Technical Report No.: 704062419903-00

Date: 2024-07-29

Client:	RISEN LVDIAN (ZHEJIANG) BUILDING MATERIALS CO., LTD Room 2003 Minghao Building No.1688 Binsheng Road, Binjiang District 310000 Hangzhou City, Zhejiang Province PEOPLE'S REPUBLIC OF CHINA
Manufacture:	Risen Energy (YIWU) Co., Ltd (106291) No.599, Sufu Road Suxi Town 322000 Yiwu City, Zhejiang Province PEOPLE'S REPUBLIC OF CHINA
Test object:	Product: Crystalline Silicon Photovoltaic modules Model: See clause 1.4
Test specification:	AS 4040.1-1992(R2016) Methods of testing sheet roof and wall cladding Method 1: Resistance to concentrated loads. IEC61215-2:2021 Terrestrial photovoltaic (PV) modules – Design qualification and type approval –Part 2: Test procedures. IEC TS 60904-13:2018 Photovoltaic devices –Part 13: Electroluminescence of photovoltaic modules
Purpose of examination:	• Testing and evaluation (visual / partial) according to the test specification
Test result:	The test result show that the presented product is in compliance with the specific requirements.

Any use for advertising purposes must be granted in writing. This technical report may only be quoted in full. This report is the result of a single examination of the object in question. It does not imply a general statement regarding the quality of products from regular production. For further details please see testing and certification regulation, chapter A-3.3.

www.tuvsud.com

TÜV®

TÜV SÜD Certification and Testing (China) Co., Ltd.
Shanghai Branch
TÜV SÜD Group SMN

No. 151 Heng Tong Road Shanghai 200070 P. R. China
Telephone : +86 21 6141-0100

1. Description of the test object

1.1 Picture(s)

See annex 4.

1.2 Function

Manufacturer's specification for intended use:
The PV modules for electricity generation systems with max. voltage of 1500 V DC.

Manufacturer's specification for predictive use:
N/A

1.3 Consideration of the foreseeable use

☒ Not applicable
☐ Covered through the applied standard
☐ Covered by the following comment*
☐ Covered by attached risk analysis

1.4 Technical Data

Model	:	LDM144-10-xxxBNDG (xxx=590 to 620, in steps of 5)
Rated output Power at STC	:	Same as above
Max. system voltage	:	1500 V DC

2. Order

2.1 Date of Purchase Order, Customer's Reference

2024-07-12

2.2 Test Sample(s)

- Reception date(s):
  2024-07-09

www.tuvsud.com

TÜV SÜD Certification and Testing (China) Co., Ltd.
Shanghai Branch
TÜV SÜD Group SMN

No. 151 Heng Tong Road Shanghai 200070 P. R. China
Telephone : +86 21 6141-0100

- Location(s) of reception:
  Taier Labs (Jiaxing) Co., Ltd.
  Building 7, 3556 Linggongtang Road, Nanhu District, Jiaxing, Zhejiang, China
- Condition of test sample(s):
  In good condition
- Information of test sample(s):

Sample #	Type/model	Series number	Remark
1	LDM144-10-590BNDG	482312I2503434	Control module
2	LDM144-10-590BNDG	482312I2506549	Test module
3	LDM144-10-590BNDG	482312I2506532	Test module
4	LDM144-10-590BNDG	482312I2506515	Control module
5	LDM144-10-590BNDG	482312I2506409	Test module
6	LDM144-10-590BNDG	482312I2506571	Test module

2.3 Date(s) of Testing 2024-07-16

2.4 Location(s) of Testing Taier Labs (Jiaxing) Co., Ltd.
Building 7, 3556 Linggongtang Road, Nanhu District, Jiaxing, Zhejiang, China

2.5 Points of Non-Compliance or Exceptions of the Test Procedure

- N/A.

3. Test Results

- “Decision rule according to IEC Guide 115:2023, clause .4.3.3 was applied.”
- “Decision rule (based on ILAC-G8) for an upper specification limit (A lower limit or specification with an up-per and a lower limit is treated similarly.):
  - Compliance with the requirement: If a specification limit is not breached by a measurement result plus the expanded uncertainty with a 95% coverage probability, then compliance with the specification will be stated (e.g. Pass).

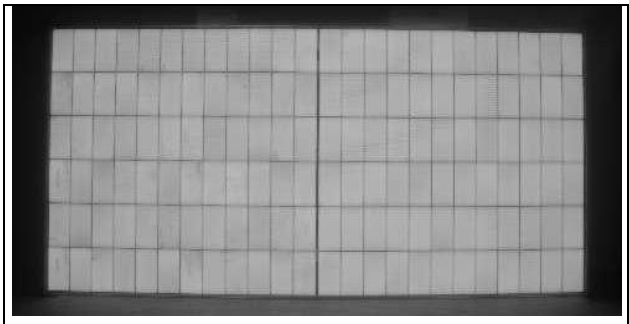
TÜV SÜD Certification and Testing (China) Co., Ltd.
Shanghai Branch
TÜV SÜD Group SMN

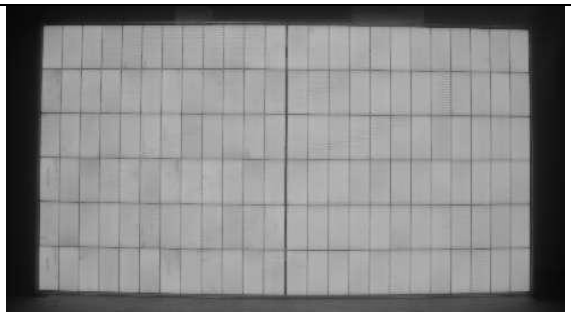
No. 151 Heng Tong Road Shanghai 200070 P. R. China
Telephone : +86 21 6141-0100

3.1 Positive Test Results

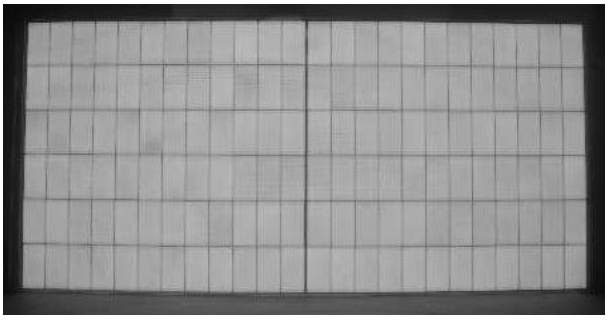
TABLE 01: MQT 01 ini: Initial Visual inspection		P
Test Date [YYYY-MM-DD]..... :	2024-07-16	—
Sample #	Nature and position of initial findings – comments or attach photos	—
1	No major visual defects found	P
2	No major visual defects found	P
3	No major visual defects found	P
4	No major visual defects found	P
5	No major visual defects found	P
6	No major visual defects found	P
Supplementary information: N/A		

TABLE 02: MQT 06.1 Initial Performance at STC							P
Test Date [YYYY-MM-DD]..... :	2024-07-16						—
Test method..... :	☒ Simulator ☐ Natural sunlight						—
Sample #	Isc [A]	Voc [V]	Imp [A]	Vmp [V]	Pmax [W]	FF [%]	Result
1	14.05	52.11	13.35	44.22	590.60	80.68	—
2	13.93	52.07	13.12	44.17	579.62	79.89	—
3	14.00	52.04	13.29	44.14	586.61	80.52	—
4	14.02	52.06	13.31	44.14	587.67	80.49	—
5	14.01	52.13	13.34	44.23	589.95	80.77	—
6	13.94	52.05	13.28	44.12	585.76	80.73	—
Supplementary information: EL pictures.							
Sample # 1			Sample # 2				

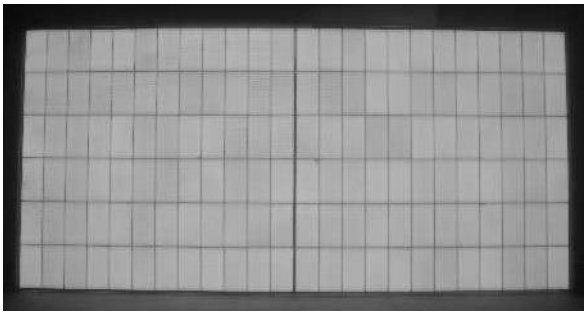




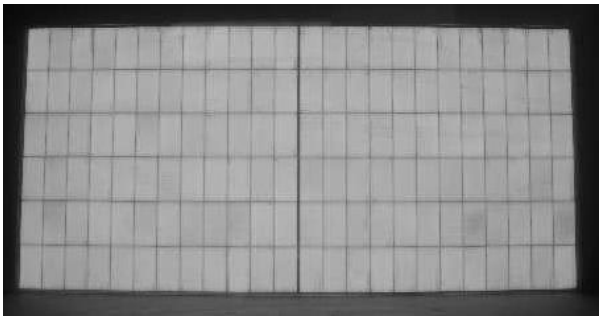
Sample # 3



Sample # 4



Sample # 5



Sample # 6

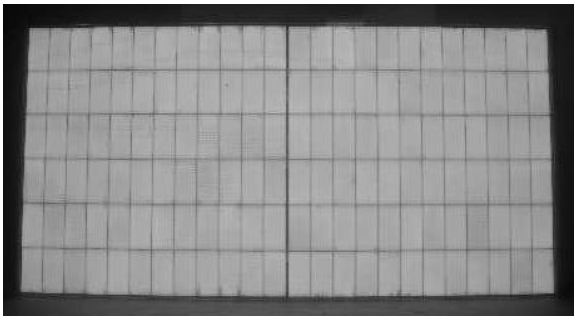


TABLE 04: MQT 03 ini: Initial Insulation test				P
Test Date [YYYY-MM-DD].....:	2024-07-16			—
Test Voltage applied [V] .....:	8000/1500			—
Size of module [m²] .....:	2.69			—
Required Resistance [MΩ].....:	≥14.87			—
Sample #	Measured	Dielectric breakdown		Result
	MΩ	Yes (description)	No	
1	>9999	—	No Dielectrical breakdown	P

www.tuvsud.com

TÜV SÜD Certification and Testing (China) Co., Ltd.
Shanghai Branch
TÜV SÜD Group SMN

No. 151 Heng Tong Road Shanghai 200070 P. R. China
Telephone : +86 21 6141-0100

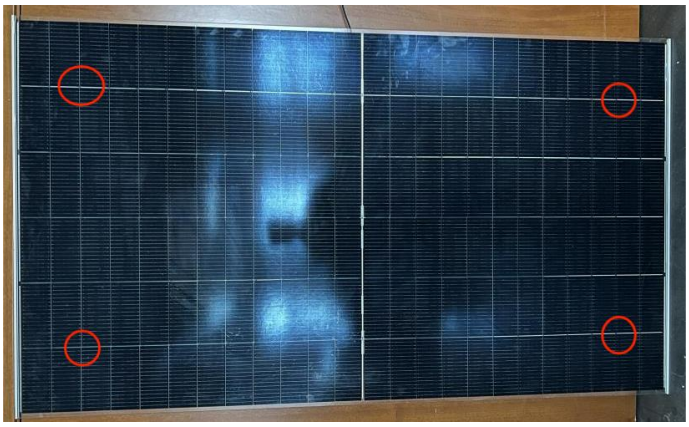
2	>9999	—	No Dielectrical breakdown	P
3	>9999	—	No Dielectrical breakdown	P
4	>9999	—	No Dielectrical breakdown	P
5	>9999	—	No Dielectrical breakdown	P
6	>9999	—	No Dielectrical breakdown	P
Supplementary information: The measurement limit of the equipment is 9999 MΩ				

TABLE 05: MQT 15 ini: Initial Wet leakage current test				P
Test Date [YYYY-MM-DD] .....:		2024-07-16		—
Test Voltage applied [V] .....:		1500		—
Solution resistivity [Ω/ cm] .....:		< 3,500 Ω/ cm at 22 ± 2°C	3065	—
Solution temperature [°C].....:		22.1		—
Size of module [m²] .....:		2.69		—
Sample #	Required Resistance [MΩ]	Measured [MΩ]		Result
1	≥14.87	649		P
2	≥14.87	725		P
3	≥14.87	849		P
4	≥14.87	655		P
5	≥14.87	593		P
6	≥14.87	625		P
Supplementary information: N/A				

TABLE 06: Resistance to concentrated loads		P
Test Date [YYYY-MM-DD]..... :	2024-07-17	—
Mounting method ..... :	According to the Installation Manual	—
Test load for serviceability limit state[KN] / Test duration[s] ..... :	0.5 / 60	—
Test load for strength limit state[KN] / Test duration[s] ..... :	1.08 / 60	—

Loading system ..... :	Concentrated load shall be applied in a direction normal to the roof through a circular loading pad of rubber or similar material 100±2 mm in diameter and 50±2 mm in thickness. The loading pad shall have a Shore durometer hardness of 30±3. The load shall be transmitted to the rubber pad through a disc of steel, 100±2 mm in diameter and not less than 10 mm in thickness.	
Sample #	Nature and position of initial findings – comments or attach photos	—
2	No major visual defects found	P
3	No major visual defects found	P

Supplementary information: Four test locations were designated by client as below.



The module is mounted on profiled steel sheet with 4 clamps on the short frame and 4 clamps on the long side.

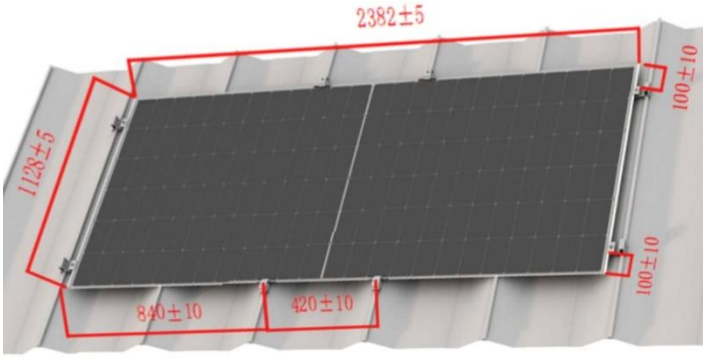


TABLE 06: Resistance to concentrated loads		P
Test Date [YYYY-MM-DD] ..... :	2024-07-17	—

www.tuvsud.com

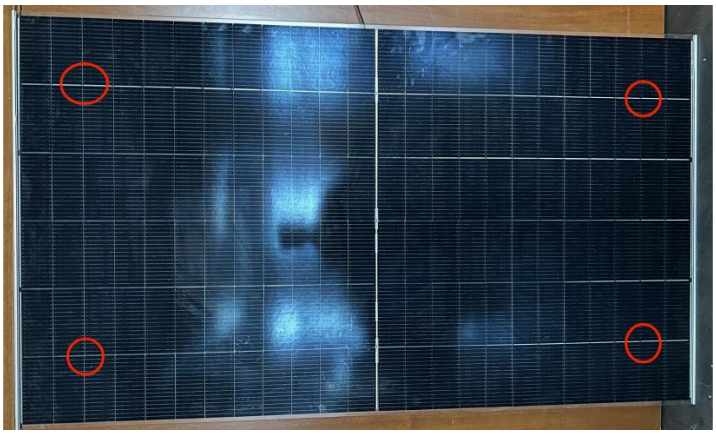
TÜV SÜD Certification and Testing (China) Co., Ltd.
Shanghai Branch
TÜV SÜD Group SMN

No. 151 Heng Tong Road Shanghai 200070 P. R. China
Telephone : +86 21 6141-0100

Mounting method ..... :	According to the Installation Manual	—
Test load for serviceability limit state[KN] / Test duration[s] ..... :	0.77 / 60	—
Test load for strength limit state[KN] / Test duration[s] ..... :	1.65 / 60	—
Loading system ..... :	Concentrated load shall be applied in a direction normal to the roof through a circular loading pad of rubber or similar material 100±2 mm in diameter and 50±2 mm in thickness. The loading pad shall have a Shore durometer hardness of 30±3. The load shall be transmitted to the rubber pad through a disc of steel, 100±2 mm in diameter and not less than 10 mm in thickness.	

Sample #	Nature and position of initial findings – comments or attach photos	—
5	No major visual defects found	P
6	No major visual defects found	P

Supplementary information: Four test locations were designated by client as below.



The module is mounted on profiled steel sheet with 4 clamps on the short frame and 4 clamps on the long side.

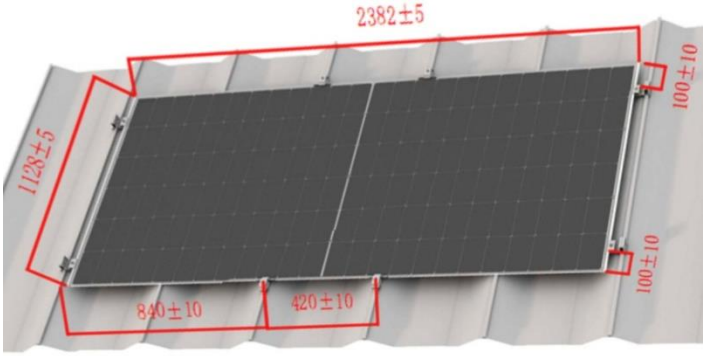


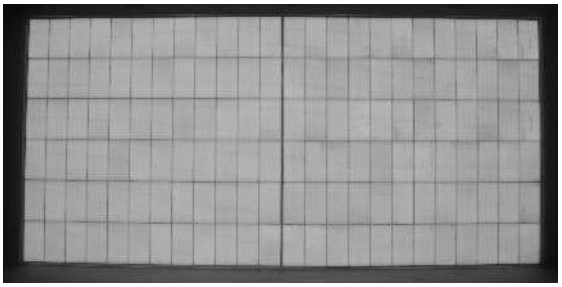
TABLE 07: MQT 01: Final visual inspection		P
Test Date [YYYY-MM-DD]..... :	2024-07-18	—
Sample #	Nature and position of initial findings – comments or attach photos	—
1	No major visual defects found	P
2	No major visual defects found	P
3	No major visual defects found	P
4	No major visual defects found	P
5	No major visual defects found	P
6	No major visual defects found	P
Supplementary information: N/A		

TABLE 08: MQT 06.1 Final Performance at STC								P
Test Date [YYYY-MM-DD] ..... :	2024-07-18							—
Test method ..... :	☒ Simulator ☐ Natural sunlight							—
Sample #	Isc [A]	Voc [V]	Imp [A]	Vmp [V]	Pmax [W]	FF [%]	Power Degradation [%]	Result
1	14.06	52.14	13.35	44.24	590.39	80.56	-0.04	P
2	13.85	52.05	13.11	44.17	579.24	80.35	-0.07	P
3	13.93	52.14	13.26	44.25	586.95	80.84	+0.06	P
4	13.99	52.13	13.28	44.25	587.71	80.56	+0.01	P

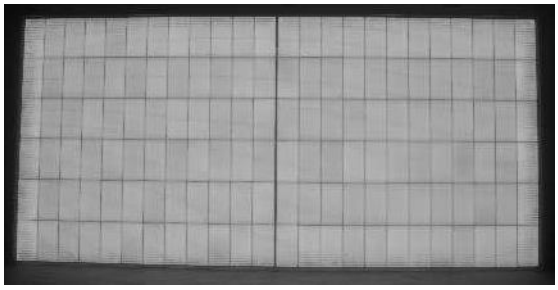
5	14.00	52.17	13.31	44.28	589.53	80.74	-0.07	P
6	13.94	52.10	13.23	44.23	585.15	80.55	-0.10	P

Supplementary information: EL pictures.

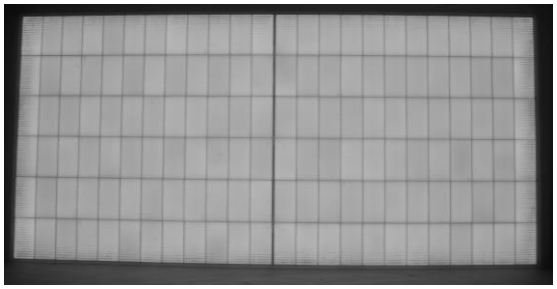
Sample # 1



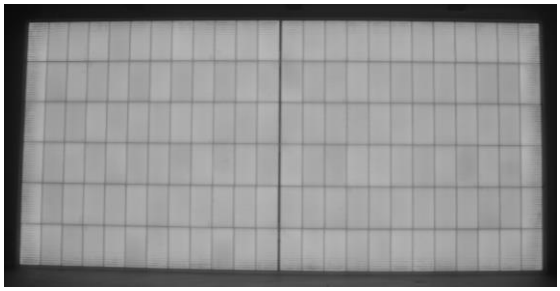
Sample # 2



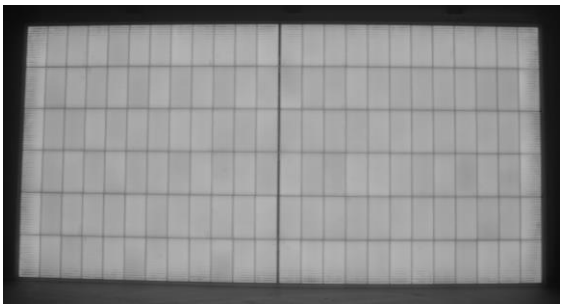
Sample # 3



Sample # 4



Sample # 5



Sample # 6

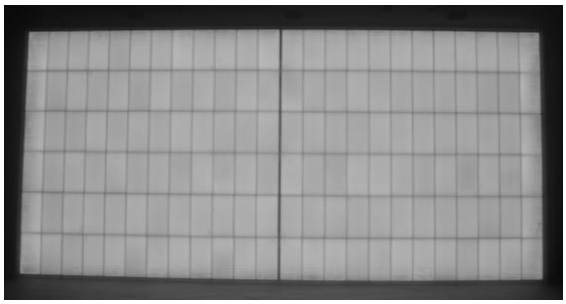


TABLE 09: MQT 03: Final Insulation test			P
Test Date [YYYY-MM-DD].....:		2024-07-18	—
Test Voltage applied [V] .....:		8000/1500	—
Size of module [m²] .....:		2.69	—
Required Resistance [MΩ]..... :		≥14.87	—
Sample #	Measured	Dielectric breakdown	Result

TÜV SÜD Certification and Testing (China) Co., Ltd.
Shanghai Branch
TÜV SÜD Group SMN

No. 151 Heng Tong Road Shanghai 200070 P. R. China
Telephone : +86 21 6141-0100

	MΩ	Yes (description)	No	
1	>9999	—	No Dielectrical breakdown	P
2	>9999	—	No Dielectrical breakdown	P
3	>9999	—	No Dielectrical breakdown	P
4	>9999	—	No Dielectrical breakdown	P
5	>9999	—	No Dielectrical breakdown	P
6	>9999	—	No Dielectrical breakdown	P
Supplementary information: The measurement limit of the equipment is 9999 MΩ.				

TABLE 10: MQT 15: Final wet leakage current test				P
Test Date [YYYY-MM-DD] .....:		2024-07-18		—
Test Voltage applied [V] .....:		1500		—
Solution resistivity [Ω/ cm] .....:		< 3,500 Ω/ cm at 22 ± 2°C	3084	—
Solution temperature [°C].....:		22.0		—
Size of module [m²] .....:		2.69		—
Sample #	Required Resistance [MΩ]	Measured [MΩ]		Result
1	≥14.87	754		P
2	≥14.87	685		P
3	≥14.87	762		P
4	≥14.87	687		P
5	≥14.87	495		P
6	≥14.87	585		P
Supplementary information: N/A				

3.2 Points of Non-Compliance according to the test specification

- None

TÜV SÜD Certification and Testing (China) Co., Ltd.
Shanghai Branch
TÜV SÜD Group SMN

No. 151 Heng Tong Road Shanghai 200070 P. R. China
Telephone : +86 21 6141-0100

4. Remarks

4.1 General

N/A

4.2 Factory surveillance cycle

Your production facility is currently on a

☐ Annual (12 month)
☐ Bi-Annual (6 month)
☐ Quarterly (3 month)
☒ N/A

4.3 Additional information for routine tests to be performed by the factory(ies)

Routine tests for electrical appliances / equipment:

N/A

5. Documentation

Annex 1	Product Description Sheet
Annex 2	Statement of the estimated uncertainty of the test results
Annex 3	List of measurement equipment
Annex 4	Pictures of the product

6. Summary

The test specification is met.

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
TÜV SÜD Group

Tested by: Tang Meng
Printed name,function & signature

Approved by: Li Qiaoying
Printed name,function & signature

www.tuvsud.com

TÜV SÜD Certification and Testing (China) Co., Ltd.
Shanghai Branch
TÜV SÜD Group SMN

No. 151 Heng Tong Road Shanghai 200070 P. R. China
Telephone : +86 21 6141-0100

Annex 1: Product Description Sheet (Manufacturers and type references)

A1.1	MODULE TYPE/S
	LDM144-10- xxxBNDG, xxx=590 to 620 in steps of 5, 144 cells xxx is standing for rated output power at STC

A1.2	MODULE DESIGN	
	Module dimensions (L x W x H) [mm] ..... :	2382 x 1128 x 10.8
	Weights ..... :	30.3 kg (approx.)
	Front/Rear cover bonding classification ..... :	☐ rigid/flexible ☒ rigid/rigid ☐ flexible/flexible

A1.3	SOLAR CELL	
	Cell type reference ..... :	Risen Energy Co., Ltd. Model: RSTCS192B(16BB), ½ cut, N type TOPCon cell
	Cell dimensions L x W x T (± %) [mm] ..... :	182(±3)x96(±3)
	Cell thickness [µm] ..... :	130±13
	Cell area [cm²] ..... :	166.47～183.15

A1.4	IDENTIFICATION OF MATERIALS	
	Front cover ..... :	China National Building Materials New Energy Resources Co.,Ltd. Model: coating tempered glass Thickness: 2.0 mm
	Rear cover ..... :	China National Building Materials New Energy Resources Co.,Ltd. Model: tempered glass, with glaze on internal surface (White glaze) Thickness: 2.0 mm
	Encapsulation material front side ..... :	ZhejiangSinopont Technology Co.,Ltd. Model::POE(PO8110) Thickness: 0.5mm.
	Encapsulation material back side ..... :	ZhejiangSinopont Technology Co.,Ltd. Model::POE(PO8110) Thickness: 0.5mm.
	Frame parts ..... :	Yu Run aluminum Co., LTD Anodized aluminum alloy. Model: 6063-T6, assembled by key corners. Colour: silvery and black Thickness: 10.8 mm
	Mounting parts ..... :	N/A

	Adhesive for frame .....:	Shanghai Huitian New Material Co., Ltd Model:: HT906Z.
	Edge sealing.....:	N/A
	Internal wiring .....:	N/A
	Cell connector.....:	Supplier: Risen (Ningbo) New Material Co.,Ltd Sn60Pb40. Base Cu,Purity ≥99.97%. Cross-sectional area:Φ0.26mm
	String connector .....:	Supplier: Risen (Ningbo) New Material Co.,Ltd. Model:Base Cu(TU1). Purity ≥99.97%, Coating material Sn60Pb40 Cross-sectional area:4*0.25mm, 4*0.4mm
	Soldering material.....:	N/A
	Fluxing agent .....:	Supplier: ASAHI SOLDER Company Limited Model: SF105
	Junction box.....:	Supplier: Zhejiang Twinsel Electronic Technology Co., LTD Model: PV-SY017-25, DC 1500 V, 25A, IP 68, -40 ℃ to 85 ℃;
	Cable.....:	Supplier: Zhejiang Twinsel Electronic Technology Co., LTD Model: 62930 IEC 131&UL 12AWG1*4mm^2
	Connector .....:	Supplier: Zhejiang Twinsel Electronic Technology Co., LTD Model: SY02
	Bypass diode .....:	Supplier: Zhejiang Twinsel Electronic Technology Co., LTD Model: SBRB5050TS
	Potting material.....:	Supplier: Shanghai Huitian New Material Co., Ltd. Model: HT-5299W-S
	Adhesive for junction box .....:	Supplier: Shanghai Huitian New Material Co., Ltd. Model:HT906Z
	Additional material (e. g. fixing tape, insulation tape) .....:	Supplier: 3M Model: UV-100

A1.5	module design - minimum distances	
	Between cells.....:	1.0 mm
	Between cell and accessible surfaces.....:	11.9 mm

TÜV SÜD Certification and Testing (China) Co., Ltd.
Shanghai Branch
TÜV SÜD Group SMN

No. 151 Heng Tong Road Shanghai 200070 P. R. China
Telephone : +86 21 6141-0100

	Between any current carrying part and accessible surfaces .....:	11.9 mm

A1.6	module design - electrical configuration	
	Total number of cells .....:	144
	Serial-parallel connection of cells .....:	24*2/24*2/24*2
	Cells per bypass diode .....:	48
	No. of bypass diodes .....:	3

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

Pmax measurement uncertainty: 2.6% (k=2)

Voc measurement uncertainty: 0.6% (k=2)

Isc measurement uncertainty: 2.4% (k=2)

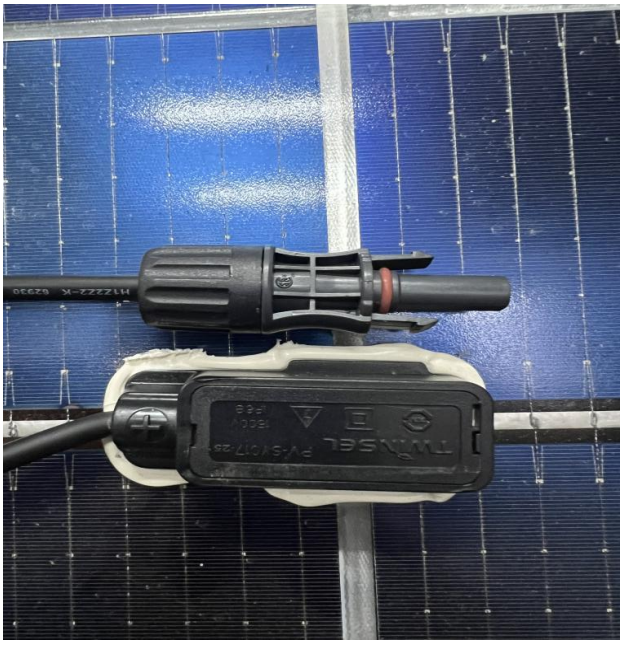
TÜV SÜD Certification and Testing (China) Co., Ltd.
Shanghai Branch
TÜV SÜD Group SMN

No. 151 Heng Tong Road Shanghai 200070 P. R. China
Telephone : +86 21 6141-0100

Annex 3: List of measurement equipment

Testing / measuring equipment	Equipment model	Equipment ID	Last Calibration date —Calibration due date
tape measure	91341	JXYQ-034	2024.04.18—2025.04.19
Ruler	0-300mm	JXYQ-035	2024.04.18—2025.04.19
Vernier caliper	0-150mm	JXYQ-033	2024.04.18—2025.04.19
Programmable control voltage insulation meter	ZW-DY1000	JXYQ-019	2024.04.18—2025.04.19
Electronic scale	TCS-50KG	JXYQ-047	2024.04.18—2025.04.19
Module pulse simulator	GIV-20A2616	JXYQ-043	2025.05.04—2025.05.05
Infrared thermometer	FLUKE-59	JXYQ-021	2025.04.26—2025.04.27
Resistance to concentrated loads test device	/	JXYQ-150	/

Annex 4: Pictures of the product



-- END OF REPORT --

www.tuvsud.com

TÜV SÜD Certification and Testing (China) Co., Ltd.
Shanghai Branch
TÜV SÜD Group SMN

No. 151 Heng Tong Road Shanghai 200070 P. R. China
Telephone : +86 21 6141-0100