BFRC, Unit A2, Access 442, Silkin Way, Hadley Park East, Telford TF1 6QX
enquiries@bfrc.org
+44 (0) 20 7403 9200

Calculation of Thermal Transmittance

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

Thermal Performance of Windows, Doors & Shutters

CONFIDENTIAL

Report reference:	U25-008-7A
Prepared for:	Bereco Ltd Unit 5 Aspen Court Centurion Business Park Rotherham, S60 1FB
Project:	Tilt and Turn Window
Issued by:	Sue Peatey
Issue date:	9 April 2025

20057

Any opinions and interpretations expressed in this report are outside the scope of UKAS accreditation.

The results in this report relate only to the products calculated and technical drawings received and do not necessarily relate to samples from the production line of the above named company. This report does not constitute in any way a warranty or representation to the performance or quality of the said product. The above named company has supplied all technical specifications. BFRC and its representatives accept no liability for misuse of this report.

1 Introduction

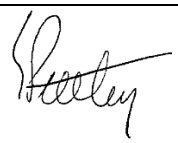
This document details the thermal performance calculation of the window configuration as detailed below.

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

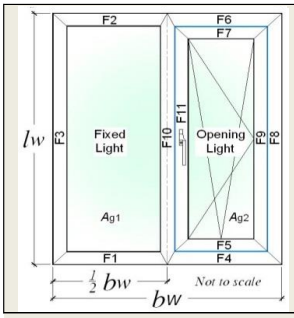
3.2 Frame thermal transmittance and linear thermal transmittance (in accordance with BS EN ISO 10077-1: 2017)

Frame Profile	Frame Thermal Transmittance (U_f)	Linear Thermal Transmittance (ψ)
Fixed Sill	1.4 W/m²K	0.043 W/m.K
Fixed Head	1.4 W/m²K	0.043 W/m.K
Fixed Jamb	1.4 W/m²K	0.043 W/m.K
Opening Sill	1.4 W/m²K	0.043 W/m.K
Opening Head	1.4 W/m²K	0.044 W/m.K
Opening Jamb	1.4 W/m²K	0.044 W/m.K
Mullion	1.4 W/m²K	0.086 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^2K

4. U-value calculation



Sample Style:
Casement

Fixed Light / Tilt+Turn

Report Number:	U25-008-7	Issue No 1.0: *04/02/2025*
Report Date:	02 April 2025	
Project Details:	Timber tilt and turn window	

This spreadsheet is the property of BFRC and is not valid unless approved by BFRC testing

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

Parameter	Symbol		Units
Total window height ***0DP***	l_w	1480	mm
Total window width ***0DP***	b_w	1537.5	mm

Frame offset:	No

Nominal 4mm etc to ***0DP***, 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/(m²·K)
g -value - ***2DP*** $g_\perp$	0.49	

Thermal transmittance of window from hot box test		
U_w - *2DP*		W/(m²·K)

Frame dimensions:	(b_f)	Frame width, b_f (mm)	Gasket protrusion, b_{gf} (mm)	Frame & gasket widths (mm)	
All frame values round to nearest 1mm, gaskets to ***1DP***	F1 fixed sill	133	0.4	133.4	
	F2 fixed head	118	0.4	118.4	
	F3 fixed jamb	80	0.4	80.4	Total
F4 + F5 sash sill	F4 fixed sash sill	53	n/a	53.0	133.4
	F5 moving sash sill	80	0.4	80.4	
F6 + F7 sash head	F6 fixed sash head	38	n/a	38.0	118.4
	F7 moving sash head	80	0.4	80.4	
F8 + F9 sash jamb	F8 Fixed sash jamb	38	n/a	38.0	118.4
	F9 moving sash jamb	80	0.4	80.4	
F10 + F11 mullion	F10 fixed mullion	63	0.4	63.4	143.8
	F11 moving mullion	80	0.4	80.4	
	Total gasket area	0.0029223		m^2	

Window Dimensions:			Area	
Section	Length (m)	Width (m)	No gasket (m^2)	With gasket (m^2)
Fixed Light	1.2290	0.6573	0.8078	0.8063
Opening light	1.2290	0.5393	0.6627	0.6613
Total glazing, A_g			1.4705	1.4676
Frame	(m)	(m)	(m^2)	(m^2)
F1	0.7688	0.1330	0.0948	0.0951
F2	0.7688	0.1180	0.0841	0.0844
F3	1.4800	0.0800	0.1084	0.1089
F4	0.7688	0.0530	0.0279	0.0279
F5	0.6993	0.0800	0.0495	0.0498
F6	0.7688	0.0380	0.0389	0.0389
F7	0.6993	0.0800	0.0495	0.0498
F8	1.4800	0.0380	0.0545	0.0545
F9	1.3890	0.0800	0.1047	0.1052
F10	1.4800	0.0630	0.0879	0.0883
F11	1.3890	0.0800	0.1047	0.1052
Total Frame			0.8050	0.8079
Total Window, A_w			2.2755	2.2755
Percentage fixed light glass area			35.50%	35.43%
Percentage opening light glass area			29.12%	29.06%
Percentage glass area (total)			64.62%	64.49%

Where a *Uw* 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 ***0DP***				
	L_f^{2D} W/(m·K)	b_p (mm)		L_ψ^{2D} W/(m·K)	b_g (mm)
F1 fixed sill	**0.4119**	**190**		**0.4313**	**190**
F2 fixed head	**0.3898**	190		**0.4092**	190
F3 fixed jamb	**0.3363**	190		**0.3557**	190
F4 + F5 sash sill	**0.4107**	190		**0.4306**	190
F6 + F7 sash head	**0.3837**	190		**0.4038**	190
F8 + F9 sash jamb	**0.3837**	190		**0.4038**	190
F10 + F11 mullion	**0.6445**	380		**0.6838**	380

Frame: Section	Frame width, b_f (m)	Frame U-value, U_f (W/(m²·K))	Frame areas, A_f (m^2)	Frame heat flow, HU (W/K)	Linear trans, Ψ (W/(m·K))	Linear length, l_g (m)	Junction heat flow, Hψ (W/K)
F1 fixed sill	0.1330	1.4275	0.0948	0.1354	0.0429	0.6573	0.0282
F2 fixed head	0.1180	1.4217	0.0841	0.1196	0.0429	0.6573	0.0282
F3 fixed jamb	0.0800	1.4283	0.1084	0.1548	0.0429	1.2290	0.0527
F4 + F5 sash sill	0.1330	1.4185	0.0774	0.1098	0.0434	0.5393	0.0234
F6 + F7 sash head	0.1180	1.3700	0.0884	0.1212	0.0436	0.5393	0.0235
F8 + F9 sash jamb	0.1180	1.3700	0.1592	0.2182	0.0436	1.2290	0.0536
F10 + F11 mullion	0.1430	1.4016	0.1926	0.2699	0.0863	1.2290	0.1060
		Totals	0.8050	1.1288		Total	0.3156

Solar Factor, *g*-value:		
	F_w	0.9
	g_w	0.28

Other parameters needed for calculation, taken from simulations:

λ_p =	0.035	W/(m·K)	R_{se} =	0.04	m²·K /W	$d_p=d_g$ =	0.024 m
R_p =	0.6857	m²·K /W	R_{tot} =	0.8557	m²·K /W	R_{se} =	0.13 m²·K /W
						U_p =	1.1686 W/(m²·K)

U_{window}			
	No bars; or attached bars	1.31	W/(m²·K)
	Single cross bar in IGU	1.4	
	Multiple cross bar in IGU	1.5	
	Glazing bar (Georgian bar)	1.7	

Thermal transmittance, W/(m²·K)	U_{window}	1.3
Solar factor	g_{window}	0.28

BFRC Certified Simulator No

Simulator Name: Sue Peatey — **S166**

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

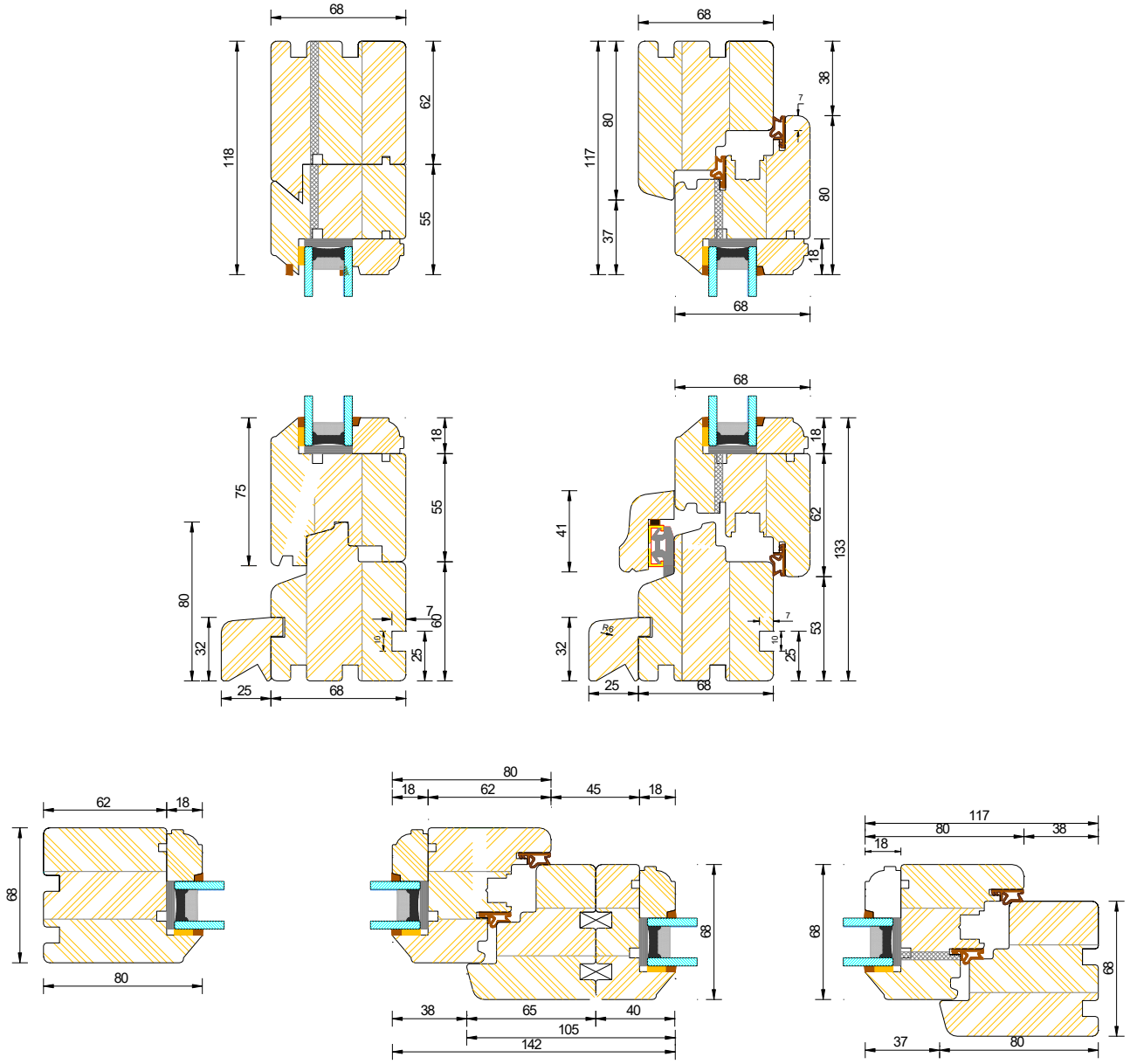
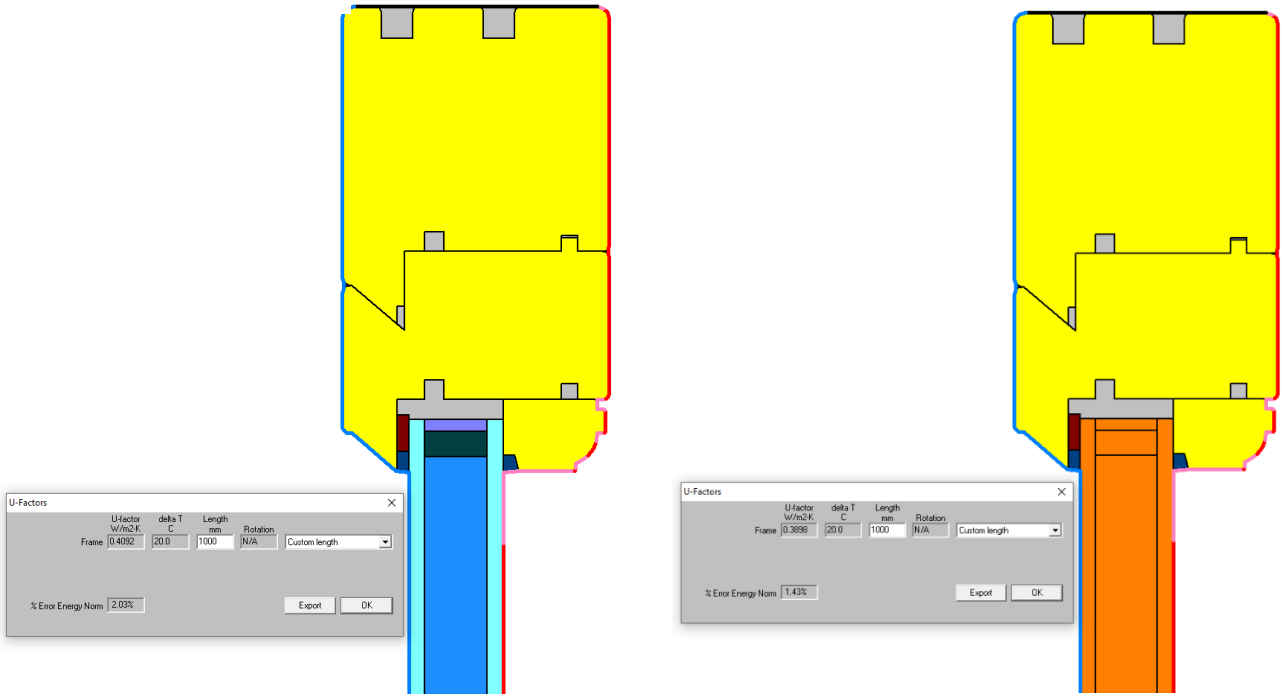


Figure 2. Simulation of fixed head profile

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

Internal Environment
R_{si} Normal = 0.13 m^2K/W
R_{si} Reduced = 0.20 m^2K/W
Temperature = 20 ^0C

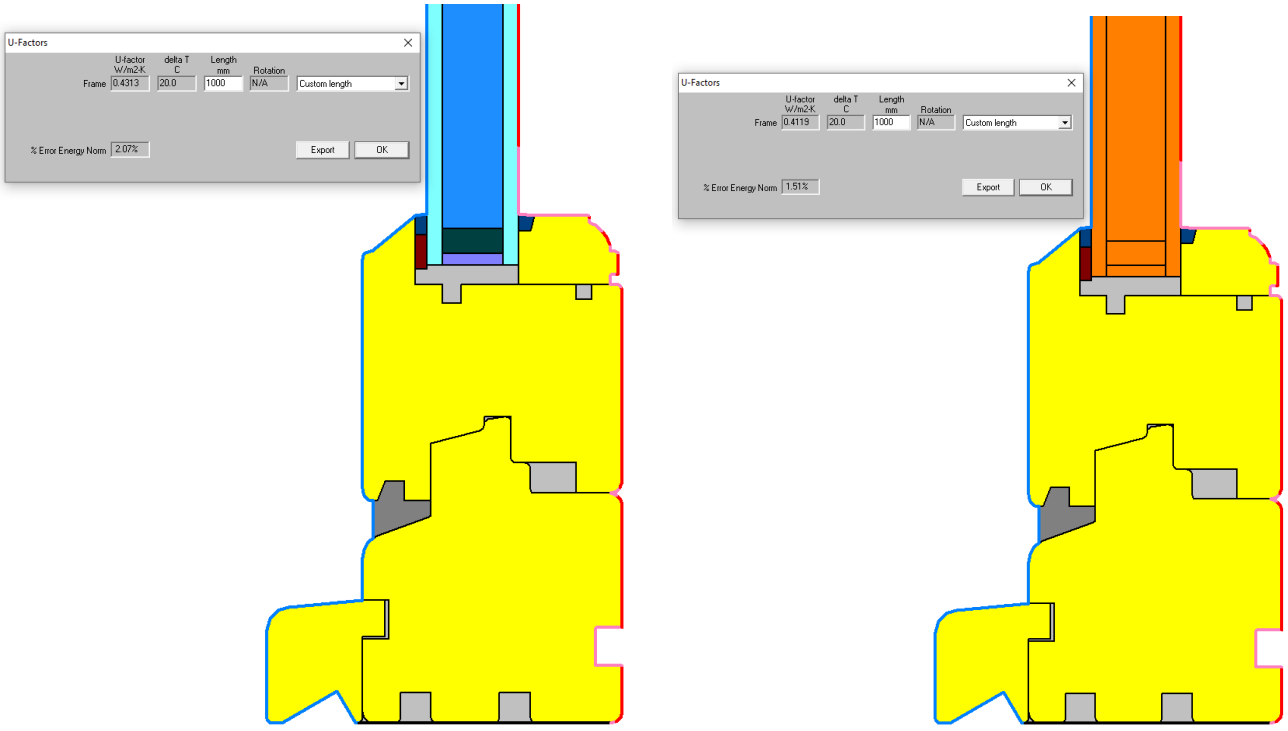


Quad Tree Mesh Parameter 9

Figure 3. Simulation of fixed sill profile.

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

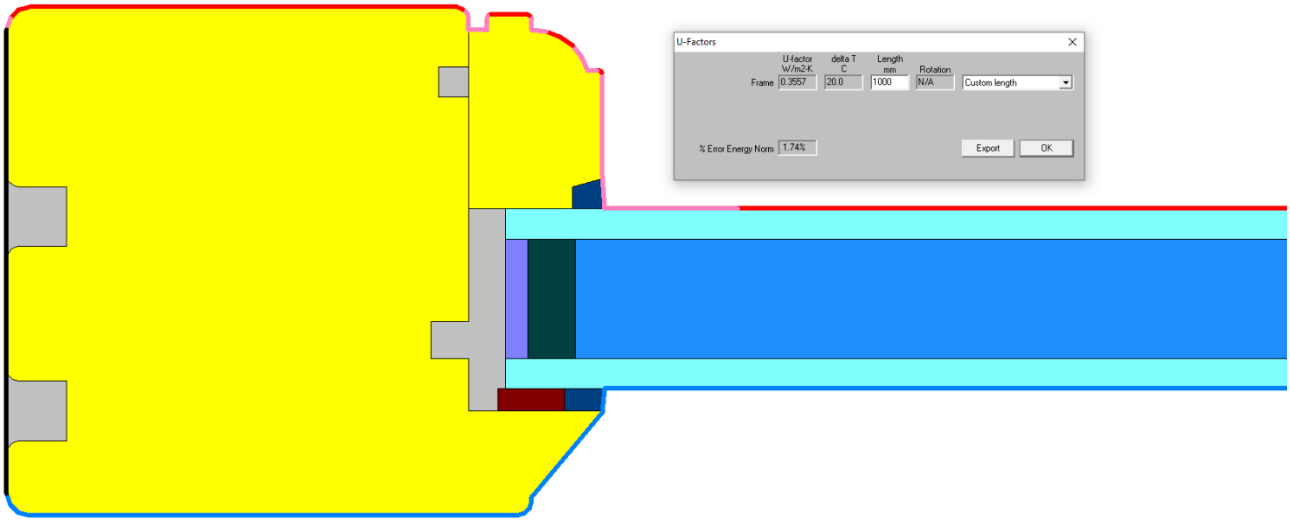
Internal Environment
R_{si} Normal = 0.13 m^2K/W
R_{si} Reduced = 0.20 m^2K/W
Temperature = 20 ^0C



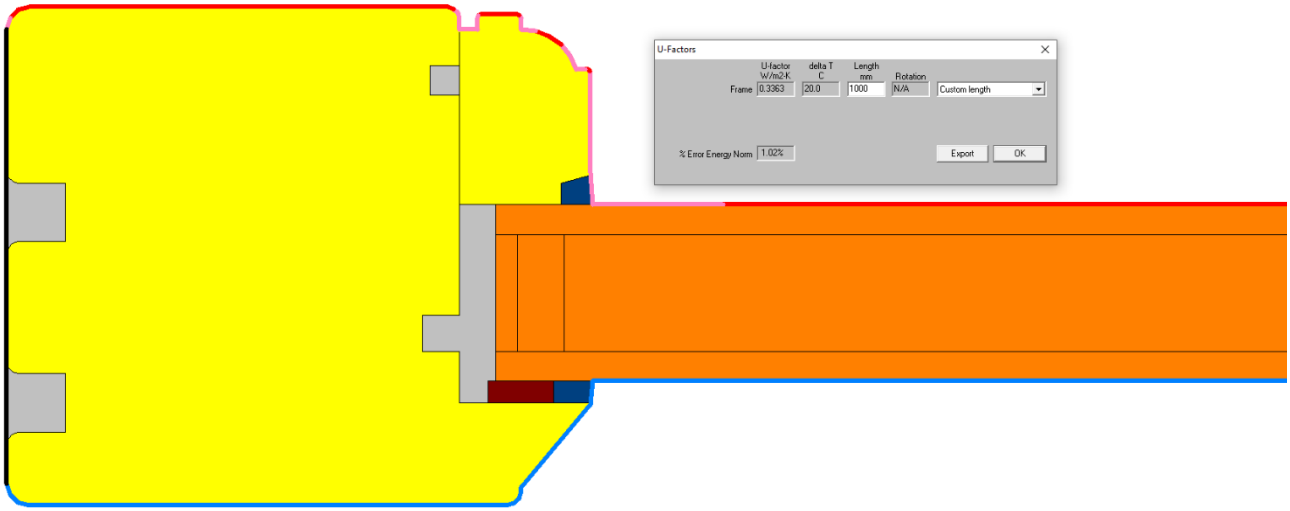
Quad Tree Mesh Parameter 9

Figure 4. Simulation of fixed jamb profile.

Internal Environment
R_{si} Normal = 0.13 m^2K/W
R_{si} Reduced = 0.20 m^2K/W
Temperature = 20 ^0C



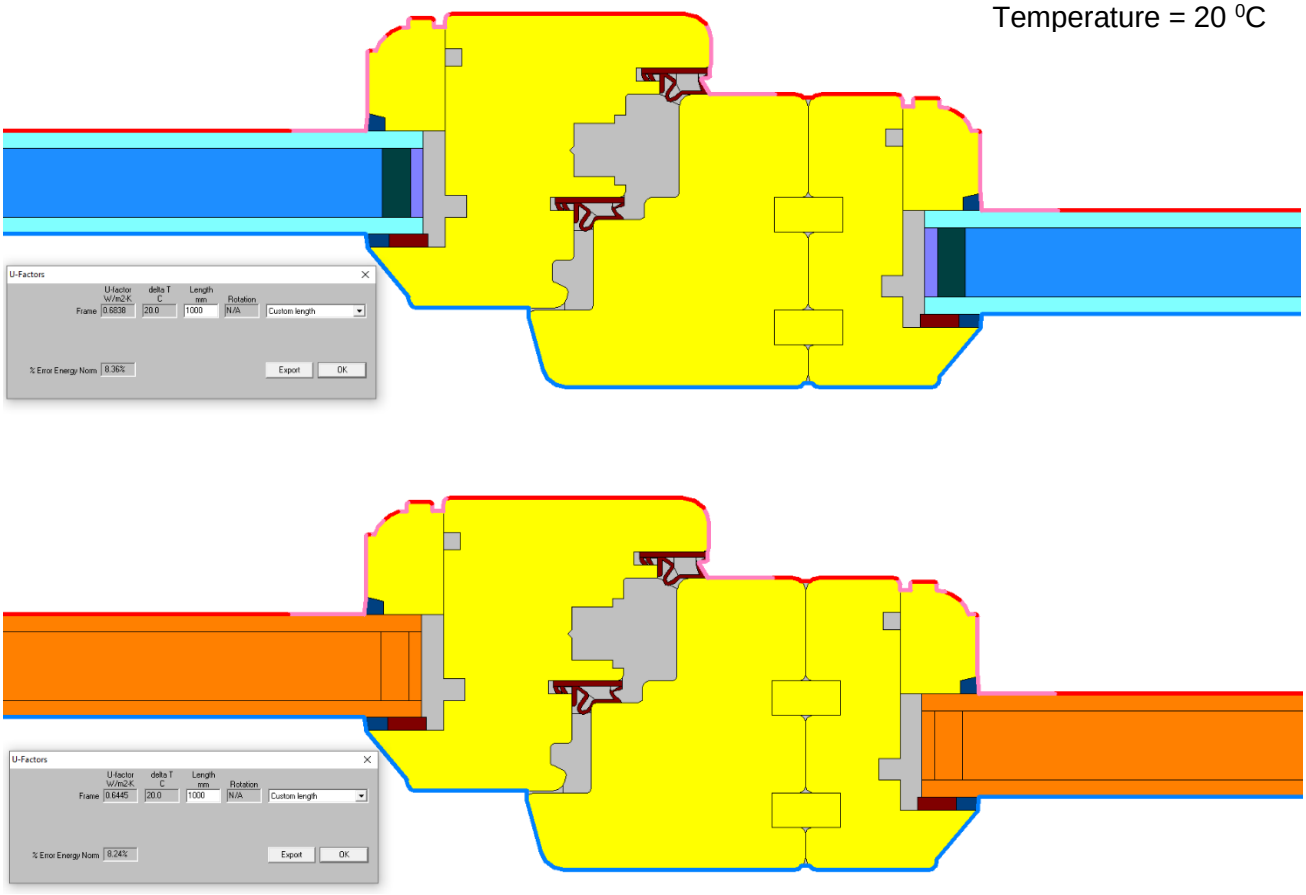
Quad Tree Mesh Parameter 9



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

Figure 5. Simulation of mullion profile.

Internal Environment
R_{si} Normal = 0.13 m^2K/W
R_{si} Reduced = 0.20 m^2K/W
Temperature = 20 ^0C



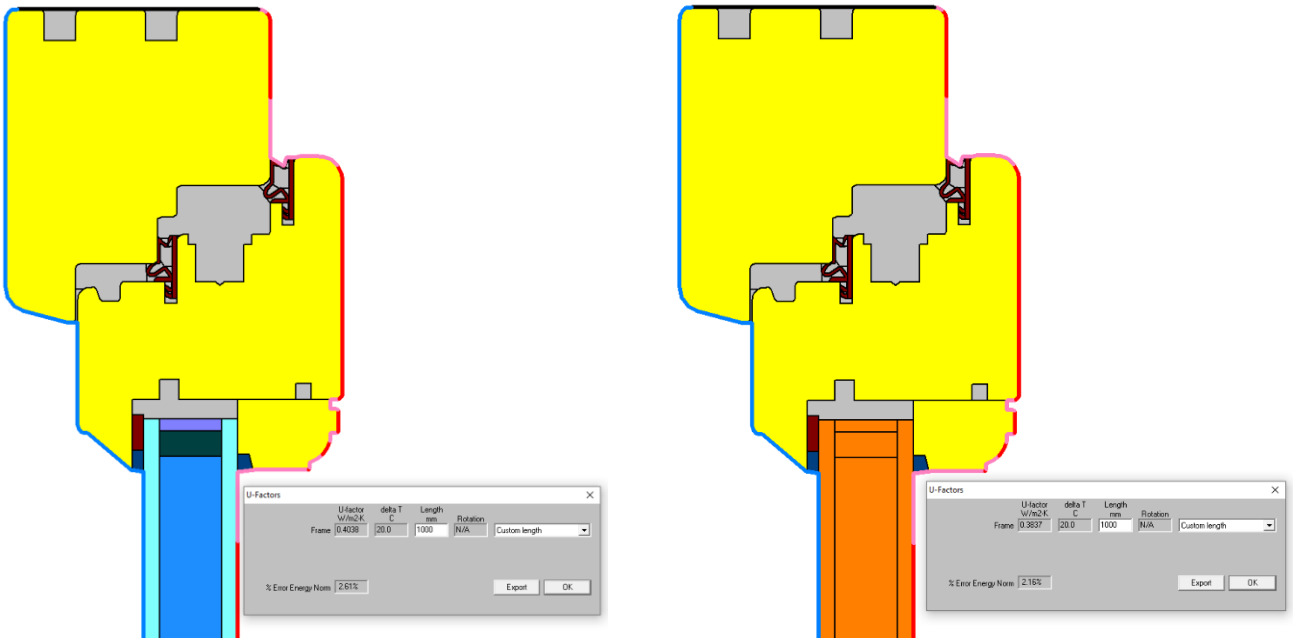
External Environment
R_{si} Normal = 0.04 m^2K/W
R_{si} Reduced = 0.04 m^2K/W
Temperature = 0 ^0C

Quad Tree Mesh Parameter 9

Figure 6. Simulation of opening head and jamb profile

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

Internal Environment
R_{si} Normal = 0.13 m^2K/W
R_{si} Reduced = 0.20 m^2K/W
Temperature = 20 ^0C

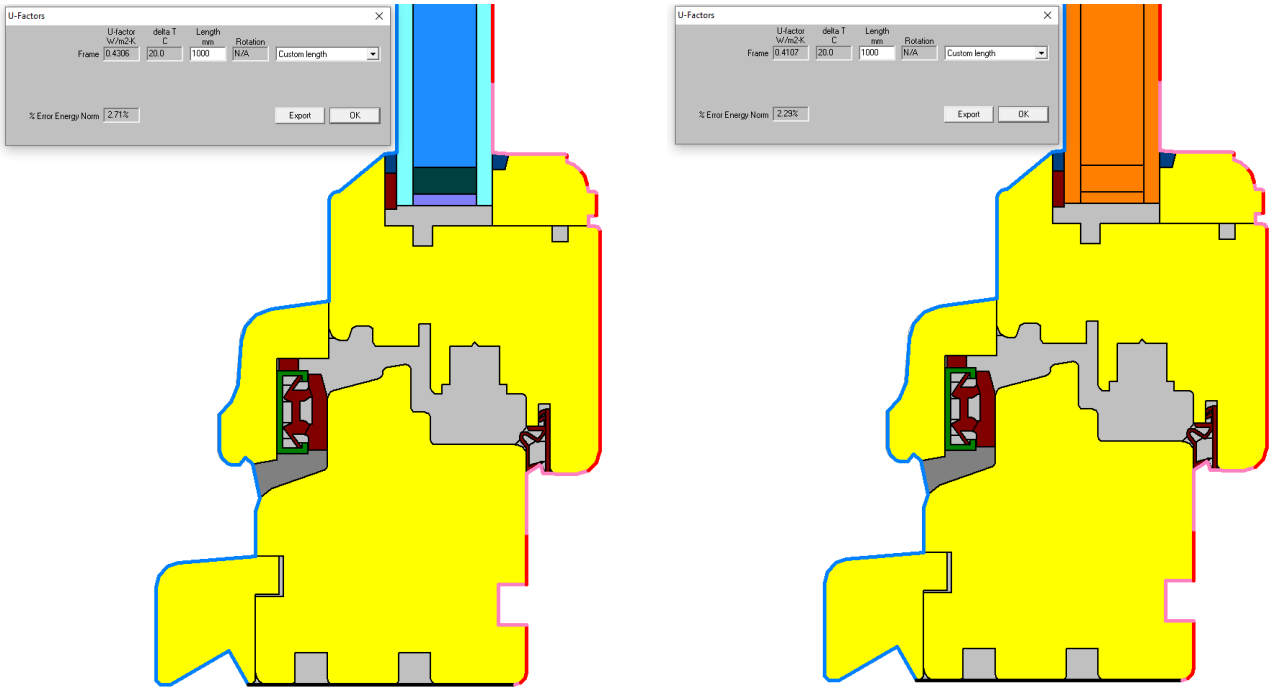


Quad Tree Mesh Parameter 9

Figure 7. Simulation of opening sill profile.

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

Internal Environment
R_{si} Normal = 0.13 m^2K/W
R_{si} Reduced = 0.20 m^2K/W
Temperature = 20 ^0C



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 15)
	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
	PVC-U rigid	0.17	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

Spaces 1

Glazing orientation		
	Vertical	
Resistivity panes	1	m·K/W

Outside

	Pane 1		Pane 2
		90%	
Gas		Gas	
		Argon	
Thickness (mm)	4.0	16	4.0
Normal emissivity		0.89	0.01
$\sum d_j \cdot r_j$ =	0.008	Uncoated	

Calculate

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	$\sum 1/h_s$	λeff	ΔT
	$W/(m^2 \cdot K)$	$(m^2 \cdot K)/W$	W/(mK)	
1	1.045	0.77939	0.0205	15
2	1.045	0.77939	0.0205	15

G-Value Data

Calumen

SAINT-GOBAIN

4 (16 Argon 90) 4 [Swisspacer Advance]

Coating: PLANITHERM ONE T FG #3

Computed by: Sue Peatey | Computed on: 02/04/2025 | 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

Swisspacer Advance
Psi-values (Ψg) 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**
Acoustic measurement values according to EN 12758 and from notified body	
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/m²
Sustainability	
Carbon footprint	
The value is calculated regarding the composition computed based on the standard EN 15804+A2 (2019)	
Global Warming Potential (GWP) – A1-A3	**EN 15804+A2 (2019)**
(kg, CO_2 eq./m²) European average	33

BFRC TESTING

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

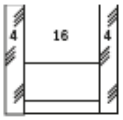
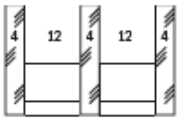
based on determination of the equivalent thermal conductivity of spacers by measurement

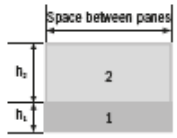
swisspacer SAINT-GOBAIN

swisspacer

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

	Product name	Spacer height h in mm	Material	Thickness d in mm
Profile description	ADVANCE 	6.5 Spacer category C	Thermally improved aluminium foil / SAN-GF	– 0.02 1.0

	Representative glass constructions	Metal with thermal break	Plastic	Wood	Wood/Metal
Representative frame profiles					
Representative psi value double-sheet thermally insulating glass W/mK	 Double-sheet insulating glass U_g=1.1 W/m²K	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 W/m²K	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 mm	Box 2 · h_2 = 6.5 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 ± 0.003 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:

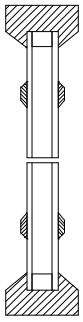
ift ROSENHEIM

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.

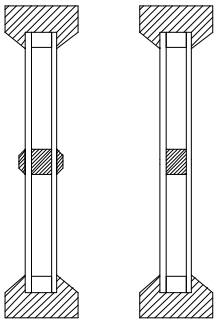
1. Attached bar(s)

Window with attached bar(s)	**1.3 W/m^{2}K**



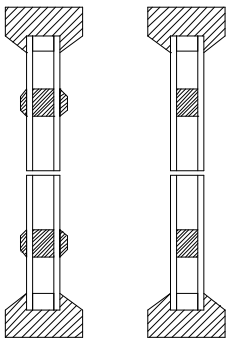
2. Single cross bar in the IGU with or without attached bars

Window with single cross bar in the IGU with or without attached bars	**1.4 W/m^{2}K**



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**



4. Glazing bar (Georgian bar)

Window with glazing bar (Georgian bar)	**1.7 W/m^{2}K**