Test Report

CITIZEN SOLAR PRIVATE LIMITED

REPORT NUMBER: 4790739969.3.1-OTHER-S1

PROJECT NUMBER: 4790739969.3.1

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

☐**Other:**

(#Refer Page no. for Test lab location)

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	**OTHER**		
Item Under Test	Photovoltaic Module		
Model	CSPL-144MHC-TF-540		
Number of Samples	01		
UL. Sample Identification	6190605	**Refer Summary of Test results for multiple samples**	
Manufacturer Serial Number (if any)	CSPL23050019		
Condition of IUT on receipt	Good		
Date of Receipt	15 June 2023		
Applicable Standard	CEC-300-2018-009-CMF, Guidelines for California's Solar Electric Incentive Programs IEC 61215, Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval, Edition 2, Issue Date 04/27/2005		
Date of Testing (Start date)	2 January 2024	**End Date**	23 January 2024
UL general ambient condition	**Temperature in °C**		(23 ±5)°C
	Relative humidity in %		<70 %
Date of Issue	22 March 2024		
Test In-charge	Naveen Kumar N		

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Jayalakshmi M Digitally signed by Jayalakshmi M Date: 2024.03.22 17:03:25 +05'30' Jayalakshmi M Engineering Project Associate	Moumita Debnath Digitally signed by Moumita Debnath Date: 2024.03.22 17:50:24 +05'30' Moumita Debnath Engineering Leader
Reviewed by	**Authorized signatory**

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General Remarks (If any)

UL Company did not select the sample(s), determine whether the sample(s) was representative of production samples, witness the production of the test sample(s), nor were we provided with information relative to the formulation or identification of component materials used in the test sample(s). The test results apply only to the actual samples tested.

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Summary of Test Results

This report is prepared only for the additional performance testing (beyond UL 1703 or UL 61730-1 and UL 61730-2 PV module safety standards) required by the CEC guideline CEC-300-2018-009-CMF – Titled “GUIDELINES FOR CALIFORNIA’S SOLAR ELECTRIC INCENTIVE PROGRAMS, (SENATE BILL 1), SEVENTH EDITION” dated December 2018. This report does not include an evaluation of the provided samples’ compliance to UL 1703, UL 61730-1 or UL 61730-2.

Samples of the photovoltaic module type “CSPL-144MHC-TF-540” was submitted by the manufacturer for examination and test.

Based on CEC (California Energy Commission) Guidelines for California’s Solar Incentive Programs, seventh Edition, December 2018 requirements a reduced IEC 61215 test program was conducted on the above samples. Test results relate only to the items tested.

Description of Item under Test (IUT)

1.1. **Sample selection procedure.**

All the sample were selected and provided by client, UL LLC did not select the sample[s], determine whether the sample[s] was representative of production samples, witness the production of the test sample[s], nor were we provided with information relative to the formulation or identification of component materials used in the test sample[s].

The following procedure must be followed to select representative models for additional testing. It is based on the procedure from Appendix B of the document CEC-300-2018-009-CMF – Titled “GUIDELINES FOR CALIFORNIA’S SOLAR ELECTRIC INCENTIVE PROGRAMS, (SENATE BILL 1), SEVENTH EDITION” dated December 2018.

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1.1.1. Grouping of Modules for Testing:

For testing and reporting of performance values, families of similar modules may be grouped together to reduce the required number of tests. Module similarity for grouping of modules for testing shall be determined by the ISO/IEC 17025 accredited laboratory performing the additional testing as required on pages B-1 and B-2 of CEC-300-2018-009-CMF. IEC TS 62915, Photovoltaic (PV) Modules – Type approval, design and safety qualification – Retesting shall be used for guidance.

NRTL certification to UL 1703 or UL 61730-1 and UL 61730-2 of the PV models tested in this report was conducted by:
[X] UL Solutions, under file: E532868
[ ] Other NRTL, as stated by the PV module manufacturer

Verification of module components is the responsibility of the NRTL that has certified the model to UL 1703 or UL 61730-1 and UL 61730-2.

The module manufacturer has identified the construction of each Main group selected for testing by entering component details in the table below. Component-level verification and factory surveillance is the responsibility of the accredited NRTL that certifies the PV model(s) to UL 1703 or UL 61730-1 and UL 61730-2. (If only one construction is used then there is only one Main group):

One samples of the photovoltaic module type CSPL-144MHC-TF-540" was submitted by the manufacturer for examination and test.

Main Group	**1**
Construction item.	CSPL-144MHC-TF-540
Highest power model in group	545W
Module size	2279 X 1133 x 35mm
Encapsulant	Manufactured By: Renewsys India Pvt Ltd., Bangalore, Type: Model No: Conserv P UVT 14FC (Front) & Conserv P 360-14FC (Back), Thickness: 0.45±5%mm.
Substrate	Manufactured By: Renewsys India Pvt. Ltd., Bangalore, Model: PRESERV-1-300 TF (For Transparent Backsheet) Total Thickness: 360 µm, RTI: 140ºC, FSI: 25 Type: Model: PRESERV-1-300WD (For White Backsheet), Total Thickness: 360µm, RTI: 140ºC, FSI: 30

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Superstrate	Manufactured By: Borosil Renewables Ltd. India Type: High transmission low iron tampered AR coated glass, Thickness 3.2 mm, Textured, High Transmission (>94% for ARC)
Cells	Manufacturer By: United Renewable Energy Co.Ltd Type: Mono-crystalline PERC Bifacial Solar half cut cell- M10 cell size
Number of cells	144
Number of strings	3
Tabbing	Interconnect wires - Solder plated copper wires used for cell-to-cell connections, 10 bus wires in parallel, each wire 0.35 mm diameter minimum. Solder composition 60Sn40Pb. End ribbons - Solder plated copper ribbons used for connections between interconnect ribbons and junction box. 6 mm wide, 0.35 mm min. thick. (Middle) and 4 mm wide, 0.35 mm. thick (Top and Bottom) Solder composition 60Sn40Pb.
Junction box	Junction Box: Manufactured by Genx PV India Private Limited, Type: GXSB-01 rated 1500 Vdc, 25 A max Potted with RTV “5299W-S” manufactured by SHANGHAI HUITIAN NEW MATERIAL CO LTD. Cabel: Dhash PV Technologies Pvt., Ltd. Compliance: 4 mm2, 1x4mm2, 1.5 KV DC, IEC 62930 compliance Connector: Manufactured By: DhaSh PV Technologies Private Limited Bangalore, Type: MC4 COMATIBLE MODEL: DS01, 1500V DC, 35A, IEC 62852 Compliance

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The ratings of each model within the identified Main group shall be entered into the following table(s).

Main Group No.	[1]					
Model	Front Side Ratings Provided By The Manufacturer					
	Open Circuit Voltage at STC, (V dc)	Rated Voltage at STC, (V dc)	Max System Voltage, (V dc)	Rated Current at STC, (A dc)	Short Circuit Current at STC, A dc)	Rated Max Power at STC, (Watts)
CSPL-144MHC-TF-520	49.01	41.14	1500	12.65	13.55	520
CSPL-144MHC-TF-525	49.16	41.29	1500	12.73	13.63	525
CSPL-144MHC-TF-530	49.31	41.45	1500	12.80	13.69	530
CSPL-144MHC-TF-535	49.46	41.60	1500	12.88	13.76	535
CSPL-144MHC-TF-540	49.61	41.75	1500	12.95	13.83	540
CSPL-144MHC-TF-545	49.76	41.90	1500	13.02	13.90	545

Note: Tolerance for Isc, Voc is ±2%, and Pmax is -0%/+2%\

1. For each Main group, the following tests (Test Lot 1) shall be performed on a model number (Model 2) that has an STC power rating that is within 95 percent (rounded to the nearest watt) of the highest STC power rating in the group (Model 1):

    a. Nominal operating cell temperature (NOCT) determination
    b. Temperature coefficient of short-circuit current
    c. Temperature coefficient of open-circuit voltage
    d. Temperature coefficient of maximum power

Test Lot 1		
Model 1	Rated Maximum Power at STC, (Watts)	Main Group Number
CSPL-144MHC-TF-540	540	1

Each Main group shall be split into subgroups according to the following criteria.

2. To determine the model with lowest STC Maximum Power which can be included in the first subgroup of the Main group, following criteria apply:

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$$\frac{\text{STC Maximum Power rating (Model 2)}}{\text{STC Maximum Power rating (Model 3)}} \leq 0.9$$

All of the models with Maximum Power ratings falling between Model 1 and Model 3 constitute the first subgroup.

Note: No further subgroup identified.

Enter those models in the table. (Create additional tables as needed).

Main Group:		**1**
Subgroup:		**1**
Model	Rated Maximum Power at STC, (Watts)	Identify Sample to be used for testing (Model 2)
CSPL-144MHC-TF-520	520	540
CSPL-144MHC-TF-525	525	
CSPL-144MHC-TF-530	530	
CSPL-144MHC-TF-535	535	
CSPL-144MHC-TF-540	**540**	
CSPL-144MHC-TF-545	545	

Each test model identified within each subgroup shall be selected for Test Lot 2.

Copy the models identified for testing into the following table.

Test Lot 2			
Model	Rated Maximum Power at STC, (Watts)	Main Group	Subgroup
CSPL-144MHC-TF-540	540	1	1

Each model identified for testing shall be subjected to the following tests (Test Lot 2):

(10.6) Performance at Standard Test Conditions (STC)
(10.6) Performance at Standard Test Conditions (NOCT)
(10.7) Performance at Low Irradiance

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Test Results:

2.1. Maximum Power Determination (IEC 61215 Clause 10.2)

Test date [yyyy-mm-dd]: 2024-01-02

Model no.	Voc (V)	Vmp (V)	Isc (Amps)	Imp (Amps)	Pmp (W)
CSPL-144MHC-TF-540	49.93	42.02	13.53	12.90	542.18

2.2. Measurement of Temperature Coefficients (IEC 61215 Clause 10.4)

Test date [yyyy-mm-dd]: 2024-01-03.

Model tested / (S/N)	CSPL-144MHC-TF-540 S/N: CSPL23050019
Short circuit current (αs) (%/°C)	0.0258
Maximum Power Current (αm) (%/°C)	0.0018
Open circuit voltage (βo) (%/°C)	-0.2223
Maximum Power Voltage (βm) (%/°C)	-0.2943
Peak (max.) power (δ) (%/°C)	-0.2920

2.3. Measurement of Nominal Operating Cell Temperature (NOCT) (IEC 61215 Clause 10.5)

Test date [yyyy-mm-dd]: 2024-01-11 to 2024-01-14

Model tested/ (S/N)	CSPL-144MHC-TF-540 S/N: CSPL23050019
Nominal operating cell temperature (NOCT)	45.61°C

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2.4. Performance at Standard Test Conditions (STC) (IEC 61215 Clause 10.6)

Test date [yyyy-mm-dd]: 2024-01-23

TABLE: Performance at STC					
Model no.	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmp (W)
CSPL-144MHC-TF-540	49.79	41.79	13.51	12.93	540.28

2.5. Performance at Nominal Operating Cell Temperature (NOCT) (IEC 61215 Clause 10.6)

Test date [yyyy-mm-dd]: 2024-01-23

TABLE: Performance at NOCT					
Model no.	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmp (W)
CSPL-144MHC-TF-540	46.83	39.37	10.85	10.27	404.35

2.6. Performance at Low Irradiance (IEC 61215 Clause 10.7)

Test date [yyyy-mm-dd]: 2024-01-23

TABLE: Performance at Low Irradiance					
Model no.	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmp (W)
CSPL-144MHC-TF-540	46.83	41.95	2.71	2.57	107.97

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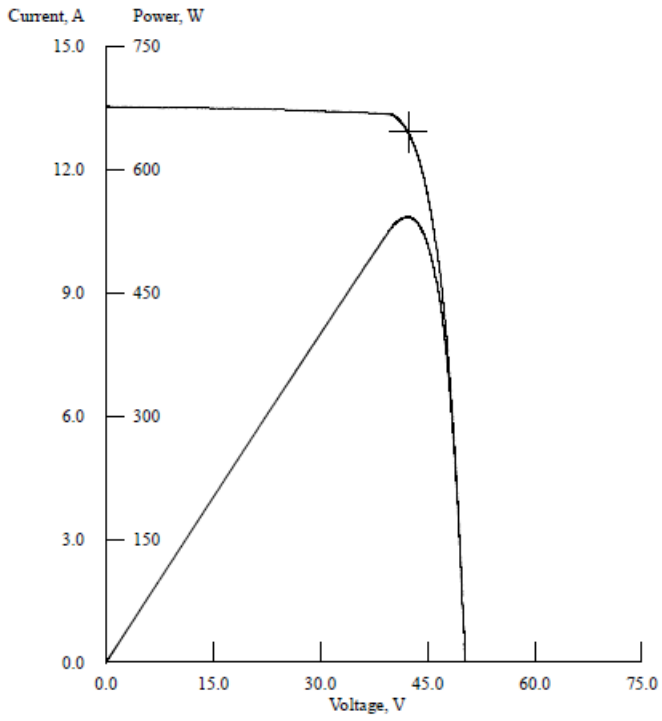
Appendix

PIV Graphs:



5600

Title: CITIZEN SOLAR_4790739969.3.1
Comment: INITIAL PIV
Operator: Admin
ID: 6190605 (CSPL23050019)
Module Type: ModuleType1
17:21:50 02-01-2024
Measured Temperature = 25.2°C
Corrected Temperature = 25.0°C
Irr Meas = 100.0mW/cm²
Irr Corr = 100.0mW/cm²
Voc = 49.93V
Isc = 13.53A
Pmax = 542.18W
Vpm = 42.02V
Ipm = 12.90A
FF = 0.80
Eff,m = 21.01%
Eff,c = 23.01%
Rs = 0.22 Ohm
Rsh = 103.17 Ohm

Load Voltage: 5.300 V
IV Points: 3916

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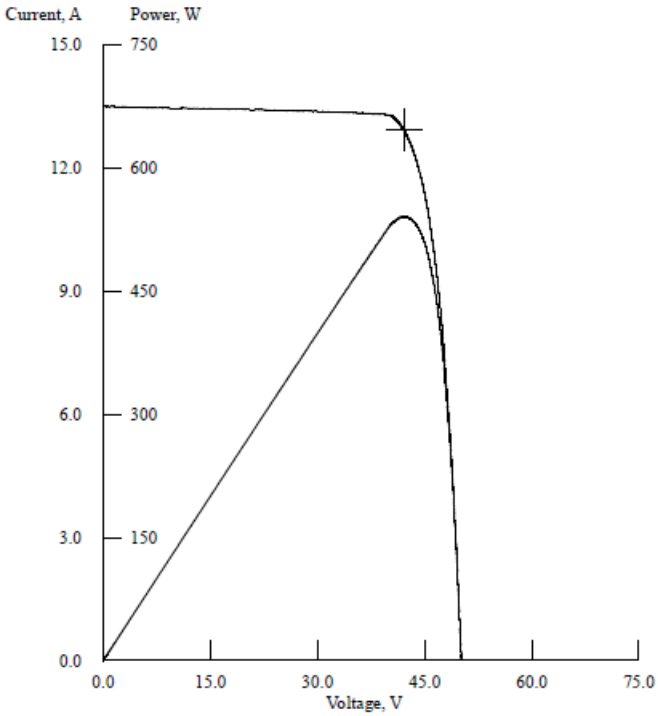

5600

Title: CITIZEN SOLAR_4790739969.3.1
Comment: PIV@STC
Operator: Admin
ID: 6190605
Module Type: ModuleType1
11:22:26 23-01-2024
Measured Temperature = 24.7°C
Corrected Temperature = 25.0°C
Irr Meas = 100.0mW/cm²
Irr Corr = 100.0mW/cm²
Voc = 49.79V
Isc = 13.51A
Pmax = 540.28W
Vpm = 41.79V
Ipm = 12.93A
FF = 0.80
Eff,m = 20.93%
Eff,c = 22.93%
Rs = 0.23 Ohm
Rsh = 71.31 Ohm

Load Voltage: 5.300 V
IV Points: 3917

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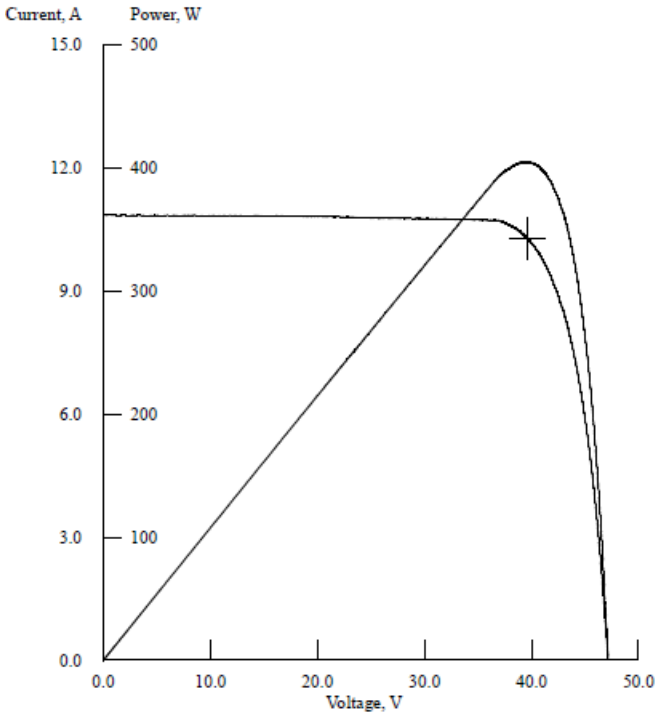

5600

Title: CITIZEN SOLAR_4790739969.3.1
Comment: PIV@NOCT
Operator: Admin
ID: 6190605
Module Type: ModuleType1
10:50:53 23-01-2024
Measured Temperature = 45.9°C
Irr Meas = 80.0mW/cm²
Irr Corr = 80.0mW/cm²
Voc = 46.83V
Isc = 10.85A
Pmax = 404.35W
Vpm = 39.37V
Ipm = 10.27A
FF = 0.80
Eff,m = 19.58%
Eff,c = 21.45%
Rs = 0.25 Ohm
Rsh = 303.04 Ohm

Load Voltage: 4.600 V
IV Points: 3602

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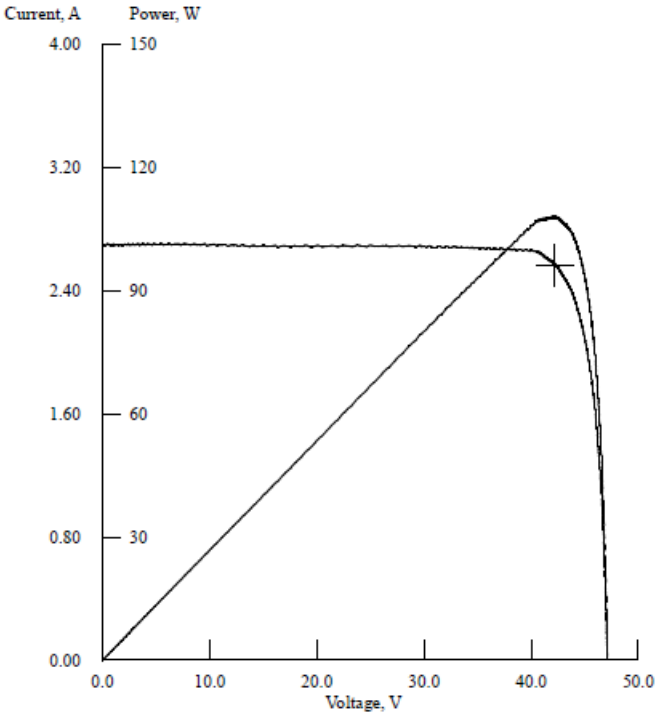

5600

Title: CITIZEN SOLAR_4790739969.3.1
Comment: PIV@LOW IRR
Operator: Admin
ID: 6190605
Module Type: ModuleType1
11:24:32 23-01-2024
Measured Temperature = 24.8°C
Corrected Temperature = 25.0°C
Irr Meas = 20.1mW/cm²
Irr Corr = 20.0mW/cm²
Voc = 46.83V
Isc = 2.71A
Pmax = 107.97W
Vpm = 41.95V
Ipm = 2.57A
FF = 0.85
Eff,m = 20.92%
Eff,c = 22.91%
Rs = 0.44 Ohm
Rsh = 413.63 Ohm

Load Voltage: 2.100 V
IV Points: 3758

*****End of Report******

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