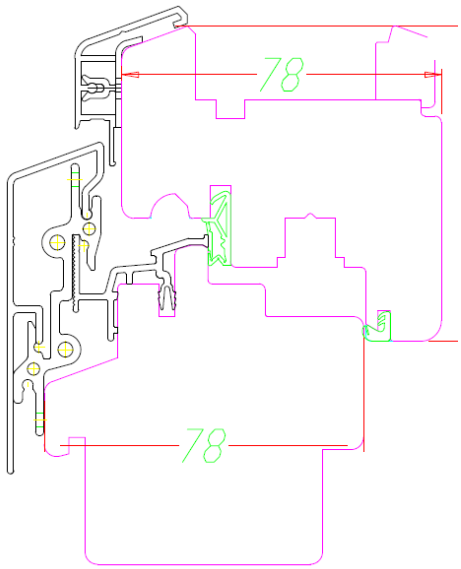

Calculation of the thermal transmittance of windows

Requested by: SeiCom Uksetehas Oü

VTT EXPERT SERVICES LTD

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Order	By email November 11th, 2014 / Ülo Noorvee , SeiCom Uksetehas Oü / VTT-O-162453-14
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Assignment **Calculation of the thermal transmittance of windows**

Structures The structures of the tilt and turn windows (2 pcs.) are shown in appendices 1 – 2. The materials and the dimensions are:

Type:	**Wooden window**
Dimensions:	Breath and height 1230 x 1480. Frame depth is 78 mm.
Materials:	Frame and casement of window are made of 3 layer glue laminated pine timber. The bottom frame has aluminium cladding.
Glazing:	In the casement glazing IGU with double glazing and 18 mm spacers or triple glazing and 16 mm spacers. Different spacers and glazing options are presented in the table 3.
Sealing strips:	In the casement two sealing strips Deventer SP 125 and Deventer SP33b.
Hardware:	Tilt and turn system of Siegenia-Aubi / Titan AF.

Type:	**Wooden-aluminium window**
Dimensions:	Breath and height 1230 x 1480. Frame depth is 78 mm + 9 mm aluminium cladding.
Materials:	Frame and casement of window are made of 3 layer glue laminated pine timber. All frames have aluminium cladding.
Glazing:	In the casement glazing IGU with double glazing and 18 mm spacers or triple glazing and 16 mm spacers. Different spacers and glazing options are presented in the table 3.

Sealing strips: In the casement two sealing strips Deventer SP 125 and Deventer SP33b.

Hardware: Tilt and turn system of Siegenia-Aubi / Titan AF.

Calculation

The calculation of the thermal transmittance of windows (U-value) is based on standards EN 10077-2 /3/, EN 10077-1 /2/ and EN 673 /1/. The calculation was done with the computer programs THERM /4/ and WINDOW /5/.

The average thermal transmittance (U_W) of a window is obtained using equation (1).

$$U_W = \frac{A_g U_g + A_f U_f + l_g \psi_g}{A_g + A_f} \qquad (1)$$

where

U_g is the thermal transmittance of the glazing, W/(m^2 K)
U_f is the thermal transmittance of the frame, W/(m^{2}K)
Ψ_g is the linear thermal transmittance for the glazing, W/(m K)
A_g is the area of the glazing, m^2
A_f is the area of the frame, m^2
l_g is the perimeter length of the glazing, m.

The average solar heat gain is based on the data delivered by glass manufacturer, which is reduced to the total area of the window by using formula:

$$g_W = \frac{A_g}{A_g + A_f} \cdot g_g \qquad (2)$$

where

g_W is the average solar heat gain reduced to the total area of the window [-]
g_g is the average solar heat gain of the glazing [-]
A_g is the area of the glazing [m^2]
A_f is the total area of the frame and the sash [m^2]

Input data

The calculation was done using figures shown in tables 1 to 2 as input data. The filling gas of insulating glass units was assumed to consist of 90 % argon or krypton and 10 % of air.

Table 1. Material data.

Material	Emissivity (-)	Thermal conductivity (W/mK)	Material	Emissivity (-)	Thermal conductivity (W/mK)
aluminium	0.90	160	glass	0.837	1.0
polyisobutylene	0.90	0.20	pine	0.90	0.13
polysulphide	0.90	0.40	weather-strip	0.90	0.25
polystyrene	0.9	0.16	TPS	0.90	0.25
polycarbonate	0.9	0.2	silicone	0.90	0.35
silica gel	0.9	0.13	stainless steel	0.20	17
desiccant	0.90	0.13			

Table 2. Surface thermal resistances.

Surface thermal resistances	Value	
Thermal resistance on exterior surface	0.04	$(m^2K)/W$
Thermal resistance on interior surface; reduced radiation/convection	0.20	$(m^2K)/W$
Thermal resistance on interior surface	0.13	$(m^2K)/W$

Results

The thermal transmittance of glazing and frame and the linear thermal transmittance of glazing and opaque panel edges are calculated by using the computer programs THERM /4/ and WINDOW /5/. The thermal transmittance values (U_g) of the glazing systems were supplied by the manufacturer (Saint-Gobain Glass).

The results are presented in table 3. The average thermal transmittance of the windows calculated by using formula 1 is shown in column $U_{W.}$

Table 3. The thermal transmittance of different parts of the window and the average thermal transmittance.

No	Window	Frame depth	1. glass	gas	spacer	2. glass	gas	spacer	3. glass	height	width	Bottom frame U_f	Bottom frame Psi	Upper & side frame U_f	Upper & side frame Psi	U-value U_g	U-value $\mathbf{U_w}$	g_g	g_w
1	Wooden window	78	planilux	argon	alu 18	PL Ultra N				1.48	1.23	1.57	0.073	1.24	0.075	1.14	**1.4**	0.62	0.43
2	Wooden window	78	PL Ultra N	argon	alu 16	planilux	argon	alu 16	PL Ultra N	1.48	1.23	1.52	0.090	1.20	0.091	0.58	**1.0**	0.50	0.34
3	Wooden window	78	Planilux	argon	Chr U 18	PL ONE				1.48	1.23	1.57	0.042	1.24	0.043	1.06	**1.2**	0.51	0.35
4	Wooden window	78	PL ONE	argon	Chr U 16	planilux	argon	Chr U 16	PL ONE	1.48	1.23	1.52	0.043	1.20	0.043	0.53	**0.88**	0.38	0.26
5	Wooden window	78	PL ONE	argon	Swissp 16	planilux	argon	Swissp 16	PL ONE	1.48	1.23	1.52	0.050	1.20	0.051	0.53	**0.89**	0.38	0.26
6	Wooden window	78	PL ONE	krypton	Chr U 16	planilux	krypton	Chr U 16	PL ONE	1.48	1.23	1.52	0.044	1.20	0.044	0.44	**0.82**	0.38	0.26
7	Wooden-aluminium window	78+9	planilux	argon	alu 18	PL Ultra N				1.48	1.23	1.56	0.077	1.21	0.079	1.14	**1.4**	0.62	0.43
8	Wooden-aluminium window	78+9	PL Ultra N	argon	alu 16	planilux	argon	alu 16	PL Ultra N	1.48	1.23	1.51	0.093	1.17	0.094	0.58	**1.0**	0.50	0.34
9	Wooden-aluminium window	78+9	planilux	argon	Chr U 18	PL ONE				1.48	1.23	1.56	0.043	1.21	0.044	1.06	**1.2**	0.51	0.35
10	Wooden-aluminium window	78+9	PL ONE	argon	Chr U 16	planilux	argon	Chr U 16	PL ONE	1.48	1.23	1.51	0.044	1.17	0.044	0.53	**0.87**	0.38	0.26
11	Wooden-aluminium window	78+9	PL ONE	argon	Swissp 16	planilux	argon	Swissp 16	PL ONE	1.48	1.23	1.51	0.051	1.17	0.052	0.53	**0.89**	0.38	0.26
12	Wooden-aluminium window	78+9	PL ONE	krypton	Chr U 16	planilux	krypton	Chr U 16	PL ONE	1.48	1.23	1.51	0.044	1.17	0.045	0.44	**0.81**	0.38	0.26

Markings in the table:

planilux	is Saint-Gobain Glass Planilux float-glass (4 mm)
PL Ultra N	is Saint-Gobain Glass Planitherm Ultra N (4 mm)
PL ONE	is Saint-Gobain Glass Planitherm ONE (4 mm)
alu xx	is aluminium spacer (xx mm)
Chr U xx	is Chromatech Ultra spacer (xx mm)
Swissp xx	is Swisspacer (xx mm)

Espoo 5.12.2014

Pekka Sipari
Senior Expert

Petri Kukkonen
Expert

VTT Expert Services Ltd is notified body No. NB 0809.

FINAS-accreditation service has accredited our laboratory (T001, VTT Expert Services Ltd) to perform calculations according to the standards [1 – 3].

Appendices 2 pcs.

Distribution Customer Original
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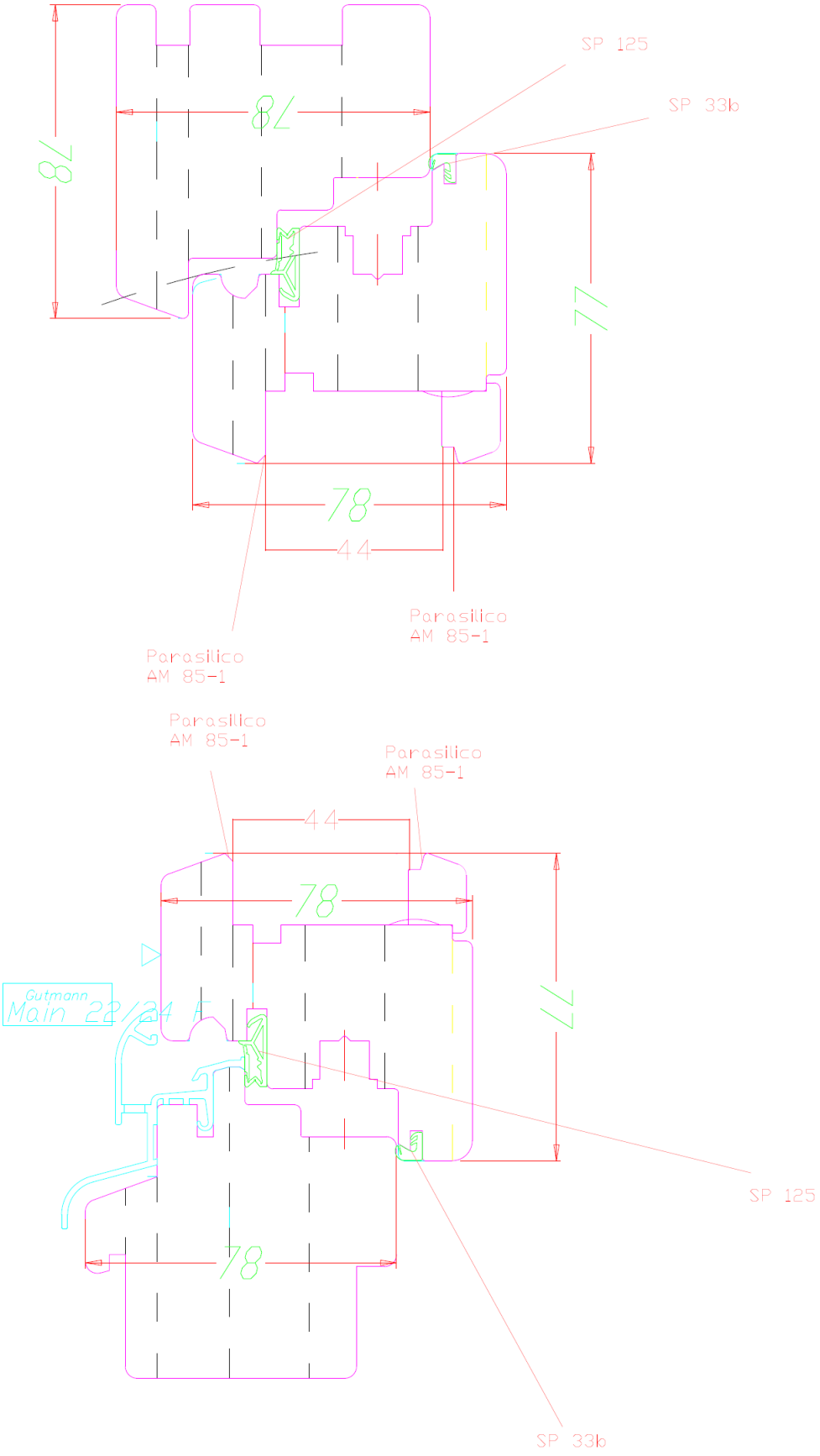
ilac-MRA FINAS Finnish Accreditation Service T001 (EN ISO/IEC 17025)

References

1. SFS-EN 673 Glass in building. Determination of thermal transmittance (U value). Calculation method. 2011-03-28. 1+18 p.
2. SFS-EN ISO 10077-1 Thermal performance of windows, doors and shutters - Calculation of thermal transmittance. Part 1: General (ISO 10077-1:2006). 2006-09-16. 1 + 2 + 35 p..
3. SFS-EN ISO 10077-2. Thermal performance of windows, doors and shutters. Calculation of thermal transmittance. Part 2: Numerical method for frames (ISO 10077-2:2012). 2012-03-01. 36 p.
4. THERM program, version 5.2. Window and Daylight Group, Applied Science Division, Lawrence Berkeley Laboratory, University of California. USA. 2003
5. WINDOW program, version 5.2. Window and Daylight Group, Applied Science Division, Lawrence Berkeley Laboratory, University of California. USA. 2005.

SeiCom: Wooden window



SeiCom: Wooden-aluminium window