Roof

Roof construction
created on 30.3.2018

Thermal protection

U = 0,230 W/(m²K)

EnEV Bestand*: U<0,24 W/(m²K)

excellent insufficient

Moisture proofing

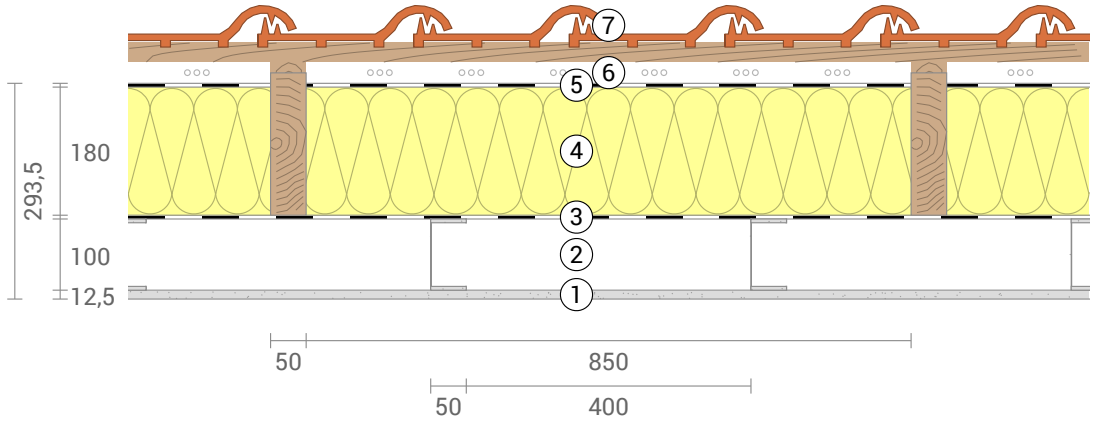
No condensate

excellent insufficient

Heat protection

Temperature amplitude damping: 3,2
phase shift: 5,3 h
Thermal capacity inside: 13,5 kJ/m²K

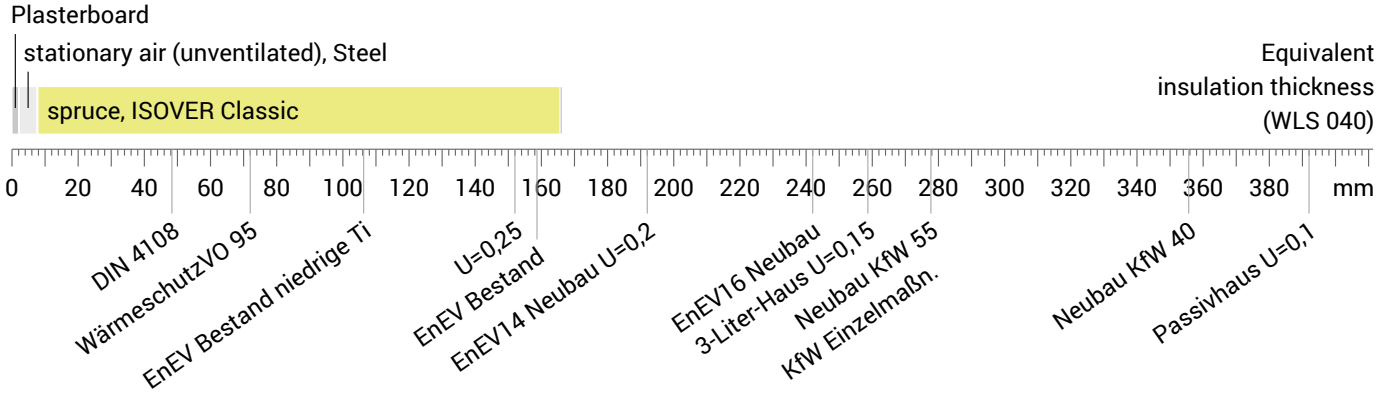
excellent insufficient



1. Plasterboard (12,5 mm)
2. stationary air (100 mm)
3. Strotex 110 PL
4. ISOVER Classic (180 mm)
5. Strotex 1300 Basic
6. Rear ventilated level
7. Dachziegel inkl. Lattung

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 0,040 W/mK.

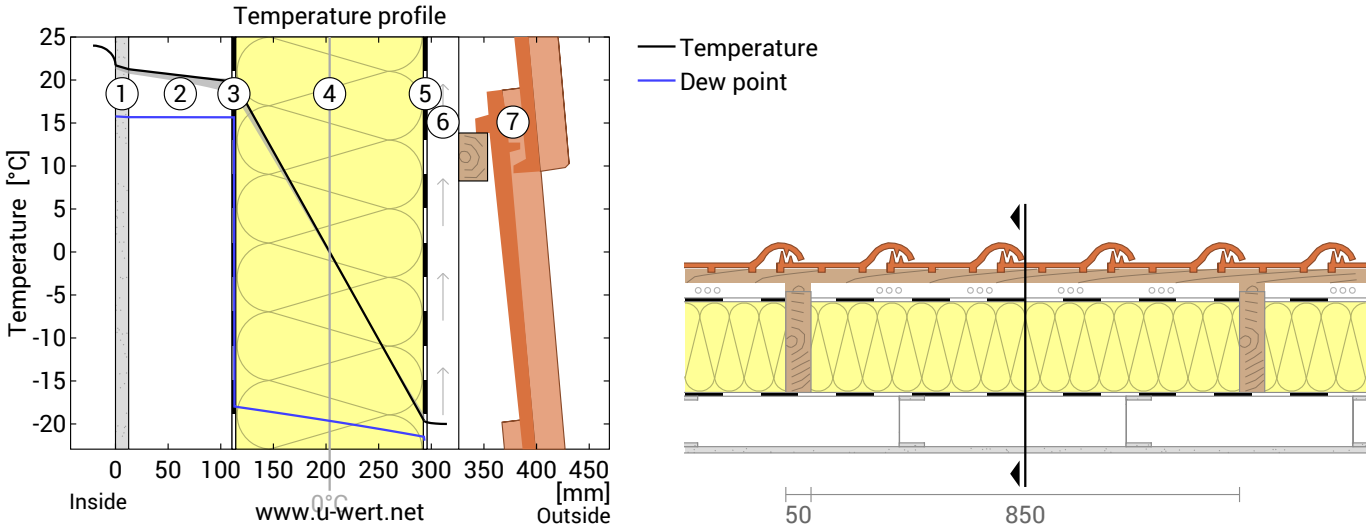


Inside air :	24,0°C / 60%			Thickness:	42,7 cm
Outside air:	-20,0°C / 83%	sd-value:	9,6 m	Weight:	0 kg/m²
Surface temperature.:	21,3°C / -19,6°C			Heat capacity:	19.1 kJ/m²K

*Comparison to the maximum U-value according to the german EnEV 2014/2016 for first-time installation or renewal of Decken, Dächer und Dachschrägen (Anlage 3, Tabelle 1, Zeile 4a).

Roof, U=0,23 W/(m²K)

Temperature profile



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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 [m²K/W]	Temperatur [°C] min	max	Weight [kg/m²]
		Thermal contact resistance*		0,100	21,3	24,0	
1	1,25 cm	Plasterboard	0,250	0,050	20,7	21,7	8,5
2	10 cm	stationary air (unventilated)	0,625	0,160	18,3	21,3	0,1
	10 cm	Steel (0,13%)	50,000	0,002	20,1	20,8	1,0
	0,5 cm	Steel (Width: 0.06 cm)	50,000	0,000	20,9	20,9	0,1
	0,5 cm	Steel (Width: 0.06 cm)	50,000	0,000	20,0	20,0	0,1
	0,06 cm	Steel (Width: 5 cm)	50,000	0,000	20,0	20,1	0,5
	0,06 cm	Steel (Width: 5 cm)	50,000	0,000	20,8	20,9	0,5
3	0,05 cm	Strotex 110 PL	0,220	0,002	18,3	20,1	0,1
4	18 cm	ISOVER Classic	0,041	4,390	-19,6	20,1	no information
	20 cm	spruce (Width: 5 cm)	0,130	1,538	-19,2	18,6	5,0
5	0,05 cm	Strotex 1300 Basic	0,130	0,004	-19,6	-19,2	0,1
		Thermal contact resistance*		0,100	-20,0	-19,0	
6		Rear ventilated level (outside air)			-20,0	-20,0	0,0
7		Dachziegel inkl. Lattung			-20,0	-20,0	51,5
	42,65 cm	Whole component		4,345			>67

*Thermal contact resistances according to DIN 6946 for the U-value calculation. Rsi=0,25 and Rse=0,04 according to DIN 4108-3 were used for moisture proofing and temperature profile.

Surface temperature inside (min / average / max):	21,3°C	21,5°C	21,7°C
Surface temperature outside (min / average / max):	-19,6°C	-19,6°C	-19,0°C

Roof, U=0,23 W/(m²K)

Moisture proofing

This calculation was carried out with a user-defined climate for the winter period, which deviates from DIN 4108-3.

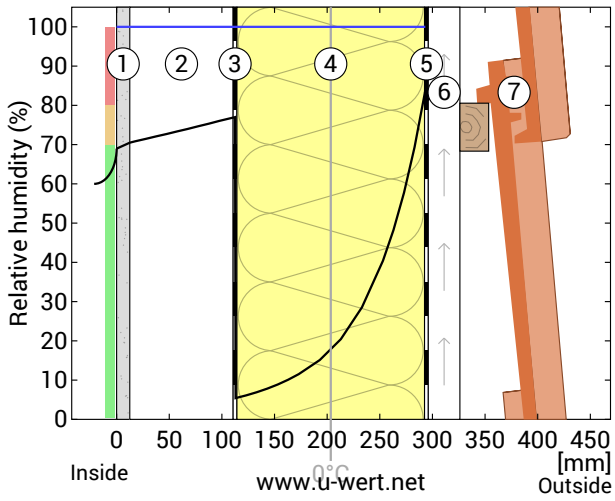
This calculation:	inside:	24°C	60%	outside:	-20°C	83%
Requested by DIN 4108-4:	inside:	20°C	50%	outside:	-5°C	80%

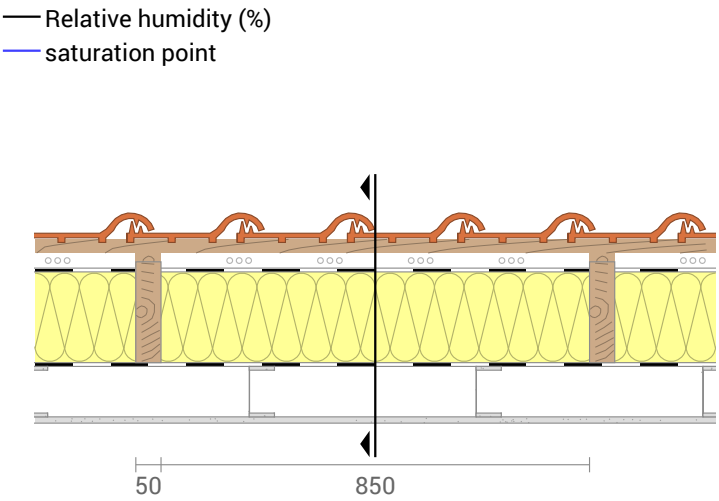
This component is free of condensate under the given climate conditions.

#		Material	sd-value [m]	Condensate [kg/m²]	[Gew.-%]	Weight [kg/m²]
1	1,25 cm	Plasterboard	0,05	-		8,5
2	10 cm	stationary air (unventilated)	0,01	-		0,1
	10 cm	Steel (0,13%)	9,00	-		1,0
	0,5 cm	Steel (Width: 0.06 cm)	180,00	-		0,1
	0,5 cm	Steel (Width: 0.06 cm)	180,00	-		0,1
	0,06 cm	Steel (Width: 5 cm)	1500	-		0,5
	0,06 cm	Steel (Width: 5 cm)	1500	-		0,5
3	0,05 cm	Strotex 110 PL	8,00	-		0,1
4	18 cm	ISOVER Classic	0,18	-		no information
	20 cm	spruce (Width: 5 cm)	10,00	-	-	5,0
5	0,05 cm	Strotex 1300 Basic	0,02	-		0,1
	42,65 cm	Whole component	9,59			>67

Humidity

The temperature of the inside surface is 21,3 °C leading to a relative humidity on the surface of 71%.Some kinds of mould start to grow at relative air humidities of 70% or more, mould cannot be excluded!. To avoid mould formation, the surface temperature should be increased by (additional) insulation.
The following figure show the relative humidity inside the component.





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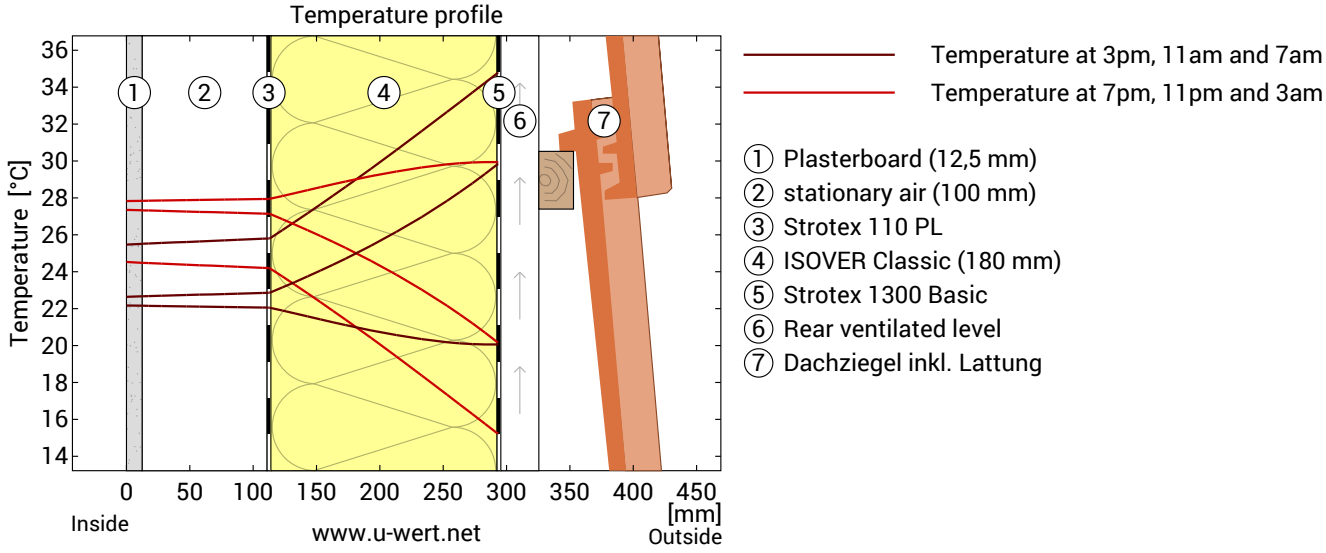
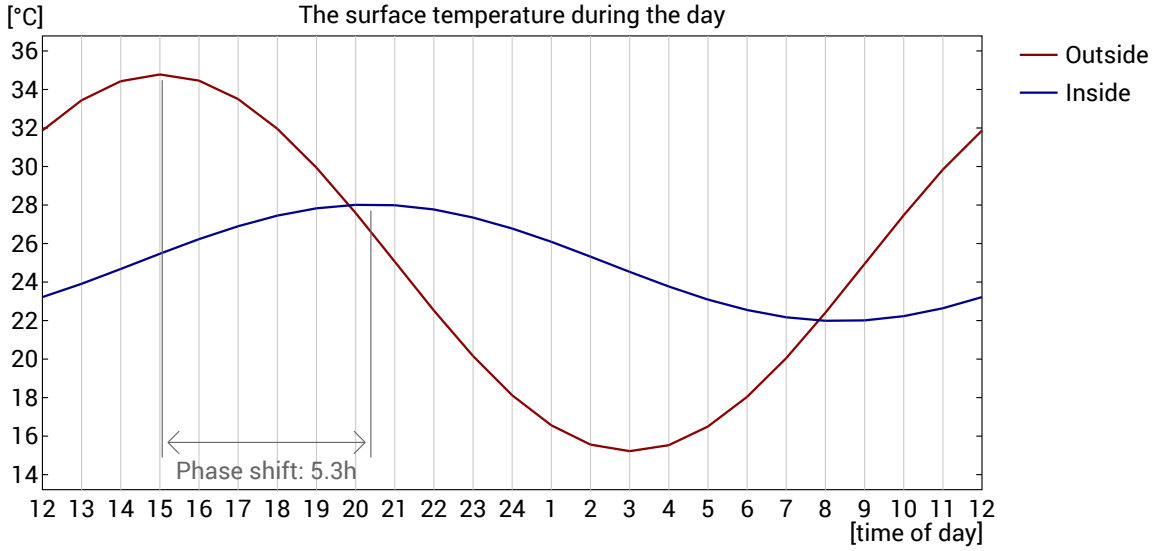
To calculate the diffusion currents a two-dimensional finite element method was used. More information on the section 'humidity' on the input form.

Roof, U=0,23 W/(m²K)

Heat protection

For the analysis of the heat protection, the temperature changes within the component were simulated during a hot summer day:





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*	5,3 h	Time of maximum interior temperature	20:30
Amplitude attenuation **	3,2	Thermal fluctuation on exterior surface:	19,6°C
TAV ***	0,310	Temperature fluctuation on interior surface	6,1°C

* 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 / amplitude attenuation

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