Criteria and Algorithms for Certified Passive House Components: Opaque construction systems

Version 3.1_en, 07.02.2022 kk/el

Contents

Note: Certificates are currently only being issued for arctic, cold, cool-temperate and warm-temperate regions (see Section 2.3). Criteria for all climate zones except the cool-temperate climate zone are subject to modifications as these criteria are currently in the experimental phase.

Legal note: For all construction details, only the heat flow shall be examined. The absence of condensation and internal moisture transport processes and protection from entry of moisture as well as other aspects relating to building physics, practical construction or structural stability are not covered by these investigations. The applicant, designer or manufacturer are responsible for this as necessary. The PHI assumes that the submitted documents are free of third-party rights. By submitting the documents for certification, the applicant declares that he or she is in possession of all rights to the full extent.

1 Preface

Passive House buildings provide optimal thermal comfort with very low energy costs, and they lie within the economically profitable range with reference to their life-cycle costs. In order to achieve this level of comfort and the low life-cycle costs, the thermal quality of the components used in Passive Houses must meet stringent requirements. These requirements are directly derived from Passive House criteria for hygiene and comfort 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 widespread application, and to provide planners and building owners with reliable characteristic values for input into energy balancing tools. The present document contains the criteria and algorithms for the calculation and certification of opaque building components.

2 Certification criteria

2.1 *Verifying Passive House suitability, certificate*

The Passive House suitability of products is verified using the U-values of the opaque building components (walls, floors and roofs), the linear thermal bridges (Ψ-values) and minimum surface temperature / temperature factor of the junctions listed in table 2, which are calculated in accordance with ISO 10211. All assemblies are then assessed according to DIN EN ISO 13788 to check the risk of interstitial condensation. The results are then compared against the criteria listed in Table 1; where the criteria are met, the system can be certified, see 4.3.2.

Documentation (see 4.2) provided by the manufacturer applying for a certificate form the basis for this. Opaque building systems can be certified in the categories construction system, floor slab system, wall system and roof system. The information contained in the certificate and the respective data sheets includes the manufacturer and system description, certificate category and suitability for the climate zones and the relevant characteristic values for input in the PHPP and designPH.

2.2 *Criteria for issue of the certificate*

For issue of the certificate, the following criteria must be complied with in the context of certification:

2.2.1 Criteria to be fulfilled depending on the climate zone

Table 1: Certification criteria

<table>
<tr><th>Climate zone</th><th>Hygiene criterion[8]</th><th>Comfort criterion</th><th colspan="3">Efficiency criteria</th><th colspan="2">Moisture criteria[6]</th></tr>
<tr><td></td><td>$f_{Rsi=0.25\ m^2K/W}$ ≥[3]</td><td>U-value of the installed window[1] ≤</td><td>U-value of the exterior building component $U_{opaque} * f_{R\ PHI}$[2] ≤</td><td>Purely opaque details $f_{Rsi=0.25\ m^2K/W}$ ≥[3]</td><td>Absence of thermal bridges Ψ_a ≤[4]</td><td>Condensation</td><td>Ma limit according to DIN EN ISO 13788 ≤</td></tr>
<tr><td></td><td>[-]</td><td>[W/(m²K)]</td><td>[W/(m²K)]</td><td>[-]</td><td>[W/(mK)]</td><td>[-]</td><td>[g/m²]</td></tr>
<tr><td>1 Arctic</td><td>0.80</td><td>0.45 (0.35)</td><td>0.09</td><td>0.90</td><td rowspan="7">0.010[5]</td><td rowspan="7">Condensation should be completely evaporated at the end of 12 months</td><td rowspan="7">200[7]</td></tr>
<tr><td>2 Cold</td><td>0.75</td><td>0.65 (0.52)</td><td>0.12</td><td>0.88</td></tr>
<tr><td>3 Cool, temperate</td><td>0.70</td><td>0.85 (0.70)</td><td>0.15</td><td>0.86</td></tr>
<tr><td>4 Warm,temperate</td><td>0.65</td><td>1.05 (0.90)</td><td>0.25</td><td>0.82</td></tr>
<tr><td>5 Warm</td><td>0.55</td><td>1.25 (1.10)</td><td>0.50</td><td>0.74</td></tr>
<tr><td>6 Hot</td><td>None</td><td>1.25 (1.10)</td><td>0.50</td><td>0.74</td></tr>
<tr><td>7 Very hot</td><td>None</td><td>1.05 (0.90)</td><td>0.25</td><td>0.82</td></tr>
</table>

1 applies for vertical windows with a test size of 1.23*1.48 m. The criteria for other transparent building components can be taken from the relevant certification criteria. Value in brackets: respective reference glazing.
2 $f_{R,\ PHI}$: Reduction factor: always 1, exception: areas in contact with the ground and towards the unheated basement in the climate zones 1-4: 0.6; e.g. for climate zone 3 the U-value criterion becomes 0.25 W/(m²K).
3 $f_{Rsi=0.25\ m^2K/W}$ ≥ see Section 3.8.
4 as a thermal bridge loss coefficient based on external dimensions and length. Specific constructions such as inner edges are exempted from this criterion.
5 Geometric thermal bridges, where the insulation thickness around the junction is consistent, but the calculation methodology results in a Psi-value of > 0.010 W/(mK), are exempt from this criterion.
6 These criteria are based on the Glaser Method and allow an assessment of the likelihood of the occurrence of interstitial condensation during the winter. This method brings more reliable results for lightweight and airtight components used in cool and non-humid locations away from the equator that do not contain materials with a large water or heat storage capacity. Where the criteria are not met following this approach, a dynamic simulation according to EN 15026 can be carried out to provide greater detail. It is the responsibility of the architect to ensure the appropriate assessments have been carried out for specific buildings, which may include more detailed analyses than those carried out for this certification. In addition on-site measurements like airtightness testing as well as trained tradespeople help to ensure construction quality.
7 The Ma limit (maximum accumulated moisture content) is based on the ISO 13788 and reflects the maximum amount of condensate in order to prevent run-off of liquid water from watertight surfaces. It may make sense in certain cases to calculate a more specific Ma limit according to the materials present in the wall, roof and floor constructions.
8 For door thresholds the dew point criterion applies according to section 6.

2.2.2 Airtightness of all standard building components and connection details

A professional quality standard of airtightness must be ensured in the building and at the connection details in terms of planning as well as execution, and will be checked during the certification process based on the documents submitted. Where conditions in the region of deployment require it, windtightness of the system should also be considered.

2.2.3 Special cases

Regularly occurring or recurrent penetrations and geometric features of the building components are taken into account in the U-value calculation of the standard building components. The criteria for the thermal bridge coefficients must be complied with under consideration of these special cases.

2.3 *Assignment of climate zones (regions with identical requirements)*

The climate zone is assigned based on the location of the manufacturer's headquarters, or any other facility where the manufacturer conducts its operations. The nearest PHPP climate data set will be used; further climate data sets can be requested from PHI where this is uncertain, e.g. in regions with wide variations in altitude. The certification criteria and a certificate that is issued based on them are valid for the assigned climate zone and also for climates with lesser requirements, bearing in mind however that more economical solutions may be possible. These climate zones are as follows:

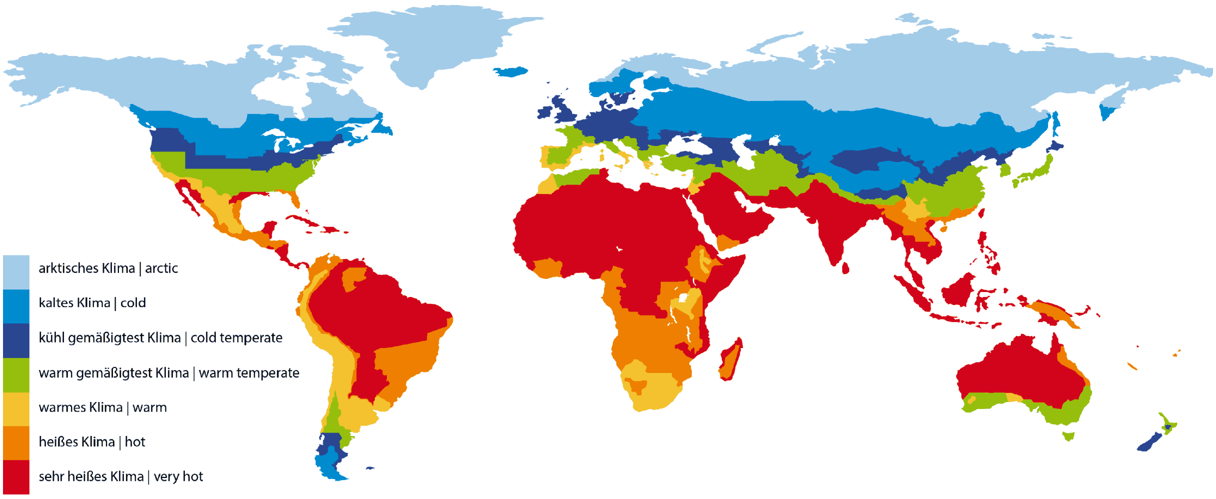
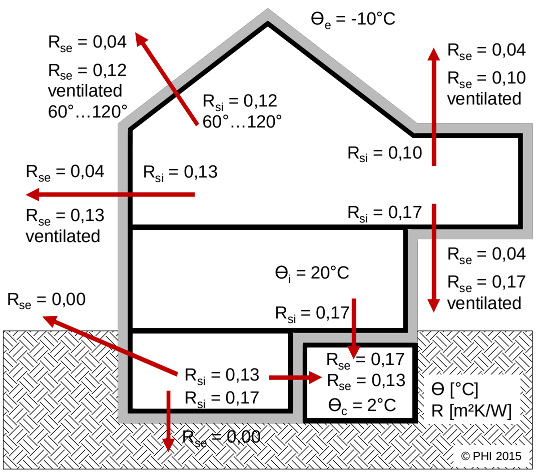


Figure 1: Assignment of regions with identical requirements, based on studies by the PHI

3 Boundary conditions, calculation

All calculations will be carried out by the Passive House Institute. Calculations performed by the manufacturer or third parties shall only be accepted in exceptional cases and after prior consultation.

3.1 *Temperatures and heat transfer resistances for heat flow simulation*



R_{si} is always set as 0.25 m²K/W for calculating the temperature factors.

3.2 *Minimum value of the thermal transmittance, thermal conductivities*

The U-value is calculated in accordance with general technical rules; interruptions of the insulation layers of the standard building component are included in its thermal resistance. The resulting U-value must correspond with the criterion.

In principle, the rated value of the thermal conductivity is taken into account when calculating the U-values. This applies unless other provisions have been made known by the Passive House Institute.

If there is no rated value, then a nominal value of the thermal conductivity determined by a recognised materials testing institute in accordance with the relevant norms can be used as a basis. Similarly to the rated value additions, this nominal value is normally multiplied by 1.20 and the result is used in the calculation, see Section 4.2.

3.3 *Thermal bridge calculation, absence of thermal bridges*

Absence of thermal bridges is verified by means of multi-dimensional heat flow simulations. The fundamental principles for this, especially regarding the specified calculation approaches for building components that are in contact with the ground, are to be found in the publications by the PHI.

In special cases, such as the connection situation of the internal edge to the exterior wall, the equivalent Ψ-value may exceed 0.01 W/(mK); the requirements of the hygiene criterion will remain unaffected by this. The Ψ-value for the installation thermal bridge of the window frame in the case of window and door installation situations can also exceed 0.01 W/(mK). The maximum thermal resistance of the installed element will remain unaffected by this. The final decision regarding the need for compliance shall be made by the Passive House Institute.

3.4 *Airtightness*

This should be verified by detail representation, text descriptions of the creation of the airtight layer, the materials used for this and a general description of the overall system. The graphical representation should be such that the layers and connections of the membranes and sealing materials to the walls and windows frames are recognisable. All connection details must be planned and executed in a permanently airtight manner.

The airtight layers must be clearly identified in the submitted documents (e.g. outlined in red ink).

3.5 *Doors, windows and French windows*

A reference Passive House frame specified by the Passive House Institute or an actual Passive House frame equipped with glazing corresponding to the reference glazing of the selected climate zone shall be used for window and French window connections in the submitted construction system.

French windows shall be tested in a connection situation in the area of the balcony connection without any influence by the ground.

Component size: window: 1.23 m * 1.48 m., French window: 1.10 m * 2.20 m, roof window: 1.14 m * 1.40 m.

Other specifications for certified French windows and patio doors: see "Criteria and algorithms for certified Passive House components: Transparent building components".

3.6 *Special regulations*

If selective penetrations form part of the construction system to be certified, a distinction should be made:

Dowels or other attachment elements occurring regularly across the area should be converted to the overall U-value of the wall system; this must remain below the required U-value. Selective thermal bridge loss coefficients are determined by means of 3-dimensional heat flow simulations.

Regularly occurring projections (e.g. in the foundation or base of the wall, balcony attachments etc.) should also be determined by means of 3D heat flow simulations and should be converted to the linear thermal bridge; the equivalent Ψ-value thus calculated must remain below 0.01 W/(mK).

In the context of certification of the system, the corresponding outdoor temperatures shall be adopted for opaque building components in the case of rooms or hollow spaces outside of the thermal envelope area. The unheated basement is the only exception.

3.7 *Geometric specification*

The external dimension is the reference dimension for effective lengths for U-value calculation.

3.8 *Calculation of f_{Rsi}*

The temperature factor $f_{Rsi=0.25\,m^2K/W}$ defines the coldest point which can occur on the interior surface of a construction system. For example, if the temperature factor is 0.7, then 70% of the temperature difference between the inside and outside air is still present at the interior surface. If the temperature factor is achieved, then mould and condensation formation can be safely prevented at normal outdoor temperatures, indoor temperatures and indoor air humidity levels. The colder the outdoor climate is, the higher the requirement for the temperature factor will be. 0.25 m²K/W in the index means that the heat transfer resistance to be used is 0.25 m²K/W.

Calculation of the temperature factor f_{Rsi}: $$f_{Rsi} = \frac{\theta_{si} - \theta_a}{\theta_i - \theta_a}$$

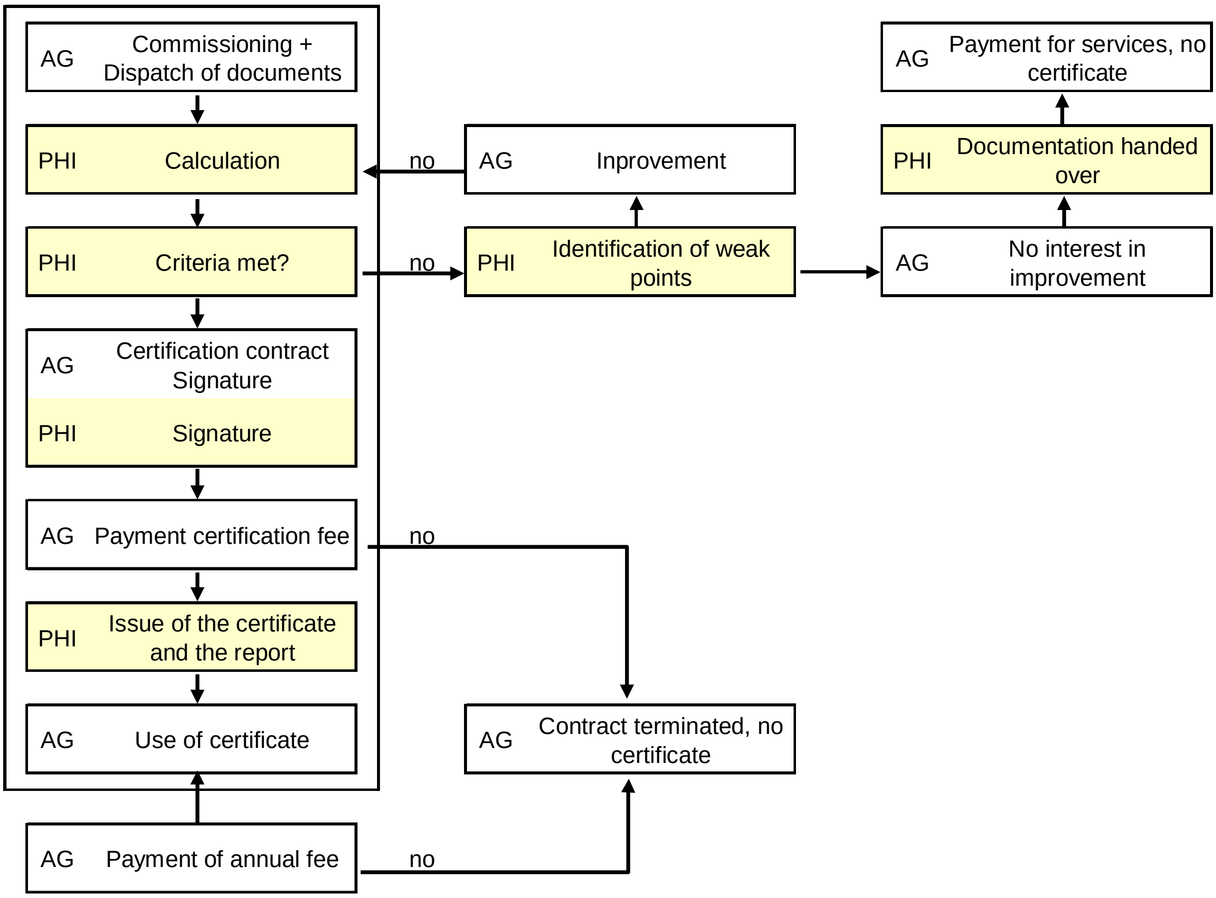
with θ_{si}: minimum interior surface temperature as per multi-dimensional heat flow calculation [°C]

θ_a: outside temperature as per multi-dimensional heat flow calculation [°C]

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

4 General information, services provided by the Passive House Institute

4.1 *Certification procedure*



4.2 *Documents required*

The applicant should provide the following documents to the PHI for the calculation, and also any other documents requested.

1. Detail drawings of the required connection situations submitted as dxf or dwg files and as pdf files or publishable image files in the formats pdf, bmp, jpg or png. Materials with different thermal conductivities should be shown differently.
   The drawings of all standard building component assemblies should be shown with at least 3 recurrent interruptions or standard construction elements (if present) and the required connection situations formed with at least 2 metres of the respective building component and depiction of the sub-constructions or the assigned interruptions.
   Depending on the special features of the system specific to the manufacturer, construction elements or dummy constructions may be provided by the PHI if necessary. These may be specified for example for window frames, floor slab assemblies or basement constructions for use during the certification procedure.
   Tables should be provided with information relating to rated values of the thermal conductivities, layer thicknesses and descriptions of materials for all building component assemblies. The latest template provided by the PHI is to be used for this. All materials, including those outside of the standard assemblies of the building components should be listed and specified in detail.

2. The rated[1] values of the thermal conductivities of the materials used for the chosen assemblies and connections must be verified in advance of commencement of analysis, either in accordance with DIN V 4108-4, DIN EN ISO 10077-2 or DIN EN ISO 10456, or if different from these, based on the results of examination by a

[1] It is critical here to differentiate between the declared lambda value, λ_D, and the rated or design lambda value, λ_R – the former is determined under laboratory conditions, whereas the latter takes into account operating conditions and the ageing of the material.

recognised testing laboratory to ISO 8302; EN 12664, EN 12667, EN 12939, a general building permit or a general building approval examination (including CE marking, declaration of conformity or local equivalent if outside of the EU). The PHI reserves the right to apply a security surcharge of up to 25% of a given value if it is not possible to state a rated value for the thermal conductivity. Different thermal conductivities of anisotropic materials depending on the direction of heat flow shall be taken into account. For example, a factor of 2.2 shall be adopted for wood. Location specific variations due to fluctuations in humidity and temperature may also need to be taken into account for products intended for buildings in extreme climates.

3. It is necessary to provide exact information about the geometry and number of sub-constructions, centre distances, and spacers in system-related area units and the additional use of materials if such elements are used, and where necessary, these should be shown as additional detail drawings. In the case of systems with approvals, the assigned technical data sheets must be provided. In addition, it is necessary to mention separately the ascertained point heat loss coefficients in [W/K].

4. Verification relating to water absorption of insulation materials that are in contact with the ground when fully submerged in water for a long time, water absorption due to diffusion, closed cell structure and the calculated poorest value (rated value) of the thermal conductivity in [W/(mK)]) which is to be used.

5. Complete documents relating to general building permits or comparable documents for load-transferring insulation materials in contact with the ground.

4.3 *Services provided by the Passive House Institute*

4.3.1 Certification procedure

1. Processing of the CAD drawings and preparation of the calculation models of the available details for subsequent heat flow simulations.
2. Calculation of the U-values of the standard building component assemblies.
3. Calculation of the equivalent thermal conductivities according to the methodology set out in the supplement to this document and U-values of the standard building component assemblies, thermal bridge loss coefficients, temperature factors and surface temperatures based on the submitted documents with reference to compliance with the certification criteria.
4. Additional calculation of variants for checking thermotechnical improvement or checking the creation of airtight levels in submitted connection situations. The costs for calculating variants shall be charged to the client after prior consultation.
5. Documentation of the results of the certification using isothermal images, specific value sheets and final evaluation of the construction system to be certified, in German or English.

4.3.2 Certificate (after a successful certification procedure, payment of annual fee and provision of a signed, stamped and dated copy of PHI's contract concerning general terms and conditions and use of the component seal):

Issue of the certificate by the Passive House Institute. Inclusion of the certified product in the Institute's own component database and the Passive House Planning Package (PHPP) database, and in the newsletters issued by the networks iPHA and IG Passivhaus, permission to use the component seal in the form of a vector graphics image.

4.4 *Coming into force, temporary provisions, further development*

The certification criteria and calculation regulations for Passive House suitable opaque 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. Previously issued certificates have the right of continuance. Old certificates may be changed upon request and applied for. Changes in layout with adaption of the Seal only will be made without charge; new calculations will incur costs. The Passive House Institute retains the right to make future changes.

4.5 *Required two-dimensional connection details for the certification categories*

Two dimensional connection details form the majority of the calculations considered in construction system certification; the diagram below shows the standard connection details. There are different requirements depending on the certification category; for further details see section 5.

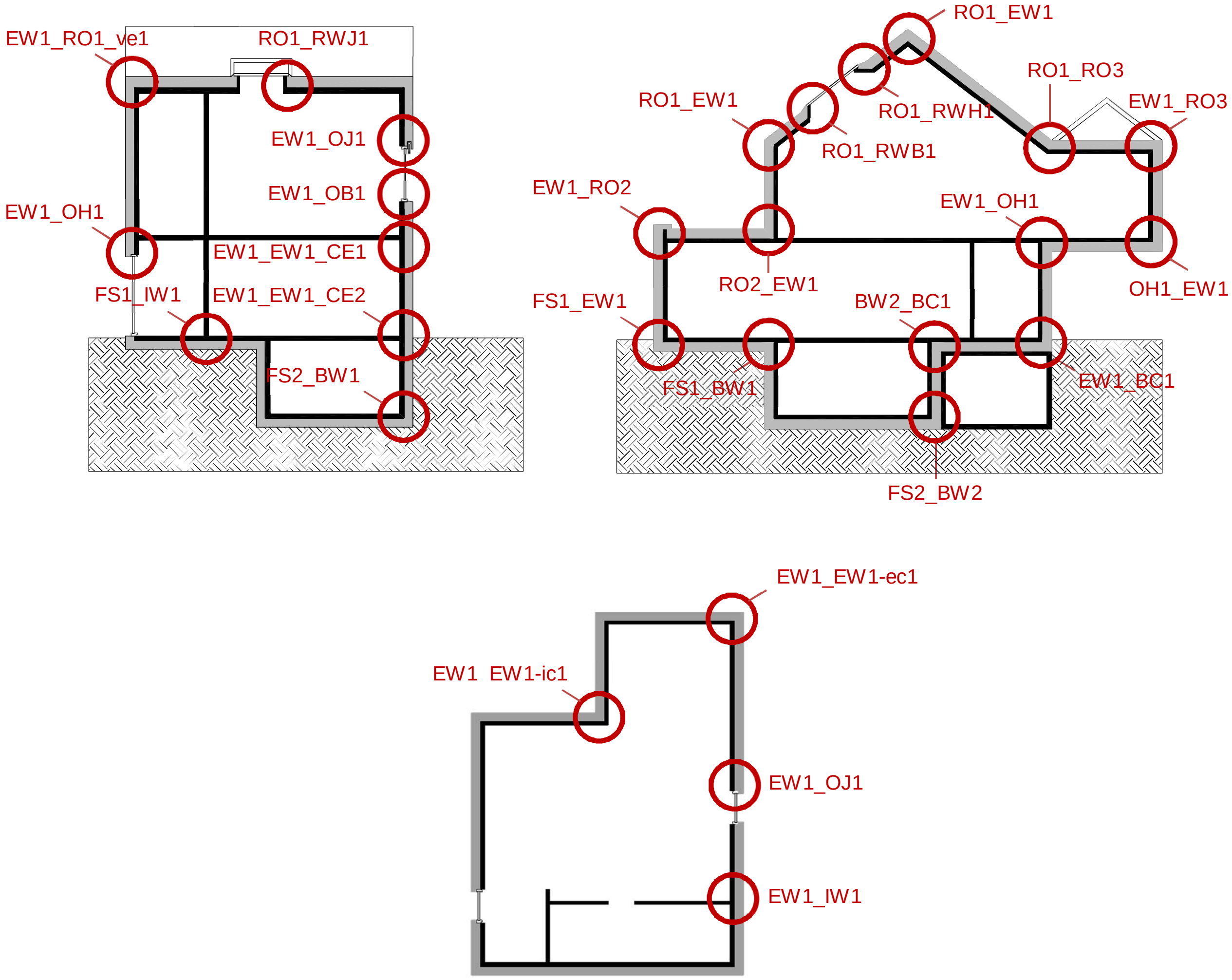


Figure 2: Required connection details

4.6 *Required three-dimensional connection details*

Where three-dimensional or 'point' thermal bridges exist in the standard construction of walls, floors and roofs, these must be taken into account in the U-value calculation as a ΔU or surcharge, based on the number of elements per m² of external area[2]. Depending on the complexity, this can be done in one of two ways:

- For ETICS systems using EPS with simple façade anchors, the values established in Appendix A of the Passive House Institute publication 'Protokollband Nr. 35: Thermal Bridges and Structural Engineering – the Limits of Thermal Bridge Free Construction' may be used, as long as the design is comparable.
- Where this approach is not applicable, the χ-value [W/K] of the element must be calculated by PHI using three-dimensional FEM software in accordance with ISO 10211.

Point thermal bridges can also occur as part of two-dimensional connections, for example where roof beams continue through the external wall to the outside; such penetrations must also be modelled in three-dimensions by PHI and taken into account in the linear heat loss value. These cases should be discussed with PHI prior to certification.

The values of components already certified by PHI can be used without the need for further analysis. Service penetrations are not taken into account in the certification, however these should be considered in the energy balance calculations of real world construction projects.

[2] This figure is to be provided by the manufacturer. Depending on the classification of the building and the climate for which the construction system is intended, the number of point thermal bridges required per square metre of external wall may vary; the most conservative figure should be used to ensure the resulting U-values are on the safe side.

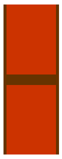
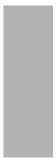
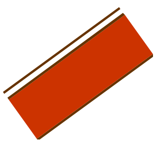
5 Acronyms for categories, building components and connections

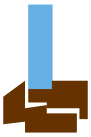
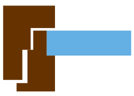
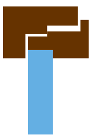
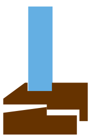
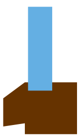
5.1 *Abbreviations for subgroups of opaque construction systems*

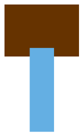
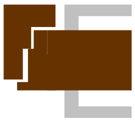
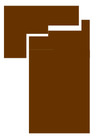
Description	Abbreviation
CONSTRUCTION SYSTEM	cs
WALL SYSTEM	wa
ROOF SYSTEM	rc
FLOOR SLAB SYSTEM	fs

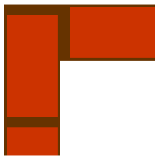
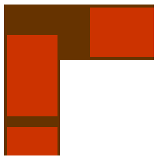
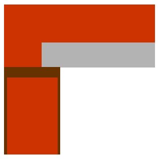
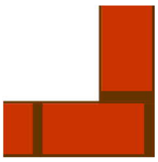
5.2 *Abbreviations for building components and specification of connections*

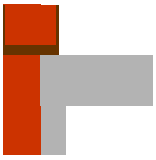
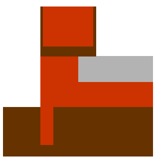
Table 2: Categories and two-dimensional connection details (individual details can be left out in agreement with the PHI). Abbreviations are explained below.

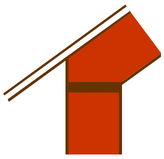
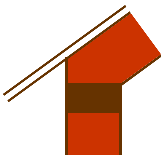
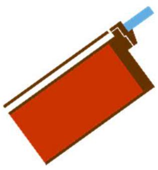
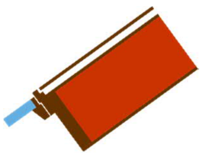
Element(s)	Image	Designation	Certification category				Note
			cs	wa	rc	fs	
External wall (e.g. EIFS)		EW1	X	X		X	For roof and floor systems standard wall constructions will be used (EIFS; lightweight timber and concrete formwork)
External wall (e.g. lightweight timber)		EW2	(X)	(X)		X	
Basement wall		BW1					
Separating internal wall		IW1	X	X			
structural internal wall		IW2	(X)	(X)			
Roof		RO1	X	X	X		

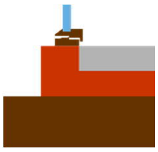
Floor slab		FS1	X	X		X	
Basement ceiling		BC1					
Overhang		OH1					
Ceiling		CE1	X	X			
Ceiling (thicker)		CE2					
Window bottom (openable)		OB1	X	X			
Window side (openable)		OJ1	X	X		X	
Window top (openable)		OH1	X	X		X	
Window threshold (openable)		OT1	X	X		X	
Window bottom (fixed)		FB1					

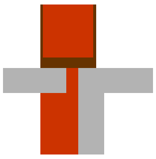
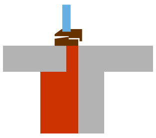
Window side (fixed)		FJ1						
Window top (fixed)		FH1						
Door threshold		DT1					(X)	
Door locking side		DJ1					(X)	
Door hinge side		DJ2					(X)	
Door top		DH1					(X)	
Roof window bottom		RWB1				X		
Roof window top		RWH1				X		
Roof window side		RWJ1				X		
Exterior wall exterior corner (e.g. WDVS)		EW1_EW1_ec1	X	X				

Exterior wall exterior corner (e.g. lightweight timber)		EW2_EW2_ec1	(X)	(X)			
Exterior wall exterior corner (e.g. lightweight timber, reinforced)		EW2_EW2_ec2	(X)	(X)			
Exterior wall exterior corner (e.g. hybrid)		EW1_EW2_ec1	(X)	(X)			
Exterior wall interior corner (e.g. WDVS)		EW1_EW1_ic1	X	X			
Exterior wall interior corner (e.g. lightweight timber)		EW2_EW2_ic1	(X)	(X)			
Exterior wall interior corner (e.g. lightweight timber, reinforced)		EW2_EW2_ic2	(X)	(X)			
Exterior wall interior corner (e.g. hybrid)		EW1_EW2_ic1	(X)	(X)			
Exterior wall, separating internal wall		EW1_IW1	X	X			
Exterior wall, structural internal wall		EW1_IW2	(X)	(X)			
Roof ridge		RO1_RO1	X		X		

Ceiling connection		EW1_EW1_CE1	X	X			
Ceiling connection (thicker ceiling)		EW1_EW1_CE2	(X)	(X)			
Ceiling connection (hybrid)		EW1_EW2_CE1	(X)	(X)			
Ceiling connection (hybrid, thicker ceiling)		EW1_EW2_CE2	(X)	(X)			
Floor slab edge (with EIFS wall)		FS1_EW1	X	X		(X)	
Floor slab edge (with EIFS-wall, plus insulation apron)		FS1_EW1_pv1	(X)	(X)		(X)	
Floor slab edge (with EIFS-wall, plus insulation apron)		FS1_EW1_ph1	(X)	(X)		(X)	
Floor slab edge (sunken slab)		FS2_EW1	(X)	(X)		(X)	
Floor slab edge (with lightweight timber wall plus insulation apron)		FS1_EW2_pv1	(X)	(X)		(X)	
Floor slab, separating internal wall		FS1_IW1	X			X	

Floor slab, structural internal wall		FS1_IW2	(X)			(X)	
Eaves		EW1_RO1_ea1	X	X	X		
Eaves		EW2_RO1_ea1	(X)	(X)	(X)		
Eaves		EW2_RO1_ea2	(X)	(X)	(X)		
Eaves (attic/cold roof)		EW1_RO1_CE1	(X)	(X)	(X)		
Verge		EW1_RO1_ve1	X	X	X		
Parapet		EW1_RO1_pp1	(X)	(X)	(X)		
Roof window bottom		RO1_RWB1_1			X		
Roof window top		RO1_RWH1_1			X		
Roof window side		RO1_RWJ1_1			X		

Window bottom connection (openable)		EW1_OB1_1	X	X			
Window bottom connection (openable, offset position)		EW1_OB1_2					
Window bottom connection (fixed)		EW1_FB1_1					
Window bottom connection (fixed, offset position)		EW1_FB1_2					
Window bottom, floor slab		FS1_OT1_1	X	X		X	
Window side connection (openable)		EW1_OJ1_1					
Window side connection (openable, covered with insulation)		EW1_OJ1_1a	X	X			
Window side connection (openable, offset position)		EW1_OJ1_2					
Window side connection (openable, offset position, covered with insulation)		EW1_OJ1_2a					
Window side connection (fixed)		EW1_FJ1_2					

Window side connection (fixed, covered)		EW1_FJ1_2a						
Window connection top (openable)		EW1_OH1_2a	X	X				
Window connection top (openable, venetian blind)		EW1_OH1_2a_V1						
Window connection side (openable, venetian blind)		EW1_OJ1_2a_V1						
Balcony connection		EW1_EW1_CE1_BC1						
Basement ceiling, balcony connection		EW1_EW2_CE1_BC1						
Basement ceiling, balcony connection, window threshold		EW1_EW2_CE1_BC1 _ST1_1						

The connection details contained in the table are only given as examples for understanding the nomenclature. If the corresponding connection situation is not present in the table, the appropriate designation must be agreed with the PHI before certification.

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

Region 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} $=0{,}25 m^2K/W$	$\theta_{Si,min}$	f_{Rsi} $=0{,}25 m^2K/W$		Orientation	[°]	$U_{W,inst.}$	U_W
									vertical	90	0,45	0,40
1	Arctic	-34,00	0,40	9,20	0,80	6,00	0,74	-50	inclined	45	0,50	0,50
									horizontal	0	0,60	0,60
									vertical	90	0,65	0,60
2	Cold	-16,00	0,45	11,00	0,75	7,80	0,66	-28	inclined	45	0,70	0,70
									horizontal	0	0,80	0,80
									vertical	90	0,85	0,80
3	Cool-temperate	-5	0,50	13	0,70	9	0,57	-16	inclined	45	1,00	1,00
									horizontal	0	1,10	1,10
									vertical	90	1,05	1,00
4	Warm-temperate	3,00	0,55	14,00	0,65	10,70	0,45	-9	inclined	45	1,10	1,10
									horizontal	0	1,20	1,20
									vertical	90	1,25	1,20
5	Warm	10,00	0,70	15,50	0,55	14,30	0,43	-4	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