BS EN 674:2011

BSI Standards Publication

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

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee B/520/4, Properties and glazing methods.

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

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ISBN 978 0 580 71595 2

ICS 81.040.20

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 July 2011.

Amendments issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 674

June 2011

ICS 81.040.20

Supersedes EN 674:1997

English Version

Glass in building - Determination of thermal transmittance (*U* value) - Guarded hot plate method

Verre dans la construction - Détermination du coefficient de transmission thermique, *U* - Méthode de l'anneau de garde

Glas im Bauwesen - Bestimmung des Wärmedurchgangskoeffizienten (*U*-Wert) - Verfahren mit dem Plattengerät

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Ref. No. EN 674:2011: E

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Foreword

This document (EN 674:2011) has been prepared by Technical Committee CEN/TC 129 “Glass in building”, the secretariat of which is held by NBN.

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of an identical text or by endorsement, at the latest by December 2011, and conflicting national standards shall be withdrawn at the latest by December 2011.

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.

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1 Scope

This European Standard specifies a measurement method to determine the thermal transmittance of glazing with flat and parallel surfaces. Structured surfaces, e.g. patterned glass, can be considered to be flat.

This European Standard applies to multiple glazing with outer panes which are not transparent to far infrared radiation, which is the case for soda lime silicate glass products, borosilicate glass and glass ceramics. Internal elements may be far infrared transparent.

The procedure specified in this European Standard determines the *U* value[1)] (thermal transmittance) in the central area of glazing. The edge effects, due to the thermal bridge through the spacer of an insulating glass unit or through the window frame are not included. Furthermore energy transfer due to solar radiation is not taken into account.

The procedure specified in this European Standard should generally only be considered when the calculation method detailed in EN 673 is inappropriate or unsuitable.

The document for the calculation of the overall *U* value of windows, doors and shutters (see [3]) gives normative reference to the *U* value evaluated for the glazing components according to this standard.

A vertical position of the glazing is specified.

U values evaluated according to the present standard are used for product comparison as well as for other purposes, in particular for predicting:

- heat loss through glazing;
- conduction heat gains in summer;
- condensation on glazing surfaces;
- the effects of the absorbed solar radiation in determining the solar factor (see [1]).

Reference should be made to [4], [5], or other European Standards dealing with heat loss calculations for the application of glazing *U* values determined by this standard.

The determination of the thermal transmittance is performed for conditions which correspond to the average situation for glazing in practice.

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.

EN 12898, *Glass in building — Determination of the emissivity*

ISO 8302:1991, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Guarded hot plate apparatus*

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1) In some countries the symbol k has been used hitherto.

3 Terms and definitions

For the purposes of this standard, the following terms and definitions apply:

3.1
***U* value**
parameter of glazing: which characterizes the heat transfer through the central part of the glazing, i.e. without edge effects, which states the steady-state density of heat transfer rate per temperature difference between the environmental temperatures on each side, and which is given in watts per square metre Kelvin [W/(m^2·K)]

3.2
declared value
U value obtained under standardized boundary conditions

NOTE See 10.2.

4 Basic formula

The *U* value depends on the thermal resistance of the multiple glazing and on the external and internal surface heat transfer coefficients according to the relation:

$$\frac{1}{U} = R + \frac{1}{h_e} + \frac{1}{h_i} \tag{1}$$

where

- R is the thermal resistance of the multiple glazing in square metres Kelvins per Watt $\left[(m^2 \cdot K)/W\right]$;
- h_e is the external surface heat transfer coefficient in Watts per square metre Kelvin $\left[(m^2 \cdot K)/W\right]$;
- h_i is the internal surface heat transfer coefficient in Watts per square metre Kelvin $\left[(m^2 \cdot K)/W\right]$.

According to this standard, the surface to surface thermal resistance is determined by measurements taken using the guarded hot plate method. Thereupon the declared value is determined according to Equation (1) with the values for the internal and external heat transfer coefficients specified in 10.2.

5 Brief outline of the measuring procedure

The surface to surface thermal resistance of the multiple glazing is determined by means of the guarded hot plate method laid down in ISO 8302. The recommendations of that standard shall be complied with except for variations contained in this standard and for variations resulting from the special structure of the glazing.

Within the present context further requirements are necessary, viz. the size of the test specimens and the performance of the measurements are laid down to meet special requirements for measuring multiple glazing (see Clause 6 to Clause 12).

6 Test apparatus

For the measurement of the thermal resistance of the specimen, the two specimen apparatus is used. Figure 1 gives a general outline of this apparatus including special requirements for the measurement of multiple glazing.

A square flat plate assembly consisting of a heater and metal surface plates and called the heating unit is sandwiched between two nearly identical specimens.

The thermal flux is transferred through the specimens to separate square isothermal flat assemblies called the cooling units.

The heating unit consists of a separate central metering section, where the unidirectional constant heat flux can be established, surrounded by a guard section separated by a narrow gap. The metering section has dimensions of 500 mm x 500 mm. The cooling units have surface dimensions as large as those of the heating unit, including the guard heater.

To ensure sufficient contact between the specimens and the adjacent surface plates, rubber sponge sheets in the quality of natural rubber with a thickness of about 3 mm shall be used.

A minimum of three equally spaced thermocouples shall be positioned on the specimen diagonal on each side to determine the average surface temperatures. Such thermocouples shall have a thickness not exceeding 0,2 mm; the junctions shall be flattened so as not to exceed 0,2 mm and a contact material (e.g. zinc oxide loaded silicon grease or metal tape) shall be used to insure a good thermal contact between the junction and the specimen.

The specimens shall be of such a size as to completely cover the heating unit surface. Additional edge insulation and/or auxiliary guard sections are required as stated in ISO 8302.

The glass layers of multiple glazing in contact with the apparatus make critical the correct detection of imbalance across the gap due to the high thermal conductivity of the glass. The installation of imbalance sensors as indicated in Figure 4b) of ISO 8302:1991 is most probably the only way of detecting with acceptable accuracy the actual imbalance through the gap when testing multiple glazing, see 2.1.1.3 to 2.1.1.5 of ISO 8302:1991. When a guarded hot plate is intended for tests on multiple glazing, the imbalance error shall be evaluated according to 2.2.1 of ISO 8302:1991, using the thermal conductivity of the glass, i.e. 1 W/(m K), as the specimen thermal conductivity. If the resulting calculated imbalance error is larger than 1 % (instead of the 0,5 % required by 2.1.4.1.1 of ISO 8302:1991), then the imbalance error shall be assessed using the experimental procedure of 2.4.4 of ISO 8302:1991. If the 1 % limit is still exceeded, the gap design and the imbalance detection system shall be reviewed before attempting any test on multiple glazing.

7 Dimensions of the specimens

The specimens shall be square and have dimensions of preferably 800 mm x 800 mm with a maximum spread ranging from 750 mm x 750 mm to 850 mm x 850 mm.

The two specimens needed for the measurement shall be as identical as possible. The difference in thickness between the two specimens measured at the edges shall not be more than 2 %.

The surfaces of the specimens shall be flat and parallel.

Specimen sizes down to 450 mm x 450 mm may be used if it can be shown that no convection occurs in the gas space and that the errors occurring are not greater than those allowed for the 800 mm x 800 mm arrangement.

8 Preparation of the specimens

The sum of the bowing or dishing of the outer panes in the central area of each specimen shall not exceed 0,5 mm. The control of bowing or dishing effects is performed by cooling down the specimens to 10 °C until isothermal equilibrium is reached and by measuring immediately before the specimens are positioned in the test apparatus for the measurement.

In the case of excessive bowing, a correction of the thickness of the specimens in the central area may be performed by a corresponding pressure change. In the case of excessive dishing such a correction for gas fillings except air is only allowed if the needed correction (by introducing a small volume of air) does not exceed 0,5 mm.

9 Performance of the measurements

The measurements shall be taken with the specimens in a vertical position.

The measurements shall be performed at a mean temperature of each specimen of (10 ± 0,5) °C. The mean temperature difference between the hot and the cold surface of the specimens shall be (15 ± 0,5) K.

10 Evaluation of the results

10.1 Thermal resistance of the multiple glazing

The thermal resistance *R* is calculated according to the equation:

$$R = \frac{2A(T_1 - T_2)}{\Phi} \quad m^2 \cdot K/W \qquad (2)$$

where

Φ is the average power supplied to the central section of the heating unit in watts (W);

T_1 is the average hot side temperature of the specimens in Kelvins (K);

T_2 is the average cold side temperature of the specimens in Kelvins (K);

A is the metering area in square metres (m^2).

10.2 Declared *U* Value

The declared *U* value is calculated according to Equation (1).

For multiple glazing without a coating having an emissivity lower than 0,837 on the outer surfaces, the following standardized values for the surface heat transfer coefficients are used:

— internal heat transfer coefficient: h_i = 7,7 W/(m^2 K);

— external heat transfer coefficient: h_e = 25 W/(m^2 K).

For a multiple glazing with a coating having an emissivity lower than 0,837 on the surface adjacent to the inner room, the standardized value of h_i is modified according to the equation:

$$h_i = 3{,}6 + 4{,}1 \frac{\varepsilon}{0{,}837} \ \text{W/(m}^2\text{·K)} \quad (3)$$

where

ε is the corrected emissivity of the surface;

0,837 is the corrected emissivity of uncoated soda lime silicate glass and borosilicate glass.

The corrected emissivity shall be determined by reference to EN 12898.

Values lower than 0,837 for ε shall be taken into account only if the surface is clean and water condensation on the coated surface can be excluded.

Improvements of the *U* value due to externally exposed coated surfaces with an emissivity lower than 0,837 are not taken into account.

NOTE The application of the *U* value of an external building element obtained in standardised boundary conditions for calculating heat losses is not strictly consistent on the basis of dry resultant temperature in internally heated spaces. In most practical cases it is adequate, but for glazing elements with relatively large surface area and particularly with internal low emissivity surface, errors may arise. In such cases reference is made to [4], [5] or other relevant European Standards.

10.3 Design *U* value

For the application of glazing *U* values in building design the use of a declared value may not always be sufficiently accurate. In special circumstances, a design value shall be determined using this standard. Design *U* values appropriate to the position of the glazing and the environmental conditions shall be determined using the correct boundary values of h_e and h_i, which shall be stated.

11 Expression of the results

11.1 *U* values

U values shall be expressed in W/(m^2·K) rounded to one decimal figure. If the second decimal is five, it shall be rounded to the higher value.

EXAMPLE 1: 1,53 becomes 1,5.

EXAMPLE 2 1,55 becomes 1,6.

EXAMPLE 3 1,549 becomes 1,5.

11.2 Thermal resistance

Thermal resistance shall be rounded to three decimal figures.

11.3 Intermediate values

In computations, intermediate values shall not be rounded.

12 Test report

12.1 Information included in the test report

The test report shall state the following elements according to 12.2 to 12.4.

12.2 Identification of each glazing specimen

- Length (mm)
- Width (mm)
- Total thickness measured at the edges (mm)
- Thickness of each pane of glass or other glazing material (mm)
- Thickness of gas space (s) measured at the edges (mm)
- Type of gas filling (if known)
- Position and emissivity of IR-reflecting coating(s) (if known)
- Bowing or dishing (mm)

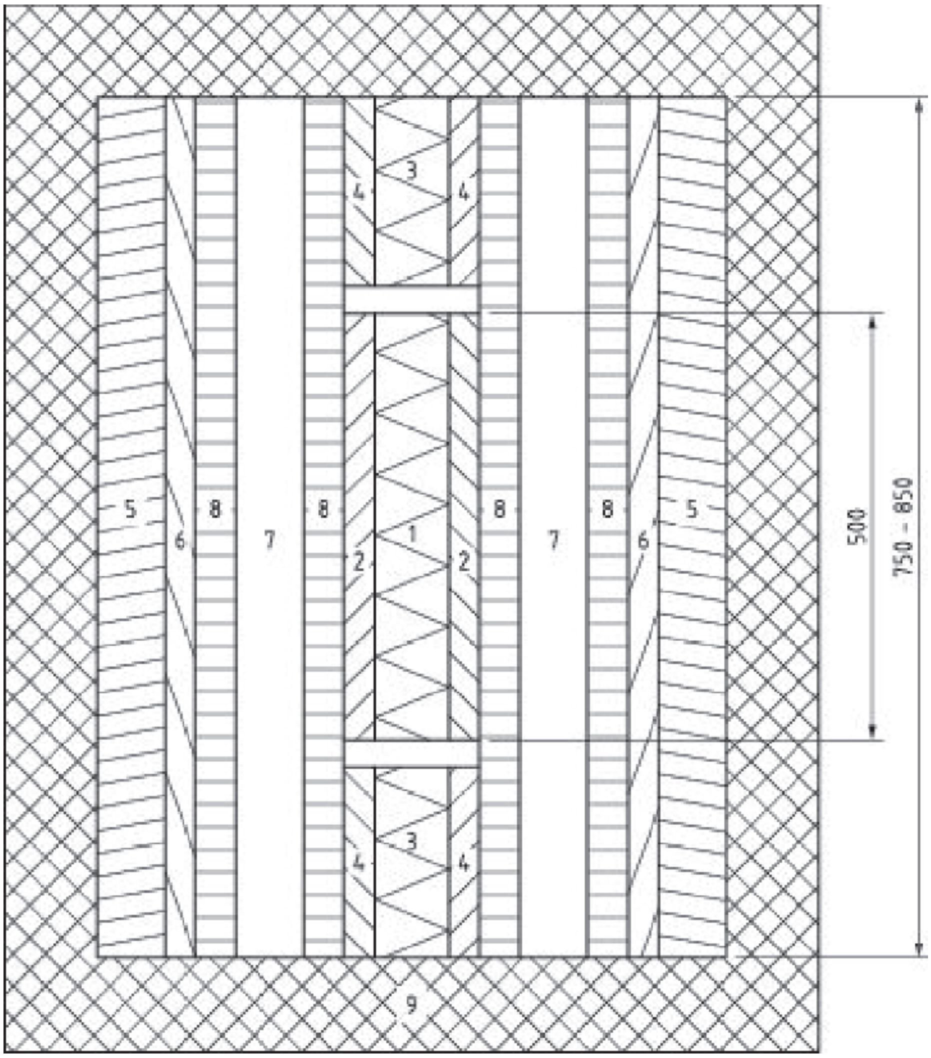
12.3 Cross section of the specimen

A figure shall show the structure of the specimen (position and thickness of glass panes, position and thickness of gas space(s), type of gas filling, position of internal foils and of IR reflecting coatings, etc.).

12.4 Results

- Average power supplied (W)
- Metering area (m^2)
- Mean surface temperature on the hot side of each specimen (°C)
- Mean surface temperature on the cold side of each specimen (°C)
- Mean temperature difference between hot and cold side of each specimen (K)
- Mean temperature of each specimen (°C)
- Thermal resistance ($m^2 \cdot K/W$)
- Corrected emissivity of the surface adjacent to the inner room in case of coatings which modify the emissivity
- Internal heat transfer coefficient h_i , in case of coatings which modify the emissivity [W/($m^2 \cdot$K)]
- *U* value [W/($m^2 \cdot$K)]
- h_e and h_i if values different from the standardized ones are used to calculate a design *U* value, in which case the expression "design *U* value" shall be used [W/($m^2 \cdot$K)]

Dimensions in millimetres



Key

1 {Metering area heater **2** Metering area surface plates}	Metering Section of Heating Unit
3 {Guard heater **4** Guard surface plates}	Guard Section of Heating Units

5 Cooling units

6 Cooling unit surface plates

7 Specimens

8 Rubber sponge sheets

9 Insulating material

Figure 1 — Guarded hot plate apparatus

Bibliography

[1] EN 410, *Glass in building — Determination of luminous and solar characteristics of glazing*

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

[3] EN ISO 10077-1, *Thermal performance of windows, doors and shutters — Calculation of thermal transmittance — Part 1: General (ISO 10077-1:2006)*

[4] EN ISO 10211, *Thermal bridges in building construction — Heat flows and surface temperatures — Detailed calculations (ISO 10211:2007)*

[5] EN ISO 13790, *Energy performance of buildings — Calculation of energy use for space heating and cooling (ISO 13790:2008)*

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