

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

Test Report

Photovoltaic Module Tests
according to Client's Requirements

TÜV Report No. CN230BF9 001

Shanghai, April 2023




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<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> 28.02.2023
Identification: <i>Bezeichnung:</i>	Refer to Page 4	
Order No.: <i>Auftragsnummer:</i>	244497179	Quotation No.: <i>Angebotsnummer:</i> 245796477
Place of testing: <i>Ort der Prüfung:</i>	TÜV Rheinland (Shanghai) Co., Ltd.	
Testing laboratory: <i>Prüflaboratorium:</i>	TÜV Rheinland (Shanghai) Co., Ltd. B1-13F No. 177, Lane 777, West Guangzhong Road, Jing'an District Shanghai 200072, P. R. China	
Test specification: <i>Prüfgrundlage:</i>	Refer to IEC 61215-2: 2016, etc.	
Test Result: <i>Prüfergebnis:</i>	Refer to the verdict of the test report	
tested by / geprüft:	reviewed by / kontrolliert:	
07.04.2023	 Project Engineer/ Daniel W. S. Wang	 Technical Reviewer/ Wenya Lu
Date <i>Datum</i>	Title/Name <i>Titel/Name</i>	Signature <i>Unterschrift</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
TC200	– Thermal cycling 200 cycles	UV15	– UV preconditioning 15kWh/m ²
TC50	– Thermal cycling 50 cycles	HF10	– Humidity freeze 10 cycles
DH1000	– Damp heat 1000h	HI	– Hail test
HS	– Hot-spot endurance test	ML	– Mechanical load 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

<input type="checkbox"/>	Random sampling from production (e.g. during factory audit (FA) or inline inspection)
<input type="checkbox"/>	Random sampling from the warehouse, container or transportation boxes
<input checked="" type="checkbox"/>	Modules have been submitted by the manufacturer/ client without random sampling by TÜV Rheinland
Supplementary information: NA	

Module test assignment

Module manufacturer	Module type	Remarks / constructional characteristics
Trina	TSM-430NEG9R.28	mono c-Si module, 144pcs

Sample #	1	2	3	4	5	6	7	8	9	10	11
Sample number	A03230200519676	A03230200519677									
Test items											
Visual inspection	x	x									
Maximum power determination	x	x									
EL imaging	x	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: 2016, MQT01)

Test Date [DD-MM-YYYY]..... :	18.03.2023	—
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: 2016, MQT02)

Test Date [DD-MM-YYYY]..... :	19.03.2023	—				
Test method..... :	<input checked="" type="checkbox"/> indoor <input type="checkbox"/> outdoor	—				
Irradiance [W/m²]..... :	1000	—				
Module temperature [°C]..... :	25 ± 1	—				
Sample #	Pmpp [W]	Vmpp [V]	Imp [A]	Voc [V]	Isc [A]	FF [%]
1	434.5	43.48	9.993	51.52	10.554	79.9
2	432.0	43.26	9.985	51.29	10.511	80.1
Supplementary information: N/A						

Initial insulation test (Refer to IEC 61215-2: 2016, MQT03)

Test Date [DD-MM-YYYY]..... :	22.03.2023	—				
Maximum system voltage [VDC]	1500	—				
High voltage applied [VDC]	4000	—				
Insulation resistance measured at [VDC]	1500	—				
Sample #	Measured	Area	Result*	Dielectric breakdown		Verdict
	GΩ	m²	GΩ * m²	Yes (description)	No	
2	17.6	2.00	35.20	-	No	P
* Pass requirement is higher 0.04 GΩ*m²; Insulation tester can measure up to 100 GΩ.						

Initial wet leakage current test (Refer to IEC 61215-2: 2016, MQT15)

Test Date [DD-MM-YYYY]..... :	22.03.2023	—		
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	
2	6980	2.00	13960	P
* Minimum requirement acc. to the standard is 40 MΩ*m²; Insulation tester can measure up to 10000 MΩ.				

Initial EL-images

Test Date [DD-MM-YYYY]..... :	18.03.2023	—
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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: 2016, MQT17)

Test Date [DD-MM-YYYY]..... :	22.03.2023	—
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: 2016, MQT01)

Test Date [DD-MM-YYYY]..... :	22.03.2023	—
Sample #	Nature and position of initial findings	Verdict
2	No visual defect	P
Supplementary information: N/A		

Maximum power determination after Hail test (Refer to IEC 61215-2: 2016, MQT02)

Test Date [DD-MM-YYYY]..... :	24.03.2023	—					
Module temperature [°C]..... :	25 ± 1	—					
Irradiance [W / m ²]..... :	1000	—					
Sample #	Pmpp [W]	Vmpp [V]	Imp [A]	Voc [V]	Isc [A]	FF [%]	Degradation [%]
2	430.0	43.10	9.977	51.13	10.523	79.9	-0.45
Supplementary information: N/A							

Insulation test after Hail test (Refer to IEC 61215-2: 2016, MQT03)

Test Date [DD-MM-YYYY]..... :	25.03.2023	—				
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
	GΩ	m ²	GΩ * m ²	Yes (description)	No	
2	18.70	2.00	37.40	-	No	P
* Pass requirement is higher 0.04 GΩ*m ² ; Insulation tester can measure up to 100 GΩ.						

Wet leakage current test after Hail test (Refer to IEC 61215-2: 2016, MQT15)

Test Date [DD-MM-YYYY]..... :	25.03.2023	—		
Insulation resistance measured at [V _{DC}]	1500	—		
Solution resistivity [Ω cm]	< 3,500	—		
Solution temperature [°C]..... :	22 ± 3	—		
Sample #	Measured	Area	Result*	Verdict
	MΩ	m ²	MΩ * m ²	
2	3790	2.00	7580	P
* Minimum requirement acc. to the standard is 40 MΩ*m ² ; Insulation tester can measure up to 10000 MΩ.				

EL-images after Hail test

Test Date [DD-MM-YYYY]..... :	23.03.2023	—		
Current applied..... :	I _{sc} ± 5%	—		
Sample #	Remarks			—
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:
 - o Uncertainty in P_{mpp} within $\pm 2.5 \%$, $k=2$
 - o Uncertainty in I_{sc} within $\pm 2.4 \%$, $k=2$
 - o Uncertainty in V_{oc} within $\pm 0.9 \%$, $k=2$

Appendix 3: Photos of the modules



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

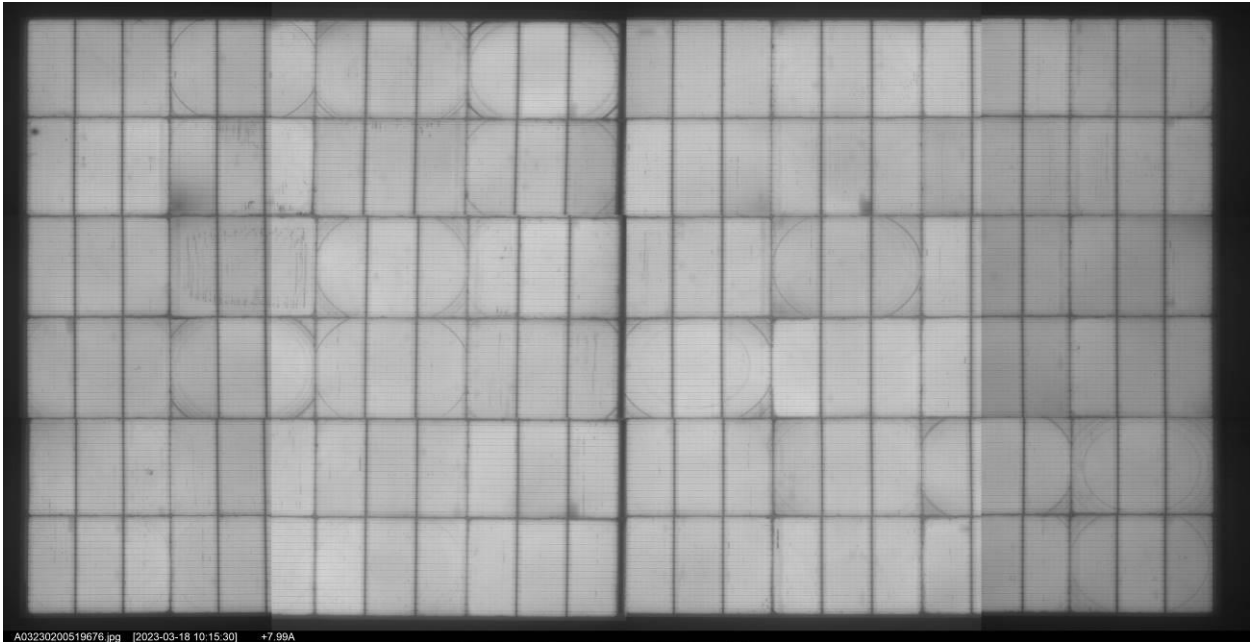


Fig. 5: EL-image of sample 1 (initial)

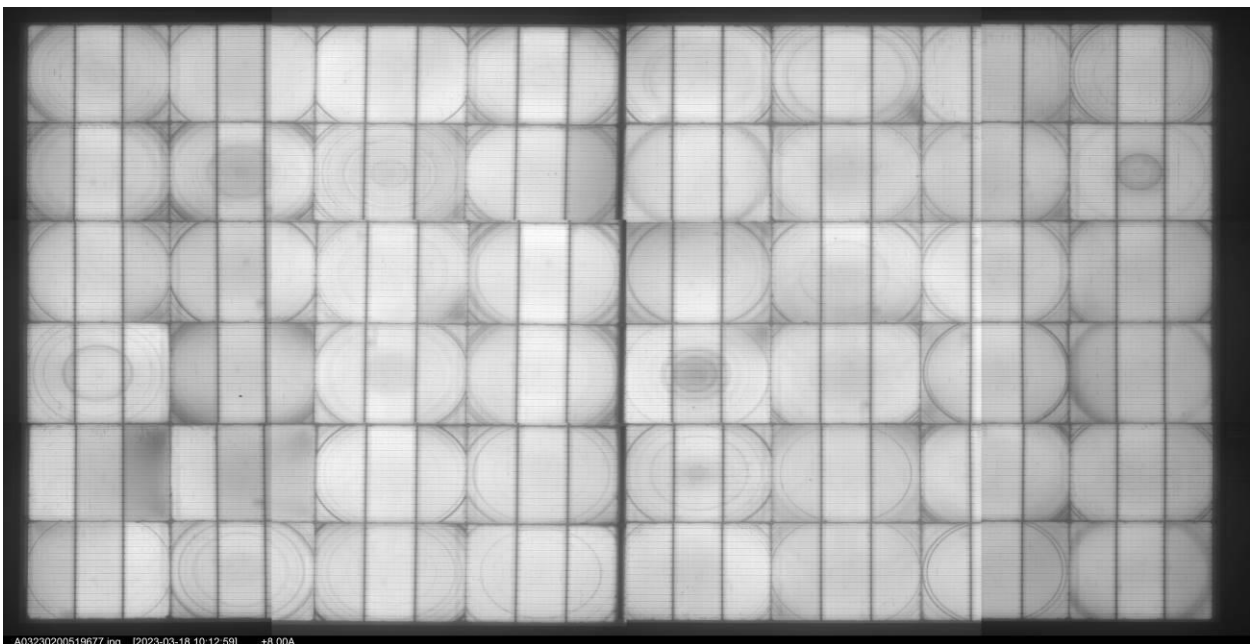


Fig. 6: EL-image of sample 2 (initial)

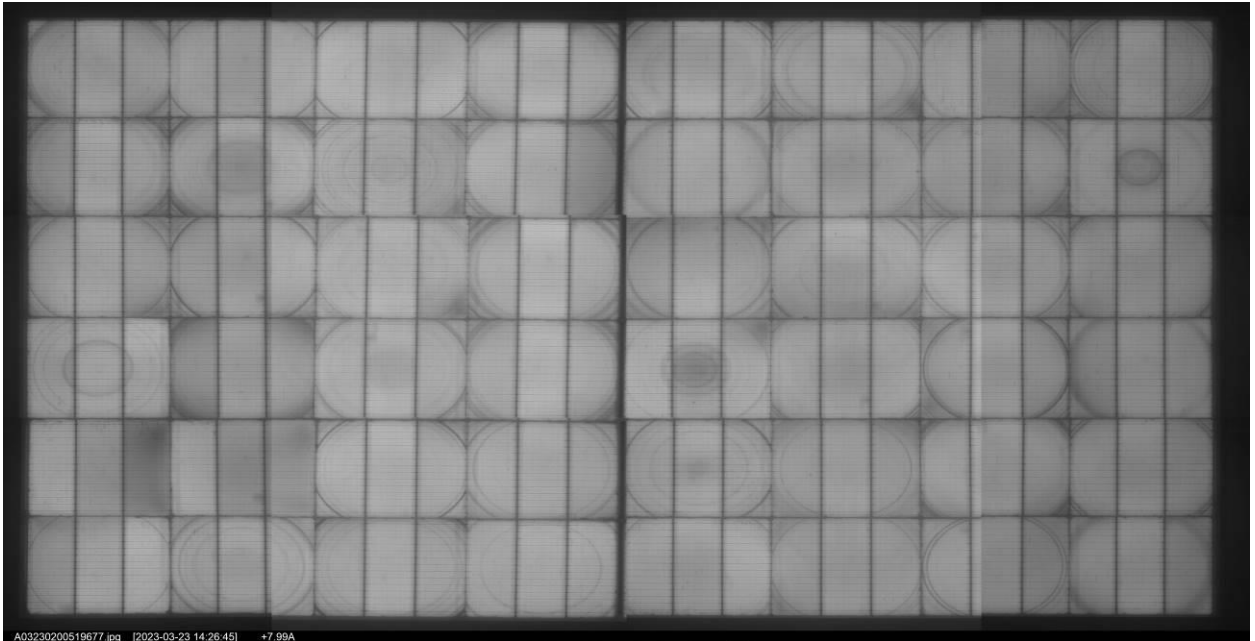


Fig. 7: EL-image of sample 2 (after HI test)

End of Test Report