ENERGY RATING REPORT

REPORT NUMBER: 2396

Window System	Optima Chamfered/Sculptured
Window Type	Casement
Size & Style	1230mm x 1480mm Side Hung next to Fixed
Frame Material	PVC-U
Outer Frame Reference	QC/QS02 (60mm)
Outer Frame Reinforcement	QR02S (Steel)
Mullion Reference	QC/QS11 (66mm)
Mullion Reinforcement	QR10S (Steel)
Vent Reference	QC/QS30
Vent Reinforcement	QR30S (Steel) All round.
Glazing Bead Reference	QC50
Glazing Bead Detail	PVC-U Bead with PVC-P Co-Ex Gasket
Gaskets	PVC-P Bubble Co-extruded to profiles
Weatherseals	PVC-P Bubble Co-extruded to profiles
Glazing Description	28mm Double Glazed Unit
Outer Pane	4mm Extraclear
Cavity	20mm 90% Argon
Inner Pane	4mm Climaguard A+
Spacer Bar	Thermobar

RESULTS

BFRC ENERGY RATING BAND		**A**	
BFRC Energy Rating Index		**2**	**kWh/(m²·yr)**
Thermal Transmittance	**(U_{window})**	**1.4**	**W/(m²·K)**
Solar Factor	**(g_{window})**	**0.45**	
Air Leakage Heat Loss	**(L_{factor})**	**0.00**	**W/(m²·K)**

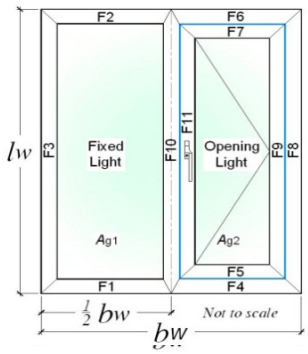
Prepared by: Sam Bott (Certified Simulator No. 122)
Design Technician
Epwin Window Systems

Signed:

Date: 06th November 2018

BFRC Certified Simulator 122

The simulations in this report were performed using Therm 5.2.14
In accordance substantially with BS EN ISO 10077-2:2012



Sample Style:

Casement

Fixed Light / Side Hung

Blue line illustrates opening light length (air leakage)

Report Number:	2396
Report Date:	06 November 2018
Project Details:	Optima Casement Full Steel Reinforcement Climaguard A+, Thermobar

Issue No 22.1: 11/03/2013

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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 ***0DP***	l_w	1480	mm
Total window width ***0DP***	b_w	1230	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		20	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	1.219	W/(m²·K)
g-value - ***2DP***	$g_\perp$	0.73	

Thermal transmittance of window from hot box test

U_w - *2DP* = W/(m²·K)

Window Dimensions:

Section	Length (m)	Width (m)	Area No gasket (m^2)	Area With gasket (m^2)
Fixed Light	1.3600	0.5220	0.7099	0.7099
Opening light	1.2700	0.4320	0.5486	0.5486
Total glazing, A_g			1.2586	1.2586
Frame	(m)	(m)	(m^2)	(m^2)
F1	0.6150	0.0600	0.0341	0.0341
F2	0.6150	0.0600	0.0341	0.0341
F3	1.4800	0.0600	0.0852	0.0852
F4	0.6150	0.0600	0.0341	0.0341
F5	0.5220	0.0450	0.0215	0.0215
F6	0.6150	0.0600	0.0341	0.0341
F7	0.5220	0.0450	0.0215	0.0215
F8	1.4800	0.0600	0.0852	0.0852
F9	1.3600	0.0450	0.0592	0.0592
F10	1.4800	0.0660	0.0937	0.0937
F11	1.3600	0.0450	0.0592	0.0592
Total Frame			0.5618	0.5618
Total Window, A_w			1.8204	1.8204
Percentage fixed light glass area			39.00%	39.00%
Percentage opening light glass area			30.14%	30.14%
Percentage glass area (total)			69.14%	69.14%

Solar Factor, *g*-value:

F_w	0.9
g_w	0.45

U_{window}		W/(m²·K)
	No bars; or attached bars	1.40
	Single cross bar in IGU	1.5
	Multiple cross bar in IGU	1.6
	Glazing bar (Georgian bar)	1.8

BFRC Rating kWh/(m²·yr)	Label index	EWER Rating Scale	Window Rating
≥10	2	A+	A
0 to <10 ⇦		⇨ A ⇦	
-10 to <0		B	
-20 to <-10		C	
-30 to <-20		D	
-50 to <-30		E	
-70 to <-50		F	

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	60	0.0	60.0	
	F2 fixed head	60	0.0	60.0	
	F3 fixed jamb	60	0.0	60.0	Total
F4 + F5 sash sill	F4 fixed sash sill	60	n/a	60.0	105.0
	F5 moving sash sill	45	0.0	45.0	
F6 + F7 sash head	F6 fixed sash head	60	n/a	60.0	105.0
	F7 moving sash head	45	0.0	45.0	
F8 + F9 sash jamb	F8 Fixed sash jamb	60	n/a	60.0	105.0
	F9 moving sash jamb	45	0.0	45.0	
F10 + F11 mullion	F10 fixed mullion	66	0.0	66.0	111.0
	F11 moving mullion	45	0.0	45.0	
	Total gasket area		0	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 fixed sill	0.2685	190	0.3324	190
F2 fixed head	0.2685	190	0.3324	190
F3 fixed jamb	0.2685	190	0.3324	190
F4 + F5 sash sill	0.3510	190	0.4147	190
F6 + F7 sash head	0.3510	190	0.4147	190
F8 + F9 sash jamb	0.3510	190	0.4147	190
F10 + F11 mullion	0.5749	380	0.7031	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, (W/(m·K))	Linear length, l_g (m)	Junction heat flow, Hψ (W/K)
F1 fixed sill	0.0600	1.2104	0.0341	0.0413	0.0282	0.5220	0.0147
F2 fixed head	0.0600	1.2104	0.0341	0.0413	0.0282	0.5220	0.0147
F3 fixed jamb	0.0600	1.2104	0.0852	0.1031	0.0282	1.3600	0.0383
F4 + F5 sash sill	0.1050	1.4774	0.0556	0.0821	0.0280	0.4320	0.0121
F6 + F7 sash head	0.1050	1.4774	0.0556	0.0821	0.0280	0.4320	0.0121
F8 + F9 sash jamb	0.1050	1.4774	0.1444	0.2133	0.0280	1.2700	0.0355
F10 + F11 mullion	0.1110	1.6500	0.1529	0.2523	0.0567	1.3150	0.0746
Totals			0.5618	0.8155	Total		0.2020

Air Leakage loss:

Air leakage at 50 Pa per hour & per unit length of opening light (BS 6375-1) - ***2DP*** = 0.02 m³/(m·h)

Opening light length	3.7640	m	Total air leakage	0.075	m^3/h
L_{50}	0.04	$m^3/(m^2 \cdot h)$	Heat loss = 0.0165 L_{50}	0.00	W/(m²·K)

Other parameters needed for calculation, taken from simulations:

λ_p =	0.035	W/(m·K)	R_{se} =	0.04	²·K /W	$d_p = d_g$ =	0.028 m
R_p =	0.8000	m²·K /W	R_{tot} =	0.9700	²·K /W	R_{se} =	0.13 m²·K /W
						U_p =	1.0309 W/(m²·K)

BFRC Rating =

218.6g_{window} - 68.5 x (U_{window} + Effective L_{50}) = 2.47

Climate zone is: UK

Thermal transmittance, W/(m²·K)	U_{window}	1.4
Solar factor	g_{window}	0.45
Window air leakage heat loss, W/(m²·K)	L_{factor}	0.00

British Fenestration Rating Council

BFRC Certified Simulator 122

Simulator Name: Samuel Bott

Version 13 01/06/2017. Calculations according to BS EN 673:2011

Number of spaces
1

Spaces 1

Glazing orientation	Vertical	
Resistivity panes	1	m·K/W

Outside

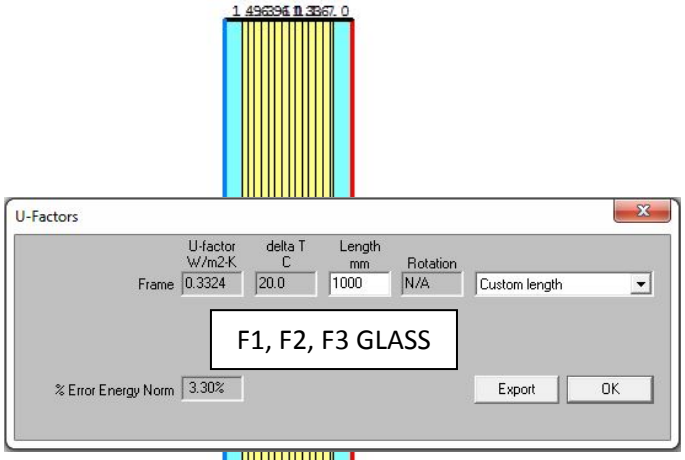
	Pane 1		Pane 2
		90%	
		Gas	
		Argon	
Thickness (mm)	4.0	20	4.0
Normal emissivity		0.89	0.05
$\sum d_j \cdot r_j$=	0.008	Uncoated	

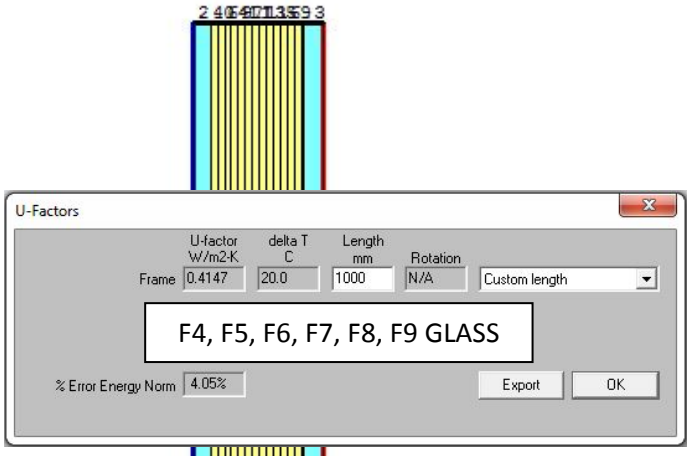
Total Unit Thickness
28 mm

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/(m²·K)	(m²·K)/W	W/(mK)	
1	1.219	0.64228	0.0311	15
2	1.219	0.64228	0.0311	15


U-Factors
U-factor W/m2-K
delta T C
Length mm
Rotation
Frame 0.3324 20.0 1000 N/A Custom length
F1, F2, F3 GLASS
% Error Energy Norm 3.30%
Export
OK


U-Factors
U-factor W/m2-K
delta T C
Length mm
Rotation
Frame 0.4147 20.0 1000 N/A Custom length
F4, F5, F6, F7, F8, F9 GLASS
% Error Energy Norm 4.05%
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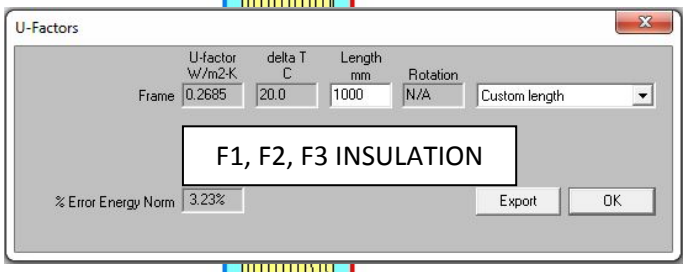
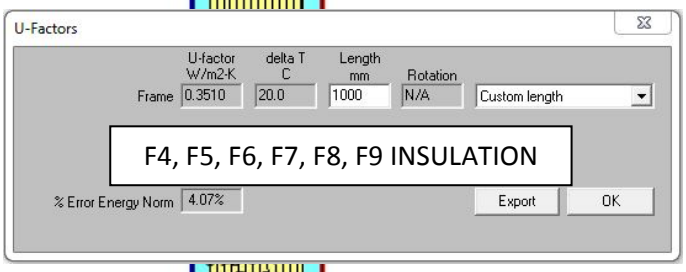
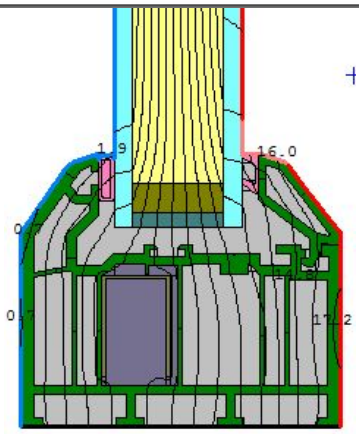
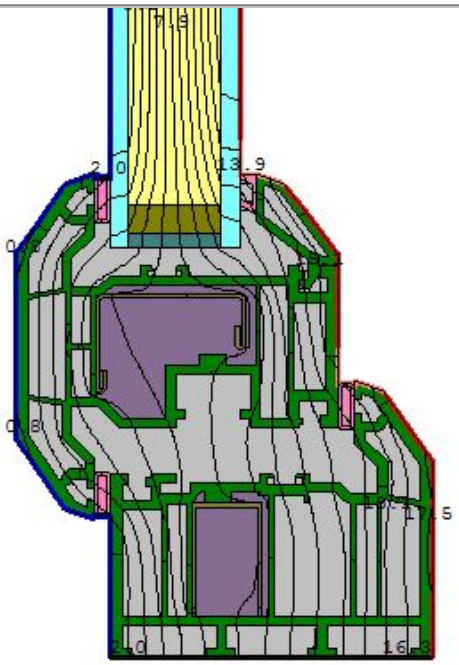
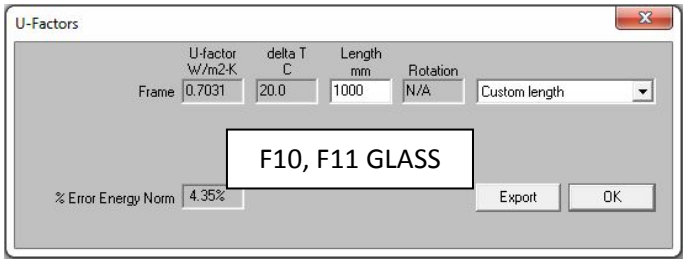
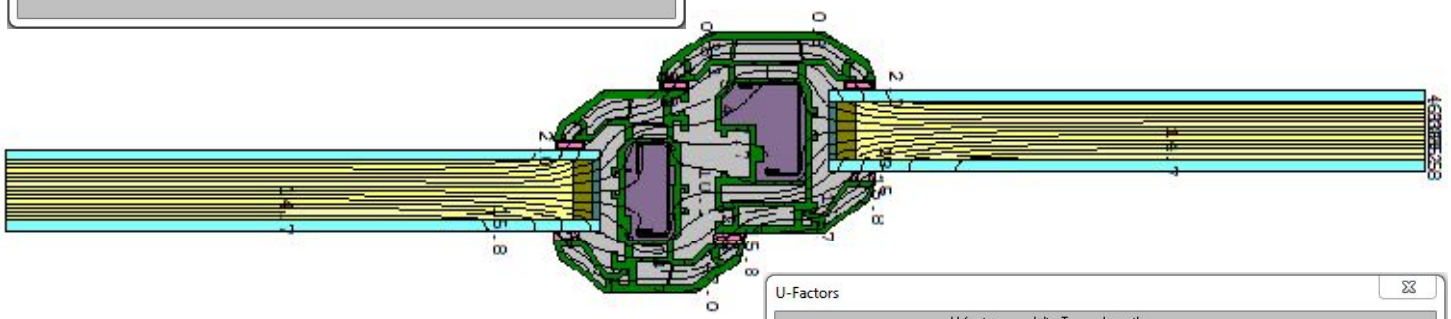

U-Factors
U-factor W/m2-K
delta T C
Length mm
Rotation
Frame 0.2685 20.0 1000 N/A Custom length
F1, F2, F3 INSULATION
% Error Energy Norm 3.23%
Export
OK

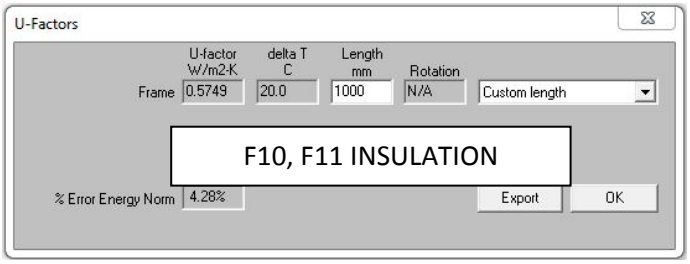

U-Factors
U-factor W/m2-K
delta T C
Length mm
Rotation
Frame 0.3510 20.0 1000 N/A Custom length
F4, F5, F6, F7, F8, F9 INSULATION
% Error Energy Norm 4.07%
Export
OK

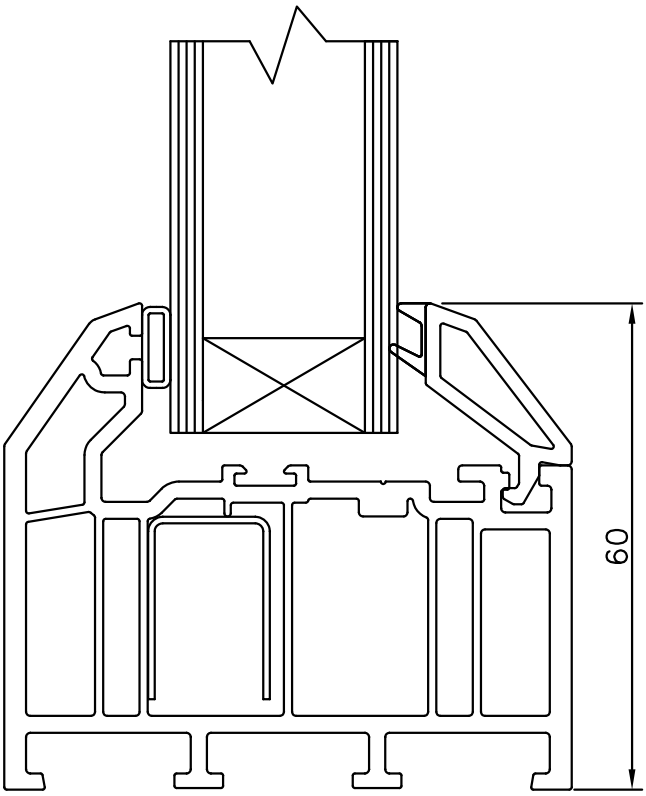





U-Factors
U-factor W/m2-K
delta T C
Length mm
Rotation
Frame 0.7031 20.0 1000 N/A Custom length
F10, F11 GLASS
% Error Energy Norm 4.35%
Export
OK




U-Factors
U-factor W/m2-K
delta T C
Length mm
Rotation
Frame 0.5749 20.0 1000 N/A Custom length
F10, F11 INSULATION
% Error Energy Norm 4.28%
Export
OK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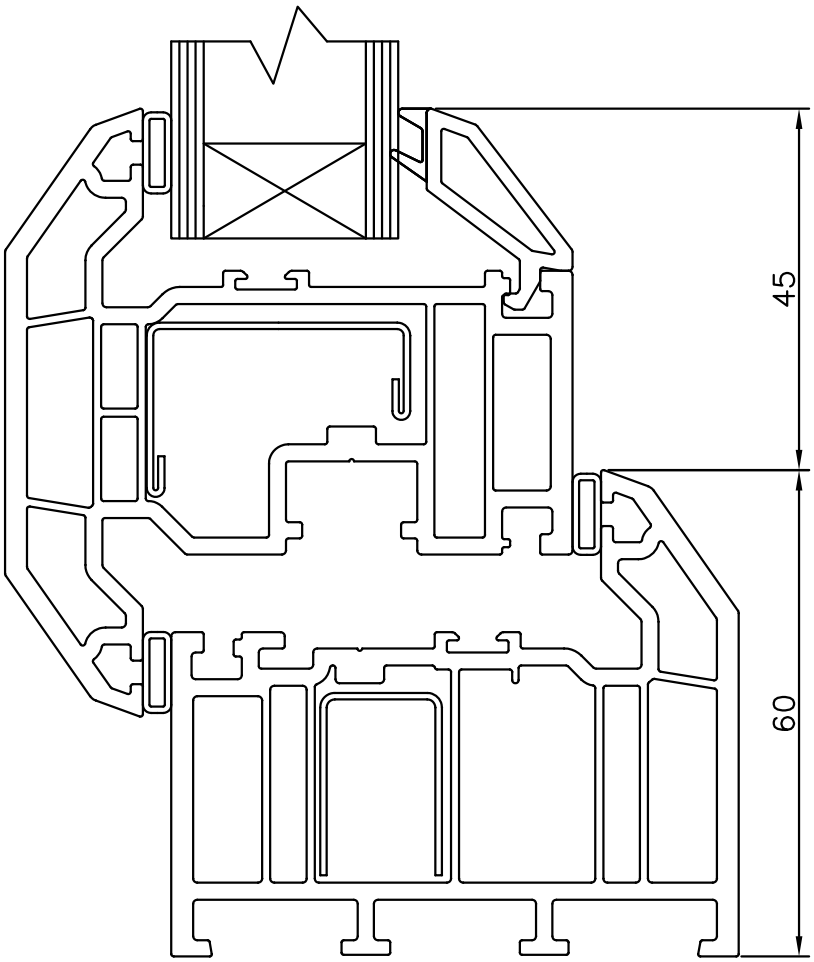
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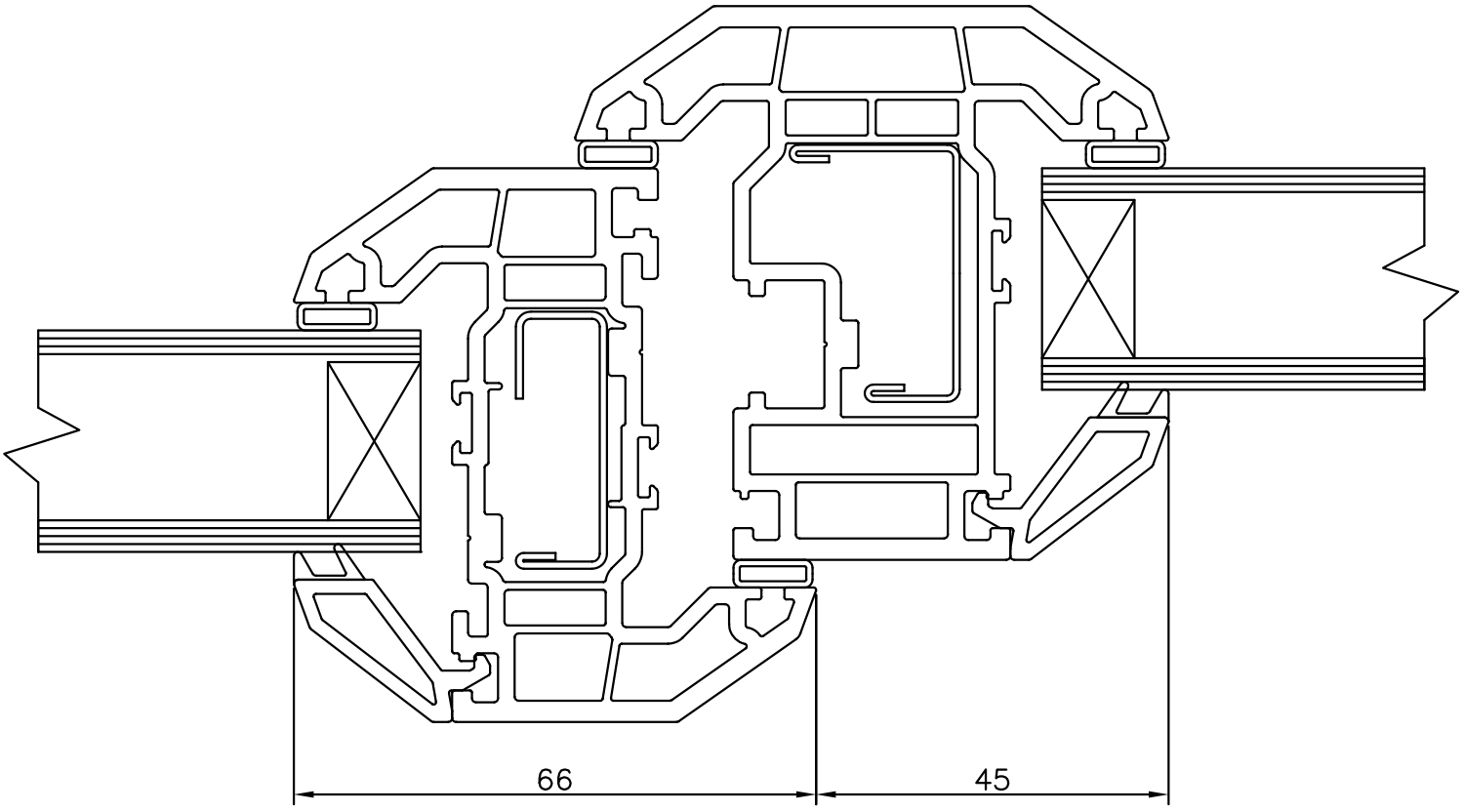

66
45

New Project 27

Make-up Name	Glass 1 & Coating	Glass 2 & Coating	Transmittance		Reflectance			U-Value (U_g in W/m²·K)	Solar Factor (g)	Secondary Heat Transfer (q_i)
			Visible (τ_v %)	Solar (τ_e %)	Visible		Solar			
					ρ_v % out	ρ_v % in	ρ_e % out			
Default Make-up 01	Guardian ExtraClear (CE)	ClimaGuard® A+ (CE) on Guardian ExtraClear (CE)	79.5	64.0	13.4	13.4	19.5	1.2	72.9	8.9

Calculation Standard: EN 410:2011 / EN 673:2011

Default Make-up 01

Outdoors

GLASS 1	Guardian ExtraClear (CE) Thickness = 5/32" = 4mm	#1 ----- #2 -----
GAP 1	10% Air, 90% Argon, 20mm (.787")	
GLASS 2	Guardian ExtraClear (CE) Thickness = 5/32" = 4mm	#3 ClimaGuard® A+ (CE) #4 -----

Total Unit (Nominal) = 1 3/32 in / 28 mm Slope = 90°

Estimated Nominal Glazing Weight: 19.17 kg/m²

Indoors

Important Notes

The performance values shown above represent NOMINAL VALUES for the center of glass with no spacer system or framing. Slight variations may occur due to manufacturing tolerances, point of manufacture, and type of instrumentation used to measure the optical properties. For configurations that include non-specular (diffuse) components, performance results cannot be verified and should only be used as a general indication of performance. For configurations which include ceramic frit coating, the actual values may vary significantly based upon the thickness and composition of the frit. For configurations with coatings laminated facing the PVB, there may be a noticeable color change. Guardian recommends a full size mock-up be approved. Calculations and terms in this report are based on EN 410:2011 and EN 673:2011. Sloped glass U-Value calculations are performed per EN 673:2011. Solar Factor (g) and Secondary Heat Transfer (qi) results are removed as no sloped-glass calculation method is prescribed by the standard for these attributes. The KIWA logo and KIWA Validation Report MD - 14/477/GL are provided as evidence of validation of the Guardian Performance Calculator software, program version 4.1, for execution of calculations of luminous and solar characteristics of glazing and thermal transmittance, according to EN 410:2011 and EN 673:2011.

Explanation of Terms

% Transmittance Visible or Light Transmittance (τ_v %) is the percentage of visible light at normal incidence (90° to surface) that is transmitted by the glass. Visible Light is defined as radiant energy in the wavelength range of 380 nm to 780 nm with Ill. D65 and CIE 2° observer.

% Ultraviolet (UV) Transmittance (τ_{uv} %) is the percentage of ultraviolet light at normal incidence directly transmitted by the glass. Ultraviolet Light is defined as radiant energy from the sun having a wavelength range of 280 nm to 380 nm at an air mass of 1.0, global, per CIE #85: 1989.

% Solar Energy Direct Transmittance (τ_e %) is the percentage of solar energy at normal incidence directly transmitted by the glass. Solar Energy is the radiant energy from the sun having a wavelength range of 300 nm to 2500 nm at an air mass of 1.0, global, per CIE #85: 1989.

% Reflectance Visible Outdoors or Light Reflectance Out (ρ_v % out) is the percentage of visible light at normal incidence directly reflected by the glass back outdoors.

Data sheet Psi values for windows

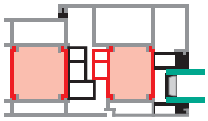
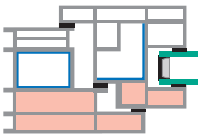
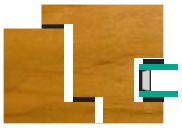
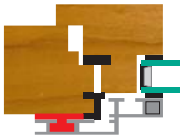
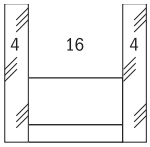
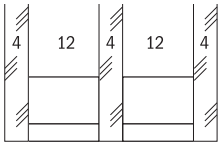
based on determination of the equivalent thermal conductivity of spacers by measurement

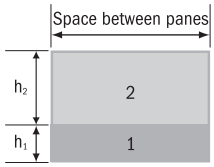
THERMOSEAL GROUP
Dedicated to Insulated Glass

Thermoseal Group Ltd
Gavin Way, Nexus Point,
Off Holford Drive
Birmingham B6 7AF, United Kingdom

RAL GÜTEZEICHEN MEHRSCHEIBEN ISOLIERGLAS

	Product name	Space height in mm	Material	Thickness d in mm
Cross-section	Thermobar™ Warm Edge Spacer Tube 	6,5	modified polypropylene glass filled / modified polyester film	1.0 / 1.2 0.027

	Representative glass constructions	Metal with thermal break	Plastic	Wood	Wood/Metal
Representative frame profile					
Representative psi value double-sheet thermally insulating glass W/mK	 Double-sheet insulating glass U_g=1.1 W/m²K	0.036	0.032	0.031	0.032
Representative psi value triple-sheet thermally insulating glass W/mK	 Triple-sheet insulating glass U_g=0.7 W/m²K	0.031	0.030	0.029	0.030

		Space between panes in mm	$\lambda_{eq,2B}$ in W/mK	
			Box 1 · h_1 = 3 mm	Box 2 · h_2 = 6.5 mm
Two Box model Characteristic values		Can be used for all spacer widths	0.40	0.14

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:
Hochschule Rosenheim University of Applied Sciences
ift ROSENHEIM

WINTECH
BUILDING ENVELOPE TESTING

Technical Report

Report No	R16359
Product Tested:	Optima – Side Hung Casement – Open Out
Test Conducted for:	Epwin Window Systems Division Stafford Park 6 Telford Shropshire TF3 3AT United Kingdom
Standard Specified:	BS 6375 Pt 1:2009 BS EN 1026: 2000 BS EN 12207:2000 BS EN 1027:2000 BS EN 12208:2000 BS EN 12210:2000 BS EN 12211:2000
Project No:	16359
Date of Test:	5th May 2016
Test Conducted at:	Wintech Engineering Limited Halesfield 2 Telford Shropshire TF7 4QH
Test Conducted by:	D Woodcock Laboratory Technician
Report Compiled by:	S Ward Laboratory Apprentice
Authorised by:	M Wass Technical Director

Revision 2 – This Report has been amended to include an updated sample description and replaces all previous versions. 08/11/2016

6. Test Results

6.1 Lab Conditions

The conditions measured inside the laboratory were as follows:

Temperature °C	Humidity %rh	Atmospheric Pressure kPa
26.0	28.0	99.8

6.2 Air Permeability

6.2.1 Reference Air Permeability

Class	Reference air permeability @ 100 Pa based on Area ($m^3/h/m^2$)	Reference air permeability @ 100 Pa based on length of opening joint ($m^3/h/m$)
0	*Not Tested*	*Not Tested*
1	50	12.50
2	27	6.75
3	9	2.25
4	3	0.75

The required air permeability figures for all additional pressure steps in all classifications were calculated using the equation given in BS EN 12207: 2000.

6.2.2 Air Permeability – Results

Calculated area of test sample 1.08 m^2
Measured length of opening joints 3.90 m

6.2.2.1 Initial Air Permeability Tests 1 & 2

Pressure Differential Pa	Air Permeability Rate Infiltration & Exfiltration Tests **$m^3/hr/m^2$ - Area**			Air Permeability Rate Infiltration & Exfiltration Tests **$m^3/hr/m$ - Length of Joint**		
	Test No. 1	**Test No. 2**	**Average**	**Test No. 1**	**Test No. 2**	**Average**
50	0.18	0.00	0.09	0.05	0.00	0.02
100	0.00	0.18	0.09	0.00	0.05	0.02
150	0.00	0.27	0.13	0.00	0.07	0.04
200	0.18	0.09	0.13	0.05	0.02	0.04
250	0.18	0.00	0.09	0.05	0.00	0.02
300	0.09	0.00	0.04	0.02	0.00	0.01
450	0.18	0.62	0.40	0.05	0.17	0.11
600	0.27	0.45	0.36	0.07	0.12	0.10

6.2.2.1 Repeat Air Permeability Tests 6 & 7

Pressure Differential Pa	Air Permeability Rate Infiltration & Exfiltration Tests **$m^3/hr/m^2$ - Area**			Air Permeability Rate Infiltration & Exfiltration Tests **$m^3/hr/m$ - Length of Joint**		
	Test No. 6	**Test No. 7**	**Average**	**Test No. 6**	**Test No. 7**	**Average**
50	0.09	0.18	0.13	0.02	0.05	0.04
100	0.09	0.36	0.22	0.02	0.10	0.06
150	0.18	0.36	0.27	0.05	0.10	0.07
200	0.27	0.45	0.36	0.07	0.12	0.10
250	0.36	0.27	0.31	0.10	0.07	0.09
300	0.18	0.09	0.13	0.05	0.02	0.04
450	0.36	0.89	0.62	0.10	0.25	0.17
600	0.45	0.54	0.49	0.12	0.15	0.14

MATERIAL THERMAL CONDUCTIVITY VALUES

MATERIAL	λ value W/m-K	SOURCE	EMISSIVITY
Aluminium (Si Alloys) (painted)	160	EN ISO 10077-2	0.9
Aluminium (Si Alloys) (unpainted)	160	EN ISO 10077-2	0.3
Butyl Solid / Hot Melt	0.24	EN ISO 10077-2	0.9
EPDM	0.25	EN ISO 10077-2	0.9
EPS 70	0.038	BS EN 13163 (& manufacturer)	0.9
Glass	1.0	EN ISO 10077-2	0.9
GRP SKIN 0.4	0.4	EN ISO 10077-2	0.9
Hardwood	0.18	EN ISO 10077-2	0.9
CEN Insulation Panel	0.035	EN ISO 10077-2 (Annex C)	0.9
MDF (0.14)	0.14	EN ISO 12524	0.9
MDF (0.18)	0.18	EN ISO 12524	0.9
Pile Weather Stripping (polyester mohair)	0.14	EN ISO 10077-2	0.9
Molecular Sieve (dessicant)	0.1	EN ISO 10077-2	0.9
Plywood (0.24)	0.24	EN ISO 12524	0.9
Polyamide (nylon)	0.25	EN ISO 10077-2	0.9
Polyamide 6.6	0.3	EN ISO 10077-2	0.9
Polycarbonate	0.2	EN ISO 10077-2	0.9
Polyethylene HD	0.5	EN ISO 10077-2	0.9
Polyisobutylene	0.2	EN ISO 10077-2	0.9
Polypropylene, solid	0.22	EN ISO 10077-2	0.9
Polysulfide	0.4	EN ISO 10077-2	0.9
PU (polyurethane)	0.4	EN ISO 10077-2	0.9
PVC, flexible (PVC-P)	0.14	EN ISO 10077-2	0.9
PVC, rigid (PVC-U)	0.17	EN ISO 10077-2	0.9
Silica Gel (dessicant)	0.13	EN ISO 10077-2	0.9
Silicone, pure	0.35	EN ISO 10077-2	0.9
Softwood	0.13	EN ISO 10077-2	0.9
Stainless Steel	17	EN ISO 10077-2	0.3
Steel	50	EN ISO 10077-2	0.3