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Technical Report No. 704062000620

Rev. 00

Dated 2020-04-14

Client name: Shanghai JA Solar Technology Co., Ltd. (072092)
Client address: No. 118, Lane 3111, West Huancheng Road, Fengxian District, 201401, Shanghai, People's Republic of China

Client contact: Ms. Wenli Gong

Manufacturing place: Shanghai JA Solar Technology Co., Ltd. (072092)
No. 118, Lane 3111, West Huancheng Road, Fengxian District, 201401, Shanghai, People's Republic of China

Hefei JA Solar Technology Co., Ltd (079395)
No. 999, Changning Road, Hi-tech Zone, 230088 Hefei City, Anhui Province, PEOPLE'S REPUBLIC OF CHINA

JA SOLAR CO., LTD. (072056)
Jinglong Street, Ningjin County, 055550 Xingtai, Hebei, PEOPLE'S REPUBLIC OF CHINA

JA Solar (Xingtai) Co., Ltd (095903)
No. 1688, Chang An Road, Xingtai Economic Development Area, 054000 Xingtai City, Hebei Province, PEOPLE'S REPUBLIC OF CHINA

Vina Solar Technology Co., Ltd (090968)
E12 factory, lot CN-03, Van Trung Industrial park, 21000 Bac Giang Province, Vietnam

HT SOLAR VIETNAM LIMITEDCOMPANY (097323)
F3 lot, factory F3-1, F3-2, Trang Due Industrial Park, An Duong District, a part of Dinh Vu-Cat Hai Economic Zone, Hai Phong City, Vietnam. 180000

Test subject: Product: Photovoltaic module

Test specification: IEC 61215-2:2016, Clause 4.1 Visual Inspection (MQT 01)
IEC 61215-2:2016, Clause 4.6 Performance at STC (MQT 06)
IEC 61215-2:2016, Clause 4.3 Insulation test (MQT 03)
IEC 61215-2:2016, Clause 4.15 Wet leakage current test (MQT 15)
IEC 61215-2:2016, Clause 4.17 Hail test (MQT 17)



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IEC 61215-2:2016, Clause 4.19 Stabilization (MQT 19.1)

Purpose of examination: • Test according to the test specification.

Test result: The present test results show in clause 3.

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1 Description of the test subject

1.1 Function

Manufacturer's specification for intended use:

The PV modules for electricity generation systems with max. voltage of 1500 V DC.

1.2 Consideration of the foreseeable misuse

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

1.3 Technical Data

Test sample No.	Model serial No.	Remark/constructional characteristic
Sample 1 (HA2020TL-125-001X)	202M6W7252447313	JAM72D20-440/MB
Sample 2 (HA2020TL-125-002X)	202M6W7252447320	JAM72D20-440/MB

Applicable Modules (due to same materials and similar construction):

JAM72D20-xxx/MB, xxx= 430 to 470 in step of 5

JAM60D20-xxx/MB, xxx= 355 to 390 in step of 5

xxx is standing for rated output power at STC

2 Order

2.1 Date of Purchase Order, Customer's Reference

The order dated 2020-03-16

2.2 Receipt of Test Sample, Location

Changzhou HuaYang Inspection and Testing Technology Co., Ltd

No.8 Lanxiang Road, Wujin Economic Development Zone, Changzhou, Jiangsu, China

2.3 Date of Testing

2020-03-19 to 2020-03-25

2.4 Location of Testing

Changzhou HuaYang Inspection and Testing Technology Co., Ltd



No.8 Lanxiang Road, Wujin Economic Development Zone, Changzhou, Jiangsu, China

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

N/A

3 Test Results

3.1	TABLE 01: MQT 01 ini - Initial Visual inspection		P
Test Date [YYYY-MM-DD].....:		2020-03-19	—
Sample No.	Nature and position of initial findings – comments or attach photos		Verdict
1	No major visual defects found		P
2	No major visual defects found		P
Supplementary information: N/A			

3.2	TABLE 02: MQT 19.1 ini - Initial stabilization						P
3.2.1.1	TABLE 02.1: MQT 06.1 - ini: Performance at STC before initial stabilization (single-side front)						P
Test Date [YYYY-MM-DD]		2020-03-19					—
Test method.....:		☒ Simulator ☐ Natural sunlight					—
Sample #	Isc [A]	Voc [V]	Imp [A]	Vmp [V]	Pmax [W]	FF [%]	Result
1	11.243	49.236	10.800	41.310	446.147	80.60	—
2	11.275	49.320	10.761	41.554	447.147	80.41	—
Supplementary information: N/A							

3.2.1.2	TABLE 02.2: MQT 06.1 ini - Performance at STC before initial stabilization (single-side back)						P
Test Date [YYYY-MM-DD]		2020-03-19					—
Test method.....:		☒ Simulator ☐ Natural sunlight					—
Sample #	Isc [A]	Voc [V]	Imp [A]	Vmp [V]	Pmax [W]	FF [%]	Result
1	7.438	48.545	7.069	41.350	292.301	80.95	—
2	7.456	48.581	7.123	41.411	294.973	81.43	—
Supplementary information: N/A							

3.2.2		TABLE 02.3: MQT 19.1 ini - Initial Stabilization procedure						P
Light exposure method				☒ Simulator ☐ Natural sunlight				
Abbreviation: Regarding light source “S” for Solar simulator and “N” for Natural sunlight								
Stabilization criterion x per IEC 61215-1-x				1				
Sample #		1	Test Date (YYYY-MM-DD) start/end..... :			2020-03-19 / 2020-03-24		
Test cycle	Integrated irradiation (kWh/m²)		Irradiance (W/m²)	Module temperature (°C)	Resistive load	P _{max} (W) at the end of cycle	P _{max} – P _{min} / P _{average} (%)	Stable (Yes/No)
Initial (F)	—		—	—	—	446.147	—	—
1	5		800~1000	50 ± 10	MPPT	444.457	—	—
2	5		800~1000	50 ± 10	MPPT	443.827	0.52	Yes
Initial (R)	—		—	—	—	292.301	—	—
1	5		800~1000	50 ± 10	MPPT	291.880	—	—
2	5		800~1000	50 ± 10	MPPT	291.361	0.32	Yes
Sample #		2	Test Date (YYYY-MM-DD) start/end..... :			2020-03-19 / 2020-03-24		
Test cycle	Integrated irradiation (kWh/m²)		Irradiance (W/m²)	Module temperature (°C)	Resistive load	P _{max} (W) at the end of cycle	P _{max} – P _{min} / P _{average} (%)	Stable (Yes/No)
Initial (F)	—		—	—	—	447.147	—	—
1	5		800~1000	50 ± 10	MPPT	445.556	—	—
2	5		800~1000	50 ± 10	MPPT	444.064	0.69	Yes
Initial (R)	—		—	—	—	294.973	—	—
1	5		800~1000	50 ± 10	MPPT	293.417	—	—
2	5		800~1000	50 ± 10	MPPT	292.587	0.81	Yes
Supplementary information: N/A								
☐ Other stabilization procedures								
Sample #		Test Date (YYYY-MM-DD) start/end						
—		—						
Test method description:								
Supplementary information: see Annex 3 for verification of this alternative stabilization procedure								

3.3.1	TABLE 03.1: MQT 06.1 ini - Performance at STC after initial stabilization (single-side front)	P
Test Date [YYYY-MM-DD]	2020-03-24	—
P _{max} (lab) lower limit (W)	See table below: P _{max} [W] – Min calc.	—



$\bar{P}_{max}(Lab)$ lower limit (W):					430.192				—	
Voc(lab) upper limit (V):					See table below: Voc [V] Max. calc.				—	
Isc (lab) upper limit (A):					See table below: Isc [A] Max. calc.				—	
Test method.....:					☒ Simulator ☐ Natural sunlight				—	
Sample #	Isc [A]		Voc [V]		Imp [A]	Vmp [V]	Pmax [W]		FF [%]	Result
	Meas.	Max. calc.	Meas.	Max. calc.			Meas.	Min. calc.		
1	11.242	11.563	49.198	49.749	10.743	41.312	443.827	417.286	80.25	P
2	11.196	11.563	49.318	49.749	10.663	41.646	444.064	417.286	80.42	P
Average	—						443.946	430.192	—	P
Supplementary information: The limit values are calculated considering manufacturer's tolerances t of rated nameplate values and laboratory measurement uncertainties m .										

3.3.2		TABLE 03.2: MQT 06.1 ini - Performance at STC after initial stabilization (single-side rear)								P
Test Date [YYYY-MM-DD]					2020-03-24					—
Pmax(lab) lower limit (W)					See table below: Pmax [W] – Min calc.					—
$\bar{P}_{max}(Lab)$ lower limit (W)					—					—
Voc(lab) upper limit (V)					See table below: Voc [V] Max. calc.					—
Isc (lab) upper limit (A)					See table below: Isc [A] Max. calc.					—
Test method.....					☒ Simulator ☐ Natural sunlight					—
Sample #	Isc [A]		Voc [V]		Imp [A]	Vmp [V]	Pmax [W]		FF [%]	Result
	Meas.	Max. calc.	Meas.	Max. calc.			Meas.	Min. calc.		
1	7.420	—	48.478	—	7.058	41.278	291.361	—	81.00	—
2	7.399	—	48.541	—	7.053	41.481	292.587	—	81.47	—
Average	—						291.974	—	—	—
Supplementary information: The limit values are calculated considering manufacturer's tolerances t of rated nameplate values and laboratory measurement uncertainties m .										

3.3.3	TABLE 03.3: MQT 06.1 ini - Performance at STC after initial stabilization (Equivalent irradiance)		P
Test Date [YYYY-MM-DD]:		2020-03-24	—
Pmax(lab) lower limit (W):		See table below: Pmax [W] – Min calc.	—



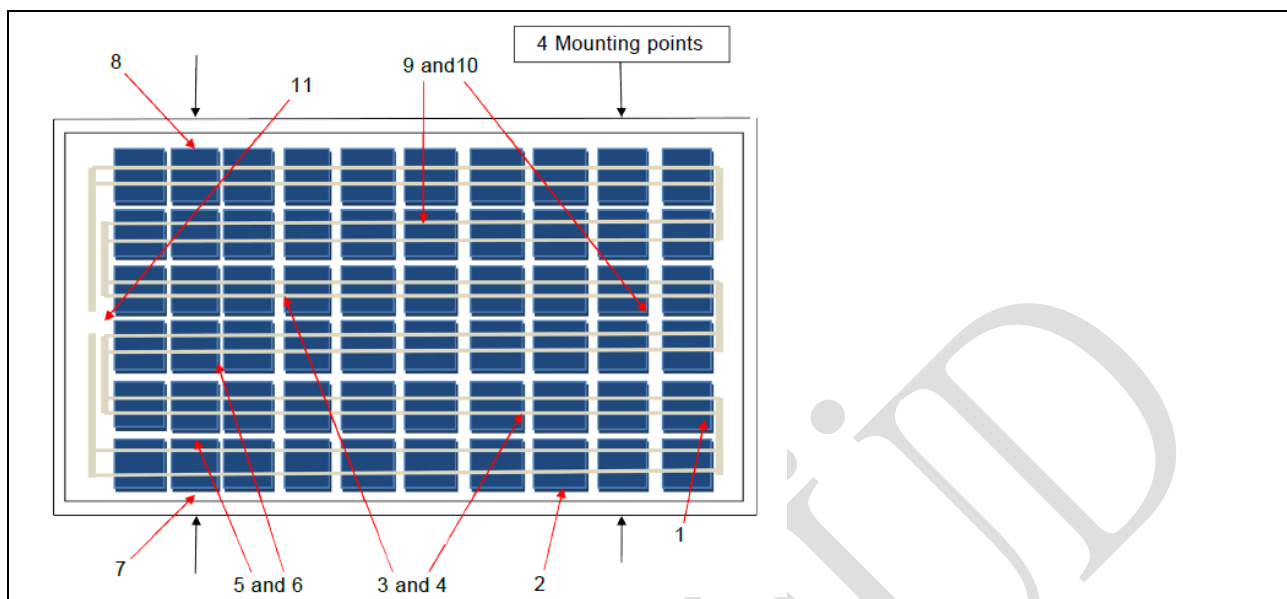
$\bar{P}_{max}(Lab)$ lower limit (W):					—					—
Voc(lab) upper limit (V):					See table below: Voc [V] Max. calc.					—
Isc (lab) upper limit (A):					See table below: Isc [A] Max. calc.					—
Test method.....:					☒ Simulator ☐ Natural sunlight					—
Sample #	Isc [A]		Voc [V]		Imp [A]	Vmp [V]	Pmax [W]		FF [%]	Result
	Meas.	Max. calc.	Meas.	Max. calc.			Meas.	Min. calc.		
1	12.150	—	49.505	—	11.590	41.690	483.198	—	80.33	—
2	12.221	—	49.287	—	11.720	41.256	483.515	—	80.27	—
Average	—						483.357	—	—	—
Supplementary information: The limit values are calculated considering manufacturer's tolerances t of rated nameplate values and laboratory measurement uncertainties m . equivalent irradiance is the effective value calculated when backside irradiance is 135W/m ² .										

3.4		TABLE 04: MQT 03 ini - Initial Insulation test			P
Test Date [YYYY-MM-DD]		2020-03-24			—
Test Voltage applied [V]		8000/1500			—
Size of module [m²].....		2.23			—
Required Resistance [MΩ]		17.95			—
Sample #	Measured	Dielectric breakdown			Result
	MΩ	Yes (description)		No	
1	>2000			No	P
2	>2000			No	P
Supplementary information: the maximum resistance measurement range is 2000MΩ.					

3.5	TABLE 05: MQT 15 ini - Initial Wet leakage current test								P
Test Date [YYYY-MM-DD]	2020-03-24								—
Test Voltage applied [V]	1500								—
Solution temperature [°C]	22.4								—
Size of module [m ²].....	2.23								—
Sample #	Required Resistance [MΩ]				Measured [MΩ]				Result
1	17.95				>2000				P
2	17.95				>2000				P

Supplementary information: Solution resistivity 2238 [$\Omega \cdot \text{cm}$], the maximum resistance measurement range is 2000M Ω .

3.6	TABLE 06: MQT 17 - Hail impact test						P
Test Date [YYYY-MM-DD].....:	2020-03-25						—
Sample #	2						—
Ice ball size [mm] :	1	2	3	4	5	6	—
	45.8	45.2	43.6	45.4	44.8	44.0	
	7	8	9	10	11		
	44.5	44.1	45.0	44.3	45.2		
Ice ball weight [g] :	1	2	3	4	5	6	—
	44.8	45.4	45.1	44.6	43.4	43.8	
	7	8	9	10	11		
	45.1	43.7	45.4	43.6	44.2		
Ice ball velocity [m/s] :	1	2	3	4	5	6	—
	31.0	31.4	30.3	30.5	31.2	30.8	
	7	8	9	10	11		
	30.6	29.8	30.5	30.0	30.6		
Number of impact locations..... :	11						—
Supplementary information: (impact location descriptions)							



3.7	TABLE 07: MQT 01 - Visual inspection after hail impact test	P
TABLE 19.9: MQT 01 - Visual inspection after hail impact test		P
Test Date [YYYY-MM-DD].....:	2020-03-25	—
Sample #	Nature and position of initial findings – comments or attach photos	—
2	No major visual defects found	P
Supplementary information: N/A		

3.8		TABLE 08: MQT 15 - Wet leakage current test after hail impact test		P
Test Date [YYYY-MM-DD].....:		2020-03-25		—
Test Voltage applied [V].....:		1500		—
Solution temperature [°C]		21.9		—
Size of module [m²].....:		2.23		—
Sample #	Measured [MΩ]		Required Resistance [MΩ]	Result
2	17.95		>2000	P
Supplementary information: Solution resistivity 2337 [Ω·cm], the maximum resistance measurement range is 2000MΩ.				

3.9		TABLE 09: MQT 03 - Insulation test after hail impact test			P
Test Date [YYYY-MM-DD]		2020-03-25			—
Test Voltage applied [V]		8000/1500			—
Size of module [m²].....		2.23			—
Required Resistance [MΩ].....		17.95			—
Sample #	Measured	Dielectric breakdown			Result
	MΩ	Yes (description)		No	
2	>2000			No	P
Supplementary information: the maximum resistance measurement range is 2000MΩ.					

3.10.1	TABLE 10.1: MQT 06.1 - Final Performance at STC (single-side front)								P
Test Date [YYYY-MM-DD]	2020-03-25								—
Test method	☒ Simulator ☐ Natural sunlight								—
Sample #	Isc [A]	Voc [V]	Imp [A]	Vmp [V]	Pmax [W]	FF [%]	Pmax [W] (Lab_GateNo.1)	Power Degradation [%]	Result
1	11.207	49.202	10.724	41.328	443.196	80.37	443.827	-0.142	P
2	11.198	49.325	10.658	41.640	443.786	80.35	444.064	-0.063	P
Supplementary information: The IV curves (didn't not) show any additional kinks or other unusual characteristics as compared to the initial IV curve.									

3.10.2	TABLE 10.2: MQT 06.1 - Final Performance at STC (single-side rear)								P
Test Date [YYYY-MM-DD]	2020-03-25								—
Test method	☒ Simulator ☐ Natural sunlight								—
Sample #	Isc [A]	Voc [V]	Imp [A]	Vmp [V]	Pmax [W]	FF [%]	Pmax [W] (Lab_GateNo.1)	Power Degradation [%]	Result
1	7.411	48.494	7.039	41.328	290.915	80.95	291.361	-0.153	P
2	7.385	48.527	7.035	41.494	291.906	81.45	292.587	-0.233	P
Supplementary information: The IV curves (didn't not) show any additional kinks or other unusual characteristics as compared to the initial IV curve.									

3.10.3	TABLE 10.3: MQT 06.1 - Final Performance at STC (Equivalent irradiance)								P
Test Date [YYYY-MM-DD]	2020-03-25								—
Test method	☒ Simulator ☐ Natural sunlight								—

Sample #	Isc [A]	Voc [V]	Imp [A]	Vmp [V]	Pmax [W]	FF [%]	Pmax [W] (Lab_GateNo.1)	Power Degradation [%]	Result
1	12.168	49.506	11.586	41.650	482.569	80.11	483.198	-0.130	P
2	12.242	49.287	11.687	41.355	483.323	80.10	483.515	-0.040	P

Supplementary information: The IV curves (didn't not) show any additional kinks or other unusual characteristics as compared to the initial IV curve.

equivalent irradiance is the effective value calculated when backside irradiance is 135W/m².

3.11	TABLE 11: MQT 01 - Final Visual inspection		P
Test Date [YYYY-MM-DD].....:		2020-03-25	—
Sample No.	Nature and position of initial findings – comments or attach photos		Verdict
1	No major visual defects found		P
2	No major visual defects found		P
Supplementary information: N/A			

TABLE 13.7: MQT 18.2 - Bypass diode functionality test					P
Test Date [YYYY-MM-DD]		2020-03-25			—
☐ Method A					—
Ambient temperature [°C]					—
Current flow applied [A]					—
Sample #	VFM	VFMrated	VFM = (N × VFMrated) ± 10 %		Result
			☐ Yes ☐ No		—
Supplementary information:					
☒ Method B					—
	IV curve after shading				Result
Diode 1	Turn on				P
Diode 2	Turn on				P
Diode 3	Turn on				P
Supplementary information: N/A					



4 Remark
N/A

5 Appendix

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

A1.1	MODULE TYPE/S
	JAM72D20-440/MB

A1.2	MODULE DESIGN
	Module dimensions (L x W x H) [mm]..... : 2124x1049x35
	Weights..... : 27.6
	Front/Rear cover bonding classification : ☐ rigid/flexible ☒ rigid/rigid ☐ flexible/flexible

A1.3	SOLAR CELL
	Cell type reference : JA Solar Technology Yangzhou Co., Ltd. Cell type: JACMABP-9, P type mono crystalline silicon, 9 busbars
	Cell dimensions L x W x T ($\pm$ %) [mm] : 167 x 83.5 $\pm$ 1.5
	Cell thickness [μ m] : 180 $\pm$ 18
	Cell area [cm ²] : 138.56

A1.4	IDENTIFICATION OF MATERIALS
	Front cover : Caihong (Hefei) Photovoltaic Co., Ltd. Type: Heat strengthened AR-coated glass, Thickness: 2.0 mm
	Rear cover : Caihong (Hefei) Photovoltaic Co., Ltd. Type: Heat strengthened glass with white glaze, Thickness: 2.0 mm
	Encapsulation material front side : Hangzhou First Applied Material Co., Ltd. Type: TF4, material: PO, thickness: 0.65 $\pm$ 0.15 mm
	Encapsulation material back side..... : Hangzhou First Applied Material Co., Ltd. Type: TF4, material: PO, thickness: 0.65 $\pm$ 0.15 mm



	Frame parts..... :	Zhaoqing Asia Aluminum Factory Co., Ltd. Anodized aluminum alloy, 6005-T6, silvery colour, assembled by key corners
	Mounting parts :	N/A
	Adhesive for frame :	Jiangsu Tianchen New Materials CO., LTD Type: HT-8258, Rated HB at min. 2.0 mm thick, RTI=105, CTI=0 UL certified, No. E344820
	Edge sealing :	N/A
	Internal wiring..... :	N/A
	Cell connector :	TaiCang JuRen PV Material Co., Ltd Cross section: $\Phi 0.35 \pm 0.02$ mm thick, round wire ribbon, Material: Base Cu ($\geq 99.97\%$), coating: 63%Sn/37%Pb
	String connector :	TaiCang JuRen PV Material Co., Ltd Cross section: 0.35×6 mm, Material: Base Cu ($\geq 99.97\%$), Coating Sn63%Pb37%, coating thickness 0.025 mm per side
	Soldering material :	Sn63%Pb37%
	Fluxing agent..... :	Shenzhen Vital New Material Co., Ltd. Type: WTO-PV105A, no clean halogen free liquid flux.
	Junction box :	Shanghai JA Solar Technology Co., Ltd. Type: PVJB-JA-004, DC 1500 V, 15A, IP 68(1m, 1h), -40 °C to 85 °C, TÜV SÜD certified, No. B 0720920287 Rev.03
	Cable :	Shanghai JA Solar technology co., Ltd. Type: H1Z2Z2-K $1 \times 4 \text{ mm}^2$, 1500V DC, -40 °C to 90 °C, TÜV SÜD certified, No. B 072092 0283 Rev. 02
	Connector :	QC Solar (Suzhou) Corporation Type: QC 4.10-35, DC 1500V, 41A, IP 68(1m, 1h), -40 °C to 85 °C TÜV Rheinland certified, No. R 50353779
	Bypass diode..... :	Panjit International Inc. Type: SB3045DY, Schottky, Max. peak reverse voltage 45 V, Max. average forward current 30 A, Max. junction temperature 200 °C.



	Potting material	Jiangsu Tianchen New Materials CO., LTD Type: HT-6360A/HT-6360B, Rated V-0 at min. 3.0 mm thick, RTI=105, CTI=0 UL certified, No. E344820
	Adhesive for junction box	Jiangsu Tianchen New Materials CO., LTD Type: HT-8258, Rated HB at min. 2.0 mm thick, RTI=105, CTI=0 UL certified, No. E344820
	Additional material (e. g. fixing tape, insulation tape).....	1) Fixing tape: Cybrid Technologies Inc. Type: FF-3665 2) Marking label: AVERY (CHINA) CO LTD Type: 72826T, 50 microns Bright Silver PET TC/S333(c)(d)

A1.5	MODULE DESIGN - MINIMUM DISTANCES	
	Between cells	1.5 mm
	Between cell and accessible surfaces.....	15.5 mm
	Between any current carrying part and accessible surfaces	14.25 mm

A1.6	MODULE DESIGN - ELECTRICAL CONFIGURATION	
	Total number of cells	144
	Serial-parallel connection of cells.....	SPS
	Cells per bypass diode	48
	No. of bypass diodes	3

Appendix 2: Photos



Appendix 3: List of measurement equipment

No.	Test Item	Main testing Equipment	Calibrate until
1	Visual inspection	Visual inspection table HYJC-YS-033	2019-09-15
2	Visual inspection	Illumination photometer HYJC-YS-070	2019-08-15
3	Performance at STC Bypass diode functionality test	Module pulse simulator HYJC-YS-021	2019-11-20
4	Insulation test Wet leakage current test	Programmable control voltage insulation meter HYJC-YS-086	2019-09-15
5	Wet leakage current test	Conductance meter HYJC-YS-076	2019-07-09
7	Hail test	Hail tester HYJC-YS-036	2019-12-17
8	Stabilization	level C steady state simulator HYJC-YS-006	2019-11-20
All equipment used for tests having a significant effect on the accuracy or validity of the result of the test is calibrated before being put into service.			

Appendix 4: Statement of the estimated uncertainty of the test results

The power measurement uncertainty is 2.12% (K=2).

6 Summary

N/A

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

Engineer: Ting Rongwei
Rongwei Jing
Project Handler

Technical Report checked: _____
Guangxia Fu
Designated Reviewer