

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Measurement procedures for materials used in photovoltaic modules –
Part 1-7: Encapsulants – Test procedure of optical durability**

**Procédures de mesure des matériaux utilisés dans les modules
photovoltaïques –
Partie 1-7: Encapsulants – Procédure d'essai de la durabilité optique**



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IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**MEASUREMENT PROCEDURES FOR
MATERIALS USED IN PHOTOVOLTAIC MODULES –****Part 1-7: Encapsulants –
Test procedure of optical durability**

FOREWORD

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International Standard IEC 62788-1-7 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
82/1669/FDIS	82/1704/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 62788 series, published under the general title *Measurement procedures for materials used in photovoltaic modules*, 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- withdrawn,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

IEC 61215-2 (covering module design qualification and type approval) specifies a UV preconditioning of $54 \text{ MJ}\cdot\text{m}^{-2}$ ($15 \text{ kWh}\cdot\text{m}^{-2}$), which would be encountered after ~40 ideal sunny days of exposure to the AM1.5G UV spectrum in IEC 60904-3. IEC 61730-2 presently specifies 4x the same UV exposure, i.e., 5 months UV dose. The International PV Quality Assurance Task Force (PVQAT) leads global efforts to craft quality and reliability standards for solar energy technologies. These standards will allow stakeholders to quickly assess a solar photovoltaic (PV) module's performance and ability to withstand weather stresses, thereby reducing risk and adding confidence for those developing products, designing incentive programs, and determining private investments. As developed in conjunction with PVQAT, this part of IEC 62788-1 is intended to supplement module qualification, which typically covers reliability issues related to infant mortality, i.e., the first months of field use. This part of IEC 62788-1 may also facilitate the pre-qualification of encapsulation materials using coupon specimens, because long term weathering is not practical for larger module specimens. This part of IEC 62788-1 also importantly uses high fidelity UV irradiation (relative to the terrestrial solar spectrum), which is not practical to apply to module specimens (due to the lack of available commercial equipment and the anticipated cost of operation). This part of IEC 62788-1 is not presently specified for pre-qualification purposes in other standards, but may be used for that purpose by module manufacturers.

The optical performance (transmittance) of polymeric frontsheets and backsheets is not covered in this part of IEC 62788-1. These components are addressed in the IEC TS 62788-2.

MEASUREMENT PROCEDURES FOR MATERIALS USED IN PHOTOVOLTAIC MODULES –

Part 1-7: Encapsulants – Test procedure of optical durability

1 Scope

IEC 61215-2 provides a set of qualification tests that indicate that a PV module design is likely to be free of flaws that will result in early failure. However, IEC 61215-2 does not address the long term wear-out of PV modules. This part of IEC 62788-1 is designed as a more rigorous qualification test, using accelerated UV exposure at elevated temperature to determine whether polymeric encapsulants can suffer loss of optical transmittance. IEC 61215-2 already includes a UV preconditioning test (MQT 10), however, the parameters for that test only represent a limited level of exposure (~weeks of UV dose). This test procedure is intended for representative coupon specimens, applying stress at a greater intensity (designed relative to Phoenix, AZ), using a radiation spectrum that is more similar to the terrestrial solar spectrum, and using a duration of exposure that is more relevant to the PV application (i.e., equivalent to several years of outdoor exposure). This test quantifies the degradation rate of encapsulants so that the risk of the materials losing optical transmittance during operation in the terrestrial environments can be managed. The quantitative correlation between climate (or location of use), a specific application (utility-installation, residential-installation, roof-mount, rack-mount, use of a tracker, the system electrical configuration and its operation), and the test can be established for each specific encapsulant material, but is beyond the scope of this document.

The method herein is intended to qualify encapsulants for use in a PV module. This document is intended to apply to encapsulants used in PV modules deployed under temperature conditions of normal use, as defined in IEC TS 63126. The use of this method for encapsulants in modules deployed under conditions of higher temperature is specified elsewhere, for example IEC TS 63126. The method here is intended to be used to examine a particular encapsulant and does not cover incompatibilities between the encapsulant and other packaging materials. This document covers PV technology constructed using a transparent incident surface/encapsulant/photovoltaic device construction, the relevance to other geometries where the encapsulant layer is located behind the photovoltaic device layer, is outside the scope of this document. In the case of bifacial cell technology, the module can accept light from its front and back surfaces – the transmittance of a frontsheet (if used), encapsulant, and transparent backsheet (if used) is relevant for both active surfaces. The optical durability of frontsheets and backsheets, however, is addressed separately in the IEC TS 62788-2. Thin coatings that might be added for antireflection or anti-soiling purposes are outside the scope of this document. The method in this document can be used for other purposes (e.g., research and development); many details of alternate uses of the method (e.g., alternate test durations or measurement increments) are not described here.

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 61215-2, *Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 2: Test procedures*

IEC 61730-1, *Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction*

IEC TS 61836, *Solar photovoltaic energy systems – Terms, definitions and symbols*

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 wavelength*

IEC TS 62788-7-2, *Measurement procedures for materials used in photovoltaic modules – Part 7-2: Environmental exposures – Accelerated weathering tests of polymeric materials*

IEC TS 62915, *Photovoltaic (PV) modules – Type approval, design and safety qualification – Retesting*

IEC TS 63126¹, *Guidelines for qualifying PV modules, components, and materials for operation at high temperatures*

ISO 291, *Plastics – Standard atmospheres for conditioning and testing*

ASTM G7, *Standard practice for atmospheric environmental exposure testing of nonmetallic materials*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TS 61836 and IEC 61730-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

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

4 Principle

The total spectral transmittance shall be quantified using a spectrophotometer equipped with an integrating sphere (IEC 62788-1-4). Artificial weathering shall be performed at stable specified irradiance, temperature, and relative humidity conditions using an environmental chamber (IEC TS 62788-7-2). The changes in transmittance resulting from weathering shall be quantified using subsequent spectrophotometer measurement(s). The results of this artificial weathering test may be benchmarked against natural weathering, for example ASTM G7.

5 Apparatus

5.1 Spectrophotometer for transmittance measurements

A double beam or single beam spectrophotometer equipped with an integrating sphere and conforming to the requirements of IEC 62788-1-4 shall be used.

5.2 Environmental chamber for weathering

An artificial weathering apparatus shall be used, as specified in IEC TS 62788-7-2. The weathering apparatus shall meet the requirements of the artificial accelerated weathering method specified, for example IEC TS 62788-7-2, method A3.

¹ Under preparation. Stage at the time of publication: IEC/DTS 63126:2019.