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TÜV Rheinland (Shanghai) Co., Ltd.
Solar & Commercial Products

Test Report

Photovoltaic Module Tests
according to Client's Requirements

TÜV Report No. CN24N2CW 001

Shanghai, January 2024

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Test report No.: *Prüfbericht - Nr.:*	**CN24N2CW 001**	Page 1 / 11
Client **(Customer No. + address):** *Auftraggeber* *(Kunden-Nr. + Adresse):*	**Trina Solar Co., Ltd.** No. 2 TianHe Road, Trina PV Industrial Park, New District Changzhou City, 213031 Jiangsu, P.R. China	
Test Item: *Gegenstand der Prüfung:*	Photovoltaic (PV) Module(s)	**Date of receipt:** *Eingangsdatum:* N/A
Identification: *Bezeichnung:*	Refer to Page 4	
Order No.: *Auftragsnummer:*	244568326	**Quotation No.:** *Angebotsnummer:* 245826263
Place of testing: *Ort der Prüfung:*	TÜV Rheinland (Suzhou) Co., Ltd.	
Testing laboratory: *Prüflaboratorium:*	**TÜV Rheinland (Suzhou) Co., Ltd.**	
Test specification: *Prüfgrundlage:*	Refer to IEC 61215-2:2021, etc.	
Test Result: *Prüfergebnis:*	Refer to the verdict of the test report	

tested by / *geprüft:*

12.01.2024	Project Engineer/ Daniel Wang	Daniel Wang
Date *Datum*	**Title/Name** *Titel/Name*	**Signature** *Unterschrift*

reviewed by / *kontrolliert:*

12.01.2024	Technical Reviewer/ Wenyao Lu	Wenyao Lu
Date *Datum*	**Title/Name** *Titel/Name*	**Signature** *Unterschrift*

Other Aspects / *Sonstiges:*

N/A

TÜV Rheinland (Shanghai) Co., Ltd. 莱茵技术(上海)有限公司 检验检测专用章 (01) *Inspection/Testing*

Abkürzungen:	***P(ass)***	=	***entspricht Prüfgrundlage***	***Abbreviations:***	***P(ass)***	=	***passed***
	F(ail)	=	***entspricht nicht Prüfgrundlage***		***F(ail)***	=	***failed***
	N/A	=	***nicht anwendbar***		***N/A***	=	***not applicable***
	N/T	=	***nicht getestet***		***N/T***	=	***not tested***

Table of Content

General Information

Abbreviations used in the report:

Pmax	– Maximum power point	Vmpp	– Maximum power point voltage
Impp	– Maximum power point current	Voc	– Open circuit voltage
Isc	– Short circuit current	FF	– Fill factor
MPD	– Maximum Power determination	EL	– Electroluminescence imaging
HI	– Hail test		

Possible test case verdicts:

Test case does not apply to the test object ..... :	N/A
Test object does meet the requirement ..... :	Pass (P)
Test object does not meet the requirement ..... :	Fail (F)

Further Remarks

- The test verdicts presented in this report relate only to the test specimen.
- This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.
- IV curves are only included in the report if they show any deviations. If required, other IV curves will be provided upon request.
- Any question regards the report, please contact to TÜV Rheinland (Shanghai) within one week after report issued.

Sampling and Test Assignment

Sampling procedure

☐	Random sampling from production (e.g. during factory audit (FA) or inline inspection)
☐	Random sampling from the warehouse, container or transportation boxes
☒	Modules have been submitted by the manufacturer/ client without random sampling by TÜV Rheinland
Supplementary information: NA	

Module test assignment

Module manufacturer	Serial number	Module type	Remarks / constructional characteristics
Trina Solar Co., Ltd.	A05231100600187	TSM-495NEG18R.28	½ mono cut-cell c-Si module, 108 pcs
	A05231100600727		

Sample #	1	2	3	4	5	6	7	8	9	10	11
Sample number / Test items	A05231100600187	A05231100600727									
Visual inspection	x	x									
Maximum power determination	x	x									
EL imaging	x	x									
Reference module	x										
Insulation test		x									
Wet leakage current test		x									
Hail test		x									

Legend:
x Selected sample for test
Test sequence is required by client.

Tables

Initial visual inspection (Refer to IEC 61215-2:2021, MQT01)

Test Date [DD-MM-YYYY].....:	03.01.2024	—
Sample #	Nature and position of initial findings	Verdict
1	No visual defect	—
2	No visual defect	—
Supplementary information: N/A		

Initial maximum power determination (Refer to IEC 61215-2:2021, MQT02)

Test Date [DD-MM-YYYY].....:	03.01.2024					—
Test method.....:	☒ indoor		☐ outdoor			—
Irradiance [W/m²].....:	1000					—
Illuminated direction	☒ front side		☐ rear side			—
Module temperature [°C].....:	25 ± 1					—
Sample #	Pmpp [W]	Vmpp [V]	Impp [A]	Voc [V]	Isc [A]	FF [%]
1	496.0	32.88	15.085	38.90	15.816	80.6
2	495.5	32.84	15.089	38.95	15.847	80.3
Supplementary information: N/A						

Initial insulation test (Refer to IEC 61215-2:2021, MQT03)

Test Date [DD-MM-YYYY].....:	03.01.2024					—
Maximum system voltage [VDC] .....:	1500					—
High voltage applied [VDC].....:	4000					—
Insulation resistance measured at [VDC]..:	1500					—
Sample #	Measured	Area	Result*	Dielectric breakdown		Verdict
	MΩ	m²	MΩ * m²	Yes (description)	No	
1	6980	2.22	15496	-	No	P
2	7040	2.22	15629	-	No	P
* Pass requirement is higher 0.04 GΩ*m²						

Initial wet leakage current test (Refer to IEC 61215-2:2021, MQT15)

Test Date [DD-MM-YYYY].....:	03.01.2024			—
Insulation resistance measured at [V_{DC}]....:	1500			—
Solution resistivity [Ω cm].....:	< 3,500			—
Solution temperature [°C].....:	22 ± 3			—
Sample #	Measured	Area	Result*	Verdict
	MΩ	m²	MΩ * m²	
1	144	2.22	320	P
2	151	2.22	335	P

* Minimum requirement acc. to the standard is 40 MΩ*m²

Initial EL-images

Test Date [DD-MM-YYYY].....:	03.01.2024	—
Current applied.....:	Isc ± 5%	—
Sample #	Remarks	—
1	N/A	—
2	N/A	—
Supplementary information: Refer to Appendix 4: EL-images.		

Hail test (Refer to IEC 61215-2:2021, MQT17)

Test Date [DD-MM-YYYY].....:	04.01.2024	—
Ice ball diameter [mm].....:	35	—
Ice ball mass [g].....:	20.7 ± 2%	
Ice ball velocity [m/s].....:	27.2 ± 5%	
Number of impact locations .....:	11	
Sample #	—	—
2	—	P
Supplementary information: N/A		

Visual inspection after Hail test (Refer to IEC 61215-2:2021, MQT01)

Test Date [DD-MM-YYYY].....:	04.01.2024	—
Sample #	Nature and position of initial findings	Verdict
1	No visual defect	P
2	No visual defect	P
Supplementary information: N/A		

Maximum power determination after Hail test (Refer to IEC 61215-2:2021, MQT02)

Test Date [DD-MM-YYYY].....:	05.01.2024						—
Test method.....:	☒ indoor	☐ outdoor					—
Irradiance [W/m²] .....:	1000						
Illuminated direction	☒ front side	☐ rear side					—
Module temperature [°C] .....:	25 ± 1						—
Sample #	Pmpp [W]	Vmpp [V]	Impp [A]	Voc [V]	Isc [A]	FF [%]	Degradation [%]
1	497.0	32.96	15.080	38.93	15.824	80.7	0.20
2	496.5	32.94	15.074	39.00	15.817	80.5	0.20
Supplementary information: N/A							

Insulation test after Hail test (Refer to IEC 61215-2:2021, MQT03)

Test Date [DD-MM-YYYY].....:	05.01.2024	—

Maximum system voltage [V_{DC}] .....:				1500		—
High voltage applied [V_{DC}] .....:				4000		—
Insulation resistance measured at [V_{DC}]....:				1500		—
Sample #	Measured	Area	Result*	Dielectric breakdown		Verdict
	MΩ	m²	MΩ * m²	Yes (description)	No	
1	8450	2.22	18759	-	No	P
2	8170	2.22	18137	-	No	P
* Pass requirement is higher 0.04 GΩ*m²						

Wet leakage current test after Hail test (Refer to IEC 61215-2:2021, MQT15)

Test Date [DD-MM-YYYY].....:	05.01.2024			—
Insulation resistance measured at [V_{DC}]....:	1500			—
Solution resistivity [Ω cm].....:	< 3,500			—
Solution temperature [°C].....:	22 ± 3			—
Sample #	Measured	Area	Result*	Verdict
	MΩ	m²	MΩ * m²	
1	187	2.22	415	P
2	153	2.22	340	P
* Minimum requirement acc. to the standard is 40 MΩ*m²				

EL-images after Hail test

Test Date [DD-MM-YYYY].....:	05.01.2024	—
Current applied.....:	Isc ± 5%	—
Sample #	Remarks	—
1	N/A	—
2	N/A	—
Supplementary information: Refer to Appendix 4: EL-images.		

Appendix 1: Main measuring equipment and used software

Main measuring equipment

Device	Index no	Measured variable	Application
Pulsed solar load	PV-446	Current, voltage, irradiance	Pulsed solar simulator measurements
IR-sensor	PV-201 PV-202 PV-204 PV-211	Specimen temperature	Pulsed solar simulator measurements

Measurement related software

Program name	Version no.	Date	Application
Pulsed Solar Simulator Software	HighLight-R2.4.5	02.06.2021	Operating software pulsed solar simulator

Appendix 2: Statement of the estimated uncertainty of the test verdicts

- The verdicts of performance rating are only related to the test samples that were subjected to the tests. They cannot be generalised to the modules from the series production.
- The MPD measurement was performed with a pulsed solar simulator of Class AAA according to IEC60904-9:2007. The extended measurement uncertainty is:
  - Uncertainty in P_{mpp} within ± 2.5 %, k=2
  - Uncertainty in I_{SC} within ± 2.4 %, k=2
  - Uncertainty in V_{OC} within ± 0.9 %, k=2

Appendix 3: Photos of the modules

Module type: TSM-495NEG18R.28

Fig. 1: front view of module

Fig. 2: rear view of module

Fig. 3: label of module

Fig. 4: junction box of module

Appendix 4: EL-images

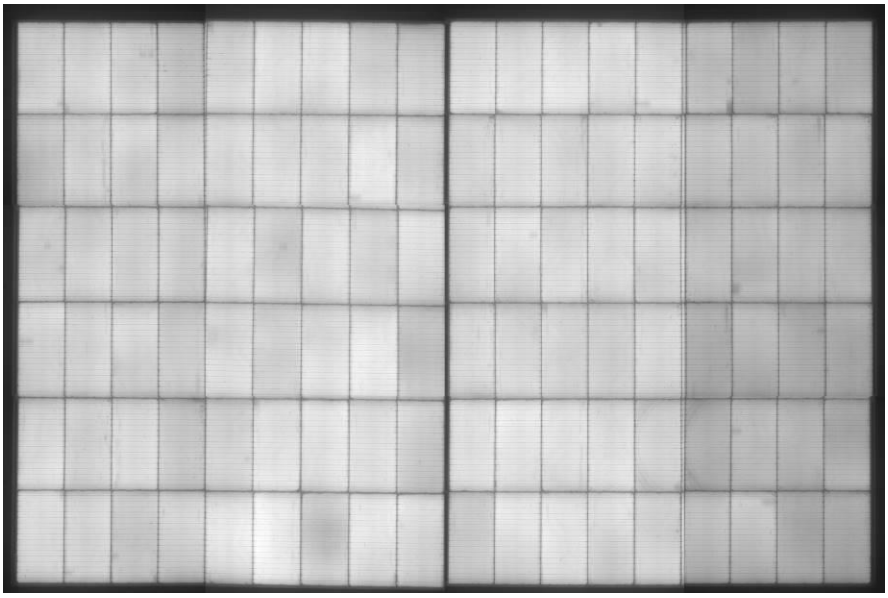

Fig. 5: EL-image of sample 1 (initial)

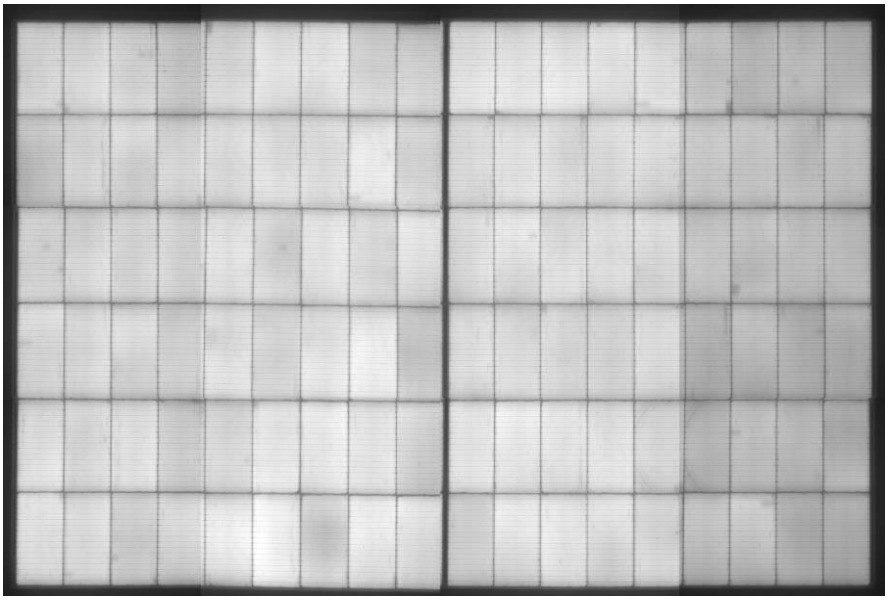

Fig. 6: EL-image of sample 1 (after HI test)

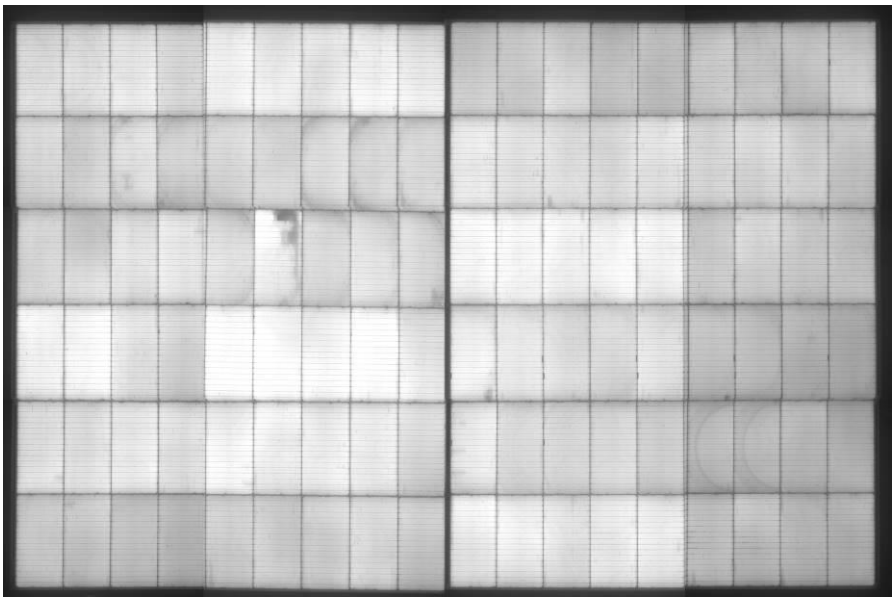

Fig. 7: EL-image of sample 2 (initial)

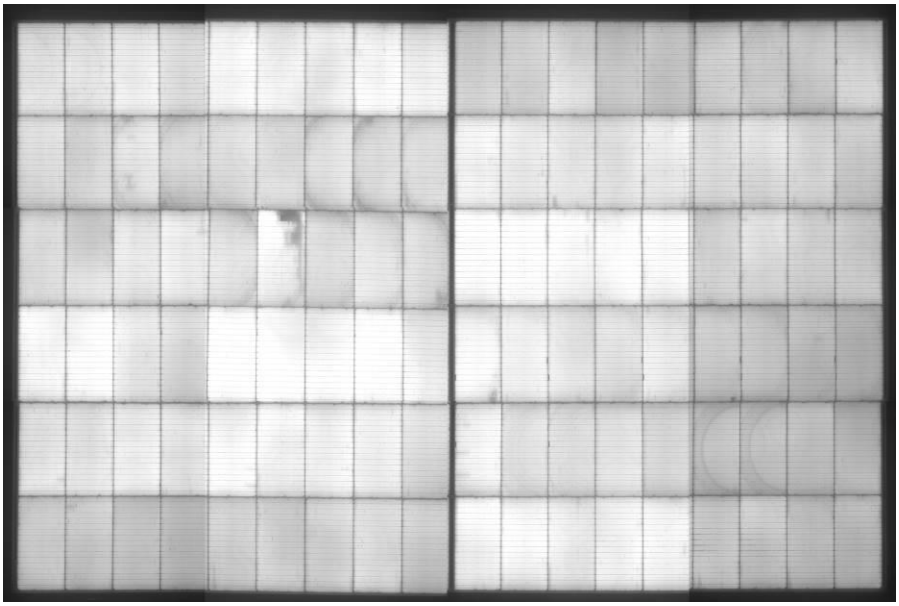

Fig. 8: EL-image of sample 2 (after HI test)

End of Test Report