SEMI PV56-1214
TEST METHOD FOR PERFORMANCE CRITERIA OF PHOTOVOLTAIC (PV) CELLS AND MODULES PACKAGE

This Standard was technically approved by the Photovoltaic Global Technical Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on November 11, 2014. Available at www.semiviews.org and www.semi.org in December 2014.

1 Purpose

1.1 The purpose of this Standard is to standardize requirements of the test method for performance criteria of photovoltaic (PV) cells/modules package for transportation.

1.2 The photovoltaic industry, with crystalline silicon as a dominant segment, is expanding rapidly to meet growing renewable energy demands all over the world. Recent failure-rate analysis indicates that a large portion of the accelerated PV module qualification failures are related to the failure of the package itself. That is leading to the loss of cells during shipping. Damage of shipping caused PV cells/modules failure is one of the serious problems and is relative to 25 years reliability in the field.

1.3 The cell/module makers and buyers, or any other party interested, can thus have common standards to refer to when desired. This Standard also assists and certifies whether the PV cells/modules package is a good design before shipping.

2 Scope

2.1 The proposed Standard aims to develop criteria of PV cells/modules packages so that the industry can benefit from using a common and baseline specification. In order to simulate and consider all of the conditions, it shall include the handling, processing and transportation for some cartons of packaged cells or one unit pallet (see Figure 1) indoors and outdoors. This Test Method is based on the following scenarios, as appropriate.

2.1.1 Static loading for stacking cartons of cells/modules.

2.1.2 Handling and processing shipping cartons of cells/modules in a fab.

2.1.3 Inclined impact cartons by falling from a forklift truck or hand pallet truck.

2.1.4 Loading or unloading cartons with rope.

2.1.5 Improper operation of forklift truck; leads to cartons of cells/modules sliding along the inclined plane.

2.1.6 Transporting pallet cartons of cells/modules from fab to fab.

2.1.7 This Standard will describe:

2.1.7.1 Test method for basic transport shipment system and functional performance requirements.

2.1.7.2 Test method, measurement instruction and criteria for performance.

2.1.7.3 Performance criteria of cells/modules packaging previously not defined in the PV industry.

NOTICE: SEMI Standards and Safety Guidelines do not purport to address all safety issues associated with their use. It is the responsibility of the users of the Documents to establish appropriate safety and health practices, and determine the applicability of regulatory or other limitations prior to use.

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Figure 1
Handling Unitized Cartons of Cells by Forklift Truck

3 Limitations

3.1 This Standard is not intended for specifying the orientation of a PV cells/modules inside the package, the transportation vehicles, or the packaging materials.

3.2 This Standard is recommended only for c-Si product, the general packaging and transportation environment.

4 Referenced Standards and Documents

4.1 *SEMI Standards and Safety Guidelines*

SEMI PV23 — Test Method for Mechanical Vibration of Crystalline Silicon Photovoltaic (PV) Modules in Shipping Environment

SEMI PV38 — Test Method for Mechanical Vibration of c-Si PV Cells in Shipping Environment

4.2 *ASTM Standards*[1]

ASTM D880-92 — Standard Test Method for Impact Testing for Shipping Containers and Systems

ASTM D4169 — Standard Practice for Performance Testing of Shipping Containers and Systems

ASTM D4332 — Standard Practice for Conditioning Containers, Packages, or Packaging Components for Testing

ASTM D4728 — Standard Test Method for Random Vibration Testing of Shipping Containers

ASTM D6179-97 — Standard Test Methods for Rough Handling of Unitized Loads and Large Shipping Cases and Crates

4.3 *IEC Standards*[2]

IEC 60410 — Sampling Plans and Procedures for Inspection by Attributes

IEC 60904-1 — Photovoltaic Devices – Part 1: Measurements of Photovoltaic Current-Voltage Characteristics

IEC 61215 — Crystalline Silicon Terrestrial Photovoltaic (PV) Modules – Design Qualification and Type Approval

4.4 *ISO Standards*[3]

ISO 3534 — Statistics – Vocabulary and Symbols

[1] ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA; Telephone: +1.610.832.9585, Fax: +1.610.832.9555, http://www.astm.org

[2] International Electrotechnical Commission, 3 rue de Varembé, Case Postale 131, CH-1211 Geneva 20, Switzerland; Telephone: +41.22.919.02.11, Fax: +41.22.919.03.00, http://www.iec.ch

[3] International Organization for Standardization, ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland; Telephone: +41.22.749.01.11, http://www.iso.org

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4.5 *ISTA Standards*[4]

ISTA 3E 2009 — Unitized Loads of Same Product

ISTA 3H 2011 — Products or Packaged-Products in Mechanically Handled Bulk Transport Containers

NOTICE: Unless otherwise indicated, all documents cited shall be the latest published versions.

5 Terminology

5.1 *Abbreviations and Acronyms*

5.1.1 *c-Si* — crystalline silicon

5.1.2 *EL* — electroluminescence

5.1.3 G_{rms} — root-mean-square acceleration

5.1.4 I_{sc} — short-circuit current

5.1.5 *I-V* — current-voltage

5.1.6 *PL* — photoluminescence

5.1.7 P_{max} — maximum power

5.1.8 *PV* — photovoltaic

5.1.9 *STC*— standard test condition

5.1.10 V_{oc} — open-circuit voltage

5.2 *Definitions*

5.2.1 *block* — a stacking package of sample cells.

5.2.2 *defects* — the damage of package or the imperfection of c-Si like broken cell, crack or micro-cracks, cell with chips, holes in cells, etc.

5.2.3 *shipment* — a large amount of goods sent together to a place or the act of sending them.

5.2.4 *standard test condition (STC)* — for solar cells. Cell temperature: 25°C, AM 1.5G, Irradiance: 1000 W/m^2.

5.2.5 *test carton* — stacked blocks in one carton for testing.

5.2.6 *test pallet* — a complete, filled unit-loads during the test.

6 Apparatus

6.1 *Reliability Tests*

6.1.1 *Temperature Recording Apparatus* — In compliance with the apparatus section of ASTM D4332, to show and record environment temperature during the treatment of unit load.

6.1.2 *Humidity Recording Apparatus* — In compliance with the apparatus section of ASTM D4332, to show and record environment humidity during the treatment of unit load.

6.1.3 *Chamber and Control Apparatus* — In compliance with the apparatus section of ASTM D4332, to provide and control the temperature and humidity of environment during the optional atmospheric conditioning.

6.1.4 *Incline Impact Tester* — In compliance with the apparatus section of ASTM D880-92, to perform incline shock test.

6.1.5 *Rotational Edge Drop Test System* — In compliance with the apparatus section of ASTM D6179-97 to perform rotational edge drop test.

[4] International Safe Transit Association, 1400 Abbott Road, Suite 160, East Lansing, MI 48823-1900, USA; Telephone: +1.517.333.3437, Fax: +1.517.333, 3813, http://www.ista.org

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