BS EN ISO 10077-2:2012

Incorporating corrigendum July 2012

BSI Standards Publication

Thermal performance of windows, doors and shutters — Calculation of thermal transmittance

Part 2: Numerical method for frames

bsi.

...making excellence a habit.™

National foreword

This British Standard is the UK implementation of EN ISO 10077-2:2012. It is identical to ISO 10077-2:2012, incorporating corrigendum July 2012. It supersedes BS EN ISO 10077-2:2003, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/540, Energy performance of materials, components and buildings.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Published by BSI Standards Limited 2013

ISBN 978 0 580 80255 3

ICS 91.060.50; 91.120.10

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 April 2012.

Amendments/corrigenda issued since publication

Date	Text affected
30 April 2013	Implementation of ISO corrigendum July 2012: Subclauses 6.3.2.1 and 6.3.3 modified

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 10077-2

April 2012

ICS 91.060.50; 91.120.10

Incorporating corrigendum July 2012

English Version

Thermal performance of windows, doors and shutters - Calculation of thermal transmittance - Part 2: Numerical method for frames (ISO 10077-2:2012)

Performance thermique des fenêtres, portes et fermetures - Calcul du coefficient de transmission thermique - Partie 2: Méthode numérique pour les encadrements (ISO 10077-2:2012)

Wärmetechnisches Verhalten von Fenstern, Türen und Abschlüssen - Berechnung des Wärmedurchgangskoeffizienten - Teil 2: Numerisches Verfahren für Rahmen (ISO 10077-2:2012)

This European Standard was approved by CEN on 29 February 2012.

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. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

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

Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN ISO 10077-2:2012: E

Foreword

This document (EN ISO 10077-2:2012) has been prepared by Technical Committee ISO/TC 163 "Thermal performance and energy use in the built environment" in collaboration with Technical Committee CEN/TC 89 “Thermal performance of buildings and building components” the secretariat of which is held by SIS.

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 August 2012, and conflicting national standards shall be withdrawn at the latest by August 2012.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN ISO 10077-2:2003.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Endorsement notice

The text of ISO 10077-2:2011 has been approved by CEN as a EN ISO 10077-2:2012 without any modification.

Contents

Page

Foreword ... **iv**

Introduction ... **v**

1 Scope ... **1**

2 Normative references ... **1**

3 Terms, definitions and symbols ... **1**

4 Calculation method ... **2**
4.1 General principle ... **2**
4.2 Validation of the calculation programme ... **3**
4.3 Determination of the thermal transmittance ... **3**

5 Treatment of solid sections and boundaries ... **3**
5.1 Solid materials ... **3**
5.2 Emissivity of surfaces ... **3**
5.3 Boundaries ... **4**
5.4 Roller shutter boxes ... **4**
5.5 Extensions of window frame profiles ... **6**

6 Treatment of cavities ... **6**
6.1 General ... **6**
6.2 Cavities in glazing ... **6**
6.3 Unventilated air cavities in frames and roller shutter boxes ... **6**
6.4 Ventilated air cavities and grooves ... **10**

7 Report ... **11**
7.1 General ... **11**
7.2 Geometrical data ... **12**
7.3 Thermal data ... **12**
7.4 Results ... **12**

Annex A (informative) **Thermal conductivity of selected materials** ... **13**

Annex B (normative) **Surface resistances** ... **15**

Annex C (normative) **Determination of the thermal transmittance** ... **17**

Annex D (normative) **Examples for the validation of calculation programmes** ... **21**

Annex E (informative) **Wood species listed in Annex A** ... **33**

Bibliography ... **36**

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 10077-2 was prepared by Technical Committee ISO/TC 163, *Thermal performance and energy use in the built environment*, Subcommittee SC 2, *Calculation methods*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 89, *Thermal performance of buildings and building components*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This International Standard is one of a series of standards on methods for the design and evaluation of the thermal performance of building equipment and industrial installations.

This second edition cancels and replaces the first edition (ISO 10077-2:2003), which has been technically revised. The main changes compared to the previous edition are given in the following table:

Clause	Changes
5.1	Clarified use of measured data.
5.4	Added calculation rules for roller shutter boxes and added new figure.
5.5	Added calculation rules for extensions of window frame profiles and new added figure.
Annex A	Added Table A.2 — Thermal conductivity of timber species.
Annex A	Added Table A.3 — Typical emissivities of metallic surfaces.
Annex B	Added Table B.2 for roller shutter boxes.
C.2	Added calculation rules for the combination of frame constructions with insulating glazing units (IGU) and Figure C.3 showing a representative metal spacer incorporated in an IGU.
Annex D	Updated Figures D.1 to D.10 for frame sections.

ISO 10077 consists of the following parts, under the general title *Thermal performance of windows, doors and shutters — Calculation of thermal transmittance*:

— *Part 1: General*

— *Part 2: Numerical method for frames*

Introduction

ISO 10077 consists of two parts. The method in this part of ISO 10077 is intended to provide calculated values of the thermal characteristics of frame profiles, suitable to be used as input data in the calculation method of the thermal transmittance of windows, doors and shutters given in ISO 10077-1. It is an alternative to the test method specified in EN 12412-2. In some cases, the hot box method is preferred, especially if physical and geometrical data are not available or if the profile is a complicated geometrical shape.

Although the method in this part of ISO 10077 basically applies to vertical frame profiles, it is an acceptable approximation for horizontal frame profiles (e.g. sill and head sections) and for products used in sloped positions (e.g. roof windows). For calculations made with the glazing units in place, the heat flow pattern and the temperature field within the frame are useful by-products of this calculation.

This part of ISO 10077 does not cover building façades and curtain walling. These are covered in ISO 12631[1)] or EN 13947.

1) To be published.

Thermal performance of windows, doors and shutters — Calculation of thermal transmittance —

Part 2: Numerical method for frames

1 Scope

This part of ISO 10077 specifies a method and gives reference input data for the calculation of the thermal transmittance of frame profiles and of the linear thermal transmittance of their junction with glazing or opaque panels.

The method can also be used to evaluate the thermal resistance of shutter profiles and the thermal characteristics of roller shutter boxes and similar components (e.g. blinds).

This part of ISO 10077 also gives criteria for the validation of numerical methods used for the calculation.

This part of ISO 10077 does not include effects of solar radiation, heat transfer caused by air leakage or three-dimensional heat transfer such as pin point metallic connections. Thermal bridge effects between the frame and the building structure are not included.

2 Normative references

The following referenced documents are indispensable for the application 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 7345, *Thermal insulation — Physical quantities and definitions*

ISO 10211, *Thermal bridges in building construction — Heat flows and surface temperatures — Detailed calculations*

ISO 10456: 2007, *Building materials and products — Hygrothermal properties — Tabulated design values and procedures for determining declared and design thermal values*

ISO 12567-2:2005, *Thermal performance of windows and doors — Determination of thermal transmittance by hot box method — Part 2: Roof windows and other projecting windows*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

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

EN 12519, *Windows and pedestrian doors — Terminology*

3 Terms, definitions and symbols

For the purposes of this document, the terms and definitions given in ISO 7345 and EN 12519 apply.

Symbol	Definition	Unit
A	area	m^2
b	width, i.e. perpendicular to the direction of heat flow	m
d	depth, i.e. parallel to the direction of heat flow	m
E	intersurface emittance	—
F	view factor	—
h	heat transfer coefficient	W/(m^2·K)
L^{2D}	two-dimensional thermal conductance or thermal coupling coefficient	W/(m·K)
l	length	m
q	density of heat flow rate	W/m^2
R	thermal resistance	m^2·K/W
T	thermodynamic temperature	K
U	thermal transmittance	W/(m^2·K)
σ	Stefan-Boltzmann constant	W/(m^2·K^4)
ε	emissivity	—
λ	thermal conductivity	W/(m·K)
Ψ	linear thermal transmittance	W/(m·K)

Subscripts	
a	convective (surface to surface)
e	external (outdoor)
g	glazing
eq	equivalent
f	frame
fr	frame adjacent to roller shutter box
i	internal (indoor)
p	panel
r	radiative
s	space (air or gas space)
sb	shutter box
se	external surface
si	internal surface

4 Calculation method

4.1 General principle

The calculation shall be carried out using a two-dimensional numerical method conforming to ISO 10211. The elements shall be divided such that any further division does not change the calculated result significantly. ISO 10211 gives criteria for judging whether sufficient sub-divisions have been used.

Vertical orientation of frame sections and air cavities is assumed for calculations using this part of ISO 10077 for the purposes of assigning equivalent thermal conductivity values (see 7.3); this applies irrespective of the intended orientation of the actual window, including roof windows.

4.2 Validation of the calculation programme

To ensure the suitability of the calculation programme used, calculations shall be carried out on the examples described in Annex D. The calculated two-dimensional thermal conductance L^{2D} shall not differ from the corresponding values given in Table D.3 by more than ±3 %. This will lead to an accuracy of the thermal transmittance, U, and the linear thermal transmittance Ψ, of about 5 %.

NOTE The ± deviations in Tables D.3 and D.4 are standard deviations from a round-robin and are not to be confused with ±3 % specified above.

4.3 Determination of the thermal transmittance

The thermal transmittance of a frame section shall be determined with the glazing replaced by an insulating panel according to Annex C, with the external and internal surface resistances taken from Annex B. The linear thermal transmittance of the interaction of frame and glazing shall be determined from calculations with the glazing in place and with the glazing replaced by an insulated panel.

NOTE 1 The interaction of the frame and the building structure is considered separately for the building as a whole. It is not part of the thermal transmittance of the frame section.

NOTE 2 In the case of an overlap between the frame section and part of the wall, the linear thermal transmittance could be negative.

5 Treatment of solid sections and boundaries

5.1 Solid materials

For the purpose of this part of ISO 10077, thermal conductivity values used for solid materials shall be obtained according to one of the following:

— Table A.1 of this part of ISO 10077;

— tabulated values given in ISO 10456;

— product standards;

— technical approvals by a recognized national body;

— measurements according to an appropriate International Standard.

Measurements shall be used only if there is no tabulated data or data according to relevant product standards or a technical approval. Measurements shall be performed at a mean temperature of 10 °C using the appropriate method by an institute accredited (as specified in ISO/IEC 17025) to carry out those measurements, on samples that have been conditioned at 23 °C and 50 % RH to constant mass (change in mass not more than 0,1 % over 24 h). To ensure that the thermal conductivity values are representative of the material (that is, that the value incorporates likely variability of the material and the measurement uncertainty), one of the following methods shall be used for obtaining the thermal conductivity value from measured data used in the calculations:

— The thermal conductivity is the declared value obtained from the measured data (at least three different samples from different lots representing the usual product variation, with ageing taken into consideration) according to a statistical evaluation as defined in ISO 10456: 2007, Annex C, 90 % fractile.

— If less than three samples, use the mean value multiplied by a factor of 1,25.

5.2 Emissivity of surfaces

Normally, the emissivity of surfaces bounding an air cavity shall have an emissivity of 0,9. Metallic surfaces such as aluminium alloy frame, steel reinforcement and other metals/alloys have lower emissivity. Typical values of the emissivity for metallic surfaces are given in Table A.3. Values less than 0,9 may be used only if taken from Table A.3 or measured in accordance with an appropriate standard by an institute accredited (as specified in ISO/IEC 17025) to carry out those measurements. Where based on measured values there shall be at least three samples and the results shall be evaluated according to the statistical treatment in ISO 10456.

5.3 Boundaries

The external and internal surface resistances depend on the convective and radiative heat transfer to the external and internal environments. If an external surface is not exposed to normal wind conditions, the convective part may be reduced in edges or junctions between two surfaces. The surface resistances for horizontal heat flow are given in Annex B. These values shall be used for calculations by this part of ISO 10077 irrespective of the intended orientation of the actual window, including roof windows. Surface condensation shall be assessed on the basis of the lowest internal surface temperature calculated using the surface resistances in Annex B.

The cutting plane of the infill and the cutting plane to neighbouring material shall be taken as adiabatic (see Figure 3 and Annex D)

The reference temperature conditions shall be 20 °C internal and 0 °C external.

5.4 Roller shutter boxes

Calculation of the thermal transmittance of a roller shutter box shall be done with the following boundary conditions:

— the top of the roller shutter box: adiabatic;

— the bottom of the roller shutter box where it adjoins the window frame: adiabatic for a distance of 60 mm;

— surfaces adjacent to the internal environment: surface resistance of 0,13 $m^2 \cdot K/W$;

— surfaces adjacent to the external environment: surface resistance of 0,04 $m^2 \cdot K/W$.

The cavity within the roller shutter box shall be treated as (see Figure 1):

— if $e_1 + e_3 \leq 2$ mm: unventilated. The equivalent thermal conductivity of an unventilated air cavity is calculated according to 6.3. Additional hardware, e.g. brushes, gaskets etc., can be taken into account for determination of e_1 and e_3;

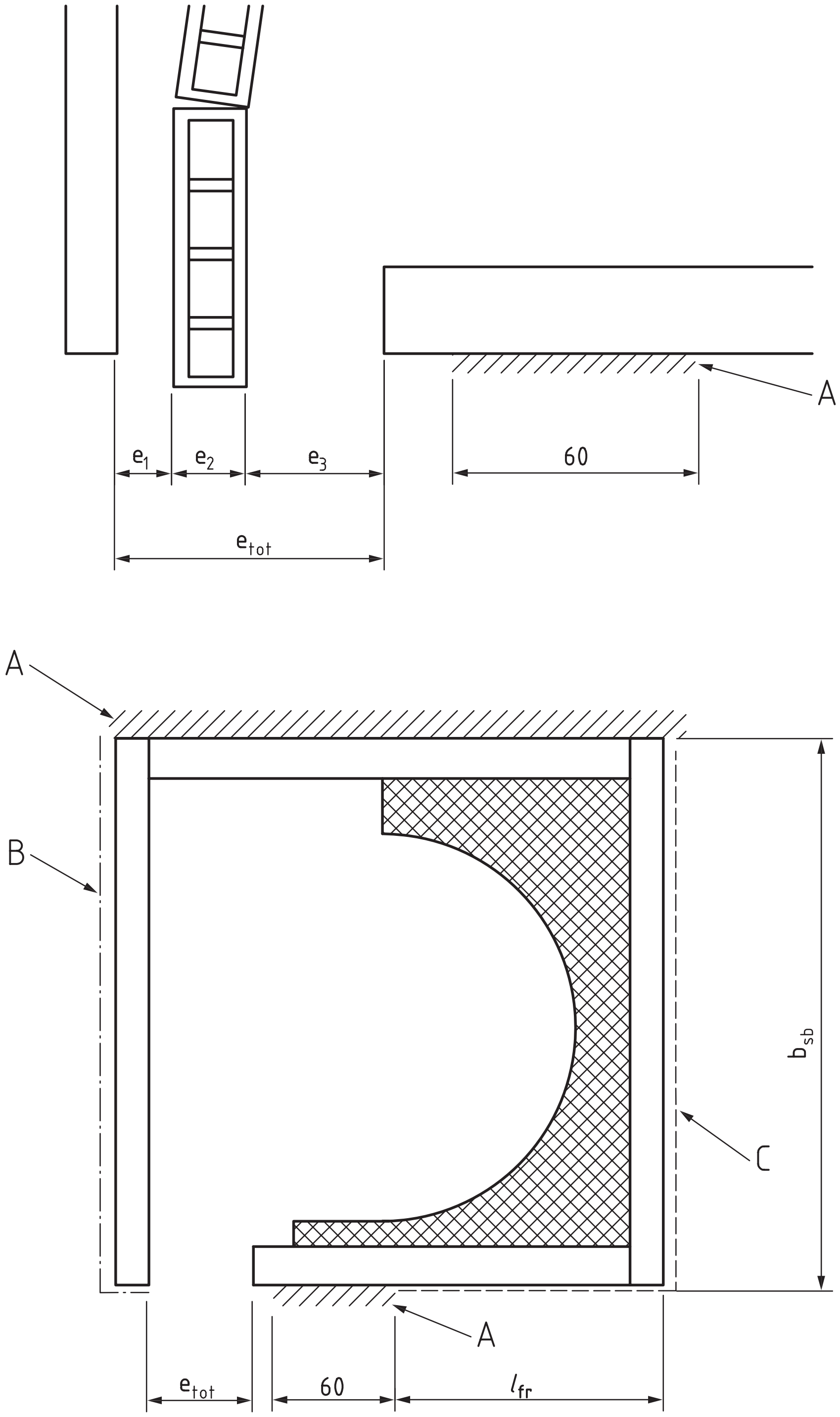
— if $e_{tot} \leq 35$ mm: slightly ventilated. The equivalent thermal conductivity is twice that of an unventilated cavity of the same size;

— if $e_{tot} > 35$ mm: well ventilated taking the air temperature within the cavity equal to the external air temperature but with a surface resistance of 0,13 $m^2 \cdot K/W$.

The relevant height of the roller shutter box, b_{sb}, used for the calculation is the projected distance between the upper and lower adiabatic boundary (see Figure 1).

The assessment may be done with insulation on either or both of the boundaries B and C indicated in Figure 1. If that is the case, the thickness and thermal conductivity of the insulation shall be stated in the calculation report.

Dimensions in millimetres



Key

Boundaries (see Annex B):

A adiabatic boundary

B external surface resistance

C internal surface resistance

b_{sb} height of the roller shutter box

e_1, e_3 widths of air gaps on either side of the shutter where it exits from the shutter box

e_2 thickness of shutter

e_{tot} $e_1 + e_2 + e_3$

l_{fr} frame length

NOTE The window frame (boundary A) is 60 mm wide but located with respect to the roller shutter box according to the actual situation.

Figure 1 — Schematic example for the treatment of the boundaries for roller shutter boxes

5.5 Extensions of window frame profiles

For frames with special extensions overlapping the wall or other building elements, such as Z-shaped profiles, the extensions shall be disregarded as illustrated in Figure 2. This applies to all profiles with special extensions (e.g. H-shape) where the extensions overlap the wall or other building elements. Other boundaries shall be treated as defined in Figure 3.

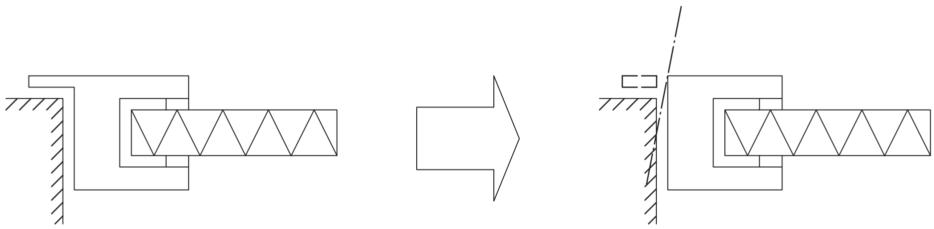


Figure 2 — Treatment of profiles with extensions (Z-shape)

NOTE 1 This approximation is for assessment of thermal transmittance. It is not appropriate for assessment of condensation risk.

NOTE 2 The extension of the frame profile is disregarded in the calculation of the thermal transmittance of the window (see ISO 10077-1).

6 Treatment of cavities

6.1 General

The heat flow rate in cavities shall be represented by an equivalent thermal conductivity λ_{eq}. This equivalent thermal conductivity includes the heat flow by conduction, by convection and by radiation, and depends on the geometry of the cavity and on the adjacent materials.

6.2 Cavities in glazing

The equivalent thermal conductivity of an unventilated space between glass panes in glazing shall be determined according to EN 673. The resulting equivalent conductivity shall be used in the whole cavity, up to the edge.

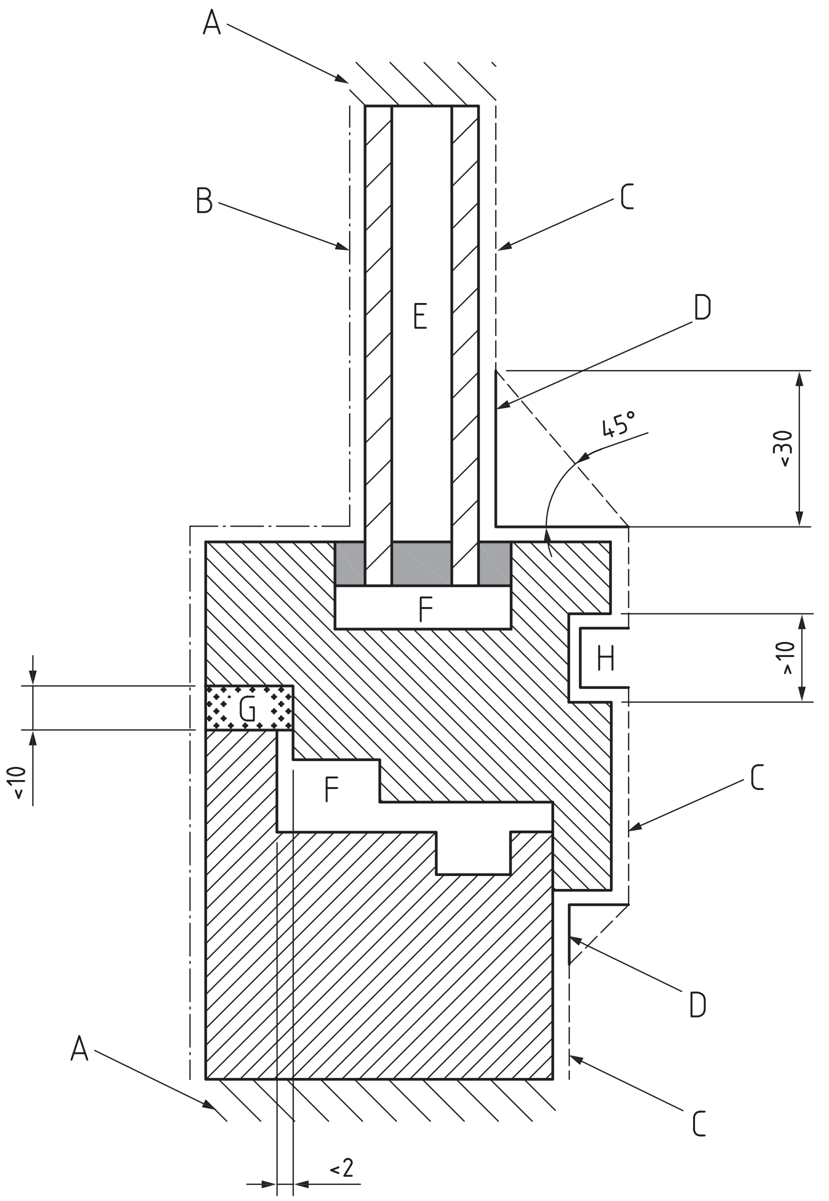
NOTE The correlations for high aspect ratio cavities used in EN 673 tend to give low values for the equivalent thermal conductivity. More accurate correlations are given in ISO 15099.

6.3 Unventilated air cavities in frames and roller shutter boxes

6.3.1 Definition

Air cavities are unventilated if they are completely closed or connected either to the exterior or to the interior by a slit with a width not exceeding 2 mm (see Figure 3). Otherwise, the cavity shall be treated as ventilated.

Dimensions in millimetres



Key

Boundaries (see Annex B): Cavities and grooves:

A adiabatic boundary

B external surface resistance

C internal surface resistance

D increased surface resistance

E glazing (see 6.2)

F unventilated cavity (see 6.3)

G slightly ventilated cavity or groove (see 6.4.1)

H well ventilated cavity or groove (see 6.4.2)

Figure 3 — Schematic example for the treatment of cavities and grooves of a frame section and the treatment of the boundaries

NOTE Figure 3 illustrates a window. The same principles are applicable to roof windows, but the adiabatic part of the boundary is different; an example of a roof window is shown in Figure D.5.

6.3.2 Unventilated rectangular cavities

6.3.2.1 Equivalent thermal conductivity

The equivalent thermal conductivity λ_{eq} of the cavity in direction 1 is given by Equation (1).

$$\lambda_{eq} = \frac{d}{R_s} \qquad (1)$$

where

d is the dimension of the cavity in the direction of heat flow (see Figure 4);

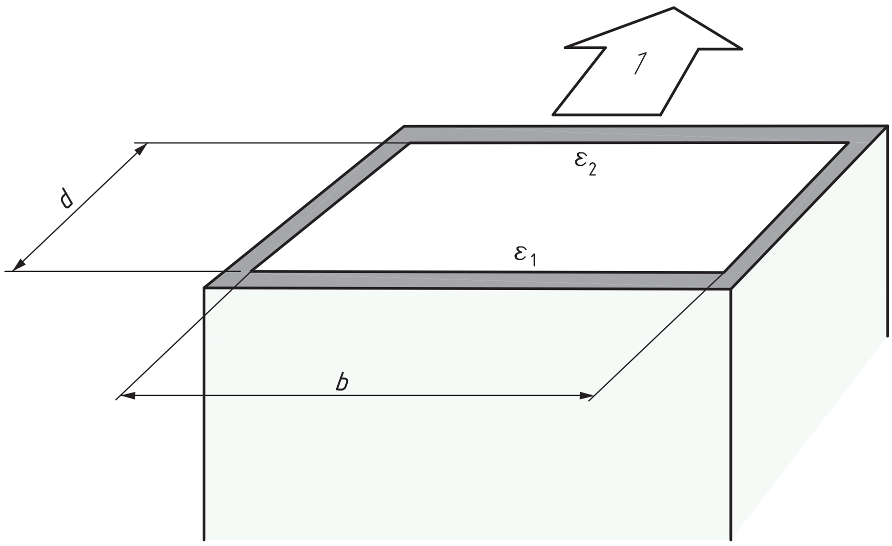
R_s is the thermal resistance of the cavity, given by Equation (2):

$$R_s = \frac{1}{h_a + h_r} \qquad (2)$$

where

h_a is the convective heat transfer coefficient;

h_r is the radiative heat transfer coefficient.



Key

1 heat flow direction

b dimension perpendicular to the direction of heat flow

d dimension of cavity in the direction of heat flow

ε_1 and ε_2 emissivities of the surfaces

Figure 4 — Rectangular cavity

6.3.2.2 Convective heat transfer coefficient

The convective heat transfer coefficient, h_a, is:

If b < 5 mm

$$h_a = \frac{C_1}{d} \tag{3}$$

where

$C_1 = 0{,}025$ W / (m·K);

otherwise

$$h_a = \max\left\{ \frac{C_1}{d} ; C_2\, \Delta T^{1/3} \right\} \tag{4}$$

where

C_1 = 0,025 W/(m·K);

C_2 = 0,73 W/(m^2·K$^{4/3}$);

ΔT is the maximum surface temperature difference in the cavity.

If no other information is available, use ΔT = 10 K for which

$$h_a = \max\left\{ \frac{C_1}{d} ; C_3 \right\} \tag{5}$$

where

C_1 = 0,025 W/(m·K);

C_3 = 1,57 W/(m^2·K);

6.3.2.3 Radiative heat transfer coefficient

$$h_r = 4\sigma T_m^3\, E\, F \tag{6}$$

where

σ = 5,67 × 10^{-8} W/(m^2·K^4) is the Stefan-Boltzmann constant;

$E = \left(\frac{1}{\varepsilon_1} + \frac{1}{\varepsilon_2} - 1\right)^{-1}$ is the intersurface emittance;

$F = \frac{1}{2}\left(1 + \sqrt{1 + (d/b)^2} - d/b\right)$ is the view factor for a rectangular section;

ε_1 and ε_2 are the emissivities of the surfaces indicated in Figure 4.

The values of the emissivities should be given to two decimal places. If no other information is available use ε_1 = 0,90 and ε_2 = 0,90.

NOTE Emissivity data for metallic surfaces are given in Table A.3.

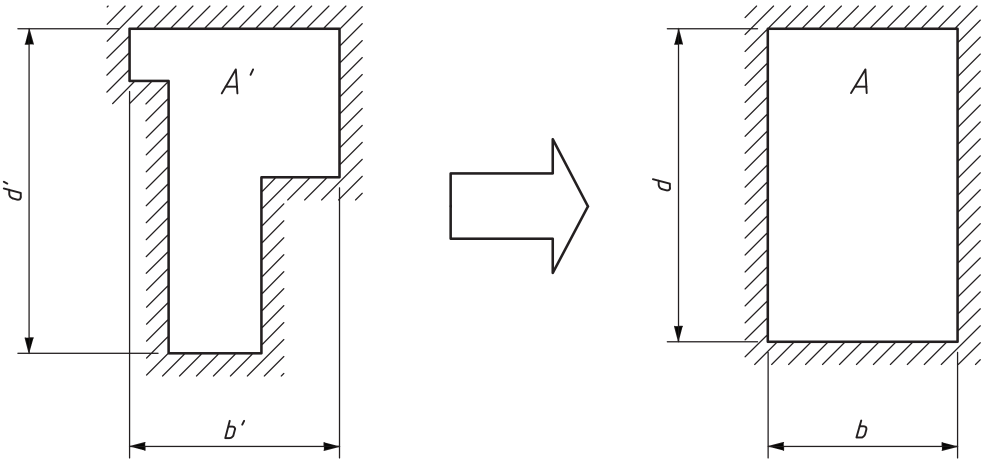
If no other information is available, use T_m = 283 K for which

$$h_r = C_4 \left(1 + \sqrt{1 + \left(d/b \right)^2} - d/b \right) \tag{7}$$

where C_4 = 2,11 W/(m²·K)

6.3.3 Unventilated non-rectangular air cavities

Non-rectangular air cavities (T-shape, L-shape, etc.) are transformed into rectangular air cavities with the same area ($A = A'$) and aspect ratio ($d/b = d'/b'$) (see Figure 5) and then 6.3.2 is applied.



Key

A area of the equivalent rectangular air cavity

d, b depth and width of the equivalent air cavity

A' area of the true cavity

d', b' depth and width of the smallest circumscribing rectangle

Figure 5 — Transformation of non-rectangular air cavities

The transformation is given by

$$b = \sqrt{A' \frac{b'}{d'}} \tag{8}$$

$$d = \sqrt{A' \frac{d'}{b'}} \tag{9}$$

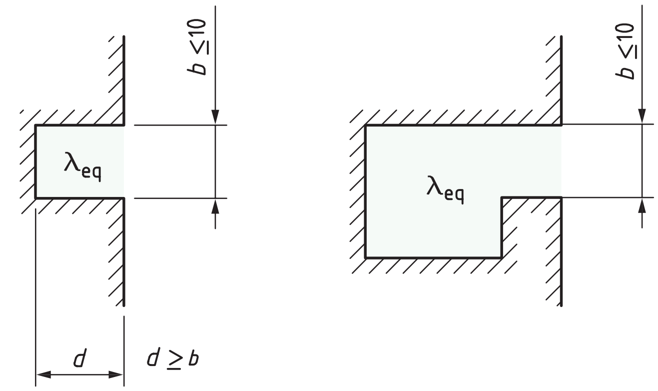
Cavities with one dimension not exceeding 2 mm or cavities with an interconnection not exceeding 2 mm shall be considered as separate.

6.4 Ventilated air cavities and grooves

6.4.1 Slightly ventilated cavities and grooves with small cross-section

Grooves with small cross-sections (see Figure 6) at the external or internal surfaces of profiles and cavities connected to the external or internal air by a slit greater than 2 mm but not exceeding 10 mm shall be considered as slightly ventilated air cavities. The equivalent conductivity is twice that of an unventilated air cavity of the same size according to 6.3.

Dimensions in millimetres



Key

λ_{eq} equivalent thermal conductivity

Figure 6 — Examples of slightly ventilated cavities and grooves with small cross-section

6.4.2 Well-ventilated cavities and grooves with large cross-section

In cases not covered by 6.3 and 6.4.1, in particular when the width b of a groove or of a slit connecting a cavity to the environment exceeds 10 mm, it is assumed that the whole surface is exposed to the environment. Therefore, the surface resistance R_{si} or R_{se} according to 5.2 shall be used at the developed surface; see Figure 7.

In the case of a large cavity connected by a single slit and a developed surface exceeding the width of the slit by a factor of ten, the surface resistance with reduced radiation shall be used (see Annex B).

Dimensions in millimetres

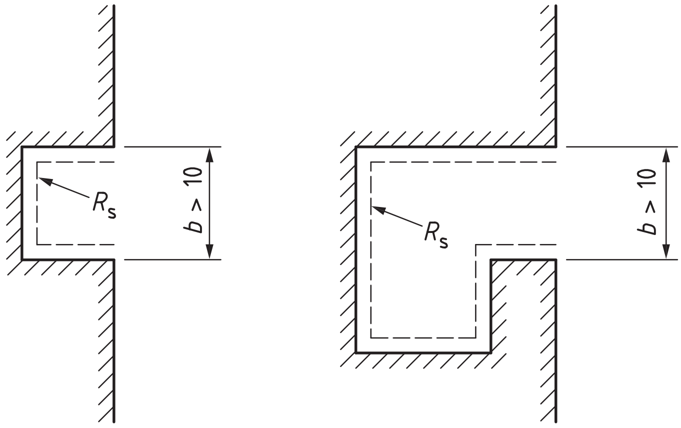


Figure 7 — Examples for well-ventilated cavities and grooves

7 Report

7.1 General

The calculation report shall include all information necessary to allow the calculation to be repeated. The sources of all data not taken from this part of ISO 10077 shall be given in the report. The type of software tool(s) used for the calculation shall be specified.

7.2 Geometrical data

A scale drawing of the sections (preferably using 1:1 scale) shall be included in the report. The drawing shall give the dimensions and a description of the materials used. The minimum information to be given is:

— for metallic frames, the thickness, position, type and number of thermal breaks;

— for plastic frames, the presence and position of metal stiffening (reinforcements);

— the thickness of wooden or plastic frames, preferably indicated on a scale drawing;

— the internal and external projected frame areas, preferably indicated on a scale drawing;

— the depth and the thickness of the glazing or panel in the frame;

— for a roller shutter box, the dimensions of the roller shutter box, the position of the window frame and the ventilation of the cavity (see 5.4).

7.3 Thermal data

7.3.1 Thermal conductivity

All materials of the frame section shall be listed together with the thermal conductivity values used for the calculation. The data given in Annex A should preferably be used. If other sources are used, this shall be clearly stated and reference made to the sources.

7.3.2 Emissivity

For cavities, the emissivity of the surrounding surfaces shall be stated with reference to Table A.3 where appropriate, and supporting evidence, including references, shall be provided if values less than 0,9 are used.

7.3.3 Boundary conditions

The internal and external surface resistances and the adiabatic boundaries, together with the internal and external air temperature, shall be indicated on the drawing. In the case of a roller shutter box, the location of any insulation applied to the surfaces of the roller shutter box shall be stated, together with its thickness and thermal conductivity.

7.4 Results

The total heat flow rate or the density of heat flow rate, the thermal transmittance of the frame section and the linear thermal transmittance according to Annex C shall be given to two significant figures (i.e. to one decimal place if greater than or equal to 1,0, to two decimal places if less than 1,0, and to three decimal places if less than 0,1).

Annex A
(informative)

Thermal conductivity of selected materials

Table A.1 includes the thermal conductivities of the materials used for the given groups. With a few exceptions, the values were taken from ISO 10456, which also includes other materials.

Table A.1 — Thermal conductivities of materials

Group	Material[a]	Density kg/m³	Thermal conductivity W/(m·K)
Frame	Copper	8 900	380
	Aluminium (Si Alloys)	2 800	160
	Brass	8 400	120
	Steel	7 800	50
	Stainless steel,[b] austenitic or austenitic-ferritic	7 900	17
	Stainless steel,[b] ferritic or martensitic	7 900	30
	PVC (polyvinylchloride), rigid	1 390	0,17
	Hardwood[c]	700	0,18
	Softwood[d]	500	0,13
	Softwood[d]	450	0,12
	Fibreglass (UP-resin)*	1 900	0,40
Glass	Soda lime glass	2 500	1,00
	PMMA (polymethylmethacrylate)	1 180	0,18
	Polycarbonates	1 200	0,20
Thermal break	ABS (acrylonitrile butadiene styrene)	1 050	0,20
	Polyamide (nylon)	1 150	0,25
	Polyamide 6.6 with 25 % glass fibre	1 450	0,30
	Polyethylene HD, high density	980	0,50
	Polyethylene LD, low density	920	0,33
	Polypropylene, solid	910	0,22
	Polypropylene with 25 % glass fibre	1 200	0,25
	PU (polyurethane), rigid	1 200	0,25
	PVC-U (polyvinylchloride), rigid	1 390	0,17
Weather stripping	PCP (polychloroprene), e.g. Neoprene	1 240	0,23
	EPDM (ethylene propylene diene monomer)	1 150	0,25
	Silicone, pure	1 200	0,35
	Silicone, filled	1 450	0,50
	PVC, flexible (PVC-P) 40 % softener	1 200	0,14
	Pile weather stripping (polyester mohair)*		0,14
	Elastomeric foam, flexible	60 to 80	0,05

Table A.2 — Table A.1 (*continued*)

Group	Material[a]	Density kg/m^3	Thermal conductivity W/(m·K)
Sealant and glass edge material	PU (polyurethane)	1 500	0,40
	Butyl rubber, solid/hot melt	1 200	0,24
	Polysulfide	1 700	0,40
	Silicone, pure	1 200	0,35
	Silicone, filled	1 450	0,40
	Polyisobutylene	930	0,20
	Polyester resin	1 400	0,19
	Silica gel (desiccant)	720	0,13
	Molecular sieve (desiccant)*	650 to 750	0,10
	Silicone foam, low density	750	0,12
	Silicone foam, medium density*	820	0,17

[a] Most materials are taken from ISO 10456 except those marked with.*

[b] EN 10088-1, contains extensive lists of properties of stainless steels which may be used when the precise composition of the stainless steel is known.

[c] Hardwood: wood from trees of the botanical group Dicotyledonae (see also Table A.2).

[d] Softwood: wood from trees of the botanical group Gymnosperms (see also Table A.2).

For the application of this part of ISO 10077, the thermal conductivity of timber can be taken from Table A.2 depending on the timber species.

Table A.3 — Thermal conductivity of timber species

Code for timber species[a]	Thermal conductivity, λ W/(m·K)
ABAL, PCAB, PCST, PNCN, THPL	0,11
KHXX, LADC, LAER, LAGM, LAOC, LAXX, PCGL, PHWS, PNSY, PSMN, SHLR, SWMC, TMIV, TSHT	0,13
ENCY, ENUT, EUXX, HEXM, HEXN, MIXX, OCRB, SHDR, TEGR, TGHC	0,16
AFXX, CLXX, EUGL, EUGR, EUSL, EUUG, EUUP, INXX, PHMG, PMPN, QCXA, QCXE, ROPS	0,18

[a] Annex E contains the list of wood species designated by these codes.

Table A.4 — Typical emissivities of metallic surfaces

Description	Normal emissivity
untreated aluminium surfaces	0,1
slightly oxidized aluminium surfaces (up to 5 µm)	0,3
metallic surfaces (general, including galvanised)	0,3
anodised, painted or powder coated surfaces	0,9

NOTE An untreated surface is one that has had no artificial treatment (e.g. anodising, galvanising, painting).

Annex B
(normative)

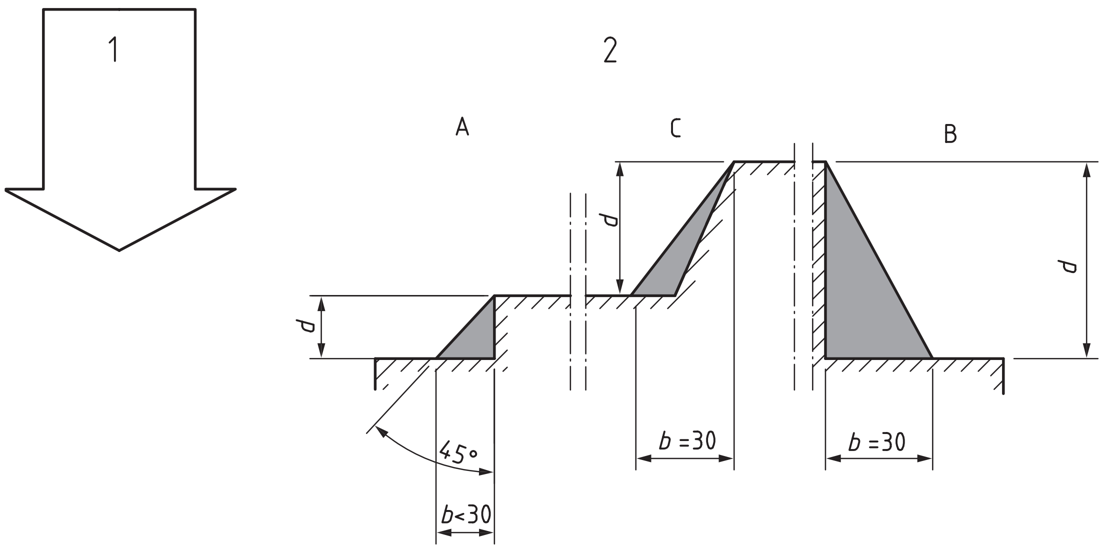
Surface resistances

Table B.1 — Surface resistances for profiles (horizontal heat flow)

Position	External, R_{se} $m^2·K/W$	Internal, R_{si} $m^2·K/W$
Normal (plane surface)	0,04	0,13
Reduced radiation/convection [in edges or junctions between two surfaces (see Figure B.1)]	0,04	0,20
NOTE These values correspond to the surface resistance values given in ISO 6946, which also gives further information about the influence of convection and radiation on surface resistances.		

Where simulation software requires inclined surfaces to be represented by orthogonal meshing, the surface resistance may be corrected by multiplying by the ratio of the actual surface length to the length as represented in the simulation model.

Dimensions in millimetres



Key

1 direction of heat flow

2 internal surface

Figure B.1 — Schematic representation of surfaces with an increased surface resistance due to a reduced radiation/convection heat transfer

In Figure B.1 the shading indicates the distances over which increased surface resistances apply. These are the distances b and d, where b is equal to the depth d, but not greater than 30 mm.

EXAMPLE 1 $b = d$ when $d \leq 30$ mm

EXAMPLE 2 $b = 30$ mm when $d > 30$ mm

EXAMPLE 3:For application to a sloped surface, $b = 30$ mm when $d > 30$ mm.

Table B.2 — Surface resistances for calculation of roller shutter boxes

Heat flow direction	External, R_{se} $m^2 \cdot K/W$	Internal, R_{si} $m^2 \cdot K/W$
Horizontal	0,04	0,13
Vertical	0,04	0,13
NOTE The value for the internal surface resistance for vertical heat flow takes into account the effect of heat flow in an upward direction and also the effect of reduced radiation/convection.		

Annex C
(normative)

Determination of the thermal transmittance

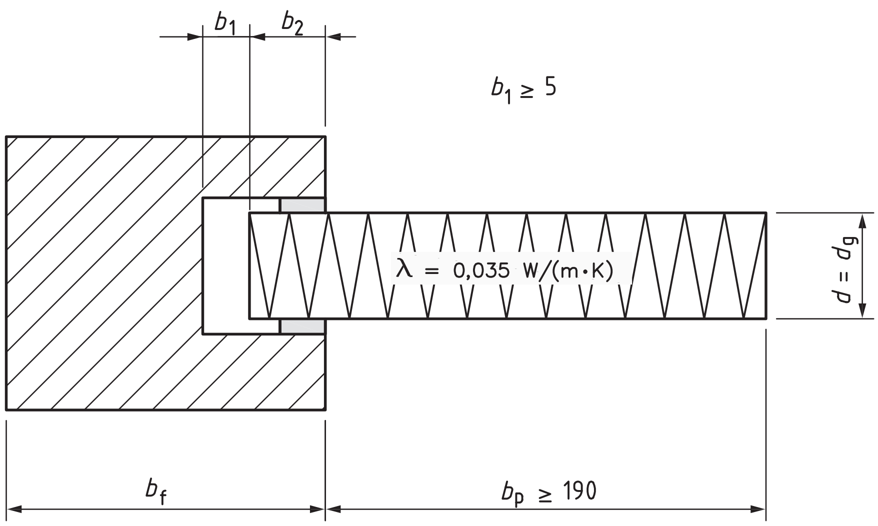
C.1 Thermal transmittance of the frame section

The thermal transmittance of the frame section, U_f, is defined as follows. With reference to Figure C.1, in the calculation model the glazing or opaque panel is replaced by an insulation panel with thermal conductivity λ = 0,035 W/(m·K) inserted into the frame, with clearance b_1 not less than 5 mm. The overlap b_2 is equal to that of the glazing which the insulation panel replaces. The length of the panel shall be at least 190 mm measured from the most protruding part of the frame, ignoring any protruding gasket(s). For protruding gaskets this means that the visible panel length could be less than 190 mm. The opposite end of the panel is considered as an adiabatic boundary. The frame model shall contain all materials used in manufacturing the window except the glazing or opaque panel, which is replaced by the insulation panel. The thickness d of the insulation panel shall be:

— where the frame is designed for a specific thickness, that of the glazing or opaque panel being replaced;

— where the frame can be used with several glazing thicknesses, 24 mm for double glazing or 36 mm for triple glazing.

Dimensions in millimetres



Key

d_g glazing thickness

Figure C.1 — Schematic of profile section with insulation panel installed

NOTE Figures D.1 to D.7 illustrate some typical window profiles, indicating the boundary conditions for the numerical calculations.

In the case of a roof window, the adiabatic parts of the boundary are those where the frame of the roof window is in contact with the roof, when the roof window is installed according to the manufacturer's instructions. If the method of installation of the roof window cannot be determined from the manufacturer's installation instructions, it shall be modelled as depicted in Figure 2 of ISO 12567-2:2005.

The two-dimensional thermal conductance L_f^{2D}, of the section shown in Figure C.1 consisting of frame and insulation panel is calculated. The value of the thermal transmittance of the frame, U_f, is defined by:

$$U_f = \frac{L_f^{2D} - U_p\ b_p}{b_f} \tag{C.1}$$

where

U_f is the thermal transmittance of the frame section, expressed in W/(m²·K);

L_f^{2D} is the thermal conductance of the section shown in Figure C.1, expressed in W/(m·K);

U_p is the thermal transmittance of the central area of the panel, expressed in W/(m²·K);

b_f is the projected width of the frame section (without protruding gaskets), expressed in m;

b_p is the visible width of the panel, expressed in m.

b_f is the larger of the projected widths as seen from both sides. b_p is measured on the same side as b_f.

NOTE L^{2D} is calculated from the total heat flow rate per length through the section divided by the temperature difference between both adjacent environments (see ISO 10211).

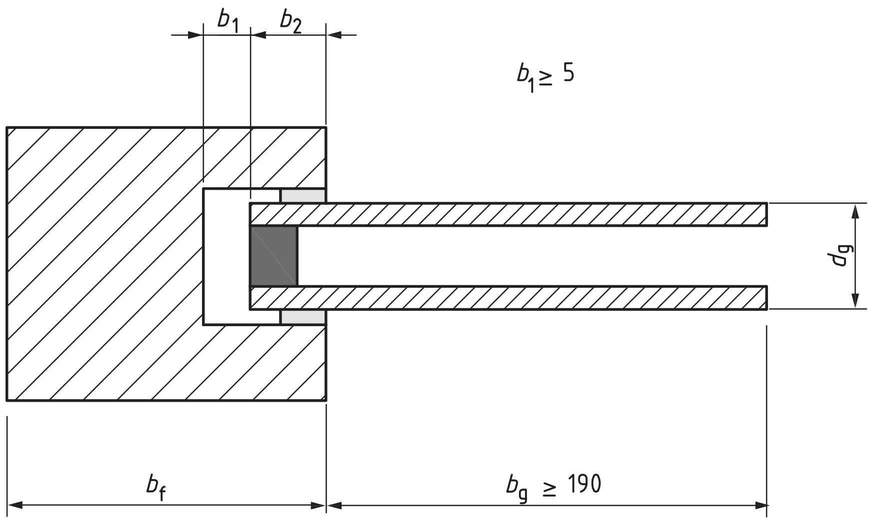
C.2 Linear thermal transmittance of the junction with the glazing or opaque panel

The thermal transmittance of the glazing, U_g, is applicable to the central area of the glazing and does not include the effect of the spacer at the edge of the glazing. The thermal transmittance of the frame, U_f, is applicable in the absence of glazing. The linear thermal transmittance, Ψ, describes the additional heat flow caused by the interaction of the frame and the glass edge, including the effect of the spacer.

To calculate the two-dimensional thermal coupling coefficient of the section consisting of the frame and the glazing including the spacer effect, the frame section with a projected frame width, b_f, and thermal transmittance U_f is completed by glazing with thermal transmittance U_g and length b_g (see Figure C.2). The value of the linear thermal transmittance, Ψ, is defined by Equation (C.2).

The same procedure applies to frame sections for doors with opaque panels instead of glazing.

Dimensions in millimetres



Key

d_g glazing thickness

Figure C.2 — Schematic of profile section with glazing installed

$$\Psi = L_{\Psi}^{2D} - U_f\, b_f - U_g\, b_g \qquad (C.2)$$

where

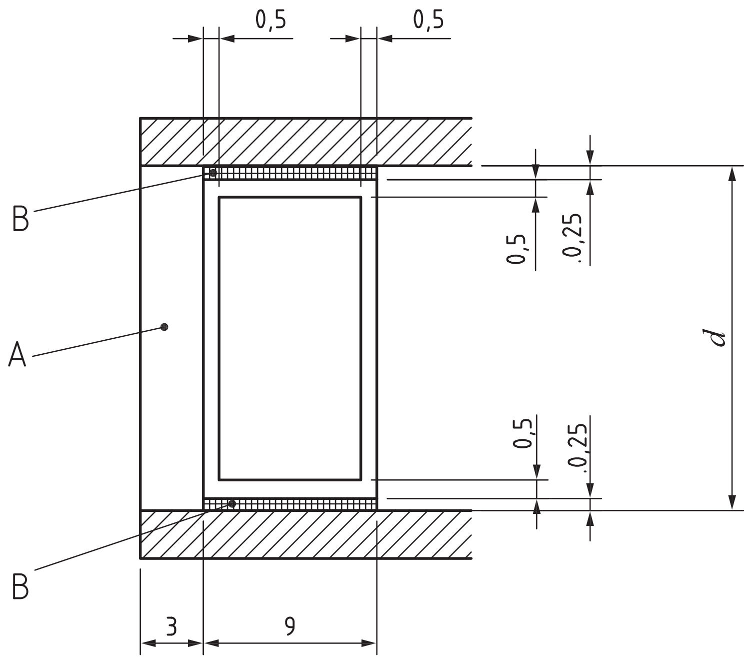
Ψ	is the linear thermal transmittance, expressed in W/(m·K);
L_{Ψ}^{2D}	is thermal conductance of the section shown in Figure C.2, expressed in W/(m·K);
U_f	is the thermal transmittance of the frame section, expressed in W/(m²·K);
U_g	is the thermal transmittance of the central area of the glazing, expressed in W/(m²·K);
b_f	is the projected width of the frame section, expressed in m;
b_g	is the visible width of the glazing, expressed in m.

b_f is the larger of the projected widths as seen from both sides. b_g is measured on the same side as b_f.

A visible length of the panel or glass of 190 mm is sufficient for glazing with a thickness up to 60 mm. In other cases, the length needs to be increased (see ISO 10211).

To calculate Ψ-values for the combination of frame constructions with insulating glazing units (IGU), including metallic spacers, when there is no detailed information about the geometry of the metal spacer, the following spacer shall be used.

The depth of the spacer d is the width of the cavity of the IGU reduced by 0,5 mm. This is because of a thickness of 0,25 mm of the inner sealant (butyl rubber) on either size of the spacer. For example, if the width of the cavity in the IGU is 16 mm, the depth d of the spacer is 15,5 mm. The general geometry of the spacer and the integration in the IGU is shown in Figure C.3. If no other information is available, the outer sealant should be polysulfide of thickness 3 mm.



Dimensions in millimetres

Key

A polysulfide

B butylene

Figure C.3 — Representative metal spacer incorporated in an IGU

Representative Ψ-values of thermally improved spacers can be established on the basis of representative profile sections and representative glass units. A detailed procedure is given in Reference [10].

Annex D
(normative)

Examples for the validation of calculation programmes

D.1 General

This annex gives criteria for the validation of a calculation program. As stated in 4.2, application of a programme to frame sections in Figures D.1 to D.10 shall lead to results for L^{2D} differing by no more than 3 % from those given in Tables D.3 and D.4. Anisotropic thermal conductivity values were used for the equivalent thermal conductivity of airspaces in these calculations (see 6.3.2).

D.2 Figures

In Figures D.1 to D.10 the key shown in Tables D.1 and D.2 applies.

Table D.1 — Boundary

Key	Surface resistance, R_s m²·K/W	Temperature, θ °C
A adiabatic	infinity	—
B external	see Annex B	0
C internal	see Annex B	20

Table D.2 — Materials

Key	Material	Thermal conductivity, λ W/(m·K)
a	insulation panel	0,035
b	soft wood	0,13
c	PVC	0,17
d	EPDM	0,25
e	polyamide 6.6 with 25 % glass fibre	0,30
f	glass	1,00
g	steel	50
h	aluminium[a]	160
i	pile weather stripping (polyester mohair)	0,14
k	polyamide	0,25
l	PU (polyurethane), rigid	0,25
m	polysulfide	0,40
n	silica gel (desiccant)	0,13
o	gas filling	0,034[a]

[a] Equivalent thermal conductivity of the gas filling.

NOTE All surfaces have emissivity 0,9.

Dimensions in millimetres

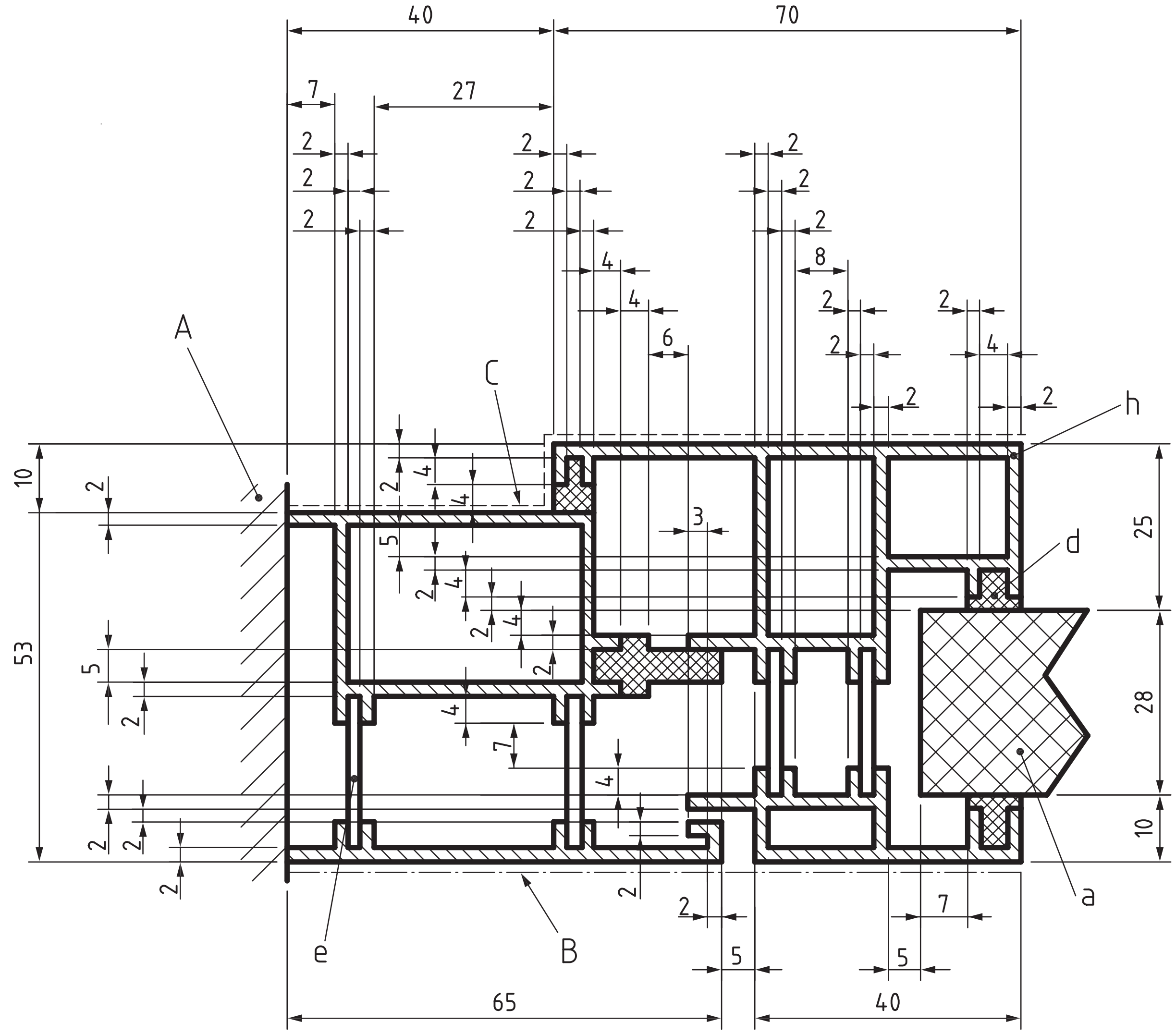


Figure D.1 — Aluminium frame section with thermal break and insulation panel (b_f = 110 mm)

Dimensions in millimetres

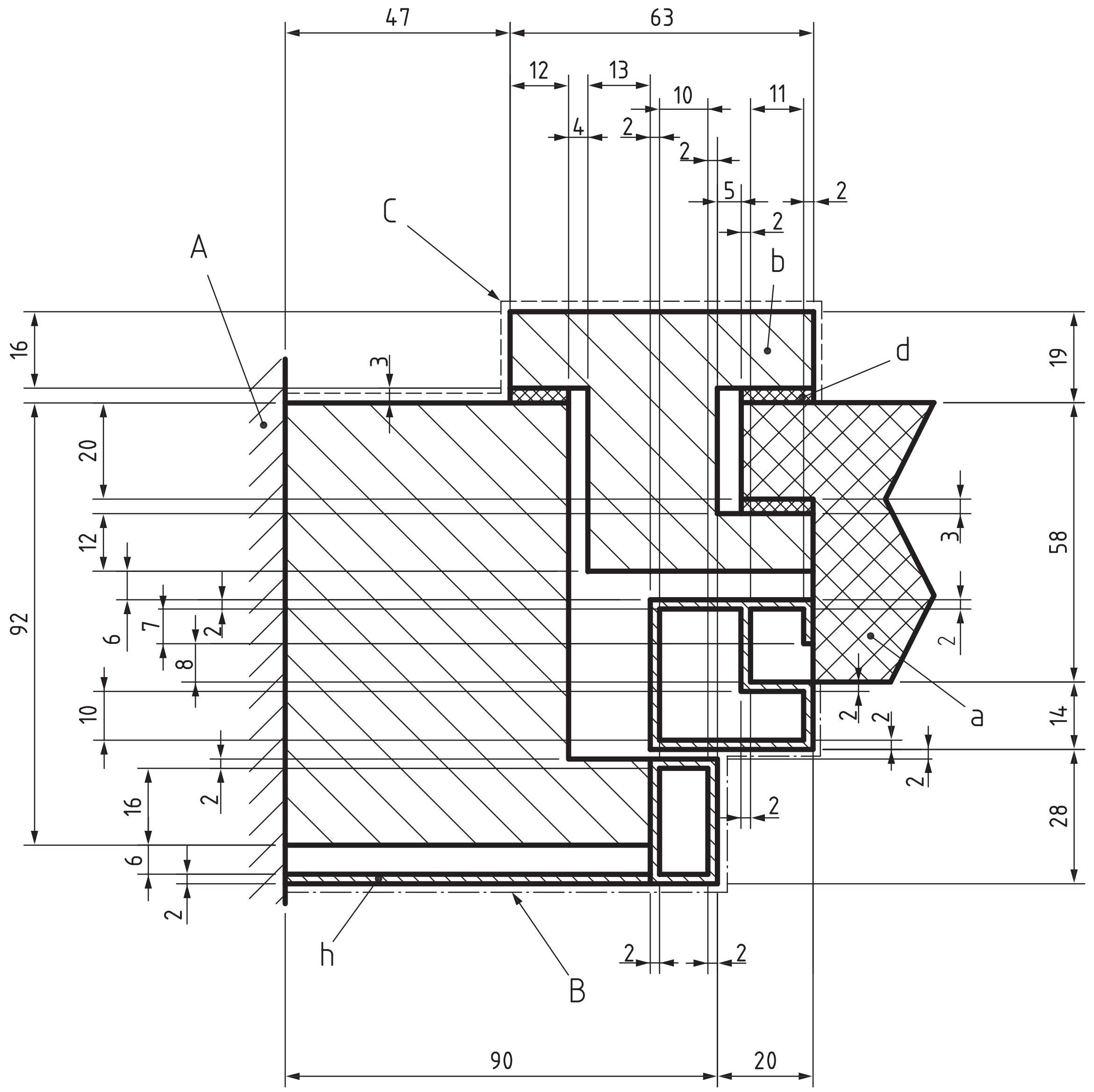


Figure D.2 — Aluminium clad wood frame section and insulation panel (b_f = 110 mm)

Dimensions in millimetres

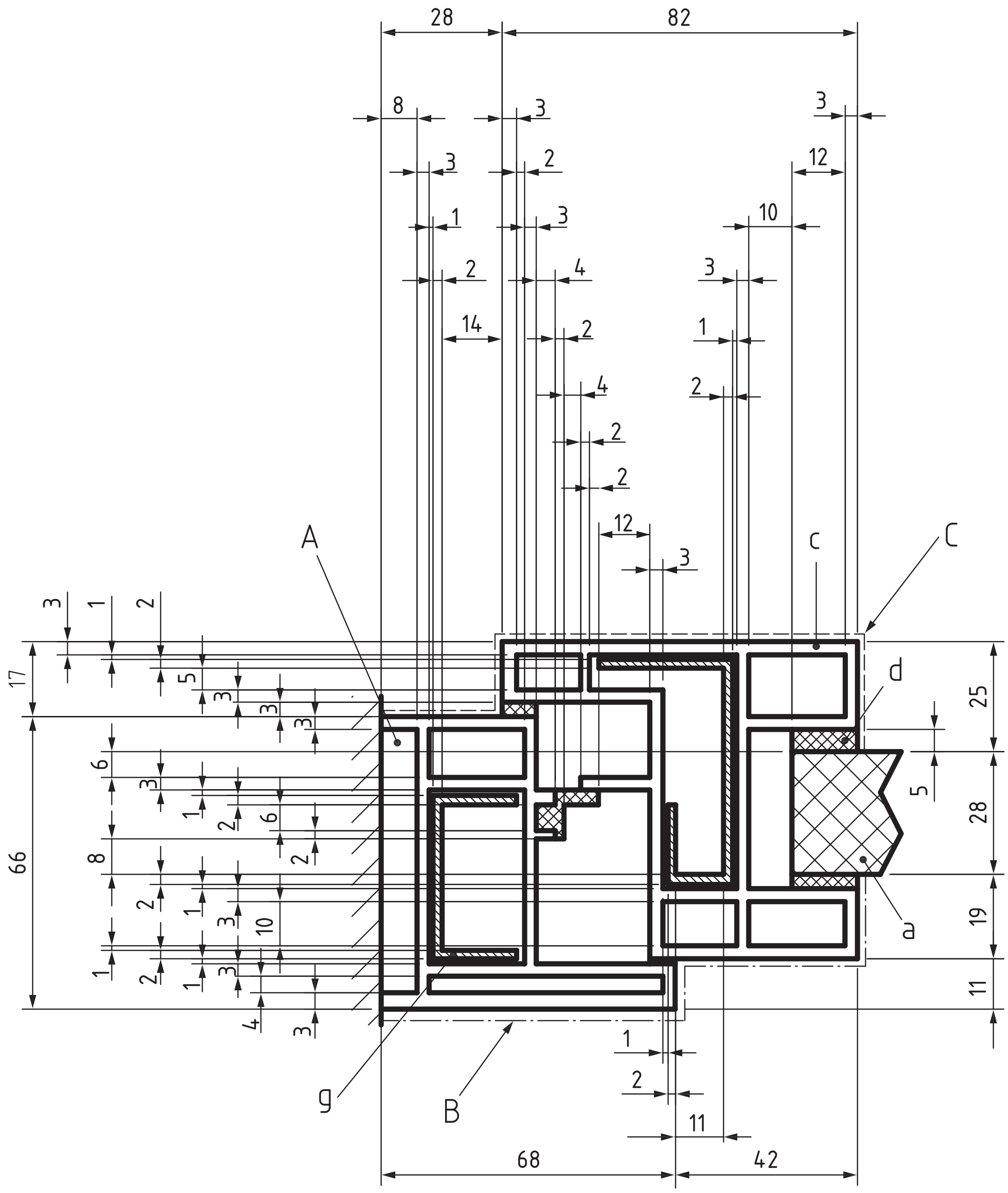


Figure D.3 — PVC frame section with steel reinforcement and insulation panel (b_f = 110 mm)

Dimensions in millimetres

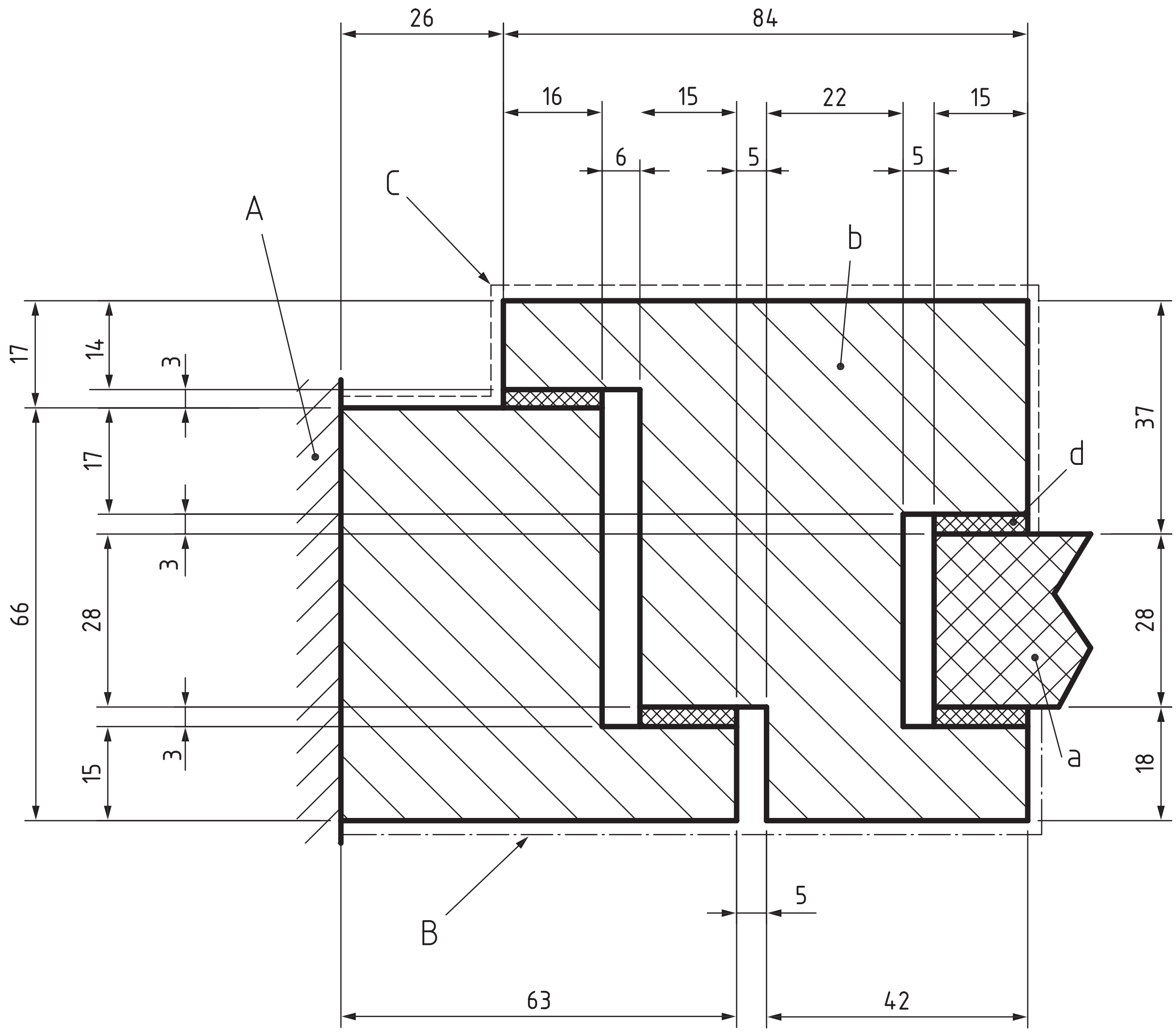
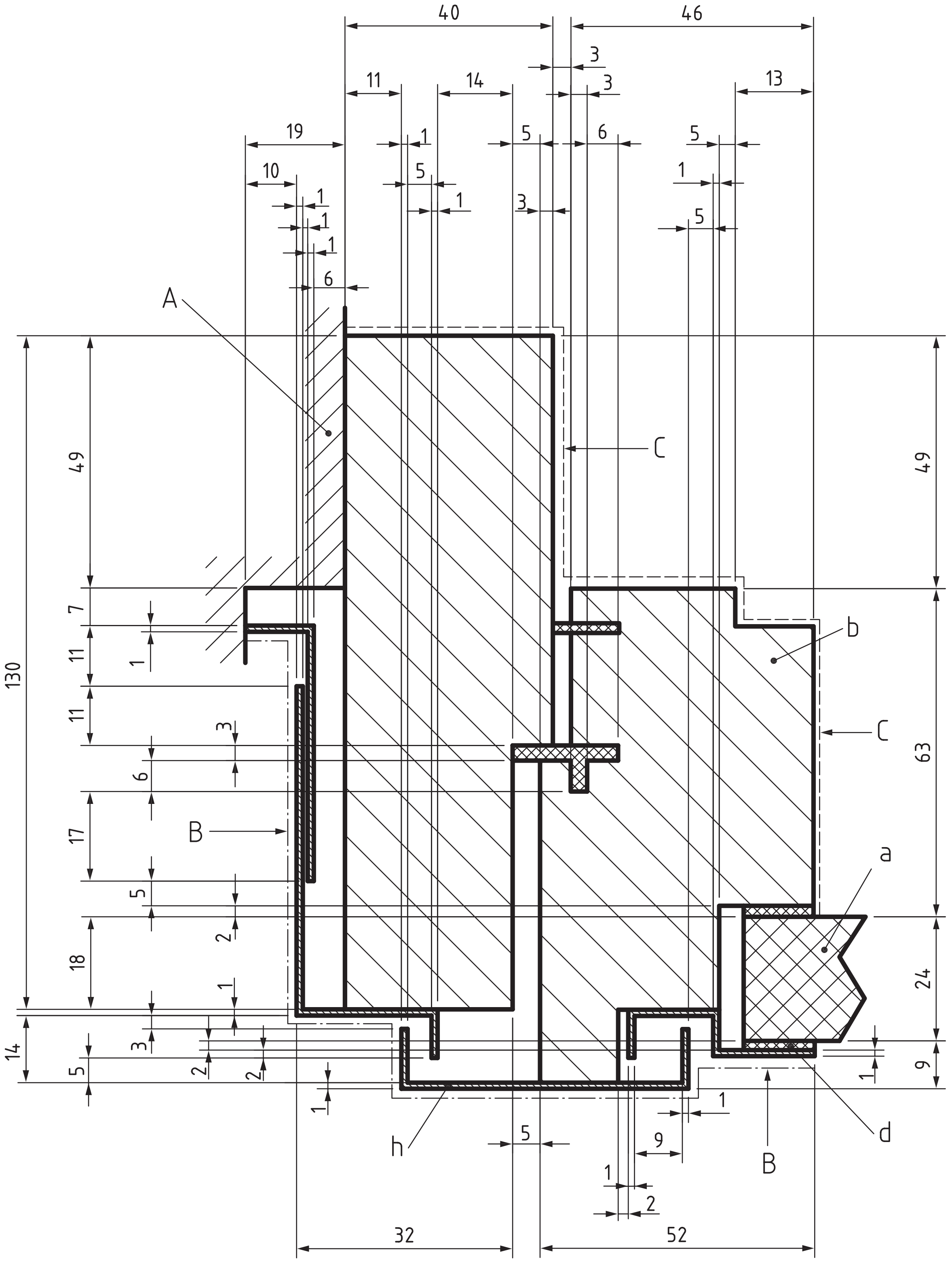


Figure D.4 — Wood frame section and insulation panel (b_f = 110 mm)

Dimensions in millimetres



NOTE The projected frame width, b_f, is 89 mm.

Figure D.5 — Roof window frame section and insulation panel

Dimensions in millimetres

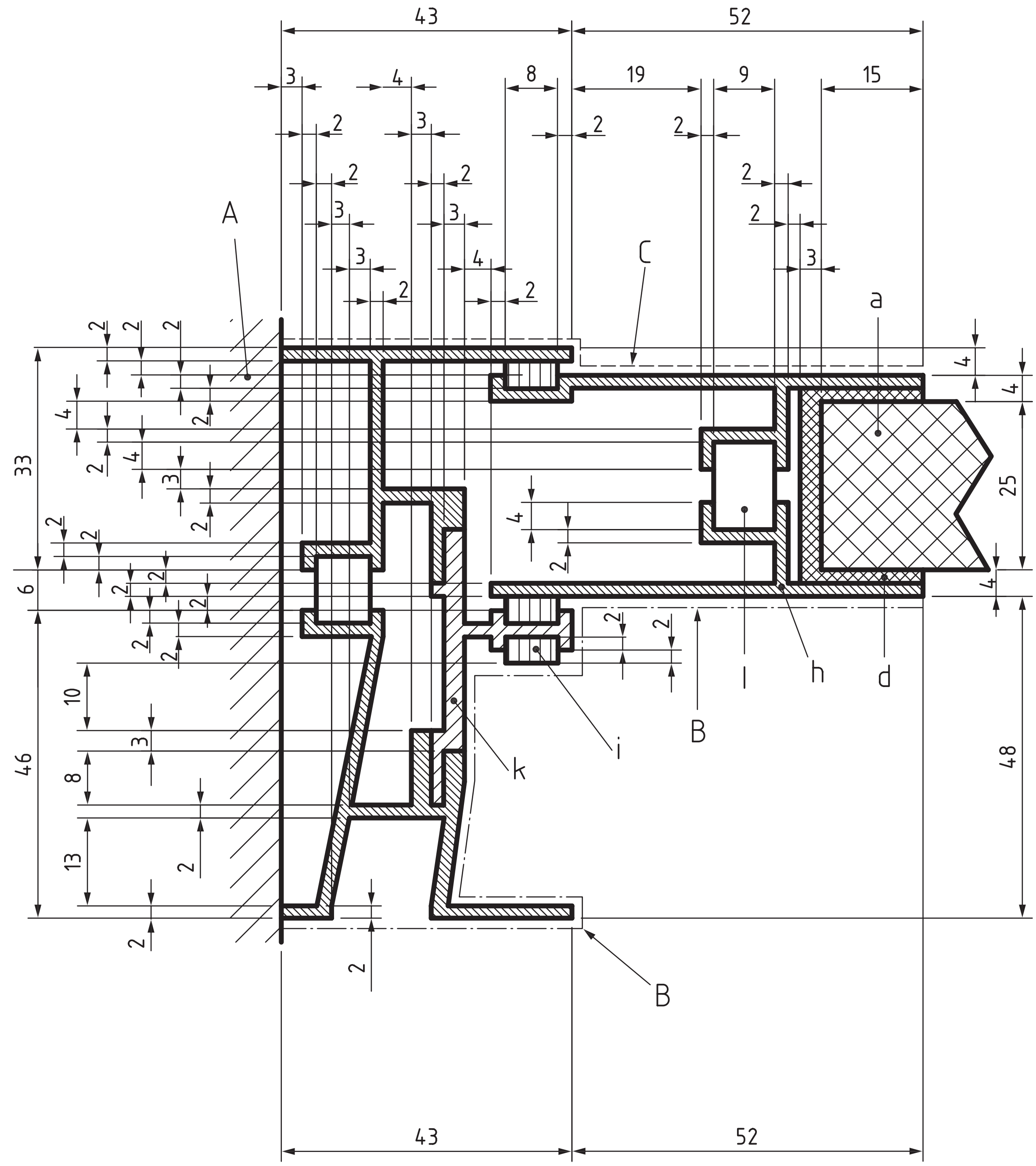


Figure D.6 — Sliding window frame section and insulation panel (b_f = 95 mm)

Dimensions in millimetres

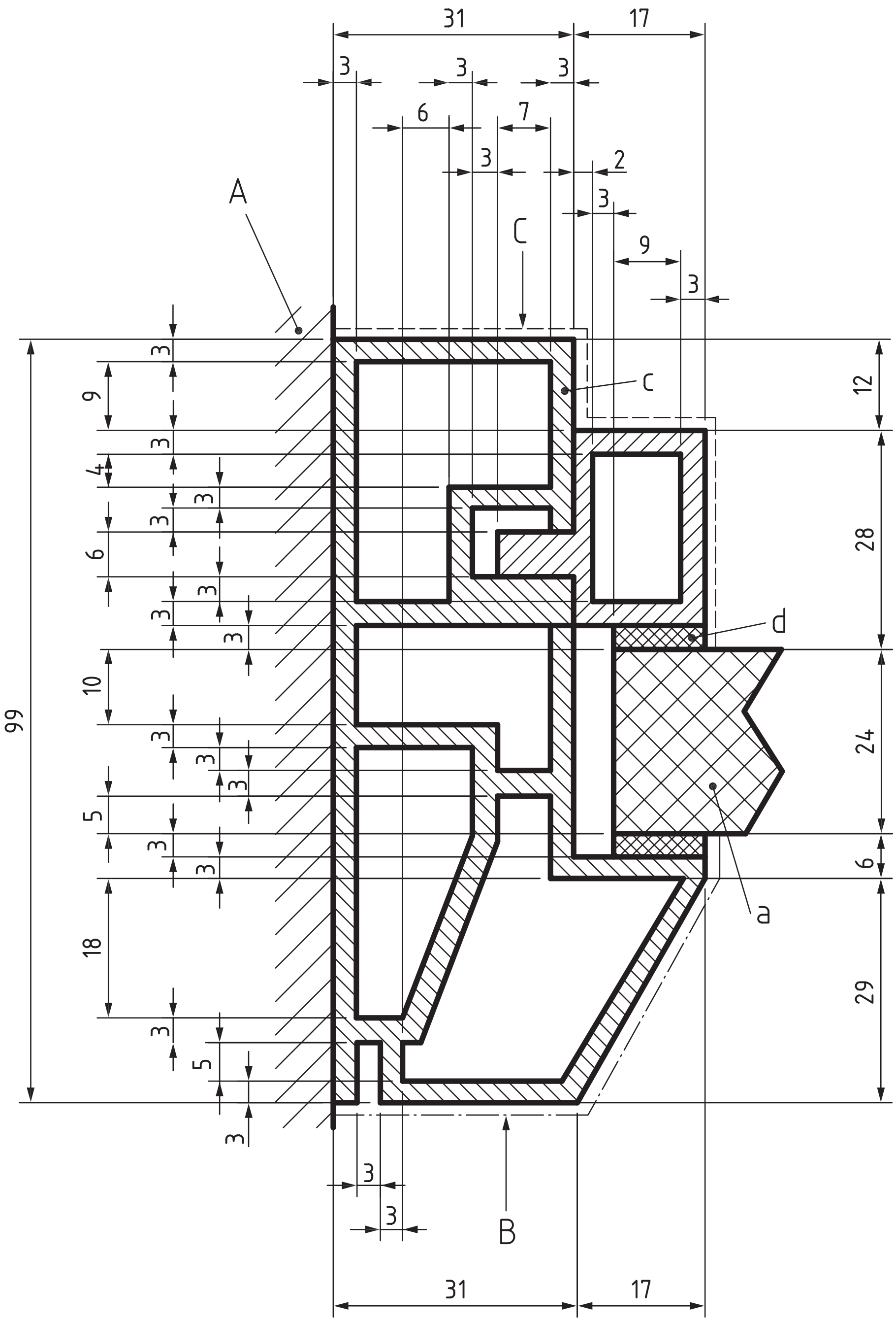


Figure D.7 — Fixed frame section and insulation panel (b_f = 48 mm)

Dimensions in millimetres

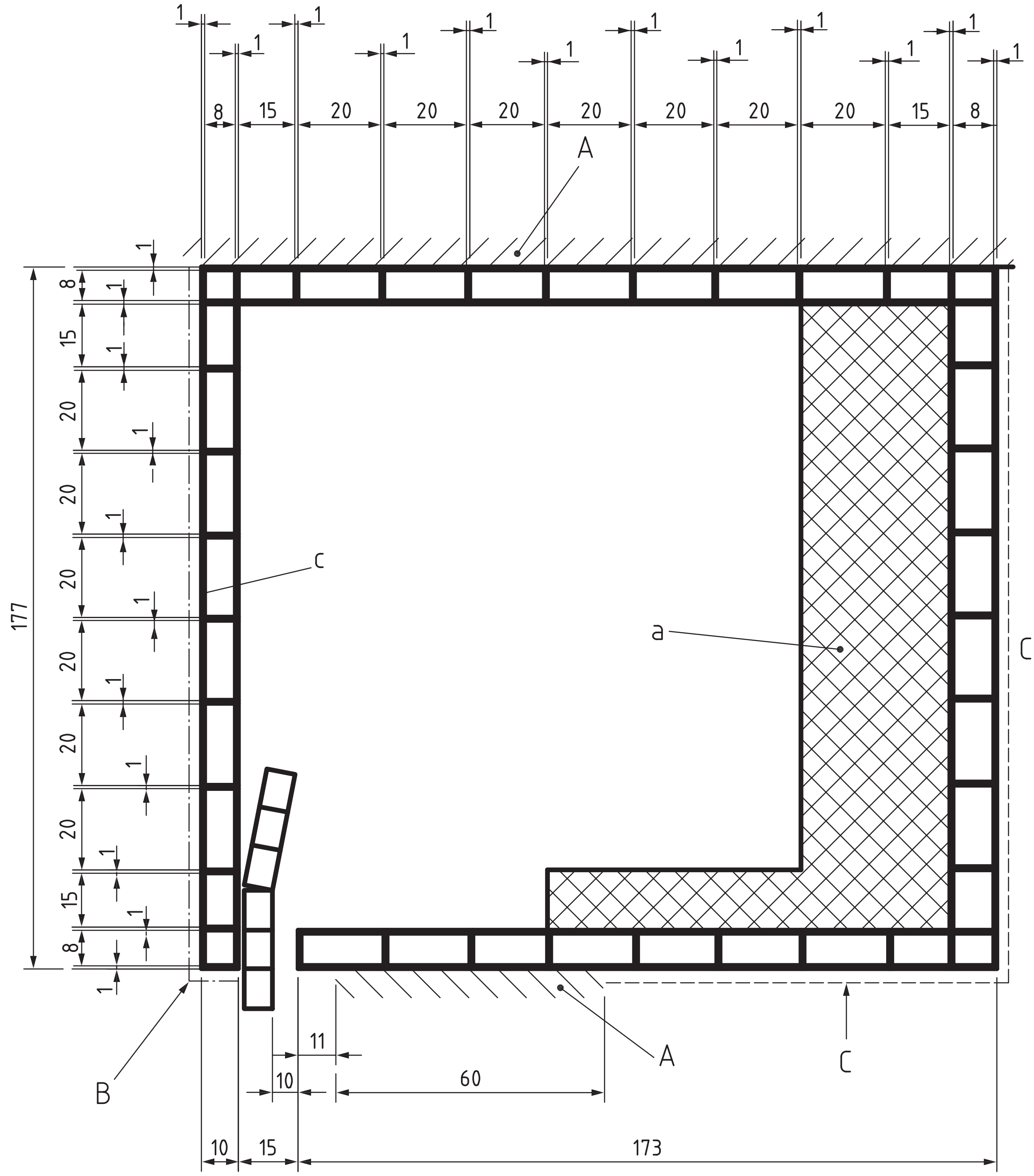


Figure D.8 — Roller shutter box (b_{sb} = 177 mm)

Dimensions in millimetres

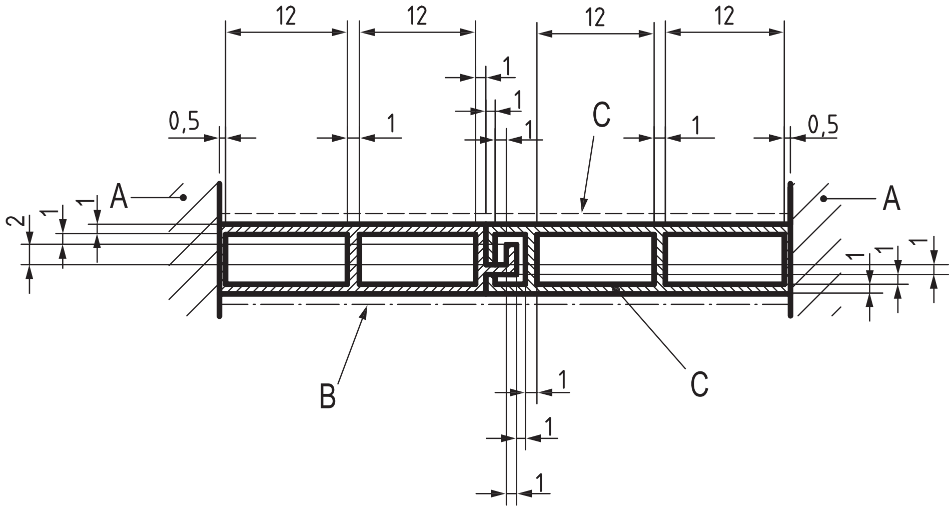


Figure D.9 — PVC shutter profile (*b* = 57 mm)

Dimensions in millimetres

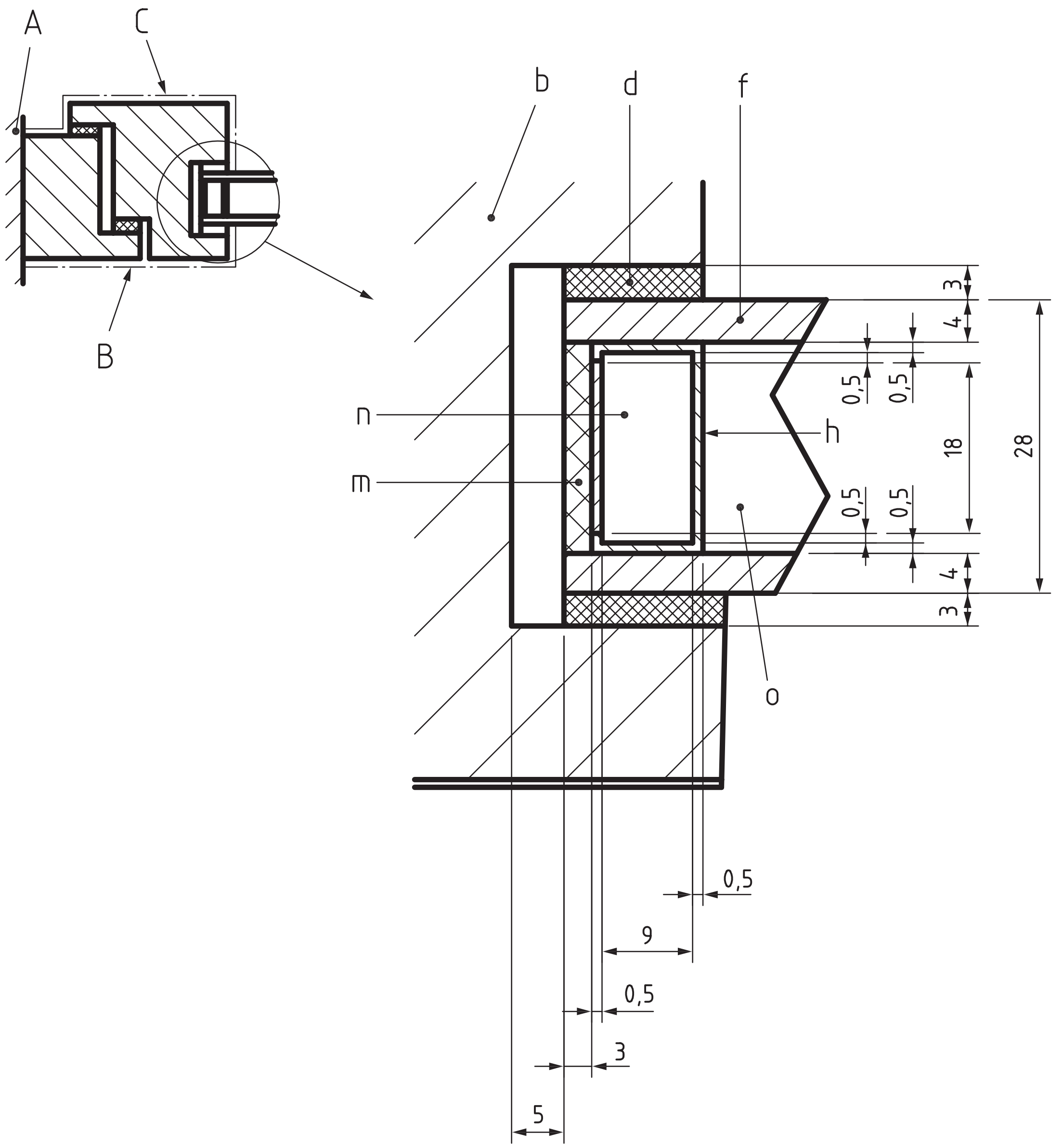


Figure D.10 — Example of the determination of a linear thermal transmittance of a wood frame section (see Figure D.4) and of a glazing with U_g = 1,3 W/(m^2·K) with a conventional glass edge system

To achieve a thermal transmittance of the central area of glazing, U_g, of 1,3 W/(m^2·K), the space of the insulating glass unit is filled with a solid material, marked “o”, with a thermal conductivity of 0,034 W/(m·K).

D.3 Results

Table D.3 — Calculated thermal conductance L^{2D} and thermal transmittance

Example	L^{2D} W/(m·K)	U_f W/(m²·K)
Figure D.1	0,550 (0,007)	3,22 (0,06)
Figure D.2	0,263 (0,001)	1,44 (0,03)
Figure D.3	0,424 (0,006)	2,07 (0,06)
Figure D.4	0,346 (0,001)	1,36 (0,01)
Figure D.5	0,408 (0,007)	2,08 (0,08)
Figure D.6	0,659 (0,008)	4,67 (0,09)
Figure D.7	0,285 (0,002)	1,31 (0,03)
Figure D.8	0,181 (0,003)	1,05 (0,02)
Figure D.9	0,207 (0,001)	3,64 (0,01)
NOTE To avoid rounding errors the values are given to three significant figures.		

Table D.4 — Calculated thermal conductance L_{Ψ}^{2D} and linear thermal transmittance

Example	L_{Ψ}^{2D} W/(m·K)	Ψ W/(m·K)
Figure D.10	0,481 (0,004)	0,084 (0,004)

The bracketed data in Tables D.3 and D.4 are standard deviations from a round-robin calculation of nine institutions from Europe and North America (June 2000).

Annex E
(informative)

Wood species listed in Annex A

Annexe E
(informative)

Espèce de bois énumérées dans l'Annexe A

Anhang E
(informative)

In Anhang A aufgeführten Holzarten

NOTE 1 The codes and names were taken from EN 13556 wherever possible (see Reference [8]).

NOTE 2 The abbreviation spp. (species pluralis) means that such an assortment may comprise (similar) timbers originating from several botanical species.

NOTE 3 Names in "quotation marks" are commercial names which have become common by long-standing use. Such denominations are, however, not correct from the botanical point of view.

NOTE 1 Les codes et dénominations ont été pris de l'EN 13556 autant que possible (voir Référence [8]).

NOTE 2 L'abréviation spp. (species pluralis) signifie qu'un tel assortiment peut contenir des bois (similaires) de plusieurs espèces botaniques.

NOTE 3 Les dénominations entre «parenthèses» sont des noms commerciaux qui sont devenus communs par un long usage. Du point de vue botanique, de telles dénominations ne sont toutefois pas correctes.

ANMERKUNG 1 Die Kurzzeichen und Namen wurden soweit möglich aus EN 13556 übernommen (siehe Literaturhinweise [8]).

ANMERKUNG 2 Das Kürzel spp. (species pluralis) besagt, dass in dem entsprechenden Sortiment (ähnliche) Hölzer mehrerer botanischer Arten enthalten sein können.

ANMERKUNG 3 Namen in „Anführungszeichen" sind Handelsnamen, die sich durch langjährigen Gebrauch eingebürgert haben. Botanisch sind diese Bezeichnungen jedoch nicht korrekt.

Botanical name **Dénomination botanique** **Botanischer Name**	**Code** **Code** **Kurzzeichen**	**English name**	**Dénomination française**	**Deutscher Name**
Abies alba	ABAL	silver fir	sapin blanc	Tanne, Weißtanne
Afzelia spp.	AFXX	afzelia	doussié	Afzelia
Calophyllum spp.	CLXX	bintangor	bintangor	Bintangor
Entandrophragma cylindricum	ENCY	sapele	sapelli	Sapelli
Entandrophragma utile	ENUT	utile	sipo	Sipo
Eucalyptus delegatensis *Eucalyptus obliqua* *Eucalyptus regnans*	EUXX	“Tasmanian oak”	«chêne de Tasmanie»	„Tasmanian oak“
Eucalyptus globulus	EUGL	southern blue gum	eucalyptus bleu	Blue gum, Globulus
Eucalyptus saligna *Eucalyptus grandis* *Eucalyptus urophylla* *Eucalyptus uro-grandis*	EUSL EUGR EUUP EUUG	saligna gum eucalyptus	eucalyptus saligna eucalyptus	Sidney blue gum Eukalyptus
Heritiera spp.	HEXM	mengkulang	mengkulang	Mengkulang
Heritiera utilis *Heritiera densiflora*	HEXN	niangon	niangon	Niangon
Intsia bijuga *Intsia palembanica*	INXX	merbau	merbau	Merbau
Khaya spp.	KHXX	African mahogany	Acajou d’Afrique	Khaya (Mahagoni)
Larix spp. *Larix decidua* *Larix x eurolepis* *Larix gmelina* *Larix oocarpa*	LAXX LADC LAER LAGM LAOC	Larch European larch Dunkeld larch Siberian larch Western larch	mélèze mélèze d’Europe mélèze de Dunkeld mélèze de Sibérie western larch	Lärche Lärche Dunkeld-Lärche Sibirische Lärche Kanadische Lärche
Milicia excelsa *Milicia regia*	MIXX	iroko	iroko	Iroko, Kambala
Ocotea rubra	OCRB	red louro	louro vermelho	Louro vermelho
Picea abies	PCAB	Norway spruce	épicéa	Fichte
Picea glauca	PCGL	white spruce	eastern spruce	Western white spruce, Weißfichte
Picea sitchensis	PCST	Sitka spruce	Sitka spruce	Sitka spruce, Sitkafichte
Parashorea spp.	PHMG	meranti gerutu	gerutu	Gerutu, Heavy White Seraya
Parashorea spp.	PHWS	white seraya	white seraya	Light white seraya
Pometia pinnata	PMPN	taun	kasai	Kasai, Matoa

Botanical name Dénomination botanique Botanischer Name	Code Code Kurzzeichen	English name	Dénomination française	Deutscher Name
Pinus contorta	PNCN	lodgepole pine	pin de Murray	Lodgepole Pine, Drehkiefer
Pinus sylvestris	PNSY	Scots pine	pin sylvestre	Kiefer, Föhre
Pseudotsuga menziesii	PSMN	Oregon pine “Douglas fir”	Douglas (pin d’Oregon)	Oregon Pine, Douglasie
Quercus spp.	QCXA QCXE	American White Oak European oak	Chêne blanc d’Amérique chêne	Amerikanische Weißeiche Eiche
Robinia pseudoacacia	ROPS	robinia (Black locust)	robinier	Robinie
Shorea spp.	SHDR	dark red meranti	dark red meranti	Dark red meranti
Shorea spp.	SHLR	light red meranti	light red meranti	Light red meranti
Swietenia macrophylla	SWMC	American mahogany[a]	Acajou d’Amérique[a]	Amerikanisches Mahagoni[a]
Tectona grandis	TEGR	teak	teck	Teak
Terminalia ivorensis	TMIV	idigbo	framiré	Framiré
Tieghemella africana *Tieghemella heckelii*	TGAF TGHC	makoré makoré	douka makoré	Makoré Makoré
Thuja plicata	THPL	“western red cedar”	«western red cedar»	„western red cedar“, Rotzeder
Tsuga heterophylla	TSHT	western hemlock	western hemlock	Western hemlock, Hemlock
		[a] The species Swietenia macrophylla (SWMC, American Mahogany) is listed as “endangered species” under the CITES agreement. The availability may therefore be restricted.	[a] L’espèce Swietenia macrophylla (SWMC, Acajou d’Amérique) est énumérée en tant qu’ «espèce en danger de disparition» selon la convention CITES. En conséquence la disponibilité peut être limitée.	[a] Die Holzart Swietenia macrophylla (SWMC, Echtes Mahagoni) wird laut CITES-Abkommen als gefährdete Holzart geführt. Die Verfügbarkeit kann daher beschränkt sein.

Bibliography

[1] ISO 6946, *Building components and building elements — Thermal resistance and thermal transmittance — Calculation method*

[2] ISO 10077-1, *Thermal performance of windows, doors and shutters — Calculation of thermal transmittance — Part 1: General*

[3] ISO 12631[2)], *Thermal performance of curtain walling — Calculation of thermal transmittance*

[4] ISO 15099, *Thermal performance of windows, doors and shading devices — Detailed calculations*

[5] EN 10088-1, *Stainless steels — Part 1: List of stainless steels*

[6] EN 12412-2, *Thermal performance of windows, doors and shutters — Determination of thermal transmittance by hot box method — Part 2: Frames*

[7] EN 12664, *Thermal performance of building materials and products — Determination of thermal resistance by means of guarded hot plate and heat flow meter methods — Dry and moist products of medium and low thermal resistance*

[8] EN 13556, *Round and sawn timber — Nomenclature of timbers used in Europe*

[9] EN 13947, *Thermal performance of curtain walling — Calculation of thermal transmittance*

[10] ift Guideline WA-08engl/1, *Thermally improved spacers — Part 1: Determination of representative* Ψ*-values for profile sections of windows*, ift Rosenheim, November 2008

2) To be published.

This page deliberately left blank

This page deliberately left blank

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email bsmusales@bsigroup.com.

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Copyright

Useful Contacts:

Customer Services
Tel: +44 845 086 9001
Email (orders): orders@bsigroup.com
Email (enquiries): cservices@bsigroup.com

Subscriptions
Tel: +44 845 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

bsi.

...making excellence a habit.™