WESTPAK, INC.

Solar Module Testing Overview

SOLAR MODULE TESTING

Photovoltaic technologies will play a vital part in the world's energy supply as the cost of providing traditional energy technologies continues to increase. One of the challenges of solar technology is producing modules that are robust enough to withstand the environmental, mechanical, electrical and other challenges that will be encountered throughout the product lifecycle. Westpak has the knowledge and expertise to help you verify your product's durability; giving you a high degree of confidence in the reliability of the module design.

MODULE TESTING STANDARDS OVERVIEW

Current Standards

IEC 61215/61646 – These standards cover PV (Photovoltaic) and thin-film PV modules respectively. Tests include design qualification, performance, durability, safety and robustness. The requirements of these two standards are almost identical.
IEC 62108 – This standard covers CPV (Concentrator Photovoltaic) modules. The test inputs are similar to IEC 61215 and 61646, but covers some of the differences in the concentrator design.
IEC 61730-2 – This standard covers safety concerns and is similar to UL 1703. Individual test inputs are mostly comprised of testing conducted in IEC 61215/61646 or UL 1703.
UL 1703 – This standard covers safety concerns of solar modules. Some test inputs overlap with the IEC standards. Additionally material testing may be required depending on module design.

Legacy Standards

IEEE 1262 / 1513 – These standards cover PV and CPV modules respectively. Both documents have been largely incorporated into the IEC requirements listed above.

NON STANDARD TESTING WITH WESTPAK

With the complex construction of solar modules and their rigorous design, transportation, installation and longevity requirements, many aspects of R&D and lifecycle testing are not covered by the scope of the standards listed above.
Westpak understands that the development of photovoltaic systems require a multitude of specialized testing services. In addition to the required test inputs listed in our literature, Westpak has the capability to perform various tensile, compression, vibration, shock, pressure and other tests to verify the performance of the product design. Westpak can also perform fragility and transit testing of packaged units. Please go to our website (www.westpak.com) for more information about these other testing services.

ABOUT WESTPAK

Westpak, established in 1986, is a leading independent product and package testing company with laboratories in San Jose and San Diego California. Westpak specializes in environmental, product reliability, distribution packaging and related custom testing services. Westpak strives to deliver accurate and reliable test information to help our customers make informed decisions in product/package performance, product development and regulatory compliance. Our philosophy is "Integrity is the priceless component in testing."

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Solar Module Testing - Environmental

WHAT IS ENVIRONMENTAL SOLAR MODULE TESTING?

Environmental tests are extremely important as they try to accelerate the aging of a module by using extreme temperature and humidity conditions and electrical tests to determine the performance and reliability of the module. Measuring the performance of modules exposed to these adverse conditions helps to ensure they will survive years of inclement weather once they are installed. Westpak can offer module temperature and electrical data logging throughout the duration of the test, as well as a simulated load input. We are continually working to expand our solar-related environmental testing capabilities; please go to our website (www.westpak.com) for the most current list of tests that we offer. Additional ASTM, IEC, IEEE, UL or other test inputs may be available upon request.

Environmental Tests

Name of Test	Brief Explanation (Test Specifications may vary)	Typical Test Specs
Thermal Cycling	Rapid cycling of temperature extremes between -40oC and +85oC (or +90oC) for 200 cycles at 6 hours per cycle. Test for the ability to withstand thermal mismatch, fatigue, or other stresses caused by rapid, non-uniform, or repeated changes of temperature.	UL 1703 - 35 IEC 61215 - 10.11 IEC 62108 - 10.6 IEC 61646 - 10.11 IEEE 1262 - 5.7 ASTM E 1171 - 6.5 IEEE 1513 - 5.7
Humidity Freeze Cycling	Rapid cycling of both temperature and humidity extremes. Similar to thermal cycling with high humidity. Typically ten 24-hour cycles. Determines the ability to withstand high temperature and high humidity followed by freezing temperatures.	UL 1703 (36)* IEC 61215 (10.12)* IEC 61646 (10.12) IEC 62108 (10.8)* IEC 61730-2 (MST 52) IEEE 1262 (5.8) IEEE 1513 (5.8) ASTM E 1171 (6.6)
Damp Heat Test	+85° C & 85% RH for 1000 hours. Tests for the ability to withstand the effects of long-term penetration of humidity.	IEC 61215 (10.13)* IEC 61646 (10.13) IEC 62108 (10.7)* IEC 61730-2 (MST 53) IEC 60068-2-21 IEEE 1262 (5.13) IEEE 1513 (5.10) ASTM E 1171 (6.7)

*ISO 17025 Accredited test inputs

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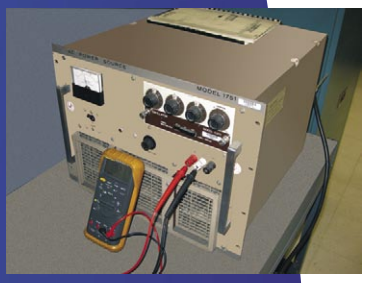
Solar Module Testing - Electrical

WHAT IS ELECTRICAL SOLAR MODULE TESTING?



Electrical tests are conducted to verify that the solar module can withstand electrical overloads without compromising safety, performance or integrity. Additionally electrical tests are conducted after environmental and mechanical test inputs to confirm that the module has not been adversely affected. We are continually working to expand our solar testing capabilities; please go to our website (www.westpak.com) for the most current list of tests that we offer. Additional ASTM, IEC, IEEE, UL or other test inputs may be available upon request.

Electrical Tests

Name of Test	Brief Explanation (Test Specifications may vary)	Typical Test Specs
Ground Path Continuity / Bonding Path Resistance	Electrical continuity test. Verifies adequacy of all electrical continuity between all exposed conductive parts and the grounding point under high current conditions.	IEC 62108 (10.3) IEC 61730-2 (MST 13) UL 1703 (25, 45) IEEE 1262 (5.3) IEEE 1513 (5.3)
Electrical Isolation (Including Wet / Dry Hipot, Leakage Current and Dielectric Voltage Withstand Tests)	Measures the quality of electrical insulation under various conditions. Verifies the adequacy of electrical insulation between all active parts of the power generating circuit and the frame or the outside world.	IEC 61215 (10.3) IEC 61646 (10.3) IEC 62108 (10.4, 10.5) IEC 61730-2 (MST 16) UL 1703 (21, 26, 27) IEEE 1262 (5.4, 5.5, 5.6) IEEE 1513 (5.4, 5.5, 5.6)
Bypass/Blocking Diode Terminal Test (Non-intrusive)	Electrical performance of blocking and bypass diodes. Assesses the adequacy of the thermal design and the relative long-term reliability of bypass/blocking diodes used to limit the detrimental effects of system hot-spot susceptibility.	IEC 61215 (10.18) IEC 61646 (10.18) IEC 62108 (10.11) IEC 61730-2 (MST 25) IEEE 1262 (5.15) IEEE 1513 (5.12)
Impulse Voltage	Verify insulation can withstand over-voltages.	U. L. 1703 --21
Voltage, Current and Power Measurement (I-V Curve)	Determining the voltage and current output of a module under varying electrical load. Also used to determine the maximum power of the module.	IEC 61215 (10.2, 10.6, 10.7) IEC 61646 (10.2, 10.6, 10.7) UL 1703 (20, 44)
Temperature Coefficients	Determines the effect of temperature on the current, voltage, and peak power output of a module.	IEC 61215 (10.4, 10.5) IEC 61646 (10.4, 10.5) IEC 61730-2 (MST 21) UL 1703 (19)
Hot Spot Endurance	Partially shade areas of the module to generate hot spots. Module must not exhibit certain types of damage.	IEC 61215 (10.9) IEC 61646 (10.9) IEC 62108 (10.17) IEC 61730-2 (MST 22) UL 1703 (39)

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Solar Module Testing - Mechanical

WHAT IS MECHANICAL SOLAR MODULE TESTING?

Mechanical test inputs are used to simulate physical hazards that the module may see once installed. The materials and module construction must last through the claimed warranty period and physical testing is vital to the product development cycle. We are continually working to expand our mechanical solar testing capabilities; please go to our website (www.westpak.com) for the most current list of tests that we offer. Additional ASTM, IEC, IEEE, UL or other test inputs may be available upon request.

Mechanical Tests

Name of Test	Brief Explanation (Test Specifications may vary)	Typical Test Specs
Terminal Robustness	Tensile and/or torque test on electrical terminations. Assesses the ability to withstand the normal stresses associated with handling and installation.	IEC 61215 (10.14) IEC 61646 (10.14) IEC 62108 (10.12) IEC 61730-2 (MST 42) UL 1703 (22/29/42) IEEE 1262 (5.9) IEEE 1513 (5.9)
Mechanical Loading Test	Mechanical loading by placing weight on modules to simulate physical load conditions. Determines the ability of the module to withstand wind, snow, ice, or other static loads.	IEC 61215 (10.16) IEC 61646 (10.16) IEC 62108 (10.13) IEC 61730-2 (MST 34) UL 1703 (41) IEEE 1262 (5.11)
Impact Test	Verifies the module can withstand impact forces.	UL 1703 (30)
Surface Cut Susceptibility	Verifies the covering substrate can withstand surface cuts.	UL 1703 (24) IEEE 1262 (5.12) IEC 61730-2 (MST 12)
Push Test	Module is subjected to point loading in several areas.	UL 1703 (23)
Hail Impact Test	Simulated hail impacts. Determines the ability to withstand and survive a severe hailstorm.	IEC 61215 (10.17) IEC 61646 (10.17) IEC 62108 (10.9) IEEE 1262 (5.14) IEEE 1513 (5.11)

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