Quantifizierung Wärmebrücken

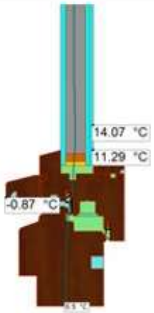
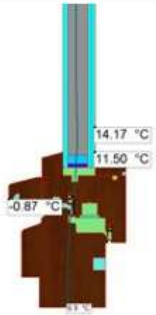
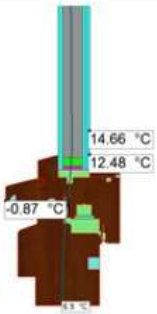
Fenster- und Fensteranschluss

Leitdetails für typische Fenstersanierungslösungen unter Angabe der Wärmedurchgangskoeffizienten und der Psi-Werte.

Analyse des hygrothermischen Risikos an kritischen Punkten

Am Beispiel eines neuen Einfachfensters mit Isolierverglasung eingebaut in eine historische Natursteinmauer

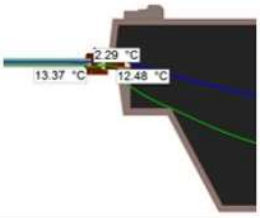
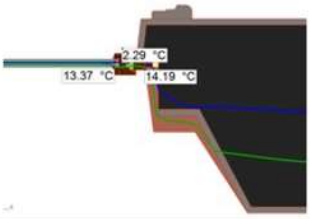
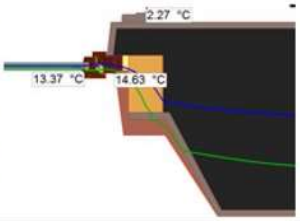
Optimierung am Glasabstandshalter

Fensterrahmen unten	Abstandshalter 1	Abstandshalter 2	Abstandshalter 3
Simulation Fenster mit 3 verschiedenen Lösungen für den Glas-Abstandshalter			
Beschreibung	Warm-Edge-Edelstahl-Abstandhalter mit 6,5mm und einer Wandstärke von 0,18 mm (Chromatech)	7 mm hoher Warm-Edge-Edelstahl-Abstandhalter mit 0,15 mm Wandstärke mit geriffelter Oberfläche zur Lichtbrechung (Chromatech Plus)	Reduzierte Profilhöhe: 6,9 mm; niedriger Wärmedurchlass: Edelstahl 15,0 W/(mK), Spezialkunststoff 0,17 W/(mK) (Chromatech Ultra)
f_{Rsi}	0.583	0.593	0.640
T_{min}	11.3°C	11.5°C	12.5°C
U_f in W/m²K; ψ_g in W/mK	1.55 0.063	1.55 0.060	1.55 0.0458

*bei Außentemperatur von -0.9 und rel. Feuchte innen 42.5%

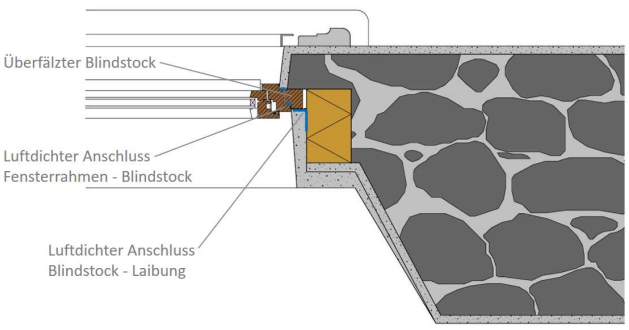
Detail Glasabstandhalter: Die thermische Simulation des unteren Profils des für einen Fensteraustausch vorgeschlagenen Fensters ergibt einen Wärmebrückenkoeffizienten der Verglasungskante, ψg, von 0,063 W/mK und einen Kondensationstemperaturfaktor, fRsi, von 0,583. Letzterer erfüllt nicht die Anforderungen des Casaclima R-Protokolls. Es wird vorgeschlagen den ursprünglich vorgesehenen Abstandhalter aus Edelstahl (1) mit einem Abstandhalter aus Edelstahl mit optimierter Geometrie (2) oder mit einem Hybrid-Abstandhalter aus Spezialkunststoff und einer feinen Struktur aus Edelstahl (3) zu ersetzen. Wie in Abbildung dargestellt, verursachen diese Abstandhalter keine hygrothermischen Risiken und führen zu einer Verbesserung der Wärmebrücke.

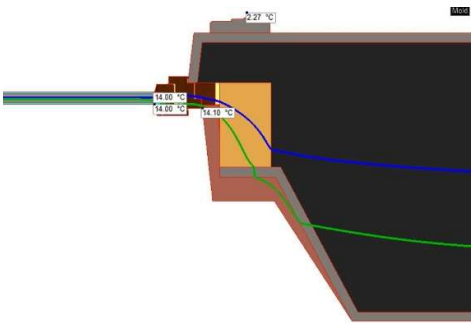
Optimierung Fenster-Wand-Anschluss

Detail	Horizontalanschluss seitlich Fenster-Natursteinmauer		
	Bestehender Fenster-Wand-Anschluss	Verbesserung	Weitere Verbesserung
Horizontal-anschluss Fenster-Wand			
Maßnahme	Austausch Fenster, ohne weitere Maßnahmen	+ 4 cm Dämmputz λ 0,057 W/mK + 0-2 cm keilförmig in der Laibung	+ Dämmung im Hohlraum λ 0,043 seitlich hinter dem bestehenden Putz
T_{min}	12.5°C (< 12.6°C)	14.2 (> 12.6°C)	14.6 (> 12.6°C)
f_{Rsi}	0.580 (< 0.587)	0.629 (> 0.587)	0.630 (> 0.587)
Ergebnis	Anforderungen nicht erfüllt. Gefahr von Tauwasser-/Schimmelbildung*	Anforderungen erfüllt. Keine Gefahr von Tauwasser-/Schimmelbildung*	Anforderungen erfüllt. Keine Gefahr von Tauwasser-/Schimmelbildung*
	✗	✓	✓

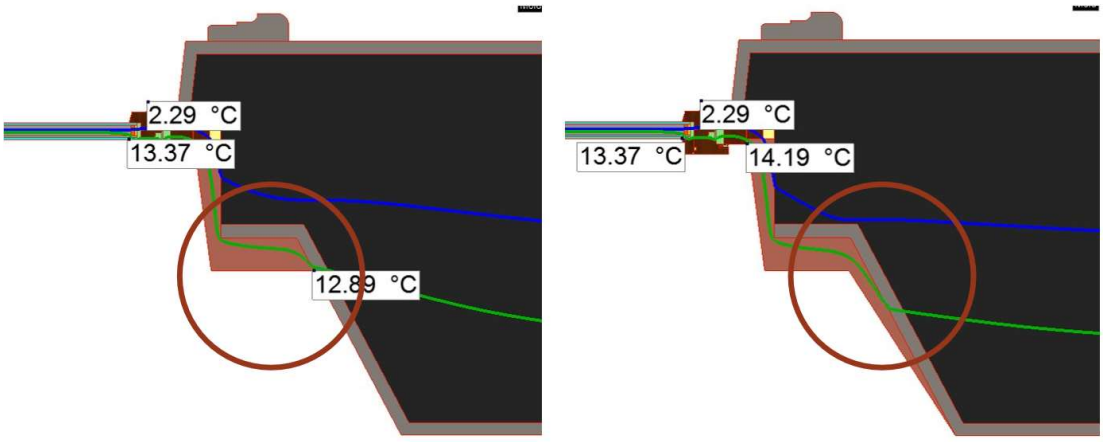
* siehe Schimmelisotherm in grün bei 12,6°C; gemäß Klimahaus Anforderungen

Detail der horizontalen Fenster-Wand-Verbindung: In der Abbildung werden drei Ausführungsvarianten für den Fenster-Wandanschluss nach dem Fensteraustausch dargestellt. Sie zeigt, dass ein Austausch des Fensters ohne weitere Maßnahmen an der Laibung, aus hygrothermischer Sicht nicht zu empfehlen ist. Es wird vorgeschlagen, (i) die Brüstung und die Laibungen mit mindestens vier cm Dämmputz (λ 0,057 W/mK) zu dämmen und (ii) eine flexible Dämmung in dem Hohlraum, hinter dem vorhandenen Putz seitlich und unterhalb des Fensters (der nach dem Entfernen des alten Fensters zum Vorschein gekommen ist) hinzuzufügen.

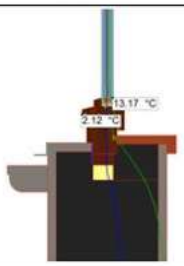
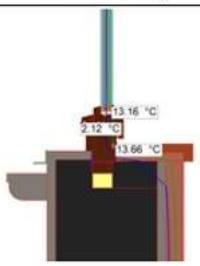
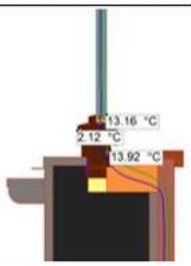




Darüber hinaus empfehlen wir, die Luftdichtheit am Fenster-Blindstock-Wandanschluss zu verbessern und den Dämmputz keilförmig auslaufen zu lassen, um hygrothermische Risiken am Übergangspunkt zu vermeiden.



Unterer Anschluss - Parapet, Fenster mit Chromatherm

Detail	Vertikalanschluss unten Fenster-Natursteinmauer		
	Bestand	Verbesserung	Weitere Verbesserung
Horizontal-anschluss Fenster-Wand			
Maßnahme	Austausch Fenster, ohne weitere Maßnahmen	+ 4 cm Dämmputz λ 0,057 W/mK auf der Brüstung + 2 cm horizontal	+ 4 cm Dämmputz λ 0,057 W/mK auf der Brüstung + 2 cm horizontal +Dämmung λ 0,043 W/mK in Hohlraum horizontal
T_{min}	13.2 (> 12.6°C)	13.2 (> 12.6°C)	13.9 (> 12.6°C)
f_{Rsi}	0.589 (> 0.587)	0.618 (> 0.587)	0.618 (> 0.587)
ψ in W/mK	1.5931	0.7208	0.7691
Ergebnis	Anforderungen knapp erfüllt. Gefahr von Tauwasser-/Schimmelbildung*	Anforderungen erfüllt. Keine Gefahr von Tauwasser-/Schimmelbildung*	Anforderungen erfüllt. Keine Gefahr von Tauwasser-/Schimmelbildung*
	✓	✓	✓

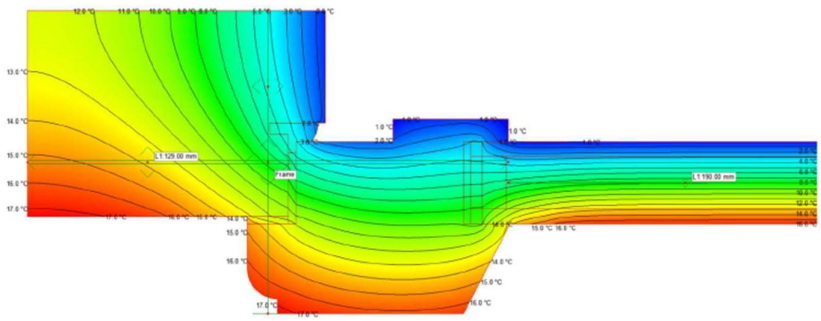
* siehe Schimmelisotherm in grün bei 12,6°C; gemäß Klimahaus Anforderungen

Detail der vertikalen Fenster-Wand-Verbindung (unten): In der Abbildung werden ebenfalls drei Ausführungsvarianten für den Fenster-Wandanschluss nach dem Fensteraustausch dargestellt. Ohne weitere Maßnahmen an der Brüstung werden die Anforderungen (unter Standardbedingungen) knapp erfüllt. Eine aus hygrothermischer Sicht sicherere Lösung ist die innenseitige Dämmung der Brüstung mit vier cm Dämmputz (λ 0,057 W/mK) (+ 2 cm horizontal) oder, wenn vorhanden, zusätzlich den entstandenen Hohlraum zu dämmen.

Werte für typische Kastenfenster saniert mit Isolierverglasung (innere Fensterebene)

Frame Uf computation
ISO 10077-2 (2017) - radiosity

Transmittance Uf: 1.64 W/m²K



Materials

Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
Box 1	0.4000	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
Box 2	0.6100	0.900	
EPDM	0.2500	0.900	
Larch	0.1300	0.900	
Argon	1.0512	0.900	
10077 radiosity	-	0.900	

Frame Uf transmittance computation

Frame width Bf: 129.00 mm Panel width Bp: 190.00 mm

Uf = ([Φf/ΔT] - Σ [UxBp])/ Bf

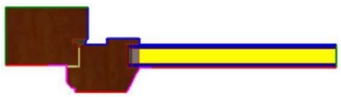
Uf = ([15.0961 W/m / 20.00 °C]-[2.7247 W/m²K x0.1900 m]-[- x-])/ 0.1290 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	0.7548 W/mK
Φf, flow with ISO10077 panel:	15.0961 W/m
Flow error:	0.000001
Triangles:	4110

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000

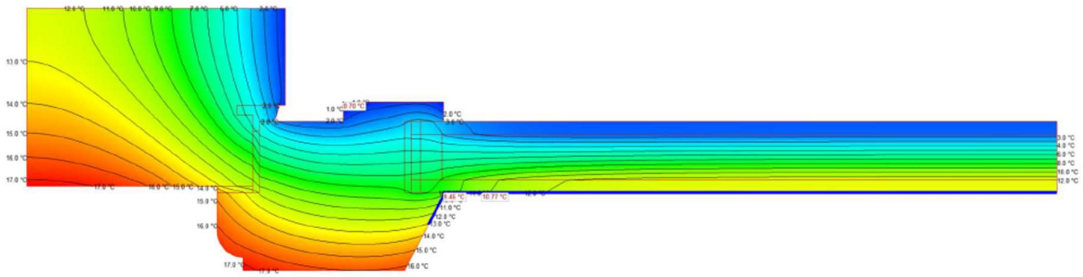


Project:	Apartment Troi	Detail:	Rahmen l,r,o,b innen	File:	Rahmen l,r,o,u innen
Client:	-	Date:	28/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: 0.025 W/mK
Superficial condensation: 221 mm



ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [15.0961 W/m / 20.00 °C] - [1.6430 W/m²K*0.1290 m]-[2.7247 W/m²K*0.1900 m]-[-*-]*

Glazing transmittance Ug=2.72 W/m²K Frame transmittance Uf=1.64 W/m²K
Glazing size Bg: 190 mm Frame size Bf: 129 mm

Simulation with glazing

Lψ2D, with glazing:	0.7548 W/mK
Φψ, flow with glazing:	15.0961 W/m
Flow error:	0.000001
Triangles:	4110

Boundary conditions

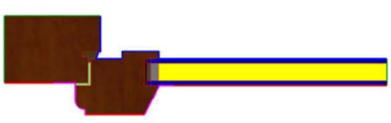
ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0

Boundary temperatures

Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	269.00	10.768	17.366	13.954	12.5096
External	292.16	0.697	3.582	2.067	-15.0961
Adiabatic	157.00	1.344	17.333	10.504	0.0029
Rsi increased	87.51	9.458	17.366	14.088	2.5865

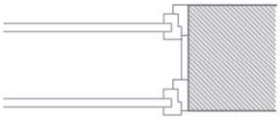
Materials

Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
Box 1	0.4000	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
Box 2	0.6100	0.900	
EPDM	0.2500	0.900	
Larch	0.1300	0.900	
Argon	1.0512	0.900	
10077 radiosity	-	0.900	



Project:	Apartment Troi	Detail:	Rahmen l,r,o,b innen	File:	Rahmen l,r,o,u innen
Client:	-	Date:	28/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator



Frame Uf transmittance computation

ISO 10077-2 (2017) - radiosity

Transmittance Uf: 1.92 W/m²K

-
-

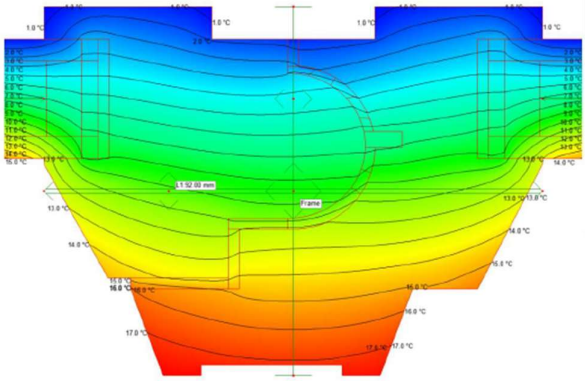
Frame Uf transmittance computation

Uf = ([Φf/ΔT] - Σ [UxBp])/Bf

Uf = ([25.2420 W/m / 20.00 °C]-[2.7244 W/m ²K x0.1900 m]-[2.7244 W/m ²K x0.1900 m])/0.0920 m

Simulation with ISO10077 panel

Lf2D, with panel ISO10077:	1.2621 W/mK
Φf, flow with panel ISO10077:	25.2420 W/m
Flow error:	0.000002
Triangles:	7757



Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000
Rs internal cavities		20.000	0.3000

Materials

Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
Box 1	0.4000	0.900	
Box 2	0.6100	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
EPDM	0.2500	0.900	
Larch	0.1300	0.900	
Argon	1.0512	0.900	
Argon	1.0512	0.900	
10077 radiosity	-	0.900	

Frame length Bf: 92.00 mm Panel length Bp: 380.00 mm

Project:	Apartment Troi	Detail:	Stulp innen	File:	-
Client:	-	Date:	28/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa

ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: 0.050 W/mK

Superficial condensation: 446 mm

-
-

ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [25.2420 W/m / 20.00 °C] - [1.9243 W/m ²K*0.0920 m]-[2.7244 W/m²K*0.1900 m]-[2.7244 W/m²K*0.1900 m]*

Glazing transmittance Ug=2.72 W/m²K *Frame transmittance Uf=1.92 W/m²K*

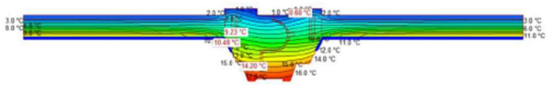
Glazing size Bg: 380 mm *Frame size Bf: 92 mm*

Boundary table

Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	395.84	10.476	17.873	13.034	21.2115
External	496.00	0.600	3.474	2.036	-25.2420
Adiabatic	44.00	2.175	12.905	7.538	-0.0000
Rsi increased	126.38	9.229	17.873	13.797	3.9201
Rs internal cavities	6.16	14.200	15.943	14.623	0.1104

Simulation with glazing

Lψ2D, with glazing:	1.2621 W/mK
Φψ, flow with glazing:	25.2420 W/m
Flow error:	0.000002
Triangles:	7757



Boundary conditions

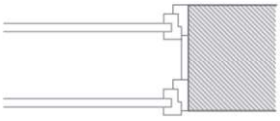
ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0
4	Rs internal cavities		20.000	0.3000	65.0

Materials

Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
Box 1	0.4000	0.900	
Box 2	0.6100	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
EPDM	0.2500	0.900	
Larch	0.1300	0.900	
Argon	1.0512	0.900	
Argon	1.0512	0.900	
10077 radiosity	-	0.900	

Project:	Apartment Troi	Detail:	Stulp innen	File:	-
Client:	-	Date:	28/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator



Frame Uf transmittance computation
ISO 10077-2 (2017) - radiosity

Transmittance Uf: 1.60 W/m²K

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-

Frame Uf transmittance computation

Uf = ([Φf/ΔT] - Σ [UxBp])/Bf

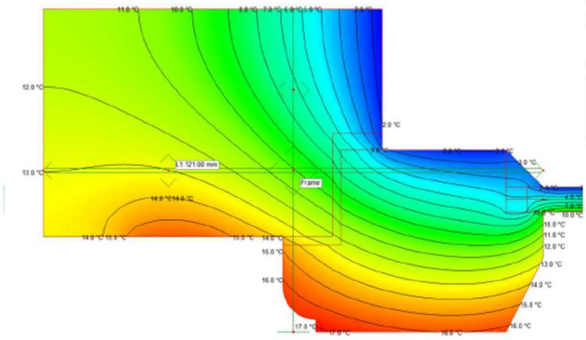
Uf = ([25.1538 W/m / 20.00 °C]-[5.6818 W/m²K x0.1900 m]-[- x-])/0.1210 m

Simulation with ISO10077 panel

Lf2D, with panel ISO10077:	1.2577 W/mK
Φf, flow with panel ISO10077:	25.1538 W/m
Flow error:	0.000000
Triangles:	2432

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000



Materials

Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
Larch	0.1300	0.900	
Air	0.0673	0.900	
Putty	0.5000	0.900	

Frame length Bf: 121.00 mm Panel length Bp: 190.00 mm

Project:	Apartment Troi	Detail:	Rahmen l,r,o aussen	File:	-
Client:	-	Date:	28/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: -0.016 W/mK

Superficial condensation: 235 mm

-
-

ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [25.1538 W/m / 20.00 °C] - [1.6015 W/m²K*0.1210 m]-[5.6818 W/m²K*0.1900 m]-[-*-]*

Glazing transmittance Ug=5.68 W/m²K *Frame transmittance Uf=1.60 W/m²K*

Glazing size Bg: 190 mm *Frame size Bf: 121 mm*

Boundary table

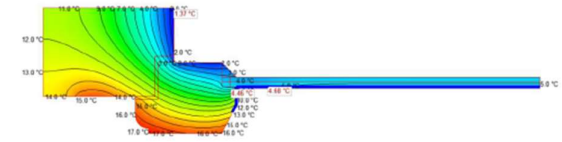
Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	239.00	4.679	17.210	8.319	21.4749
External	266.73	1.367	4.545	3.772	-25.1538
Adiabatic	163.00	1.367	14.953	10.314	0.0372
Rsi increased	93.69	4.461	17.210	12.147	3.6789

Simulation with glazing

Lψ2D, with glazing:	1.2577 W/mK
Φψ, flow with glazing:	25.1538 W/m
Flow error:	0.000000
Triangles:	2432

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0



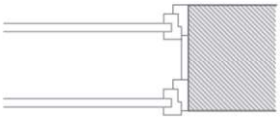
Materials

Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
Larch	0.1300	0.900	
Air	0.0673	0.900	
Putty	0.5000	0.900	

Project:	Apartment Troi	Detail:	Rahmen l,r,o aussen	File:	-
Client:	-	Date:	28/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

Kastenfenster



Frame Uf transmittance computation

ISO 10077-2 (2017) - radiosity

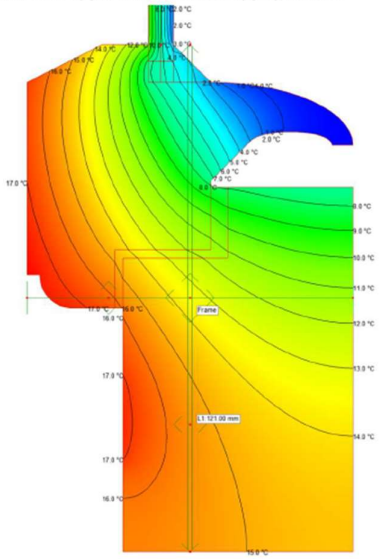
Transmittance Uf: 1.19 W/m²K

-
-

Frame Uf transmittance computation

Uf = ([Φf/ΔT] - Σ [UxBp])/Bf

Uf = ([23.5193 W/m / 20.00 °C]-[5.4945 W/m²K x0.1900 m]-[- x-])/0.1210 m



Simulation with ISO10077 panel

Lf2D, with panel ISO10077:	1.1760 W/mK
Φf, flow with panel ISO10077:	23.5193 W/m
Flow error:	0.000006
Triangles:	2678

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000
Rs external cavities		0.000	0.3000

Materials

Name	λx [W/mK]	ε	Color
Air	0.0735	0.900	
Larch	0.1300	0.900	
Putty	0.5000	0.900	
Glass	0.5000	0.900	

Frame length Bf: 121.00 mm Panel length Bp: 190.00 mm

Project:	Apartment Troi	Detail:	Rahmen u aussen	File:	-
Client:	-	Date:	28/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa

ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: -0.012 W/mK

Superficial condensation: 227 mm

-
-

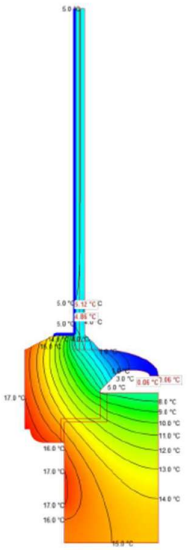
ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [23.5193 W/m / 20.00 °C] - [1.1929 W/m²K*0.1210 m]-[5.4945 W/m²K*0.1900 m]-[-*-]*

Glazing transmittance Ug=5.49 W/m²K *Frame transmittance Uf=1.19 W/m²K*

Glazing size Bg: 190 mm *Frame size Bf: 121 mm*



Boundary table

Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	239.00	5.119	17.926	8.959	20.2980
External	242.65	0.062	4.396	3.685	-22.3560
Adiabatic	168.00	4.396	16.697	13.333	0.0198
Rsi increased	93.69	4.861	17.926	13.123	3.2214
Rs external cavities	74.88	0.062	8.008	4.660	-1.1632

Simulation with glazing

Lψ2D, with glazing:	1.1760 W/mK
Φψ, flow with glazing:	23.5193 W/m
Flow error:	0.000006
Triangles:	2678

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0
5	Rs external cavities		0.000	0.3000	65.0

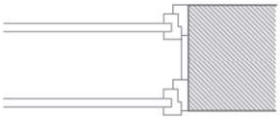
Materials

Name	λx [W/mK]	ε	Color
Air	0.0735	0.900	
Larch	0.1300	0.900	
Putty	0.5000	0.900	
Glass	0.5000	0.900	

Project:	Apartment Troi	Detail:	Rahmen u aussen	File:	-
Client:	-	Date:	28/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

Kastenfenster



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Frame Uf transmittance computation
ISO 10077-2 (2017) - radiosity

Transmittance Uf: 2.28 W/m²K

-
-

Frame Uf transmittance computation

Uf = ([Φf/ΔT] - Σ [UxBp])/Bf

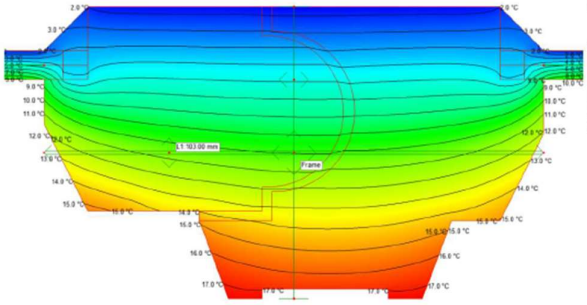
Uf = ([47.2523 W/m / 20.00 °C]-[5.6818 W/m ²K x0.1900 m]-[5.6818 W/m ²K x0.1900 m])/0.1030 m

Simulation with ISO10077 panel

Lf2D, with panel ISO10077:	2.3626 W/mK
Φf, flow with panel ISO10077:	47.2523 W/m
Flow error:	0.000002
Triangles:	7138

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000



Materials

Name	λx [W/mK]	ε	Color
Larch	0.1300	0.900	
Putty	0.5000	0.900	
Glass	1.0000	0.900	
Air	0.0675	0.900	

Frame length Bf: 103.00 mm Panel length Bp: 380.00 mm

Project:	Apartment Troi	Detail:	Stulp aussen	File:	-
Client:	-	Date:	28/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: -0.031 W/mK

Superficial condensation: 478 mm

-
-

ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [47.2523 W/m / 20.00 °C] - [2.2751 W/m ²K*0.1030 m]-[5.6818 W/m²K*0.1900 m]-[5.6818 W/m²K*0.1900 m]*

Glazing transmittance Ug=5.68 W/m²K *Frame transmittance Uf=2.28 W/m²K*

Glazing size Bg: 380 mm *Frame size Bf: 103 mm*

Boundary table

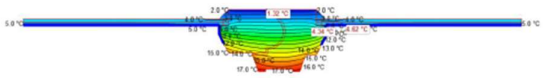
Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	389.00	4.621	17.389	6.535	40.2925
External	490.46	1.321	4.545	3.854	-47.2523
Adiabatic	12.00	4.545	5.227	4.886	-0.0000
Rsi increased	164.43	4.337	17.389	11.534	6.9599

Simulation with glazing

Lψ2D, with glazing:	2.3626 W/mK
Φψ, flow with glazing:	47.2523 W/m
Flow error:	0.000002
Triangles:	7138

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0



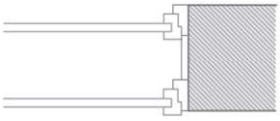
Materials

Name	λx [W/mK]	ε	Color
Larch	0.1300	0.900	
Putty	0.5000	0.900	
Glass	1.0000	0.900	
Air	0.0675	0.900	

Project:	Apartment Troi	Detail:	Stulp aussen	File:	-
Client:	-	Date:	28/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

Kastenfenster



Linear thermal bridge computation	-
EN-ISO 10211:2008 Linear transmittance ψ: 0.0038 W/mK	- - -

ψ Computation

ψ = [Φ/ΔT] - Σ [UxL]

ψ = [44.2821 W/m / 20.00 °C] - [2.2103 W/mK]

L1D Computation (2.2103 W/mK)

U1*l1 = [5.4576 W/m²K x 0.4050 m] = 2.2103 W/mK
U2*l2 = [- x -] = -
U3*l3 = [- x -] = -
U4*l4 = [- x -] = -

L2D with bridge	2.2141 W/mK
L1D without bridge	2.2103 W/mK
ΔTemperatures:	20.00 °C
Average flux with bridge	44.2821 W/m
Flux without bridge	44.2065 W/m
Flux error	0.000000

Boundary conditions

Name	Col	Air T [°C]	R type	R [m²K/W]
Adiabatic		-	Constant	-
Internal		20.000	ISO 6946 Internal	-
External		0.000	Constant	0.0400

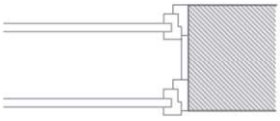
Materials

Name	λx [W/mK]	ε	Color
Larch	0.1300	0.900	
Putty	0.5000	0.900	
Glass	1.0000	0.900	

Project :	Apartment Troi	Detail:	Sprossen	File:	Sprosse
Reference :	-	Date:	28/09/2019	Software:	Mold Simulator - 4.0.5 b839 64bit

Mold Simulator

Kastenfenster



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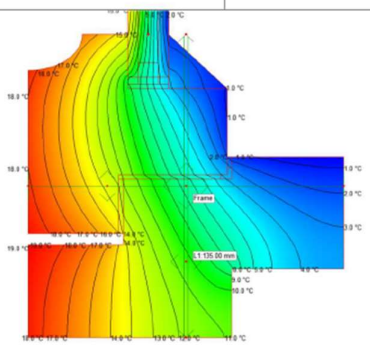
Neues Kastenfenster

Frame Uf computation
ISO 10077-2 (2017) - radiosity

Transmittance Uf: 1.22 W/m²K



Materials

Name	λx [W/mK]	ε	Color
Larch	0.1300	0.900	
EPDM	0.2500	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
Glass	1.0000	0.900	
Box 1	0.4000	0.900	
Box 2	0.6100	0.900	
Putty	0.5000	0.900	
Cripto	0.0458	0.900	
10077 radiosity	-	0.900	

Frame Uf transmittance computation

Frame width Bf: 135.00 mm Panel width Bp: 190.00 mm

Uf = ([Φf/ΔT] - Σ [UxBp])/Bf

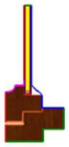
Uf = ([14.0415 W/m / 20.00 °C]-[2.6617 W/m²K x0.1900 m]-[- x-])/0.1350 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	0.7021 W/mK
Φf, flow with ISO10077 panel:	14.0415 W/m
Flow error:	0.000008
Triangles:	4086

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000
Rs internal cavities		20.000	0.3000

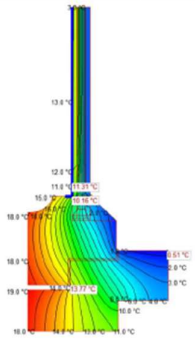


Project:	Aerztehaus Ried	Detail:	Rahmen n o,u,l,r innen	File:	Rahmen innen o,u,l,r
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: 0.032 W/mK
Superficial condensation: 214 mm



ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [14.0415 W/m / 20.00 °C] - [1.2163 W/m²K*0.1350 m]-[2.6617 W/m²K*0.1900 m]-[-*-]*

Glazing transmittance Ug=2.66 W/m²K *Frame transmittance Uf=1.22 W/m²K*

Glazing size Bg: 190 mm *Frame size Bf: 135 mm*

Simulation with glazing

Lψ2D, with glazing:	0.7021 W/mK
Φψ, flow with glazing:	14.0415 W/m
Flow error:	0.000008
Triangles:	4086

Boundary conditions

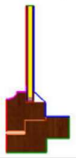
ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0
4	Rs internal cavities		20.000	0.3000	65.0

Boundary temperatures

Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	290.00	11.308	19.030	14.955	11.2541
External	307.95	0.512	2.891	1.824	-14.0415
Adiabatic	239.42	0.512	18.555	8.774	-0.0287
Rsi increased	66.09	10.165	18.207	14.342	1.8696
Rs internal cavities	89.67	13.766	19.030	16.929	0.9178

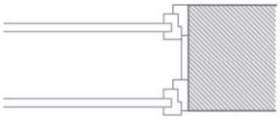
Materials

Name	λx [W/mK]	ε	Color
Larch	0.1300	0.900	
EPDM	0.2500	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
Glass	1.0000	0.900	
Box 1	0.4000	0.900	
Box 2	0.6100	0.900	
Putty	0.5000	0.900	
Cripto	0.0458	0.900	
10077 radiosity	-	0.900	



Project:	Aerztehaus Ried	Detail:	Rahmen n o,u,l,r innen	File:	Rahmen innen o,u,l,r
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator



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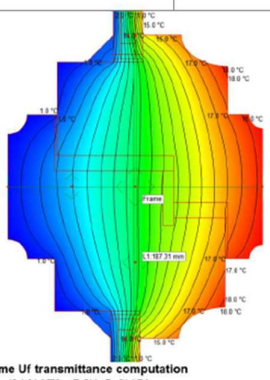
Frame Uf computation
ISO 10077-2 (2017) - radiosity

Transmittance Uf: 1.22 W/m²K



Materials

Name	λx [W/mK]	ε	Color
Cripto	0.0458	0.900	
Cripto	0.0458	0.900	
Larch	0.1300	0.900	
EPDM	0.2500	0.900	
Putty	1.0000	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
Glass	1.0000	0.900	
Box 1	0.4000	0.900	
Box 2	0.6100	0.900	
10077 radiosity	-	0.900	

Frame Uf transmittance computation

Frame width Bf: 187.31 mm Panel width Bp: 380.00 mm

Uf = ([Φf/ΔT] - Σ [UxBp])/ Bf

Uf = ([26.4885 W/m / 20.00 °C]-[2.6614 W/m²K x0.1900 m]-[2.6613 W/m²K x0.1900 m])/ 0.1873 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	1.3244 W/mK
Φf, flow with ISO10077 panel:	26.4885 W/m
Flow error:	0.000004
Triangles:	6583

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000

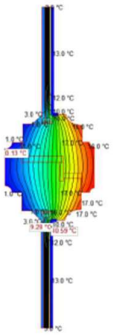
Project:	Aerztehaus Ried	Detail:	Setzholz innen	File:	Setzholz innen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: 0.085 W/mK

Superficial condensation: 428 mm



ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [26.4885 W/m / 20.00 °C] - [1.2183 W/m²K*0.1873 m]-[2.6614 W/m²K*0.1900 m]-[2.6613 W/m²K*0.1900 m]/*

Glazing transmittance Ug=2.66 W/m²K Frame transmittance Uf=1.22 W/m²K

Glazing size Bg: 380 mm Frame size Bf: 187 mm

Simulation with glazing

Lψ2D, with glazing:	1.3244 W/mK
Φψ, flow with glazing:	26.4885 W/m
Flow error:	0.000004
Triangles:	6583

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0

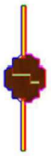
Boundary temperatures

Name	L [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	462.43	10.591	18.778	13.968	21.4577
External	666.43	0.131	3.214	1.590	-26.4885
Adiabatic	36.33	2.126	13.073	7.599	-0.0000
Rsi increased	228.11	9.279	18.778	15.589	5.0307

Materials

Name	λx [W/mK]	ε	Color
Cripto	0.0458	0.900	
Cripto	0.0458	0.900	
Larch	0.1300	0.900	
EPDM	0.2500	0.900	
Putty	1.0000	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
Glass	1.0000	0.900	
Box 1	0.4000	0.900	
Box 2	0.6100	0.900	

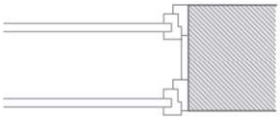
Name	λx [W/mK]	ε	Color
10077 radiosity	-	0.900	



Project:	Aerztehaus Ried	Detail:	Setzholz innen	File:	Setzholz innen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

Kastenfenster



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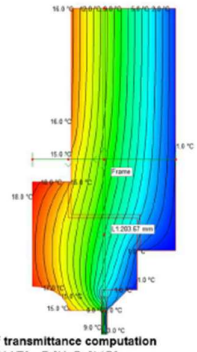
Frame Uf computation
ISO 10077-2 (2017) - radiosity

Transmittance Uf: 1.55 W/m²K



Materials

Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
Putty	0.5000	0.900	
Larch	0.1300	0.900	
Air	0.0826	0.900	

Frame Uf transmittance computation

Uf = ([Φf/ΔT] - Σ [UxBp])/ Bf

Uf = ([28.1301 W/m / 20.00 °C]-[5.7471 W/m ²K x0.1900 m]-[- x-])/ 0.2037 m

Frame width Bf: 203.67 mm Panel width Bp: 190.00 mm

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	1.4065 W/mK
Φf, flow with ISO10077 panel:	28.1301 W/m
Flow error:	0.000004
Triangles:	1878

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000

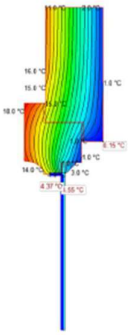
Project:	Aerztehaus Ried	Detail:	Rahmen horizontal aussen o,l,r	File:	Schnitt horizontal aussen o,l,r
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: -0.001 W/mK

Superficial condensation: 224 mm



ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [28.1301 W/m / 20.00 °C] - [1.5497 W/m ²K*0.2037 m]-[5.7471 W/m²K*0.1900 m]-[-*-]*

Glazing transmittance Ug=5.75 W/m²K *Frame transmittance Uf=1.55 W/m²K*

Glazing size Bg: 190 mm *Frame size Bf: 204 mm*

Simulation with glazing

Lψ2D, with glazing:	1.4065 W/mK
Φψ, flow with glazing:	28.1301 W/m
Flow error:	0.000004
Triangles:	1878

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0

Boundary temperatures

Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	337.50	4.546	18.477	10.635	24.3118
External	431.67	0.148	4.598	2.607	-28.1301
Adiabatic	74.50	1.109	16.309	8.469	-0.0001
Rsi increased	120.40	4.366	18.477	13.657	3.8182

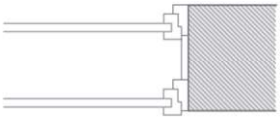
Materials

Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
Putty	0.5000	0.900	
Larch	0.1300	0.900	
Air	0.0826	0.900	

Project:	Aerztehaus Ried	Detail:	Rahmen horizontal aussen o,l,r	File:	Schnitt horizontal aussen o,l,r
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

Kastenfenster



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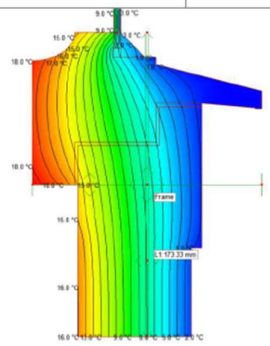
Frame Uf computation
ISO 10077-2 (2017) - radiosity

Transmittance Uf: 1.57 W/m²K



Materials

Name	λx [W/mK]	ε	Color
Larch	0.1300	0.900	
Putty	0.5000	0.900	
Glass	1.0000	0.900	
Air	0.1101	0.900	

Frame Uf transmittance computation

Frame width Bf: 173.33 mm Panel width Bp: 190.00 mm

Uf = ([Φf/ΔT] - Σ [UxBp])/ Bf

Uf = ([27.2612 W/m / 20.00 °C]-[5.7471 W/m ²K x0.1900 m]-[- x-])/ 0.1733 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	1.3631 W/mK
Φf, flow with ISO10077 panel:	27.2612 W/m
Flow error:	0.000001
Triangles:	2052

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000

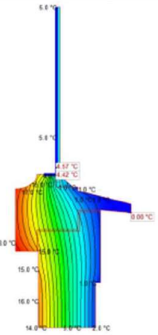
Project:	Aerztehaus Ried	Detail:	Rahmen u aussen	File:	Schnitt vertikal aussen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: -0.001 W/mK

Superficial condensation: 224 mm



ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [27.2612 W/m / 20.00 °C] - [1.5693 W/m ²K*0.1733 m]-[5.7471 W/m²K*0.1900 m]-[-*-]*

Glazing transmittance Ug=5.75 W/m²K Frame transmittance Uf=1.57 W/m²K

Glazing size Bg: 190 mm Frame size Bf: 173 mm

Simulation with glazing

Lψ2D, with glazing:	1.3631 W/mK
Φψ, flow with glazing:	27.2612 W/m
Flow error:	0.000001
Triangles:	2052

Boundary conditions

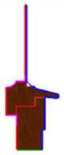
ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0

Boundary temperatures

Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	307.17	4.575	18.498	10.064	23.4774
External	466.29	0.002	4.598	2.339	-27.2613
Adiabatic	68.58	1.189	16.054	8.374	-0.0001
Rsi increased	120.42	4.416	18.498	13.716	3.7838

Materials

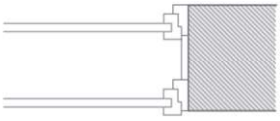
Name	λx [W/mK]	ε	Color
Larch	0.1300	0.900	
Putty	0.5000	0.900	
Glass	1.0000	0.900	
Air	0.1101	0.900	



Project:	Aerztehaus Ried	Detail:	Rahmen u aussen	File:	Schnitt vertikal aussen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

Kastenfenster



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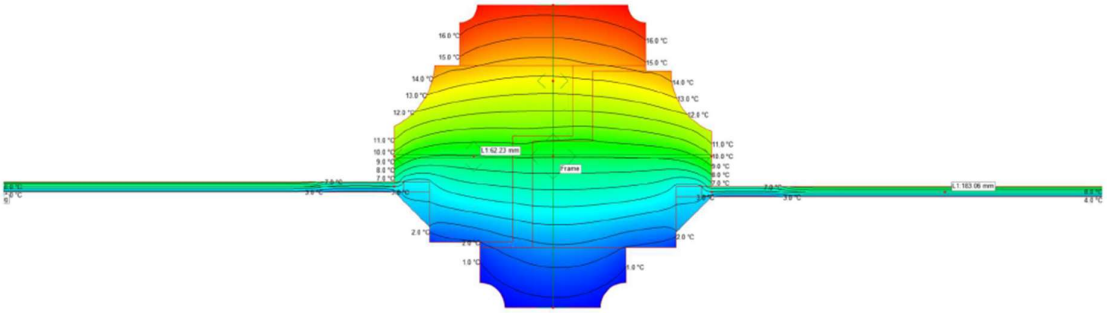
Frame Uf computation ISO 10077-2 (2017) - radiosity	Transmittance Uf: 2.63 W/m²K	-



Materials

Name	λx [W/mK]	ε	Color
Putty	1.0000	0.900	
Larch	0.1300	0.900	
Glass	1.0000	0.900	
Air	0.0764	0.900	

Frame Uf transmittance computation

Frame width Bf: 62.23 mm Panel width Bp: 366.17 mm

Uf = ([Φf/ΔT] - Σ [UxBp])/Bf

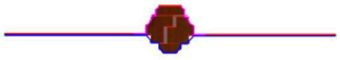
Uf = ([45.5536 W/m / 20.00 °C]-[5.8140 W/m²K x0.1831 m]-[5.8140 W/m²K x0.1831 m])/0.0622 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	2.2777 W/mK
Φf, flow with ISO10077 panel:	45.5536 W/m
Flow error:	0.000003
Triangles:	5114

Boundary conditions

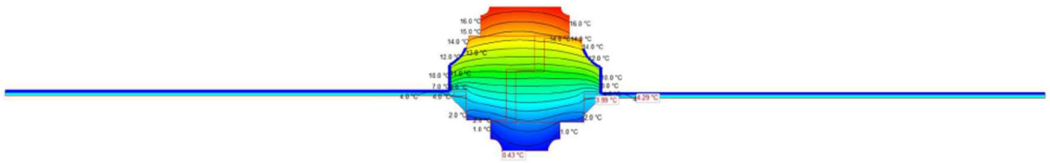
Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000



Project:	Aerztehaus Ried	Detail:	Stulp aussen	File:	Stulp aussen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa ISO 10077-2 (2017) - radiosity	Linear transmittance ψ: -0.015 W/mK Superficial condensation: 472 mm	-



ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

Glazing transmittance Ug=5.81 W/m²K Frame transmittance Uf=2.63 W/m²K

*ψ = [45.5536 W/m / 20.00 °C] - [2.6258 W/m²K*0.0622 m]-[5.8140 W/m²K*0.1831 m]-[5.8140 W/m²K*0.1831 m]*

Glazing size Bg: 366 mm Frame size Bf: 62 mm

Simulation with glazing

Lψ2D, with glazing:	2.2777 W/mK
Φψ, flow with glazing:	45.5536 W/m
Flow error:	0.000003
Triangles:	5114

Boundary conditions

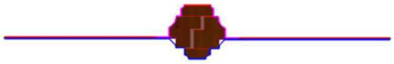
ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0

Boundary temperatures

Name	L [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	366.17	4.287	16.901	5.799	39.9992
External	460.52	0.431	4.651	3.957	-45.5537
Adiabatic	4.00	4.651	4.884	4.767	0.0000
Rsi increased	120.08	3.991	16.901	10.749	5.5543

Materials

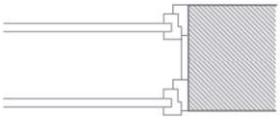
Name	λx [W/mK]	ε	Color
Putty	1.0000	0.900	
Larch	0.1300	0.900	
Glass	1.0000	0.900	
Air	0.0764	0.900	



Project:	Aerztehaus Ried	Detail:	Stulp aussen	File:	Stulp aussen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

Kastenfenster



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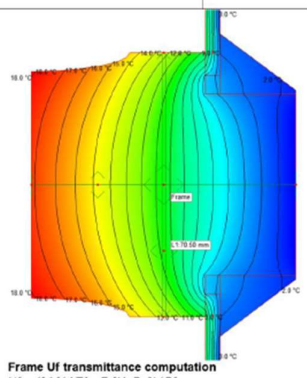
Frame Uf computation

ISO 10077-2 (2017) - radiosity

Transmittance Uf: 2.23 W/m²K



Materials

Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
Putty	1.0000	0.900	
Larch	0.1300	0.900	

Frame Uf transmittance computation

Frame width Bf: 70.50 mm Panel width Bp: 380.33 mm

Uf = ([Φf / ΔT] - Σ [UxBp]) / Bf

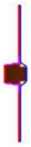
Uf = ([46.2199 W/m / 20.00 °C]-[5.7471 W/m²K x0.1903 m]-[5.7471 W/m²K x0.1900 m]) / 0.0705 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	2.3110 W/mK
Φf, flow with ISO10077 panel:	46.2199 W/m
Flow error:	0.000001
Triangles:	1617

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000



Project:	Aerztehaus Ried	Detail:	Kaempfer aussen	File:	Kaempfer aussen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

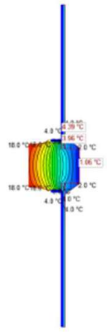
Frame Simulator

ψ and condensation computa

ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: -0.032 W/mK

Superficial condensation: 480 mm



ψ computation

ψ = [Φψ / ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [46.2199 W/m / 20.00 °C] - [2.2256 W/m²K*0.0705 m]-[5.7471 W/m²K*0.1903 m]-[5.7471 W/m²K*0.1900 m*

Glazing transmittance Ug=5.75 W/m²K Frame transmittance Uf=2.23 W/m²K

Glazing size Bg: 380 mm Frame size Bf: 70 mm

Simulation with glazing

Lψ2D, with glazing:	2.3110 W/mK
Φψ, flow with glazing:	46.2199 W/m
Flow error:	0.000001
Triangles:	1617

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0

Boundary temperatures

Name	L [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	390.50	4.390	18.036	6.926	39.2715
External	470.70	1.064	4.598	3.928	-46.2199
Adiabatic	8.00	4.598	5.057	4.828	-0.0000
Rsi increased	145.60	3.958	18.036	10.456	6.9485

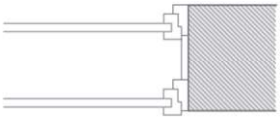
Materials

Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
Putty	1.0000	0.900	
Larch	0.1300	0.900	

Project:	Aerztehaus Ried	Detail:	Kaempfer aussen	File:	Kaempfer aussen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

Kastenfenster



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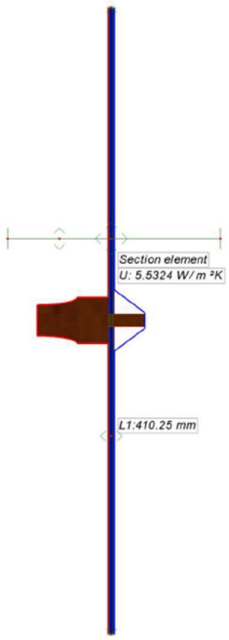
Linear thermal bridge computation

EN-ISO 10211:2008 **Linear transmittance ψ: -0.0028 W/mK**

-
-
- - -



ψ Computation

ψ = [Φ/ΔT] - Σ [UxL]

ψ = [45.3374 W/m / 20.00 °C] - [2.2696 W/mK]

L1D Computation (2.2696 W/mK)

U1*l1 = [5.5324 W/m²K x 0.4102 m] = 2.2696 W/mK
U2*l2 = [- x -] = -
U3*l3 = [- x -] = -
U4*l4 = [- x -] = -

L2D with bridge	2.2669 W/mK
L1D without bridge	2.2696 W/mK
ΔTemperatures:	20.00 °C
Average flux with bridge	45.3374 W/m
Flux without bridge	45.3930 W/m
Flux error	0.000001

Boundary conditions

Name	Col	Air T [°C]	R type	R [m²K/W]
Adiabatic		-	Constant	-
Internal		20.000	ISO 6946 Internal	-
External		0.000	Constant	0.0400

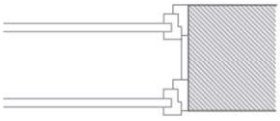
Materials

Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
Putty	1.0000	0.900	
Larch	0.1300	0.900	

Project :	Aerztehaus Ried	Detail:	Sprosse aussen	File:	Sprosse aussen
Reference :	-	Date:	16/09/2019	Software:	Mold Simulator - 4.0.5 b839 64bit

Mold Simulator

Kastenfenster



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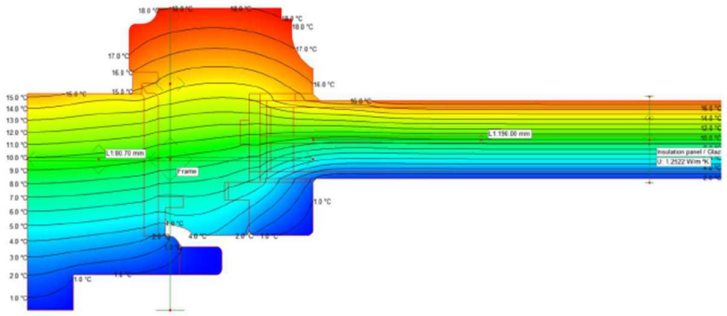
Energieeffizienter Prototyp für Kastenfenster

Frame Uf computation
ISO 10077-2 (2017) - radiosity

Transmittance Uf: 1.43 W/m²K



Materials

Name	λx [W/mK]	ε	Color
EPDM	0.2500	0.900	
Box 1	0.6100	0.900	
Norway spruce	0.1100	0.900	
Glass	1.0000	0.900	
Box 1	0.4000	0.900	
Cripto	0.9890	0.900	
Cripto	1.0432	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
Silicone filled	0.5000	0.900	
10077 radiosity	-	0.900	

Frame Uf transmittance computation

Frame width Bf: 80.70 mm Panel width Bp: 190.00 mm

Uf = ([Φf/ΔT] - Σ [UxBp])/Bf

Uf = ([9.9157 W/m / 20.00 °C]-[1.7965 W/m²K x0.1900 m]-[- x-])/0.0807 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	0.4958 W/mK
Φf, flow with ISO10077 panel:	9.9157 W/m
Flow error:	0.000008
Triangles:	11149

Boundary conditions

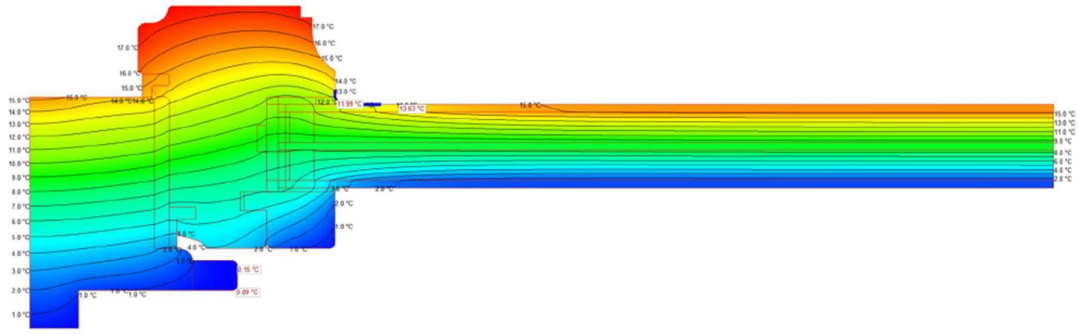
Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000
Rs external cavities		0.000	0.3000

Project:	Aufschnaiter Schule	Detail:	Rahmen o,u,l,r innen	File:	Rahmen o_u_l_r innen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: 0.039 W/mK
Superficial condensation: 23 mm



ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [9.9157 W/m / 20.00 °C] - [1.4304 W/m²K*0.0807 m]-[1.7965 W/m²K*0.1900 m]-[-*-]*

Glazing transmittance Ug=1.80 W/m²K Frame transmittance Uf=1.43 W/m²K
Glazing size Bg: 190 mm Frame size Bf: 81 mm

Simulation with glazing

Lψ2D, with glazing:	0.4958 W/mK
Φψ, flow with glazing:	9.9157 W/m
Flow error:	0.000008
Triangles:	11149

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0
5	Rs external cavities		0.000	0.3000	65.0

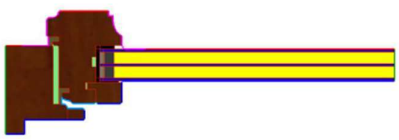
Boundary temperatures

Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	218.19	13.627	17.766	15.469	7.6044
External	292.38	0.090	3.526	1.294	-9.4558
Adiabatic	82.99	0.528	15.317	7.346	0.0006
Rsi increased	96.08	11.990	17.766	15.189	2.3114
Rs external cavities	51.44	0.154	4.381	2.682	-0.4598

Materials

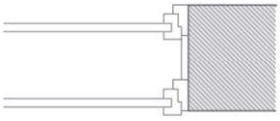
Name	λx [W/mK]	ε	Color
EPDM	0.2500	0.900	
Box 1	0.6100	0.900	
Norway spruce	0.1100	0.900	
Glass	1.0000	0.900	
Box 1	0.4000	0.900	
Cripto	0.9890	0.900	
Cripto	1.0432	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
Silicone filled	0.5000	0.900	

Name	λx [W/mK]	ε	Color
10077 radiosity	-	0.900	



Project:	Aufschnaiter Schule	Detail:	Rahmen o,u,l,r innen	File:	Rahmen o_u_l_r innen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator



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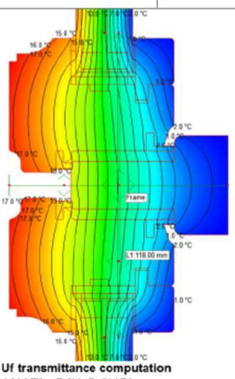
Frame Uf computation
ISO 10077-2 (2017) - radiosity

Transmittance Uf: 1.62 W/m²K



Materials

Name	λx [W/mK]	ε	Color
European larch	0.1300	0.900	
Silicone filled	0.5000	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
EPDM	0.2500	0.900	
Glass	1.0000	0.900	
Box 1	0.4000	0.900	
Box 2	0.6100	0.900	
Cripto	0.0432	0.900	
Cripto	0.0409	0.900	
Cripto	0.0432	0.900	
Cripto	0.0409	0.900	
10077 radiosity	-	0.900	

Frame Uf transmittance computation

Frame width Bf: 118.00 mm Panel width Bp: 376.00 mm

Uf = ([Φf/ΔT] - Σ [UxBp])/Bf

Uf = ([18.8538 W/m / 20.00 °C]-[1.7959 W/m²K x0.1880 m]-[1.7959 W/m²K x0.1880 m])/0.1180 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	0.9427 W/mK
Φf, flow with ISO10077 panel:	18.8538 W/m
Flow error:	0.000009
Triangles:	16320

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000
Rs internal cavities		20.000	0.3000
Rs external cavities		0.000	0.3000

Project:	Aufschnaiter Schule	Detail:	Kaempfer innen	File:	Kaempfer innen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: 0.076 W/mK

Superficial condensation: 64 mm

ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [18.8538 W/m / 20.00 °C] - [1.6201 W/m²K*0.1180 m]-[1.7959 W/m²K*0.1880 m]-[1.7959 W/m²K*0.1880 m]*

Glazing transmittance Ug=1.80 W/m²K Frame transmittance Uf=1.62 W/m²K

Glazing size Bg: 376 mm Frame size Bf: 118 mm

Simulation with glazing

Lψ2D, with glazing:	0.9427 W/mK
Φψ, flow with glazing:	18.8538 W/m
Flow error:	0.000009
Triangles:	16320

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0
4	Rs internal cavities		20.000	0.3000	65.0
5	Rs external cavities		0.000	0.3000	65.0

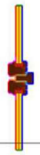
Boundary temperatures

Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	423.24	13.514	17.341	15.410	14.9434
External	554.44	0.142	3.296	1.335	-18.5091
Adiabatic	44.00	1.432	15.316	8.450	0.0000
Rsi increased	108.78	11.819	17.302	14.521	2.9802
Rs internal cavities	49.12	12.222	16.719	14.319	0.9303
Rs external cavities	40.38	1.077	3.540	2.560	-0.3446

Materials

Name	λx [W/mK]	ε	Color
European larch	0.1300	0.900	
Silicone filled	0.5000	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
EPDM	0.2500	0.900	
Glass	1.0000	0.900	
Box 1	0.4000	0.900	
Box 2	0.6100	0.900	
Cripto	0.0432	0.900	
Cripto	0.0409	0.900	

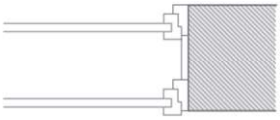
Name	λx [W/mK]	ε	Color
Cripto	0.0432	0.900	
Cripto	0.0409	0.900	
10077 radiosity	-	0.900	



Project:	Aufschnaiter Schule	Detail:	Kaempfer innen	File:	Kaempfer innen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

Kastenfenster



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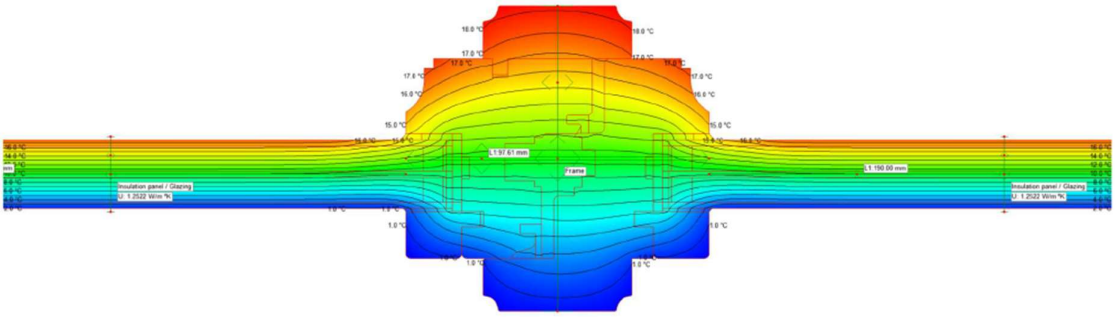
Frame Uf computation
ISO 10077-2 (2017) - radiosity

Transmittance Uf: 1.37 W/m²K



Materials

Name	λx [W/mK]	ε	Color
Box 1	0.4000	0.900	
Box 2	0.6100	0.900	
Cripto	1.0473	0.900	
Cripto	0.9885	0.900	
Cripto	1.0470	0.900	
Cripto	0.9885	0.900	
Norway spruce	0.1100	0.900	
Putty	0.5000	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
Glass	1.0000	0.900	
EPDM	0.2500	0.900	
10077 radiosity	-	0.900	

Frame Uf transmittance computation

Frame width Bf: 97.61 mm Panel width Bp: 380.00 mm

Uf = ([Φf/ΔT] - Σ [UxBp])/Bf

Uf = ([17.6212 W/m / 20.00 °C]-[1.7955 W/m²K x0.1900 m]-[1.7956 W/m²K x0.1900 m])/0.0976 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	0.8811 W/mK
Φf, flow with ISO10077 panel:	17.6212 W/m
Flow error:	0.000002
Triangles:	12838

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000

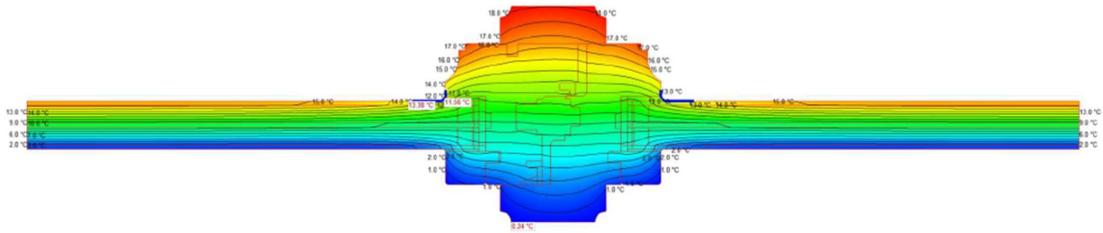
Project:	Aufschnaiter Schule	Detail:	Stulp innen	File:	Stulp innen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: 0.065 W/mK

Superficial condensation: 45 mm



ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [17.6212 W/m / 20.00 °C] - [1.3738 W/m²K*0.0976 m]-[1.7955 W/m²K*0.1900 m]-[1.7956 W/m²K*0.1900 m*

Glazing transmittance Ug=1.80 W/m²K Frame transmittance Uf=1.37 W/m²K

Glazing size Bg: 380 mm Frame size Bf: 98 mm

Simulation with glazing

Lψ2D, with glazing:	0.8811 W/mK
Φψ, flow with glazing:	17.6212 W/m
Flow error:	0.000002
Triangles:	12838

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0

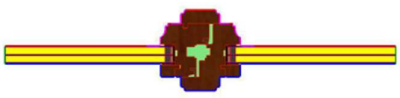
Boundary temperatures

Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	391.61	13.381	18.338	15.384	13.9056
External	540.56	0.237	3.269	1.304	-17.6212
Adiabatic	44.00	1.430	15.314	8.448	-0.0000
Rsi increased	158.20	11.557	18.338	15.303	3.7155

Materials

Name	λx [W/mK]	ε	Color
Box 1	0.4000	0.900	
Box 2	0.6100	0.900	
Cripto	1.0473	0.900	
Cripto	0.9885	0.900	
Cripto	1.0470	0.900	
Cripto	0.9885	0.900	
Norway spruce	0.1100	0.900	
Putty	0.5000	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	

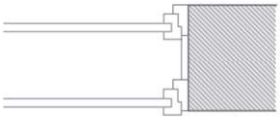
Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
EPDM	0.2500	0.900	
10077 radiosity	-	0.900	



Project:	Aufschnaiter Schule	Detail:	Stulp innen	File:	Stulp innen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

Kastenfenster



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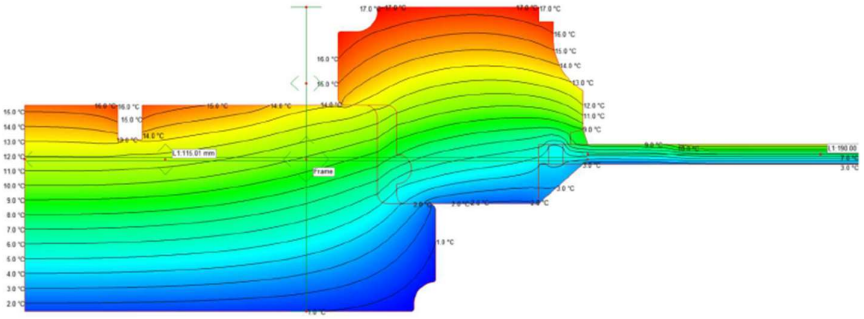
Frame Uf computation

ISO 10077-2 (2017) - radiosity

Transmittance Uf: 2.06 W/m²K



Materials

Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
Norway spruce	0.1100	0.900	
Putty	0.5000	0.900	
10077 radiosity	-	0.900	

Frame Uf transmittance computation

Frame width Bf: 115.01 mm Panel width Bp: 190.00 mm

Uf = ([Φf/ΔT] - Σ [UxBp])/ Bf

Uf = ([26.4197 W/m / 20.00 °C]-[5.7472 W/m ²K x0.1900 m]-[- x-])/ 0.1150 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	1.3210 W/mK
Φf, flow with ISO10077 panel:	26.4197 W/m
Flow error:	0.000012
Triangles:	8118

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000
Rs internal cavities		20.000	0.3000

Project:	Aufschnaiter Schule	Detail:	Rahmen oo,ol,or aussen	File:	Rahmen oo_ol_or aussen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

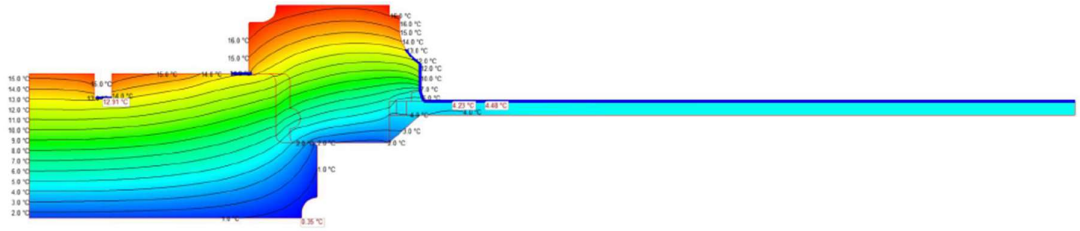
Frame Simulator

ψ and condensation computa

ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: -0.008 W/mK

Superficial condensation: 250 mm



ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [26.4197 W/m / 20.00 °C] - [2.0614 W/m ²K*0.1150 m]-[5.7472 W/m²K*0.1900 m]-[-*-]*

Glazing transmittance Ug=5.75 W/m²K *Frame transmittance Uf=2.06 W/m²K*

Glazing size Bg: 190 mm *Frame size Bf: 115 mm*

Simulation with glazing

Lψ2D, with glazing:	1.3210 W/mK
Φψ, flow with glazing:	26.4197 W/m
Flow error:	0.000012
Triangles:	8118

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0
4	Rs internal cavities		20.000	0.3000	65.0

Boundary temperatures

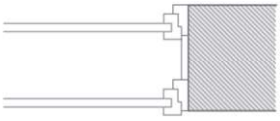
Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	249.01	4.484	16.987	8.345	22.3242
External	329.68	0.349	4.598	3.206	-26.4195
Adiabatic	46.00	1.447	15.407	8.118	0.0004
Rsi increased	94.04	4.234	16.987	12.056	3.7353
Rs internal cavities	19.00	12.912	16.051	14.311	0.3603

Materials

Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
Norway spruce	0.1100	0.900	
Putty	0.5000	0.900	
10077 radiosity	-	0.900	

Project:	Aufschnaiter Schule	Detail:	Rahmen oo,ol,or aussen	File:	Rahmen oo_ol_or aussen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator



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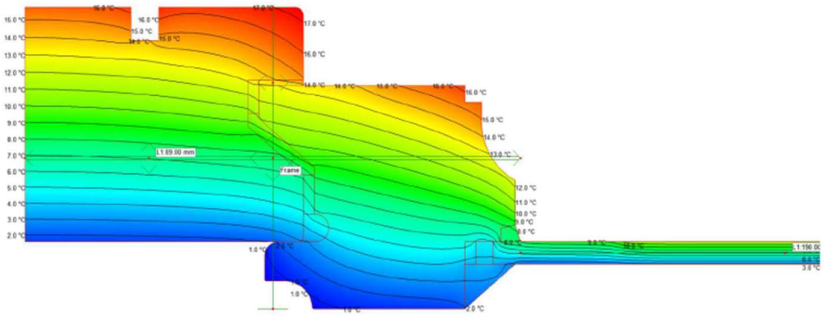
Frame Uf computation
ISO 10077-2 (2017) - radiosity

Transmittance Uf: 2.11 W/m²K



Materials

Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
Norway spruce	0.1100	0.900	
Putty	0.5000	0.900	
10077 radiosity	-	0.900	

Frame Uf transmittance computation
Frame width Bf: 89.00 mm Panel width Bp: 190.00 mm

Uf = ([Φf/ΔT] - Σ [UxBp])/ Bf

Uf = ([25.4092 W/m / 20.00 °C]-[5.7471 W/m²K x0.1900 m]-[- x-])/ 0.0890 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	1.2705 W/mK
Φf, flow with ISO10077 panel:	25.4092 W/m
Flow error:	0.000005
Triangles:	5097

Boundary conditions

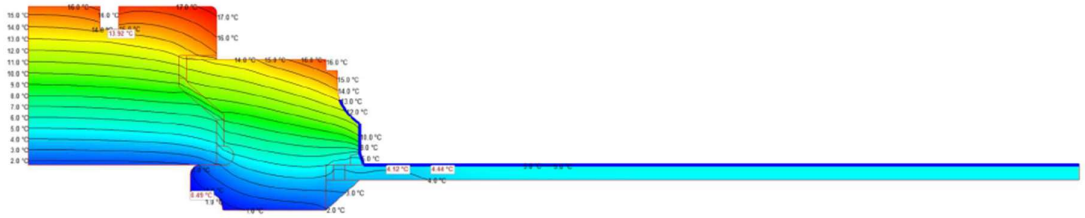
Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000
Rs internal cavities		20.000	0.3000

Project:	Aufschnaiter Schule	Detail:	Rahmen ul,ur aussen	File:	Rahmen ul_ur aussen
Client:	-	Date:	17/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: -0.009 W/mK
Superficial condensation: 240 mm



ψ computation

ψ = [Φψ/ ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [25.4092 W/m / 20.00 °C] - [2.1072 W/m²K*0.0890 m]-[5.7471 W/m²K*0.1900 m]-[-*-]*

Glazing transmittance Ug=5.75 W/m²K *Frame transmittance Uf=2.11 W/m²K*
Glazing size Bg: 190 mm *Frame size Bf: 89 mm*

Simulation with glazing

Lψ2D, with glazing:	1.2705 W/mK
Φψ, flow with glazing:	25.4092 W/m
Flow error:	0.000005
Triangles:	5097

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0
4	Rs internal cavities		20.000	0.3000	65.0

Boundary temperatures

Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	232.00	4.439	17.244	7.852	21.6801
External	294.82	0.495	4.598	3.447	-25.4093
Adiabatic	46.00	1.557	15.653	8.436	-0.0000
Rsi increased	78.69	4.118	17.246	11.233	3.4494
Rs internal cavities	17.00	13.918	16.565	15.064	0.2797

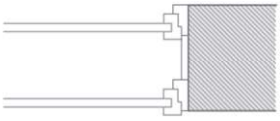
Materials

Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
Norway spruce	0.1100	0.900	
Putty	0.5000	0.900	
10077 radiosity	-	0.900	

Project:	Aufschnaiter Schule	Detail:	Rahmen ul,ur aussen	File:	Rahmen ul_ur aussen
Client:	-	Date:	17/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

Kastenfenster



Frame Uf computation
ISO 10077-2 (2017) - radiosity

Transmittance Uf: 2.14 W/m²K

Materials

Name	λx [W/mK]	ε	Color
Norway spruce	0.1100	0.900	
EPDM	0.2500	0.900	
Standard	1.0000	0.900	
Putty	0.5000	0.900	
10077 radiosity	-	0.900	

Frame Uf transmittance computation

Frame width Bf: 102.28 mm Panel width Bp: 188.97 mm

Uf = ([Φf / ΔT] - Σ [UxBp]) / Bf

Uf = ([25.9550 W/m / 20.00 °C]-[5.7471 W/m²K x0.1890 m]-[- x-]) / 0.1023 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	1.2978 W/mK
Φf, flow with ISO10077 panel:	25.9550 W/m
Flow error:	0.000012
Triangles:	8007

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000
Rs internal cavities		20.000	0.3000
Rs external cavities		0.000	0.3000

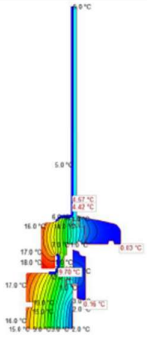
Project:	Aufschnaiter Schule	Detail:	Rahmen uu aussen	File:	Rahmen uu aussen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: -0.008 W/mK

Superficial condensation: 279 mm



ψ computation

ψ = [Φψ / ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [25.9550 W/m / 20.00 °C] - [2.1444 W/m²K*0.1023 m]-[5.7471 W/m²K*0.1890 m]-[-*-]*

Glazing transmittance Ug=5.75 W/m²K *Frame transmittance Uf=2.14 W/m²K*

Glazing size Bg: 189 mm *Frame size Bf: 102 mm*

Simulation with glazing

Lψ2D, with glazing:	1.2978 W/mK
Φψ, flow with glazing:	25.9550 W/m
Flow error:	0.000012
Triangles:	8007

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0
4	Rs internal cavities		20.000	0.3000	65.0
5	Rs external cavities		0.000	0.3000	65.0

Boundary temperatures

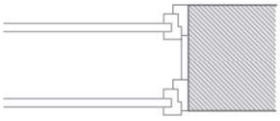
Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	252.45	4.574	18.378	8.827	21.6959
External	352.95	0.025	4.598	2.767	-24.4200
Adiabatic	46.00	1.722	15.938	8.842	0.0003
Rsi increased	66.16	4.416	17.544	11.355	2.8598
Rs internal cavities	74.54	9.698	18.374	14.368	1.3994
Rs external cavities	115.28	0.161	9.951	3.994	-1.5348

Materials

Name	λx [W/mK]	ε	Color
Norway spruce	0.1100	0.900	
EPDM	0.2500	0.900	
Standard	1.0000	0.900	
Putty	0.5000	0.900	
10077 radiosity	-	0.900	

Project:	Aufschnaiter Schule	Detail:	Rahmen uu aussen	File:	Rahmen uu aussen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator



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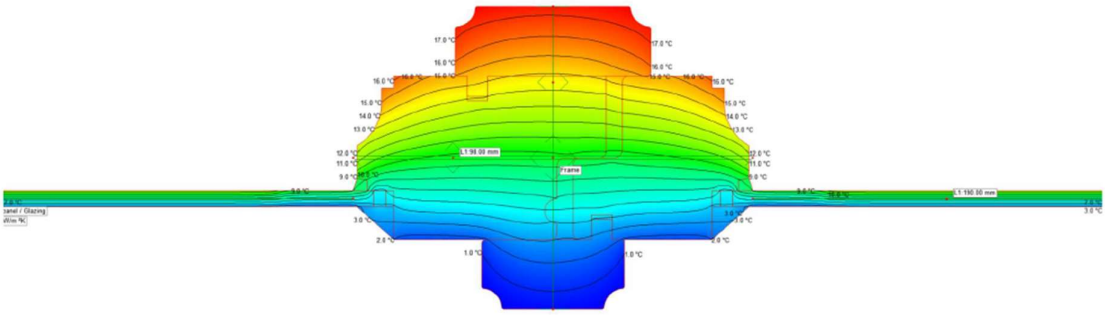
Frame Uf computation

ISO 10077-2 (2017) - radiosity

Transmittance Uf: 2.05 W/m²K



Materials

Name	λx [W/mK]	ε	Color
Putty	0.5000	0.900	
Glass	1.0000	0.900	
Norway spruce	0.1100	0.900	
10077 radiosity	-	0.900	

Frame Uf transmittance computation

Frame width Bf: 98.00 mm Panel width Bp: 380.00 mm

Uf = ([Φf / ΔT] - Σ [UxBp]) / Bf

Uf = ([47.3374 W/m / 20.00 °C]-[5.7471 W/m²K x0.1900 m]-[5.7471 W/m²K x0.1900 m]) / 0.0980 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	2.3669 W/mK
Φf, flow with ISO10077 panel:	47.3374 W/m
Flow error:	0.000001
Triangles:	13046

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000

Project:	Aufschnaiter Schule	Detail:	Stulp aussen	File:	Stulp aussen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

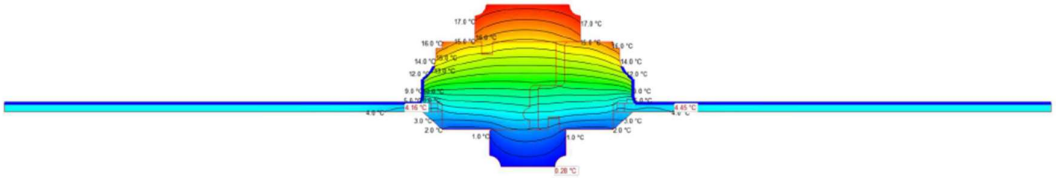
Frame Simulator

ψ and condensation computa

ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: -0.018 W/mK

Superficial condensation: 479 mm



ψ computation

ψ = [Φψ / ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [47.3374 W/m / 20.00 °C] - [2.0460 W/m²K*0.0980 m]-[5.7471 W/m²K*0.1900 m]-[5.7471 W/m²K*0.1900 m]*

Glazing transmittance Ug=5.75 W/m²K Frame transmittance Uf=2.05 W/m²K

Glazing size Bg: 380 mm Frame size Bf: 98 mm

Simulation with glazing

Lψ2D, with glazing:	2.3669 W/mK
Φψ, flow with glazing:	47.3374 W/m
Flow error:	0.000001
Triangles:	13046

Boundary conditions

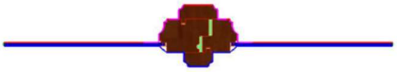
ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0

Boundary temperatures

Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	388.00	4.454	17.770	6.403	40.5811
External	514.19	0.281	4.598	3.683	-47.3374
Adiabatic	8.00	4.598	5.058	4.828	-0.0000
Rsi increased	166.77	4.160	17.770	11.898	6.7563

Materials

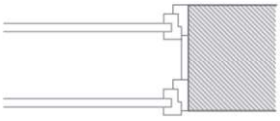
Name	λx [W/mK]	ε	Color
Putty	0.5000	0.900	
Glass	1.0000	0.900	
Norway spruce	0.1100	0.900	
10077 radiosity	-	0.900	



Project:	Aufschnaiter Schule	Detail:	Stulp aussen	File:	Stulp aussen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

Kastenfenster



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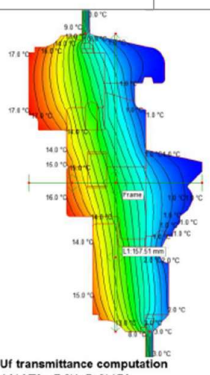
Frame Uf computation

Simplified ISO 10077-2 (2017) - single eq. cond.

Transmittance Uf: 2.14 W/m²K



Materials

Name	λx [W/mK]	ε	Color
European larch	0.1300	0.900	
Glass	1.0000	0.900	
Silicone filled	0.5000	0.900	
EPDM	0.2500	0.900	
TPE with mineral additives	0.1800	0.900	
10077 single eq. cond.	-	0.900	
10077 single eq. cond. slightly vent.	-	0.900	
10077 single eq. cond.	-	0.900	

Frame Uf transmittance computation

Uf = ([Φf / ΔT] - Σ [UxBp]) / Bf

Uf = ([50.2097 W/m / 20.00 °C]-[5.7471 W/m²K x0.1900 m]-[5.7472 W/m²K x0.1910 m]) / 0.1575 m

Frame width Bf: 157.51 mm Panel width Bp: 380.97 mm

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	2.5105 W/mK
Φf, flow with ISO10077 panel:	50.2097 W/m
Flow error:	0.000000
Triangles:	14588

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000

Project:	Aufschnaiter Schule	Detail:	Kaempfer aussen	File:	Kaempfer aussen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

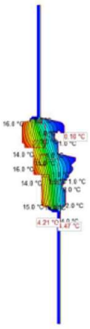
Frame Simulator

ψ and condensation computa

Simplified ISO 10077-2 (2017) - single eq. cond.

Linear transmittance ψ: -0.017 W/mK

Superficial condensation: 479 mm



ψ computation

ψ = [Φψ / ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [50.2097 W/m / 20.00 °C] - [2.1433 W/m²K*0.1575 m]-[5.7471 W/m²K*0.1900 m]-[5.7472 W/m²K*0.1910 m]*

Glazing transmittance Ug=5.75 W/m²K Frame transmittance Uf=2.14 W/m²K

Glazing size Bg: 381 mm Frame size Bf: 158 mm

Simulation with glazing

Lψ2D, with glazing:	2.5105 W/mK
Φψ, flow with glazing:	50.2097 W/m
Flow error:	0.000000
Triangles:	14588

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0

Boundary temperatures

Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	446.89	4.472	16.966	7.447	43.1512
External	632.89	0.096	4.879	3.173	-50.2097
Adiabatic	8.00	4.598	5.057	4.828	-0.0000
Rsi increased	170.19	4.209	16.966	11.705	7.0585

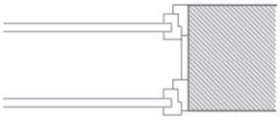
Materials

Name	λx [W/mK]	ε	Color
European larch	0.1300	0.900	
Glass	1.0000	0.900	
Silicone filled	0.5000	0.900	
EPDM	0.2500	0.900	
TPE with mineral additives	0.1800	0.900	
10077 single eq. cond.	-	0.900	
10077 single eq. cond. slightly vent.	-	0.900	
10077 single eq. cond.	-	0.900	

Project:	Aufschnaiter Schule	Detail:	Kaempfer aussen	File:	Kaempfer aussen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

Kastenfenster



Linear thermal bridge computation

EN-ISO 10211:2008 **Linear transmittance ψ: 0.0067 W/mK**

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-
- - -

ψ Computation

ψ = [Φ/ΔT] - Σ [UxL]

ψ = [44.9279 W/m / 20.00 °C] - [2.2397 W/mK]

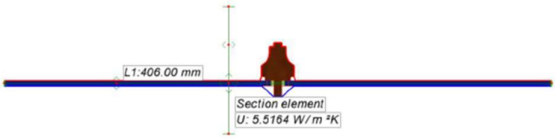
L1D Computation (2.2397 W/mK)

U1*l1 = [5.5164 W/m²K x 0.4060 m] = 2.2397 W/mK
U2*l2 = [- x -] = -
U3*l3 = [- x -] = -
U4*l4 = [- x -] = -

L2D with bridge	2.2464 W/mK
L1D without bridge	2.2397 W/mK
ΔTemperatures:	20.00 °C
Average flux with bridge	44.9279 W/m
Flux without bridge	44.7932 W/m
Flux error	0.000001

Boundary conditions

Name	Col.	Air T [°C]	R type	R [m²K/W]
Adiabatic		-	Constant	-
Internal		20.000	ISO 6946 Internal	-
External		0.000	Constant	0.0400



Materials

Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
Putty	1.0000	0.900	
Norway spruce	0.1100	0.900	
10077 radiosity	-	0.900	

Project :	Aufschnaiter Schule	Detail:	Sprosse aussen	File:	Sprossen aussen
Reference :	-	Date:	16/09/2019	Software:	Mold Simulator - 4.0.5 b839 64bit

Mold Simulator

Linear thermal bridge computation

EN-ISO 10211:2008 **Linear transmittance ψ: 0.0830 W/mK**

-
-
- - -

ψ Computation

ψ = [Φ/ΔT] - Σ [UxL]

ψ = [24.3643 W/m / 20.00 °C] - [1.1352 W/mK]

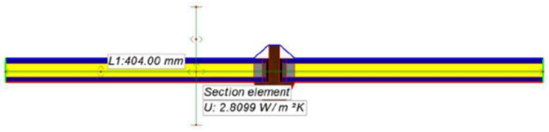
L1D Computation (1.1352 W/mK)

U1*l1 = [2.8099 W/m²K x 0.4040 m] = 1.1352 W/mK
U2*l2 = [- x -] = -
U3*l3 = [- x -] = -
U4*l4 = [- x -] = -

L2D with bridge	1.2182 W/mK
L1D without bridge	1.1352 W/mK
ΔTemperatures:	20.00 °C
Average flux with bridge	24.3643 W/m
Flux without bridge	22.7039 W/m
Flux error	0.000002

Boundary conditions

Name	Col.	Air T [°C]	R type	R [m²K/W]
Adiabatic		-	Constant	-
Internal		20.000	ISO 6946 Internal	-
External		0.000	Constant	0.0400

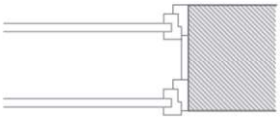


Materials

Name	λx [W/mK]	ε	Color
Argon	1.0217	0.900	
Argon	1.0216	0.900	
Larch	0.1300	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
Glass	1.0000	0.900	
Putty	0.5000	0.900	
Box 1	0.4000	0.900	
Box 2	0.6100	0.900	

Project :	Dante Schule	Detail:	Sprosse innen	File:	Sprosse innen
Reference :	-	Date:	16/09/2019	Software:	Mold Simulator - 4.0.5 b839 64bit

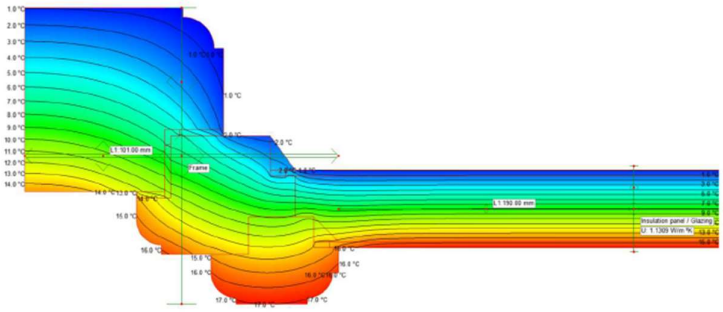
Mold Simulator



Werte für typische Verbundfenster 1910er/1920er Jahre

Frame Uf computation
ISO 10077-2 (2017) - radiosity

Transmittance Uf: 1.90 W/m²K



Materials

Name	λx [W/mK]	ε	Color
European larch	0.1300	0.900	
Glass	1.0000	0.900	
EPDM	0.2500	0.900	
Silicone	0.5000	0.900	
Air	1.2302	0.900	
10077 radiosity	-	0.900	

Frame Uf transmittance computation

Frame width Bf: 101.00 mm Panel width Bp: 190.00 mm

Uf = ([Φf / ΔT] - Σ [UxBp]) / Bf

Uf = ([14.8524 W/m / 20.00 °C] - [2.8081 W/m²K x 0.1900 m] - [- x -]) / 0.1010 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	0.7426 W/mK
Φf, flow with ISO10077 panel:	14.8524 W/m
Flow error:	0.000001
Triangles:	6984

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000

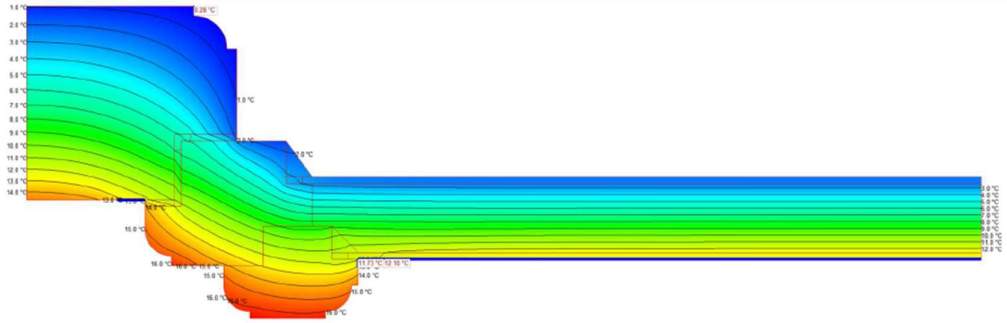
Project:	Dante Schule	Detail:	Rahmen l,r,o	File:	Rahmen l_r_o
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: 0.017 W/mK

Superficial condensation: 215 mm



ψ computation

ψ = [Φψ / ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [14.8524 W/m / 20.00 °C] - [1.8975 W/m²K*0.1010 m] - [2.8081 W/m²K*0.1900 m] - [-*-]*

Glazing transmittance Ug=2.81 W/m²K *Frame transmittance Uf=1.90 W/m²K*

Glazing size Bg: 190 mm *Frame size Bf: 101 mm*

Simulation with glazing

Lψ2D, with glazing:	0.7426 W/mK
Φψ, flow with glazing:	14.8524 W/m
Flow error:	0.000001
Triangles:	6984

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0

Boundary temperatures

Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	237.00	12.097	16.860	13.299	12.2162
External	333.31	0.285	2.752	1.782	-14.8524
Adiabatic	84.00	0.958	14.771	7.290	0.0007
Rsi increased	97.70	11.734	16.860	14.603	2.6363

Materials

Name	λx [W/mK]	ε	Color
European larch	0.1300	0.900	
Glass	1.0000	0.900	
EPDM	0.2500	0.900	
Silicone	0.5000	0.900	
Air	1.2302	0.900	
10077 radiosity	-	0.900	

Project:	Dante Schule	Detail:	Rahmen l,r,o	File:	Rahmen l_r_o
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

Verbundfenster 1910er/1920er Jahre

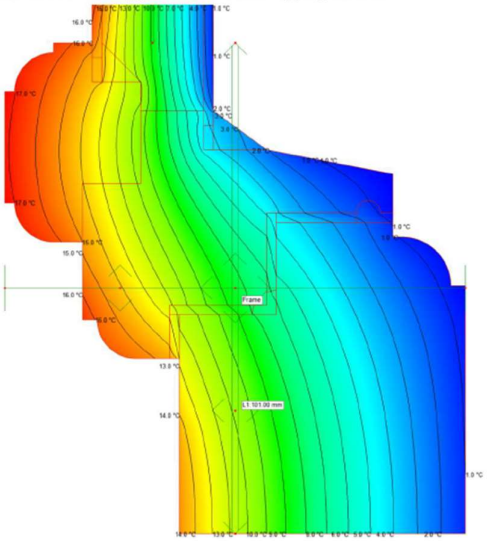
Frame Uf transmittance computation
ISO 10077-2 (2017) - radiosity

Transmittance Uf: 1.80 W/m²K

Frame Uf transmittance computation

Uf = ([Φf/ΔT] - Σ [UxBp])/Bf

Uf = ([14.6744 W/m / 20.00 °C]-[2.8083 W/m²K x0.1900 m]-[- x-])/0.1010 m



Simulation with ISO10077 panel

Lf2D, with panel ISO10077:	0.7337 W/mK
Φf, flow with panel ISO10077:	14.6744 W/m
Flow error:	0.000012
Triangles:	8613

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000

Materials

Name	λx [W/mK]	ε	Color
Air	0.1153	0.900	
Glass	1.0000	0.900	
Silicone	0.5000	0.900	
European larch	0.1300	0.900	
EPDM	0.2500	0.900	
10077 radiosity	-	0.900	

Frame length Bf: 101.00 mm Panel length Bp: 190.00 mm

Project:	Dante Schule	Detail:	Rahmen u	File:	Rahmen u
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: 0.018 W/mK

Superficial condensation: 214 mm

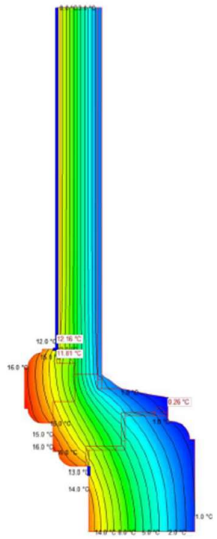
ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [14.6744 W/m / 20.00 °C] - [1.7986 W/m²K*0.1010 m]-[2.8083 W/m²K*0.1900 m]-[-*-]*

Glazing transmittance Ug=2.81 W/m²K *Frame transmittance Uf=1.80 W/m²K*

Glazing size Bg: 190 mm *Frame size Bf: 101 mm*



Boundary table

Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	237.00	12.156	16.956	13.345	12.1318
External	328.78	0.264	2.862	1.785	-14.6745
Adiabatic	84.00	1.012	14.933	7.442	-0.0025
Rsi increased	97.70	11.807	16.956	14.795	2.5426

Simulation with glazing

Lψ2D, with glazing:	0.7337 W/mK
Φψ, flow with glazing:	14.6744 W/m
Flow error:	0.000012
Triangles:	8613

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0

Materials

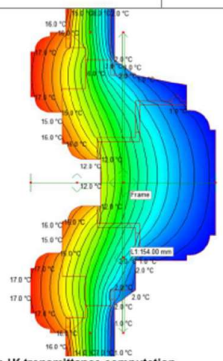
Name	λx [W/mK]	ε	Color
Air	0.1153	0.900	
Glass	1.0000	0.900	
Silicone	0.5000	0.900	
European larch	0.1300	0.900	
EPDM	0.2500	0.900	
10077 radiosity	-	0.900	

Project:	Dante Schule	Detail:	Rahmen u	File:	Rahmen u
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

Frame Uf computation
ISO 10077-2 (2017) - radiosity

Transmittance Uf: 1.87 W/m²K



Materials

Name	λx [W/mK]	ε	Color
PVC Dichtung	0.1400	0.900	
Air	0.1153	0.900	
Glass	1.0000	0.900	
Air	0.1153	0.900	
Silicone filled	0.5000	0.900	
European larch	0.1300	0.900	
10077 radiosity	-	0.900	

Frame Uf transmittance computation

Frame width Bf: 154.00 mm Panel width Bp: 380.00 mm

Uf = ([Φf/ΔT] - Σ [UxBp])/Bf

Uf = ([27.8219 W/m / 20.00 °C]-[2.8081 W/m²K x0.1900 m]-[2.8082 W/m²K x0.1900 m])/0.1540 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	1.3911 W/mK
Φf, flow with ISO10077 panel:	27.8219 W/m
Flow error:	0.000001
Triangles:	14014

Boundary conditions

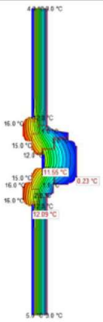
Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000

Project:	Dante Schule	Detail:	Kaempfer	File:	Kaempfer
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: 0.035 W/mK
Superficial condensation: 440 mm



ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [27.8219 W/m / 20.00 °C] - [1.8737 W/m²K*0.1540 m]-[2.8081 W/m²K*0.1900 m]-[2.8082 W/m²K*0.1900 m]/0.3800 m*

Glazing transmittance Ug=2.81 W/m²K Frame transmittance Uf=1.87 W/m²K

Glazing size Bg: 380 mm Frame size Bf: 154 mm

Simulation with glazing

Lψ2D, with glazing:	1.3911 W/mK
Φψ, flow with glazing:	27.8219 W/m
Flow error:	0.000001
Triangles:	14014

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0

Boundary temperatures

Name	L [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	426.00	12.086	16.913	13.168	22.3891
External	614.09	0.229	2.819	1.812	-27.8219
Adiabatic	50.00	2.245	12.697	7.471	0.0000
Rsi increased	195.39	11.554	16.913	14.439	5.4328

Materials

Name	λx [W/mK]	ε	Color
PVC Dichtung	0.1400	0.900	
Air	0.1153	0.900	
Glass	1.0000	0.900	
Air	0.1153	0.900	
Silicone filled	0.5000	0.900	
European larch	0.1300	0.900	
10077 radiosity	-	0.900	

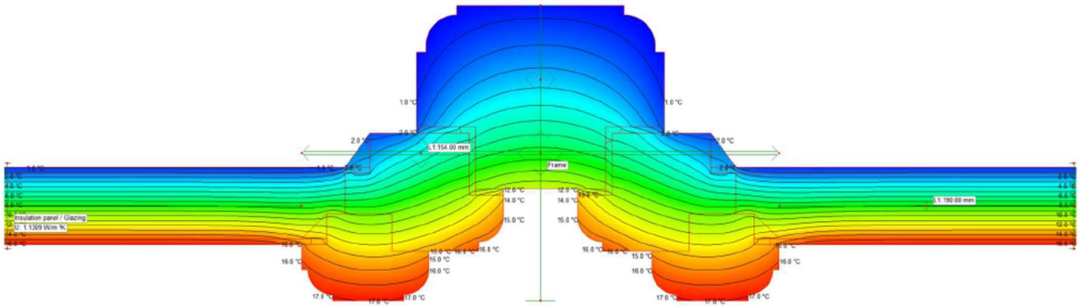
Project:	Dante Schule	Detail:	Kaempfer	File:	Kaempfer
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

Verbundfenster 1910er/1920er Jahre

Frame Uf computation
ISO 10077-2 (2017) - radiosity

Transmittance Uf: 1.93 W/m²K



Materials

Name	λx [W/mK]	ε	Color
European larch	0.1300	0.900	
Air	1.2302	0.900	
EPDM	0.2500	0.900	
Glass	1.0000	0.900	
Silicone	0.5000	0.900	
Air	1.2302	0.900	
10077 radiosity	-	0.900	

Frame Uf transmittance computation

Frame width Bf: 154.00 mm Panel width Bp: 380.00 mm

Uf = ([Φf / ΔT] - Σ [UxBp]) / Bf

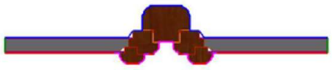
Uf = ([27.9787 W/m / 20.00 °C]-[2.8081 W/m²K x0.1900 m]-[2.8081 W/m²K x0.1900 m]) / 0.1540 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	1.3989 W/mK
Φf, flow with ISO10077 panel:	27.9787 W/m
Flow error:	0.000002
Triangles:	13792

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000

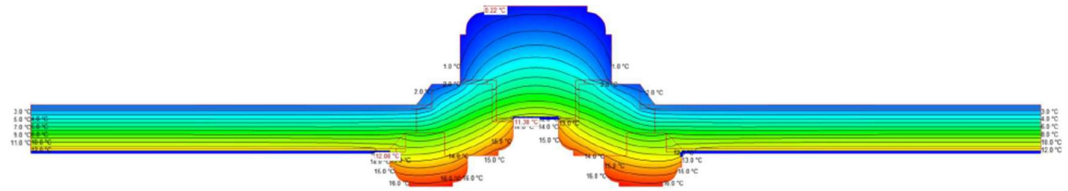


Project:	Dante Schule	Detail:	Setzholz	File:	Setzholz
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: 0.034 W/mK
Superficial condensation: 446 mm



ψ computation

ψ = [Φψ / ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [27.9787 W/m / 20.00 °C] - [1.9314 W/m²K*0.1540 m]-[2.8081 W/m²K*0.1900 m]-[2.8081 W/m²K*0.1900 m]*

Glazing transmittance Ug=2.81 W/m²K Frame transmittance Uf=1.93 W/m²K
Glazing size Bg: 380 mm Frame size Bf: 154 mm

Simulation with glazing

Lψ2D, with glazing:	1.3989 W/mK
Φψ, flow with glazing:	27.9787 W/m
Flow error:	0.000002
Triangles:	13792

Boundary conditions

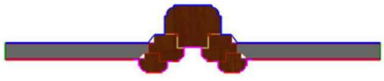
ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0

Boundary temperatures

Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	426.00	12.083	16.825	13.153	22.4376
External	618.62	0.218	2.628	1.809	-27.9787
Adiabatic	50.00	2.245	12.697	7.470	-0.0000
Rsi increased	195.39	11.380	16.825	14.328	5.5411

Materials

Name	λx [W/mK]	ε	Color
European larch	0.1300	0.900	
Air	1.2302	0.900	
EPDM	0.2500	0.900	
Glass	1.0000	0.900	
Silicone	0.5000	0.900	
Air	1.2302	0.900	
10077 radiosity	-	0.900	



Project:	Dante Schule	Detail:	Setzholz	File:	Setzholz
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

Verbundfenster 1910er/1920er Jahre

Linear thermal bridge computation

EN-ISO 10211:2008 **Linear transmittance ψ: 0.0065 W/mK**

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-

ψ Computation

ψ = [Φ/ΔT] - Σ [UxL]

ψ = [44.4089 W/m / 20.00 °C] - [2.2139 W/mK]

L1D Computation (2.2139 W/mK)

U1*l1 = [5.5626 W/m²K x 0.3980 m] = 2.2139 W/mK
U2*l2 = [- x -] = -
U3*l3 = [- x -] = -
U4*l4 = [- x -] = -

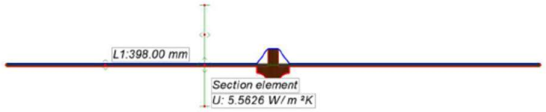
L2D with bridge	2.2204 W/mK
L1D without bridge	2.2139 W/mK
ΔTemperatures:	20.00 °C
Average flux with bridge	44.4089 W/m
Flux without bridge	44.2785 W/m
Flux error	0.000000

Boundary conditions

Name	Col.	Air T [°C]	R type	R [m²K/W]
Adiabatic		-	Constant	-
Internal		20.000	ISO 6946 Internal	-
External		0.000	Constant	0.0400

Materials

Name	λx [W/mK]	ε	Color
European larch	0.1300	0.900	
Putty	0.5000	0.900	
Putty	1.0000	0.900	



Project :	Dante Schule	Detail:	Sprosse aussen	File:	2 - PSI+ISO13788 - 2 environments
Reference :	-	Date:	16/09/2019	Software:	Mold Simulator - 4.0.5 b839 64bit

Mold Simulator

Linear thermal bridge computation

EN-ISO 10211:2008 **Linear transmittance ψ: 0.0075 W/mK**

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-

ψ Computation

ψ = [Φ/ΔT] - Σ [UxL]

ψ = [44.4680 W/m / 20.00 °C] - [2.2159 W/mK]

L1D Computation (2.2159 W/mK)

U1*l1 = [5.5676 W/m²K x 0.3980 m] = 2.2159 W/mK
U2*l2 = [- x -] = -
U3*l3 = [- x -] = -
U4*l4 = [- x -] = -

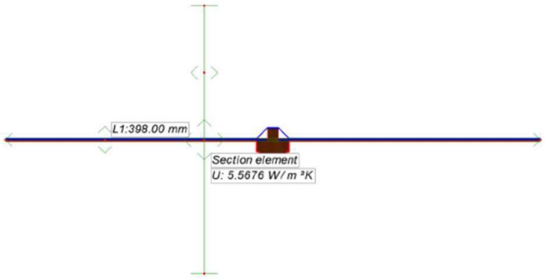
L2D with bridge	2.2234 W/mK
L1D without bridge	2.2159 W/mK
ΔTemperatures:	20.00 °C
Average flux with bridge	44.4680 W/m
Flux without bridge	44.3184 W/m
Flux error	0.000001

Boundary conditions

Name	Col.	Air T [°C]	R type	R [m²K/W]
Adiabatic		-	Constant	-
Internal		20.000	ISO 6946 Internal	-
External		0.000	Constant	0.0400

Materials

Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
Putty	0.5000	0.900	
European larch	0.1300	0.900	



Project :	Dante Schule	Detail:	Sprosse innen	File:	2 - PSI+ISO13788 - 2 environments
Reference :	-	Date:	16/09/2019	Software:	Mold Simulator - 4.0.5 b839 64bit

Mold Simulator

Verbundfenster 1910er/1920er Jahre

Linear thermal bridge computation	
EN-ISO 10211:2008	Linear transmittance ψ: 0.0107 W/mK

ψ Computation

ψ = [Φ/ΔT] - Σ [UxL]

ψ = [22.2919 W/m / 20.00 °C] - [1.1039 W/mK]

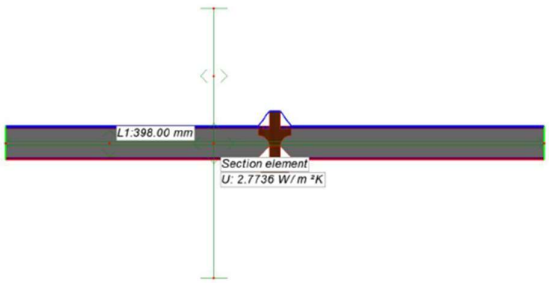
L1D Computation (1.1039 W/mK)

U1*l1 = [2.7736 W/m²K x 0.3980 m] = 1.1039 W/mK
U2*l2 = [- x -] = -
U3*l3 = [- x -] = -
U4*l4 = [- x -] = -

L2D with bridge	1.1146 W/mK
L1D without bridge	1.1039 W/mK
ΔTemperatures:	20.00 °C
Average flux with bridge	22.2919 W/m
Flux without bridge	22.0775 W/m
Flux error	0.000002

Boundary conditions

Name	Col.	Air T [°C]	R type	R [m²K/W]
Adiabatic		-	Constant	-
Internal		20.000	ISO 6946 Internal	-
External		0.000	Constant	0.0400



Materials

Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
Air	1.1716	0.900	
Putty	0.5000	0.900	
Air	1.1716	0.900	
European larch	0.1300	0.900	

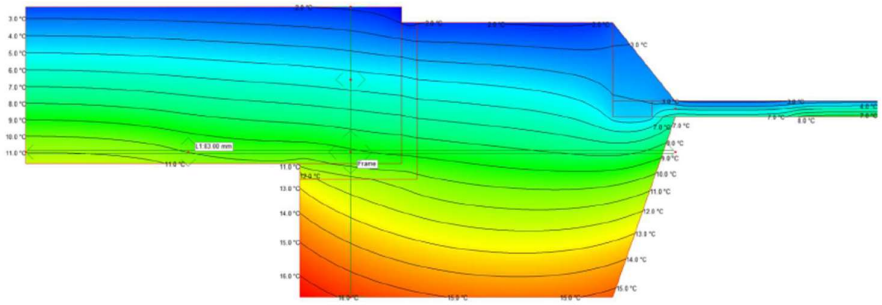
Project :	Dante Schule	Detail:	Sprossen	File:	Sprosse
Reference :	-	Date:	16/09/2019	Software:	Mold Simulator - 4.0.5 b839 64bit

Mold Simulator

Werte für typische Kastenfenster saniert mit Isolierverglasung (innere Fensterebene)

Frame Uf computation
ISO 10077-2 (2017) - radiosity

Transmittance Uf: 2.80 W/m²K



Materials

Name	λx [W/mK]	ε	Color
Putty	1.0000	0.900	
Larch	0.1300	0.900	
Glass	1.0000	0.900	
Air	0.0539	0.900	

Frame Uf transmittance computation

Frame width Bf: 83.00 mm Panel width Bp: 190.00 mm

Uf = ([Φf/ΔT] - Σ [UxBp])/Bf

Uf = ([26.6115 W/m / 20.00 °C]-[5.8140 W/m²K x0.1900 m]-[- x-])/0.0830 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	1.3306 W/mK
Φf, flow with ISO10077 panel:	26.6115 W/m
Flow error:	0.000001
Triangles:	1703

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000

Project:	Knablhof	Detail:	Rahmen o,l,r aussen	File:	Rahmen o,l,r aussen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: -0.007 W/mK
Superficial condensation: 270 mm

ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [26.6115 W/m / 20.00 °C] - [2.8047 W/m²K*0.0830 m]-[5.8140 W/m²K*0.1900 m]-[-*-]*

Glazing transmittance Ug=5.81 W/m²K Frame transmittance Uf=2.80 W/m²K

Glazing size Bg: 190 mm Frame size Bf: 83 mm

Simulation with glazing

Lψ2D, with glazing:	1.3306 W/mK
Φψ, flow with glazing:	26.6115 W/m
Flow error:	0.000001
Triangles:	1703

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0

Boundary temperatures

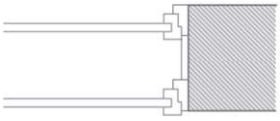
Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	233.00	4.263	16.565	7.152	23.0275
External	279.81	1.235	4.651	3.804	-26.6115
Adiabatic	22.00	2.346	11.703	6.757	0.0002
Rsi increased	73.35	3.921	16.565	10.228	3.5840

Materials

Name	λx [W/mK]	ε	Color
Putty	1.0000	0.900	
Larch	0.1300	0.900	
Glass	1.0000	0.900	
Air	0.0539	0.900	

Project:	Knablhof	Detail:	Rahmen o,l,r aussen	File:	Rahmen o,l,r aussen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator



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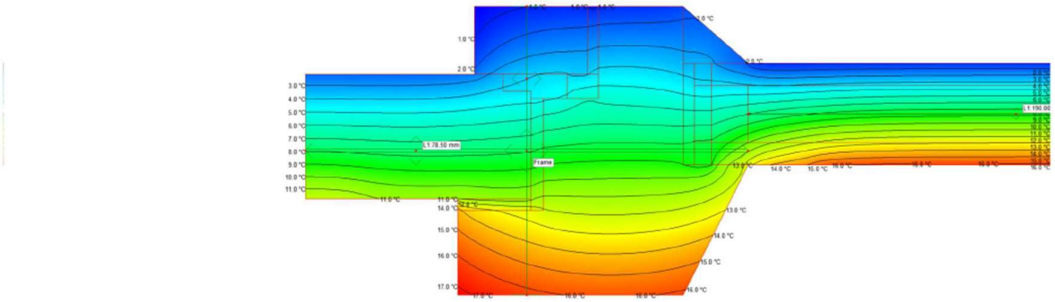
Frame Uf computation
ISO 10077-2 (2017) - radiosity

Transmittance Uf: 2.40 W/m²K



Materials

Name	λx [W/mK]	ε	Color
Larch	0.1300	0.900	
EPDM	0.2500	0.900	
Argon	1.0433	0.900	
Glass	1.0000	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
Putty	0.5000	0.900	
Box 1	0.4000	0.900	
Box 2	0.6100	0.900	
10077 radiosity	-	0.900	

Frame Uf transmittance computation

Frame width Bf: 78.50 mm Panel width Bp: 190.00 mm

Uf = ([Φf / ΔT] - Σ [UxBp]) / Bf

Uf = ([15.1075 W/m / 20.00 °C] -[2.8455 W/m²K x0.1900 m]-[- x-]) / 0.0785 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	0.7554 W/mK
Φf, flow with ISO10077 panel:	15.1075 W/m
Flow error:	0.000008
Triangles:	2218

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000

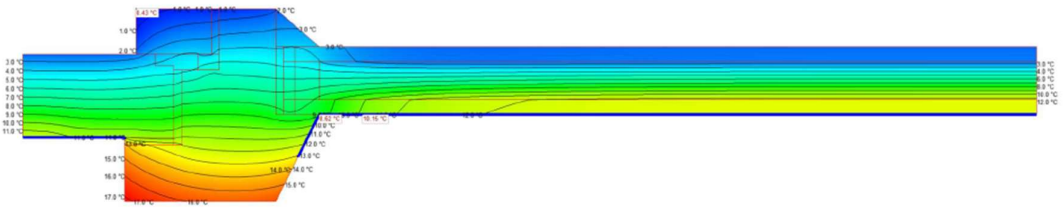
Project:	Dante Schule	Detail:	Rahmen o,u,l,r innen	File:	Rahmen o,u,l,r innen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: 0.026 W/mK

Superficial condensation: 247 mm



ψ computation

ψ = [Φψ / ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [15.1075 W/m / 20.00 °C] - [2.4024 W/m²K*0.0785 m]-[2.8455 W/m²K*0.1900 m]-[-*-]*

Glazing transmittance Ug=2.85 W/m²K Frame transmittance Uf=2.40 W/m²K

Glazing size Bg: 190 mm Frame size Bf: 79 mm

Simulation with glazing

Lψ2D, with glazing:	0.7554 W/mK
Φψ, flow with glazing:	15.1075 W/m
Flow error:	0.000008
Triangles:	2218

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0

Boundary temperatures

Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	228.50	10.147	17.222	12.928	12.4298
External	284.24	0.431	3.617	2.126	-15.1074
Adiabatic	40.00	2.184	12.595	7.143	-0.0007
Rsi increased	71.21	8.625	17.222	12.480	2.6777

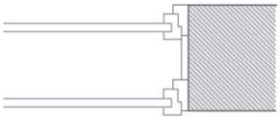
Materials

Name	λx [W/mK]	ε	Color
Larch	0.1300	0.900	
EPDM	0.2500	0.900	
Argon	1.0433	0.900	
Glass	1.0000	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
Putty	0.5000	0.900	
Box 1	0.4000	0.900	
Box 2	0.6100	0.900	
10077 radiosity	-	0.900	

Project:	Dante Schule	Detail:	Rahmen o,u,l,r innen	File:	Rahmen o,u,l,r innen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

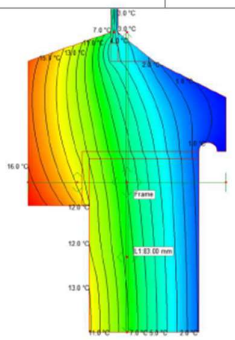
Kastenfenster



Frame Uf computation

ISO 10077-2 (2017) - radiosity

Transmittance Uf: 2.41 W/m²K



Materials

Name	λx [W/mK]	ε	Color
Air	0.0827	0.900	
Larch	0.1300	0.900	
Putty	0.5000	0.900	
Glass	1.0000	0.900	

Frame Uf transmittance computation

Frame width Bf: 83.00 mm Panel width Bp: 190.00 mm

Uf = ([Φf/ΔT] - Σ [UxBp])/ Bf

Uf = ([25.9661 W/m / 20.00 °C]-[5.8140 W/m²K x0.1900 m]-[- x-])/ 0.0830 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	1.2983 W/mK
Φf, flow with ISO10077 panel:	25.9661 W/m
Flow error:	0.000003
Triangles:	2076

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000

Project:	Dante Schule	Detail:	Rahmen u aussen	File:	Rahmen u aussen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa

ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: -0.006 W/mK

Superficial condensation: 264 mm

ψ computation

ψ = [Φψ/ ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [25.9661 W/m / 20.00 °C] - [2.4073 W/m²K*0.0830 m]-[5.8140 W/m²K*0.1900 m]-[-*-]*

Glazing transmittance Ug=5.81 W/m²K Frame transmittance Uf=2.41 W/m²K

Glazing size Bg: 190 mm Frame size Bf: 83 mm

Simulation with glazing

Lψ2D, with glazing:	1.2983 W/mK
Φψ, flow with glazing:	25.9661 W/m
Flow error:	0.000003
Triangles:	2076

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0

Boundary temperatures

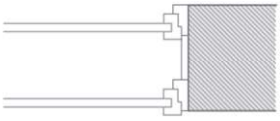
Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	233.00	4.339	16.977	7.355	22.6629
External	300.52	0.193	4.651	3.456	-25.9660
Adiabatic	32.50	1.842	13.199	7.233	0.0003
Rsi increased	73.35	4.118	16.977	10.994	3.3032

Materials

Name	λx [W/mK]	ε	Color
Air	0.0827	0.900	
Larch	0.1300	0.900	
Putty	0.5000	0.900	
Glass	1.0000	0.900	

Project:	Dante Schule	Detail:	Rahmen u aussen	File:	Rahmen u aussen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator



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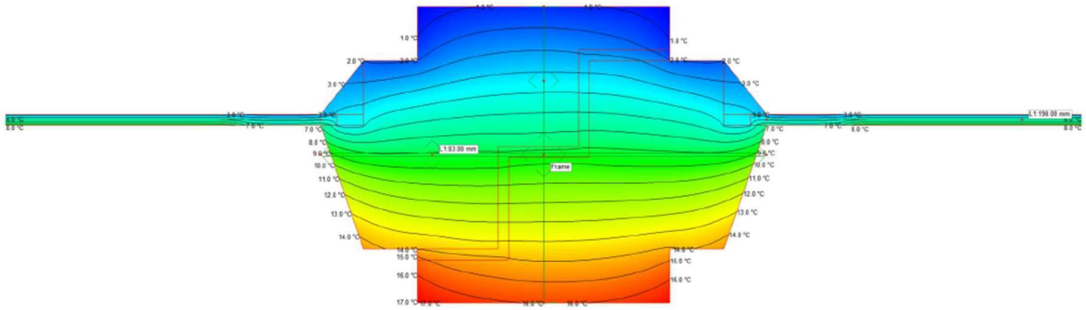
Frame Uf computation
ISO 10077-2 (2017) - radiosity - unventilated

Transmittance Uf: 2.34 W/m²K



Materials

Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
Putty	0.5000	0.900	
Larch	0.1300	0.900	
Air	0.0837	0.900	

Frame Uf transmittance computation

Frame width Bf: 83.00 mm Panel width Bp: 380.00 mm

Uf = ([Φf/ΔT] - Σ [UxBp])/Bf

Uf = ([47.8001 W/m / 20.00 °C]-[5.8140 W/m²K x0.1900 m]-[5.8140 W/m²K x0.1900 m])/0.0830 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	2.3900 W/mK
Φf, flow with ISO10077 panel:	47.8001 W/m
Flow error:	0.000001
Triangles:	2080

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000

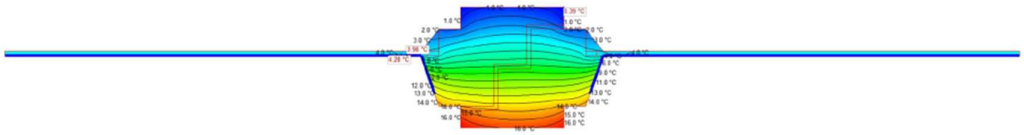
Project:	Dante Schule	Detail:	Stulp aussen	File:	Stulp aussen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity - unventilated

Linear transmittance ψ: -0.013 W/mK

Superficial condensation: 454 mm



ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [47.8001 W/m / 20.00 °C] - [2.3389 W/m²K*0.0830 m]-[5.8140 W/m²K*0.1900 m]-[5.8140 W/m²K*0.1900 m]/0.3800 m = -0.013 W/mK*

Glazing transmittance Ug=5.81 W/m²K Frame transmittance Uf=2.34 W/m²K

Glazing size Bg: 380 mm Frame size Bf: 83 mm

Simulation with glazing

Lψ2D, with glazing:	2.3900 W/mK
Φψ, flow with glazing:	47.8001 W/m
Flow error:	0.000001
Triangles:	2080

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0

Boundary temperatures

Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	397.00	4.283	17.004	6.201	42.1396
External	492.61	0.392	4.651	3.881	-47.8001
Adiabatic	4.00	4.651	4.884	4.767	-0.0000
Rsi increased	118.70	3.982	17.004	10.463	5.6606

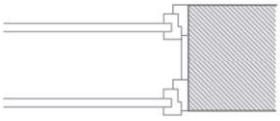
Materials

Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
Putty	0.5000	0.900	
Larch	0.1300	0.900	
Air	0.0837	0.900	

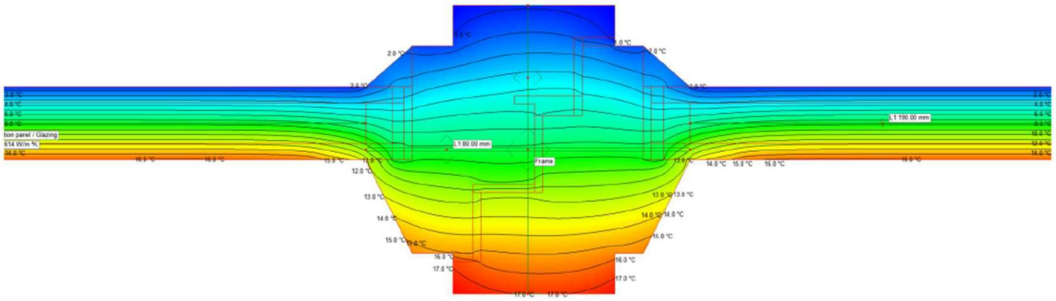
Project:	Dante Schule	Detail:	Stulp aussen	File:	Stulp aussen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

Kastenfenster



Frame Uf computation ISO 10077-2 (2017) - radiosity	Transmittance Uf: 2.05 W/m²K	-



Materials

Name	λx [W/mK]	ε	Color
EPDM	0.2500	0.900	
Box 2	0.6100	0.900	
Box 1	0.4000	0.900	
Glass	1.0000	0.900	
Larch	0.1300	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
Putty	0.5000	0.900	
Argon	1.0433	0.900	
Argon	1.0433	0.900	
10077 radiosity	-	0.900	

Frame Uf transmittance computation

Uf = ([Φf / ΔT] - Σ [UxBp]) / Bf

Uf = ([25.9328 W/m / 20.00 °C]-[2.8455 W/m²K x0.1900 m]-[2.8455 W/m²K x0.1900 m]) / 0.0800 m

Frame width Bf: 80.00 mm Panel width Bp: 380.00 mm

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	1.2966 W/mK
Φf, flow with ISO10077 panel:	25.9328 W/m
Flow error:	0.000000
Triangles:	4132

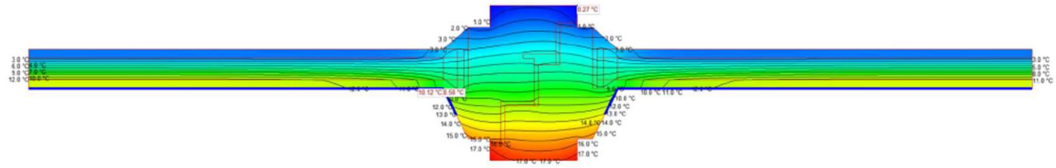
Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000

Project:	Dante Schule	Detail:	Stulp innen	File:	Stulp innen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa ISO 10077-2 (2017) - radiosity	Linear transmittance ψ: 0.051 W/mK Superficial condensation: 436 mm	-



ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [25.9328 W/m / 20.00 °C] - [2.0483 W/m²K*0.0800 m]-[2.8455 W/m²K*0.1900 m]-[2.8455 W/m²K*0.1900 m] / 0.0100 m*

Glazing transmittance Ug=2.85 W/m²K Frame transmittance Uf=2.05 W/m²K

Glazing size Bg: 380 mm Frame size Bf: 80 mm

Simulation with glazing

Lψ2D, with glazing:	1.2966 W/mK
Φψ, flow with glazing:	25.9328 W/m
Flow error:	0.000000
Triangles:	4132

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0

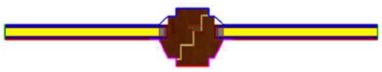
Boundary temperatures

Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	397.00	10.121	17.768	12.767	22.0880
External	487.48	0.274	3.663	2.128	-25.9328
Adiabatic	36.00	2.274	12.596	7.434	0.0000
Rsi increased	111.43	8.578	17.768	13.099	3.8447

Materials

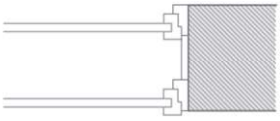
Name	λx [W/mK]	ε	Color
EPDM	0.2500	0.900	
Box 2	0.6100	0.900	
Box 1	0.4000	0.900	
Glass	1.0000	0.900	
Larch	0.1300	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
Putty	0.5000	0.900	
Argon	1.0433	0.900	
Argon	1.0433	0.900	

Name	λx [W/mK]	ε	Color
10077 radiosity	-	0.900	



Project:	Dante Schule	Detail:	Stulp innen	File:	Stulp innen
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator



Linear thermal bridge computation	
EN-ISO 10211:2008	Linear transmittance ψ: 0.0077 W/mK

-
-

ψ Computation

ψ = [Φ/ΔT] - Σ [UxL]

ψ = [45.1532 W/m / 20.00 °C] - [2.2499 W/mK]

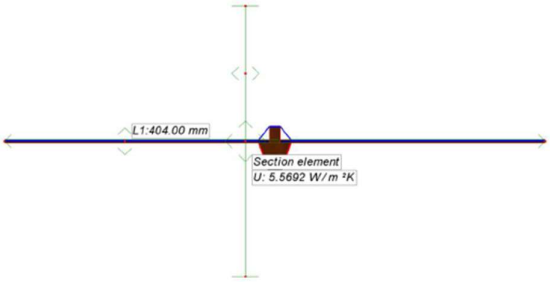
L1D Computation (2.2499 W/mK)

U1*l1 = [5.5692 W/m²K x 0.4040 m] = 2.2499 W/mK
U2*l2 = [- x -] = -
U3*l3 = [- x -] = -
U4*l4 = [- x -] = -

L2D with bridge	2.2577 W/mK
L1D without bridge	2.2499 W/mK
ΔTemperatures:	20.00 °C
Average flux with bridge	45.1532 W/m
Flux without bridge	44.9988 W/m
Flux error	0.000000

Boundary conditions

Name	Col	Air T [°C]	R type	R [m²K/W]
Adiabatic		-	Constant	-
Internal		20.000	ISO 6946 Internal	-
External		0.000	Constant	0.0400



Materials

Name	λx [W/mK]	ε	Color
Larch	0.1300	0.900	
Glass	1.0000	0.900	
Putty	1.0000	0.900	

Project :	Dante Schule	Detail:	Sprosse aussen	File:	Sprosse au en
Reference :	-	Date:	16/09/2019	Software:	Mold Simulator - 4.0.5 b839 64bit

Mold Simulator

Linear thermal bridge computation	
EN-ISO 10211:2008	Linear transmittance ψ: 0.0830 W/mK

-
-

ψ Computation

ψ = [Φ/ΔT] - Σ [UxL]

ψ = [24.3643 W/m / 20.00 °C] - [1.1352 W/mK]

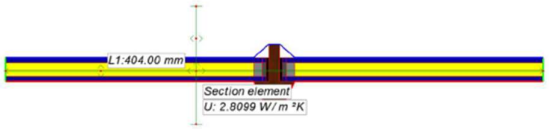
L1D Computation (1.1352 W/mK)

U1*l1 = [2.8099 W/m²K x 0.4040 m] = 1.1352 W/mK
U2*l2 = [- x -] = -
U3*l3 = [- x -] = -
U4*l4 = [- x -] = -

L2D with bridge	1.2182 W/mK
L1D without bridge	1.1352 W/mK
ΔTemperatures:	20.00 °C
Average flux with bridge	24.3643 W/m
Flux without bridge	22.7039 W/m
Flux error	0.000002

Boundary conditions

Name	Col	Air T [°C]	R type	R [m²K/W]
Adiabatic		-	Constant	-
Internal		20.000	ISO 6946 Internal	-
External		0.000	Constant	0.0400

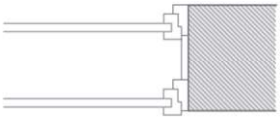


Materials

Name	λx [W/mK]	ε	Color
Argon	1.0217	0.900	
Argon	1.0216	0.900	
Larch	0.1300	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
Glass	1.0000	0.900	
Putty	0.5000	0.900	
Box 1	0.4000	0.900	
Box 2	0.6100	0.900	

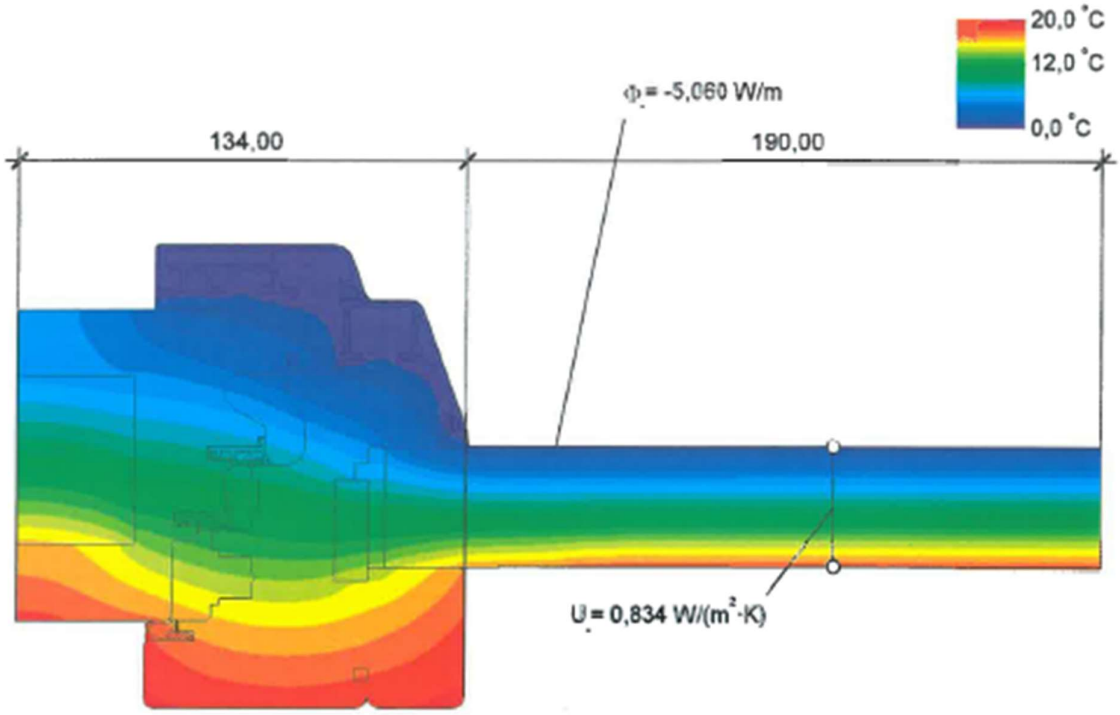
Project :	Dante Schule	Detail:	Sprosse innen	File:	Sprosse innen
Reference :	-	Date:	16/09/2019	Software:	Mold Simulator - 4.0.5 b839 64bit

Mold Simulator



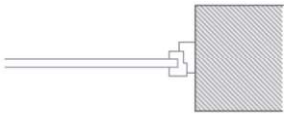
Austausch Fensterkonstruktion (Einfachfenster)

U_{f1} λ=0,11 W/mK
Nodo laterale/superiore

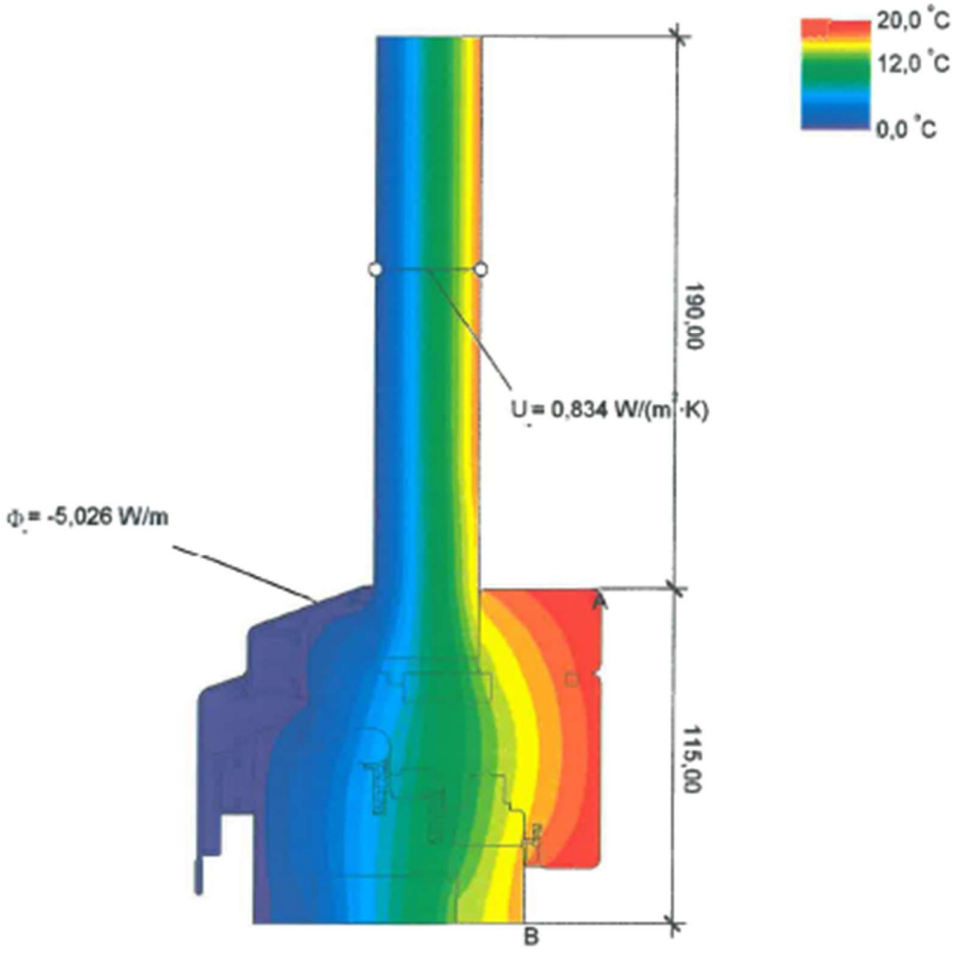


$$U_f = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{5,060}{20,000} - 0,834 \cdot 0,190}{0,134} = 0,70 \text{ W/(m}^2\text{·K)}$$

TESTING LABORATORY · LEGNOLEGNO · Via Pio La Torre 11 42013 Correggio (RE) ITALY

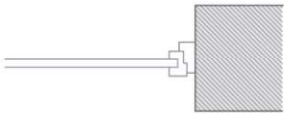


U_{f2} λ=0,11 W/mK
Nodo inferiore finestra

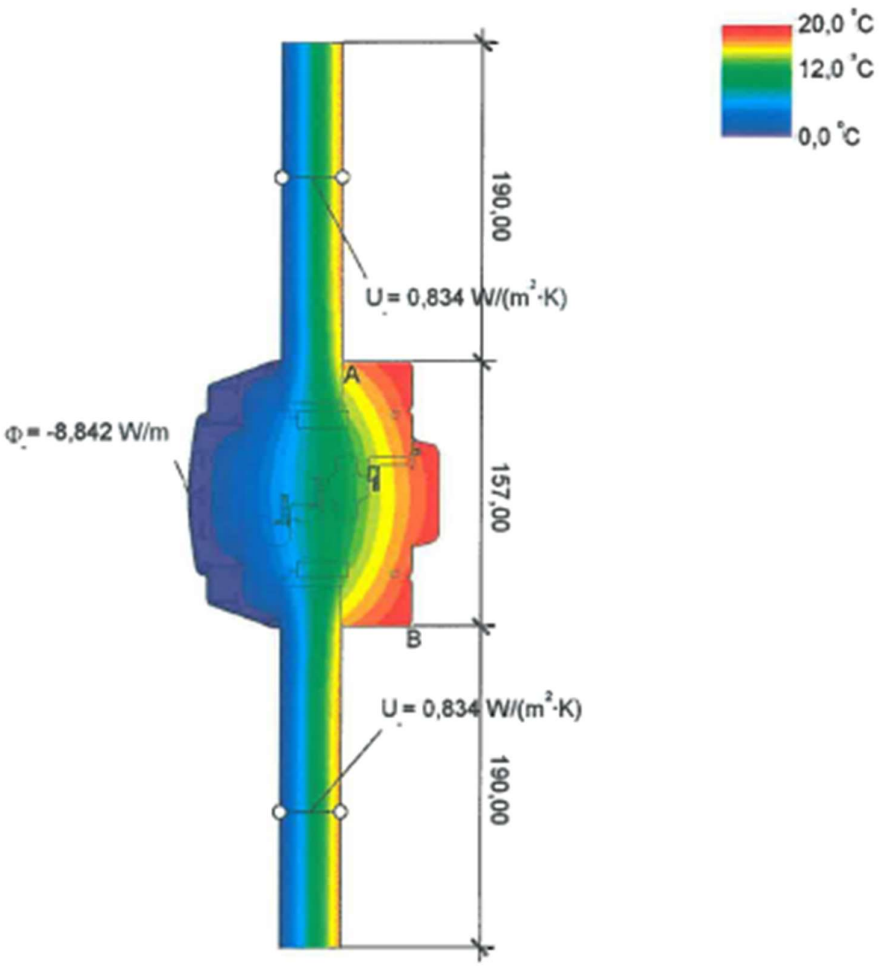


$$U_{f,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{5,026}{20,000} - 0,834 \cdot 0,190}{0,115} = 0,81 \text{ W/(m}^2\text{·K)}$$

TESTING LABORATORY · LEGNOLEGNO · Via Pio La Torre, 11 · 45018 Corneggio (RO) · ITALY



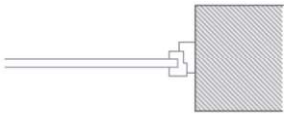
U_{f3} λ=0,11 W/mK
Nodo centrale



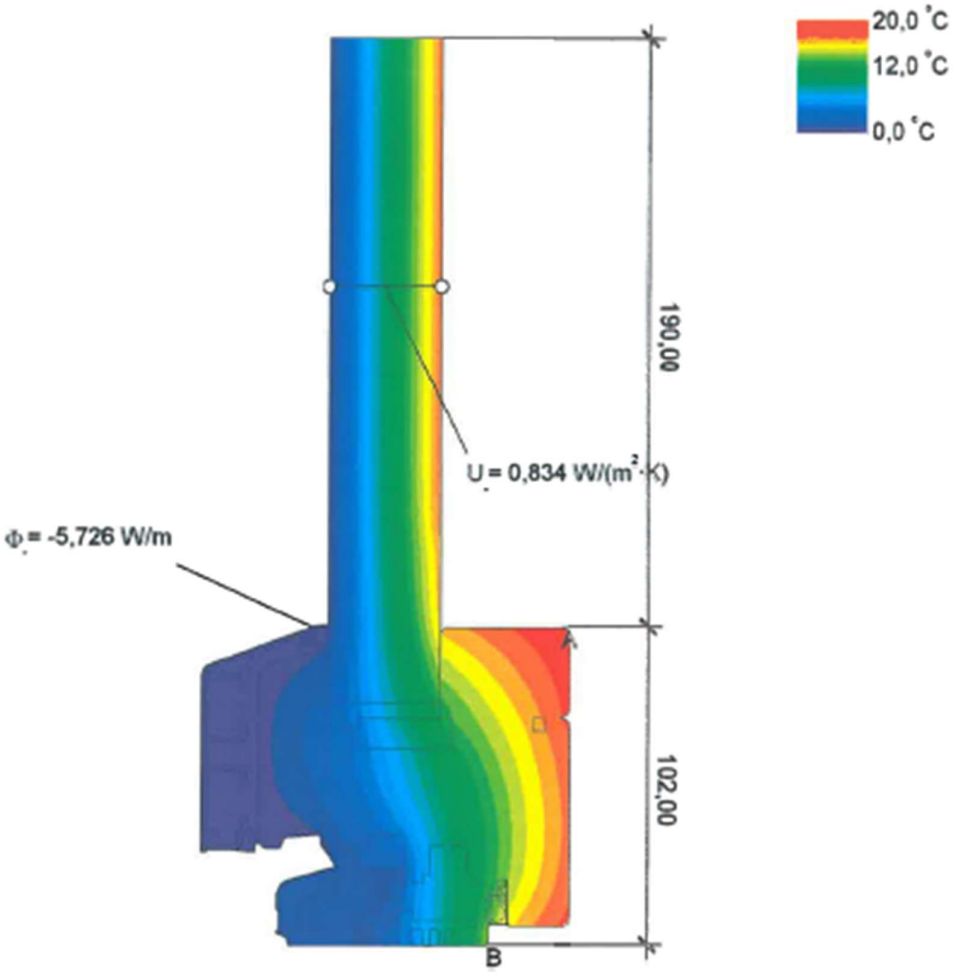
$$U_f = \frac{\frac{\Phi}{\Delta T} - U_{p1} \cdot b_{p1} - U_{p2} \cdot b_{p2}}{b_f} = \frac{\frac{8,842}{20,000} - 0,834 \cdot 0,190 - 0,834 \cdot 0,190}{0,157} = 0,80 \text{ W/(m}^2\text{·K)}$$

TESTING LABORATORY · LEGNOLEGNO · Via Pio La Torre, 11 42015 Correggio (RE) ITALY

Neues Einfachfenster

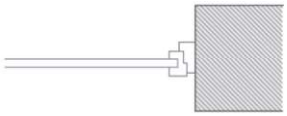


U_{f4} λ=0,11 W/mK
Nodo inferiore portafinestra

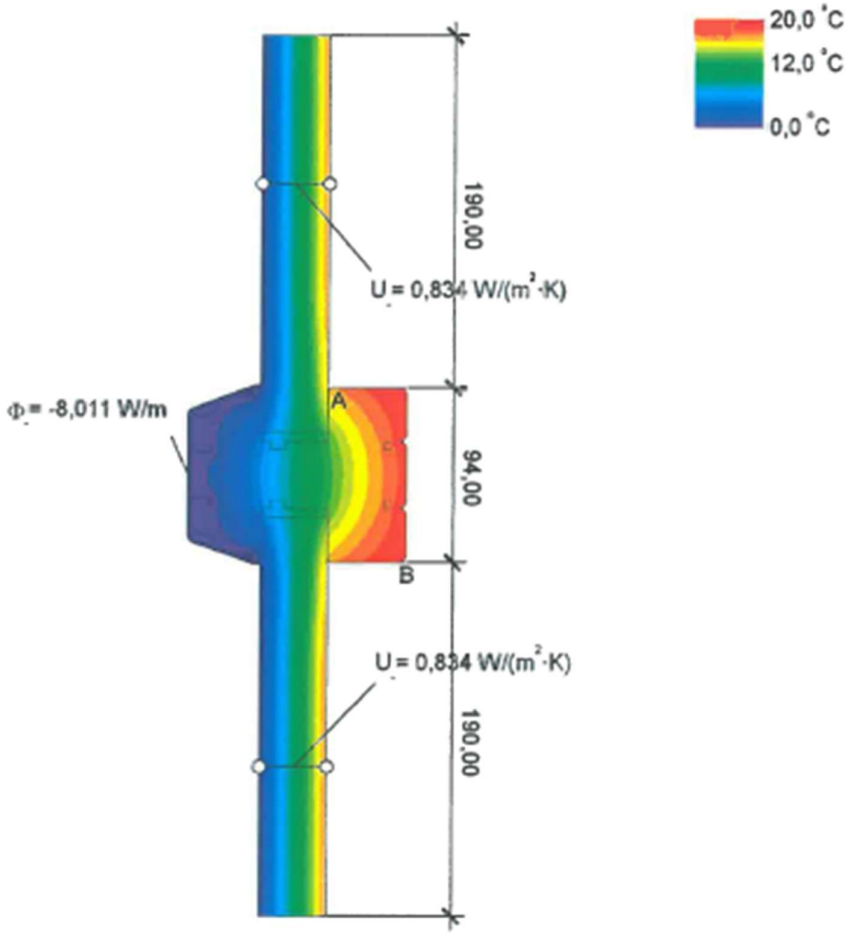


$$U_f = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{5,726}{20,000} - 0,834 \cdot 0,190}{0,102} = 1,3 \text{ W/(m}^2\text{·K)}$$

TESTING LABORATORY · LEGNOLEGNO ·
Via P.ta La Torre, 11
42015 Correggio (RE)
ITALY

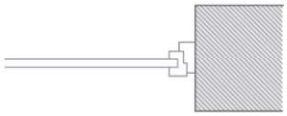


U_{f5} λ=0,11 W/mK
Nodo traversa rompitratta

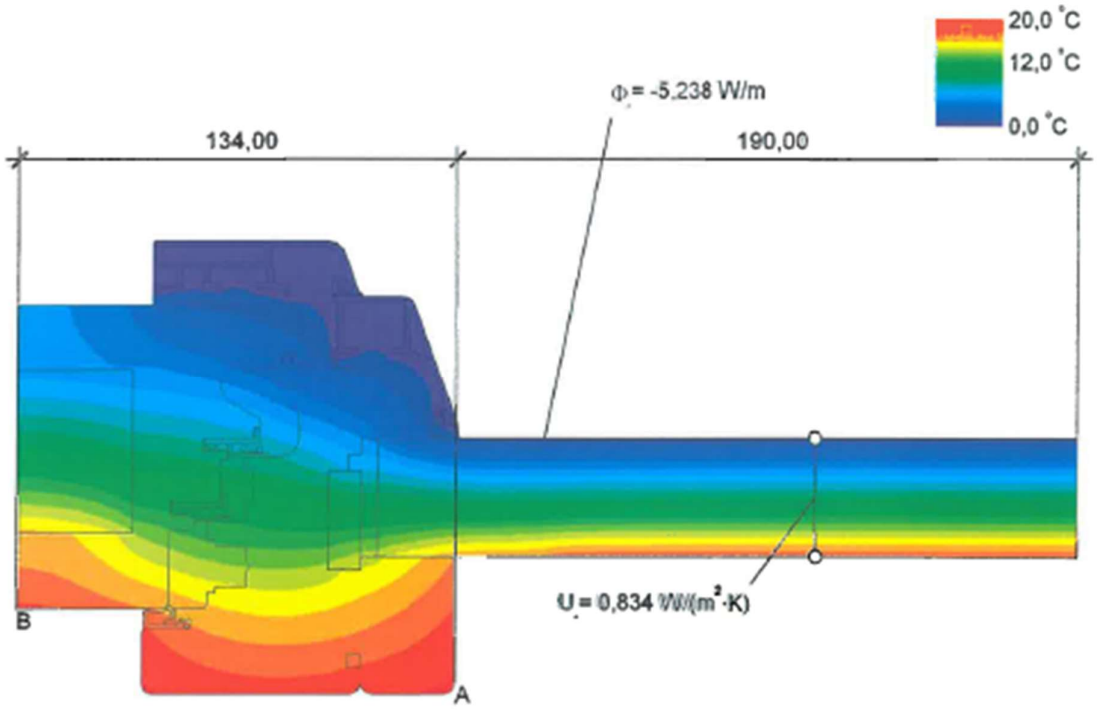


$$U_{f,A,B} = \frac{\frac{\Phi}{\Delta T} - U_{p1} \cdot b_{p1} - U_{p2} \cdot b_{p2}}{b_f} = \frac{\frac{8,011}{20,000} - 0,834 \cdot 0,190 - 0,834 \cdot 0,190}{0,094} = 0,89 \text{ W/(m}^2\text{·K)}$$

TESTING LABORATORY · LEGNOLEGNO ·
Via Pio La Torre, 11
42015 Correggio (RE)
ITALY

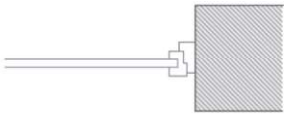


U_{f1} λ=0,13 W/mK
Nodo laterale/superiore

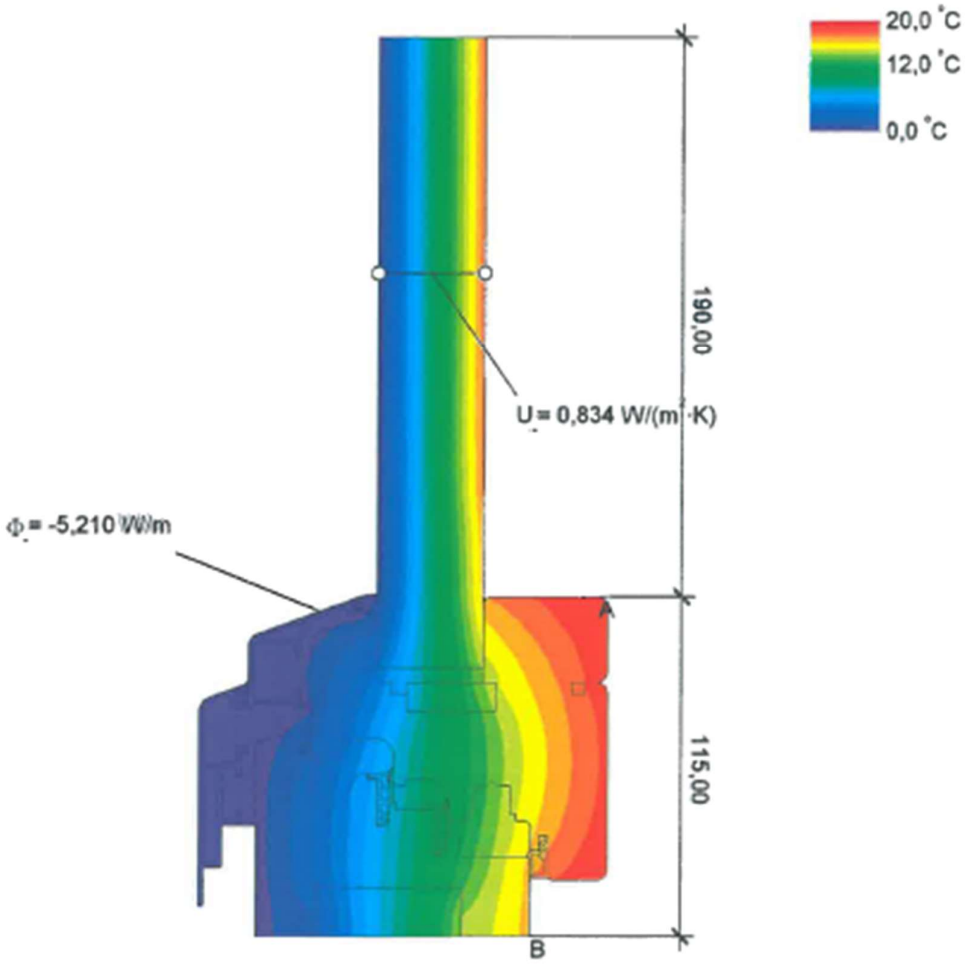


$$U_f = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{5,238}{20,000} - 0,834 \cdot 0,190}{0,134} = 0,77 \text{ W/(m}^2\text{·K)}$$

TESTING LABORATORY · LEGNOLEGNO · Via Pio La Torre, 11 42015 Correggio (RE) ITALY



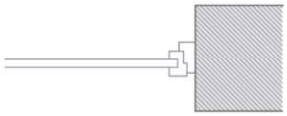
U_{f2} λ=0,13 W/mK
Nodo inferiore finestra



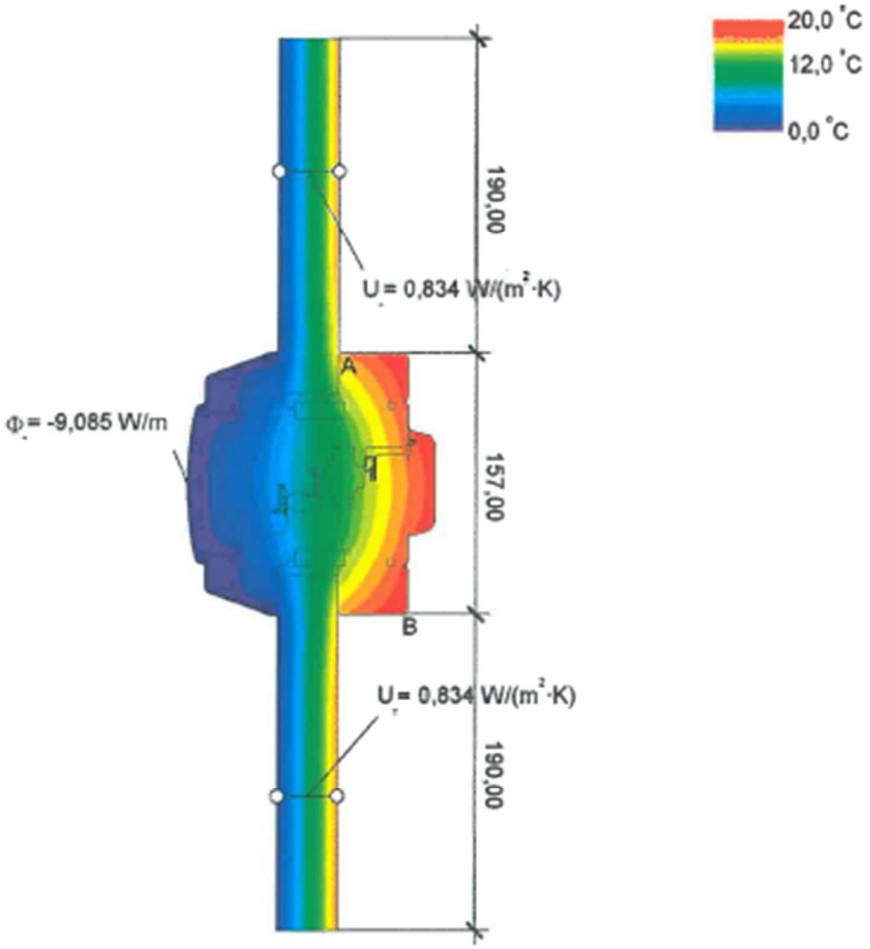
$$U_f = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{5,210}{20,000} - 0,834 \cdot 0,190}{0,115} = 0,89 \text{ W/(m}^2\text{·K)}$$

TESTING LABORATORY · LEGNOLEGNO · Via Pio La Torre, 11 42015 Correggio (RE) ITALY

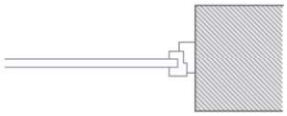
Neues Einfachfenster



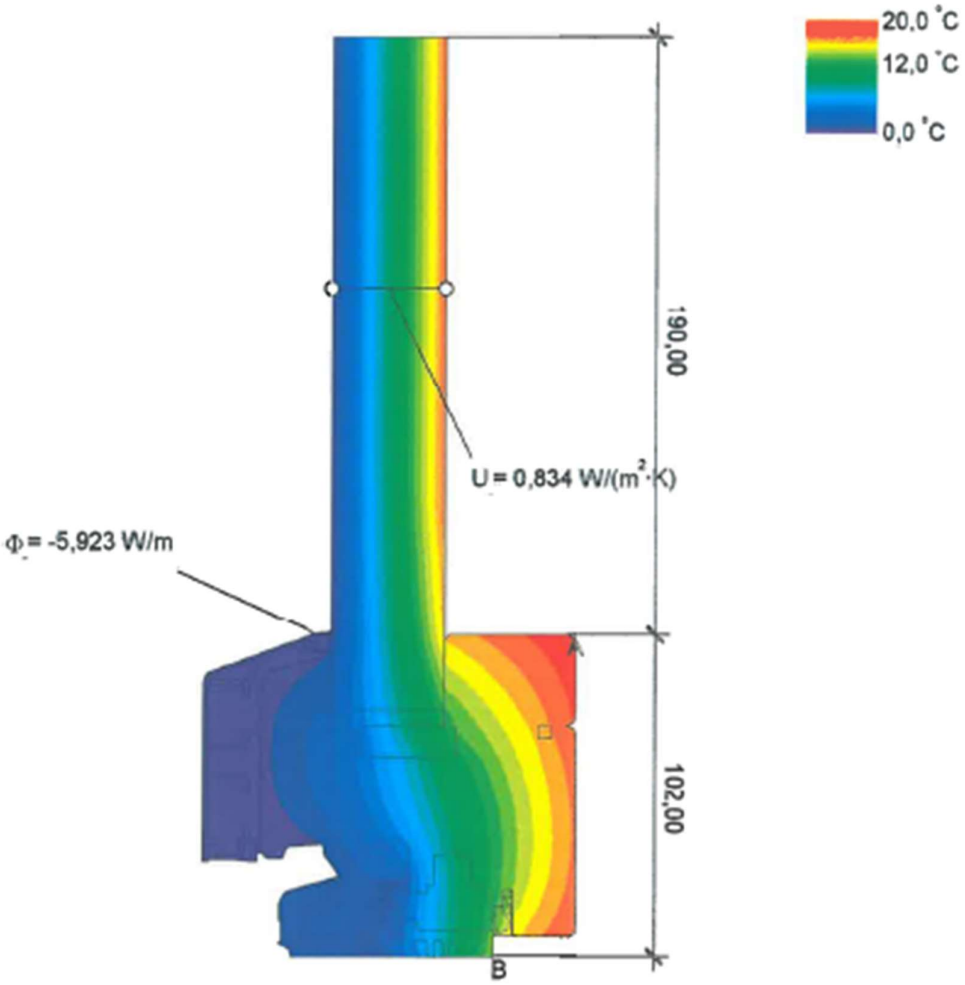
U_{f3} λ=0,13 W/mK
Nodo centrale



$$U_{f,A,B} = \frac{\frac{\Phi}{\Delta T} - U_{p1}\cdot b_{p1} - U_{p2}\cdot b_{p2}}{b_f} = \frac{\frac{9,085}{20,000} - 0,834\cdot 0,190 - 0,834\cdot 0,190}{0,157} = 0,87\ W/(m^2\cdot K)$$

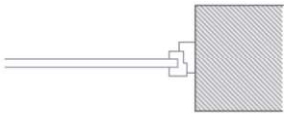


U_{f4} λ=0,13 W/mK
Nodo inferiore portafinestra

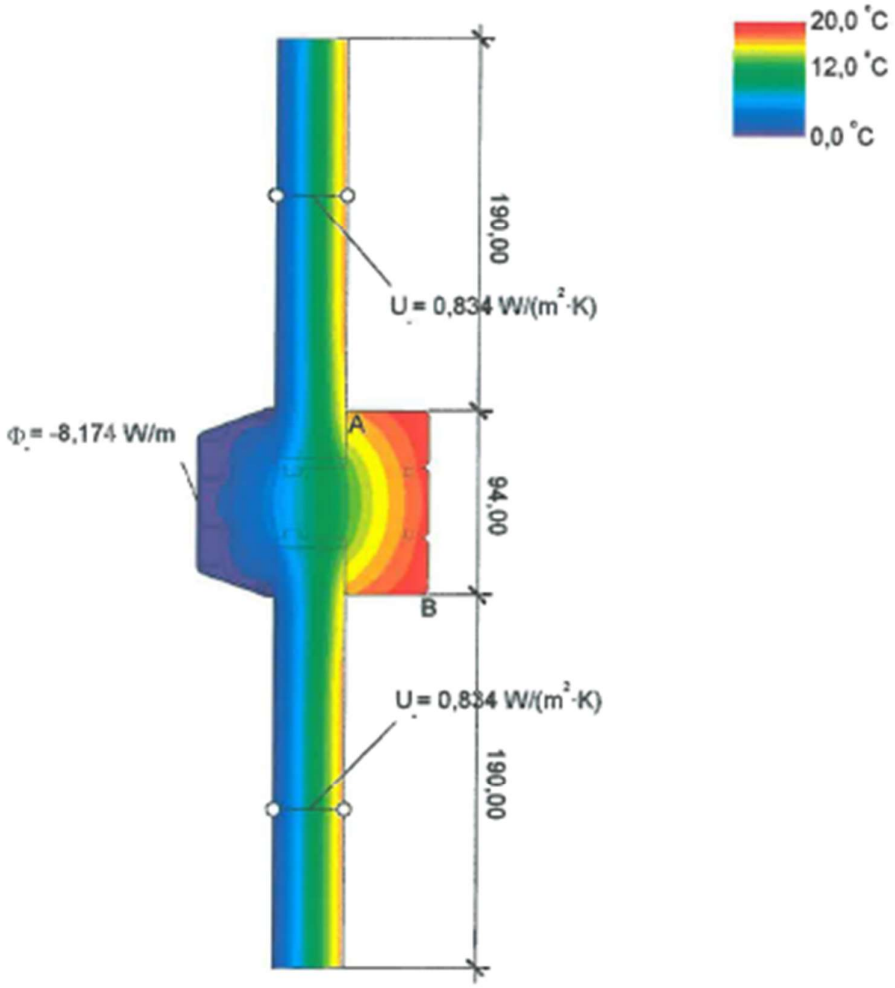


$$U_f = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{5,923}{20,000} - 0,834 \cdot 0,190}{0,102} = 1,3 \text{ W/(m}^2\text{·K)}$$

TESTING LABORATORY · LEGNOLEGNO · Via Pio La Torre, 11 42015 Correggio (RE) ITALY



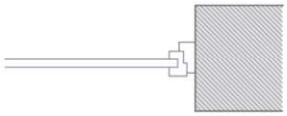
U_{f5} λ=0,13 W/mK
Nodo traversa rompitratta



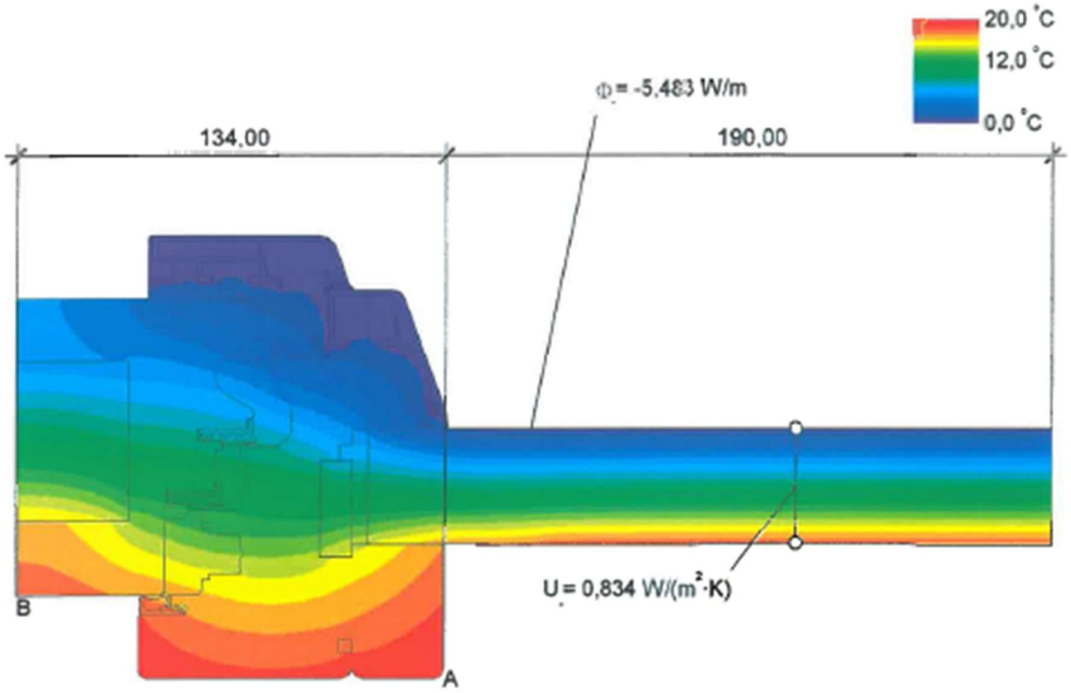
$$U_f = \frac{\frac{\Phi}{\Delta T} - U_{p1}\cdot b_{p1} - U_{p2}\cdot b_{p2}}{b_f} = \frac{\frac{8,174}{20,000} - 0,834\cdot 0,190 - 0,834\cdot 0,190}{0,094} = 0,97\ W/(m^2\cdot K)$$

TESTING LABORATORY · LEGNOLEGNO

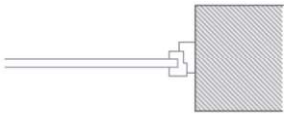
Neues Einfachfenster



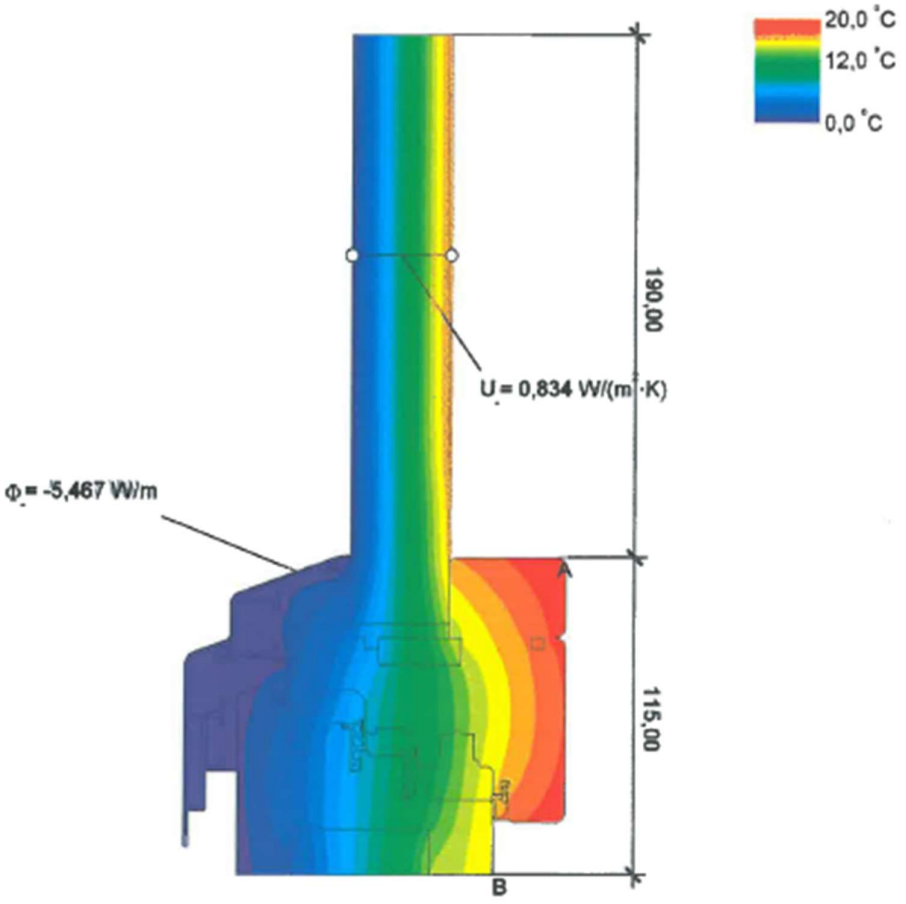
U_{f1} λ=0,16 W/mK
Nodo laterale/superiore



$$U_r = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_r} = \frac{\frac{5,483}{20,000} - 0,834 \cdot 0,190}{0,134} = 0,86 \text{ W/(m}^2\text{·K)}$$

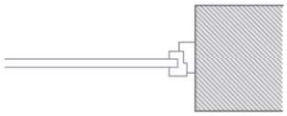


U_{f2} λ=0,16 W/mK
Nodo inferiore finestra

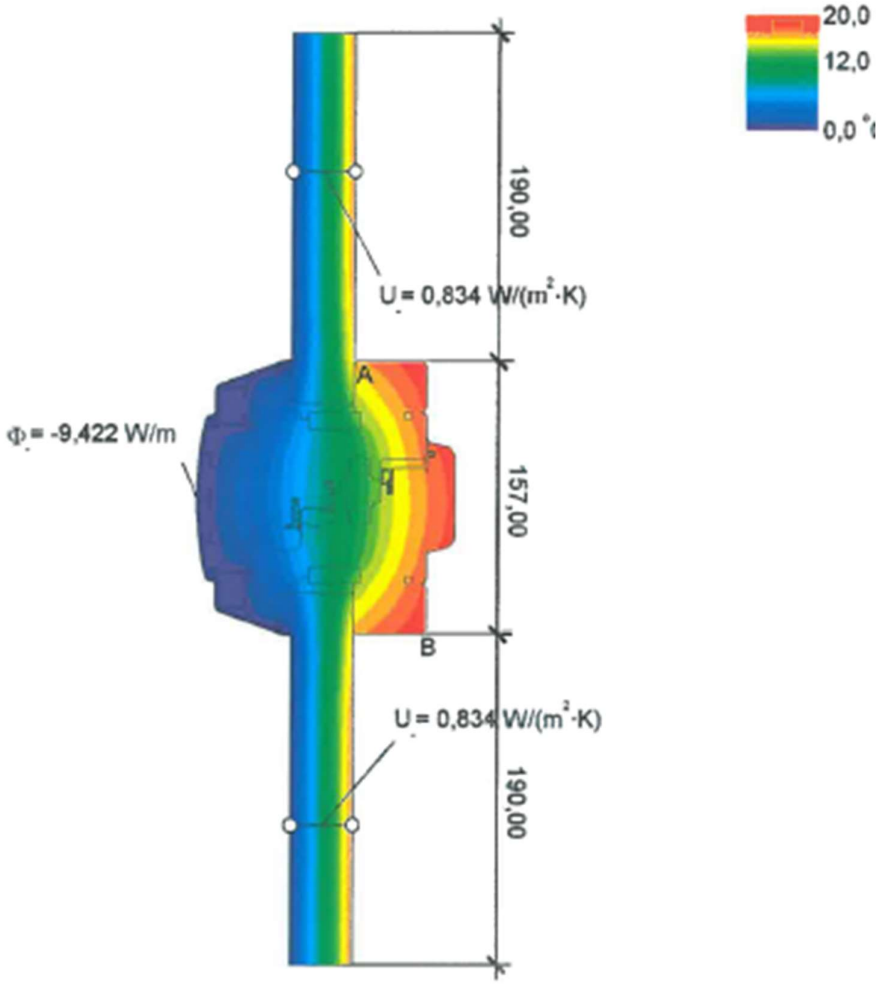


$$U_f = \frac{\frac{\Phi}{\Delta T} - U_g \cdot b_g}{b_f} = \frac{\frac{5,467}{20,000} - 0,834 \cdot 0,190}{0,115} = 1,0\ W/(m^2 \cdot K)$$

TESTING LABORATORY
Via Fra Lr Torre, 11
42015 Correggio (RE)
ITALY
LEGNOLEGNO



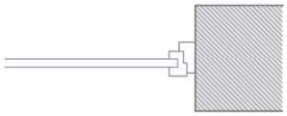
U_{f3} λ=0,16 W/mK
Nodo centrale



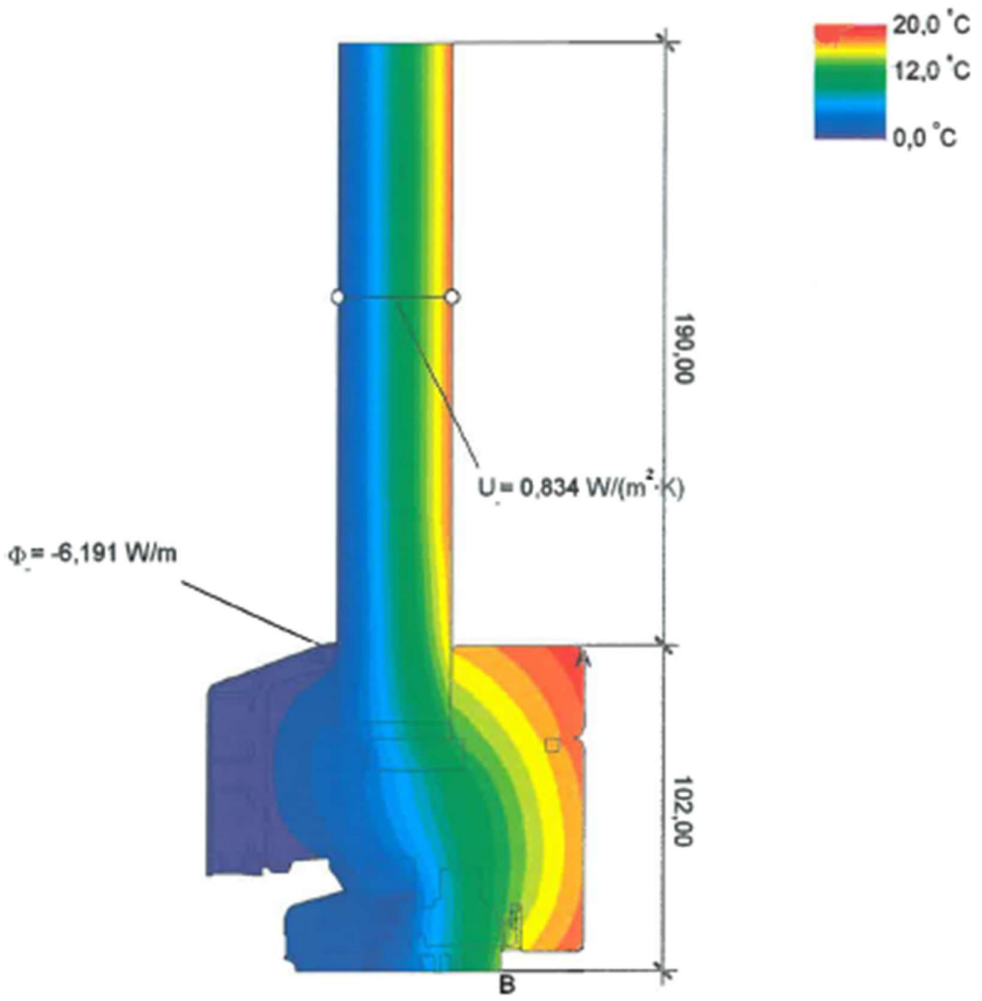
$$U_f = \frac{\frac{\Phi}{\Delta T} - U_{p1}\cdot b_{p1} - U_{p2}\cdot b_{p2}}{b_f} = \frac{\frac{9{,}422}{20{,}000} - 0{,}834\cdot 0{,}190 - 0{,}834\cdot 0{,}190}{0{,}157} = 0{,}98\ \mathrm{W/(m^2\cdot K)}$$

TESTING LABORATORY · LEGNOLEGNO · Via Pio La Torre, 11 42015 Correggio (RE) ITALY

Neues Einfachfenster

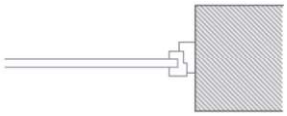


U_{f4} λ=0,16 W/mK
Nodo inferiore portafinestra

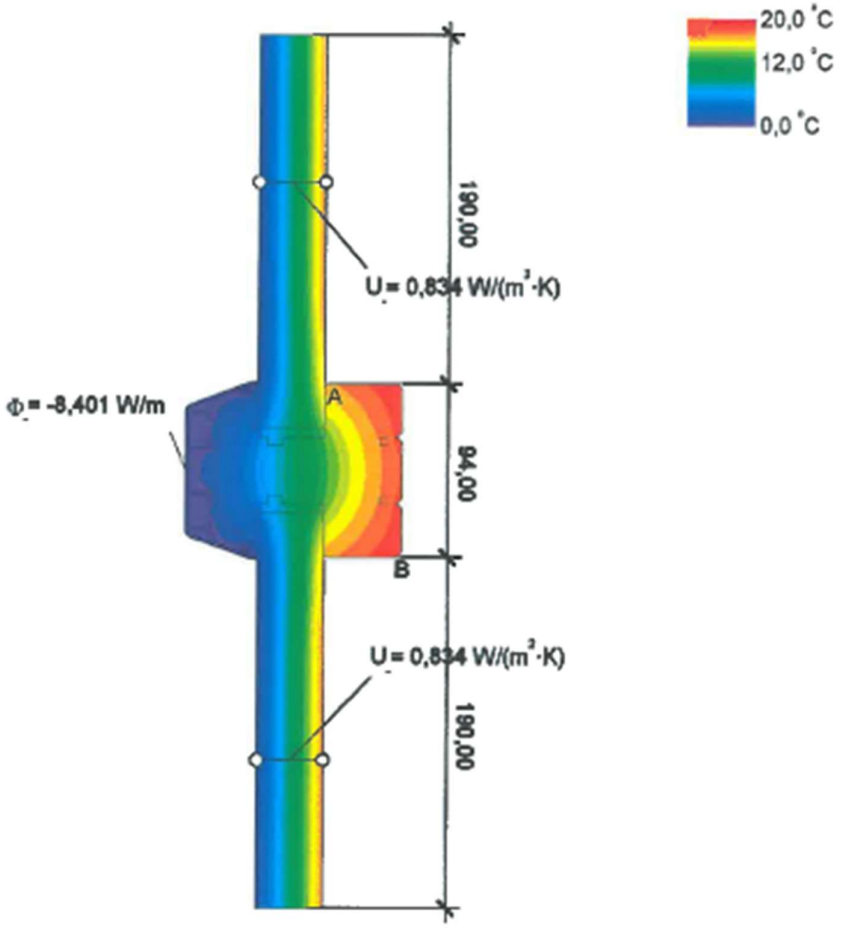


$$U_f = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{6,191}{20,000} - 0,834 \cdot 0,190}{0,102} = 1,5 \text{ W/(m}^2\text{·K)}$$

TESTING LABORATORY · LEGNOLEGNO · Via Pio La Torre, 11 I-2013 Ortisei (BZ) ITALY

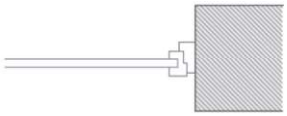


U_{f5} λ=0,16 W/mK
Nodo traversa rompitratta

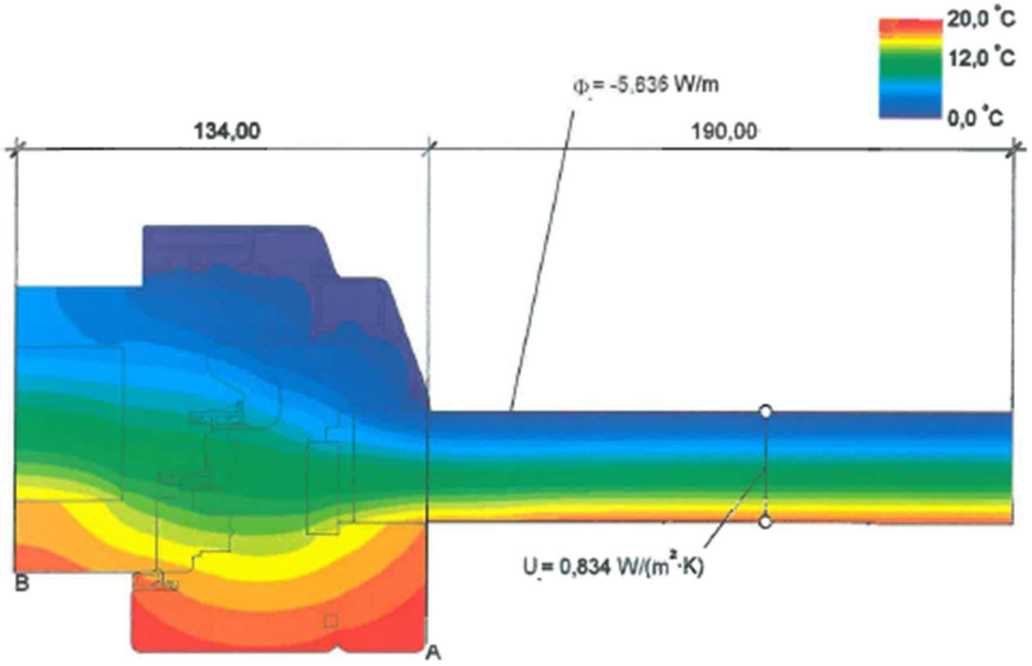


$$U_f = \frac{\frac{\Phi}{\Delta T} - U_{p1}\cdot b_{p1} - U_{p2}\cdot b_{p2}}{b_f} = \frac{\frac{8,401}{20,000} - 0,834\cdot 0,190 - 0,834\cdot 0,190}{0,094} = 1,1\ W/(m^2\cdot K)$$

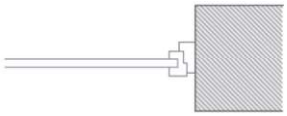
TESTING LABORATORY · LEGNOLEGNO · Via Po La Torre, 11 42015 Correggio (RE) ITALY



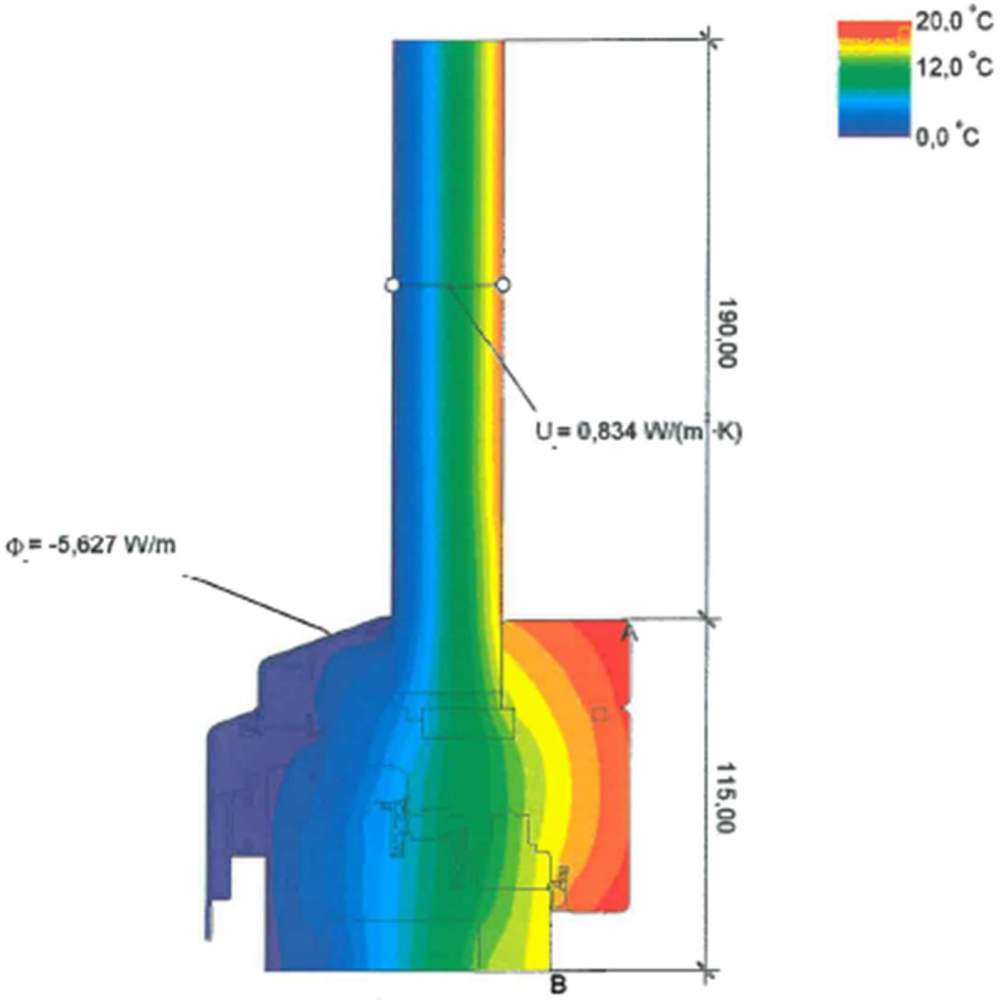
U_{f1} λ=0,18 W/mK
Nodo laterale/superiore



$$U_f = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{5{,}636}{20{,}000} - 0{,}834 \cdot 0{,}190}{0{,}134} = 0{,}92 \text{ W/(m}^2\text{·K)}$$



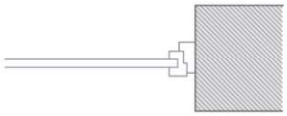
U_{f2} λ=0,18 W/mK
Nodo inferiore finestra



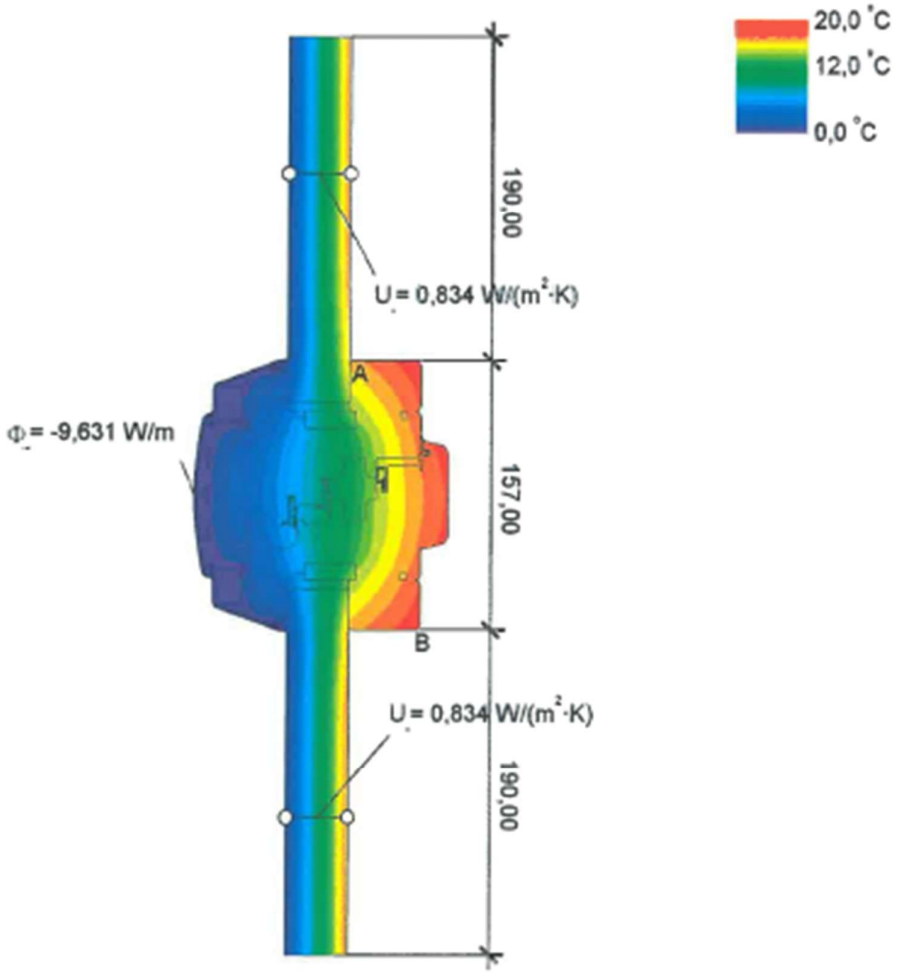
$$U_f = \frac{\frac{\Phi}{\Delta T} - U_g \cdot b_g}{b_f} = \frac{\frac{5,627}{20,000} - 0,834 \cdot 0,190}{0,115} = 1,1 \text{ W/(m}^2\text{·K)}$$

TESTING LABORATORY · LEGNOLEGNO
Via Pio La Torre, 11
42015 Correggio (RE)
ITALY

Neues Einfachfenster

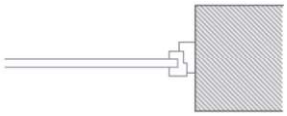


U_{f3} λ=0,18 W/mK
Nodo centrale

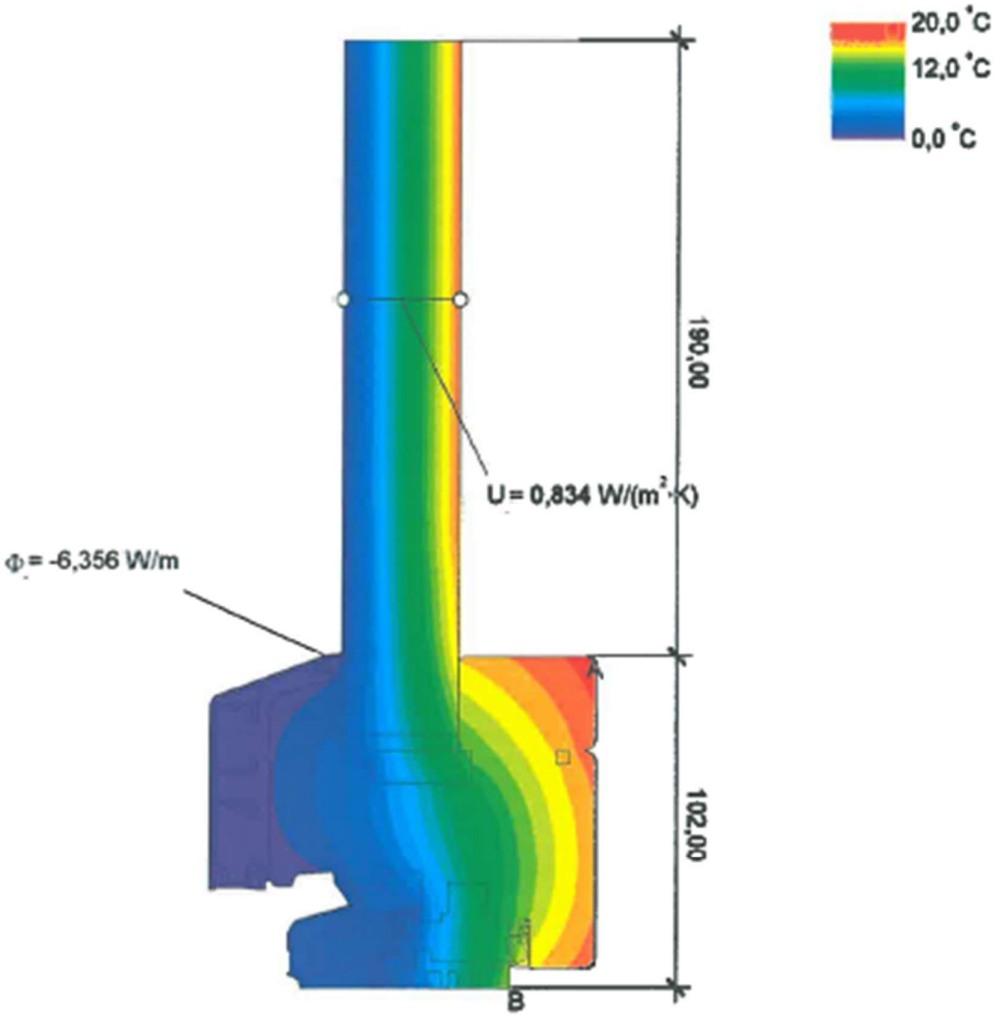


$$U_f = \frac{\frac{\Phi}{\Delta T} - U_{p1}\cdot b_{p1} - U_{p2}\cdot b_{p2}}{b_f} = \frac{\frac{9{,}631}{20{,}000} - 0{,}834\cdot 0{,}190 - 0{,}834\cdot 0{,}190}{0{,}157} = 1{,}0\ \mathrm{W/(m^2\cdot K)}$$

TESTING LABORATORY · LEGNOLEGNO · Via Fio La Torre, 11 42015 Correggio (RE) ITALY

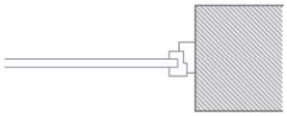


U_{f4} λ=0,18 W/mK
Nodo inferiore portafinestra



$$U_f = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{6,356}{20,000} - 0,834 \cdot 0,190}{0,102} = 1,6 \text{ W/(m}^2\text{·K)}$$

TESTING LABORATORY · LEGNOLEGNO · Via Pio La Torre, 11 42019 Quattro (RE) ITALY



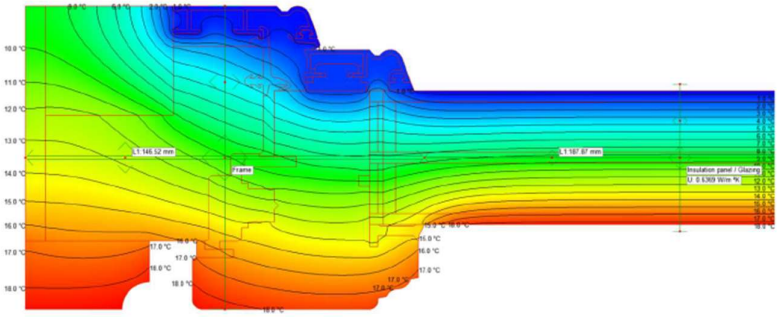
eurac research

efre·fesr Südtirol · Alto Adige
efre regional. innovativ. nachhaltig.
fesr regionale. innovativo. sostenibile.

Austausch Fensterkonstruktion (Einfachfenster)

Frame Uf computation
ISO 10077-2 (2017) - radiosity

Transmittance Uf: 1.05 W/m²K



Materials

Name	λx [W/mK]	ε	Color
Box 2	0.6100	0.900	
Box 1	0.4000	0.900	
Glass	1.0000	0.900	
Argon	1.0380	0.900	
Argon	1.0970	0.900	
Larch	0.1300	0.900	
Aluminium (anodized/coated)	160.0000	0.900	
PVC flexible	0.1400	0.900	
Steel	50.0000	0.900	
Polyurethane high density	0.0400	0.900	
EPDM	0.2500	0.900	
Silicone	1.0000	0.900	
10077 radiosity	-	0.900	

Frame Uf transmittance computation

Frame width Bf: 146.52 mm Panel width Bp: 187.87 mm

Uf = ([Φf / ΔT] - Σ [UxBp]) / Bf

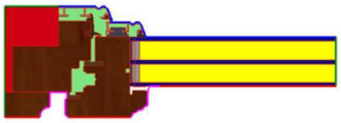
Uf = ([10.0967 W/m / 20.00 °C] - [1.7272 W/m²K x 0.1879 m] - [- x -]) / 0.1465 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	0.5048 W/mK
Φf, flow with ISO10077 panel:	10.0967 W/m
Flow error:	0.000001
Triangles:	13146

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000

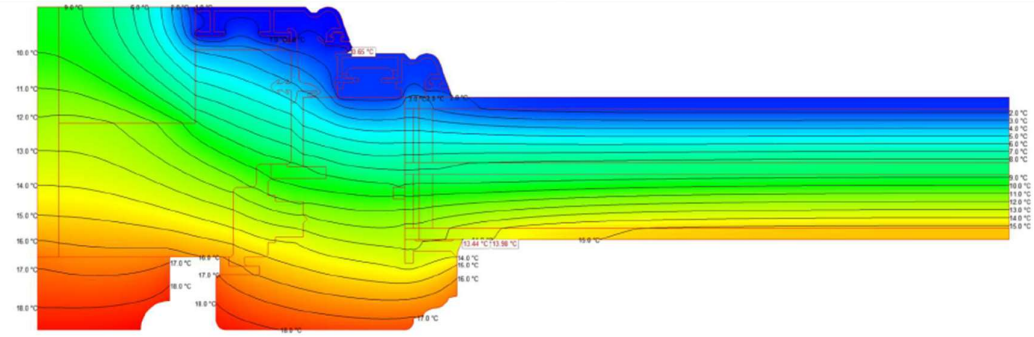


Project:	Villa Castelli	Detail:	Rahmen l,r,o mit Aluminiumverkleidung	File:	Rahmen o,l,r
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: 0.026 W/mK
Superficial condensation: 0 mm



ψ computation

ψ = [Φψ / ΔT] - [Uf x Bf] - Σ [Ug x Bg]

*ψ = [10.0967 W/m / 20.00 °C] - [1.0513 W/m²K*0.1465 m] - [1.7272 W/m²K*0.1879 m] - [-*-]*

Glazing transmittance Ug=1.73 W/m²K *Frame transmittance Uf=1.05 W/m²K*
Glazing size Bg: 188 mm *Frame size Bf: 147 mm*

Simulation with glazing

Lψ2D, with glazing:	0.5048 W/mK
Φψ, flow with glazing:	10.0967 W/m
Flow error:	0.000001
Triangles:	13146

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0

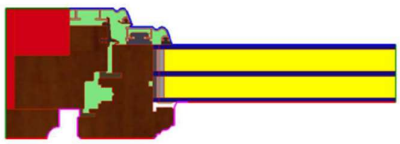
Boundary temperatures

Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	275.01	13.981	18.854	16.236	7.9626
External	306.94	0.650	2.274	1.316	-10.0967
Adiabatic	214.39	0.831	18.621	10.798	-0.0029
Rsi increased	129.45	13.436	18.854	16.703	2.1341

Materials

Name	λx [W/mK]	ε	Color
Box 2	0.6100	0.900	
Box 1	0.4000	0.900	
Glass	1.0000	0.900	
Argon	1.0380	0.900	
Argon	1.0970	0.900	
Larch	0.1300	0.900	
Aluminium (anodized/coated)	160.0000	0.900	
PVC flexible	0.1400	0.900	
Steel	50.0000	0.900	

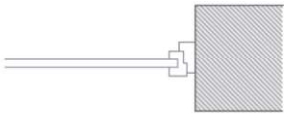
Name	λx [W/mK]	ε	Color
Polyurethane high density	0.0400	0.900	
EPDM	0.2500	0.900	
Silicone	1.0000	0.900	
10077 radiosity	-	0.900	



Project:	Villa Castelli	Detail:	Rahmen l,r,o mit Aluminiumverkleidung	File:	Rahmen o,l,r
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

Neues Einfachfenster



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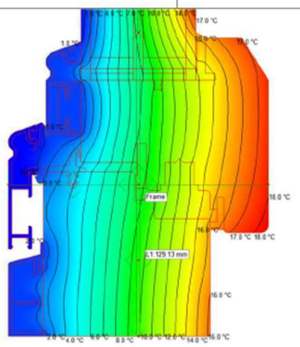
Frame Uf computation

ISO 10077-2 (2017) - radiosity

Transmittance Uf: 1.32 W/m²K



Materials

Name	λx [W/mK]	ε	Color
EPDM	0.2500	0.900	
PVC flexible	0.1400	0.900	
Aluminium (anodized/coated)	160.0000	0.900	
Steel	50.0000	0.900	
Argon	0.0906	0.900	
Argon	0.0960	0.900	
Larch	0.1300	0.900	
Silicone	0.5000	0.900	
Glass	1.0000	0.900	
Box 1	0.4000	0.900	
Box 2	0.6100	0.900	
10077 radiosity	-	0.900	

Frame Uf transmittance computation

Frame width Bf: 129.13 mm Panel width Bp: 187.87 mm

Uf = ([Φf/ΔT] - Σ [UxBp])/Bf

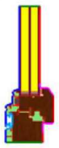
Uf = ([10.4327 W/m / 20.00 °C]-[1.7269 W/m²K x0.1879 m]-[- x-])/0.1291 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	0.5216 W/mK
Φf, flow with ISO10077 panel:	10.4327 W/m
Flow error:	0.000000
Triangles:	13203

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000
Rs external cavities		0.000	0.3000



Project:	Villa Castelli	Detail:	Rahmen u mit Aluminiumverkleidung	File:	Rahmen u
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

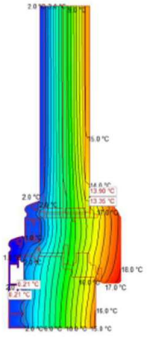
Frame Simulator

ψ and condensation computa

ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: 0.027 W/mK

Superficial condensation: 0 mm



ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [10.4327 W/m / 20.00 °C] - [1.3179 W/m²K*0.1291 m]-[1.7269 W/m²K*0.1879 m]-[-*-]*

Glazing transmittance Ug=1.73 W/m²K *Frame transmittance Uf=1.32 W/m²K*

Glazing size Bg: 188 mm *Frame size Bf: 129 mm*

Simulation with glazing

Lψ2D, with glazing:	0.5216 W/mK
Φψ, flow with glazing:	10.4327 W/m
Flow error:	0.000000
Triangles:	13203

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0
5	Rs external cavities		0.000	0.3000	65.0

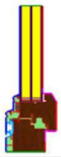
Boundary temperatures

Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	261.99	13.900	18.296	15.844	8.3754
External	337.83	0.206	2.218	1.185	-10.0102
Adiabatic	134.99	1.281	16.205	7.934	0.0093
Rsi increased	102.17	13.348	18.296	15.973	2.0573
Rs external cavities	140.17	0.205	2.924	0.904	-0.4225

Materials

Name	λx [W/mK]	ε	Color
EPDM	0.2500	0.900	
PVC flexible	0.1400	0.900	
Aluminium (anodized/coated)	160.0000	0.900	
Steel	50.0000	0.900	
Argon	0.0906	0.900	
Argon	0.0960	0.900	
Larch	0.1300	0.900	
Silicone	0.5000	0.900	
Glass	1.0000	0.900	

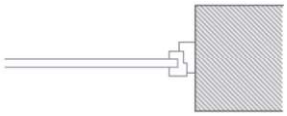
Name	λx [W/mK]	ε	Color
Box 1	0.4000	0.900	
Box 2	0.6100	0.900	
10077 radiosity	-	0.900	



Project:	Villa Castelli	Detail:	Rahmen u mit Aluminiumverkleidung	File:	Rahmen u
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

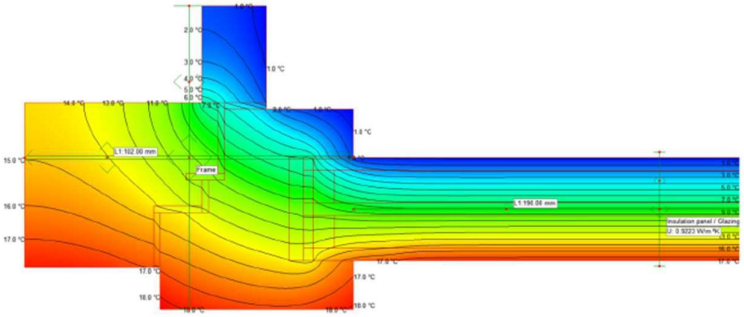
Neues Einfachfenster



Austausch Fensterkonstruktion (Einfachfenster)

Frame Uf computation
ISO 10077-2 (2017) - radiosity

Transmittance Uf: 1.04 W/m²K



Materials

Name	λx [W/mK]	ε	Color
Larch	0.1300	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
EPDM	0.2500	0.900	
Glass	1.0000	0.900	
Box 1	0.4000	0.900	
Box 1	0.6100	0.900	
Argon	1.0242	0.900	
Argon	1.0709	0.900	
10077 radiosity	-	0.900	

Frame Uf transmittance computation

Frame width Bf: 102.00 mm Panel width Bp: 190.00 mm

Uf = ([Φf/ΔT] - Σ [UxBp])/Bf

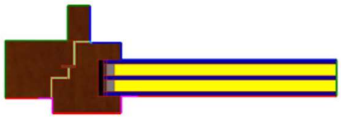
Uf = ([10.1291 W/m / 20.00 °C]-[1.9012 W/m²K x0.1900 m]-[- x-])/0.1020 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	0.5065 W/mK
Φf, flow with ISO10077 panel:	10.1291 W/m
Flow error:	0.000010
Triangles:	4691

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000
Rs external cavities		0.000	0.3000

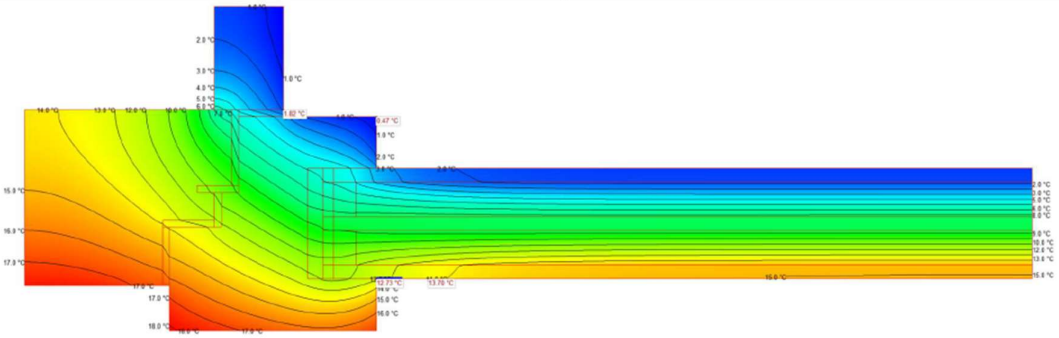


Project:	Villa Tribus	Detail:	Rahmen l,r,u	File:	Rahem l,r,o
Client:	-	Date:	22/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: 0.039 W/mK
Superficial condensation: 9 mm



ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [10.1291 W/m / 20.00 °C] - [1.0412 W/m²K*0.1020 m]-[1.9012 W/m²K*0.1900 m]-[-*-]*

Glazing transmittance Ug=1.90 W/m²K Frame transmittance Uf=1.04 W/m²K

Glazing size Bg: 190 mm Frame size Bf: 102 mm

Simulation with glazing

Lψ2D, with glazing:	0.5065 W/mK
Φψ, flow with glazing:	10.1291 W/m
Flow error:	0.000010
Triangles:	4691

Boundary conditions

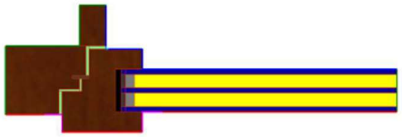
ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0
5	Rs external cavities		0.000	0.3000	65.0

Boundary temperatures

Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	264.00	13.696	18.158	15.622	8.8907
External	259.87	0.473	3.599	1.553	-10.0904
Adiabatic	187.87	0.521	17.842	9.812	0.0136
Rsi increased	56.00	12.729	18.158	15.578	1.2383
Rs external cavities	4.00	1.821	3.473	2.906	-0.0387

Materials

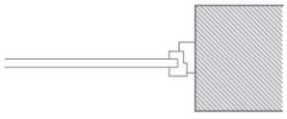
Name	λx [W/mK]	ε	Color
Larch	0.1300	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
EPDM	0.2500	0.900	
Glass	1.0000	0.900	
Box 1	0.4000	0.900	
Box 1	0.6100	0.900	
Argon	1.0242	0.900	
Argon	1.0709	0.900	
10077 radiosity	-	0.900	



Project:	Villa Tribus	Detail:	Rahmen l,r,u	File:	Rahem l,r,o
Client:	-	Date:	22/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

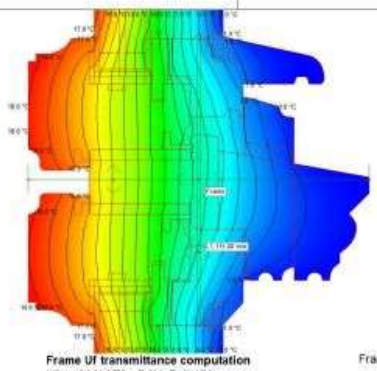
Neues Einfachfenster



Energieeffizienter Prototyp für Verbundfenster

Frame Uf computation
ISO 10077-2 (2017) - radiosity

Transmittance Uf: 1.22 W/m²K



Materials

Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
Box 1	0.4000	0.900	
Box 2	0.6100	0.900	
Putty	0.5000	0.900	
Silicone	0.5000	0.900	
EPDM	0.2500	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
European larch	0.1300	0.900	
Air	0.1313	0.900	
Air	0.1311	0.900	
Cripto	0.0440	0.900	
Cripto	0.0424	0.900	
Cripto	0.0440	0.900	
Cripto	0.0424	0.900	
10077 radiosity	-	0.900	

Frame Uf transmittance computation

Uf = ((Φf / ΔT] - Σ [UxBp])/ Bf

Uf = ((13.7353 W/m / 20.00 °C]-[1.3498 W/m²K x0.1880 m]-[1.3493 W/m²K x0.1900 m])/0.1150 m

Frame width Bf: 115.00 mm Panel width Bp: 378.00 mm

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	0.6868 W/mK
Φf, flow with ISO10077 panel:	13.7353 W/m
Flow error:	0.000014
Triangles:	15928

Boundary conditions

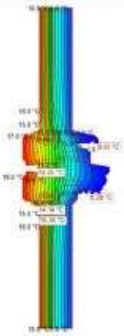
Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000
Rs internal cavities		20.000	0.3000
Rs external cavities		0.000	0.3000

Project:	Waaghaus	Detail:	Kaempfer	File:	Kaempfer
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: 0.037 W/mK
Superficial condensation: 0 mm



ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [13.7353 W/m / 20.00 °C] - [1.2187 W/m²K*0.1150 m]-[1.3498 W/m²K*0.1880 m]-[1.3403 W/m²K*0.1900 m*

Glazing transmittance Ug=1.35 W/m²K Frame transmittance Uf=1.22 W/m²K
Glazing size Bg: 378 mm Frame size Bf: 115 mm

Simulation with glazing

Lψ2D, with glazing:	0.6868 W/mK
Φψ, flow with glazing:	13.7353 W/m
Flow error:	0.000014
Triangles:	15928

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0
4	Rs internal cavities		20.000	0.3000	65.0
5	Rs external cavities		0.000	0.3000	65.0

Boundary temperatures

Name	L [mm]	Min T [°C]	Max T [°C]	Av. T [°C]	Q [W/m]
Internal	423.24	15.338	18.049	16.642	10.9322
External	610.96	0.013	1.727	0.887	-13.5435
Adiabatic	101.99	1.102	16.524	8.935	0.0000
Rsi increased	106.62	14.137	18.049	16.032	2.1154
Rs internal cavities	50.28	14.250	17.606	15.897	0.6877
Rs external cavities	46.45	0.197	2.703	1.238	-0.1916

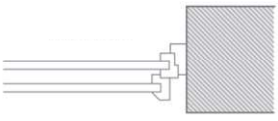
Materials

Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
Box 1	0.4000	0.900	
Box 2	0.6100	0.900	
Putty	0.5000	0.900	
Silicone	0.5000	0.900	
EPDM	0.2500	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
European larch	0.1300	0.900	
Air	0.1313	0.900	

Name	λx [W/mK]	ε	Color
Air	0.1311	0.900	
Cripto	0.0440	0.900	
Cripto	0.0424	0.900	
Cripto	0.0440	0.900	
Cripto	0.0424	0.900	
10077 radiosity	-	0.900	

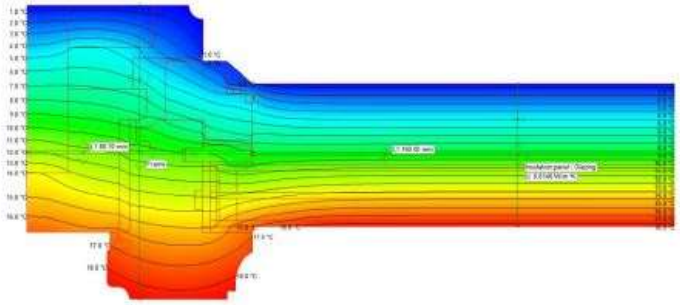
Project:	Waaghaus	Detail:	Kaempfer	File:	Kaempfer
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator



Frame Uf computation
ISO 10077-2 (2017) - radiosity

Transmittance Uf: 1.08 W/m²K



Materials

Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
European larch	0.1300	0.900	
Insulation	0.0400	0.900	
EPDM	0.2500	0.900	
Cripto	1.0009	0.900	
Cripto	1.0361	0.900	
Box 2	0.6100	0.900	
Box 1	0.4000	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
Putty	0.5000	0.900	
Air	1.0816	0.900	
10077 radiosity	-	0.900	

Frame Uf transmittance computation

Frame width Bf: 80.70 mm Panel width Bp: 190.00 mm

Uf = ([Φf / ΔT] - Σ [UxBp]) / Bf

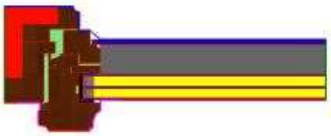
Uf = ([7.3035 W/m / 20.00 °C] -[1.3507 W/m²K x0.1900 m]-[- x-]) / 0.0807 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	0.3652 W/mK
Φf, flow with ISO10077 panel:	7.3035 W/m
Flow error:	0.000027
Triangles:	14757

Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000

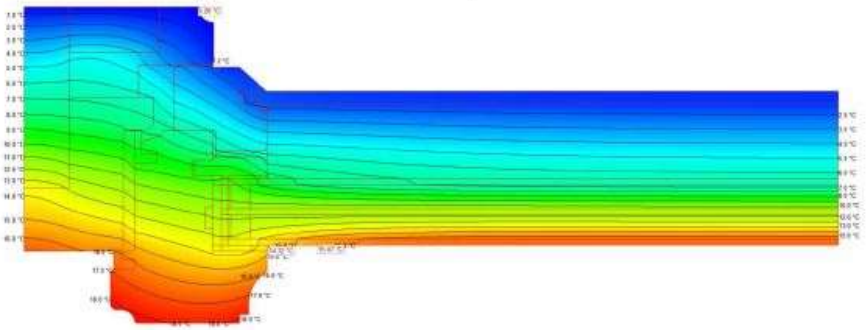


Project:	Waaghaus	Detail:	Rahmen l,r,o	File:	Rahmen l,r,o
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: 0.021 W/mK
Superficial condensation: 0 mm



ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [7.3035 W/m / 20.00 °C] - [1.0831 W/m²K*0.0807 m]-[1.3607 W/m²K*0.1900 m]-[-*-]*

Glazing transmittance Ug=1.35 W/m²K Frame transmittance Uf=1.08 W/m²K
Glazing size Bg: 190 mm Frame size Bf: 81 mm

Simulation with glazing

Lψ2D, with glazing:	0.3652 W/mK
Φψ, flow with glazing:	7.3035 W/m
Flow error:	0.000027
Triangles:	14757

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0

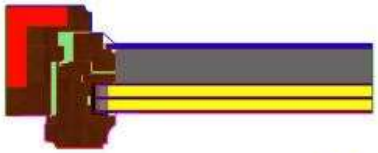
Boundary temperatures

Name	L [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	227.43	15.469	18.360	16.743	5.6980
External	291.83	0.261	1.637	1.001	-7.3034
Adiabatic	131.98	0.397	16.767	8.239	-0.0007
Rsi increased	87.31	14.322	18.180	16.322	1.6056

Materials

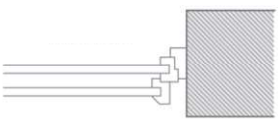
Name	λx [W/mK]	ε	Color
Glass	1.0000	0.900	
European larch	0.1300	0.900	
Insulation	0.0400	0.900	
EPDM	0.2500	0.900	
Cripto	1.0009	0.900	
Cripto	1.0361	0.900	
Box 2	0.6100	0.900	
Box 1	0.4000	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	

Name	λx [W/mK]	ε	Color
Putty	0.5000	0.900	
Air	1.0816	0.900	
10077 radiosity	-	0.900	



Project:	Waaghaus	Detail:	Rahmen l,r,o	File:	Rahmen l,r,o
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator



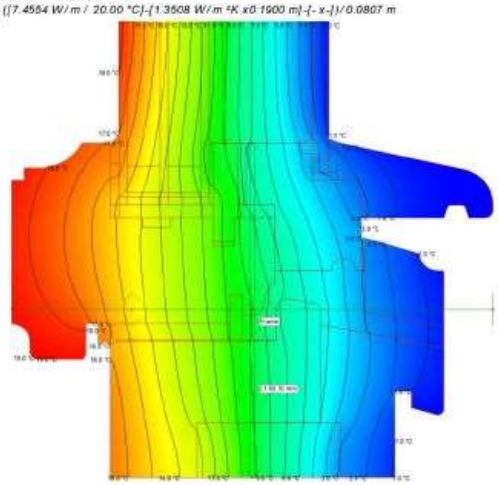
Frame Uf transmittance computation
ISO 10077-2 (2017) - radiosity

Transmittance Uf: 1.19 W/m²K

Frame Uf transmittance computation

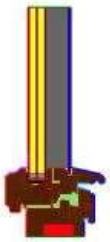
Uf = ([Φf/ΔT] - Σ [UxBp])/ Bf

Uf = ([7.4554 W/m / 20.00 °C]-[1.3508 W/m ²K x0.1900 m]-[- x-])/0.0807 m



Simulation with ISO10077 panel

Lf2D, with panel ISO10077:	0.3728 W/mK
Φf, flow with panel ISO10077:	7.4554 W/m
Flow error:	0.000018
Triangles	15836



Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000
Rs internal cavities		20.000	0.3000
Rs external cavities		0.000	0.3000

Materials

Name	λx [W/mK]	ε	Color
Box 1	0.4000	0.900	
Box 2	0.6100	0.900	
Glass	1.0000	0.900	
European larch	0.1300	0.900	
Air	0.1315	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
Putty	0.5000	0.900	
EPDM	0.2500	0.900	
Cripto	0.0424	0.900	
Cripto	0.0441	0.900	
PUR Polyurethane	0.0400	0.900	
10077 radiosity	-	0.900	

Frame length Bf: 80.70 mm Panel length Bp: 190.00 mm

Project:	Waaghaus	Detail:	Rahmen u	File:	Rahmen u
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator

ψ and condensation computa
ISO 10077-2 (2017) - radiosity

Linear transmittance ψ: 0.020 W/mK

Superficial condensation: 0 mm

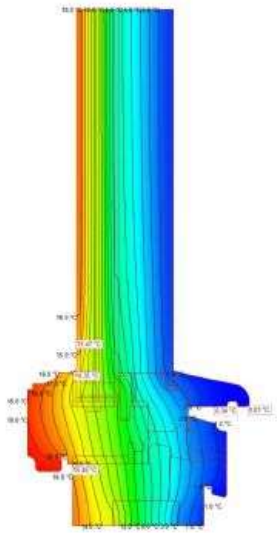
ψ computation

ψ = [Φψ/ΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [7.4554 W/m / 20.00 °C] - [1.1941 W/m ²K*0.0807 m]-[1.3508 W/m²K*0.1900 m]-[-*-]*

Glazing transmittance Ug=1.35 W/m²K *Frame transmittance Uf=1.19 W/m²K*

Glazing size Bg: 190 mm *Frame size Bf: 81 mm*



Boundary table

Name	L [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	258.79	15.469	18.826	16.846	6.2781
External	325.83	0.014	1.762	0.888	-7.2344
Adiabatic	120.06	0.858	16.652	8.034	-0.0004
Rsi increased	47.02	14.350	18.224	16.018	0.9362
Rs internal cavities	22.51	15.462	18.526	16.786	0.2412
Rs external cavities	45.60	0.343	2.755	1.453	-0.2209

Simulation with glazing

Lg2D, with glazing:	0.3728 W/mK
Φψ, flow with glazing:	7.4554 W/m
Flow error:	0.000018
Triangles:	15836

Boundary conditions

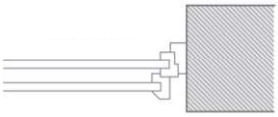
ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0
4	Rs internal cavities		20.000	0.3000	65.0
5	Rs external cavities		0.000	0.3000	65.0

Materials

Name	λx [W/mK]	ε	Color
Box 1	0.4000	0.900	
Box 2	0.6100	0.900	
Glass	1.0000	0.900	
European larch	0.1300	0.900	
Air	0.1315	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
Putty	0.5000	0.900	
EPDM	0.2500	0.900	
Cripto	0.0424	0.900	
Cripto	0.0441	0.900	
PUR Polyurethane	0.0400	0.900	
10077 radiosity	-	0.900	

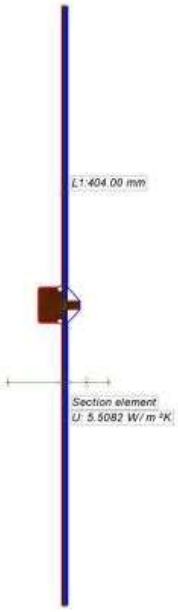
Project:	Waaghaus	Detail:	Rahmen u	File:	Rahmen u
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator



Linear thermal bridge computation

EN-ISO 10211:2008 — **Linear transmittance ψ: 0.0095 W/mK**



ψ Computation

ψ = [Φ/ΔT] - Σ [UxL]

ψ = [44.6968 W/m / 20.00 °C] - [2.2253 W/mK]

L1D Computation (2.2253 W/mK)

U1*l1 = [5.5082 W/m²K x 0.4040 m] = 2.2253 W/mK
U2*l2 = [- x -] = -
U3*l3 = [- x -] = -
U4*l4 = [- x -] = -

L2D with bridge	2.2348 W/mK
L1D without bridge	2.2253 W/mK
ΔTemperatures:	20.00 °C
Average flux with bridge	44.6968 W/m
Flux without bridge	44.5060 W/m
Flux error	0.000001

Boundary conditions

Name	Col.	Air T [°C]	R type	R [m²K/W]
Adiabatic		-	Constant	-
Internal		20.000	ISO 6946 Internal	-
External		0.000	Constant	0.0400

Materials

Name	λx [W/mK]	ε	Color
Putty	0.5000	0.900	
Silicone	0.5000	0.900	
Glass	1.0000	0.900	
European larch	0.1300	0.900	

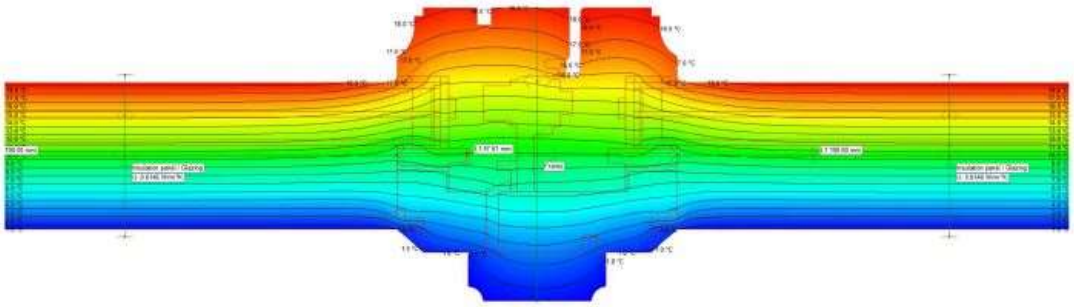
Project :	Waaghaus	Detail:	Sprosse	File:	2 - PSI+ISO13788 - 2 environments
Reference :	-	Date:	16/09/2019	Software:	Mold Simulator - 4.0.5 b839 64bit

Mold Simulator

Frame Uf computation

ISO 10077-2 (2017) - radiosity

Transmittance Uf: 1.29 W/m²K



Materials

Name	λx [W/mK]	ε	Color
EPDM	0.2500	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
Cripto	0.9993	0.900	
Glass	1.0000	0.900	
Cripto	1.0390	0.900	
Putty	0.3500	0.900	
European larch	0.1300	0.900	
Box 1	0.4000	0.900	
Silicone	0.3500	0.900	
Box 2	0.6100	0.900	
Air	1.0755	0.900	
Air	0.0605	0.900	
Air	0.0605	0.900	
Air	1.0767	0.900	
Cripto	0.9989	0.900	
Cripto	1.0400	0.900	
10077 radiosity	-	0.900	

Frame Uf transmittance computation

Frame width Bf: 97.61 mm Panel width Bp: 380.00 mm

Uf = ([Φf/ΔT] - Σ [UxBp])/Bf

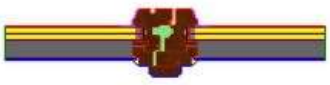
Uf = ([13.5496 W/m / 20.00 °C]-[1.3484 W/m²K x0.1900 m]-[1.3489 W/m²K x0.1900 m])/0.0976 m

Simulation with ISO10077 panel

Lf2D, with ISO10077 panel:	0.6775 W/mK
Φf, flow with ISO10077 panel:	13.5496 W/m
Flow error:	0.000004
Triangles:	14248

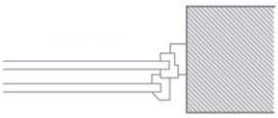
Boundary conditions

Name	Col.	Air T [°C]	R [m²K/W]
Internal		20.000	0.1300
External		0.000	0.0400
Adiabatic		-	-
Rsi increased		20.000	0.2000
Rs internal cavities		20.000	0.3000

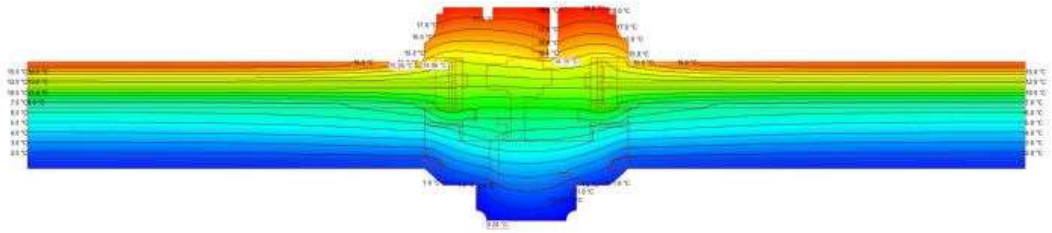


Project:	Waaghaus	Detail:	Stulp	File:	Stulp
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator



ψ and condensation computa ISO 10077-2 (2017) - radiosity	Linear transmittance ψ: 0.039 W/mK Superficial condensation: 0 mm	



ψ computation

ψ = [ΦψΔT] - [UfxBf] - Σ [UgxBg]

*ψ = [13.5496 W/m / 20.00 °C] - [1.2929 W/m²K*0.0976 m]-[1.3484 W/m²K*0.1900 m]-[1.3489 W/m²K*0.1900 m]*

Glazing transmittance Ug=1.35 W/m²K *Frame transmittance Uf=1.29 W/m²K*

Glazing size Bg: 380 mm *Frame size Bf: 98 mm*

Simulation with glazing

Lψ2D, with glazing:	0.6775 W/mK
Φψ, flow with glazing:	13.5496 W/m
Flow error:	0.000004
Triangles:	14248

Boundary conditions

ID	Name	Col.	Air T [°C]	R [m²K/W]	H [%]
0	Internal		20.000	0.1300	65.0
1	External		0.000	0.0400	65.0
2	Adiabatic		-	-	65.0
3	Rsi increased		20.000	0.2000	65.0
4	Rs internal cavities		20.000	0.3000	65.0

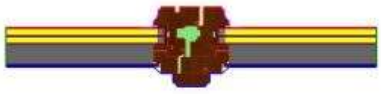
Boundary temperatures

Name	L. [mm]	Min T. [°C]	Max T. [°C]	Av. T. [°C]	Q [W/m]
Internal	415.11	15.283	18.220	16.627	10.7695
External	513.80	0.244	1.519	1.055	-13.5496
Adiabatic	101.99	1.098	16.519	6.928	0.0000
Rsi increased	95.60	14.063	18.151	15.834	1.9914
Rs internal cavities	69.67	14.191	18.220	16.604	0.7887

Materials

Name	λx [W/mK]	ε	Color
EPDM	0.2500	0.900	
Butyl (isobutene) solid/hot melt	0.2400	0.900	
Cripto	0.9893	0.900	
Glass	1.0000	0.900	
Cripto	1.0390	0.900	
Putty	0.3500	0.900	
European larch	0.1300	0.900	
Box 1	0.4000	0.900	
Silicone	0.3500	0.900	

Name	λx [W/mK]	ε	Color
Box 2	0.6100	0.900	
Air	1.0755	0.900	
Air	0.0605	0.900	
Air	0.0603	0.900	
Air	1.0767	0.900	
Cripto	0.9989	0.900	
Cripto	1.0400	0.900	
10077 radiosity	-	0.900	



Project:	Waaghaus	Detail:	Stulp	File:	Stulp
Client:	-	Date:	16/09/2019	Software:	Frame Simulator - 4.0.5 b839 64bit

Frame Simulator