Passive House Institute

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

Recommended for | Empfohlen für

Warm, temperate climate | Clima cálido - templado

Window frame
Marco de ventana

1656wi04

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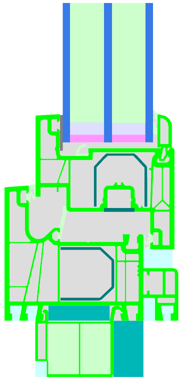
Product | Producto:	**Certification LINEAR**
Client | Fabricante:	**GEALAN Fenster-Systeme GmbH**
Spacer | Separador:	**SWISSPACER Ultimate**
Date | Fecha:	**30.11.2020**
Author | Autor:	**Prof. Dr.-Ing. Benjamin Krick**



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.

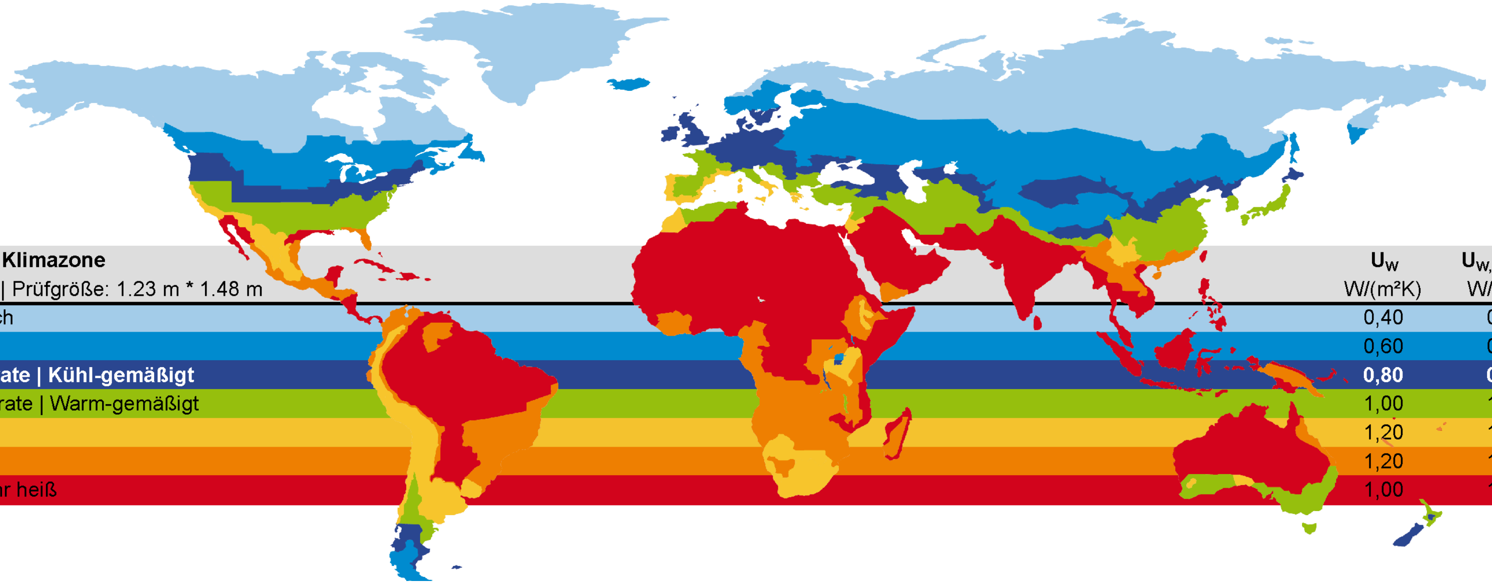
Also the hygiene criterion must be met. For reasons of hygiene, this criterion limits the minimum individual temperature on window surfaces to prevent condensate and mold growth.

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

La posibilidad de renunciar a un sistema de calefacción independiente de las viviendas pasivas implica unos requisitos de calidad muy elevados para los componentes empleados. Cuanto más frío es el clima, mayores son las exigencias. Por ese motivo, el Passivhaus Institut ha identificado las regiones con los mismos requisitos y fijado los criterios de certificación para estas. Estos están disponibles en la página del Passivhaus Institut para su descarga gratuita.
Si no se ha previsto ningún suministro de calefacción por debajo de las ventanas, el coeficiente de la transmitancia térmica de la ventana empleada (valor U de la ventana) UW no puede superar el valor máximo para el clima en cuestión a fin de evitar desagradables pérdidas por radiación y corrientes descendientes de aire frío. De esto resultan para una calidad de acristalamiento determinada los umbrales para la pérdida de calor en el área del marco de la ventana. En este contexto resulta relevante la situación constructiva de la ventana. Por ese motivo, también ha fijado un valor máximo para UW, instalado, que se comprobó a modo de ejemplo en el marco de la certificación.

Del mismo modo, se debe satisfacer el criterio de higiene. Este limita la temperatura individual mínima en el interior de la superficie de la ventana para evitar la aparición de agua condensada y moho.

El Passivhaus Institut (PHI) ha establecido los requisitos que aparecen a continuación para lograr al reconocimiento como “Componente certificado para vivienda pasiva”.



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.

Las ventanas se clasifican en categorías de eficiencia en función de las pérdidas de calor por la parte opaca. Estas categorías incluyen los valores U del marco, las anchuras del marco, los valores Ψ del borde del vidrio y las longitudes del borde del vidrio.

El balance entre la pérdida y la ganancia térmica es relevante para las viviendas pasivas. Debido a que las ganancias solares son difíciles de registrar, resulta útil cuantificar las pérdidas en función de las partes de la ventana y hacer un balance que no permite las ganancias solares. Esto es lo que determina Ψ_{opak}.

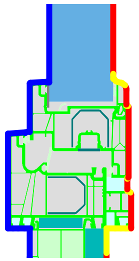
El cálculo de los valores térmicos específicos de las secciones del marco se ha realizado sobre la base de la norma ISO 10077-1:2010 y 10077-2:2012. La conductividad térmica se ha tomado de las normas pertinentes o las autorizaciones de las autoridades constructivas, o se ha determinado según los valores de medición de la norma ISO 10077-2:2012 Parte 5.1 En el caso de una pieza de vidrio, los modelos tienen 40 cm de altura, y los modelos de dos piezas de vidrio, 60 cm de altura.

Los espaciadores se modelaron con arreglo a los modelos de dos cajas del grupo de trabajo "Warm Edge" de la asociación de vidrio plano (Bundesverband Flachglas) de Alemania. Los coeficientes de puentes térmicos se han calculado a modo de ejemplo para construcciones de paredes típicas. Estos valores solo pueden utilizarse en instalaciones idénticas para realizar el cálculo del balance energético. Los modelos para las paredes tienen 1,41 m de altura, y la altura del vidrio y del marco es de 40 cm. La ranura de instalación mide 1 cm.

Para elaborar los modelos y realizar el cálculo de los flujos de calor se empleó el programa Flixo 7 Professional de la empresa Infomind. A continuación, se pueden consultar las condiciones marco empleadas.

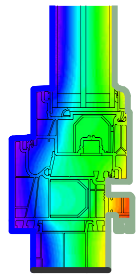
$$\Psi_{opak} = \Psi_g + \frac{U_f \cdot A_f}{l_g}$$

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



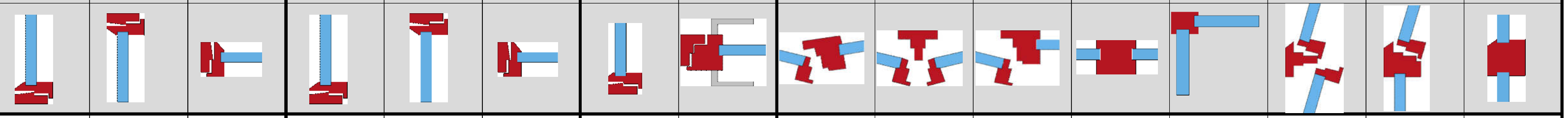
Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε	φ[%]
Adiabatic | Adiabat	0,000				
Exterior | Außen		-10,000	0,040		
Interior, frame, normal		20,000	0,130		
Interior, frame, reduced		20,000	0,200		
e 0,3 Cavity I Hohlraum				0,300	
e 0,9 Cavity I Hohlraum				0,900	

Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε	φ[%]
Adiabatic | Adiabat	0,000				
Exterior | Außen		-10,000	0,040		
e 0,3 Cavity I Hohlraum				0,300	
e 0,9 Cavity I Hohlraum				0,900	
fRsi: Interior | Innen		20,000	0,250		



frame values | Rahmenwerte

GEALAN Fenster-Systeme GmbH		bo Bottom	to Top	si Side	bof Bottom fixed	tof Top fixed	sif Side fixed	th Thres-hold	sh Side door	fm Flying mullion	m2 Mullion	m1 Mullion	m Mullion fixed	ec Corner	t2 Transom	t1 Transom	t Transom fixed
Certification LINEAR		Inferior	Superior	Lateral	Inferior fijo	Superior fijo	Lateral fijo	Umbral	Puerta lateral	Montante móvil	Montante	Montante	Montante fijo	Esquina	Trave-saño	Trave-saño	Trave-saño fijo
Spacer | Separador: SWISSPACER Ultimate																	
Temperaturefactor / Factor de temp.	$f_{Rsi=0,25m^2k/W}$	0,69	0,68	0,68						0,63	0,65	0,66					
Frame width / Ancho del marco	b_f [mm]	140	110	110						152	170	134					
U-value frame / Valor-U marco	**Uf** [W/(m²K)]	0,99	1,02	1,02						1,22	1,23	1,22					
Ψ-glass edge / Ψ borde del vidrio	**Ψg** [W/(mK)]	0,027	0,028	0,028						0,027	0,027	0,027					
U-value window / Valor-U ventana	Uw [W/(m²K)] @Ug= 0,9 W/(m²K)		**1,004**														
Ψ_{opaque}	Ψ_{opaque} W/(mK)		**0,158**														
Passive House effiziency class / Clasificación de eficiencia Passive House			**phC**														



EIFS | SATE U-Wall = 0,228 W/(m²K)

	bo	to	si	bof	tof	sif	th	sh
$\Psi_{install}$ [W/(mK)]	0,039	0,007	0,007					
$U_{W, installed}$ [W/(m²K)]		1,05						

Lightwight timber construction | Entramado ligero de madera U-Wall = 0,189 W/(m²K)

	bo	to	si	bof	tof	sif	th	sh
$\Psi_{install}$ [W/(mK)]	0,013	0,004	0,004					
$U_{W, installed}$ [W/(m²K)]		1,02						

Formwork blocks | Bloques de hormigón U-Wall = 0,251 W/(m²K)

	bo	to	si	bof	tof	sif	th	sh
$\Psi_{install}$ [W/(mK)]	0,017	-0,006	-0,006					
$U_{W, installed}$ [W/(m²K)]		1,00						

Ventilated facade | Fachada ventilada U-Wall = 0 W/(m²K)

	bo	to	si	bof	tof	sif	th	sh
$\Psi_{install}$ [W/(mK)]								
$U_{W, installed}$ [W/(m²K)]								

Cavity wall | Muro con cámara U-Wall = 0 W/(m²K)

	bo	to	si	bof	tof	sif	th	sh
$\Psi_{install}$ [W/(mK)]								
$U_{W, installed}$ [W/(m²K)]								

Contact person | Ansprechpartner

GEALAN Fenster-Systeme GmbH, Jörn Werner
+34673726806 joern,werner@gealan.de

Construction:

PVC frame insulated EPS-foam, 0.035W/(mK). Frame 7001 with reinforcement 7730 and bottom frame extension 7202 IKD, Profil frame inside 5261, mullion 7060 with reinforcement 7732, sash 7072 STV with reinforcement 7730.
Pane thickness: 48 mm (4/18/4/18/4), rebate depth: 14 mm.
Maximum window size up to 30 kg/m² glass weight: White and Colored sash 7072 STV 7730 0.90 * 2.1 m.

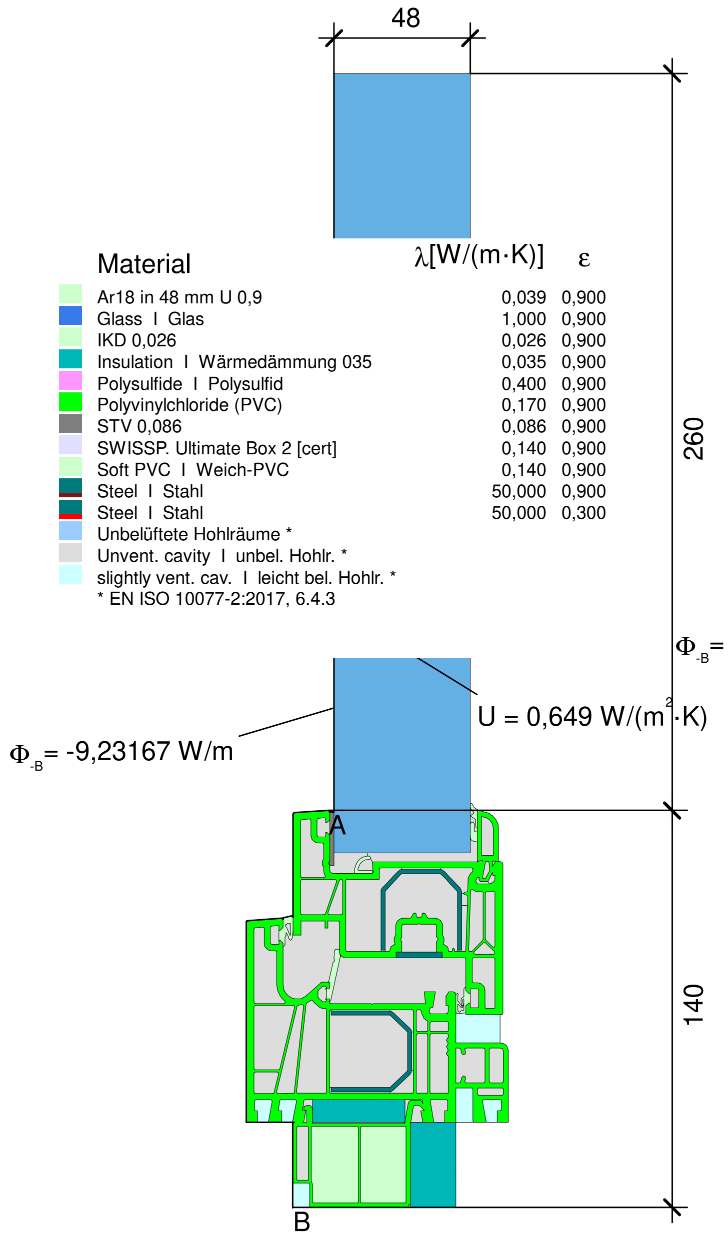
Descripción:

Marco de PVC EPS, 0,035 W/(mK). Marco 7001 con refuerzo 7730 y ensanche inferior 7202 IKD,
Perfil marco interior 5261, batiente 7060 con refuerzo 7732, hoja 7072 STV con refuerzo 7730.
Espesor del acristalamiento 48 mm (4/18/4/18/4), Altura de solape: 14 mm.
Tamaño máximo de la ventana hasta 30 kg / m² de peso del vidrio: Hoja 7072 STV 7730 en blanco e color 0,90 * 2,1 m.

Calculation | Cálculo

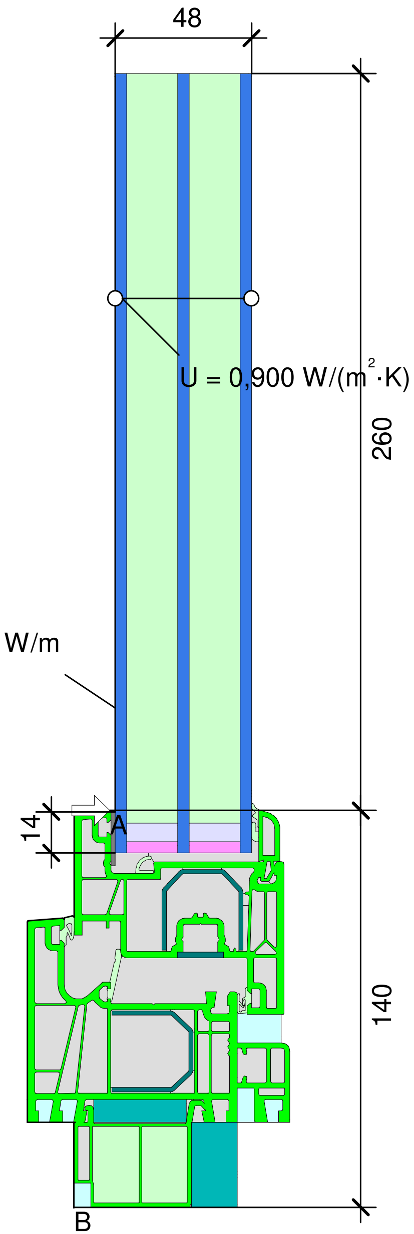
Passivhaus Institut Darmstadt 30.11.2020

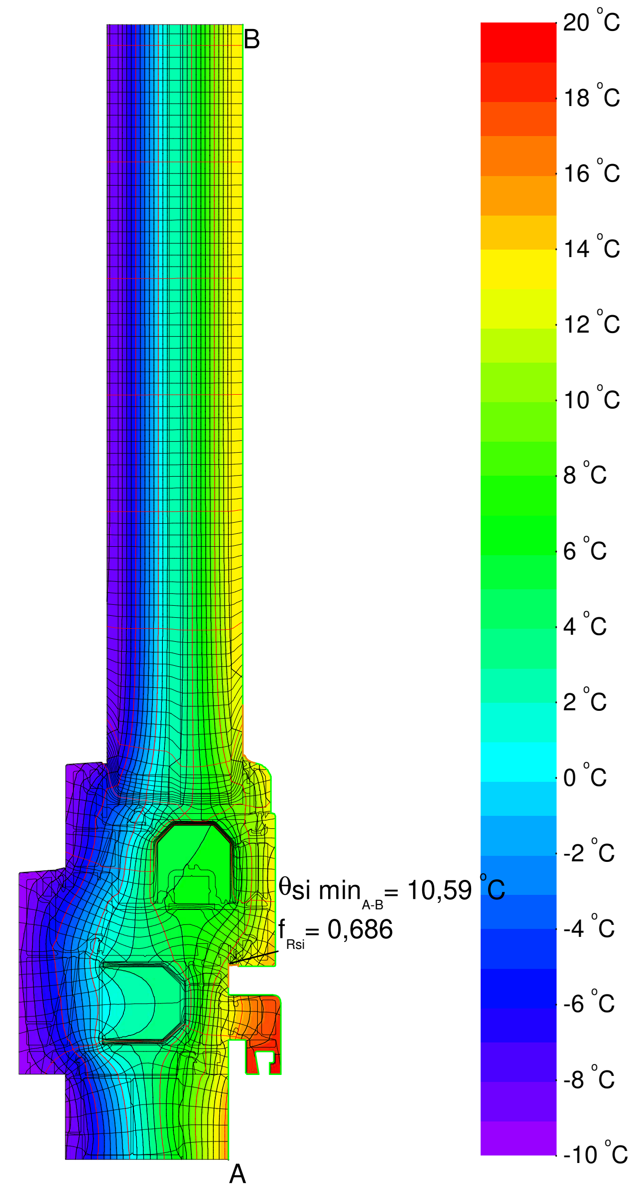
Passive House Institute



Material	λ[W/(m·K)]	ε
Ar18 in 48 mm U 0,9	0,039	0,900
Glass I Glas	1,000	0,900
IKD 0,026	0,026	0,900
Insulation I Wärmedämmung 035	0,035	0,900
Polysulfide I Polysulfid	0,400	0,900
Polyvinylchloride (PVC)	0,170	0,900
STV 0,086	0,086	0,900
SWISSP. Ultimate Box 2 [cert]	0,140	0,900
Soft PVC I Weich-PVC	0,140	0,900
Steel I Stahl	50,000	0,900
Steel I Stahl	50,000	0,300
Unbelüftete Hohlräume *		
Unvent. cavity I unbel. Hohlr. *		
slightly vent. cav. I leicht bel. Hohlr. *		

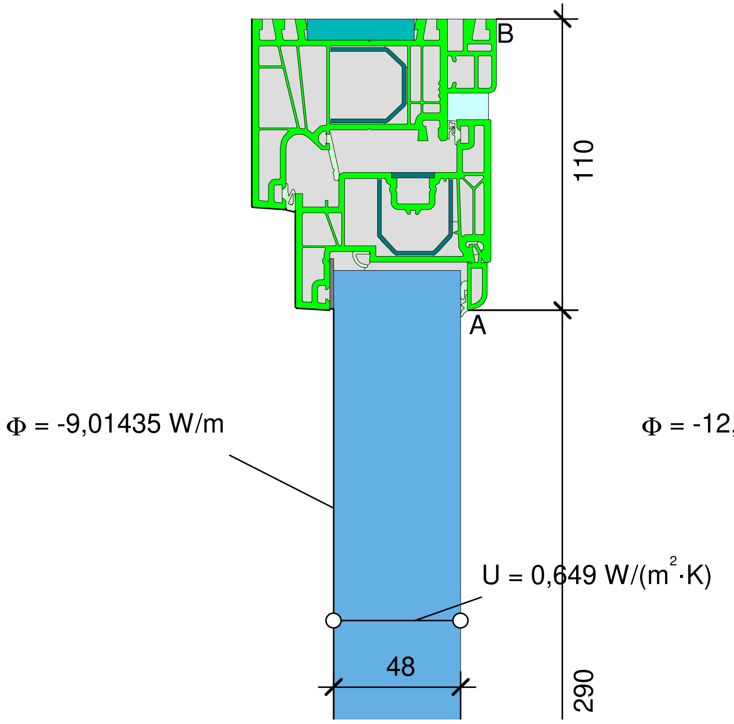
* EN ISO 10077-2:2017, 6.4.3

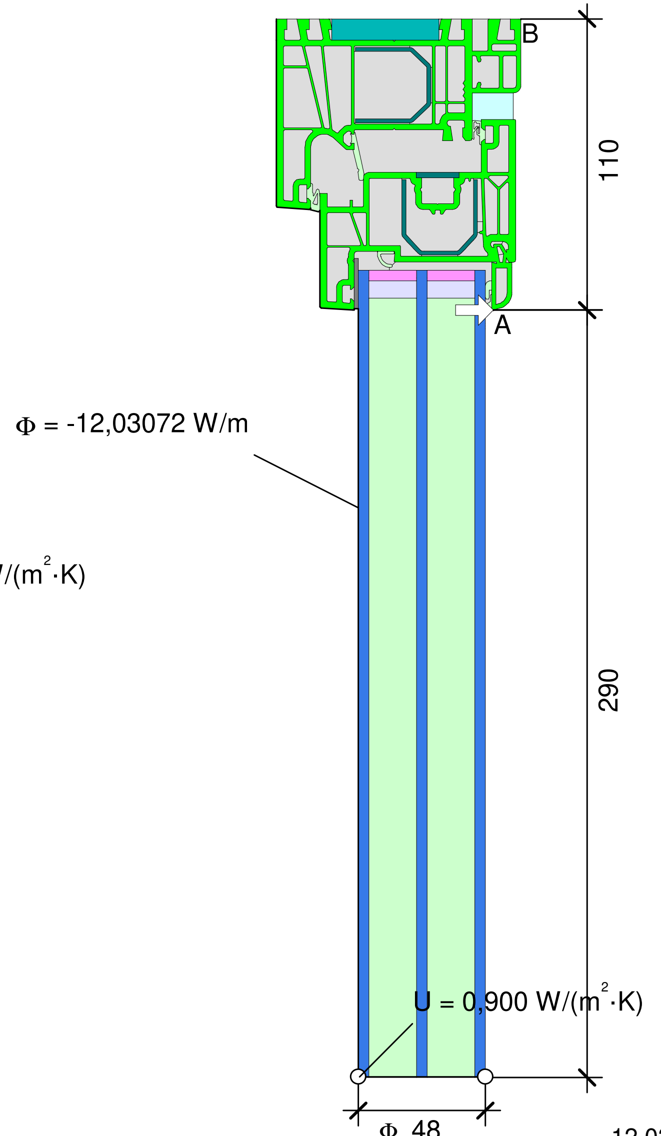


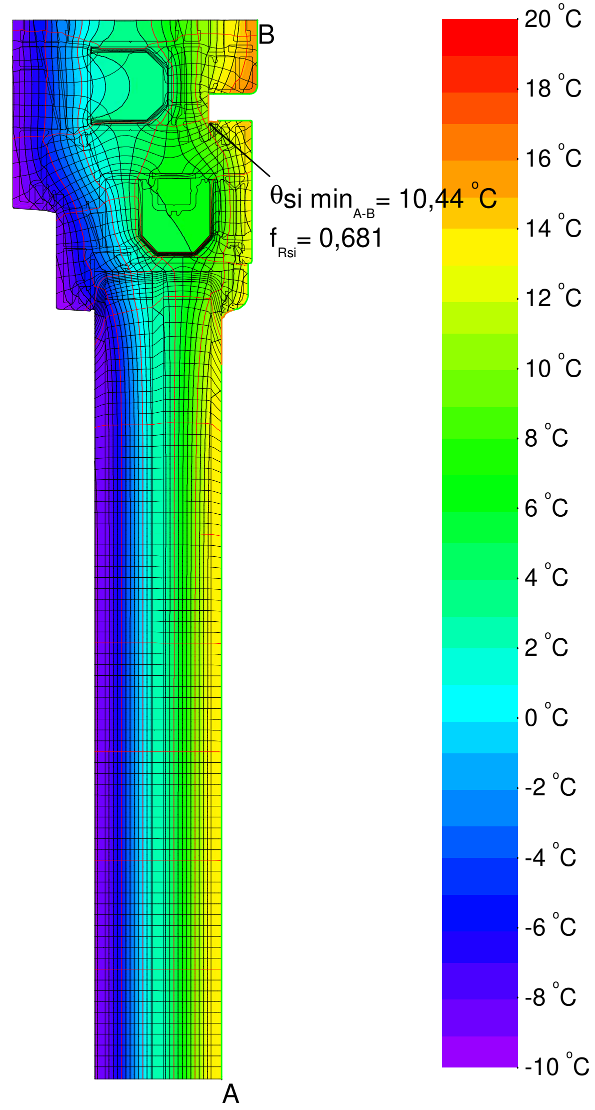


$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{9,232}{30,000} - 0,649 \cdot 0,260}{0,140} = 0,993\ W/(m^2 \cdot K)$$

$$\Psi_{ed\,A} = \frac{\Phi}{\Delta T} - U_g \cdot b_g - U_f \cdot b_f = \frac{12,013}{30,000} - 0,900 \cdot 0,260 - 0,993 \cdot 0,140 = 0,027\ W/(m \cdot K)$$





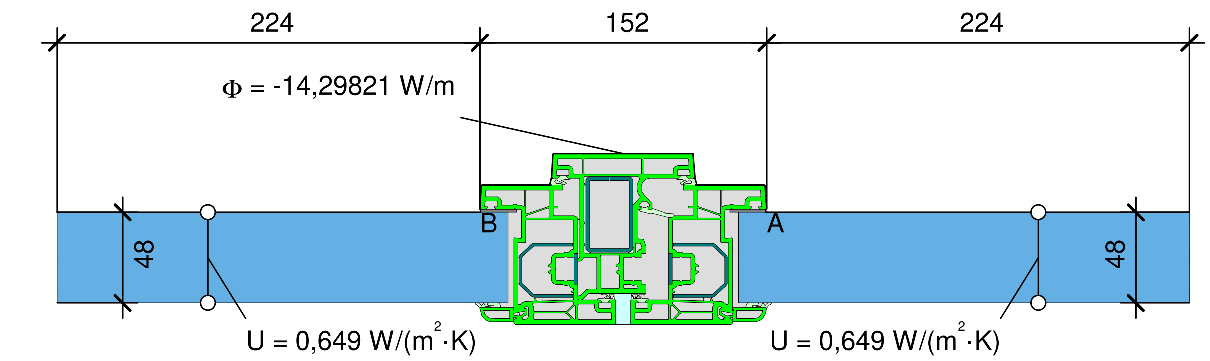


Material	λ[W/(m·K)]	ε
Ar18 in 48 mm U 0,9	0,039	0,900
Glass I Glas	1,000	0,900
Insulation I Wärmedämmung 035	0,035	0,900
Polysulfide I Polysulfid	0,400	0,900
Polyvinylchloride (PVC)	0,170	0,900
STV 0,086	0,086	0,900
SWISSP. Ultimate Box 2 [cert]	0,140	0,900
Soft PVC I Weich-PVC	0,140	0,900
Steel I Stahl	50,000	0,300
Steel I Stahl	50,000	0,900
Unvent. cavity I unbel. Hohlr. *		
slightly vent. cav. I leicht bel. Hohlr. *		

* EN ISO 10077-2:2017, 6.4.3

$$\Psi_{ed\,A} = \frac{\Phi}{\Delta T} - U_g \cdot b_g - U_f \cdot b_f = \frac{12{,}031}{30{,}000} - 0{,}900 \cdot 0{,}290 - 1{,}021 \cdot 0{,}110 = 0{,}028\ W/(m \cdot K)$$

$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{9{,}014}{30{,}000} - 0{,}649 \cdot 0{,}290}{0{,}110} = 1{,}021\ W/(m^2 \cdot K)$$



Material	λ[W/(m·K)]	ε
Ar18 in 48 mm U 0,9	0,039	0,900
Glass I Glas	1,000	0,900
Hart-Polyvinylchlorid (PVC)	0,170	0,900
Polysulfide I Polysulfid	0,400	0,900
Polyvinylchloride (PVC)	0,170	0,900
STV 0,086	0,086	0,900
SWISSP. Ultimate Box 2 [cert]	0,140	0,900
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Unbelüftete Hohlräume *		
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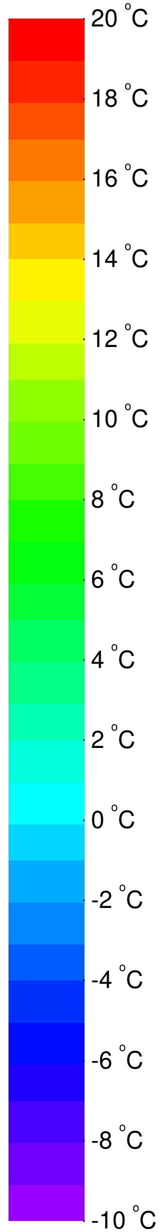
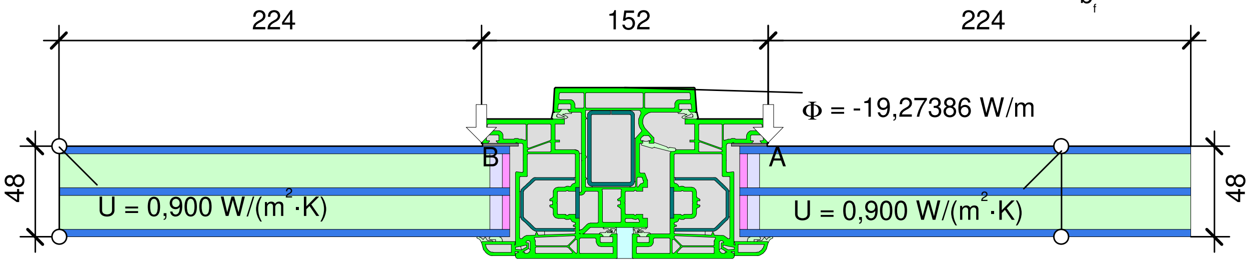
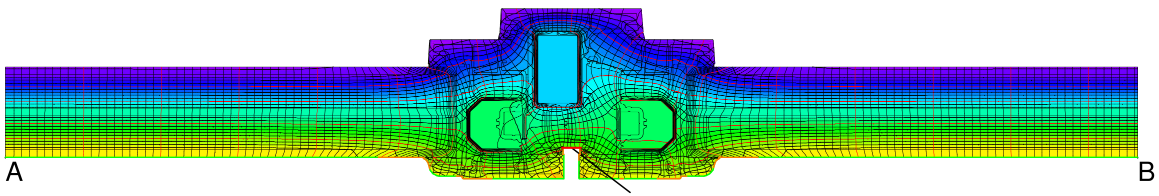


$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_{p1}\cdot b_{p1} - U_{p2}\cdot b_{p2}}{b_f} = \frac{\frac{14,298}{30,000} - 0,649\cdot 0,224 - 0,649\cdot 0,224}{0,152} = 1,223\ W/(m^2\cdot K)$$

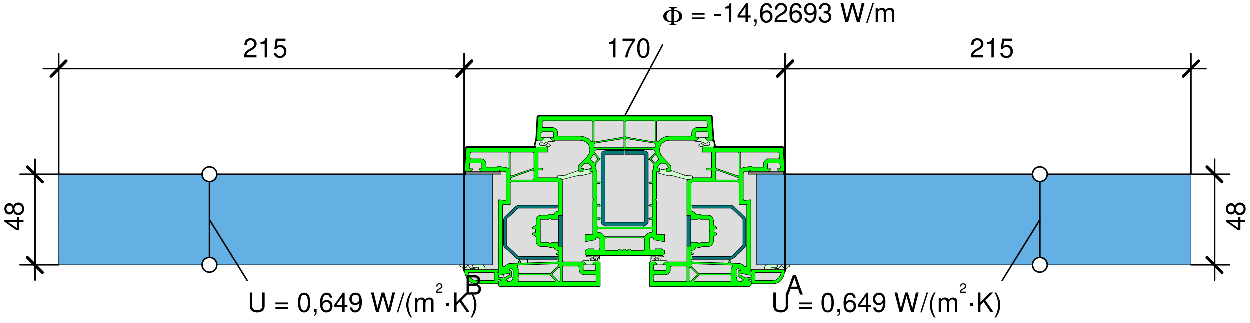


$$\Psi_{ed\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_{g1}\cdot b_{g1} - U_f\cdot b_f - U_{g2}\cdot b_{g2}}{2} = \frac{\frac{19,274}{30,000} - 0,900\cdot 0,224 - 1,223\cdot 0,152 - 0,900\cdot 0,224}{2} = 0,027\ W/(m\cdot K)$$



$\theta si\ min_{A\text{-}B} = 8,90\ ^\circ C$

$f_{Rsi} = 0,630$



Material	λ[W/(m·K)]	ε
Ar18 in 48 mm U 0,9	0,039	0,900
Glass I Glas	1,000	0,900
Hart-Polyvinylchlorid (PVC)	0,170	0,900
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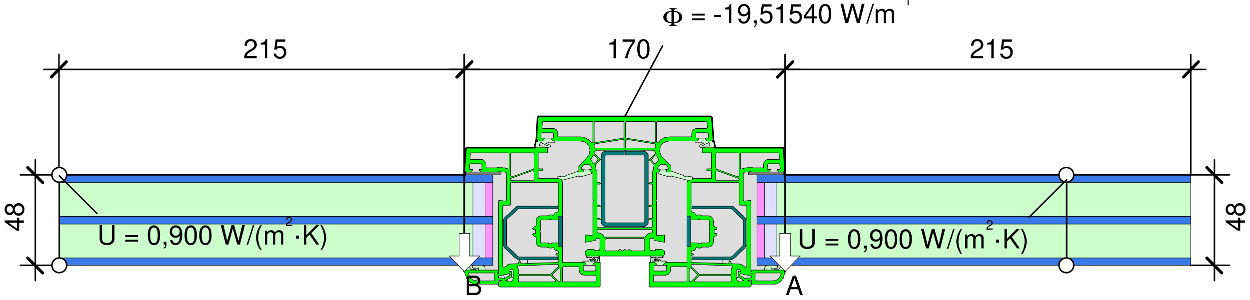
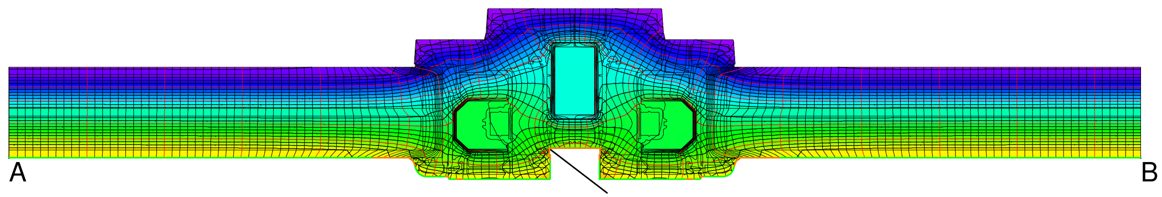
Unvent. cavity I unbel. Hohlr. *		

* EN ISO 10077-2:2017, 6.4.3

$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_{p1}\cdot b_{p1} - U_{p2}\cdot b_{p2}}{b_f} = \frac{\frac{14,627}{30,000} - 0,649\cdot 0,215 - 0,649\cdot 0,215}{0,170} = 1,227\ W/(m^2\cdot K)$$

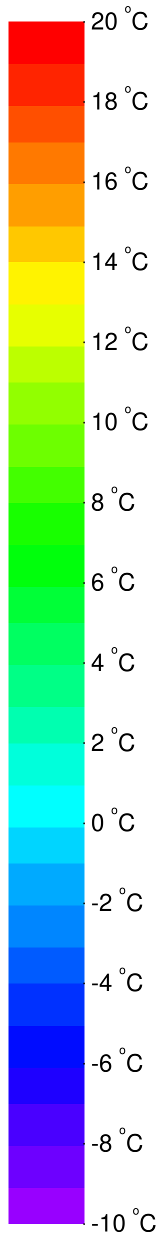


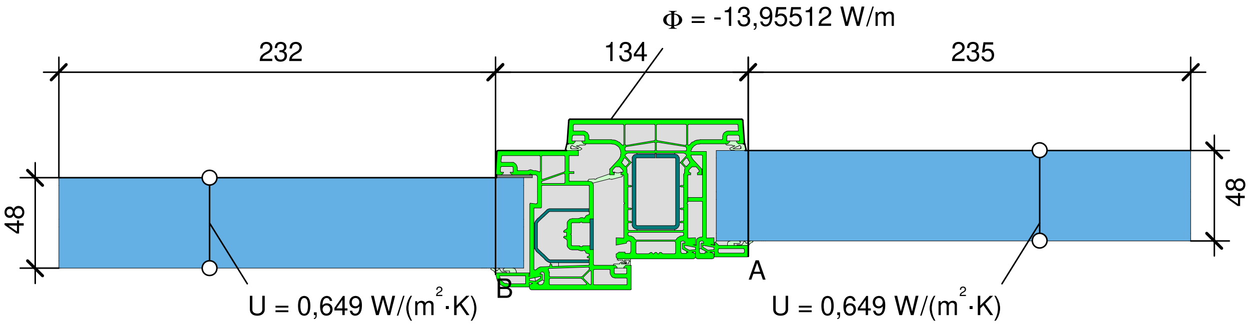
$$\Psi_{ed\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_{g1}\cdot b_{g1} - U_f\cdot b_f - U_{g2}\cdot b_{g2}}{2} = \frac{\frac{19,515}{30,000} - 0,900\cdot 0,215 - 1,227\cdot 0,170 - 0,900\cdot 0,215}{2} = 0,027\ W/(m\cdot K)$$



$\theta_{si\ min_{A-B}}$ = 9,57 °C

f_{Rsi} = 0,652





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IKD 0,026	0,026	0,900
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Unvent. cavity I unbel. Hohlr. *		

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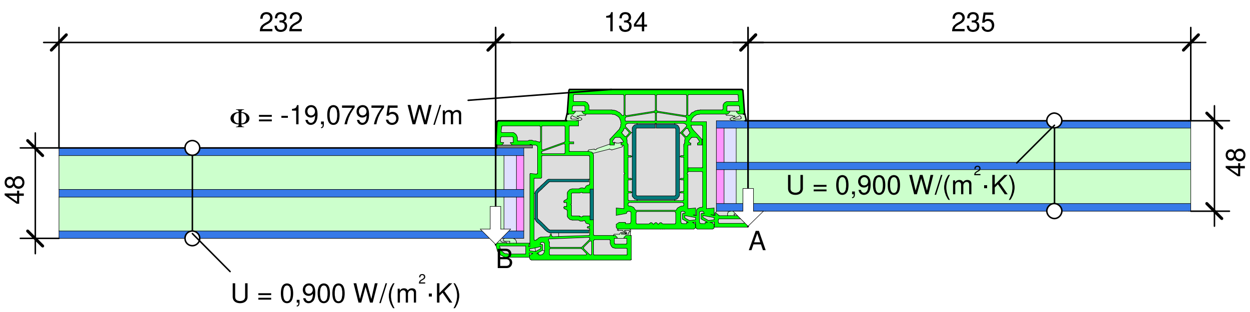
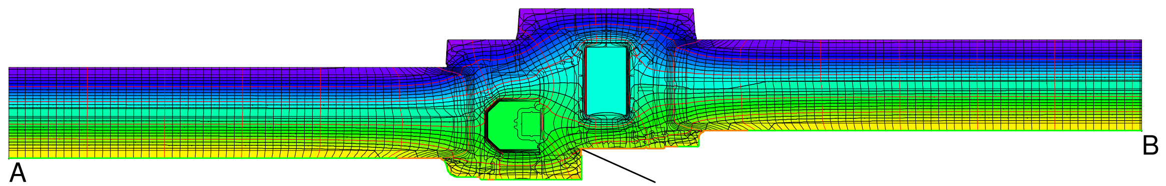
$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_{p1}\cdot b_{p1} - U_{p2}\cdot b_{p2}}{b_f} = \frac{\frac{13{,}955}{30{,}000} - 0{,}649\cdot 0{,}235 - 0{,}649\cdot 0{,}232}{0{,}134} = 1{,}216\ \mathrm{W/(m^2\cdot K)}$$

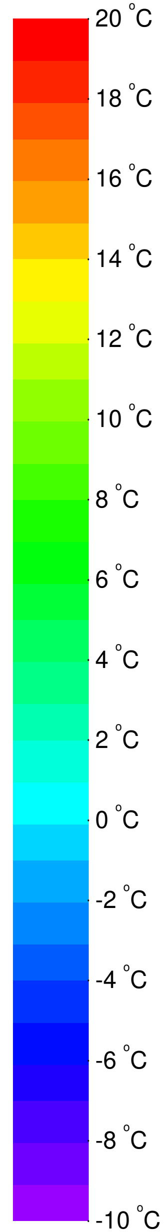


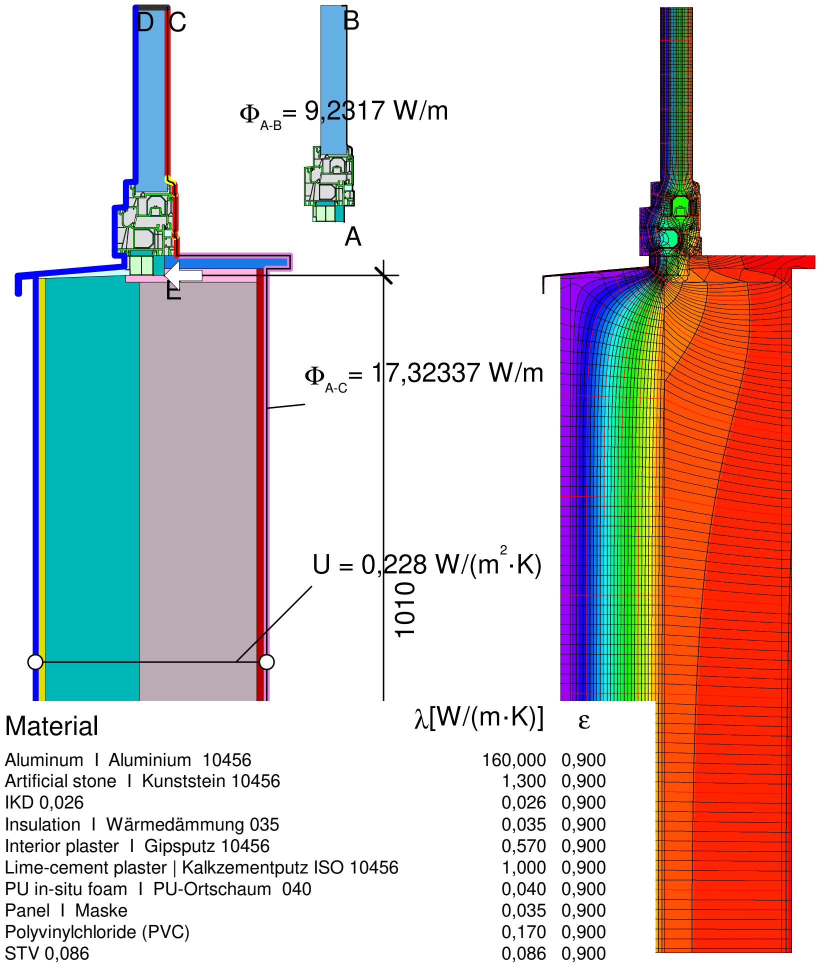
$$\Psi_{ed\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_{g1}\cdot b_{g1} - U_f\cdot b_f - U_{g2}\cdot b_{g2}}{2} = \frac{\frac{19{,}080}{30{,}000} - 0{,}900\cdot 0{,}235 - 1{,}216\cdot 0{,}134 - 0{,}900\cdot 0{,}232}{2} = 0{,}027\ \mathrm{W/(m\cdot K)}$$



$\theta si\ min_{A\text{-}B} = 9{,}69\ ^\circ C$

$f_{Rsi} = 0{,}656$

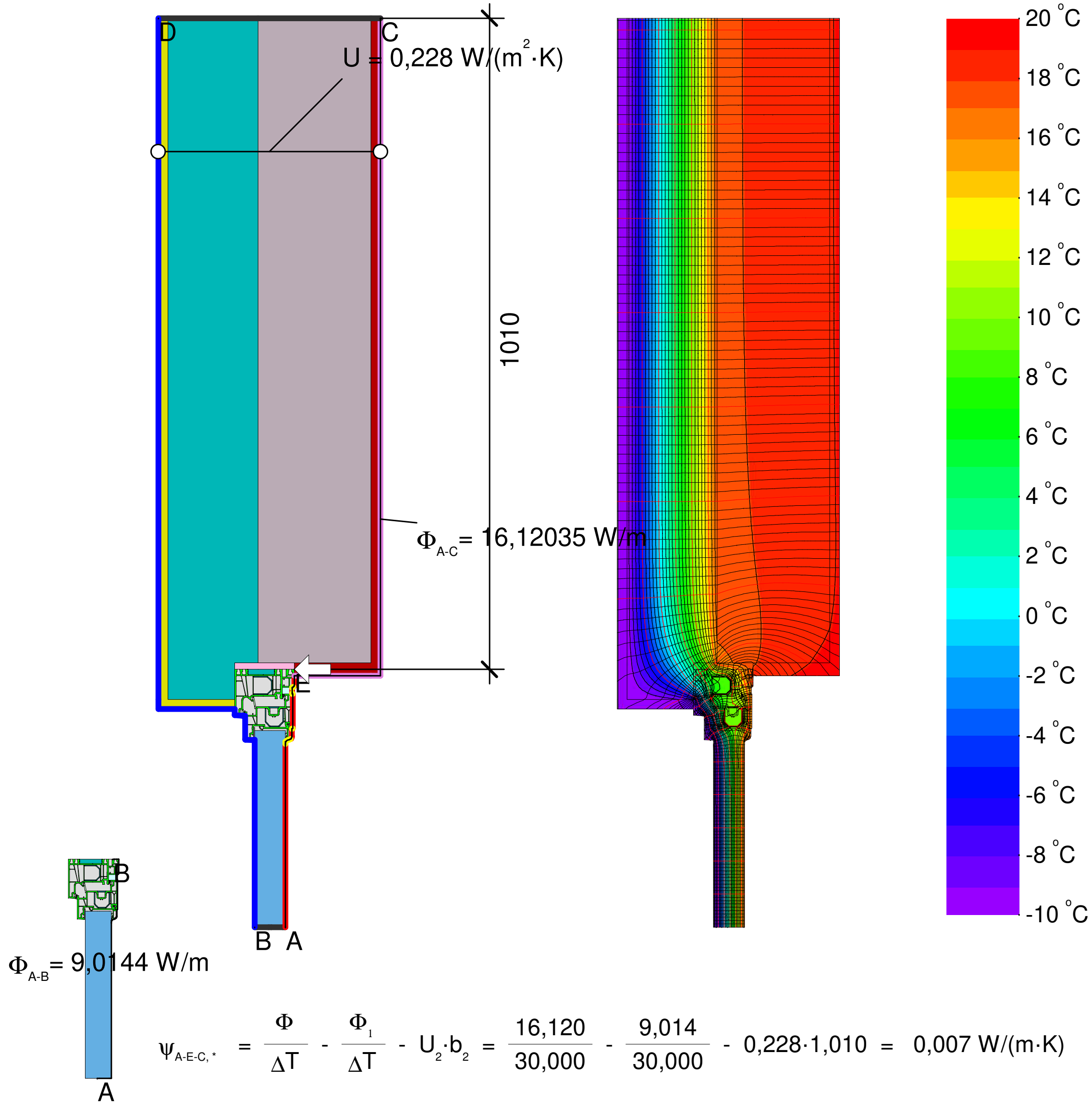




Material

Material	λ[W/(m·K)]	ε
Aluminum I Aluminium 10456	160,000	0,900
Artificial stone I Kunststein 10456	1,300	0,900
IKD 0,026	0,026	0,900
Insulation I Wärmedämmung 035	0,035	0,900
Interior plaster I Gipsputz 10456	0,570	0,900
Lime-cement plaster | Kalkzementputz ISO 10456	1,000	0,900
PU in-situ foam I PU-Ortschaum 040	0,040	0,900
Panel I Maske	0,035	0,900
Polyvinylchloride (PVC)	0,170	0,900
STV 0,086	0,086	0,900
Sand-lime stone I Kalksandstein 1745	1,000	0,900
Soft PVC I Weich-PVC	0,140	0,900
Steel I Stahl	50,000	0,900
Steel I Stahl	50,000	0,300
Unbelüftete Hohlräume *		
Unvent. cavity I unbel. Hohlr. *		
slightly vent. cav. I leicht bel. Hohlr. *		

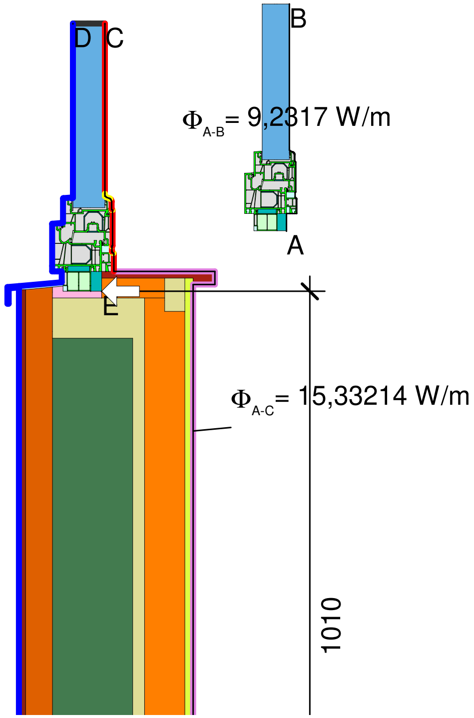
* EN ISO 10077-2:2017, 6.4.3

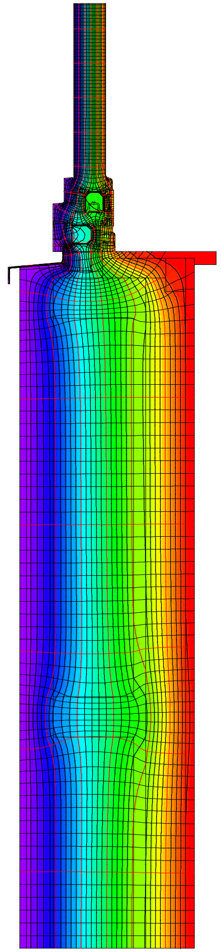


$$\Psi_{A-E-C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{16,120}{30,000} - \frac{9,014}{30,000} - 0,228 \cdot 1,010 = 0,007 \text{ W/(m·K)}$$

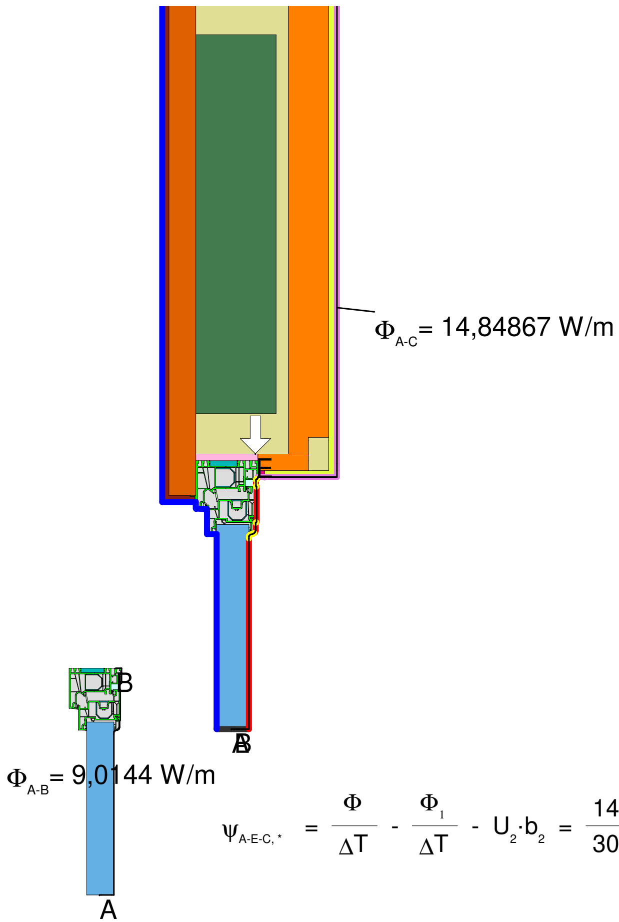
$$\Psi_{A-E-C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{17,323}{30,000} - 0,228 \cdot 1,010 - \frac{9,232}{30,000} = 0,039 \text{ W/(m·K)}$$

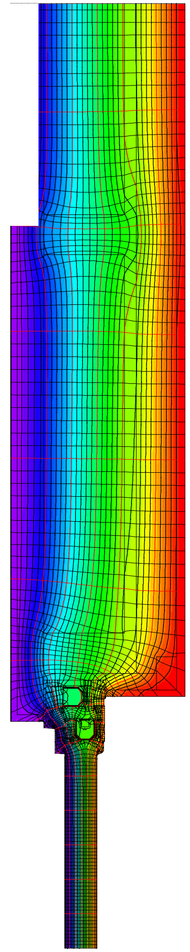
Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic | Adiabat	0,000			
Exterior | Außen		-10,000	0,040	
Interior | Innen		20,000	0,130	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	
e 0,3 Cavity I Hohlraum				0,300
e 0,9 Cavity I Hohlraum				0,900

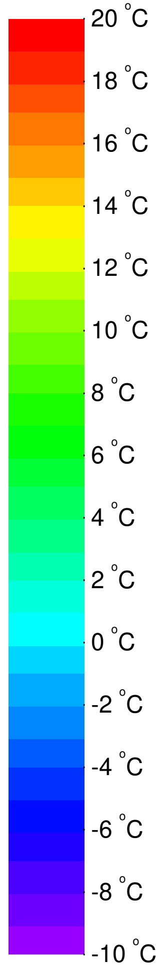




Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic | Adiabat	0,000			
Exterior I Außen		-10,000	0,040	
Interior I Innen		20,000	0,130	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	
e 0,3 Cavity I Hohlraum				0,300
e 0,9 Cavity I Hohlraum				0,900





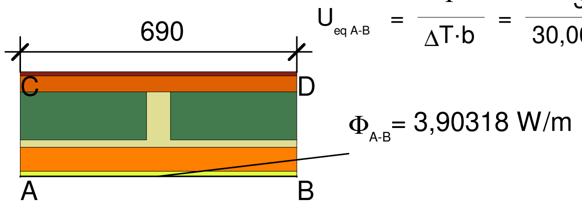


Material	λ[W/(m·K)]	ε
Aluminum I Aluminium 10456	160,000	0,900
Gipskartonplatten 900 kg/m3 10456	0,250	0,900
Holzweichfaserplatte	0,050	0,900
IKD 0,026	0,026	0,900
Insulation I Wärmedämmung 035	0,035	0,900
Insulation I Wärmedämmung 040	0,040	0,900
Kunstharzputz 4108-4	0,700	0,900
Nutzholz 500 kg/m3, auch OSB 10456	0,130	0,900
Nutzholz 700 kg/m3 10456	0,180	0,900
PUR-Ortschaum WLG 040	0,040	0,900
Panel I Maske	0,035	0,900
Polyvinylchloride (PVC)	0,170	0,900
STV 0,086	0,086	0,900
Soft PVC I Weich-PVC	0,140	0,900
Steel I Stahl	50,000	0,900
Steel I Stahl	50,000	0,300
Unbelüftete Hohlräume *		
Unvent. cavity I unbel. Hohlr. *		
Wärmedämmung 040	0,040	0,900
Zellulose 040	0,040	0,900
slightly vent. cav. I leicht bel. Hohlr. *		

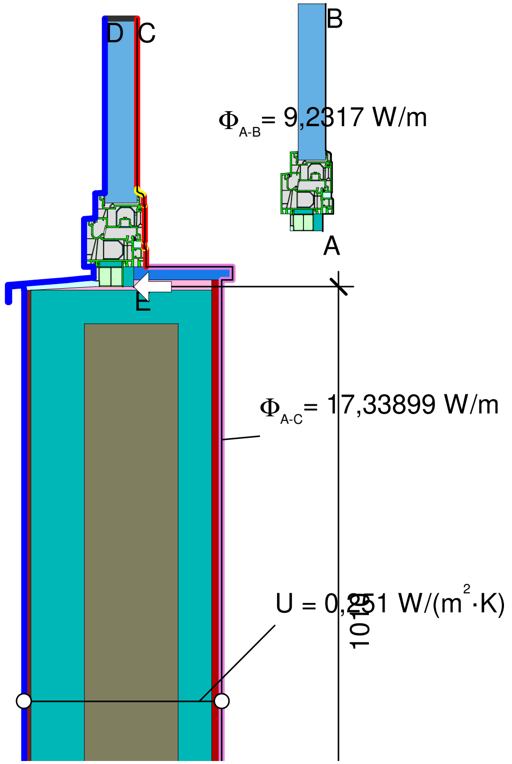
* EN ISO 10077-2:2017, 6.4.3

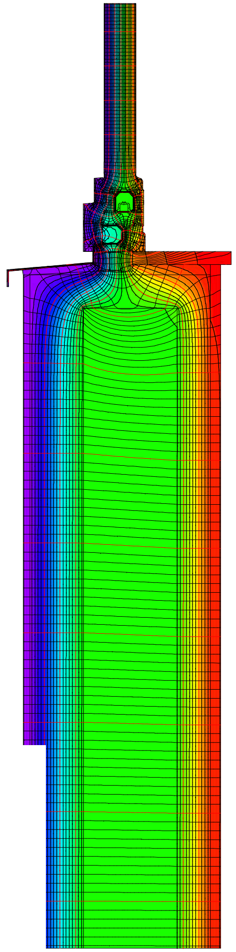
$$\Psi_{A\text{-}E\text{-}C,\cdot} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{14,849}{30,000} - \frac{9,014}{30,000} - 0,189 \cdot 1,010 = 0,004\ W/(m \cdot K)$$

$$U_{eq\ A\text{-}B} = \frac{\Phi}{\Delta T \cdot b} = \frac{3,903}{30,000 \cdot 0,690} = 0,189\ W/(m^2 \cdot K)$$

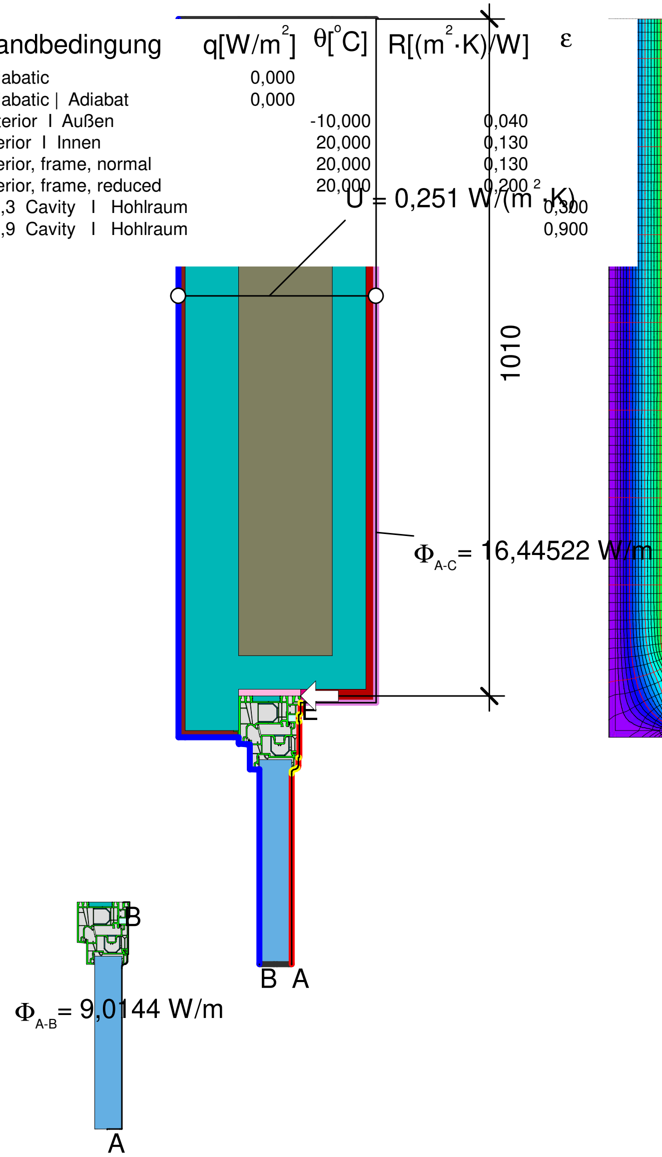


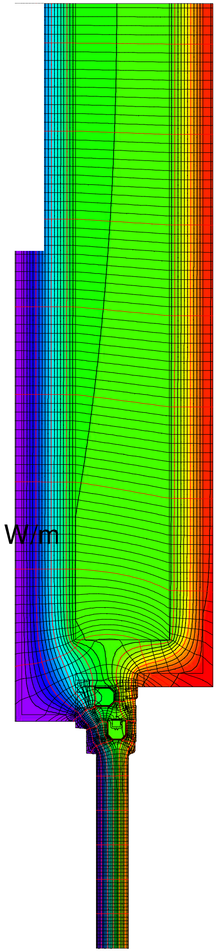
$$\Psi_{A\text{-}E\text{-}C,\cdot} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{15,332}{30,000} - 0,189 \cdot 1,010 - \frac{9,232}{30,000} = 0,013\ W/(m \cdot K)$$

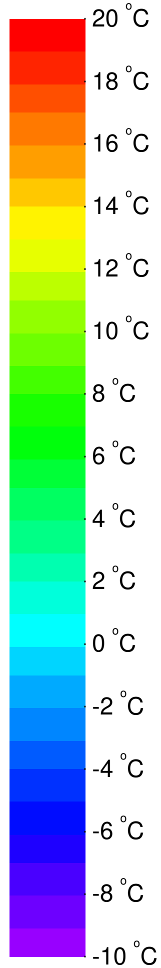




Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,000			
Adiabatic | Adiabat	0,000			
Exterior I Außen		-10,000	0,040	
Interior I Innen		20,000	0,130	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	
e 0,3 Cavity I Hohlraum				0,300
e 0,9 Cavity I Hohlraum				0,900







Material	λ[W/(m·K)]	ε
Aluminum I Aluminium 10456	160,000	0,900
Beton armiert (mit 1% Stahl) 10456	2,300	0,900
EPS, Mineralwolle 035	0,035	0,900
Gipsputz 1300 kg/m3 10456	0,570	0,900
IKD 0,026	0,026	0,900
Insulation I Wärmedämmung 035	0,035	0,900
Kunstharzputz 4108-4	0,700	0,900
Kunststein 10456	1,300	0,900
PUR-Ortschaum WLG 040	0,040	0,900
Panel I Maske	0,035	0,900
Polyvinylchloride (PVC)	0,170	0,900
STV 0,086	0,086	0,900
Soft PVC I Weich-PVC	0,140	0,900
Steel I Stahl	50,000	0,900
Steel I Stahl	50,000	0,300
Unbelüftete Hohlräume *		
Unvent. cavity I unbel. Hohlr. *		
slightly vent. cav. I leicht bel. Hohlr. *		

* EN ISO 10077-2:2017, 6.4.3

$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{16{,}445}{30{,}000} - \frac{9{,}014}{30{,}000} - 0{,}251 \cdot 1{,}010 = -0{,}006\ W/(m \cdot K)$$

$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{17{,}339}{30{,}000} - 0{,}251 \cdot 1{,}010 - \frac{9{,}232}{30{,}000} = 0{,}017\ W/(m \cdot K)$$