



**Headquarter:**

Via Cadriano, 23 - 40057 Granarolo dell'Emilia (BO)

**Laboratory:**

Via Fabio Filzi, 68 - 20032 Cormano (MI)

# TEST REPORT

*Number:*

**L0011966/F rev.00**

*Issue date:*

**2023-06-28**

*Final address:*

**Philadelphia Solar**

**Al Qastal Industrial Area, 11814 Amman, Jordan**

*Testing sample:*

**(Photovoltaic Modules)**

**PS-M144(HCBF)-540W**

*Test type:*

**PAN File Parameters Determination**

*Reference Standard:*

**IEC 61215-2:2016**

**IEC 61853-1:2011**

*This report consists of 16 pages, including annexes, and cannot be reproduced in part without a written permission.*

**Headquarter:**

Via Cadriano, 23 - 40057 Granarolo dell'Emilia (BO)

**Laboratory:**

Via Fabio Filzi, 68 - 20032 Cormano (MI)

<p><b>Test Report</b>  <b>IEC 61215-2:2016</b>  <b>Terrestrial photovoltaic (PV) modules – Design qualification and type approval –</b>  <b>Part 2: Test procedures</b>  <b>IEC 61853-1:2011</b>  <b>Photovoltaic (PV) module performance testing and energy rating –</b>  <b>Part 1: Irradiance and temperature performance measurements and power rating</b></p>	
<p><b>Test Report</b>  Approved by</p>	<p>Maurizio Lorenzon - <i>Head of the Lab</i></p>
<p>Tested by</p>	<p>Sergio Merighi  </p>
<p>Issued date</p>	<p>2023-06-28</p>
<p><b>Test laboratory</b>  Name  Address</p>	<p><b>Kiwa Cermet Italia S.p.A</b>  Via Filzi 68, 20032 Cormano (MI)</p>
<p><b>Final Addressee</b>  Name  Address  Contact person</p>	<p><b>Philadelphia Solar</b>  Al Qastal Industrial Area, 11814 Amman, Jordan  Mr. Osama Ara'r</p>
<p><b>Test details</b>  Reference standard  Requested</p>	<p><u>IEC 61215-2:2016</u>  MQT 04 Measurement of temperature coefficients  MQT 06.1 Performance at STC  <u>IEC 61853-1:2011</u>  Maximum power determination under different temperature and irradiance level  PAN File Parameters Determination</p>
<p><b>Sample details</b>  Brand  Manufacturer  Model/reference type</p>	<p> <b>Philadelphia Solar</b>  Delivering Clean Energy Solutions  <b>Philadelphia Solar</b>  PS-M144(HCBF)-540W</p>
<p><b>Remarks</b></p>	<p>\</p>



**Headquarter:**

Via Cadriano, 23 - 40057 Granarolo dell'Emilia (BO)

**Laboratory:**

Via Fabio Filzi, 68 - 20032 Cormano (MI)

<b>TESTS</b>	
<b>List of Performed Test (Test name)</b> <b><u>IEC 61215-2:2016</u></b> MQT 04 Measurement of temperature coefficients MQT 06.1 Performance at STC  <b><u>IEC 61853-1:2011</u></b> Maximum power determination under different temperature and irradiance level PAN File Parameters Determination	<b>Test site</b>  Kiwa Cermet Italia S.p.A Via Fabio Filzi 68, 20032 Cormano (MI)
<b>Remarks:</b> \	

**Headquarter:**

Via Cadriano, 23 - 40057 Granarolo dell'Emilia (BO)

**Laboratory:**

Via Fabio Filzi, 68 - 20032 Cormano (MI)

<b>TECHNICAL SPECIFICATIONS OF THE SAMPLE UNDER TEST</b>	
<b>General features</b>	
Model designation	PS-M144(HCBF)-540W
Module total length x width x height [mm]	2277 x 1133 x 35
<b>Cell</b>	
Cell dimensions (length x width) (mm)	182 x 91
Cell thickness ( $\mu\text{m}$ )	175 $\pm$ 17.5
Cell technology	Mono-Si, Bifacial
Cell manufacturer	United Renewable Energy
Cell model type / part of number	Black 22 Series
Number of bus bar	10
Total number of cells	144 half cells (72 full cells)
Number of cells in series	72
Number of cells in parallel	72
Number of cells for each diode	48
Electrical circuit (S, SP, PS)	SP
<b>Diode</b>	
Number of bypass diodes	3
Diode manufacturer	JMTHY
Diode model type / part of number	MK5050
Bypass diode rating [A]	50
Bypass diode max junction temperature [ $^{\circ}\text{C}$ ]	200
<b>Cell connectors and string connectors (PV ribbon)</b>	
Cell connectors manufacturer	TaiCang Juren
Cell connectors material (please declare the metallic percentage, e.g. Sn60Pb40)	Sn60Pb40
Cell connectors dimensions (width x thickness) (mm x mm)	Round 0.35 -0.005/+0.015 mm
String connectors manufacturer	TaiCang Juren
String interconnect material (please declare the metallic percentage, e.g. Sn60Pb40)	Sn60Pb40
String connectors dimensions (width x thickness) (mm x mm)	5 x 0.4
Solder bonding technique and material	N/A
Fluxing agent	Kester - 952-S
<b>Superstrate (front cover)</b>	
Superstrate manufacturer	Xinyi PV Products (Anhui) Holdings. Ltd.
Superstrate material	AR coated, Tempered Glass
Superstrate model type / part number	3.2-mm thick
Superstrate thickness (mm)	3.2-mm thick
<b>Substrate (rear cover)</b>	
Substrate manufacturer	Cybrid
Substrate material	Transparent -kpf
Substrate model type / part number	Cynagard 465A(R)
Substrate thickness [mm]	0.320
<b>Frame</b>	
Frame manufacturer	Jiangsu Davin Solar Technology
Frame material	Anodized Aluminium 6063-T6
Frame model type / part number	N/A
Frame thickness (mm)	35
Frame adhesive manufacturer	Shanghai Huitian New Material Co.
Frame adhesive material	RTV Sealant
Frame adhesive model type / part number	HT906Z



**Headquarter:**

Via Cadriano, 23 - 40057 Granarolo dell'Emilia (BO)

**Laboratory:**

Via Fabio Filzi, 68 - 20032 Cormanò (MI)

<b>Edge sealing</b>	
Edge sealing manufacturer	N/A
Edge sealing material	N/A
<b>Encapsulant</b>	
Encapsulant manufacturer (front side)	SVECK
Encapsulant material (front side)	EVA
Encapsulant model type / part number (front side)	SV-15296P
Encapsulant manufacturer (back side)	SVECK
Encapsulant material (back side)	EVA
Encapsulant model type / part number (back side)	SV-15297P
<b>Junction box</b>	
Junction box manufacturer	JMTHY
Junction box model type / part number	JM37xy
Junction box potting material (if any)	5299W-S, part A & B
Junction box adhesive manufacturer	Shanghai Huitian New Material Co.
Junction box adhesive material	RTV Sealant
Junction box adhesive model type / part number	HT906Z
Cable type	JMTHY
Cable manufacturer	H1Z2Z2-K
Connector type/model	JMTHY
Connector manufacturer	PV-JM608
<b>Insulation tape</b>	
Insulation tape manufacturer	N/A
Insulation tape material	N/A
<b>Cell fixing tape</b>	
Insulation tape manufacturer	Cybrid Technologies
Insulation tape material	FF-3665
<b>Label</b>	
Nameplate label manufacturer	SUZHOU ZhengAo Packing Material CO., LTD
Nameplate label material	polymers
Ink type	Compatible
<b>Electrical specifications label</b>	
Maximum system voltage [V]	1500
Open-circuit voltage, VOC [V]	49.8
VOC tolerance [%]	±5
Short-circuit current, ISC [A]	13.62
ISC tolerance [%]	±5
Maximum power voltage, VMP [V]	41.70
Maximum power current, IMP [A]	12.95
Maximum power, PMP [W]	540
Power tolerance [%]	±3
Maximum overcurrent protection rating [A]	25
Safety factor $\gamma_m$	1.5
Design Load [Pa]	3600 front; 1600 back
Pollution Degree	1
Rated operating altitude (m)	2000
<b>Remarks:</b> The data in this table were provided by the customer If the information provided by the customer can affect the validity of the results, the laboratory declines any responsibility	



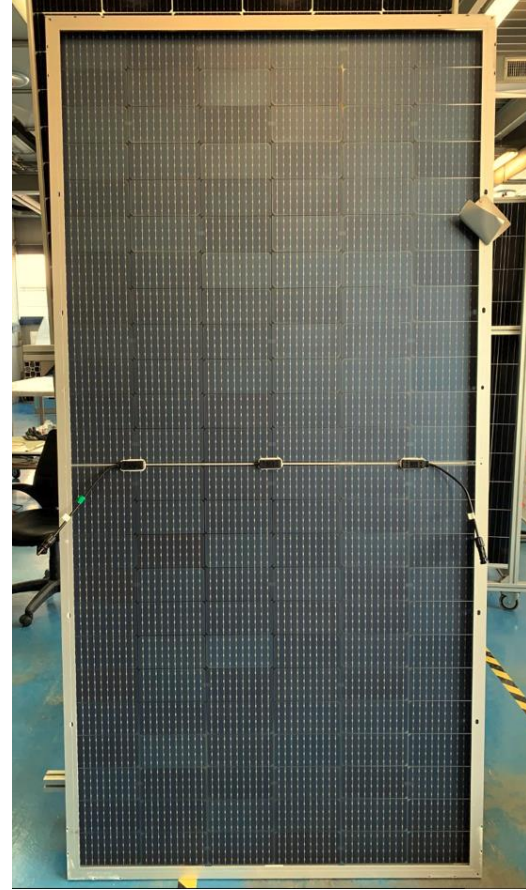
**Headquarter:**

Via Cadriano, 23 - 40057 Granarolo dell'Emilia (BO)

**Laboratory:**

Via Fabio Filzi, 68 - 20032 Cormano (MI)

**Pictures of samples: front and back side**



**Nameplate marking:**

<p>PS091022B144014017</p>	<p><b>Philadelphia Solar</b> Delivering Clean Energy Solutions</p>	Maximum Power (Pmp)	540 W	Tolerance (%)	±3
		Open Circuit Voltage (Voc)	49.8 V	Tolerance (%)	±5
<p><b>Product: PS-M144(HCBF)-540W</b></p> <p>Sales Dept. + 962 6 471 6601          Fax: + 962 6 471 6602          Philadelphia Solar, Al Qastal Industrial Area 2          P.O. Box 143808, 11814 Amman, Jordan          www.Philadelphia-solar.com</p>		Short Circuit Current (Isc)	13.62 A	Tolerance (%)	±5
		Voltage at Maximum Power (Vmp)	41.7 V		
		Current at Maximum Power (Imp)	12.95 A		
		Maximum System Voltage	1500 V		
		Maximum Over Current Protection Rating	25 A		
		Protection Class	II		
		Module efficiency	20.9 %		
		Module Dimensions (LXWXH)	2277x1133x35 mm		
		Module Weight	29 kg	Tolerance (%)	±3
		Bitacility Ratio	60 %	Tolerance (%)	±5

Values at Standard Testing Conditions STC (Air Mass AM 1.5, Irradiance 1000 W/m<sup>2</sup>, Cell Temperature 25 °C).





**Headquarter:**

Via Cadriano, 23 - 40057 Granarolo dell'Emilia (BO)

**Laboratory:**

Via Fabio Filzi, 68 - 20032 Cormano (MI)

**Test result Abbreviation:**

Not applicable	N/A
The sample is conformed to the requirements	P (Pass)
The sample is not conformed to the requirements	F (Fail)

**Dates**

Receipt date of testing samples	2022/11/02
Test date	from 2023/05/01 to 2020/05/30

**Abbreviations and Symbols**

- Pmp – Maximum power
- Vmp – Maximum power voltage
- Imp – Maximum power current
- Isc – Short circuit current
- Voc – Open circuit voltage
- FF – Fill factor
- G. ref – reference irradiance
- T. ref – reference temperature

**Remarks**

The test results shown in this test report are exclusively referred to the tested samples. The results refer to the sample as received. This test report cannot be reproduced in part without a written permission of KIWA S.p.a. "(Cf. annex #)" it refers to other information annexed to the report. "(see annexed table)" it refers to a table annexed to the report.



**Headquarter:**

Via Cadriano, 23 - 40057 Granarolo dell'Emilia (BO)

**Laboratory:**

Via Fabio Filzi, 68 - 20032 Cormano (MI)

**GENERAL PRODUCT INFORMATION AND OTHER REMARKS:**

- New module type:
- Modifications (if yes, please choose the applicable modification according to the IEC TS 62915):
- Original test report ref. No:
- Modification according to the IEC TS 62915:
  - Test programs for crystalline silicon PV modules
    - 4.2.1 Modification to frontsheet
    - 4.2.2 Modification to encapsulation system
    - 4.2.3 Modification to cell technology
    - 4.2.4 Modification to cell and string interconnect material or technique
    - 4.2.5 Modification to backsheet
    - 4.2.6 Modification to electrical termination
    - 4.2.7 Modification to bypass diode
    - 4.2.8 Modification to electrical circuitry
    - 4.2.9 Modification to edge sealing
    - 4.2.10 Modification to frame and/or mounting structure
    - 4.2.11 Change in PV module size
    - 4.2.12 Higher or lower output power (by 10 % or more) with the identical design and size and using the identical cell process
    - 4.2.13 Increase of over-current protection rating
    - 4.2.14 Increase of system voltage
    - 4.2.15 Change in cell fixing tape
  - Test programs for thin-film PV modules
    - 4.3.1 Modification to frontsheet
    - 4.3.2 Modification to encapsulation system
    - 4.3.3 Modification to front contact (e. g. TCO)
    - 4.3.4 Modification to cell technology
    - 4.3.5 Modification to cell layout
    - 4.3.6 Modification to back contact
    - 4.3.7 Modification to edge deletion
    - 4.3.8 Modification to interconnect material or technique
    - 4.3.9 Modification to backsheet
    - 4.3.10 Modification to electrical termination
    - 4.3.11 Modification to bypass diode
    - 4.3.12 Modification to edge sealing
    - 4.3.13 Modification to frame and/or mounting structure
    - 4.3.14 Change in PV module size
    - 4.3.15 Higher or lower output power (by 10 % or more) with the identical design and size
    - 4.3.16 Increase of over-current protection rating
    - 4.3.17 Increase of system voltage
- Other: **PAN File Parameters Determination**

**Remarks:** \




**Headquarter:**

Via Cadriano, 23 - 40057 Granarolo dell'Emilia (BO)

**Laboratory:**

Via Fabio Filzi, 68 - 20032 Cormanò (MI)

<b>TABLE 1</b>	<b>SAMPLING</b>	
	Sampling is made under the responsibility of the customer	
	The customer has selected 2 samples	
	The tested PV modules/samples has been sent by the customer	

<b>TABLE 2</b>	<b>MARKING</b>	
	Name, monogram or symbol of manufacturer:	 <b>Philadelphia Solar</b> Delivering Clean Energy Solutions
	Type or model number:	PS-M144(HCBF)-540W
	Serial number of the tested samples	PS091022B144014018 PS091022B144014017
	Maximum system voltage:	1500 V
	Production site:	<b>Philadelphia Solar</b> Al Qastal Industrial Area, 11814 Amman, Jordan

<b>TABLE 3</b>	<b>TEST PROCEDURES</b>	
<b>IEC 61215-2</b>		
MQT 04	Measurement of temperature coefficients	Table 4.4
MQT 06	Performance at STC	Table 4.6
<b>IEC 61853-1</b>		
Maximum power determination under different temperature and irradiance level		Table 8.1
<b>Remarks:</b> Deviation from test method: Maximum power determination tests at 75°C not done; 2 samples used for testing		

<b>TABLE 4</b>	<b>UNCERTAINTY</b>	
<b>Measured parameter</b>	<b>Expanded Uncertainty</b>	<b>Unit</b>
<b>Maximum Power Determination</b>		
V <sub>oc</sub>	0.2	%
I <sub>sc</sub>	3.2	%
P <sub>mp</sub>	3.6	%
Irradiance	30	Wm <sup>-2</sup>
Temperature	0.6	°C

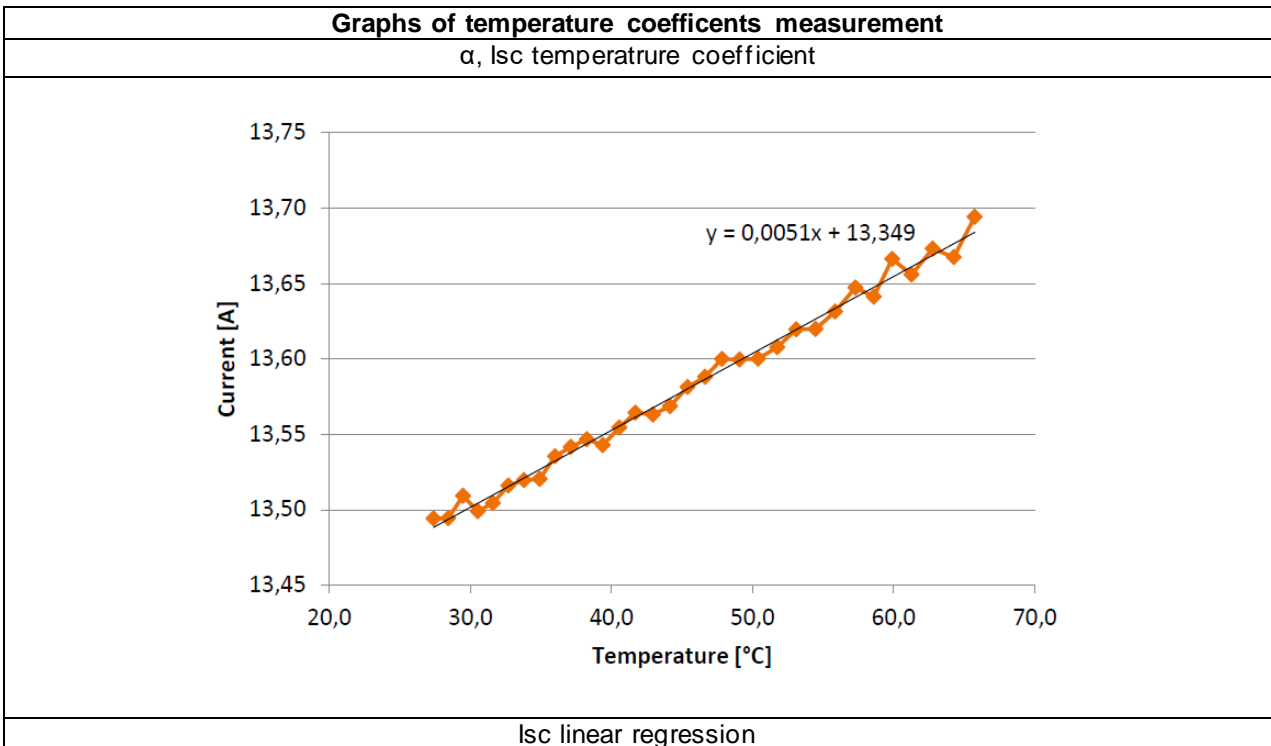
**Headquarter:**

Via Cadriano, 23 - 40057 Granarolo dell'Emilia (BO)

**Laboratory:**

Via Fabio Filzi, 68 - 20032 Cormanò (MI)

Test 4.4   TABLE 4.4: Measurement of temperature coefficients MQT 04 (*)		
(*) Performed by PI Photovoltaik-Institut Berlin AG test report Number G202378-1_La_V1 (Member of group Kiwa)		
Irradiance	1000 W/m <sup>2</sup>	
Maximum temperature	66 °C	
Minimum temperature	27 °C	
	Relative temperature coefficients	Standard deviation
$\alpha$ , I <sub>sc</sub> temperature coefficient:	0.038 %/K	4.9 %/K
$\beta$ , V <sub>oc</sub> temperature coefficient:	-0.244 %/K	1.16 %/K
$\delta$ , P <sub>mp</sub> temperature coefficient:	-0.316 %/K	1.61 %/K
FF temperature coefficient	-0.117 %/K	3.42 %/K



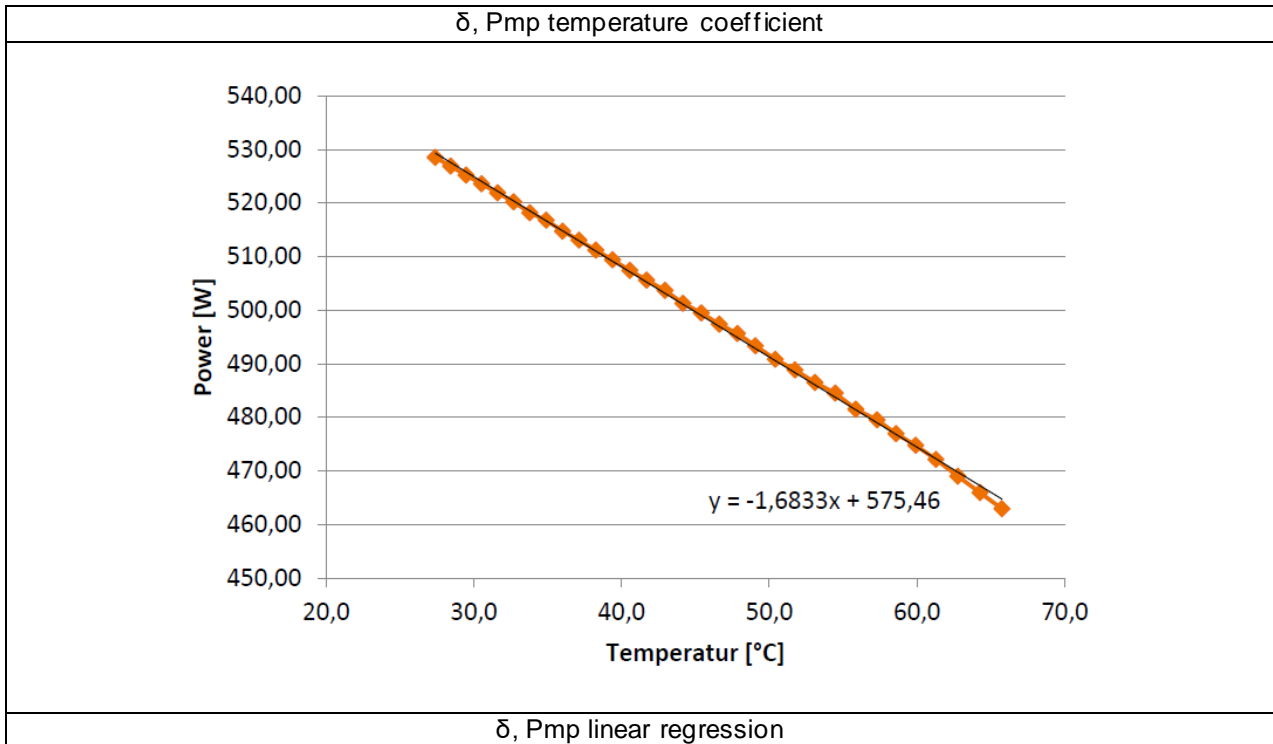
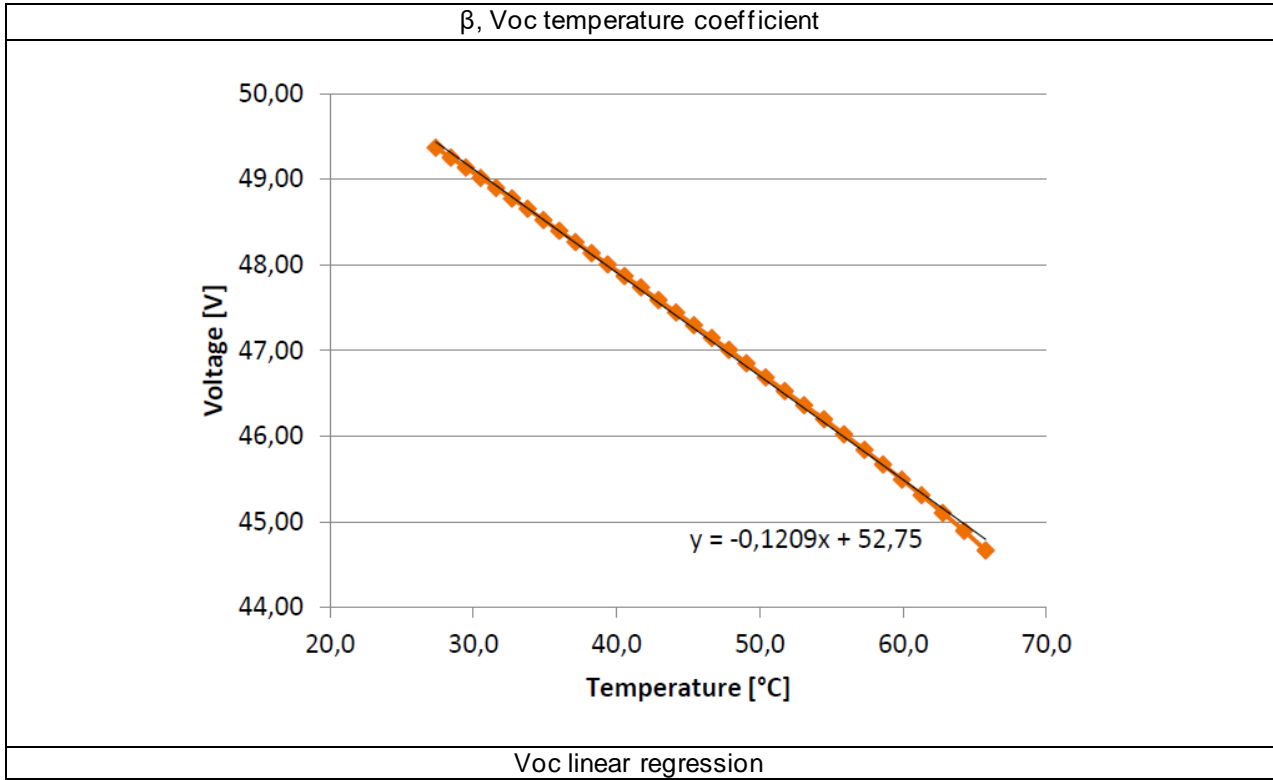


**Headquarter:**

Via Cadriano, 23 - 40057 Granarolo dell'Emilia (BO)

**Laboratory:**

Via Fabio Filzi, 68 - 20032 Cormano (MI)



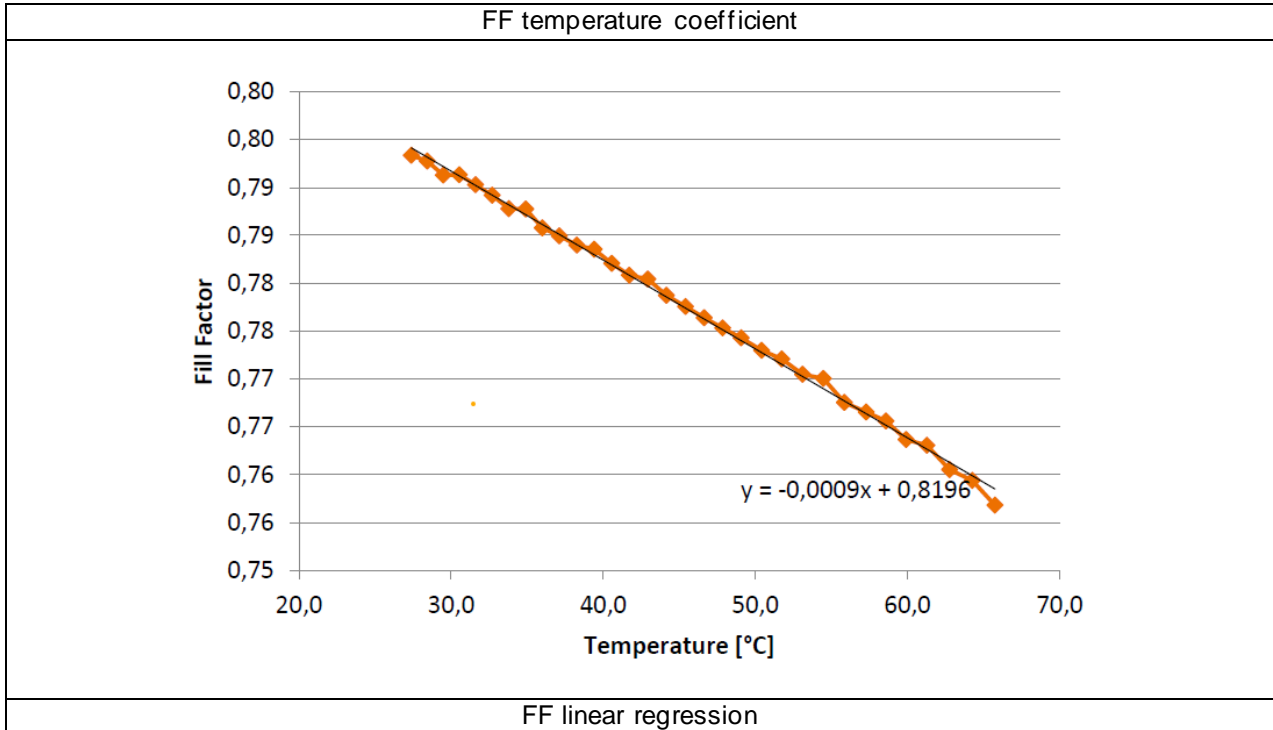


**Headquarter:**

Via Cadriano, 23 - 40057 Granarolo dell'Emilia (BO)

**Laboratory:**

Via Fabio Filzi, 68 - 20032 Cormano (MI)





**Headquarter:**

Via Cadriano, 23 - 40057 Granarolo dell'Emilia (BO)

**Laboratory:**

Via Fabio Filzi, 68 - 20032 Cormano (MI)

Test 4.6		TABLE 4.6: Performance at STC MQT 06.1							
MQT 06.1 - STC - Standard Test Conditions									
Initial measurements									
Temperature (°C)						25			
Irradiance (W/m <sup>2</sup> )						1000			
Light Source Spectrum						AM1.5			
Sample serial number	Test date	Temp (°C)	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmp (W)	Eff (%)	FF (%)
PS091022B144014018	2023/05/12	25.0	49.89	42.29	13.31	12.78	540.6	21.0	81.4
PS091022B144014017	2023/05/19	25.0	49.68	41.89	13.47	12.88	539.4	20.9	80.6
<i>Supplementary information:</i> Test has been performed indoor.									
<i>Remarks:</i> /									

Table 8.1 Maximum power determination under different temperature and irradiance level						
Flash test data for each sample at the real irradiance and temperature conditions in table 2 of the IEC 61853-1						
Sample 1, Serial number PS091022B144014018						
G. ref	T. ref	Voc	Vmp	Isc	Imp	Pmp
1100	25	50.25	42.53	14.55	13.91	591.37
1000	25	49.89	42.29	13.31	12.78	540.60
800	25	49.44	42.27	10.66	10.22	432.19
600	25	48.92	42.21	7.99	7.69	324.51
400	25	48.12	41.94	5.33	5.14	215.61
200	25	46.63	41.16	2.80	2.57	105.82
100	25	45.33	40.18	1.41	1.29	51.93
1100	50	47.14	39.13	14.71	13.95	545.90
1000	50	47.02	39.13	13.50	12.83	501.96
800	50	46.35	38.87	10.81	10.23	397.56
600	50	45.87	38.57	8.07	7.65	295.23
400	50	44.91	38.18	5.38	5.08	193.95
1000	15	50.96	43.54	13.36	12.86	559.99
800	15	50.51	43.52	10.71	10.29	448.00
600	15	49.95	43.45	8.03	7.70	334.62
400	15	49.08	42.85	5.36	5.22	223.49
200	15	47.45	42.22	2.79	2.60	109.96
100	15	46.07	41.25	1.37	1.30	53.74



**Headquarter:**

Via Cadriano, 23 - 40057 Granarolo dell'Emilia (BO)

**Laboratory:**

Via Fabio Filzi, 68 - 20032 Cormano (MI)

Sample 3, Serial number PS091022B144014017						
G. ref	T. ref	Voc	Vmp	Isc	Imp	Pmp
1100	25	50.00	42.23	14.47	14.05	593.41
1000	25	49.68	41.89	13.47	12.88	539.41
800	25	49.32	42.17	10.80	10.33	435.82
600	25	48.79	42.10	8.10	7.78	327.47
400	25	47.96	41.78	5.40	5.20	217.33
200	25	46.48	41.09	2.86	2.60	106.86
100	25	45.18	40.09	1.41	1.30	52.26
1100	50	46.89	38.83	14.74	13.97	542.55
1000	50	46.81	38.92	13.50	12.79	497.67
800	50	46.46	39.01	10.83	10.25	399.96
600	50	45.81	38.91	8.11	7.65	297.80
400	50	45.03	38.62	5.42	5.11	197.30
1000	15	51.04	43.57	13.36	12.85	559.82
800	15	50.69	43.69	10.69	10.27	448.81
600	15	49.83	43.34	8.03	7.67	332.37
400	15	49.07	43.16	5.34	5.17	223.06
200	15	47.62	42.42	2.79	2.59	110.05
100	15	46.39	41.51	1.35	1.31	54.33



**Headquarter:**

Via Cadriano, 23 - 40057 Granarolo dell'Emilia (BO)

**Laboratory:**

Via Fabio Filzi, 68 - 20032 Cormanò (MI)

<b>PMAX vs. Irradiance &amp; Temperature</b>			
Average P <sub>MAX</sub> Determined by Laboratory Results according to the IEC 61853-1 based on Table 2			
Average P <sub>max</sub> [W] Results Acquired over Multiple Irradiances per Temperature			
Irradiance [W/m <sup>2</sup> ]	Module Temperature		
	15°C	25°C	50°C
100	54.04	52.09	-
200	110.01	106.34	-
400	223.28	216.47	195.62
600	333.5	325.99	296.52
800	448.4	434.01	398.76
1000	559.9	540.00	499.82
1100	-	592.39	544.23

**Final Result**

The PAN file is based on several performance data organized in different tabs within PVsyst software:

1. in the tab "Basic Data" are specified the nameplate parameters;
2. in the tab "Additional Data/Low-light data" are entered the data related to the maximum power determination under different temperature and irradiance level;
3. in the tab "Model parameters" are defined the R<sub>sh</sub>, R<sub>sh0</sub> and R<sub>exp</sub> as default values and are entered the P<sub>max</sub> temperature coefficient.





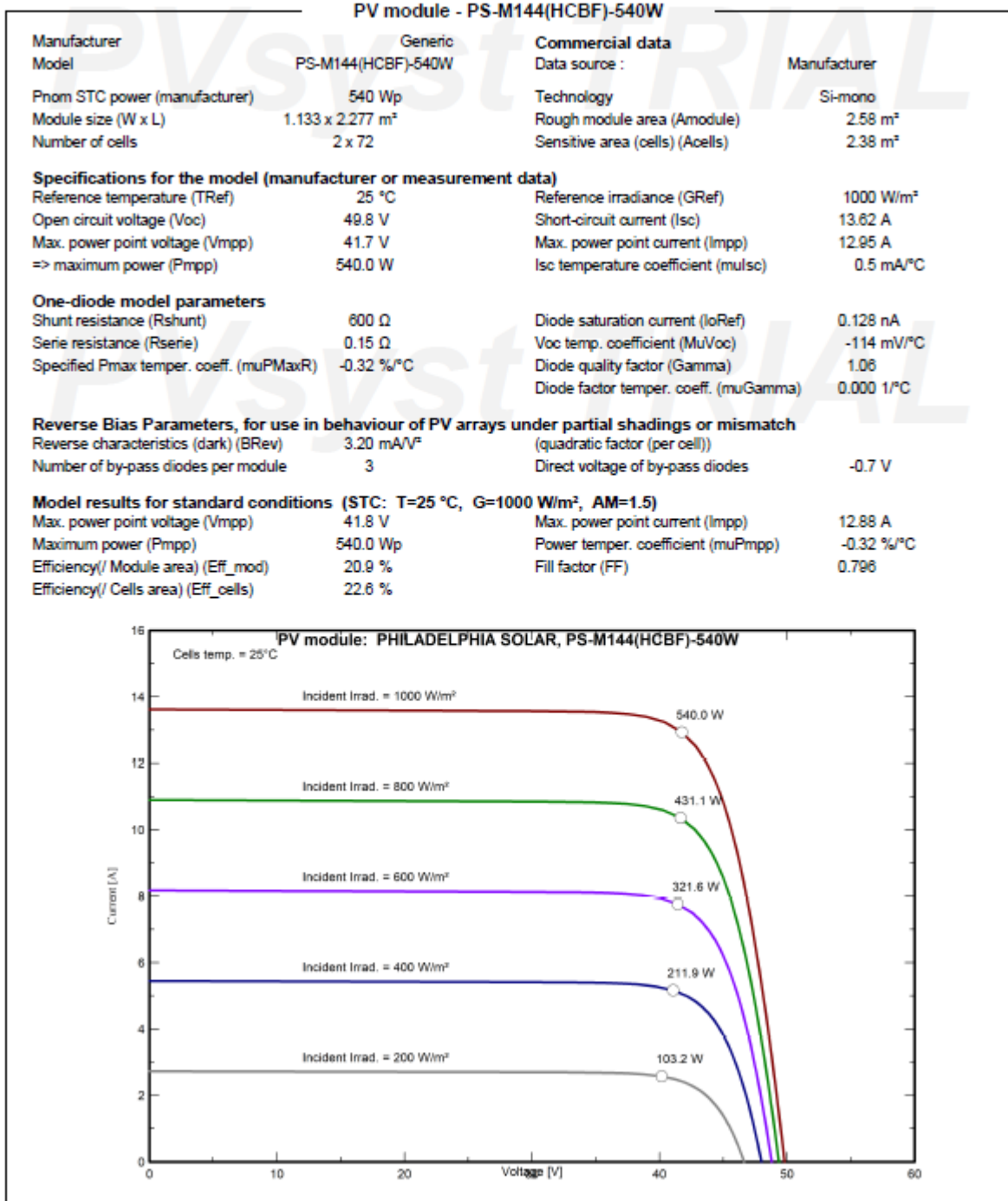
**Headquarter:**

Via Cadriano, 23 - 40057 Granarolo dell'Emilia (BO)

**Laboratory:**

Via Fabio Filzi, 68 - 20032 Cormanò (MI)

**Optimized PAN File result:**



----- End of the Test Report n. L000011966/F rev.00 -----