: ☐ class 0: no symbol	P
	PV modules provided with a functional earth terminal is provided with a symbol according to IEC 60417-5018:2011-07.	No such part	N/A
	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	PV modules provided with terminals for field wiring rated for use with all types of wiring	N/A

Absatz *Clause*	**Photovoltaic (PV) modules** Anforderungen - Prüfungen / *Requirements - Tests*	Messergebnisse - Bemerkungen *Measuring results - Remarks*	Ergebnis *Result*
	marked with a similar statement referring to the rated material.	material, do not need to be marked.	
8.2.1.2	**Symbols (Clause 6.2.2.2 of IEC 61730-1:2023)**		
8.2.1.2.1	**Equipotential bonding (Clause 6.2.2.2.1 of IEC 61730-1:2023)**		
	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
8.2.2	**Documentation (Clause 6.2.3 of IEC 61730-1:2023 and Clause 5.2 of IEC 61215-1:2021)**		
8.2.2.1	**General (Clause 6.2.3.1 of IEC 61730-1:2023 and Clause 5.2 of IEC 61215-1:2021)**		
	Documentation describing 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
	The documentation assures that installers and operators receive appropriate and sufficient instructions for safe installation, use and maintenance of the PV modules that it accompanies.	Available in data sheet / installation manual	P
	The documentation is supplied in at least one of the official languages of the country where the PV modules will be installed.	Available in data sheet / installation manual	P
	International symbols are used where applicable.	Available in data sheet / 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.	Available in data sheet / installation manual	P
	Documentation is provided in paper form in each shipping unit or as an electronic link.	Available in data sheet / installation manual	P
	- The web address is marked on the device or provided in an information sheet enclosed with each shipping unit.	Available in data sheet / installation manual	P
	- The web address is in the form of a Uniform Resource Locator (URL – http://www.___.com/___/), or a Quick Response Code (QRcode).	Available in data sheet / installation manual	P
	- The web address link takes the user to an internet page containing the required information or a direct link to the required information.	Available in data sheet / installation manual	P
	- The file is in a file format that is commonly used and is downloadable.	Available in data sheet / installation manual	P
	The needs for maintaining and supporting information during the life cycle of the PV modules is taken into account when planning the preparation of information for use as in IEC/IEEE 82079-1.	Available in data sheet / installation manual	P

Absatz *Clause*	**Photovoltaic (PV) modules** Anforderungen - Prüfungen / *Requirements - Tests*	Messergebnisse - Bemerkungen *Measuring results - Remarks*	Ergebnis *Result*
	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 5 of IEC 61730-1:2023	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
	- For bifacial modules, a clear indication which side is designed as the front side, or if both are designed for prolonged exposure to direct sunlight (> 300 W/m^2).	N/A	N/A
	- Short-circuit current bifaciality coefficient φ_{Isc} - Open-circuit voltage bifaciality coefficient φ_{Voc} - Maximum power bifaciality coefficient φ_{Pmax}	N/A	N/A
	- Minimum radius of curvature	N/A	N/A
	- A module temperature rating of 70 °C, (or if tested to IEC TS 63126 Level 1 or Level 2, 80 °C or 90°C)	N/A	N/A
	- Connector manufacturer and model used; refer to manual for designated mating connectors	Available in data sheet / installation manual	P
	- A link (website or QR code) to required documentation if a paper copy of the documentation required is not included with the module	Available in data sheet / installation manual	P
	- 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
	- 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
	- Performance at low irradiance (MQT 07) is specified.	Available in data sheet /	P

Absatz *Clause*	**Photovoltaic (PV) modules** Anforderungen - Prüfungen / *Requirements - Tests*	Messergebnisse - Bemerkungen *Measuring results - Remarks*	Ergebnis *Result*
		installation manual	
	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
8.2.2.2	**Suitable environmental and mounting conditions (Clause 6.2.3.2 of IEC 61730-1:2023 and Clause 5.2 of IEC 61215-1:2021)**		
	The documentation states the environmental and mounting conditions for which the module has been qualified, including:		—
	The maximum rated altitude the PV module is designed for	≤ 2000 m above sea level	P
	Indication of the negative (upward) and positive (downward) design load ratings during the static mechanical load test according to MST 34	Available in installation manual	P
	For bifacial PV modules, the exposure side meets the following requirements:	N/A	N/A
	- Clear indication of which side(s) of the module have been tested for the front side exposure	N/A	N/A
	- The back side is restricted for use with indirect or limited direct sunlight (less than 300 W/m^2) unless tested as a front side	N/A	N/A
	- Each side meets the requirements for front side if both sides of a module are intended for use with prolonged exposure to direct sunlight (>300 W/m^2)	N/A	N/A
	Temperature range from a lower limit of environmental temperature of −40 °C to the upper limit set by a 98th percentile module operating temperature of 70 °C (80 °C or 90 °C if tested to Level 1 or Level 2 conditions as described in IEC TS 63126)	Available in installation manual	P
	Guidance on geographic areas, mounting conditions and system design and installation factors where the anticipated 98th percentile module operating temperature will be greater than 70 °C (or 80°C or 90°C if tested to Level 1 or Level 2 conditions)	Available in installation manual	P
	Factors that can increase voltage or current beyond the STC values are given in the documentation, including the following or equivalent statements:	Available in installation manual	P

Absatz	**Photovoltaic (PV) modules**	Messergebnisse - Bemerkungen	Ergebnis
Clause	Anforderungen - Prüfungen / *Requirements - Tests*	*Measuring results - Remarks*	*Result*
	- "A photovoltaic module is likely to experience conditions that produce higher current and/or voltage than reported at standard test conditions. Factors to consider include module temperature and front side irradiance (and, for bifacial modules, ground or roof albedo, row spacing, and installation height). Accordingly, the values of V_{OC} and I_{SC} (or for bifacial modules, $I_{SC\text{-}aBSI)}$ marked on this PV module should be multiplied by a factor of 1,25 when determining voltage and current ratings for components connected to the PV output."	Available in installation manual	P
	- "The safety factor of 1,25 given for the minimum voltage rating of the components in the example statement above may be modified during the design of a system according to the minimum temperature of the location of the installation and the temperature coefficient for V_{OC}. The safety factor of 1,25 given for conductor current ratings values for I_{SC} (or for bifacial modules, $I_{SC\text{-}aBSI}$) may be adjusted based on the maximum values of irradiance incident on the front side of the module (and the rear side for bifacial modules). To this purpose, a full simulation for the specific location and module orientation (and for bifacial modules, ground albedo, row spacing and installation height) is required. Further guidance for the choice of a safety factor other than 1,25 is given in IEC 62548."	Available in installation manual	P
	The documentation includes a statement advising that artificially concentrated sunlight producing a PV module's current above the value reported on the nameplate shall not be directed onto the front side or the back side of the PV module.	Available in installation manual	P
	The documentation reports if the PV modules were evaluated according to the following standards:	N/A	N/A
	- IEC 61701: Salt mist corrosion testing	N/A	N/A
	- IEC 62716: Ammonia corrosion testing	N/A	N/A
	- IEC 62109-3: Safety of power converters for use in photovoltaic power systems – Part 3: particular requirements for electronic devices in combination with photovoltaic elements	N/A	N/A
	- IEC TS 63126: Guidelines for qualifying PV modules, components and materials for operation at high temperatures	N/A	N/A
8.2.2.3	**Mounting (Clause 6.2.3.3 of IEC 61730-1:2023 and Clause 5.2.2 of IEC 61215-1:2021)**		
	The documentation includes adequate information and instructions for each mounting methods listed in the manufacturer's mounting instructions as well as:		—
	- A statement indicating the minimum mechanical means for securing the PV module evaluated during the mechanical load test (MST 34 of IEC 61730-2:2023) and the conformity to the mechanical load requirements of the series IEC 61215	Evaluated with Static mechanical load test (MST 34) and Module breakage test (MST 32)	P
	- Limitations to the mounting situation (e.g.slope, orientation, mounting means, cooling, specific spacing and any other condition that can influence the safety of the PV module installation)	No limitations indicated.	P

Absatz *Clause*	**Photovoltaic (PV) modules** Anforderungen - Prüfungen / *Requirements - Tests*	Messergebnisse - Bemerkungen *Measuring results - Remarks*	Ergebnis *Result*
	- Type of adhesive and the allowable substrates if adhesives are used for mounting (i.e.flexible modules)	N/A	N/A
	- The manufacturer and unique part number of the adhesive, the required surface preparation, adhesive application process, and curing condition if adhesives are specified for use in the field to provide mechanical securement to specific roof coverings or mounting systems	N/A	N/A
8.2.2.4	**Connectors/wiring (Clause 6.2.3.4 of IEC 61730-1:2023)**		
	The documentation includes a detailed description of the following information related to the connectors and wiring method:		—
	- Minimum cable diameters, rated voltage, current and temperature of cables for PV modules intended for field wiring and compliance with IEC 62930, type 131 or type 133; or EN 50618	☒ IEC 62930	P
	- Limitations on wiring methods and wire management that apply to the junction box for the PV module	No limitations indicated.	P
	- Statement that wiring to interconnect modules shall be rated for the application, and it is important that the user is aware of national installation codes.	Available in installation manual	P
	- Specific model / types together with the manufacturer name / brand of the PV connector(s) to which the PV module connectors can be mated	Available in installation manual	P
	- The bonding method(s) to be used, if applicable, is specified either all provided or specified hardware	Available in installation manual	P
	- The type and ratings of bypass diode to be used (if applicable)	Available in installation manual	P
8.2.2.5	**Fire ratings (Clause 6.2.3.5 of IEC 61730-1:2023)**		
	- a statement indicating the fire rating(s)	☒ fire rating(s) and applied standards ☐ statement that resistance to external fire sources was not evaluated	P

8.3	**Electrical components and insulation (Clause 5.3 of IEC 61730-1:2023)**		
8.3.1	**Internal wiring (Clause 6.3.2 of IEC 61730-1:2023)**		
	Internal wiring has sufficient current carrying capacity for the relevant application.	Verified by MST 14 and MST 26	P
8.3.2	**Junction boxes for PV modules (Clause 6.3.6 of IEC 61730-1:2023)**		
	Junction boxes for PV modules fulfil the requirements of IEC 62790:2020 and additional requirements in 6.5.2.2.3 of IEC 61730-1:2023 or UL 3730:2014.	☒ IEC 62790:2020	P
	Module level testing is performed to validate adhesion/connection of the junction box to the module and minimum clearance and creepage distances.	Verified by MST 01	P

Absatz	**Photovoltaic (PV) modules**	Messergebnisse - Bemerkungen	Ergebnis
Clause	Anforderungen - Prüfungen / *Requirements - Tests*	*Measuring results - Remarks*	*Result*
8.3.3	**External wiring and cables (Clause 6.3.3 of IEC 61730-1:2023)**		
	External wires and cables fulfil the requirements of IEC 62930:2017.	☒ IEC 62930:2017 (type 131 or type 133) ☐ EN 50618 (alternative to IEC 62930 type 131)	P
8.3.4	**Module overcurrent protection rating (Clause 6.3.4 of IEC 61730-1:2023)**		
	Overcurrent protecting rating is determined according to IEC 60269-6.	Compliance verified by reverse current overload test (MST 26)	P
8.3.5	**Connectors (Clause 6.3.5 of IEC 61730-1:2023)**		
	External DC connectors fulfil the requirements of IEC 62852:2014 + Amd. 1:2020 and requirements in 6.5.2.2 of IEC 61730-1:2023 or/and UL 6703:2014.	☒ IEC 62852:2014 + Amd. 1:2020	P
	Connectors are marked in accordance with 6.2 of IEC 61730-1:2023.	Verified by MST 01	P
8.3.6	**Frontsheets and backsheets (Clause 6.3.7 of IEC 61730-1:2023)**		
	Material of frontsheet:	☒ Glass ☐ Polymeric material ☐ Others	—
	Material of backsheet:	☐ Glass ☒ Polymeric material ☐ Others	—
	Polymeric frontsheets and backsheets fulfil the requirements of IEC 62788-2-1.	Compliance checked	P
	Backsheets are restricted for use with indirect or limited direct sunlight equal to or lower than 300 W/m^2.	Compliance checked	P
	The DTI requirements listed in Table 3 and Table 4 of IEC 61730-1:2023 are fulfilled by single or multiple layers of RUI as described in IEC 62788-2-1.	See tables in 8.7	P
	Adhesion of frontsheet and backsheet to encapsulant or glass is appropriate.	Compliance checked at module level by IEC 61730-2:2023 tests listed in this report.	P
8.3.7	**Insulation barriers (Clause 6.3.8 of IEC 61730-1:2023)**		
	Polymeric insulation barrier meets the relevant requirements of Clause 6.5.2 of IEC 61730-1:2023).	See 8.5.1 Part of IEC 62790:2020 qualification	P
	Barrier is held in place while keeping its required electrical and mechanical properties.	Compliance checked by IEC 61730-2:2023 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
8.3.8	**Electrical connections (Clause 6.3.9 of IEC 61730-1:2023)**		
8.3.8.1	**General (Clause 6.3.9.1 of IEC 61730-1:2023)**		

Absatz *Clause*	**Photovoltaic (PV) modules** Anforderungen - Prüfungen / *Requirements - Tests*	Messergebnisse - Bemerkungen *Measuring results - Remarks*	Ergebnis *Result*
	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 is taken that connections do not become loose, e.g. by using a washer.	Verified by MST 01 / MST 13	P
	End of a stranded conductor is not consolidated by soft soldering.	Compliance checked by MST 01.	P
	Measures are taken to prevent contact stress impairing electrical conductivity.	Compliance checked by MST 01.	P
8.3.8.2	**Terminals for external cables and PV connector ribbons (Clause 6.3.9.2 of IEC 61730-1:2023)**		
	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 62790:2020 and additional RTE, RTI, and TI requirements in 6.5.2.2.3 of IEC 61730-1:2023 or/and UL 3730:2014.	☒ IEC 62790:2020	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 62790:2020 qualification.	P
8.3.9	**Encapsulant (Clause 6.3.10 of IEC 61730-1:2023)**		
	Thermal properties are sufficient for intended application.	Compliance checked by IEC 61730-2:2023 tests listed in this report.	P
	The insulation properties according to Clause 6.5.2.2 of IEC 61730-1:2023 are met, if applicable.	Compliance checked by IEC 61730-2:2023 tests listed in this report.	P
8.3.10	**Bypass diodes (Clause 6.3.11 of IEC 61730-1:2023)**		
	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

Absatz	**Photovoltaic (PV) modules**	Messergebnisse - Bemerkungen	Ergebnis
Clause	Anforderungen - Prüfungen / *Requirements - Tests*	*Measuring results - Remarks*	*Result*
8.4	**Mechanical and electromechanical connections (Clause 6.4 of IEC 61730-1:2023)**		
8.4.1	**General (Clause 6.4.1 of IEC 61730-1:2023)**		
	Type of connection:	☒ Connection within frame ☐ Mounting interfaces via adhesive ☒ Frame to clamp a mounting system ☒ Equipotential bonding ☒ Attachment of junction box ☐ 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 the corresponding component standards.	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
8.4.2	**Screw connections (Clause 6.4.2 of IEC 61730-1:2023)**		
	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
8.4.3	**Rivets (Clause 6.4.3 of IEC 61730-1:2023)**		
	Rivets that have the double function of being concurrently electrical and mechanical connections are locked against loosening.	No rivet is used.	N/A

Absatz	**Photovoltaic (PV) modules**	Messergebnisse - Bemerkungen	Ergebnis
Clause	Anforderungen - Prüfungen / *Requirements - Tests*	*Measuring results - Remarks*	*Result*
8.4.4	**Thread-cutting screws (Clause 6.4.4 of IEC 61730-1:2023)**		
	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
8.4.5	**Form / press / tight fit (Clause 6.4.5 of IEC 61730-1:2023)**		
	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
8.4.6	**Connections by adhesives (Clause 6.4.6 of IEC 61730-1:2023)**		
	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. Example: Adhesion layer in multi-layer backsheet foil. Passed, if all lab tests passed.	
	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 7.5.2.2	P
	Connection by adhesive which is considered as cemented joint fulfills the requirements of Clause 5.6.4.2 IEC 61730-1:2023.	No cemented joints	N/A
8.4.7	**Other connections (Clause 6.4.7 of IEC 61730-1:2023)**		

Absatz *Clause*	**Photovoltaic (PV) modules** Anforderungen - Prüfungen / *Requirements - Tests*	Messergebnisse - Bemerkungen *Measuring results - Remarks*	Ergebnis *Result*
	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
8.5	**Materials (Clause 6.5 of IEC 61730-1:2023)**		
8.5.1	**Polymeric materials (Clause 6.5.2 of IEC 61730-1:2023)**		
8.5.1.1	**General (Clause 6.5.2.1 of IEC 61730-1:2023)**		
	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 61730-1:2023	No cemented joints	N/A
8.5.1.2	**Polymeric materials used as electrical insulation (Clause 6.5.2.2 of IEC 61730-1:2023)**		
8.5.1.2.1	**General (Clause 6.5.2.2.1 of IEC 61730-1:2023)**		
	The material which serves as functional insulation is appropriate according to 6.6.4.4 of IEC 61730-1:2023.	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
	The material relied upon for insulation in thin layers is appropriate for the application according to 6.6.4.2 of IEC 61730-1:2023.	Components are evaluated according to the relevant requirement in the applicable component standard.	P
	Insulation is not impaired by short-term or long-term thermal stresses that can occur in manufacturing processes, transportation, and during normal operation by electrical stress and weathering to an extent that it does not comply with the requirements of IEC 61730-1:2023 and IEC 61730-2:2023.	N/A	N/A

Absatz *Clause*	**Photovoltaic (PV) modules** Anforderungen - Prüfungen / *Requirements - Tests*	Messergebnisse - Bemerkungen *Measuring results - Remarks*	Ergebnis *Result*
8.5.1.2.2	**Endurance to electrical stress (Clause 6.5.2.2.2 of IEC 61730-1:2023)**		
	Materials used as electrical insulation are in compliance with the insulation coordination requirements.	See 8.6.3	P
	Materials relied upon for insulation (RUI) have sufficient breakdown strength and comply with 6.6.4.2 of IEC 61730-1:2023.	N/A	N/A
	The polymeric material which is part of a potential tracking path is resistant to surface tracking, in coordination with the design dimensions in 6.6.3 of IEC 61730-1:2023.	N/A	N/A
8.5.1.2.3	**Endurance to thermal stress (Clause 6.5.2.2.3 of IEC 61730-1:2023)**		
	Materials used as relied upon insulation have a minimum RTE, RTI or TI in accordance with IEC 60216-5 or IEC 60216-1 of at least 90 °C.	☒ TI ☐ RTE ☐ RTI	P
8.5.2	**Metallic materials (Clause 6.5.3 of IEC 61730-1:2023)**		
8.5.2.1	**General (Clause 6.5.3.1 of IEC 61730-1:2023)**		
	Metallic components withstand a minimum corrosion atmospheric category level C2 in ISO 9224:2012.		
	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
8.5.2.2	**Current carrying parts (Clause 6.5.3.2 of IEC 61730-1:2023)**		
	Assessed parts:	N/A	N/A
	Current-carrying parts have sufficient mechanical strength and electrical conductivity.	Compliance checked by IEC 61730-2:2023 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
8.5.3	**Adhesives (Clause 6.5.4 of IEC 61730-1:2023)**		
	Adhesives are appropriate for the application.	Compliance is checked by relevant tests of IEC 61730-2:2023, including MST 42, MST 34, MST 01, MST 11 and MST 17.	

8.6	**Protection against electric shock (Clause 6.6 of IEC 61730-1:2023)**		
8.6.1	**General (Clause 6.6.1 of IEC 61730-1:2023)**		

Absatz *Clause*	**Photovoltaic (PV) modules** Anforderungen - Prüfungen / *Requirements - Tests*	Messergebnisse - Bemerkungen *Measuring results - Remarks*	Ergebnis *Result*
	Adequate protection against contact with hazardous live parts is provided and poses no risk of electric shock.	See section 8.6.2 - 8.6.4	P
8.6.2	**Protection against accessibility to hazardous live parts (Clause 6.6.2 of IEC 61730-1:2023)**		
8.6.2.1	**General (Clause 6.6.2.1 of IEC 61730-1:2023)**		
	Class of module	See safety ratings	—
	For Class 0 and Class II modules, adequate protection against accessibility to hazardous live parts (> Please select Voc) is provided.	Compliance is checked by MST 01 and MST 11.	P
	For Class 0 PV modules, accessible metal parts are separated by at least basic insulation.	Table 2 in Clause 5.6.2.3 of IEC 61730-1:2023	P
	Class II PV modules are constructed and enclosed that only parts separated from hazardous live parts by double or reinforced insulation are accessible.	Table 2 in Clause 5.6.2.3 of IEC 61730-1:2023	P
	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 61730-1:2023	P
	Polymeric 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 6.5.2 of IEC 61730-1:2023 due to their application.	Table 2 in Clause 5.6.2.3 of IEC 61730-1:2023	P
8.6.2.2	**Protection by means of enclosures and insulation barriers (Clause 6.6.2.2 of IEC 61730-1:2023)**		
	Enclosures or insulation barriers are designed that, after mounting, the live parts are not accessible (even after possible deformation).	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
	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
8.6.2.3	**Protection by means of insulation of live parts (Clause 6.6.2.3 of IEC 61730-1:2023)**		

Absatz *Clause*	**Photovoltaic (PV) modules** Anforderungen - Prüfungen / *Requirements - Tests*	Messergebnisse - Bemerkungen *Measuring results - Remarks*	Ergebnis *Result*
	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 6.6.2.3 of IEC 61730-1:2023.	Compliance verified by evaluation of materials and components.	P
8.6.3	**Insulation coordination (Clause 6.6.3 of IEC 61730-1:2023)**		
	Clearance and creepage distances fulfil the requirements in Table 3 and Table 4 of IEC 61730-1:2023) (Clause 6.6.3.1 of IEC 61730-1:2023).	Compliance verified by evaluation of materials and components.	P
	Pollution degree (Clause 6.6.3.2.1 of IEC 61730-1:2023):	See tables in 8.7	P
	Material group (Clause 6.6.3.2.2 IEC 61730-1:2023):	See tables in 8.7	P
8.6.3.1	**Creepage distance (Clause 6.6.3.3 of IEC 61730-1:2023)**		
	Minimum values for creepage distance are in accordance with Table 3 or Table 4 of IEC 61730-1:2023). Compliance is checked by MST 57.	See tables in 8.7	P
	Minimum creepage distance requirements between live parts of different potential inside the junction box are verified according to Table 3 and Table 4 of IEC 61730-1:2023 related to the relevant working voltage considering pollution degree.	See tables in 8.7	P
8.6.3.2	**Clearance (Clause 6.6.3.4 of IEC 61730-1:2023)**		
	Clearance values are met for air gaps between conductive parts. Compliance is checked by MST 57.	See tables in 8.7	P
	Derating factor for altitude above 2000 m is considered.	Compliance checked by MST 14	P
	Minimum clearance distance requirements between live parts of different potential inside the junction box are verified according to Table 3 and Table 4 of IEC 61730-1:2023 related to the relevant working voltage.	See tables in 8.7	P
8.6.4	**Distance through functional and replied upon insulation (Clause 6.6.4 of IEC 61730-1:2023)**		
8.6.4.1	**General (Clause 6.6.4.1 of IEC 61730-1:2023)**		
8.6.4.2	**Thin layers – relied upon insulation (Clause 6.6.4.2 of IEC 61730-1:2023)**		
	Relied upon insulation in thin layers is applied at	N/A	N/A
	Design requirements of frontsheets and backsheets fulfil the requirements of IEC 62788-2-1.	See 8.3.6	P
	Thickness of the other insulation materials used for RUI, except glass or ceramic materials, are verified by MST 04 (insulation thickness test) and MST 16 (insulation test) after MST 12 (cut susceptibility test).	N/A	N/A
	The thickness requirement (DTI) of row 4) of Table 3 and Table 4 of IEC 61730-1:2023 is fulfilled.	N/A	N/A
	For a single-layer construction that the RUI layers contributing to the DTI fulfils the following requirements:	N/A	N/A

Absatz *Clause*	**Photovoltaic (PV) modules** Anforderungen - Prüfungen / *Requirements - Tests*	Messergebnisse - Bemerkungen *Measuring results - Remarks*	Ergebnis *Result*
	- Minimum thickness complies with thin-layers requirements in Table 3 or Table 4 of IEC 61730-2:2023.	N/A	N/A
	- RTE/TI/RTI complies with 6.5.2.2.3 of IEC 61730-1:2023.	N/A	N/A
	- Insulation provides sufficient dielectric strength. Test voltage (2000V + 4 times system voltage)….: V	N/A	N/A
	For a multiple-layer construction that the RUI layers contributing to the DTI fulfils the following requirements:	N/A	N/A
	- Each layer providing RUI meets the following requirements:	N/A	N/A
	- RTE/TI/RTI complies with 6.5.2.2.3 of IEC 61730-1:2023.	N/A	N/A
	- One layer meets the dielectric strength requirements for reinforced insulation; or at least two layers each meet the dielectric strength requirements for basic insulation (1 000 V + 2 times the system voltage…. : V)	N/A	N/A
	- The full multilayer construction meets the following requirements:	N/A	N/A
	- DTI value is in compliance with values according to line 4) "DTI" of Table 3 and Table of IEC 61730-1:2023.	N/A	N/A
	- Test voltage for entire multi-layer sheet providing relied upon insulation (2000V + 4 times system voltage) ·····.: V	N/A	N/A
8.6.4.3	**Cemented joints (Clause 6.6.4.3 of IEC 61730-1:2023)**		
	Cemented joints were considered as	☐ Edge seal ☐ Interface between junction box and mounting surface ☐ Others ☒ No cemented joints	—
	Distances along cemented joints comply with the minimum distances as required in table 3 or table 4 of IEC 61730-1:2023.	No cemented joints	N/A
	Distance along cemented joints, req./meas. [mm]:	No cemented joints	N/A
	A distance between two rigid parts other than used for junction boxes is 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.	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

Absatz *Clause*	**Photovoltaic (PV) modules** Anforderungen - Prüfungen / *Requirements - Tests*	Messergebnisse - Bemerkungen *Measuring results - Remarks*	Ergebnis *Result*
	- The electrically insulating adhesive / sealant has a volume resistivity of bigger than 50 × 10^6 Ω cm (dry) / bigger than 10 × 10^6 Ω cm (wet).	No cemented joints	N/A
	- Peel test (MST 35) was passed (rigid / flexible or flexible / flexible)	No cemented joints	N/A
	- Lap shear strength test (MST 36) was passed (rigid / rigid)	No cemented joints	N/A
	A distance between two rigid parts or rigid to flexible parts used for junction boxes is considered as cemented joint if following requirement is met:	No cemented joints	N/A
	- The measured distances through cemented joints at adhesive area of junction box do not fall below the minimum values listed in Tables 3 and 4 of IEC 61730-1:2023.	No cemented joints	N/A

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

8.7	**Clearance and creepage distances (Clause 5.6.3.4 of IEC 61730-1:2023) and Evaluation of clearances, creepage distances and distance through functional insulation (MST 57 of IEC 61730-2:2023)**

Table 1: Design evaluation

Module type: SYMN156TBDO620 (Under STC) / SYMN156TBDO682 (BNPI) (BOM1)

Clearance (cl) and creepage distance (cr) at/of/between:	Line of table 3or 4	Type of insulation	Pollution degree	CTI Material group	Working voltage [V]	Clearance[a] cl & Creepage cr [mm]			
						Required	Design	Measured (initial)	Measured (final)
Position 1: Shortest distance string connector – module edge	1a	☐ Functional ☐ Basic ☐ Suppl. ☒ Reinforced	☒ 1 ☐ 2 ☐ 3	☒ I ☐ II ☐ IIIa ☐ N/A	1500	19.4	12.31	10.4	12.31
Position 2: Shortest distance cell – module edge	1a	☐ Functional ☐ Basic ☐ Suppl. ☒ Reinforced	☒ 1 ☐ 2 ☐ 3	☒ I ☐ II ☐ IIIa ☐ N/A	1500	19.4	12.31	10.4	12.31
Position 3: Cell to cell	2	☐ Functional ☐ Basic ☐ Suppl. ☒ Reinforced	☒ 1 ☐ 2 ☐ 3	☒ I ☐ II ☐ IIIa ☐ N/A	< 35	0.1	1.7	0.2	1.7
Position 4: String to string	2	☐ Functional ☐ Basic ☐ Suppl. ☒ Reinforced	☒ 1 ☐ 2 ☐ 3	☒ I ☐ II ☐ IIIa ☐ N/A	< 35	0.1	1.8	0.2	1.8
Position 5: Any other position:	3	☐ Functional ☐ Basic ☐ Suppl. ☒ Reinforced	☒ 1 ☐ 2 ☐ 3	☒ I ☐ II ☐ IIIa ☐ N/A	< 35	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 clearence which is verified by Impulse voltage test according to IEC 60664-1.

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

8.7	**Clearance and creepage distances (Clause 5.6.3.4 of IEC 61730-1:2023) and Evaluation of clearances, creepage distances and distance through functional insulation (MST 57 of IEC 61730-2:2023)**

Table 2: PV module evaluation MST 01 initial

Sample no.			1-2,1-4,1-6,1-7,1-8						
Clearance (cl) and creepage distance (cr) at/of/between:	Line of table 3or 4	Type of insulation	Pollution degree	CTI Material group	Working voltage [V]	Clearance[a] cl & Creepage cr [mm]			
						Required	Design	Measured (initial)	Measured (final)
Position 1: Shortest distance string connector – module edge	1a	☐ Functional ☐ Basic ☐ Suppl. ☒ Reinforced	☒ 1 ☐ 2 ☐ 3	☒ I ☐ II ☐ IIIa ☐ N/A	1500	19.4	12.31	10.4	12.31
Position 2: Shortest distance cell – module edge	1a	☐ Functional ☐ Basic ☐ Suppl. ☒ Reinforced	☒ 1 ☐ 2 ☐ 3	☒ I ☐ II ☐ IIIa ☐ N/A	1500	19.4	12.31	10.4	12.31
Position 3: Cell to cell	2	☐ Functional ☐ Basic ☐ Suppl. ☒ Reinforced	☒ 1 ☐ 2 ☐ 3	☒ I ☐ II ☐ IIIa ☐ N/A	< 35	0.1	1.7	0.2	1.7
Position 4: String to string	2	☐ Functional ☐ Basic ☐ Suppl. ☒ Reinforced	☒ 1 ☐ 2 ☐ 3	☒ I ☐ II ☐ IIIa ☐ N/A	< 35	0.1	1.8	0.2	1.8
Position 5: Any other position:	3	☐ Functional ☐ Basic ☐ Suppl. ☒ Reinforced	☒ 1 ☐ 2 ☐ 3	☒ I ☐ II ☐ IIIa ☐ N/A	< 35	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 clearence which is verified by Impulse voltage test according to IEC 60664-1.

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

8.7	**Clearance and creepage distances (Clause 5.6.3.4 of IEC 61730-1:2023) and Evaluation of clearances, creepage distances and distance through functional insulation (MST 57 of IEC 61730-2:2023)**

Table 3: PV module evaluation MST 01 final

Sample no.			1-2,1-4,1-6,1-7,1-8						
Clearance (cl) and creepage distance (cr) at/of/between:	Line of table 3or 4	Type of insulation	Pollution degree	CTI Material group	Working voltage [V]	Clearance[a] cl & Creepage cr [mm]			
						Required	Design	Measured (initial)	Measured (final)
Position 1: Shortest distance string connector – module edge	1a	☐ Functional ☐ Basic ☐ Suppl. ☒ Reinforced	☒ 1 ☐ 2 ☐ 3	☒ I ☐ II ☐ IIIa ☐ N/A	1500	19.4	12.31	10.4	12.31
Position 2: Shortest distance cell – module edge	1a	☐ Functional ☐ Basic ☐ Suppl. ☒ Reinforced	☒ 1 ☐ 2 ☐ 3	☒ I ☐ II ☐ IIIa ☐ N/A	1500	19.4	12.31	10.4	12.31
Position 3: Cell to cell	2	☐ Functional ☐ Basic ☐ Suppl. ☒ Reinforced	☒ 1 ☐ 2 ☐ 3	☒ I ☐ II ☐ IIIa ☐ N/A	< 35	0.1	1.7	0.2	1.7
Position 4: String to string	2	☐ Functional ☐ Basic ☐ Suppl. ☒ Reinforced	☒ 1 ☐ 2 ☐ 3	☒ I ☐ II ☐ IIIa ☐ N/A	< 35	0.1	1.8	0.2	1.8
Position 5: Any other position:	3	☐ Functional ☐ Basic ☐ Suppl. ☒ Reinforced	☒ 1 ☐ 2 ☐ 3	☒ I ☐ II ☐ IIIa ☐ N/A	< 35	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 clearence which is verified by Impulse voltage test according to IEC 60664-1.

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)**		
	After stabilization, each individual module shall meet: $P_{\max}(\text{Lab}) \cdot \left(1 + \frac{\frac{1.65}{2}\lvert m_1\rvert}{100}\right) \geq P_{\max}(\text{NP}) \cdot \left(1 - \frac{\lvert t_1\rvert}{100}\right)$ $P_{\max}(\text{Lab}) \cdot \left(1 + \frac{\frac{1.65}{2}\lvert m_1\rvert}{100}\right) \geq P_{\max}(\text{NP})$	See table “Gate #1 evaluation”	P
	After stabilization, each individual module shall meet: $V_{\text{OC}}(\text{Lab}) \cdot \left(1 + \frac{\frac{1.65}{2}\lvert m_2\rvert}{100}\right) \leq V_{\text{OC}}(\text{NP}) \cdot \left(1 + \frac{\lvert t_2\rvert}{100}\right)$	See table “Gate #1 evaluation”	P
	After stabilization, each individual module shall meet: $I_{\text{SC}}(\text{Lab}) \cdot \left(1 + \frac{\frac{1.65}{2}\lvert m_3\rvert}{100}\right) \leq I_{\text{SC}}(\text{NP}) \cdot \left(1 + \frac{\lvert t_3\rvert}{100}\right)$	See table “Gate #1 evaluation”	P
	After stabilization, each individual module that is used for the qualification of low end power classes shall meet: $P_{\max}(\text{Lab}) \cdot \left(1 - \frac{\frac{1.65}{2}\lvert m_1\rvert}{100}\right) \leq P_{\max 4}(\text{NP}) \cdot \left(1 + \frac{\lvert t_4\rvert}{100}\right)$	See table “Gate #1 evaluation”	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		—
—	**Verification of rated label values (Gate #1) (BNPI) (Clause 7.2.1 of IEC 61215-1:2021)**		
	After stabilization, each individual module shall meet: $P_{\max\,(\text{BNPI})}(\text{Lab}) \cdot \left(1 + \frac{\frac{1.65}{2}\lvert m_{1(\text{BNPI})}\rvert}{100}\right) \geq P_{\max\,(\text{BNPI})}(\text{NP}) \cdot \left(1 - \frac{\lvert t_{1(\text{BNPI})}\rvert}{100}\right)$ $P_{\max\,(\text{BNPI})}(\text{Lab}) \cdot \left(1 + \frac{\frac{1.65}{2}\lvert m_{1(\text{BNPI})}\rvert}{100}\right) \geq P_{\max\,(\text{BNPI})}(\text{NP})$	See table “Gate #1 evaluation”	P
	After stabilization, each individual module shall meet: $V_{\text{OC}\,(\text{BNPI})}(\text{Lab}) \cdot \left(1 + \frac{\frac{1.65}{2}\lvert m_{2(\text{BNPI})}\rvert}{100}\right) \leq V_{\text{OC}\,(\text{BNPI})}(\text{NP}) \cdot \left(1 + \frac{\lvert t_{2(\text{BNPI})}\rvert}{100}\right)$	See table “Gate #1 evaluation”	P
	After stabilization, each individual module shall meet:	See table “Gate #1 evaluation”	P

Absatz	**Photovoltaic (PV) modules**	Messergebnisse - Bemerkungen	Ergebnis
Clause	Anforderungen - Prüfungen / *Requirements - Tests*	*Measuring results - Remarks*	*Result*
	$I_{SC(BNPI)}(\text{Lab}) \cdot \left(1 + \frac{\frac{1.65}{2}\lvert m_{3(BNPI)}\rvert}{100}\right) \leq I_{SC\ (BNPI)}(\text{NP}) \cdot \left(1 + \frac{\lvert t_{3(BNPI)}\rvert}{100}\right)$		
	After stabilization, each individual module that is used for the qualification of low end power classes shall meet: $P_{max\ (BNPI)}(\text{Lab}) \cdot \left(1 - \frac{\frac{1.65}{2}\lvert m_{1(BNPI)}\rvert}{100}\right) \leq P_{max4(BNPI)}(\text{NP}) \cdot \left(1 + \frac{\lvert t_{4(BNPI)}\rvert}{100}\right)$	See table “Gate #1 evaluation”	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		—
9.1.2	**Maximum power degradation during type approval testing (Gate #2) (STC) (Clause 7.2.2 of IEC 61215-1:2021)**		
	At the end of each test sequence, each test sample shall meet: $P_{max}(\text{Lab_Gate\ \#2}) \geq 0.95 \times P_{max}(\text{Lab_Gate\ \#1}) \cdot \left(1 - \frac{r}{100}\right)$	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)**		
	At the end of each test sequence, each test sample shall meet: $P_{max\ (BNPI)}(\text{Lab_Gate\ \#2}) \geq 0.95 \times P_{max\ (BNPI)}(\text{Lab_Gate\ \#1}) \cdot \left(1 - \frac{r_{(BNPI)}}{100}\right)$	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: -			

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

III	**IEC 61215-2:2021 and IEC 61730-2:2023 – Test procedures**

10	**Overview of tests and test results**

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

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

Absatz *Clause*	**Photovoltaic (PV) modules** Anforderungen - Prüfungen / *Requirements - Tests*	Messergebnisse - Bemerkungen *Measuring results - Remarks*	Ergebnis *Result*
Sequence M		—	—
Module breakage test (MST 32)		See table 10.41	P
Sequence I		—	—
Ignitability test (MST 24)		See table 10.42	P
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)		N/A	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.			

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)	07/04/2024 for BOM1 18/07/2024 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
2-1		No major visual defects	P
2-2		No major visual defects	P
Supplementary information: N/A			

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

10.2	**Insulation test (initial) – MQT 03 / MST 16**					
Test date (dd/mm/yyyy)				13/05/2024		—
Maximum system voltage [V_{DC}]				1500		
Cemented joints?				☒ No ☐ 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	50.00	2.80	140.00	-	No	P
1-2	50.00	2.80	140.00	-	No	P
1-3	50.00	2.80	140.00	-	No	P
1-4	50.00	2.80	140.00	-	No	P
1-5	50.00	2.80	140.00	-	No	P
1-9	50.00	2.80	140.00	-	No	P
1-10	50.00	2.80	140.00	-	No	P
1-11	50.00	2.80	140.00	-	No	P
1-12	50.00	2.80	140.00	-	No	P
1-13	50.00	2.80	140.00	-	No	P
1-14	50.00	2.80	140.00	-	No	P
1-15	50.00	2.80	140.00	-	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.
Insulation tester can measure up to 50.00 GΩ.

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)		13/05/2024		—
Maximum system voltage [V_{DC}]		1500		
Cemented joints?		☒ No ☐ 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	50000.0	2.80	140000.0	P
1-2	50000.0	2.80	140000.0	P
1-3	50000.0	2.80	140000.0	P
1-4	50000.0	2.80	140000.0	P
1-5	50000.0	2.80	140000.0	P
1-9	50000.0	2.80	140000.0	P
1-10	50000.0	2.80	140000.0	P
1-11	50000.0	2.80	140000.0	P
1-12	50000.0	2.80	140000.0	P
1-13	50000.0	2.80	140000.0	P
1-14	50000.0	2.80	140000.0	P
1-15	50000.0	2.80	140000.0	P
Supplementary information: Minimum requirement is 40 MΩ·m². Insulation tester can measure up to 50000.0 MΩ.				

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)	13/05/2024		—
Applied force [N]	10		
Sample no.	Contact with live electrical part?	R_{iso} [MΩ]	
1-1	☐ Yes ☒ No	> 50	P
1-2	☐ Yes ☒ No	> 50	P
1-4	☐ Yes ☒ No	> 50	P
1-9	☐ Yes ☒ No	> 50	P
1-10	☐ Yes ☒ No	> 50	P
1-11	☐ Yes ☒ No	> 50	P
Supplementary information: The resistance tester can measure up to 50.0 MΩ.			

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)		13/05/2024	—
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]	
1-2	86.7 / 87.3 / 88.0	1.39 / 1.40 / 1.41	P
1-3	90.7 / 91.2 / 89.8	1.45 / 1.46 / 1.44	P
1-4	83.3 / 84.0 / 82.9	1.33 / 1.34 / 1.33	P
1-5	89.0 / 88.7 / 89.5	1.42 / 1.42 / 1.43	P
1-10	91.2 / 92.0 / 93.1	1.46 / 1.47 / 1.49	
1-12	91.2 / 92.0 / 90.9	1.46 / 1.47 / 1.45	P
1-13	88.7 / 87.8 / 86.9	1.42 / 1.40 / 1.39	P
1-14	93.9 / 80.9 / 82.1	1.34 / 1.29 / 1.31	P
1-15	86.2 / 87.2 / 88.1	1.38 / 1.41 / 1.42	P
Supplementary information: N/A			

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)			09/04/2024 - 30/04/2024 for BOM1 18/07/2024 - 19/07/2024 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	—	615.3	0.91	P
	Light-soaking 1	5	616.9		
	Light-soaking 2	5	611.3		
1-2	Initial	—	601.7	0.78	P
	Light-soaking 1	5	603.3		
	Light-soaking 2	5	606.4		
1-3	Initial	—	605.4	0.38	P
	Light-soaking 1	5	607.5		
	Light-soaking 2	5	607.7		
1-4	Initial	—	602.2	0.29	P
	Light-soaking 1	5	601.7		
	Light-soaking 2	5	603.5		
1-5	Initial	—	605.3	0.24	P
	Light-soaking 1	5	606.8		
	Light-soaking 2	5	606.6		
1-12	Initial	—	601.1	0.37	P
	Light-soaking 1	5	603.3		
	Light-soaking 2	5	603.3		
1-13	Initial	—	610.1	0.19	P
	Light-soaking 1	5	609.6		
	Light-soaking 2	5	609.0		
1-14	Initial	—	626.6	0.53	P
	Light-soaking 1	5	627.9		
	Light-soaking 2	5	624.6		
1-15	Initial	—	615.6	0.64	P
	Light-soaking 1	5	616.8		
	Light-soaking 2	5	616.6		
2-1	Initial	—	642.5	0.08	P

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

	Light-soaking 1	5	642.5		
	Light-soaking 2	5	642.0		
2-2	Initial	—	643.7	0.55	P
	Light-soaking 1	5	642.9		
	Light-soaking 2	5	640.2		

Supplementary information:
* Stabilization criterion: $(P_{max}-P_{min})/P_{avg} \leq 1$ % for three consecutive measurements.
Initial measurement corresponds to MQT 02 of IEC 61215-2:2021.

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)	30/04/2024	—
Irradiance [W/m^2]	1000*	
Module temperature [°C]	25±1	
Test method	☒ Simulator ☐ Natural sunlight	
Sample no.	Appearance of initial IV-curve	
1-2	No kinks or other unusual characteristics	P
1-4	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 / *Requirements - Tests*	*Measuring results - Remarks*	*Result*

10.8	**Performance at STC (initial) – MQT 06.1**

10.8.1	**Performance at STC (initial) (front side) – MQT 06.1**						
Test date (dd/mm/yyyy)			13/05/2024 for BOM1 19/07/2024 for BOM2				—
Test method			☒ Simulator ☐ Natural sunlight				
Illuminated side			☒ Front side ☐ 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	609.0	47.57	12.801	56.17	13.495	80.3	N/A
1-2	603.5	47.61	12.675	56.43	13.351	80.1	N/A
1-3	606.6	47.83	12.681	56.33	13.351	80.7	N/A
1-4	603.3	47.72	12.643	56.40	13.245	79.9	N/A
1-5	603.1	47.71	12.623	56.41	13.235	79.8	N/A
1-12	615.7	48.61	12.665	56.99	13.345	81.0	N/A
1-13	606.5	47.82	12.682	56.31	13.352	80.6	N/A
1-14	606.4	47.46	12.778	56.09	13.475	80.2	N/A
1-15	619.6	48.54	12.765	56.87	13.484	80.8	N/A
2-1	642.0	48.42	13.261	57.39	13.912	80.4	N/A
2-2	640.2	48.20	13.282	57.40	13.940	80.0	N/A
Supplementary information: The non-illuminated side was covered with non-reflective background and aperture.							

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)			13/05/2024 for BOM1 19/07/2024 for BOM2				—
Test method			☒ Simulator ☐ Natural sunlight				
Illuminated side			☐ Front side ☒ 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	477.5	48.03	9.984	56.01	11.010	78.0	N/A
1-2	488.6	49.04	9.963	56.53	10.844	79.7	N/A
1-3	479.0	48.03	9.974	56.01	11.010	77.7	N/A
1-4	480.7	48.06	10.001	55.89	11.087	77.6	N/A
1-5	490.6	48.86	10.041	56.59	10.798	80.3	N/A
1-12	489.7	48.76	10.023	56.43	11.405	76.1	N/A
1-13	476.1	48.13	9.891	55.64	11.481	74.5	N/A
1-14	490.6	48.86	10.041	56.49	10.698	80.3	N/A
1-15	478.0	47.88	9.985	55.96	11.033	77.4	N/A
2-1	510.1	48.26	10.570	56.79	11.498	80.1	N/A
2-2	511.8	48.11	10.638	56.86	11.461	79.4	N/A
Supplementary information: The non-illuminated side was covered with non-reflective background and aperture.							

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	0.8159	0.9972	0.7841	N/A
1-2	0.8018	0.9926	0.7823	N/A
1-3	0.8247	0.9926	0.7937	N/A
1-4	0.8304	0.9922	0.7924	N/A
1-5	0.8091	0.9930	0.7968	N/A
1-12	0.8458	0.9923	0.7903	N/A
1-13	0.8520	0.9920	0.7851	N/A
1-14	0.8091	0.9930	0.7968	N/A
1-15	0.8330	0.9922	0.7923	N/A
2-1	0.7945	0.9967	0.7971	N/A
2-2	0.7994	0.9981	0.8009	N/A
Supplementary information: N/A				

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)			13/05/2024 for BOM1 19/07/2024 for BOM2				—
Test method			☐ Simulator ☐ Natural sunlight				
Illuminated side			☒ Front side ☐ Rear side				
Ambient temperature [°C]			25 ± 2				
Irradiance [W/m²]			1000 + φ•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	672.4	47.59	14.130	56.40	14.909	80.0	N/A
1-2	689.9	48.61	14.192	57.14	14.945	80.8	N/A
1-3	667.4	47.75	13.977	56.64	14.773	79.8	N/A
1-4	670.2	47.82	14.014	56.53	14.754	80.4	N/A
1-5	680.6	48.60	14.003	57.18	14.746	80.7	N/A
1-12	683.9	48.42	14.126	56.89	14.855	80.9	N/A
1-13	667.6	47.39	14.088	56.27	14.921	79.5	N/A
1-14	680.6	48.60	14.003	57.18	14.746	80.7	N/A
1-15	666.4	47.71	13.966	56.61	14.788	79.6	N/A
2-1	719.0	48.16	14.930	57.31	15.320	80.1	N/A
2-2	717.0	48.01	14.935	57.36	15.335	79.4	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.

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_{max4}	t_4 [%]	±3.0	
Measurement uncertainty of test laboratory	for P_{max}	m_1 [%]	± 2.73 (for BOM1) ± 3.00 (for BOM2)	
	for V_{OC}	m_2 [%]	± 1.03 (for BOM1) ± 0.90 (for BOM2)	
	for I_{SC}	m_3 [%]	± 2.87 (for BOM1) ± 2.80 (for BOM2)	

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	609.0	625.6	620.0	601.4	P
1-2	603.5	620.0	620.0	601.4	P
1-3	606.6	623.2	620.0	601.4	P
1-4	603.3	619.8	620.0	601.4	P
1-5	603.1	619.6	620.0	601.4	P
1-12	615.7	632.5	620.0	601.4	P
1-13	606.5	623.1	620.0	601.4	P
1-14	606.4	623.0	620.0	601.4	P
1-15	619.6	636.5	620.0	601.4	P
2-1	642.0	661.3	645.0	625.7	P
2-2	640.2	659.4	645.0	625.7	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

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	$P_{max,meas,avg}$ [W]	$P_{max,meas,avg,m1}$ [W]	$P_{max,NP}$ [W]	—
SYMN156TBDO620 (BOM1)	608.2	624.8	620.0	P
SYMN156TBD645 (BOM2) (Higher power end)	641.1	660.3	645.0	P

Supplementary information:

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

$P_{max,meas,avg,m1}$ = Arithmetic average of meas. max. STC power taking positive measurement uncertainty into account

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	56.17	56.75	56.53	58.23	P
1-2	56.43	57.01	56.53	58.23	P
1-3	56.33	56.91	56.53	58.23	P
1-4	56.40	56.98	56.53	58.23	P
1-5	56.41	56.99	56.53	58.23	P
1-12	56.99	57.58	56.53	58.23	P
1-13	56.31	56.89	56.53	58.23	P
1-14	56.09	56.67	56.53	58.23	P
1-15	56.87	57.46	56.53	58.23	P
2-1	57.39	57.91	57.51	59.24	P
2-2	57.40	57.92	57.51	59.24	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

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	13.495	13.882	13.630	14.039	P
1-2	13.351	13.734	13.630	14.039	P
1-3	13.351	13.734	13.630	14.039	P
1-4	13.245	13.625	13.630	14.039	P
1-5	13.235	13.615	13.630	14.039	P
1-12	13.345	13.728	13.630	14.039	P
1-13	13.352	13.735	13.630	14.039	P
1-14	13.475	13.862	13.630	14.039	P
1-15	13.484	13.871	13.630	14.039	P
2-1	13.912	14.302	13.930	14.348	P
2-2	13.940	14.330	13.930	14.348	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

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 $P_{max(BNPI)}$	$t_{1(BNPI)}$ [%]	±3.0	—
	for $V_{OC(BNPI)}$	$t_{2(BNPI)}$ [%]	±3.0	
	for $I_{SC(BNPI)}$	$t_{3(BNPI)}$ [%]	±3.0	
	for $P_{max4(BNPI)}$	$t_{4(BNPI)}$ [%]	±3.0	
Measurement uncertainty of test laboratory	for $P_{max(BNPI)}$	$m_{1(BNPI)}$ [%]	± 2.73 (for BOM1) ± 3.00 (for BOM2)	
	for $V_{OC(BNPI)}$	$m_{2(BNPI)}$ [%]	± 1.03 (for BOM1) ± 0.90 (for BOM2)	
	for $I_{SC(BNPI)}$	$m_{3(BNPI)}$ [%]	± 2.87 (for BOM1) ± 2.80 (for BOM2)	

10.9.6	**Evaluation of output power for each module (BNPI)**				
Sample no.	$P_{max(BNPI),meas}$ [W]	$P_{max(BNPI),meas,m1(BNPI)}$ [W]	$P_{max(BNPI),NP}$ [W]	$P_{max(BNPI),NP,t1(BNPI)}$ [W]	—
1-1	672.4	690.8	682.0	661.5	P
1-2	689.9	708.7	682.0	661.5	P
1-3	667.4	685.6	682.0	661.5	P
1-4	670.2	688.5	682.0	661.5	P
1-5	680.6	699.2	682.0	661.5	P
1-12	683.9	702.6	682.0	661.5	P
1-13	667.6	685.8	682.0	661.5	P
1-14	680.6	699.2	682.0	661.5	P
1-15	666.4	684.6	682.0	661.5	P
2-1	719.0	740.6	710.0	688.7	P
2-2	717.0	738.5	710.0	688.7	P

Supplementary information:
Pass criteria follow requirements of section 7.2.1 of IEC 61215-1:2021.
$P_{max(BNPI),meas,m1(BNPI)}$ = Measured maximum BNPI power taking positive measurement uncertainty into account
$P_{max(BNPI),NP,t1(BNPI)}$ = Nominal maximum BNPI power taking negative rated production tolerance into account

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	$P_{max(BNPI),meas,avg}$ [W]	$P_{max(BNPI),meas,avg,m1(BNPI)}$ [W]	$P_{max(BNPI),NP}$ [W]	—
SYMN156TBDO682 (BOM1)	675.4	693.8	682.0	P
SYMN156TBD710 (BOM2) (Higher power end)	718.0	739.5	710.0	P

Supplementary information:

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

$P_{max,meas,avg,m1}$ = Arithmetic average of meas. max. BNPI power taking positive measurement uncertainty into account

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]	$V_{oc(BNPI),NP,t2(BNPI)}$ [V]	—
1-1	56.40	56.98	56.53	58.23	P
1-2	57.14	57.73	56.53	58.23	P
1-3	56.64	57.22	56.53	58.23	P
1-4	56.53	57.11	56.53	58.23	P
1-5	57.18	57.77	56.53	58.23	P
1-12	56.89	57.48	56.53	58.23	P
1-13	56.27	56.85	56.53	58.23	P
1-14	57.18	57.77	56.53	58.23	P
1-15	56.61	57.19	56.53	58.23	P
2-1	57.31	57.83	57.51	59.24	P
2-2	57.36	57.88	57.51	59.24	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
$V_{oc(BNPI),NP,t2(BNPI)}$ = Nominal open-circuit voltage taking positive rated production tolerance into account

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	14.909	15.337	14.990	15.440	P
1-2	14.945	15.374	14.990	15.440	P
1-3	14.773	15.197	14.990	15.440	P
1-4	14.754	15.177	14.990	15.440	P
1-5	14.746	15.169	14.990	15.440	P
1-12	14.855	15.281	14.990	15.440	P
1-13	14.921	15.349	14.990	15.440	P
1-14	14.746	15.169	14.990	15.440	P
1-15	14.788	15.212	14.990	15.440	P
2-1	15.320	15.749	15.320	15.780	P
2-2	15.335	15.764	15.320	15.780	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

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)	30/05/2024-07/06/2024			—
Sample no.	1-1			
Cell interconnection circuit	☐ S	☒ SP	☐ PS	
Module temperature at thermal equilibrium [°C]	43.4			
Cell of complete module with highest shunt resistance shaded				
Maximum measured cell temperature [°C]	181.0			
Shading rate [%]	50.0			
1st worst case cell of complete module with lowest shunt resistance shaded				
Maximum measured cell temperature [°C]	183.0			
Shading rate [%]	60.0			
2nd worst case cell of complete module with lowest shunt resistance shaded				
Maximum measured cell temperature [°C]	179.0			
Shading rate [%]	50.0			
Cell adjacent to module edge with lowest shunt resistance shaded				
Maximum measured cell temperature [°C]	186.0			
Shading rate [%]	60.0			
Supplementary information: The exposure was performed under aBSI which is equal to 1000W/m^2 + φ•300W/m^2.				

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)		07/06/2024	—
Sample no.	Requirement	Nature and position of findings	
1-1	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)				07/06/2024		—
Maximum system voltage [V_{DC}]				1500		
Cemented joints?				☒ No	☐ 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	50.00	2.80	140.00	-	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. Insulation tester can measure up to 50.00 GΩ.						

10.13.3	**Wet leakage current test after Hot-spot endurance test – MQT 15 / MST 17**			
Test date (dd/mm/yyyy)		07/06/2024		—
Maximum system voltage [V_{DC}]		1500		
Cemented joints?		☒ No	☐ 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	50000.0	2.80	140000.0	P
Supplementary information: Minimum requirement is 40 MΩ·m². Insulation tester can measure up to 50000.0 MΩ.				

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

10.13.4	**Maximum power determination after Hot-spot endurance test – MQT 02 / MST 03**							
Test date (dd/mm/yyyy)			08/06/2024					—
Test method			☒ Simulator ☐ 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 [%]		
1-1	608.0	47.47	12.701	56.11	13.395	80.1		P
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)		08/06/2024		—
Test method		☐ Method A ☒ Method B		
Sample no.	Diode 1	Diode 2	Diode 3	
1-1	working properly	working properly	working properly	P
Supplementary information: This test verifies that the sample shows the electrical characteristics of a functional photovoltaic device.				

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)	15/05/2024-29/05/2024		—
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	☒ Front side	☒ Rear side	
Operation mode	☒ Short-circuit	☐ Open-circuit	
Sample no.	—		
1-2	—		N/A
1-3	—		N/A
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)	29/05/2024		—
Sample no.	Requirement	Nature and position of findings	
1-2	No major visual defects	No major visual defects	P
1-3		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)				29/05/2024		—
Maximum system voltage [V_{DC}]				1500		
Cemented joints?				☒ No	☐ 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	50.00	2.80	140.00	-	No	P
1-3	50.00	2.80	140.00	-	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. Insulation tester can measure up to 50.00 GΩ.						

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)		29/05/2024		—
Maximum system voltage [V_{DC}]		1500		
Cemented joints?		☒ No ☐ 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	50000.0	2.80	140000.0	P
1-3	50000.0	2.80	140000.0	P

Supplementary information:
Minimum requirement is 40 MΩ·m².
Insulation tester can measure up to 50000.0 MΩ.

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

10.17	**Cyclic (dynamic) mechanical load test – MQT 20**		
Test date (dd/mm/yyyy)		06/06/2024	—
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)		
1-2	No		P
1-3	No		P
Supplementary information: N/A			

10.17.1	**Visual inspection after Cyclic (dynamic) mechanical load test – MQT 01**		
Test date (dd/mm/yyyy)		06/06/2024	—
Sample no.	Requirement	Nature and position of findings	
1-2	No major visual defects	No major visual defects	P
1-3		No major visual defects	P
Supplementary information: N/A			

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

10.17.2	**Insulation test after Cyclic (dynamic) mechanical load test – MQT 03**					
Test date (dd/mm/yyyy)				06/06/2024		—
Maximum system voltage [V_{DC}]				1500		
Cemented joints?				☒ No	☐ 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	50.00	2.80	140.00	-	No	P
1-3	50.00	2.80	140.00	-	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.
Insulation tester can measure up to 50.00 GΩ.

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)		06/06/2024		—
Maximum system voltage [V_{DC}]		1500		
Cemented joints?		☒ No ☐ 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	50000.0	2.80	140000.0	P
1-3	50000.0	2.80	140000.0	P

Supplementary information:
Minimum requirement is 40 MΩ·m².
Insulation tester can measure up to 50000.0 MΩ.

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)		13/06/2024-21/06/2024	—
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)		
1-2	No		P
1-3	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)		21/06/2024	—
Sample no.	Requirement	Nature and position of findings	
1-2	No major visual defects	No major visual defects	P
1-3		No major visual defects	P
Supplementary information: N/A			

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

10.18.2	**Insulation test after Thermal cycling test (50 cycles) – MQT 03 / MST 16**						
Test date (dd/mm/yyyy)				21/06/2024			—
Maximum system voltage [V_{DC}]				1500			
Cemented joints?				☒ No ☐ 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	50.00	2.80	140.00	-	No		P
1-3	50.00	2.80	140.00	-	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.
Insulation tester can measure up to 50.00 GΩ.

10.18.3	**Wet leakage current test after Thermal cycling test (50 cycles) – MQT 15 / MST 17**			
Test date (dd/mm/yyyy)		21/06/2024		—
Maximum system voltage [V_{DC}]		1500		
Cemented joints?		☒ No ☐ 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	50000.0	2.80	140000.0	P
1-3	50000.0	2.80	140000.0	P

Supplementary information:
Minimum requirement is 40 MΩ·m².
Insulation tester can measure up to 50000.0 MΩ.

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

10.19	**Humidity-freeze test – MQT 12 / MST 52**		
Test date (dd/mm/yyyy)		22/06/2024-02/07/2024	—
Total number of cycles		50	
Sample no.	Open circuits (yes/no)		
1-2	No		P
1-3	No		P
Supplementary information: N/A			

10.19.1	**Visual inspection after Humidity-freeze test – MQT 01 / MST 01**		
Test date (dd/mm/yyyy)		02/07/2024	—
Sample no.	Requirement	Nature and position of findings	
1-2	No major visual defects	No major visual defects	P
1-3		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)				02/07/2024		—
Maximum system voltage [V_{DC}]				1500		
Cemented joints?				☒ No ☐ 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	50.00	2.80	140.00	-	No	P
1-3	50.00	2.80	140.00	-	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.
Insulation tester can measure up to 50.00 GΩ.

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)		02/07/2024		—
Maximum system voltage [V_{DC}]		1500		
Cemented joints?		☒ No ☐ 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	50000.0	2.80	140000.0	P
1-3	50000.0	2.80	140000.0	P

Supplementary information:
Minimum requirement is 40 MΩ·m².
Insulation tester can measure up to 50000.0 MΩ.

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

10.20	**Retention of junction box on mounting surface – MQT 14.1 / MST 42**	
Test date (dd/mm/yyyy)	02/07/2024	—
Sample no.	1-2	
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)	02/07/2024		—
Sample no.	Requirement	Nature and position of findings	
1-2	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)				02/07/2024			—
Maximum system voltage [V_{DC}]				1500			
Cemented joints?				☒ No ☐ 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			
				Yes (description)	No		
1-2	50.00	2.80	140.00	-	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. Insulation tester can measure up to 50.00 GΩ.							

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)		02/07/2024		—
Maximum system voltage [V_{DC}]		1500		
Cemented joints?		☒ No ☐ 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	50000.0	2.80	140000.0	P

Supplementary information:
Minimum requirement is 40 MΩ·m².
Insulation tester can measure up to 50000.0 MΩ.

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)	22/05/2024-03/07/2024	—
Total duration [h]	1000	
Sample no.	—	
1-4	—	N/A
1-5	—	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)	03/07/2024		—
Sample no.	Requirement	Nature and position of findings	
1-4	No major visual defects	No major visual defects	P
1-5		No major visual defects	P

Supplementary information: N/A

10.23.2	**Insulation test after Damp heat test – MQT 03 / MST 16**					
Test date (dd/mm/yyyy)				03/07/2024		—
Maximum system voltage [V_{DC}]				1500		
Cemented joints?				☒ No	☐ 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	
1-4	50.00	2.80	140.00	-	No	P
1-5	50.00	2.80	140.00	-	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.
Insulation tester can measure up to 50.00 GΩ.

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)		03/07/2024		—
Maximum system voltage [V_{DC}]		1500		
Cemented joints?		☒ No ☐ 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]	
1-4	50000.0	2.80	140000.0	P
1-5	50000.0	2.80	140000.0	P

Supplementary information:
Minimum requirement is 40 MΩ·m².
Insulation tester can measure up to 50000.0 MΩ.

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

10.24	**Retention of junction box on mounting surface – MQT 14.1 / MST 42**	
Test date (dd/mm/yyyy)	03/07/2024	—
Sample no.	1-4	
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)	03/07/2024		—
Sample no.	Requirement	Nature and position of findings	
1-4	No major visual defects	No major visual defects	P
Supplementary information: N/A			

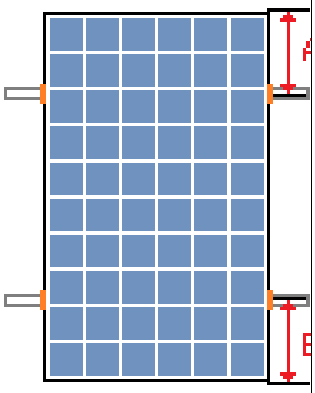
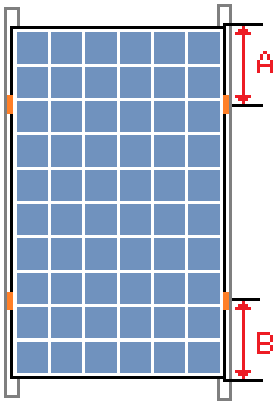
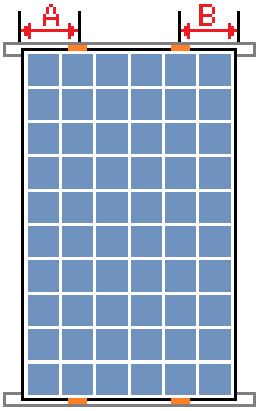
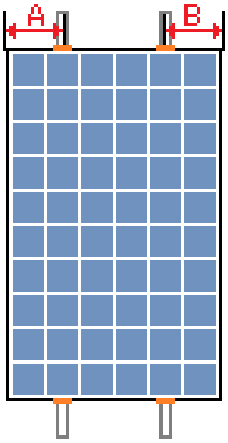
10.24.2	**Insulation test after Retention of junction box on mounting surface – MQT 03 / MST 16**						
Test date (dd/mm/yyyy)				03/07/2024			—
Maximum system voltage [V_{DC}]				1500			
Cemented joints?				☒ No	☐ Yes		
High voltage applied [V_{DC}]				10800			
Insulation resistance measured at [V_{DC}]				2025			
Sample no.	R_{iso} [GΩ]	A [m²]	R_{iso}·A [GΩ·m²]	Dielectric breakdown			
				Yes (description)	No		
1-4	50.00	2.80	140.00	-	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.							

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)		03/07/2024		—
Maximum system voltage [V_{DC}]		1500		
Cemented joints?		☒ No ☐ 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]	
1-4	50000.0	2.80	140000.0	P

Supplementary information:
Minimum requirement is 40 MΩ·m².
Insulation tester can measure up to 50000.0 MΩ.

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)	08/07/2024		—
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	2 rails and 4 clamps		
Test configuration	Variant 1 	Variant 2 	
	Variant 3 	Variant 4 	

Sample no.	Open circuits (yes/no)	—
1-4	No	P

Supplementary information: See photos in appendix.
Load was applied pneumatically. The coverage ratio of automated system (discrete-point application) is 10%.

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

10.25.1	**Visual inspection after Static mechanical load test – MQT 01 / MST 01**		
Test date (dd/mm/yyyy)	08/07/2024		—
Sample no.	Requirement	Nature and position of findings	
1-4	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**					
Test date (dd/mm/yyyy)				08/07/2024		—
Maximum system voltage [V_{DC}]				1500		
Cemented joints?				☒ No ☐ 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	
1-4	50.00	2.80	140.00	-	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. Insulation tester can measure up to 50.00 GΩ.						

10.25.3	**Wet leakage current test after Static mechanical load test – MQT 15 / MST 17**			
Test date (dd/mm/yyyy)		08/07/2024		—
Maximum system voltage [V_{DC}]		1500		
Cemented joints?		☒ No ☐ 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]	
1-4	50000.0	2.80	140000.0	P
Supplementary information: Minimum requirement is 40 MΩ·m². Insulation tester can measure up to 50000.0 MΩ.				

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

10.26	**Hail test – MQT 17**	
Test date (dd/mm/yyyy)	08/07/2024	—
Ice ball diameter [mm]	25	
Ice ball mass [g]	7.53 ± 5 %	
Ice ball velocity [m/s]	23 ± 5 %	
Number of impact locations	11	
Sample no.	—	
1-5	—	N/A
Supplementary information: N/A		

10.26.1	**Visual inspection after Hail test – MQT 01**		
Test date (dd/mm/yyyy)	08/07/2024		—
Sample no.	Requirement	Nature and position of findings	
1-5	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)				08/07/2024		—
Maximum system voltage [V_{DC}]				1500		
Cemented joints?				☒ No	☐ 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	50.00	2.80	140.00	-	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. Insulation tester can measure up to 50.00 GΩ.						

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)		08/07/2024		—
Maximum system voltage [V_{DC}]		1500		
Cemented joints?		☒ No ☐ 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	50000.0	2.80	140000.0	P

Supplementary information:
Minimum requirement is 40 MΩ·m².
Insulation tester can measure up to 50000.0 MΩ.

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

10.28	**Materials creep test – MST 37**		
Test date (dd/mm/yyyy)		13/05/2024-22/05/2024	—
Temperature [°C]		105 ± 5	
Duration [h]		200	
Worst case mounting angle [°]		90	
Sample no.	—		
1-6	—		N/A
Supplementary information: N/A			

10.28.1	**Visual inspection after Materials creep test – MST 01**		
Test date (dd/mm/yyyy)		22/04/2024	—
Sample no.	Requirement	Nature and position of findings	
1-6	Creepage and clearance distances acc. to IEC 61730-1:2023, Table 3 are met.	No major visual defects	P
Supplementary information: N/A			

10.28.2	**Insulation test after Materials creep test – MST 16**					
Test date (dd/mm/yyyy)				22/05/2024		—
Maximum system voltage [V_{DC}]				1500		
Cemented joints?				☒ No	☐ 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	
1-6	50.00	2.80	140.00	-	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. Insulation tester can measure up to 50.00 GΩ.						

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

10.28.3	**Wet leakage current test after Materials creep test – MST 17**			
Test date (dd/mm/yyyy)		22/05/2024		—
Maximum system voltage [V_{DC}]		1500		
Cemented joints?		☒ No ☐ 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]	
1-6	50000.0	2.80	140000.0	P
Supplementary information: Minimum requirement is 40 MΩ·m².				

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

10.29	**Damp heat test (200h) – MST 53**		
Test date (dd/mm/yyyy)		24/05/2024-02/06/2024	—
Total duration [h]		200	
Sample no.	—		
1-7	—		N/A
1-8	—		N/A
Supplementary information: N/A			

10.29.1	**Visual inspection after Damp heat test (200h) – MST 01**		
Test date (dd/mm/yyyy)		02/06/2024	—
Sample no.	Requirement	Nature and position of findings	
1-7	No major visual defects	No major visual defects	P
1-8	No major visual defects	No major visual defects	P
Supplementary information: N/A			

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

10.29.2	**Insulation test after Damp heat test (200h) – MST 16**					
Test date (dd/mm/yyyy)				02/06/2024		—
Maximum system voltage [V_{DC}]				1500		
Cemented joints?				☒ No	☐ 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	
1-7	50.00	2.80	140.00	-	No	P
1-8	50.00	2.80	140.00	-	No	P

Supplementary information: N/A
Minimum requirement is 0.04 GΩ·m² for A > 0.1 m² and 0.4 GΩ for A ≤ 0.1 m².
Insulation tester can measure up to 50.00 GΩ.

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

10.30	**UV test (front side) – MST 54**		
Test date (dd/mm/yyyy)	06/06/2024-21/06/2024		—
Module temperature [°C]	60 ± 5		
Ratio of UV-B irradiation (280 – 320 nm) [%]	3 – 10		
UV irradiation dose (280 – 400 nm) [kWh/m²]	60		
Operation mode	☐ Short-circuit	☐ Open-circuit	
Sample no.	—		
1-7	—		N/A
Supplementary information: The sample front side was exposed.			

10.30.1	**Visual inspection after UV test (front side) – MST 01**		
Test date (dd/mm/yyyy)		21/06/2024	—
Sample no.	Requirement	Nature and position of findings	
1-7	No major visual defects	No major visual defects	P
Supplementary information: N/A			

10.30.2	**Insulation test after UV test (front side) – MST 16**					
Test date (dd/mm/yyyy)				21/06/2024		—
Maximum system voltage [V_{DC}]				1500		
Cemented joints?				☒ No	☐ 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	
1-7	50.00	2.80	140.00	-	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. Insulation tester can measure up to 50.00 GΩ.						

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

10.31	**UV test (back side) – MST 54**		
Test date (dd/mm/yyyy)	06/06/2024-21/06/2024		—
Module temperature [°C]	60 ± 5		
Ratio of UV-B irradiation (280 – 320 nm) [%]	3 – 10		
UV irradiation dose (280 – 400 nm) [kWh/m²]	60		
Operation mode	☐ Short-circuit	☐ Open-circuit	
Sample no.	—		
1-8	—		N/A
Supplementary information: The sample back side was exposed.			

10.31.1	**Visual inspection after UV test (back side) – MST 01**		
Test date (dd/mm/yyyy)		21/06/2024	—
Sample no.	Requirement	Nature and position of findings	
1-8	No major visual defects	No major visual defects	P
Supplementary information: N/A			

10.31.2	**Insulation test after UV test (back side) – MST 16**					
Test date (dd/mm/yyyy)				21/06/2024		—
Maximum system voltage [V_{DC}]				1500		
Cemented joints?				☒ No	☐ 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	50.00	2.80	140.00	-	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. Insulation tester can measure up to 50.00 GΩ.						

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

10.32	**Humidity-freeze test – MST 52**		
Test date (dd/mm/yyyy)		21/06/2024-01/07/2024	—
Total number of cycles		10	
Sample no.	Open circuits (yes/no)		
1-7	No		P
1-8	No		P
Supplementary information: N/A			

10.32.1	**Visual inspection after Humidity-freeze test – MST 01**		
Test date (dd/mm/yyyy)		01/07/2024	—
Sample no.	Requirement	Nature and position of findings	
1-7	No major visual defects	No major visual defects	P
1-8	No major visual defects	No major visual defects	P
Supplementary information: N/A			

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

10.32.2	**Insulation test after Humidity-freeze test – MST 16**					
Test date (dd/mm/yyyy)				01/07/2024		—
Maximum system voltage [V_{DC}]				1500		
Cemented joints?				☒ No ☐ 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	
1-7	50.00	2.80	140.00	-	No	P
1-8	50.00	2.80	140.00	-	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.
Insulation tester can measure up to 50.00 GΩ.

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

10.34	**Cold conditioning test 1 – MST 55**		
Test date (dd/mm/yyyy)		11/04/2024-13/04/2024	—
Temperature [°C]		-40 ± 3	
Duration [h]		48	
Sample no.	—		
1-6	—		N/A
Supplementary information: N/A			

10.34.1	**Visual inspection after Cold conditioning test 1 – MST 01**		
Test date (dd/mm/yyyy)		13/04/2024	—
Sample no.	Requirement	Nature and position of findings	
1-6	No major visual defects	No major visual defects	P
Supplementary information: N/A			

10.34.2	**Insulation test after Cold conditioning test 1 – MST 16**					
Test date (dd/mm/yyyy)				13/04/2024		—
Maximum system voltage [V_{DC}]				1500		
Cemented joints?				☒ No	☐ 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	
1-6	50.00	2.80	140.00	-	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.
Insulation tester can measure up to 50.00 GΩ.

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

10.35	**Dry heat conditioning test– MST 56**		
Test date (dd/mm/yyyy)		13/04/2024-22/04/2024	—
Temperature [°C]		105 ± 5	
Relative humidity [%]		< 50	
Duration [h]		200	
Sample no.	—		
1-6	—		N/A
Supplementary information: N/A			

10.35.1	**Visual inspection after Dry heat conditioning test– MST 01**		
Test date (dd/mm/yyyy)		22/04/2024	—
Sample no.	Requirement	Nature and position of findings	
1-6	No major visual defects	No major visual defects	P
Supplementary information: N/A			

10.35.2	**Insulation test after Dry heat conditioning test– MST 16**					
Test date (dd/mm/yyyy)				22/04/2024		—
Maximum system voltage [V_{DC}]				1500		
Cemented joints?				☒ No	☐ 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	
1-6	50.00	2.80	140.00	-	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. Insulation tester can measure up to 50.00 GΩ.						

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

10.36	**Humidity-freeze test 1 – MST 52**		
Test date (dd/mm/yyyy)		23/04/2024-02/05/2024	—
Total number of cycles		10	
Sample no.	Open circuits (yes/no)		
1-6	No		P
Supplementary information: N/A			

10.36.1	**Visual inspection after Humidity-freeze test 1 – MST 01**		
Test date (dd/mm/yyyy)		02/05/2024	—
Sample no.	Requirement	Nature and position of findings	
1-6	No major visual defects	No major visual defects	P
Supplementary information: N/A			

10.36.2	**Insulation test after Humidity-freeze test 1 – MST 16**					
Test date (dd/mm/yyyy)				02/05/2024		—
Maximum system voltage [V_{DC}]				1500		
Cemented joints?				☒ No	☐ 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	
1-6	50.00	2.80	140.00	-	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. Insulation tester can measure up to 50.00 GΩ.						

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

10.37	**Cold conditioning test 2 – MST 55**		
Test date (dd/mm/yyyy)		03/05/2024-05/05/2024	—
Temperature [°C]		-40 ± 3	
Duration [h]		48	
Sample no.	—		
1-6	—		N/A
Supplementary information: N/A			

10.37.1	**Visual inspection after Cold conditioning test 2 – MST 01**		
Test date (dd/mm/yyyy)		05/05/2024	—
Sample no.	Requirement	Nature and position of findings	
1-6	No major visual defects	No major visual defects	P
Supplementary information: N/A			

10.37.2	**Insulation test after Cold conditioning test 2 – MST 16**					
Test date (dd/mm/yyyy)				05/05/2024		—
Maximum system voltage [V_{DC}]				1500		
Cemented joints?				☒ No	☐ 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	
1-6	50.00	2.80	140.00	-	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. Insulation tester can measure up to 50.00 GΩ.						

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

10.38	**Humidity-freeze test 2 – MST 52**		
Test date (dd/mm/yyyy)		05/05/2024-15/05/2024	—
Total number of cycles		10	
Sample no.	Open circuits (yes/no)		
1-6	No		P
Supplementary information: N/A			

10.38.1	**Visual inspection after Humidity-freeze test 2 – MST 01**		
Test date (dd/mm/yyyy)		15/05/2024	—
Sample no.	Requirement	Nature and position of findings	
1-6	No major visual defects	No major visual defects	P
Supplementary information: N/A			

10.38.2	**Insulation test after Humidity-freeze test 2 – MST 16**					
Test date (dd/mm/yyyy)				15/05/2024		—
Maximum system voltage [V_{DC}]				1500		
Cemented joints?				☒ No	☐ 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	
1-6	50.00	2.80	140.00	-	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. Insulation tester can measure up to 50.00 GΩ.						

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

10.38.3	**Wet leakage current test after Humidity-freeze test 2 – MST 17**			
Test date (dd/mm/yyyy)		15/05/2024		—
Maximum system voltage [V_{DC}]		1500		
Cemented joints?		☒ No ☐ 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]	
1-6	50000.0	2.80	140000.0	P

Supplementary information:
Minimum requirement is 40 MΩ·m².
Insulation tester can measure up to 50000.0 MΩ.

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

10.39	**Impulse voltage test – MST 14**		
Test date (dd/mm/yyyy)		28/04/2024	—
Maximum system voltage [V]		1500	
Rated impulse voltage [V]		16000	
Impulse test voltage [V]		19680	
Lab altitude [m]		4	
Sample no.	Test results		
1-9	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)		28/04/2024	—
Sample no.	Requirement	Nature and position of findings	
1-9	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)				28/04/2024		—
Maximum system voltage [V_{DC}]				1500		
Cemented joints?				☒ No	☐ 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	
1-9	50.00	2.80	140.00	-	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. Insulation tester can measure up to 50.00 GΩ.						

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)		06/06/2024	—
Weight of impactor [kg]		45.5 ± 0.5	
Drop height [mm]		300	
Mounting technique used		Rails and clamps	
Sample no.	Test results		
1-10	☒	No breakage occurred	P
	☐	PV module separated from the mounting structure or from the framing	
	☐	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			

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

10.41	**Ignitability test – MST 24**	
Test date (dd/mm/yyyy)	23/06/2024	—
Sample no.	1-11	
Surface exposure		
☐ Ignition occurs		P
☐ The flame tip reaches a height of 150 mm above the flame application point at < 20s.		P
Backsheet foil exposures		
☐ Ignition occurs		N/A
☐ The flame tip reaches a height of 150 mm above the flame application point at < 20s.		N/A
Frame adhesive exposures		
☐ Ignition occurs		P
☐ The flame tip reaches a height of 150 mm above the flame application point at < 20s.		P
Backrail adhesive exposure		
☐ Ignition occurs		P
☐ The flame tip reaches a height of 150 mm above the flame application point at < 20s.		P
Junction box adhesive exposures		
☐ Ignition occurs		P
☐ The flame tip reaches a height of 150 mm above the flame application point at < 20s.		P
Edge sealing exposures		
☐ Ignition occurs		N/A
☐ The flame tip reaches a height of 150 mm above the flame application point at < 20s.		N/A
Type label		
☐ Ignition occurs		P
☐ The flame tip reaches a height of 150 mm above the flame application point at < 20s.		P
Supplementary information: -		

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

10.42	**Potential induced degradation test – MQT 21**	
Test date (dd/mm/yyyy)	07/05/2024-11/05/2024	—
Chamber air temperature [°C]	85	
Chamber relative humidity [%]	85	
Test duration [h]	96	
Sample no.	—	
1-12	+1500	N/A
1-13	+1500	N/A
1-14	-1500	N/A
1-15	-1500	N/A
Supplementary information: N/A		

10.42.1	**Visual inspection after Potential induced degradation test – MQT 01**		
Test date (dd/mm/yyyy)	11/05/2024		—
Sample no.	Requirement	Nature and position of findings	
1-12	No major visual defects	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
Supplementary information: N/A			

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

10.42.2	**Insulation test after Potential induced degradation test – MQT 03**					
Test date (dd/mm/yyyy)				11/05/2024		—
Maximum system voltage [V_{DC}]				1500		
Cemented joints?				☒ No	☐ 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	
1-12	50.00	2.80	140.00	-	No	P
1-13	50.00	2.80	140.00	-	No	P
1-14	50.00	2.80	140.00	-	No	P
1-15	50.00	2.80	140.00	-	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.
Insulation tester can measure up to 50.00 GΩ.

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

10.42.3	**Wet leakage current test after Potential induced degradation test – MQT 15**			
Test date (dd/mm/yyyy)		11/05/2024		—
Maximum system voltage [V_{DC}]		1500		
Cemented joints?		☒ No ☐ 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]	
1-12	50000.0	2.80	140000.0	P
1-13	50000.0	2.80	140000.0	P
1-14	50000.0	2.80	140000.0	P
1-15	50000.0	2.80	140000.0	P

Supplementary information:
Minimum requirement is 40 MΩ·m².
Insulation tester can measure up to 50000.0 MΩ.

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)	22/05/2024		—
Sample no.	1-16, 1-17		
Fire class test specification	A		
Test results			
Did any portion of the module blow off or fall off the test deck in the form of flaming / glowing brands?	☐ Yes	☒ No	P
Did any portion of the roof desk fall away in the form of glowing particles?	☐ Yes	☒ No	
Was the flame spread beyond 1.82m for Class A, 2.40m for Class B or 3.96m for Class C?	☐ Yes	☒ No	
Was there a significant lateral spread-of-flame from the path directly exposed to the test flame?	☐ Yes	☒ No	
Supplementary information: Short module edges were mounted end-to-end.			

10.43.2	**Burning brand test**		
Test date (dd/mm/yyyy)	24/05/2024		—
Sample no.	1-18		
Fire class test specification	A		
Test results			
Did any portion of the module blow off or fall off the test deck in the form of flaming / glowing brands?	☐ Yes	☒ No	P
Did any portion of the roof desk fall away in the form of glowing particles?	☐ Yes	☒ No	
Did the brand burn a hole through the roof covering or through any part of the module?	☐ Yes	☒ No	
Did any sustained flaming of the module occur?	☐ Yes	☒ No	
Supplementary information: N/A			

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)	08/07/2024 for 1-2 03/07/2024 for 1-4	—
Irradiance [W/m²]	1000*	
Module temperature [°C]	25 ± 1	
Test method	☒ Simulator ☐ Natural sunlight	
Sample no.	Appearance of final IV-curve	
1-2	No kinks or other unusual characteristics	P
1-4	No kinks or other unusual characteristics	P
Supplementary information: N/A		

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**	
Test date (dd/mm/yyyy)	03/07/2024 for 1-2,1-3,1-4,1-5 12/05/2024 for 1-12,1-13,1-14,1-15	
Test method	☒ Simulator ☐ 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_{mpp} [A]	V_{oc} [V]	I_{sc} [A]	FF [%]	Degra-dation [%]	—
1-2	605.7	47.49	12.735	56.31	13.432	79.9	0.36	
1-3	609.2	47.56	12.751	56.08	13.462	80.6	0.43	
1-4	594.8	47.57	12.505	56.49	13.245	79.5	-1.41	
1-5	607.1	47.79	12.702	56.58	13.387	80.2	0.66	
1-12	613.7	48.51	12.565	56.79	13.245	81.0	-0.32	
1-13	604.5	47.62	12.582	56.21	13.252	80.5	-0.33	
1-14	604.4	47.36	12.578	56.19	13.375	80.1	-0.33	
1-15	617.6	48.24	12.665	56.67	13.384	80.6	-0.32	

Supplementary information:
Negative degradation means power *loss*.

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**

10.46.1	**Bifaciality Coefficients (final)**			
Sample no.	φ_{Isc}	φ_{Voc}	φ_{Pmax}	—
1-2	0.8018	0.9926	0.7823	—
1-3	0.8247	0.9926	0.7937	—
1-4	0.8304	0.9922	0.7924	—
1-5	0.8091	0.9930	0.7968	—
1-12	0.8458	0.9923	0.7903	—
1-13	0.8520	0.9920	0.7851	—
1-14	0.8091	0.9930	0.7968	—
1-15	0.8092	0.9920	0.7868	—
Supplementary information: N/A				

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

10.46.2	**Performance at BNPI (final) – MQT 06.1**	
Test date (dd/mm/yyyy)	03/07/2024 for 1-2,1-3,1-4,1-5 12/05/2024 for 1-12,1-13,1-14,1-15	—
Test method	☒ Simulator ☐ Natural sunlight	
Illuminated side	☒ Front side ☐ Rear side	
Ambient temperature [°C]	25 ± 2	
Irradiance [W/m²]	1000 + φ•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 [%]	
1-2	666.7	47.42	14.061	56.46	14.848	79.5	-3.36	P
1-3	663.0	47.49	14.085	56.22	14.876	80.2	-0.66	P
1-4	656.9	47.59	13.805	56.69	14.644	79.1	-1.98	P
1-5	669.4	47.74	14.020	56.72	14.792	79.8	-1.65	P
1-12	681.9	48.42	14.126	56.89	14.855	80.9	-0.29	P
1-13	665.6	47.32	14.028	56.17	14.821	79.6	-0.30	P
1-14	678.6	48.61	14.001	57.08	14.726	80.2	-0.29	P
1-15	664.4	47.72	13.936	56.51	14.728	79.8	-0.30	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.

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	—
Reproducibility $r_{(BNPI)}$ for $P_{max(BNPI)}$ [%]	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]	—
1-2	603.5	568.7	605.7	P
1-3	606.6	571.7	609.2	P
1-4	603.3	568.5	594.8	P
1-5	603.1	568.4	607.1	P
1-12	615.7	580.2	613.7	P
1-13	606.5	571.6	604.5	P
1-14	606.4	571.5	604.4	P
1-15	619.6	583.9	617.6	P

Supplementary information:
Pass criteria follow requirements of section 7.2.1 of IEC 61215-1:2021.
$P_{max,meas,Gate\ \#1}$ = Measured initial maximum STC power
$P_{max,meas,Gate\ \#1,r}$ = Measured initial maximum STC power taking reproducibility and degradation of 5% into account
$P_{max,meas,Gate\ \#2}$ = Measured final maximum STC power

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]	—
1-2	689.9	650.2	666.7	P
1-3	667.4	629.0	663.0	P
1-4	670.2	631.6	656.9	P
1-5	680.6	641.4	669.4	P
1-12	683.9	644.5	681.9	P
1-13	667.6	629.1	665.6	P
1-14	680.6	641.4	678.6	P
1-15	666.4	628.0	664.4	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

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)	03/07/2024 for 1-1,1-2,1-3,1-4,1-5 12/05/2024 for 1-12,1-13,1-14,1-15			—
Test method		☐ Method A	☒ 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
1-12	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.

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)	03/07/2024		—
Applied force [N]	10		
Sample no.	Contact with live electrical part?	R_{iso} [MΩ]	
1-2	☐ Yes ☒ No	≥60	P
1-4	☐ Yes ☒ No	≥60	P
Supplementary information: The resistance tester can measure up to 60.0 MΩ.			

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)		03/07/2024	—
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]	
1-2	94.2/97.9/89.5	1.26/1.31/1.19	P
1-4	92.9/101.4/106.2	1.24/1.35/1.42	P
1-10	95.1/88.6/92.0	1.27/1.18/1.23	P
Supplementary information: N/A			

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)	03/07/2024	—
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
Supplementary information:N/A		

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)	03/07/2024	—
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
Supplementary information: N/A		

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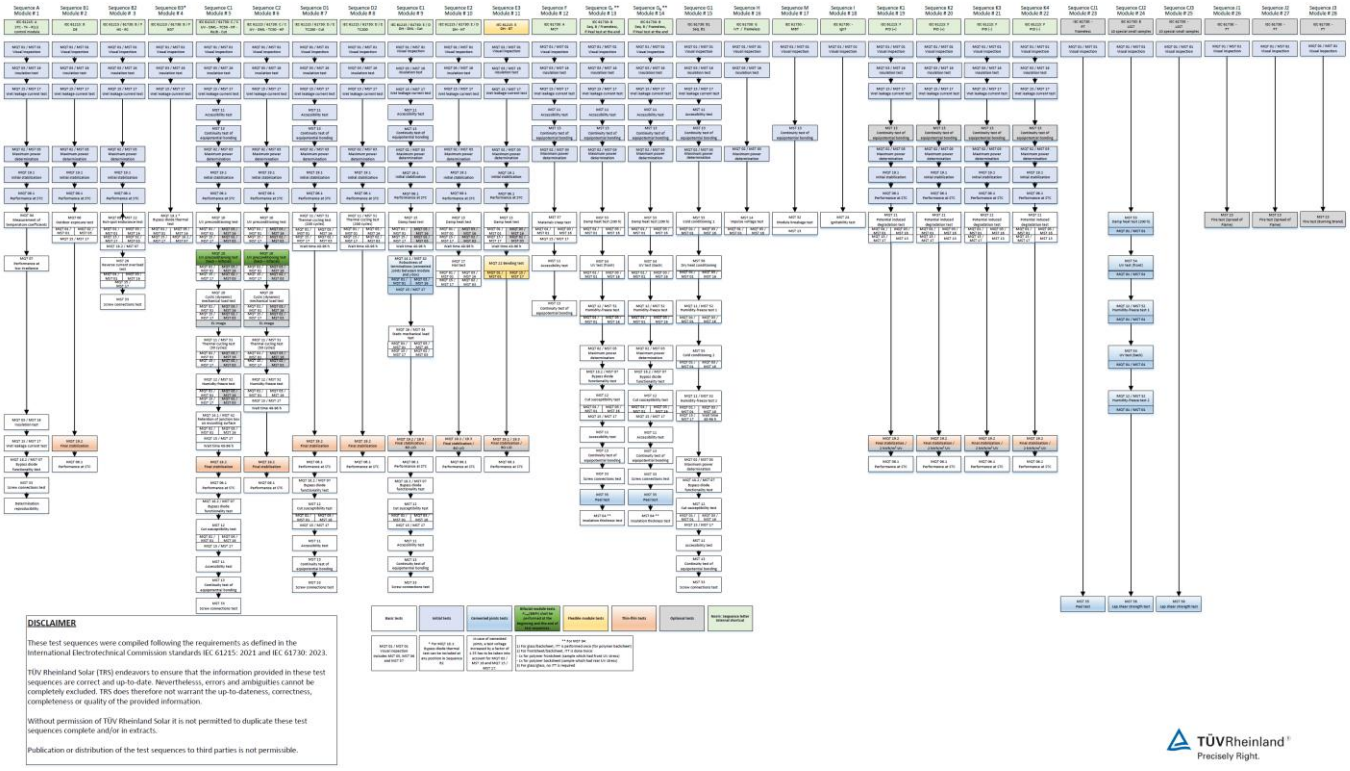
Appendix A: Test charts

Acc. to IEC 61215:2021 / IEC 61730:2023:



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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 61215:2016 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:
  - 2σ (P_{mpp}) ≤ ± 3.0 %
  - 2σ (I_{SC}) ≤ ± 2.8 %
  - 2σ (V_{OC}) ≤ ± 0.9 %
- The reproducibility parameter r with the solar simulator is 0.8%

Relative measurements were performed with a flash type solar simulator.

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Appendix C: History of reporting and certification

Project no.	Report no.	Certificate no.	Date of issue	Remarks
326022609	CN24PF66 001	PV 50631004 0001	16/05/2024	Basic project
326034570	CN24PF66 002	PV 50631004 0002	05/07/2024	Introduce to new model types and materials

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Appendix D: Photos
Module type: SYMN156TBDO620 (STC) / SYMN156TBDO682 (BNPI) (BOM1)

Fig. 1: front view of test sample

Fig. 2: rear view of test sample

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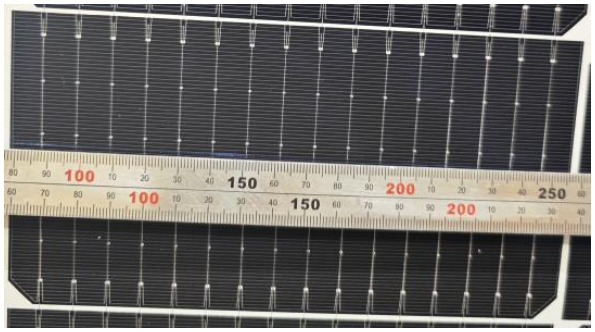

Fig. 3: detail view of solar cell

Fig. 4: detail view of type label

FOTO-DOKUMENTATION
PHOTO DOCUMENTATION

Fig. 5: detail view of closed junction box

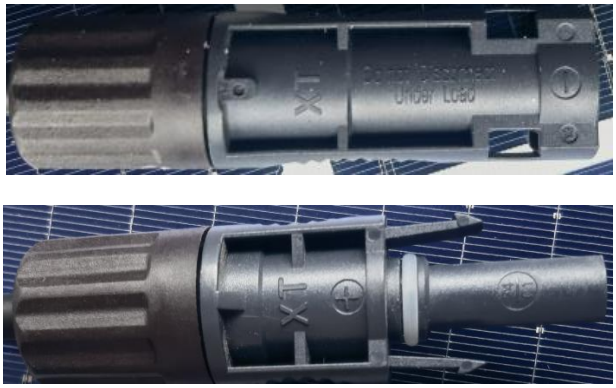

Fig. 6: detail view of connector

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Fig. 7: detail view of cable

Fig. 8: detail view of equipotential bonding hole

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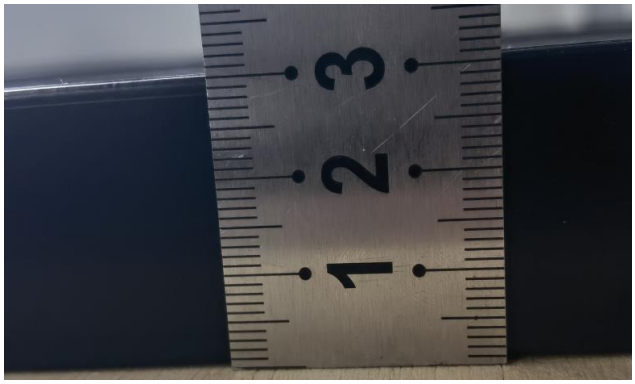

Fig. 9: detail view of frame

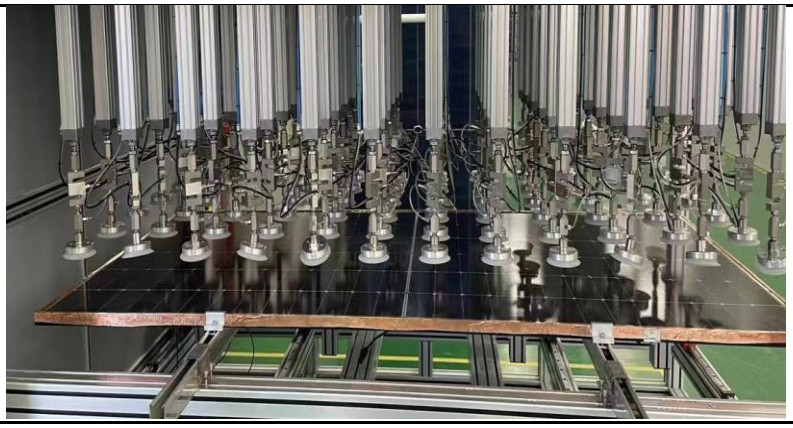

Fig. 10: view of mechanical load mounting

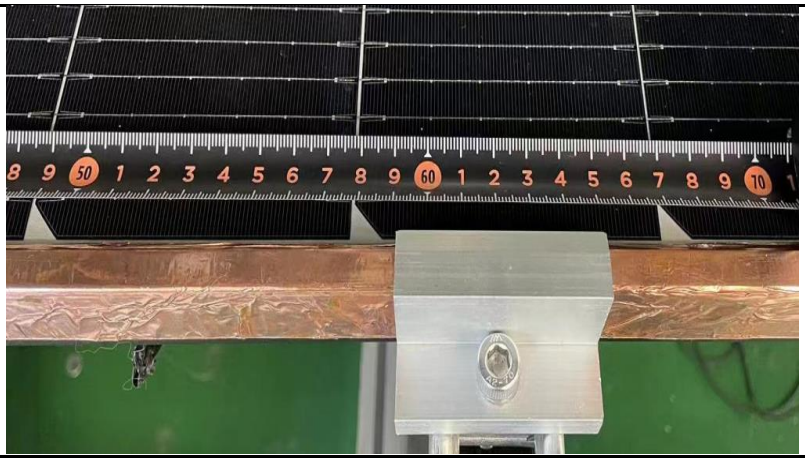

Fig. 11: detail view of mounting method

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Module type: SYMN156TBD645 (STC) / SYMN156TBD710 (BNPI) (BOM2)

Fig. 10: front view of test sample

Fig. 11: rear view of test sample

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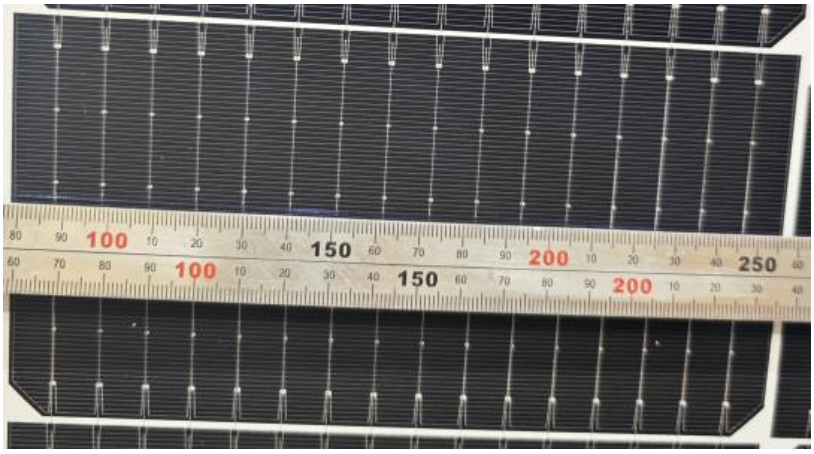

Fig. 12: detail view of solar cell

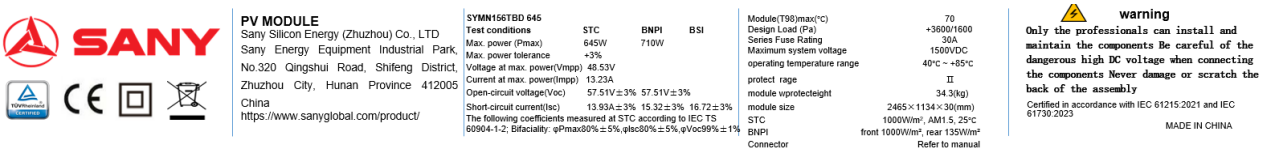

Fig. 13: detail view of type label

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Fig. 14: detail view of closed junction box

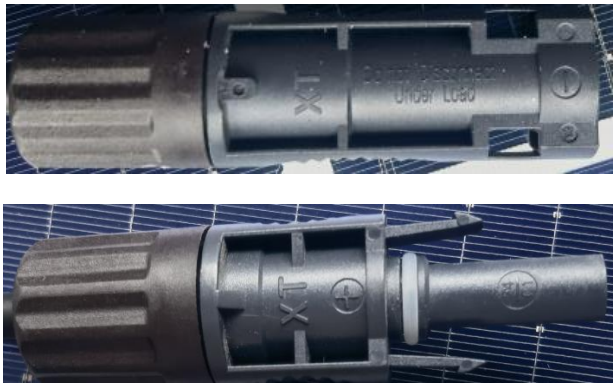

Fig. 15: detail view of connector

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Fig. 16: detail view of cable

Fig. 17: detail view of equipotential bonding hole

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Fig. 18: detail view of frame

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Appendix E: Declaration

营业执照变更通知书

尊敬的客户：

三一硅能（株洲）有限公司营业执照于 2023 年 8 月 3 日进行了公司注册地址变更，变更内容：
变更前，住所：湖南省株洲市石峰区铜塘湾街道铜霞路 255 号隆信国际 1 号栋 518-50 室
变更后，住所：湖南省株洲市石峰区铜塘湾街道清霞路 333 号

特此通知。

Notice of change of business license

Dear customer:

The business license of Sany Silicon Energy (Zhuzhou) Co., Ltd. changed the registered address of the company on August 3, 2023, and the changes are as follows:

Before change, Address: Room 518-50, Building 1, Longxin International, 255 Tongxia Road, Tongtangwan Street, Shifeng District, Zhuzhou City, Hunan Province

After change, address: No. 333 Qingxia Road, Tongtangwan Street, Shifeng District, Zhuzhou City, Hunan Province

We hereby inform you.

三一硅能（株洲有限公司）
Sany Silicon Energy (Zhuzhou) Co., Ltd.

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Statement

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

Change cell type as below:

Solar cell 1: SYCN182T16 change to SYCN182T1634 182.2mm x 91mm, 182.2mm x 91.875mm 16BB

Solar cell 2 SYCN18AT16 change to SYCN191T1638 182.2mm x 95.8mm, 191.6mm x 91.1mm 16BB

These solar cells have identical anti-reflective coating, metallization, crystallization process, cell thickness et. expect for cell dimension.

Sany Silicon Energy (Zhuzhou) Co., Ltd.