Passive House Institute

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

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

Window Mounting System
Fenstermontagesystem

1610pm04

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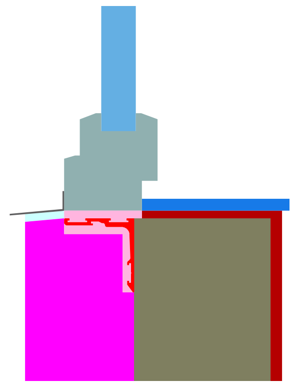
Product I Produkt: **SoudaFrame SWI 140 mm insulation**

Client I Auftraggeber: **Soudal NV**

Date I Datum: **11.09.2020**

Author I Autor: **Prof. 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.

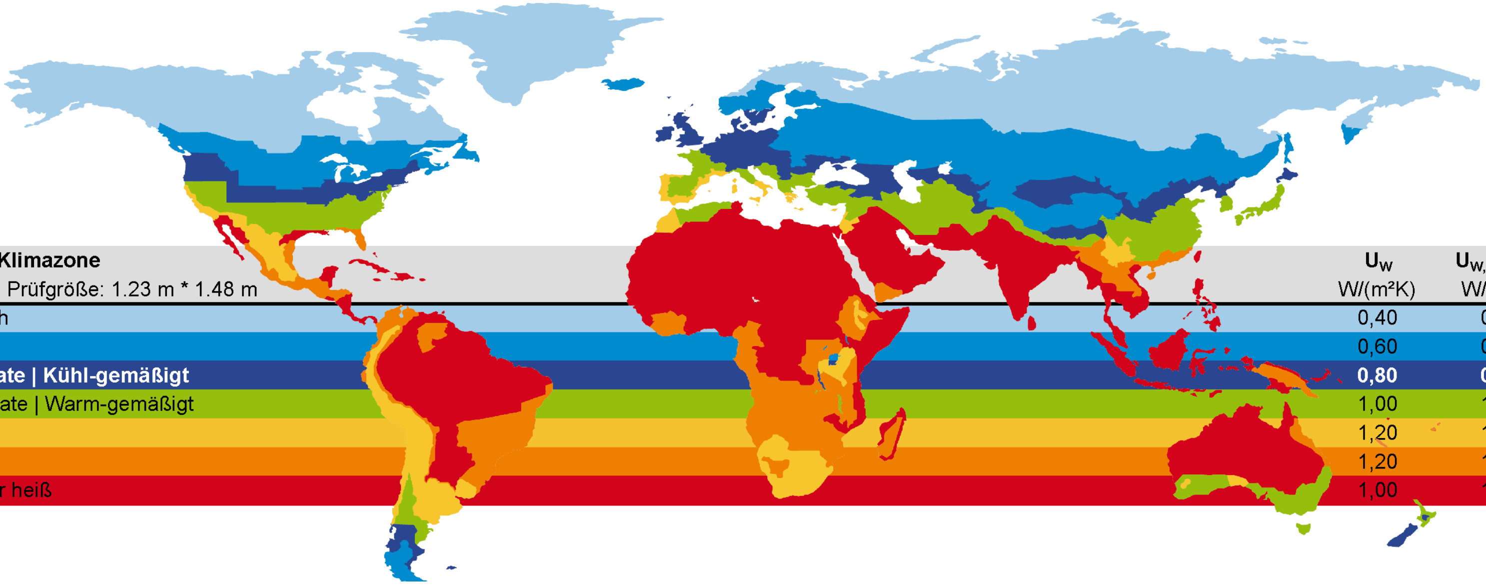
The below stated requirements for awarding the label "Certified Passive House Component" have been set by the Passive House Institute (PHI).

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	-

Frame values | Rahmenwerte

Soudal NV **SoudaFrame SWI**		Integral frame | Integralrahmen bo Bottom Unten	to Top Oben	si Side Seitl.	U-value window Fenster-U-Wert Uw [W/(m²K)] @Ug= 0.9 W/(m²K)	Vinyl/Timber | Holz/PVC bo Bottom Unten	to Top Oben	si Side Seitl.	U-value window Fenster-U-Wert Uw [W/(m²K)] @Ug= 0.9 W/(m²K)	Metal | Metall bo Bottom Unten	to Top Oben	si Side Seitl.	U-value window Fenster-U-Wert Uw [W/(m²K)] @Ug= W/(m²K)
Frame width Rahmenbreite	b_f [mm]	100	100	100		125	125	125		140	140	140	
U-value frame Rahmen-U-Wert	**Uf** [W/(m²K)]	1,11	0,99	0,99	**1,00**	0,92	0,92	0,92	**1,00**	0,85	0,85	0,85	**1,00**
Ψ-glass edge Glasrand-Ψ-Wert	**Ψg** [W/(mK)]	0,027	0,027	0,027		0,038	0,038	0,038		0,049	0,049	0,049	
Installation | Einbau													
SoudaFrame SWI 90					Installed				Installed				Installed
Not covered	$Ψ_{install}$ [W/(mK)]	0,043				0,022	0,022	0,022	**1,06**	0,020	0,020	0,020	**1,05**
Partially covered	$Ψ_{install}$ [W/(mK)]						0,013	0,013	**1,04**				
Completely covered	$Ψ_{install}$ [W/(mK)]		-0,013	-0,013	**1,00**		0,003	0,003	**1,02**				
With shading	$Ψ_{install}$ [W/(mK)]						0,019	0,010	**1,04**				
SoudaFrame SWI 130													
Not covered	$Ψ_{install}$ [W/(mK)]	0,020				0,015	0,013	0,013	**1,04**	0,017	0,015	0,015	**1,04**
Partially covered	$Ψ_{install}$ [W/(mK)]						0,011	0,011	**1,03**				
Completely covered	$Ψ_{install}$ [W/(mK)]		-0,003	-0,003	**1,01**		0,007	0,007	**1,03**				
SoudaFrame SWI 160													
Not covered	$Ψ_{install}$ [W/(mK)]												
Partially covered	$Ψ_{install}$ [W/(mK)]												
Completely covered	$Ψ_{install}$ [W/(mK)]												
SoudaFrame SWI 200													
Not covered	$Ψ_{install}$ [W/(mK)]												
Partially covered	$Ψ_{install}$ [W/(mK)]												
Completely covered													
%													
Not covered	$Ψ_{install}$ [W/(mK)]												
Partially covered	$Ψ_{install}$ [W/(mK)]												
Completely covered	$Ψ_{install}$ [W/(mK)]												

Contact person | Ansprechpartner

Soudal NV,
Steven Van Orshaegen

VanOrshaegen@soudal.com

Description

Window mounting system made from GRP (0,19 W/(mK)), system width 90, 130 160, 200 mm. Assembly by way of adhesive and mechanical fixing. Additional thermal losses by reinforcing brackets made from steel determined by 3D heat flux simulation. Losses are to be inlcuded where the load exceeds a certain level, see certification report.

Beschreibung

Fenstermontagesystem aus GFK (0,19 W/(mK)) in den Ausladungen 90, 130, 160 und 200 mm. Befestigung durch Verkleben und Verschraubung. Zusätzliche Wärmeverluste über Verstärkungswinkel aus Stahl wurden über 3D Wärmestromsimulation ermittelt und sind anzusetzen, falls eine bestimmte Last überschritten wird, vgl. Zertifikatebericht.

criteria would be met @ Ug=0,60 W/(m²K)

criteria not met

Calculation I Berechnung

Passivhaus Institut Darmstadt

11.09.2020 kk

Passive House Institute

The thermal losses through the reinforcement steel brackets for higher window loads were determined by 3D-thermal flux simulations performed by the Passive House Institute for all frame variants with the metal frame. The minimum mesh size is 1 mm.

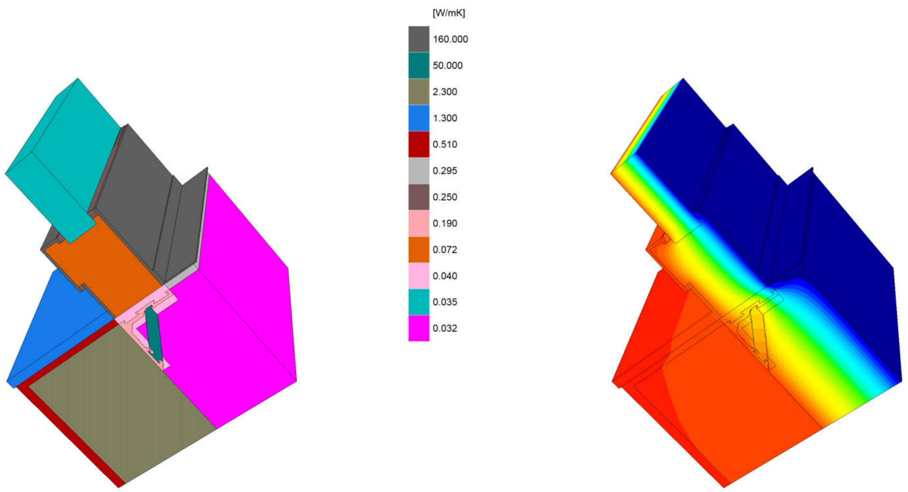
After simulating the thermal flux, the model was calculated again without the bracket to be able to calculate the χ-values, which were determined to 1.25 mW/K for the 90 mm frame and 1.62 mW/K for the 130 mm frame.

The following table shows the additional losses of reinforcement brackets and how many to use at what load.

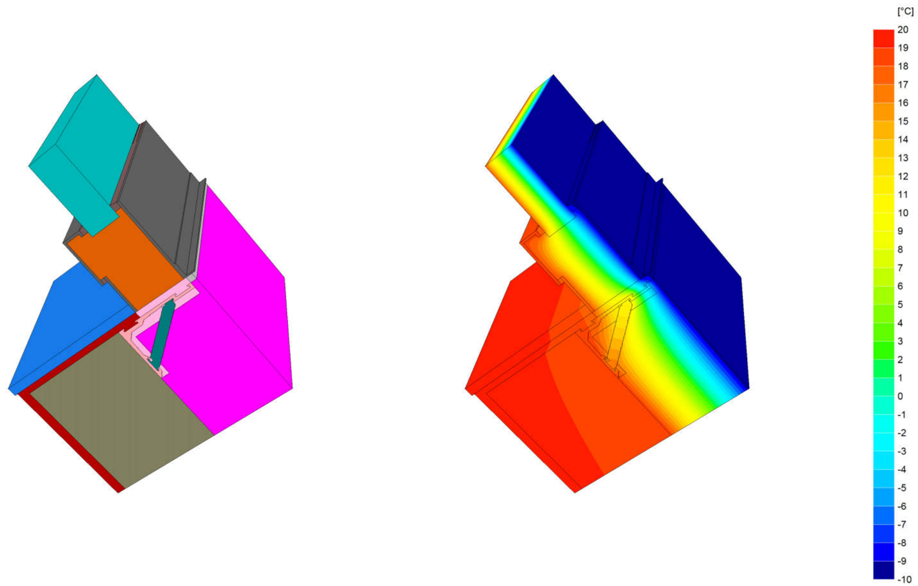
Number of brackets	**0**	**2**	**3**	**4**	**per meter**
SWI 90		1,25			χ [mW/K]
Maximum load	787	-	-	-	kg/m
Additional losses	0				W/(mK)
SWI 130		1,62			χ [mW/K]
Maximum load	222	629	679	729	kg/m
Additional losses	0	0,003	0,005	0,006	W/(mK)

Die Wärmeverluste über die verstärkenden Stahlwinkel für höhere Lasten wurde mittels 3D-Wärmestrom-simulation durch das PHI ermittelt mit dem Aluminiumrahmen ermittelt. Die minimale Maschenweite des Netzes beträgt 1 mm.

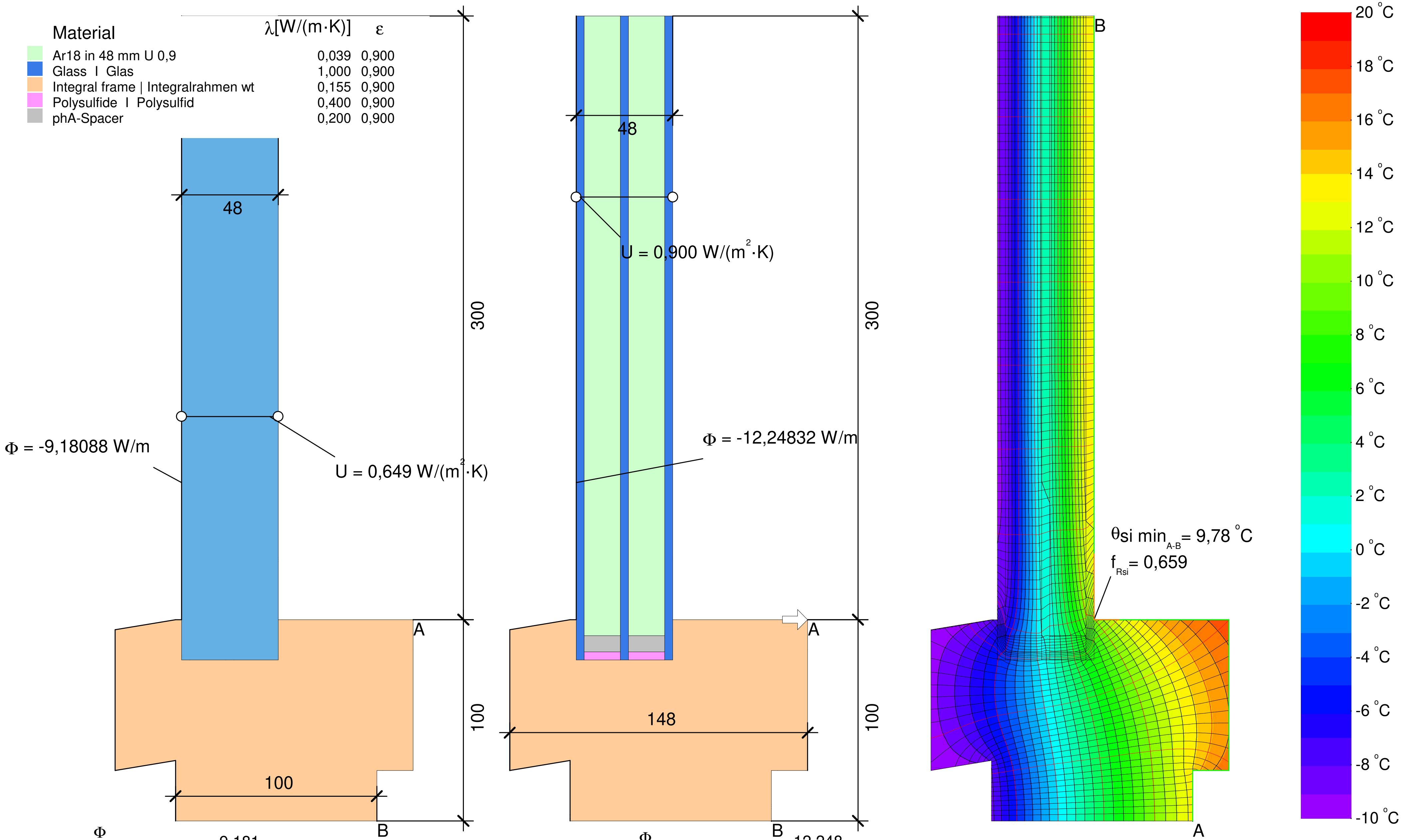
Nach der Wärmestromberechnung wurde die Simulation ohne Stahlwinkel wiederholt um den χ-Wert zu bestimmen, der für den 90 mm Rahmen 1,25 mW/K beträgt. Für den 130 mm Rahmen wurden 1.62 mW/K ermittelt.



SoudaFrame SWI 90



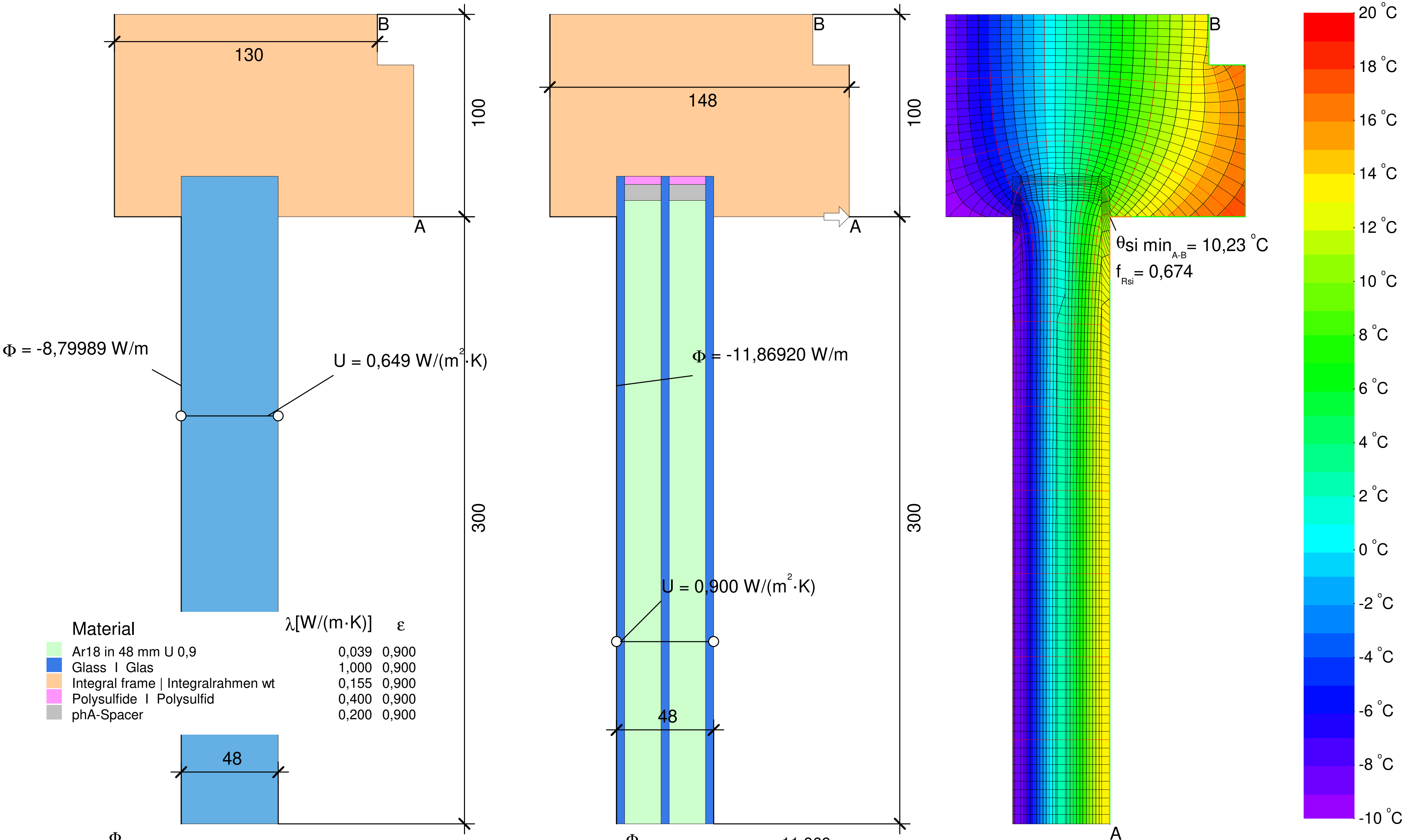
SoudaFrame SWI 130



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{9,181}{30,000} - 0,649 \cdot 0,300}{0,100} = 1,114 \text{ W/(m}^2\cdot\text{K)}$$

$$\Psi_{ed\,A} = \frac{\Phi}{\Delta T} - U_g \cdot b_g - U_f \cdot b_f = \frac{12,248}{30,000} - 0,900 \cdot 0,300 - 1,114 \cdot 0,100 = 0,027 \text{ W/(m}\cdot\text{K)}$$

Integral frame, e.g. vinyl or timber | Integralrahmen, z.B. Kunststoff oder Holz

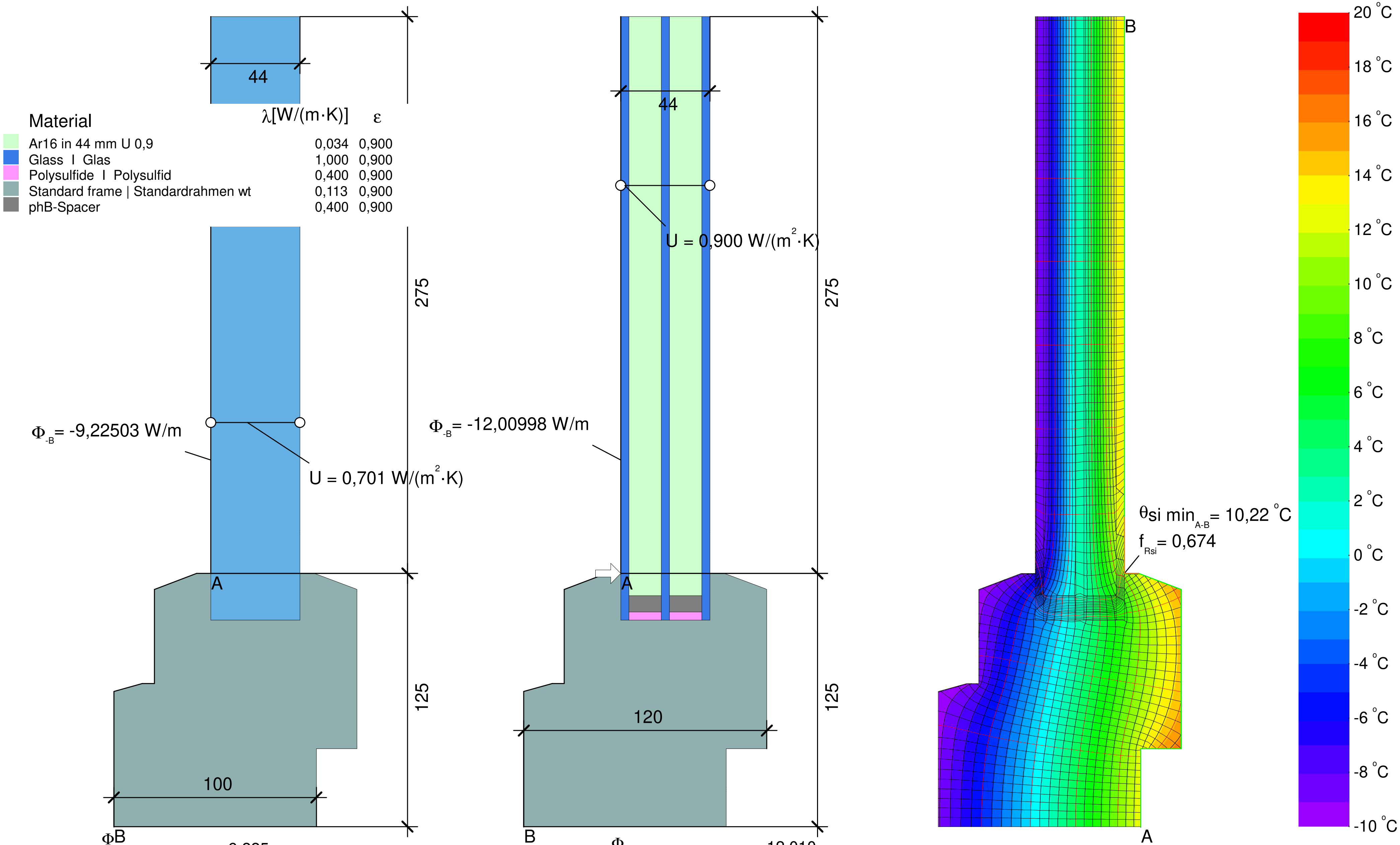


Material	λ[W/(m·K)]	ε
Ar18 in 48 mm U 0,9	0,039	0,900
Glass I Glas	1,000	0,900
Integral frame | Integralrahmen wt	0,155	0,900
Polysulfide I Polysulfid	0,400	0,900
phA-Spacer	0,200	0,900

$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{8{,}800}{30{,}000} - 0{,}649 \cdot 0{,}300}{0{,}100} = 0{,}987\ \mathrm{W/(m^2 \cdot K)}$$

$$\Psi_{ed\,A} = \frac{\Phi}{\Delta T} - U_g \cdot b_g - U_f \cdot b_f = \frac{11{,}869}{30{,}000} - 0{,}900 \cdot 0{,}300 - 0{,}987 \cdot 0{,}100 = 0{,}027\ \mathrm{W/(m \cdot K)}$$

Integral frame, e.g. vinyl or timber | Integralrahmen, z.B. Kunststoff oder Holz

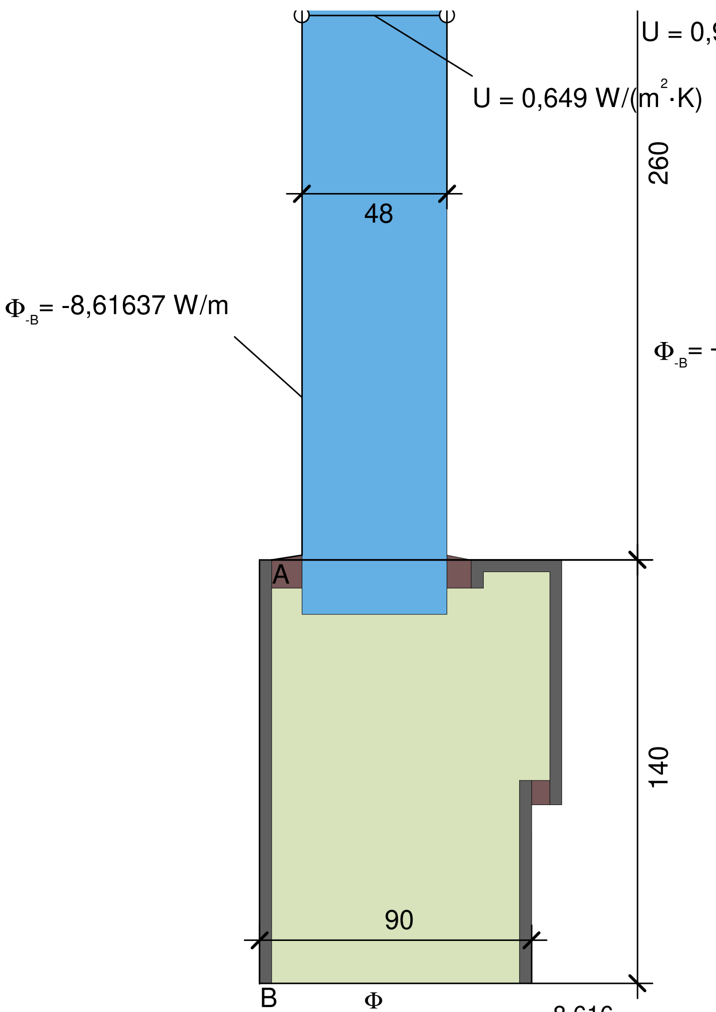


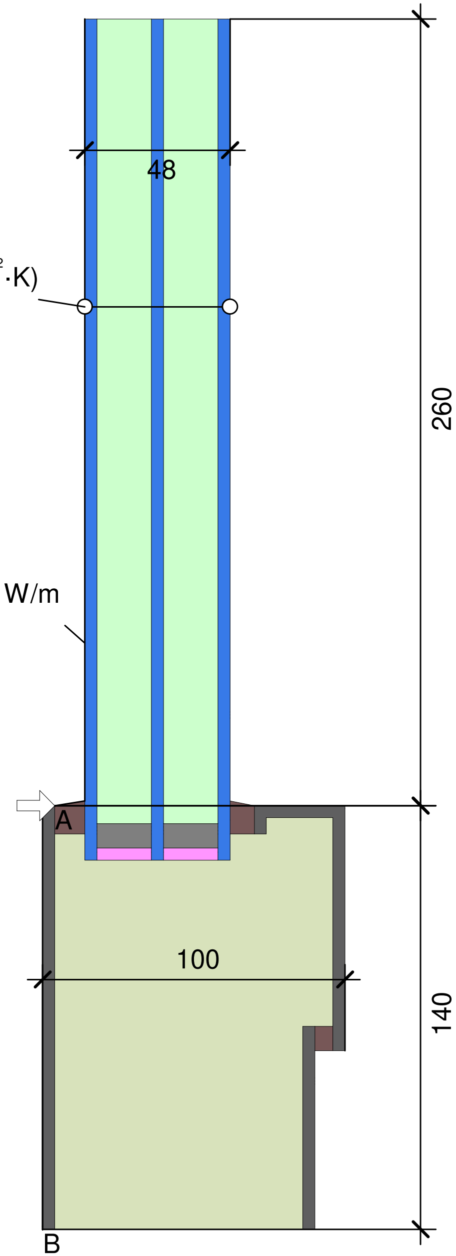
$$U_{f\,A,B} = \frac{\frac{\Phi B}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{9,225}{30,000} - 0,701 \cdot 0,275}{0,125} = 0,918\ \mathrm{W/(m^2 \cdot K)}$$

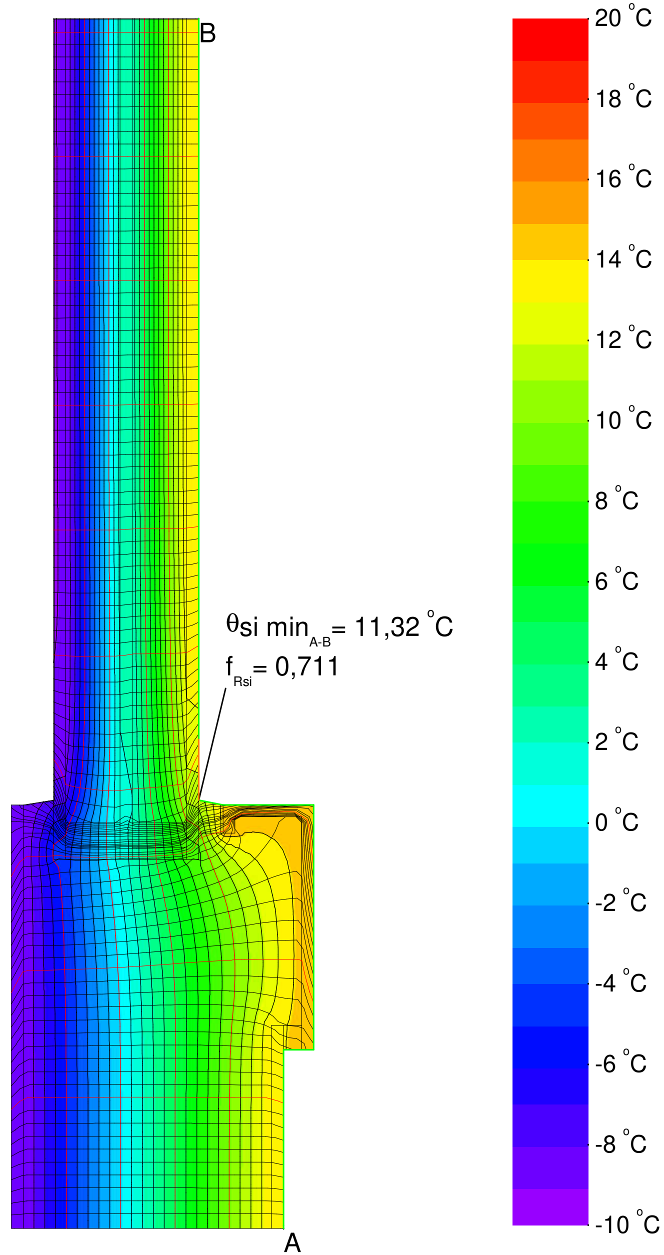
$$\psi_{ed\,A} = \frac{\Phi}{\Delta T} - U_g \cdot b_g - U_f \cdot b_f = \frac{12,010}{30,000} - 0,900 \cdot 0,275 - 0,918 \cdot 0,125 = 0,038\ \mathrm{W/(m \cdot K)}$$

Standard frame, e.g. vinyl or timber | Standardrahmen, z.B. Kunststoff oder Holz

Material	λ[W/(m·K)]	ε
Aluminum I Aluminium 10456	160,000	0,900
Ar18 in 48 mm U 0,9	0,039	0,900
EPDM	0,250	0,900
Filling aluminium frame | Füllung Alurahmen wt	0,084	0,900
Glass I Glas	1,000	0,900
Polysulfide I Polysulfid	0,400	0,900
phB-Spacer	0,400	0,900



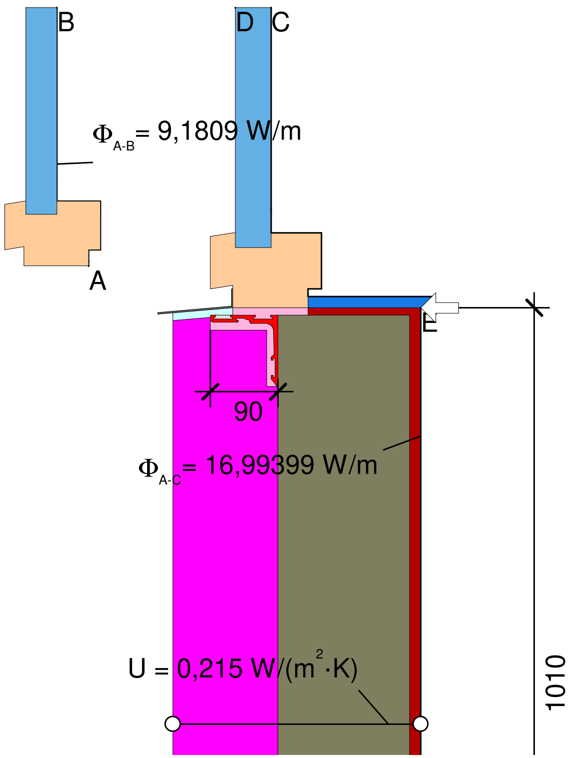


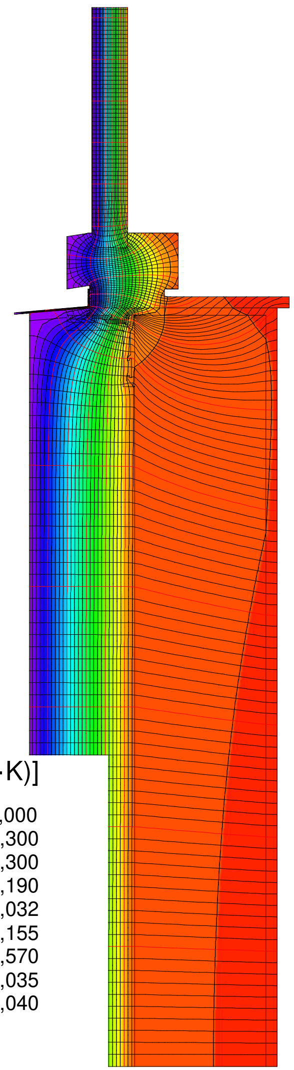


$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{8{,}616}{30{,}000} - 0{,}649 \cdot 0{,}260}{0{,}140} = 0{,}847 \text{ W/(m}^2\cdot\text{K)}$$

$$\Psi_{ed\,A} = \frac{\Phi}{\Delta T} - U_g \cdot b_g - U_f \cdot b_f = \frac{12{,}038}{30{,}000} - 0{,}900 \cdot 0{,}260 - 0{,}847 \cdot 0{,}140 = 0{,}049 \text{ W/(m}\cdot\text{K)}$$

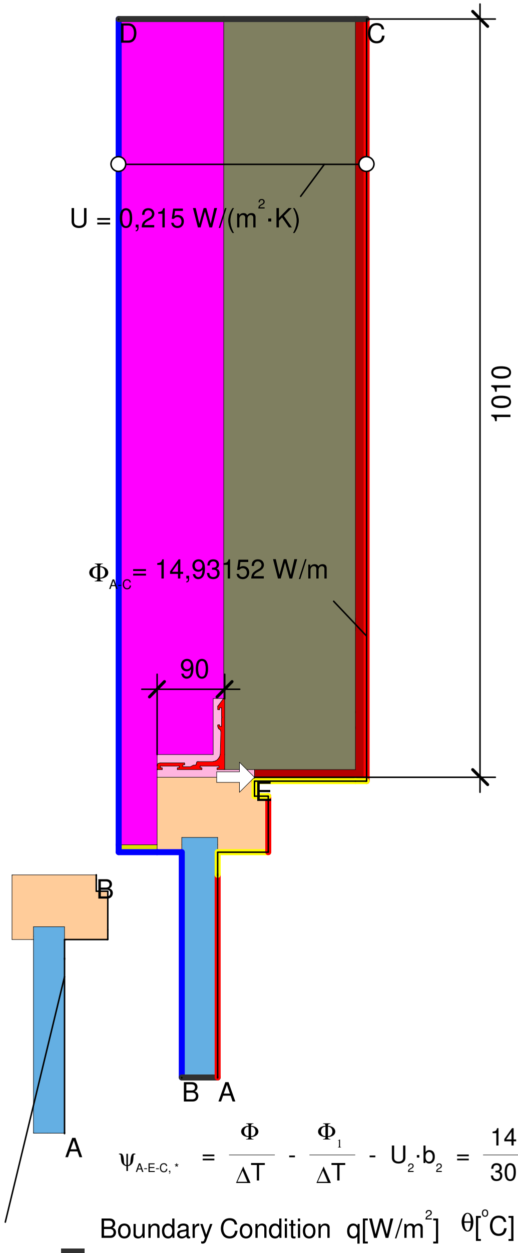
Aluminium frame | Aluminium Rahmen

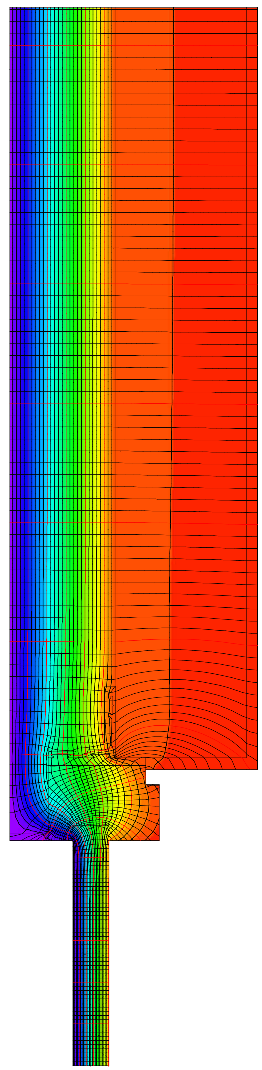


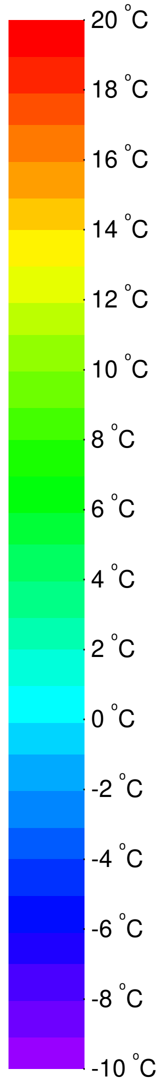


Material	λ[W/(m·K)]
Aluminum I Aluminium 10456	160,000
Artificial stone I Kunststein 10456	1,300
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300
GRP Polyesterbased 0.19	0,190
Insulation Wärmedämmung 032	0,032
Integral frame | Integralrahmen wt	0,155
Interior plaster I Gipsputz 10456	0,570
Panel I Maske	0,035
Soudal Flexifoam	0,040
Unvent. cavity I unbel. Hohlr. *	
slightly vent. cav. I leicht bel. Hohlr. *	

* EN ISO 10077-2:2017, 6.4.3







$$\psi_{A\text{-}E\text{-}C,\cdot} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{14{,}932}{30{,}000} - \frac{8{,}800}{30{,}000} - 0{,}215 \cdot 1{,}010 = -0{,}013 \text{ W/(m·K)}$$

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε	φ[%]
Adiabatic | Adiabat	0,000				
Exterior | Außen		-10,000	0,040		
Interior, frame, normal		20,000	0,130		
Interior, frame, reduced		20,000	0,200		

$$\psi_{A\text{-}E\text{-}C,\cdot} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{16{,}994}{30{,}000} - 0{,}215 \cdot 1{,}010 - \frac{9{,}181}{30{,}000} = 0{,}043 \text{ W/(m·K)}$$

SoudaFrame SWI 90

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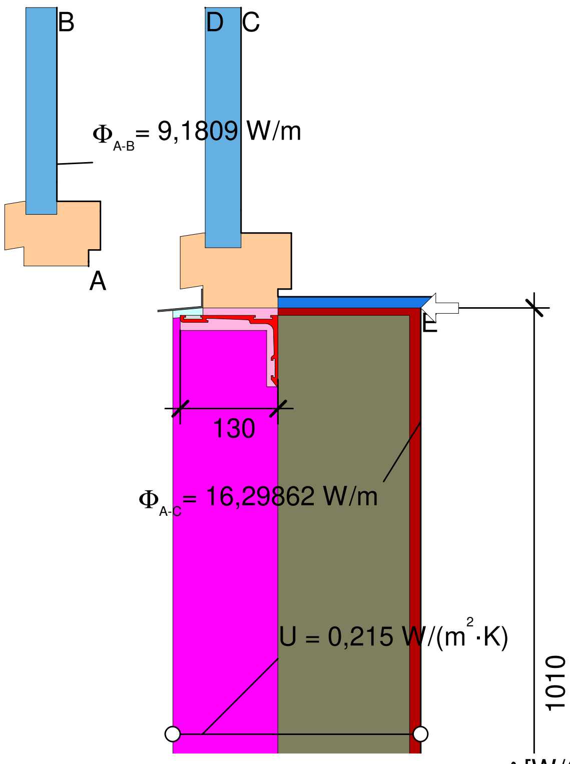
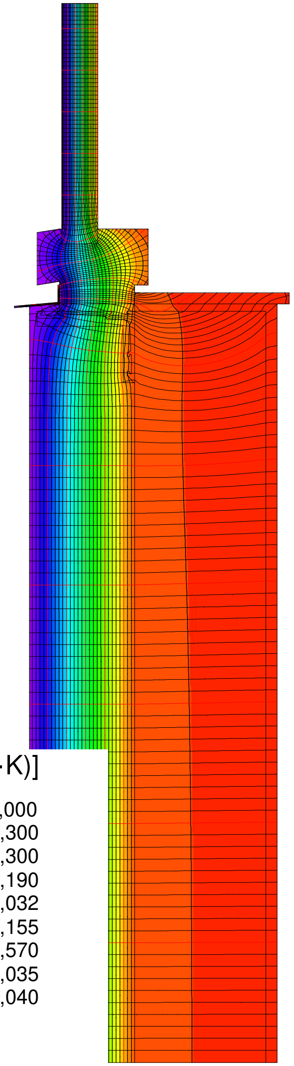
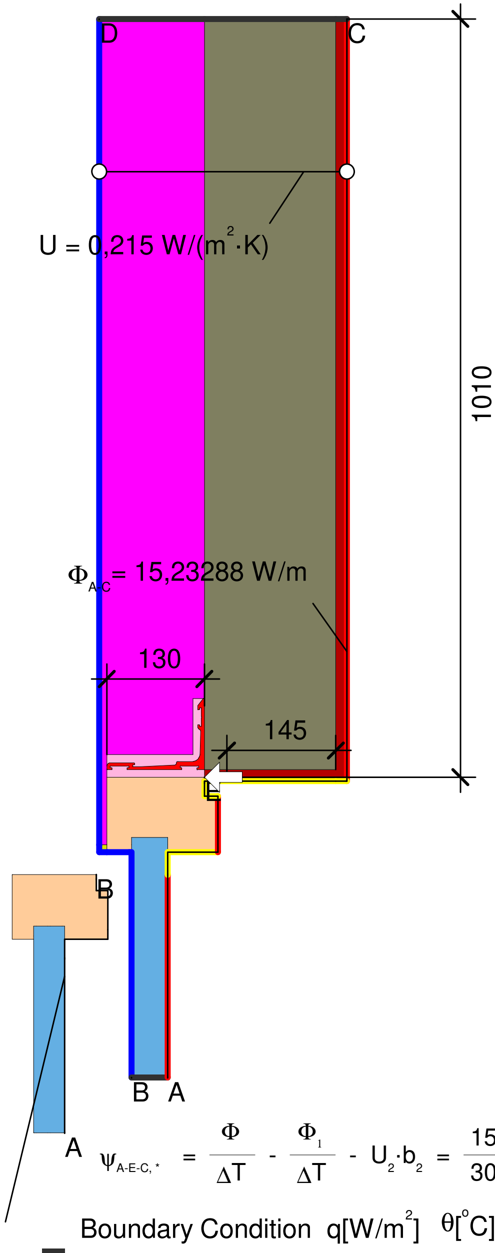
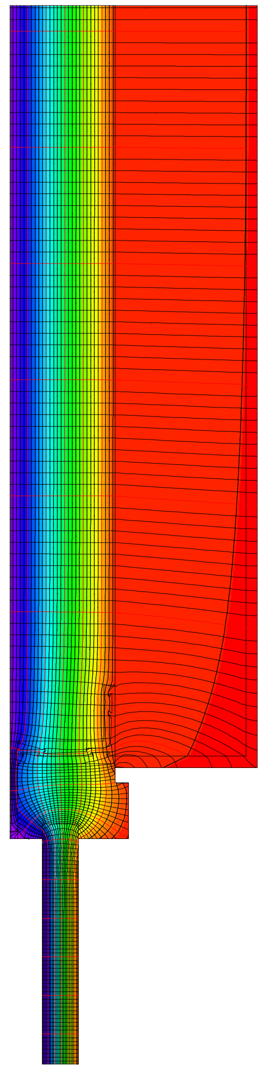


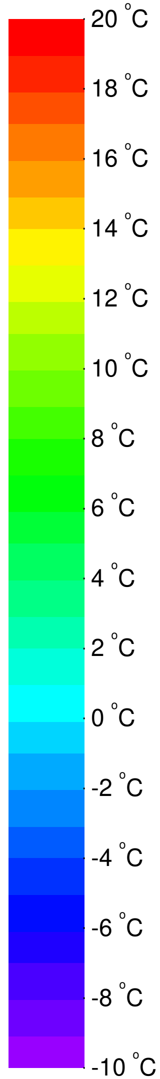


Material	λ[W/(m·K)]
Aluminum I Aluminium 10456	160,000
Artificial stone I Kunststein 10456	1,300
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300
GRP Polyesterbased 0.19	0,190
Insulation Wärmedämmung 032	0,032
Integral frame | Integralrahmen wt	0,155
Interior plaster I Gipsputz 10456	0,570
Panel I Maske	0,035
Soudal Flexifoam	0,040
Unvent. cavity I unbel. Hohlr. *	
slightly vent. cav. I leicht bel. Hohlr. *	

* EN ISO 10077-2:2017, 6.4.3





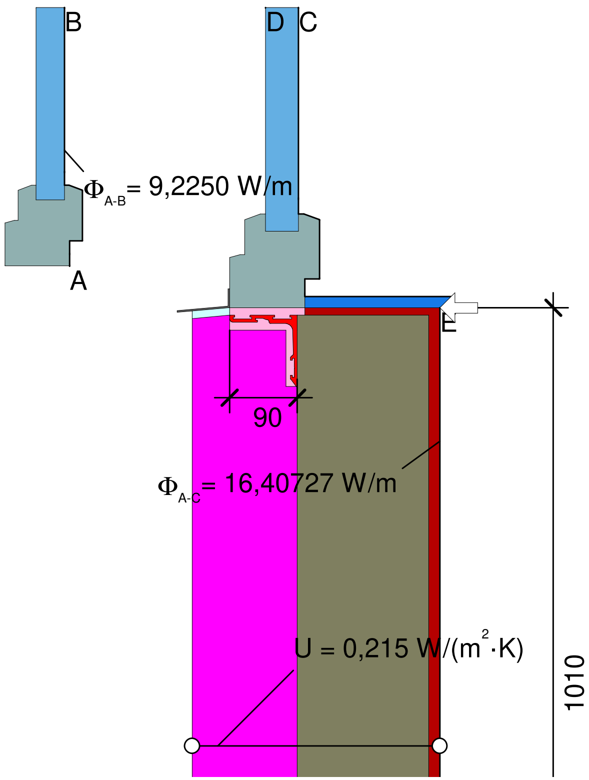


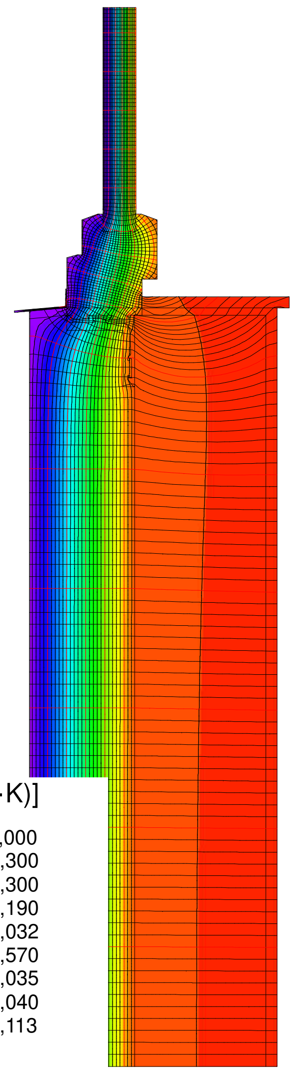
$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{15{,}233}{30{,}000} - \frac{8{,}800}{30{,}000} - 0{,}215 \cdot 1{,}010 = -0{,}003\ \text{W/(m·K)}$$

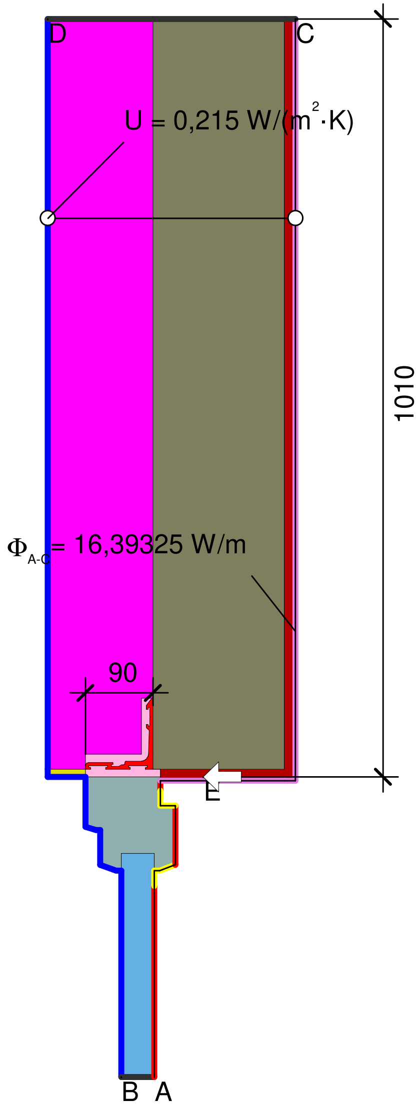
Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic | Adiabat	0,000			
Exterior | Außen		-10,000	0,040	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	

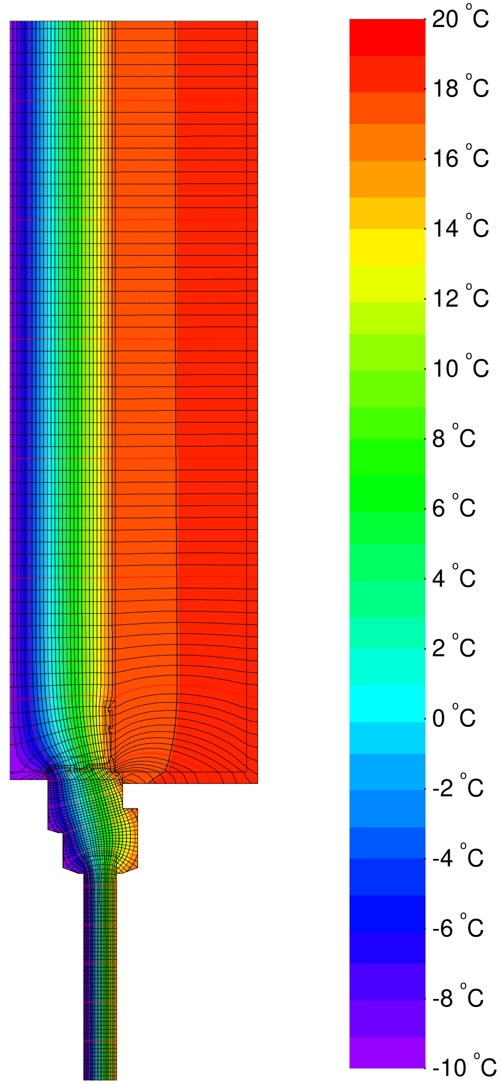
$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{16{,}299}{30{,}000} - 0{,}215 \cdot 1{,}010 - \frac{9{,}181}{30{,}000} = 0{,}020\ \text{W/(m·K)}$$

SoudaFrame SWI 130









Material	λ[W/(m·K)]
Aluminum I Aluminium 10456	160,000
Artificial stone I Kunststein 10456	1,300
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300
GRP Polyesterbased 0.19	0,190
Insulation Wärmedämmung 032	0,032
Interior plaster I Gipsputz 10456	0,570
Panel I Maske	0,035
Soudal Flexifoam	0,040
Standard frame | Standardrahmen wt	0,113
slightly vent. cav. I leicht bel. Hohlr. *	

* EN ISO 10077-2:2017, 6.4.3

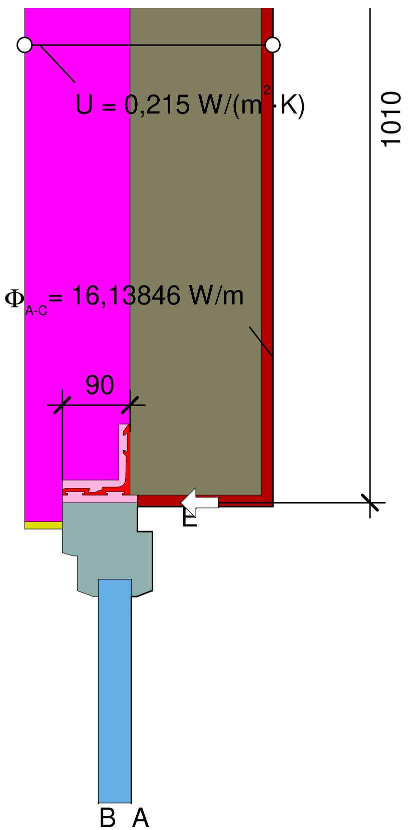
$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{16,393}{30,000} - \frac{9,225}{30,000} - 0,215 \cdot 1,010 = 0,022\ \text{W/(m·K)}$$

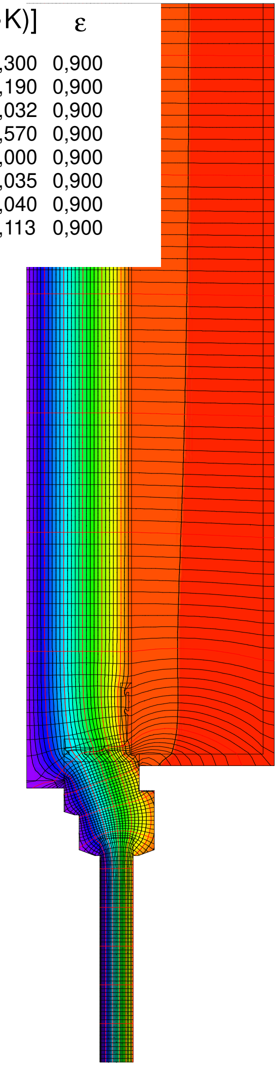
$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{16,407}{30,000} - 0,215 \cdot 1,010 - \frac{9,225}{30,000} = 0,022\ \text{W/(m·K)}$$

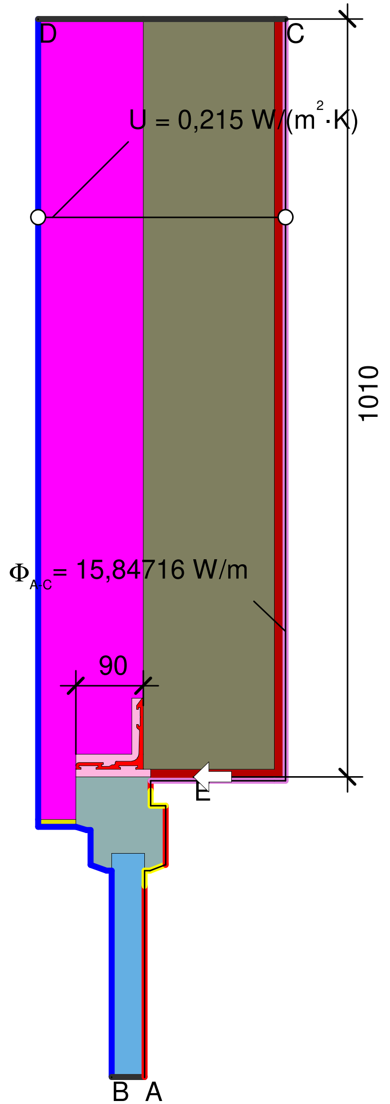
Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic | Adiabat	0,000			
Exterior | Außen		-10,000	0,040	
Interior | Innen		20,000	0,130	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	

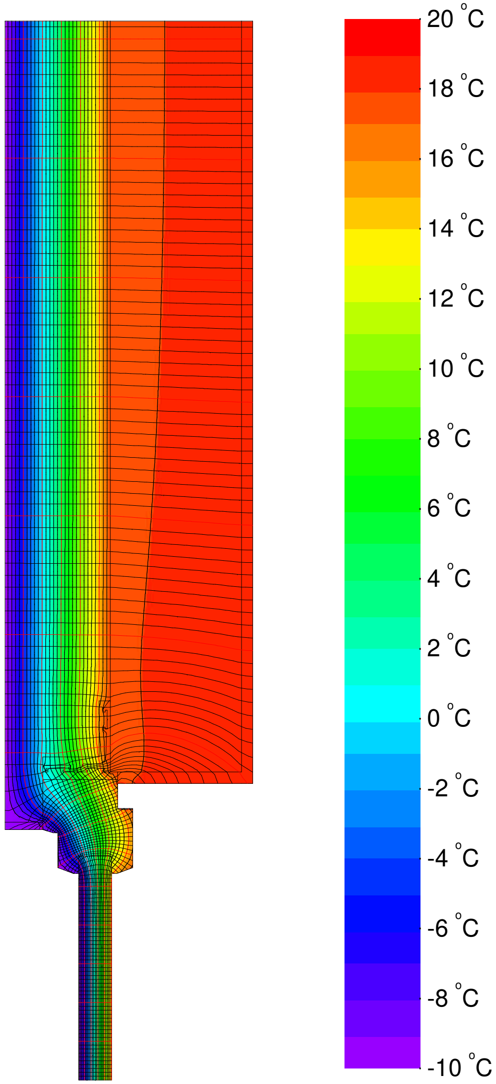
SoudaFrame SWI 90

Material	λ[W/(m·K)]	ε
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300	0,900
GRP Polyesterbased 0.19	0,190	0,900
Insulation Wärmedämmung 032	0,032	0,900
Interior plaster I Gipsputz 10456	0,570	0,900
Mörtel, Zement, Sand	1,000	0,900
Panel I Maske	0,035	0,900
Soudal Flexifoam	0,040	0,900
Standard frame | Standardrahmen wt	0,113	0,900



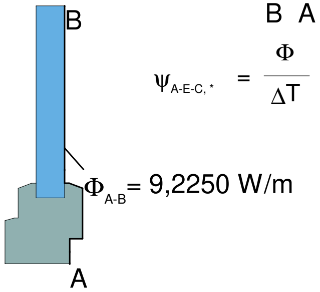






$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{16{,}138}{30{,}000} - \frac{9{,}225}{30{,}000} - 0{,}215 \cdot 1{,}010 = 0{,}013 \text{ W/(m·K)}$$

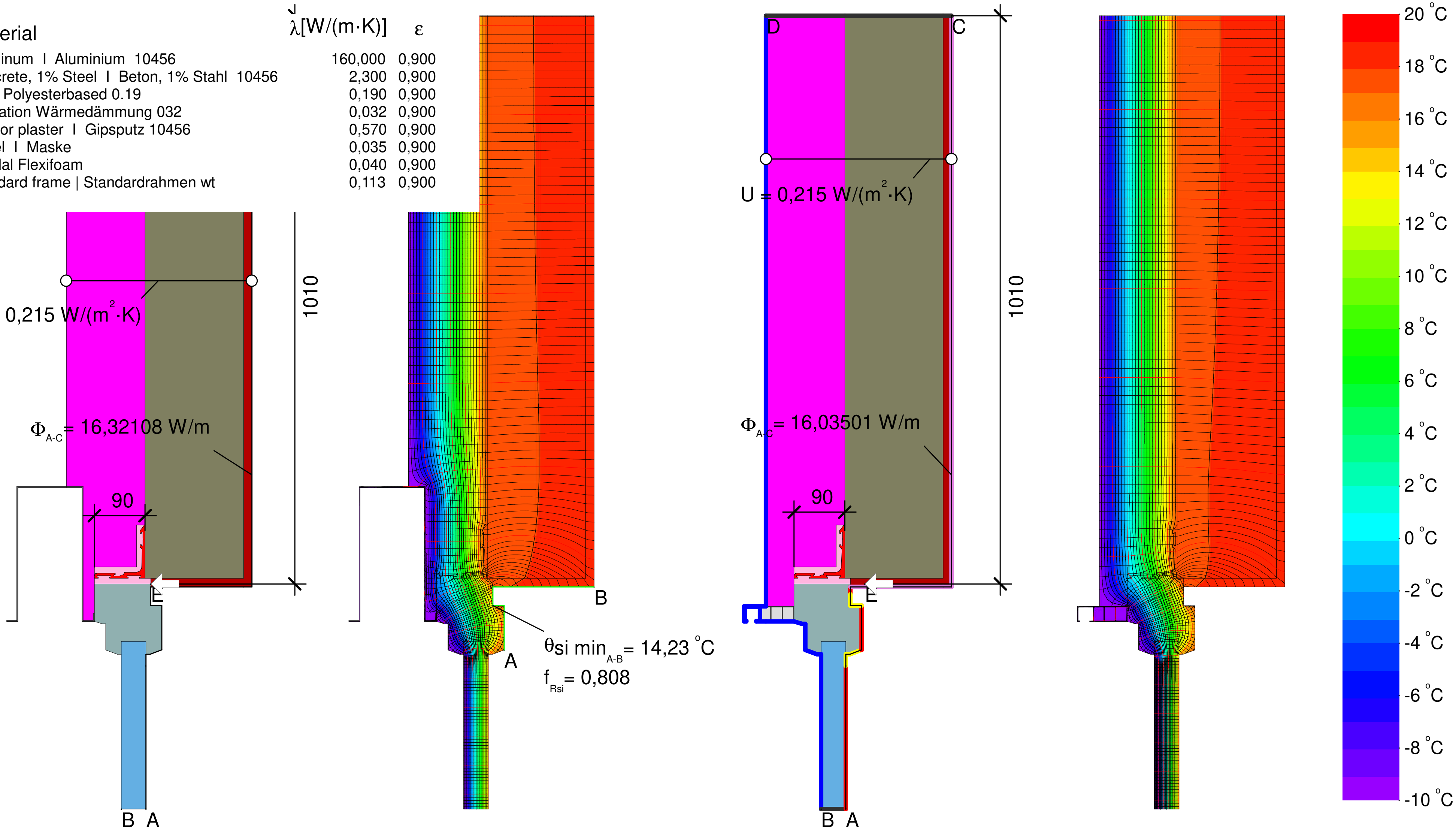
$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{15{,}847}{30{,}000} - \frac{9{,}225}{30{,}000} - 0{,}215 \cdot 1{,}010 = 0{,}003 \text{ W/(m·K)}$$



SoudaFrame SWI 90

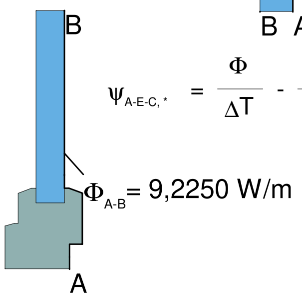
Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic | Adiabat	0,000			
Exterior | Außen		-10,000	0,040	
Interior | Innen		20,000	0,130	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	

Material	λ[W/(m·K)]	ε
Aluminum I Aluminium 10456	160,000	0,900
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300	0,900
GRP Polyesterbased 0.19	0,190	0,900
Insulation Wärmedämmung 032	0,032	0,900
Interior plaster I Gipsputz 10456	0,570	0,900
Panel I Maske	0,035	0,900
Soudal Flexifoam	0,040	0,900
Standard frame | Standardrahmen wt	0,113	0,900



$$\psi_{A\text{-}E\text{-}C,\cdot} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{16,321}{30,000} - \frac{9,225}{30,000} - 0,215 \cdot 1,010 = 0,019\ W/(m \cdot K)$$

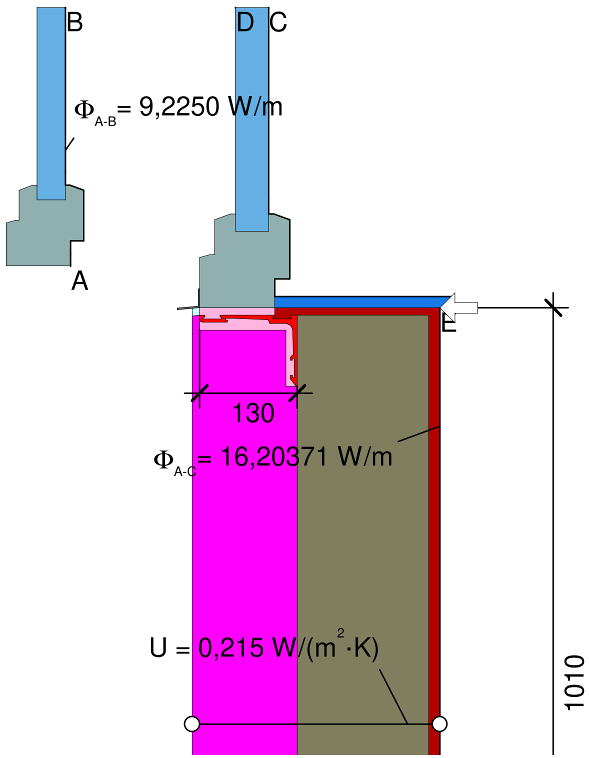
$$\psi_{A\text{-}E\text{-}C,\cdot} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{16,035}{30,000} - \frac{9,225}{30,000} - 0,215 \cdot 1,010 = 0,010\ W/(m \cdot K)$$

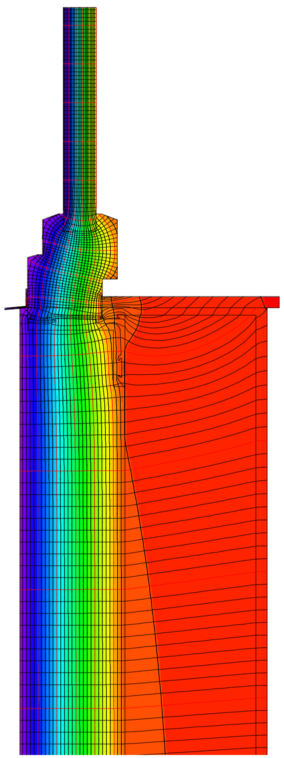


SoudaFrame SWI 90

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic | Adiabat	0,000			
Exterior | Außen		-10,000	0,040	
Interior | 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

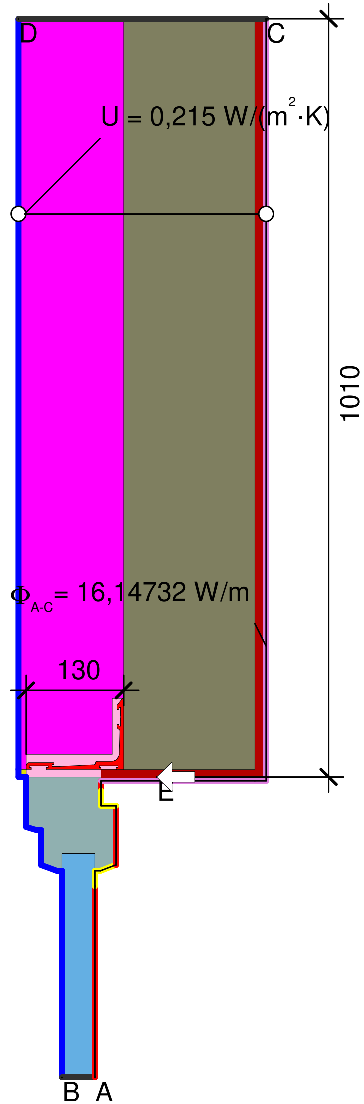
Passive House Institute

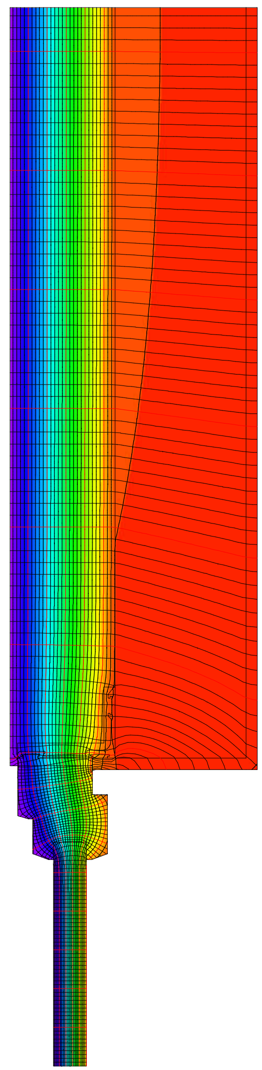


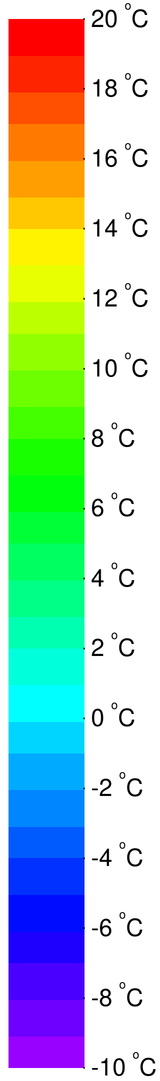


Material	λ[W/(m·K)]	ε	δ[mg/(m·h·Pa)]
Aluminum I Aluminium 10456	160,000	0,900	6,400e-9
Artificial stone I Kunststein 10456	1,300	0,900	0,014
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300	0,900	0,006
GRP Polyesterbased 0.19	0,190	0,900	1,000
Insulation Wärmedämmung 032	0,032	0,900	0,640
Interior plaster I Gipsputz 10456	0,570	0,900	0,080
Panel I Maske	0,035	0,900	
Soudal Flexifoam	0,040	0,900	0,010
Standard frame | Standardrahmen wt	0,113	0,900	0,640
slightly vent. cav. I leicht bel. Hohlr. *			0,640

* EN ISO 10077-2:2017, 6.4.3







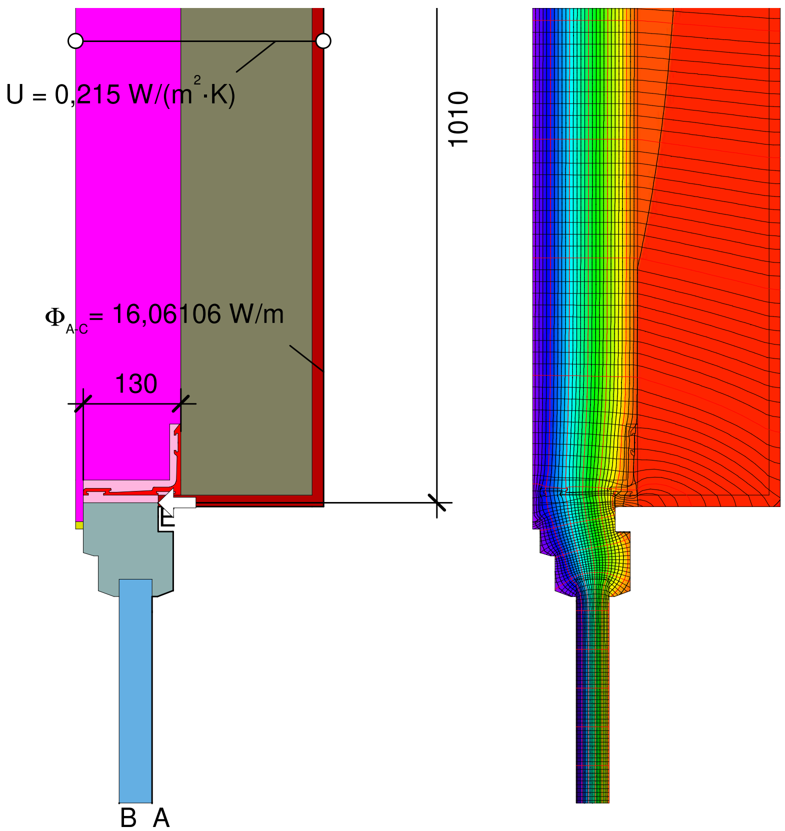
$$\Psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{16,147}{30,000} - \frac{9,225}{30,000} - 0,215 \cdot 1,010 = 0,013\ W/(m \cdot K)$$

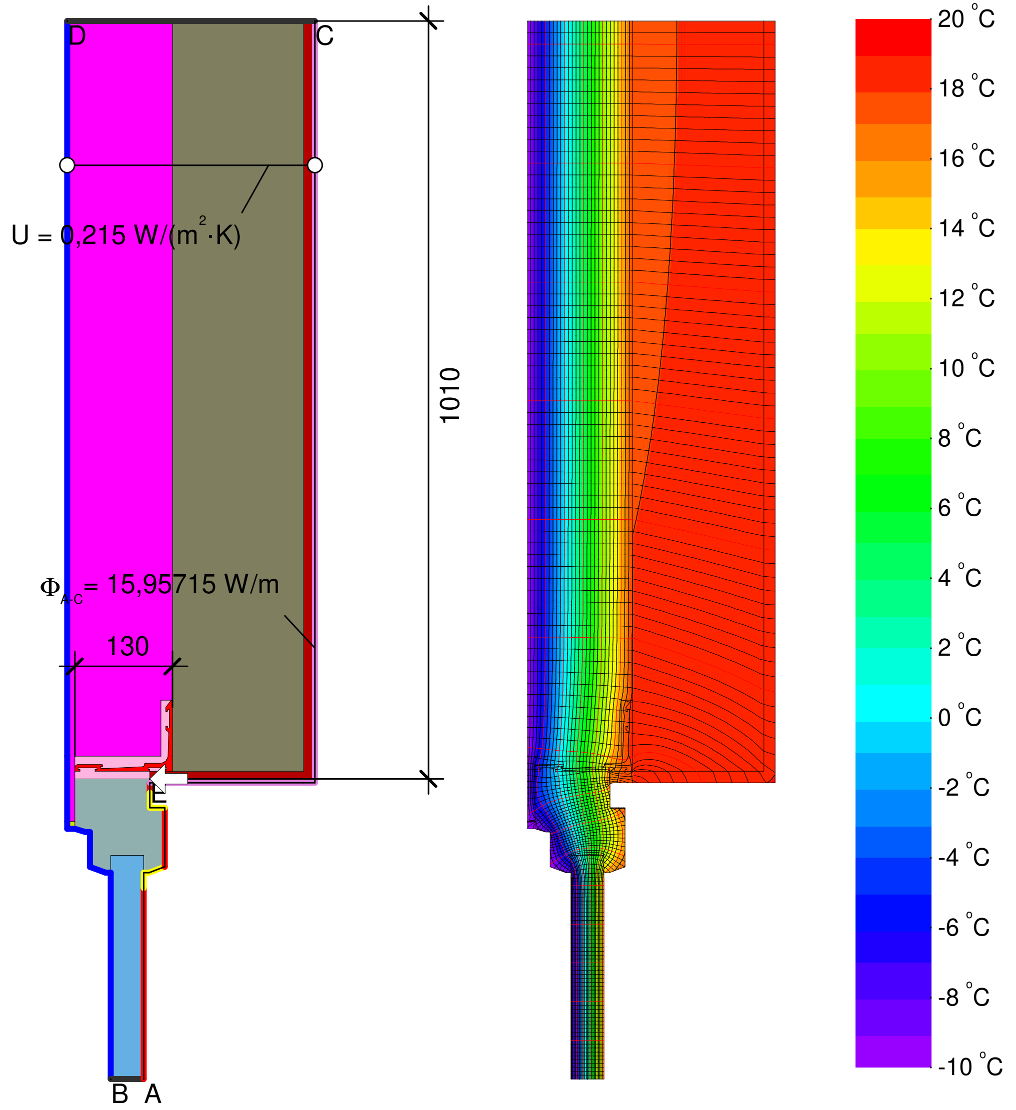
$$\Psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{16,204}{30,000} - 0,215 \cdot 1,010 - \frac{9,225}{30,000} = 0,015\ W/(m \cdot K)$$

Boundary Condition	q[W/m^2]	θ[°C]	R[(m^2·K)/W]	ε	φ[%]
Adiabatic | Adiabat	0,000				
Exterior | Außen		-10,000	0,040		
Interior | Innen		20,000	0,130		
Interior, frame, normal		20,000	0,130		
Interior, frame, reduced		20,000	0,200		

SoudaFrame SWI 130

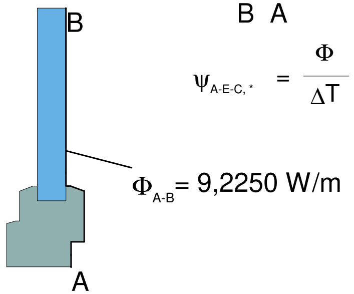
Material	λ[W/(m·K)]	ε	δ[mg/(m·h·Pa)]
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300	0,900	0,006
GRP Polyesterbased 0.19	0,190	0,900	1,000
Insulation Wärmedämmung 032	0,032	0,900	0,640
Interior plaster I Gipsputz 10456	0,570	0,900	0,080
Mörtel, Zement, Sand	1,000	0,900	0,080
Panel I Maske	0,035	0,900	
Soudal Flexifoam	0,040	0,900	0,010
Standard frame | Standardrahmen wt	0,113	0,900	0,640





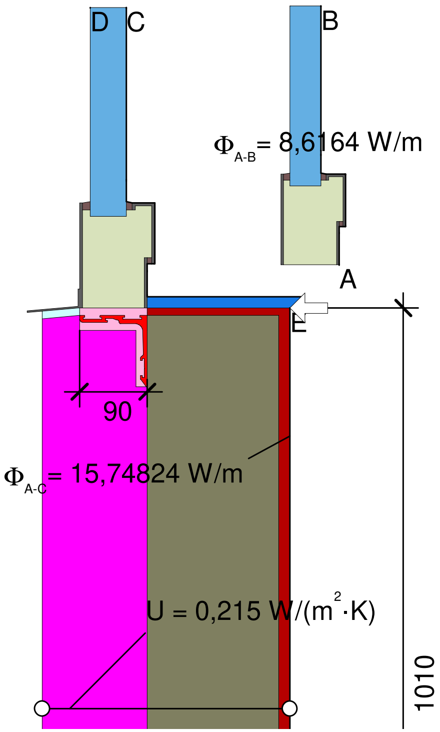
$$\psi_{A\text{-}E\text{-}C,\cdot} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{16{,}061}{30{,}000} - \frac{9{,}225}{30{,}000} - 0{,}215 \cdot 1{,}010 = 0{,}011 \text{ W/(m·K)}$$

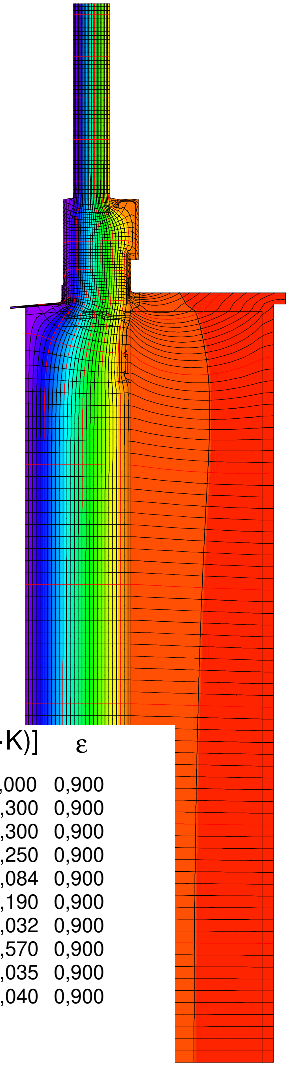
$$\psi_{A\text{-}E\text{-}C,\cdot} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{15{,}957}{30{,}000} - \frac{9{,}225}{30{,}000} - 0{,}215 \cdot 1{,}010 = 0{,}007 \text{ W/(m·K)}$$

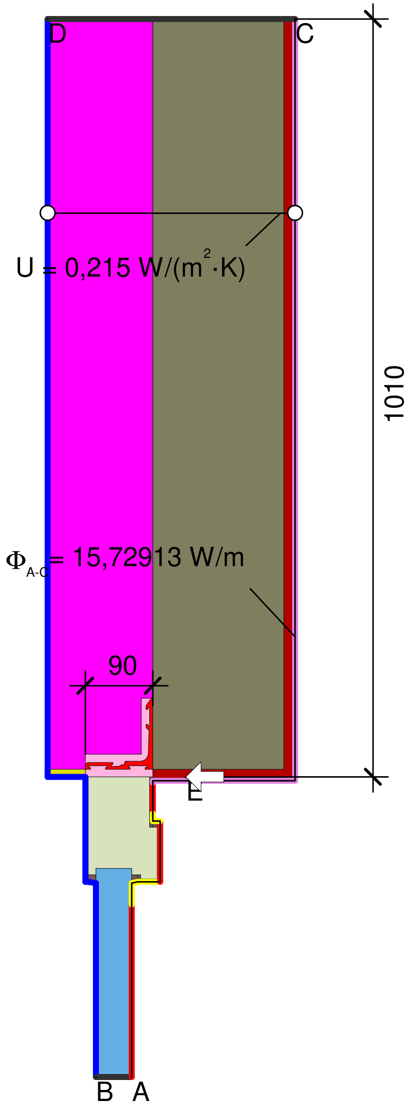


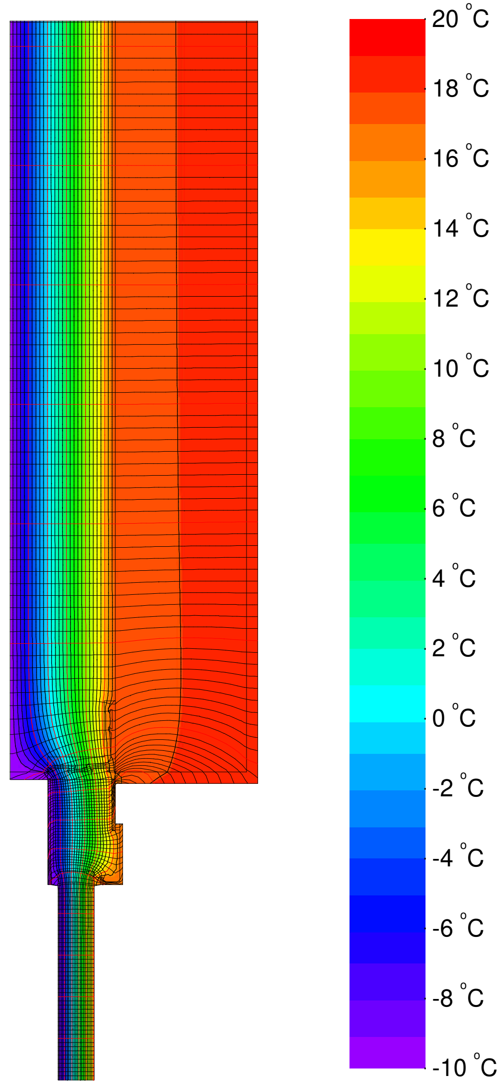
Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε	φ[%]
Adiabatic | Adiabat	0,000				
Exterior | Außen		-10,000	0,040		
Interior | Innen		20,000	0,130		
Interior, frame, normal		20,000	0,130		
Interior, frame, reduced		20,000	0,200		

SoudaFrame SWI 130









Material	λ[W/(m·K)]	ε
Aluminum I Aluminium 10456	160,000	0,900
Artificial stone I Kunststein 10456	1,300	0,900
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300	0,900
EPDM	0,250	0,900
Filling aluminium frame | Füllung Alurahmen wt	0,084	0,900
GRP Polyesterbased 0.19	0,190	0,900
Insulation Wärmedämmung 032	0,032	0,900
Interior plaster I Gipsputz 10456	0,570	0,900
Panel I Maske	0,035	0,900
Soudal Flexifoam	0,040	0,900
slightly vent. cav. I leicht bel. Hohlr. *		

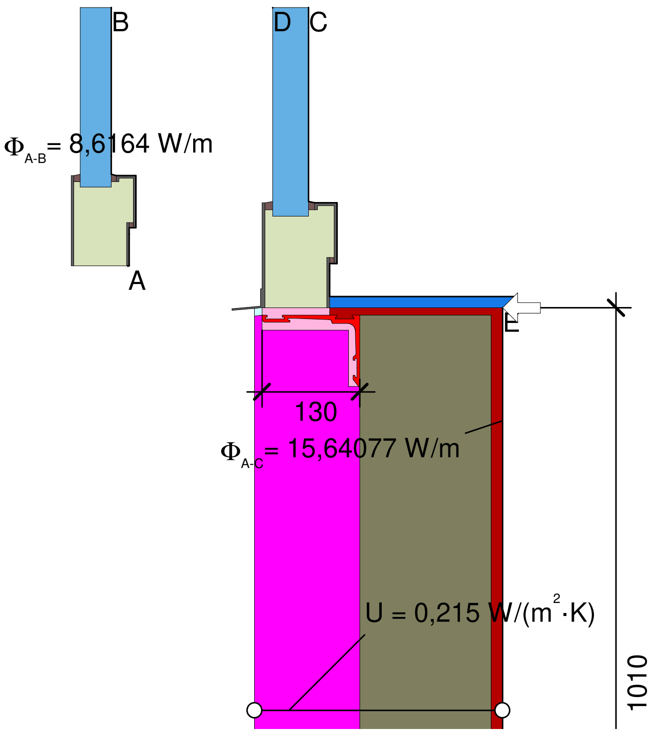
* EN ISO 10077-2:2017, 6.4.3

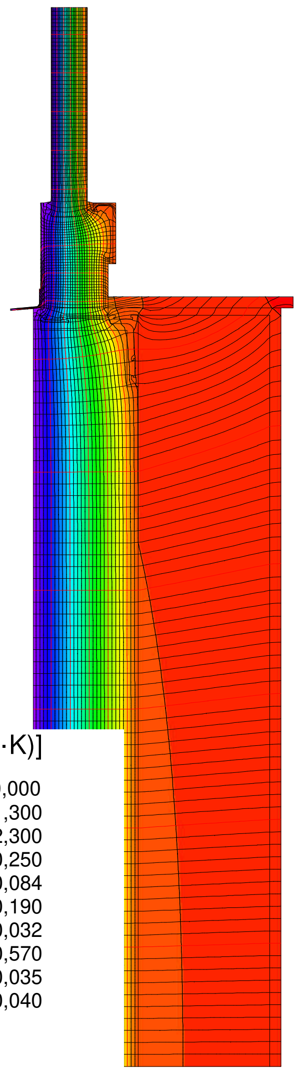
$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{15,729}{30,000} - \frac{8,616}{30,000} - 0,215 \cdot 1,010 = 0,020 \text{ W/(m·K)}$$

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic | Adiabat	0,000			
Exterior | Außen		-10,000	0,040	
Interior | Innen		20,000	0,130	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	

$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{15,748}{30,000} - 0,215 \cdot 1,010 - \frac{8,616}{30,000} = 0,020 \text{ W/(m·K)}$$

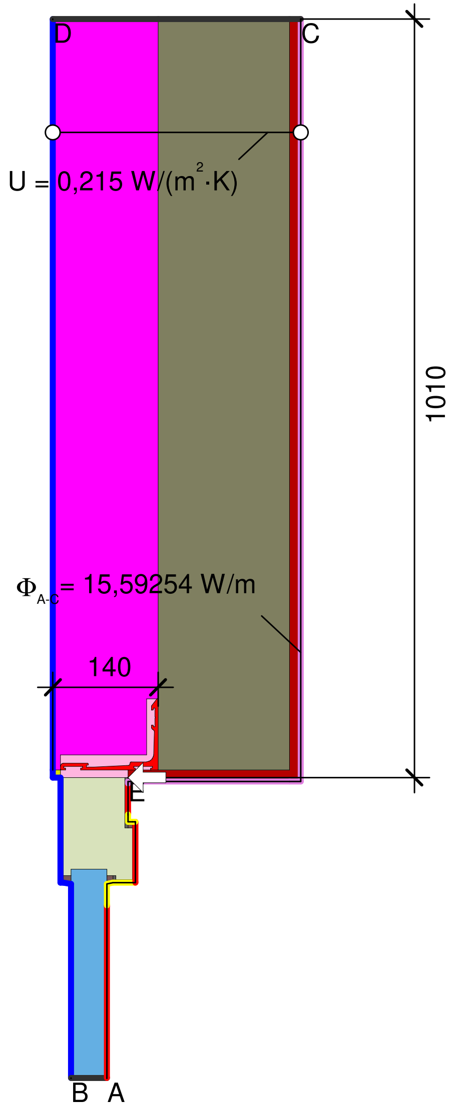
SoudaFrame SWI 90

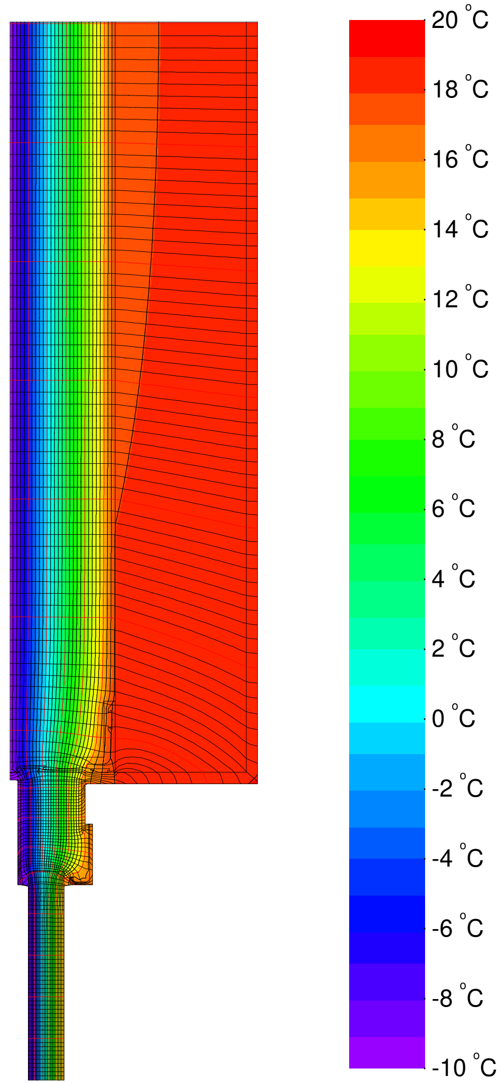




Material	λ[W/(m·K)]
Aluminum I Aluminium 10456	160,000
Artificial stone I Kunststein 10456	1,300
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300
EPDM	0,250
Filling aluminium frame | Füllung Alurahmen wt	0,084
GRP Polyesterbased 0.19	0,190
Insulation Wärmedämmung 032	0,032
Interior plaster I Gipsputz 10456	0,570
Panel I Maske	0,035
Soudal Flexifoam	0,040
slightly vent. cav. I leicht bel. Hohlr. *	

* EN ISO 10077-2:2017, 6.4.3





$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{15,593}{30,000} - \frac{8,616}{30,000} - 0,215 \cdot 1,010 = 0,015\ W/(m \cdot K)$$

$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{15,641}{30,000} - 0,215 \cdot 1,010 - \frac{8,616}{30,000} = 0,017\ W/(m \cdot K)$$

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε	φ[%]
Adiabatic | Adiabat	0,000				
Exterior | Außen		-10,000	0,040		
Interior | Innen		20,000	0,130		
Interior, frame, normal		20,000	0,130		
Interior, frame, reduced		20,000	0,200		

SoudaFrame SWI 130