

Calculation of Thermal Transmittance

Report in Accordance with BS EN ISO 10077-1:2017

Thermal Performance of Windows, Doors & Shutters

CONFIDENTIAL

Report reference:	U25-008-5A
Prepared for:	Bereco Ltd Unit 5 Aspen Court Centurion Business Park Rotherham, S60 1FB
Project:	Traditional Flush Casement Window
Issued by:	Sue Peatey
Issue date:	27 March 2025



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1 Introduction

This document details the thermal performance calculation of the window configuration as detailed below.

The results in this report relate only to the simulated specimen using the drawings and specification received.

The frame profile results detailed below are provided by computer simulation using LBL software program THERM 5.2 and validated against proofs in Annex I (I1 to I10) of BS EN ISO 10077-2:2017.

The frame profile results detailed below are provided from methods contained in BS EN ISO 10077-1:2017 and in accordance with thermal transmittance requirements detailed in BS EN 14351-1:2006 +A1:2010. Cavities are calculated in accordance with BS EN ISO 10077-2 section 6.4.3 Treatment of cavities using the single equivalent thermal conductivity method.

2.0 Authorisation

Report Issued By:	Sue Peatey Technical Officer	
Report Checked By:	Richard Bate Technical Director	

3 Results

3.1 U-Value

The thermal performance of the window (U_w) in accordance with EN ISO 10077-1:2017 is:

1.3 W/m²K

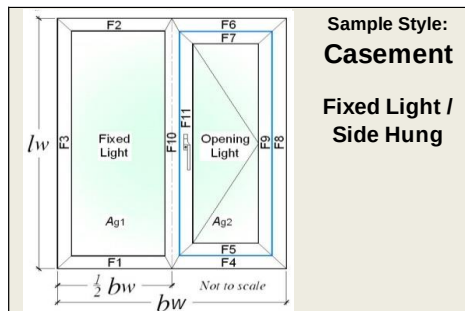
3.2 Frame thermal transmittance and linear thermal transmittance (in accordance with BS EN ISO 10077-1: 2017)

Frame Profile	Frame Thermal Transmittance (U_f)	Linear Thermal Transmittance (ψ)
Sill	1.5 W/m ² K	0.045 W/m.K
Head	1.3 W/m ² K	0.044 W/m.K
Jamb	1.5 W/m ² K	0.045 W/m.K
Mullion	1.4 W/m ² K	0.088 W/m.K

3.3 Centre pane U-Value of glazing calculated in accordance with BS EN 673: 2011

Glazing unit	Centre pane U-value (U_g)
Unit thickness = 24mm Outer pane = 4mm St Gobain Planiclear Cavity = 16mm 90% Argon Inner pane = 4mm St Gobain Planitherm One Spacer bar = St Gobain Swisspacer Advance	1.0 W/m ² K

4. U-value calculation



Sample Style:
Casement
Fixed Light /
Side Hung

Report Number: U25-008-5
Report Date: 03 March 2025
Project Details: Traditional Flush Casement

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Input Values:
Yellow input, green intermediary, blue finals X' DP is no. of decimal places to enter

Parameter	Symbol	Units
Total window height ODP	l_w	1480 mm
Total window width ODP	b_w	1537.5 mm

Frame offset: **No**

Nominal 4mm etc to **ODP**, others **1DP**

Glazing dimensions and properties:			
Thickness of pane 1	4	mm	
Pane 1/2 distance	16	mm	
Gas fill (1/2)	Argon 90%		
Thickness of pane 2	4	mm	
Complete next 3 cells for TG IGU			
Pane 2/3 distance		mm	
Gas fill (2/3)			
Thickness of pane 3		mm	
Glazing Trans. - 3DP	U_g	1.045	W/(m ² ·K)
g-value - 2DP	$g_{\perp}$	0.49	

Thermal transmittance of window from hot box test			
U_w - 2DP			W/(m ² ·K)

Frame dimensions:					
	(b)	Frame width, b_f (mm)	Gasket protrusion, b_{gt} (mm)	Frame & gasket widths (mm)	
All frame values round to nearest 1mm, gaskets to 1DP	F1 fixed sill	129	0.4	129.4	Total
	F2 fixed head	102	0.4	102.4	
	F3 fixed jamb	100	0.4	100.4	
F4 + F5 sash sill	F4 fixed sash sill	65	n/a	65.0	129.4
	F5 moving sash sill	64	0.4	64.4	
F6 + F7 sash head	F6 fixed sash head	58	n/a	58.0	102.4
	F7 moving sash head	44	0.4	44.4	
F8 + F9 sash jamb	F8 Fixed sash jamb	56	n/a	56.0	100.4
	F9 moving sash jamb	44	0.4	44.4	
F10 + F11 mullion	F10 fixed mullion	119	0.4	119.4	163.8
	F11 moving mullion	44	0.4	44.4	
Total gasket area			0.00293672	m ²	

Window Dimensions:			Area	
Section	Length (m)	Width (m)	No gasket (m ²)	With gasket (m ²)
Fixed Light	1.2490	0.6093	0.7610	0.7595
Opening light	1.2490	0.5653	0.7060	0.7045
Total glazing, A_g			1.4670	1.4640
Frame	(m)	(m)	(m ²)	(m ²)
F1	0.7688	0.1290	0.0889	0.0891
F2	0.7688	0.1020	0.0703	0.0705
F3	1.4800	0.1000	0.1365	0.1369
F4	0.7688	0.0650	0.0412	0.0412
F5	0.6533	0.0640	0.0390	0.0392
F6	0.7688	0.0580	0.0462	0.0462
F7	0.6533	0.0440	0.0268	0.0270
F8	1.4800	0.0560	0.0794	0.0794
F9	1.3570	0.0440	0.0573	0.0578
F10	1.4800	0.1190	0.1656	0.1661
F11	1.3570	0.0440	0.0573	0.0578
Total Frame			0.8085	0.8115
Total Window, A_w			2.2755	2.2755
Percentage fixed light glass area			33.44%	33.38%
Percentage opening light glass area			31.03%	30.96%
Percentage glass area (total)			64.47%	64.34%

Solar Factor, g-value:		
F_w	0.9	
g_w	0.28	

Where a U_w value from hot box testing is available, no L_f^{2D} or L_{ψ}^{2D} values need to be entered					
Frame conductance:		All L values to 4DP . All b values to ODP			
		$W/(m \cdot K)$	b_p (mm)	$W/(m \cdot K)$	b_g (mm)
F1 fixed sill	L_f^{2D}	0.4171	190	L_{ψ}^{2D}	0.4390
F2 fixed head		0.3580	190		0.3783
F3 fixed jamb		0.3749	190		0.3961
F4 + F5 sash sill		0.4171	190		0.4390
F6 + F7 sash head		0.3580	190		0.3783
F8 + F9 sash jamb		0.3749	190		0.3961
F10 + F11 mullion		0.6732	380		0.7139

Frame:							
Section	Frame width, b_f (m)	Frame U-value, U_f (W/(m ² ·K))	Frame areas, A_f (m ²)	Frame heat flow, H_U (W/K)	Linear trans, ψ (W/(m·K))	Linear length, l_g (m)	Junction heat flow, H_{ψ} (W/K)
F1 fixed sill	0.1290	1.5121	0.0889	0.1344	0.0454	0.6093	0.0277
F2 fixed head	0.1020	1.3330	0.0703	0.0937	0.0438	0.6093	0.0267
F3 fixed jamb	0.1000	1.5286	0.1365	0.2086	0.0447	1.2490	0.0558
F4 + F5 sash sill	0.1290	1.5121	0.0802	0.1213	0.0454	0.5653	0.0257
F6 + F7 sash head	0.1020	1.3330	0.0730	0.0973	0.0438	0.5653	0.0248
F8 + F9 sash jamb	0.1000	1.5286	0.1368	0.2091	0.0447	1.2490	0.0558
F10 + F11 mullion	0.1630	1.4057	0.2229	0.3134	0.0877	1.2490	0.1095
Totals				0.8085	1.1777	Total	0.3259

Other parameters needed for calculation, taken from simulations:					
$\lambda_p =$	0.035	W/(m·K)	$R_{se} =$	0.04	m ² ·K/W
$R_p =$	0.6857	m ² ·K/W	$R_{tot} =$	0.8557	m ² ·K/W
$d_p = d_g =$	0.024	m	$R_{se} =$	0.13	m ² ·K/W
			$U_p =$	1.1686	W/(m ² ·K)

U_{window}			W/(m ² ·K)
No bars; or attached bars	1.33		
Single cross bar in IGU	1.4		
Multiple cross bar in IGU	1.5		
Glazing bar (Georgian bar)	1.7		

Thermal transmittance, W/(m ² ·K)	U_{window}	1.3
Solar factor	g_{window}	0.28

BFRC Certified
Simulator No

S166



Simulator Name: **Sue Peatey**

Figure 1. Cross section drawing, including dimensions, of window.

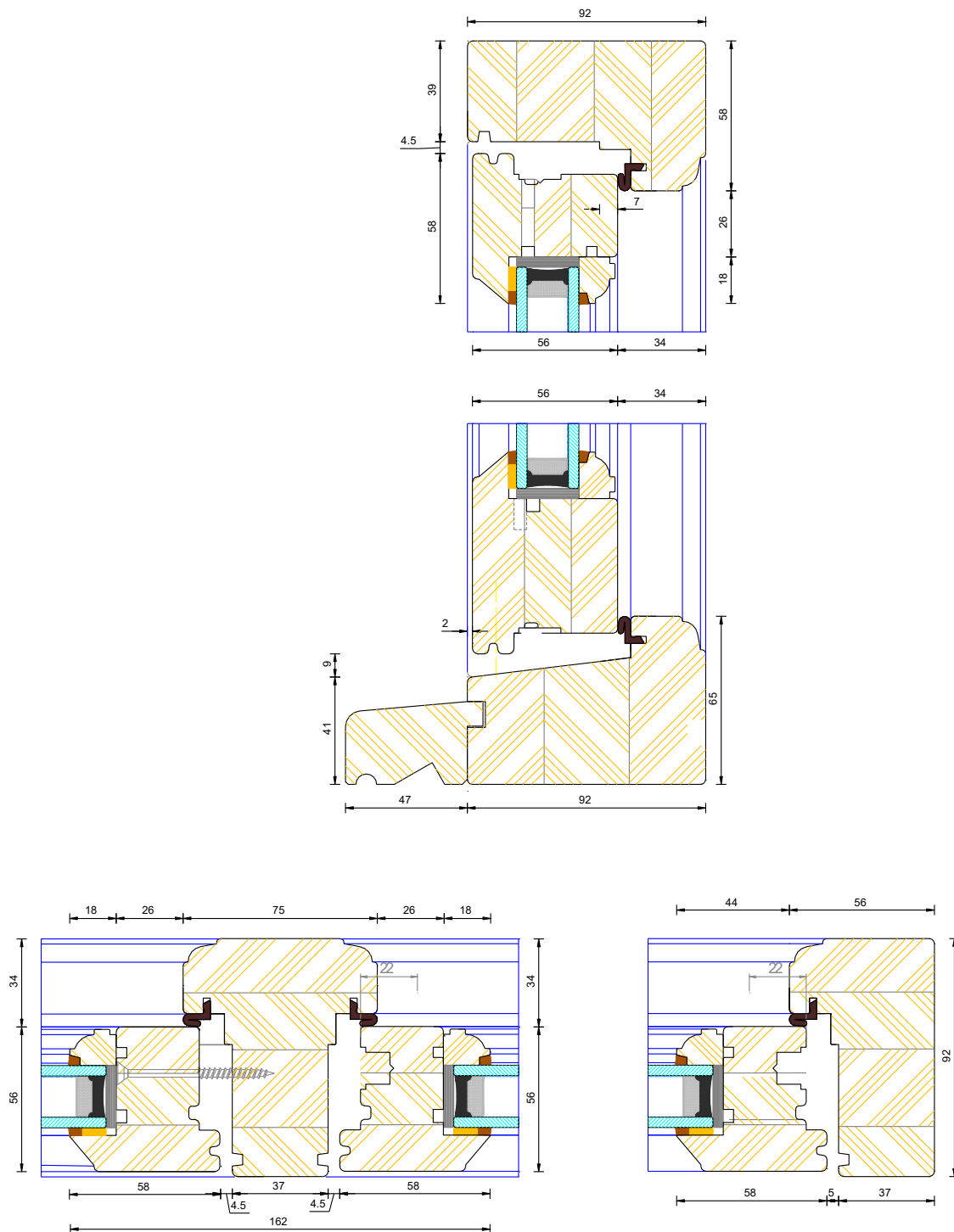


Figure 2. Simulation of head profile

External Environment

R_{si} Normal = $0.04 \text{ m}^2\text{K/W}$

R_{si} Reduced = $0.04 \text{ m}^2\text{K/W}$

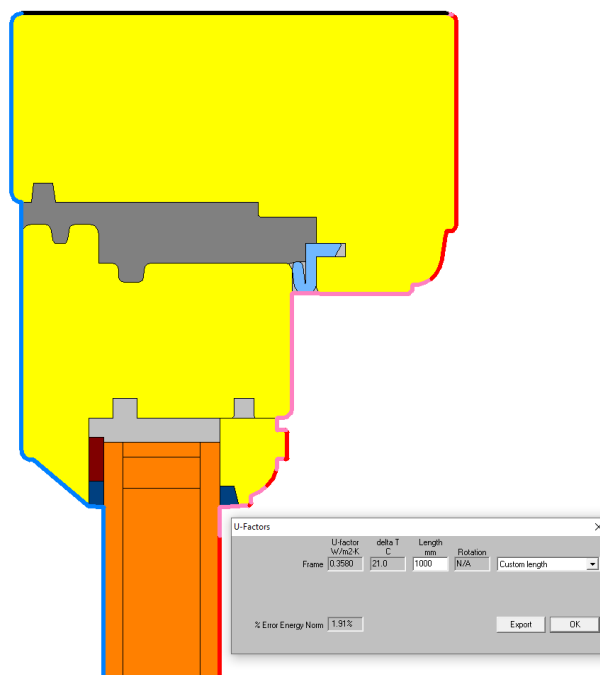
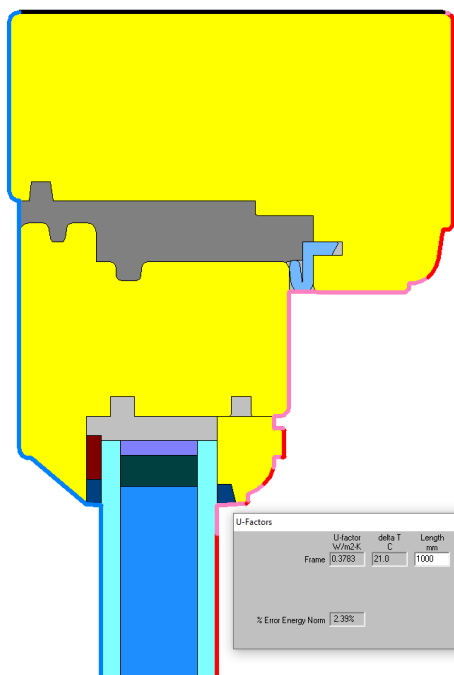
Temperature = 0°C

Internal Environment

R_{si} Normal = $0.13 \text{ m}^2\text{K/W}$

R_{si} Reduced = $0.20 \text{ m}^2\text{K/W}$

Temperature = 20°C

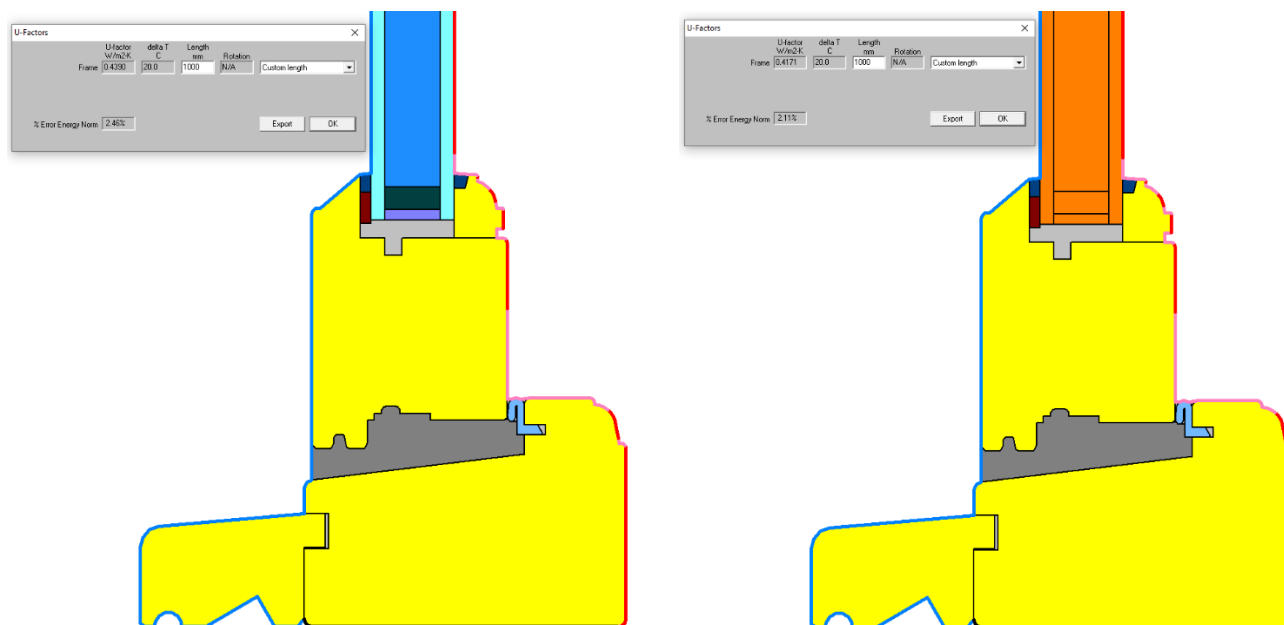


Quad Tree Mesh Parameter 9

Figure 3. Simulation of sill profile.

External Environment
 R_{si} Normal = $0.04 \text{ m}^2\text{K/W}$
 R_{si} Reduced = $0.04 \text{ m}^2\text{K/W}$
Temperature = 0°C

Internal Environment
 R_{si} Normal = $0.13 \text{ m}^2\text{K/W}$
 R_{si} Reduced = $0.20 \text{ m}^2\text{K/W}$
Temperature = 20°C



Quad Tree Mesh Parameter 9

Figure 4. Simulation of jamb profile.

Internal Environment

R_{si} Normal = $0.13 \text{ m}^2\text{K/W}$

R_{si} Reduced = $0.20 \text{ m}^2\text{K/W}$

Temperature = 20°C

External Environment

R_{si} Normal = $0.04 \text{ m}^2\text{K/W}$

R_{si} Reduced = $0.04 \text{ m}^2\text{K/W}$

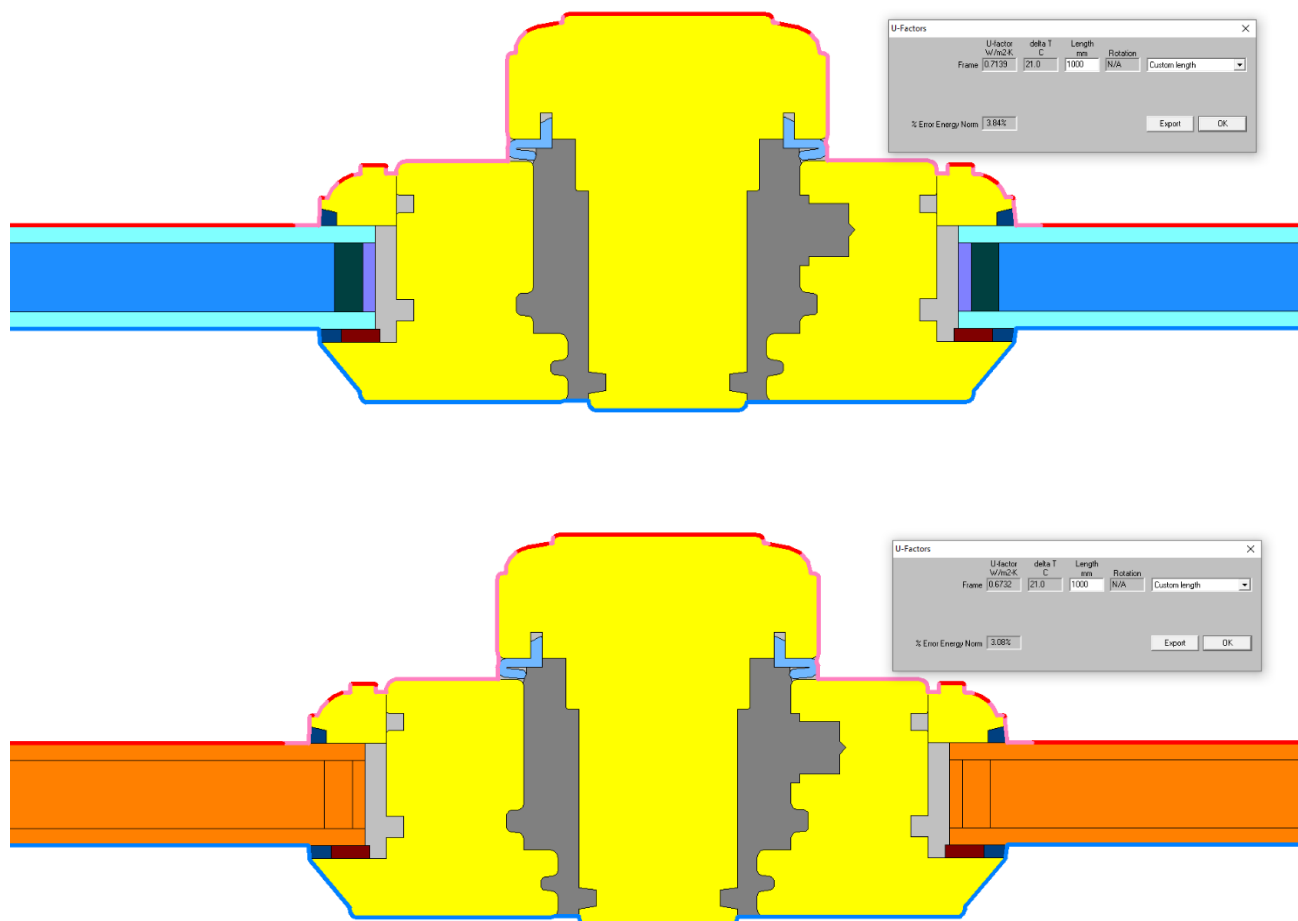
Temperature = 0°C



Quad Tree Mesh Parameter 9

Figure 5. Simulation of mullion profile.

Internal Environment
 R_{si} Normal = $0.13 \text{ m}^2\text{K/W}$
 R_{si} Reduced = $0.20 \text{ m}^2\text{K/W}$
Temperature = 20°C



External Environment
 R_{se} Normal = $0.04 \text{ m}^2\text{K/W}$
 R_{se} Reduced = $0.04 \text{ m}^2\text{K/W}$
Temperature = 0°C

Quad Tree Mesh Parameter 9

Key To Figures

	Material	Thermal Conductivity W/(m.K)	Source
	Softwood	0.13	Annex D of BS 10077-2
	Soda Lime Glass	1.0	Annex D of BS 10077-2
	EPDM	0.25	Annex D of BS 10077-2
	Swisspacer Advance	0.29	BF Datasheet W24 (see page 13)
	Polysulfide/Polyurethane	0.4	Annex D of BS 10077-2
	Silicone	0.35	Annex D of BS 10077-2
	Polyurethane foam	0.05	Table 3 of BS 10456
	Insulation panel	0.035	Annex D of BS 10077-2

Glazing unit 4-16-4 Low E 0.01 uncorrected 90% argon 10% air filled

BTF 01 Issue 0, September 2023. Calculations according to BS EN 673:2011

Number of spaces		1	
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Glazing orientation		Vertical	
Resistivity panes	1	m·K/W	

Outside		Spaces 1	
90%		Gas	
Argon		Gas	
Thickness (mm)	4.0	16	4.0
Normal emissivity	0.89	0.01	
$\sum d_i \cdot r_i =$	0.008	Uncoated	

For uncoated surfaces input 0.89 for normal emissivity, which corresponds to a corrected emissivity of 0.837

External, R_{se}	0.04	$(m^2 \cdot K)/W$
Internal, R_{si}	0.13	$(m^2 \cdot K)/W$

Iteration number	U value	$\sum 1/h_s$
	$W/(m^2 \cdot K)$	$(m^2 \cdot K)/W$
1	1.045	0.77939
2	1.045	0.77939

λ_{eff}	ΔT
$W/(mK)$	
0.0205	15
0.0205	15

G-Value Data



4 (16 Argon 90) 4 [Swisspacer Advance]

Coating: PLANITHERM ONE T FG #3

Computed by: Sue Peatey

Computed on: 12/02/2025

Product catalog: United Kingdom

Norms: EN410:2011

Glazing type



Glazing 1

PLANICLEAR (4mm) - Annealed



Cavity 1

Argon 90% 16 mm
Swisspacer Advance



Glazing 2

PLANITHERM ONE T FG
PLANICLEAR (4mm) - Annealed



Swisspacer Advance

Psi-values (Ψ_g) for double glazing

For windows

Metal with thermal break	0.047 W/(m.K)
Plastic	0.039 W/(m.K)
Wood	0.039 W/(m.K)
Wood / Metal	0.042 W/(m.K)

For facade profiles

Wood / Metal	0.066 W/(m.K)
Metal with thermal break (di = 100mm)	0.088 W/(m.K)
Metal with thermal break (di = 200mm)	0.093 W/(m.K)

Source: ift Rosenheim directive WA-08/3 and WA-22/2 ("Warm edge" working group) / Bundesverband Flachglas (German Flat Glass Association) window data sheets

Simulated performance datas

Luminous Factors	CIE015:2018
Light Transmittance (TL)	67%
Outdoor Reflectance (RLe)	25%
Indoor Reflectance (RLi)	25%
Energy Factors	EN410:2011
Transmittance (TE)	43%
Outdoor Reflectance (Ree)	42%
Indoor Reflectance (Rei)	40%
Absorptance A1 (AE1)	8%
Absorptance A2 (AE2)	7%
Solar Factors	EN410:2011
Solar Factor (g)	0.49
Shading Coefficient (SC)	0.57
Thermal Transmission	EN673:2011
Ug	1.0 W/(m2.K)
Angle relative to the vertical	0°
Acoustics	EN 12758
<i>Acoustic measurement values according to EN 12758 and from notified body</i>	
Rw (C;Ctr)	31 (-1; -4) dB
Ra	30 dB
Ra,tr	27 dB
STC (ASTM E413)	N/A
OITC (ASTM E1332)	N/A
Color Rendering	CIE015:2018
Transmission (Ra)	97.1
Reflection (Ra)	96
Safety Class	EN12600
Pendulum Body Resistance	NPD
Anti-Burglary	EN356
Burglar Resistance	NPD
Manufacturing Sizes	
Nominal Thickness	24.0 mm
Weight	20 kg/m ²
Sustainability	
Carbon footprint	
<i>The value is calculated regarding the composition computed based on the standard EN 15804+A2 (2019)</i>	
Global Warming Potential (GWP) - A1-A3	EN 15804+A2 (2019)
(kg, CO ₂ eq./m ²) European average	33

Conductivity of Spacer

August 2014 – No. W24 – Revision index 7-01/2025 – valid until June 30th, 2025

'WARM EDGE' WORKING PARTY

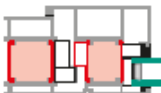
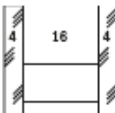
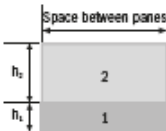


Data sheet Psi values for windows

based on determination of the equivalent thermal conductivity of spacers by measurement



SWISSPACER
Vetrotech Saint-Gobain (International) AG
Industriestrasse 8
CH-8574 Lengwil

	Product name	Spacer height in mm		Material	Thickness d in mm
Profile description		6.5	Spacer category C	Thermally improved aluminium foil / SAN-GF	- 0.02
					1.0
Representative frame profiles	Representative glass constructions	Metal with thermal break	Plastic	Wood	Wood/Metal
					
Representative psi value double-sheet thermally insulating glass W/mK	 Double-sheet insulating glass $U_g=1.1 \text{ W/m}^2\text{K}$	0.047	0.039	0.039	0.042
Representative psi value triple-sheet thermally insulating glass W/mK	 Triple-sheet insulating glass $U_g=0.7 \text{ W/m}^2\text{K}$	0.042	0.037	0.037	0.040
Two box model Characteristic values		Space between panes in mm	$\lambda_{eq,2B}$ in W/mK		
			Box 1 · $h_1 = 3 \text{ mm}$	Box 2 · $h_2 = 6.5 \text{ mm}$	
		Can be used for all spacer widths	0.40	0.29	

Explanations

The equivalent thermal conductivity has been determined in accordance with the ift guideline WA-17engl/ 1 "Thermally improved spacers - Determination of the equivalent thermal conductivity by measurement". The representative linear heat transfer coefficients calculated in this way (representative psi values) apply to typical frame profiles and glazing for the determination of the heat transfer coefficient U_w of windows. They have been determined under the boundary conditions (frame profiles, glazing, glass mounting depth, back covering, primary and secondary sealant) defined in the ift guideline WA-08engl/3 "Thermally improved spacers - Part 1: Determination of the representative Psi value for window frame profiles". This guideline also governs the area of validity and application of the representative psi values. In order to avoid rounding errors, the psi values in the data sheet have been given at 0.001 W/mK. The method for the arithmetical determination of the psi values has an accuracy of $\pm 0.003 \text{ W/mK}$. Differences of less than 0.005 W/mK are not significant. For further information, refer to the Bulletin 004/2008 "Guide to Warm Edge" of Bundesverband Flachglas.

Characteristic values determined by:

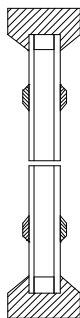


Appendix – Thermal transmittance for windows with bars

Where the window is fitted with bars the following thermal transmittance values will apply, following the principles of Annex J of BS EN 14351-1.

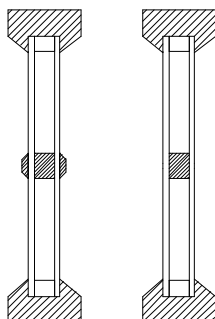
1. Attached bar(s)

Window with attached bar(s)	1.3 W/m ² K
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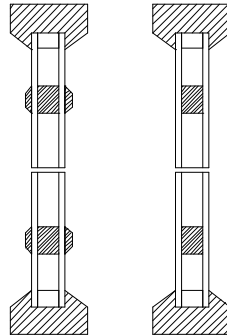
2. Single cross bar in the IGU with or without attached bars

Window with single cross bar in the IGU with or without attached bars	1.4 W/m ² K
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3. Multiple cross bars in the IGU with or without attached bars

Window with multiple cross bars in the IGU with or without attached multiple bars	1.5 W/m ² K
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4. Glazing bar (Georgian bar)

Window with glazing bar (Georgian bar)	1.7 W/m ² K
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