




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

## **Test Report**

Photovoltaic Module Tests  
according to Client's Requirements

**TÜV Report No. CN25N73T 003**

**Shanghai, April 2025**

<b>Test report No.:</b> CN25N73T 003		Page 2 / 15			
<i>Prüfbericht - Nr.:</i>					
<b>Client</b> (Customer No. + address): <i>Auftraggeber</i> (Kunden-Nr. + Adresse):	<b>Tongwei Co.,Ltd.</b> No.588, Middle Section Tianfu Avenue, High-Tech Zone, Chengdu, China(Sichuan)Pilot Free Trade Zone, Chengdu, 610041 Sichuan P.R. China				
<b>Test Item:</b> <i>Gegenstand der Prüfung:</i>	Photovoltaic (PV) Module(s)	<b>Date of receipt:</b> <i>Eingangsdatum:</i> 12/03/2025			
<b>Identification:</b> <i>Bezeichnung:</i>	TWMNH-66HD610				
<b>Order No.:</b> <i>Auftragsnummer:</i>	326098417	<b>Quotation No.:</b> <i>Angebotsnummer:</i> 245865069			
<b>Testing location:</b> <i>Prüfört:</i>	<b>TÜV Rheinland (Suzhou) Co., Ltd.</b> Building 14, Plainvim (Taicang) Modern Industrial Park, No. 525 South Lingang Road, Shaxi Town, Taicang, Suzhou, Jiangsu				
<b>Test specification:</b> <i>Prüfgrundlage:</i>	Refer to section 3 for test methodology				
<b>Test Result:</b> <i>Prüfergebnis:</i>	See section 5 for detailed results				
<b>tested by / geprüft:</b>	<b>reviewed by / kontrolliert:</b>				
09/04/2025	Project Engineer/ Susie Li 	09/04/2025			
		Technical Reviewer/ Wenyao Lu 			
<b>Date</b> <i>Datum</i>	<b>Title/Name</b> <i>Titel/Name</i>	<b>Signature</b> <i>Unterschrift</i>	<b>Date</b> <i>Datum</i>	<b>Title/Name</b> <i>Titel/Name</i>	<b>Signature</b> <i>Unterschrift</i>
<b>Other Aspects / Sonstiges:</b>					
- This report is the separate version based on CN25N73T 001.					
					
<b>Abkürzungen:</b> P(ass) = entspricht Prüfgrundlage F(ail) = entspricht nicht Prüfgrundlage N/A = nicht anwendbar N/T = nicht getestet			<b>Abbreviations:</b> P(ass) = passed F(ail) = failed N/A = not applicable N/T = not tested		
<b>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.</b>					
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

<b>1</b>	<b>General Information .....</b>	<b>5</b>
<b>2</b>	<b>Executive Summary .....</b>	<b>6</b>
<b>3</b>	<b>Test Methodology.....</b>	<b>7</b>
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
<b>4</b>	<b>Sampling and Test Assignment.....</b>	<b>10</b>
4.1	Sampling procedure .....	10
4.2	Module test assignment.....	10
<b>5</b>	<b>Test Results .....</b>	<b>11</b>
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
<b>6</b>	<b>Annex .....</b>	<b>14</b>
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 003
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/m<sup>2</sup>, 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·m<sup>2</sup>.

### 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

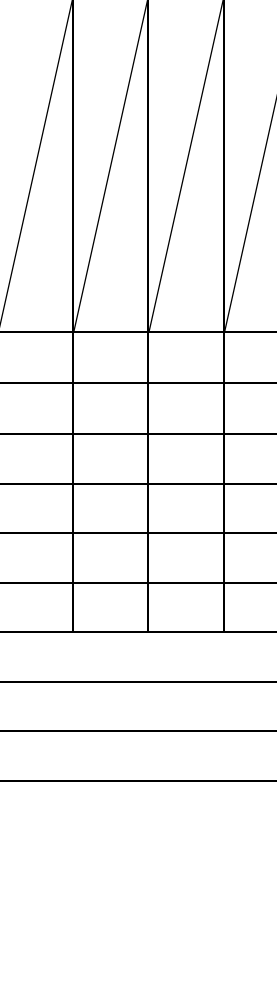
### 4.1 Sampling procedure

<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

<b>Module manufacturer</b>	Tongwei Co.,Ltd.
<b>Module type</b>	TWMNH-66HD610
<b>Module technology</b>	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	Y3M24C005011679 																					
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 <sup>2</sup> ]		1000				
Illuminating direction		<input checked="" type="checkbox"/> Front		<input type="checkbox"/> Rear		
Sample #	P <sub>max</sub> [W]	V <sub>mpp</sub> [V]	I <sub>mpp</sub> [A]	V <sub>oc</sub> [V]	I <sub>sc</sub> [A]	FF [%]
1	618.9	41.03	15.085	48.83	15.885	79.8
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 <sub>sc</sub> ± 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 <sup>2</sup>	GΩ·m <sup>2</sup>	Yes (description)	No	

1	26.50	2.70	71.55	—	No	P
Pass criteria: No dielectric breakdown, insulation resistance shall be greater than 40 MΩ·m <sup>2</sup> .						

### 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 <sup>2</sup>	MΩ·m <sup>2</sup>		
1	8140.0	2.70	21978.0	P	
Pass criteria: No dielectric breakdown, insulation resistance shall be greater than 40 MΩ·m <sup>2</sup> .					

### 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 <sup>2</sup> ]	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	618.6	41.06	15.064	48.78	15.856	80.0	-0.05	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 $\Omega$	m <sup>2</sup>	G $\Omega$ ·m <sup>2</sup>	Yes (description)	No	
1	24.30	2.70	65.61	—	No	P
Pass criteria: No dielectric breakdown, insulation resistance shall be greater than 40 M $\Omega$ ·m <sup>2</sup> .						

## 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 [ $\Omega$ ·cm]	< 3500				
Solution temperature [°C]	22 $\pm$ 2				
Sample #	Measured	Area	Result	Verdict	
	M $\Omega$	m <sup>2</sup>	M $\Omega$ ·m <sup>2</sup>		
1	7600.0	2.70	20520.0	P	
Pass criteria: No dielectric breakdown, insulation resistance shall be higher than 40 M $\Omega$ ·m <sup>2</sup> .					

**6 Annex**

**6.1 Annex 1: Photos of test module**



Figure 1: Front view of test module type TWMNH-66HD610



Figure 2: Rear view of test module type TWMNH-66HD610

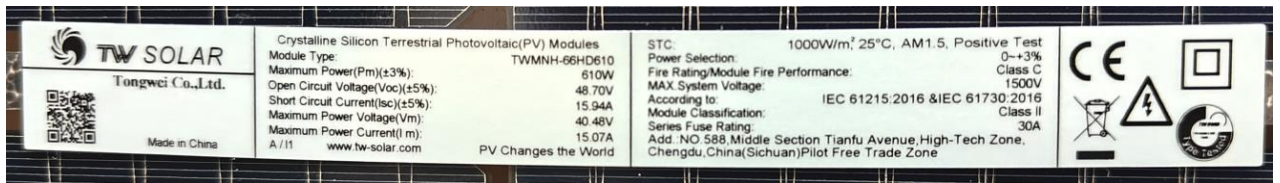
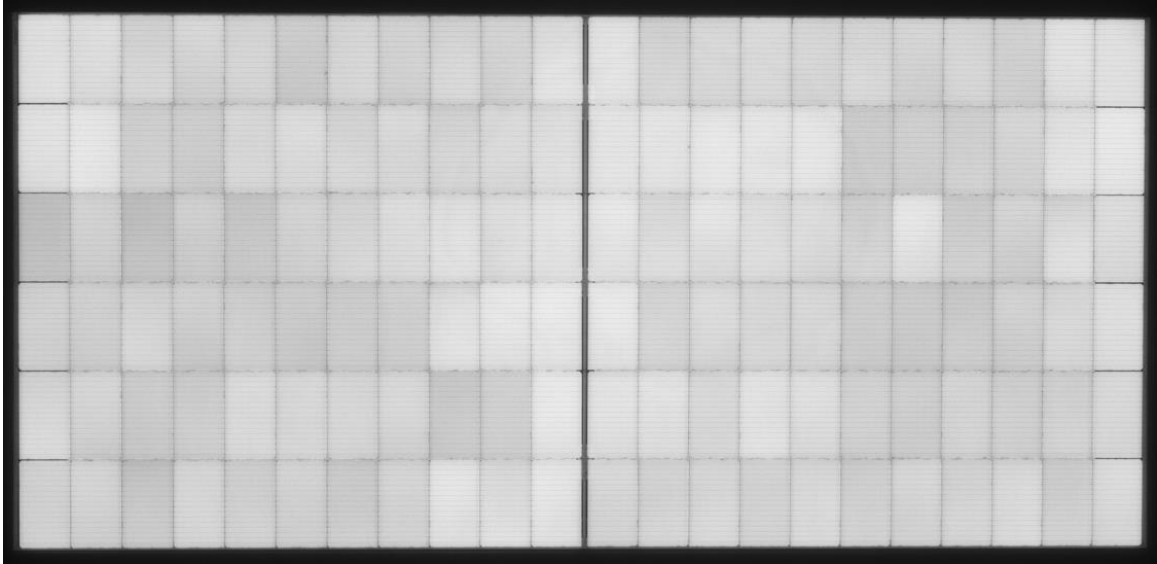


Figure 3: Rating label of test module type TWMNH-66HD610

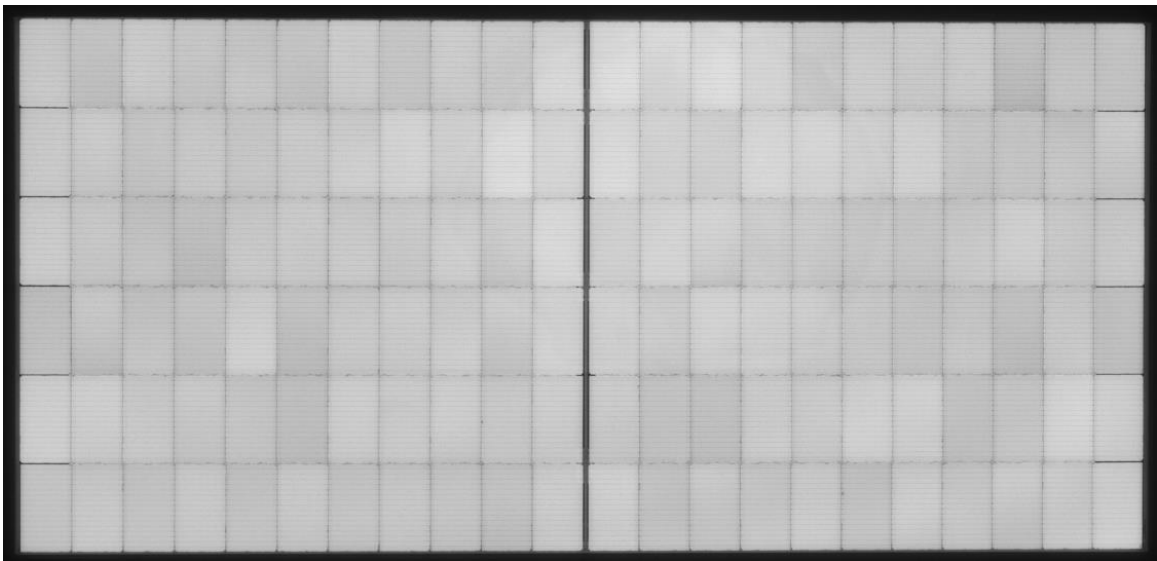


Figure 4: Junction boxes of test module type TWMNH-66HD610

**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**