

# TECHNICAL SPECIFICATION

**Nanomanufacturing – Reliability assessment –  
Part 4-1: Nanophotonic products – Optical stability test of quantum dot enabled  
light conversion films: Temperature, humidity and light exposure**

Document Preview

[IEC TS 62876-4-1:2025](https://standards.iteh.ai/catalog/standards/iec/30c3617c-f95b-4022-8b78-7c9caaf1f9a8/iec-ts-62876-4-1-2025)

<https://standards.iteh.ai/catalog/standards/iec/30c3617c-f95b-4022-8b78-7c9caaf1f9a8/iec-ts-62876-4-1-2025>



**THIS PUBLICATION IS COPYRIGHT PROTECTED**  
**Copyright © 2025 IEC, Geneva, Switzerland**

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

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

Tel.: +41 22 919 02 11  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

**About the IEC**

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

**About IEC publications**

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

**IEC publications search - [webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)**

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

**IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)**

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

**IEC Customer Service Centre - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)**

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: [sales@iec.ch](mailto:sales@iec.ch).

**IEC Products & Services Portal - [products.iec.ch](http://products.iec.ch)**

Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

**Electropedia - [www.electropedia.org](http://www.electropedia.org)**

The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

International  
Standards  
Document Preview  
[standards.iteh.ai](http://standards.iteh.ai)

[IEC TS 62876-4-1:2025](http://standards.iteh.ai/catalog/standards/iec/30c3617c-f95b-4022-8b78-7c9caaf1f9a8/iec-ts-62876-4-1-2025)

<https://standards.iteh.ai/catalog/standards/iec/30c3617c-f95b-4022-8b78-7c9caaf1f9a8/iec-ts-62876-4-1-2025>

# TECHNICAL SPECIFICATION

---

**Nanomanufacturing – Reliability assessment –  
Part 4-1: Nanophotonic products – Optical stability test of quantum dot enabled  
light conversion films: Temperature, humidity and light exposure**

Document Preview

[IEC TS 62876-4-1:2025](https://standards.iteh.ai/catalog/standards/iec/30c3617c-f95b-4022-8b78-7c9caaf1f9a8/iec-ts-62876-4-1-2025)

<https://standards.iteh.ai/catalog/standards/iec/30c3617c-f95b-4022-8b78-7c9caaf1f9a8/iec-ts-62876-4-1-2025>

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

---

ICS 07.120

ISBN 978-2-8327-0165-2

**Warning! Make sure that you obtained this publication from an authorized distributor.**

## CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references .....	7
3 Terms, definitions and abbreviated terms .....	8
3.1 Terms and definitions.....	8
3.2 Abbreviated terms.....	8
4 General requirements .....	8
4.1 Q-LCF.....	8
4.2 Tests .....	9
4.2.1 General .....	9
4.2.2 Quantity of specimens .....	10
4.2.3 Equipment specifications .....	10
4.2.4 Test methods.....	10
4.2.5 Caution.....	11
4.3 Measurements .....	11
4.3.1 General .....	11
4.3.2 General testing conditions .....	12
4.3.3 Measurement instrument specifications .....	12
4.3.4 Conditioning .....	12
4.3.5 Data collection.....	12
4.3.6 Measurement methods of Q-LCFs in simulated direct-lit BLU.....	13
4.3.7 Measurement methods of width of invalid edge.....	13
4.3.8 Pass or fail criteria.....	14
5 Test methods.....	14
5.1 T1 – High temperature and blue light exposure .....	14
5.1.1 Purpose.....	14
5.1.2 Temperature and light.....	14
5.1.3 Data logging .....	14
5.1.4 Output .....	15
5.1.5 Required equipment .....	15
5.2 T2 – Damp heat and blue light exposure .....	15
5.2.1 Purpose.....	15
5.2.2 Temperature, humidity and light.....	15
5.2.3 Data logging .....	15
5.2.4 Output .....	16
5.2.5 Required equipment .....	16
5.3 T3 – Damp heat .....	16
5.3.1 Purpose.....	16
5.3.2 Procedure.....	16
5.3.3 Temperature and humidity .....	16
5.3.4 Data logging .....	16
5.3.5 Output .....	16
5.3.6 Required equipment .....	16
5.4 T4 – Low temperature .....	16
5.4.1 Purpose.....	16

5.4.2	Temperature .....	16
5.4.3	Data logging .....	16
5.4.4	Output .....	17
5.4.5	Required equipment .....	17
5.5	T5 – Thermal cycling.....	17
5.5.1	Purpose .....	17
5.5.2	Temperature .....	17
5.5.3	Data logging .....	17
5.5.4	Output .....	17
5.5.5	Required equipment .....	17
6	Report .....	18
Annex A (informative) Case study of Q-LCF reliability assessment .....		19
A.1	Test sample .....	19
A.2	Test method.....	19
A.3	Test results .....	19
Bibliography.....		24
Figure 1 – Overview of stresses that Q-LCF are exposed to in service environments .....		9
Figure 2 – General reliability test procedure.....		9
Figure 3 – Example of measurement setup for invalid edge .....		13
Figure 4 – Lighting assembly .....		15
Figure A.1 – Trend plots of Q-LCFs during accelerated aging tests.....		23
Table 1 – Summary of stresses utilized in this document .....		10
Table 2 – Summary overview of relevant test methods and main control parameters .....		11
Table 3 – Pass or fail criteria .....		14
Table A.1 – Test results of Q-LCF accelerated aging tests.....		19

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**NANOMANUFACTURING –  
RELIABILITY ASSESSMENT –**

**Part 4-1: Nanophotonic products – Optical stability test of quantum dot enabled light conversion films: Temperature, humidity and light exposure**

## FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC TS 62876-4-1 has been prepared by IEC technical committee 113: Nanotechnology for electrotechnical products and systems. It is a Technical Specification.

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

Draft	Report on voting
113/866/DTS	113/886/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.

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](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/publications](http://www.iec.ch/publications).

A list of all parts in the IEC 62876 series, published under the general title *Nanomanufacturing – Reliability assessment*, 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 [webstore.iec.ch](http://webstore.iec.ch) in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

## iTeh Standards (<https://standards.iteh.ai>) Document Preview

[IEC TS 62876-4-1:2025](https://standards.iteh.ai/catalog/standards/iec/30c3617c-f95b-4022-8b78-7c9caaf1f9a8/iec-ts-62876-4-1-2025)

<https://standards.iteh.ai/catalog/standards/iec/30c3617c-f95b-4022-8b78-7c9caaf1f9a8/iec-ts-62876-4-1-2025>

## INTRODUCTION

Quantum dots (QDs), as luminescent nanomaterials, exhibit broad absorption spectra and narrow emission spectra. Using the same excitation source to excite QDs of different particle size, it is possible to emit spectra with different peak wavelengths. Based on the above characteristics, QDs are used in display products, which can greatly improve the display colour gamut.

Nowadays, as a typical product of quantum dot technology application, quantum dot enabled light conversion film (Q-LCF) is widely used in the display field. Under normal working conditions, Q-LCF in a backlight module will be continuously irradiated by high-energy excitation light (such as blue light) to emit converted light. Under the combined action of water vapour and oxygen from the environment, the optical properties of the QDs in Q-LCF will slowly deteriorate. In order to ensure the quality and stability of Q-LCF products, it is essential to scientifically design a reliability test standard to evaluate product quality. Reliability assessment can be used, for example, to authorize advancement to the next step in product development, or to authorize progress payments, or to proceed with delivery and acceptance of products.

This document provides reliability test and evaluation criteria for Q-LCF. In this document, Q-LCFs are used as the test objects. Accelerated aging tests containing stress factors of temperature, humidity, light are imposed on the test objects to obtain performance shift data and change trend.

**iTeh Standards**  
**(<https://standards.iteh.ai>)**  
**Document Preview**

[IEC TS 62876-4-1:2025](https://standards.iteh.ai/catalog/standards/iec/30c3617c-f95b-4022-8b78-7c9caaf1f9a8/iec-ts-62876-4-1-2025)

<https://standards.iteh.ai/catalog/standards/iec/30c3617c-f95b-4022-8b78-7c9caaf1f9a8/iec-ts-62876-4-1-2025>



## NANOMANUFACTURING – RELIABILITY ASSESSMENT –

### Part 4-1: Nanophotonic products – Optical stability test of quantum dot enabled light conversion films: Temperature, humidity and light exposure

#### 1 Scope

This part of IEC 62876, which is a Technical Specification, establishes a general reliability testing programme to verify the reliability of the performance of quantum dots nanomaterials, and quantum dot enabled light conversion films (Q-LCFs).

The Q-LCF is used as subassemblies for the fabrication of nano-enabled photoelectrical display devices, mainly liquid crystal display (LCD) currently, with other components.

This testing programme defines standardized aging conditions, methodologies and data assessment for Q-LCF product.

The results of these tests define a stability under standardized aging conditions for quantitative evaluation of the reliability of the Q-LCF.

The procedures specified in this document were designed for Q-LCF but can be extended to serve as a guideline for other kinds of light conversion films or related subassemblies as well.

#### 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 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-27:2008, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60068-2-78:2012, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC TS 62565-4-4:2025, *Nanomanufacturing – Product specifications – Part 4-4: Nanophotonic products – Blank detail specifications: Quantum dot enabled light conversion films*

IEC 62595-2-1:2016, *Display lighting unit – Part 2-1: Electro-optical measuring methods of LED backlight unit*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

### 3 Terms, definitions and abbreviated terms

#### 3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

##### 3.1.1

##### **quantum dot**

##### **QD**

crystalline nanoparticle that exhibits size-dependent properties due to quantum confinement effects on the electronic states

[SOURCE: ISO/TS 27687:2008, 4.7]

##### 3.1.2

##### **quantum dot enabled light conversion film**

##### **Q-LCF**

optical film based on quantum dots that converts high energy light at a particular wavelength into low energy light at another wavelength

##### 3.1.3

##### **invalid edge**

edge of Q-LCF with a significant decline in optical performance, failing to function

#### 3.2 Abbreviated terms

BLU	backlight unit
FWHM	full width at half maxima
LCE	light conversion efficiency
QD	quantum dot
Q-LCF	quantum dot enabled light conversion film
$\lambda_p$	peak wavelength
$L_v$	luminance

### 4 General requirements

#### 4.1 Q-LCF

The Q-LCF is typically an individual subassembly which will be used by an assembler to fabricate display panel product to be sold to the end user. The purpose of this document is to assess the reliability of the Q-LCF. The test samples shall be selected randomly from a group of films cut from a big Q-LCF in a clean environment such that test samples are representative for the ensemble film. The physical size of the samples shall be no less than 18 cm × 18 cm. The samples shall not show visible curling, cracking, damage, wrinkles, and no scratches or dirt on the surface.