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Edition 1.0 2013-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Photovoltaic (PV) modules – Ammonia corrosion testing

Modules photovoltaïques (PV) – Essai de corrosion à l'ammoniac

IEC 62716:2013

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FOREWORD

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International Standard IEC 62716 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

The text of this standard is based on the following documents:

FDIS	Report on voting
82/769/FDIS	82/778/RVD

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

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

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

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- withdrawn,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

The contents of the corrigendum of May 2014 have been included in this copy.

PHOTOVOLTAIC (PV) MODULES – AMMONIA CORROSION TESTING

1 Scope and object

Photovoltaic (PV) modules are electrical devices intended for continuous outdoor exposure during their lifetime. Highly corrosive wet atmospheres, such as in the environment of stables of agricultural companies, 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 ammonia) causing permanent damages that could impair their functioning and safe operation.

This standard describes test sequences useful to determine the resistance of PV modules to ammonia (NH_3). All tests included in the sequences, except the bypass diode functionality test, are fully described in IEC 61215, IEC 61646 and IEC 61730-2. They are combined in this standard to provide means to evaluate possible faults caused in PV modules when operating under wet atmospheres having high concentration of dissolved ammonia (NH_3).

This standard applies to flat plate PV modules. The structure of this standard follows closely IEC 61701.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61215:2005, *Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval*

IEC 61646:2008, *Thin-film terrestrial photovoltaic (PV) modules – Design qualification and type approval*

IEC 61730-2:2004, *Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

ISO 6988:1985, *Metallic and other non organic coatings – Sulfur dioxide test with general condensation of moisture*

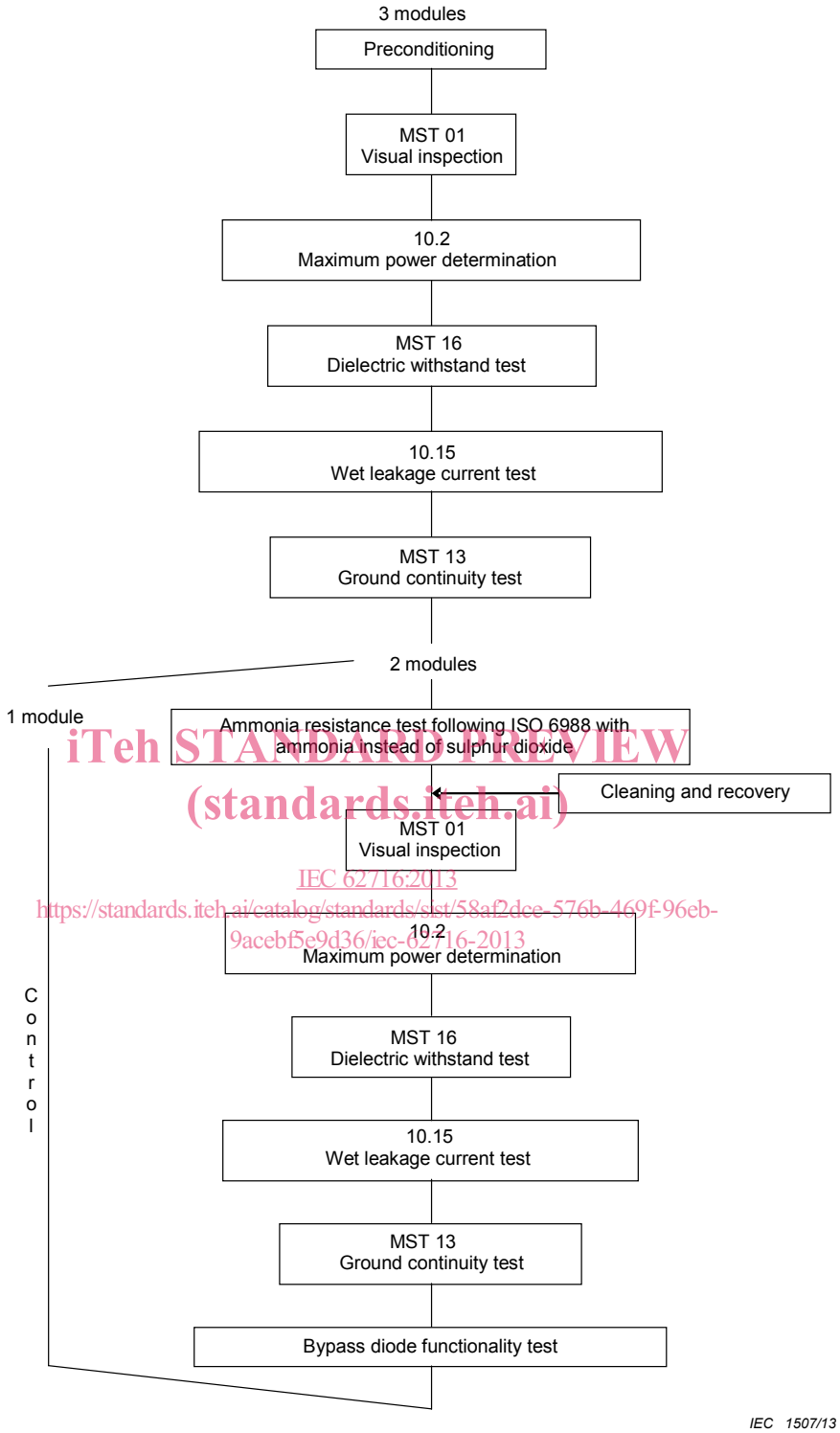
3 Samples

Three identical samples of the model of PV module or assembly of interest shall be subjected to any of the testing sequences included in Figures 1 or 2, depending on the PV technology considered, namely crystalline silicon or thin-film 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 ammonia exposure test.

If a full-size sample is too large to fit into the environmental chambers required for the ammonia exposure 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 has to be indicated and reported in the test report item g), see Clause 11.

If the PV module is provided with means for grounding then they constitute a part of the test sample.

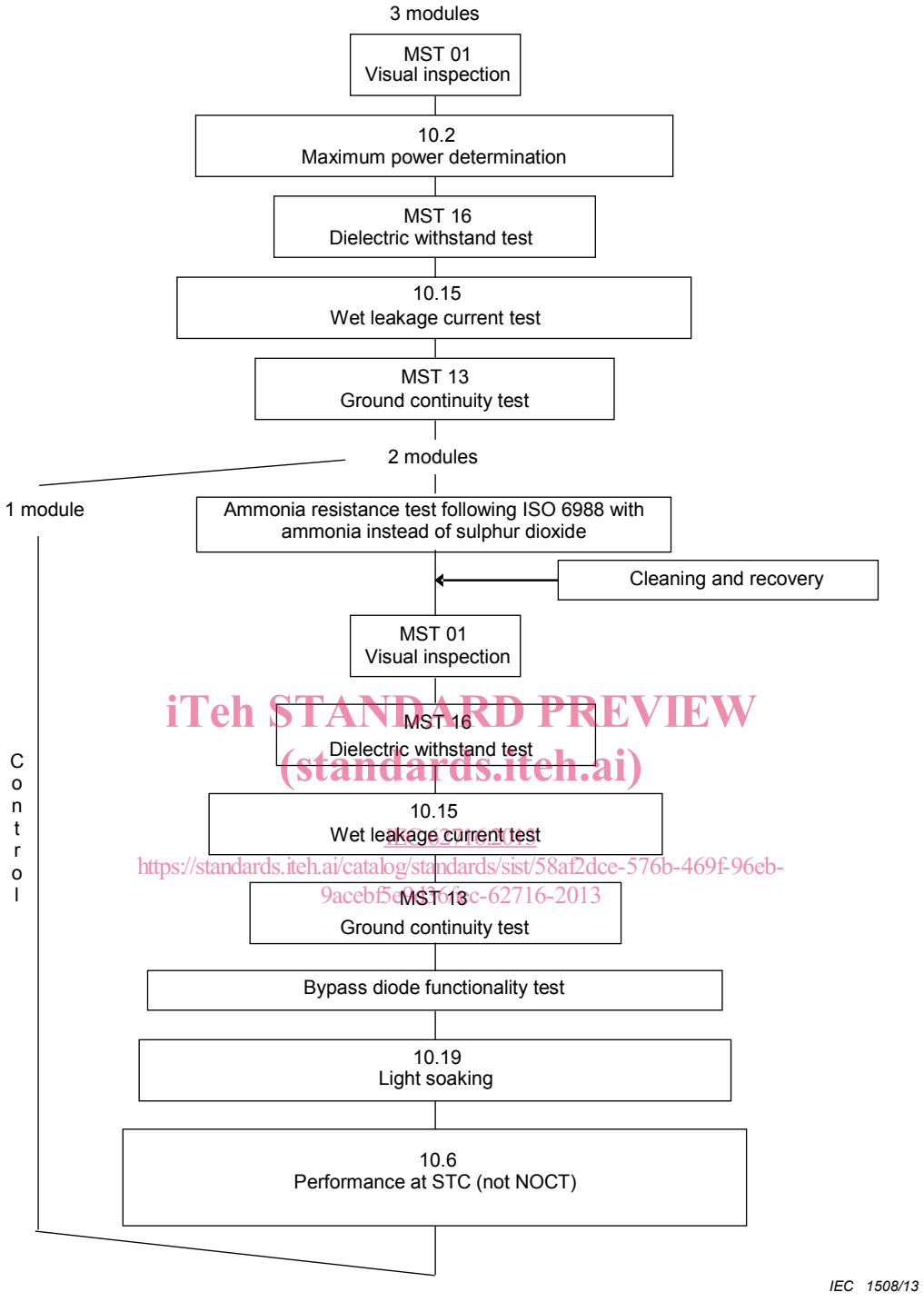
The test results relate only to the sample structure as tested. If a module manufacturer uses several sources for PV module components, additional test samples are required. Samples shall be chosen in such way, that each encapsulation material used and any component forming an outer surface of the module used in the product range is represented.



NOTE 1 Preconditioning and tests 10.2 and 10.15 are taken from IEC 61215:2005. Tests MST 01, MST 13 and MST 16 are taken from IEC 61730-2:2004.

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

Figure 1 – Ammonia resistance test sequence for crystalline PV modules



NOTE 1 Tests 10.2, 10.6, 10.15 and 10.19 are taken from IEC 61646:2008. Tests MST 01, MST 13 and MST 16 are taken from IEC 61730-2:2004.

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

NOTE 3 A maximum power determination can be added after ammonia resistance testing according to test 10.2 of IEC 61646:2008 for diagnostic purposes. Whether light soaking is required is dependend on the kind of thin-film technology tested.

NOTE 4 Test 10.6 is performed as a part of the requirements cooresponding to test 10.19 as described in IEC 61646:2008. For the remaining requirements use test MST 01 instead of 10.1 and MST 16 instead of 10.13.

Figure 2 – Ammonia resistance test sequence for thin-film PV modules

4 Test procedures

4.1 General

All tests included in Figures 1 or 2, except the bypass diode functionality test, are fully described (including purpose, apparatus, procedure and requirements) in the IEC standards from where the specific tests are taken (see notes in the figures). Tests included in Figures 1 or 2 shall be performed in the specified order. Any changes and deviations shall be recorded and reported in details, as required in Clause 11, item l).

4.2 Bypass diode functionality test

4.2.1 Purpose

The purpose of this test is to verify that the bypass diode(s) of the test samples remain(s) functional following the ammonia exposure. In case of modules without bypass diodes this test can be omitted.

4.2.2 Apparatus

a) DC power source capable of applying a current up to 1,25 times the Standard Test Conditions (STC) short-circuit current of the sample under test and means for monitoring the flow of current through the test sample during the test period.

b) Equipment for measuring the voltage drop across the test sample at an accuracy of ± 0,5 % of reading.

c) Equipment for measuring test current at an accuracy of ± 0,5 % of reading.

4.2.3 Procedure

This procedure can be conducted in any ambient within (25 ± 10) °C. During the test the sample shall not be subjected to illumination.

a) Electrically short any blocking diodes incorporated to the test sample.

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

c) Connect the DC power source´s positive output to the test sample negative leads and the DC power source's negative output to the test sample positive leads 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.

   In the case of modules with overlapping bypass diode circuits, it may be necessary to install a jumper cable to assure that all of the current is flowing through one bypass diode.

d) 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.

4.2.4 Requirements

After the 1 h of current flow check that the bypass diode(s) remain(s) operational. A possible method is to again pass a forward current through the diode(s) by passing a reverse current through the cells and then monitor the temperature of the diode(s) with the aid of a thermal IR camera. Diode(s) shall reach thermal equilibrium with the environment after step d) above before applying this procedure. Another option is to shade a solar cell protected by each diode (one per string, step by step) in the PV module and verify the characteristics of the resulting I-V curve (under illumination close to Standard Test Conditions) to check if the bypass diode(s) is (are) working.

5 Preconditioning

All test samples shall be preconditioned with either global or direct normal sunlight (natural or simulated) according to the specifications given in the applicable design qualification and type approval IEC Standard applicable to the PV module technology considered, i.e., IEC 61215:2005 for crystalline silicon and IEC 61646:2008 for thin-film materials. At the time of writing this standard no preconditioning is specified for thin-film technologies in IEC 61646:2008.

6 Initial measurements

6.1 General

The following initial measurements shall be performed on the selected samples depending on the PV module technology being evaluated.

6.2 Crystalline silicon

The test sequence is shown in Figure 1.

– Tests according to IEC 61215:2005:
  a) 10.2: Maximum power determination
  b) 10.15: Wet leakage current test
– Tests according to IEC 61730-2:2004:
  c) MST 01: Visual inspection
  d) MST 13: Ground continuity test
  e) MST 16: Dielectric withstand test

NOTE The reference before each test corresponds to its identification in the relevant IEC standard.

6.3 Thin-film technologies

The test sequence is shown in Figure 2.

– Tests according to IEC 61646:2008:
  a) 10.2: Maximum power determination

     NOTE 1 The only purpose of this test is to verify that the PV module is operational before being subjected to the subsequent tests of the sequence.

  b) 10.15: Wet leakage current test
– Tests according to IEC 61730-2:2004:
  c) MST 01: Visual inspection
  d) MST 13: Ground continuity test
  e) MST 16: Dielectric withstand test

NOTE 2 The reference before each test corresponds to its identification in the relevant IEC standard.

7 Ammonia resistance test procedure

7.1 Testing facility and material

As described in Clause 3 of ISO 6988:1985.

7.2 Test conditions and execution

The test conditions are fixed in Table 1.