

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

Test Report

Photovoltaic Module Tests
according to Client's Requirements

TÜV Report No. CN233N2U 001

Shanghai, January 2024

Test report No.:		CN233N2U 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>		244565588		Quotation No.: <i>Angebotsnummer:</i> 245824756	
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:		
 Project Engineer/ Daniel Wang			 Technical Reviewer/ Wenyao Lu		
10.01.2024	Date	Title/Name	Signature	10.01.2024	Date
Datum		Titel/Name	Unterschrift	Datum	
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:

P _{max}	– Maximum power point	V _{mpp}	– Maximum power point voltage
I _{mp}	– Maximum power point current	V _{oc}	– Open circuit voltage
I _{sc}	– Short circuit current	FF	– Fill factor
STC	– Performance at STC	EL	– Electroluminescence imaging
OD test	– Outdoor exposure 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.	A05231100600812	TSM-495NEG18R.28	½ mono cut-cell c-Si module, 132 pcs
	A05231100601093		

Sample #	1	2	3	4	5	6	7	8	9	10	11
Sample number	A05231100600812	A05231100601093									
Test items											
Visual inspection	x	x									
Performance at STC	x	x									
EL imaging	x	x									
Reference module	x										
Insulation test		x									
Wet leakage current test		x									
Outdoor exposure 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].....:	13.12.2023	—
Sample #	Nature and position of initial findings	Verdict
1	No visual defect	—
2	No visual defect	—
Supplementary information: N/A		

Initial performance at STC (Refer to IEC 61215-2:2021, MQT06.1)

Test Date [DD-MM-YYYY].....:			14.12.2023			—
Test method			☒ indoor	☐ outdoor		—
Irradiance [W/m²]			1000			—
Illuminated direction.....:			☒ front side	☐ rear side		—
Module temperature [°C]			25			—
Sample #	Pmpp [W]	Vmpp [V]	Impp [A]	Voc [V]	Isc [A]	FF [%]
1	494.5	32.80	15.076	38.90	15.843	80.2
2	494.9	32.88	15.052	38.96	15.811	80.3
Supplementary information: N/A						

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

Test Date [DD-MM-YYYY].....:				15.12.2023		—
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	7542	2.22	16743	-	No	P
2	7321	2.22	16253	-	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].....:	15.12.2023			—
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	200	2.22	444	P
2	246	2.22	546	P

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

Initial EL-images

Test Date [DD-MM-YYYY].....:	14.12.2023	—
Current applied	Isc ± 5%	—
Sample #	Remarks	—
1	N/A	—
2	N/A	—
Supplementary information: Refer to Appendix 4: EL-images.		

Outdoor exposure test (Refer to IEC 61215-2:2021, MQT08)

Test Date [DD-MM-YYYY].....:	20.12.2023 ~ 03.01.2024	—
Total irradiation [kWh/m²]	60	—
Sample #	Resistive load [yes/no]	—
2	Yes	P
Supplementary information: N/A		

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

Test Date [DD-MM-YYYY].....:	05.01.2024	—
Sample #	Nature and position of initial findings	Verdict
1	No visual defect	P
2	No visual defect	P
Supplementary information: N/A		

Performance at STC after OD test (Refer to IEC 61215-2:2021, MQT06.1)

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			—
Sample #	Pmpp [W]	Vmpp [V]	Impp [A]	Voc [V]	Isc [A]	FF [%]	Degradation [%]
1	494.7	32.85	15.062	38.93	15.819	80.3	—
2	494.0	32.90	15.013	38.93	15.750	80.6	-0.20
Supplementary information: N/A							

Insulation test after OD 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	6530	2.22	14497	-	No	P
2	7321	2.22	16253	-	No	P

* Pass requirement is higher 0.04 GΩ*m²

Wet leakage current test after OD 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	255	2.22	566	P
2	246	2.22	546	P

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

EL-images after OD test

Test Date [DD-MM-YYYY].....:	05.01.2024		—
Current applied	I _{sc} ± 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 STC 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



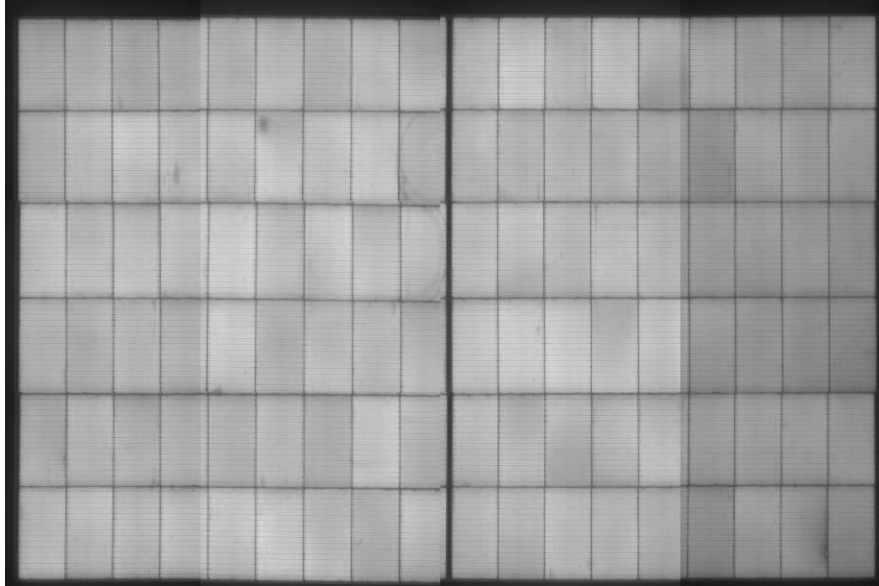
Fig. 2: rear view of module



Fig. 3: label of module



Fig. 4: junction box of module

Appendix 4: EL-images

of sample 1 (initial)

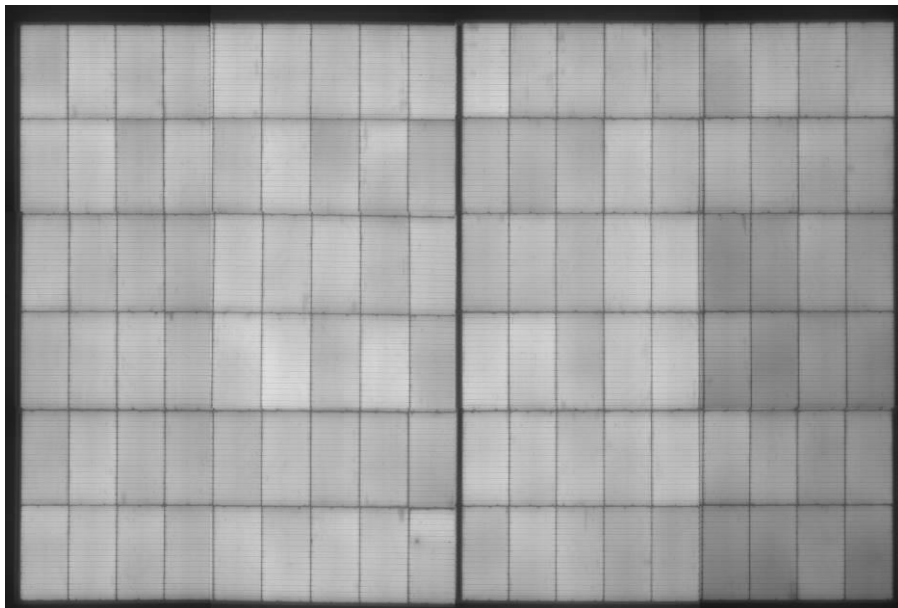


Fig. 5: EL-image of sample 2 (initial)

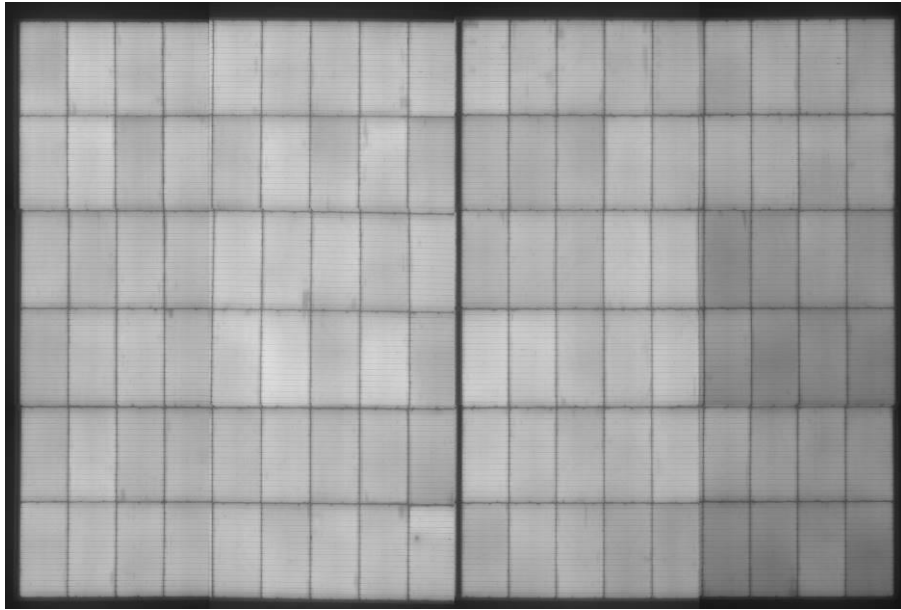


Fig. 6: EL-image of sample 2 (after OD test)

End of Test Report