



**Headquarter:**

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

**Laboratory:**

Via Fabio Filzi, 68 - 20032 Cormano (MI)



**LAB N° 0001 L**

# TEST REPORT

*Number:*

**L0011146/A rev.00**

*Issue date:*

**2021-11-11**

*Final address:*

**Philadelphia Solar  
Al Qastal Industrial Area,  
Amman – Jordan**

*Testing sample:*

**(Photovoltaic Modules)  
PS-M72(HC)-445**

*Test type:*

**Golden Sample**

*Reference Standard:*

**IEC 61215-2:2016 / EN 61215-2:2017  
IEC 61215-1-1:2016 / EN 61215-1-1:2016**

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| <b>Test Report</b><br><b>IEC 61215-2:2016 / EN 61215-2:2017</b><br><b>Terrestrial photovoltaic (PV) modules – Design qualification and type approval –</b><br><b>Part 2: Test procedures</b><br><b>IEC 61215-1-1:2016 / EN 61215-1-1:2016</b><br><b>Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Special</b><br><b>requirements for testing of crystalline silicon photovoltaic (PV) modules.</b> |  |
|---|--|
| <b>Test Report</b>  |  |
| Approved by   | Stefano Brambillasca - <i>Head of the Lab</i>  |
| Issued date   | 2021-11-11   |
| <b>Test laboratory</b>  |  |
| Name  | <b>Kiwa Cermet Italia S.p.A</b>  |
| Address   | Via Filzi 68, 20032 Cormano(MI)  |
| <b>Final Addressee</b>  |  |
| Name  | <b>Philadelphia Solar</b>  |
| Address   | Al Qastal Industrial Area, Amman – Jordan  |
| Contact person  | Ms. Marwa Ghaith   |
| <b>Test details</b>   |  |
| Reference standard  | IEC 61215-2:2016 – IEC 61215-1-1   |
| Requested   | <u>IEC 61215-2 – IEC 61215-1-1</u><br><br>MQT 01 Visual inspection → N/A <sup>1</sup><br>MQT 02 Maximum power determination → N/A <sup>1</sup><br>MQT 03 Insulation test → N/A <sup>1</sup><br>MQT 04 Measurement of temperature coefficients<br>MQT 05 Measurement of nominal module operating temperature → N/A <sup>1</sup><br>MQT 06.1 Performance at STC<br>MQT 06.2 Performance at NMOT → N/A <sup>1</sup><br>MQT 07 Performance at low irradiance → N/A <sup>1</sup><br>MQT 08 Outdoor exposure test → N/A <sup>1</sup><br>MQT 09 Hot-spot endurance test → N/A <sup>1</sup><br>MQT 10 UV preconditioning test → N/A <sup>1</sup><br>MQT 11 Thermal cycling test → N/A <sup>1</sup><br>MQT 12 Humidity-freeze test → N/A <sup>1</sup><br>MQT 13 Damp heat test → N/A <sup>1</sup><br>MQT 14 Robustness of terminations → N/A <sup>1</sup><br>MQT 15 Wet leakage current test → N/A <sup>1</sup><br>MQT 16 Static mechanical load test → N/A <sup>1</sup><br>MQT 17 Hail test → N/A <sup>1</sup><br>MQT 18 Bypass diode testing → N/A <sup>1</sup><br>MQT 19 Stabilization |

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|  |  |
|--|--|
| <b>Requested</b>   | <u>IEC 61730-2</u><br>MST 01 Visual inspection → N/A <sup>1</sup><br>MST 02 Performance at STC → N/A <sup>1</sup><br>MST 03 Maximum power determination → N/A <sup>1</sup><br>MST 04 Insulation thickness test → N/A <sup>1</sup><br>MST 05 Durability of markings → N/A <sup>1</sup><br>MST 06 Sharp edge test → N/A <sup>1</sup><br>MST 07 Bypass diode functionality test → N/A <sup>1</sup><br>MST 11 Accessibility test → N/A <sup>1</sup><br>MST 12 Cut susceptibility test → N/A <sup>1</sup><br>MST 13 Continuity test of equipotential bonding → N/A <sup>1</sup><br>MST 14 Impulse voltage test → N/A <sup>1</sup><br>MST 16 Insulation test → N/A <sup>1</sup><br>MST 17 Wet leakage current test → N/A <sup>1</sup><br>MST 21 Temperature test → N/A <sup>1</sup><br>MST 22 Hot-spot endurance test → N/A <sup>1</sup><br>MST 23 Fire Test → N/A <sup>1</sup><br>MST 24 Ignitability test → N/A <sup>1</sup><br>MST 25 Bypass diode thermal test → N/A <sup>1</sup><br>MST 26 Reverse current overload test → N/A <sup>1</sup><br>MST 32 Module breakage test → N/A <sup>1</sup><br>MST 33 Screw connections test → N/A <sup>1</sup><br>MST 34 Static mechanical load test → N/A <sup>1</sup><br>MST 35 Peel test → N/A <sup>1</sup><br>MST 36 Lap shear strength test → N/A <sup>1</sup><br>MST 37 Materials creep test → N/A <sup>1</sup><br>MST 42 Robustness of terminations test → N/A <sup>1</sup><br>MST 51 Thermal cycling test → N/A <sup>1</sup> N/A <sup>1</sup><br>MST 52 Humidity freeze test → N/A <sup>1</sup><br>MST 53 Damp heat test → N/A <sup>1</sup><br>MST 54 UV test → N/A <sup>1</sup><br>MST 55 Cold conditioning → N/A <sup>1</sup><br>MST 56 Dry heat conditioning → N/A <sup>1</sup> |
| <b>Sample details</b><br><br>Brand<br><br><br>Manufacturer<br>Model/reference type | Photovoltaic Modules (PV)<br><br><br><b>Philadelphia Solar</b><br><small>DELIVERING CLEAN ENERGY SOLUTIONS</small><br><br><b>Philadelphia Solar</b><br>PS-M72(HC)-445   |
| <b>Remarks</b>   | N/A <sup>1</sup> → Not required for Golden Sample  |



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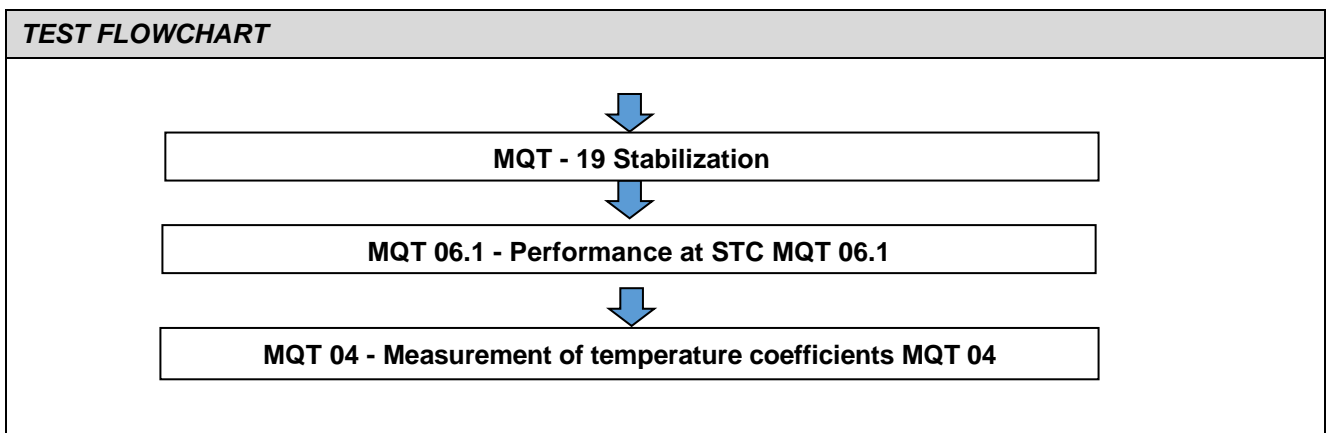
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| <b>TESTS</b>   |   |
|--|---|
| <b>List of Performed Test (Test name)</b><br><b>IEC 61215-2 - IEC 61215-1-1</b><br>MQT 04 Measurement of temperature coefficients<br>MQT 06.1 Performance at STC<br>MQT 19 Stabilization | <b>Test site</b><br>Kiwa Cermet Italia S.p.A<br>Via Filzi 68, 20032 Cormano(MI) |
| Remarks: /   |   |



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| <b>TECHNICAL SPECIFICATIONS OF THE SAMPLE UNDER TEST</b> |  |
|--|--|
| <b>General features</b>                                  |  |
| Model designation  | <b>PS-M72(HC)-445</b>                    |
| Module total length x width x height [mm]                | 2094 x 1038 x 35                         |
| Module weight [kg]                                       | 24                                       |
| <b>Cell</b>  |  |
| Cell dimensions (length x width) [mm]                    | 166 x 83                                 |
| Cell technology  | Mono PERC_MBB                            |
| Cell manufacturer  | Tongwei                                  |
| Cell model type / part of number                         | N/A                                      |
| Number of bus bar  | 9  |
| Total number of cells                                    | 144                                      |
| Number of cells in series                                | 72                                       |
| Number of cells for each diode                           | 24                                       |
| <b>Diode</b>   |  |
| Number of bypass diodes                                  | 3  |
| Diode manufacturer                                       | JMTH                                     |
| Diode model type / part of number                        | THY2550                                  |
| Bypass diode rating [A]                                  | 25                                       |
| Bypass diode max junction temperature [°C]               | 200                                      |
| thermal resistance from junction to case [°C/W]          | <i>Not declared</i>                      |
| <b>Interconnection</b>                                   |  |
| Cell connectors manufacturer                             | Tai Cang Juren                           |
| Cell Interconnect type (material)                        | Sn60 Pb40                                |
| Cell Interconnect dimensions [mm x mm]                   | Diameter: 0.35 -0.005/+0.015 mm          |
| String connectors manufacturer                           | Tai Cang Juren                           |
| String Interconnect material and supplier model no.      | <i>Not declared</i>                      |
| String Interconnect dimensions [mm x mm]                 | Thickness 0.39-0.01/+0.015mm, width: 6mm |
| Solder bonding technique and material                    | Laser Autobussing                        |
| Fluxing agent  | Low solid. No clean flux                 |
| <b>Superstrate and substrate</b>                         |  |
| Superstrate type/model and material                      | Tempered Glass                           |
| Superstrate manufacturer and part #                      | Xinyi                                    |
| Superstrate thickness [mm]                               | 3.2                                      |
| Substrate type/model and material                        | Polymeric Backsheet                      |
| Substrate manufacturer and part #                        | KPF                                      |
| Substrate thickness [mm]                                 | 0.32                                     |
| <b>Frame</b>   |  |
| Frame type/material                                      | Aluminum Frame                           |
| Frame manufacturer                                       | Davin                                    |
| Frame thickness [mm]                                     | 35                                       |
| Frame adhesive   | RTV Sealant                              |
| <b>Encapsulant</b>                                       |  |
| Encapsulant type   | EVA                                      |
| Encapsulant manufacturer and part #                      | Sveck / 96 and 97                        |
| <b>Junction box</b>                                      |  |
| Junction box manufacturer and part #                     | JMTHY                                    |
| Junction box type/model                                  | JM07                                     |
| Junction box fixing adhesive                             | RTV sealant                              |
| Cable type   | H1Z2Z2-K                                 |
| Cable manufacturer                                       | JMTHY                                    |
| Connector type/model                                     | PV-JM608                                 |
| Connector manufacturer                                   | JMTHY                                    |

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| <b>Electrical specifications label</b>  |                     |
|---|---------------------|
| Maximum system voltage [V]  | 1500                |
| Open-circuit voltage, VOC [V]   | 49.38               |
| VOC tolerance [%]   | ± 5                 |
| Short-circuit current, ISC [A]  | 11.23               |
| ISC tolerance [%]   | ± 5                 |
| Maximum power voltage, VMP [V]  | 41.56               |
| Maximum power current, IMP [A]  | 10.72               |
| Maximum power, PMP [W]  | 445                 |
| Power tolerance   | ± 3                 |
| Maximum overcurrent protection rating [A]   | 20                  |
| Safety factor $\gamma_m$  | <i>Not declared</i> |
| Design Load Front [Pa]  | 3600                |
| Design Load Back [Pa]   | 1600                |
| Material group  | <i>Not declared</i> |
| Pollution Degree  | <i>Not declared</i> |
| <b>Note:</b> <i>The data in this table were provided by the customer<br/>If the information provided by the customer can affect the validity of the results, the laboratory declines any responsibility</i> |                     |

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**Nameplate marking:**



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





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|   |   |
|---|---|
| <b>Test result Abbreviation:</b>  |   |
| Not applicable  | N/A   |
| The sample is conformed to the requirements   | P (Pass)  |
| The sample is not conformed to the requirements   | F (Fail)  |
| <b>Dates</b>  |   |
| Receipt date of testing samples   | 2021/10/14  |
| Test date   | from 2021/10/26 to 2021/11/09   |
| <b>Abbreviations and Symbols</b>  |   |
| Pmp – Maximum power   | HF – Humidity Freeze  |
| Vmp – Maximum power voltage   | DH – Damp Heat  |
| Imp – Maximum power current   | TC – Thermal Cycling  |
| Isc – Short circuit current   | $\alpha$ – Current temperature coefficient  |
| Voc – Open circuit voltage  | $\beta$ – Voltage temperature coefficient   |
| FF – Fill factor  | $\delta$ – Power temperature coefficient  |
| Eff – Cell efficiency   | NMOT – Nominal Module Operating Temperature                                       |
| STC – Standard Test Conditions  | VFM <sub>rated</sub> – Rated diode(s) forward voltage                             |
| MQT – Module Quality Tests  | NP – Nameplate  |
| MST – Module Safety Tests   | m <sub>2</sub> – The measurement uncertainty in % of laboratory for Voc           |
| VFM – Measured diode(s) forward voltage   | t <sub>1</sub> – The manufacturer's rated lower production tolerance in % for Pmp |
| m <sub>1</sub> – The measurement uncertainty in % of laboratory for Pmp   | t <sub>3</sub> – The manufacturer's rated upper production tolerance in % for Isc |
| m <sub>3</sub> – The measurement uncertainty in % of laboratory for Isc   | @ – At value of   |
| t <sub>2</sub> – The manufacturer's rated upper production tolerance in % for Voc   |   |
| r – Pmp measurement reproducibility   |   |
| <b>Remarks</b>  |   |
| 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. |   |



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**LAB N° 0001 L****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
- Golden Sample

**Remarks: /**

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| <b>TABLE 1</b> | <b>SAMPLING</b>   |  |
|----------------|---|--|
|                | Sampling is made under the responsibility of the customer   |  |
|                | The customer has selected 01 sample                         |  |
|                | The tested PV modules/samples has been sent by the customer |  |

| <b>TABLE 2</b> | <b>MARKING</b>                            |  |
|----------------|---|--|
|                | Name, monogram or symbol of manufacturer: |  |
|                | Type or model number:                     | PS-M72(HC)-445   |
|                | Serial number of the tested samples       | PS280921M1441023646  |
|                | Maximum system voltage:                   | 1500 V   |
|                | Production site:                          | <b>Philadelphia Solar</b><br>Al Qastal Industrial Area, Amman –<br>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  |
| MQT 19             | Stabilization                           | Table 4.19 |

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| <b>TABLE 4</b>   |              | <b>UNCERTAINTY</b>              |                                |          |                          |                             |                   |
|--|--------------|---------------------------------|--------------------------------|----------|--------------------------|-----------------------------|-------------------|
| <b>Measured parameter</b>  | <b>Range</b> | <b>Probability distribution</b> | <b>Level of Confidence (%)</b> | <b>k</b> | <b>Degree of freedom</b> | <b>Expanded Uncertainty</b> | <b>Unit</b>       |
| <b>Test 4.4 - Measurement of temperature coefficients MQT 04</b> |              |                                 |                                |          |                          |                             |                   |
| $\alpha$   | @0.004       | t-student                       | 95                             | 2        | $\infty$                 | 0.001                       | A°C <sup>-1</sup> |
| $\beta$  | @-0.129      | t-student                       | 95                             | 2        | $\infty$                 | 0.010                       | V°C <sup>-1</sup> |
| $\delta$   | @-1.338      | t-student                       | 95                             | 2        | $\infty$                 | 0.230                       | W°C <sup>-1</sup> |
| <b>Test 4.6.1 - Performance at STC and NMOT MQT 06.1</b>         |              |                                 |                                |          |                          |                             |                   |
| V <sub>oc</sub>  | @49.54       | Normal                          | 95                             | 2        | $\infty$                 | 0.09                        | V                 |
| I <sub>sc</sub> measured   | @11.29       | Normal                          | 95                             | 2        | $\infty$                 | 0.019                       | A                 |
| I <sub>sc</sub> evaluated  | @11.29       | Normal                          | 95                             | 2        | $\infty$                 | 0.36                        | A                 |
| V <sub>mp</sub>  | @42.10       | Normal                          | 95                             | 2        | $\infty$                 | 0.38                        | V                 |
| I <sub>mp</sub>  | @10.81       | Normal                          | 95                             | 2        | $\infty$                 | 0.36                        | A                 |
| P <sub>mp</sub>  | @455.1       | Normal                          | 95                             | 2        | $\infty$                 | 16.4                        | W                 |
| FF   | -            | Normal                          | 95                             | 2        | $\infty$                 | 2.9                         | %                 |
| eff  | -            | Normal                          | 95                             | 2        | $\infty$                 | 1.1                         | %                 |
| Irradiance   | @1000        | Normal                          | 95                             | 2        | $\infty$                 | 30                          | Wm <sup>-2</sup>  |
| Temperature  | 0.0÷50.0     | Normal                          | 95                             | 2        | $\infty$                 | 0.6                         | °C                |
| <b>Test 4.19 - Stabilization MQT 19</b>                          |              |                                 |                                |          |                          |                             |                   |
| P <sub>mp</sub>  | 454.4÷455.1  | Normal                          | 95                             | 2        | $\infty$                 | 16.4                        | W                 |
| Irradiance   | @1000        | Normal                          | 95                             | 2        | $\infty$                 | 30                          | Wm <sup>-2</sup>  |
| Temperature (module)   | 0.0÷100.0    | Normal                          | 95                             | 2        | $\infty$                 | 0.6                         | °C                |

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**IEC 61215-2 – IEC 61215-1-1**

| Test 4.4   |  |                | TABLE 4.4: Measurement of temperature coefficients MQT 04 |                 |  |
|--|--|----------------|---|-----------------|--|
| Sample serial number   |  |                | PS280921M1441023646                                       |                 |  |
| Test date  |  |                | 2021/11/09  |                 |  |
| Temperature range (°C)   |  |                | 25÷55   |                 |  |
| Step of temperature (°C)   |  |                | 5   |                 |  |
| Irradiance (W/m <sup>2</sup> )                                     |  |                | 1000  |                 |  |
| Light Source Spectrum  |  |                | AM1.5   |                 |  |
| $\alpha$ (A/°C)  |  | $\beta$ (V/°C) |   | $\delta$ (W/°C) |  |
| 0.004  |  | -0.129         |   | -1.338          |  |
| $\alpha$ (%/°C)  |  | $\beta$ (%/°C) |   | $\delta$ (%/°C) |  |
| 0.039  |  | -0.260         |   | -0.295          |  |
| <u>Supplementary information:</u> Tests have been performed indoor |  |                |   |                 |  |
| Remarks: /   |  |                |   |                 |  |

| 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 (%) |  |
| PS280921M1441023646  | 2021/10/27 | 25.0                                   | 49.54   | 42.10   | 11.29   | 10.81   | 455.1   | 22.9    | 81.4   |  |
| <u>Supplementary information:</u> Tests have been performed indoor |            |  |         |         |         |         |         |         |        |  |
| Remarks: /   |            |  |         |         |         |         |         |         |        |  |

| TABLE 4.19: Stabilization MQT 19                            |  |                                |                         |                             |
|---|--|--------------------------------|-------------------------|-----------------------------|
| Test 4.19.1   |  | Initial stabilization MQT 19.1 |                         |                             |
| Test date   |  | 2021/10/26                     |                         |                             |
| Sample serial number  |  | PS280921M1441023646            |                         |                             |
| Test Step   | Integrated irradiation for each step (kWh/m <sup>2</sup> ) | Irradiance (W/m <sup>2</sup> ) | Module temperature (°C) | Pmp (W) at the end of cycle |
| Initial   | -  | 1000                           | 25.0                    | 454.4                       |
| 1   | 5.4  | 1000                           | 25.0                    | 454.9                       |
| 2   | 5.0  | 1000                           | 25.0                    | 455.1                       |
| Pmin (W)  |  | Pmax (W)                       |                         | Pav (W)                     |
| 454.4   |  | 455.1                          |                         | 454.8                       |
| Result < x  |  |                                |                         |                             |
| 0.0015  |  |                                |                         |                             |
| <u>Supplementary information:</u> Continuous Sun Simulator. |  |                                |                         |                             |
| <u>Remarks:</u>   |  |                                |                         |                             |
| x = 0.01 shall be used for crystalline silicon PV modules.  |  |                                |                         |                             |
| $(P_{\max} - P_{\min}) / P_{\text{average}} < x$            |  |                                |                         |                             |

----- End of the Test Report n. L0011146/A rev.00 -----