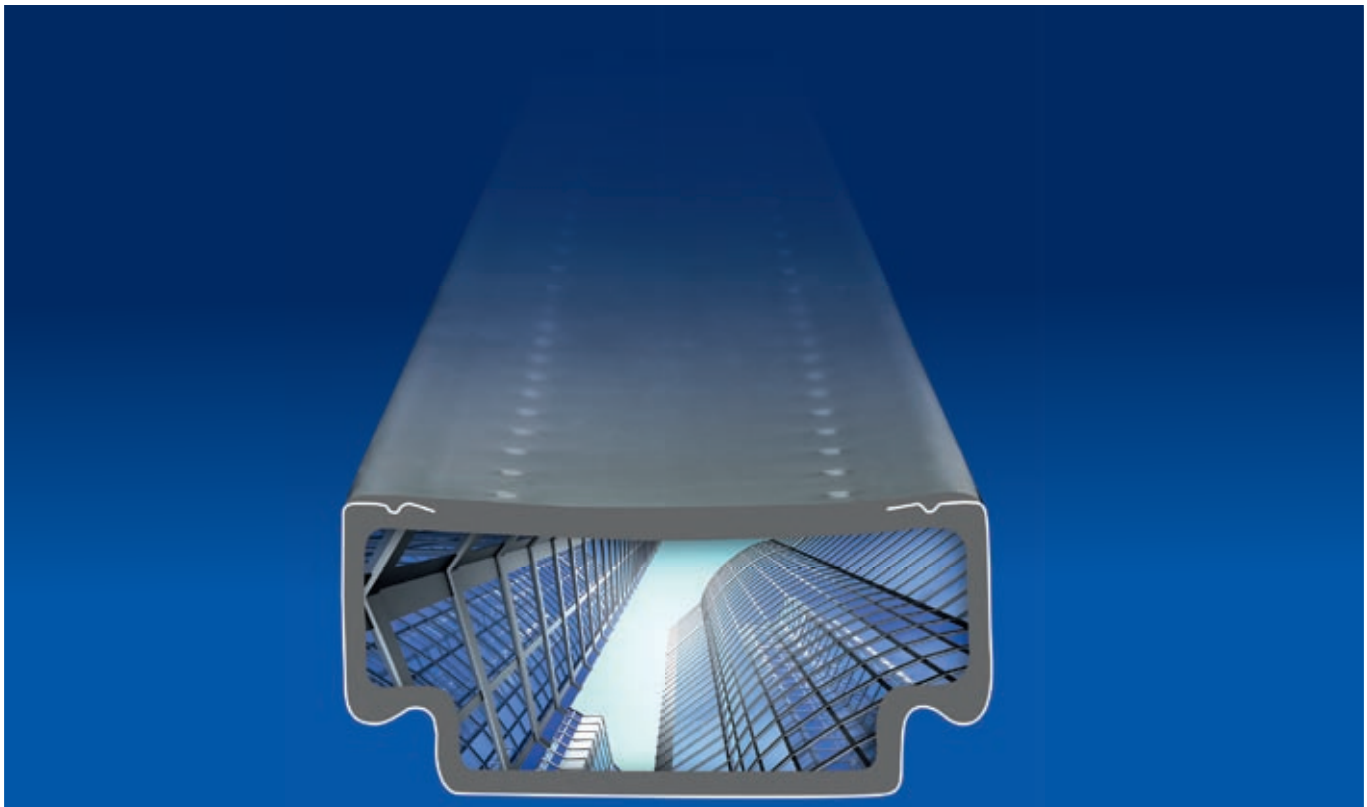


THE WHOLE WORLD OF PERFECT INSULATION ...

TECHNOFORM **GLASSINSULATION**

The company

Technoform Glass Insulation GmbH, a member company of the German Technoform group with its headquarters in Lohfelden, near Kassel, is specialised in the design, development, production and sale of spacers and muntin bar systems for insulating glass units. Always on the lookout for new opportunities to improve insulation quality in and around the window, Technoform Glass Insulation has become a competent partner for architects, planners, float glass manufacturers, glass coaters, insulating glass manufacturers, window fabricators, consumers and anyone else who values energy efficiency.

Hybrid spacers in plastic and stainless steel for extremely stable and gas-impermeable connections are the basis for optimum U-values for insulated glazing. Technoform Glass Insulation is the world leader in this market segment.

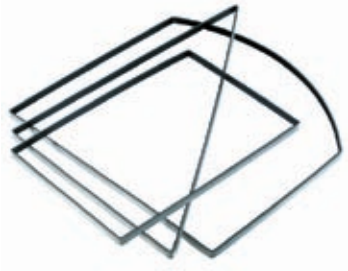
Extensive experience, forward-looking planning, flexibility and custom solutions characterise the performance of the TGI® team. A team that makes its entire expertise available to our customers on a daily basis.

The TGI®-Spacer

TGI®-Spacers are manufactured of stainless steel combined with a high quality plastic polypropylene as a strengthening and insulating material due to its low heat conductivity. The perfect symbiosis of both materials allows only a very low heat transfer while guaranteeing extreme impermeability against gas diffusion and humidity. Therefore, Technoform has designed a spacer for thermal separation that offers low Psi-values for the glass edge, whatever frame material is used. The result is a significant improvement in the thermal transmittance coefficient of windows U_w-value.

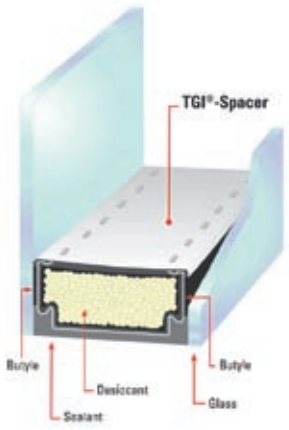
TGI®-Spacers are tested according to European Standard EN 1279-2, -3, -6 and on UV-resistance.

Therefore, high quality and safety are guaranteed for the production of insulating glass units.



The TGI®-Muntin bar

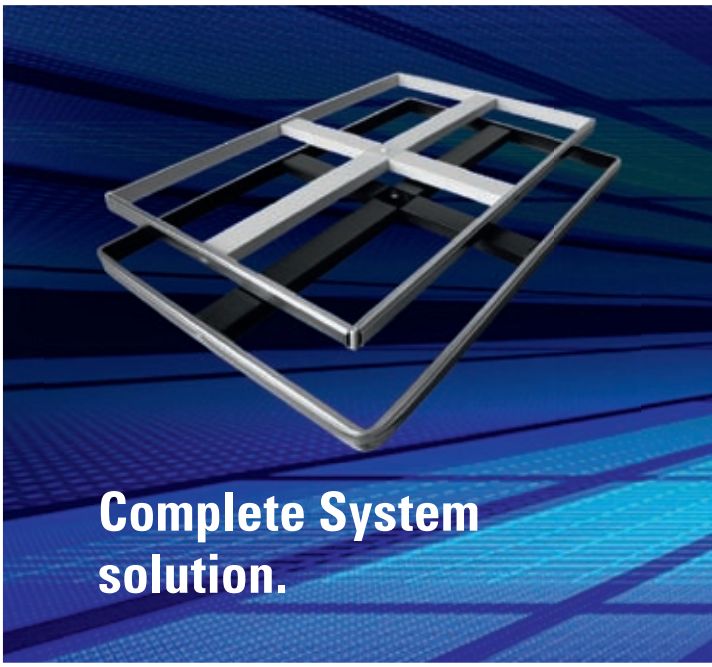
The TGI®-Muntin bar – which can be positioned in the space within the insulating glass unit without any direct contact with the glass – is identical to the TGI®-Spacer in terms of its external appearance. This will give insulating glass manufacturers a complete thermally optimised system which will satisfy the rigorous requirements regarding thermal insulation – both today and in the future.



Processing

TGI®-Spacers can be processed on all standard forming machines. Whether angular or round, any shape can be realised in the frame manufacturing process and procedures. Connectors specially designed and ideally matched for use with TGI®-Spacers can be used in the assembly process.

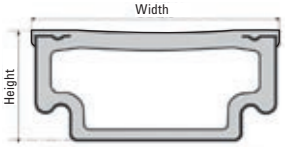
Your innovative partner for the Warm Edge.



Complete System solution.

TGI®-Spacers: Colours

- RAL 7035 | Light grey
- RAL 7040 | Dark grey
- RAL 8003 | Light brown
- RAL 8016 | Dark brown
- RAL 9005 | Black
- RAL 9016 | White

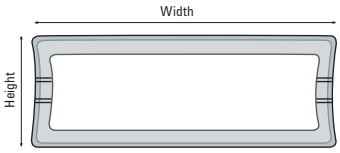


TGI®-Spacers: Sizes

Article		Width	Height
TGI®-Spacer	8 mm	7,5 mm	7 mm
TGI®-Spacer	10 mm	9,5 mm	7 mm
TGI®-Spacer	12 mm	11,5 mm	7 mm
TGI®-Spacer	14 mm	13,5 mm	7 mm
TGI®-Spacer	15 mm	14,5 mm	7 mm
TGI®-Spacer	16 mm	15,5 mm	7 mm
TGI®-Spacer	18 mm	17,5 mm	7 mm
TGI®-Spacer	20 mm	19,5 mm	7 mm
TGI®-Spacer	22 mm	21,5 mm	7 mm
TGI®-Spacer	24 mm	23,5 mm	7 mm

TGI®-Muntin bars: Colours

- RAL 7035 | Light grey
- RAL 7040 | Dark grey
- RAL 9005 | Black



TGI®-Muntin bars: Sizes

Article	Width	Height
TGI®-Muntin bar	21,5 mm	9,5 mm
TGI®-Muntin bar	25,5 mm	9,5 mm
TGI®-Muntin bar	31,5 mm	9,5 mm
TGI®-Muntin bar	21,5 mm	11,5 mm
TGI®-Muntin bar	25,5 mm	11,5 mm
TGI®-Muntin bar	31,5 mm	11,5 mm

$$U_w = \frac{U_f \cdot A_f + U_g \cdot A_g + \psi \cdot l_f}{A_w}$$

U_w = Thermal transmission coefficient, window
U_f = Thermal transmission coefficient, frame
U_g = Thermal transmission coefficient, glass
A_w = Window area
A_f = Frame area
A_g = Glass area
l_f = Length of edge, frame – glass
ψ = Linear thermal coefficient, composite edge

$$T_{oi} = T_{la} + f_{Rsi} \cdot (T_{li} - T_{la})$$

T_{oi} = Inner surface temperature
T_{li} = Indoor air temperature +20 °C
T_{la} = Outdoor air temperature -10 °C
f_{Rsi} = Temperature factor at Rsi R_{si} = 0.20m² K/W

Boundary conditions:

Total window area Aw 1,82 m2
Frame proportion 30% Af 0,55 m2
Glass proportion 70% Ag 1,27 m2
Edge length lf 4,54 m

All technical values have been determined on the basis of the standard guidelines stipulated by the 'Warme Kante' working committee of the Bundesverband Flachglas BF (National Association of Flat Glass Industries), Troisdorf.

TGI®-Spacers: Thermal values in comparison

Stainless Steel 15
PP 0,193

Frame	Wooden window		uPVC window		Aluminium window		Wood/aluminium window	
Double glazing	**2 IG**		**2 IG**		**2 IG**		**2 IG**	
	Aluminium spacer	TGI® Spacer	Aluminium spacer	TGI® Spacer	Aluminium spacer	TGI® Spacer	Aluminium spacer	TGI® Spacer
ψ-Value	0,081 W/mK	0,041 W/mK	0,077 W/mK	0,041 W/mK	0,111 W/mK	0,051 W/mK	0,092 W/mK	0,045 W/mK
U_w Window	1,36 W/m²K	1,26 W/m²K	1,32 W/m²K	1,23 W/m²K	1,53 W/m²K	1,38 W/m²K	1,42 W/m²K	1,30 W/m²K
Temperature factor f_{Rsi}	0,47	0,62	0,51	0,65	0,49	0,65	0,41	0,58
Surface temperature T_{oi} at -10 °C, +20 °C	4,1 °C	8,6 °C	5,3 °C	9,5 °C	4,7 °C	9,5 °C	2,3 °C	7,4 °C

Frame	Wooden window		uPVC window		Aluminium window		Wood/aluminium window	
Triple glazing	**3 IG**		**3 IG**		**3 IG**		**3 IG**	
	Aluminium spacer	TGI® Spacer	Aluminium spacer	TGI® Spacer	Aluminium spacer	TGI® Spacer	Aluminium spacer	TGI® Spacer
ψ-Value	0,086 W/mK	0,040 W/mK	0,075 W/mK	0,039 W/mK	0,111 W/mK	0,046 W/mK	0,097 W/mK	0,043 W/mK
U_w Window	1,10 W/m²K	0,98 W/m²K	1,04 W/m²K	0,95 W/m²K	1,25 W/m²K	1,09 W/m²K	1,15 W/m²K	1,02 W/m²K
Temperature factor f_{Rsi}	0,54	0,70	0,56	0,70	0,57	0,73	0,49	0,67
Surface temperature T_{oi} at -10 °C, +20 °C	6,2 °C	11,0 °C	6,8 °C	11,0 °C	7,1 °C	11,9 °C	4,7 °C	10,1 °C

compliant with Bundesverband Flachglas

TGI®-Spacer: User guidelines

We recommend processing our TGI®-Spacer to comply with the quality regulations of Mehrscheiben-Isolierglas e.V. The system descriptions are to be supplemented in agreement with the appropriate standard institutes. System tests are passed with the sealant materials polysulfide, polyurethane and silicone according to EN 1279-2 and -3. Tests according to EN 1279-6 regarding fogging have been performed for each shade of colour. Further the test according ISO 4892 UV-resistance is guaranteed. Test certificates can be provided at any time.

Storage*

TGI®-Spacers and muntin bars must be stored in dry conditions and may never be subjected to moisture in order to prevent corrosion on the metal surface. Air moisture due to temperature differences (inside/outside) can furthermore cause condensation in the cavity of the spacer, which could lead to a pre-loading of the dessicant.

Handling*

To prevent bending or deformation during handling, the TGI®-Spacer may only be removed from the palette in a bundle and handled by two people. The packing film may only be removed after placing the bundle on the delivery table.

Cutting*

A suitable hard metal saw blade must be used to cut TGI®-Spacers and muntin bars to length; this also minimises waste.

Assembly of frames

Straight connectors in steel and plastic and plastic corner connectors are matched to the geometries of TGI®-Spacers. Care must be taken to ensure that butylisation in the corners is carried out in a manner that ensures impermeability (see butylising). The connectors are available from Technoform Glass Insulation GmbH, as well as from Kronenberg or Cera.

Bending of frames*

TGI®-Spacers must be kept dry and free from grease and dust. The TGI®-Spacer can be bent in a cold state on all standard benders. Suitable machines and supplementary tooling should be obtained from machine manufacturers. An additional angle of approx. 10° to 12° should be set.

Filling of desiccant*

The TGI®-Spacer can be filled automatically. The suitability of the drill to be used for preparation for desiccant filling must be checked. The hole has to be drilled completely through the wall of the spacer to ensure sufficient desiccant per frame. If frames of the TGI®-Spacer are in width 12 mm and larger, two sides of the frame should be filled. In the case of widths smaller than 12 mm, the filling of all four sides is recommended. On black spacers, any residual desiccant dust will be visible and must be removed before the final sealing of the insulating glass pane.

Butylisation*

TGI®-Spacers can be butylised on manual and automatic butyl extruders. Because the bending on large TGI®-Spacer frames is higher than on comparable aluminium-spacer frames, larger frames should be butylised manually. Prior to butylisation it must be ensured that sufficient area at the edge of the glass is de-coated to guarantee that the butylisation is in contact with the de-coated area of the glass even in the corner areas. Butylisation must be applied evenly on both sides and must be free from gaps in the corner areas. Butylisation thickness after pressing must be > 0.3 mm in the corner areas.

Gas-filling

Filling with gas-filling presses or subsequently through drill-holes.

Sealant materials

The adhesion of conventional sealing substances has been tested on our TGI®-Spacer. Using the sealing substances polysulfide, polyurethane and silicone, a cohesive break was found after storage at 53° C and 100% relative humidity over a period of 100 hours. Test results can be supplied on request. Further information on the processing of our TGI®-Spacer with proprietary sealing materials can be obtained from the appropriate sealing material supplier.

Sealing process*

Sealing can be performed by sealing machines or manual application. To ensure the gas impermeability of the edge system, the edge sealing has to consist of a minimum of 3 mm of a secondary sealing material. There should not be any air locked either in the material or on the mating surfaces.

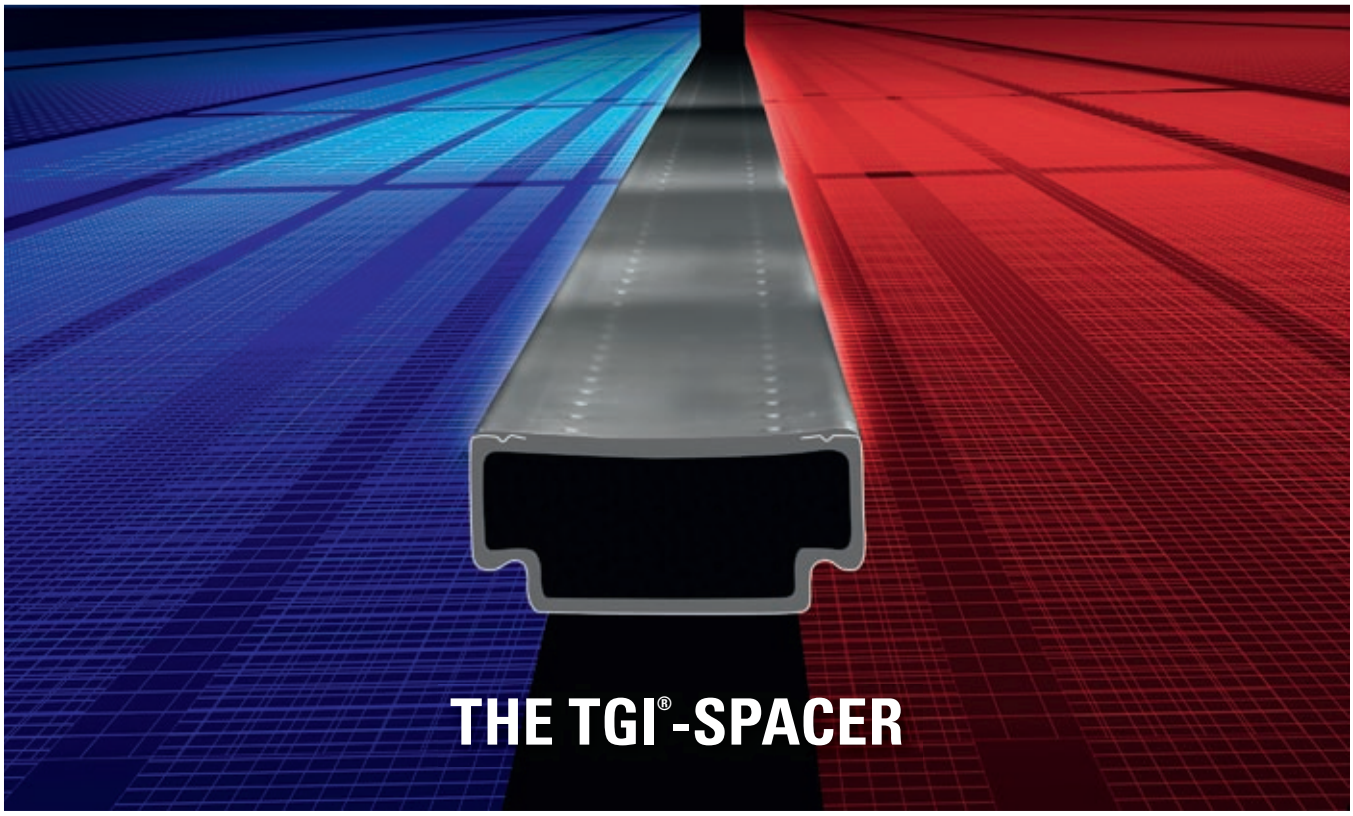
Installing muntin bars*

For the application of muntin bars it is possible to use conventional compressed-air clips. If pressure is too high, there is a risk of a break in the plastic part of the spacer. Therefore air pressure needs to be reduced. The tested air pressure ranges at a level of 3 bar. Connecting plugs which lie flat against the TGI®-Spacer are still to be used as the cavity created when moulding is applied increases the risk of splitting.

*Differences to conventional aluminium-spacers

TGI®-Spacer: Specifications and tests

Properties	Unit	Guideline	Test-method	Inspection-method	Documentation
Checks on the product					
Colour	RAL-colour	9005, 7035, 7040, 8003, 8016, 9016	Visual after RAL pattern plates	Every production	TGI®
Measurements	mm	See drawing	Caliper	Every production	Control card
Perforation	–	Gateway	TGI® pressure test instruction PA 03.6TGI04	Every production	Control card
Adhesion from the second sealant to the metal part of the spacer	min	> 10 min	EN 1279-6	Every new metal foil batch	TGI®
Material entrance tests plastic material					
PP Homopolymer Melt Flow Rate (230 °C-2,16 kg)	g/10 min	3,0 bis 4,0	ISO 1133	On every delivery	Test certificate supplier
Talcum Melt Flow Rate (230 °C-2,16 kg)	g/10 min	3,0 bis 4,0	ISO 1133	On every delivery	Test certificate supplier
PP Copolymer Melt Flow Rate (230 °C-2,16 kg)	g/10 min	0,7 bis 1,00	ISO 1133	On every delivery	Test certificate supplier
IR-spectrum	–	–	CSTB le Document Technique d' Application (DTA) Rèfèrences Avis Technique 6/07-1733	–	TGI®
Thermal-gravimetric analysis	–	–	CSTB le Document Technique d' Application (DTA) Rèfèrences Avis Technique 6/07-1733	–	TGI®
Fogging PP-granular material	mg	G < 2,0 mg	DIN 75 201 B	At new materials	TGI®
UV-resistance	–	Visual inseption discoloration 5 years	ISO 4892-2	At new materials	TGI®
Material entrance tests stainless steel					
Elongation	%	min 40	DIN 53 504	On every delivery	Test certificate
Tensile strength	N/mm	600 - 800	DIN 53 504	On every delivery	Test certificate
Wall thickness metal foil	mm	0,1	Outside micrometer	On every delivery	TGI®
Adhesion secondary sealant	–	Cohesion fracture	TGI® test instruction PA 03.6TGI01	Every new metal foil batch	TGI®
Thermal conductivity Stainless steel type 1.4301	W/mK	15	EN 10088-1	When changing the type of metal	TGI®
Standardise checks at the Iso glass					
Fogging test unit	–	Visual inspection film	EN 1279-6 at + 60 °C and + 80 °C	When changing the type of plastic	TGI®
Gas loss rate	% / a	Li < 1,00 % / a	EN 1279-3	When changing the spacer type of plastic	TGI®
Humidity absorption	%	Lav ≤ 20, Lm ≥ 25	EN 1279-2	When changing the spacer type of plastic	TGI®



Lower thermal energy transmission

Superior stability

Excellent forming properties

Minimum memory effect

Absolute traceability

Worldwide present ...

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Technoform Group

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