INTERNATIONAL STANDARD

ISO 10077-1

Second edition
2006-09-15

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

Part 1: General

Performance thermique des fenêtres, portes et fermetures — Calcul du coefficient de transmission thermique —

Partie 1: Généralités

Reference number
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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 10077-1 was prepared by Technical Committee ISO/TC 163, *Thermal performance and energy use in the built environment*, Subcommittee SC 2, *Calculation methods*.

This second edition cancels and replaces the first edition (ISO 10077-1:2000), the following clauses and subclauses of which have been technically revised.

Clause	Changes
Introduction	Added new paragraph explaining the various parts of the overall thermal transmittance
1	Amended 4th paragraph to permit calculation of U-value of roof windows
2	References to ISO rather than EN ISO where applicable
4.3	Added “including sashes if present” to the definition of areas
4.4	Clarification that sealing gaskets are ignored in the determination of areas. Dimensions to be measured to nearest mm.
5.1.1	Third from last paragraph inserted concerning roof windows
5.3	Data on shutters moved to Annex G
6	Added paragraph to say that declared values are to be obtained for horizontal heat flow (as in ISO 10292 and EN 673)
7.1	Second dash, drawing to give details also for metal frames
Table A.1	Added surface resistance values for horizontal or inclined window
Annex E	Complete revision of Annex E. It has been changed to normative, because it provides default values that are to be used in the absence of detailed values.
Annex F	Complete revision of Annex F, using the new values in Annex E

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

The calculation method described in this part of ISO 10077 is used to evaluate the thermal transmittance of windows and doors, or as part of the determination of the energy use of a building.

An alternative to calculation is testing of the complete window or door according to ISO 12567-1 or, for roof windows, according to ISO 12567-2.

The calculation is based on four component parts of the overall thermal transmittance:

— for elements containing glazing, the thermal transmittance of the glazing, calculated using EN 673 or measured according to EN 674 or EN 675;

— for elements containing opaque panels, the thermal transmittance of the opaque panels, calculated according to ISO 6946 and/or ISO 10211 (all parts) or measured according to ISO 8301 or ISO 8202;

— thermal transmittance of the frame, calculated using ISO 10077-2, measured according to EN 12412-2, or taken from Annex D of this part of ISO 10077;

— linear thermal transmittance of the frame/glazing junction, calculated according to ISO 10077-2 or taken from Annex E of this part of ISO 10077.

More detailed equations for calculation of heat flow through windows can be found in ISO 15099.

The thermal transmittance of curtain walling can be calculated using prEN 13947.

EN 13241-1 gives procedures applicable to doors intended to provide access for goods and vehicles.

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

Part 1: General

1 Scope

This part of ISO 10077 specifies methods for the calculation of the thermal transmittance of windows and pedestrian doors consisting of glazed and/or or opaque panels fitted in a frame, with and without shutters.

This part of ISO 10077 allows for

— different types of glazing (glass or plastic; single or multiple glazing; with or without low emissivity coatings, and with spaces filled with air or other gases);

— opaque panels within the window or door;

— various types of frames (wood, plastic, metallic with and without thermal barrier, metallic with pinpoint metallic connections or any combination of materials);

— where appropriate, the additional thermal resistance introduced by different types of closed shutter, depending on their air permeability.

The thermal transmittance of roof windows and other projecting windows can be calculated according to this part of ISO 10077, provided that the thermal transmittance of their frame sections is determined by measurement or by numerical calculation.

Default values for glazing, frames and shutters are given in the informative annexes. Thermal bridge effects at the rebate or joint between the window or door frame and the rest of the building envelope are excluded from the calculation.

The calculation does not include

— effects of solar radiation,

— heat transfer caused by air leakage,

— calculation of condensation,

— ventilation of air spaces in double and coupled windows,

— surrounding parts of an oriel window.

The part of ISO 10077 does not apply to

— curtain walls and other structural glazing,

— industrial, commercial and garage doors.

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 6946, *Building components and building elements — Thermal resistance and thermal transmittance — Calculation method*

ISO 7345, *Thermal insulation — Physical quantities and definitions*

ISO 8301, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Heat flow meter apparatus*

ISO 8302, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Guarded hot plate apparatus*

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

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

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

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*

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

3 Terms, definitions, symbols and units

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 673 and ISO 7345 apply.

In Clause 4 of this part of ISO 10077, descriptions are given of a number of geometrical characteristics of glazing and frame.

3.2 Symbols and units

Symbol	Quantity	Unit
A	area	m^2
R	thermal resistance	$m^2 \cdot K/W$
U	thermal transmittance	$W/(m^2 \cdot K)$
b	width	m
d	distance, thickness	m
l	length	m
q	density of heat flow rate	W/m^2
Ψ	linear thermal transmittance	$W/(m \cdot K)$
λ	thermal conductivity	$W/(m \cdot K)$

3.3 Subscripts

D	door	i	internal
W	window	j	summation index
WS	window with closed shutter	p	panel (opaque)
d	developed	s	space (air or gas space)
e	external	se	external surface
f	frame	sh	shutter
g	glazing	si	internal surface

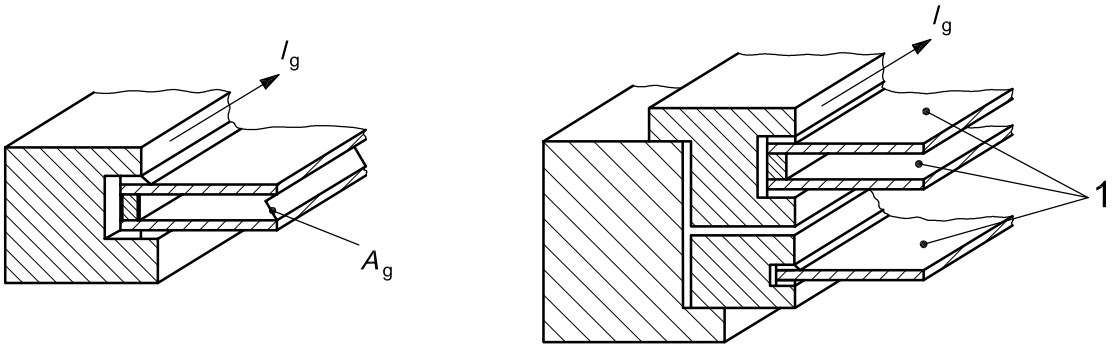
4 Geometrical characteristics

4.1 Glazed area, opaque panel area

The glazed area, A_g, or the opaque panel area, A_p, of a window or door is the smaller of the visible areas seen from both sides; see Figure 1. Any overlapping of gaskets is ignored.

4.2 Total visible perimeter of the glazing

The total perimeter of the glazing, l_g, (or the opaque panel, l_p) is the sum of the visible perimeter of the glass panes (or opaque panels) in the window or door. If the perimeters are different on either side of the pane or panel, then the larger of the two shall be used; see Figure 1.



Key
1 glass

Figure 1 — Illustration of glazed area and perimeter

4.3 Frame areas

For the definition of the areas, see also Figure 3.

$A_{f,i}$ Internal projected frame area:

The internal projected frame area is the area of the projection of the internal frame, including sashes if present, on a plane parallel to the glazing panel.

$A_{f,e}$ External projected frame area:

The external projected frame area is the area of the projection of the external frame, including sashes if present, on a plane parallel to the glazing panel.

A_f Frame area:

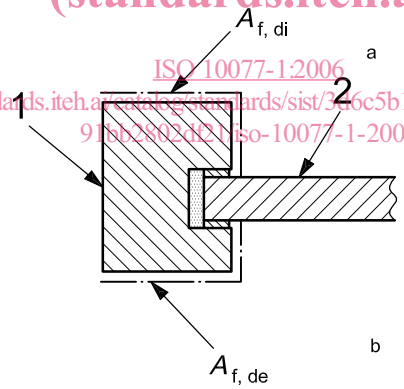
The frame area is the larger of the two projected areas seen from both sides.

$A_{f,di}$ Internal developed frame area:

The internal developed frame area is the area of the frame, including sashes if present, in contact with the internal air (see Figure 2).

$A_{f,de}$ External developed frame area:

The external developed frame area is the area of the frame, including sashes if present, in contact with the external air (see Figure 2).



Key

1 frame
2 glazing

a Internal.
b External.

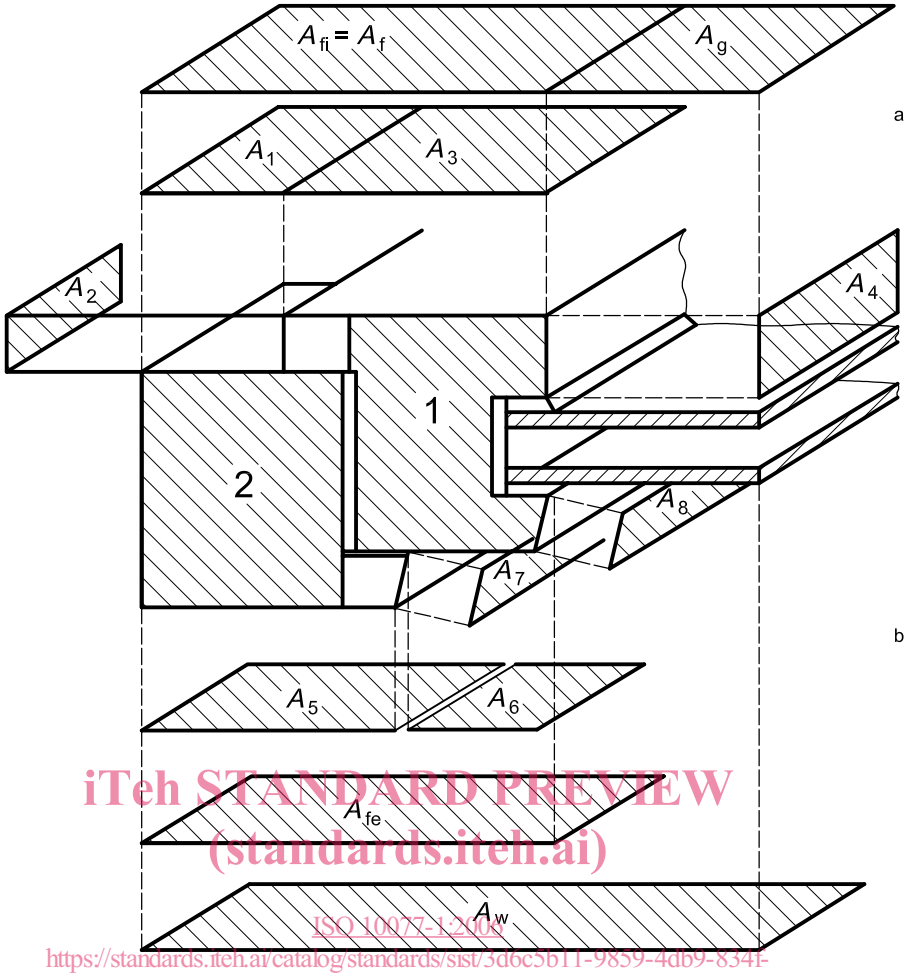
Figure 2 — Internal and external developed area

4.4 Window area

The window area, A_w, is the sum of the frame area, A_f, and the glazing area, A_g, (or the panel area, A_p).

The frame area and the glazed area are defined by the edge of the frame, i.e. sealing gaskets are ignored for the purposes of determination of the areas.

Window dimensions (height, width, frame width and frame thickness) shall be determined to the nearest millimetre.



Key

1 sash (moveable)
2 frame (fixed)

a Internal.
b External.

$A_f = \max(A_{f,i}; A_{f,e})$
$A_w = A_f + A_g$
$A_{f,di} = A_1 + A_2 + A_3 + A_4$
$A_{f,de} = A_5 + A_6 + A_7 + A_8$

NOTE 1 The frame area, A_f, includes the area of the fixed frame together with that of any moveable sash or casement.

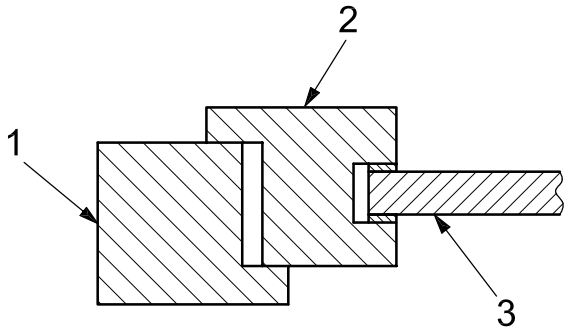
NOTE 2 Drip trays and similar protuberances are not considered as parts of the developed area.

Figure 3 — Illustration of the various areas

5 Calculation of thermal transmittance

5.1 Windows

5.1.1 Single windows



Key

1 frame (fixed)
2 sash (moveable)
3 glazing (single or multiple)

Figure 4 — Illustration of single window

The thermal transmittance of a single window, U_W, shall be calculated using Equation (1):

$$U_W = \frac{\sum A_g U_g + \sum A_f U_f + \sum l_g \Psi_g}{\sum A_g + \sum A_f} \quad (1)$$

where

U_g is the thermal transmittance of the glazing;

U_f is the thermal transmittance of the frame;

Ψ_g is the linear thermal transmittance due to the combined thermal effects of glazing, spacer and frame;

and the other symbols are defined in Clause 4. The summations included in Equation (1) are used to allow for different parts of the glazing or frame, e.g. several values of A_f are needed when different values of U_f apply to the sill, head, jambs and dividers.

In the case of single glazing the last term of the numerator in Equation (1) shall be taken as zero (no spacer effect) because any correction is negligible.

When there are both opaque panels and glazed panes, U_W, is calculated using Equation (2):

$$U_W = \frac{\sum A_g U_g + \sum A_p U_p + \sum A_f U_f + \sum l_g \Psi_g + \sum l_p \Psi_p}{\sum A_g + \sum A_p + \sum A_f} \quad (2)$$

where

U_p is the thermal transmittance of the opaque panel(s);

Ψ_p is the linear thermal transmittance for the opaque panel(s).

Ψ_p may be taken as zero if

— the internal and external facings of the panel are of material with thermal conductivity less than 0,5 W/(m·K), and

— the thermal conductivity of any bridging material at the edges of the panel is less than 0,5 W/(m·K).

In other cases, Ψ_p shall be calculated in accordance with ISO 10077-2.

U_g shall be obtained in accordance with 5.2.

U_f for roof windows shall be either

— calculated in accordance with ISO 10077-2, or

— measured in accordance with EN 12412-2 with specimens mounted within the aperture in the surround panel flush with the cold side, in accordance with in ISO 12567-2.

For other windows, U_f shall be

— calculated in accordance with ISO 10077-2, or

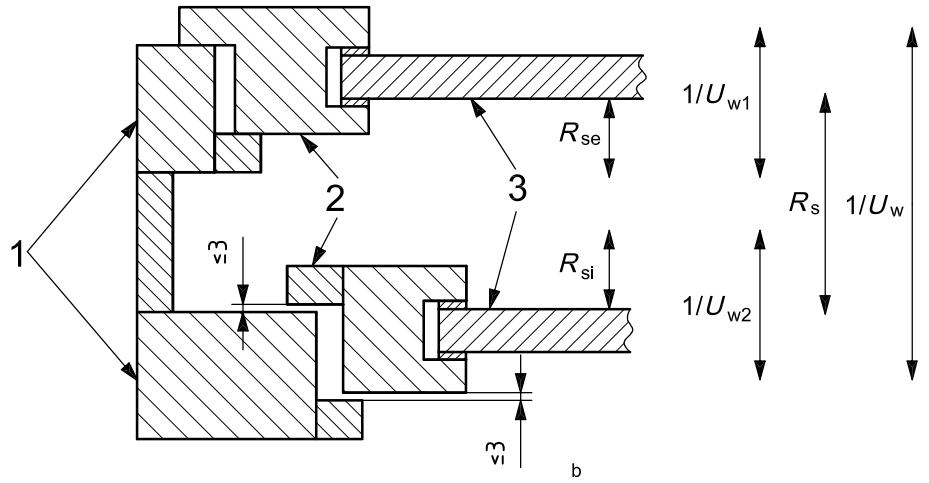
— measured in accordance with EN 12412-2, or

— obtained from Annex D.

Linear thermal transmittance may be calculated in accordance with ISO 10077-2 or taken from Annex E.

5.1.2 Double windows

Dimensions in millimetres



Key

1 frame (fixed)
2 sash (moveable)
3 glazing (single or multiple)

a Internal.
b External.

Figure 5 — Illustration of double window