Criteria for Certified Passive House Components: Attic Staircase

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Functional requirements

Passive House buildings provide optimal comfort with minimum energy costs and prove cost-effective over their life-cycles. In order to achieve such comfort and low life-cycle costs, the thermal quality of the components used in Passive Houses must meet stringent requirements. These requirements are directly derived from the hygiene and comfort criteria for Passive House buildings.

In order to prevent condensation and mould formation, the temperature factor is $f_{Rsi=0.25\ m^2k/W} \geq 0.7$ everywhere.

In contrast with the average operative indoor temperature, the minimum surface temperature may deviate by a maximum of 4.2K. A greater difference may lead to unpleasant cold air descent and perceptible radiant heat deprivation.

The criteria and algorithms for calculation of attic stairs are explained below.

Boundary conditions for assessment of attic staircases as "Certified Passive House Components"

Initial values:

Indoor air temperature	(T_i):	20	°C
Outdoor air temperature	(T_i):	0	°C
Thermal resistance – inside (horizontally)	(R_{si}):	0.13	m²K/W
Thermal resistance – inside (up)	(R_{si}):	0.10	m²K/W
Thermal resistance – inside (down)	(R_{si}):	0.17	m²K/W
Thermal resistance – outside (horizontally)	(R_{se}):	0.04	m²K/W
Thermal resistance – outside (up)	(R_{se}):	0.04	m²K/W
Thermal resistance – outside (down)	(R_{se}):	0.04	m²K/W
Thermal resistance – outside, ventilated (horizontally)	(R_{se}):	0.13	m²K/W
Thermal resistance – outside, ventilated (up) inclination of component up to 60°	(R_{se}):	0.10	m²K/W
Thermal resistance – outside, ventilated (up) inclination of component greater than 60°	(R_{se}):	0.13	m²K/W
Thermal resistance – outside, ventilated (down)	(R_{se}):	0.17	m²K/W
Thermal resistance – basement	(R_{sc}):	0.17	m²K/W
Thermal resistance – ground	(R_{sg}):	0.00	m²K/W

Differing from the boundary conditions stated in DIN 4108-2, an outside temperature of 0 °C was used to determine the minimal interior surface temperature. The higher thermal resistances inside the room (R_{si} = 0.25 m²K/W) are used to determine the surface temperatures in accordance with DIN ISO 13788.

Symbols

Symbols	Unit	Explanation
Q	[W]	Heat flow
A	$[m^2]$	Reference area
?	[K]	Temperature
? ?	[K]	Temperature difference
U	$[W/(m^2K)]$	Thermal transmittance
?	[W/K]	Point thermal transmittance
l	[m]	Reference length
?	[W/(mK)]	Linear thermal transmittance
R_s	$[(m^2K)/W]$	Heat transfer resistance
?	[W/(mK)]	Thermal conductivity

Measurement reference:

External dimensions

Climatic scope:

These certification criteria and the certificate issued on the basis of these criteria where applicable are only valid for the cool, temperate Central European climate zone.

Model dimensions

W = maximum 70cm
L = maximum 140 cm

The manufacturer shall provide a 3D model with closed solids. This model must be dimensioned for a maximum clear opening size of 1.40 m x 0.70 m including the installation gap.

Requirements for issue of the certificate

1. The suitability of an attic staircase for a Passive House can be attested if the average thermal transmittance does not exceed $U_D \leq 1.00$ W/(m²K) for a test size of 0.70 m x 1.40 m. Separate calculation of the thermal transmittance is necessary for this.

2. The average thermal transmittance should be $U_{D,installed} \leq 1.10$ W/(m²K) in the installed state at two installation situations defined by the Passive House Institute (see section on installation situations).

3. The temperature factor should be $f_{Rsi=0.25\ m^2k/W} \geq 0.7$ everywhere

4. The manufacturer must present an understandable concept or verification regarding airtightness of the installed components.

5. There is no entitlement to certification.

Table 1 – Definitions and specifications

Orientation	Test measurement (b * h)	U -and Ψ -values included in calculation	Installation situations	Additionally
Horizontally	0.70 * 1.40	All round	Reinforced concrete wood beam ceiling	Airtightness concept

The certificate consists of the actual certificate in which the most important product information have been summarised, and diagrams and illustrations of the components and their installation situations. In agreement with the Passive House, further variants or additional frame sections and installation situations may be calculated and stated in the data sheet upon request.

Calculation of the thermal characteristic values

Calculation of the thermal characteristic values takes place in two separate steps in order to allow detailed calculation of the thermal transmittance of the panel (pnl) and the frame (f). This enables exact application in the project planning by the planner, also for dimensioning of attic staircases which do not correspond with the test size. A three-dimensional model with all selective penetrations is simulated for calculating the thermal transmittance of the panel.

The following applies (I):

$$U_{pnl} = \frac{Q_{pnl}}{A_{pnl} * \Delta_{\Theta}}$$

The overall model with the cover box is also simulated. The difference between the two heat flows leads to the determination of a frame parameter, hereafter called U_f.

The following applies (II):

$$U_f = \frac{(Q_{total} - U_{pnl} * A_{pnl} * \Delta_{\Theta})}{A_f * \Delta_{\Theta}}$$

The total thermal transmittance U_D is obtained from the addition of the respective thermal transmittances taking into account the respective area percentage. In doing so, A_D is specified as the sum obtained from 0.70 m x 1.40 m.

The following applies (III):

$$U_D = \frac{(A_{pnl} * U_{pnl} + A_f * U_f)}{A_D}$$

The requirements for the average thermal transmittance in the installed state are based on the requirements for thermal comfort. Besides a concept for an airtight connection, proof of suitability of the component must also be provided for two installation situations which have been defined by the Passive House Institute.

For calculating the thermal transmittance in the installed state, it is necessary to determine the thermal transmittance using the length of the installation gap.

The following applies (IV):

$$\chi_e = \frac{[Q - (A_{ges}.* U_{Decke} * \Delta_\Theta + A_D * U_D * \Delta_\Theta)]}{\Delta_\Theta}$$

The following applies (V):

$$\psi_e = \frac{\chi_e}{l_e}$$

The following applies (VI):

$$U_{D, eingebaut} = U_D + l_D * \psi_e$$

Installation situations

Thermal transmittances for installation are also determined in addition to the regular heat flow through the components being tested. Two constructions for the top floor ceiling as defined by the Passive House Institute are to be used for this purpose. These represent a common structure for ceilings retrofitted with insulation, which is often used in constructions.

Bauteil Nr.	Bauteil-Bezeichnung
1	Geschossdecke Holzbalkendecke

Wärmeübergangswiderstand [m²K/W] innen R_{si}: 0,10; außen R_{sa}: 0,10

	Teilfläche 1	λ [W/(mK)]	Teilfläche 2 (optional)	λ [W/(mK)]	Teilfläche 3 (optional)	λ [W/(mK)]	Summe Breite Dicke [mm]
1.	Gipskarton	0,250					13
2.	Spalierlatten	0,130	Luft	0,080			15
3.	Lehmschlag	0,500			Holzbalken	0,130	100
4.	Luft	0,300			Holzbalken	0,130	70
5.	Dielen	0,130					20
6.	Dämmung	0,035					200
7.							
8.							
			Flächenanteil Teilfläche 2	66,6%	Flächenanteil Teilfläche 3	16,4%	Summe 41,8 cm

U-Wert: 0,147 W/(m²K)

Bauteil Nr.	Bauteil-Bezeichnung
2	Geschossdecke Stahlbeton

Wärmeübergangswiderstand [m²K/W] innen R_{si}: 0,10; außen R_{sa}: 0,10

	Teilfläche 1	λ [W/(mK)]	Teilfläche 2 (optional)	λ [W/(mK)]	Teilfläche 3 (optional)	λ [W/(mK)]	Summe Breite Dicke [mm]
1.	Gipskarton	0,250					13
2.	UK Holz	0,130	Luft	0,080			15
3.	Stahlbeton	2,300					160
4.	Dämmung	0,035					200
5.							
6.							
7.							
8.							
			Flächenanteil Teilfläche 2	66,6%	Flächenanteil Teilfläche 3		Summe 38,8 cm

U-Wert: 0,161 W/(m²K)

It is advised that the calculation of the installation situations should only be performed if the components meet the criteria for a certified Passive House component.

Required documents

The following documents should be provided by the manufacturer to the PHI for the calculation:

1. Detail drawing of the building component (all different cross-sections) with dimensions, as DWG files. All geometries must consist of closed polylines. Materials with different thermal conductivities should be indicated as such and should be shaded in different colours.

2. 3D solid model of the building component as a DWG file, as well as a detail drawing of the practice-oriented and standardised installation with information about the system-specific application, including all building elements, fittings and screwed connections which are necessary for a realistic simulation.

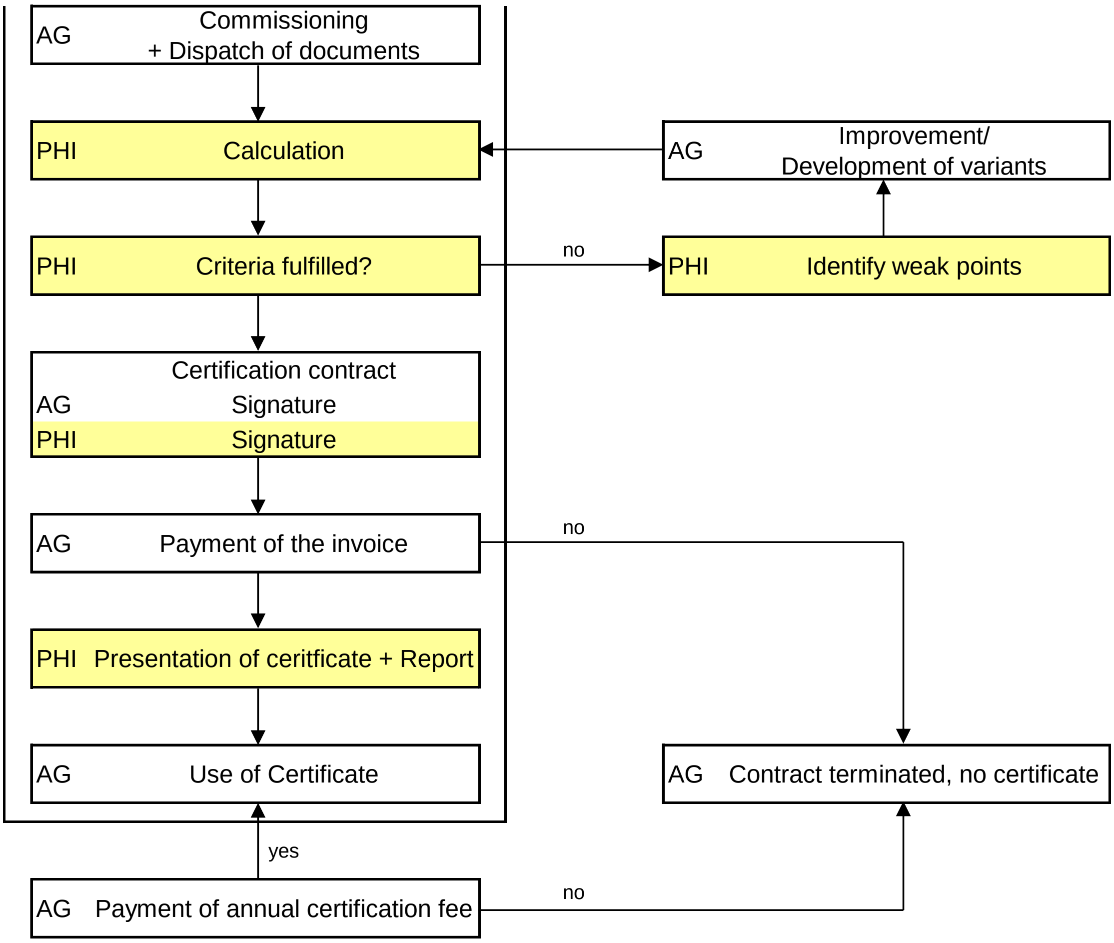
3. Information about the **materials and the rated values of the thermal conductivities used** (and density if necessary). It must be possible to assign the materials clearly on the basis of the drawings (legend, hachure). The rates values of the thermal conductivities of the materials used should be given in accordance with DIN V 4108-4, DIN EN ISO 10077-2 or DIN EN ISO 10456. If the thermal conductivity of a material is not listed in any of these standards, it can be substantiated on the base of general building approval permits or by means of a general building approval examination. If the rated value of the thermal conductivity cannot be given, the PHI will determine the rated value according to the procedure suggested in Section 5 of the DIN EN ISO 10077-2.

Services provided by the Passive House Institute

- Processing of the CAD drawings for further calculation in accordance with the documents available.
- Creation of a reference model or suitable installation situation.
- Creation of a three-dimensional calculation model for determining the point thermal bridge coefficient.
- Calculation of the average thermal transmittance.
- Calculation of variants for optimisation of the components used. After prior consultation the costs incurred for the calculation of variants will be invoiced to the client.

- Calculation of the linear installation thermal bridges arising in common installation situations.
- Documentation with isothermal images, result sheets and final report.
- Use of the certificate including presentation of the certified product on the Passive House Institute website and in the continually updated "List of Certified Components".

Certification procedure



Legal validity, temporary provisions, further development

The certification criteria and calculation regulations for Passive House suitable attic staircases shall become fully effective with the publication of this document. The Passive House Institute retains the right to make future changes.

Appendix 1: Characteristic values of materials (normative)

Farbe Coulour	λ W/mK	Description
		Insulation
	0.004	Vacuum insulation panel
	0.029	PU-Foam
	0.030	PU-Foam
	0.031	EPS-Foam
	0.032	EPS-Foam, Mineral Whool
	0.033	In-Situ-PU-Foam - Controlled conditions
	0.035	XPS-Foam, EPS-Foam, Mineral Whool
	0.035	PE-Foam
	0.04	Mineral Whool, Cellulose
	0.04	Soft wood fibre board
	0.045	Cork
	0.05	PU in-situ foam
	0.05	Soft wood fibre board
	0.06	Compressed tape
	0.09	Recycled PU material
	0.09	DWD (vapour-permeable insulating panels), lightweight panel of wood shavings
		Plastic
	0.14	PVC low density
	0.17	PVC high density
	0.18	ABS
	0.19	Glass fibre reinforced plastic
	0.22	Polypropylene (PP)
	0.24	Butyl
	0.25	PU, rigid (Polyurethane)
	0.25	EPDM
	0.30	Polyamide (PA)
	0.35	Silicone
	0.40	Polysulphide
		Wood
	0.13	Softwood ~500kg/m³, OSB ~650kg/m³
	0.13	Softwood ~500kg/m³
	0.17	Derived timber board ~700kg/m³ (plywood, chipboard, MDF)
	0.18	Hardwood ~700kg/m³
	0.29	2,2x Softwood ~500kg/m³ (heat flow in direction of fibres)
		Mineral-based materials
	0.25	Plasterboard
	0.51	Interior plaster/gypsum board
	0.70	Exterior plaster
	0.87	Lime plaster
	0.50	Vertically perforated brick
	0.57	TVG concrete hollow blocks
	0.63	TVG solid block
	0.80	Solid brick
	1.0	Sand-lime brick
	1.4	Screed
	1.6	Unreinforced concrete
	1.7	Steel block ceiling
	2.0	Ground
	2.3	Reinforced concrete
	3.5	Marble
		Metal
	17	Non-corrosive steel
	50	Steel
	160	Aluminium silicum alloy
	200	Aluminium
		Window materials
	1	Glass with variable emissivity
	1	Glass
	0.10	Molecular sieve
	0.29	Polybutyl
	0.19	Swisspacer V replacement
	0.44	ChromaTec Ultra replacement
	0.178	Superspacer TriSeal replacement
	0.25	TPS replacement
	1.00	TGI replacement
	2.40	Spacer stainless steel
	20.00	Spacer aluminium

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