Prüfbericht-Nr.: *Test report no.*:	**DE24Q9CH 001**	**Auftrags-Nr.:** *Order no.*:	30010 1769	Seite 1 von 21 *Page 1 of 21*
Kunden-Referenz-Nr.: *Client reference no.*:	1604806	**Auftragsdatum:** *Order date:*	2024-01-19	
Auftraggeber: *Client*:	Trina Solar (Germany) GmbH (for add. information see page 3)			
Prüfgegenstand: *Test item*:	Photovoltaik Module			
Bezeichnung / Typ-Nr.: *Identification / Type no.*:	TSM-425NEG9R.28 (representative for various additional module types)			
Auftrags-Inhalt: *Order content*:	Hail impact test with the aim of recommendation/classification for VFK "Hagelregister"			
Prüfgrundlage: *Test specification*:	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*			

Wareneingangsdatum: *Date of sample receipt*:	2024-02-05
Prüfmuster-Nr.: *Test sample no:*	see "List of test samples"
Prüfzeitraum: *Testing period*:	2024-02-07 – 2024-03-18
Ort der Prüfung: *Place of testing*:	Am Grauen Stein, 51105 Köln, Cologne
Prüflaboratorium: *Testing laboratory:*	TÜV Rheinland Solar GmbH
Prüfergebnis*: *Test result**:	Siehe Sonstiges / See Other

geprüft von: *tested by:*	X Signiert von: Juergen Sommer	**genehmigt von:** *authorized by*:	X Signiert von: Ulrich Fritzsch
Datum: *Date:*	2024-03-21	**Ausstellungsdatum:** *Issue date:*	2024-03-21
Stellung / Position:	Sachverständige(r)/Expert	**Stellung** / Position:	Sachverständige(r)/Expert

Sonstiges / *Other*:

*** 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)
- Beschlusssammlung HSR – formal - Version 23 (30.08.2022)
- Beschlusssammlung HSR - technisch - Version 19 (13/09/2018)

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

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

Anmerkungen
Remarks

A

Alle eingesetzten Prüfmittel waren zum angegebenen Prüfzeitraum gemäß eines festgelegten Kalibierungsprogramms unseres Prüfhauses kalibriert. Sie entsprechen den in den Prüfprogrammen hinterlegten Anforderungen. Die Rückverfolgbarkeit der eingesetzten Prüfmittel ist durch die Einhaltung der Regelungen unseres Managementsystems gegeben.
Detaillierte Informationen bezüglich Prüfkonditionen, Prüfequipment und Messunsicherheiten sind im Prüflabor vorhanden und können auf Wunsch bereitgestellt werden.

The equipment used durinag 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.

B

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.

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C

Prüfklausel mit der Note * wurden an qualifizierte Unterauftragnehmer vergeben und sind unter der jeweiligen Prüfklausel des Berichts beschrieben.
Abweichungen von Prüfspezifikation(en) oder Kundenanforderungen sind in der jeweiligen Prüfklausel im Bericht aufgeführt.

*Test clauses with remark of * are subcontracted to qualified subcontractors and descripted under the respective test clause in the report.*
Deviations of testing specification(s) or customer requirements are listed in specific test clause in the report.

D

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.

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.

E

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.

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.

F

Revision History

Revision	*Date*	*Nature of changes*	*Page*
-	2024-03-21	Original issue	

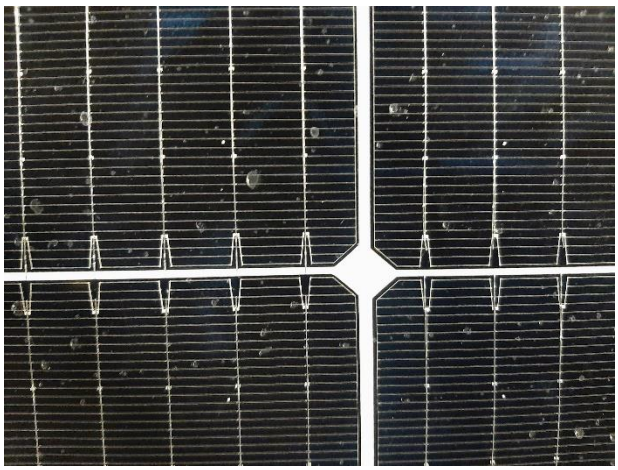
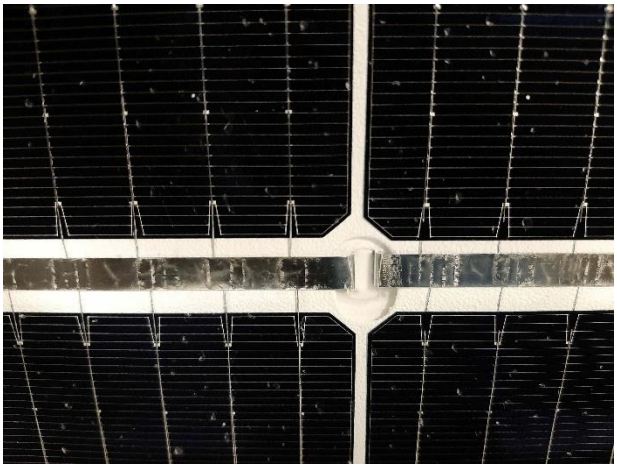
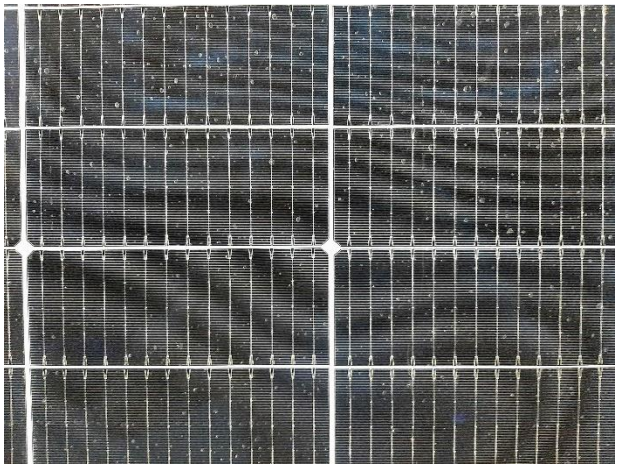
Produktbeschreibung
Product description

1	**Auftraggeber** *Client*	Trina Solar (Germany) GmbH Werner-Eckert-Str. 4 81829 München Germany	[via] *Trina Solar (Schweiz) AG* *Birkenweg 4* *8304 Wallisellen* *Switzerland*

2	**Produktdetails** *Product details*	**Allgemeine Informationen ;** General Information	
		Brand name	Trina Solar
		Type name	TSM-425 NEG9R.28
		Product category	PV-module
		Year of production	2023
		Power class [W]	425
		Cell technology	Mono
		Cell dimension (l / w) [mm]	182 / 70 (cut)
		No. of cells	144
		Max. system voltage [V]	1500
		Thickness of glazing [mm]	1.6 (front)
		Glazing (front)	Semi Hardened, low-reflection white glass
		Thickness of glazing [mm]	1.6 (back)
		Glazing (front)	Semi Hardened white glass
		Frame material	Aluminium
		Frame thickness [mm]	30
		Dimensionen ; Dimension	
		Dimension (l / w / h) [mm]	1765 / 1135 / 30
		Gross area [m²]	2.003

3	**Technische Dokumentation** *Technical documentation*	for detailed constructional data see *Certificate* Z2 070321 0097 Rev. 51, *Report and Annexes issued by TÜV Süd* *Technical Datasheet "TSM-NEG9R.28" issued by Trina Solar* *Technical Datasheet "TSM-NEG9RC.27" issued by Trina Solar* *Technical Datasheet "TSM-NEG9R.25" issued by Trina Solar*
4	**Hersteller** *Manufacturer*	Trina Solar Co., Ltd.
5	**Sonstiges** *Other*	- The tested module type might be also available in different powerclasses. - Further the result is aplicable to additional types; for more details see "*General remarks*" - Mounting: Symetric (across mounting holes / 335 mm from corner)
6	**Prüfmusterbereit-stellung**: *Test sample obtaining*	☒ Sending by customer ☐ Sampling by TÜV Rheinland Group ☒ others: randomly chosen from existing test batch

Produktbeschreibung
Product description

Sample - Front (example)	Sample - Back (example)
	
Example of junction box	**Example of cells**
	
Example of junction box position	**Example of cells**
	

Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*

-	**Result summary table**

Test	Date [DD Month YYYY]		Summary of main test results	—
	Initial (1st)	Final (2nd)		
Insulation test	15 February 2024	11 March 2024	No visual defects	P
Wet leakage current test	15 February 2024	11 March 2024	No visual defects	P
Performance at STC	15 February 2024	18 March 2024	No visual defects	P
Electroluminescence images	15 February 2024	18 March 2024	No visual defects	P
Impact resistance	11 March 2024		HW3 with 30 mm ice balls passed	P
Final inspection	18 March 2024		see *Final evaluation*	P

Supplementary information:

- All results are related to the tested sample
- According to test procedure the tested PV module is **recommended** to be **classified in HW3**
- 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: -

Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*

-	**Visual inspection (Initial)**		
Test date [YYYY-MM-DD]		2024-02-09	—
Sample No.	Nature and position of initial findings		
HV2024000236	No relevant visual defects		P

Supplementary information: -

Type plate (example)

-	**List of test samples**		
Sample No.	Sample S/N	Remarks / constructional characteristics	—
HV2024000236	A03230401209491	-	

Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*

-	**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]				2024-02-15 and *2024-03-18				
Sample No.	P_{max} [W]	V_{mpp} [V]	I_{mpp} [A]	V_{oc} [V]	I_{sc} [A]	FF [%]	Degradation [%]	
HV2024000236	420.5	42.76	9.83	51.14	10.43	78.8	-	P
	422.7	42.77	9.88	51.21	10.46	78.9	(-)	P
Supplementary information: -								

-	**Insulation test (ISO)**

General; for all following measurements						
Maximum system voltage [V_{DC}]			1500			—
High voltage applied [V_{DC}]	1st		3000			
	2nd		8000			
Insulation resistance measured at [V_{DC}]			1000			
Initial / Final*						
Test date [YYYY-MM-DD]			2024-02-15 and *2024-03-11			
Sample No.	Measured	Area	Result*	Dielectric breakdown		
	[GΩ]	[m²]	[GΩ × m²]	Yes (description)	No	
HV2024000236	1.0	2.00	2.0	-	x	P
	1.0	2.00	2.0	-	x	P

Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*

-	**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]		2024-02-15 and *2024-03-11		
Sample No.	Measured	Area	Result	
	[MΩ]	[m²]	[MΩ × m²]	
HV2024000236	480	2.00	960	P
	564	2.00	1128	P

-	**Electroluminescence images (EL)** Analysis of electroluminescence images (see also *Annex : Additional information*)		
Initial / Final*			—
Test date [YYYY-MM-DD]		2024-02-15 and *2024-03-18	
Sample No.	Reverse current applied [A]	Attributes	
HV2024000236	10	No conspicuousness/findings	
	10	No conspicuousness/findings	
Supplementary information: Estimated analysis without guarantee			

Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
-	**Impact resistance test (general)**		

Test date [YYYY-MM-DD] Day code	2024-03-11[a]
Sample-No. ID code	HV2024000236[236]
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]	9 (hermetically sealed)
Storage temperature of ice ball [°C]	-20
Ambient conditions (mean) [°C and % RH]	[a]23.1 and 48.9
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

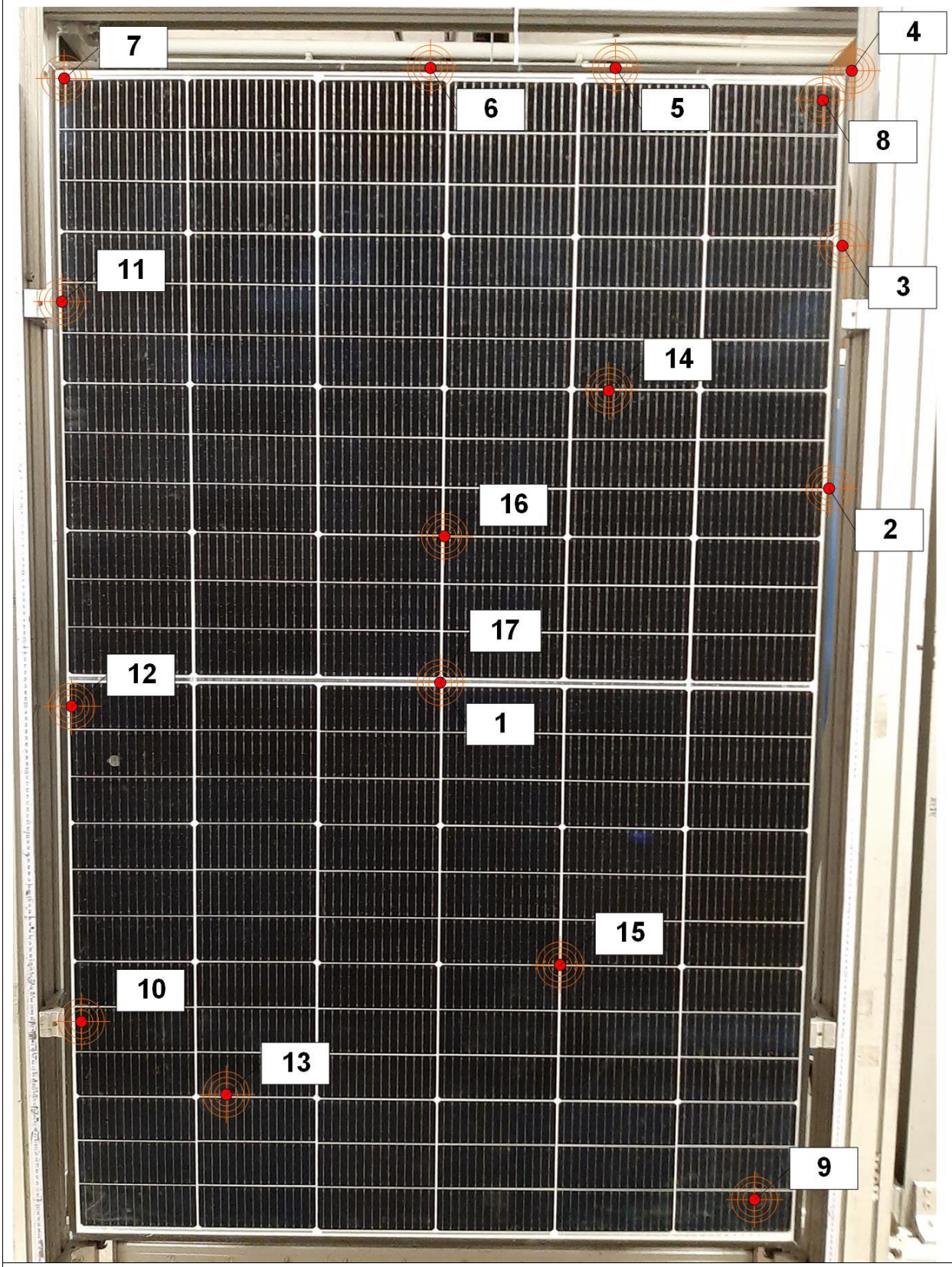
Example of Test Set-up

Mounting elements

Supplementary information:

Prüfbericht-Nr.: DE24Q9CH **001** *Test report no.:*			Seite 10 von 21 *Page 10 of 21*
Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*

Overview of impact positions



Supplementary information: -

Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*

- **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***				
	After initial control measurements (Ice ball diameter = 30 mm)								
236	a	1	3/12 – 4/13	Over the junction box	11	12.51	25.33	*4.01*	P
		2	3/12 – 4/13	Over the junction box	11	12.57	26.03	*4.26*	P
		3	600 mm from right top	Vertical frame	-	12.77	26.12	*4.36*	P
		4	250 mm from right top	Vertical frame	-	12.58	25.12	*3.97*	P
		5	right top	Tip of frame	-	12.34	24.27	*3.63*	P
		6	250 mm from right top	Horizontal frame	-	12.49	24.81	*3.84*	P
		7	600 mm from right top	Horizontal frame	-	12.81	25.72	*4.24*	P
		8	1/24 (15 mm)	Corner of module window	1	12.65	25.46	*4.10*	P
		9	6/24 (50 mm)	Far away from other impacts	10	12.52	24.31	*3.70*	P
		10	6/1 (75 mm)	Far away from other impacts	9	12.64	25.33	*4.05*	P
		11	1/5	Near mounting position	8	12.86	25.77	*4.27*	P
		12	1/20	Near mounting position	7	12.54	24.87	*3.88*	P
		13	1/12	Edge of module window	2	12.69	25.33	*4.07*	P
		14	2/3 – 2/4	Near interconnects	6	12.37	24.26	*3.64*	P
		15	5/18 – 5/19	Near interconnects	5	12.51	24.96	*3.90*	P
		16	4/6 – 5/7	Over edges of circuit	4	12.63	25.24	*4.02*	P
		17	3/15 – 4/16	Over edges of circuit	3	12.32	24.17	*3.60*	P
	Change to final measurement and inspection								—

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

Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
-	**Final inspection (general)**		
Test date [YYYY-MM-DD]		2024-03-18	—
Sample-No.	Potential problem	Evaluation*/**	
		HW3	
HV2024000236	Technical problems	HW 3 **passed**; with 30 mm Slight cracks visible under use of electroluminescence NO power degradation detectable*	P
	Visual problems (distance; > 5 m)	HW 3 **passed**; with 30 mm NO cracks visible ; NO dents visible	P
	Visual problems (near; < 0.5 m)	HW 3 **passed**; with 30 mm NO cracks visible ; NO dents visible	-
NOTE	Individual additional remarks: All results are related to the tested samples. * referred to measuring uncertainty **see also *Final evaluation* and *Annex : Additional information*		—
Supplementary information: -			

Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
-	**General remarks and subblementary information**		
	Measuring uncertainties		
	All results only refer to the test samples that were subjected to testing. The extended total measuring uncertainty for weight, velocity and performance is: u (k=2) ≤ ± 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 64290170581766 , *incl. Annexes* *issued by TÜV Süd*	Z2 070321 0097 Rev. 51 *issued by TÜV Süd*	—
Technical data sheets *"TSM-NEG9R.28" issued by Trina Solar* *"TSM-NEG9RC.27" issued by Trina Solar* *"TSM-NEG9R.25" issued by Trina Solar*		

Others - The result of the tested sample is also equivalent to:

Main Types

- **TSM-*xxx*NEG9R.28**
  - power classes 425- 450 W (144 cells)
  - cells (mono / half-cut)
  - cell category (monofacial)
  - frame color (black ; only)
  - backsheet / encapsulation color (white ; only)
  - frame thickness (30 mm ; only)
  - maximum system voltage (1500 V_{DC} ; only)

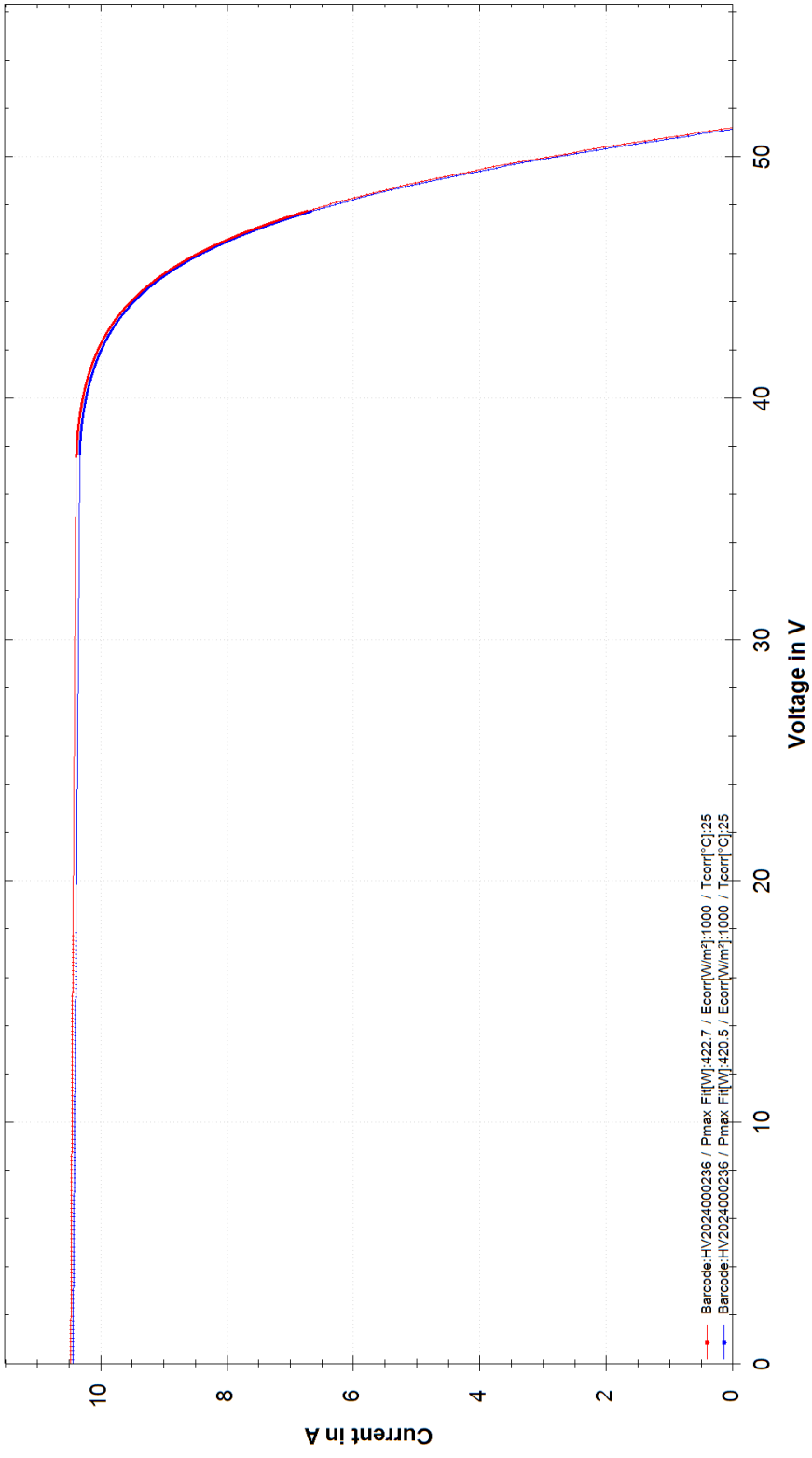
- **TSM-*xxx*NEG9RC.27**
  - power classes 415- 445 W (144 cells)
  - cell category (bi-facial)
  - frame color (black ; only)
  - backsheet / encapsulation color (transparent ; only)

- **TSM-*xxx*NEG9R.25**
  - power classes 425- 450 W (144 cells)
  - cell category (monofacial)
  - frame color (black ; only)
  - backsheet / encapsulation color (black ; only)

The recommendation ***"HW3"*** **is aplicable to the various power ranges** of above listed main types and endings.

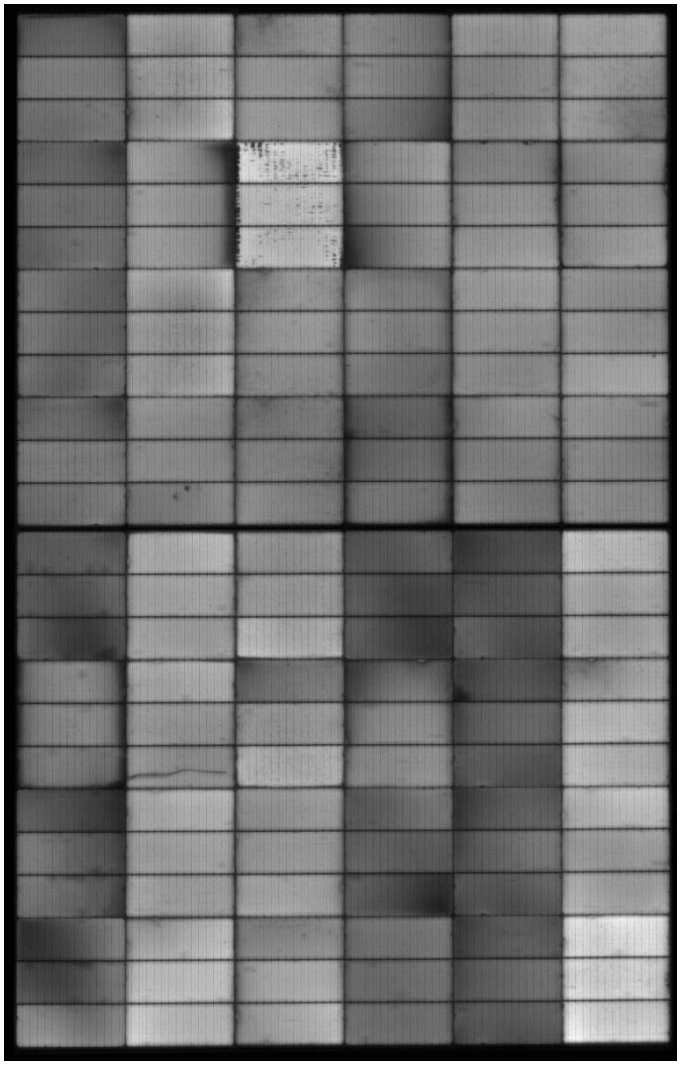
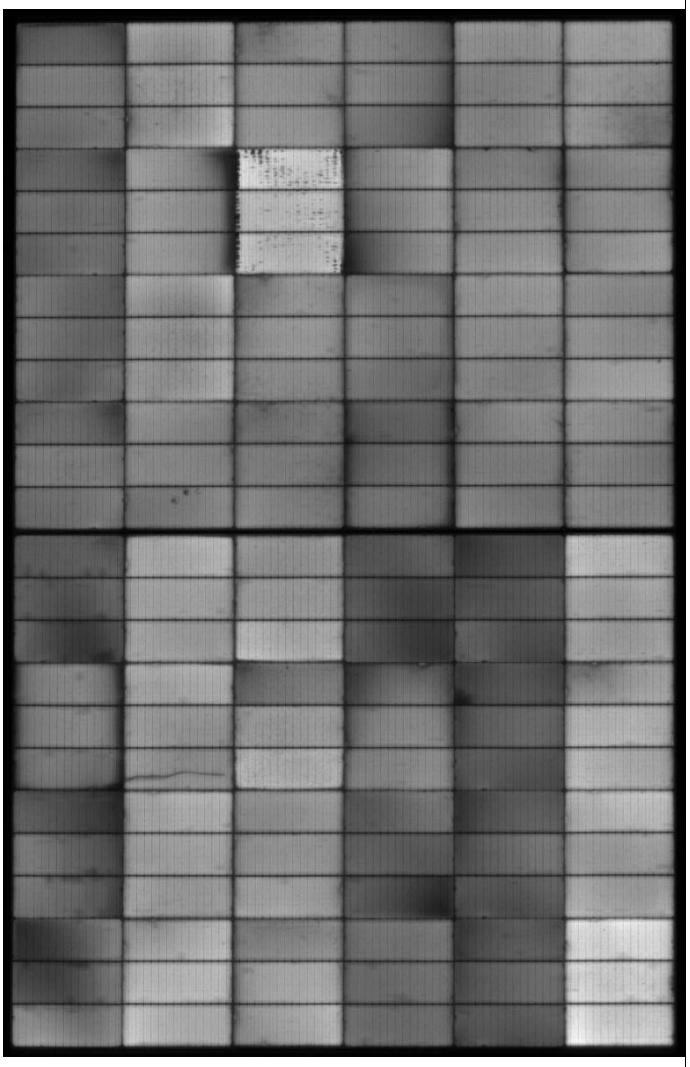
Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
-	**Annex: Additional information**		

IV-curve *initial* vs. *final for 30 mm Hail Impact*



Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
-	**Annex: Additional information**		

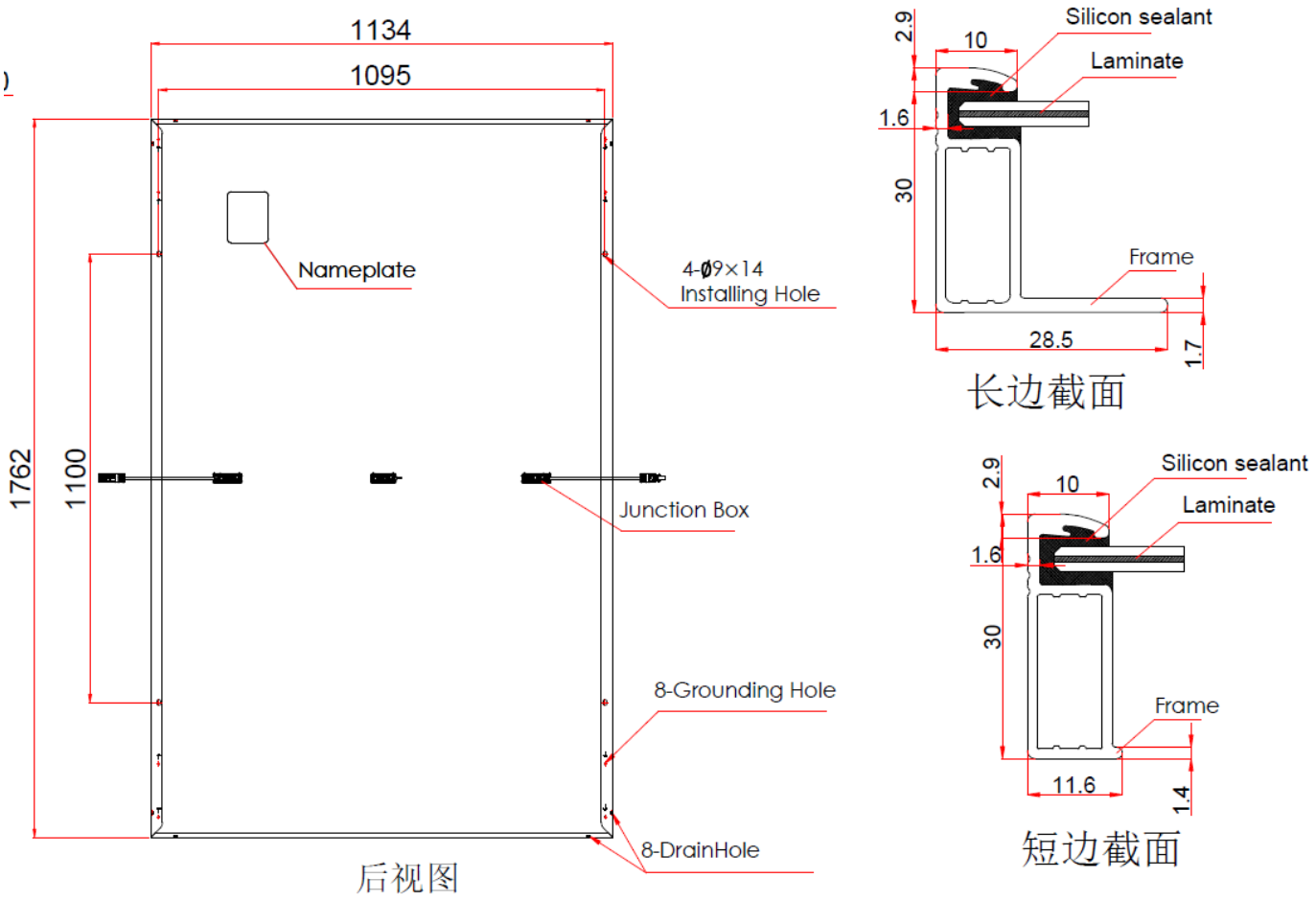
Electroluminescence image - *for 30 mm Hail Impact*

Initial	*final*
	

Supplementary information: -

Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
-	**Annex: Additional information**		

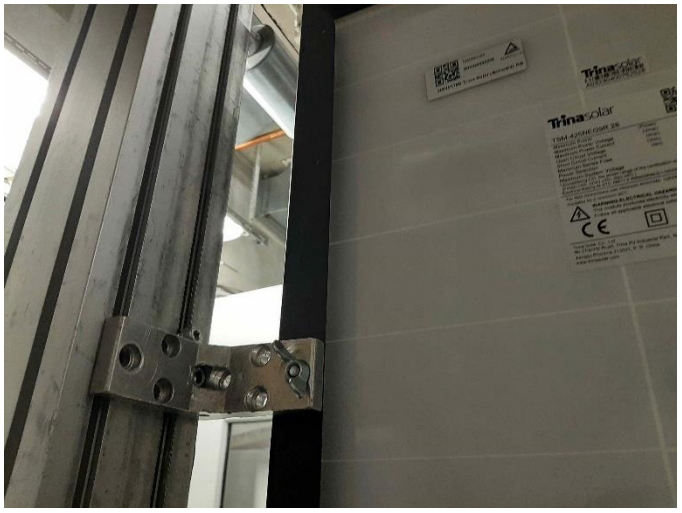
Frame - Extract of drawing or datasheet

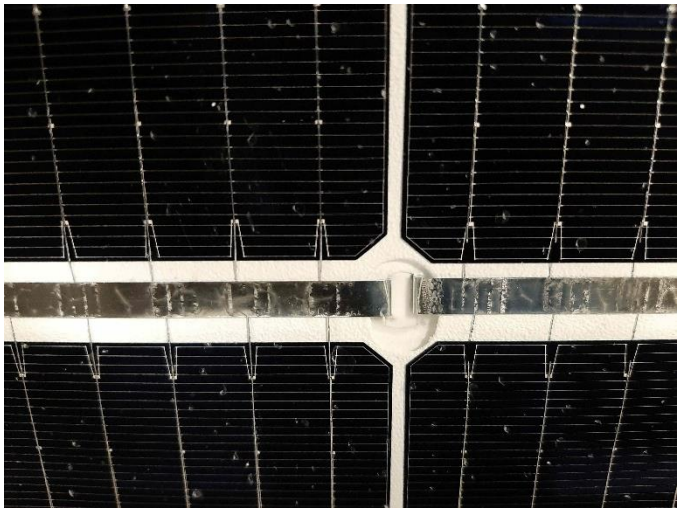


Supplementary information: -

Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
-	**Annex: Additional photo documentation**		

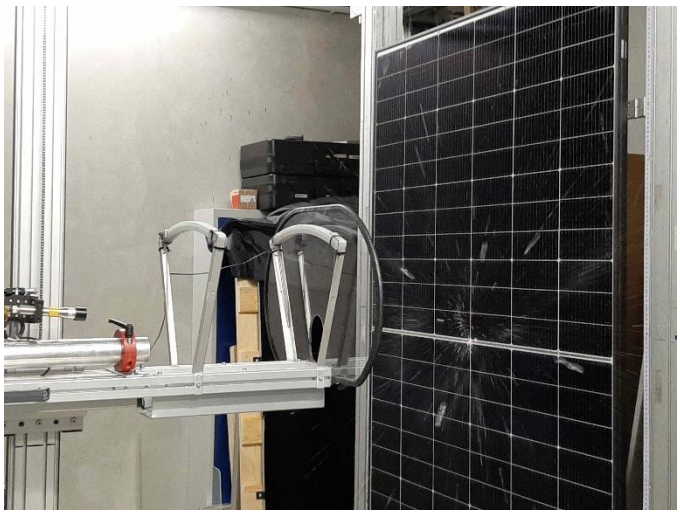
Test Set-up (example)

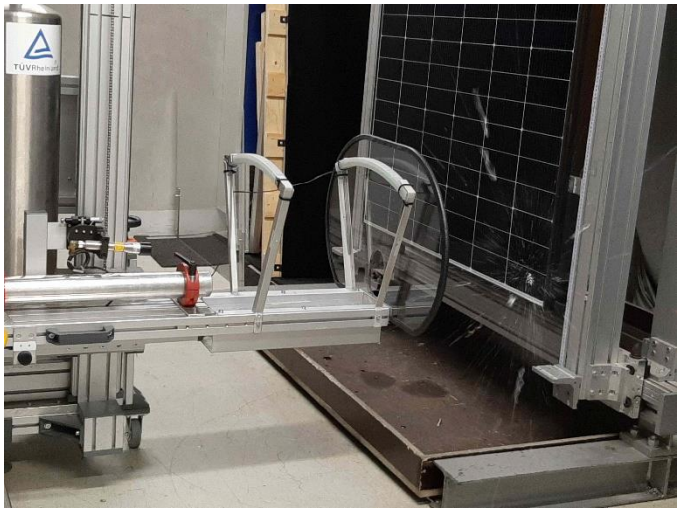
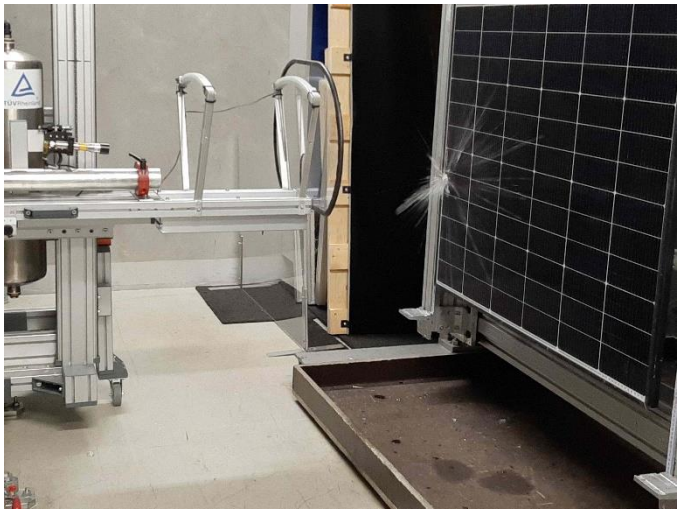




Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
-	**Annex: Additional photo documentation**		

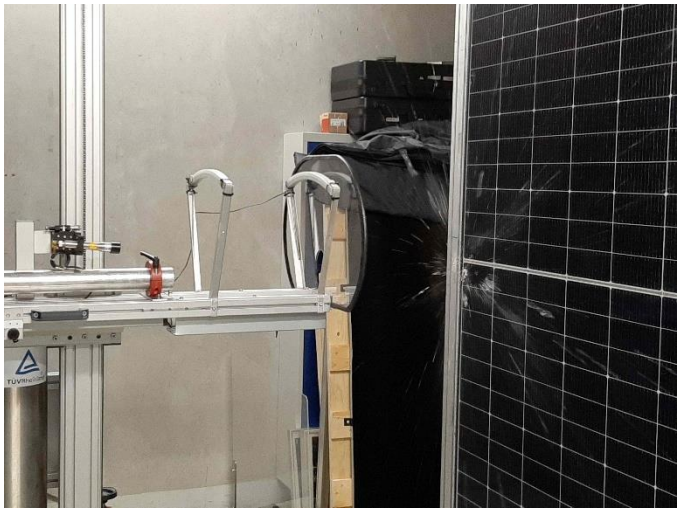
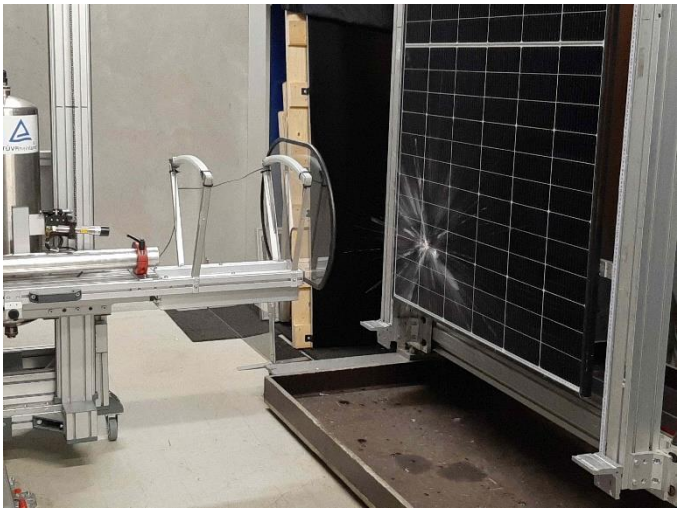
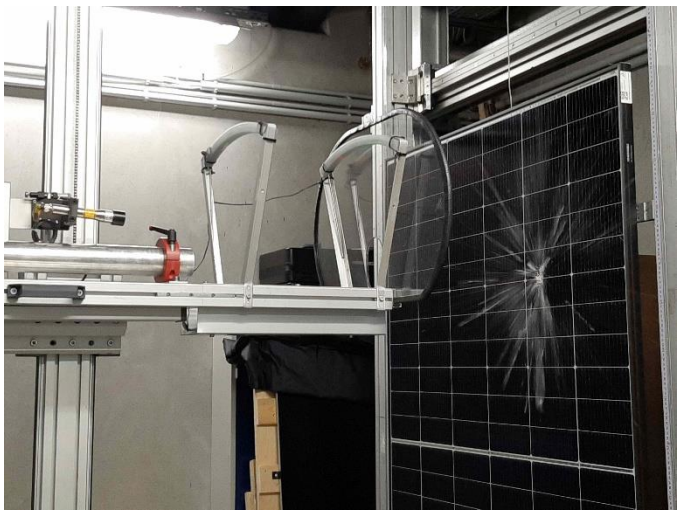
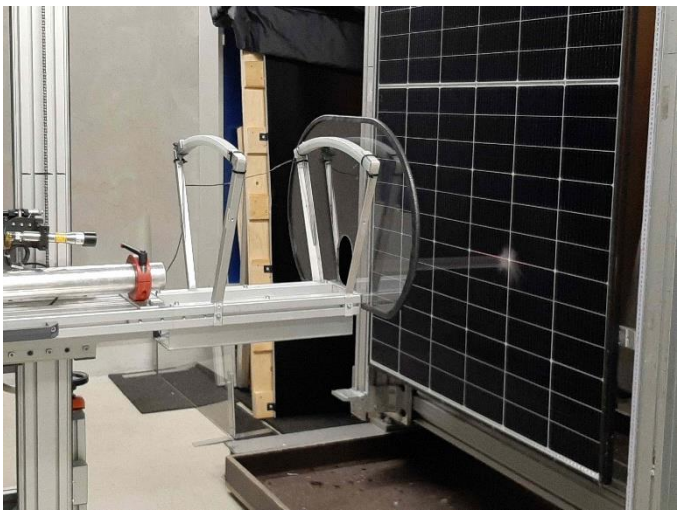
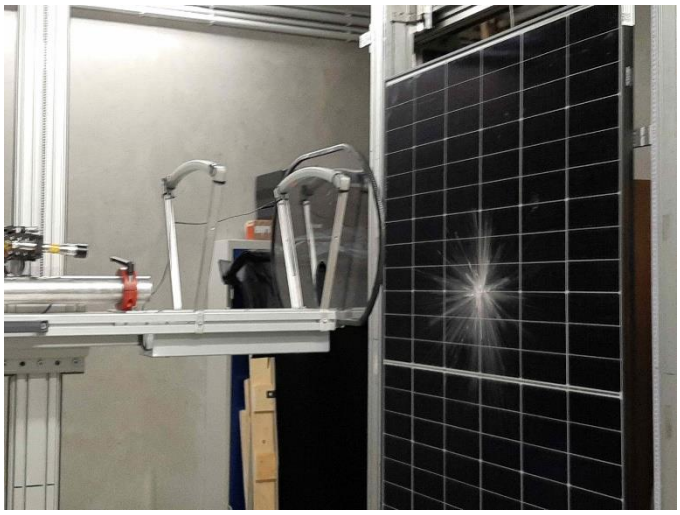
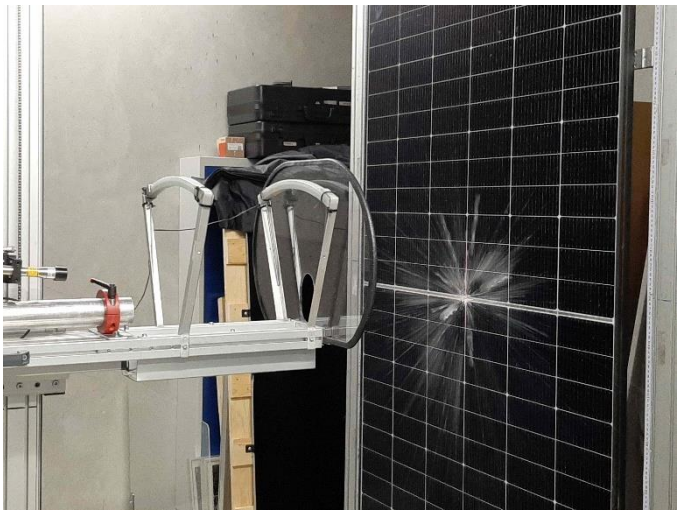
Example of Impacts on Module (30 mm)




Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
-	**Annex: Additional photo documentation**		

Example of Impacts on Module (30 mm)

Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
-	**Annex: Additional photo documentation**		

Example of Impacts on Frame (30 mm)

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- - - End of report - - -