

SEMI PV100-0623

TEST METHOD OF WIND UPLIFT RESISTANCE FOR PHOTOVOLTAIC MODULES ROOF (BIPV)

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1 Purpose

1.1 This Standard specifies the test method for wind uplift resistance of photovoltaic module roof (BIPV) products which are exposed to various wind conditions.

1.2 The test method defined in this Standard applies to all components as assembled in a photovoltaic module roof (BIPV) product. The test method is designed to evaluate the stability of the PV module roof on its support system and to measure the ultimate strength of the main components included in the PV module roof system exposed to various wind conditions.

1.3 This Standard specifies the evaluation requirements for performance of photovoltaic system in the complete photovoltaic module roof before and after wind uplift resistance test.

2 Scope

2.1 This Standard is suitable to determine the wind uplift resistance performance of photovoltaic module roof products that are parallel to and directly combined with the roof or photovoltaic module roofing products that replace the original roof.

2.2 This Standard applies to the following types of photovoltaic module roof structures: assembly components such as photovoltaic modules by means of utilizing mechanical fasteners, adhesive, hot asphalt, welding, or combination thereof, to roof deck.

2.3 This Standard covers the test requirements of performance such as wet leakage, maximum output power, visual inspection and other performance of photovoltaic part installed in photovoltaic module roof system before and after the wind uplift resistance test.

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 General Requirement

3.1 All kinds of apparatus for sample installation, preparation and testing shall operate normally at the temperature of $20 \pm 15^{\circ}\text{C}$.

3.2 The requirements of this Standard shall be used to measure and describe the performance of the roof assembly in response to exposure from simulated wind uplift pressure under controlled laboratory conditions.

3.3 The performance of the photovoltaic module roof system depends partly on all the components in the photovoltaic module product system and partly on how they interact. This Standard takes the photovoltaic module roof system as a whole when evaluate its wind resistance classification.

3.4 A suitable test method selected from the methods described in this Standard could be utilized to evaluate the wind uplift resistance performance of PV module roofing systems. A PV module roof system that meets all the conditions of acceptance as described in Chapter 10 shall receive a wind uplift resistance rating which match the maximum strength.

3.5 The components for a test specimen shall compose a complete photovoltaic module roof system, which shall be consistent with the actual engineering project. The components of the engineering test specimen shall be selected and built under conditions representative of those in actual construction, and the stress conditions of the specimen shall be simulated as accurately as possible, and the specimen shall not be deformed during installation and fixing.

4 Referenced Standards and Documents

4.1 *ANSI® Standards*¹

ANSI FM 4474 — American National Standard for Evaluating the Simulated Wind Uplift Resistance of Roof Assemblies Using Static Positive and/or Negative Differential Pressures

4.2 *ASTM® Standards*²

ASTM E1592 — Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference

4.3 *IEC® Standards*³

IEC 60904 — Photovoltaic Devices

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

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

IEC 61730 — Photovoltaic (PV) Module Safety Qualification

IEC/TS 61836 — Solar Photovoltaic Energy Systems – Terms, Definitions and Symbols

4.4 *UL® Standards*⁴

UL 580 — Test for Uplift Resistance of Roof Assemblies

4.5 *National Standards of Canada*⁵

CSA A123.21 — Standard Test Method for the Dynamic Wind Uplift Resistance of Membrane-Roofing Systems

4.6 *SAC Standards*⁶

GB/T 39794.1 — Test method for wind uplift resistance of metal roof-Part 1: Static pressure method

GB/T 39794.2 — Test method for wind uplift resistance of metal roof-Part 2: Dynamic pressure method

¹ American National Standards Institute, 25 West 43rd Street, New York, NY 10036, USA; Telephone: +1.212.642.4900, Fax: +1.212.398.0023, <http://www.ansi.org>. ANSI trademark is owned by American National Standards Institute.

² 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.

³ International Electrotechnical Commission, 3 rue de Varembé, 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 Underwriters Laboratory, 333 Pfingsten Road Northbrook Illinois, 60062, USA; Telephone: +1.847.272.8800, <http://www.ul.com>. UL trademark is owned by Underwriters Laboratory.

⁵ Standards Council of Canada, 600-55 Metcalfe Street, Ottawa, Ontario, K1P 6L5, Canada, 416-747-2233, <http://www.store.csagroup.org>

⁶ Standardization administration and State Administration for Market Regulation, No 9, Madian East Road, Haidian District, Beijing, China, +86.010.82262967, <https://std.sacinfo.org.cn/gnoc>

4.7 China National Standards⁷

GB 50205 — Standard for Acceptance of Construction Quality of Steel Structures

GB 50896 — Technical Code for Application of Profiled Metal Sheets

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

5 Terminology

5.1 Definitions

5.1.1 *integration structure* — a structure that fixes multi-functional accessories such as base plate, thermal insulation material, membrane, and outer envelope structure to the roof platform.

5.1.2 *photovoltaic module roof* — the combination of photovoltaic modules and panels and the securement means for installing the photovoltaic modules and panels as a roof covering and generating power.

5.1.3 *photovoltaic modules* — complete and environmentally protected assembly of interconnected photovoltaic cells as defined in IEC/TS 61836.

5.1.4 *profiled metal sheet* — the metal plate is cold formed to be a continuous wave or other cross-section profiled metal sheet along the width direction of the sheet as defined in GB 50896.

5.1.5 *pressure difference* — absolute air pressure difference between indoor and external surfaces of photovoltaic module roof. When the pressure on the outdoor surface is higher than that on the indoor surface, the pressure difference is positive; otherwise, it is negative.

5.1.6 *roof deck* — a fixed platform under waterproof and thermal insulation structures in a roof system.

5.1.7 *wind uplift resistance* — the performance of the system assemblies to resist wind uplift forces on photovoltaic module roof.

6 Summary of Test Method

6.1 Before the wind uplift resistance test, the photovoltaic modules in the photovoltaic module roof system shall be inspected according to the requirements in the IEC 61215 standard, including visual inspection, maximum output power determination, and wet leakage current test.

6.2 Wind uplift resistance test methods include static pressure method and dynamic pressure method. According to different pressure application positions, positive pressure method, negative pressure method or positive and negative pressure superposition method can be selected, as shown in Figures 1, 2, and 3.

6.3 The test specimens shall be of sufficient size to determine the performance of all typical parts of the photovoltaic module roof system. All parts of the test specimen shall be full size, using the same materials, details, and methods of construction and anchorage as used on actual buildings.

⁷ Ministry of Housing and Urban-Rural Development of the People's Republic of China and General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China, No 9, Sanlihe Road, Haidian District, Beijing, China, +86.010.58934446, www.mohurd.gov.cn

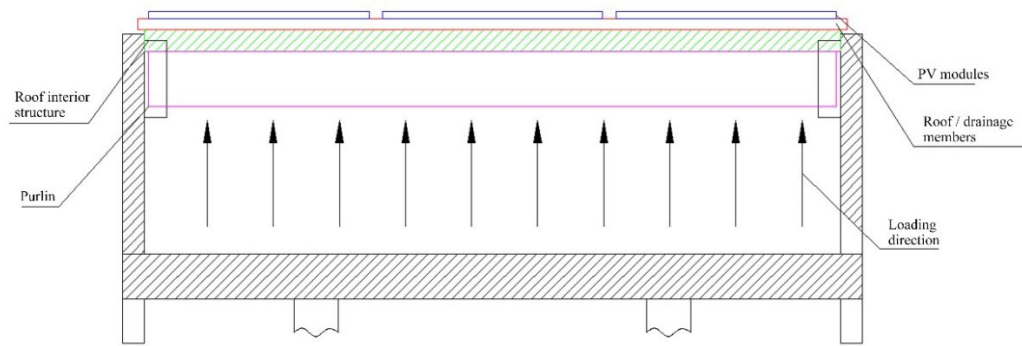


Figure 1
Positive Pressure Method

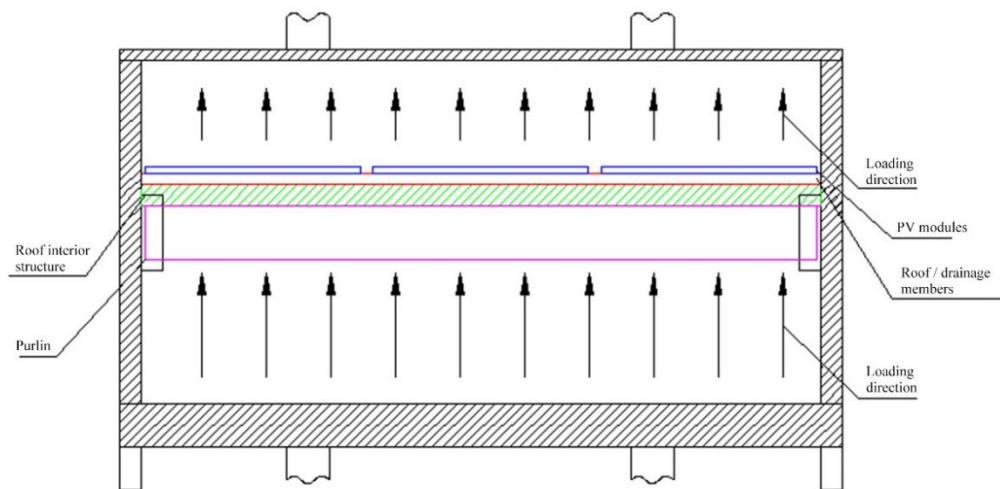


Figure 2
Positive and Negative Pressure Superposition Method

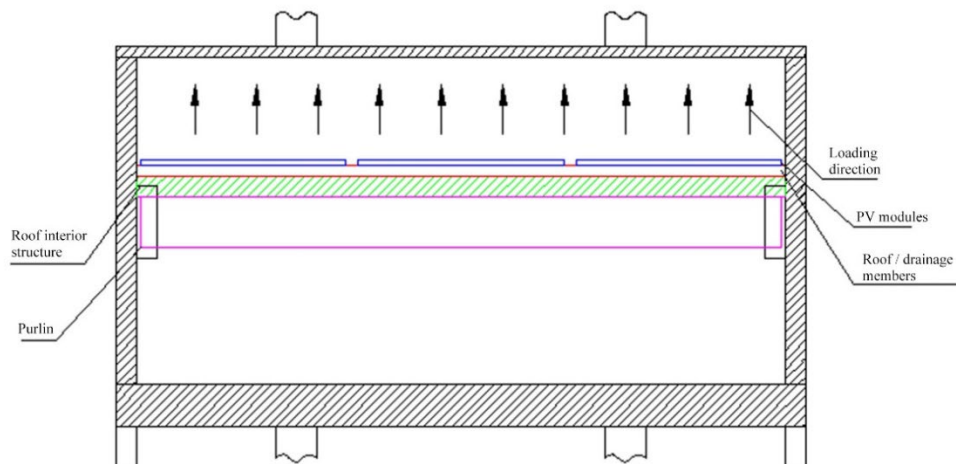


Figure 3
Negative Pressure Method

6.4 If photovoltaic module roof system described in § 6.3, in which the photovoltaic module is installed on a roof, in other words, the photovoltaic module do not directly contact with the indoor space as used actual application, the photovoltaic module roofing system needs to evaluate the stability of the photovoltaic module on its support and evaluate the performance of the photovoltaic module (as shown in Figure 4).

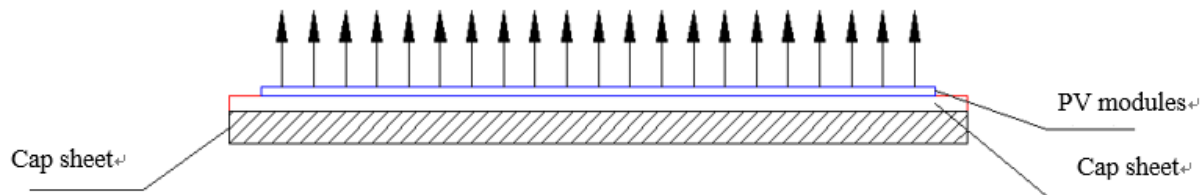


Figure 4
Static Mechanical Dynamic Pressure Test Apparatus

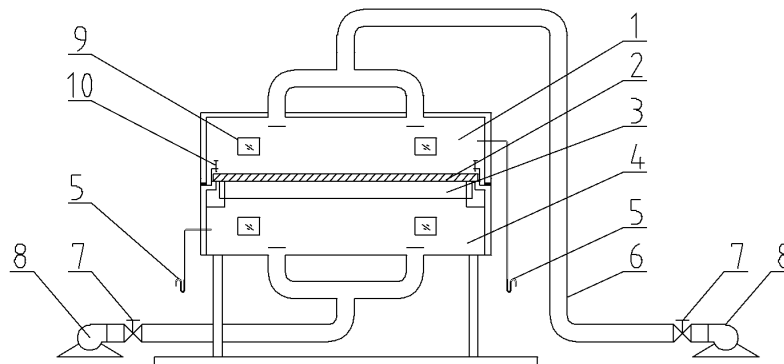
6.5 The apparatus shown in Figure 4 refers to the static mechanical and dynamic pressure test apparatus of IEC 61215 standard.

6.6 After the tests above are completed, the photovoltaic modules in the photovoltaic module roof system shall be inspected according to the requirements in the IEC 61215 standard by the means mentioned in § 6.1.

7 Apparatus

7.1 Composition of Wind Uplift Resistance Test Apparatus

7.1.1 The uplift resistance test apparatus consists of top and bottom pressure chamber, installation frame (such as purlin), pressure supply system (including air supply equipment, pressure control device and air pipeline), pressure measuring device, etc. (refer to Figure 5 as shown in UL 580 and GB/T39794.2). The top pressure chamber and its supporting of the wind-resistant test apparatus could not be installed when static pressure testing.



#1 1 — Top pressure chamber, 2 — Specimen, 3 — Installation frames (e.g., purlins) 4 — Bottom pressure chamber, 5 — Pressure measuring devices, 6 — Air pipe, 7 — Pressure control device, 8 — Air supply equipment, 9 — Inspection window, 10 — Specimen fixing clamps.

Figure 5
Wind Uplift Resistant Test Apparatus