Test Report

ift ROSENHEIM

Number 19-003862-PR04 (PB-K20-06-en-01)

Owner (Client)
ALUMINCO S.A.
Megali Rahi
32011 Inofita Viotias
Greece

Product **Metal profiles with thermal break**

Designation System: **ALUMINCO SL2700 (SLIDING DOOR)**

Details
Material Aluminium alloy - painted - powder coated; Projected width from - to 43 mm - 186 mm; Structural depth 174 mm; Thickness of infill 33.5 mm; Edge cover of infill 10 mm; Thermal break; Material Polyamide 6.6 with 25 % glass fibre (PA 66 GF25); Surface treatment untreated; Inlay material User specific – "Neocoat EPS 200 (HBCD free)"; Casement; Designation 2700-201 / 2700-203; Inlay material User specific – "POL PE 22x12" / User specific – "Neocoat EPS 200 (HBCD free)"; Frame; Designation 2700-101 / 2700-102 / 2700-104; Inlay material User specific – "POL PE 22x12"; Additional casement profile; Designation 2700-301 / 2700-302 / 2700-501

Special features

Order Calculation of thermal transmittance

Contents The test report contains a total of 4 pages and annexes (21 pages).

Note The test report shall only be published in its unabbreviated form.
The "Guidance Sheet for the Use of ift Test Documents" applies.

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Testing and Calibration – EN ISO/IEC 17025
Inspection – EN ISO/IEC 17020
Product Certification – EN ISO/IEC 17065
Certification of Management Systems – EN ISO/IEC 17021

Notified Body 0757
PÜZ-Stelle: BAY 18

ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-11349-01-00

1 Execution

1.1 Sampling and product description

The following details have been presented to ift:

Sampler:	ALUMINCO S.A., 32011 Inofita Viotias (Greece)
Sampling date:	15.11.2019
Evidence:	ift Rosenheim did not receive a sampling report.
Description:	For product identification the specimen tested is described/represented in the Annex. Material specifications, item numbers and other company-specific descriptions are details provided by the client and will be checked for plausibility by ift.
Test specimen no.:	19-003862-PK04

1.2 Basic documents *) of the procedures

EN ISO 10077-2:2017 - 07

Thermal performance of windows, doors and shutters - Calculation of thermal transmittance - Part 2 - Numerical method for frames

SG 06-mandatory NB-CPD/SG06/11/083 2011 - 09

EN 14351-1:2006 Treatment of unventilated rectangular cavities when calculating thermal properties to EN ISO 10077-2

*) and the relevant national versions, e.g. DIN EN

1.3 Short description of the procedures

Calculation was made by means of a FEM-calculation program verified according to standard. The simulation model converted from the test specimen drawing was divided into a sufficient number of elements, showing that a smaller scale did not lead to a significant change of the total heat flow. The materials and/or boundary conditions were attributed, thus evaluating the total heat flow. Then the thermal transmittance was calculated from the heat flow.

2 Detailed results

Calculation of thermal transmittance according to EN ISO 10077-2:2017-07

Project-No.	19-003862-PR04
Basis	EN ISO 10077-2:2017-07 Thermal performance of windows, doors and shutters - Calculation of thermal transmittance - Part 2 - Numerical method for frames SG 06-mandatory NB-CPD/SG06/11/083 2011-09 EN 14351-1:2006 Treatment of unventilated rectangular cavities when calculating thermal properties to EN ISO 10077-2
Test equipment	Sim/029204 - flixo 8.0
Test specimen	Metal profiles with thermal break
Test specimen No.	19-003862-PK04
Date of test	10.12.2019
Test engineer in charge	Till Stübben
Test engineer	Markus Paccagnel

Implementation of tests

Deviations	There have been no deviations from the test method as specified in the standard/basis.

Determination of the thermal transmittance U_f

The thermal transmittance of a frame profile is based on:

$$U_f = \frac{L_f^{2D} - U_p \cdot b_p}{b_f}$$

with

$$L_f^{2D} = \frac{\Phi_{ges}}{\Delta T}$$

	Definition	Unit
U_f	thermal transmittance of frame profile	W/(m²K)
b_f	projected width of frame profile	m
b_p	visible width of glazing	m
U_p	thermal transmittance of infill panel	W/(m²K)
L_f^{2D}	two-dimensional thermal conductivity	W/(mK)
Φ_{ges}	linear heat flow rate	W/m
ΔT	temperature difference (internal to external)	K

Specimen No.	b_f	b_p	U_p	Method of equivalent thermal conductivity			Radiosity method		
				L_f^{2D}	U_f 1)	U_f 2)	L_f^{2D}	U_f 1)	U_f 2)
-01	0,124	0,190	0,887	0,451	2,29	**2,3**	0,443	2,22	**2,2**
-02	0,124	0,190	0,887	0,508	2,74	**2,7**	0,499	2,67	**2,7**
-03	0,096	0,380	0,887	0,717	3,95	**4,0**	0,689	3,67	**3,7**
-04	0,186	0,380	0,887	0,715	2,03	**2,0**	0,713	2,02	**2,0**
-05	0,045	0,190	0,887	0,246	1,73	**1,7**	0,245	1,69	**1,7**
-06	0,043	0,380	0,887	0,690	8,17	**8,2**	0,686	8,07	**8,1**
-07	0,117	0,190	0,887	0,464	2,53	**2,5**	0,444	2,36	**2,4**
-08	0,117	0,190	0,887	0,483	2,69	**2,7**	0,470	2,58	**2,6**

1) detailed calculation result

2) calculation result rounded to two digits indicating the value, in accordance with the regulation of EN ISO 10077-2

The calculated values of the thermal transmittance U_f can be used for profiles made of aluminium with lacquered or powder coated surface and with an untreated surface in the thermal break.

3 Summary

3.1 Result

Calculation of thermal transmittance according to EN ISO 10077-2:2017-07
(Radiosity-Method)

$$U_f = 1.7\ W/(m^2K) – 8.1\ W/(m^2K)$$

Calculation of thermal transmittance according to EN ISO 10077-2:2017-07
(Method with equivalent thermal conductivity),
SG 06-mandatory NB-CPD/SG06/11/083 2011-09

$$U_f = 1.7\ W/(m^2K) – 8.2\ W/(m^2K)$$

3.2 Instructions for use

The result can be transferred under the manufacturer's own responsibility, taking into account the corresponding provisions of the test standard.

This test/evaluation does not allow any statement to be made on further characteristics of the present structure regarding performance and quality, in particular the effects of weathering and ageing.

The test was performed according to standard and the details for identification of the test specimen are complete; on the basis of this Test Report an "ift-Nachweis" (Evidence) can be issued.

ift Rosenheim
15.12.2019

Konrad Huber, Dipl.-Ing. (FH)
Head of Testing Department
Building Physics

Till Stübben, Dipl.-Ing. (FH)
Operating Testing Officer
Building Physics

Contents list of Annexes

Annex no.	title / content	pages
1	Description of the test specimen	4
2	Representation of product/test specimen	16

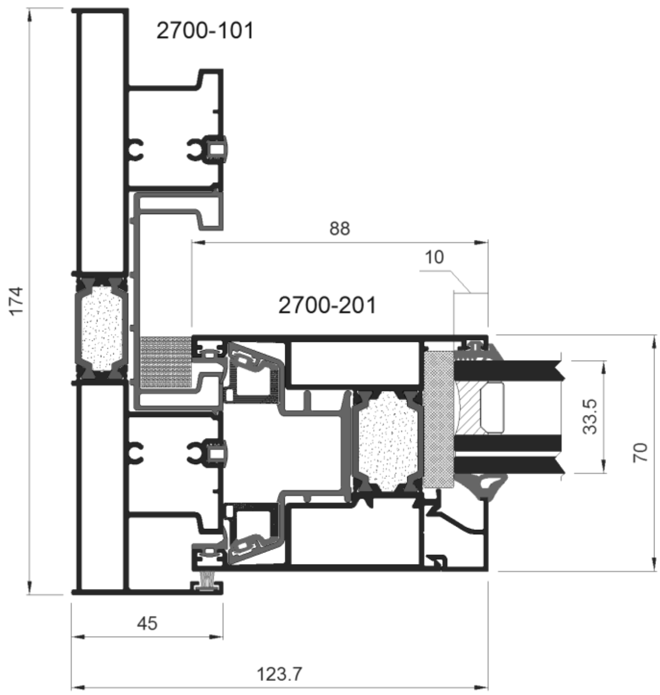


Fig. 1 Cross section test specimen -01*

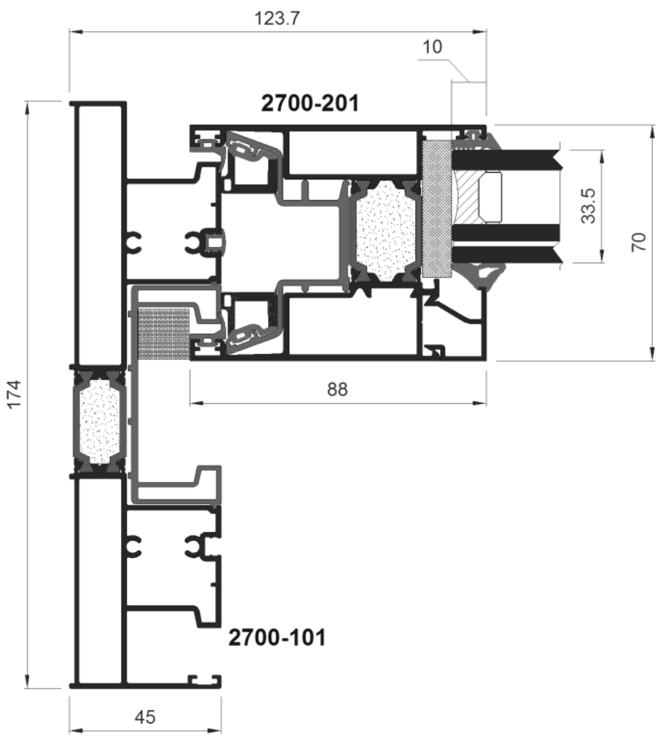


Fig. 2 Cross section test specimen -02*

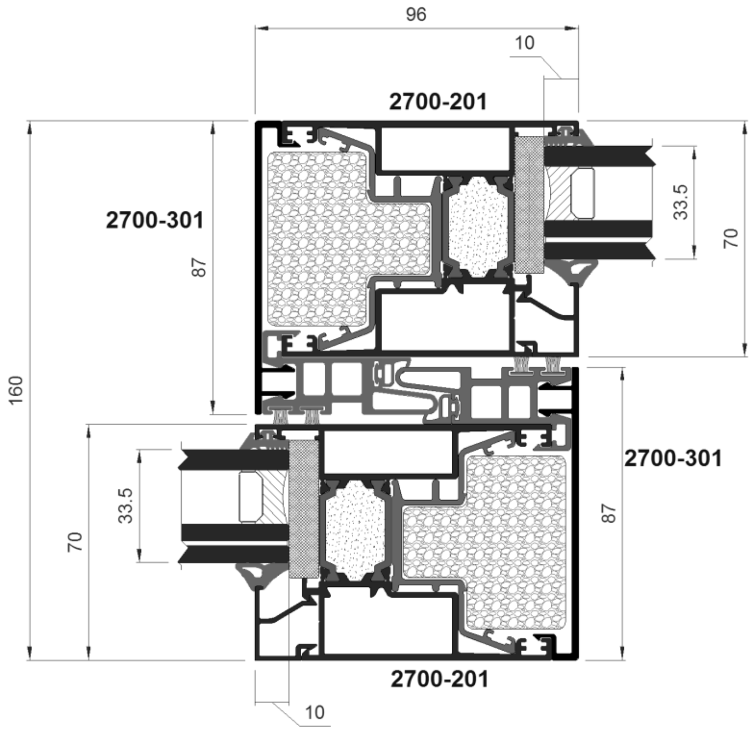


Fig. 3 Cross section test specimen -03*

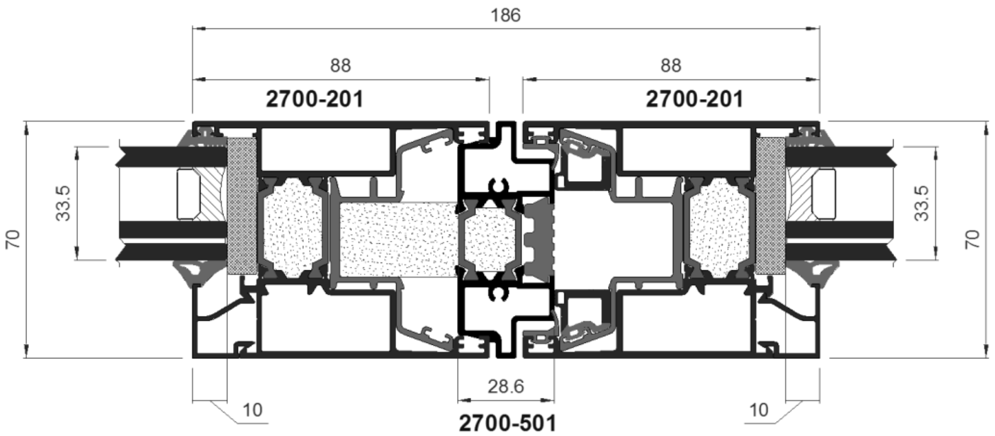


Fig. 4 Cross section test specimen -04*

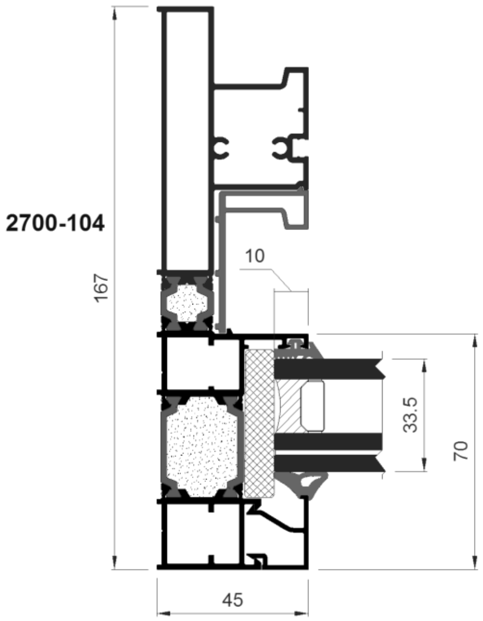


Fig. 5 Cross section test specimen -05*

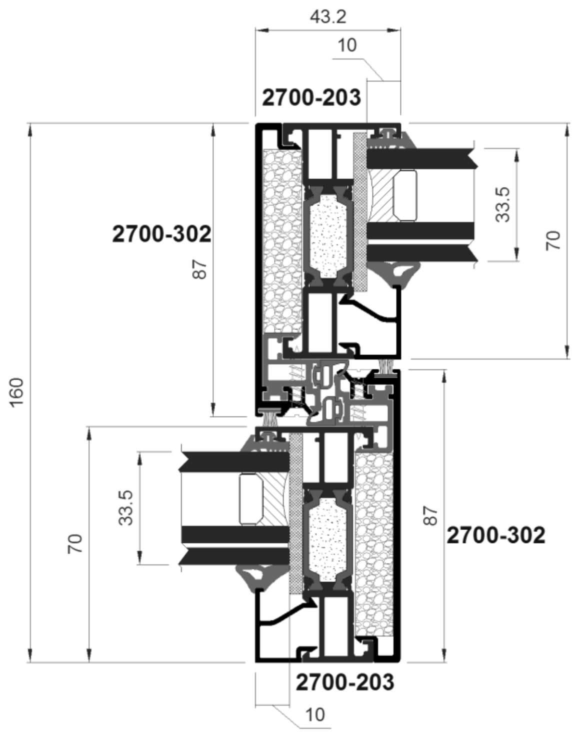


Fig. 6 Cross section test specimen -06*

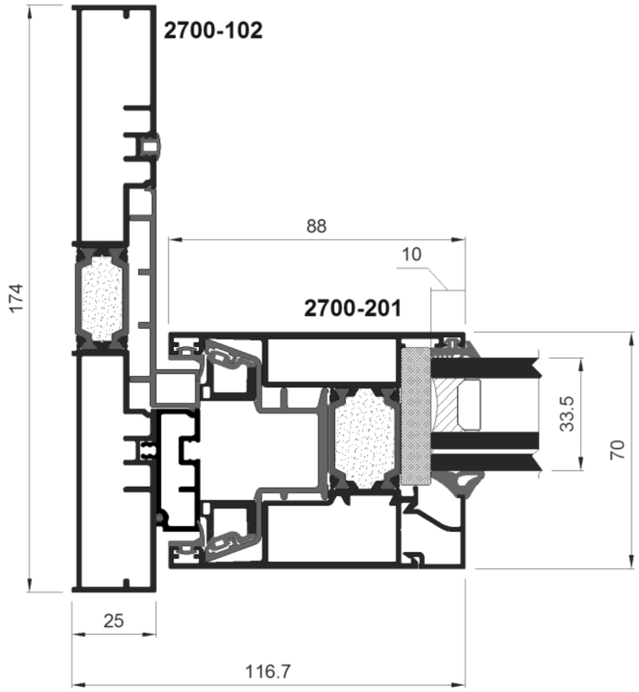


Fig. 7 Cross section test specimen -07*

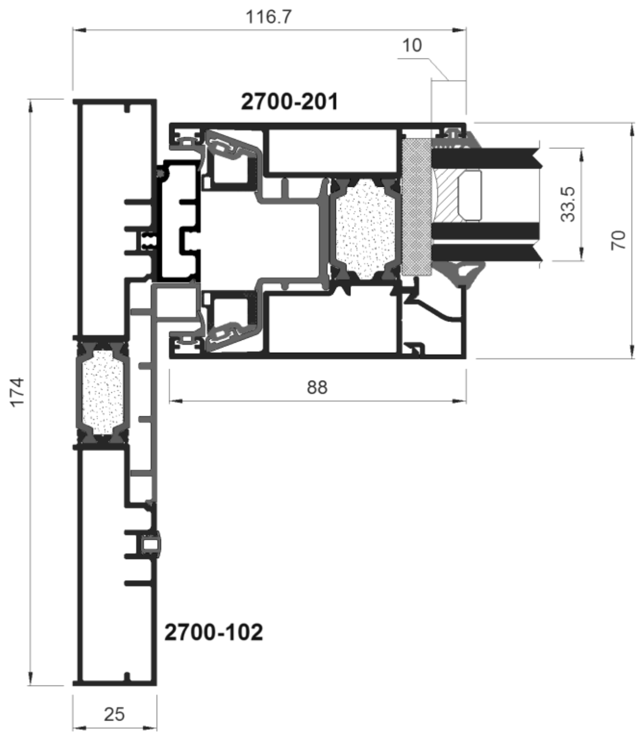
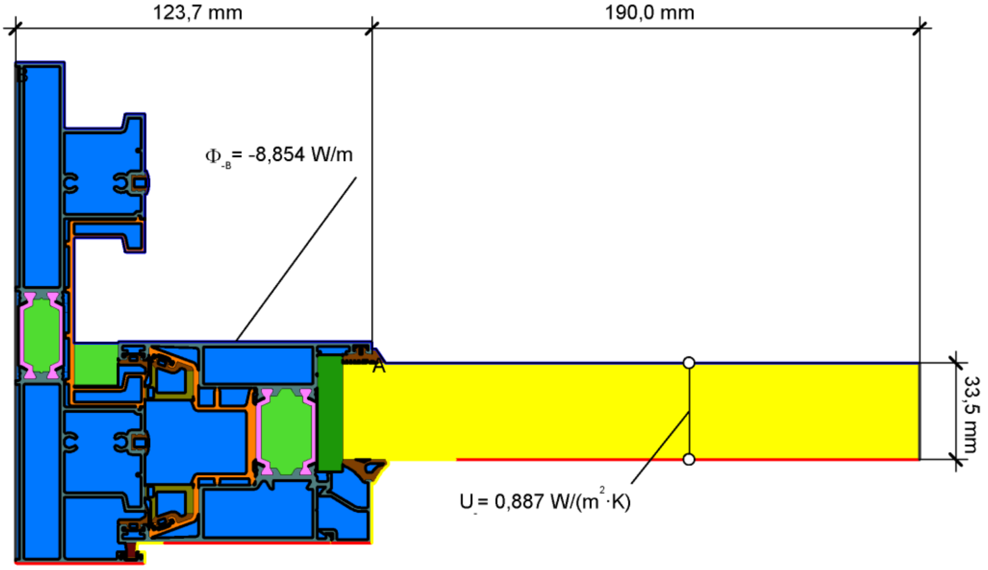


Fig. 8 Cross section test specimen -08*

* For calculation of the thermal transmittance U_f the glazing was supplanted by a replacement panel acc. to EN ISO 10077-2.

Protocol: FEM-Calculation



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{8{,}854}{20{,}000} - 0{,}887 \cdot 0{,}190}{0{,}124} = 2{,}2\ \mathrm{W/(m^2 \cdot K)}$$

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,0			
Epsilon 0,9				0,90
External		0,0	0,040	
Internal reduced		20	0,20	
Internal standard		20	0,13	

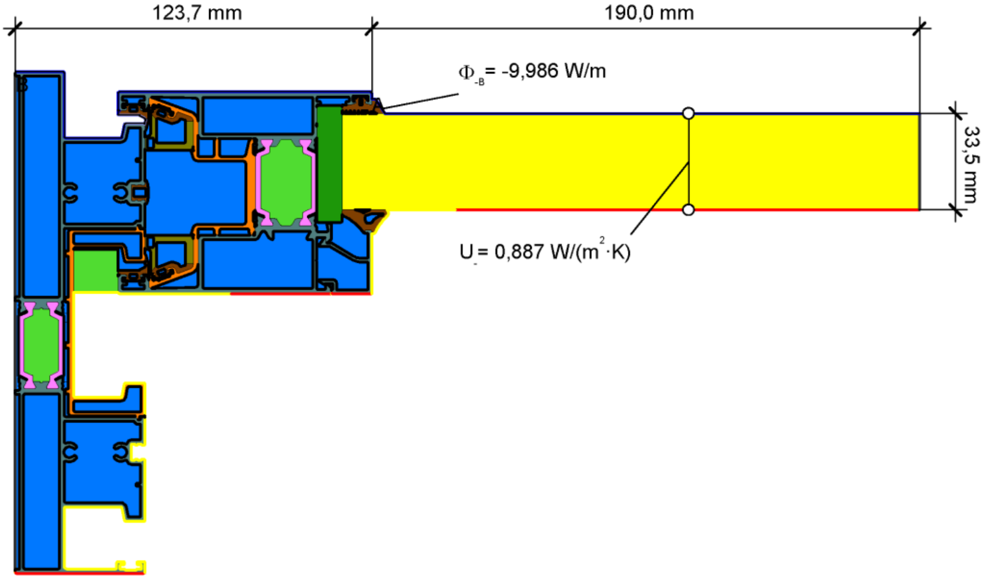
Material	λ[W/(m·K)]	ε
Aluminium alloy - anodised - painted -powder coated	160	0,90
Aluminium alloy - anodised - painted -powder coated (1)	160	0,90
Elastomeric foam, flexible	0,050	0,90
Ethylene-Propylendien Monomer (EPDM)	0,25	0,90
Neocoat EPS 200 (HBCD free)	0,030	0,90
POL PE 22x12	0,038	0,90
PVC (polyvinylchloride), rigid	0,17	0,90
Polyamide 6.6 with 25% glass fiber	0,30	0,90
Polyester mohair (brush seal)	0,14	0,90
Replacement panel EN ISO 10077-2	0,035	0,90
Unventilated air cavity **		
** EN ISO 10077-2:2017, 6.4.2		

The data is based on EN ISO 10456 and EN ISO 10077-2.
The thermal conductivities and/or emissivities of the materials which are not based on that standards are deposited at ift-Rosenheim.
The documents have been evaluated. They are in accordance with the requirements of the current version of EN ISO 10077-2.
The emissivity of low emissive layers must be ensured by a factory production control.

Prüfer / Bearbeiter: Markus Paccagnel Programmversion (letzte Speicherung): flixo pro 8.0.923.1 Anzahl finiter Elemente: 55006
Speicherdatum: 10.12.2019 Dokumentenvorlage (Template): 2018_03_ift_Template_v3.flt Rel. Wärmestromfehler: 3,7e-010

Fig. 1 Simulation model test specimen -01 (Radiosity-Method)

Protocol: FEM-Calculation



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{9,986}{20,000} - 0,887 \cdot 0,190}{0,124} = 2,7\ W/(m^2 \cdot K)$$

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,0			
Epsilon 0,9				0,90
External		0,0	0,040	
External, Slightly ventilated air cavity		0,0	0,30	
Internal reduced		20	0,20	
Internal standard		20	0,13	

Material	λ[W/(m·K)]	ε
Aluminium alloy - anodised - painted -powder coated	160	0,90
Aluminium alloy - anodised - painted -powder coated (1)	160	0,90
Elastomeric foam, flexible	0,050	0,90
Ethylene-Propylendien Monomer (EPDM)	0,25	0,90
Neocoat EPS 200 (HBCD free)	0,030	0,90
POL PE 22x12	0,038	0,90
PVC (polyvinylchloride), rigid	0,17	0,90
Polyamide 6.6 with 25% glass fiber	0,30	0,90
Replacement panel EN ISO 10077-2	0,035	0,90
Unventilated air cavity **		
** EN ISO 10077-2:2017, 6.4.2		

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Anzahl finiter Elemente: 55006
Rel. Wärmestromfehler: 3,7e-010

Fig. 2 Simulation model test specimen -02 (Radiosity-Method)

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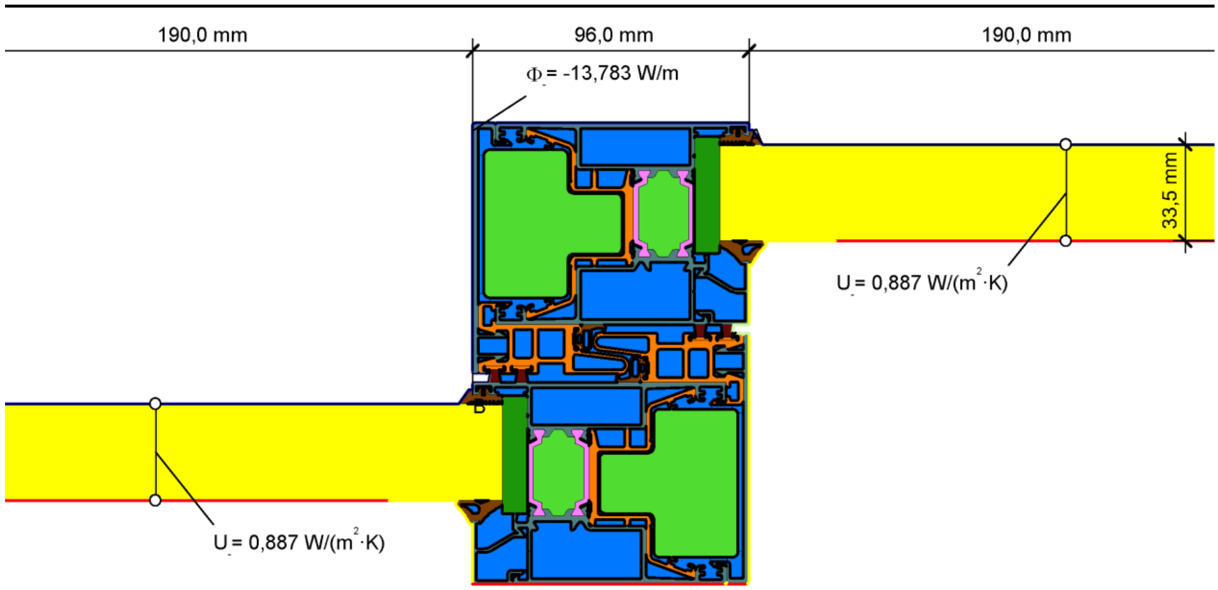
Protocol: FEM-Calculation



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_{p1} \cdot b_{p1} - U_{p2} \cdot b_{p2}}{b_f} = \frac{\frac{13,783}{20,000} - 0,887 \cdot 0,190 - 0,887 \cdot 0,190}{0,096} = 3,7\ W/(m^2 \cdot K)$$

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,0			
Epsilon 0,9				0,90
External		0,0	0,040	
External, Slightly ventilated air cavity		0,0	0,30	
Internal reduced		20	0,20	
Internal standard		20	0,13	
Internal, Slightly ventilated air cavity		20	0,30	

Material	λ[W/(m·K)]	ε
Aluminium alloy - anodised - painted -powder coated	160	0,90
Aluminium alloy - anodised - painted -powder coated (1)	160	0,90
Ethylene-Propylendien Monomer (EPDM)	0,25	0,90
Neocoat EPS 200 (HBCD free)	0,030	0,90
POL PE 22x12	0,038	0,90
PVC (polyvinylchloride), rigid	0,17	0,90
PVC (polyvinylchloride), rigid (1)	0,17	0,90
Polyamide 6.6 with 25% glass fiber	0,30	0,90
Polyester mohair (brush seal)	0,14	0,90
Replacement panel EN ISO 10077-2	0,035	0,90
Unventilated air cavity **		

** EN ISO 10077-2:2017, 6.4.2

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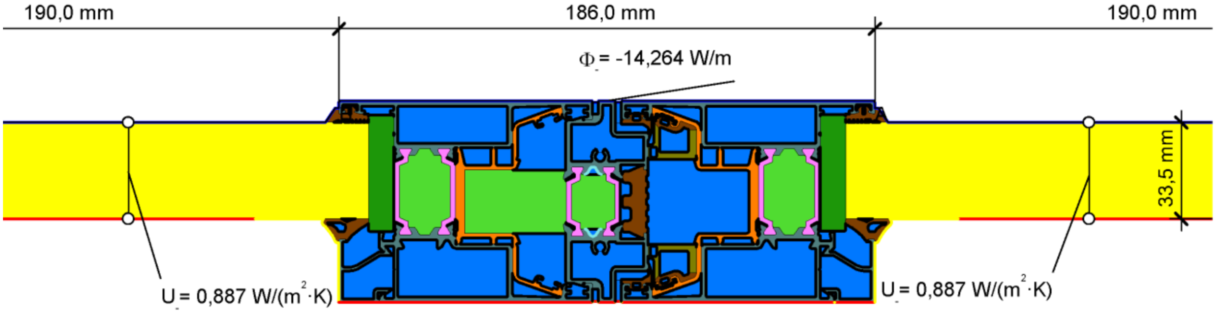
Dokumentenvorlage (Template): 2018_03_ift_Template_v3.flt
Anzahl finiter Elemente: 55006
Rel. Wärmestromfehler: 3,7e-010

Fig. 3 Simulation model test specimen -03 (Radiosity-Method)

Protocol: FEM-Calculation



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_{p1}\cdot b_{p1} - U_{p2}\cdot b_{p2}}{b_f} = \frac{\frac{14,264}{20,000} - 0,887\cdot 0,190 - 0,887\cdot 0,190}{0,186} = 2,0\ W/(m^2\cdot K)$$

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,0			
Epsilon 0,1				0,10
Epsilon 0,9				0,90
External		0,0	0,040	
Internal reduced		20	0,20	
Internal standard		20	0,13	

Material	λ[W/(m·K)]	ε
Aluminium alloy - anodised - painted -powder coated	160	0,90
Aluminium alloy - anodised - painted -powder coated (1)	160	0,10
Aluminium alloy - anodised - painted -powder coated (1)	160	0,90
Elastomeric foam, flexible	0,050	0,90
Ethylene-Propylendien Monomer (EPDM)	0,25	0,90
Neocoat EPS 200 (HBCD free)	0,030	0,90
POL PE 22x12	0,038	0,90
PVC (polyvinylchloride), rigid	0,17	0,90
Polyamide 6.6 with 25% glass fiber	0,30	0,90
Replacement panel EN ISO 10077-2	0,035	0,90
Unventilated air cavity **		
** EN ISO 10077-2:2017, 6.4.2		

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Prüfer / Bearbeiter: Markus Paccagnel
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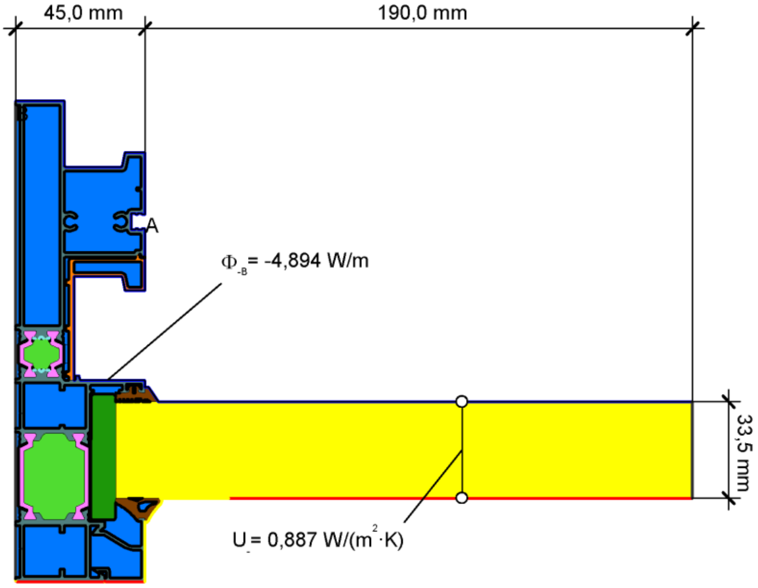
Programmversion (letzte Speicherung): flixo pro 8.0.923.1
Dokumentenvorlage (Template): 2018_03_ift_Template_v3.flt
Anzahl finiter Elemente: 55006
Rel. Wärmestromfehler: 3,7e-010

Fig. 4 Simulation model test specimen -04 (Radiosity-Method)

Protocol: FEM-Calculation



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{4{,}894}{20{,}000} - 0{,}887 \cdot 0{,}190}{0{,}045} = 1{,}7\ \mathrm{W/(m^2 \cdot K)}$$

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,0			
Epsilon 0,1				0,10
Epsilon 0,9				0,90
External		0,0	0,040	
Internal reduced		20	0,20	
Internal standard		20	0,13	

Material	λ[W/(m·K)]	ε
Aluminium alloy - anodised - painted -powder coated	160	0,10
Aluminium alloy - anodised - painted -powder coated	160	0,90
Aluminium alloy - anodised - painted -powder coated (1)	160	0,90
Ethylene-Propylendien Monomer (EPDM)	0,25	0,90
Neocoat EPS 200 (HBCD free)	0,030	0,90
POL PE 22x12	0,038	0,90
PVC (polyvinylchloride), rigid	0,17	0,90
Polyamide 6.6 with 25% glass fiber	0,30	0,90
Replacement panel EN ISO 10077-2	0,035	0,90
Unventilated air cavity **		
** EN ISO 10077-2:2017, 6.4.2		

The data is based on EN ISO 10456 and EN ISO 10077-2.
The thermal conductivities and/or emissivities of the materials which are not based on that standards are deposited at ift-Rosenheim.
The documents have been evaluated. They are in accordance with the requirements of the current version of EN ISO 10077-2.
The emissivity of low emissive layers must be ensured by a factory production control.

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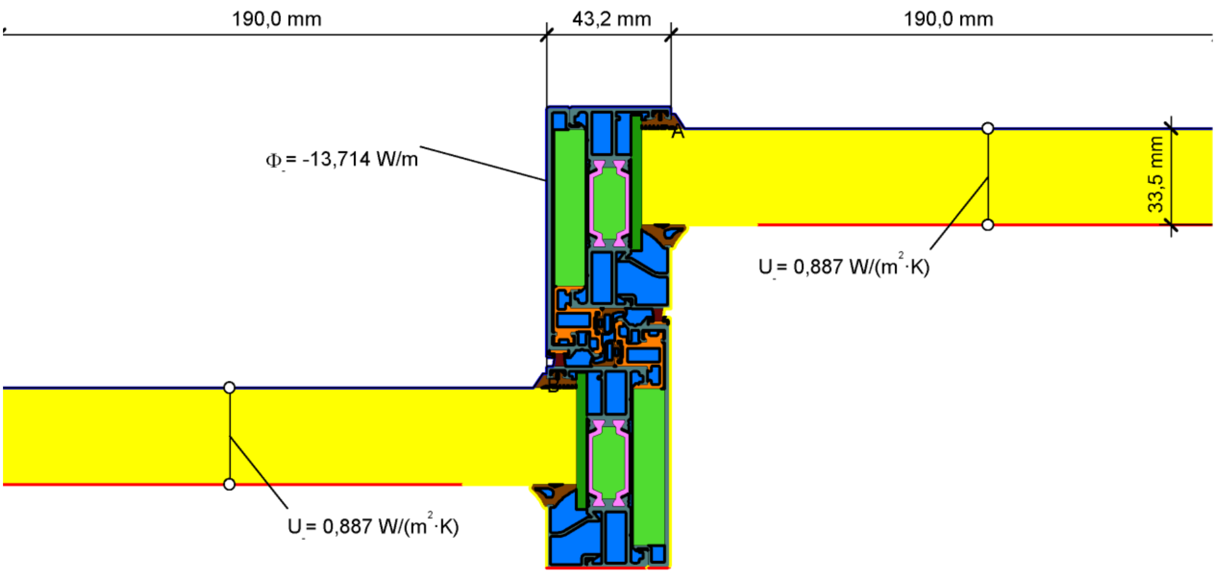
Speicherdatum: 10.12.2019
Programmversion (letzte Speicherung): flixo pro 8.0.923.1
Dokumentenvorlage (Template): 2018_03_ift_Template_v3.flt
Anzahl finiter Elemente: 55006
Rel. Wärmestromfehler: 3,7e-010

Fig. 5 Simulation model test specimen -05 (Radiosity-Method)

Protocol: FEM-Calculation



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_{p1} \cdot b_{p1} - U_{p2} \cdot b_{p2}}{b_f} = \frac{\frac{13,714}{20,000} - 0,887 \cdot 0,190 - 0,887 \cdot 0,190}{0,043} = 8,1\ W/(m^2 \cdot K)$$

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,0			
Epsilon 0,9				0,90
External		0,0	0,040	
Internal reduced		20	0,20	
Internal standard		20	0,13	

Material	λ[W/(m·K)]	ε
Aluminium alloy - anodised - painted -powder coated	160	0,90
Aluminium alloy - anodised - painted -powder coated (1)	160	0,90
Ethylene-Propylendien Monomer (EPDM)	0,25	0,90
Neocoat EPS 200 (HBCD free)	0,030	0,90
POL PE 22x12	0,038	0,90
PVC (polyvinylchloride), rigid	0,17	0,90
Polyamide 6.6 with 25% glass fiber	0,30	0,90
Polyester mohair (brush seal)	0,14	0,90
Replacement panel EN ISO 10077-2	0,035	0,90
Unventilated air cavity **		

** EN ISO 10077-2:2017, 6.4.2

The data is based on EN ISO 10456 and EN ISO 10077-2.
The thermal conductivities and/or emissivities of the materials which are not based on that standards are deposited at ift-Rosenheim.
The documents have been evaluated. They are in accordance with the requirements of the current version of EN ISO 10077-2.
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Dokumentenvorlage (Template): 2018_03_ift_Template_v3.flt
Anzahl finiter Elemente: 55006
Rel. Wärmestromfehler: 3,7e-010

Fig. 6 Simulation model test specimen -06 (Radiosity-Method)

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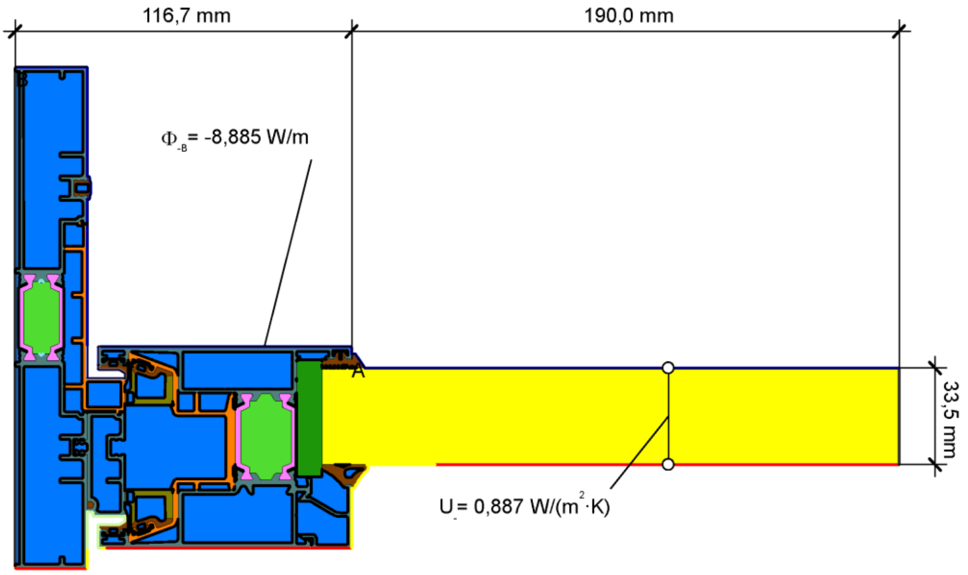
Protocol: FEM-Calculation



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{8,885}{20,000} - 0,887 \cdot 0,190}{0,117} = 2,4\ W/(m^2 \cdot K)$$

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,0			
Epsilon 0,1				0,10
Epsilon 0,9				0,90
External		0,0	0,040	
External, Slightly ventilated air cavity		0,0	0,30	
Internal reduced		20	0,20	
Internal standard		20	0,13	
Internal, Slightly ventilated air cavity		20	0,30	

Material	λ[W/(m·K)]	ε
Aluminium alloy - anodised - painted -powder coated	160	0,10
Aluminium alloy - anodised - painted -powder coated	160	0,90
Aluminium alloy - anodised - painted -powder coated (1)	160	0,90
Elastomeric foam, flexible	0,050	0,90
Ethylene-Propylendien Monomer (EPDM)	0,25	0,90
Neocoat EPS 200 (HBCD free)	0,030	0,90
POL PE 22x12	0,038	0,90
PVC (polyvinylchloride), rigid	0,17	0,90
Polyamide 6.6 with 25% glass fiber	0,30	0,90
Replacement panel EN ISO 10077-2	0,035	0,90
Unventilated air cavity **		

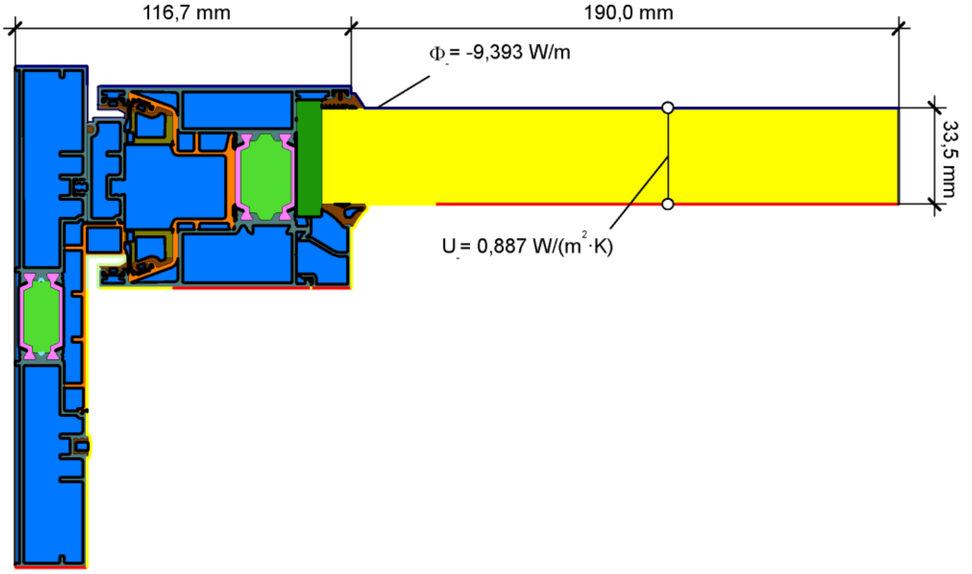
** EN ISO 10077-2:2017, 6.4.2

The data is based on EN ISO 10456 and EN ISO 10077-2.
The thermal conductivities and/or emissivities of the materials which are not based on that standards are deposited at ift-Rosenheim.
The documents have been evaluated. They are in accordance with the requirements of the current version of EN ISO 10077-2.
The emissivity of low emissive layers must be ensured by a factory production control.

Prüfer / Bearbeiter: Markus Paccagnel
Speicherdatum: 10.12.2019
Programmversion (letzte Speicherung): flixo pro 8.0.923.1
Dokumentenvorlage (Template): 2018_03_ift_Template_v3.flt
Anzahl finiter Elemente: 55006
Rel. Wärmestromfehler: 3,7e-010

Fig. 7 Simulation model test specimen -07 (Radiosity-Method)

Protocol: FEM-Calculation



$$U_f = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{9{,}393}{20{,}000} - 0{,}887 \cdot 0{,}190}{0{,}117} = 2{,}6\ W/(m^2 \cdot K)$$

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,0			
Epsilon 0,1				0,10
Epsilon 0,9				0,90
External		0,0	0,040	
External, Slightly ventilated air cavity		0,0	0,30	
Internal reduced		20	0,20	
Internal standard		20	0,13	
Internal, Slightly ventilated air cavity		20	0,30	

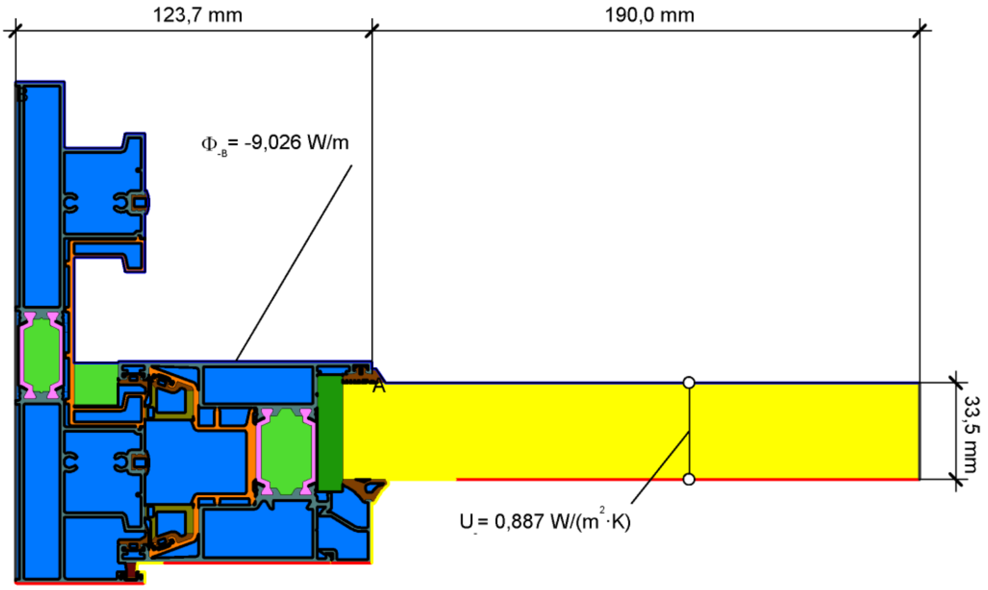
Material	λ[W/(m·K)]	ε
Aluminium alloy - anodised - painted -powder coated	160	0,10
Aluminium alloy - anodised - painted -powder coated	160	0,90
Aluminium alloy - anodised - painted -powder coated (1)	160	0,90
Elastomeric foam, flexible	0,050	0,90
Ethylene-Propylendien Monomer (EPDM)	0,25	0,90
Neocoat EPS 200 (HBCD free)	0,030	0,90
POL PE 22x12	0,038	0,90
PVC (polyvinylchloride), rigid	0,17	0,90
Polyamide 6.6 with 25% glass fiber	0,30	0,90
Replacement panel EN ISO 10077-2	0,035	0,90
Unventilated air cavity **		
** EN ISO 10077-2:2017, 6.4.2		

The data is based on EN ISO 10456 and EN ISO 10077-2.
The thermal conductivities and/or emissivities of the materials which are not based on that standards are deposited at ift-Rosenheim.
The documents have been evaluated. They are in accordance with the requirements of the current version of EN ISO 10077-2.
The emissivity of low emissive layers must be ensured by a factory production control.

Prüfer / Bearbeiter: Markus Paccagnel
Speicherdatum: 10.12.2019
Programmversion (letzte Speicherung): flixo pro 8.0.923.1
Dokumentenvorlage (Template): 2018_03_ift_Template_v3.flt
Anzahl finiter Elemente: 55006
Rel. Wärmestromfehler: 3,7e-010

Fig. 8 Simulation model test specimen -08 (Radiosity-Method)

Protocol: FEM-Calculation



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{9{,}026}{20{,}000} - 0{,}887 \cdot 0{,}190}{0{,}124} = 2{,}3\ \text{W/(m}^2\cdot\text{K)}$$

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,0			
Epsilon 0,9				0,90
External		0,0	0,040	
Internal reduced		20	0,20	
Internal standard		20	0,13	

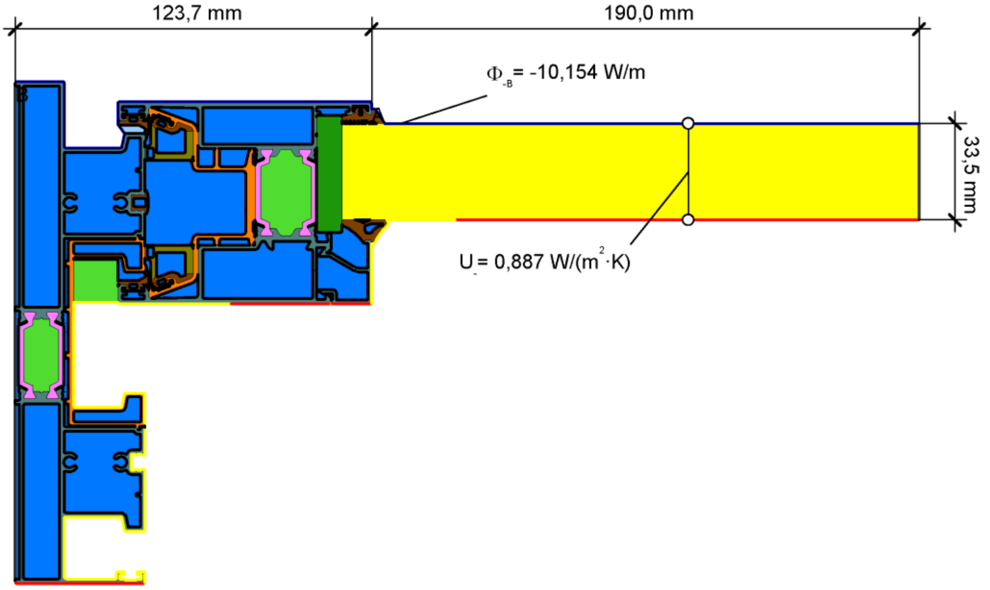
Material	λ[W/(m·K)]	ε
Aluminium alloy - anodised - painted -powder coated	160	0,90
Aluminium alloy - anodised - painted -powder coated (1)	160	0,90
Elastomeric foam, flexible	0,050	0,90
Ethylene-Propylendien Monomer (EPDM)	0,25	0,90
Neocoat EPS 200 (HBCD free)	0,030	0,90
POL PE 22x12	0,038	0,90
PVC (polyvinylchloride), rigid	0,17	0,90
Polyamide 6.6 with 25% glass fiber	0,30	0,90
Polyester mohair (brush seal)	0,14	0,90
Replacement panel EN ISO 10077-2	0,035	0,90
Unventilated air cavity **		
** EN ISO 10077-2:2017, 6.4.3/anisotrop		

The data is based on EN ISO 10456 and EN ISO 10077-2.
The thermal conductivities and/or emissivities of the materials which are not based on that standards are deposited at ift-Rosenheim.
The documents have been evaluated. They are in accordance with the requirements of the current version of EN ISO 10077-2.
The emissivity of low emissive layers must be ensured by a factory production control.

Prüfer / Bearbeiter: Markus Paccagnel
Speicherdatum: 10.12.2019
Programmversion (letzte Speicherung): flixo pro 8.0.923.1
Dokumentenvorlage (Template): 2018_03_ift_Template_v3.flt
Anzahl finiter Elemente: 55006
Rel. Wärmestromfehler: 2,9e-010

Fig. 9 Simulation model test specimen -01 (Method with equivalent thermal conductivity)

Protocol: FEM-Calculation



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{10{,}154}{20{,}000} - 0{,}887 \cdot 0{,}190}{0{,}124} = 2{,}7\ \mathrm{W/(m^2 \cdot K)}$$

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,0			
Epsilon 0,9				0,90
External		0,0	0,040	
Internal reduced		20	0,20	
Internal standard		20	0,13	

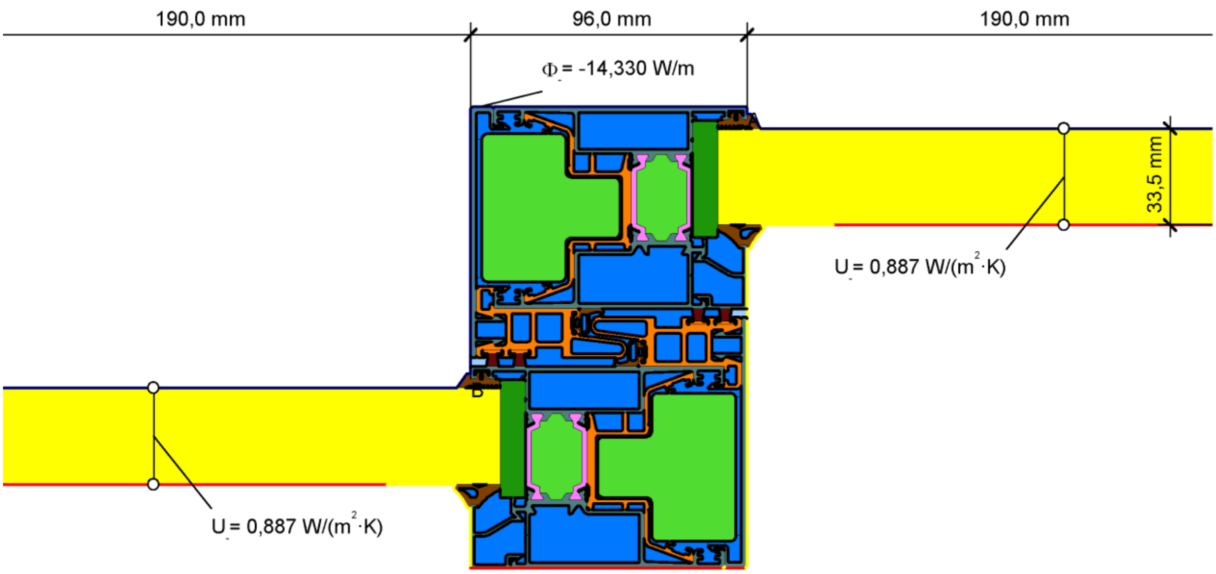
Material	λ[W/(m·K)]	ε
Aluminium alloy - anodised - painted -powder coated	160	0,90
Aluminium alloy - anodised - painted -powder coated (1)	160	0,90
Elastomeric foam, flexible	0,050	0,90
Ethylene-Propylendien Monomer (EPDM)	0,25	0,90
Neocoat EPS 200 (HBCD free)	0,030	0,90
POL PE 22x12	0,038	0,90
PVC (polyvinylchloride), rigid	0,17	0,90
Polyamide 6.6 with 25% glass fiber	0,30	0,90
Replacement panel EN ISO 10077-2	0,035	0,90
Slightly ventilated air cavity **		
Unventilated air cavity **		
** EN ISO 10077-2:2017, 6.4.3/anisotrop		

The data is based on EN ISO 10456 and EN ISO 10077-2.
The thermal conductivities and/or emissivities of the materials which are not based on that standards are deposited at ift-Rosenheim.
The documents have been evaluated. They are in accordance with the requirements of the current version of EN ISO 10077-2.
The emissivity of low emissive layers must be ensured by a factory production control.

Prüfer / Bearbeiter: Markus Paccagnel
Speicherdatum: 10.12.2019
Programmversion (letzte Speicherung): flixo pro 8.0.923.1
Dokumentenvorlage (Template): 2018_03_ift_Template_v3.flt
Anzahl finiter Elemente: 55006
Rel. Wärmestromfehler: 2,9e-010

Fig. 10 Simulation model test specimen -02 (Method with equivalent thermal conductivity)

Protocol: FEM-Calculation



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_{p1}\cdot b_{p1} - U_{p2}\cdot b_{p2}}{b_f} = \frac{\frac{14,330}{20,000} - 0,887\cdot 0,190 - 0,887\cdot 0,190}{0,096} = 4,0\ W/(m^2\cdot K)$$

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,0			
Epsilon 0,9				0,90
External		0,0	0,040	
Internal reduced		20	0,20	
Internal standard		20	0,13	

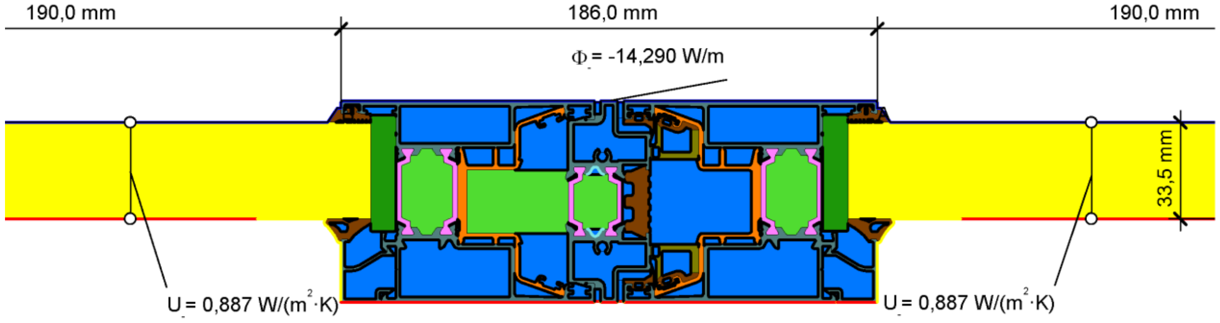
Material	λ[W/(m·K)]	ε
Aluminium alloy - anodised - painted -powder coated	160	0,90
Aluminium alloy - anodised - painted -powder coated (1)	160	0,90
Ethylene-Propylendien Monomer (EPDM)	0,25	0,90
Neocoat EPS 200 (HBCD free)	0,030	0,90
POL PE 22x12	0,038	0,90
PVC (polyvinylchloride), rigid	0,17	0,90
PVC (polyvinylchloride), rigid (1)	0,17	0,90
Polyamide 6.6 with 25% glass fiber	0,30	0,90
Polyester mohair (brush seal)	0,14	0,90
Replacement panel EN ISO 10077-2	0,035	0,90
Slightly ventilated air cavity **		
Unventilated air cavity **		
** EN ISO 10077-2:2017, 6.4.3/anisotrop		

The data is based on EN ISO 10456 and EN ISO 10077-2.
The thermal conductivities and/or emissivities of the materials which are not based on that standards are deposited at ift-Rosenheim.
The documents have been evaluated. They are in accordance with the requirements of the current version of EN ISO 10077-2.
The emissivity of low emissive layers must be ensured by a factory production control.

Prüfer / Bearbeiter: Markus Paccagnel Programmversion (letzte Speicherung): flixo pro 8.0.923.1 Anzahl finiter Elemente: 55006
Speicherdatum: 10.12.2019 Dokumentenvorlage (Template): 2018_03_ift_Template_v3.flt Rel. Wärmestromfehler: 2,9e-010

Fig. 11 Simulation model test specimen -03 (Method with equivalent thermal conductivity)

Protocol: FEM-Calculation



$$U_{f,A,B} = \frac{\frac{\Phi}{\Delta T} - U_{p1} \cdot b_{p1} - U_{p2} \cdot b_{p2}}{b_f} = \frac{\frac{14,290}{20,000} - 0,887 \cdot 0,190 - 0,887 \cdot 0,190}{0,186} = 2,0\ W/(m^2 \cdot K)$$

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,0			
Epsilon 0,1				0,10
Epsilon 0,9				0,90
External		0,0	0,040	
Internal reduced		20	0,20	
Internal standard		20	0,13	

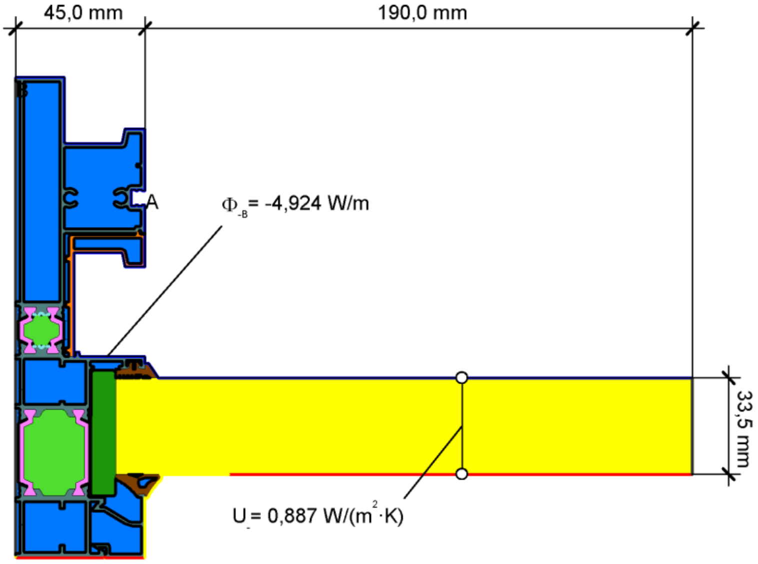
Material	λ[W/(m·K)]	ε
Aluminium alloy - anodised - painted -powder coated	160	0,90
Aluminium alloy - anodised - painted -powder coated (1)	160	0,10
Aluminium alloy - anodised - painted -powder coated (1)	160	0,90
Elastomeric foam, flexible	0,050	0,90
Ethylene-Propylendien Monomer (EPDM)	0,25	0,90
Neocoat EPS 200 (HBCD free)	0,030	0,90
POL PE 22x12	0,038	0,90
PVC (polyvinylchloride), rigid	0,17	0,90
Polyamide 6.6 with 25% glass fiber	0,30	0,90
Replacement panel EN ISO 10077-2	0,035	0,90
Unventilated air cavity **		
** EN ISO 10077-2:2017, 6.4.3/anisotrop		

The data is based on EN ISO 10456 and EN ISO 10077-2.
The thermal conductivities and/or emissivities of the materials which are not based on that standards are deposited at ift-Rosenheim.
The documents have been evaluated. They are in accordance with the requirements of the current version of EN ISO 10077-2.
The emissivity of low emissive layers must be ensured by a factory production control.

Prüfer / Bearbeiter: Markus Paccagnel
Speicherdatum: 10.12.2019
Programmversion (letzte Speicherung): flixo pro 8.0.923.1
Dokumentenvorlage (Template): 2018_03_ift_Template_v3.flt
Anzahl finiter Elemente: 55006
Rel. Wärmestromfehler: 2,9e-010

Fig. 12 Simulation model test specimen -04 (Method with equivalent thermal conductivity)

Protocol: FEM-Calculation



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{4{,}924}{20{,}000} - 0{,}887 \cdot 0{,}190}{0{,}045} = 1{,}7\ \text{W/(m}^2\cdot\text{K)}$$

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,0			
Epsilon 0,1				0,10
Epsilon 0,9				0,90
External		0,0	0,040	
Internal reduced		20	0,20	
Internal standard		20	0,13	

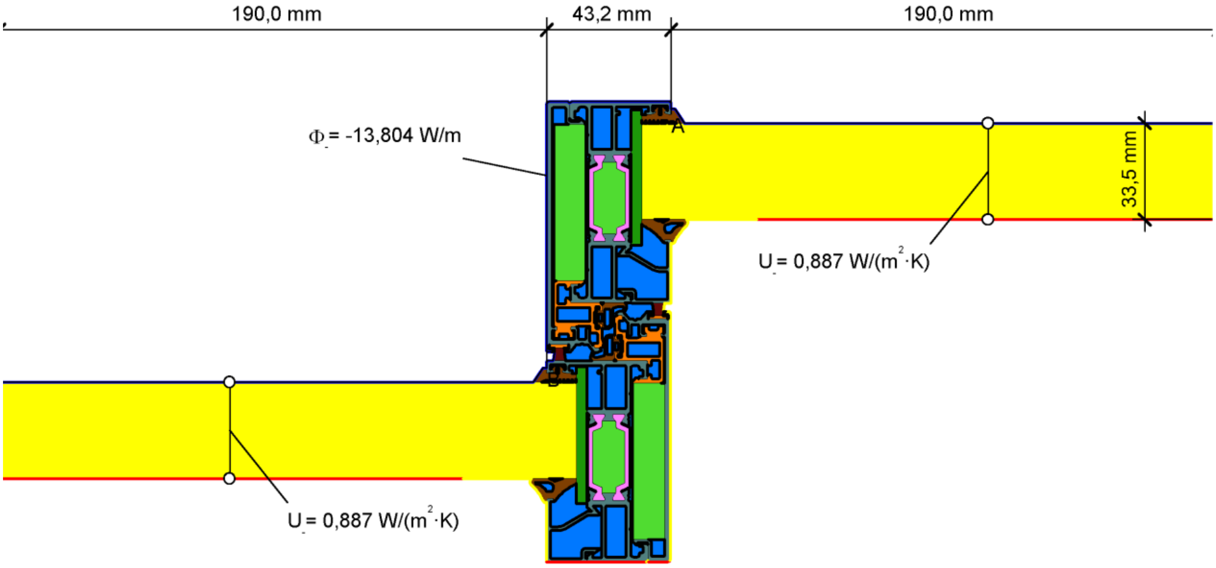
Material	λ[W/(m·K)]	ε
Aluminium alloy - anodised - painted -powder coated	160	0,10
Aluminium alloy - anodised - painted -powder coated	160	0,90
Aluminium alloy - anodised - painted -powder coated (1)	160	0,90
Ethylene-Propylendien Monomer (EPDM)	0,25	0,90
Neocoat EPS 200 (HBCD free)	0,030	0,90
POL PE 22x12	0,038	0,90
PVC (polyvinylchloride), rigid	0,17	0,90
Polyamide 6.6 with 25% glass fiber	0,30	0,90
Replacement panel EN ISO 10077-2	0,035	0,90
Unventilated air cavity **		
** EN ISO 10077-2:2017, 6.4.3/anisotrop		

The data is based on EN ISO 10456 and EN ISO 10077-2.
The thermal conductivities and/or emissivities of the materials which are not based on that standards are deposited at ift-Rosenheim.
The documents have been evaluated. They are in accordance with the requirements of the current version of EN ISO 10077-2.
The emissivity of low emissive layers must be ensured by a factory production control.

Prüfer / Bearbeiter: Markus Paccagnel
Speicherdatum: 10.12.2019
Programmversion (letzte Speicherung): flixo pro 8.0.923.1
Dokumentenvorlage (Template): 2018_03_ift_Template_v3.flt
Anzahl finiter Elemente: 55006
Rel. Wärmestromfehler: 2,9e-010

Fig. 13 Simulation model test specimen -05 (Method with equivalent thermal conductivity)

Protocol: FEM-Calculation



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_{p1}\cdot b_{p1} - U_{p2}\cdot b_{p2}}{b_f} = \frac{\frac{13,804}{20,000} - 0,887\cdot 0,190 - 0,887\cdot 0,190}{0,043} = 8,2\ W/(m^2\cdot K)$$

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,0			
Epsilon 0,9				0,90
External		0,0	0,040	
Internal reduced		20	0,20	
Internal standard		20	0,13	

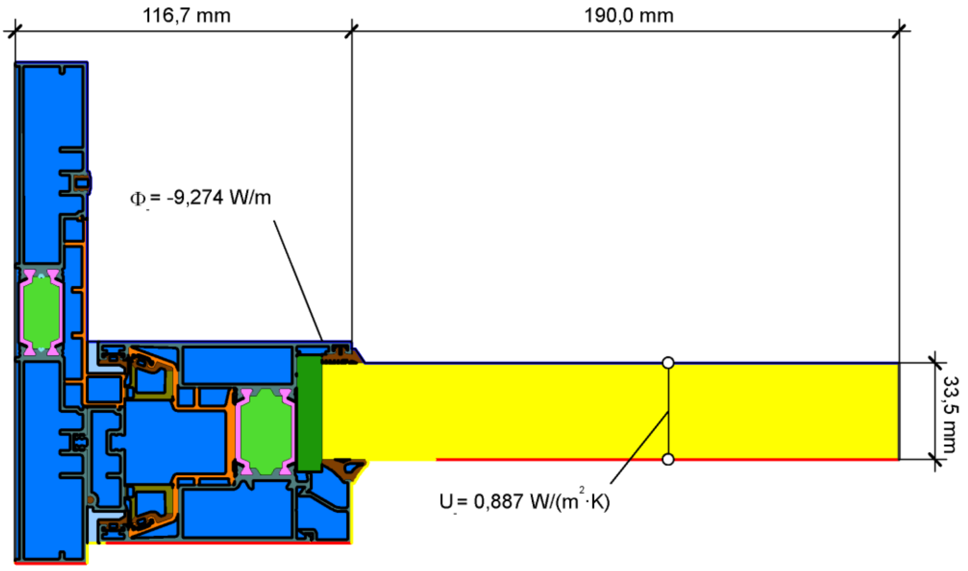
Material	λ[W/(m·K)]	ε
Aluminium alloy - anodised - painted -powder coated	160	0,90
Aluminium alloy - anodised - painted -powder coated (1)	160	0,90
Ethylene-Propylendien Monomer (EPDM)	0,25	0,90
Neocoat EPS 200 (HBCD free)	0,030	0,90
POL PE 22x12	0,038	0,90
PVC (polyvinylchloride), rigid	0,17	0,90
Polyamide 6.6 with 25% glass fiber	0,30	0,90
Polyester mohair (brush seal)	0,14	0,90
Replacement panel EN ISO 10077-2	0,035	0,90
Unventilated air cavity **		
** EN ISO 10077-2:2017, 6.4.3/anisotrop		

The data is based on EN ISO 10456 and EN ISO 10077-2.
The thermal conductivities and/or emissivities of the materials which are not based on that standards are deposited at ift-Rosenheim.
The documents have been evaluated. They are in accordance with the requirements of the current version of EN ISO 10077-2.
The emissivity of low emissive layers must be ensured by a factory production control.

Prüfer / Bearbeiter: Markus Paccagnel
Speicherdatum: 10.12.2019
Programmversion (letzte Speicherung): flixo pro 8.0.923.1
Dokumentenvorlage (Template): 2018_03_ift_Template_v3.flt
Anzahl finiter Elemente: 55006
Rel. Wärmestromfehler: 2,9e-010

Fig. 14 Simulation model test specimen -06 (Method with equivalent thermal conductivity)

Protocol: FEM-Calculation



$$U_f = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{9,274}{20,000} - 0,887 \cdot 0,190}{0,117} = 2,5\ W/(m^2 \cdot K)$$

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,0			
Epsilon 0,1				0,10
Epsilon 0,9				0,90
External		0,0	0,040	
Internal reduced		20	0,20	
Internal standard		20	0,13	

Material	λ[W/(m·K)]	ε
Aluminium alloy - anodised - painted -powder coated	160	0,10
Aluminium alloy - anodised - painted -powder coated	160	0,90
Aluminium alloy - anodised - painted -powder coated (1)	160	0,90
Elastomeric foam, flexible	0,050	0,90
Ethylene-Propylendien Monomer (EPDM)	0,25	0,90
Neocoat EPS 200 (HBCD free)	0,030	0,90
POL PE 22x12	0,038	0,90
PVC (polyvinylchloride), rigid	0,17	0,90
Polyamide 6.6 with 25% glass fiber	0,30	0,90
Replacement panel EN ISO 10077-2	0,035	0,90
Slightly ventilated air cavity **		
Unventilated air cavity **		

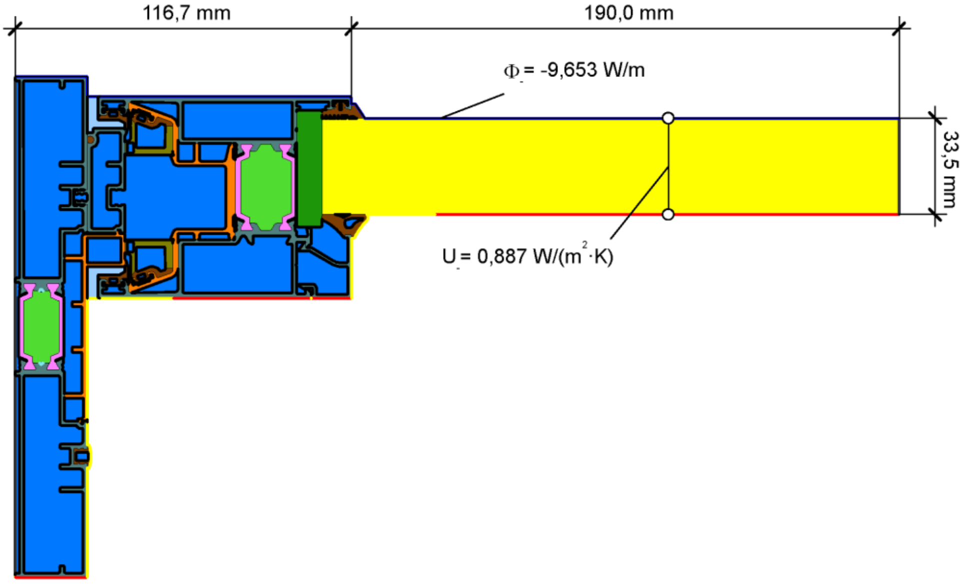
** EN ISO 10077-2:2017, 6.4.3/anisotrop

The data is based on EN ISO 10456 and EN ISO 10077-2.
The thermal conductivities and/or emissivities of the materials which are not based on that standards are deposited at ift-Rosenheim.
The documents have been evaluated. They are in accordance with the requirements of the current version of EN ISO 10077-2.
The emissivity of low emissive layers must be ensured by a factory production control.

Prüfer / Bearbeiter: Markus Paccagnel
Speicherdatum: 10.12.2019
Programmversion (letzte Speicherung): flixo pro 8.0.923.1
Dokumentenvorlage (Template): 2018_03_ift_Template_v3.flt
Anzahl finiter Elemente: 55006
Rel. Wärmestromfehler: 2,9e-010

Fig. 15 Simulation model test specimen -07 (Method with equivalent thermal conductivity)

Protocol: FEM-Calculation



$$U_f = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{9{,}653}{20{,}000} - 0{,}887 \cdot 0{,}190}{0{,}117} = 2{,}7\ W/(m^2 \cdot K)$$

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic	0,0			
Epsilon 0,1				0,10
Epsilon 0,9				0,90
External		0,0	0,040	
Internal reduced		20	0,20	
Internal standard		20	0,13	

Material	λ[W/(m·K)]	ε
Aluminium alloy - anodised - painted -powder coated	160	0,10
Aluminium alloy - anodised - painted -powder coated	160	0,90
Aluminium alloy - anodised - painted -powder coated (1)	160	0,90
Elastomeric foam, flexible	0,050	0,90
Ethylene-Propylendien Monomer (EPDM)	0,25	0,90
Neocoat EPS 200 (HBCD free)	0,030	0,90
POL PE 22x12	0,038	0,90
PVC (polyvinylchloride), rigid	0,17	0,90
Polyamide 6.6 with 25% glass fiber	0,30	0,90
Replacement panel EN ISO 10077-2	0,035	0,90
Slightly ventilated air cavity **		
Unventilated air cavity **		
** EN ISO 10077-2:2017, 6.4.3/anisotrop		

The data is based on EN ISO 10456 and EN ISO 10077-2.
The thermal conductivities and/or emissivities of the materials which are not based on that standards are deposited at ift-Rosenheim.
The documents have been evaluated. They are in accordance with the requirements of the current version of EN ISO 10077-2.
The emissivity of low emissive layers must be ensured by a factory production control.

Prüfer / Bearbeiter: Markus Paccagnel
Speicherdatum: 10.12.2019
Programmversion (letzte Speicherung): flixo pro 8.0.923.1
Dokumentenvorlage (Template): 2018_03_ift_Template_v3.flt
Anzahl finiter Elemente: 55006
Rel. Wärmestromfehler: 2,9e-010

Fig. 16 Simulation model test specimen -08 (Method with equivalent thermal conductivity)