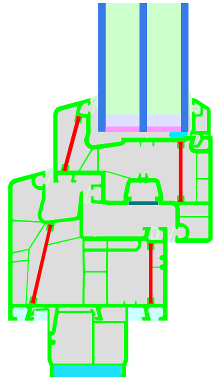
Report - Certified Passive House Component I Bericht - Zertifizierte Passivhaus Komponente

Passive House Institute

Recommended for | Empfohlen für
warm, temperate climate | warm-gemäßigtes Klima

Window system
Fenstersystem

1091ws04



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Product I Produkt:	**Energeto 8000 (Fenstersystem)**
Client I Auftraggeber:	**aluplast Ibérica S.L.U.**
Spacer I Abstandhalter:	**SWISSPACER Ultimate**
Date I Datum:	**30.06.2017**
Author I Autor:	**Dr.-Ing. Benjamin Krick**

Because a separate heating system is not necessarily required in Passive Houses, high demands are placed on the quality of the building components used. The colder the climate, the higher the requirements for the components. To cover this, PHI has identified regions of similar requirements, and defined certification criteria. These criteria are available for free download at the website of the Passive House Institute.

If no radiator is placed under the window, its thermal transmittance U_W (U-value) may not exceed a climate-dependent value in order to prevent unpleasant radiation losses and cold down droughts. For a given quality of glazing, this results in restriction of the thermal losses of the window frame and the glass edge. In that context, the installation situation of the window in the wall is relevant. Because of that, a $U_{W,installed}$ exemplary tested for the certification has been defined.

Also the hygiene criterion must be met. For reasons of hygiene, this criterion limits the minimum individual temperature on window surfaces to prevent condensate and mold growth.

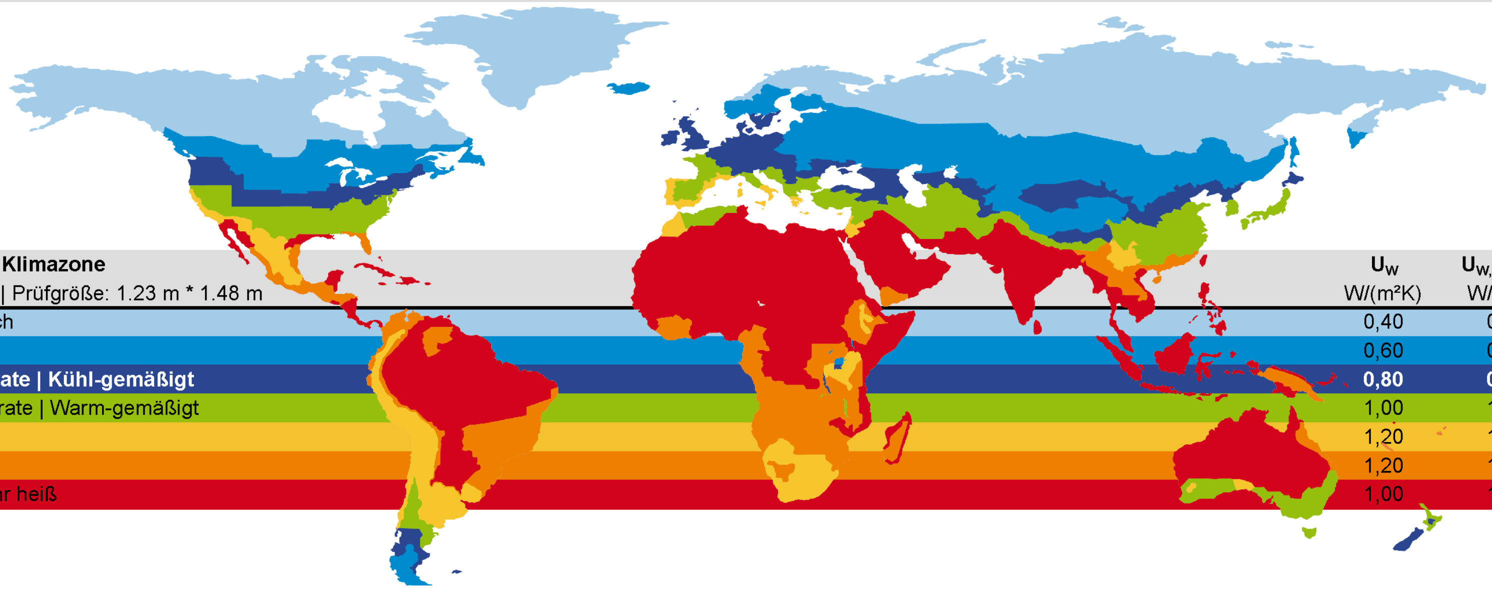
The below stated requirements for awarding the label "Certified Passive House Component" have been set by the Passive House Institute (PHI).

Passivhäuser stellen aufgrund der Möglichkeit, auf ein separates Heizsystem zu verzichten, hohe Anforderungen an die Qualität der verwendeten Bauteile. Dabei steigen die Anforderungen, je kälter das Klima ist. Darum hat das Passivhaus Institut Regionen gleicher Anforderung identifiziert und für diese Zertifizierungskriterien festgelegt. Die Kriterien sind auf der Homepage des Passivhaus Instituts als kostenfreier Download verfügbar.

Wird keine gezielte Heizwärmezufuhr unter den Fenstern vorgesehen, darf der Wärmedurchgangskoeffizient der verwendeten Fenster (Fenster-U-Wert) U_W einen vom Klima abhängigen Höchstwert nicht überschreiten, damit es nicht zu störendem Strahlungswärmeentzug und Kaltluftabfall am Fenster kommt. Daraus ergeben sich bei gegebener Verglasungsqualität Grenzen für den Wärmeverlust im Bereich des Fensterrahmens.In diesem Kontext ist die Einbausituation des Fensters relevant. Darum wurde auch für $U_{W,eingebaut}$ ein Maximalwert festgelegt, der im Rahmen der Zertifizierung beispielhaft geprüft wurde.

Des Weiteren ist das Hygienekriterium zu erfüllen. Dieses Kriterium begrenzt die minimale Einzeltemperatur an der Innenseite der Fensteroberfläche, um Tauwasserausfall und Schimmelbildung zu vermeiden.

Durch das Passivhaus Institut (PHI) wurden die unten stehenden Anforderungen zum Erlangen der Auszeichnung "Zertifizierte Passivhaus Komponente" festgesetzt.



Climate zone | Klimazone Reference size | Prüfgröße: 1.23 m * 1.48 m	U_W W/(m²K)	$U_{W,installed}$ W/(m²K)	U_g for cert. W/(m²K)	$f_{Rsi=0,25\ m^2K/W}$ -
1 Arctic | Arktisch	0,40	0,45	0,35	0,80
2 Cold | Kalt	0,60	0,65	0,52	0,75
3 Cool, temperate | Kühl-gemäßigt	**0,80**	**0,85**	**0,70**	**0,70**
4 Warm, temperate | Warm-gemäßigt	1,00	1,05	0,90	0,65
5 Warm | Warm	1,20	1,25	1,10	0,55
6 Hot | Heiß	1,20	1,25	1,10	-
7 Very hot | Sehr heiß	1,00	1,05	0,90	-

Certified windows are ranked by the thermal losses through the not transparent parts. These **efficiency classes** include the U-Value of the frame, the frame width, the Ψ-Value of the Glass edge and the length of the Glass edge.
Relevant for passive houses is the energy balance, the sum out of losses and gains. Because the solar gains are difficult to quote it is useful to rate the parts of the window, which do not allow solar gains. This is determined by Ψ_{opaque}.

The simulation of the thermal values of the frame sections are based on the regulations of the standard ISO 10077-1:2010 and 10077-2:2012. The thermal conductivities of the used materials refer to relevant standards, technical approvals or have been determined by measured values according to ISO 10077-2:2012, chapter 5.1. In case of one glazing, the models are to 40 cm height, in case of 2 glazing 60 cm in height.

The **spacers** were modeled according to the actual 2-Box-models of the working group “Warm Edge” of the Federal glass association (Bundesverband Flachglas) of Germany. Thermal bridge coefficients were calculated for typical **installation situations**. These values may be used in case of identical installations only in energy balance calculations. The wall-models are 1.41 m in height, glass and frame are 40 cm height, the installation gap is 1 cm.

For modeling and simulations, the software Flixo 7 of Infomind was used. For the used **boundary conditions**, please have a look at following drawings and tables.

Die Fenster werden abhängig von den Wärmeverlusten durch den opaken Teil in **Effizienzklassen** eingestuft. In diese Wärmeverluste gehen die Rahmen-U-Werte, die Rahmenbreiten, die Glasrand-Ψ-Werte und die Glasrandlängen ein.
Für das Passivhaus ist die Bilanz aus Wärmeverlusten und Wärmegewinnen relevant. Da die solaren Gewinne schwer fassbar sind, ist es zweckmäßig, die Verluste über die Bereiche zu quantifizieren und zu einer Bilanzierung heran zu ziehen, über die keine solaren Gewinne möglich sind. Dies leistet Ψ_{opak}.

Die **Berechnung der thermischen Kennwerte** der Rahmenschnitte erfolgte auf der Grundlage der ISO 10077-1:2010 und 10077-2:2012. Die Wärmeleitfähigkeiten stammen aus einschlägigen Normen, bauaufstichtlichen Zulassungen oder wurden anhand von messwerten nach den Regeln der ISO 10077-2:2012 Abschnitt 5.1 determiniert. Dabei sind die Modelle mit einem Glasteil stets 40 cm, Modelle mit 2 Glasteilen stets 60 cm hoch.

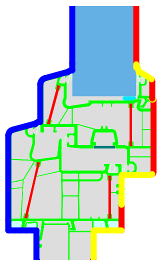
Zur Abbildung der **Abstandhalter** wurde auf die jeweils aktuellen 2-Box-Modelle des Arbeitskreises Warme Kante des Bundesverbandes Flachglas zurückgegriffen.

Die **Wärmebrückenverlustkoeffizienten** wurden beispielhaft für typische **Wandaufbauten** berechnet. Diese dürfen in der Gebäudeenergiebilanzierung nur bei identischer Konstruktion zum Ansatz gebracht werden. Die Modelle für Wandaufbauten sind stets 1,41 m hoch, wobei die Höhe des Glases und Rahmens 40 cm beträgt. Es wird eine Einbaufuge von 1 cm angesetzt.

Zur Berechnung der Bildung der Modelle und zur Berechnung der Wärmeströme wurde das Programm Flixo 7 Professional der Firma Infomind genutzt. Die Randbedingungen wurden wie unten gezeigt angesetzt.

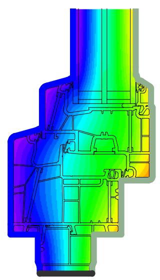
$$\Psi_{opak} = \Psi_g + \frac{U_f \cdot A_f}{l_g}$$

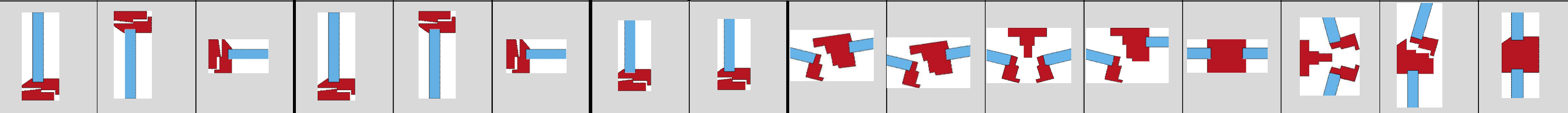
max. Ψ_{opak} [W/(mK)]	Efficiency class Effizienzklasse	Name Bezeichnung
0,065	phA+	Very advanced component
0,110	phA	Advanced component
0,155	phB	Basic component
0,200	phC	Certifiable component



Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,000			
Exterior I Außen		-10,000	0,040	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	
e 0,9 Cavity I Hohlraum				0,900

Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,000			
Exterior I Außen		-10,000	0,040	
e 0,9 Cavity I Hohlraum				0,900
fRsi: Interior I Innen		20,000	0,250	



frame values | Rahmenwerte		bo Bottom	to Top	s Side	bof Bottom fixed	tof Top fixed	sf Side fixed	th Thres-hold	th_2 Thres-hold	fm Flying mullion	fm_2 Flying mullion	m2 Mullion	m1 Mullion	m Mullion fixed	t2 Transom	t1 Transom	t Transom fixed
aluplast Ibérica S.L.U. Energeto 8000 (Fenstersystem)		Unten	Oben	Seitl.	Unten fest	Oben fest	Seitl. fest	Schwe-lle	Schwe-lle	Stulp	Stulp	Pfosten	Pfosten	Pfosten fest	Kämpfer	Kämpfer	Kämpfer fest
Spacer I Abstandhalter: SWISSPACER Ultimate																	
Temperaturefactor Temperaturfaktor	$f_{Rsi=0,25m^2k/W}$	0,68	0,71	0,71	0,69	0,73	0,73	0,46	0,42	0,62	0,62	0,67	0,68	0,72	0,67	0,68	0,72
Frame width Rahmenbreite	b_f [mm]	148	119	119	110	80	80	82	89	162	142	181	143	104	181	143	104
U-value frame Rahmen-U-Wert	**Uf** [W/(m²K)]	1,12	0,96	0,96	1,08	0,83	0,83	1,48	1,63	1,00	1,05	1,06	1,04	1,00	1,06	1,04	1,00
Ψ-glass edge Glasrand-Ψ-Wert	**Ψg** [W/(mK)]	0,024	0,024	0,024	0,023	0,023	0,023	0,023	0,022	0,023	0,022	0,023	0,023	0,023	0,023	0,023	0,023
U-value window Fenster-U-Wert	Uw [W/(m²K)] @Ug= 0,9 W/(m²K)	**0,994**			**0,962**												
Ψ_{opaque} Ψ_{opak}	Ψ_{opaque} W/(mK)	**0,165**			**0,108**												
Passive House effiziency class Passivhaus Effizienzklasse		**phC**			**phA**												

Installation | Einbau		bo	to	s	bof	tof	sf	th	th_2
EIFS | WDVS U-Wall = 0,23 W/(m²K)									
	$\Psi_{install}$ [W/(mK)]	0,001	-0,006	-0,006	-0,002	-0,009	-0,009	0,048	
	$U_{W, installed}$ [W/(m²K)]	0,98			0,94				
Lightwight timber construction | Holzleichtbau U-Wall = 0,19 W/(m²K)									
	$\Psi_{install}$ [W/(mK)]	-0,001	0,004	0,004	0,000	0,002	0,002		
	$U_{W, installed}$ [W/(m²K)]	1,00			0,97				
Formwork blocks | Betonschalungsstein U-Wall = 0,25 W/(m²K)									
	$\Psi_{install}$ [W/(mK)]	0,001	-0,004	-0,004	-0,040	-0,007	-0,007		
	$U_{W, installed}$ [W/(m²K)]	0,99			0,92				
Ventillated facade | Vorhangfassade U-Wall = 0,13 W/(m²K)									
	$\Psi_{install}$ [W/(mK)]								
	$U_{W, installed}$ [W/(m²K)]								
Cavity wall | Zweischaliges Mauerwerk U-Wall = 0,13 W/(m²K)									
	$\Psi_{install}$ [W/(mK)]								
	$U_{W, installed}$ [W/(m²K)]								

Contact person | Ansprechpartner

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Construction: Multi-chamber vinyl window frame, reinforced by Polyamide with 25% glassfibre (0,30 W/(mK)). Pane glued to the frame.
Note: At some not installed frame sections the temperature factor is not achieved. That might leed to hygienic subotimal conditions in case of very low exterior temperatures.
Pane thickness: 48 mm (4/18/4/18/4), rebate depth: 18 mm, spacer: SWISSPACER Ultimate

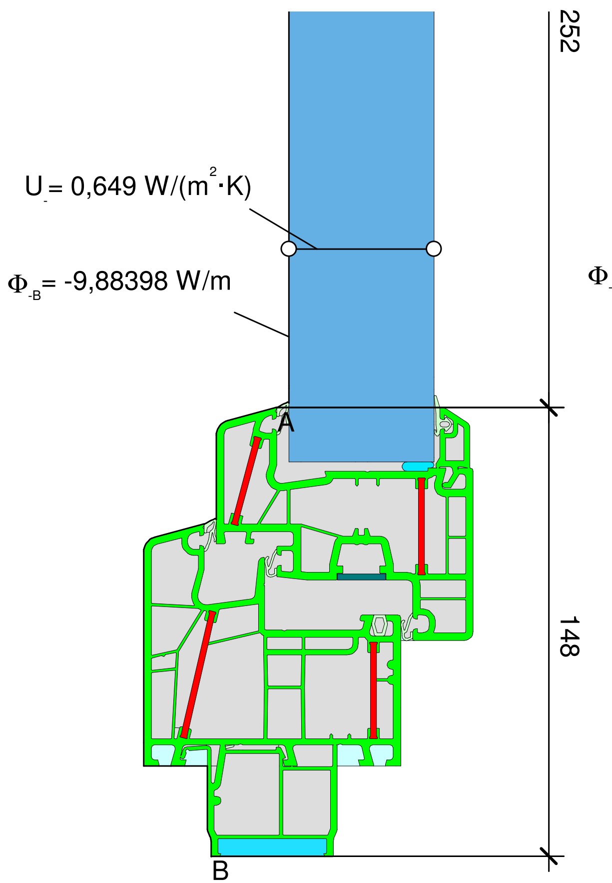
Konstruktion: Mehrkammer-Kunststoff Fensterrahmen mit 85 mm Bautiefe. Rahmenverstärkung aus Polyamid mit 25% Glasfaser (0,30 W/(mK)). Verglasung verklebt
Hinweis: Der erforderliche Temperaturfaktor wird an einigen Mittelprofilen nicht erreicht. Bei sehr kalten Außentemperaturen kann es zu hygienisch problematischen Verhältnissen kommen.
Glasstärke: 48 mm (4/18/4/18/4), Glaseinstand: 18 mm, Abstandhalter: SWISSPACER Ultimate

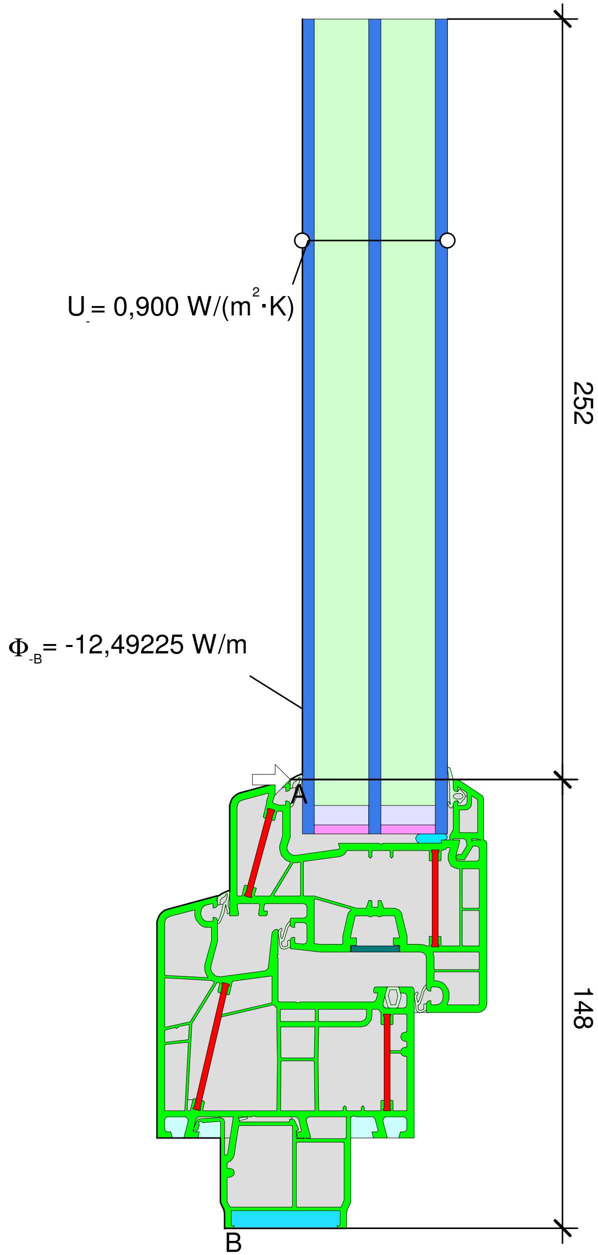
Calculation I Berechnung

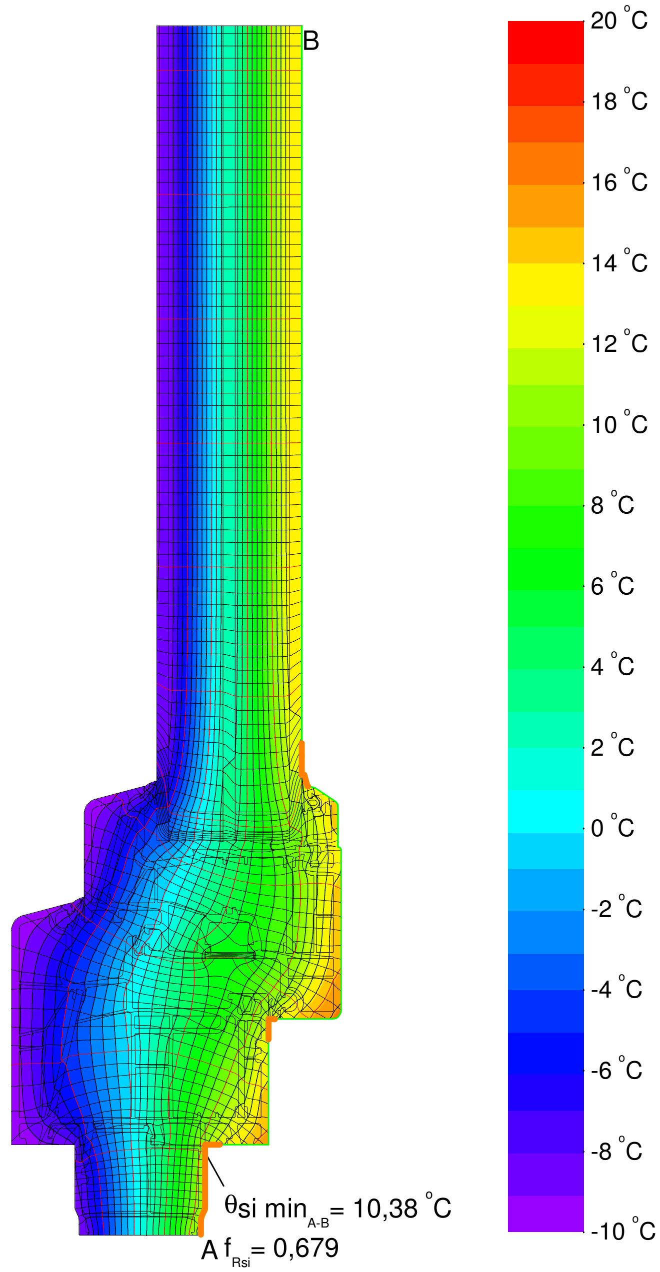
Passivhaus Institut Darmstadt 30.06.2017

Passive House Institute

Material	λ[W/(m·K)]	ε
Ar18 in 48 mm U 0,9	0,039	
Glass I Glas	1,000	0,900
PU foam I PU Schaum 030	0,030	
PU resin I PU Harz	0,250	0,900
Polyamide 25% Glassfiber	0,300	0,900
Polysulfide I Polysulfid	0,400	0,900
Polyvinylchloride (PVC)	0,170	0,900
SWISSP. Ultimate Box 2 [cert]	0,140	
Soft PVC I Weich-PVC	0,140	0,900
Steel I Stahl	50,000	0,900
Unvent. cavity I unbel. Hohlr.		
slightly vent. cav. I leicht bel. Hohlr.		

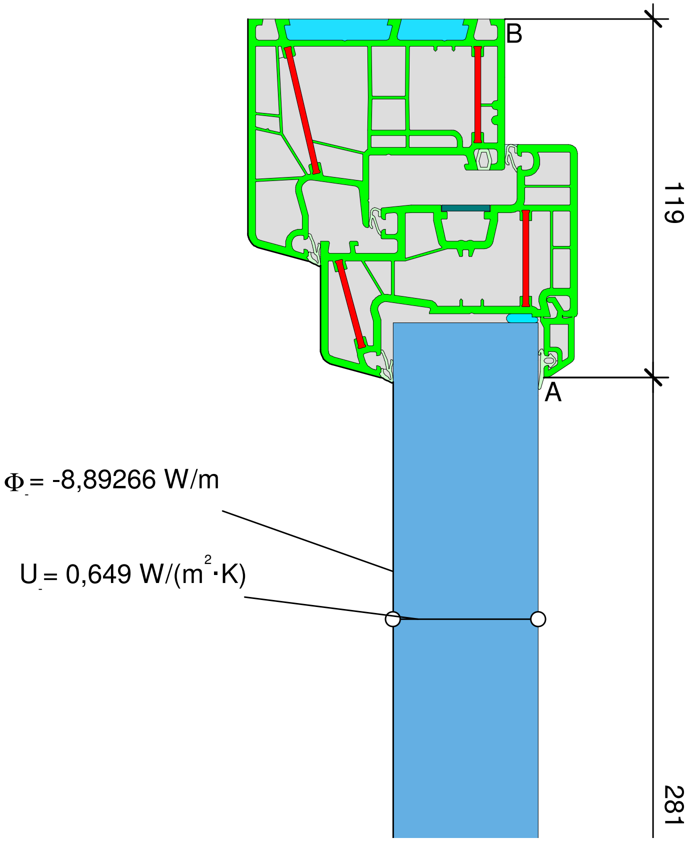




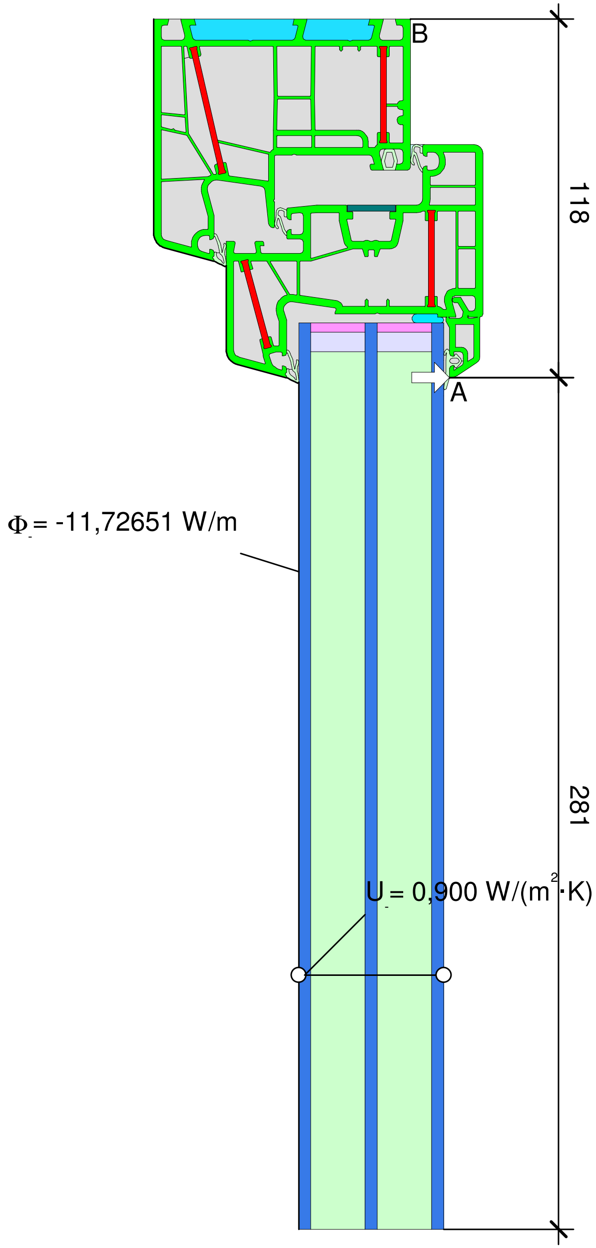


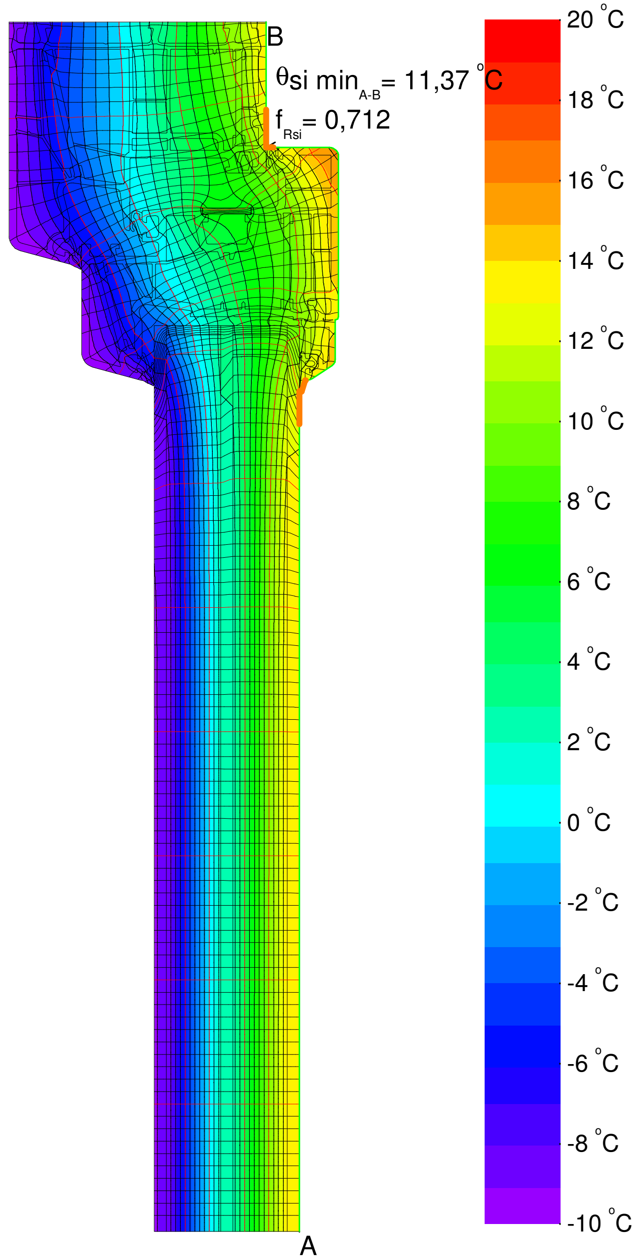
$$U_{f\,A,B} = \frac{\dfrac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\dfrac{9{,}884}{30{,}000} - 0{,}649 \cdot 0{,}252}{0{,}148} = 1{,}121\ W/(m^2 \cdot K)$$

$$\psi_A = \frac{\Phi}{\Delta T} - U_g \cdot b_g - U_f \cdot b_f = \frac{12{,}492}{30{,}000} - 0{,}900 \cdot 0{,}252 - 1{,}121 \cdot 0{,}148 = 0{,}024\ W/(m \cdot K)$$



Material	λ[W/(m·K)]	ε
Ar18 in 48 mm U 0,9	0,039	
Glass I Glas	1,000	0,900
PU foam I PU-Schaum 030	0,030	
PU-Seal I PU Dichtung	0,250	0,900
Polyamide 25% Glassfiber	0,300	0,900
Polysulfide I Polysulfid	0,400	0,900
Polyvinylchloride (PVC)	0,170	0,900
SWISSP. Ultimate Box 2 [cert]	0,140	
Soft PVC I Weich-PVC	0,140	0,900
Steel I Stahl	50,000	0,900
Undefined Material	0,010	
Unvent. cavity I unbel. Hohlr.		
slightly vent. cav. I leicht bel. Hohlr.		





$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{8,893}{30,000} - 0,649 \cdot 0,282}{0,119} = 0,960\ W/(m^2 \cdot K)$$

$$\psi_A = \frac{\Phi}{\Delta T} - U_g \cdot b_g - U_f \cdot b_f = \frac{11,727}{30,000} - 0,900 \cdot 0,282 - 0,960 \cdot 0,119 = 0,024\ W/(m \cdot K)$$

Material	λ[W/(m·K)]	ε
Ar18 in 48 mm U 0,9	0,039	
Glass I Glas	1,000	0,900
PU foam I PU Schaum 030	0,030	
Polyamide 25% Glassfiber	0,300	0,900
Polysulfide I Polysulfid	0,400	0,900
Polyvinylchloride (PVC)	0,170	0,900
SWISSP. Ultimate Box 2 [cert]	0,140	
Soft PVC I Weich-PVC	0,140	0,900
Undefined Material	0,010	
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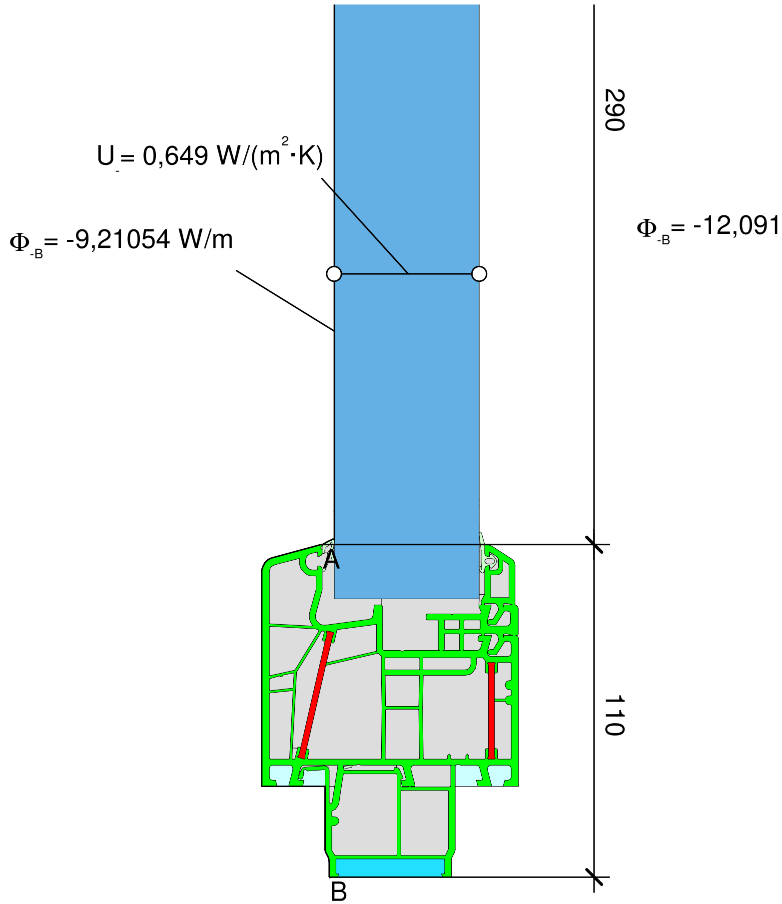
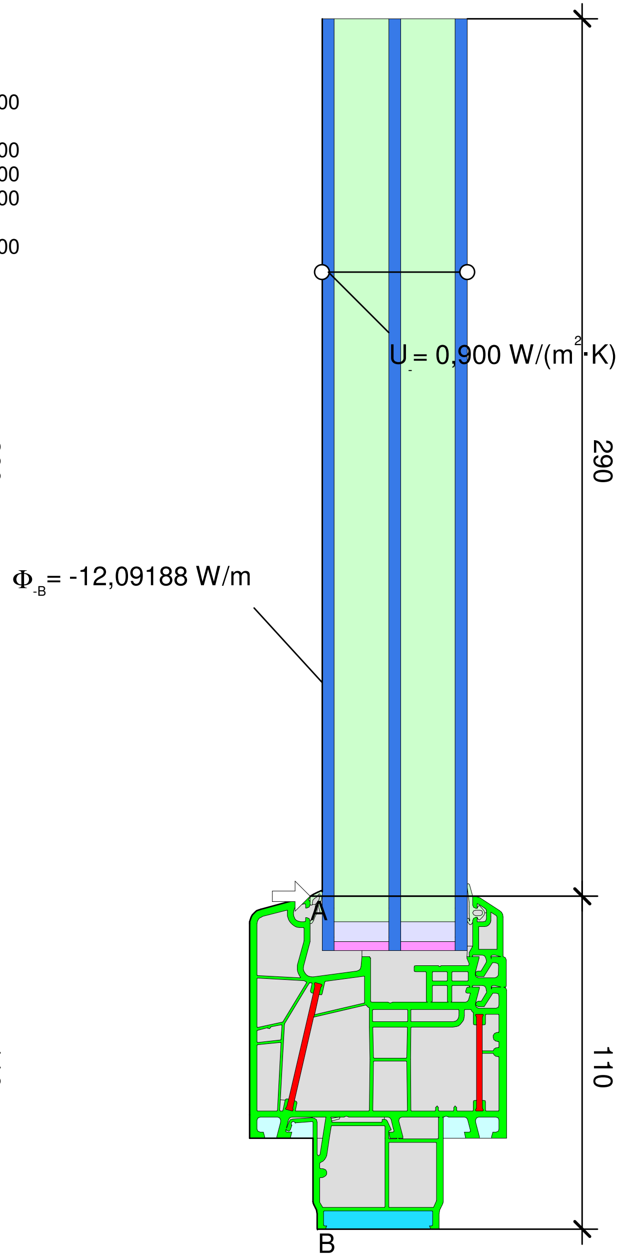
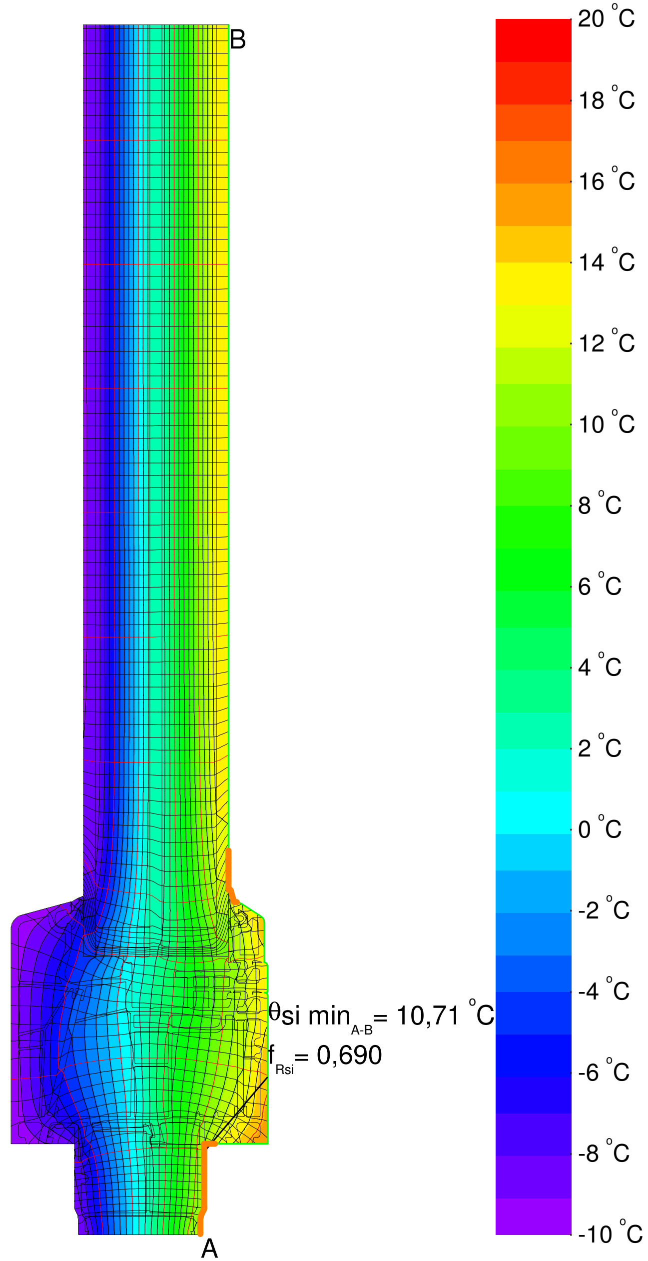
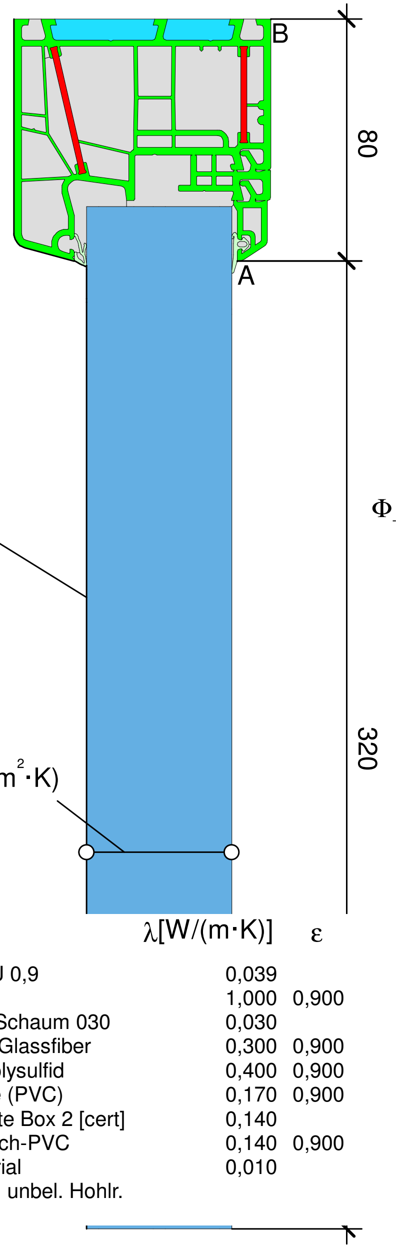


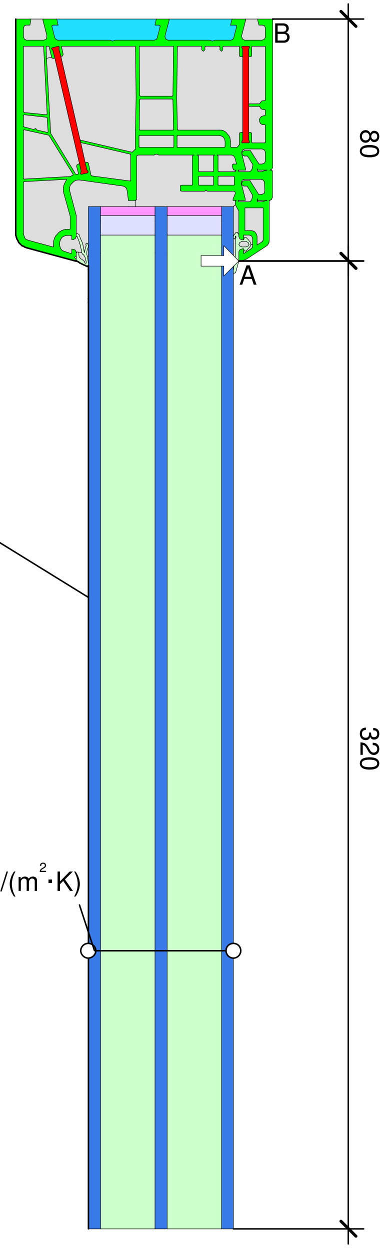


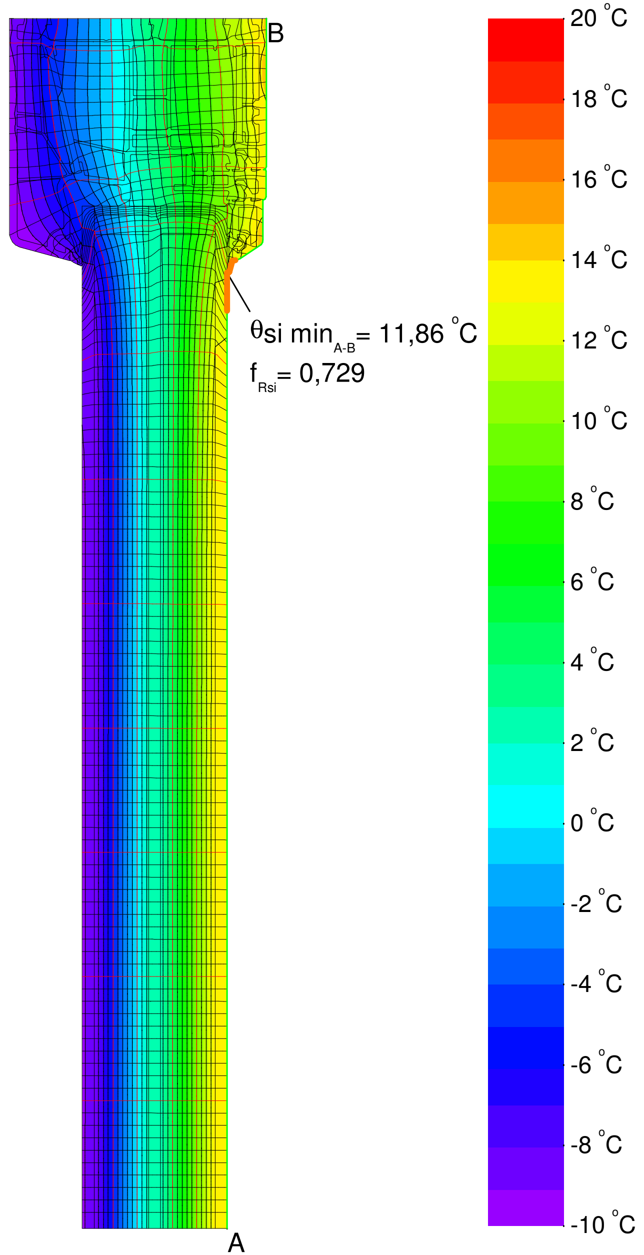


$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{9,211}{30,000} - 0,649 \cdot 0,290}{0,110} = 1,081 \text{ W/(m}^2\cdot\text{K)}$$

$$\psi_A = \frac{\Phi}{\Delta T} - U_g \cdot b_g - U_f \cdot b_f = \frac{12,092}{30,000} - 0,900 \cdot 0,290 - 1,081 \cdot 0,110 = 0,023 \text{ W/(m·K)}$$







Material	λ[W/(m·K)]	ε
Ar18 in 48 mm U 0,9	0,039	
Glass I Glas	1,000	0,900
PU foam I PU-Schaum 030	0,030	
Polyamide 25% Glassfiber	0,300	0,900
Polysulfide I Polysulfid	0,400	0,900
Polyvinylchloride (PVC)	0,170	0,900
SWISSP. Ultimate Box 2 [cert]	0,140	
Soft PVC I Weich-PVC	0,140	0,900
Undefined Material	0,010	
Unvent. cavity I unbel. Hohlr.		

$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{8{,}230}{30{,}000} - 0{,}649 \cdot 0{,}320}{0{,}080} = 0{,}834\ \mathrm{W/(m^2 \cdot K)}$$

$$\psi_A = \frac{\Phi}{\Delta T} - U_g \cdot b_g - U_f \cdot b_f = \frac{11{,}330}{30{,}000} - 0{,}900 \cdot 0{,}320 - 0{,}834 \cdot 0{,}080 = 0{,}023\ \mathrm{W/(m \cdot K)}$$

Material	λ[W/(m·K)]	ε
Aluminum I Aluminium 10456	160,000	0,900
Ar18 in 48 mm U 0,9	0,039	
Glass I Glas	1,000	0,900
PU-Seal I PU Dichtung	0,250	0,900
Polyamide 25% Glassfiber	0,300	0,900
Polysulfide I Polysulfid	0,400	0,900
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Steel I Stahl	50,000	0,900
Undefined Material	0,010	
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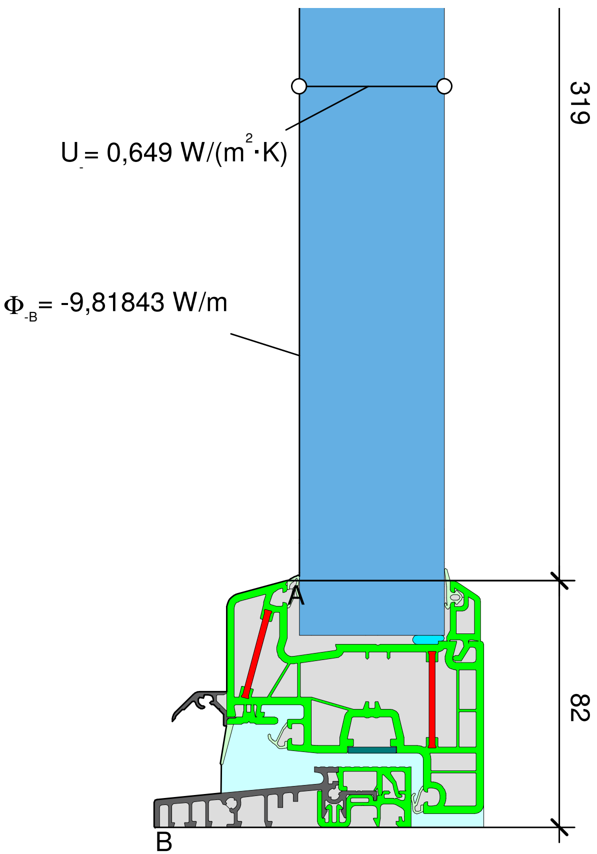

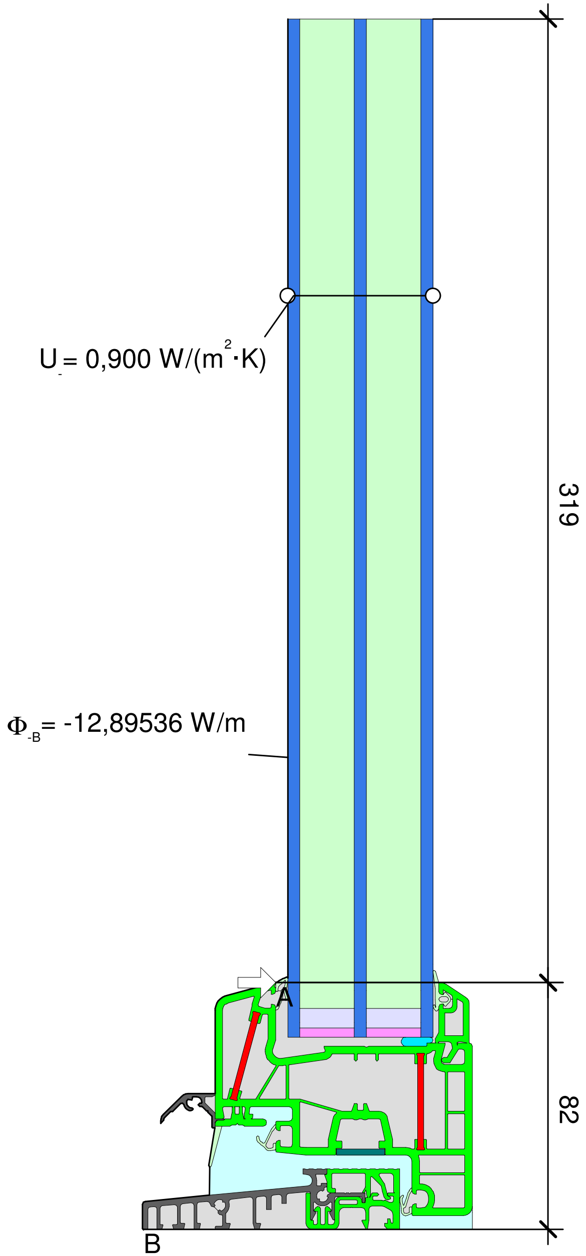

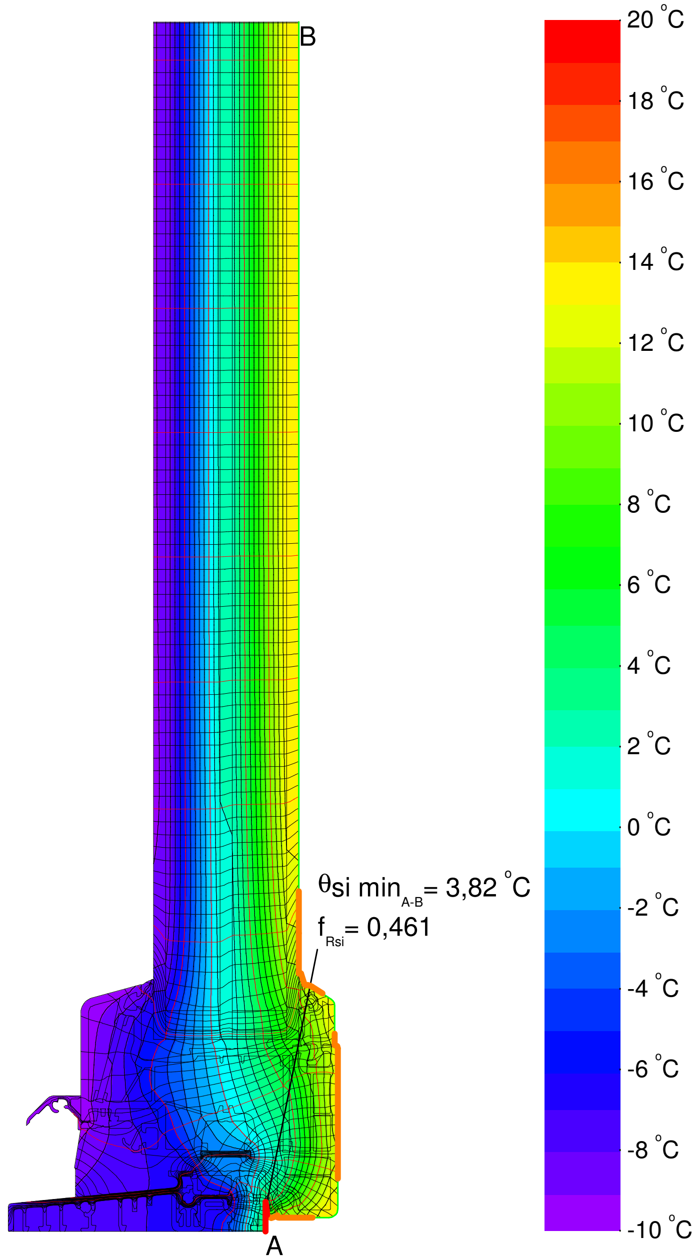

$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{9,818}{30,000} - 0,649 \cdot 0,319}{0,082} = 1,480\ W/(m^2 \cdot K)$$

$$\psi_A = \frac{\Phi}{\Delta T} - U_g \cdot b_g - U_f \cdot b_f = \frac{12,895}{30,000} - 0,900 \cdot 0,319 - 1,480 \cdot 0,082 = 0,023\ W/(m \cdot K)$$

Material	λ[W/(m·K)]	ε
Aluminum I Aluminium 10456	160,000	0,900
Ar18 in 48 mm U 0,9	0,039	
Glass I Glas	1,000	0,900
PU-Seal I PU Dichtung	0,250	0,900
PVC soft I PVC weich 10077	0,140	0,900
Polyamid 25% glassfibre I Glasfaser 10077	0,300	0,900
Polysulfide I Polysulfid	0,400	0,900
Polyvinylchloride (PVC)	0,170	0,900
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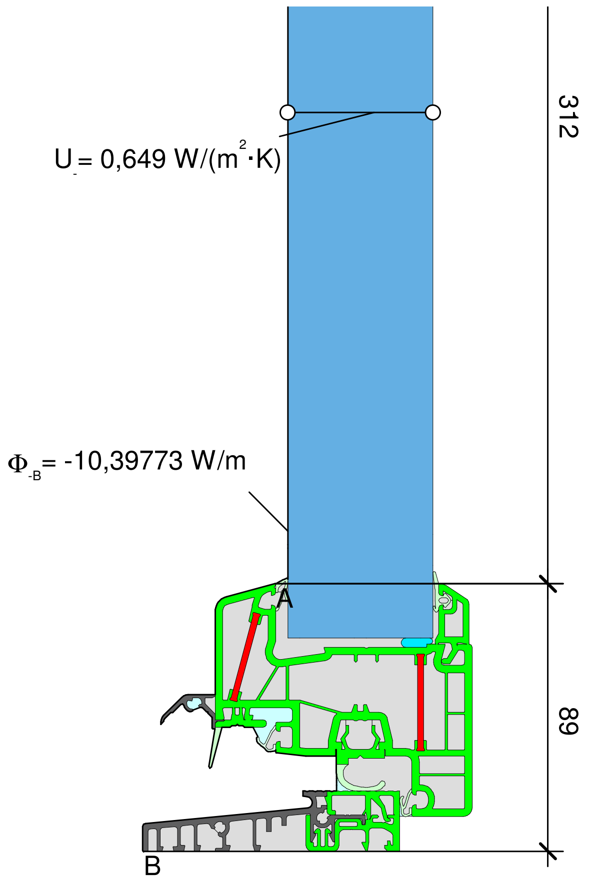
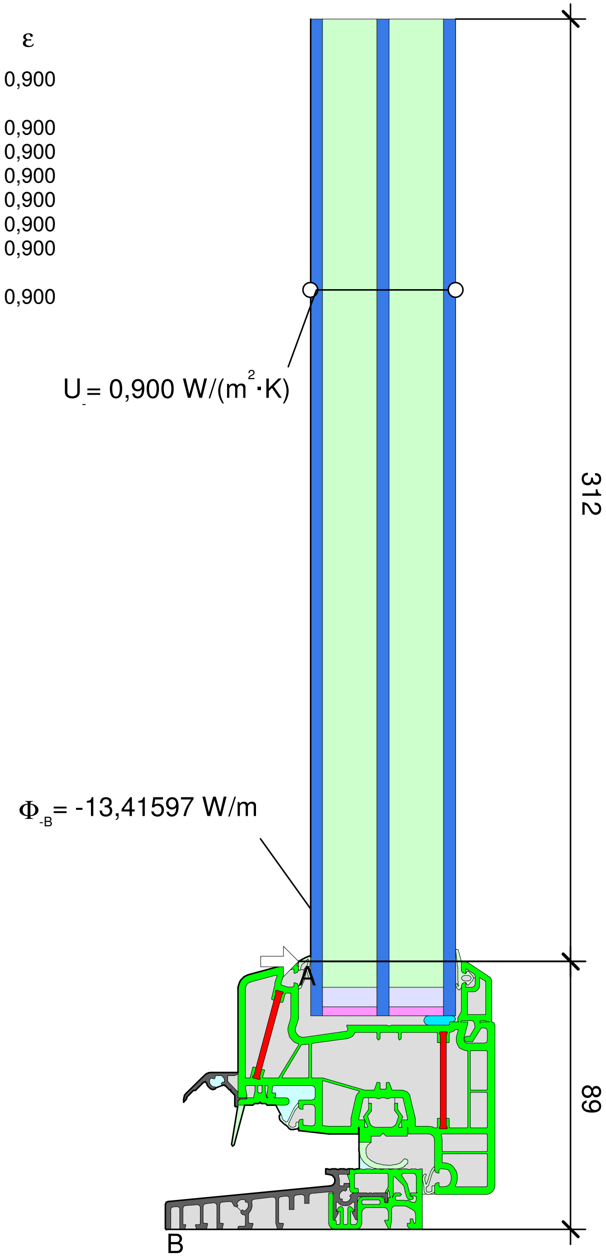
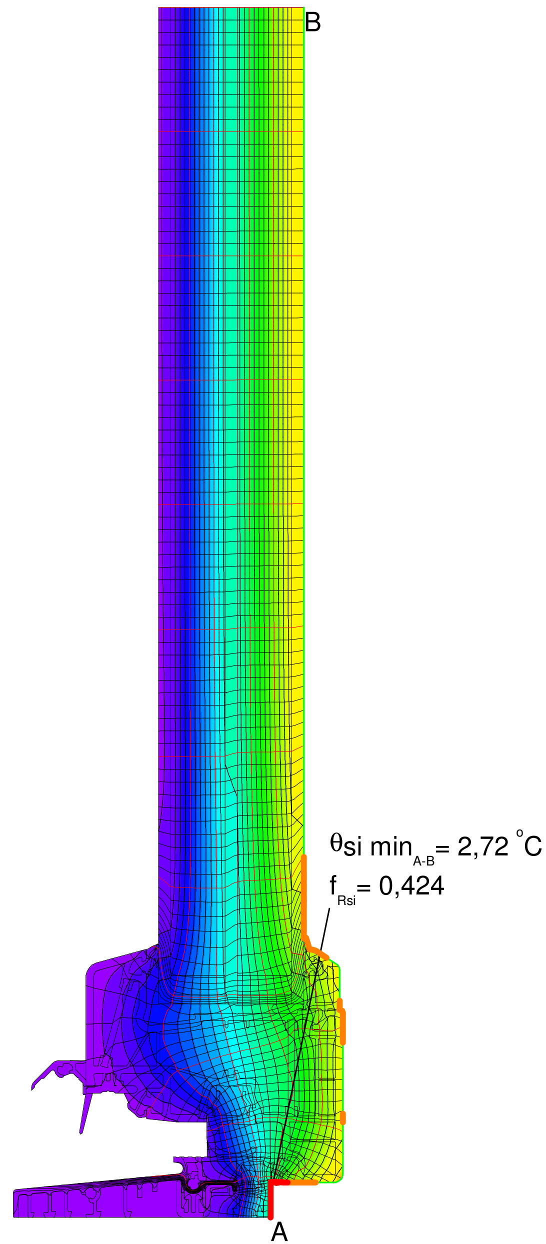
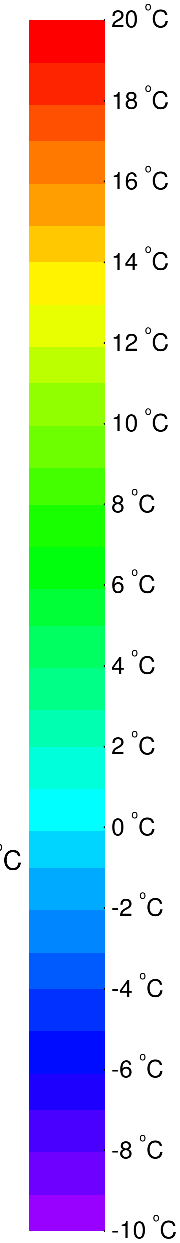
slightly vent. cav. I leicht bel. Hohlr.		



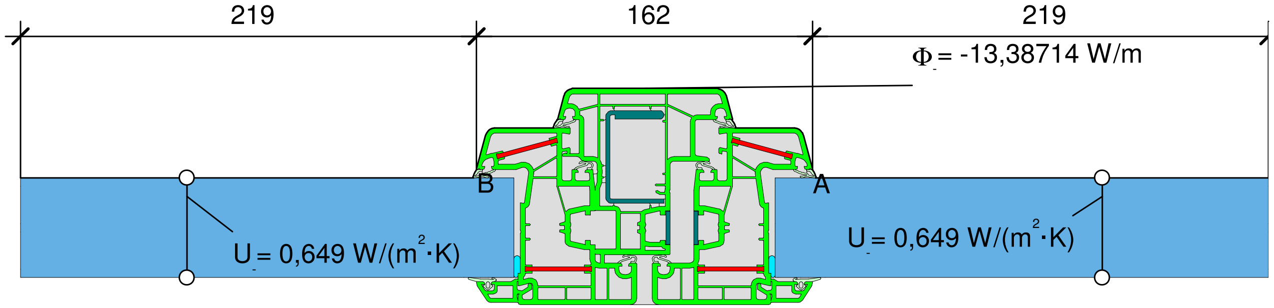






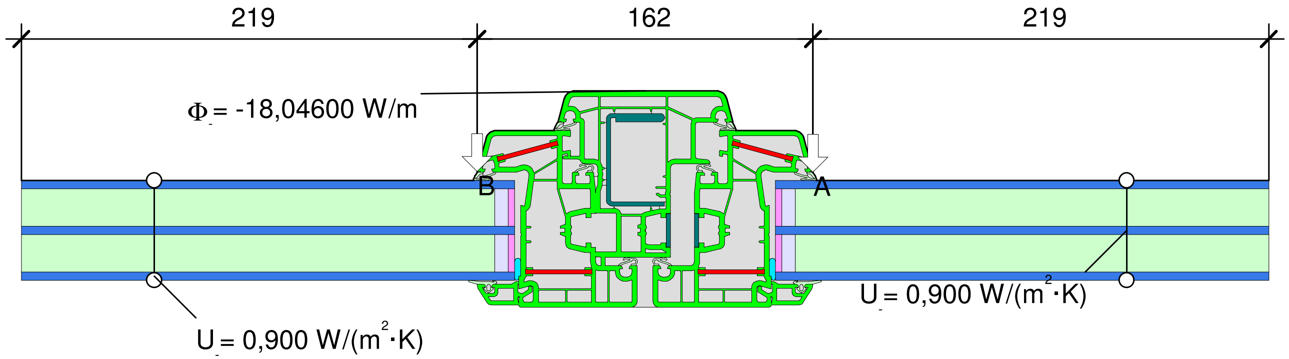
$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{10,398}{30,000} - 0,649 \cdot 0,312}{0,089} = 1,633 \text{ W/(m}^2\cdot\text{K)}$$

$$\Psi_A = \frac{\Phi}{\Delta T} - U_g \cdot b_g - U_f \cdot b_f = \frac{13,416}{30,000} - 0,900 \cdot 0,312 - 1,633 \cdot 0,089 = 0,022 \text{ W/(m}\cdot\text{K)}$$

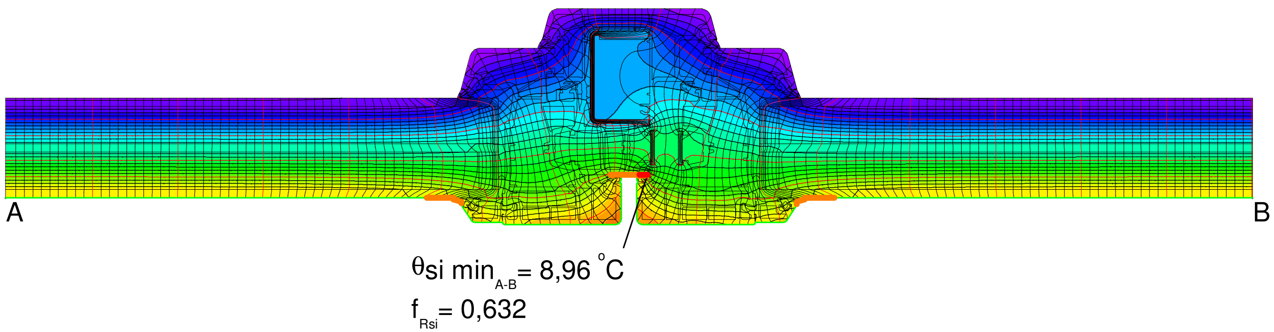


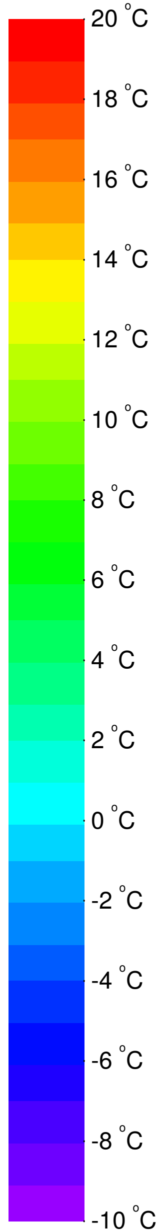
Material	λ[W/(m·K)]	ε
Ar18 in 48 mm U 0,9	0,039	
Glass I Glas	1,000	0,900
PU-Seal I PU Dichtung	0,250	0,900
Polyamide 25% Glassfiber	0,300	0,900
Polysulfide I Polysulfid	0,400	0,900
Polyvinylchloride (PVC)	0,170	0,900
SWISSP. Ultimate Box 2 [cert]	0,140	
Soft PVC I Weich-PVC	0,140	0,900
Steel I Stahl	50,000	0,900
Steel I Stahl	50,000	0,300
Unvent. cavity I unbel. Hohlr.		

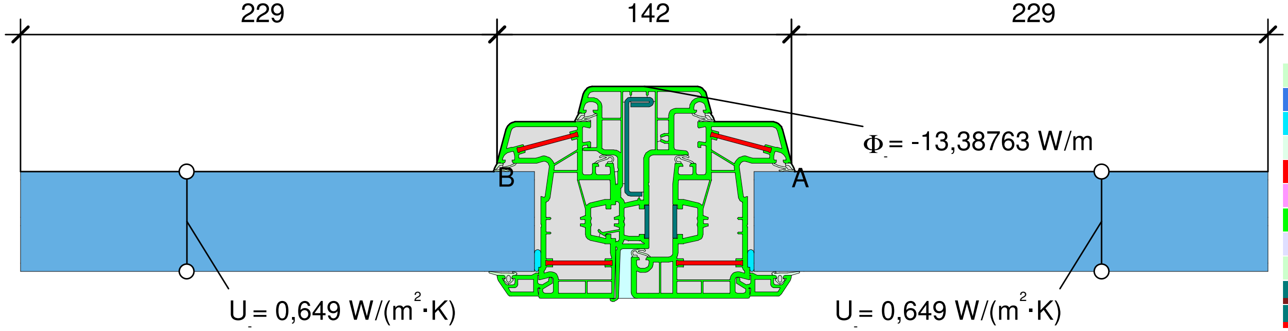
$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_{p1}\cdot b_{p1} - U_{p2}\cdot b_{p2}}{b_f} = \frac{\frac{13,387}{30,000} - 0,649\cdot 0,219 - 0,649\cdot 0,219}{0,162} = 1,002\ \mathrm{W/(m^2\cdot K)}$$



$$\Psi_{A,B} = \frac{\frac{\Phi}{\Delta T} - U_{g1}\cdot b_{g1} - U_f\cdot b_f - U_{g2}\cdot b_{g2}}{2} = \frac{\frac{18,046}{30,000} - 0,900\cdot 0,219 - 1,002\cdot 0,162 - 0,900\cdot 0,219}{2} = 0,023\ \mathrm{W/(m\cdot K)}$$

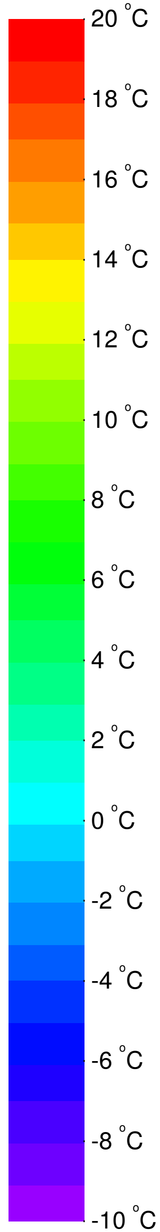


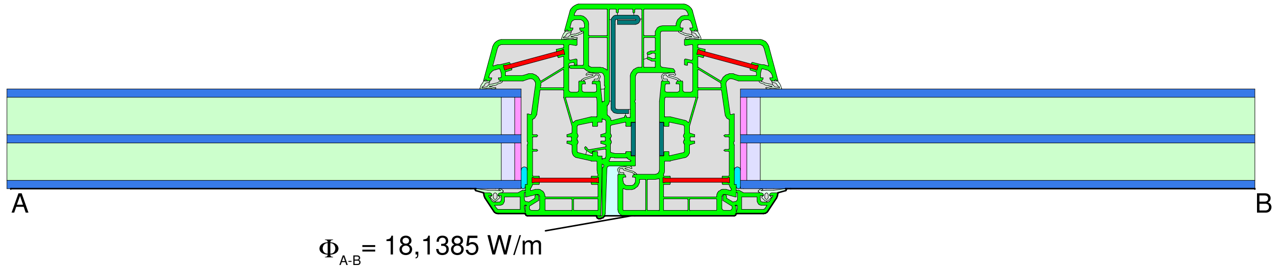


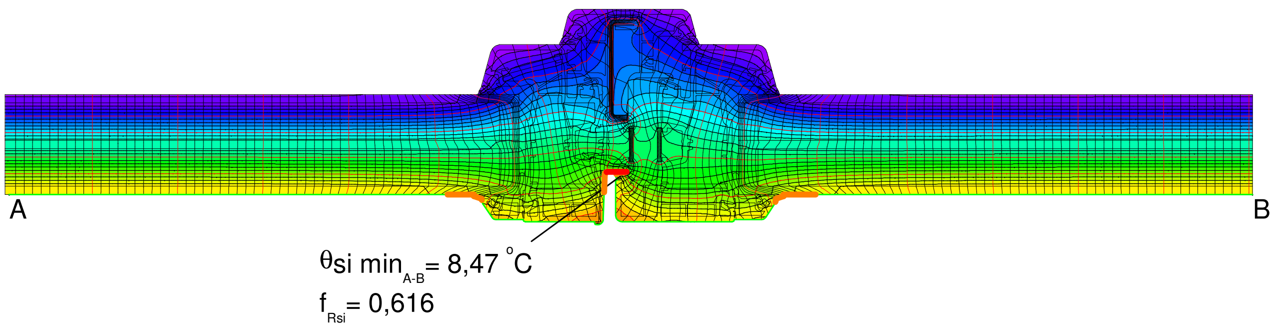


$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_{p1}\cdot b_{p1} - U_{p2}\cdot b_{p2}}{b_f} = \frac{\frac{13{,}388}{30{,}000} - 0{,}649\cdot 0{,}229 - 0{,}649\cdot 0{,}229}{0{,}142} = 1{,}052\ \mathrm{W/(m^2\cdot K)}$$

Material	λ[W/(m·K)]	ε
Ar18 in 48 mm U 0,9	0,039	
Glass I Glas	1,000	0,900
PU-Seal I PU Dichtung	0,250	0,900
PVC soft I PVC weich 10077	0,140	0,900
Polyamide 25% Glassfiber	0,300	0,900
Polysulfide I Polysulfid	0,400	0,900
Polyvinylchloride (PVC)	0,170	0,900
SWISSP. Ultimate Box 2 [cert]	0,140	
Soft PVC I Weich-PVC	0,140	0,900
Steel I Stahl	50,000	0,900
Steel I Stahl	50,000	0,300
Undefined Material	0,010	
Unvent. cavity I unbel. Hohlr.		
slightly vent. cav. I leicht bel. Hohlr.		

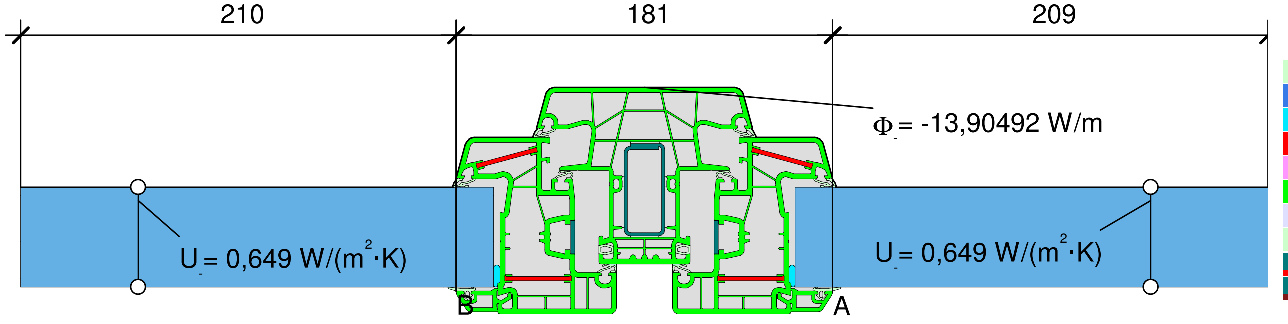




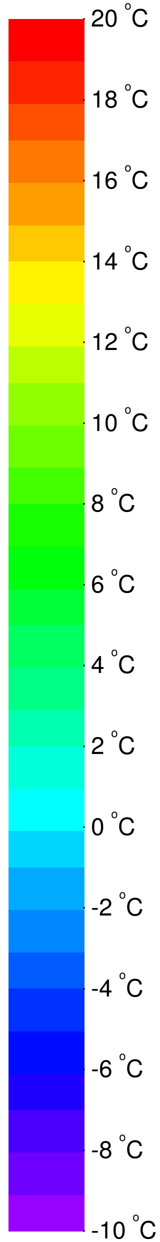


fm_2 - FLYING MULLION I STULP 142 mm **aluplast Ibérica S.L.U. SWISSPACER Ultimate Energeto 8000 (Fenstersystem) 1091ws04**

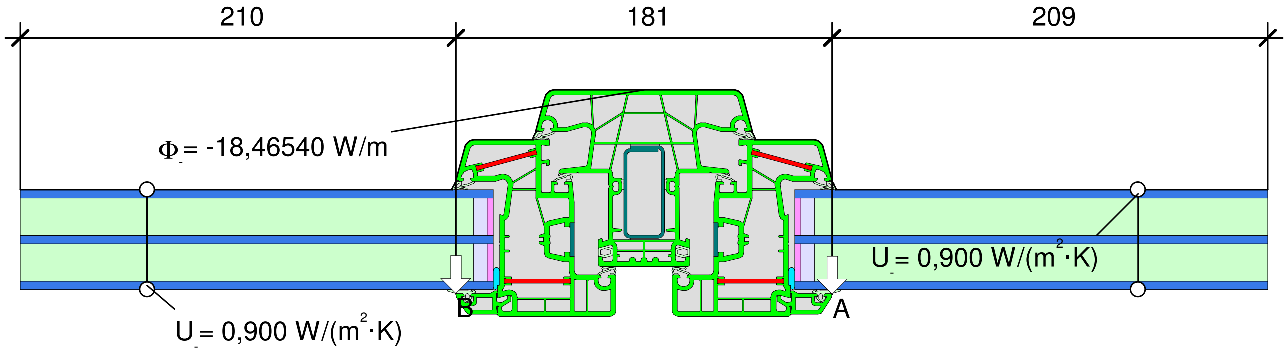
Passive House Institute



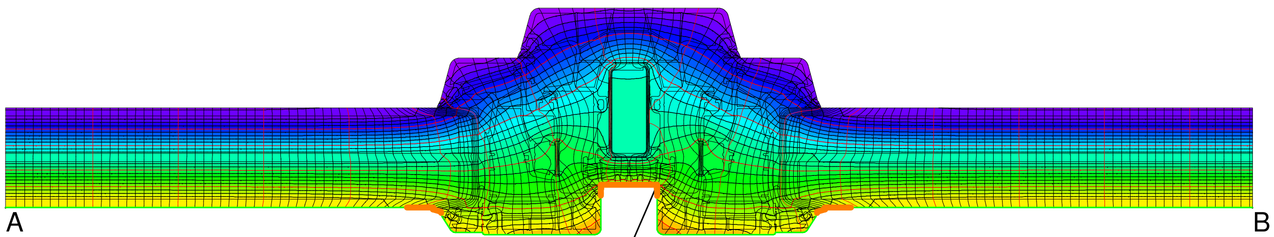
Material	λ[W/(m·K)]	ε
Ar18 in 48 mm U 0,9	0,039	
Glass I Glas	1,000	0,900
PU-Seal I PU Dichtung	0,250	0,900
Polyamide 25% Glassfiber	0,300	0,900
Polysulfide I Polysulfid	0,400	0,900
Polyvinylchloride (PVC)	0,170	0,900
SWISSP. Ultimate Box 2 [cert]	0,140	
Soft PVC I Weich-PVC	0,140	0,900
Steel I Stahl	50,000	0,300
Steel I Stahl	50,000	0,900
Undefined Material	0,010	
Unvent. cavity I unbel. Hohlr.		
slightly vent. cav. I leicht bel. Hohlr.		



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_{p1}\cdot b_{p1} - U_{p2}\cdot b_{p2}}{b_f} = \frac{\frac{13{,}905}{30{,}000} - 0{,}649\cdot 0{,}210 - 0{,}649\cdot 0{,}210}{0{,}181} = 1{,}059\ \mathrm{W/(m^2\cdot K)}$$

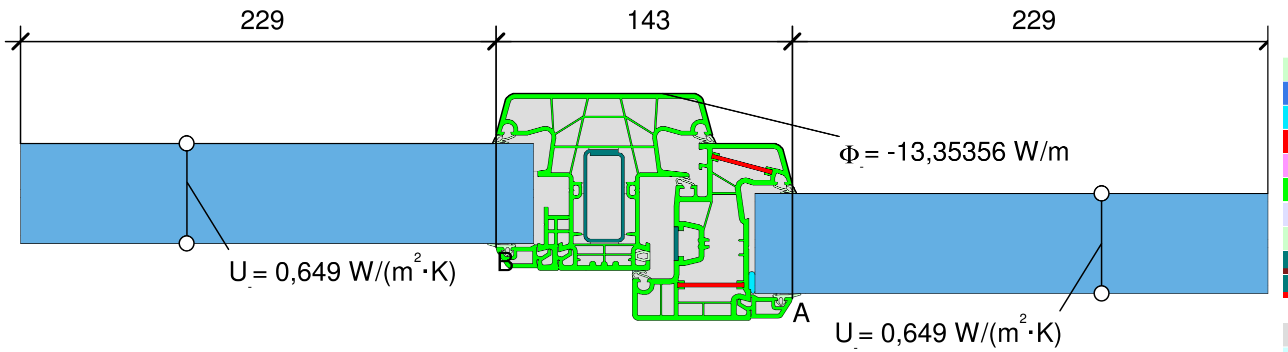


$$\Psi_{A,B} = \frac{\frac{\Phi}{\Delta T} - U_{g1}\cdot b_{g1} - U_f\cdot b_f - U_{g2}\cdot b_{g2}}{2} = \frac{\frac{18{,}465}{30{,}000} - 0{,}900\cdot 0{,}210 - 1{,}059\cdot 0{,}181 - 0{,}900\cdot 0{,}210}{2} = 0{,}023\ \mathrm{W/(m\cdot K)}$$



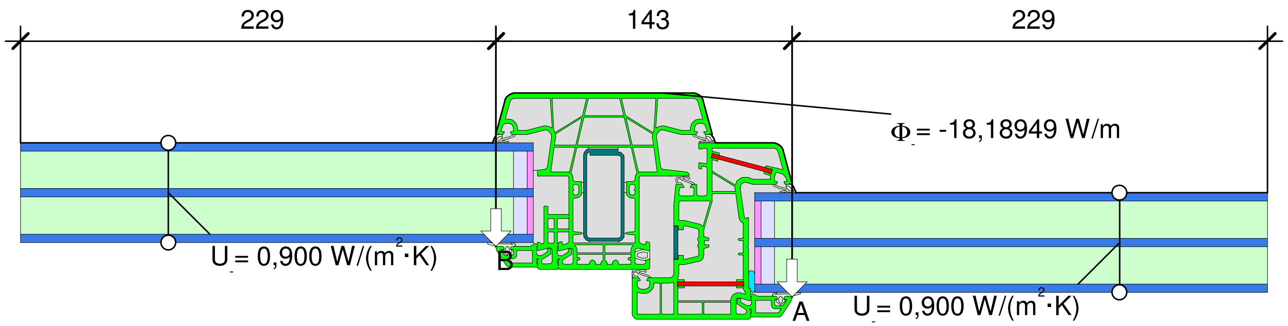
$\theta si\ min_{A\text{-}B} = 10{,}03\ ^{\circ}C$

$f_{Rsi} = 0{,}668$

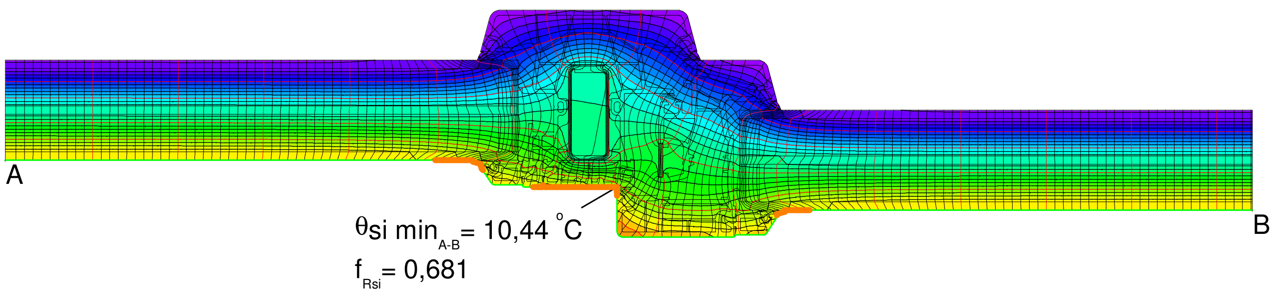


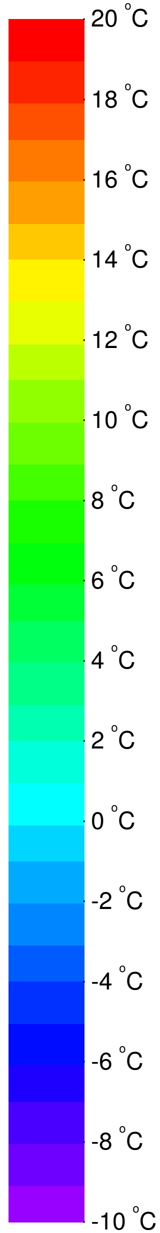
Material	λ[W/(m·K)]	ε
Ar18 in 48 mm U 0,9	0,039	
Glass I Glas	1,000	0,900
PU-Seal I PU Dichtung	0,250	0,900
Polyamide 25% Glassfiber	0,300	0,900
Polysulfide I Polysulfid	0,400	0,900
Polyvinylchloride (PVC)	0,170	0,900
SWISSP. Ultimate Box 2 [cert]	0,140	
Soft PVC I Weich-PVC	0,140	0,900
Steel I Stahl	50,000	0,900
Steel I Stahl	50,000	0,300
Undefined Material	0,010	
Unvent. cavity I unbel. Hohlr.		
slightly vent. cav. I leicht bel. Hohlr.		

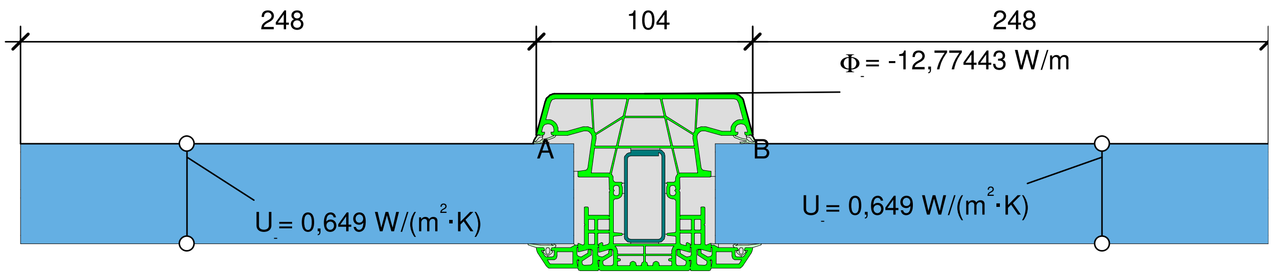
$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_{p1}\cdot b_{p1} - U_{p2}\cdot b_{p2}}{b_f} = \frac{\frac{13{,}354}{30{,}000} - 0{,}649\cdot 0{,}229 - 0{,}649\cdot 0{,}229}{0{,}143} = 1{,}041\ W/(m^2\cdot K)$$



$$\Psi_{A,B} = \frac{\frac{\Phi}{\Delta T} - U_{g1}\cdot b_{g1} - U_f\cdot b_f - U_{g2}\cdot b_{g2}}{2} = \frac{\frac{18{,}189}{30{,}000} - 0{,}900\cdot 0{,}229 - 1{,}041\cdot 0{,}143 - 0{,}900\cdot 0{,}229}{2} = 0{,}023\ W/(m\cdot K)$$

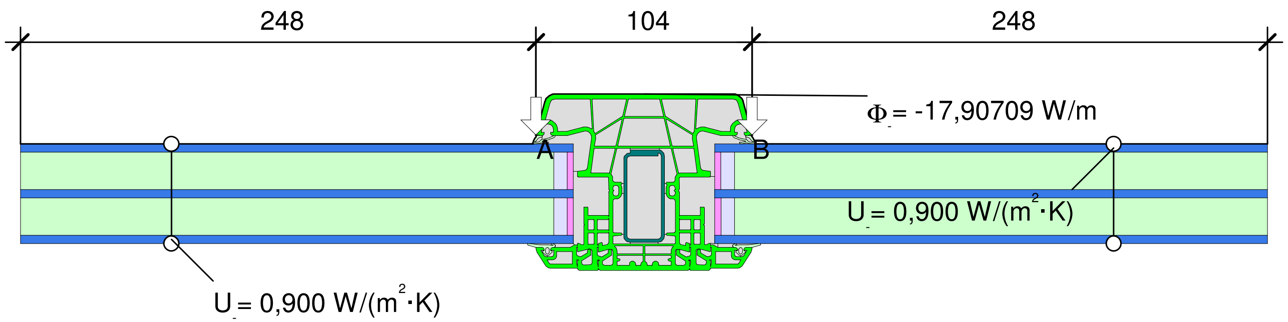




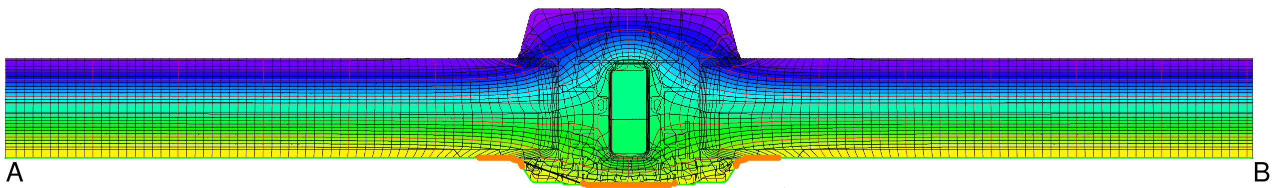


Material	λ[W/(m·K)]	ε
Ar18 in 48 mm U 0,9	0,039	
Glass I Glas	1,000	0,900
Polysulfide I Polysulfid	0,400	0,900
Polyvinylchloride (PVC)	0,170	0,900
SWISSP. Ultimate Box 2 [cert]	0,140	
Soft PVC I Weich-PVC	0,140	0,900
Steel I Stahl	50,000	0,300
Undefined Material	0,010	
Unvent. cavity I unbel. Hohlr.		

$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_{p1}\cdot b_{p1} - U_{p2}\cdot b_{p2}}{b_f} = \frac{\frac{12{,}774}{30{,}000} - 0{,}649\cdot 0{,}248 - 0{,}649\cdot 0{,}248}{0{,}104} = 1{,}000\ \mathrm{W/(m^2\cdot K)}$$

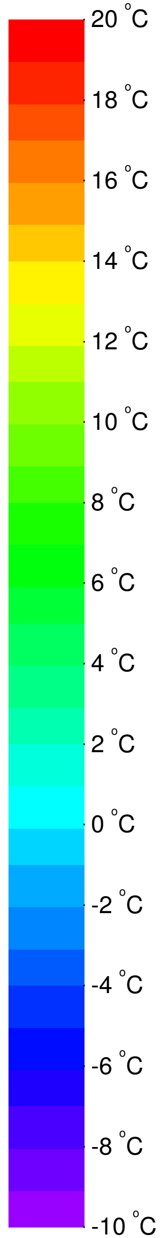


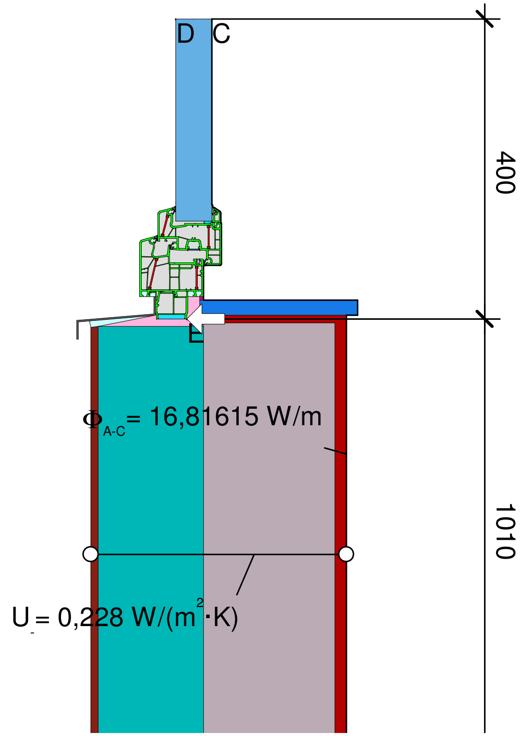
$$\Psi_{A,B} = \frac{\frac{\Phi}{\Delta T} - U_{g1}\cdot b_{g1} - U_f\cdot b_f - U_{g2}\cdot b_{g2}}{2} = \frac{\frac{17{,}907}{30{,}000} - 0{,}900\cdot 0{,}248 - 1{,}000\cdot 0{,}104 - 0{,}900\cdot 0{,}248}{2} = 0{,}023\ \mathrm{W/(m\cdot K)}$$

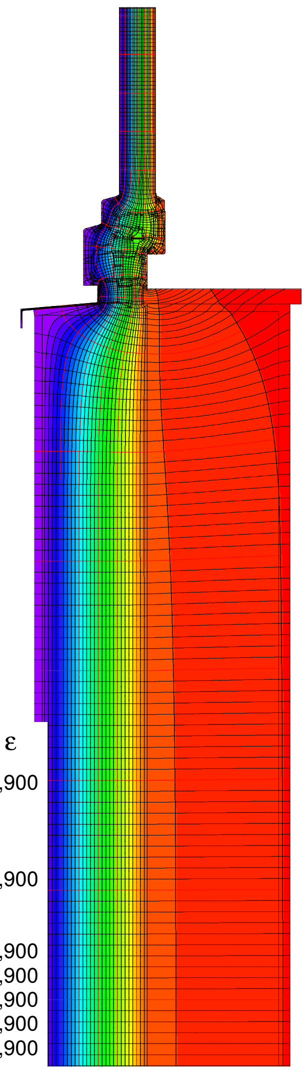


$\theta si\ min_{A-B}$ = 11,60 °C

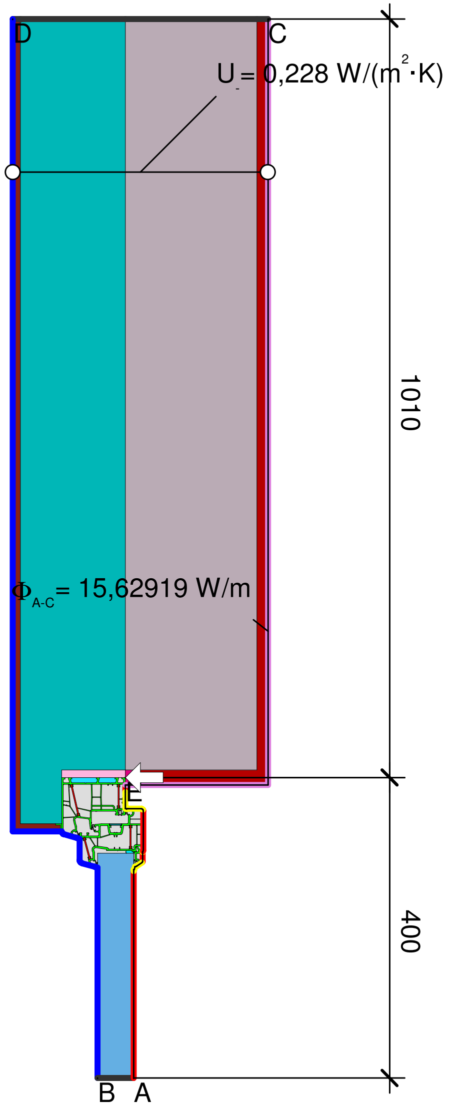
f_{Rsi} = 0,720

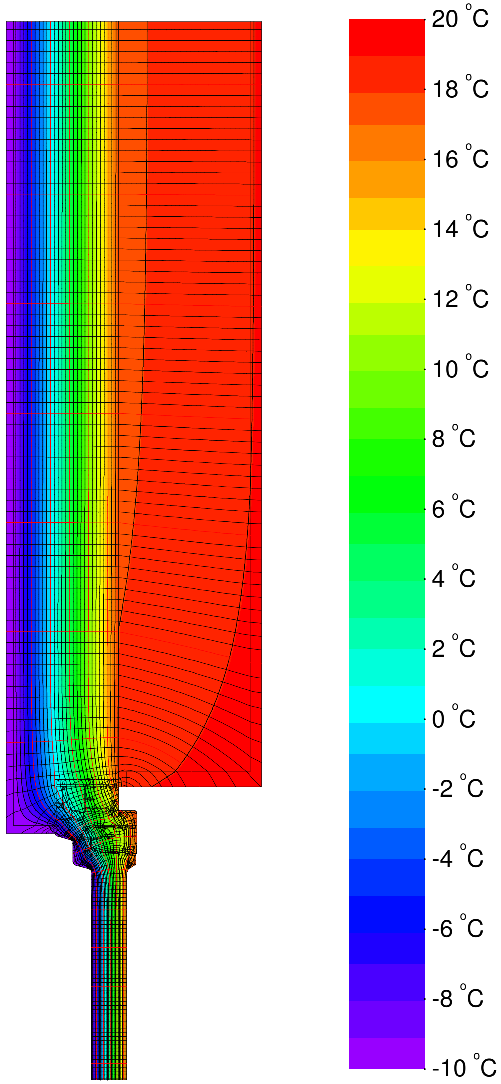






Material	λ[W/(m·K)]	ε
Aluminum I Aluminium 10456	160,000	0,900
EPS, Mineralwolle 035	0,035	
Gipsputz 1300 kg/m3 10456	0,570	
Kalksandstein 1800 kg/m3 1745	1,000	
Kunstharzputz 4108-4	0,700	0,900
Kunststein 10456	1,300	
PU foam I PU Schaum 030	0,030	
PU resin I PU Harz	0,250	0,900
PUR-Ortschaum WLG 040	0,040	0,900
Panel I Maske	0,035	0,900
Polyamide 25% Glassfiber	0,300	0,900
Polyvinylchloride (PVC)	0,170	0,900
Silicone I Silikon	0,350	
Soft PVC I Weich-PVC	0,140	0,900
Steel I Stahl	50,000	0,900
Unvent. cavity I unbel. Hohlr.		
slightly vent. cav. I leicht bel. Hohlr.		

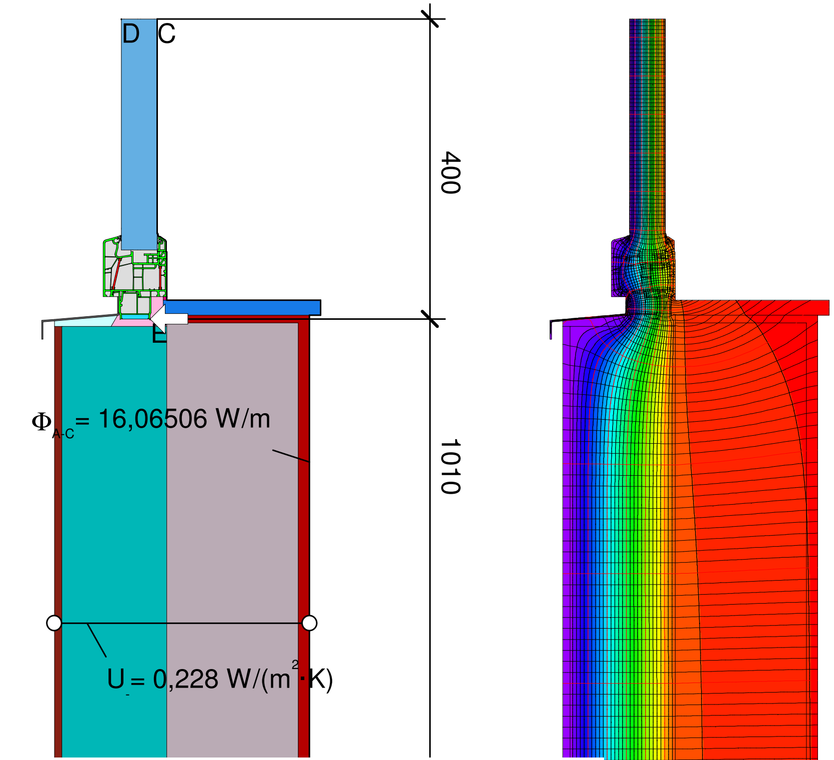




$$\Psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{15,629}{30,000} - \frac{8,893}{30,000} - 0,228 \cdot 1,010 = -0,006 \text{ W/(m·K)}$$

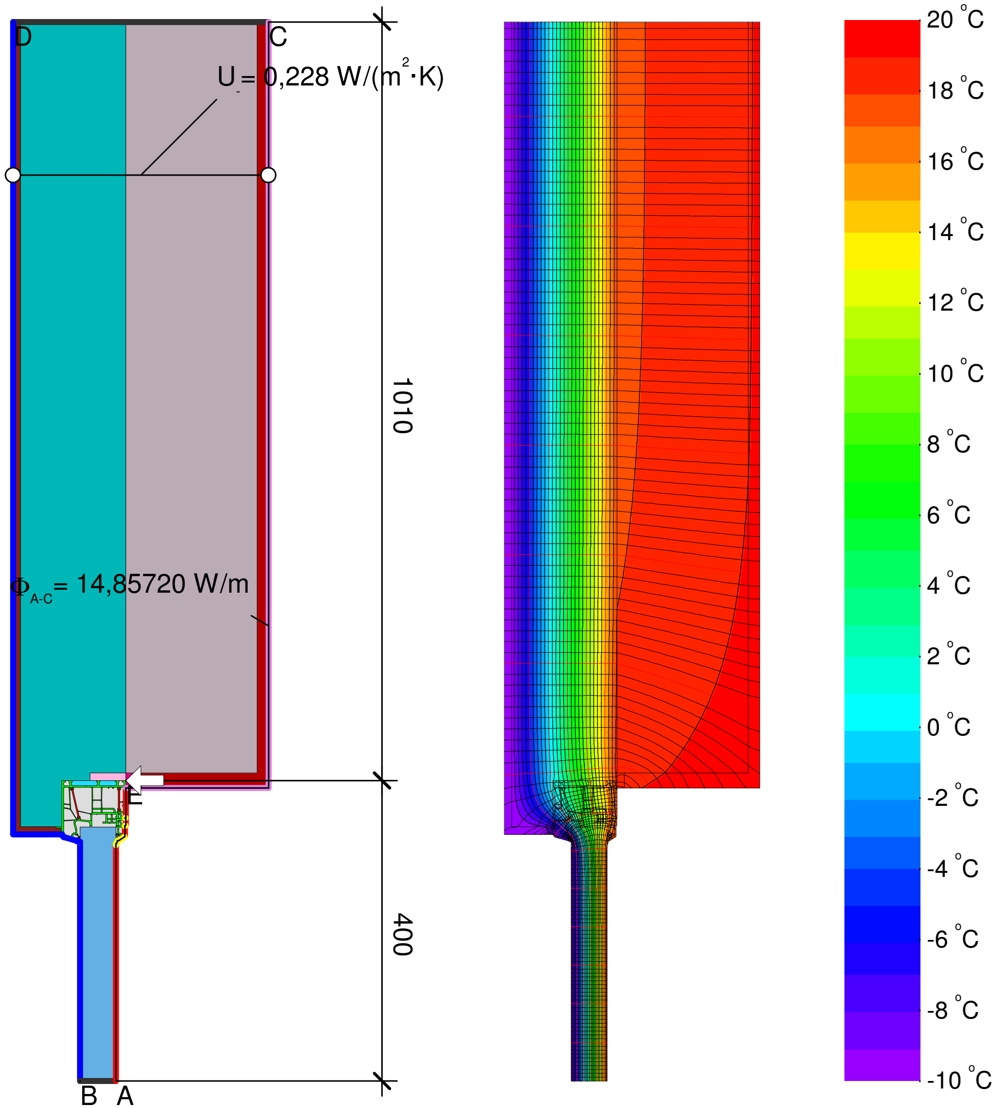
Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,000			
Exterior I Außen		-10,000	0,040	
Interior I Innen		20,000	0,130	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	
e 0,9 Cavity I Hohlraum				0,900

$$\Psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{16,816}{30,000} - 0,228 \cdot 1,010 - \frac{9,884}{30,000} = 0,001 \text{ W/(m·K)}$$



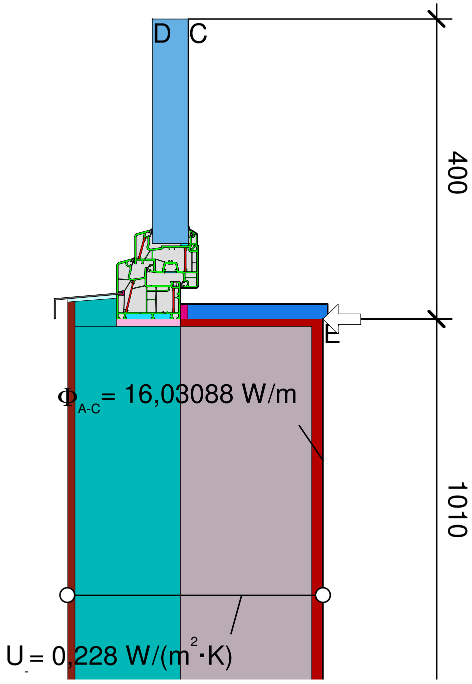
Material	λ[W/(m·K)]	ε
Aluminum I Aluminium 10456	160,000	0,900
EPS, Mineralwolle 035	0,035	0,900
Gipsputz 1300 kg/m3 10456	0,570	
Kalksandstein 1800 kg/m3 1745	1,000	
Kunstharzputz 4108-4	0,700	0,900
Kunststein 10456	1,300	
PU foam I PU Schaum 030	0,030	
PUR-Ortschaum WLG 040	0,040	0,900
Panel I Maske	0,035	0,900
Polyamide 25% Glassfiber	0,300	0,900
Polyvinylchloride (PVC)	0,170	0,900
Silicone I Silikon	0,350	
Soft PVC I Weich-PVC	0,140	0,900
Undefined Material	0,010	
Unvent. cavity I unbel. Hohlr.		
slightly vent. cav. I leicht bel. Hohlr.		

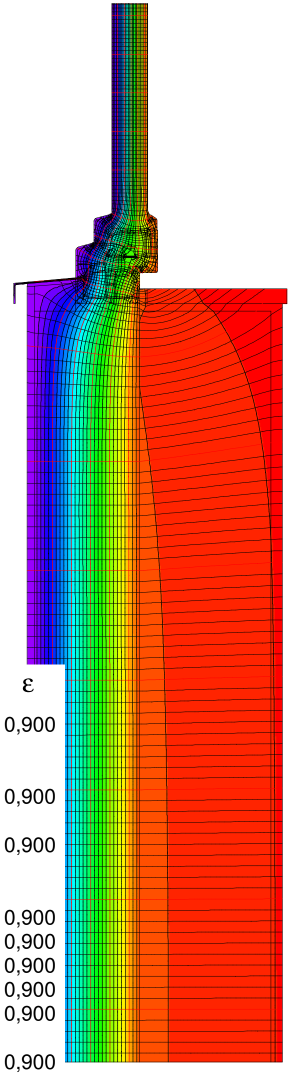
$$\Psi_{A-E-C,\cdot} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{16{,}065}{30{,}000} - 0{,}228\cdot 1{,}010 - \frac{9{,}210}{30{,}000} = -0{,}002 \text{ W/(m·K)}$$

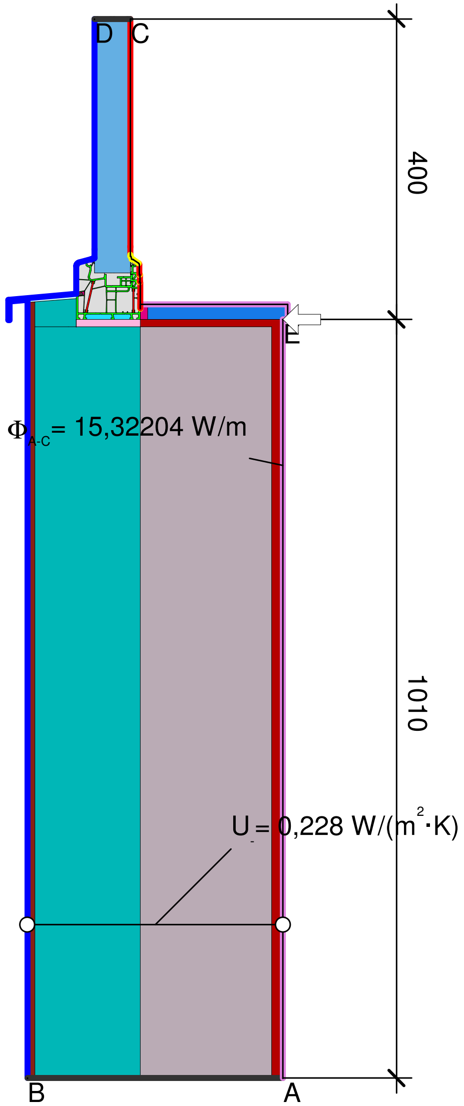


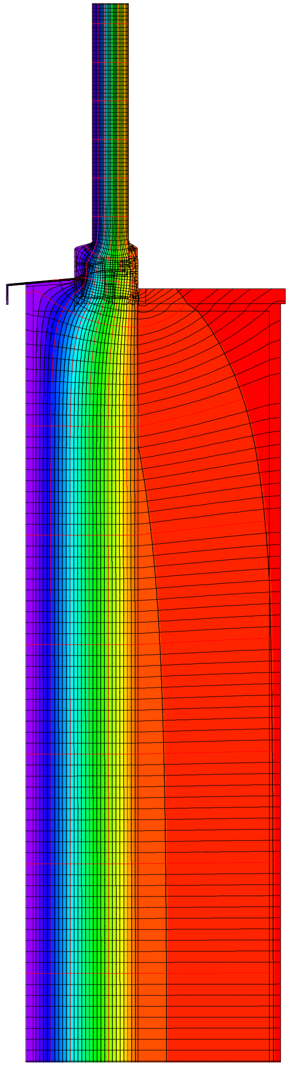
$$\Psi_{A-E-C,\cdot} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{14{,}857}{30{,}000} - \frac{8{,}230}{30{,}000} - 0{,}228\cdot 1{,}010 = -0{,}009 \text{ W/(m·K)}$$

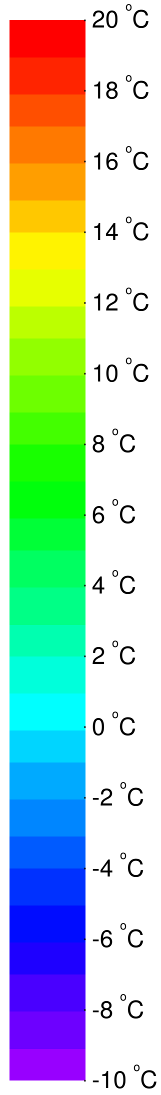
Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic | Adiabat	0,000			
Exterior I Außen		-10,000	0,040	
Interior I Innen		20,000	0,130	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	
e 0,9 Cavity I Hohlraum				0,900











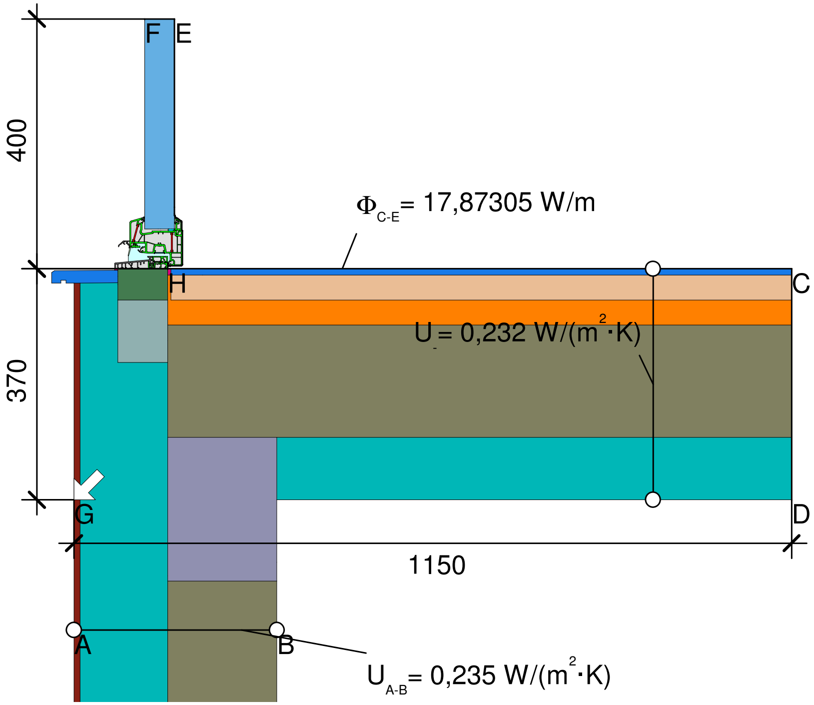
Material	λ[W/(m·K)]	ε
Aluminiumlegierungen 10456	160,000	0,900
EPS, Mineralwolle 035	0,035	
Gipsputz 1300 kg/m3 10456	0,570	
Insulation I Wärmedämmung 035	0,035	0,900
Kalksandstein 1800 kg/m3 1745	1,000	
Kunstharzputz 4108-4	0,700	0,900
Kunststein 10456	1,300	
PU foam I PU-Schaum 030	0,030	
PU-Seal I PU Dichtung	0,250	0,900
PUR-Ortschaum WLG 040	0,040	0,900
Panel I Maske	0,035	0,900
Polyamide 25% Glassfiber	0,300	0,900
Polyvinylchloride (PVC)	0,170	0,900
Silicone I Silikon	0,350	
Soft PVC I Weich-PVC	0,140	0,900
Steel I Stahl	50,000	0,900
Undefined Material	0,010	
Unvent. cavity I unbel. Hohlr.		
slightly vent. cav. I leicht bel. Hohlr.		

$$\Psi_{A\text{-}E\text{-}C,\cdot} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{15,322}{30,000} - 0,228 \cdot 1,010 - \frac{8,230}{30,000} = 0,006 \text{ W/(m·K)}$$

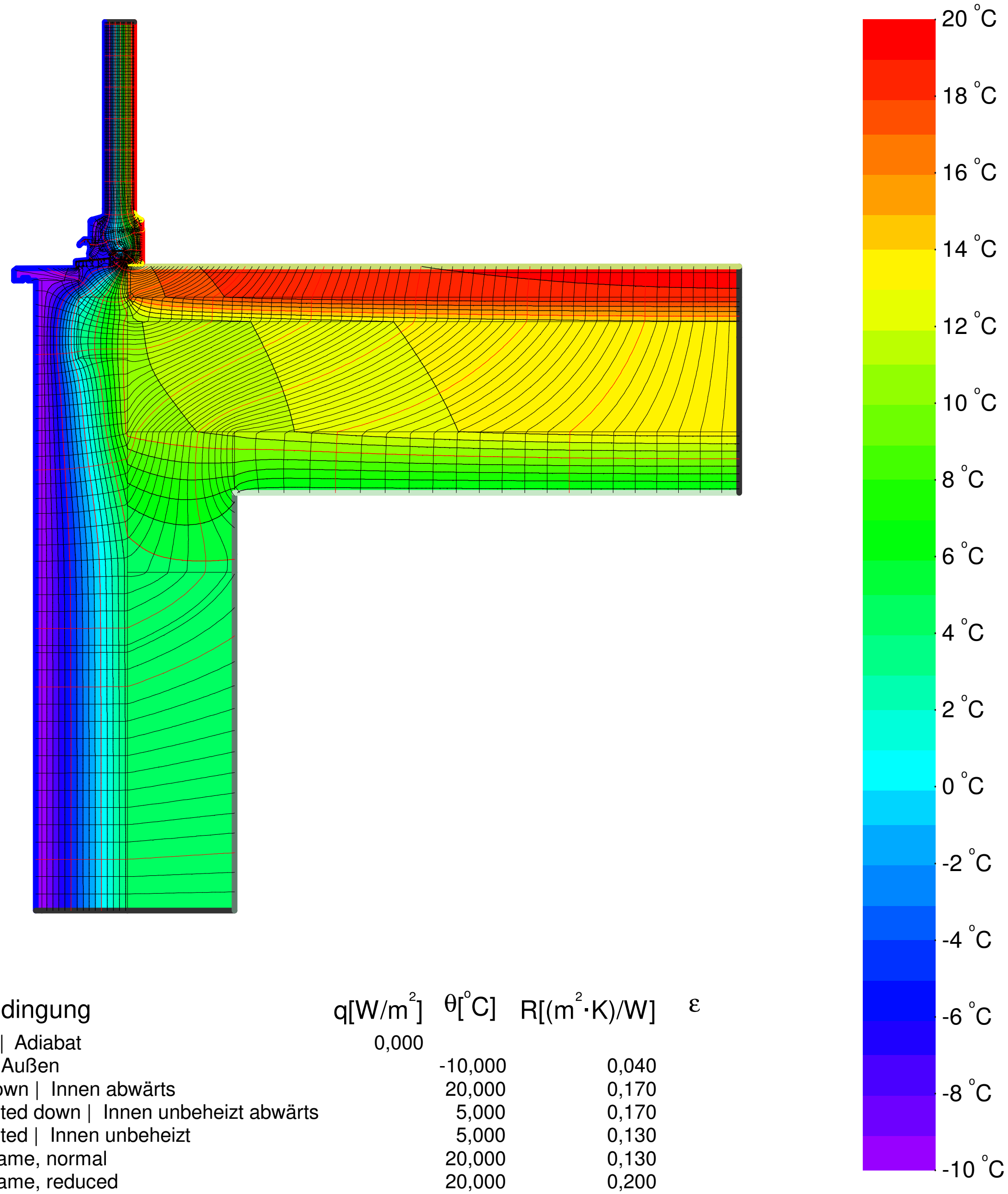
Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,000			
Adiabatic | Adiabat	0,000			
Exterior | Außen		-10,000	0,040	
Interior I Innen		20,000	0,130	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	
e 0,9 Cavity I Hohlraum				0,900

$$\Psi_{A\text{-}E\text{-}C,\cdot} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{16,031}{30,000} - 0,228 \cdot 1,010 - \frac{8,893}{30,000} = 0,008 \text{ W/(m·K)}$$

Passive House Institute



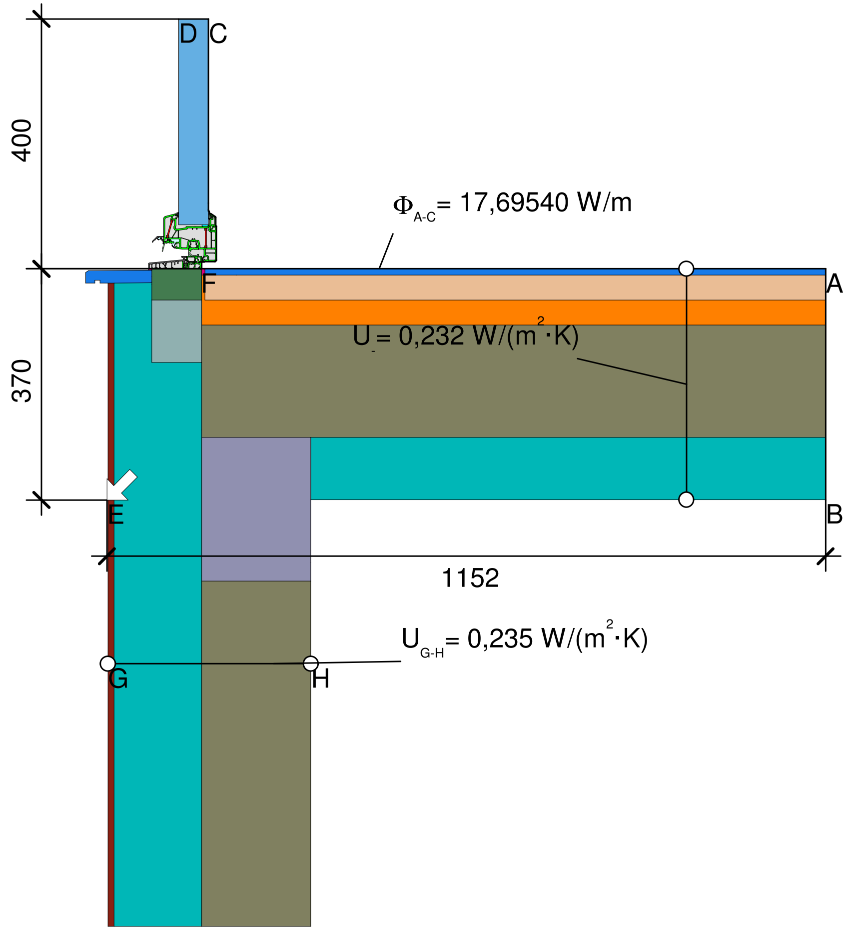
Material	λ[W/(m·K)]	ε
Aluminum I Aluminium 10456	160,000	0,900
Artificial stone I Kunststein 10456	1,300	
Cement screed I Zement-Estrich 4108	1,400	
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300	
Gas concrete I Porenbeton 750 4108	0,240	
Insulation I Dämmstoff 040	0,040	0,900
Insulation I Wärmedämmung 035	0,035	
Insulation I Wärmedämmung 040	0,040	
Organic compound plaster I Kunstharzputz 4108-4	0,700	
PU-Seal I PU Dichtung	0,250	0,900
Panel I Maske	0,035	0,900
Polyamide 25% Glassfiber	0,300	0,900
Polyvinylchloride (PVC)	0,170	0,900
Silicone I Silikon	0,350	0,900
Soft PVC I Weich-PVC	0,140	0,900
Spruce, Fir I Fichte, Tanne	0,110	
Steel I Stahl	50,000	0,900
Undefined Material	0,010	
Unvent. cavity I unbel. Hohlr.		
slightly vent. cav. I leicht bel. Hohlr.		

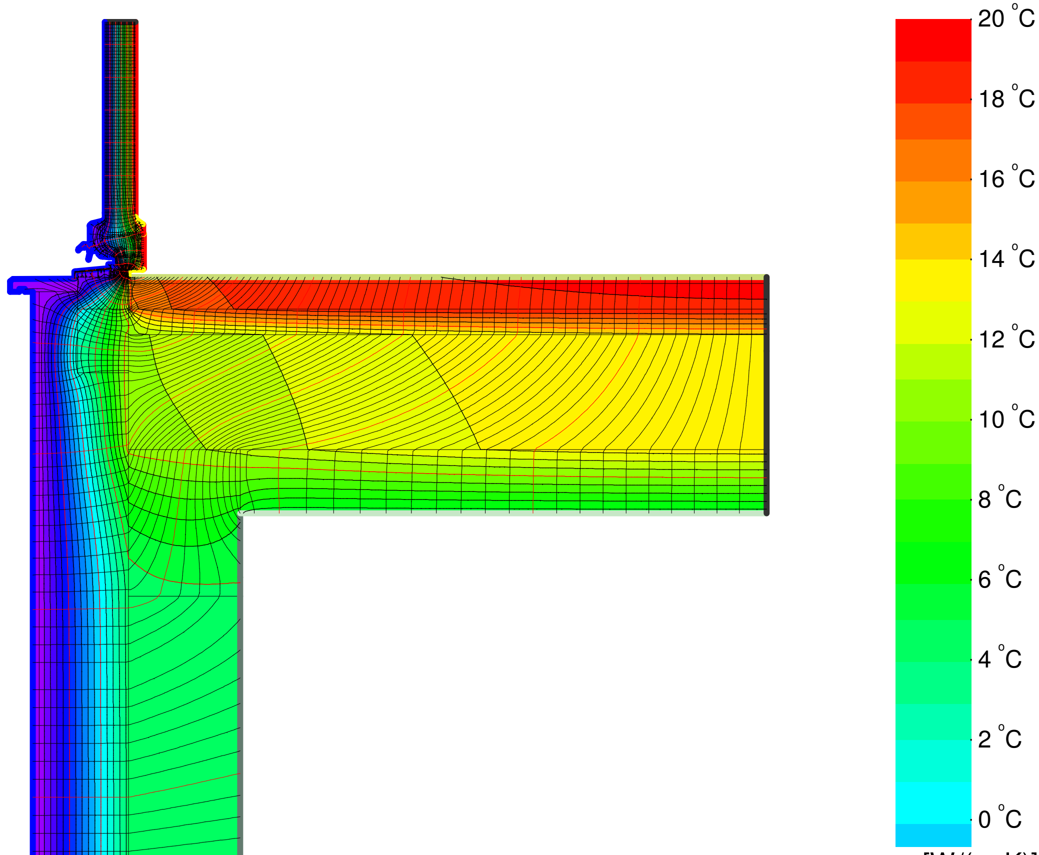


Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic | Adiabat	0,000			
Exterior | Außen		-10,000	0,040	
Int. flux down | Innen abwärts		20,000	0,170	
Int. unheated down | Innen unbeheizt abwärts		5,000	0,170	
Int. unheated | Innen unbeheizt		5,000	0,130	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	
e 0,9 Cavity I Hohlraum				0,900

$$\Psi_{C\text{-}G\text{-}E,\cdot} = \frac{\Phi - U_1 \cdot b_1 \cdot \Delta T_1 - U_2 \cdot b_2 \cdot \Delta T_2 - \Phi_3}{\Delta T} = \frac{17{,}873 - 0{,}232 \cdot 1{,}150 \cdot 15{,}000 - 0{,}235 \cdot 0{,}370 \cdot 30{,}000 - 9{,}818}{30{,}000} = 0{,}048 \text{ W/(m·K)}$$

EIFS THRESHOLD I WDVS SCHWELLE Balkontür Dreh-Kipp t Ibérica S.L.U. SWISSPACER Ultimate Energeto 8000 (Fenstersystem) 1091ws04

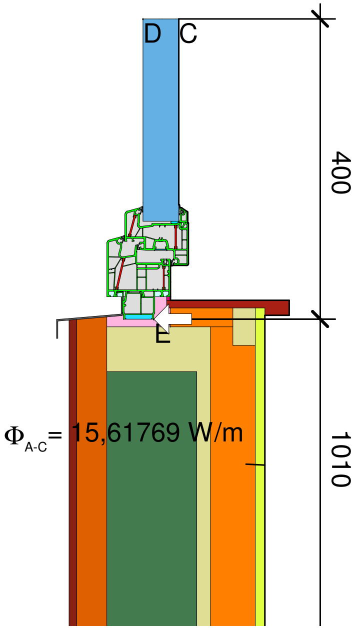


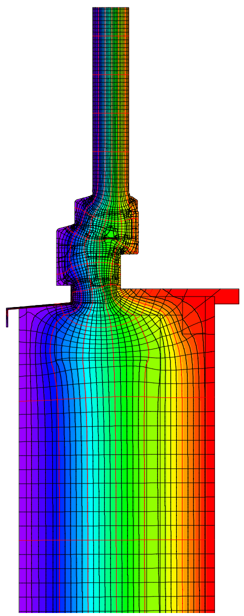


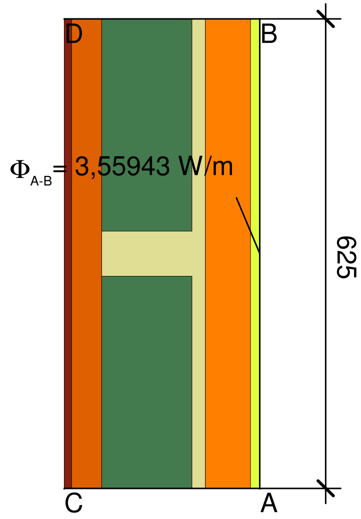
Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic | Adiabat	0,000			
Exterior I Außen		-10,000	0,040	
Int. flux down | Innen abwärts		20,000	0,170	
Int. unheated down | Innen unbeheizt abwärts		5,000	0,170	
Int. unheated | Innen unbeheizt		5,000	0,130	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	
e 0,9 Cavity I Hohlraum				0,900

Material	λ[W/(m·K)]	ε
Aluminum I Aluminium 10456	160,000	0,90
Artificial stone I Kunststein 10456	1,300	
Cement screed I Zement-Estrich 4108	1,400	
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300	
Gas concrete I Porenbeton 750 4108	0,240	
Insulation I Dämmstoff 040	0,040	0,90
Insulation I Wärmedämmung 035	0,035	
Insulation I Wärmedämmung 040	0,040	
Maske	0,035	0,90
Organic compound plaster I Kunstharzputz 4108-4	0,700	
PU-Seal I PU Dichtung	0,250	0,90
PVC soft I PVC weich 10077	0,140	0,90
Polyamid 25% glassfibre I Glasfaser 10077	0,300	0,90
Polyvinylchloride (PVC)	0,170	0,90
Silicone I Silikon	0,350	0,90
Soft PVC I Weich-PVC	0,140	0,90
Spruce, Fir I Fichte, Tanne	0,110	
Unvent. cavity I unbel. Hohlr.		
slightly vent. cav. I leicht bel. Hohlr.		

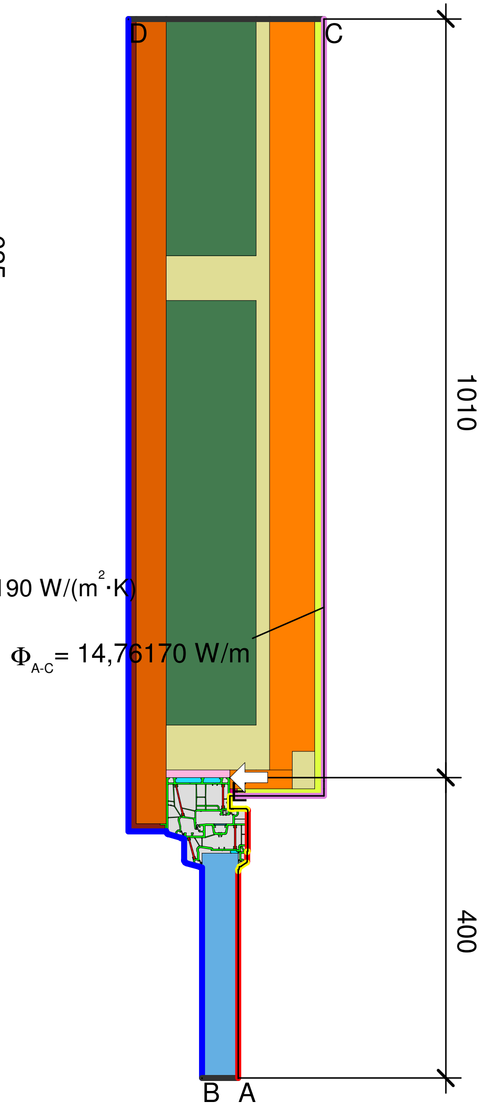
$$\psi_{A\text{-}E\text{-}C,\cdot} = \frac{\Phi - U_1 \cdot b_1 \cdot \Delta T_1 - U_2 \cdot b_2 \cdot \Delta T_2 - \Phi_3}{\Delta T} = \frac{17{,}695 - 0{,}232 \cdot 1{,}152 \cdot 15{,}000 - 0{,}235 \cdot 0{,}370 \cdot 30{,}000 - 10{,}398}{30{,}000} = 0{,}023 \text{ W/(m·K)}$$

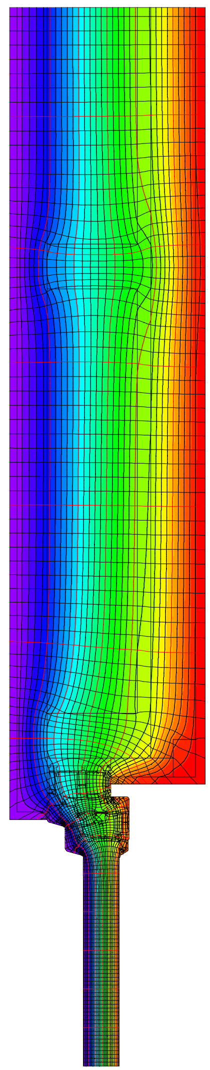


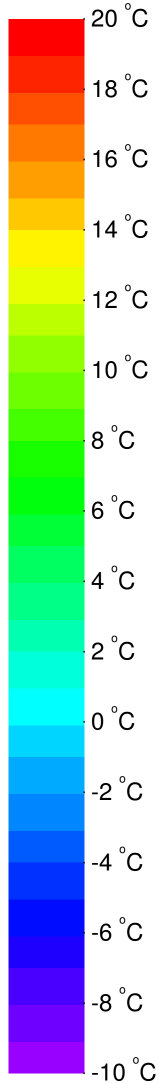




$$U_{eq\ A-B} = \frac{\Phi}{\Delta T \cdot b} = \frac{3,559}{30,000 \cdot 0,625} = 0,190\ W/(m^2 \cdot K)$$





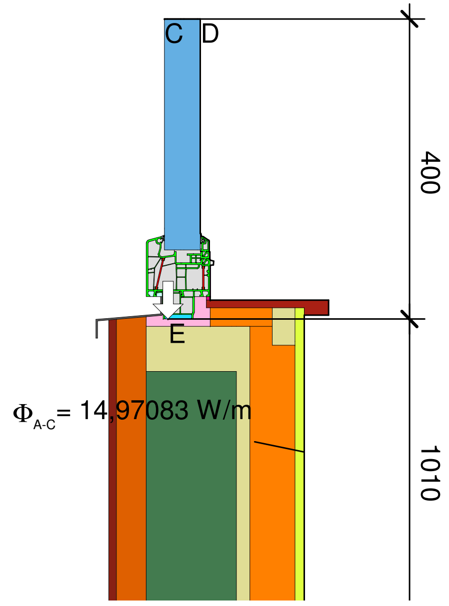


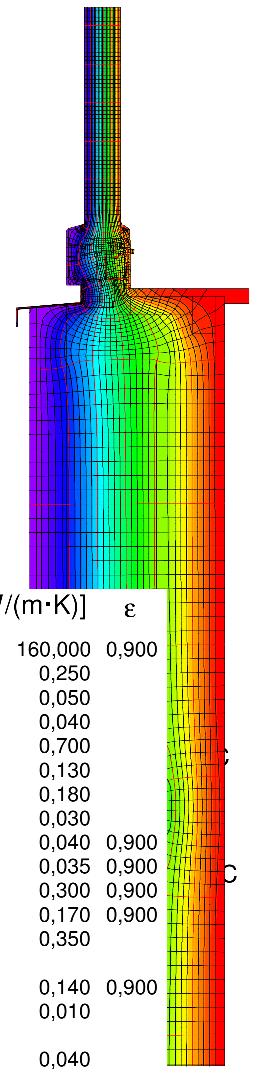
Material	λ[W/(m·K)]	ε
Aluminum I Aluminium 10456	160,000	0,900
Gipskartonplatten 900 kg/m3 10456	0,250	
Holzweichfaserplatte	0,050	
Insulation I Wärmedämmung 040	0,040	
Kunstharzputz 4108-4	0,700	
Nutzholz 500 kg/m3, auch OSB 10456	0,130	
Nutzholz 700 kg/m3 10456	0,180	
PU foam I PU Schaum 030	0,030	
PU resin I PU Harz	0,250	0,900
PUR-Ortschaum WLG 040	0,040	0,900
Panel I Maske	0,035	0,900
Polyamide 25% Glassfiber	0,300	0,900
Polyvinylchloride (PVC)	0,170	0,900
Silicone I Silikon	0,350	
Slightly vent. cavity I schwach bel. Hohlr. 10077		
Soft PVC I Weich-PVC	0,140	0,900
Steel I Stahl	50,000	0,900
Unvent. cavity I unbel. Hohlr.		
Wärmedämmung 040	0,040	
Zellulose 040	0,040	
slightly vent. cav. I leicht bel. Hohlr.		

$$\Psi_{A-E-C,\cdot} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{14,762}{30,000} - \frac{8,893}{30,000} - 0,190 \cdot 1,010 = 0,004\ W/(m \cdot K)$$

Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,000			
Adiabatic | Adiabat	0,000			
Exterior I Außen		-10,000	0,040	
Interior I Innen		20,000	0,130	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	
e 0,9 Cavity I Hohlraum				0,900

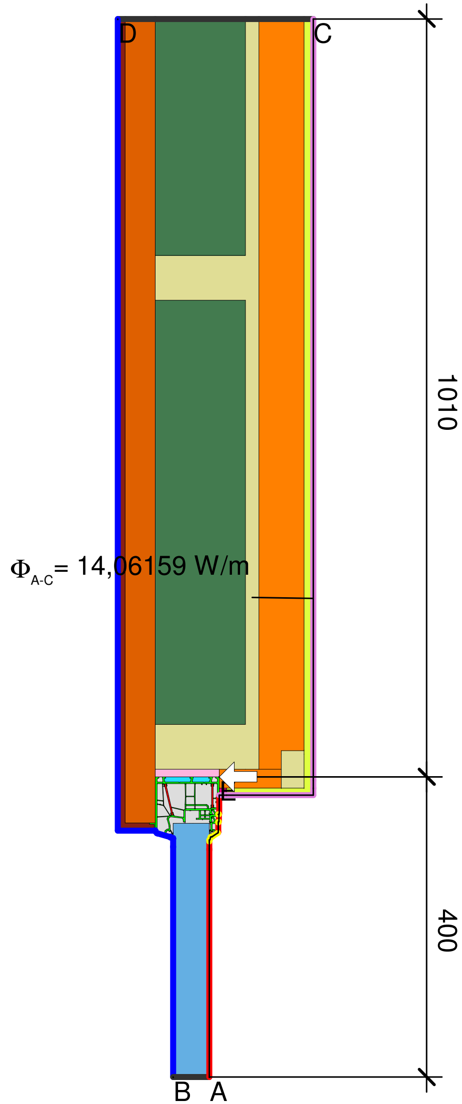
$$\Psi_{A-E-C,\cdot} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{15,618}{30,000} - 0,190 \cdot 1,010 - \frac{9,884}{30,000} = -0,001\ W/(m \cdot K)$$

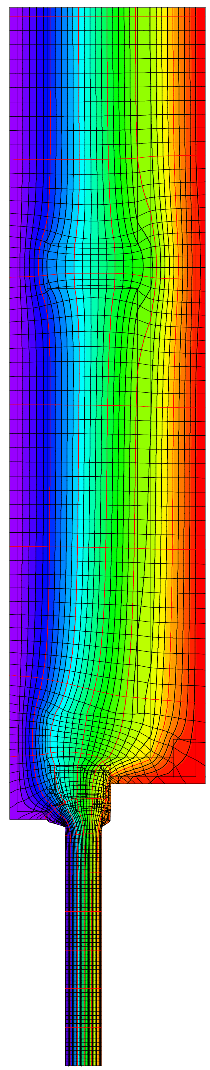


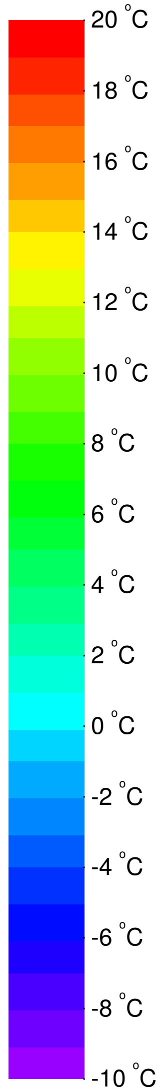


Material	λ[W/(m·K)]	ε
Aluminum I Aluminium 10456	160,000	0,900
Gipskartonplatten 900 kg/m3 10456	0,250	
Holzweichfaserplatte	0,050	
Insulation I Wärmedämmung 040	0,040	
Kunstharzputz 4108-4	0,700	
Nutzholz 500 kg/m3, auch OSB 10456	0,130	
Nutzholz 700 kg/m3 10456	0,180	
PU foam I PU Schaum 030	0,030	
PUR-Ortschaum WLG 040	0,040	0,900
Panel I Maske	0,035	0,900
Polyamide 25% Glassfiber	0,300	0,900
Polyvinylchloride (PVC)	0,170	0,900
Silicone I Silikon	0,350	
Slightly vent. cavity I schwach bel. Hohlr. 10077		
Soft PVC I Weich-PVC	0,140	0,900
Undefined Material	0,010	
Unvent. cavity I unbel. Hohlr.		
Wärmedämmung 040	0,040	
Zellulose 040	0,040	
slightly vent. cav. I leicht bel. Hohlr.		

$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{14,971}{30,000} - 0,190 \cdot 1,010 - \frac{9,210}{30,000} = 0,000\ \mathrm{W/(m \cdot K)}$$

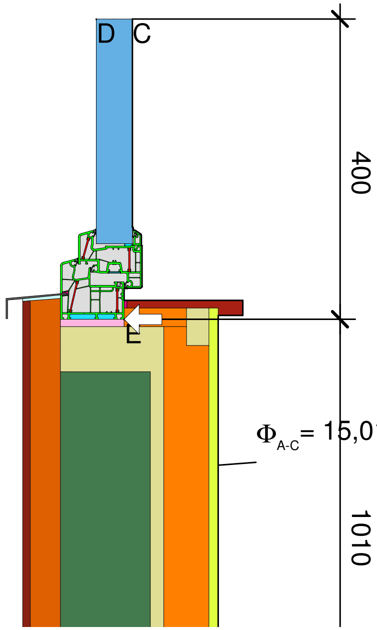


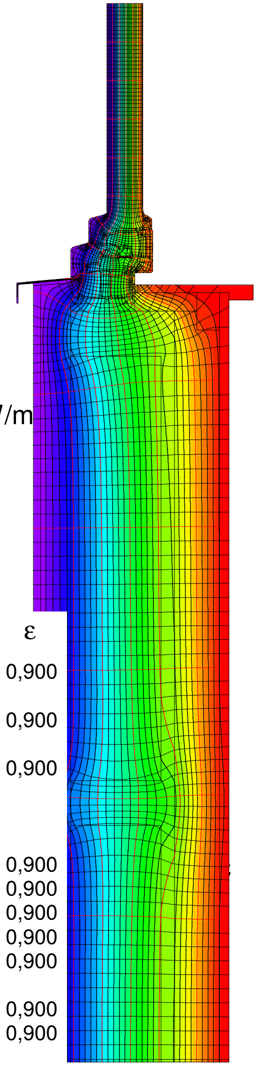




$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{14,062}{30,000} - \frac{8,230}{30,000} - 0,190 \cdot 1,010 = 0,002\ \mathrm{W/(m \cdot K)}$$

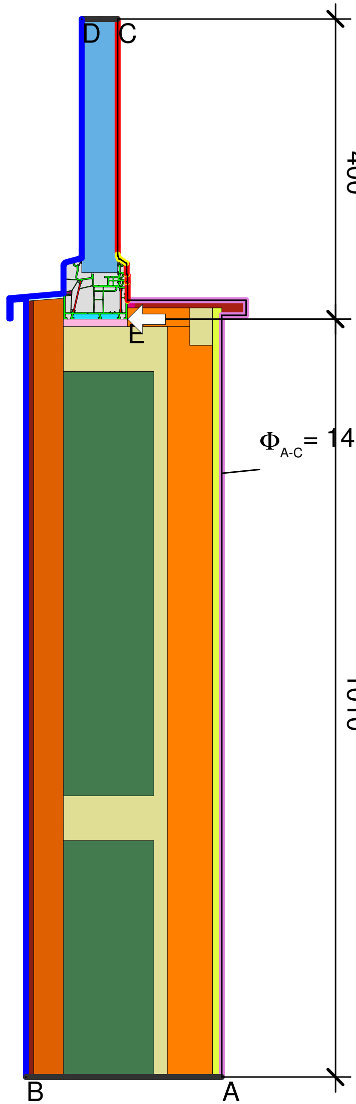
Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic | Adiabat	0,000			
Exterior I Außen		-10,000	0,040	
Interior I Innen		20,000	0,130	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	
e 0,9 Cavity I Hohlraum				0,900

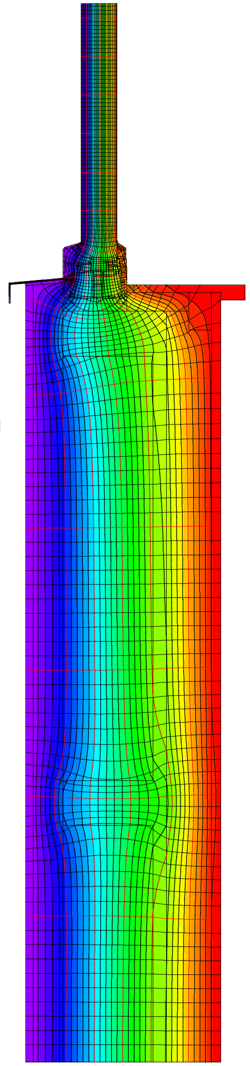


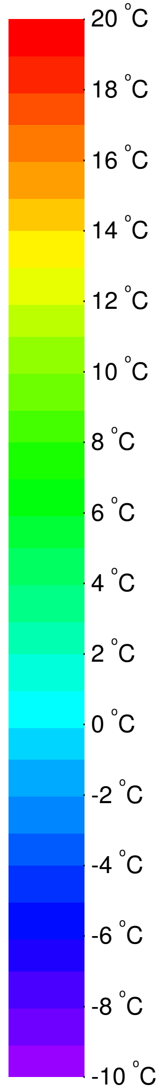


Material	λ[W/(m·K)]	ε
Aluminiumlegierungen 10456	160,000	0,900
Gipskartonplatten 900 kg/m3 10456	0,250	
Holzweichfaserplatte	0,050	0,900
Insulation I Wärmedämmung 040	0,040	
Kunstharzputz 4108-4	0,700	0,900
Nutzholz 500 kg/m3, auch OSB 10456	0,130	
Nutzholz 700 kg/m3 10456	0,180	
PU foam I PU-Schaum 030	0,030	
PU-Seal I PU Dichtung	0,250	0,900
PUR-Ortschaum WLG 040	0,040	0,900
Panel I Maske	0,035	0,900
Polyamide 25% Glassfiber	0,300	0,900
Polyvinylchloride (PVC)	0,170	0,900
Silicone I Silikon	0,350	
Soft PVC I Weich-PVC	0,140	0,900
Steel I Stahl	50,000	0,900
Undefined Material	0,010	
Unvent. cavity I unbel. Hohlr.		
Wärmedämmung 040	0,040	
Zellulose 040	0,040	
slightly vent. cav. I leicht bel. Hohlr.		

$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{15{,}018}{30{,}000} - 0{,}190 \cdot 1{,}010 - \frac{8{,}893}{30{,}000} = 0{,}012\ \mathrm{W/(m \cdot K)}$$





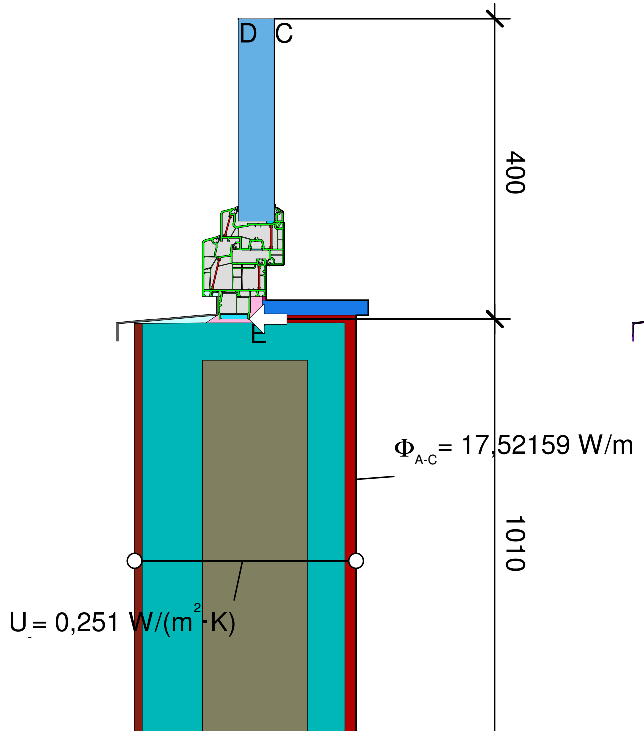


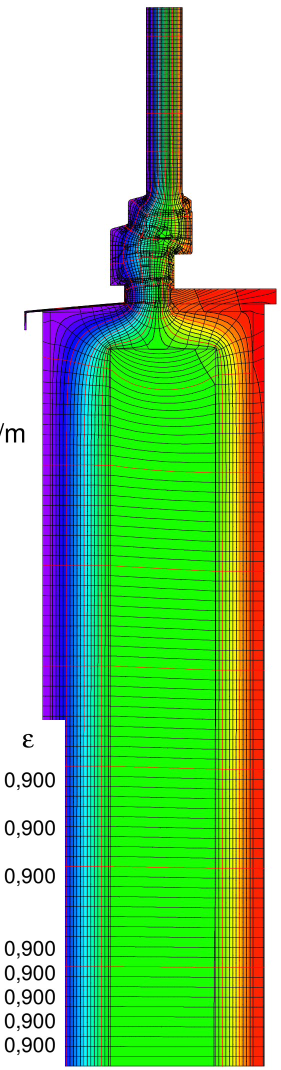
$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{14{,}392}{30{,}000} - 0{,}190 \cdot 1{,}010 - \frac{8{,}230}{30{,}000} = 0{,}013\ \mathrm{W/(m \cdot K)}$$

Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,000			
Adiabatic | Adiabat	0,000			
Exterior | Außen		-10,000	0,040	
Interior I Innen		20,000	0,130	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	
e 0,9 Cavity I Hohlraum				0,900

TIMBER altern. installation I HOLZLEICHTBAU altern. Einbau : Ibérica S.L.U. SWISSPACER Ultimate Energeto 8000 (Fenstersystem) 1091ws04

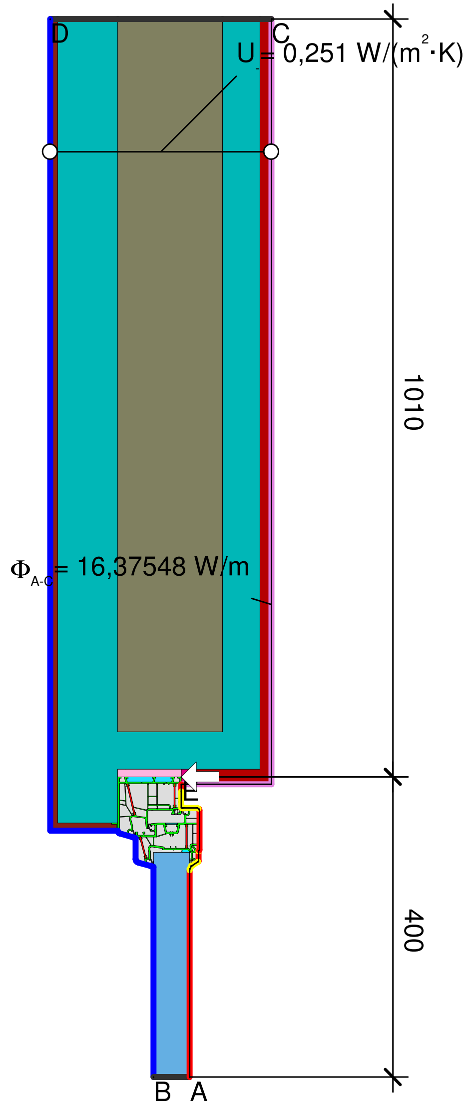
Passive House Institute

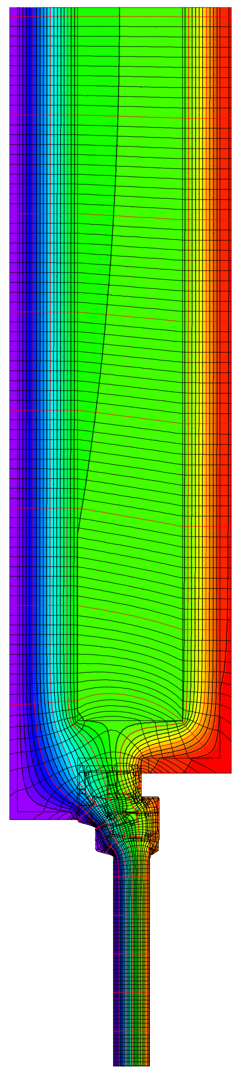


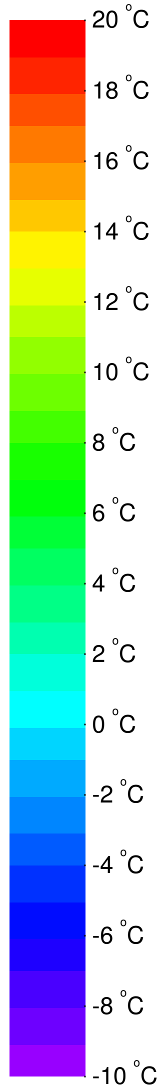


Material	λ[W/(m·K)]	ε
Aluminum I Aluminium 10456	160,000	0,900
Beton armiert (mit 1% Stahl) 10456	2,300	
EPS, Mineralwolle 035	0,035	0,900
Gipsputz 1300 kg/m3 10456	0,570	
Kunstharzputz 4108-4	0,700	0,900
Kunststein 10456	1,300	
PU foam I PU Schaum 030	0,030	
PU resin I PU Harz	0,250	0,900
PUR-Ortschaum WLG 040	0,040	0,900
Panel I Maske	0,035	0,900
Polyamide 25% Glassfiber	0,300	0,900
Polyvinylchloride (PVC)	0,170	0,900
Silicone I Silikon	0,350	
Soft PVC I Weich-PVC	0,140	0,900
Steel I Stahl	50,000	0,900
Unvent. cavity I unbel. Hohlr.		
slightly vent. cav. I leicht bel. Hohlr.		

$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{17{,}522}{30{,}000} - 0{,}251 \cdot 1{,}010 - \frac{9{,}884}{30{,}000} = 0{,}001 \text{ W/(m·K)}$$

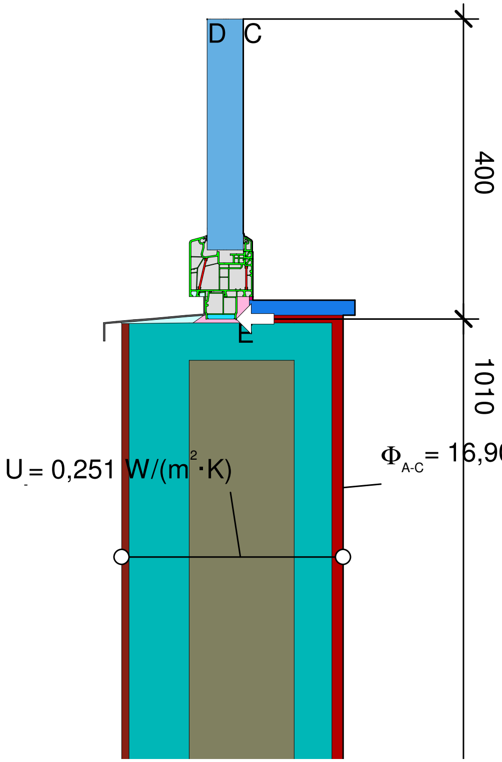


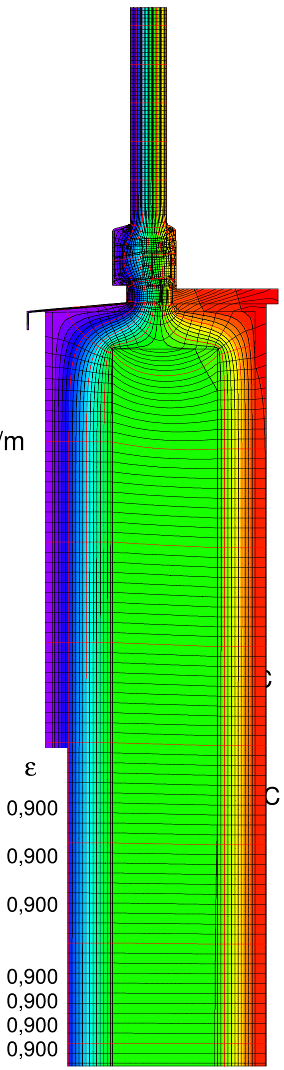




$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{16{,}375}{30{,}000} - \frac{8{,}893}{30{,}000} - 0{,}251 \cdot 1{,}010 = -0{,}004 \text{ W/(m·K}$$

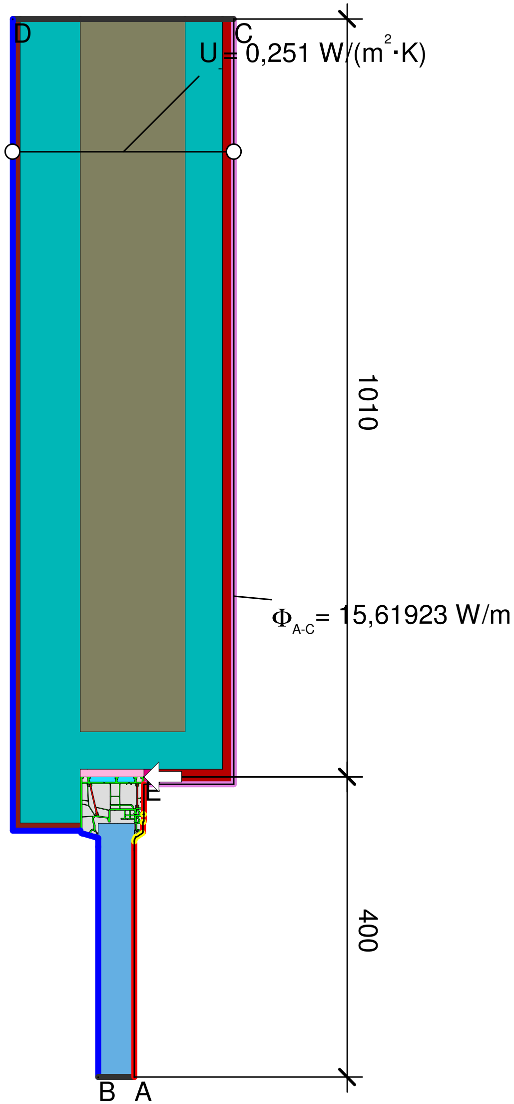
Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,000			
Exterior I Außen		-10,000	0,040	
Interior I Innen		20,000	0,130	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	
e 0,9 Cavity I Hohlraum				0,900

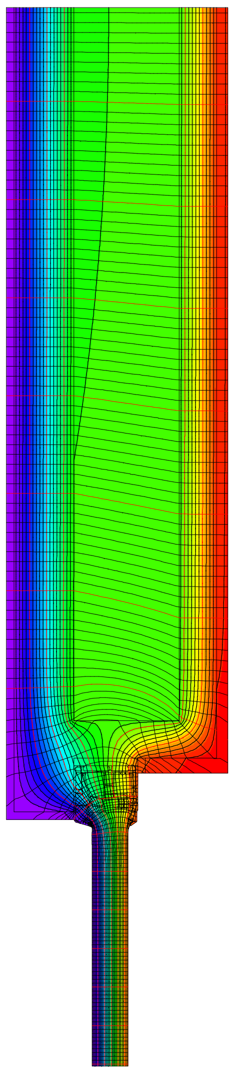


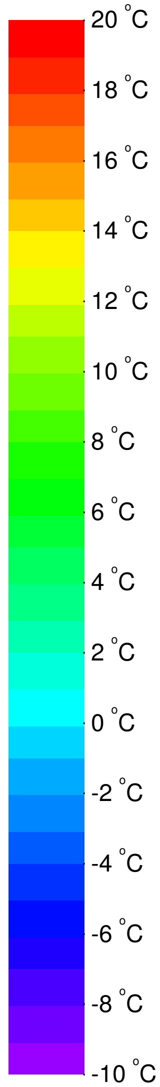


Material	λ[W/(m·K)]	ε
Aluminum I Aluminium 10456	160,000	0,900
Beton armiert (mit 1% Stahl) 10456	2,300	
EPS, Mineralwolle 035	0,035	0,900
Gipsputz 1300 kg/m3 10456	0,570	
Kunstharzputz 4108-4	0,700	0,900
Kunststein 10456	1,300	
PU foam I PU Schaum 030	0,030	
PUR-Ortschaum WLG 040	0,040	0,900
Panel I Maske	0,035	0,900
Polyamide 25% Glassfiber	0,300	0,900
Polyvinylchloride (PVC)	0,170	0,900
Silicone I Silikon	0,350	
Soft PVC I Weich-PVC	0,140	0,900
Undefined Material	0,010	
Unvent. cavity I unbel. Hohlr.		
slightly vent. cav. I leicht bel. Hohlr.		

$$\psi_{A\text{-}E\text{-}C,\cdot} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{16,901}{30,000} - 0,251 \cdot 1,010 - \frac{9,210}{30,000} = 0,003\ \text{W/(m·K)}$$







$$\psi_{A\text{-}E\text{-}C,\cdot} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{15,619}{30,000} - \frac{8,230}{30,000} - 0,251 \cdot 1,010 = -0,007\ \text{W/(m·K)}$$

Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,000			
Adiabatic | Adiabat	0,000			
Exterior I Außen		-10,000	0,040	
Interior I Innen		20,000	0,130	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	
e 0,9 Cavity I Hohlraum				0,900

FORMWORK BLOCKS FIXED I BETON SCHALUNGSSTEIN FEST **Ibérica S.L.U. SWISSPACER Ultimate Energeto 8000 (Fenstersystem) 1091ws04**

Passive House Institute