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Bundesverband
Flachglas

Calculating the U_w value of glazing bar windows

Calculating the U_W value of glazing bar windows

1.0 Introduction

Spacers in the edge seal and glazing bars are thermal 'defects' that have to be taken into account when determining the U_W value of windows. Until now, the U_W value has been taken into account with additional values in EN 14351-1. These flat-rate additional values are based on outdated technology and therefore no longer represent today's reality – and the U_W-values are very unfavourable as a result. DIN EN ISO 10077-1 [1] enables the calculation of the exact U_W values to be performed. Glass-partitioning glazing bars (as in Fig. 1 below) are not the subject of this BF Bulletin.

2.0 Flat-rate additions for glazing bars as per EN 14351-1]

The product standard for windows (EN 14351-1) specifies additions for glazing bar windows in Annex J (Fig. 1).

No distinction is made here as to whether they are 'Georgian glazing bars' that are still covered on the outside by a cover strip, or purely decorative bars inside the cavity that remain visible in a plan view. No differentiation is made between conventional glazing bars made of aluminium and thermally-improved glazing bars made of plastic. Whether glazing bars are provided in one or both cavities in triple insulating glazing is not important when determining the amount to be added – and neither the spacing between the glass and the glazing bars, nor the width of the bars are considered.

These additions to the U_W value are easy to use, but in many cases, their values are incommensurately high for glazing bar windows.

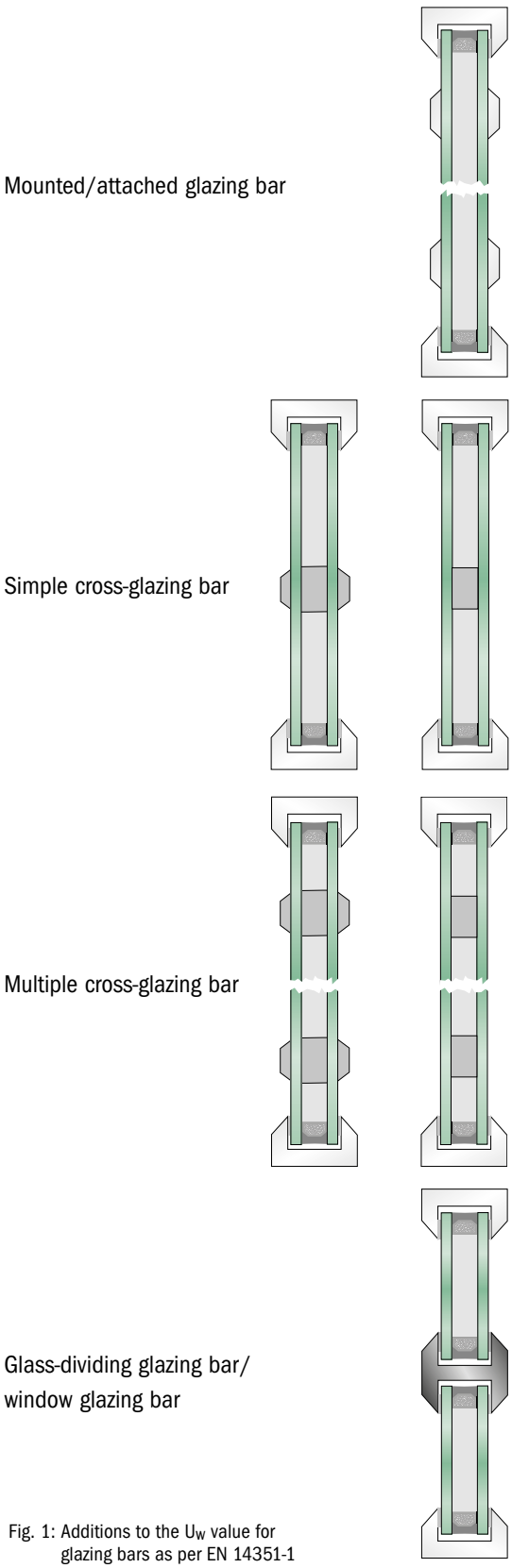


Fig. 1: Additions to the U_W value for glazing bars as per EN 14351-1

3.0 The research project of the BF 'Glazing Bars' Ad-Hoc group

The Psi values of the glazing bars can be determined using a detailed calculation as per EN ISO 10077-2. When linear heat transfer coefficients for glazing bars are taken into account (glazing bar Psi values), the U_w values obtained in most cases are more advantageous than those resulting from the use of the flat-rate additions. However, this course of action involves considerable expense, since the range of glazing bar variants is considerably greater than in a spacer system.

A research project at ift Rosenheim (initiated and funded by the BF 'Glazing Bars' ad hoc group) was therefore carried out dealing with the topic of glazing bars in terms of their thermal performance. The aim of the project was to determine standard-rate glazing bar Psi values by calculating linear heat transfer coefficients Ψ_{gb} for different glazing bar types. These standard values were then incorporated into EN ISO 10077-1 in tabular form.

In September 2015, the final report was published, entitled 'Creation of simplified tables to take into account the effect of glazing bars while determining the U value of windows'. The influencing factors on glazing bar Psi values were analysed by typical calculations (Fig. 2 and Table 1).

When using system-specific Psi values, the BF recommends the commissioning of qualified building physicists.

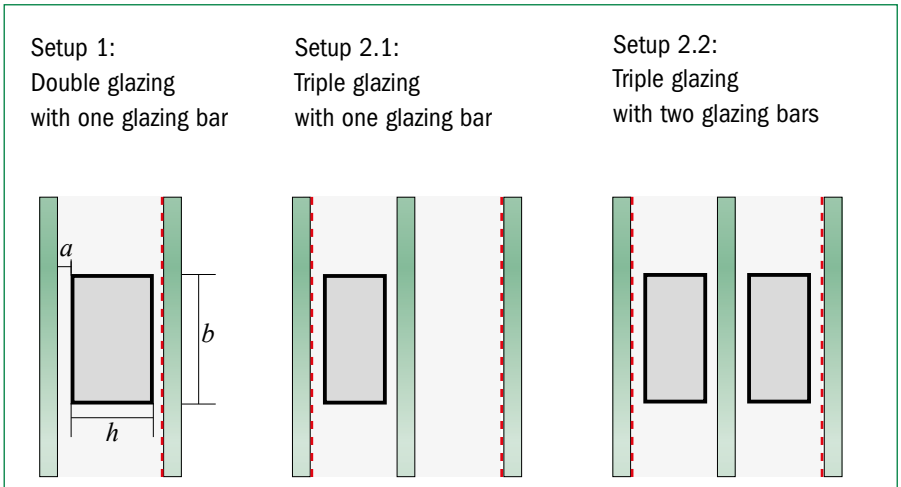


Fig. 2: Schematic representation of setups for calculating Ψ_{gb} values for glazing bars in double and triple glazing windows [3]

Influencing factor	***Relevance***
Coating (emissivity) of the glass panes	Coating influences Ψ_{gb} values
Thermal conductivity of the glazing bar material	Division into two material groups (aluminium or plastic) recommended
Distance a on both sides between glazing bars and glass	The larger a is, the smaller the Ψ_{gb} value
Width b of glazing bar	Ψ_{gb} values rise with increasing width of the bar
In triple insulating glass: Glazing bars inside one or both cavities	Significant effect
Wall thickness of glazing bars	No significant effect
Height of the glazing bar h	No significant effect (the distance a to the glass is decisive)

Table 1: Influencing factors in glazing bar Psi values and their relevance

4.0 Tables with standard-rate glazing bar Psi values

As with the heat bridge at the glass edge, the standard glazing bar Psi value Ψ_{gb} (gb = glazing bar) is multiplied by the total length of the fitted glazing bars and proportionately added to the U_w value.

$$U_w = \frac{A_g \cdot U_g + A_f \cdot U_f + l_g \cdot \Psi_g + l_{gb} \cdot \Psi_{gb}}{A_w}$$

Fig. 3: Formula for the calculation of the heat transfer coefficient U_w of glazing bar windows

Explanation of abbreviations:

U_w = Heat transfer coefficient of the window
A_g = Surface area of the glazing
U_g = Heat transfer coefficient of the glazing
A_f = Surface area of the frame
U_f = Heat transfer coefficient of the frame
A_w = Total area of the window
Ψ_g = Linear thermal transmittance as a result of the combined thermal influence of the glass, spacers and frames
l_{gb} = Length of the spacers
Ψ_{gb} = Linear thermal transmittance as a result of the combined thermal influence of glass and glazing bars
l_{gb} = Length of the glazing bars

As a result of the research project [3], two tables (see Tables 2 and 3) with standard-rate glazing bar Psi values were integrated into EN ISO 10077-1, for the following field of application:

- For glazing bars (hollow chamber profiles) made of metal and plastic
- Glazing bar width b ≤ 30 mm (see Fig. 2)
- Distance a ≥ 2 mm and a ≥ 4 mm (see Fig. 2)

Linear heat transfer coefficients for metal bars integrated into multi-pane insulating glass (≤ 160 W/(mK))

Glazing	***Distance a in mm***	***Ψ value in W/mK***	
		Glazing without low e coating	Glazing with low e coating
Double	≥ 2	0.03	0.07
	≥ 4	0.01	0.04
Triple with glazing bar inside one cavity	≥ 2	-/-	0.03
	≥ 4	-/-	0.01
Triple with glazing bar inside both cavities	≥ 2	-/-	0.05
	≥ 4	-/-	0.02

Table 2

Linear heat transfer coefficients for metal bars integrated into multi-pane insulating glass (≤ 0.30 W/mK)

Glazing	***Distance a in mm***	***Ψ value in W/mK***	
		Glazing without low e coating	Glazing with low e coating
Double	≥ 2	0.00	0.04
	≥ 4	0.00	0.02
Triple with glazing bar inside one cavity	≥ 2	-/-	0.02
	≥ 4	-/-	0.01
Triple with glazing bar inside both cavities	≥ 2	-/-	0.03
	≥ 4	-/-	0.02

Table 3

5.0 Calculation example Window with internal glazing bars (sash bars) Comparison: Flat-rate addition and new EN 10077-1

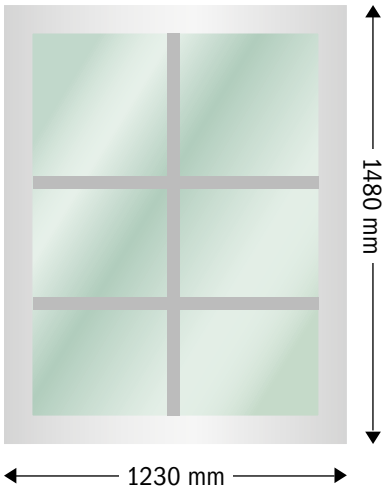
Basic data

Width	1230 mm
Height	1480 mm
Frame portion	30%
U_g value	0.6 W/m²K
U_f value	1.1 W/m²K
Ψ value for spacer	0.045 W/mK

Intermediate results

Window area	1.820 m²
Glass area	1.274 m²
Frame area	0.546 m²
Glass width	1.029 m
Glass height	1.238 m
Spacer length	4.535 m
Glazing bar length	3.296 m

$$U_w = \frac{A_g \cdot U_g + A_f \cdot U_f + l_g \cdot \Psi_g + l_{gb} \cdot \Psi_{gb}}{A_w}$$



Results

	U_w value *without glazing bar*	***U_w value*** *with 6 fields*	***U_w value*** *with 6 fields 10 mm bar height*	***U_w value*** *with 6 fields 8 mm bar height*	***U_w value*** *with 6 fields both cavities 9.5 mm aluminium glazing bar height*	***U_w value*** *with 6 fields both cavities 9.5 mm plastic glazing bar height 2*
Calculation according to		EN 14351-1	EN 10077-1	EN 10077-1	EN 10077-1	EN 10077-2
Ψ value of bar 26 mm (visible width) in W/mK	omitted	Flat-rate addition for U_w value (0.2 W/m²K)	0.03	0.01	0.05	0.03
Exact U_w value in W/m²K	0.862	1.062	0.916	0.880	0.953	0.916
U_w value as per standard in W/m²K	0.86	1.1	0.92	0.88	0.95	0.92

In window constructions with triple glazing, an improvement of more than 0.2 W/m²K can be achieved in the exact calculation of the thermal bridge bar in the cavity as per the new EN 10077-1 [1] compared to the flat-rate assessment as per EN 14351. This is nominally more than the flat-rate addition itself. It results from the unfavourable rounding-off rules in the flat-rate addition for U_w values.

In the case of CE marking and the declaration of the performance of windows, the U_w valueof a window can be calculated according to EN 14351-1 for two formats. 1.23 m x 1.48 m for a window area of not more than 2.3 m² or 1.48 m x 2.18 m for all sizes if the U_g value is 1.9 W/m²K (EN 673) at most.

6.0 Literature

[1] EN ISO 10077-1:2016, Draft (2016) Thermal performance of windows, doors and shutters – Calculation of thermal transmittance – Part 1: General Berlin, Beuth Verlag GmbH

[2] EN ISO 10077-2:2012 Thermal performance of windows, doors and shutters – Calculation of thermal transmittance – Part 2: Numerical method for frames Berlin, Beuth Verlag GmbH

[3] ift-Forschungsbericht ‚Psi-Werte von Sprossen – Erarbeitung von vereinfachten Tabellen zur Berücksichtigung des Einflusses von Sprossen im Rahmen der Ermittlung des U-Wertes von Fenstern' Rosenheim, ift Rosenheim, September 2015 (unpublished)

This bulletin was produced by: 'Glazing Bars' ad hoc group, based on the BF Bulletin 004/2008 'Guide to the "Warm Edge"' (Author: Fr. Meyer-Quel) at Bundesverband Flachglas e. V. · Mülheimer Strasse 1 · D-53840 Troisdorf

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