



**TESTING AND MEASURING EQUIPMENT/ALLOWED SUBCONTRACTING**

**PHOTOVOLTAIC (PV) MODULE SAFETY QUALIFICATION –  
Part 2: Requirements for testing  
IEC 61730-2:2016**

R = Required by Lab  
S = May be subcontracted  
SPTL = Specialized Facility

Clause	Testing	Testing / measuring equipment / material needed	Subcontracting
10.2	Visual inspection (MST 01)	<ul style="list-style-type: none"> <li>- Lamp: Illumination &gt;1000lux</li> <li>- Camera</li> <li>- Vernier calliper, measuring tape</li> </ul>	R
10.3	Performance at STC (MST 02)	<ul style="list-style-type: none"> <li>For Performance at STC</li> <li>- All equipment for 10.3</li> <li>- Means to measure temperature with an accuracy of +/-1°C and repeatability of +/-0.5°C</li> <li>- Equipment to cool/heat a module to STC</li> </ul>	R
10.4	Maximum power determination (MST 03)	<ul style="list-style-type: none"> <li>- Radiant source (natural sunlight or a solar simulator class BBA or better in accordance with IEC 60904-9)</li> <li>- PV reference device in accordance with IEC 60904-2</li> <li>- Means to measure spectral responsivity of the module according to IEC 60904-8</li> <li>- Means to measure spectral distribution of the radiant source</li> <li>- Suitable mount for supporting module and the reference device</li> <li>- Means to measure temperature with an accuracy of +/-1°C and repeatability of +/-0.5°C</li> <li>- Apparatus for measuring an I-V curve in accordance with IEC 60904-1</li> </ul>	R
10.5	Insulation thickness test (MST 04)	<ul style="list-style-type: none"> <li>- Means to measure the thickness of the individual layers separating the electric circuitry from the outer surface in a measurement uncertainty not greater than ±10 % including reproducibility.</li> </ul>	S

**TESTING AND MEASURING EQUIPMENT/ALLOWED SUBCONTRACTING**

**PHOTOVOLTAIC (PV) MODULE SAFETY QUALIFICATION –  
Part 2: Requirements for testing  
IEC 61730-2:2016**

Clause	Testing	Testing / measuring equipment / material needed	Subcontracting
10.6	Durability of markings (MST 05)	<ul style="list-style-type: none"> <li>- The petroleum spirits to be used for the test is aliphatic solvent hexane having a maximum aromatics content of 0,1 % by volume, a kauributenol value of 29, an initial boiling point of approximately 65 °C, a dry point of approximately 69 °C and a mass per unit volume of approximately 0,7 kg/l.</li> <li>- Cloth</li> </ul>	R
10.7	Sharp edge test (MST 06)	<ul style="list-style-type: none"> <li>- Suitable sharp edge tester</li> <li>- Alternatively a sharp edge test described in ISO 8124-1 can be performed to confirm compliance.</li> </ul>	R
10.8	Bypass diode functionality test (MST 07)	<p>Test equipment shall be either of the equipment of Method A or Method B.</p> <p>Method A</p> <ul style="list-style-type: none"> <li>- Means for measuring current-voltage curve within 1 s; e.g. IV-curve tracer.</li> <li>- Accuracy of the voltage and current measurement shall be at least 1 % of reading.</li> </ul> <p>Method B</p> <ul style="list-style-type: none"> <li>- All equipment for 10.3</li> </ul>	R
10.9	Accessibility test (MST 11)	<ul style="list-style-type: none"> <li>- A cylindrical test fixture Type 11 according to Figure 7 of IEC 61032:1997.</li> <li>- An ohmmeter or continuity tester.</li> <li>- Means for applying the test fixture with force of 10 N.</li> </ul>	R

**TESTING AND MEASURING EQUIPMENT/ALLOWED SUBCONTRACTING**

**PHOTOVOLTAIC (PV) MODULE SAFETY QUALIFICATION –  
Part 2: Requirements for testing  
IEC 61730-2:2016**

Clause	Testing	Testing / measuring equipment / material needed	Subcontracting
10.10	Cut susceptibility test (MST 12)	- A test fixture as shown in Figure 3 61730-2, designed to draw a defined shaped object over the surface of the PV module with an applied force of $8,9 \text{ N} \pm 0,5 \text{ N}$ . The defined shaped object shall be a $0,64 \text{ mm} \pm 0,05 \text{ mm}$ thick hardened steel blade sufficiently rigid as not to bend sideways during the test. The tip shall have a top angle of $90^\circ \pm 2^\circ$ and shall be rounded with a radius of $0,115 \text{ mm} \pm 0,025 \text{ mm}$ .	R
10.11	Continuity test of equipotential bonding (MST 13)	- A constant current supply capable of producing a current that is 2,5 times the maximum overcurrent protection rating of the PV module under test. - A suitable voltmeter.	R
10.12	Impulse voltage test (MST 14)	- The test equipment and procedure shall comply with IEC 60060-1, see Figure 4. Due to the variable and comparably high capacity of many samples compensation measures may be applicable to fulfil the required waveform tolerances.	SPTL
10.13	Insulation test (MST 16)	- DC voltage source, with current limitation, capable of applying the following levels: The maximum test voltage $U_{\text{Test}}$ shall be equal to 2 000 V plus four times the maximum system voltage for Class II and equal to 1 000 V plus two times the maximum system voltage for Class 0. For Class III the test voltage is 500 V. Cemented joints within PV modules shall be tested with an increased test voltage. The following applies: $U_{\text{Test}}(\text{cemented joint}) = U_{\text{Test}} \cdot 1.35$ as required by IEC 61730-1. All non-cemented joints shall be tested with normal $U_{\text{Test}}$ . - Insulation resistance meter	R



**TESTING AND MEASURING EQUIPMENT/ALLOWED SUBCONTRACTING**

**PHOTOVOLTAIC (PV) MODULE SAFETY QUALIFICATION –  
Part 2: Requirements for testing  
IEC 61730-2:2016**

Clause	Testing	Testing / measuring equipment / material needed	Subcontracting
10.14	Wet leakage current test (MST 17)	<ul style="list-style-type: none"><li>- Shallow trough or tank</li><li>- Spray equipment</li><li>- Electrical conductivity meter</li><li>- Means to measure temperature</li><li>- Insulation resistance meter</li><li>- DC voltage source, with current limitation, capable of applying a test voltage 500 V or maximum rated system voltage of the module</li><li>- Cemented joints within PV modules shall be tested with an increased test voltage. The following applies: <math>U_{Test}(\text{cemented joint}) = U_{Test} \cdot 1.35</math> as required by IEC 61730-1. All non-cemented joints shall be tested with normal <math>U_{Test}</math>.</li></ul>	R

**TESTING AND MEASURING EQUIPMENT/ALLOWED SUBCONTRACTING**

**PHOTOVOLTAIC (PV) MODULE SAFETY QUALIFICATION –  
Part 2: Requirements for testing  
IEC 61730-2:2016**

Clause	Testing	Testing / measuring equipment / material needed	Subcontracting
10.15	Temperature test (MST 21)	<p>Test equipment shall be either of the equipment of Outdoor method or Solar simulator method.</p> <p><b>Outdoor method</b></p> <ul style="list-style-type: none"> <li>- A black painted platform constructed of a suitable wooden plate that has sufficient mechanical strength to avoid warping under temperature influence. Behind the board a thermal insulation with a U-value of less than 0,5 W/(m<sup>2</sup> K) shall be placed.</li> <li>- A pyranometer mounted in the plane of the structure within 30 cm of the test PV module.</li> <li>- Instruments to measure wind speed down to 0,25 m/s installed approximately 0,7 m above the top of the platform.</li> <li>- An environmental temperature sensor, with a time constant equal to, or less than, that of the PV module, installed in a shaded enclosure with good ventilation. The sensor shall be placed left or right of the platform so that no thermal interference can occur.</li> <li>- A temperature monitoring system capable of measuring PV module component temperatures with accuracy of <math>\pm 2</math> K.</li> <li>- A data acquisition system capable of recording the parameters within an interval of no more than 5 s.</li> <li>- Maximum power point tracking device or a resistive load sized such that at STC the PV module operates near the maximum power point</li> </ul>	R



**TESTING AND MEASURING EQUIPMENT/ALLOWED SUBCONTRACTING**

**PHOTOVOLTAIC (PV) MODULE SAFETY QUALIFICATION –  
Part 2: Requirements for testing  
IEC 61730-2:2016**

Clause	Testing	Testing / measuring equipment / material needed	Subcontracting
		<p><b>Solar simulator method</b></p> <ul style="list-style-type: none"> <li>- A continuous source sun simulator class BBC or better according to IEC 60904-9 shining from top to the horizontally mounted test platform with an average irradiance of 1 000 W/m<sup>2</sup> in the area of testing (PV module area plus 20 cm surrounding the PV module).</li> <li>- Reference cell to measure the irradiance in the test plane.</li> <li>- Cold sky to avoid heat from the light source influencing the test results.</li> <li>- A black painted test platform parallel to the light source which has sufficient mechanical strength to avoid warping under temperature influence.</li> <li>- Means for mounting the test PV module directly flat to the test platform.</li> <li>- A handheld anemometer to ensure a wind speed during the test of &lt; 0,25 m/s; typically the wind speed will be close to 0 m/s during the test.</li> <li>- An air temperature sensor, with a time constant equal to, or less than, that of the PV module, installed in a shaded enclosure with good ventilation. The sensor shall be placed left or right of the platform so that no thermal interference can occur.</li> <li>- A temperature monitoring system capable of measuring PV module component temperatures with an accuracy of ± 2 °C.</li> <li>- A data acquisition system capable of recording the parameters within an interval of no more than 5 s.</li> <li>- Maximum power point tracking device or a resistive load sized such that at STC the PV module operates near the maximum power point.</li> </ul>	R

**TESTING AND MEASURING EQUIPMENT/ALLOWED SUBCONTRACTING**

**PHOTOVOLTAIC (PV) MODULE SAFETY QUALIFICATION –  
Part 2: Requirements for testing  
IEC 61730-2:2016**

Clause	Testing	Testing / measuring equipment / material needed	Subcontracting
10.16	Hot-spot endurance test (MST 22)	<ul style="list-style-type: none"> <li>- Radiant source (natural sunlight or a steady-state solar simulator class BBB or better in accordance with IEC 60904-9 (irradiance 1000 +/- 100 W/m<sup>2</sup>))</li> <li>- Radiant source in determining the worst case shadowing condition for monolithically integrated (MLI) thin film technologies. (ex. pulsed or non-continuous solar simulator class BBB or better in accordance with IEC 60904-9 (irradiance 800-1000W/m<sup>2</sup>))</li> <li>- Module I-V curve tracer</li> <li>- Equipment for current measurement</li> <li>- Equipment to record irradiance levels, integrated irradiance and ambient temperature</li> <li>- Opaque covers:</li> <li>- Temperature detector</li> <li>- Means to cool the module to temperature 50°C during the test</li> </ul>	R
10.17	Fire test (MST 23)	<ul style="list-style-type: none"> <li>- Fire resistance requirements for a PV module intended for building applications are defined in local or national building codes. (see Annex B within IEC 61730-2 ed.2.)</li> </ul>	S
10.18	Ignitability test (MST 24)	<ul style="list-style-type: none"> <li>- Test cabinet acc. to 4.2 of ISO 11925-2:2010</li> <li>- Burner acc. to 4.3 of ISO 11925-2:2010</li> <li>- Specimen holder acc. to 4.5 and 4.6 of ISO 11925-2:2010</li> <li>- Mean to condition specimens at a temperature of 23 °C ± 2 °C and a relative humidity of 50 % ± 5 % for a minimum period of 48 h.</li> </ul>	S

**TESTING AND MEASURING EQUIPMENT/ALLOWED SUBCONTRACTING**

**PHOTOVOLTAIC (PV) MODULE SAFETY QUALIFICATION –  
Part 2: Requirements for testing  
IEC 61730-2:2016**

Clause	Testing	Testing / measuring equipment / material needed	Subcontracting
10.19	Bypass diode thermal testing (MST 25)	<ul style="list-style-type: none"> <li>- Apparatus to heat the module to temperature 30°C +/- 2°C, 50°C +/- 2°C, 70°C +/- 2°C and 90°C +/- 2°C.</li> <li>- Means for applying a pulse current equal to the STC short-circuit current with a pulse width not exceeding 1 ms.</li> <li>- Means for measuring the junction voltage of the bypass diodes to an accuracy of 2 %</li> <li>- Means for monitoring the flow of current through the module</li> <li>- Apparatus to heat the module to temperature 75°C +/- 5°C</li> <li>- Equipment for applying a current to 1,25 times the short-circuit current of the module as measured at STC</li> </ul>	R
10.20	Reverse Current overload test (MST 26)	<ul style="list-style-type: none"> <li>- Support plate has thermal conductivity not higher than 0,5 W/m2K</li> <li>- White single layer tissue paper should conform to 12 g/m<sup>2</sup> – 30 g/m<sup>2</sup> (ISO 4046-4).</li> <li>- DC power supply</li> </ul>	R
10.21	Module breakage test (MST 32)	<ul style="list-style-type: none"> <li>- The impactor shall be a bag made of a suitable material and capable to be filled to the required weight using a suitable filling material (e.g. steel balls or pellets). The exterior of the bag shall be wrapped with tape as shown in the Figure 5 in order to avoid uneven surfaces like stitching. When filled, the impactor bag shall have dimensions as described in Figure 5 and a weight of 45,5 kg ± 0,5 kg. The ratio of widest diameter to height shall be between 1:1,5 to 1:1,4.</li> <li>- A test frame similar to that shown in Figure 6 and Figure 7 shall be provided to minimise movement and deflection during testing. The structure framing and bracing shall be steel channel (approximately 100 mm x 200 mm or larger) and shall have a minimum moment of inertia of approximately 187 cm<sup>4</sup>. The frame shall be welded or securely bolted at the corners to minimize twisting during impact. It shall also be bolted to the floor to prevent movement during impact testing.</li> </ul>	R



**TESTING AND MEASURING EQUIPMENT/ALLOWED SUBCONTRACTING**

**PHOTOVOLTAIC (PV) MODULE SAFETY QUALIFICATION –  
Part 2: Requirements for testing  
IEC 61730-2:2016**

Clause	Testing	Testing / measuring equipment / material needed	Subcontracting
10.22	Screw connections test (MST 33)	<ul style="list-style-type: none"> <li>- Suitable test screwdriver or spanner, applying a torque as shown in Table 7 within IEC 61730-2:2016</li> <li>- Means for replicating maximum normalized temperature determined by MST 21 such as climatic chamber.</li> </ul>	R
10.23	Static mechanical load test (MST 34)	<ul style="list-style-type: none"> <li>- Rigid test base which enables the modules to be mounted front side up or front side down</li> <li>- Test apparatus, capable of applying a uniform load corresponding to at least 2400 Pa on the module surfaces</li> <li>- Means for monitoring the continuity of the internal circuit of the module</li> </ul>	R
10.24	Peel test (MST 35)	<ul style="list-style-type: none"> <li>- Tensile-testing machine, complying with the requirements of ISO 5893, capable of measuring force with an accuracy corresponding to class 1 and with a rate of traverse of the moving grip of 50 mm/min <math>\pm</math> 5 mm/min.</li> <li>- Fixture, for holding the test piece to the moving grip of the testing machine in a) so that the direction of pull to cause separation is at all times during the test 90 <math>\pm</math> 10 <math>^{\circ}</math> to the plane of the bond between the polymer and the rigid substrate, i.e. making an angle of 90<math>^{\circ}</math> with the surface of the fixture.</li> </ul>	R
10.25	Lap shear strength test (MST 36)	<ul style="list-style-type: none"> <li>- The apparatus (tensile-testing machine) is specified in ISO 4587:2003, Clause 4.</li> </ul>	R
10.26	Materials creep test (MST 37)	<ul style="list-style-type: none"> <li>- A climatic chamber with automatic temperature control with means for circulating the air inside capable of subjecting one or more PV modules to the conditions specified in 10.25.3</li> <li>- Means for mounting or supporting the PV module in the chamber, so as to allow free circulation of the surrounding air.</li> <li>- Means for measuring and recording the temperature of the PV module to an accuracy of <math>\pm</math> 1 <math>^{\circ}</math>C.</li> </ul>	R

**TESTING AND MEASURING EQUIPMENT/ALLOWED SUBCONTRACTING**

**PHOTOVOLTAIC (PV) MODULE SAFETY QUALIFICATION –  
Part 2: Requirements for testing  
IEC 61730-2:2016**

Clause	Testing	Testing / measuring equipment / material needed	Subcontracting
10.27	Robustness of terminations test (MST 42)	<ul style="list-style-type: none"> <li>- Means for applying a force of 40 N to the centre of the test object</li> <li>- Means for applying a force according Table 1 and a torque according to Table 2</li> <li>- Cord anchorage pull test equipment</li> <li>- Vernier calliper</li> </ul>	R
10.28	Thermal cycling test (MST 51)	<ul style="list-style-type: none"> <li>- Climatic chamber capable to produce a temperature cycle in accordance to figure 9 with an accuracy of +/- 2°C at the low and high extremes.</li> <li>- Means for measuring and recording the module temperature to an accuracy of +/- 2°C and repeatability of +/-0.5°C.</li> <li>- Means for applying current to the modules</li> <li>- Means for monitoring current through the modules</li> </ul>	R
10.29	Humidity-freeze test (MST 52)	<ul style="list-style-type: none"> <li>- Climatic chambers capable to produce a temperature/humidity cycle according to figure 10 with accuracy of +/- 2°C and +/- 5% relative humidity at the low and high extremes.</li> <li>- Means for measuring and recording the module temperature to an accuracy of +/- 2°C and repeatability of +/- 0.5°C.</li> <li>- Means for monitoring the continuity of the internal circuit of the module</li> <li>- Means for applying current to the modules</li> <li>- Means for monitoring current through the modules</li> </ul>	R
10.30	Damp-Heat test (MST 53)	<ul style="list-style-type: none"> <li>- Climatic chamber capable to carry out the test in accordance with IEC 60068-2-78</li> </ul>	R

**TESTING AND MEASURING EQUIPMENT/ALLOWED SUBCONTRACTING**

**PHOTOVOLTAIC (PV) MODULE SAFETY QUALIFICATION –  
Part 2: Requirements for testing  
IEC 61730-2:2016**

Clause	Testing	Testing / measuring equipment / material needed	Subcontracting
10.31	UV test (MST 54) – 15kWh UV test (MST 54) – (2x) 60kWh	<ul style="list-style-type: none"> <li>- UV meters working in wavelength ranges 280–320 nm and 320–400 nm with an accuracy of +/- 15%</li> <li>- UV light source with irradiance non-uniformity in the test plane +/- 15% , no appreciable irradiance at wavelengths below 280 nm and total UV irradiance &lt; 250 W/m<sup>2</sup></li> <li>- Equipment to control the module temperature in the range 60 +/- 5° C</li> <li>- Temperature monitoring equipment with an accuracy of +/- 2°C and repeatability of +/-0.5°C</li> </ul>	R – 15kWh SPTL – (2x) 60kWh
10.32	Cold conditioning test (MST 55)	<ul style="list-style-type: none"> <li>- Climatic chamber shall fulfil requirements of IEC 60068-3-5.</li> <li>- Means for monitoring the module temperature.</li> </ul>	R
10.33	Dry heat conditioning test (MST 56)	<ul style="list-style-type: none"> <li>- Climatic chamber shall fulfil requirements of IEC 60068-3-5.</li> <li>- Means for monitoring the module temperature.</li> <li>- Means for measuring relative humidity inside climatic chamber.</li> </ul>	R