

Development of a New Standard for Transport Simulation on Complete PV-Module shipping units in Combination with Thermo-Mechanical Stress

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In the IEC standards for type approval testing of photovoltaic modules IEC 61215 and IEC 61646 it is noticeable, that mechanical load testing (clause 10.16) is only considering static loads. To estimate and characterize also the performance and lifetime behavior of PV modules in regard to dynamic loads, additional tests need to be carried out under different load parameters. A variety of mechanical stresses has to be expected during the life-time of a PV module. The stresses are caused by vibration e.g. during transportation, by wind and from thermo-mechanical loads. Since different scientific work has been published by several institutes and companies dealing with the examination of PV modules under the influences of transport impacts, a joint sub group within Working Group 2 of the Technical Committee of IEC (IEC TC82/WG2) started to elaborate a draft standard for these relevant product-specific issues.

Approach

- PV modules are generally exposed to different kinds of mechanical and thermo-mechanical impacts in nature (wind, humidity, temperatures, snow etc.)
- In general mechanical loads influence the properties and quality of the solar cells, encapsulation, conductors, glass, frames, etc.
- The standard draft is designed so that its test sequence can coordinate with those of IEC 61215 or IEC 61646
- The standard draft shall describe methods for the simulation of transportation of stacks of modules and describe subsequent environmental tests; it is not part of the type approval testing

Therefore, the following standard draft focuses on vibration tests, shock tests and subsequent environmental stress testing



Figure 1 & 2: A complete shipping unit exposed to transport-like vibrations and handling induced shocks (rotational flat drop test)

Test Item

It is recommended to use regular shipping units as marketed by the manufacturer.

A minimum of 10 modules shall be included in the shipping unit. B or C grade modules or module dummies can be used to fill the stack.

The subsequent environmental tests are performed on selected modules (see figure 3 – test sequence)

Transport Simulation

The state of the art test method for transport simulation is based on a broadband random noise acceleration (see PSD diagram).

To achieve a broadly accepted standard the applied test profile is not fixed to one special test profile. But for comparability reasons some requirements are needed:

- Minimum Frequency range: 5 – 200 Hz
- Minimum Test severity (between 5 – 200 Hz): 0,49 g_{RMS}
- Minimum Test duration: 180 minutes
 - Main reference: ASTM D 4169

For the reproduction of typical handling induced stress, the complete shipping unit will be exposed to shocks and rotational flat drop tests.

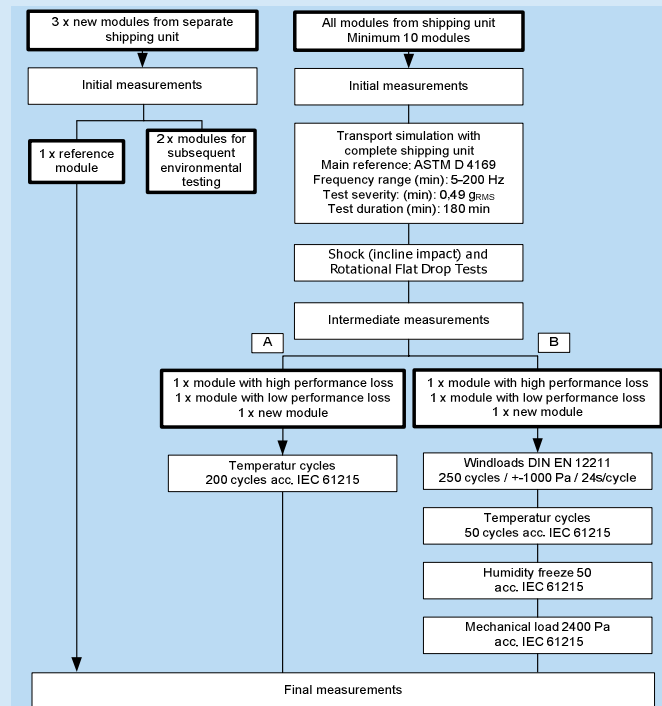


Figure 3: Test plan for transport simulation on complete shipping units and further single module tests

Environmental Tests

Six selected modules will be exposed to two different test sequences (A & B).

Path A can be integrated into the IEC 61215 certification process of a PV module type family.

Path B is a combination of thermo-mechanical stresses which represent different kinds of mechanical and thermo-mechanical impacts in nature.

Results

- This draft shall guide and support the manufacturer of PV modules to assess the risk of impacts on shipping goods and to evaluate the applied packing concept.
- Through the standardization a comparability and quality estimation of packaging is given

Further Tasks

An extended approach shall be realized in a separate part to the future standard (Part 2: Rough handling of individual PV modules). Part 2 shall support installers as a guideline and help manufacturers getting a 'feeling' about the risk for their modules.

Previously performed tests revealed that in handling or mounting situations defects occur on cell level. These may influence relevant safety aspects in a long-term perspective.

Transport task group members : NREL, Westpack, VDZ, TÜV Rheinland