


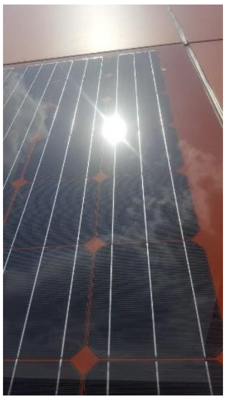

Q-Air – detailed properties

- Seasonal variability of solar heat gain (g – value)
- Centre of glass heat transmission (U_g)
- Light transmission (LT), solar heat gain (g)
- Temperature dependency of the centre of glass U_g value
- Linear heat transmittance value (ψ – values)
- Sound insulation
- EN 1279-2 certificate

July 2019

REFLEX

Q-Air

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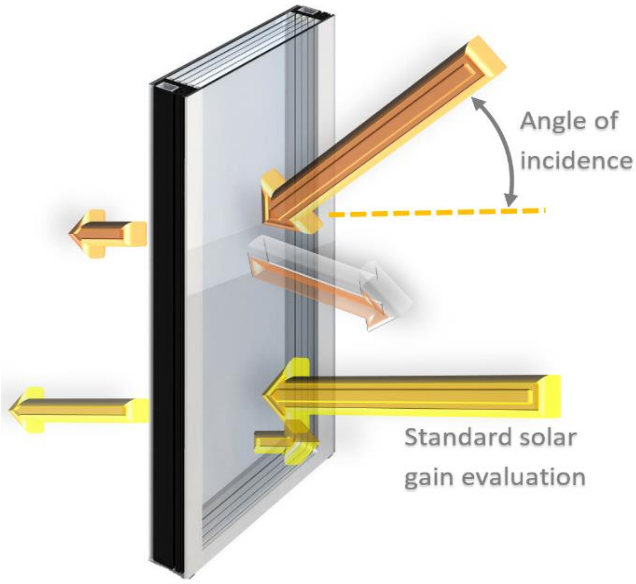
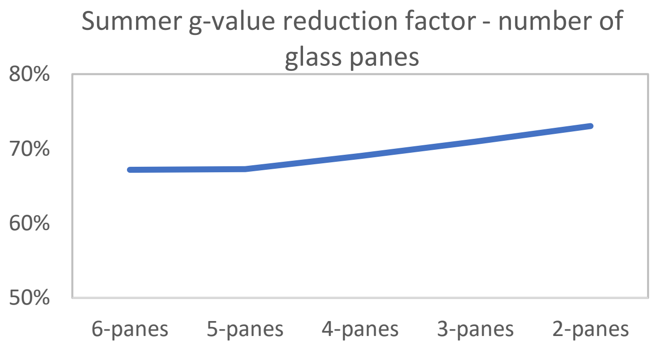
Solar gain seasonal variability



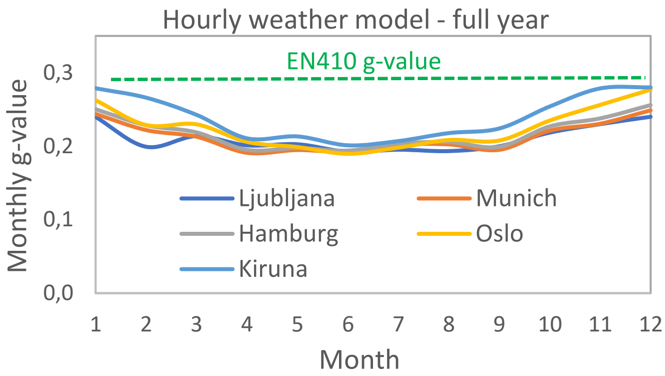
The change in solar heat-gain (g-value) originates in direct solar light being partially reflected at many layers of glass. Transmitted solar energy diminishes more at high angles of incidence as light reflections increase with angle of incidence[1].

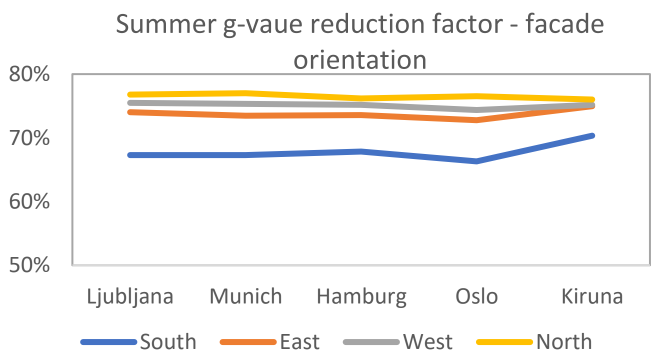


Our research showed that the relative g-value reduction effect is independent of the coated solar control glass selection. It depends, however on the number of glass panes. We model the monthly average g-value reduction effect with a real *hourly weather model* with direct and diffuse (cloud cover) light with accurate incidence angles.

It might come as a surprise that the summer effective g-value according to hourly weather data is also fairly independent of the place (geographical latitude).

For annual cooling demand calculations, we recommend that the *hourly weather model reduction factor* is used for a glass unit having 4 to 6-panes. Solar gain, g-value is thus calculated as:





$$g_{\text{effective}} = RF \times g_{\text{standard EN410}}$$

where:

South façade	Reduction factor, RF = 0,67
East, west, north façade	Reduction factor, RF = 0,75

[1] Kralj, Aleš, et al. "Investigations of 6-pane glazing: Properties and possibilities." *Energy and Buildings* **190** (2019): 61-68. Click HERE to see the Open access article.

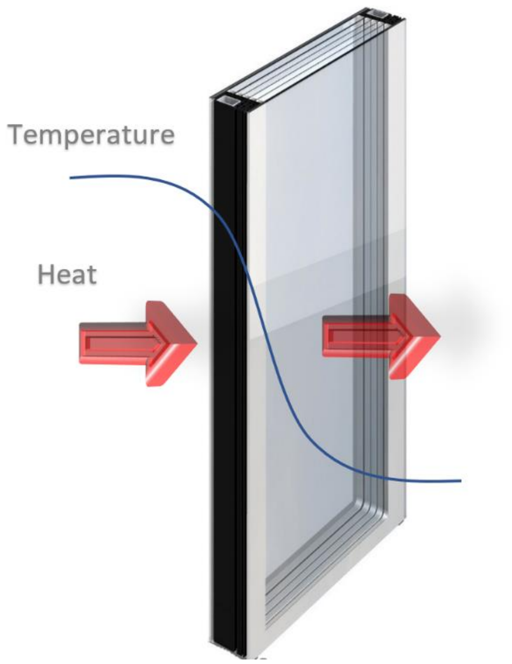
Centre of glass heat transmission (U_g)

Calculation standard:

- EN673:2011

Boundary conditions:

T_i	(internal)	**20°C**
T_e	(external)	**0°C**
h_i		**7.7 W/m²K**
h_e		**25 W/m²K**



Model data synopsis:

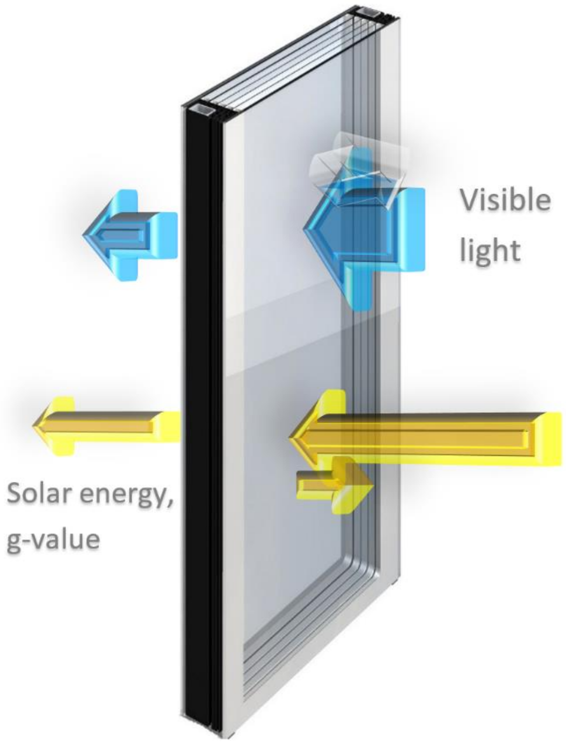
	Glass	Gap	Glass	Gap	Glass	Gap	Glass	Gap	Glass	Gap	Inside Glass
Q-AIR3L					6 mm	18 mm	3 mm	18 mm	3 mm	18 mm	3 mm
Q-AIR3E					8 mm	18 mm	3 mm	18 mm	3 mm	18 mm	55.2
Q-AIR4L			6 mm	18 mm	3 mm	18 mm	3 mm	18 mm	3 mm	18 mm	44.2
Q-AIR4K			8 mm	14 mm	3 mm	14 mm	3 mm	14 mm	3 mm	14 mm	55.2
Q-AIR4G			10 mm	18 mm	4 mm	18 mm	4 mm	18 mm	4 mm	18 mm	55.2
Q-AIR5	8 mm	18 mm	3 mm	18 mm	3 mm	18 mm	3 mm	18 mm	4 mm	16 mm	55.2
Q-AIR5G	10 mm	18 mm	4 mm	18 mm	4 mm	18 mm	4 mm	18 mm	5 mm	18 mm	55.2

Krypton 95% *
Argon 90% *
Air
* Low-E coated glass on at least one side.

Centre of glass thermal transmittance (U_g):

Q-AIR3L	0.36 W/m²K
Q-AIR3E	0.49 W/m²K
Q-AIR4L	0.27 W/m²K
Q-AIR4G	0.35 W/m²K
Q-AIR4K	0.28 W/m²K
Q-AIR5	0.26 W/m²K
Q-AIR5G	0.26 W/m²K

Light transmission (LT), EN410 solar heat gain (g)



	Selectable light transmittance (EN410)	Total solar energy transmittance, g-value [1] (EN410)	Number of glass panes	Vented expansion chamber
Q-AIR3L	0,32 – 0,61	0,20 – 0,35	4	No
Q-AIR3E	0,32 – 0,61	0,20 – 0,35	4	Yes
Q-AIR4L	0,30 – 0,55	0,18 – 0,31	5	No
Q-AIR4K	0,30 – 0,55	0,18 – 0,31	5	Yes
Q-AIR4G	0,30 – 0,55	0,18 – 0,29	5	Yes
Q-AIR5	0,27 – 0,51	0,17 – 0,29	6	Yes
Q-AIR5G	0,27 – 0,51	0,17 – 0,29	6	Yes

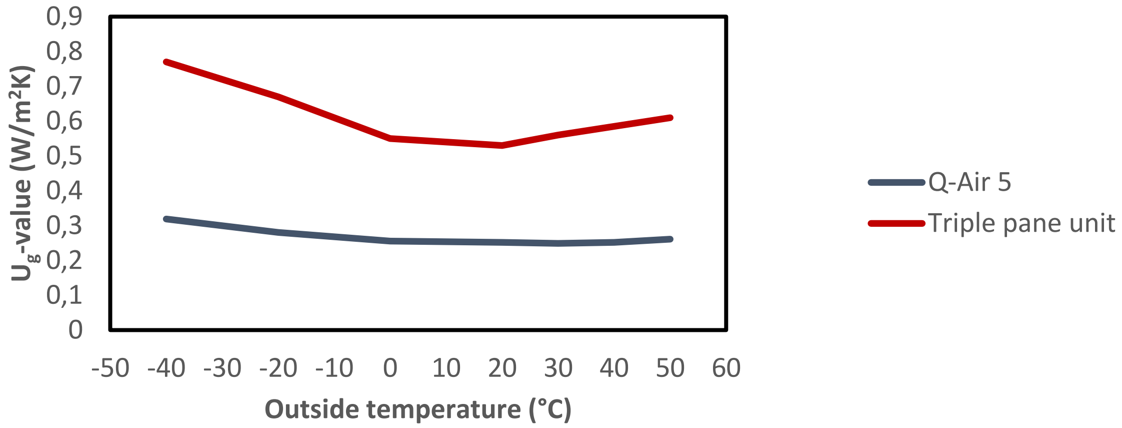
[1] This is the $g_{standard(EN410)}$ value. Total solar energy transmittance of each glazing unit depends on the light transmittance selection.

Data is calculated with LBNL Window 7.7 program.

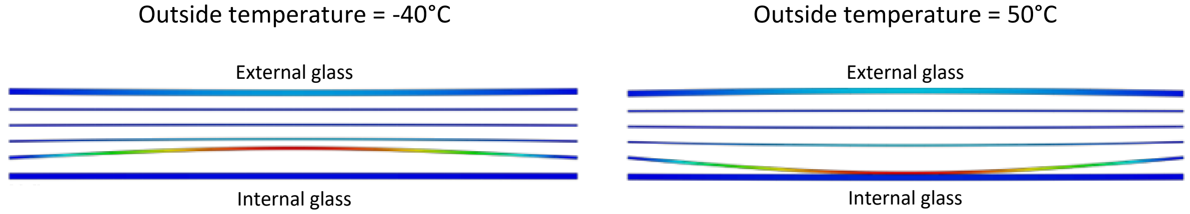
Temperature dependency of the centre of glass U_g value

Heat transfer through the glazed unit consists of heat radiation exchange among the glass panes and gas-gap related heat transfer combining conduction and convection. Q-Air reduces heat transfer using low thermal conductivity gas, which in most applications is argon and through the application of Low-E coatings, which mitigate heat radiation. Sealed glass units' centre of glass U value (U_g) change with exterior conditions.

A simulated (EN 673) glass deflection's dependent U_g for the Q-Air 5 and triple pane unit:



Below you find FEM analysis (Q-Air 5) layout of the glass panes at most extreme points from diagram above:



U_g-values were calculated with Berkeley Lab Window 7.4. according to EN673:2011

$T_{outdoor}$ (°C)	Solar irradiation (W)	U_g (W/m²K) (Temperature depended)	U_g (W/m²K) (Temperature & deflection depended)
- 40	0	0.311	0.319
-20	0	0.271	0.280
0	0	0.254	0.256
20	383	0.261	0.252
30	683	0.264	0.249
40	783	0.268	0.252
50	783	0.271	0.261

Modelled panel size: 750 x 1500 mm;
Boundary conditions for center of glass thermal transmittance calculation: Internal temperature T_i = 22 °C; external temperature T_e = from -40°C to 50°C; internal heat transfer coefficient h_i = 7.0 W/m²K; external heat transfer coefficient h_e = 15.0 W/mK;
External glass: Arcon Sunbelt A70;
Q-Air 5 characteristic: g-value = 0.30; T_{vis} = 0.46; T_{sol} = 0.20; R_{fvis} = 0.20; R_{fsol} = 0.43;

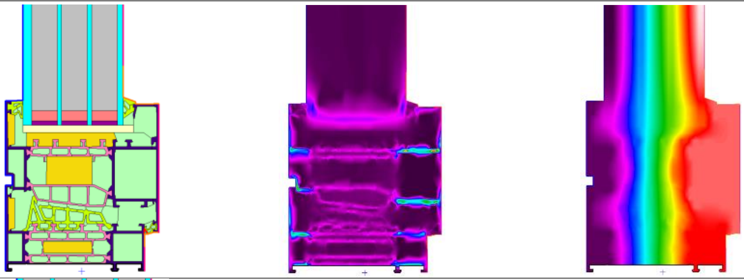
Linear heat transmittance value (ψ – values)

Calculation standard: ISO 10077-2:2012

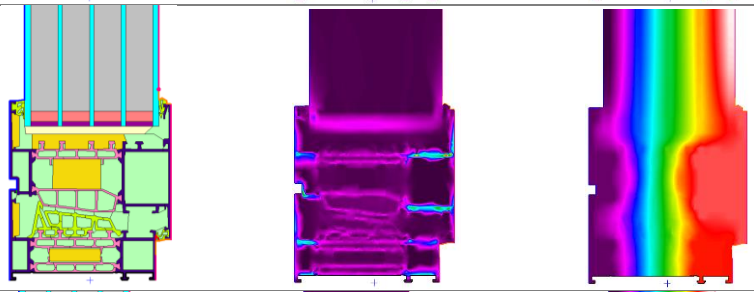
- Thermal conductivities, boundary conditions ISO 10077-2:2012.
- TGI spacer within a two-box model is with λ=0,34 W/m^{2}K – according to IFT report 2010. [2]
- Calculation tool: LBNL Therm 7.7.
- Modelled height of the edge-of-glass, b_g = b_p = 300 mm.

Linear thermal transmittances (ψ):

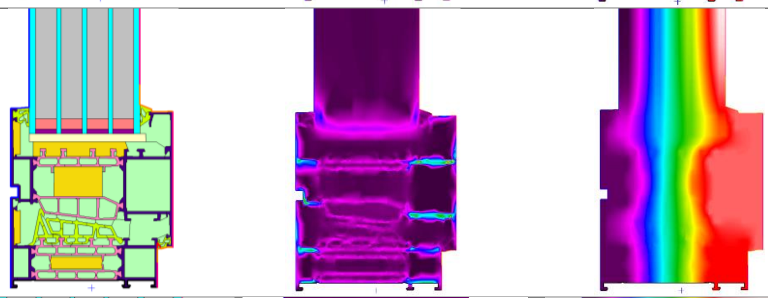
Q-AIR3L	0.031 W/mK
Q-AIR3E	0.031 W/mK



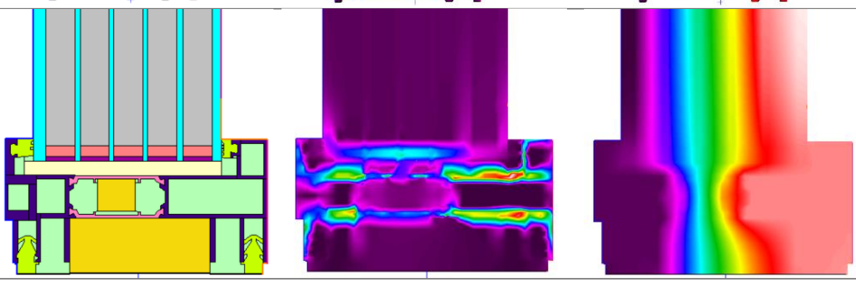
Q-AIR4L	0.027 W/mK
Q-AIR4G	0.027 W/mK



Q-AIR4K	0,034 W/mK



Q-AIR5	0.030 W/mK
Q-AIR5G	0.030 W/mK



[2] Shin, Mi-Su, et al. "Determination of equivalent thermal conductivity of window spacers in consideration of condensation prevention and energy saving performance." *Energies* **10**.5 (2017): 717.

Gustavsen, Arild, et al. "Key elements of and material performance targets for highly insulating window frames." *Energy and Buildings* **43**.10 (2011): 2583-2594.

Sound insulation

By default, thick Q-Airs, Q-Air 4G, Q-Air 5, and Q-Air 5G offer sound insulation, Rw, of 43 dB, where with glass options 55 dB is available. Thinner Q-Airs, Q-Air 3L, Q-Air 3E, Q-Air 4L and Q-Air 4K offer sound insulation performance, Rw, 35 dB or better.

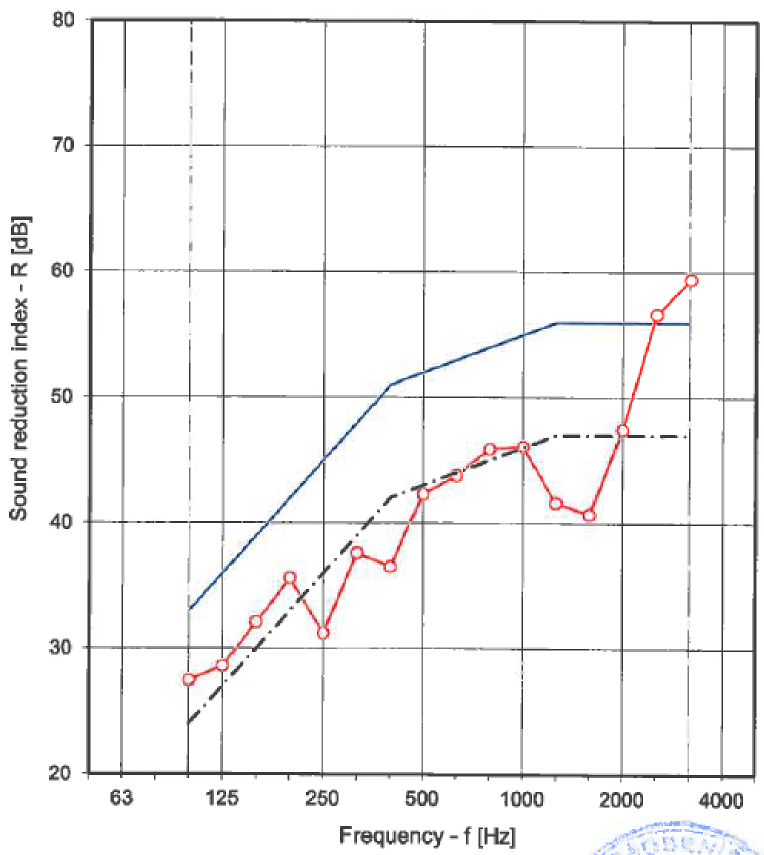
Q-Air 5 test result example:

Surface area of the test specimen:	1,87 m^2
Air temperature:	18 ^{0}C
Relative air humidity:	50 %
Static pressure:	980 hPa
Source room volume:	52 m^3
Receiving room volume:	50,1 m^3

--- . --- . --- shifted curve of reference values

——— curve of reference values (ISO 717-1)

Frequency f Hz	*R* (third oct.) dB
50	
63	
80	
100	27,5
125	28,6
160	32,1
200	35,6
250	31,2
315	37,6
400	36,5
500	42,3
630	43,8
800	45,9
1000	46,1
1250	41,6
1600	40,7
2000	47,5
2500	56,7
3150	59,5
4000	
5000	



Rating according to SIST EN ISO 717-1 (2013) :

$R_w (C;C_{tr})$ = 43 (-1;-3) dB

Evaluation based on laboratory measurement results, using sound intensity.

LJUBLJANA

IFT EN 1279-2 certificate

Issued to Trimo (program owner at the time).

ift-Nachweis

Classification Report

Number	18-000461-PR01 (NW-H01-09-en-01)
Owner	Trimo d.o.o. Prijateljeva cesta 12 8210 Trebnje Slovenia
Product	Insulated glass unit quintuple
Designation	System: Q-Air 5
Details	Overall dimensions (W x H) 352 x 502 ; Glass configuration 4 / 18 / 3 / 18 / 3 / 18 / 3 / 18 / 4; **Spacer:** Manufacturer Technoform Holding GmbH, - Kassel; Designation TGI Spacer M; Material Polypropylene with stainless steel; **Secondary sealant:** Manufacturer Kömmerling, Chemische Fabrik GmbH - Pirmasens; Designation GD 920; Material Based on silicone; **Primary sealant:** Manufacturer Designation Material
Special features	IGU with 5 glass panes, internal panes have one hole each

Result

Long term test method according to EN 1279-2 :2002-11

Requirement: fulfilled

ift Rosenheim
17.07.2018

Miriam Keill, B.Eng.
Deputy Head of Testing Department
Material Testing

Maximilian Weiß, B.Sc.
Operating Testing Officer
Material Testing

Ve-PB1-4902-en/ (01.06.2018)

Basis *)

EN 1279-2 :2002-11

*) and corresponding national versions e.g. DIN EN)

Test report: 18-000461-PR01 PB-H01-09-en-01

Representation

Validity

There is no time limit.
When using this document the up-to-dateness of above basis and the conformity of the product have to be observed.

The data and results given relate solely to the tested/described specimen. This test/evaluation does not allow any statement to be made on further characteristics of the present structure regarding performance and quality.

Notes on publication

The ift-Guidance Sheet "Conditions and Guidance for the Use of ift Test Documents" applies.

Identity-Check

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Testing and Calibration – EN ISO/IEC 17025
Inspection – EN ISO/IEC 17020
Product Certification – EN ISO/IEC 17065
Certification of Management Systems – EN ISO/IEC 17021

Notified Body 0757
PÜZ-Stelle: BAY 18

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