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

Test Report

Photovoltaic Module Tests

according to Client's Requirements

TÜV Report No. CN23ZNGA 001

Shanghai, June 2023

Test report No.: *Prüfbericht - Nr.:*	**CN23ZNGA 001**		Page 2 / 15
Client (Customer No. + address): *Auftraggeber (Kunden-Nr. + Adresse):*	**Win Win Precision Technology Co., Ltd.** 4F., NO.180, Sec/2, Gongdao 5th Road, East., Dist., Hsinchu City, Taiwan		
Test Item: *Gegenstand der Prüfung:*	Photovoltaic (PV) Module(s)	**Date of receipt:** *Eingangsdatum:*	12/06/2023
Identification: *Bezeichnung:*	WST-430NGX-D3		
Order No.: *Auftragsnummer:*	244521505	**Quotation No.:** *Angebotsnummer:*	P01086262
Testing location: *Prüfort:*	**TÜV Rheinland (Shanghai) Co., Ltd.** B1-13F No. 177, Lane 777, West Guangzhong Road, Jing'an District Shanghai 200072, P. R. China		
Test specification: *Prüfgrundlage:*	Refer to section 3 for test methodology		
Test Result: *Prüfergebnis:*	See section 5 for detailed results		

tested by / *geprüft:*			**reviewed by** / *kontrolliert:*		
29/06/2023	Project Engineer/ Daniel Wang	Daniel Wang	29/06/2023	Reviewer/ Wenyao Lu	Wenyao Lu
Date *Datum*	**Title/Name** *Titel/Name*	**Signature** *Unterschrift*	**Date** *Datum*	**Title/Name** *Titel/Name*	**Signature** *Unterschrift*

Other Aspects / *Sonstiges: N/A.*

TÜV Rheinland (Shanghai) Co., Ltd. * Inspection/Testing *

Abkürzungen:				*Abbreviations:*			
	P(ass)	=	*entspricht Prüfgrundlage*		*P(ass)*	=	*passed*
	F(ail)	=	*entspricht nicht Prüfgrundlage*		*F(ail)*	=	*failed*
	N/A	=	*nicht anwendbar*		*N/A*	=	*not applicable*
	N/T	=	*nicht getestet*		*N/T*	=	*not tested*

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1 General Information

Date(s) of performance of tests： 14/06/2023 – 28/06/2023

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	HT	– 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.
- I-V curves are only included in this report if they show any deviations. If required, other I-V curves will be provided upon request.
- Any question in regards to this report, please contact TÜV Rheinland (Shanghai) Co., Ltd. within one week after report issued.
- Acceptance criteria mentioned in this report are provided by client.

2 Executive Summary

TÜV Rheinland has performed module tests for Win Win Precision Technology Co., Ltd.

at TÜV Rheinland (Shanghai) Co., Ltd.

The results provided are related to PV modules tested for 1st batch 1 pc module.

Table 1: Test result summary

Test	Quantity	Results	Report no.
VI	1	See section 5.1 for details	CN23ZNGA 001
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	
Hail	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: 2016, 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-273	Measure defects	Visual inspection

3.2 Maximum power determination

Maximum power determination test is performed in accordance with IEC 61215-2: 2016, 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 ±0.8%, k=2. The described experimental setup shows a combined expanded measurement uncertainty, which is less than ±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
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

Table 4: Measurement related software for maximum power determination

Program	Version no.	Date	Application
Pulsed Solar Simulator Software	HighLight-R2.4.5	02.06.2021	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 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_{MAX} within ± 2.5 %, k=2
  - Uncertainty in I_{SC} within ± 2.4 %, k=2
  - Uncertainty in V_{OC} within ± 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 Impp 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: 2016, MQT 03.

Acceptance criteria:

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

3.5 Wet leakage current test

This test is to be performed referring to standard IEC 61215-2: 2016, 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: 2016, MQT 17.

4 Sampling and Test Assignment

4.1 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

4.2 Module test assignment

Table 5: Module assignment

Module manufacturer		WINAICO					
Module type		WST-430NGX-D3					
Module technology		Mono N-Type Bifacial half-cell c-Si Module, 108 pcs					
No.	**S/N**	**VI**	**MPD**	**EL**	**INS**	**WLC**	**Hail**
1	23E01100FAC05395	x	x	x	x	x	x
x: selected samples for test							
Supplementary information: N/A							

5 Test Results

5.1 Visual inspection

Test date [DD/MM/YYYY]	14/06/2023	
Sample #	Nature and position of findings	Verdict
1	No visual defect	P
Supplementary information: N/A.		

5.2 Maximum power determination

Test date [DD/MM/YYYY]			15/06/2023			
Module temperature [°C]			corrected to 25			
Irradiance [W/m²]			1000			
Illuminating direction			☒ Front		☐ Rear	
Sample #	Pmax [W]	Vmpp [V]	Impp [A]	Voc [V]	Isc [A]	FF [%]
1	421.9	32.73	12.890	38.78	13.549	80.3
Supplementary information: The non-illuminated side was covered with non-reflective background.						

5.3 Electroluminescence

Test date [DD/MM/YYYY]	15/06/2023
Current applied	Isc ± 5%
Sample #	Remarks
1	No significant defect
Supplementary information: Refer to Annex 2: EL Imaging.	

5.4 Insulation test

Test date [DD/MM/YYYY]				15/06/2023		
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	
1	12.50	1.95	24.38	—	No	P
* Pass criteria: No dielectric breakdown, insulation resistance shall be higher than 40 MΩ·m².						

5.5 Wet leakage current test

Test date [DD/MM/YYYY]	15/06/2023			
Insulation resistance measured at [VDC]	1500			
Solution resistivity [Ω·cm]	< 3500			
Solution temperature [°C]	22 ± 2			
Sample #	Measured	Area	Result	Verdict
	MΩ	m²	MΩ·m²	
1	3850.0	1.95	7507.5	P
Pass criteria: No dielectric breakdown, insulation resistance shall be higher than 40 MΩ·m².				

5.6 Hail test

Test date [DD/MM/YYYY]	25/06/2023	
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 #	—	Verdict
1	—	P

5.6.1 Visual inspection after HT

Test date [DD/MM/YYYY]	25/06/2023	
Sample #	Nature and position of findings	Verdict
1	No visual defect	P
Supplementary information: N/A.		

5.6.2 Maximum power determination after HT

Test date [DD/MM/YYYY]			28/06/2023					
Module temperature [°C]			corrected to 25					
Irradiance [W/m²]			1000					
Illuminating direction			☒ Front			☐ Rear		
Sample #	Pmax[W]	Vmpp [V]	Impp [A]	Voc [V]	Isc [A]	FF [%]	Degradation * [%]	Verdict
1	421.4	32.76	12.861	38.78	13.593	79.9	-0.13	P
* Negative value means power loss. Supplementary information: The non-illuminated side was covered with non-reflective background.								

5.6.3 Electroluminescence after HT

Test date [DD/MM/YYYY]	28/06/2023
Current applied	Isc ± 5%
Sample #	Remarks
1	No significant defect
Supplementary information: Refer to Annex 2: EL Imaging.	

5.6.4 Insulation test after HT

Test date [DD/MM/YYYY]				28/06/2023		
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	
1	8.26	1.95	16.11	—	No	P
* Pass criteria: No dielectric breakdown, insulation resistance shall be higher than 40 MΩ·m².						

5.6.5 Wet leakage current test after HT

Test date [DD/MM/YYYY]	28/06/2023			
Insulation resistance measured at [VDC]	1500			
Solution resistivity [Ω·cm]	< 3500			
Solution temperature [°C]	22 ± 2			
Sample #	Measured	Area	Result	Verdict
	MΩ	m²	MΩ·m²	
1	4260.0	1.95	8307.0	P
Pass criteria: No dielectric breakdown, insulation resistance shall be higher than 40 MΩ·m².				

6 Annex

6.1 Annex 1: Photos of test module

Figure 1: Front view of module WST-430NGX-D3

Figure 2: Rear view of module WST-430NGX-D3

Figure 3: Rating label of module type WST-430NGX-D3

Figure 4: Junction boxes of module type WST-430NGX-D3