REPORT

issued by an Accredited Testing Laboratory

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HS Hansen A/S
Bredgade 4
DK-6949 LEM ST
Danmark

Determination of thermal transmittance

(3 appendices)

Work requested

The client supplied drawings of window for determination of its total U-value. Appendix 3 shows the design of the constructions.

Product name:	Millennium AU
Product type:	Operable window (Turn-tilt fitting)
Product category:	Aluminium frames with thermal break
Glass options:	Standardrude
Spacer:	TGI
Daylight size:	1.23 x 1.48 m^2
Producer of window:	HS Hansen A/S
Drawings:	Millennium_AU_G40.dwg

Methods

Numerical calculation for relevant profile sections was performed using the THERM 6.3 program according to SS-EN ISO 10077-2: 2017. The Ug-value is calculated according to SS-EN 637: 2011. The compilation of the windows total U_W-value is performed according to SS-EN ISO 10077-1: 2017. Material data, boundary conditions and glass structure are shown in Appendix 1. Appendix 2 presents the results of calculated profile sections in greater detail. Cavities in the calculation program Therm 6.3 are calculated according to equivalent lambda method according to SS-EN ISO 10077-2: 2017.

Calculation results

Name	Spacer	Glass combination	Size (B x H)	U_w (W/(m^2K))
G40AU	TGI-16 and TGI -18	6-18Ar-4-16Ar-6	1.23 x 1.48 m^2	1.0

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Appendices

1 Material data and boundary conditions
2 Calculation results
3 Calculated sections

Appendix 1

Material data and boundary conditions

Table 1 Glazing unit G40AU

Glass	Product name	Thickness	Cavity (gas)	Spacer	Position	Coating	Emissivity $\varepsilon_{korr.}$
					1	-	0,837
1	Planiclear	6mm					
		18mm	90% Argon	TGI	2	Planitherm LUX	0,087
					3	-	0,837
2	Planiclear	4mm					
		16mm	90% Argon	TGI	4	-	0,837
					5	Planitherm XN	0,040
3	Planiclear	6mm					
					6		0,837

Total thickness: 50mm

U_g = 0.60 W/(m^{2}K), according to SS-EN 673.

Table 2

Material	Thermal conductivity, W/(m·K)	Source
Aluminium	160	1
Glass	1.0	1
Silicon	0.35	1
Polyamide 6.6	0.30	1
TGI eq1	0.40	2
TGI eq2	0.30	2
TPE	0.25	3
Norton band	0.14	3
Cavity (air)*	Calculated according to SS-EN ISO 10077-2:2017	

1 = SS-EN ISO 10077-2:2017
2 = according to producer (box-model)
3 = according to client

* Non rectangular air cavities are transformed into equivalent rectangular air cavities in accordance with SS-EN ISO 10077-2:2017 and the thermal conductivity is then calculated for this equivalent air cavity. The emissivity of surfaces are set according to the drawing from client which is attached in appendix 3.

The air temperature and surface resistance have been taken as ϑ_i = +20 °C and R_{si} = 0.13 m²K/W (0.20 m²K/W for inward corners) on the inside and ϑ_e = 0 °C and R_{se} = 0.04 m²K/W on the outside.

Calculation was carried out according to detailed section as shown in appendix 3. Adjacent sections (adiabatic) was placed 190 mm from the edge of the glass and along adjoining wall. Only fittings which have influence on the U-value is taken into account in the calculation.

Appendix 2

Calculation results

Calculation was carried out according to detailed section as shown in appendix 3. Adjacent sections (adiabatic) was placed 190 mm from the edge of the glass and along adjoining wall. Only fittings which have influence on the U-value is taken into account in the calculation.

Calculations of the profile section was performed 2018-08-14.

U-value for the window is calculated using area weighting of U-value for each part and correction for edge losses near the glass edge according to SS-EN ISO 10077-1:2017 and -2: 2017.

Table 3 Calculated ψ- och U-value for window with size 1.23 m x 1.48 m

Name	Spacer	**Frame height b_f, (m)**	**ψ-value, W/(mK)**	**U-value, W/(m²K)**	
		Side, top and Bottom	Side, top and Bottom	U_f Side, top and Bottom	U_w Window 1.23×1.48 m²
G40AU	TGI-18 / TGI-16	0.056	0.044	2.35	1.003

Based on comparison between calculated and measured U-values for windows, the ratio (U-calculated / U-measured) of 0.99 ± 0.12 for 95% of the cases, which translates to a calculation uncertainty of less than 10%.

Appendix 3

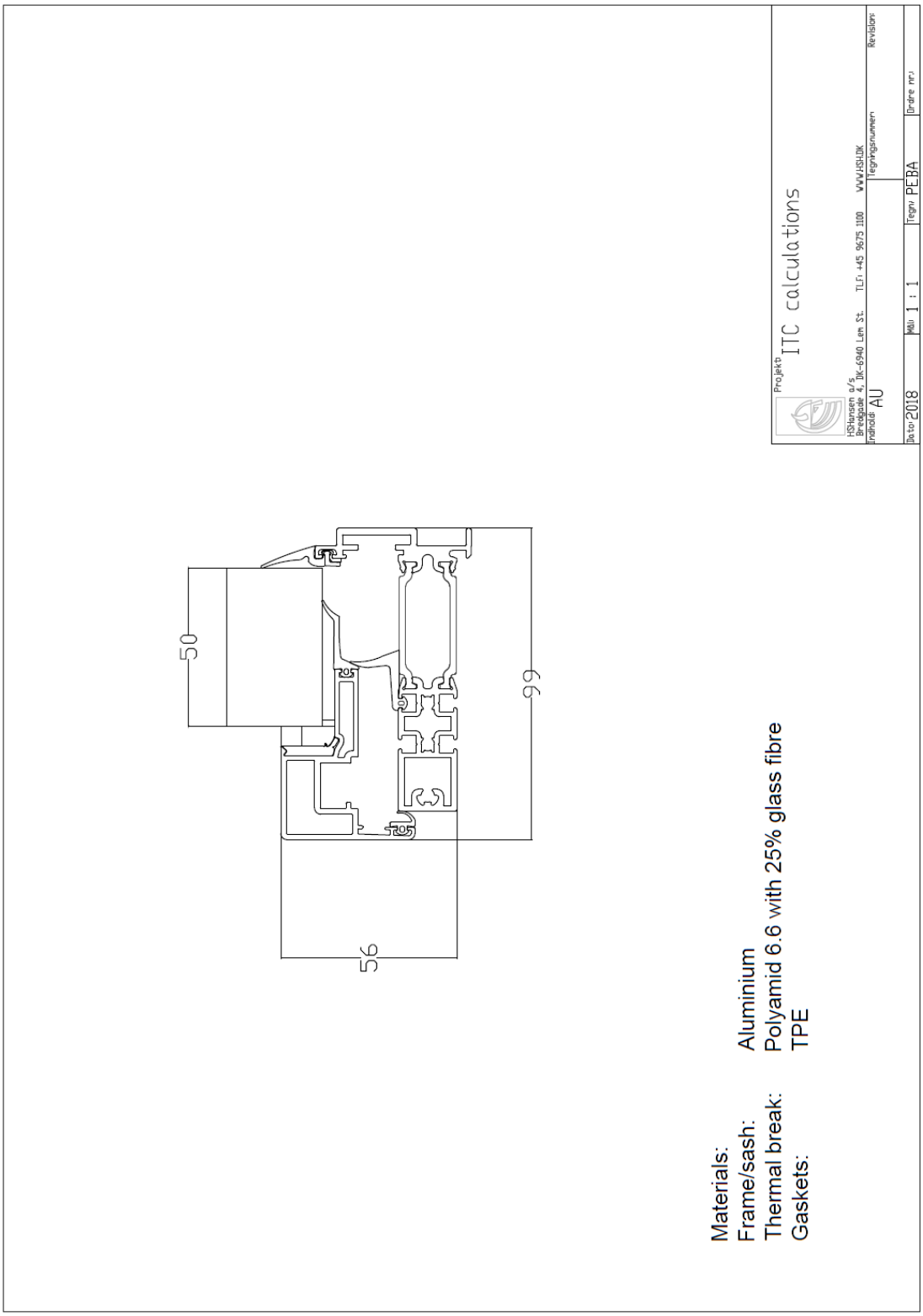


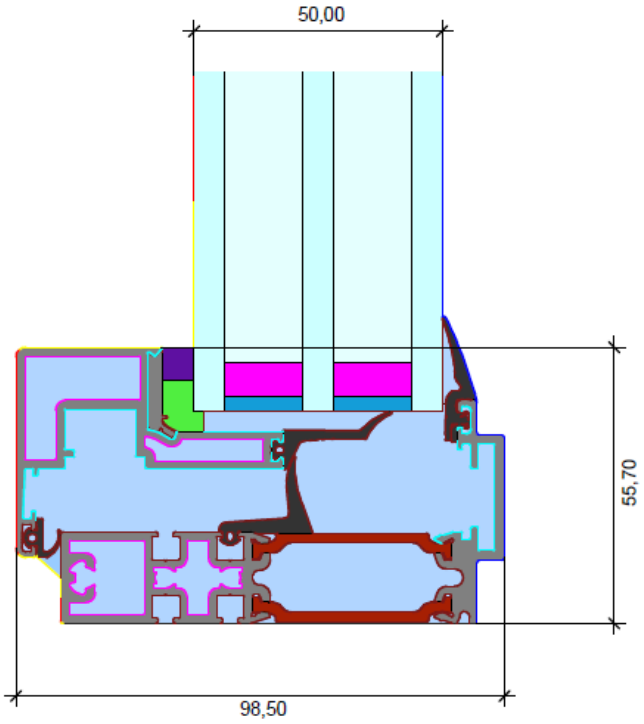
Figure 1 Drawing of section

Appendix 3

Projekt: 35862_Aarhus Universitet

System: Millennium AU

Snit: G40



Name	λ[W/(m·K)]	ε
Aluminium (SI alloys)	160,000	0,300
Aluminium (SI alloys)	160,000	0,100
Aluminium (SI alloys)	160,000	0,900
Gasfilling(65)	0,022	
Gasfilling(66)	0,022	
Norton band (0,140)	0,140	0,900
Polyamid 6.6 with 25% glassfibre	0,300	0,900
Polysulfide	0,400	0,900
Silicone, pure	0,350	0,900
Slightly ventilated air cavity, Eps=0.9		
Soda lime glass	1,000	0,900
TGI	0,300	
TPE (0,250)	0,250	0,900
Unventilated air cavity, Eps=0.9		

Comments:
Calculated according to European Standard: EN ISO 10077-2:2012.
Profile combinations and their U_f values are calculated with an infill panel. The U_f value does not depend on the inserted glass pane or spacer.
The passing of isotherms through the profile is documented by using a glass pane as shown on drawing.
Final U-values for windows (U_w), doors (U_D) or curtain walls (U_{CW}) depends on used glass panes and/or infill panels.

03-07-2018
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Figure 2 Materials used by client

Appendix 3

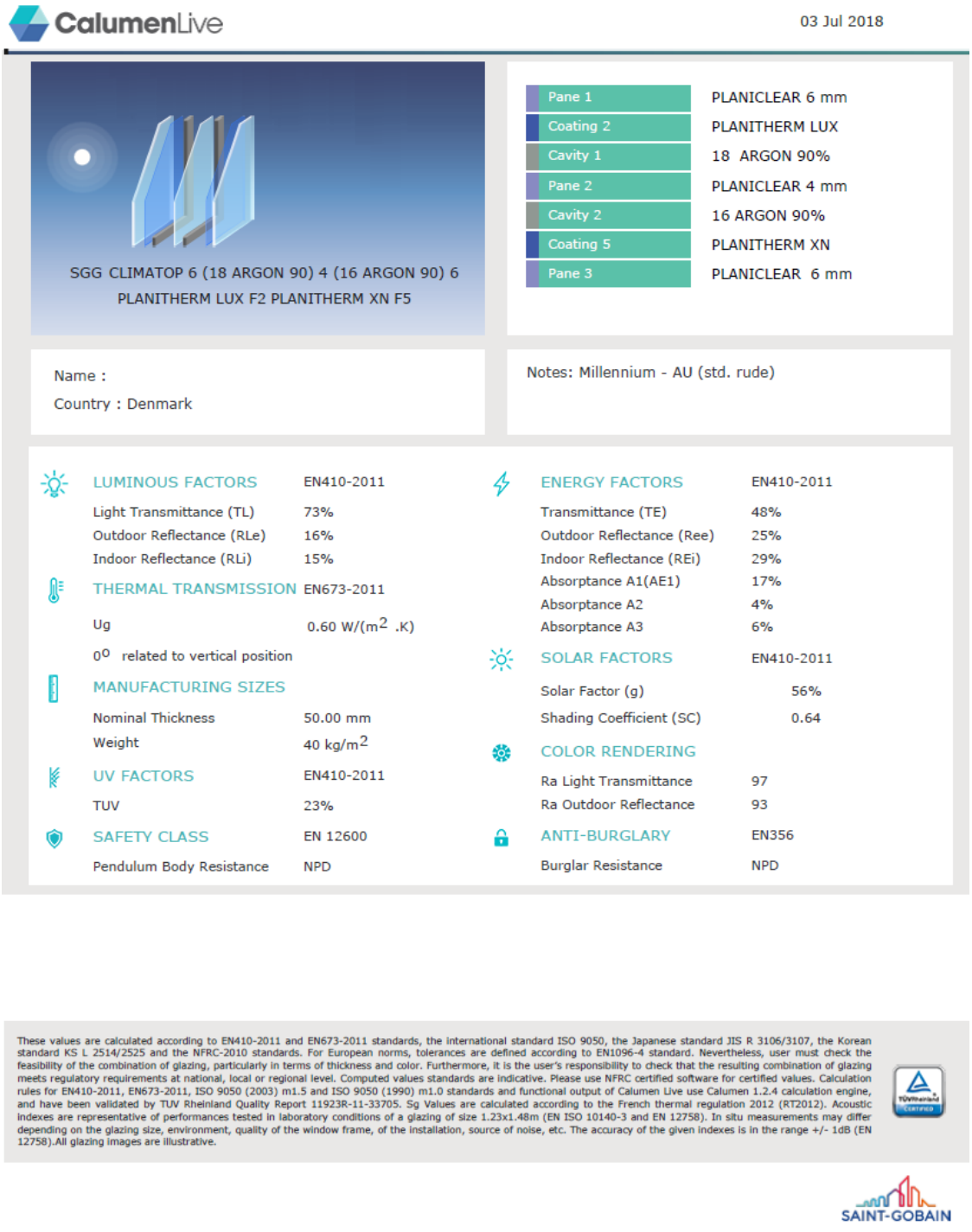

Figure 3 Glass specification

Appendix 3

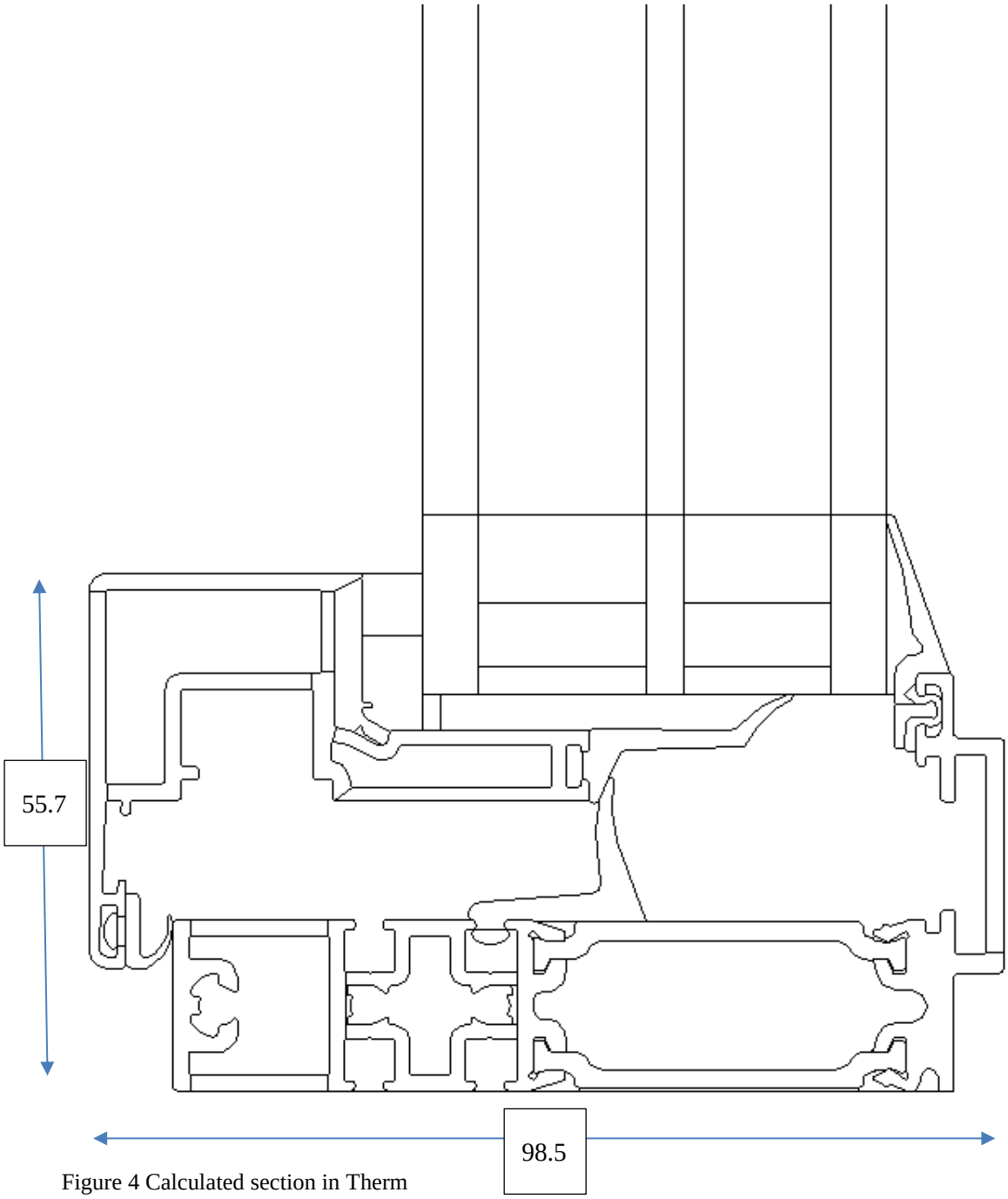

Figure 4 Calculated section in Therm