INTERNATIONAL STANDARD

ISO 8980-3

Fourth edition
2022-06

Ophthalmic optics — Uncut finished spectacle lenses —

Part 3: Transmittance specifications and test methods

Optique ophtalmique — Verres de lunettes finis non détourés —

Partie 3: Spécifications relatives au facteur de transmission et méthodes d'essai

Reference number
ISO 8980-3:2022(E)

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Published in Switzerland

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Foreword

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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).

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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.

This document was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 7, *Ophthalmic optics and instruments*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 170, *Ophthalmic optics,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This fourth edition cancels and replaces the third edition (ISO 8980-3:2013), which has been technically revised.

The main changes are as follows:

— terms and definitions, previously in Clause 3, have been referenced to ISO 13666;

— requirements regarding claimed transmittance properties have been added in 6.6;

— references have been updated as appropriate and needed;

— descriptions of requirements throughout the document have been updated and amended for clarification.

A list of all parts in the ISO 8980 series can be found on the ISO website.

Ophthalmic optics — Uncut finished spectacle lenses —

Part 3: Transmittance specifications and test methods

1 Scope

This document specifies requirements for the transmittance properties of uncut and unmounted finished spectacle lenses, including attenuation of solar radiation.

This document is not applicable to

— spectacle lenses having specific transmittance or absorption characteristics prescribed for medical reasons,

— products to which specific personal protective equipment transmittance standards apply, and

— products intended for direct observation of the sun, such as for solar-eclipse viewing.

NOTE 1 By reference to ISO 21987 and ISO 14889, this document also applies to lenses mounted in spectacles.

NOTE 2 Optical and geometric requirements are given for uncut finished spectacle lenses in ISO 8980-1 and ISO 8980-2, and for mounted lenses, in ISO 21987.

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.

ISO 11664-1, *Colorimetry — Part 1: CIE standard colorimetric observers*

ISO 11664-2, *Colorimetry — Part 2: CIE standard illuminants*

ISO 13666:2019, *Ophthalmic optics — Spectacle lenses — Vocabulary*

ISO 14889, *Ophthalmic optics — Spectacle lenses — Fundamental requirements for uncut finished lenses*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13666 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 https://www.electropedia.org/

4 Symbols

The symbols for the characteristic luminous transmittances of photochromic lenses are given in Table 1.

Table 1 — Symbols for the characteristic luminous transmittances of photochromic lenses

Symbols	Characteristic luminous transmittances
$\tau_{v\,0}$	Luminous transmittance in the faded state as reached at (23 ± 2) °C after specified conditioning.
$\tau_{v\,1}$	Luminous transmittance in the darkened state as reached at (23 ± 2) °C after specified irradiation simulating mean outdoor conditions.
$\tau_{v\,W}$	Luminous transmittance in the darkened state as reached at (5 ± 2) °C after specified irradiation simulating outdoor conditions at low temperatures.
$\tau_{v\,S}$	Luminous transmittance in the darkened state as reached at (35 ± 2) °C after specified irradiation simulating outdoor conditions at high temperatures.
$\tau_{v\,R}$	Luminous transmittance in the darkened state as reached at (23 ± 2) °C after specified irradiation simulating reduced light conditions.
NOTE 1 When describing a photochromic lens, the luminous transmittance refers to the faded state before exposure to optical radiation, and the darkened state after exposure to optical radiation.	
NOTE 2 The symbol for the luminous transmittance in reduced light conditions, $\tau_{v\,R}$, has been changed from $\tau_{v\,A}$ which is in ISO 13666. This is to avoid possible confusion with the luminous transmittance measured in CIE standard illuminant A, which is also frequently given the symbol $\tau_{v\,A}$.	

5 Classification

Spectacle lenses are classified with respect to transmittance as follows:

a) clear lenses, with no intended colour/tint in transmission;

b) uniformly tinted lenses;

c) gradient-tinted lenses;

d) photochromic lenses;

e) polarizing lenses.

NOTE b) or c) can be combined with d) and/or e).

6 Requirements

6.1 General

The fundamental requirements for uncut finished lenses, including reference to 6.3, are in ISO 14889. For other than photochromic lenses, the requirements shall apply at a temperature of (23 ± 5) °C, and shall apply at the design reference point unless specified otherwise. For photochromic lenses, the applicable temperatures are given in Table 1.

The results of all calculations of values to be assessed against the requirements of this document shall be rounded to the same precision as the statement of requirement.

NOTE For example, luminous transmittance is stated as an integer, UV transmittance to one decimal place, consistent with Table 1.

6.2 General transmittance requirements

6.2.1 Tint descriptions, categories, and UV transmittance requirements

Spectacle lenses shall be nominated to one of five tint descriptions or luminous transmittance categories as specified in Table 2. Lenses shall be tested as described in Clause 7.

A spectacle lens nominated by the manufacturer as having a luminous transmittance, τ_v, that is in category 0, 1, 2 or 3 shall have a luminous transmittance at its design reference point that shall not lie outside the limits of the stated category by more than 2 % absolute.

A spectacle lens nominated by the manufacturer as having a luminous transmittance, τ_v, that is in category 4 shall have a luminous transmittance, τ_v, at its design reference point that shall not lie outside the limits of that category by more than 20 % relative to the stated luminous transmittance.

For gradient-tinted lenses, the overlap in luminous transmittance allowed between categories shall be double that for uniformly tinted lenses.

A lens nominated by the manufacturer as having a luminous transmittance, τ_v, that is in a particular category shall comply with the ultraviolet (UV) transmittance requirements of that category, regardless of the actual luminous transmittance. For example, a lens nominated to have a luminous transmittance in category 2 but actually having a luminous transmittance of 45 % (category 1, or category 2 allowing for the 2 % tolerance) shall comply with the UV transmittance requirements of a category 2 lens.

Any lens that does not meet the UV transmittance requirements in Table 2 shall include the warning indicated in 8 g).

6.2.2 Tolerances on luminous transmittance of tinted lenses

A tint should be ordered by reference to a manufacturer's sample. Such a tint should not be visibly different from the tint of the sample and its assessment is not restricted to its luminous transmittance, τ_v, measured by spectrophotometer.

A lens ordered by a specific luminous transmittance, τ_v, shall have a measured, τ_v, at the design reference point within ±8 % absolute of that ordered.

The tint of the two lenses of a pair should not be visibly different.

Table 2 — Categories for luminous transmittance and the related permissible transmittance in the ultraviolet solar spectral range

		Visible spectral range	Ultraviolet spectral range	
		380 nm to 780 nm	315 nm to 380 nm UV-A	280 nm to 315 nm UV-B
Tint description	**Luminous transmittance category**	Range of luminous transmittance τ_v	Maximum value of solar UV-A transmittance τ_{SUVA}	Maximum value of solar UV-B transmittance τ_{SUVB}
Clear or very light tint	0	$\tau_v > 80$ %	τ_v	0,05 τ_v
Light tint	1	80 % ≥ τ_v > 43 %	τ_v	0,05 τ_v
Medium tint	2	43 % ≥ τ_v > 18 %	0,5 τ_v	1,0 % absolute or 0,05 τ_v, whichever is greater
Dark tint	3	18 % ≥ τ_v > 8 %	0,5 τ_v	1,0 % absolute
Very dark tint	4	8 % ≥ τ_v > 3 %	1,0 % absolute or 0,25 τ_v, whichever is greater	1,0 % absolute
NOTE For the convenience of the reader, formulae are presented in Annex F in summation form.				

6.3 Spectral transmittance requirements of spectacle lenses intended for driving and road use

6.3.1 General

Spectacle lenses having a luminous transmittance, τ_v, less than or equal to 8 % are not intended for driving and road use. Therefore, there are no requirements for such lenses in this clause.

6.3.2 Spectral transmittance

The spectral transmittance, $\tau(\lambda)$, at any wavelength in the range 475 nm to 650 nm shall be not less than 0,20 τ_v.

6.3.3 Daylight use

The luminous transmittance, τ_v, of spectacle lenses for driving and road use during daylight shall be greater than 8 % at the design reference point.

6.3.4 Driving in twilight or at night

Spectacle lenses with a luminous transmittance, τ_v, less than 75 % shall not be used for driving and road use in twilight or at night. In the case of photochromic spectacle lenses, this requirement applies when tested in accordance with 7.5.3.5.

6.3.5 Relative visual attenuation coefficient (quotient) for incandescent traffic signal light detection

Spectacle lenses for driving and road use shall have a relative visual attenuation coefficient (quotient), Q_{signal}, not less than:

a) 0,80 for Q_{red};

b) 0,60 for Q_{yellow};

c) 0,60 for Q_{green};

d) 0,40 for Q_{blue}.

The relative visual attenuation coefficients (quotients), Q_{signal}, shall be calculated according to ISO 13666:2019, 3.17.8, with the spectral data as specified in Annex A. An alternative calculation can be made in summation form according to E.6 with the spectral data as specified in Annex A.

6.4 Additional transmittance requirements for special types of spectacle lenses

6.4.1 Photochromic spectacle lenses

6.4.1.1 General

Two categories are typically used to characterize photochromic spectacle lenses, corresponding to the faded state and to the darkened state. Additional lens states may be specified under various temperatures (see 6.4.1.3) and moderate light levels (see 6.4.1.4). Transmittances shall be determined according to the method in 7.5. The UV transmittance in any state shall conform to the values specified for that category in Table 2.

6.4.1.2 Photochromic response

When tested by the methods described in 7.5.3.1 to 7.5.3.3, the ratio of the luminous transmittance of a photochromic lens (see 7.5.1) in its faded state, $\tau_{v\,0}$, to that in its darkened state, $\tau_{v\,1}$, after 15 min irradiation, shall be at least 1,25, as given by Formula (1):

$$\frac{\tau_{v\,0}}{\tau_{v\,1}} \geq 1{,}25 \tag{1}$$

6.4.1.3 Photochromic response at various temperatures

If the influence of temperature on photochromic response is stated, it shall be determined by measuring the luminous transmittance of the lens (see 7.5.1) in the darkened state using the procedure described in 7.5.3.6 at 5 °C ($\tau_{v\,W}$), 23 °C ($\tau_{v\,1}$) and 35 °C ($\tau_{v\,S}$).

The manufacturer can use additional temperatures, provided this information is made available.

6.4.1.4 Photochromic response at moderate light levels

If the photochromic response at moderate light levels is stated, it shall be determined by measuring the luminous transmittance of the lens (see 7.5.1) in the darkened state, $\tau_{v\,R}$, using the procedure described in 7.5.3.4.

6.4.2 Polarizing spectacle lenses

6.4.2.1 Polarizing efficiency

When tested according to the method in 7.6, the polarizing efficiency shall be >78 % for luminous transmittance categories 2, 3, 4 and >60 % for luminous transmittance category 1.

6.4.2.2 Orientation

When tested according to the method in 7.6, the actual plane of transmittance shall be at (90 ± 5)° from the horizontal reference.

This reference is constituted by

— the permanent alignment reference markings for power-variation lenses and position-specific single-vision lenses,

— the dividing line for straight-top and E-line multifocal lenses, and to the tangent to the mid-point of the dividing line of curved-top multifocal lenses in their intended orientation,

— the marking according to 6.4.2.3 for single-vision and multifocal lenses with no other geometric orientation properties, and

— for finished lenses, the horizontal line joining the boxed centres of the lenses when fitted to the intended frame.

6.4.2.3 Marking

Polarizing finished single-vision and multifocal lenses with no other geometric orientation properties shall include permanent or non-permanent marking on the horizontal meridian to identify clearly the intended horizontal orientation.

Alternatively, if manufacturers or suppliers choose to include marking on the vertical meridian of the finished lenses to indicate the plane of transmission, this alternative method of marking shall be clearly identified. In this case, the same tolerance as stated in 6.4.2.2 (±5°) applies for the difference between the marking and the actual plane of transmittance.

6.4.3 Gradient-tinted spectacle lenses

The requirements for gradient-tinted spectacle lenses shall be determined at the design reference point of the spectacle lens. It is recommended that gradient tints be ordered by reference to a manufacturer's sample lens, identification code, name or reference number.

6.5 Resistance to ultraviolet radiation

Following irradiation as specified in 7.7, the absolute change in the luminous transmittance ($\tau_v' - \tau_v$) of the lenses shall be less than or equal to 5 % absolute, where τ_v' is the luminous transmittance after irradiation. This tolerance shall also apply to photochromic lenses in the faded state when measured after conditioning according to 7.5.3.1, following testing according to 7.7.

In addition, the following shall be met:

a) for photochromic filters $\frac{\tau_{v\,0}}{\tau_{v\,1}}$ shall be ≥1,25;

b) the UV requirements for the initial τ_v shall continue to be satisfied;

c) if originally intended for driving and road use, the requirements of 6.3 shall continue to be satisfied.

6.6 Claimed UV absorption/transmittance properties

6.6.1 General

In cases where it is claimed that a lens reaches a certain percentage of UV absorption or UV transmittance better than the requirement in Table 2, the relevant requirement(s) below shall apply. For reference, Annex B shall be used.

6.6.2 Solar UV absorption

In the case where it is claimed that a lens has x % solar UV absorption, the solar UV transmittance of the lens, τ_{SUV}, shall not exceed (100,5 - x) %.

6.6.3 Solar UV transmittance

In the case where it is claimed that a lens has less than x % solar UV transmittance, the solar UV transmittance of the lens, τ_{SUV}, shall not exceed (x + 0,5) %.

6.6.4 Solar UV-A absorption

In the case where it is claimed that a lens has x % solar UV-A absorption, the solar UV-A transmittance of the lens, τ_{SUVA}, shall not exceed (100,5 - x) %.

6.6.5 Solar UV-A transmittance

In the case where it is claimed that a lens has less than x % solar UV-A transmittance, the solar UV-A transmittance of the lens, τ_{SUVA}, shall not exceed (x + 0,5) %.

6.6.6 Solar UV-B absorption

In the case where it is claimed that a lens has x % solar UV-B absorption, the solar UV-B transmittance of the lens, τ_{SUVB}, shall not exceed (100,5 - x) %.

6.6.7 Solar UV-B transmittance

In the case where it is claimed that a lens has less than x % solar UV-B transmittance, the solar UV-B transmittance of the lens, τ_{SUVB}, shall not exceed (x + 0,5) %.

7 Test methods

7.1 General

This clause specifies reference methods for transmittance properties of spectacle lenses.

For purposes of quality control, etc., alternative test methods can be used provided they have been shown to be equivalent and include uncertainties of measurement no greater than those required of the reference method.

7.2 Spectral transmittance

The uncertainties of the test methods determining transmittance values shall be not greater than:

— 2 % absolute, for transmittance >20 %;

— 1 % absolute, for luminous transmittance ≤20 %;

— 10 % relative, for UV transmittance of lenses with luminous transmittance ≤20 %.

These measurement uncertainties shall be based on a confidence level of 95 %.

NOTE Guidelines for evaluating uncertainty can be found in ISO/IEC Guide 98-3. Advice on the specific issues in evaluating uncertainty of measurement in lenses can be found in ISO 18526-2:2020, Annex B. The user can refer to operating manuals and other information provided by manufacturers of specific instruments for additional information.

7.3 Luminous transmittance and relative visual attenuation coefficient (quotient)

7.3.1 The spectral distribution of standard illuminant D65 as specified in ISO 11664-2 and the luminous efficiency of the average human eye for photopic vision (2° observer) as specified in ISO 11664-1 shall be used to determine the luminous transmittance, τ_v. When calculating the luminous transmittance, τ_v, from the spectral transmittance $\tau(\lambda)$, the step width (wavelength interval) shall not exceed 10 nm.

7.3.2 When calculating the relative visual attenuation coefficient (quotient), Q_{signal}, for incandescent signal lights from the spectral transmittance $\tau(\lambda)$, the step width shall not exceed 5 nm. The relevant formula, from ISO 13666, is as given by Formula (2):

$$Q_{signal} = \frac{\tau_{signal}}{\tau_v} \tag{2}$$

where

τ_v is given in E.5;

τ_{signal} is given in E.6;.

NOTE Calculations are currently based on the measured values of $E_{signal}(\lambda)$ for traffic signal lights using incandescent quartz-halogen lamps given in Table A.1. Calculations using values for LED signals will give different results than those using the values for quartz-halogen lamps.