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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, 7.2.2017



Walter Schmidli  
CEO, Infomind GmbH

## Summary

flixo pro 8.0.923.1  
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

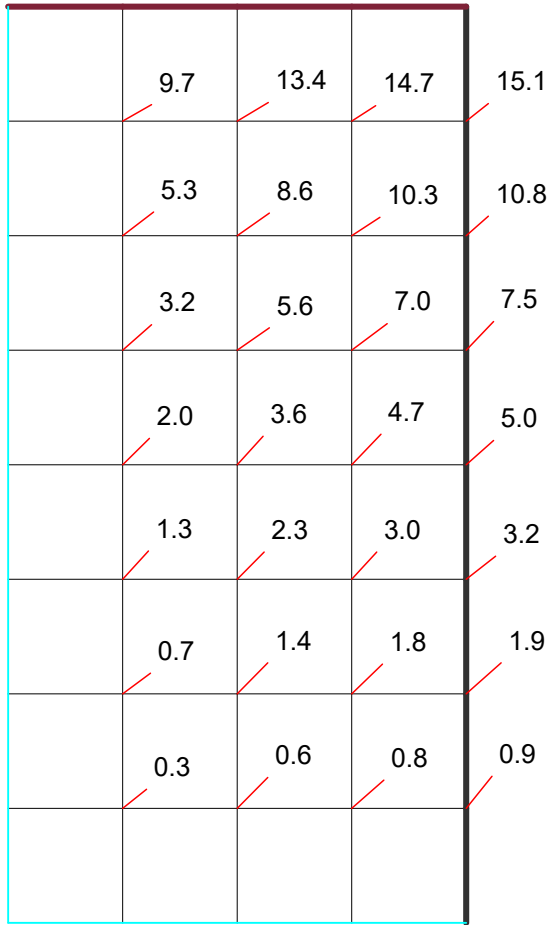
All temperatures calculated by flixo are identical to the ones of the standard.

### Example A.1.3

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

## Example A.1.2

fixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.2

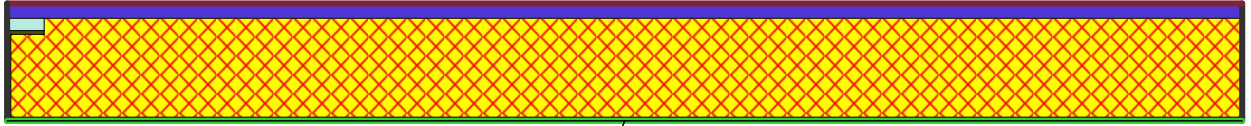


| Material    | $\lambda$ [W/(m·K)] | $\varepsilon$ |
|-------------|---------------------|---------------|
| Material 1  | 1.000               |               |
| Material 1A | 1.000               |               |

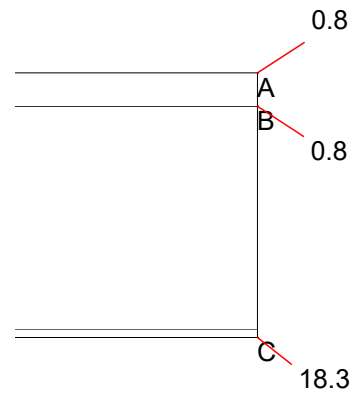
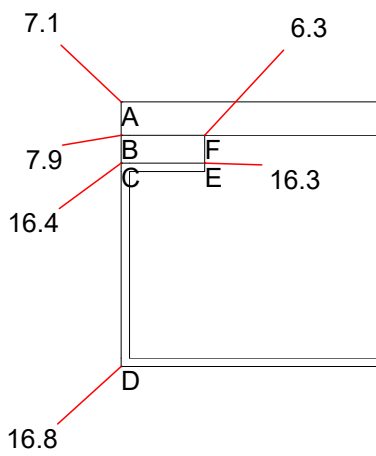
| Boundary Condition  | $q$ [W/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\varepsilon$ |
|---|-------------------------|---------------|-----------------------------|---------------|
| <span style="color: cyan;">■</span> 0 degree                |                         | 0.000         |                             |               |
| <span style="color: maroon;">■</span> 20 degree             |                         | 20.000        |                             |               |
| <span style="color: black;">■</span> Symmetry/Model section |                         | 0.000         |                             |               |

### Example A.1.3

flixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.2



$\Phi = 9.5 \text{ W/m}$



| Material  | $\lambda$ [W/(m·K)] | $\epsilon$ |
|---|---------------------|------------|
| Aluminium                                       | 230.000             |            |
| Concrete, medium density 1800 kg/m <sup>3</sup> | 1.150               |            |
| Insulation                                      | 0.029               |            |
| Timber 450 kg/m <sup>3</sup> (softwoods)        | 0.120               |            |

| Boundary Condition | q [W/m <sup>2</sup> ] | $\theta$ [°C] | R [(m <sup>2</sup> ·K)/W] | $\epsilon$ |
|--------------------|-----------------------|---------------|---------------------------|------------|
| 0/0.06             |                       | 0.000         | 0.060                     |            |
| 20/0.11            |                       | 20.000        | 0.110                     |            |
| Adiabatic          | 0.000                 |               |                           |            |

## Summary

flixo pro 8.0.923.1  
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. |
|----------|----------------|-------|-------|
| <b>A</b> | 44.12          | 44.12 | 0.0%  |
| <b>B</b> | 5.15           | 5.15  | 0.0%  |
| <b>C</b> | 8.29           | 8.29  | 0.0%  |
| <b>D</b> | 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. |
|-----------------------|----------------|-------|-------|
| <b>S<sub>1i</sub></b> | 4.67           | 4.68  | 0.01  |
| <b>S<sub>2i</sub></b> | 7.25           | 7.26  | 0.01  |
| <b>S<sub>3i</sub></b> | 9.18           | 9.19  | 0.01  |
| <b>S<sub>4i</sub></b> | 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

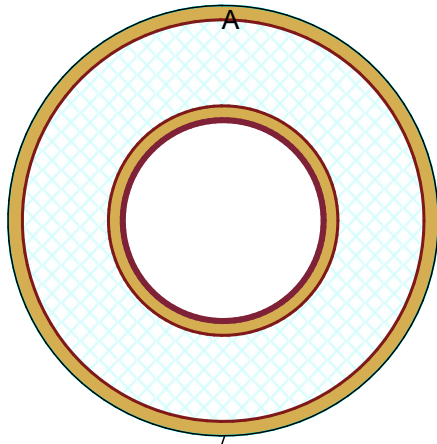
|          | EN ISO 10077-2 | flixo | Diff |
|----------|----------------|-------|------|
| <b>Φ</b> | 0.826          | 0.832 | 0.7% |

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%.

### Example G.1

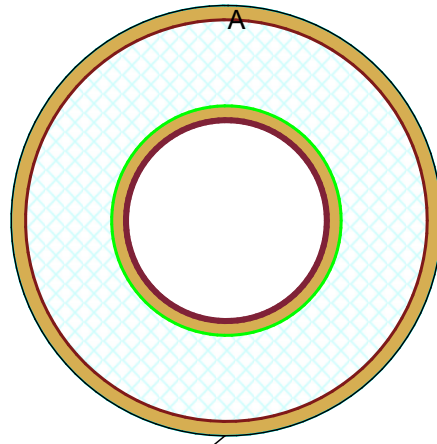
fixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.2

**Variant A**



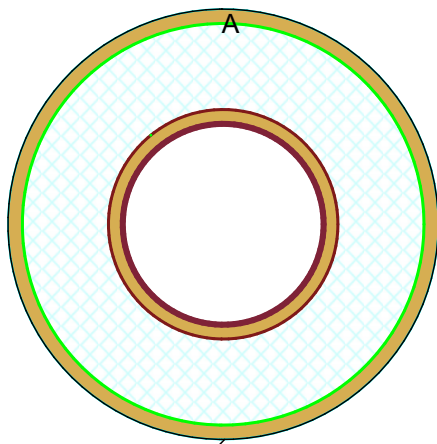
$\Phi_{A-A} = -44.12 \text{ W/m}$

**Variant B**



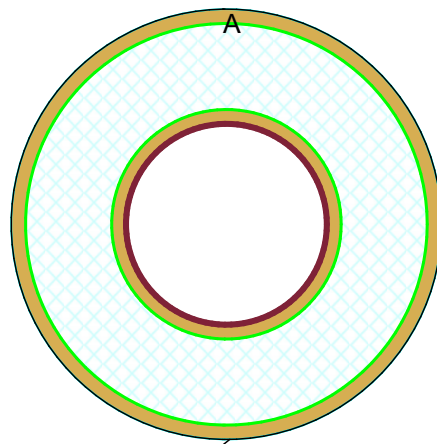
$\Phi_{A-A} = -5.15 \text{ W/m}$

**Variant C**



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

**Variant D**



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

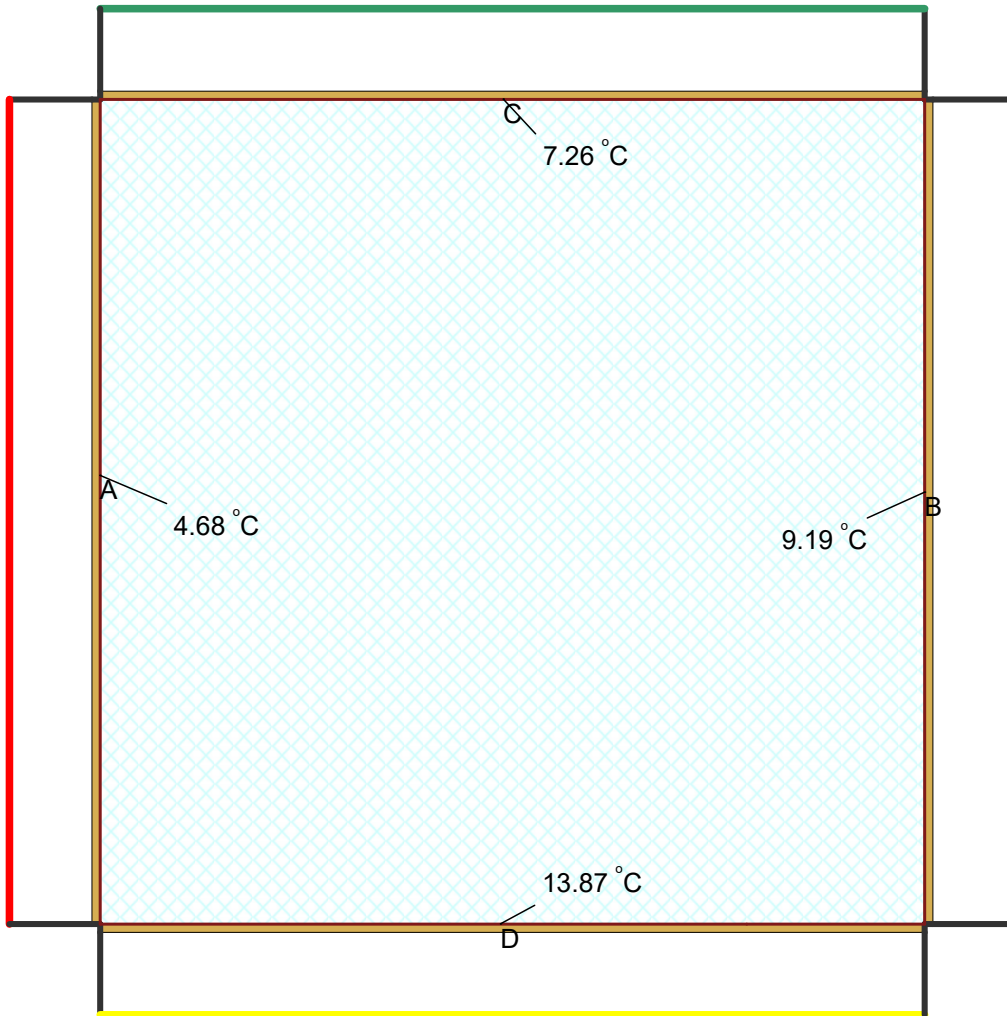
| Material          | $\lambda$ [W/(m·K)] | $\epsilon$ |
|-------------------|---------------------|------------|
| Perfect Conductor | 99999999.000        | 0.900      |
| Perfect Conductor | 99999999.000        | 0.100      |
| Vacuum            |                     |            |

| Boundary Condition | $q$ [W/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\epsilon$ |
|--------------------|-------------------------|---------------|-----------------------------|------------|
| 0 degree           |                         | 0.000         |                             |            |
| 20 degree          |                         | 20.000        |                             |            |
| Epsilon 0.1        |                         |               |                             | 0.100      |
| Epsilon 0.9        |                         |               |                             | 0.900      |

## Example G.2

fixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.2



| Material               | $\lambda$ [W/(m·K)]     | $\epsilon$    |                             |            |  |
|------------------------|-------------------------|---------------|-----------------------------|------------|--|
| Material 1             | 1.000                   |               |                             |            |  |
| Perfect Conductor      | 99999999.000            | 0.900         |                             |            |  |
| Vacuum                 |                         |               |                             |            |  |
| Boundary Condition     | $q$ [W/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\epsilon$ |  |
| 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                   |               |                             |            |  |

### Example G.3

fixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.2



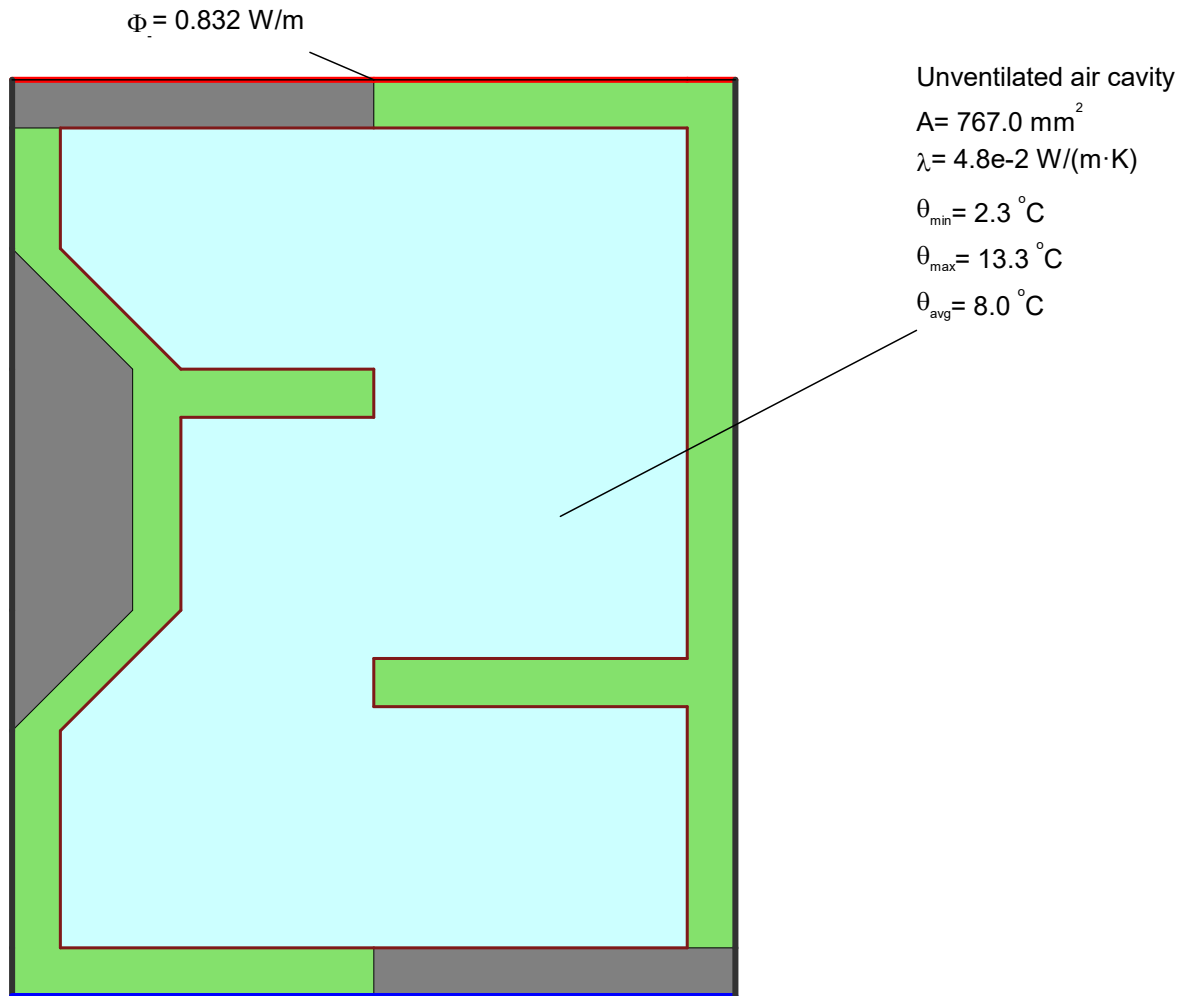
| Material    | $\lambda$ [W/(m·K)] | $\varepsilon$ |
|-------------|---------------------|---------------|
| Material 1  | 1.000               |               |
| Material 1A | 1.000               |               |

| Boundary Condition     | $q$ [W/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\varepsilon$ |
|------------------------|-------------------------|---------------|-----------------------------|---------------|
| 0 degree               |                         | 0.000         |                             |               |
| 20 degree              |                         | 20.000        |                             |               |
| Symmetry/Model section | 0.000                   |               |                             |               |



## Example G.4

flixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.2



Cavity equivalent conduction direction: 21.7°

| Material                   | $\lambda[\text{W}/(\text{m}\cdot\text{K})]$ | $\varepsilon$ |
|----------------------------|---|---------------|
| 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           | $q[\text{W}/\text{m}^2]$ | $\theta[^\circ\text{C}]$ | $R[(\text{m}^2\cdot\text{K})/\text{W}]$ | $\varepsilon$ |
|------------------------------|--------------------------|--------------------------|---|---------------|
| Epsilon 0.9                  |                          |                          |   | 0.900         |
| Exterior, normal             |                          | 0.000                    | 0.040                                   |               |
| Interior, normal, horizontal |                          | 20.000                   | 0.130                                   |               |
| Symmetry/Model section       | 0.000                    |                          |   |               |

## Summary

flixo pro 8.0.923.1  
 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:

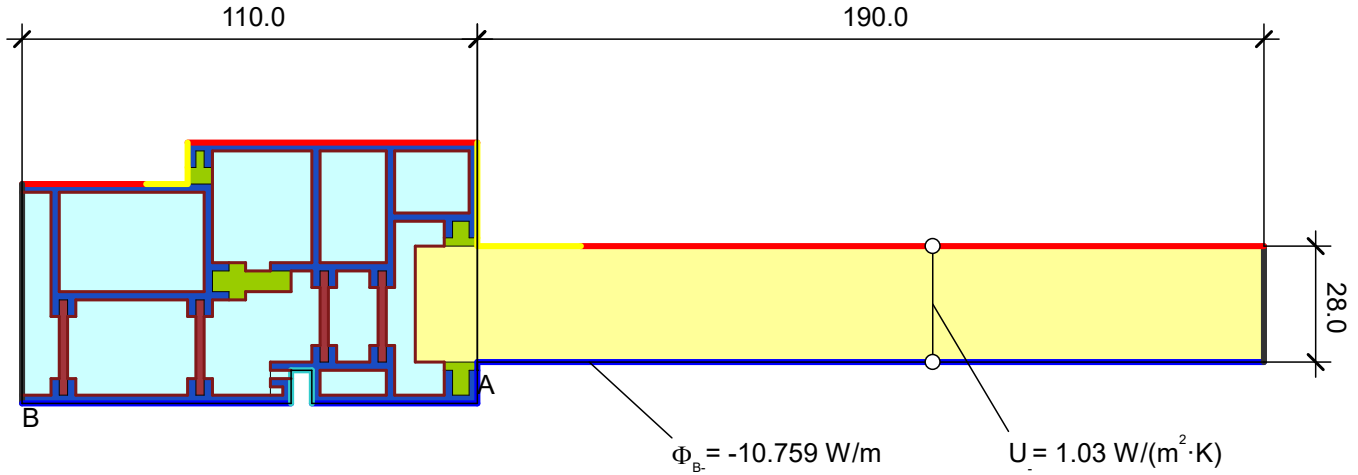
| EN ISO 10077-2:2017 |          |              |              |        | flixo  |              |       |       |        |              |
|---------------------|----------|--------------|--------------|--------|--------|--------------|-------|-------|--------|--------------|
| Name                | Standard | min          | max          | Uf/Psi | Q      | L            | bf    | Up/Ug | Uf/Psi | Diff.        |
| H.1                 | 0.539    | <b>0.523</b> | <b>0.555</b> | 3.110  | 10.759 | <b>0.538</b> | 0.110 | 1.031 | 3.11   | <b>-0.2%</b> |
| H.2                 | 0.508    | <b>0.493</b> | <b>0.523</b> | 2.830  | 10.131 | <b>0.507</b> | 0.110 | 1.031 | 2.82   | <b>-0.2%</b> |
| H.3                 | 0.252    | <b>0.244</b> | <b>0.260</b> | 1.350  | 5.046  | <b>0.252</b> | 0.110 | 0.547 | 1.35   | <b>0.0%</b>  |
| H.4                 | 0.400    | <b>0.388</b> | <b>0.412</b> | 1.860  | 7.995  | <b>0.400</b> | 0.110 | 1.031 | 1.86   | <b>0.0%</b>  |
| H.5                 | 0.344    | <b>0.334</b> | <b>0.354</b> | 1.340  | 6.884  | <b>0.344</b> | 0.110 | 1.031 | 1.35   | <b>0.0%</b>  |
| H.6                 | 0.407    | <b>0.395</b> | <b>0.419</b> | 2.070  | 8.150  | <b>0.408</b> | 0.089 | 1.169 | 2.09   | <b>0.2%</b>  |
| H.7                 | 0.637    | <b>0.618</b> | <b>0.656</b> | 4.440  | 12.702 | <b>0.635</b> | 0.095 | 1.131 | 4.42   | <b>-0.3%</b> |
| H.8                 | 0.281    | <b>0.273</b> | <b>0.289</b> | 1.230  | 5.624  | <b>0.281</b> | 0.048 | 1.169 | 1.23   | <b>0.0%</b>  |
| H.9                 | 0.188    | <b>0.182</b> | <b>0.194</b> | 1.060  | 3.755  | <b>0.188</b> | 0.177 |       | 1.06   | <b>0.0%</b>  |
| H.10                | 0.208    | <b>0.202</b> | <b>0.214</b> | 3.640  | 4.160  | <b>0.208</b> | 0.057 |       | 3.65   | <b>0.0%</b>  |
| H.11                | 0.478    | <b>0.464</b> | <b>0.492</b> | 0.083  | 9.589  | <b>0.479</b> | 0.110 | 1.305 | 0.083  | <b>0.2%</b>  |

The maximum relative difference of the heat flow calculated by flixo regarding to the one of the standard is 0.3%.

This is smaller than the maximal accepted difference of 3%.

## Example H.1

flixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.2



$$U_{f,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{10.759}{20.000} - 1.031 \cdot 0.190}{0.110} = 3.11 \text{ W}/(\text{m}^2 \cdot \text{K})$$

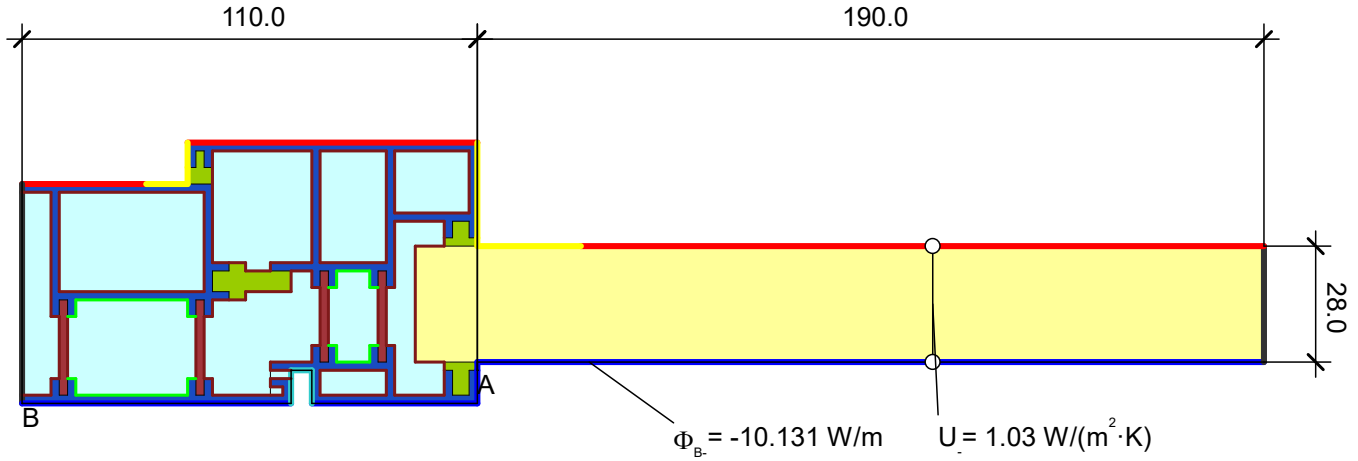
| Material                                | $\lambda$ [W/(m·K)] | $\epsilon$ |
|---|---------------------|------------|
| Aluminium (Si Alloys)                   | 160.000             | 0.900      |
| EPDM (ethylene propylene diene monomer) | 0.250               | 0.900      |
| Panel                                   | 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/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\epsilon$ |
|--|-------------------------|---------------|-----------------------------|------------|
| 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                   |               |                             |            |

## Example H.2

flixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.2



$$U_{f,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{10.131}{20.000} - 1.031 \cdot 0.190}{0.110} = 2.82 \text{ W}/(\text{m}^2 \cdot \text{K})$$

| Material                                | $\lambda$ [W/(m·K)] | $\epsilon$ |
|---|---------------------|------------|
| 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      |

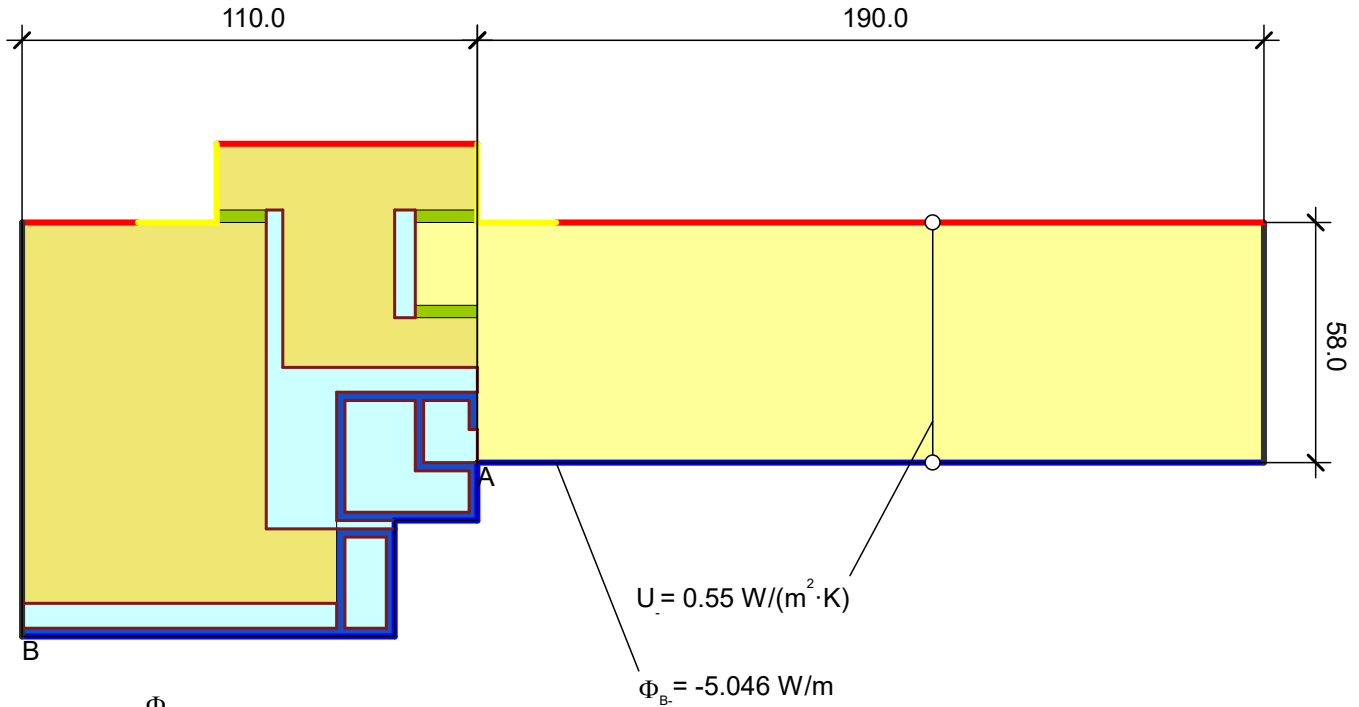
Unventilated air cavity \*\*

\*\* EN ISO 10077-2:2017, 6.4.2

| Boundary Condition                     | $q$ [W/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\epsilon$ |
|--|-------------------------|---------------|-----------------------------|------------|
| 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                   |               |                             |            |

### Example H.3

flixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.2



$$U_{f,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{5.046}{20.000} - 0.547 \cdot 0.190}{0.110} = 1.35 \text{ W}/(\text{m}^2 \cdot \text{K})$$

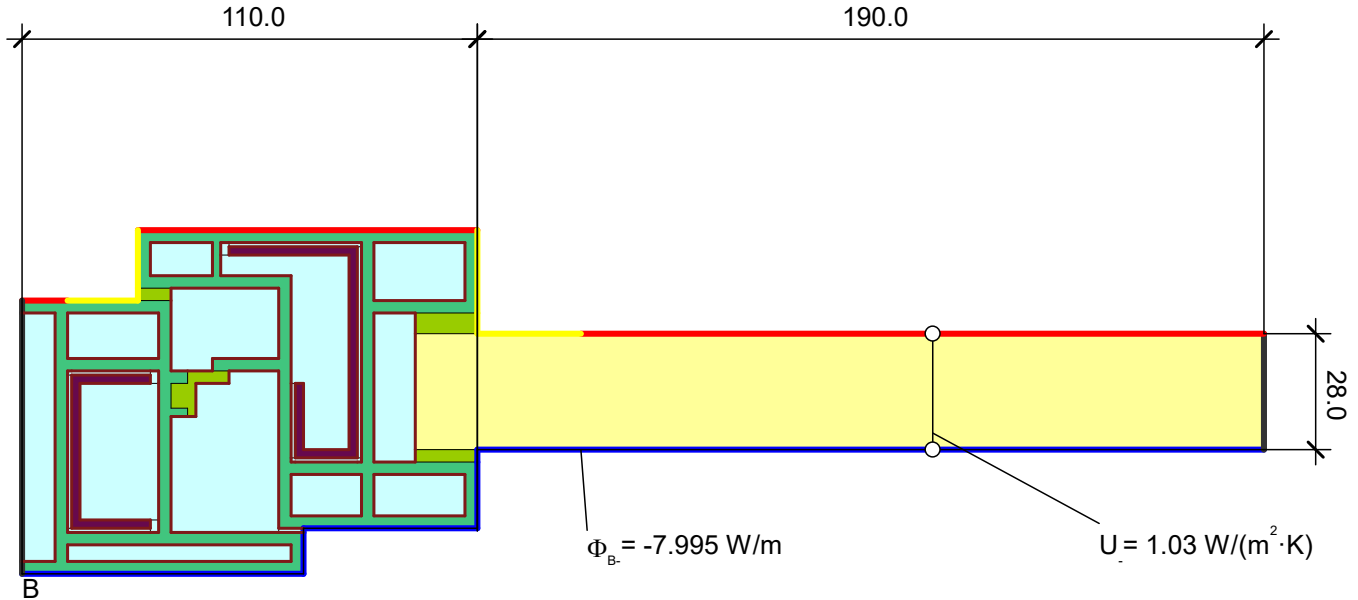
| Material                                  | $\lambda$ [W/(m·K)] | $\epsilon$ |
|---|---------------------|------------|
| Aluminium (Si Alloys)                     | 160.000             | 0.900      |
| EPDM (ethylene propylene diene monomer)   | 0.250               | 0.900      |
| Panel                                     | 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/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\epsilon$ |
|--------------------------|-------------------------|---------------|-----------------------------|------------|
| 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                   |               |                             |            |

## Example H.4

flixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.2



$$U_{f,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{7.995}{20.000} - 1.031 \cdot 0.190}{0.110} = 1.85 \text{ W}/(\text{m}^2 \cdot \text{K})$$

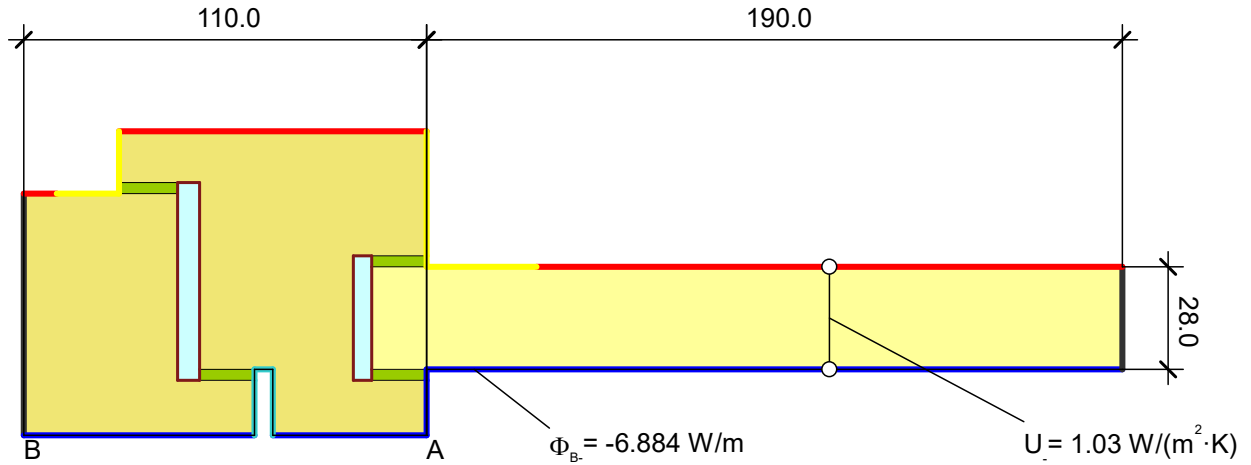
| Material                                | $\lambda$ [W/(m·K)] | $\epsilon$ |
|---|---------------------|------------|
| EPDM (ethylene propylene diene monomer) | 0.250               | 0.900      |
| PVC-U (polyvinylchloride), rigid        | 0.170               | 0.900      |
| Panel               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

\*\* EN ISO 10077-2:2017, 6.4.2

| Boundary Condition       | $q$ [W/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\epsilon$ |
|--------------------------|-------------------------|---------------|-----------------------------|------------|
| 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                   |               |                             |            |

## Example H.5

flixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.2



$$U_{f,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{6.884}{20.000} - 1.031 \cdot 0.190}{0.110} = 1.35 \text{ W}/(\text{m}^2 \cdot \text{K})$$

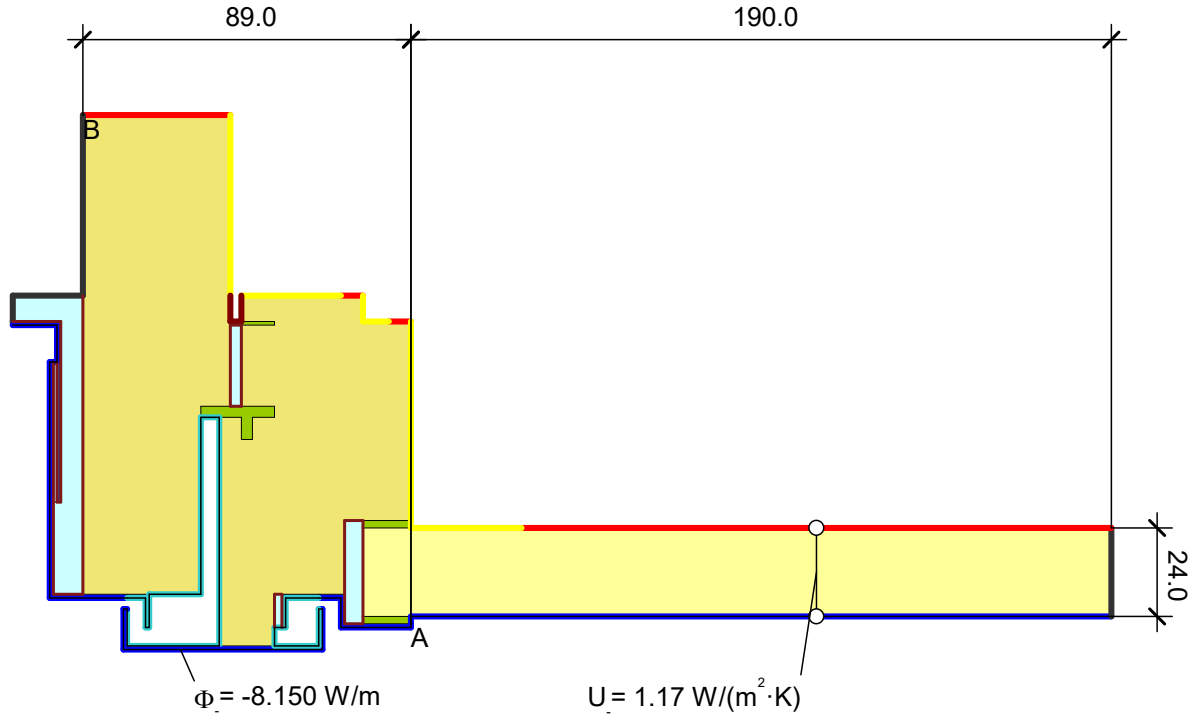
| Material                                  | $\lambda$ [W/(m·K)] | $\epsilon$ |
|---|---------------------|------------|
| EPDM (ethylene propylene diene monomer)   | 0.250               | 0.900      |
| Panel                                     | 0.035               | 0.900      |
| Softwood 500, typical construction timber | 0.130               | 0.900      |
| Unventilated air cavity **                |                     |            |

\*\* EN ISO 10077-2:2017, 6.4.2

| Boundary Condition                     | $q$ [W/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\epsilon$ |
|--|-------------------------|---------------|-----------------------------|------------|
| 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                   |               |                             |            |

## Example H.6

flixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.2



$$U_{f,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{8.150}{20.000} - 1.169 \cdot 0.190}{0.089} = 2.08 \text{ W/(m}^2 \cdot \text{K)}$$

| Material                                  | $\lambda$ [W/(m·K)] | $\epsilon$ |
|---|---------------------|------------|
| 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 **                |                     |            |

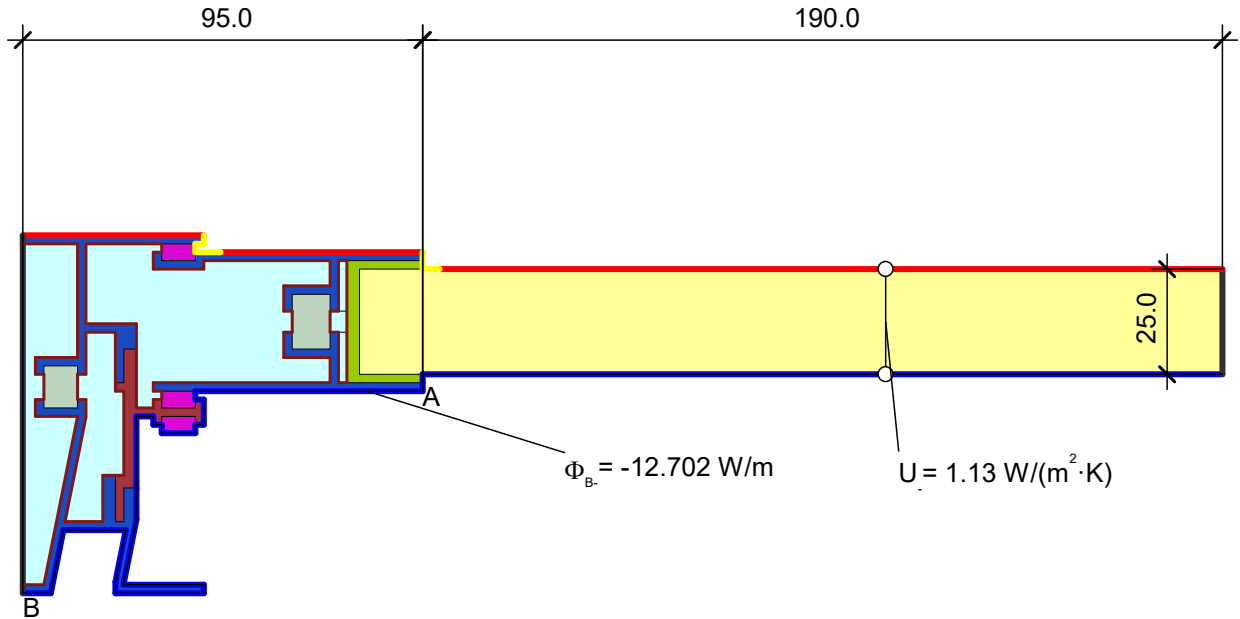
\*\* EN ISO 10077-2:2017, 6.4.2

| Boundary Condition                     | $q$ [W/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\epsilon$ |
|--|-------------------------|---------------|-----------------------------|------------|
| 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                   |               |                             |            |



## Example H.7

flixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.2



$$U_{f,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{12.702}{20.000} - 1.131 \cdot 0.190}{0.095} = 4.42 \text{ W}/(\text{m}^2 \cdot \text{K})$$

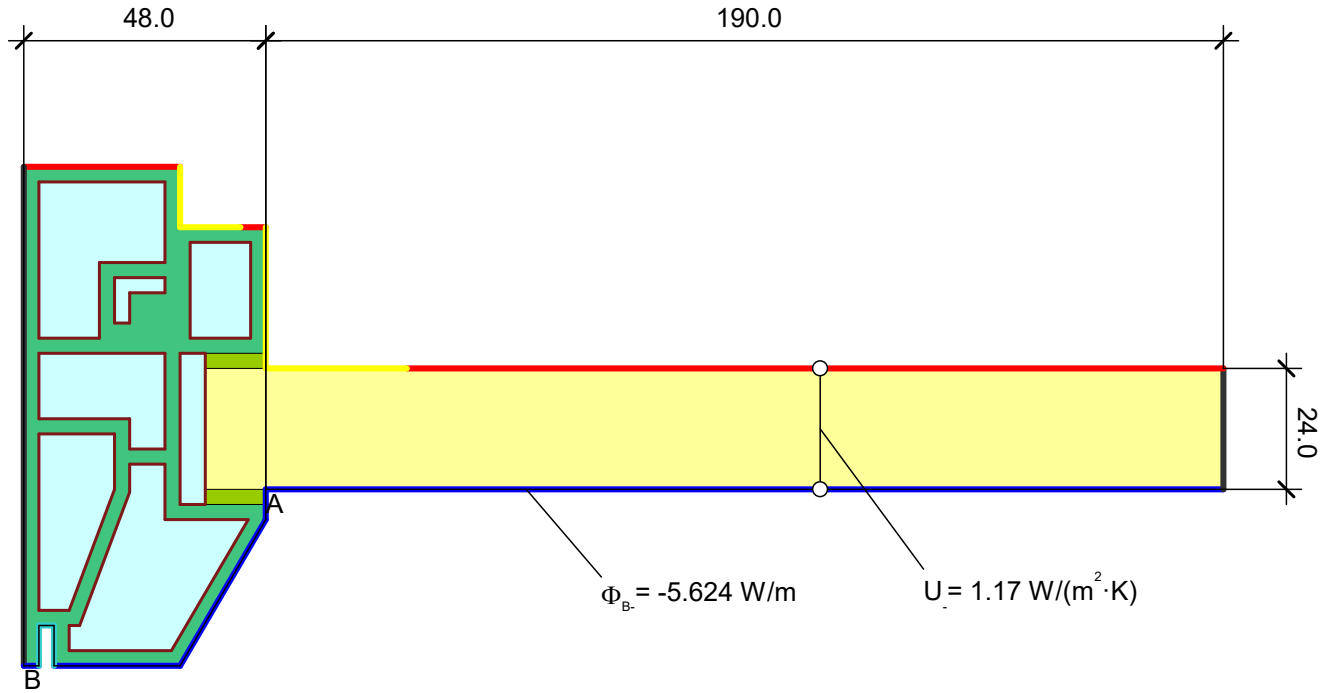
| Material                                  | $\lambda$ [W/(m·K)] | $\epsilon$ |
|---|---------------------|------------|
| Aluminium (Si Alloys)                     | 160.000             | 0.900      |
| EPDM (ethylene propylene diene monomer)   | 0.250               | 0.900      |
| PU (polyurethane)                         | 0.250               | 0.900      |
| Panel                                     | 0.035               |            |
| Pile weather stripping (polyester mohair) | 0.140               | 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/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\epsilon$ |
|--------------------------|-------------------------|---------------|-----------------------------|------------|
| 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                   |               |                             |            |

### Example H.8

flixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.2



$$U_{f,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{5.624}{20.000} - 1.169 \cdot 0.190}{0.048} = 1.23 \text{ W}/(\text{m}^2 \cdot \text{K})$$

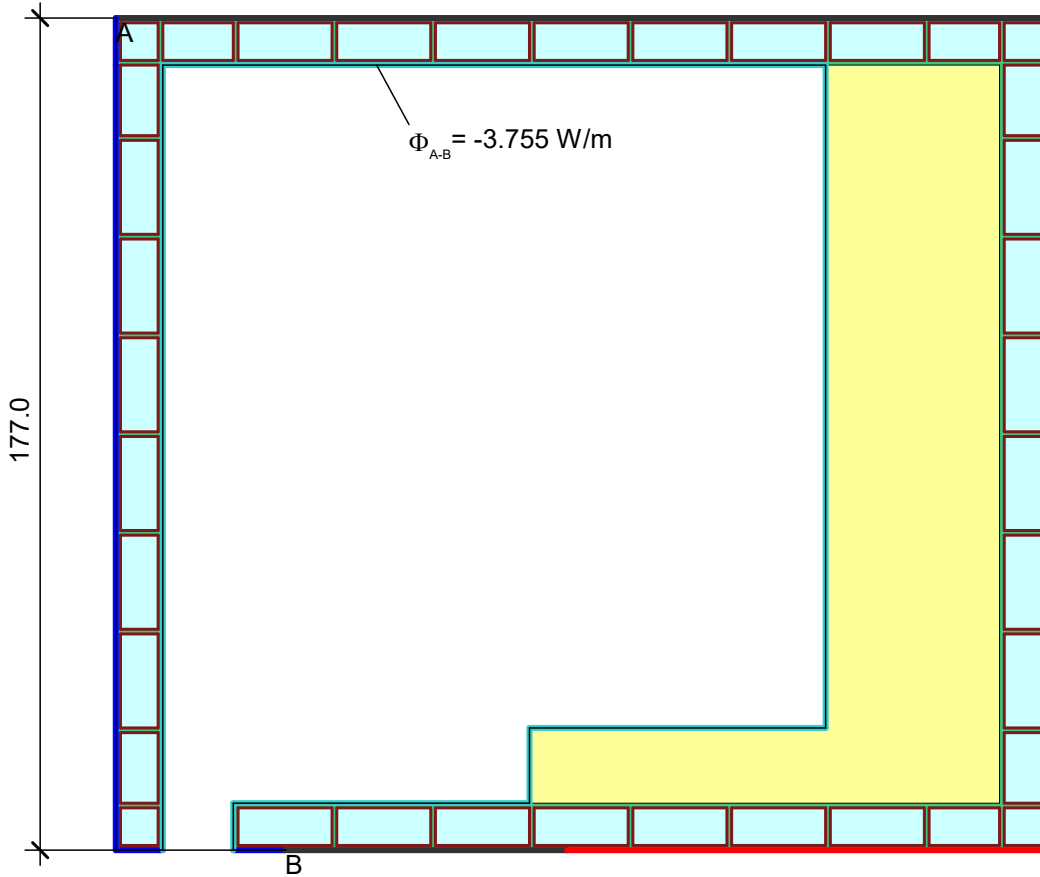
| Material                                | $\lambda$ [W/(m·K)] | $\epsilon$ |
|---|---------------------|------------|
| EPDM (ethylene propylene diene monomer) | 0.250               | 0.900      |
| PVC-U (polyvinylchloride), rigid        | 0.170               | 0.900      |
| Panel               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

\*\* EN ISO 10077-2:2017, 6.4.2

| Boundary Condition                     | $q$ [W/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\epsilon$ |
|--|-------------------------|---------------|-----------------------------|------------|
| 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                   |               |                             |            |

## Example H.9

flixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.2



$$U_{sb\ A-B} = \frac{\Phi}{\Delta T \cdot b} = \frac{3.755}{20.000 \cdot 0.177} = 1.06 \text{ W}/(\text{m}^2 \cdot \text{K})$$

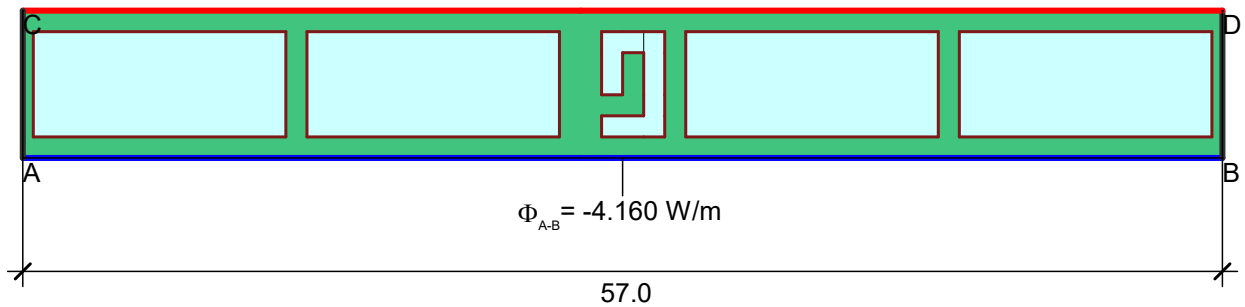
| Material  | $\lambda$ [W/(m·K)] | $\varepsilon$ |
|---|---------------------|---------------|
| <span style="color: red;">■</span> PVC-U (polyvinylchloride), rigid | 0.170               | 0.900         |
| <span style="color: yellow;">■</span> Panel                         | 0.035               |               |
| <span style="color: cyan;">■</span> Unventilated air cavity **      |                     |               |

\*\* EN ISO 10077-2:2017, 6.4.2

| Boundary Condition   | $q$ [W/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\varepsilon$ |
|--|-------------------------|---------------|-----------------------------|---------------|
| <span style="color: red;">■</span> Epsilon 0.9                             |                         |               |                             | 0.900         |
| <span style="color: cyan;">■</span> Exterior, Slightly ventilated cavities |                         | 0.000         | 0.300                       |               |
| <span style="color: blue;">■</span> Exterior, frame                        |                         | 0.000         | 0.040                       |               |
| <span style="color: red;">■</span> Interior, Slightly ventilated cavities  |                         | 20.000        | 0.300                       |               |
| <span style="color: red;">■</span> Interior, normal                        |                         | 20.000        | 0.130                       |               |
| <span style="color: black;">■</span> Symmetry/Model section                | 0.000                   |               |                             |               |

## Example H.10

flixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.2



$$U_{\text{eq A-B}} = \frac{\Phi}{\Delta T \cdot b} = \frac{4.160}{20.000 \cdot 0.057} = 3.65 \text{ W}/(\text{m}^2 \cdot \text{K})$$

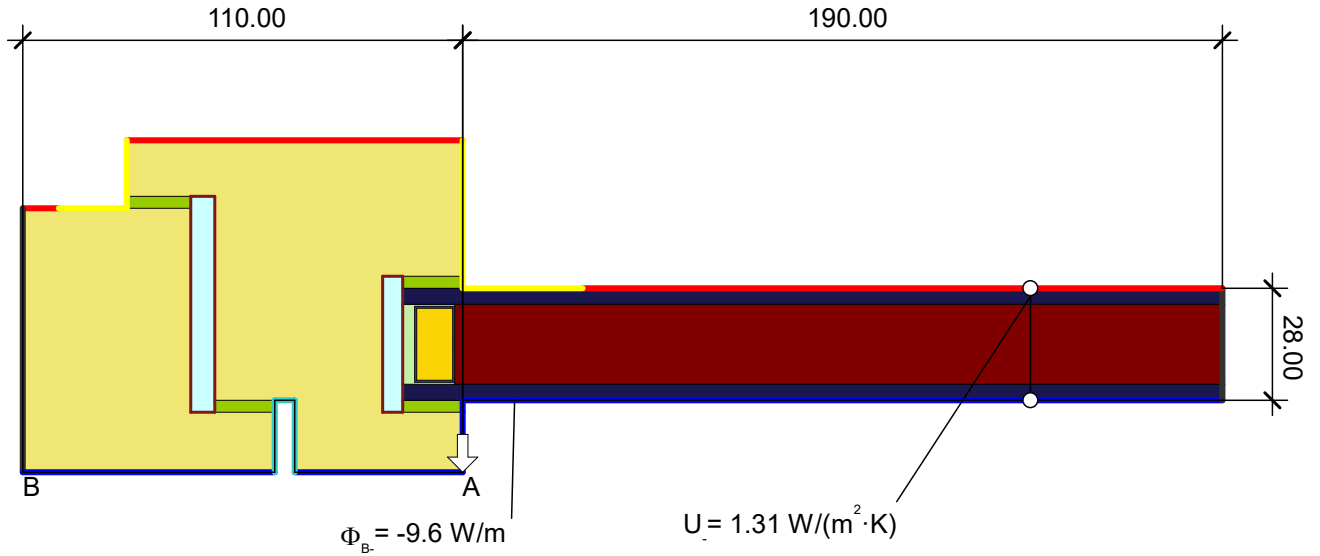
| Material  | $\lambda$ [W/(m·K)] | $\epsilon$ |
|---|---------------------|------------|
| <span style="color: green;">■</span> PVC-U (polyvinylchloride), rigid | 0.170               | 0.900      |
| <span style="color: cyan;">■</span> Unventilated air cavity **        |                     |            |
| ** EN ISO 10077-2:2017, 6.4.2   |                     |            |

| Boundary Condition  | $q$ [W/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\epsilon$ |
|---|-------------------------|---------------|-----------------------------|------------|
| <span style="color: brown;">■</span> Epsilon 0.9            |                         |               |                             | 0.900      |
| <span style="color: blue;">■</span> Exterior, frame         |                         | 0.000         | 0.040                       |            |
| <span style="color: red;">■</span> Interior, frame, normal  |                         | 20.000        | 0.130                       |            |
| <span style="color: black;">■</span> Symmetry/Model section | 0.000                   |               |                             |            |

## Example H.11

flixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.2



$$\psi_A = \frac{\Phi}{\Delta T} - U_g \cdot b_g - U_f \cdot b_f = \frac{9.589}{20.000} - 1.305 \cdot 0.190 - 1.348 \cdot 0.110 = 0.083 \text{ W/(m} \cdot \text{K)}$$

| Material                                  | $\lambda$ [W/(m·K)] | $\epsilon$ |
|---|---------------------|------------|
| Aluminium (Si Alloys)                     | 160.000             |            |
| EPDM (ethylene propylene diene monomer)   | 0.250               | 0.900      |
| Glazing                                   | 0.034               |            |
| Polysulfide                               | 0.400               | 0.900      |
| Silica gel (desiccant)                    | 0.130               |            |
| 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/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\epsilon$ |
|--|-------------------------|---------------|-----------------------------|------------|
| 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                   |               |                             |            |

## Summary

flixo pro 8.0.923.1  
 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:

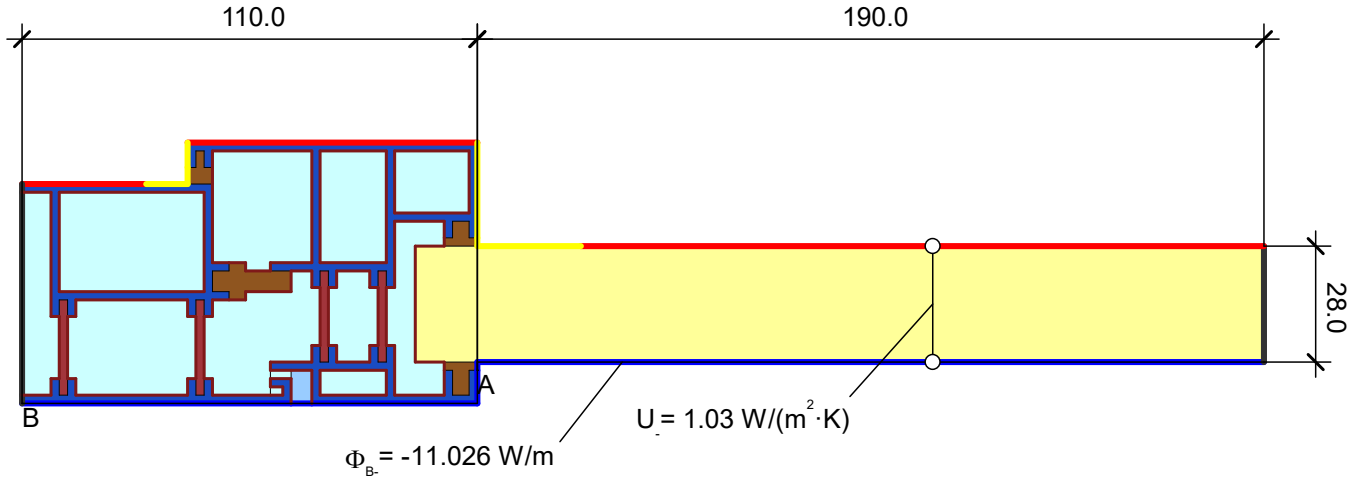
| EN ISO 10077-2:2017 |          |              |              |        | flixo         |              |       |       |        |              |
|---------------------|----------|--------------|--------------|--------|---------------|--------------|-------|-------|--------|--------------|
| Name                | Standard | min          | max          | Uf/Psi | Q             | L            | bf    | Up/Ug | Uf/Psi | Diff.        |
| I.1                 | 0.550    | <b>0.534</b> | <b>0.567</b> | 3.22   | <b>11.026</b> | <b>0.551</b> | 0.110 | 1.031 | 3.23   | <b>0.2%</b>  |
| I.2                 | 0.263    | <b>0.255</b> | <b>0.271</b> | 1.44   | <b>5.213</b>  | <b>0.261</b> | 0.110 | 0.547 | 1.43   | <b>-0.8%</b> |
| I.3                 | 0.424    | <b>0.411</b> | <b>0.437</b> | 2.07   | <b>8.298</b>  | <b>0.415</b> | 0.110 | 1.031 | 1.99   | <b>-2.1%</b> |
| I.4                 | 0.346    | <b>0.336</b> | <b>0.356</b> | 1.36   | <b>6.915</b>  | <b>0.346</b> | 0.110 | 1.031 | 1.36   | <b>0.0%</b>  |
| I.5                 | 0.408    | <b>0.396</b> | <b>0.420</b> | 2.08   | <b>7.987</b>  | <b>0.399</b> | 0.089 | 1.169 | 1.99   | <b>-2.2%</b> |
| I.6                 | 0.659    | <b>0.639</b> | <b>0.679</b> | 4.67   | <b>13.363</b> | <b>0.668</b> | 0.095 | 1.131 | 4.77   | <b>1.4%</b>  |
| I.7                 | 0.285    | <b>0.276</b> | <b>0.294</b> | 1.31   | <b>5.658</b>  | <b>0.283</b> | 0.048 | 1.169 | 1.27   | <b>-0.7%</b> |
| I.8                 | 0.181    | <b>0.176</b> | <b>0.186</b> | 1.05   | <b>3.611</b>  | <b>0.181</b> | 0.177 |       | 1.02   | <b>0.0%</b>  |
| I.9                 | 0.207    | <b>0.201</b> | <b>0.213</b> | 3.64   | <b>4.135</b>  | <b>0.207</b> | 0.057 |       | 3.63   | <b>0.0%</b>  |
| I.10                | 0.481    | <b>0.467</b> | <b>0.495</b> | 0.084  | <b>9.622</b>  | <b>0.481</b> | 0.110 | 1.305 | 0.083  | <b>0.0%</b>  |

The maximum relative difference of the heat flow calculated by flixo regarding to the one of the standard is 2.1%.

This is smaller than the maximal accepted difference of 3%.

## Example I.1

flixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.3



$$U_{f,AB} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{11.026}{20.000} - 1.031 \cdot 0.190}{0.110} = 3.23 \text{ W}/(\text{m}^2 \cdot \text{K})$$

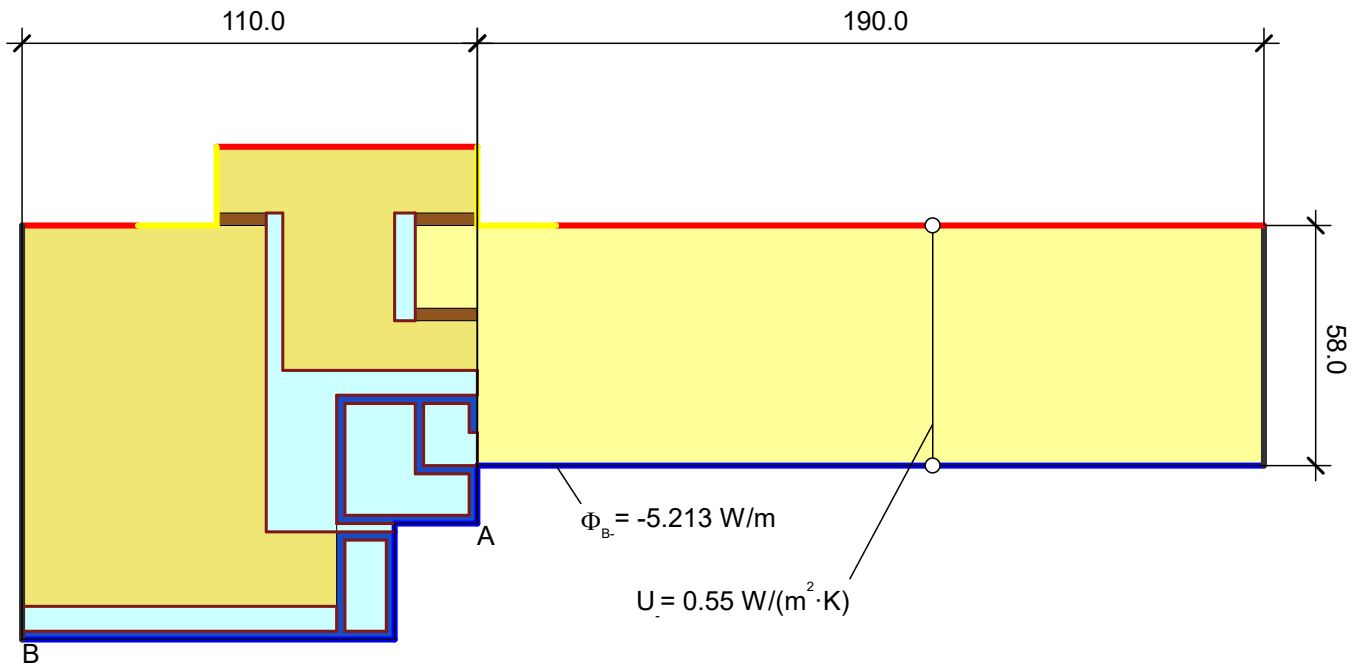
| Material                                | $\lambda$ [W/(m·K)] | $\epsilon$ |
|---|---------------------|------------|
| Aluminium (Si Alloys)                   | 160.000             | 0.900      |
| EPDM (ethylene propylene diene monomer) | 0.250               | 0.900      |
| Panel                                   | 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 <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\epsilon$ |
|--------------------------|-------------------------|---------------|-----------------------------|------------|
| 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                   |               |                             |            |

## Example I.2

flixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.3



$$U_{f,AB} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{5.213}{20.000} - 0.547 \cdot 0.190}{0.110} = 1.42 \text{ W}/(\text{m}^2 \cdot \text{K})$$

| Material                                  | $\lambda$ [W/(m·K)] | $\epsilon$ |
|---|---------------------|------------|
| 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 **                |                     |            |

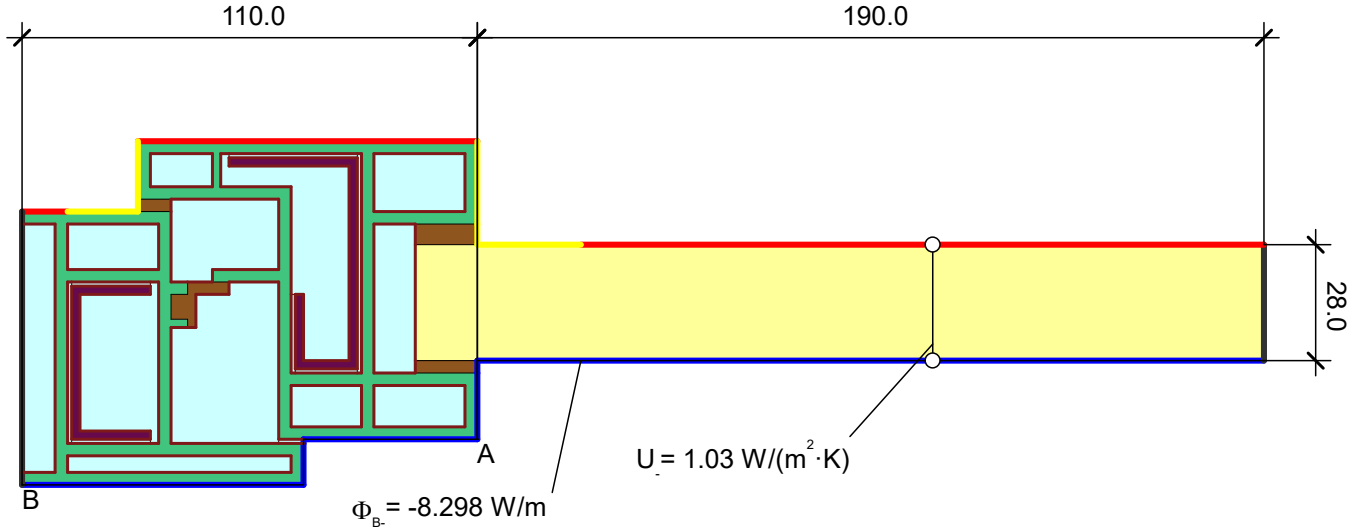
\*\* EN ISO 10077-2:2017, 6.4.3

| Boundary Condition       | $q$ [W/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\epsilon$ |
|--------------------------|-------------------------|---------------|-----------------------------|------------|
| 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                   |               |                             |            |



### Example I.3

flixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.3



$$U_{f,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{8.298}{20.000} - 1.031 \cdot 0.190}{0.110} = 1.99 \text{ W}/(\text{m}^2 \cdot \text{K})$$

| Material                                | $\lambda$ [W/(m·K)] | $\epsilon$ |
|---|---------------------|------------|
| 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      |

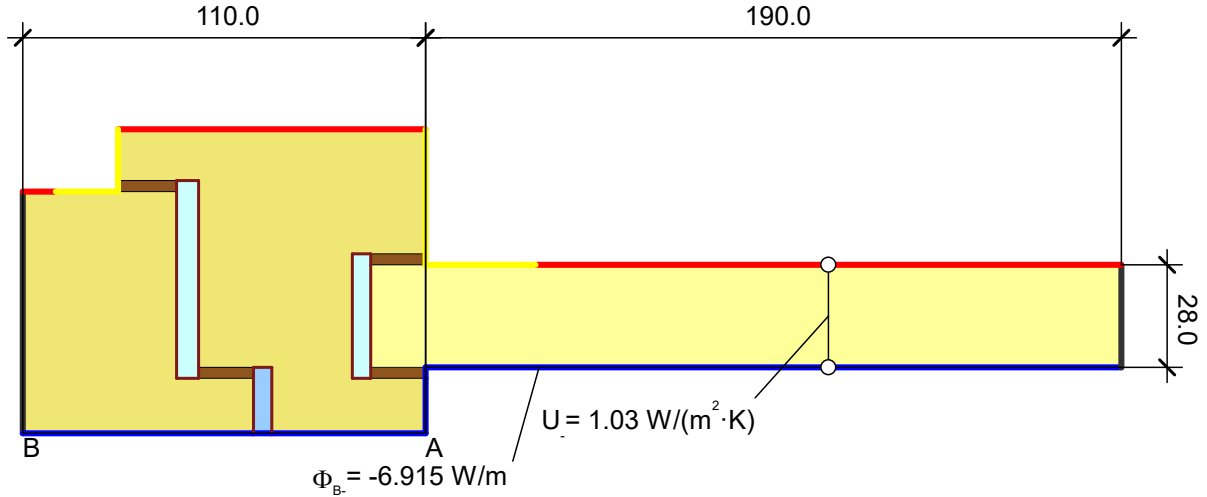
Unventilated air cavity \*\*

\*\* EN ISO 10077-2:2017, 6.4.3

| Boundary Condition       | $q$ [W/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\epsilon$ |
|--------------------------|-------------------------|---------------|-----------------------------|------------|
| 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                   |               |                             |            |

## Example I.4

flixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.3



$$U_{f,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{6.915}{20.000} - 1.031 \cdot 0.190}{0.110} = 1.36 \text{ W}/(\text{m}^2 \cdot \text{K})$$

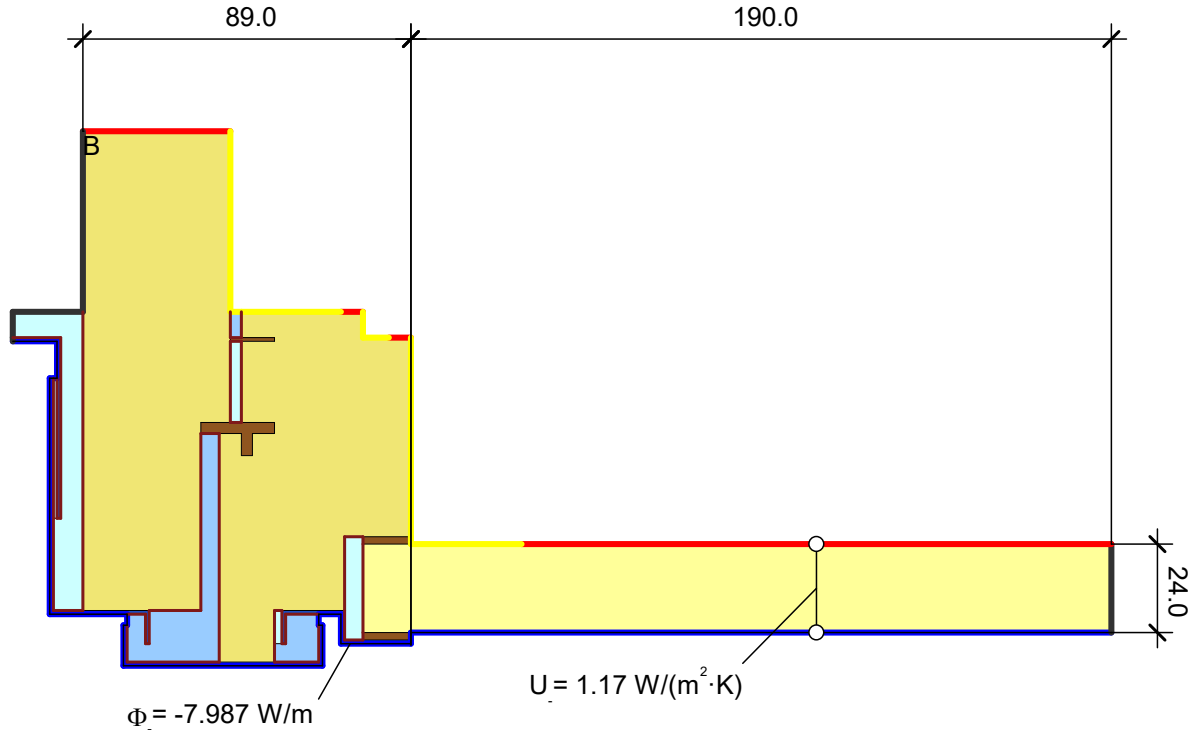
| Material                                    | $\lambda$ [W/(m·K)] | $\varepsilon$ |
|---|---------------------|---------------|
| ■ EPDM (ethylene propylene diene monomer)   | 0.250               | 0.900         |
| ■ Panel                                     | 0.035               | 0.900         |
| ■ 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/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\varepsilon$ |
|----------------------------|-------------------------|---------------|-----------------------------|---------------|
| ■ 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                   |               |                             |               |

## Example I.5

flixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.3



$$U_{fA,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{7.987}{20.000} - 1.169 \cdot 0.190}{0.089} = 1.99 \text{ W}/(\text{m}^2 \cdot \text{K})$$

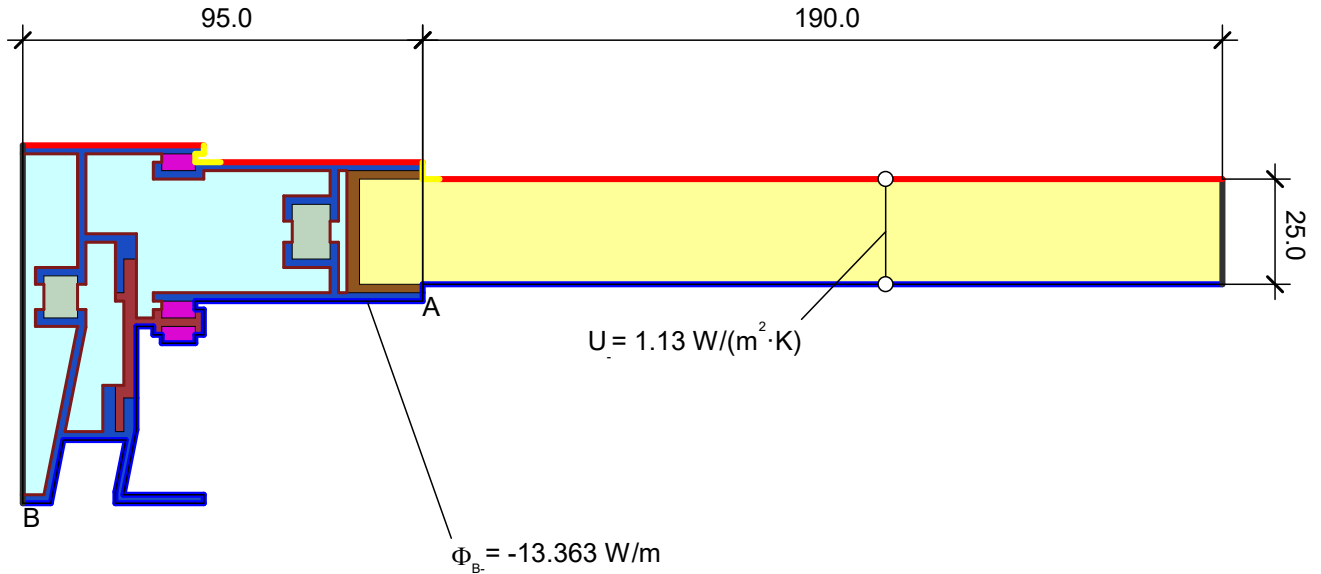
| Material                                  | $\lambda$ [W/(m·K)] | $\epsilon$ |
|---|---------------------|------------|
| Aluminium (Si Alloys)                     | 160.000             | 0.900      |
| EPDM (ethylene propylene diene monomer)   | 0.250               | 0.900      |
| Panel                                     | 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/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\epsilon$ |
|--------------------------|-------------------------|---------------|-----------------------------|------------|
| 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                   |               |                             |            |

## Example I.6

flixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.3



$$U_{fA,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{13.363}{20.000} - 1.131 \cdot 0.190}{0.095} = 4.77 \text{ W}/(\text{m}^2 \cdot \text{K})$$

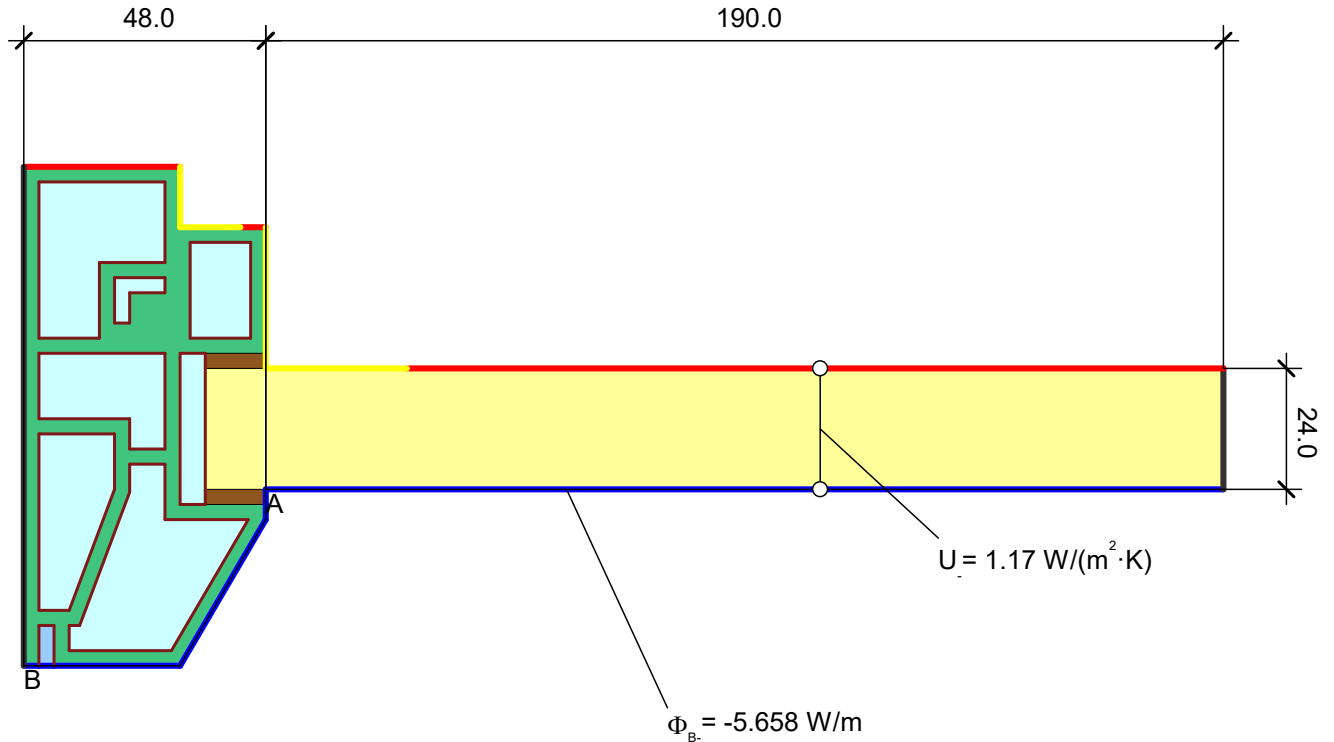
| Material                                  | $\lambda$ [W/(m·K)] | $\epsilon$ |
|---|---------------------|------------|
| Aluminium (Si Alloys)                     | 160.000             | 0.900      |
| EPDM (ethylene propylene diene monomer)   | 0.250               | 0.900      |
| PU (polyurethane)                         | 0.250               | 0.900      |
| Panel                                     | 0.035               |            |
| Pile weather stripping (polyester mohair) | 0.140               | 0.900      |
| Polyamid 6.6 with 25% glass fibre         | 0.300               | 0.900      |
| Unventilated air cavity **                |                     |            |

\*\* EN ISO 10077-2:2017, 6.4.3

| Boundary Condition       | $q$ [W/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\epsilon$ |
|--------------------------|-------------------------|---------------|-----------------------------|------------|
| 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                   |               |                             |            |

## Example I.7

flixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.3



$$U_{fA,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{5.658}{20.000} - 1.169 \cdot 0.190}{0.048} = 1.27 \text{ W}/(\text{m}^2 \cdot \text{K})$$

| Material                                | $\lambda$ [W/(m·K)] | $\epsilon$ |
|---|---------------------|------------|
| EPDM (ethylene propylene diene monomer) | 0.250               | 0.900      |
| PVC-U (polyvinylchloride), rigid        | 0.170               | 0.900      |
| Panel                                   | 0.035               | 0.900      |

Slightly ventilated air cavity \*\*

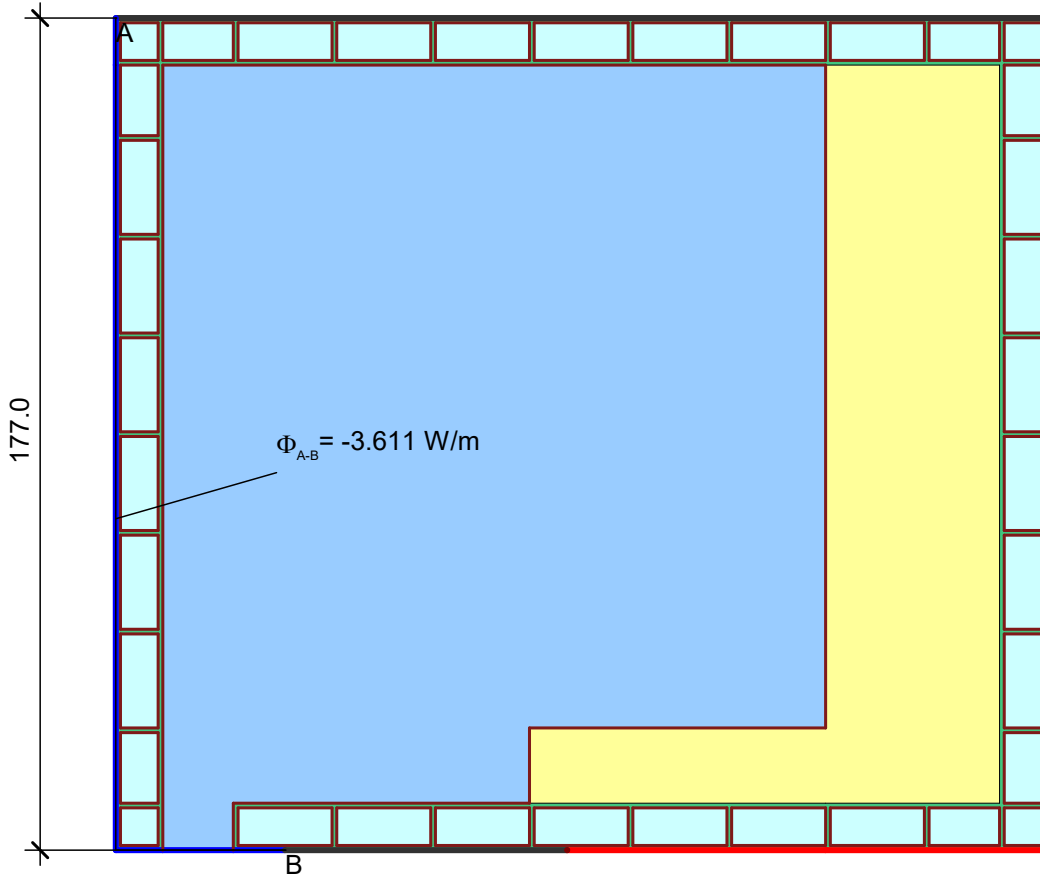
Unventilated air cavity \*\*

\*\* EN ISO 10077-2:2017, 6.4.3

| Boundary Condition       | $q$ [W/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\epsilon$ |
|--------------------------|-------------------------|---------------|-----------------------------|------------|
| 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                   |               |                             |            |

## Example I.8

flixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.3



$$U_{sb\ A-B} = \frac{\Phi}{\Delta T \cdot b} = \frac{3.611}{20.000 \cdot 0.177} = 1.02\ \text{W}/(\text{m}^2 \cdot \text{K})$$

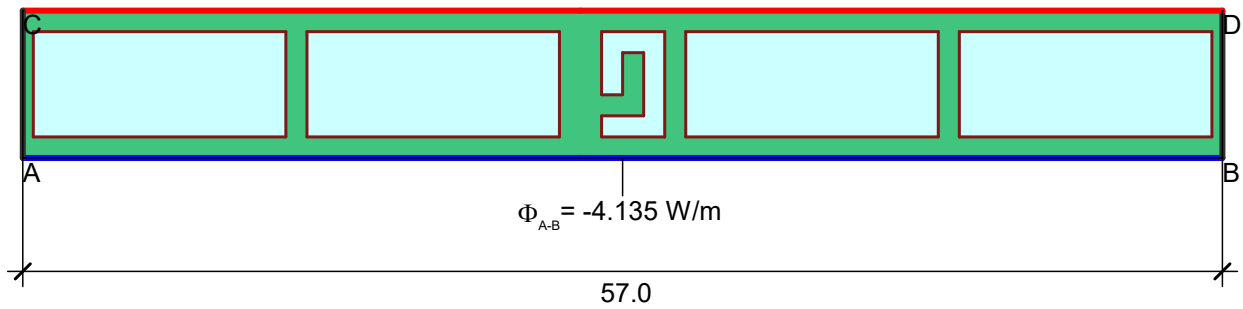
| Material                          | $\lambda$ [W/(m·K)] | $\varepsilon$ |
|-----------------------------------|---------------------|---------------|
| PVC-U (polyvinylchloride), rigid  | 0.170               | 0.900         |
| Panel                             | 0.035               | 0.900         |
| Slightly ventilated air cavity ** |                     |               |
| Unventilated air cavity **        |                     |               |

\*\* EN ISO 10077-2:2017, 6.4.3

| Boundary Condition                     | $q$ [W/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\varepsilon$ |
|--|-------------------------|---------------|-----------------------------|---------------|
| 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                   |               |                             |               |

## Example I.9

flixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.3

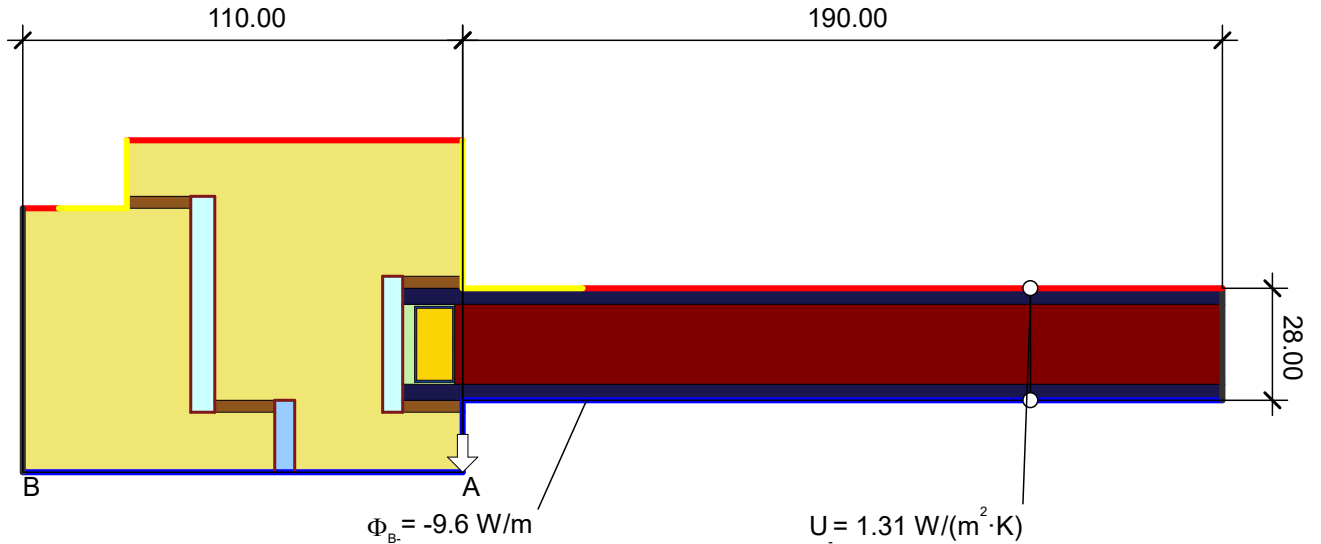


$$U_{\text{eq A-B}} = \frac{\Phi}{\Delta T \cdot b} = \frac{4.135}{20.000 \cdot 0.057} = 3.63 \text{ W}/(\text{m}^2 \cdot \text{K})$$

| Material  | $\lambda$ [W/(m·K)]     | $\varepsilon$ |                             |               |
|---|-------------------------|---------------|-----------------------------|---------------|
| <span style="color: green;">■</span> PVC-U (polyvinylchloride), rigid | 0.170                   | 0.900         |                             |               |
| <span style="color: cyan;">■</span> Unventilated air cavity **        |                         |               |                             |               |
| ** EN ISO 10077-2:2017, 6.4.3   |                         |               |                             |               |
| Boundary Condition  | $q$ [W/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\varepsilon$ |
| <span style="color: brown;">■</span> Epsilon 0.9                      |                         |               |                             | 0.900         |
| <span style="color: blue;">■</span> Exterior, frame                   |                         | 0.000         | 0.040                       |               |
| <span style="color: red;">■</span> Interior, frame, normal            |                         | 20.000        | 0.130                       |               |
| <span style="color: black;">■</span> Symmetry/Model section           | 0.000                   |               |                             |               |

### Example I.10

flixo pro 8.0.923.1  
 EN ISO 10077-2:2017, 6.4.3



$$\psi_A = \frac{\Phi}{\Delta T} - U_g \cdot b_g - U_f \cdot b_f = \frac{9.622}{20.000} - 1.305 \cdot 0.190 - 1.363 \cdot 0.110 = 0.083 \text{ W}/(\text{m} \cdot \text{K})$$

| Material                                  | $\lambda$ [W/(m·K)] | $\epsilon$ |
|---|---------------------|------------|
| Aluminium (Si Alloys)                     | 160.000             |            |
| EPDM (ethylene propylene diene monomer)   | 0.250               | 0.900      |
| Glazing                                   | 0.034               |            |
| Polysulfide                               | 0.400               | 0.900      |
| Silica gel (desiccant)                    | 0.130               |            |
| 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/m <sup>2</sup> ] | $\theta$ [°C] | $R$ [(m <sup>2</sup> ·K)/W] | $\epsilon$ |
|--------------------------|-------------------------|---------------|-----------------------------|------------|
| 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                   |               |                             |            |