Evidence of Performance
Calculation of thermal transmittance

Test Report
No. 19-001768-PR01
(PB-K20-06-en-01)

ROSENHEIM

Client

Modulotherm Sp.z.o.o.
Slaska 96
66-400 Gorzów Wielkopolski
Poland

Product

Additional profiles and
Additional profiles in combination with hollow chamber profiles – plastic, in wall connection

Designation: Expansion system

Performance-relevant product details: Material Polyvinylchloride (PVC-U) rigid / User specific - EPS "Klinaryt"; Projected width B in mm 124; Reinforcement; Material Steel, galvanized; Frame; Profile section, width in mm 73; Thickness in mm 82; Casement; Profile section, width in mm 84; Thickness in mm 82; Additional profile 1; Profile section, width in mm 30; Thickness in mm 61; Additional profile 2; Profile section, width in mm 36; Thickness in mm 58; Glazing; Construction in mm 4/18/4/18/4; Thermal transmittance U_g in W/(m²K) 0.5 (as specified by client); Spacer; Type Standard metal spacer acc. to EN ISO 10077-2; Structure connection; Wall construction Monolithic wall with external thermal insulation composite system (ETICS)

Special features

Results

Calculation of thermal transmittance (Radiosity-Method) based on EN ISO 10077-2:2017 and determination of isothermal lines.

$$U_f = 0.53\ \text{W/(m}^2\text{K)} – 1.2\ \text{W/(m}^2\text{K)}$$

The isothermal lines are shown in Annex 2 of this test report. Local influences by screwing are not considered. The functionality of the structure connection was not checked. The structure connection must be carried out according to the principles of building physics as described in the ift mounting guide

ift Rosenheim
09.12.2020

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

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

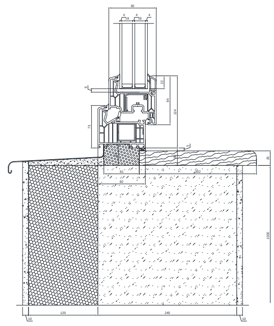
Basis *)

Based on
EN ISO 10077-2:2017-07
EN ISO 13788:2012-12
EN ISO 10211:2017-07

*) Correspond/s to the national standard/s (e.g. DIN EN)

Representation

Exemplary test specimen



Furhter drawings see annex.

Instructions for use

The results obtained can be used as evidence in accordance with the above basis.

Validity

The data and results given relate solely to the tested/described specimen. 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.

Notes on publication

The ift-Guidance Sheet "Conditions and Guidance for the Use of ift Test Documents" applies. The document may only be published in full.

Contents

The report contains a total of 5 page/s and annexes (10 pages).

1 Object

1.1 Description of test specimen

Product	Additional profiles and additional profiles in combination with hollow chamber profiles – plastic, in wall connection
Material	Polyvinylchlorid (PVC-U), rigid / User specific - EPS “Klinaryt”
Projected width in mm	124
Reinforcement	
Material	Steel, galvanized
Frame profiles	
Manufacturer	Veka AG
System designation	Veka Slide 82 (as specified by client)
Frame	
Width in mm	73
Depth in mm	82
Reinforcement	
Width in mm	30
Depth in mm	30
Thickness in mm	1.5
Casement	
Width in mm	84
Depth in mm	82
Reinforcement	
Width in mm	30
Depth in mm	39
Thickness in mm	1.8
Glazing	
Construction in mm	4/18/4/18/4
Thermal transmittance U_g in W/(m²K)	0.5 (as specified by client)
Edge cover in mm	22

Spacer

Type	Standard metal spacer acc. to EN ISO 10077-2

Structure connection

Wall construction	Monolithic wall with external thermal insulation composite system (ETICS)
Material / Thickness in mm / Thermal conductivity in W/(mK)	Exterior plaster / 10 / 0.28 Thermal insulation / 120 / 0.035 Brickwork / 240 / 0.81 Interior plaster / 10 / 0.28
Assembly situation	Structure connection at bottom: Additional profiles

Additional profiles at the back of the frame

Profile 1

Material	User specific - EPS “Klinaryt”
Thermal conductivity in W/(mK)	0.033
Width in mm	30
Thickness in mm	61

Profile 2

Material	Polyvinylchlorid (PVC-U), rigid
Width in mm	36
Thickness in mm	58

The description is based on specifications provided by the client and on inspection of the test specimen at the **ift.** (Item designations/ numbers as well as material specifications were provided by the client, unless designated as *„**ift**-tested“*.)

Test specimen are described in the annex "Product/Sample description".

1.2 Sampling

The following data for sampling have been presented to **ift**:

Sampler: Modulotherm Sp.z.o.o., 66-400 Gorzów Wielkopolski (Poland)

Date: 17.07.2020

Documentation: ift Rosenheim did not receive a sampling report.

ift-test specimen-No.:19-001768-PK01

2 Procedure

2.1 Basic documents *) of the processes

Based on 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

EN ISO 13788:2012-12
Hygrothermal performance of building components and building elements - Internal surface temperature to avoid critical surface humidity and interstitial condensation - Calculation methods

EN ISO 10211:2017-07
Thermal bridges in building construction - Heat flows and surface temperatures - Detailed calculations

*) correspond/s to the national standard/s, e.g. DIN EN

Deviation to the test standard and information:
There is no technical data sheet for the additional profile made of EPS foam with thermal conductivity 0,033 W/mK. The additional profiles are not part of the U_W-value calculation according to EN ISO 10077-1.

2.2 Short description of process

Calculation was made by means of a FEM-calculation programme 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 and the isothermal lines were determined.

ROSENHEIM

3 Detailed results

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

Project-No.	19-001768-PR01
Basis	Based on 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/029379 - flixo 8.1
Test specimen	Additonal profiles - plastic and EPS
Test specimen No.	19-001768-PK01
Date of test	07.12.2020
Test engineer in charge	Till Stübben
Test engineer	Till Stübben

Implementation of tests

Deviations: There have been the following deviations from the test method specified in the standard/basis:
Calculation of thermal transmittance Uf without the use of a replacement panel according to EN ISO 10077-2.

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)
-01-2	0,030			0,016	0,533	**0,53**	0,016	0,533	**0,53**
-02-2	0,030			0,038	1,28	**1,3**	0,037	1,24	**1,2**

1) detailed calculation result

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

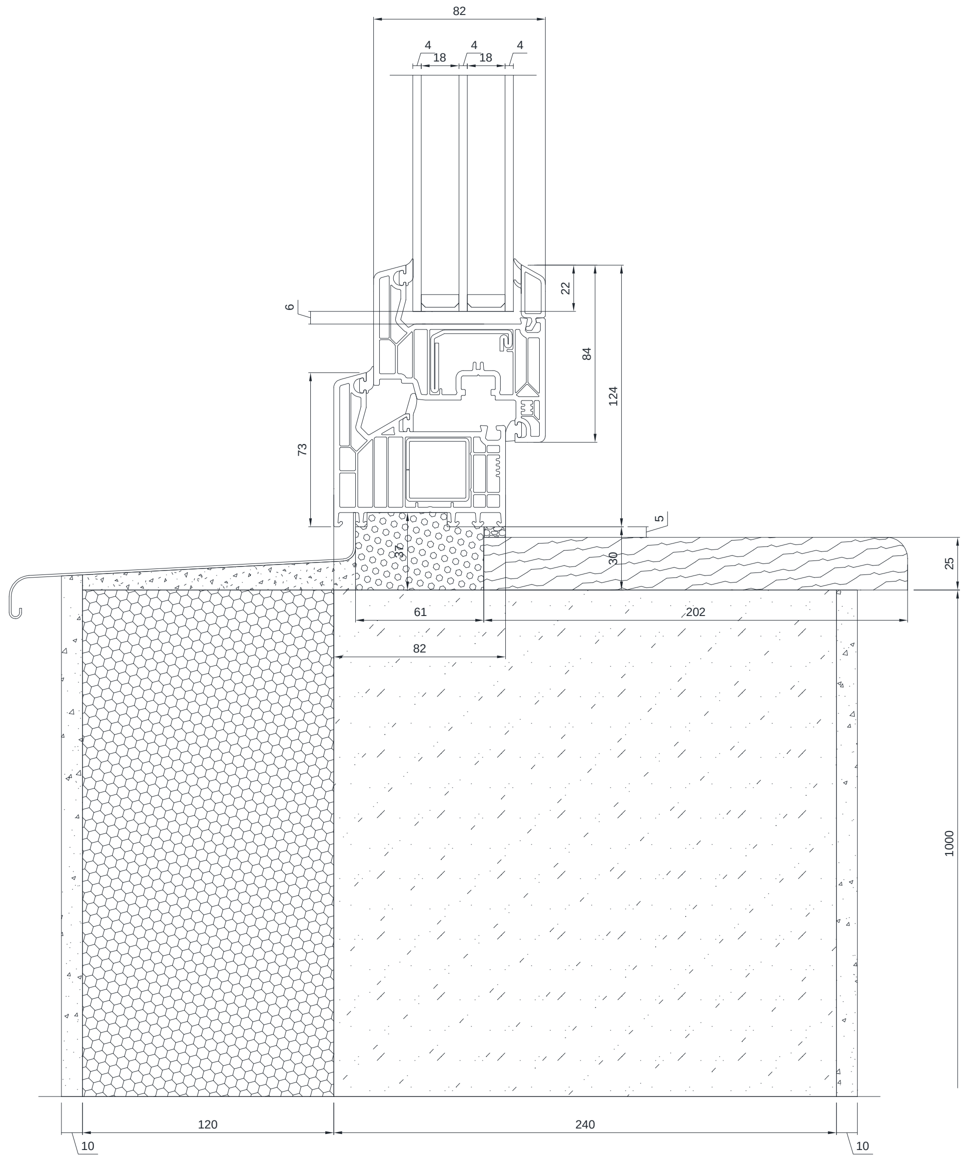


Fig. 1 Cross section test specimen -01-1

Notice: Local influences by screwing are not considered. The functionality of the structure connection was not checked. The structure connection must be carried out according to the principles of building physics as described in the ift mounting guide.

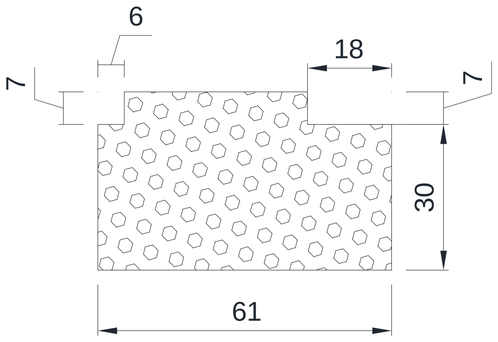


Fig. 2 Cross section test specimen -01-2

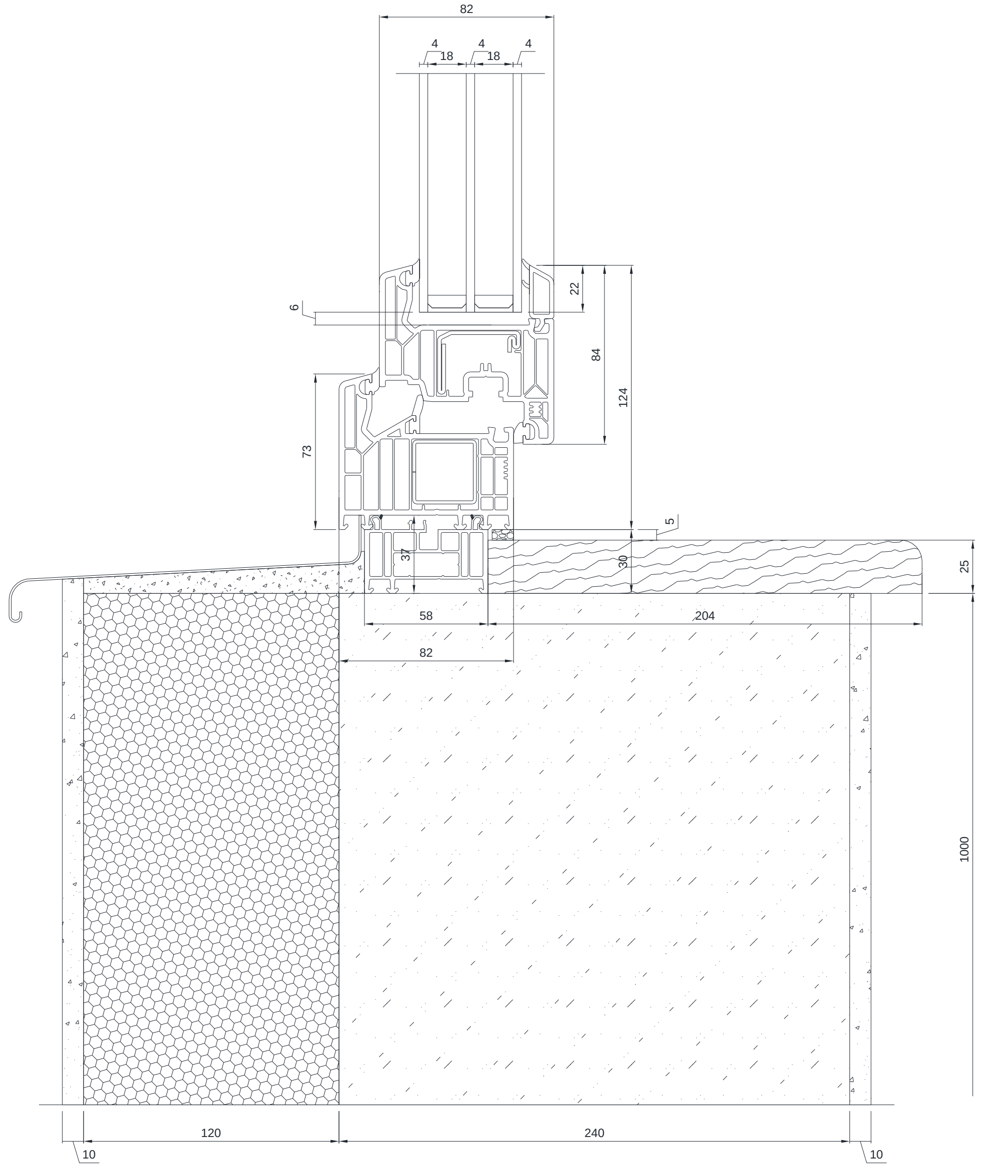


Fig. 3 Cross section test specimen -02-1

Notice: Local influences by screwing are not considered. The functionality of the structure connection was not checked. The structure connection must be carried out according to the principles of building physics as described in the ift mounting guide.

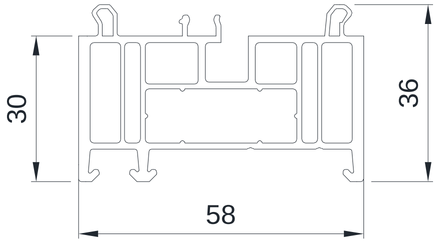


Fig. 4 Cross section test specimen -02-2

Test Report No. 19-001768-PR01 (PB-K20-06-en-01) dated 09.12.2020
Client: Modulotherm Sp.z.o.o., 66-400 Gorzów Wielkopolski (Poland)

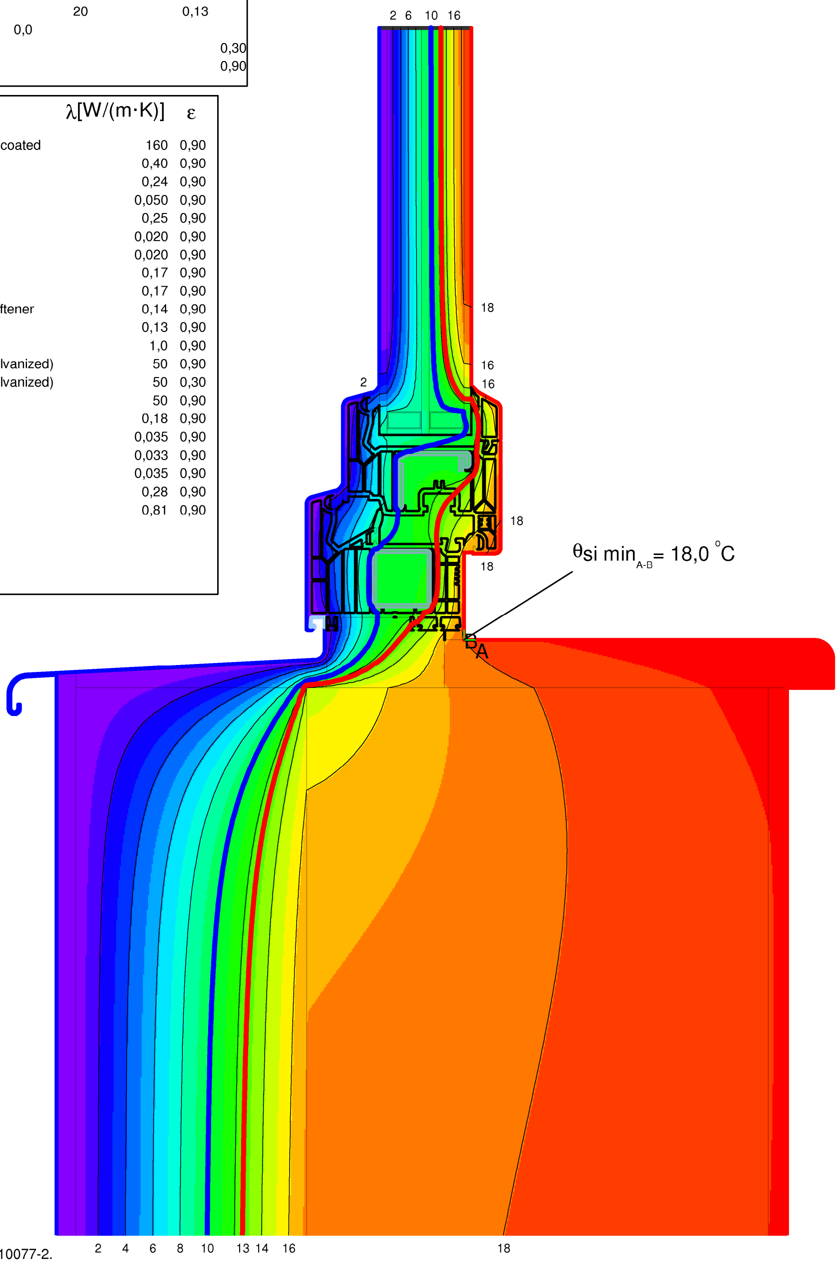
ROSENHEIM

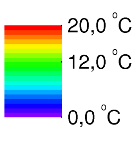
Protocol: FEM-Calculation

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
External		0,0	0,040	
External - Slightly ventilated air cavity		0,0	0,30	
Internal Rsi 0.13		20	0,13	
Adiabatic	0,0			
Epsilon 0.3				0,30
Epsilon 0.9				0,90

Material	λ[W/(m·K)]	ε
Aluminium alloy - anodised - painted -powder coated	160	0,90
Box1 (Polysulfide) - 3.0mm	0,40	0,90
Butyl, (isobutene), solid/hot melt	0,24	0,90
Elastomeric foam, flexible	0,050	0,90
Ethylene-Propylendien Monomer (EPDM)	0,25	0,90
Gasfilling(5)	0,020	0,90
Gasfilling(6)	0,020	0,90
PVC (polyvinylchloride), rigid	0,17	0,90
PVC (polyvinylchloride), rigid (1)	0,17	0,90
Polyvinylchloride (PVC), flexible, with 40 % softener	0,14	0,90
Silica gel (desiccant)	0,13	0,90
Soda lime glass (including "float glass")	1,0	0,90
Steel - metallic surface (general - including galvanized)	50	0,90
Steel - metallic surface (general - including galvanized)	50	0,30
Steel - painted or powder coated	50	0,90
Timber 700 kg/m³	0,18	0,90
User specific - EPS	0,035	0,90
User specific - EPS "Klinaryt"	0,033	0,90
User specific - PUR mounting foam	0,035	0,90
User specific - Plaster "Knauf"	0,28	0,90
User specific - Wall (silicate)	0,81	0,90
Unventilated air cavity *		

* EN ISO 10077-2:2017, 6.4.2



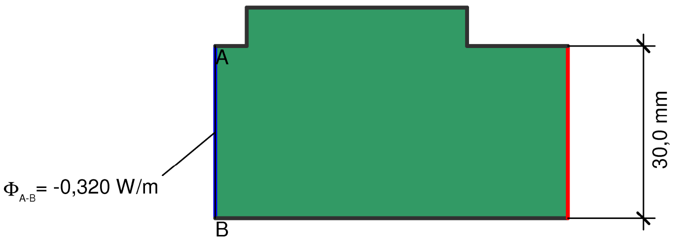


The data is based on EN ISO 10456 and EN ISO 10077-2.
The thermal conductivities and/or emissivities of the materials which are not based on that standards are deposited at ift-Rosenheim.
The documents have been evaluated. They are in accordance with the requirements of the current version of EN ISO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

Prüfer / Bearbeiter: Till Stübben
Speicherdatum: 07.12.2020
Programmversion (letzte Speicherung): flixo pro 8.1.1002.1
Dokumentenvorlage (Template): 2020_07_ift_Template_v3-2.flt
Anzahl finiter Elemente: 54469
Rel. Wärmestromfehler: 5,9e-011

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

Protocol: FEM-Calculation



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

Material	λ[W/(m·K)]	ε
User specific - EPS "Klinaryt"	0,033	0,90

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: Till Stübben
Speicherdatum: 07.12.2020

Programmversion (letzte Speicherung): flixo pro 8.1.1002.1
Dokumentenvorlage (Template): 2020_07_ift_Template_v3-2.flt

Anzahl finiter Elemente: 54469
Rel. Wärmestromfehler: 5,9e-011

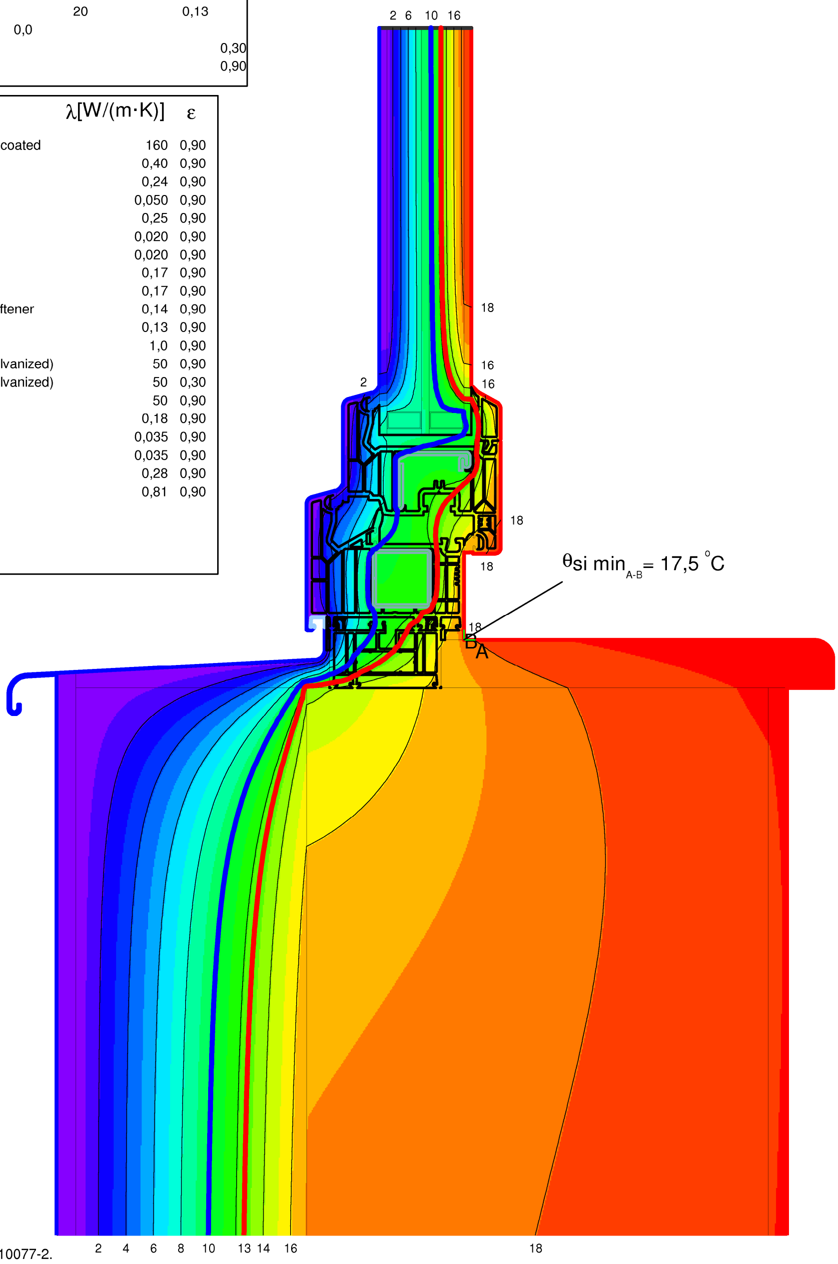
Fig. 2: Simulation model test specimen -01-2 (Radiosity-Method)

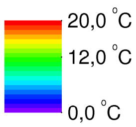
Protocol: FEM-Calculation

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
External		0,0	0,040	
External - Slightly ventilated air cavity		0,0	0,30	
Internal Rsi 0.13		20	0,13	
Adiabatic	0,0			
Epsilon 0.3				0,30
Epsilon 0.9				0,90

Material	λ[W/(m·K)]	ε
Aluminium alloy - anodised - painted -powder coated	160	0,90
Box1 (Polysulfide) - 3.0mm	0,40	0,90
Butyl, (isobutene), solid/hot melt	0,24	0,90
Elastomeric foam, flexible	0,050	0,90
Ethylene-Propylendien Monomer (EPDM)	0,25	0,90
Gasfilling(1)	0,020	0,90
Gasfilling(2)	0,020	0,90
PVC (polyvinylchloride), rigid	0,17	0,90
PVC (polyvinylchloride), rigid (1)	0,17	0,90
Polyvinylchloride (PVC), flexible, with 40 % softener	0,14	0,90
Silica gel (desiccant)	0,13	0,90
Soda lime glass (including "float glass")	1,0	0,90
Steel - metallic surface (general - including galvanized)	50	0,90
Steel - metallic surface (general - including galvanized)	50	0,30
Steel - painted or powder coated	50	0,90
Timber 700 kg/m³	0,18	0,90
User specific - EPS	0,035	0,90
User specific - PUR mounting foam	0,035	0,90
User specific - Plaster "Knauf"	0,28	0,90
User specific - Wall (silicate)	0,81	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.

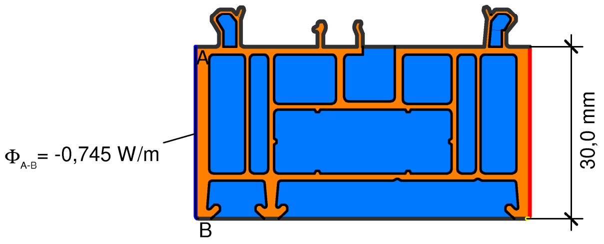
Prüfer / Bearbeiter: Till Stübben
Speicherdatum: 07.12.2020

Programmversion (letzte Speicherung): flixo pro 8.1.1002.1
Dokumentenvorlage (Template): 2020_07_ift_Template_v3-2.flt

Anzahl finiter Elemente: 54469
Rel. Wärmestromfehler: 5,9e-011

Fig. 3: Simulation model test specimen -02-1 (Radiosity-Method)

Protocol: FEM-Calculation



Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
External		0,0	0,040	
Internal frame reduced		20	0,20	
Internal frame standard		20	0,13	
Adiabatic	0,0			
Epsilon 0.9				0,90

Material	λ[W/(m·K)]	ε
PVC (polyvinylchloride), rigid (1)	0,17	0,90
Polyvinylchloride (PVC), flexible, with 40 % softener	0,14	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: Till Stübben
Speicherdatum: 07.12.2020
Programmversion (letzte Speicherung): flixo pro 8.1.1002.1
Dokumentenvorlage (Template): 2020_07_ift_Template_v3-2.flt
Anzahl finiter Elemente: 54469
Rel. Wärmestromfehler: 5,9e-011

Fig. 4: Simulation model test specimen -02-2 (Radiosity-Method)

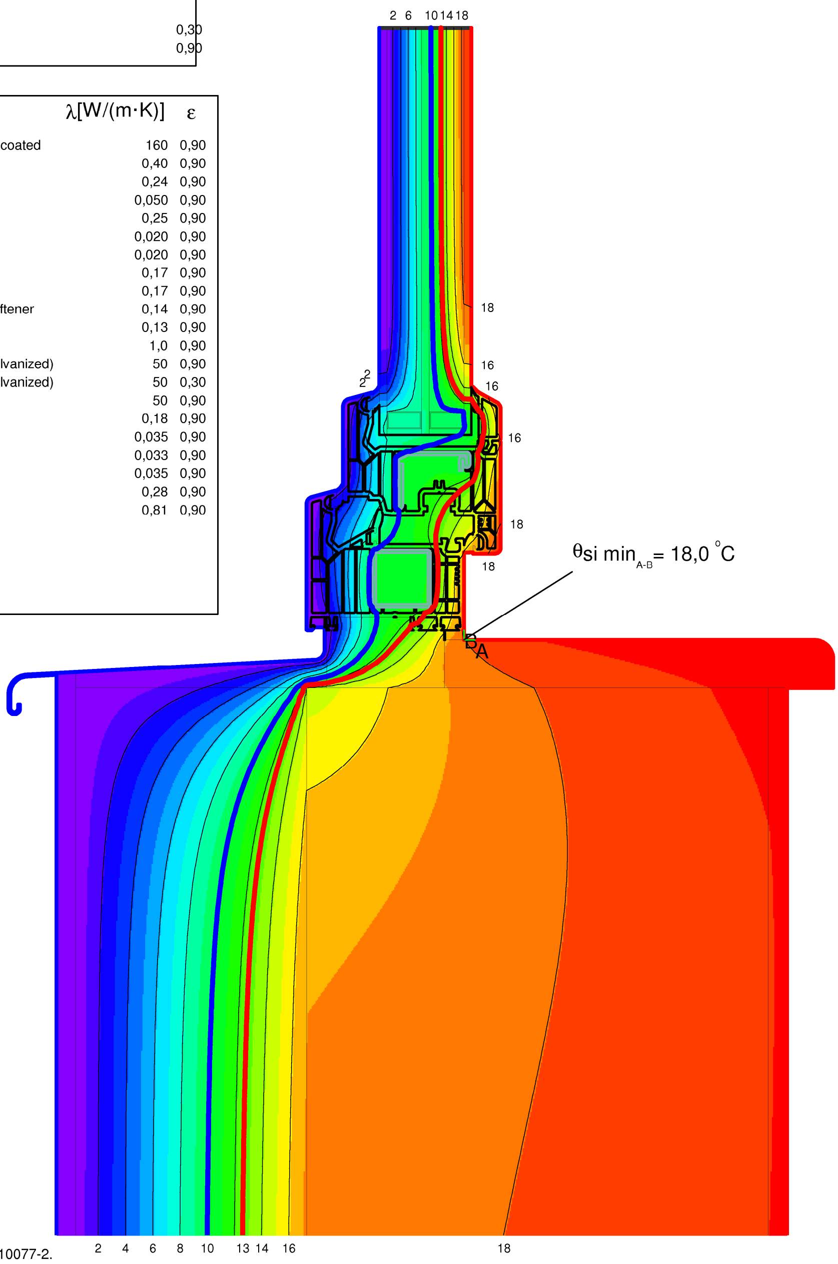
ift ROSENHEIM

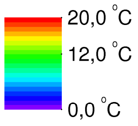
Protocol: FEM-Calculation

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
External		0,0	0,040	
Internal Rsi 0.13		20	0,13	
Adiabatic	0,0			
Epsilon 0.3				0,30
Epsilon 0.9				0,90

Material	λ[W/(m·K)]	ε
Aluminium alloy - anodised - painted -powder coated	160	0,90
Box1 (Polysulfide) - 3.0mm	0,40	0,90
Butyl, (isobutene), solid/hot melt	0,24	0,90
Elastomeric foam, flexible	0,050	0,90
Ethylene-Propylendien Monomer (EPDM)	0,25	0,90
Gasfilling(3)	0,020	0,90
Gasfilling(4)	0,020	0,90
PVC (polyvinylchloride), rigid	0,17	0,90
PVC (polyvinylchloride), rigid (1)	0,17	0,90
Polyvinylchloride (PVC), flexible, with 40 % softener	0,14	0,90
Silica gel (desiccant)	0,13	0,90
Soda lime glass (including "float glass")	1,0	0,90
Steel - metallic surface (general - including galvanized)	50	0,90
Steel - metallic surface (general - including galvanized)	50	0,30
Steel - painted or powder coated	50	0,90
Timber 700 kg/m³	0,18	0,90
User specific - EPS	0,035	0,90
User specific - EPS "Klinaryt"	0,033	0,90
User specific - PUR mounting foam	0,035	0,90
User specific - Plaster "Knauf"	0,28	0,90
User specific - Wall (silicate)	0,81	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.

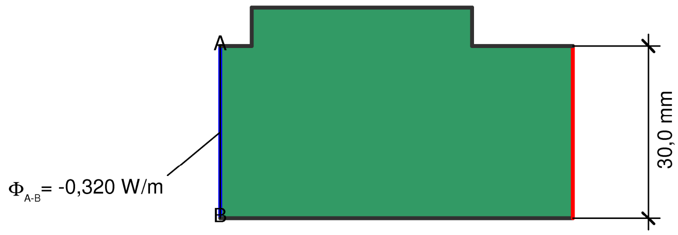
Prüfer / Bearbeiter: Till Stübben
Speicherdatum: 07.12.2020

Programmversion (letzte Speicherung): flixo pro 8.1.1002.1
Dokumentenvorlage (Template): 2020_07_ift_Template_v3-2.flt

Anzahl finiter Elemente: 55072
Rel. Wärmestromfehler: 1,1e-010

Fig. 5: Simulation model test specimen -01-1 (Method with equivalent thermal conductivity)

Protocol: FEM-Calculation



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

Material	λ[W/(m·K)]	ε
User specific - EPS "Klinaryt"	0,033	0,90

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: Till Stübben
Speicherdatum: 07.12.2020
Programmversion (letzte Speicherung): flixo pro 8.1.1002.1
Dokumentenvorlage (Template): 2020_07_ift_Template_v3-2.flt
Anzahl finiter Elemente: 55072
Rel. Wärmestromfehler: 1,1e-010

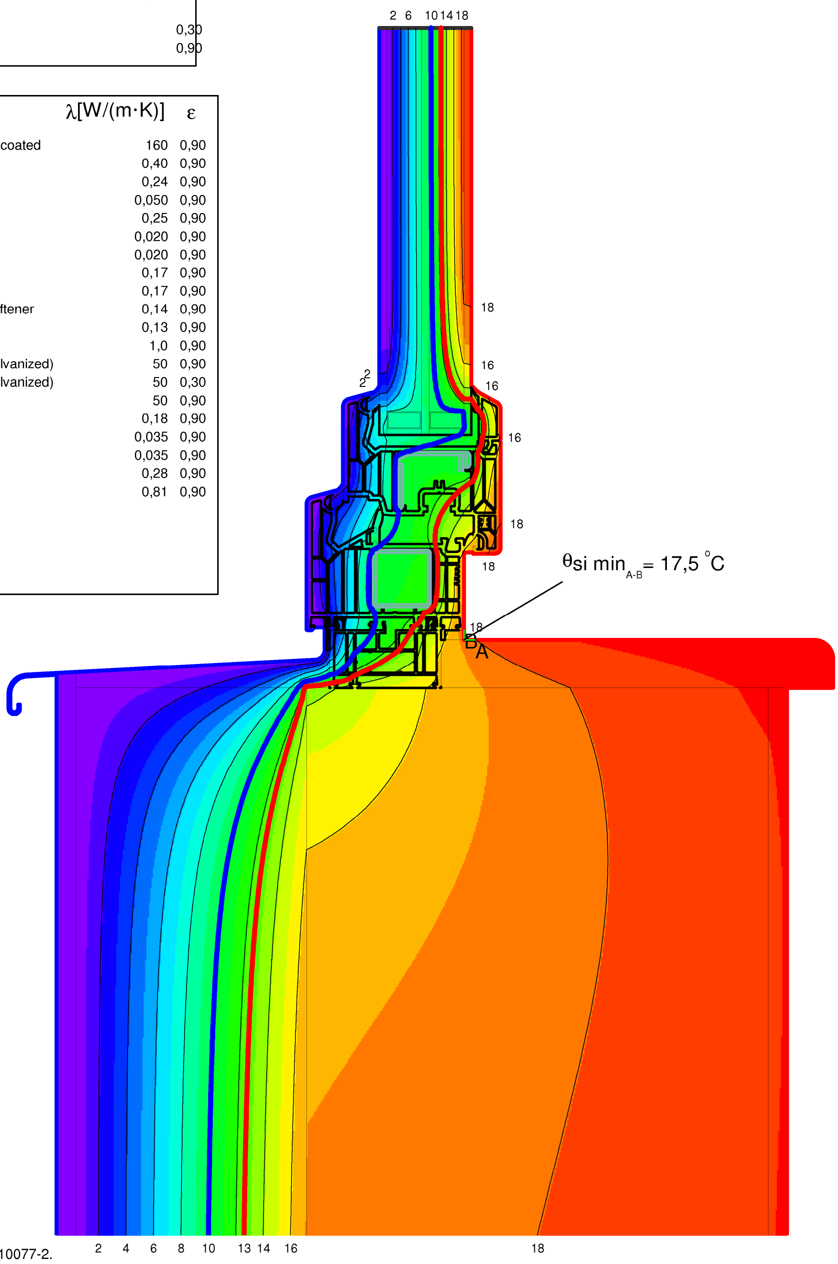
Fig. 7: Simulation model test specimen -02-1 (Method with equivalent thermal conductivity)

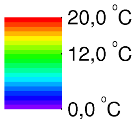
Protocol: FEM-Calculation

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
External		0,0	0,040	
Internal Rsi 0.13		20	0,13	
Adiabatic	0,0			
Epsilon 0.3				0,30
Epsilon 0.9				0,90

Material	λ[W/(m·K)]	ε
Aluminium alloy - anodised - painted -powder coated	160	0,90
Box1 (Polysulfide) - 3.0mm	0,40	0,90
Butyl, (isobutene), solid/hot melt	0,24	0,90
Elastomeric foam, flexible	0,050	0,90
Ethylene-Propylendien Monomer (EPDM)	0,25	0,90
Gasfilling(1)	0,020	0,90
Gasfilling(2)	0,020	0,90
PVC (polyvinylchloride), rigid	0,17	0,90
PVC (polyvinylchloride), rigid (1)	0,17	0,90
Polyvinylchloride (PVC), flexible, with 40 % softener	0,14	0,90
Silica gel (desiccant)	0,13	0,90
Soda lime glass (including "float glass")	1,0	0,90
Steel - metallic surface (general - including galvanized)	50	0,90
Steel - metallic surface (general - including galvanized)	50	0,30
Steel - painted or powder coated	50	0,90
Timber 700 kg/m³	0,18	0,90
User specific - EPS	0,035	0,90
User specific - PUR mounting foam	0,035	0,90
User specific - Plaster "Knauf"	0,28	0,90
User specific - Wall (silicate)	0,81	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.

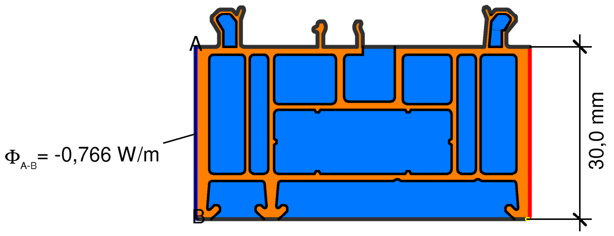
Prüfer / Bearbeiter: Till Stübben
Speicherdatum: 07.12.2020

Programmversion (letzte Speicherung): flixo pro 8.1.1002.1
Dokumentenvorlage (Template): 2020_07_ift_Template_v3-2.flt

Anzahl finiter Elemente: 55072
Rel. Wärmestromfehler: 1,1e-010

Fig. 6: Simulation model test specimen -01-2 (Method with equivalent thermal conductivity)

Protocol: FEM-Calculation



Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
External		0,0	0,040	
Internal frame reduced		20	0,20	
Internal frame standard		20	0,13	
Adiabatic	0,0			
Epsilon 0.9				0,90

Material	λ[W/(m·K)]	ε
PVC (polyvinylchloride), rigid (1)	0,17	0,90
Polyvinylchloride (PVC), flexible, with 40 % softener	0,14	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: Till Stübben
Speicherdatum: 07.12.2020
Programmversion (letzte Speicherung): flixo pro 8.1.1002.1
Dokumentenvorlage (Template): 2020_07_ift_Template_v3-2.flt
Anzahl finiter Elemente: 55072
Rel. Wärmestromfehler: 1,1e-010

Fig. 8: Simulation model test specimen -02-2 (Method with equivalent thermal conductivity)