



# 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, 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



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.

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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.

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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.

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**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.

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## 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 ( $\psi$ -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 each step in modernisations that are 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<sup>1</sup>. The frame U-values, frame widths, the glass edge  $\Psi$ -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 ( $\chi_{GT}$ ) are included in the calculation of the losses similarly to  $\Psi_g$ . The same applies for heat losses due to screws. For the certification of

<sup>1</sup> 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  $\Psi_{opaque}$  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  $\Psi_{opaque}$  is, the better the energy balance of the window will be.

window systems the heat losses through leaks are also included in the calculation as  $H_{ve}$ <sup>2</sup>.

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

| Climate zone     | Hygiene criterion<br>$f_{Rsi=0.25} \text{ m}^2\text{K/W} \geq$ | Component U-value <sup>1</sup><br>[W/(m <sup>2</sup> K)] | U-value installed<br>[W/(m <sup>2</sup> K)] | Reference glazing<br>[W/(m <sup>2</sup> K)] |
|------------------|--|--|---|---|
| 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  |

<sup>1</sup> 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 building components compared to the limit value of the vertical component is increased by 0.10 W/(m<sup>2</sup>K), while that of the horizontal component is increased by 0.20 W/(m<sup>2</sup>K). Exception: in cool-temperate climates the limit value of the inclined component is increased by 0.20 W/(m<sup>2</sup>K), while that of the horizontal building component is increased by 0.30 W/(m<sup>2</sup>K).

Table 2: Passive House efficiency classes for transparent building components

| $\Psi_{opaque}$<br>[W/(mK)] | Passive House efficiency class | Description             |
|-----------------------------|--------------------------------|-------------------------|
| $\leq 0.065$                | phA+                           | Very advanced component |
| $\leq 0.110$                | phA                            | Advanced component      |
| $\leq 0.155$                | phB                            | Basic component         |
| $\leq 0.200$                | phC                            | Certifiable component   |

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

<sup>2</sup>  $H_{ve} = \frac{\Delta p}{100Pa}^{2/3} \rho \cdot c_p \cdot Q_{100}$  where  $\Delta p = 6Pa$ ,  $\rho \cdot c_p$  = heat capacity of air: 0.344 Wh/(m<sup>3</sup>K),  $Q_{100}$  = air permeability coefficient (m<sup>3</sup>/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 <sup>3</sup> | Additional specifications  |  |
|--|---------------------------------------|---------------------------------|---|----|-----|-----|-----|----|----|-----|-----|-----|---|-----|-----|---|--|--|
|  |                                       | bo                              | s | to | bof | sf  | tof | th | sh | fm  | m2  | m1  | m | t2  | t1  |   |  | t  |
| Window frame (wi)  | 1.23 * 1.48                           | X                               | X | X  |     |     |     |    |    | (x) | (x) |     |   |     |     |   | EIFS + two others;<br>Sliding doors: EIFS.<br>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 <sup>4</sup> | X                               | X | X  | X   | X   | X   | X  | X  | (X) | (X) | X   | X | (x) | (x) | X   |  | CE labelling <sup>5</sup> , airtightness: $Q_{100} \leq 0.25 \text{ m}^3/(\text{h}^*\text{m})$ |
| Entrance door (ed)                                       | 1.10*2.20                             |                                 | X | X  |     |     |     | X  | X  |     |     |     |   |     |     |   |  | Airtightness: ( $Q_{100} \leq 2.25 \text{ m}^3/(\text{h}^*\text{m})$ ), under climate load     |
| Door system (ds)   | 1,10, 2,20<br>2,20, 2,20              |                                 | X | X  | (X) | (X) | (X) | X  | X  | (X) | (X) | (X) |   |     |     |   |  | As ed, with additional consideration of jamb details and/or double-leaf doors                  |
| Sliding door (sl)  | 2.4 * 2.5                             |                                 | X | X  | X   | X   | X   | X  |    |     |     | X   |   |     |     |   |  | Testing of airtightness  |
| Curtain wall façade (cw)                                 | Modulmaß<br>1.20 * 2.50               |                                 |   |    | X   | X   | X   |    |    |     |     | X   | X |     |     | X   |  | /  |
| Glass roof (cwi) (45°)                                   | see section 3.7                       |                                 |   |    | X   | X   | X   |    |    |     |     | X   | X |     |     | X   | Lightweight roof construction  | /  |
| Roof window (rw) (45°)                                   | 1.14 * 1.40                           | X                               | X | X  |     |     |     |    |    |     |     |     |   |     |     |   | /  |  |
| Skylight, rooflight, access hatch (sk) (0°) <sup>6</sup> | 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 rooflight                                     | 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  
**bo**: frame section bottom, **s**: frame section side, **to**: frame section top, **..f**: for frames with fixed glazing, **th**: threshold, **sh**: frame section side with window hardware, **fm**: flying mullion, **m**: mullion, **t**: transom, **..1**: with one opening element, **..2**: with two opening elements

<sup>3</sup> 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

<sup>4</sup> Two elements linked to a flying mullion or fixed mullion

<sup>5</sup> Or equivalent including testing of airtightness, protection from driving rain, suitability for use.

<sup>6</sup> 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)

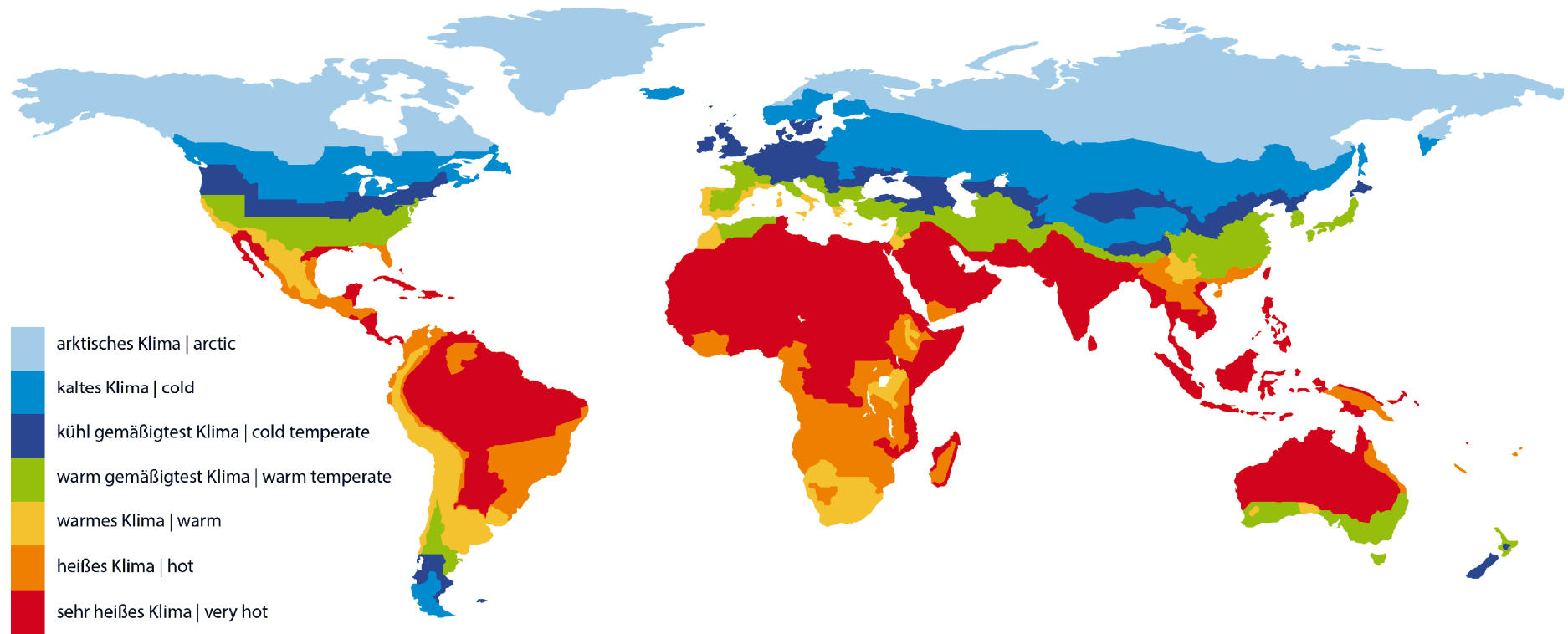


Figure 1: Assignment of regions with identical requirements

### 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  $f_{R_{si}=0.25}$ <sup>7</sup> 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:  $|\theta_{si} - \theta_{op}| \leq 4.2K$

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 4.2K. A greater difference may lead to unpleasant cold air descent and radiant heat deprivation. The operative temperature ( $\theta_{op}$ ) 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:

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

<sup>7</sup>  $f_{R_{si}}$  is the temperature factor at the coldest point of the window frame.

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<br>0° ... 60°  | Horizontal<br>60° ... 120° | Downward<br>0° ... 60° |                  |
| Inside (EN 6946)                         | 0.10  | 0.13                       | 0.17                   | 20               |
| Inside – sloped glazing                  | $R_{Si} = -0.03 \cdot \cos \beta + 0.13$<br>( $\beta$ = angle of inclination to horizontal) |                            |                        |                  |
| Increased on inside (at glass edge area) | 0.20  |                            |                        |                  |
| Inside determination of $f_{R_{si}}$     | 0.25  |                            |                        |                  |
| Outside (EN 6946)                        | 0.04  |                            |                        | -10              |
| Outside (ventilated)                     | 0.13  |                            |                        |                  |
| Outside (against ground)                 | 0.00  |                            |                        |                  |

### 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  $\theta_{si}$ : minimum interior surface temperature as per heat flow calculation [°C]  
 $\theta_e$ : outside temperature as per heat flow calculation [°C]  
 $\theta_i$ : inside temperature as per heat flow calculation [°C]

### 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 Table 1. 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]

$\sum l_i \cdot \psi_i$ : Sum of all installed lengths [m] multiplied by the respective installed  $\Psi$ -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.

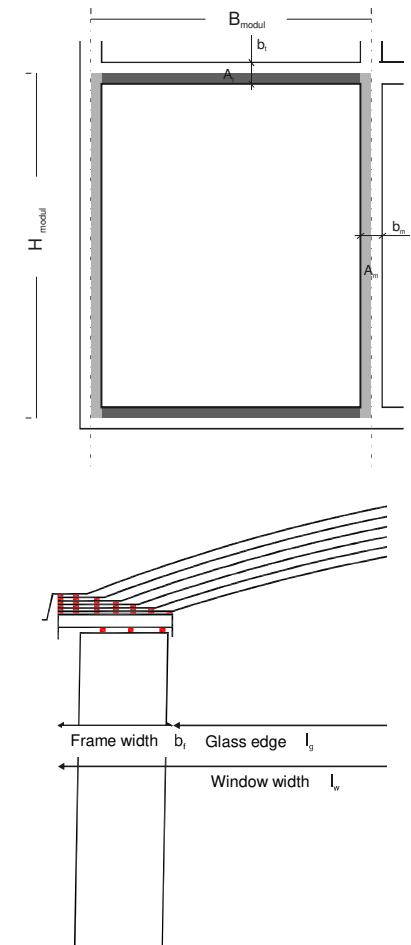
#### Curtain-wall façades, glass roofs, and opening elements in glass roofs

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

#### Skylights and domelights

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. 0.30 W/(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 domelights, 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 $\Psi$ -value

Ascertained by means of a two-dimensional heat flow simulation; see DIN EN ISO 10077-2 Appendix C. Deviation: profiles, for example for connecting window sills, belong to the frame. The actual glass insertion depth should be used.

#### Installation $\Psi$ -value

Ascertained by means of a two-dimensional heat flow simulation; the model for determining the  $\Psi$ -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.

$\Psi_{\text{install}}$  is determined as follows

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

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  $\Delta U$  and can be determined by a measurement in accordance with EN 1241-2 or by calculation using 3D heat flow software. Alternatively, for screws made of steel, an overall value of  $\Delta U = 0.300 \text{ W}/(\text{m}^2\text{K})$  is used for a distance between 0.2 and 0.3 m between the screws.

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

$\Delta U$ , due to the influence of screws, is calculated as follows:

$Q_s$ : 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]

$\Delta\theta$ : 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  $\chi_{GT}$  and can be determined by measurement in accordance with EN 1241-2 or through calculation using heat flow software. Alternatively, for glass carriers made of metal:  $\chi_{GT} = 0.040 \text{ W}/\text{K}$ , non-metallic glass carriers with screws:  $\chi_{GT} = 0.004 \text{ W}/\text{K}$ , non-metallic glass carrier:  $\chi_{GT} = 0.003 \text{ W}/\text{K}$ .

$X_{gc}$  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.

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

$X_{gc}$  [W/(mK)] is calculated as follows:

$Q_{gc}$ : Heat flow with glass carrier [W]

$Q_0$ : Heat flow without glass carrier [W]

$\Delta\theta$ : Temperature difference between the inside and the outside [K]

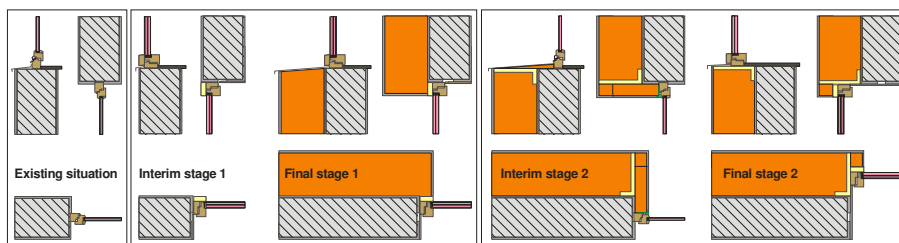
### 3.9 EnerPHit suitability

Windows and window systems can also be characterised as EnerPHit components. This distinction is made clear on the certificate and in the database by means of the EnerPHit Component Seal.

Suitability is verified if the certification criteria are also achieved for each step of a modernisation that is carried out in a step-by-step manner:

1. Window replacement as a first step:

- The new window is installed flush with the exterior wall (in terms of the installation criterion a slight deviation from the limit value is possible).
- In a second step, the new insulation of the façade is extended to cover the window frame.



## 2. Window replacement as a second step:

- a. A mounting frame is installed all around the installation opening, the new insulation is joined to this. The old frame is improved by using reveal insulation.
- b. The old window frame is removed, the new window frame is inserted.

The PHI will provide further information relating to this modernisation procedure. A sample installation situation will also be made available. It is possible to derogate from these specifications upon request and a verifiably suitable alternative procedure and can be described and presented in detail. Suitability of the alternative will be checked by the PHI. The hygiene criterion will also be tested in the installed state with the interior boundary condition  $0.25 \text{ m}^2\text{K/W}$ .

### 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  $U_g$  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

- 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:
  - o Laboratory conditions
  - o Boundary conditions according to DIN EN 1121, test climate d: inside  $23 \pm 2 \text{ }^\circ\text{C}$ ,  $30 \pm 5\%$  relative air humidity; outside  $-15 \pm 2 \text{ }^\circ\text{C}$ , test climate e: inside  $25 \pm 5 \text{ }^\circ\text{C}$ ; temperature load outside due to infrared source  $55 \pm 5 \text{ }^\circ\text{C}$  above inside temperature. Only for wooden entrance doors: test climate "C": inside  $23 \pm 2 \text{ }^\circ\text{C}$ ,  $30 \pm 5\%$  relative air humidity; outside  $3 \pm 2 \text{ }^\circ\text{C}$ ,  $85 \pm 5\%$  relative air humidity
  - o In deviation from 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 readjusted during the measurement of the air permeability coefficient.
- Additional variants with glazing can be stated in the certificate. The  $U_g$  value of the actually installed glazing is used to calculate the  $U_D$  values.
- Additionally other frame sections can be shown for glazing at the side and skylights. 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.

#### Basic approach for thermal conductivities

- Basically, 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.

### 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

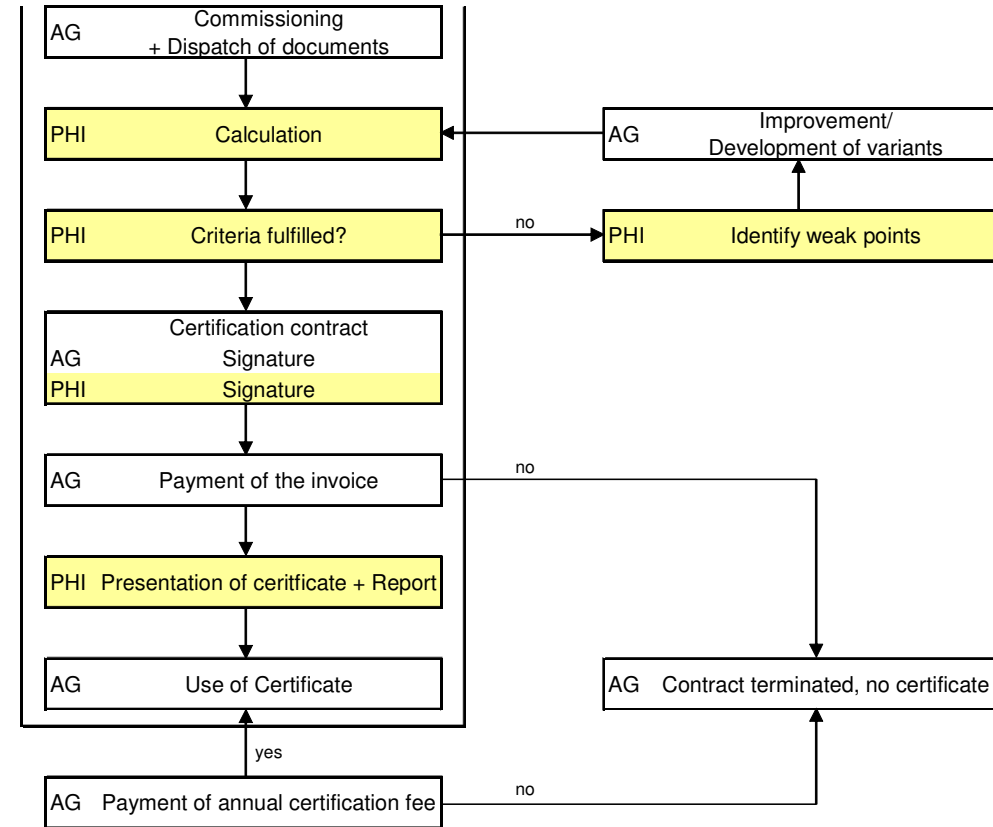
- Warm edge spacers can be chosen freely by the certificate holder. The 2-Box models of the “Warm Edge Working Group” should be referred to (Box 2 for spacers) for calculation.
- The secondary seal (Box 1) is also freely selectable provided that it has been approved for the chosen spacer. The height of the secondary seal is selected according to DIN 18545:2015 depending on the size of the reference element of the corresponding category. For categories in which the longest side of the reference element is less than or equal to 1.5 m, a 4 mm edge overlap is assumed, for larger elements this is 6 mm. For structural glazing, 6 mm must always 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.

## 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  $\Psi$ -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                             |
| bo        | bottom section                              | Rahmenschnitt unten                         |
| bof       | bottom section for fixed glazing            | Rahmenschnitt unten für Festverglasung      |
| cw        | curtain wall                                | Pfosten-Riegel-Fassade                      |
| cwi       | glass roof                                  | Glasdach                                    |
| D         | entrance door                               | Haustüre                                    |
| ec        | exterior corner                             |   |
| f         | frame                                       | Rahmen                                      |
| 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                                       |
| m         | mullion for fixed glazing                   | Pfosten für Festverglasung                  |
| m1        | mullion with one opening element            | Pfosten mit einem Öffnungselement           |
| m2        | mullion with two opening elements           | Pfosten mit zwei Öffnungselementen          |
| ocwi      | opening element in glass roof               | Öffnungselement im Glasdach                 |
| $R_{se}$  | heat transfer resistance - external surface | Wärmeübergangswiderstand Außenoberfläche    |
| $R_{si}$  | heat transfer resistance - internal surface | Wärmeübergangswiderstand Innenoberfläche    |
| rw        | roof window                                 | Dachflächenfenster                          |
| s         | side section                                | Rahmenschnitt seitlich                      |
| sf        | side section for fixed glazing              | Rahmenschnitt seitlich für Festverglasung   |
| sh        | side with handle                            | Seitlich mit Drückergarnitur                |
| sk        | skylight                                    | Oberlicht, Lichtkuppel                      |
| sl        | sliding door                                | Schiebetüre                                 |
| t         | transom for fixed glazing                   | Kämpfer für Festverglasung                  |
| t1        | transom with one opening element            | Kämpfer mit einem Öffnungselement           |
| t2        | transom with two opening elements           | Kämpfer mit zwei Öffnungselementen          |
| th        | threshold                                   | Schwelle                                    |
| to        | top section                                 | Rahmenschnitt oben                          |
| tof       | top section for fixed glazing               | Rahmenschnitt oben für Festverglasung       |
| U         | heat transfer coefficient                   | Wärmedurchgangskoeffizient                  |
| ve        | ventilation                                 | Lüftung                                     |
| W         | window                                      | Fenster                                     |
| wi        | window                                      | Fenster                                     |
| ws        | window system                               | Fenstersystem                               |
| xx        | folding window                              | Faltanlage                                  |
| $\beta$   | inclination                                 | Neigungswinkel                              |
| X         | thermal bridge coefficient, point           | Wärmebrückenverlustkoeffizient, punktförmig |
| $\Psi$    | thermal bridge coefficient, linear          | Wärmebrückenverlustkoeffizient, linear      |

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

| Region No. | Name           | Boundary condition for hygiene criterion |      | Hygiene criterion |           | Ambient temperature for comfort criterion [°C] | Maximum heat transmission coefficient |      |               |       |
|------------|----------------|--|------|-------------------|-----------|--|---------------------------------------|------|---------------|-------|
|            |                | $\theta_a$                               | rHi  | $\theta_{Si,min}$ | $f_{Rsi}$ |  | Orientation                           | [°]  | $U_{W,inst.}$ | $U_W$ |
| 1          | Arctic         | -34,00                                   | 0,40 | 9,20              | 0,80      | -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      | -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      | -16  | vertical                              | 90   | 0,85          | 0,80  |
|            |                |  |      |                   |           |  | inclined                              | 45   | 1,00          | 1,00  |
|            |                |  |      |                   |           |  | horizontal                            | 0    | 1,30          | 1,30  |
| 4          | Warm-temperate | 3,00                                     | 0,55 | 14,00             | 0,65      | -9   | vertical                              | 90   | 1,25          | 1,20  |
|            |                |  |      |                   |           |  | inclined                              | 45   | 1,30          | 1,30  |
|            |                |  |      |                   |           |  | horizontal                            | 0    | 1,40          | 1,40  |
| 5          | Warm           | 10,00                                    | 0,70 | 15,50             | 0,55      | -4   | vertical                              | 90   | 1,55          | 1,50  |
|            |                |  |      |                   |           |  | inclined                              | 45   | 1,60          | 1,60  |
|            |                |  |      |                   |           |  | horizontal                            | 0    | 1,70          | 1,70  |
| 6          | Hot            | not relevant                             |      | not defined       |           | not relevant                                   |                                       | 1,80 | 1,80          |       |
| 7          | Very hot       | not relevant                             |      | not defined       |           | not relevant                                   |                                       | 1,00 | 1,00          |       |