IEC 62805-2

Edition 1.0 2017-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Method for measuring photovoltaic (PV) glass –
Part 2: Measurement of transmittance and reflectance

Méthode de mesure du verre photovoltaïque (PV) –
Partie 2: Mesurage du facteur de transmission et du facteur de réflexion

IEC 62805-2:2017-08(en-fr)

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CONTENTS

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METHOD FOR MEASURING PHOTOVOLTAIC (PV) GLASS –

Part 2: Measurement of transmittance and reflectance

FOREWORD

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International Standard IEC 62805-2 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

The text of this standard is based on the following documents:

FDIS	Report on voting
82/1298/FDIS	82/1322/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62805, published under the general title *Method for measuring photovoltaic (PV) glass*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

This document differentiates from the other standards related to transmittance and reflectance test as follows:

- the scope of this document is restricted to transmittance and reflectance measurement for PV glass,
- the wavelength range is typically from 280 nm to 1 250 nm which is related to the spectral response of common solar cells,
- in order to harmonize the calculation of the transmittance and reflectance of PV glass, the photon irradiance was used instead of the spectral solar irradiance,
- apparatus conditions such as the integrating sphere type and diameter are specified.

This part of IEC 62805 establishes IEC requirements for providing procedures and calculation methods for measuring the transmittance and reflectance of glass used in photovoltaic (PV) modules.

Types of PV glass include ultra-clear patterned glass, anti-reflective coated glass, transparent conductive oxide (TCO) glass and other kind of glass used in PV modules. With the rapid growth of the global PV industry, the amount of PV glass being used has increased tremendously. The optical properties including the transmittance and reflectance of PV glass play an important role in determining the performance of PV modules.

At present, the methods used to measure the transmittance and reflectance of PV glass by different laboratories and manufacturers can be quite different because there is no standard method being used. While there are other international standards for the measurement of transmittance and reflectance of glass or other transparent materials, the spectral irradiance is used for performing the calculations, and the wavelength range incorporates either the visible spectrum or the entire solar spectrum depending on the different applications of the glass under test. See for example ISO 9050, and ISO 13837. As photon flux is important in determining the number of carriers that are generated and hence the current produced by a solar cell, the spectral photon flux (photon irradiance) is used in this document for calculation of the transmittance and reflectance of PV glass. The wavelength range is restricted to the solar cell response range, typically from 280 nm to 1 250 nm. The transmittance of ultra-clear patterned PV glass from different manufacturers could vary depending upon whether the spectral solar irradiance or the spectral photon irradiance is used in the calculation, even if the same test apparatus and procedure is applied. In addition the measuring conditions, the apparatus requirements and sample preparation method are modified to correctly measure PV glass.

The aim of this document is:

- to provide a specific method for measuring transmittance and reflectance of PV glass, especially PV glass having both specular and diffuse optical properties;
- to develop the procedure for measuring transmittance and reflectance in the solar cell response wavelength range, typically from 280 nm to 1 250 nm;
- to provide a method for calculating the transmittance and reflectance using the spectral photon irradiance spectrum in the solar cell response wavelength range, typically from 280 nm to 1 250 nm.

METHOD FOR MEASURING PHOTOVOLTAIC (PV) GLASS –

Part 2: Measurement of transmittance and reflectance

1 Scope

This part of IEC 62805 specifies methods for measuring the transmittance and reflectance of glass used in photovoltaic (PV) modules and provides instructions on how to calculate the effective hemispherical transmittance and reflectance of this glass.

This document is applicable to PV glasses used in PV modules, including ultra-clear patterned glass, anti-reflective coated (AR) glass, transparent conductive oxide coated (TCO) glass and other kinds of PV glass used in PV modules.

These test methods are designed to provide reproducible data appropriate for comparison of results among laboratories or at different times by the same laboratory and for comparison of data obtained on different PV glasses.

These test methods have been found practical for glass having both specular and diffuse optical properties.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60904-3:2016, *Photovoltaic devices – Part 3: Measurement principles for terrestrial photovoltaic (PV) solar devices with reference spectral irradiance data*

IEC 62788-1-4, *Measurement procedures for materials used in Photovoltaic Modules – Part 1-4: Encapsulants – Measurement of optical transmittance and calculation of the solar-weighted photon transmittance, yellowness index, and UV cut-off frequency*

IEC 62805-1:2017, *Method for measuring photovoltaic (PV) glass – Part 1: Measurement of total haze and spectral distribution of haze*

ISO 9050, *Glass in building – Determination of light transmittance, solar direct transmittance, total solar energy transmittance, ultraviolet transmittance and related glazing factors*

3 Terms and definitions

For the purposes of this document, the terms and definitions in IEC 62805-1 and the following apply.

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- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
effective hemispherical transmittance of photon irradiance
ratio of the transmitted photon irradiance to the incident photon irradiance in the wavelength range of 280 nm to 1 250 nm

Note 1 to entry: The transmitted photon irradiance is collected over an entire hemisphere for detection.

Note 2 to entry: The term “effective” in the title refers to the effective wavelength range which is related to the spectral response characterization of solar cells. In this document, the wavelength range of 280 nm to 1 250 nm is chosen as the representative response spectrum of the common solar cells, including crystalline silicon solar cells, silicon thin film solar cells and others. If the PV glass is used in a PV module in which the response spectrum of the solar cells is beyond the range of 280 nm to 1 250 nm, a different effective wavelength range will be specified.

3.2
effective hemispherical reflectance of photon irradiance
ratio of the total reflected photon irradiance to the incident photon irradiance in the wavelength range of 280 nm to 1 250 nm

Note 1 to entry: The reflected photon irradiance is collected over an entire hemisphere for detection.

4 Apparatus

4.1 General

Double-beam instruments or single-beam instruments with stabilized light source, integrating sphere and other elements according to IEC 62805-1.

4.2 Performance of test instrument

Performance of the test instruments shall conform to the requirement of IEC 62805-1.

5 Test specimens and reference standards

5.1 Test specimens

Test specimens shall conform to the requirements of IEC 62805-1.

5.2 Reference standard

For transmittance measurement, an air layer shall be used as the 100 % transmittance reference standard for the measurement baseline.

For reflectance measurement, a laboratory certified, calibrated reference standard with characteristics similar to PV glass sample shall be used as the 100 % reflectance reference standard for the measurement baseline. For example, a certified coated quartz sample may be used as a working reference for measurements of glass.

6 Conditioning

The test shall be done in an environment maintained at (23 ± 2) °C and (40 ± 15) % relative humidity.

The specimen of coated PV glass, such as AR glass and TCO glass, shall be maintained in the same environment for not less than 4 h prior to measurement unless otherwise agreed between customer or supplier.

7 Procedure

7.1 General

Transmittance and reflectance measurements shall be performed in accordance with the procedure in ISO 9050.

The wavelength range of the measurement shall be at least over the range from 280 nm to 1 250 nm with preferred wavelength intervals of 1 nm, but a coarser interval up to 5 nm is allowed if the resultant transmittance and reflectance versus wavelength curves are smooth over the wavelength range of interest.

Adequate time shall be allowed for the lamp of instrument to reach equilibration (typical 15 min to 30 min of warm-up time).

The scanning wavelength range from 280 nm to 1 250 nm shall be set up first for the instrument before any measurements are performed.

7.2 Measurement of spectral hemispherical transmittance

7.2.1 Instrument calibration

First, use an air layer as the standard for the 100 % calibration with no specimen at the transmittance port. Cover the reflectance port with a standard white plate. Perform baseline or 100 % line calibration for the instrument.

Then, block the sample beam as completely as possible. Perform dark or 0 % line calibration for the instrument.

Baseline and dark calibrations shall be performed at least once during each continuous measurement period.

7.2.2 Sample measurement

Put the test specimen at the location 3 as shown in IEC 62805-1:2017, Figure 1, with its external (air) surface facing the incident beam and with its internal (cell) surface flushing against the transmittance port of the sphere. Perform a scan with the same instrument parameters as the calibration scans over the wavelength range from 280 nm to 1 250 nm with preferred wavelength intervals of 1 nm. The spectral transmittance $\tau(\lambda)$ for each wavelength shall be obtained after being automatically corrected by the instrument's software using the 100 % line and 0 % line data.

The uncoated side of TCO glass samples shall face the incident beam, while the coated side of anti-reflective glass samples shall face the incident beam. For ultra-clear patterned glass, the smooth side of the glass samples shall face the incident beam. In the case of float glass, the tin rich side shall face the incident beam.

NOTE To reduce the influence of haze for the measurement, samples of TCO glass can also be tested with refractive index matching liquid on the surface of TCO coating side while the refractive index of TCO coating is known and the index matching liquid can be prepared.

7.3 Measurement of spectral hemispherical reflectance

7.3.1 Instrument calibration

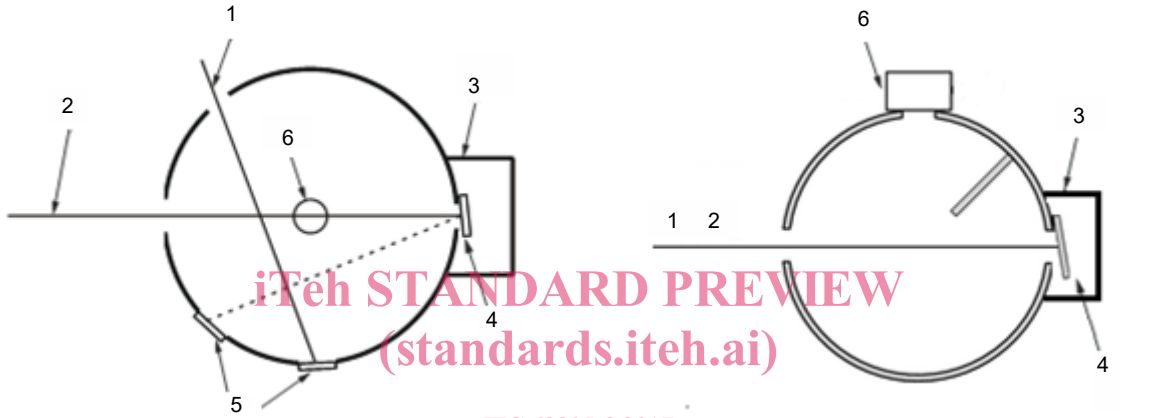
First, keep the transmittance port open and put the the reference standard as in 5.2 on the reflectance port. Perform baseline or 100 % line calibration for the instrument.

Then, replace the white standard plate covering the reflectance port with a light trap. Perform dark or 0 % line calibration for the instrument.

Baseline and dark calibrations shall be performed at least once during each continuous measurement period.

7.3.2 Sample measurement

Put the test specimen at the location 4 as shown in Figure 1 with its external (air) surface facing the incident beam and with its internal (cell) surface flushing against the sample port of the sphere. Perform a scan with the same instrument parameters as the calibration scans over the wavelength range from 280 nm to 1 250 nm with preferred wavelength interval of 1 nm. The spectral reflectance $R(\lambda)$ for each wavelength shall be obtained after being automatically corrected by the instrument's software using the 100 % line and 0 % line data.



a) Double beam **b) Single beam**

Key

1 reference beam

2 sample beam

3 light trap

4 sample/reflectance port

5 reference port

6 detector (at the bottom or on the top of the integrating sphere)

Figure 1 – Schematic of the integrating sphere for reflectance measurement