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Calculation of Thermal Transmittance

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

Thermal Performance of Windows, Doors & Shutters

CONFIDENTIAL

Report reference:	U25-008-3A
Prepared for:	Bereco Ltd Unit 5 Aspen Court Centurion Business Park Rotherham, S60 1FB
Project:	Spiral Balance Vertical Sliding Sash Window
Issued by:	Sue Peatey
Issue date:	27 March 2025

20057

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1 Introduction

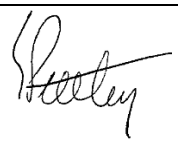
This document details the thermal performance calculation of the window configuration as detailed below.

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

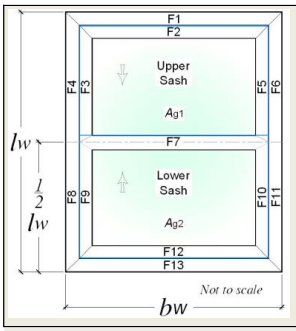
3.2 Frame thermal transmittance and linear thermal transmittance (in accordance with BS EN ISO 10077-1: 2017)

Frame Profile	Frame Thermal Transmittance (U_f)	Linear Thermal Transmittance (ψ)
Head	1.4 W/m²K	0.045 W/m.K
Upper Jambs	1.3 W/m²K	0.045 W/m.K
Mid Rail	3.6 W/m²K	0.091 W/m.K
Lower Jambs	1.3 W/m²K	0.045 W/m.K
Sill	1.3 W/m²K	0.045 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:

Vertical Sliding Sash

Report Number: U25-008-3 Report Issue No.1.1: 11/02/2025
Report Date: 20/02/2025
Project Details: Spiral Balance Sliding sash 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 place 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, d_{p1}	**4.0**	mm
Glazing fill thickness 1/2, d_{gf1}	**16.0**	mm
Gas fill (1/2)	**Argon 90%**	
Thickness of pane 2, d_{p2}	**4.0**	mm
Complete next 3 cells for TG IGU		
Glazing fill thickness 2/2, d_{gf2}		mm
Gas fill (2/3)		
Thickness of pane 3, d_{p3}		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)

Window Dimensions:			Area, A	
Section	Length, l (m)	Width, b (m)	No gasket (m²)	With gasket (m²)
Upper glazing	0.6210	1.3395	0.8318	0.8301
Lower glazing	0.6020	1.3395	0.8064	0.8047
Total of glazing			1.6382	1.6348
Frame	m	m	m²	m²
F1	1.5375	0.0560	0.0830	0.0830
F2	1.4255	0.0430	0.0594	0.0600
F3	0.6840	0.0430	0.0281	0.0284
F4	0.7400	0.0560	0.0399	0.0399
F5	0.6840	0.0430	0.0281	0.0284
F6	0.7400	0.0560	0.0399	0.0399
F7	1.4255	0.0400	0.0553	0.0564
F8	0.7400	0.0560	0.0395	0.0395
F9	0.6720	0.0430	0.0274	0.0277
F10	0.6720	0.0430	0.0274	0.0277
F11	0.7400	0.0560	0.0395	0.0395
F12	1.4255	0.0500	0.0691	0.0697
F13	1.5375	0.0680	0.1007	0.1007
Total Frame			0.6373	0.6407
Total Window, Aw			2.2755	2.2755
Percentage upper glass area			36.56%	36.48%
Percentage lower glass area			35.44%	35.36%
Percentage glass area (total)			71.99%	71.85%

Solar Factor, *g* -value:		
glazing area A_g (m²)		1.7151
F_w		0.9
g_w		0.33

U_{window}			
	No bars; or attached bars	**1.34**	W/(m²·K)
	Single cross bar in IGU	**1.4**	
	Multiple cross bar in IGU	**1.5**	
	Glazing bar (Georgian bar)	**1.7**	

Frame dimensions (All frame values to 0dp, gaskets to 1DP)		Frame height, b_f (mm)	Gasket protrusion (mm)	With gasket (mm)	Total
F1 fixed top rail		**56**	n/a	56.0	99.4
F2 moving top rail		**43**	**0.4**	43.4	
F3 top (LH) jamb (moving sash)		**43**	**0.5**	43.5	99.5
F4 top (LH) jamb (fixed frame)		**56**	n/a	56.0	
F5 top (RH) jamb (moving sash)		**43**	**0.5**	43.5	99.5
F6 top (RH) jamb (fixed frame)		**56**	n/a	56.0	
F7 mid rail	(upper)	**40**	**0.4**	40.8	40.8
	(lower)		**0.4**		
F8 bottom (LH) jamb (fixed frame)		**56**	n/a	56.0	99.5
F9 bottom (LH) jamb (moving sash)		**43**	**0.5**	43.5	
F10 bottom (RH) jamb (moving sash)		**43**	**0.5**	43.5	99.5
F11 bottom (RH) jamb (fixed frame)		**56**	n/a	56.0	
F12 bottom moving rail		**50**	**0.4**	50.4	118.4
F13 bottom fixed rail		**68**	n/a	68.0	
Total gasket area			0.0033646	m^2	

Where a *Uw* value from hot box testing is available, no $L_f{}^{2D}$ or $L_\psi{}^{2D}$ 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)		$L_\psi{}^{2D}$ W/(m·K)	b_g (mm)
F1+F2 top rail	**0.3603**	**190**		**0.3818**	190
F3+F4 top (LH) jamb	**0.3516**	190		**0.3733**	190
F5+F6 top (RH) jamb	**0.3516**	190		**0.3733**	190
F7 mid rail	**0.5883**	380		**0.6323**	380
F8+F9 bottom (LH) jamb	**0.3510**	190		**0.3729**	190
F10+F11 bottom (RH) jamb	**0.3510**	190		**0.3729**	190
F12+F13 bottom rail	**0.3807**	190		**0.4026**	190

Frame: Section	Frame width, b_f (m)	Frame U-value, U_f W/(m²·K)	Frame areas, A_f m²	Frame heat flow, HU W/K	Linear trans, Ψ W/(m·K)	Linear length, l_g m	Junction heat flow, Hψ W/K
F1+F2 top rail	0.0990	1.3966	0.1424	0.1989	0.0450	1.3395	0.0603
F3+F4 top left jamb	0.0990	1.3087	0.0679	0.0889	0.0452	0.6210	0.0281
F5+F6 top right jamb	0.0990	1.3087	0.0679	0.0889	0.0452	0.6210	0.0281
F7 mid rail	0.0400	3.6057	0.0553	0.1994	0.0910	1.3395	0.1219
F8+F9 btm left jamb	0.0990	1.3027	0.0669	0.0872	0.0454	0.6020	0.0273
F10+F11 btm right jamb	0.0990	1.3027	0.0669	0.0872	0.0454	0.6020	0.0273
F12+F13 bottom rail	0.1180	1.3446	0.1699	0.2284	0.0454	1.3395	0.0608
Totals			0.6373	0.9789	Total		0.3537

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)

Thermal transmittance, W/(m²·K)	U_{window}	**1.3**
Solar factor	g_{window}	**0.33**

Simulator Name: Sue Peatey

BFRC Certified Simulator No S166

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

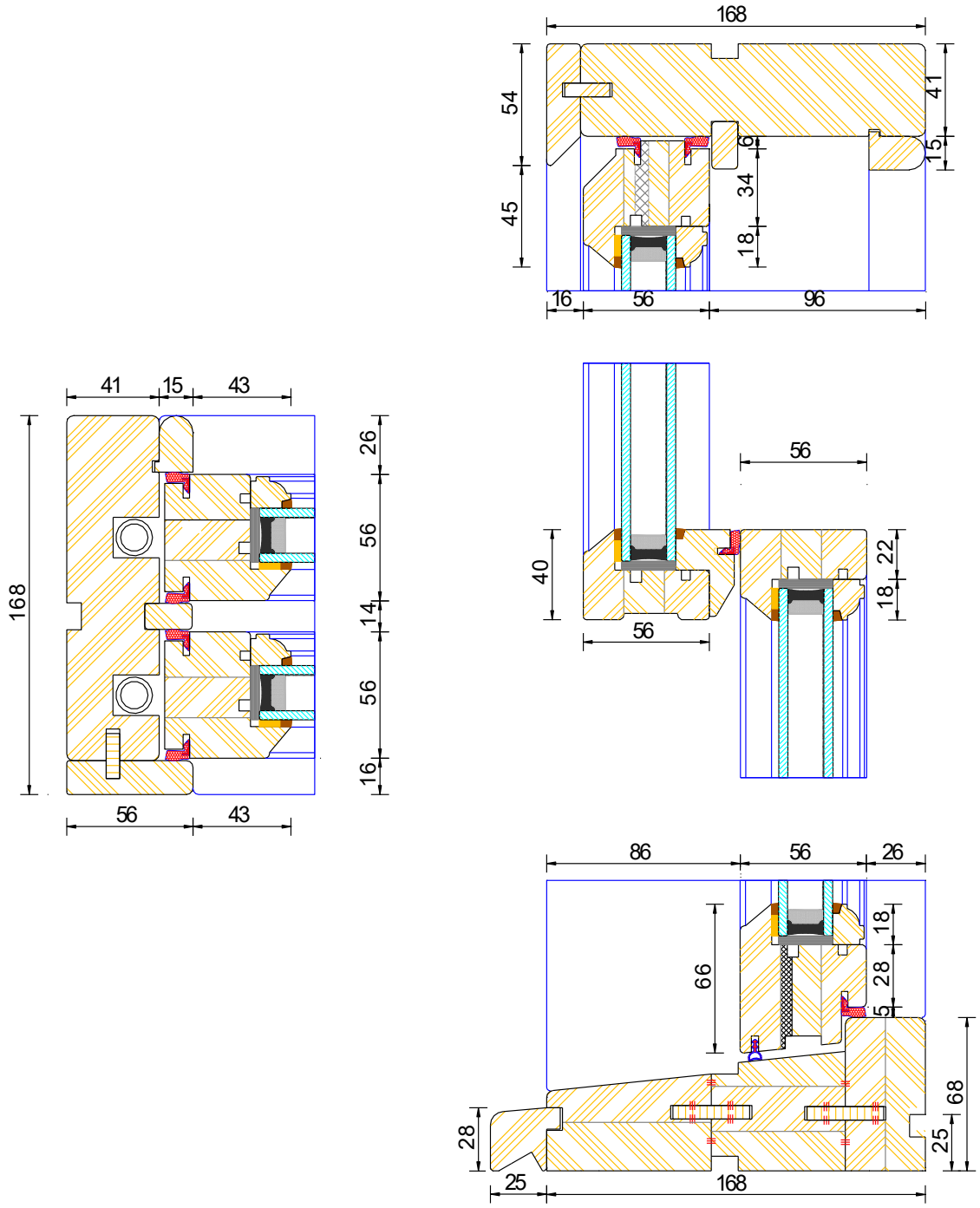
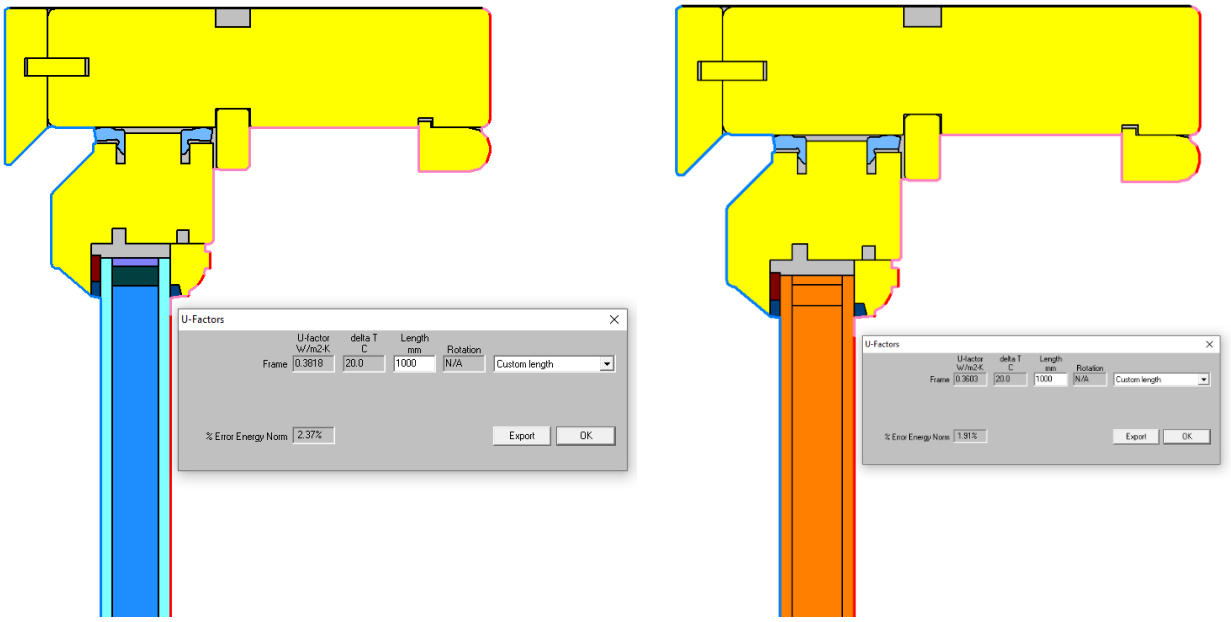


Figure 2. Simulation of head profile

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

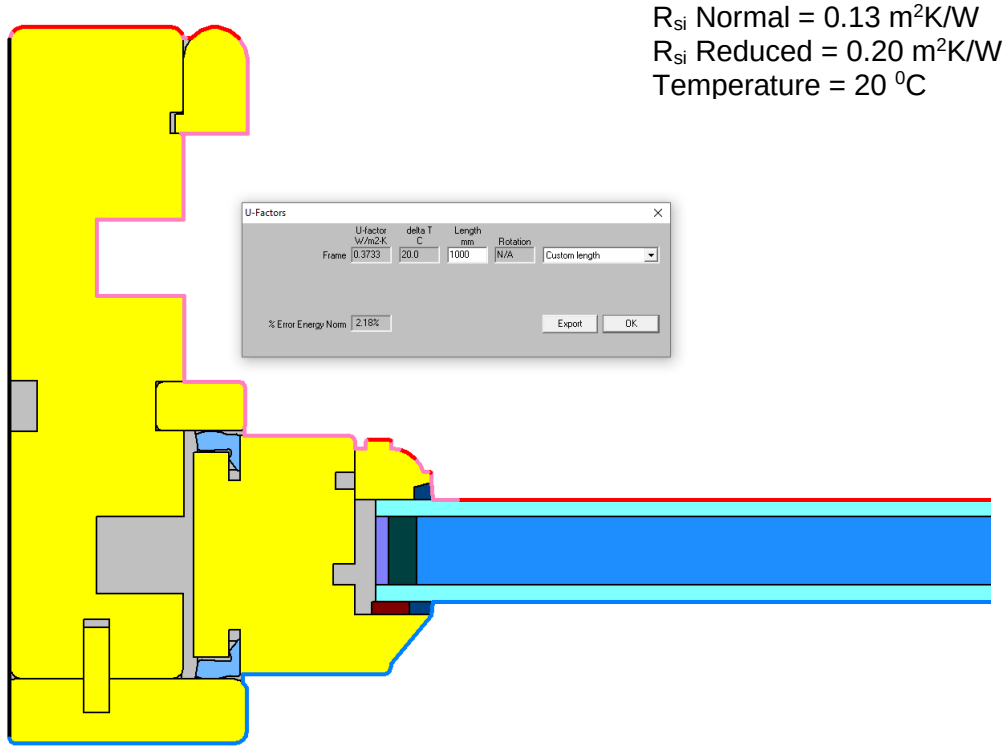
Internal Environment
R_{si} Normal = 0.13 m^2K/W
R_{si} Reduced = 0.20 m^2K/W
Temperature = 20 ^0C



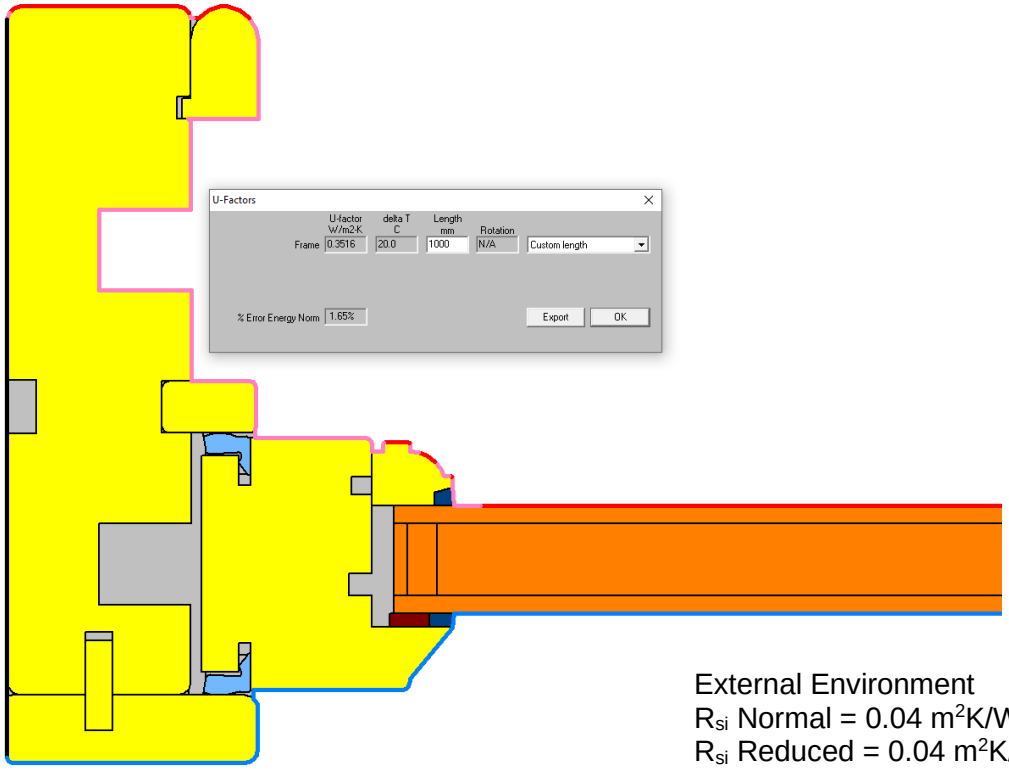
Quad Tree Mesh Parameter 9

Figure 3. Simulation of upper 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

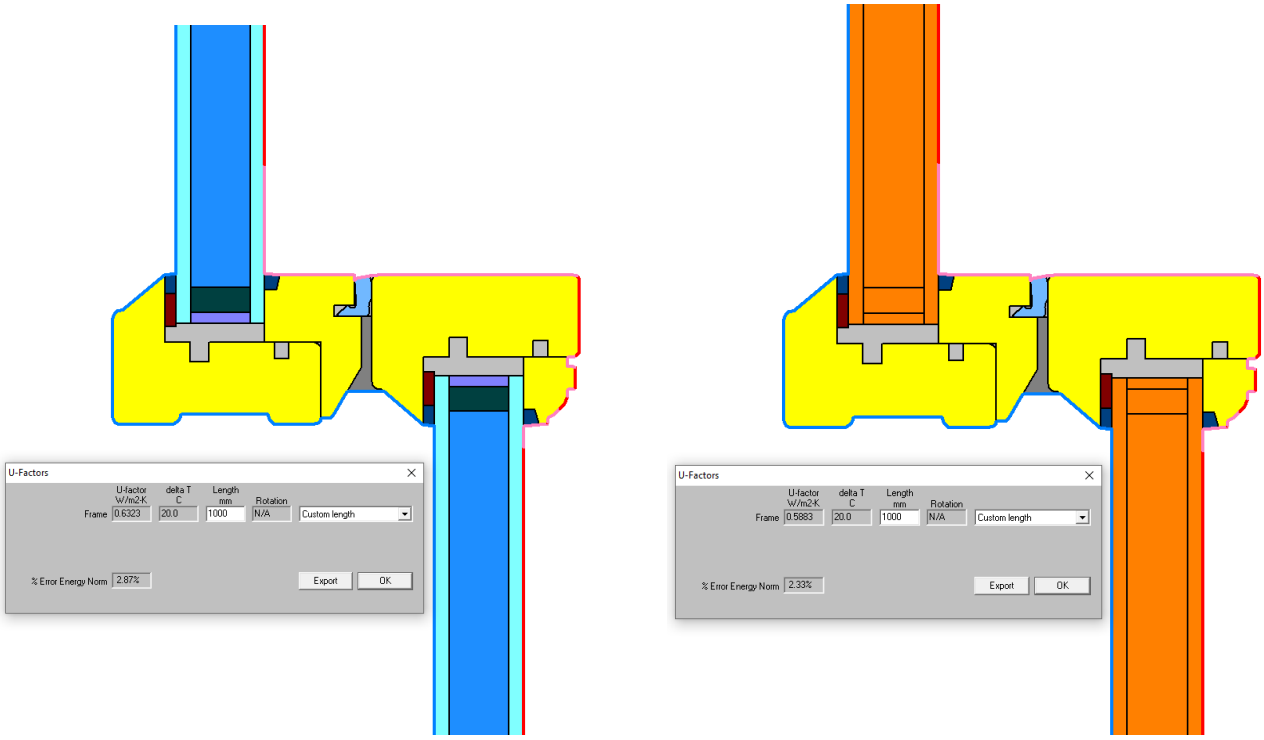


External Environment
R_{si} Normal = 0.04 m^2K/W
R_{si} Reduced = 0.04 m^2K/W
Temperature = 0 ^0C

Figure 4. Simulation of mid rail profile.

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

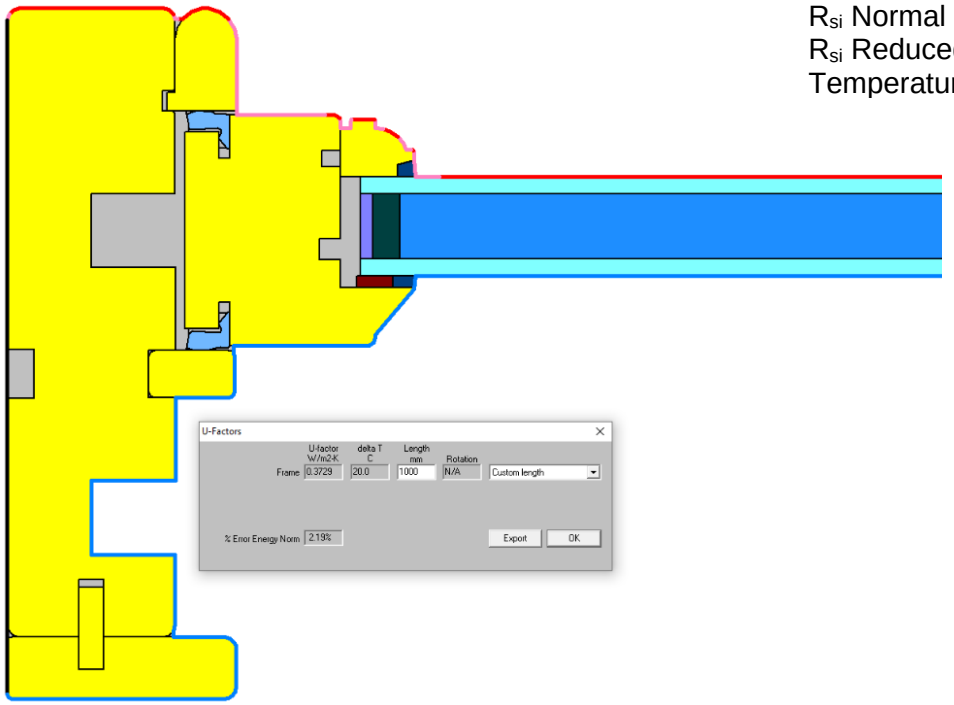
Internal Environment
R_{si} Normal = 0.13 m^2K/W
R_{si} Reduced = 0.20 m^2K/W
Temperature = 20 ^0C



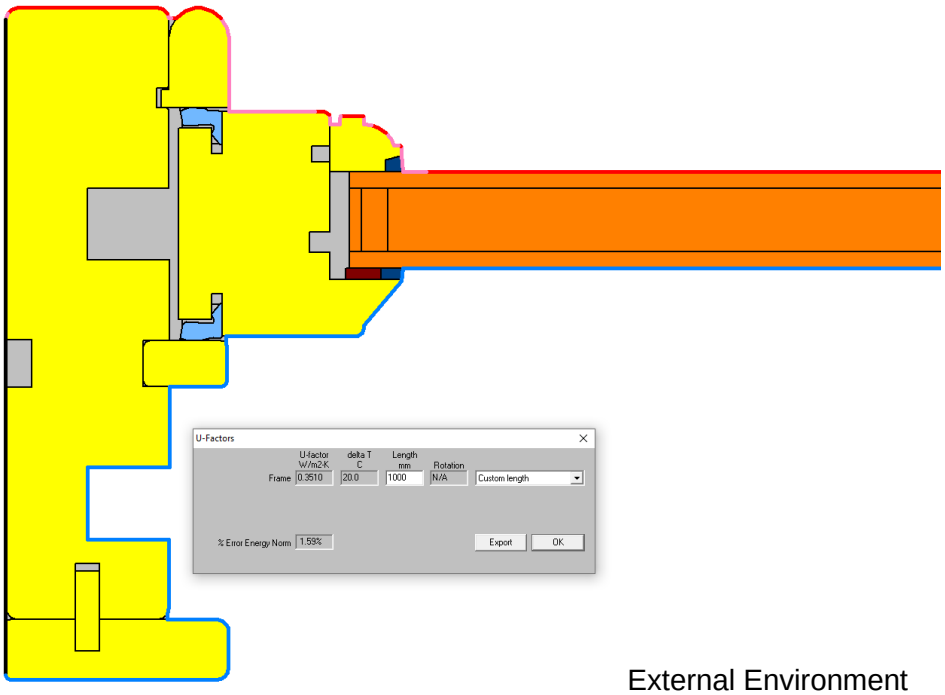
Quad Tree Mesh Parameter 9

Figure 5. Simulation of lower 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 6. Simulation of 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 16)
	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

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: 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

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

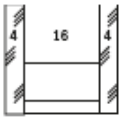
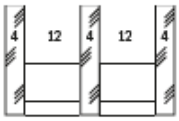
based on determination of the equivalent thermal conductivity of spacers by measurement

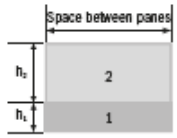
swisspacer SAINT-GOBAIN

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:

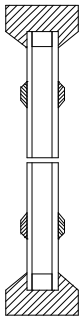
ift ROSENHEIM

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.

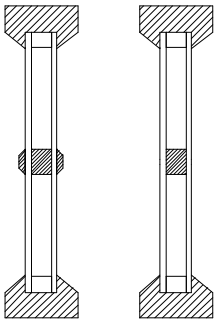
1. Attached bar(s)

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



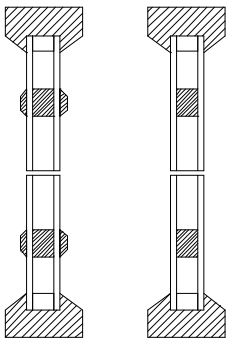
2. Single cross bar in the IGU with or without attached bars

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**