THERMAL PERFORMANCE CALCULATION

Analysis undertaken and report prepared on behalf of XXXXX for XXXXXXX

DOCUMENT REF :- XXX/TP/XXXXX Rev 01
Document title :- U value analysis typical curtain wall
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Revisions

Rev 01 Initial issue of calculations

XXXXXXXX

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This document provides an assessment of the thermal performance only and does not indicate or contain assessments of the façade suitability regarding any other aspects, including but not limited to, structural and fire resistance. These must be assessed by the client and their specialist engineers.

Contents

Summary

This calculation document has been compiled to demonstrate the thermal performance i.e. U value of the typical curtain wall screens to be installed at XXXXXXX project in XXXXXXX.

The calculation has been undertaken on behalf of XXXXXX and relates to their calculation request number E1614-CR-001.

Façade examined is as shown on drawing XXXXX.

- The calculated U value for the glazed curtain wall screen with vent is 1.5 W/m²K.
- The calculated U value for the non-vision curtain wall screen is 0.68 W/m²K.
- The calculated mean U value for the curtain wall screens is 1.1 W/m²K.

The above values satisfy the project specified targets of 1.6 W/m²K.

Note: The temperature range used in this document is 20°C (0–20) and has been utilised for the purposes of U value calculations only. For the ranges analysed for façades the U value is independent of the temperature range.

Expression of results

From BR 443: "Conventions for U-value calculations" section 6.

The final result should be rounded to two significant figures (to two decimal places if the value is less than 1.0, one decimal place if more than 1.0). Round to the nearest value, with 1 to 4 being rounded downwards, and 5 to 9 being rounded upwards. The final value has been expressed as such.

Curtain Wall (Vision + Vent)

Façade Creations

Project width = 0.065

EDGE EFFECT HEAT LOSS (W/K) Perimeter values included in frame bar calculations.

Glazed Infill Heat Loss

Ref	Unit type	Mullion module	Transom module	No. of units	Width (m)	Height (m)	Area (m^2)	Area Tot (m^2) Ag	(W/m^2K) Ug	(W/K) Ag × Ug
1	Vision	0.932	2.38	1	0.867	2.315	2.007105	2.007105	1	2.007105
2	Panel PA2	0.533	1.504	1	0.468	1.439	0.673452	0.673452	1.1	0.7407972
3	Panel PA2	0.533	0.877	1	0.282	0.626	0.176532	0.176532	0.44	0.0776741
5	Panel PA1	0.533	0.52	1	0.468	0.455	0.21294	0.21294	0.19	0.0404586
6	Panel PA1	0.932	0.52	1	0.867	0.455	0.394485	0.394485	0.19	0.0749522
								3.464514		**2.940987**

Summary

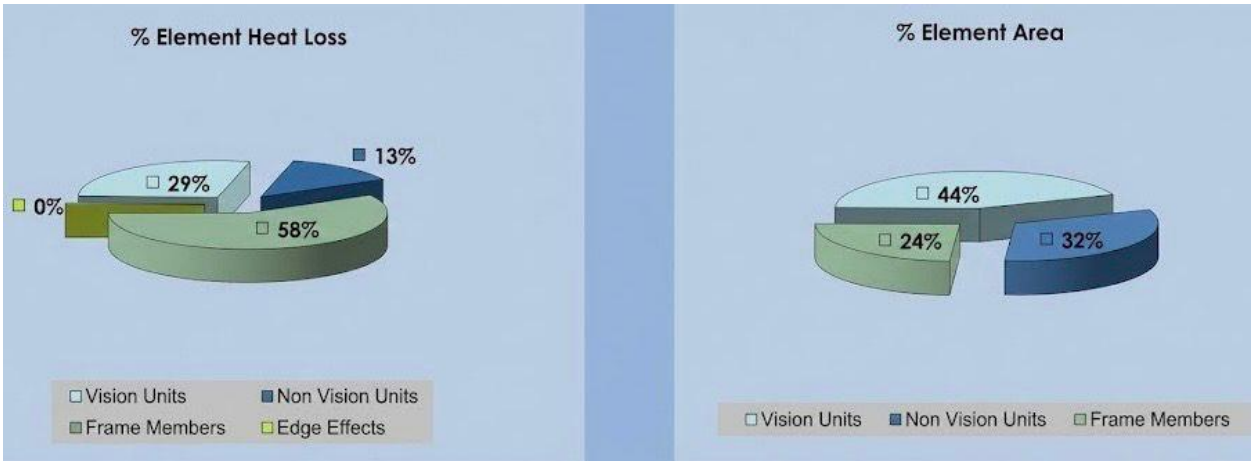
Item	Value
Total heat loss through glazed units	2.940987 W/K
Total heat loss due to edge effects	Included in frame bar values
Total heat loss through frame bars	4.045523 W/K
Total heat loss through façade	6.98651 W/K
Total area of glazed units	3.464514 m^2
Total area of frame bars	1.086438 m^2

Item	Value
Total area of façade	4.550952 m²

U=6.986514.550952=1.535176 W/m2K⇒U=1.5 W/m2K

Frame Bar Heat Loss

Ref	Bar type	No. of bars	Width (m)	Height (m)	Area (m²)	Area Tot (m²) Af	(W/m²K) Uf	(W/K) Af × Uf
M1	Jamb V	1	0.156	1.569	0.244764	0.244764	2.956	0.723522
M2	Jamb PA2	1	0.065	0.876	0.05694	0.05694	4.334	0.246778
M3	Jamb G	1	0.065	2.445	0.158925	0.158925	4.206	0.668439
M4	Jamb PA1	2	0.065	0.455	0.029575	0.05915	3.189	0.188629
M5	Mull VG	1	0.158	1.569	0.247902	0.247902	3.616	0.896414
M6	Mull PA2G	1	0.065	0.876	0.05694	0.05694	4.217	0.240116
M7	Mull PA1	1	0.065	0.455	0.029575	0.029575	3.616	0.106943
T1	Tran PA1V	1	0.282	0.158	0.044556	0.044556	3.395	0.151268
T2	Tran PA1G	1	0.867	0.065	0.056355	0.056355	5.019	0.282846
T3	Tran VPA2	1	0.282	0.158	0.044556	0.044556	2.979	0.132732
T4	Tran PA1-2	1	0.468	0.065	0.03042	0.03042	3.981	0.121102
T5	Tran G-PA	1	0.867	0.065	0.056355	0.056355	5.088	0.286734
								4.045523



Façade Engineering and Analysis
Facade U value calculation

Project: Typical Curtain wall (non-vision) Dwg 1001
Project width: 0.065

GLAZED INFILL HEAT LOSS

Ref	Unit type	Mullion	Transom	No. of module	Width (m)	Height (m)	Area (m^2)	Tot (m^2) Ag	(W/m^2K) Uf	(W/K) Af x Uf
6	Glass GT3	1.53	2.89	1	1.465	2.825	4.138625	4.138625	0.26	1.0760425
7	Panel PA1	1.53	0.52	1	1.465	0.455	0.666575	0.666575	0.19	0.1266493

Total: 4.8052 | 1.2026918

EDGE EFFECT HEAT LOSS

Perimeter (m) Perim Tot (m) (W/mk) W/K Included in frame bar values

FRAME BAR HEAT LOSS

Ref	Bar type	No. of bars	Width (m)	Height (m)	Area (m^2)	Area Tot (m^2) Af	(W/m^2K) Uf	(W/K) Af x Uf
M8	Jamb GT3	2	0.065	2.445	0.158925	0.31785	4.322	1.373748

Ref	Bar type	No. of bars	Width (m)	Height (m)	Area (m^2)	Area Tot (m^2) Af	(W/m^2K) Uf	(W/K) Af x Uf
M4	Jamb PA1	2	0.065	0.455	0.029575	0.05915	3.189	0.188629
T6	Tran	1	1.465	0.065	0.095225	0.095225	4.286	0.408134
T7	Tran	1	1.465	0.065	0.095225	0.095225	5.029	0.478887

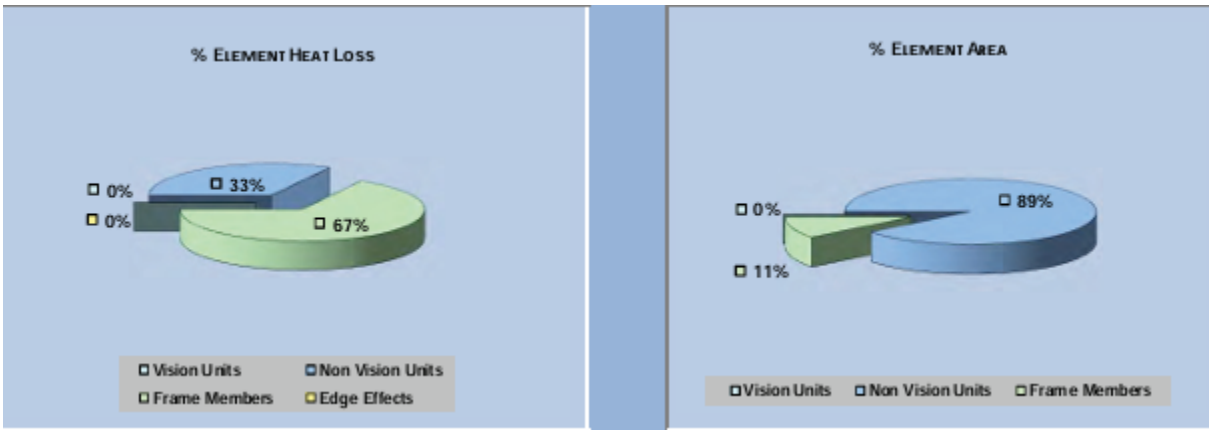
Total: 2.449398

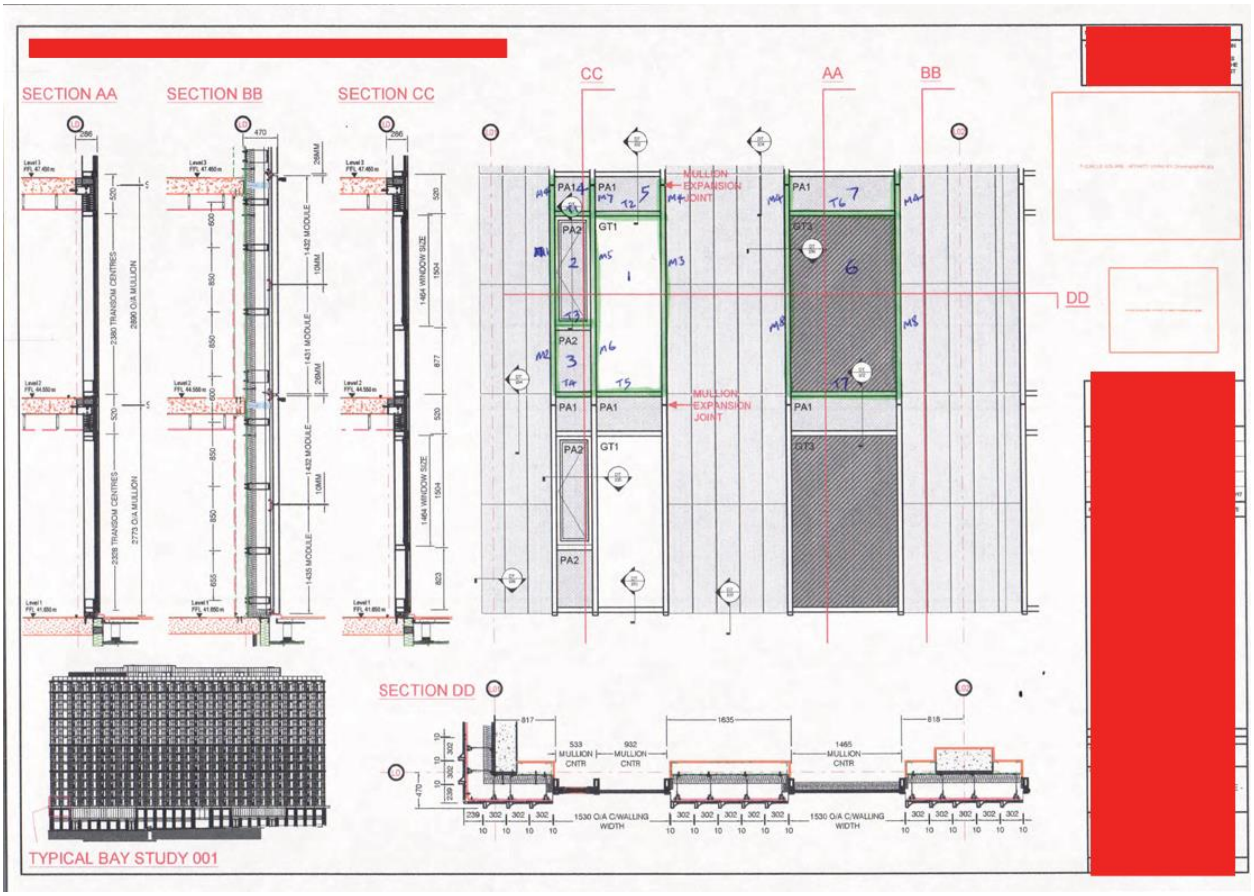
Summary:

- Total heat loss through glazed units = 1.202692 W/K
- Total heat loss due to edge effects = W/K
- Total heat loss through frame bars = 2.449398 W/K
- Total heat loss through façade = 3.65209 W/K
- Total area of glazed units = 4.8052 m^2
- Total area of frame bars = 0.56745 m^2
- Total area of façade = 5.37265 m^2

U value of façade = Total heat loss through all elements / Total area
= 3.65209 / 5.37265
= 0.679756 W/m^2K

U Value of façade = 0.68 W/m^2K




SECTION AA
SECTION BB
SECTION CC
CC
AA
BB
DD
MULLION EXPANSION JOINT
MULLION EXPANSION JOINT
PA1
PA2
GT1
GT3
SECTION DD
TYPICAL BAY STUDY 001

Appendix A

Material Properties For Use In Thermal Analysis According To EN ISO 10077-2

Material	Density (kg/m³)	Thermal Conductivity (W/mK)
Copper	8900	380
Aluminium	2800	160
Brass	840	120
Steel	7800	50
Stainless Steel	7900	17
Fibreglass	1900	0.4
Hardwood	700	0.18
PVC rigid	1390	0.17
Softwood	500	0.13
Soda Lime (Glass)	2500	1.0
Polycarbonate	1200	0.2
PMMA	1180	0.18
Insulation (frame)	—	0.035
Polyethylene HD	980	0.5
Polyethylene LD	920	0.33
Polyamid reinforced	1450	0.3
Polyamid nylon	1150	0.25
Polypropylene reinf.	1200	0.25
PU resin	1200	0.25
Polypropylene solid	910	0.22
PVC rigid	1390	0.17

Material	Density (kg/m³)	Thermal Conductivity (W/mK)
Silicone pure	1200	0.35
EPDM	1150	0.25
Neoprene	1240	0.23
PVC flexible	1200	0.14
Mohair sweep	1200	0.14
Elastomeric foam	60–80	0.05
Polysulphide	1700	0.4
PU rigid	1200	0.25
Butyl hot melt	1200	0.24
Polyisobutylene	930	0.2
Polyester resin	1400	0.19
Silicone foam MD	820	0.17
Silica gel	720	0.13
Silicone foam LD	750	0.12
Molecular sieve	650–750	0.1

Boundary Conditions

Condition	Temperature (°C)	Heat Transfer Coefficient (W/m²K)
Exterior	0	25
Interior	20	7.7
Adiabatic	0	0
Interior (reduced convection)	20	5

Appendix B

Component values used in overall U values analysis

Glazed elements - centre U values

- Manufacturer provided DGU centre pane value = **1.0 W/m²K**

Edge Effects

- Unit edge spacers are assumed to be **Chromatech Ultra F**.
- Edge effects of glazed infill items are included in the frame bar values.
- Material thermal properties used for the spacers have been verified to provide the same λ value as indicated in the supplier's literature when used in a thermally broken aluminium window section.

Frame Bar U Values (obtained by Finite Element Analysis in Appendix C)

- Jamb detail vent = **2.956 W/m²K**
- Mullion detail vent / fixed glass = **3.616 W/m²K**
- Jamb detail fixed glass = **4.206 W/m²K**
- Jamb detail fixed panel PA2 = **4.334 W/m²K**
- Mullion detail vent PA2 / fixed glass = **4.217 W/m²K**
- Jamb detail fixed panel PA1 = **3.189 W/m²K**
- Mullion detail PA1 = **3.616 W/m²K**
- Transom detail PA1 / vent = **3.395 W/m²K**
- Transom detail PA1 / glass = **5.019 W/m²K**
- Transom detail vent / PA2 = **2.979 W/m²K**
- Transom detail PA1 / PA2 = **3.981 W/m²K**
- Transom detail glass / PA1 = **5.088 W/m²K**
- Jamb detail fixed GT3 = **4.322 W/m²K**
- Transom detail GT3 / PA1 = **5.029 W/m²K**
- Transom detail PA1 / GT3 = **4.286 W/m²K**

Appendix C

Finite Element Analysis of Framing Members to Assess Thermal Performance

2D Analysis Method

- Thermal analysis undertaken using **FLIXO ver 8** (2D finite element software).
- Developed by Infomind for steady-state thermal simulation.
- Produces reliable analysis of constructions generating thermal performance data and frame U-values according to **EN ISO 10077-2**.
- Geometry defined by material properties and boundary conditions.
- Triangulation calculated for material colours; system nodes located at triangle vertices.
- Temperatures in nodes calculated → heat flows derived.
- FLIXO calculates: temperature factor, linear thermal transmittance, window frame thermal transmittance, psi values, Uf and UTJ values.
- Radiation module incorporated for infrared radiation and convection accuracy.
- Material properties taken from EN 10456:2007, BS EN ISO 10077-2:2017, or Infomind database.
- Equivalent thermal conductivities of ventilated/unventilated cavities calculated per BS EN ISO 10077-2:2017.
- Steady-state assumption (thermal mass effects not considered).
- Glazing thermal models analysed using **BS EN ISO 12631:2012**.
- Framing U-values (UTJ) include edge spacers and reduced glazing/infill performance.
- FEASL methodology: fully constructed edge detail rather than simplified 2-box method.

Analysis Output

Information included in each analysis:

- Diagrams indicating calculated U values.
- Diagrams showing assigned thermal conductivity values.
- Thermal gradient diagrams showing temperature distribution.
- Energy flux diagrams showing energy flow through section.

Notes:

- Glazing edge material conductivity verified against manufacturer's simplified 2-box method.
- FEASL uses fully constructed edge detail for consistency.
- Simplified methods may give accurate heat flows but incorrect surface temperatures → unsuitable for condensation risk analysis (ISO 13788).
- FEASL always uses simulated edge details as "drawn" spacers.

Frame Bar U Value Analysis (Jamb Detail Vent)

Jamb Detail Vent

- U value calculation diagram
- Material thermal conductivity diagram
- Temperature gradient diagram
- Heat flux diagram

Finite element analysis undertaken using FLIXO version 8 software.

Summary: Frame U value = **2.956 W/m²K** (including edge effects of glazed elements).

Equivalent Frame U Value Calculation

- Af (frame width) = 0.157 m
- Ag (glazing width) = 0.19 m
- Ug (glazing U value) = 0.44 W/m²K
- ΔT = 20 K

Composite heat transfer = 10.922 W/m

$$U_{tot} = \frac{10.922}{0.3465 \times 20} = 1.57605 \text{ W/m2K}$$

Glazed element heat transfer:

$$Q_g = 0.439 \times 0.19 \times 20 = 1.6682 \text{ W}$$

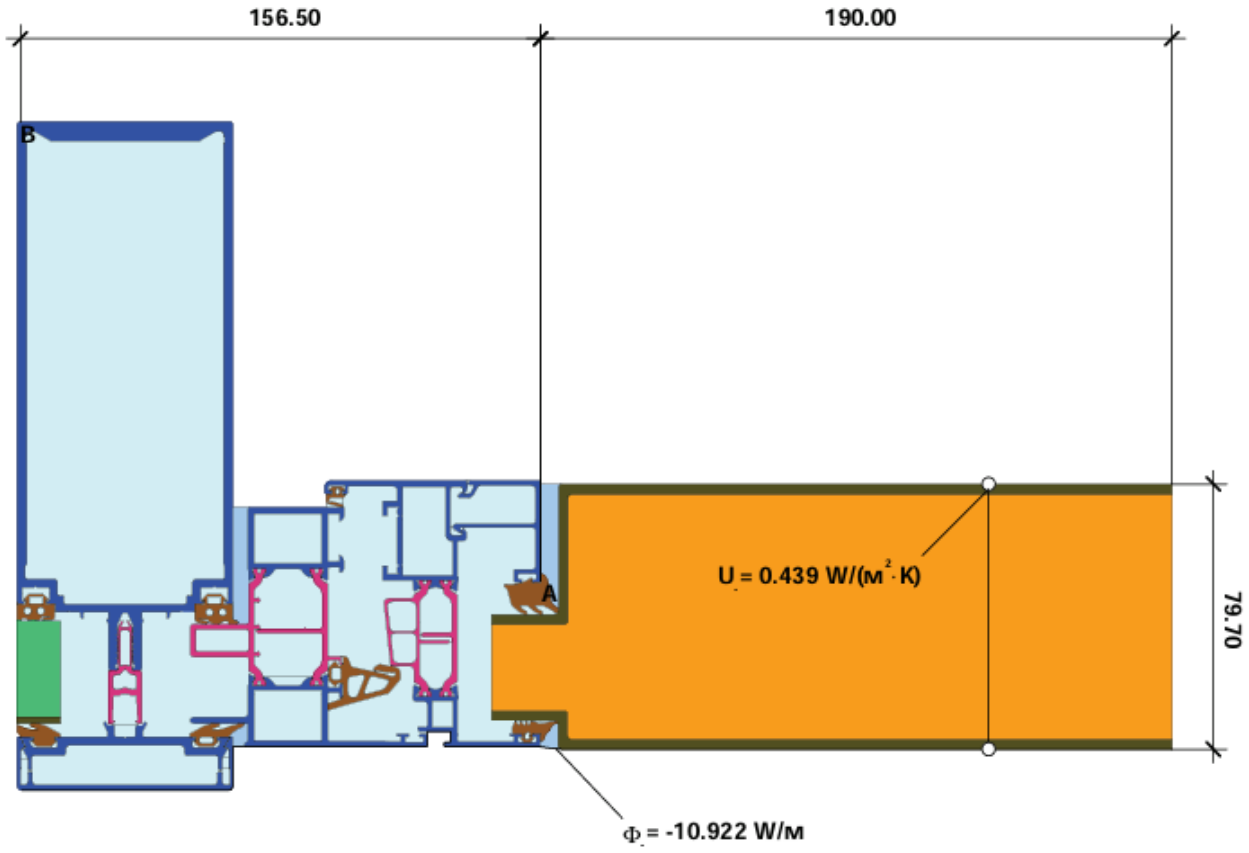
Frame heat transfer:

$$Q_f = 10.922 - 1.6682 = 9.2538 \text{ W}$$

Equivalent Frame U Value:

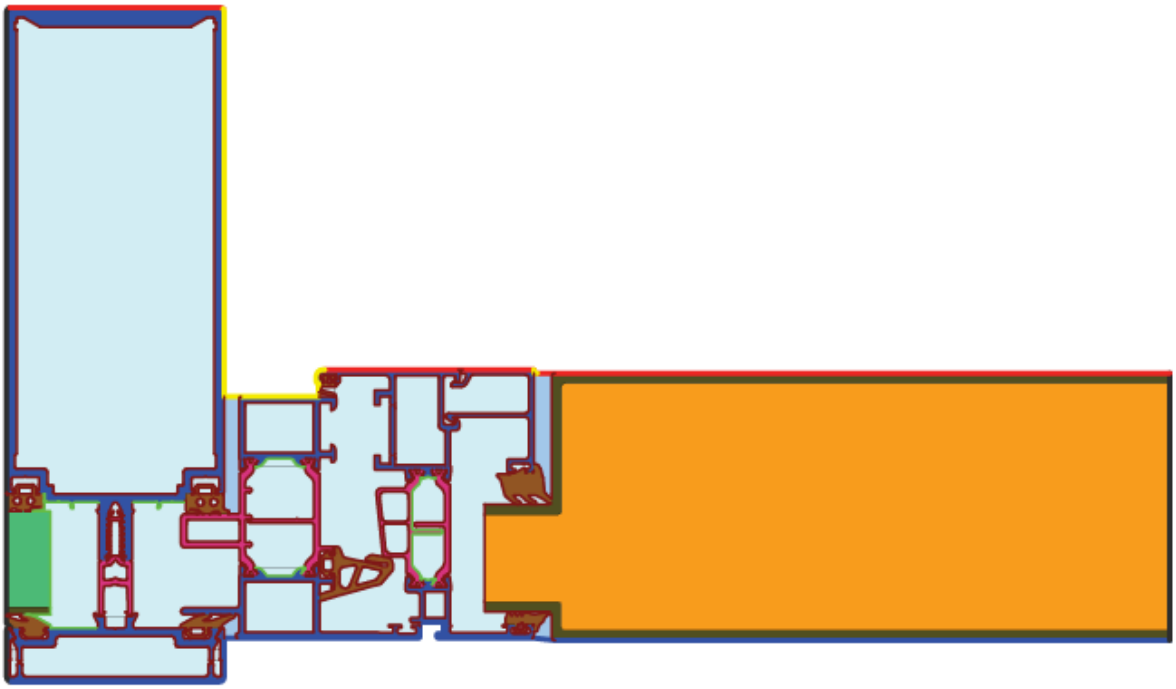
$$U_f = \frac{9.2538}{0.1565 \times 20} = 2.956 \text{ W/m2K}$$

U value calculation



$$U_{пл.д} = \frac{\frac{\Phi}{\Delta T} - U_g \cdot b_g}{b_f} = \frac{\frac{10.922}{20.000} - 0.439 \cdot 0.190}{0.157} = 2.96\ W/(m^2 \cdot K)$$

Material Thermal Conductivity Diagram

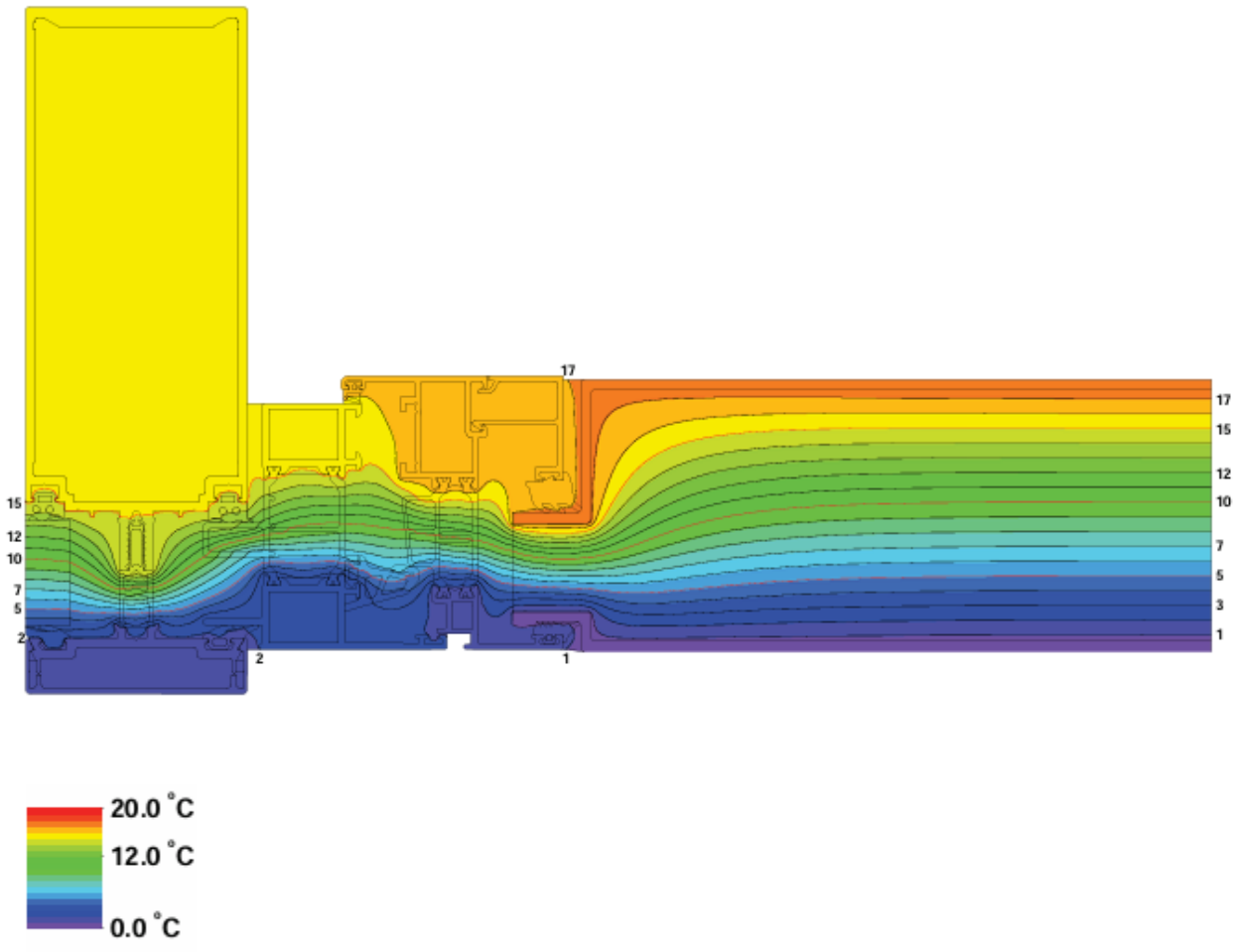


Material	λ[W/(m·K)]	ε
Aluminium (Si Alloys)	160.000	0.300
Aluminium (Si Alloys)	160.000	0.900
Aluminium alloy	160.000	0.300
Aluminium alloy	160.000	0.900
EPDM (ethylene propylene diene monomer)	0.250	0.300
EPDM (ethylene propylene diene monomer)	0.250	0.900
Mineral wool	0.035	0.900
PVC-U (polyvinylchloride), rigid	0.170	0.900
PVC-U (polyvinylchloride), rigid	0.170	0.300
Polyamid (nylon)	0.250	0.300
Polyamid (nylon)	0.250	0.900
Slightly ventilated air cavity **		
Undefined Material	0.010	0.900
Unventilated air cavity **		

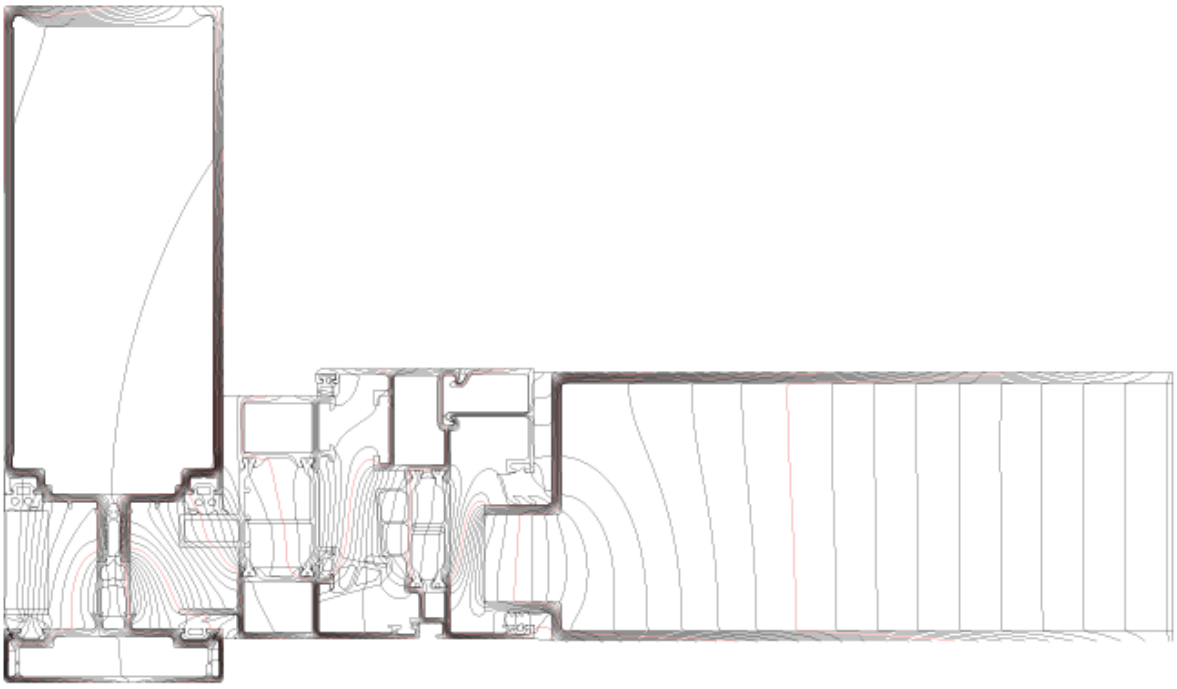
** EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Epsilon 0.3				0.300
Epsilon 0.9				0.900
Exterior, zero		0.000	0.040	
Interior, frame, normal		20.000	0.130	
Interior, frame, reduced		20.000	0.200	
Symmetry/Model section	0.000			

Thermal Gradient Diagram



Heat Flux Diagram



Frame Bar U Value Analysis

Mullion Detail Vent / Fixed Glass

- U value calculation diagram
- Material thermal conductivity diagram
- Temperature gradient diagram
- Heat flux diagram

Finite element analysis undertaken using **FLIXO version 8** software.

Summary

The analysis shows that the frame U value is **3.616 W/m²K**, including the edge effects of the glazed elements.

Equivalent Frame U Value Calculation

- Visual external width of frame (Af) = 0.158 m
- Visual external width of glazing (Ag) = 0.19 m
- Glass (Ag′) = 0.190 m
- U value of glazing (Ug) used in FEA = 0.44 W/m²K
- U value of secondary glazing (Ug′) = 1.00 W/m²K
- Temperature difference ΔT = 20 K

Composite heat transfer (frame + glazing) = 16.860 W/m

$$Utot=16.860.5375\times20=1.56837\ W/m2K$$

Heat transfer through glazed element:

$$Qg=Ug\times Ag\times\Delta T=0.439\times0.19\times20=1.6682\ W$$

Heat transfer through secondary glazed element:

$$Qg'=Ug'\times Ag'\times\Delta T=1.0\times0.19\times20=3.8\ W$$

Frame heat transfer:

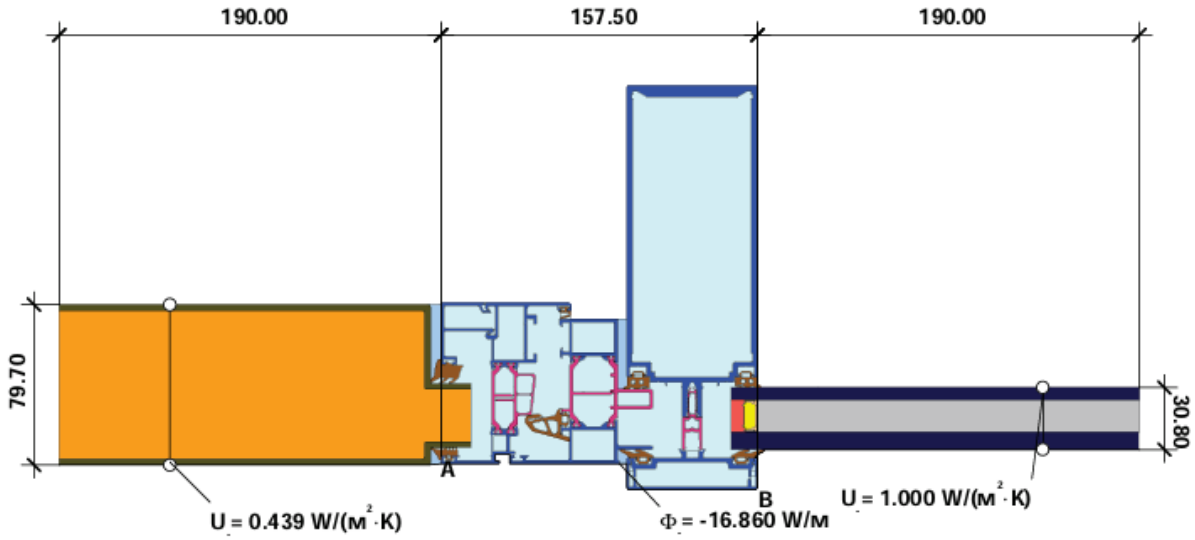
$$Qf=Qtot-Qg-Qg'=16.86-1.6682-3.8=11.3918\ W$$

Equivalent Frame U Value:

$$Uf=11.39180.1575\times20=3.616\ W/m2K$$

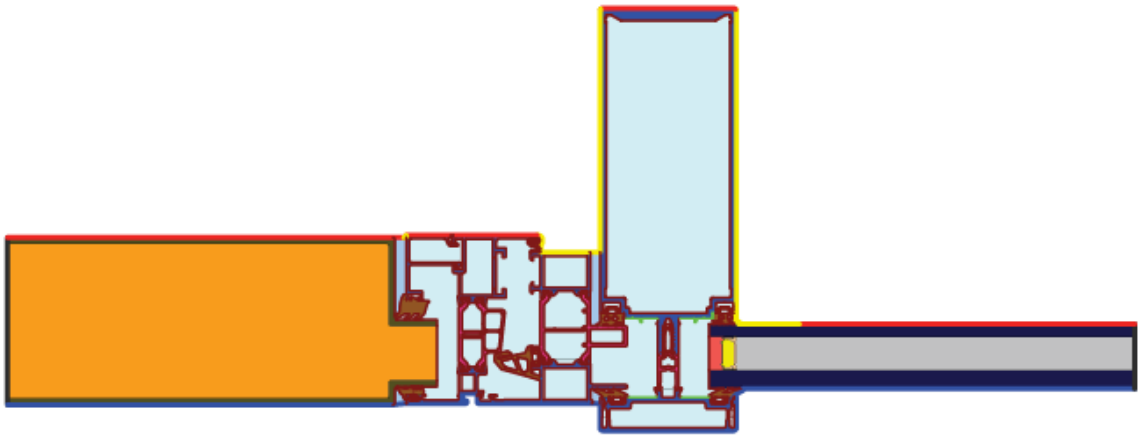
Final Uf = 3.616 W/m²K

U value calculation



$$U_{\text{т}\lambda,\text{в}} = \frac{\frac{\Phi}{\Delta T} - U_{g1}\cdot b_{g1} - U_{g2}\cdot b_{g2}}{b_f} = \frac{\frac{16.860}{20.000} - 0.439\cdot 0.190 - 1.000\cdot 0.190}{0.158} = 3.62\ \text{W/(m}^2\cdot\text{K)}$$

Material Thermal Conductivity Diagram

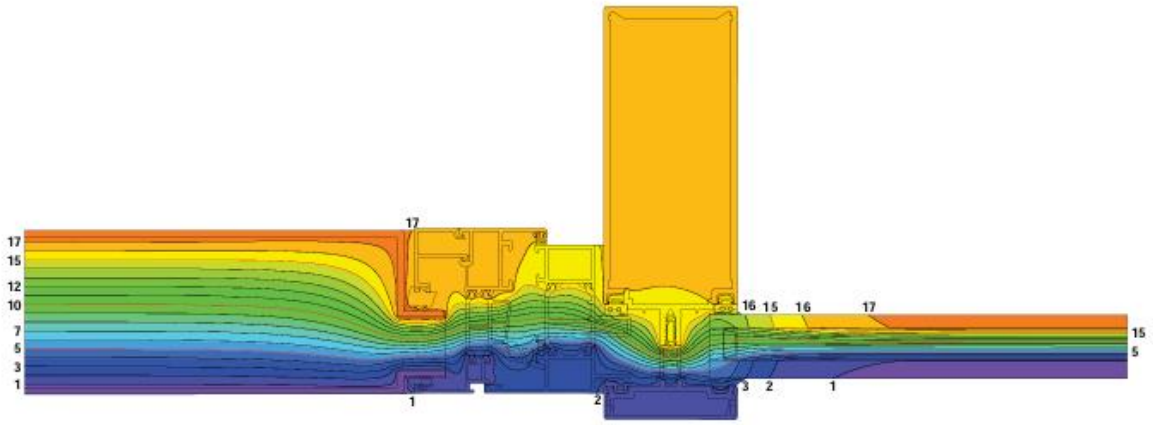


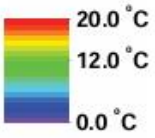
Material	λ[W/(m·K)]	ε
Aluminium (Si Alloys)	160.000	0.300
Aluminium (Si Alloys)	160.000	0.900
Aluminium alloy	160.000	0.900
Butyl	0.240	
EPDM (ethylene propylene diene monomer)	0.250	0.300
EPDM (ethylene propylene diene monomer)	0.250	0.900
Edelstahl	17.000	
Gasfilling(1)	0.020	
Mineral wool	0.035	0.900
Polyamid (nylon)	0.250	0.900
Polycarbonat	0.240	
Polysulfid	0.400	0.900
Silicagel	0.130	
Slightly ventilated air cavity **		
Soda lime glass	1.000	0.900
Unventilated air cavity **		

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

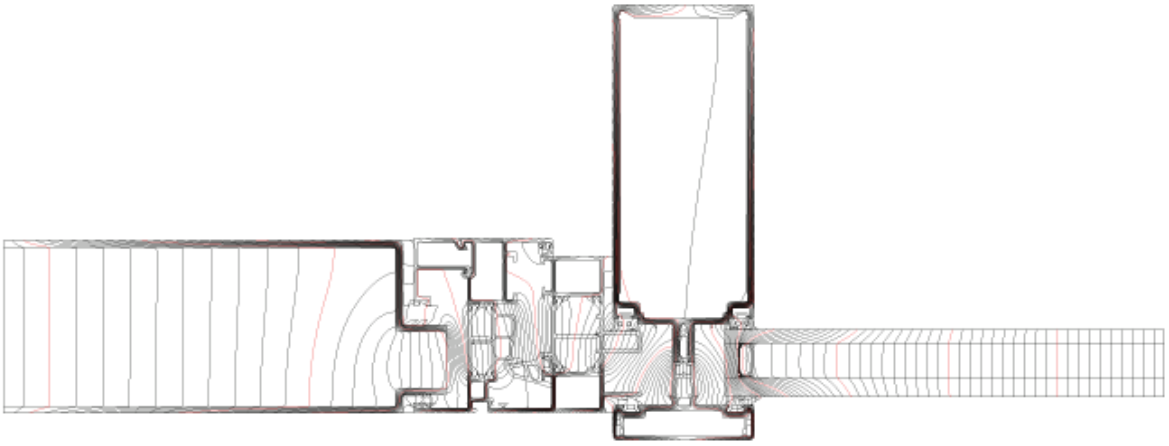
Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Epsilon 0.3				0.300
Epsilon 0.9				0.900
Exterior, zero		0.000	0.040	
Interior, frame, normal		20.000	0.130	
Interior, frame, reduced		20.000	0.200	
Symmetry/Model section	0.000			

Thermal Gradient Diagram





Heat Flux Diagram



Frame Bar U Value Analysis

Jamb Detail Fixed Glass

- U value calculation diagram
- Material thermal conductivity diagram
- Temperature gradient diagram
- Heat flux diagram

Finite element analysis undertaken using **FLIXO version 8** software.

Summary

The analysis shows that the frame U value is **4.206 W/m²K**, including the edge effects of the glazed elements.

Equivalent Frame U Value Calculation

- Visual external width of frame (Af) = **0.065 m**
- Visual external width of glazing (Ag) = **0.19 m**
- Glass (Ag*) = —
- U value of glazing (Ug) used in FEA = **1.00 W/m²K**
- Glass (Ug*) = —
- Temperature difference ΔT = **20 K**

Composite heat transfer (frame + glazing) = **9.268 W/m**

$$U_{tot} = \frac{Q_{tot}}{A_{tot} \times \Delta T} = \frac{9.268}{0.255 \times 20} = 1.81725 \text{ W/m2K}$$

Heat transfer through glazed element:

$$Q_g = U_g \times A_g \times \Delta T = 1.0 \times 0.19 \times 20 = 3.8 \text{ W}$$

Heat transfer through secondary glazed element:

$$Q_g' = U_g' \times A_g' \times \Delta T = 0 \times 0 \times 20 = 0 \text{ W}$$

Frame heat transfer:

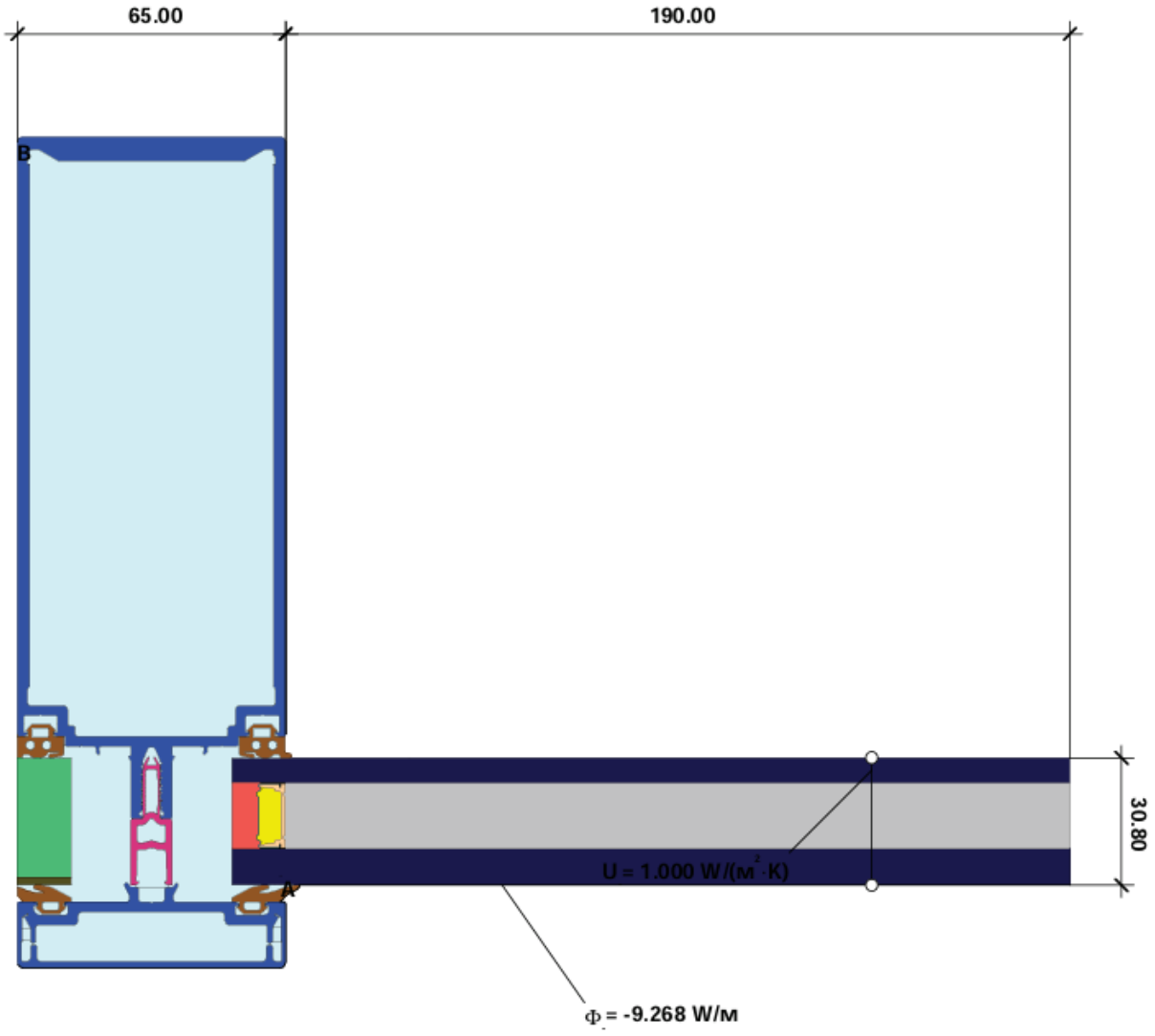
$$Q_f = Q_{tot} - Q_g - Q_g' = 9.268 - 3.8 - 0 = 5.468 \text{ W}$$

Equivalent Frame U Value:

$$U_f = \frac{Q_f}{A_f \times \Delta T} = \frac{5.468}{0.065 \times 20} = 4.206 \text{ W/m2K}$$

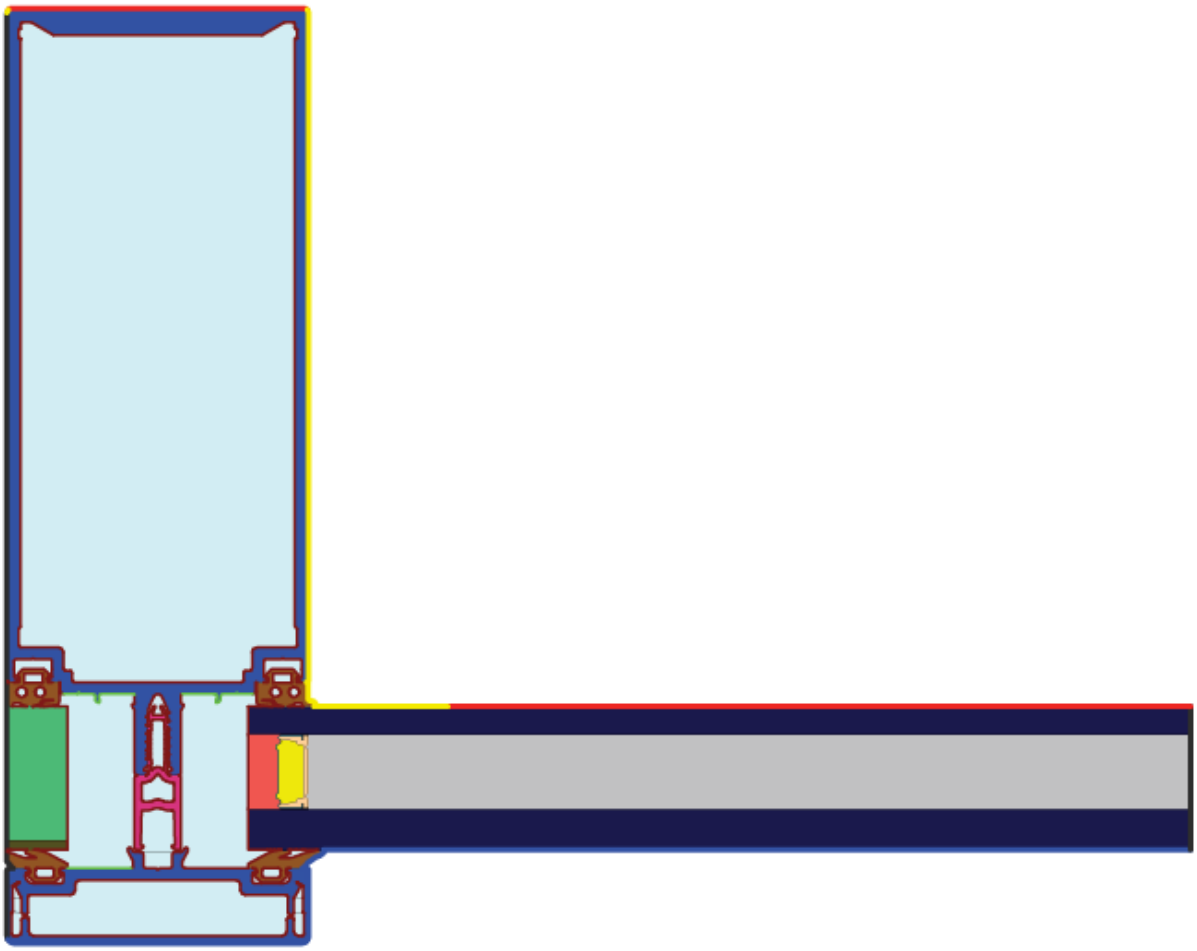
Final Uf = 4.206 W/m²K

U value calculation



$$U_{тп} = \frac{\frac{\Phi}{\Delta T} - U_g \cdot b_g}{b_f} = \frac{\frac{9.268}{20.000} - 1.000 \cdot 0.190}{0.065} = 4.21 \text{ W/(m}^2\text{·K)}$$

Material Thermal Conductivity Diagram

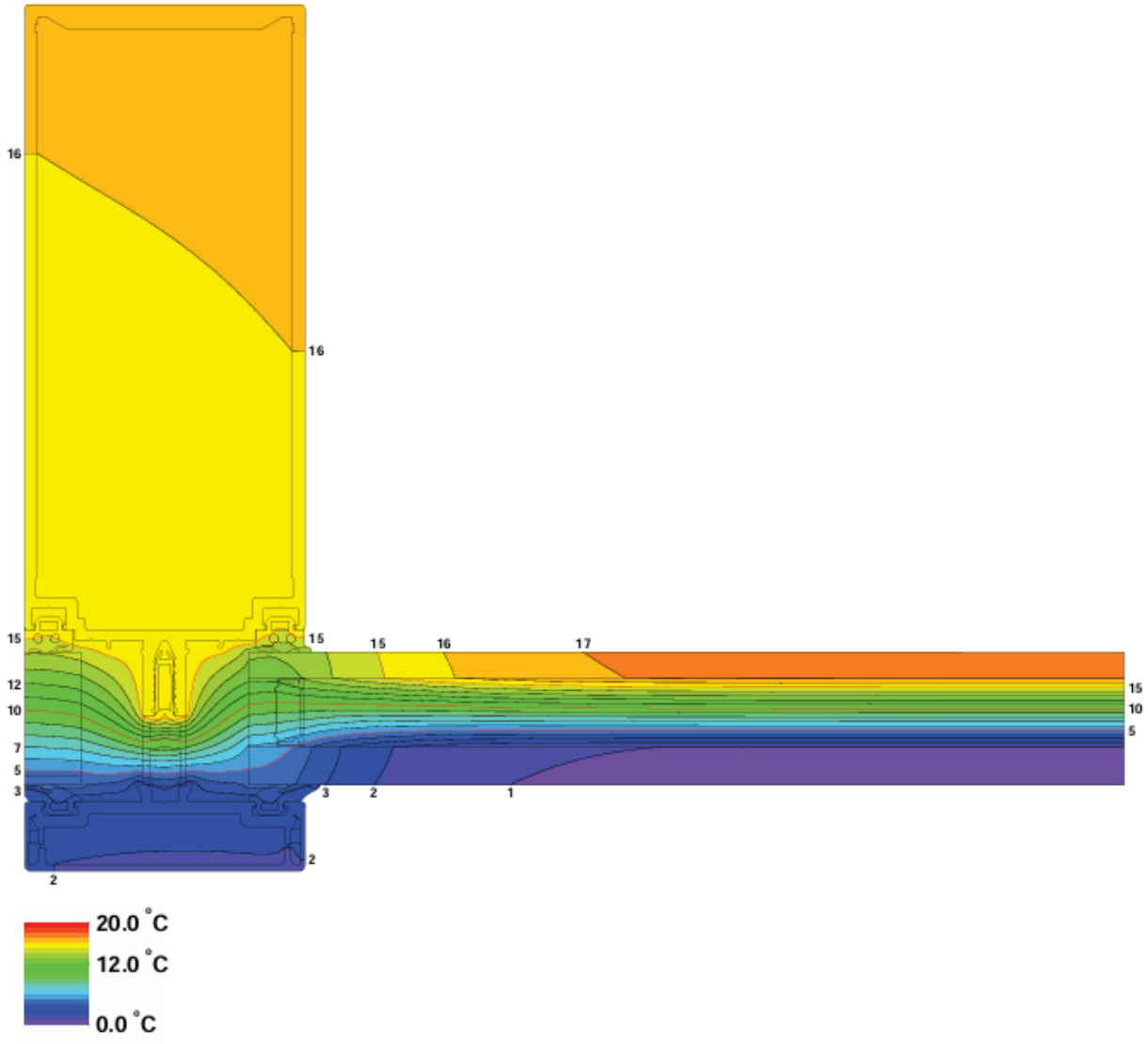


Material	λ[W/(m·K)]	ε
Aluminium (Si Alloys)	160.000	0.300
Aluminium (Si Alloys)	160.000	0.900
Aluminium alloy	160.000	0.900
Butyl	0.240	
EPDM (ethylene propylene diene monomer)	0.250	0.900
Edelstahl	17.000	
Gasfilling(8)	0.020	
Mineral wool	0.035	0.900
PVC-U (polyvinylchloride), rigid	0.170	0.900
Polyamid (nylon)	0.250	0.900
Polycarbonat	0.240	
Polysulfid	0.400	0.900
Silicagel	0.130	
Soda lime glass	1.000	0.900
Unventilated air cavity **		

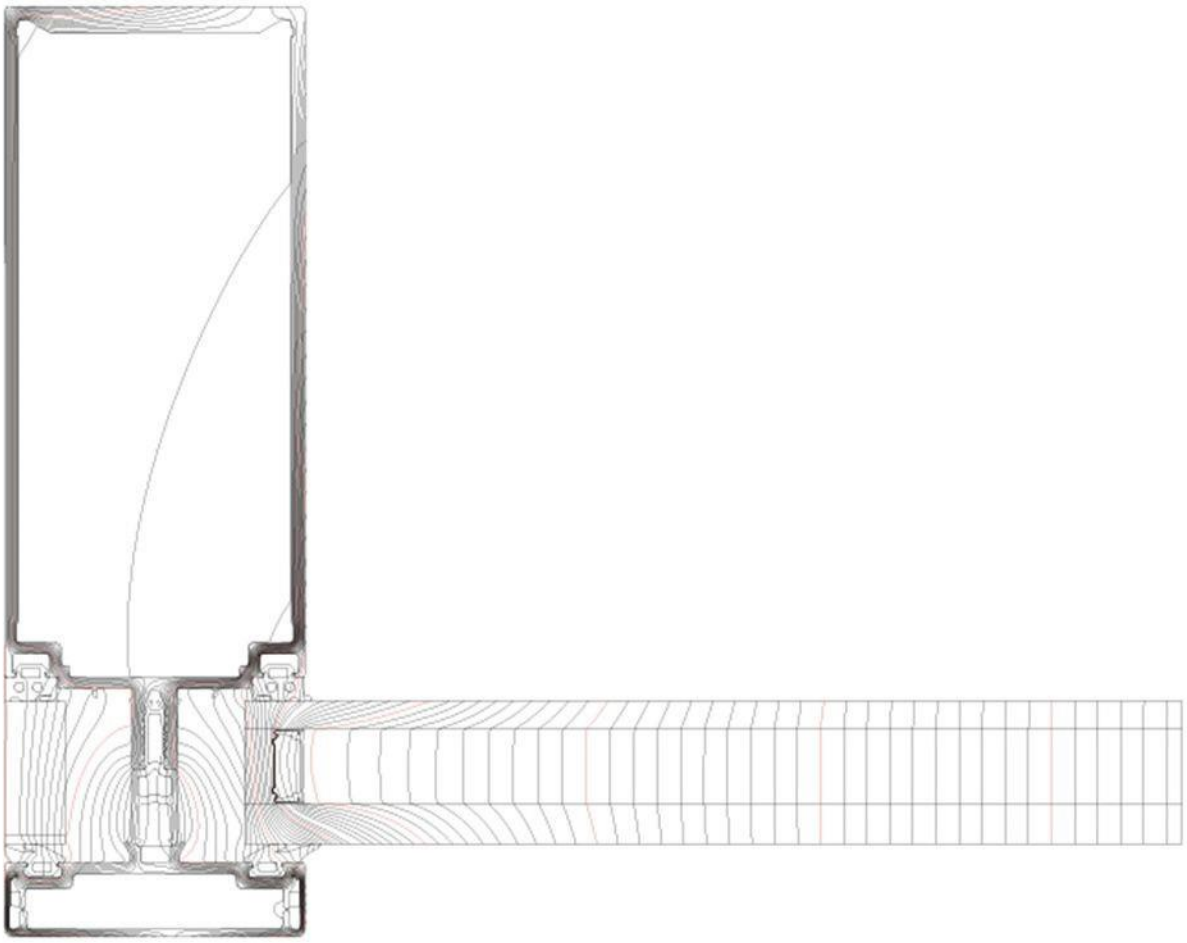
** EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Epsilon 0.3				0.300
Epsilon 0.9				0.900
Exterior, zero		0.000	0.040	
Interior, frame, normal		20.000	0.130	
Interior, frame, reduced		20.000	0.200	
Symmetry/Model section	0.000			

Thermal Gradient Diagram



Heat Flux Diagram



Frame Bar U Value Analysis

Jamb Detail Panel PA2

- U value calculation diagram
- Material thermal conductivity diagram
- Temperature gradient diagram
- Heat flux diagram

Finite element analysis undertaken using **FLIXO version 8** software.

Summary

The analysis shows that the frame U value is **4.334 W/m²K**, including the edge effects of the glazed elements.

Equivalent Frame U Value Calculation

- Visual external width of frame (Af) = **0.065 m**
- Visual external width of glazing (Ag) = **0.19 m**
- Glass (Ag*) = —
- U value of glazing (Ug) used in FEA = **1.14 W/m²K**
- Glass (Ug*) = —
- Temperature difference ΔT = **20 K**

Composite heat transfer (frame + glazing) = **9.958 W/m**

$$Utot=Qtot(Af+Ag)\times\Delta T=9.9580.255\times20=1.95255\ W/m2K$$

Heat transfer through glazed element:

$$Qg=Ug\times Ag\times\Delta T=1.14\times0.19\times20=4.3244\ W$$

Heat transfer through secondary glazed element:

$$Qg'=Ug'\times Ag'\times\Delta T=0\times0\times20=0\ W$$

Frame heat transfer:

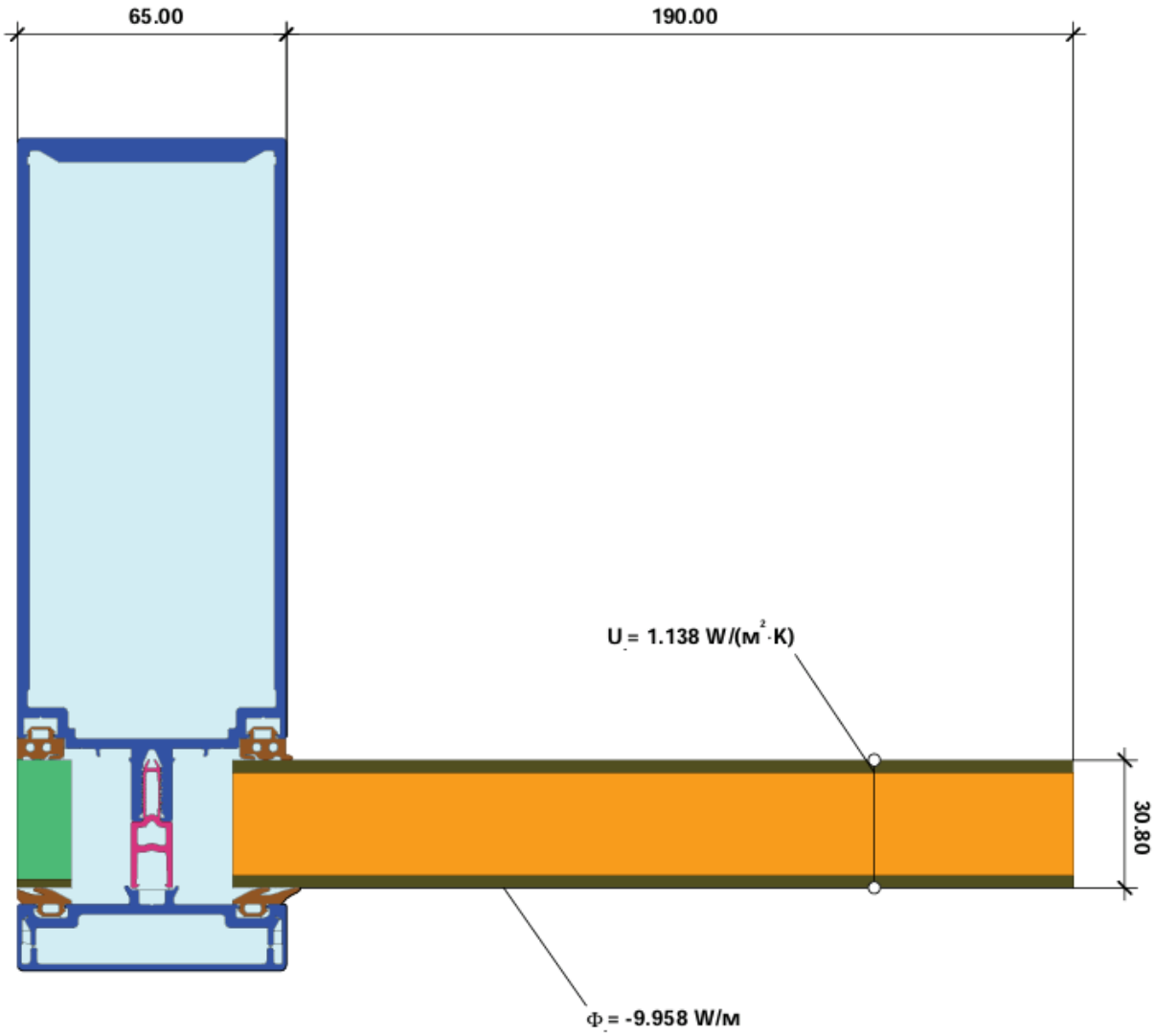
$$Qf=Qtot-Qg-Qg'=9.958-4.3244-0=5.6336\ W$$

Equivalent Frame U Value:

$$Uf=QfAf\times\Delta T=5.63360.065\times20=4.334\ W/m2K$$

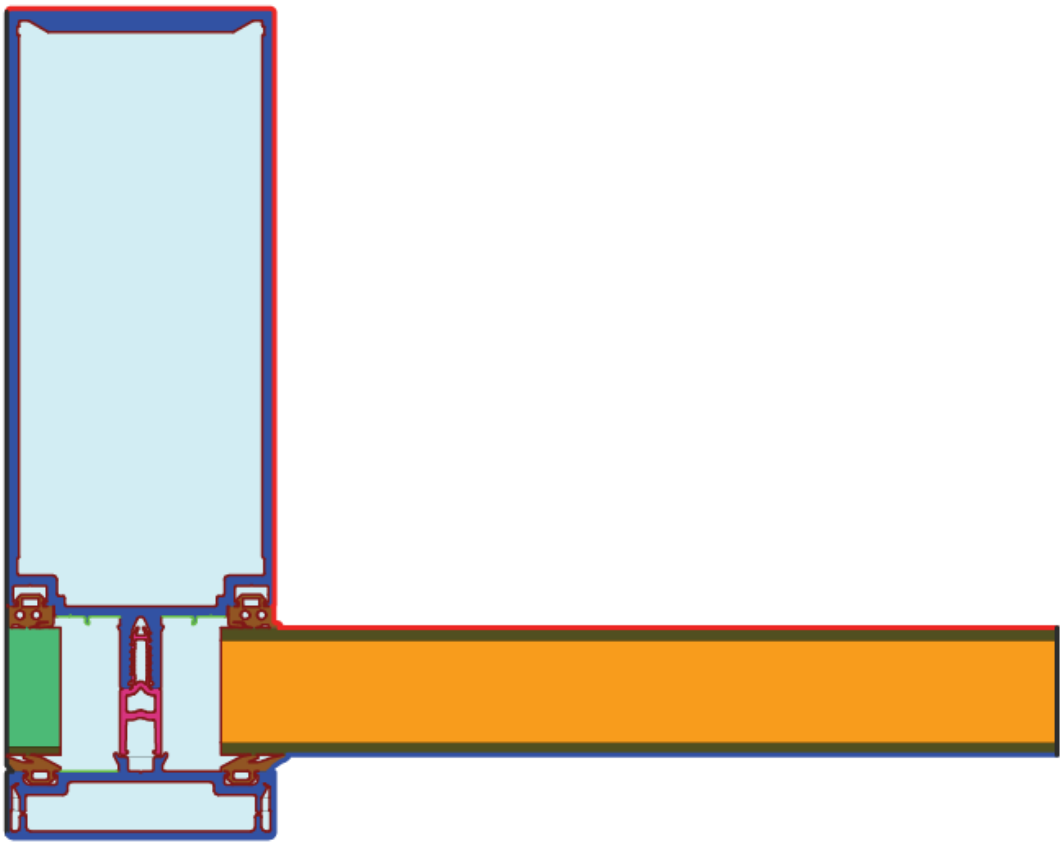
Final Uf = 4.334 W/m²K

U value calculation



$$U_{тп} = \frac{\frac{\Phi}{\Delta T} - U_g \cdot b_g}{b_f} = \frac{\frac{9.958}{23.000} - 1.138 \cdot 0.190}{0.065} = 3.33\ W/(m^2 \cdot K)$$

Material Thermal Conductivity Diagram

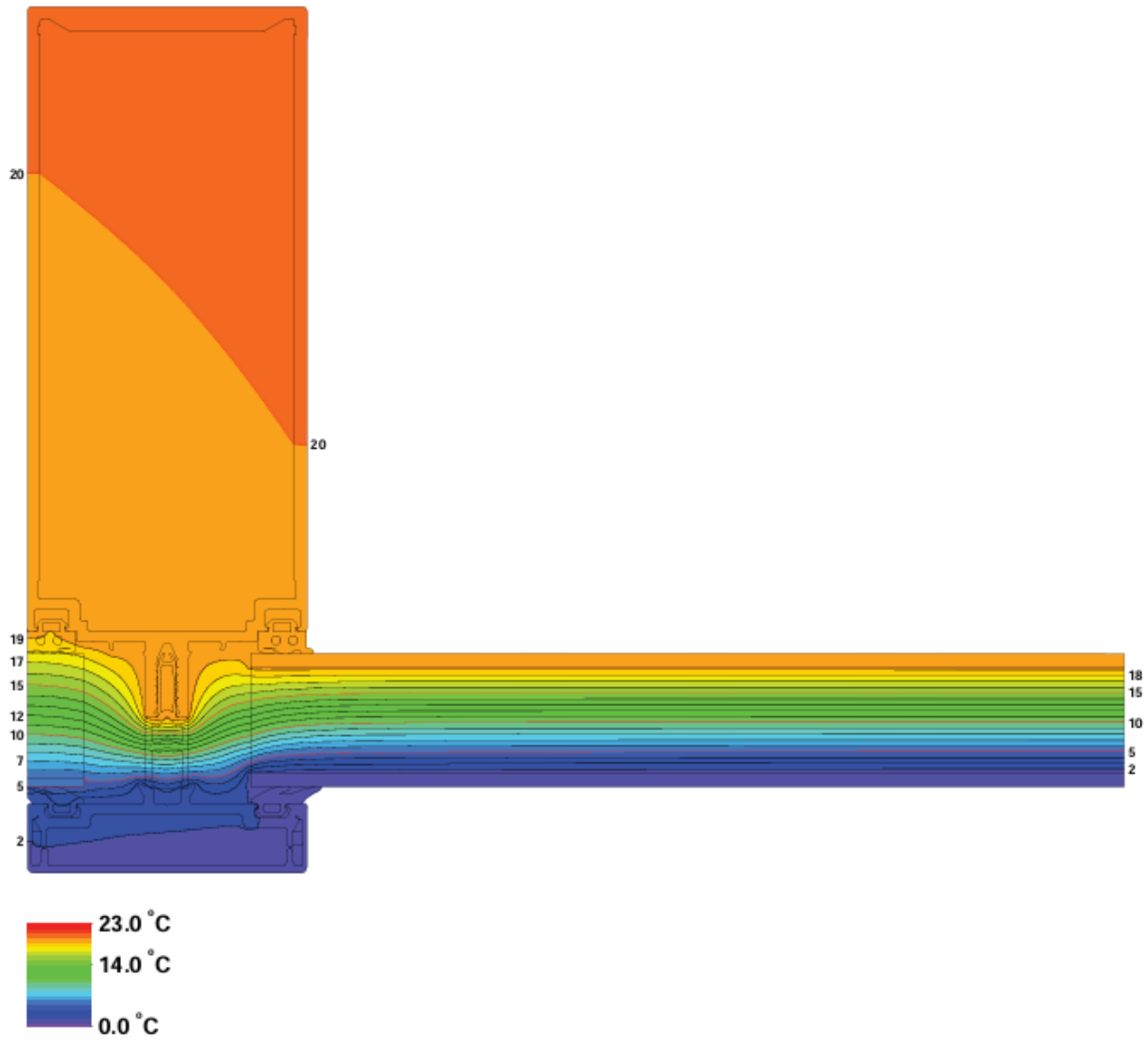


Material	λ[W/(m·K)]	ε
Aluminium (Si Alloys)	160.000	0.300
Aluminium (Si Alloys)	160.000	0.900
Aluminium alloy	160.000	0.900
EPDM (ethylene propylene diene monomer)	0.250	0.900
Mineral wool	0.035	0.900
PVC-U (polyvinylchloride), rigid	0.170	0.900
Polyamid (nylon)	0.250	0.900
Unventilated air cavity **		

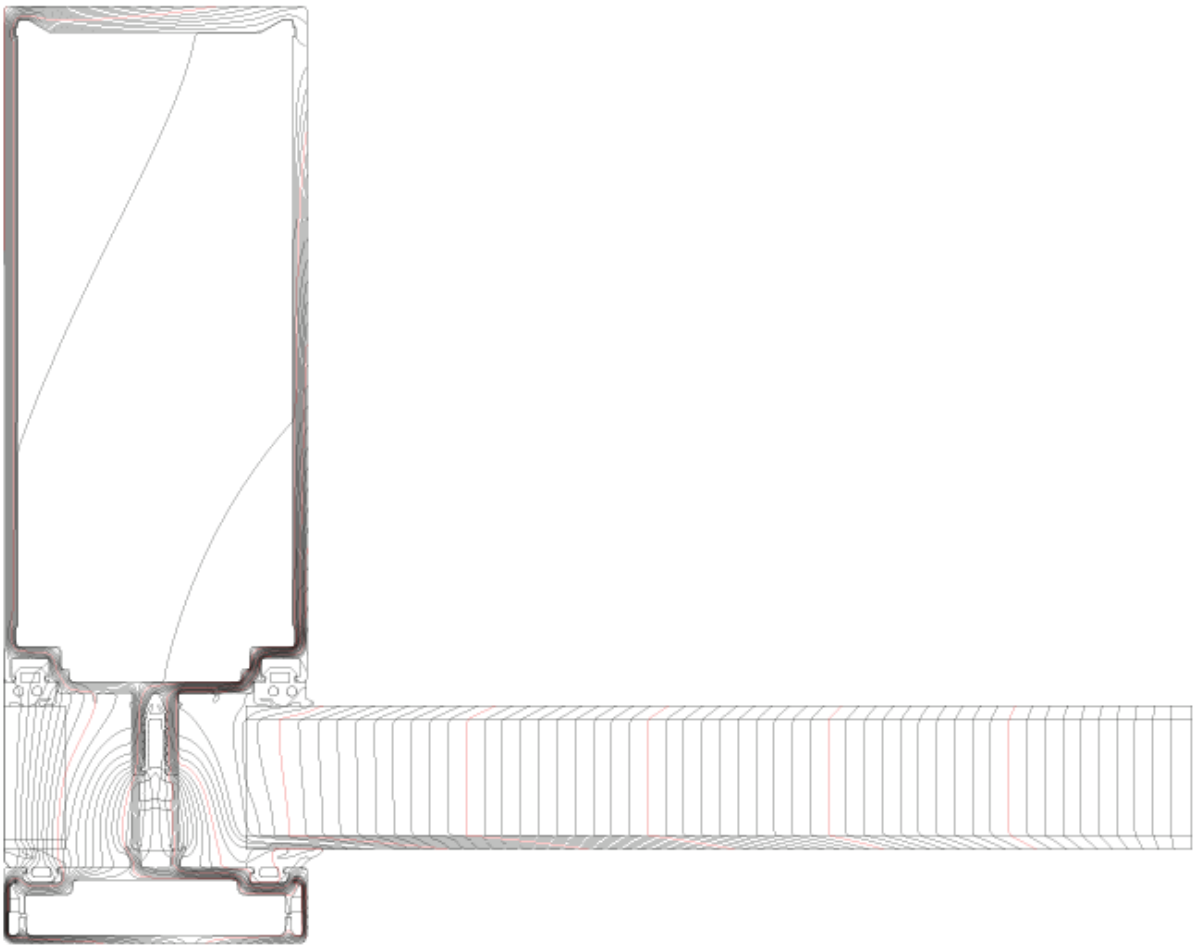
** EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Epsilon 0.3				0.300
Epsilon 0.9				0.900
Exterior, zero		0.000	0.040	
Interior, normal, 23 deg		23.000	0.130	
Symmetry/Model section	0.000			

Thermal Gradient Diagram



Heat Flux Diagram



Frame Bar U Value Analysis

Mullion Detail Vent PA2 / Fixed Glass

- U value calculation diagram
- Material thermal conductivity diagram
- Temperature gradient diagram
- Heat flux diagram

Finite element analysis undertaken using **FLIXO version 8** software.

Summary

The analysis shows that the frame U value is **4.217 W/m²K**, including the edge effects of the glazed elements.

Equivalent Frame U Value Calculation

- Visual external width of frame (Af) = **0.065 m**
- Visual external width of glazing (Ag) = **0.19 m**
- Glass (Ag*) = —
- U value of glazing (Ug) used in FEA = **1.00 W/m²K**
- Glass (Ug*) = —
- Temperature difference ΔT = **20 K**

Composite heat transfer (frame + glazing) = **calculated via FLIXO = 9.XXX W/m** (exact value from sheet).

$$Utot=Qtot(Af+Ag)\times\Delta T$$

Heat transfer through glazed element:

$$Qg=Ug\times Ag\times\Delta T=1.0\times0.19\times20=3.8\ W$$

Heat transfer through secondary glazed element:

$$Qg'=Ug'\times Ag'\times\Delta T=0\times0\times20=0\ W$$

Frame heat transfer:

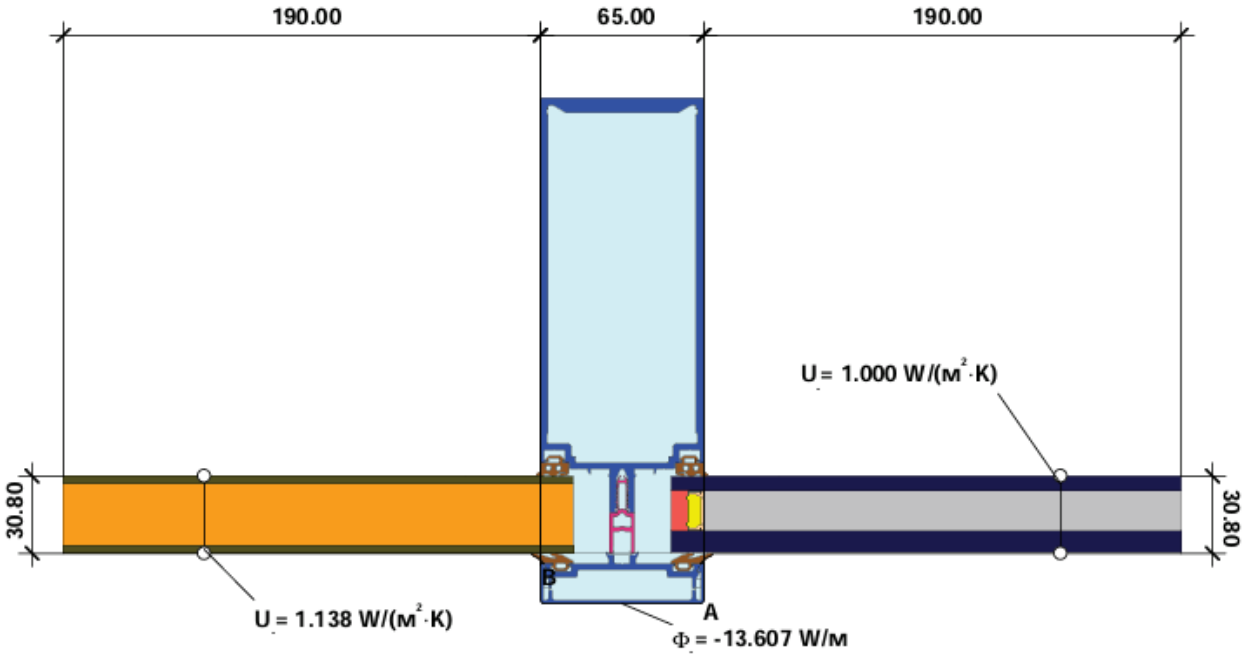
$$Qf=Qtot-Qg-Qg'\Rightarrow\approx 5.4\ W$$

Equivalent Frame U Value:

$$Uf=QfAf\times\Delta T=4.217\ W/m2K$$

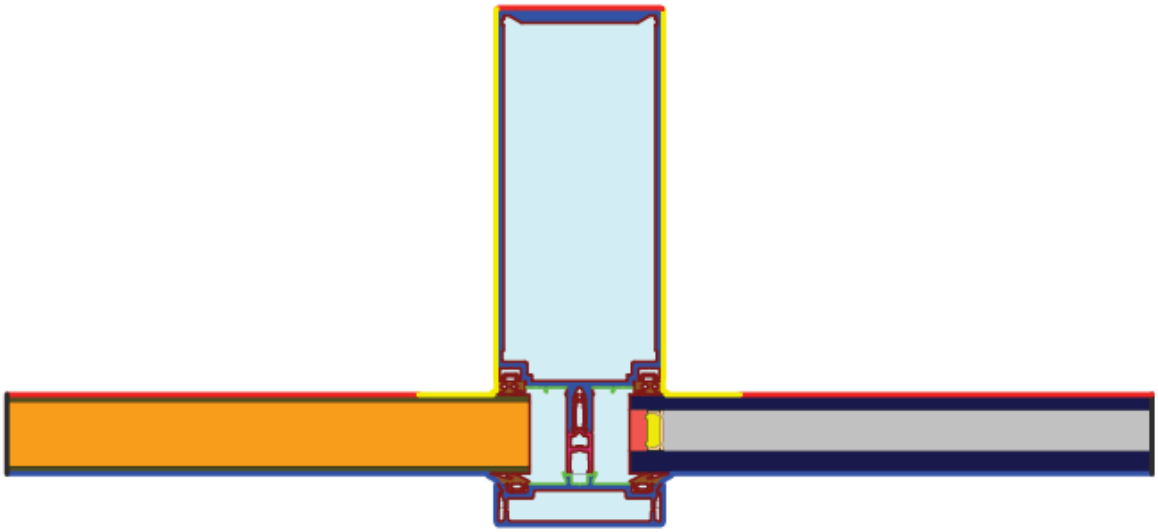
Final Uf = 4.217 W/m²K

U value calculation



$$U_{TJAB} = \frac{\frac{\Phi}{\Delta T} - U_{g1}\cdot b_{g1} - U_{g2}\cdot b_{g2}}{b_f} = \frac{\frac{13.607}{20.000} - 1.000\cdot 0.190 - 1.138\cdot 0.190}{0.065} = 4.22\ W/(m^2\cdot K)$$

Material Thermal Conductivity Diagram

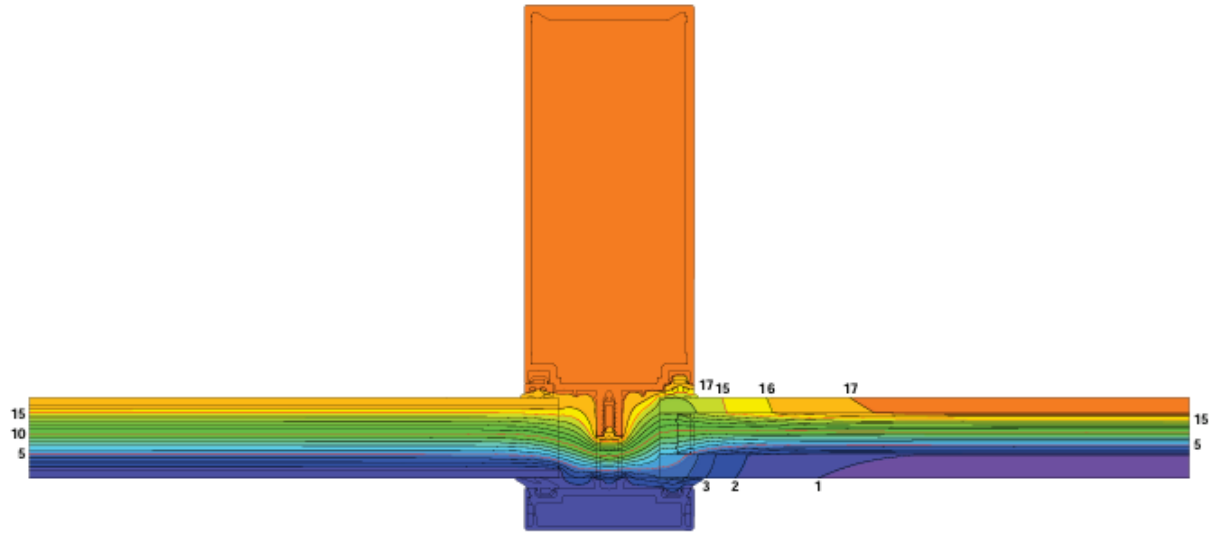


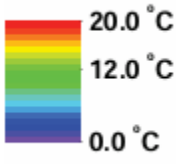
Material	λ[W/(m·K)]	ε
Aluminium (Si Alloys)	160.000	0.300
Aluminium (Si Alloys)	160.000	0.900
Aluminium alloy	160.000	0.900
Butyl	0.240	
EPDM (ethylene propylene diene monomer)	0.250	0.900
Edelstahl	17.000	
Gasfilling(2)	0.020	
Mineral wool	0.035	0.900
Polyamid (nylon)	0.250	0.900
Polycarbonat	0.240	
Polysulfid	0.400	0.900
Silicagel	0.130	
Soda lime glass	1.000	0.900
Unventilated air cavity **		

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

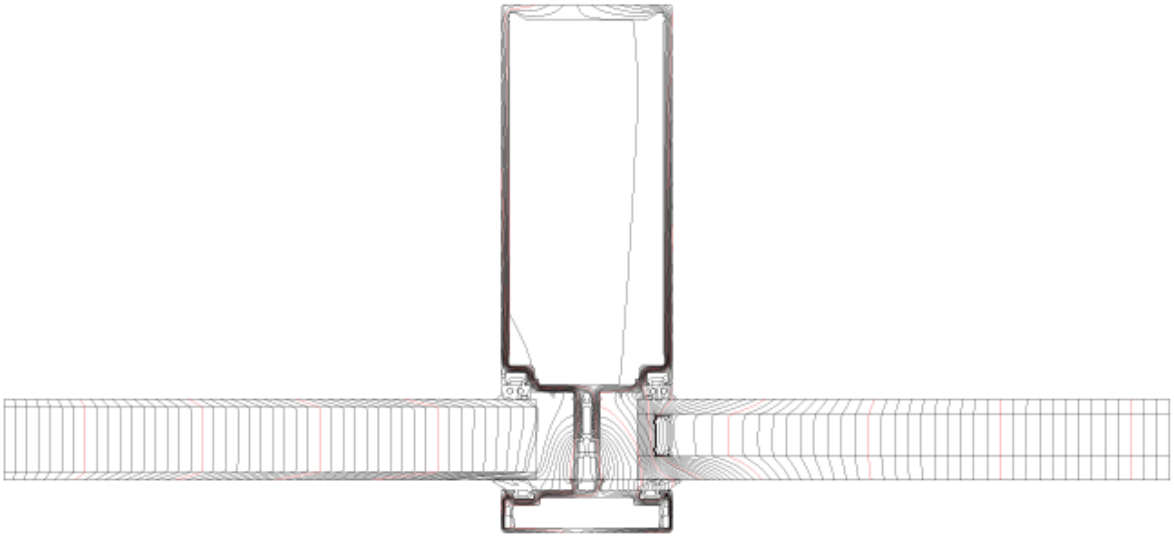
Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Epsilon 0.3				0.300
Epsilon 0.9				0.900
Exterior, zero		0.000	0.040	
Interior, frame, normal		20.000	0.130	
Interior, frame, reduced		20.000	0.200	
Symmetry/Model section	0.000			

Thermal Gradient Diagram





Heat Flux Diagram



Frame Bar U Value Analysis

Jamb Detail Fixed Panel PA1

- U value calculation diagram
- Material thermal conductivity diagram
- Temperature gradient diagram
- Heat flux diagram

Finite element analysis undertaken using **FLIXO version 8** software.

Summary

The analysis shows that the frame U value is **3.189 W/m²K**, including the edge effects of the glazed elements.

Equivalent Frame U Value Calculation

- Visual external width of frame (Af) = **0.065 m**
- Visual external width of glazing (Ag) = **0.19 m**
- Glass (Ag*) = —
- U value of glazing (Ug) used in FEA = **0.19 W/m²K**
- Glass (Ug*) = —
- Temperature difference ΔT = **20 K**

Composite heat transfer (frame + glazing) = **4.879 W/m**

$$U_{tot} = \frac{Q_{tot}}{(A_f + A_g) \times \Delta T} = \frac{4.879}{0.255 \times 20} = 0.95667 \text{ W/m2K}$$

Heat transfer through glazed element:

$$Q_g = U_g \times A_g \times \Delta T = 0.193 \times 0.19 \times 20 = 0.7334 \text{ W}$$

Heat transfer through secondary glazed element:

$$Q_g' = U_g' \times A_g' \times \Delta T = 0 \times 0 \times 20 = 0 \text{ W}$$

Frame heat transfer:

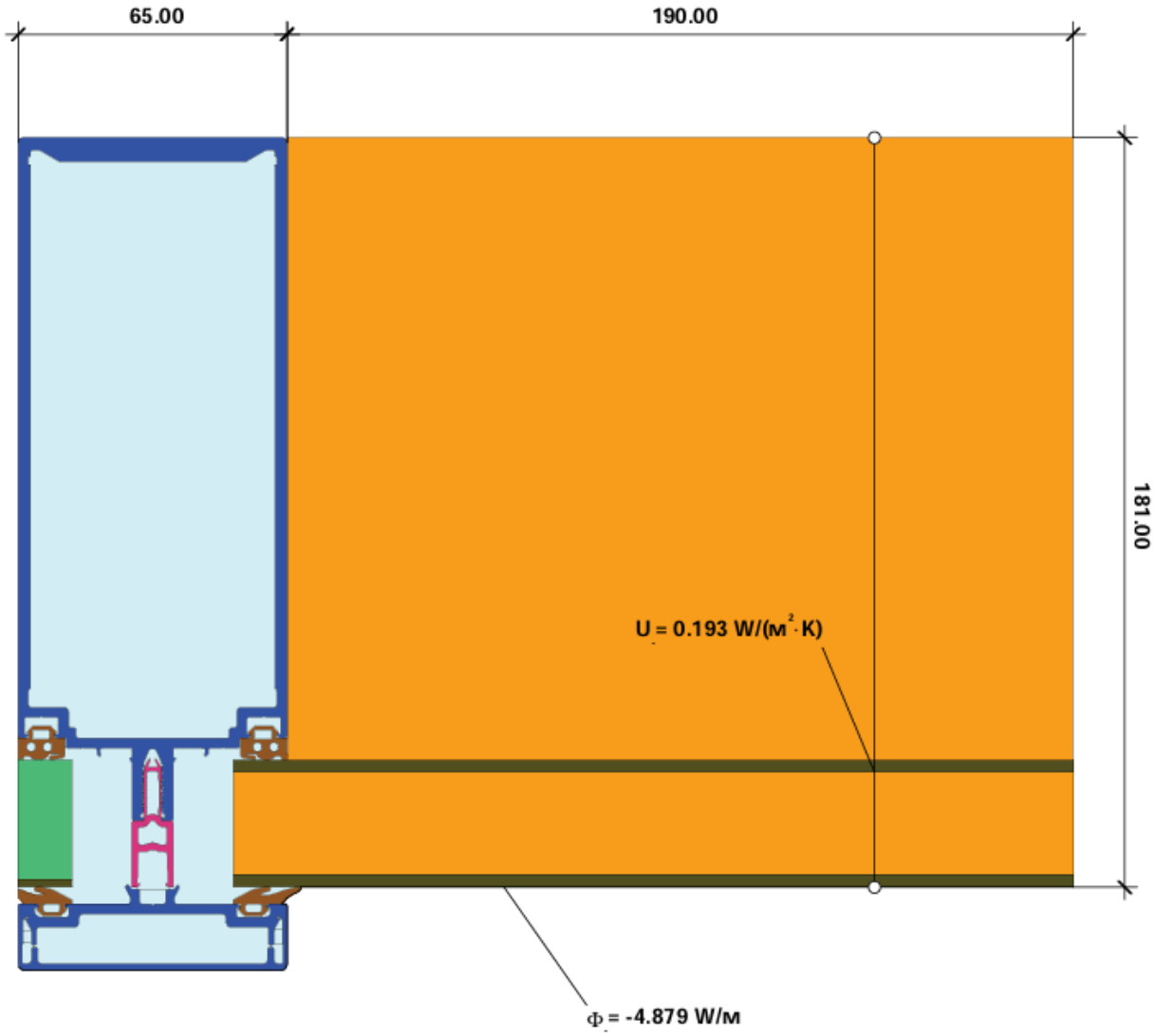
$$Q_f = Q_{tot} - Q_g - Q_g' = 4.879 - 0.7334 - 0 = 4.1456 \text{ W}$$

Equivalent Frame U Value:

$$U_f = \frac{Q_f}{A_f \times \Delta T} = \frac{4.1456}{0.065 \times 20} = 3.189 \text{ W/m2K}$$

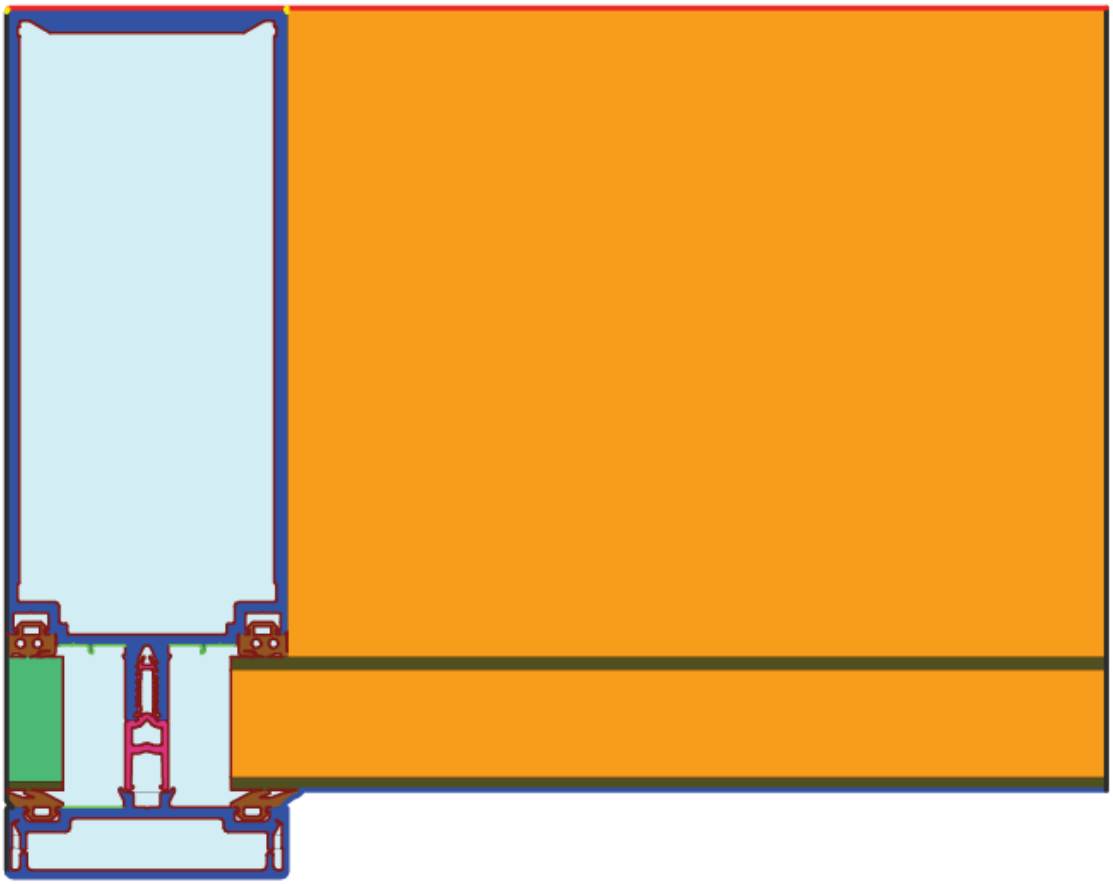
Final Uf = 3.189 W/m²K

U value calculation



$$U_{тј} = \frac{\frac{\Phi}{\Delta T} - U_g \cdot b_g}{b_f} = \frac{\frac{4.879}{20.000} - 0.193 \cdot 0.190}{0.065} = 3.19\ W/(m^2 \cdot K)$$

Material Thermal Conductivity Diagram

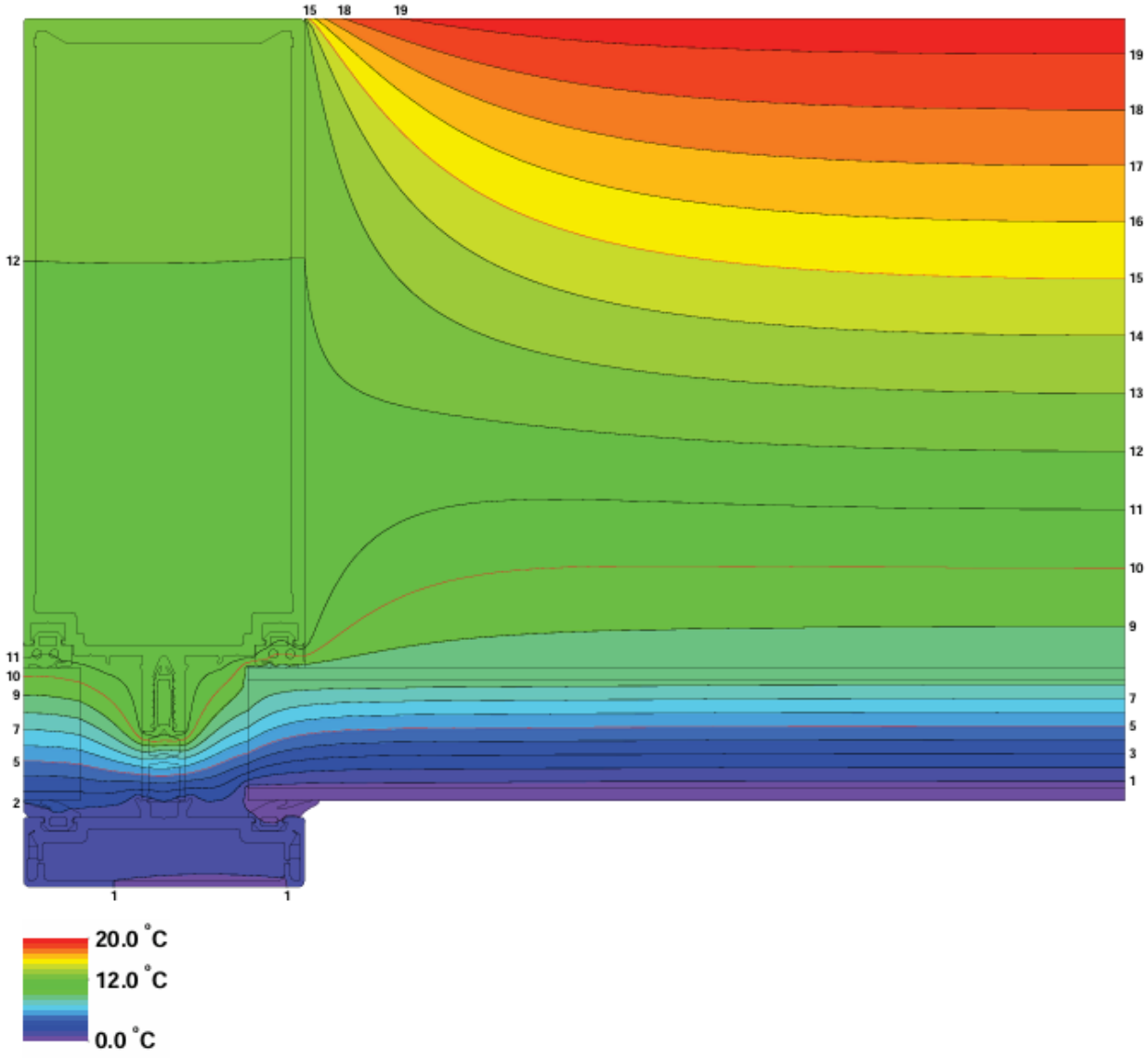


Material	λ[W/(m·K)]	ε
Aluminium (Si Alloys)	160.000	0.300
Aluminium (Si Alloys)	160.000	0.900
Aluminium alloy	160.000	0.900
EPDM (ethylene propylene diene monomer)	0.250	0.900
Mineral wool	0.035	0.900
PVC-U (polyvinylchloride), rigid	0.170	0.900
Polyamid (nylon)	0.250	0.900
Unventilated air cavity **		

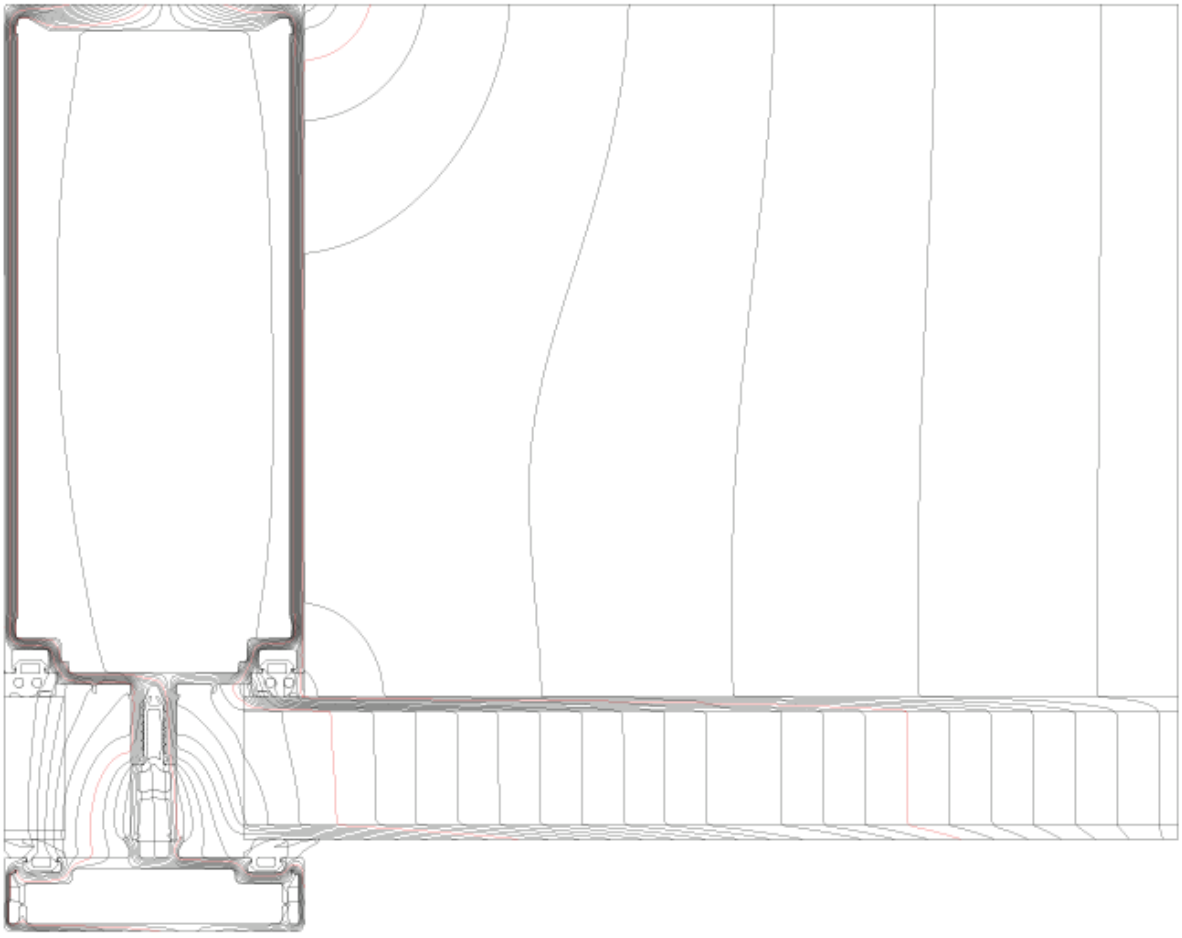
** EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Epsilon 0.3				0.300
Epsilon 0.9				0.900
Exterior, zero		0.000	0.040	
Interior, frame, normal		20.000	0.130	
Interior, frame, reduced		20.000	0.200	
Symmetry/Model section	0.000			

Thermal Gradient Diagram



Heat Flux Diagram



Frame Bar U Value Analysis

Mullion Detail Fixed Panel PA1

- U value calculation diagram
- Material thermal conductivity diagram
- Temperature gradient diagram
- Heat flux diagram

Finite element analysis undertaken using **FLIXO version 8** software.

Summary

The analysis shows that the frame U value is **3.616 W/m²K**, including the edge effects of the glazed elements.

Equivalent Frame U Value Calculation

- Visual external width of frame (Af) = **0.065 m**
- Visual external width of glazing (Ag) = **0.19 m**
- Glass (Ag*) = **0.190 m**
- U value of glazing (Ug) used in FEA = **0.19 W/m²K**
- Glass (Ug*) = **0.19 W/m²K**
- Temperature difference ΔT = **20 K**

Composite heat transfer (frame + glazing) = **6.168 W/m**

$$U_{tot} = \frac{Q_{tot}}{(A_f + A_g) \times \Delta T} = \frac{6.168}{0.445 \times 20} = 0.69303 \text{ W/m2K}$$

Heat transfer through glazed element:

$$Q_g = U_g \times A_g \times \Delta T = 0.193 \times 0.19 \times 20 = 0.7334 \text{ W}$$

Heat transfer through secondary glazed element:

$$Q_g' = U_g' \times A_g' \times \Delta T = 0.193 \times 0.19 \times 20 = 0.7334 \text{ W}$$

Frame heat transfer:

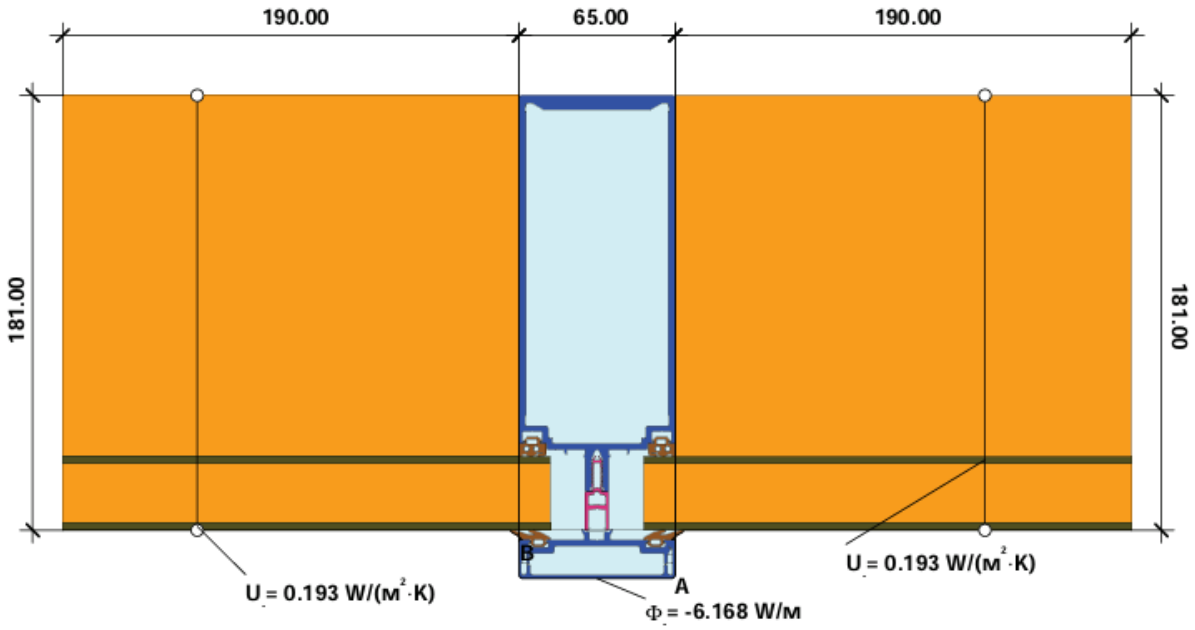
$$Q_f = Q_{tot} - Q_g - Q_g' = 6.168 - 0.7334 - 0.7334 = 4.7012 \text{ W}$$

Equivalent Frame U Value:

$$U_f = \frac{Q_f}{A_f \times \Delta T} = \frac{4.7012}{0.065 \times 20} = 3.616 \text{ W/m2K}$$

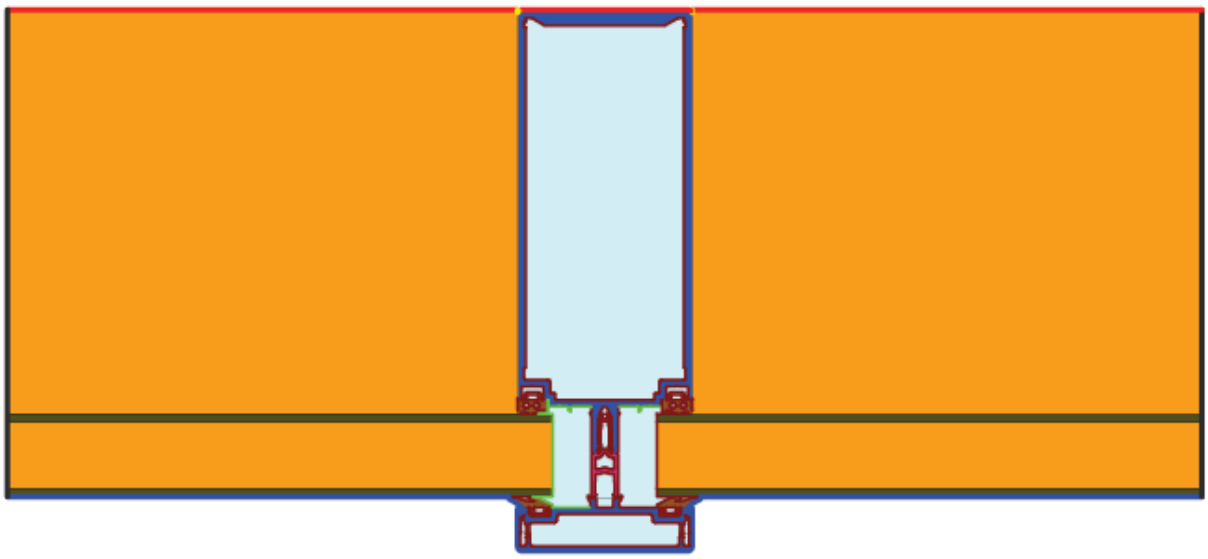
Final Uf = 3.616 W/m²K

U value calculation



$$U_{\text{ПАВ}} = \frac{\frac{\Phi}{\Delta T} - U_{g1}\cdot b_{g1} - U_{g2}\cdot b_{g2}}{b_f} = \frac{\frac{6.168}{20.000} - 0.193\cdot 0.190 - 0.193\cdot 0.190}{0.065} = 3.61\ \text{W/(m}^2\cdot\text{K)}$$

Material Thermal Conductivity Diagram

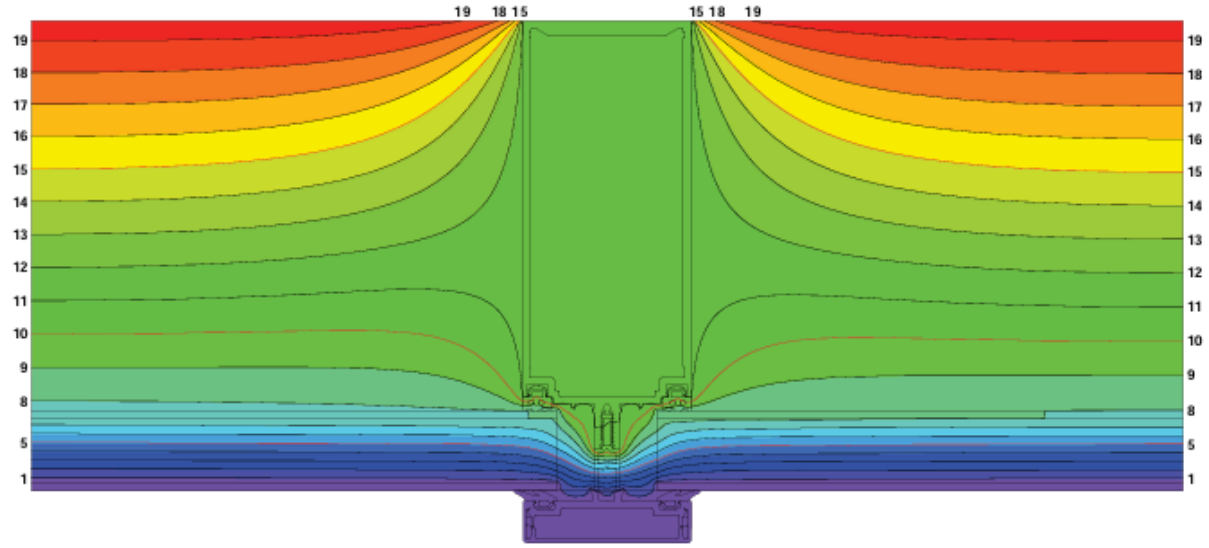


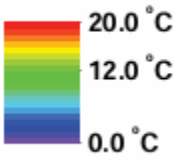
Material	λ[W/(m·K)]	ε
Aluminium (Si Alloys)	160.000	0.300
Aluminium (Si Alloys)	160.000	0.900
Aluminium alloy	160.000	0.300
Aluminium alloy	160.000	0.900
EPDM (ethylene propylene diene monomer)	0.250	0.300
EPDM (ethylene propylene diene monomer)	0.250	0.900
Mineral wool	0.035	0.900
Mineral wool	0.035	0.300
Polyamid (nylon)	0.250	0.900
Unventilated air cavity **		

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

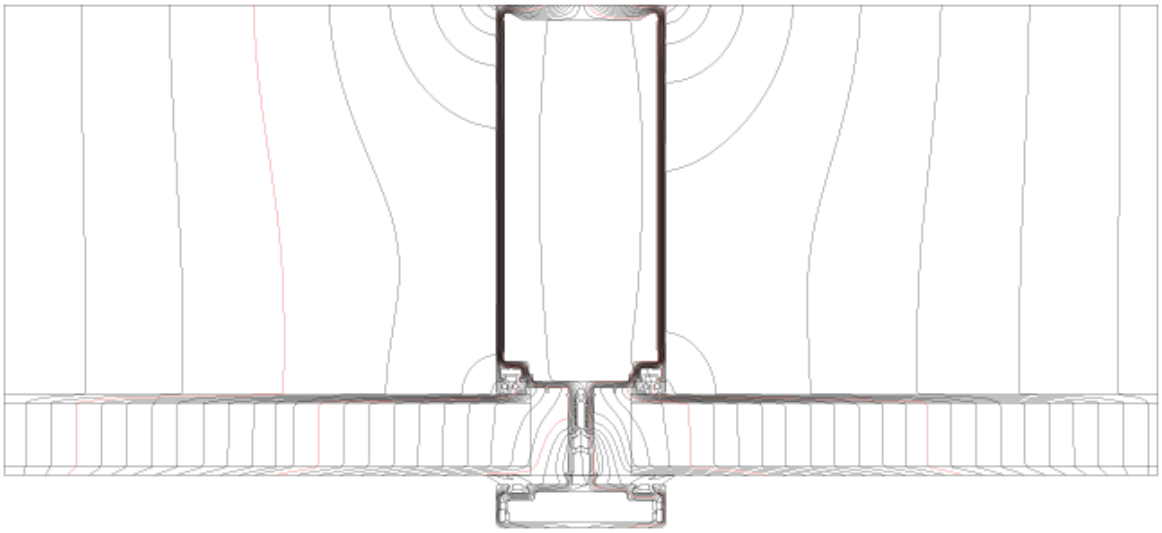
Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Epsilon 0.3				0.300
Epsilon 0.9				0.900
Exterior, zero		0.000	0.040	
Interior, frame, normal		20.000	0.130	
Interior, frame, reduced		20.000	0.200	
Symmetry/Model section	0.000			

Thermal Gradient Diagram





Heat Flux Diagram



Frame Bar U Value Analysis

Transom Detail Fixed Panel PA1 / Vent

- U value calculation diagram
- Material thermal conductivity diagram
- Temperature gradient diagram
- Heat flux diagram

Finite element analysis undertaken using **FLIXO version 8** software.

Summary

The analysis shows that the frame U value is **3.395 W/m²K**, including the edge effects of the glazed elements.

Equivalent Frame U Value Calculation

- Visual external width of frame (Af) = **0.158 m**
- Visual external width of glazing (Ag) = **0.19 m**
- Glass (Ag*) = **0.190 m**
- U value of glazing (Ug) used in FEA = **0.19 W/m²K**
- Glass (Ug*) = **0.44 W/m²K**
- Temperature difference ΔT = **20 K**

Composite heat transfer (frame + glazing) = **13.097 W/m**

$$U_{tot} = \frac{Q_{tot}}{(A_f + A_g) \times \Delta T} = \frac{13.097}{0.5375 \times 20} = 1.21833 \text{ W/m2K}$$

Heat transfer through glazed element:

$$Q_g = U_g \times A_g \times \Delta T = 0.193 \times 0.19 \times 20 = 0.7334 \text{ W}$$

Heat transfer through secondary glazed element:

$$Q_g' = U_g' \times A_g' \times \Delta T = 0.439 \times 0.19 \times 20 = 1.6682 \text{ W}$$

Frame heat transfer:

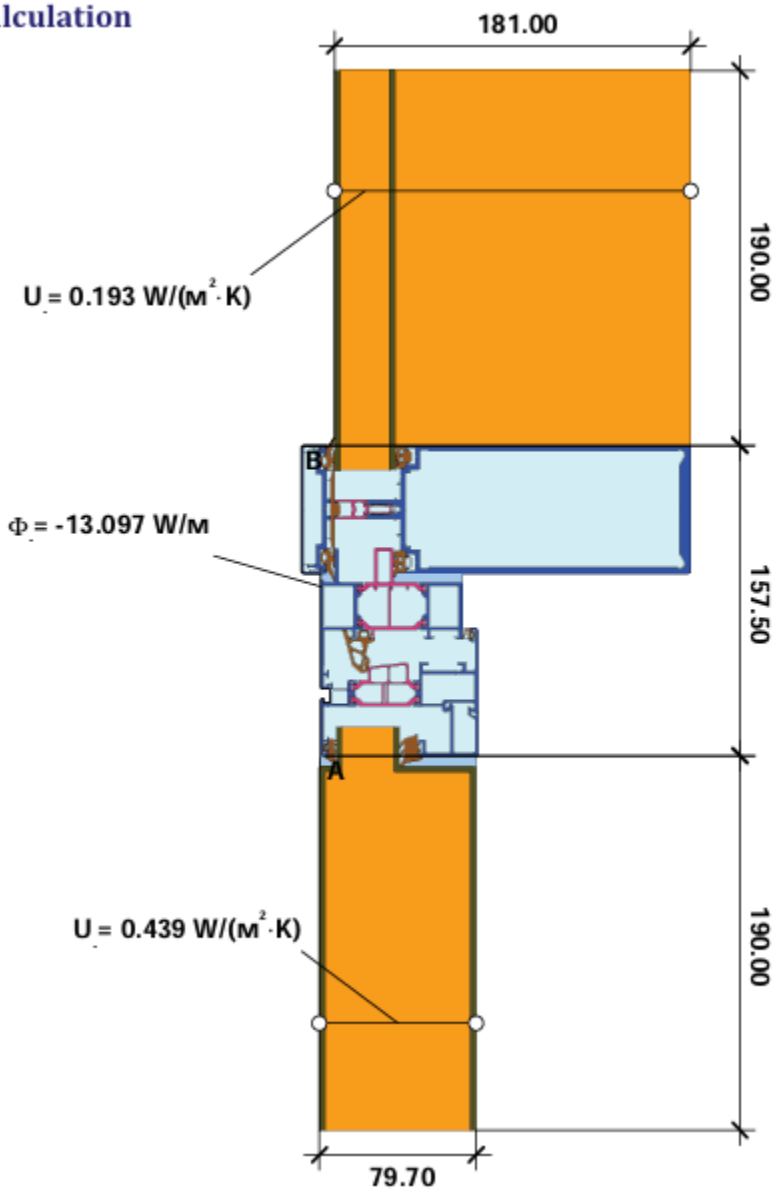
$$Q_f = Q_{tot} - Q_g - Q_g' = 13.097 - 0.7334 - 1.6682 = 10.6954 \text{ W}$$

Equivalent Frame U Value:

$$U_f = \frac{Q_f}{A_f \times \Delta T} = \frac{10.6954}{0.1575 \times 20} = 3.395 \text{ W/m2K}$$

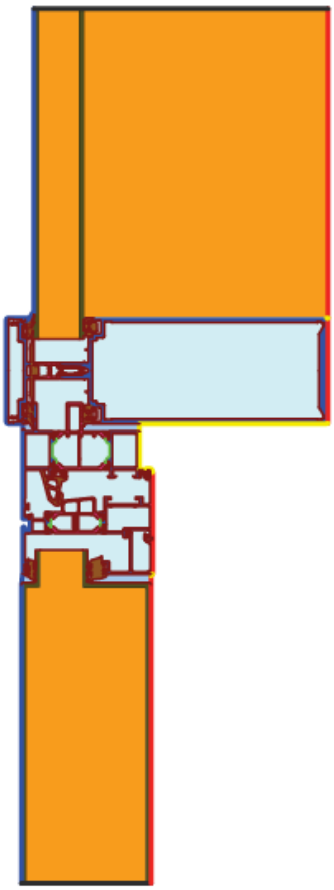
Final Uf = 3.395 W/m²K

U value calculation



$$U_{TJA,B} = \frac{\frac{\Phi}{\Delta T} - U_{g1} \cdot b_{g1} - U_{g2} \cdot b_{g2}}{b_f} = \frac{\frac{13.097}{20.000} - 0.439 \cdot 0.190 - 0.193 \cdot 0.190}{0.158} = 3.39 \text{ W/(m}^2\text{·K)}$$

Material Thermal Conductivity Diagram

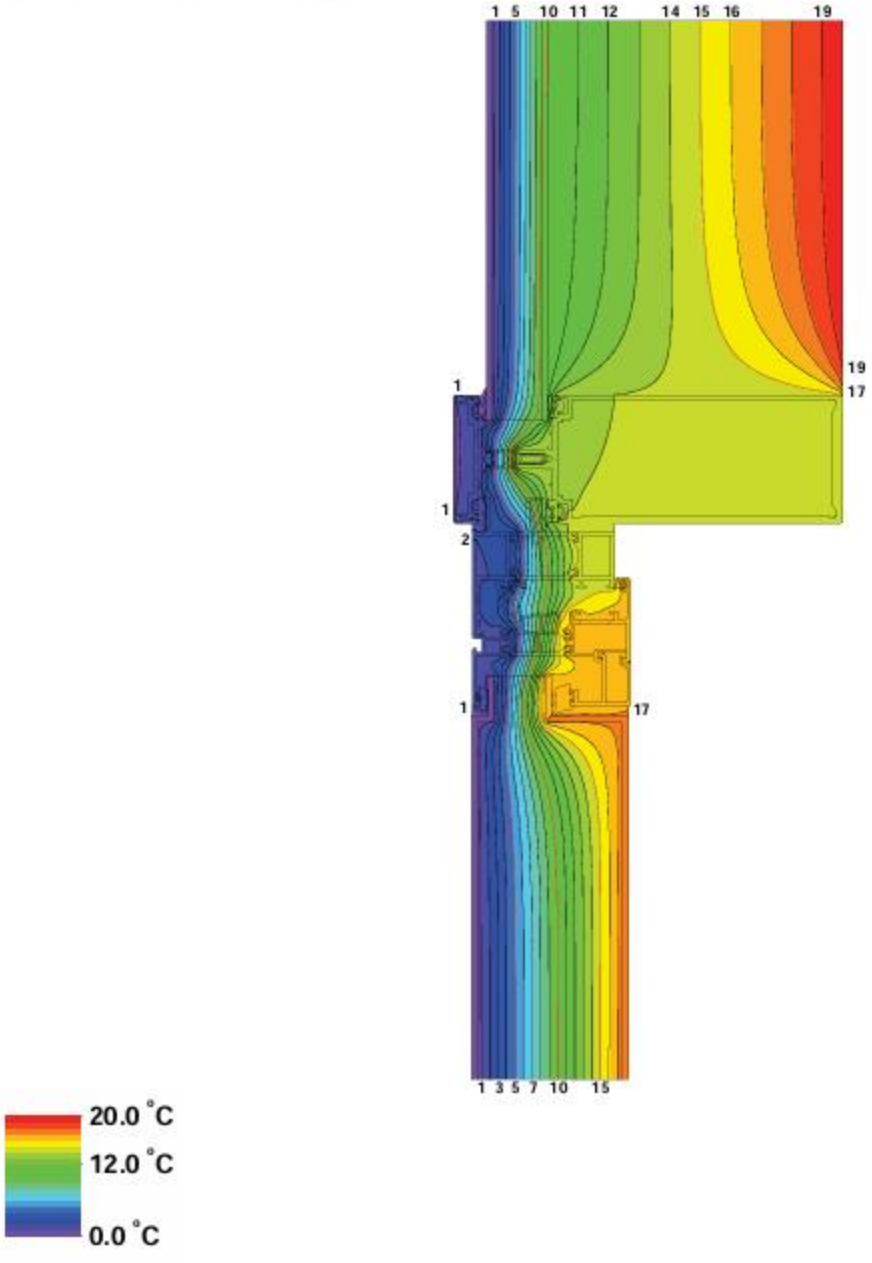


Material	λ[W/(m·K)]	ε
Aluminium (Si Alloys)	160.000	0.300
Aluminium (Si Alloys)	160.000	0.900
Aluminium alloy	160.000	0.900
EPDM (ethylene propylene diene monomer)	0.250	0.900
Mineral wool	0.035	0.900
Polyamid (nylon)	0.250	0.300
Polyamid (nylon)	0.250	0.900
Slightly ventilated air cavity **		
Unventilated air cavity **		

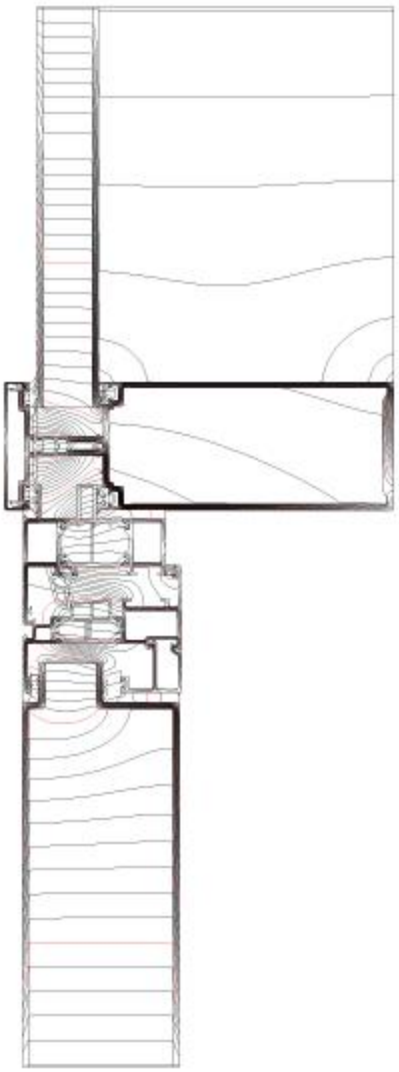
** EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Epsilon 0.3				0.300
Epsilon 0.9				0.900
Exterior, zero		0.000	0.040	
Interior, frame, normal		20.000	0.130	
Interior, frame, reduced		20.000	0.200	
Symmetry/Model section	0.000			

Thermal Gradient Diagram



Heat Flux Diagram



Frame Bar U Value Analysis

Transom Detail Fixed Panel PA1 / Glass

- U value calculation diagram
- Material thermal conductivity diagram
- Temperature gradient diagram
- Heat flux diagram

Finite element analysis undertaken using **FLIXO version 8** software.

Summary

The analysis shows that the frame U value is **5.019 W/m²K**, including the edge effects of the glazed elements.

Equivalent Frame U Value Calculation

- Visual external width of frame (Af) = **0.065 m**
- Visual external width of glazing (Ag) = **0.19 m**
- Glass (Ag*) = **0.190 m**
- U value of glazing (Ug) used in FEA = **0.19 W/m²K**
- Glass (Ug*) = **1.00 W/m²K**
- Temperature difference ΔT = **20 K**

Composite heat transfer (frame + glazing) = **11.058 W/m**

$$U_{tot} = \frac{Q_{tot}}{A_{tot} \times \Delta T} = \frac{11.058}{0.445 \times 20} = 1.24247 \text{ W/m2K}$$

Heat transfer through glazed element:

$$Q_g = U_g \times A_g \times \Delta T = 0.193 \times 0.19 \times 20 = 0.7334 \text{ W}$$

Heat transfer through secondary glazed element:

$$Q_g' = U_g' \times A_g' \times \Delta T = 1.0 \times 0.19 \times 20 = 3.8 \text{ W}$$

Frame heat transfer:

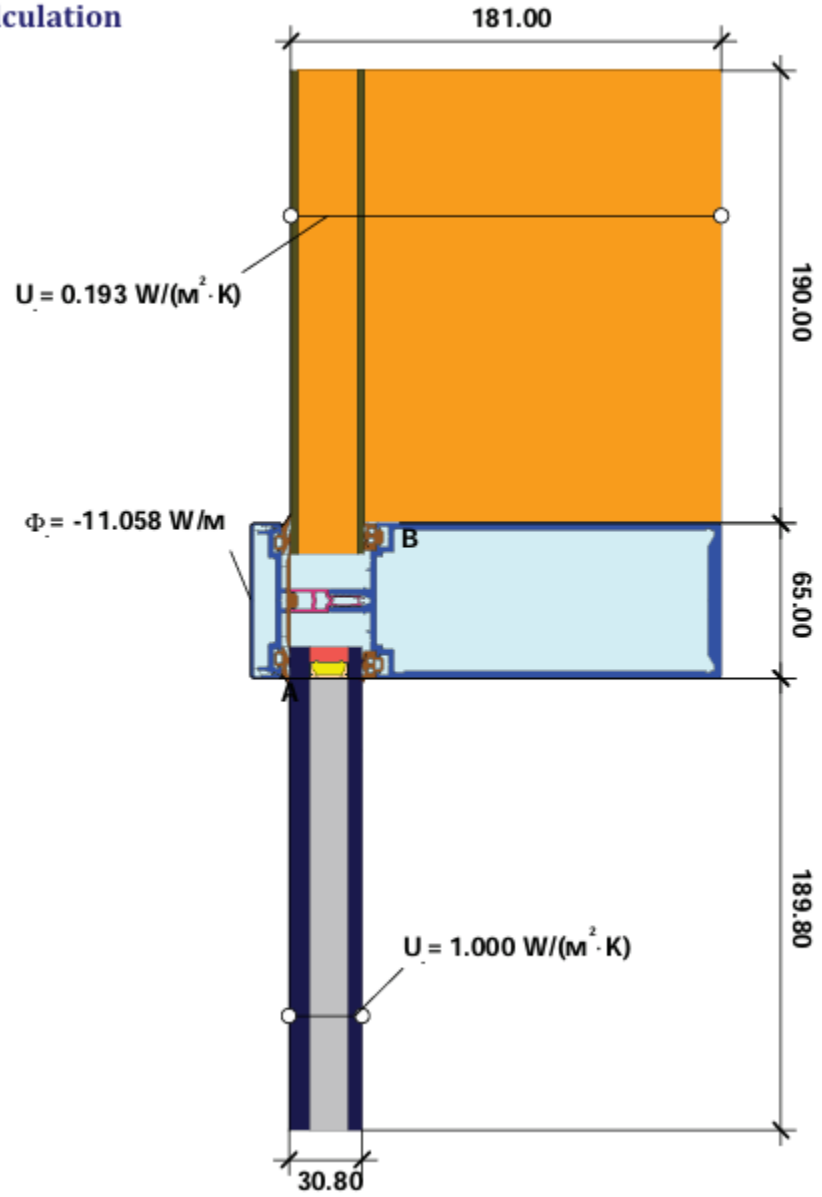
$$Q_f = Q_{tot} - Q_g - Q_g' = 11.058 - 0.7334 - 3.8 = 6.5246 \text{ W}$$

Equivalent Frame U Value:

$$U_f = \frac{Q_f}{A_f \times \Delta T} = \frac{6.5246}{0.065 \times 20} = 5.019 \text{ W/m2K}$$

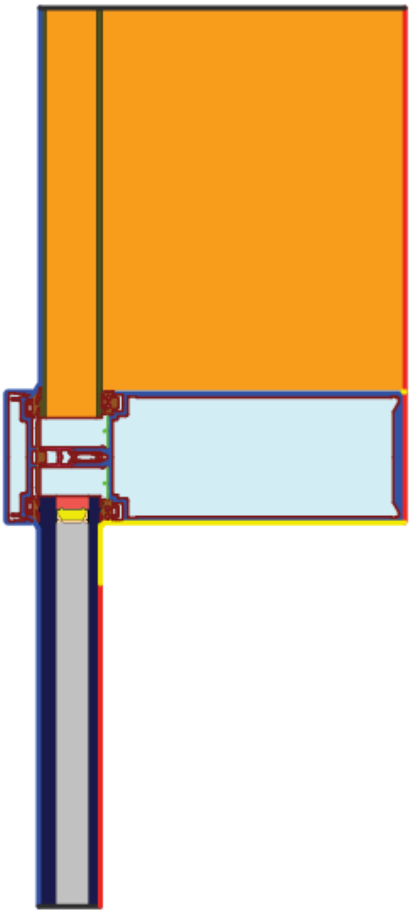
Final Uf = 5.019 W/m²K

U value calculation



$$U_{плд} = \frac{\frac{\Phi}{\Delta T} - U_{g1} \cdot b_{g1} - U_{g2} \cdot b_{g2}}{b_f} = \frac{\frac{11.058}{20.000} - 1.000 \cdot 0.190 - 0.193 \cdot 0.190}{0.065} = 5.02 \text{ W/(m}^2 \cdot \text{K)}$$

Material Thermal Conductivity Diagram

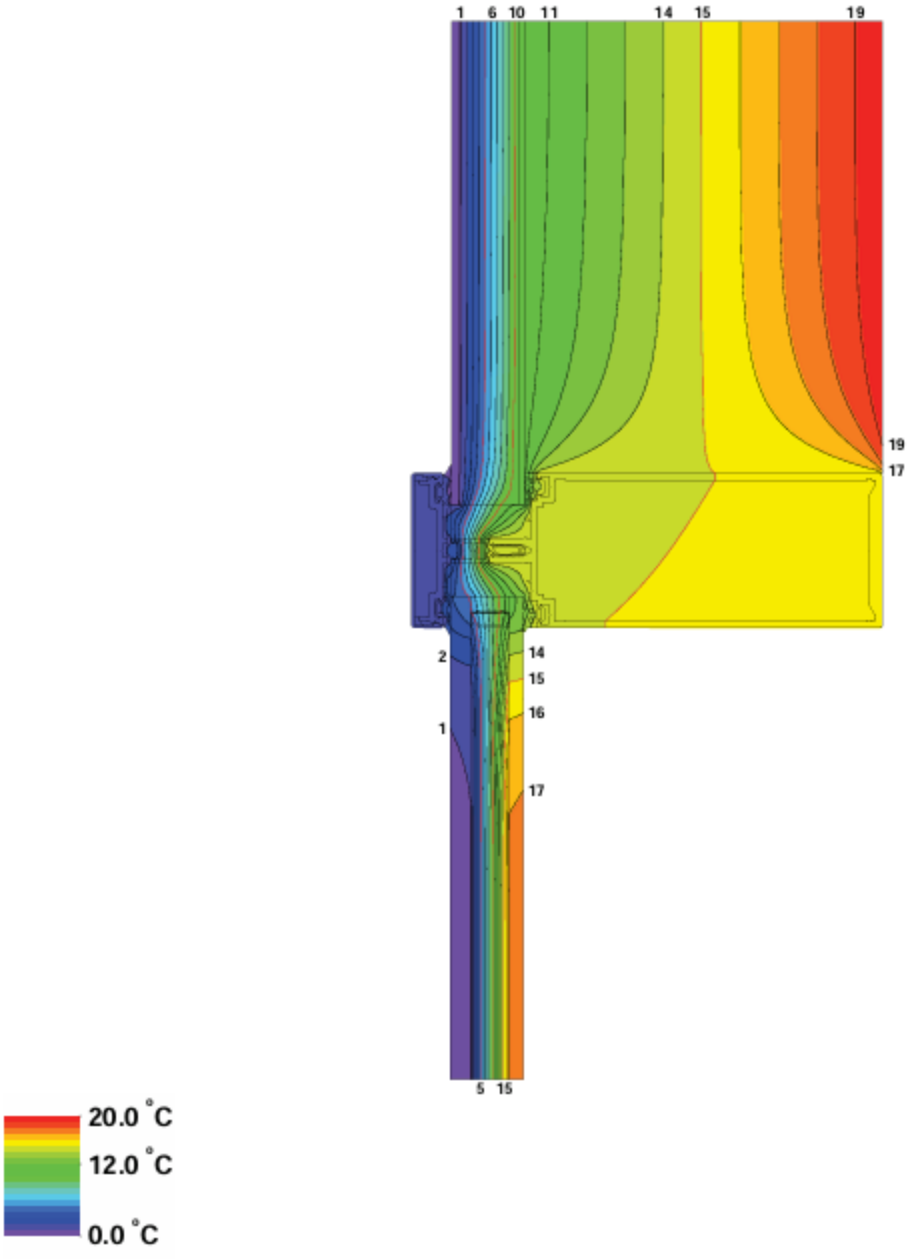


Material	λ[W/(m·K)]	ε
Aluminium (Si Alloys)	160.000	0.300
Aluminium (Si Alloys)	160.000	0.900
Aluminium alloy	160.000	0.900
Butyl	0.240	
EPDM (ethylene propylene diene monomer)	0.250	0.900
Edelstahl	17.000	
Gasfilling(1)	0.020	
Mineral wool	0.035	0.900
Polyamid (nylon)	0.250	0.900
Polycarbonat	0.240	
Polysulfid	0.400	0.900
Silicagel	0.130	
Soda lime glass	1.000	0.900
Unventilated air cavity **		

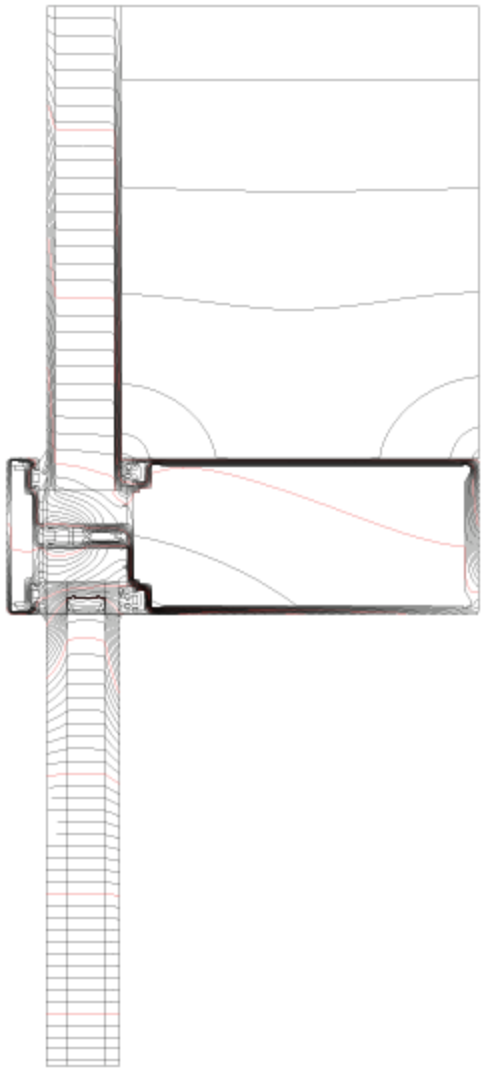
** EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Epsilon 0.3				0.300
Epsilon 0.9				0.900
Exterior, zero		0.000	0.040	
Interior, frame, normal		20.000	0.130	
Interior, frame, reduced		20.000	0.200	
Symmetry/Model section	0.000			

Thermal Gradient Diagram



Heat Flux Diagram



Frame Bar U Value Analysis

Transom Detail Vent / PA2

- U value calculation diagram
- Material thermal conductivity diagram
- Temperature gradient diagram
- Heat flux diagram

Finite element analysis undertaken using **FLIXO version 8** software.

Summary

The analysis shows that the frame U value is **2.979 W/m²K**, including the edge effects of the glazed elements.

Equivalent Frame U Value Calculation

- Visual external width of frame (Af) = **0.158 m**
- Visual external width of glazing (Ag) = **0.19 m**
- Glass (Ag*) = **0.190 m**
- U value of glazing (Ug) used in FEA = **0.44 W/m²K**
- Glass (Ug*) = **1.14 W/m²K**
- Temperature difference ΔT = **20 K**

Composite heat transfer (frame + glazing) = **15.378 W/m**

$$U_{tot} = \frac{Q_{tot}}{(A_f + A_g) \times \Delta T} = \frac{15.378}{0.5375 \times 20} = 1.43051 \text{ W/m2K}$$

Heat transfer through glazed element:

$$Q_g = U_g \times A_g \times \Delta T = 0.439 \times 0.19 \times 20 = 1.6682 \text{ W}$$

Heat transfer through secondary glazed element:

$$Q_g' = U_g' \times A_g' \times \Delta T = 1.138 \times 0.19 \times 20 = 4.3244 \text{ W}$$

Frame heat transfer:

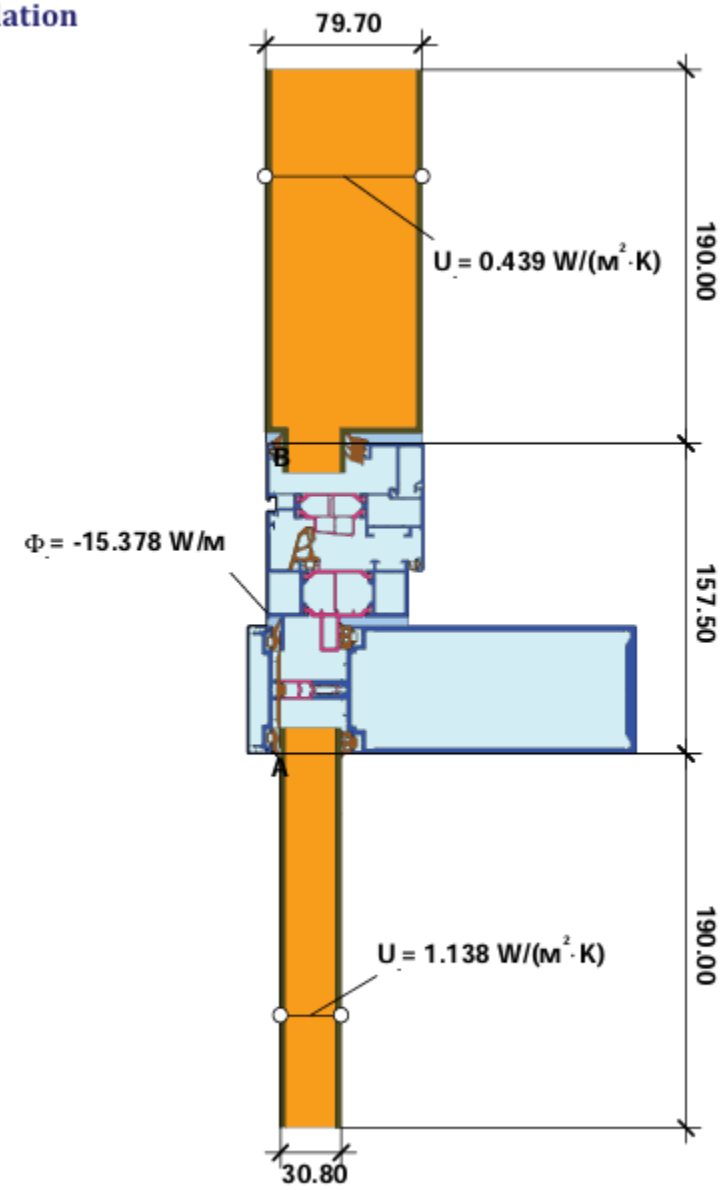
$$Q_f = Q_{tot} - Q_g - Q_g' = 15.378 - 1.6682 - 4.3244 = 9.3854 \text{ W}$$

Equivalent Frame U Value:

$$U_f = \frac{Q_f}{A_f \times \Delta T} = \frac{9.3854}{0.1575 \times 20} = 2.979 \text{ W/m2K}$$

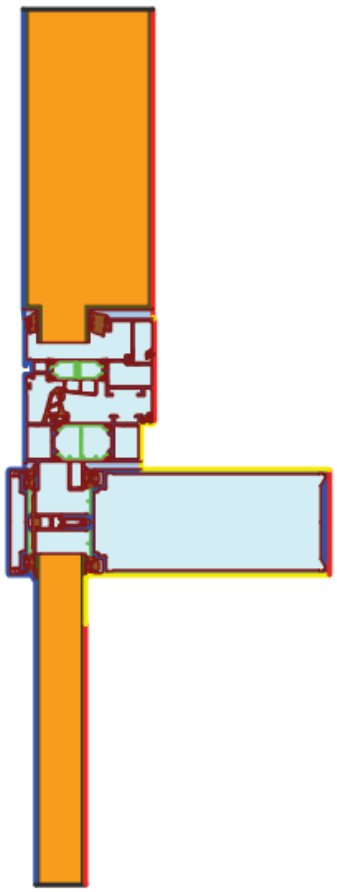
Final Uf = 2.979 W/m²K

U value calculation



$$U_{плав} = \frac{\frac{\Phi}{\Delta T} - U_{g1} \cdot b_{g1} - U_{g2} \cdot b_{g2}}{b_f} = \frac{\frac{15.378}{20.000} - 1.138 \cdot 0.190 - 0.439 \cdot 0.190}{0.158} = 2.98 \text{ W/(m}^2 \cdot \text{K)}$$

Material Thermal Conductivity Diagram



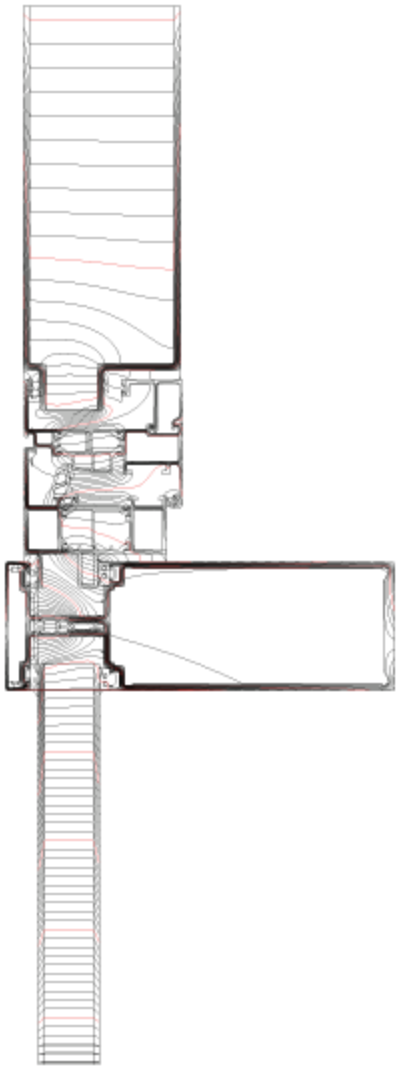
Material	λ[W/(m·K)]	ε
Aluminium (Si Alloys)	160.000	0.300
Aluminium (Si Alloys)	160.000	0.900
Aluminium alloy	160.000	0.900
EPDM (ethylene propylene diene monomer)	0.250	0.900
Mineral wool	0.035	0.900
Polyamid (nylon)	0.250	0.300
Polyamid (nylon)	0.250	0.900
Slightly ventilated air cavity **		
Unventilated air cavity **		

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

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Epsilon 0.3				0.300
Epsilon 0.9				0.900
Exterior, zero		0.000	0.040	
Interior, frame, normal		20.000	0.130	
Interior, frame, reduced		20.000	0.200	
Symmetry/Model section	0.000			

Thermal Gradient Diagram

Heat Flux Diagram



Frame Bar U Value Analysis

Transom Detail PA2 / PA1

- U value calculation diagram
- Material thermal conductivity diagram
- Temperature gradient diagram
- Heat flux diagram

Finite element analysis undertaken using **FLIXO version 8** software.

Summary

The analysis shows that the frame U value is **3.981 W/m²K**, including the edge effects of the glazed elements.

Equivalent Frame U Value Calculation

- Visual external width of frame (Af) = **0.065 m**
- Visual external width of glazing (Ag) = **0.19 m**
- Glass (Ag*) = **0.190 m**
- U value of glazing (Ug) used in FEA = **1.14 W/m²K**
- Glass (Ug*) = **0.19 W/m²K**
- Temperature difference ΔT = **20 K**

Composite heat transfer (frame + glazing) = **10.233 W/m**

$$U_{tot} = \frac{Q_{tot}}{(A_f + A_g) \times \Delta T} = \frac{10.233}{0.445 \times 20} = 1.14978 \text{ W/m2K}$$

Heat transfer through glazed element:

$$Q_g = U_g \times A_g \times \Delta T = 1.138 \times 0.19 \times 20 = 4.3244 \text{ W}$$

Heat transfer through secondary glazed element:

$$Q_g' = U_g' \times A_g' \times \Delta T = 0.193 \times 0.19 \times 20 = 0.7334 \text{ W}$$

Frame heat transfer:

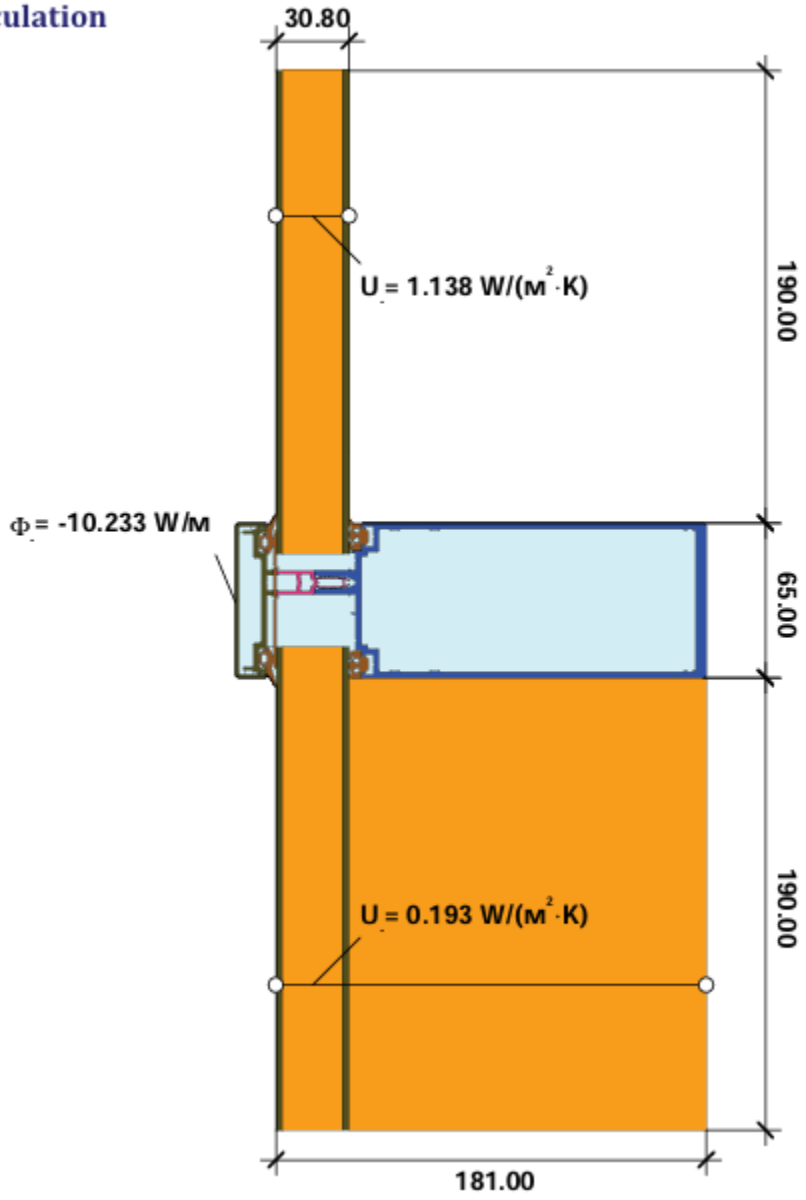
$$Q_f = Q_{tot} - Q_g - Q_g' = 10.233 - 4.3244 - 0.7334 = 5.1752 \text{ W}$$

Equivalent Frame U Value:

$$U_f = \frac{Q_f}{A_f \times \Delta T} = \frac{5.1752}{0.065 \times 20} = 3.981 \text{ W/m2K}$$

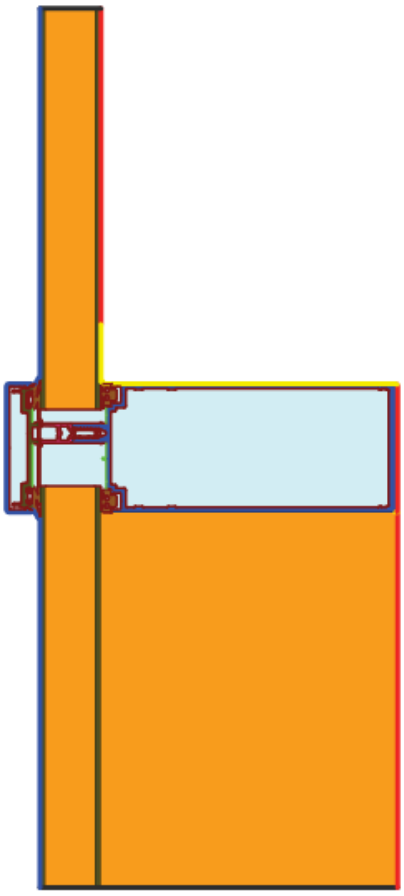
Final Uf = 3.981 W/m²K

U value calculation



$$U_{\text{п}} = \frac{\frac{\Phi}{\Delta T} - U_{g1}\cdot b_{g1} - U_{g2}\cdot b_{g2}}{b_f} = \frac{\frac{10.233}{20.000} - 0.193\cdot 0.190 - 1.138\cdot 0.190}{0.065} = 3.98\ \text{W/(m}^2\cdot\text{K)}$$

Material Thermal Conductivity Diagram

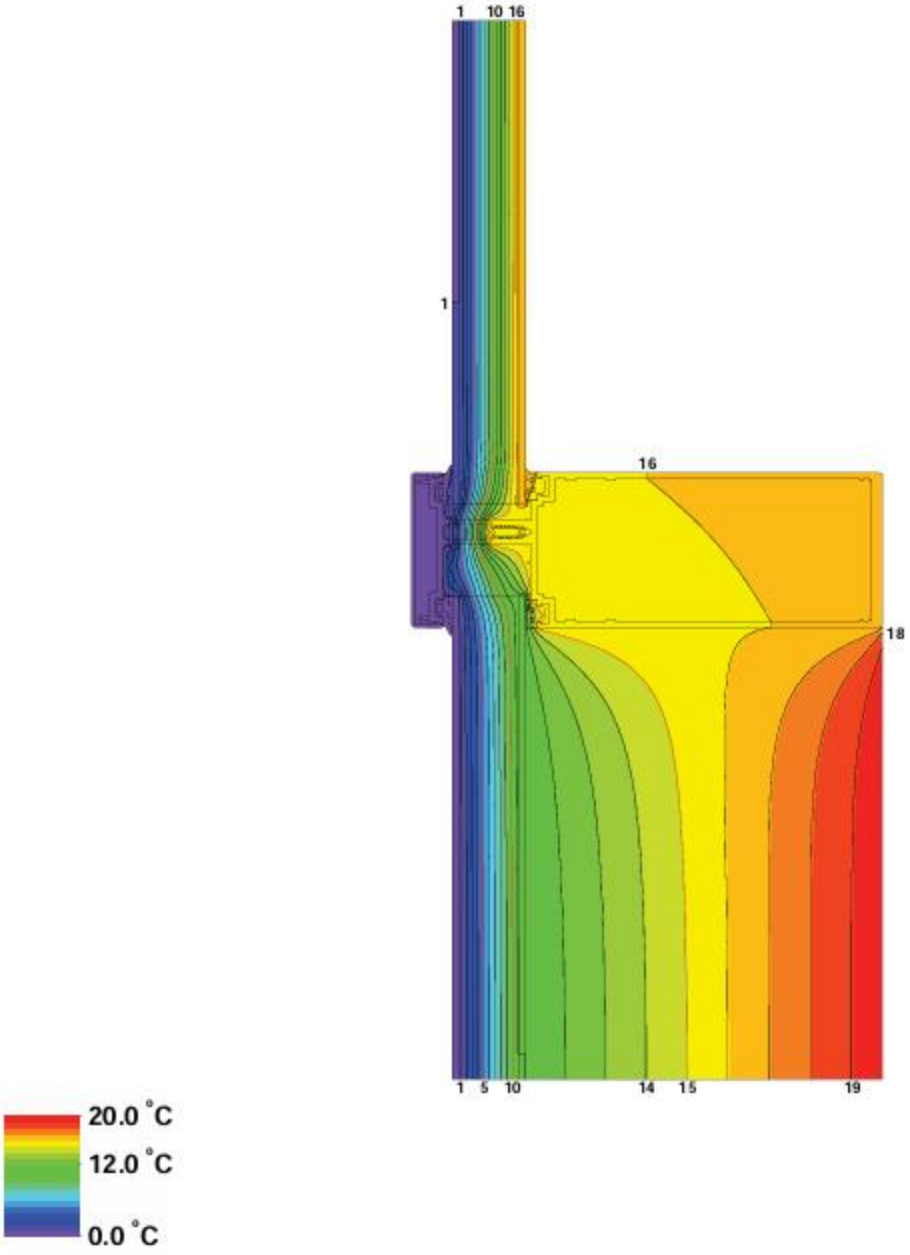


Material	λ[W/(m·K)]	ε
Aluminium (Si Alloys)	160.000	0.300
Aluminium (Si Alloys)	160.000	0.900
Aluminium alloy	160.000	0.300
Aluminium alloy	160.000	0.900
EPDM (ethylene propylene diene monomer)	0.250	0.900
Mineral wool	0.035	0.900
Polyamid (nylon)	0.250	0.900
Unventilated air cavity **		

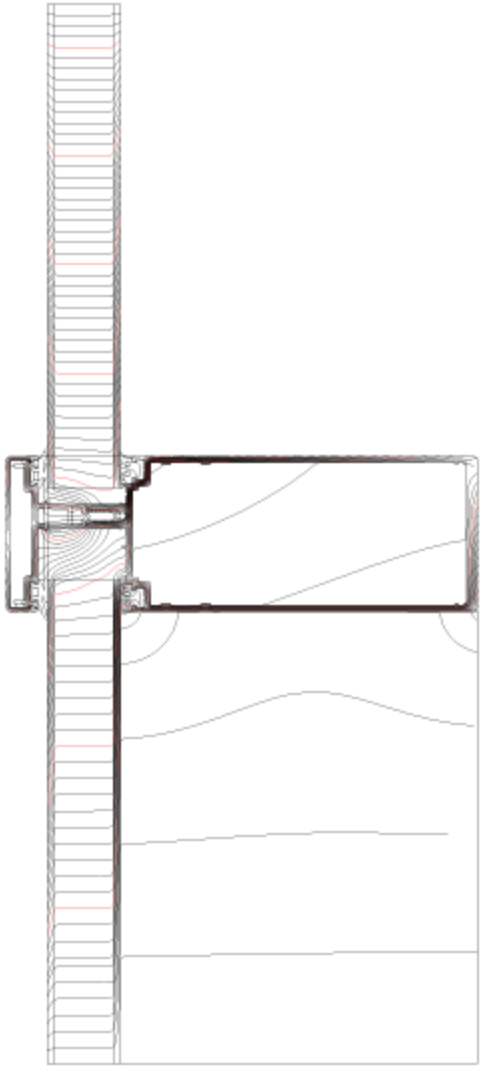
** EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Epsilon 0.3				0.300
Epsilon 0.9				0.900
Exterior, zero		0.000	0.040	
Interior, frame, normal		20.000	0.130	
Interior, frame, reduced		20.000	0.200	
Symmetry/Model section	0.000			

Thermal Gradient Diagram



Heat Flux Diagram



Frame Bar U Value Analysis

Transom Detail Glass / PA1

- U value calculation diagram
- Material thermal conductivity diagram
- Temperature gradient diagram
- Heat flux diagram

Finite element analysis undertaken using **FLIXO version 8** software.

Summary

The analysis shows that the frame U value is **5.088 W/m²K**, including the edge effects of the glazed elements.

Equivalent Frame U Value Calculation

- Visual external width of frame (Af) = **0.065 m**
- Visual external width of glazing (Ag) = **0.19 m**
- Glass (Ag*) = **0.190 m**
- U value of glazing (Ug) used in FEA = **1.00 W/m²K**
- Glass (Ug*) = **0.19 W/m²K**
- Temperature difference ΔT = **20 K**

Composite heat transfer (frame + glazing) = **11.148 W/m**

$$Utot=Qtot(Af+Ag)\times\Delta T=11.1480.445\times20=1.25258\ W/m2K$$

Heat transfer through glazed element:

$$Qg=Ug\times Ag\times\Delta T=1.0\times0.19\times20=3.8\ W$$

Heat transfer through secondary glazed element:

$$Qg'=Ug'\times Ag'\times\Delta T=0.193\times0.19\times20=0.7334\ W$$

Frame heat transfer:

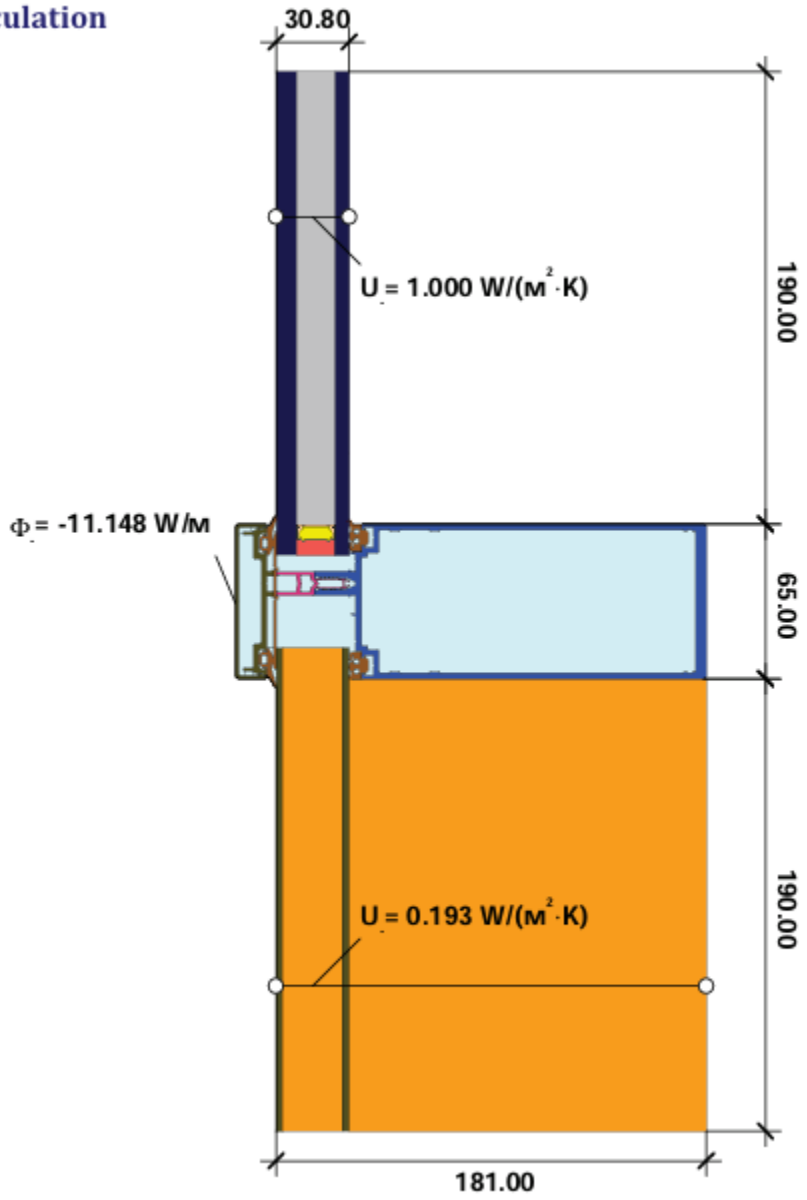
$$Qf=Qtot-Qg-Qg'=11.148-3.8-0.7334=6.6146\ W$$

Equivalent Frame U Value:

$$Uf=QfAf\times\Delta T=6.61460.065\times20=5.088\ W/m2K$$

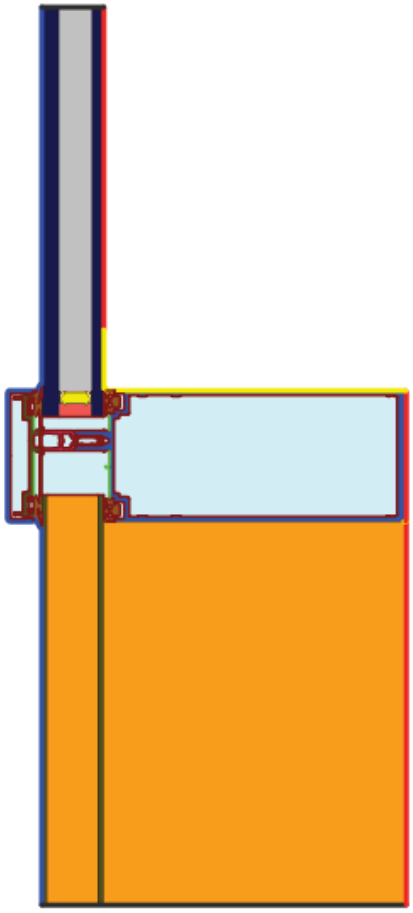
Final Uf = 5.088 W/m²K

U value calculation



$$U_{\text{п}} = \frac{\frac{\Phi}{\Delta T} - U_{g1}\cdot b_{g1} - U_{g2}\cdot b_{g2}}{b_{f}} = \frac{\frac{11.148}{20.000} - 0.193\cdot 0.190 - 1.000\cdot 0.190}{0.065} = 5.09\ \text{W/(m}^2\cdot\text{K)}$$

Material Thermal Conductivity Diagram

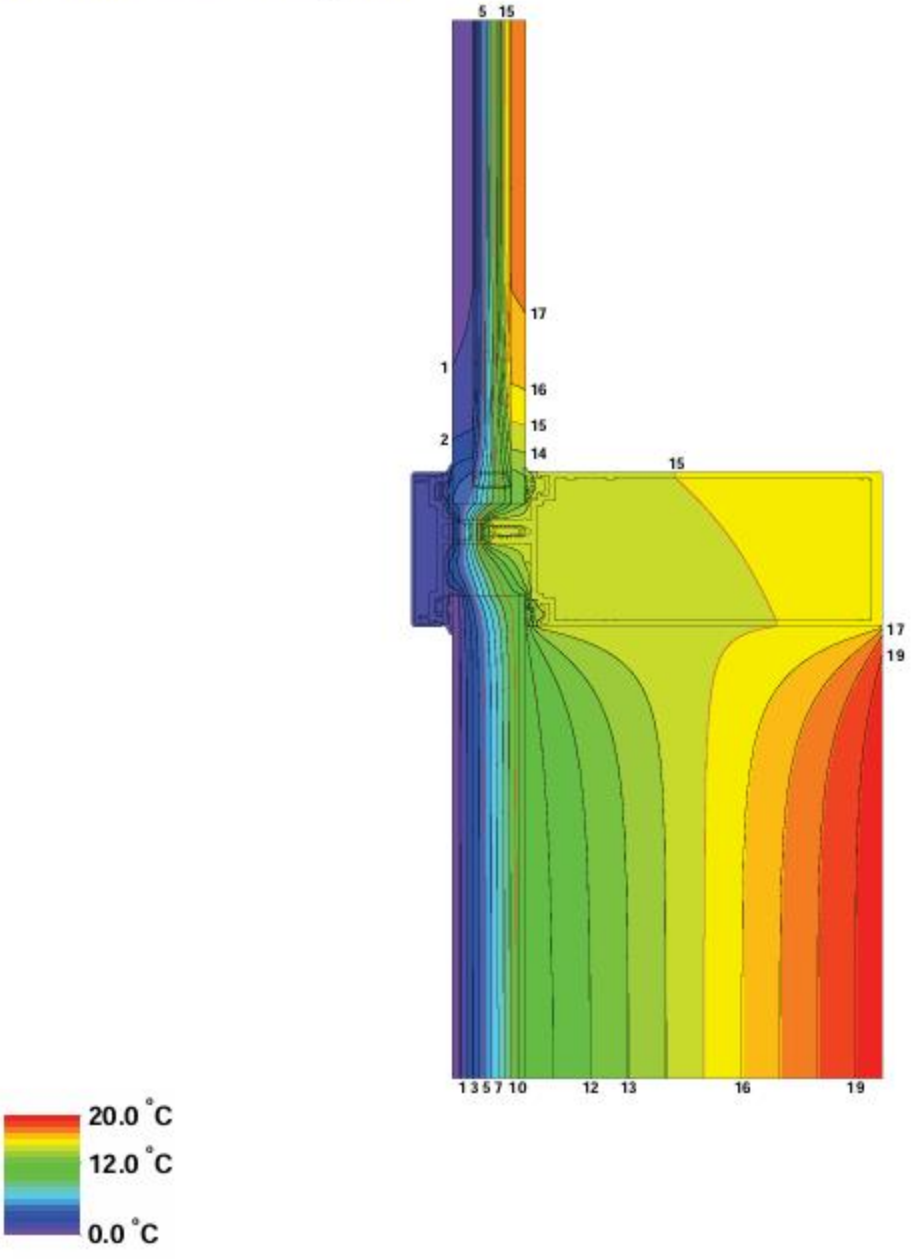


Material	λ[W/(m·K)]	ε
Aluminium (Si Alloys)	160.000	0.300
Aluminium (Si Alloys)	160.000	0.900
Aluminium alloy	160.000	0.300
Aluminium alloy	160.000	0.900
Butyl	0.240	
EPDM (ethylene propylene diene monomer)	0.250	0.900
Edelstahl	17.000	
Gasfilling(3)	0.020	
Mineral wool	0.035	0.900
Polyamid (nylon)	0.250	0.900
Polycarbonat	0.240	
Polysulfid	0.400	0.900
Silicagel	0.130	
Soda lime glass	1.000	0.900
Unventilated air cavity **		

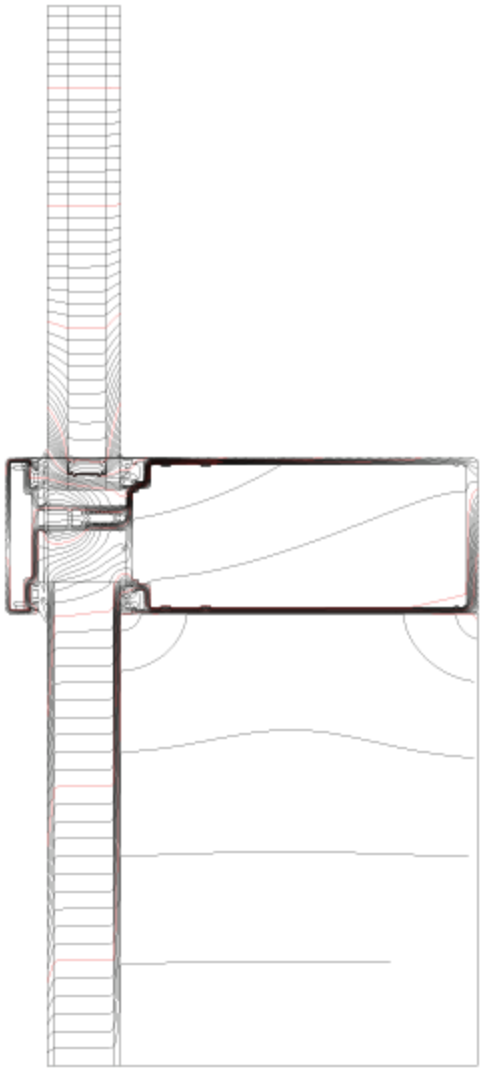
** EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Epsilon 0.3				0.300
Epsilon 0.9				0.900
Exterior, zero		0.000	0.040	
Interior, frame, normal		20.000	0.130	
Interior, frame, reduced		20.000	0.200	
Symmetry/Model section	0.000			

Thermal Gradient Diagram



Heat Flux Diagram



Frame Bar U Value Analysis

Jamb Detail Fixed GT3

- U value calculation diagram
- Material thermal conductivity diagram
- Temperature gradient diagram
- Heat flux diagram

Finite element analysis undertaken using **FLIXO version 8** software.

Summary

The analysis shows that the frame U value is **4.322 W/m²K**, including the edge effects of the glazed elements.

Equivalent Frame U Value Calculation

- Visual external width of frame (Af) = **0.065 m**
- Visual external width of glazing (Ag) = **0.19 m**
- Glass (Ag*) = **0.190 m**
- U value of glazing (Ug) used in FEA = **0.44 W/m²K**
- Glass (Ug*) = **1.00 W/m²K**
- Temperature difference ΔT = **20 K**

Composite heat transfer (frame + glazing) = **calculated via FLIXO = 11.XXX W/m**

$$Utot=Qtot(Af+Ag)\times\Delta T$$

Heat transfer through glazed element:

$$Qg=Ug\times Ag\times\Delta T=0.44\times0.19\times20=1.672\ W$$

Heat transfer through secondary glazed element:

$$Qg'=Ug'\times Ag'\times\Delta T=1.0\times0.19\times20=3.8\ W$$

Frame heat transfer:

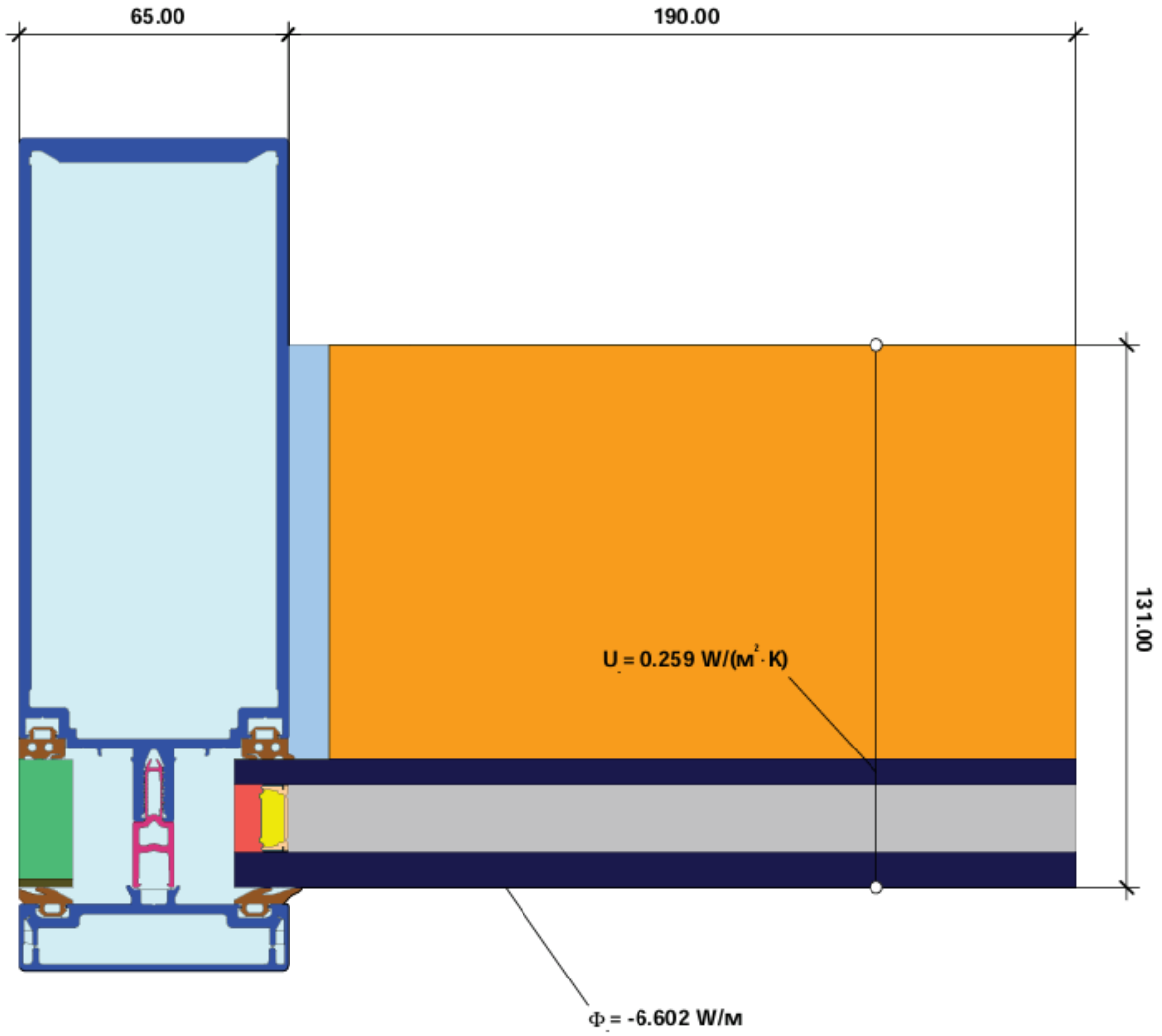
$$Qf=Qtot-Qg-Qg'\Rightarrow\approx 5.8\ W$$

Equivalent Frame U Value:

$$Uf=QfAf\times\Delta T=4.322\ W/m2K$$

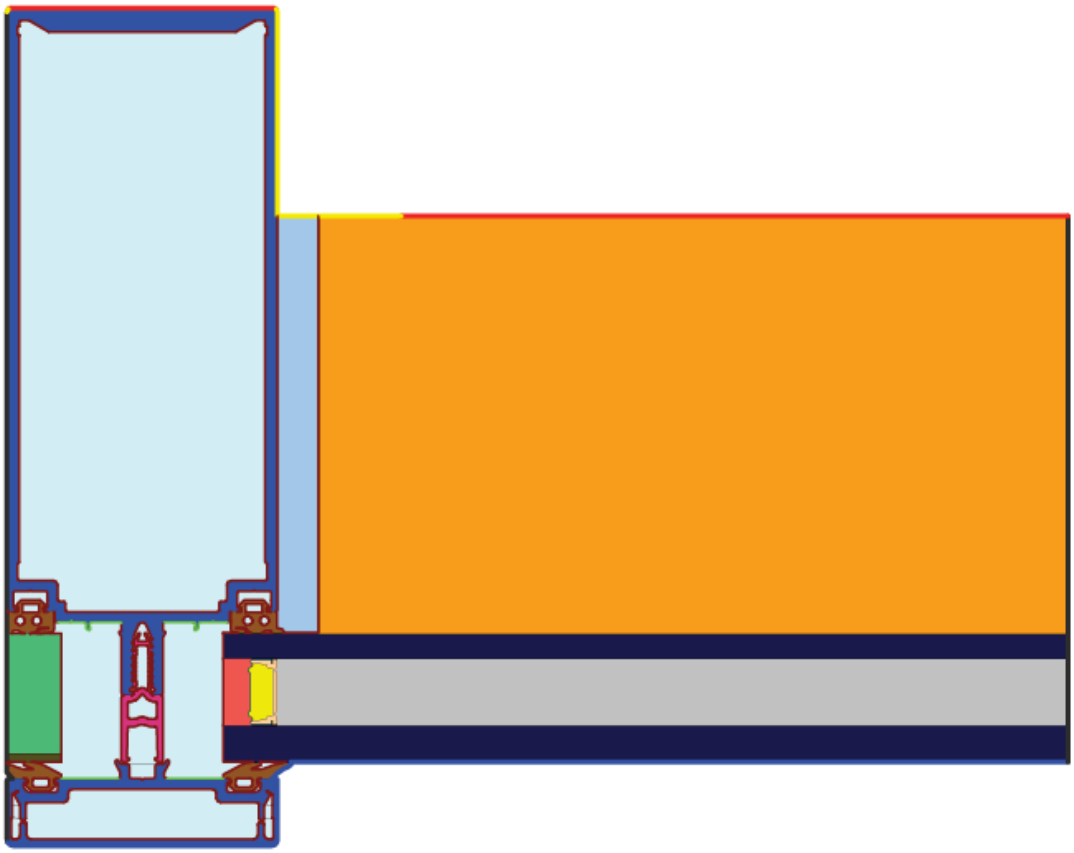
Final Uf = 4.322 W/m²K

U value calculation



$$U_{\text{п}} = \frac{\frac{\Phi}{\Delta T} - U_g \cdot b_g}{b_f} = \frac{\frac{6.602}{20.000} - 0.259 \cdot 0.190}{0.065} = 4.32 \text{ W/(m}^2\text{·K)}$$

Material Thermal Conductivity Diagram

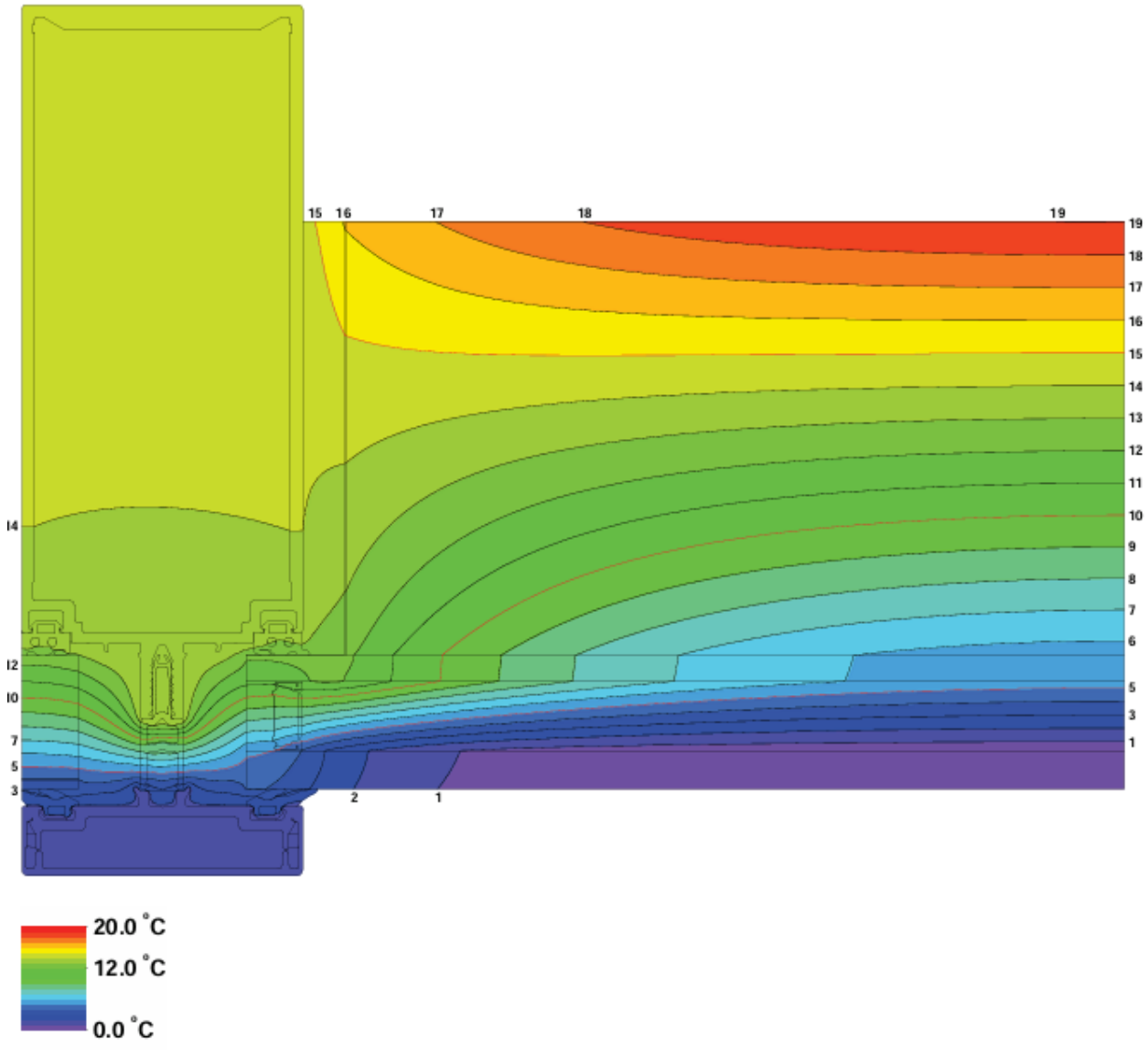


Material	λ[W/(m·K)]	ε
Aluminium (Si Alloys)	160.000	0.300
Aluminium (Si Alloys)	160.000	0.900
Aluminium alloy	160.000	0.900
Butyl	0.240	
EPDM (ethylene propylene diene monomer)	0.250	0.900
Edelstahl	17.000	
Gasfilling(1)	0.020	
Mineral wool	0.035	0.900
PVC-U (polyvinylchloride), rigid	0.170	0.900
Polyamid (nylon)	0.250	0.900
Polycarbonat	0.240	
Polysulfid	0.400	0.900
Silicagel	0.130	
Slightly ventilated air cavity **		
Soda lime glass	1.000	0.900
Unventilated air cavity **		

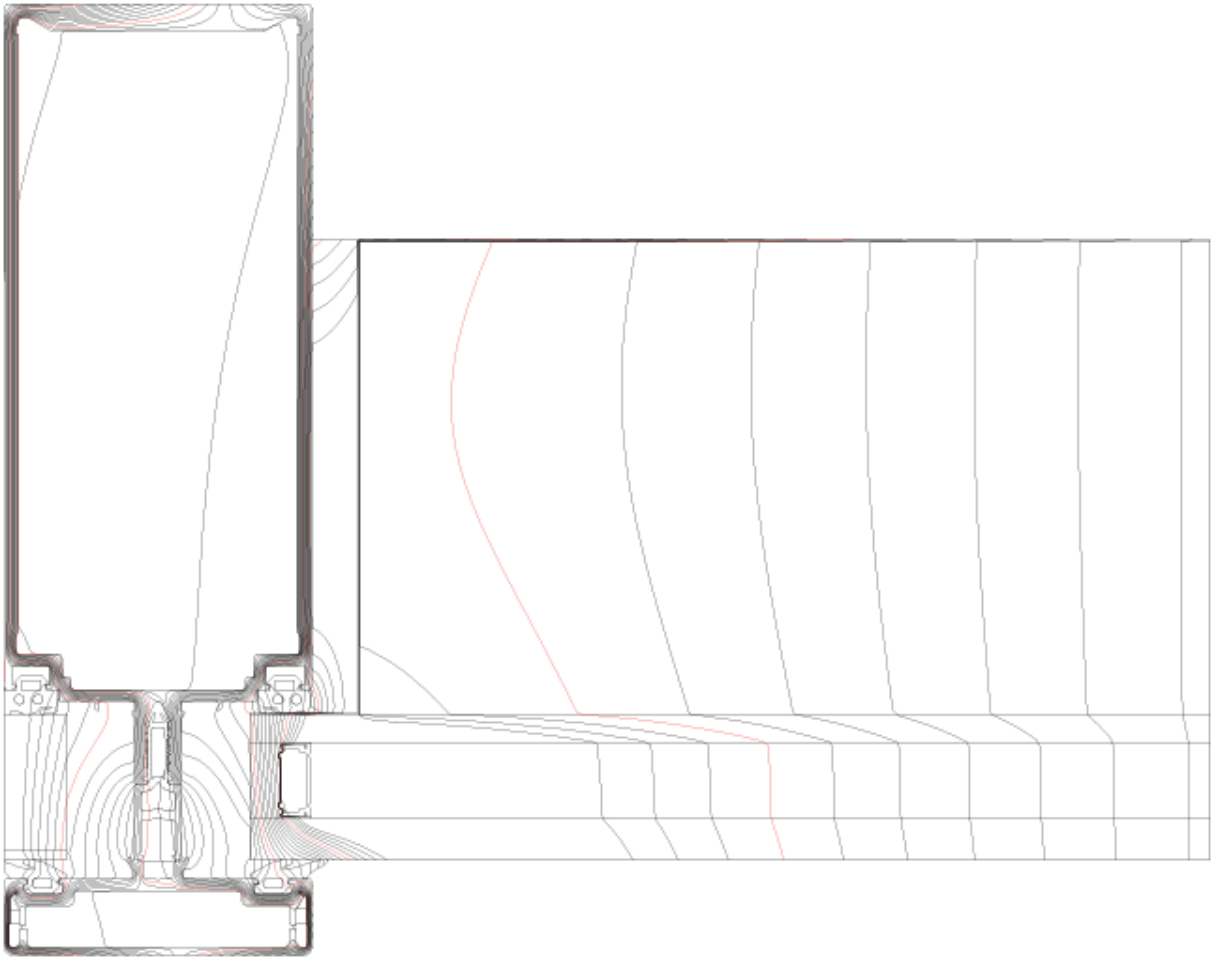
** EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Epsilon 0.3				0.300
Epsilon 0.9				0.900
Exterior, zero		0.000	0.040	
Interior, frame, normal		20.000	0.130	
Interior, frame, reduced		20.000	0.200	
Symmetry/Model section	0.000			

Thermal Gradient Diagram



Heat Flux Diagram



Frame Bar U Value Analysis

Transom Detail GT3 / PA1

- U value calculation diagram
- Material thermal conductivity diagram
- Temperature gradient diagram
- Heat flux diagram

Finite element analysis undertaken using **FLIXO version 8** software.

Summary

The analysis shows that the frame U value is **5.029 W/m²K**, including the edge effects of the glazed elements.

Equivalent Frame U Value Calculation

- Visual external width of frame (Af) = **0.065 m**
- Visual external width of glazing (Ag) = **0.19 m**
- Glass (Ag*) = **0.190 m**
- U value of glazing (Ug) used in FEA = **0.26 W/m²K**
- Glass (Ug*) = **0.19 W/m²K**
- Temperature difference ΔT = **20 K**

Composite heat transfer (frame + glazing) = **8.255 W/m**

$$Utot=Qtot(Af+Ag)\times\Delta T=8.2550.445\times20=0.92753\ W/m2K$$

Heat transfer through glazed element:

$$Qg=Ug\times Ag\times\Delta T=0.259\times0.19\times20=0.9842\ W$$

Heat transfer through secondary glazed element:

$$Qg'=Ug'\times Ag'\times\Delta T=0.193\times0.19\times20=0.7334\ W$$

Frame heat transfer:

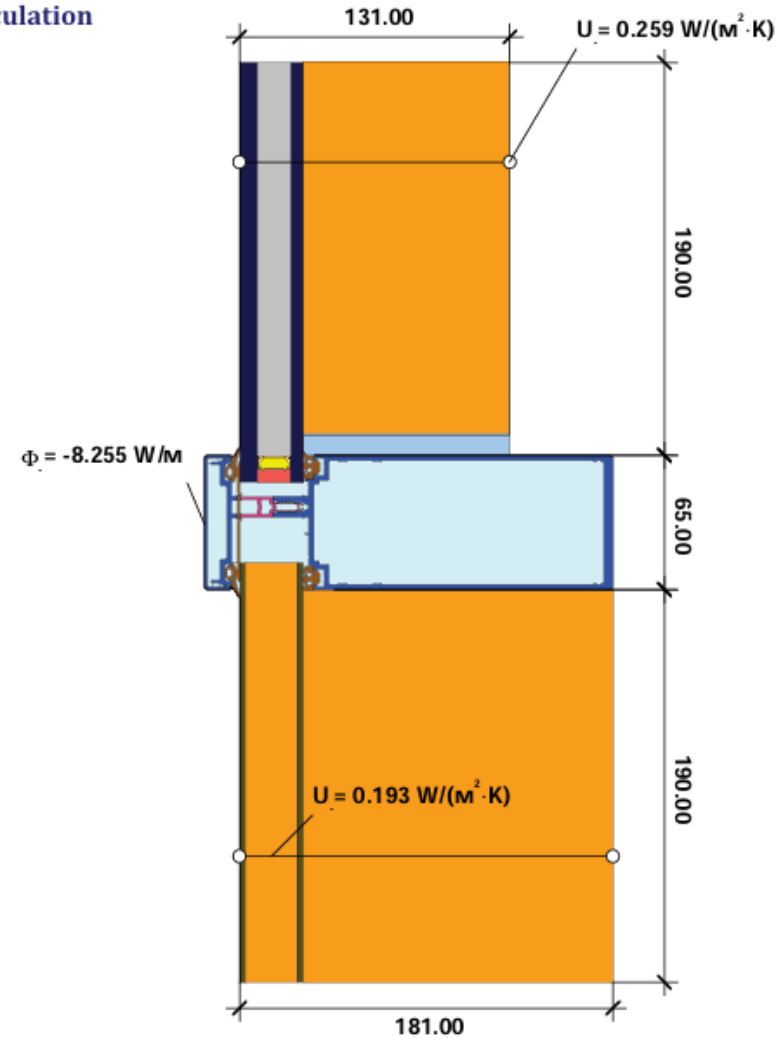
$$Qf=Qtot-Qg-Qg'=8.255-0.9842-0.7334=6.5374\ W$$

Equivalent Frame U Value:

$$Uf=QfAf\times\Delta T=6.53740.065\times20=5.029\ W/m2K$$

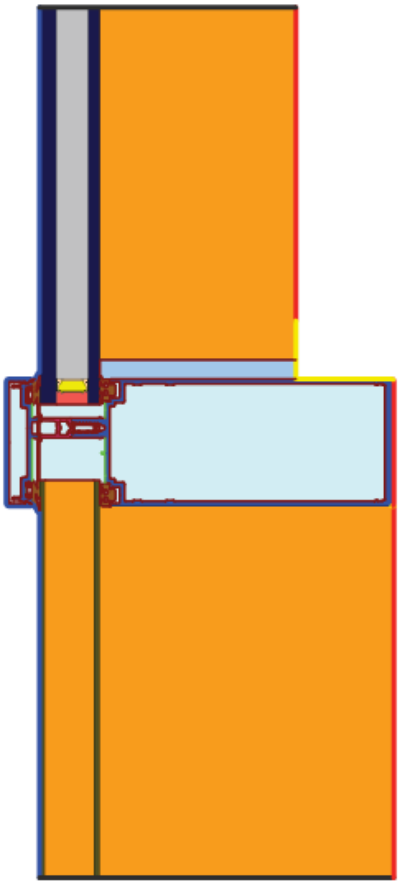
Final Uf = 5.029 W/m²K

U value calculation



$$U_{\text{п}} = \frac{\frac{\Phi}{\Delta T} - U_{g1}\cdot b_{g1} - U_{g2}\cdot b_{g2}}{b_f} = \frac{\frac{8.255}{20.000} - 0.193\cdot 0.190 - 0.259\cdot 0.190}{0.065} = 5.03\ \text{W/(m}^2\cdot\text{K)}$$

Material Thermal Conductivity Diagram

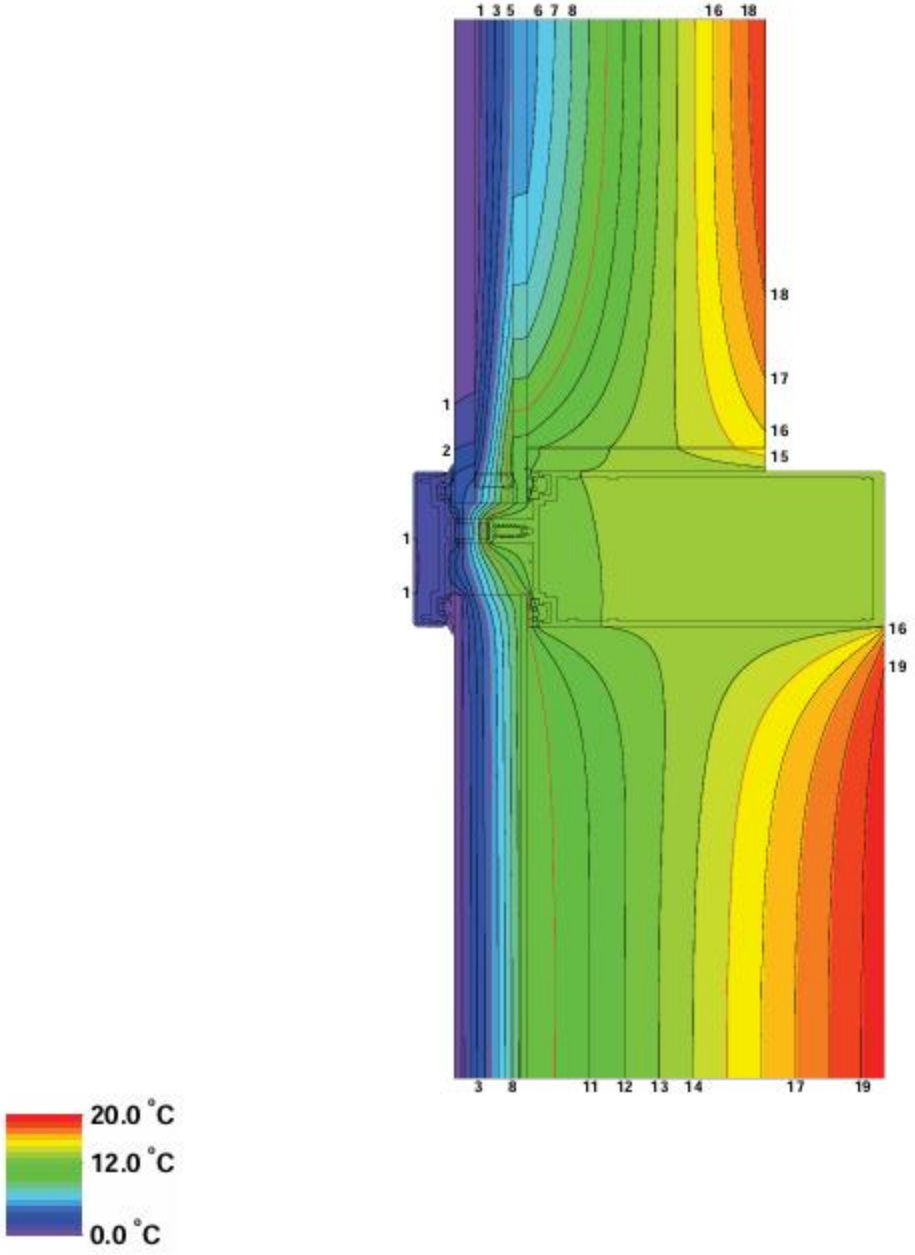


Material	λ[W/(m·K)]	ε
Aluminium (Si Alloys)	160.000	0.300
Aluminium (Si Alloys)	160.000	0.900
Aluminium alloy	160.000	0.900
Butyl	0.240	
EPDM (ethylene propylene diene monomer)	0.250	0.900
Edelstahl	17.000	
Gasfilling(2)	0.020	
Mineral wool	0.035	0.900
Polyamid (nylon)	0.250	0.900
Polycarbonat	0.240	
Polysulfid	0.400	0.900
Silicagel	0.130	
Slightly ventilated air cavity **		
Soda lime glass	1.000	0.900
Unventilated air cavity **		

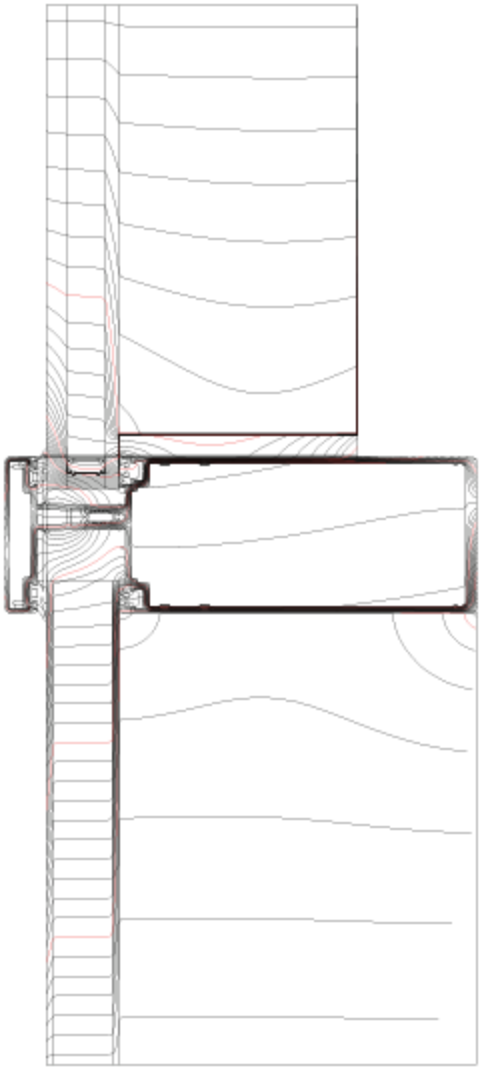
** EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Epsilon 0.3				0.300
Epsilon 0.9				0.900
Exterior, zero		0.000	0.040	
Interior, frame, normal		20.000	0.130	
Interior, frame, reduced		20.000	0.200	
Symmetry/Model section	0.000			

Thermal Gradient Diagram



Heat Flux Diagram



Frame Bar U Value Analysis

Transom Detail PA1 / GT3

- U value calculation diagram
- Material thermal conductivity diagram
- Temperature gradient diagram
- Heat flux diagram

Finite element analysis undertaken using **FLIXO version 8** software.

Summary

The analysis shows that the frame U value is **4.286 W/m²K**, including the edge effects of the glazed elements.

Equivalent Frame U Value Calculation

- Visual external width of frame (Af) = **0.065 m**
- Visual external width of glazing (Ag) = **0.19 m**
- Glass (Ag*) = **0.190 m**
- U value of glazing (Ug) used in FEA = **0.19 W/m²K**
- Glass (Ug*) = **0.26 W/m²K**
- Temperature difference ΔT = **20 K**

Composite heat transfer (frame + glazing) = **7.286 W/m**

$$U_{tot} = \frac{Q_{tot}}{(A_f + A_g) \times \Delta T} = \frac{7.286}{0.445 \times 20} = 0.81865 \text{ W/m2K}$$

Heat transfer through glazed element:

$$Q_g = U_g \times A_g \times \Delta T = 0.193 \times 0.19 \times 20 = 0.7334 \text{ W}$$

Heat transfer through secondary glazed element:

$$Q_g' = U_g' \times A_g' \times \Delta T = 0.258 \times 0.19 \times 20 = 0.9804 \text{ W}$$

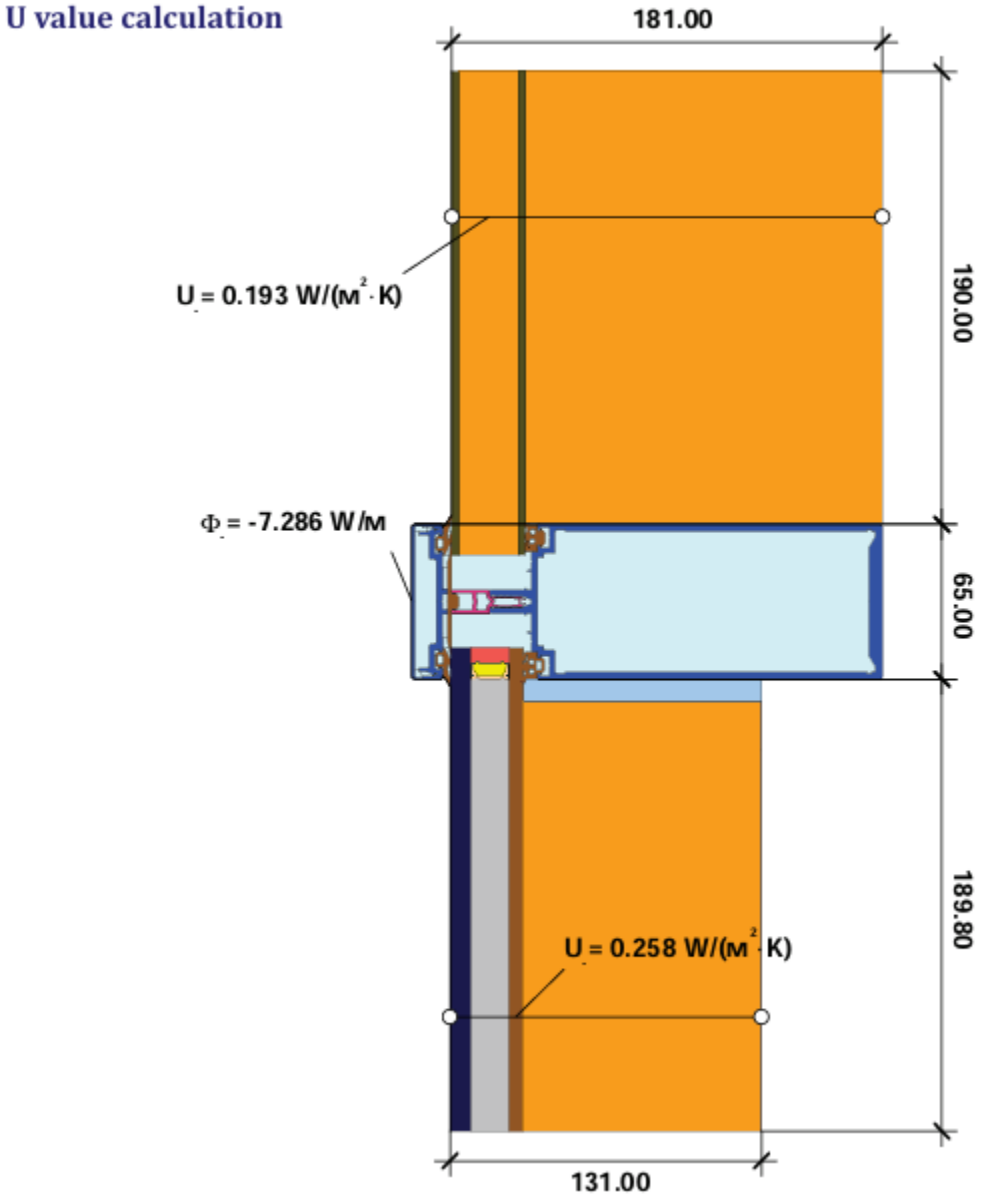
Frame heat transfer:

$$Q_f = Q_{tot} - Q_g - Q_g' = 7.286 - 0.7334 - 0.9804 = 5.5722 \text{ W}$$

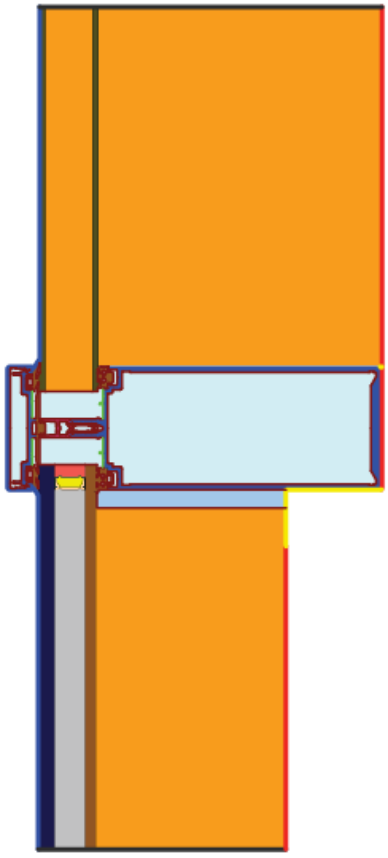
Equivalent Frame U Value:

$$U_f = \frac{Q_f}{A_f \times \Delta T} = \frac{5.5722}{0.065 \times 20} = 4.286 \text{ W/m2K}$$

Final Uf = 4.286 W/m²K



Material Thermal Conductivity Diagram



Material	λ[W/(m·K)]	ε
Aluminium (Si Alloys)	160.000	0.300
Aluminium (Si Alloys)	160.000	0.900
Aluminium alloy	160.000	0.900
Butyl	0.240	
EPDM (ethylene propylene diene monomer)	0.250	0.900
Edelstahl	17.000	
Gasfilling(2)	0.020	
Mineral wool	0.035	0.900
Polyamid (nylon)	0.250	0.900
Polycarbonat	0.240	
Polysulfid	0.400	0.900
Silicagel	0.130	
Slightly ventilated air cavity **		
Soda lime glass	1.000	0.900
Unventilated air cavity **		

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Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
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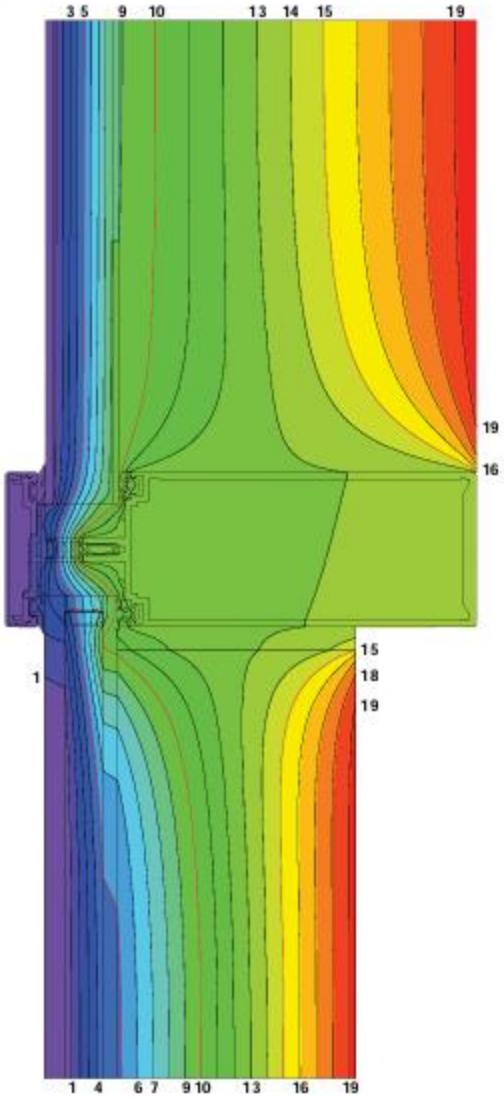
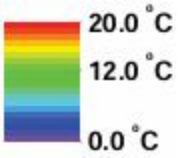
Symmetry/Model section	0.000			

Thermal Gradient Diagram





Heat Flux Diagram