

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

Test report No.:		CN24N2CW 001		Page 1 / 11	
<i>Prüfbericht - Nr.:</i>					
Client (Customer No. + address): <i>Auftraggeber</i> (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: <i>Gegenstand der Prüfung:</i>		Photovoltaic (PV) Module(s)		Date of receipt: <i>Eingangsdatum:</i> N/A	
Identification: <i>Bezeichnung:</i>		Refer to Page 4			
Order No.: <i>Auftragsnummer:</i>		244568326		Quotation No.: <i>Angebotsnummer:</i> 245826263	
Place of testing: <i>Ort der Prüfung:</i>		TÜV Rheinland (Suzhou) Co., Ltd.			
Testing laboratory: <i>Prüflaboratorium:</i>		TÜV Rheinland (Suzhou) Co., Ltd.			
Test specification: <i>Prüfgrundlage:</i>		Refer to IEC 61215-2:2021, etc.			
Test Result: <i>Prüfergebnis:</i>		Refer to the verdict of the test report			
tested by / geprüft:			reviewed by / kontrolliert:		
12.01.2024 Project Engineer/ Daniel Wang			12.01.2024 Technical Reviewer/ Wenyao Lu		
Date <i>Datum</i>	Title/Name <i>Titel/Name</i>	Signature <i>Unterschrift</i>	Date <i>Datum</i>	Title/Name <i>Titel/Name</i>	Signature <i>Unterschrift</i>
		<i>Daniel Wang</i>			<i>Wenyao Lu</i>
Other Aspects / Sonstiges:					
N/A					
Abkürzungen: P(ass) = entspricht Prüfgrundlage F(ail) = entspricht nicht Prüfgrundlage N/A = nicht anwendbar N/T = nicht getestet			Abbreviations: P(ass) = passed F(ail) = failed N/A = not applicable N/T = not tested		
This test report relates to the listed test samples. Without permission of the test centre this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any safety mark on this or similar products. Dieser Prüfbericht bezieht sich nur auf die gelisteten Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens.					



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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	A05231100600187	A05231100600727									
Test items											
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]	Ipp [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 $40 \text{ M}\Omega \cdot \text{m}^2$

Initial EL-images

Test Date [DD-MM-YYYY].....:	03.01.2024	—
Current applied	Isc $\pm 5\%$	—
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].....:	$20.7 \pm 2\%$	
Ice ball velocity [m/s].....:	$27.2 \pm 5\%$	
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]	Ipp [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	—
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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 $\pm 2.5 \%$, $k=2$
 - Uncertainty in I_{SC} within $\pm 2.4 \%$, $k=2$
 - Uncertainty in V_{OC} within $\pm 0.9 \%$, $k=2$

Appendix 3: Photos of the modules

Module type: TSM-495NEG18R.28



Fig. 1: front view of module



Fig. 2: rear view of module

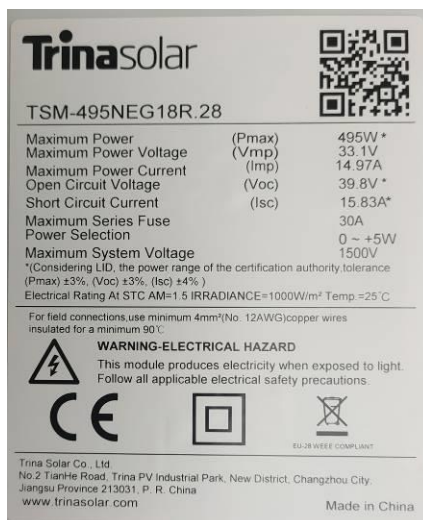


Fig. 3: label of module



Fig. 4: junction box of module

Appendix 4: EL-images

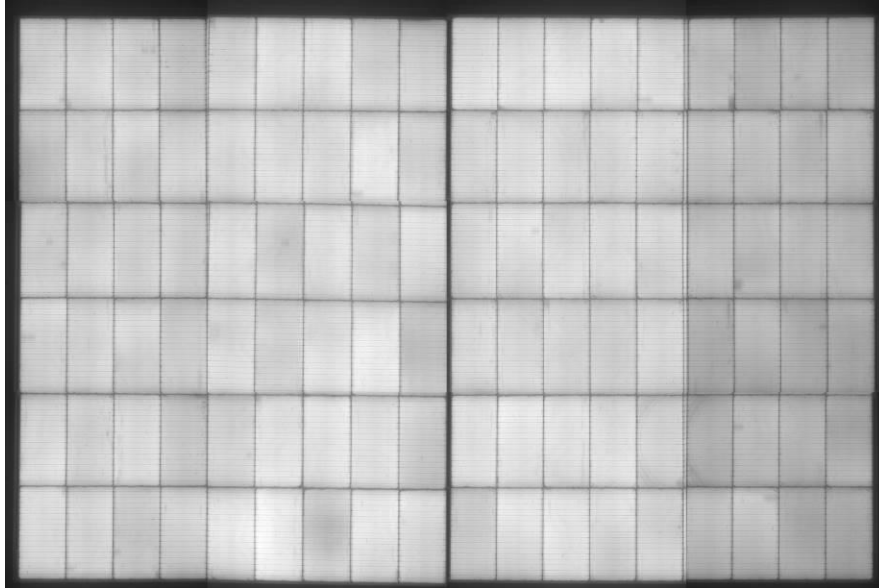


Fig. 5: EL-image of sample 1 (initial)

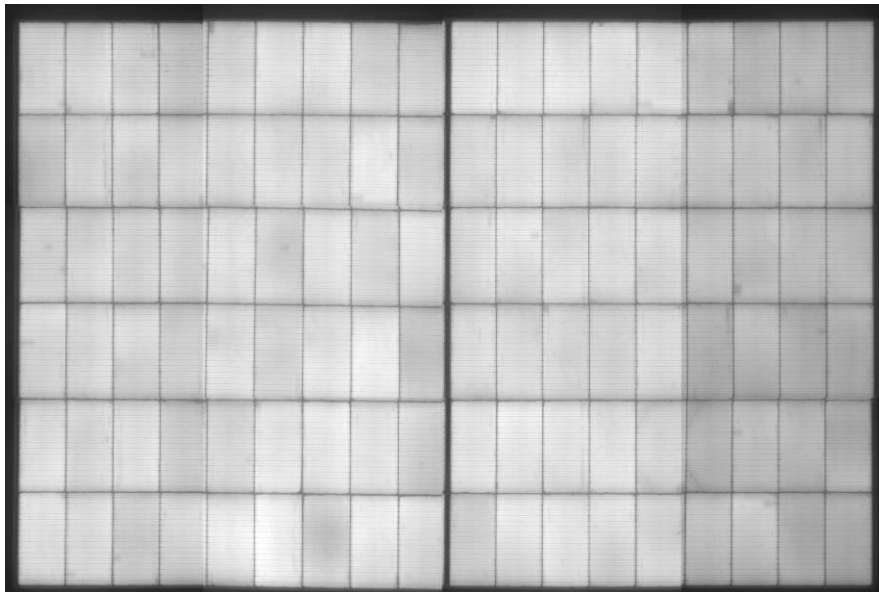


Fig. 6: EL-image of sample 1 (after HI test)

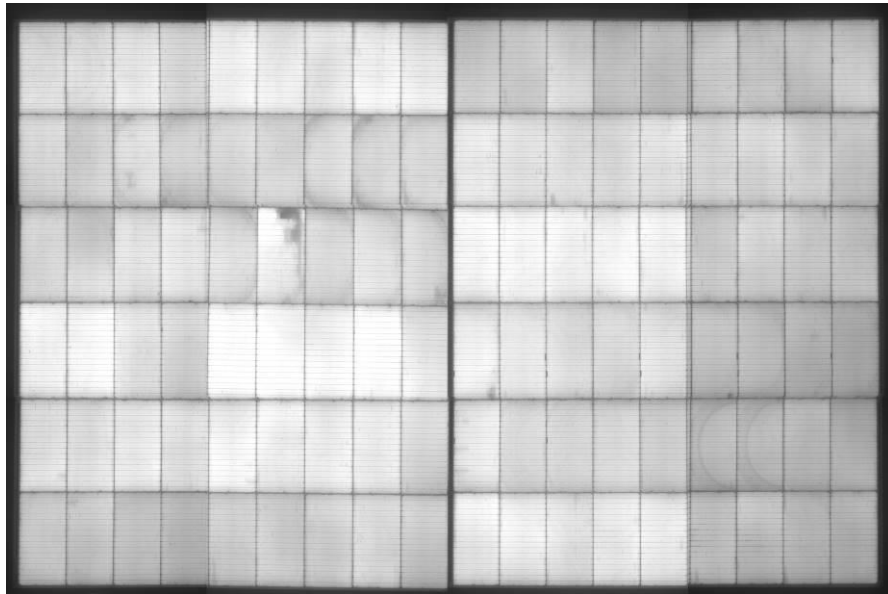


Fig. 7: EL-image of sample 2 (initial)

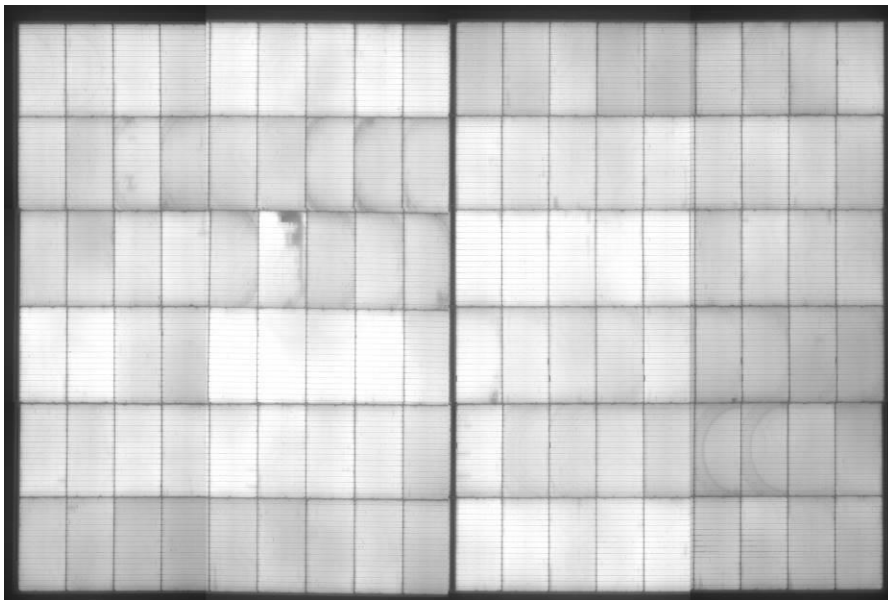


Fig. 8: EL-image of sample 2 (after HI test)

End of Test Report