

M-Cabin roof

Roof construction
created on 6.10.2020

Thermal protection

$U = 0,25 \text{ W}/(\text{m}^2\text{K})$

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



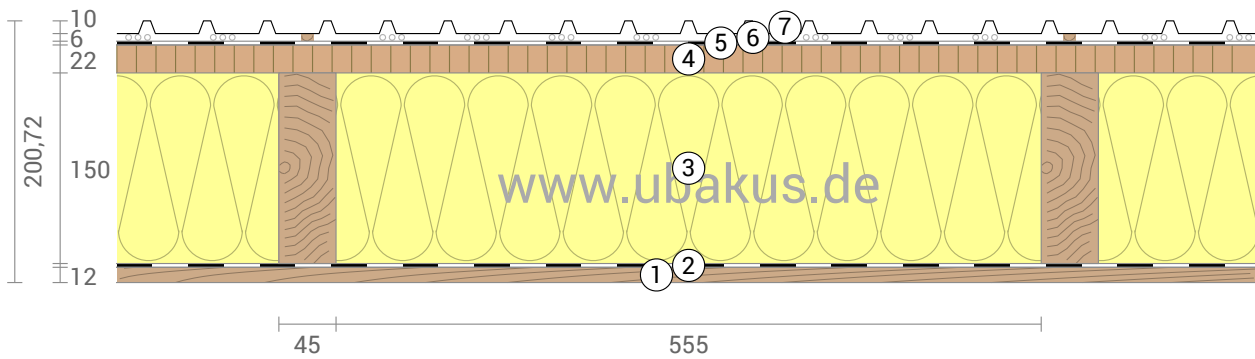
Moisture proofing

No condensate



Heat protection

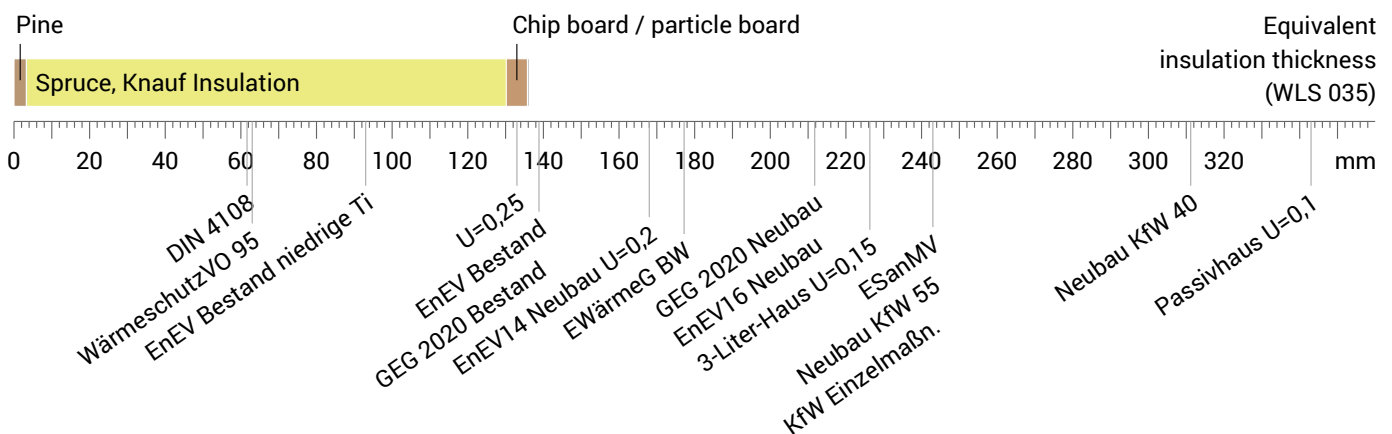
Temperature amplitude damping: 4,6
phase shift: 7,3 h
Thermal capacity inside: 18,3 kJ/m²K



- ① Pine (12 mm)
- ② SIGA Majrex
- ③ Knauf Insulation (150 mm)
- ④ Chip board / particle board (22 mm)
- ⑤ Tyvek® Supro / Tape
- ⑥ Rear ventilated level (6 mm)
- ⑦ trapezoidal sheet (10 mm)

Impact of each layer and comparison to reference values

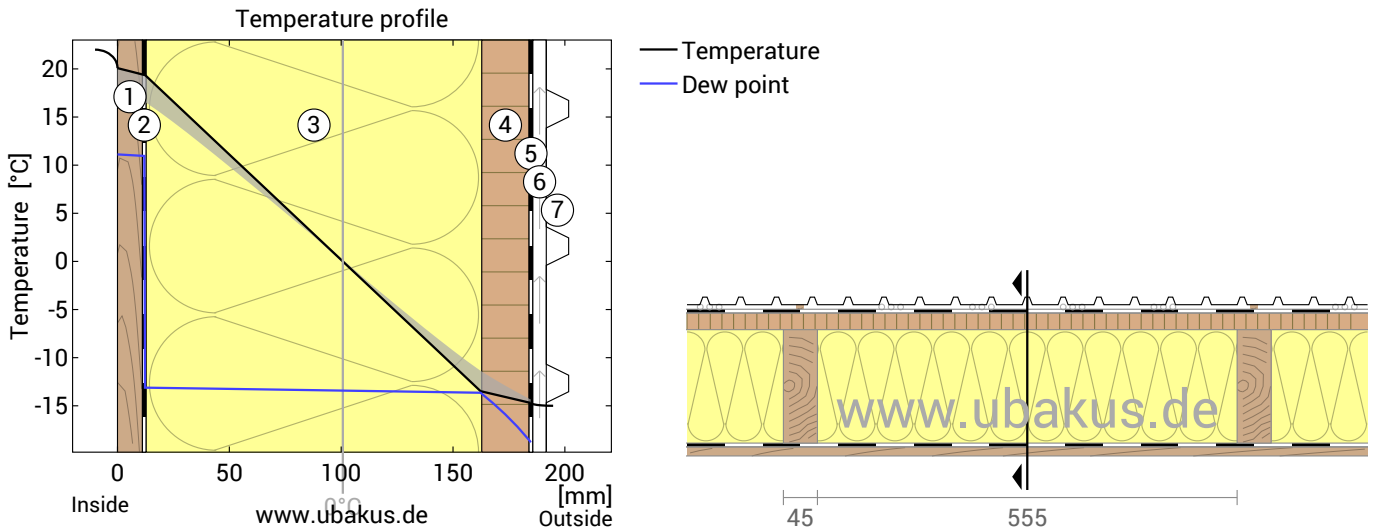
For the following figure, the thermal resistances of the individual layers were converted in millimeters insulation. The scale refers to an insulation of thermal conductivity 0,035 W/mK.



Inside air :	22,0°C / 50%		Thickness:	20,1 cm
Outside air:	-15,0°C / 70%	sd-value: 19,6 m	Weight:	34 kg/m ²
Surface temperature.:	18,2°C / -14,6°C		Heat capacity:	52 kJ/m ² K

M-Cabin roof, $U=0,25 \text{ W}/(\text{m}^2\text{K})$

Temperature profile



- | | | |
|-----------------------------|---------------------------------------|-----------------------------|
| ① Pine (12 mm) | ④ Chip board / particle board (22 mm) | ⑦ trapezoidal sheet (10 mm) |
| ② SIGA Majrex | ⑤ Tyvek® Supro / Tape | |
| ③ Knauf Insulation (150 mm) | ⑥ Rear ventilated level (6 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	λ [W/mK]	R [m ² K/W]	Temperatur [°C]		Weight [kg/m ²]
				min	max	
	Thermal contact resistance*		0,100	18,2	22,0	
1	1,2 cm Pine	0,130	0,092	16,6	20,1	6,2
2	0,03 cm SIGA Majrex	2,300	0,000	16,6	19,4	0,2
3	15 cm Knauf Insulation	0,035	4,286	-13,5	19,4	6,9
	15 cm Spruce (7,5%)	0,130	1,154	-11,5	17,2	5,1
4	2,2 cm Chip board / particle board	0,140	0,157	-14,7	-11,4	14,3
5	0,042 cm Tyvek® Supro / Tape	0,230	0,002	-14,7	-14,3	0,1
	Thermal contact resistance*		0,100	-15,0	-14,3	
6	0,6 cm Rear ventilated level (outside air)			-15,0	-15,0	0,0
7	1 cm trapezoidal sheet			-15,0	-15,0	1,0
20,072 cm Whole component			4,081			33,8

*Thermal contact resistances according to DIN 6946 for the U-value calculation. $R_{si}=0,25$ and $R_{se}=0,04$ according to DIN 4108-3 were used for moisture proofing and temperature profile.

Surface temperature inside (min / average / max): 18,2°C 19,8°C 20,1°C
 Surface temperature outside (min / average / max): -14,7°C -14,6°C -14,3°C

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Moisture proofing

For the calculation of the amount of condensation water, the component was exposed to the following constant climate for 90 days: inside: 22°C und 50% Humidity; outside: -15°C und 70% Humidity (Climate according to user input).

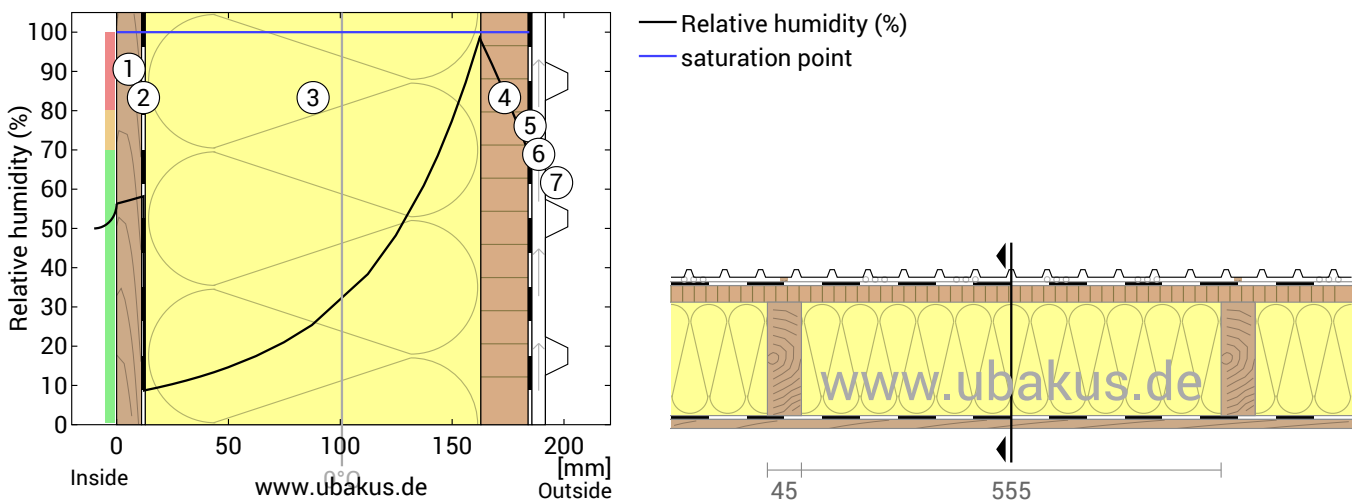
This component is free of condensate under the given climate conditions.

#	Material	sd-value [m]	Condensate [kg/m ²]	Condensate [Gew.-%]	Weight [kg/m ²]
1	1,2 cm Pine	0,24	-	-	6,2
2	0,03 cm SIGA Majrex	17,80	-	-	0,2
3	15 cm Knauf Insulation	0,15	-	-	6,9
	15 cm Spruce (7,5%)	3,00	-	-	5,1
4	2,2 cm Chip board / particle board	1,10	-	-	14,3
5	0,042 cm Tyvek® Supro / Tape	0,03	-	-	0,1
	20,072 cm Whole component	19,57			33,8

Humidity

The temperature of the inside surface is 18,2 °C leading to a relative humidity on the surface of 63%.Mould formation is not expected under these conditions.

The following figure shows the relative humidity inside the component.



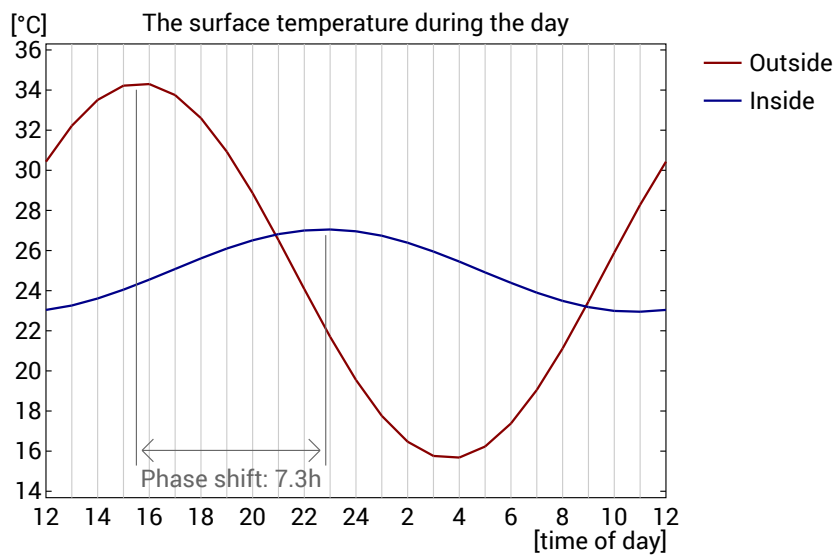
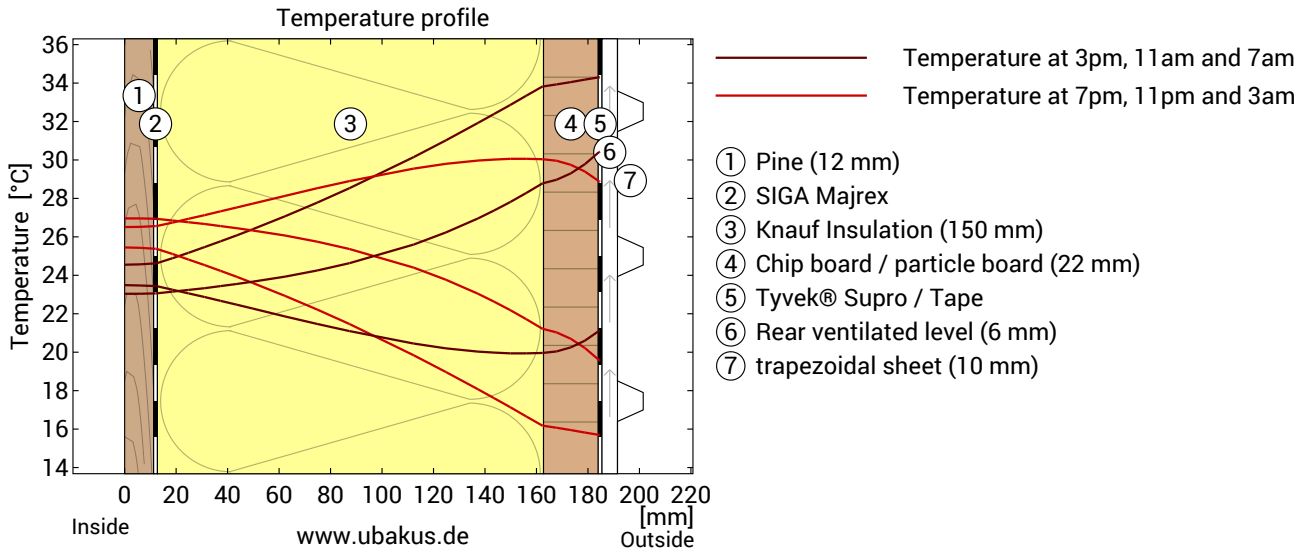
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- ③ Knauf Insulation (150 mm)
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- ⑤ Tyvek® Supro / Tape
- ⑥ Rear ventilated level (6 mm)
- ⑦ trapezoidal sheet (10 mm)

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.

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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*	7,3 h	Heat storage capacity (whole component):	52 kJ/m ² K
Amplitude attenuation **	4,6	Thermal capacity of inner layers:	18.3 kJ/m ² K
TAV ***	0,220		

* 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.