


Prüfbericht-Nr.: <i>Test report no.:</i>	CN246S3Y 001	Auftrags-Nr.: <i>Order no.:</i>	326018267	Seite 1 von 14 Page 1 of 14
Kunden-Referenz-Nr.: <i>Client reference no.:</i>	2496578	Auftragsdatum: <i>Order date:</i>	25/04/2024	
Auftraggeber: <i>Client:</i>	Sany Silicon Energy (Zhuzhou) Co., Ltd. Room 518-50, Building 1, Longxin International, No.255, Tongxia Road, Tongtangwan Street, Shifeng District, Zhuzhou City, Hunan Province, P.R. China			
Prüfgegenstand: <i>Test item:</i>	Photovoltaic (PV) module			
Bezeichnung / Typ-Nr.: <i>Identification / Type no.:</i>	See module type designation on page 3			
Auftrags-Inhalt: <i>Order content:</i>	Testing and Qualification of Inshore Photovoltaic Modules			
Prüfgrundlage: <i>Test specification:</i>	2 PfG 2930/02.23 Inshore Photovoltaic Modules: Testing and Qualification			
Wareneingangsdatum: <i>Date of sample receipt:</i>	05/04/2024			
Prüfmuster-Nr.: <i>Test sample no.:</i>	Refer to page 6-7			
Prüfzeitraum: <i>Testing period:</i>	07/04/2024 - 05/07/2024			
Ort der Prüfung: <i>Place of testing:</i>	Refer to page 5			
Prüflaboratorium: <i>Testing laboratory:</i>	TÜV Rheinland (Shanghai) Co., Ltd.			
Prüfergebnis*: <i>Test result*:</i>	Pass			
geprüft von: <i>tested by:</i>	<u>X</u>	genehmigt von: <i>authorized by:</i>	<u>X</u>	
Datum: <i>Date:</i>	24/07/2024	Ausstellungsdatum: <i>Issue date:</i>	24/07/2024	
Stellung / Position:	Project Engineer	Stellung / Position:	Authorizer	
Sonstiges / <i>Other:</i> <ul style="list-style-type: none"> - Basic qualification for page 3 listed model types. - Valid in conjunction with TÜV Rheinland certificate PV 50631004. - Valid only for the material combination as listed in Constructional Data Form (CDF) No. CN246S3Y 001 in Appendix 2. 				
Zustand des Prüfgegenstandes bei Anlieferung: <i>Condition of the test item at delivery:</i>		Prüfmuster vollständig und unbeschädigt <i>Test item complete and undamaged</i>		
* Legende: P(ass) = entspricht o.g. Prüfgrundlage(n) F(ail) = entspricht nicht o.g. Prüfgrundlage(n) N/A = nicht anwendbar N/T = nicht getestet * Legend: P(ass) = passed a.m. test specification(s) F(ail) = failed a.m. test specification(s) N/A = not applicable N/T = not tested				
Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens. <i>This test report only relates to the above mentioned test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any test mark.</i>				

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Anmerkungen
Remarks

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

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Produktbeschreibung*Product description*

1	<div>Produktdetails</div> <div>Product details</div>	<div>New model types:</div> <div>Max. System Voltage: up to 1500 VDC (Voc at STC):</div> <div>With cut of mono c-Si cells: (Under STC)</div> <div>SYMN156TBDOxxx (xxx=615-645, in steps of 5, 156 cells)</div> <div>SYMN156TBDLxxx (xxx=615-645, in steps of 5, 156 cells)</div> <div>With cut of mono c-Si cells: (Under BNPI)</div> <div>SYMN156TBDOxxx (xxx=677-710, 156 cells)</div> <div>SYMN156TBDLxxx (xxx=677-710, 156 cells)</div> <div>xxx represents output power in Wp</div>										
2	<div>Verwendete Materialien</div> <div>Used materials</div>	See Constructional Data Form (CDF) No. CN246S3Y 001 in Appendix 2										
3	<div>Adresse(n) der Fertigungsstätte(n)</div> <div>Address(es) of the manufacturing site(s)</div>	<table><tr><td>Name / Description:</td><td>Sany Silicon Energy (Zhuzhou) Co., Ltd.</td></tr><tr><td>Street:</td><td>Sany Energy Equipment Industrial Park, No.320 Qingshui Road, Shifeng District</td></tr><tr><td>Postcode / City, Country:</td><td>412005 / Zhuzhou City, Hunan Province, P.R. China</td></tr><tr><td>Type of production:</td><td>Crystalline PV-module</td></tr><tr><td>Inspection report No.and date</td><td>CN23RWL8 002 / 13/05/2024</td></tr></table>	Name / Description:	Sany Silicon Energy (Zhuzhou) Co., Ltd.	Street:	Sany Energy Equipment Industrial Park, No.320 Qingshui Road, Shifeng District	Postcode / City, Country:	412005 / Zhuzhou City, Hunan Province, P.R. China	Type of production:	Crystalline PV-module	Inspection report No.and date	CN23RWL8 002 / 13/05/2024
Name / Description:	Sany Silicon Energy (Zhuzhou) Co., Ltd.											
Street:	Sany Energy Equipment Industrial Park, No.320 Qingshui Road, Shifeng District											
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Type of production:	Crystalline PV-module											
Inspection report No.and date	CN23RWL8 002 / 13/05/2024											

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Produktbeschreibung
Product description

<p>4 Zusammenfassung der Prüfergebnisse <i>Summary of test results</i></p>	<p>According to the inquiry the testing and qualification of inshore photovoltaic (PV) modules should be assessed in accordance with 2 PfG 2930/02.23.</p> <p>The test of the requirements of 2 PfG 2930/02.23 were all fulfilled according to its regulations of the pass criteria. The module types listed on page 3 have been fully certified according to the IEC 61215-1:2021; IEC 61215-1-1:2021; IEC 61215-2:2021; IEC 61730-1:2016; IEC 61730-2:2016; EN IEC 61215-1:2021; EN IEC 61215-1-1:2021; EN IEC 61215-2:2021; EN IEC 61730-1:2018; EN IEC 61730-2:2018 standards and it is the prerequisite to be certified for inshore PV module qualification hence it is recommended that certificate should be granted.</p> <p>Basic qualification for model types as listed on page 3. The tests were performed on SYMN156TBDO620 as representative models. The test results are presented within this test report.</p> <p>The differences of model types are as below:</p> <ul style="list-style-type: none"> • SYMN156TBDOxxx series are for modules with 156 pcs 182.2x91.875mm N-type solar cells; • SYMN156TBDLxxx series are for modules with 156 pcs 182.2x91.875mm N-type solar cells; <p>Letter "O" for the model types used onside of the Ocean, 'L' for the model types used onside of the Lake.</p> <p>The test report is valid only for the materials as listed in Constructional Data Form (CDF) in Appendix 2 of this test report.</p> <p>Test results cover submitted testing samples only.</p> <p>This test report includes the following appendices: Appendix 1: Tables of test results Appendix 2: Constructional Data Form Appendix 3: Photos of the modules Appendix 4: EL-images</p> <p><i>Summary of test locations:</i> 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 Salt mist corrosion testing was performed at China Testing & Certification International Group Co., Ltd., China Photovoltaic Product Test Center, with address No.1, South side of Yanmi Road, economic development zone, Miyun District, Beijing, P.R. China.</p>
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History of reporting and certification

Project no.	Report no.	Certificate no.	Date of issue	Remarks
N/A	N/A	N/A	N/A	N/A

— Abbreviations used in the report

P_{MAX}	Maximum power
V_{MPP}	Maximum power voltage
I_{MPP}	Maximum power current
V_{OC}	Open circuit voltage
I_{SC}	Short circuit current
V_{sys}	System voltage
I_R	Reverse current
FF	Fill factor
STC	Standard Test Conditions
BNPI	Bifacial Name Plate Irradiance
IV	Current-voltage characteristics
PID	Potential Induced Degradation

— Sampling procedure

<input type="checkbox"/>	Random sampling from production (e.g. during factory audit or inline inspection)
<input type="checkbox"/>	Random sampling from the warehouse, container or transportation boxes
<input checked="" type="checkbox"/>	Modules have been submitted by the manufacturer/ client without random sampling by TÜV Rheinland
<input type="checkbox"/>	Others:

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Produktbeschreibung*Product description*

5 List of test samples				
Sample No.	Sample S/N	Module type	Remarks / constructional characteristics	Test item
Module type: SYMN156TBDO620 (Under STC) / SYMN156TBDO682 (Under BNPI)				
1	2403001B2D00001	SYMN156TBDO620	Front cover: 2.0mm Semi-tempered AR coated glass from Hunan Kibing Solar Technology Co., Ltd.	Control
2	2403001B2D00008	SYMN156TBDO620	Encapsulation material: EP304 (between front glass and cell) / EP304 (between cell and back glass) from HANGZHOU FIRST APPLIED MATERIAL CO., LTD	Saltwater, PID
3	2403001B2D00009	SYMN156TBDO620	Rear cover: 2.0mm Semi-Tempered mesh glazed back glass from Hunan Kibing Solar Technology Co., Ltd.	Saltwater, PID
4	2403001B2D00010	SYMN156TBDO620	Solar Cell: SYCN182T1634, 182.2 x 91.875 (±0.25) x 0.13 (±0.015), Topcon, 16BB from Sany Silicon Energy (Zhuzhou) Co., Ltd.	Saltwater, PID
5	2403001B2D00015	SYMN156TBDO620	Frame: 30mm, GF-R/M, GRPU, black from Zhejiang DeYiLong Technology Co., Ltd.	Saltwater, PID
6	2403001B2D00002	SYMN156TBDO620	Adhesive of frame sealing: 1527 from H.B.Fuller (Suzhou) Advanced Material Co., Ltd.	SML, DML, TC, HF
7	240300132D00013	SYMN156TBDO620	Cell connector: Φ0.26mm Sn60/Pb40 from Suzhou YourBest new-type materials Co., Ltd	SML, DML, TC, HF
8	2403001B2D00019	SYMN156TBDO620	String connector: 6.0mm x 0.3mm, 4.0mm x 0.3mm Sn60/Pb40 from Suzhou YourBest new-type materials Co., Ltd	DH
9	2403001B2D00022	SYMN156TBDO620	Fluxing agent: AATF9800-MBB from Shenzhen Tongfang Electronic New-Material CO., LTD	DH
10	2403001B2D00003	SYMN156TBDO620	Fixing Tape: D60F6-2 from SuZhou Rongzhi Electronic Technology Co., Ltd	Salt Mist - Control
11	2403001B2D00004	SYMN156TBDO620	Junction box: PV-XT1609Nxyz from Suzhou Xtong Photovoltaic Technologies Co., Ltd.	Salt Mist
12	2403001B2D00005	SYMN156TBDO620	Cable: 62930 IEC 131 1 x 4.0mm ² from Suzhou Xtong Photovoltaic Technologies Co., Ltd.	Salt Mist
			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.	

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Produktbeschreibung
Product description

			Potting Material in junction box: 1533 from H.B.Fuller (Suzhou) Advanced Material Co., Ltd.	
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Supplementary information: N/A

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Absatz Clause	Anforderungen - Prüfungen Requirements – Tests 2 PfG 2930/02.23	Messergebnisse – Bemerkungen Measuring results - Remarks	Ergebnis Result
5	Testing		
5.1	Initial Stabilization		
	$(P_{\max} - P_{\min}) / P_{\text{average}}$ was less than 1% after stabilization	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
5.2	Characterization Tests (Initial)		
	There was no visual evidence of a major defect, as defined in Clause 8 of IEC 61215-1.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	Performance at STC as defined in subclause 4.6 of IEC 61215-2:2021	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	Electroluminescent Imaging as defined in subclause 5.8 of IEC TS 63209-1	See Appendix 4	—
	The insulation resistance test (IEC 61215-2:2021 MQT 03) requirements were met.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	The wet leakage current test (IEC 61215-2:2021 MQT 15) requirements were met.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	The continuity of equipotential bonding test (IEC 61730-2: 2021 MST 13) requirements were met.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
5.3	Final Stabilization	See Appendix 1	P <input type="checkbox"/> F <input type="checkbox"/> N/A <input checked="" type="checkbox"/> N/T <input type="checkbox"/>
5.4	Test Sequence 1		
5.4.1	Saltwater Immersion Testing - ASTM E 1524 – 98		
	<ul style="list-style-type: none"> - Solution: 3.63 kg of dry sea salt for every 94.6 L of tap water - Specific gravity and temperature of solution..... : 1.025 ± .005 at 15 ± 3°C - Water depth : sufficient to cover the uppermost module with at least 75 mm of the solution - Test duration.....: 48 h 	See Appendix 1	—

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5.4.2	PID Testing - IEC TS 63209-1:2021		
	<ul style="list-style-type: none"> - Chamber temperature : 85 °C ± 2°C - Chamber relative humidity : 95 % ± 3% RH - Test duration..... : 192h dwell at above stated temperature and relative humidity - Test voltage : 1 500 V 	See Appendix 1	—
5.4.3	Requirements		
	There was no visual evidence of a major defect after each stress test, as defined in Clause 8 of IEC 61215-1.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	Electroluminescent Imaging as defined in subclause 5.8 of IEC TS 63209-1	See Appendix 4	—
	The insulation resistance test (IEC 61215-2:2021 MQT 03) requirements were met after each stress test.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	The wet leakage current test (IEC 61215-2:2021 MQT 15) requirements test were met after each stress.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	The continuity of equipotential bonding test (IEC 61730-2: 2016 MST 13) requirements were met after 5.4.1.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	In the end of the test sequence, the degradation of P_{MAX} was less than 5%, referenced to the module's initial measured output power.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	The bypass diode(s) remained operational according to 4.18.2.4 of IEC 61215-2:2021	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
5.5	Test Sequence 2		
5.5.1	Static mechanical load test (SML) – IEC 61215-2: 2021		
	Static mechanical load test.....: 5 400 Pa (downward) / 2 400 Pa (upward)	See Appendix 1	—
5.5.2	Cyclic (Dynamic) mechanical load test (DML) – IEC TS 62782:2016		
	Cyclic (Dynamic) mechanical load test.: 1 000 Pa x 1 000 times	See Appendix 1	—
5.5.3	Thermal cycling test – IEC 61215-2: 2021		

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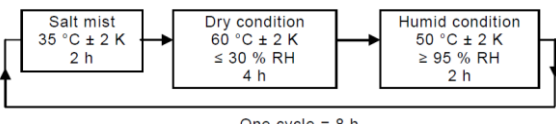
Absatz Clause	Anforderungen - Prüfungen Requirements – Tests 2 PfG 2930/02.23	Messergebnisse – Bemerkungen Measuring results - Remarks	Ergebnis Result
	Thermal cycling test.....: 50 cycles	See Appendix 1	—
5.5.4	Humidity test – IEC 61215-2: 2021		
	Humidity freeze test.....: 10 cycles	See Appendix 1	—
5.5.5	Requirements		
	There was no visual evidence of a major defect after each stress test, as defined in Clause 8 of IEC 61215-1.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	Electroluminescent Imaging as defined in subclause 5.8 of IEC TS 63209-1	See Appendix 4	—
	The insulation resistance test (IEC 61215-2:2021 MQT 03) requirements were met after each stress test.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	The wet leakage current test (IEC 61215-2:2021 MQT 15) requirements test were met after each stress.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	The continuity of equipotential bonding test (IEC 61730-2: 2016 MST 13) requirements were met after 5.4.1.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	In the end of the test sequence, the degradation of P_{MAX} was less than 5%, referenced to the module's initial measured output power.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	The bypass diode(s) remained operational according to 4.18.2.4 of IEC 61215-2:2021	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
5.6	Test Sequence 3		
5.6.1	Damp heat Test – IEC 61215-2:2021		
	Test duration.....: 2000 h	See Appendix 1	—
5.6.2	Requirements		
	There was no visual evidence of a major defect after each stress test, as defined in Clause 8 of IEC 61215-1.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>

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Absatz Clause	Anforderungen - Prüfungen Requirements – Tests 2 PfG 2930/02.23	Messergebnisse – Bemerkungen Measuring results - Remarks	Ergebnis Result
	Electroluminescent Imaging as defined in subclause 5.8 of IEC TS 63209-1	See Appendix 4	—
	The insulation resistance test (IEC 61215-2:2021 MQT 03) requirements were met after each stress test.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	The wet leakage current test (IEC 61215-2:2021 MQT 15) requirements test were met after each stress.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	The continuity of equipotential bonding test (IEC 61730-2: 2016 MST 13) requirements were met after 5.4.1.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	In the end of the test sequence, the degradation of P_{MAX} was less than 5%, referenced to the module's initial measured output power.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	The bypass diode(s) remained operational according to 4.18.2.4 of IEC 61215-2:2021	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
5.7	Test Sequence 4		
5.7.1	Salt mist corrosion test – IEC 61701:2020		
	Test method 8:  - Mist pH level.....: 3.5 - Mist temperature (°C).....: 50 - Mist humidity (%).....: 95 - Total exposure hours (hrs).....: 1440	See Appendix 1	—
5.7.2	Requirements		
	There was no visual evidence of a major defect after each stress test, as defined in Clause 8 of IEC 61215-1.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	Electroluminescent Imaging as defined in subclause 5.8 of IEC TS 63209-1	See Appendix 4	—

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Absatz Clause	Anforderungen - Prüfungen Requirements – Tests 2 PfG 2930/02.23	Messergebnisse – Bemerkungen Measuring results - Remarks	Ergebnis Result
	The insulation resistance test (IEC 61215-2:2021 MQT 03) requirements were met after each stress test.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	The wet leakage current test (IEC 61215-2:2021 MQT 15) requirements test were met after each stress.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	The continuity of equipotential bonding test (IEC 61730-2: 2016 MST 13) requirements were met after 5.4.1.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	In the end of the test sequence, the degradation of P_{MAX} was less than 5%, referenced to the module's initial measured output power.	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	The bypass diode(s) remained operational according to 4.18.2.4 of IEC 61215-2:2021	See Appendix 1	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
5.8	Test Sequence 5 (optional)		
5.8.1	Ammonia Corrosion Testing – IEC 62716:2013		
	<ul style="list-style-type: none"> 1st test section : 8 hrs under 60 °C ± 3 °C, 100 % RH, 6 667 ppm of NH₃-concentration 2nd test section....: 16 hrs under 18 °C to 28 °C, max. 75 % RH, 0 ppm of NH₃-concentration Test duration : 480 hrs (20 cycles) 	N/A	—
5.8.2	Requirements		
	There was no visual evidence of a major defect after each stress test, as defined in Clause 8 of IEC 61215-1.	N/A	P <input type="checkbox"/> F <input type="checkbox"/> N/A <input checked="" type="checkbox"/> N/T <input type="checkbox"/>
	Electroluminescent Imaging as defined in subclause 5.8 of IEC TS 63209-1	N/A	—
	The insulation resistance test (IEC 61215-2:2021 MQT 03) requirements were met after each stress test.	N/A	P <input type="checkbox"/> F <input type="checkbox"/> N/A <input checked="" type="checkbox"/> N/T <input type="checkbox"/>
	The wet leakage current test (IEC 61215-2:2021 MQT 15) requirements test were met after each stress.	N/A	P <input type="checkbox"/> F <input type="checkbox"/> N/A <input checked="" type="checkbox"/> N/T <input type="checkbox"/>

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Absatz Clause	Anforderungen - Prüfungen Requirements – Tests 2 PfG 2930/02.23	Messergebnisse – Bemerkungen Measuring results - Remarks	Ergebnis Result
	The continuity of equipotential bonding test (IEC 61730-2: 2016 MST 13) requirements were met after 5.4.1.	N/A	P <input type="checkbox"/> F <input type="checkbox"/> N/A <input checked="" type="checkbox"/> N/T <input type="checkbox"/>
	In the end of the test sequence, the degradation of P_{MAX} was less than 5%, referenced to the module's initial measured output power.	N/A	P <input type="checkbox"/> F <input type="checkbox"/> N/A <input checked="" type="checkbox"/> N/T <input type="checkbox"/>
	The bypass diode(s) remained operational according to 4.18.2.4 of IEC 61215-2:2021	N/A	P <input type="checkbox"/> F <input type="checkbox"/> N/A <input checked="" type="checkbox"/> N/T <input type="checkbox"/>
5.9	Test Sequence 6 (optional)		
5.9.1	Wind Tunnel Testing – JGJ/T 338		
	Test conditions.....: The PV module together with the supporting structure shall be installed according to installation documentation. The test shall be conducted under dynamic wind velocity of 20m/s, 30m/s, 40m/s, 50m/s and 60m/s.	N/A	—
5.9.2	Requirements		
	There was no visual evidence of a major defect after each stress test, as defined in Clause 8 of IEC 61215-1.	N/A	P <input type="checkbox"/> F <input type="checkbox"/> N/A <input checked="" type="checkbox"/> N/T <input type="checkbox"/>
	Electroluminescent Imaging as defined in subclause 5.8 of IEC TS 63209-1	N/A	—
	The insulation resistance test (IEC 61215-2:2021 MQT 03) requirements were met after each stress test.	N/A	P <input type="checkbox"/> F <input type="checkbox"/> N/A <input checked="" type="checkbox"/> N/T <input type="checkbox"/>
	The wet leakage current test (IEC 61215-2:2021 MQT 15) requirements test were met after each stress.	N/A	P <input type="checkbox"/> F <input type="checkbox"/> N/A <input checked="" type="checkbox"/> N/T <input type="checkbox"/>
	The continuity of equipotential bonding test (IEC 61730-2: 2016 MST 13) requirements were met after 5.4.1.	N/A	P <input type="checkbox"/> F <input type="checkbox"/> N/A <input checked="" type="checkbox"/> N/T <input type="checkbox"/>
	In the end of the test sequence, the degradation of P_{MAX} was less than 5%, referenced to the module's initial measured output power.	N/A	P <input type="checkbox"/> F <input type="checkbox"/> N/A <input checked="" type="checkbox"/> N/T <input type="checkbox"/>

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Absatz <i>Clause</i>	Anforderungen - Prüfungen <i>Requirements – Tests</i> 2 PfG 2930/02.23	Messergebnisse – Bemerkungen <i>Measuring results - Remarks</i>	Ergebnis <i>Result</i>
	The bypass diode(s) remained operational according to 4.18.2.4 of IEC 61215-2:2021	N/A	P <input type="checkbox"/> F <input type="checkbox"/> N/A <input checked="" type="checkbox"/> N/T <input type="checkbox"/>
6	Evaluation		
	Test samples in compliance with all pass criteria in clause 5	See Appendix 1 for details	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	CDF (Constructional Data Form) containing specific design of PV modules	See Appendix 2 for details	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>
	TÜV Rheinland certification of IEC 61215 series and IEC 61730 series	Certificate No. PV 50631004	P <input checked="" type="checkbox"/> F <input type="checkbox"/> N/A <input type="checkbox"/> N/T <input type="checkbox"/>

End of Test Report

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TABELLEN DER TESTERGEBNISSE
TABLES OF TEST RESULTS

Appendix 1: Tables of test results

5.1	Initial stabilization – accord. to 2 PfG 2930/02.23, 5.1				
<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight <input type="checkbox"/> Other stabilization procedures					
Test date [DD/MM/YYYY]			09/04/2024 - 13/05/2024		—
Irradiance [W/m²]			1000		
Module temperature [°C]			50		
Sample no.	Test	Integrated irradiation [kWh/m²]	P _{max} [W]	Stabilization [%] *	
1	Initial	—	615.3	0.91	P
	Light-soaking 1	5	616.9		
	Light-soaking 2	5	611.3		
2	Initial	—	601.7	0.78	P
	Light-soaking 1	5	603.3		
	Light-soaking 2	5	606.4		
3	Initial	—	605.4	0.38	P
	Light-soaking 1	5	607.5		
	Light-soaking 2	5	607.7		
4	Initial	—	602.2	0.29	P
	Light-soaking 1	5	601.7		
	Light-soaking 2	5	603.5		
5	Initial	—	605.3	0.24	P
	Light-soaking 1	5	606.8		
	Light-soaking 2	5	606.6		
6	Initial	—	601.1	0.37	P
	Light-soaking 1	5	603.3		
	Light-soaking 2	5	603.3		
7	Initial	—	610.1	0.19	P
	Light-soaking 1	5	609.6		
	Light-soaking 2	5	609.0		
8	Initial	—	626.6	0.53	P
	Light-soaking 1	5	627.9		
	Light-soaking 2	5	624.6		
9	Initial	—	615.6	0.64	P
	Light-soaking 1	5	616.8		

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	Light-soaking 2	5	619.6		
10	Initial	—	601.2	0.37	
	Light-soaking 1	5	603.4		
	Light-soaking 2	5	603.5		
11	Initial	—	605.1	0.19	
	Light-soaking 1	5	606.7		
	Light-soaking 2	5	606.5		
12	Initial	—	605.3	0.38	
	Light-soaking 1	5	607.4		
	Light-soaking 2	5	607.6		

Supplementary information:

* Stabilization criterion: $(P_{\max} - P_{\min}) / P_{\text{avg}} \leq 1 \%$ for three consecutive measurements.

Initial measurement corresponds to MQT 02 of IEC 61215.

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5.2	Visual inspection (initial) – accord. to 2 PfG 2930/02.23, 5.2			
Test date [DD/MM/YYYY]		07/04/2024		—
Sample no.	Requirement		Nature and position of initial findings	Results
1	No major visual defects		No major visual defects	P
2			No major visual defects	P
3			No major visual defects	P
4			No major visual defects	P
5			No major visual defects	P
6			No major visual defects	P
7			No major visual defects	P
8			No major visual defects	P
9			No major visual defects	P
10			No major visual defects	P
11			No major visual defects	P
12			No major visual defects	P
Supplementary information: N/A				

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5.2	Electroluminescence images (Initial) – accord. to 2 PfG 2930/02.23, 5.2		
Test date [DD/MM/YYYY]		14/05/2024	—
Current applied [A]		18.45	—
Sample No.	Nature and position of initial findings		Results
2	Refer to Appendix 4 for details		—
3	Refer to Appendix 4 for details		—
4	Refer to Appendix 4 for details		—
5	Refer to Appendix 4 for details		—
10	Refer to Appendix 4 for details		—
11	Refer to Appendix 4 for details		—
12	Refer to Appendix 4 for details		—
Supplementary information: N/A			

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5.2	Insulation test (initial) – accord. to 2 PfG 2930/02.23, 5.2					
Test date [DD/MM/YYYY]				13/05/2024		—
Maximum system voltage [V _{DC}]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V _{DC}]				8000		
Insulation resistance measured at [V _{DC}]				1500		
Sample no.	R _{iso} [GΩ]	A [m²]	R _{iso} ·A [GΩ·m²]	Dielectric breakdown		Results
				Yes (description)	No	
1	50.00	2.80	140.00	-	No	P
2	50.00	2.80	140.00	-	No	P
3	50.00	2.80	140.00	-	No	P
4	50.00	2.80	140.00	-	No	P
5	50.00	2.80	140.00	-	No	P
6	50.00	2.80	140.00	-	No	P
7	50.00	2.80	140.00	-	No	P
8	50.00	2.80	140.00	-	No	P
9	50.00	2.80	140.00	-	No	P
10	50.00	2.80	140.00	-	No	P
11	50.00	2.80	140.00	-	No	P
12	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.						

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5.2	Wet leakage current test (initial) – accord. to 2 PfG 2930/02.23, 5.2			
Test date [DD/MM/YYYY]		13/05/2024		—
Maximum system voltage [V _{DC}]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V _{DC}]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R _{iso} [MΩ]	A [m²]	R _{iso} ·A [MΩ·m²]	Results
1	50000.0	2.80	140000.0	P
2	50000.0	2.80	140000.0	P
3	50000.0	2.80	140000.0	P
4	50000.0	2.80	140000.0	P
5	50000.0	2.80	140000.0	P
6	50000.0	2.80	140000.0	P
7	50000.0	2.80	140000.0	P
8	50000.0	2.80	140000.0	P
9	50000.0	2.80	140000.0	P
10	50000.0	2.80	140000.0	P
11	50000.0	2.80	140000.0	P
12	50000.0	2.80	140000.0	P
Supplementary information: Minimum requirement is 40 MΩ·m². Insulation tester can measure up to 50000.0 MΩ.				

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5.2	Continuity test of equipotential bonding (initial) – accord. to 2 PfG 2930/02.23, 5.2						
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]				
2	86.7 / 87.3 / 88.0		1.39 / 1.40 / 1.41				P
3	90.7 / 91.2 / 89.8		1.45 / 1.46 / 1.44				P
4	83.3 / 84.0 / 82.9		1.33 / 1.34 / 1.33				P
5	89.0 / 88.7 / 89.5		1.42 / 1.42 / 1.43				P
6	91.2 / 92.0 / 93.1		1.46 / 1.47 / 1.49				P
7	91.2 / 92.0 / 90.9		1.46 / 1.47 / 1.45				P
8	88.7 / 87.8 / 86.9		1.42 / 1.40 / 1.39				P
9	93.9 / 80.9 / 82.1		1.34 / 1.29 / 1.31				P
10	—		<1.0				P
11	—		<1.0				P
12	—		<1.0				P
Supplementary information: N/A							
5.2	Performance at STC (initial) – accord. to 2 PfG 2930/02.23, 5.2						
Performance at STC (initial) (front side)							
Test date (dd/mm/yyyy)			13/05/2024				—
Test method			<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight				
Illuminated side			<input checked="" type="checkbox"/> Front side <input type="checkbox"/> Rear side				
Ambient temperature [°C]			25 ± 2				
Irradiance [W/m²]			1000 ± 10				
Module temperature [°C]			25 ± 2				
Spectral mismatch			N/A				
Sample no.	P _{max} [W]	V _{mpp} [V]	I _{mpp} [A]	V _{oc} [V]	I _{sc} [A]	FF [%]	Results
1	609.0	47.57	12.801	56.17	13.495	80.3	—
2	624.6	48.61	12.849	56.95	13.525	81.1	—

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3	603.5	47.61	12.675	56.43	13.351	80.1	—
4	606.6	47.83	12.681	56.33	13.351	80.7	—
5	615.7	48.61	12.665	56.99	13.345	81.0	—
6	619.6	48.54	12.765	56.87	13.484	80.8	—
7	606.4	47.46	12.778	56.09	13.475	80.2	—
8	615.7	48.61	12.665	56.99	13.345	81.0	—
9	603.3	47.72	12.643	56.40	13.245	79.9	—
10	603.1	47.71	12.623	56.41	13.235	79.8	—
11	606.5	47.82	12.682	56.31	13.352	80.6	—
12	607.0	47.52	12.701	56.27	13.395	80.1	—

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

Performance at STC (initial) (rear side)

Test date (dd/mm/yyyy)			13/05/2024				—
Test method			<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight				
Illuminated side			<input type="checkbox"/> Front side <input checked="" type="checkbox"/> Rear side				
Ambient temperature [°C]			25 ± 2				
Irradiance [W/m²]			1000 ± 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 [%]	Results
1	477.5	48.03	9.984	56.01	11.010	78.0	—
2	488.6	49.04	9.963	56.53	10.844	79.7	—
3	479.0	48.03	9.974	56.01	11.010	77.7	—
4	480.7	48.06	10.001	55.89	11.087	77.6	—
5	490.6	48.86	10.041	56.59	10.798	80.3	—
6	489.7	48.86	10.023	56.43	11.405	76.1	—
7	476.1	48.13	9.891	55.64	11.481	74.5	—
8	490.6	48.86	10.041	56.59	10.798	80.3	—
9	478.0	47.88	9.985	55.96	11.033	77.4	—
10	478.2	47.83	9.975	55.86	11.013	77.3	—
11	480.5	48.02	10.003	55.83	11.082	77.4	—
12	477.3	48.01	9.983	56.02	11.011	78.1	—

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

Bifaciality Coefficients (initial)

Sample no.	Φ_{isc}	Φ_{voc}	Φ_{Pmax}	—
1	0.8159	0.9972	0.7841	—
2	0.8018	0.9926	0.7823	—
3	0.8247	0.9926	0.7937	—
4	0.8304	0.9922	0.7924	—
5	0.8091	0.9930	0.7968	—
6	0.8458	0.9923	0.7903	—
7	0.8520	0.9920	0.7851	—
8	0.8091	0.9930	0.7968	—
9	0.8330	0.9922	0.7923	—
10	0.8420	0.9920	0.7851	—
11	0.8191	0.9931	0.7962	—
12	0.8230	0.9921	0.7921	—

Supplementary information: N/A

Performance at BNPI (initial)

Test date (dd/mm/yyyy)			13/05/2024				—
Test method			<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight				
Illuminated side			<input checked="" type="checkbox"/> Front side <input type="checkbox"/> Rear side				
Ambient temperature [°C]			25 ± 2				
Irradiance [W/m²]			1000 + 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 [%]	Results
1	672.4	47.59	14.130	56.40	14.909	80.0	—
2	689.9	48.61	14.192	57.14	14.945	80.8	—
3	667.4	47.75	13.977	56.64	14.773	79.8	—
4	670.2	47.82	14.014	56.53	14.754	80.4	—
5	680.6	48.60	14.003	57.18	14.746	80.7	—
6	683.9	48.42	14.126	56.89	14.855	80.9	—
7	667.6	47.39	14.088	56.27	14.921	79.5	—
8	680.6	48.60	14.003	57.18	14.746	80.7	—

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9	666.4	47.71	13.966	56.61	14.788	79.6	—
10	666.3	47.72	13.956	56.51	14.768	79.7	—
11	670.3	47.81	14.012	56.52	14.744	80.1	—
12	672.1	47.58	14.110	56.30	14.919	80.1	—

Supplementary information: The non-illuminated side was covered with non-reflective background and aperture.
* The bifaciality coefficient ϕ employed is the minimum value of ϕ_{isc} and ϕ_{pmax} as documented in above table for each test sample.

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5.4.1 Saltwater immersion test – accord. to 2 PfG 2930/02.23, 5.4.1

Test Date (dd/mm/yyyy) start / end		19/05/2024 / 21/05/2024	—
Solution		3.63 kg of dry sea salt for every 94.6 L of tap water	
Specific gravity		1.025 ± 0.005	
Temperature [°C]		15 ± 3	
Water depth [mm]		85	
Duration		48 hrs	
Sample No.	—		—
2	—		N/A
3	—		N/A
4	—		N/A
5	—		N/A
Supplementary information: N/A			

5.4.3 Visual inspection after Saltwater immersion testing – accord. to 2 PfG 2930/02.23, 5.2

Test date (dd/mm/yyyy)		21/05/2024		—
Sample no.	Requirement		Nature and position of findings	
2	No major visual defects		No major visual defects	P
3			No major visual defects	P
4			No major visual defects	P
5			No major visual defects	P
Supplementary information: N/A				

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5.4.3	Insulation test after Saltwater immersion – accord. to 2 PfG 2930/02.23, 5.2					
Test date (dd/mm/yyyy)				21/05/2024		—
Maximum system voltage [V _{DC}]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V _{DC}]				8000		
Insulation resistance measured at [V _{DC}]				1500		
Sample no.	R _{iso} [GΩ]	A [m²]	R _{iso} ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
2	50.00	2.80	140.00	-	No	P
3	50.00	2.80	140.00	-	No	P
4	50.00	2.80	140.00	-	No	P
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.						

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5.4.2	PID testing – accord. to 2 PfG 2930/02.23, 5.4.2		
Test date (dd/mm/yyyy)		24/05/2024 - 03/06/2024	—
Module temperature [°C]		85 ± 2	
Chamber relative humidity [%]		95 ± 3	
System voltage [V]		+1500 for sample No. 2, 3 -1500 for sample No. 4, 5	
Duration [h]		192	
Sample no.	—		
2	—		—
3	—		—
4	—		—
5	—		—
Supplementary information: N/A			

5.4.3	Visual inspection after PID – accord. to 2 PfG 2930/02.23, 5.2		
Test date (dd/mm/yyyy)		03/06/2024	—
Sample no.	Requirement	Nature and position of findings	
2	No major visual defects	No major visual defects	P
3		No major visual defects	P
4		No major visual defects	P
5		No major visual defects	P
Supplementary information: N/A			

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5.4.3	Insulation test after PID – accord. to 2 PfG 2930/02.23, 5.2					
Test date (dd/mm/yyyy)				03/06/2024		—
Maximum system voltage [V _{DC}]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V _{DC}]				8000		
Insulation resistance measured at [V _{DC}]				1500		
Sample no.	R _{iso} [GΩ]	A [m²]	R _{iso} ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
2	50.00	2.80	140.00	-	No	P
3	50.00	2.80	140.00	-	No	P
4	50.00	2.80	140.00	-	No	P
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						

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5.4.3	Wet leakage current test after PID – accord. to 2 PfG 2930/02.23, 5.2			
Test date (dd/mm/yyyy)		03/06/2024		—
Maximum system voltage [V _{DC}]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V _{DC}]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R _{iso} [MΩ]	A [m²]	R _{iso} ·A [MΩ·m²]	
2	50000.0	2.80	140000.0	P
3	50000.0	2.80	140000.0	P
4	50000.0	2.80	140000.0	P
5	50000.0	2.80	140000.0	P
Supplementary information: Minimum requirement is 40 MΩ·m².				

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5.4.3	Continuity test of equipotential bonding after PID – accord. to 2 PfG 2930/02.23, 5.2		
Test date (dd/mm/yyyy)		03/06/2024	—
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]	
2	73.4 / 75.2 / 74.8	1.17 / 1.20 / 1.20	P
3	74.5 / 75.8 / 76.6	1.19 / 1.21 / 1.23	P
4	82.8 / 83.4 / 80.5	1.32 / 1.33 / 1.29	P
5	78.5 / 90.6 / 84.7	1.26 / 1.45 / 1.36	P
Supplementary information: N/A			

5.4.3	Bypass diode functionality test after PID – accord. to 2 PfG 2930/02.23, 5.2			
Test date (dd/mm/yyyy)		03/06/2024		—
Test method		<input type="checkbox"/> Method A <input checked="" type="checkbox"/> Method B		
Sample no.	Diode 1	Diode 2	Diode 3	
2	working properly	working properly	working properly	P
3	working properly	working properly	working properly	P
4	working properly	working properly	working properly	P
5	working properly	working properly	working properly	P
Supplementary information:				
This test verifies that the sample shows the electrical characteristics of a functional photovoltaic device.				

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5.5.1 Static mechanical load test – accord. to 2 PfG 2930/02.23, 5.5.1

Test date (dd/mm/yyyy)		06/06/2024		—
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		
Sample no.	Open circuits (yes/no)			—
6	No			P
7	No			P
Supplementary information: See photos in appendix 3. Load was applied pneumatically.				

5.5.5 Visual inspection after SML – accord. to 2 PfG 2930/02.23, 5.2

Test date (dd/mm/yyyy)		06/06/2024		—
Sample no.	Requirement		Nature and position of findings	
6	No major visual defects		No major visual defects	P
7			No major visual defects	P
Supplementary information: N/A				

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5.5.5	Wet leakage current test after SML – accord. to 2 PfG 2930/02.23, 5.2			
Test date (dd/mm/yyyy)		06/06/2024		—
Maximum system voltage [V _{DC}]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V _{DC}]		1500		
Solution resistivity [$\Omega \cdot \text{cm}$]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R _{iso} [M Ω]	A [m²]	R _{iso} •A [M $\Omega \cdot \text{m}^2$]	
6	50000.0	2.80	140000.0	P
7	50000.0	2.80	140000.0	P
Supplementary information: Minimum requirement is 40 M $\Omega \cdot \text{m}^2$.				

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5.5.5	Performance at BNPI after SML – accord. to accord. to 2 PfG 2930/02.23, 5.2						
Test date (dd/mm/yyyy)			06/06/2024				—
Test method			<input type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight				
Ambient temperature [°C]			25 ± 2				
Irradiance [W/m²]			1000 + $\varphi \cdot 135^*$				
Module temperature [°C]			25				
Sample no.	P _{max} [W]	V _{mpp} [V]	I _{mpp} [A]	V _{oc} [V]	I _{sc} [A]	FF [%]	
6	680.2	48.45	14.040	56.98	14.856	80.4	P
7	665.8	47.44	14.034	56.33	14.798	79.9	P
Supplementary information: * The bifaciality coefficient φ employed is the minimum value of φ_{Isc} and φ_{Pmax} as the initial values for each test sample.							

5.5.5	Continuity test of equipotential bonding after SML – accord. to 2 PfG 2930/02.23, 5.2		
Test date (dd/mm/yyyy)		06/06/2024	—
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]	
6	77.2 / 75.7 / 74.6	1.24 / 1.21 / 1.19	P
7	75.4 / 76.8 / 74.8	1.21 / 1.23 / 1.20	P
Supplementary information: N/A			

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5.5.2	Cyclic (dynamic) mechanical load test – accord. to 2 PfG 2930/02.23, 5.5.2		
Test date (dd/mm/yyyy)		09/06/2024	—
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		2 rails and 4 clamps	
Sample no.	Open circuits (yes/no)		
6	No		P
7	No		P
Supplementary information: N/A			

5.2	Visual inspection after DML – accord. to 2 PfG 2930/02.23, 5.2		
Test date (dd/mm/yyyy)		09/06/2024	—
Sample no.	Requirement	Nature and position of findings	
6	No major visual defects	No major visual defects	P
7		No major visual defects	P
Supplementary information: N/A			

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5.2	Insulation test after DML – accord. to 2 PfG 2930/02.23, 5.2					
Test date (dd/mm/yyyy)				09/06/2024		—
Maximum system voltage [V _{DC}]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V _{DC}]				8000		
Insulation resistance measured at [V _{DC}]				1500		
Sample no.	R _{iso} [GΩ]	A [m²]	R _{iso} ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
6	50.00	2.80	140.00	-	No	P
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.						

5.2	Wet leakage current test after DML – accord. to 2 PfG 2930/02.23, 5.2			
Test date (dd/mm/yyyy)		09/06/2024		—
Maximum system voltage [V _{DC}]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V _{DC}]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R _{iso} [MΩ]	A [m²]	R _{iso} ·A [MΩ·m²]	
6	50000.0	2.80	140000.0	P
7	50000.0	2.80	140000.0	P
Supplementary information: Minimum requirement is 40 MΩ·m².				

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5.5.5	Performance at BNPI after DML – accord. to accord. to 2 PfG 2930/02.23, 5.2						
Test date (dd/mm/yyyy)			10/06/2024				—
Test method			<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight				
Ambient temperature [°C]			25 ± 2				
Irradiance [W/m²]			1000 + $\varphi \cdot 135^*$				
Module temperature [°C]			25				
Sample no.	P _{max} [W]	V _{mpp} [V]	I _{mpp} [A]	V _{oc} [V]	I _{sc} [A]	FF [%]	
6	679.9	48.38	14.053	56.96	14.873	80.3	P
7	665.6	47.39	14.046	56.32	14.0865	79.5	P
Supplementary information: * The bifaciality coefficient φ employed is the minimum value of φ_{Isc} and φ_{Pmax} as the initial values for each test sample.							

5.5.5	Continuity test of equipotential bonding after DML – accord. to 2 PfG 2930/02.23, 5.2		
Test date (dd/mm/yyyy)		10/06/2024	—
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]	
6	73.6 / 72.5 / 74.3	1.18 / 1.16 / 1.19	P
7	77.4 / 75.8 / 74.5	1.24 / 1.21 / 1.19	P
Supplementary information: N/A			

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5.5.3	Thermal cycling test (50 cycles) – accord. to 2 PfG 2930/02.23, 5.5.3		
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)		
6	No		P
7	No		P
Supplementary information: A single 5N weight was attached to the junction box. I _{mp} (G _{BSI}) (G _{BSI} equals to 1000W/m ² + φ•300W/m ²) was applied.			

5.2	Visual inspection after TC50 – accord. to 2 PfG 2930/02.23, 5.2		
Test date (dd/mm/yyyy)		21/06/2024	—
Sample no.	Requirement	Nature and position of findings	
6	No major visual defects	No major visual defects	P
7		No major visual defects	P
Supplementary information: N/A			

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5.2	Insulation test after TC50 – accord. to 2 PFG 2930/02.23, 5.2					
Test date (dd/mm/yyyy)				21/06/2024		—
Maximum system voltage [V _{DC}]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V _{DC}]				8000		
Insulation resistance measured at [V _{DC}]				1500		
Sample no.	R _{iso} [GΩ]	A [m²]	R _{iso} ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
6	50.00	2.80	140.00	-	No	P
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.						

5.2	Wet leakage current test after TC50 – accord. to 2 PfG 2930/02.23, 5.2			
Test date (dd/mm/yyyy)		21/06/2024		—
Maximum system voltage [V _{DC}]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V _{DC}]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R _{iso} [MΩ]	A [m²]	R _{iso} ·A [MΩ·m²]	
6	50000.0	2.80	140000.0	P
7	50000.0	2.80	140000.0	P
Supplementary information: Minimum requirement is 40 MΩ·m².				

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5.5.5	Performance at BNPI after TC50 – accord. to accord. to 2 PfG 2930/02.23, 5.2						
Test date (dd/mm/yyyy)			21/06/2024				—
Test method			<input type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight				
Ambient temperature [°C]			25 ± 2				
Irradiance [W/m²]			1000 + $\varphi \cdot 135^*$				
Module temperature [°C]			25				
Sample no.	P _{max} [W]	V _{mpp} [V]	I _{mpp} [A]	V _{oc} [V]	I _{sc} [A]	FF [%]	
6	683.5	48.52	14.087	57.21	14.432	61.5	P
7	668.7	47.44	14.096	56.46	14.631	60.3	P
Supplementary information: * The bifaciality coefficient φ employed is the minimum value of φ_{Isc} and φ_{Pmax} as the initial values for each test sample.							

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5.5.4	Humidity-freeze test – accord. to accord. to 2 PfG 2930/02.23, 5.5.4		
Test date (dd/mm/yyyy)		22/06/2024 - 02/07/2024	—
Total number of cycles		10	
Sample no.	Open circuits (yes/no)		
6	No		P
7	No		P
Supplementary information: N/A			

5.2	Visual inspection after HF10 – accord. to 2 PfG 2930/02.23, 5.2		
Test date (dd/mm/yyyy)		02/07/2024	—
Sample no.	Requirement	Nature and position of findings	
6	No major visual defects	No major visual defects	P
7		No major visual defects	P
Supplementary information: N/A			

5.2	Insulation test after HF10 – accord. to 2 PfG 2930/02.23, 5.2					
Test date (dd/mm/yyyy)				02/07/2024		—
Maximum system voltage [V _{DC}]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V _{DC}]				8000		
Insulation resistance measured at [V _{DC}]				1500		
Sample no.	R _{iso} [GΩ]	A [m²]	R _{iso} ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
6	50.00	2.80	140.00	-	No	P
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.						

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5.2	Wet leakage current test after HF10 – accord. to 2 PfG 2930/02.23, 5.2			
Test date (dd/mm/yyyy)		02/07/2024		—
Maximum system voltage [V _{DC}]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V _{DC}]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R _{iso} [MΩ]	A [m²]	R _{iso} ·A [MΩ·m²]	
6	50000.0	2.80	140000.0	P
7	50000.0	2.80	140000.0	P
Supplementary information: Minimum requirement is 40 MΩ·m².				

5.5.5	Continuity test of equipotential bonding after HF10 – accord. to 2 PfG 2930/02.23, 5.2				
Test date (dd/mm/yyyy)		02/07/2024		—	
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]		
6	76.5 / 77.8 / 75.1		1.22 / 1.24 / 1.20		P
7	75.4 / 73.8 / 74.5		1.21 / 1.18 / 1.19		P
Supplementary information: N/A					

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5.2	Bypass diode functionality test after HF10 – accord. to 2 PfG 2930/02.23, 5.2			
Test date (dd/mm/yyyy)		03/07/2024		—
Test method		<input type="checkbox"/> Method A <input checked="" type="checkbox"/> Method B		
Sample no.	Diode 1	Diode 2	Diode 3	
6	working properly	working properly	working properly	P
7	working properly	working properly	working properly	P
Supplementary information: This test verifies that the sample shows the electrical characteristics of a functional photovoltaic device.				

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5.6.1	Damp heat test – accord. to 2 PfG 2930/02.23, 5.6.1		
Test date (dd/mm/yyyy)		26/04/2024 - 20/07/2024	—
Total duration [h]		2000	
Sample no.	—		
8	—		—
9	—		—
Supplementary information: N/A			

5.6.2	Visual inspection after DH2000 – accord. to 2 PfG 2930/02.23, 5.2		
Test date (dd/mm/yyyy)		20/07/2024	—
Sample no.	Requirement	Nature and position of findings	
8	No major visual defects	No major visual defects	P
9		No major visual defects	P
Supplementary information: N/A			

5.6.2	Insulation test after DH2000 – accord. to 2 PfG 2930/02.23, 5.2					
Test date (dd/mm/yyyy)				20/07/2024		—
Maximum system voltage [V _{DC}]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V _{DC}]				8000		
Insulation resistance measured at [V _{DC}]				1500		
Sample no.	R _{iso} [GΩ]	A [m²]	R _{iso} ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
8	50.00	2.80	140.00	-	No	P
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.						

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5.6.2	Wet leakage current test after DH2000 – accord. to 2 PfG 2930/02.23, 5.2			
Test date (dd/mm/yyyy)		20/07/2024		—
Maximum system voltage [V _{DC}]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V _{DC}]		1500		
Solution resistivity [Ω·cm]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R _{iso} [MΩ]	A [m²]	R _{iso} ·A [MΩ·m²]	
8	50000.0	2.80	140000.0	P
9	50000.0	2.80	140000.0	P
Supplementary information: Minimum requirement is 40 MΩ·m².				

5.6.2	Continuity test of equipotential bonding after DH2000 – accord. to 2 PfG 2930/02.23, 5.2		
Test date (dd/mm/yyyy)		20/07/2024	—
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]	
8	75.4 / 73.8 / 74.5	1.21 / 1.18 / 1.19	P
9	76.5 / 77.8 / 75.1	1.22 / 1.24 / 1.20	P
Supplementary information: N/A			

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5.6.2	Bypass diode functionality test after DH2000 – accord. to 2 PfG 2930/02.23, 5.2			
Test date (dd/mm/yyyy)		20/07/2024		—
Test method		<input type="checkbox"/> Method A <input checked="" type="checkbox"/> Method B		
Sample no.	Diode 1	Diode 2	Diode 3	
8	working properly	working properly	working properly	P
9	working properly	working properly	working properly	P
Supplementary information: This test verifies that the sample shows the electrical characteristics of a functional photovoltaic device.				

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5.7.1 Salt mist corrosion test – accord. to 2 PfG 2930/02.23, 5.7.1

Test Date (dd/mm/yyyy) start / end		21/05/2024 - 21/07/2024	—
Test method (#)		8	
Angle of inclination from horizontal (°)		75	
Mist pH level		3.5	
Mist temperature (°C)		50	
Mist humidity (%)		95	
Total exposure hours (hrs)		1440	
Sample No.	—		—
11	—		—
12	—		—
Supplementary information: N/A			

5.7.2 Visual inspection after Salt mist – accord. to 2 PfG 2930/02.23, 5.2

Test date (dd/mm/yyyy)		21/07/2024		—
Sample no.	Requirement		Nature and position of findings	
11	No major visual defects		No major visual defects	P
12			No major visual defects	P
Supplementary information: N/A				

5.7.2 Electroluminescence images after salt mist – accord. to 2 PfG 2930/02.23, 5.2

Test date (dd/mm/yyyy)		21/07/2024	—
Current applied [A]		13.40	
Sample No.	Nature and position of initial findings		
10	Refer to Appendix 4 for details		—
11	Refer to Appendix 4 for details		—
12	Refer to Appendix 4 for details		—
Supplementary information: N/A			

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TABLES OF TEST RESULTS

5.7.2	Insulation test after salt mist – accord. to 2 PfG 2930/02.23, 5.2					
Test date (dd/mm/yyyy)				21/07/2024		—
Maximum system voltage [V _{DC}]				1500		
Cemented joints?				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
High voltage applied [V _{DC}]				8000		
Insulation resistance measured at [V _{DC}]				1500		
Sample no.	R _{iso} [GΩ]	A [m²]	R _{iso} ·A [GΩ·m²]	Dielectric breakdown		
				Yes (description)	No	
11	15.00	2.80	42.00	-	No	P
12	15.00	2.80	42.00	-	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 15.00 GΩ.						

5.7.2	Wet leakage current test after salt mist – accord. to 2 PfG 2930/02.23, 5.2			
Test date (dd/mm/yyyy)		21/07/2024		—
Maximum system voltage [V _{DC}]		1500		
Cemented joints?		<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes		
Insulation resistance measured at [V _{DC}]		1500		
Solution resistivity [$\Omega \cdot \text{cm}$]		≤ 3500		
Solution temperature [°C]		22 ± 2		
Sample no.	R _{iso} [M Ω]	A [m²]	R _{iso} · A [M $\Omega \cdot \text{m}^2$]	
11	10000.0	2.80	28000.0	P
12	10000.0	2.80	28000.0	P
Supplementary information:				
Minimum requirement is 40 M $\Omega \cdot \text{m}^2$.				
Insulation tester can measure up to 10000 M Ω .				

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TABELLEN DER TESTERGEBNISSE
TABLES OF TEST RESULTS

5.7.2	Continuity test of equipotential bonding after salt mist – accord. to 2 PfG 2930/02.23, 5.2		
Test date (dd/mm/yyyy)		21/07/2024	—
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		1	
Sample no.	Max. measured voltage [mV]	Max. calculated resistance [mΩ]	
11	247.0	4.0	P
12	352.0	5.6	P
Supplementary information: N/A			

5.7.2	Bypass diode functionality test after salt mist – accord. to 2 PfG 2930/02.23, 5.2			
Test date (dd/mm/yyyy)		21/07/2024		—
Test method		<input type="checkbox"/> Method A <input checked="" type="checkbox"/> Method B		
Sample no.	Diode 1	Diode 2	Diode 3	
11	working properly	working properly	working properly	P
12	working properly	working properly	working properly	P
Supplementary information:				
This test verifies that the sample shows the electrical characteristics of a functional photovoltaic device.				

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TABELLEN DER TESTERGEBNISSE
TABLES OF TEST RESULTS

5.2 Performance at STC (final) – accord. to 2 PfG 2930/02.23, 5.2

Performance at STC (front, final)

Test date (dd/mm/yyyy)	21/07/2024 for 11, 12; 03/06/2024 for 2, 3, 4, 5; 03/07/2024 for 6, 7, 20/07/2024 for 8, 9,						
Test method	<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight						
Ambient temperature [°C]	25 ± 2						
Irradiance [W/m²]	1000 ± 10						
Module temperature [°C]	25						
Spectral mismatch	N/A						
Sample no.	P _{max} [W]	V _{mpp} [V]	I _{mpp} [A]	V _{oc} [V]	I _{sc} [A]	FF [%]	Degradation [%]
2	628.0	48.78	12.875	57.00	13.472	81.8	0.54
3	611.1	47.72	12.805	56.53	13.535	79.9	1.27
4	611.6	47.74	12.811	56.39	13.547	80.1	0.83
5	621.8	48.67	12.774	56.99	13.489	80.9	0.99
6	619.2	48.56	12.751	57.08	13.462	80.6	-0.06
7	604.7	47.49	12.735	56.31	13.432	79.9	-0.28
8	607.1	47.79	12.702	56.58	13.387	80.2	-1.39
9	594.8	47.57	12.505	56.49	13.245	79.5	-1.40
11	603.5	47.72	12.582	56.32	13.342	80.5	-0.49
12	604.0	47.42	12.601	56.22	13.375	80.2	-0.49

Supplementary information: N/A

TABELLEN DER TESTERGEBNISSE
TABLES OF TEST RESULTS

Test date (dd/mm/yyyy)			21/07/2024 for 11, 12; 03/06/2024 for 2, 3, 4, 5; 03/07/2024 for 6, 7, 20/07/2024 for 8, 9,				
Test method			<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight				
Ambient temperature [°C]			25 ± 2				
Irradiance [W/m²]			1000 ± 10				
Module temperature [°C]			25				
Spectral mismatch			N/A				
Sample no.	P _{max} [W]	V _{mpp} [V]	I _{mpp} [A]	V _{oc} [V]	I _{sc} [A]	FF [%]	Degradation [%]
2	493.2	49.24	10.015	56.62	10.955	79.5	0.94
3	480.5	48.42	9.923	56.07	11.472	74.7	0.31
4	480.9	48.49	9.917	55.95	11.045	77.8	0.04
5	493.5	49.20	10.029	56.67	11.602	75.1	0.57
6	485.9	48.89	9.939	56.67	10.603	80.9	-0.78
7	474.3	47.87	9.909	55.85	10.569	80.4	-0.37
8	481.0	48.18	9.985	56.13	10.660	80.4	-1.96
9	478.3	47.84	9.997	56.12	10.495	81.2	0.05
11	478.4	48.01	9.998	55.81	11.072	77.2	-0.44
12	475.0	48.00	9.981	55.98	11.001	78.0	-0.48

Supplementary information: N/A

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TABELLEN DER TESTERGEBNISSE
TABLES OF TEST RESULTS

Bifaciality Coefficients (final)				
Sample no.	φ_{Isc}	φ_{Voc}	φ_{Pmax}	—
2	0.8132	0.9933	0.7854	
3	0.8476	0.9919	0.7863	
4	0.8153	0.9922	0.7863	
5	0.8601	0.9944	0.7937	
6	0.7876	0.9928	0.7847	
7	0.7869	0.9918	0.7844	
8	0.7963	0.9920	0.7923	
9	0.7924	0.9935	0.8041	
11	0.7953	0.9922	0.7911	
12	0.7914	0.9932	0.8031	
Supplementary information: N/A				

TABELLEN DER TESTERGEBNISSE
TABLES OF TEST RESULTS

Performance at BNPI (final)							
Test date (dd/mm/yyyy)			21/07/2024 for 11, 12; 03/06/2024 for 2, 3, 4, 5; 03/07/2024 for 6, 7, 20/07/2024 for 8, 9,				
Test method			<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight				
Illuminated side			<input checked="" type="checkbox"/> Front side <input type="checkbox"/> Rear side				
Ambient temperature [°C]			25 ± 2				
Irradiance [W/m²]			1000 + ϕ •135*				
Module temperature [°C]			25				
Spectral mismatch			N/A				
Sample no.	P _{max} [W]	V _{mpp} [V]	I _{mpp} [A]	V _{oc} [V]	I _{sc} [A]	FF [%]	Degradation [%]
2	693.1	48.74	14.222	57.17	14.886	81.5	0.47
3	674.7	47.72	14.139	56.68	14.864	79.5	1.09
4	674.5	47.68	14.147	56.60	14.971	79.6	0.65
5	686.8	48.67	14.112	57.12	14.909	80.5	0.91
6	683.0	48.49	14.085	57.22	14.876	80.2	-0.78
7	666.7	47.42	14.061	56.46	14.848	79.5	-0.37
8	669.3	47.74	14.020	56.72	14.792	79.8	-1.66
9	656.9	47.58	13.805	56.69	14.644	79.1	-1.42
11	668.3	47.78	14.009	56.42	14.644	80.2	-0.30
12	669.1	47.58	14.098	56.31	14.819	80.1	-0.45

Supplementary information:
Negative degradation means power *loss*.
The non-illuminated side was covered with non-reflective background and aperture.
* The bifaciality coefficient ϕ employed for sample No. 2-5 is the minimum value of ϕ_{isc} and ϕ_{Pmax} as documented in this table for each test sample (final STC). The bifaciality coefficient ϕ employed for other samples is the minimum value of ϕ_{isc} and ϕ_{Pmax} as documented in table for initial STC results.

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TABELLEN DER TESTERGEBNISSE
TABLES OF TEST RESULTS

5.2	Gate #2 evaluation			
Reproducibility r for P_{\max} [%]			0.8	—
Reproducibility $r_{(\text{BNPI})}$ for $P_{\max(\text{BNPI})}$ [%]			0.8	—
Evaluation of output power for each module				
Sample no.	$P_{\max, \text{meas, Gate \#1}}$ [W]	$P_{\max, \text{meas, Gate \#1, r}}$ [W]	$P_{\max, \text{meas, Gate \#2}}$ [W]	—
2	624.6	588.6	628.0	P
3	603.5	568.7	611.1	P
4	606.6	571.7	611.6	P
5	615.7	580.2	621.8	P
6	619.6	583.9	619.2	P
7	606.4	571.5	604.7	P
8	615.7	580.2	607.1	P
9	603.3	568.5	594.8	P
11	606.5	571.6	603.5	P
12	607.0	572.0	604.0	P
Supplementary information: Pass criteria follow requirements of section 7.2.1 of IEC 61215-1:2021. $P_{\max, \text{meas, Gate \#1}}$ = Measured initial maximum STC power $P_{\max, \text{meas, Gate \#1, r}}$ = Measured initial maximum STC power taking reproducibility and degradation of 5% into account $P_{\max, \text{meas, Gate \#2}}$ = Measured final maximum STC power				

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TABELLEN DER TESTERGEBNISSE
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Evaluation of output power for each module

Sample no.	$P_{\max(\text{BNPI}),\text{meas,Gate \#1}(\text{BNPI})}$ [W]	$P_{\max(\text{BNPI}),\text{meas,Gate \#1},r(\text{BNPI})}$ [W]	$P_{\max(\text{BNPI}),\text{meas,Gate \#2}(\text{BNPI})}$ [W]	—
2	689.9	650.2	693.1	P
3	667.4	629.0	674.7	P
4	670.2	631.6	674.5	P
5	680.6	641.4	686.8	P
6	683.9	644.5	683.0	P
7	667.6	629.1	666.7	P
8	680.6	641.4	669.3	P
9	666.4	628.0	656.9	P
11	670.3	631.7	668.3	P
12	672.1	633.4	669.1	P

Supplementary information:

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

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

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


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

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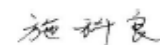
KONSTRUKTIONSDATEN FORM
CONSTRUCTIONAL DATA FORM (CDF)

Appendix 2: Constructional Data Form (CDF)

	Customers reference no.: 2498578	TÜV Rheinland report no.: CN246S3Y 001 TÜV Rheinland project no.: 326018267 (to be filled in by TÜV Rheinland)	Certificate: File: N/A (For TÜV Rheinland of N.A., Inc. use only)	Page 1 of 4
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Constructional Data Form for Photovoltaic Modules

Licence holder (full address)	Sany Silicon Energy (Zhuzhou) Co., Ltd. Room 518-50, Building 1, Longxin International, No.256, Tongxia Road, Tongtangwan Street, Shifeng District, Zhuzhou City, Hunan Province, P.R. China				
Production factory (full address)	Sany Silicon Energy (Zhuzhou) Co., Ltd. Sany Energy Equipment Industrial Park, No.320 Qingshui Road, Shifeng District, Zhuzhou City, Hunan Province 412005 P.R. China				
Type of product	Photovoltaic (PV) modules				
Trademark					
Type name or model no.	SYMNI56TBD0xxx xxx = 615-645 in steps of 5	SYMNI56TBDLxxx xxx = 615-645 in steps of 5	/	/	/
Nominal maximum output power at STC [W]	615, 620, 625, 630, 635, 640, 645	615, 620, 625, 630, 635, 640, 645	/	/	/
Nominal short-circuit current at STC [A]	13.57, 13.63, 13.69, 13.75, 13.81, 13.87, 13.93	13.57, 13.63, 13.69, 13.75, 13.81, 13.87, 13.93	/	/	/
Nominal open-circuit voltage at STC [V]	56.31, 56.53, 56.75, 56.97, 57.14, 57.32, 57.51	56.31, 56.53, 56.75, 56.97, 57.14, 57.32, 57.51	/	/	/
Tolerance of rating at STC (P _{mpp} / I _{sc} / V _{oc}) [%]	± 3/ ± 3/ ± 3	± 3/ ± 3/ ± 3	/	/	/
Nominal maximum output power at BNPI [W]	677, 682, 688, 693, 699, 704, 710	677, 682, 688, 693, 699, 704, 710	/	/	/
Nominal short-circuit current at BNPI [A]	14.93, 14.99, 15.06, 15.13, 15.19, 15.26, 15.32	14.93, 14.99, 15.06, 15.13, 15.19, 15.26, 15.32	/	/	/
Nominal open-circuit voltage at BNPI [V]	56.31, 56.53, 56.75, 56.97, 57.14, 57.32, 57.51	56.31, 56.53, 56.75, 56.97, 57.14, 57.32, 57.51	/	/	/
Tolerance of rating at BNPI (P _{mpp} / I _{sc} / V _{oc}) [%]	± 3/ ± 3/ ± 3	± 3/ ± 3/ ± 3	/	/	/
Bifaciality coefficient	80%±5%	80%±5%	/	/	/
Dimensions (L x W x H) [mm]	2465x1134x30	2465x1134x30	/	/	/
Module area [m ²]	2.80	2.80	/	/	/
Class (IEC 61730-1:2016)	II	II	/	/	/
Maximum system voltage [V _{oc}]	1500	1500	/	/	/
Pollution degree	I	I	/	/	/
Qualified as cemented joint design	No	No	/	/	/
Over-current protection rating [A]	30	30	/	/	/

Shanghai (Place) 21/07/2024 (date)  (stamp and/or signature of TÜV Rheinland)	Zhuzhou (Place) 21/07/2024 (date)  (stamp and/or signature of applicant)
Note: Any errors or omissions in the CDF shall be reported to TÜV Rheinland immediately upon receipt by the applicant.	

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KONSTRUKTIONS DATEN FORM
CONSTRUCTIONAL DATA FORM (CDF)



Customers reference no.: 2498578	TÜV Rheinland report no.: CN248S3Y 001 TÜV Rheinland project no.: 326018267 (to be filled in by TÜV Rheinland)
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Constructional Data Form for Photovoltaic Modules

Defined min. creepage distance [mm]	12.3±1	12.3±1	/	/	/
Defined min. clearance distance [mm]	12.3±1	12.3±1	/	/	/
Max. operational altitude [masl]	2000	2000	/	/	/
Design load – downwards [Pa]	3600	3600	/	/	/
Design load – upwards [Pa]	1600	1600	/	/	/
Safety factor for mechanical load	1.5	1.5	/	/	/
Number of solar cells	156	156	/	/	/
Connection of cells (S, SP, PS)	SPS	SPS	/	/	/
Number of diodes	3	3	/	/	/
Cells per diode	52	52	/	/	/

Copy of marking plate



PV MODULE
Sany Solar Energy (Zhuzhou) Co., Ltd
Sany Energy Equipment Industrial Park,
No.328 Jinghui Road, Shilong District,
Zhuzhou City, Hunan Province 412005
China
<http://www.sanygsol.com/product/>

[illegible]

- Module TSS/rms(TC)
- Design Load (T_{max})
- Series Fuse Rating
- Maximum system voltage
- operating temperature range
- rated 1800
- module approximately
- module size
- GFC
- GFI
- Consumer

70
±1800 Hz
10A
1000Hz
-6°C ~ +18°C
E
1A3kg
245~1134 (20mm)
100Watt, AM 5.25V
for 100Watt, up 10Watt
Delivery

 **warning**
Only the professionals can install and maintain the components be careful of the dangerous high DC voltage when connecting the components. Never Amuse or scratch the back of the assembly.
Certified in accordance with IEC 61218-3:2011 and IEC 61218-2:2011
MADE IN CHINA

Marking plate is in compliance with IEC 61215:2021 and IEC 61730:2023.

<u>Shanghai</u> (Place)	<u>21/07/2024</u> (date)
<u>Andreas Riem</u> (stamp and/or signature of TÜV Rheinland)	

<u>Zhuzhou</u> (Place)	<u>21/07/2024</u> (date)
<u>施科良</u> (stamp and/or signature of applicant)	

Note: Any errors or omissions in the CDF shall be reported to TÜV Rheinland immediately upon receipt by the applicant.

ANLAGE 2 zum Prüfbericht-Nr.: CN246S3Y 001
APPENDIX 2 to Test Report No.:

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KONSTRUKTIONS DATEN FORM
CONSTRUCTIONAL DATA FORM (CDF)



Customers reference no.:
2496578

TÜV Rheinland report no.:
CN246S3Y 001
TÜV Rheinland project no.:
326018267
(to be filled in by TÜV Rheinland)


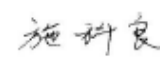
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Constructional Data Form for Photovoltaic Modules

List of critical components (add lines for multiple material sources)					
Object	Manufacturer	Type / model	Technical data / ratings	Standard (if applicable)	Certificates (if applicable)
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	—	—
Front cover	Hunan Kibing Solar Technology Co., Ltd.	Semi-tempered AR coated glass	Thickness [mm]: ≈2.0±0.2mm	—	—
Backside cover	Hunan Kibing Solar Technology Co., Ltd.	Semi-Tempered back glass	Thickness [mm]: ≈2.0±0.2mm Color: white glaze or transparent	—	—
Cell connectors	Suzhou YourBest new-type materials Co., Ltd	Sn60Pb40	Dimensions [mm]: Ø= 0.26±0.026mm	—	—
String connectors	Suzhou YourBest new-type materials Co., Ltd	Sn60Pb40	Dimensions [mm]: 0.3±0.03mm x 6.0±0.6mm 0.3±0.03mm x 4.0±0.4mm	—	—
Soldering material	—	—	—	—	—
Fluxing agent	Shenzhen Tongfang Electronic New-Material CO., LTD	AATF9800-MBB	—	—	—
Cell fixing tape	SuZhou Rongzhi Electronic Technology Co., Ltd	D60F6-2	Thickness =100±40um	—	—
Encapsulation material	HANGZHOU FIRST APPLIED MATERIAL CO., LTD	EP304 (near front glass)	Thickness = 0.5mm±10% gram weight: 380g/m²±10%;	—	—
		EP304 (near back glass)	Thickness = 0.5mm±10% gram weight: 400g/m²±10%;	—	—
Frame parts	Zhejiang DeYiLong Technology Co., Ltd.	GRPU BK30	H[mm] x W[mm]: 30x19.95mm (long frame) 30x19.95mm (short frame) Color: Black	—	—
Adhesive (frame)	H.B.Fuller (Suzhou) Advanced Material Co., Ltd.	1527	Color: White or black	—	—

Shanghai (Place) 21/07/2024 (date)  (stamp and/or signature of TÜV Rheinland)	Zhuzhou (Place) 21/07/2024 (date)  (stamp and/or signature of applicant)
Note: Any errors or omissions in the CDF shall be reported to TÜV Rheinland immediately upon receipt by the applicant.	

ANLAGE 2 zum Prüfbericht-Nr.: CN246S3Y 001
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KONSTRUKTIONS DATEN FORM
CONSTRUCTIONAL DATA FORM (CDF)



Customers reference no.:
2496578

TÜV Rheinland report no.:
CN246S3Y 001
TÜV Rheinland project no.:
326018267
(to be filled in by TÜV Rheinland)


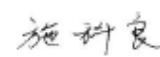
Certificate:
File: N/A

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Constructional Data Form for Photovoltaic Modules

Junction box set					
Junction box	Suzhou Xtong Photovoltaic Technologies Co., Ltd.	PV-XT1609Nxyz (x=4; y=3; z=1 or 2)	Rated. Voltage = 1500V Rated. Current = 25A Reverse current: 40A IP68	IEC 62790: 2020 EN IEC 62790: 2020	R 50524457
Cable	Suzhou Xtong Photovoltaic Technologies Co., Ltd.	62930 IEC 131 1 x 2,5mm ² / 1 x 4,0mm ² / 1 x 6,0mm ² HALOGEN FREE LOW SMOKE	Max. Voltage = 1500VDC	IEC 62930	R 50453577
Connector	Suzhou Xtong Photovoltaic Technologies Co., Ltd.	PV-XT101.2	Rated. Voltage = 1500V Rated. Current = 41A	IEC 62852:2014	R 50568733
Bypass diode	Suzhou Xtong Photovoltaic Technologies Co., Ltd.	XT4050M-B	Tj max =200°C	—	—
Adhesive 1	H.B.Fuller (Suzhou) Advanced Material Co., Ltd.	HelioSeal PVS 101	L x W [mm]: 15*15 Color: black	—	—
Adhesive 2	Cybrid Technologies Inc.	SW-4G	Color: black	—	—
Adhesive 3	H.B.Fuller (Suzhou) Advanced Material Co., Ltd.	1527	Color: White or black	—	—
Potting (junction box)	H.B.Fuller (Suzhou) Advanced Material Co., Ltd.	1533	Color: White or black	—	—
Mounting and attachment parts	—	—	—	—	—
Additional materials	—	—	—	—	—
(Optional) Accessories	—	—	—	—	—
Remarks	For construction, framed or frameless, with Junction box, cable and connector. For extension qualifications, new materials introduced shall be highlighted in bold. Substituted materials shall still be listed.				

Shanghai (Place) 21/07/2024 (date)  (stamp and/or signature of TÜV Rheinland)	Zhuzhou (Place) 21/07/2024 (date)  (stamp and/or signature of applicant)
Note: Any errors or omissions in the CDF shall be reported to TÜV Rheinland immediately upon receipt by the applicant.	

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FOTOS DER TESTPROBEN
PHOTOS OF TEST SAMPLES

Appendix 3: Photos of test samples

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



Fig. 1: front view of test sample



Fig. 2: rear view of test sample

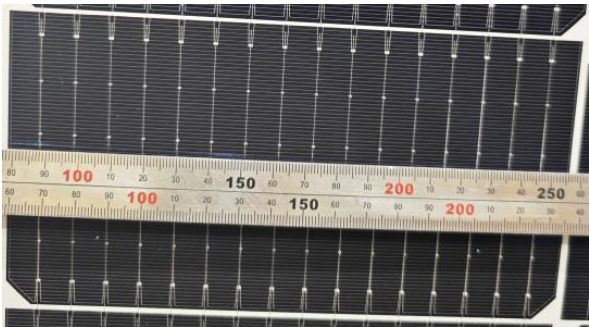


Fig. 3: detail view of solar cell



Fig. 4: detail view of closed junction box

FOTOS DER TESTPROBEN
 PHOTOS OF TEST SAMPLES

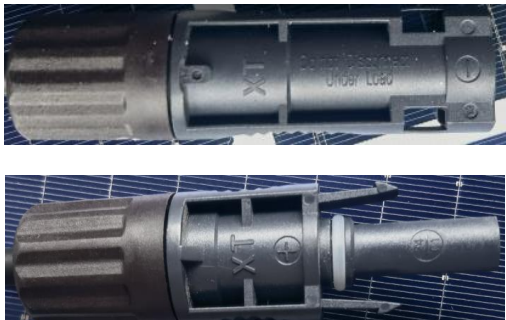


Fig. 5: detail view of connector



Fig. 6: detail view of cable



Fig. 7: detail view of equipotential bonding hole and symbol

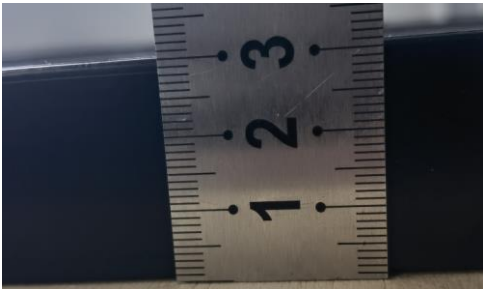


Fig. 8: detail view of frame

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FOTOS DER TESTPROBEN
PHOTOS OF TEST SAMPLES



Fig. 9: view of mechanical load mounting

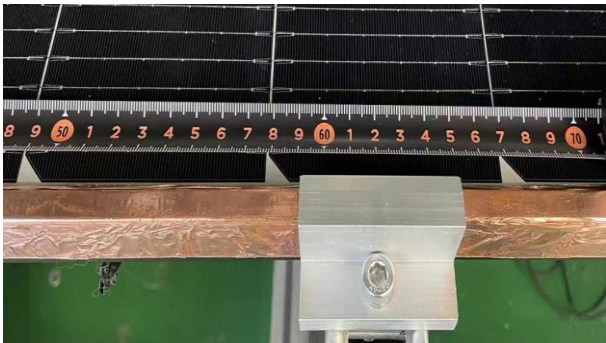


Fig. 10: detail view of mounting method



Fig. 11: detail view of type label

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ELEKTROLUMINESZIERENDE BILDGEBUNG
ELECTROLUMINESCENT IMAGE

Appendix 4: Electroluminescent Image

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

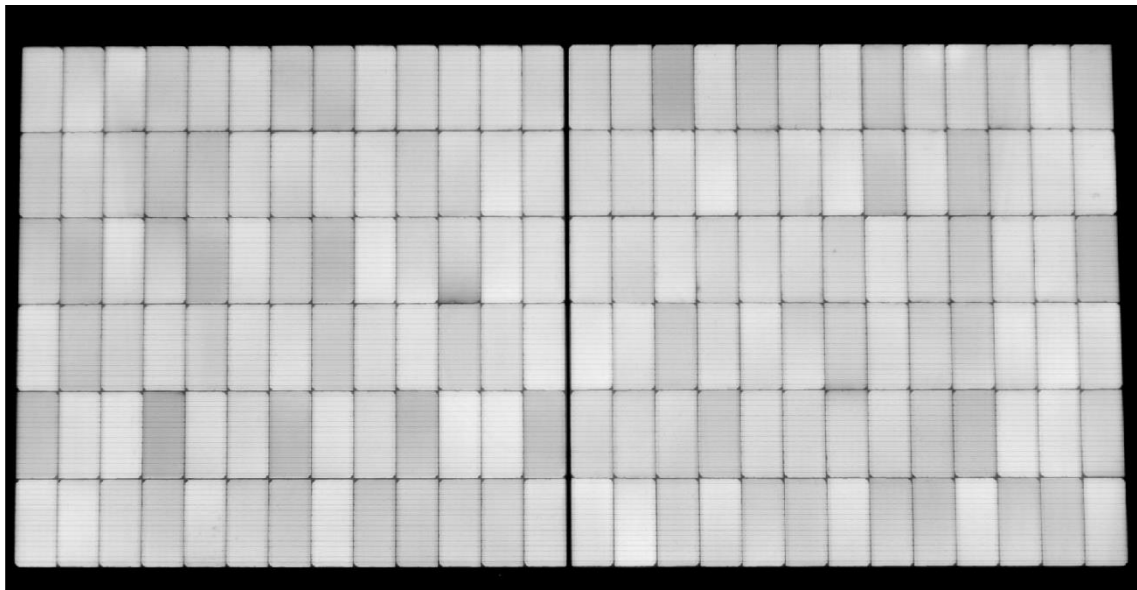


Fig. 1: 2403001B2D00001(Initial)

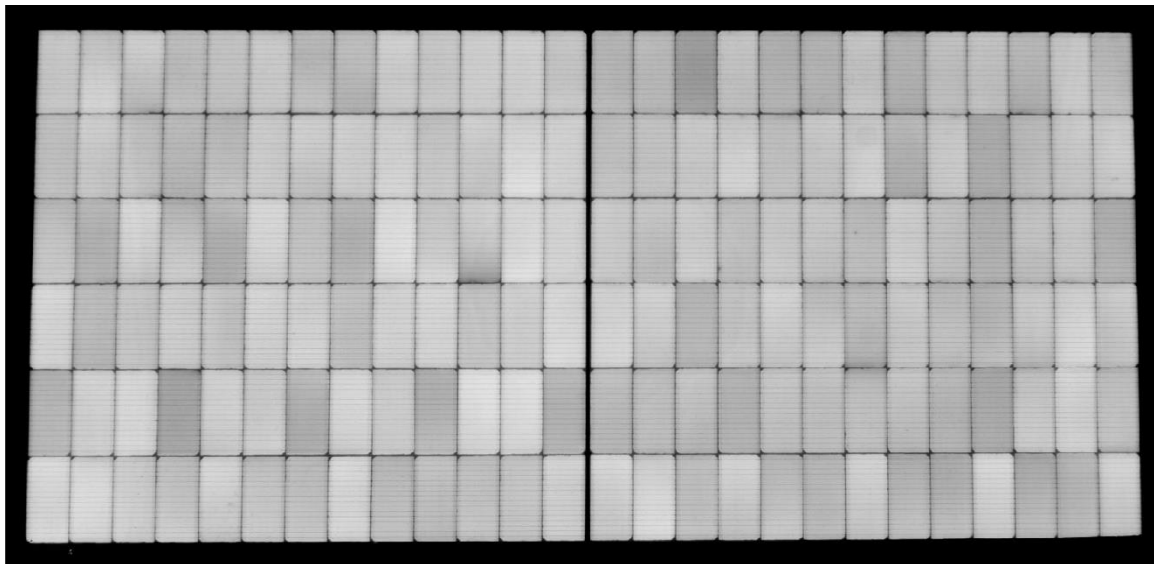


Fig. 2: 2403001B2D00001 (Final)

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ELEKTROLUMINESZIERENDE BILDGEBUNG
ELECTROLUMINESCENT IMAGE

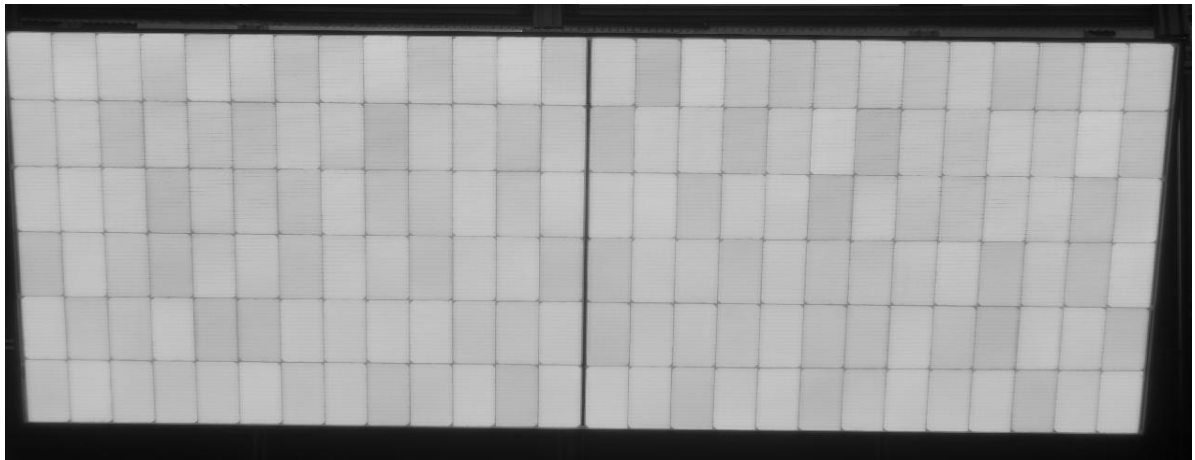


Fig. 3: 2403001B2D00008 (Initial)

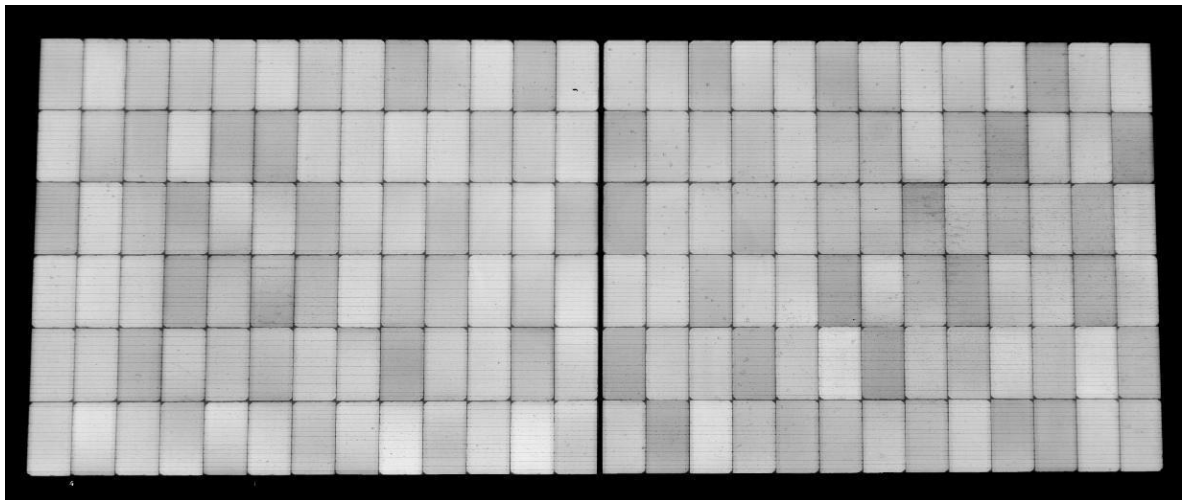


Fig. 4: 2403001B2D00008 (Final)

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ELEKTROLUMINESZIERENDE BILDGEBUNG
ELECTROLUMINESCENT IMAGE

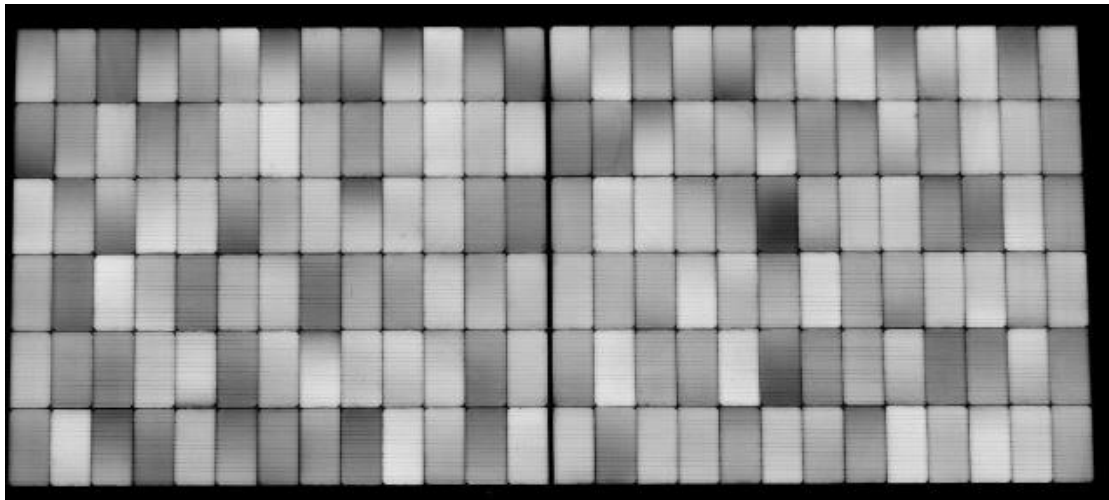


Fig. 5: 2403001B2D00009 (Initial)

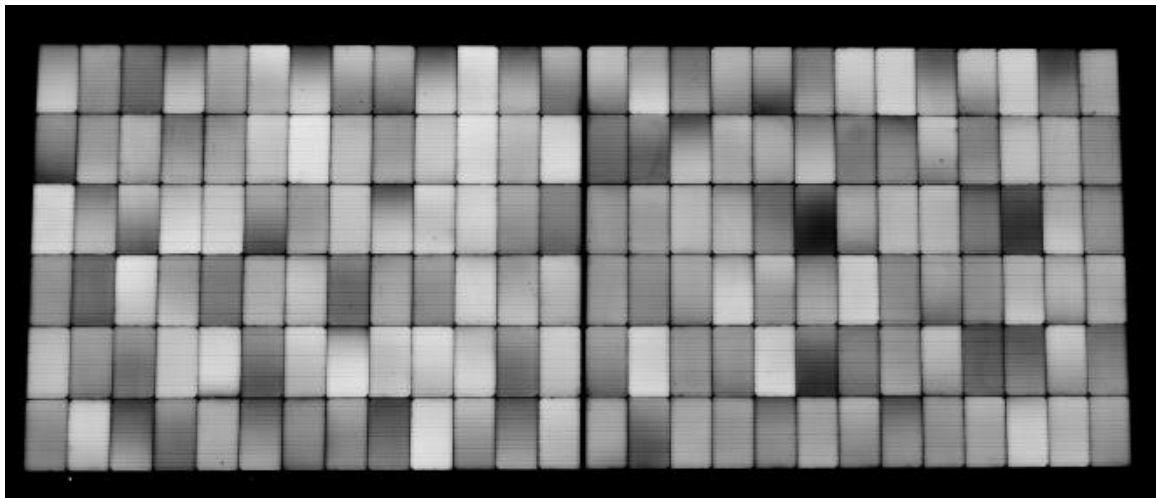


Fig. 6: 2403001B2D00009 (Final)

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ELEKTROLUMINESZIERENDE BILDGEBUNG
ELECTROLUMINESCENT IMAGE

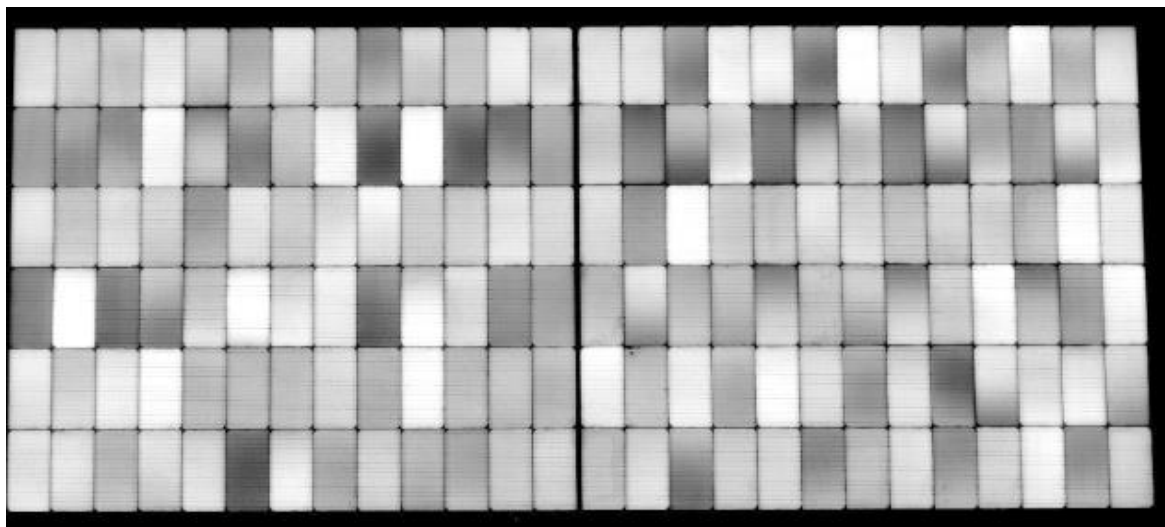


Fig. 7: 2403001B2D00010 (Initial)

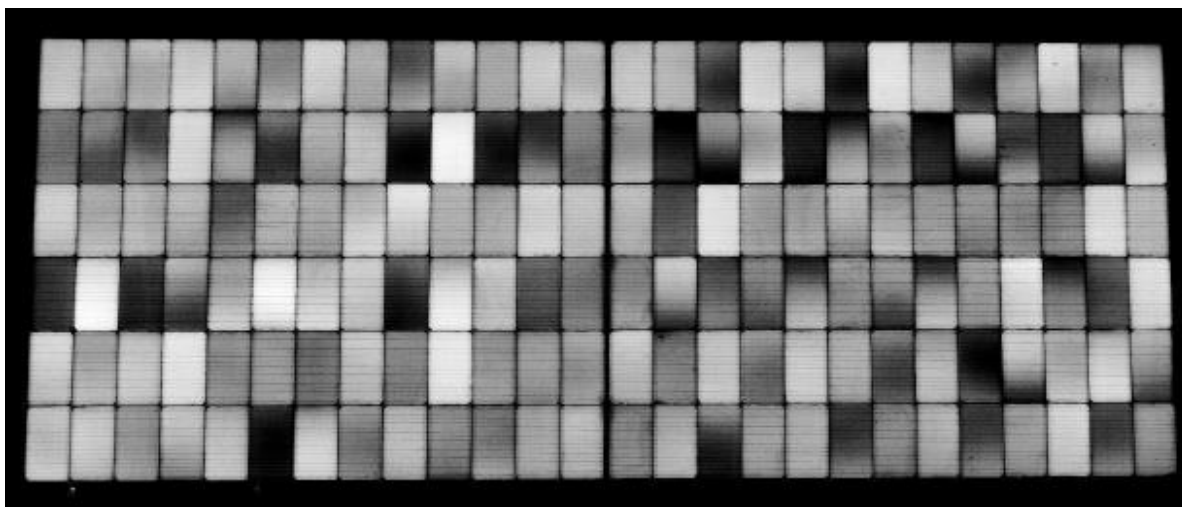


Fig. 8: 2403001B2D00010 (Initial)

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ELEKTROLUMINESZIERENDE BILDGEBUNG
ELECTROLUMINESCENT IMAGE

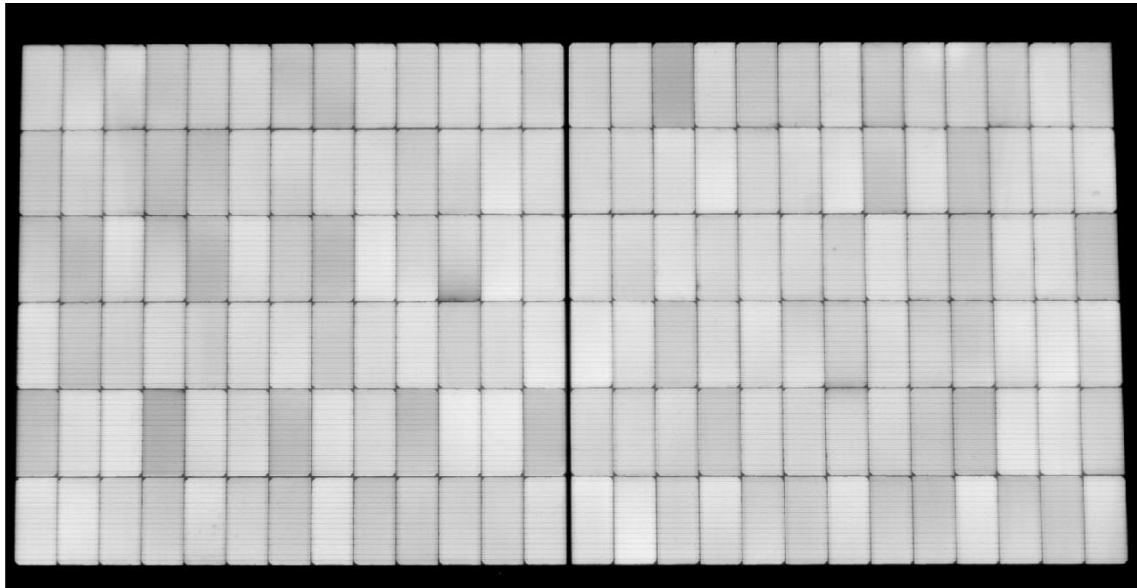


Fig. 9: 2403001B2D00015 (Initial)

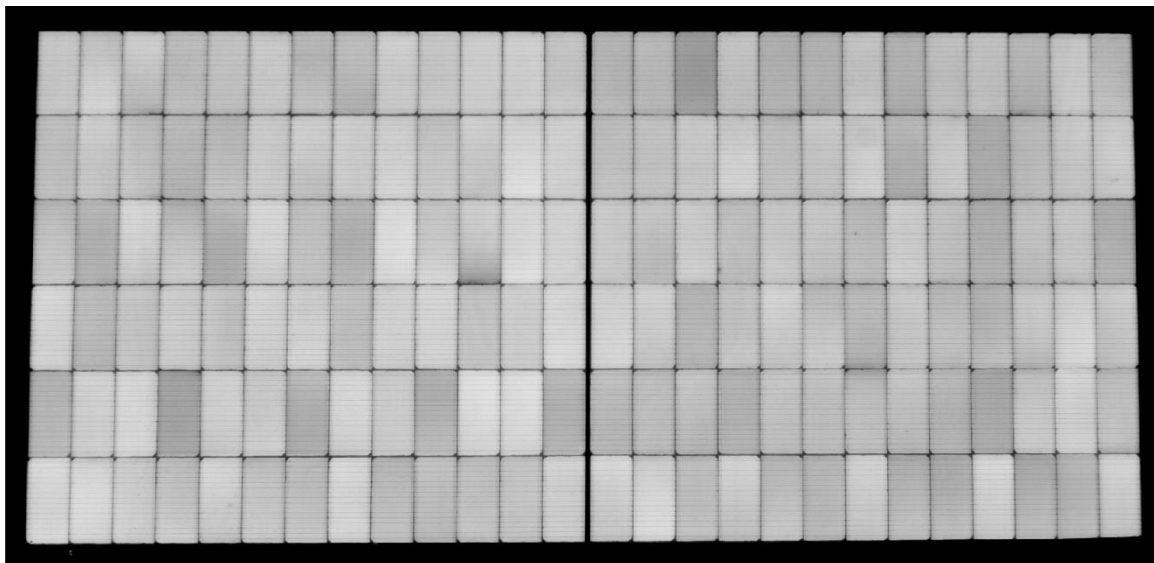


Fig. 10: 2403001B2D00015 (Final)

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ELEKTROLUMINESZIERENDE BILDGEBUNG
ELECTROLUMINESCENT IMAGE

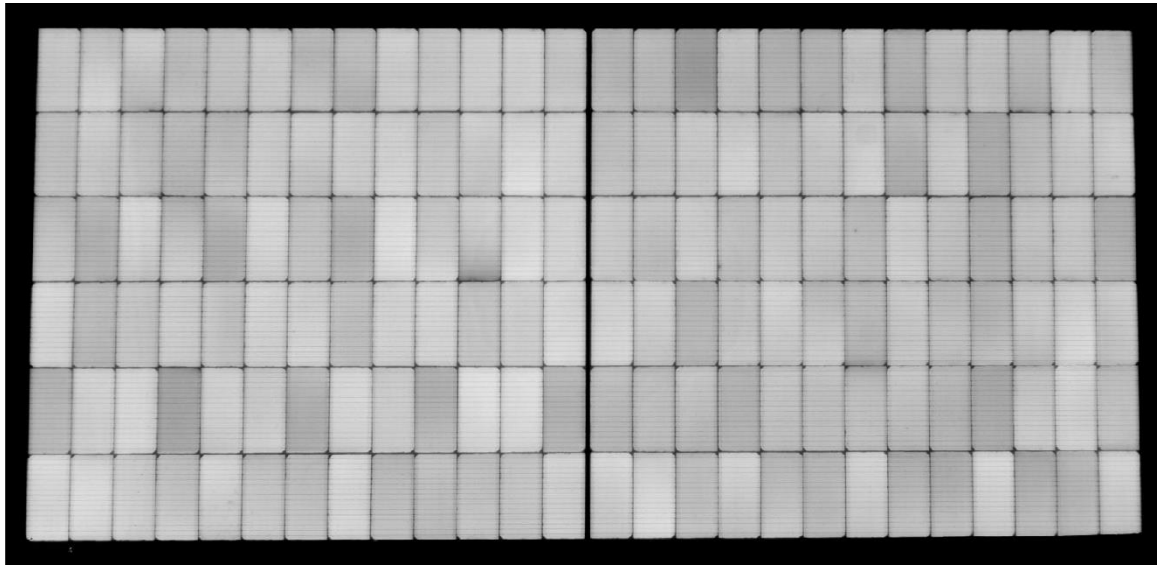


Fig. 11: 2403001B2D00003 (Initial)

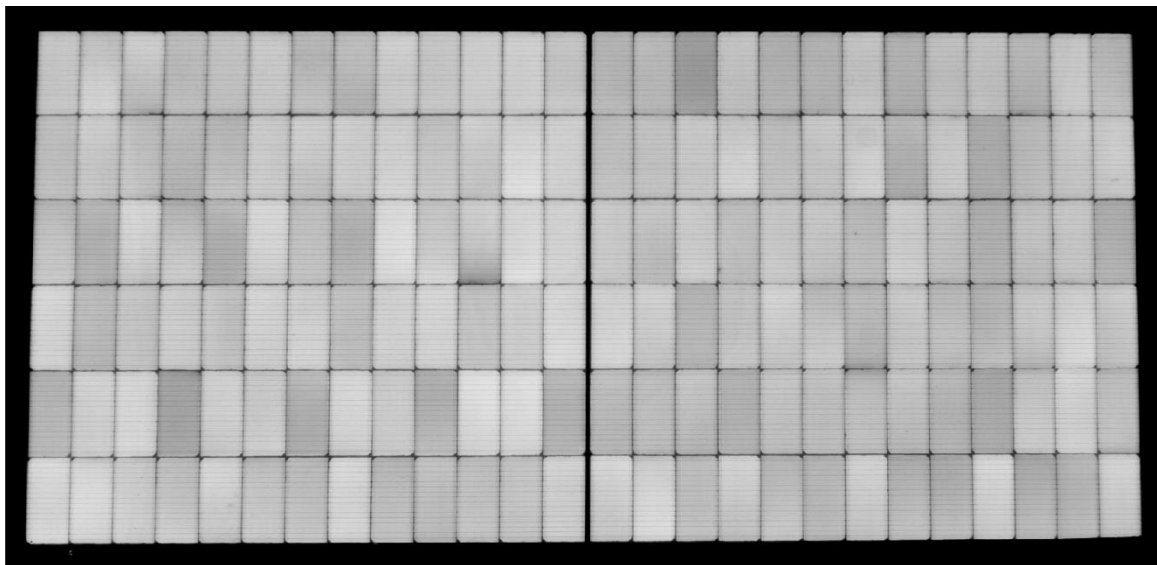


Fig. 12: 2403001B2D00003 (Final)

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ELEKTROLUMINESZIERENDE BILDGEBUNG
ELECTROLUMINESCENT IMAGE

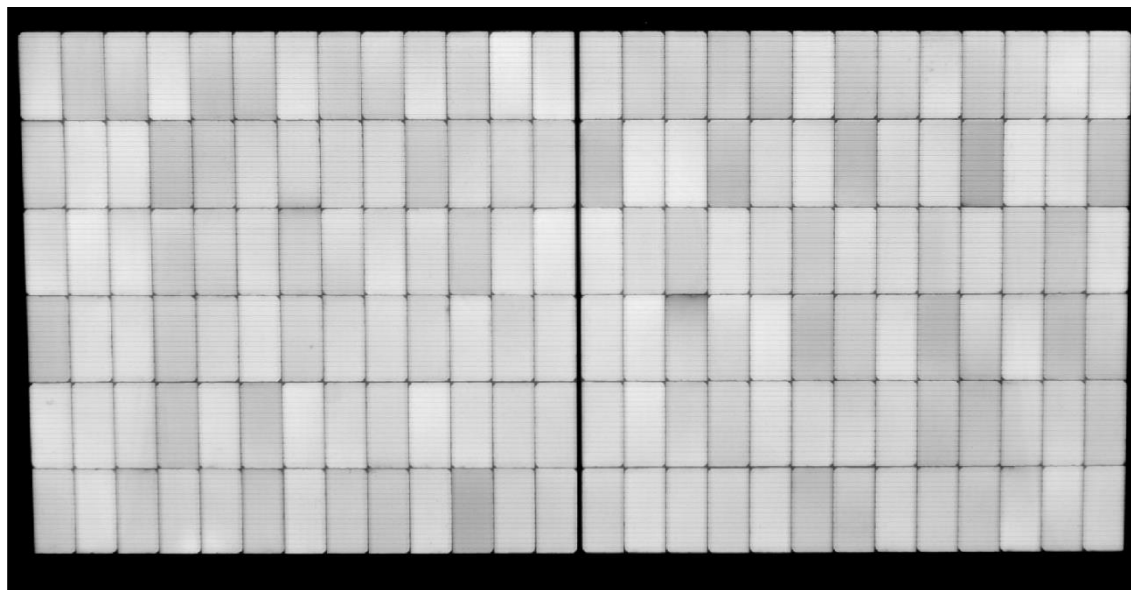


Fig. 13: 2403001B2D00004 (Initial)

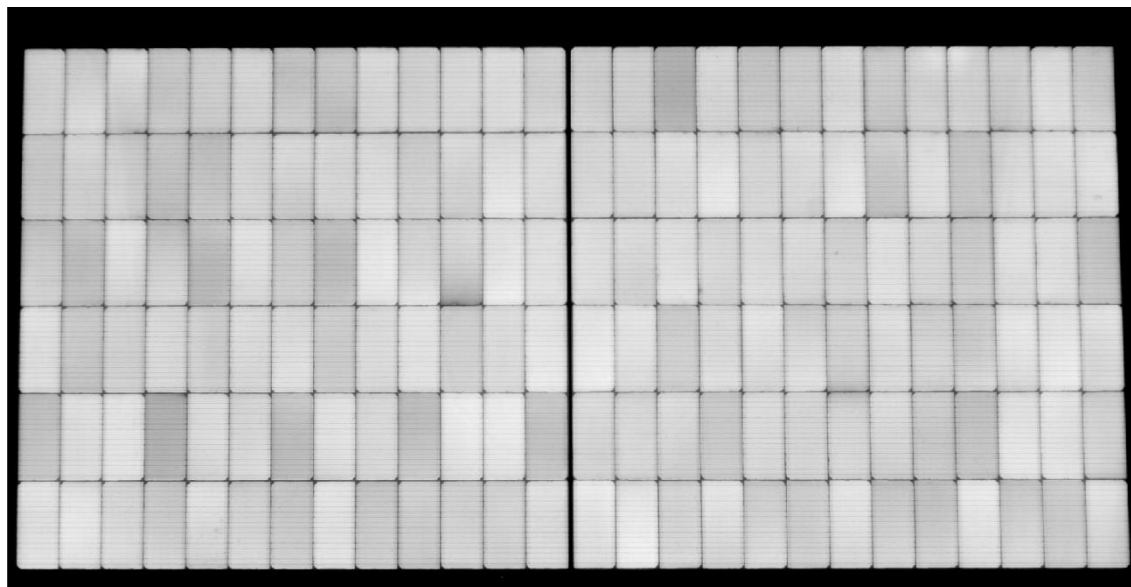


Fig. 14: 2403001B2D00004 (Final)

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ELEKTROLUMINESZIERENDE BILDGEBUNG
ELECTROLUMINESCENT IMAGE

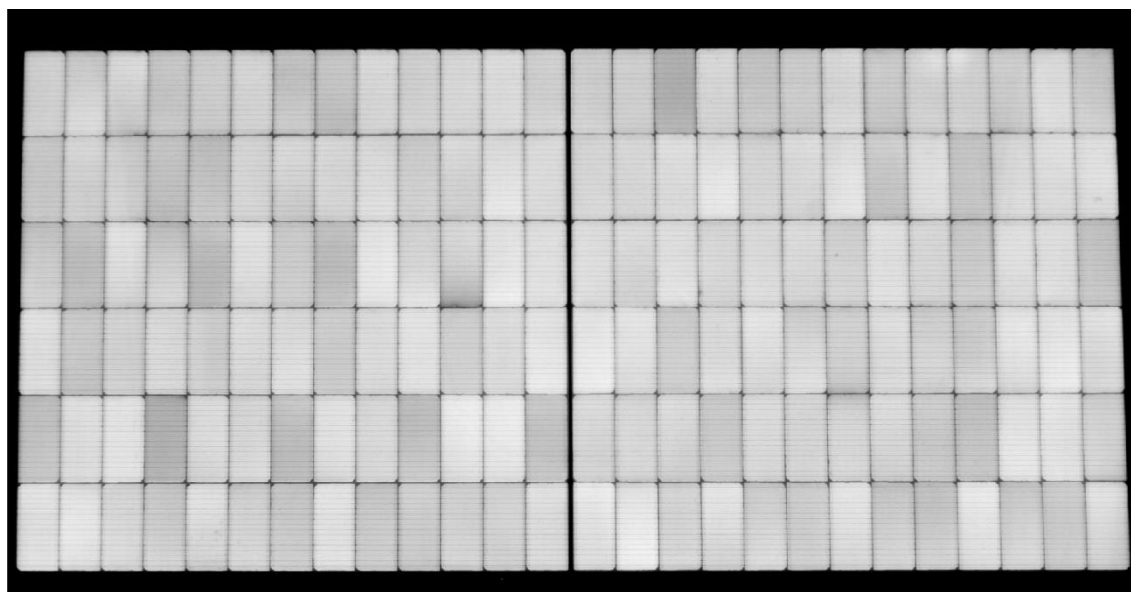


Fig. 15: 2403001B2D00005 (Initial)

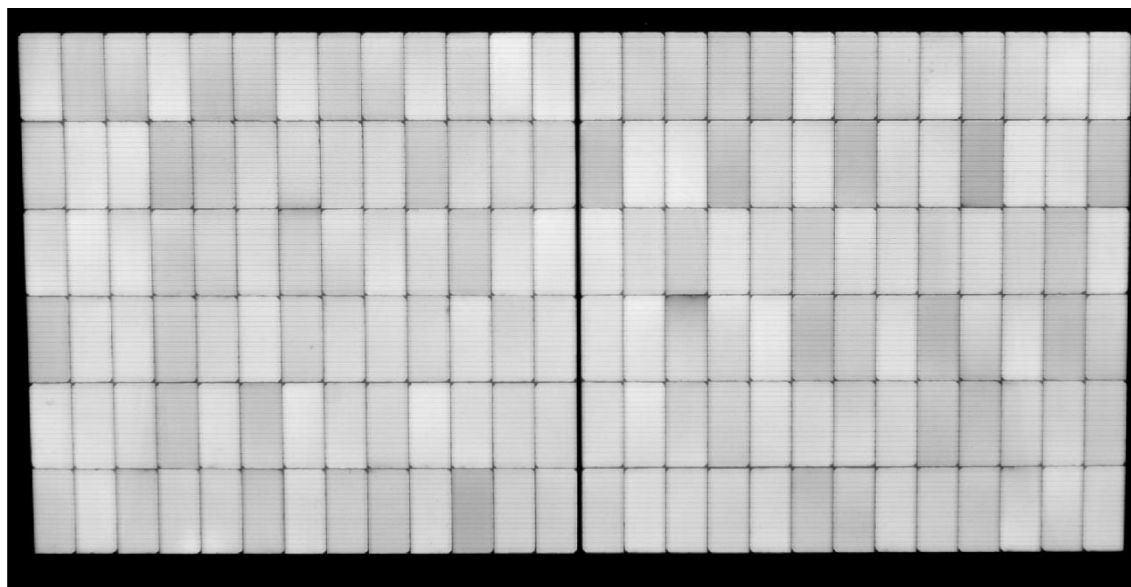


Fig. 16: 2403001B2D00005 (Final)