

## roof insulation

Exterior wall  
created on 16.6.2024

### Thermal protection

$U = 0,16 \text{ W}/(\text{m}^2\text{K})$

GEG 2020/23 Bestand\*:  $U < 0,24 \text{ W}/(\text{m}^2\text{K})$



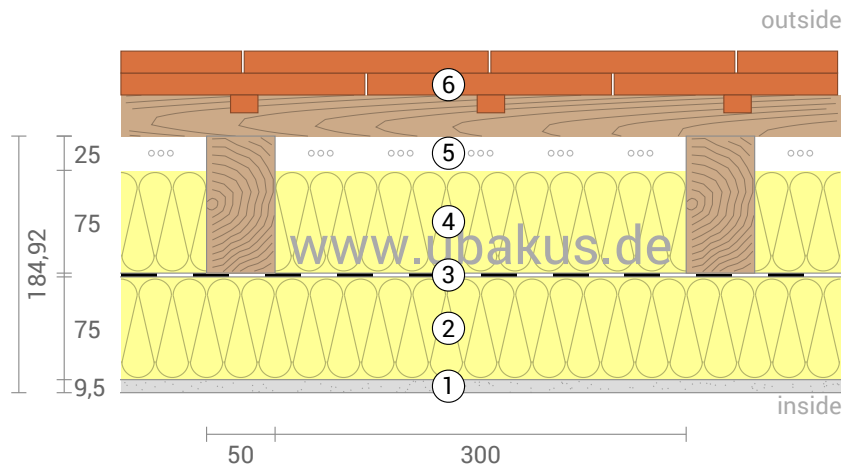
### Moisture proofing

Dries 48 days  
Condensate:  $93 \text{ g}/\text{m}^2$



### Heat protection

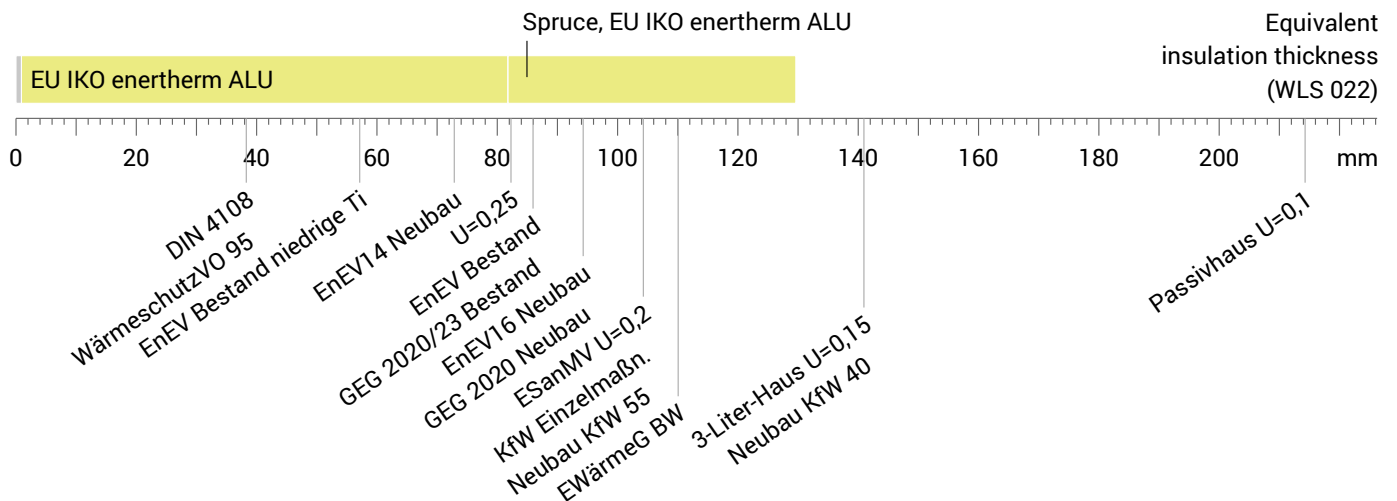
Temperature amplitude damping: 4,6  
phase shift: 7,1 h  
Thermal capacity inside:  $10,4 \text{ kJ}/\text{m}^2\text{K}$



- |                                |                                |                                   |
|--------------------------------|--------------------------------|-----------------------------------|
| ① Gypsum board (9,5 mm)        | ③ Riwega USB Micro 100/20      | ⑤ Rear ventilated level (25 mm)   |
| ② EU IKO enertherm ALU (75 mm) | ④ EU IKO enertherm ALU (75 mm) | ⑥ Plain tiles and battens (75 mm) |

### Impact of each layer and comparison to reference values

For the following figure, the thermal resistances of the individual layers were converted in millimeters insulation. The scale refers to an insulation of thermal conductivity  $0,022 \text{ W}/\text{mK}$ .



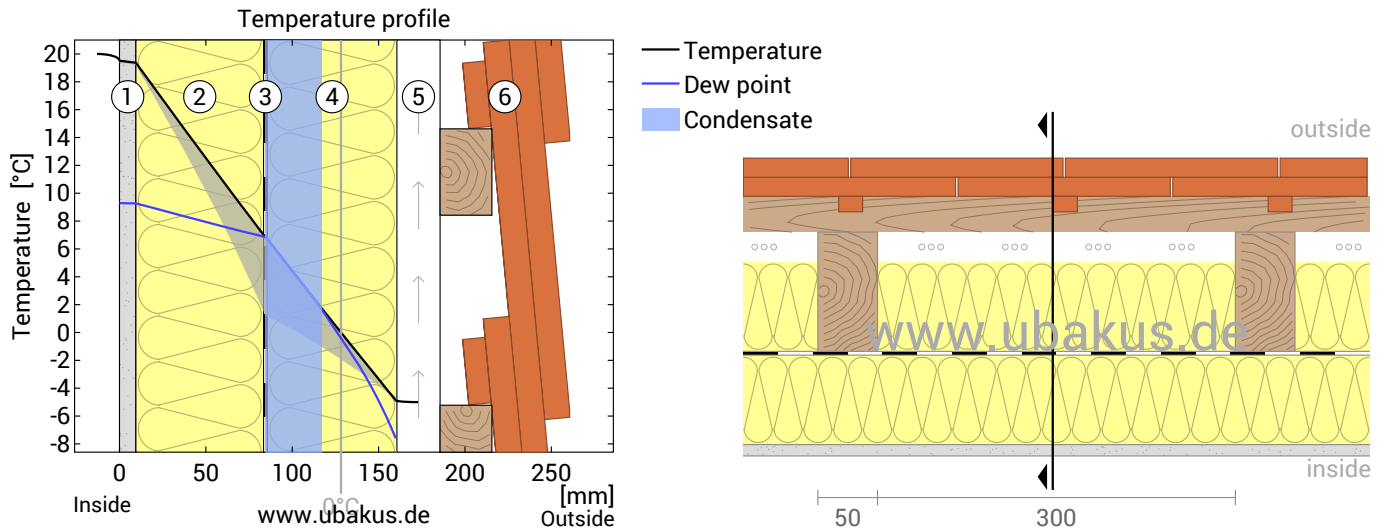
Inside air :  $20,0^\circ\text{C} / 50\%$   
Outside air:  $-5,0^\circ\text{C} / 80\%$   
Surface temperature.:  $19,4^\circ\text{C} / -4,8^\circ\text{C}$

sd-value: 192,8 m

Thickness: 26,0 cm  
Weight:  $87 \text{ kg}/\text{m}^2$   
Heat capacity:  $20 \text{ kJ}/\text{m}^2\text{K}$

roof insulation,  $U=0,16 \text{ W}/(\text{m}^2\text{K})$

## Temperature profile



- ① Gypsum board (9,5 mm)
- ② EU IKO enertherm ALU (75 mm)
- ③ Riwega USB Micro 100/20
- ④ EU IKO enertherm ALU (75 mm)
- ⑤ Rear ventilated level (25 mm)
- ⑥ Plain tiles and battens (75 mm)

**Left:** Temperature and dew-point temperature at the place marked in the right figure. The dew-point indicates the temperature, at which water vapour condensates. As long as the temperature of the component is everywhere above the dew point, no condensation occurs. If the curves have contact, condensation occurs at the corresponding position.

**Right:** The component, drawn to scale.

## Layers (from inside to outside)

| # | Material                                   | $\lambda$<br>[W/mK] | R<br>[m <sup>2</sup> K/W] | Temperatur [°C] |      | Weight<br>[kg/m <sup>2</sup> ] |
|---|--------------------------------------------|---------------------|---------------------------|-----------------|------|--------------------------------|
|   |                                            |                     |                           | min             | max  |                                |
|   | Thermal contact resistance*                |                     | 0,130                     | 19,4            | 20,0 |                                |
| 1 | 0,95 cm Gypsum board                       | 0,250               | 0,038                     | 19,2            | 19,5 | 6,5                            |
| 2 | 7,5 cm EU IKO enertherm ALU                | 0,022               | 3,409                     | 1,2             | 19,4 | 2,4                            |
| 3 | 0,042 cm Riwega USB Micro 100/20           | 0,220               | 0,002                     | 1,2             | 6,8  | 0,1                            |
| 4 | 7,5 cm EU IKO enertherm ALU                | 0,022               | 3,409                     | -4,9            | 6,8  | 2,1                            |
|   | 10 cm Spruce (Width: 5 cm)                 | 0,130               | 0,769                     | -4,6            | 1,8  | 6,4                            |
|   | Thermal contact resistance*                |                     | 0,130                     | -5,0            | -4,6 |                                |
| 5 | 2,5 cm Rear ventilated level (outside air) |                     |                           | -5,0            | -5,0 | 0,0                            |
| 6 | 7,5 cm Plain tiles and battens             |                     |                           | -5,0            | -5,0 | 70,0                           |
|   | 25,992 cm Whole component                  |                     | 6,138                     |                 |      | 87,4                           |

\*Assuming free circulating air at the inside surface.

Surface temperature inside (min / average / max): 19,4°C 19,5°C 19,5°C  
 Surface temperature outside (min / average / max): -4,9°C -4,8°C -4,6°C

roof insulation,  $U=0,16 \text{ W}/(\text{m}^2\text{K})$

## Moisture proofing

For the calculation of the amount of condensation water, the component was exposed to the following constant climate for 90 days: inside:  $20^\circ\text{C}$  und 50% Humidity; outside:  $-5^\circ\text{C}$  und 80% Humidity. This climate complies with DIN 4108-3.

Interior heat transfer resistance  $R_{si}$  (user input deviating from DIN 4108-3):  $0.13 \text{ m}^2\text{K}/\text{W}$

Under these conditions, a total of  $0,093 \text{ kg}$  of condensation water per square meter is accumulated. This quantity dries in summer in 48 days (Drying season according to DIN 4108-3:2018-10).

| # | Material                         | sd-value<br>[m] | Condensate<br>[kg/m <sup>2</sup> ]<br>[Gew.-%] | Weight<br>[kg/m <sup>2</sup> ] |
|---|----------------------------------|-----------------|------------------------------------------------|--------------------------------|
| 1 | 0,95 cm Gypsum board             | 0,04            | -                                              | 6,5                            |
| 2 | 7,5 cm EU IKO enertherm ALU      | 4,50            | 0,093                                          | 2,4                            |
| 3 | 0,042 cm Riwega USB Micro 100/20 | 20,00           | -                                              | 0,1                            |
| 4 | 7,5 cm EU IKO enertherm ALU      | 7500            | -                                              | 2,1                            |
|   | 10 cm Spruce (Width: 5 cm)       | 5,00            | -                                              | 6,4                            |
|   | 25,992 cm Whole component        | 192,78          | 0,093                                          | 87,4                           |

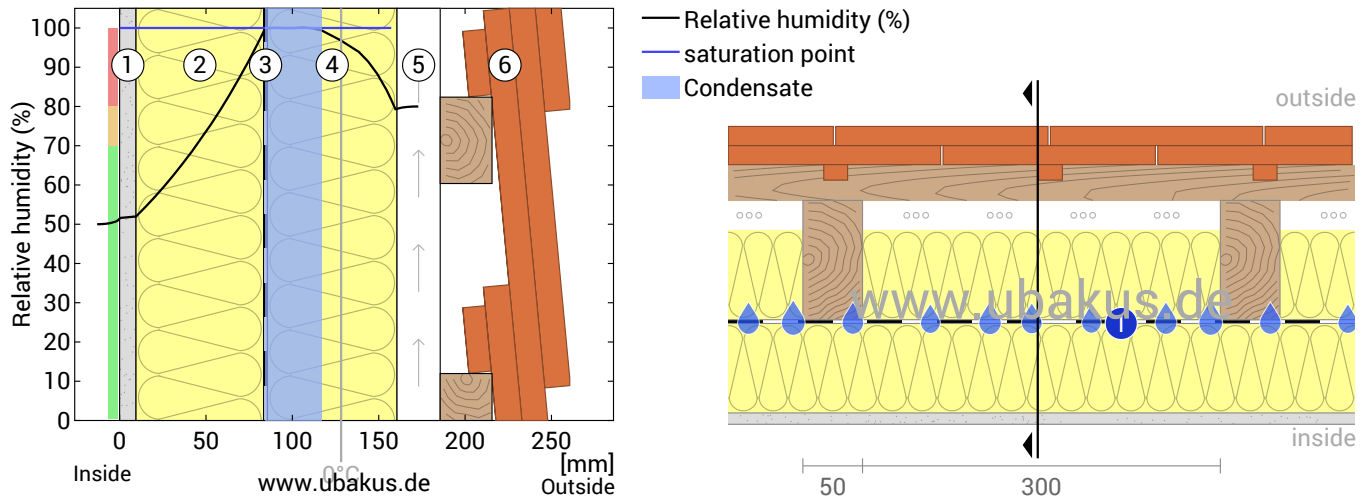
## Condensation areas

- Condensate:  $0,093 \text{ kg}/\text{m}^2$  Affected layers: Riwega USB Micro 100/20, EU IKO enertherm ALU
- Condensate:  $\sim 0 \text{ kg}/\text{m}^2$  Affected layers: EU IKO enertherm ALU

## Humidity

The temperature of the inside surface is  $19,4^\circ\text{C}$  leading to a relative humidity on the surface of 52%. Mould formation is not expected under these conditions.

The following figure shows the relative humidity inside the component.



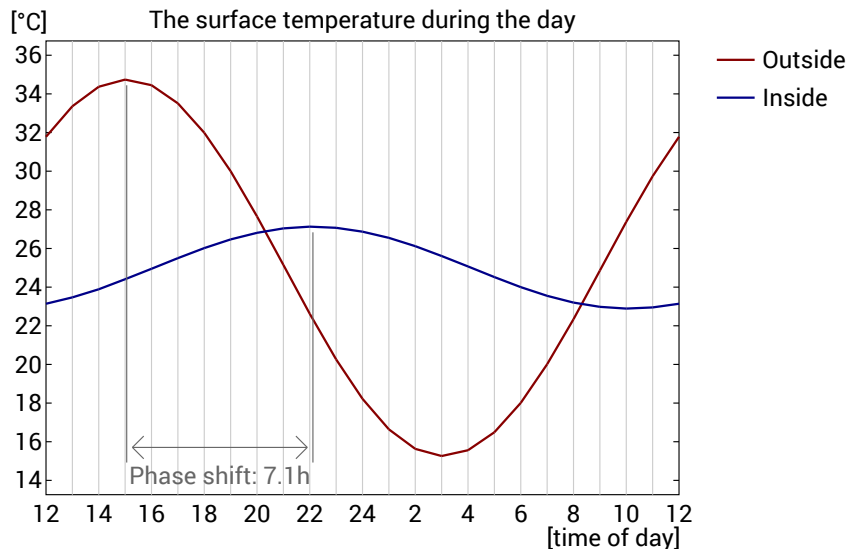
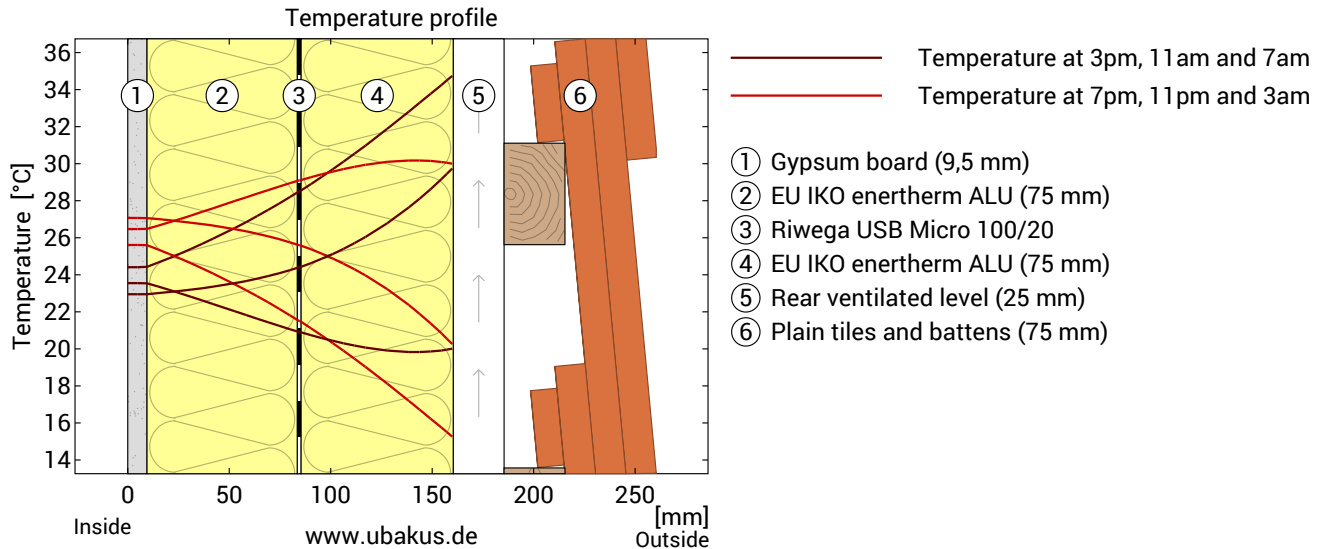
- |                                |                                |                                   |
|--------------------------------|--------------------------------|-----------------------------------|
| ① Gypsum board (9,5 mm)        | ③ Riwega USB Micro 100/20      | ⑤ Rear ventilated level (25 mm)   |
| ② EU IKO enertherm ALU (75 mm) | ④ EU IKO enertherm ALU (75 mm) | ⑥ Plain tiles and battens (75 mm) |

Notes: Calculation using the Ubakus 2D-FE method. Convection and the capillarity of the building materials were not considered. The drying time may take longer under unfavorable conditions (shading, damp / cool summers) than calculated here.

roof insulation,  $U=0,16 \text{ W}/(\text{m}^2\text{K})$

## Heat protection

The following results are properties of the tested component alone and do not make any statement about the heat protection of the entire room:



**Top:** Temperature profile within the component at different times. From top to bottom, brown lines: at 3 pm, 11 am and 7 am and red lines at 7 pm, 11 pm and 3 am.

**Bottom:** Temperature on the outer ( red ) and inner ( blue ) surface in the course of a day. The arrows indicate the location of the temperature maximum values . The maximum of the inner surface temperature should preferably occur during the second half of the night.

|                          |       |                                          |                          |
|--------------------------|-------|------------------------------------------|--------------------------|
| Phase shift*             | 7,1 h | Heat storage capacity (whole component): | 20 kJ/m <sup>2</sup> K   |
| Amplitude attenuation ** | 4,6   | Thermal capacity of inner layers:        | 10.4 kJ/m <sup>2</sup> K |
| TAV ***                  | 0,218 |                                          |                          |

\* The phase shift is the time in hours after which the temperature peak of the afternoon reaches the component interior.

\*\* The amplitude attenuation describes the attenuation of the temperature wave when passing through the component. A value of 10 means that the temperature on the outside varies 10x stronger than on the inside, e.g. outside 15-35 °C, inside 24-26 °C.

\*\*\* The temperature amplitude ratio TAV is the reciprocal of the attenuation:  $TAV = 1 / \text{amplitude attenuation}$

Note: The heat protection of a room is influenced by several factors, but essentially by the direct solar radiation through windows and the total amount of heat storage capacity (including floor, interior walls and furniture). A single component usually has only a very small influence on the heat protection of the room.

The calculations presented above have been created for a 1-dimensional cross-section of the component.