

SEMI PV85-1018 (Reapproved 0124) PRACTICE FOR METAL WRAP THROUGH (MWT) BACK CONTACT PHOTOVOLTAIC (PV) MODULE ASSEMBLY

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NOTICE: The section symbol (§) is used to reference a numbered section, paragraph, or header and all subordinate paragraphs, headers, and embedded material (i.e., EXCEPTIONS, lists) therein. The paragraph symbol (§) is used to reference a particular numbered paragraph and embedded material therein. When duplicated (i.e., §§ and §§§) the symbols are used to reference more than one section or paragraph, respectively.

1 Purpose

1.1 This Standard defines the materials, process design, technical requirements and test method of metal wrap through photovoltaic (PV) module, which provides a unified standard for the manufacture, sale and customer acceptance of module.

2 Scope

2.1 This Standard specifies the terms and definitions, material requirement, technological process, module requirement, and test method of metal wrap through PV module assembly.

2.2 This Standard applies to crystalline silicon metal wrap-through (MWT) PV module (hereinafter referred to as MWT module).

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.

3 Limitations

3.1 None.

4 Referenced Standards and Documents

4.1 SEMI Standards and Safety Guidelines

SEMI PV47 — Specification for Anti-Reflective-Coated Glass, Used in Crystalline Silicon Photovoltaic Modules

4.2 ASTM® Standards¹

ASTM D882 — Test Method for Tensile Properties of Thin Plastic Sheeting

4.3 IEC® Standards²

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

IEC 61730-1 — Photovoltaic (PV) Module Safety Qualification – Part 1: Requirements for Construction

IEC 61215-1 — Terrestrial Photovoltaic (PV) Modules – Design Qualification and Type Approval – Part 1: Requirements for Testing

IEC 61215-2 — Terrestrial Photovoltaic (PV) Modules – Design Qualification and Type Approval – Part 2: Test Procedures

IEC 62790 — Junction Boxes for Photovoltaic Modules – Safety Requirements and Tests

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>. ASTM trademark is owned by ASTM International.

² International Electrotechnical Commission, 3 rue de Varembe, Case Postale 131, CH-1211 Geneva 20, Switzerland; Telephone: +41.22.919.02.11, <http://www.iec.ch>. IEC trademark is owned by International Electrotechnical Commission.

4.4 IPC® Standards³

IPC-TM-650 — Test Methods Manual

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

5 Terminology

5.1 Abbreviations and Acronyms

5.1.1 *EVA* — ethylene-vinyl acetate copolymer

5.1.2 *MWT* — metal wrap through

5.2 Definitions

5.2.1 *flexible back contact circuit* — multilayer composite materials with circuit construction, which has important function of electric conduction, insulation, support, encapsulation and weather-proof in MWT PV module. Furthermore, in order to package and protect the module, it will only be used in concert with general PV backsheet (such as TPT, TPE, KPE) or glass.

5.2.2 *flexible circuit backsheet* — photovoltaic module backside encapsulated materials combining the layer materials with circuit construction and general PV backsheet (such as TPT, TPE, KPE), which make it not only have a function with electric conduction and insulation, but also can protect the backsheet.

5.2.3 *metal wrap through (MWT) PV module* — the laser boring and back wiring technologies have been applied in the MWT solar cells, which can eliminate the main grid line in the positive electrode. The electric current collected by the main grid line in the positive electrode will be led to the back side through the silver paste in the hole. That's to say, both the positive and negative electrodes are distributed on the back of cells.

6 Summary of Practice

6.1 This Standard specifies the requirement and corresponding test method of materials which is necessary to produce MWT module, such as cell, flexible back contact circuit, flexible circuit backsheet, encapsulation adhesive film, glass, and junction box.

6.2 This Standard elaborates the technological process of MWT cell and module, and regulates the operation processes of cell and module.

6.3 This Standard specifies the requirement and corresponding test method of MWT module.

7 Requirement of Materials

7.1 Cell

7.1.1 Appearance of Cell

7.1.1.1 The appearance of cell should meet the requirements listed in Table 1.

Table 1 Appearance Requirements of MWT Module

<i>Item</i>	<i>Requirement</i>
Broken, subfissure	Not allowed
Oxidation of grid line	Not allowed
Pinhole	Not allowed
Fingerprint	Not allowed
V-shape chipping	Not allowed

³ IPC International, 3000 Lakeside Drive, 105 N, Bannockburn, IL 60015, USA; Telephone: +1.847.615.7100, <http://www.ipc.org>. IPC trademark is owned by IPC International.

<i>Item</i>	<i>Requirement</i>
Corner chipping, edge chipping	Corner chipping: width ≤ 3 mm, depth ≤ 1 mm, unfilled corner of each cell should not exceed one; edge chipping: no penetrating edge chipping could be existed, and edge chipping of each cell should not exceed three.
Chromatic aberration	No obvious chromatic aberration is observed at 50 cm far from cell under 1000 Lx light source.
Finger interruption	The length between 0.5 mm and 2 mm should not exceed one; the length less than 0.5 mm should not exceed three. The finger interruption each grid line can't exceed one.
Scratch	Width ≤ 0.5 mm, Scratch length ≤ 20 mm, only one scratch is allowed.

7.1.1.2 Test Method of Appearance

7.1.1.2.1 Visual inspection of the cell under 1000 Lx white light source.

7.1.1.2.2 Measuring tool whose resolution is better than 0.02 mm is used to measure the appearance defect, such as edge breakage, blunt gap.

7.1.2 Dimension of Cell

7.1.2.1 The dimension of cell should meet the requirements listed in Table 2.

Table 2 Requirements of Dimension

<i>Item</i>	<i>Requirement</i>
Dimension deviation	± 0.5 mm
Thickness deviation	± 20 μ m
Curvature	The arch height should not exceed $\pm 1\%$ of cell's side length
Diameter of hole on the cell	≤ 2 mm
Positioning deviation of laser boring	± 1 mm

7.1.2.2 Test Method of Cell Dimension — Caliper whose resolution is better than 0.02 mm is used to measure the dimension of cell, and micrometer whose resolution is better than 0.01 mm is used to measure the thickness of cell.

7.1.3 Electrical Performance of Cell

7.1.3.1 The electrical performance of cell should meet the requirements listed in Table 3.

Table 3 Requirement of Electrical Performance

<i>Item</i>	<i>Requirement</i>
Parameter of electrical performance	Check according to the transfer efficiency provided by manufacturer, fluctuating range is between $+3\%$ to -1.5% .
Test of inverse current	The current is less than 1 A when the voltage is -12 V and the temperature is 25°C .

7.1.3.2 The test method of electrical performance is conducted according to in IEC 60904-1.

7.2 Flexible Back Contact Circuit

7.2.1 Requirement for Flexible Back Contact Circuit

7.2.1.1 Flexible Back Contact Circuit Appearance — There should be no oil spills, no permanent deformation folds, no bubbles, no delamination, no indentations, and it's not allowed to have color inhomogeneity within 1 m^2 area range, and no visual burrs on the conductive coatings.

7.2.1.2 Thickness and Allowable Deviation for Flexible Back Contact Circuit

7.2.1.2.1 The allowable thickness deviation for the flexible back contact circuit should be controlled within $\pm 10\%$ of the nominal value.

7.2.1.2.2 The minimal thickness of the conductive coating for the flexible back contact circuit should be not less than 90% of the nominal thickness specified in Table 4.

Table 4 Cu Foil Thickness in Unit Area

<i>Foil Code</i>	<i>Common Industrial Code</i>	<i>Nominal Thickness (μm)</i>
E	5 μm	5.1
Q	9 μm	8.5
T	12 μm	12.0
H	$\frac{1}{2}$ oz.	17.1
M	$\frac{3}{4}$ oz.	25.7
1	1 oz.	34.3
2	2 oz.	68.6
3	3 oz.	102.9
4	4 oz.	137.2
5	5 oz.	171.5
6	6 oz.	205.7
7	7 oz.	240.0
10	10 oz.	342.9
14	14 oz.	480.1

#1 As for the nominal weights which are not listed in the table, the computation formula is shown as follows:

$$\text{Thickness (mils)} = 1.35 \times \text{Weight in unit area (oz/ft}^2\text{)}$$

where 1.35 is a coefficient, which is determined by assuming the Cu foil density is fixed at 8.39 g/cm³ (5.16 oz. in³).

7.2.1.3 Restrictive Conditions for the Dimension of Flexible Back Contact Circuit

7.2.1.3.1 The length and width of the conductive coating of flexible back contact circuit should be greater than the length and width of the cell array in the module.

7.2.1.3.2 The distance between any metal parts of the flexible back contact circuit and the edges of the module should satisfy the requirements in IEC 61730-1.

7.2.1.3.3 The current-extracting terminals were employed as the soldering positions for the flexible back contact circuit, which should facilitate the soldering. The soldering area at every single soldering position should be greater than 1 cm², and the dimensions at the soldering positions in any direction should be greater than 6 mm.

7.2.1.3.4 Non-backsheet materials were utilized in the flexible back contact circuit to act as the supporting materials, in which the length and width should be 2 mm to 5 mm greater than the length and width of the conductive coatings.

7.2.1.4 The performance of the flexible back contact circuit should meet the requirements listed in Table 5.

Table 5 Performance Requirements of the Flexible Back Contact Circuit

<i>No.</i>	<i>Testing Items</i>	<i>Performance Requirements</i>
1	Total thickness	100–150 μm
2	Electrical resistance	$\leq 0.162 \Omega/\text{m}^2$
3	Insulation resistance between conductive units	$> 1.0 \text{ M}\Omega$