

**Design qualification and type approval
of PV modules
acc. to IEC 61215:2005 / IEC 61646:2008**

**TÜV Rheinland Immissionsschutz und Energiesysteme GmbH
Renewable Energies**

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Introduction, Overview

The product certification of crystalline PV modules for open-air climates is based on international standards from the series IEC 68 “Environmental Test Procedures”.

Considerable preliminary work on the definition of special test procedures for PV modules was rendered by the Research Centre of the European Commission in Ispra (Italy). The test specifications no. 503, “Terrestrial Photovoltaic (PV) Modules with Crystalline Solar Cells – Design qualification and Type Approval” developed in Ispra, were adopted in 1993 as the standard IEC 1215 of the International Electro technical Commission (now IEC 61215) and in 1995 ratified as the European standard EN 61215. In April 2005 a 2nd edition to IEC 61215 was published, which contains some changes in testing conditions and pass criteria.

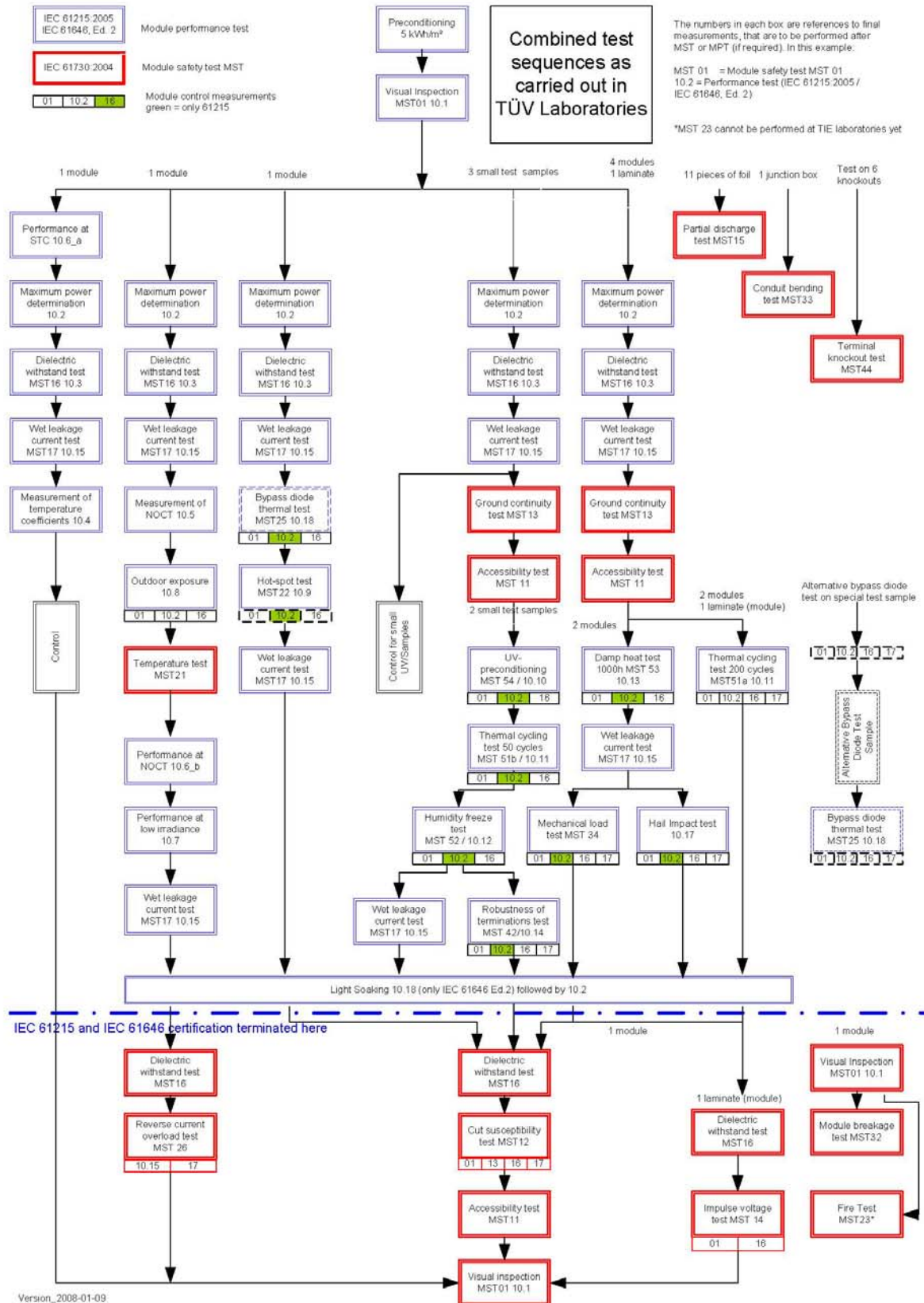
IEC 61215, comprises the examination of all parameters which are responsible for the ageing of PV modules and describes the various qualification tests on the basis of the artificial load of the materials. In particular one differs between radiation testing, thermal testing and mechanical testing.

In 1996 a comparable standard was developed for photovoltaic thin-film modules. In 2008 a second edition to this standard, namely IEC 61646 : ‘Thin-film terrestrial photovoltaic (PV) modules – Design qualification and type approval’, was released, which addresses new developments in the thin-film technologies and shall reduce testing efforts. The standard is in many aspects identical to IEC 61215. The main difference between the two standards lays in the additional test procedures to adapt to the special properties of thin-film technologies. These additional tests take the degradation behaviour of thin-film modules due to irradiance exposure into account.

Both standards list UV preconditioning of test samples. As a further option a UV exposure test was issued in 1998 and can be utilized alternatively. IEC 61345:1998 ‘UV test for photovoltaic (PV) modules’ stipulates higher minimum UV_A and UV_B doses that the modules should be exposed to.

Description of test procedure

The following diagram shows the test sequences of both IEC 61215 and IEC 61646.



Overview of IEC 61215 / IEC 61646 tests

Code	Qualification Test	Test Conditions
10.1	Visual Inspection	according defined inspection list
10.2	Maximum Power Determination	measurement according to IEC 60904
10.3	Insulation Test	1000 VDC + twice the open circuit voltage of the system at STC for 1 min, isolation resistance * module area > 40 MΩ·m ² at 500 VDC
10.4	Measurement of Temperature Coefficients	Determination of the temperature coefficients of short circuit current, open circuit voltage and maximum power in a 30°C interval
10.5	Measurement of NOCT	total solar irradiance = 800 W/m ² wind speed = 1 m/s
10.6	Performance at STC and NOCT	cell temperature = NOCT / 25°C irradiance = 800 W/m ² / 1000 E/m ² measurement according to IEC 60904
10.7	Performance at low Irradiance	cell temperature = 25°C irradiance = 200 W/m ² measurement according to IEC 60904
10.8	Outdoor Exposure Test	60 kWh/m ² solar irradiation
10.9	Hot-Spot Endurance Test	5 hour exposure to > 700 W/m ² irradiance in worst-case hot-spot condition
10.10	UV-preconditioning test	15 kWh/m ² UV-radiation (280 - 385 nm) with 5 kWh/m ² UV-radiation (280 - 320 nm) at 60°C module temperature
10.10*	UV-Exposure according IEC 61345	Min.15 kWh/m ² UV-radiation (280 - 400 nm) with 7.5 kWh/m ² UV-radiation (280 - 320 nm) at 60°C module temperature
10.11	Thermal Cycling	50 and 200 cycles -40°C to +85°C
10.12	Humidity Freeze Test	10 cycles -40°C to +85°C, 85% RH
10.13	Damp Heat	1000 h at +85°C, 85% RH
10.14	Robustness of Terminations	As in IEC 60068-2-21
10.15	Wet Leakage Test	Evaluation of insulation of the module under wet conditions
10.16	Mechanical Load Test	Three cycles of 2400 Pa uniform load, applied for 1 h to front and back surfaces in turn
10.17	Hail Test	25 mm diameter ice ball at 23 m/s, directed at 11 impact locations
10.18	Bypass diode thermal test	Asses adequacy of thermal design of by-pass diodes at a current of 1.25 x I _{sc} running through the diodes at module temperature of 75°C
10.19**	Light soaking	Light exposure of cycles of at least 43 kWh/m ² and module temperature of 50°C ± 10 °C, until P _{max} is stable within 2 %

* Tests can alternatively be used

** Tests only relevant for IEC 61646 qualification

Pass criteria

A module design shall be judged to have passed the qualification tests, and therefore to be IEC type approved, if each sample meets the following criteria:

- The degradation of the maximum power output at standard test conditions (STC) does not exceed 5% after each test nor 8 % after each test sequence;
- The requirements of tests 10.3 (and 10.20) are met;
- No major visible damage (broken, cracked, torn, bent or misaligned external surfaces; cracks in a solar cell which could remove a portion larger than 10% of its area; bubbles or delaminations; loss of mechanical integrity
- No sample has exhibited any open circuit or ground fault during the tests;
- For IEC 61646 only: the measured maximum output power after final light-soaking shall not be less than 90% of the minimum value specified by the manufacturer

Summary

The test certificate corresponding to IEC 61215 / IEC 61646 has gained acceptance in the past few years as the quality symbol for PV modules. Nowadays it is required for most national and international funding programs.

An IEC 61215 / IEC 61646 test certificate always refers to the module construction type which has been subjected to the tests. Transferral is only permissible to modules of the same construction type which fulfil the following criteria:

- all materials and module components used are identical
- in the cell connection the same number of less cells are bridged by a bypass-diode.
- the module size and the rated output power do not exceed +10 % of the module type tested.

All PV modules which fulfil these requirements are combined into one PV module type family.

On the basis of the IEC 61215 / IEC 61646 qualification of a PV-module type family, the certificate can be extended to a new module design type through the repetition of certain qualification tests.