



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

Passive House Institute

Recommended for | Empfohlen für
cool, temperate climate | kühl-gemäßigtes Klima



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Product | Produkt:

Client | Auftraggeber:

Date | Datum:

Author | Autor:

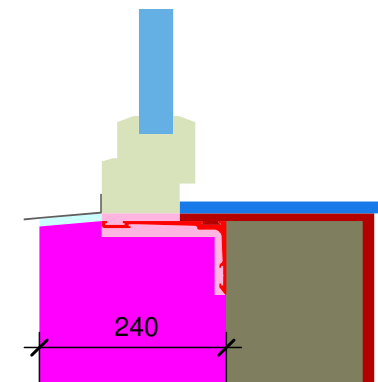
SoudaFrame SWI
240 mm insulation
Soudal NV

10.09.2020

Prof. Dr.-Ing. Benjamin Krick

Window Mounting System Fenstermontagesystem

1532pm03



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 draughts. 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).

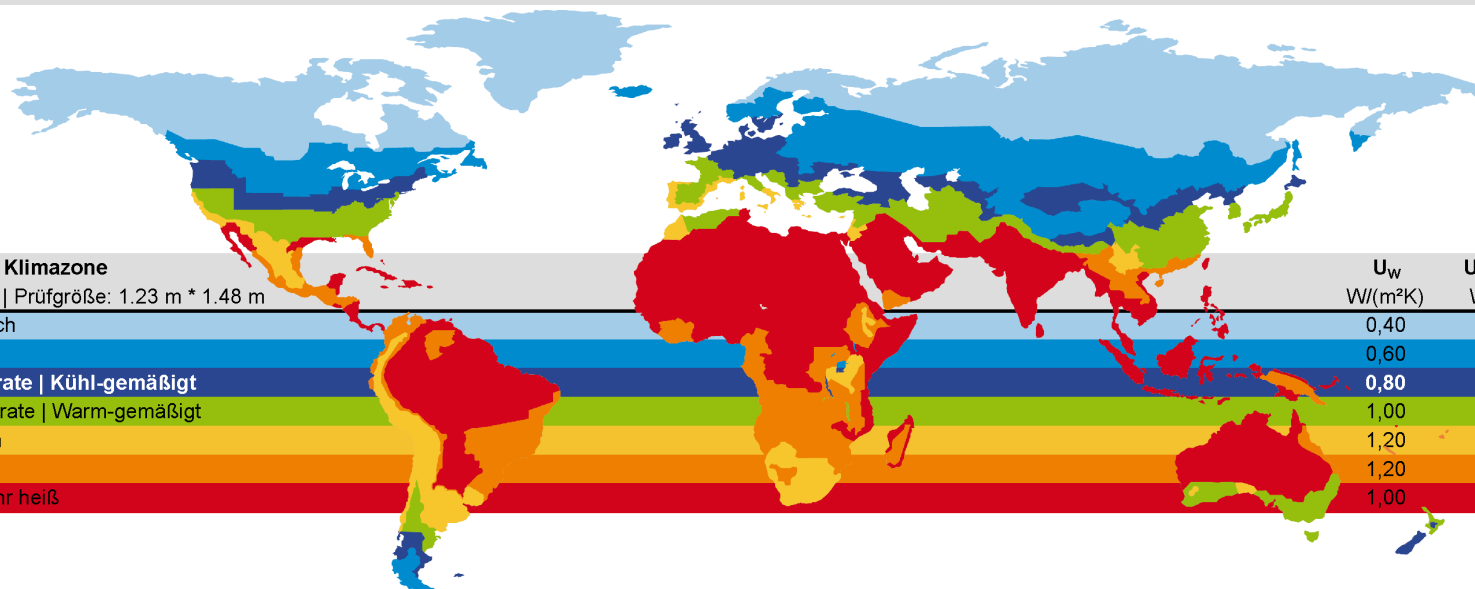
Passivhäuser stellen aufgrund der Möglichkeit, auf ein separates Heizsystem zu verzichten, hohe Anforderungen an die Qualität der verwendeten Bauteile. Dabei steigen die Anforderungen, je kälter das Klima ist. Darum hat das Passivhaus Institut Regionen gleicher Anforderung identifiziert und für diese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










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.

Wird keine gezielte Heizwärmezufuhr unter den Fenstern vorgesehen, darf der Wärmedurchgangskoeffizient der



Frame values Rahmenwerte		Integral frame Integralrahmen			U-value window Fenster-U-Wert @U _g = 0,7 W/(m²K)	Vinyl/Timber Holz/PVC			U-value window Fenster-U-Wert @U _g = 0,7 W/(m²K)	Metal Metall			U-value window Fenster-U-Wert @U _g = W/(m²K)	Contact person Ansprechpartner	
		bo Bottom	to Top	si Side		bo Bottom	to Top	si Side		bo Bottom	to Top	si Side		Soudal NV, Steven Van Orshaegen VanOrshaegen@soudal.com	
		Unten	Oben	Seitl.		Unten	Oben	Seitl.		Unten	Oben	Seitl.			
															
Frame width Rahmenbreite	b_f [mm]	100	100	100	0,80	125	125	125	0,80	140	140	140	0,80	Description	
U-value frame Rahmen-U-Wert	U_f [W/(m²K)]	0,90	0,79	0,79		0,73	0,73	0,73		0,75	0,75	0,75		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 included where the load exceeds a certain level, see certification report.	
Ψ-glass edge Glasrand-Ψ-Wert	Ψ_g [W/(mK)]	0,026	0,026	0,026		0,036	0,036	0,036		0,034	0,034	0,034			
SoudaFrame SWI 90		Installed			Installed			Installed			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. Zertifikatsbericht.				
Not covered	Ψ_{install} [W/(mK)]	0,051				0,031	0,029	0,029	0,88	0,029			0,028	0,028	0,88
Partially covered	Ψ_{install} [W/(mK)]							0,018	0,018	0,86					
Completely covered	Ψ_{install} [W/(mK)]	-0,009	-0,009	0,81				0,007	0,007	0,83					
With shading	Ψ_{install} [W/(mK)]							0,042	0,013	0,87					
SoudaFrame SWI 130		Installed			Installed			Installed			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. Zertifikatsbericht.				
Not covered	Ψ_{install} [W/(mK)]	0,026				0,019	0,018	0,018	0,85	0,020			0,020	0,020	0,86
Partially covered	Ψ_{install} [W/(mK)]							0,010	0,010	0,83					
Completely covered	Ψ_{install} [W/(mK)]	-0,014	-0,014	0,78				0,002	0,002	0,81					
SoudaFrame SWI 160		Installed			Installed			Installed			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. Zertifikatsbericht.				
Not covered	Ψ_{install} [W/(mK)]	0,017				0,016	0,016	0,016	0,84	0,019			0,018	0,018	0,85
Partially covered	Ψ_{install} [W/(mK)]							0,010	0,010	0,83					
Completely covered	Ψ_{install} [W/(mK)]	-0,013	-0,013	0,78				0,002	0,002	0,81					
SoudaFrame SWI 200		Installed			Installed			Installed			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. Zertifikatsbericht.				
Not covered	Ψ_{install} [W/(mK)]	0,018				0,016	0,016	0,016	0,84	0,019			0,019	0,019	0,85
Partially covered	Ψ_{install} [W/(mK)]							0,011	0,011	0,83					
Completely covered	Ψ_{install} [W/(mK)]	-0,008	-0,008	0,79				0,006	0,006	0,82					
%															
Not covered	Ψ_{install} [W/(mK)]														
Partially covered	Ψ_{install} [W/(mK)]														
Completely covered	Ψ_{install} [W/(mK)]														

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 included 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. Zertifikatsbericht.

criteria would be met @ U_g=0,60 W/(m²K)
criteria not met

Calculation I Berechnung

Passivhaus Institut Darmstadt
10.09.2020 kk



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.

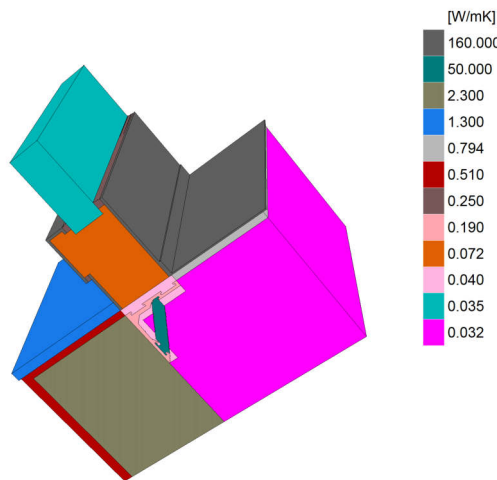
After simulating the thermal flux, the model was calculated again without the bracket to be able to calculate the χ -values, which were determined to 1.25 mW/K for the 90 mm frame, 1.48 mW/K for the 130 mm frame, 1.52 mW/K for the 160 mm frame and 1.49 mW/K for the 200 mm frame.

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

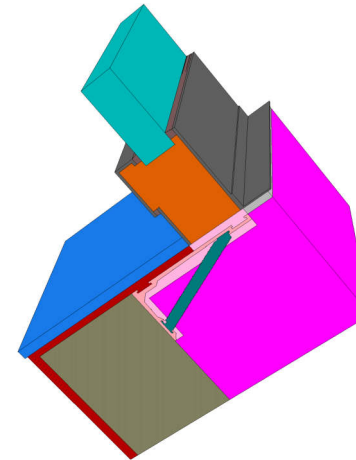
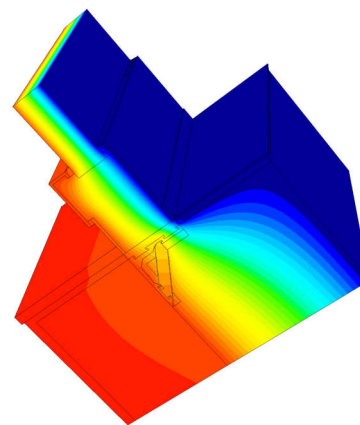
Number of brackets	0	2	3	4	per meter
SWI 90	1,25				χ [mW/K]
Maximum load	787	-	-	-	kg/m
Additional losses	0				W/(mK)
SWI 130	1,48				χ [mW/K]
Maximum load	222	629	679	729	kg/m
Additional losses	0	0,003	0,004	0,006	W/(mK)
SWI 160	1,52				χ [mW/K]
Maximum load	130	500	550	600	kg/m
Additional losses	0	0,003	0,005	0,006	W/(mK)
SWI 200	1,49				χ [mW/K]
Maximum load	61	375	425	475	kg/m
Additional losses	0	0,003	0,004	0,006	W/(mK)

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

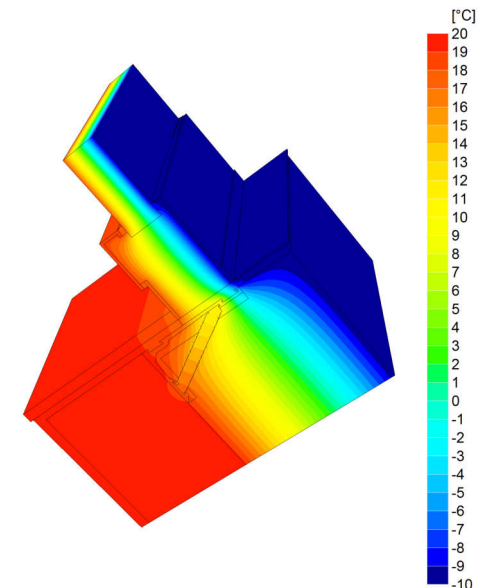
Nach der Wärmestromberechnung wurde die Simulation ohne Stahlwinkel wiederholt um den χ -Wert zu bestimmen, der für den 90 mm Rahmen 1,25 mW/K beträgt. Für den 130 mm Rahmen wurden 1.48 mW/K, für den 160 mm Rahmen 1.52 mW/K und für den 200 mm Rahmen 1.49 mW/K ermittelt.



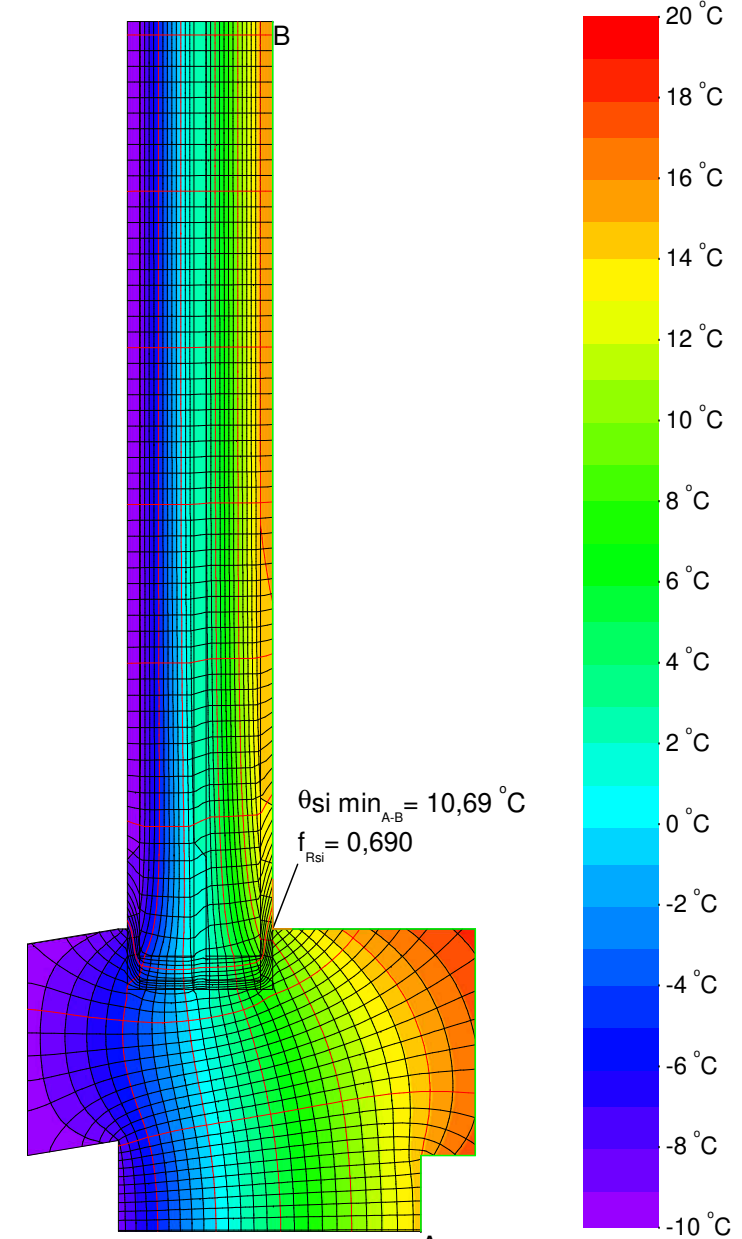
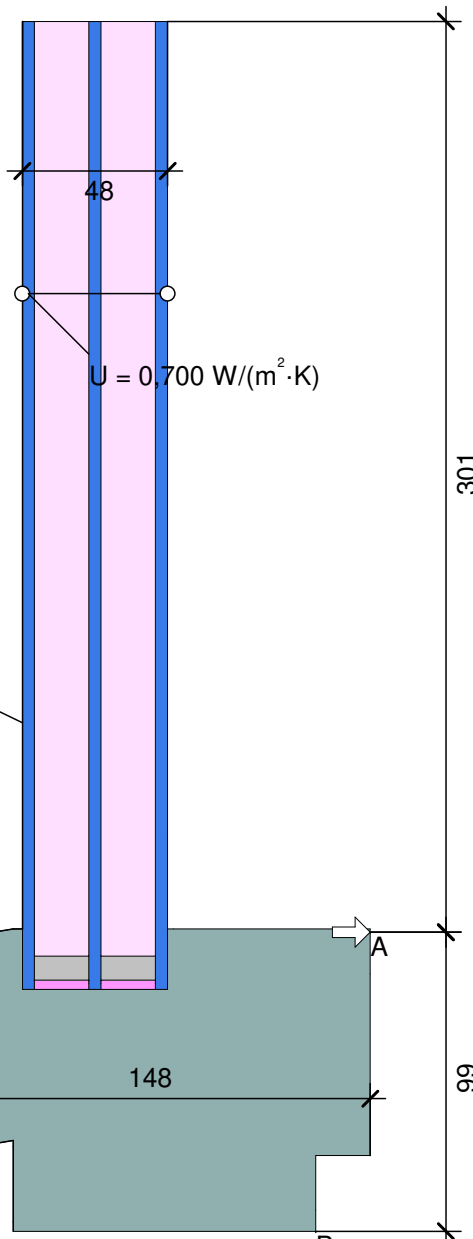
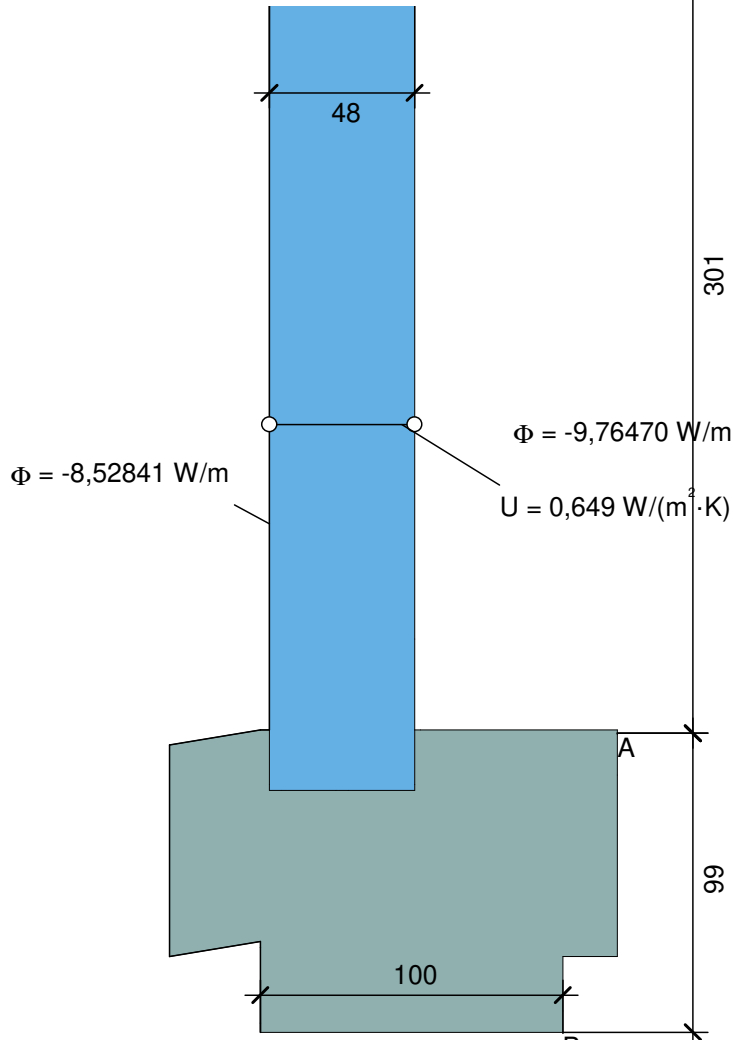
SoudaFrame SWI 90



SoudaFrame SWI 200



Material	λ [W/(m·K)]	ϵ
Ar18 in 48 mm U 0,7	0,029	0,900
Glass Glas	1,000	0,900
Integral frame Integralrahmen	0,118	0,900
Polysulfide Polysulfid	0,400	0,900
phA-Spacer	0,200	0,900

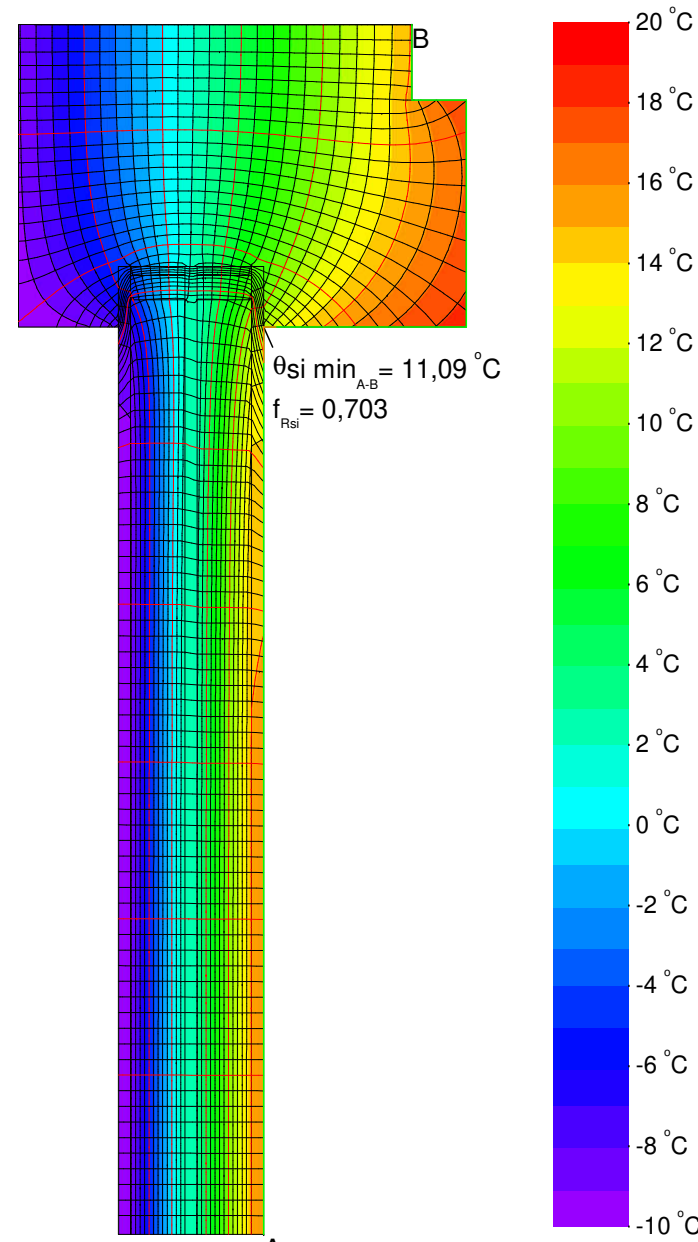
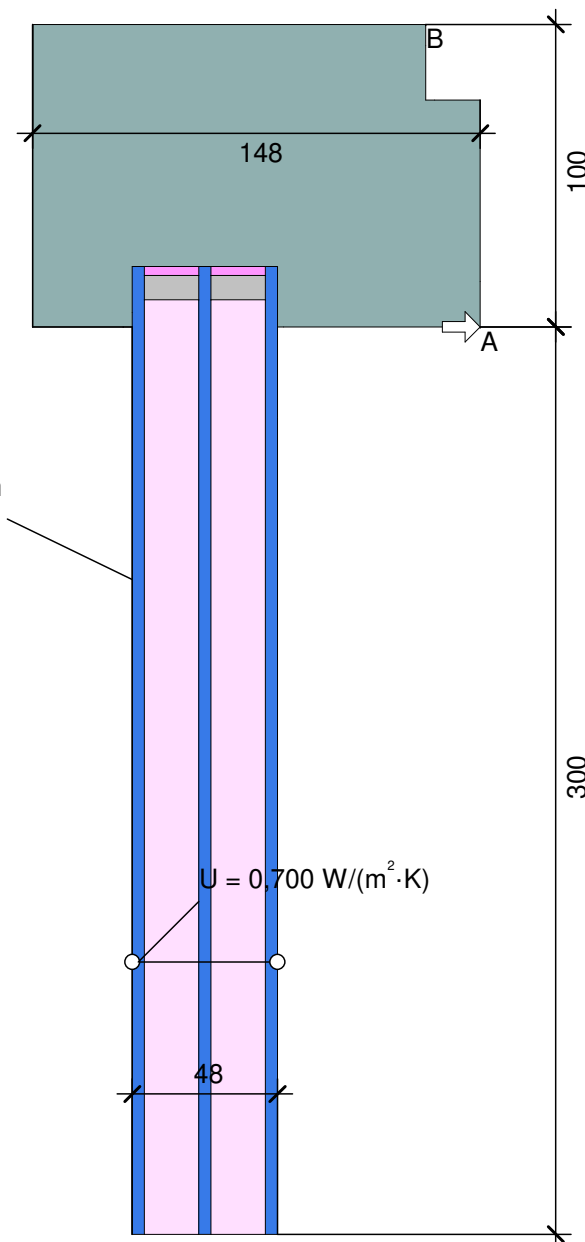
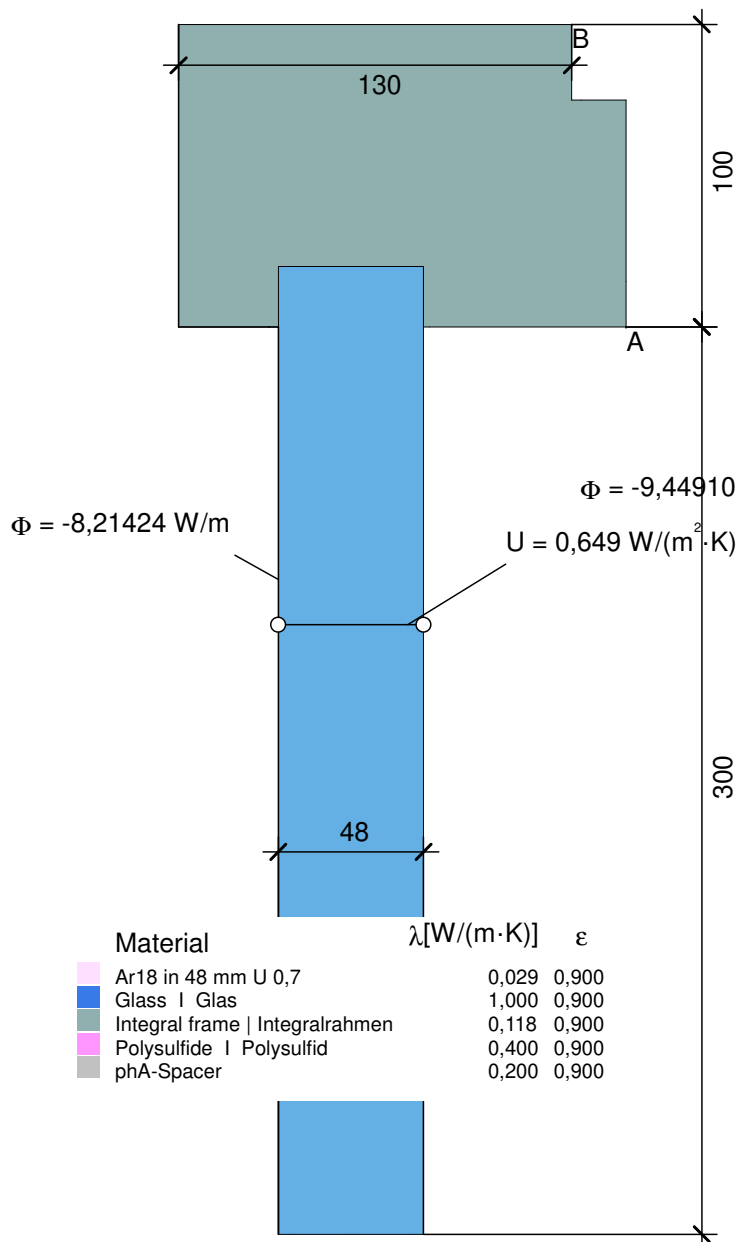


$$U_{1A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_i} = \frac{\frac{8,528}{30,000} - 0,649 \cdot 0,301}{0,099} = 0,899 \text{ W/(m}^2 \cdot \text{K)}$$

$$\psi_{edA} = \frac{\Phi}{\Delta T} - U_g \cdot b_g - U_i \cdot b_i = \frac{9,765}{30,000} - 0,700 \cdot 0,301 - 0,899 \cdot 0,099 = 0,026 \text{ W/(m} \cdot \text{K)}$$

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





Material	λ [W/(m·K)]	ϵ
Ar18 in 48 mm U 0,7	0,029	0,900
Glass Glas	1,000	0,900
Integral frame Integralrahmen	0,118	0,900
Polysulfide Polysulfid	0,400	0,900
phA-Spacer	0,200	0,900

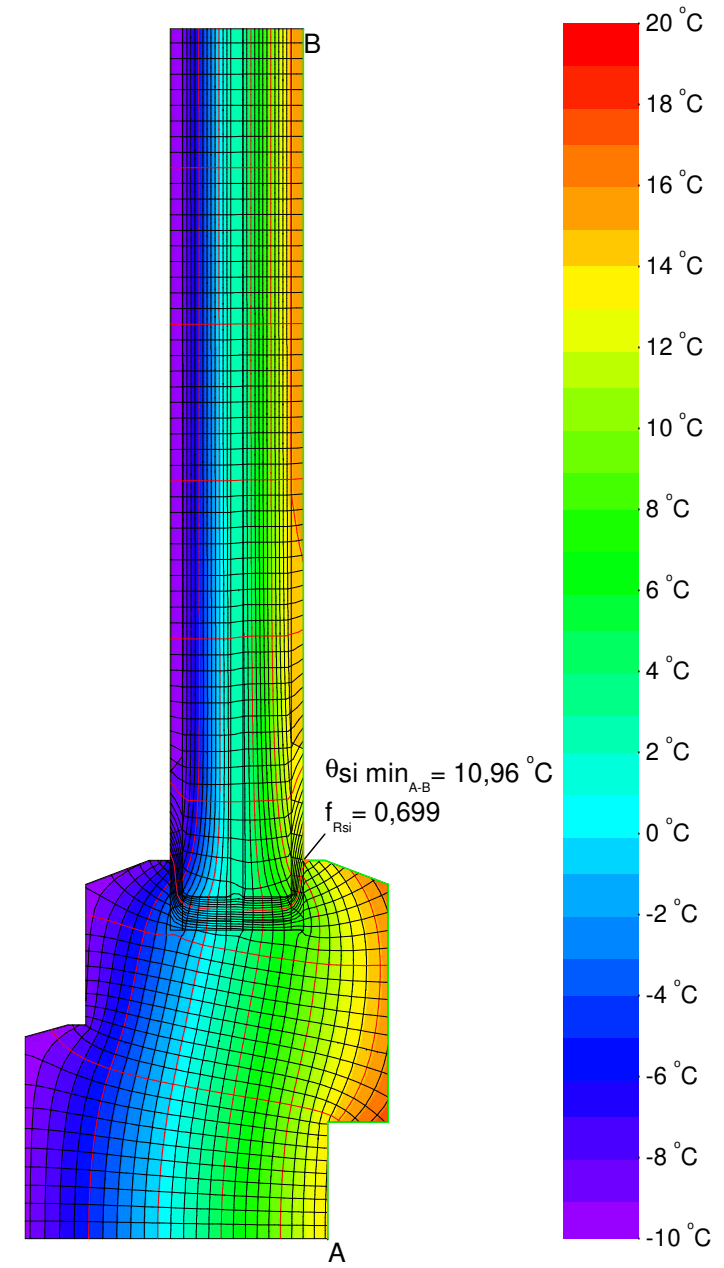
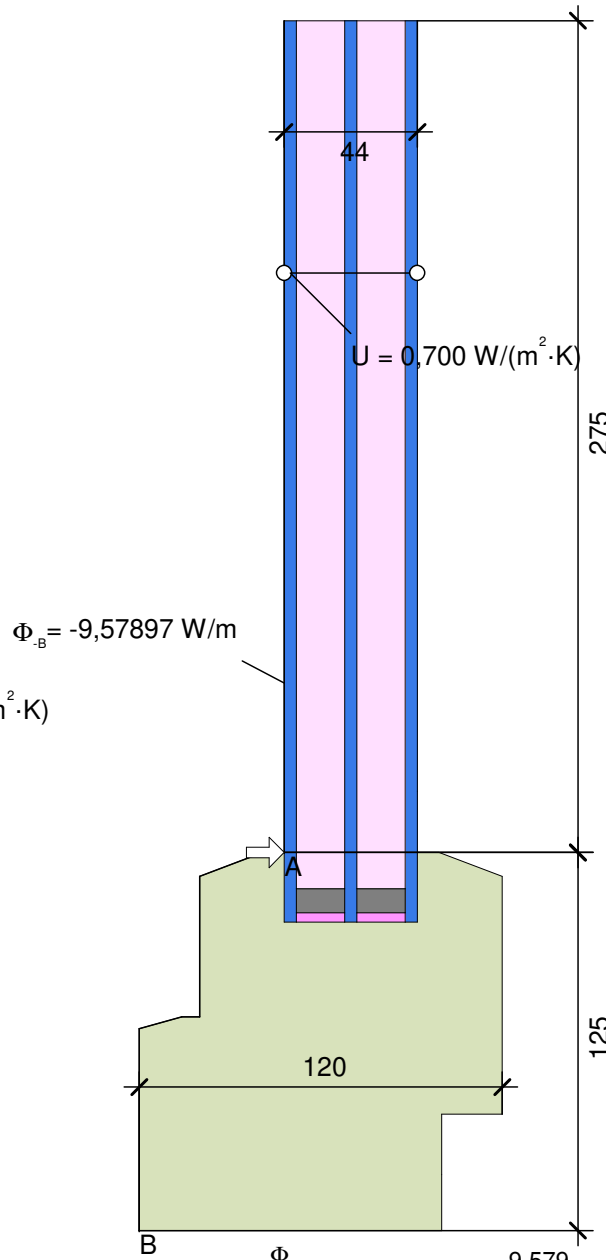
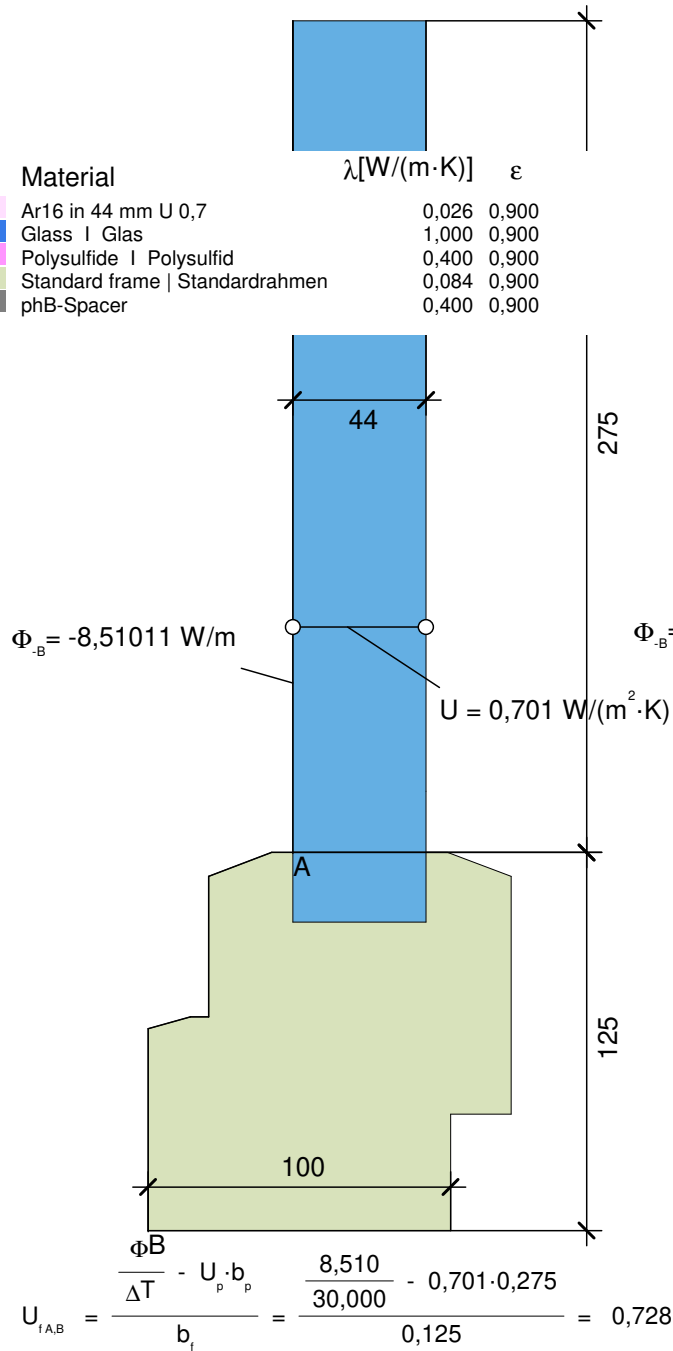
$$U_{fA,B} = \frac{\Phi}{\Delta T} - U_p \cdot b_p = \frac{8,214}{30,000} - 0,649 \cdot 0,300 = 0,792 \text{ W}/(\text{m}^2 \cdot \text{K})$$

$$\psi_{edA} = \frac{\Phi}{\Delta T} - U_g \cdot b_g - U_f \cdot b_f = \frac{9,449}{30,000} - 0,700 \cdot 0,300 - 0,792 \cdot 0,100 = 0,026 \text{ W}/(\text{m} \cdot \text{K})$$

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

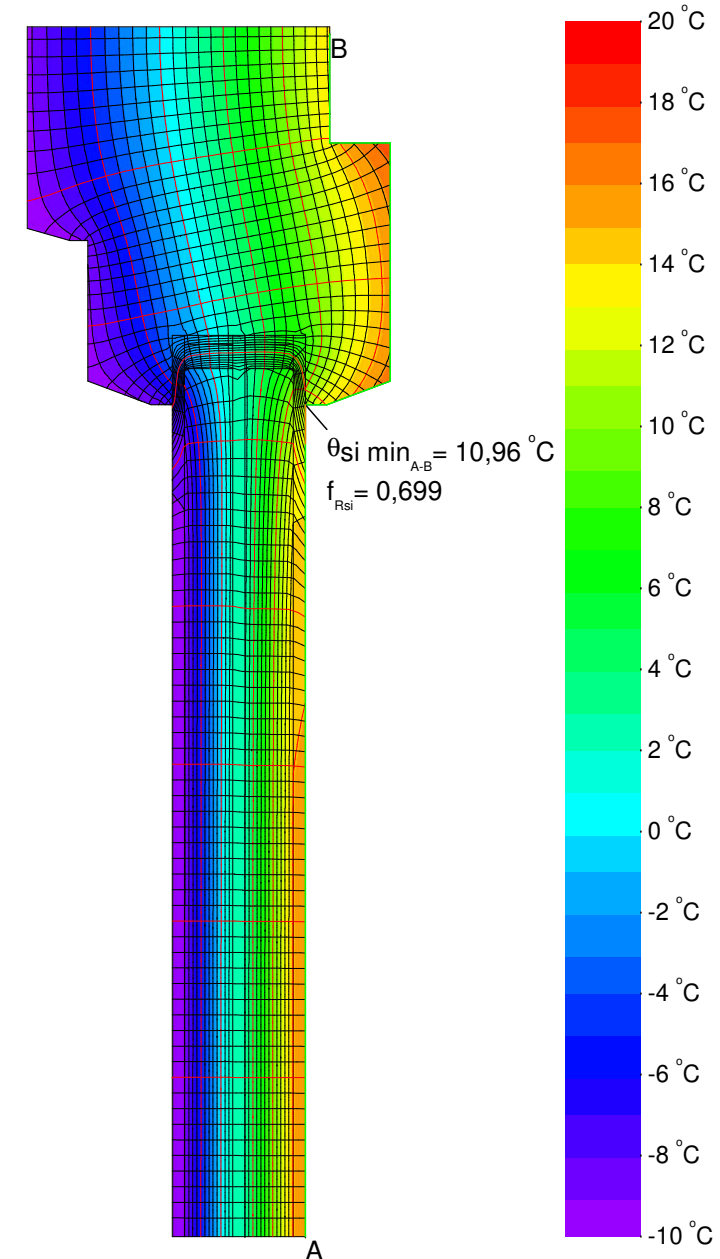
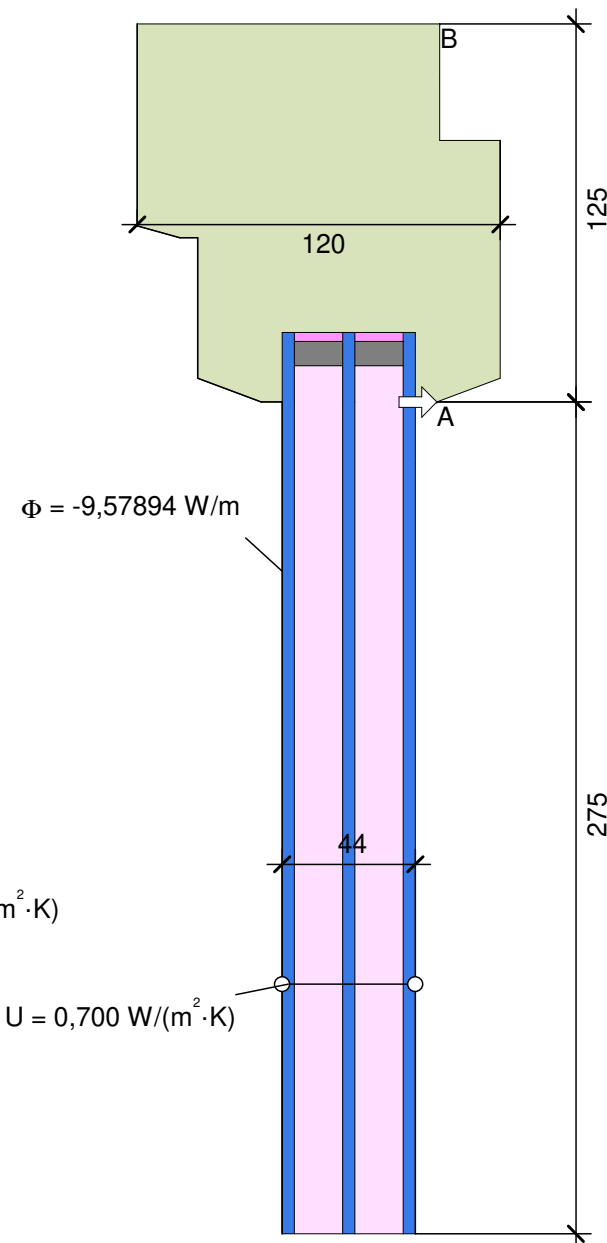
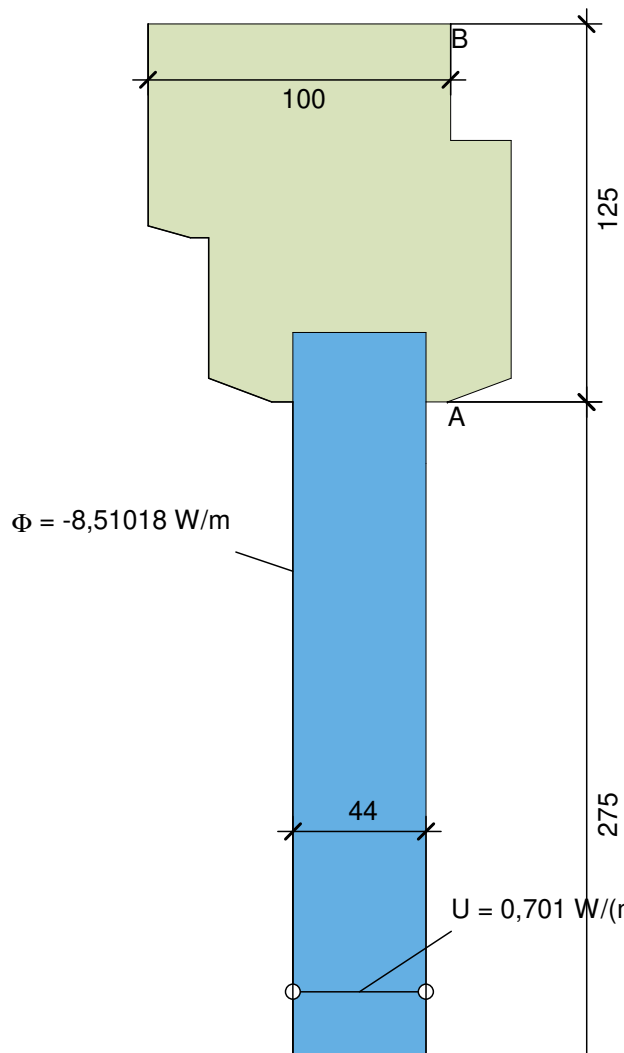


Material	λ [W/(m·K)]	ϵ
Ar16 in 44 mm U 0,7	0,026	0,900
Glass Glas	1,000	0,900
Polysulfide Polysulfid	0,400	0,900
Standard frame Standardrahmen	0,084	0,900
phB-Spacer	0,400	0,900



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





Material	$\lambda[\text{W}/(\text{m} \cdot \text{K})]$	ϵ
Ar16 in 44 mm U 0,7	0,026	0,900
Glass Glas	1,000	0,900
Polysulfide Polysulfid	0,400	0,900
Standard frame Standardrahmen	0,084	0,900
phB-Spacer	0,400	0,900

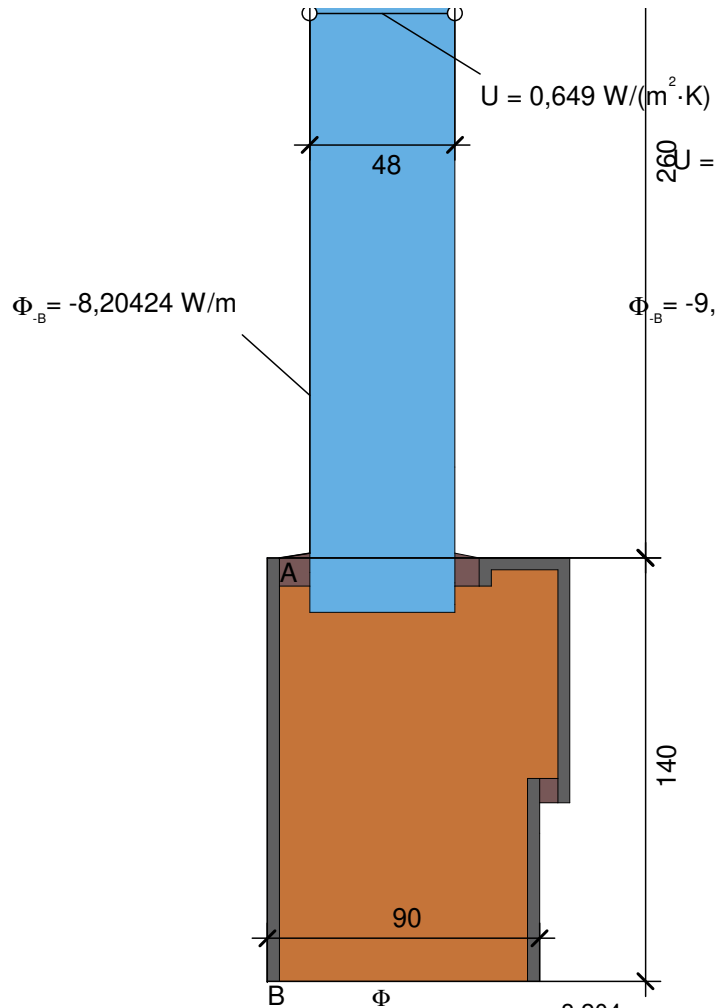
$$U_{f,A,B} = \frac{\Phi}{\Delta T} - U_p \cdot b_p = \frac{8,510}{30,000} - 0,701 \cdot 0,275 = 0,728 \text{ W}/(\text{m}^2 \cdot \text{K})_{\text{ed A}}$$

$$U_{f,A,B} = \frac{\Phi}{\Delta T} - U_g \cdot b_g - U_f \cdot b_f = \frac{9,579}{30,000} - 0,700 \cdot 0,275 - 0,728 \cdot 0,125 = 0,036 \text{ W}/(\text{m}^2 \cdot \text{K})$$

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

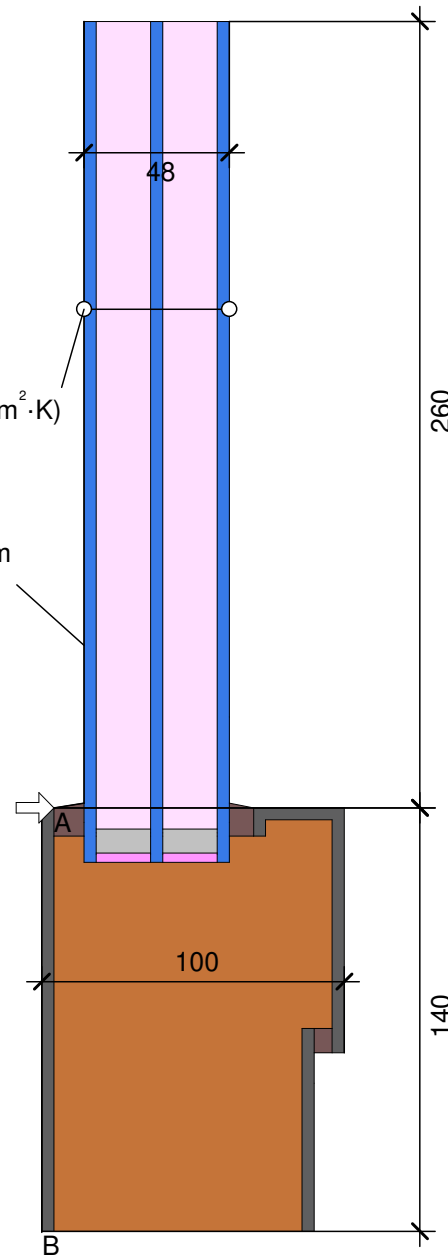


Material	λ [W/(m·K)]	ϵ
Aluminium Aluminium 10456	160,000	0,900
Ar18 in 48 mm U 0,7	0,029	0,900
EPDM	0,250	0,900
Filling aluminium frame Füllung Alurahmen	0,072	0,900
Glass Glas	1,000	0,900
Polysulfide Polysulfid	0,400	0,900
phA-Spacer	0,200	0,900

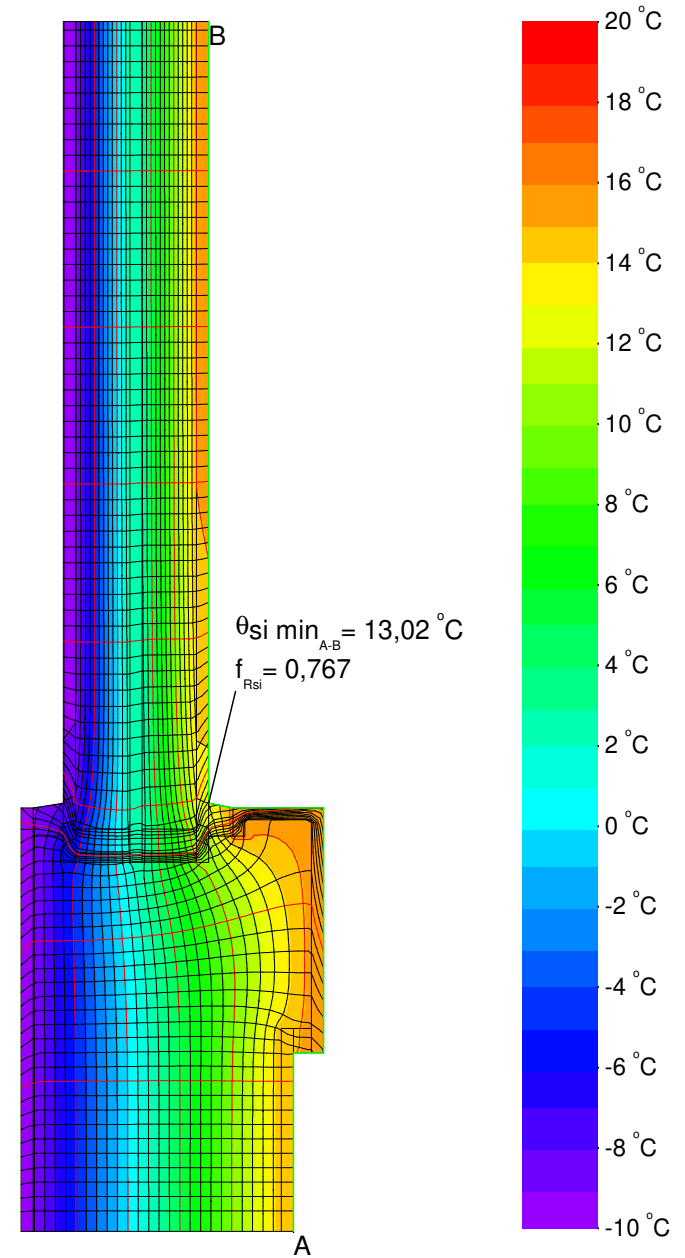


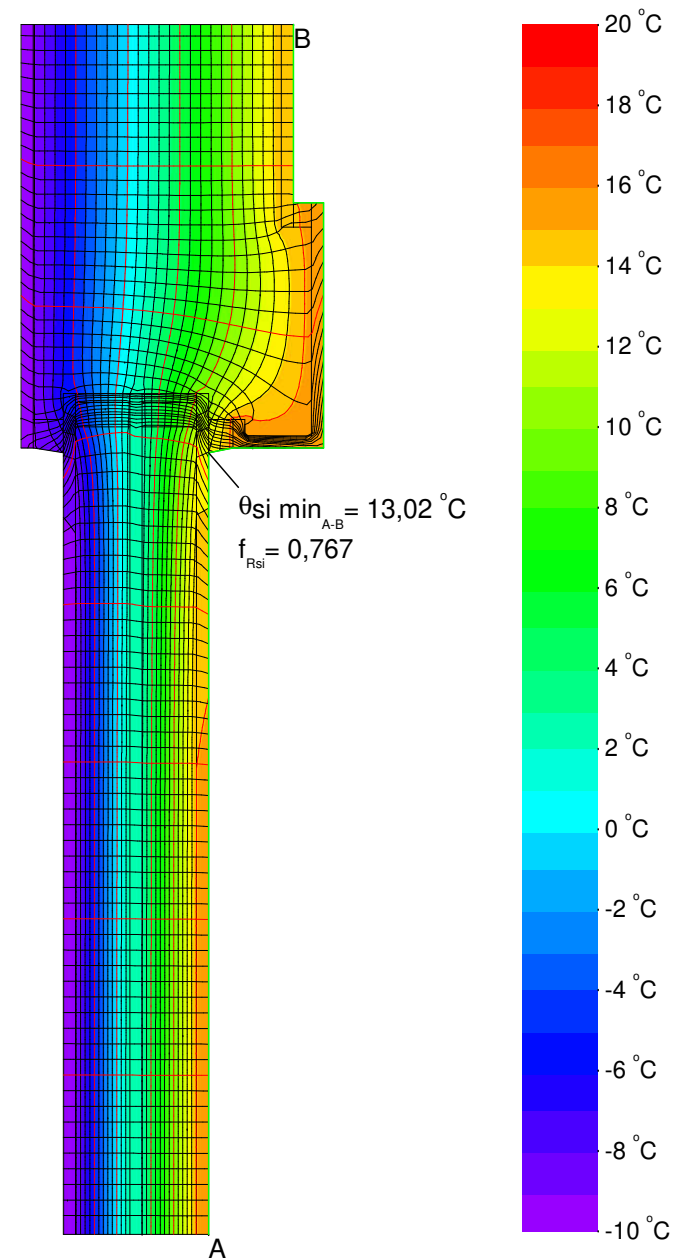
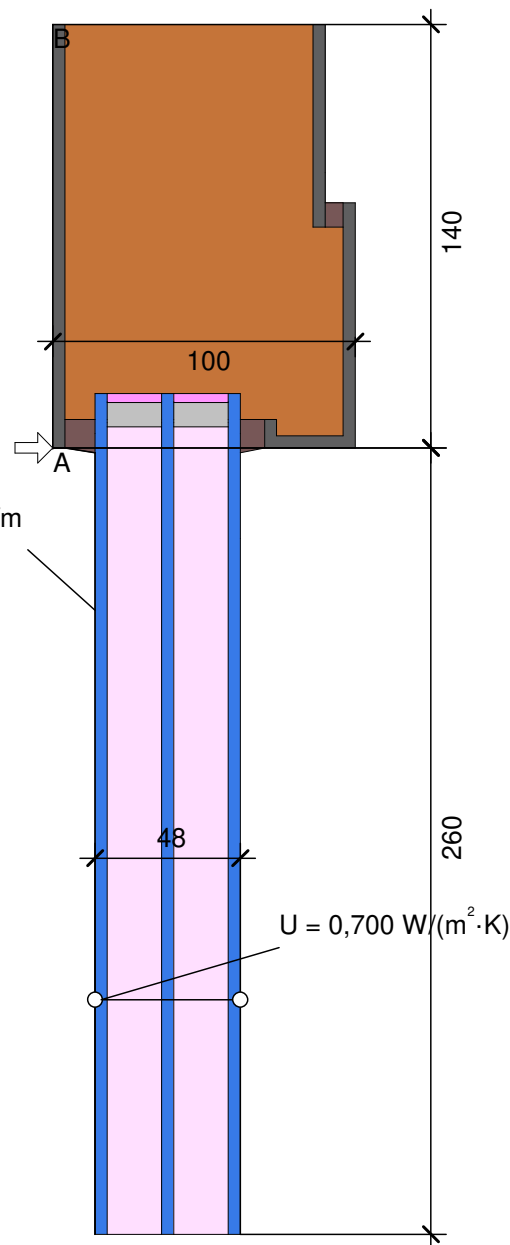
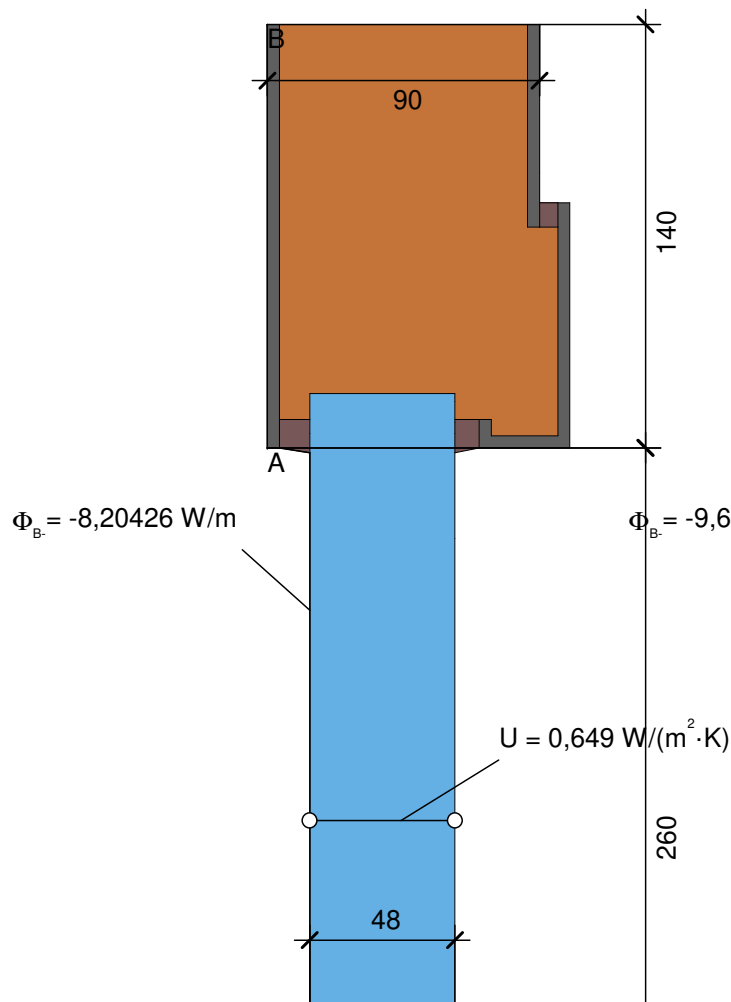
$$U_{fA,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{8,204}{30,000} - 0,649 \cdot 0,260}{0,140} = 0,749 \text{ W/(m}^2 \cdot \text{K)}$$

Aluminium frame | Aluminium Rahmen



$$\psi_{edA} = \frac{\Phi}{\Delta T} - U_g \cdot b_g - U_f \cdot b_f = \frac{9,615}{30,000} - 0,700 \cdot 0,260 - 0,749 \cdot 0,140 = 0,034 \text{ W/(m} \cdot \text{K)}$$





Material	λ[W/(m·K)]	ε
Aluminum Aluminium 10456	160,000	0,900
Ar18 in 48 mm U 0,7	0,029	0,900
EPDM	0,250	0,900
Filling aluminium frame Füllung Alurahmen	0,072	0,900
Glass Glas	1,000	0,900
Polysulfide Polysulfid	0,400	0,900
phA-Spacer	0,200	0,900

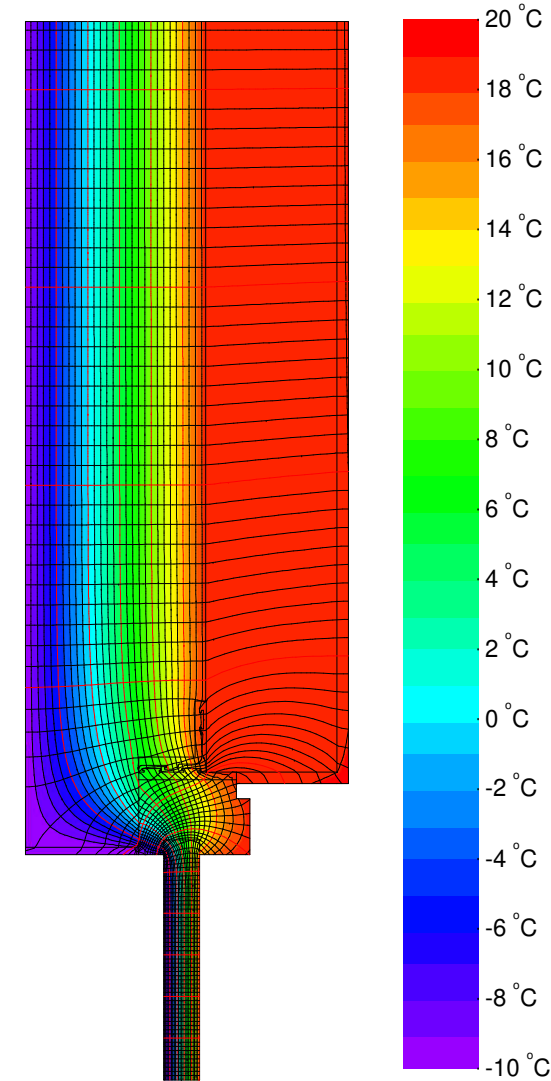
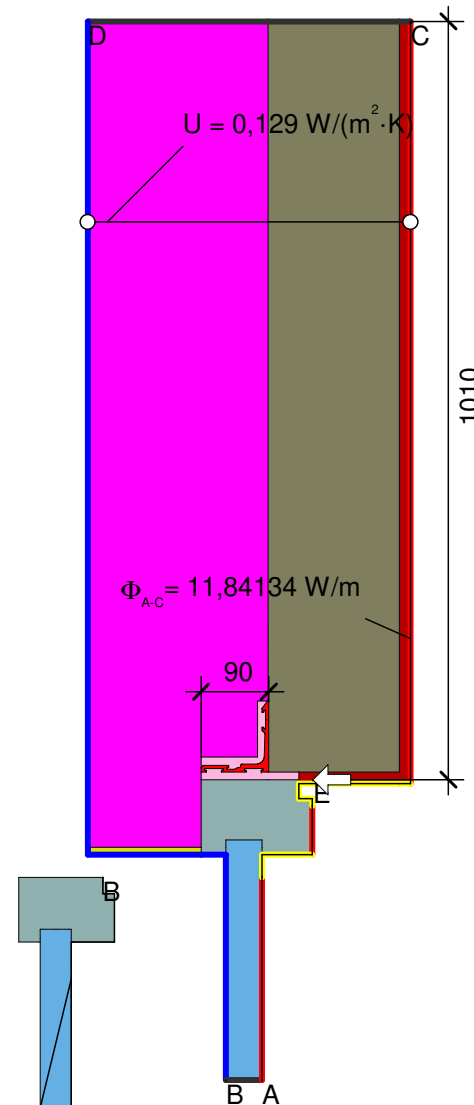
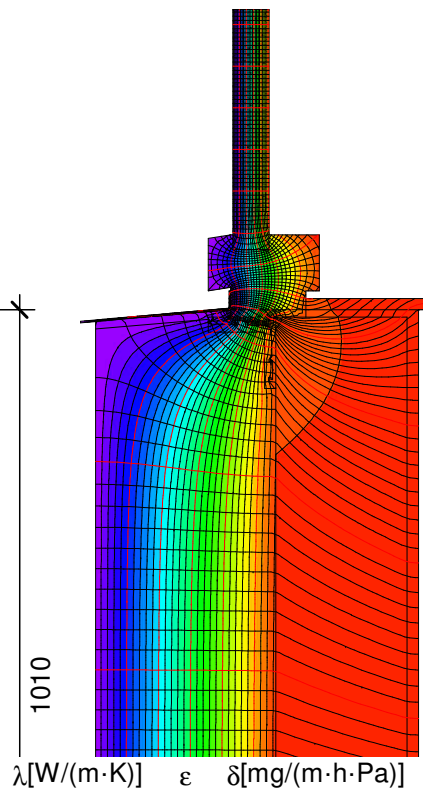
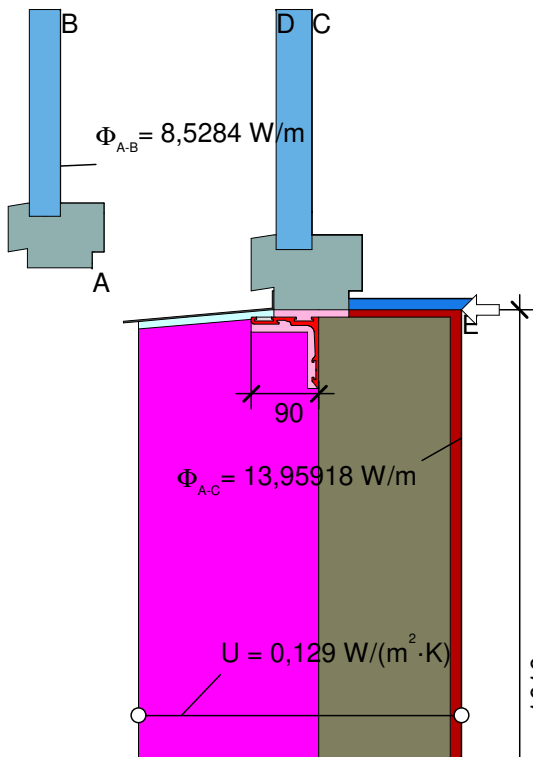
$$U_{f,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{8,204}{30,000} - 0,649 \cdot 0,260}{0,140} = 0,749 \text{ W/(m}^2 \cdot \text{K)}$$

$$\Psi_{ed A} = \frac{\Phi}{\Delta T} - U_g \cdot b_g - U_f \cdot b_f = \frac{9,615}{30,000} - 0,700 \cdot 0,260 - 0,749 \cdot 0,140 = 0,034 \text{ W/(m} \cdot \text{K)}$$

Aluminium frame | Aluminium Rahmen

to/s - TOP/SIDE | OBEN/SEITL.





Material

Aluminum Aluminium 10456	160,000	0,900	6,400e-9
Artificial stone Kunststein 10456	1,300	0,900	0,014
Concrete, 1% Steel 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
Integral frame Integralrahmen	0,118	0,900	
Interior plaster Gipsputz 10456	0,570	0,900	0,080
Panel Maske	0,035	0,900	
Soudal Flexifoam	0,040	0,900	0,010
Unvent. cavity unbel. Hohlr. *			0,640
slightly vent. cav. leicht bel. Hohlr. *			0,640

* EN ISO 10077-2:2017, 6.4.3

λ [W/(m·K)] ϵ δ [mg/(m·h·Pa)]

$$\psi_{A-E-C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{13,959}{30,000} - 0,129 \cdot 1,010 - \frac{8,528}{30,000} = 0,051 \text{ W/(m·K)}$$

$$\Phi_{A-B} = 8,2142 \text{ W/m}$$

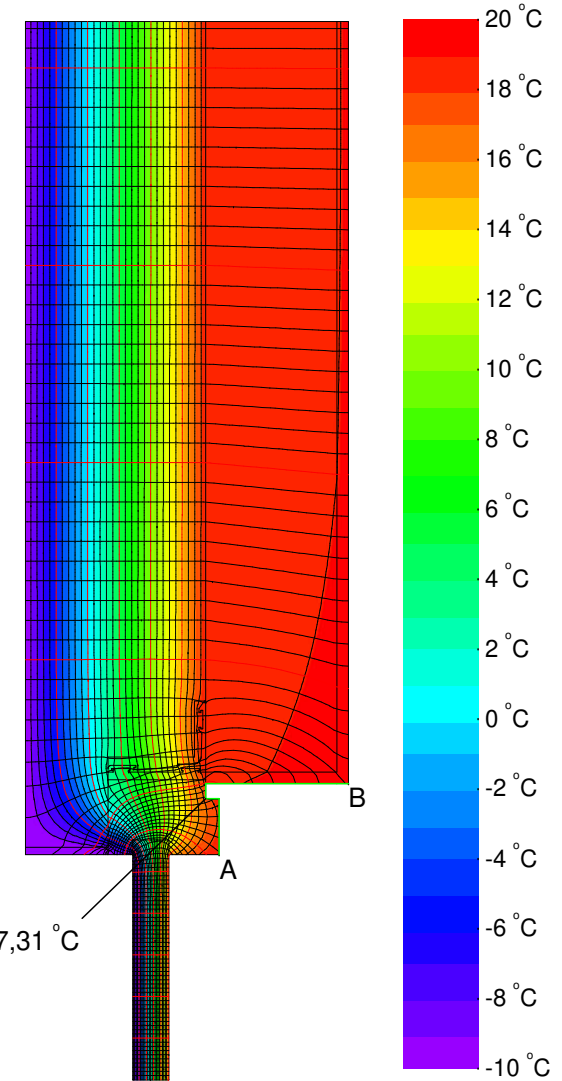
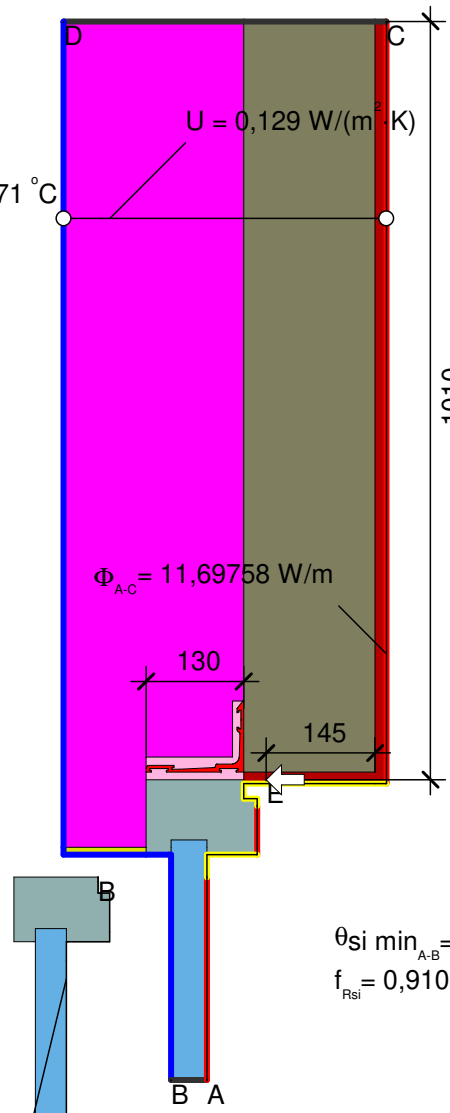
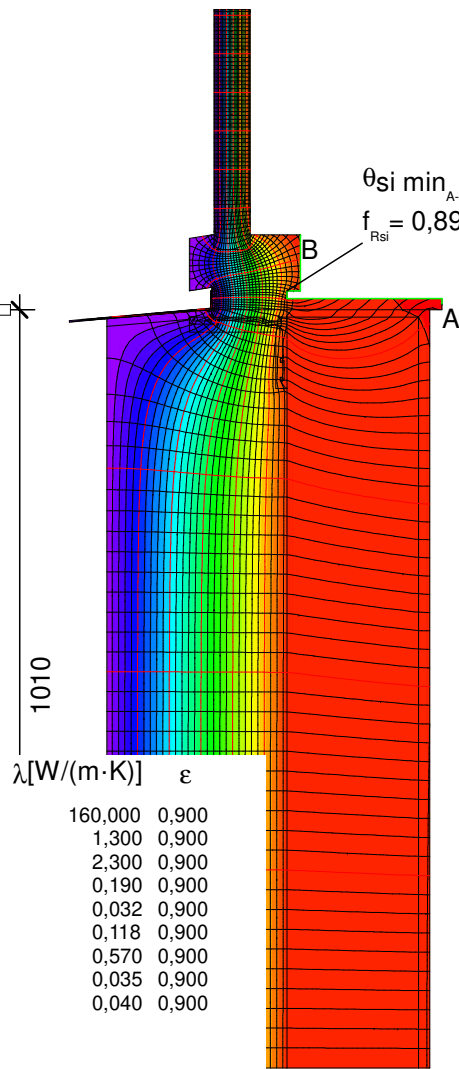
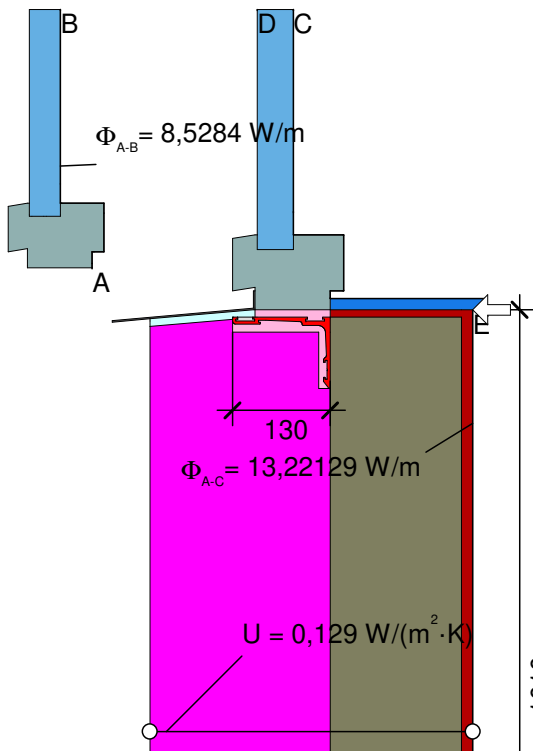
$$A_{\psi_{A-E-C,*}} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{11,841}{30,000} - \frac{8,214}{30,000} - 0,129 \cdot 1,010 = -0,009 \text{ W/(m·K)}$$

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

SoudaFrame SWI 90

Integral pos. 1





Material

Aluminum Aluminium 10456	160,000	0,900
Artificial stone Kunststein 10456	1,300	0,900
Concrete, 1% Steel Beton, 1% Stahl 10456	2,300	0,900
GRP Polyesterbased 0.19	0,190	0,900
Insulation Wärmedämmung 032	0,032	0,900
Integral frame Integralrahmen	0,118	0,900
Interior plaster Gipsputz 10456	0,570	0,900
Panel Maske	0,035	0,900
Soudal Flexifoam	0,040	0,900
Unvent. cavity unbel. Hohlr. *		
slightly vent. cav. leicht bel. Hohlr. *		

* EN ISO 10077-2:2017, 6.4.3

$$\psi_{A-E.C.} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{13,221}{30,000} - 0,129 \cdot 1,010 - \frac{8,528}{30,000} = 0,026 \text{ W}/(\text{m} \cdot \text{K})$$

$$\Phi_{A-B} = 8,2142 \text{ W}/\text{m}$$

$$\psi_{A-E.C.} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{11,698}{30,000} - \frac{8,214}{30,000} - 0,129 \cdot 1,010 = -0,014 \text{ W}/(\text{m} \cdot \text{K})$$

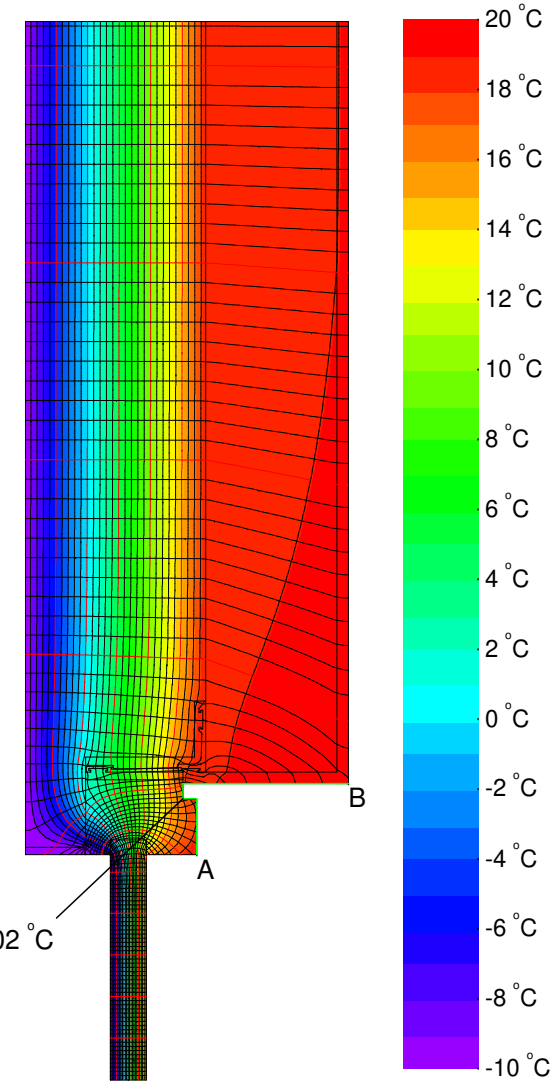
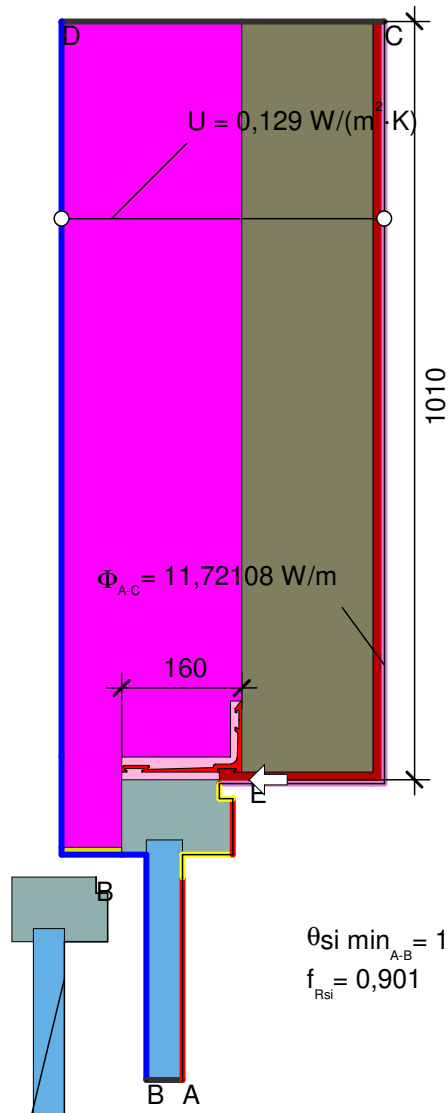
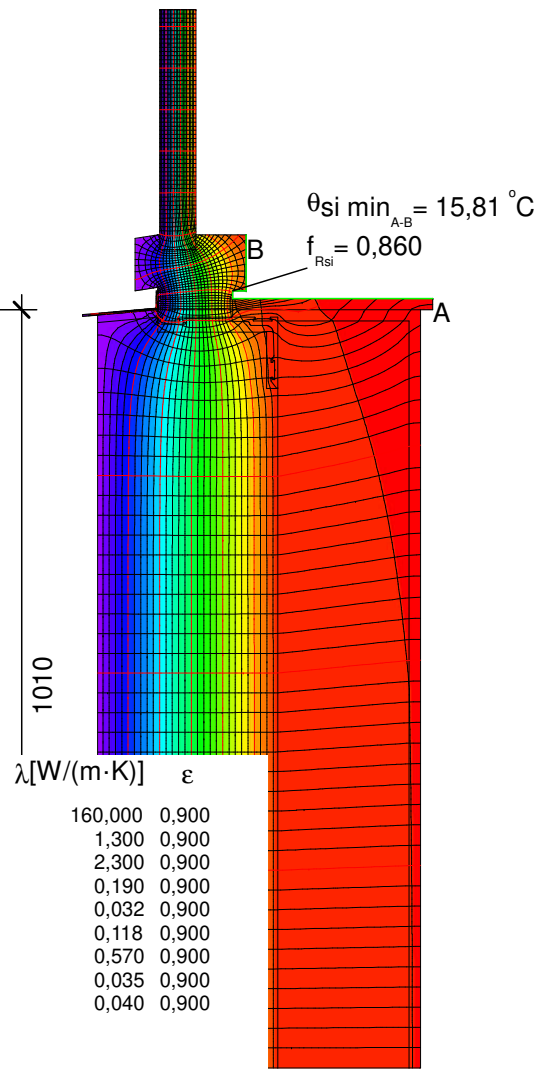
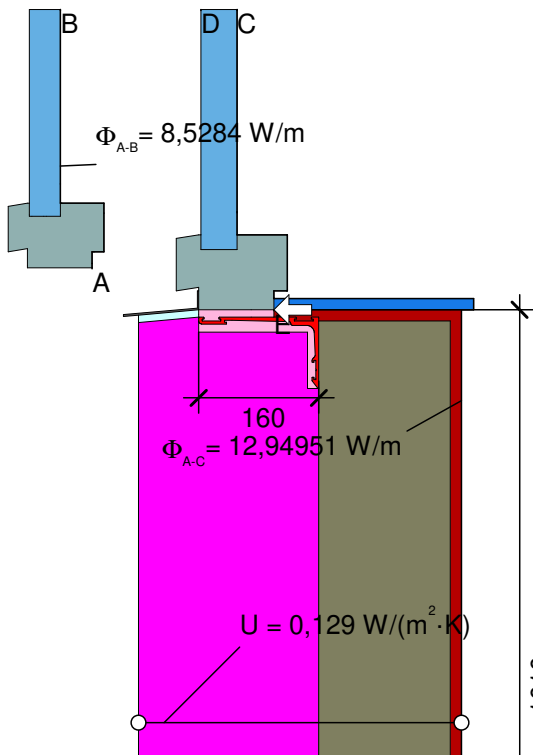
Boundary Condition

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

SoudaFrame SWI 130

Integral pos. 2





Material

- Aluminum | Aluminium 10456
- Artificial stone | Kunststein 10456
- Concrete, 1% Steel | Beton, 1% Stahl 10456
- GRP Polyesterbased 0.19
- Insulation Wärmedämmung 032
- Integral frame | Integralrahmen
- Interior plaster | Gipsputz 10456
- Panel | Maske
- Soudal Flexifoam
- slightly vent. cav. | leicht bel. Hohlr. *
- * EN ISO 10077-2:2017, 6.4.3

Material	λ [W/(m·K)]	ε
Aluminum Aluminium 10456	160,000	0,900
Artificial stone Kunststein 10456	1,300	0,900
Concrete, 1% Steel Beton, 1% Stahl 10456	2,300	0,900
GRP Polyesterbased 0.19	0,190	0,900
Insulation Wärmedämmung 032	0,032	0,900
Integral frame Integralrahmen	0,118	0,900
Interior plaster Gipsputz 10456	0,570	0,900
Panel Maske	0,035	0,900
Soudal Flexifoam	0,040	0,900

$$\psi_{A-E-C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{12,950}{30,000} - 0,129 \cdot 1,010 - \frac{8,528}{30,000} = 0,017 \text{ W/(m} \cdot \text{K)}$$

$$\psi_{A-E-C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{11,721}{30,000} - \frac{8,214}{30,000} - 0,129 \cdot 1,010 = -0,013 \text{ W/(m} \cdot \text{K)}$$

$$\Phi_{A-B} = 8,2142 \text{ W/m}$$

Boundary Condition	q [W/m²]	θ [°C]	R [(m²·K)/W]	ε
■ Adiabatic Adiat	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 160

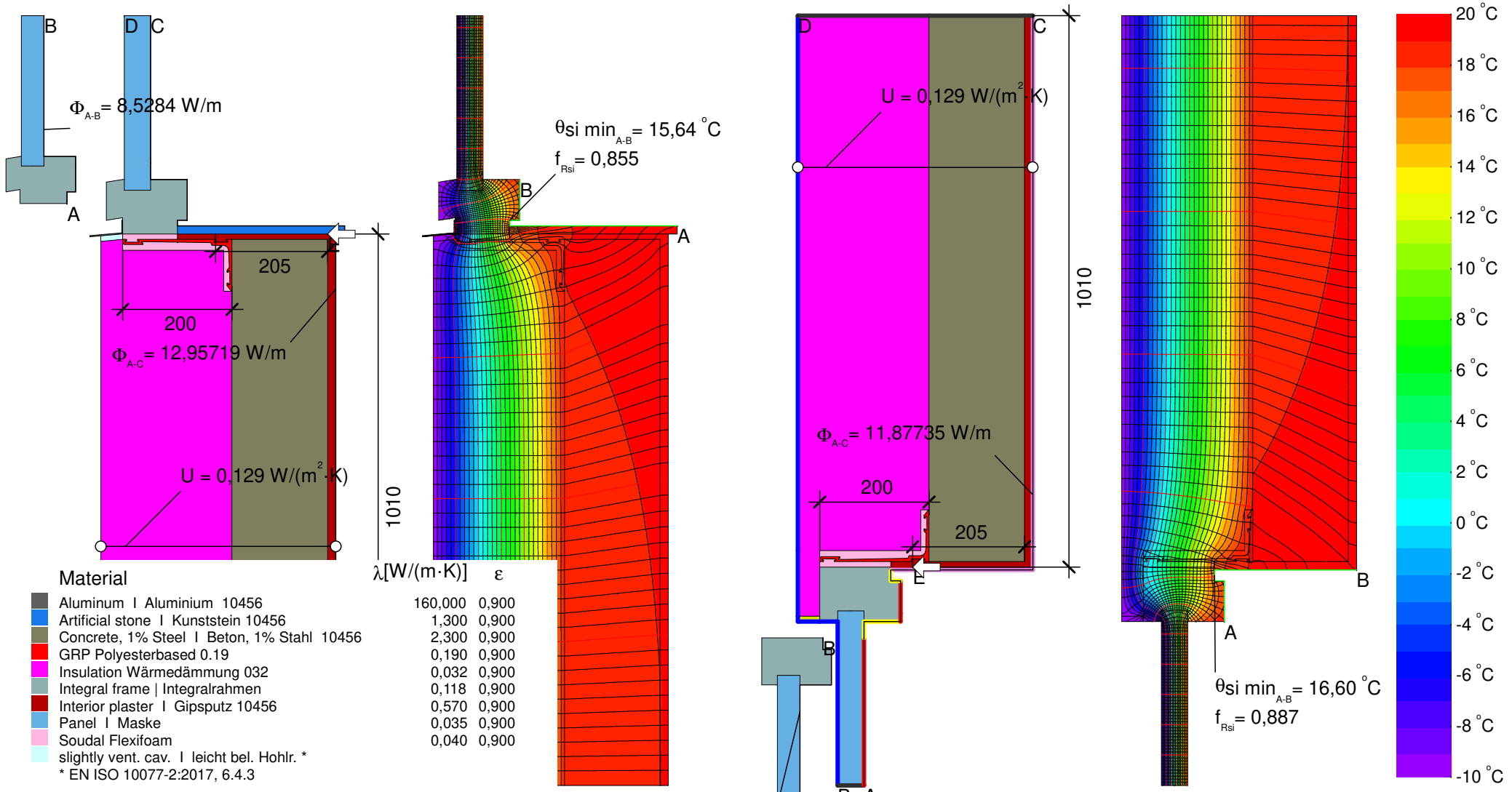
Integral pos. 3

Soudal NV

SoudaFrame SWI 1532pm03



Passive House Institute



Material

Material	λ [W/(m·K)]	ϵ
Aluminum Aluminium 10456	160,000	0,900
Artificial stone Kunststein 10456	1,300	0,900
Concrete, 1% Steel Beton, 1% Stahl 10456	2,300	0,900
GRP Polyesterbased 0.19	0,190	0,900
Insulation Wärmedämmung 032	0,032	0,900
Integral frame Integralrahmen	0,118	0,900
Interior plaster Gipsputz 10456	0,570	0,900
Panel Maske	0,035	0,900
Soudal Flexifoam	0,040	0,900
slightly vent. cav. leicht bel. Hohlr. *		

* EN ISO 10077-2:2017, 6.4.3

$$\psi_{A-E-C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{12,957}{30,000} - 0,129 \cdot 1,010 - \frac{8,528}{30,000} = 0,018 \text{ W}/(\text{m} \cdot \text{K})$$

$$\psi_{A-E-C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{11,877}{30,000} - \frac{8,214}{30,000} - 0,129 \cdot 1,010 = -0,008 \text{ W}/(\text{m} \cdot \text{K})$$

$$\Phi_{A-B} = 8,2142 \text{ W/m}$$

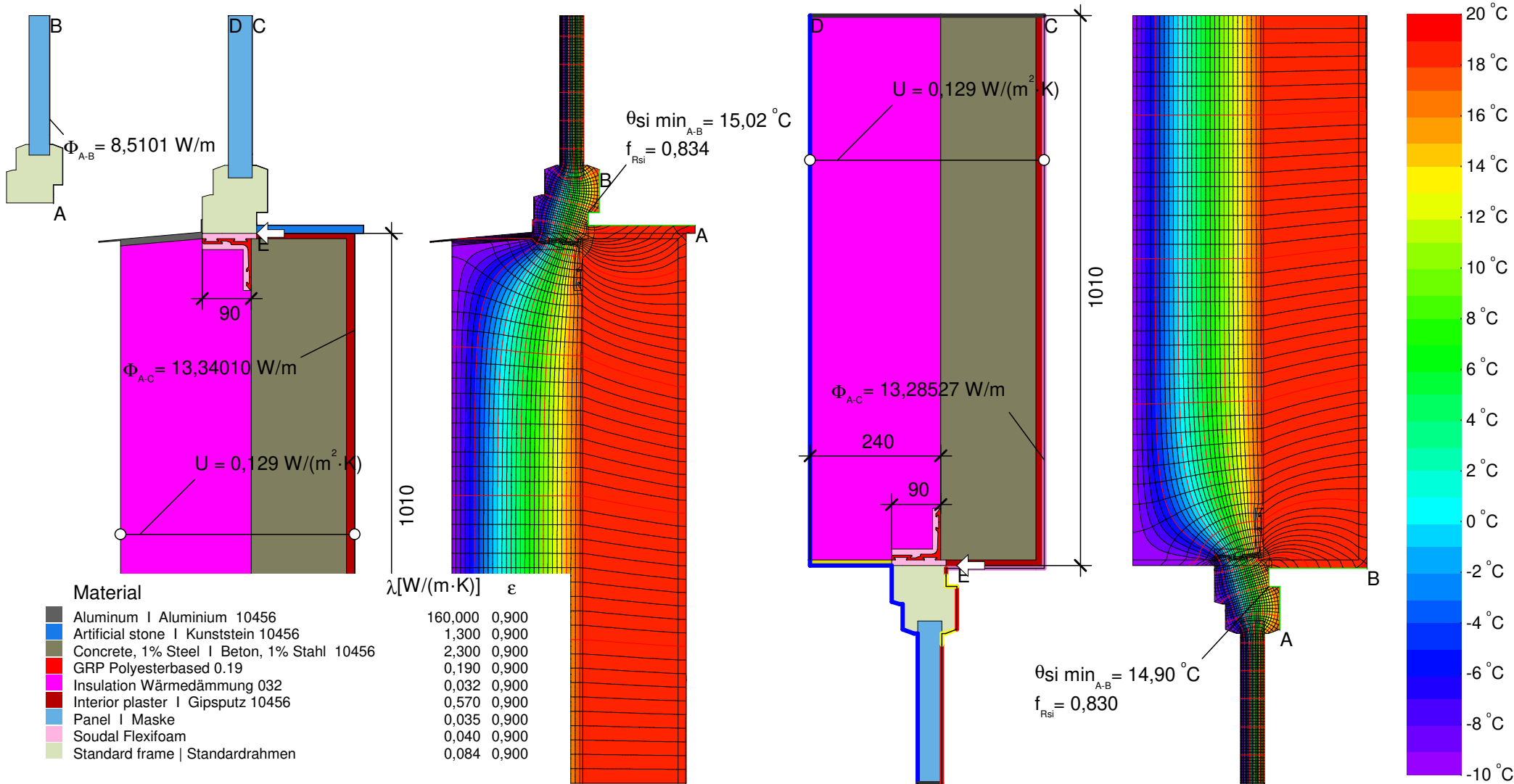
Boundary Condition

Boundary Condition	q [W/m ²]	θ [°C]	R [(m ² ·K)/W]	ϵ
Adiabatic Adiat	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 200

Integral pos. 4





Material	λ [W/(m·K)]	ϵ
Aluminum Aluminium 10456	160,000	0,900
Artificial stone Kunststein 10456	1,300	0,900
Concrete, 1% Steel 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 Gipsputz 10456	0,570	0,900
Panel Maske	0,035	0,900
Soudal Flexifoam	0,040	0,900
Standard frame Standardrahmen	0,084	0,900

$$\psi_{A-E,C} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{13,340}{30,000} - 0,129 \cdot 1,010 - \frac{8,510}{30,000} = 0,031 \text{ W}/(\text{m} \cdot \text{K})$$

$$\psi_{A-E,C} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{13,285}{30,000} - \frac{8,510}{30,000} - 0,129 \cdot 1,010 = 0,029 \text{ W}/(\text{m} \cdot \text{K})$$

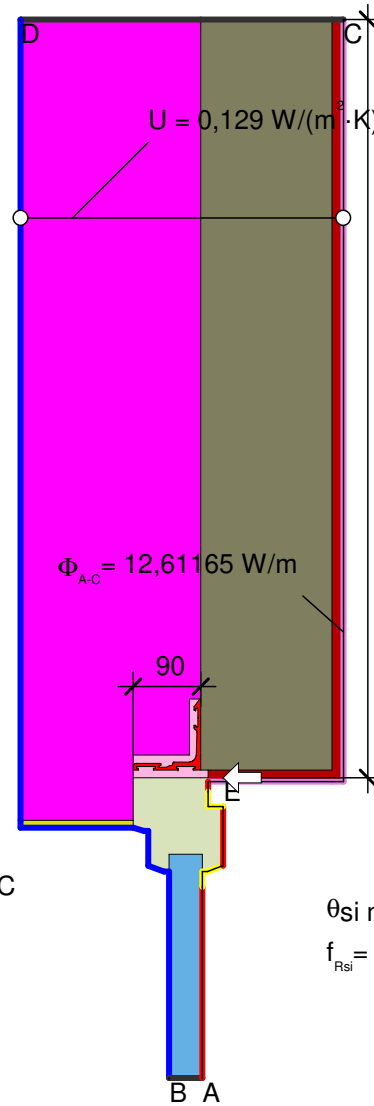
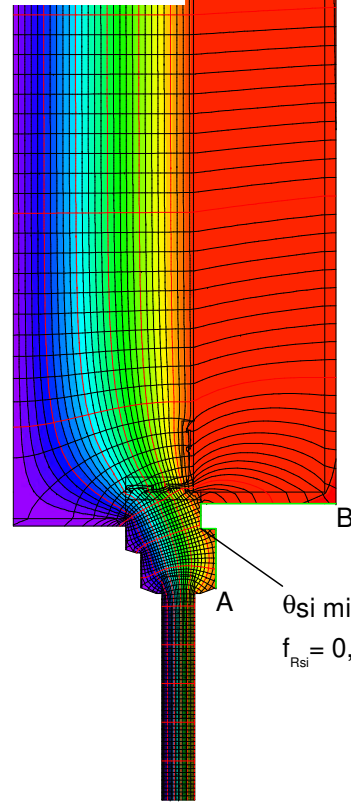
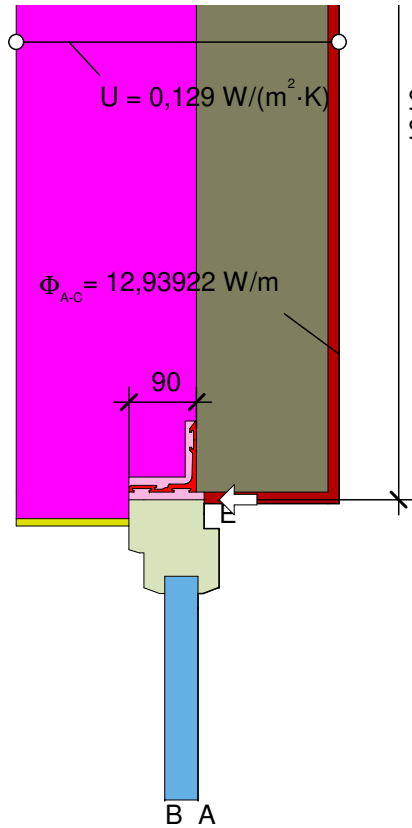
Boundary Condition	q [W/m ²]	θ [°C]	R [(m ² ·K)/W]	ϵ
Adiabatic Adiat	0,000			
Exterior Außen		-10,000	0,040	
Interior Innen		20,000	0,130	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	

SoudaFrame SWI 90

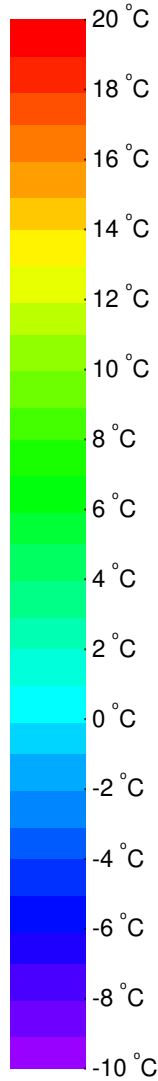
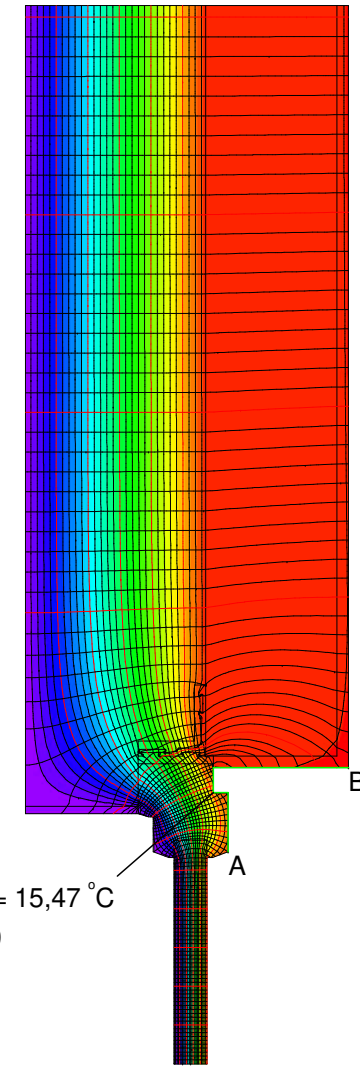
Timber, Plastic pos. 1



Material	λ [W/(m·K)]	ϵ
Concrete, 1% Steel 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 Gipsputz 10456	0,570	0,900
Mörtel, Zement, Sand	1,000	0,900
Panel Maske	0,035	0,900
Soudal Flexifoam	0,040	0,900
Standard frame Standardrahmen	0,084	0,900

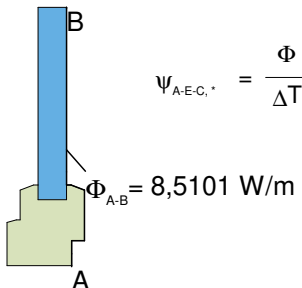


$\theta_{si\ min_{A-B}} = 15,47\ ^\circ C$
 $f_{Rsi} = 0,849$



$$\psi_{A-E,C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{12,939}{30,000} - \frac{8,510}{30,000} - 0,129 \cdot 1,010 = 0,018\ W/(m \cdot K)$$

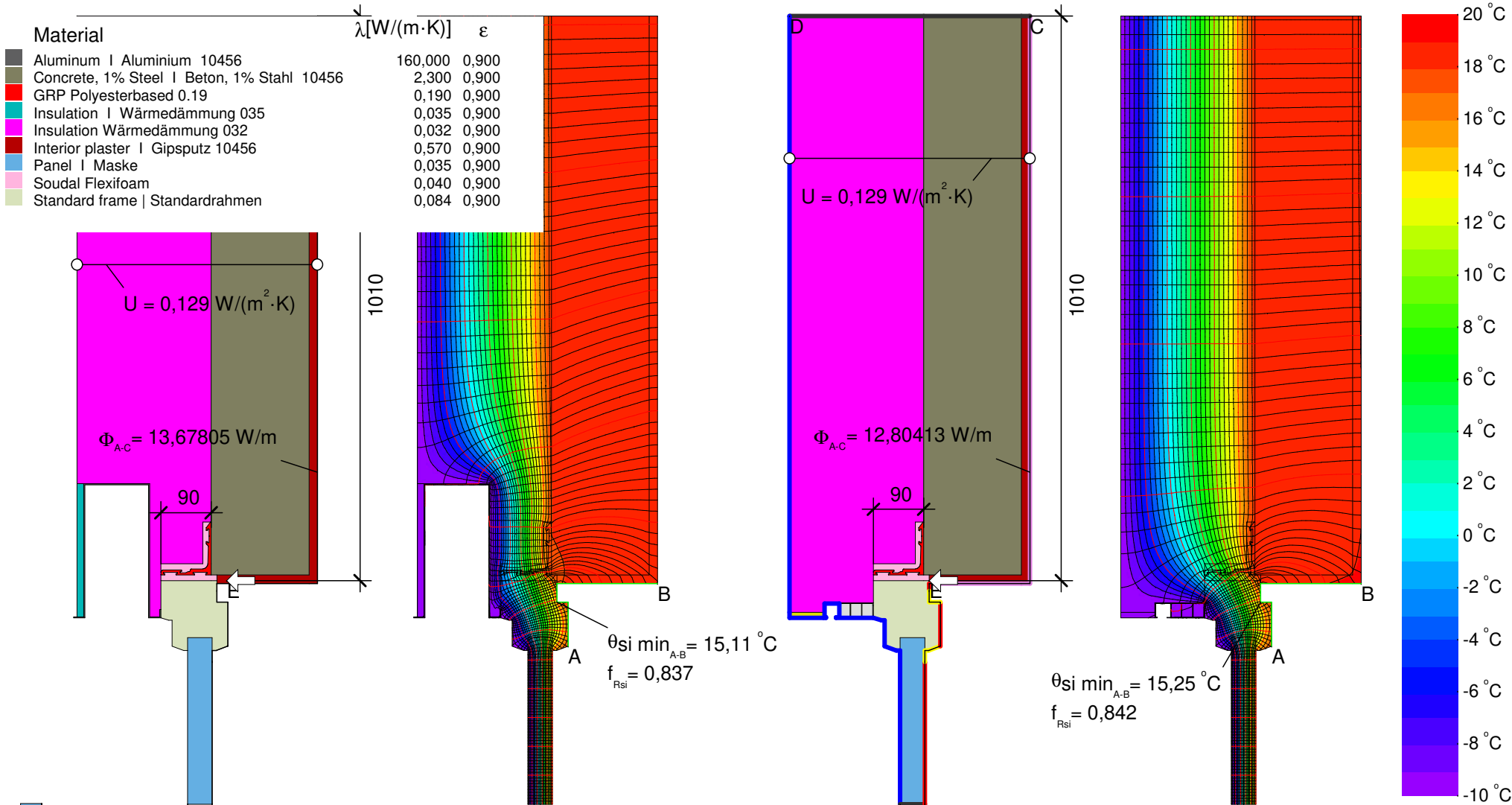
$$\psi_{A-E,C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{12,612}{30,000} - \frac{8,510}{30,000} - 0,129 \cdot 1,010 = 0,007\ W/(m \cdot K)$$



SoudaFrame SWI 90

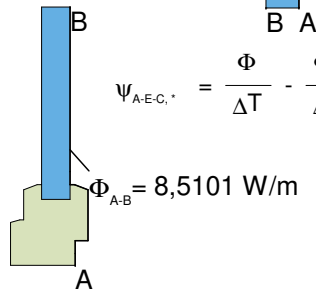
Boundary Condition	q [W/m ²]	θ [°C]	R [(m ² ·K)/W]	ϵ
Adiabatic Adiat	0,000			
Exterior Außen		-10,000	0,040	
Interior Innen		20,000	0,130	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	





$$\psi_{A-E-C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{13,678}{30,000} - \frac{8,510}{30,000} - 0,129 \cdot 1,010 = 0,042 \text{ W}/(\text{m} \cdot \text{K})$$

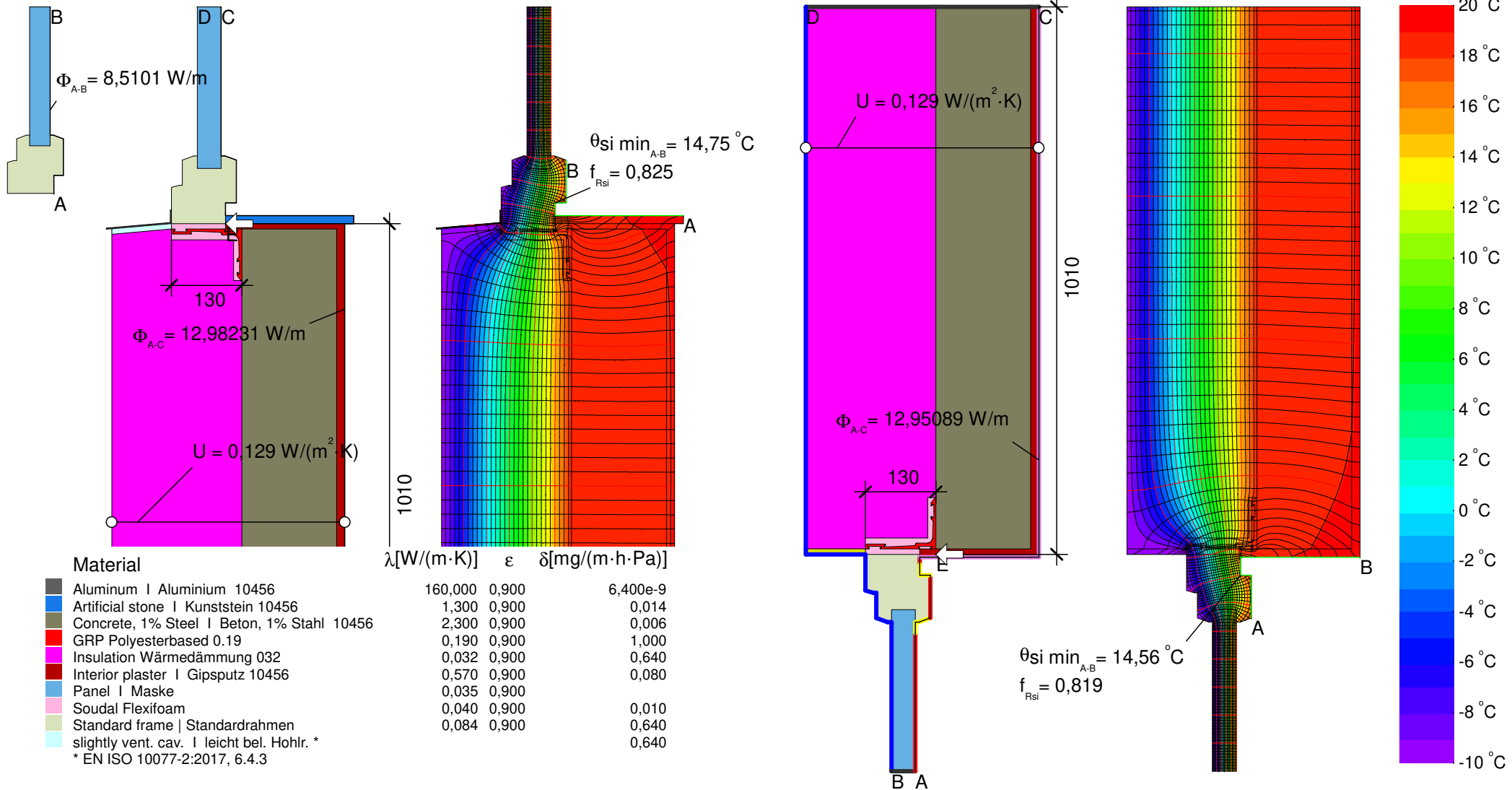
$$\psi_{A-E-C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{12,804}{30,000} - \frac{8,510}{30,000} - 0,129 \cdot 1,010 = 0,013 \text{ W}/(\text{m} \cdot \text{K})$$



Boundary Condition	q [W/m ²]	θ [°C]	R [(m ² ·K)/W]	ϵ
Adiabatic Adiat	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 Hohlraum				0,900

SoudaFrame SWI 90





$$\psi_{A-E,C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{12,982}{30,000} - 0,129 \cdot 1,010 - \frac{8,510}{30,000} = 0,019 \text{ W/(m} \cdot \text{K)}$$

$$\psi_{A-E,C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{12,951}{30,000} - \frac{8,510}{30,000} - 0,129 \cdot 1,010 = 0,018 \text{ W/(m} \cdot \text{K)}$$

Boundary Condition	q [W/m ²]	θ [°C]	R [(m ² ·K)/W]	ϵ	ϕ [%]
Adiabatic Adiat	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

Timber, Plastic pos. 2

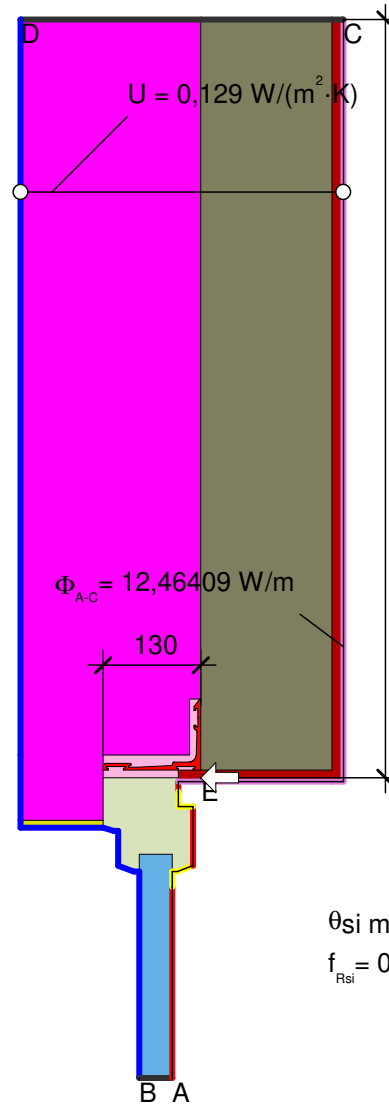
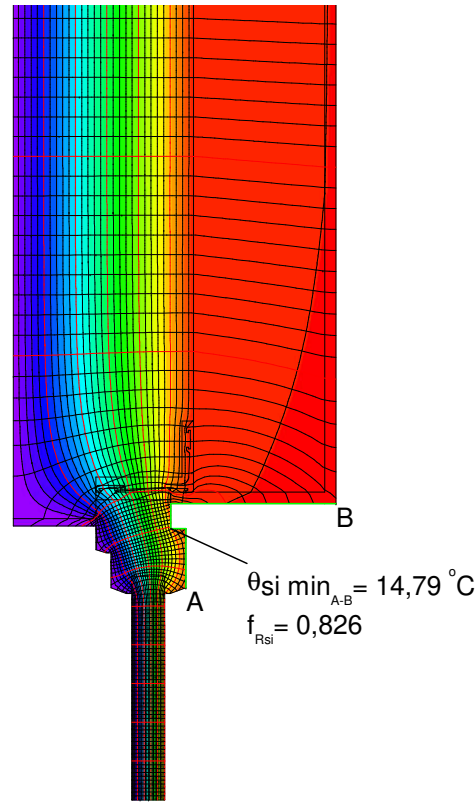
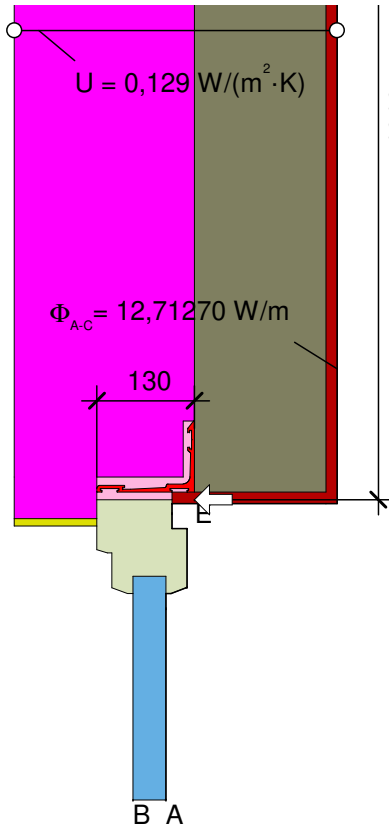
Soudal NV

SoudaFrame SWI 1532pm03

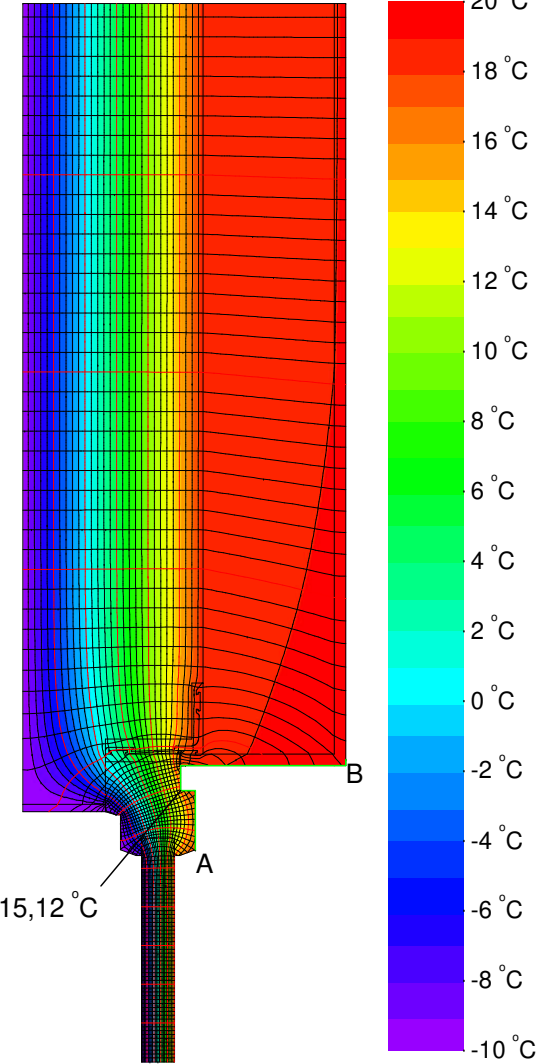


Passive House Institute

Material	λ [W/(m·K)]	ϵ	δ [mg/(m·h·Pa)]
Concrete, 1% Steel 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 Gipsputz 10456	0,570	0,900	0,080
Mörtel, Zement, Sand	1,000	0,900	0,080
Panel Maske	0,035	0,900	
Soudal Flexifoam	0,040	0,900	0,010
Standard frame Standardrahmen	0,084	0,900	0,640

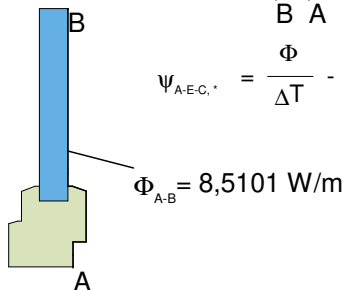


$\theta_{si\ min_{A-B}} = 15,12\ ^\circ C$
 $f_{Rsi} = 0,837$



$$\psi_{A-E-C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{12,713}{30,000} - \frac{8,510}{30,000} - 0,129 \cdot 1,010 = 0,010\ W/(m \cdot K)$$

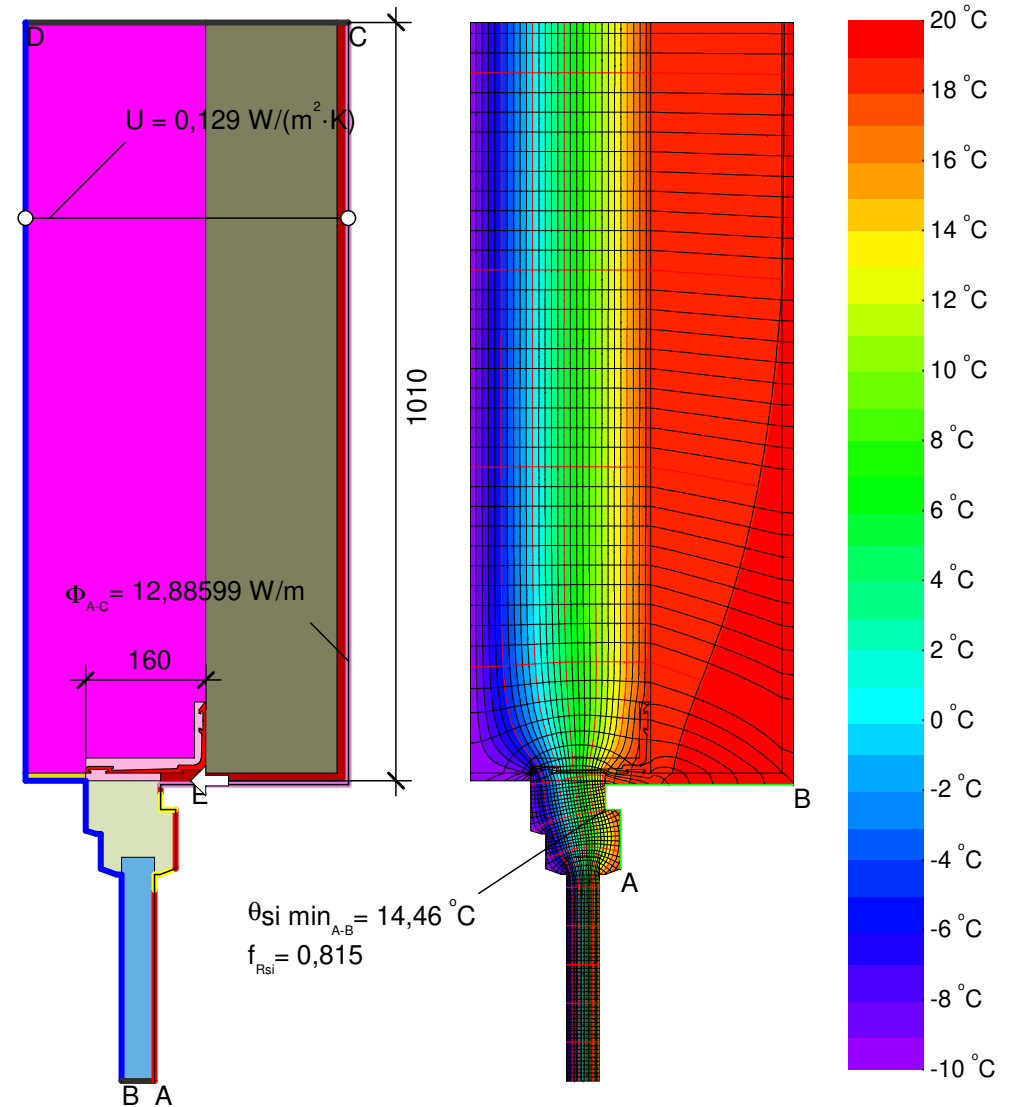
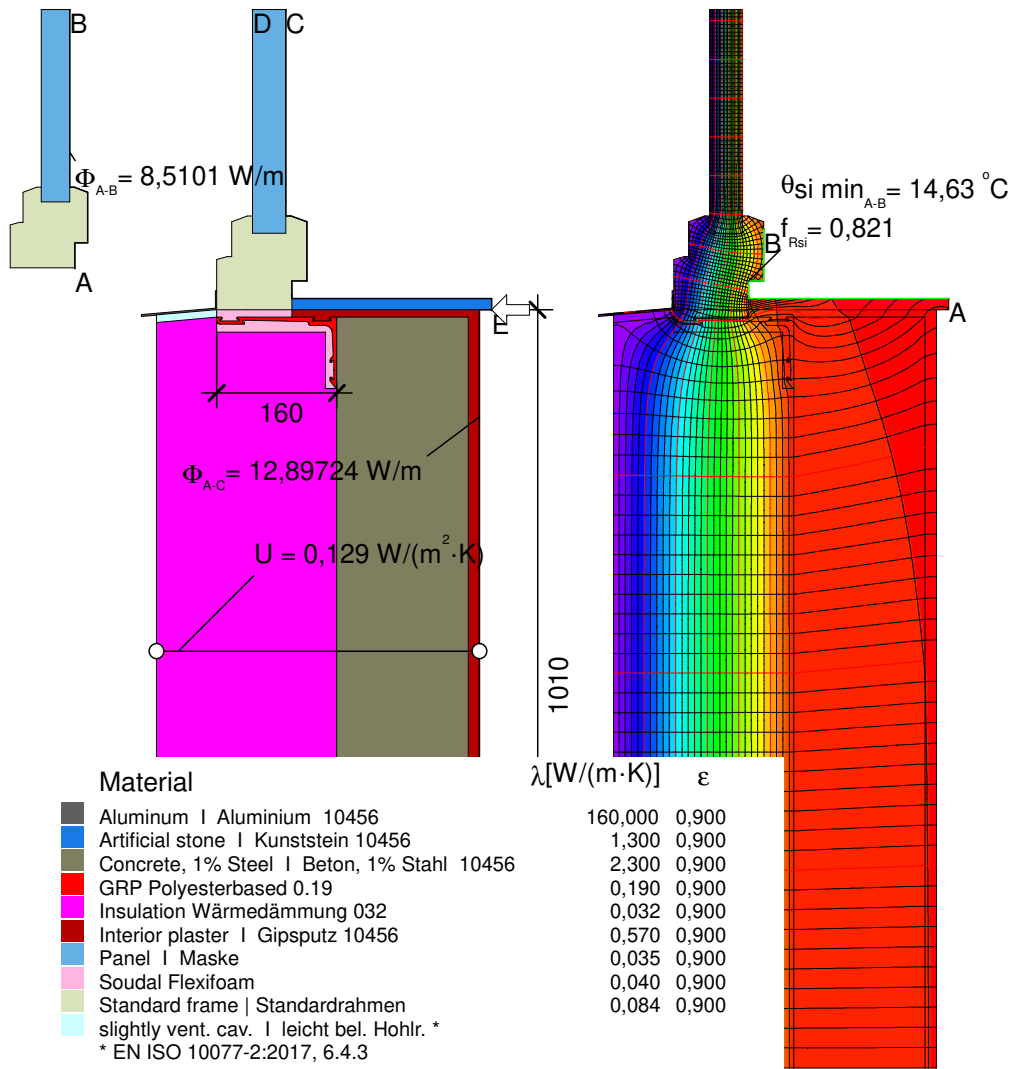
$$\psi_{A-E-C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{12,464}{30,000} - \frac{8,510}{30,000} - 0,129 \cdot 1,010 = 0,002\ W/(m \cdot K)$$



SoudaFrame SWI 130

Boundary Condition	q [W/m ²]	θ [°C]	R [(m ² ·K)/W]	ϵ	ϕ [%]
Adiabatic Adiat	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		





$$\psi_{A-E,C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{12,897}{30,000} - 0,129 \cdot 1,010 - \frac{8,510}{30,000} = 0,016 \text{ W/(m} \cdot \text{K)}$$

$$\psi_{A-E,C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{12,886}{30,000} - \frac{8,510}{30,000} - 0,129 \cdot 1,010 = 0,016 \text{ W/(m} \cdot \text{K)}$$

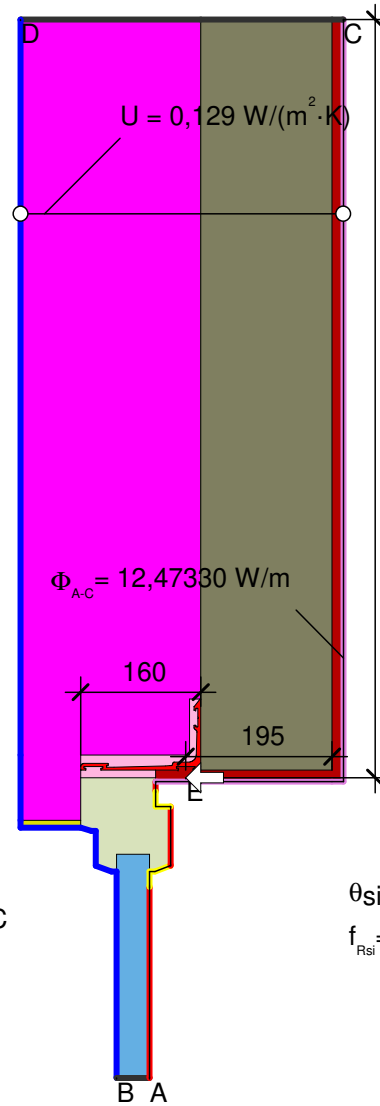
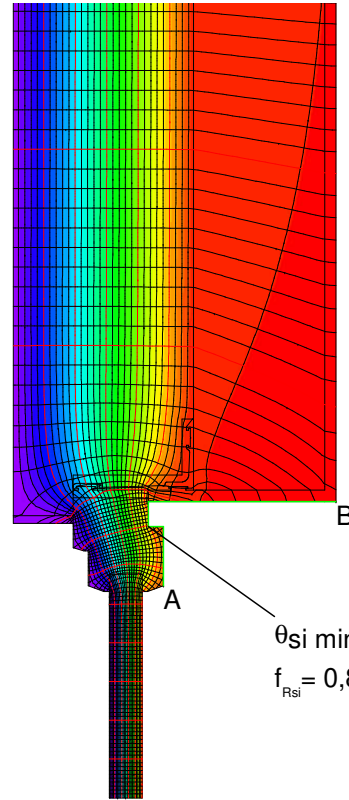
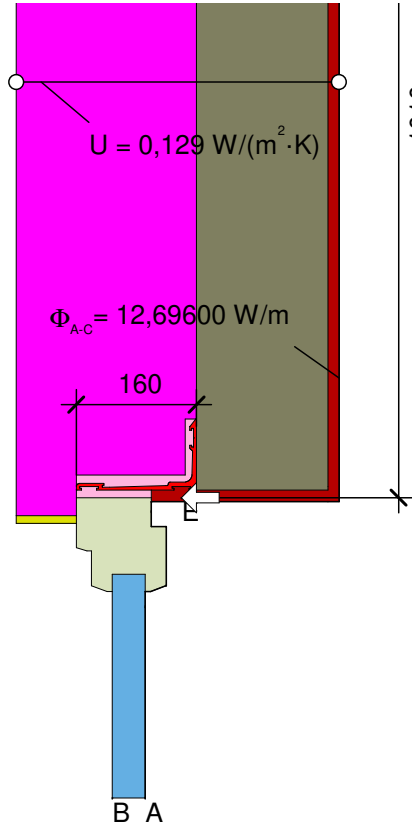
Boundary Condition	q [W/m ²]	θ [°C]	R [(m ² ·K)/W] ϵ
Adiabatic Adiat	0,000		
Exterior Außen		-10,000	0,040
Interior Innen		20,000	0,130
Interior, frame, normal		20,000	0,130
Interior, frame, reduced		20,000	0,200

SoudaFrame SWI 160

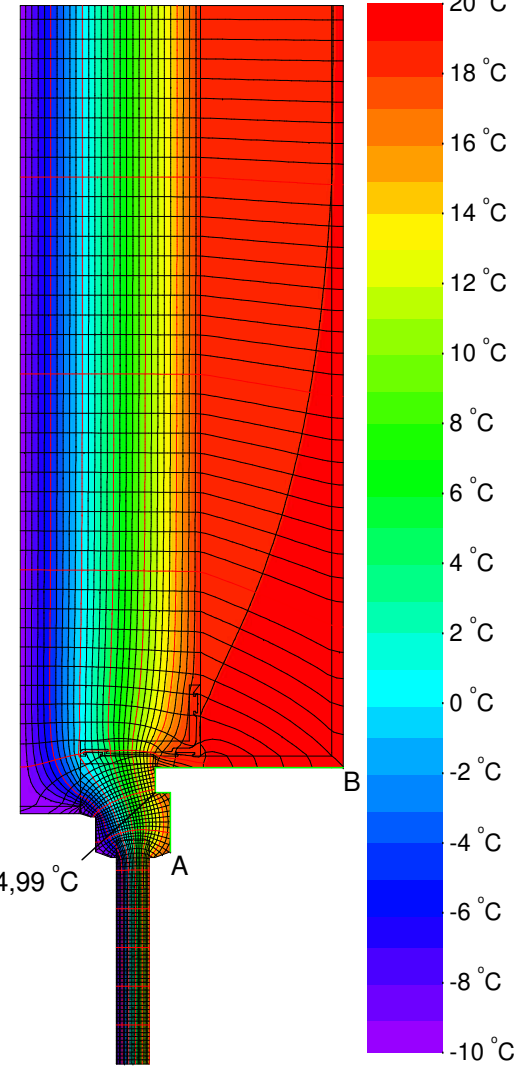
Timber, Plastic pos. 3



Material	λ [W/(m·K)]	ϵ	δ [mg/(m·h·Pa)]
Concrete, 1% Steel 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 Gipsputz 10456	0,570	0,900	0,080
Mörtel, Zement, Sand	1,000	0,900	0,080
Panel Maske	0,035	0,900	
Soudal Flexifoam	0,040	0,900	0,010
Standard frame Standardrahmen	0,084	0,900	0,640

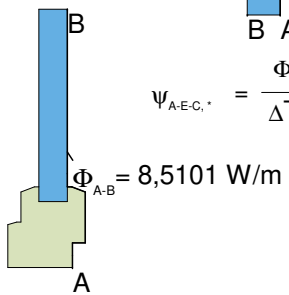


$\theta_{si\ min\ A-B} = 14,99\ ^\circ C$
 $f_{Rsi} = 0,833$



$$\psi_{A-E,C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{12,696}{30,000} - \frac{8,510}{30,000} - 0,129 \cdot 1,010 = 0,010\ W/(m \cdot K)$$

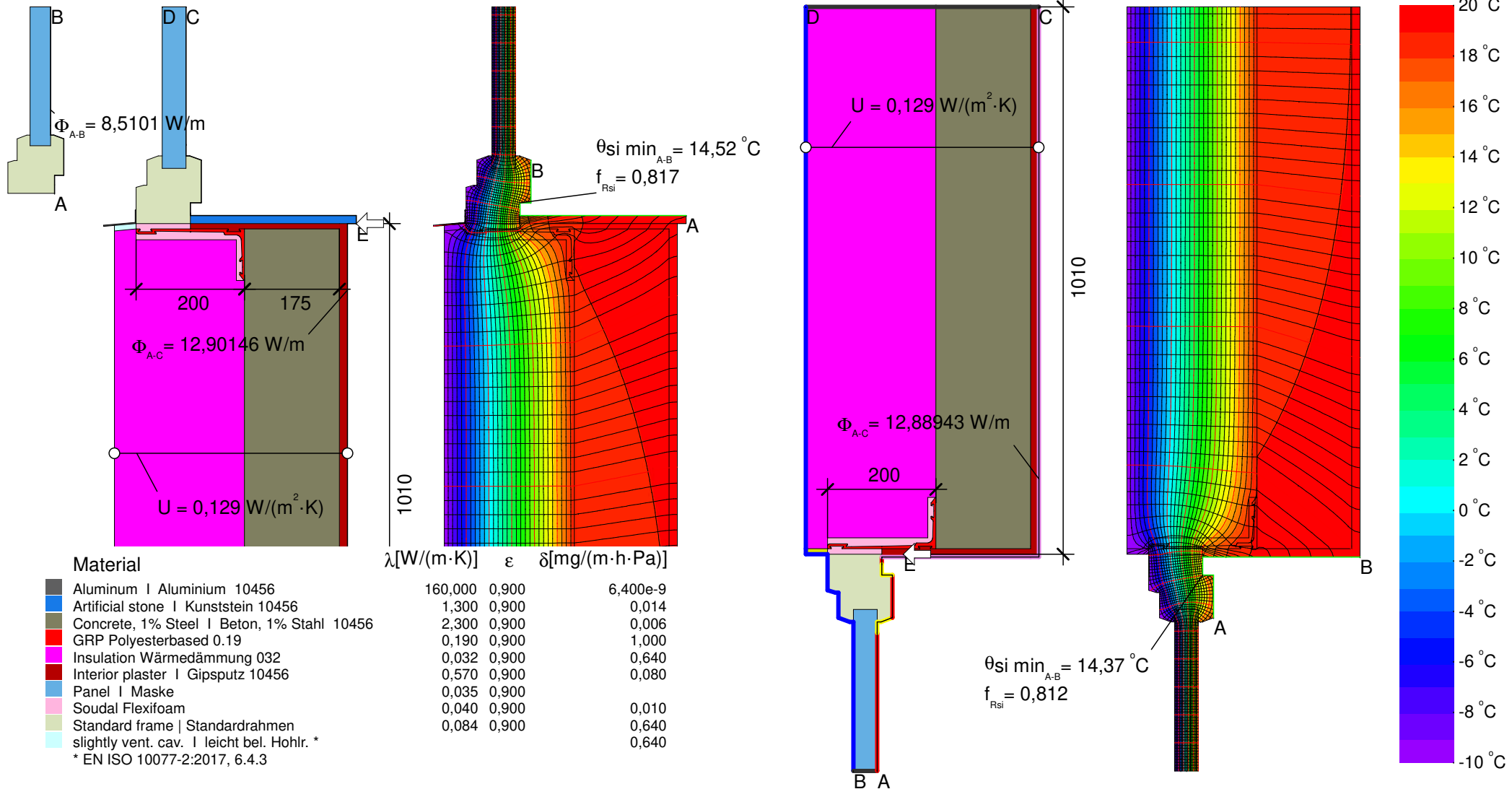
$$\psi_{A-E,C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{12,473}{30,000} - \frac{8,510}{30,000} - 0,129 \cdot 1,010 = 0,002\ W/(m \cdot K)$$



SoudaFrame SWI 160

Boundary Condition	q [W/m ²]	θ [°C]	R [(m ² ·K)/W]	ϵ	ϕ [%]
Adiabatic Adiat	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		





$$\psi_{A-E-C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{12,901}{30,000} - 0,129 \cdot 1,010 - \frac{8,510}{30,000} = 0,016 \text{ W/(m} \cdot \text{K)}$$

$$\psi_{A-E-C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{12,889}{30,000} - \frac{8,510}{30,000} - 0,129 \cdot 1,010 = 0,016 \text{ W/(m} \cdot \text{K)}$$

Boundary Condition	q [W/m ²]	θ [°C]	R [(m ² ·K)/W]	ϵ	ϕ [%]
Adiabatic Adiat	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 200

Timber, Plastic pos. 4

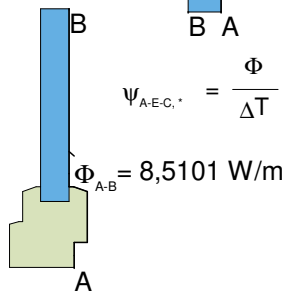
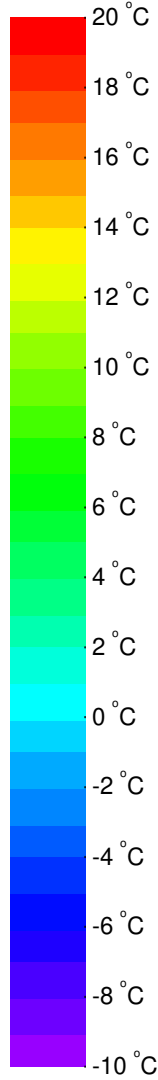
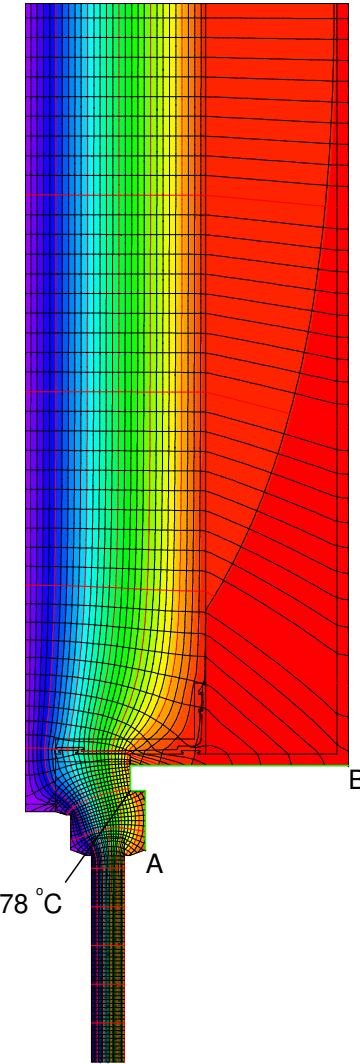
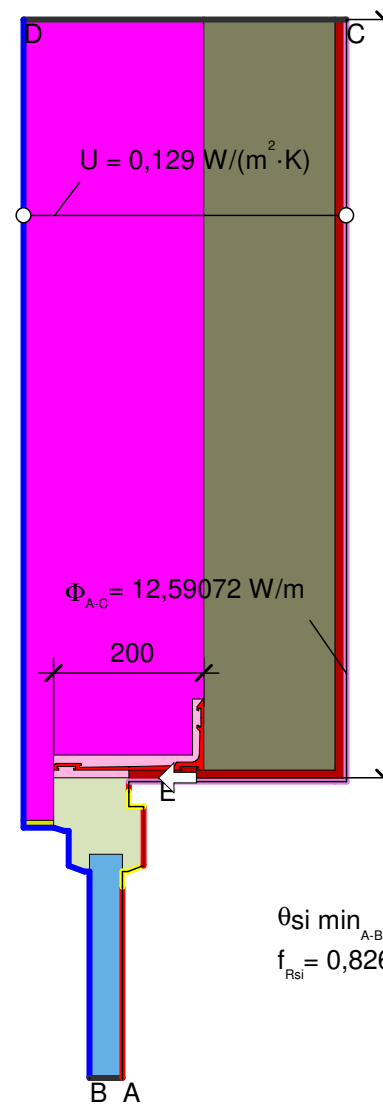
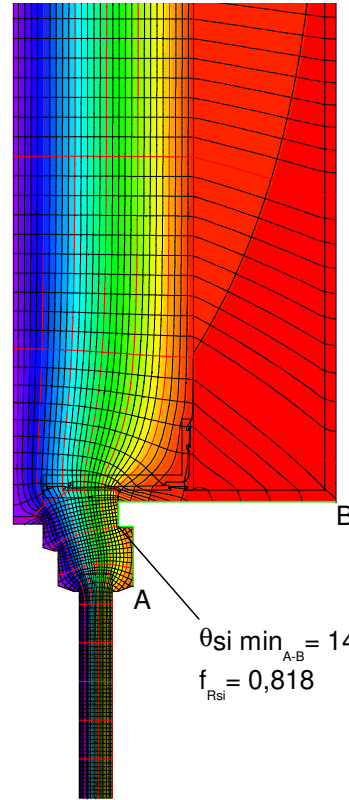
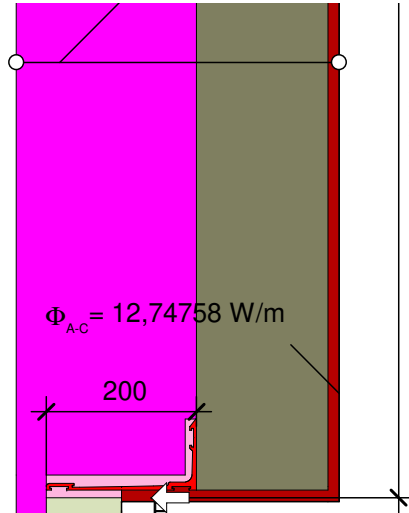
Soudal NV

SoudaFrame SWI 1532pm03



Passive House Institute

Material	λ [W/(m·K)]	ϵ	δ [mg/(m·h·Pa)]
Concrete, 1% Steel 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 Gipsputz 10456	0,570	0,900	0,080
Mörtel, Zement, Sand	1,000	0,900	0,080
Panel Maske	0,035	0,900	
Soudal Flexifoam	0,040	0,900	0,010
Standard frame Standardrahmen	0,084	0,900	0,640



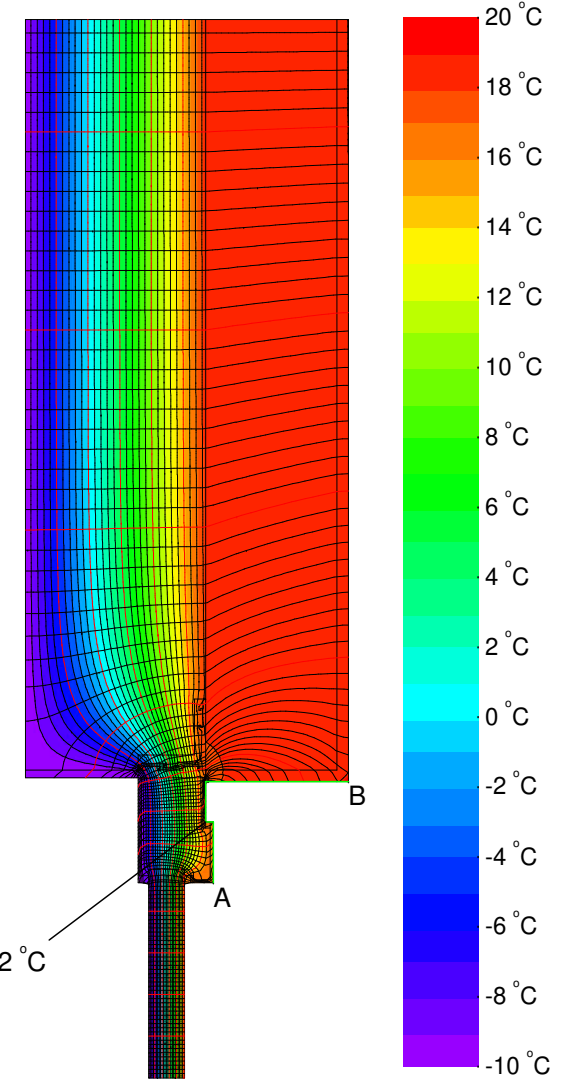
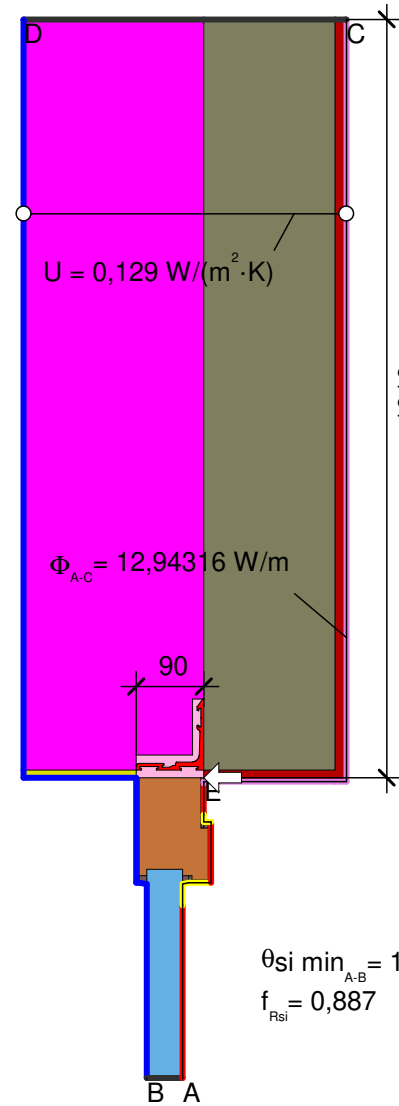
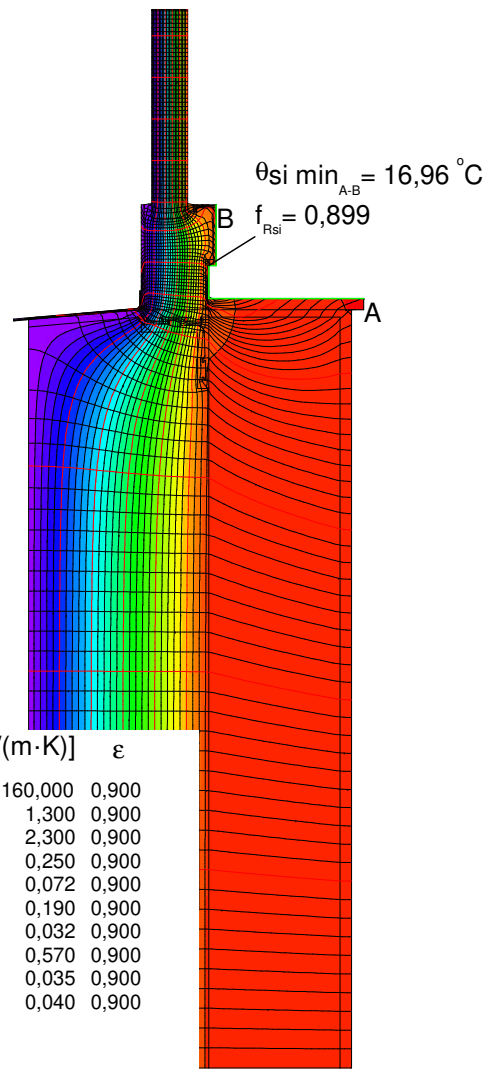
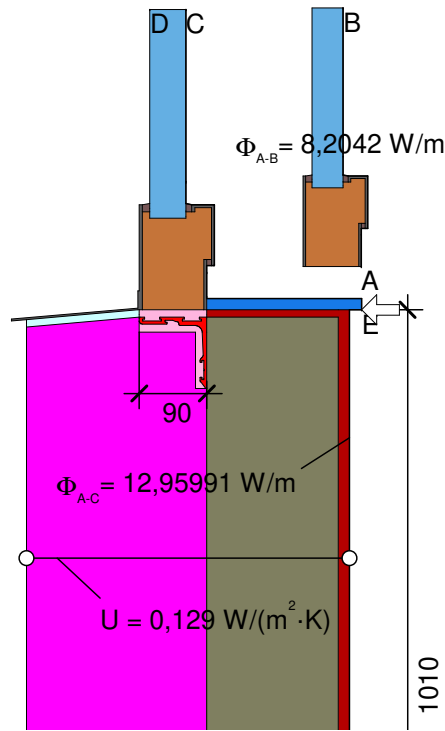
SoudaFrame SWI 200

$$\psi_{A-E-C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{12,748}{30,000} - \frac{8,510}{30,000} - 0,129 \cdot 1,010 = 0,011 \text{ W}/(\text{m} \cdot \text{K})$$

$$\psi_{A-E-C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{12,591}{30,000} - \frac{8,510}{30,000} - 0,129 \cdot 1,010 = 0,006 \text{ W}/(\text{m} \cdot \text{K})$$

Boundary Condition	q [W/m ²]	θ [°C]	R [(m ² ·K)/W]	ϵ	ϕ [%]
Adiabatic Adiat	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 Aluminium 10456	160,000	0,900
Artificial stone Kunststein 10456	1,300	0,900
Concrete, 1% Steel Beton, 1% Stahl 10456	2,300	0,900
EPDM	0,250	0,900
Filling aluminium frame Füllung Alurahmen	0,072	0,900
GRP Polyesterbased 0.19	0,190	0,900
Insulation Wärmedämmung 032	0,032	0,900
Interior plaster Gipsputz 10456	0,570	0,900
Panel Maske	0,035	0,900
Soudal Flexifoam	0,040	0,900
slightly vent. cav. leicht bel. Hohlr. *		
* EN ISO 10077-2:2017, 6.4.3		

$$\Psi_{A-E,C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{12,960}{30,000} - 0,129 \cdot 1,010 - \frac{8,204}{30,000} = 0,029 \text{ W/(m·K)}$$

$$\Psi_{A-E,C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{12,943}{30,000} - \frac{8,204}{30,000} - 0,129 \cdot 1,010 = 0,028 \text{ W/(m·K)}$$

Boundary Condition	q [W/m²]	θ [°C]	R [(m²·K)/W]	ϵ
Adiabatic Adiat	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

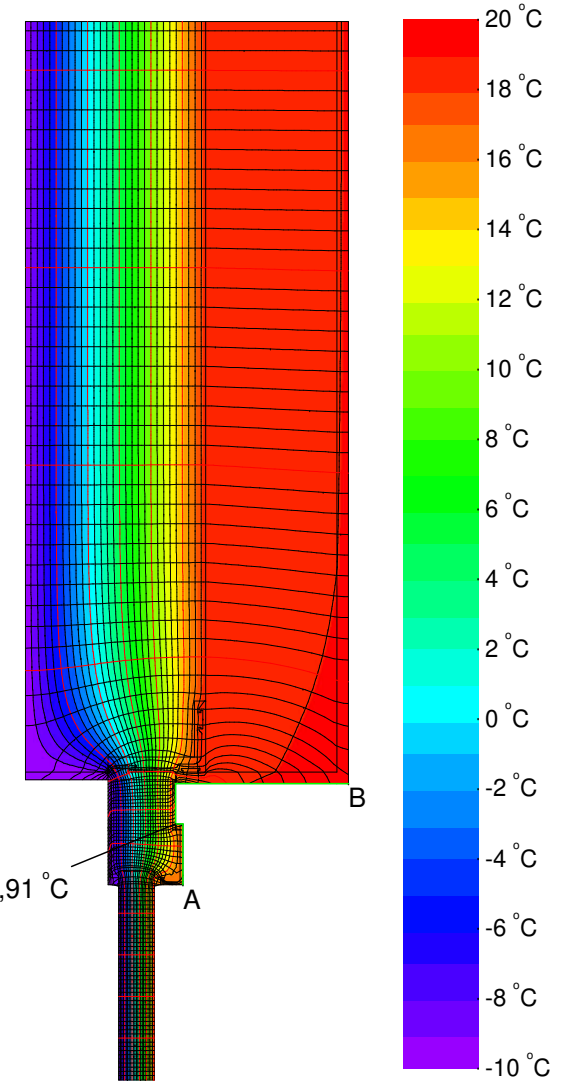
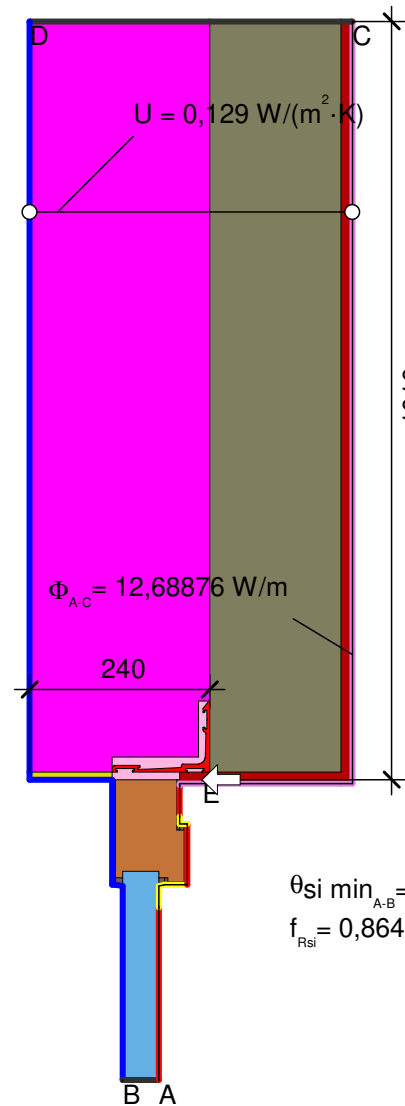
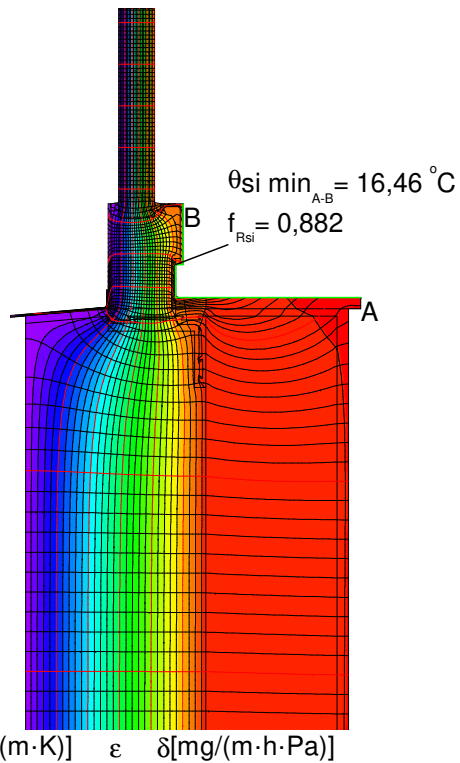
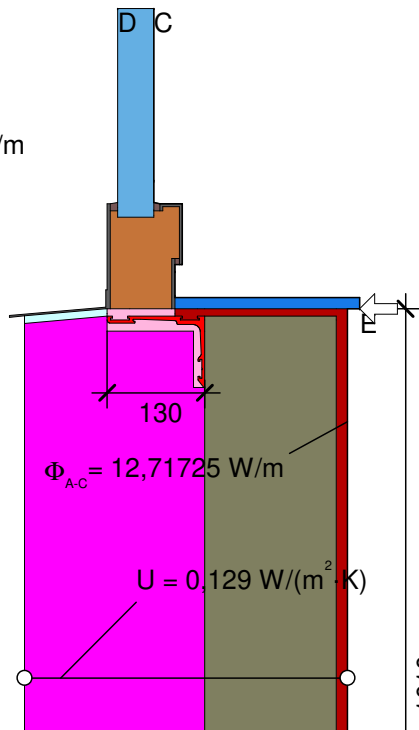
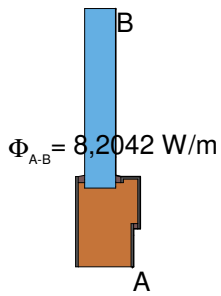
Aluminium pos. 1

Soudal NV

SoudaFrame SWI 1532pm03



Passive House Institute



Material

- Aluminum | Aluminium 10456
 - Artificial stone | Kunststein 10456
 - Concrete, 1% Steel | Beton, 1% Stahl 10456
 - EPDM
 - Filling aluminium frame | Füllung Alurahmen
 - GRP Polyesterbased 0.19
 - Insulation Wärmedämmung 032
 - Interior plaster | Gipsputz 10456
 - Panel | Maske
 - Soudal Flexifoam
 - slightly vent. cav. | leicht bel. Hohlr. *
- * EN ISO 10077-2:2017, 6.4.3

Material	λ [W/(m·K)]	ϵ	δ [mg/(m·h·Pa)]
Aluminum Aluminium 10456	160,000	0,900	6,400e-9
Artificial stone Kunststein 10456	1,300	0,900	0,014
Concrete, 1% Steel Beton, 1% Stahl 10456	2,300	0,900	0,006
EPDM	0,250	0,900	
Filling aluminium frame Füllung Alurahmen	0,072	0,900	0,213
GRP Polyesterbased 0.19	0,190	0,900	1,000
Insulation Wärmedämmung 032	0,032	0,900	0,640
Interior plaster Gipsputz 10456	0,570	0,900	0,080
Panel Maske	0,035	0,900	
Soudal Flexifoam	0,040	0,900	0,010
slightly vent. cav. leicht bel. Hohlr. *			0,640

$$\Psi_{A-E,C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{12,689}{30,000} - \frac{8,204}{30,000} - 0,129 \cdot 1,010 = 0,020 \text{ W/(m} \cdot \text{K)}$$

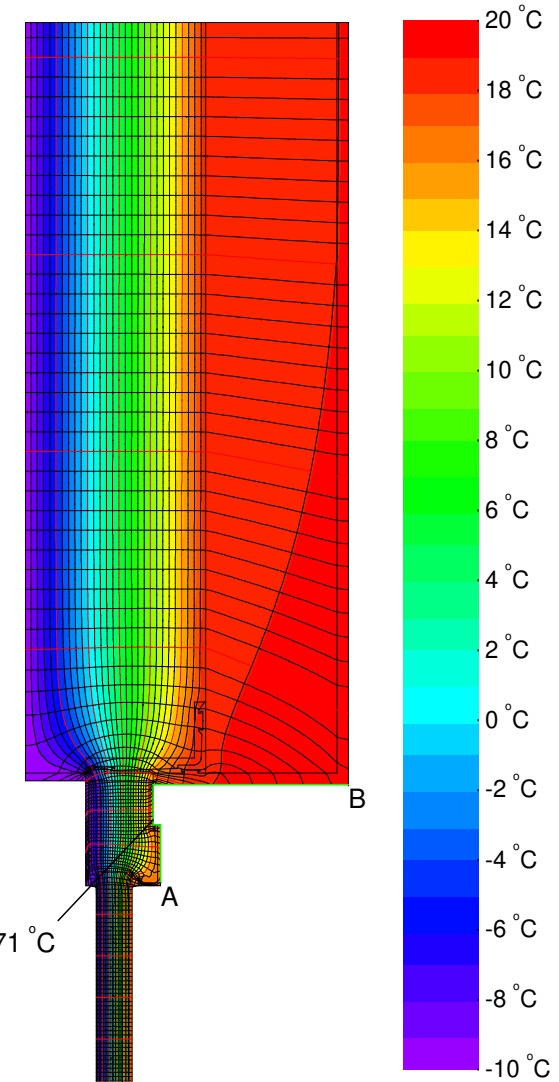
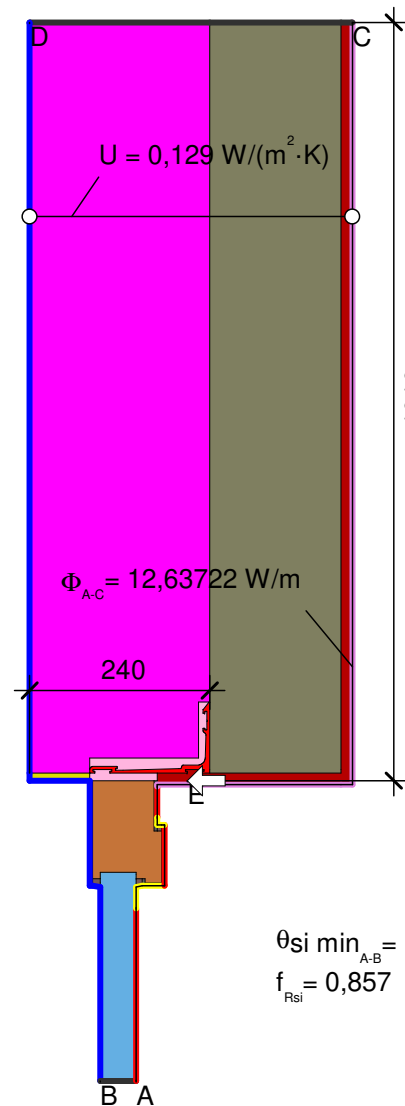
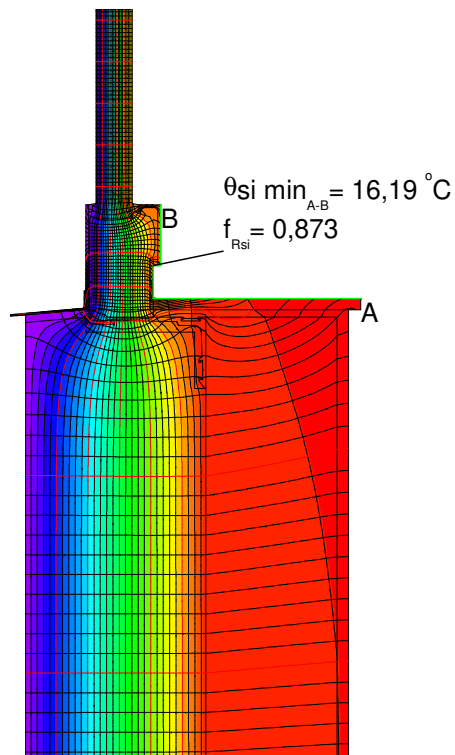
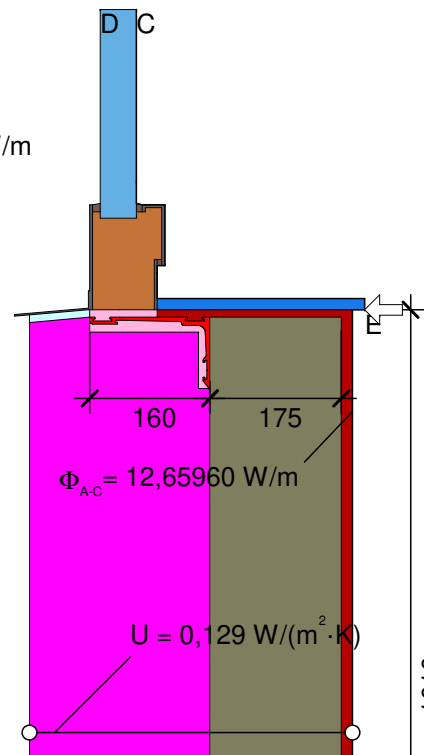
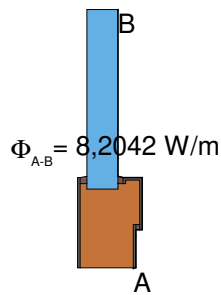
$$\Psi_{A-E,C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{12,717}{30,000} - 0,129 \cdot 1,010 - \frac{8,204}{30,000} = 0,020 \text{ W/(m} \cdot \text{K)}$$

Boundary Condition	q [W/m ²]	θ [°C]	R [(m ² ·K)/W]	ϵ	ϕ [%]
Adiabatic Adiat	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

Aluminium pos. 2





Material

Aluminum Aluminium 10456	160,000	0,900	6,400e-9
Artificial stone Kunststein 10456	1,300	0,900	0,014
Concrete, 1% Steel Beton, 1% Stahl 10456	2,300	0,900	0,006
EPDM	0,250	0,900	
Filling aluminium frame Füllung Alurahmen	0,072	0,900	0,213
GRP Polyesterbased 0.19	0,190	0,900	1,000
Insulation Wärmedämmung 032	0,032	0,900	0,640
Interior plaster Gipsputz 10456	0,570	0,900	0,080
Panel Maske	0,035	0,900	
Soudal Flexifoam	0,040	0,900	0,010
slightly vent. cav. leicht bel. Hohlr. *			0,640

* EN ISO 10077-2:2017, 6.4.3

$\lambda[\text{W/(m}\cdot\text{K)}]$ ϵ $\delta[\text{mg/(m}\cdot\text{h}\cdot\text{Pa)}]$

$$\psi_{A-E-C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{12,660}{30,000} - 0,129 \cdot 1,010 - \frac{8,204}{30,000} = 0,019 \text{ W/(m}\cdot\text{K)}$$

$$\psi_{A-E-C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{12,637}{30,000} - \frac{8,204}{30,000} - 0,129 \cdot 1,010 = 0,018 \text{ W/(m}\cdot\text{K)}$$

Boundary Condition	$q[\text{W/m}^2]$	$\theta[^\circ\text{C}]$	$R[(\text{m}^2 \cdot \text{K})/\text{W}]$	ϵ	$\phi[\%]$
Adiabatic Adiat	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 160

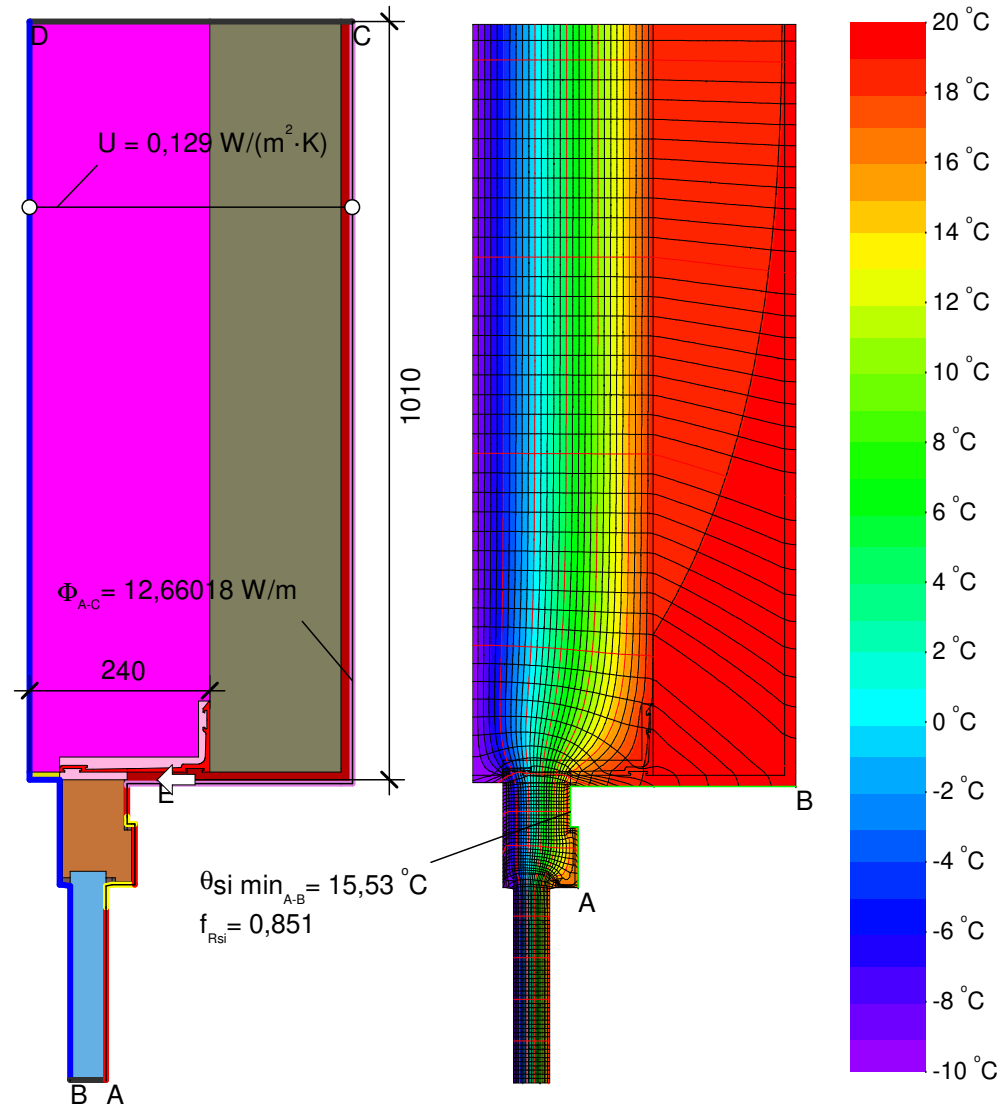
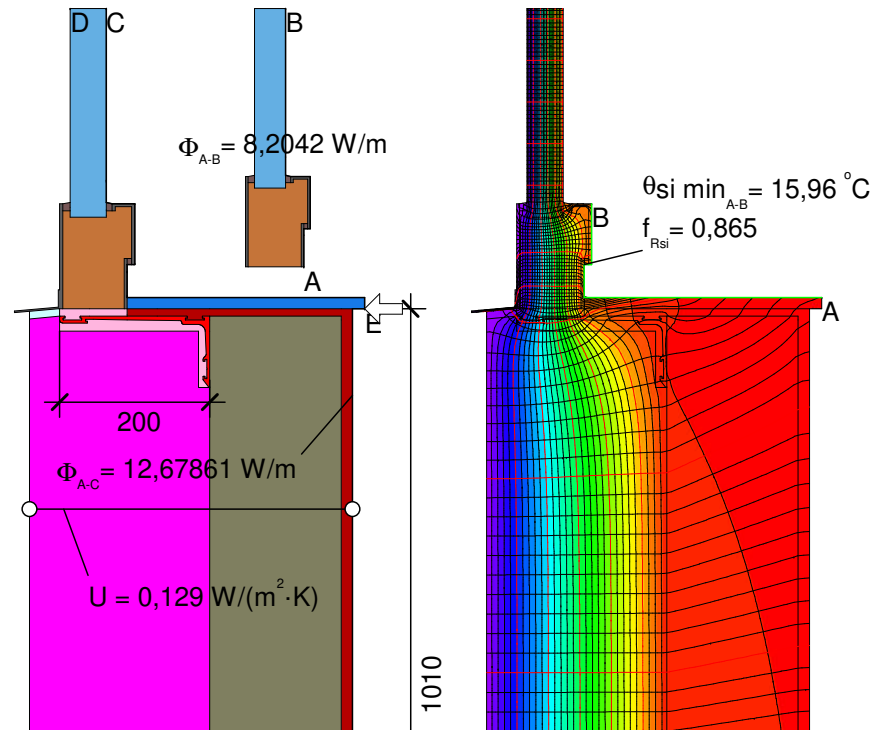
Aluminium pos. 3

Soudal NV

SoudaFrame SWI 1532pm03



Passive House Institute



Material	λ [W/(m·K)]	ϵ	δ [mg/(m·h·Pa)]
Aluminum Aluminium 10456	160,000	0,900	6,400e-9
Artificial stone Kunststein 10456	1,300	0,900	0,014
Concrete, 1% Steel Beton, 1% Stahl 10456	2,300	0,900	0,006
EPDM	0,250	0,900	
Filling aluminium frame Füllung Alurahmen	0,072	0,900	0,213
GRP Polyesterbased 0.19	0,190	0,900	1,000
Insulation Wärmedämmung 032	0,032	0,900	0,640
Interior plaster Gipsputz 10456	0,570	0,900	0,080
Panel Maske	0,035	0,900	
Soudal Flexifoam	0,040	0,900	0,010
slightly vent. cav. leicht bel. Hohlr. *			0,640

* EN ISO 10077-2:2017, 6.4.3

$$\psi_{A-E,C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{12,679}{30,000} - 0,129 \cdot 1,010 - \frac{8,204}{30,000} = 0,019 \text{ W}/(\text{m} \cdot \text{K})$$

$$\psi_{A-E,C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{12,660}{30,000} - \frac{8,204}{30,000} - 0,129 \cdot 1,010 = 0,019 \text{ W}/(\text{m} \cdot \text{K})$$

Boundary Condition	q [W/m ²]	θ [°C]	R [(m ² ·K)/W]	ϵ	ϕ [%]
Adiabatic Adiat	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 200

Aluminium pos. 4

Soudal NV

SoudaFrame SWI 1532pm03



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