



Prüfbericht-Nr.: <i>Test report no.:</i>	DE25LL6W 001	Auftrags-Nr.: <i>Order no.:</i>	30010 2782	Seite 1 von 19 Page 1 of 19
Kunden-Referenz-Nr.: <i>Client reference no.:</i>	2062211	Auftragsdatum: <i>Order date:</i>	2025-04-17	
Auftraggeber: <i>Client:</i>	Aiko Energy Netherlands B.V. (for add. information see page 3)			
Prüfgegenstand: <i>Test item:</i>	Photovoltaik Module			
Bezeichnung / Typ-Nr.: <i>Identification / Type no.:</i>	Aiko-A470-MCE54Db (representative for various module types)			
Auftrags-Inhalt: <i>Order content:</i>	Hail impact test with the aim of recommendation/classification for VFK "Hagelregister"			
Prüfgrundlage: <i>Test specification:</i>	according to / following VKF - Prüfbestimmung *** "Nr. 25 "Photovoltaik Module" - Version 1.03 (01/11/2016) following IEC 61215-2 "Terrestrial photovoltaik modules - Design qualification and type approval - Part 2: Test procedures			
Wareneingangsdatum: <i>Date of sample receipt:</i>	2025-04-16			
Prüfmuster-Nr.: <i>Test sample no.:</i>	see "List of test samples"			
Prüfzeitraum: <i>Testing period:</i>	2025-04-25 – 2025-05-06			
Ort der Prüfung: <i>Place of testing:</i>	Am Grauen Stein, 51105 Köln, Cologne			
Prüflaboratorium: <i>Testing laboratory:</i>	TÜV Rheinland Solar GmbH			
Prüfergebnis*: <i>Test result*:</i>	Siehe Sonstiges / See Other			
geprüft von: <i>tested by:</i>	X 	genehmigt von: <i>authorized by:</i>	X 	
Datum: <i>Date:</i> 2025-05-23	Signiert von: Juergen Sommer	Ausstellungsdatum: <i>Issue date:</i> 2025-05-23	Signiert von: Ulrich Fritzsche	
Stellung / Position:	Sachverständige(r)/Expert	Stellung / Position:	Sachverständige(r)/Expert	
Sonstiges / Other:	*** VKF (Vereinigung Kantonalen Feuerversicherungen) /// Additional test specifications: - Prüfbestimmung Nr 00a – Allgemeiner Teil A - Version 1.03 (01/03/2018) - Prüfbestimmung Nr 00b – Allgemeiner Teil B - Version 1.01 (01/12/2018) - Beschlussammlung HSR – formal - Version 30 (16.10.2024) - Beschlussammlung HSR - technisch - Version 19 (13/09/2018)			
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 a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any test mark.</i>				

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Anmerkungen Remarks

A	<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.</i></p> <p><i>Detailed information regarding test conditions, equipment and measurement uncertainty is available in the test laboratory and could be provided on request.</i></p>																				
B	<p>Wie vertraglich vereinbart, wurde dieses Dokument nur digital unterzeichnet. Der TÜV Rheinland hat nicht überprüft, welche rechtlichen oder sonstigen diesbezüglichen Anforderungen für dieses Dokument gelten. Diese Überprüfung liegt in der Verantwortung des Benutzers dieses Dokuments. Auf Verlangen des Kunden kann der TÜV Rheinland die Gültigkeit der digitalen Signatur durch ein gesondertes Dokument bestätigen. Diese Anfrage ist an unseren Vertrieb zu richten. Eine Umweltgebühr für einen solchen zusätzlichen Service wird erhoben.</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.</i></p>																				
C	<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>																				
D	<p>Die Entscheidungsregel für Konformitätserklärungen in diesem Prüfbericht basiert auf der "Null-Grenzwert-Regel" und der "Einfachen Akzeptanz" gemäß ILAC GC8:2019 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.</p> <p><i>The decision rule for statements of conformity in this test report is based on the "Zero Guard Band Rule" and "Simple Acceptance" in accordance to ILAC GC8:2019 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.</i></p>																				
E	<p>Wenn auf dem Bericht kein Akkreditierungshinweis aufgebracht ist, wurde der Bericht nicht im akkreditierten Bereich erstellt und ist folglich auch nicht vom EA MLA abgedeckt. Unabhängig davon wurde der Bericht auf Basis der allgemeinen Regeln der ISO/IEC 17000er Reihe erstellt. Mit "#" gekennzeichnete Prüfungen sind nicht Bestandteil der Akkreditierung D-PL-22040-01-00.</p> <p><i>If there is no accreditation notice on the report, the report has not been produced in the accredited area and is consequently not covered by the EA MLA. Regardless of this, the report has been prepared based on the general rules of the ISO/IEC 17000 series. Tests marked with "#" are not covered by the accreditation D-PL-22040-01-00.</i></p>																				
F	<table><tr><th colspan="4">Revision History</th></tr><tr><th>Revision</th><th>Date</th><th>Nature of changes</th><th>Page</th></tr><tr><td>-</td><td>2025-05-23</td><td>Original issue</td><td></td></tr><tr><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td></tr></table>	Revision History				Revision	Date	Nature of changes	Page	-	2025-05-23	Original issue									
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Produktbeschreibung

Product description

1	Auftraggeber Client	Aiko Energy Netherlands B.V. Hofplein 20 3032 AC Rotterdam Netherland <div>Additionally managed by Zhejiang Aiko Solar Technology Co., Ltd.</div>	
2	Produktdetails Product details	Allgemeine Informationen ; General Information based on datasheet	
		Brand name	Aiko Solar
		Type name	Aiko-A470-MCE54Db
		Product category	PV-module
		Year of production	2025
		Power class [W]	470
		Cell technology	Mono
		Cell dimension (l / w) [mm]	182.2 / 96.25 (cut)
		No. of cells	108
		Max. system voltage [V]	1500
		Thickness of glazing [mm]	2.0 (front) / 2.0 (back)
		Glazing (front)	high transmission, AR coated, semi-tempered
		Glazing (back)	semi-tempered
		Frame material	Aluminium
		Frame thickness [mm]	30
		Dimensionen ; Dimension	
		Dimension (l / w / h) [mm]	1762 / 1134 / 30
Gross area [m²]	1.998		
3	Technische Dokumentation Technical documentation	for detailed constructional data see Certificate PV 50614584, as well as report and Annexes issued by TÜV Rheinland Technical Datasheet “Aiko-Axxx-MCE54Db” issued by Aiko Solar	
4	Hersteller Manufacturer	Zhuhai Fushan Aiko Solar Technology Co., Ltd.	
5	Sonstiges Other	<div><div>- The tested module type might be also available in different powerclasses.</div><div>- Further the result is applicable to additional types; for more details see “General remarks”</div><div>- Mounting: Symetric (mounting holes / 331 mm from corner)</div></div>	
6	Prüfmusterbereitstellung: Test sample obtaining	<div><div><input checked="" type="checkbox"/> Sending by customer</div><div><input type="checkbox"/> Sampling by TÜV Rheinland Group</div><div><input type="checkbox"/> others: randomly chosen from existing test batch</div></div>	

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Produktbeschreibung
Product description

Sample - Front (example)



Sample - Back (example)



Example of junction box



Example of cells



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-	Result summary table			
Test	Date [DD Month YYYY]		Summary of main test results	—
	Initial (1 st)	Final (2 nd)		
Insulation test	29 April 2025	02 May 2025	-	P
Wet leakage current test	29 April 2025	02 May 2025	-	P
Performance at STC	28 April 2025	02 May 2025	-	P
Electroluminescence images	28 April 2025	02 May 2025	-	P
Impact resistance	30 April 2025		HW3 with 30 mm ice balls passed	P
Final inspection	06 May 2025		see <i>Final evaluation</i>	P
Supplementary information:				
<ul style="list-style-type: none">All results are related to the tested sample/sAccording to test procedure the tested PV module is <u>recommended</u> to be <u>classified in HW3</u>No pre-exposure necessary; no relevant plastic parts				

	Final evaluation (recommendation of testing laboratory)		
In four-eyes principle; by	J. Sommer	U. Fritzsche	—
The acceptance of recommendation and final classification is part of FER (Fachkommision Elementarschutzregister)			
Properties of component	Evaluation of hail withstand		
Water tightness	---		
Visual nature / look	HW3		
Mechanics	HW3		
Transmittance	---		
Opacity	---		
Supplementary information: -			

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-	Visual inspection (Initial)		
Test date [YYYY-MM-DD]		2025-04-28	—
Sample No.	Nature and position of initial findings		
HV2025001329	No relevant visual defects		P
HV2025001330	No relevant visual defects		P
HV2025001331	No relevant visual defects		P
Supplementary information: -			
Type plate (example)			
<div><div><div>Model: AIKO-A470-MCE54Db</div><div>STC: AM=1.5, E=1000W/m², Tc=25°C Tested according to IEC 61215: 2021 and IEC 61739: 2023 BNPL: 1000W/m²→+1155W/m² BSL: 1000W/m²→+1500W/m² Bifaciality coefficient (α): αVoc> 95% αisc> 45% αPmax> 40%</div></div><div><div>Test conditions</div><div>STC BNPL</div><div>Maximum Power (Pmax) 470 W 495W Voltage at Pmax (Vmp) 34.30V 34.30V Current at Pmax (Imp) 13.71 A 14.44A Open-Circuit Voltage (Voc) 40.70 V 40.70 V Short-Circuit Current (Isc) 14.64 A 15.49A</div></div><div><div>Power Sorting Tolerance</div><div>Pmax & Voc & Isc Tolerance Maximum System Voltage Maximum Series Fuse Rating Operating Temperature Protection Class</div></div><div><div>Isc= -16.48±3% Min. Design Load Module [Tj]max Connector Information</div><div><div>AIKO</div><div>Web:www.aikosolar.com</div><div><div>Zhejiang Aiko Solar Technology Co., Ltd. Add: No.655, Heqiao Road, Xuali Town, Yiwu 322009 Zhejiang, P.R.China</div><div><div>AIKO</div><div>Made in China</div></div></div></div></div></div>			

-	List of test samples		
Sample No.	Sample S/N	Remarks / constructional characteristics	—
HV2025001329	Z2554NB0000000000055	Pre-measured backup	
HV2025001330	Z2554NB0000000000054	Main test sample	
HV2025001331	Z2554NB0000000000061	Spare	

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-	Maximum power determination (STC)							
General; for all following measurements								—
Module temperature [°C]				corrected to 25				
Irradiance [W/m²]				1000				
Initial / Final*								
Test date [YYYY-MM-DD]				2025-04-28 and *2025-05-02				
Sample No.	P _{max} [W]	V _{mpp} [V]	I _{mpp} [A]	V _{oc} [V]	I _{sc} [A]	FF [%]	Degradation** [%]	
HV2025001330	468.2	34.80	13.45	40.18	14.39	81.0	initial	P
	468.4	34.82	13.45	40.19	14.36	81.2	-	P
Supplementary information: ** if negative only								

-	Insulation test (ISO)					
General; for all following measurements						—
Maximum system voltage [V _{DC}]				1500		
High voltage applied [V _{DC}]			1 st	3000		
			2 nd	8000		
Insulation resistance measured at [V _{DC}]				1000		
Initial / Final*						
Test date [YYYY-MM-DD]				2025-04-29 and *2025-05-02		
Sample No.	Measured	Area	Result*	Dielectric breakdown		
	[GΩ]	[m²]	[GΩ × m²]	Yes (description)	No	
HV2025001330	1.0	2.00	2.0	-	x	P
	1.0	2.00	2.0	-	x	P
Supplementary information: -						

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-	Wet leakage current test (WL)			
General; for all following measurements				—
Insulation resistance measured at [V _{DC}]		1000		
Solution resistivity [Ω cm]		< 3.500		
Solution temperature [°C]		22 ± 3		
Initial / Final*				
Test date [YYYY-MM-DD]		2025-04-29 and *2025-05-02		
Sample No.	Measured	Area	Result	
	[MΩ]	[m²]	[MΩ × m²]	
HV2025001330	1000	2.00	2000	P
	1000	2.00	2000	P
Supplementary information: -				

-	Electroluminescence images (EL) Analysis of electroluminescence images (see also <i>Annex : Additional information</i>)		
Initial / Final*			—
Test date [YYYY-MM-DD]		2025-04-28 and *2025-05-02	
Sample No.	Reverse current applied [A]	Attributes	
HV2025001330	10 (@ 1000 ms)	No significant conspicuousness/findings	
	10 (@ 1000 ms)	No additional conspicuousness/findings	
Supplementary information: Estimated analysis without guarantee			

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-	Impact resistance test (general)		
Test date [YYYY-MM-DD] Day code	2025-04-30 ^a		
Sample-No. ID code	HV2025001330 ¹³³⁰		
Method used for impact resistance	Nr. 25 "Photovoltaik Module"		
Surface conditioning	none		
Sample tilt angle [° from horizontal]	90		
Direction of shoot [°]	0 (horizontal)		
Impact angle [° from sample surface]	90		
Distance (sample to center of v ₀ -meas.) [mm]	500 to 700		
Ice ball production [week of the year]	11 (hermetically sealed)		
Storage temperature of ice ball [°C]	-20		
Ambient conditions (mean) [°C and % RH]	^a 23.1 and 53.3		
Diameter of ice ball [mm]	30		
Weight of ice ball (mean) [g]	12.7		
Velocity of ice ball (mean) [m/s]	23.9		
Impact energy (at least) [J]	3.5		

Example of Test Set-up	Mounting elements
	

Supplementary information:

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Overview of impact positions



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-	Impact resistance test – Result table								
Sample ID	Impact information					Mass of ball [g]	Velocity of ball [m/s]	Impact energy [J]	—
	Day	No.	Location & description (cells from left bottom [x/y])		IEC***				
1330	Initial - After initial control measurements (Ice ball diameter = 30 mm)								—
	a	1	3/11 - 4/12	Over edges of circuit	3	12.71	24.24	3.73	
		2	4/5 - 5/6	Over edges of circuit	4	12.52	24.44	3.74	
		3	5/12 - 5/13	Near interconnects	5	12.83	24.97	4.00	
		4	2/2 - 2/3	Near interconnects	6	12.62	24.19	3.69	
		5	1/9	Edge of module window	2	12.53	24.21	3.67	
		6	1/15	Near mounting position	7	12.42	24.01	3.58	
		7	1/3	Near mounting position	8	12.64	24.75	3.87	
		8	6/1	Far away from other impacts	9	12.67	24.51	3.81	
		9	6/18	Far away from other impacts	10	12.63	24.43	3.77	
		10	1/18	Corner of module window	1	12.83	25.02	4.02	
		11	3/10 - 4/11	Over the junction box	11	12.83	25.09	4.04	
		12	1/10 - 2/11	Over the junction box	11	12.46	24.33	3.69	
		13	5/10 - 6/11	Over the junction box	11	12.71	24.18	3.72	
		14	600 mm from corner	Vertical frame	-	12.61	24.27	3.71	
		15	300 mm from corner	Vertical frame	-	12.74	24.89	3.95	
		16	corner	Tip of frame	-	12.81	24.99	4.00	
		17	300 mm from corner	Horizontal frame	-	12.68	24.62	3.84	
		18	600 mm from corner	Horizontal frame	-	12.66	24.55	3.82	
	Change to final measurement and inspection								

Supplementary information: *value to low (not valid); **value to high (not valid); ***location acc. to IEC-standard

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-	Final inspection (general)		
Test date [YYYY-MM-DD]		2025-05-06	—
Sample-No.	Potential problem	Evaluation ^{*/**}	
		HW3	
HV2025001330	Technical problems	HW 3 passed ; <u>with 30 mm</u> NO cracks visible under use of electroluminescence NO power degradation detectable*	P
	Visual problems (distance; > 5 m)	HW 3 passed ; <u>with 30 mm</u> NO cracks visible ; NO dents visible	P
	Visual problems (near; < 0.5 m)	HW 3 passed ; <u>with 30 mm</u> NO cracks visible ; NO dents visible	-
NOTE	Individual additional remarks: All results are related to the tested samples. * referred to measuring uncertainty **see also <i>Final evaluation</i> and <i>Annex : Additional information</i>		—
Supplementary information: -			

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-	General remarks and supplementary information		
	Measuring uncertainties		
	<p>All results only refer to the test samples that were subjected to testing.</p> <p>The extended total measuring uncertainty for velocity, weight and performance is: $u(k=2) \leq \pm 2.5 \%$</p>		—

Related test reports / certificates / documents		
The construction of the tested samples is documented in the relevant report valid in conjunction with the IEC certificate.		
Document no.	Certificate no.	
<p>Technical data sheets</p> <p><i>“Aiko-Axxx-MCE54Db” issued by Aiko Solar</i></p> <p><i>“Aiko-Axxx-MCE54Dw” issued by Aiko Solar</i></p>		—

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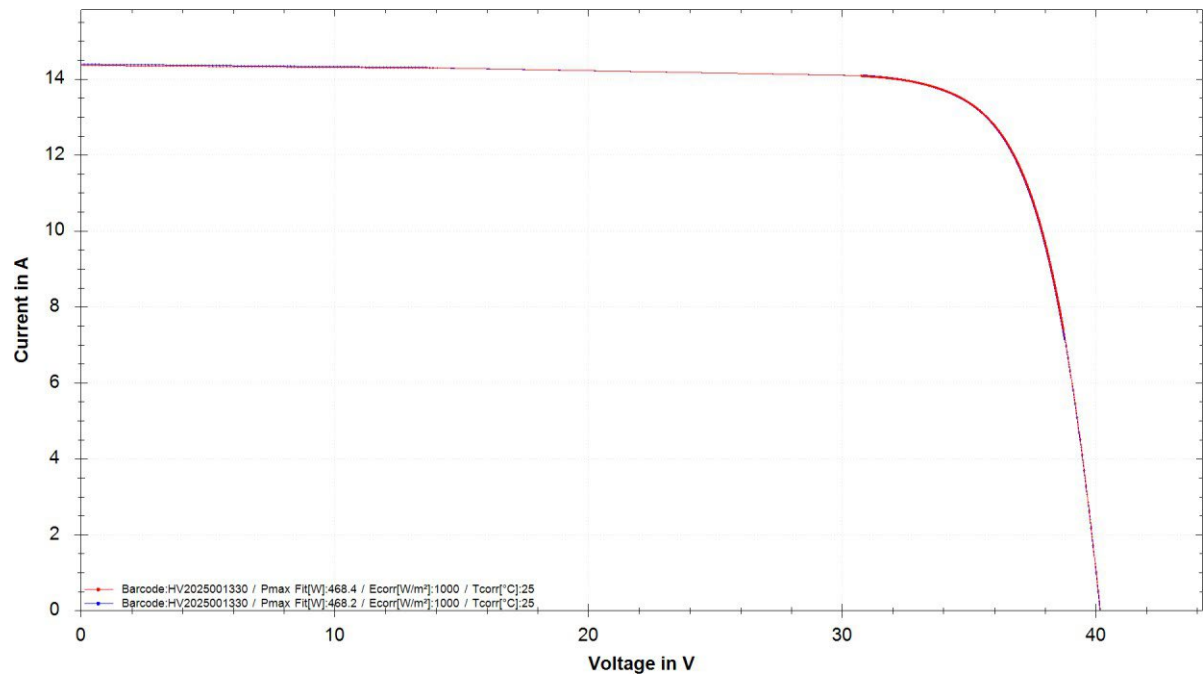
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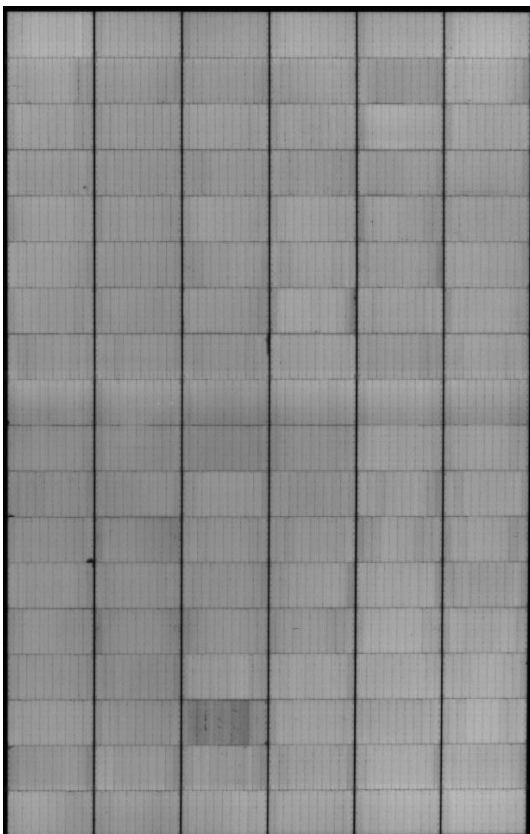
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- Annex: Additional information

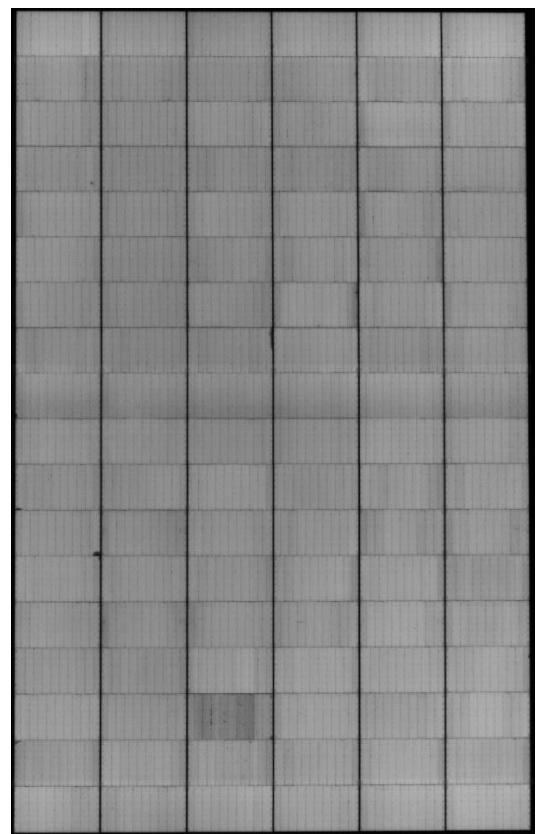
IV-curve and Electroluminescence image - for 30 mm Hail Impact (initial vs. final)



initial



final



Supplementary information: -

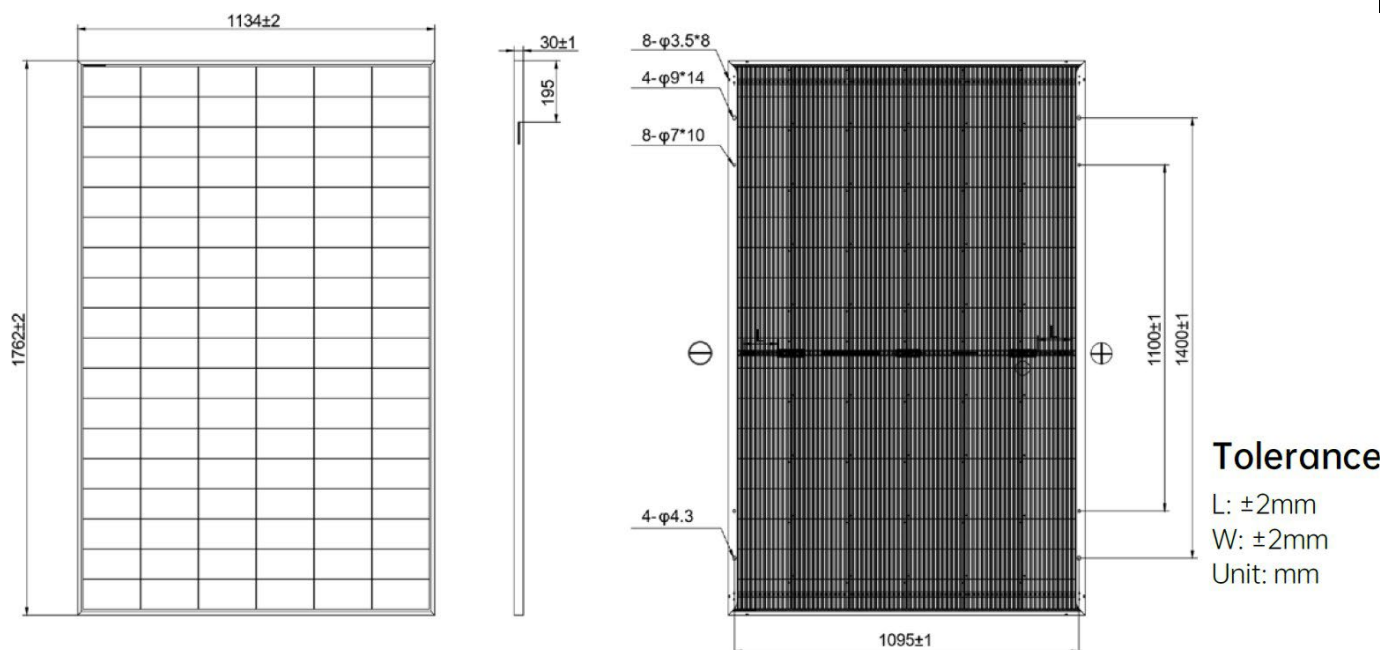
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- **Annex: Additional information**

Frame - Extract of drawing and datasheet



Supplementary information: -

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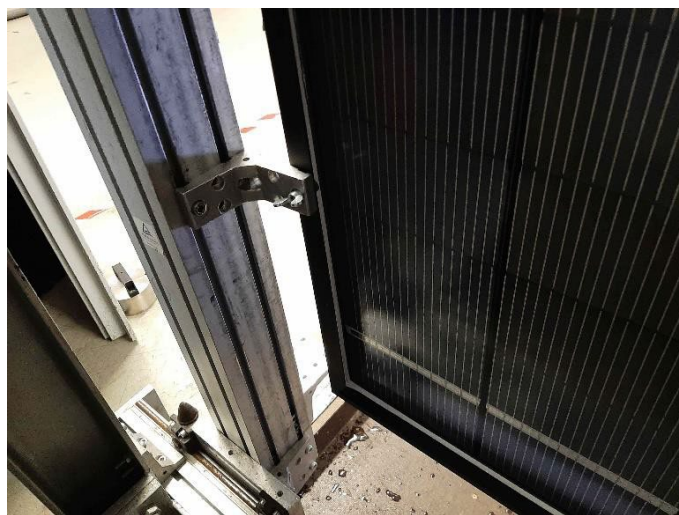
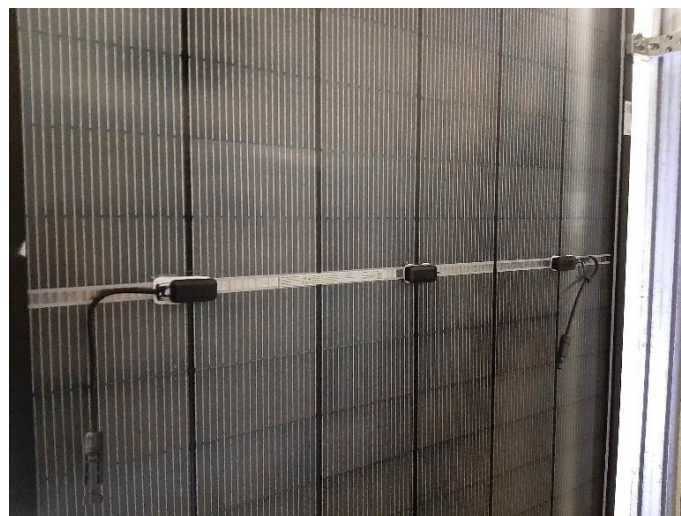
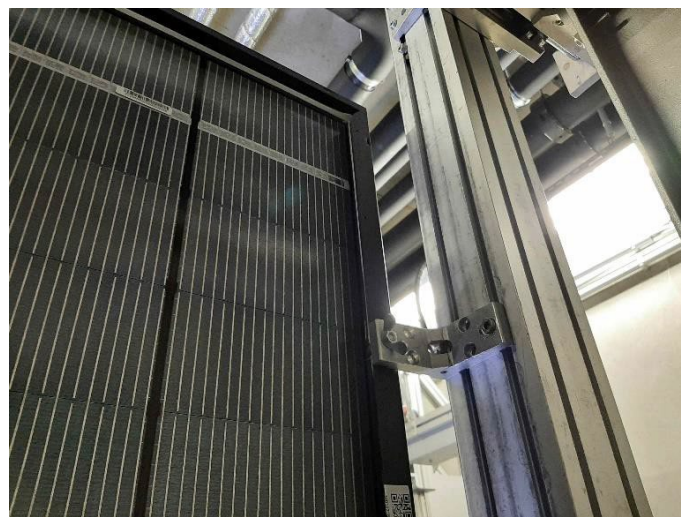
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- Annex: Additional photo documentation

Test Set-up (example)



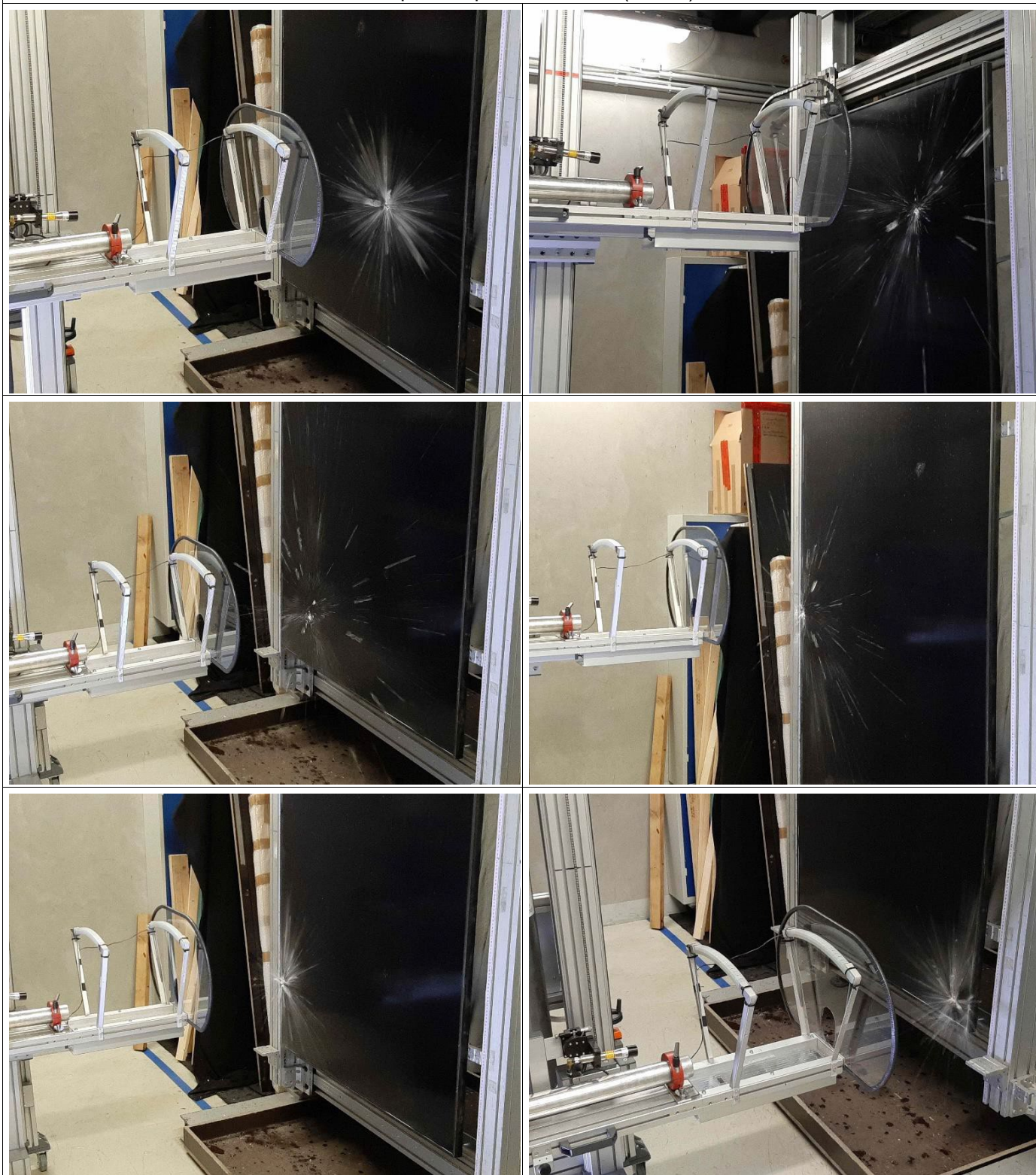
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Absatz Clause	Anforderungen - Prüfungen / Requirements - Tests	Messergebnisse – Bemerkungen/ Measuring results - Remarks	Ergebnis Result
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-	Annex: Additional photo documentation		
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Example of Impacts on Module (30 mm)



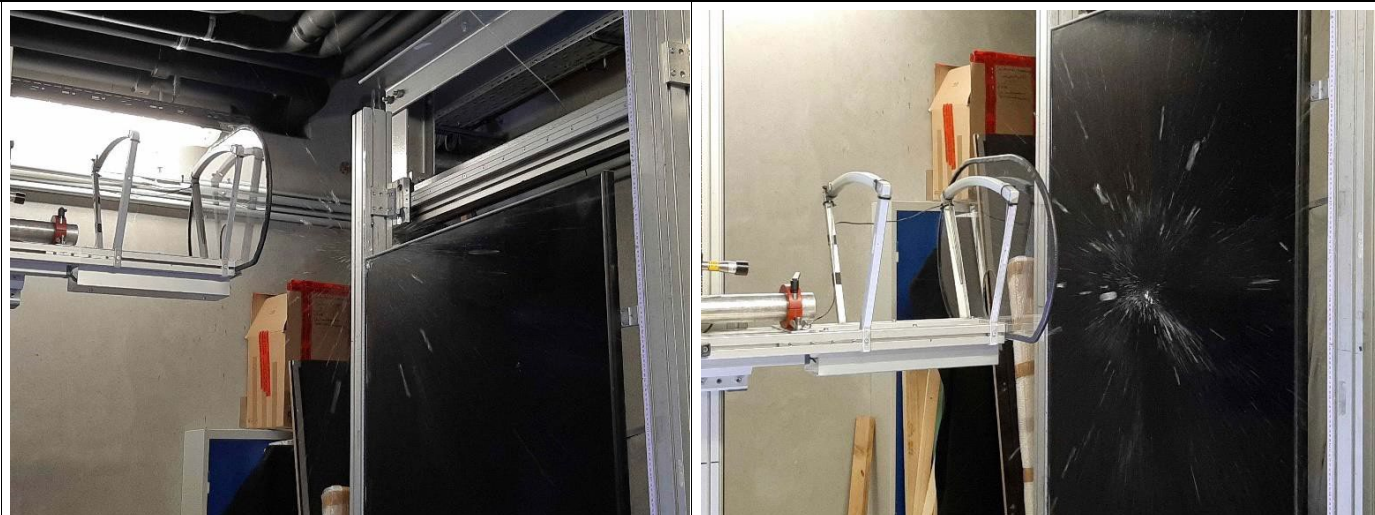
Prüfbericht-Nr.: DE25LL6W 001
Test report no.:

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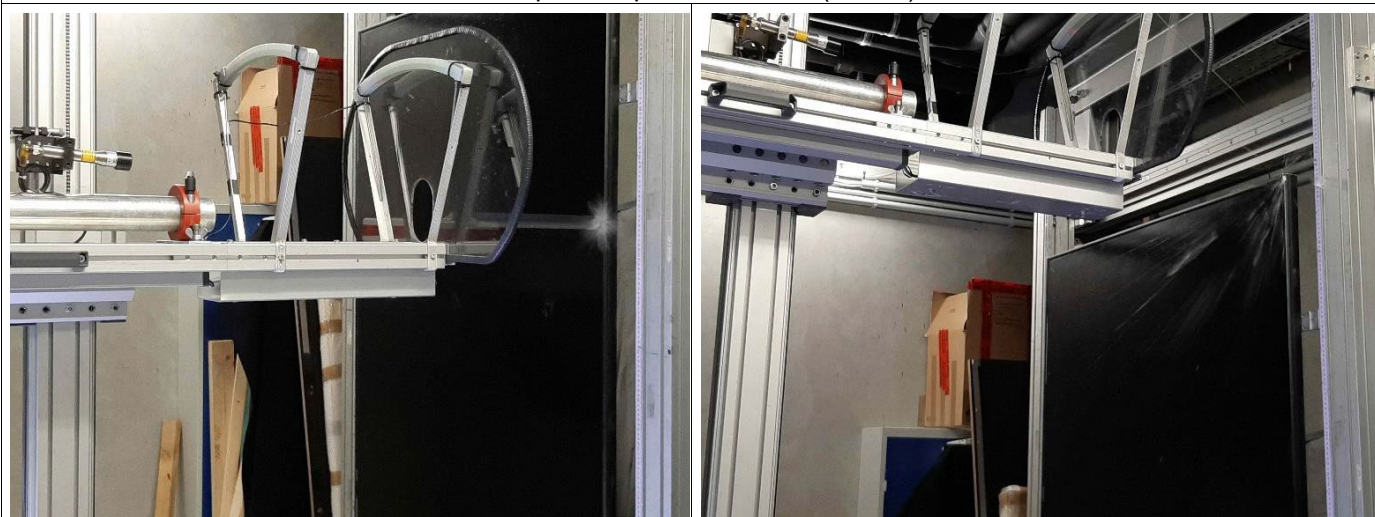
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Absatz Clause	Anforderungen - Prüfungen / Requirements - Tests	Messergebnisse – Bemerkungen/ Measuring results - Remarks	Ergebnis Result
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-	Annex: Additional photo documentation		
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Example of Impacts on Frame (30 mm)



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