

FINAL  
DRAFT

INTERNATIONAL  
STANDARD

ISO/FDIS  
23364

ISO/TC 172/SC 3

Secretariat: JISC

Voting begins on:  
**2021-01-26**

Voting terminates on:  
**2021-03-23**

---

---

## Optics and Photonics — Bulk absorption optical filters

*Optique et photonique — Filtres optiques à absorption de masse*

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[ISO/FDIS 23364](https://standards.iteh.ai/catalog/standards/sist/1939ac1d-b5da-4e33-ab91-f83ec9974ed6/iso-fdis-23364)

<https://standards.iteh.ai/catalog/standards/sist/1939ac1d-b5da-4e33-ab91-f83ec9974ed6/iso-fdis-23364>

RECIPIENTS OF THIS DRAFT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.



Reference number  
ISO/FDIS 23364:2021(E)

© ISO 2021

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[ISO/FDIS 23364](https://standards.iteh.ai/catalog/standards/sist/1939ac1d-b5da-4e33-ab91-f83ec9974ed6/iso-fdis-23364)

<https://standards.iteh.ai/catalog/standards/sist/1939ac1d-b5da-4e33-ab91-f83ec9974ed6/iso-fdis-23364>



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2021

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

# Contents

Page

<b>Foreword</b> .....	<b>iv</b>
<b>Introduction</b> .....	<b>v</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms and definitions</b> .....	<b>1</b>
3.1 Boundary conditions.....	1
3.2 Optical properties.....	2
3.3 Calculated parameters.....	5
3.4 Definition of bulk absorption filters by their function.....	6
<b>4 Measurement</b> .....	<b>7</b>
4.1 General.....	7
4.2 Measurement conditions.....	7
<b>5 Numerical specification and graphical representation of spectral characteristics</b> .....	<b>7</b>
5.1 General.....	7
5.2 Rules for the numerical specification of spectral characteristics.....	8
5.2.1 Rules for the spectral characteristics, $\tau_i$ , $\tau$ , $\tau_V$ , $a$ , $E$ , $D$ or $\theta$ .....	8
5.2.2 Rules for the cut-off wavelength and peak transmittance.....	8
5.3 Rules for the graphical representation of spectral characteristics.....	9
5.4 Graphical representation of optical functions.....	10
5.4.1 General.....	10
5.4.2 Attenuating function (ND).....	10
5.4.3 Function bandpass (BP) or bandrejection (BR).....	11
5.4.4 Function shortpass (SP) or longpass (LP).....	13
<b>Annex A (informative) Graphical representation of transmission using a diabatic scale as an ordinate</b> .....	<b>15</b>
<b>Annex B (informative) Recommendation for the thickness of the witness sample</b> .....	<b>17</b>
<b>Annex C (informative) Spectral weighting function for luminous transmittance</b> .....	<b>19</b>
<b>Bibliography</b> .....	<b>20</b>

## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html). (standards.iteh.ai)

This document was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 3, *Optical materials and components*. ISO/FDIS 23364

[https://standards.iteh.ai/catalog/standards/sist/1939ac1d-b5da-4e33-ab91-](https://standards.iteh.ai/catalog/standards/sist/1939ac1d-b5da-4e33-ab91-85c91711b56a/iso-23364)

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

## Introduction

The optical properties of a bulk absorption filter are characterized by spectrophotometric values. These values relate to the energy transported by electromagnetic waves (radiant or luminous) and they vary as a function of the wavelength. Additional influences can be caused by scattering.

NOTE 1 The functional spectral dependency is generally indicated by including the wavelength,  $\lambda$ , in parentheses as part of the symbol.

NOTE 2 The wavelength,  $\lambda$ , can be replaced by the wavenumber,  $\sigma$ , or the photon energy,  $h\nu$ ,  $h$  = Planck constant;  $\nu$  = frequency. The units recommended are the nanometre (nm) or the micrometre ( $\mu\text{m}$ ) for the wavelength, the reciprocal centimetre ( $\text{cm}^{-1}$ ) for the wavenumber and the electron volt (eV) for the photon energy. Bulk absorption filters are defined according to their function, i.e. according to the nature of the principal modification of the spectral transmission (see [Table 1](#)).

## iTeh STANDARD PREVIEW (standards.iteh.ai)

[ISO/FDIS 23364](#)

<https://standards.iteh.ai/catalog/standards/sist/1939ac1d-b5da-4e33-ab91-f83ec9974ed6/iso-fdis-23364>

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

ISO/FDIS 23364

<https://standards.iteh.ai/catalog/standards/sist/1939ac1d-b5da-4e33-ab91-f83ec9974ed6/iso-fdis-23364>

# Optics and Photonics — Bulk absorption optical filters

## 1 Scope

This document specifies filter functions of uncoated bulk absorption filters for optical applications excluding ophthalmic optics (spectacles) and gives a standard form for their specification. Additionally, basic definitions and a description of the specification concerning optical bulk absorption filters are given.

This document specifies the optical properties of the filters and the test and measurement methods whenever necessary.

This document does not specify any material properties (internal quality, homogeneity, etc.) and it does not apply to any production method.

This document applies to both the raw material (filter glass, filter plastics, etc.) and the polished component.

NOTE 1 Colorimetric parameters for the description of the filter function are specified in e.g. ISO 11664-1 and ISO 11664-2.

NOTE 2 For filters where the spectral transmission characteristics are achieved by the application of optical coatings see ISO 9211 series.

NOTE 3 In case of high power applications further optical effects may occur.

## 2 Normative references

ISO/FDIS 23364

<https://standards.iteh.ai/catalog/standards/sist/1939ac1d-b5da-4e33-ab91-183ec974ed0/iso-11664-23364>

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.

ISO 9211-1, *Optics and photonics — Optical coatings — Part 1: Vocabulary*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9211-1 and the following terms and definitions apply.

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

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

### 3.1 Boundary conditions

#### 3.1.1

##### **optical surface**

optically effective surface, into which the radiation enters the bulk absorption filter or from which it leaves

Note 1 to entry: In general, bulk absorption filters are made as plane parallel plates and have two optical surfaces which are opposite to each other.

**3.1.2**  
**angle of incidence**

$\theta$   
angle between the normal to the optical surface and the incident ray

Note 1 to entry: Unless otherwise specified, the angle of incidence is equal to 0°; this means the incident rays are normal to the optical surface.

[SOURCE: ISO 9211-1:2018, 3.1.2.6, modified — Note 1 to entry was added.]

**3.1.3**  
**thickness**

$d$   
geometrical length that the radiation passes through the bulk absorption filter at normal incidence to the optical surfaces

Note 1 to entry: At normal incidence onto a plano-parallel bulk absorption filter the path of the radiation is equal to the thickness  $d$  of the bulk absorption filter. All parameters and characteristic numbers of this standard are referenced to the case of normal incidence of the light, when the path and the thickness of the bulk absorption filter are the same.

Note 2 to entry: For the case of non-normal incidence of the light, the thickness is not equal to the path of the light.

**3.1.4**  
**witness sample**

sample, which represents the bulk absorption filter component and which is used for spectral measurements and environmental testing

Note 1 to entry: The details about the witness sample and the measurement (i.e. material, surface condition, geometry, number per batch) may be subject of the negotiation between manufacturer and customer.

[SOURCE: ISO 9211-1:2018, 3.1.1.6, modified — In the note “sampling procedures” has been replaced by “measurement”.]

ISO/FDIS 23364  
<https://standards.iteh.ai/catalog/standards/sist/1939ac1d-b5da-4e33-ab91-f83ec9974ed6/iso-fdis-23364>

**3.2 Optical properties**

**3.2.1**  
**spectral transmittance**

$\tau(\lambda)$   
ratio of the spectral radiant flux transmitted to that of the incident radiant flux

Note 1 to entry: The spectral transmittance is dependent on the internal absorption properties, especially on the travel path of the light, as well as on the optical properties of the surface.

$$\tau(\lambda) = \frac{\Phi_{e\lambda,2}}{\Phi_{e\lambda,1}} \tag{1}$$

where

- $\Phi_{e\lambda,1}$  is the incident spectral radiant flux;
- $\Phi_{e\lambda,2}$  is the transmitted spectral radiant flux.

Note 2 to entry: See [Figure 1](#).

Note 3 to entry: Wherever the Greek letter  $\tau$  is mistakable T may be used.

Note 4 to entry: If necessary, the transmittance can be represented as an average over a wavelength range from  $\lambda_1$  to  $\lambda_2$  as follows:

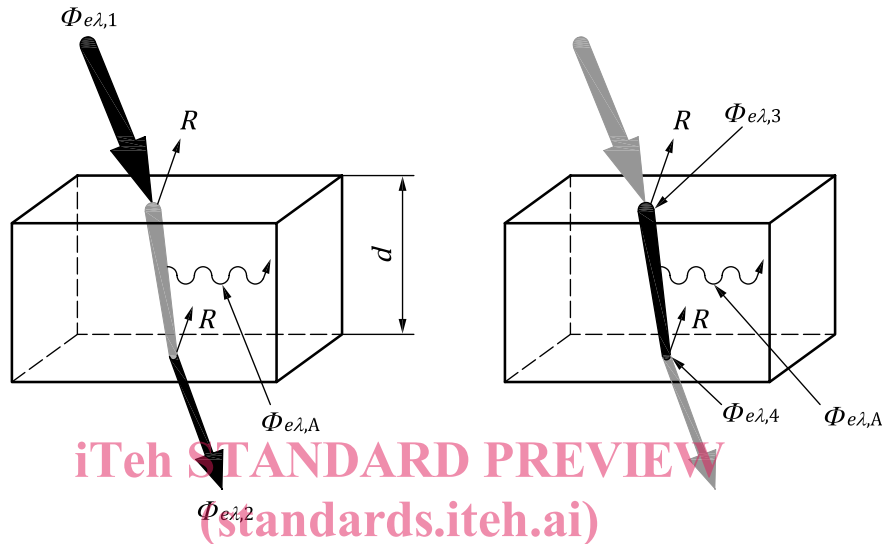


$$\tau_{\text{ave}}(\lambda_1 \text{ to } \lambda_2) = \frac{\int_{\lambda_1}^{\lambda_2} \tau(\lambda) d\lambda}{\lambda_2 - \lambda_1} \approx \frac{\sum_{i=1}^m \tau(\lambda_i) \Delta\lambda}{\lambda_2 - \lambda_1} = \frac{\sum_{i=1}^m \tau(\lambda_i)}{m} \quad (2)$$

where

$$\Delta\lambda = (\lambda_2 - \lambda_1)/m$$

Note 5 to entry: The subscript “ave” stands for “average”. As an alternative the subscript “avg” may be used



NOTE The light falls onto the optical surface at normal incidence, however, it is sketched at an angle in order to visualize the surface reflection  $R$ . That means, travel path of the light and geometrical thickness  $d$  are the same.

<https://standards.iteh.ai/catalog/standards/sist/1939ac1d-b5da-4e33-ab91-832e9174e174/iso-8133-64>

**Figure 1 — Sketch for depicting the differences between transmittance and internal transmittance**

### 3.2.2 spectral internal transmittance

$\tau_i(\lambda)$

ratio of the spectral radiant flux arriving without reflection at the exit surface of the bulk absorption filter to that of the entered radiation

Note 1 to entry: The internal transmittance describes the properties inside the material, thus surface effects do not have an influence.

Note 2 to entry: The subscript “i” stands for “internal”.

$$\tau_i(\lambda) = \frac{\Phi_{e\lambda,4}}{\Phi_{e\lambda,3}} \quad (3)$$

where

$\Phi_{e\lambda,3}$  is the spectral radiant flux, which has entered the volume;

$\Phi_{e\lambda,4}$  is the spectral radiant flux, which is going to leave the volume.

Note 3 to entry: For bulk absorption filters with a homogeneous distribution of absorption within the material the following applies:

$$\tau_i = e^{-\alpha_1 d} \quad (4)$$

where

$\alpha_1$  is the absorption coefficient;

$d$  is the thickness of the bulk absorption filter.

From this context, the internal transmittance can be calculated for different thicknesses of the bulk absorption filter (at normal incidence) by:

$$\tau_{i,d_1} = \left( \tau_{i,d_2} \right)^{\left( \frac{d_1}{d_2} \right)} \tag{5}$$

where

$\tau_{i,d_1}$  is the internal transmittance that corresponds to the thickness  $d_1$  ;

$\tau_{i,d_2}$  is the internal transmittance that corresponds to the thickness  $d_2$  .

Note 4 to entry: See [Figure 1](#).

**3.2.3 cut-off wavelength of the internal transmittance**

$\lambda_{i0,5}$   
wavelength in the transition between a region of high and a region of low transmittance, where the transmittance has a value of  $\tau_i = 0,5$

Note 1 to entry: The subscript “i” stands for “internal”.

**3.2.4 cut-off wavelength of the transmittance**

$\lambda_{0,5}$   
wavelength in the transition between a region of high and a region of low transmittance, where the transmittance has a value of  $\tau = 0,5$

Note 1 to entry: The Annex A of ISO 9211-2 defines  $\lambda'_{0,5}$  and  $\lambda''_{0,5}$  as the wavelength where the transmittance is half of  $\tau_A$  or  $\tau_M$ .

**3.2.5 spectral absorptance**

$a(\lambda)$   
ratio of the spectral concentration of radiant flux absorbed to that of the incident radiation

**3.2.6 refractive index**

$n(\lambda)$   
ratio of the velocity of propagation of electromagnetic radiation in vacuum to the velocity of propagation in a medium

[SOURCE: ISO 9211-1]

**3.2.7 reflection factor**

$P(\lambda)$   
ratio of *spectral transmittance* ([3.2.1](#)) to internal transmittance

$$P(\lambda) = \frac{\tau(\lambda)}{\tau_i(\lambda)} \tag{6}$$

Note 1 to entry: When neglecting diffuse scattering the following formula applies at normal incidence onto the bulk absorption filter:

$$P(\lambda) = \frac{2n(\lambda)}{n^2(\lambda) + 1} \quad (7)$$

Note 2 to entry: Because the spectral dependency of  $P(\lambda)$  is weak, a constant reflection factor is used in most cases. Unless otherwise specified, a constant reflection factor is used, which is derived at the d-line (587,6 nm).

$$P = P_d = P(\lambda = 586,7 \text{ nm}) = \frac{2n_d}{n_d^2 + 1} \quad (8)$$

Note 3 to entry: P is the greek upper case letter Rho.

### 3.3 Calculated parameters

#### 3.3.1

##### spectral optical density

$D(\lambda)$

logarithm to the base 10 of the reciprocal of the *spectral transmittance* (3.2.1)

$$D(\lambda) = \lg \frac{1}{\tau(\lambda)} \quad (9)$$

#### 3.3.2

##### spectral extinction

$E(\lambda)$

logarithm to the base 10 of the reciprocal of the *spectral internal transmittance* (3.2.2)

$$E(\lambda) = \lg \frac{1}{\tau_i(\lambda)} = \frac{\alpha_1 d}{\ln(10)} \quad (10)$$

Note 1 to entry: Extinction = Absorbance. Sometimes letter A is used.

#### 3.3.3

##### spectral diabolic transmittance

$\theta(\lambda)$

a characterization of the *spectral internal transmittance* (3.2.2) represented by the following formula:

$$\theta(\lambda) = 1 - \lg \left( \lg \frac{1}{\tau_i(\lambda)} \right) \quad (11)$$

Note 1 to entry: For transformation of spectral internal transmittance and spectral diabolic transmittance see [Annex A](#).

#### 3.3.4

##### luminous transmittance

$\tau_V$

ratio of the luminous flux transmitted by an ocular or filter to the incident luminous flux for a specified illuminant and photopic vision

Note 1 to entry: This is usually expressed as a percentage and is calculated from the following formula:

$$\tau_V = 100 \times \frac{\int_{380 \text{ nm}}^{780 \text{ nm}} \tau(\lambda) \cdot S_{D65}(\lambda) \cdot V(\lambda) \cdot d\lambda}{\int_{380 \text{ nm}}^{780 \text{ nm}} S_{D65}(\lambda) \cdot V(\lambda) \cdot d\lambda} \quad (12)$$

where