BS EN 12428:2013

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Industrial, commercial and garage doors — Thermal transmittance — Requirements for the calculation

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee B/538/5, Industrial and commercial garage doors and gates.

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

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Industrial, commercial and garage doors - Thermal transmittance - Requirements for the calculation

Portes et portails équipant les locaux industriels, commerciaux et les garages - Transmission thermique - Exigences pour les calculs

Tore - Wärmedurchgangskoeffizient - Anforderungen an die Berechnung

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Foreword

This document (EN 12428:2013) has been prepared by Technical Committee CEN/TC 33 “Doors, windows, shutters, building hardware and curtain walling”, the secretariat of which is held by AFNOR.

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of an identical text or by endorsement, at the latest by July 2013, and conflicting national standards shall be withdrawn at the latest by July 2013.

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 12428:2000.

- This European Standard shows updated procedures for the calculation of thermal transmittance, including different types of glazing, frames and/or panels.
- Symbols and units have been added to Clause 3.
- Clauses 4 and 5 have been revised.
- Clause 4 now includes descriptions and definition about the geometrical characteristics.
- Clause 5 now defines the calculation method including information about boundaries, cavities, point bridges and the calculation method.
- New Annex A informs about energy efficiency.

This document is one of a series of performance standards identified within the product standard EN 13241-1.

European Standards as well as relevant national regulations and standards will enable the actual exposure levels to be determined for the individual locations of the products.

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Introduction

Industrial, commercial and garage doors often contain different kinds of materials, joined in different ways, and can exhibit numerous variations of geometrical shape and thermal conductivity values. Thermal bridges around the door or gate perimeter and between door or gate elements affect the thermal transmittance of the complete door or gate in a significant way.

The result of calculations, carried out following the procedures specified in this paper, can be used for comparison of the thermal transmittance of different types of industrial, commercial and garage doors or as part of the input data for calculating the heat consumption of a building.

The standard EN ISO 10077 (all parts) describes a calculation method suitable for windows and pedestrian doors. Although this method basically applies to vertical windows, references to some parts of this method have been made concerning boundary conditions and the treatment of cavities.

EN ISO 12631 specifies a procedure for calculating the thermal transmittance of curtain wall structures. The principles of the single assessment method have been used in this paper.

1 Scope

1.1 General

This European Standard specifies a method for calculating the thermal transmittance of industrial, commercial and garage doors in a closed position.

The doors are intended for installation in areas in the reach of people, for which the main intended uses are giving safe access for goods, vehicles and persons in industrial, commercial or residential premises.

The doors may be manually or power operated.

This document applies to all doors provided in accordance with EN 13241-1.

The calculation can include different types of glazing, frames with or without thermal breaks, and different types of opaque panels and thermal bridge effects at the edge of the panel or joint between the glazed area, the frame area and the panel area.

This paper does not include the effects of solar radiation, heat transfer caused by air leakage, calculation of condensation, additional heat transfer at the corners and edges of the door connections to the main building structure, or thermal effects between the door and the main building structure.

1.2 Exclusions

It does not apply to:

— lock gates and dock gates;

— doors on lifts;

— doors on vehicles;

— armoured doors;

— doors mainly for the retention of animals;

— theatre textile curtains;

— horizontally moving doors less than 2,5 m wide and 6,25 m^2 area, designed principally for pedestrian use;

— revolving doors of any size;

— doors outside the reach of people (such as crane gantry fences);

— railway barriers;

— barriers used solely for vehicles.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

EN 12433-1:1999, *Industrial, commercial and garage doors and gates — Terminology — Part 1: Types of doors*

EN 12433-2:1999, *Industrial, commercial and garage doors and gates — Terminology — Part 2: Parts of doors*

EN ISO 6946:2007, *Building components and building elements — Thermal resistance and thermal transmittance — Calculation method (ISO 6946:2007)*

EN ISO 7345:1995, *Thermal insulation — Physical quantities and definitions (ISO 7345:1987)*

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

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

EN ISO 12631:2012, *Thermal performance of curtain walling — Calculation of thermal transmittance* (ISO 12631:2012)

3 Terms, definitions, symbols and units

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12433-1:1999, EN 12433-2:1999, EN ISO 7345:1995 and EN ISO 6946:2007 apply.

The thermal transmittance of glazing units, U_g, is defined according to EN 673 which does not include the edge effects.

3.2 Symbols and units

Symbol	**Quantity**	**Unit**
A	area	m²
Q	heat loss per length	W/m
W	width	m
H	height	m
L	length	m
d	depth	m
ϑ	temperature	°C
U_g	thermal transmittance	W/(m²K)
ℓ	distance	m

ε	emissivity	
λ	thermal conductivity	W/(m·K)
ψ	linear thermal transmittance	W/(m·K)

3.3 Subscripts

Symbol	**Subscripts**
D	industrial, commercial or garage door or gate
door	door (daylight opening)
p	panel
g	glazing
tot	total
joint	connection between two filling elements

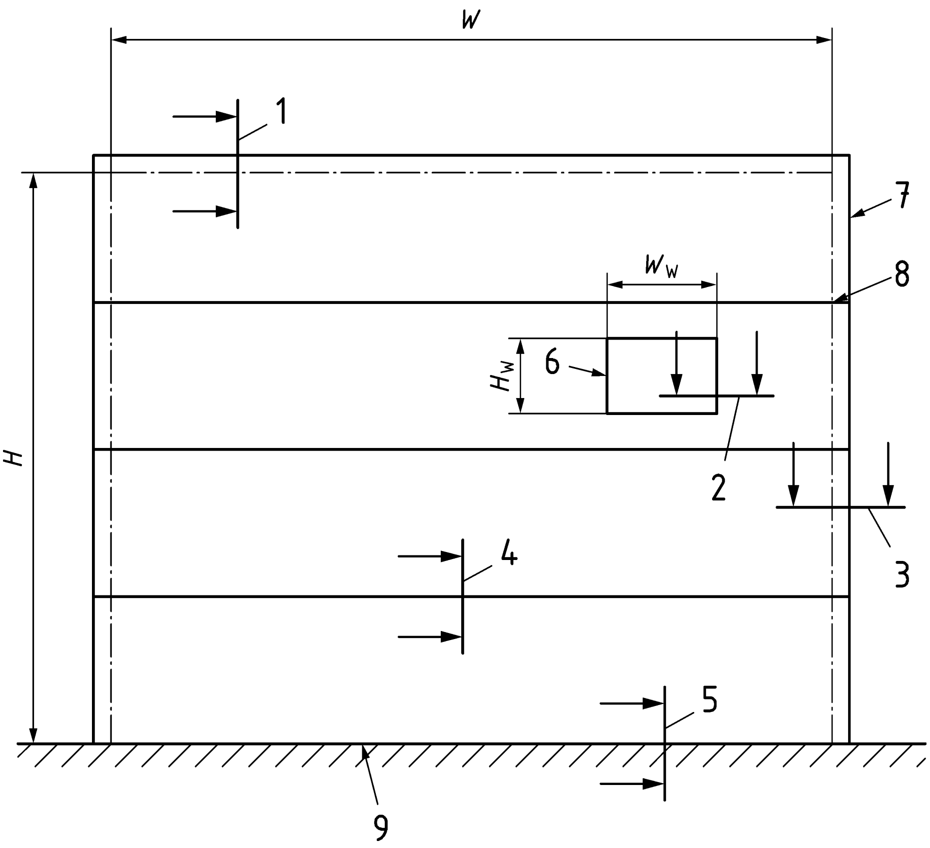
3.4 Superscripts

Definition of the areas for ψ joint: see EN ISO 12631:2012, 6.2.2.3.

4 Geometrical characteristics

The main definitions for the boundaries and areas are shown in Figure 1.

The door is divided into areas/lengths of different kinds (windows, panel sections) with additional heat flows. Representative parts of the industrial, commercial or garage door shall be modelled (indicated by 1-1 to 5-5 in Figure 1) and its heat losses shall be calculated.



Key

W	daylight width
H	daylight height
Ww	width of window
Hw	height of window
Door	W x H
Window	Ww x Hw

1 gap at top edge of door and opening
2 joint round window in panel
3 gap at side of door and opening
4 joint between panels
5 gap between bottom edge of door and floor
6 window
7 door edge
8 daylight vertical edge
9 floor

Figure 1 — Sketch of a door (from the inside)

5 Calculation

5.1 General principle

The calculations shall be carried out using a two-dimensional numerical method conforming to EN ISO 10211.

It is assumed that the principal heat flow in a section is perpendicular to a plane parallel to the external and internal surfaces. But at the perimeter of an industrial, commercial or garage door and between door sections the heat flow will be two or three dimensional. The heat flow can be conducted along components with high thermal conductivity around parts with high thermal resistance, especially where metal parts connect (for instance internal surface sheet – end cap/edge profile – external surface sheet).

The linear thermal transmittance of the connections between the door panel and surrounding construction or between panels is determined as the additional heat flow compared to the one-dimensional heat flow through the door panel.

All components in the industrial, commercial or garage door or gate that affect the heat flow should be included in the thermal transmittance. This value is calculated as the total heat flow rate through the door, divided by the temperature difference (20 °C) and the partition wall aperture area (width × height).

The surrounding walls and floor are regarded as adiabatic and consequently as having no influence on the thermal transmittance of the door.

Input data (thermal properties) shall be evaluated by measurement, two- or three-dimensional finite element or finite difference software calculation or by tables or diagrams.

5.2 Boundaries

The external and internal surface resistances for horizontal heat flow are given in EN ISO 10077-2:2012, Annex B. Definitions of increased surface resistance due to reduced radiation/convection heat transfer are shown in EN ISO 10077-2:2012, Figure B.1.

The cut-off plane through the panel and surround wall/floor in the main building structure shall be taken as adiabatic. The adiabatic boundary through the panel can either be a plane of symmetry or where no edge effects are present. The distance from the edge to the adiabatic cut-off plane shall be chosen in such way that increasing the distance does not change the calculated ψ -value significantly (see EN ISO 12631:2012, 5.2).

5.3 Cavities

5.3.1 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, convection and radiation and depends on the geometry of the cavity and on the adjacent materials.

5.3.2 Cavities in glazing

The equivalent thermal conductivity of an unventilated space between panes (glass or plastics) shall be determined according to EN 673. The resulting value shall be used for the whole cavity.

5.3.3 Cavities in the door or gate

The air cavities shall be divided into three categories depending on the size of the slit that connects the cavity to the exterior or interior. Rules for the treatment of cavities are given in EN ISO 10077-2:2012, Clause 6.

Non-rectangular air cavities shall be transformed into equivalent rectangular air cavities in accordance with EN ISO 10077-2, and the thermal conductivity shall then be calculated for this equivalent air cavity. If no other information is available, use emissivity ε = 0,9 and mean temperature 10 °C.

5.4 Point bridges and hardware components

The influence on the U_D-value of screws penetrating into the insulation from one facing, and the hardware components, shall be taken in account.

This influence may be evaluated by measurements on a specimen with metal screws and hardware components, and the same specimen with plastic screws and without hardware components. ΔU_D can also be evaluated by a three-dimensional calculation according to EN ISO 10211.

The influence of thermal bridges and hardware components on the thermal transmittance can be taken into account by a general value of $\Delta U_{tb} + h_c$ = 0,1 W/m²K.

5.5 Calculation method

5.5.1 General

In this paper the single assessment method using the length-related linear thermal transmittance (EN ISO 12631:2012, 6.2) is described.

The single assessment method is based on detailed computer calculations of the heat transfer through a complete joint between two elements. The heat loss (between adiabatic lines) is calculated using two-dimensional finite element or finite difference software. The additional heat flow compared to the one-dimensional heat flow through the panel, due to the combined thermal effects of the panel, thermal bridging at the edge and the wall position, is characterised by the ψ -value (ψ_{joint}). Then by area and length weighting the U-values and ψ -values, the overall door or gate U_D-value can be calculated. This method can be used for any door system.

5.5.2 Single assessment method using length-related linear thermal transmittance

The heat loss Q_{joint}, which represents the additional heat loss due to making a joint between two filling elements (EN ISO 12631:2012, 6.2.2.3) can be calculated as:

$$Q_{joint} = Q_{tot} - (U_{p1} \cdot \ell_{p1} + U_{p2} \cdot \ell_{p2}) \cdot \Delta\,\delta$$

The linear thermal transmittance is then calculated according to:

$$\psi_{joint} = Q_{tot} / \Delta\,\vartheta - U_{p1} \cdot \ell_{p1} - U_{p2} \cdot \ell_{p2} \text{ (between panels)}$$

where

ℓ_{p1}, ℓ_{p2} = distance between cut-off planes

or

$$\psi_{joint} = Q_{tot} / \Delta\,\vartheta - U_p \cdot \ell_p \text{ (between wall/floor and panel)}$$

where

ℓ_p = distance between the cut-off plane in the panel and the wall opening (edge of the wall)

If the door consists of a combination of panels and glazing the thermal transmittance of the door (U_{door}) is calculated according to:

$$U_D = \{\Sigma\ (A_p U_p) + \Sigma\ (A_g U_g) + \Sigma\ (\psi_{joint}.L_{joint}) / \Sigma\ A_p + \Sigma\ A_g\} + \Delta\,U_{tb} + h_c$$

where

L_{joint} = length of all joints (perimeter of windows, top/bottom/side lengths of the door) and

$\Delta\,U_{tb} + h_c$ = an additional value to take into account the influence of thermal bridges (tb) and

hardware components (h_c) on the heat transfer.

Annex A
(informative)

Thermal insulation related to buildings (energy efficiency)

The calculation method in this standard gives a U-value in W/m^{2}K for thermal resistance of an industrial door used for access of vehicles accompanied by pedestrians.

With a view to energy efficiency (energy saving) it shall be remembered, however, that this performance is only achieved when the door is closed. In practice, the evidence shows that doors are left open for longer periods than is perhaps necessary or acceptable. Therefore, it is difficult to see how reducing U-values can improve energy efficiency without radical changes in work place practices or operation mode of the door.

In keeping with the whole building approach mandated by the EPBD[1)] building designers should be working on a whole building principle rather than an elemental basis which results in a beneficial evaluation of those factors in the construction of the building envelope that contribute significantly to energy conservation in the buildings use.

Therefore, it is important that building designers and specification writers should seek to:

— set achievable values for products calculated in accordance with the European Product Standard EN 13241-1 and EN 12428;

— consider awareness of the classification possibilities and the availability and need to implement appropriate technologies;

— consider specifying improved power operated doors specification including appropriate control systems;

— consider changes to supporting constructions (e. g. lobbies, screens);

— consider the use of double doors (e. g. insulated external doors, rapid acting internal doors for operational use).

There is a common misconception that energy conservation is best achieved (only) through U-value improvements. Due to the non-linear shape of the U-value / thickness graph there is a danger of achieving diminishing returns from additional thickness of doors; up to present time the U-values commonly specified for construction in the EU there has been an approximately linear relationship but as the move to seek lower U-values continues this is no longer the case.

Concern has been expressed that much of this good work is wasted as long as the practice of leaving doors open for unnecessarily long periods prevails.

Therefore a study with a simplified calculation bases has been undertaken by TC33 / WG5 relating to the energy losses through doors taking into consideration:

— heat transmission with closed door by temperature difference,

— air leakage through a closed door due to wind,

— air leakage through a closed door due to a chimney affect and

1) Energy Performance of Buildings Directive (Directive 2002/91/EC).

— air infiltration with a door open (due to wind).

To get an overview of the relationship between the different energy losses a case has been calculated (simplified calculation) with the following values:

a) Local / metrological data[2)]

1) Building / door located in Paris

2) Door direction west-south-west

3) Average air temperature in heating season T_o=10 °C

4) Average wind speed in heating season 5,0 m/sec

5) Correction due to position of door C_w=34,7 %

6) Heating days C_h=243 days

b) Building / doors data (dimensions)

1) Building height: 8 m

2) Volume V of the building 1 600 m³, 8 000 m³ and 16 000 m³

3) Door sizes A) 3 m x 3 m and B) 4 m x 4 m

4) Door U-value = 1,5 W/m²K

5) Air permeability Class 2 (12 m³/m²h)

6) Heater capacity to calculation with 20 W/m³

c) Building data (intended use)

1) Temperature inside building T_i =18 °C

2) Time door open per cycle t_c = 5 min

3) Door cycles per year n = 1 000

4) Working days per week = 5

The results of the calculation are summarised as follows:

2) Internet based metrological average values.

Table A.1 — Calculation results

	Energy loss kW/h/m^2	
	Door A) size 3 m x 3 m	**Door B) size 4 m x 4 m**
Heat transmission	450	800
Air leakage	439	705
Infiltration 1 600 m^3 building	1 664	1 676
Infiltration 8 000 m^3 building	7 123	8 175
Infiltration 16 000 m^3 building	8 837	13 161

The full calculation is contained in a CEN/TC33 / WG5 documentation.

Bibliography

[1] EN 13241-1, *Industrial, commercial and garage doors and gates — Product standard — Part 1: Products without fire resistance or smoke control characteristics*

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

[3] Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings, OJ L 1, 4.1.2003, p. 65-71

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