



TC-6168



Test Report

CITIZEN SOLAR PRIVATE LIMITED

REPORT NUMBER: 4790739969.6.1-NABL-S1

PROJECT NUMBER: 4790739969.6.1

ULR NUMBER: TC616823100000503F

Select the applicable test

locations:

LOCATION 1:

UL India Private Limited,
Laboratory building, Kalyani
Platina Campus, Sy.no.129/4, EPIP
Zone, Phase II, Whitefield,
Bangalore - 560 066
P:91-80-41384400

LOCATION 2:

UL India Private Limited,
Oak building, Kalyani Platina
Campus, Sy.No.129/4,
EPIP Zone, Phase II, Whitefield,
Bangalore, Karnataka - 560 066

LOCATION 3:

UL India Private Limited, 30/A, I
Stage, Vishveshwarya Industrial
Estate, Doddanekkundi Industrial
Area, Bangalore - 560048

QR code-





Report Number: 4790739969.6.1-NABL-S1
 ULR Number: TC616823100000503F



TEST DISCIPLINE: ELECTRONICS
PRODUCT GROUP: SOLAR PANEL

General details

Customer / Applicant	Citizen Solar Private Limited New Survey No.966, Village: Indrad, Chhatral Kadi Road, Ta.Kadi, Dist. Mehsana, Gujarat-382715		
Manufacturer	Citizen Solar Private Limited New Survey No.966, Village: Indrad, Chhatral Kadi Road, Ta.Kadi, Dist. Mehsana, Gujarat-382715		
Program	NABL		
Item Under Test	Photovoltaic module		
Model	CSPL-144MHC-WF-545		
Number of Samples	04		
UL. Sample Identification	Refer Pg No.3	Refer Summary of Test results for multiple samples	
Manufacturer Serial Number (if any)	Refer Pg No.3		
Condition of IUT on receipt	Good		
Date of Receipt	16 June 2023		
Applicable Standard	IEC 61853-1 Edition 1.0, 2011-01- Photovoltaic (PV) module performance testing and energy rating –Part 1: Irradiance and temperature performance measurements and power rating.		
Date of Testing (Start date)	23 June 2023	End Date	3 August 2023
UL general ambient condition	Temperature in °C		(23 ±5) °C
	Relative humidity in %		<70 %
Date of Issue	11 August 2023		
Test In-charge	N Naveenkumar		

Fill in the rows with information or add hyphen (-)

M Jayalakshmi Engineering Project Associate Reviewed by	N Srimathy Project Engineer Authorized signatory
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General Remarks (If any)

- 1) The test results below in this report will relate only to the items tested.
- 2) This report shall not be reproduced except in full, without the written approval of the testing laboratory.

Description of Item under Test (IUT)

Mono crystalline PV modules of was tested for IEC 61853-1. Out of 4 samples, 3 samples were considered as test samples and 1 sample considered as control.

Sample No.	Sample Identification Number	Date Received MM/DD/YYYY	Test Date MM/DD/YYYY	Product Description	Serial Number
S1	6190571 control	06-16-2023	06/23/2023 To 08/03/2023	PV module 545W	CSPL23050174
S2	6190572			PV module 545W	CSPL23050176
S3	6190574			PV module 545W	CSPL23050182
S4	6190575			PV module 545W	CSPL23050183

Note:

- 1) Samples were selected and provided by Client.
- 2) No sample manufacturing witnessing/oversight performed.

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Summary of Test Results

S. No.	Item	Result
3.1	Visual Inspection as Received	No Visual defects found
3.2	Stabilization	Average degradation less than 1%.
3.3	Performance at STC after stabilization	Average Pmax = 551.29 Minimum Pmax = 550.73 Maximum Pmax = 551.69
3.4	Performance according to IEC61853-1	Refer individual test table for details
3.5	Measurement of temperature coefficients	$\alpha(\text{ISC}) = 0.04\%$ $\beta(\text{Voc}) = -0.23\%$ $\delta(\text{Pmp}) = -0.30\%$

P: Meets the requirements F: Does not meet the requirement NA: Not applicable

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ULR Number: TC616823100000503F**Master Equipment and Calibration details**

Serial No.	Test Equipment	UL. Equipment ID	Calibration status (Valid up to)
1	Fixture, For Testing, Table	160912	N/A
2	Datalogger, RH & Temperature	68611	2024-01-11
3	Magnifying Lens, Without Ruler	76645	N/A
4	Meter and/or Sensor, Light	211906	2023-10-09
5	Apparatus, Solar Simulator	199796	2024-06-28
6	Datalogger, RH & Temperature	64832	2023-09-07
7	Thermometer, Infrared	199638	2024-04-06
8	Measuring Tool, Rigid Ruler	177816	2024-01-10
9	Reference Standard, Voltage or Current	226647	2023-11-08
10	Datalogger	199233	2024-06-09
11	Apparatus, Pyranometer, Solar Diffuse Radiance	54584	2025-08-26
12	Fixture, For Testing, Support	175617	N/A
13	Load, Resistive, Fixed	199819	2024-06-06
14	Load, Resistive, Fixed	199820	2024-06-06

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Serial No.	Test Equipment	UL. Equipment ID	Calibration status (Valid up to)
15	Load, Resistive, Fixed	199821	2024-06-06
16	Load, Resistive, Fixed	199822	2024-06-06
17	Apparatus, Solar Simulator	199796	2024-06-28
18	Datalogger, RH & Temperature	64832	2023-09-07
19	Thermometer, Infrared	199638	2024-04-06
20	Reference Standard, Voltage or Current	226647	2023-11-08
21	Datalogger	199233	2024-06-09
22	Apparatus, Pyranometer, Solar Diffuse Radiance	54584	2025-08-26
23	Fixture, For Testing, Support	175617	N/A
24	Load, Resistive, Fixed	199819	2024-06-06
25	Load, Resistive, Fixed	199820	2024-06-06
26	Load, Resistive, Fixed	199821	2024-06-06
27	Load, Resistive, Fixed	199822	2024-06-06
28	Fixture, For Testing, Table	160912	N/A
29	Datalogger, RH & Temperature	68611	2024-01-11

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Serial No.	Test Equipment	UL Equipment ID	Calibration status (Valid up to)
30	Magnifying Lens, Without Ruler	76645	N/A
31	Meter and/or Sensor, Light	211906	2023-10-09
32	Apparatus, Solar Simulator	199796	2024-06-28
33	Datalogger, RH & Temperature	64832	2023-09-07
34	Thermometer, Infrared	199638	2024-04-06
35	Reference Standard, Voltage or Current	226647	2023-11-08
36	Apparatus, Solar Simulator	199796	2024-06-28
37	Datalogger, RH & Temperature	64832	2023-09-07
38	Thermometer, Infrared	199638	2024-04-06
39	Reference Standard, Voltage or Current	226647	2023-11-08
40	Chamber, Climatic, Temp	70192	2024-04-11
41	Apparatus, Solar Simulator	199796	2024-06-28
42	Datalogger, RH & Temperature	64832	2023-09-07
43	Thermometer, Infrared	199638	2024-04-06
44	Reference Standard, Voltage or Current	226647	2023-11-08

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Serial No.	Test Equipment	UL. Equipment ID	Calibration status (Valid up to)
45	Chamber, Climatic, Temp	70192	2024-04-11
46	Apparatus, Solar Simulator	199796	2024-06-28
47	Datalogger, RH & Temperature	64832	2023-09-07
48	Thermometer, Infrared	199638	2024-04-06
49	Reference Standard, Voltage or Current	226647	2023-11-08
50	Chamber, Climatic, Temp	70192	2024-04-11

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Test methodology adopted.

As per standard IEC 61853-1 - Photovoltaic (PV) Module Performance Testing and Energy Rating – Part 1: Irradiance and Temperature Performance Measurements and Power Rating – Edition.1- 2011-01

Test Observation (If any)

Visual Inspection

10.1	TABLE: Visual inspection (Initial)	P
Test Date [MM/DD/YYYY].....:	06/23/2023	—
Sample #	Nature and position of initial findings – comments or attach photos	—
S1	No visual defects found	P
S2	No visual defects found	P
S3	No visual defects found	P
S4	No visual defects found	P
Supplementary information: Lab Ambient: 25.3°C, 49.8%RH		

3.2 Performance at STC before stabilization

Description and Setup

The performance at STC according to IEC61215-2 has been determined by use of a class A pulsed sun simulator according to IEC 60904-9 and a photovoltaic reference device according to IEC 60904-2 of the same technology as the sample under test.

- Before each test the photovoltaic reference device was placed on the pulsed sun simulator to adjust the test equipment and assure the correctness of the measurement.
- After adjusting the pulsed sun simulator, the sample under test was placed on the test area and hold at a temperature of 25°C +/-1°C.
- The current-voltage characteristics were measured and recorded at an irradiance of 1000 W/m².

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Result:

10.2 TABLE: Maximum Power Determination at STC – Before Preconditioning						
Test Date (MM/DD/YYYY) start/end:			06/23/2023			
Cell temperature (°C):			25			
Irradiance (W/m ²):			1000			
Sample No.	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmp (W)	FF (%)
S1	49.97	42.30	13.59	13.05	552.12	81
S2	49.99	42.41	13.63	13.06	553.83	81
S3	49.95	42.28	13.61	13.10	553.97	81
S4	49.95	42.23	13.61	13.10	553.15	81
Supplementary information: $U(P_{mp})$: <u>1.7%</u> , $U(I_{sc})$: <u>1.7%</u> , $U(V_{oc})$: <u>1.4%</u> ; $k = 2$						

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3.3 Stabilization:

Description and Setup:

The module was exposed to total irradiance according to IEC 61215-2, First Edition, 2016.

The following formula shall be taken as the criterion to assess whether a module has reached its stabilized electrical power output:

$$(P_{max} - P_{min}) / P_{average} < x$$

Where x is defined in the technology specific parts of this standard, x=0.01 for c-Si modules.

Result:

Sample No.	Interval	Integrated irradiation (kWh/m ²)	Average Irradiance (W/m ²)/ Exposed Time (h:m)	Module temp. (°C)	Resistive Load (Ω)	Pmax of Stage (W)	Avr. Degradation (%)	Stable (Yes/No)
S1	Initial	-	-	-	-	552.12	-	-
	1 st	5.04	711.62	38.45	4	551.28	-	-
	2 nd	5.05	688.43	40.66	4	550.73	0.3	Yes
S2	Initial	-	-	-	-	553.83	-	-
	1 st	5.04	711.62	38.45	4	552.85	-	-
	2 nd	5.05	688.43	40.66	4	551.69	0.4	Yes
S3	Initial	-	-	-	-	553.97	-	-
	1 st	5.04	711.62	38.45	4	552.79	-	-
	2 nd	5.05	688.43	40.66	4	551.68	0.4	Yes
S4	Initial	-	-	-	-	553.15	-	-
	1 st	5.04	711.62	38.45	4	551.86	-	-
	2 nd	5.05	688.43	40.66	4	551.06	0.4	Yes

Supplementary information: Test date [MM/DD/YYYY] 06/24/2023 to 07/01/2023

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3.4 Visual Inspection after Stabilization

Description and Setup:

Samples were visually inspected according to IEC 61215-2, First Edition, 2016.

Result:

10.1	TABLE: Visual inspection (after Stabilization)	P
Test Date [MM/DD/YYYY]	07/03/2023	—
Sample #	Nature and position of initial findings – comments or attach photos	—
S1	No Visual defects found	P
S2	No Visual defects found	P
S3	No Visual defects found	P
S4	No Visual defects found	P
Supplementary information: 25.2 __ °C, __ 48.4% __ RH		

3.5 Performance at STC after stabilization

Description and Setup:

The performance at STC according to IEC61215-2 has been determined by use of a class A pulsed sun simulator according to IEC 60904-9 and a photovoltaic reference device according to IEC 60904-2 of the same technology as the sample under test.

- Before each test the photovoltaic reference device was placed on the pulsed sun simulator to adjust the test equipment and assure the correctness of the measurement.

After adjusting the pulsed sun simulator, the sample under test was placed on the test area and hold at a temperature of 25°C +/-1°C.

The current-voltage characteristics were measured and recorded at an irradiance of 1000 W/m².

Result:

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10.2 TABLE: Maximum Power Determination at STC – After Preconditioning						
Test Date (MM/DD/YYYY) start/end			07/03/2023			
Cell temperature (°C)			25			
Irradiance (W/m ²)			1000			
Sample No.	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmp (W)	FF (%)
S1	49.95	42.29	13.65	13.02	550.73	81
S2	49.92	42.23	13.67	13.06	551.69	81
S3	49.95	42.21	13.62	13.07	551.68	81
S4	49.94	42.19	13.65	13.06	551.06	81
Supplementary information:		<i>Estimated measurement uncertainty : : U(P_{mp}): _1.7%_, U(Isc): _1.7%_, U(V_{oc}): _1.4%_; k = 2. Measured STC power agrees with the manufacturer's rated power range within the test laboratories measurement uncertainty</i>				

3.6 PERFORMANCE AT STC & NOCT - MEASUREMENTS IN A SOLAR SIMULATOR

10.6 TABLE: Performance at STC and NOCT							P
Test Date [MM/DD/YYYY]			08/03/2023			—	
Sample			S1			—	
Wind velocity [m/s]high/low			--			—	
Test method			<input checked="" type="checkbox"/> indoor <input type="checkbox"/> outdoor			—	
Ambient air temperature [°C] high/low			--			—	
Irradiance [W/m ²]high/low			STC: 1000 / NOCT: 800			—	
Module temperature [°C] high/low			STC-25.0, NOCT- 46.20			—	
Data corrected to the STC Standard Reference Environment (SRE)							
Condition	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]	
STC	49.98	42.18	13.59	13.04	550.10	81.00	
NOCT	46.95	39.69	10.93	10.44	414.42	81.00	
Supplementary information: NOCT temperature is provided by manufacturer							

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10.7		TABLE: Performance at low irradiance					P
Test Date [MM/DD/YYYY]		08/03/2023					—
Sample		S1					
Investigation wind velocity (m/s)		--					
Ambient air temperature [°C]		24.8					—
Irradiance [W/m ²](200 W/m ²)		200					—
Module temperature [°C]		25					—
Test method		<input type="checkbox"/> Data corrected to a 25°C cell temperature and 200 W/m ² irradiance. <input checked="" type="checkbox"/> Directly measured					—
Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]	
S1	46.97	41.78	2.72	2.61	108.91	85.00	
Supplementary information: N/A							

		TABLE: PERFORMANCE AT HIGH TEMPERATURE CONDITION					P
Test Date [MM/DD/YYYY]		08/03/2023					—
Sample		S1					
Investigation wind velocity (m/s)		--					
Ambient air temperature [°C]		25.1					—
Irradiance [W/m ²]		1000					—
Module Cell temperature [°C]		75					—
Test method		<input checked="" type="checkbox"/> Directly measured					—
Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]	
S1	44.32	36.33	13.75	12.96	470.74	77.00	
Supplementary information: N/A							

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TABLE: PERFORMANCE AT LOW TEMPERATURE CONDITION							P
Test Date [MM/DD/YYYY]					08/03/2023		—
Sample					S1		
Investigation wind velocity (m/s)					--		
Ambient air temperature [°C]					25.3		—
Irradiance [W/m ²]					500		—
Module Cell temperature [°C]					15		—
Test method					<input checked="" type="checkbox"/> Directly measured		—
Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]	
S1	49.99	43.69	6.72	6.51	284.58	85.00	
Supplementary information: N/A							

3.7 Performance according to IEC61853-1: 2011-01, Ed 01, Clause 8.2

Description and Setup:

The measurements were taken according to IEC 61853-1 1st edition rev. date 2011-01 clause 8.2 with a Class A pulsed solar simulator.

Matrices of module performance with respect to temperature and irradiance were measured and separate tables for Isc, Voc, Vmax and Pmax were generated using sufficient data to assure statistical validity to the measurements (see clause 8.3.11 and 8.5.11 of IEC 61853-1).

After generating the matrix of parameters, the modules were remeasured at STC to verify that the performance is stable.

Result:

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Test Table: Performance according to IEC61853-1: 2011-01, Ed 01, Clause 8.2

Sample: S2							
Irr (W/m ²)	Tc (°C)	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmax (W)	FF
100	15	47.07	42.35	1.35	1.29	54.53	86.00
	25	45.61	40.60	1.36	1.31	53.01	85.00
	50	NA	NA	NA	NA	NA	NA
	75	NA	NA	NA	NA	NA	NA
200	15	48.40	43.29	2.69	2.59	112.19	86.00
	25	46.93	41.47	2.73	2.63	108.89	85.00
	50	NA	NA	NA	NA	NA	NA
	75	NA	NA	NA	NA	NA	NA
400	15	49.53	43.74	5.40	5.22	228.22	85.00
	25	48.23	42.29	5.44	5.24	221.58	84.00
	50	45.08	38.50	5.48	5.24	201.69	82.00
	75	NA	NA	NA	NA	NA	NA
600	15	50.30	43.98	8.10	7.80	343.05	84.00
	25	48.99	42.48	8.16	7.83	332.62	83.00
	50	45.91	39.09	8.22	7.86	307.13	81.00
	75	43.15	36.11	8.27	7.82	282.44	79.00
800	15	50.80	43.86	10.76	10.41	456.42	83.00
	25	49.49	42.40	10.88	10.44	442.86	82.00

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	50	46.47	39.15	10.95	10.48	410.27	81.00
	75	43.69	36.19	11.02	10.43	377.33	78.00
1000	15	51.22	44.02	13.46	12.97	571.19	83.00
	25	49.89	42.30	13.61	13.03	551.36	81.00
	50	46.98	38.95	13.69	13.07	509.09	79.00
	75	44.40	36.11	13.77	13.03	470.59	77.00
1100	15	NA	NA	NA	NA	NA	NA
	25	50.07	42.13	14.99	14.34	604.36	81.00
	50	47.07	38.94	15.12	14.36	559.33	79.00
	75	44.46	36.08	15.22	14.31	516.50	76.00
Sample: S3							
Irr (W/m2)	Tc (°C)	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmax (W)	FF
100	15	47.05	41.97	1.35	1.30	54.56	86.00
	25	45.63	40.50	1.37	1.31	52.93	85.00
	50	NA	NA	NA	NA	NA	NA
	75	NA	NA	NA	NA	NA	NA
200	15	48.41	43.28	2.69	2.59	112.15	86.00
	25	46.97	41.45	2.73	2.63	108.80	85.00
	50	NA	NA	NA	NA	NA	NA
	75	NA	NA	NA	NA	NA	NA
400	15	49.54	43.73	5.38	5.20	227.39	85.00

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	25	48.30	42.17	5.45	5.24	220.97	84.00
	50	45.15	38.74	5.47	5.22	202.26	82.00
	75	NA	NA	NA	NA	NA	NA
600	15	50.34	43.80	8.07	7.81	342.25	84.00
	25	49.04	42.33	8.17	7.86	332.54	83.00
	50	45.94	39.06	8.19	7.83	305.84	81.00
	75	43.14	35.89	8.23	7.82	280.66	79.00
800	15	50.81	43.86	10.78	10.40	456.34	83.00
	25	49.55	42.44	10.90	10.43	442.64	82.00
	50	46.52	39.05	10.96	10.45	408.20	80.00
	75	43.72	35.92	11.03	10.45	375.31	78.00
1000	15	51.26	43.82	13.48	12.99	569.24	82.00
	25	49.94	42.22	13.63	13.07	551.80	81.00
	50	46.85	39.07	13.71	13.02	508.75	79.00
	75	44.26	36.09	13.80	13.00	469.40	77.00
1100	15	NA	NA	NA	NA	NA	NA
	25	50.16	42.11	15.01	14.38	605.50	80.00
	50	47.23	38.86	15.10	14.43	560.69	79.00
	75	44.55	36.20	15.19	14.25	515.96	76.00

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Sample: S4							
Irr (W/m ²)	Tc (°C)	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmax (W)	FF
100	15	46.94	41.84	1.35	1.30	54.34	86.00
	25	45.67	40.24	1.37	1.32	52.93	85.00
	50	NA	NA	NA	NA	NA	NA
	75	NA	NA	NA	NA	NA	NA
200	15	48.29	43.14	2.70	2.60	112.12	86.00
	25	47.03	41.58	2.72	2.62	108.90	85.00
	50	NA	NA	NA	NA	NA	NA
	75	NA	NA	NA	NA	NA	NA
400	15	49.59	43.84	5.39	5.20	227.81	85.00
	25	48.30	42.21	5.45	5.23	220.83	84.00
	50	45.08	38.64	5.47	5.23	201.92	82.00
	75	NA	NA	NA	NA	NA	NA
600	15	50.33	44.18	8.09	7.79	344.03	85.00
	25	49.07	42.24	8.17	7.87	332.38	83.00
	50	45.93	39.17	8.21	7.84	307.09	81.00
	75	43.23	36.17	8.26	7.82	282.91	79.00
800	15	50.78	43.81	10.76	10.36	454.08	83.00
	25	49.59	42.38	10.89	10.45	442.75	82.00
	50	46.48	39.25	10.96	10.44	409.80	80.00

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	75	43.78	36.28	11.03	10.40	377.33	78.00
1000	15	51.30	43.90	13.48	12.98	569.98	82.00
	25	49.98	42.25	13.62	13.04	550.79	81.00
	50	46.92	38.94	13.73	13.07	508.88	79.00
	75	44.36	36.14	13.81	13.03	470.99	77.00
1100	15	NA	NA	NA	NA	NA	NA
	25	50.13	42.29	15.01	14.29	604.30	80.00
	50	47.18	39.03	15.22	14.40	561.85	78.00
	75	44.47	36.22	15.32	14.30	517.93	76.00

Average of Samples: S2 to S4

Irr (W/m ²)	Tc (°C)	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmax (W)	FF
100	15	47.02	42.05	1.35	1.30	54.48	86.00
	25	45.64	40.45	1.37	1.31	52.96	85.00
	50	NA	NA	NA	NA	NA	NA
	75	NA	NA	NA	NA	NA	NA
200	15	48.37	43.24	2.69	2.59	112.15	86.00
	25	46.98	41.50	2.73	2.63	108.86	85.00
	50	NA	NA	NA	NA	NA	NA
	75	NA	NA	NA	NA	NA	NA
400	15	49.55	43.77	5.39	5.21	227.81	85.00

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	25	48.28	42.22	5.45	5.24	221.13	84.00
	50	45.10	38.63	5.47	5.23	201.96	82.00
	75	NA	NA	NA	NA	NA	NA
600	15	50.32	43.99	8.09	7.80	343.11	84.33
	25	49.03	42.35	8.17	7.85	332.51	83.00
	50	45.93	39.11	8.21	7.84	306.69	81.00
	75	43.17	36.06	8.25	7.82	282.00	79.00
800	15	50.80	43.84	10.77	10.39	455.61	83.00
	25	49.54	42.41	10.89	10.44	442.75	82.00
	50	46.49	39.15	10.96	10.46	409.42	80.33
	75	43.73	36.13	11.03	10.43	376.66	78.00
1000	15	51.26	43.91	13.47	12.98	570.14	82.33
	25	49.94	42.26	13.62	13.05	551.32	81.00
	50	46.92	38.99	13.71	13.05	508.91	79.00
	75	44.34	36.11	13.79	13.02	470.33	77.00
1100	15	NA	NA	NA	NA	NA	NA
	25	50.12	42.18	14.76	14.34	604.72	80.33
	50	47.16	38.94	15.15	14.40	560.62	78.67
	75	44.49	36.17	15.24	14.29	516.80	76.00

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3.8 Measurement of temperature coefficients

Description and Setup:

The measurements were taken according to IEC 61853-1 1st edition rev. date 2011-01 with a Class A pulsed solar simulator.

The purpose is to determine the following temperature coefficients:

- Short Circuit current (α)
- Open circuit voltage (β)
- Peak (max) power (δ)

The coefficients so determined are valid at the irradiance at which the measurements were made.

- The current-voltage characteristics were measured and recorded at an irradiance of 1000 W/m².
- The original data is from "Performance measurements according to IEC61853-1"

Results:

Statement of uncertainty:

Expanded measurement uncertainty statement for Maximum power measurement:

$U(P_{mp})$: 1.7%, $U(I_{sc})$: 1.7%, $U(V_{oc})$: 1.4%

The expanded measurement uncertainty resulting from the standard measurement uncertainty multiplied with a factor $k=2$ is specified, denoting the deviations of the measurement value within a probability of 95%.

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Measurement of temperature coefficients

Results

Sample No.	α [%/°C]	β [%/°C]	δ [%/°C]
S2	0.03	-0.23	-0.30
S3	0.04	-0.23	-0.30
S4	0.04	-0.23	-0.30
Average	0.04	-0.23	-0.30

TABLE 1 "AVERAGE MEASUREMENT OF TEMPERATURE COEFFICIENTS"

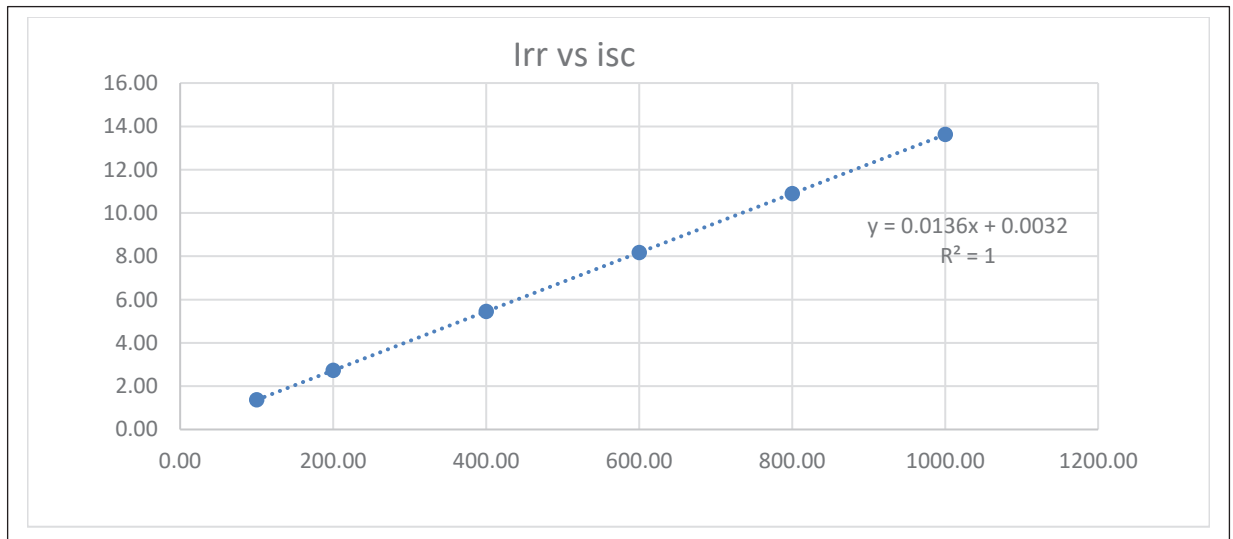
Note:

α – Temperature coefficient of I_{sc}

β – Temperature coefficient of V_{oc}

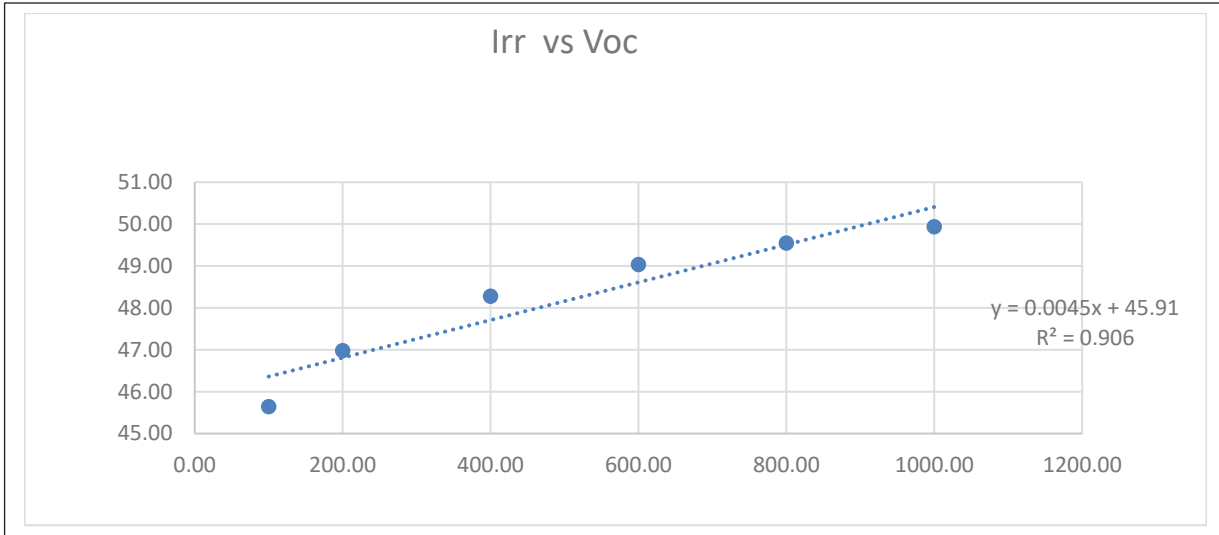
δ – Temperature coefficient of P_{max}

Interpolation of I_{sc} with respect to irradiance (IEC 61853-1:2011-01. Ed.1.0 Clause 9.1)

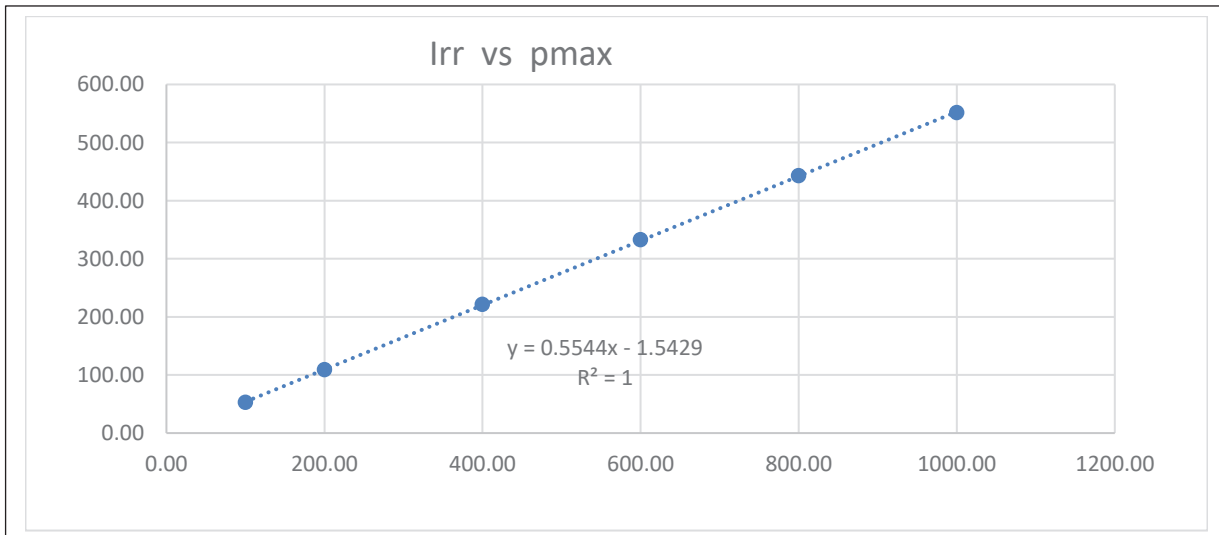




Interpolation of Voc with respect to irradiance (IEC 61853-1:2011-01. Ed.1.0 Clause 9.1)

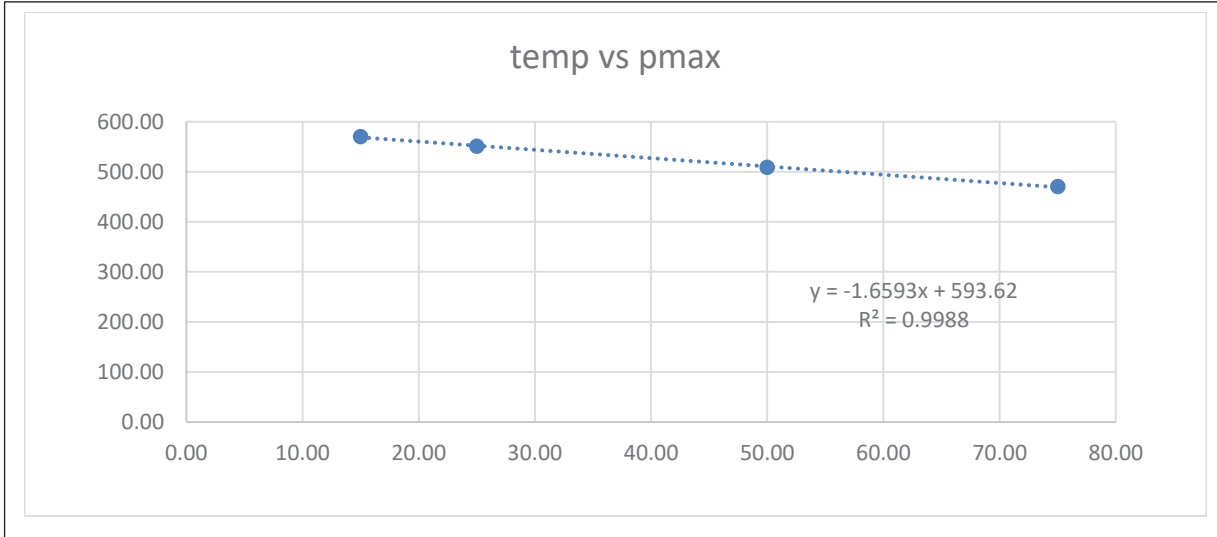


Interpolation of Pmax with respect to irradiance (IEC 61853-1:2011-01. Ed.1.0 Clause 9.1)

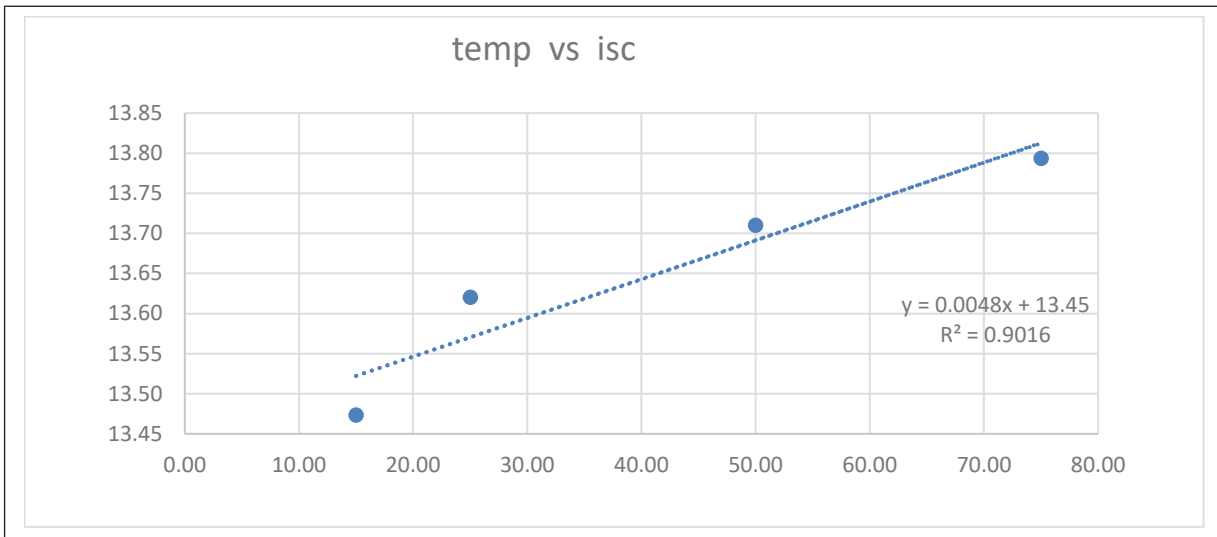




Interpolation of Pmax with respect to temperature (IEC 61853-1:2011-01. Ed.1.0 Clause 9.1)



Interpolation of Isc with respect to temperature (IEC 61853-1:2011-01. Ed.1.0 Clause 9.1)

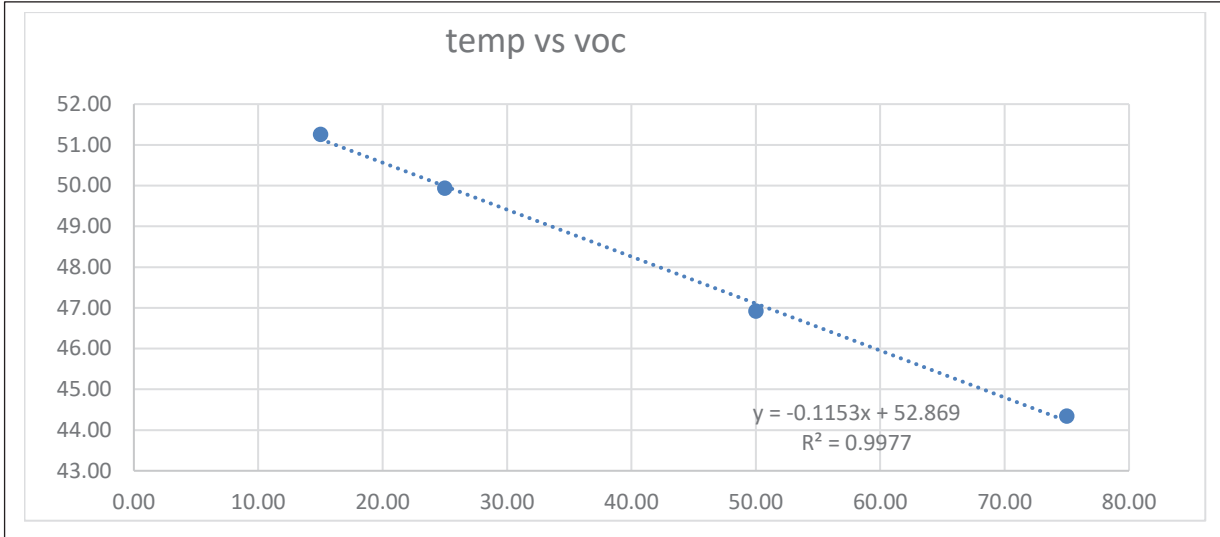




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Interpolation of Voc with respect to temperature (IEC 61853-1:2011-01. Ed.1.0 Clause 9.1)



Appendix:

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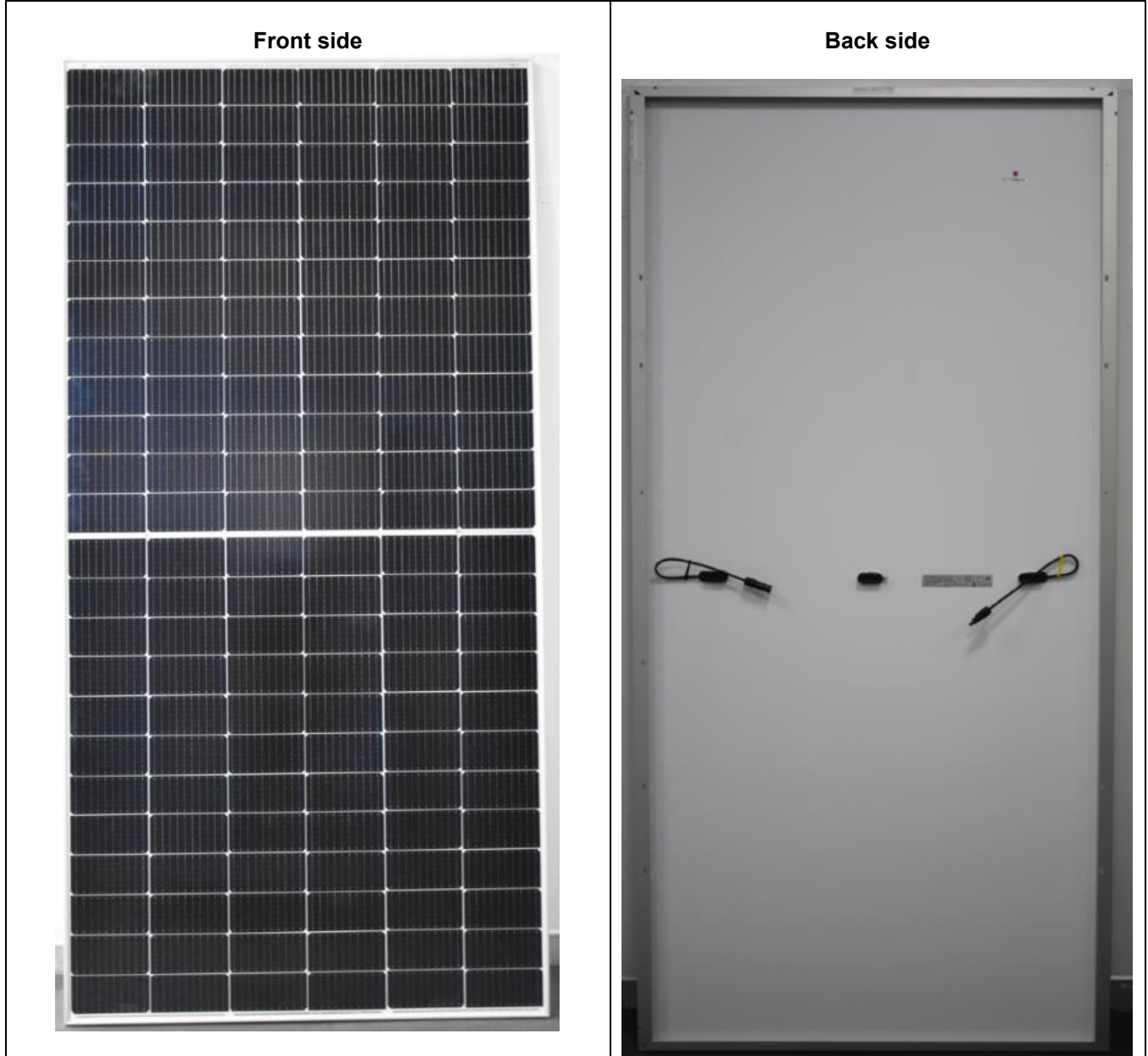
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Photographs: - PV Module - CSPL-144MHC-WF-545



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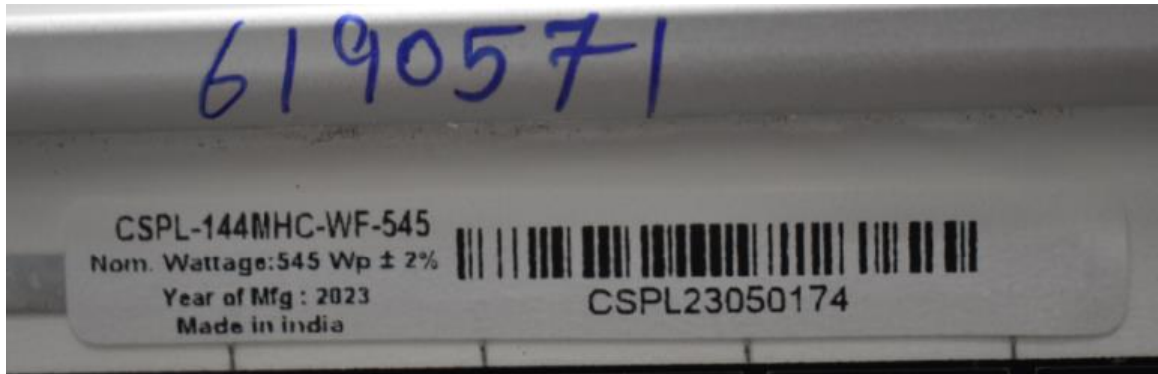


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Back label & inside laminate marking

CITIZEN SOLAR PVT LTD New Survey No.966, Village: Indrad, Chhatrai Kadi Road, Ta. Kadi, Dist. Mehsana, Gujarat-382715 Email - info@citizensolar.com, Customer Care No : 8000111222 ISO 9001:2015 ISO 14001:2015 ISO 45001:2018 MODEL: CSPL-144MHC-WF-545 Note: For serial number refer front side of the module Before installation, please refer citizen Module Installation Manual & Citizen Standard Warranty documents. All documents are available on company website www.citizensolar.com	Electrical Parameters Rated Power (Pmax) Open Circuit Voltage (Voc) Short Circuit Current (Isc) Voltage at Maximum Power (Vmp) Current at Maximum Power (Imp)	STC 545 W (0-2 %) 50.80 V ± 2 % 13.36 A ± 2 % 42.20 V 12.90 A	Maximum System Voltage Module Weight Protection against Electric Shock Application Class Fire Safety Class Maximum Series Fuse Rating Module Dimension(L x W x H) (mm)	1500 V 28 KG Class II A C 25 A 2279x1133x35	
	Power measured at STC: In 1000W/m², Temp 25°C, AM 1.5 Warning: Electrical Hazard. The unit produces electricity, if exposed to light. Don't disconnect the plugs under load. Dispose of the module as per regulations after the end of its working life.				



Junction Box



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Connectors



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Bill of Material as declared by manufacturer:

Module	
Front Cover..... :	High transmission low iron tampered AR coated glass, Thickness 3.2 mm, Textured, High Transmission (>94% for ARC) , Manufacturer By: Borosil Renewables Ltd. India
Rear Cover..... :	Manufacturer By: Renewsys India Pvt Ltd, Bangalore Model: PRESERV-1-300WD (For White) Total Thickness: 395 µm
Encapsulation material..... :	Manufacturer By: Renewsys India Pvt Ltd, Bangalore, Model No: Conserve P UVT 14FC (Front) 600GSM & Conserve P 360-14FC (Back) 550GSM
Frame..... :	Anodized Aluminium Alloy- 6063 -T6, 15 - 20 micron. Manufacturer By: Vinitech Metal Private Limited
Dimensions (l x w x h) [mm]..... :	2279mm x1133 mm x35 mm
Module area [m ²]..... :	2.58 [m ²]
PV Cell..... :	Manufacturer By: United Renewable Energy Co. Ltd Mono-crystalline PERC Bifacial Solar half cut cell- M10, cell size /Format: 182 mm x 182 mm ± 0.5 mm, Thickness: 175 µm±17.5 µm
Cell- and string connectors..... :	Manufacturer By: Shanghai Sunby Solar Technology Co Ltd, China Tin coated copper wire Top & bottom 0.35*4mm, JB connector 0.35*6mm.
Junction box..... :	Manufacturer By: DhaSh PV Technologies Private Limited Bangalore. Model: DSJB12Y Type: Split Type Rated voltage: 1500 VDC, IP68, Class II, Application Class A, PD1, Flammability class: UL-94 V0, 5VA
Adhesive for frame:	Manufacturer By: Shanghai Huitian New Material Co Ltd Silicone sealant Model-HT906Z IN HAI =0, HWI = 3, Flame class HB75(WT)
Adhesive for junction box:	Manufacturer By: Shanghai Huitian New Material Co Ltd Silicone sealant Model-HT906Z IN HAI =0, HWI = 3, Flame class HB75(WT)
Tape	Model 7946, Manufacturer By: TESA TAPES INDIA PVT.LTD
Bypass diode:	Diode Type/ Number MK5045, Standard: IEC 62790:2020, 25A Max rated current Manufacturer By: Taizhou Chuangda Electronics Co. Ltd

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