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INTERNATIONAL STANDARD

NORME INTERNATIONALE

AMENDMENT 1
AMENDEMENT 1

Photovoltaic (PV) systems – Requirements for testing, documentation and maintenance – Part 1: Grid connected systems – Documentation, commissioning tests and inspection

Systèmes photovoltaïques (PV) – Exigences pour les essais, la documentation et la maintenance – Partie 1: Systèmes connectés au réseau électrique – Documentation, essais de mise en service et examen

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FOREWORD

This amendment has been prepared by the IEC technical committee 82: Solar photovoltaic energy systems.

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

FDIS	Report on voting
82/1415/FDIS	82/1426/RVD

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

The committee has decided that the contents of this amendment and the base publication will remain unchanged until the stability date indicated on the IEC website 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- withdrawn,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.

2 Normative references

Replace the following standard:

IEC TS 62548:2013, *Photovoltaic (PV) arrays – Design requirements*

By:

IEC 62548:2016, *Photovoltaic (PV) arrays – Design requirements*

Add the following new note after IEC 62548:

NOTE In some countries IEC 60364-7-712 is preferred over IEC 62548. Both standards are expected to provide similar results.

Add the following new normative reference:

IEC 60891:2009, *Photovoltaic devices – Procedures for temperature and irradiance corrections to measured I-V characteristics*

3 Terms and definitions

Add the following new terms:

3.17
string wiring harness
prefabricated cable assembly that aggregates the output of multiple PV string conductors along a single main cable

Note 1 to entry: The harness may or may not include fusing on the individual string conductors. The wiring harness typically does not include a disconnect device in line.

Note 2 to entry: An IEC standard for string wiring harnesses is under development.

3.18
Harness Sub Array
HSA
group of PV strings connected in parallel using a string wiring harness

Note 1 to entry: For the purposes of this document, the HSA shall have a combined $I_{SC\text{-}STC}$ of no greater than 30 A and combine no more than 10 PV strings.

Note 2 to entry: In some subclauses of this document, HSA tests are presented as an alternative to individual string tests. The 30 A and 10 string limits defined herein set the limit where a HSA test is considered a safe and valid alternative to individual string tests.

Note 3 to entry: This note applies to the French language only.

4.9 Test results and commissioning data

Replace the existing text of this subclause by the following new text:

Copies of all test and commissioning data shall be provided. As a minimum, these shall include the results from the verification tests detailed in Clauses 5 to 9 of this document (see also model forms in Annexes A to C).

5 Verification

Replace “IEC TS 62548:2013” *by* “IEC 62548:2016” *throughout this clause*.

5.2.8 DC system – Selection and erection of electrical equipment

e) *Delete the first sentence of the note.*

5.3.3 Test regimes for systems with module level electronics

Add the following new note at end of this subclause:

NOTE Typically I-V curve testing and electroluminescence inspection are not possible for those systems. Module level data can be used to find performance problems on module level instead.

5.3.4 Category 1 test regime – All systems

Replace:

d) String open circuit voltage test.
e) String circuit current test (short circuit or operational).

By:

d) String or HSA open circuit voltage test.

e) String or HSA circuit current test (short circuit or operational).

Delete Note 2.

5.3.5 Category 2 test regime

Replace:

a) String I-V curve test.

By:

a) String or HSA I-V curve test.

6.3 PV string combiner box test

Replace:

While it is possible to do a polarity test with a digital multimeter, when checking a large number of circuits, the appearance of the "-" symbol can be relatively easy to overlook. As an alternative, the following test sequence indicates a reverse connection through a substantially different voltage reading.

By:

Polarity of PV strings may be tested by a digital multimeter between positive and negative, or between one of the poles and ground, and checking that all the measured values are consistently positive or negative.

Sometimes when checking a large number of circuits, the appearance of the "-" symbol can be relatively easy to overlook, so the alternative method detailed below may also be used, and should only be used where the meter being used for tests has a range of at least twice V_{oc}.

6.5.2.1 General

Replace the existing text by the following:

6.5.2.1.1 Overview

The short circuit current of each PV string or HSA should be measured using suitable test apparatus. The making / interruption of string or HSA short circuit currents is potentially hazardous and a suitable test procedure, such as that described in 6.5.2.2, should be followed.

The measured values should be compared with either the value from an adjacent identical string or from a calculated expected value.

In general, the measured value should be within ± 10 % of the expected value. Where the difference is > 10 %, a visual appraisal of the sunlight conditions may be used to consider the

validity of the current readings; the string should also be investigated for any obvious issues such as shading, damage or installation defects.

NOTE The use of an irradiance meter or visual appraisal of the sunlight conditions is included herein solely as a means of determining if the measured current is within the band expected. As noted in 6.5.1, the short circuit current test is intended to detect faults rather than give any indication of system performance. System performance measurements are deemed to be part of a Category 2 test regime and are best achieved by performing an I-V curve test.

6.5.2.1.2 Comparison to calculated value

An expected value can be obtained from the module manufacturer's power curves (selecting the appropriate curve for the irradiation conditions at the time of the test); or calculated from manufacturer's data (normalizing the current at 1 000 W/m^2 to the measured irradiance – see also IEC 60891:2009).

The measured value should typically be within ± 10 % of the calculated value.

6.5.2.1.3 Comparison to adjacent string

For systems with multiple identical strings (strings with same number and type of modules), measurements of currents in individual strings can be compared between each other.

Where there are stable irradiance conditions, the currents in the identical strings should be the same (typically within ± 10 % of the average string current).

For non-stable irradiance, where the irradiance levels change rapidly due to clouds, etc., it is possible that variations between expected levels and between strings will vary more than 10 %. Under such conditions, the following methods may be adopted:

- Testing may be delayed. When irradiance conditions are stable, either short circuit current testing may be performed on the strings again, or alternatively operational testing as per 6.5.3.
- Tests may be done using multiple meters, with one meter on a reference string. The two readings will be taken simultaneously, and would be expected to be within ± 10 % of each other.

6.5.3 PV String – Operational test

Replace the existing text by the following:

With the system switched on and in normal operation mode (inverters maximum power point tracking), the current from each PV string or HSA should be measured. This is done using a suitable clip-on ammeter placed around the string cable, or by using the ammeters/current transformers integrated into manufacturer string combiner boxes or inverters.

The measured values should be compared with either the values from an adjacent identical string as per 6.5.2.1.3 or from a calculated expected value, as per 6.5.2.1.2.

For non-stable irradiance conditions, the following methods may be adopted:

- Testing may be delayed.
- Tests may be done using multiple meters, with one meter on a reference string.
- An irradiance meter reading may be used to adjust the current readings.
- A specialized PV test meter (with irradiance measurement) may be used.
- An I-V curve test may be performed.

NOTE I-V curve testing is described in 7.2.

Table 2 – Minimum values of insulation resistance – PV arrays up to 10 kWp

In the first column, replace:

> 500

By:

500 to 1 000.

Add the following new line at the end of the table:

> 1 000	1 500	1

6.7.3.3 Insulation resistance – PV arrays above 10 kWp

Method A

Replace:

- combined strings, where the total combined capacity is no more than 10 kWp.

By:

- combined strings.

Method B

Replace the first paragraph by the following:

Method B is an alternative that allows for testing of an entire array (or sub-array). Arrays (or sub-arrays) may pass the requirements of Table 2; hence Method B provides a shortcut (testing the entire array at the outset). If testing fails using Method B, then testing on subsections should be performed using Method A.

7.2.2 I-V curve measurement of V_{oc} and I_{sc}

In the second paragraph, replace:

The string under test should be isolated and connected to the I-V curve test device.

By:

The string or HSA under test should be isolated and connected to the I-V curve test device.

7.2.3 I-V curve measurement – Array performance

Modify the title of this subclause as follows:

I-V curve measurement – Array performance check

Replace the existing second paragraph by the following:

PV string or HSA and array performance measurements shall be performed at stable irradiance conditions of at least 400 W/m^2 as measured in the plane of the array.

In note 1, add the following sentence:

For an assessment of a PV system's performance, see IEC TS 61724-2:2016.

In note 2, replace the first sentence by the following:

NOTE 2 The maximum power, current and voltage of a PV string or HSA are directly affected by irradiance and temperature, and are indirectly affected by any changes in the shape of the I-V curve.

Replace:

- The string under test should be isolated and connected to the I-V curve test device.

By:

- The circuit(s) under test should be isolated and connected to the I-V curve test device.

7.2.4 I-V curve measurement – Identification of module / array defects or shading issues

Replace the last sentence of the penultimate paragraph by the following:

Curves should be the same (typically within 10 % between maximum and minimum values for stable irradiance and temperature conditions).

NOTE Accuracy of measuring equipment, variations in test conditions and module power tolerance are of importance when assessing deviations.

7.3.1 General

Add, at the end of the subclause, the following new note 2, and renumber the existing note as note 1:

NOTE 2 See also IEC TS 62446-3:2017.

Annex B (informative) Model inspection report

Replace "IEC TS 62548:2013" *by* "IEC 62548:2016" *throughout this annex*.