Report in Accordance with
BFRC Guidelines and Regulations

Product description:
Ultimate 2 PVC-U Vertical Sliding Window

CONFIDENTIAL

Client:	Roseview Windows Yardley Road Industrial Estate Olney Bucks MK46 5EA
Project:	Ultimate 2 PVC-U Vertical Sliding Window
Project reference:	CU16173-3
Prepared By:	Richard Bate Technical Director
Issue date:	29 June 2016

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Approved Simulator 001

1   Introduction

The U-value calculations of the Rehau S719 PVC-U vertical sliding window detailed below were commissioned by Willie Kerr of Roseview Windows.

2   Validation of Program

The Therm 5.2 analysis software has been validated against proofs in Annex D (D1 to D10) of BS EN ISO 10077-2:2012.

3   Analysis Method

The frame profile results detailed below are provided by computer simulation using LBL software program THERM 5.2 and BFRC guidelines and regulations.

4   Summary of Results

A summary of results are detailed in the following sections. The details supplied for the analysis as well as all information required to verify the analysis can be found in the attached CD.

4.1   Frame thermal transmittance (following the principles of BS EN ISO 10077-2)

Rehau S719 Frame Profile	Frame Thermal Transmittance (U_f)
Head	1.5 W/(m²·K)
Upper Jamb	1.5 W/(m²·K)
Mid Rail	3.4 W/(m²·K)
Lower Jamb	1.8 W/(m²·K)
Cill	1.9 W/(m².K)

4.2   Linear thermal transmittance (following the principles of BS EN ISO 10077-2)

Rehau S719 Frame Profile	Linear Thermal Transmittance (ψ)
Head	0.030 W/(m·K)
Upper Jamb	0.030 W/(m·K)
Mid Rail	0.074 W/(m·K)
Lower Jamb	0.031 W/(m·K)
Cill	0.029 W/(m·K)

4.3   Centre pane U-Value of glazing calculated in accordance with BS EN 673.

Glazing Unit	Centre Pane U-value (U_g)
4-20-4 Low-E 0.05 uncorrected emissivity (St Gobain Planitherm Total+), 90% Argon, 10% Air filled, low iron outer pane (St Gobain Diamant) glazing unit with Thermobar spacer bar with 3mm Polysulfide/Polyurethane secondary seal.	1.2 W/(m²·K)

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4.4 The thermal performance of the windows (Uw) in accordance with BFRC guidelines and regulations:

Rehau S719 Frame Profile	Window U-Value
PVC-U frame system with partial steel reinforcement to BFRC requirements with 4-20-4 Low-E 0.05 uncorrected emissivity (St Gobain Planitherm Total+), 90% Argon, 10% Air filled, low iron outer pane (St Gobain Diamant) glazing unit with Thermobar spacer bar with 3mm Polysulfide/Polyurethane secondary seal.	1.5 W/(m²·K)

4.5 The Effective L_{50} in accordance with BFRC guidelines and regulations:

Rehau S719 Frame Profile	Effective L_{50}
Air permeability at 50 pa	0.01 W/(m²·K)

4.6 Total solar energy transmittance (g) in accordance with EN 410

Rehau S719 Frame Profile	g_{window}
PVC-U frame system with partial steel reinforcement to BFRC requirements with 4-20-4 Low-E 0.05 uncorrected emissivity (St Gobain Planitherm Total+), 90% Argon, 10% Air filled, low iron outer pane (St Gobain Diamant) glazing unit with Thermobar spacer bar with 3mm Polysulfide/Polyurethane secondary seal.	0.50

5.0 BFRC Rating

5.1 Rehau S719 window system

Rehau S719 Frame Profile	Rating
PVC-U frame system with partial steel reinforcement to BFRC requirements with 4-20-4 Low-E 0.05 uncorrected emissivity (St Gobain Planitherm Total+), 90% Argon, 10% Air filled, low iron outer pane (St Gobain Diamant) glazing unit with Thermobar spacer bar with 3mm Polysulfide/Polyurethane secondary seal.	+ 4 (Rating Scale A)

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6.0   Authorisation

	Prepared by:
Signature:	*Richard Bate*
Name:	Richard Bate
Title:	Technical Director

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Technical Specification

Profiles		Ref. No.	Material Type/Manufacturer's Name & Density (Timber only)	Dimensions (Height & Width)
Outer Frame	Head & Jambs	559500	PVC-U - Rehau	66mm x 137mm
	Sill	559570	PVC-U - Rehau	62mm x 149mm
	Cover stop	559610	PVC-U - Rehau	-
Sash	Head & Upper Jambs	559510	PVC-U - Rehau	42.5mm x 57mm
	Lower Jambs	559520	PVC-U – Rehau	52.5mm x 57mm
	Upper meeting rail	standring-134	PVC-U - Rehau	35mm x 66.4mm
	Lower meeting rail	559510	PVC-U – Rehau	42.5mm x 57mm
	Sill	559540	PVC-U - Rehau	81mm x 57mm
Glazing Bead		559590	PVC-U - Rehau	24.3mm x 10.5mm
Joint Type		N/A	N/A	
Joint Adhesives		N/A	N/A	

Reinforcements		Ref. No.	Material Type/ Manufacturer's Name	Dimensions (Height & Width)
Outer Frame		N/A	N/A	N/A
Sash	Head & Jambs	219000	Steel - Rehau	16.3mm x 39.5mm
	Upper meeting rail	N/A	N/A	N/A
	Lower meeting rail	219000	Steel – Rehau	16.3mm x 39.5mm
	Sill	T2860	Steel - DBR	40mm x 40mm

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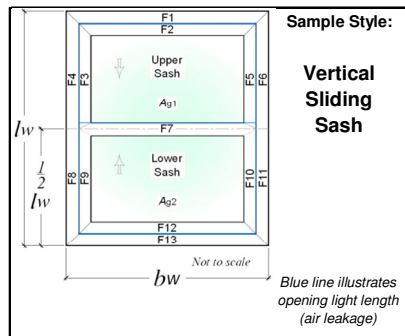
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Weather Seals	Ref. No.	Material Type/ Manufacturer's Name	Continuous or Joined @ Corners
Glazing Bead	-	Flexible PVC – Co-extruded to bead	
Glazing Rebate	235203	Universal Gasket, co-extruded to frame	
Casement Perimeter Seal	235203	Brush seal	
Frame Rebate	219180	Polyamide (nylon) Brush seal	

Glazing Component	Specification
Overall sealed unit: 1. Thickness (mm)	1. 28mm
Outer pane 1. Thickness (mm) 2. Manufacturer 3. Description	1. 4mm 2. St Gobain 3. Diamant
Inner pane: 1. Thickness 2. Manufacturer 3. Description	1. 4mm 2. St Gobain 3. Planitherm Total+
Spacer bar: 1. Manufacturer 2. Description	1. Thermoseal 2. Thermobar
Cavity 1. Distance (mm) 2. Gas %	1. 20mm 2. Argon 90% Air 10%
Edge seal 1. Manufacturer 2. Description	1. N/A 2. 3mm Polysulfide/Polyurethane secondary seal

Additional Notes
Steel/aluminium reinforcement is present in all frame profiles.

Air leakage data is taken from ERA Test report ref. R1036 dated 4 August 2015 (data at 50Pa pressure = 0.15).

Solar heat gain figures are calculated from g-values supplied by the product manufacturer from EN 410 calculations for the glass units used in this simulation. The value used is 0.75. |

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BFRC Spreadsheet

BUILDCHECK

Sample Style:

Vertical Sliding Sash

l_w

$\frac{1}{2} l_w$

bw

Not to scale

Blue line illustrates opening light length (air leakage)

Report Number:	U16176-3	Report Issue No.15.1	*(11/03/13)*
Report Date:	18/05/2016		

Project Details: PVC-U Vertical Slider, Planitherm Total+, Diamant, Argon & Thermobar

THIS SPREADSHEET IS THE PROPERTY OF THE BFRC AND CAN ONLY BE USED IN CONJUNCTION WITH A BFRC LICENCE APPLICATION

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	1230	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}	**20.0**	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	**1.219**	W/(m²·K)
g-value - **2DP** $g\perp$	**0.75**	

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

Frame dimensions (All frame values to 0dp, gaskets to 1DP)	Frame height, b_f (mm)		Gasket protrusion (mm)	With gasket (mm)	Total
	Internal	External			
F1 fixed top rail	66	66	n/a	66.0	99.7
F2 moving top rail	33	33	0.7	33.7	
F3 top (LH) jamb (moving sash)	33	33	1.0	34.0	100.0
F4 top (LH) jamb (fixed frame)	66	66	n/a	66.0	
F5 top (RH) jamb (moving sash)	33	33	1.0	34.0	100.0
F6 top (RH) jamb (fixed frame)	66	66	n/a	66.0	
F7 mid rail (upper)	45		0.0	46.0	46.0
F7 mid rail (lower)			1.0		
F8 bottom (LH) jamb (fixed frame)	66	66	n/a	66.0	100.0
F9 bottom (LH) jamb (moving sash)	33	33	1.0	34.0	
F10 bottom (RH) jamb (moving sash)	33	33	1.0	34.0	100.0
F11 bottom (RH) jamb (fixed frame)	66	66	n/a	66.0	
F12 bottom moving rail	59		1.0	60.0	122.0
F13 bottom fixed rail	62		n/a	62.0	
			Total gasket area	0.005211	m²

Window Dimensions:

	Length, l	Width, b	Area, A No gasket	With gasket
Section	m	m	m²	m²
Upper glazing	0.6185	1.0320	0.6383	0.6363
Lower glazing	0.5965	1.0320	0.6156	0.6123
Total of glazing			1.2539	1.2487
Frame	m	m	m²	m²
F1	1.2300	0.0660	0.0768	0.0768
F2	1.0980	0.0330	0.0351	0.0359
F3	0.6740	0.0330	0.0213	0.0219
F4	0.7400	0.0660	0.0467	0.0467
F5	0.6740	0.0330	0.0213	0.0219
F6	0.7400	0.0660	0.0467	0.0467
F7	1.0980	0.0450	0.0479	0.0490
F8	0.7400	0.0660	0.0468	0.0468
F9	0.6780	0.0330	0.0210	0.0216
F10	0.6780	0.0330	0.0210	0.0216
F11	0.7400	0.0660	0.0468	0.0468
F12	1.0980	0.0590	0.0628	0.0639
F13	1.2300	0.0620	0.0722	0.0722
Total Frame			0.5665	0.5717
Total Window, Aw			1.8204	1.8204
Percentage upper glass area			35.06%	34.96%
Percentage lower glass area			33.82%	33.64%
Percentage glass area (total)			68.88%	68.59%

Solar Factor, g- value:	glazing area A_g (m²)	1.3577
	F_w	0.9
	g_w	0.50

U_{window}	No bars; or attached bars	1.52	
	Single cross bar in IGU	1.6	W/(m²·K)
	Multiple cross bar in IGU	1.7	
	Glazing bar (Georgian bar)	1.9	

BFRC Rating kWh/(m²·yr)	Label index	EWER Rating Scale	Window Rating
≥10		A+	
0 to <10 ⇦		⇨ A ⇦	
-10 to <0		B	
-20 to <-10	**4**	C	**A**
-30 to <-20		D	
-50 to <-30		E	
-70 to <-50		F	

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**			
		W/(m·K)	b_p (mm)	W/(m·K)	b_g (mm)
F1+F2 top rail		**0.3462**	**190**	**0.4116**	190
F3+F4 top (LH) jamb		**0.3462**	190	**0.4116**	190
F5+F6 top (RH) jamb		0.3462	190	0.4116	190
F7 mid rail	L_f^{2D}	**0.5453**	380	L_ψ^{2D} **0.6906**	380
F8+F9 bottom (LH) jamb		**0.3708**	190	**0.4376**	190
F10+F11 bottom (RH) jamb		0.3708	190	0.4376	190
F12+F13 bottom rail		**0.4216**	190	**0.4866**	190

Frame:	Frame width, b_f	Frame U-value, U_f	Frame areas, A_f	Frame heat flow, HU	Linear trans, Ψ	Linear length, l_g	Junction heat flow, HΨ
Section	m	W/(m²·K)	m²	W/K	W/(m·K)	m	W/K
F1+F2 top rail	0.0990	1.5184	0.1120	0.1700	0.0297	1.0320	0.0306
F3+F4 top left jamb	0.0990	1.5184	0.0680	0.1032	0.0297	0.6185	0.0183
F5+F6 top right jamb	0.0990	1.5184	0.0680	0.1032	0.0297	0.6185	0.0183
F7 mid rail	0.0450	3.4122	0.0479	0.1635	0.0738	1.0320	0.0762
F8+F9 btm left jamb	0.0990	1.7669	0.0678	0.1198	0.0311	0.5965	0.0185
F10+F11 btm right jamb	0.0990	1.7669	0.0678	0.1198	0.0311	0.5965	0.0185
F12+F13 bottom rail	0.1210	1.8655	0.1350	0.2518	0.0293	1.0320	0.0302
Totals			0.5665	1.0315		Total	0.2108

Air Leakage loss:
Air leakage at 50 Pa per hour & per unit length of opening light (BS 6375-1) - **2DP**   **0.15**   m³/(m·h)

Opening light length, $l_{opening}$	6.2460	m	Total air leakage	0.937	m³/h
L_{50}	0.51	m³/(m²·h)	Heat loss = 0.0165 L_{50}	0.01	W/(m²·K)

Other parameters needed for calculation, taken from simulations: $d_p = d_g =$ 0.028 m

$\lambda_p =$	0.035	W/(m·K)	$R_{se} =$	0.04	m²·K/W	$R_{se} =$	0.13	m²·K/W
$R_p =$	0.8000	m²·K/W	$R_{tot} =$	0.9700	m²·K/W	$U_p =$	1.0309	W/(m²·K)

BFRC Rating =
218.6g_{window} - 68.5 x (U_{window} + Effective L_{50}) = **4.49**

Climate zone is: **UK**

Thermal transmittance, W/(m²·K)	U_{window}	1.5
Solar factor	g_{window}	0.50
Window air leakage heat loss, W/(m²·K)	L_{factor}	0.01

British Fenestration Rating Council

BFRC Certified
Simulator **001**

Simulator Name: **Richard Bate**
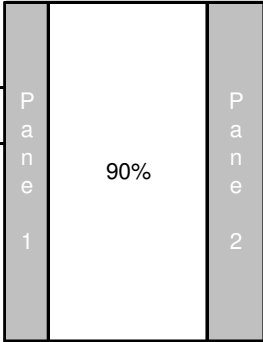
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BS EN 673 Spreadsheet

Version 12 18/06/2015. Calculations according to BS EN 673:2011

Number of spaces
1

Help

Spaces   1

Glazing orientation
Vertical

Resistivity panes	1	m·K/W

Outside | Pane 1 | 90% | Pane 2 |

Calculate

Gas
Argon

Thickness (mm)	4.0	20	4.0
Normal emissivity		0.89	0.05	

$\sum d_j \cdot r_j =$ 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	(m²·K)/W
Internal, R_{si}	0.13	(m²·K)/W

Iteration number	U value W/(m²·K)	$\sum 1/h_s$ (m²·K)/W	λeff W/(mK)	ΔT
1	1.219	0.64228	0.0311	15
2	1.219	0.64228	0.0311	15

Thermal Conductivity Values Used

Material/Conductivity W/(m.K)	Reference
Rigid PVC-U / 0.17	(Annex A BS EN ISO 10077-2)
Steel / 50.0	(Annex A BS EN ISO 10077-2)
EPDM / 0.25	(Annex A BS EN ISO 10077-2)
Flexible PVC / 0.14	(Annex A BS EN ISO 10077-2)
Polyamide (nylon) / 0.25	(Annex A BS EN ISO 10077-2)
Soda Lime Glass / 1.0	(Annex A BS EN ISO 10077-2)
Polysulfide/Polyurethane / 0.40	(Annex A BS EN ISO 10077-2)
Thermobar spacer / 0.14	BF Datasheet (see page 9)
Silicone / 0.35	(Annex A BS EN ISO 10077-2)

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Spacer Data Sheet

'WARM EDGE' WORKING PARTY — BF

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

	Product name		Spacer height in mm	Material	Thickness d in mm
Cross-section	Thermobar™		6.5	modified polypropylene glass filled / modified polyester film	1.0 / 1.2 0.027

		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	Space between panes	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-17/1 "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 UW 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-08/2 "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 "Compass 'Warm Edge' for Windows" of Bundesverband Flachglas.
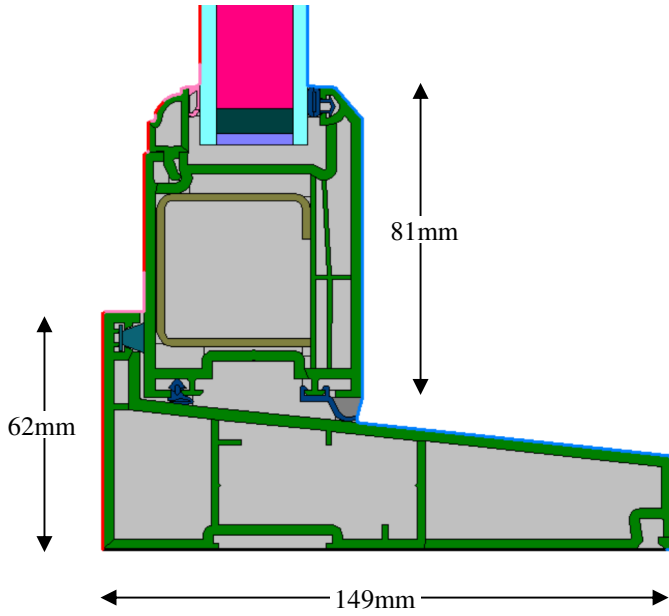
Characteristic values determined by: Hochschule Rosenheim — ift

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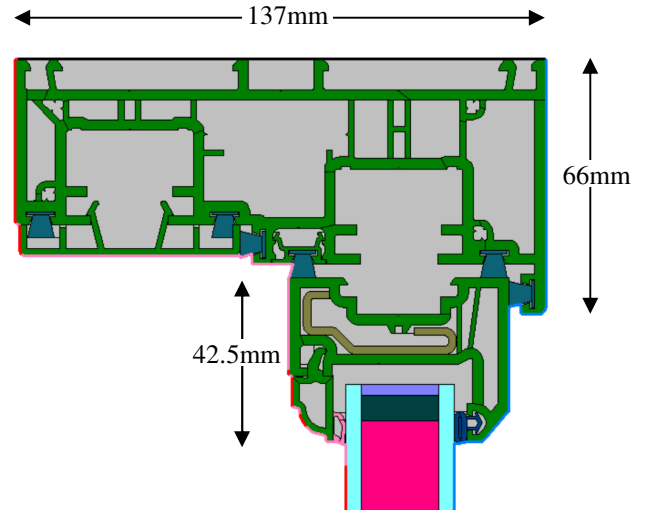Report for: Roseview Windows   Page 9 of 11
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Appendix

Profile Drawings
(See Technical Specification for dimensions)

Sill

Head

81mm

62mm
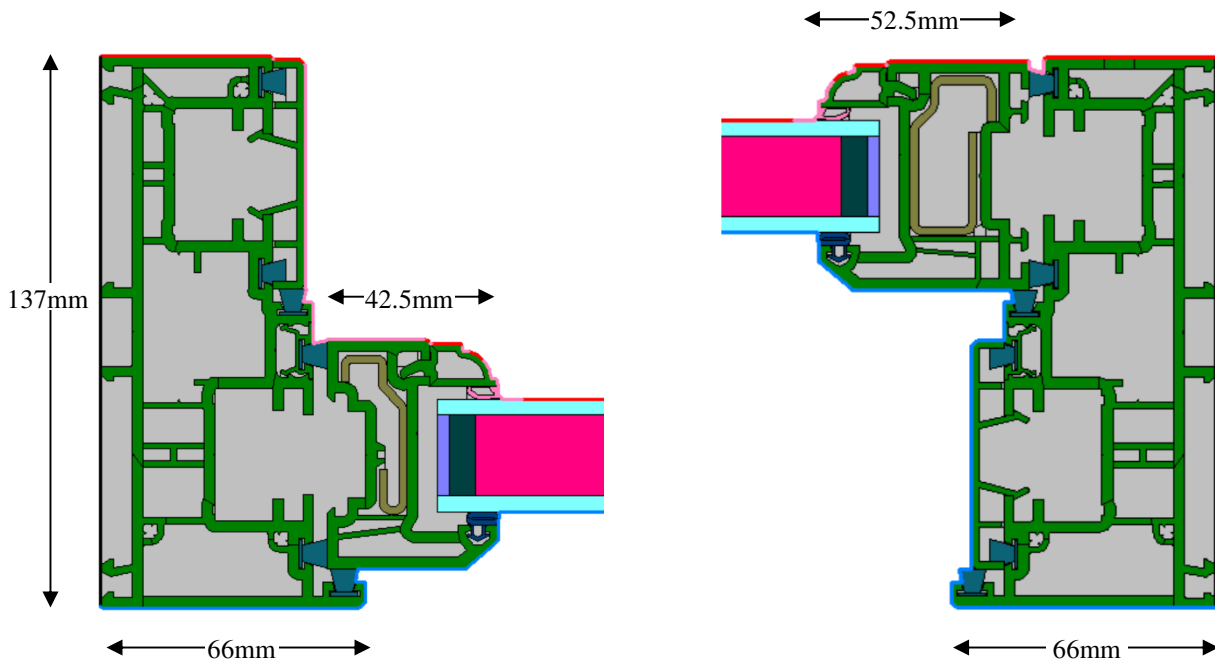
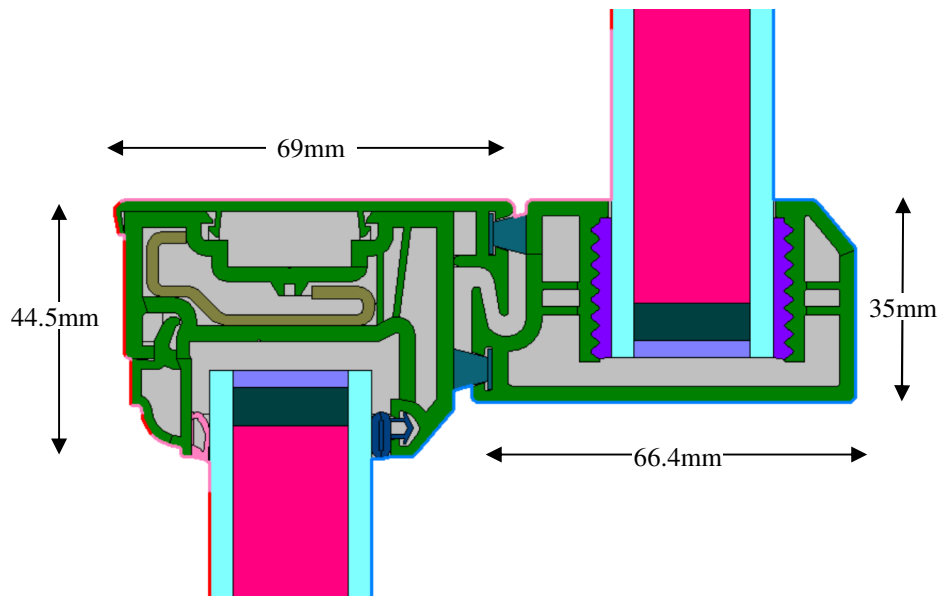149mm

137mm

66mm

42.5mm

Jambs

137mm

42.5mm

66mm

52.5mm

66mm

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Meeting Rail

69mm

44.5mm

35mm

66.4mm

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