Test Report issued under the responsibility of:

VDE

TEST REPORT
IEC 62716:2013
Photovoltaic (PV) modules
- Ammonia corrosion testing -

Test Report Reference No. .....:	TRPVM-2020-402733-2
Date of issue (YYYY-MM-DD) .....:	2021-10-25
Total number of pages .....:	40
Name of Testing Laboratory preparing the Report.....:	TAIER LABS (JIAXING) CO., LTD.
Applicant's name .....:	Zhejiang Beyondsun Green Energy Technology Co., Ltd.
Address.....:	No.888, Zhili Section of G318 Zhili Town, Huzhou City, Zhejiang province, China.
Test specification.....:	
Standard.....:	IEC 62716:2013
Test procedure .....:	VDE-scheme ☒
Non-standard test method .....:	N/A
Test Report Form No. .....:	IEC62716_1B
Test Report Form Originator.....:	**VDE** Testing and Certification Institute
Master TRF.....:	Dated 2019-10

This report is not valid as a CB Test Report unless signed by an approved CB Testing Laboratory and appended to a CB Test Certificate issued by an NCB in accordance with IECEE 02.

General disclaimer:

The test results 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 CB Testing Laboratory. The authenticity of this Test Report and its contents can be verified by contacting the NCB, responsible for this Test Report.

Test item description .....:	Photovoltaic (PV) Module(s)
Trade Mark.....:	Beyondsun
Manufacturer.....:	TSHM450-144HW
Model/Type reference.....:	Zhejiang Beyondsun Green Energy Technology Co., Ltd.
Ratings.....:	See page 6

Responsible Testing Laboratory (as applicable), testing procedure and testing location(s):

☒	Testing Laboratory:	TAIER LABS (JIAXING) CO., LTD	
Testing location/ address.....:		Building 7, 3556 Linggongtang Road, Nanhu, District, Jiaxing, Zhejiang	
Tested by (name, function, signature).....:		Guangyuan Chen Testing Engineer (Authorization of test report)	陈光远
Approved by (name, function, signature).....:		Chengying Shi Technical certification officer	施成营
☐	Testing procedure: CTF Stage 1:		
Testing location/ address.....:			
Tested by (name, function, signature).....:			
Approved by (name, function, signature).....:			
☐	Testing procedure: CTF Stage 2:		
Testing location/ address.....:			
Tested by (name + signature).....:			
Witnessed by (name, function, signature).....:			
Approved by (name, function, signature).....:			
☐	Testing procedure: CTF Stage 3:		
☐	Testing procedure: CTF Stage 4:		
Testing location/ address.....:			
Tested by (name, function, signature).....:			
Witnessed by (name, function, signature).....:			
Approved by (name, function, signature).....:			
Supervised by (name, function, signature).....:			

List of Attachments (including a total number of pages in each attachment):	
	attachment number / number of pages
Installation manual	N/A
Drawings mechanical	N/A
Circuit diagram	N/A
Photographs	N/A
Component datasheets / certificates	N/A
Others:	
Product Description Sheet (Manufacturers and type references)	N/A
List of test equipment used	N/A
Test table for verifying other stabilization procedure	N/A

Summary of testing:

Tests performed (name of test and test clause):

IEC 62716:2013, Ammonia Corrosion Test on:

☒ Crystalline silicon PV module

☒ Full-sized module for testing

☐ Smaller representative sample module for testing

☐ Thin-film PV module

☐ Full-sized module for testing

☐ Smaller representative sample module for testing

The modules TSHM450-144HW are tested as representative for all modules certified in VDE license 40050436, using the same BOM. All tests have been performed by TÜV Rheinland in report number 60442241 001 which has been issued on 2021-05-28. See attachment 1 for details.

Testing location:

See page 2.

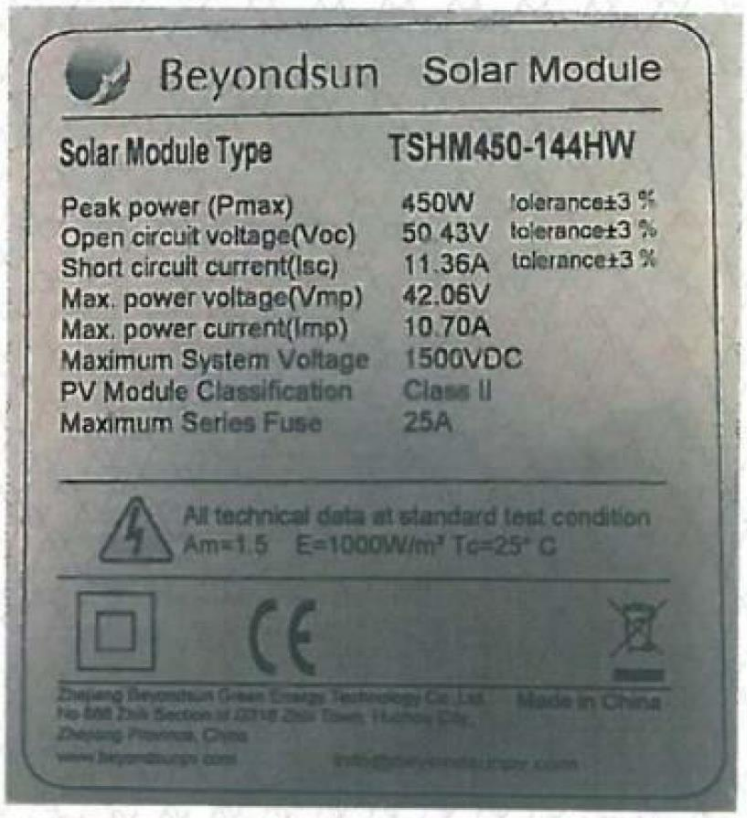
Summary of compliance with National Differences (List of countries addressed):

N/A

Copy of marking plate:

The artwork below may be only a draft. The use of certification marks on a product must be authorized by the respective NCBs that own these marks.

(Note: The marking plate represents all models covered by this report except for difference in electrical ratings and model designation. See “General product information” for electrical ratings for all models. As there will be other lower wattages to be covered under same report which follows same back label format.)



Test item particulars .....:	
Accessories and detachable parts included in the evaluation.....:	--
Mounting system used .....:	--
Other options included .....:	--
Possible test case verdicts:	
- test case does not apply to the test object ..... :	N/A
- test object does meet the requirement ..... :	P (Pass)
- test object does not meet the requirement ..... :	F (Fail)
Abbreviations which may be used in the report:	
Pmax – Maximum power	HF – Humidity Freeze
Vmp – Maximum power voltage	DH – Damp Heat
Imp – Maximum power current	TC – Thermal Cycling
Isc – Short circuit current	α – Current temperature coefficient
Voc – Open circuit voltage	β – Voltage temperature coefficient
FF – Fill factor	δ – power temperature coefficient
STC – Standard Test Conditions (25°C, 1 000 W/m²)	NMOT – Nominal Module Operating Temperature (20°C, 800 W/m²)
MQT – Module Quality Tests	$V_{FMrated}$ – Rated diode(s) forward voltage
VFM – Measured diode(s) forward voltage	NP – Nameplate
m_1 – the measurement uncertainty in % of laboratory for Pmax	m_2 – the measurement uncertainty in % of laboratory for Voc
m_3 – the measurement uncertainty in % of laboratory for Isc	t_1 – the manufacturer's rated lower production tolerance in % for Pmax
t_2 – the manufacturer's rated upper production tolerance in % for Voc	t_3– the manufacturer's rated upper production tolerance in % for Isc
r – Pmax measurement reproducibility	
Testing Dates (YYYY-MM-DD)	
Date of first test item received..... :	2021-01-20
Dates of tests (beginning/end) ..... :	2021-02-22 / 2021-03-22

GENERAL REMARKS:
"(See Enclosure #)" refers to additional information appended to the report. "(See appended table)" refers to a table appended to the report. **This TRF has been created in cooperation with CTL ETF-9 and German National Committee (DKE).** **The originator's responsibility of this TRF in IECEE CB Scheme has been assigned to TÜV SÜD Product Service GmbH.** Throughout this report a ☐ comma / ☒ point is used as the decimal separator.
Manufacturer's Declaration per sub-clause 4.2.5 of IECEE 02:

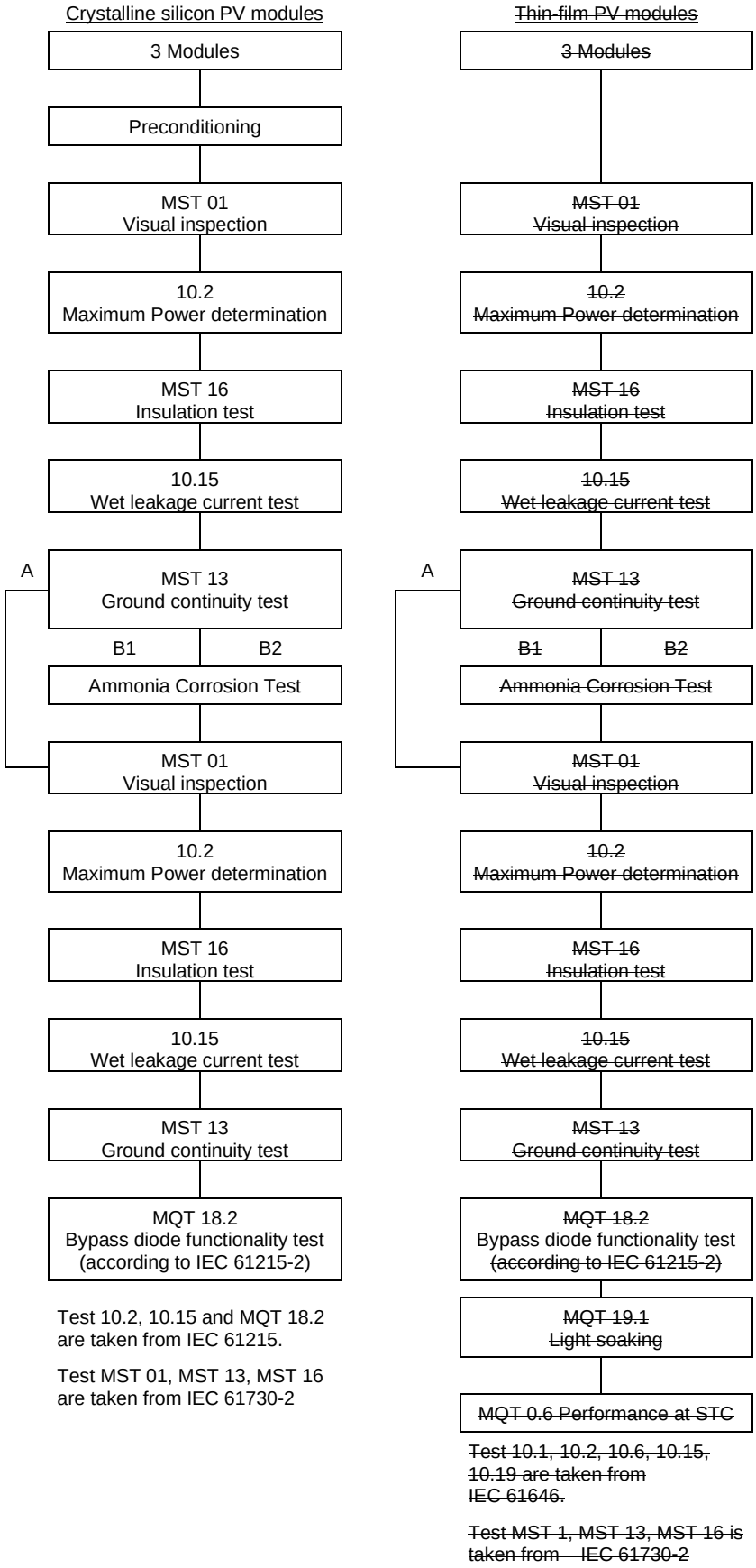
The application for obtaining a CB Test Certificate includes more than one factory location and a declaration from the Manufacturer stating that the sample(s) submitted for evaluation is (are) representative of the products from each factory has been provided..... :	☐ Yes ☒ Not applicable
When differences exist; they shall be identified in the General product information section.	
Name and address of factory (factories) ..... :	All listed in VDE license 40050436.

PRODUCT ELECTRICAL RATINGS:			
Module type	TSHM450-144HW		
Voc [V] /Tolerance	50.43+/-4%		
Vmp [V]	42.06		
Imax [Adc]	10.70		
Isc [Adc] /Tolerance	11.43+/-4%		
Pmp [W] /Tolerance	450+/-3%		
Maximum system voltage [V]	1500		
Maximum Over-Current Protection Rating [A]	25		
Note:			

MODULE GROUP ASSIGNMENT:

Sample #	Sample Group ID	Type/model	Sample S/N	Remark
M1	A	TSHM450-144HW	82061718100013	
M2	B1	TSHM450-144HW	82061718100043	
M3	B2	TSHM450-144HW	82061718100048	
Supplementary information				

10	**TEST PROCEDURES** Note: Deviations from test sequence are possible but must be documented.



IEC 62716:2013			
Clause	Requirement + Test	Result - Remark	Verdict
4	**MARKING**		P
	Name, monogram or symbol of manufacturer :	Beyondsun	P
	Type or model number..... :	TSHM450-144HW	P
	Serial number ..... :	8xxxxxxxxxxxxx	P
	Polarity of terminals or leads ..... :	+/- sign on connector	P
	Maximum system voltage ..... :	1500 V	P
	The date and place of manufacture..... :	Traceable by serial number	P
	Initial examination	All modules	P
10	Preconditioning .....:	5 Wh/m^2	P
10.1	Visual inspection .....:	See attached TÜV Reports	P
10.2	Maximum power determination	See attached TÜV Reports	P
10.3	Insulation test .....:	See attached TÜV Reports	P
10.15	Wet leakage current test / Wet insulation test .:	See attached TÜV Reports	P
MST13	Ground continuity test .....:	See attached TÜV Reports	P
Group A	Control Module	Sample Group ID A	P
Group B	2 Modules	Sample Group ID B	P
	Ammonia Corrosion Test .....:	See attached TÜV Reports	P
	Final measurement	All modules	P
10.1	Visual inspection .....:	See attached TÜV Reports	P
10.2	Maximum power determination / Electrical performance measurement .....:	See attached TÜV Reports	P
10.3	Insulation test .....:	See attached TÜV Reports	P
10.15	Wet leakage current test .....:	See attached TÜV Reports	P
MST13	Ground continuity test .....:	See attached TÜV Reports	P
Diode	Bypass diode functionality test .....:	See attached TÜV Reports	P
10.19	Light soaking .....:		N/A
10.6	Performance at STC .....:		N/A

Attachment 1:

Produkte
Products

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Prüfbericht-Nr.: *Test Report No.:*	**60442241 001**	**Auftrags-Nr.:** *Order No.:*	244244351	Seite 1 von 32 *Page 1 of 32*
Kunden-Referenz-Nr.: *Client Reference No.:*	2254907	**Auftragsdatum:** *Order date:*	30/05/2019	
Auftraggeber: *Client:*	**Zhejiang Beyondsun Green Energy Technology Co., Ltd.** No.888 Zhili Section of G318 Zhili Town,Huzhou City,Zhejiang Province,China			
Prüfgegenstand: *Test item:*	Photovoltaic (PV) modules			
Bezeichnung / Typ-Nr.: *Identification / Type No.:*	See module type designation list on page 2.			
Auftrags-Inhalt: *Order content:*	Ammonia corrosion testing for photovoltaic (PV) modules			
Prüfgrundlage: *Test specification:*	IEC 62716:2013, EN 62716:2013 Photovoltaic (PV) modules - Ammonia corrosion testing			
Wareneingangsdatum: *Date of receipt:*	20/01/2021	Detaillierte Fotodokumentation siehe Anlage zu diesem Bericht *Detailed photo documentation see appendix to this report*		
Prüfmuster-Nr.: *Test sample No.:*	See page 5			
Prüfzeitraum: *Testing period:*	22/02/2021 - 22/03/2021			
Ort der Prüfung: *Place of testing:*	Refer to page 3			
Prüflaboratorium: *Testing laboratory:*	TÜV Rheinland (Shanghai) Co., Ltd.			
Prüfergebnis*: *Test result*:*	Pass			

geprüft von / *tested by*:

Datum *Date*	Name / Stellung *Name / Position*	Unterschrift *Signature*
28/05/2021	Joy Sun / Project Engineer	Joy Sun

kontrolliert von / *reviewed by*:

Datum *Date*	Name / Stellung *Name / Position*	Unterschrift *Signature*
28/05/2021	Lei C. L. Chen / Reviewer	Lei Chen

Sonstiges / *Other*:

- Basic qualifaction for page 2 listed module types.
- Valid in conjunction with TÜV Rheinland certificate PV 50481089.
- Valid only for the material combination as listed in Constructional Data Form (CDF) in annex 1 of this report.

Zustand des Prüfgegenstandes bei Anlieferung: Prüfmuster vollständig und unbeschädigt
Condition of the test item at delivery: *Test item complete and undamaged*

* Legende:	1 = sehr gut	2 = gut	3 = befriedigend	4 = ausreichend	5 = mangelhaft
	P(ass) = entspricht o.g. Prüfgrundlage(n)		F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
Legend:	*1 = very good*	*2 = good*	*3 = satisfactory*	*4 = sufficient*	*5 = poor*
	P(ass) = passed a.m. test specification(s)		*F(ail) = failed a.m. test specification(s)*	*N/A = not applicable*	*N/T = not tested*

TÜV Rheinland (Shanghai) Co., Ltd.
TÜV Rheinland Building, No. 177, Lane 777, West Guangzhong Road, Zhabei District, Shanghai 200072, P.R. China

Produkte
Products

TÜVRheinland®

Prüfbericht-Nr.: 60442241 001
Test Report No.:

Seite 2 von 32
Page 2 of 32

Produktbeschreibung
Product description

1	**Produktdetails** *Product details* New model types: Max. System Voltage: up to 1500 VDC (Voc at STC): With ½ cut mono c-Si cells: TSHMxxx-144HW (xxx=435-465, in steps of 5, 144 cells) TSHMxxx-132HW (xxx=400-425, in steps of 5, 132 cells) TSHMxxx-120HW (xxx=365-385, in steps of 5, 120 cells) TSHMxxx-108HW (xxx=330-345, in steps of 5, 108 cells) TSHMxxx-96HW (xxx=290-305, in steps of 5, 96 cells) TSHMxxx-72HW (xxx=220-230, in steps of 5, 72 cells) Max. System Voltage: up to 1000 VDC (Voc at STC): TSHMxxx-144W (xxx=435-465, in steps of 5, 144 cells) TSHMxxx-132W (xxx=400-425, in steps of 5, 132 cells) TSHMxxx-120W (xxx=365-385, in steps of 5, 120 cells) TSHMxxx-108W (xxx=330-345, in steps of 5, 108 cells) TSHMxxx-96W (xxx=290-305, in steps of 5, 96 cells) TSHMxxx-72W (xxx=220-230, in steps of 5, 72 cells) xxx represents output power in Wp
2	**Verwendete Materialien** *Used materials* See Constructional Data Form (CDF) in annex 1 of this report for more details.
3	**Adresse(n) der Fertigungsstätte(n)** *Address(es) of the manufacturing site(s)*

Name / Description:	Zhejiang Beyondsun Green Energy Technology Co., Ltd.
Street:	No.888 Zhili Section of G318 Zhili Town
Postcode / City, Country:	313008 / Huzhou City,Zhejiang Province,China
Type of production:	c-Si PV-module production
Inspection report No / Inspection date	60414818 001 / 27/08/2020

Produktbeschreibung
Product description

4 Zusammenfassung der Prüfergebnisse
Summary of test results

According to the inquiry the resistance to ammonia corrosion of photovoltaic (PV) modules should be assessed in accordance with IEC 62716:2013, EN 62716:2013.

The test of the requirements of IEC 62716:2013, EN 62716:2013 were all fulfilled according to its regulations of the pass criteria. The above listed module types have been fully certified according to the IEC 61215-1:2016, IEC 61215-1-1:2016, IEC 61215-2:2016, IEC 61730-1:2016, IEC 61730-2:2016, and EN 61215-1:2016; EN 61215-1-1:2016; EN 61215-2:2017; EN IEC 61730-1:2018; EN IEC 61730-2:2018 standards before ammonia corrosion testing was applied.

- This is a basic qualification testing according to standard IEC 62716:2013, EN 62716:2013. The tests were performed on TSHM450-144HW as representative model. The test results are documented within this test report.

- The materials and combinations in below table have been approved on module with glass-backsheet construction module under 1500V maximum system voltage according to standard IEC 61215-2:2016 and IEC 61730-2:2016. Following materials are not the critical materials for ammonia corrosion testing. No additional testing is considered necessary for the following modifications.

Object	Manufacturer / trademark	Type / model	Technical data / ratings	Previous approved test report No.
Cell connectors	Jiangyin ESUN new materials technology Co., Ltd.	Sn60Pb40	L(mm)xT(mm) 1.0x0.23/0.25/0.27	60410450 001
Cell connectors	Changzhou Greateen New Energy Technology Co., Ltd	Sn60Pb40	L(mm)xT(mm) 1.0x0.23/0.25/0.27	60410450 001
		Sn60Pb40	Φ=0.32mm	60410450 002
Cell connectors	Changzhou Benjamin photovoltaic New material Technology Co Ltd.	Sn60Pb40	Φ=0.35mm/0.32mm	60410450 003
String connectors	Jiangyin ESUN new materials technology Co., Ltd.	Sn60Pb40	L(mm)xT(mm) 5.0x0.35 6.0x0.35	60410450 001
String connectors	Changzhou Greateen New Energy Technology Co., Ltd	Sn60Pb40	L(mm)xT(mm) 6.0x0.35	60410450 001
String connectors	Changzhou Benjamin photovoltaic New material Technology Co Ltd.	Sn60Pb40	L(mm)xT(mm) 5.0x0.35	60410450 003
Bypass diode	ChangZhou Star Sea Electronics Co.,Ltd.	FMK4525A for FT50xy(x=1)	Tj max =200°C	60410450 001

Summary of test location:
All the tests were performed at China Building Material Test & Certification Group Co., Ltd.
Address: No.1 Guanzhuang Dongli, Chaoyang District, Beijing, P.R. China.
Refer to report No. WT2021L11A00013 in annex 2 for more details.

Produktbeschreibung
Product description

	The appendix of this test report includes the following annexes: Annex 1: Constructional Data Form (CDF) (7 pages) Annex 2: Test report from China Building Material Test & Certification Group Co., Ltd. (20 pages)

Produkte
Products

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Prüfbericht-Nr.: 60442241 001 *Test Report No.:*			Seite 5 von 32 *Page 5 of 32*
Absatz	**IEC 62716:2013, EN 62716:2013**	Messergebnisse - Bemerkungen	Bewertung
Clause	Anforderungen - Prüfungen / *Requirements - Tests*	*Measuring results - Remarks*	*Evaluation*

-	**List of test samples**		
Module type: TSHM450-144HW			—
Sample No.	Sample S/N	Remarks / constructional characteristics	
1	820617181200013	Front cover: 3.2 mm Tempered Low Iron Pattern Glass with AR from Flat Glass Group Co., Ltd. Rear cover: Cynagard205A(R) from Cybrid tecnologies Inc. Solar cell: 166S-9BB (mono c-Si with 9 dotted busbars) from Zhejiang Beyondsun PV Co., Ltd Encapsulation material: F406P and TF8 from Hangzhou First PV Material Co., Ltd. Frame: Anodized Aluminium Alloy 6005-T5 from Huzhou Bei Sheng aluminum technology Co.,LTD, thickness=35mm Frame and junction box adhesive: HT906Z, Color: White from Shanghai Huitian New Chemical Material Co., Ltd. String connector: Sn60Pb40 from Changzhou Greateen New Energy Technology Co.,Ltd. L(mm)xT(mm)=5.0x0.35 Cell connector: Sn60Pb40 from Changzhou Greateen New Energy Technology Co.,Ltd. Φ=0.35mm Junction box: FT50xy from Zhejiang Renhe Photovoltaic Technology Co., Ltd. Cable: H1Z2Z2-K 1X1,5...35mm² from Zhejiang Renhe Photovoltaic Technology Co., Ltd. Connectors: 05-8 from Zhejiang Renhe Photovoltaic Technology Co., Ltd. Bypass diode: FMK4530T from Zhejiang Renhe Photovoltaic Technology Co., Ltd. Potting material: 5299W-S from Shanghai Huitan New Material Co., Ltd. Fixing tape: UV-1 from 3M. Fluxing agent: SF56 from Singapore Asahi Chemical & Solder Industries Pte Ltd Insulation tape: BEC-201 from SuZhou First PV Material Co., Ltd.	
2	820617181200043		
3	820617181200048		
Supplementary information : N/A			

Produkte
Products

TÜVRheinland®

Prüfbericht-Nr.: 60442241 001
Test Report No.:

Seite 6 von 32
Page 6 of 32

ZUSATZDOKUMENTATION
ADDITONAL DOCUMENTATION

Annex 1: Constructional Data Form (CDF)

Produkte *Products*		TÜVRheinland®
Our Reference 60442241 001		Appendix No. 1
Constructional Data Form (CDF) for Photovoltaic (PV) Modules for Ammonia IEC 62716:2013, EN 62716:2013 (1500V + 1000V)		Page 1 of 7

License Holder.....: (full address)	Zhejiang Beyondsun Green Energy Technology Co., Ltd. No.888 Zhili Section of G318 Zhili Town,Huzhou City,Zhejiang Province,China
Production Factory: (full address)	Zhejiang Beyondsun Green Energy Technology Co., Ltd. No.888 Zhili Section of G318 Zhili Town,Huzhou City,Zhejiang Province,China
Type of Product.....:	Photovoltaic (PV) Modules
Trademark .....:	Beyondsun TRUNSUN SOLAR

Module family A: ½ cut Mono c-Si cell type (Max. System Voltage: 1500V)

Type Name or Model No.....	TSHMxxx-144HW	TSHMxxx-132HW	TSHMxxx-120HW	TSHMxxx-108HW	SHMxxx-96HW
Maximum System Voltage [VDC]	1500	1500	1500	1500	1500
Rated Maximum Power [W].....:	435, 440, 445, 450, 455, 460, 465	400, 405, 410, 415, 420, 425	365, 370, 375, 380, 385	330, 335, 340, 345	290, 295, 300, 305
Rated Short Circuit Current [A].....:	11.15, 11.22, 11.29, 11.36, 11.43, 11.50, 11.57	11.18, 11.25, 11.32, 11.40, 11.47, 11.54	11.17, 11.24, 11.31, 11.38, 11.46	11.21, 11.31, 11.41, 11.51	11.15, 11.25, 11.36, 11.46
Rated Open Circuit Voltage [V].....:	49.85, 50.05, 50.26, 50.43, 40.63, 50.84, 51.04	45.72, 45.93, 46.14, 46.35, 46.56, 46.77	41.55, 41.77, 42.00, 42.23, 42.45	37.55, 37.72, 37.88, 38.03	33.23, 33.43, 33.63, 33.83
Tolerance of Rating Pmax / Isc / Voc [%]:	3 / 4 / 3	3 / 4 / 3	3 / 4 / 3	3 / 4 / 3	3 / 4 / 3
Over-current protection rating[A]:	20 / 25	20 / 25	20 / 25	20 / 25	20 / 25
Classification (IEC 61730).....:	Class II	Class II	Class II	Class II	Class II
Fire rating.....:	Class C	Class C	Class C	Class C	Class C
Dimensions (l x w x h) [mm].....:	2094×1038×35	1925×1038×35	1755×1038×35	1587×1038×35	1417×1038×35
Module area [m²].....:	2.17	2.00	1.82	1.65	1.47
Min. creepage distance [mm].....:	13.75	13.75	13.75	13.75	13.75
Number of solar cells	144	132	120	108	96
Cells per bypass diode	48	44	40	36	32
Serial/parallel connection of cells	SPS	SPS	SPS	SPS	SPS
Type Name or Model No.....	TSHMxxx-72HW	—	—	—	—

Shanghai, 2021-05-17 (City) (Date)	Huzhou 2021-05-17 (City) (Date)
Joy Sun	Wei Liao
TÜV Rheinland Group	(Stamp and/or signature of applicant)

QMF-RT-39008SHG Version: 1.1 / 2010-03-11/ approved by: U.Therhaag

Produkte
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TÜVRheinland®

Prüfbericht-Nr.: 60442241 001
Test Report No.:

Seite 7 von 32
Page 7 of 32

ZUSATZDOKUMENTATION
ADDITONAL DOCUMENTATION

Produkte
Products

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Our Reference 60442241 001 **Appendix No. 1**

Constructional Data Form (CDF) for Photovoltaic (PV) Modules for Ammonia IEC 62716:2013, EN 62716:2013 (1500V + 1000V) Page 2 of 7

Maximum System Voltage [VDC]	1500				
Rated Maximum Power [W] ..... :	220, 225, 230				
Rated Short Circuit Current [A] ..... :	11.22, 11.36, 11.50				
Rated Open Circuit Voltage [V] ..... :	25.03, 25.22, 25.43				
Tolerance of Rating Pmax / Isc / Voc [%] :	3 / 4 / 3				
Over-current protection rating[A]:	20 / 25				
Classification (IEC 61730) ..... :	Class II				
Fire rating ..... :	Class C				
Dimensions (l x w x h) [mm] ..... :	1079×1038×35				
Module area [m²] ..... :	1.12				
Min-creepage distance [mm] ..... :	13.75				
Number of solar cells	72				
Cells per bypass diode	24				
Serial/parallel connection of cells	SPS				
Module family B: ½ cut Mono c-Si cell type (Max. System Voltage: 1000V)					
Type Name or Model No.	TSHMxxx-144W	TSHMxxx-132W	TSHMxxx-120W	TSHMxxx-108W	SHMxxx-96W
Maximum System Voltage [VDC]	1000	1000	1000	1000	1000
Rated Maximum Power [W] ..... :	435, 440, 445, 450, 455, 460, 465	400, 405, 410, 415, 420, 425	365, 370, 375, 380, 385	330, 335, 340, 345	290, 295, 300, 305
Rated Short Circuit Current [A] ..... :	11.15, 11.22, 11.29, 11.36, 11.43, 11.50, 11.57	11.18, 11.25, 11.32, 11.40, 11.47, 11.54	11.17, 11.24, 11.31, 11.38, 11.46	11.21, 11.31, 11.41, 11.51	11.15, 11.25, 11.36, 11.46
Rated Open Circuit Voltage [V] ..... :	49.85, 50.05, 50.26, 50.43, 40.63, 50.84, 51.04	45.72, 45.93, 46.14, 46.35, 46.56, 46.77	41.55, 41.77, 42.00, 42.23, 42.45	37.55, 37.72, 37.88, 38.03	33.23, 33.43, 33.63, 33.83
Tolerance of Rating Pmax / Isc / Voc [%] :	3 / 4 / 3	3 / 4 / 3	3 / 4 / 3	3 / 4 / 3	3 / 4 / 3
Over-current protection rating[A]:	20 / 25	20 / 25	20 / 25	20 / 25	20 / 25

Shanghai, 2021-05-17 (City) (Date)
Joy Sun
TÜV Rheinland Group

Huzhou 2021-05-17 (City) (Date)
Wen Xiao
(Stamp and/or signature of applicant)

QMF-RT-39008SHG Version: 1.1 / 2010-03-11/ approved by: U.Therhaag

Produkte
Products

TÜVRheinland®

Prüfbericht-Nr.: 60442241 001
Test Report No.:

Seite 8 von 32
Page 8 of 32

ZUSATZDOKUMENTATION
ADDITONAL DOCUMENTATION

Produkte
Products

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Our Reference 60442241 001 **Appendix No. 1**

Constructional Data Form (CDF) for Photovoltaic (PV) Modules for Ammonia IEC 62716:2013, EN 62716:2013 (1500V + 1000V) Page 3 of 7

Classification (IEC 61730):	Class II	Class II	Class II	Class II	Class II
Fire rating:	Class C	Class C	Class C	Class C	Class C
Dimensions (l x w x h) [mm]:	2094×1038×35	1925x1038x35	1755×1038×35	1587×1038×35	1417×1038×35
Module area [m²]:	2.17	2.00	1.82	1.65	1.47
Min. creepage distance [mm]:	13.75	13.75	13.75	13.75	13.75
Number of solar cells	144	132	120	108	96
Cells per bypass diode	48	44	40	36	32
Serial/parallel connection of cells	SPS	SPS	SPS	SPS	SPS

Type Name or Model No.	TSHMxxx-72W
Maximum System Voltage [VDC]	1000
Rated Maximum Power [W]:	220, 225, 230
Rated Short Circuit Current [A]:	11.22, 11.36, 11.50
Rated Open Circuit Voltage [V]:	25.03, 25.22, 25.43
Tolerance of Rating Pmax / Isc / Voc [%]:	3 / 4 / 3
Over-current protection rating[A]:	20 / 25
Classification (IEC 61730):	Class II
Fire rating:	Class C
Dimensions (l x w x h) [mm]:	1079×1038×35
Module area [m²]:	1.12
Min. creepage distance [mm]:	13.75
Number of solar cells	72
Cells per bypass diode	24

Shanghai, 2021-05-17
(City) (Date)
Joy Sun
TÜV Rheinland Group

Hangzhou 2021-05-17
(City) (Date)
(Stamp and/or signature of applicant)

QMF-RT-39008SHG Version: 1.1 / 2010-03-11/ approved by: U.Therhaag

Produkte
Products

TÜVRheinland®

Prüfbericht-Nr.: 60442241 001
Test Report No.:

Seite 9 von 32
Page 9 of 32

ZUSATZDOKUMENTATION
ADDITONAL DOCUMENTATION

Produkte *Products*		TÜVRheinland®
Our Reference 60442241 001		**Appendix No. 1**
Constructional Data Form (CDF) for Photovoltaic (PV) Modules for Ammonia IEC 62716:2013, EN 62716:2013 (1500V + 1000V)		Page 4 of 7

Serial/parallel connection of cells	SPS				

Copy of marking plate:

Beyondsun Solar Module

Solar Module Type	TSHM435-144HW
Peak power (Pmax)	435W tolerance±3%
Open circuit voltage (Voc)	49.85V tolerance±3%
Short circuit current (Isc)	11.15A tolerance±4%
Max. power voltage (Vmp)	41.47V
Max. power current (Imp)	10.49A
Maximum System Voltage	1500VDC
PV Module Classification	Class II
Maximum Series Fuse	25 A

All technical data at standard test condition Am=1.5 E=1000W/m² Tc= 25° C

Zhejiang Beyondsun Green Energy Technology Co.,Ltd. Made In China
No.888 Zhili Section of G318 Zhili Town, Huzhou City, Zhejiang Province, China
www.beyondsunpv.com info@beyondsunpv.com

TRUNSUN SOLAR Solar Module

Solar Module Type	TSHM465-144W
Peak power (Pmax)	465W tolerance±3%
Open circuit voltage (Voc)	51.04V tolerance±3%
Short circuit current (Isc)	11.57A tolerance±4%
Max. power voltage (Vmp)	42.63V
Max. power current (Imp)	10.91A
Maximum System Voltage	1000VDC
PV Module Classification	Class II
Maximum Series Fuse	25 A

All technical data at standard test condition Am=1.5 E=1000W/m² Tc= 25° C

Zhejiang Beyondsun Green Energy Technology Co.,Ltd. Made In China
No.888 Zhili Section of G318 Zhili Town, Huzhou City, Zhejiang Province, China
www.beyondsunpv.com info@beyondsunpv.com

Remark: The rating label is presented to show the lay-out of the design of the nameplates.

Shanghai, (City) 2021-05-17 (Date)	Huzhou (City) 2021-05-17 (Date)
Joy Sun TÜV Rheinland Group	(Stamp and/or signature of applicant)

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Produkte
Products

TÜVRheinland®

Prüfbericht-Nr.: 60442241 001
Test Report No.:

Seite 10 von 32
Page 10 of 32

ZUSATZDOKUMENTATION
ADDITONAL DOCUMENTATION

Produkte
Products

TÜVRheinland®

Our Reference 60442241 001 **Appendix No. 1**

Constructional Data Form (CDF) for Photovoltaic (PV) Modules for Ammonia IEC 62716:2013, EN 62716:2013 (1500V + 1000V) Page 5 of 7

List of Critical Components (add lines for multiple material sources)

Object	Manufacturer / trademark	Type / model	Technical data / ratings	Standard (if applicable)	Certificates (if applicable)
Front cover	FLAT GLASS GROUP CO.,LTD	Tempered Low Iron Pattern Glass with AR	Thickness:3.2mm	—	—
Rear cover	Cybrid Technologies Inc.	Cynagard 205A(R)	Max. System voltage = DC 1500V Thickness=311.5μm PVDF/Adhesive/PET/Primer coating 22.5/10/275/4 μm TI: 120°C	2 PfG 1793 / 11.17	Q 50428378
Encapsulation material	Hangzhou First Applied Mterial Co., Ltd.	F406P (between front cover and cells)	Thickness=0.60mm	—	—
		TF8 (between cell and rear cover)	Thickness=0.60mm	—	—
Solar cell	Zhejiang Beyondsun PV Co.,Ltd.	166S-9BB (mono c-Si cell with 9 dotted busbars)	Halved size: 166mmx83mmx190μm (±30μm)	—	—
Cell connectors 1	Jiangyin ESUN new materials technology Co., Ltd.	Sn60Pb40	L(mm)xT(mm) 1.0x0.23/0.25/0.27	—	—
Cell connectors 2	Changzhou Greateen New Energy Technology Co., Ltd	Sn60Pb40	L(mm)xT(mm) 1.0x0.23/0.25/0.27	—	—
		Sn60Pb40	Φ=0.35mm/0.32mm	—	—
Cell connectors 3	Changzhou Benjamin photovoltaic New material Technology Co Ltd.	Sn60Pb40	Φ=0.35mm/0.32mm	—	—
String connectors 1	Jiangyin ESUN new materials technology Co., Ltd.	Sn60Pb40	L(mm)xT(mm) 5.0x0.35 6.0x0.35	—	—
String connectors 2	Changzhou Greateen New Energy Technology Co., Ltd	Sn60Pb40	L(mm)xT(mm) 5.0x0.35 6.0x0.35	—	—
String connectors 3	Changzhou Benjamin photovoltaic New material Technology Co Ltd.	Sn60Pb40	L(mm)xT(mm) 5.0x0.35	—	—

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ZUSATZDOKUMENTATION
ADDITONAL DOCUMENTATION

Produkte *Products*		TÜVRheinland®
Our Reference 60442241 001		**Appendix No. 1**
Constructional Data Form (CDF) for Photovoltaic (PV) Modules for Ammonia IEC 62716:2013, EN 62716:2013 (1500V + 1000V)		Page 6 of 7

Object	Manufacturer / trademark	Type / model	Technical data / ratings	Standard (if applicable)	Certificates (if applicable)
Frame parts	Huzhou bei sheng aluminum technology co., Ltd.	Anodized Aluminium Alloy 6005-T5	Thickness=35mm, (Drawing No.: PED04-16082914B)	—	—
Adhesive (frame)	Shanghai Huitian New Chemical Material Co., Ltd.	HT906Z Color: White	Silicon	—	—
Fluxing agent	Singapore Asahi Chemical & Solder Industries Pte Ltd	SF56	—	—	—
Fixing tape	3M	UV-1	Thickness: 0.06mm	—	—
Insulation tape	Suzhou First PV Material Co., Ltd.	BEC-201	Thickness:265μm	—	—

Shanghai, 2021-05-17
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TÜV Rheinland Group

HuZhou 2021-05-17
(City) (Date)
Wei Xiao
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ADDITONAL DOCUMENTATION

Produkte
Products

TÜVRheinland®

Our Reference 60442241 001 **Appendix No. 1**

Constructional Data Form (CDF) for Photovoltaic (PV) Modules for Ammonia IEC 62716:2013, EN 62716:2013 (1500V + 1000V) Page 7 of 7

Object	Manufacturer / trademark	Type / model	Technical data / ratings	Standard	Certificates
Junction Box Combination					
Junction box	Zhejiang Renhe Photovoltaic Technology Co., Ltd.	FT50xy	Max. Voltage = 1500V for FT50xy(y=B, D or F) Max. Voltage = 1000V for FT50xy(y=A, C or E) Rated Current = 16A for x=1; 18A for x=2; 20A for x=3; 25A for x=4; 28A for x=5 Reverse Current = 41A	IEC 62790:2014 EN 62790:2015	R 50415465
Cable	Zhejiang Renhe Photovoltaic Technology Co., Ltd.	H1Z2Z2-K 1X1,5...35mm²	Rated Voltage = 1500V	EN 50618:2014	R 50318681
Connectors	Zhejiang Renhe Photovoltaic Technology Co., Ltd.	05-8	Rated Voltage = 1500V Rated Current = 30A	IEC 62852:2014	R 50334688
Bypass diode	ChangZhou Star Sea Electronics Co.,Ltd.	FMK4525A for FT50xy(x=1)	Tj max =200	—	—
	Zhejiang Renhe Photovoltaic Technology Co., Ltd.	FMK4530T for FT50xy(x=3)	Tj max =200	—	—
Adhesive (junction box)	Shanghai Huitian New Chemical Material Co., Ltd.	HT906Z Color: White	Silicon	—	—
Potting material	Shanghai Huitian New Chemical Material Co., Ltd	5299W-S	—	—	—
	Beijing Tonsan New Material Technology Co., Ltd.	TS1521	—	—	—

Shanghai, 2021-05-17
(City) (Date)
Joy Sun
TÜV Rheinland Group

Huizhou 2021-05-17
(City) (Date)
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Annex 2: Test report from China Building Material Test & Certification Group Co., Ltd

CMA 180021283916 CAL (2018)国认监认字(691)号 ilac-MRA CNAS 中国认可 国际互认 检测 TESTING CNAS L0690

TEST REPORT

Report Number:WT2021L11A00013

Entrusted by:	TÜV Rheinland（Shanghai）Co., Ltd.
Description of product:	Photovoltaic Module
Test Type:	Entrustment test

China Photovoltaic Product Test Center

China Building Material Test & Certification Group Co., Ltd.

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Notice

1. This test report is invalid without the seal or, with partial seal.
2. This test report is invalid without the signatures of the related persons.
3. This test report is invalid if erased, altered or copied partially.
4. Any doubt should inform us within 15 days after receiving the test report.
5. The commissioned testing samples and commission information are provided by the applicant. The test results presented in this report relate only to the object tested.
6. This test report is printed on anti-counterfeiting paper,copies made from original should have grid shadings. The numbers on the back of the data sheet are random numbers not related with the report.

Contact :

Address: No.1 Guanzhuang Dongli, Chaoyang District, Beijing, P.R. China.

Postal code:100024

Website : www.ctc.ac.cn

The reception tel: (86-10) 51167681

The reception e-mail: ywjd@ctc.ac.cn

The complaint tel: (86-10) 51167679

The complaint e-mail : cxts@ctc.ac.cn

G0003814

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ADDITONAL DOCUMENTATION

China Photovoltaic Product Test Center
Test Report

Report Number : WT2021L11A00013 **Page 1 of 17**

Description of product	Photovoltaic Module	**Test Type**	Entrustment test
Entrusted by	TÜV Rheinland (Shanghai) Co., Ltd.	**Trade Mark**	—
Produced by	Zhejiang Beyondsun Green Energy Technology Co., Ltd. (Provided by entrusting party)	**Status of sample**	OK
Date of reception	2021-01-20	**Sample quantity**	3
Sample description	TSHM450-144HW, 2094mm×1038mm×35mm, Monocrystalline silicon.		
Standard of test	IEC 62716:2013.	**Date of test**	2021-02-22 to 2021-03-22
Pass criteria	IEC 62716:2013.		
Test item	See the details on page of "Test item".		
Conclusion	The test results meet the requirments of the IEC 62716:2013. The test data are reported from page 3 to page 7. (Seal) **Date of issue:** 2021-04-07		
Remarks	Required by entrusting party: Samples do not need to be preconditioned.		

Issued by : **Checked by :** **Edited by :**

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China Photovoltaic Product Test Center
Test Report

Report Number : WT2021L11A00013 Page 2 of 17

Test Procedures:

—	List of test samples

Sample No.	Sample S/N	Remarks	Module type
WTLA00013-1	820617181200013	Control module	TSHM450-144HW
WTLA00013-2	820617181200043	Module for ammonia corrosion test	TSHM450-144HW
WTLA00013-3	820617181200048	Module for ammonia corrosion test	TSHM450-144HW

Remark:
The test location is in Guanzhuang.

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ADDITONAL DOCUMENTATION

China Photovoltaic Product Test Center
Test Report

Report Number : WT2021L11A00013 Page 3 of 17

6.2 c)	Visual inspection (Initial)	
Test Date [YYYY-MM-DD]	2021-02-22	—
Sample No.	Nature and position of initial findings	
1	No major visual defects	P
2	No major visual defects	P
3	No major visual defects	P
Supplementary information: N/A		

6.2 a)	Maximum power determination (Initial)						
Test Date [YYYY-MM-DD]			2021-02-22				—
Module temperature [°C]			25.1~25.2				
Irradiance [W/m²]			1000.0~1000.1				
Sample No.	Pmax [W]	Vmpp [V]	Impp [A]	Voc [V]	Isc [A]	FF [%]	
1	452.317	41.736	10.838	49.586	11.350	80.371	—
2	451.744	41.816	10.803	49.590	11.300	80.612	—
3	452.690	41.767	10.839	49.593	11.351	80.415	—
* A pulse solar simulator class AAA conforming to the requirements of IEC-60904-9 is used.							
Supplementary information: N/A.							

6.2 e)	Dielectric withstand test (Initial) - MST 16					
Test Date [YYYY-MM-DD]			2021-02-23			—
Maximum system voltage [V_{DC}]			1500			
High voltage applied [V_{DC}]			8000			
Insulation resistance measured at [V_{DC}]			1500			
Sample No.	Measured	Area	Result*	Dielectric breakdown		
	[GΩ]	[m²]	[GΩ·m²]	Yes (description)	No	
1	>15.00	2.174	> 32.61	—	No	P
2	>15.00	2.174	> 32.61	—	No	P
3	>15.00	2.174	> 32.61	—	No	P
* Minimum requirement acc. to the standard is 0.04 GΩ·m².						
Supplementary information: N/A						

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ADDITONAL DOCUMENTATION

China Photovoltaic Product Test Center
Test Report

Report Number : WT2021L11A00013 Page 4 of 17

6.2 b)	Wet leakage current test (Initial)			
Test Date [YYYY-MM-DD]		2021-02-23		—
Insulation resistance measured at [V_{DC}]		1500		
Solution resistivity [Ω cm]		≤3500	2223	P
Solution temperature [°C]		22 ± 3	20.1	P
Sample No.	Measured	Area	Result*	—
	MΩ	m²	MΩ·m²	
1	>15000	2.174	>32610	P
2	>15000	2.174	>32610	P
3	>15000	2.174	>32610	P
* Minimum requirement acc. to the standard is 40 MΩ·m²				
Supplementary information: N/A				

6.2 d)	Ground continuity test (Initial) - MST 13		
Test Date [YYYY-MM-DD]		2021-02-24	—
Maximum over-current protection rating [A]		25.0	
Current applied [A]		62.5	
Location of designated grounding point		At the longer side of frame	
Location of second contacting point		The greatest physical displacement of adjacent side	
Sample No.	Voltage [mV]	Resistance [mΩ]	
1	—	<1	P
2	—	<1	P
3	—	<1	P
Supplementary information: N/A			

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ADDITONAL DOCUMENTATION

China Photovoltaic Product Test Center
Test Report

Report Number : WT2021L11A00013 **Page 5 of 17**

7	Ammonia corrosion test		
Test Date [YYYY-MM-DD]		2021-03-02 / 2021-03-22	—
NH_3 concentration [ppm]		6659~6665	
Temperature [°C]		58.0~59.6	
Relative humidity [%]		97.4~99.2	
Course of cycle (1 day)		- exposure of NH_3 for 8 hours and 60°C with nearly 100% condensation on the samples - drying for 16 hours at18°C~28°C and max. 75%RH	
Duration		20 cycles = 480 hours (20 days)	
Sample #	Nature and position of initial findings		
2	—		P
3	—		P
Supplementary information: N/A			

9.2 c)	Visual inspection after ammonia corrosion test (Final)	
Test Date [YYYY-MM-DD]	2021-03-22	—
Sample No.	Nature and position of initial findings	
2	No major visual defects	P
3	No major visual defects	P
Supplementary information: N/A		

9.2 a)	Maximum power determination after ammonia corrosion test (Final)							
Test Date [YYYY-MM-DD]			2021-03-22					—
Module temperature [°C]			25.1					
Irradiance [W/m²]			1000.3					
Sample No.	Pmax [W]	Vmpp [V]	Impp [A]	Voc [V]	Isc [A]	FF [%]	Degradation [%]	
2	450.371	41.896	10.750	49.666	11.248	80.621	-0.304	P
3	452.372	41.847	10.810	49.702	11.309	80.482	-0.070	P
* A pulse solar simulator class AAA conforming to the requirements of IEC-60904-9 is used.								
Supplementary information: Maximum allowable P_{max} degradation after this test is 5 %.								

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ADDITONAL DOCUMENTATION

China Photovoltaic Product Test Center
Test Report

Report Number : WT2021L11A00013 Page 6 of 17

9.2 e)	Dielectric withstand test after ammonia corrosion test (Final)					
Test Date [YYYY-MM-DD]				2021-03-22		—
Maximum system voltage [V_{DC}]				1500		
High voltage applied [V_{DC}]				8000		
Insulation resistance measured at [V_{DC}]				1500		
Sample No.	Measured	Area	Result*	Dielectric breakdown		
	[GΩ]	[m²]	[GΩ·m²]	Yes (description)	No	
2	>15.00	2.174	> 32.61	—	No	P
3	>15.00	2.174	> 32.61	—	No	P
* Minimum requirement acc. to the standard is 0.04 GΩ·m².						
Supplementary information:N/A						

9.2 b)	Wet leakage current test after ammonia corrosion test (Final)			
Test Date [YYYY-MM-DD]	2021-03-22			—
Insulation resistance measured at [V_{DC}]	1500			
Solution resistivity [Ω cm]	≤3500	2219		P
Solution temperature [°C]	22 ± 3	20.6		P
Sample No.	Measured	Area	Result*	—
	MΩ	m²	MΩ·m²	
2	>15000	2.174	>32610	P
3	>15000	2.174	>32610	P
* Minimum requirement acc. to the standard is 40 MΩ·m²				
Supplementary information: N/A				

9.2 d)	Ground continuity test after ammonia corrosion test (Final) - MST 13		
Test Date [YYYY-MM-DD]	2021-03-22		—
Maximum over-current protection rating [A]	25.0		
Current applied [A]	62.5		
Location of designated grounding point	At the longer side of frame		
Location of second contacting point	The greatest physical displacement of adjacent side		
Sample No.	Voltage [mV]	Resistance [mΩ]	
2	—	<1	P
3	—	<1	P
Supplementary information: N/A			

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ADDITONAL DOCUMENTATION

China Photovoltaic Product Test Center
Test Report

Report Number : WT2021L11A00013 Page 7 of 17

9.2 f)	Bypass diode functional test after ammonia corrosion test (Final)			
Test Date [YYYY-MM-DD]		2021-03-22		—
Diode manufacturer		—		
Diode type designation		—		
Number of diodes in junction box		3		
Sample #	Diode 1	Diode 2	Diode 3	
2	Functional	Functional	Functional	P
3	Functional	Functional	Functional	P
Supplementary information: N/A				

ZUSATZDOKUMENTATION
ADDITONAL DOCUMENTATION

China Photovoltaic Product Test Center
Test Report

Report Number : WT2021L11A00013 Page 8 of 17

Abbreviations used in the report

Pmax	Maximum power
Impp	Maximum power point current
Vmpp	Maximum power point voltage
Isc	Short circuit current
Voc	Open circuit voltage
FF	Fill factor

Statement of the estimated uncertainty of the test verdicts

- Electrical performance rating is outside the scope of IEC 61215:2005 qualification testing. The verdicts of performance rating are only related to the test samples that were subjected to the tests. They cannot be generalised to the modules from the series production.
- The calibration to STC was performed with a class AAA solar simulator. The extended measurement uncertainty is:

Extended measurement uncertainty of Isc U_{rel}= 2.34% (k=2) ;

Extended measurement uncertainty of Voc U_{rel}= 0.78% (k=2) ;

Extended measurement uncertainty of Pmp U_{rel}= 2.48% (k=2)。

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ADDITONAL DOCUMENTATION

China Photovoltaic Product Test Center
Test Report

Report Number : WT2021L11A00013 Page 9 of 17

Appendix A: Sample photos
Module type: TSHM450-144HW

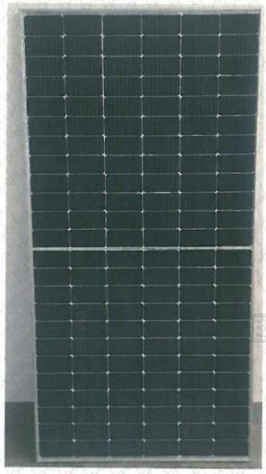

Fig. 1: front view of test sample

Fig. 2: rear view of test sample

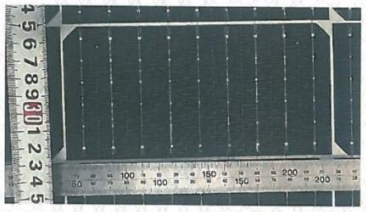

Fig. 3: detail view of solar cell

Fig. 4: detail view of type label

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ADDITONAL DOCUMENTATION

China Photovoltaic Product Test Center
Test Report

Report Number : WT2021L11A00013 Page 10 of 17

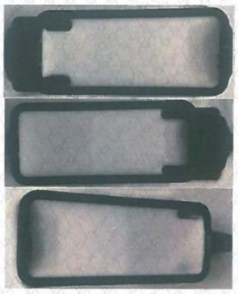

Fig. 5: detail view of open junction box

Fig. 6: detail view of closed junction box

Fig. 7: detail view of connector

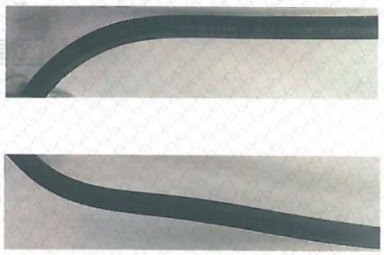

Fig. 8: detail view of cable

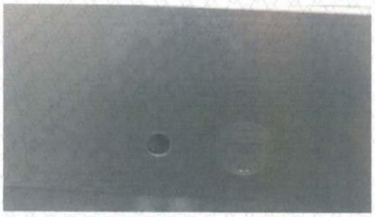

Fig. 9: detail view of grounding hole and symbol

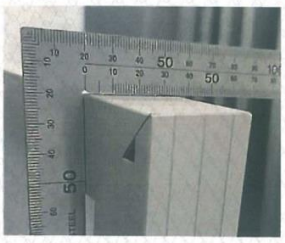

Fig. 10: detail view of frame edge

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ADDITONAL DOCUMENTATION

China Photovoltaic Product Test Center
Test Report

Report Number : WT2021L11A00013 Page 11 of 17
Appendix B: EL-images
Module type: TSHM450-144HW

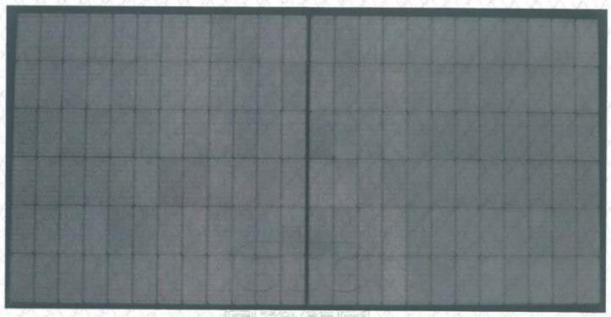

Fig. 11: EL-image of sample 820617181200013 (initial)

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China Photovoltaic Product Test Center
Test Report

Report Number : WT2021L11A00013 Page 12 of 17

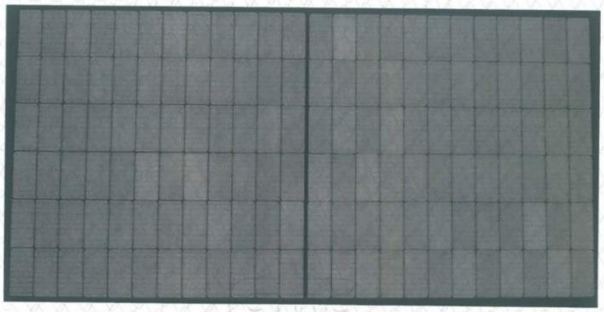

Fig. 12: EL-image of sample 820617181200043 (initial)

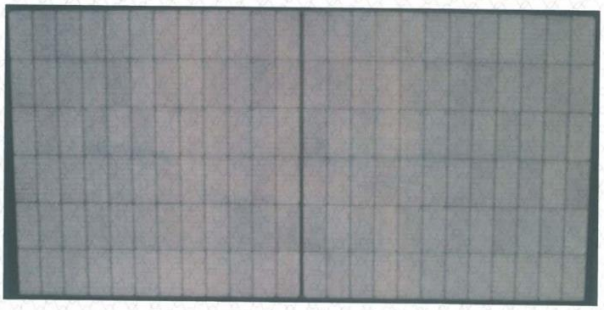

Fig. 13: EL-image of sample 820617181200043 (final)

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ADDITONAL DOCUMENTATION

China Photovoltaic Product Test Center
Test Report

Report Number : WT2021L11A00013 Page 13 of 17

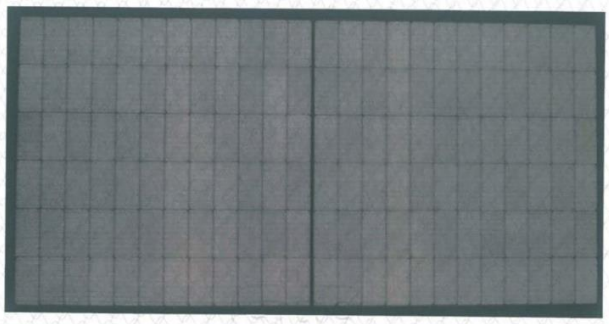

Fig. 14: EL-image of sample 820617181200048 (initial)

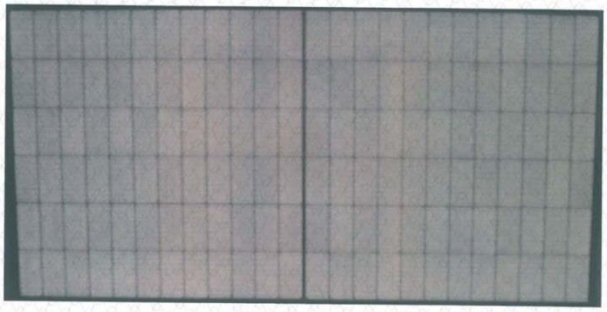

Fig. 15: EL-image of sample 820617181200048 (final)

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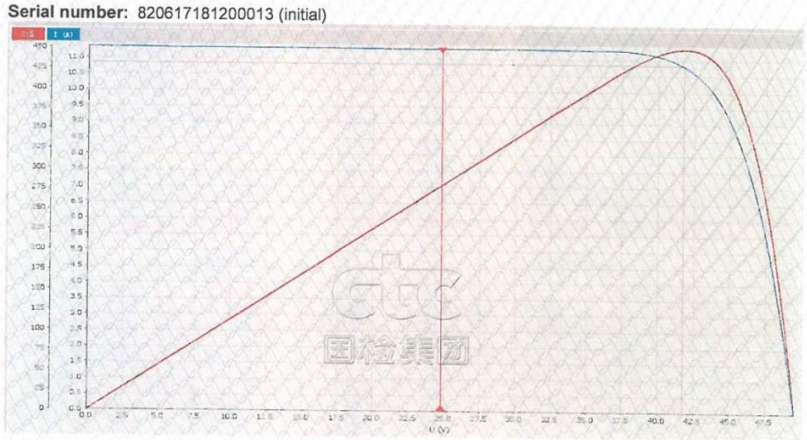
ADDITONAL DOCUMENTATION

China Photovoltaic Product Test Center
Test Report

Report Number : WT2021L11A00013 **Page 14 of 17**

Appendix C: I-V Characteristic Curve
Module type: TSHM450-144HW

Serial number: 820617181200013 (initial)



Serial number: 820617181200013 (final)
N/A

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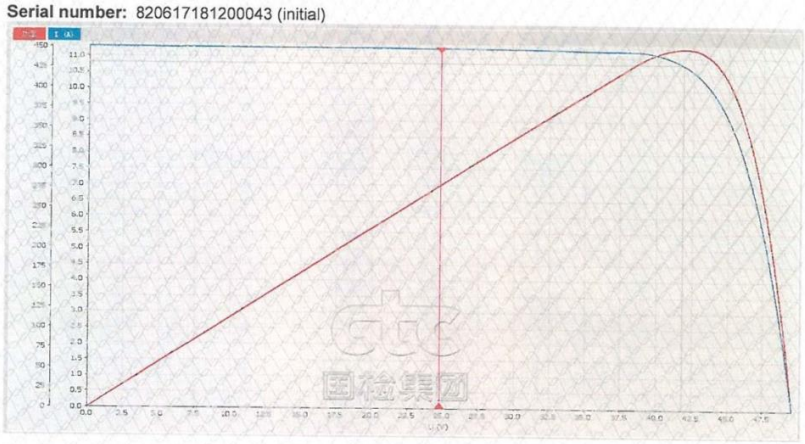
ZUSATZDOKUMENTATION
ADDITONAL DOCUMENTATION

China Photovoltaic Product Test Center
Test Report

Report Number : WT2021L11A00013 Page 15 of 17

Serial number: 820617181200043 (initial)



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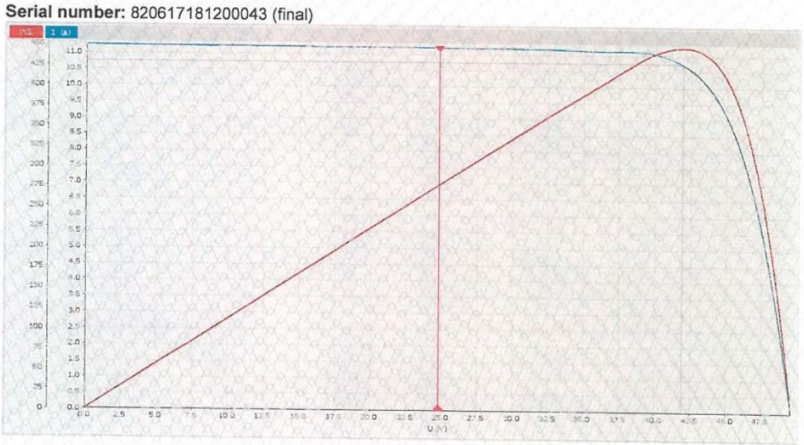

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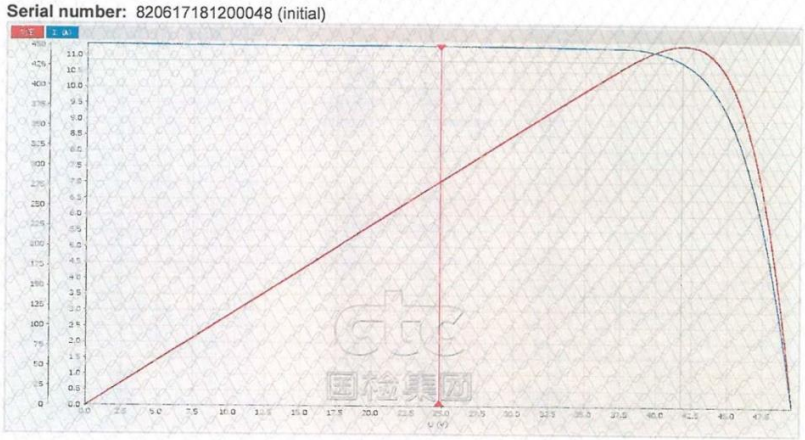
ZUSATZDOKUMENTATION
ADDITONAL DOCUMENTATION

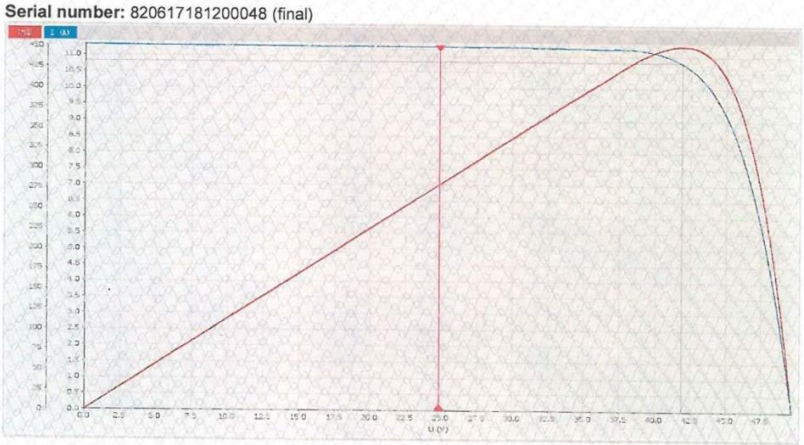
China Photovoltaic Product Test Center
Test Report

Report Number : WT2021L11A00013 Page 16 of 17

Serial number: 820617181200048 (initial)



Serial number: 820617181200048 (final)



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ADDITONAL DOCUMENTATION

China Photovoltaic Product Test Center
Test Report

Report Number : WT2021L11A00013 Page 17 of 17

Appendix D: List of measurement equipment

Sequence No.	Equipment	Identification	Next calibration date (MM/DD/YYYY)
1	Irradiance illuminometer	GF-28 1010A	03/12/2022
2	Visual inspection platform	GF-24 WGCS-1	10/26/2021
3	Pulsed-state solar simulator	GF-119 HighLight3	11/09/2021
4	Hygrothermograph	GF-94-2 NWSF-1AT	06/28/2021
5	Withstanding voltage / Insulation resistance tester	GF-06-3 EX7472	06/22/2021
6	Hygrothermograph	GF-94-1 NWSF-1AT	06/28/2021
7	Tank	GF-16 SC-2	01/07/2022
8	Resistivity meter	GF-02 TP-220	01/10/2022
9	Ground continuity tester	GF-268 ZW-PVGD0	01/17/2022
10	DC power	GF-10 Lambda	12/30/2021
11	Hygrothermograph	GF-30-2 WS-2020B1	10/25/2021
12	EL tester	GF-48 OPT200	02/16/2022
13	Ammonia corrosion test system	GF-125NH3-PSTEST-5000	06/19/2021

End of Test Report

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CTC Profile

After nearly 70 years of unremitting efforts and persistent pursuit, China Building Material Test & Certification Group Co., Ltd. (hereinafter referred to as "CTC") has developed into a large-scale, comprehensive, third-party test and certification service organization in the field of building materials and construction engineering in China.

As the first a-share "China" prefix listed company consisting of inspection and certification together, branches throughout the country and has more than 30 national and industrial level testing laboratory, which could provide comprehensive solutions on quality, safety, environmental protection, green, energy conservation and other issues for all kinds of customers, such as building materials production enterprises, construction engineering, decoration engineering, railway and rail traffic engineering, municipal engineering, electrical engineering, industrial furnace, renewable resources, new energy, the life that occupy the home and so on.

CTC has always been driven by "scientific and technological innovation", adhering to the core concept of "delivering trust and service development", promoting the brand value of customers, escorting the sustainable development of the industry, and contributing to the realization of "quality revitalization" and " the Belt and Road Initiative".

CTC is the legal entity of the center and bears the legal responsibility of this report.

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