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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Photovoltaic (PV) modules – Salt mist corrosion testing

Modules photovoltaïques (PV) – Essai de corrosion au brouillard salin

IEC 61701:2020-06(en-fr)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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COMMISSION ELECTROTECHNIQUE INTERNATIONALE

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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PHOTOVOLTAIC (PV) MODULES – SALT MIST CORROSION TESTING

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International Standard IEC 61701 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

This third edition cancels and replaces the second edition issued in 2011. This edition constitutes a technical revision.

The main technical changes with respect to the previous edition are as follows:

- The scope has been updated to better reflect the applicability of the Standard.
- Test methods and requirements have been condensed and aligned with the new editions of IEC 61215-1, IEC 61215-2, and IEC 61730-2. References to crystalline silicon versus thin film technologies have been eliminated. The old Figure 2 on the thin film test sequence has been eliminated.
- The salt mist test references have been updated to harmonize with changes to IEC 60068-2-52.

- A normative annex A has been added to provide guidance on which of the test methods in IEC 60068-2-52 are applicable to different applications. This includes references to new test methods in the latest edition of IEC 60068-2-52.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
82/1693/FDIS	82/1725/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

PHOTOVOLTAIC (PV) MODULES – SALT MIST CORROSION TESTING

1 Scope

Photovoltaic (PV) modules are electrical devices normally intended for continuous outdoor exposure during their lifetime. Highly corrosive wet atmospheres, such as marine environments or locations near the ocean or other large bodies of salt water, could eventually degrade some of the PV module components (corrosion of metallic parts, deterioration of the properties of some non-metallic materials – such as protective coatings and plastics – by assimilation of salts, etc.) causing permanent degradation that could impair their functioning. Temporary corrosive atmospheres are also present in places where salt is used in winter periods to melt ice formations on streets and roads.

This document describes test sequences useful to determine the resistance of different PV modules to corrosion from salt mist containing Cl (NaCl, $MgCl_2$, etc.). All tests included in the sequences are fully described in IEC 61215-2, IEC 62108, IEC 61730-2 and IEC 60068-2-52. The bypass diode functionality test in this document is modified from its description in IEC 61215-2. They are combined in this document to provide means to evaluate possible faults caused in PV modules when operating under wet atmospheres having high concentration of dissolved salt (NaCl). Depending on the specific nature of the surrounding atmosphere to which the module is exposed in real operation several testing methods can be applied, as defined in IEC 60068-2-52. Guidance for determining the applicability of this document and selecting an appropriate method is provided in Annex A.

This document can be applied to both flat plate PV modules and concentrator PV modules and assemblies.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2-52, *Environmental testing – Part 2-52: Tests – Test Kb: Salt mist, cyclic (sodium chloride solution)*

IEC 61215-1, *Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 1: Test requirements*

IEC 61215-2, *Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 2: Test procedures*

IEC 61730-2, *Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing*

IEC TS 61836, *Solar photovoltaic energy systems – Terms, definitions and symbols*

IEC 62108, *Concentrator photovoltaic (CPV) modules and assemblies – Design qualification and type approval*

ISO 9223, *Corrosion of metals and alloys – Corrosivity of atmospheres – Classification, determination and estimation*

ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TS 61836 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

4 Samples

Three identical samples of the model of PV module or assembly of interest shall be subjected to any of the testing sequences included in Figure 1 or Figure 2 for non-concentrator PV or concentrator photovoltaic (CPV) respectively. As the figures indicate one of these samples should be used as a control. The control sample should be used as a check every time the test samples are measured to evaluate the effect of the salt mist test.

In the case of CPV different situations for choosing the sample may occur. For non-field-adjustable focus-point CPV systems or modules, 3 modules are required to complete the testing sequence included in Figure 2. For field-adjustable focus-point CPV systems or assemblies, 3 receivers (including secondary optics sections, if applicable) and 3 primary optics sections are required to complete the testing sequence included in Figure 2. A complete description of the different types and components of CPV modules and assemblies can be found in IEC 62108.

If a full-size sample is too large to fit into the environmental chambers required for the salt mist test then a smaller representative sample may be specially designed and manufactured for this test. The representative sample should be carefully designed so that it can reveal similar failure mechanisms as the full-size one, and the fabrication process of the representative sample should be as identical as possible to the process of the full-size ones. The fact that the test has been made on representative samples and not on the full-size samples shall be reported in the test report under item g), Clause 8.

If the PV module is provided with means for earthing then the earthing connection shall be tested as part of the module.

5 Test summary

After stabilization, tests are performed to characterize the PV module and confirm it is operational prior to the salt mist exposure. After the exposure, specimens are cleaned and allowed to recover. Then this sequence is repeated and the bypass diode functional test is performed.

All tests included in this document and in Figure 1 and Figure 2 are fully described (including purpose, apparatus, procedure and requirements) in the referenced clauses of the IEC Standards listed. Tests included in Figure 1 or Figure 2 shall be performed in the specified order. In the case of CPV if some test procedures included in this document are not applicable to a specific design configuration, the manufacturer and the testing agency shall tailor a comparable test program, based on the principles described in this document. Any changes and deviations shall be recorded and reported in detail, as required in Clause 8, item l).

6 Test sequence

6.1 General

Refer to Figure 1 for the complete test sequence for non-concentrator PV modules and Figure 2 for concentrator photovoltaic (CPV) modules.

6.2 Stabilization

All test samples shall undergo electrical stabilization procedures according to MQT 19 in IEC 61215-2 and any technology specific requirements in the IEC 61215-1-x series.

6.3 Initial and final measurements of non-concentrator modules

For non-concentrator modules, perform the following tests plus any technology specific modifications described in the 61215-1-x series. The reference MQT (Module Qualification Test) and MST (Module Safety Test) numbers correspond to the identification in the relevant document IEC 61215-2 and IEC 61730-2, respectively.

a) MQT 01: Visual inspection
b) MQT 19: Stabilization
c) MQT 02: Maximum power determination
d) MQT 03: Insulation test
e) MST 17: Wet leakage current test
f) MST 13: Continuity test of equipotential bonding

6.4 Initial and final measurements of concentrator photovoltaic (CPV) modules

For concentrator photovoltaic (CPV) modules, perform the following tests according to IEC 62108:

a) 10.1: Visual inspection
b) 10.2: Electrical performance measurement
c) 10.3: Earth path continuity test
d) 10.4: Electrical insulation test
e) 10.5: Wet insulation test

NOTE The reference before each test corresponds to its corresponding subclause in IEC 62108.

6.5 Salt mist test procedure

6.5.1 A minimum of two test specimens shall be exposed to a cyclic salt mist test according to one of the methods, except Test Method 2 or Test Method 3, described in IEC 60068-2-52. Refer to Annex A for guidelines on choosing the appropriate test method.

6.5.2 During testing the face of the PV module normally exposed to solar irradiance shall be inclined 15° to 30° from vertical inside the salt fog chamber. If using separate chambers for the different test conditions, care shall be taken to avoid loss of any salt solution deposits from specimens during transitions. The module may be placed vertically in the humidity chamber used for the humidity storage portion of the test.

6.6 Cleaning and recovery

After the salt mist test all samples shall be washed to remove the adherent salt using running tap water (not artificially pressurised) for a maximum time of 5 min per square metre of area of the sample. Once the washing is finished distilled or demineralized water shall be used to rinse the samples, followed by complete drying at room temperature. The use of a fan to accelerate drying is allowed. Caution is recommended when blowing air to accelerate drying

because excessive air flow can force moisture to penetrate areas it may not normally reach. The temperature of the water used for washing shall not exceed 35 °C. During cleaning or drying, wiping specimens with cloths, gauzes or any other material shall be avoided. After drying, the recovery time shall be minimised and the applicable testing sequence shall be continued as soon as possible to avoid further damage produced by salt depositions.

6.7 Measurements after salt mist

After the salt mist test, cleaning, and recovery the test samples shall be re-tested according to 6.3 for non-concentrator modules or 6.4 for CPV modules.

6.8 Bypass diode test

6.8.1 Purpose

This test is performed following the salt mist exposure only if the module includes bypass or blocking diodes. Its purpose is to verify that the bypass or blocking diode(s) of the test samples remains functional.

6.8.2 Procedure

Perform the test according to MQT 18.1 of IEC 61215-2 except omitting the application of heat to the specimen. For any technology specific requirements refer to the appropriate 61215-1-x series document. The modified test steps are as follows:

a) Electrically short any blocking diodes incorporated to the test sample. Some modules have overlapping bypass diode circuits. In this case it may be necessary to install a jumper cable to ensure that all of the current is flowing through one bypass diode.

b) Determine the rated STC short-circuit current of the test sample from its label or data sheet.

c) Connect the DC power source's positive output to the test sample negative lead, and the DC power source's negative output to the test sample positive lead by using wires of the manufacturer's minimum recommended wire gauge. Follow the manufacturer's recommendations for wire entry into the wiring compartment. With this configuration the current shall pass through the cells in the reverse direction and through the diode(s) in the forward direction.

Apply a current equal to of 1,25 times (± 5 %) the STC short-circuit current of the test sample for a period of 1 h.

6.8.3 Requirements

After the 1 h of current flow check that the bypass diode(s) remains operational according to MQT 18.2 of IEC 61215-2.

7 Requirements

7.1 General

The two PV samples that undergo the testing sequences included in Figure 1 or Figure 2 shall exhibit no mechanical deterioration or corrosion of module components which would significantly impair their function during their intended life.

7.2 Non-concentrator PV modules

All pass fail criteria corresponding to tests MQT 01, MQT 02, MQT 03, MST 17, MST 13 and MQT 18.2 shall be fulfilled according to what is specified in IEC 61215-1, IEC 61215-2, and IEC 61730-2 for these specific tests, taking into account any technology specific requirements or modifications in the IEC 61215-1-x series.

7.3 Concentrator photovoltaic (CPV) modules

7.3.1 No significant amount of water should remain inside the test sample after the salt mist test (the depth of the remaining water should not reach any electrically active parts in any possible position).

7.3.2 After the salt mist test the relative power degradation shall not exceed 7 % if the I-V measurement is under outdoor natural sunlight, or 5 % if the I-V measurement is under solar simulator.

7.3.3 All pass fail criteria corresponding to tests in IEC 62108 10.1, 10.2, 10.3, 10.4 and 10.5 shall be fulfilled according to what is specified for these specific tests.

7.3.4 The bypass diode requirements of 6.8 shall be met.

8 Test report

A test report with measured performance characteristics and test results shall be prepared by the test agency. The test report shall contain the following data:

a) a title;

b) name and address of the test laboratory and location where the tests were carried out;

c) unique identification of the report and of each page, and a clear identification of the purpose of the test report;

d) name and address of client, where appropriate;

e) reference to sampling procedure, where relevant;

f) date of receipt of test items and date(s) of test, where appropriate;

g) description and identification of the items tested. If the test has been made on representative samples and not on the full-size samples this has to be clearly indicated;

h) characterization and condition of the test items;

i) identification of test method used;

j) characteristics of the salt solution used;

k) test method applied for the salt mist test according to IEC 60068-2-52 including test duration;

l) any deviations from, additions to or exclusions from the test method, and any other information relevant to a specific test, such as environmental conditions;

m) measurements, examinations and derived results supported by tables, graphs, sketches and photographs as appropriate including any failures observed;

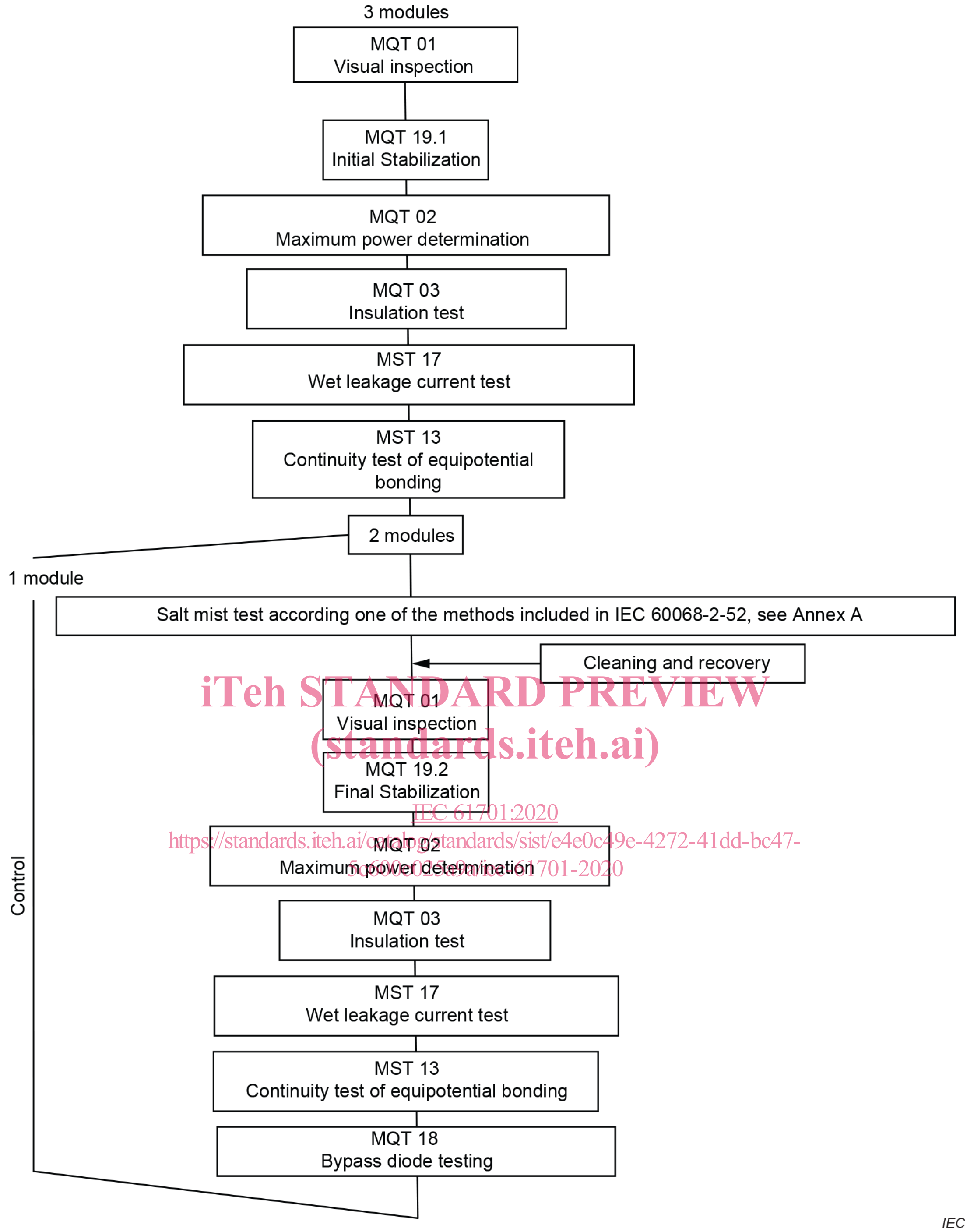
n) a statement of the estimated uncertainty of the test results (where relevant);

o) a signature and title, or equivalent identification of the person(s) accepting responsibility for the content of the report, and the date of issue;

p) where relevant, a statement to the effect that the results relate only to the items tested;

q) a statement that the report shall not be reproduced except in full, without the written approval of the laboratory.

A copy of this report shall be kept by the laboratory and manufacturer for reference purposes.


3 modules
MQT 01
Visual inspection
MQT 19.1
Initial Stabilization
MQT 02
Maximum power determination
MQT 03
Insulation test
MST 17
Wet leakage current test
MST 13
Continuity test of equipotential bonding
2 modules
1 module
Salt mist test according one of the methods included in IEC 60068-2-52, see Annex A
Cleaning and recovery
MQT 01
Visual inspection
MQT 19.2
Final Stabilization
MQT 02
Maximum power determination
MQT 03
Insulation test
MST 17
Wet leakage current test
MST 13
Continuity test of equipotential bonding
MQT 18
Bypass diode testing
Control
IEC

NOTE 1 Tests designated with MQT are taken from IEC 61215-2 and with MST are taken from IEC 61730-2 .

NOTE 2 The control module should be used as a check every time the test modules are measured to evaluate the effect of the salt mist test.

Figure 1 – Salt mist corrosion testing sequence for non-concentrator PV modules