

Address: PO BOX 4321, PALMERSTON, NT 0831
ABN: 44 600 817 463

Mob: 0402 123 891
Email: admin@albright.net.au

WIND PRESSURE TESTING OF TW SOLAR PANEL MODELS: TWMNH-54HDXXX; (SOLAR PHOTOVOLTAIC MODULES)

ACE REFERENCE: ACE 25-161.02, REV: 03

Date of Issue: 16th October 2025

Tongwei Co., Ltd.

Attention: Mr Leon Hu

Mob: +86 028 60666066

Email: HUL038@tongwei.com

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

RE: TW Solar Panel Modules, TWMNH-54HDXXX, 1961 mm x 1134 mm x 30 mm, 26.5 kg; Models: TWMNH-54HD500; TWMNH-54HD505; TWMNH-54HD510; TWMNH-54HD515 & TWMNH-54HD520, with 3 Supports at 800 mm & 2 Supports at 1200 mm Centres

This Test Report certifies the Recommended Design Wind Pressure(s) for the above-mentioned TW Solar Panels, Models: TWMNH-54HDXXX, 1961 mm x 1134 mm x 30 mm, 26.5 kg. This Test Report is for the testing of the PV Module Frames only, and does not cover the supporting elements/ rails and or associated fixings of the tested panels to the supporting elements/ rails.

This Report verifies that the PV Modules are capable of withstanding the Design Wind Loads when installed to an approved railing system with the corresponding support points as listed in Table 1.

Albright Consulting Engineers (ACE) Pty Ltd were engaged by Tongwei Co., Ltd. to carry out and witness 6 individual mechanical load tests (simulated static, wind load strength test). The testing was performed on new panels supplied by Tongwei Co., Ltd.

A total of 6 individual panels were tested. The following tests were carried out:

- Test Scope 1: 3 individual test samples with 3 supports/ clamps at 800 mm centres;
- Test Scope 2: 3 individual test samples with 2 supports/ clamps at 1200 mm centres;

The solar panel module(s) were mounted front side up using fixing clamps and brackets, which are then bolted to the test bed chassis. This is was to imitate a real-world situation; (this process was repeated for each test sample).

A constant pressure/ load was applied by an airbag located the back of the panel. A calibrated digital manometer was used to measure and track the design test pressures, while a calibrated digital deflection meter was used to measure and record the centre (vertical) deflection of the solar panel at 1kPa intervals. The electrical continuity or the cells themselves were not monitored during each of the tests.



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Note that a mechanical load testing and or simulated static, wind load strength testing was carried out for the above-mentioned solar panel module samples and the support fixing configuration(s). The testing procedure that was adopted is generally accordance to the methods outlined in AS4040 (series), Static Strength Test Regime.

The 6 individual simulated static, wind load strength tests were conducted and observed by Nicholas Kastellorizios a representative of Albright Consulting Engineers in Darwin Northern Territory, on the 9th October 2025. The behaviour of the modules was observed and recorded.

Material Variability Factor AS/NZS 1170.0, Table B1 – kt:

The applied factor for variability for 1 individual test sample (1 individual units tested per support centre) and adopting a coefficient of variation of structural characteristics of 10% in accordance with AS/NZS 1170.0, Table B1 (when determining the allowable design capacity) is 1.46.

The applied factor for variability for 2 individual test samples (2 individual units tested per support centre) and adopting a coefficient of variation of structural characteristics of 10% in accordance with AS/NZS 1170.0, Table B1 (when determining the allowable design capacity) is 1.38.

The applied factor for variability for 3 individual test samples (3 individual units tested per support centre) and adopting a coefficient of variation of structural characteristics of 10% in accordance with AS/NZS 1170.0, Table B1 (when determining the allowable design capacity) is 1.33.

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Results & Observations:

Test No.1, x3 Samples, TW Solar Panel Modules: TWMNH-54HD500, 1961 mm x 1134 mm x 30 mm, 26.5 kg, with 3 Supports at 800 mm Centres. Serial Numbers: N1E257001000001; N1E257001000009 & N1E257001000018

The above-mentioned solar panel samples were mounted to the test rig with 3 supports at **800 mm** centres apart on each side with a cantilever/ overhang of approximately **180.5 mm** at each end.

During all three individual tests, the solar panel modules were observed to be able to support an equivalent design test pressure of **6.0 kPa**, with a centre vertical deflection **65.5 mm** (approximately).

It was observed that during each test, as the test pressures were increased, the top flanges of the longer rail framing elements appeared to roll inwards. This rolling or torsional effect caused concentrated pressures/ stresses to form directly to the top (glass) face of the panel. This was more evident at the clamping zones of the panel, as localised indentations to the top face of solar panel modules were observed during each case.

It was also observed during all three test procedures; while increasing the design test pressure, the shorter rail framing elements of the solar panel modules curved/ buckled upwards in an arch like manner.

When the test pressures were increased beyond 6.0 kPa, this caused the solar panel module(s) to dislodge/ pop out from the fixing clamps. However, the solar panel module did not appear to shatter or fail.

The top flanges of the rails had experienced minor crushing caused by the high bearing stresses/ pressures at the fixing clamps.

During the testing scope, the glass front face of the solar panel modules did not appear to shatter or crack (only during the one case).

There were visually obvious signs of minor structural fatigue occurring at the shorter framing elements of the solar panel modules that did not fail. Indicating that the plastic limit of the material may have been reached.

In all three cases, after the test pressure was released, there was a permanent deflection of approximately 10 mm to 15 mm observed at the centre of shorter framing elements.

This indicated that the frames had started to yielded/ entered the plastic phase of the material.

(Note there were very consistent results and observations during all three tests)

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Results & Observations:

Test No.2, x3 Samples, TW Solar Panel Modules: TWMNH-54HD500, 1961 mm x 1134 mm x 30 mm, 26.5 kg, with 2 Supports at 1200 mm Centres. Serial Numbers: N1E257001000011; N1E257001000014 & N1E257001000015

The above-mentioned solar panel samples were mounted to the test rig with 2 supports at **1200 mm** centres apart on each side with a cantilever/ overhang of approximately **380.5 mm** at each end.

During all three individual tests, the solar panel modules were observed to be able to support an equivalent design test pressure of **6.0 kPa**, with a centre vertical deflection **76 mm** (approximately).

It was observed that during each test, as the test pressures were increased, the top flanges of the longer rail framing elements appeared to roll inwards. This rolling or torsional effect caused concentrated pressures/ stresses to form directly to the top (glass) face of the panel. This was more evident at the clamping zones of the panel, as localised indentations to the top face of solar panel modules were observed during each case.

It was also observed during all three test procedures; while increasing the design test pressure, the shorter rail framing elements of the solar panel modules curved/ buckled upwards in an arch like manner.

When the test pressures were increased slightly 6.0 kPa, this caused the solar panel module(s) to dislodge/ pop out from the fixing clamps. However, the solar panel module did not appear to shatter or fail.

The top flanges of the rails had experienced minor crushing caused by the high bearing stresses/ pressures at the fixing clamps.

During the testing scope, the glass front face of the solar panel modules did not appear to shatter or crack (only during the one case).

There were visually obvious signs of minor structural fatigue occurring at the shorter framing elements of the solar panel modules that did not fail. Indicating that the plastic limit of the material may have been reached.

In all three cases, after the test pressure was released, there was a permanent deflection of approximately 10 mm to 15 mm observed at the centre of shorter framing elements.

This indicated that the frames had started to yielded/ entered the plastic phase of the material.

(Note there were very consistent results and observations during all three tests)

Other Observations:

In our opinion the changes to the physical geometry of the solar panel modules is a major contributing factor to the overall failure and performance of the panel, i.e., the grade of aluminium; the depth of the frame being 30 mm, as well as the length of the shorter rails being wider at 1134 mm.

The reductions in capacities when compared to other models tested previously are likely due to the overall system not being as stiff or robust as previous models. Previous models had deeper framing elements with 40mm to 45mm thicker framing and glass elements, with wider flanges to all framing elements, and were also narrower (approx. 990mm), which provided an overall stiffer system, giving them the ability to resist these concentrated localised pressures at the clamping zones, as well as at the corners of the frame.

Other likely factors that may have contributed to the failure or affected performance of these panels include:

1. Thickness & Grade of Glass Face;
2. Thickness of Backing Material;
3. Material used for Backing Material, dual layer glass solar panels appear to be less flexible than solar panels with PET (polyester) or fluoropolymers (PVF, PVDF, PTFE) backing materials;
4. Grade of Aluminium used in the manufacturer of the Frame;
5. Alternative framing elements, some rails do not have flanges, only a thin narrow box sections;
6. Inner Frame Connections/ Junctions;
7. Glass Supports within Frame;
8. Lack of and or quality of Adhesive of between the rails & Sheeting Layers.
9. Packing. Transport and Handling of Samples.
10. Smoothness of top flange at clamping locations; causing lack of friction with clamping.

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Table 1: Test Summary: Recommended Ultimate Design Strength, Limit Design Capacity

Test	Panel Manufacturer, Model & Size (mm)	Support Centres (mm)	Maximum Applied Load (kPa)	Material Variability Factor AS/NZS 1170.0 Table B1 – kt	Recommended Ultimate Design Strength Limit State Design Capacity (kPa)
No.1	X3 Samples: TW Solar Panel Modules: TWMNH-54HDXXX, 1961 mm x 1134 mm x 30 mm, 26.5 kg	3 Supports at 800mm	6.0	1.33	4.51
No.2	X3 Samples: TW Solar Panel Modules: TWMNH-54HDXXX, 1961 mm x 1134 mm x 30 mm, 26.5 kg	2 Supports at 1200mm	6.0	1.33	4.51

Note that the above mentioned Recommended Ultimate Design Strength, Limit Design Capacities are only applicable to the models & power series stated within this certificate, as well as listed on the attached data sheet.

Note that the Project Engineer/ Design Engineer should consider the panel deflection as a design criteria. These deflections could cause the panels to dislodge/ pop out of the fixing clamps.

TW Solar Panel Modules, TWMNH-54HDXXX, Mechanical Properties:

Cell Type:	TNC (N Type Monocrystalline Cell)
Cells:	108 [6x18]
Dimensions:	1961 mm x 1134 mm x 30 mm
Weight:	26.5 kg
Backing Material/ Substrate:	2.0 mm Semi Tempered Glass
Front Material/ Superstrate:	2.0 mm AR Coating Semi Tempered Glass
Frame:	30 mm Black Anodized Aluminium Frame

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Summary:

We recommended and verify that the **TWMNH-54HDXXX, 1961 mm x 1134 mm x 30 mm, 26.5 kg; Models: TWMNH-54HD500; TWMNH-54HD505; TWMNH-54HD510; TWMNH-54HD515 & TWMNH-54HD520**, Solar Panel Modules can resist the following vertical design loads, with a Recommended Ultimate Design Strength (Limit State Design Capacity), as listed for the following support conditions:

- **Supported on purlins/ battens, 3 supports/ rails at 800 mm centres: 4.51 kPa;**
- **Supported on purlins/ battens, 2 supports/ rails at 1200 mm centres: 4.51 kPa;**

This Report has been prepared on behalf of and for the exclusive use of Tongwei Co., Ltd. and is for the testing of the PV Module Frame only; and **not** the supporting elements, clamps, rails and or associated fixings of the PV Modules to the rails.

The Recommended Ultimate Design Strength, Limit State Design Capacities, (kPa) are only applicable for the panel model; size, weight and support/ rail spacing's as the above-mentioned tested model(s). Any additional power output models referenced may also be covered under this certificate provided that they are referenced in the same technical datasheet (attached); are mechanically & physically identical to the (tested): **TW Solar Panel Modules: TWMNH-54HD500, 1961 mm x 1134 mm x 30 mm, 26.5 kg**; and that they are manufactured in the exact same way with the exact same materials as the (tested): **TW Solar Panel Modules: TWMNH-54HD500, 1961 mm x 1134 mm x 30 mm, 26.5 kg**. Refer to Appendix A for datasheet.

This certificate and certification is no longer valid if:

1. If any of the Engineering & Mechanical Properties used in the manufacture of the solar panel modules/ models is altered or changed in any way to the above mentioned tested solar panel modules/ models.
2. If any of the manufacturing processes or techniques used in the manufacture of the solar panel modules/ models is altered or changed in any way to the above mentioned tested solar panel modules/ models.
3. It is the responsibility of the manufacturer to confirm if there has been any alterations, changes or revisions to the physical makeup of the frame, i.e. aluminium grade, front glass face or backing sheet, etc.; or if the manufacturing process has altered or changed in any way, re-testing may be required.
4. This certificate is rendered invalid if any changes have occurred to the tested modules/ models as noted above.

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Important Notes:

1. Note that the deflection criteria of the panels themselves may govern or limit the structural design and should be considered in high design wind pressure zones; as excessive deflections may cause the panel's to slip and or pop out from the fixing clamps.
2. The panel fixing clamps; the support rails; their associated fixings or the fixings of the L Feet to the immediate supporting structure, were not tested as part of the test procedure/ scope, and therefore no comment can be made as to their role as a potential failure mode. Note that these elements must be individually evaluated and confirmed by the Project Engineer and or the Design Engineer, as they may limit the structural design or capacity of the total structural system.
3. The railing system is excluded from this certification and is designed & certified by others.
4. The immediate supporting elements for the PV Roof Mounted Solar Panel System is also excluded from this certification and is designed & certified by others.
5. This Report verifies the Design Wind Pressures for the above referenced Solar Panel Modules/ Modes. However, they are subject to the analysis and approval by the Project Engineer; Design Engineer and or Approved Competent Person on a project by project basis. Note that the Design Engineer must confirm that the Design Wind Pressures are less than the Recommend Capacities referenced within this report, for each specific project.

Company Name if certification issued on behalf of a corporation Albright Services Group Pty Ltd, Trading as Albright Consulting Engineers		Company NT Registration Number 215037ES	
I certify that reasonable care has been taken to ensure that the structural engineering aspects of the works as described above have been designed in accordance with the requirements of the Building Code of Australia and the Northern Territory Building Regulations			
Name Nicholas Kastellorizios Nominee for Albright Services Group Pty Ltd, Trading as Albright Consulting Engineers	Nominee/Individual NT Registration Number 215037ES	Signature 	Date 16/10/2025

Please contact our office if you require any further information in relation to this report.

Nicholas Kastellorizios
Director/ Structural Engineer
Albright Consulting Engineers



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Appendix:

TWMNH-54HDXXX, 1961 mm x 1134 mm x 30 mm, 26.5 kg; Models: TWMNH-54HD500; TWMNH-54HD505; TWMNH-54HD510; TWMNH-54HD515 & TWMNH-54HD520



High Power Output
Low LCOE



Maximum Power
520W



TWMNH

N-type Half-cell
Bifacial Black Frame Module (54)

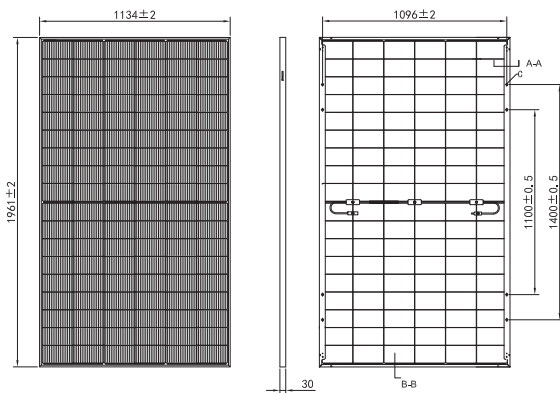
54HD500-520W

Tongwei Co.,Ltd.
<https://en.tongwei.cn/>



Learn More

Drawings (Unit: mm)



Electrical characteristics (STC)

Module type:	TWMNH-54 HD500	TWMNH-54 HD505	TWMNH-54 HD510	TWMNH-54 HD515	TWMNH-54 HD520
Maximum Power: P _{max} [W]	500	505	510	515	520
Open Circuit Voltage: V _{oc} [V]	40.06	40.24	40.42	40.60	40.80
Short Circuit Current: I _{sc} [A]	15.89	15.92	15.95	15.98	16.05
Voltage at Maximum Power: V _{mp} [V]	33.70	33.94	34.19	34.43	34.67
Current at Maximum Power: I _{mp} [A]	14.84	14.88	14.92	14.96	15.00
Module Efficiency: η [%]	22.5	22.7	22.9	23.2	23.4

* STC: Irradiance 1000W/m², Cell Temperature 25°C, AM=1.5, Power measurement tolerance: ±3%

Electrical characteristics (BNPI)

Maximum Power: P _{max} [W]	552.0	557.6	563.1	568.8	574.1
Open Circuit Voltage: V _{oc} [V]	40.06	40.24	40.42	40.60	40.80
Short Circuit Current: I _{sc} [A]	17.54	17.57	17.61	17.64	17.72
Voltage at Maximum Power: V _{mp} [V]	33.70	33.94	34.19	34.43	34.67
Current at Maximum Power: I _{mp} [A]	16.38	16.43	16.47	16.52	16.56

* BNPI: Front side irradiance 1000W/m², Rear side irradiance 135W/m², Cell Temperature=25°C, AM=1.5, Power measurement tolerance: ±3%

Electrical characteristics with different rear side power gain

5%	Maximum Power: P _{max} [W]	525	530	535	540	546
	Module Efficiency: η [%]	23.6	23.8	24.1	24.3	24.6
15%	Maximum Power: P _{max} [W]	575	580	586	592	598
	Module Efficiency: η [%]	25.9	26.1	26.4	26.6	26.9
25%	Maximum Power: P _{max} [W]	625	631	637	643	650
	Module Efficiency: η [%]	28.1	28.4	28.6	28.9	29.2

Temperature rating

Temperature Coefficient of P _{max}	-0.28%/°C
Temperature Coefficient of V _{oc}	-0.24%/°C
Temperature Coefficient of I _{sc}	+0.046%/°C

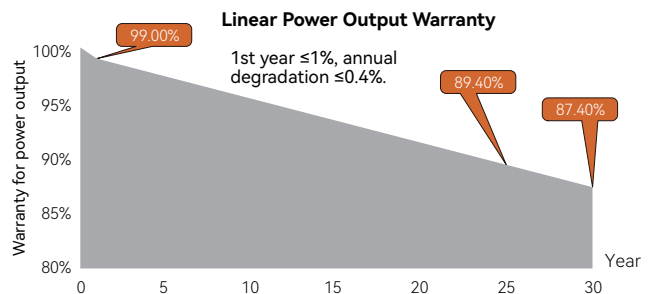
Operating parameters

Operating Temperature	-40°C~+70°C
Module [T ₉₈] max	70°C
Maximum System Voltage	1500V DC
Maximum Series Fuse Rating	30A
Power Selection Tolerance	0~+3%
Bifaciality coefficient of P _{max}	80±5%
Bifaciality coefficient of V _{oc}	98±5%
Bifaciality coefficient of I _{sc}	80±5%
Fire Class Rating	Class C

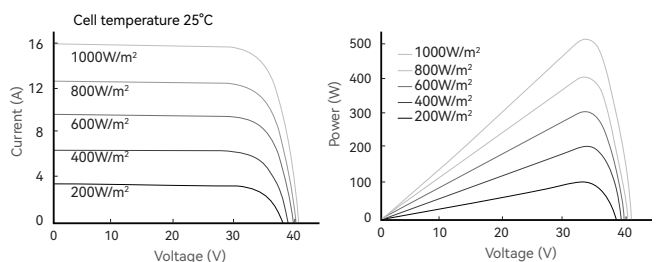
Mechanical parameters

Cell Type	TNC (N Type Monocrystalline Cell)
Cell Orientation	108[6×18]
Dimensions	1961±2×1134±2×30mm
Weight	26.5kg
Front Glass	2.0mm AR coating semi tempered glass
Rear Glass	2.0mm semi tempered glass
Frame	Anodized aluminum alloy black frame
Junction Box	IP68, 3diodes
Cable	4.0mm ²
Cable length	+1200mm, -1200mm, length can be customized
Connector	TW-PVCON-01(Tongwei Solar) PV-KST4-EVO2/xy_UR, PV-KBT4-EVO2/xy_UR(Staubli) PV-KST4-EVO2A/xy, PV-KBT4-EVO2A/xy(Staubli) PV-ZH202B(Zhejiang Zhonghuan Sunter)
Max static test load	Front side 5400Pa,Rear side 2400Pa
Per pallet	36pcs
Packaging	864pcs per 40'HC

Warranty



I-V Curve



Certifications

Quality Management System and Product Certification

ISO 9001: 2015 / Quality management systems
ISO 14001: 2015 / Environmental management systems
ISO 45001: 2018 / Occupational health and safety management systems
ISO 50001: 2018 / Energy management systems
IEC 62941: 2019 / Quality system for PV module manufacturing
IEC 61215(2021) / IEC 61730(2023)



Email: sales@tongwei.com Website: <https://en.tongwei.cn/> Add: No.588, Middle Section Tianfu Avenue, High-Tech Zone, Chengdu, China (Sichuan) Pilot Free Trade Zone Tel: +86-028-60707985

Statement: With technological process and product update, there maybe deviation between the technical parameters of Tongwei's module products and the technical parameters contained in the specification, and Tongwei Solar has the right to adjust the technical parameters at any time without notifying the customer, the final interpretation of the technical specification is vested in Tongwei Solar. (TP Glass-AU-20250523) Made in China