

	<b>CORTIZO TECHNOLOGICAL CENTRE</b> <b>THERMAL CALCULATION REPORT</b> <b>Nº EXP: 20230525_1</b>	 <b>ALUMINIOS CORTIZO SA</b> <b>Extramundi, s/n</b> <b>CP 15901 Padrón</b> <b>A Coruña</b>
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## CALCULATION REPORT

### 1. PETITIONARY.

**CLIENT:** *Cortizo Sistemas S.A.*

**ADDRESS:** *Extramundi s/n*  
*15901 – Padrón (A Coruña)*

### 2. SAMPLE CHARACTERISTICS.

<b>PROFILE MANUFACTURER:</b>	CORTIZO SISTEMAS	<b>SERIES:</b>	CASEMENT
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<b>DATE OF REPORT:</b>	25/05/2023
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ELEMENT	COMPONENT	MATERIAL	REFERENCE
<b>FRAME</b>	Frame	<i>Aluminium</i>	3831
<b>SASH</b>	Sash	<i>Aluminium</i>	3821
<b>VARIOUS</b>	Transom	<i>Aluminium</i>	3851
	Glazing bed	<i>Aluminium</i>	3810
	Glazing gasket	<i>EPDM</i>	240124 / 240135
	Outer frame gasket	<i>EPDM</i>	373801
	Insulating foam	<i>POL NA 30 FR</i>	320024

### THERMAL TRANSMITTANCE ACHIEVED:

$$U_w = 1,4 \text{ W}/(\text{m}^2 \cdot \text{K}) *$$

\*Thermal transmittance using a side hung opening with a lateral fixed light with dimensions 1440x1330 mm, and glazing with  $U_g=1,0 \text{ W}/(\text{m}^2 \cdot \text{K})$  and  $\Psi=0,039 \text{ W}/(\text{m} \cdot \text{K})$ .

*This certificate is a translation of the original certificate in Spanish with the same document number. In case of litigation, the Spanish version is considered to be authorized and valid for any purpose.*

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### 3. SCOPE.

Determination of the conductivity of the frame according to regulation UNE EN 10077-2 “Thermal performance of windows, doors and shutters. Calculation of thermal transmittance. Numerical method for frames.”

Determination of the  $U_w$  thermal transmission coefficient of the window according to regulation UNE EN 10077-1 “Thermal performance of windows, doors and shutters. Calculation of thermal transmittance. Part 1: General.”.

### 4. OBJECTIVE.

The objective of this report is to thermally characterise the carpentry profiles whose drawings in CAD format are sent by the client. For that purpose, the thermal transmittance coefficients of the profiles will be calculated and graphic representations of the temperature distributions resulting from the calculation will be made.

The report will present the calculation of a complete window, including the glass, taking into account the iteration edge effect between the frame and sash assembly and the glass itself.

### 5. CALCULATION HYPOTHESIS.

This simulation has been carried out using Flixo Professional software , 8.1.1000.1 version. This is a computer-based tool based on the finite element method for the resolution of the two-dimensional heat transmission equation. This computer software has been tested using the examples proposed by the standard ISO 10077-2.

The procedure consists in importing into CAD the sections of the profiles to be calculated, identifying all the materials present in those sections and characterising each of them.

The standard ISO 10077-2 establishes the procedure to calculate the thermal transmittance coefficient of the frame. This value is calculated for each section according to the following expression:

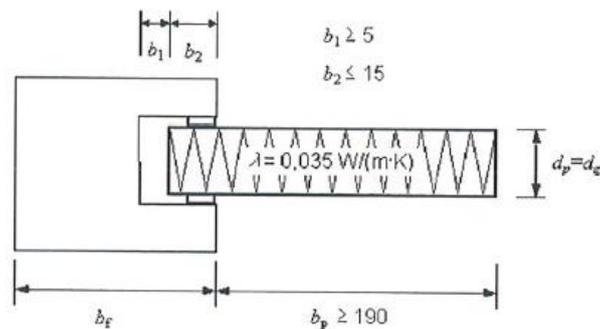
$$U_f = \frac{L_f^{2D} - U_p * b_p}{b_f}$$

Being:

- $U_f$ : Thermal transmittance coefficient of the frame.



- $L_f^{2D}$  = Linear thermal transmission of the section, replacing the glazing with a calibration panel of the same thickness and a thermal conductivity of  $\lambda=0,035$  W/(m<sup>2</sup>·K).
- $U_p$  = Thermal transmittance coefficient in the centre of the calibration panel.
- $b_p$  = Visible length of the calibration panel.
- $b_f$  = Projected length of the frame.



The boundary condition values of the issue were obtained from Annex H of the standard UNE EN ISO 10077-2. They are as follows:

Superficie		Resistencia superficial Normal (superficie plana). $R_s$ (m <sup>2</sup> ·K/W)	Resistencia superficial aumentada (bordes o uniones entre superficies). $R_s$ (m <sup>2</sup> ·K/W)	Temperatura $\theta$ (°C)
A	Adiabática	infinito	infinito	-
B	Externa	0.04	0.04	0
C	Interna	0.13	0.2	20

The previously calculated values, representative of the window cross-sections, as well as the glass transmittance value used, are used according to the guidelines of UNE EN ISO 10077-1, for the calculation of the total thermal transmittance.

For the emissivity of the surfaces, the default value  $\epsilon=0.9$  according to EN ISO 10077-2 has been taken.

## 6. SAMPLE DESCRIPTION.

### 6.1 Regarding the thermal transmittance calculation of the frame ( $U_f$ ).

The values of the thermal conductivity of the materials,  $\lambda$ , used in the calculations are obtained from table H.2 as found in the standard:

Key	Material	Thermal conductivity, $\lambda$ W/(m·K)
a	insulation panel	0.035
b	soft wood	0.13
c	PVC	0.17
d	EPDM	0.25
e	polyamide 6.6 with 25% glass fibre	0.3
f	glass	1.0
g	steel	50
h	aluminium <sup>a</sup>	160
i	pile weather stripping (polyester mohair)	0.14
k	polyamide	0.25
l	PU (polyurethane), rigid	0.25
m	polysulfide	0.40
n	silical gel (desiccant)	0.13
o	gas filling	0.034 <sup>b</sup>

a Introduce a comment in the report about the superficial treatment, like coated or anodising, if the surface emissivity is  $\varepsilon_n = 0.85$ .  
b Equivalent thermal conductivity of the gas filling

Note: The conductivity of the elements indicated in the following table are provided directly by the customer, based on the material file provided by the manufacturer:

MATERIAL	CONDUCTIVITY
Pol Na 30 FR	0,036 W/(m·K)
HITEP	0,19 W/(m·K)

### 6.2 Regarding the thermal transmittance calculation of the window ( $U_w$ ).

For the calculation of the thermal transmission coefficient of the entire window,  $U_w$ , a side hung opening with a lateral fixed light with dimensions 1440x1330 mm (width x height) was used, as described in figure 1. The glass composition is “4 (16) 4” with thermal transmittance  $U_g=1.0$  W/(m<sup>2</sup>·K), and the value of the linear thermal coefficient of the spacer bar is  $\Psi=0,039$  W/(m·K) as described in more detail in point 8.2.



**7. SECTIONS CALCULATED.**

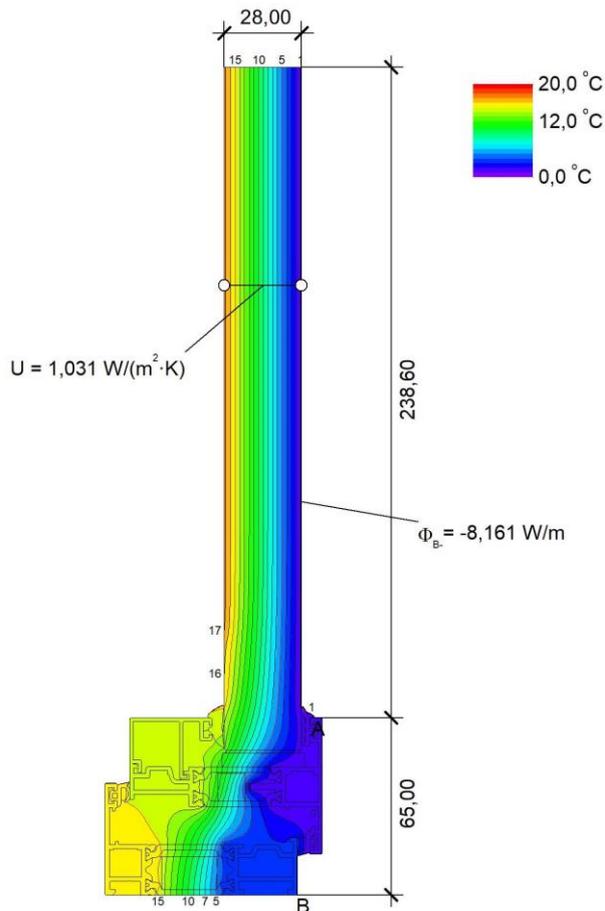
The sections calculated using the software Flixo Professional are described below:

Section 1:



Material	$\lambda$ [W/(m·K)]	$\epsilon$	Boundary Condition	$q$ [W/m <sup>2</sup> ]	$\theta$ [°C]	$R$ [(m <sup>2</sup> ·K)/W]	$\epsilon$
Aluminium (Si Alloys)	160,000	0,900	Epsilon 0.9				0,900
EPDM (ethylene propylene diene monomer)	0,250	0,900	Exterior, frame	0,000	0,040		
HITEP	0,190	0,900	Interior, frame, normal	20,000	0,130		
POLNA30FR	0,036	0,900	Interior, frame, reduced	20,000	0,200		
Panel	0,035	0,900	Symmetry/Model section	0,000			
Unventilated air cavity *							

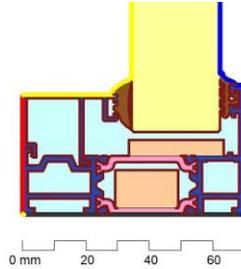
\* EN ISO 10077-2:2017, 6.4.2



$$U_{1A,B} = \frac{\frac{8,161}{20,000} - 1,031 \cdot 0,239}{0,065} = 2,5 \text{ W/(m}^2 \cdot \text{K)}$$

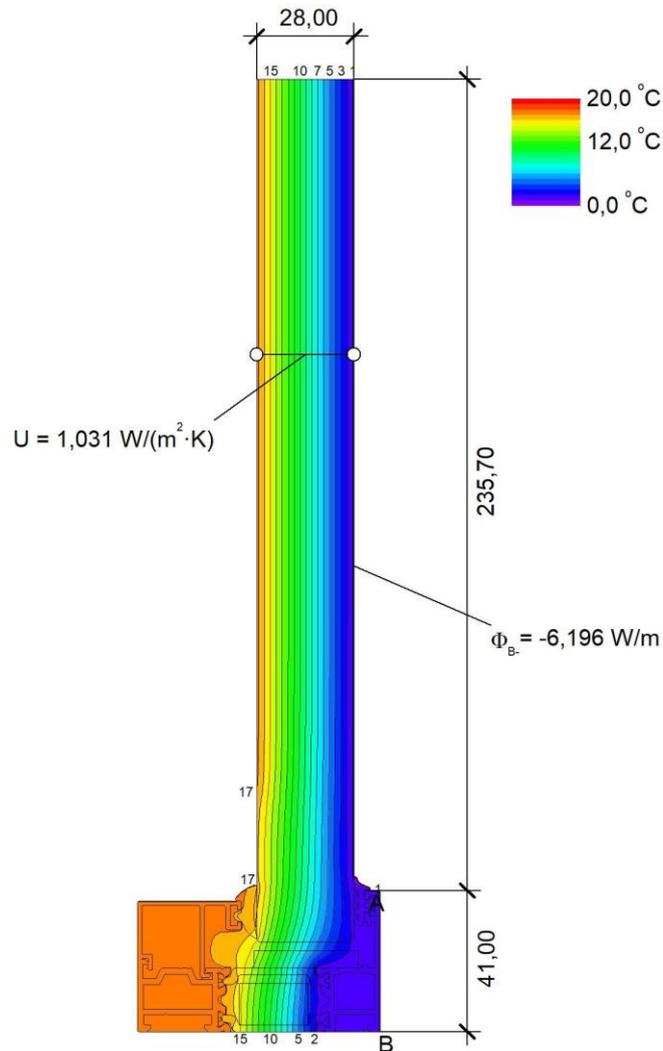


Section 2:



Material	$\lambda$ [W/(m·K)]	$\epsilon$	Boundary Condition	$q$ [W/m <sup>2</sup> ]	$\theta$ [°C]	$R$ [(m <sup>2</sup> ·K)/W]	$\epsilon$
Aluminium (Si Alloys)	160,000	0,900	Epsilon 0.9				0,900
EPDM (ethylene propylene diene monomer)	0,250	0,900	Exterior, frame	0,000		0,040	
HITEP	0,190	0,900	Interior, frame, normal	20,000		0,130	
POLNA30FR	0,036	0,900	Interior, frame, reduced	20,000		0,200	
Panel	0,035	0,900	Symmetry/Model section	0,000			
Unventilated air cavity *							

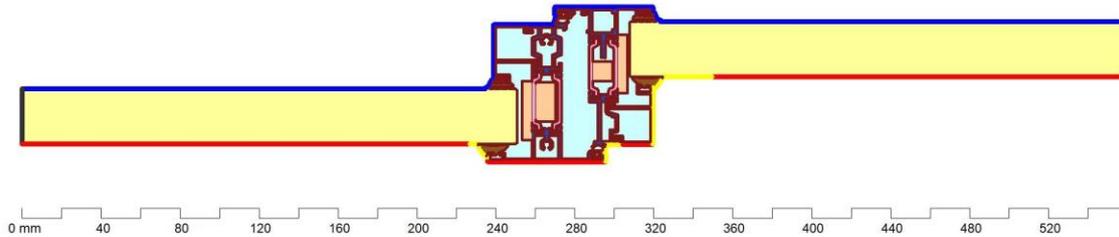
\* EN ISO 10077-2:2017, 6.4.2



$$U_f = \frac{\frac{6,196}{20,000} - 1,031 \cdot 0,236}{0,041} = 1,6 \text{ W/(m}^2 \cdot \text{K)}$$

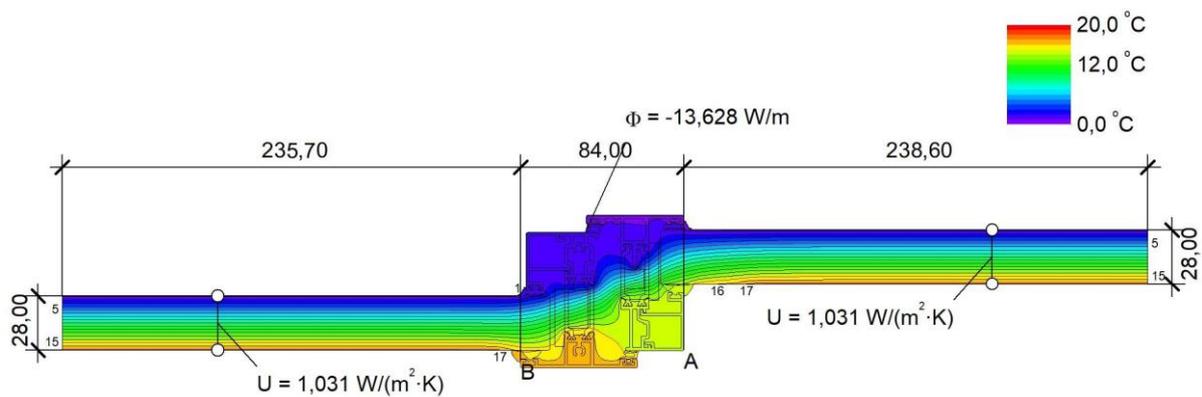


Section 3:



Material	$\lambda$ [W/(m·K)]	$\epsilon$	Boundary Condition	$q$ [W/m <sup>2</sup> ]	$\theta$ [°C]	$R$ [(m <sup>2</sup> ·K)/W]	$\epsilon$
Aluminium (Si Alloys)	160,000	0,900	Epsilon 0.9				0,900
EPDM (ethylene propylene diene monomer)	0,250	0,900	Exterior, frame	0,000		0,040	
HITEP	0,190	0,900	Interior, frame, normal	20,000		0,130	
POLNA30FR	0,036	0,900	Interior, frame, reduced	20,000		0,200	
Panel	0,035	0,900	Symmetry/Model section	0,000			
Unventilated air cavity *							

\* EN ISO 10077-2:2017, 6.4.2



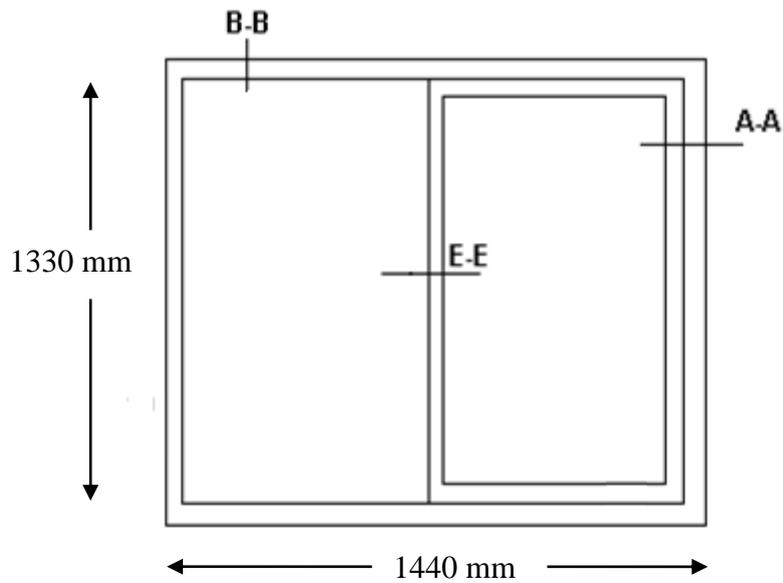
$$U_{fAB} = \frac{\frac{13,628}{20,000} - 1,031 \cdot 0,239 - 1,031 \cdot 0,236}{0,084} = 2,3 \text{ W/(m}^2 \cdot \text{K)}$$

## 8. RESULTS.

### 8.1 Thermal transmittance calculation of the frame.

RESULT:	W/(m <sup>2</sup> ·K)
Thermal transmittance section A-A (Section 1)	2,5
Thermal transmittance section B-B (Section 2)	1,6
Thermal transmittance section E-E (Section 3)	2,3

The diagram of the window is attached below:



### 8.2 Thermal transmittance calculation of the glass.

The glass used for the calculation responds to a 4mm external pane of clear float glass coated with Low-E coating; a 16 mm chamber filled with Argon gas and air in proportions of 90% and 10 respectively, and a 4 mm internal pane.

The thermal transmission coefficient of the glass used is  $U_g = 1,0 \text{ W}/(\text{m}^2 \cdot \text{K})$ .

### 8.3 Thermal transmittance calculation of the window.

For the calculation of the thermal transmission of the complete frame,  $U_w$ , calculations are carried out according to the standard UNE-EN ISO 10077-1, which states:

$$U_w = \frac{\sum A_g U_g + \sum A_f U_f + \sum l_g \Psi_g}{\sum A_g + \sum A_f}$$

Being:

- $A_g$  is the area corresponding to the glazed area (glass).
- $A_f$  is the area corresponding to each section of the frame described in previous sections.
- $U_g$  is the transmittance of the glass as indicated in previous sections.
- $U_f$  is the transmittance of each frame section as described in previous sections.
- $l_g$  is the total visible glazing perimeter.
- $\Psi_g$  is the linear thermal coefficient for spacer bars or the border factor.

In our case, the linear thermal coefficient of the “WARM EDGE” spacer bar with value  $\Psi=0,039 \text{ W}/(\text{m} \cdot \text{K})$  have been taken.

Therefore, the results of the calculation are as follows:

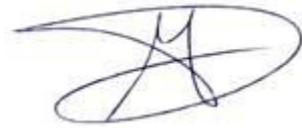
	Uf	Af	Ug	Ag	Ψg	lg	ΣU*A	(ΣU*A+Σψ*I)/(ΣA)
seccion A-A	2,5	0,17	-	-	-	-	0,43	1,40
seccion B-B	1,6	0,11	-	-	-	-	0,18	
seccion C-C								
seccion D-D								
seccion E-E	2,3	0,11	-	-	-	-	0,25	
Glass	-	-	1,0	1,53	-	-	1,53	
Ψ	-	-	-	-	0,04	7,80	0,30	
ΣA	-	0,39	-	1,53	-	-	2,69	
ΣAg+ΣAf				1,921				
<b>Uw</b>								

CALCULATION RESULT:

<b><math>U_w = 1,40 \text{ W}/(\text{m}^2 \cdot \text{K})</math></b>
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*Daniel Castro Lado*  
Laboratory technician

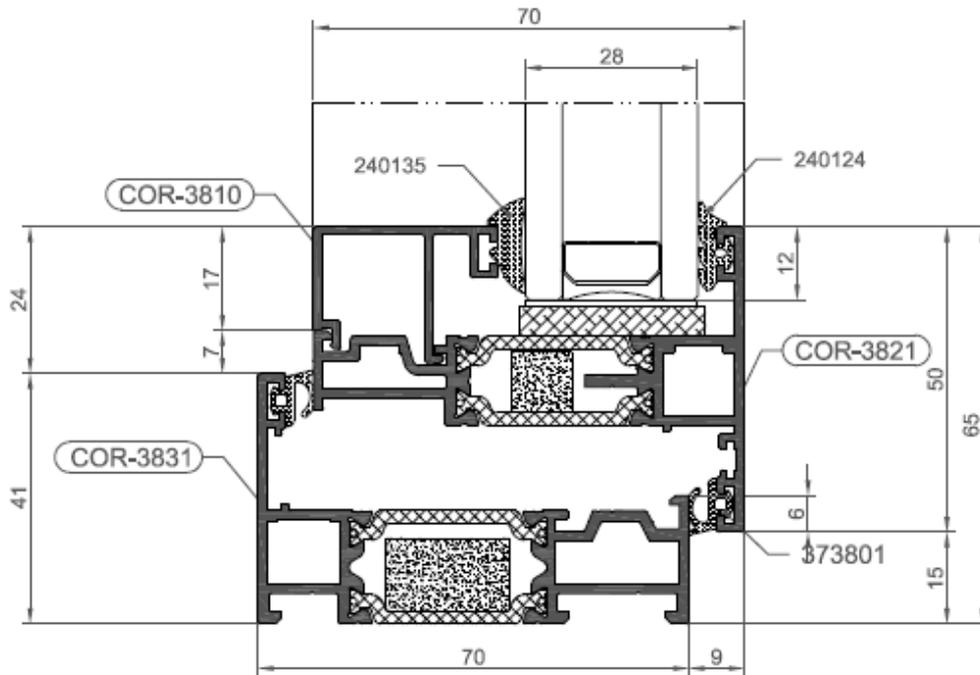



*David Macía Arias*  
Laboratory manager

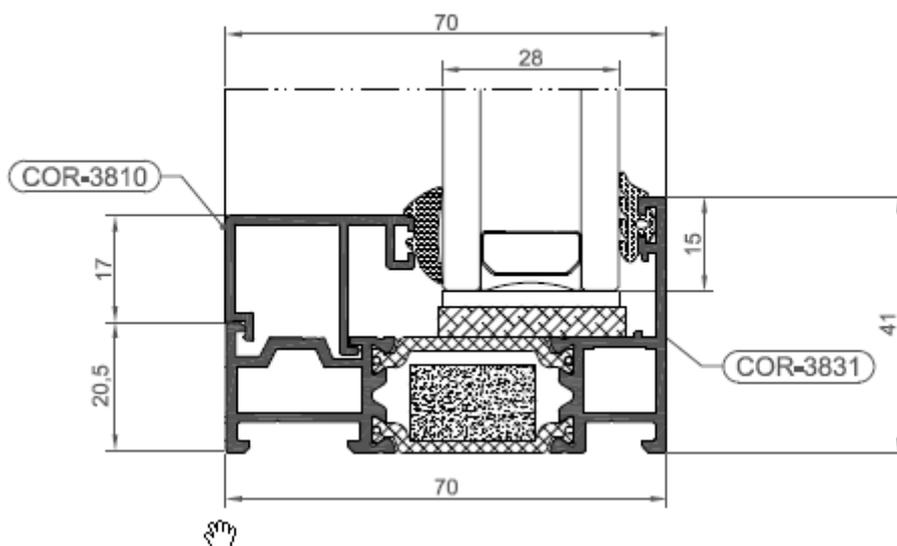


## ANNEX 1. TECHNICAL DOCUMENTATION.

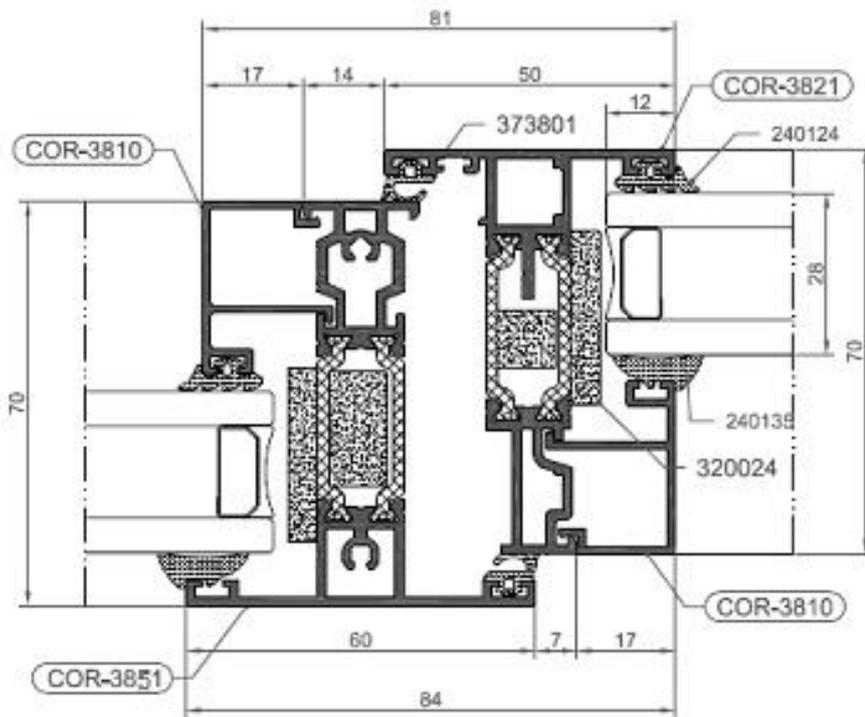
The information provided by the client for the calculations is described below:



Section 1



Section 2



Section 3



## **ANNEX 2. THERMAL TRANSMITTANCE CALCULATIONS ACCORDING TO THE GLASS TRANSMITTANCE.**

The following table shows the window thermal transmittance in accordance with the transmittance  $U_g$  of the glass installed, using the window characteristics described in this report.

$U_g$ W/(m <sup>2</sup> ·K)	$U_w^*$ W/(m <sup>2</sup> ·K)
0,5	1,0
0,6	1,1
0,7	1,2
0,8	1,2
0,9	1,3
1	1,4
1,1	1,5
1,2	1,6
1,3	1,6
1,4	1,7
1,5	1,8
1,6	1,9
1,7	2,0
1,8	2,0
1,9	2,1
2	2,3
2,1	2,4
2,2	2,4
2,3	2,5
2,4	2,6
2,5	2,7

\*The values indicated in the table correspond to a window with the previously described characteristics. A side hung opening with a lateral fixed light with dimensions 1440x1330 mm (width x height)

- For the calculation, glass with  $U_g$  lower than 1 W/(m<sup>2</sup>·K) is considered as a triple glazing with a low emissivity coating on at least one of its surfaces and spacer bar type “Warm Edge” ( $\Psi=0.032$  W/(m·K)). Glass with  $1 < U_g < 2$  W/(m<sup>2</sup>·K) is considered as a double glazing with a low emissivity coating on at least one of its surfaces and spacer bar type “Warm Edge” ( $\Psi=0.039$  W/(m·K)). Lastly, glass with  $U_g \geq 2$  W/(m<sup>2</sup>·K) has no low emissivity coating ( $\Psi=0.060$  W/(m·K)).

- Any variation in the window dimensions or type of glass can lead to variations in the results.