Prüfbericht-Nr.: *Test report no.*:	**300100179.001**	**Auftrags-Nr.:** *Order no.*:	300100 179	Seite 1 von 32 *Page 1 of 32*
Kunden-Referenz-Nr.: *Client reference no.*:	2330545	**Auftragsdatum:** *Order date:*	2021-04-08	
Auftraggeber: *Client*:	Ennogie ApS (for add. information see page 3)			
Prüfgegenstand: *Test item*:	PV-module (roof integrated mounting system)			
Bezeichnung / Typ-Nr.: *Identification / Type no.*:	Ennogie Solardach Panel			
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*:	2022-08-26			
Prüfmuster-Nr.: *Test sample no:*	see "List of test samples"			
Prüfzeitraum: *Testing period*:	2022-08-29 – 2022-12-11			
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:* 2023-03-02		**Ausstellungsdatum:** *Issue date:* 2023-03-02	
Stellung / Position:	Sachverständige(r)/Expert	**Stellung** / Position:	Sachverständige(r)/Expert

Sonstiges / *Other*:

RnD-result only
*** 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 (01/01/2010)
- Beschlusssammlung HSR – formal - Version 23 (28.04.2020)
- Beschlusssammlung HSR - technisch - Version 19 (13/09/2018)

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

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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

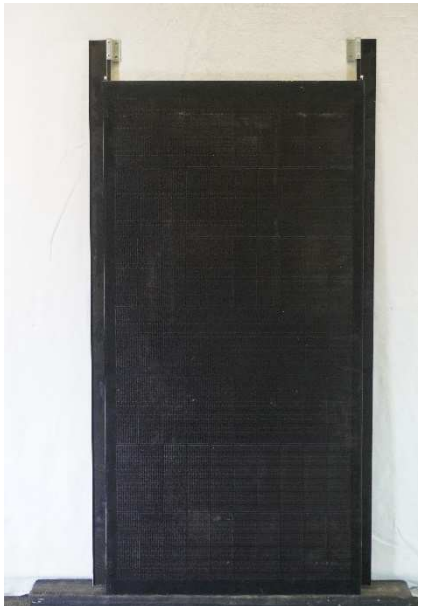
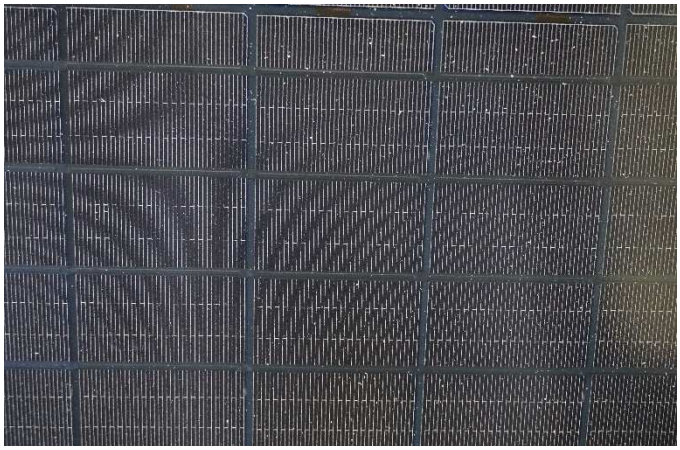
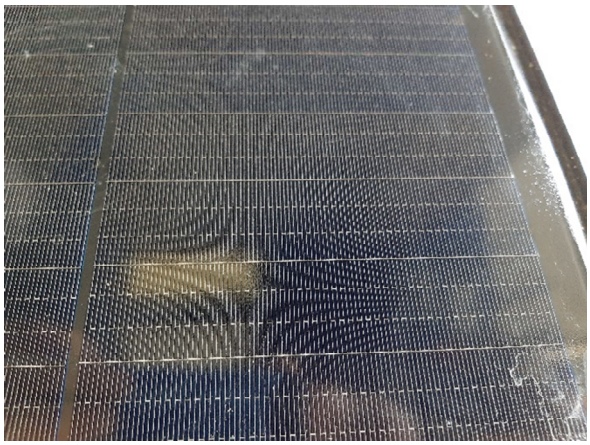
Revision History

Revision	*Date*	*Nature of changes*	*Page*
-	02/03/2023	Original issue	

Produktbeschreibung
Product description

1	**Auftraggeber** *Client*	Ennogie ApS 16 Orebygardvej 7400 Herning Denmark		
2	**Produktdetails** *Product details*	**Allgemeine Informationen ;** General Information		
		Brand name	Ennogie Solardach	
		Type name	EN-115B (GSA069-115W) *by GermanSolar Asia Pte.*	DM152O-130BE (ERS-0191 (130W)) *by FG Nex Solar*
		Product category	PV-module (roof integrated mounting system)	
		Year of production	2022	
		Power class [W]	115	130
		Cell technology	Mono	Mono shingled
		Cell dimension (l / w) [mm]	51 / 30	
		No. of cells	70	76
		Max. system voltage [V]	1000	
		Thickness of glazing [mm]	3.2 (front) / 3.2 (back)	
		Glazing (front)	Toughened Solarglass	
		Glazing (back)	Toughened Solarglass	
		Rail material	Galvanized steel	
		Rail thickness [mm]	0.6	
		Dimensionen ; Dimension		
		Dimension (l / w / h) [mm]	1200 / 600 / 7.5 (incl. rail 30 - 40)	
		Gross area [m²]	0.72 (incl. rail 0.865)	
3	**Technische Dokumentation** *Technical documentation*	for detailed constructional data see *Original certificate (not available/finished)* *Technical Datasheet "Solar 115 W 02-22"* and *"Solar 130 W 02-22"* *issued by Ennogie*		
4	**Hersteller** *Manufacturer*	GermanSOlar Asia Pte., Ltd. 18 Boon Lay Way 06- 107 Tradehub 21 Singapore (609966)	FG-NEX 18# Yangxing Road, Yanqiao Industrial Park,Huishan District, Wuxi, Jiangsu, China	
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 on wooden roof simulation		
6	**Prüfmusterbereit-stellung**: *Test sample obtaining*	☒ Sending by customer ☐ Sampling by TÜV Rheinland Group ☐ others:		

Produktbeschreibung
Product description

Sample - Front (example)	Sample - Back (example)
	
Cells (example)	Cells (example)
	
Modul-Frame-Connection	Upper frame and mounting part
	

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	—
		Start	End		
Insulation test	initial	31 August 2022	01 December 2022	No visual defects	P
	final	08 November 2022	05 December 2022	No visual defects	P
Wet leakage current test	initial	31 August 2022	01 December 2022	No visual defects	P
	final	08 November 2022	05 December 2022	No visual defects	P
Performance at STC	initial	28 September 2022	01 December 2022	No visual defects	P
	final	08 November 2022	01 December 2022	No visual defects	P
Electro-luminescence images	initial	28 September 2022		No visual defects	P
	final	08 November 2022		No visual defects	P
Impact resistance	40 mm (HW4)	08 November 2022	01 December 2022	HW4 with 40 mm ice balls passed	P
Final inspection		08 November 2022	05 December 2022	see *Final evaluation*	P

Supplementary information:

- All results are related to the tested sample
- According to test procedure the tested photovoltaic module is **able** to be **classified in HW4**
- 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		HW4	
Mechanics		HW4	
Transmittance		- - -	
Opacity		- - -	

Supplementary information: limited to plain; thus passive modules, ridge, flashing and eaves were not part of testing

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

-	**Visual inspection (Initial)**		
Test date [DD/MM/YYYY]		31/08/2022 and 01/12/2022	—
Sample No.	Nature and position of initial findings		
HV2022003209	No visual defects		P
HV2022003210	No visual defects		P
HV2022004201	No visual defects		P

Supplementary information: -

Type plate (example)

-	**List of test samples**		
Sample No.	Sample S/N	Remarks / constructional characteristics	
HV2022003209	06927115N2107230906	GermanSolar Asia Pte., Ltd. --- GSA069-115W	—
HV2022003210	06927115N2110251644	GermanSolar Asia Pte., Ltd. --- GSA069-115W	
HV2022004201	8076772128800784	FG-NEX --- ERS-0191 (130 W)	

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

Test date [DD/MM/YYYY]	28/09/2022 and 01/12/2022

Sample No.	P_{max} [W]	V_{mpp} [V]	I_{mpp} [A]	V_{oc} [V]	I_{sc} [A]	FF [%]	
HV2022003209	110.7	39.7	2.8	47.4	3.0	79.2	P
HV2022003210	111.9	38.6	2.9	46.6	3.1	78.3	P
HV2022004201	125.7	43.7	2.9	50.7	3.2	78.1	P

Supplementary information: -

Final

Test date [DD/MM/YYYY]	08/11/2022 and 01/12/2022

Sample No.	P_{max} [W]	V_{mpp} [V]	I_{mpp} [A]	V_{oc} [V]	I_{sc} [A]	FF [%]	
HV2022003209	110.7	39.6	2.8	47.3	3.0	79.1	P
HV2022003210	114.2	39.3	2.9	47.0	3.1	79.0	P
HV2022004201	126.2	43.8	2.9	50.9	3.2	78.1	P

Supplementary information: -

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

- **Insulation test (ISO)**

General; for all following measurements						
Maximum system voltage [V_{DC}]		1000				—
High voltage applied [V_{DC}]	1st	3000				
	2nd	6000				
Insulation resistance measured at [V_{DC}]		1000				
Initial						
Test date [DD/MM/YYYY]		31/08/2022 and 01/12/2022				
Sample No.	Measured [GΩ]	Area [m²]	Result* [GΩ × m²]	Dielectric breakdown Yes (description)	Dielectric breakdown No	
HV2022003209	1.0	0.86	0.86	-	x	P
HV2022003210	1.0	0.86	0.86	-	x	P
HV2022004201	1.0	0.86	0.86	-	x	P
Final						—
Test date [DD/MM/YYYY]		08/11/2022 and 05/12/2022				
Sample No.	Measured [GΩ]	Area [m²]	Result* [GΩ × m²]	Dielectric breakdown Yes (description)	Dielectric breakdown No	
HV2022003209	1.0	0.86	0.86	-	x	P
HV2022003210	1.0	0.86	0.86	-	x	P
HV2022004201	1.0	0.86	0.86	-	x	P

Supplementary information: *Minimum requirement acc. to the standard is 0.04 GΩ × m².

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					
Test date [DD/MM/YYYY]		31/08/2022 and 01/12/2022			
Sample No.	Measured [MΩ]	Area [m²]	Result* [MΩ × m²]		
HV2022003209	81.1	0.86	69.8		P
HV2022003210	118.1	0.86	101.5		P
HV2022004201	1000.0	0.86	859.0		P
Final					—
Test date [DD/MM/YYYY]		08/11/2022 and 05/12/2022			
Sample No.	Measured [MΩ]	Area [m²]	Result* [MΩ × m²]		
HV2022003209	82.4	0.86	70.9		P
HV2022003210	123.6	0.86	106.3		P
HV2022004201	???	0.86			P
Supplementary information: * Minimum requirement acc. to the standard is 40 MΩ × m²					

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

-	**Electroluminescence images (EL)** Analysis of electroluminescence images (see also *Annex : Additional information*)		
Initial			—
Test date [DD/MM/YYYY]		28/09/2022	
Sample No.	Reverse current applied [A]	Attributes	
HV2022003209	5	No conspicuousness/findings	
HV2022003210	4	No conspicuousness/findings	
HV2022004201	N/A	*Because of special internal interconnection not applicable*	
Supplementary information: -			
Final			—
Test date [DD/MM/YYYY]		08/11/2022	
Sample No.	Reverse current applied [A]	Attributes (referred to *Initial*)	
HV2022003209	5	No additional findings	
HV2022003210	4	No additional findings	
HV2022004201	N/A	*Because of special internal interconnection not applicable*	
Supplementary information: Estimated analysis without guarantee			

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

-	**Impact resistance test (general)**

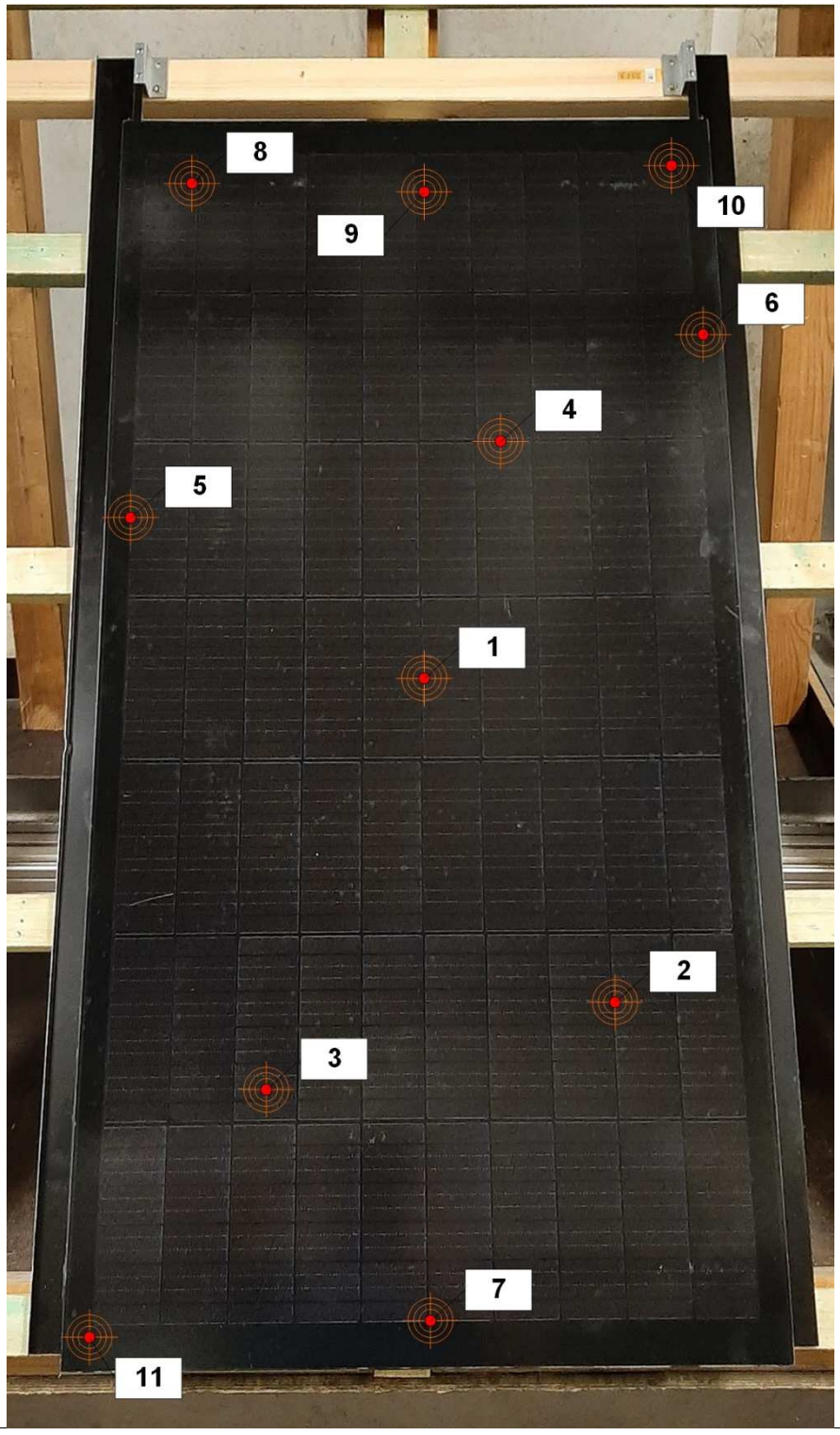
Test date [DD/MM/YYYY] Day code	08/11/2022[a]
Sample-No. ID code	HV2022003210[IEC]
Method used for impact resistance	Prüfbestimmung Nr. 25 “Photovoltaik Module”
Surface conditioning	none
Sample tilt angle [° from horizontal]	45
Direction of shoot [°]	45 (horizontal)
Impact angle [° from sample surface]	90
Distance (sample to center of v_0-meas.) [mm]	500 to 700
Ice ball production [week of the year]	42 (hermetically sealed)
Storage temperature of ice ball [°C]	-20
Ambient conditions (mean) [°C and % RH]	[a]23.2 and 52.6
Diameter of ice ball [mm]	40
Weight of ice ball (mean) [g]	30.0
Velocity of ice ball (mean) [m/s]	27.5
Impact energy (at least) [J]	11.1

Example of Test Set-up	Example of Impact
	

Supplementary information:

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

Overview of impact positions *IEC*



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Supplementary information: -

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

- **Impact resistance test – Result table (40 mm – HW4)**

Sample ID	Impact information					Mass of ball [g]	Velocity of ball [m/s]	Impact energy [J]	—
	Day	No.	Location & description (line/cell from left bottom corner)		IEC***				
IEC	After initial control measurements (Ice ball diameter = 35 mm)								
	a	1	5/4 – 6/4	Near interconnects	5	29.57	28.33	*11.87*	P
		2	8/2 – 9/2	Near interconnects	6	29.28	27.57	*11.13*	P
		3	3/2	Over edges of circuit	3	29.41	28.03	*11.55*	P
		4	7/6	Over edges of circuit	4	29.44	28.49	*11.95*	P
		5	1/5	Near mounting position	7	29.47	28.16	*11.68*	P
		6	10/6	Near mounting position	8	29.07	27.69	*11.14*	P
		7	5/1 – 6/1	Edge of module window	2	28.97	27.77	*11.17*	P
		8	7/1 (75 mm)	Far away from other impacts	9	29.44	28.35	*11.83*	P
		9	6/7	Over the junction box	11	29.32	28.25	*11.70*	P
		10	10/7 (50 mm)	Far away from other impacts	10	28.89	27.79	*11.16*	P
		11	1/1 (20 mm)	Corner of module window	1	29.44	28.02	*11.56*	P
	Change to frame impacts								—

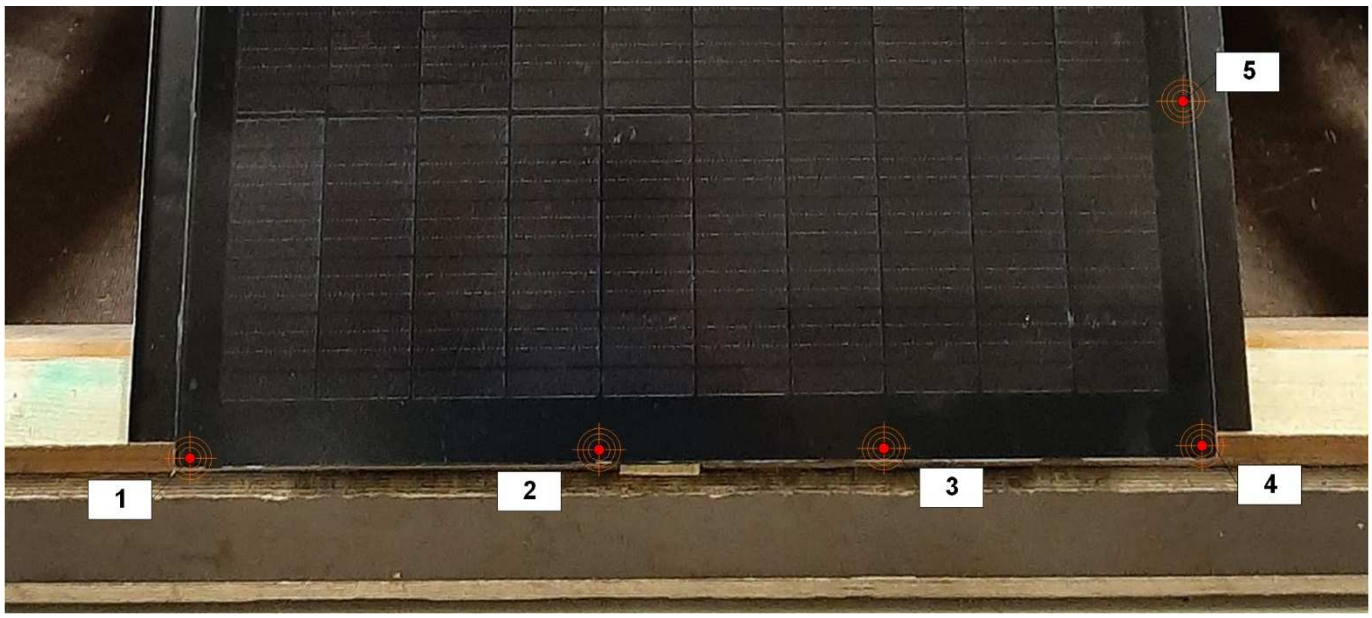
Supplementary information: *value to low (not valid); **value to high (not valid); ***location acc. to IEC-standard

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

-	**Impact resistance test (Critical area)**

Test date [DD/MM/YYYY] Day code	08/11/2022[a]
Sample-No. ID code	HV2022003209[VKF]
Method used for impact resistance	Prüfbestimmung Nr. 25 “Photovoltaik Module”
Surface conditioning	none
Sample tilt angle [° from horizontal]	45
Direction of shoot [°]	45 (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]	42 (hermetically sealed)
Storage temperature of ice ball [°C]	-20
Ambient conditions (mean) [°C and % RH]	[a]23.2 and 52.6
Diameter of ice ball [mm]	40
Weight of ice ball (mean) [g]	30.0
Velocity of ice ball (mean) [m/s]	27.5
Impact energy (at least) [J]	11.1

Overview of Impact positions *VKF* (approx.)



Supplementary information: 1/5 of diameter from edges

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

- **Impact resistance test – Result table (Critical area)**

Sample ID	Impact information					Mass of ball [g]	Velocity of ball [m/s]	Impact energy [J]	—
	Day	No.	Location & description (distance from relevant tip)		IEC***				
VKF	Additional impacts on frame (Ice ball diameter = 40 mm)								
	a	1	Corner – left (8 mm)	Critical area (1/5 D)	-	28.87	28.48	*11.71*	P
		2	Edge – left bottom (8 mm)			28.89	27.75	*11.12*	P
		3	Edge – right bottom (8 mm)			28.77	27.79	*11.11*	P
		4	Corner – right (8 mm)			29.03	27.71	*11.15*	P
		5	Edge – right (8 mm)			28.79	27.83	*11.15*	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*

-	**Additional impact resistance test (general)**

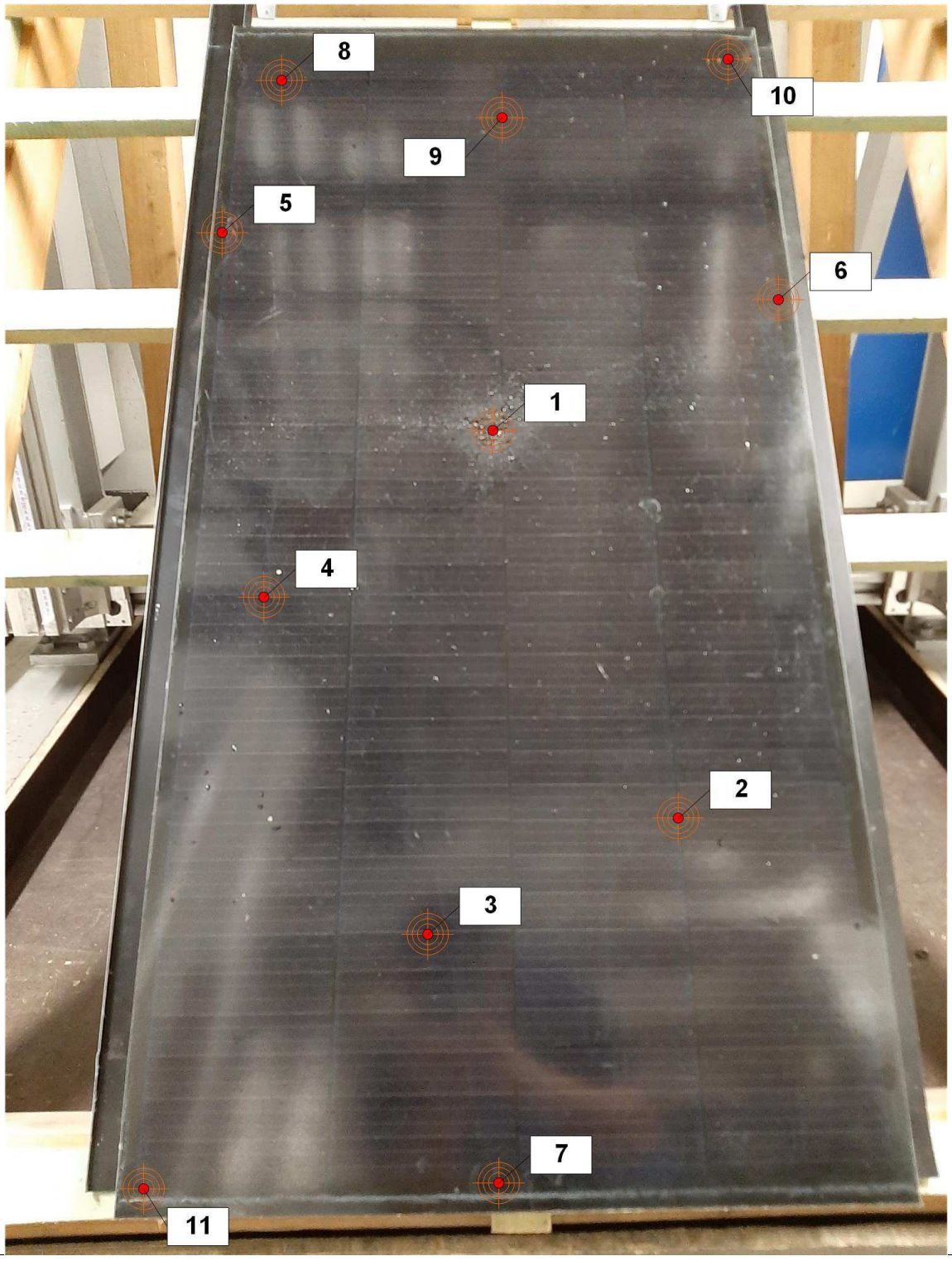
Test date [DD/MM/YYYY] Day code	01/12/2022[b]
Sample-No. ID code	HV2022004201[ADD]
Method used for impact resistance	Prüfbestimmung Nr. 25 “Photovoltaik Module”
Surface conditioning	none
Sample tilt angle [° from horizontal]	45
Direction of shoot [°]	45 (horizontal)
Impact angle [° from sample surface]	90
Distance (sample to center of v_0-meas.) [mm]	500 to 700
Ice ball production [week of the year]	42 (hermetically sealed)
Storage temperature of ice ball [°C]	-20
Ambient conditions (mean) [°C and % RH]	[b]22.9 and 53.3
Diameter of ice ball [mm]	40
Weight of ice ball (mean) [g]	30.0
Velocity of ice ball (mean) [m/s]	27.5
Impact energy (at least) [J]	11.1

Example of Test Set-up	Example of Impact
	

Supplementary information:

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

Overview of impact positions *ADD*



—

Supplementary information: -

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

- **Additional impact resistance test – Result table (40 mm – HW4)**

Sample ID	Impact information					Mass of ball [g]	Velocity of ball [m/s]	Impact energy [J]	—
	Day	No.	Location & description (line/cell from left bottom corner)		IEC***				
ADD	After initial control measurements (Ice ball diameter = 35 mm)								
	b	1	5/4 – 6/4	Near interconnects	5	29.44	28.00	*11.54*	P
		2	3/5 – 4/5	Near interconnects	6	29.41	27.91	*11.45*	P
		3	2/3 – 2/4	Over edges of circuit	3	29.44	27.99	*11.53*	P
		4	1/8 – 1/9	Over edges of circuit	4	29.30	27.81	*11.33*	P
		5	1/15	Near mounting position	7	29.35	27.93	*11.45*	P
		6	4/14	Near mounting position	8	29.39	27.69	*11.27*	P
		7	2/1 – 3/1	Edge of module window	2	29.26	27.57	*11.12*	P
		8	1/19 (75 mm)	Far away from other impacts	9	29.33	27.87	*11.39*	P
		9	3/18	Over the junction box	11	29.41	28.02	*11.55*	P
		10	4/19 (50 mm)	Far away from other impacts	10	29.38	28.10	*11.60*	P
		11	1/1 (20 mm)	Corner of module window	1	29.44	28.10	*11.62*	P
	Change to frame impacts								—

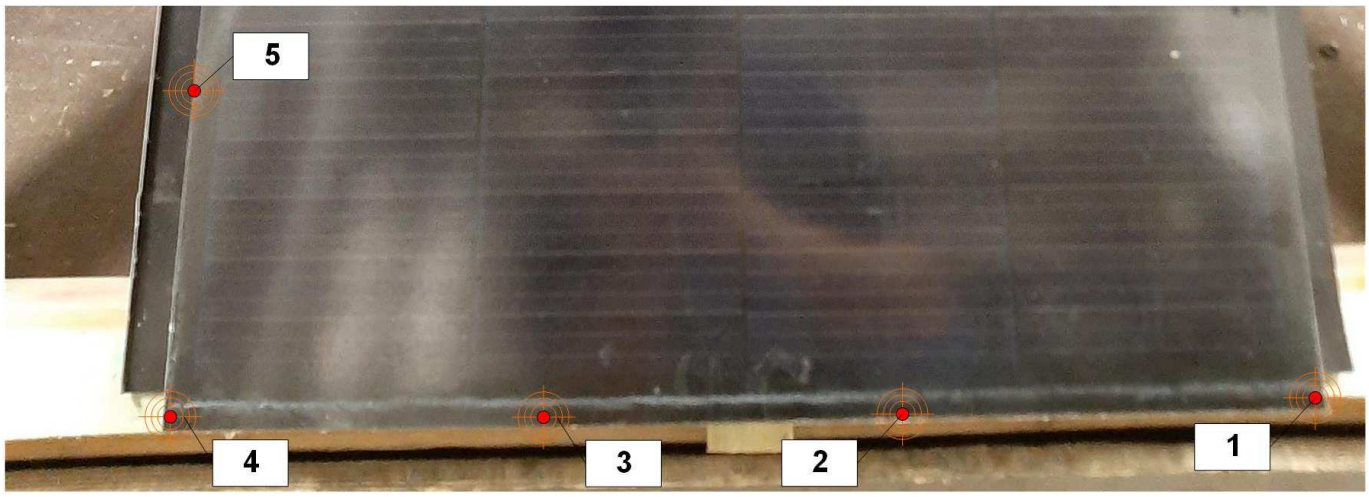
Supplementary information: *value to low (not valid); **value to high (not valid); ***location acc. to IEC-standard

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

-	**Impact resistance test (Critical area)**

Test date [DD/MM/YYYY] Day code	01/12/2022[b]
Sample-No. ID code	HV2022004201[ADD]
Method used for impact resistance	Prüfbestimmung Nr. 25 “Photovoltaik Module”
Surface conditioning	none
Sample tilt angle [° from horizontal]	45
Direction of shoot [°]	45 (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]	42 (hermetically sealed)
Storage temperature of ice ball [°C]	-20
Ambient conditions (mean) [°C and % RH]	[a]22.9 and 53.3
Diameter of ice ball [mm]	40
Weight of ice ball (mean) [g]	30.0
Velocity of ice ball (mean) [m/s]	27.5
Impact energy (at least) [J]	11.1

Overview of Impact positions *ADD* (approx.)



Supplementary information: 1/5 of diameter from edges

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

- **Impact resistance test – Result table (Critical area)**

Sample ID	Impact information					Mass of ball [g]	Velocity of ball [m/s]	Impact energy [J]	—
	Day	No.	Location & description (distance from relevant tip)		IEC***				
ADD	Additional impacts on frame (Ice ball diameter = 40 mm)								
	b	1	Corner – right (8 mm)	Critical area (1/5 D)	-	29.12	27.65	*11.13*	P
		2	Edge – right bottom (8 mm)			29.25	27.77	*11.28*	P
		3	Edge – left bottom (8 mm)			29.37	27.7	*11.27*	P
		4	Corner – left (8 mm)			29.19	27.78	*11.26*	P
		5	Edge – left (8 mm)			29.29	27.64	*11.19*	P
	Change to final measurement and inspection								—

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

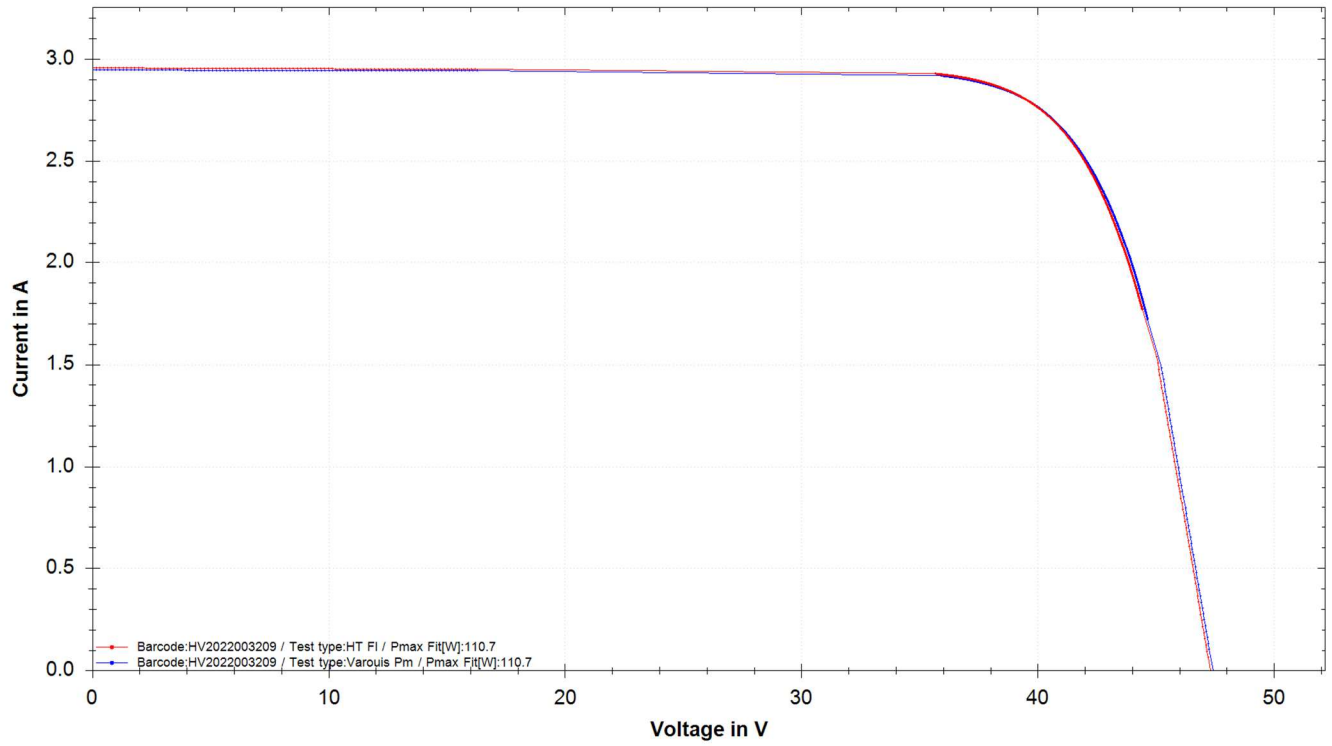
Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
-	**Final inspection (general)**		
Test date [DD/MM/YYYY]		08/11/2022 and 05/12/2022	—
Sample-No.	Potential problem	Evaluation	
HV2022003209 and HV2022003210 and HV2022004201	Technical problems	HW 4 **passed**; with 40 mm NO cracks visible under use of electroluminescence NO power degradation detectable*	P*/**
	Visual problems (distance; > 0.5 m)	HW 4 **passed**; with 40 mm NO cracks visible NO dents visible	P
	Visual problems (near; < 0.5 m)	HW 4 **passed**; with 40 mm NO cracks visible NO dents visible	P
	Individual additional remarks: All results are related to the tested samples. Metal part of mounting system which are part of the PV-module were out of range for hailstone impacts; thus not free exposed areas. Other parts like passive modules or metal parts like ridge, eaves and flashing were not part of testing * 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 is: u (k=2) ≤ ± 2.5 %			

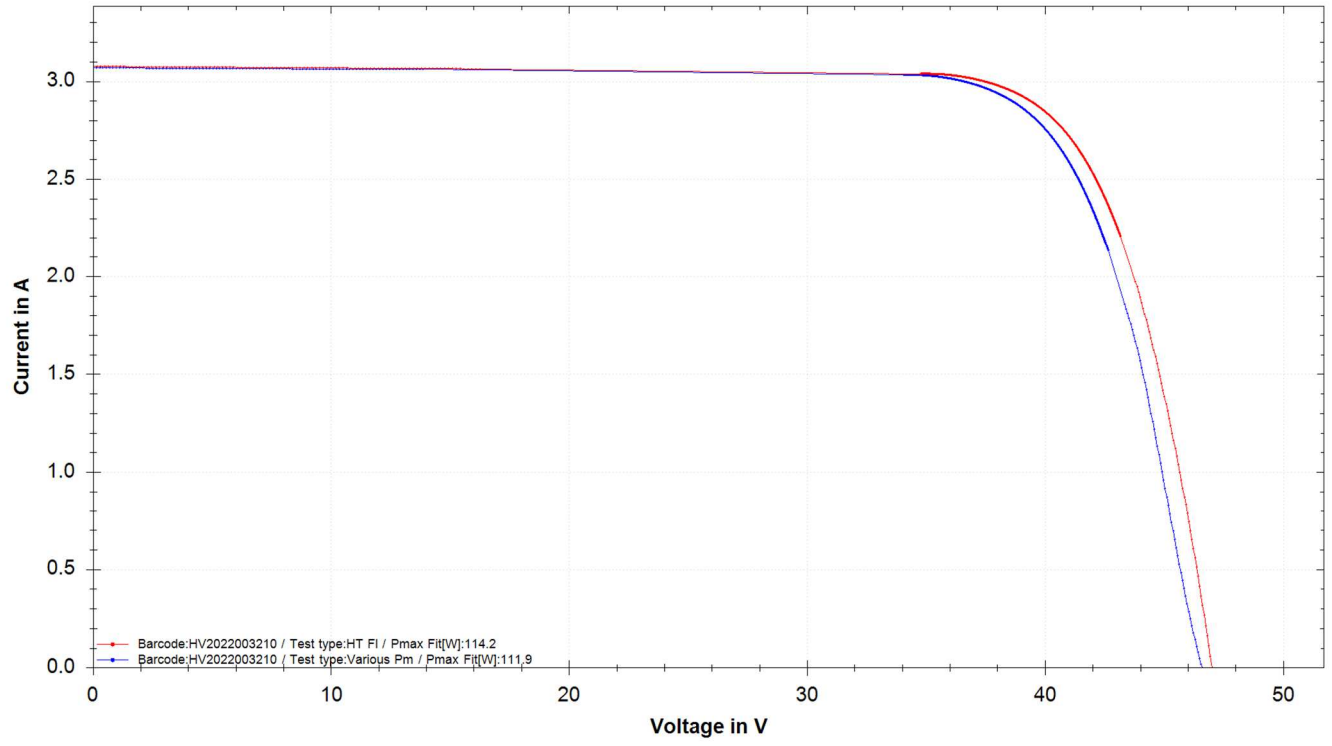
Related test reports / certificates / documents		
The construction of the tested samples is documented in the relevant report valid in conjunction with the IEC certificate.		—
Test report no.	Certificate no.	
see *Original certificate (not available/finished)*	*n.a.*	
Technical Datasheet *"Solar 115 W 02-22"* and *"Solar 130 W 02-22"* *issued by Ennogie*		

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

IV-curve *initial* vs. *final for 40 mm Hail Impact (VKF)*

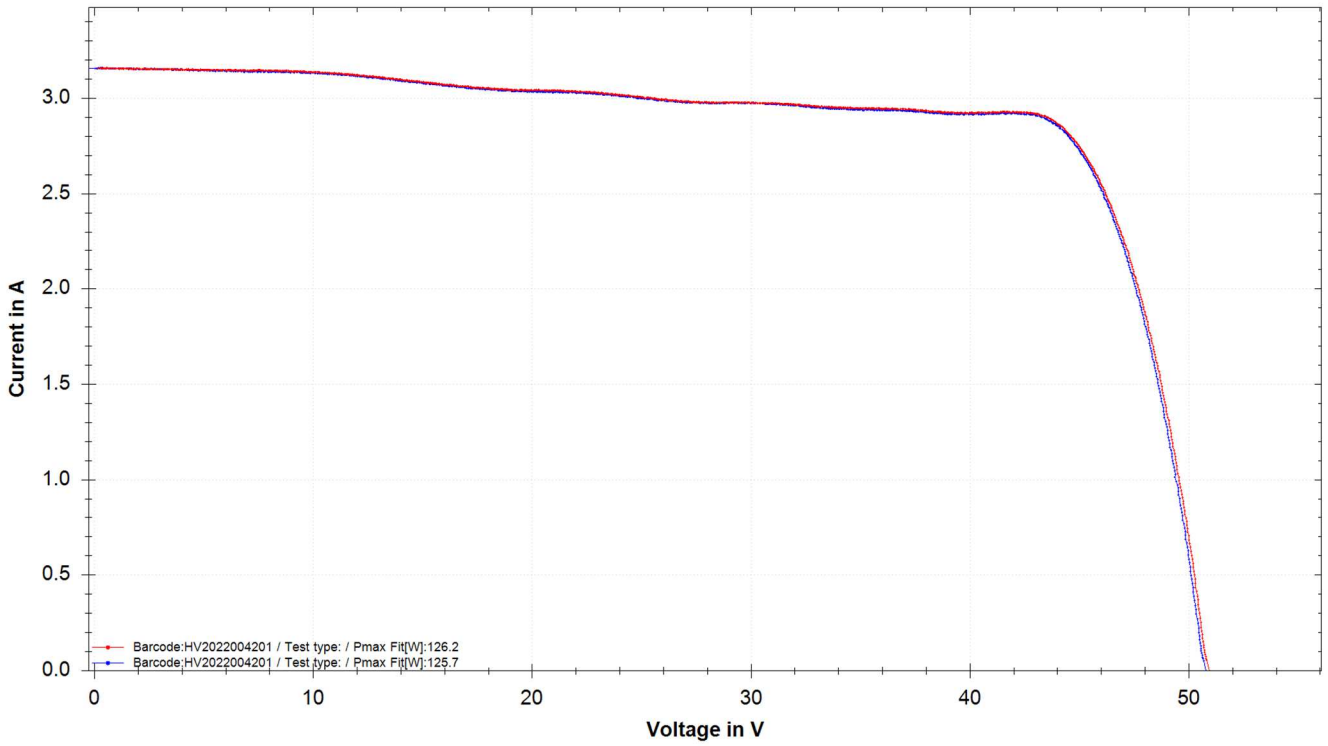


IV-curve *initial* vs. *final for 40 mm Hail Impact (IEC)*



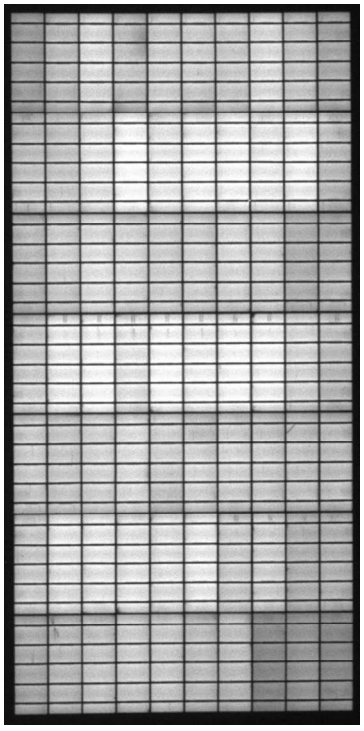
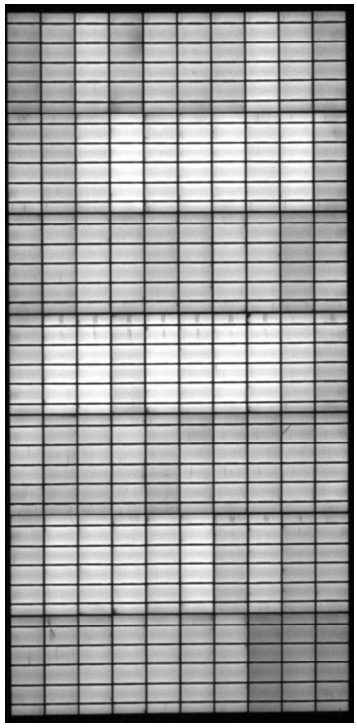
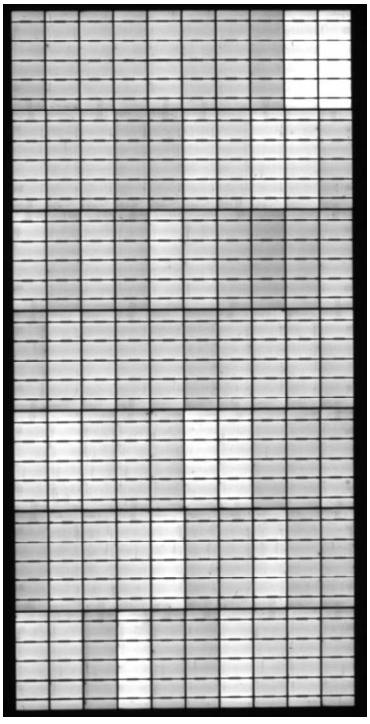
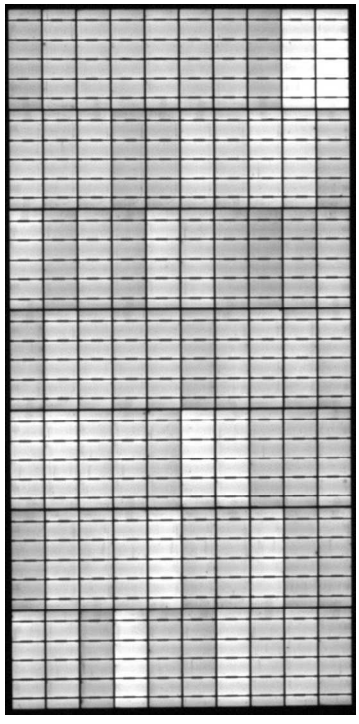
Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
-	**Annex: Additional information**		

IV-curve *initial* vs. *final for 40 mm Hail Impact (ADD)*



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

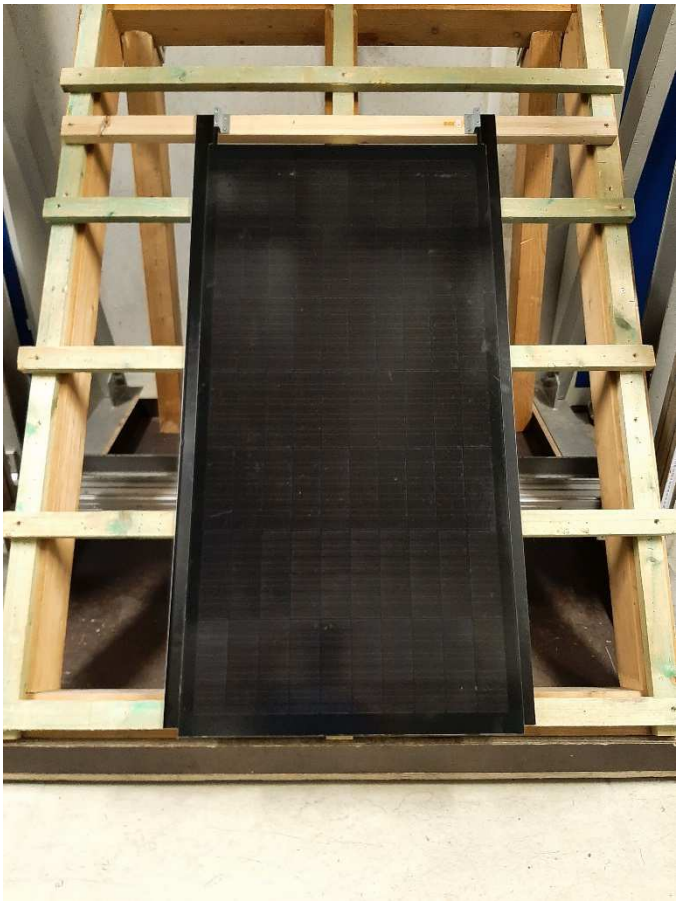
Electroluminescence image - *for 40 mm Hail Impact*

Initial (VKF)	*final (VKF)*
	
Initial (IEC)	*final (IEC)*
	

Supplementary information: -

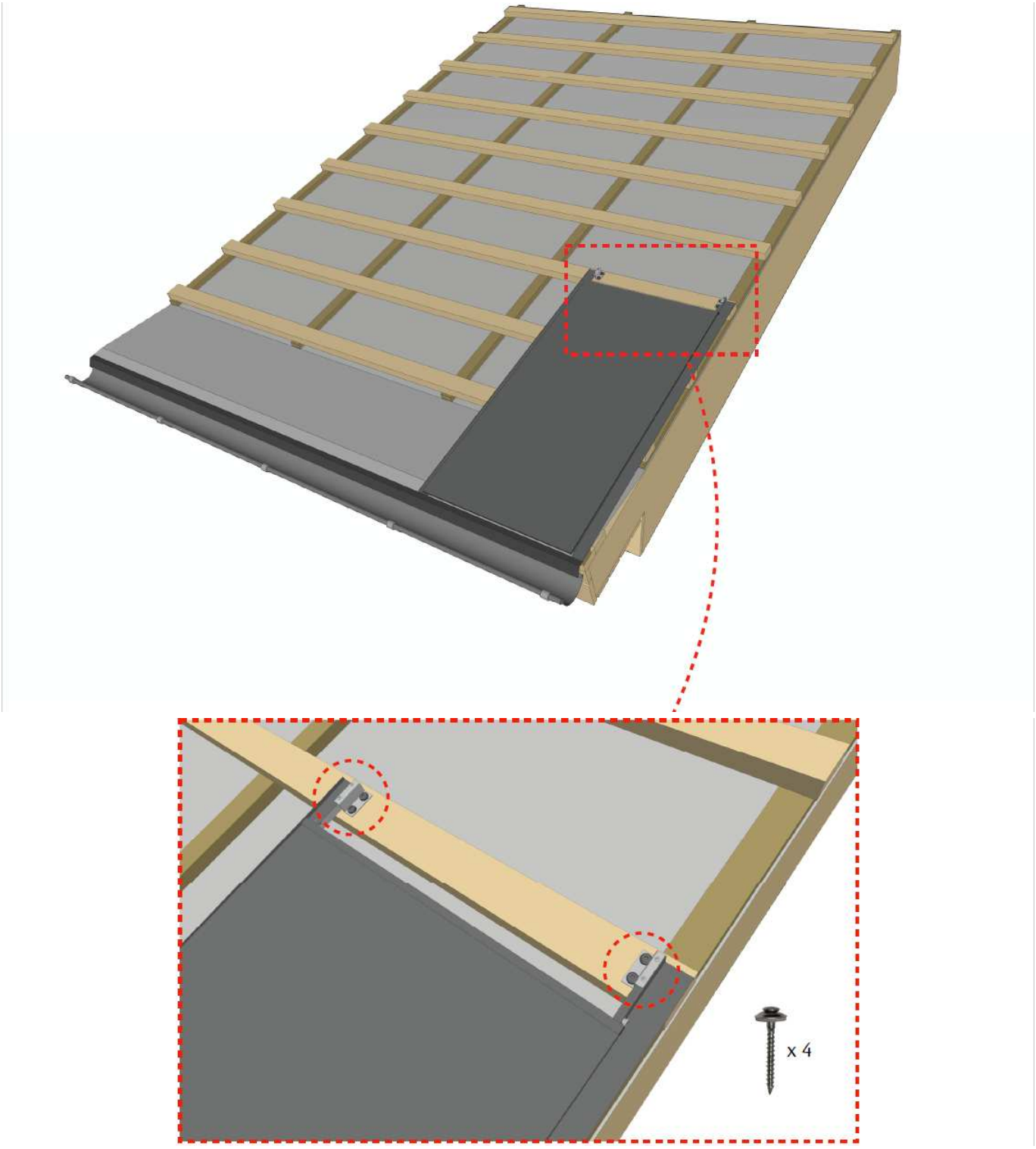
Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
-	**Annex: Additional photo documentation**		

Test Set-up (example)



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

Mounting instruction (extract only) – Ennogie Lightrail installation manual *(26/09/2022)*



Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
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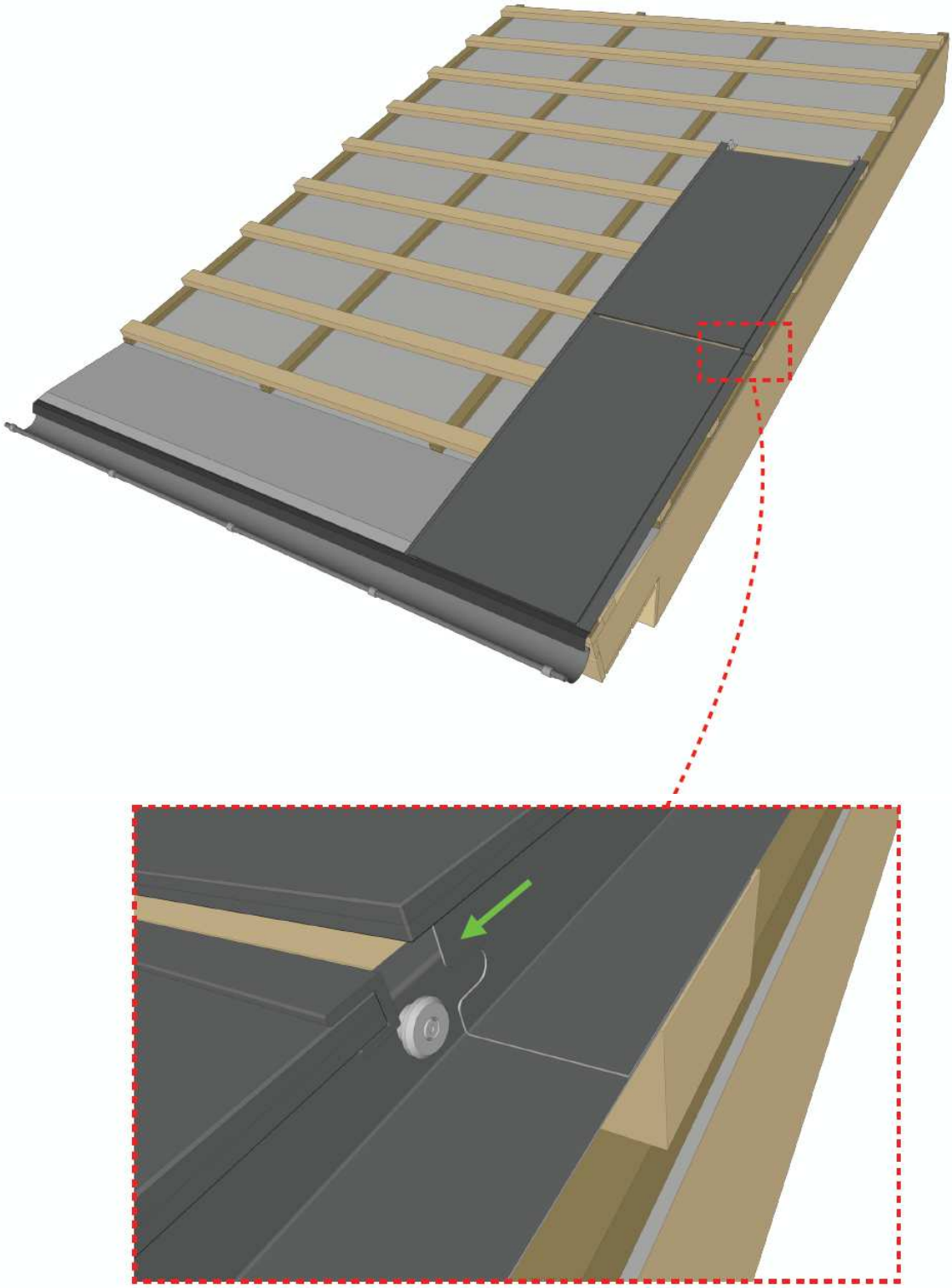
Mounting instruction (extract only) – Ennogie Lightrail installation manual *(26/09/2022)*



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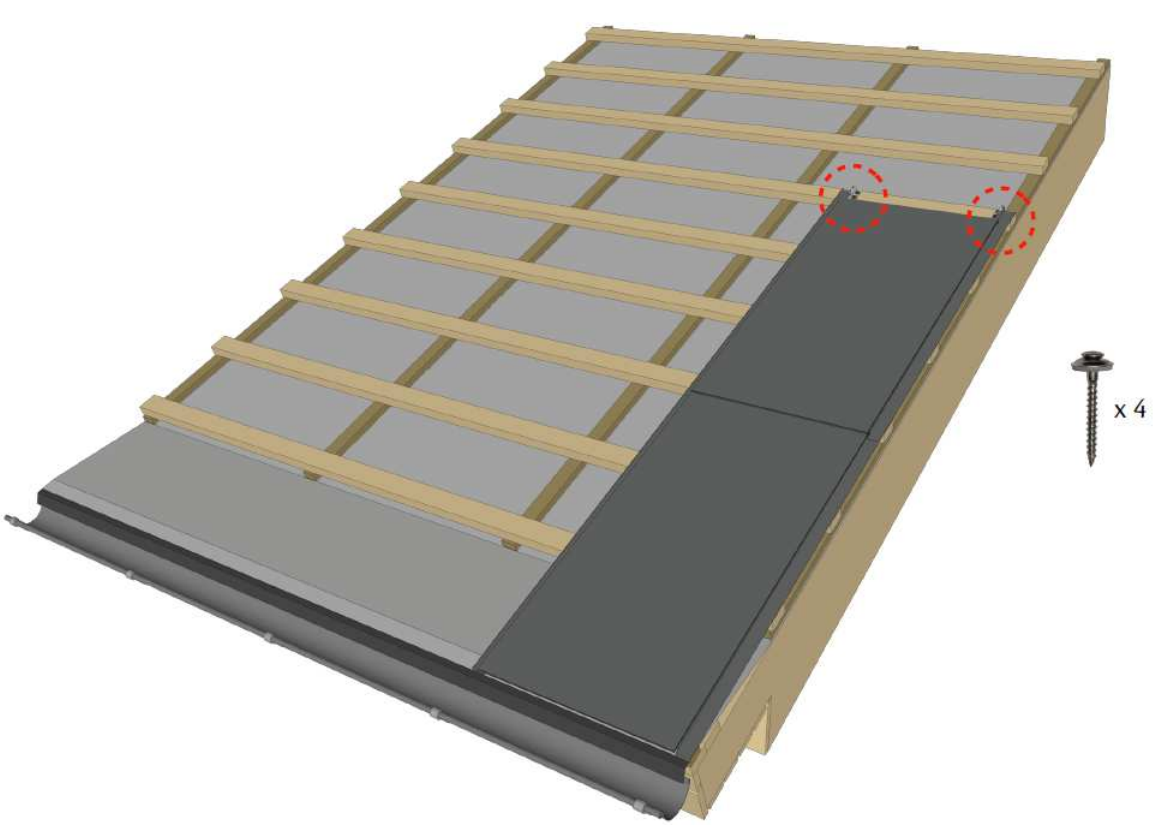
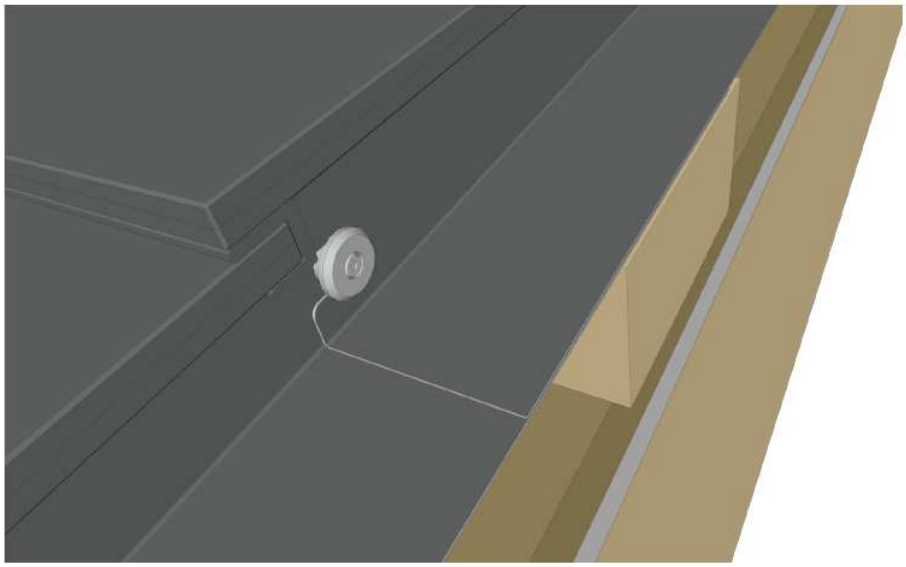
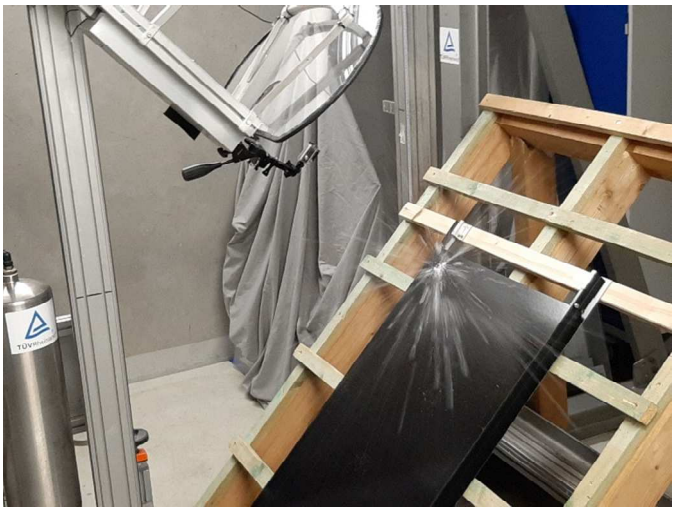


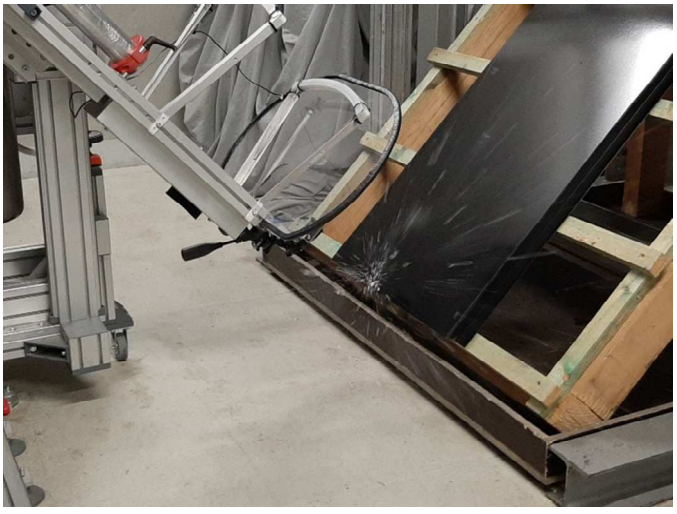


Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
-	**Annex: Additional photo documentation**		

Example of Impacts on Module *IEC* (40 mm)



Example of Impacts on Module Edge *VKF* (40 mm)



Example of Impacts on Corner *VKF* (40 mm)

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

Example of Impacts on Module *ADD*(40 mm)

Example of Impacts on Corner *ADD* (40 mm)

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