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flixo Version 8: fully validated thermal bridge software

flixo version 8 and all previous versions fulfill all validation samples of following European standards:

- EN ISO 10211: 2017 (Thermal bridges in building construction – Heat flows and surface temperatures – detailed calculations)
- EN ISO 10077-2: 2017 (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 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 8 is a fully, concerning the standards validated thermal bridge simulation software and can be used accordingly.

Zurich, 14.4.2023

Walter Schmidli

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Summary

flixo pro 8.2.1173.1

EN ISO 10077-2:2017, 6.4.2

flixo satisfies all criterias of the validation samples of Annex A EN ISO 10211:2017 for 2 dimensional thermal bridge softwares. Below you find the compilation of the results:

Example A.1.2

All temperatures calculated by flixo are identical to the ones of the standard.

Example A.1.3

All temperatures as well the heat flow calculated by flixo are identical to the ones of the standard.

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Example A.1.2

flixo pro 8.2.1173.1

EN ISO 10077-2:2017, 6.4.2

Material	λ[W/(m·K)]
Material 1	1.000
Material 1A	1.000

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]
0 degree		0.000	
20 degree		20.000	
Symmetry/Model section	0.000		

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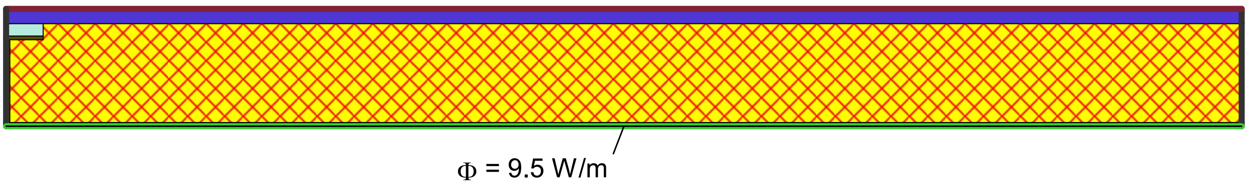
Example A.1.3

flixo pro 8.2.1173.1

EN ISO 10077-2:2017, 6.4.2



	Material	λ[W/(m·K)]
	Aluminium	230.000
	Concrete, medium density 1800 kg/m3	1.150
	Insulation	0.029
	Timber 450 kg/m3 (softwoods)	0.120

	Boundary Condition	q[W/m^2]	θ[°C]	R[(m^2·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 pro 8.2.1173.1

EN ISO 10077-2:2017, 6.4.2

flixo satisfies all criterias of the validation samples of Annex G EN ISO 10077-2:2017. Below you find the compilation of the results:

Example G.1

	EN ISO 10077-2	flixo	Diff.
A	44.12	44.12	0.0%
B	5.15	5.15	0.0%
C	8.29	8.29	0.0%
D	3.42	3.42	0.0%

All heat flows calculated with flixo are identical with the ones of the standard.

Example G.2

	EN ISO 10077-2	flixo	Diff.
S_{1i}	4.67	4.68	0.01
S_{2i}	7.25	7.26	0.01
S_{3i}	9.18	9.19	0.01
S_{4i}	13.89	13.87	0.02

The maximal difference of temperatures calculated by flixo compared to the ones of the standard is 0.02°. This is smaller than the maximal accepted difference of 0.2°.

Example G.3

All temperatures calculated by flixo are identical to the ones of the standard.

Example G.4

	EN ISO 10077-2	flixo	Diff
Φ	0.826	0.832	0.7%

The relative difference of the heat flow calculated by flixo compared to the one of the standard is 0.7%. This is smaller than the maximal accepted difference of 3%.

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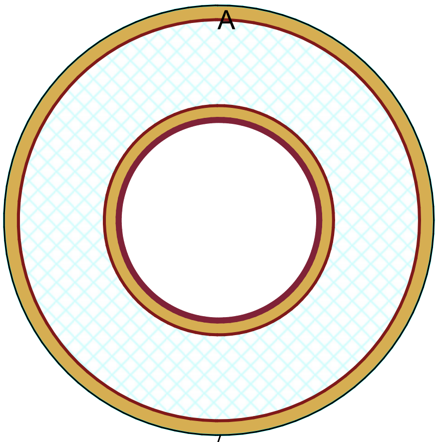
Example G.1

flixo pro 8.2.1173.1

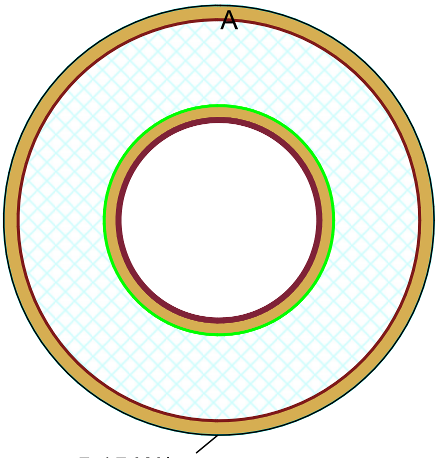
EN ISO 10077-2:2017, 6.4.2

Variant A



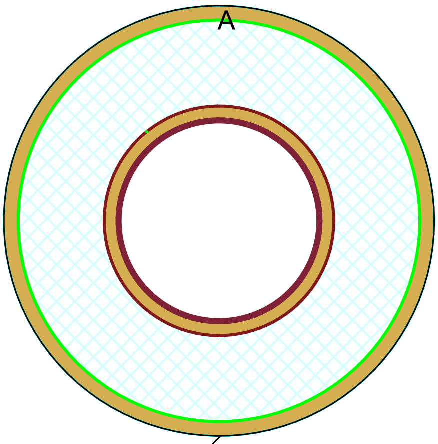
$\Phi_{A\text{-}A}$ = -44.12 W/m

Variant B



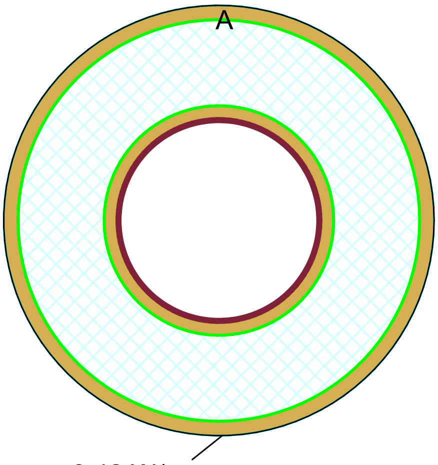
$\Phi_{A\text{-}A}$ = -5.15 W/m

Variant C



$\Phi_{A\text{-}A}$ = -8.29 W/m

Variant D



$\Phi_{A\text{-}A}$ = -3.42 W/m

Material	λ[W/(m·K)]	ε
Perfect Conductor	99999999.000	0.900
Perfect Conductor	99999999.000	0.100
Vacuum		

Boundary Condition	$q[W/m^2]$	$\theta[^{\circ}C]$	$R[(m^2 \cdot K)/W]$	ε
0 degree		0.000		
20 degree		20.000		
Epsilon 0.1				0.100
Epsilon 0.9				0.900

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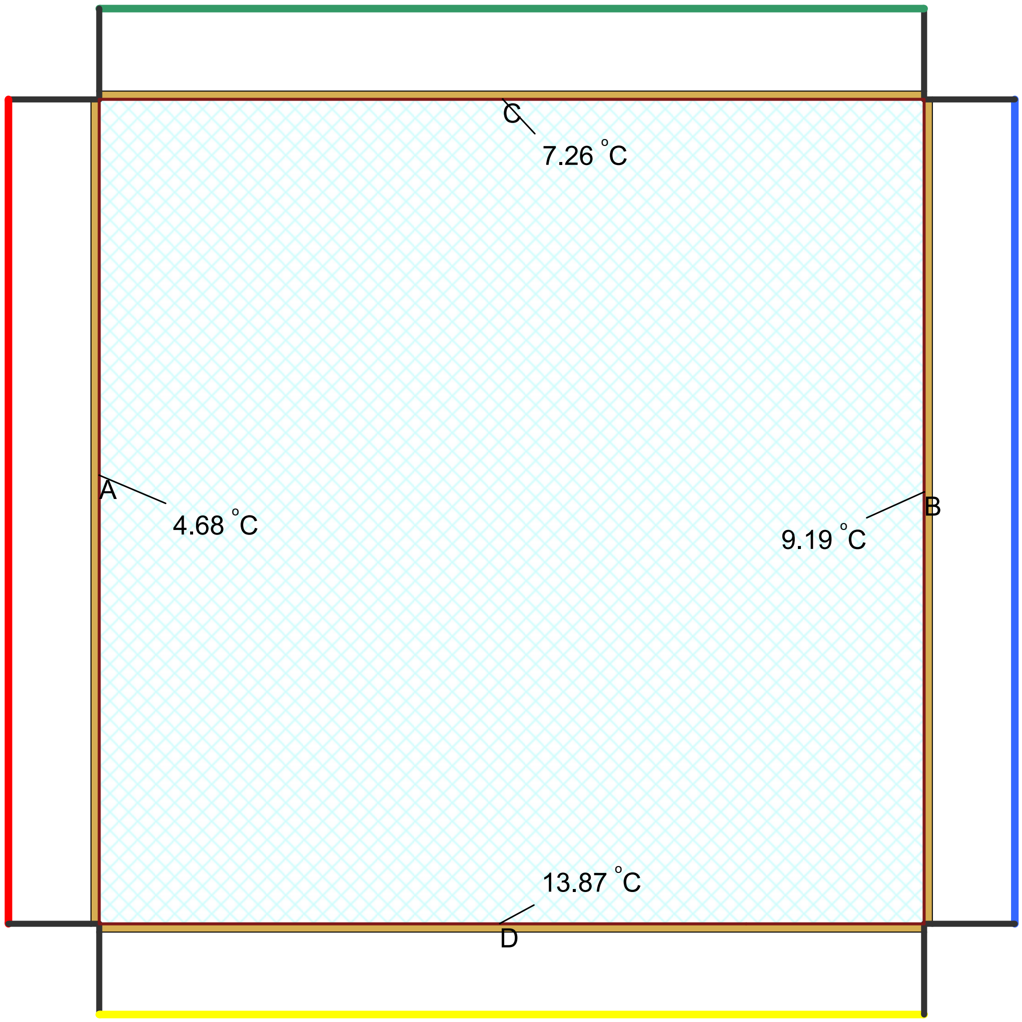
Example G.2

flixo pro 8.2.1173.1

EN ISO 10077-2:2017, 6.4.2



	Material	λ[W/(m·K)]	ε
	Material 1	1.000	0.900
	Perfect Conductor	99999999.000	0.900
	Vacuum		

	Boundary Condition	q[W/m^2]	θ[°C]	R[(m^2·K)/W]	ε
	Epsilon 0.9				0.900
	S1e		0.000	0.100	
	S2e		5.000	0.100	
	S3e		10.000	0.100	
	S4e		20.000	0.100	
	Symmetry/Model section	0.000			

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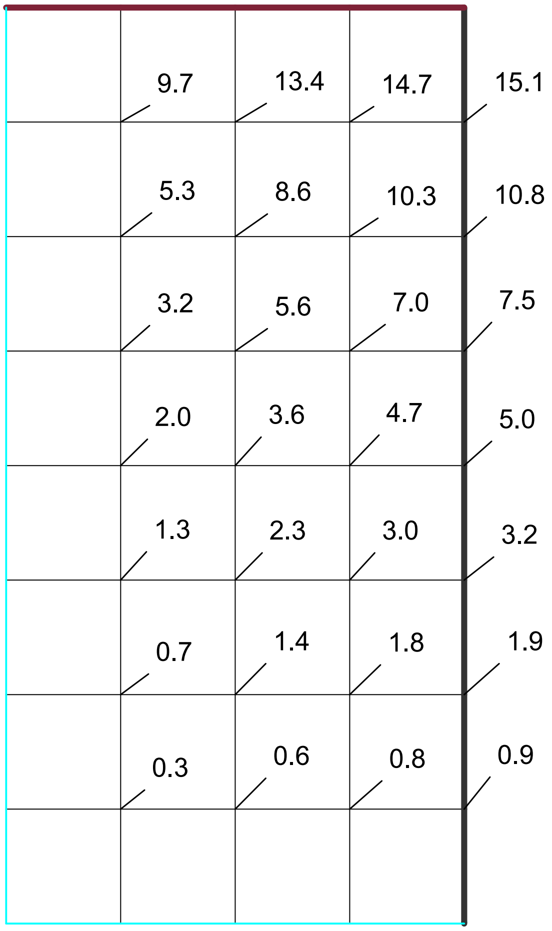
Example G.3

flixo pro 8.2.1173.1

EN ISO 10077-2:2017, 6.4.2



Material	λ[W/(m·K)]
Material 1	1.000
Material 1A	1.000

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]
0 degree		0.000	
20 degree		20.000	
Symmetry/Model section	0.000		

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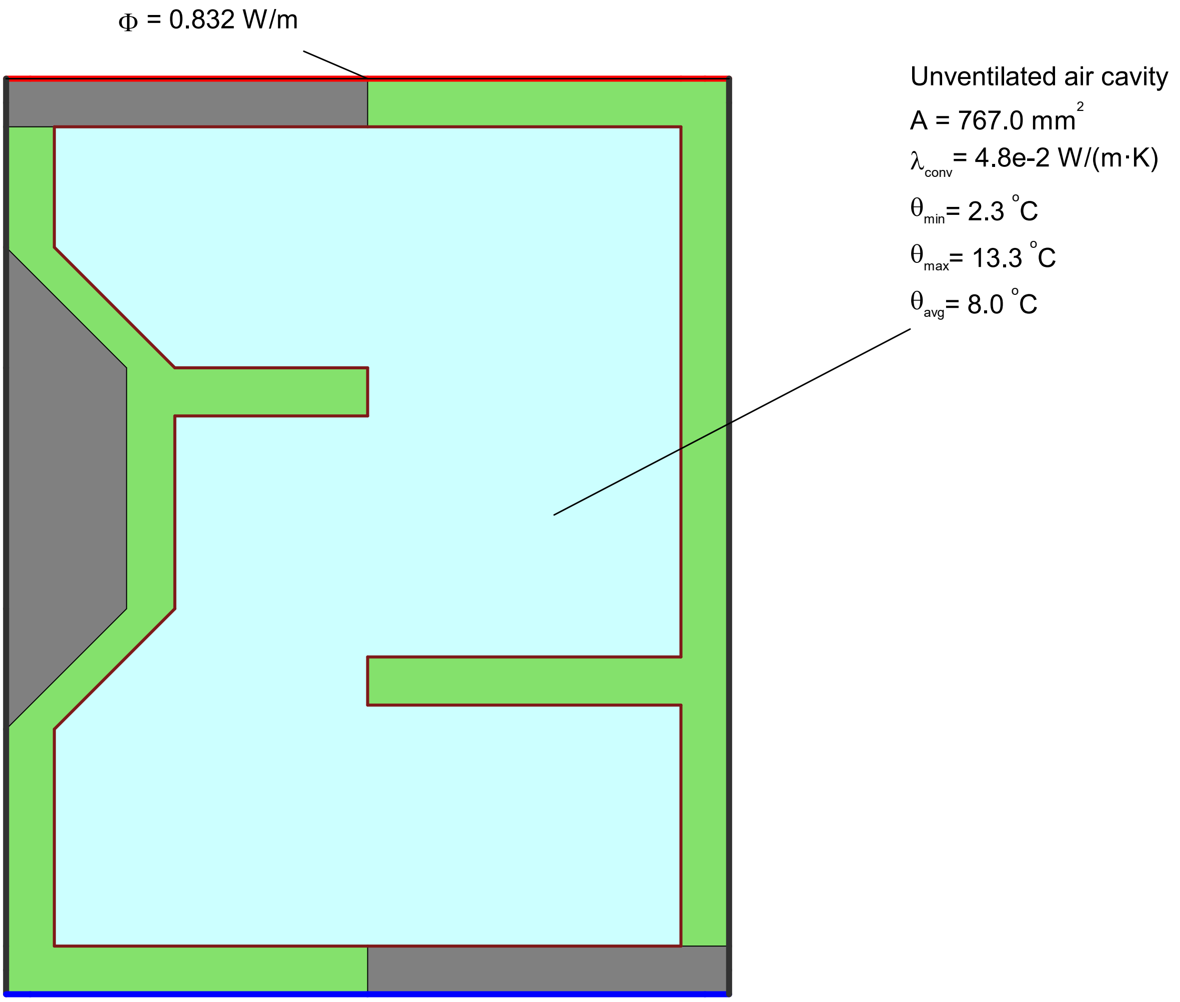
Example G.4

flixo pro 8.2.1173.1

EN ISO 10077-2:2017, 6.4.2



Cavity equivalent conduction direction: 21.7°

Material	λ[W/(m·K)]	ε
Material a	0.300	0.900
Material b	0.001	0.900
Unventilated air cavity *		

* EN ISO 10077-2:2017, 6.4.2

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

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Summary

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EN ISO 10077-2:2017, 6.4.2

flixo satisfies all criterias of the validation samples of Annex H EN ISO 10077-2:2017. Below you find the compilation of the results:

EN ISO 10077-2:2017										
Name	Standard	min	max	Uf/Psi	Q	L	bf	Up/Ug	Uf/Psi	Diff.
H.1	0.539	**0.523**	**0.555**	3.11	10.797	**0.540**	0.110	1.031	3.13	**0.2%**
H.2	0.508	**0.493**	**0.523**	2.83	10.178	**0.509**	0.110	1.031	2.85	**0.2%**
H.3	0.252	**0.244**	**0.260**	1.35	5.033	**0.252**	0.110	0.547	1.34	**0.0%**
H.4	0.400	**0.388**	**0.412**	1.86	7.994	**0.400**	0.110	1.031	1.85	**0.0%**
H.5	0.344	**0.334**	**0.354**	1.34	6.884	**0.344**	0.110	1.031	1.35	**0.0%**
H.6	0.407	**0.395**	**0.419**	2.07	8.150	**0.408**	0.089	1.169	2.08	**0.2%**
H.7	0.637	**0.618**	**0.656**	4.44	12.654	**0.633**	0.095	1.131	4.40	**-0.6%**
H.8	0.281	**0.273**	**0.289**	1.23	5.641	**0.282**	0.048	1.169	1.25	**0.4%**
H.9	0.188	**0.182**	**0.194**	1.06	3.755	**0.188**	0.177		1.06	**0.0%**
H.10	0.208	**0.202**	**0.214**	3.64	4.160	**0.208**	0.057		3.65	**0.0%**
H.11	0.478	**0.464**	**0.492**	0.083	9.518	**0.476**	0.110	1.305	0.080	**-0.4%**

The maximum relative difference of the heat flow calculated by flixo regarding to the one of the standard is 0.6%.
This is smaller than the maximal accepted difference of 3%.

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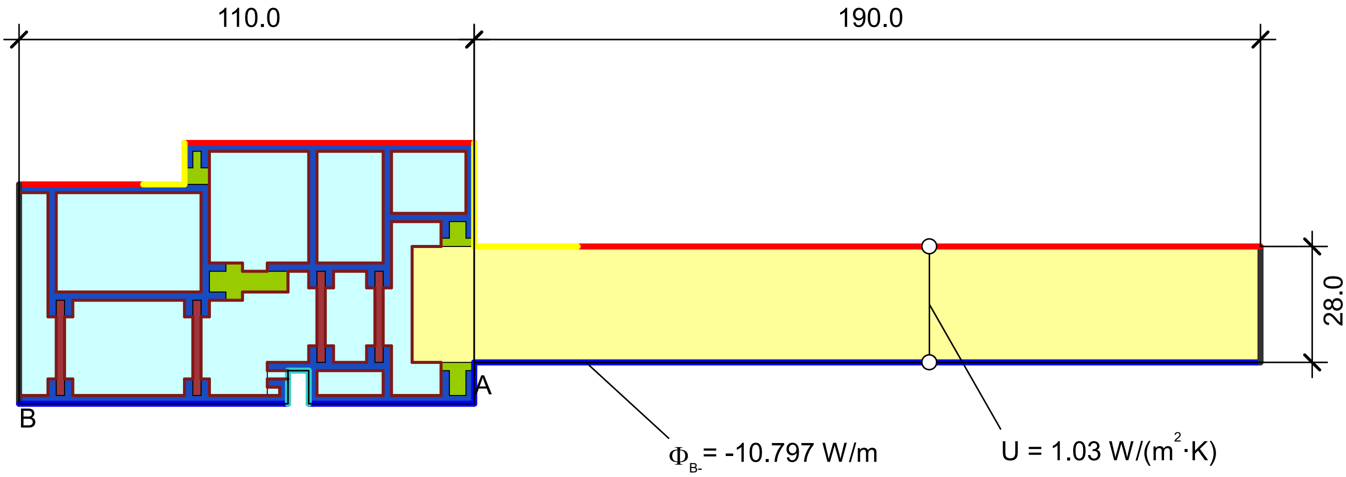
Example H.1

flixo pro 8.2.1176.1
EN ISO 10077-2:2017, 6.4.2



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{10.797}{20.0} - 1.031 \cdot 0.19}{0.11} = 3.13\ \text{W/(m}^2\cdot\text{K)}$$

Material	λ[W/(m·K)]	ε
Aluminium (Si Alloys)	160.000	0.900
EPDM (ethylene propylene diene monomer)	0.250	0.900
Panel	0.035	0.900
Polyamid 6.6 with 25% glass fibre	0.300	0.900
Unventilated air cavity *		

* EN ISO 10077-2:2017, 6.4.2

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Epsilon 0.9				0.900
Exterior, Slightly ventilated cavities		0.000	0.300	
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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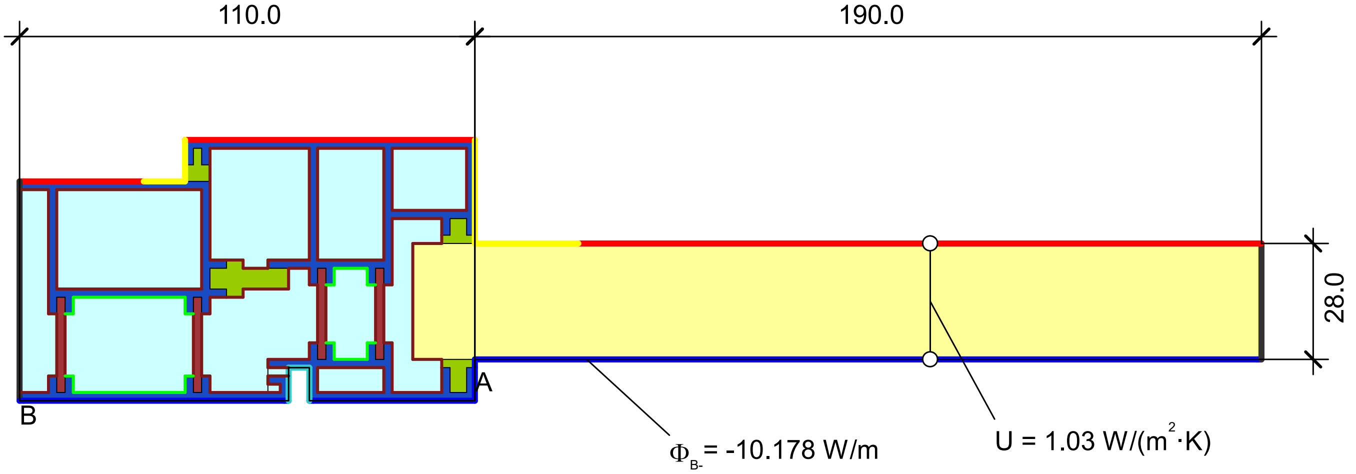
Example H.2

flixo pro 8.2.1176.1
EN ISO 10077-2:2017, 6.4.2



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{10.178}{20.0} - 1.031 \cdot 0.19}{0.11} = 2.85\ \mathrm{W/(m^2 \cdot K)}$$

Material	λ[W/(m·K)]	ε
Aluminium (Si Alloys)	160.000	0.100
Aluminium (Si Alloys)	160.000	0.900
EPDM (ethylene propylene diene monomer)	0.250	0.900
Panel	0.035	0.900
Polyamid 6.6 with 25% glass fibre	0.300	0.900
Unventilated air cavity *		

* EN ISO 10077-2:2017, 6.4.2

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Epsilon 0.1				0.100
Epsilon 0.9				0.900
Exterior, Slightly ventilated cavities		0.000	0.300	
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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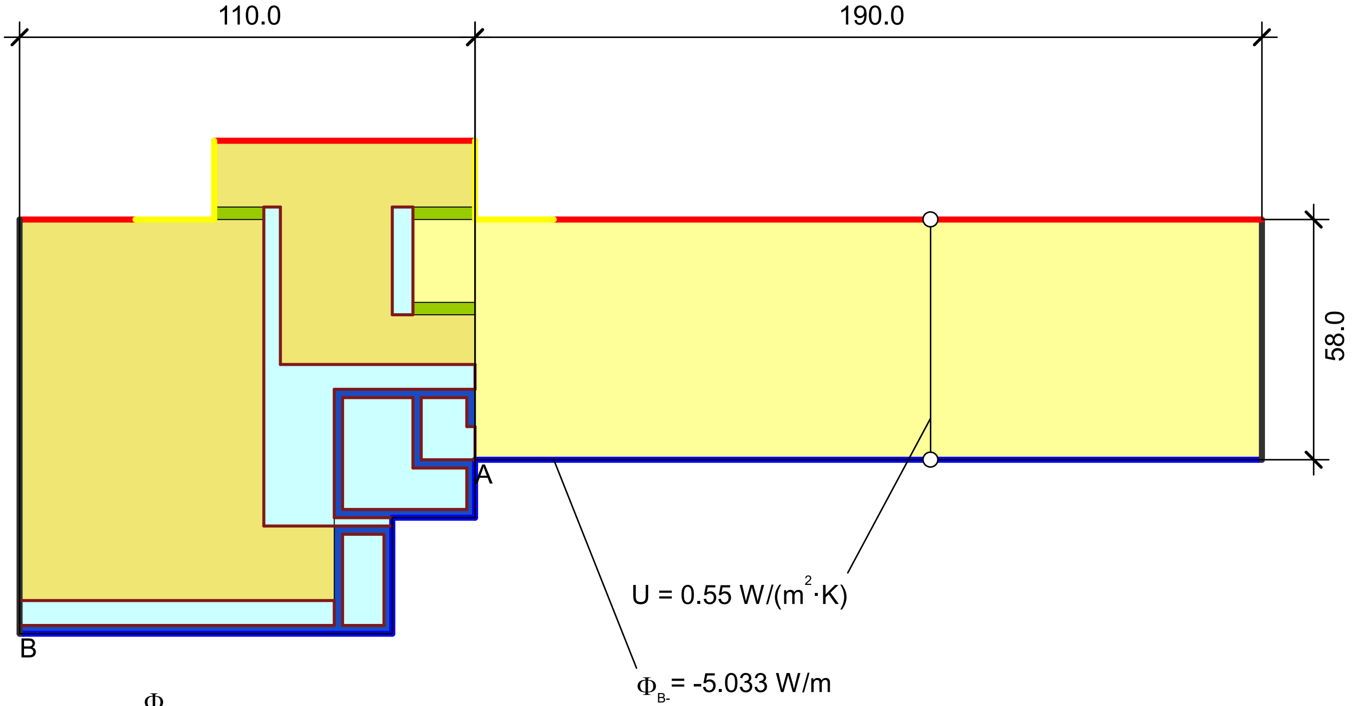
Example H.3

flixo pro 8.2.1176.1
EN ISO 10077-2:2017, 6.4.2



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{5.033}{20.0} - 0.547 \cdot 0.19}{0.11} = 1.34\ \mathrm{W/(m^2 \cdot K)}$$

	Material	λ[W/(m·K)]	ε
■ (blue)	Aluminium (Si Alloys)	160.000	0.900
■ (green)	EPDM (ethylene propylene diene monomer)	0.250	0.900
■ (light yellow)	Panel	0.035	0.900
■ (tan)	Softwood 500, typical construction timber	0.130	0.900
■ (light cyan)	Unventilated air cavity *		

* EN ISO 10077-2:2017, 6.4.2

	Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
■ (dark red)	Epsilon 0.9				0.900
■ (blue)	Exterior, frame		0.000	0.040	
■ (red)	Interior, frame, normal		20.000	0.130	
■ (yellow)	Interior, frame, reduced		20.000	0.200	
■ (dark grey)	Symmetry/Model section	0.000			

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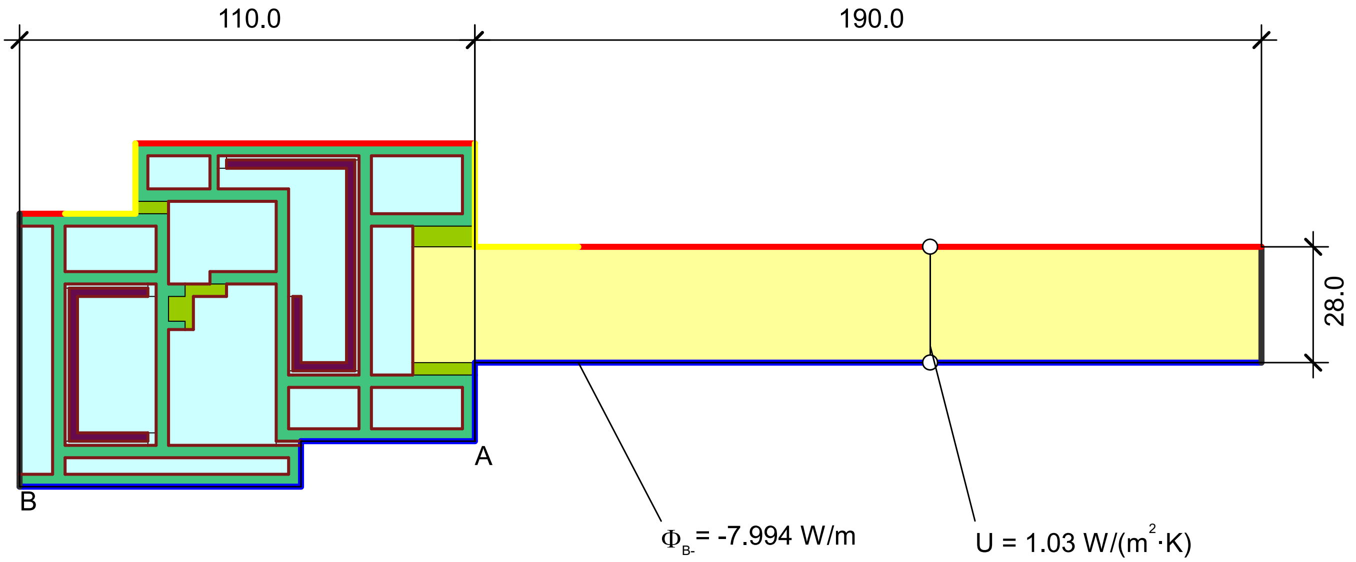
Example H.4

flixo pro 8.2.1176.1
EN ISO 10077-2:2017, 6.4.2



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{7.994}{20.0} - 1.031 \cdot 0.19}{0.11} = 1.85\ \text{W/(m}^2\cdot\text{K)}$$

	Material	λ[W/(m·K)]	ε
	EPDM (ethylene propylene diene monomer)	0.250	0.900
	PVC-U (polyvinylchloride), rigid	0.170	0.900
	Panel	0.035	0.900
	Steel	50.000	0.900
	Unventilated air cavity *		

* EN ISO 10077-2:2017, 6.4.2

	Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
	Epsilon 0.9				0.900
	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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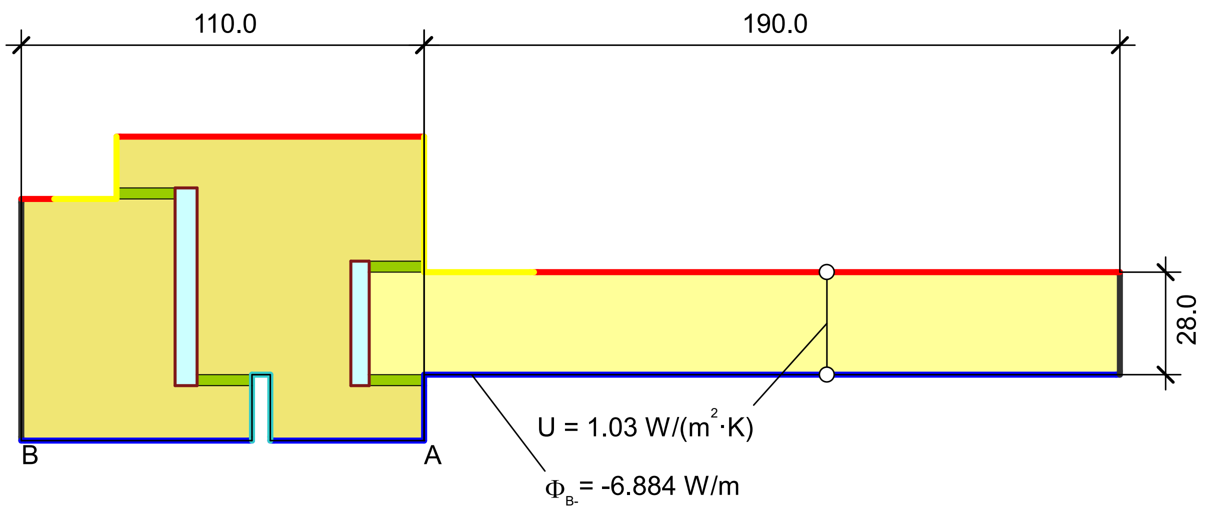
Example H.5

flixo pro 8.2.1176.1
EN ISO 10077-2:2017, 6.4.2



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{6.884}{20.0} - 1.031 \cdot 0.19}{0.11} = 1.35\ \mathrm{W/(m^2 \cdot K)}$$

	Material	λ[W/(m·K)]	ε
	EPDM (ethylene propylene diene monomer)	0.250	0.900
	Panel	0.035	0.900
	Softwood 500, typical construction timber	0.130	0.900
	Unventilated air cavity *		

* EN ISO 10077-2:2017, 6.4.2

	Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
	Epsilon 0.9				0.900
	Exterior, Slightly ventilated cavities		0.000	0.300	
	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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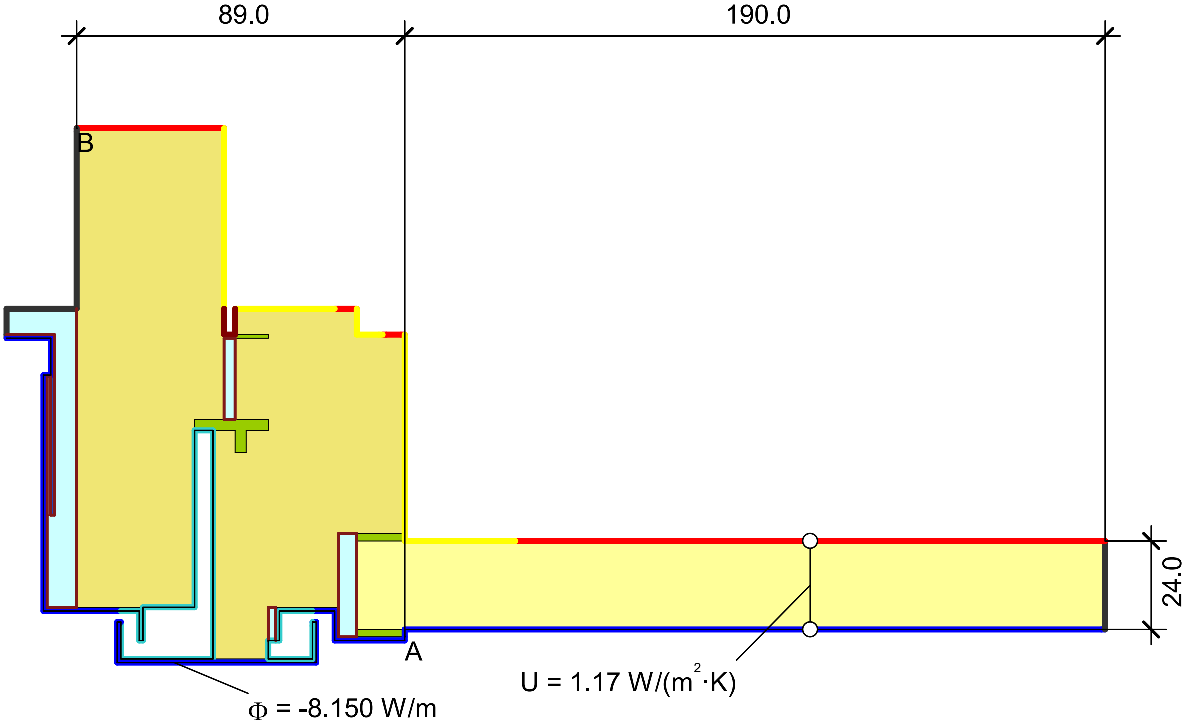
Example H.6

flixo pro 8.2.1176.1
EN ISO 10077-2:2017, 6.4.2



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{8.15}{20.0} - 1.169 \cdot 0.19}{0.089} = 2.08\ W/(m^2 \cdot K)$$

Material	λ[W/(m·K)]	ε
Aluminium (Si Alloys)	160.000	0.900
EPDM (ethylene propylene diene monomer)	0.250	0.900
Panel	0.035	0.900
Softwood 500, typical construction timber	0.130	0.900
Unventilated air cavity *		

* EN ISO 10077-2:2017, 6.4.2

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

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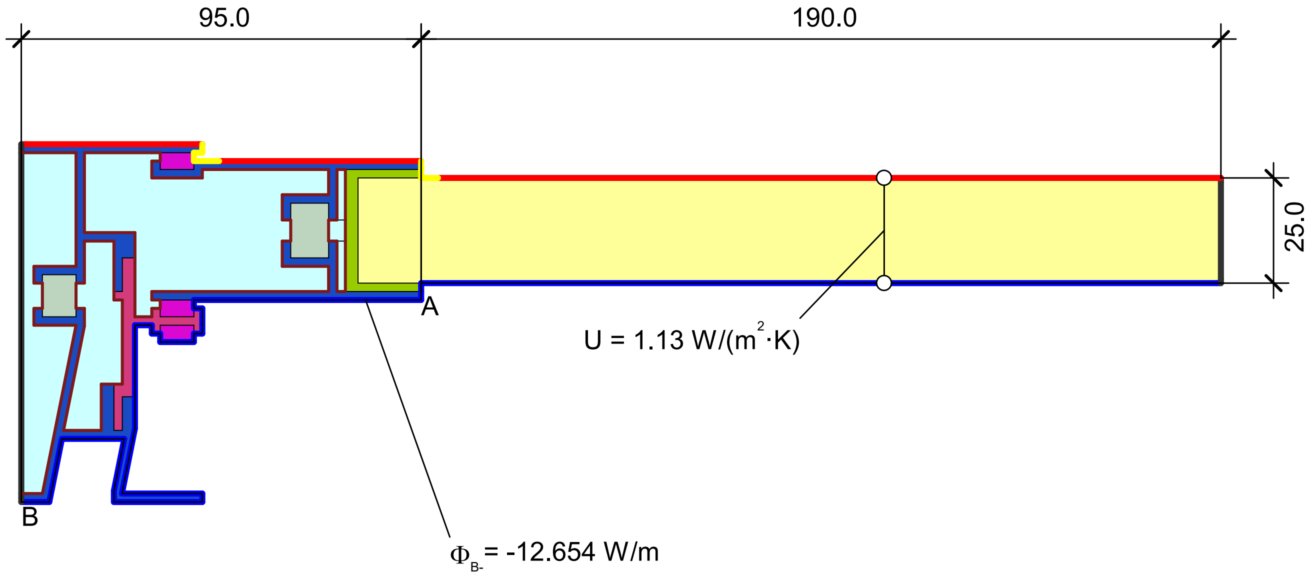
Example H.7

flixo pro 8.2.1176.1
EN ISO 10077-2:2017, 6.4.2



$$U_{f\,A,B} = \frac{\dfrac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\dfrac{12.654}{20.0} - 1.131 \cdot 0.19}{0.095} = 4.40\ \mathrm{W/(m^2 \cdot K)}$$

Material	λ[W/(m·K)]	ε
Aluminium (Si Alloys)	160.000	0.900
EPDM (ethylene propylene diene monomer)	0.250	0.900
PU (polyurethane)	0.250	0.900
Panel	0.035	0.900
Pile weather stripping (polyester mohair)	0.140	0.900
Polyamid (nylon)	0.250	0.900
Unventilated air cavity *		

* EN ISO 10077-2:2017, 6.4.2

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Epsilon 0.9				0.900
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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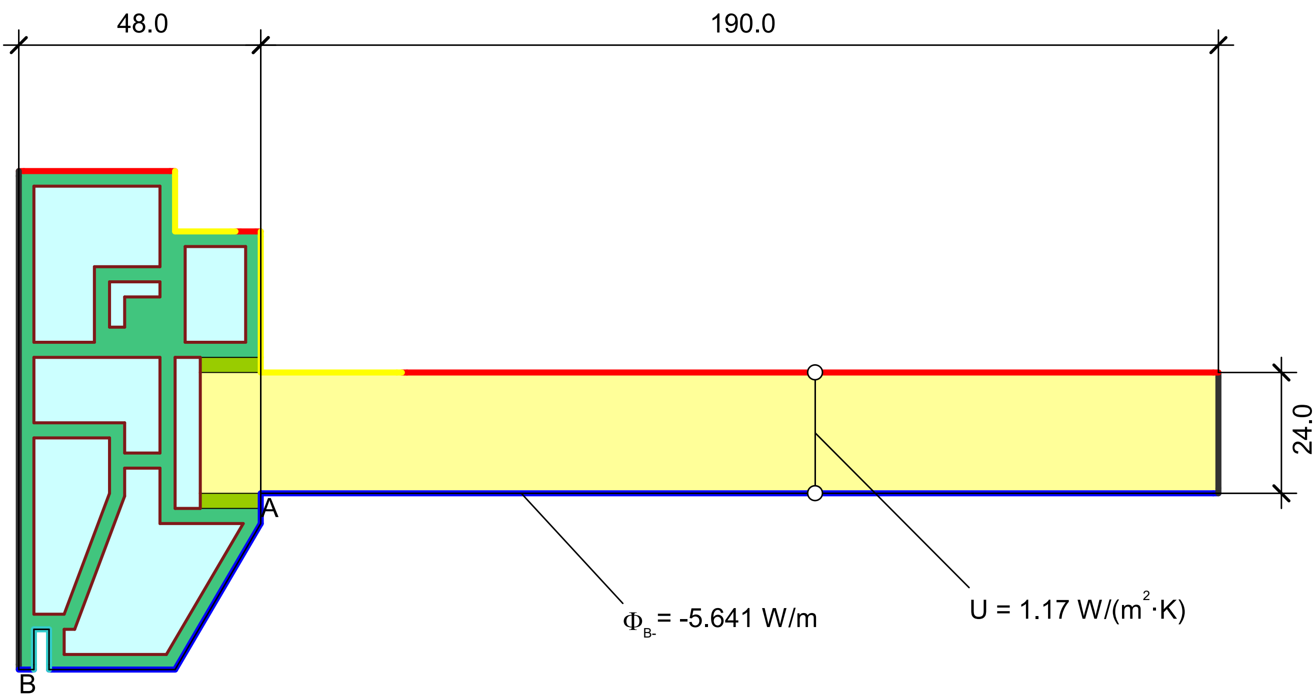
Example H.8

flixo pro 8.2.1176.1
EN ISO 10077-2:2017, 6.4.2



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{5.641}{20.0} - 1.169 \cdot 0.19}{0.048} = 1.25\ \mathrm{W/(m^2 \cdot K)}$$

	Material	λ[W/(m·K)]	ε
	EPDM (ethylene propylene diene monomer)	0.250	0.900
	PVC-U (polyvinylchloride), rigid	0.170	0.900
	Panel	0.035	0.900
	Unventilated air cavity *		

* EN ISO 10077-2:2017, 6.4.2

	Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
	Epsilon 0.9				0.900
	Exterior, Slightly ventilated cavities		0.000	0.300	
	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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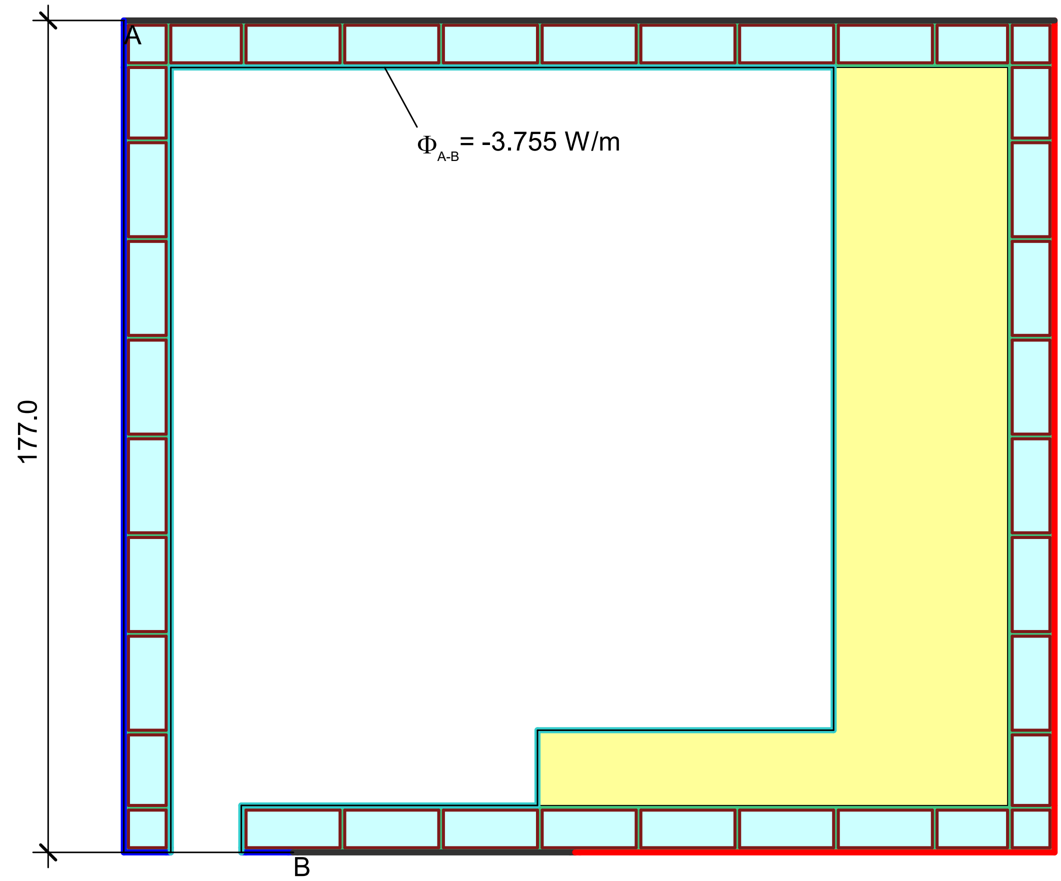
Example H.9

flixo pro 8.2.1176.1
EN ISO 10077-2:2017, 6.4.2



$$U_{SB\ A-B} = \frac{\Phi}{\Delta T \cdot b} = \frac{3.755}{20.0 \cdot 0.177} = 1.06\ W/(m^2 \cdot K)$$

Material	λ[W/(m·K)]	ε
PVC-U (polyvinylchloride), rigid	0.170	0.900
Panel	0.035	0.900
Unventilated air cavity *		

* EN ISO 10077-2:2017, 6.4.2

Boundary Condition	$q[W/m^2]$	$\theta[°C]$	$R[(m^2 \cdot K)/W]$	ε
Epsilon 0.9				0.900
Exterior, Slightly ventilated cavities		0.000	0.300	
Exterior, frame		0.000	0.040	
Interior, Slightly ventilated cavities		20.000	0.300	
Interior, normal		20.000	0.130	
Symmetry/Model section	0.000			

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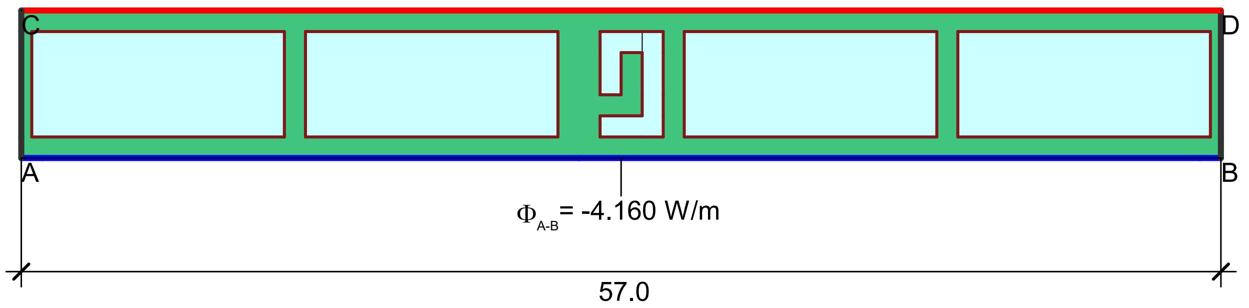
Example H.10

flixo pro 8.2.1176.1
EN ISO 10077-2:2017, 6.4.2



$$U_{eq\ A\text{-}B} = \frac{\Phi}{\Delta T \cdot b} = \frac{4.16}{20.0 \cdot 0.057} = 3.65\ W/(m^2 \cdot K)$$

Material	λ[W/(m·K)]	ε
PVC-U (polyvinylchloride), rigid	0.170	0.900
Unventilated air cavity *		
* EN ISO 10077-2:2017, 6.4.2		

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

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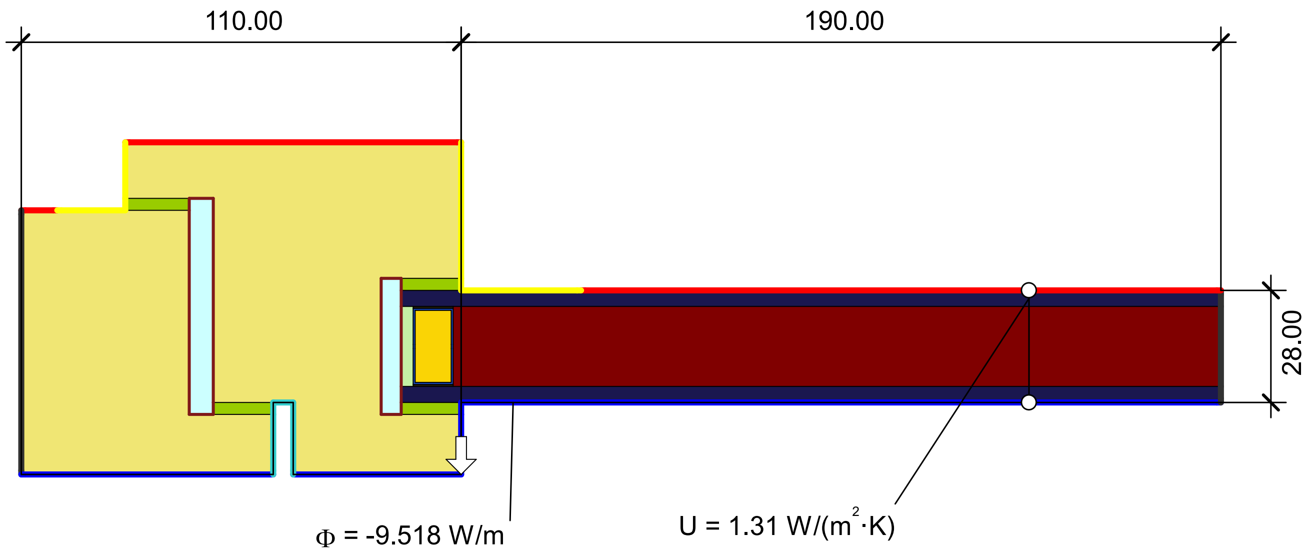
Example H.11

flixo pro 8.2.1176.1
EN ISO 10077-2:2017, 6.4.2



$$\psi_{ed} = \frac{\Phi}{\Delta T} - U_g \cdot b_g - U_f \cdot b_f = \frac{9.518}{20.0} - 1.305 \cdot 0.19 - 1.348 \cdot 0.11 = 0.080 \text{ W/(m·K)}$$

Material	λ[W/(m·K)]	ε
Aluminium (Si Alloys)	160.000	0.900
EPDM (ethylene propylene diene monomer)	0.250	0.900
Glazing	0.034	0.900
Polyisobutylene	0.200	0.900
Polysulfide	0.400	0.900
Silica gel (desiccant)	0.130	0.900
Soda lime glass	1.000	0.900
Softwood 500, typical construction timber	0.130	0.900
Unventilated air cavity *		

* EN ISO 10077-2:2017, 6.4.2

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Epsilon 0.9				0.900
Exterior, Slightly ventilated cavities		0.000	0.300	
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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Summary

flixo pro 8.2.1176.1
EN ISO 10077-2:2017, 6.4.3

flixo satisfies all criterias of the validation samples of Annex I EN ISO 10077-2:2017. Below you find the compilation of the results:

EN ISO 10077-2:2017										
Name	Standard	min	max	Uf/Psi	Q	L	bf	Up/Ug	Uf/Psi	Diff.
I.1	0.550	**0.534**	**0.567**	3.22	11.025	**0.551**	0.110	1.031	3.23	**0.2%**
I.2	0.263	**0.255**	**0.271**	1.44	5.216	**0.261**	0.110	0.547	1.43	**-0.8%**
I.3	0.424	**0.411**	**0.437**	2.07	8.299	**0.415**	0.110	1.031	1.99	**-2.1%**
I.4	0.346	**0.336**	**0.356**	1.36	6.915	**0.346**	0.110	1.031	1.36	**0.0%**
I.5	0.408	**0.396**	**0.420**	2.08	7.987	**0.399**	0.089	1.169	1.99	**-2.2%**
I.6	0.659	**0.639**	**0.679**	4.67	13.324	**0.666**	0.095	1.131	4.75	**1.1%**
I.7	0.285	**0.276**	**0.294**	1.31	5.658	**0.283**	0.048	1.169	1.27	**-0.7%**
I.8	0.181	**0.176**	**0.186**	1.05	3.611	**0.181**	0.177		1.02	**0.0%**
I.9	0.207	**0.201**	**0.213**	3.64	4.135	**0.207**	0.057		3.63	**0.0%**
I.10	0.481	**0.467**	**0.495**	0.084	9.549	**0.477**	0.110	1.305	0.080	**-0.8%**

The maximum relative difference of the heat flow calculated by flixo regarding to the one of the standard is 2.2%.
This is smaller than the maximal accepted difference of 3%.

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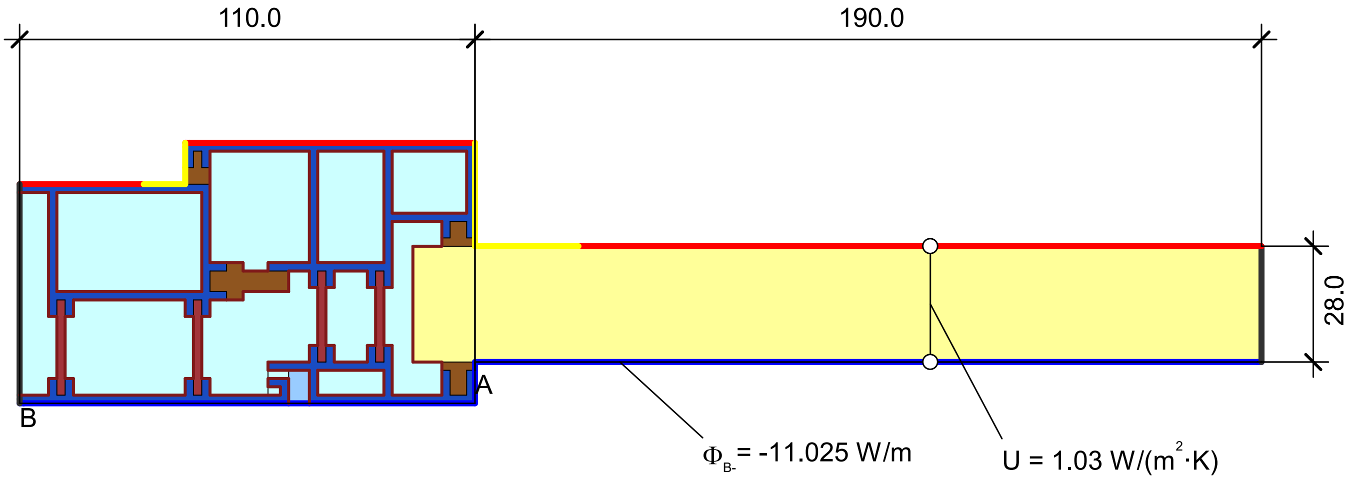
Example I.1

flixo pro 8.2.1176.1
EN ISO 10077-2:2017, 6.4.3



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{11.025}{20.0} - 1.031 \cdot 0.19}{0.11} = 3.23\ W/(m^2 \cdot K)$$

	Material	λ[W/(m·K)]	ε
■	Aluminium (Si Alloys)	160.000	0.900
■	EPDM (ethylene propylene diene monomer)	0.250	0.900
■	Panel	0.035	0.900
■	Polyamid 6.6 with 25% glass fibre	0.300	0.900
■	Slightly ventilated air cavity *		
■	Unventilated air cavity *		

* EN ISO 10077-2:2017, 6.4.3

	Boundary Condition	$q[W/m^2]$	θ[°C]	$R[(m^2 \cdot K)/W]$	ε
■	Epsilon 0.9				0.900
■	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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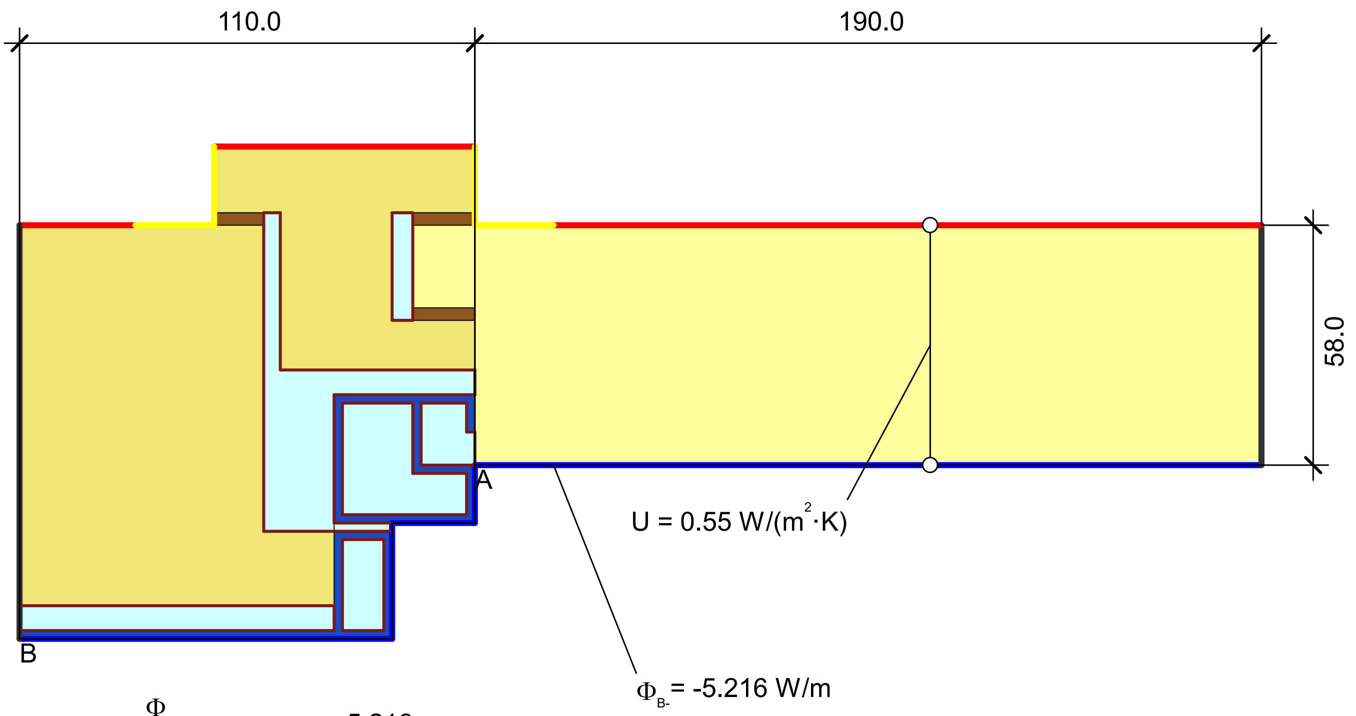
Example I.2

flixo pro 8.2.1176.1
EN ISO 10077-2:2017, 6.4.3



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{5.216}{20.0} - 0.547 \cdot 0.19}{0.11} = 1.43\ \mathrm{W/(m^2 \cdot K)}$$

	Material	λ[W/(m·K)]	ε
■ (blue)	Aluminium (Si Alloys)	160.000	0.900
■ (brown)	EPDM (ethylene propylene diene monomer)	0.250	0.900
■ (light yellow)	Panel	0.035	0.900
■ (yellow)	Softwood 500, typical construction timber	0.130	0.900
■ (light cyan)	Unventilated air cavity *		

* EN ISO 10077-2:2017, 6.4.3

	Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
■ (dark red)	Epsilon 0.9				0.900
■ (blue)	Exterior, frame		0.000	0.040	
■ (red)	Interior, frame, normal		20.000	0.130	
■ (yellow)	Interior, frame, reduced		20.000	0.200	
■ (dark grey)	Symmetry/Model section	0.000			

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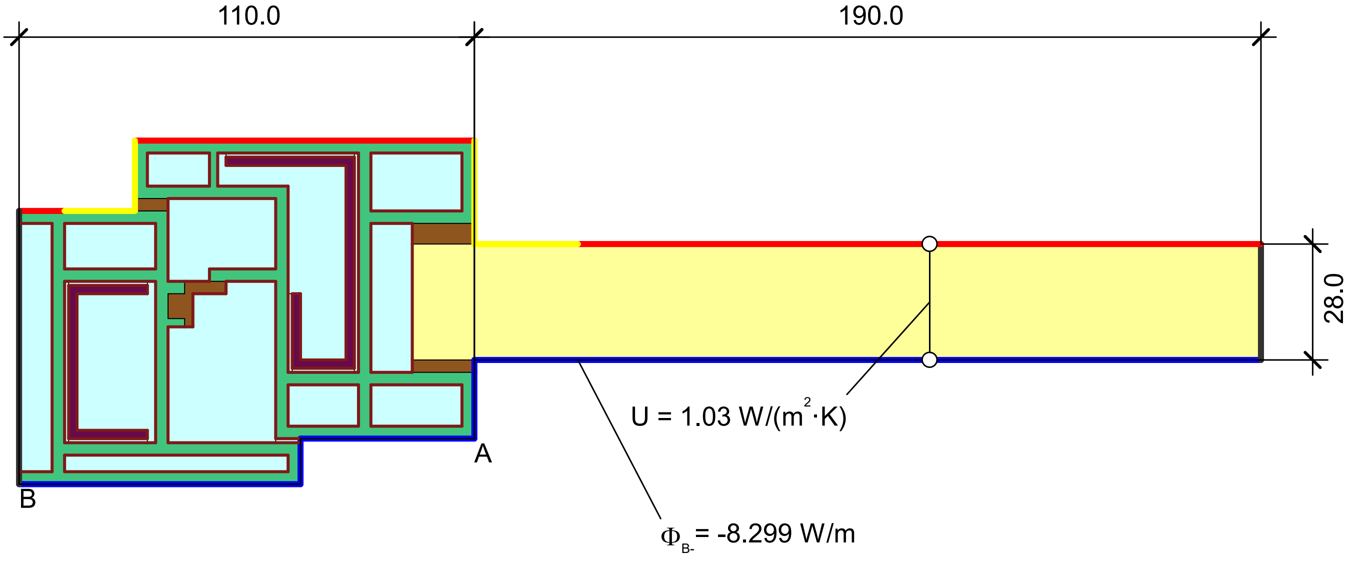
Example I.3

flixo pro 8.2.1176.1
EN ISO 10077-2:2017, 6.4.3



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{8.299}{20.0} - 1.031 \cdot 0.19}{0.11} = 1.99\ W/(m^2 \cdot K)$$

	Material	λ[W/(m·K)]	ε
	EPDM (ethylene propylene diene monomer)	0.250	0.900
	PVC-U (polyvinylchloride), rigid	0.170	0.900
	Panel	0.035	0.900
	Steel	50.000	0.900
	Unventilated air cavity *		

* EN ISO 10077-2:2017, 6.4.3

	Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
	Epsilon 0.9				0.900
	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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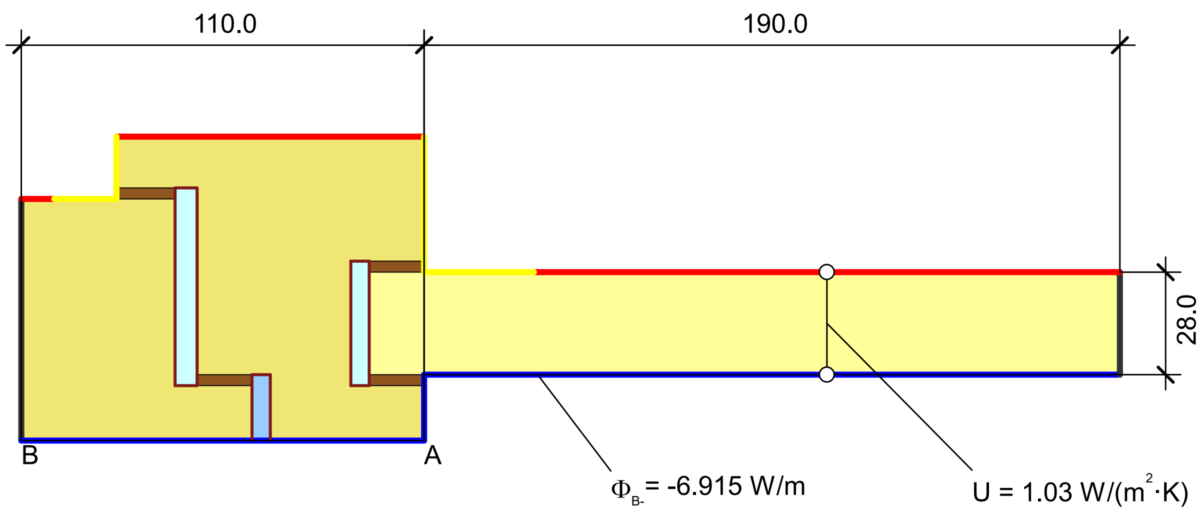
Example I.4

flixo pro 8.2.1176.1
EN ISO 10077-2:2017, 6.4.3



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{6.915}{20.0} - 1.031 \cdot 0.19}{0.11} = 1.36\ \mathrm{W/(m^2 \cdot K)}$$

Material	λ[W/(m·K)]	ε
EPDM (ethylene propylene diene monomer)	0.250	0.900
Panel	0.035	0.900
Slightly ventilated air cavity *		
Softwood 500, typical construction timber	0.130	0.900
Unventilated air cavity *		

* EN ISO 10077-2:2017, 6.4.3

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Epsilon 0.9				0.900
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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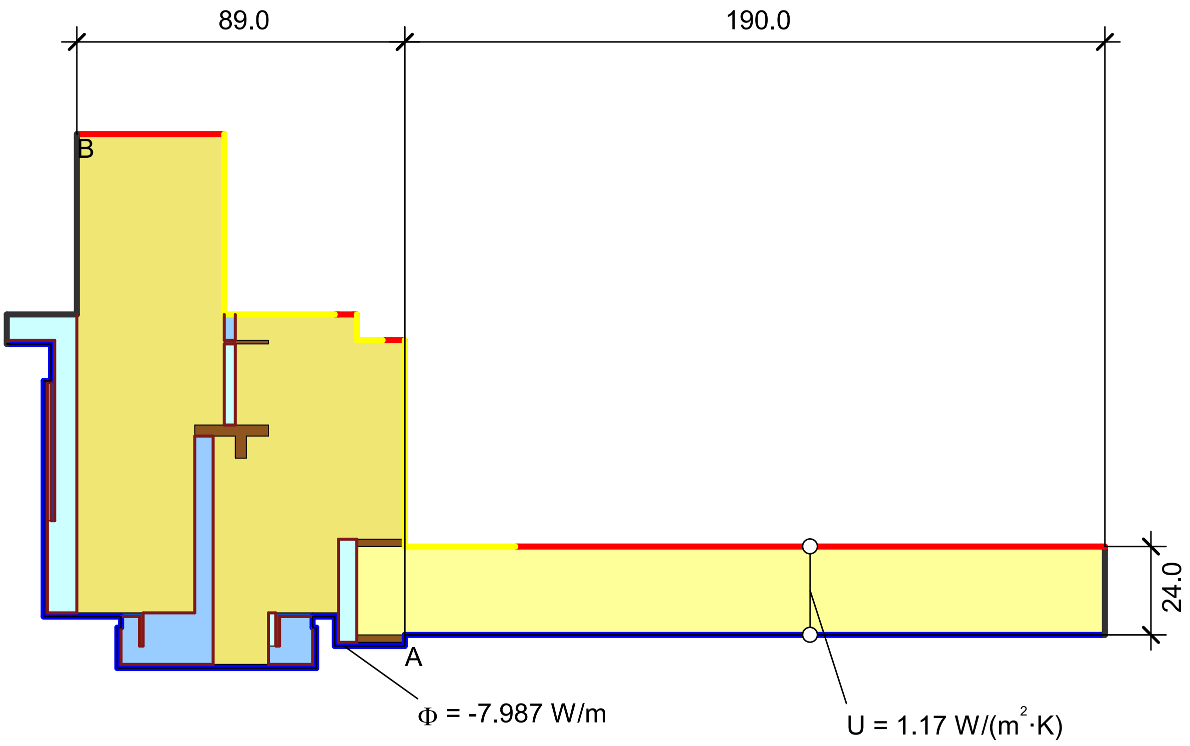
Example I.5

flixo pro 8.2.1176.1
EN ISO 10077-2:2017, 6.4.3



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{7.987}{20.0} - 1.169 \cdot 0.19}{0.089} = 1.99\ \text{W/(m}^2\cdot\text{K)}$$

Material	λ[W/(m·K)]	ε
Aluminium (Si Alloys)	160.000	0.900
EPDM (ethylene propylene diene monomer)	0.250	0.900
Panel	0.035	0.900
Slightly ventilated air cavity *		
Softwood 500, typical construction timber	0.130	0.900
Unventilated air cavity *		

* EN ISO 10077-2:2017, 6.4.3

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Epsilon 0.9				0.900
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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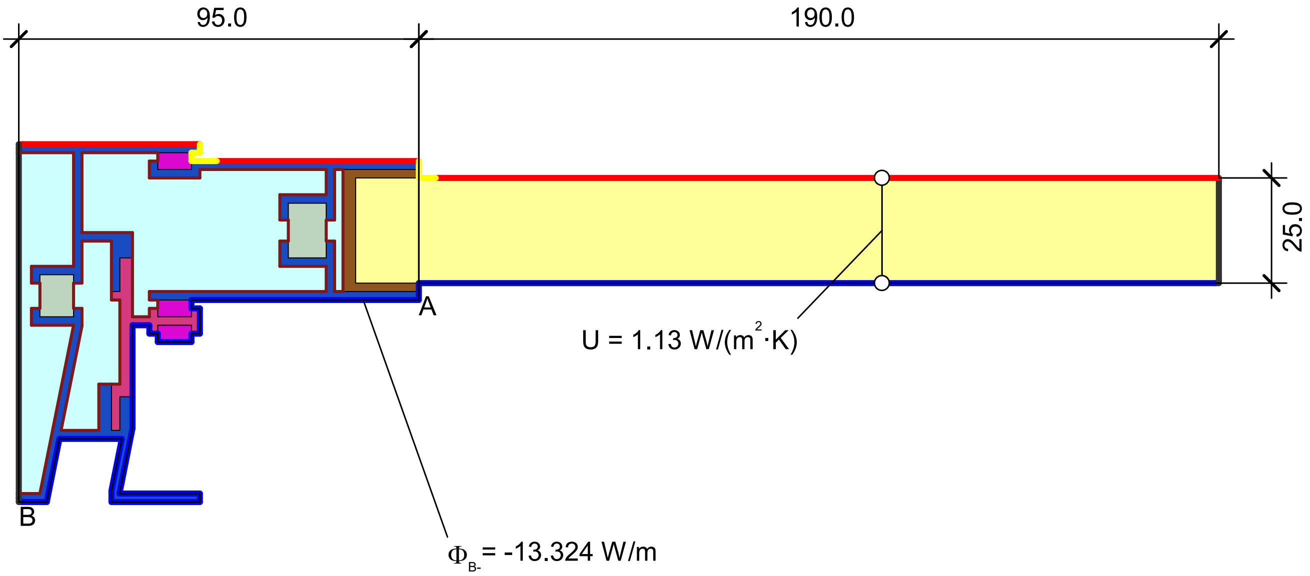
Example I.6

flixo pro 8.2.1176.1
EN ISO 10077-2:2017, 6.4.3



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{13.324}{20.0} - 1.131 \cdot 0.19}{0.095} = 4.75\ \mathrm{W/(m^2 \cdot K)}$$

	Material	λ[W/(m·K)]	ε
■	Aluminium (Si Alloys)	160.000	0.900
■	EPDM (ethylene propylene diene monomer)	0.250	0.900
■	PU (polyurethane)	0.250	0.900
■	Panel	0.035	0.900
■	Pile weather stripping (polyester mohair)	0.140	0.900
■	Polyamid (nylon)	0.250	0.900
■	Unventilated air cavity *		

* EN ISO 10077-2:2017, 6.4.3

	Boundary Condition	$q[W/m^2]$	$\theta[^\circ C]$	$R[(m^2 \cdot K)/W]$	ε
■	Epsilon 0.9				0.900
■	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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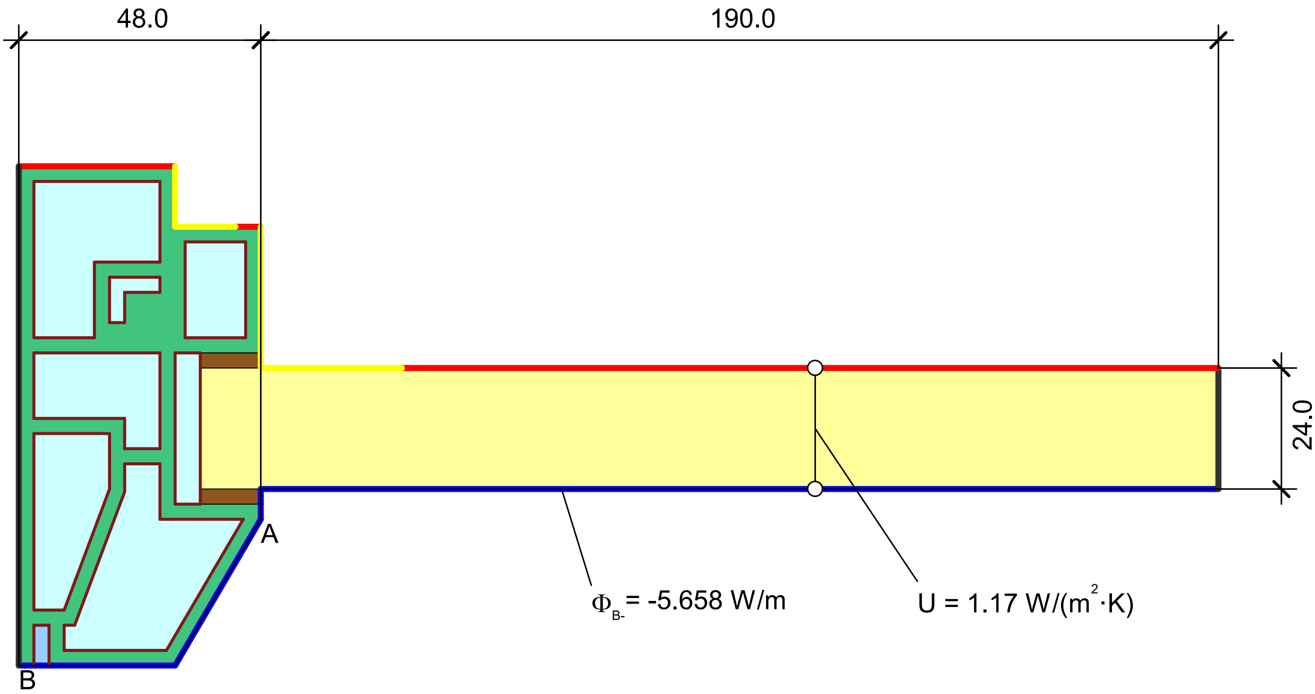
Example I.7

flixo pro 8.2.1176.1
EN ISO 10077-2:2017, 6.4.3



$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{5.658}{20.0} - 1.169 \cdot 0.19}{0.048} = 1.27\ \mathrm{W/(m^2 \cdot K)}$$

	Material	λ[W/(m·K)]	ε
■ (brown)	EPDM (ethylene propylene diene monomer)	0.250	0.900
■ (green)	PVC-U (polyvinylchloride), rigid	0.170	0.900
■ (light yellow)	Panel	0.035	0.900
■ (light blue)	Slightly ventilated air cavity *		
■ (pale cyan)	Unventilated air cavity *		
	* EN ISO 10077-2:2017, 6.4.3		

	Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
■ (dark red)	Epsilon 0.9				0.900
■ (blue)	Exterior, frame		0.000	0.040	
■ (red)	Interior, frame, normal		20.000	0.130	
■ (yellow)	Interior, frame, reduced		20.000	0.200	
■ (dark grey)	Symmetry/Model section	0.000			

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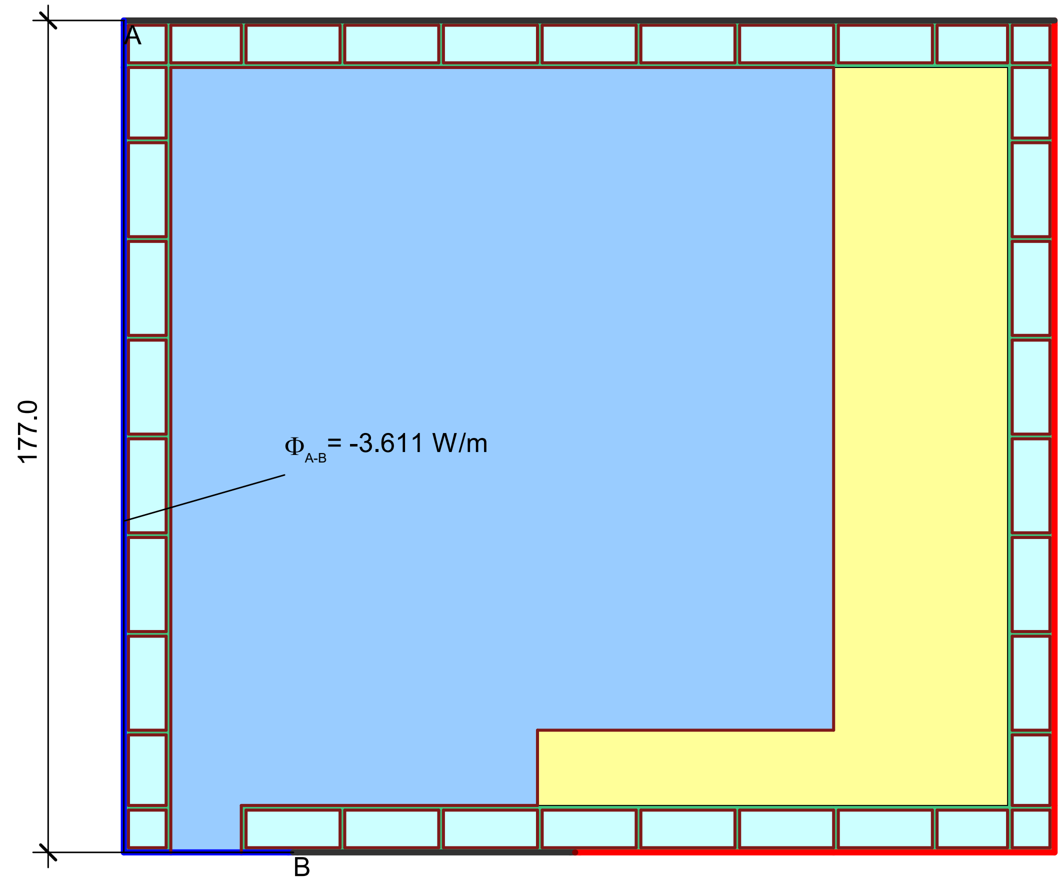
Example I.8

flixo pro 8.2.1176.1
EN ISO 10077-2:2017, 6.4.3



$$U_{SB\ A\text{-}B} = \frac{\Phi}{\Delta T \cdot b} = \frac{3.611}{20.0 \cdot 0.177} = 1.02\ W/(m^2 \cdot K)$$

Material	λ[W/(m·K)]	ε
PVC-U (polyvinylchloride), rigid	0.170	0.900
Panel	0.035	0.900
Slightly ventilated air cavity *		
Unventilated air cavity *		

* EN ISO 10077-2:2017, 6.4.3

Boundary Condition	q[W/m^2]	θ[°C]	R[(m^2·K)/W]	ε
Epsilon 0.9				0.900
Exterior, frame		0.000	0.040	
Interior, Slightly ventilated cavities		20.000	0.300	
Interior, normal		20.000	0.130	
Symmetry/Model section	0.000			

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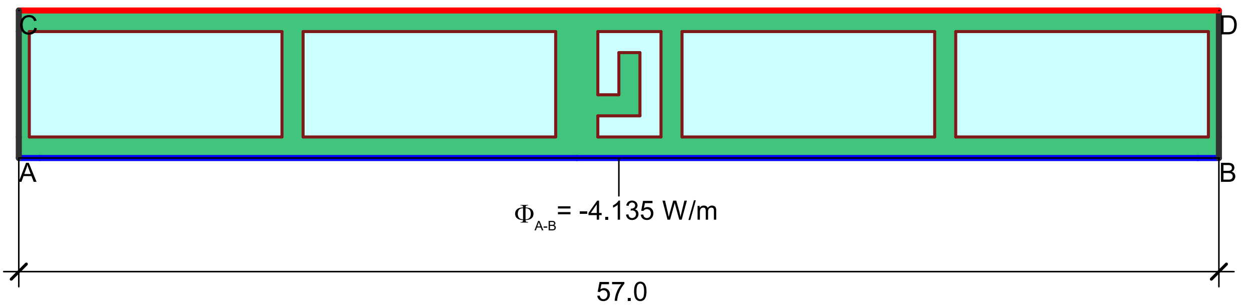
Example I.9

flixo pro 8.2.1176.1
EN ISO 10077-2:2017, 6.4.3



$$U_{eq\ A\text{-}B} = \frac{\Phi}{\Delta T \cdot b} = \frac{4.135}{20.0 \cdot 0.057} = 3.63\ W/(m^2 \cdot K)$$

	Material	λ[W/(m·K)]	ε
■	PVC-U (polyvinylchloride), rigid	0.170	0.900
■	Unventilated air cavity *		
	* EN ISO 10077-2:2017, 6.4.3		

	Boundary Condition	$q[W/m^2]$	θ[°C]	$R[(m^2 \cdot K)/W]$	ε
■	Epsilon 0.9				0.900
■	Exterior, frame		0.000	0.040	
■	Interior, frame, normal		20.000	0.130	
■	Symmetry/Model section	0.000			

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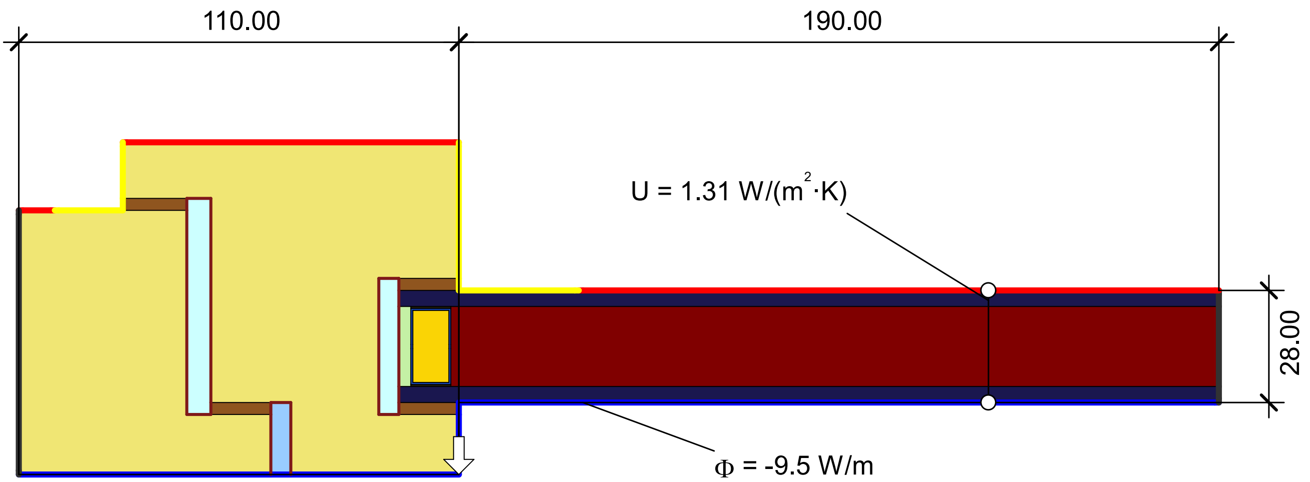
Example I.10

flixo pro 8.2.1176.1
EN ISO 10077-2:2017, 6.4.3



$$\Psi_{ed} = \frac{\Phi}{\Delta T} - U_g \cdot b_g - U_f \cdot b_f = \frac{9.549}{20.0} - 1.305 \cdot 0.19 - 1.362 \cdot 0.11 = 0.080 \text{ W/(m·K)}$$

Material	λ[W/(m·K)]	ε
Aluminium (Si Alloys)	160.000	0.900
EPDM (ethylene propylene diene monomer)	0.250	0.900
Glazing	0.034	0.900
Polyisobutylene	0.200	0.900
Polysulfide	0.400	0.900
Silica gel (desiccant)	0.130	0.900
Slightly ventilated air cavity *		
Soda lime glass	1.000	0.900
Softwood 500, typical construction timber	0.130	0.900
Unventilated air cavity *		

* EN ISO 10077-2:2017, 6.4.3

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Epsilon 0.9				0.900
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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