Information. Criteria and Algorithms for Certified Passive House Components: Transparent Building Components and Opening Elements in the Building Envelope

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This document includes the component categories window frames, frames with fixed glazing, window systems, entrance doors, sliding doors, folding door systems, mullion-transom façades, glass roofs, opening elements in glass roofs, element-facades, skylights/dome lights, and roof windows.

Note: Certificates are currently only being issued for the ‘arctic’, ‘cold’, ‘cool, temperate’, ‘warm, temperate’ and ‘warm’ climate regions. The criteria for climate zones ‘warm, temperate’ and ‘warm’ as well as the category ‘Window System’ are subject to specific changes as these criteria are in the trial phase.

Certificate: approved thermal quality

The market for highly energy-efficient buildings is expanding rapidly, and the demand for reliable high-performance components is growing. However, requirements and possibilities for achieving this are often unclear with some manufacturers specifying characteristic values which they cannot guarantee.

The Passive House Institute certifies highly energy-efficient components according to international criteria, in order to meet the requirements for comfort, hygiene and energy efficiency. In the context of the certification process, the Institute provides advice to manufacturers in relation to the optimisation of their products. This results in improved, future-proof products and reliable thermal characteristic values for input into energy balance software programmes.

Advantages of certification:

- Consultations relating to product development for highly efficient buildings
- Access to a growing market
- Increased market visibility and product recognition
- Independently tested & certified: use of the Passive House Component Seal
- Inclusion in the Component Database of the Passive House Institute
- Incorporation into the PHPP energy balance software programme for buildings

Passive House Institute

The **Passive House Institute** (PHI) is an independent research institute which has played a decisive role in the development of the Passive House concept. The Passive House Standard is the only globally recognised energy standard for buildings which stands for tangible and verifiable efficiency values.

www.passivehouse.com

All products certified by the PHI are accordingly listed in the **Passive House Component Database** and made accessible to the international public. Integrated tools and information offer a high added value for building owners, designers and manufacturers.

database.passivehouse.com

PHPP

The **Passive House Planning Package (PHPP)** is a cost-saving energy balance tool for highly energy efficient buildings. It has been validated on the basis of measured projects, provides precise results and can be used reliably by all.

www.passivehouse.com

iPHA

iPHA, the International Passive House Association is the PHI's network of experts which is committed to the propagation of the Passive House concept and the dissemination of the relevant expertise and information. It brings together scientists and building owners as well as architects, designers and manufacturers.

https://www.passivehouse-international.org/

Contents

1 Preface

Passive House buildings provide optimal thermal comfort with minimum energy expenditure; they lie within the economically profitable range with reference to their life-cycle costs. To achieve this level of 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 Passive House criteria for hygiene, comfort and efficiency as well as from feasibility studies. The Passive House Institute has established component certification in order to define quality standards, facilitate the availability of highly efficient products and promote their expansion, and to provide planners and building owners with reliable characteristic values for input into energy balancing tools.

2 Certification criteria

2.1 Verifying Passive House suitability, certificate

Passive House suitability is verified using the U-value of the components and the temperature factor at the coldest point of the component. The heat transfer coefficients (U-values) and the thermal bridge loss coefficients (ψ-values) are determined based on DIN EN ISO 10077, EN 673 and DIN EN 12631. Passive House suitability is verified for the specified dimensions of the products to be certified, see Table 3. Verification of the hygiene criterion is provided using 2-dimensional heat flow calculations of the standard cross-sections. The most unfavourable temperature factor shall be applicable. In addition, efficiency classes should be stated, see Section 2.3. Class phC must be achieved at least.

The certificate contains the product name, representation of a frame cross-section and the efficiency class as well as verification of certifiability and the relevant characteristic values, illustrations and drawings. Table 1 contains the requirements that need to be met for the various climate zones. The corresponding dimensions can be found in Table 3.

2.2 Verification of EnerPHit suitability

In addition, windows and window systems can be characterised as EnerPHit components if the certification criteria are also achieved for a modernisation that is carried out in a step-by-step manner. The hygiene criterion is also checked in the installed state. See Section 3.9 for further information.

2.3 Passive House efficiency classes

In addition, windows and all other glazed components are also allocated to efficiency classes, depending on the heat losses through the opaque part[1]. The frame U-values, frame widths, the glass edge Ψ-values and the glass edge lengths are included in these heat losses (see *Table 2*). The average values of the respective characteristic values are used. In the case of curtain wall façades and inclined glazing, the heat losses through the glass carriers (χ_{GT}) are included in the calculation of the losses similarly to Ψ_g. The same applies for heat losses due to screws. For the certification of window systems the heat losses through leaks are also included in the calculation as H_{ve}[2].

Table 1: Adequate certification criteria and U-values of the reference glazing

Climate zone	Hygiene criterion[1] $f_{Rsi = 0.25\ m^2K/W}$ ≥	Component U-value[2] [W/(m²K)]	U-value installed [W/(m²K)]	Reference glazing [W/(m²K)]
1 Arctic	0.80	0.40	0.45	0.35
2 Cold	0.75	0.60	0.65	0.52
3 Cool-temperate	0.70	0.80	0.85	0.70
4 Warm-temperate	0.65	1.00	1.05	0.90
5 Warm	0.55	1.20	1.25	1.10
6 Hot	None	1.20	1.25	1.10
7 Very hot	None	1.00	1.05	0.90

1 For door thresholds the dew point criterion applies according to section 6.
2 The following applies for inclined (45°) and horizontal (0°) components: the actual U_g value of the glazing used for the reference inclination, determined according to DIN EN 673, alternatively according to ISO 15099, should be used. The limit value in the installed state is the same as the limit value of the uninstalled component. The limit value of the component U-value for inclined and horizontal building components see section 6.

Table 2: Passive House efficiency classes for transparent building components

Ψ_{opaque} [W/(mK)]	Passive House efficiency class	Description
≤ 0.065	phA+	Very advanced component
≤ 0.110	phA	Advanced component
≤ 0.155	phB	Basic component
≤ 0.200	phC	Certifiable component

$$\Psi_{opak} = \Psi_g + \frac{U_f \cdot A_f}{l_g} + H_{ve} + 2 \cdot \chi_{gc}$$

[1] As information on possible solar gains is not available, U_w does not adequately describe the effect of the window in the building. That is why the PHI uses Ψ_{opaque} which is a parameter for the heat losses via the opaque parts of the window. Solar irradiation is not included here either, but because all losses through the frame are specified, a reliable statement can be made about the possible gains and thus the window's energy balance: the smaller the Ψ_{opaque} is, the better the energy balance of the window will be.

[2] $H_{ve} = \frac{\Delta p}{100Pa}^{2/3} \rho \cdot c_p \cdot Q_{100}$ where $\Delta_p = 6Pa$, $\rho \cdot c_p$ = heat capacity of air: 0.344 Wh/(m³K), Q_{100} = air permeability coefficient (m³/hm) at 100 Pa

2.4 *Certification categories and scope of certification*

Table 3: Categories: Definitions and specifications

Category	External frame dimensions (b * h) [m]	Frame sections to be calculated															Installation situations to be calculated[3]	Additional specifications
		OB	OJ	OH	FB	FJ	FH	OT	DL	fm	2m	1m	0m	2t	1t	0t		
Window frame (wi)	1.23 * 1.48	X	X	X						*(x)*	*(x)*						EIFS + two others; Sliding doors: EIFS. Entrance door: Section bottom only EIFS.	/
Frame with fixed glazing (fx)					X	X	X						*X*					/
Window system (ws)	1.23 * 1.48, 2.46 * 1.48[4]	X	X	X	*X*	*X*	*X*	*X*	*X*	(X)	(X)	*X*	*X*	*(x)*	*(x)*	*X*		CE labelling[5], airtightness: $Q_{100} \le 0.25$ $m^3/(h*m)$
Entrance door (ed)	1.10 * 2.20		X	X				X	X									Airtightness: ($Q_{100} \le 2.25$ $m^3/(h*m)$), under climate load
Door system (ds)	1,10 * 2,20 2,20 * 2,20		X	X	(X)	(X)	(X)	X	X	(X)	(X)	(X)						As 'ed', with additional consideration of fixed glazed elements
Sliding door (sl)	2.40 * 2.50		X	X	X	X	X	X				X						Testing of airtightness
Curtain wall façade (cw)	Modulmaß 1.20 * 2.50 see section 3.7				X	X	X					*X*	X			X		Screws and glass carrier are to be considered
Glass roof (cwi) (45°)					X	X	X					*X*	X			X	Lightweight roof construction	/
Roof window (rw) (45°)	1.14 * 1.40	X	X	X														/
Element façade (ef)	0.60 * 1.35 (+) 3.00 * 1.35				X	X	X						X			X	Connection to ceiling + mounting	Opaque panel at ceiling levels, 3D Simulation of mounting brackets, Screws and glass support to be considered
Skylight, roof light, access hatch (sk) (0°)[6]	1.50 * 1.50	X	X	X	(X)	(X)	(X)										Reinforced concrete flat roof, lightweight roof construction	For access hatches no efficiency class will be given
Continuous roof light	1.50 * 4.50				X	X	X						2					Three-dimensional thermal bridges are considered
Opening in glass roof (ocwi) (45°)	1.20 * 2.50	X	X	X													3 certified transom-mullion façades	/

X: included in the calculation; *X*: stated for informative purposes; (X): alternative. One option must be chosen and delivered by the manufacturer.
OB: frame section bottom (openable), **OJ**: frame section side (openable), **OH**: frame section top (openable, **F**: for frames with fixed glazing, **T**: threshold, **DL**: frame section side with window hardware, **fm**: flying mullion, **m**: mullion, **t**: transom, **1**: with one opening element, **2**: with two opening elements

[3] Installation situations are specified by the PHI, deviation from specifications is possible if required, and other installation situations can be calculated. The U-value of the walls/roofs may not exceed the maximum value permissible in the criteria for opaque building components. Additional installation situations will be calculated for verifying EnerPHit suitability, see Section 3.9. Elements, used for installation, are to be considered.
[4] Two elements linked to a flying mullion or fixed mullion
[5] Or equivalent including testing of airtightness, protection from driving rain, wind deflection resistance, suitability for use.
[6] The criterion U_g must be verified for the actual geometry. The criteria U_{sk} and $U_{sk,installed}$ must be verified for glazing that projects horizontally.

2.5 Assignment of the climate zones (regions with identical requirements)

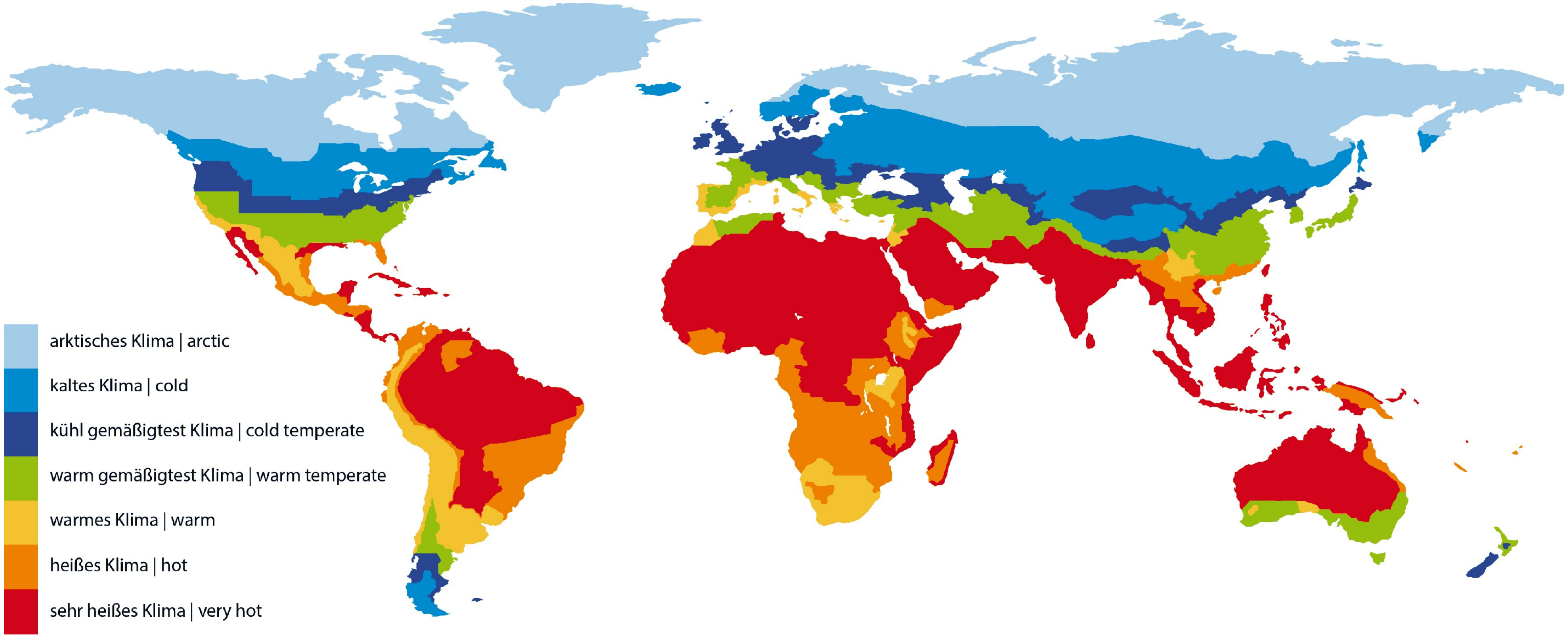


Figure 1: Assignment of regions with identical requirements

3 Functional requirements, boundary conditions, calculation

3.1 *Functional requirement for the Passive House criterion for hygiene*

Maximum water activity (interior building components): **$a_w \leq 0.80$**

This requirement restricts the minimum temperature at the window surface for health reasons. Mould growth may occur if water activity exceeds 0.80. Such conditions should therefore be consistently avoided. For boundary conditions, see 3.4. Water activity is the relative humidity either in a material's pores or directly on its surface. This results in the temperature factors $f_{Rsi = 0.25}$ [7] given in Table 1 as acceptable certification criteria for different climates.

3.2 *Functional requirement for the Passive House criterion for comfort*

Minimum temperature of volume enclosing surfaces: **$|\theta_{si} - \theta_{op}| \leq 4.2\ K$**

This temperature difference requirement limits the minimum average temperature of a window in heating climates for reasons of comfort. In contrast with the average operative indoor temperature, the minimum surface temperature may deviate by a maximum of 4.2 K. A greater difference may lead to unpleasant cold air descent and radiant heat deprivation. The operative temperature (θ_{op}) is the average obtained from the air temperature and the temperature of the space-enclosing surfaces. It is also known as the perceived temperature and is assumed to be 22 °C in the formula below.
The maximum heat transfer coefficients (U-values) of installed certified transparent Passive House building components under heating dominated situations can be calculated from this temperature difference criterion using the formula below:

$$U_{transparent,installed} \leq \frac{4{,}2\,K}{(-0{,}03 \cdot \cos\beta + 0{,}13)\ m^2K/W \cdot (\theta_{op} - \theta_e)}$$

Due to the additional heat losses from the installation-based thermal bridge, the requirement is increased by 0.05 W/(m²K) for the uninstalled components and by 0.10 W/(m²K) for the glazing, with reference to the heat transfer coefficients of the installed components.
In the context of feasibility studies it was shown that in warmer heating climates, the economic optimum is achieved with better heat transfer coefficients than are required for the comfort criterion alone. In these climate zones, heat transfer coefficients, which are based on the economic optimum are specified for the certification. The same applies for cold climates. This results in the heat transfer coefficients given in Table 1 as acceptable certification criteria for different climates.

3.3 *Passive House criterion: Limiting the risk of draughts: $v_{air} \leq 0.1$ m/s*

The air velocity in the living area must be less than 0.1 m/s. This requirement restricts the air permeability of a building component as well as cold air descent. For vertical surfaces, adherence to the temperature difference requirement means compliance with the draught requirement. This has not been examined conclusively for inclined surfaces. For vertical surfaces, compliance with the temperature difference requirement means that the draught criterion is also complied with. For inclined surfaces this has not yet been examined conclusively.

3.4 *Boundary conditions for heat flow simulation*

Table 4: Boundary conditions for heat flow simulation

Climate	**Heat transfer resistance R_S [m²K/W]**			**Temperature [°C]**
	Upward 0° ... 60°	Horizontal 60° ... 120°	Downward 0° ... 60°	
Inside (EN 6946)	0.10	0.13	0.17	20
Inside – sloped glazing	$R_{Si} = -0.03 \cdot \cos\beta + 0.13$ (ß = angle of inclination to horizontal)			
Increased on inside (at glass edge area)	0.20			
Inside determination of f_{Rsi}	0.25			
Outside (EN 6946)	0.04			-10
Outside (ventilated)	0.13			
Outside (against ground)	0.00			-10

[7] f_{Rsi} is the temperature factor at the coldest point of the window frame, as an alternative the coldest point in the installed state. At glass dividing sections, (e. g. mullions) the required temperature factor has to be met on at least one of the sections displayed.

3.5 Calculation of f_{Rsi}

Calculation of the temperature factor at the glass edge f_{Rsi}: $f_{Rsi} = \frac{\theta_{si} - \theta_e}{\theta_i - \theta_e}$

with θ_{si}: minimum interior surface temperature as per heat flow calculation [°C]

θ_e: outside temperature as per heat flow calculation [°C]

θ_i: inside temperature as per heat flow calculation [°C]

The result is calculated to 4 decimal places and stated to 2 decimal places.

3.6 Calculation of U-values

In order to obtain directly comparable thermal parameters, the same glazing U-values are used for individual components in the different regions, see façades. The actual glazing U-value is used for horizontal and inclined components.

U-value of an uninstalled transparent building component

$$U = \frac{U_g \cdot A_g + U_f \cdot A_f + \Psi_g \cdot l_g}{A_g + A_f}$$

U: Heat transfer coefficient of the uninstalled transparent building component [W/(m²K)] according to DIN EN ISO 10077-1:2009 Section 5.1.

U-value of an installed transparent building component

$$U_{installed} = \frac{U \cdot A_W + \sum l_i \cdot \psi_i}{A_W}$$

$U_{installed}$: Heat transfer coefficient of the installed transparent building component [W/(m²K)]

A_W: Area of the window ($A_g + \sum A_f$) [m²]

$\sum l_i * \Psi_i$: Sum of all installed lengths [m] multiplied by the respective installed Ψ-value [W/(mK)]. For determination of the geometric characteristic values, see Section 3.7; for determination of the installation-based thermal bridges see Section 3.8.

3.7 Geometric characteristic values

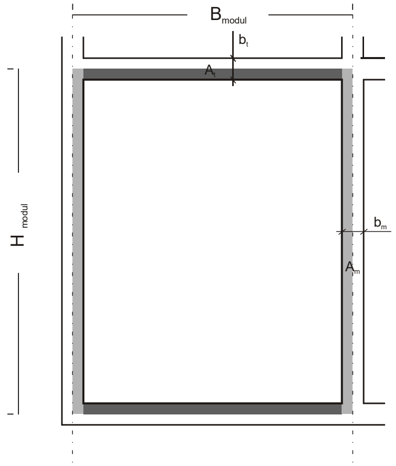
Façade and roof windows

See DIN EN ISO 10077-1, Section 4

In addition: profiles, for example for connecting window sills, are considered part of the frame.

Curtain-wall façades, glass roofs, and opening elements in glass roofs

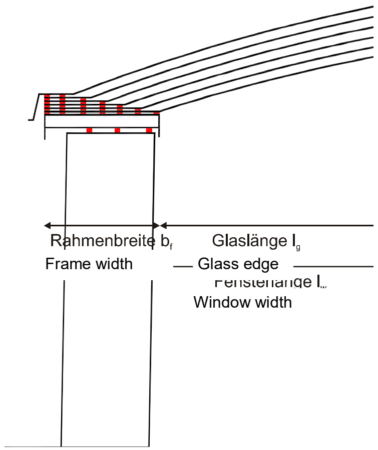
See DIN EN 12631. Variance: the unit size is the testing size (B_{unit} * H_{unit} = 1.2 m * 2.5 m). The left and bottom sides are installed. Similarly to windows, the full width of the mullion/transom is used.



Skylights and dome lights

See DIN EN ISO 10077-1 Section 4. In addition or as variance: l_g is the clearance size between the frames; b_f is the horizontally projecting frame width. Fixing attachments etc. are not considered part of the frame width. Skylight frames and crowns are included in the installation-based thermal bridge. They are not considered part of the frame. 0.30W/(m²K) is specified as the maximum U-value for skylight frames/crowns. This value should be verified in accordance with DIN EN ISO 6946.

With curved dome lights, the actual length of the glass or its area differs from the horizontally projecting glass area to be entered in the PHPP. In the certificate and the data sheet, the projected area is given with a correspondingly increased U-value, adjusted for the reduced area. These values can be taken directly for the PHPP.



3.8 Thermal characteristic values

Frame U-value and glass edge Ψ-value

Ascertained by means of a two-dimensional heat flow simulation; see DIN EN ISO 10077-2 Appen-

dix C. Deviation: profiles, for example for connecting window sills, belong to the frame. The actual glass insertion depth should be used.
Frame U-values are calculated to 4 decimal places and stated to 2 decimal places. Alternatively 3 decimal places can be stated.
Ψ-values are calculated to 5 decimal places and stated to 3 decimal places. Alternatively, 4 decimal places can be stated.

Installation Ψ-value

Ascertained by means of a two-dimensional heat flow simulation; the model for determining the Ψ-value at the glass edge is extended with the exact details of the connection situation. It should be ensured that the model is sufficiently large. As a rule, point attachments of the frame are not included.

$\Psi_{install}$ is determined as follows

$$\Psi_{install} = \frac{Q_{install} - Q_{glass-edge} - U_{wall} \cdot l_{wall} \cdot \Delta\theta}{\Delta\theta}$$

Since the exterior frame dimensions are used in the energy balance (PHPP), the same reference dimensions are used here. Accordingly, the installation gap is included in the installation-based thermal bridge.

Determining the influence of screws in curtain-wall façades

The influence of screws is represented by ΔU and can be determined by a measurement in accordance with DIN EN 1241-2 or by calculation using 3D heat flow software. Alternatively, for screws made of steel, an overall value of *ΔU* = 0.300 W/(m²K) is used for a distance between 0.2 and 0.3 m between the screws. *ΔU,* due to the influence of screws, is calculated as follows:

$$\Delta U = \frac{(Q_S - Q_0)}{l \cdot \Delta\theta \cdot b_t}$$

Q_S:	Heat flow with screws (determined numerically or by measurement) [W]
Q_0:	Heat flow without screws (determined numerically or by measurement) [W]
l:	Length of the calculation model [m]
Δθ:	Temperature difference between the inside and outside (boundary conditions of the numerical method or the measurement) [K]

If the transoms and mullions have different widths, the smaller width should be used for calculation.

Determining the influence of glass carriers in curtain-wall façades

The influence of glass carriers is represented by the point thermal bridge coefficient of the glass carrier χ_{GT} and can be determined by measurement in accordance with DIN EN 1241-2 or through calculation using heat flow software. Alternatively, for glass carriers made of metal: χ_{GT} = 0.040 W/K, non-metallic glass carriers with screws: χ_{GT} = 0.004 W/K, non-metallic glass carrier: χ_{GT} = 0.003 W/K.

X_{gc} is included in the calculation of the U-value of the façade, multiplied with the number of glass carriers present in the unit. If the glass carriers are screwed in place or attached to bolts, then these screws or bolts must be included in the calculation. Glass carriers that are able to support triple glazing corresponding with the unit size should be used.
X_{gc} [W/(mK)] is calculated as follows:

$$\chi_{gc} = \frac{Q_{gc} - Q_0}{\Delta\theta} \cdot l$$

Q_{gc}:	Heat flow with glass carrier [W]
Q_0:	Heat flow without glass carrier [W]
Δθ:	Temperature difference between the inside and the outside [K]

3.9 EnerPHit suitability

Windows and window systems can also be labelled as EnerPHit components. This labelling is indicated in the database by the EnerPHit component seal, and the certificates then contain the details of a step-by-step refurbishment that have been examined.
Suitability is deemed to be proven if the comfort and hygiene criteria are also achieved in at least one final state of a step-by-step refurbishment and the dew point criterion is met in the intermediate state. If no step-by-step refurbishment is carried out, the regular installation situations are recommended on the certificate.
The suitability for step-by-step modernisation can be verified using the following scenarios. The manufacturer is free to choose at least one scenario, but several or alternative steps can also be tested. The following scenarios can be tested:

A: Replacement of the window - external insulation in the second step:

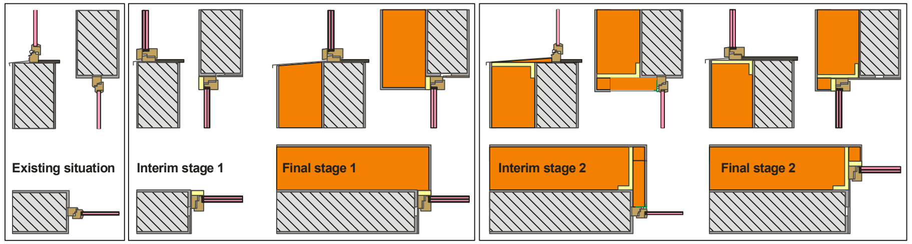
Intermediate state 1: The new window is installed flush with the external wall, any intermediate solutions must be made driving rain-proof

Final state 1: In the second step, the window is over-insulated with the new façade insulation

B: Replacement of the window in the second step:

Intermediate state 2: A mounting frame is installed around the installation opening, to which the new insulation is connected. The old frame is insulated with reveal insulation.

Final stage 2: The old window frame is removed, the new window frame is installed and connected in a technically correct manner.



The PHI can provide further information on this refurbishment method on request. An example installation situation will also be provided. On request, it is possible to deviate from this template and a demonstrably suitable alternative procedure can be described and presented in detail. The hygiene criterion is also tested in the installed state with an internal thermal resistance of 0.25 m²K/W. If the comfort criterion for the respective climate zone is not achieved with the reference Ug value specified in Table 1, the maximum thermal transmittance of the glazing (Ug) required for compensation is determined and shown on the certificate together with the heat loss coefficients of the installed thermal bridges. It must be ensured that the thermal transmittance coefficients of the glazing correspond to standard market and realistic values, if necessary by providing evidence for the respective climate zone.

3.10 Additional consideration of shading elements

Window-integrated or other types of shading elements can be included in the certification. For this, verification of the shading factors of the elements must be provided and the shading elements must be calculated in the installation situations and/or the window (in addition). The possibility of shading will be shown prominently in the certificate and the component database of the Passive House Institute.

3.11 Special regulations

Compound and box windows

- Glazing U-value U_g to be used: the actual glazing U-value of the combined insulated glass unit, the intermediate space and the glazing in front. The reference U_g value that is best for the insulated glass unit is used.
- Thermal conductivity of the intermediate air space taken from the R-value in accordance with the table in DIN EN ISO 10077-2 Appendix C. The R-value for 50 mm given in the mentioned table can be used for intermediate air spaces larger than 50 mm. Alternatively, DIN EN ISO 673 can be used for calculation.
- Basic approach for the calibration plate of box windows: geometry of glass panes as calibration plate, intermediate air space as before, for compound windows: as stated in DIN EN ISO 10077-2.

Entrance doors

- The maximum allowable height of the threshold profile is 20 mm (see DIN 18040-1, -2, section 4.3.3.1).
- Under all the boundary conditions mentioned below, the entrance door achieves the airtightness class 3 in accordance with DIN EN 12207 (based on the joint length).
- Airtightness of a complete door element is determined through measurement in accordance with DIN EN 1026 under the following boundary conditions:
  - Laboratory conditions. The laboratory must be accredited by the relevant national regulating body, but does not need to be a Notified Body.
  - Boundary conditions according to DIN EN 1121, test climate d: inside 23 ± 2 °C, 30 ± 5 % relative air humidity; outside -15 ± 2 °C, test climate e: inside 25 ± 5 °C; temperature load outside due to infrared source 55 ± 5 °C above inside temperature. Only for wooden entrance doors: test climate "C": inside 23 ± 2 °C, 30 ± 5 % relative air humidity; outside 3 ± 2 °C, 85 ± 5 % relative air humidity. Where these conditions cannot be replicated by any testing laboratory in the relevant country, an alternative strategy to evidence airtightness under climate load must be agreed with PHI.
  - In deviation from DIN EN 1121 the test must be carried out for a closed but

unlocked door. For simplification of the test procedure, deformation of the door can be measured under the given climatic boundary conditions and re-adjusted during the measurement of the air permeability coefficient.
  - Where a door is fully glazed, airtightness testing can be dispensed with, so long as it can be demonstrated that the door is sufficiently air sealed.
- Additional variants with glazing can be stated in the certificate. The U_g-value of the actually installed glazing can be used to calculate the U_D values.
- Additionally other frame sections can be shown for glazing at the side and sky-lights. The reference U_g-value can be used.
- The minimum temperature factor of the respective climate zone may be lower at the threshold profile.

In special cases, 3D heat flow simulations may become necessary which must be agreed between the client and the PHI.

Plastic / vinyl windows

- In the case of plastic windows, adequate reinforcement shall be used for the respective reference size.
- The reinforcement must also be suitable for coloured window frames. Otherwise, the certificate will explicitly state a limitation to certain colours.
- The certificate state the maximum permissible element size with the reinforcement used.

Aluminium windows

- A window is only considered as an 'aluminium window' where the aluminium has a structural function.

Element facades

- Element facades are calculated in the same way as curtain walls, i.e. taking into account the thermal bridge loss coefficients of glass supports and the mechanical fixing of the pressure plates.
- Brackets and mounting elements connecting different parts, as well as the connection to the slab edge are to be considered
- For the upper part of the component in the area of the (suspended) ceiling, an opaque panel can be considered with its actual thermal performance; thermal bridges in connection the mullions and transoms are to be considered.

Basic approach for thermal conductivities (λ)

- In principle, only the rated value of the conductivity is taken into account.
- If no rated value is available, the procedure in DIN EN ISO 10077-2:2012 Section 5.1 is to be followed.
- Anisotropic behaviour of materials is to be considered: λ in direction of the fibre = correction factor * λ perpendicular to the fibres. For timber, the correction factor is 2.2. For fibre reinforced materials, a correction factor of 1.5 is applied, as long as no other evidence is given.

Reduced emissivities of metal surfaces

- In closed cavities these will be assigned according to DIN EN ISO 10077-2
- Lower values can be assigned following submission of sufficient evidence

Spacers

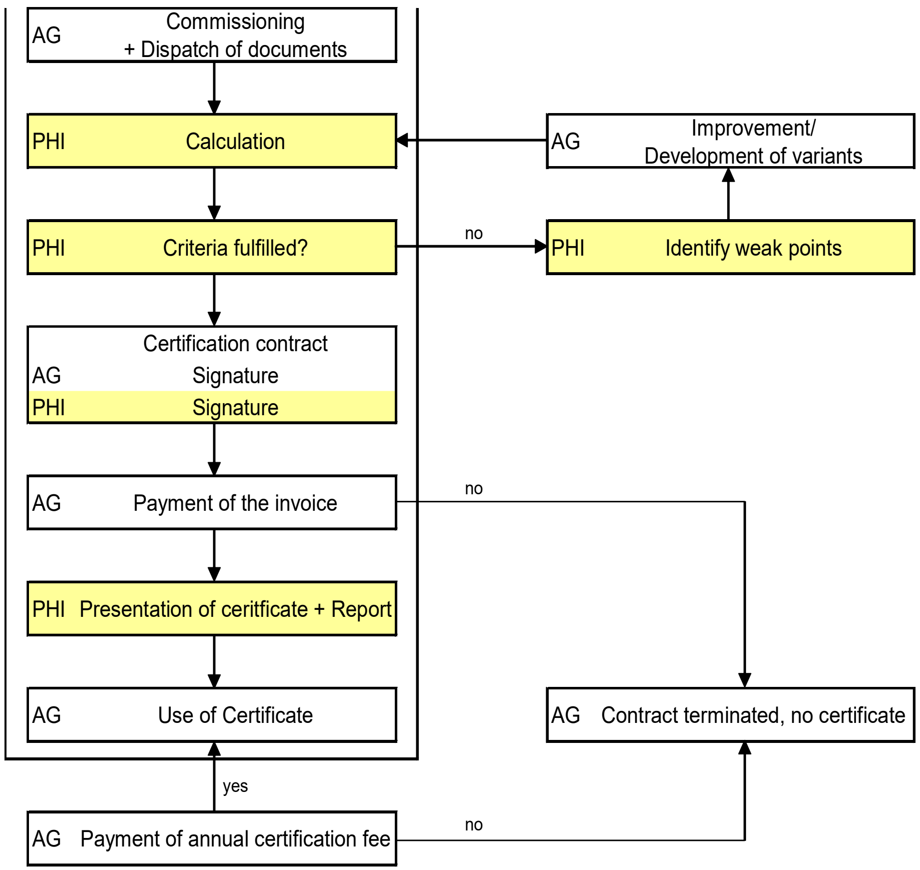
- Warm edge spacers can be chosen freely by the certificate holder. The 2-Box models of the "Warm Edge Working Group" should be referred to (Box 2 for spacers) for calculation.
- The secondary seal (Box 1)
  - Can also be freely selected, provided that it has been approved for the chosen spacer.
  - For categories in which the longest side of the reference element is less than or equal to 1.5 m, a 4 mm sealant thickness is assumed as standard; for larger elements this is 6 mm.
  - For structural glazing, 6 mm must always be used.
  - Where the manufacturer provides suitable evidence that their glass supplier uses a certain sealant thickness, then this can be used. Details of this will be noted in the 'description' section of the certificate.
  - If the selected spacer requires a greater sealant thickness, this should be used.
- Beyond this, there is the possibility of certification with a spacer category corresponding with the criteria for "Spacers in low-e glazing" of the Passive House Institute. The following reference spacers are acceptable for this purpose: Height of box 2: 7 mm, thermal conductivity of box 2: [W/(mK)]: phA: 0.2, phB: 0.4, phC: 1.0.

Other stipulations

- For windows and fixed glazing, the connection at the top of masonry walls with a compound insulation system is calculated without the concrete lintel.
- The bottom frame section must specifically provide the possibility of drainage. This draining facility is part of the window frame and is not part of the installation situation.
- Concealed and mounting frames are treated as part of the installation location.
- With the exception of the cold and arctic climates, a product must at least achieve the requirements of the climate zone of the address stated on the component certificate. The decisive factor is the climate zone of the respective PHPP climate data set. Exceptions to this rule can be made if the named location is located in the border area of two climate zones.

4 Formal aspects, services provided by the Passive House Institute

4.1 Certification procedure



4.2 Documents required

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

1. **Sectional drawings** (for all different sections) of the window frames or mullion/transoms, including installed low-e triple glazing, as DXF or DWG files.

2. Information about the **materials and rated values of the conductivities** used (and the density, if necessary). It must be possible to assign the materials clearly on the basis of the drawings (legend; hachure). The rated 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 basis of general building approval permits or by a general building approval examination. If a rated value for the thermal conductivity cannot be given, the PHI reserves the right to apply a security surcharge of 25 %.

3. Exact **product information about the spacer**. If necessary, exact information about the geometry and materials, if the spacer is as yet not known to the PHI.

4. **Drawings of installation variants** for installation in three Passive House suitable exterior walls with maximum U-values corresponding to the climate zone. Sectional drawings (for all different sections) as DXF- or DWG-files.

4.3 Services provided by the Passive House Institute

Frame sections and installation situations:

1. Processing of the relevant CAD drawings according to the documents to be provided, for further calculation in accordance with Table 3.
2. Calculation of the U-values and Ψ-values required for certification based on DIN EN 10077 and calculation of the temperature factor.
3. Calculation of variants for the thermal optimisation of the frame in consultation with the client.

The costs incurred for the calculation of variants will be invoiced to the client after prior consultation.

Documentation with the certificate report including representation of isotherms.

Certification:

4. Use of the certificate
5. Implementation of thermal characteristic values of the product in the Passive House Planning Package PHPP.
6. Use of the seal "Certified Passive House component" and if applicable, "EnerPHit Component" by the client.

Presentation in the component database of the Passive House Institute

The component will be presented in the component database of the Passive House Institute together with the certificate. In the category "Window System" the component can be shown as an actual image or a rendering (to be provided by the client). In this category an option is available for showing further information about the certified product, such as photographs, illustrations and technical documents.
Availability of the component in different countries can be indicated and shown.
Furthermore, for an extra charge (in addition to the certificate fee) it is possible to show other production sites or distribution locations in addition to the head office of the certificate subscriber using a map.

4.4 Coming into effect, temporary provisions, further development

The certification criteria and calculation regulations for Passive House suitable transparent building components shall become fully effective with the publication of this document. All previously published criteria shall cease to apply with the coming into force of these provisions. Existing certificates will remain valid until further notice. The Passive House Institute retains the right to make future changes.

5 Abbreviations, indices, formula symbols

	English	Deutsch
A	area	Fläche
a_W	water activity	Wasseraktivität
OB	bottom section, openable	Rahmenschnitt unten, öffenbar
FB	bottom section for fixed glazing	Rahmenschnitt unten für Festverglasung
cw	curtain wall	Pfosten-Riegel-Fassade
cwi	glass roof	Glasdach
DJ	entrance door, jamb / hinge side	Eingangstür, Bandseite
DL	entrance door, locking side	Eingangstür, Schlossseite
ec	exterior corner	Außenecke
ed	entrance door	Haustüre
f	frame	Rahmen
FH	top section for fixed glazing	Rahmenschnitt oben für Festverglasung
FJ	side section for fixed glazing	Rahmenschnitt seitlich für Festverglasung
fm	flying mullion	Stulp
f_{Rsi}	temperature factor	Temperaturfaktor
fx	fixed window	Rahmen mit Festverglasung
g	glass edge	Glasrand
g	glass	Glas
gc	glass carrier	Glasträger
H	heat loss	Wärmeverlust
i	installation	Einbau
K	Kelvin	Kelvin
l	length	Länge
0m	mullion for fixed glazing	Pfosten für Festverglasung
1m	mullion with one opening element	Pfosten mit einem Öffnungselement
2m	mullion with two opening elements	Pfosten mit zwei Öffnungselementen
ocwi	opening element in glass roof	Öffnungselement im Glasdach
OH	top section	Rahmenschnitt oben
OJ	side section, openable	Rahmenschnitt seitlich, öffenbar
OJ2	side with handle	Seitlich mit Drückergarnitur
OT	threshold	Schwelle
Rse	heat transfer resistance - external surface	Wärmeübergangswiderstand Außenoberfläche
Rsi	heat transfer resistance - internal surface	Wärmeübergangswiderstand Innenoberfläche
rw	roof window	Dachflächenfenster
sk	skylight	Oberlicht, Lichtkuppel
sl	sliding door	Schiebetüre
0t	transom for fixed glazing	Kämpfer für Festverglasung
1t	transom with one opening element	Kämpfer mit einem Öffnungselement
2t	transom with two opening elements	Kämpfer mit zwei Öffnungselementen
U	heat transfer coefficient	Wärmedurchgangskoeffizient
ve	ventilation	Lüftung
W	window	Fenster
wi	window	Fenster
ws	window system	Fenstersystem
xx	folding window	Faltanlage
β	inclination	Neigungswinkel
χ	thermal bridge coefficient, point	Wärmebrückenverlustkoeffizient, punktförmig
Ψ	thermal bridge coefficient, linear	Wärmebrückenverlustkoeffizient, linear

6 Selected boundary conditions for determining the hygiene and comfort criteria (informative)

Re-gion No.	Name	Boundary condition for hygiene criterion		Hygiene criterion		Dewpoint criterion		Ambient temperature for comfort criterion [°C]	Maximum heat transmission coefficient			
		θ_a	rHi	$\theta_{Si,min}$	f_{Rsi} =0,25m²K/W	$\theta_{Si,min}$	f_{Rsi} =0,25m²K/W		Orientation	[°]	$U_{W,inst.}$	U_W
1	Arctic	-34,00	0,40	9,20	0,80	6,00	0,74	-50	vertical	90	0,45	0,40
									inclined	45	0,50	0,50
									horizontal	0	0,60	0,60
2	Cold	-16,00	0,45	11,00	0,75	7,80	0,66	-28	vertical	90	0,65	0,60
									inclined	45	0,70	0,70
									horizontal	0	0,80	0,80
3	Cool-temperate	-5	0,50	13	0,70	9	0,57	-16	vertical	90	0,85	0,80
									inclined	45	1,00	1,00
									horizontal	0	1,10	1,10
4	Warm-temperate	3,00	0,55	14,00	0,65	10,70	0,45	-9	vertical	90	1,05	1,00
									inclined	45	1,10	1,10
									horizontal	0	1,20	1,20
5	Warm	10,00	0,70	15,50	0,55	14,30	0,43	-4	vertical	90	1,25	1,20
									inclined	45	1,30	1,30
									horizontal	0	1,40	1,40
6	Hot	not relevant		not defined		not relevant		not relevant			1,25	1,20
7	Extremly hot, often humid	not relevant		not defined		not relevant		not relevant			1,05	1,00