IEC 63203-301-1

Edition 1.0 2024-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Wearable electronic devices and technologies –
Part 301-1: Test method of electrochromic films for wearable equipment**

**Technologies et dispositifs électroniques prêts-à-porter –
Partie 301-1: Méthode d'essai des films électrochromes pour les équipements prêts-à-porter**

IEC 63203-301-1:2024-03(en-fr)

IEC 63203-301-1

Edition 1.0 2024-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Wearable electronic devices and technologies –
Part 301-1: Test method of electrochromic films for wearable equipment

Technologies et dispositifs électroniques prêts-à-porter –
Partie 301-1: Méthode d'essai des films électrochromes pour les équipements prêts-à-porter

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 59.080.80

ISBN 978-2-8322-8461-2

Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

WEARABLE ELECTRONIC DEVICES AND TECHNOLOGIES –

Part 301-1: Test method of electrochromic films for wearable equipment

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 63203-301-1 has been prepared by IEC technical committee 124: Wearable electronic devices and technologies. It is an International Standard.

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

Draft	Report on voting
124/263/FDIS	124/273/RVD

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 International Standard 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. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 63203 series, published under the general title *Wearable electronic devices and technologies*, 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 in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

WEARABLE ELECTRONIC DEVICES AND TECHNOLOGIES –

Part 301-1: Test method of electrochromic films for wearable equipment

1 Scope

This part of IEC 63203-301-1 specifies procedures and definitions for the test method of electrochromic films for wearable equipment. This document deals with the colour changing range in visible light and the electrochromic properties of transmittance, response time and evaluation method of long-term stability. This document excludes applications of electrochromic films to displays.

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 60068-1, *Environmental testing – Part 1: General and guidance*

3 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
transmittance
ratio of transmitted power to incident power for given conditions of spectral composition, polarization and geometrical distribution

Note 1 to entry: In optics, frequently expressed as transmittance density or as a percentage. In communication applications, generally expressed in decibels.

[SOURCE: IEC 60050-731:1991, 731-03-31]

3.2
response time
time from a sudden change of a control quantity until the corresponding change of an output quantity has reached a specified fraction of its final value

[SOURCE: IEC 60050-431:1980, 431-02-12]

3.3
darkening time
time when a control quality suddenly becomes saturated until the corresponding change of an output quantity has reached a dark stage of its final value

3.4
bleaching time
time from a sudden change of a control quantity until such time as the corresponding change of an output quantity has reached a bright stage of its final value

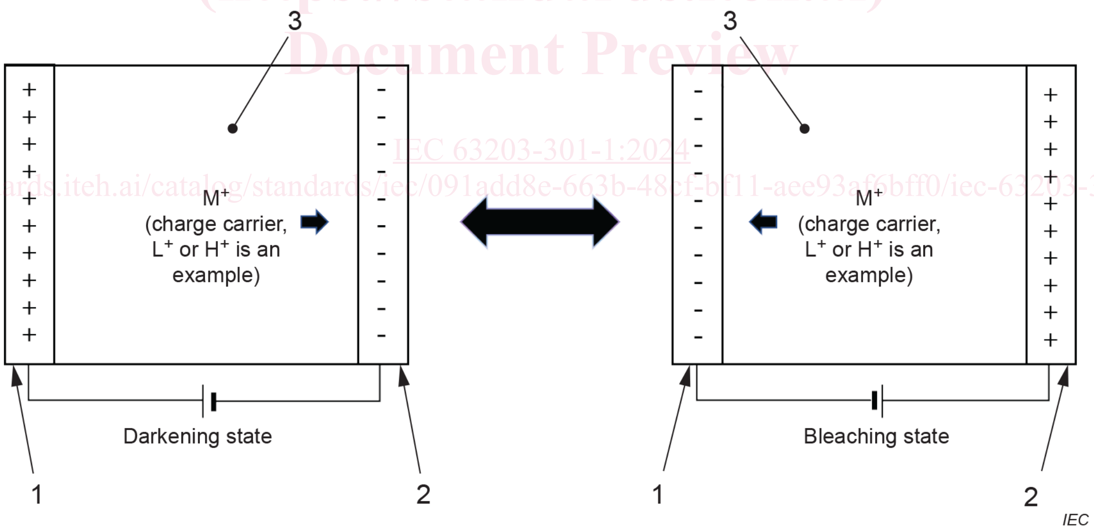
3.5
long-term stability
property of the electrochromic system which implies that for a sufficiently small initial displacement from the rest position or for a sufficiently small disturbance the state variables remain within a sufficiently small neighbourhood of the rest position in the long term

4 Test method of electrochromic films for wearable equipment

4.1 Overview

The electrochromic films have such characteristics that as the ions of H^+ or Li^+ (H^+ or Li^+ is given by way of example) are injected or released by application of an electric field the films change colour. Figure 1 shows the two statuses of electrochromic film. The electrochromic film consists of a pair of the electrochromic layers on the transparent electrode which can be applied to the external electric field. As the external electric field is applied on the transparent electrodes, the internal electrical potential of electrochromic layers has been changed. The changed potential affects the transmittance of the electrochromic layers.

In order to use the electrochromic films, the transmittance change, the response time, and the long-term stability for colour changing of the devices should be measured. The test procedure of the properties is described in 4.3.



Key

1 working electrode

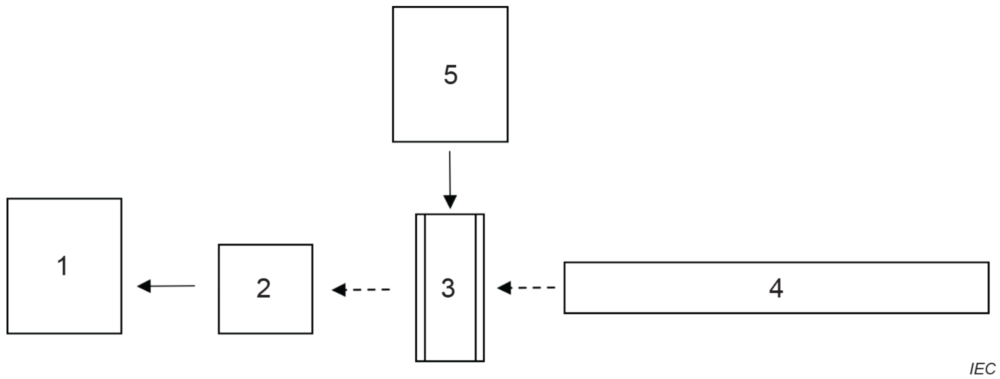
2 counter electrode

3 electrolyte

Figure 1 – Schematic diagram of the electrochromic films: bleached and darkening

4.2 Equipment and tools

In order to test the device under test, a voltage generator (DC power supply), a sample stage, a spectrometer, a computer and an optical measurement system shall be used to evaluate the electrochromic optical shutter element. The voltage generator shall generate a constant voltage level during the measurement and should also be controlled by 0,1 V step-wise voltage change. The wavelength for measurement should be changed from 380 nm to 750 nm. The detector should collect the light which is transmitted through electrochromic film.



Key

1 power meter

2 detector

3 electrochromic film

4 light source

5 potentiostat

Figure 2 – Schematic figure of the test equipment and tools

In Figure 2 the electrochromic film which is to be evaluated is located between the light source and the detector. The light source can change the wavelength from 380 nm to 750 nm and the detector can collect the transmitting light intensity using a photodetector showing the signal level on the power meter. The transmittance of the electrochromic film can be changed with the applied field generated by the potentiostat.

4.3 Test procedure

The detailed test procedures are described below. The test environment shall be in accordance with IEC 60068-1, with a temperature of 25 °C ± 2 °C and a humidity of 50 % ± 2 %, under 300 lux. The percentage of transmittance is calculated by the ratio of the radiance in wavelength transmitted by that surface over the radiance received by that surface, as shown in Formula (1).

$$\tau(\%T) = \frac{\varphi_t}{\varphi_m} \times 100 \quad (1)$$

where

τ is the transmittance;

φ_t is the radiance in wavelength transmitted; and

φ_m is the radiance received by that surface.

1) Turn on the light source and stabilize the lamp (for more than 10 min).
2) Perform the transmittance calibration without the sample. The transmittance calibration is based on a transmittance of 0 % when the shutter of the light source is closed, and a transmittance of 100 % when the shutter of the light source is open.
3) Attach an electrochromic film to the sample stage.
4) Set the output voltage from the bleaching voltage to the darkening voltage by 0,1 V for a period of 10 s and duty of 50 % using the function generator and power meter.
5) Apply the power to the electrochromic film to drive the maximum bleached transmittance, and then change the driving voltage to the minimum darkened transmittance, which makes one cycle (continue for 20 cycles).
6) Measure the spectral transmittance in the visible range (380 nm to 750 nm) while the voltage applied (for more than 10 cycles).
7) From the results measured in step 6), the transmittance value in the darkened state is evaluated.
8) From the results measured in step 6), the transmittance value in the bleached state is evaluated.
9) Calculate the response time from the measured results. The darkened change time is the time required for 90 % of the range of transmittance change in step 8).
10) To measure the long-term stability, the procedure of steps 4) to 9) should be repeated for 10 000 cycles including step 5) and step 6). The number of repetitions may be decided by agreement between the user and the supplier.

4.4 Measurement and data analysis

For the transmittance discoloration time of the electrochromic optical shutter element, Figure 3 a) and Figure 3 b) show the bleaching time and darkening time of the electrochromic optical shutter device, respectively. The discoloration time was defined as the time required for 90 % transmission transition. As shown in Figure 3, the bleaching time was $r_{b,90}$ and the darkening time was $r_{d,90}$. See Annex A for guidance on transmittance measurement.

In Figure 3 a), the auxiliary vertical lines show the response time for bleaching. The top line of the three auxiliary horizontal lines shows the maximum transmittance of the film and the bottom line is for the minimum transmittance of the film. The bleaching process starts from the time of $r_{b,s}$ to the 90 % finished mark at $r_{b,e}$. The transmittance changes from $t_{b,s}$ to $t_{b,90}$ and the maximum bleached states shows the maximum transmittance of $t_{b,e}$. The range of the transmittance change for bleaching is calculated by subtraction from $t_{b,90}$ of $t_{b,s}$. The middle line of the three auxiliary horizontal lines shows the 90 % mark of the range of transmittance change.

In Figure 3 b), the auxiliary vertical lines show the response time for darkening. The bottom line of the three auxiliary horizontal lines shows the minimum transmittance of the film and the top line is for the maximum transmittance of the film. The darkening process starts from the time of $r_{d,s}$ to the 90 % finished mark at $r_{d,e}$. The transmittance changes from $t_{d,s}$ to $t_{d,90}$ and the maximum darkened states shows the minimum transmittance of $t_{d,e}$. The range of the transmittance change for darkening is also calculated by subtraction of the minimum transmittance from the maximum transmittance. The middle line of the three auxiliary horizontal lines shows the 90 % mark of the range of transmittance change for darkening.