

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

Test Report

Photovoltaic Module Tests
according to Client's Requirements

TÜV Report No. CN25N73T 002

Shanghai, April 2025




Test report No.: CN25N73T 002		Page 2 / 15
<i>Prüfbericht - Nr.:</i>		
Client (Customer No. + address): <i>Auftraggeber</i> (Kunden-Nr. + Adresse):	Tongwei Co.,Ltd. No.588, Middle Section Tianfu Avenue, High-Tech Zone, Chengdu, China(Sichuan)Pilot Free Trade Zone, Chengdu, 610041 Sichuan P.R. China	
Test Item: <i>Gegenstand der Prüfung:</i>	Photovoltaic (PV) Module(s)	Date of receipt: <i>Eingangsdatum:</i> 12/03/2025
Identification: <i>Bezeichnung:</i>	TWMNF-66HD710	
Order No.: <i>Auftragsnummer:</i>	326098417	Quotation No.: <i>Angebotsnummer:</i> 245865069
Testing location: <i>Prüfört:</i>	TÜV Rheinland (Suzhou) Co., Ltd. Building 14, Plainvim (Taicang) Modern Industrial Park, No. 525 South Lingang Road, Shaxi Town, Taicang, Suzhou, Jiangsu	
Test specification: <i>Prüfgrundlage:</i>	Refer to section 3 for test methodology	
Test Result: <i>Prüfergebnis:</i>	See section 5 for detailed results	
tested by / geprüft:		reviewed by / kontrolliert:
09/04/2025	Project Engineer/ Susie Li 	09/04/2025
		Technical Reviewer/ Wenyao Lu 
Date <i>Datum</i>	Title/Name <i>Titel/Name</i>	Signature <i>Unterschrift</i>
Other Aspects / Sonstiges:		
- This report is the separate version based on CN25N73T 001.		
		
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.		

Table of Content

1	General Information	5
2	Executive Summary	6
3	Test Methodology	7
3.1	Visual inspection.....	7
3.2	Maximum power determination	7
3.3	Electroluminescence	8
3.4	Insulation test	8
3.5	Wet leakage current test.....	9
3.6	Hail test.....	9
4	Sampling and Test Assignment	10
4.1	Sampling procedure	10
4.2	Module test assignment.....	10
5	Test Results	11
5.1	Initial visual inspection.....	11
5.2	Initial maximum power determination.....	11
5.3	Initial electroluminescence	11
5.4	Initial insulation test	11
5.5	Initial wet leakage current test.....	12
5.6	Hail test (35mm)	12
5.6.1	Visual inspection after HI test.....	12
5.6.2	Maximum power determination after HI test.....	12
5.6.3	Electroluminescence after HI test.....	13
5.6.4	Insulation test after HI test.....	13
5.6.5	Wet leakage current test after HI test.....	13
6	Annex	14
6.1	Annex 1: Photos of test module	14
6.2	Annex 2: EL-imaging	15

List of Tables

Table 1: Test result summary	6
Table 2: Measuring equipment for visual inspection	7
Table 3: Measuring equipment for maximum power determination	8
Table 4: Measurement related software for maximum power determination	8
Table 5: Module assignment	10

1 General Information

Date(s) of performance of tests: 13/03/2025 – 26/03/2025

Abbreviations used in this report:

Pmax	– Maximum power	Vmpp	– Maximum power point voltage
Impp	– Maximum power point current	Voc	– Open circuit voltage
Isc	– Short circuit current	FF	– Fill factor
VI	– Visual inspection	MPD	– Maximum power determination
EL	– Electroluminescence	INS	– Insulation test
WLC	– Wet leakage current test	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.
- Any question in regard to this report, please contact TÜV Rheinland (Shanghai) Co., Ltd. within one week after report issued.
- Acceptance criteria are mentioned in this report.

2 Executive Summary

TÜV Rheinland has performed module tests for Tongwei Co.,Ltd. at TÜV Rheinland (Suzhou) Co., Ltd. The results provided are related to PV modules tested for 1 pc module.

Table 1: Test result summary

Test	Quantity	Results	Report no.
VI	1	See section 5.1 for details	CN25N73T 002
MPD	1	See section 5.2 for details	
EL	1	See section 5.3 for details	
INS	1	See section 5.4 for details	
WLC	1	See section 5.5 for details	
HI	1	See section 5.6 for details	

3 Test Methodology

3.1 Visual inspection

The Visual inspection is performed in accordance with IEC 61215-2: 2021, MQT 01 and comprises the verification of the following:

- Front of the module
 - Inclusions in the laminate
 - Inclusions in the glass
 - Broken cells
 - Scratches, bubbles or defects in the glass that may compromise the performance or safety of the module
 - Bubbles
 - Yellowing
 - Condition of the frame
 - Condition of welded parts
- Back of the module
 - Scratches or cuts in the back sheet
 - Any kind of bubbles or delamination
 - Bumps or depressions on the back sheet

Table 2: Measuring equipment for visual inspection

Device	Index no.	Measured variable	Application
Ruler	PV-454	Measure defects	Visual inspection

3.2 Maximum power determination

Maximum power determination test is performed in accordance with IEC 61215-2: 2021, MQT 02. Power measurements are performed with an AAA pulsed solar simulator in a dark chamber designed to reduce the impact of indirect light. Temperature correction is applied by using the temperature coefficient which was provided by the manufacturer. The measurement reproducibility is confined within $\pm 0.8\%$, $k=2$. The described experimental setup shows a combined expanded measurement uncertainty, which is less than $\pm 2.5\%$, $k=2$ under the commonly referred Standard Test Condition (as detailed in IEC 61215: 1000W/m², 25°C and AM1.5G)

Table 3: Measuring equipment for maximum power determination

Device	Index no.	Measured variable	Application
Primary calibrated reference solar cell	PV-012	Global irradiance coplanar with specimen	Pulsed solar simulator measurements
Solar simulator	PV-481	Current, voltage, irradiance	Pulsed solar simulator measurements
IR-sensor	PV-209 PV-210 PV-216 PV-499	Specimen temperature	Pulsed solar simulator measurements

Table 4: Measurement related software for maximum power determination

Program	Version no.	Date	Application
PASAN SPROD Tester	STC V2.9.2	26.01.2018	Operating software pulsed solar simulator

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.
- The power measurement was performed with a pulsed solar simulator of Class AAA according to IEC60904-9:2020. The extended measurement uncertainty is:
 - o Uncertainty in P_{MAX} within $\pm 2.5 \%$, $k=2$
 - o Uncertainty in I_{SC} within $\pm 2.4 \%$, $k=2$
 - o Uncertainty in V_{OC} within $\pm 0.9 \%$, $k=2$

3.3 Electroluminescence

The electroluminescence test makes cracks and other cell related defects visible.

This test is to be performed referring to standard IEC TS 60904-13: 2018.

The test sample is installed in a dark tunnel to prevent light entering the test area or reaching the test sample. A current close to the sample's rated I_{sc} for around 40 seconds is injected and then the EL image taken.

3.4 Insulation test

This test is to be performed referring to standard IEC 61215-2: 2021, MQT 03.

Acceptance criteria:

Measured insulation resistance times the area of the module shall not be less than $40 \text{ M}\Omega \cdot \text{m}^2$.

3.5 Wet leakage current test

This test is to be performed referring to standard IEC 61215-2: 2021, MQT 15.

Acceptance criteria:

Measured insulation resistance times the area of the module shall not be less than 40 MΩ·m².

3.6 Hail test

This test is to be performed referring to standard IEC 61215-2: 2021, MQT 17.

Acceptance criteria:

Power degradation for each tested module ≤ 5%.

4 Sampling and Test Assignment

4.1 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

4.2 Module test assignment

Table 5: Module assignment

Module manufacturer	Tongwei Co.,Ltd.
Module type	TWMNF-66HD710
Module technology	½ cut n-TOPCon c-Si cell Bifacial Module, 132 pcs

Sample #	1	2	3	4	5	6	7	8	9	10	11
Sample number	H6E246003000319										
Test items	/										
VI	x										
MPD	x										
EL	x										
INS	x										
WLC	x										
HI	x										
Legend:											
x	Selected sample for test										
Test sequence is required by client.											

5 Test Results

5.1 Initial visual inspection

Test date [DD/MM/YYYY]	13/03/2025	
Sample #	Nature and position of findings	Verdict
1	No visual defect	P
Supplementary information: N/A.		

5.2 Initial maximum power determination

Test date [DD/MM/YYYY]		20/03/2025				
Module temperature [°C]		25 ± 1				
Irradiance [W/m ²]		1000				
Illuminating direction		<input checked="" type="checkbox"/> Front		<input type="checkbox"/> Rear		
Sample #	P _{max} [W]	V _{mpp} [V]	I _{mpp} [A]	V _{oc} [V]	I _{sc} [A]	FF [%]
1	714.5	41.09	17.387	48.81	18.261	80.2
Supplementary information: The non-illuminated side was covered with non-reflective background.						

5.3 Initial electroluminescence

Test date [DD/MM/YYYY]	20/03/2025	
Current applied	I _{sc} ± 5%	
Sample #	Remarks	
1	N/A	
Supplementary information: Refer to Annex 2: EL-imaging.		

5.4 Initial insulation test

Test date [DD/MM/YYYY]		20/03/2025				
Maximum system voltage [VDC]		1500				
High voltage applied [VDC]		8000				
Insulation resistance measured at [VDC]		1500				
Sample #	Measured	Area	Result	Dielectric breakdown		Verdict
	GΩ	m ²	GΩ·m ²	Yes (description)	No	

1	27.50	3.10	85.25	—	No	P
Pass criteria: No dielectric breakdown, insulation resistance shall be greater than 40 MΩ·m ² .						

5.5 Initial wet leakage current test

Test date [DD/MM/YYYY]	20/03/2025			
Insulation resistance measured at [VDC]	1500			
Solution resistivity [Ω·cm]	< 3500			
Solution temperature [°C]	22 ± 2			
Sample #	Measured	Area	Result	Verdict
	MΩ	m ²	MΩ·m ²	
1	8370.0	3.10	25947.0	P
Pass criteria: No dielectric breakdown, insulation resistance shall be greater than 40 MΩ·m ² .				

5.6 Hail test (35mm)

Test date [DD/MM/YYYY]	26/03/2025		
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 #	—		Verdict
1	—		P
Supplementary information: N/A.			

5.6.1 Visual inspection after HI test

Test date [DD/MM/YYYY]	26/03/2025	
Sample #	Nature and position of findings	Verdict
1	No visual defect	P
Supplementary information: N/A.		

5.6.2 Maximum power determination after HI test

Test date [DD/MM/YYYY]	26/03/2025
Module temperature [°C]	25 ± 1
Irradiance [W/m ²]	1000

Illuminating direction			<input checked="" type="checkbox"/>	Front			<input type="checkbox"/>	Rear	
Sample #	Pmax[W]	Vmpp [V]	Impp [A]	Voc [V]	Isc [A]	FF [%]	Degradation* [%]	Verdict	
1	711.0	40.95	17.360	48.75	18.234	80.0	-0.49	P	
* Negative value means power loss.									
Supplementary information: The non-illuminated side was covered with non-reflective background.									

5.6.3 Electroluminescence after HI test

Test date [DD/MM/YYYY]	26/03/2025
Current applied	Isc \pm 5%
Sample #	Remarks
1	N/A
Supplementary information: Refer to Annex 2: EL-imaging.	

5.6.4 Insulation test after HI test

Test date [DD/MM/YYYY]		26/03/2025				
Maximum system voltage [VDC]		1500				
High voltage applied [VDC]		8000				
Insulation resistance measured at [VDC]		1500				
Sample #	Measured	Area	Result	Dielectric breakdown		Verdict
	G Ω	m ²	G Ω ·m ²	Yes (description)	No	
1	23.40	3.10	72.54	—	No	P
Pass criteria: No dielectric breakdown, insulation resistance shall be greater than 40 M Ω ·m ² .						

5.6.5 Wet leakage current test after HI test

Test date [DD/MM/YYYY]		26/03/2025				
Insulation resistance measured at [VDC]		1000				
Solution resistivity [Ω ·cm]		< 3500				
Solution temperature [°C]		22 \pm 2				
Sample #	Measured	Area	Result	Verdict		
	M Ω	m ²	M Ω ·m ²			
1	7560.0	3.10	23436.0	P		
Pass criteria: No dielectric breakdown, insulation resistance shall be higher than 40 M Ω ·m ² .						

6 Annex

6.1 Annex 1: Photos of test module



Figure 1: Front view of test module type TWMNF-66HD710



Figure 2: Rear view of test module type TWMNF-66HD710

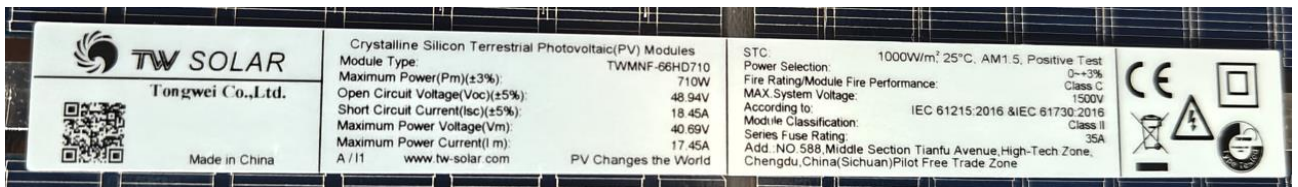


Figure 3: Rating label of test module type TWMNF-66HD710



Figure 4: Junction boxes of test module type TWMNF-66HD710

6.2 Annex 2: EL-imaging

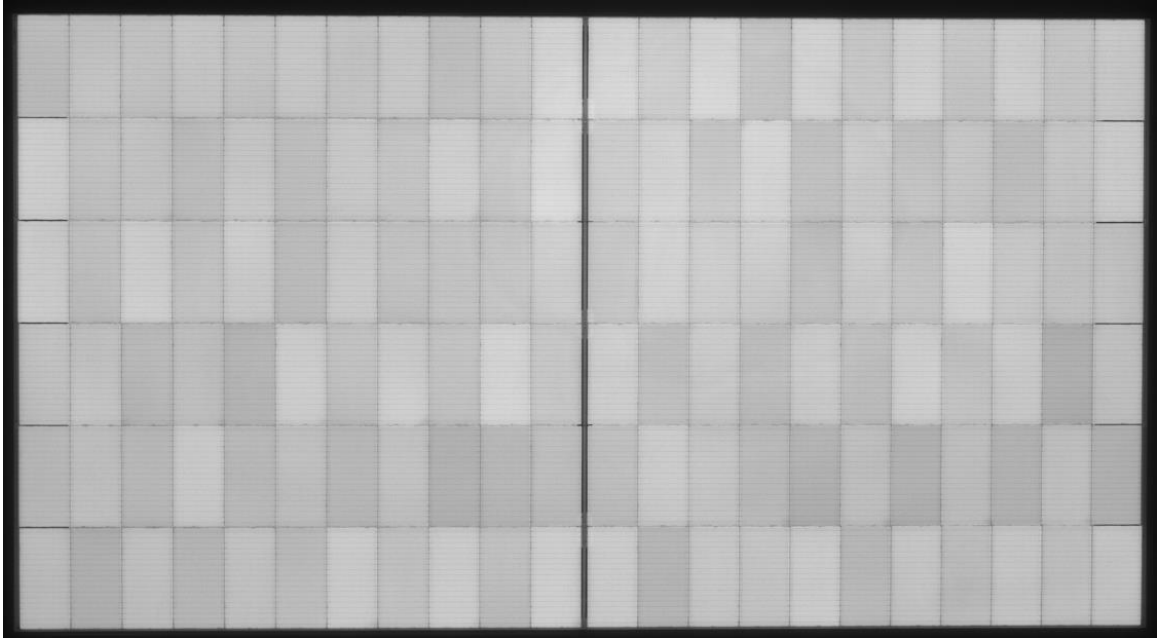


Figure 5: EL-image of sample #1 (initial)

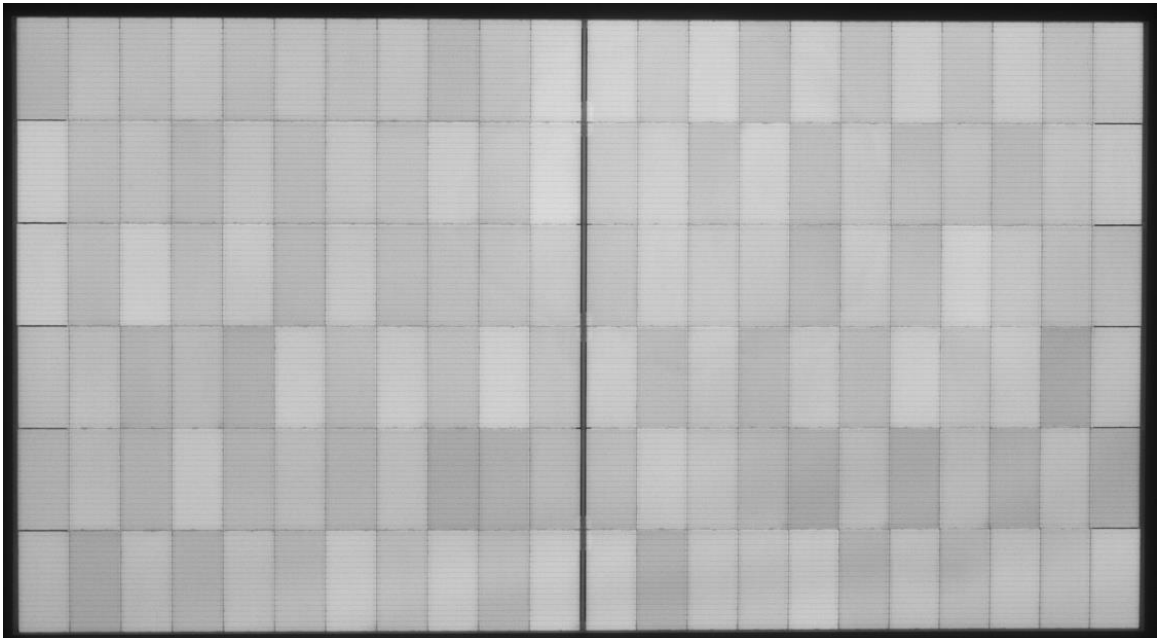


Figure 6: EL-image of sample #1 (after HI test)

End of Test Report