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Test Report

No. TRPVP10079/24P/01

Commission Testing
according to IEC 61215-2 / EN IEC 61215-2

Applicant: **Tongwei Co., Ltd.**

No. 588, Middle Section Tianfu Avenue, High-Tech Zone,
Chengdu, China (Sichuan) Pilot Free Trade Zone

File No.: PVP10079/24P-01

Designed: by: Cara Chen 数字签名者：Cara Chen 日期：2024.11.28 20:48:39 +08'00'
(Project Engineer)

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(Technical Certifier)

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TÜVNORD

Test Report

File No.: PVP10079/24P Test Report No.: TRPVP10079/24P/01

Applicant ..... :	**Tongwei Co., Ltd.** No. 588, Middle Section Tianfu Avenue, High-Tech Zone, Chengdu, China (Sichuan) Pilot Free Trade Zone
Manufacturer ..... :	**Tongwei Solar (Hefei) Co., Ltd.** No.888, Changning Road, High-tech District, Hefei City, Anhui Province, 230088, P.R. China
Factory..... :	**Tongwei Solar (Hefei) Co., Ltd.** No.888, Changning Road, High-tech District, Hefei City, Anhui Province, 230088, P.R. China
Order No. ..... :	QT-PVP10079/24P
Date of Application ..... :	2024-10-24
Product ..... :	Crystalline Silicon Terrestrial Photovoltaic (PV) Modules
Module type(s)..... :	**PV Modules:** TWMNH-48HD440
General Information • Maximum System Voltage.... : • Electrical Protection Class.... : • Fire Safety Class ..... :	 DC 1500V Class II Class C
Type of examination ..... :	Commission testing only
Testing Period ..... :	2024-10-30/2024-11-07
Responsible Testing Laboratory :	**TÜV NORD Testing (Suzhou) Co., Ltd.** Zone E, 1st Floor, East side of South Building 3, No. 50, Beiguandu Road, Yuexi Street, Suzhou, Jiangsu Province, China

Test results listed in this test report refer exclusively to the mentioned test sample.

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The submitted test samples as described in the reports hereunder are based on the requirements:
IEC 61215-2:2021 / EN IEC 61215-2:2021 “Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 2: Test procedures”

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Test Report

File No.: PVP10079/24P Test Report No.: TRPVP10079/24P/01

Summary of testing
According to the enquiry of the applicant, a commission testing was performed according to IEC 61215-2:2021/ EN IEC 61215-2:2021. Testing items are listed in page 9 of this report. At the end of the test, the passing criteria is that the maximum power degradation of each module is less than 5%. TWMNH-48HD440 was delivered to lab and conducted with hail impact test. All tests were successfully completed.

General remarks

Test item particulars:	
Accessories and detachable parts included in the evaluation .....:	N/A
Options included .....:	N/A
Abbreviations used in the report:	
HF - Humidity Freeze	TC - Thermal Cycling
DH - Damp Heat	EL - Electroluminescence
STC - Standard Test Conditions (1000W/m^2, AM1.5, 25°C)	BNPI - Bifacial nameplate irradiance, corresponding to 1000W/m^2 on the module front and 135 W/m^2 on the module rear
BSI - Bifacial stress irradiance, corresponding to 1000W/m^2 on the module front and 300W/m^2 on the module rear	aBSI - Applied bifacial stress irradiance, corresponding to 1000W/m^2 on the module front and more than 300W/m^2 or the manufacturer's claimed irradiance value on the module rear
P_{max} - Maximum power	I_{sc} - Short circuit current
V_{oc} - Open circuit voltage	I_{mp} - Maximum power current
V_{mp} - Maximum power voltage	FF - Fill factor
φ - Bifaciality refers to the ratios between the main I-V characteristics of the rear side and the front side of a bifacial device, typically at Standard Test Conditions (STC) unless otherwise specified. It is quantified with reference to bifaciality coefficients, namely as φ.	
φP_{max} - Maximum power bifaciality coefficient	φI_{sc} - Short circuit current bifaciality coefficient
φV_{oc} - Open-circuit voltage bifaciality coefficient	α - Current temperature coefficient
β - Voltage temperature coefficient	γ - Power temperature coefficient
Possible test case verdicts:	
Test case does not apply to the test object .....:	Not Applicable (N/A)
Test object does meet the requirement .....:	Pass (P)
Test object does not meet the requirement .....:	Fail (F)
Other remarks:	
The test verdicts presented in this report relate only to the object tested. This report shall not be reproduced except in full, without the written approval of the issuing testing laboratory. Sample #-front: Exposure under 1000W/m^2 on the front side with no irradiance on the rear side. Sample #-rear: Exposure under 1000W/m^2 on the rear side with no irradiance on the rear side. Sample #-BNPI: Exposure under BNPI on the front side with no irradiance on the rear side. "(see Annex #)" refers to additional information appended to the report. "(see Table #)" refers to a table appended to the report. Power degradation data expressed in negative value indicates a reduction of maximum power output. Power degradation data expressed in positive value indicates an increment of maximum power output. Throughout this report, a point is used as the decimal separator.	

General product information

Module type: TWMNH-48HD440

Product Electrical Ratings at STC:	
Nominal maximum power (P_{max}) [W] with tolerance.....:	440 ± 3%
Nominal open circuit voltage (V_{oc}) [V] with tolerance .....:	35.35 ± 5%
Nominal maximum power voltage (V_{mp}) [V].....:	29.67
Nominal short circuit current (I_{sc}) [A] with tolerance .....:	15.89 ± 5%
Nominal maximum power current (I_{mp}) [A].....:	14.83
Product Electrical Ratings at BNPI (only for bifacial module):	
Nominal maximum power (P_{max}) [W] with tolerance.....:	485.7 ± 3%
Nominal open circuit voltage (V_{oc}) [V] with tolerance .....:	35.35 ± 5%
Nominal maximum power voltage (V_{mp}) [V].....:	29.67
Nominal short circuit current (I_{sc}) [A] with tolerance .....:	17.54 ± 5%
Nominal maximum power current (I_{mp}) [A].....:	16.37
Product Electrical Ratings at aBSI (only for bifacial module):	
Nominal short circuit current at (I_{sc}) [A] with tolerance .....:	19.56 ± 5%
Bifaciality Coefficients:	
φP_{max} with tolerance .....:	80.0% ± 5%
φV_{oc} with tolerance .....:	100.0% ± 3%
φI_{sc} with tolerance.....:	80.0% ± 5%
Product Safety Ratings:	
Maximum system voltage [V].....:	1500
Maximum overcurrent protection rating [A] .....:	30
Safety class in accordance with IEC 61140 .....:	Class II
Fire safety class.....:	Class C
Supplementary information: aBSI: irradiance corresponding to the combination of 1000W/m^2 on the front side of the module with 300 W/m^2 irradiance for the rear side of the module.	

Testing procedure

Module type: TWMNH-48HD440

☐	Random sampling from production
☒	Prototype submitted by client
Supplementary information: N/A	

Module group assignment

Module type: TWMNH-48HD440

Sample #	Serial number	Dimension (l x w x h) [mm]	Remark
1	YF20240625S48TW210AT2162546	1762 x 1134 x 30	Hail impact test

Clause	Requirement + Test	Result - Remark	Verdict

Test result overview

Module type: TWMNH-48HD440

Initial examinations			—
MQT 01	Visual inspection ..... :	See table 4.1	P
MQT 02	Maximum power determination..... :	See table 4.2	—
MQT 03	Insulation test..... :	See table 4.3	P
MQT 15	Wet leakage current test..... :	See table 4.15	P

Sample 1#			—
MQT 17	Hail test..... :	See table 4.17	P
MQT 01	Visual inspection ..... :	See table 4.1	P
MQT 02	Maximum power determination..... :	See table 4.2	P
MQT 03	Insulation test..... :	See table 4.3	P
MQT 15	Wet leakage current test..... :	See table 4.15	P

IEC 61215-2 / EN IEC 61215-2			
Clause	Requirement + Test	Result - Remark	Verdict

Test results of IEC 61215-2 / EN IEC 61215-2

Module type: TWMNH-48HD440

4.1 Visual inspection (initial) - MQT 01		—
Test date [YYYY-MM-DD] .....:	2024-10-30	—
Sample #	Nature and position of initial findings - comments or attach photos	—
1	No visual defects	P
Supplementary information: N/A		

IEC 61215-2 / EN IEC 61215-2							
Clause	Requirement + Test		Result - Remark				Verdict
4.2 Maximum power determination (at STC, front side) - MQT 02							—
Test date [YYYY-MM-DD] .....:			2024-10-30				—
Test method .....:			☒ Solar simulator / ☐ Natural sunlight				—
Sample #	I_{sc} [A]	V_{oc} [V]	I_{mp} [A]	V_{mp} [V]	P_{max} [W]	FF [%]	—
1	15.56	35.42	14.94	30.15	450.3	81.73	—
4.2 Maximum power determination before initial stabilization (at STC, rear side, for bifacial modules) - MQT 02							—
Test date [YYYY-MM-DD] .....:			2024-10-30				—
Test method .....:			☒ Solar simulator / ☐ Natural sunlight				—
Sample #	I_{sc} [A]	V_{oc} [V]	I_{mp} [A]	V_{mp} [V]	P_{max} [W]	FF [%]	—
1	12.67	35.18	12.30	30.19	371.2	83.25	—
4.2 Maximum power determination after initial stabilization (at BNPI, for bifacial modules) - MQT 02							—
Test date [YYYY-MM-DD] .....:			2024-10-30				—
Test method .....:			☒ Solar simulator / ☐ Natural sunlight				—
Sample #	I_{sc} [A]	V_{oc} [V]	I_{mp} [A]	V_{mp} [V]	P_{max} [W]	FF [%]	—
1	17.26	35.53	16.60	29.96	497.3	81.10	—
Supplementary information: N/A							

IEC 61215-2 / EN IEC 61215-2			
Clause	Requirement + Test	Result - Remark	Verdict

4.3 Insulation test (initial) - MQT 03				—
Test date [YYYY-MM-DD] .....:		2024-10-30		—
Test voltage applied [V] .....:		2 minutes of 1500 and 1 minute of 8000		—
Sample #	Required [MΩ]	Measured [MΩ]	Dielectric breakdown?	—
1	20.0	>1000	No	P
Supplementary information: Minimum requirement according to the standard is 40MΩ·m^2. Area of the module is 2.00m^2.				

IEC 61215-2 / EN IEC 61215-2			
Clause	Requirement + Test	Result - Remark	Verdict

4.15 Wet leakage current test (initial) - MQT 15			—
Test date [YYYY-MM-DD] .....:		2024-10-30	—
Test voltage applied [V] .....:		2 minutes of 1500	—
Solution resistivity [Ω·cm] / <3500 .....:		2801	—
Solution temperature [°C] / 22±2 .....:		22.7	—
Sample #	Required [MΩ]	Measured [MΩ]	—
1	20.0	>1000	P
Supplementary information: Minimum requirement according to the standard is 40MΩ·m^2. Area of the module is 2.00m^2.			

IEC 61215-2 / EN IEC 61215-2			
Clause	Requirement + Test	Result - Remark	Verdict

4.17 Hail impact test - MQT 17								—
Sample #.....:	1#							—
Test date [YYYY-MM-DD] .....:	2024-11-06							—
Number of impact locations .....:	11							—
Ice ball size [mm] .....:	1	2	3	4	5	6		—
	34.9	34.9	34.7	34.1	34.8	34.1		
	7	8	9	10	11	—		
	34.6	34.6	34.7	34.1	34.8	—		
Ice ball weight [g] .....:	1	2	3	4	5	6		—
	20.01	20.99	20.90	20.96	20.76	20.82		
	7	8	9	10	11	—		
	20.57	20.82	20.01	20.89	20.24	—		
Ice ball velocity [m/s].....:	1	2	3	4	5	6		—
	27.89	27.60	27.30	27.01	27.65	27.35		
	7	8	9	10	11	—		
	27.12	27.07	27.62	27.36	27.61	—		
Supplementary information: N/A								
4.1 Visual inspection (after hail impact test) - MQT 01								—
Test date [YYYY-MM-DD] .....:	2024-11-06							—
Sample #	Nature and position of initial findings - comments or attach photos							—
1	No visual defects							P
Supplementary information: N/A								
4.2 Maximum power determination (after hail impact test) - MQT 02								—
Test date [YYYY-MM-DD] .....:	2024-11-07							—
Ambient temperature [°C].....:	Corrected to 25.0							—
Irradiance [W/m^2].....:	Corrected to 1000 or G_{BNPI}							—
Sample #	I_{sc} [A]	V_{oc} [V]	I_{mp} [A]	V_{mp} [V]	P_{max} [W]	FF [%]		—
1-front	15.47	35.41	14.84	30.23	448.5	81.86		—
1-rear	12.59	35.19	12.30	30.13	370.6	83.64		—
1-BNPI	17.16	35.53	16.49	30.15	497.3	81.54		—
P_{max} (STC) degradation after test [%] / ≤5:	Sample 1-front #: -0.40							P
Supplementary information: N/A								

IEC 61215-2 / EN IEC 61215-2			
Clause	Requirement + Test	Result - Remark	Verdict

4.3 Insulation test (after hail impact test) - MQT 03				—
Test date [YYYY-MM-DD] .....:		2024-11-07		—
Test voltage applied [V].....:		2 minutes of 1500 and 1 minute of 8000		—
Sample #	Required [MΩ]	Measured [MΩ]	Dielectric breakdown?	—
1	20.0	>1000	No	P
Supplementary information: Minimum requirement according to the standard is 40MΩ·m^2. Area of the module is 2.00m^2.				
4.15 Wet leakage current test (after hail impact test) - MQT 15				—
Test date [YYYY-MM-DD] .....:		2024-11-07		—
Test voltage applied [V].....:		2 minutes of 1500		—
Solution resistivity [Ω·cm] / <3500 .....:		3154		—
Solution temperature [°C] / 22±2 .....:		22.3		—
Sample #	Required [MΩ]	Measured [MΩ]		—
1	20.0	>1000		P
Supplementary information: Minimum requirement according to the standard is 40MΩ·m^2. Area of the module is 2.00m^2.				

Annex 1: List of measurement equipment

Clause	Measurement / testing	Testing / measuring equipment / material used, (Equipment ID)	Range used	Last Calibration date	Calibration due date
4.1	Visual inspection	Luminometer (TNRDTO002)	0~1500 Lux	2024-03-26	2025-03-25
4.2	Maximum power determination	Pulsed Solar Simulator (TNRDEQ043)	100~1200 W/m2	2023-12-01	2024-11-30
4.3	Insulation test	Withstanding voltage / Insulation resistance tester (TNRDTI037)	0~15 kV 0~999 MΩ	2024-08-08	2025-08-07
		Thermometer (TNRDTO003)	0~50 °C 20~90%RH	2024-03-13	2025-03-12
4.15	Wet leakage current test	Withstanding voltage / Insulation resistance tester (TNRDTI020)	0~15 kV 0~999 MΩ	2024-08-08	2025-08-07
		Conductive meter (TNRDTI004)	0~10000 μS/cm	2024-03-13	2025-03-12
4.17	Hail test	Hail impact test machine (TNRDEQ007)	16-40 m/s	2024-03-10	2025-03-09
		Electronic balance (TNRDTO009)	0~1000 g	2024-10-11	2025-10-10

Annex 2: Statement of the estimated uncertainty of the test results

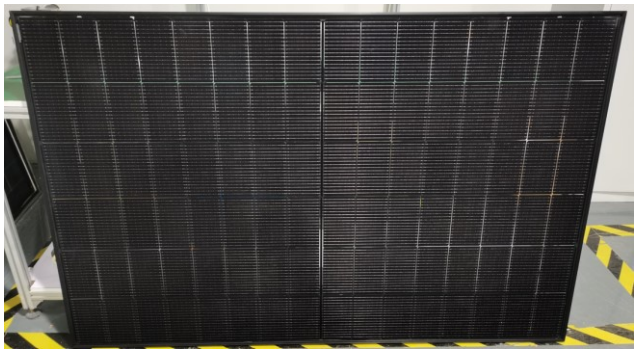
The total measuring uncertainty of P_{max} is 2.34% (k=2)

The total measuring uncertainty of I_{sc} is 2.24% (k=2)

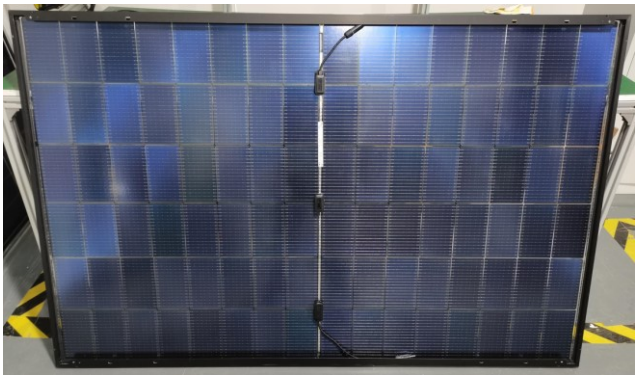
The total measuring uncertainty of V_{oc} is 0.78% (k=2)

Annex 3: Photos

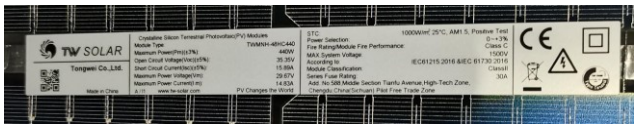
Module type: TWMNH-48HD440



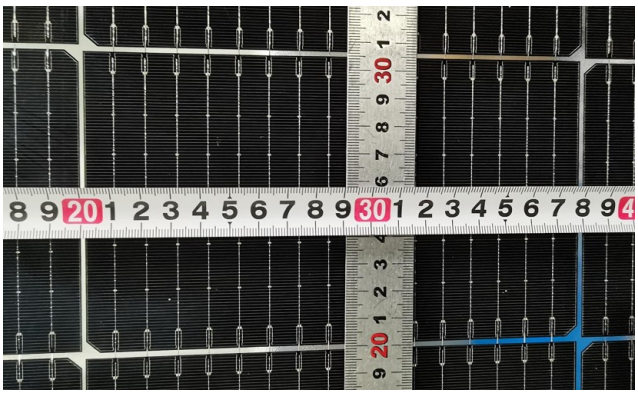
Front overview



Back overview



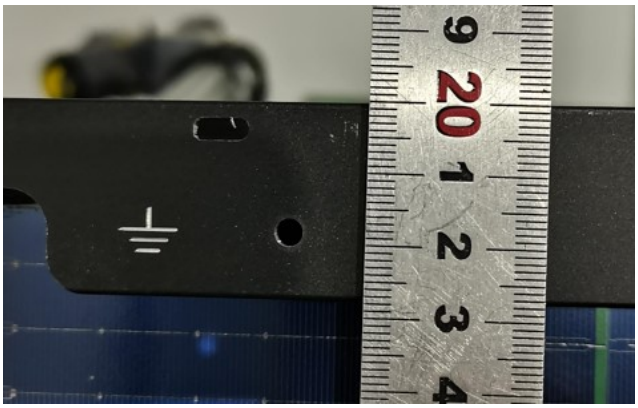
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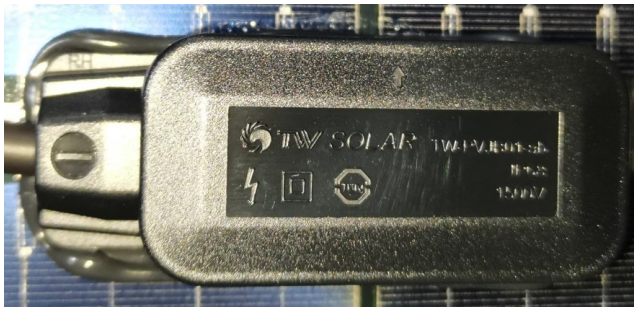
Solar cell



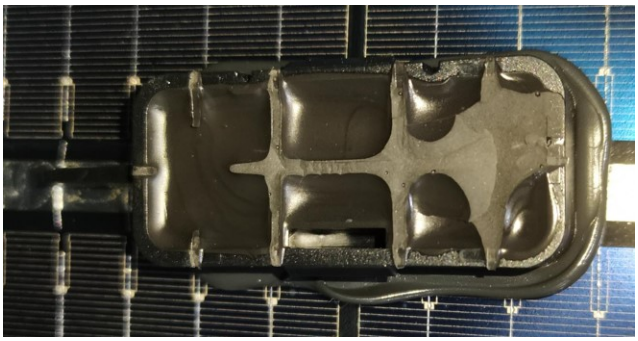
Frame



Grounding Mark



Junction box (TW-PVJB01-ab)



Junction box (opened)

N/A



Bypass diode (Junction box is potted)

Cable (62930 IEC 131 1x4.0mm²)



Mark (Do not disconnect under load)



Connectors (TW-PVCON-01)

----- End of test report -----