Information, Criteria and Algorithms for Certified Passive House Components:

Sun Protection, fall protection and Window Installation Systems

Version 2.1, 2021-07-08 kk,am,el

Note: Certificates are currently only being issued for the ‘cold’, ‘cool-temperate’ and ‘warm-temperate’ climate regions.
The application range can be expanded by way of pilot certifications on request.
Installation connections for other wall assemblies can be defined on request.
The criteria for sun protection systems are subject to specific changes as they 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 use in 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 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 verifiable 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. **www.ig-passivhaus.de**

Inhalt

Preface

Passive House buildings provide optimal thermal comfort with extremely low 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.

1 Status quo and motivation

Window installation in the insulation layer is the thermally optimal position. But the installation in the insulation layer is more difficult than in the load-bearing plane of the wall. In the example of monolithic walls, the installation of windows in the load-bearing layer may be useful or necessary.
Window installation systems help to reduce installation thermal bridges without having to use special and therefore expensive individual solutions. The mounting of a sun protection system in the insulation layer will however increase the installation thermal bridge.
Fall protection devices are possibly necessary elements for openable elements of the building envelope, a constructive thermal bridge is the result.
With this certification, the Passive House Institute sets a transparent quality standard, improves the visibility of existing solutions and creates incentives for the development of new solutions in order to make a contribution to a thermally and economically improved window installation, including sun protection system. In addition, thermal bridge loss coefficients for window installation are determined for use in energy balance programs to assist planners and manufacturers.

2 Certification criteria

2.1 Proof of suitability, certificate

The certifiability is demonstrated by the increase of the heat transfer coefficient ΔU [W/(m²K)] caused by the installation thermal bridge (efficiency criterion) in conjunction with given installation situations and window frames as well as by the minimum temperature factor at the coldest point of the installation connection (hygiene criterion). The efficiency criterion is considered fulfilled if at least one installation variant per reference frame meets this criterion.
ΔU is determined according to the following equation:

$$\Delta U = \frac{\sum \Psi_{install,i} \cdot l_{install,i}}{A_w}$$

Where:

ΔU Increase in the heat transfer coefficient of the window by installing the window [W/(m²K)]

$\Psi_{install,i}$ Thermal bridge loss coefficient of the respective installation situation [W/(mK)]

$l_{install,I}$ Length of the respective installation situation [m]

A_W Area of the window [m²]

The components must meet the comfort requirements of the climate zone of the PHPP climate data set nearest to the manufacturer's location, alternatively as shown in Figure 1, with realistic glazing.

The heat transfer coefficients (U-values) and the thermal bridge loss coefficients (ψ-values) of the window are determined on the basis of DIN EN ISO 10077-2, the installation thermal bridges according to ISO 10211.
The suitability of the system in practice must be demonstrated by proof of stability, by a conclusive assembly instruction and by explanation of the airtightness concept, including diagrams, by the manufacturer. The Passive House Institute reserves the right to carry out further investigations, if necessary, by third parties in consultation with the manufacturer.

The certificate contains the product name, a description of the product including installation situations and reference frames, proof of certifiability and relevant performance data.

Table 1: Adequate Certification criteria

<table>
<tr><th>Climate zone</th><th>Hygiene criterion $f_{Rsi=0,25\ m^2K/W} \geq$</th><th></th><th colspan="4">Efficiency criterion ΔU [W/(m²K)]</th></tr>
<tr><th></th><th></th><th>Window installation system</th><th>Fall protection</th><th>Roller shutter</th><th>Venetian blind</th><th>Rollder blind, other</th></tr>
<tr><td>1 Arctic</td><td>0.80</td><td colspan="5">Pilot certifications on request</td></tr>
<tr><td>2 Cold</td><td>0.75</td><td rowspan="3">0.05</td><td rowspan="3">0.01</td><td colspan="2">0.07</td><td>0.05</td></tr>
<tr><td>3 Cool, temperate</td><td>0.70</td><td>0.10</td><td>0.08</td><td>0.06</td></tr>
<tr><td>4 Warm, temperate</td><td>0.65</td><td colspan="2">0.16</td><td>0.12</td></tr>
<tr><td colspan="7">Proofed at a window 1.23 * 1.48 m, with sun protection an additional 1.1 * 2.2 m. For fall protection, evidence is provided on a window with 1.1 * 2.2 m. In Table 2 the climate-depending frame-glass combinations as well as the installation situations are defined.</td></tr>
</table>

2.2 Scope of investigations

2.2.1 Sun protection system

In principle, the certification can be carried out in one of two ways:

1. Using the reference window frame “wood/plastic” from table 2
2. With an existing certified Passive House window frame

The installation of the window, including sun protection, is calculated for two window sizes:

1. 1.23m x 1.48m (standard window size)
2. 1.10m x 2.20m (in case the size of the element for mounting the sun protection system or the position in the wall changes from 1.)

The side installation contains the guideway of the sun protection system, the top installation contains the housing for accommodation of the sun protection system for the respective window size. The maximum possible height of the blind is shown in the certificate. Thermally relevant mounting elements are included in the calculation if necessary, using 3D thermal simulation.

The results of these calculations are used to demonstrate that the criteria in section 2.1 are met.

It is recommended that calculations are carried out using two alternative insulation thicknesses, in order to provide the designer with further performance values in the certificate.
If the sun protection system is specially designed for certain wall construction types, e.g. lightweight timber, another wall assembly can be used.

2.2.2 Window mounting system

In addition to the proof of suitability (see 2.1), example installation thermal bridge loss coefficients are generated for input into the PHPP. For this purpose, the PHI, in consultation with the manufacturer, calculates a number of variants (different frame types, i.e. at least 3 positions in the wall, covered with insulation).
These are based on glass-frame constructions and wall structures (reinforced concrete wall with thermal insulation) adapted to the requirements of the climate zones. The installation situation is abstracted to such an extent that it can represent an ETICS, a curtain wall or a masonry cavity wall.

2.2.3 Fall protection

The calculations are carried out in analogy to the window installation systems. If the systems are designed for certain construction principles of facades, the reference situation can be deviated from and any existing parts can be taken into account (external plaster, adhesive layer, facade cladding, bracket, etc.). The thickness and thermal conductivity of the insulation layer corresponds to the reference specification of the respective climate. The prerequisite for certification is the possibility of front-wall installation of the window frame and the possibility of overinsulating the window frame. The thermal bridge loss coefficients of the assembly elements are determined by means of 3D heat flow simulation. The certificate shows the number of elements required and the resulting thermal bridge addition coefficient for the entire element. The influences of all necessary fasteners and fall protection are taken into account.

Three abstract window frame models are calculated:

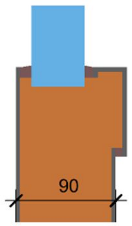
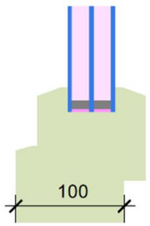
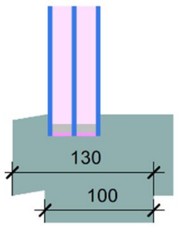
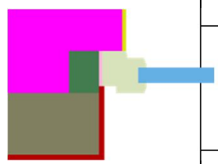
1. Frame with aluminium cladding (3 details).
   „Bottom"-connection (3 details)**:** As a rule, three different positions in the wall (e.g. inside of the frame flush with the outside of the wall, in the centre of the insulation layer, in the external third of the insulation) will be calculated.
   „Side / top"-connection: generally speaking these match the „bottom" connection and are therefore not determined separately.
2. Timber / plastic frame (9 details).
   „Bottom"-connection: See aluminium frame.
   „Side / top"-connection (6 details)**:** Where insulation does not cover the frame, this connection matches the "bottom" connection. In addition, variants where the frame is partly and fully covered by insulation are calculated.
3. Integral frame (6 details):
   „Bottom"-connection: See aluminium frame.
   „Side/top"-connection: Like „aluminium", but fully covered by insulation.
4. In addition, in one of the frames listed above, at least one additional variant **with sun protection system** is calculated: e.g. top connection with roller shutters/external venetian blinds and laterally with roller shutter rails. (2 details)

As a rule, a minimum of 26 details are to be calculated in order to determine the installation thermal bridges and the minimum surface temperature and resulting temperature factor.

Note for timber-aluminium frames: For frames with continuous aluminium cladding, the calculated installation values of the frame with aluminium cladding can be used. If the cladding only covers part of the frame, the value for wood or plastic windows can be used with a corresponding partial over-insulation.

2.3 Combinations of frame, glass and installation for different climate zones

Table 2: Definition of frames, glass combinations and installation situations

<table>
<tr><th>Climate zone</th><th colspan="8">Window frame</th><th colspan="2">Installation situation</th></tr>
<tr><td></td><td>b_f [mm]</td><td colspan="2">**Metal**
140</td><td colspan="2">**Timber / Plastic**
125</td><td colspan="3">**Integral**
100</td><td colspan="2">Plaster d = 15 mm, λ 0.57 W/(mK); Insulation d (side/bottom), λ = 0.032 W/(mK)
Concrete d = 175 mm, λ = 2.3 W/(mK)</td></tr>
<tr><td>1 Arctic
U_g= 0.35 W/(m²K)
U_W= 0.40 W/(m²K)</td><td colspan="10">Pilot certification, on request</td></tr>
<tr><td>2 Kalt
U_g= 0.52 W/(m²K)
U_W= 0.60 W/(m²K)</td><td>U_f [W/(m²K)]
Ψ_g [W/(mK)]</td><td rowspan="3"></td><td>**Bottom, side/top**
0,57
0,024</td><td rowspan="3"></td><td>**Bottom, side/top**
0,62
0,020</td><td rowspan="3"></td><td>**Bottom,**
0,66
0,020</td><td>**Side/ top**
0,59
0,020</td><td rowspan="3"></td><td>Insulation
d = 300 mm
U = 0.110 W/(m²K)</td></tr>
<tr><td>3 Kühl-gemäßigt
U_g= 0.70 W/(m²K)
U_W= 0.80 W/(m²K)</td><td>U_f [W/(m²K)]
Ψ_g [W/(mK)]</td><td>**Bottom, side/top**
0,75
0,034</td><td>**Bottom, side/top**
0,73
0,036</td><td>**Bottom,**
0,89
0,026</td><td>**Side/ top**
0,79
0,028</td><td>Insulation
d = 240 mm
U = 0.129 W/(m²K)</td></tr>
<tr><td>4 Warm-gem.
U_g= 0.90 W/(m²K)
U_W= 1.00 W/(m²K)</td><td>U_f [W/(m²K)]
Ψ_g [W/(mK)]</td><td>**Bottom, side/top**
0,85
0,049</td><td>**Bottom, side/top**
0,92
0,038</td><td>**Bottom,**
1,11
0,027</td><td>**Side/ top**
0,99
0,027</td><td>Insulation
d = 140 mm
U = 0.215 W/(m²K)</td></tr>
</table>

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

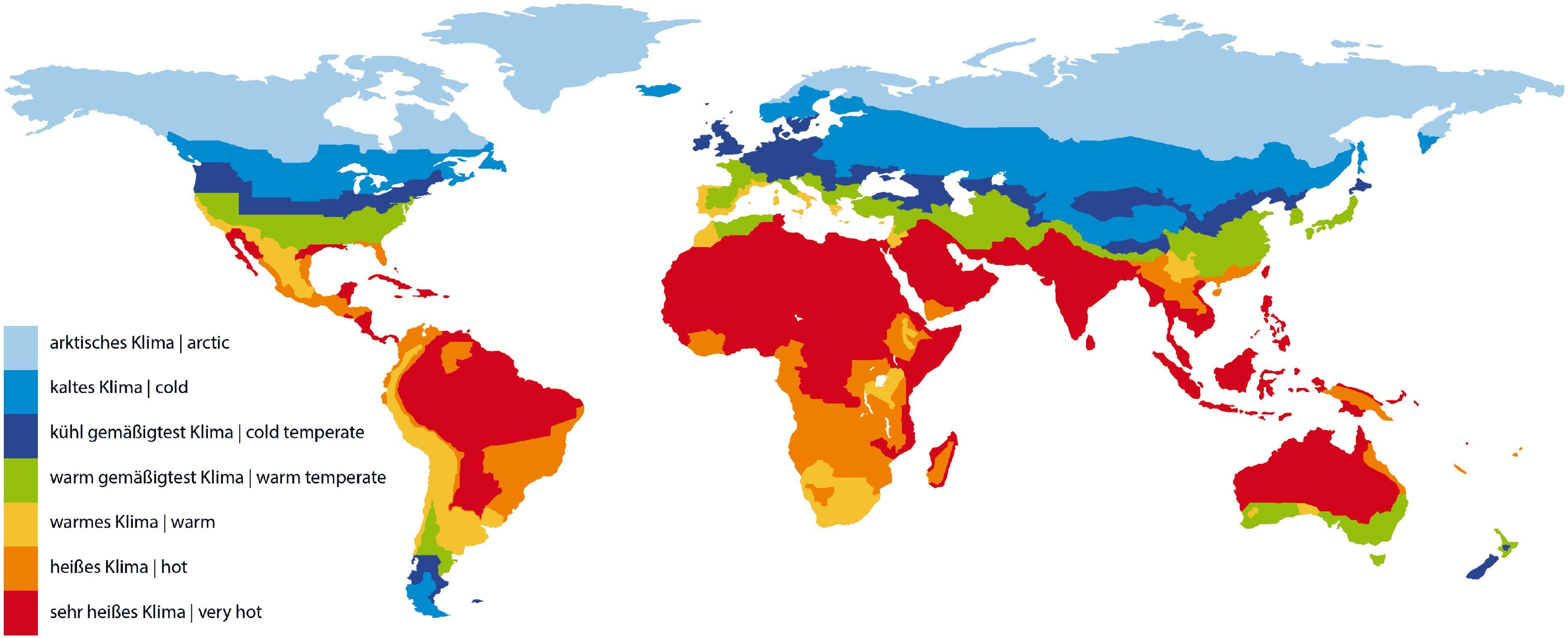


Figure 1: Assignment of regions with identical requirements

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 $f_{Rsi=0.25}$ [1] 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 (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 the document Information, Criteria and Algorithms for Certified Passive House Components: Transparent Building Components and Opening Elements in the Building Envelope as effectual 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 0.1m/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 3: 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
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			
On the inside of the element for mounting the sun protection system, see EN 10077-2 2018-1, chapter 6.3.5	≤ 2mm free cross-section: non-ventilated cavity (sun protection and small parts can also be taken into account). ≤ 35mm: weakly ventilated, 0.30 > 35mm: Well ventilated, 0.13			-10

[1] f_{Rsi} is the temperature factor at the coldest point of the window frame.

3.5 Calculation of f_{Rsi}

Calculation of the temperature factor 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]

3.6 Calculation of U-values

U-value of an uninstalled element $U = \frac{U_g \cdot A_g + U_f \cdot A_f + \Psi_g \cdot l_g}{A_g + A_f}$

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

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

U-value of an installed element

$U_{installed}$: 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 4.8; for determination of the installation-based thermal bridges see Section 4.9.

3.7 Geometric characteristic values

See. DIN EN ISO 10077-1, Section 4. In addition: profiles, for example for connecting window sills, are considered part of the frame.

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 Appendix C. Deviation: profiles, for example for connecting window sills, belong to the frame. The actual glass insertion depth should be used.

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.

Additional punctual heat losses

Additional punctual heat losses through screws, reinforcing or mounting elements are determined and taken into account by way of suitable processes.

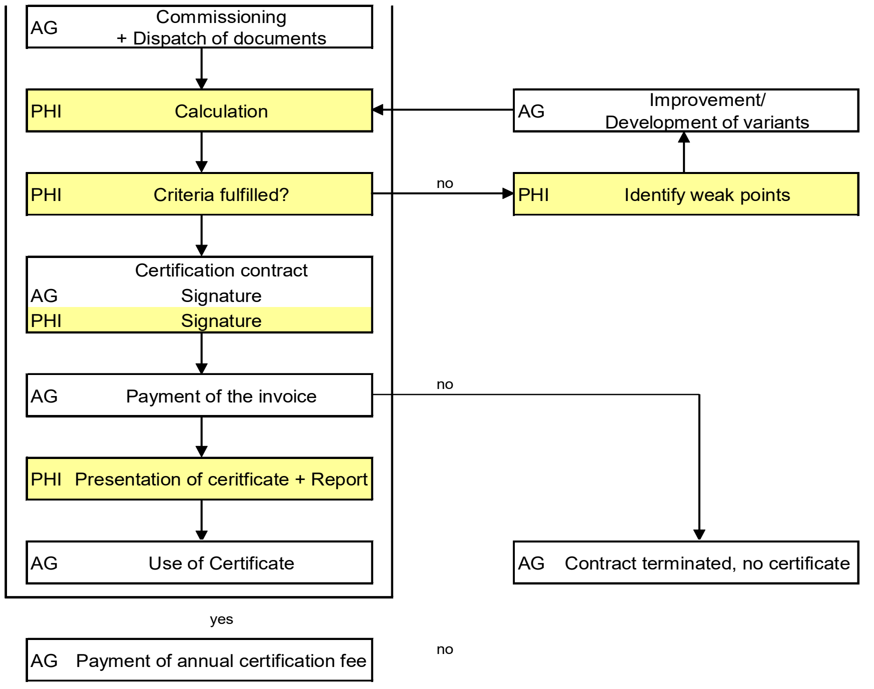
3.9 Special regulations

Application of thermal bridges

- As a 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.

4 Formal aspects, services provided by the Passive House Institute

4.1 Certification procedure



4.2 Required documentation

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

1. **Sectional drawings** (all different cuts) of the wall mounting system or sun protection system, in conjunction with wall and window frames as DXF or DWG files. The arrangement of the airtight layer must also be clearly visible in detail.
2. Specification of the **materials used and the design values of the thermal conductivity** (and possibly the density). Clearly traceable assignment of materials based on the drawings (legend, hatching). The design values of the thermal conductivities of the materials used shall be given in accordance with 4.10.
3. An **installation guide** for the window mounting or sun protection system.

4.3 Services provided by the Passive House Institute

1. Processing of the relevant CAD drawings according to the documents to be provided, for further calculation in accordance with 2.
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: Use of the certificate, use of the seal "Certified Passive House 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. On Request as an image or a rendering (to be provided by the client). Further information about the certified product, such as photographs, illustrations and technical documents can also be displayed.
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.