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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Salt mist corrosion testing of photovoltaic (PV) modules

Essai de corrosion au brouillard salin des modules photovoltaïques (PV)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SALT MIST CORROSION TESTING OF PHOTOVOLTAIC (PV) MODULES

FOREWORD

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

This second edition cancels and replaces the first edition issued in 1995. 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.

Salt mist test is based on IEC 60068-2-52 rather than IEC 60068-2-11 as in edition 1 since the former Standard is much more widely used in the electronic component field. According to this change the new edition 2 includes a cycling testing sequence that combines in each cycle a salt fog exposure followed by humidity storage under controlled temperature and relative humidity conditions. This testing sequence is more suitable to reflect the corrosion processes that happen in PV modules subjected to permanent or temporary corrosive atmospheres (NaCl). In edition 1 only a salt fog exposure was considered.

Additional tests have also been included to verify the effect of the salt mist test not only in the PV module output but also in some of its components.

Different testing sequences are considered depending on the PV module technology involved: crystalline silicon, thin-film and concentrator photovoltaic (CPV) modules.

A test report clause has also been included.

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

FDIS	Report on voting
82/667/FDIS	82/681/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- withdrawn,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.

SALT MIST CORROSION TESTING OF PHOTOVOLTAIC (PV) MODULES

1 Scope and object

Photovoltaic (PV) modules are electrical devices intended for continuous outdoor exposure during their lifetime. Highly corrosive wet atmospheres, such as marine environments, 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 damages 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 Standard 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, except the bypass diode functionality test, are fully described in IEC 61215, IEC 61646, IEC 62108, IEC 61730-2 and IEC 60068-2-52. 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 salt (NaCl). Depending on the specific nature of the surrounding atmosphere to which the module is exposed in real operation several testing severities can be applied, as defined in IEC 60068-2-52. For example severity (1) is intended to be used for PV modules used in a marine environment, or in close proximity to the sea. Severities (3) to (6) are intended for PV modules operating in locations where there could be a change between salt-laden and dry atmospheres, for examples in places where salt is used to melt ice formations. Severity (2) is not suitable for PV modules as testing conditions are too weak (this severity is originally intended for products exposed to corrosive environments from time to time that are normally protected by an enclosure) and should be avoided when applying this Standard.

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

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

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*

IEC 62108:2007, *Concentrator photovoltaic (CPV) modules and assemblies – Design qualification and type approval*

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

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, 2 or 3, depending on the PV technology considered, namely crystalline silicon, thin-film 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 3. 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 3. 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 has to be indicated and reported in the test report under item g), see Clause 11.

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

4 Test procedures

4.1 General

All tests included in Figures 1, 2 or 3, 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, 2 or 3 shall be performed in the specified order. In the case of CPV if some test procedures included in this Standard are not applicable to a specific design configuration, the manufacturer should discuss this with the testing agency to develop a comparable test program, based on the principles described in this Standard. Any changes and deviations shall be recorded and reported in detail, as required in Clause 11, item l).

4.2 Bypass diode functionality test

4.2.1 Purpose

To verify that the bypass diode(s) of the test samples remains functional following the salt fog exposure.

NOTE If in the test sample there are no bypass diodes or the bypass diodes do not have any metallic parts then this test is 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.