

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

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ICS 81.040.20

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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

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CEN

European Committee for Standardization
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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 129, Glass in building, the Secretariat of which is held by IBN.

CEN/TC 129/WG 9, Light and energy transmission, thermal insulation, prepared a working draft based on ISO/DIS 9050, *Glass in building — Determination of light transmittance, solar direct transmittance, total solar energy transmittance and ultraviolet transmittance and related glazing factors*, prepared by ISO/TC 160, Glass in building.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 1998, and conflicting national standards shall be withdrawn at the latest by October 1998.

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1 Scope

This European Standard 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 European Standard 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.

This European Standard is accordingly applicable to all transparent materials except those which show significant transmission in the wavelength region (5 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 4.2).

2 Normative references

This European Standard incorporates by dated or undated references, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

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

EN 674, *Glass in building — Determination of thermal transmittance (U value) — Guarded hot plate method.*

EN 675, *Glass in building — Determination of thermal transmittance (U value) — Heat flow meter method.*

prEN 1098, *Glass in building — Measuring method for the determination of the thermal transmittance of multiple glazing (U value) — Calibrated and guarded hot box method.*

prEN 12898, *Glass in building — Determination of the emissivity.*

3 Symbols

Sym.	Deutsch/German/Allemand	Englisch/English/Anglais	Französisch/French/Français
D_{65}	Normlichtart D_{65}	standard illuminant D_{65}	illuminant normalisé D_{65}
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	Lichttransmissionsgrad	light transmittance	facteur de transmission lumineuse
ρ_V	Lichtreflexionsgrad	light reflectance	facteur de réflexion lumineuse
τ_e	direkter Strahlungs-transmissionsgrad	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	Gesamtenergiedurchlaßgrad	total solar energy transmittance (solar factor)	facteur de transmission totale de l'énergie solaire ou facteur solaire
R_a	allgemeiner Farbwiedergabeindex	general colour rendering index	indice général de rendu des couleurs
D_λ	relative spektrale Verteilung der Normlichtart D_{65}	relative spectral distribution of illuminant D_{65}	répartition spectrale relative de l'illuminant normalisé D_{65}
$V(\lambda)$	spektraler Hellempfindlichkeitsgrad	spectral luminous efficiency	efficacité lumineuse relative spectrale
a_e	direkter Strahlungsabsorptionsgrad	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 Wärmeabgabegrad nach innen	secondary internal heat transfer factor	facteur de réémission thermique vers l'intérieur
q_e	sekundärer Wärmeabgabegrad nach außen	secondary external heat transfer factor	facteur de réémission thermique vers l'extérieur
S_λ	relative spektrale Verteilung 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
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 Verteilung der UV-Strahlung der Sonne	relative spectral distribution of UV in solar radiation	répartition spectrale relative du rayonnement ultraviolet solaire

4 Determination of characteristics

4.1 General

The characteristics are determined for quasi-parallel, near normal radiation incidence (see C.1) 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 (300 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 .

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).

Table 1 — Normalized relative spectral distribution D_λ of illuminant D₆₅ multiplied by the spectral luminous efficiency $V(\lambda)$ and by the wavelength interval $\Delta\lambda$

λ nm	$D_\lambda V(\lambda) \Delta\lambda \cdot 10^2$	λ nm	$D_\lambda V(\lambda) \Delta\lambda \cdot 10^2$
380	0,000 0	580	7,899 4
390	0,000 5	590	6,330 6
400	0,003 0	600	5,354 2
410	0,010 3	610	4,249 1
420	0,035 2	620	3,150 2
430	0,094 8	630	2,081 2
440	0,227 4	640	1,381 0
450	0,419 2	650	0,807 0
460	0,666 3	660	0,461 2
470	0,985 0	670	0,248 5
480	1,518 9	680	0,125 5
490	2,133 6	690	0,053 6
500	3,349 1	700	0,027 6
510	5,139 3	710	0,014 6
520	7,052 3	720	0,005 7
530	8,799 0	730	0,003 5
540	9,442 7	740	0,002 1
550	9,807 7	750	0,000 8
560	9,430 6	760	0,000 1
570	8,689 1	770	0,000 0
		780	0,000 0

Table 2 — Normalized relative spectral distribution of global solar radiation S_λ multiplied by the wavelength interval $\Delta\lambda$

λ nm	$S_\lambda\Delta\lambda^{1)}$	λ nm	$S_\lambda\Delta\lambda^{1)}$
300	0,000 5	1000	0,032 9
320	0,006 9	1050	0,030 6
340	0,012 2	1100	0,018 5
360	0,014 5	1150	0,013 6
380	0,017 7	1200	0,021 0
400	0,023 5	1250	0,021 1
420	0,026 8	1300	0,016 6
440	0,029 4	1350	0,004 2
460	0,034 3	1400	0,001 0
480	0,033 9	1450	0,004 4
500	0,032 6	1500	0,009 5
520	0,031 8	1550	0,012 3
540	0,032 1	1600	0,011 0
560	0,031 2	1650	0,010 6
580	0,029 4	1700	0,009 3
600	0,028 9	1750	0,006 8
620	0,028 9	1800	0,002 4
640	0,028 0	1850	0,000 5
660	0,027 3	1900	0,000 2
680	0,024 6	1950	0,001 2
700	0,023 7	2000	0,003 0
720	0,022 0	2050	0,003 7
740	0,023 0	2100	0,005 7
760	0,019 9	2200	0,006 6
780	0,021 1	2300	0,006 0
800	0,033 0	2400	0,004 1
850	0,045 3	2500	0,000 6
900	0,038 1		
950	0,022 0		

¹⁾ The relative spectral distribution of global solar radiation (direct and diffuse) is calculated from the values given in C.3 for air mass = 1; water content = 1,42 cm precipitable water; ozone content = 0,34 cm at standard temperature and pressure; albedo of earth surface = 0,2; spectral optical depth of aerosol extinction (at $\lambda = 500$ nm) = 0,1.

Table 3 — Normalized relative spectral distribution of the UV part of the global solar radiation U_λ multiplied by the wavelength interval $\Delta\lambda$

λ nm	$U_\lambda \Delta\lambda$
282,5	0,000 00
287,5	0,000 00
292,5	0,000 00
297,5	0,000 82
302,5	0,004 61
307,5	0,013 73
312,5	0,027 46
317,5	0,041 20
322,5	0,055 91
327,5	0,065 72
332,5	0,070 62
337,5	0,072 58
342,5	0,074 54
347,5	0,076 01
352,5	0,077 00
357,5	0,078 96
362,5	0,080 43
367,5	0,083 37
372,5	0,086 31
377,5	0,090 73

4.2 Light transmittance

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

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

where

- D_λ is the relative spectral distribution of illuminant D₆₅ (see C.2);
- $\tau(\lambda)$ is the spectral transmittance of the glazing;
- $V(\lambda)$ is the spectral luminous efficiency for photopic vision defining the standard observer for photometry (see C.2);
- $\Delta\lambda$ is the wavelength interval.

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

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

For double glazing:

$$\tau(\lambda) = \frac{\tau_1(\lambda) \tau_2(\lambda)}{1 - \rho_1'(\lambda) \rho_2(\lambda)} \quad (2)$$

where

- $\tau_1(\lambda)$ is the spectral transmittance of the outer pane;
- $\tau_2(\lambda)$ is the spectral transmittance of the second pane;
- $\rho_1'(\lambda)$ is the spectral reflectance of the 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.