TECHNICAL REPORT

ISO/TR 52022-2

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Energy performance of buildings — Thermal, solar and daylight properties of building components and elements —

Part 2: Explanation and justification

Performance énergétique des bâtiments — Propriétés thermiques, solaires et lumineuses des composants et éléments du bâtiment —

Partie 2: Explication et justification

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

ISO 52022-2 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 89, *Thermal performance of buildings and building components*, in collaboration with ISO Technical Committee ISO/TC 163, *Thermal performance and energy use in the built environment*, Subcommittee SC 2 *Calculation methods*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

A list of all parts in the ISO 52022 series can be found on the ISO website.

Introduction

The set of EPB standards, technical reports and supporting tools

In order to facilitate the necessary overall consistency and coherence, in terminology, approach, input/output relations and formats, for the whole set of EPB-standards, the following documents and tools are available:

a) a document with basic principles to be followed in drafting EPB-standards: CEN/TS 16628:2014[1];

b) a document with detailed technical rules to be followed in drafting EPB-standards; CEN/TS 16629:2014[2].

The detailed technical rules are the basis for the following tools:

1) a common template for each EPB-standard, including specific drafting instructions for the relevant clauses;

2) a common template for each technical report that accompanies an EPB standard or a cluster of EPB standards, including specific drafting instructions for the relevant clauses;

3) a common template for the spreadsheet that accompanies each EPB (calculation) standard, to demonstrate the correctness of the EPB calculation procedures.

Each EPB-standards follows the basic principles and the detailed technical rules and relates to the overarching EPB-standard, ISO 52000-1 [3].

One of the main purposes of the revision of the EPB-standards is to enable that laws and regulations directly refer to the EPB-standards and make compliance with them compulsory. This requires that the set of EPB-standards consists of a systematic, clear, comprehensive and unambiguous set of energy performance procedures. The number of options provided is kept as low as possible, taking into account national and regional differences in climate, culture and building tradition, policy and legal frameworks (subsidiarity principle). For each option, an informative default option is provided (Annex B).

Rationale behind the EPB technical reports

There is a risk that the purpose and limitations of the EPB standards will be misunderstood, unless the background and context to their contents – and the thinking behind them - is explained in some detail to readers of the standards. Consequently, various types of informative contents are recorded and made available for users to properly understand, apply and nationally or regionally implement the EPB standards.

If this explanation would have been attempted in the standards themselves, the result is likely to be confusing and cumbersome, especially if the standards are implemented or referenced in national or regional building codes.

Therefore each EPB standard is accompanied by an informative technical report, like this one, where all informative content is collected to ensure a clear separation between normative and informative contents (see CEN/TS 16629[2]):

— to avoid flooding and confusing the actual normative part with informative content;

— to reduce the page count of the actual standard, and

— to facilitate understanding of the set of EPB standards..

This was also one of the main recommendations from the European CENSE project[5] that that laid the foundation for the preparation of the set of EPB standards.

This technical report

This technical report accompanies the suite of EPB standards on thermal transmission properties windows, doors and curtain wallings and the standards for solar and daylight characteristics for solar protection devices combined with glazing. It relates to ISO 10077-1 [6], ISO 10077-2 [7], ISO 12631 [8], ISO 52022-1 [9] and ISO 52022-3 [10] which form part of a set of standards related to the evaluation of the energy performance of buildings (EPB).

The role and the positioning of the accompanied standard(s) in the set of EPB standards is defined in the introductions to ISO 10077-1, ISO 10077-2, ISO 12631, ISO 52022-1 and ISO 52022-3.

Accompanying spreadsheets

Concerning ISO 10077-1, ISO 10077-2, ISO 12631, ISO 52022-1 and ISO 52022-3, spreadsheets were produced for:

— ISO 10077-1;

— ISO 12631;

— ISO 52022-1.

No accompanying calculation spreadsheets were prepared on:

— ISO 10077-2: The calculation method of ISO 10077-2 cannot be implemented in a spreadsheet.

— ISO 52022-3: The calculation method of ISO 52022-3 cannot be implemented in a spreadsheet.

These spreadsheets are available at www.epb.center.

Energy performance of buildings — Thermal, solar and daylight properties of building components and elements —

Part 2: Explanation and justification

1 Scope

This document contains information to support the correct understanding and use of ISO 10077-1, ISO 10077-2, ISO 12631, ISO 52022-1 and ISO 52022-3.

This technical report does not contain any normative provision.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6946, *Building components and building elements — Thermal resistance and thermal transmittance – Calculation methods*

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

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

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

ISO 12631:2017, *Thermal performance of curtain walling — Calculation of thermal transmittance*

ISO 52022-1, *Energy performance of buildings— Thermal, solar and daylight properties of building components and elements Part 1: Simplified calculation method of the solar and daylight characteristics for solar protection devices combined with glazing*

ISO 52022-3, *Energy performance of buildings— Thermal, solar and daylight properties of building components and elements Part 3: Detailed calculation method of the solar and daylight characteristics for solar protection devices combined with glazing*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6946, ISO 7345, ISO 10077-1, ISO 10077-2, ISO 12631, ISO 52022-1 and ISO 52022-3 apply.

More information on some key EPB terms and definitions is given in ISO/TR 52000-2.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

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

4 Symbols and subscripts

For the purposes of this document, the symbols and subscripts given in ISO 7345, ISO 6946, ISO 10077-1, ISO 10077-2, ISO 12631, ISO 52022-1 and ISO 52022-3 apply.

5 Brief description of the methods

5.1 Outputs of the method

The main outputs of these standards are:

- thermal transmittance of windows, doors, curtain walls, shutter boxes and frames;
- solar and daylight characteristics (solar energy transmittance, daylight transmittance) for solar protecting devices combined with glazing.

5.2 General description of the methods

ISO 10077-1, ISO 10077-2, ISO 12631, ISO 52022-1 and ISO 52022-3 provide the methodology to obtain the energy losses due to transmission and the energy gains due to solar radiation for windows, doors and curtain walls.

The calculation of the thermal transmittance of windows, doors according to ISO 10077-1 and curtain walls according to ISO 12631 is calculated as a function of the thermal transmittance of the components and their geometrical characteristics, plus the thermal interactions between the components.

The calculation of the thermal transmittance of frame profiles, shutter boxes and the linear thermal transmittance according to ISO 10077-2 is carried out using a two dimensional numerical method.

There are two separate standards for the calculation of the solar and daylight characteristics for solar protection devices combined with glazing. ISO 52022-1 defines a simplified method based on the thermal transmittance and total solar energy transmittance of the glazing and on the light transmittance and reflectance of the solar protection device to estimate the total solar energy transmittance of a solar protection device combined with glazing. The results generally tend to lie on the safe side for cooling load estimations. The results are not intended to be used for calculating beneficial solar gains or thermal comfort criteria. The calculations according to ISO 52022-1 can in principle be performed by a pocket calculator.

For cases not covered by ISO 52022-3 more exact calculations based on the optical properties (in general the spectral data) of glass and solar protection device can be carried out in accordance with ISO 52022-3. The total solar energy transmittance, the total solar direct transmittance and the total light transmittance is calculated as a function of the thermal resistance and spectral “optical” properties (transmittance, reflectance) of the individual layers. To solve the system of equations defined in ISO 52022-3 the use of an iterative procedure and therefore in general a software tool is necessary.

6 ISO 10077-1 Thermal performance of windows, doors and shutters – Calculation of thermal transmittance – Part 1: General

6.1 General

ISO 10077-1 provides a calculation method to obtain the thermal transmittance of windows and pedestrian doors consisting of glazed and/or or opaque panels fitted in a frame, with and without shutters.

In general, the thermal transmittance or *U*-value of the window or door product or assembly is calculated as a function of the thermal transmittance of the components and their geometrical characteristics, plus the thermal interactions between the components.

An alternative to calculation according to ISO 10077-1 is testing of the complete window or door according to ISO 12567-1 or, for roof windows, according to ISO 12567-2.

The following subclauses provide information in addition to that given in ISO 10077-1.

6.2 Thermal transmittance of the glazing

If measured or calculated data are not available, the values in Annex A may be used.

6.3 Additional thermal resistance of windows with closed shutters

A shutter or blind on the outside of a window introduces an additional thermal resistance ΔR, resulting from both the air layer enclosed between the shutter and the window, and the shutter itself. ΔR depends on the thermal transmission properties of the shutter/blind and on its air permeability and is evaluated according to ISO 10077-1.

Annex B of this document gives some typical values of shutter thermal resistance and the corresponding values of ΔR, which can be used in the absence of values of R_{sh} obtained from measurement or calculation.

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

7.1 General

ISO 10077-2 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). ISO 10077-2 also gives criteria for the validation of numerical methods used for the calculation.

7.2 Calculation principle

The calculation is carried out using a two-dimensional numerical method conforming to ISO 10211. The elements are 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.

Two different approaches for the calculation of the heat transfer through cavities are given:

1. the radiosity method and;
2. the single equivalent thermal conductivity method.

The radiosity method considers that the heat transfer through an air cavity occurs simultaneously through conduction/convection and through radiation. The two phenomena are happening in parallel so that the calculation of each contribution is done separately.

When using the single equivalent thermal conductivity method the heat flow rate in cavities is represented by a single 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.

The single equivalent thermal conductivity method is equal to the calculation method given in ISO 10077-2:2012.

8 ISO 12631 Thermal performance of curtain walling – Calculation of thermal transmittance

8.1 General

ISO 12631 provides a calculation method to obtain the thermal transmittance of curtain walls consisting of glazed and/or or opaque panels fitted in a frame.

In general, the thermal transmittance or *U*-value of the curtain walling is calculated as a function of the thermal transmittance of the components and their geometrical characteristics, plus the thermal interactions between the components.

Two methods of calculating the thermal transmittance of curtain wall systems are specified:

— the single assessment method; and

— the component assessment method.

The single assessment method is based on detailed computer calculations of the heat transfer through a complete construction including mullions, transoms, and filling elements (e.g., glazing unit, opaque panel). The heat flow rate (between two adiabatic lines) is calculated by modelling each thermal joint between two filling elements (opaque panel and/or glazing unit) using two-dimensional or three-dimensional finite element analysis software. By area weighting the *U*-values of thermal joints and filling elements, the overall façade *U*-value can be calculated. This method can be used for any curtain walling system (i.e. unitised systems, stick systems, patent glazing, structural sealant glazing, rain screens, structural glazing).

The component assessment method divides the representative element into areas of different thermal properties, e.g., glazing units, opaque panels and frames. By area weighting the *U*-values of these elements with additional correction terms describing the thermal interaction between these elements (Ψ-values), the overall façade *U*-value can be calculated. This method can be used for curtain walling systems such as unitised systems, stick systems and patent glazing. Structural silicone glazing, rain screens and structural glazing are excluded from the component assessment method.

Both methods result in the same value for the thermal transmittance of a curtain wall.

8.2 Calculation examples

Annex C gives an example for the calculation of a curtain walling module according to the component method.

Annex D gives an example for the calculation of a curtain walling module according to the single assessment method.

9 ISO 52022-1 Energy performance of buildings — Thermal, solar and daylight properties of building components and elements — Part 1: Simplified calculation method of the solar and daylight characteristics for solar protection devices combined with glazing

9.1 General

ISO 52022-1 defines a simplified method for the calculation of:

— the total solar energy transmittance;

— the total solar direct transmittance;

— the total light transmittance; and

— a glazing in combination with an external or internal or integrated solar protection device.

These characteristics are calculated as a function of the “optical” properties of the solar protection device and the glazing, the thermal transmittance of the glazing and the position of the solar protection device.

The formulae given in ISO 52022-1 are based on a simple physical model and the values of the notional parameters *G* are mathematically fitted to a more precise reference calculation, following the principles of ISO 52022-3.

The results generally tend to lie on the safe side for cooling load estimations. The results are not intended to be used for calculating beneficial solar gains during heating period or thermal comfort criteria.

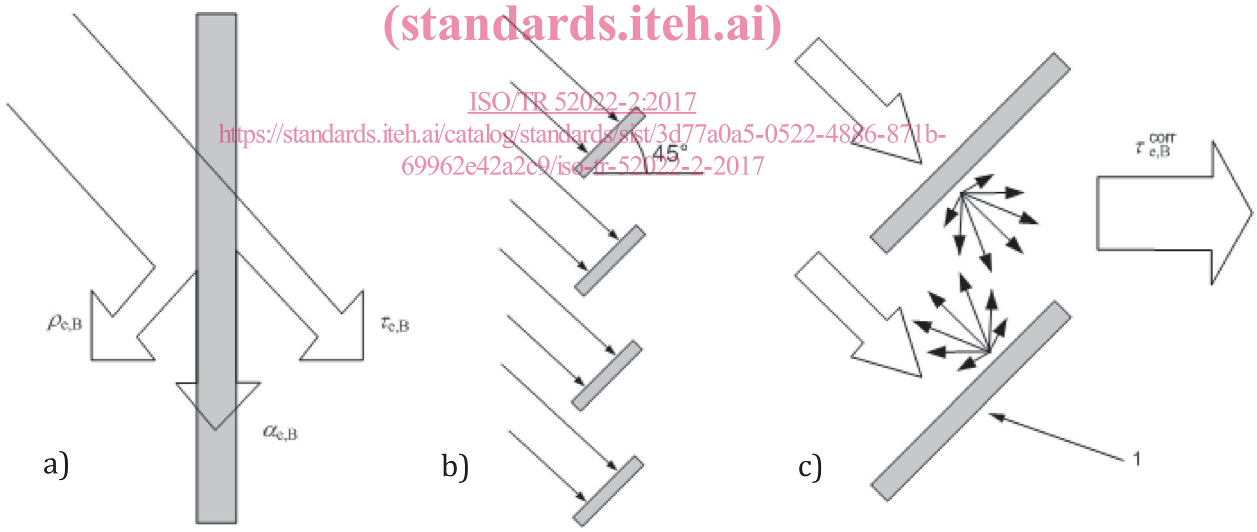
9.2 Data for typical glazing and solar protection devices

Annex E gives some typical values for the characteristics of glazing and solar protection devices which can be used in the absence of values obtained from measurement or calculation.

9.3 Solar transmittance of solar protection devices

Figure 1 shows the principles of solar transmittance of solar protection devices.

The simplified equations in ISO 52022-1 for venetian blinds open to 45° to not take into account direct solar transmittance and diffuse radiation. The reflection of the slats is to be considered diffuse. If diffuse irradiation has to be considered the relevant properties of louvre or Venetians blinds should be calculated in accordance with ISO 52022-3.



Key

1 blinds 45°

a) transmittance, absorptance and reflectance of a solar protection device

b) no direct penetration in the case of louvre or Venetian blinds open to 45°

c) principle of the correction of the transmittance in the case of blinds open to 45°

Figure 1 — Principles of solar transmittance of solar protection devices

9.4 Calculation example

Annex F gives an example of calculation for the three positions of a solar protection device in combination with a double clear glazing.

10 ISO 52022-3 Energy performance of buildings — Thermal, solar and daylight properties of building components and elements — Part 3: Detailed calculation method of the solar and daylight characteristics for solar protection devices combined with glazing

10.1 General

ISO 52022-3 defines a procedure for a detailed calculation of the solar and daylight characteristics for solar protection devices combined with glazing.

The procedure is based on the spectral transmission and reflection data of the materials, comprising the solar protection devices and the glazing, to determine the total solar energy transmittance and other relevant solar-optical data of the combination. If spectral data are not available the methodology can be adapted to use integrated data.

In the physical model the glass panes and blinds are considered as parallel, solid layers. In general, the total solar energy transmittance, the total solar direct transmittance and the total light transmittance is calculated as a function of the thermal resistance and spectral "optical" properties (transmittance, reflectance) of the individual layers.

Two sets of boundary conditions are given for the vertical position of the glazing and the blind.

Reference conditions:

These boundary conditions are consistent with the general assumptions of EN 410 and ISO 10292 and to be used for product comparison and average solar gain calculations during the heating period.

Summer conditions:

These boundary conditions are representative of more extreme conditions and are used for comfort evaluations and cooling load calculations.

10.2 Equivalent solar and light optical characteristics for louvres or venetian blinds

ISO 52022-3:2017, Annex D defines a method for the determination of equivalent solar and light optical characteristics for louvres or venetian blinds. The method is restricted to the assumptions stated in ISO 52022-3:2017, Annex D.

Annex G report defines an extended method which may be applied as an alternative method.

10.3 Calculation example

Annex H gives an example of calculation for the three positions of a solar protection device in combination with a double clear glazing.

Annex A
(informative)

ISO 10077-1: Thermal transmittance of double and triple glazing

Table A.1 gives the thermal transmittance, U_g, of double and triple glazing filled with different gases, calculated in accordance with EN 673. The values of the thermal transmittance in Table A.1 apply to the emissivities and gas concentration given.

Table A.1 — Thermal transmittance of double and triple glazing filled with different gases for vertical glazing

Glazing				Thermal transmittance for different types of gas space[a] U_g				
Type	**Glass**	**Normal emissivity**	**Dimensions** mm	**Air**	**Argon**	**Krypton**	**SF_6[b]**	**Xenon**
Double glazing	Uncoated glass (normal glass)	0,89	4–6–4	3,3	3,0	2,8	3,0	2,6
			4–8–4	3,1	2,9	2,7	3,1	2,6
			4–12–4	2,8	2,7	2,6	3,1	2,6
			4–16–4	2,7	2,6	2,6	3,1	2,6
			4–20–4	2,7	2,6	2,6	3,1	2,6
	One pane coated glass	≤ 0,2	4–6–4	2,7	2,3	1,9	2,3	1,6
			4–8–4	2,4	2,1	1,7	2,4	1,6
			4–12–4	2,0	1,8	1,6	2,4	1,6
			4–16–4	1,8	1,6	1,6	2,5	1,6
			4–20–4	1,8	1,7	1,6	2,5	1,7
	One pane coated glass	≤ 0,15	4–6–4	2,6	2,3	1,8	2,2	1,5
			4–8–4	2,3	2,0	1,6	2,3	1,4
			4–12–4	1,9	1,6	1,5	2,3	1,5
			4–16–4	1,7	1,5	1,5	2,4	1,5
			4–20–4	1,7	1,5	1,5	2,4	1,5
	One pane coated glass	≤ 0,1	4–6–4	2,6	2,2	1,7	2,1	1,4
			4–8–4	2,2	1,9	1,4	2,2	1,3
			4–12–4	1,8	1,5	1,3	2,3	1,3
			4–16–4	1,6	1,4	1,3	2,3	1,4
			4–20–4	1,6	1,4	1,4	2,3	1,4
	One pane coated glass	≤ 0,05	4–6–4	2,5	2,1	1,5	2,0	1,2
			4–8–4	2,1	1,7	1,3	2,1	1,1
			4–12–4	1,7	1,3	1,1	2,1	1,2
			4–16–4	1,4	1,2	1,2	2,2	1,2
			4–20–4	1,5	1,2	1,2	2,2	1,2

NOTE The values of thermal transmittance in the table were calculated using EN 673. They apply to the emissivities and gas concentration given.

[a] Gas concentration ≥ 90 %.

[b] The use of SF_6 is prohibited in some jurisdictions.

