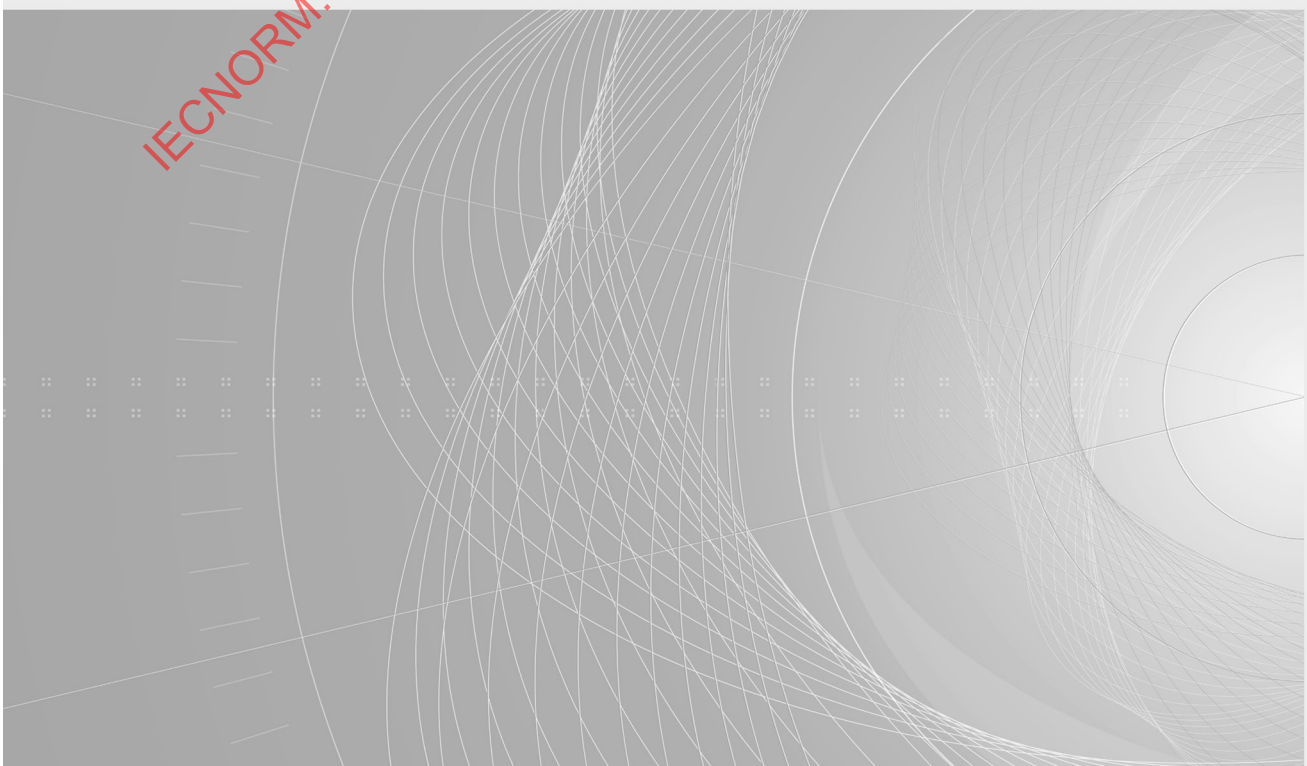
IEC TS 63209-2

Edition 1.0 2022-08

TECHNICAL SPECIFICATION

Photovoltaic modules – Extended-stress testing – Part 2: Polymeric component materials



IEC TS 63209-2:2022-08(en)

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Photovoltaic modules – Extended-stress testing – Part 2: Polymeric component materials

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 27.160

ISBN 978-2-8322-5293-2

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PHOTOVOLTAIC MODULES – EXTENDED-STRESS TESTING –

Part 2: Polymeric component materials

FOREWORD

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IEC TS 63209-2 been prepared by IEC technical committee 82: Solar photovoltaic energy systems. It is a Technical Specification.

The text of this Technical Specification: is based on the following documents:

Draft	Report on voting
82/2015/DTS	82/2058A/RVDTS

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Specification is English.

A list of all parts in the IEC 63209 series, published under the general title *Photovoltaic modules – Extended-stress testing*, can be found on the IEC website.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at http://www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under 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- withdrawn,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.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This document is intended as a guide for component suppliers, module manufacturers and downstream durability assessments, and focuses on polymeric materials in crystalline silicon module laminates.

IEC TS 63209 series describes environmental stress tests which provide data for evaluation of the long-term reliability of PV modules, probing areas not addressed in the IEC 61215 and IEC 61730 series. IEC TS 63209-1 provides a menu of extended environmental stress tests for PV modules, and this document, IEC TS 63209-2, describes complementary component level testing which probes degradation modes which are not easily understood or addressed by module level testing. This document additionally describes an overlapping suite of component level tests useful for screening individual components and component combinations for a specific bill of materials (BOM).

The testing in this document is intended for reliability evaluation only, with no pass/fail requirements.

This document does not describe any new test or stress exposures, but takes the single component testing described in the IEC 62788 series as a base line for stress exposures which are then extended. As degradation of one component can be influenced by other components (e.g. some backsheets tested with one encapsulant may perform differently than with another, and vice versa), a slate of BOM-specific tests and related stress exposures are included which are described in IEC 62788 component standards, but are not typically part of component data sheets.

This document details component level stress sequences, sample construction and evaluation test methods which can assist in a durability analysis. A particular focus is given to UV stress alone and in combination with other stressors. UV exposures, in particular, are difficult to perform accurately at the module level due to time and space constraints. Polymeric components are known to have UV-induced degradation modes which progress relatively slowly. Testing at a component level allows for smaller sample sizes, longer stress exposures, and test coupons designed to target relevant properties after applied stress.

PHOTOVOLTAIC MODULES – EXTENDED-STRESS TESTING –

Part 2: Polymeric component materials

1 Scope

This part of IEC TS 63209 includes a menu of tests to use for evaluation of the long-term reliability of materials used as backsheets and encapsulants in PV modules. It is intended to provide information to supplement the baseline testing defined in IEC 61215 and IEC 61730, which are qualification tests with pass-fail criteria. It may be used by PV stakeholders in conjunction with IEC TS 63209-1, to provide more extended stress testing of the component materials than can practically be accomplished with PV modules. The data set resulting from testing is used for reliability analysis and is not intended to be used as a pass-fail test procedure. This document addresses polymeric materials in the crystalline silicon module laminates, specifically backsheets and encapsulants in Glass/Glass or Glass/Backsheet modules. Although not specifically addressed, it is expected to also have applicability to thin film technologies.

The included environmental stress tests are intended to cause degradation that is most relevant to field experience, but these may not capture all failure modes which may be observed in various locations.

The individual component standards provide a starting point for testing, and baseline data for reference in this document may be available from a characterization sheet developed in accordance with the Uniform Characterization Forms (UCF) of IEC TS 62788-2 and IEC 62788-1-1. Extended tests using the same methods allows for trend analysis.

Additional testing is included to address interactions with other polymeric packaging material, as individual components can perform differently depending on adjacent materials. These tests are designed with BOM-specific coupons and mini-modules, intended to complement the specific module bill of materials used in the IEC TS 63209-1 module tests.

As both test specimen form factor and I-V characteristics can play a role in degradation, some multicomponent tests are designed to use a polymeric stack, while others use mini-modules.

The included stress tests are not designed to test to failure, but to be representative of stress levels of the long-term application.

These tests are not intended to provide service life estimates, or to be indicative of fitness for use in specific climate/mounting configurations. For example, the same module deployed in two different locations or with different mounting methods may degrade in different ways, so a single test protocol cannot be expected to exactly match the performance in both environments; correlation to field will depend upon where and how the product is deployed.

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 TS 60904-13:2018, *Photovoltaic devices – Part 13: Electroluminescence of photovoltaic modules*

IEC 61215-1-1:2021, *Terrestrial photovoltaic (PV) modules – Design qualification and type approval -Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules*

IEC 61215-2:2021, *Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 2: Test procedures*

IEC 61730-2, *Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing*

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

IEC 62788-1-1, *Measurement procedures for materials used in photovoltaic modules – Part 1-1: Encapsulants – Polymeric materials used for encapsulants*

IEC 62788-1-6, *Measurement procedures for materials used in photovoltaic modules – Part 1-6: Encapsulants – Test methods for determining the degree of cure in ethylene-vinyl acetate*

IEC 62788-1-7:2020, *Measurement procedures for materials used in photovoltaic modules – Part 1-7: Encapsulants – Test procedure of optical durability*

IEC TS 62788-2, *Measurement procedures for materials used in photovoltaic modules – Part 2: Polymeric materials – Frontsheets and backsheets*

IEC TS 62788-6-3, *Measurement procedures for materials used in photovoltaic modules – Part 6-3: Adhesion testing of interfaces within PV modules*

IEC TS 62788-7-2:2017, *Measurement procedures for materials used in photovoltaic modules – Part 7-2: Environmental exposures – Accelerated weathering tests of polymeric materials*

IEC TS 62804-1, *Photovoltaic (PV) modules – Test methods for the detection of potential-induced degradation – Part 1: Crystalline silicon*

IEC TS 63209-1:2021, *Photovoltaic modules – Extended-stress testing – Part 1:* Modules

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TS 62788-2, IEC 62788-1-1, IEC 62788-1-7, IEC TS 63209-1, IEC TS 61836 along with the following 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

3.1
Bill of Materials
BOM
list of the specific materials used to build a specific PV module, excluding equal alternates

3.2
Uniform Characterization Form
UCF
list of properties to be evaluated according to the tests in this document

3.3
Single Cantilever Beam
SCB
adhesion test using a single cantilever beam as described in IEC TS 62788-6-3

4 Failure modes and component interactions

Degradation of polymeric materials can occur both by chemical changes to a specific material, such as thermo-oxidative degradation, hydrolysis, photolysis, and by morphological changes, such as reordering of type or degree of crystallinity, which can significantly alter key properties. Subsequent mechanical, thermo-mechanical, or hydromechanical stresses such as obtained with thermal cycling, coefficient of thermal expansion (CTE) differentials, or from volume changes associated with moisture ingress/egress, can then induce physical degradation, such as delamination and cracking. Observed failure modes for backsheets and encapsulants are shown in Table 1.

Degradation of single components is evaluated by monitoring changes to key characteristics after single stresses (exposure to damp heat (DH), thermal, and ultraviolet (UV) as specified in the IEC 62788 series, using the Xe exposures defined in IEC TS 62788-7-2. In this document, the UV stress is extended and includes multiple data points to observe changes and allow for extrapolation to longer UV exposures. Specifics are detailed in the individual single component sections.

Observed failure modes of backsheets and encapsulants include: frontside (through glass) cracking, backside cracking, interlayer delamination, and discoloration as well as delamination and increased optical absorption of the encapsulant.

Failure modes can be influenced by other module components (see Bibliography for references providing pictures and more details). These interactions can result in both positive and negative effects as shown in Table 1. BOM specific testing is used to evaluate these effects, and adhesion.

Table 1 – Encapsulant and backsheet failure modes

Component	Degradation mode	Interactions with other components
Backsheet	cell side yellowing	**encapsulant** plus: UV filter minus: chemical interactions with base polymer, additives or impurities
	cell side cracking	
	backsheet / encapsulant delamination	
	loss of transmission (clear)	
	interlayer delamination	n/a
	air side yellowing	n/a
		encapsulant, connectors, cells • connectors provide localized stress points which can induce cracks • thickness and compliance of encapsulant can mitigate the stress from cell edges/connectors
	cell side and air side cracking	**encapsulant, connectors, cells** • connectors provide localized stress points • additive effects
Encapsulant	yellowing	**glass/backsheet** • oxygen transmission effects • additive effects
	transmission loss (non-yellowing)	**backsheet** • additive effects
	adhesion to glass	**glass** • glass treatment (adhesion promoter)
	adhesion to cell – front side	**cell**
	adhesion to cell – back side	**cell**
	adhesion to backsheet	**backsheet**

5 Selection of tests

This document contains a menu of tests, which are intended to supply information to supplement the reliability data obtained in IEC TS 63209-1. Users can select relevant tests from this list which are relevant to the targeted application. All test data is to be reported, with no pass/fail criterion applied.

6 Single component testing

6.1 Extended test procedures

This clause describes test for encapsulants and backsheets. Evaluation methods and stress exposure setpoints are the same as in the referenced IEC 62788 series specifications as shown in Table 2, with some stress durations extended from the referenced specifications.

Properties which are useful for evaluation of long-term durability of backsheets include both direct visual observations, e.g. of cracks or delamination, and secondary characteristics which inform as to the propensity to crack or delaminate. Quantitative property measurements are used to determine relative changes to project trends after stress exposures. Characterization methods for backsheets are provided in IEC TS 62788-2.

Optical transmission is the primary property for evaluating long term durability of encapsulants as a single component. This characterization method is provided in IEC 62788-1-7.

IEC TS 62788-2 and IEC 62788-1-1 specify environmental stress exposures for single component testing of backsheets and encapsulants. This document provides extended stresses for some of these tests, as shown in Table 2, in the column headed by “extended”.

Table 2 – Single component testing

Component	Specimen	Stress	Hours		Evaluation methods	Reference
			base	extended		
Backsheet	BS	DH	1 000 h		visual, mechanical, transmittance[2]	IEC TS 62788-2[1]
	G/E1/E1/BS	A3 UVX (front)[3]	4 000h	6 000 h	visual, transmittance[2]	
	G/E1/E1/(trm)/BS	A3 UVX (front)[3]	4 000 h	6 000 h	visual, mechanical, transmittance[2]	
	BS	A3 UVX (back)[3]	2 000 h	4 000 h	visual, mechanical, transmittance[2]	
	Inter layer adhesion	DH	1 000		either 180 peel OR SCB	
	RUI layers (RTI)	thermal	not applicable		mechanical	
	RUI layers (thermal failsafe)	120 °C	2 000 h		mechanical	
Encapsulant(s)	G/E1/G	A3 UVX (front)	4 000 h	6 000 h	Transmittance[2], visual, yellowness, UV cutoff	IEC 62788-1-7
	G/E2/G					

[1] When called for, the encapsulant is considered representative of others with same UV cut-on wavelength specified as in IEC TS 62788-2.

[2] Property measured for clear backsheets and encapsulants.

[3] IEC TS 62788-2 refers to “air side” for back side exposures, and “sun-facing side” for front side exposures.

G: Glass; E: Encapsulant; BS: Backsheet; trm: transparent release material as in IEC TS 62788-2;

A3: UV Xe exposure condition in IEC TS 62788-7-2.

6.2 Reporting of single component durability properties

6.2.1 Product identification

The following information shall be included in the documentation:

a) If testing was performed as an extension to IEC TS 63209-1 testing for a specific module model, include the module name, registered trade name, or registered trademark of manufacturer, and type or model number designation.

b) Type designation of backsheet, encapsulant and cell.

c) Name, address and contact information of the component manufacturers or importers.

6.2.2 Reliability test data

Report all data from selected tests. No pass-fail criteria shall be applied.

UV/xenon testing as described in IEC TS 62788-7-2:2017.

Backsheets (IEC TS 62788-2).

UCF No. 1, 2 tensile strength and elongation at break (average and standard deviation)

- unexposed

- after 1 000 h DH testing
- after 2 000 h, 4 000 h, and 6 000 h xenon weathering (front side exposures)
- after 2 000 h, 4 000 h xenon weathering (rear side exposures)

UCF No. 3, 4 interlayer adhesion

- unexposed
- after 1 000 h DH testing

UCF No. 5 (on individual RUI layers) RTE, RTI or TI (Elongation at break), OR thermal failsafe test:

- unexposed
- after 2 000 h at 120 ˚C

UCF No. 6, 7, 8 colour or transmittance

- unexposed
- after 1 000 h DH testing
- after 2 000 h, 4 000 h, and 6 000 h xenon weathering (front side exposures)
- after 2 000 h, 4 000 h xenon weathering (rear side exposures)

Encapsulants (IEC 62788-1-1)

UCF No. 9 transmission or colour

- unexposed
- after 2 000 h, 4 000 h, 6 000 h xenon weathering

7 BOM specific testing

7.1 Test procedures – test coupons

This clause describes test for encapsulants and backsheets and cells with the combination as specified in a module's Bill of Material (BOM). It is recommended that the same glass is used in the test coupon as in the module; as this can be difficult, a different product of the same type (base composition, surface texture, heat treatment) is allowed, if after solarization, the UV cut-off is the same or lower than that of the module glass. If testing adhesion between encapsulant and glass, same glass shall be used to get relevant information.

Evaluation methods and stress exposure setpoints are the same as in the referenced IEC 62788 series specifications as shown in Table 3 for glass/backsheet module designs, and Table 4 for glass/glass designs. Stress durations are extended from the referenced specifications.

Properties which are useful for evaluation of long-term durability of backsheets/encapsulant combinations include both direct visual observation, e.g. of cracks or delamination, and adhesion. Test coupon preparations and characterization methods are referenced from IEC TS 62788-2 and IEC 62788-1-1.

IEC TS 62788-2 and IEC 62788-1-1 specify environmental stress exposures for laminate structures. This document provides extended stresses for some of these tests, as shown in the column headed by "extended" in Table 3 for glass/backsheet modules, and in Table 4 for glass/glass modules.

Table 3 – BOM specific tests for Glass/Backsheet cSi modules

Component, failure mode	Specimen	Stress	Hours		Evaluation methods	Reference
			base	extended		
BS cracking (back)	G/E/E/BS (w/solder wire)	A3 1 000 / 200 TC	2x	3x	visual	IEC TS 62788-2
BS cracking (front)	G/E/E/BS* (w/solder wire)					
BS cracking (back), delamination	mini-module	DH200/ (A3 (back) 1 000/TC50/HF10), 3 times A3 100 (high fidelity version of IEC TS 63209-1:2021, 6.5			visual IEC 61215-2: MQT 03 Insulation test MQT 15 Wet leakage test	IEC TS 63209-1[1]
BS cracking (front), delamination	mini-module	DH200/ (A3 (front)-2 000/TC50/HF10), 3 times A3 100				
BS-E2	G/E1/E2/BS	DH	1 000	DH500/	Adhesion testing: Single cantilever beam test (IEC TS 62788-6-3) OR 180˚ peel	IEC TS 62788-6-3
		A3 (front)	2 000	A3 2 000/ DH 1 000		
E1-E2	G/E1E2/glass slide	DH500/ A3 2 000/ DH 1 000	1x	2X		IEC TS 62788-6-3 IEC 62788-1-1
E1-cell	G/E1/cell					
E1-glass	G/E1/glass slide					
G-E1-cell-E2-BS	mini-module	± V, DH light recovery	96	192	PID[2]	IEC 61215-2, MQT 21 IEC TS 63209-1
G: Glass; E: Encapsulant; BS: Backsheet, trm: transparent release material as in IEC TS 62788-2. A3: UV Xe exposure condition in IEC TS 62788-7-2.						

[1] The sequence is as described in IEC TS 63209-1, except using a high fidelity version of the UV exposure as in the A3 condition in IEC TS 62788-2.

[2] PID tests performed on coupons or minimodules will have different results from module-level tests; tests may be useful to evaluate the effect of backsheets or components.

Table 4 – BOM specific tests for Glass/Glass cSi modules

Degradation mode	Specimen	Stress	Hours		Evaluation methods
			base	extended	
Adhesion					
E1-E2	G/E2/E1/glass slide	DH500/	1x	2X	SCB (IEC TS 62788-6-3)
E1-cell	G/E1/cell	A3 2 000/	1x	2x	
E1-glass	G/E1/glass slide	DH 1 000	1x	2x	
Delamination	mini-module	DH200/ (A3 (back) 1 000/TC50/HF10), 3 times A3 100 (high fidelity version of IEC TS 63209-1:2021, 6.5			visual IEC 61215-2: MQT 03 Insulation test MQT 15 Wet leakage current test IEC 61730-2:
Delamination	mini-module	DH200/ (A3 (front)-2 000/TC50/HF10), 3 times A3 100			
PID*	mini-module	HV± w/DH, light recovery	96	192	IEC 61215-2 IEC 61215-1-1 IEC TS 63209-1
G: Glass; E: Encapsulant; BS: Backsheet, trm: transparent release material as in IEC TS 62788-2. A3: UV Xe exposure condition in IEC TS 62788-7-2.					
* PID tests performed on coupons or minimodules will have different results from module-level tests; tests may be useful to evaluate the effect of backsheets or components.					

7.2 Test procedure – mini-modules

7.2.1 Mini-module design

The mini-module shall be designed to be as similar as possible to the design of the full-size module. As an example, for conventional silicon modules, the mini-module will include:

- Use of the same bill of materials
- Use of lamination conditions to achieve a similar degree of cure as in the module (IEC 62788-1-6)
- Use of same spacing between cells and between the cells and the edge of the glass; if a deviation is required, spacings should be at least as large as in the full-size module
- Use of same cell-interconnection geometries
- Use of same junction box and other metal-interconnect (bus wires, etc.) geometries
- The number of cells is left to the user to define; recommendations for each test are below.

Figure 1 shows the relevant design parameters for one-cell and four-cell mini-modules. In every case, the goal is to design a mini-module that will be as similar as possible to the full-size modules with special attention to the stresses that may occur for the backsheet and other polymeric materials. The parameters for both the referenced module and the mini-module shall be reported for comparison.

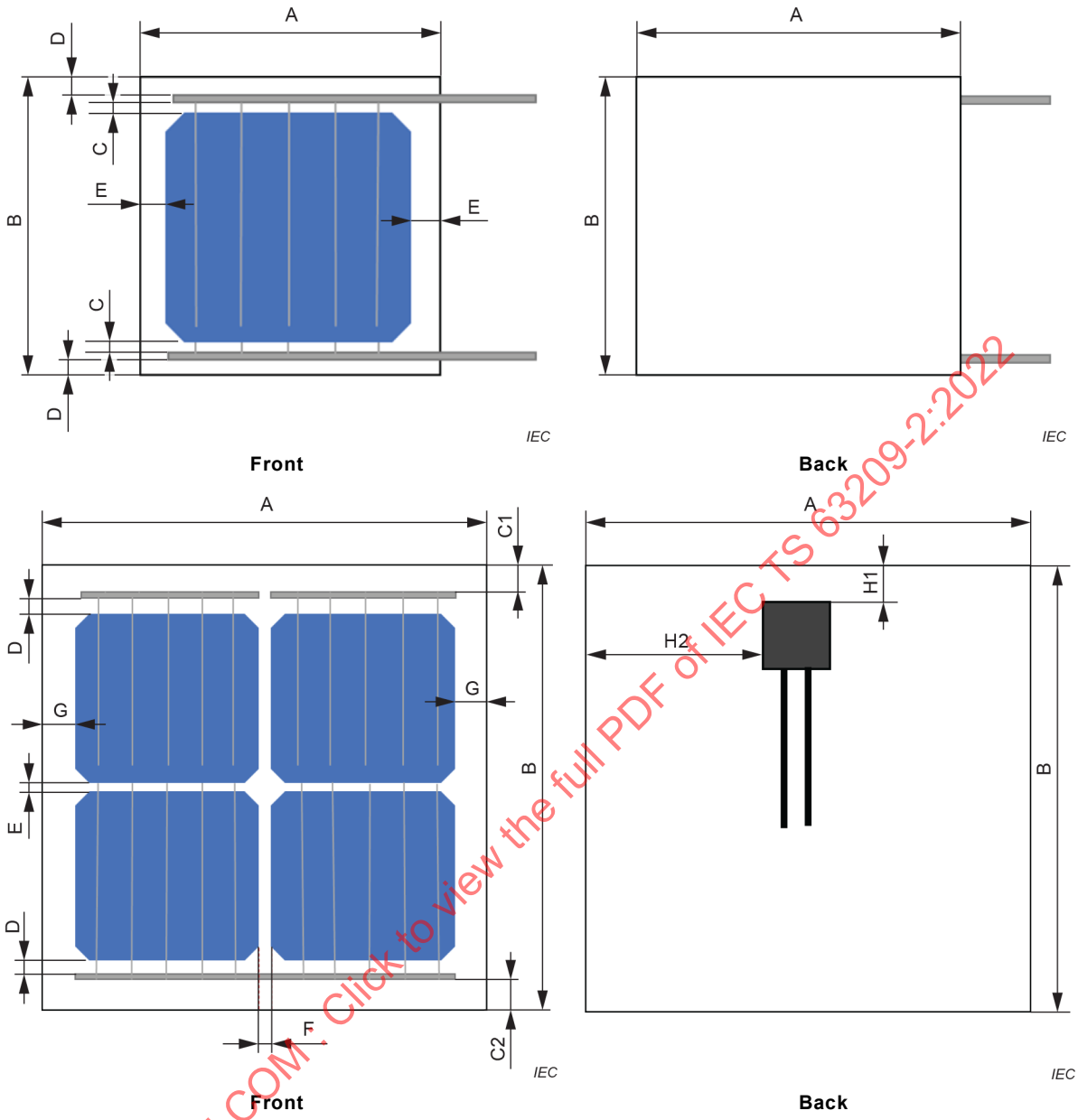

Figure 1 – Mini-module design parameters, 1-cell and 4-cell

7.2.2 Mini-module testing

7.2.2.1 UV sequential stress

Mini-module size is limited by the xenon exposure chamber. A single cell mini-module is recommended for larger cell sizes. An alternate approach is to use cut cells which will reduce the size of the mini-module; this allows for a smaller size while still maintaining the spacing between the cells and allows characterization of the areas between the cells.

The backside sequence is shown in Table 3 and Table 4, and is the same as described in IEC TS 63209-1, except that a high-fidelity light source (A3 from IEC TS 62788-7-2) is required.

The frontside sequence is shown in Table 3 and Table 4, and is the same sequence as the backside exposure, except the duration of each UV step is 2 000 h (double the duration of the UV step in the backside sequence).

7.2.2.2 PID

This test is intended only for use in screening components for effects on PID performance, and is not to be considered a replacement for the PID testing in IEC TS 63209-1. PID testing of a mini-module is not expected to directly match or correlate to PID testing of a full-size module. It can provide useful comparative information about the effects of encapsulant, backsheet and cell combinations on PID.

The PID test is carried out as described in IEC TS 63209-1, using mini-modules. One cell mini-modules are recommended. If an unframed minimodule is used, electrical bias at the edges shall be applied as in IEC TS 62804-1.

7.3 Reporting of BOM specific tests

7.3.1 Product identification

The following information shall be included in the documentation:

a) If testing was performed as an extension to IEC TS 63209 testing for a specific module model, include the module name, registered trade name, or registered trademark of manufacturer, and type or model number designation.

b) Type designation of backsheet, encapsulant and cell.

c) Name, address and contact information of the component manufacturers or importers.

d) If mini-module testing is included, the mini-module design parameters versus reference model spec as in Table 5; for alternative designs a similar comparison of the relevant parameters for the mini-module and reference module design shall be included.

Table 5 – Mini-module design parameters

Parameter (from Figure 1)		Width mm	
		Module design	Mini-module
A	Width		
B	Length		
C1	Edge to bus bar (top)		
C2	Edge to bus bar (bottom)		
D	Bus bar to cell		
E	Between cells (lengthwise)		
F	Between cells (widthwise)		
G	Edge to cell		
H1	Junction box to top edge		
H2	Junction box to left side edge		
	Cell size (width and height)		
	Number of cells, and configuration (for four cell mini-module)		

7.3.2 Reliability test data

Report all data from selected tests. No pass-fail criteria shall be applied.

- Solder bump test:
  - After each stress step, visual examination with semiquantitative rating as described in IEC TS 62788-2.

- Adhesion tests:
  - Interface targeted, and interface which failed (as defined in IEC TS 62788-2 and IEC 62788-1-1).
  - For 180˚ peel, report the peel strength (average and standard deviation) as described in IEC 62788-1-1.
  - For single cantilevered beam, report the adhesion energy (average and standard deviation as described in IEC 62788-1-1).
- Mini-module UV sequential exposure test:
  - IEC 61215-2:2021, MQT 01 Visual inspection (4.1) is completed after each stress step, with the addition of the inspection using magnification.
  - Other characterization may be completed, especially if visual change is noted. Power measurement and electroluminescence are omitted as they are unlikely to correlate with field performance of the backsheet.
  - Report the values from the following characterizations, completed at the end of the entire sequence (in addition to the final Visual inspection).
    i) IEC 61215-2:2021, MQT 03 Insulation test (4.3);
    ii) IEC 61215-2:2021, MQT 15 Wet leakage current test (4.15).
- PID test (only for extended component screening; not for module reliability analysis to complement IEC TS 63209-1)
  - IEC 61215-2:2021, MQT 01 Visual inspection (4.1).
  - IEC 61215-2:2021, MQT 19.2 Final stabilization (4.19.6).
  - IEC 61215-2:2021, MQT 06.1 Performance at STC and MQT 07 Performance at low irradiance, (4.7).
  - IEC 61215-2:2021, MQT 03 Insulation test (4.3).
  - IEC 61215-2.2021, MQT 15 Wet leakage current test (4.15.7).
  - Electroluminescent imaging according to IEC TS 60904-13:2018.

8 Uniform Characterization Form

8.1 General

The Uniform Characterization Form provides an extensive overview of properties related to long term performance of encapsulants, backsheets alone or in BOM combinations.

The UCF shall be prepared containing the results of the selected tests. Furthermore, an UCF shall include at least the following information:

a) a title;
b) name and address of the test laboratory and location where the tests were carried out;
c) unique identification of the report and each of its pages;
d) name and address of client, where appropriate;
e) if testing was performed as an extension to IEC TS 63209-1 testing for a specific module model, include the module name, registered trade name, or registered trademark of manufacturer, and type or model number designation;
f) description and identification of the BOM components (in the case of modules using two encapsulants, designate which is adjacent to the front glass, and which is adjacent to the rear glass or backsheet);
g) if mini-module testing is included, a description of the mini-module design (as in 7.3.1);
h) characterization and condition of the materials;
i) date of receipt of test item and date(s) of test, where appropriate;

j) identification of test method used;

k) reference to sampling procedure, where relevant;

l) any deviations from, additions to, or exclusions from, the test method and any other information relevant to a specific test;

m) measurements, examinations, and derived results supported by tables, graphs, sketches and photographs as appropriate;

n) statement of the estimated uncertainty of the test results (where relevant);

o) a signature and title, or equivalent identification of the person(s) accepting responsibility for the content of the report, and the date of issue;

p) where relevant, a statement to the effect that the results relate only to the items tested;

q) a statement that the report shall not be reproduced except in full, without the written approval of the laboratory.

8.2 Material test results and reporting requirements

The UCF shall be given as tabular overview of results according to Table 6 and Table 7. In the full document the table is followed by details of the test conditions as defined by the reporting requirements per test item, referencing items via the UCF number in the first column of the table. Table 6 defines the uniform characterization form for recommended (✓) or optional (O) material evaluation and ageing tests. Reported data shall include tolerances as given by reporting requirements of each test method.