

THERMAL SIMULATION REPORT

Report Number:	TCL2014-SWA-010
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:	Aluminium Bead Reference Drawing SWA-W20-010

Result

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

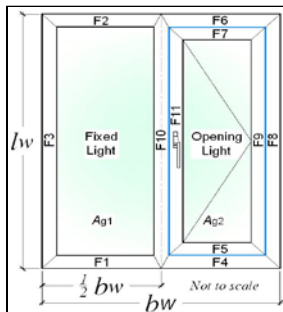
Signed: *G. Morgan*

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



**BFRC Certified
Simulator 016**



Sample Style:
Casement
Fixed Light / Side Hung

Blue line illustrates opening light length (air leakage)

Report Number: **TCL2014-SWA-010** 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 ODP	l_w	1480 mm
Total window width ODP	b_w	1230 mm

Nominal 4mm etc to ODP , 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/(m ² ·K)
g -value - 2DP	g

Frame dimensions:	(b _f)	Without gasket	Gasket protrusion	With gasket	
		(mm)	(mm)	(mm)	
All frame values to nearest 0.5mm, gaskets to 1DP	F1 fixed sill	23	0.7	23.7	Total
	F2 fixed head	23	0.7	23.7	
	F3 fixed jamb	23	0.7	23.7	
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	m ²

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

Window Dimensions:	Length		Area	
	(m)	(m)	No gasket (m ²)	With gasket (m ²)
Section	(m)	(m)	(m ²)	(m ²)
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)	(m ²)	(m ²)
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, n_d , r^{2D} or L_{ψ}^{2D} values need to be entered						
Frame conductance:	All L values to 4DP . All b values to ODP	All L values to 4DP . All b values to ODP		All L values to 4DP . All b values to ODP		
		$W/(m^2 \cdot K)$	b_p (mm)	$W/(m^2 \cdot K)$	b_p (mm)	
F1 fixed sill	L_f^{2D}	0.4540	190	L_{ψ}^{2D}	0.4140	190
F2 fixed head		0.4540	190		0.4140	190
F3 fixed jamb		0.4540	190		0.4140	190
F4 + F5 sash sill		0.6630	190		0.6250	190
F6 + F7 sash head		0.6630	190		0.6250	190
F8 + F9 sash jamb		0.6630	190		0.6250	190
F10 + F11 mullion		1.0980	380		1.0210	380

Frame:	b_f (no gaskets) (m)	U_f (W/(m ² ·K))	Frame areas (no gaskets) (m ²)	Heat flow (W/K)	ψ (W/(m·K))	l_g (m)	Heat flow (W/K)
Section	(m)	(W/(m ² ·K))	(m ²)	(W/K)	(W/(m·K))	(m)	(W/K)
F1 fixed sill	0.0230	6.5669	0.0135	0.0888	0.0513	0.5615	0.0288
F2 fixed head	0.0230	6.5669	0.0135	0.0888	0.0513	0.5615	0.0288
F3 fixed jamb	0.0230	6.5669	0.0335	0.2201	0.0513	1.4340	0.0736
F4 + F5 sash sill	0.0560	6.4293	0.0317	0.2040	0.0533	0.5155	0.0275
F6 + F7 sash head	0.0560	6.4293	0.0317	0.2040	0.0533	0.5155	0.0275
F8 + F9 sash jamb	0.0560	6.4293	0.0797	0.5127	0.0533	1.3680	0.0729
F10 + F11 mullion	0.0740	6.6497	0.1062	0.7063	0.1056	1.4010	0.1479
Totals				0.3100	2.0249	Total	0.4070

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			
Opening light length	3.8710 m	Total air leakage	0.000 m ³ /h
L_{50}	0.00 m ³ /(m ² ·h)	Heat loss = 0.0165 L_{50}	0.00 W/(m ² ·K)

Other parameters needed for calculation, taken from simulations:
 $\lambda_p = 0.035$ 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/(m ² ·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/(m ² ·K)	U _{window} 2.3
Solar factor	g _{window} N/A
Window air leakage heat loss, W/(m ² ·K)	L _{factor} N/A



Simulator Name: **Dr Gary Morgan**

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			P a n e 1	90%	P a n e 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	$\sum 1/h_s$	λ_{eff}	ΔT
	W/(m ² ·K)	(m ² ·K)/W	W/(mK)	
1	1.114	0.7199	0.0111	15
2	1.114	0.7199	0.0111	15

Simulation software: WinIso2D 7.80

Date: 30.04.2014

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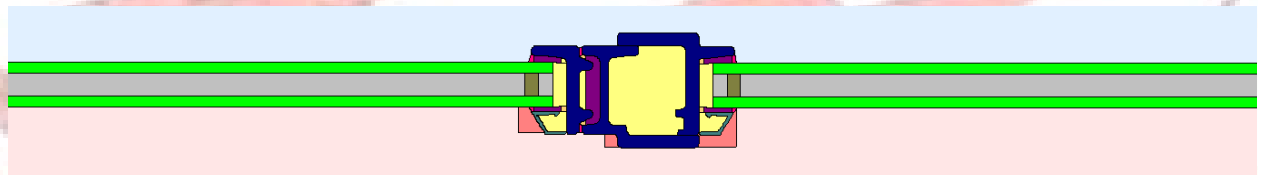


Calculation of the linear thermal transmission coefficient Ψ according to EN ISO 10077-2

Simulation model:

Dimensions (width x height): 453,64 x 61,69 mm

Number of elements in simulation model: X-direction: 369; Y-direction: 124



Boundary conditions:

External:

Temperature Θ_e : 0,00 °C

Surface resistance R_{se} : 0,040 m²K/W

Internal:

Temperature Θ_i : 20,00 °C

Surface resistance R_{si} 1: 0,130 m²K/W

Surface resistance R_{si} 2: 0,200 m²K/W

Results:

Temperature difference dT : 20,00 K

Total heat flow Q : 20,425 W/m

2D thermal conductance L_{2D} : 1,021 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: 0,106 W/mK

Materials:

Material	R (m ² K/W)	T (°C)	Q(gesamt) (W/m)	10077 konform
****ADIABAT****	0,000	0,000	0,000	
1 boundary condition inside 0,13, 20°C, 50%	0,130	20,000	16,845	X
1 boundary condition outside 0,04, 0°C, 80%	0,040	0,000	-20,425	X
1 boundary condition inside 0,20, 20°C, 50%	0,200	20,000	3,579	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
3 alu (Si-Leg.) 160	160,000	0,900		X
3 structural steel 50 (2)	50,000	0,900		X
3 structural steel 50	50,000	0,900		X
2 Float Glass 1.0	1,000	0,837		X
5 PVC soft	0,140	0,900		X
5 Elastomeric Foam Flexible	0,050	0,900		X
6 Silicon, unfilled	0,350	0,900		X
6 Super Spacer Standard	0,130	0,900		-
6 butyle	0,240	0,900		X
SZR L=0.0111	0,011	0,900		-

Simulation software: WinIso2D 7.80

Date: 30.04.2014

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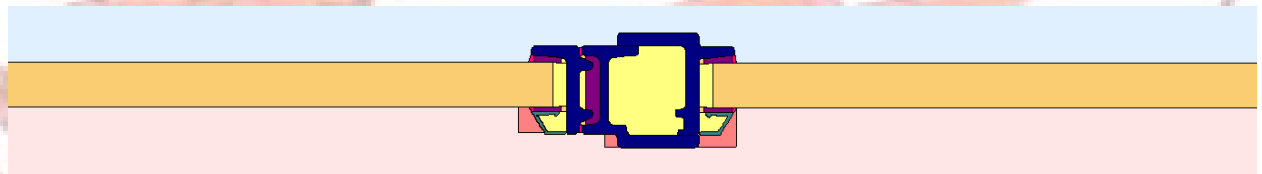


Calculation of the thermal transmission coefficient U_f according to EN ISO 10077-2:2003-12

Simulation model:

Dimensions (width x height): 453,64 x 61,69 mm

Number of elements in simulation model: X-direction: 369; Y-direction: 124



Boundary conditions:

External:

Temperature Θ_e :	0,00	°C
Surface resistance R_{se} :	0,040	m ² K/W

Internal:

Temperature Θ_i :	20,00	°C
Surface resistance R_{si} 1:	0,130	m ² K/W
Surface resistance R_{si} 2:	0,200	m ² K/W

Results:

Temperature difference dT :	20,00	K
Total heat flow Q :	21,962	W/m
2D thermal conductance $L2D$:	1,098	W/mK
Length 1:	190,00	mm
U-value 1:	1,595	W/m ² K
Length 2:	190,00	mm
U-value 2:	1,595	W/m ² K
U_f -value:	6,474	W/m ² K

Materials:

Material	R (m ² K/W)	T (°C)	Q(gesamt) (W/m)	10077 konform
****ADIABAT****	0,000	0,000	0,000	
1 boundary condition inside 0,13, 20°C, 50%	0,130	20,000	16,845	X
1 boundary condition outside 0,04, 0°C, 80%	0,040	0,000	-20,425	X
1 boundary condition inside 0,20, 20°C, 50%	0,200	20,000	3,579	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
3 alu (Si-Leg.) 160	160,000	0,900		X
3 structural steel 50 (2)	50,000	0,900		X
3 structural steel 50	50,000	0,900		X
2 Float Glass 1.0	1,000	0,837		X
5 PVC soft	0,140	0,900		X
5 Elastomeric Foam Flexible	0,050	0,900		X
6 Silicon, unfilled	0,350	0,900		X
6 Super Spacer Standard	0,130	0,900		-
6 butyle	0,240	0,900		X
SZR L=0.0111	0,011	0,900		-

Simulation software: WinIso2D 7.80

Date: 30.04.2014

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

Simulation model:

Dimensions (width x height): 212,18 x 51,79 mm

Number of elements in simulation model: X-direction: 153; Y-direction: 77



Boundary conditions:

External:

Temperature Θ_e : 0,00 °C

Surface resistance R_{se} : 0,040 m²K/W

Internal:

Temperature Θ_i : 20,00 °C

Surface resistance R_{si} 1: 0,130 m²K/W

Surface resistance R_{si} 2: 0,200 m²K/W

Results:

Temperature difference dT : 20,00 K

Total heat flow Q : 8,276 W/m

2D thermal conductance L_{2D} : 0,414 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: 0,051 W/mK

Materials:

Material	R (m ² K/W)	T (°C)	Q(gesamt) (W/m)	10077 konform
****ADIABAT****	0,000	0,000	0,000	
1 boundary condition inside 0,13, 20°C, 50%	0,130	20,000	7,248	X
1 boundary condition outside 0,04, 0°C, 80%	0,040	0,000	-8,276	X
1 boundary condition inside 0,20, 20°C, 50%	0,200	20,000	1,028	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
3 alu (Si-Leg.) 160	160,000	0,900		X
3 structural steel 50 (2)	50,000	0,900		X
3 structural steel 50	50,000	0,900		X
2 Float Glass 1.0	1,000	0,837		X
5 PVC soft	0,140	0,900		X
5 Elastomeric Foam Flexible	0,050	0,900		X
6 Silicon, unfilled	0,350	0,900		X
6 Super Spacer Standard	0,130	0,900		-
6 butyle	0,240	0,900		X
SZR L=0.0111	0,011	0,900		-

Simulation software: WinIso2D 7.80

Date: 30.04.2014

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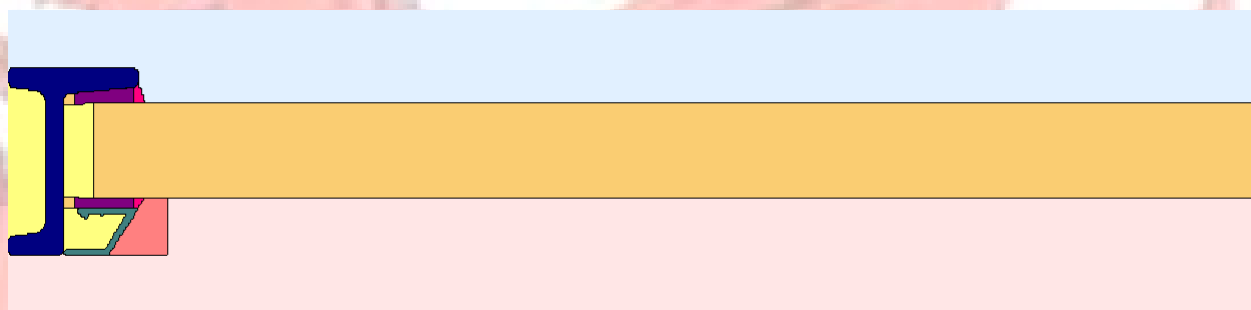


Calculation of the thermal transmission coefficient U_f according to EN ISO 10077-2:2003-12

Simulation model:

Dimensions (width x height): 212,18 x 51,79 mm

Number of elements in simulation model: X-direction: 153; Y-direction: 77



Boundary conditions:

External:

Temperature Θ_e : 0,00 °C

Surface resistance R_{se} : 0,040 m²K/W

Internal:

Temperature Θ_i : 20,00 °C

Surface resistance R_{si} 1: 0,130 m²K/W

Surface resistance R_{si} 2: 0,200 m²K/W

Results:

Temperature difference dT : 20,00 K

Total heat flow Q : 9,087 W/m

2D thermal conductance $L2D$: 0,454 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: 6,578 W/m²K

Materials:

Material	R (m ² K/W)	T (°C)	Q(gesamt) (W/m)	10077 konform
****ADIABAT****	0,000	0,000	0,000	
1 boundary condition inside 0,13, 20°C, 50%	0,130	20,000	7,248	X
1 boundary condition outside 0,04, 0°C, 80%	0,040	0,000	-8,276	X
1 boundary condition inside 0,20, 20°C, 50%	0,200	20,000	1,028	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
3 alu (Si-Leg.) 160	160,000	0,900		X
3 structural steel 50 (2)	50,000	0,900		X
3 structural steel 50	50,000	0,900		X
2 Float Glass 1.0	1,000	0,837		X
5 PVC soft	0,140	0,900		X
5 Elastomeric Foam Flexible	0,050	0,900		X
6 Silicon, unfilled	0,350	0,900		X
6 Super Spacer Standard	0,130	0,900		-
6 butyle	0,240	0,900		X
SZR L=0.0111	0,011	0,900		-

Simulation software: WinIso2D 7.80

Date: 30.04.2014

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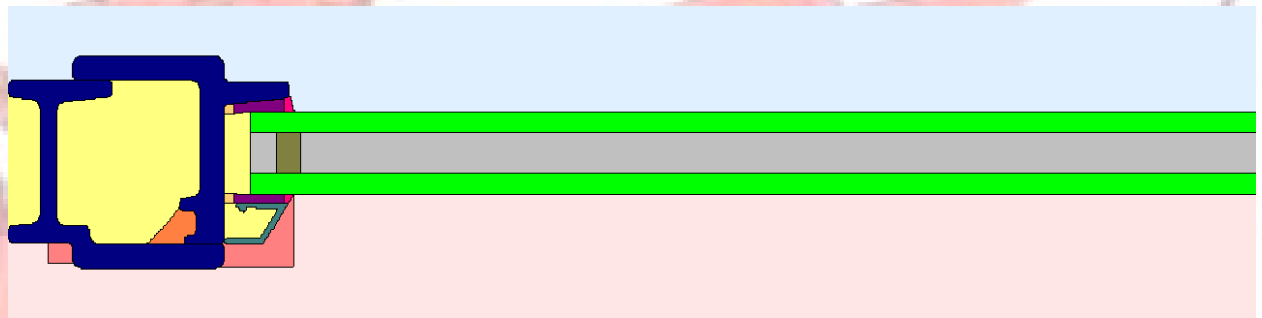


Calculation of the linear thermal transmission coefficient Ψ according to EN ISO 10077-2

Simulation model:

Dimensions (width x height): 245,20 x 61,69 mm

Number of elements in simulation model: X-direction: 230; Y-direction: 109



Boundary conditions:

External:

Temperature Θ_e : 0,00 °C

Surface resistance R_{se} : 0,040 m²K/W

Internal:

Temperature Θ_i : 20,00 °C

Surface resistance R_{si} 1: 0,130 m²K/W

Surface resistance R_{si} 2: 0,200 m²K/W

Results:

Temperature difference dT : 20,00 K

Total heat flow Q : 12,496 W/m

2D thermal conductance $L2D$: 0,625 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: 0,054 W/mK

Materials:

Material	R (m ² K/W)	T (°C)	Q(gesamt) (W/m)	10077 konform
****ADIABAT****	0,000	0,000	0,000	
1 boundary condition inside 0,13, 20°C, 50%	0,130	20,000	9,970	X
1 boundary condition outside 0,04, 0°C, 80%	0,040	0,000	-12,496	X
1 boundary condition inside 0,20, 20°C, 50%	0,200	20,000	2,526	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
3 alu (Si-Leg.) 160	160,000	0,900		X
3 structural steel 50 (2)	50,000	0,900		X
3 structural steel 50	50,000	0,900		X
2 Float Glass 1.0	1,000	0,837		X
5 PVC soft	0,140	0,900		X
5 Elastomeric Foam Flexible	0,050	0,900		X
6 Silicon, unfilled	0,350	0,900		X
6 Super Spacer Standard	0,130	0,900		-
6 butyle	0,240	0,900		X
SZR L=0.0111	0,011	0,900		-

Simulation software: WinIso2D 7.80

Date: 30.04.2014

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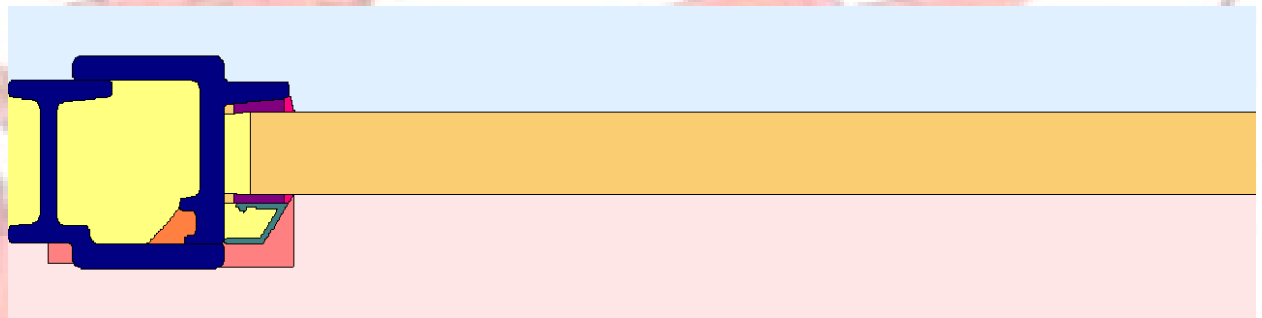


Calculation of the thermal transmission coefficient U_f according to EN ISO 10077-2:2003-12

Simulation model:

Dimensions (width x height): 245,20 x 61,69 mm

Number of elements in simulation model: X-direction: 230; Y-direction: 109



Boundary conditions:

External:

Temperature Θ_e : 0,00 °C

Surface resistance R_{se} : 0,040 m²K/W

Internal:

Temperature Θ_i : 20,00 °C

Surface resistance R_{si} 1: 0,130 m²K/W

Surface resistance R_{si} 2: 0,200 m²K/W

Results:

Temperature difference dT : 20,00 K

Total heat flow Q : 13,250 W/m

2D thermal conductance $L2D$: 0,663 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: 6,419 W/m²K

Materials:

Material	R (m ² K/W)	T (°C)	Q(gesamt) (W/m)	10077 konform
****ADIABAT****	0,000	0,000	0,000	
1 boundary condition inside 0,13, 20°C, 50%	0,130	20,000	9,970	X
1 boundary condition outside 0,04, 0°C, 80%	0,040	0,000	-12,496	X
1 boundary condition inside 0,20, 20°C, 50%	0,200	20,000	2,526	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
3 alu (Si-Leg.) 160	160,000	0,900		X
3 structural steel 50 (2)	50,000	0,900		X
3 structural steel 50	50,000	0,900		X
2 Float Glass 1.0	1,000	0,837		X
5 PVC soft	0,140	0,900		X
5 Elastomeric Foam Flexible	0,050	0,900		X
6 Silicon, unfilled	0,350	0,900		X
6 Super Spacer Standard	0,130	0,900		-
6 butyle	0,240	0,900		X
SZR L=0.0111	0,011	0,900		-