



Mini Cube (Accelerated Life Testing Lab) Thermal cycles on photovoltaic modules

The test in a nutshell



Test duration
(days / months)



Temperature
range

terraXcube

terraXcube is Eurac Research's extreme climate simulation centre at the NOI Techpark in Bolzano, South Tyrol, Italy. Within its chambers, even the most extreme of all our Planet's environmental conditions can be created. By combining hypobaric and altitude technology with state-of-the-art environmental simulation, we aim to investigate the effects of extreme climate conditions on humans, ecological processes and industrial products.

The climate chambers differ in size and equipment and can accommodate people, plants and other living organisms for up to extended periods and have the space to accommodate large machines and products.

Each day our team breaks new ground with scientists and industry partners and prepares the path to gain discoveries.

Test description

A photovoltaic module is composed of several components: photovoltaic cells, glass, metal frame, metal strings, sheets of plastic materials, all with a specific coefficient of thermal expansion. Continuous changes in temperature over the course of a day or season can therefore, create stresses and strains in the materials as well as between the components of a module installed in a photovoltaic system in the long term. This can lead to visual defects and a deterioration in energy performance. The test investigates the ability of a photovoltaic module to withstand long-term thermal stress due to repeated and sudden changes in temperature.

A group of up to four photovoltaic modules is tested according to the IEC 61215 standard (thermal cycling test).

The photovoltaic modules are delivered to the technicians and placed in a support structure inside the Mini Cube (Accelerated Life Testing Lab) climate chamber used by Eurac Research's Institute for Renewable Energy. Once temperature sensors are installed, the device is connected to a DC generator. Finally, the data acquisition system is configured and the climate cycles are programmed.

The modules are brought to a temperature of -40°C with a predefined ramp, and after reaching thermal equilibrium, they are heated up to a temperature of $+85^{\circ}\text{C}$. In this last part of the thermal ramp, the modules are supplied with a defined value of direct current. Once thermal equilibrium has been reached, they are cooled down to -40°C and the cycle is repeated. Each cycle has a total duration of about 5 hours, which is then repeated 200 times unless a different number has been agreed upon with the customer.

The test is a visual and performance check of the photovoltaic modules, which can be carried out at intervals of cycles priorly arranged with the customer, or at the end of the series of cycles. The visual check consists of observing the occurrence of visual defects, such as broken front glass, frame deformations or delamination phenomena. The performance check involves the measurement of the characteristic curve at standard conditions of 1000 W/m^2 and 25°C , and will be supported by the ISO 17025 accredited laboratory "Solare-PV" (Accredia, LAB N° 1785L), using the solar simulator managed by the Eurac Research Institute for Renewable Energies. This measurement will determine the degradation of the electrical characteristics of the module, primarily of the power, during thermal cycles.

Upon customer request, an electroluminescence test can also be carried out. This test can detect defects in the module that are not visible to the naked eye, such as fractures in the photovoltaic cells or breaks in the metal connections between cells.

In the Mini Cube (Accelerated Life Testing Lab) it is possible to carry out other long-term climatic tests on photovoltaic modules, such as:

- Humidity freeze tests, to test the ability of the photovoltaic module to withstand hot-humid environments, followed by sub-zero temperatures.
- Damp heat tests, to test the ability of a photovoltaic module to withstand long-term moisture penetration.

Mini Cube (Accelerated Life Testing Lab) - General Characteristics and Environment Control

Internal dimensions	1.30 m x 1.52 m x 2.20 m (L x W x H)
Load Capacity	Photovoltaic modules with a total weight of up to 240 kg
Temperature Range <small>According to IEC 60068-3-5</small>	-40...+90°C (variability $\pm 1^\circ\text{C}$ in time $\pm 2^\circ\text{C}$ in space)
Temperature Rate of Change <small>According to IEC 60068-3-5</small>	1.7°C/min (-40...+85°C), 1.7°C/min (+85...-0°C), 1°C/min (+0...-40°C)

Other Features

Direct Current Supply	2 X supply channels 600 W each + 2 X supply channels 420 W each
Data-acquisition equipment	
Network connection	Gigabit-Ethernet (1000BaseT) PoE, Wi-Fi