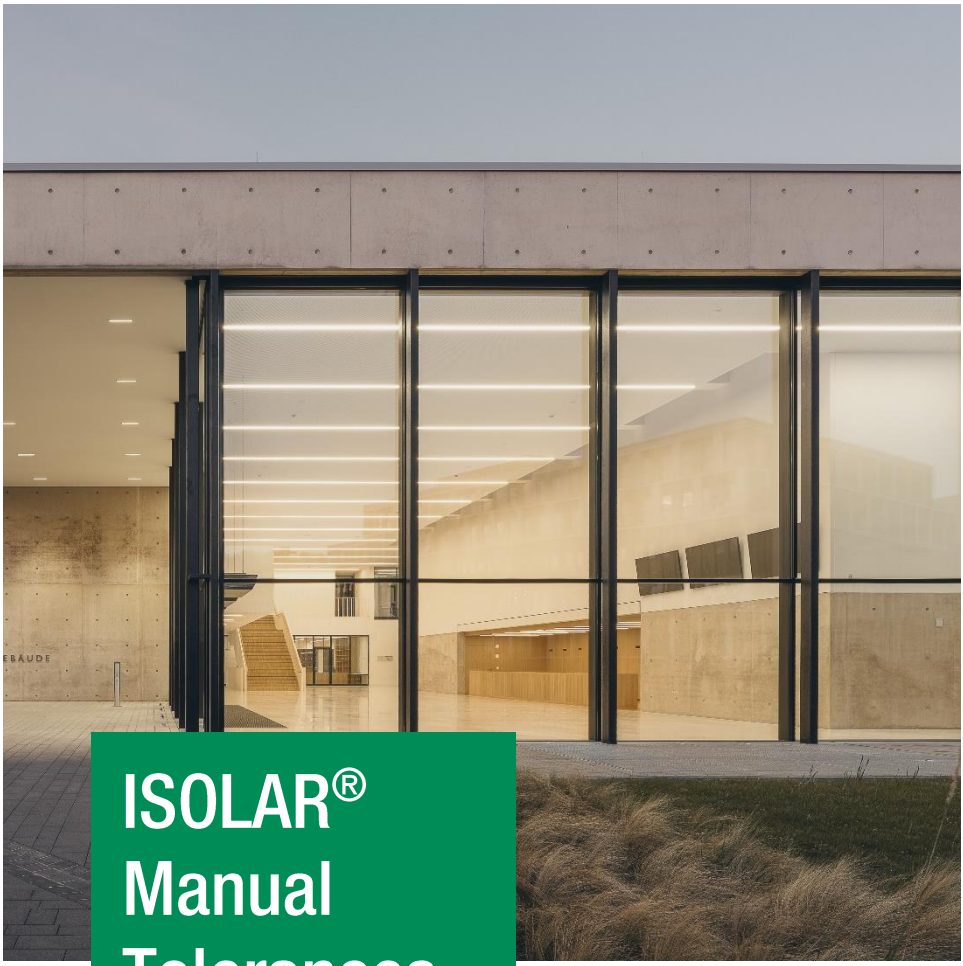


ISOLAR® Manual Tolerances

ISOLAR® GLAS

MEHR AUS GLAS

CONTENTS

1. BASE GLASS

1. BASE GLASS

The following standards are foundation for the base glass:

- EN 572-1: Glass in building - Basic soda-lime silicate glass products - Part 1: Definitions and general physical and mechanical properties; German version EN 572-1:2012+A1:2016
- EN 572-2: Glass in building - Basic soda lime silicate glass products - Part 2: Float glass; German version EN 572-2:2012
- EN 572-3: Glass in building - Basic soda lime silicate glass products - Part 3: Polished wired glass; German version EN 572-3:2012
- EN 572-4: Glass in building - Basic soda lime silicate glass products - Part 3: Polished wired glass; German version EN 572-3:201
- EN 572-5: Glass in building - Basic soda lime silicate glass products - Part 3: Polished wired glass; German version EN 572-3:2012
- EN 572-6: Glass in building - Basic soda lime silicate glass products - Part 6: Wired patterned glass; German version EN 572-6:2012
- EN 572-8: Glass in building - Basic soda-lime silicate glass products - Part 8: Supplied and final cut sizes; German version EN 572-8:2012+A1:2016

The limit deviations of the nominal thicknesses for the different glass products can be found in the above-mentioned standards.

The quality requirements and the optical and visible defects of the base glass products are also described therein. The limit deviations of the nominal thicknesses are given here as an extract from DIN EN 572-2 and DIN EN 572-5. For other base glasses, please refer to the corresponding standards.

Nominal thickness in mm	Tolerance in mm	
	Float glass	Ornament glass
2	± 0,2	± 0,5
3		
4		
5		
6		
8	± 0,3	± 0,8
10		± 1,0
12		± 1,5
14	-	
15	± 0,5	
19	± 1,0	± 2,0
25	± 1,0	-

Table 1: Tolerances of nominal thicknesses for float glass (DIN EN 572-2) and ornamental glass (DIN EN 572-5)

2. CUTTING

2. CUTTING

Should any tolerances/deviations not be regulated in this section, these shall apply in addition: DIN EN 572, DIN EN 1096-1.

2.1. TOLERANCE IN GENERAL

The so-called diagonal break must be taken into account! This depends on the respective glass thickness and the composition of the base glass (brittleness etc.).

Glass thickness in mm	Maximum value in mm
4, 5, 6	± 1,0
8, 10	± 2,0
12	± 3,0
15	+ 5,0 / - 3,0
19	+ 6,0 / - 3,0

Table 2: Diagonal break values

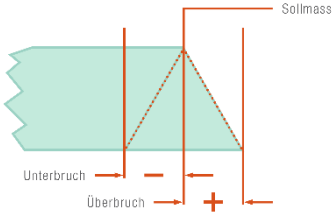


Figure 1: Diagonal break

The diagonal break must be taken into account when specifying tolerances. This means that when the edge is hemmed, the glass dimensions may change by twice the diagonal breakage value. In the case of non-rectangular units, the tolerances listed below may occur at the specified angles (similar to the trimming). The geometry of the units remains the same.

2.1.1. ACUTE ANGLE FOR FLOAT GLASS – ZONE X NOT TO BE ASSESSED

α	X
≤ 12,5°	- 30,0 mm
≤ 20°	- 18,0 mm
≤ 35°	- 12,0 mm
≤ 45°	- 8,0 mm

Table 3: Break -off

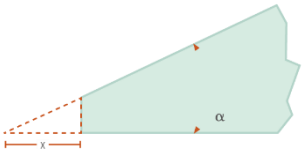


Figure 2: Zone X not to be assessed

The area of the potential break-off represents a zone that cannot be assessed. Here, irregularities can occur on the edges (e.g. breaks) as well as on the surface; these do not constitute grounds for any claim.

2.1.2. ACUTE ANGLE FOR TOUGHENED SAFETY GLASS (FT), LAMINATED SAFETY GLASS (LSG), DGU TRIMMING – ZONE X NOT TO BE ASSESSED

We reserve the right to carry out a trimming according to table 4 for production reasons. If this is not carried out, the dimensions listed in Table 4 are considered to be a zone which cannot be assessed. Here, irregularities can occur on the edges (e.g. breaks) as well as on the surface; these do not constitute grounds for complaint.

α	X
≤ 12,5°	- 65,0 mm
≤ 20°	- 33,0 mm
At angles > 20°, the trimming or the zone not to be assessed corresponds to the break.	

Table 4: Cut-back / Trimming

2.2. DIAGONAL TOLERANCE

Methode: By measuring the diagonals
Measuring equipment: Tape measure
Tolerances: Length difference between the diagonals < 2 mm

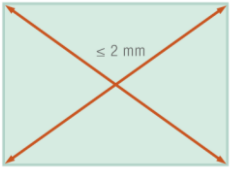
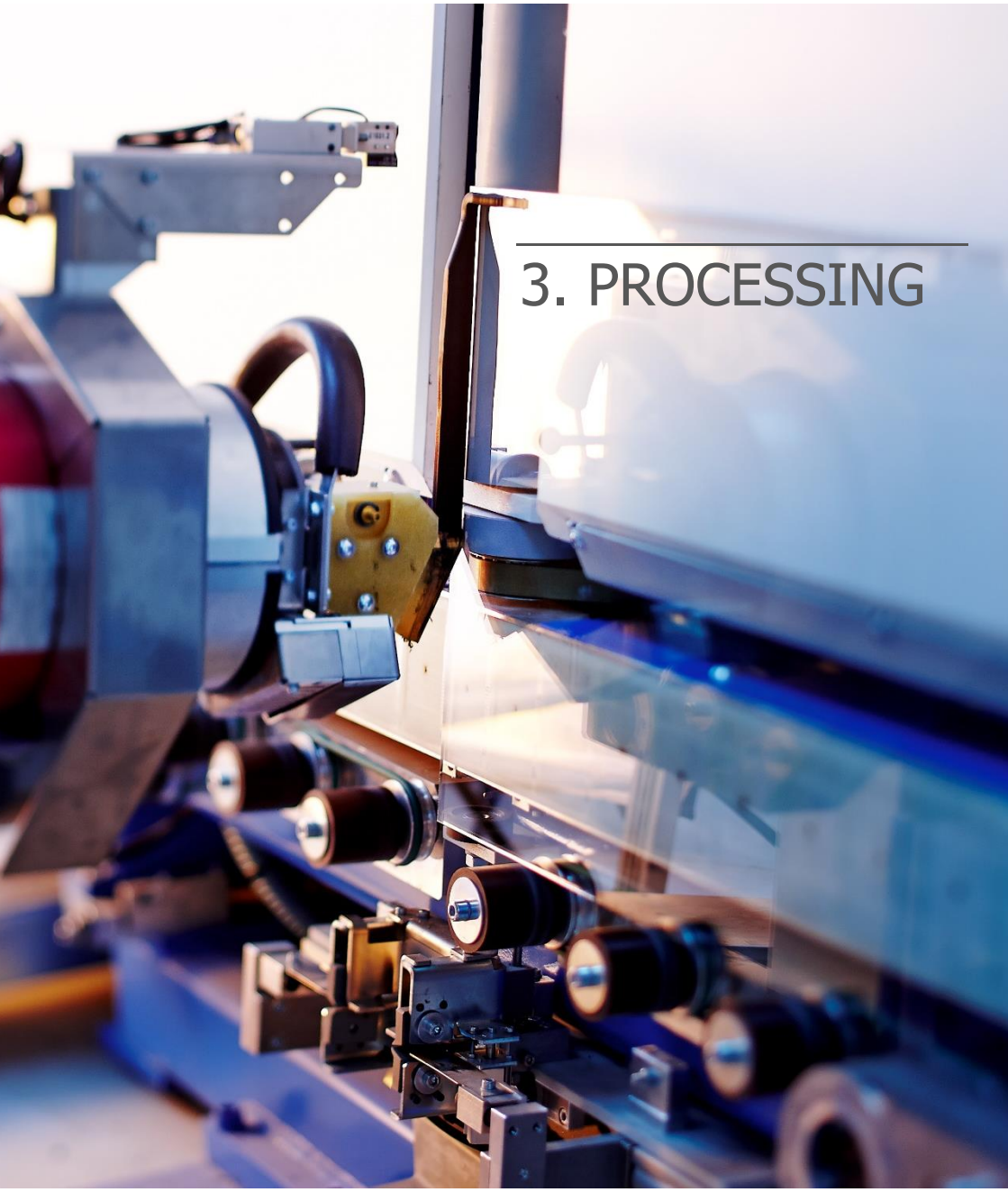


Figure 3: Schematic representation - diagonal tolerance

2.3. PATTERN DIRECTION ORNAMENTAL GLASS

The standard is: pattern direction with the height dimension.



3. PROCESSING

3. PROCESSING

The tolerances depend on the respective type of edge processing. Should any tolerances/deviations not be regulated in this section, these shall apply in addition:

- EN 572: Glass in building - Basic soda-lime silicate glass products
- EN 12150-1: Glass in building - Thermally toughened soda lime silicate safety glass - Part 1: Definition and description; German version EN 12150-1:2015+A1:201
- DIN EN 1863-1: Glass in building - Heat strengthened soda lime silicate glass - Part 1: Definition and description; German version 1863-1:2011
- DIN EN 1096-1: Glass in building - Heat strengthened soda lime silicate glass - Part 1: Definition and description; German version 1863-1:2011

3.1. EDGE PROCESSING QUALITY

DIN 1249-11, version 2017-05 is used as the basis for edge processing.

For production reasons, it is up to the manufacturer to also polish the ground edges.

3.1.1. CUT EDGE (KG)

The cut edge (trimmed edge) is the unprocessed edge produced when cutting flat glass. The edges of the cut edge are sharp. Transversely to its edges, the cut edge has slight wavy lines (Wallner lines). In general, the cut edge is smoothly broken, but irregular breaking points can also occur, especially with thicker sheets and non-rectilinear shaped sheets e.g. owing to the cutting tool’s contact points. In addition, processing points (e.g. by breaking the glass with crushing pliers) may also arise.

Conchoidal fractures which do not reduce the glass thickness of the individual pane by more than 15 % are permissible. The max. radius of the conchoidal coating must not exceed 3 mm.

3.1.2. CHAMFERED EDGE (KGS)

The chamfered edge corresponds to the cut edge, the edges of which are broken. For production reasons, the manufacturer is free to grind or polish the edge, but the quality corresponds to a hemmed edge.

3.1.3. SAWN EDGE (KGG)

Edge produced by radial or band saws at right angles or mitre angles with entry and exit marks at the starting and end points.

3.1.4. WATERJET-CUT EDGE (KWG)

Edge produced by abrasive machining of the glass sheet. It has sharp-edged edges. The edge surfaces are not flat.

3.1.5. EDGE GROUND TO SIZE (KMG)

The glass pane is brought to the required dimension by grinding the edge surface. Bare spots and conchoidal areas are permissible.

3.1.6. GROUND EDGE (KGN)

The entire edge surfaces are machined via grinding. The ground edge has a sanded matt appearance. Bare spots and conchoidal areas are not permitted. An edge machined by water jet corresponds to the ground edge.

3.1.7. POLISHED EDGE (KPO)

A polished edge is a ground edge refined by over-polishing. Matt spots are not permitted. Visible and noticeable polishing marks and polishing grooves are permissible.

For production reasons, a pane can be edge-machined on different or several machines. This can result in a different appearance of the ground or polished edges. This does not constitute grounds for any claim.

3.2. GLASS PROCESSING

3.2.1. RECTANGLES

3.2.1.1. STANDARD TOLERANCES

A distinction is made here between edge processing such as chamfering, grinding and polishing.

Therefore 2 tolerance classes are formed:

- Hemmed edge: For hemmed edges, the tolerance with diagonal break specified under cutting applies.
- Ground or polished edge: The following table applies to ground or polished edges.

Edge length in mm	d ≤ 12 mm	d = 15 + 19
≤ 1000	± 1,5	± 2,0
≤ 2000	± 2,0	± 2,5
≤ 3000	+ 2,0 / - 2,5	± 3,0
≤ 4000	+ 2,0 / - 3,0	+ 3,0 / - 4,0
≤ 5000	+ 2,0 / - 4,0	+ 3,0 / - 5,0
≤ 6000	+ 2,0 / - 5,0	+ 3,0 / - 5,0

Table 5: Standard tolerances for rectangle

Diagonal tolerance:
Dt = Diagonal tolerance
b = Width tolerance
h = Hight tolerance

Example: (Nominal dimension)
B x H = 2000 mm x 3000 mm

Calculation:
$Dt = \sqrt{b^2 + h^2}$
$Dt = \sqrt{2{,}0^2 + 2{,}5^2} = 3{,}2$
Dt ≤ 3mm → max. 3mm

The champer tolerance for custom-ground, ground or polished edges is ± 1 mm.

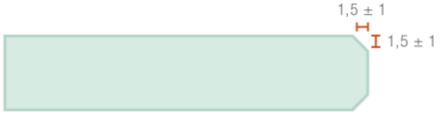


Figure 4: Edge machining - polished edge

3.2.1.2. SPECIAL TOLERANCES

Special tolerances can be achieved following a separate agreement.

3.2.2. SPECIAL SHAPES

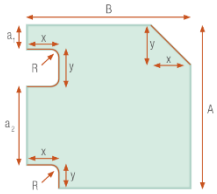
Here again, a subdivision into the grades standard and special tolerance applies, whereby it should be noted that the special machining of these special shapes is carried out on the CNC machining centre. For 15 and 19 mm glasses, table 8 below applies, plus 1 mm for all tolerances.

Edge length d ≤ 12 mm		
Standard		Special tolerance (CNC)
≤ 1000	± 2,0	+ 1,0 / - 1,0
≤ 2000	± 3,0	+ 1,0 / - 1,5
≤ 3000	± 4,0	+ 1,0 / - 2,0
≤ 4000	± 5,0	≤ 4000 + 1,0 / - 2,5
≤ 5000	- 8 / + 5	≤ 5000 – 4,0 / + 2,0
≤ 6000	- 10 / + 5	≤ 6000 – 5,0 / + 2,0

Table 6: Tolerances for special shapes

3.3. CORNER SECTIONS AND CHAMFERED CORNER/EDGE CUT-OUTS

For all machining steps listed in this section, the position tolerance must be measured from the dimensioned edge.



A = Height
B = Width
a_1 = Distance between cut out and glass edge
a_2 = Distance between cut out and cut out
x = cut out– cut off width
y = cut out– cut off hight
R = radii and cut out radii

Figure 5: Schematic representation of corner and edge cut-outs, corner sections

3.3.1. CORNER CUT-OFF CHAMFERED < 100 MM X 100 MM

3.3.1.1. STANDARD

A standard tolerance of +/- 4 mm applies to the position and dimensions.

3.4. POLISHED CORNER CUT-OFF AND CORNER/EDGE CUT-OUTS

Standard: A standard tolerance of +/- 2 mm applies to the position and dimensions. Special tolerances are possible by special arrangement.

3.5. SEAMED CORNERS

"SEAMED CORNERS" is the sanding down (matt) of existing sharp-edged formations after the above-mentioned edge processing.

For production reasons, the corner joint may vary (round corner pol./fine r = 2 mm) or may not be present.

This does not constitute grounds for claims.
α = approximately equal-angled.

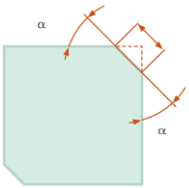


Figure 6: Schematic representation of seamed corners

3.6. HOLE DRILLING

The hole position or position tolerances correspond to the tolerances of the edge machining.

3.6.1. DRILL HOLE DIAMETER

Nominal drill hole, Ø	Tolerance in mm
4 ≤ Ø ≤ 20	± 1,0
20 < Ø 100	± 2,0
100 < Ø	Inquire with the manufacturer

Table 7: Tolerance of hole diameter

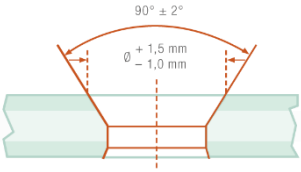


Figure 7: Counter hole tolerance

COUNTERSUNK HOLES IN LAMINATED SAFETY GLASS

The cylindrical borehole of the counter-plane must be manufactured with a diameter 4 mm larger than the core diameter of the counterbore.

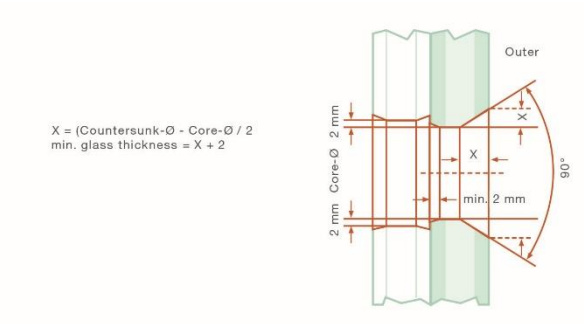


Figure 8: Schematic representation of a counterbore in LSG

3.6.2. DRILLED HOLE LOCATION

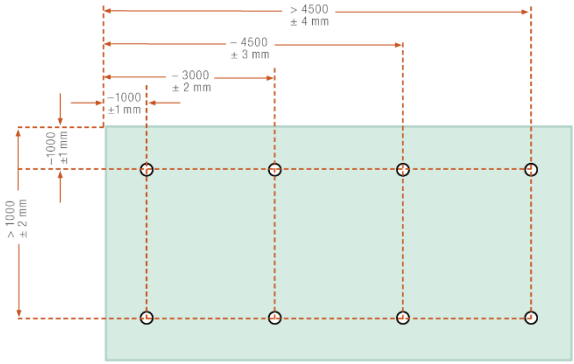


Figure 9: Schematic representation of drill hole position

3.6.3. DRILL HOLE DIAMETER AND POSITIONING OF 4 – 12 MM FT GLASS

Edge machining	Edges arrised
Minimum diameter	D ≥ S –hole edge bevelled
Distance hole edge – glass edge	≥ 2 S
Distance hole edge – hole edge	≥ 2 S
Distance in corner area	See Fig 10

S = glass thickness

Table 8: FT glass 4 - 12 mm size/position

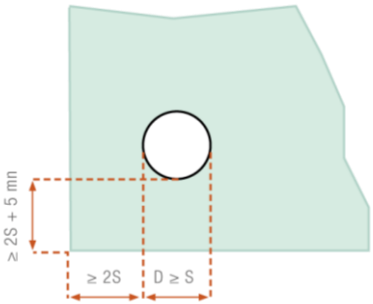


Figure 10: Schematic representation of hole size/positioning

Boreholes drilled in the corner area (up to 50 mm of the hole centre) must have an asymmetrical position (at least 5 mm difference between X and Y distance to the corner). If this is NOT possible, the holes must be drilled as slotted holes (because of the increased risk of TSG breakage). The tolerances of the borehole positions are also decisive for the position of the slots).

3.6.4. MINIMUM DISTANCES FROM EDGE OF HOLE TO EDGE OF HOLE

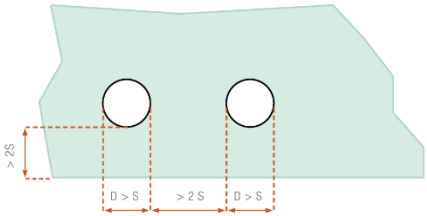


Figure 11: Schematic representation of hole size/positioning

3.6.5. HOLE SIZE / POSITIONING OF 15 MM AND 19 MM FT GLASS

Edge machining	Edges fine ground
Minimum diameter	18 mm –hole edge bevelled
Distance hole edge – glass	30 mm
Distance hole edge – hole edge	45 mm
Distance in corner area	See Fig 12

Table 9: FT glass 15 mm hole size/positioning

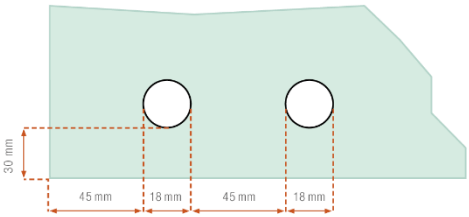


Figure 12: Schematic representation of TSG 15 mm hole size/positioning

Edge machining	Edges fine ground
Minimum diameter	18 mm –hole edge bevelled
Distance hole edge – glass	40 mm
Distance hole edge – hole edge	60 mm
Distance in corner area	See Fig 13

Table 10: FT glass 19 mm hole size/positioning

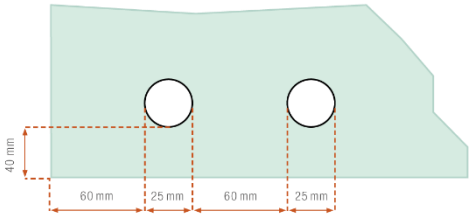


Figure 13: Schematic representation of TSG 19 mm hole size/positioning

5. SCREEN PRINTING & EMAIL

4. SCREEN PRINTING & EMAIL

ASSESSMENT GUIDELINE FOR THE VISUAL QUALITY OF ENAMELLED/SCREEN-PRINTED GLASSES

Reprinted with the kind permission of the German Flat Glass Association, last updated March 2014.

4.1. SCOPE OF APPLICATION

This guideline applies to the assessment of the visual quality of fully or partially enamelled glasses produced by the applying and baking of ceramic inks as toughened or semi-tempered glass.

This guideline does not apply to coloured glass according to EN 16477 or otherwise printed glasses. Aspects relating to building regulations are not covered by this guideline.

The notes and tolerances mentioned in section 5.3 “Inspection” also apply in principle to other ink types, for example organic inks. The specific properties of these ink types are not described in this guideline.

So-called lacquered glasses, which can be thermally tempered, are coated with ceramic inks. Therefore, this guideline also applies to these products.

In order to assess the products, it is necessary to inform the manufacturer with the order about the specific application and the constructive and visual requirements. This concerns in particular the following information:

- Indoor and/or outdoor use
- Use for the transparent viewing area (viewing from both sides e.g. partitions, etc.)
- Application with direct backlighting
- Edge quality as well as ink-free edge (for free-standing edges, ground or polished edge machining is recommended. A framed edge is assumed for a camfered version).
- Further processing of the mono panes, e.g. into multi-pane insulating glass (MIG) or LG/LSG and/or printing with orientation

towards the film

- Printing on position 1 for outdoor use

If enamelled glasses are bonded to LSG or MIG, each enamelled pane is assessed individually (like mono panes).

4.2. PROCESSES/NOTES/TERMS

4.2.1. GENERAL

The enamel ink consists of inorganic substances which are responsible for the colouring and which are subject to minor variations. These substances are mixed with glass flow. During the thermal tempering process (TSG, heat-soaked TSG and TVG) the glass flow encloses the coloured bodies and bonds with the glass surface. Only after this firing process can the final colouration be seen.

The inks are selected in such a way that they bond with the surface of the glass within a few minutes at a glass surface temperature of approx. 600 – 620°C. This temperature window is very narrow and cannot always be exactly reproduced, especially with panes of different sizes and colours.

Furthermore, the type of application is also decisive for the colour impression. Due to the thin ink application, a screen or digital print provides less covering power for the ink than a product manufactured in a rolling process with a thicker and therefore denser ink application. The covering power also depends on the selected ink.

The glass surface can be fully or partially enamelled by different application methods. The enamel is usually applied to the side facing away from the weathering (position 2 or more). Exceptions must be agreed with the manufacturer. For the application on position 1 (weather side), special inks are used. The ceramic inks (enamel) are largely scratch-resistant and conditionally acid-resistant; resistance to light and adhesion correspond to the durability of ceramic enamel inks.

Cloud formation is possible with full-surface enamelling with translucent inks. These features may become visible when the panes are backlit. It must be taken into account that with translucent inks, a medium applied directly to the reverse side (ink side) (sealants, panel adhesives, insulation, brackets, etc.) can shine through.

When using metallic inks, care must be taken to ensure that they are not exposed to moisture. The use of these inks must be agreed with the manufacturer.

If printed panes are additionally provided with functional layers for e.g. solar control and/or thermal insulation, the relevant standards and guidelines for assessing the visual quality of the end product must be observed. Including EN 1096 and/or previously mentioned guidelines for glass in the construction industry. The printed area shall be assessed in accordance with this guideline. If solar control and/or thermal insulation is applied, the relevant standards and guidelines for assessing the visual quality of the end product must be observed. Including Including EN 1096 and/or the above mentioned guidelines for glass in the construction industry. The printed area shall be assessed in accordance with this guideline.

4.2.2. PROCESSING

4.2.2.1. ROLLER COATING PROCESS.

The flat glass pane is passed under a grooved rubber roller which transfers the enamel ink to the glass surface. This ensures an even, homogeneous, full-surface ink distribution.

Typically, the grooved structure of the roller can be seen up close (ink side). Normally, however, these “grooves” can hardly be seen from the front (when viewed through the glass). Rolled enamel glass is generally not suitable for the transparent viewing area, which means these applications must be agreed in advance with the manufacturer.

A so-called “starry sky” (very small flaws) can appear in the enamel.

Due to the process, an “ink rollover” is possible on all edges, which can be slightly wavy, especially on the longitudinal edges (seen in the direction of the rolling system). However, the edge surface usually remains colourless. The installation situation must therefore be agreed in advance with the manufacturer. Optionally, the enamel ink can be applied with a spray gun.

4.2.2.2. CASTING PROCESS

The glass sheet runs horizontally through a so-called “casting veil” whereby the surface is completely covered with ink. By adjusting the amount of ink and the throughput speed, the thickness of the ink application can be controlled over a relatively wide area. However, due to a slight unevenness of the casting lip, there is a possibility that stripes of varying thicknesses are caused in the longitudinal direction (casting direction). Applications for the transparent viewing area must be agreed with the manufacturer in advance.

The “ink rollover” at the edges is much greater than with the roller-coating process and can only be avoided with great effort. If ink-free visible edges are required, this must be specified in the order.

4.2.2.3. SCREEN PRINTING PROCESS

In contrast to the processes described above, here it is possible to apply ink over the entire surface or parts of it. On a horizontal screen printing table, the ink is applied to the glass surface through a close-meshed screen with a scraper. The thickness of the ink application is influenced by the mesh size of the screen and the thread diameter. The ink application is generally thinner than with the roller-coating and casting process and appears opaque or translucent, depending on the chosen ink.

Depending on the ink, light stripes in the direction of printing – and crossways as well – and occasional slight smearing are typical of the production process.

The edges of the panes usually remain ink-free during screen printing, but may have a slight colour bulge in the hem area, so that a reference to free-standing edges is necessary for application-oriented production.

With this process, multi-colour prints can be realised. For example, a so-called double screen printing, in which two different inks can be recognised depending on the surface being viewed. Tolerances e.g. for equal coverage, must be clarified with the manufacturer.

It is possible to print on selected ornamental glass, but always check with the manufacturer.

4.2.2.4. DIGITAL PRINTING PROCESS

The ceramic ink is applied directly to the glass surface by a method similar to that used by an ink jet printer and the thickness of the ink application can vary. The ink is generally applied thinner than with roller coating, casting, or screen printing processes and, depending on the ink selected, can be opaque or translucent. A high print resolution of up to 360 dpi is currently possible.

Typical for the production process are slightly visible stripes in the printing direction. These are unavoidable from a production point of view. The edges of the panes usually remain ink-free during digital printing, but may have a slight colour bulge in the hem area, so that a reference to free-standing edges is necessary for application-oriented production.

The print edges are exactly straight in the print direction and slightly serrated crossways to the print direction Ink spray mist may occur along the print edges. With dot, hole and text motifs, the print edges show a serration which, like the ink spray mist, is only visible up close.

4.3. INSPECTION

In general, the inspection is based on the view through the glass on the enamel and complaints need not be specially marked. The glazing inspection shall be carried out from a distance of at least 3 m and from a vertical viewpoint or viewing angle of max. 30° from the vertical. Testing is performed in diffuse daylight (such as overcast skies) without direct sunlight or artificial lighting against a monochrome, opaque background. In the case of previously agreed special applications, these are to be used as test conditions.

When using as LG/LSG, the tolerance resulting from the offset mismatch must be taken into account in the position and design tolerance, if necessary.

Depending on the pattern, a so-called “moire” can occur with motifs that are applied by a screen printing process. The moire effect (from the French moirer “to marble”) becomes noticeable when regular fine grids are superimposed by additional apparently coarse grids. Their appearance is similar to the resulting patterns, that are similar to the patterns from interference. This effect is physically induced.

If prints are used to cover profiles of glued facades, for instance, the design may show through if the inks are very light. Suitable inks must be used here.

This guideline serves exclusively to assess the enamelling of the visible area in the installed state. For an assessment of the glass, Annex F of EN 1279-1: 2018 is used.

Defect types / tolerances for enamelled glasses		
Permissible punctiform areas in the enamel**	Ø 0.5 – 1.0 mm max. 3 units/m^2, with distance > 100 mm	
Hairline scratches and burnt-in foreign bodies	permissible up to 10 mm in length	
Clouds / Staining*	not permitted	
Water stains	not permitted	
Ink rollover at the edges	Permitted for framed panes and for drill holes with additional mechanical brackets or covers, otherwise not permitted For unframed panes with a ground or polished edge: • Permissible on the bezel in the roller-coating process, not permissible on the edge Permissible in the casting process • Not permitted in the screen printing process • Not permitted in the digital printing process Due to the process, digital printing may produce very small splashes of ink in the immediate vicinity of the print edges only	
Unprinted glass edge	Screen printing and digital printing permissible up to 2.0	
Linear structures permissible	in printing	
Enamel position tolerance (a) see Fig. 15	Pane size ≤ 2000 mm: ± 2.0 mm Pane size ≤ 3000 mm: ± 3.0 mm Pane size ≤ 3000 mm: ± 4.0 mm	
Tolerance of the dimensions for parts enamelling (b)) see Fig. 15	Edge length of the print area: ≤ 1000 mm ≤ 3000 mm > 3000 mm	Tolerance range: ± 2,0 mm ± 3,0 mm ± 4,0 mm
Design geometry (c) (d) see Fig. 15	depending on the size Edge length of the print area: ≤ 30 mm ≤ 100 mm > 500 mm ≤ 1000 mm ≤ 2000 mm ≤ 3000 mm > 3000 mm	 Tolerance range: ± 0,8 mm ± 1,0 mm ± 1,2 mm ± 2,0 mm ± 2,5 mm ± 3,0 mm ± 4,0 mm
Colour deviations	The colours are evaluated through the glass (enamel ink on position 2). Colour deviations in the range of E ≤ 5 mm (float) or E ≤ 4 mm (white glass) for the same glass thickness are permissible.	

Table 11: Defect types / tolerances for enamelled glass

* Defects < 0.5 mm (“starry sky” or “pinholes” – tiny defects in the enamel) are permissible and are generally not taken into account. The repair of imperfections with enamel ink before the tempering process or with organic paint after the tempering process is permissible. Organic lacquer must not be used in the area of the edge seal of insulated glass.

** With fine decors (screening with partial areas smaller than 5 mm), a so-called moire effect can occur. For this reason, coordination with the manufacturer is necessary.

*** The enamel position tolerance is measured from the reference point, which must be agreed with the manufacturer.

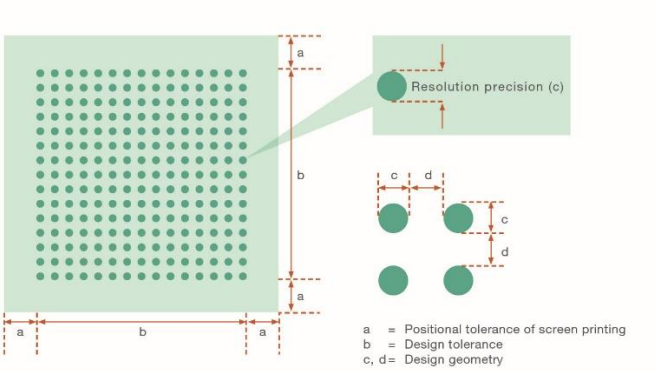


Figure 14: Position and design tolerances for measurement with printed glasses

The following notes apply to geometric figures or so-called perforated masks under 3 mm in size or gradients from 0 to 100 %:

- If dots, lines or figures of this size are lined up with a small space between them, the human eye reacts very sensitively.
- Tolerances of the geometry or the distance in the range of tenths of a millimetre are noticeable as rough deviations.
- These applications must always be checked for feasibility with the manufacturer. The production of a 1:1 sample is recommended.

4.4. ASSESSMENT OF THE COLOUR IMPRESSION

Colour deviations cannot be excluded in principle, as these can occur due to several unavoidable influences.

Due to the influences mentioned below, under certain light and viewing conditions a discernible colour difference between two enamelled glass sheets may prevail, which can be classified very subjectively by the viewer as “disturbing” or “not disturbing”.

4.4.1. TYPE OF BASE GLASS AND INFLUENCE OF INK

The intrinsic colour of the glass, which depends essentially on the thickness and type of glass (e.g. tinted glasses, low-iron glasses, etc.), leads to a different colour impression of the enamel (enamel position 2). In addition, this glass can be provided with different coatings, such as solar control layers (increasing the light reflection of the surface), reflection-reducing coatings or even be slightly embossed, as is the case with structural glasses. Colour deviations during enamelling cannot be ruled out due to fluctuations in ink production and the burning-in process.

4.4.2. TYPE OF LIGHT IN WHICH THE OBJECT IS VIEWED

The lighting conditions are constantly changing depending on the time of the year and day and the prevailing weather. This means that the spectral colours of the light that impinge on the colour through the different media (air, 1st surface, glass body) are present in the range of the visible spectrum (380 nm – 780 nm) with different intensities.

The first surface already reflects a part of the occurring light more or less depending on the angle of incidence. The “spectral colours” impinging on the ink are partially reflected or absorbed by the ink (colour pigments). As a result, the colour appears different depending on the light source and place of observation as well as the background.

4.4.3. OBSERVER OR TYPE OF OBSERVER

The human eye reacts very differently to different colours. While even a very small colour difference is clearly perceived in blue tones, colour differences are less perceived in green colours.

Tolerances for the colour uniformity of prints on glass should be chosen so that a viewer can hardly notice any colour deviations under normal conditions. There is no normative definition.

The tolerances represent a compromise between productivity and the demand for the visual impression of the insulating glasses in a building with a normal installation situation.

Depending on the variation of natural light, the position of the observer with the viewing angle and distance, ambient colour, colour neutrality and degree of surface reflection, the tolerance values are only to be used as a guide. All circumstances should be individually assessed on site, at the respective property – especially the property in its specific environment.

Inks are objectively represented for production control in the CIE L*a*b* system, based on the standardised reference illuminant D65 and an observation angle of 10°.

The desired position in the a, b colour coordinate system, as well as the brightness characterised by the letter L, are subject to slight variations due to production. In cases where the customer requires an objective evaluation standard for the colour location, the procedure must be agreed in advance with the supplier.

The basic procedure is defined below:

- Sampling of one or more colours
- Selection of one or more colours. Definition of tolerances per colour in agreement with the customer. The measurement values on which this is based must be determined with glass-specific colorimeters and under the same conditions (same colour system, same type of light, same geometry, same observer). Verification of feasibility by the supplier with regard to compliance with the specified tolerance (scope of order, availability of raw materials, etc.)
- Production of a 1:1 production sample and approval by the customer
- Production of the order within the specified tolerances
- The ordering of large quantities of the same colour within one order should be placed once and not in partial orders.

4.5. OTHER INFORMATION

The products' other properties can be found in the national building regulations and the applicable standards, in particular:

- EN 12150
- EN 1863
- EN 14179
- EN 14449

Enamelled glasses can only be produced in toughened safety glass (TSG or heat-soaked TSG) or semi-tempered glass versions. Subsequent processing of the glass, regardless of the type, may have a significant effect on the properties of the product and is not permitted.

Enamelled glasses can be used as monolithic panes or processed into LSG and MIG. The prescribed marking of the panes is carried out in accordance with the standards.

In addition to the guideline printed in this section, the following notes apply:

Application with enamel or partial enamel and screen printing or partial screen printing to the film for LSG must be checked for feasibility with the manufacturer. This is especially true when using etching tone to the film, as the optical density of the etching tone can be greatly reduced and the effect of the etching tone is only maintained when used on level 1 or 4.

Special colours e.g. metallic effects, slide-resistant coatings or combinations of several colours can be produced on request. The respective special properties or the appearance of the product should be clarified with the manufacturer.

Enamelled and screen-printed glasses can only be produced in toughened safety glass or semi-tempered glass versions.

Subsequent processing of the glass, regardless of the type, may have a significant effect on the properties of the product and is not permitted.

Enamelled glasses can be used as a monolithic pane or in combination with laminated safety glass or insulating glass. In this case, the user must take the relevant regulations, standards and guidelines of the user into account.

Enamelled glasses in the toughened safety glass version can be heat-soak tested. The respective necessity of the heat-soak test must be checked by the user and the manufacturer must be informed.

The static values of enamelled glasses are not the same as those of unprinted or enamelled glass.

4.6. METALLIC INKS

In addition to the guideline printed in this section, the following note applies:

In the case of metallic inks, the manufacturing process and the pigmentation can lead to recognisable differences in the perception of the colour impression, which do not allow a uniform, homogeneous appearance to be achieved for glasses put up next to or on top of each other. This is a product-specific characteristic of metallic inks and creates a lively facade image even when viewed from different angles.

5. THERMALLY TOUGHENED SAFETY GLASS

5. THERMALLY TOUGHENED SODA LIME SILICATE SAFETY GLASS

The basis is the “Guideline for the Assessment of the Visual Quality of Glass for the Construction Industry”, as of March 2019, published by the German Flat Glass Association among others. If any tolerances/deviations are not regulated in this section, the following applies in addition:

FT:
EN 12150-1: Glass in building - Thermally toughened soda lime silicate safety glass - Part 1: Definition and description; German version EN 12150-1:2015+A1:2019

HS:
EN 1863-1: Glass in building - Heat strengthened soda lime silicate glass - Part 1: Definition and description; German version 1863-1:2011

FT – Heat Soaked:
DIN EN 14179-1: Glass in building - Heat soaked thermally toughened soda lime silicate safety glass - Part 2: Evaluation of conformity/Product standard; German version EN 14179-2:2005

5.1. GENERAL DISTORTION – VALID FOR FT/HS/FT – HAEET SOAKED MADE OF FLOAT GLASS

- Norm 0.3% of the measured distance. The test shall be carried out on the edges and on the diagonal and none of the values measured shall exceed 0.3% of the measured distance.
- For square formats with an aspect ratio between 1:1 and 1:1.3 and for thin glass thicknesses < 6 mm, the deviation from straightness is greater than for narrow rectangular formats due to the tempering process. This also applies to aspect ratios > 1:20.

5.2. LOCAL DISTORTION – VALID FOR FT/HS/FT – HAEET SOAKED MADE OF FLOAT GLASS

- Norm 0.3 mm on a 300 mm measuring distance.
- The measurement must be carried out at a distance of at least 25 mm from the edge.

5.3. ASSESSMENT OF THE VISUAL QUALITY OF FT MADE FROM SPECIAL GLASSES

The following table is to be used for the assessment of ornamental glasses. In addition, the product specifications of the respective manufacturers must be observed. With ornamental glasses, symmetry of the structure cannot be guaranteed when using several panes next to each other in one surface. The pattern direction should be specified in the order. If this information is missing, the glass is manufactured with the pattern direction parallel to the height edge. For production reasons, design shifts or slight colour differences are possible with ornamental and coloured glasses.

Permissibility per unit or m^2 Ornamental glass, clear and body-tinted as well as enamelled or surface-treated						
Unit	Hairline scratches** not noticeable	Drawing bubble closed	Spherical bubble closed	Inclusions crystalline	Flat edge damage* chamfer-ed edge	Slight conchoidal fractures* chamfered edge
pro m^2 glass area	permissible on entire surface	L ≤ 20 mm W ≤ 1 mm permitted 1 unit	≥ 3,0 mm bis 5,0 mm zulässig 1 Stück	≥ 3.0 mm up to 5.0 mm	permissible	permissible
		L≤ 10.0 mm W ≤ 1,0 mm permitted on overall area, however not in a cumulative form	< 3.0 mm permissible on overall area, however not in a cumulative form	permissible on overall area, however not in a cumulative form		

Table 12: Tolerances for ornamental glass

* No deeper than 15 % of the pane thickness into the glass volume
** Hairline scratches i.e. surface damage that cannot be felt with a fingernail

Since ornamental glass is subject to a custom manufacturing process, spherical or linear inclusions and bubble formation are an expression of the characteristic quality. Pattern deviations as a result of roller changes are excluded and thus not subject to complaint.

5.4. DEVIATION OF THE MARKING

In addition to the normal regulations for the marking of safety glasses, we reserve the right to apply, change or to change the position of the marking on glasses, even if they are expressly ordered without a permanent marking or with a specific permanent marking. We would like to point out that the changes mentioned above do not constitute grounds for complaint and therefore cannot lead to a replacement of the glasses.

5.5. HF HEAT SOAKED

When using FT, it cannot be ruled out that glass breakage may occur due to foreign matter inclusions (e.g. nickel sulphide). The risk of breakage can be reduced by means of a heat soak test (HST test), which is subject to a charge, and does not completely exclude the risk of breakage.

The cause of the glass breakage must be proven by the user. This applies in particular to glass breakage as a result of foreign matter inclusions (e.g. nickel sulphide).

Within Europe, heat-soaked toughened safety glass is a building product according to EN 14179, while in Germany, the application of heat-soaked toughened safety glass is subject to the state building regulations, which require the use of externally monitored, thermally tempered soda-lime toughened safety glass (TSG hot-soaked). The monitoring requirements are more extensive than for heat-soaked toughened safety glass according to EN 14179, and the customer can request a works certificate according to DIN EN 10204: 2005-1 as proof of the heat soaking carried out.

5.5.1. LABELLING / MARKING

The permanent and visible marking of heat-soaked TSG shall contain at least the following information:

- Name or Product of the manufacturer;
- Number of this European Standard: EN 14179-1;

6.LAMINATED SAFETY TOLERANCES

6. LAMIANTED SAFTEY GLASS TOLERANCEN

6.1. DIMENSIONAL TOLERANCES

Should any tolerances/deviations not be regulated in this section, these shall apply in addition:

- EN 12543-1: Glass in building - Laminated glass and laminated safety glass - Part 1: Definitions and description of component parts (ISO/DIS 12543-1:2020); German and English version prEN ISO 12543-1:2020
- EN 12543-5: Glass in building - Laminated glass and laminated safety glass - Part 5: Dimensions and edge finishing (ISO/DIS 12543-5:2020); German and English version prEN ISO 12543-5:2020
- EN 12543-6: Glass in building - Laminated glass and laminated safety glass - Part 6: Appearance (ISO/DIS 12543-6:2020); German and English version prEN ISO 12543-6:2020

The corresponding dimensional tolerances of the primary products used in the LSG unit are valid, plus the permissible offset tolerances as listed in Tables 19 and 20.

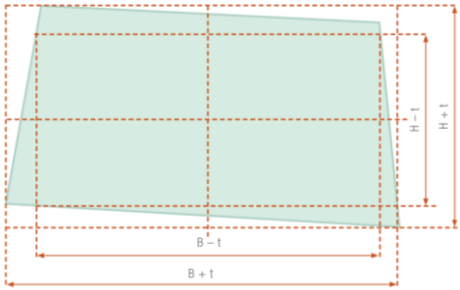


Figure 15: Limit dimensions for rectangular pane dimensions

Example:
LSG made from 6 mm FT / 0.76 PVB / 6 mm HS; edges polished

Dimensional tolerance of the single pane:	± 1.5 mm
Additional offset tolerance:	± 2 mm

Results in a sum of the permissible offset tolerance = ± 3.5 mm

6.2. SHIFT TOLERANCE (OFFSET / EDGE STEP)

The individual panes can shift against each other in the laminating process for manufacturing reasons.

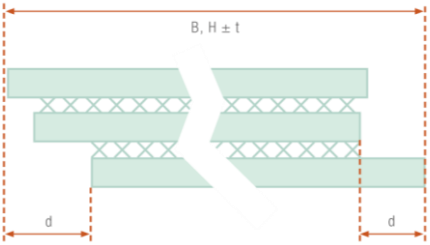


Figure 16: Offset with LSG

For LSG consisting of two or more glasses, each individual pane is machined as standard. The cutting tolerances are added to the displacement tolerances.

The unit's longest edge is used in table 19 or 20.

Nominal dimension L or H in mm	Maximum permissible offset in mm
L, H ≤ 1000	2,0
1000 < L, H ≤ 2000	3,0
2000 < L, H ≤ 4000	4,0
L, H > 4000	6,0

Table 13: Maximum offset for machined sizes and stock dimensions

Special shapes Pane size	Maximum allowable offset (d) per LSG nominal		
	≤ 8 mm	≤ 20 mm	> 20 mm
≤ 2000	1,5	3,0	4,5
> 2000-4000	3,0	4,0	5,5
> 4000	4,5	5,0	6,0

Table 14: LSG - offset with special shapes

With LSG units consisting of FT glasses with a width of less than 20 cm and a height of more than 150 cm, the long edges of the glasses may warp (glass is then no longer rectangular, but "banana-shaped"), offset not according to point 6.2, these are unavoidable for production reasons and are no grounds for complaint.

6.3. THICKNESS TOLERANCE

The thickness dimension for LSG must not exceed the sum of the thickness dimensions of the individual glass panes as specified in the standards for base glass (e.g. DIN EN 572-2). If the total thickness of the interlayer is < 2 mm, an additional limit deviation of ± 0.1 mm applies. If the total thickness is > 2 mm, an additional limit deviation of ± 0.2 mm applies.

Example:
Laminated glass, made of 2 x float glass with a nominal thickness of 3 mm and an interlayer of 0.5 mm. According to DIN EN 572-2, the deviation limits for float glass with a nominal thickness of 3 mm are ± 0.2 mm. Therefore, the nominal thickness is 6.5 mm and the limit deviations are ± 0.5 mm.

6.4. PROCESSING

In the case of LSG units made of two or more glasses, the edges of the single panes can be designed KG, KGS, KMG, KGN, or KPO. The entire package can also be machined on the glass edge. In the case of TSG or TVG glasses, subsequent levelling of the edge offset is not possible. For combinations of non-toughened glass, reworking is permitted.

6.5. DISTORTION TOLERANCE / PLANARITY DEVIATION

Planarity deviations from the level: 3 mm/rm edge length. With LSG, the tolerances for local warping are additionally maintained.

6.6. FLAWS IN THE VISIBLE SURFACE

The specifications for defects in the glass pane, the interlayer and test procedures with regard to appearance are based on the definitions and admissibility in DIN EN ISO 12543-1 and DIN EN 12543-6. Special attention is paid to the acceptance criteria in the field of vision. These criteria are applied to products at the time of delivery.

6.6.1. DEFECT DEFINITIONS

In particular, the following definitions shall apply.

6.6.2. PUNCTIFORM FLAWS

This type of defect includes opaque stains, bubbles and foreign bodies.

6.6.3. LINEAR FLAWS

This type of defect includes foreign bodies and scratches or grinding marks.

6.6.4. INTERLAYER FLAWS

Interlayer flaws such as wrinkles, shrinkage and stripes.

6.6.5. OPAQUE STAINS

Visible flaws in laminated glass (e.g. tin stains, inclusions in the glass in the interlayer).

6.6.6. BUBBLES

Usually air bubbles, which can be in the glass or in the interlayer.

6.6.7. FOREIGN BODIES

Any unwanted object that has penetrated into the laminated glass during production.

6.6.8. SCRATCHES OR SANDING MARKS

Linear damage to the outer surface of the laminated glass.

6.6.9. GROOVES

Sharply pointed cracks or fissures running from an edge into the glass.

6.6.10. WRINKLES

Beeinträchtigungen, die durch Falten in der Zwischenschicht entstehen und nach der Herstellung sichtbar sind.

6.6.11. STRIPES DUE TO INHOMOGENEITY OF THE INTERLAYER

Optical distortions in the interlayer caused by manufacturing defects in the interlayer and visible after manufacture.

6.6.12. PUNCTIFORM FLAWS IN THE VISIBLE SURFACE

When checked in accordance with the test procedures specified in section 6.8, the admissibility of punctiform defects depends on the following:

- Size of the defect
- Frequency of the defect
- Size of the pane
- Number of panes as components of the laminated glass

This is shown in Table 15. Defects smaller than 0.5 mm are not considered. Defects larger than 3 mm are not permitted

Note: The admissibility of punctiform defects in laminated glass is independent of the thickness of the individual glass.

Note: An accumulation of defects occurs when four or more faults are spaced < 200 mm apart. This distance is reduced to 180 mm for triple-glazed laminated glass, to 150 mm for four-glazed laminated glass and to 100 mm for five- or multi-glazed laminated glass. The number of defects allowed in Table 21 is increased by 1 for each individual interlayer thicker than 2 mm.

Defect size d in mm		0,5 < d ≤ 1,0	1,0 < d ≤ 3,0			
Pane size A in m²	Panes	For all Sizes	A ≤ 1	1 < A ≤ 2	2 < A ≤ 8	A > 8
Number of permissible defects	2 3 4 5	No limitation, but no accumulation of defects	1 2 3 4	2 3 4 5	1/m² 1,5/m² 2/m² 2,5/m²	1,2/m² 1,8/m² 2,4/m² 3/m²

Table 15: Punctiform flaws permissible in the visible surface

6.6.13. LINEAR FLAWS IN THE VISIBLE SURFACE

When tested according to the test procedure given in paragraph 6.8, linear defects are permitted as stated in Table 22.

Pane size	Number of permissible defects > 30 mm in length [a)]
≤ 5 m²	Not permitted
5 bis 8 m²	1
> 8 m²	2
[a)] Linear defects of less than 30 mm in length are permitted	

Table 16: Permissible linear flaws in the visible surface

6.7. DEFECTS IN THE EDGE SURFACE

6.7.1. DEFECTS IN THE EDGE AREA FOR FRAMED EDGES

When tested in accordance with the test procedure in section 6.8, defects not exceeding 5 mm in diameter are permitted in the edge area. For pane dimensions ≤ 5 $m^{2,}$ the width of the edge area is 15 mm The width of the edge area increases by 20 mm for pane sizes > 5 m^2. If bubbles are present, the area covered with bubbles shall not exceed 5 % of the edge area.

6.7.2. GROOVES

Grooves are not permitted.

6.7.3. WRINKLES AND STRIPES

Wrinkles and stripes are not allowed in the visible surface.

6.7.4. DEFECTS ON EDGES THAT ARE NOT FRAMED

Laminated glass is usually installed in frames; if, exceptionally, it is unframed, only the following edge designs may be used:

- ground edge
- polished edge
- mitre edge

Under these conditions, conchoidal fractures, bubbles, defects in the interlayer and retractions of the interlayer are permitted if they are not visible when inspected.

Visible edges must be specified when ordering in order to achieve the best possible edge quality, but the production-related setting-off edge remains visible, as do film residues in the hem area. If no visible edge is specified, film residues on the edge are permitted.

In the case of external glazing with freely weathered glass edges, the hygroscopic properties of the PVB film in the edge zone of 15 mm can, in a product-specific manner and depending on the environmental conditions, cause changes in the colour impression. These changes are permitted. In the case of fixed-size production of LSG, film protrusions may be present, especially at the stand edge.

6.8. INSPECTION PROCEDURE

The laminated glass to be viewed is placed vertically in front of and parallel to a matt grey background and exposed to diffuse daylight or equivalent light. The observer is located at a distance of 2 m from the pane and views it at an angle of 90° (with the matt background on the other side of the glass pane).

Defects that are disturbing when viewed in this way must be marked. Subsequently, the assessment is carried out according to specification.

With LSG interlayers, anisotropies-like dark-coloured stains, stripes and rings may occur which are visible under certain conditions and cannot be avoided during production and are therefore no grounds for complaint.

6.9. COLOUR FILMS

With coloured films and matt films, there is a loss of colour intensity over time due to weathering (e.g.: UV exposure). As a result, subsequent deliveries of glass may show more or less visually perceptible differences in colour compared to already installed glasses of the same type. This does not constitute grounds for claim.

6.10. LSG WITH STEPS

In principle, the film protrusions are cut off in the area of the step for all laminated glass with a step. In the case of double-glazed LSG units, this is generally feasible and must be agreed.

In the case of LSG glasses consisting of three or more glasses and where the central pane(s) is (are) set back to the outer panes, the film is cut off if the step width is equal to the glass thickness of the central pane or the step depth is equal to the glass thicknesses of the central panes. For all other step sizes, an agreement must be made on the film cutback.

As far as the removal of the film is feasible as described, residues cannot be completely avoided from a production point of view and do not constitute grounds for complaint. With all step formations not as above described, if film residues cannot be removed for the steps, this does not represent grounds for complaint.

The customer should be advised of an equivalent to be pushed into the LSG unit (width, depth ...).

Due to the production process, film residues exist at the glass edges; these can be deformed at the setting-off edge by support points and do not constitute grounds for complaint.

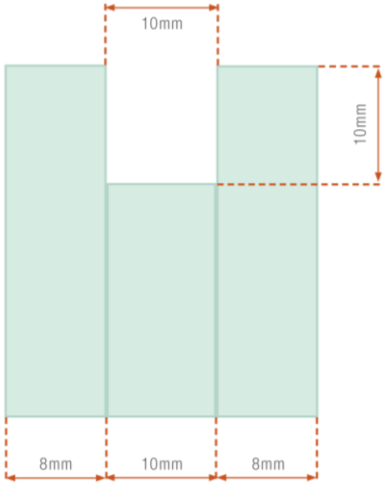


Figure 17: LSG with steps

7. SOLAR CONTROL AND THERMAL INSULATING COATINGS

7. SOLAR CONTROL AND THERMAL INSULATING COATINGS

7.1. SCOPE OF APPLICATION

This guideline applies to the assessment of the quality of coated glasses (thermal insulation and solar control coatings).

For the purposes of this guideline, coated glass means float glass, thermally toughened safety glass, semi-tempered glass, laminated glass and laminated safety glass which has been coated using the magnetron process (sputtering)..

7.2. PROCESSES AND REFERENCES TO STANDARDS AND GUIDELINES

7.2.1. PROCESSES

Industrially applied thin film coatings for flat glass can be divided into:

- Vacuum processes
- Chemical processes

7.2.1.1. VACUUM PROCESSES

Vacuum processes are characterised by the fact that the coating material is brought into a vaporous state in a vacuum and then condenses on the substrate – the glass surface. Coatings to be evaluated under this guideline include both non-toughenable and toughenable coatings.

7.2.1.2. CHEMICAL PROCESSES

The chemical processes are coatings via a chemical reaction of the coating material on the hot glass surface at atmospheric pressure. These coatings are also called pyrolytic coatings.

Other chemical processes include coating by chemical reduction, in which layers are deposited by reducing the coating material in contact with the glass surface at atmospheric pressure, and sol-gel coating.

7.2.2. REFERENCES TO STANDARDS AND GUIDELINES

(in the latest applicable version)

EN 1096:	Glass in building - Coated glass
EN 572:	Glass in building - Basic soda-lime silicate glass products
EN 12150:	Glass in building - Thermally toughened soda lime silicate safety glass
EN 1863:	Glass in building - Heat strengthened soda lime silicate glass
EN 12543:	Glass in building - Laminated glass and laminated safety glass
EN 1279:	Glass in Building - Insulating glass units
DIN 58196-6:	Thin layers for optics Part 6: Adhesion test with an adhesive tape
EN 410:	Glas im Bauwesen – Bestimmung der lichttechnischen und strahlungsphysikalischen Kenngrößen von Verglasungen
EN 12898:	Glass in building - Determination of luminous and solar characteristics of glazing
DIN 5033:	Colorimetry
ISO 11479-2:	Glass in building – Coated glass – Colour of façade

GEPVP Code of Practice for in-situ Measurement and Evaluation of the Colour of Coated Glass used in Facades (Herausgegeben durch die “European Association of Flat Glass Manufacturers”)

Model Administrative Regulation for Technical Building Regulations (MVV-TB) Section C2.11 “Building products made of glass”)

Guideline for assessing the visual quality of glass for the construction industry (published by the German Federal Association of Glazier Trades/Hadamar, the German Flat Glass Association/ Troisdorf and the VFF Window + Facade Association/Frankfurt-Main.

Guideline for the assessment of the visual quality of enamelled and screen-printed glass (published by the German Flat Glass Association/Troisdorf and the Professional Association for Structural Glass Construction/Cologne)

Processing guidelines for arcon coatings

Processing guidelines for heat treatable arcon coatings

7.3. REQUIREMENTS FOR ENERGY CONSERVATION AND THERMAL INSULATION PARAMETERS

The requirements in Tab. 17 for the photometric and radiometric parameters of the coated single pane are in accordance with EN1096-4.

The photometric and radiometric parameters of the coated single pane listed in Table 17 are determined by calculation and/or measurement according to DIN EN 410. The emissivity is determined according to DIN EN 12898.

Coated glasses within the scope of this specification are intended for use in multiple insulating glasses.

Parameter	Determina-tion according	Deter-mined value	Speci-fied value	Requirement
Light transmittance	EN 410	$\tau_{v,m}$	$\tau_{v,d}$	$\tau_{v,m} = \tau_{v,d} \pm 0.03$
Light reflectance: first side second side	EN 410	$\rho_{v,m}$ $\rho'_{v,m}$	$\rho_{v,d}$ $\rho'_{v,d}$	$\rho_{v,m} = \rho_{v,d} \pm 0.03$ $\rho'_{v,m} = \rho'_{v,d} \pm 0.03$
Energy trans-transmittance	EN 410	$\tau_{e,m}$	$\tau_{e,d}$	$\tau_{e,m} = \tau_{e,d} \pm 0.03$
Energy reflectance: first side second side	EN 410	$\rho_{e,m}$ $\rho'_{e,m}$	$\rho_{e,d}$ $\rho'_{e,d}$	$\rho_{e,m} = \rho_{e,d} \pm 0.03$ $\rho'_{e,m} = \rho'_{e,d} \pm 0.03$
Normal emissivity	EN 12898	ε_m	ε_d	$\varepsilon_m \leq \varepsilon_d + 0.02$, if $\varepsilon_d \geq 0.10$ $\varepsilon_m \leq \varepsilon_d + 0.01$, i$\varepsilon_d < 0.10$

Table 17: Information on photometric and energy parameters 1

7.4. REQUIREMENTS FOR MECHANICAL PROPERTIES

There is no generally accepted standard for testing the scratch resistance of coated glasses. The ISOLAR® partner company evaluates the scratch resistance and delamination resistance during production using in-house test procedures. The results of these test procedures allow conclusions to be drawn about subsequent practical stresses.

The evaluation of the mechanical properties (adhesive strength) "on site" is carried out according to DIN 58196-6 using a commercially available transparent adhesive tape, e.g. type "Tesa 57370" from Beiersdorf. The specimens to be tested are stressed before further processing to sharpness level K1 according to section 4 of the above-mentioned standard. As a result of this test, no delamination of the layer system may occur.

The ISOLAR® partner company reserves the right to verify the mechanical properties of the product using internal testing procedures in order to make a final assessment.

7.5. FAILURE EVALUATION OF COATED GLASS

The evaluation of coated glass (stock sizes or cuts) is based on the acceptance criteria for defects as defined in DIN EN 1096-1, Section 7.4 (see Table 18).

Defect type	Acceptance criteria		
	Pane to pane	Individual pane	
Homogeneity defect[1] /Stain	Allowed as long as visually not	Allowed as long as visually not disturbing	
		Main field	Edge zone
Punctiform defects:	Not applicable		
Dirt spots / pinprick defects			
> 3 mm		Not	Not permitted
>2 mm and ≤ 3 mm		Permitted, if not more than 1/m²	Permitted, if not more than 1/m²
Nest formations;		Not permitted	Allowed as long as within the range of
Scratches:			
> 75 mm		Not permitted	Permitted as long as they are more than 50 mm apart
≤ 75 mm		Permitted as long as the local density is not visually disturbing	Permitted as long as the local density is not visually disturbing

Table 18: Acceptance criteria for defects in coated glass according to DIN EN 1096-1

[1] Homogeneity error: still detectable deviations in colour, reflectance or transmittance within a glass pane or from pane to pane – see also point 7.6

7.6. COLOUR EVALUATION OF COATED GLASS

7.6.1. GENERAL DEFINITIONS CONCERNING COLOUR EVALUATION

For the evaluation of the reflection colour (exterior view of the facade), solar control coatings on level 2 and thermal insulation products (low-e) on level 3 must be used in the insulating glass composite. Vertical viewing is agreed.

Colour differences in the transmission colour cannot be evaluated “on site” with a colour measuring instrument, as no measuring instrument exists for this purpose. An evaluation is therefore only possible by visual observation.

In addition to the coating, the transmission and reflection colour are influenced by the type of glass, the glass thickness and the uncoated counter pane in the insulating glass.

It must also be noted that the evaluation of colour is subject to subjective influences, as the sensitivity of the human eye is very individual. In addition, a variety of influences play a role in the colour perception of a facade, such as:

- the daylight: a dull or cloudy sky can bring out colour differences that are not visible under direct sunlight
- distance and viewing angle
- the eye of the observer
- the background: the lack of interior lighting in the building (dark background) can increase the perception of colour differences
- environment: the presence of buildings in the immediate vicinity, which may be reflected in the facade

Toughened glass such as FT or HS show so-called “anisotropy effects” in the form of striped or circular, grey or coloured reflections. This effect, which occurs with heat-treated glasses, depends on the type and direction of the lighting (position of the sun, cloud cover, etc.), glass thickness and shape as well as the viewing angle and can be additionally intensified and changed in colour with coated glasses

Not fully screen-printed toughened safety glass (depending on the respective design) cannot be measured in colour..

7.6.2. COLOURS IN THE CIELAB COLOUR SPACE

A suitable basis for the colour measurement of coated glasses is the spectrum measurement in reflection for the assessment of a facade's exterior appearance or in transmission for the assessment of the view. From the spectra, clear values can be determined to describe the colour.

In the CIELAB colour space, the L* value indicates the brightness, a* indicates the red-green components and b* the yellow-blue components (see Fig. 18). The centre is colour-neutral. Colour and brightness can thus be unambiguously described by a point in a three-dimensional coordinate system.

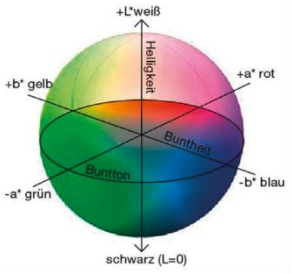


Figure 18: CIELAB colour space

The L*, a* and b* values can be used to evaluate the colour of a facade, when looking at the outside (in reflection), or to evaluate the transmission properties of a glass pane.

Colour differences between two samples can be evaluated by calculating ΔL*, Δa* and Δb* as shown below.

$$\Delta L^* = L^*_{Probe2} - L^*_{Probe1}$$

$$\Delta a^* = a^*_{Probe2} - a^*_{Probe1}$$

$$\Delta b^* = b^*_{Probe2} - b^*_{Probe1}$$

In colour measurement, it is common practice to express colour differences by calculated ΔE* values

$$\Delta E^* = \sqrt{(\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2})}$$

The ISOLAR® partner company considers ΔE* values to be insufficiently accurate for the colour evaluation of coated glasses, so ΔL*, Δa* and Δb* values are used.

7.6.3. MEASUREMENT OF COLOUR

The parameters L*, a* and b* can be determined with spectrometers in running production as well as with hand-held colorimeters “on site”. The sensitivity of these devices is comparable to that of the human eye. Since the measurements are related to the standardised light source (standard illuminant D65) and the standard observer (2° standard observer), accurate measurement results can be obtained independently of external factors (illumination, environment and background of the building) and the subjective colour perception of an individual. The surface to be measured must always be free of contamination.

Hand-held colorimeters allow colour measurement in reflection at an angle of 90°. In contrast, the reflection measurement during production is carried out at different viewing angles.

When measuring the colour in reflection (exterior view of the facade) with a hand-held colorimeter, the coated pane of the insulating glass must always be measured[2].

[2] In the case of solar control coatings (coating on level 2), the measurement can be carried out in an insulating glass composite on the outside. In contrast, the coated individual pane must be measured in the case of thermal insulation coatings (coating on level 3), otherwise the measurement results will be falsified by the uncoated counter pane

7.6.4. ASSESSMENT OF THE HOMOGENEITY OF A FACADE

The following sections describe the procedure for determining the colour of coated glasses on site

7.6.4.1. COLOUR DIFFERENCES WITHIN A PANE

Colour differences within a pane (e.g. stripes or stains) can be measured and evaluated “on site” with a hand-held colorimeter. For this purpose, the L*, a* and b* values are determined at at least 3 points in each of the two areas in which the colour differences were detected (see Fig. 19). According to ISO 11479-2, an immediate edge area of 15 cm is not included in the evaluation for coated fixed dimensions, as there may be slight colour differences between the edge areas and the centre of the panes. Furthermore, the colour measurement may be affected by the proximity to the frame of the insulating glass.

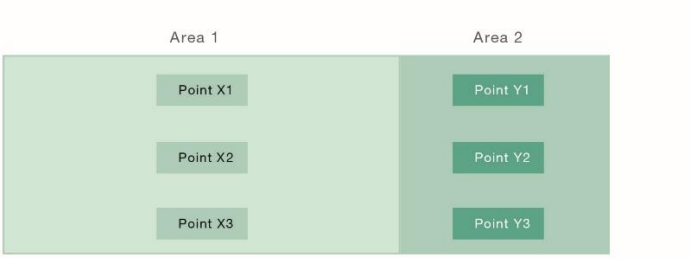


Figure19: Example of colour measurement for colour differences within a pane

The ΔL*, Δa* and Δb* values, based on the average values for each area, are calculated according to the equations (1), (2) and (3). Using the indices Area 2 and Area 1 for the colours to be compared, the following applies:

$$\Delta L^* = L^*_{Bereich2} - L^*_{Bereich1} \quad (1)$$

$$\Delta a^* = a^*_{Bereich2} - a^*_{Bereich1} \quad (2)$$

$$\Delta b^* = b^*_{Bereich2} - b^*_{Bereich1} \quad (3)$$

For the ΔL*, Δa* and Δb* values, the requirements of section 7.6.4.3. shall apply.

7.6.4.2. COLOUR DIFFERENCES BETWEEN TWO ADJACENT PANES

Colour differences between two adjacent panes can be measured and evaluated “on site” with a hand-held colorimeter.

For this purpose, the L*, a* and b* values of each of the adjacent panes are determined at at least 3 points (e.g. along a diagonal, see Fig. 20).

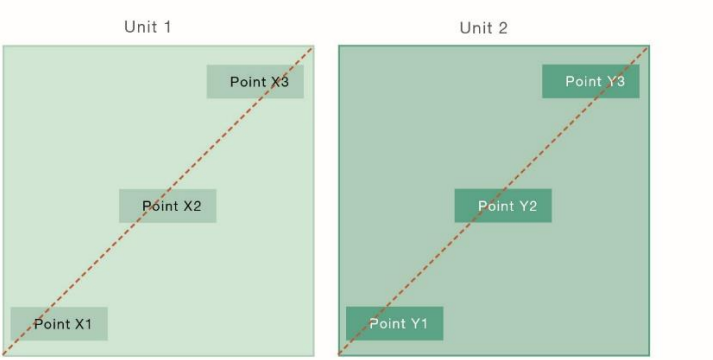


Figure 20: Example of colour measurement for colour differences within adjacent panes

Then the average L*, a* and b* are calculated for each pane.

The ΔL*, Δa* and Δb* values represent the differences between the mean values for each pane and are calculated according to the equations (4), (5) and (6).

If the indices Pane 2 and Pane 1 are used for the colours to be compared, the following applies

$$\Delta L^* = L^*_{Scheibe2} - L^*_{Scheibe1} \quad (4)$$

$$\Delta a^* = a^*_{Scheibe2} - a^*_{Scheibe1} \quad (5)$$

$$\Delta b^* = b^*_{Scheibe2} - b^*_{Scheibe1} \quad (6)$$

where Pane 1 is the reference pane.

The reference pane can be compared with each of the adjacent panes – top, bottom, left and right.

The evaluation can only be carried out for the panes of a product of the same type of glass, identical insulating glass structure and background conditions, and from the same viewing height.

For the ΔL*, Δa* and Δb* values, the requirements of section 7.6.4.3. shall apply.

7.6.4.3. REQUIREMENTS FOR COLOUR MEASUREMENTS

For the cases described in section 7.6.4.1 and 7.6.4.2, the requirements of Table 19 apply.

	Solar control and low-e (level 2)	low-e (level 3)
ΔL*	4	3
Δa*	3	3
Δb*	3	3

Table 19: Requirements for colour measurements

The tolerances within manufacture are defined in such a way that a homogeneous colour appearance of the facade is guaranteed. Deviating requirements are possible product and project-related on request.

7.6.5. COLOUR UNIFORMITY OF NON-TOUGHENED AND TOUGHENED PRODUCT VERSIONS

Certain coatings are available both in a non-toughenable and toughenable
version, whereby the toughenable version must be generally prestressed to achieve the specified properties.

The photometric and physical radiation characteristics of the non-toughenable and toughenable version of an arcon coating are matched.

The colour of the non-toughenable and toughenable versions of an arcon coating is also matched. However, the colour appearance can be perceived differently in transmission and reflection, so that colour uniformity cannot be guaranteed. When used in a facade at the same time, arcon strongly recommends a sample be taken in original size beforehand.

In turn, coatings with the suffix “oHT” can be used either heat treated or non-heat treated. The simultaneous use of a pre-toughened (e.g. FT) and non-pretoughened product (e.g. float, LSG) with the suffix “oHT” in a facade is possible, but in this case arcon strongly recommends that a sample be taken in original size beforehand.

7.6.6. ANGULAR DEPENDENCE OF ARCHITECTURAL GLASS COATINGS

The colour impression of thermal insulation and sun control products changes under the angle. This is particularly pronounced in double and triple silver coatings with a high selectivity and cannot be avoided due to production reasons.

This angle dependence cannot be measured “on site”, which means an objective assessment is not permissible.

Consequently, the colour homogeneity of a facade at an angle can only be assessed by visual inspection. The maximum angle must not exceed 45° (see Fig. 21).

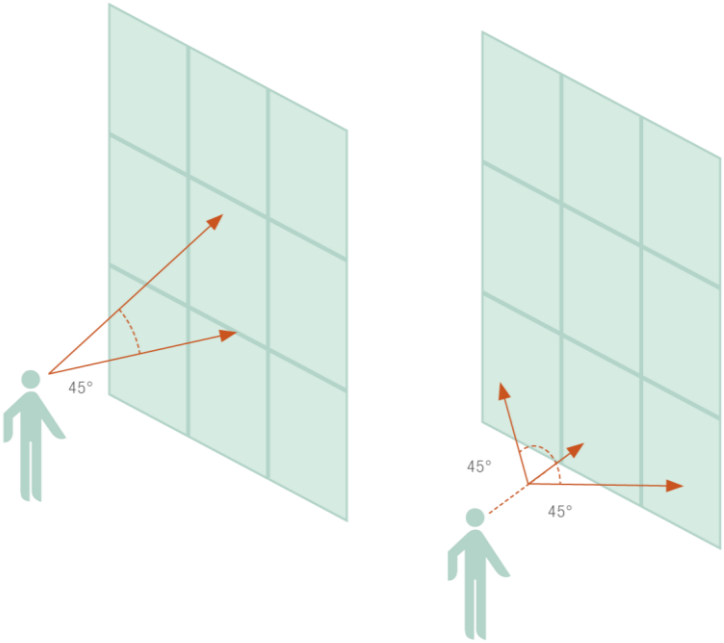


Figure 21: Visual observation of angle dependence

8. INSULATING GLASS UNIT

8. INSULATING GLASS UNIT

Should any tolerances/deviations not be regulated in this section, these shall apply in addition:

- EN 1279-1: Glass in Building - Insulating glass units - Part 1: Generalities, system description, rules for substitution, tolerances and visual quality; German version EN 1279-1:2018
- EN 1096-1: Glass in building - Coated glass - Part 1: Definitions and classification; German version EN 1096-1:2012

8.1. EDGE SEAL

The tolerance for the spacer position relative to the glass edges is ± 2.5 mm. In the case of float glass panes, the sealing or adhesive compound of the unit may protrude a maximum of 2 mm over the spacer into the inter-pane cavity and onto the glass pane. Deviations from this require a separate agreement. In the area of corners and connectors as well as when using special glass (e.g. ornamental glass), it is unavoidable that higher sealing or adhesive compound residues protrude into the inter-pane cavity or onto the glass pane. This is for technical reasons and no grounds for complaints.

8.2. THICKNESS TOLERANCE AT THE EDGE SEAL

The measured values of the thickness must not deviate from the specified nominal thickness by more than the thickness tolerances specified in the following table (DIN EN 1279-1:2018-10).

Glazing	Pane	MIG thickness
Double glazing	all panes are unstressed float glass	±1.0 mm
	at least one pane is made of laminated glass, ornamental glass or is not unstressed glass	±1.5 mm
Triple glazing	all panes are unstressed float glass	±1.4 mm
	at least one pane is made of laminated glass, ornamental glass or is not unstressed glass	+2.8 mm/−1.4 mm
[a] If a glass component has a nominal thickness of more than 12 mm for unstressed or toughened glass, or a nominal thickness of 20 mm for laminated glass, the manufacturer of the laminated insulating glass should be consulted.		

Table 20: Thickness deviation limits for multi-pane insulating glasses (DIN EN 1279-1:2018-10)

8.3. DIMENSIONAL TOLERANCE / OFFSET

8.3.1. SIZE TOLERANCES

The limit deviations of the length dimensions correspond to those of the preliminary products plus the permissible offset.

8.3.2. OFFSET FOR RECTANGLES

The measured values of width and height must not deviate from the nominal values given by more than the tolerances specified in the following table (DIN EN 1279-1: 2018-10). The offset of the washers must not be more than the values given in the following table (DIN EN 1279-1: 2018-10).

Double/triple MIG	tolerances for W and H offset	Offset
all panes ≤ 6 mm and (W und H) ≤ 2 000 mm	±2 mm	≤ 2 mm
6 mm < thickest pane ≤ 12 mm or 2 000 mm < (W or H) ≤ 3 500 mm	±3 mm	≤ 3 mm
3 500 mm < (W or H) ≤ 5 000 mm and the thickest pane ≤ 12 mm	±4 mm	≤ 4 mm
1 pane > 12 mm or (W or H) > 5 000 mm	±5 mm	≤ 5 mm
The thicknesses are nominal thicknesses.		

Table 21: Dimensional tolerances of multi-pane insulating glasses (DIN EN 1279-1_2018-10)

8.3.3. OFFSET WITH SPECIAL SHAPES

Edge length	Offset
< 2000 mm edge length	2.0 mm
2001 - 3500 mm edge length	3.0 mm
> 3500 mm edge length	4.0 mm

Table 22: Offset for insulating glass – special shapes

8.4. COATING EDGE-DELETION

If the potential coating of the glass makes this necessary, the coating in the edge area of the insulating glass unit is usually removed by grinding. This serves to prevent layer corrosion from the edge and to ensure the transmission of force between the second sealing stage and the glass. As a result, processing traces may become visible, which means that this glass surface differs from the area that has not been de-coated. This also applies to glass protrusion with step insulating glass.

The width of the edge de-coating is usually 10 mm ± 2 mm. The width of the edge de-coating must be adjusted accordingly for insulating glasses with, for example, an increased contact of the second sealing stage on the glass due to the design. The tolerance of ± 2 mm also applies to a matched width of edge de-coating.

If the glass edge is not covered, a visually recognisable coloured, e.g.

reddish line may appear at the contact surface of the first sealing stage and the coating. This is caused by the interference system of the coating. This optical appearance is irrelevant for the functionality of the edge seal, because no force transmission is required at the contact surface of the first sealing stage and the glass.

8.4.1. CUT TO SIZE PANE - COATING

In the case of fixed dimension coatings, it cannot be ruled out that coating residues may occur on the glass edges and on the outside of the insulating glass. These residues are due to technical reasons and cannot be avoided and are therefore state of the art. The residues corrode and weather by themselves after some time. An alternative to edge de-coating for fixed dimension coatings is to mask the area intended for edge de-coating.

8.5. SPACER

Spacer profiles with plugged and bent corner systems as well as prefabricated, flexible spacers or a hot-applied spacer matrix are used, which can vary depending on the production process and material properties. Depending on the manufacturing technique, gas filling holes may be visible in the spacer. The colour of the spacer influences the reflection behaviour in the edge area. Plugged spacer connections can appear open up to 2 mm; this is production-related and therefore no grounds for complaint.

The legal requirement for the traceability of building products is usually fulfilled by a marking on the spacer in the case of multi-pane insulating glass. Colour, size, type and attachment may vary due to manufacturing technology.

8.6. INSULATING GLASS WITH ALARM FUNCTION

VdS Recognition
Insulating glasses that emit an alarm generally require an Association of German Property Insurers (VdS) approval. arcon has been approved by the VdS under the approval number G 114002.

Functionality
The alarm glass consists of toughened safety glass. A conductor loop (alarm claw) is printed on one surface of the glass before thermal tempering. This is burned into the glass surface during the tempering process. The electrically conductive alarm claw is integrated into the alarm system.

If force is applied beyond the load limits, the alarm glass will break into a multitude of small fragments. The electrically conductive alarm claw is interrupted several times. As a consequence, an alarm is triggered in combination with the alarm signalling system. The alarm is only possible in combination with an alarm signalling system.

Requirements for glazing and connection of the alarm glasses
Since there is currently no standard for alarm glass or burglar alarm systems, the following requirements are based on the “Guideline for Burglar Alarm Systems – Planning and Installation” of the Association of German Property Insurers in Cologne.

- The arcon alarm panes must not be placed on the cable connection points during storage, transport or installation.
- The arcon alarm insulating glasses must be glazed in accordance with the applicable glazing guidelines of the glazier trade.
- arcon alarm insulating glass may only be glazed in glazing systems with a ventilated, sealant-free rabbet area. This also applies to wooden windows.
- The glazing systems must comply with Stress Group Vf 5 of the Rosenheimer tables. (e.g. double-sided glazing tape with sealant or profile or pressure glazing systems or mixed systems of the two).
- All sealing materials must be compatible with the materials in contact and be electrically non-conductive.
- The TSG alarm pane must always be installed on the attack side.
- Pane marking must be observed.
- Before and after glazing, each arcon alarm pane must be checked for proper function by measuring the electrical resistance of the alarm claw and comparing it with the resistance value on the sticker. During the test it is to be checked and ensured that all 4 pins are present in the connector, are not bent or otherwise damaged.

- The installation of the alarm glasses must be carried out in such a way that they are difficult to remove from the outside (glass retaining strips inside). If this is not possible, it must be ensured that removing the glasses leads to the alarm.

- Alarm glasses must – as far as possible – be held on all sides. In individual cases, any exposed glass faces must be monitored electrically for access using auxiliary tools.
- All cable connection points provided by the customer must be protected against moisture. The connection of the connection cable with the extension cable in the facade area is carried out with a flat plug connection, which, if realised properly, provides reliable protection against the effects of moisture. The plug or cap must be removed before the plug and socket are joined together. After joining the flat plug connection, make sure that the locking device attached to the socket engages in the plug.
- Make sure that the upper corner block is not in the area of the alarm loop. With swing or turn/tilt sashes, the alarm claw should therefore be planned on the hinge side from the outset.
- In glazing systems where vapour pressure equalisation to the outside is not possible for design reasons (e.g. roof glazing), it is essential that the alarm claw is placed in one of the upper corners.
- The alarm claw may be installed in the corners of arcon alarm insulating glass. The position of the alarm claw must be specified when ordering.
- The rabbet clearance should be at least 5 mm to prevent the cable from being bent sharply. At the insulating glass edges where the alarm claw is positioned, the glass rabbet height must be at least 20 mm so that the spacer from the insulating glass does not protrude into the clear window area. At these edges, the visible height of the edge seal is approx. 15 mm (with alarm claw).

Basic requirements and installation instructions can be found on the label of each tested alarm glass pane.

← Bitte übersetzen

Figure 22: Label for tested alarm glass panes

The following points must be observed for cable installation undertaken by the customer:

- The connection points of arcon alarm glasses must not be subjected to mechanical stress.
- When passing the cable through frame profiles, the cable must be protected from damage (e.g. by cable bushings).
- The room-side cable ducting in the frame profile must be sealed.
- Cable routing must be carried out in such a way that subsequent cable damage caused by screws, crushing etc. can be ruled out.
- The total resistance of all alarm claws per primary line (including line resistance) must not exceed 150 % of the resistance change required to trigger the alarm.

Electrical characteristics
The electrical connection is integrated in the edge seal and is provided with an approx. 30 cm long four-core round cable with a moisture-protected flat plug (IP 67).

Cable resistance of alarm claw: 4.5 Q ± 1.5 Q
(incl. connection cable of 30 cm
and an extension of 1.5 m)

Insulation resistance:> 10 MQ

8.7. VISUAL QUALITY OF MULTI-PANE INSULATING GLASS

According to DIN EN 1279-1:2018-10, appendix F

8.7.1. GENERAL

This chapter applies to the assessment of the visual quality of multi-pane insulating glass made of glass components according to section 5.2 of DIN EN 1279-1:2018-10.

The requirements for the optical and visual quality of glass components must be taken from the relevant European standards.

Tables 23-25 show the maximum permissible defects per multi-pane insulating glass unit and the defects that apply specifically to this unit. These tables must not be used for multiple-pane insulating glass where at least one component is made of ornamental glass, wired glass, wired ornamental glass, drawn flat glass or fire-resistant laminated glass.

The tables cover MIG types A, B and C.

8.7.2. OBSERVATION CONDITIONS

The panes must be inspected in the transparent, not the top, view.

Deviations must not be marked on the pane.

The multiple pane insulating glasses must be observed from the inside to the outside at a distance of 3 m from the glass surface and at a viewing angle as perpendicular as possible to the glass surface for up to one minute per square metre. The assessment shall be made in diffuse daylight (e.g. overcast sky), without direct sunlight or artificial lighting.

Multi-pane insulating glasses which are assessed from the outside must be assessed in the installation condition, taking into account the usual viewing distance, but at least 3 m distance. The viewing angle must be as perpendicular as possible to the glass surface.

Figure 23 defines the following observation areas.

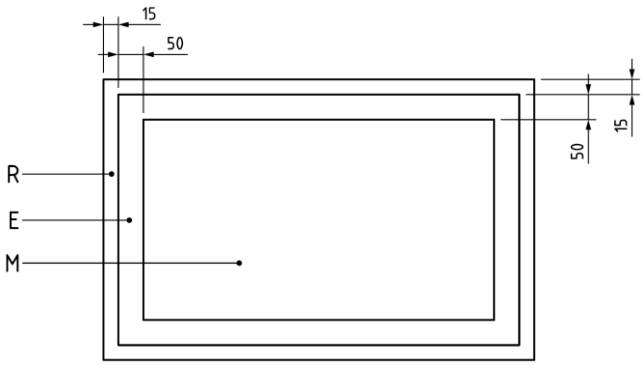


Figure 23: Observation areas

Key:

R = rabbet zone:

Zone of 15 mm, which is usually covered by the frame or, in the case of a frameless edge, corresponds to the edge seal.

E = edge zone:

edge zone of the visible surface, with a width of 50 mm

M = main zone

8.7.3. MULTI-PANE INSULATING GLASS WITH TWO PANES MADE OF MONOLITHIC GLASSES

8.7.3.1. PUNCTIFORM FLAWS

The maximum number of punctiform defects is specified in Table 23.

Zone	Size of the defect (without halo) Ø in mm	Pane size S			
		S ≤ 1	1 < S ≤	2 < S ≤ 3	S < 3
R	all sizes	no limitation			
E	Ø ≤ 1	allowed if less than 3 in each area with Ø ≤ 20cm			
	1 < Ø ≤ 3	4	1 je Meter Kantenlänge		
	Ø > 3	not permitted			
M	Ø ≤ 1	allowed if less than 3 in each area with Ø ≤ 20cm			
	1< Ø ≤ 2	2	3	1< Ø ≤ 2	2
	Ø > 2	not permitted			

Table 23: Permitted number of punctiform defects

8.7.3.2. RESIDUES

The maximum permissible number of punctiform and stain residues is specified in Table 24.

Zone	Dimensions and type Ø in mm	Pane surface S	
		S ≤ 1	1 < S
R	all	no limitation	
E	punctiform Ø ≤ 1	no limitation	
	punctiform with 1 mm < Ø ≤ 3	4	1 je Meter Kantenlänge
	Stain Ø ≤ 17	1	
	punctiform Ø > 3 and stains Ø > 17	at most 1	
M	punctiform Ø ≤ 1	a maximum of 3 is permitted in	
	punctiform 1 < Ø ≤ 3	a maximum of 2 is permitted in	
	punctiform Ø > 3 and stains Ø > 17	not permitted	

Table 24: Permissible number of spot and stain residues

8.7.3.3. LINEAR/EXTENDED DEFECT

The maximum number of linear/elongated defects is specified in Table 25.

Very fine scratches are permissible, provided they do not form an accumulation.

Area	Individual length mm	Individual length total mm
R	no limitation	
R	≤ 30	≤ 90
M	≤ 15	≤ 45

Table 25: Permissible number of linear/elongated defects

8.7.4. INSULATING GLASS UNITS WITH MORE THAN TWO PANES MADE FROM MONOLITHIC GLASS

The permissible number of deviations specified in paragraph 8.7.3 increases by 25&% for each additional glass component (in the case of multiple-pane insulating glass or in a laminated glass component). The number of permissible defects is always rounded up.

Example:

- unit with triple glazing consisting of three panes of monolithic glass: the number of permissible defects according to 8.7.3 is multiplied by 1.25;
- unit with double glazing consisting of two panes of laminated glass, each with two glass components: the number of permissible errors in accordance with 8.7.3 is multiplied by 1.5.

8.7.5. INSULATING GLASS UNITS WITH HEAT-TREATED GLASS

The visual quality of tempered safety glass with and without hot-storage testing and of semi-tempered glass must meet the requirements of the respective product standard when installed in an insulating glass or in laminated glass which is a component of an insulating glass.

In addition to these requirements, in the case of heat-treated float glass, warpage in relation to the total length of the glass edge must not exceed 3 mm per 1000 mm of glass edge length. Greater warpage may occur with square or nearly square formats (up to 1:1.5) and with single panes with a nominal thickness of less than 6 mm.

8.7.6. EDGE DEFECTS

Permissible edge defects are specified for each glass pane component in the respective standards.

External, shallow damage to the edge or shells which do not impair the glass strength and do not exceed the width of the edge seal are permissible.

Inner shells without loose fragments, which are filled by the sealant, are permissible.

8.7.7. TOLERANCE FOR THE STRAIGHT LINE OF THE SPACER

For double glazing, the tolerance for the straight line of the spacer is 4 mm up to an edge length of 3.5 m and 6 mm for longer edge lengths. The permissible deviation of the spacer(s) from the parallel straight glass edge or other spacers (e.g. in triple glazing) is 3 mm up to an edge length of 2.5 m. For longer edge lengths, the permissible deviation is 6 mm.

Figure 24 shows examples of spacer position deviation.

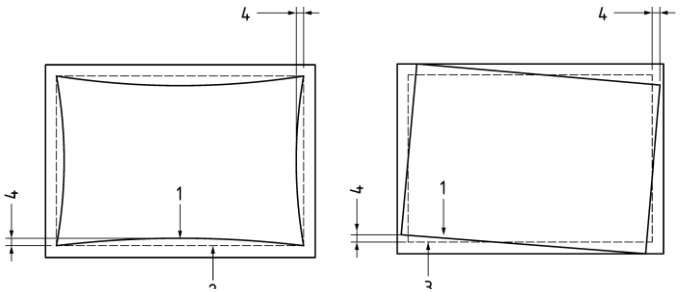


Figure 24: Examples of spacer position deviation

Key:

1 spacer
2 theoretical shape of the spacer
3 theoretical position of the spacer
4 deviation

8.7.8. CURVED INSULATING GLASS

The visual quality of curved insulating glass and its glass components must meet the requirements of ISO 11485-1 and ISO 11485-2.

8.8. FURTHER VISUAL ASPECTS OF MULTI-PANE INSULATING GLASS

8.8.1. GENERAL

There may be some physical effects visible on the glass surface that should not be taken into account when assessing the visual quality. They are not considered defects.

8.8.2. VARIATIONS IN THE COLOUR IMPRESSION

Due to the iron oxide content in the glass, the coating process, the coating itself, variations in glass thickness and the pane structure of the multi-pane insulating glass, variations in the colour impression are possible which cannot be avoided.

8.8.3. DIFFERENCES IN THE COLOUR OF THE MULTI-PANE INSULATING GLASS

In MIG facades containing coated glass, colours can appear in different shades, an effect that may be enhanced when viewed at an angle. Possible causes of colour differences include slight variations in the colour of the substrate to which the coating is applied and slight variations in the thickness of the coating itself. An objective assessment of the colour differences can be made with the help of ISO 11479-2.

8.8.4. INTERFERENCE PHENOMENA

In multi-pane insulating glass made of float glass, interference phenomena can cause spectral colours to become visible. Optical interference occurs when two or more light waves overlap at one point.

These phenomena are perceived as variations in the intensity of the coloured areas which change when pressure is applied to the glass. This physical effect is further enhanced by the parallelism of the glass surfaces. Interference phenomena occur randomly and cannot be avoided.

8.8.5. SPECIFIC EFFECTS DUE TO BAROMETRIC CONDITIONS

A multi-pane insulating glass encloses a volume of air or other gases which is hermetically sealed by the edge seal. The condition of the gas is essentially determined by the height above SL, the atmospheric pressure and the air temperature prevailing at the place of manufacture at the time of manufacture. If the multi-pane insulating glass is installed at a different height above sea level or if the temperature or atmospheric pressure (higher or lower pressure) changes, the panes bend inwards or outwards, causing optical distortion.

8.8.6. MULTIPLE REFLECTIONS

Multiple reflections can occur with varying intensity on the surfaces of the glasses. These reflections are particularly visible when the background viewed through the glazing is dark. This effect is a physical property of all multi-pane insulating glasses.

8.8.7. ANISOTROPY (IRIDESCENCE)

Multi-pane insulating glasses with a heat-treated glass component may show visible distortions, which are called anisotropy, see EN 12150-1, EN 1863-1.

8.8.8. CONDENSATION ON THE EXTERNAL SURFACES OF MULTILAYER INSULATING GLASS

Condensation can occur on the outer glass surfaces if the glass surface is colder than the adjacent air.

The extent of condensation on the outer surfaces of a glass pane is determined by the U value, air humidity, air movement and the inside and outside temperature.

If the relative humidity of the environment is high and the surface temperature of the pane falls below the ambient temperature, condensation occurs on the glass surface.

8.8.9. WETTING OF GLASS SURFACES

The appearance of glass surfaces may vary due to rollers, fingerprints, labels, suction cups, sealant residues, silicone compounds, smoothing agents, lubricants, environmental influences etc. This can occur if the glass surfaces are wet due to condensation, rain or cleaning water.

8.8.10. DRYING AGENT IN THE CAVITY

Due to production and processing tolerances, desiccant may get into the space between the panes and collect along the edge. This is a visual imperfection but cannot be claimed as a defect of the glass. The function of the multi-pane insulating glass is still given. Any claims in regard to this matter will be rejected.

9. SYSTEMS IN INSULATING GLASS UNITS

9. SYSTEMS IN INSULATION GLASS UNITS

Guidelines for the assessment of visual quality for systems in multi-pane insulating glass.

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9.1.1. SCOPE OF APPLICATION

This guideline applies to the assessment of the visual quality of movable and rigid systems installed in the inter-pane cavity, such as lamellas, foils, light-deflecting profiles, pleated blinds, etc., with all visible parts. The assessment of MIG is carried out in accordance with the relevant guidelines and standards.

9.1.2. ASSESSMENT

The visual quality of the installed systems is assessed in accordance with the following inspection principles and criteria such as viewing angle, viewing areas, admissibility and the respective special features of the individual systems. The remaining room-side visible surface of the integrated systems in the installed state is evaluated.

9.1.3. UNITS

This guideline considers the functionality of one independent unit. It is not considering or to evaluate the uniform movement of numerous elements.

9.1.4. FURTHER GUIDELINES AND STANDARDS

- DIN 18073 “Roller shutters, sun control and darkening systems in the construction industry”
- EN 13120 “Shutters inside – performance and safety requirements”

9.2. INSPECTION PRINCIPLES

Preliminary remarks

- Noises caused by the opening or tilting of windows and by travelling movements have technically origins and do not constitute a defect.
- Evaluation criteria only apply to systems that are aligned in a horizontal or vertical position.
- The area between the lamellas and the spacer is not a visual criterion.
- Signs of wear and tear are not the subject of visual quality.

9.2.1. LAMELLA SYSTEMS

For lamella systems, the inspection is based on the visible surfaces of the lamellas, the head profile and the foot or end profile, and the position of the lamella in the upper and lower end position (no partial surfaces, such as half-lowered hangings). In the case of laterally held systems (e.g. via tensioning cords), the lamella profiles are assessed with regard to the surface and the lateral holders.

9.2.2. FOIL SYSTEMS – PLISSE SYSTEMS

In the case of foil and plisse systems, the surfaces and their appearance with regard to the formation of waves and wrinkles in their upper and lower end positions, as well as the individual parts, must be assessed.

9.2.3. INSPECTION CONDITIONS AND VIEWING DISTANCES

Inspection conditions and viewing distances from the specifications listed in product standards for the glazing under consideration may deviate from these and are not taken into account in this guideline. The inspection conditions described in these product standards often cannot be observed on the object.

Product	Viewing angle	Distance from the viewing area
Shutter system	90°	1.5 m
Folio system*	90°	2.0 m
Light deflecting system*	90°	2.0 m
Laterally clamped lamella system	90°	1.5 m

Table 26: Inspection conditions for systems with diffuse reflection

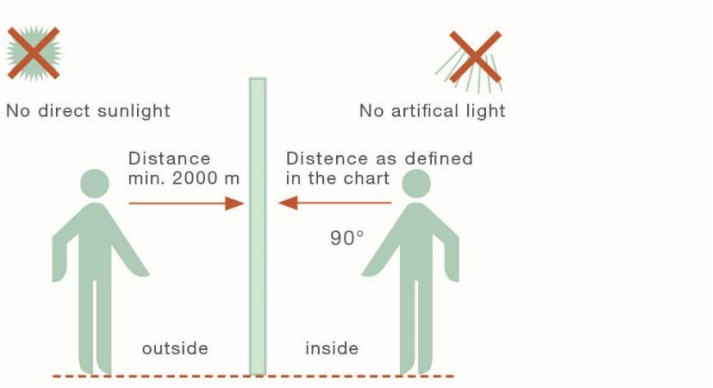


Figure 25: Inspection conditions and viewing distances

9.2.4. VIEWING AREAS

The area to be assessed is divided into

- Edge zone = 10% of the edge area from the respective width and height dimension (less strict assessment)
- Main zone = remaining visible area from the centre of the area to the edge zone (strict assessment)

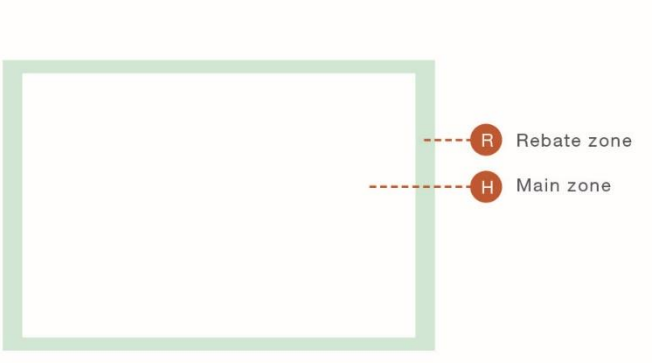


Figure 5: Viewing areas

9.3. PERMISSIBILITIES FOR LAMELLA SYSTEMS

9.3.1. DETECTABLE SURFACE DEVIATIONS

9.3.1.1. ABRASION

Due to the movement of the lamellas when turning and when moving up and down, technically induced abrasion in the area of the guide rails, tension cables, elevator cords and belts etc. cannot be excluded. The evaluation of such residues or discolouration is carried out according to tables 31, 32, 33 and 34.

Assessment criteria	Assessment
Discoloration of the lamella ends due to abrasion	according to table 30
Abrasion marks in the inter-pane cavity	conditionally permissible according to Table 30
Residues: e.g. butyl on the lamellas	conditionally permissible according to Table 30

Table 26: Lamella abrasion

Examples	
	
	

Table 27: Lamella abrasion – example

Colour of the lamellas Colour of the staining	Contrast
	0 – 20%
	20 – 40%
	40 – 60%
	60 – 80%
	80 – 100%

Table 28: Lamella staining

	Contrast				
Depth of	0 – 20%	20 – 40%	40 – 60%	60 – 80%	100%
t ≤ 5 mm	OK	OK	OK	OK	OK
t ≤ 15 mm	OK	OK	OK	OK	no
t ≤ 25 mm	OK	OK	OK	no	no
t ≤ 35 mm	OK	OK	no	no	no
> 35 mm	no	no	no	no	no

Table 29: Lamella discoloration contrast

9.3.1.2. SPOTS, INCLUSIONS, STAINS, COATING DEFECTS

Shall be evaluated as follows.

Permissible per m^2 of surface area:

- Edge zone: max. 4 units Ø ≤ 3 mm
- Main zone: max. 2 units Ø ≤ 2 mm

9.3.1.3. SCRATCHES IN THE MAIN AND EDGE ZONES

Hairline scratches barely visible and not accumulated are permitted, if the sum of their individual lengths is not greater than 30 mm. The maximum individual length of scratches is 15 mm.

9.3.2. PERMISSIBLE LAMELLA OFFSET

- The lamella offset is assessed by the two maximally offset lamellas of a pane.
- The slat offset is only evaluated for one-piece hangings. This guideline is not valid for split hangings (two hangings in one pane).

Pane width		Maximum lamella offset
by	until	
0 mm	1000 mm	6 mm
1001 mm	2000 mm	8 mm
2001 mm		10 mm

Table 30: Lamella offset

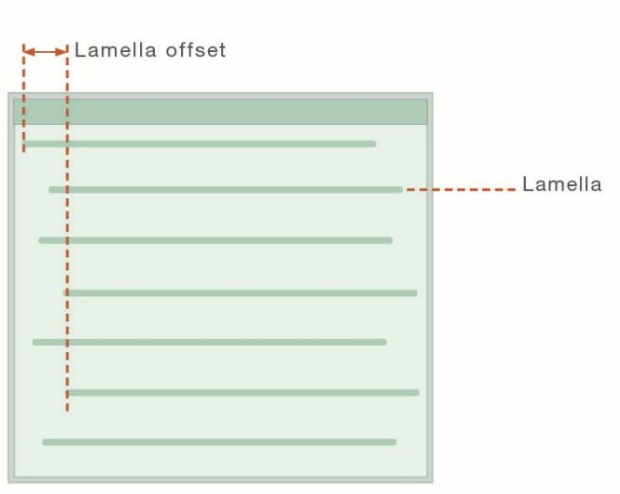


Figure 6: Lamella offset

9.3.3. DEVIATION FROM PERPENDICULARITY/BIAS

The maximum permissible deviation A from perpendicularity in the upper and lower end position is 6 mm per metre, lamella length L, but not more than 15 mm.

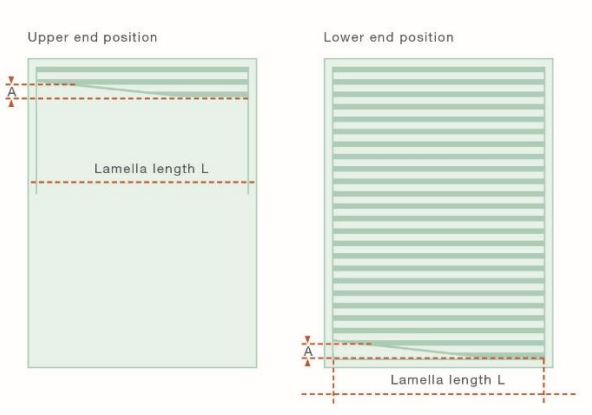


Figure 7: Skewed lamella hanging

9.3.4. PERMISSIBLE DEVIATION FROM THE SHAPE

9.3.4.1. PERMISSIBLE SKEWING/DISTORTION

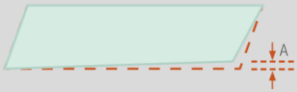
Skewing/distortion (EN 13120)	
 Angular deflection V between one end of the lamella and the other end	2 mm/m
Local distortion	permissible in the area of the press cut

Table 31: Lamella skewing/distortion

9.3.4.2. PERMISSIBLE DEFORMATION

The assessment of lamella deflection is made with them in a closed hanging position

Deformation D (EN 13120):		
 bar: 4 mm Lamella (measured in a closed hanging position)	Length of the lamellas in m	Maximum values of deflection of lamellas in mm
	L ≤ 1.5	5
	1.5 < L ≤ 2.5	10
	2.5 < L ≤ 3.5	15
	L > 3.5	20
Lamella camber C (EN 13120):		
	L = length of the lamella C =1/2 L2	

Table 32: Lamella deflection

9.3.5. PERMISSIBLE DEVIATION IN THE CASE OF INCOMPLETE TURNING OF LAMELLAS

2% of the total number of lamellas. The lamellas may get stuck when they move down so that they only fold into the intended position when the lamellas are turned. Lamellas getting stuck on an ongoing basis is not permitted.

9.3.6. MINIMUM CLOSING ANGLE

The closing angle of lamella systems must correspond to the system description. The minimum closing angle should be 45° unless otherwise specified.

9.3.7. UNEVEN LIGHT TRANSMISSION

Irregular light passages between the lamellas are permissible,

- as long as these are attributable to tolerances of the individual components as specified,
- the other blinds' tolerances are observed

Uneven light transmission can be caused by, among other things

- uneven deflection of individual lamellas
- Closing angle tolerances

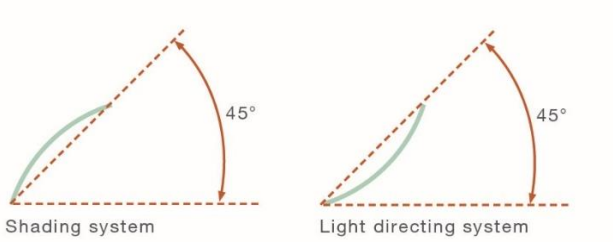


Figure 8: Uneven light transmission

9.3.8. CLOSING ANGLE TOLERANCES IN THE AREA

Assessed are:

- the average value of 3 consecutive lamellas
- for hanging heights 90%, 50% (centre), 10%

The maximum angular deviation in relation to the centre of the hanging may be:

Systems	up to a height of:	from a height of:	Tolerance
Shading systems	1000 mm		± 8°
		1001 mm	± 12°
Light deflecting	1000 mm		± 10°
		1001 mm	± 12°

Table 33: Closing angle tolerances in the area

9.3.9. ACCURACY OF THE OPENING ANGLE OF LAMELLA SYSTEMS THAT ONLY CLOSE ON ONE SIDE

The assessment of lamella deflection is made with them in a closed hanging position

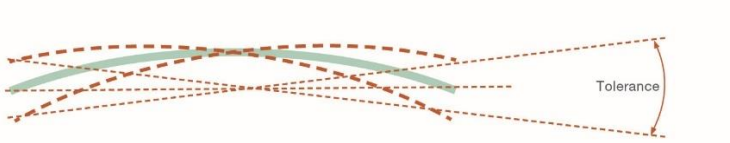


Figure 9: Accuracy of the opening angle of lamella systems that only close on one side

After maximum opening of the lamella system, the lamellas in the middle third of the height of a vertical pane may deviate from the horizontal according to the following table:

Pane height from in mm	Pane height to in mm	Tolerance
	1000	± 7°
1001	2000	± 8°
2001	3000	± 9°
3000		± 10°

Table 34: Tolerance at maximum opening of the lamella system

9.3.10. PIVOTABILITY OF BILATERALLY CLOSING LAMELLA SYSTEMS WITH CENTRAL MOUNTING

The pivotability of the lamellas is in accordance with DIN 18 073 and must be at least 90° around the longitudinal axis.

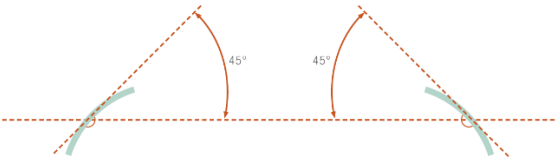


Figure 10: Pivotability of bilaterally closing lamella systems

9.3.11. PIVOTABILITY OF UNILATERALLY CLOSING LAMELLA SYSTEMS WITH CENTRAL MOUNTING

The pivotability of the lamellas is only assessed on the closing side and must be at least 45° around the longitudinal axis.

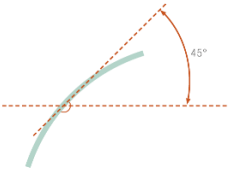


Figure 11: Pivotability of unilaterally closing lamella systems

9.3.12. LAMELLA OVERLAPPING

The individual lamellas must overlap by at least 1 mm at maximum closing angle.

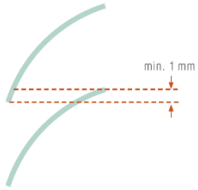


Figure 12: Lamella overlapping

9.3.13. LAMELLA CLOSURE

When the hanging is closed and the viewing angle is horizontal (90° to the hanging), a direct view must not be possible.

9.4. ROLLER BLIND AND PLISSEE SYSTEMS

9.4.1. DETECTABLE SURFACE DEFECTS

(the hanging area to be evaluated is determined according to point 9.2.4)

Edge zone:

1. **Inclusions, bubbles, spots, stains, embossing defects, residues, coating defects etc.**
   Pane area < 1 m2, max. 4 units a ≤ 3 mm pane area > 1 m2, max. 4 units/m2 a ≤ 3 mm

2. **Scratches**
   Sum of individual lengths max. 90 mm individual length max. 30 mm

Main zone:

1. **Inclusions, bubbles, spots, stains, embossing defects, residues, coating defects etc.**
   Pane surface < 1 m2, max. 2 units at 2 mm
   Pane surface < 1 m2, max. 3 units at 2 mm
   Pane surface < 2 m2, max. 5 units at 2 mm

2. **Scratches**
   Sum of individual lengths max. 45 mm individual length max. 15 mm not accumulated.

9.4.2. DEVIATION FROM PERPENDICULARITY

Deviations from perpendicularity are assessed in the following positions:

- upper end position (roller blind/plissee open)
- lower end position (roller blind/plissee closed)

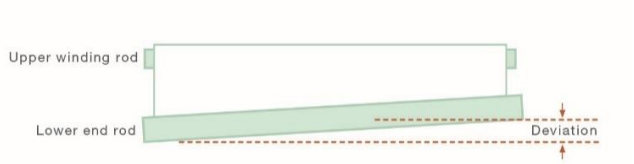


Figure 13: Deviation from perpendicularity

The maximum permissible deviation A from perpendicularity in the upper and lower end position is 15 mm.

9.4.3. WAVE AND WRINKLE FORMATION

Waves and wrinkles are not a defect as long as they do not affect system functioning.

9.4.4. LIGHT TRANSMISSION

- Direct light transmission (passage of light, without obstruction by the hanging etc.) is not permitted.
- Indirect light transmission (e.g. via reflections) is permitted.

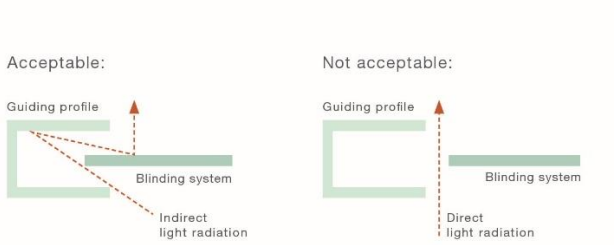


Figure 14: Light transmission

9.4.5. ROLLING IN OF FREE HANGING EDGES

A free hanging edge is a cut edge which is not attached to any other component (end rod, winding tube, etc.).

Rolling in of free hanging edges is permitted if:

- there is no direct light transmission when viewed at right angles.
- the function of the roller blind is not disturbed by this.

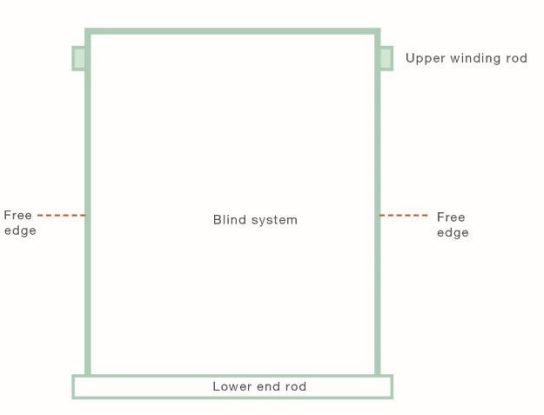


Figure 15: Rolling in of free hanging edges

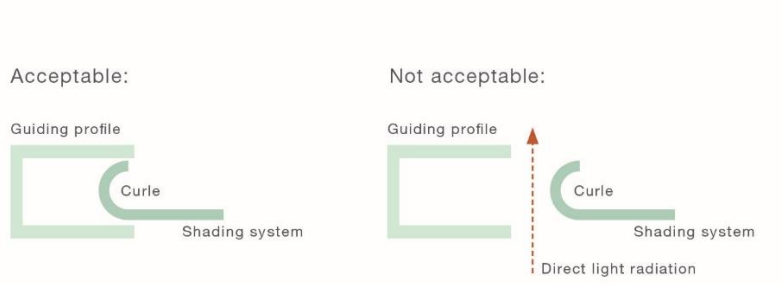


Figure 16: Evaluation of rolling in of free hanging edges

9.4.6. CHANGE IN HANGING IN THE AREA OF GUIDES

Changes to the hanging, such as abrasion in the area of guides, are permitted if the view does not change by more than 20%.

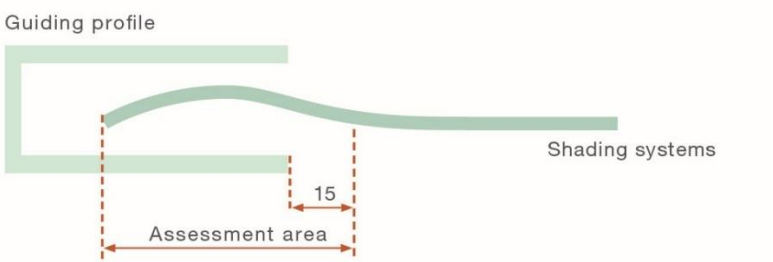


Figure 17: Change in hanging in the area of guides

9.4.7. PLISSEE SYSTEMS

Due to the weight of the fabric, the pleat width changes between the first and last pleats. This phenomenon is more noticeable in hangings with heights of more than 1 m than in smaller hangings. The difference in progression is not grounds for complaint, as it is based on the properties of the fabric. The initial folds naturally tend to flatten slightly, also due to the effect of heat, but this does not affect the folding. The fabric must ensure that the folds collapse properly during every lifting operation.

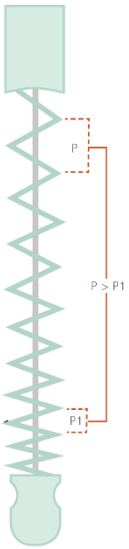


Figure 18: Plissee systems

9.5. GENERAL INFORMATION

This guideline represents an evaluation standard for the assessment of the visual quality of lamellas, roller blinds and plissee systems in MIG. The assessment should generally be based on the assumption that, in addition to the visual quality, the essential characteristics of the product must also be taken into account in order to fulfil its functions.

A synchronisation of several units cannot be guaranteed.

9.6. SPECIAL NOTES

9.6.1. GAP

For technical reasons, a visible gap can occur on the left and/or right of the head profile in all systems. Effects due to temperature-related length changes cannot be excluded and are no ground for complaint.

9.6.2. LADDER CORDS

The individual lamellas are fixed in position by so-called ladder cords. These ladder cords can change their position depending on the system. Furthermore, the unfolding of these ladder cords does not take place consistently.

9.6.3. COVERS

With all systems, covers can be used on the glass surfaces. These covers can consist of enamel or films on glass, for example. They are not subject to evaluation by this guideline and must be considered separately.

9.7. SCOPE OF APPLICATION ISOLAR SOLARLUX® VARIODIRECT

These glazing and processing guidelines only apply to ISOLAR SOLARLUX® variodirect in insulating glass, which is used in a product-compatible manner in window, facade and partition wall systems made of proven and customary materials and profiles that correspond to the state of the art. The material compatibility with adjacent materials must be tested.

Compliance with this guideline is mandatory for the installation of this glazing and is a prerequisite for the warranty.

The generally applicable guidelines for professional glazing in their current version apply. In particular:

- DIN 18 361 – Glazing work
- BF Guideline for the assessment of visual quality for systems in multi-pan insulating glass
- ISOLAR glazing guidelines for insulating glazing
- The recognised rules of technology
- DIN 18 073 – Roller shutters, solar control and darkening systems in the construction industry

The glazing rebates are to be designed in accordance with DIN 18545 Part 1. Drainage of the rebate area of the insulating glass unit must be ensured at all times and under all circumstances.

Otherwise, the provisions of Document 3 of the Institute of Glazier Trades for Glazing Technology and Fixed Construction's Hadamar "Blocking Guidelines" shall apply.

Only by complying with these guidelines is it possible to produce technically/structurally-physically perfect glazing with ISOLAR SOLARLUX® variodirect blinds integrated into the inter-pane cavity. This guideline is a prerequisite for achieving and maintaining the type-appropriate functions of ISOLAR SOLARLUX® variodirect blinds in insulating glass.

This guideline only applies to rooms with normal room temperature and humidity. It does not apply to swimming pools, special damp rooms and spaces with loads and requirements that exceed the usual

level.

All ISOLAR SOLARLUX® variodirect units must be operated in final operation together with the motor control unit and regulated power supply units approved according to ISOLAR® glass specifications in order to achieve a proper function and system-compatible operation. No warranty can be given in case of non-compliance.

9.8. STORAGE AND TRANSPORT

All products from the ISOLAR SOLARLUX® variodirect range must be carefully protected and stored away from dirt, moisture and heat/direct sunlight. In principle, ISOLAR SOLARLUX® variodirect may only be transported in a vertical position.

ISOLAR SOLARLUX® variodirect are delivered with the blinds raised. It must be ensured that during storage and transport the panes are never placed on the plug connection or connection contacts. ISOLAR SOLARLUX® variodirect may only be manipulated with the blinds package raised and in the installation position. Damage to the cable pull system could otherwise occur.

9.9. CONTROL SYSTEM AND POWER SUPPLY

ISOLAR SOLARLUX® variodirect are driven by a 24 Volt direct current electric motor. The power supply is usually provided by a power supply unit. The power supply of 230 V must be provided by the customer and the electrical connections must be made according to local requirements.

9.10. IGU INSULATING GLASS UNITS

ISOLAR SOLARLUX variodirect may only be installed in vertical areas. When using turn/tilt and bottom-hung sashes, a maximum angle of inclination of 3° from the vertical is permissible. A plug connection is required for power supply (connection cable end protrudes laterally by approx. 10 cm). The arrangement of this connection is top right, seen from the outside. The serial number for identification is located, seen from the inside, at the top right (motor side) on the underside of the head profile.

9.10.1. WINDOW / INSULATING GLASS GLAZING

When dimensioning the substructure, special attention must be paid to the deflection limitation of the insulating glasses at the edges of the

pane.

9.11. GLASS REBATE DESIGN

Today's technical knowledge only allows sealing systems with a free rebate space for metal and plastic frames. The glazing rebates must always be designed in accordance with DIN 18 545 Part 1.

For ISOLAR SOLARLUX® variodirect, the following special features must be taken into account:

A sharp kink in the connection cable must be avoided, whereby it must be ensured that the clearance between the glass edge and the rebate base of ≥ does not fall below 7 mm for ISOLAR SOLARLUX® variodirect under any circumstances. The connecting cable and plugs must not impede the vapour pressure equalisation or the water flow in the rebate. The glass recess must not exceed 20 mm. When planning and using special constructions (e.g. passive house windows) with larger glass recesses, the ISOLAR® partner company producing the product must be consulted prior to execution.

9.12. WINDOW SYSTEMS

ISOLAR SOLARLUX® variodirect is suitable for installation in commercially available profile systems. Due to the system there is an edge seal of approx. 14 mm, which must be covered by a profile system. The use of sealing profiles with a correspondingly large lip overlap made of EPDM is recommended.

9.12.1. METAL AND PLASTIC WINDOWS

All glazing systems used must guarantee a perfect long-term seal of the glass rebate under all occurring conditions in order to guarantee its function. The table "Stress groups for the glazing of windows", as well as explanations of it by the Institute for Window Technology in Rosenheim, are considered part of this guideline.

9.12.2. WOODEN WINDOWS

Glazing with a sealant-free rebate space is also prescribed for wooden windows. According to the current state of the art, this is possible for almost all designs. If an "opening" of the glass rebate for vapour pressure equalisation purposes is impossible, the glazing can be carried out with a filled rebate space. However, it should be noted that even the smallest defect or leakage in the frame or glazing

system can cause damage to the insulating glass in the short term because moisture that has penetrated is retained. The warranty does not apply to damage caused by this.

The glazing system must be selected so that a glazing tape is used, at least on the outside. The outer glazing tape must ensure that the glasses are not clamped in the rebate and that no local overstressing can occur in the installed state.

9.12.3. COMPOSITE SYSTEMS

Composite designs such as wood/aluminium, plastic/aluminium, wood/plastic or similar must be provided with vapour pressure equalisation in the same way as the designs described above.

9.13. WINDOW CONTACTS

With turn and tilt units, it is important to ensure that there is always a window contact in the rebate area, which interrupts the current flow when opening. If window contacts are installed for wireless transition between sash and >fixing frame, their installation position must be determined so that no moisture can act on the contacts. It is recommended to place the contacts in the vertical area on the hinge side.

The cables must be laid in loops so that length changes can be compensated.

9.14. CABLE CONNECTIONS

Only connecting cables approved by the ISOLAR® glass partner company are to be used. Use connecting cables approved by ISOLAR® GLAS. It is not recommended to use connecting cables longer than 20 m, as voltage losses may occur. In the case of star-shaped cabling, care should be taken to use cable lengths that are as equal as possible. All cables must not be subjected to any tensile stress.

Contact with standing water must be avoided, cable connections in the rebate area must therefore always be placed in the rebate along vertical glass edges. Connecting strands must not impede the vapour pressure equalisation and the water flow in the rebate.

No fluctuations may be transmitted to the connecting strands of the panes when installed. Cable connections must be properly insulated.

Only acid-free solder must be used for soldered connections. All drilled holes, recesses, edges, corners etc. through or over which cables are laid must be deflashed in order to prevent injury and the resulting interruption of the cable connection.

9.15. POWER SUPPLY

If pressure contacts are used between movable and immovable frame parts for wireless transfer, they must be mounted exclusively in the dry area of the frames.

It is necessary to coordinate the pressure contacts with the control system. ISOLAR SOLARLUX® variodirect can be designed with pressure contacts, whereby the power supply is interrupted when the windows are opened.

9.16. STRUCTURAL ENGINEERING

The static proof of the insulating glasses must be carried out by the client by authorised test engineers. Local wind and climatic loads as well as increased pane temperatures must be taken into account.

Deformation due to wind pressure, or so-called deformation, in relation to the centre of the pane must not exceed 15 mm. Deformation under climatic loads per individual pane, relative to the centre of the pane, may be max. -5.0 mm for SR 32 mm. The glazing and processing guidelines for ISOLAR SOLARLUX® variodirect must be strictly observed.

9.17. INSTALLATION INSTRUCTIONS

9.17.1. SETTING BLOCK INSTALLATION

The glazing units must be installed and blocked professionally, whereby the general guidelines for blocking insulating glasses must be applied. The window units must be designed in such a way that the insulating glasses do not have any load-bearing functions and that no mechanical stresses occur in the glass. The block material used must be compatible with the edge seal of the insulating glass, and, if LSG is used, also with the PVB film laminate.

Blocking must not close the openings for vapour pressure equalisation. The insulating glasses must rest in their entire thickness and the block width must be matched to the total glass thickness. Electrical cables must not be pinched or damaged by the

blocking. The weight of the pane must be perfectly transferred to the frame construction.

ISOLAR SOLARLUX® variodirect must be installed horizontally and vertically in the frame. When installing on site in sashes or fixed glazing, after adjusting and aligning the insulating glass unit, the lamella curtain must be lowered for the liftable and lowerable blind types and then the block must be made so that the hanging and end rod hang freely and symmetrically between the spacers. There must be no contact between the end rod and lateral, vertical spacers in the insulating glass. During commissioning, it must be checked when moving up and down and it must be ensured that the distance between the end rod and the spacer is evenly distributed to the left and right. Touching the glass during operation can lead to functional restrictions and damage.

9.17.2. CONNECTION

The connectors must be cleaned before plugging in. The processor must pull the connecting cables into the construction or into the empty conduits to be provided by the customer.

Before installing the ISOLAR SOLARLUX® variodirect units, the cables must be checked for damage or short circuits. It must be ensured that the connector plug on the motor-driven blind types is firmly connected to the contacts on the board.

9.17.3. FUNCTION CHECK

The inspection of the blinds must be carried out independently of the mains supply. The blinds must not be connected to controls or a transformer ready for operation. The inspection must be carried out with an independent power supply unit before and after glazing.

The function check may only be carried out at temperatures of > 10 degrees Celsius. When testing and commissioning the blinds at low outside temperatures (<10 °C), the inter-pane cavity must be checked before the blinds are moved or approval must be obtained from the ISOLAR® partner company. A minimum of 23 mm SZR must exist for drive operation with the systems 29 and 32 mm and symmetrical glass construction.

Function check is understood to mean the time at which the ISOLAR SOLARLUX® variodirect unit is first electrically connected after delivery and the blind is moved up or down. The function check must

be carried out a max. of 14 days after delivery with a blind test device (independent, as described above) and must be carried out at the 1st delivery point, in any case before installing the panes.

A warranty claim regarding the function of the blind is only valid if the final inspection form is sent to the relevant ISOLAR® partner company within 14 days of delivery. This accompanying document serves as a basis in case of a complaint. If the blind is not returned to the respective ISOLAR® partner company within the mentioned period, the warranty or liability expires.

After successful inspection of the blind in the finished facade or the installed window at the installation site, the blind is to be left in the lowered state and the lamellas are to be set to transparent if necessary.

In order to avoid the risk of seasonally dependent and undesired adhesion of the lamellas to each other in insulating glasses in new condition, the hanging should not be left permanently (> 7 days) in the gathered condition.

9.17.4. COMMISSIONING IN UNHEATED BUILDINGS

Commissioning at low ambient temperatures i.e. below 10 degrees Celsius, is not permitted. This must be observed especially during the construction phase and in unheated buildings.

10. FIRE-RESISTANT GLASS ISOLAR ARDOREX®

10. ARNOLD-FIRE® FIRE-RESISTANT GLASS

10.1. EDGE SEALANT

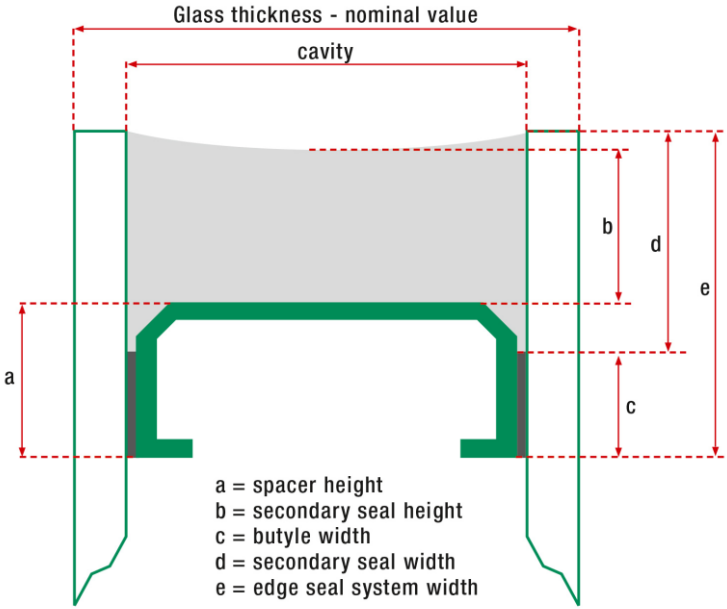


Figure 39: Fire-resistant glass edge seal (schematic)

Requirements for the fire-resistant glass edge seal (2-stage):	
Sealing width e:	13 ± 3 mm
Adhesive overlap b:	> 4 mm
Adhesive width d:	≥ 7 mm
Butyl width c:	≥ 3 mm
Butyl interruptions:	Not permitted, butyl widths ≤ 1 mm are considered
Butyl application:	Not in the SZR, no thread in the adhesive
Adhesive:	Bubble-free, without marbling

Table 35: Requirements for the fire-resistant glass edge seal

10.2. PLANARITY

Due to the use of double toughened safety glass in the production of an Arnold-Fire ® unit, optical distortions may occur. The planarity of these ESG glasses can be influenced by the filling technique.

10.3. SPECIAL VISUAL FEATURES

Bubbles and inclusions can occur especially in the edge area up to 100 mm from the edge of the pane and near the corners.

For the edge zone of 20 mm directly adjacent to the glass recess, it applies that generally production-related visual irregularities in the form of inclusions, streaks, bubbles and inhomogeneity in the interlayer are permissible and do not impair the free view.

The isolated defects and irregularities caused by the filling technique as well as the distortions mentioned above do not affect the free view through the panes and are excluded from the warranty.

Slight distortions in the edge area R (area 10% of the respective width and height dimensions, see guideline for assessing the visual quality of insulating glass, Hadamar guideline) are permissible for this product.

In laminated glass, streaky phenomena similar to transparent threads can also occur in the main zone (H); these are production-related, cannot be completely avoided and do not constitute grounds for complaint.

10.4. EDGE OFFSET AND THICKNESS TOLERANCES

The edge offset of Arnold Fire® is permissible at ± 3.0 mm. The thickness tolerance is permissible at ± 1.5 mm for laminated glass and ± 3.0 mm for insulating glass.

10.5. TEMPERATURE RESISTANCE

The fire-resistant Arnold-Fire® glass as laminated glass as well as multi-pane insulating glass is temperature-resistant from -20°C to 50°C.

10.6. UV RESISTANCE

The specific composition of the fire protection layer offers the full UV and light resistance of Arnold-Fire® without the additional UV protection of UV absorbing PVB films.

10.7. MANUFACTURER'S INSTRUCTIONS

The "Technical Information Sheet for ISOLAR Multi-Pane Insulating Glass" from March 2003 continues to be valid for the assessment of Arnold-Fire®.

These laminated glasses may exhibit intrinsic colours or a cloudy appearance caused by the raw materials, which can become visually perceptible with increasing thickness, over time and under unfavourable light conditions.

Complaints of less than 0.5 mm will not be considered. Existing fault areas (halo) may not be larger than 3 mm.

11. LIST OF FIGURES AND TABLES

This print version was created as of October 2021. Due to technical progress, the data may change. The latest and valid version of our Tolerances Manual is available at www.isolar.de.

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