Test Report

RAYZON SOLAR PRIVATE LIMITED

REPORT NUMBER: 4790927511.3.1-OTHER-S1

PROJECT NUMBER: 4790927511.3.1

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	Rayzon Solar Private Limited Block no 94/1/1F,94/1/3,102/1,103,104,105,109,110,118,119,120 Kim Mandvi Road, Nr. Hariya Talav B/H Aron Pipe, Karanj, Surat, Gujarat-394110, INDIA.		
Manufacturer	Rayzon Solar Private Limited Block no 94/1/1F,94/1/3,102/1,103,104,105,109,110,118,119,120 Kim Mandvi Road, Nr. Hariya Talav B/H Aron Pipe, Karanj, Surat, Gujarat-394110, INDIA.		
Program	**OTHER**		
Item Under Test	Photovoltaic Module		
Model	RS545144MBC		
Number of Samples	01		
UL. Sample Identification	6271661	**Refer Summary of Test results for multiple samples**	
Manufacturer Serial Number (if any)	RSBL1M0060723159320		
Condition of IUT on receipt	Good		
Date of Receipt	15 July 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)	9 February 2024	**End Date**	7 March 2024
UL general ambient condition	**Temperature in °C**		(23 ±5)°C
	Relative humidity in %		<70 %
Date of Issue	21 March 2024		
Test In-charge	N NaveenKumar		

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Kantha Raju Digitally signed by Kantha Raju Date: 2024.03.21 13:20:41 +05'30' Kantha Raju H S Senior Project Engineer	Moumita Debnath Digitally signed by Moumita Debnath Date: 2024.03.21 14:22:31 +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 "RS545144MBC" 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: E529329
[ ] 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 “RS545144MBC” was submitted by the manufacturer for examination and test.

Main Group	**1**
Construction item.	RS545144MBC
Highest power model in group	RS560144MBC
Module size	2278 X 1144 X 40 mm
Encapsulant	Front side (on top of the cells): Alishan Green Energy Private Limited, R/C(QIHE2. E522747) Type: Alishan Front EVA Thickness: 0.6 mm Rear side (on bottom of the cells): Manufactured by: Alishan Green Energy Private Limited, R/C(QIHE2. E522747) Type: Alishan FC Thickness: 0.6 mm
Substrate	Manufactured by: Jolywood (Suzhou) Sunwatt Co., ltd.

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	Type: FFC-JW30(plus), FFC/PET/FFC, overall thickness - 0.315mm, Color: Black
Superstrate	Manufactured by: Flat (Hong Kong) Co Limited (FLAT), Type: AR Coated, Low iron, Tempered glass, Thickness: 3.2mm,
Cells	Manufactured by: Solar Space Technology (Laos) Sole Co.,Ltd (Solar Space), Type: M10 P-Type Bifacial Mono PERC solar cell, dimension: 182 (±0.5) X 91 (±0.5) mm
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 0.32 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, 0.30 mm. thick (Top and Bottom) Solder composition 60Sn40Pb.
Junction box	Junction Box: Manufactured by: 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: APAR Industries Limited, type PV Wire, 12 AWG, rated sunlight resistant, 90°C wet or dry, 2000 V. Outer diameter – 6.4 mm Connector: Genx PV India Private Limited, Type: GXC-01, IP68 rated 1500 Vdc, 30 A max. with 12 AWG cable Bypass diode: Manufactured by Genx PV India Private Limited, type “MK5045”.

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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)
RS560144MBC	50.22	43.20	1500	12.97	13.43	560
RS555144MBC	50.05	43.06	1500	12.90	13.39	555
RS550144MBC	49.87	42.91	1500	12.83	13.36	550
RS545144MBC	49.70	42.77	1500	12.76	13.33	545
RS540144MBC	49.53	42.62	1500	12.69	13.30	540
RS535144MBC	49.28	42.37	1500	12.65	13.24	535
RS530144MBC	49.13	42.15	1500	12.60	13.20	530
RS525144MBC	48.98	41.93	1500	12.56	13.16	525

Note: Tolerance for Isc, Voc is ±5%, and Pmax is -0%/+3%\

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
RS545144MBC	545	1

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

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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:

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

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)
RS525144MBC	525	545
RS530144MBC	530	
RS535144MBC	535	
RS540144MBC	540	
RS545144MBC	**545**	
RS550144MBC	550	
RS555144MBC	555	
RS560144MBC	560	

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 1			
Model	Rated Maximum Power at STC, (Watts)	Main Group	Subgroup
RS545144MBC	545	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]: 2024-02-09

Model no.	Voc (V)	Vmp (V)	Isc (Amps)	Imp (Amps)	Pmp (W)
RS545144MBC	49.86	41.83	13.59	13.06	546.20

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

Test Date [YYYY-MM-DD]: 2024-02-09

Model tested / (S/N)	RS545144MBC/ (RSBL1M0060723159320)
Short circuit current (αs) (%/°C)	0.0264
Maximum Power Current (αm) (%/°C)	-0.0113
Open circuit voltage (βo) (%/°C)	-0.2244
Maximum Power Voltage (βm) (%/°C)	-0.2965
Peak (max.) power (δ) (%/°C)	-0.3071

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

Test Date [YYYY-MM-DD]: 2024-02-14 to 2024-02-22.

Model tested/ (S/N)	RS545144MBC (RSBL1M0060723159320)
Nominal operating cell temperature (NOCT)	45.96°C

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

Test Date [YYYY-MM-DD]: 2024-03-07

TABLE: Performance at STC					
Model no.	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmp (W)
RS545144MBC	49.89	42.06	13.55	12.92	543.21

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

Test Date [YYYY-MM-DD]: 2024-03-07

TABLE: Performance at NOCT					
Model no.	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmp (W)
RS545144MBC	46.81	39.15	10.91	10.35	405.34

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

Test Date [YYYY-MM-DD]: 2024-03-07

TABLE: Performance at Low Irradiance					
Model no.	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmp (W)
RS545144MBC	46.88	41.49	2.71	2.61	108.14

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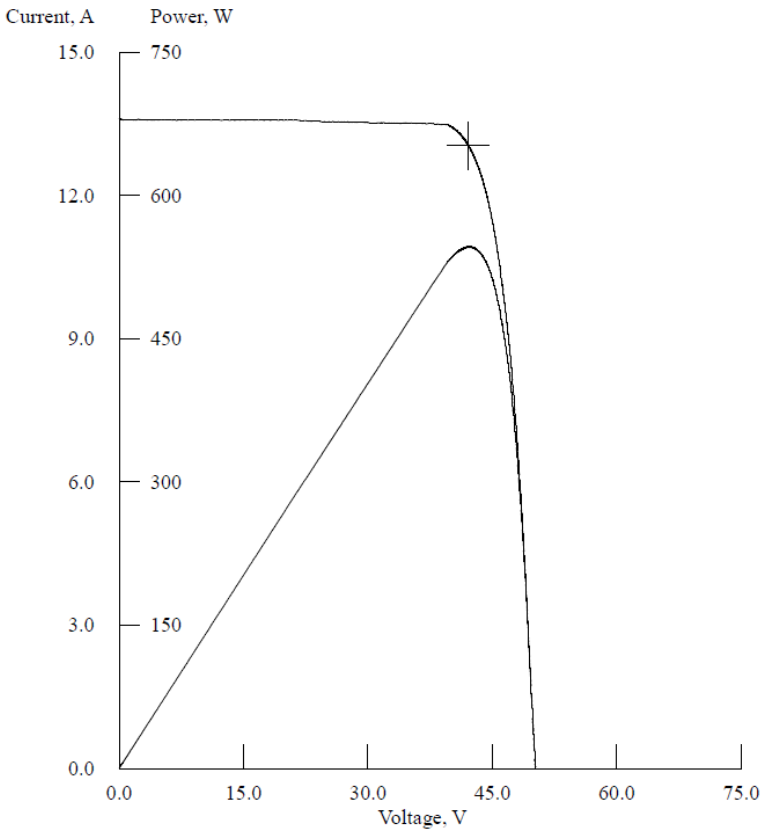
Appendix

PIV Graphs:



5600

Title: RAYSON SOLAR_4790927511
Comment: INITIAL PIV
Operator: Admin
ID: 6271661 (RSBL1M0060723159320)
Module Type: ModuleType1
11:01:07 09-02-2024
Measured Temperature = 24.2°C
Corrected Temperature = 25.0°C
Irr Meas = 100.0mW/cm²
Irr Corr = 100.0mW/cm²
Voc = 49.86V
Isc = 13.59A
Pmax = 546.20W
Vpm = 41.83V
Ipm = 13.06A
FF = 0.81
Eff,m = 21.16%
Eff,c = 23.18%
Rs = 0.33 Ohm
Rsh = 227.86 Ohm

Load Voltage: 5.300 V
IV Points: 3953

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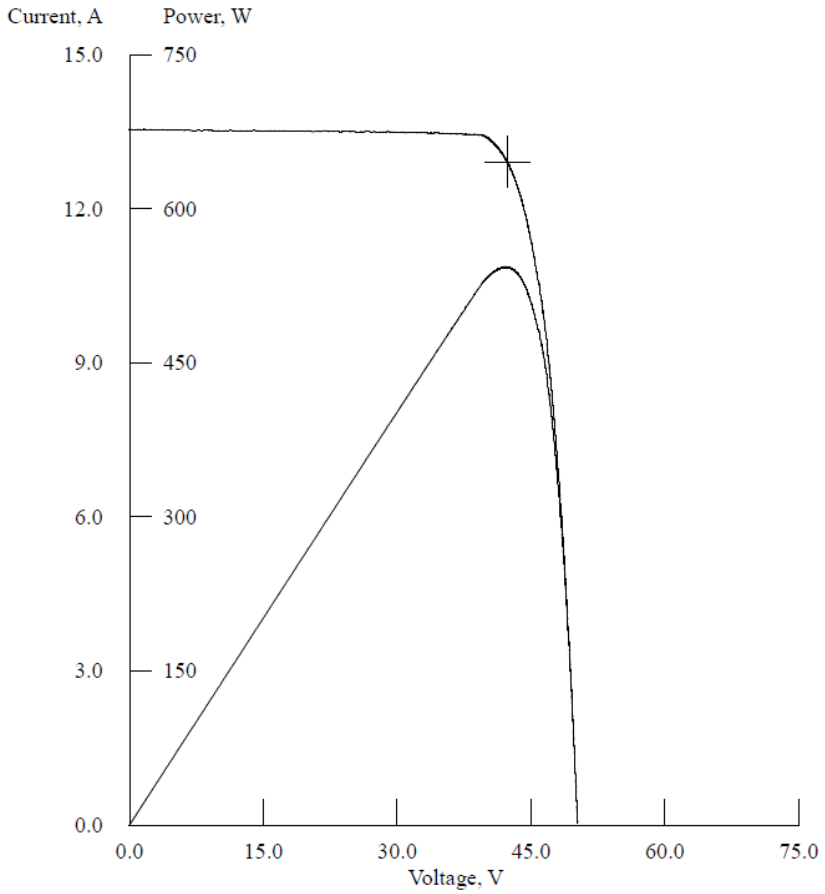

5600

Title: RAYSON SOLAR_4790927511
Comment: PIV@STC
Operator: Admin
ID: 6271661
Module Type: ModuleType1
17:22:34 07-03-2024
Measured Temperature = 24.8°C
Corrected Temperature = 25.0°C
Irr Meas = 100.1mW/cm²
Irr Corr = 100.0mW/cm²
Voc = 49.89V
Isc = 13.55A
Pmax = 543.21W
Vpm = 42.06V
Ipm = 12.92A
FF = 0.80
Eff,m = 21.06%
Eff,c = 23.06%
Rs = 0.24 Ohm
Rsh = 324.54 Ohm

Load Voltage: 5.300 V
IV Points: 3647

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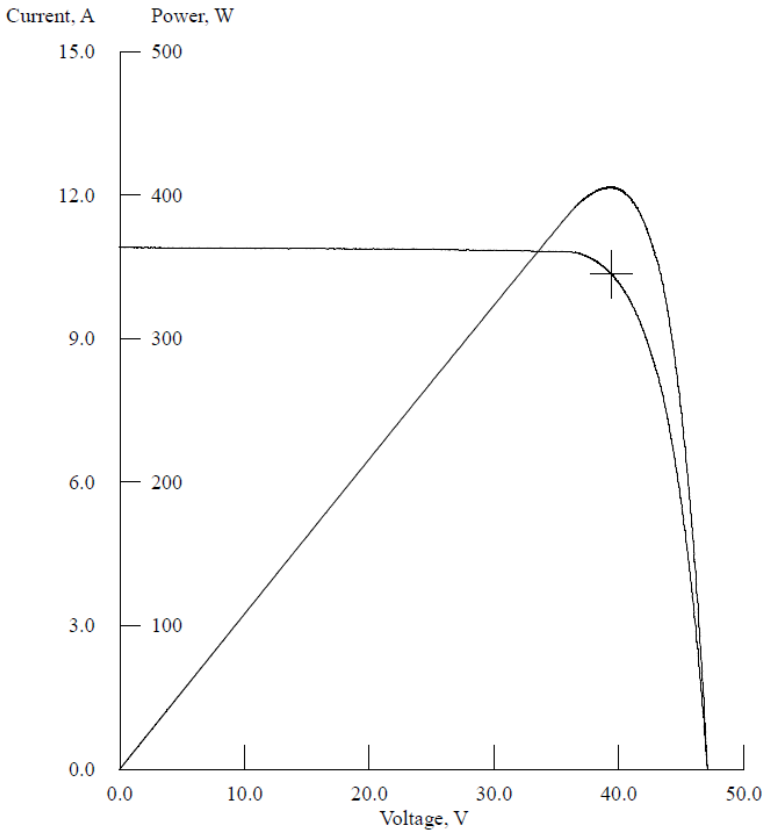

5600

Title: RAYSON SOLAR_4790927511
Comment: PIV@NOCT
Operator: Admin
ID: 6271661
Module Type: ModuleType1
16:42:03 07-03-2024
Measured Temperature = 45.9°C
Irr Meas = 80.0mW/cm²
Irr Corr = 80.0mW/cm²
Voc = 46.81V
Isc = 10.91A
Pmax = 405.34W
Vpm = 39.15V
Ipm = 10.35A
FF = 0.79
Eff,m = 19.64%
Eff,c = 21.50%
Rs = 0.30 Ohm
Rsh = 155.46 Ohm

Load Voltage: 4.600 V
IV Points: 3270

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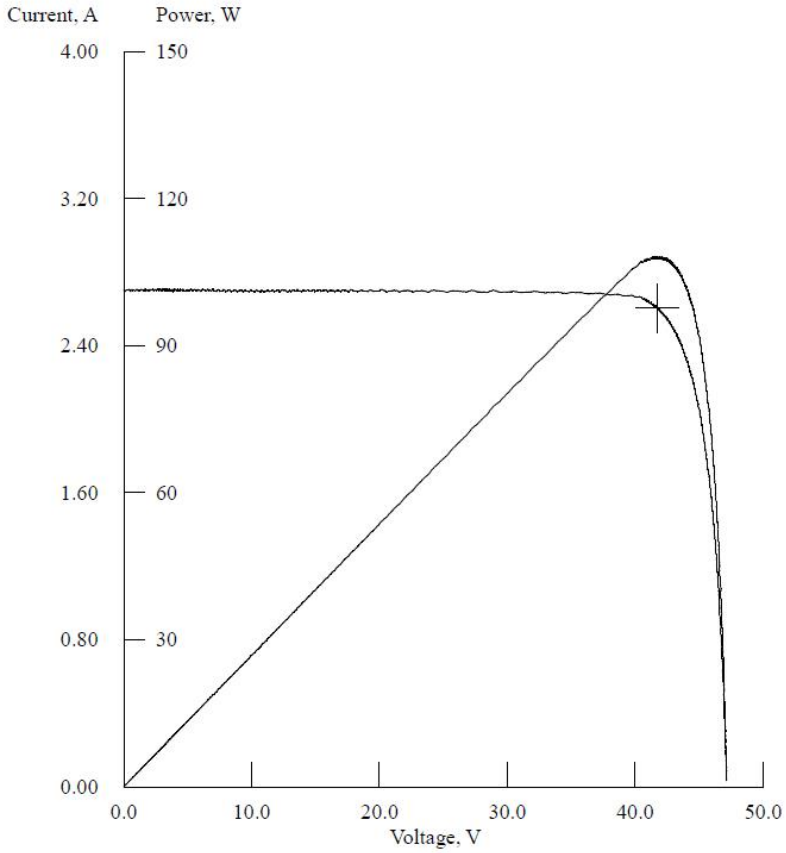

5600

Title: RAYSON SOLAR_4790927511
Comment: PIV@LOW IRR
Operator: Admin
ID: 6271661
Module Type: ModuleType1
17:24:04 07-03-2024
Measured Temperature = 24.9°C
Corrected Temperature = 25.0°C
Irr Meas = 20.1mW/cm²
Irr Corr = 20.0mW/cm²
Voc = 46.88V
Isc = 2.71A
Pmax = 108.14W
Vpm = 41.49V
Ipm = 2.61A
FF = 0.85
Eff,m = 20.96%
Eff,c = 22.95%
Rs = 0.57 Ohm
Rsh = 271.29 Ohm

Load Voltage: 2.100 V
IV Points: 3706

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

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