SLOVENSKI STANDARD
oSIST prEN 410:2025

01-februar-2025

Steklo v gradbeništvu - Določevanje svetlobnih in sončnih karakteristik stekla

Glass in building - Determination of luminous and solar characteristics of glazing

Glas im Bauwesen - Bestimmung der lichttechnischen und strahlungsphysikalischen Kenngrößen von Verglasungen

Verre dans la construction - Détermination des caractéristiques lumineuses et solaires des vitrages

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ICS:

81.040.20 Steklo v gradbeništvu Glass in building

oSIST prEN 410:2025 **en,fr,de**

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 410

December 2024

ICS 81.040.20

Will supersede EN 410:2011

English Version

Glass in building - Determination of luminous and solar characteristics of glazing

Verre dans la construction - Détermination des caractéristiques lumineuses et solaires des vitrages

Glas im Bauwesen - Bestimmung der lichttechnischen und strahlungsphysikalischen Kenngrößen von Verglasungen

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 129.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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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.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (prEN 410:2024) has been prepared by Technical Committee CEN/TC 129 “Glass in building”, the secretariat of which is held by NBN.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 410:2011.

In comparison with the previous edition, the following technical modifications have been made:

a) changes to the calculation of the internal heat transfer coefficient for consistency with EN 673:2024;

b) clarification provided that UV transmittance is determined only for the total range and not split into UVA and UVB;

c) modification to normalized relative spectral distribution of global solar radiation based on 10 nm wavelength intervals;

d) ambiguity relating to the area-weighting procedure for screen printed glass has been clarified;

e) introduction of a matrix method for non-scattering incoherent optical systems, including multiple layers;

f) modifications to the formulae to permit calculation and declaration of the luminous and solar properties of BIPV glazing.

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Introduction

Whilst this document presents the formulae for the exact calculations of the spectral characteristics of glazing, it does not consider the uncertainty of the measurements necessary to determine the spectral parameters that are used in the calculations. It should be noted that, for simple glazing systems where few measurements are required, the uncertainty of the results will be satisfactory if correct measurements procedures have been followed. When the glazing systems become complex and a large number of measurements are required to determine the spectral parameters, the uncertainty is cumulative with the number of measurements and should be considered in the final results.

The term interface used in this document, is considered to be a surface characterized by its transmission and reflections of light intensities. That is, the interaction with light is incoherent, all phase information being lost. In the case of thin films (not described in this document), interfaces are characterized by transmission and reflections of light amplitudes, i.e. the interaction with light is coherent and phase information is available. Finally, for clarity, a coated interface can be described as having one or more thin films, but the entire stack of thin films is characterized by its resulting transmission and reflection of light intensities.

In Annex B, the procedure for the calculation of spectral characteristics of laminated glass makes specific reference to coated glass. The same procedure can be adopted for filmed glass (e.g. adhesive backed polymeric film applied to glass).

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1 Scope

This document specifies methods of determining the luminous and solar characteristics of glazing in buildings. These characteristics can serve as a basis for lighting, heating and cooling calculations of rooms and permit comparison between different types of glazing.

This document applies both to conventional glazing and to absorbing or reflecting solar-control glazing, used as vertical or horizontal glazed apertures. The appropriate formulae for single, double and triple glazing are given. A matrix method is provided as an alternative calculation method.

This document introduces a method to determine the luminous and solar properties of Building-Integrated Photovoltaic (BIPV) glazing.

This document is accordingly applicable to all transparent materials except those which show significant transmission in the wavelength region 5 µm to 50 µm of ambient temperature radiation, such as certain plastic materials.

Materials with light-scattering properties for incident radiation are dealt with as conventional transparent materials subject to certain conditions (see 5.2).

Angular light and solar properties of glass in building are excluded from this document. However, research work in this area is summarized in Bibliographic references [1], [2] and [3].

Guidance on the measurement of luminous and spectral properties of glass can be found in the Bibliography [4].

Vacuum Insulating Glass (VIG) is excluded from the scope of this document. For determination of the g value of VIG, please refer to ISO 19916-1.

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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.

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EN 673, *Glass in building — Determination of thermal transmittance (U value) — Calculation method*

EN 12898:2019, *Glass in building — Determination of the emissivity*

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 http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp/

3.1
light transmittance
fraction of the incident light that is transmitted by the glass

3.2
light reflectance
fraction of the incident light that is reflected by the glass

3.3

total solar energy transmittance (solar factor)

fraction of the incident solar radiation that is totally transmitted by the glass

3.4

solar direct transmittance

fraction of incident solar radiation that is directly transmitted by the glass

3.5

normal emissivity

ratio, in a direction normal to the surface, of the emissive power of the surface of the glass to the emissive power of a black body

Note 1 to entry: Normal emissivity is determined in accordance with EN 12898.

3.6

solar direct reflectance

fraction of the incident solar radiation that is reflected by the glass

3.7

ultraviolet transmittance

fraction of the incident UV component of the solar radiation that is transmitted by the glass

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3.8

colour rendering index (in transmission)

change in colour of an object as a result of the light being transmitted by the glass

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3.9

shading coefficient

ratio of the solar factor of the glass to the solar factor of a reference glass (clear float)

3.10

planar PV module

planar device designed to convert solar radiation into electricity by the photovoltaic effect

Note 1 to entry: The glazing configuration of a planar PV module may be, but is not restricted to, a coated or uncoated pane of glass, a coated polymer film, a glass-polymer laminate or a glass-polymer-glass laminate. For the sake of brevity, the term PV module will be understood to mean a planar PV module in Annex E.

3.11

building-integrated photovoltaic (BIPV) glazing

architectural glazing that incorporates a (planar) PV module as one of its panes

Note 1 to entry: In this context, architectural glazing refers to glazed apertures in buildings.

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3.12

optically homogeneous

attribute of glazing with optical properties, which, when determined using a spectrophotometer in accordance with this European Standard, are independent of the position selected for measurement

Note 1 to entry: Many thin-film PV modules are examples of optically homogeneous glazing.

3.13

optically inhomogeneous

attribute of glazing with optical properties, which, when determined using a spectrophotometer in accordance with this document, vary significantly (i.e. by an amount greater than measurement tolerances) on the position selected for measurement

Note 1 to entry: Typically, this refers to areas on a scale of cm^2 that have a visibly different appearance, e.g. crystalline PV cells surrounded by a transparent embedding material.

3.14

open circuit

OC

with reference to a PV device, an electrical state in which the output electric current is zero

Note 1 to entry: Adapted from 3.4.57 of IEC TS 61836.

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3.15

maximum power point

MPP

point on a PV device's current-voltage characteristic where the product of electric current and voltage yields the maximum electrical power under specified operating conditions

[SOURCE: IEC TS 61836, 3.4.43.3]

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3.16

standard test conditions

STC

reference values of in-plane irradiance (GI,ref = 1 000 W/m^2), photovoltaic cell junction temperature (25 °C), and a reference spectral irradiance distribution calculated for air mass = 1,5, used during the testing of any photovoltaic device

[SOURCE: IEC TS 61836, 3.4.87]

3.17

conversion efficiency

ratio of electric power generated by a PV device per unit area to its incident irradiance

[SOURCE: IEC TS 61836, 3.1.17]

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4 Symbols

Sym.	Deutsch/German/Allemand	Englisch/English/Anglais	Französisch/French/Français
D65	Normlichtart D65	standard illuminant D65	illuminant normalisé D65
UV	Ultravioletter Strahlungsbereich	ultraviolet radiation	rayonnement ultraviolet
τ_{UV}	Ultravioletter Transmissionsgrad	ultraviolet transmittance	facteur de transmission de l'ultraviolet
$\tau(\lambda)$	Spektraler Transmissionsgrad	spectral transmittance	facteur de transmission spectrale
$\rho(\lambda)$	Spektraler Reflexionsgrad	spectral reflectance	facteur de réflexion spectrale
τ_V	Lichtransmissionsgrad	light transmittance	facteur de transmission lumineuse
ρ_v	Lichtreflexionsgrad	light reflectance	facteur de réflexion lumineuse
τ_e	direkter Strahlungstrans-missionsgrad	solar direct transmittance	facteur de transmission directe de l'énergie solaire
ρ_e	direkter Strahlungs-reflexionsgrad	solar direct reflectance	facteur de réflexion directe de l'énergie solaire
g	Gesamtenergiedurchlaß- grad	total solar energy transmittance (solar factor)	facteur de transmission totale de l'énergie solaire ou facteur solaire
R_a	allgemeiner Farbwieder-gabeindex	general colour rendering index	indice général de rendu des couleurs
D_λ	relative spektrale Vertei- lung der Normlichtart D65	relative spectral distribution of illuminant D65	répartition spectrale relative de l'illuminant normalisé D65
$V(\lambda)$	spektraler Hellempfindlich-keitsgrad	spectral luminous efficiency	efficacité lumineuse relative spectrale
α_e	direkter Strahlungsabsorp tionsgrad	solar direct absorptance	facteur d'absorption directe de l'énergie solaire
Φ_e	Strahlungsleistung (Strahlungsfluß)	incident solar radiant flux	flux énergétique solaire incident
q_i	sekundärer Wärmeabgabe-grad nach innen	secondary internal heat transfer factor	facteur de réémission thermique vers l'intérieur
q_e	sekundärer Wärme-abgabegrad nach außen	secondary external heat transfer factor	facteur de réémission thermique vers l'extérieur

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Sym.	Deutsch/German/Allemand	Englisch/English/Anglais	Französisch/French/Français
α_{elec}	Anteil der insgesamt absorbierten Solarstrahlung, der als Strom von der PV-Zellenfläche einer BIPV-Verglasungseinheit abgeführt wird	proportion of total absorbed solar radiation that is extracted from the PV cell-covered area of a BIPV glazing unit as electricity	proportion du rayonnement solaire total absorbé qui est extrait de la surface couverte de cellules photovoltaïques d'un vitrage BIPV, sous forme d'électricité
S_λ	relative spektrale Vertei- lung der Sonnenstrahlung	relative spectral distribution of solar radiation	répartition spectrale relative du rayonnement solaire
h_e	Wärmeübergangs- koeffizient nach außen	external heat transfer coefficient	coefficient d'échange thermique extérieur
h_i	Wärmeübergangs- koeffizient nach innen	internal heat transfer coefficient	coefficient d'échange thermique intérieur
ε	korrigierter Emissionsgrad	corrected emissivity	émissivité corrigée
ε_n	normaler Emissionsgrad	normal emissivity	émissivité normale
Λ	Wärmedurchlaßkoeffizient	thermal conductance	conductance thermique
λ	Wellenlänge	wavelength	longueur d'onde
$\Delta\lambda$	Wellenlängenintervall	wavelength interval	intervalle de longueur d'onde
U_λ	relative spektrale Vertei-Lung der UV-Strahlung der Sonne	relative spectral distribution of UV in solar radiation	répartition spectrale relative du rayonnement ultraviolet solaire
SC	Durchlassfaktor	shading coefficient	coefficient d'ombrage
$I(\lambda)$	normalisierter spektraler Strahlungsfluß	spectral normalized radiant flow	flux radiant spectral normalisé
η_{mod}	elektrischer Wirkungsgrad eines PV-Moduls	photovoltaic conversion efficiency of a PV module	efficacité de conversion de puissance du module photovoltaïque
A	Fläche	surface area	superficie
r	Reflexionsgrad an der Oberfläche	reflectance on interface	facteur de réflexion à l'interface
CR	Deckungsgrad	coverage ratio	taux de couverture
$\eta_{cell,mod}$	elektrischer Wirkungsgrad eines hypothetischen PV-Moduls mit 100 % Zelldeckungsgrad	power conversion efficiency of a hypothetical PV module with 100% cell coverage ratio	efficacité de conversion de puissance d'un module photovoltaïque hypothétique

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5 Determination of characteristics

5.1 General

The characteristics are determined for quasi-parallel, near normal radiation incidence (see Bibliography, [4]) using the radiation distribution of illuminant D65 (see Table 1), solar radiation in accordance with Table 2 and ultraviolet (UV) radiation in accordance with Table 3.

The characteristics are as follows:

— the spectral transmittance $\tau(\lambda)$ and the spectral reflectance $\rho\ (\lambda)$ in the wavelength range from 300 nm to 2 500 nm;

— the light transmittance τ_v and the light reflectance ρ_v for illuminant D65;

— the solar direct transmittance τ_e and the solar direct reflectance ρ_e;

— the total solar energy transmittance (solar factor) g ;

— the UV-transmittance τ_{UV};

— the general colour rendering index R_a;

— the total shading coefficient, SC.

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To characterize glazing, the principal parameters are τ_v and g; the other parameters are optional to provide additional information.

If the value of a given characteristic is required for different glass thicknesses (in the case of uncoated glass) or for the same coating applied to different substrates, it can be obtained by calculation (in accordance with Annex A).

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A procedure for the calculation of the spectral characteristics of laminated glass is given in Annex B.

Guidelines on determining the spectral characteristics of screen-printed glass are given in Annex C.

A modified matrix method is provided as an alternative calculation method is given in Annex D.

Modifications to the formulae to permit calculation and declaration of the luminous and solar properties of BIPV glazing are given in Annex E.

The convention adopted in this document is for the incident radiation to be from left to right. The left side is also referred to as outside or outdoors, whereas the right side is also referred to as inside or indoors.

5.2 Light transmittance

The light transmittance τ_v of the glazing is calculated using the following formula:

$$\tau_v = \frac{\sum_{\lambda=380\ nm}^{780\ nm} D_\lambda \cdot \tau(\lambda) \cdot V(\lambda) \cdot \Delta\lambda}{\sum_{\lambda=380\ nm}^{780\ nm} D_\lambda \cdot V(\lambda) \cdot \Delta\lambda} \quad (1)$$

where

D_λ is the relative spectral distribution of illuminant D65 (see Bibliography [5]);

$\tau(\lambda)$ is the spectral transmittance of the glazing;

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V(λ) is the spectral luminous efficiency for photopic vision defining the standard observer for photometry (see Bibliography [5]);

$\Delta\lambda$ is the wavelength interval.

Table 1 indicates the values for $D_\lambda \cdot V(\lambda) \cdot \Delta\lambda$ for wavelength intervals of 10 nm. The table has been drawn up in such a way that $\sum D_\lambda \cdot V(\lambda) \cdot \Delta\lambda = 1$.

In the case of multiple glazing, the spectral transmittance $\tau(\lambda)$ is calculated from the spectral transmittances and reflectances of the individual components as follows:

For double glazing:

$$\tau(\lambda) = \frac{\tau_1(\lambda) \cdot \tau_2(\lambda)}{1 - \rho'_1(\lambda) \cdot \rho_2(\lambda)} \quad (2)$$

where

$\tau_1(\lambda)$ is the spectral transmittance of the first (outer) pane;

$\tau_2(\lambda)$ is the spectral transmittance of the second pane;

$\rho_1'(\lambda)$ is the spectral reflectance of the first (outer) pane, measured in the direction opposite to the incident radiation;

$\rho_2(\lambda)$ is the spectral reflectance of the second pane, measured in the direction of the incident radiation.

The above is illustrated in Figure 1.

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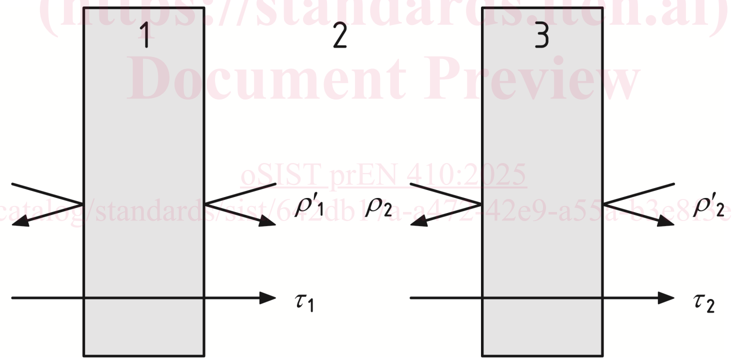

Key

1 pane 1

2 cavity

3 pane 2

Figure 1 — Transmittance and reflectance in a double glazing insulating glass unit