**Headquarter:**
Via Cadriano, 23 - 40057 Granarolo dell'Emilia (BO)
**Laboratory:**
Via Fabio Filzi, 68 - 20032 Cormano (MI)

LAB N° 0001 L

# TEST REPORT

*Number:*
**L0012337/A rev.00**

*Issue date:*
**2023-05-17**

*Final address:*
**PHILADELPHIA SOLAR**
**Alqastel Industrial Area, Ammam,Jordan**

*Testing sample:*
***(Photovoltaic Modules)***
**PS-M144(HCBF)-540 W**

*Test type:*
**Extreme hail test**

*Test result:*
**PASS**

*Reference Standard:*
**IEC 61215-1:2021 / EN 61215-1: 2021**
**IEC 61215-2: 2021 / EN 61215-2: 2021**
**IEC 61215-1-1: 2021 / EN 61215-1-1: 2021**
**PTG 60 1.01 Electroluminescence test**

**Headquarter:**
Via Cadriano, 23 - 40057 Granarolo dell'Emilia (BO)
**Laboratory:**
Via Fabio Filzi, 68 - 20032 Cormano (MI)

LAB N° 0001 L

# Test Report
## IEC 61215-1:2021/ EN 61215-1:2021
## Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 1: Test requirements
## IEC 61215-2:2021 / EN 61215-2:2021
## Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 2: Test procedures
## IEC 61215-1-1:2021/ EN 61215-1-1:2021
## Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Special requirements for testing of crystalline silicon photovoltaic (PV) modules
## PTG 60 1.01 Elettroluminescenza

| | |
|---|---|
| **Test Report** | |
| Approved by | Maurizio Lorenzon - *Head of the Lab*<br>Digitally signed by: LORENZON MAURIZIO<br>Date: 17/05/2023 18:05:42 |
| Tested by | Andrea Cupido<br>Sergio Merighi |
| Issued date | 2023-05-17 |
| **Test laboratory** | |
| Name | **Kiwa Cermet Italia S.p.A** |
| Address | Via Fabio Filzi 68, 20032 Cormano (MI) |
| **Final Addressee** | |
| Name | **Philadelphia Solar** |
| Address | Alqastel Industrial Area, Ammam,Jordan |
| Contact person | Ms. Marwa Ghaith |
| **Test details** | |
| Reference standard | IEC 61215-2:2021 – IEC 61215-1-1 – IEC 61730-2 |
| Requested | IEC 61215-2 – IEC 61215-1-1<br>MQT 01 Visual inspection<br>MQT 02 Maximum power determination<br>MQT 03 Insulation test → N/A[1]<br>MQT 04 Measurement of temperature coefficients → N/A[1]<br>MQT 05 Measurement of nominal module operating temperature → N/A[1]<br>MQT 06.1 Performance at STC → N/A[1]<br>MQT 06.2 Performance at NMOT→ N/A[1]<br>MQT 07 Performance at low irradiance → N/A[1]<br>MQT 08 Outdoor exposure test → N/A[1]<br>MQT 09 Hot-spot endurance test → N/A[1]<br>MQT 10 UV preconditioning test → N/A[1]<br>MQT 11 Thermal cycling test → N/A[1]<br>MQT 12 Humidity-freeze test → N/A[1]<br>MQT 13 Damp heat test → N/A[1] |

| | |
|---|---|
| | MQT 14 Robustness of terminations → N/A[1]<br>MQT 15 Wet leakage current test<br>MQT 16 Static mechanical load test → N/A[1]<br>MQT 17 Hail test<br>MQT 18 Bypass diode testing → N/A[1]<br>MQT 19.1 Initial stabilization → N/A[1]<br>MQT 19.2 Final stabilization → N/A[2]<br>IEC 61730-2<br>MST 01 Visual inspection → N/A[1]<br>MST 02 Performance at STC → N/A[1]<br>MST 03 Maximum power determination → N/A[1]<br>MST 04 Insulation thickness test → N/A[1]<br>MST 05 Durability of markings → N/A[1]<br>MST 06 Sharp edge test → N/A[1]<br>MST 07 Bypass diode functionality test → N/A[1]<br>MST 11 Accessibility test → N/A[1]<br>MST 12 Cut susceptibility test → N/A[1]<br>MST 13 Continuity test of equipotential bonding → N/A[2]<br>MST 14 Impulse voltage test → N/A[1]<br>MST 16 Insulation test → N/A[1]<br>MST 17 Wet leakage current test → N/A[1]<br>MST 21 Temperature test → N/A[1]<br>MST 22 Hot-spot endurance test → N/A[1]<br>MST 23 Fire Test → N/A[1]<br>MST 24 Ignitability test → N/A[1]<br>MST 25 Bypass diode thermal test → N/A[1]<br>MST 26 Reverse current overload test → N/A[1]<br>MST 32 Module breakage test → N/A[1]<br>MST 33 Screw connections test → N/A[1]<br>MST 34 Static mechanical load test → N/A[1]<br>MST 35 Peel test → N/A[1]<br>MST 36 Lap shear strength test → N/A[1]<br>MST 37 Materials creep test → N/A[1]<br>MST 42 Robustness of terminations test → N/A[1]<br>MST 51 Thermal cycling test → N/A[1]<br>MST 52 Humidity freeze test → N/A[1]<br>MST 53 Damp heat test → N/A[1]<br>MST 54 UV test → N/A[1]<br>MST 55 Cold conditioning → N/A[1]<br>MST 56 Dry heat conditioning → N/A[1]<br>**INTERNAL METHOD**<br>1.01 Electroluminescence test |

**Headquarter:**
Via Cadriano, 23 - 40057 Granarolo dell'Emilia (BO)
**Laboratory:**
Via Fabio Filzi, 68 - 20032 Cormano (MI)

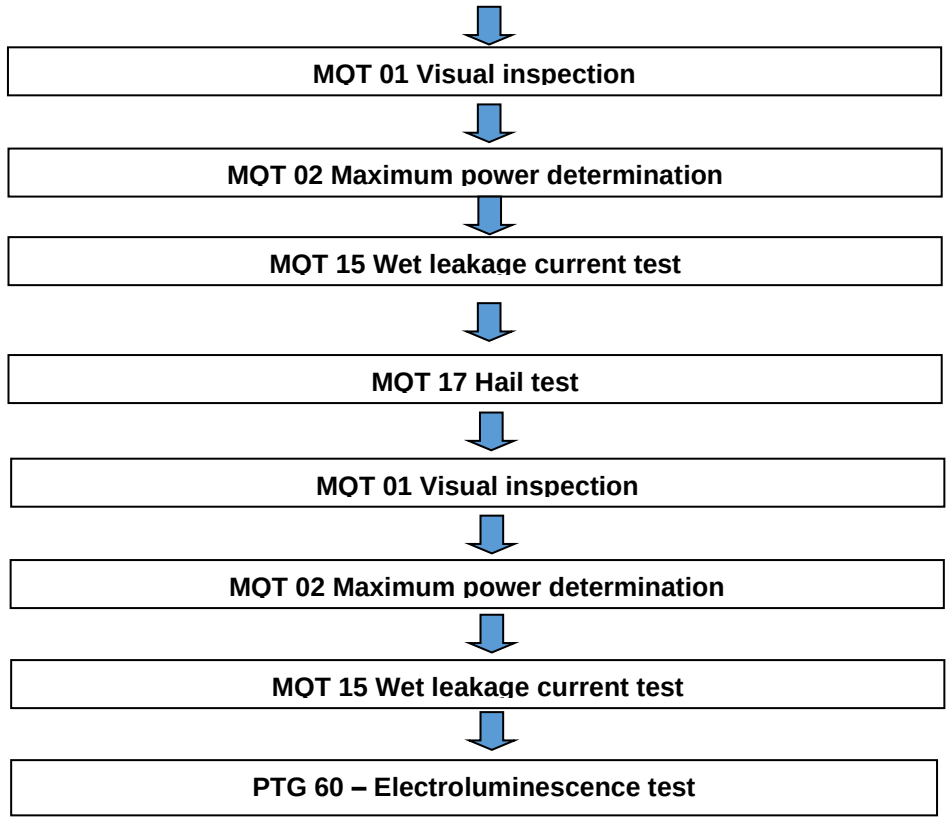
LAB N° 0001 L

| Sample details | Photovoltaic Modules (PV) |
|---|---|
| Brand | Philadelphia Solar DELIVERING CLEAN ENERGY SOLUTIONS |
| Manufacturer | PHILADELPHIA SOLAR |
| Model/reference type | PS-M144(HCBF) – 540 W |
| **Remarks** | N/A[1] → Not required by the customer |

| ***TESTS*** | |
|---|---|
| **List of Performed Test (Test name)** | **Test site** |
| **IEC 61215-2 - IEC 61215-1-1** | |
| MQT 01 Visual inspection [1] | Kiwa Cermet Italia S.p.A |
| MQT 02 Maximum power determination | Via Fabio Filzi 68, 20032 Cormano (MI) |
| MQT 15 Wet leakage current test [1] | |
| MQT 17 Hail test | |
| **INTERNAL METHOD** | |
| 1.01 Electroluminescence test | |

**Remarks:** [1] The Declarations of Conformity the expanded measurement uncertainty is not taken into account, therefore, in the case of values approaching the acceptability limits, we consider a level of risk of up to 50% of erroneous acceptance (if the value coincides with the limit, the risk level is equal to 50%). Similarly, in the case of a value exceeding the acceptability limit, the risk level of erroneous rejection can be up to 50%.

***TEST FLOWCHART***

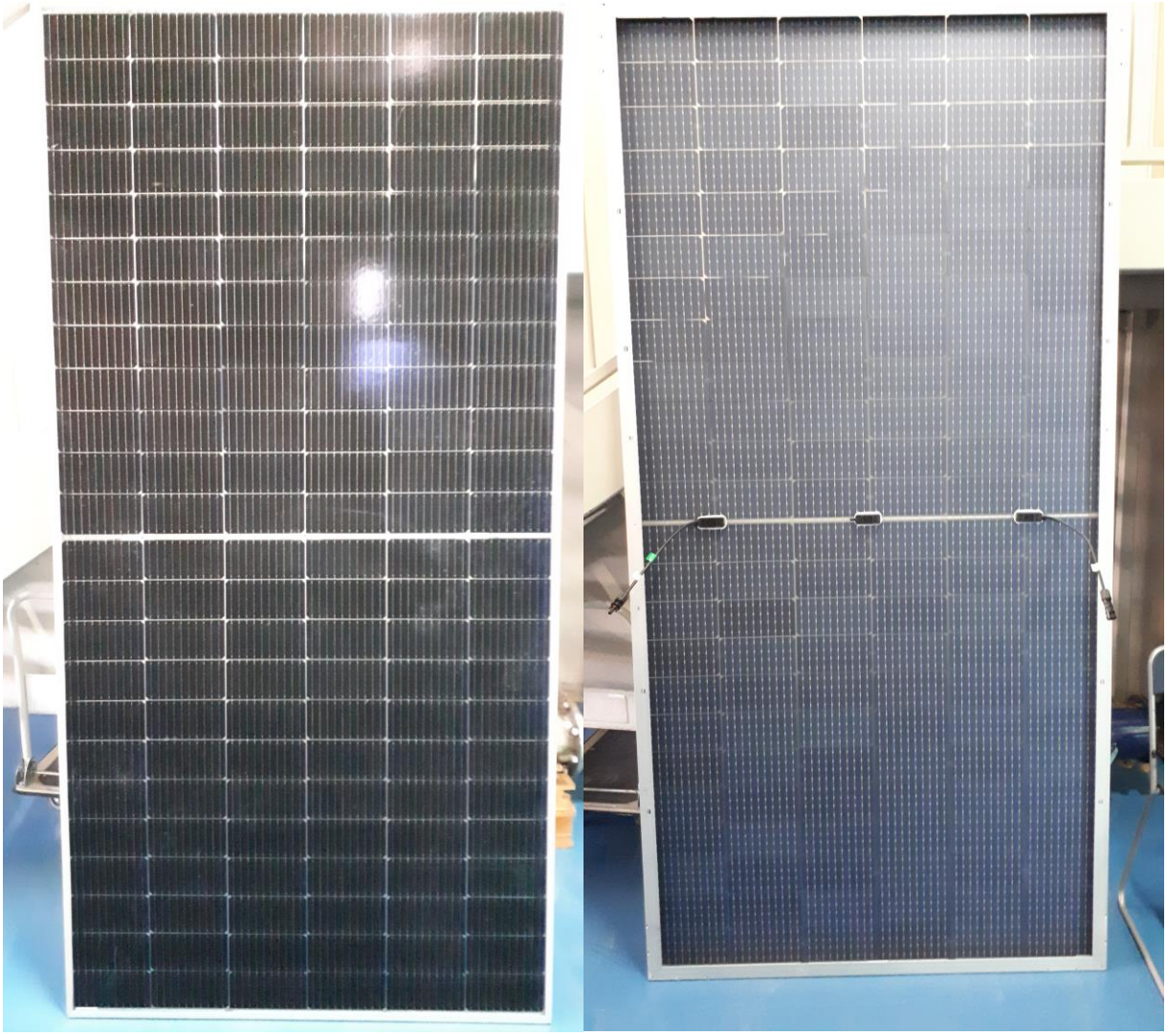


| ***TECHNICAL SPECIFICATIONS OF THE SAMPLE UNDER TEST*** | |
|---|---|
| ***General features*** | |
| Model designation | PS-M144(HCBF) – 540 W |
| Module dimensions (length x width x height) (mm) | 2277x1133x35 |
| Module weight (kg) | Not declared |
| ***Cell*** | |
| Cell dimensions (length x width) (mm) | 182x182 |
| Cell thickness (mm) | 175 ± 17.5 |
| Cell technology | Mono-crystalline, Bifacial Solar Cells |
| Cell manufacturer | United Renewable Energy |
| Cell model type / part number | Black22 Series |
| Number of bus bars | 10 |
| Total number of cells | 144 Half Cell (72 full cell) |
| Number of cells in series | |
| Number of cells in parallel | |
| Number of cells for each diode | 48 half cell |
| Electrical circuit (S, SP, PS) | 72 in series/ 2 in parallel |
| ***Diode*** | |
| Number of bypass diodes | 3 |
| Diode manufacturer | JMTHY |
| Diode model type / part number | MK5050 |
| Bypass diode rated current (A) | 50 |
| Bypass diode max junction temperature (°C) | 200 |
| ***Cell connectors and string connectors (PV ribbon)*** | |
| 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 |
| Soldering material | Sn60Pb40 |
| Fluxing agent | Kester 952-S |
| ***Superstrate (front cover)*** | |
| 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 |
| ***Substrate (rear cover)*** | |
| Substrate manufacturer | Cybrid |
| Substrate material | Transparent- kpf |
| Substrate model type / part number | Cynagard 465A(R) |
| Substrate thickness (mm) | 0.320 |
| ***Encapsulant*** | |
| 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 |
| ***Junction box, cables and connectors*** | |
| Junction box manufacturer | JMTHY |
| Junction box model type / part number | JM37xy |
| Junction box potting material (if any) | Shanghai Huitian New Material Co. |
| 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 | H1Z2Z2-K |
| Cable manufacturer | JMTHY |
| Connector type/model | PV-JM608 |
| Connector manufacturer | JMTHY |
| ***Insulation tape*** | |
| Insulation tape manufacturer | N/A |
| Insulation tape material | N/A |
| ***Cell fixing tape*** | |
| Cell fixing material manufacturer | Cybrid Technologies |
| Cell fixing material | FF-3665 |
| ***Label*** | |
| Nameplate label manufacturer | SUZHOU ZhengAo Packing Materal CO., LTD |
| Nameplate label material | polymers |
| Nameplate label adhesive | N/A |
| Barcode ID material | N/A |
| Barcode ID adhesive | N/A |
| ***PV electrical and mechanical data*** | |
| 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 Positive [Pa] (Snow) | 3600 |
| Design Load Negative [Pa] (Wind) | 1600 |
| Hail test - Ice ball diameter (mm) | 45 |
| Material group | N/A |
| Pollution Degree (PD) according to IEC 60664-1 | 1 |
| Rated operating altitude (m) | 2000 |
| **Remarks**: 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 | |

***Nameplate marking:***


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



| | |
|---|---|
| ***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 | 2023/04/28 |

***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
Eff – Cell efficiency
STC – Standard Test Conditions
MQT – Module Quality Tests
MST – Module Safety Tests
VFM – Measured diode(s) forward voltage
m1 – The measurement uncertainty in % of laboratory for Pmp
m3 – The measurement uncertainty in % of laboratory for Isc
t2 – The manufacturer's rated upper production tolerance in % for Voc
r – Pmp measurement reproducibility
HF – Humidity Freeze
DH – Damp Heat
TC – Thermal Cycling
α – Current temperature coefficient
β – Voltage temperature coefficient
δ – Power temperature coefficient
NMOT – Nominal Module Operating Temperature
VFMrated – Rated diode(s) forward voltage
NP – Nameplate
m2 – The measurement uncertainty in % of laboratory for Voc
t1 – The manufacturer's rated lower production tolerance in % for Pmp
t3 – The manufacturer's rated upper production tolerance in % for Isc
@ – At value of

***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.

***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:** ***extreme hail test according to the table "TEST FLOWCHART".***

**Remarks**: /

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

| ***TABLE 2*** | ***MARKING*** | |
|---|---|---|
| | Name, monogram or symbol of manufacturer: | Philadelphia Solar DELIVERING CLEAN ENERGY SOLUTIONS |
| | Type or model number: | PS-M144(HCBF)- 540 W |
| | Serial number of the tested samples | PS091022B144014017 |
| | Maximum system voltage: | 1500 V |
| | Production site: | PHILADELPHIA SOLAR Alqastel Industrial Area, Ammam,Jordan |
| *Supplementary information: /* | | |

| ***TABLE 3*** | ***TEST PROCEDURES*** | |
|---|---|---|
| ***IEC 61215-2*** | | |
| MQT 01 | Visual inspection | Table 4.1 |
| MQT 02 | Maximum power determiantion | Table 4.2 |
| MQT 15 | Wet leakage current test | Table 4.15 |
| MQT 17 | Hail test | Table 4.17 |
| ***INTERNAL METHOD*** | | |
| 1.01 | Electroluminescence | Table 1.01 |

| ***TABLE 4*** | ***IEC 61215-1: MAJOR VISUAL DEFECTS*** | |
|---|---|---|
| | a) Broken, cracked, or torn external surfaces. | Table 10.2 |
| | b) Bent or misaligned external surfaces, including superstrates, substrates, frames and junction boxes to the extent that the operation of the PV module would be impaired. | Table 10.2 |
| | c) Bubbles or delaminations forming a continuous path between electric circuit and the edge of the module. | Table 10.2 |
| | d) If the mechanical integrity depends on lamination or other means of adhesion, the sum of the area of all bubbles shall not exceed 1 % of the total module area. | Table 10.2 |
| | e) Evidence of any molten or burned encapsulant, backsheet, frontsheet, diode or active PV component. | Table 10.2 |
| | f) Loss of mechanical integrity to the extent that the installation and operation of the module would be impaired. | Table 10.2 |
| | g) Cracked/broken cells which can remove more than 10 % of the cell's photovoltaic active area from the electrical circuit of the PV module. | Table 10.2 |
| | h) Voids in, or visible corrosion of any of the layers of the active (live) circuitry of the module extending over more than 10 % of any cell. | Table 10.2 |
| | i) Broken interconnections, joints or terminals. | Table 10.2 |
| | j) Any short-circuited live parts or exposed live electrical parts. | Table 10.2 |
| | k) Module markings (label) are no longer attached or the information is unreadable. | Table 10.2 |

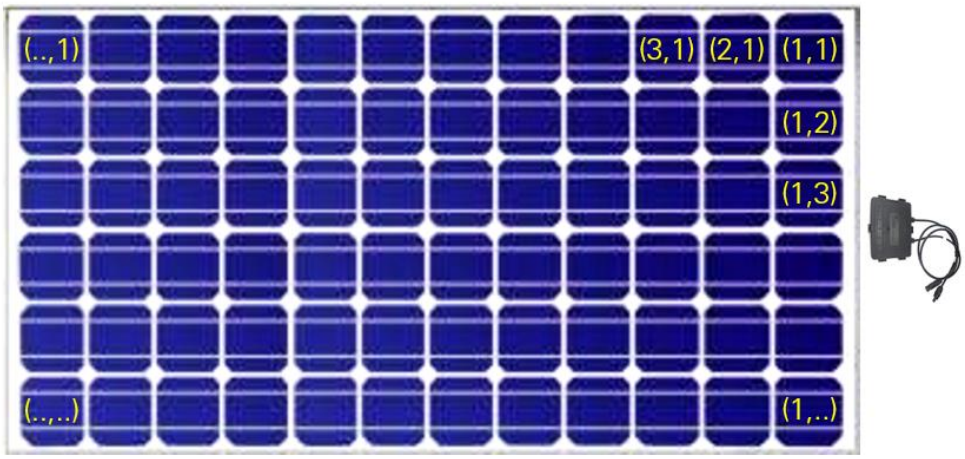



*Figure 4 - Cells identification number*

| ***TABLE 5*** | | |
|---|---|---|
| **Measured parameter** | **Expanded Uncertainty** | **Unit** |
| **Test 4.1 - Visual Inspection MQT 01** | | |
| Length (Caliper) | 0.5 | mm |
| Length (Tape) | 2 | mm |
| **Test 4.2 - Maximum power determination MQT 02** | | |
| $V_{oc}$ | 0.3 | % |
| $I_{sc}$ | 2.5 | % |
| $P_{mp}$ | 3 | % |
| Irradiance | 21 | $Wm^{-2}$ |
| Temperature | 0.7 | °C |
| **Test 4.15 - Wet leakage current test MQT 15** | | |
| Electrical Insulation (surface > 0.1 $m^2$) | 25 | %[1] |
| Voltage | 1 | % |
| Humidity | 3 | %RH |
| Resistivity | 165 | Ωcm |
| Temperature | 0.6 | °C |
| [1]Percentage on the reading value given in $M\Omega m^2$ | | |
| **Test 4.17 - Hail test MQT 17** | | |
| Hail speed | 0.7 | m/s |
| Hail diameter | 0.46 (@25 mm) | mm |
| Hail weight | 0.1 (@25 mm) | g |
| Hail diameter | 1.26 (@45 mm) | mm |
| Hail weight | 0.8 (@45 mm) | g |
| Hail diameter | 0.86 (@55 mm) | mm |
| Hail weight | 0.7 (@55 mm) | g |
| **Remarks** | | |
| **Test 1.01 - Electroluminescence test** | | |
| Current | 0.01 | A |
| Voltage | 0.01 | V |
| Time | 0.4 | s |
| **Remarks**<br>The measurement uncertainties stated in this document have been determined according to EA-4/02. Usually, they have been estimated as expanded uncertainty obtained multiplying the standard uncertainty by the coverage factor k = 2 corresponding to a confidence level of about 95%. | | |

**IEC 61215-1-1**

| IEC 61215-1-1:2016<br>Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Special requirements for testing of crystalline silicon photovoltaic (PV) modules | | | |
|---|---|---|---|
| 5 | Marking and documentation | This test of IEC 61215-1:2021 is applicable without modifications. | — |
| 6 | Testing | This test of IEC 61215-1:2021 is applicable without modifications. | — |
| 7 | Pass criteria | This test of IEC 61215-1:2021 is applicable without modifications.<br>The maximum allowable value of reproducibility is set to r = 1,0 %.<br>The maximum allowable value of measurement uncertainty is set to $m_1$ = 3,0 %. | — |
| 8 | Major visual defects | This test of IEC 61215-1:2021 is applicable without modifications. | — |
| 9 | Report | This test of IEC 61215-1:2021 is applicable without modifications. | — |
| 10 | Modifications | This test of IEC 61215-1:2021 is applicable without modifications. | — |
| 11 | Test flow and procedures | This test of IEC 61215-1:2021 is applicable without modifications. | — |
| 11.1 | Visual inspection (MQT 01) | This test of IEC 61215-2:2021 is applicable without modifications. | — |
| 11.2 | Maximum power determination (MQT 02) | This test of IEC 61215-2:2021 is applicable without modifications. | — |
| 11.3 | Insulation test (MQT 03) | This test of IEC 61215-2:2021 is applicable without modifications. | — |
| 11.4 | Measurement of temperature coefficients (MQT 04) | This test of IEC 61215-2:2021 is applicable without modifications. | — |
| 11.5 | Measurement of nominal module operating temperature (NMOT) (MQT 05) | This test of IEC 61215-2:2021 is applicable without modifications. | — |
| 11.6 | Performance at STC (MQT 06.1) and NMOT (MQT 06.2) | This test of IEC 61215-2:2021 is applicable without modifications. | — |
| 11.7 | Performance at low irradiance (MQT 07) | This test of IEC 61215-2:2021 is applicable without modifications. | — |
| 11.8 | Outdoor exposure test (MQT 08) | This test of IEC 61215-2:2021 is applicable without modifications. | — |

| | | | |
|---|---|---|---|
| 11.9 | Hot-spot endurance test (MQT 09) | This test of IEC 61215-2:2021 is applicable without modifications. | — |
| 11.10 | UV preconditioning test (MQT 10) | This test of IEC 61215-2:2021 is applicable without modifications. | — |
| 11.11 | Thermal cycling test (MQT 11) | This test of IEC 61215-2:2021 is applicable without modifications.<br>For monofacial modules the applied current shall be equal to the STC peak power current.<br>For bifacial modules the applied current shall be to the peak power current at the elevated iraadiance level BSI. | — |
| 11.12 | Humidity-freeze test (MQT 12) | This test of IEC 61215-2:2021 is applicable without modifications. | — |
| 11.13 | Damp heat test (MQT 13) | This test of IEC 61215-2:2021 is applicable without modifications. | — |
| 11.14 | Robustness of terminations test (MQT 14) | This test of IEC 61215-2:2021 is applicable without modifications. | — |
| 11.15 | Wet leakage current test (MQT 15) | This test of IEC 61215-2:2021 is applicable without modifications. | — |
| 11.16 | Static mechanical load test (MQT 16) | This test of IEC 61215-2:2021 is applicable without modifications. | — |
| 11.17 | Hail test (MQT 17) | This test of IEC 61215-2:2021 is applicable without modifications. | — |
| 11.18 | Bypass diode thermal test (MQT 18) | This test of IEC 61215-2:2021 is applicable without modifications. | — |
| 11.19 | Stabilization (MQT 19) | This test of IEC 61215-2:2021 is applicable without modifications. For the definition of stabilization as per test MQT 19 of IEC 61215-2:2021, x = 0,01 shall be used for crystalline silicon PV modules. | — |
| 11.20 | Cyclic (dynamic) mechanical load test (MQT 20) | This test of IEC 61215-2:2021 is applicable without modifications. | — |
| 11.21 | Potential induced degradation test (MQT 21) | This test of IEC 61215-2:2021 is applicable without modifications. | — |
| 11.22 | Bending test (MQT 22) | This test of IEC 61215-2:2021 is applicable without modifications. | — |

## IEC 61215-2 – IEC 61215-1-1

| **Test 4.1** | **TABLE 4.1: Visual Inspection MQT 01** | | |
|---|---|---|---|
| **Initial Examination** | | | |
| Sample serial number | Test Date | Nature and position of initial finding - description | P/F |
| PS091022B144014017 | 2023/04/28 | No major visual defects | P |
| **Final examinations** | | | |
| ***IEC 61215*** | | | |
| ***After the 4.17 Hail test MQT 17*** | | | |
| PS091022B144014017 | 2023/04/28 | No major visual defects | P |
| | | | |
| *Supplementary information*: The requirements of the final visual inspection are listed in the Table 4.<br>For identification of cell number see figure 4.<br>*Remarks: /* | | | |

| **Test 4.2** | **TABLE 4.2: Maximum power determination MQT 02** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Initial measurements** | | | | | | | | | |
| Temperature (°C) | | | | | | 25 | | | |
| Irradiance (W/m$^2$) | | | | | | 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 (%) |
| PS091022B144014017 | 2023/04/28 | 25.0 | 49.66 | 42.05 | 13.51 | 12.89 | 542.2 | 21.1 | 80.8 |
| **Final measurements** | | | | | | | | | |
| Temperature (°C) | | | | | | 25 | | | |
| Irradiance (W/m$^2$) | | | | | | 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 (%) |
| PS091022B144014017 | 2023/04/28 | 25.0 | 49.63 | 42.07 | 13.35 | 12.77 | 537.3 | 20.9 | 81.1 |
| *Supplementary information: /* | | | | | | | | | |

| **Test 4.15** | **TABLE 4.15: Wet leakage current test MQT 15** |
|---|---|
| Admissible resistivity of the water solution (Ω*cm) | < 3500 |
| Admissible temperature of the water solution (°C) | 22 ± 2 |
| DC Voltage (V) | 1500 |
| Module Area ($m^2$) | 2.579 |

| Sample serial number | Test date | Resistivity of the water solution (Ω*cm) | Water solution temperature (°C) | Environment | | Applied Voltage (V) | MΩ*$m^2$ @ Applied Voltage | P/F |
|---|---|---|---|---|---|---|---|---|
| | | | | Temp. (°C) | Humidity (%R.H.) | | | |
| **Initial values** | | | | | | | | |
| PS091022B144014017 | 2023/04/28 | 1097 | 22.8 | 25.1 | 38 | 1584 | 19088 | P |
| **Final values** | | | | | | | | |
| ***IEC 61215*** | | | | | | | | |
| ***After the 4.17 Hail test MQT 17*** | | | | | | | | |
| PS091022B144014017 | 2023/04/28 | 1097 | 22.8 | 25.1 | 38 | 1585 | 18620 | P |

*Supplementary information*: /

*Remarks:* Test has been passed (P) if:
- For modules with an area of less than 0,1 $m^2$ the insulation resistance shall not be less than 400 MΩ.
- For modules with an area larger than 0,1 $m^2$ the measured insulation resistance times the area of the module shall not be less than 40 MΩ·$m^2$.

| **Test 4.17** | **TABLE 4.17: Hail test MQT17** | |
|---|---|---|
| Test date | | 2023/04/28 |
| Sample serial number | | PS091022B144014017 |
| Spheres reference diameter (mm) | | 45 ± 5% |
| Spheres reference weight (g) | | 43.9 ± 5% |
| Spheres reference speed (m/sec) | | 30.7 ± 5% |

| SHOT NO. | VELOCITY (m/s) | P/F |
|---|---|---|
| N .1 | 30.2 | P |
| N. 2 | 30.9 | P |
| N. 3 | 29.9 | P |
| N. 4 | 29.5 | P |
| N. 5 | 30.2 | P |
| N. 6 | 29.7 | P |
| N. 7 | 29.3 | P |
| N. 8 | 29.2 | P |
| N. 9 | 29.5 | P |
| N. 10 | 30.6 | P |
| N. 11 | 29.3 | P |

***Control tests***

| 4.1 Visual Inspection MQT 01 (P/F) | 4.15 Wet leakage current test MQT 15 (P/F) |
|---|---|
| P | P |

*Supplementary information:*

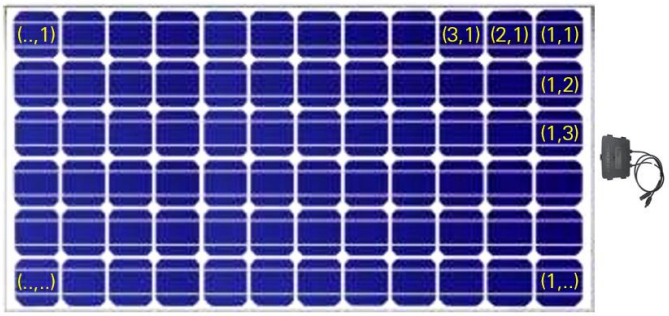
| Shot No. | Location |
|---|---|
| 1 | Any corner of the module window, not more than one radius from the module edge. |
| 2 | Any edge of the module, not more than one radius of ice-ball from the module edge. |
| 3, 4 | Over edges of the circuit (e.g. individual cells). |
| 5, 6 | Over the circuit near interconnects (i.e. cell interconnects and bus ribbons). |
| 7, 8 | On the module window, not more than half diameter of ice ball from one of the points at which the module is mounted to the supporting structure. |
| 9, 10 | On the module window, at points farthest from the points selected above. |
| 11 | Any points which may prove especially vulnerable to hail impact like over the junction box. |

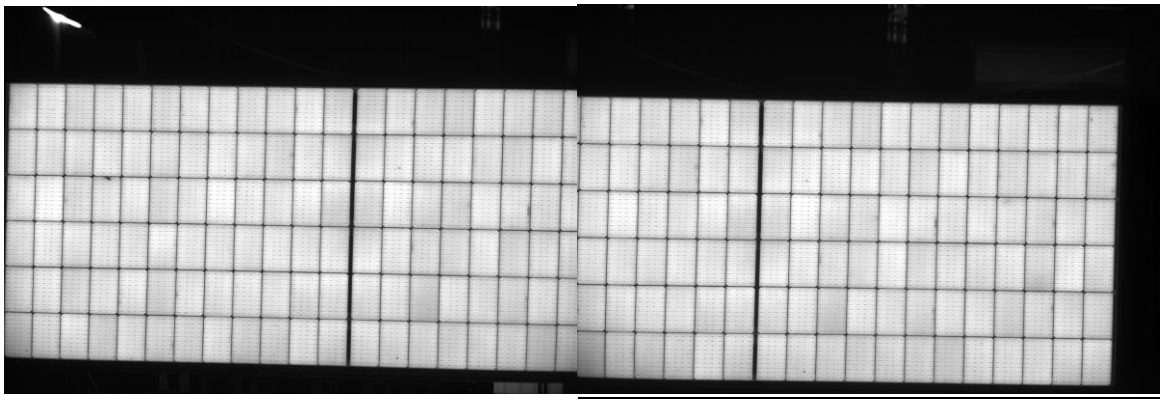
*Remarks:* The module passes (P) the test if:
- No evidence of major visual defects, as defined in Table 4 (Table 4.1);
- Wet leakage current shall meet the same requirements as for the initial measurements (Table 4.15).

| **Test 1.01** | **TABLE 1.01: Electroluminescence test** | | | | | |
|---|---|---|---|---|---|---|
| Sample serial number | Test date | Environmental Temperature (°C) | Exposure time (s) | Reverse current (A) | Supply Voltage (V) | ISC (A) |
| **Initial examination** | | | | | | |
| PS091022B144014017 | 2023/05/16 | 25.2 | 5 | 12.95 | 54.04 | 13.62 |

*Supplementary information:* **The Electroluminescence test is a qualitative test, its result cannot be PASS or FAIL.**

*Cells identification number:*



1. Micro cracks for example on cells (3;23)

*Figure 1.01.1 – Sample n. PS091022B144014017 Electroluminescence test*

---------- End of the Test Report n. L0012337/A rev.00----------