THERMAL SIMULATION REPORT

Report Number:	**TCL2014-SWA-016**
Prepared For:	**Steel Window Association 42 Heath Street Tamworth Staffordshire B79 7HJ**
Window System Identifier:	**W40**
Meeting Rail Identifier:	**SW5/SWX8**
Vent Frame Identifier:	**SW5/SW8**
Fixed Outer Frame Identifier:	**SW7**
Glazing System:	**4mm Planitherm One/4S – 8mm 90% Krypton – 4mm Planilux -8 mm 90% Krypton – 4mm Planitherm One/4S**
Spacer Bar:	**8mm Edgetech Super Spacer Standard with butyl secondary sealant**
Notes:	**Aluminium Bead Reference Drawing SWA-W40-014**

Result

Thermal Transmittance (U_{Window})	**1.8**	*W/(m^{2}K)*

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

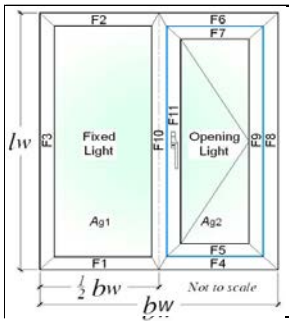
Report Prepared By *Dr Gary Morgan*
Therm Consulting

Signed: *G Morgan*

Date: *22nd May 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-016 Issue No 22.1: 11/03/2013

Report Date: 22 May 2014

Project Details: 4-8-4-8-4 Planitherm One / 4S (x2) Clear Float 90% Krypton Super Spacer Standard

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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	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	8	mm
Gas fill (2/3)	Krypton 90%	
Thickness of pane 3	4.0	mm
Glazing Trans. - *3DP* U_g	0.602	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)	Frame width, b_f (mm)	Gasket protrusion, b_{gf} (mm)	Frame & gasket widths (mm)	
All frame values round to neares 1mm, gaskets to *1DP*	F1 fixed sill	29	0.5	29.5	
	F2 fixed head	29	0.5	29.5	
	F3 fixed jamb	29	0.5	29.5	Total
F4 + F5 sash sill	F4 fixed sash sill	39	n/a	39.0	54.5
	F5 moving sash sill	15	0.5	15.5	
F6 + F7 sash head	F6 fixed sash head	39	n/a	39.0	54.5
	F7 moving sash head	15	0.5	15.5	
F8 + F9 sash jamb	F8 Fixed sash jamb	39	n/a	39.0	54.5
	F9 moving sash jamb	15	0.5	15.5	
F10 + F11 mullion	F10 fixed mullion	54	0.5	54.5	70.0
	F11 moving mullion	15	0.5	15.5	
	Total gasket area		0.00387	m^2	

Window Dimensions:

Section	Length (m)	Width (m)	Area No gasket (m^2)	Area With gasket (m^2)
Fixed Light	1.4220	0.5590	0.7949	0.7929
Opening light	1.3720	0.5190	0.7121	0.7102
Total glazing, A_g			1.5070	1.5031
Frame	(m)	(m)	(m^2)	(m^2)
F1	0.6150	0.0290	0.0170	0.0173
F2	0.6150	0.0290	0.0170	0.0173
F3	1.4800	0.0290	0.0421	0.0428
F4	0.6150	0.0390	0.0227	0.0227
F5	0.5490	0.0150	0.0080	0.0083
F6	0.6150	0.0390	0.0227	0.0227
F7	0.5490	0.0150	0.0080	0.0083
F8	1.4800	0.0390	0.0562	0.0562
F9	1.4020	0.0150	0.0208	0.0215
F10	1.4800	0.0540	0.0781	0.0788
F11	1.4020	0.0150	0.0208	0.0215
Total Frame			0.3134	0.3173
Total Window, A_w			1.8204	1.8204
Percentage fixed light glass area			43.67%	43.56%
Percentage opening light glass area			39.12%	39.01%
Percentage glass area (total			82.78%	82.57%

Where a U_w value from hot box testing is available, ne $L_f{}^{2D}$ 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	0.3940	190	0.3620	190
F2 fixed head	0.3940	190	0.3620	190
F3 fixed jamb	0.3940	190	0.3620	190
F4 + F5 sash sill	0.5270	190	0.5000	190
F6 + F7 sash head	0.5270	190	0.5000	190
F8 + F9 sash jamb	0.5270	190	0.5000	190
F10 + F11 mullion	0.8360	380	0.7760	380

Frame:

Section	Frame width, b_f (m)	Frame U-value, U (W/(m²·K))	Frame areas, A (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	0.0290	6.8319	0.0170	0.1163	0.0495	0.5590	0.0277
F2 fixed head	0.0290	6.8319	0.0170	0.1163	0.0495	0.5590	0.0277
F3 fixed jamb	0.0290	6.8319	0.0421	0.2875	0.0495	1.4220	0.0704
F4 + F5 sash sill	0.0540	6.1319	0.0307	0.1883	0.0545	0.5190	0.0283
F6 + F7 sash head	0.0540	6.1319	0.0307	0.1883	0.0545	0.5190	0.0283
F8 + F9 sash jamb	0.0540	6.1319	0.0770	0.4722	0.0545	1.3720	0.0748
F10 + F11 mullion	0.0690	6.4384	0.0989	0.6367	0.1030	1.3970	0.1439
Totals			0.3134	2.0055		Total	0.4009

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	3.9020	m	Total air leakage	0.000	m^3/h
L_{50}	0.00	$m^3/(m^2 \cdot h)$	Heat loss = 0.0165 L_{50}	0.00	W/(m²·K)

Solar Factor, *g*-value:

F_w	0.9
g_w	0.00

U_{window}		W/(m²·K)
	No bars; or attached bars	1.82
	Single cross bar in IGU	1.9
	Multiple cross bar in IGU	2.0
	Glazing bar (Georgian bar)	2.2

Other parameters needed for calculation, taken from simulations:

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

BFRC Rating kWh/(m²·yr)	Label index	EWER Rating Scale	Window Rating
≥10	N/A	A+	N/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	

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}	1.8
Solar factor	g_{window}	N/A
Window air leakage heat loss, W/(m²·K)	L_{factor}	N/A

British Fenestration Rating Council

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
2	

			Spaces	1		2	
Glazing orientation				Pane 1	Pane 2	Pane 3	
	Vertical						
Resistivity panes	1	m·K/W		90%		90%	
Outside							
Emissivities							
Calculate				Gas		Gas	
				Krypton		Krypton	
	Thickness (mm)		4.0	8	4.0	8	44
	Normal emissivity			0.01	0.89	0.89	0.01
	$\sum d_j \cdot r_j =$	0.052			Uncoated	Uncoated	

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

Iteration number	U value	$\sum 1/h_s$	λeff	ΔT	λeff	ΔT
	W/(m²·K)	(m²·K)/W	W/(mK)		W/(mK)	
1	0.602	1.4398	0.0111	7.5	0.0111	7.5
2	0.602	1.4398	0.0111	7.5	0.0111	7.5

Simulation software: WinIso2D 7.80
Date: 22.05.2014
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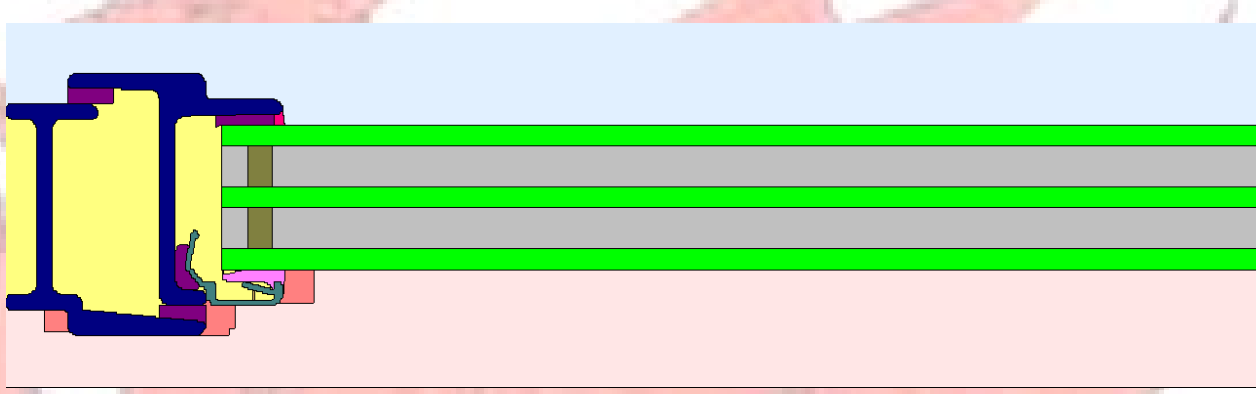
Calculation of the linear thermal transmission coefficient Ψ according to EN ISO 10077-2

Simulation model:

Dimensions (width x height): 243,99 x 70,90 mm

Number of elements in simulation model: X-direction: 217; 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:		10,005	W/m
2D thermal conductance L2D:	0,500	W/mK	
Length top/left:	190,00	mm	
U-value top/left:		0,602	W/m²K
Length bottom/right:		0,00	mm
U-value bottom/right:		0,000	W/m²K
Ψ-value:		0,055	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	7,755	X
1 boundary condition outside 0,04, 0°C, 80%	0,040	0,000	-10,005	X
1 boundary condition intside 0,20, 20°C, 50%	0,200	20,000	2,250	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 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
6 Silicon, unfilled	0,350	0,900	X
5 Elastomeric Foam Flexible	0,050	0,900	X
6 Super Spacer Standard	0,130	0,900	X
6 butyle	0,240	0,900	X
3 alu (Si-Leg.) 160	160,000	0,900	X
SZR L=0.0108	0,011	0,900	-

Simulation software: WinIso2D 7.80
Date: 22.05.2014
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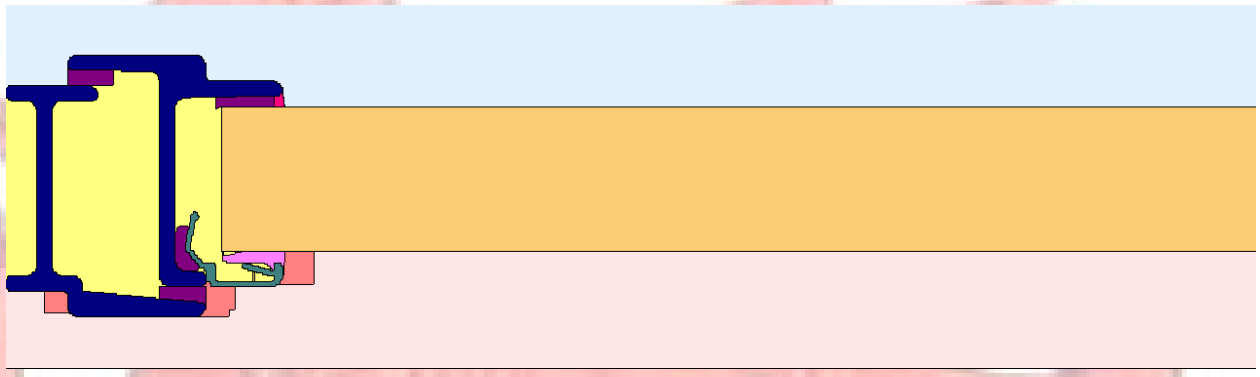
Calculation of the thermal transmission coefficient U_f according to EN ISO 10077-2:2003-12
Simulation model:

Dimensions (width x height): 243,99 x 70,90 mm
Number of elements in simulation model: X-direction: 217; 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:	10,536	W/m
2D thermal conductance L2D:	0,527	W/mK
Length 1:	190,00	mm
U-value 1:	1,031	W/m²K
Length 2:	0,00	mm
U-value 2:	0,000	W/m²K
U_f-value:	6,128	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	7,755	X
1 boundary condition outside 0,04, 0°C, 80%	0,040	0,000	-10,005	X
1 boundary condition intside 0,20, 20°C, 50%	0,200	20,000	2,250	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 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
6 Silicon, unfilled	0,350	0,900	X
5 Elastomeric Foam Flexible	0,050	0,900	X
6 Super Spacer Standard	0,130	0,900	X
6 butyle	0,240	0,900	X
3 alu (Si-Leg.) 160	160,000	0,900	X
SZR L=0.0108	0,011	0,900	-

Simulation software: WinIso2D 7.80
Date: 22.05.2014
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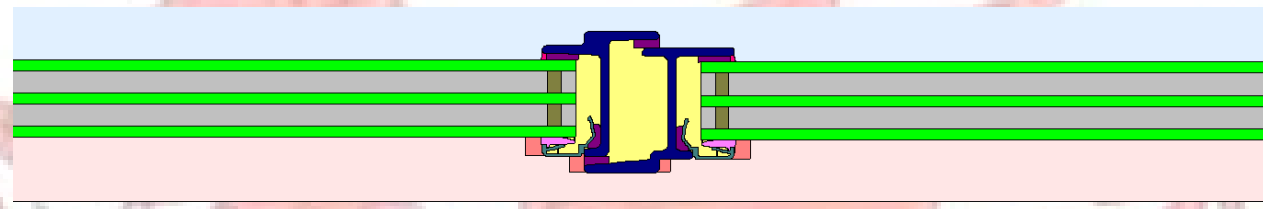
Calculation of the linear thermal transmission coefficient Ψ according to EN ISO 10077-2
Simulation model:

Dimensions (width x height): 448,98 x 69,99 mm
Number of elements in simulation model: X-direction: 356; Y-direction: 142



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:	15,513	W/m
2D thermal conductance L2D:	0,776	W/mK
Length top/left:	190,00	mm
U-value top/left:	0,602	W/m²K
Length bottom/right:	190,00	mm
U-value bottom/right:	0,602	W/m²K
Ψ-value:	0,102	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	12,642	X
1 boundary condition outside 0,04, 0°C, 80%	0,040	0,000	-15,513	X
1 boundary condition intside 0,20, 20°C, 50%	0,200	20,000	2,871	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 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
6 Silicon, unfilled	0,350	0,900	X
5 Elastomeric Foam Flexible	0,050	0,900	X
6 Super Spacer Standard	0,130	0,900	X
6 butyle	0,240	0,900	X
3 alu (Si-Leg.) 160	160,000	0,900	X
SZR L=0.0108	0,011	0,900	-
PS 025 (EPS)	0,025	0,900	-

Simulation software: WinIso2D 7.80
Date: 22.05.2014
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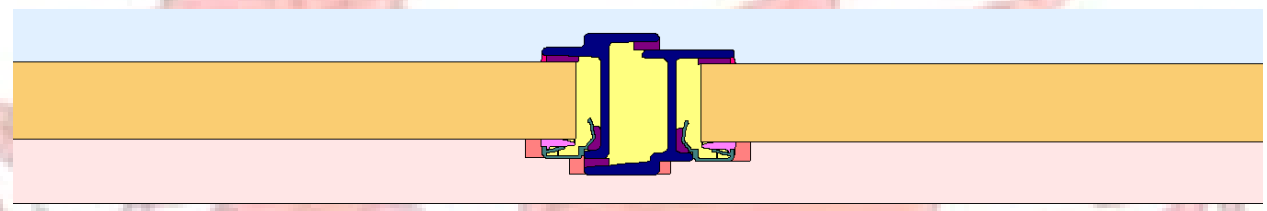
Calculation of the thermal transmission coefficient U_f according to EN ISO 10077-2:2003-12
Simulation model:

Dimensions (width x height): 448,98 x 69,99 mm
Number of elements in simulation model: X-direction: 356; Y-direction: 142



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:	16,725	W/m
2D thermal conductance L2D:	0,836	W/mK
Length 1:	190,00	mm
U-value 1:	1,031	W/m²K
Length 2:	190,00	mm
U-value 2:	1,031	W/m²K
U_f-value:	6,442	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	12,642	X
1 boundary condition outside 0,04, 0°C, 80%	0,040	0,000	-15,513	X
1 boundary condition intside 0,20, 20°C, 50%	0,200	20,000	2,871	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 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
6 Silicon, unfilled	0,350	0,900	X
5 Elastomeric Foam Flexible	0,050	0,900	X
6 Super Spacer Standard	0,130	0,900	X
6 butyle	0,240	0,900	X
3 alu (Si-Leg.) 160	160,000	0,900	X
SZR L=0.0108	0,011	0,900	-
PS 025 (EPS)	0,025	0,900	-

Simulation software: WinIso2D 7.80
Date: 22.05.2014
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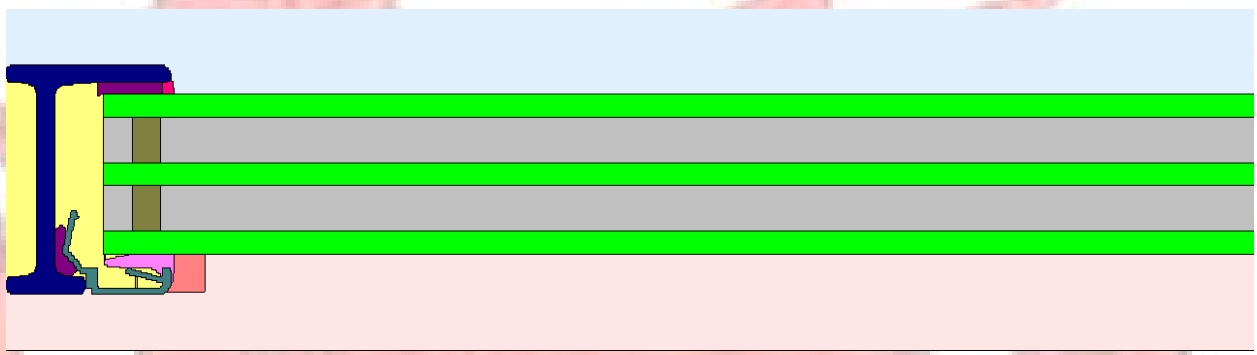
Calculation of the linear thermal transmission coefficient Ψ according to EN ISO 10077-2
Simulation model:

Dimensions (width x height): 219,00 x 60,00 mm
Number of elements in simulation model: X-direction: 163; Y-direction: 81



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:		7,248	W/m
2D thermal conductance L2D:	0,362	W/mK	
Length top/left:	190,00	mm	
U-value top/left:		0,602	W/m²K
Length bottom/right:		0,00	mm
U-value bottom/right:		0,000	W/m²K
Ψ-value:		0,050	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	6,544	X
1 boundary condition outside 0,04, 0°C, 80%	0,040	0,000	-7,248	X
1 boundary condition intside 0,20, 20°C, 50%	0,200	20,000	0,703	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 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
6 Silicon, unfilled	0,350	0,900	X
5 Elastomeric Foam Flexible	0,050	0,900	X
6 Super Spacer Standard	0,130	0,900	X
6 butyle	0,240	0,900	X
3 alu (Si-Leg.) 160	160,000	0,900	X
SZR L=0.0108	0,011	0,900	-

Simulation software: WinIso2D 7.80
Date: 22.05.2014
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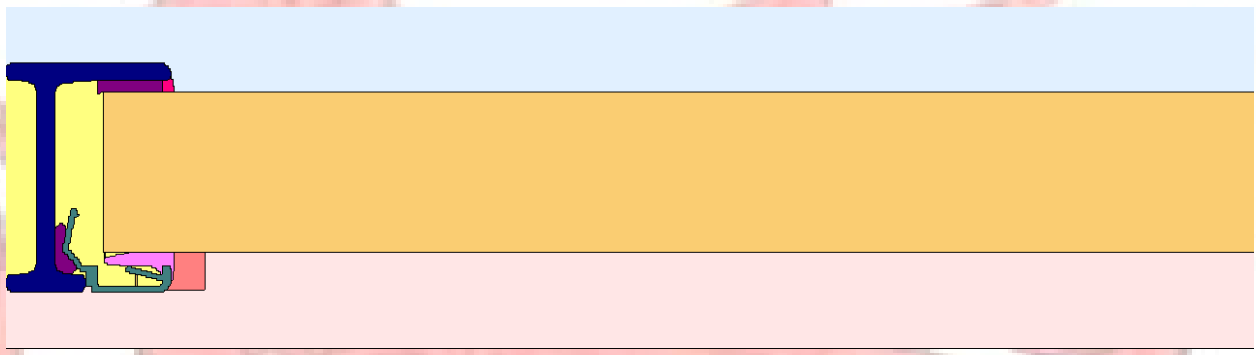
Calculation of the thermal transmission coefficient U_f according to EN ISO 10077-2:2003-12
Simulation model:

Dimensions (width x height): 219,00 x 60,00 mm
Number of elements in simulation model: X-direction: 163; Y-direction: 81



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:	7,870	W/m
2D thermal conductance L2D:	0,394	W/mK
Length 1:	190,00	mm
U-value 1:	1,031	W/m²K
Length 2:	0,00	mm
U-value 2:	0,000	W/m²K
U_f-value:	6,814	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	6,544	X
1 boundary condition outside 0,04, 0°C, 80%	0,040	0,000	-7,248	X
1 boundary condition intside 0,20, 20°C, 50%	0,200	20,000	0,703	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 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
6 Silicon, unfilled	0,350	0,900	X
5 Elastomeric Foam Flexible	0,050	0,900	X
6 Super Spacer Standard	0,130	0,900	X
6 butyle	0,240	0,900	X
3 alu (Si-Leg.) 160	160,000	0,900	X
SZR L=0.0108	0,011	0,900	-