

<b>Prüfbericht-Nr.:</b> <i>Test report no.:</i>	<b>DE23LV46 001</b>	<b>Auftrags-Nr.:</b> <i>Order no.:</i>	30010 1590	Seite 1 von 20 Page 1 of 20
<b>Kunden-Referenz-Nr.:</b> <i>Client reference no.:</i>	1433756	<b>Auftragsdatum:</b> <i>Order date:</i>	2023-10-09	
<b>Auftraggeber:</b> <i>Client:</i>	Dualsun SAS (for add. information see page 3)			
<b>Prüfgegenstand:</b> <i>Test item:</i>	Photovoltaik Module			
<b>Bezeichnung / Typ-Nr.:</b> <i>Identification / Type no.:</i>	FLASH DS425-108M10TB-03			
<b>Auftrags-Inhalt:</b> <i>Order content:</i>	Hail impact test with the aim of recommendation/classification for VFK "Hagelregister"			
<b>Prüfgrundlage:</b> <i>Test specification:</i>	according to / following VKF - Prüfbestimmung *** "Nr. 25 "Photovoltaik Module" - Version 1.03 (01/11/2016) following IEC 61215-2 "Terrestrialphotovoltaik modules - Design qualification and type approval - Part 2: Test procedures			
<b>Wareneingangsdatum:</b> <i>Date of sample receipt:</i>	2023-07-23			
<b>Prüfmuster-Nr.:</b> <i>Test sample no.:</i>	see "List of test samples"			
<b>Prüfzeitraum:</b> <i>Testing period:</i>	2023-11-20 – 2023-12-07			
<b>Ort der Prüfung:</b> <i>Place of testing:</i>	Am Grauen Stein, 51105 Köln, Cologne			
<b>Prüflaboratorium:</b> <i>Testing laboratory:</i>	TÜV Rheinland Solar GmbH			
<b>Prüfergebnis*:</b> <i>Test result*:</i>	Siehe Sonstiges / See Other			
<b>geprüft von:</b> <i>tested by:</i>	X 	<b>genehmigt von:</b> <i>authorized by:</i>	X 	
<b>Datum:</b> <i>Date:</i> 2023-12-07	Signiert von: Juergen Sommer	<b>Ausstellungsdatum:</b> <i>Issue date:</i> 2023-12-07	Signiert von: Ulrich Fritsch	
<b>Stellung / Position:</b>	Sachverständige(r)/Expert	<b>Stellung / Position:</b>	Sachverständige(r)/Expert	
<b>Sonstiges / Other:</b>	*** VKF (Vereinigung Kantonaler 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 23 (30.08.2022) - Beschlussammlung HSR - technisch - Version 19 (13/09/2018)			
<b>Zustand des Prüfgegenstandes bei Anlieferung:</b> <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
<b>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.</b> <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>				

V05

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**Anmerkungen**  
Remarks

<b>A</b>	<p>Alle eingesetzten Prüfmittel waren zum angegebenen Prüfzeitraum gemäß eines festgelegten Kalibrierungsprogramms unseres Prüfhauses kalibriert. Sie entsprechen den in den Prüfprogrammen hinterlegten Anforderungen. Die Rückverfolgbarkeit der eingesetzten Prüfmittel ist durch die Einhaltung der Regelungen unseres Managementsystems gegeben.</p> <p>Detaillierte Informationen bezüglich Prüfbedingungen, 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>B</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. TÜV 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, TÜV 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>																				
<b>C</b>	<p>Prüfklausel mit der Note * wurden an qualifizierte Unterauftragnehmer vergeben und sind unter der jeweiligen Prüfklausel des Berichts beschrieben. Abweichungen von Prüfspezifikation(en) oder Kundenanforderungen sind in der jeweiligen Prüfklausel im Bericht aufgeführt.</p> <p><i>Test clauses with remark of * are subcontracted to qualified subcontractors and described under the respective test clause in the report.</i></p> <p><i>Deviations of testing specification(s) or customer requirements are listed in specific test clause in the report.</i></p>																				
<b>D</b>	<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>																				
<b>E</b>	<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>																				
<b>F</b>	<table border="1"> <thead> <tr> <th colspan="4">Revision History</th> </tr> <tr> <th>Revision</th> <th>Date</th> <th>Nature of changes</th> <th>Page</th> </tr> </thead> <tbody> <tr> <td>-</td> <td>07/12/2023</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> </tbody> </table>	Revision History				Revision	Date	Nature of changes	Page	-	07/12/2023	Original issue									
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**Produktbeschreibung**  
Product description

1	<b>Auftraggeber</b> <i>Client</i>	DualSun S.A.S. 2 rue Marc Donadille 13453 Marseille France																																					
2	<b>Produktdetails</b> <i>Product details</i>	<table border="1"> <tr> <th colspan="2"><b>Allgemeine Informationen ; General Information</b></th> </tr> <tr> <td>Brand name</td> <td>DualSun FLASH</td> </tr> <tr> <td>Type name</td> <td>DS425-108M10TB-03</td> </tr> <tr> <td>Product category</td> <td>PV-module</td> </tr> <tr> <td>Year of production</td> <td>2023</td> </tr> <tr> <td>Power class [W]</td> <td>425</td> </tr> <tr> <td>Cell technology</td> <td>Mono (Topcon)</td> </tr> <tr> <td>Cell dimension (l / w) [mm]</td> <td>182 / 91 (half cut)</td> </tr> <tr> <td>No. of cells</td> <td>108</td> </tr> <tr> <td>Max. system voltage [V]</td> <td>1500</td> </tr> <tr> <td rowspan="2">Thickness of glazing [mm]</td> <td>2.0 (front)</td> </tr> <tr> <td>2.0 (back)</td> </tr> <tr> <td>Glazing (front)</td> <td>Hardened, low-reflection white glass</td> </tr> <tr> <td>Glazing (back)</td> <td>Hardened, white glass</td> </tr> <tr> <td>Frame material</td> <td>Aluminium</td> </tr> <tr> <td>Frame thickness [mm]</td> <td>30</td> </tr> <tr> <th colspan="2"><b>Dimensionen ; Dimension</b></th> </tr> <tr> <td>Dimension (l / w / h) [mm]</td> <td>1722 / 1133 / 30</td> </tr> <tr> <td>Gross area [m<sup>2</sup>]</td> <td>1.951</td> </tr> </table>	<b>Allgemeine Informationen ; General Information</b>		Brand name	DualSun FLASH	Type name	DS425-108M10TB-03	Product category	PV-module	Year of production	2023	Power class [W]	425	Cell technology	Mono (Topcon)	Cell dimension (l / w) [mm]	182 / 91 (half cut)	No. of cells	108	Max. system voltage [V]	1500	Thickness of glazing [mm]	2.0 (front)	2.0 (back)	Glazing (front)	Hardened, low-reflection white glass	Glazing (back)	Hardened, white glass	Frame material	Aluminium	Frame thickness [mm]	30	<b>Dimensionen ; Dimension</b>		Dimension (l / w / h) [mm]	1722 / 1133 / 30	Gross area [m <sup>2</sup> ]	1.951
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3	<b>Technische Dokumentation</b> <i>Technical documentation</i>	for detailed constructional data see <i>Test Report "CN23GYU7 007" and Annexes issued by TÜV Rheinland</i> <i>Technical Datasheet "FLASH DSxxx-108M10TB-03" v1.1 (10/23) issued by DualSun</i>																																					
4	<b>Hersteller</b> <i>Manufacturer</i>	DualSun S.A.S.																																					
5	<b>Sonstiges</b> <i>Other</i>	<ul style="list-style-type: none"> <li>- The tested module type might be also available in different powerclasses.</li> <li>- Further the result is applicable to additional types; for more details see "<i>General remarks</i>"</li> <li>- Mounting: Clamping (70 mm width) / Symetric (across mounting holes / 170 mm from corner)</li> </ul>																																					
6	<b>Prüfmusterbereitstellung:</b> <i>Test sample obtaining</i>	<input checked="" type="checkbox"/> Sending by customer <input type="checkbox"/> Sampling by TÜV Rheinland Group <input checked="" type="checkbox"/> others: randomly chosen from existing test batch																																					

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**Produktbeschreibung**  
*Product description*

Sample - Front (example)



Sample - Back (example)



Example of junction box



Example of cells



Example of break-through from cells to junction box





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- Result summary table				
Test	Date [DD Month YYYY]		Summary of main test results	—
	Initial (1 <sup>st</sup> )	Final (2 <sup>nd</sup> )		
Insulation test	22 November 2023	23 November 2023	No visual defects	P
Wet leakage current test	22 November 2023	23 November 2023	No visual defects	P
Performance at STC	22 November 2023	05 December 2023	No visual defects	P
Electro-luminescence images	22 November 2023	05 December 2023	No visual defects	P
Impact resistance	22 November 2023		HW3 with 30 mm ice balls passed	P
Final inspection	07 December 2023		see <i>Final evaluation</i>	P
Supplementary information: <ul style="list-style-type: none"> <li>All results are related to the tested sample</li> <li>According to test procedure the tested PV module is <b>recommended</b> to be <b>classified in HW3</b></li> <li>No pre-exposure necessary; no relevant plastic parts</li> </ul>				

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: -			

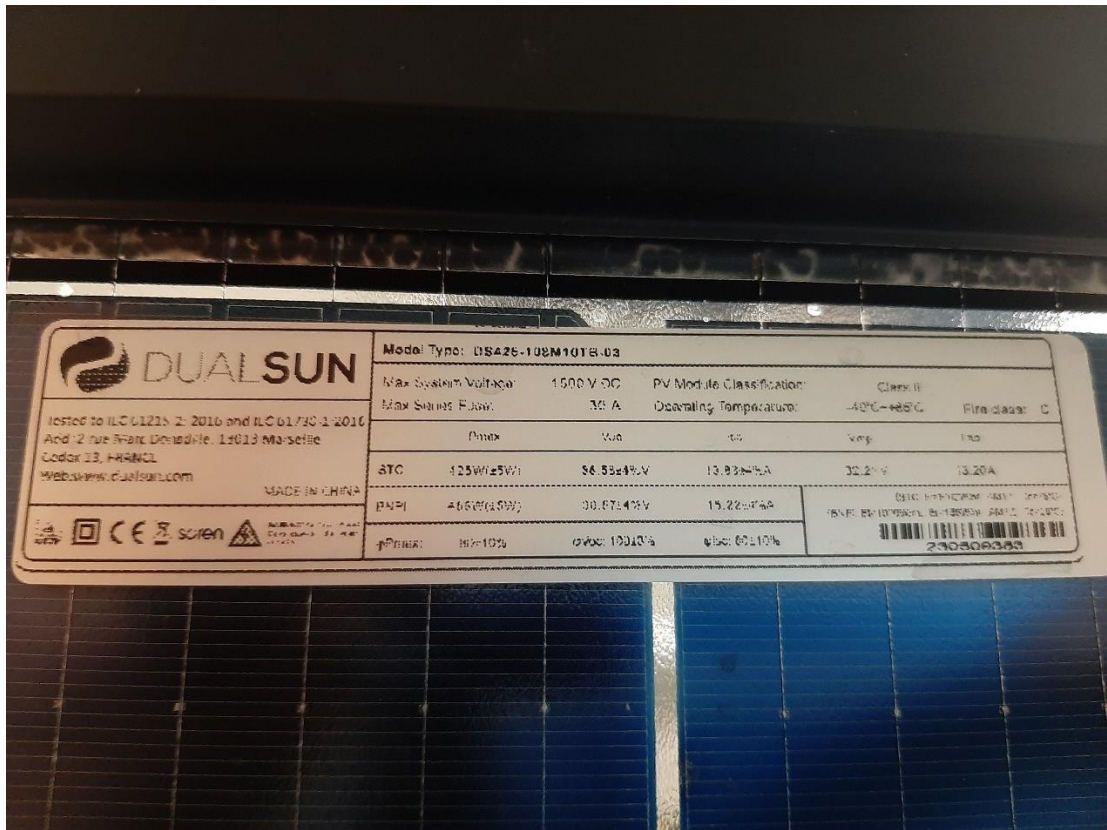
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-	Visual inspection (Initial)		
Test date [DD/MM/YYYY]	20/11/2023		—
Sample No.	Nature and position of initial findings		—
HV2023003365	No relevant visual defects		P
HV2023003366	No relevant visual defects		P

Supplementary information: -

Type plate (example)



-	List of test samples		
Sample No.	Sample S/N	Remarks / constructional characteristics	
HV2023003365	DMAABT9F48235VZ03503	Spare	
HV2023003366	DMAABT9F48235VZ03501	HW3 with 30 mm ice balls	

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-	<b>Maximum power determination (STC)</b>							
General; for all following measurements								
Module temperature [°C]				corrected to 25				—
Irradiance [W/m <sup>2</sup> ]				1000				
Initial / Final*								
Test date [DD/MM/YYYY]				22/11/2023 and *05/12/2023				
Sample No.	P <sub>max</sub> [W]	V <sub>mpp</sub> [V]	I <sub>mpp</sub> [A]	V <sub>oc</sub> [V]	I <sub>sc</sub> [A]	FF [%]	Degradation [%]	
HV2023003366	416.9	33.31	12.52	39.3	13.2	80.4	-	P
	420.8	33.36	12.61	39.33	13.3	80.4	---	P
Supplementary information: -								

-	<b>Insulation test (ISO)</b>							
General; for all following measurements								
Maximum system voltage [V <sub>DC</sub> ]				1500				—
High voltage applied [V <sub>DC</sub> ]			1 <sup>st</sup>	4000				
			2 <sup>nd</sup>	8000				
Insulation resistance measured at [V <sub>DC</sub> ]				1000				
Initial / Final*								
Test date [DD/MM/YYYY]				22/11/2023 and *23/11/2023				
Sample No.	Measured	Area	Result*	Dielectric breakdown				
	[GΩ]	[m <sup>2</sup> ]	[GΩ × m <sup>2</sup> ]	Yes (description)		No		
HV2023003366	1.0	1.95	2.0	-		x		P
	1.0	1.95	2.0	-		x		P

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<b>Absatz</b> <i>Clause</i>	<b>Anforderungen - Prüfungen /</b> <i>Requirements - Tests</i>	<b>Messergebnisse – Bemerkungen/</b> <i>Measuring results - Remarks</i>	<b>Ergebnis</b> <i>Result</i>

-	<b>Wet leakage current test (WL)</b>				
General; for all following measurements				—	
Insulation resistance measured at [V <sub>DC</sub> ]		1000			
Solution resistivity [ $\Omega$ cm]		< 3.500			
Solution temperature [°C]		22 ± 3			
Initial / Final*					
Test date [DD/MM/YYYY]		22/11/2023 and *23/11/2023			
Sample No.	Measured	Area	Result*		
	[M $\Omega$ ]	[m <sup>2</sup> ]	[M $\Omega$ × m <sup>2</sup> ]		
HV2023003366	1000	1.95	1950		P
	1000	1.95	1950		P

-	<b>Electroluminescence images (EL)</b>			
Analysis of electroluminescence images (see also <i>Annex : Additional information</i> )				
Initial / Final*				—
Test date [DD/MM/YYYY]		22/11/2023 and *05/12/2023		
Sample No.	Reverse current applied [A]	Attributes		
HV2023003366	10	No conspicuousness/findings		
	10	No conspicuousness/findings		
Supplementary information: Estimated analysis without guarantee				



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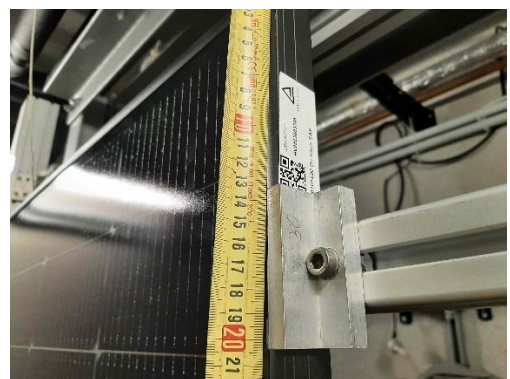
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-	<b>Impact resistance test (general)</b>		
Test date [DD/MM/YYYY] Day code	22/11/2023 <sup>a</sup>		
Sample-No. ID code	HV2023003366 <sup>3366</sup>		
Method used for impact resistance	Nr. 25 "Photovoltaik Module"		
Surface conditioning	none		
Sample tilt angle [° from horizontal]	90		
Direction of shoot [°]	0 (horizontal)		
Impact angle [° from sample surface]	90		
Distance (sample to center of v <sub>0</sub> -meas.) [mm]	500 to 700		
Ice ball production [week of the year]	45 (hermetically sealed)		
Storage temperature of ice ball [°C]	-20		
Ambient conditions (mean) [°C and % RH]	<sup>a</sup> 23.3and 47.4		
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



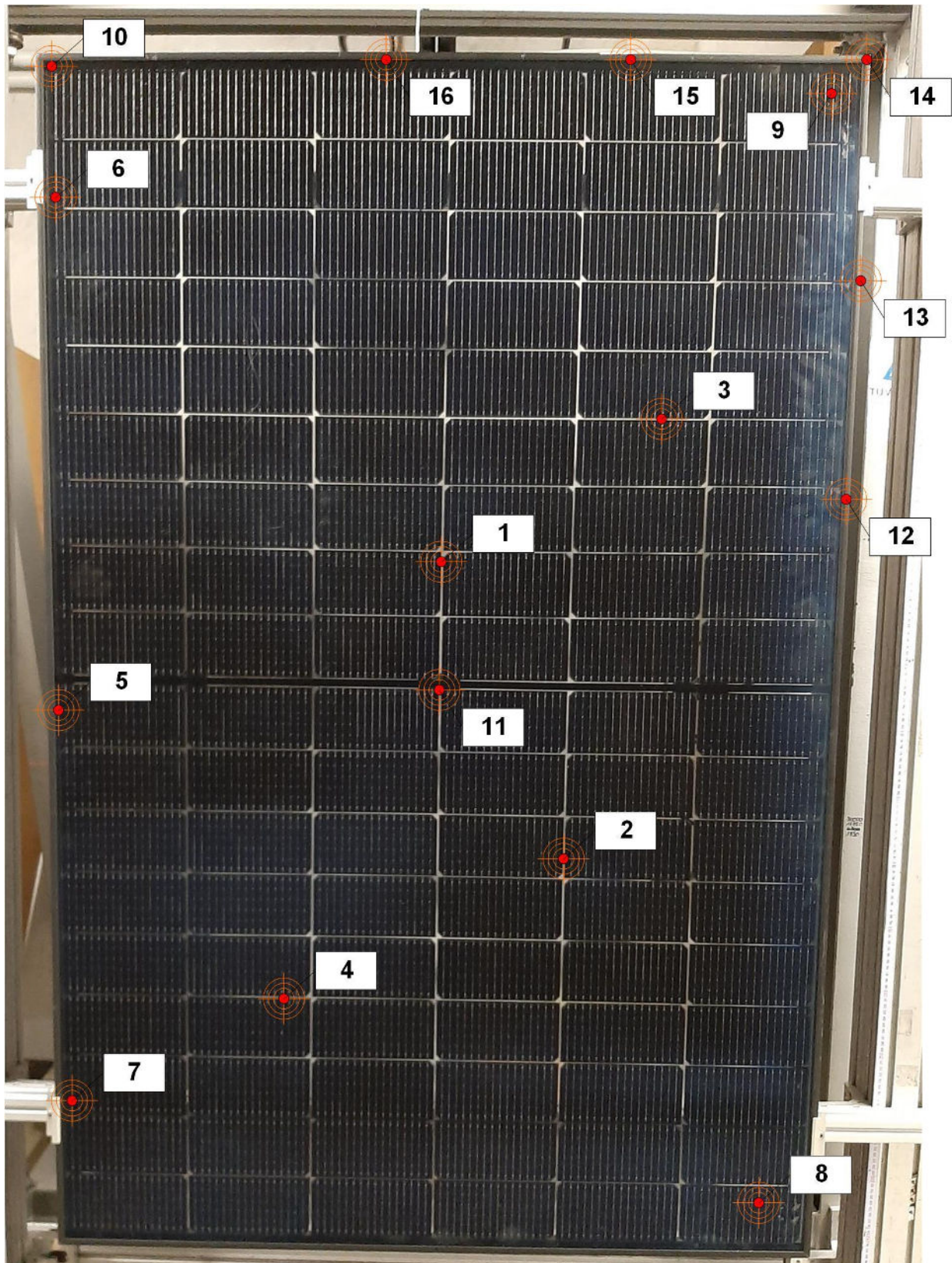
Supplementary information:

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Overview of impact positions



Supplementary information: -



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-	<b>Impact resistance test – Result table (HW3)</b>								
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***					
3366	a	After initial control measurements (Ice ball diameter = 30 mm)							
		1	3/11 – 4/11	Over edges of circuit	3	12.33	23.83	3.50	P
		2	4/7 – 5/7	Over edges of circuit	4	12.38	23.89	3.53	P
		3	5/13 – 5/14	Near interconnects	5	12.46	23.97	3.58	P
		4	2/4 – 2/5	Near interconnects	6	12.84	24.37	3.81	P
		5	1/9	Edge of module window	2	12.96	24.25	3.81	P
		6	1/17	Near mounting position	7	12.82	24.42	3.82	P
		7	1/3	Near mounting position	8	12.84	24.75	3.93	P
		8	6/1 (75 mm)	Far away from other impacts	9	12.94	24.81	3.98	P
		9	6/18 (50 mm)	Far away from other impacts	10	13.02	24.96	4.06	P
		10	1/18 (15 mm)	Corner of module window	1	13.20	25.13	4.17	P
		11	3/9 – 4/10	Over the junction box (hole in backside glazing)	11	13.14	25.05	4.12	P
		12	600 mm from left top	Vertical frame	-	13.03	24.61	3.95	P
		13	350 mm from left top	Vertical frame	-	13.11	24.93	4.07	P
		14	right bottom	Tip of frame	-	13.02	24.97	4.06	P
		15	350 mm from left top	Horizontal frame	-	13.04	24.74	3.99	P
		16	600 mm from left top	Horizontal frame	-	13.00	24.88	4.02	P
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)		
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Test date [DD/MM/YYYY]	07/12/2023	
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Sample-No.	Potential problem	Evaluation*/**	—
		HW3	
HV2023003366	Technical problems	<b>HW 3 passed;</b> <u>with 30 mm</u> NO cracks visible under use of electroluminescence NO power degradation detectable*	P
	Visual problems (distance; > 5 m)	<b>HW 3 passed;</b> <u>with 30 mm</u> NO cracks visible ; NO dents visible	P
	Visual problems (near; < 0.5 m)	<b>HW 3 passed;</b> <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 and Annex : Additional information</i>		—

Supplementary information: -

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<b>Absatz</b> <i>Clause</i>	<b>Anforderungen - Prüfungen /</b> <i>Requirements - Tests</i>	<b>Messergebnisse – Bemerkungen/</b> <i>Measuring results - Remarks</i>	<b>Ergebnis</b> <i>Result</i>

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

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.	
Test report No. CN23GYU7 007, <i>incl. Annexes</i> <i>issued by TÜV Rheinland</i>	PV 50599295	
Technical data sheets <i>"FLASH DSxxx-108M10TB-03" v1.1 (10/23) issued by DualSun</i>		

Others - The result of the tested sample is also equivalent to:	
<i>Main Types</i>	
<ul style="list-style-type: none"> <li>• <b>FLASH DSxxx-108M10TB-03</b> <ul style="list-style-type: none"> <li>○ power classes 420 - 430 W (108 cells)</li> <li>○ cells (mono / bi-facial)</li> <li>○ frame color (transparent ; only)</li> <li>○ backsheet / encapsulation color (black mesh ; only)</li> <li>○ frame thickness (30 mm ; only)</li> <li>○ maximum system voltage (1500 V<sub>DC</sub> ; only)</li> </ul> </li> </ul>	
The recommendation " <b>HW3</b> " is applicable to the various power ranges of above listed main types and endings.	



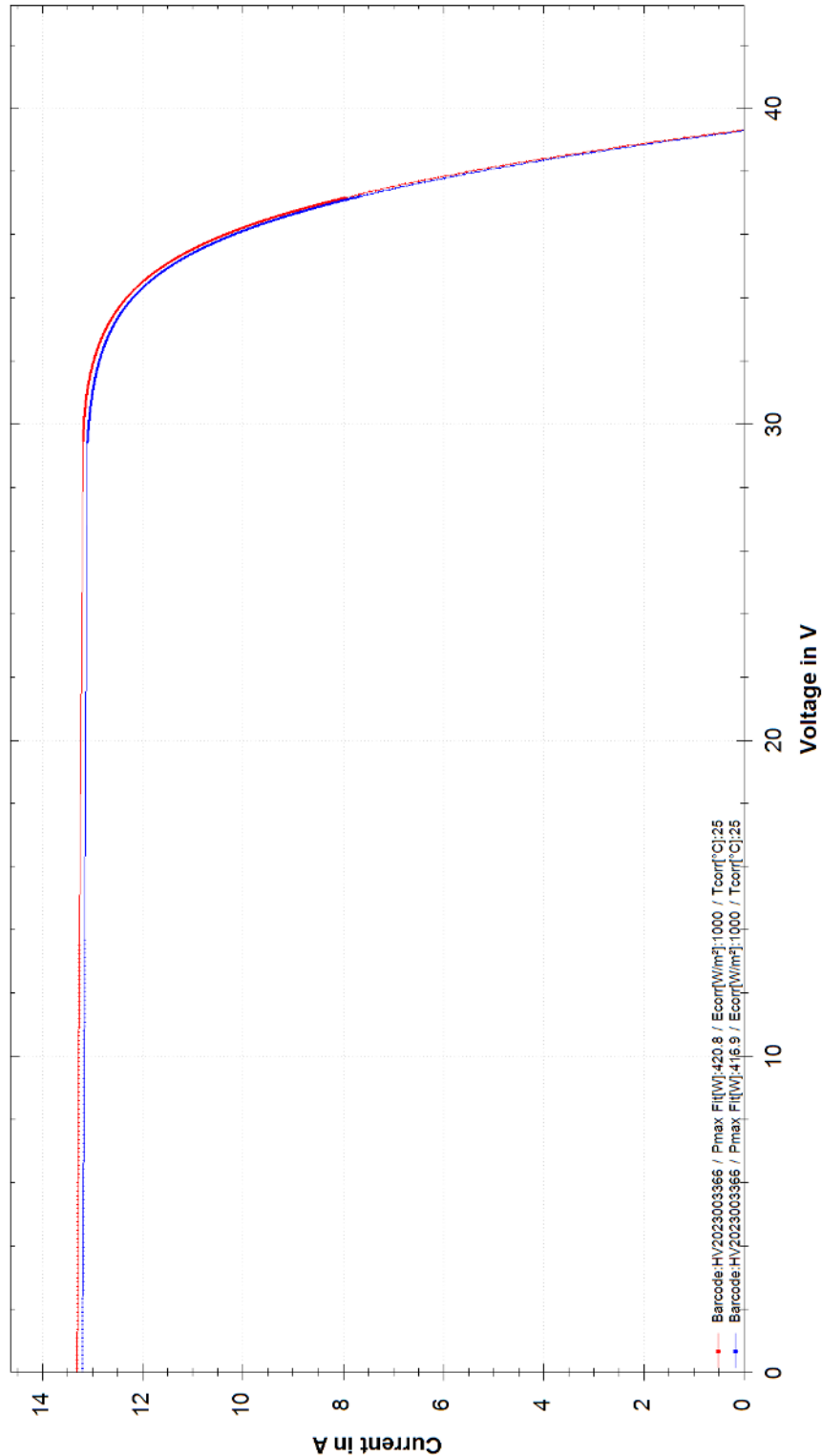
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-	Annex: Additional information
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IV-curve initial vs. final for 30 mm Hail Impact



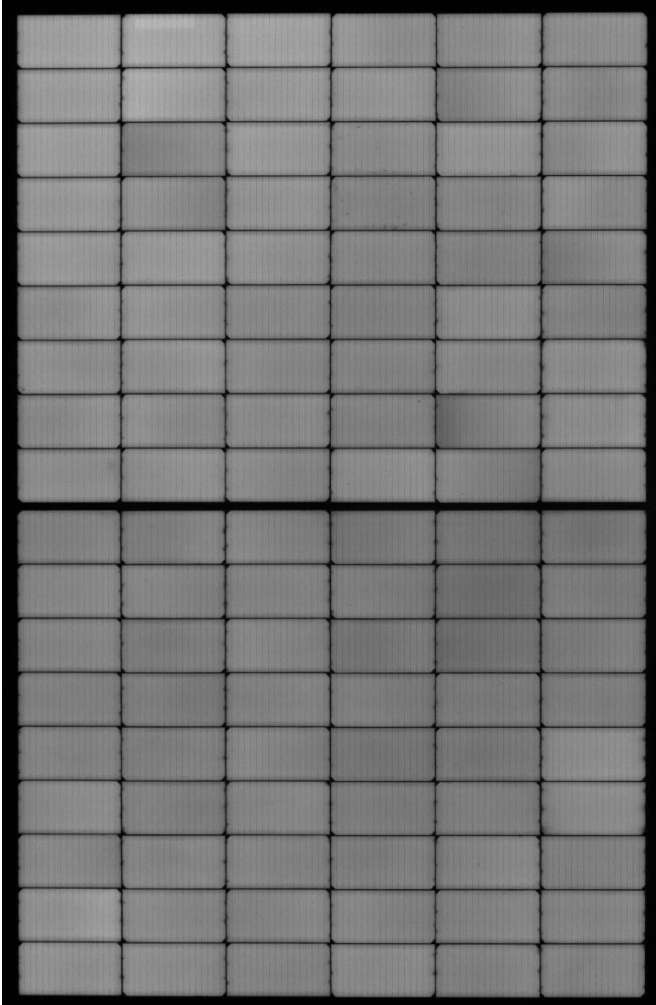
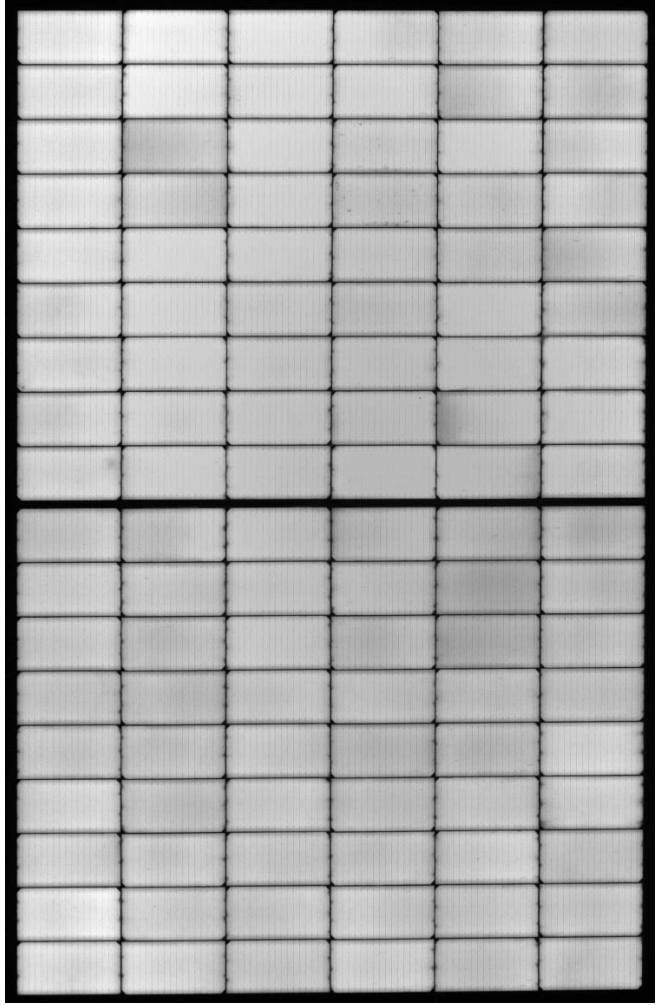
Barcode:HV2023003366 / Pmax, Fil[W]:420.8 / Ecorr[W/m²]:1000 / Tcorr[C]:25  
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-	<b>Annex: Additional information</b>		
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Electroluminescence image - for 30 mm Hail Impact

<i>Initial</i>	<i>final</i>
	

Supplementary information: -

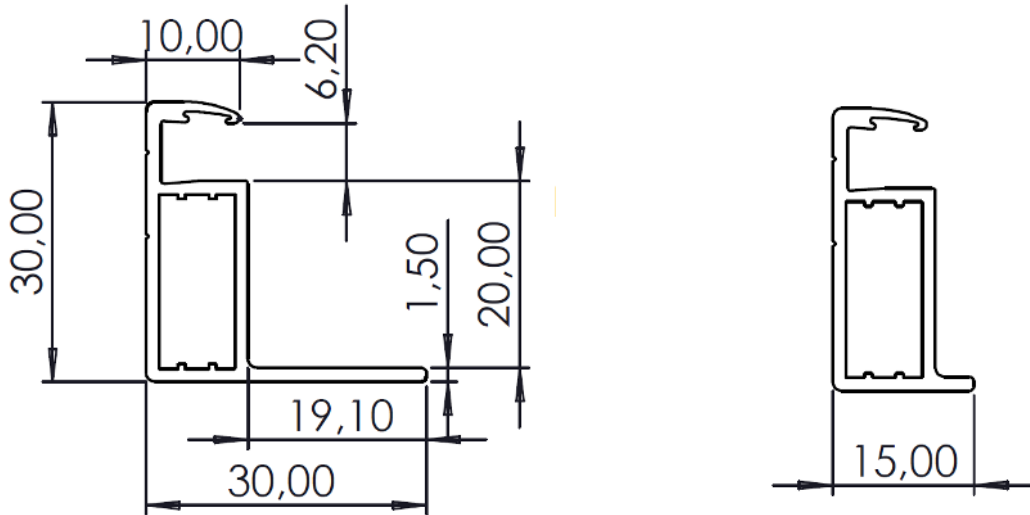
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- Annex: Additional information

Frame - Extract of drawing



Supplementary information: -



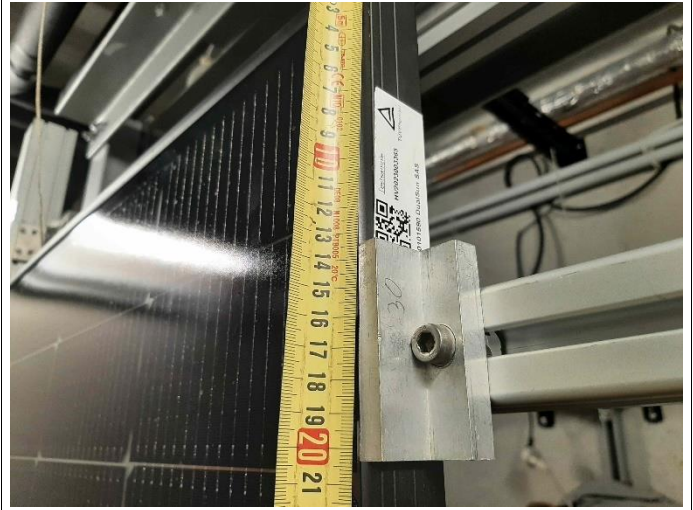
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- Annex: Additional photo documentation

Test Set-up (example)





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- Annex: Additional photo documentation

Example of Impacts on Module (30 mm)





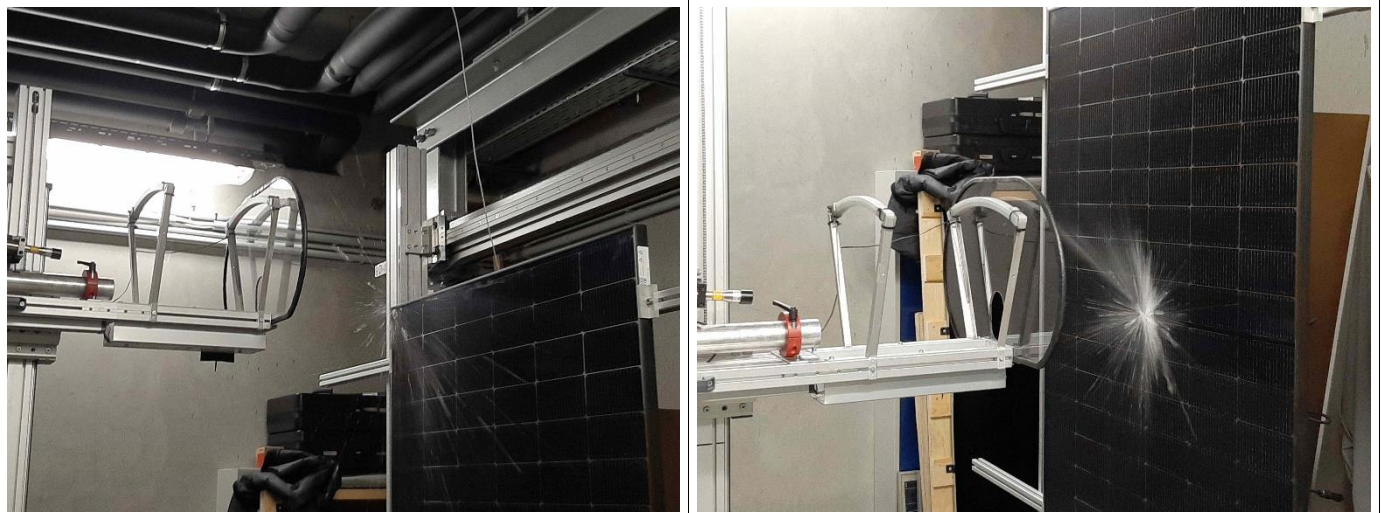
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-	<b>Annex: Additional photo documentation</b>		
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Example of Impacts on Module (30 mm)



Example of Impacts on Frame (30 mm)



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--- End of report ---