THERMAL SIMULATION REPORT

Report Number:	**TCL2014-SWA-009**
Prepared For:	**Steel Window Association 42 Heath Street Tamworth Staffordshire B79 7HJ**
Window System Identifier:	**W20**
Fixed Outer Frame Identifier:	**W7**
Transom Frame Identifier:	**W8/W2**
Vent Frame Identifier:	**W8/W5**
Glazing System:	**4 mm Planilux – 8 mm 90% Krypton – 4 mm Planitherm One or Planitherm 4S**
Spacer Bar:	**8mm Edgetech Super Spacer Standard with butyl secondary sealant**
Notes:	**Mild Steel Bead Reference Drawing SWA-W20-009**

Result

Thermal Transmittance (U_{window})	**2.3**	*W/(m^2K)*

(Window Configuration as defined in BS EN 14351-1 Annex E)
(1230mm wide x 1480mm high – vent next to fixed light)

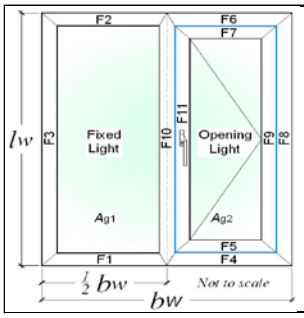
Report Prepared By *Dr Gary Morgan*
Therm Consulting

Signed: *G Morgan*

Date: *30th April 2014*

The simulations in this report were performed using Win IsoPro 7.80 strictly according to EN ISO 10077 – 2:2012
The files generated are attached to this report as appendices

British Fenestration Rating Council
BFRC Certified Simulator 016



Sample Style:

Casement

Fixed Light / Side Hung

Blue line illustrates opening light length (air leakage)

Report Number: TCL2014-SWA-009 Issue No.21: 04/03/2009

Report Date: 30 April 2014

Project Details: W20 Steel Frame 4mm Planilux 8mm 90% Krypton 4mm Planitherm One / 4S Edgetech Super Spacer Standard

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

Nominal 4mm etc to *0DP* , others *1DP*			
Glazing dimensions and properties:			
Thickness of pane 1	4	mm	
Pane 1/2 distance	8	mm	
Gas fill (1/2)	Krypton 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	1.114	W/(m²·K)	
g -value - *2DP* $g_\perp$			

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

Frame dimensions:	(b_f)	Without gasket (mm)	Gasket protrusion (mm)	With gasket (mm)	
All frame values to nearest 0.5mm, gaskets to *1DP*	F1 fixed sill	23	0.7	23.7	
	F2 fixed head	23	0.7	23.7	
	F3 fixed jamb	23	0.7	23.7	Total
F4 + F5 sash sill	F4 fixed sash sill	43	n/a	43	56.7
	F5 moving sash sill	13	0.7	13.7	
F6 + F7 sash head	F6 fixed sash head	43	n/a	43	56.7
	F7 moving sash head	13	0.7	13.7	
F8 + F9 sash jamb	F8 Fixed sash jamb	43	n/a	43	56.7
	F9 moving sash jamb	13	0.7	13.7	
F10 + F11 mullion	F10 fixed mullion	61	0.7	61.7	75.4
	F11 moving mullion	13	0.7	13.7	
	Total gasket area	0.0054267	m²		

Window Dimensions:			Area	
	Length	Width	No gasket	With gasket
Section	(m)	(m)	(m²)	(m²)
Fixed Light	1.4340	0.5615	0.8052	0.8024
Opening light	1.3680	0.5155	0.7052	0.7026
Total glazing, A_g			1.5104	1.5050
Frame	(m)	(m)	(m²)	(m²)
F1	0.6150	0.0230	0.0135	0.0139
F2	0.6150	0.0230	0.0135	0.0139
F3	1.4800	0.0230	0.0335	0.0345
F4	0.6150	0.0430	0.0249	0.0249
F5	0.5415	0.0130	0.0069	0.0072
F6	0.6150	0.0430	0.0249	0.0249
F7	0.5415	0.0130	0.0069	0.0072
F8	1.4800	0.0430	0.0618	0.0618
F9	1.3940	0.0130	0.0180	0.0189
F10	1.4800	0.0610	0.0883	0.0893
F11	1.3940	0.0130	0.0180	0.0189
Total Frame			0.3100	0.3154
Total Window, A_w			1.8204	1.8204
Percentage fixed light glass area			44.23%	44.08%
Percentage opening light glass area			38.74%	38.59%
Percentage glass area (total			82.97%	82.67%

Where a U_d value from hot box testing is available, nd $L_f{}^{2D}$ 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	**0.4700**	**190**		**0.4270**	**190**
F2 fixed head	**0.4700**	190		**0.4270**	190
F3 fixed jamb	**0.4700**	190		**0.4270**	190
F4 + F5 sash sill	**0.6440**	190		**0.6090**	190
F6 + F7 sash head	**0.6440**	190		**0.6090**	190
F8 + F9 sash jamb	**0.6440**	190		**0.6090**	190
F10 + F11 mullion	**1.0980**	380		**1.0200**	380

Frame:	b_f (no gaskets)	U_f	Frame areas (no gaskets)	Heat flow	Ψ	l_g	Heat flow
Section	(m)	(W/(m²·K))	(m²)	(W/K)	(W/(m·K))	(m)	(W/K)
F1 fixed sill	0.0230	7.2626	0.0135	0.0983	0.0483	0.5615	0.0271
F2 fixed head	0.0230	7.2626	0.0135	0.0983	0.0483	0.5615	0.0271
F3 fixed jamb	0.0230	7.2626	0.0335	0.2434	0.0483	1.4340	0.0693
F4 + F5 sash sill	0.0560	6.0900	0.0317	0.1933	0.0563	0.5155	0.0290
F6 + F7 sash head	0.0560	6.0900	0.0317	0.1933	0.0563	0.5155	0.0290
F8 + F9 sash jamb	0.0560	6.0900	0.0797	0.4856	0.0563	1.3680	0.0770
F10 + F11 mullion	0.0740	6.6497	0.1062	0.7063	0.1046	1.4010	0.1465
		Totals	0.3100	2.0184		Total	0.4051

Solar Factor, g-value:	F_w	0.9
	g_w	0.00

U_{window}	U_w	2.26	W/(m²·K)

Air Leakage loss:					
Air leakage at 50 Pa per hour & per unit length of opening light (BS 6375-1) *2DP*					m³/(m·h)
Opening light length	3.8710	m	Total air leakage	0.000	m³/h
L_{50}	0.00	m³/(m²·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	m²·K /W	R_{se} =	0.13	m²·K /W
Panel thickness, $d_p = d_g$ =	0.016	m	R_p =	0.4571	m²·K /W	R_{tot} =	0.6271	m²·K /W	U_p =	1.5945	W/(m²·K)

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

BFRC Rating =	
218.6g_{window} - 68.5 x (U_{window} + Effective L_{50}) =	**N/A**
Climate zone is:	**UK**
Thermal transmittance, W/(m²·K) U_{window}	**2.3**
Solar factor g_{window}	**N/A**
Window air leakage heat loss, W/(m²·K) L_{factor}	**N/A**

Simulator Name: Dr Gary Morgan

British Fenestration Rating Council

BFRC Certified Simulator 016

Version 11 23/10/2012. Calculations according to BS EN 673:2011

Number of spaces	Help
1	

		Spaces		1		
Glazing orientation			Pane 1	90%	Pane 2	
	Vertical					
Resistivity panes	1	m·K/W				
	Outside					
Emissivities						
Calculate				Gas		
				Krypton		
	Thickness (mm)		4.0	8	4.0	
	Normal emissivity			0.89	0.01	
	$\sum d_j \cdot r_j$=	0.008		Uncoated		

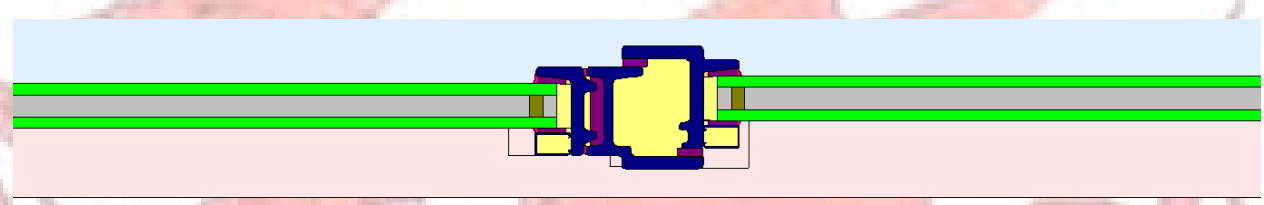
For uncoated surfaces input 0.89 for normal emissivity, which corresponds to a corrected emissivity of 0.837

Iteration number	U value W/(m²·K)	$\sum 1/h_s$ (m²·K)/W	λeff W/(mK)	ΔT
1	1.114	0.7199	0.0111	15
2	1.114	0.7199	0.0111	15

Simulation software: WinIso2D 7.80
Date: 29.04.2014
File: C:\Users\Gary\Documents\MyDocs from Thermbridge\Thermal Simulation Output Files\Steel Window Association\May 2014\W20 - Thermal Simulations\W20 Domestic Mild Steel Bead\W20 Domestic Mild Steel Bead Mullion.f2d

Calculation of the linear thermal transmission coefficient Ψ according to EN ISO 10077-2
Simulation model:

Dimensions (width x height): 454,23 x 64,69 mm
Number of elements in simulation model: X-direction: 341; Y-direction: 131



Boundary conditions:

External:

Temperature Θe:	0,00	°C
Surface resistance Rse:	0,040	m²K/W

Internal:

Temperature Θi:	20,00	°C
Surface resistance Rsi 1:	0,130	m²K/W
Surface resistance Rsi 2:	0,200	m²K/W

Results:

Temperature difference dT:	20,00	K
Total heat flow Q:	20,399	W/m
2D thermal conductance L2D:	1,020	W/mK
Length top/left:	190,00	mm
U-value top/left:	1,114	W/m²K
Length bottom/right:	190,00	mm
U-value bottom/right:	1,114	W/m²K
Ψ-value:	0,105	W/mK

Materials:

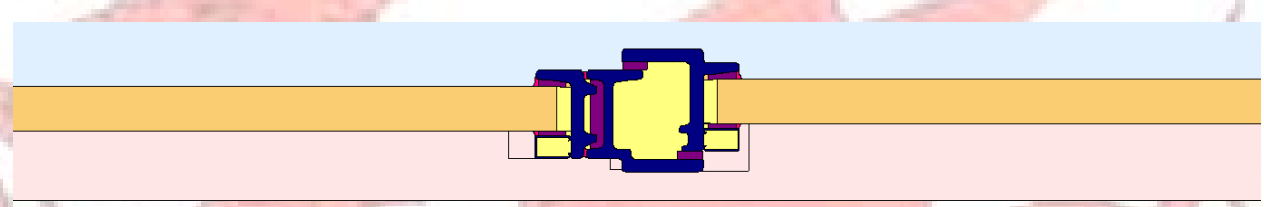
Material	R (m²K/W)	T (°C)	Q(gesamt) (W/m)	10077 konform
****ADIABAT****	0,000	0,000	0,000	
1 boundary condition intside 0,13, 20°C, 50%	0,130	20,000	16,246	X
1 boundary condition outside 0,04, 0°C, 80%	0,040	0,000	-20,399	X
1 boundary condition intside 0,20, 20°C, 50%	0,200	20,000	4,154	X
1 air EN ISO 10077-2 (cavities in profiles)				X
1 air EN ISO 10077-2 (cavities in profiles <=2mm)				X
1 air EN ISO 10077-2 (cavities in profiles, sparse ventilated)				X

Material	L (W/mK)	Emiss	10077 konform
2 float 1.0	1,000	0,837	-
3 structural steel 50	50,000	0,900	X
5 Elastomeric Foam Flexible	0,050	0,900	X
6 Silicon, unfilled	0,350	0,900	X
6 butyle	0,240	0,900	X
6 Super Spacer Standard	0,130	0,900	-
SZR L=0.0111	0,011	0,900	-

Simulation software: WinIso2D 7.80
Date: 29.04.2014
File: C:\Users\Gary\Documents\MyDocs from Thermbridge\Thermal Simulation Output Files\Steel Window Association\May 2014\W20 - Thermal Simulations\W20 Domestic Mild Steel Bead\W20 Domestic Mild Steel Bead Mullion.f2d

Calculation of the thermal transmission coefficient U_f according to EN ISO 10077-2:2003-12
Simulation model:

Dimensions (width x height): 454,23 x 64,69 mm
Number of elements in simulation model: X-direction: 341; Y-direction: 131



Boundary conditions:

External:

Temperature Θe:	0,00	°C
Surface resistance Rse:	0,040	m²K/W

Internal:

Temperature Θi:	20,00	°C
Surface resistance Rsi 1:	0,130	m²K/W
Surface resistance Rsi 2:	0,200	m²K/W

Results:

Temperature difference dT:	20,00	K
Total heat flow Q:	21,950	W/m
2D thermal conductance L2D:	1,098	W/mK
Length 1:	190,00	mm
U-value 1:	1,595	W/m²K
Length 2:	190,00	mm
U-value 2:	1,595	W/m²K
U_f-value:	6,552	W/m²K

Materials:

Material	R (m²K/W)	T (°C)	Q(gesamt) (W/m)	10077 konform
****ADIABAT****	0,000	0,000	0,000	
1 boundary condition intside 0,13, 20°C, 50%	0,130	20,000	16,246	X
1 boundary condition outside 0,04, 0°C, 80%	0,040	0,000	-20,399	X
1 boundary condition intside 0,20, 20°C, 50%	0,200	20,000	4,154	X
1 air EN ISO 10077-2 (cavities in profiles)				X
1 air EN ISO 10077-2 (cavities in profiles <=2mm)				X
1 air EN ISO 10077-2 (cavities in profiles, sparse ventilated)				X

Material	L (W/mK)	Emiss	10077 konform
2 float 1.0	1,000	0,837	-
3 structural steel 50	50,000	0,900	X
5 Elastomeric Foam Flexible	0,050	0,900	X
6 Silicon, unfilled	0,350	0,900	X
6 butyle	0,240	0,900	X
6 Super Spacer Standard	0,130	0,900	-
SZR L=0.0111	0,011	0,900	-

Simulation software: WinIso2D 7.80
Date: 29.04.2014
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Calculation of the linear thermal transmission coefficient Ψ according to EN ISO 10077-2
Simulation model:

Dimensions (width x height): 212,47 x 51,79 mm
Number of elements in simulation model: X-direction: 136; Y-direction: 66

Boundary conditions:

External:

Temperature Θe:	0,00	°C
Surface resistance Rse:	0,040	m²K/W

Internal:

Temperature Θi:	20,00	°C
Surface resistance Rsi 1:	0,130	m²K/W
Surface resistance Rsi 2:	0,200	m²K/W

Results:

Temperature difference dT:	20,00	K
Total heat flow Q:	8,534	W/m
2D thermal conductance L2D:	0,427	W/mK
Length top/left:	190,00	mm
U-value top/left:	1,114	W/m²K
Length bottom/right:	0,00	mm
U-value bottom/right:	0,000	W/m²K
Ψ-value:	0,048	W/mK

Materials:

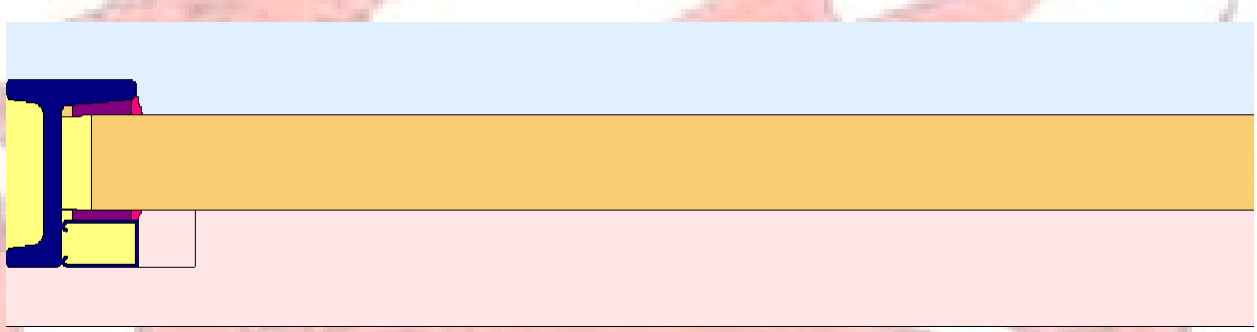
Material	R (m²K/W)	T (°C)	Q(gesamt) (W/m)	10077 konform
****ADIABAT****	0,000	0,000	0,000	
1 boundary condition intside 0,13, 20°C, 50%	0,130	20,000	7,402	X
1 boundary condition outside 0,04, 0°C, 80%	0,040	0,000	-8,534	X
1 boundary condition intside 0,20, 20°C, 50%	0,200	20,000	1,132	X
1 air EN ISO 10077-2 (cavities in profiles)				X
1 air EN ISO 10077-2 (cavities in profiles <=2mm)				X
1 air EN ISO 10077-2 (cavities in profiles, sparse ventilated)				X

Material	L (W/mK)	Emiss	10077 konform
2 float 1.0	1,000	0,837	-
3 structural steel 50	50,000	0,900	X
5 Elastomeric Foam Flexible	0,050	0,900	X
6 Silicon, unfilled	0,350	0,900	X
6 butyle	0,240	0,900	X
6 Super Spacer Standard	0,130	0,900	-
SZR L=0.0111	0,011	0,900	-

Simulation software: WinIso2D 7.80
Date: 29.04.2014
File: C:\Users\Gary\Documents\MyDocs from Thermbridge\Thermal Simulation Output Files\Steel Window Association\May 2014\W20 - Thermal Simulations\W20 Domestic Mild Steel Bead\W20 Domestic Mild Steel Bead Outer Frame.f2d

Calculation of the thermal transmission coefficient U_f according to EN ISO 10077-2:2003-12
Simulation model:

Dimensions (width x height): 212,47 x 51,79 mm
Number of elements in simulation model: X-direction: 136; Y-direction: 66



Boundary conditions:

External:

Temperature Θe:	0,00	°C
Surface resistance Rse:	0,040	m²K/W

Internal:

Temperature Θi:	20,00	°C
Surface resistance Rsi 1:	0,130	m²K/W
Surface resistance Rsi 2:	0,200	m²K/W

Results:

Temperature difference dT:	20,00	K
Total heat flow Q:	9,392	W/m
2D thermal conductance L2D:	0,470	W/mK
Length 1:	190,00	mm
U-value 1:	1,595	W/m²K
Length 2:	0,00	mm
U-value 2:	0,000	W/m²K
U_f-value:	7,241	W/m²K

Materials:

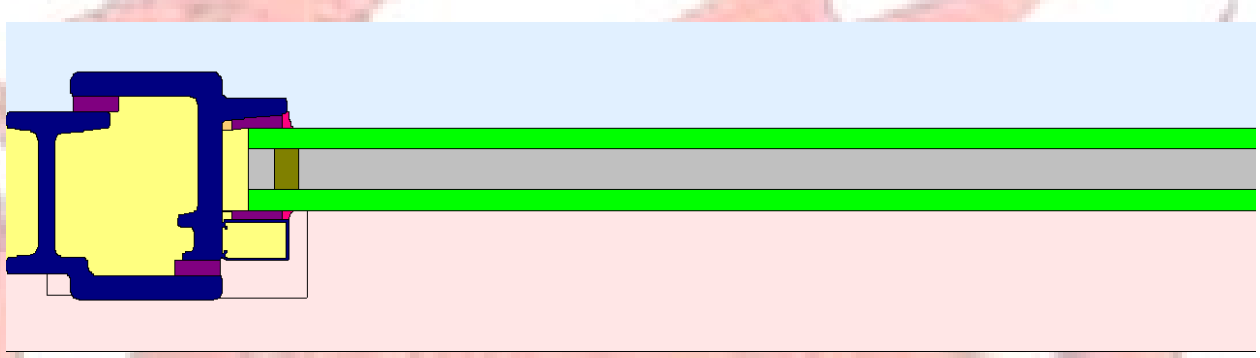
Material	R (m²K/W)	T (°C)	Q(gesamt) (W/m)	10077 konform
****ADIABAT****	0,000	0,000	0,000	
1 boundary condition intside 0,13, 20°C, 50%	0,130	20,000	7,402	X
1 boundary condition outside 0,04, 0°C, 80%	0,040	0,000	-8,534	X
1 boundary condition intside 0,20, 20°C, 50%	0,200	20,000	1,132	X
1 air EN ISO 10077-2 (cavities in profiles)				X
1 air EN ISO 10077-2 (cavities in profiles <=2mm)				X
1 air EN ISO 10077-2 (cavities in profiles, sparse ventilated)				X

Material	L (W/mK)	Emiss	10077 konform
2 float 1.0	1,000	0,837	-
3 structural steel 50	50,000	0,900	X
5 Elastomeric Foam Flexible	0,050	0,900	X
6 Silicon, unfilled	0,350	0,900	X
6 butyle	0,240	0,900	X
6 Super Spacer Standard	0,130	0,900	-
SZR L=0.0111	0,011	0,900	-

Simulation software: WinIso2D 7.80
Date: 28.04.2014
File: C:\Users\Gary\Documents\MyDocs from Thermbridge\Thermal Simulation Output Files\Steel Window Association\May 2014\W20 - Thermal Simulations\W20 Commercial Mild Steel Bead\W20 Coomercial Mild Steel Bead.f2d

Calculation of the linear thermal transmission coefficient Ψ according to EN ISO 10077-2
Simulation model:

Dimensions (width x height): 245,49 x 64,69 mm
Number of elements in simulation model: X-direction: 199; Y-direction: 104



Boundary conditions:

External:

Temperature Θe:	0,00	°C
Surface resistance Rse:	0,040	m²K/W

Internal:

Temperature Θi:	20,00	°C
Surface resistance Rsi 1:	0,130	m²K/W
Surface resistance Rsi 2:	0,200	m²K/W

Results:

Temperature difference dT:	20,00	K
Total heat flow Q:	12,188	W/m
2D thermal conductance L2D:	0,609	W/mK
Length top/left:	190,00	mm
U-value top/left:	1,114	W/m²K
Length bottom/right:	0,00	mm
U-value bottom/right:	0,000	W/m²K
Ψ-value:	0,057	W/mK

Materials:

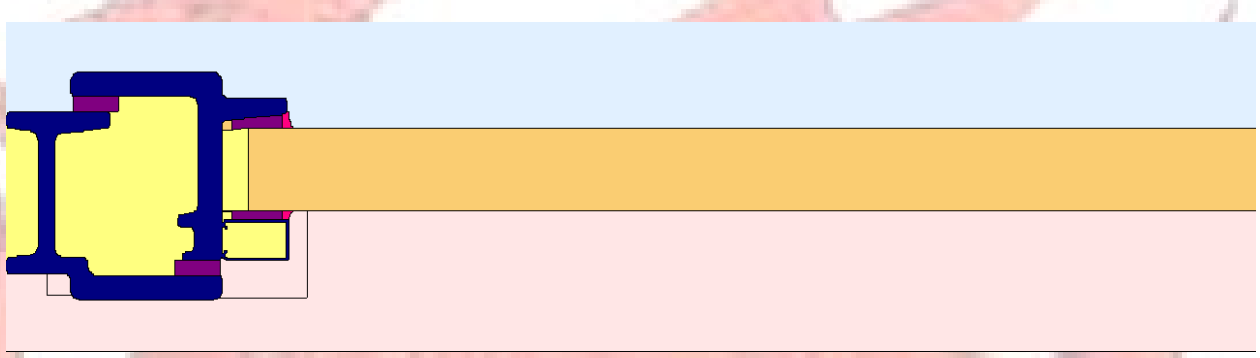
Material	R (m²K/W)	T (°C)	Q(gesamt) (W/m)	10077 konform
****ADIABAT****	0,000	0,000	0,000	
1 boundary condition intside 0,13, 20°C, 50%	0,130	20,000	9,150	X
1 boundary condition outside 0,04, 0°C, 80%	0,040	0,000	-12,188	X
1 boundary condition intside 0,20, 20°C, 50%	0,200	20,000	3,038	X
1 air EN ISO 10077-2 (cavities in profiles)				X
1 air EN ISO 10077-2 (cavities in profiles <=2mm)				X
1 air EN ISO 10077-2 (cavities in profiles, sparse ventilated)				X

Material	L (W/mK)	Emiss	10077 konform
2 float 1.0	1,000	0,837	X
3 structural steel 50	50,000	0,900	X
5 Elastomeric Foam Flexible	0,050	0,900	X
6 Silicon, unfilled	0,350	0,900	X
6 butyle	0,240	0,900	X
6 Super Spacer Standard	0,130	0,900	-
SZR L=0.0111	0,011	0,900	-

Simulation software: WinIso2D 7.80
Date: 28.04.2014
File: C:\Users\Gary\Documents\MyDocs from Thermbridge\Thermal Simulation Output Files\Steel Window Association\May 2014\W20 - Thermal Simulations\W20 Commercial Mild Steel Bead\W20 Coomercial Mild Steel Bead.f2d

Calculation of the thermal transmission coefficient U_f according to EN ISO 10077-2:2003-12
Simulation model:

Dimensions (width x height): 245,49 x 64,69 mm
Number of elements in simulation model: X-direction: 199; Y-direction: 104



Boundary conditions:

External:

Temperature Θe:	0,00	°C
Surface resistance Rse:	0,040	m²K/W

Internal:

Temperature Θi:	20,00	°C
Surface resistance Rsi 1:	0,130	m²K/W
Surface resistance Rsi 2:	0,200	m²K/W

Results:

Temperature difference dT:	20,00	K
Total heat flow Q:	12,876	W/m
2D thermal conductance L2D:	0,644	W/mK
Length 1:	190,00	mm
U-value 1:	1,595	W/m²K
Length 2:	0,00	mm
U-value 2:	0,000	W/m²K
U_f-value:	6,085	W/m²K

Materials:

Material	R (m²K/W)	T (°C)	Q(gesamt) (W/m)	10077 konform
****ADIABAT****	0,000	0,000	0,000	
1 boundary condition intside 0,13, 20°C, 50%	0,130	20,000	9,150	X
1 boundary condition outside 0,04, 0°C, 80%	0,040	0,000	-12,188	X
1 boundary condition intside 0,20, 20°C, 50%	0,200	20,000	3,038	X
1 air EN ISO 10077-2 (cavities in profiles)				X
1 air EN ISO 10077-2 (cavities in profiles <=2mm)				X
1 air EN ISO 10077-2 (cavities in profiles, sparse ventilated)				X

Material	L (W/mK)	Emiss	10077 konform
2 float 1.0	1,000	0,837	X
3 structural steel 50	50,000	0,900	X
5 Elastomeric Foam Flexible	0,050	0,900	X
6 Silicon, unfilled	0,350	0,900	X
6 butyle	0,240	0,900	X
6 Super Spacer Standard	0,130	0,900	-
SZR L=0.0111	0,011	0,900	-