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flixo Version 5: fully validated thermal bridge software

flixo Version 5 fulfills all validation samples of following European standards:

- EN ISO 10211: 2007 (Thermal bridges in building construction – Heat flows and surface temperatures – detailed calculations)
- EN ISO 10077-2: 2003 (Thermal performance of windows, doors and shutters – Calculation of thermal transmittance – Part 2: Numerical method for frames)

Until now, these are the two only standards containing validation samples for thermal simulation software in the building area. Attached you find all calculations of the validation samples done by flixo Version 5 as well the summary of all results and the comparison with the standards.

Until now there exists no further procedure or institute which certifies or labels European wide or world wide thermal bridge software. The certification is only done by fulfilling all criteria of the validation samples.

As our software is fulfilling all mentioned validation samples, ***flixo*** Version 5 is a fully, concerning the standards validated thermal bridge simulation software and can be used accordingly.

Zurich, 17.3.2009,

Walter Schmidli

CEO, Infomind GmbH

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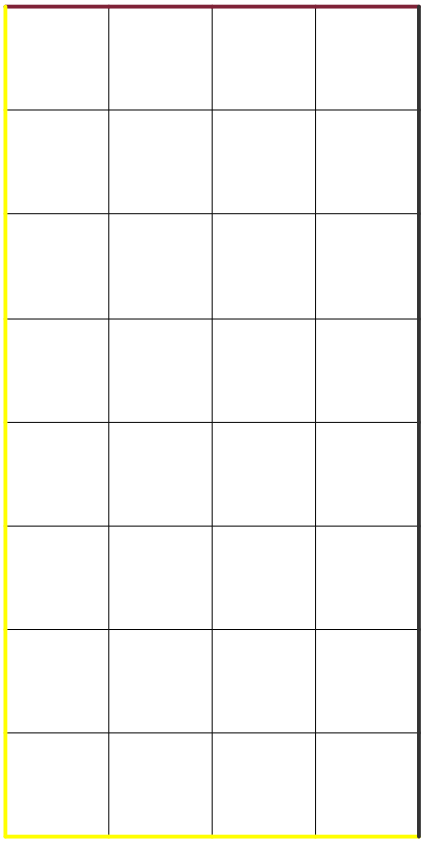

Name	λ[W/(m·K)]
Material1	1.000
Material1A	1.000

Name	q[W/m²]	θ[°C]	h[W/(m²·K)]
0 Degree		0.000	
20 Degree		20.000	
Adiabatic	0.000		

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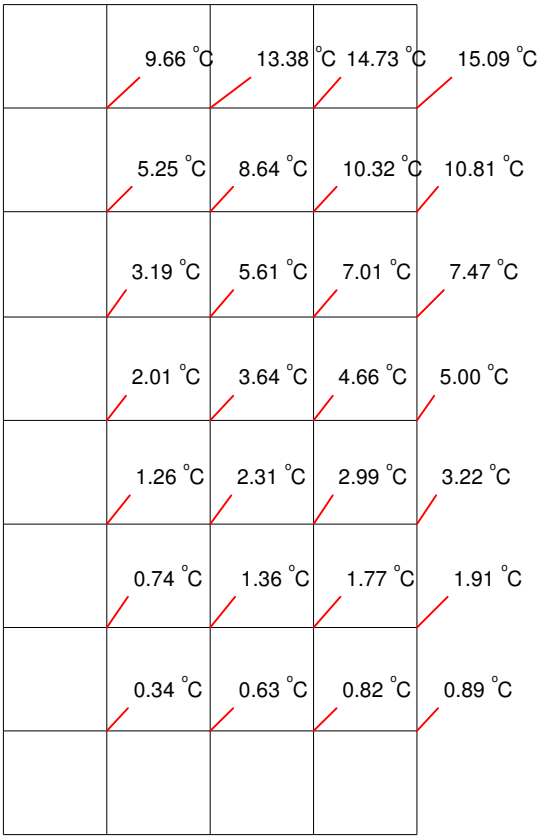

Summary

flixo fullfills the criterias for the first validation sample of EN ISO 10211: 2007
- The max. difference between the calculated temperatures and the corresponding temperatures of the Standard is 0.05°C. Therefore all temperatures are in the given acceptance range of 0.1°C.

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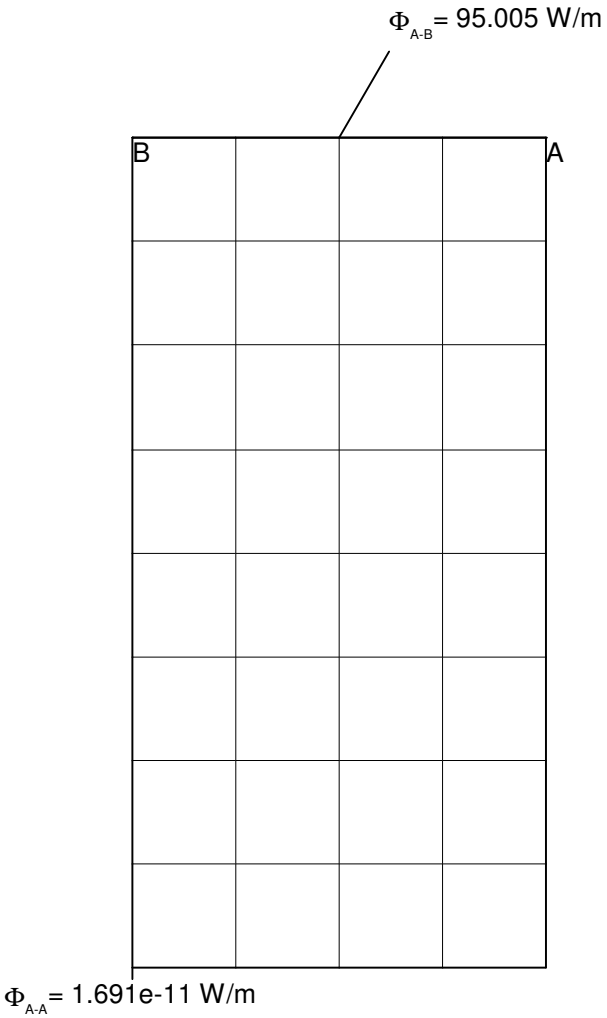

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Name	λ[W/(m·K)]
Material 1	1.150
Material 2	0.120
Material 3	0.029
Material 4	230.000

Name	q[W/m²]	θ[°C]	R[(m²·K)/W]
0/0.06		0.000	0.060
20/0.11		20.000	0.110
Adiabatic	0.000		

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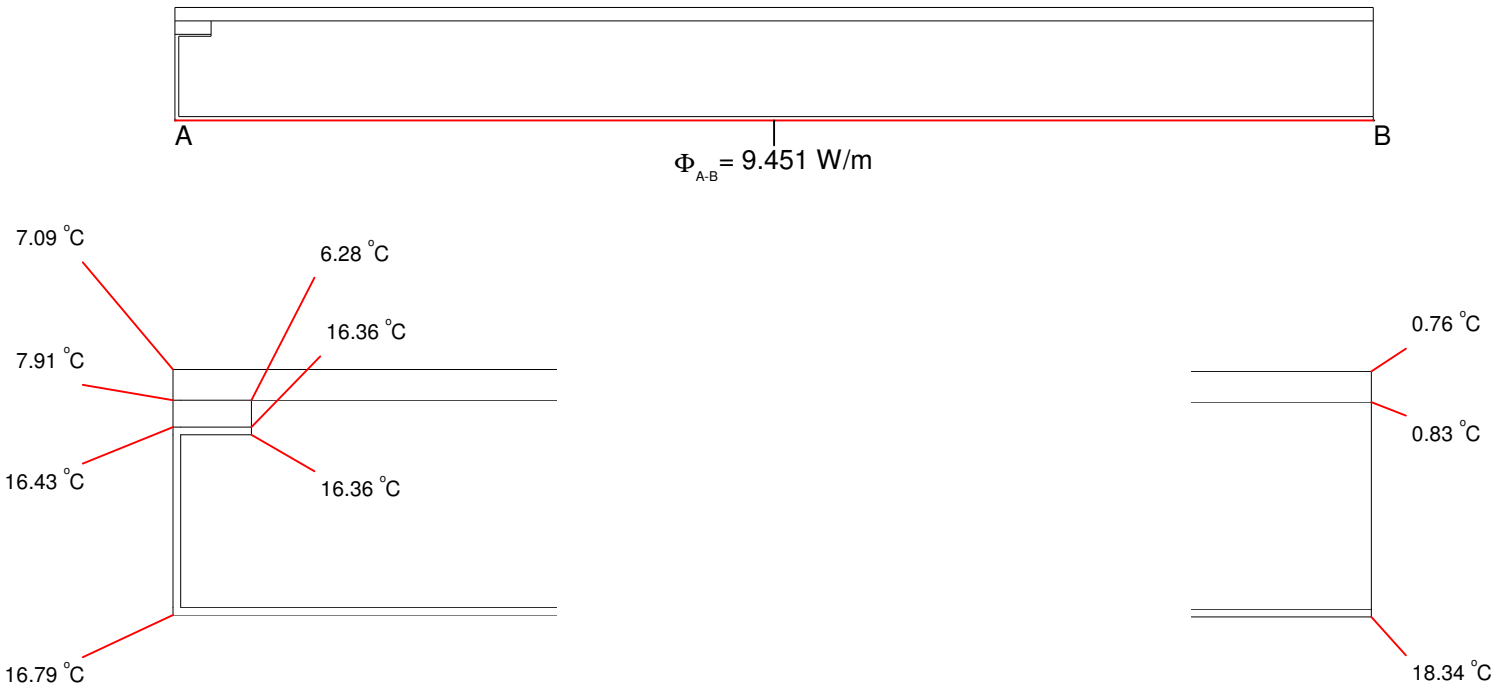

Summary

flixo fullfills all criterias for the second validation sample of EN ISO 10211: 2007
- The max. difference between the calculated temperatures and the corresponding temperatures of the Standard is 0.06°C. Therefore all temperatures are in the given acceptance range of 0.1°C.
- The difference between the calculated heat flux and the given heat flux of the Standard is 0.049 W/m. The heat flux is therefore in the given acceptance range of 0.1 W/m.

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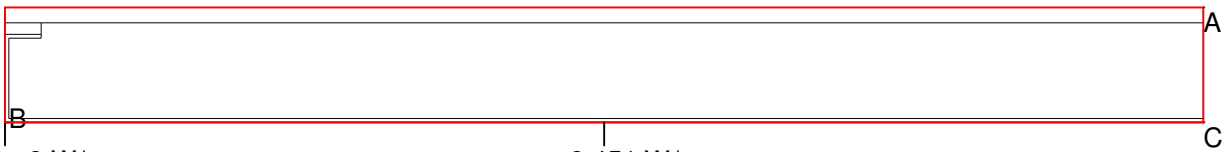

$\Phi_{A\text{-}A}$ = 5.2e-9 W/m

$\Phi_{B\text{-}C}$ = 9.451 W/m

EN ISO 10077-2:2003

Samples

Standard					*flixo*						
Name	Standard	min	max	Uf/Psi	Name	Q	L	bf	Up/Ug	Uf/Psi	Rel. Conductance Diff.
D.1	0.550	**0.534**	**0.567**	3.220	EN_IS0_10077-2_D1_EN	11.127	**0.556**	0.1100	1.0310	3.277	**1.2%**
D.2	0.263	**0.255**	**0.271**	1.440	EN_IS0_10077-2_D2_EN	5.204	**0.260**	0.1100	0.5470	1.421	**-1.1%**
D.3	0.424	**0.411**	**0.437**	2.070	EN_IS0_10077-2_D3_EN	8.273	**0.414**	0.1100	1.0310	1.980	**-2.4%**
D.4	0.346	**0.336**	**0.356**	1.360	EN_IS0_10077-2_D4_EN	6.871	**0.344**	0.1100	1.0310	1.342	**-0.7%**
D.5	0.408	**0.396**	**0.420**	2.080	EN_IS0_10077-2_D5_EN	7.952	**0.398**	0.0890	1.1690	1.972	**-2.5%**
D.6	0.659	**0.639**	**0.679**	4.670	EN_IS0_10077-2_D6_EN	13.324	**0.666**	0.0950	1.1310	4.751	**1.1%**
D.7	0.285	**0.276**	**0.294**	1.310	EN_IS0_10077-2_D7_EN	5.648	**0.282**	0.0480	1.1690	1.256	**-0.9%**
D.8	0.181	**0.176**	**0.186**	1.030	EN_IS0_10077-2_D8_EN	3.568	**0.178**	0.1770		1.008	**-1.4%**
D.9	0.207	**0.201**	**0.213**	3.640	EN_IS0_10077-2_D9_EN	4.118	**0.206**	0.0570		3.612	**-0.5%**
D.10	0.481	**0.467**	**0.495**	0.084	EN_IS0_10077-2_D10_EN	9.600	**0.480**	0.1100	1.3053	0.084	**-0.2%**

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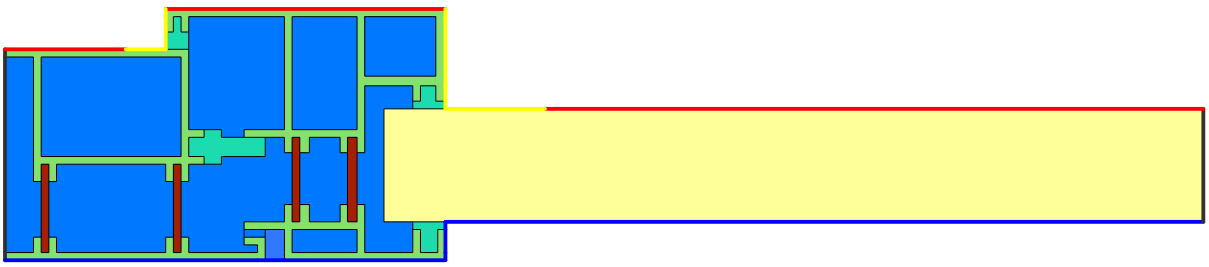

Name	λ[W/(m·K)]
Aluminium (Si alloys)	160.000
EPDM (ethylene propylene diene monomer)	0.250
Panel	0.035
Polyamid 6.6 with 25% glassfibre	0.300
Slightly ventilated air cavity, Eps=0.9	
Unventilated air cavity, Eps=0.9	

Name	q[W/m²]	θ[°C]	R[(m²·K)/W]
Exterior, frame		0.000	0.040
Interior, frame, normal		20.000	0.130
Interior, frame, reduced		20.000	0.200
Symmetry/Model section	0.000		

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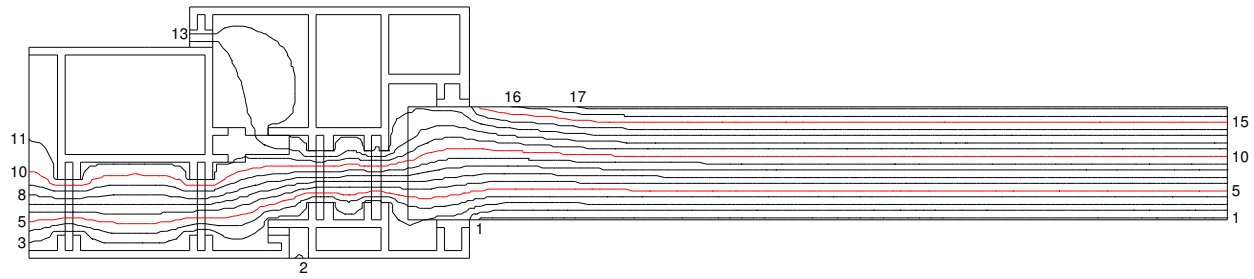

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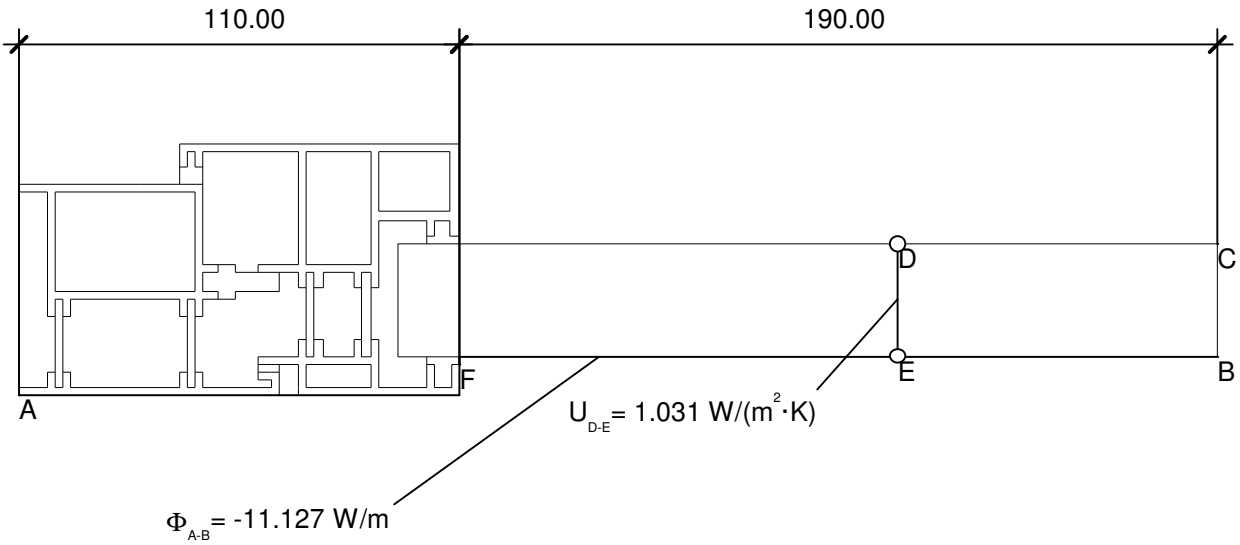

$$U_{fF} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{-11.127}{-20.000} - 1.031 \cdot 0.190}{0.110} = 3.28 \text{ W/(m}^2\text{·K)}$$

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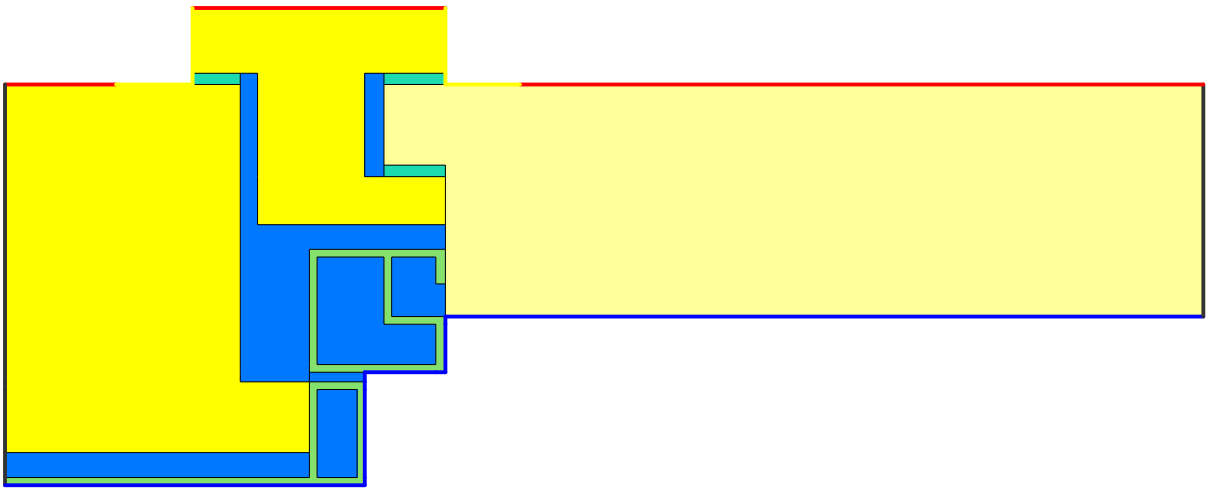

Name	λ[W/(m·K)]
Aluminium (Si alloys)	160.000
EPDM (ethylene propylene diene monomer)	0.250
Panel	0.035
Softwood (typical construction timber)	0.130
Unventilated air cavity, Eps=0.9	

Name	q[W/m²]	θ[°C]	R[(m²·K)/W]
Exterior, frame		0.000	0.040
Interior, frame, normal		20.000	0.130
Interior, frame, reduced		20.000	0.200
Symmetry/Model section	0.000		

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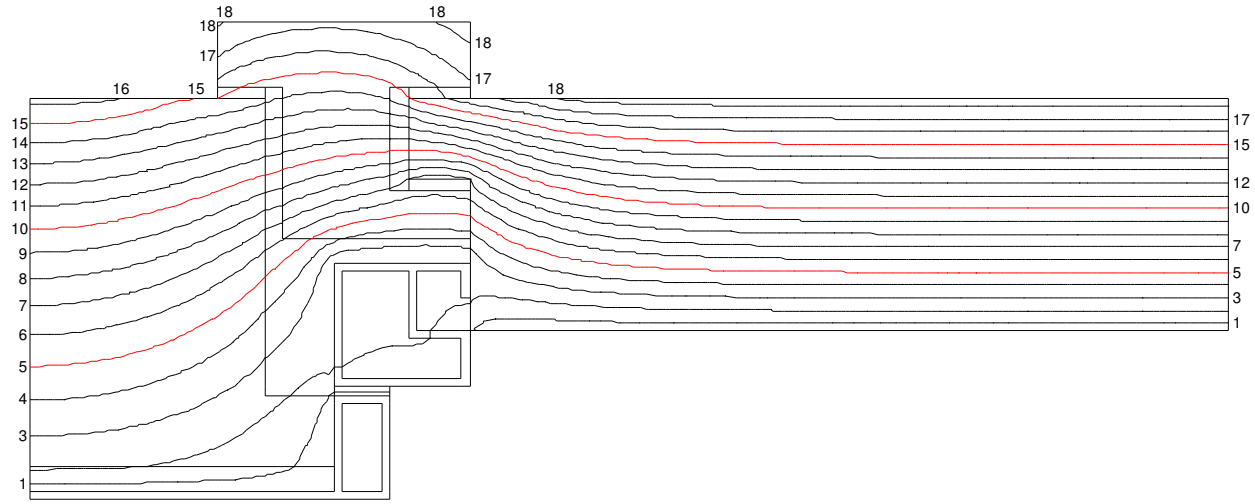

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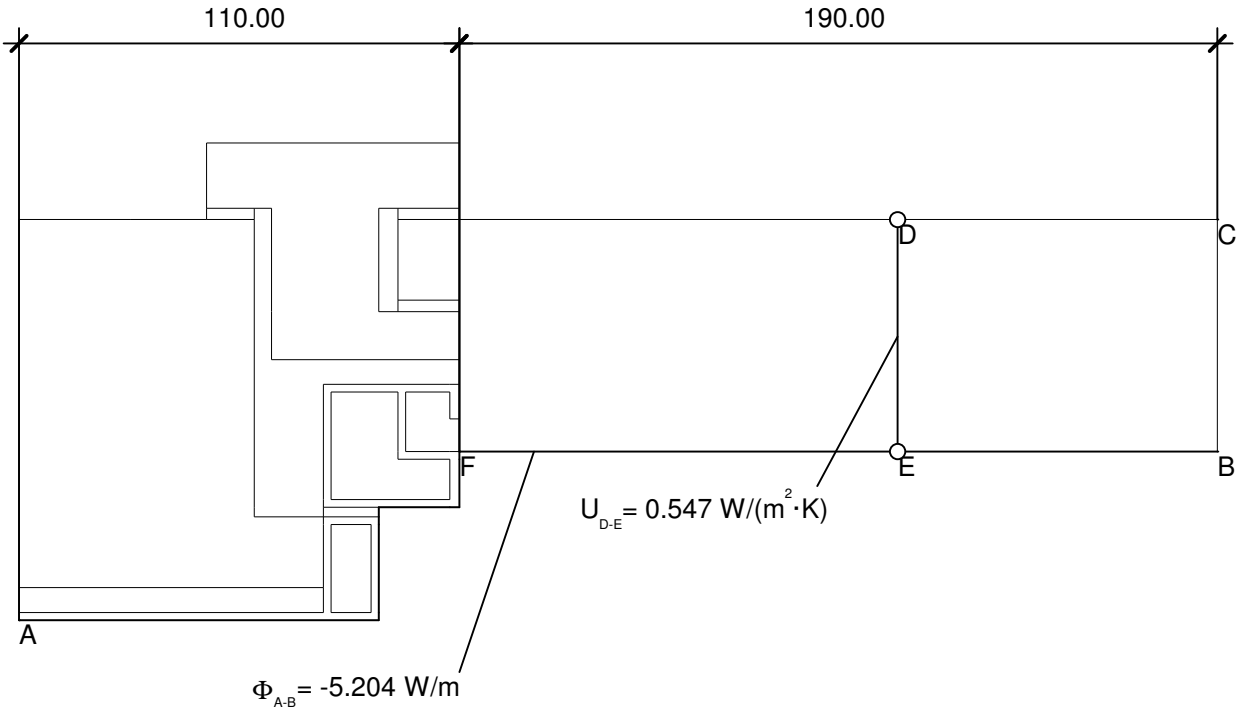

$$U_{fF} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{-5.204}{-20.000} - 0.547 \cdot 0.190}{0.110} = 1.42 \text{ W/(m}^2\text{·K)}$$

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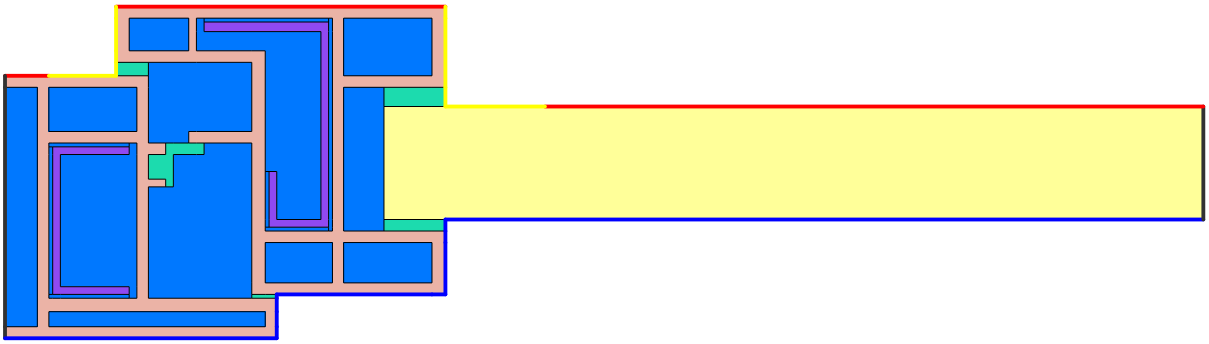

Name	λ[W/(m·K)]
EPDM (ethylene propylene diene monomer)	0.250
PVC (polyvinylchloride), rigid	0.170
Panel	0.035
Steel	50.000
Unventilated air cavity, Eps=0.9	

Name	q[W/m²]	θ[°C]	R[(m²·K)/W]
Exterior, frame		0.000	0.040
Interior, frame, normal		20.000	0.130
Interior, frame, reduced		20.000	0.200
Symmetry/Model section	0.000		

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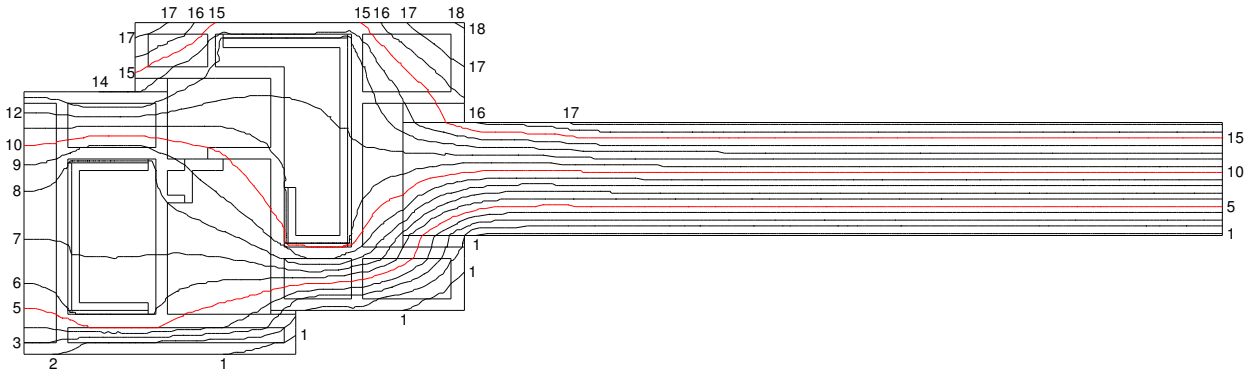

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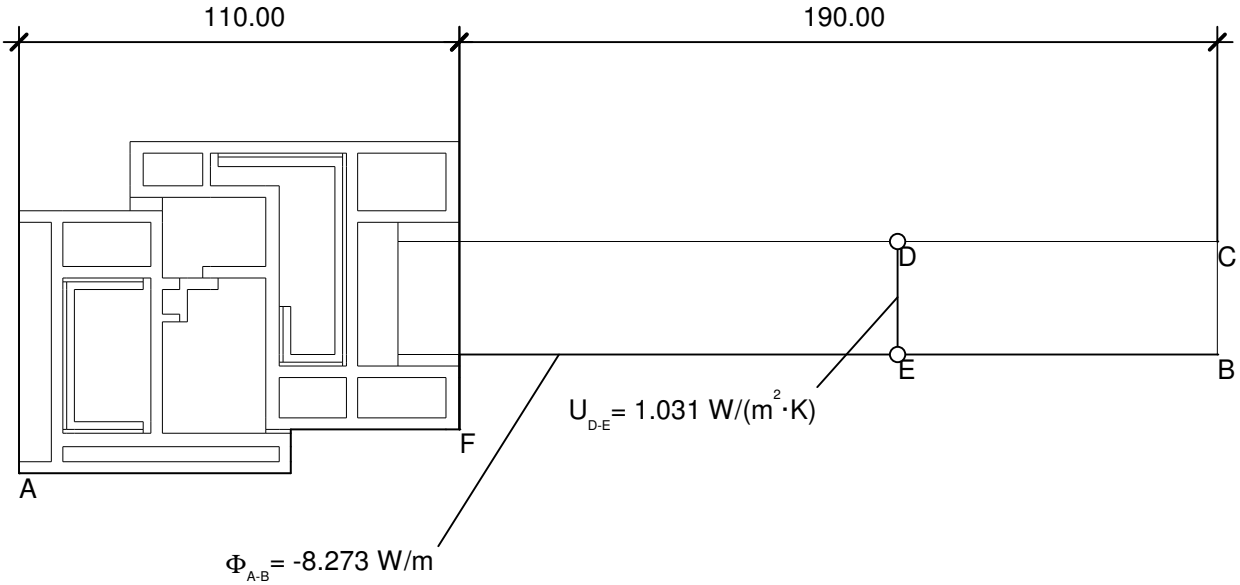

$$U_{f\,F} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{-8.273}{-20.000} - 1.031 \cdot 0.190}{0.110} = 1.98\ \mathrm{W/(m^2 \cdot K)}$$

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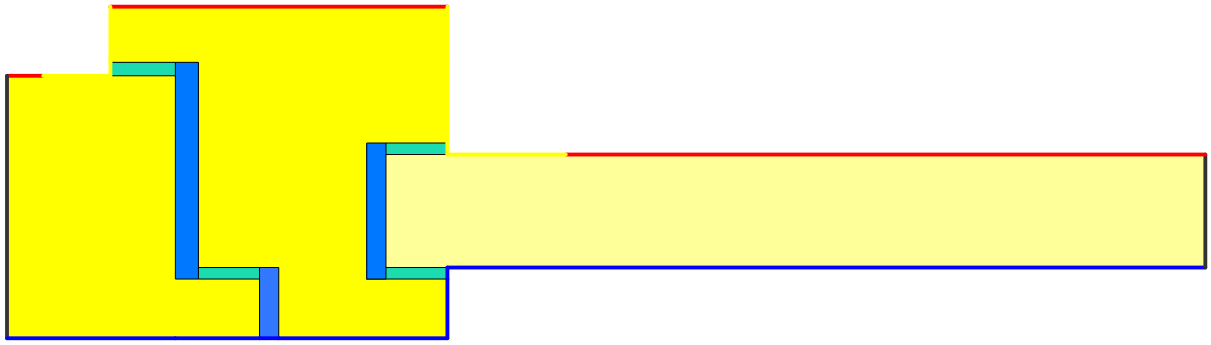

Name	λ[W/(m·K)]
Belüftete Hohlräume, Eps=0.9	
EPDM (Ethylen Propylen Dien Monomer)	0.250
Maske	0.035
Unbelüftete Hohlräume, Eps=0.9	
Weich-Holz (typisches Bauholz)	0.130

Name	q[W/m²]	θ[°C]	R[(m²·K)/W]
Exterior, frame		0.000	0.040
Interior, frame, normal		20.000	0.130
Interior, frame, reduced		20.000	0.200
Symmetry/Model section	0.000		

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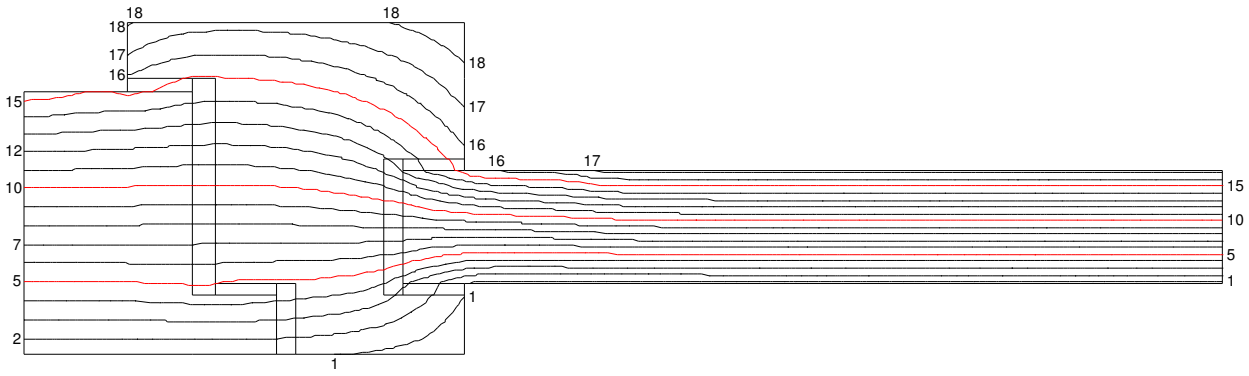

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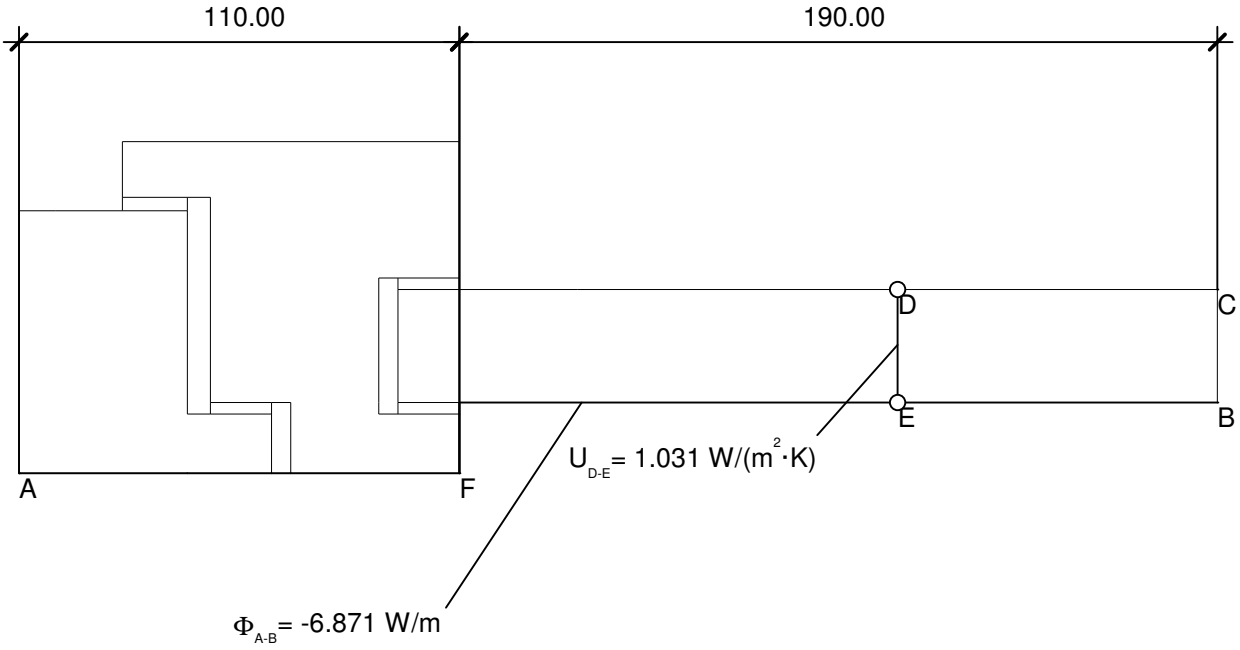

$$U_{fF} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{-6.871}{-20.000} - 1.031 \cdot 0.190}{0.110} = 1.34 \text{ W/(m}^2\text{·K)}$$

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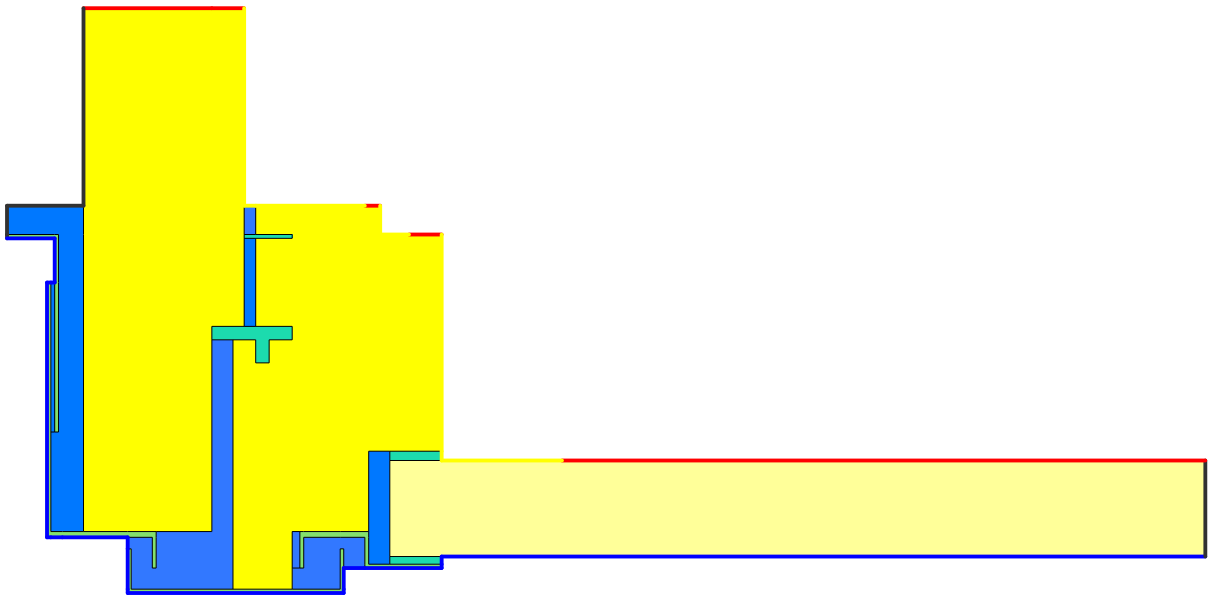

Name	λ[W/(m·K)]
Aluminium (Si alloys)	160.000
EPDM (ethylene propylene diene monomer)	0.250
Panel	0.035
Slightly ventilated air cavity, Eps=0.9	
Softwood (typical construction timber)	0.130
Unventilated air cavity, Eps=0.9	

Name	q[W/m²]	θ[°C]	R[(m²·K)/W]
Exterior, frame		0.000	0.040
Interior, frame, normal		20.000	0.130
Interior, frame, reduced		20.000	0.200
Symmetry/Model section	0.000		

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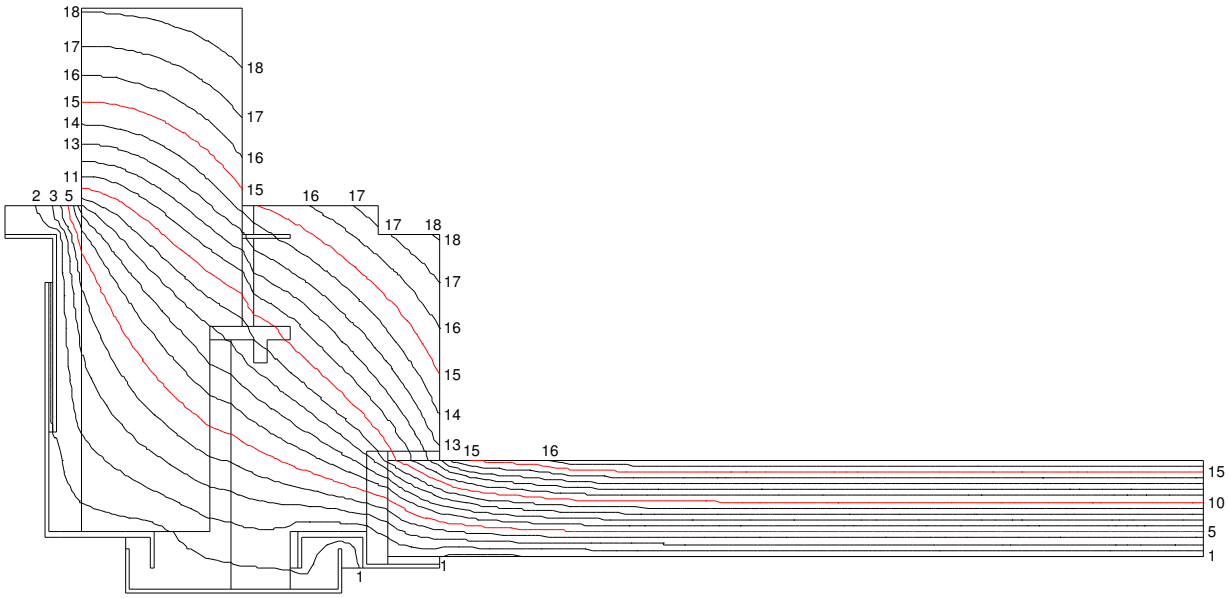

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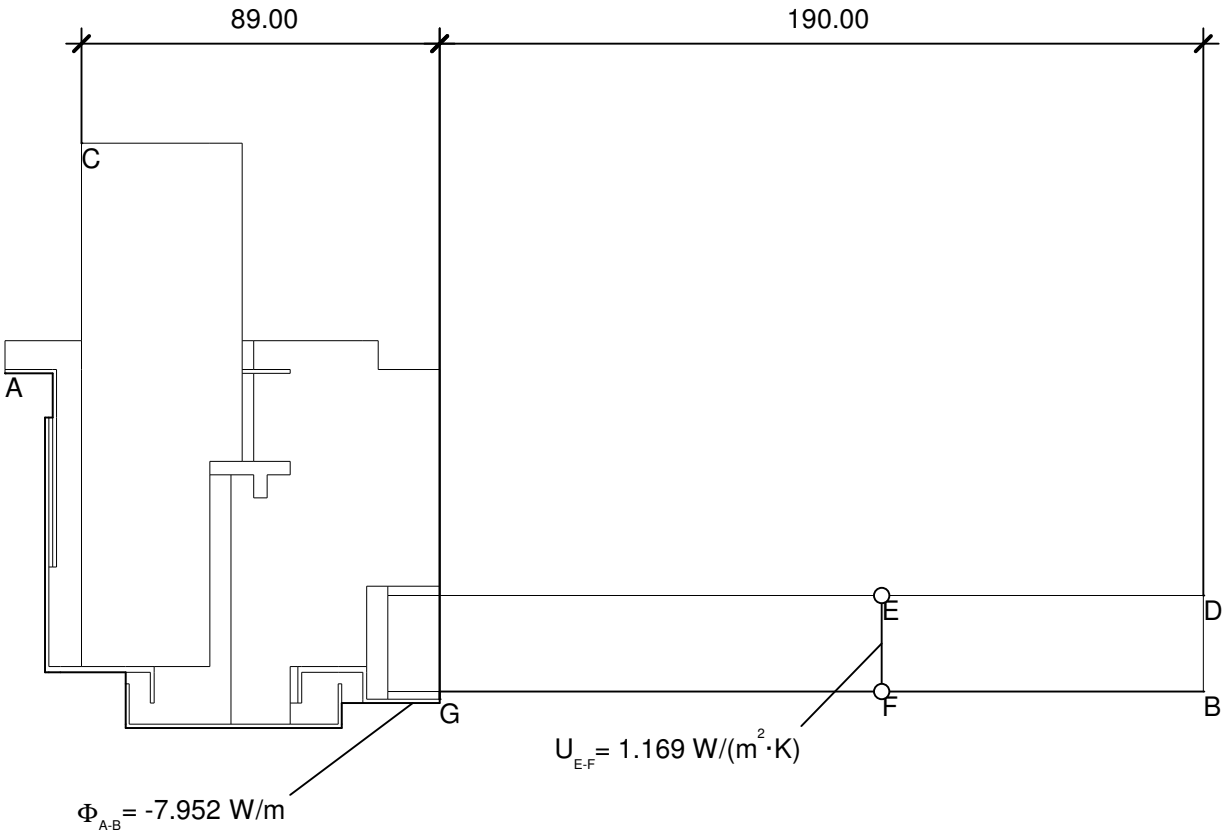

$$U_{fG} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{-7.952}{-20.000} - 1.169 \cdot 0.190}{0.089} = 1.97 \text{ W/(m}^2\text{·K)}$$

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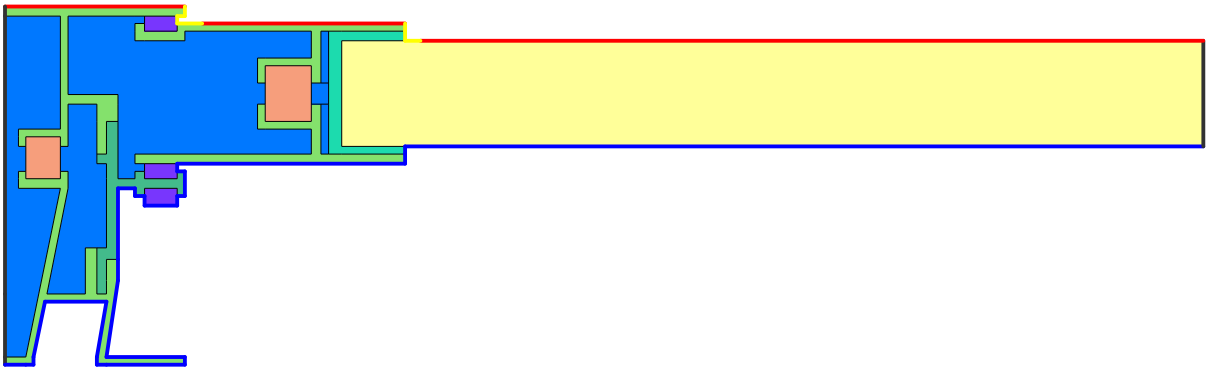

Name	λ[W/(m·K)]
Aluminium (Si alloys)	160.000
EPDM (ethylene propylene diene monomer)	0.250
Mohair (polyester) sweep	0.140
PU (polyurethane), rigid	0.250
Panel	0.035
Polyamid (nylon)	0.250
Unventilated air cavity, Eps=0.9	

Name	q[W/m²]	θ[°C]	R[(m²·K)/W]
Exterior, frame		0.000	0.040
Interior, frame, normal		20.000	0.130
Interior, frame, reduced		20.000	0.200
Symmetry/Model section	0.000		

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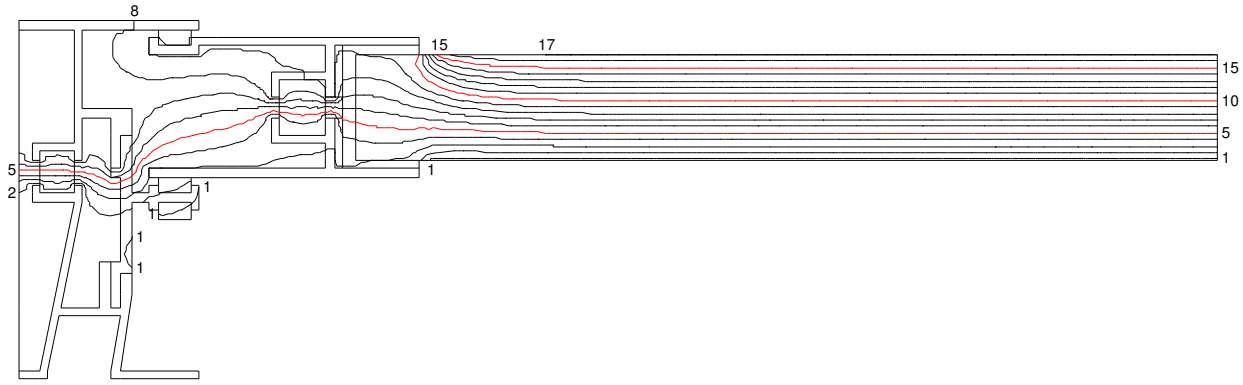

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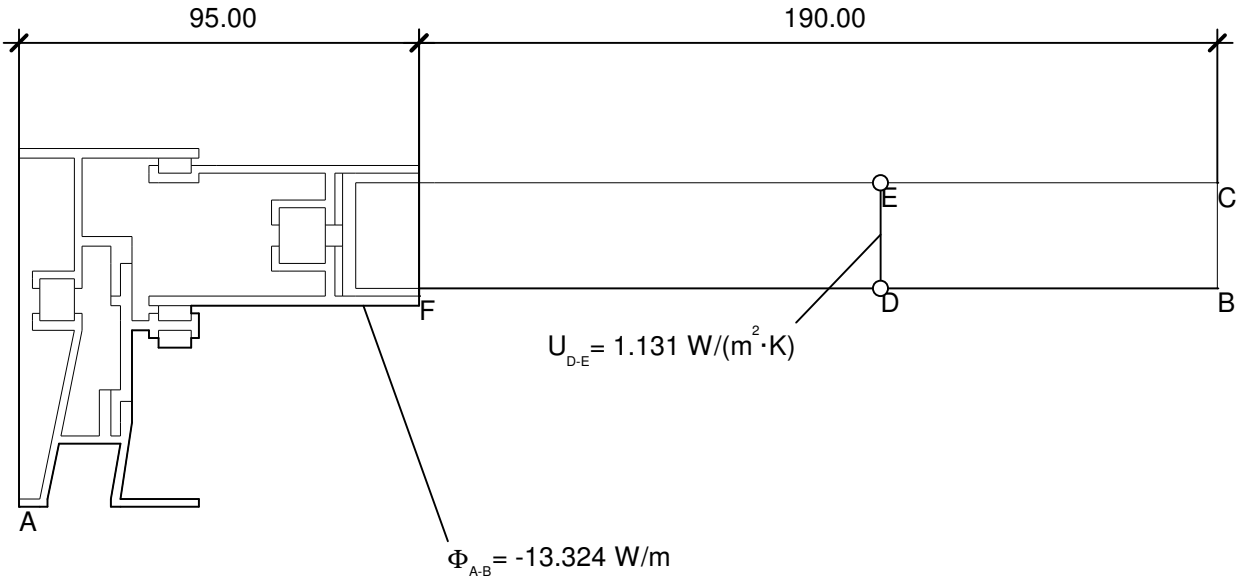

$$U_{fF} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{-13.324}{-20.000} - 1.131 \cdot 0.190}{0.095} = 4.75 \text{ W/(m}^2\text{·K)}$$

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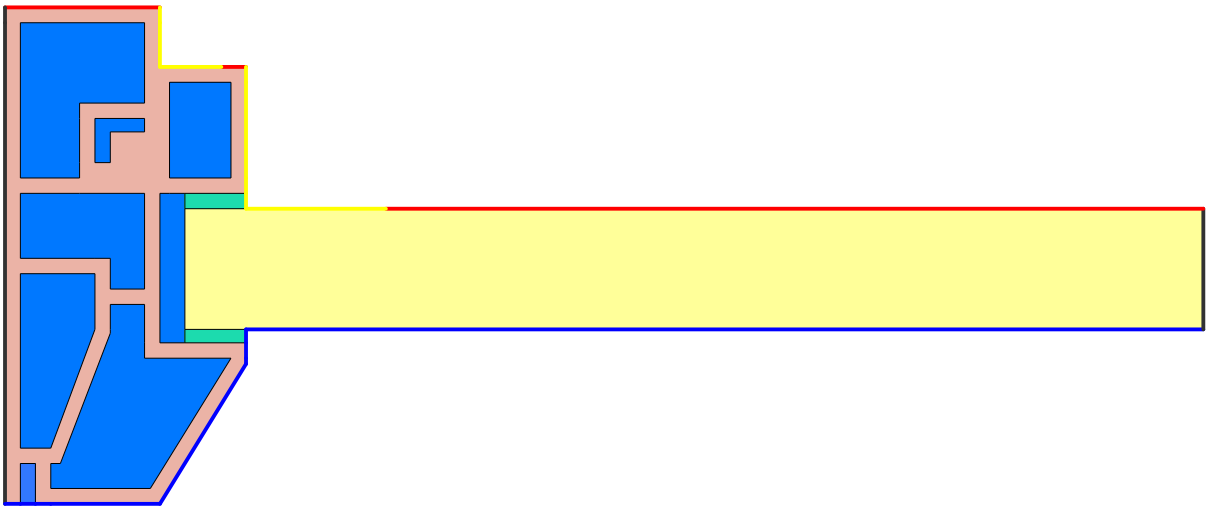

Name	λ[W/(m·K)]
EPDM (ethylene propylene diene monomer)	0.250
PVC (polyvinylchloride), rigid	0.170
Panel	0.035
Slightly ventilated air cavity, Eps=0.9	
Unventilated air cavity, Eps=0.9	

Name	q[W/m²]	θ[°C]	R[(m²·K)/W]
Exterior, frame		0.000	0.040
Interior, frame, normal		20.000	0.130
Interior, frame, reduced		20.000	0.200
Symmetry/Model section	0.000		

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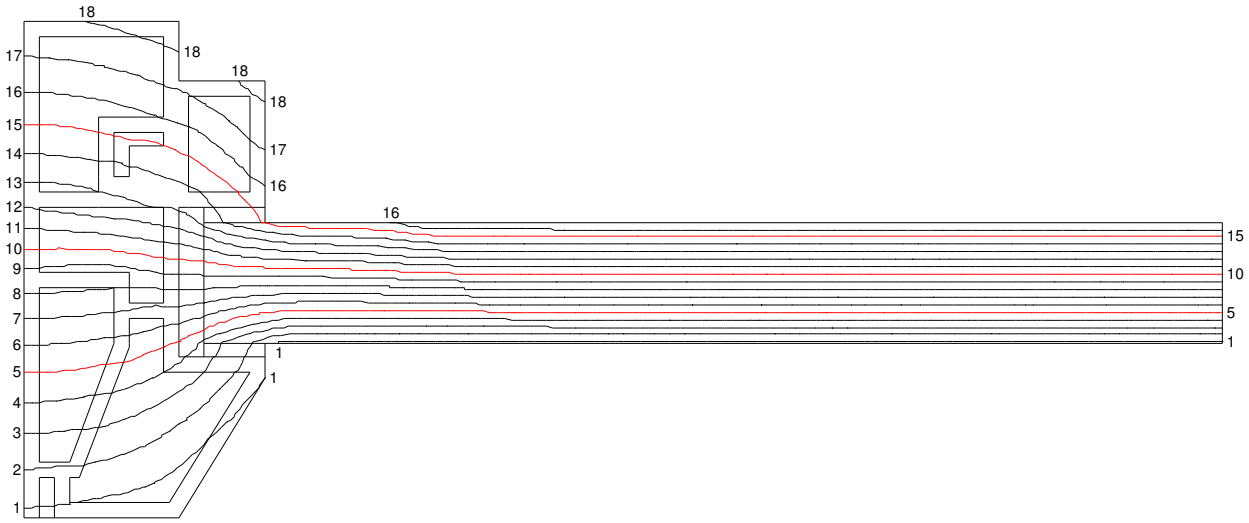

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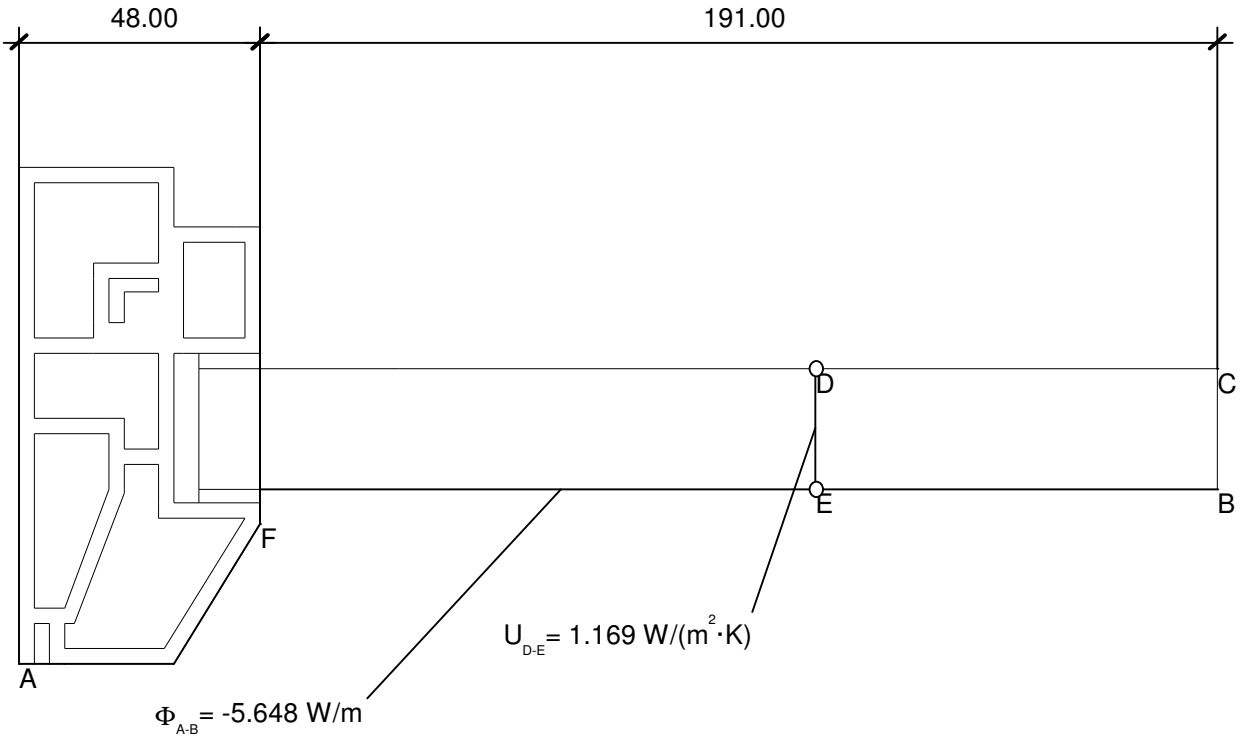

$$U_{fF} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{-5.648}{-20.000} - 1.169 \cdot 0.191}{0.048} = 1.23 \text{ W/(m}^2\text{·K)}$$

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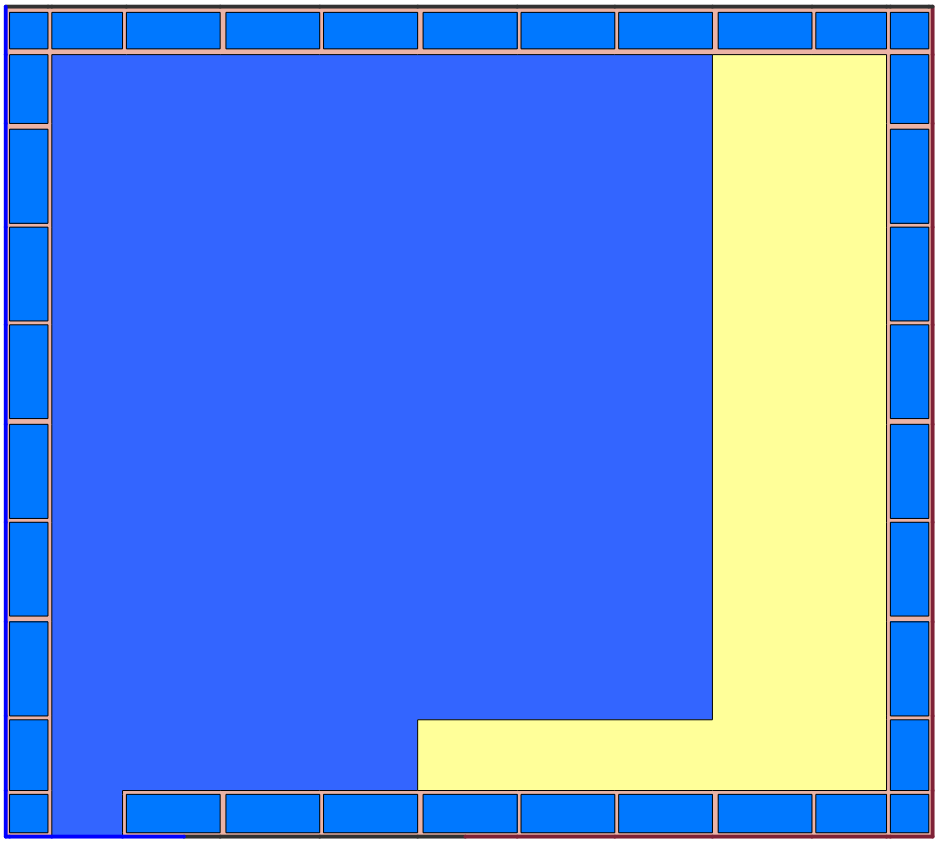

Name	λ[W/(m·K)]
PVC (polyvinylchloride), rigid	0.170
Panel	0.035
Slightly ventilated air cavity, Eps=0.9	
Unventilated air cavity, Eps=0.9	

Name	q[W/m²]	θ[°C]	R[(m²·K)/W]
Exterior, frame		0.000	0.040
Interior, normal		20.000	0.130
Symmetry/Model section	0.000		

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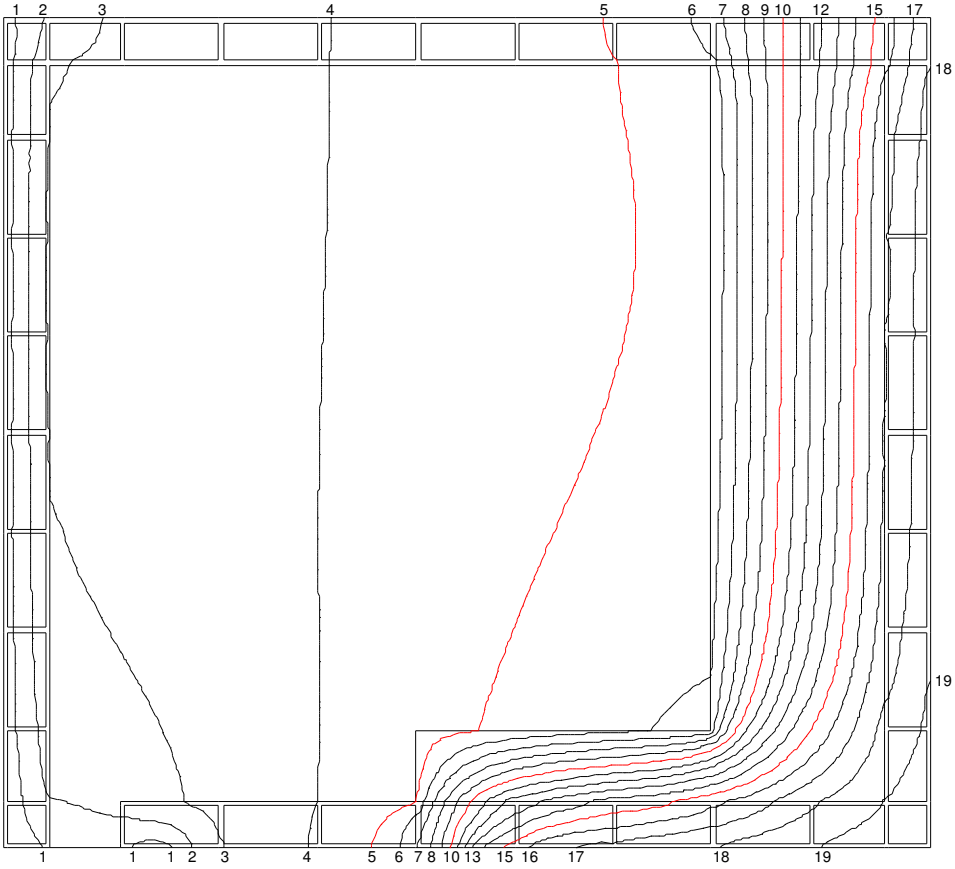

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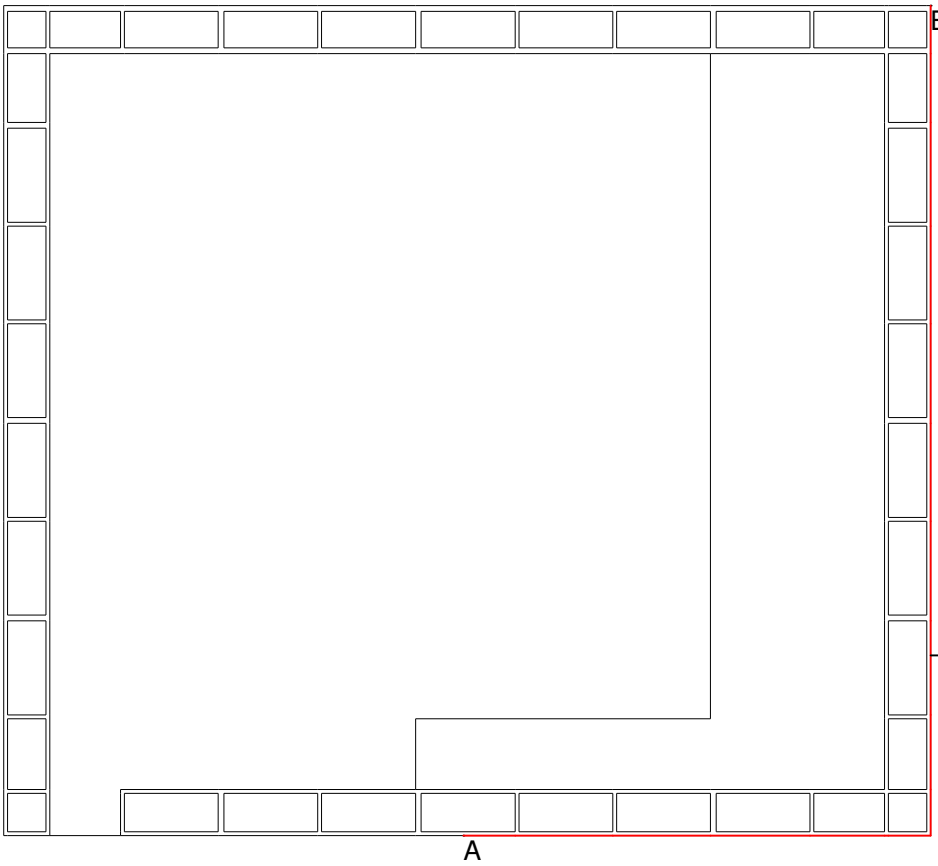

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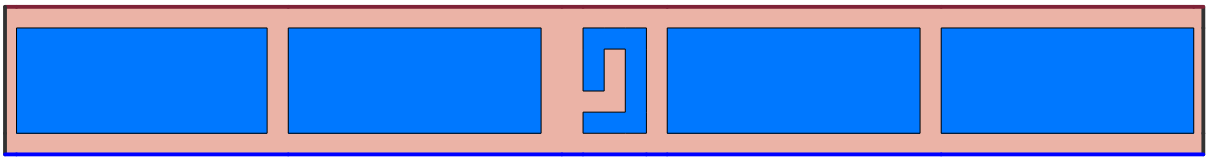

Name	λ[W/(m·K)]
PVC (polyvinylchloride), rigid	0.170
Unventilated air cavity, Eps=0.9	

Name	q[W/m²]	θ[°C]	R[(m²·K)/W]
Exterior, frame		0.000	0.040
Interior, normal		20.000	0.130
Symmetry/Model section	0.000		

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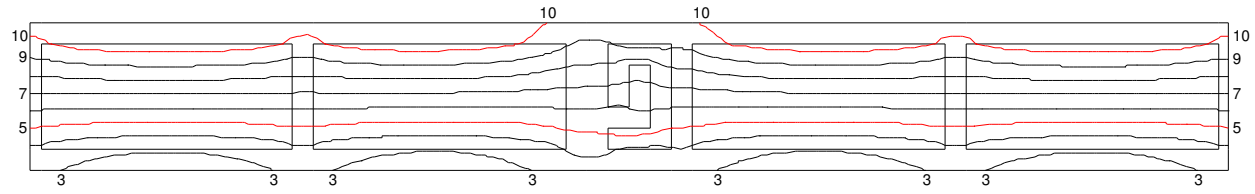

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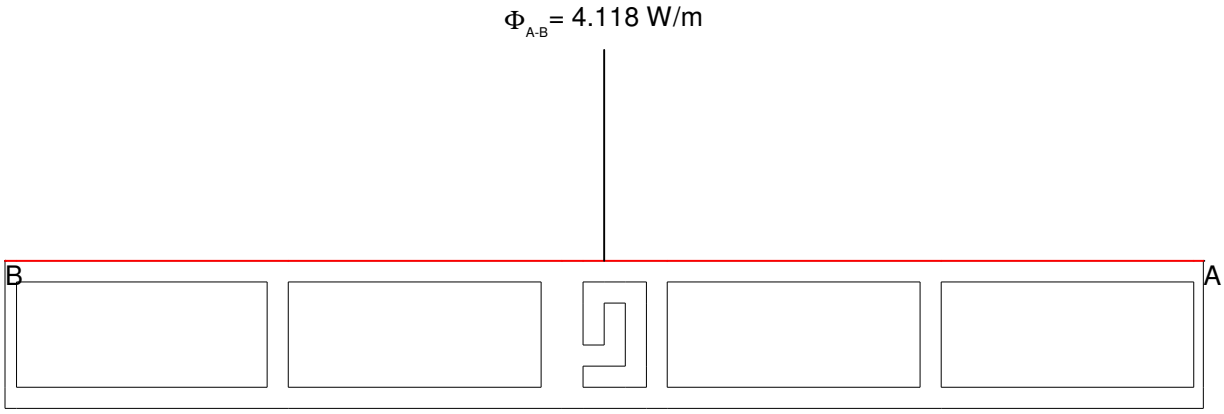

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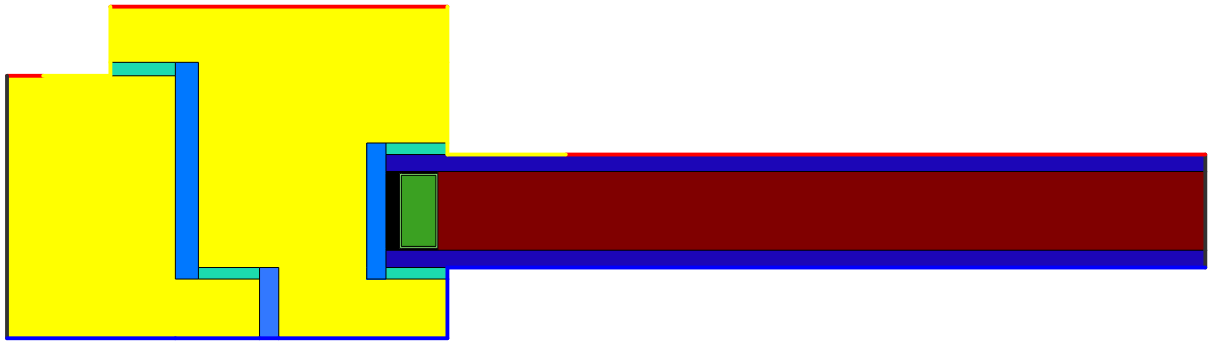

Name	λ[W/(m·K)]
Aluminium (Si alloys)	160.000
EPDM (ethylene propylene diene monomer)	0.250
Glasin filling	0.034
Polysulfide (1)	0.400
Silica gel (dessicant) (1)	0.130
Slightly ventilated air cavity, Eps=0.9	
Soda lime glass	1.000
Softwood (typical construction timber)	0.130
Unventilated air cavity, Eps=0.9	

Name	q[W/m²]	θ[°C]	R[(m²·K)/W]
Exterior, frame		0.000	0.040
Interior, frame, normal		20.000	0.130
Interior, frame, reduced		20.000	0.200
Symmetry/Model section	0.000		

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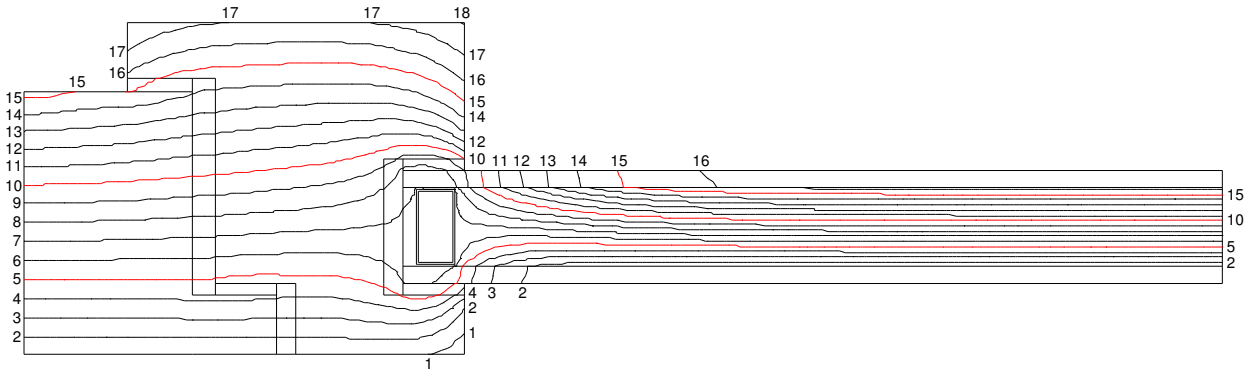

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