THERMAL TRANSMITTANCE REPORT

1. PETITIONER.

CLIENT: *Cortizo Sistemas S.A.*

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

2. SAMPLE CHARACTERISTICS.

PROFILE MANUFACTURER:	Cortizo Sistemas	**MODEL:**	COR-VISION PLUS Manual and Motorised versions

DATE OF REPORT:	08/02/2017

THERMAL TRANSMITTANCE RESULT:

U_{w}= 1,2 W/ (m^2·K) *

*** Thermal transmittance calculated based on a double-sash window, total dimension of 4000x3000 mm and glazing with glazing values Ug= 0.7 W/m2K, and warm edge Ψ=0.08. The sections, profiles and accessories used for these calculations can be found in the annex 1 of this report.**

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.

David Macía Arias
Laboratory Director

3. SCOPE.

Determination of conductivity of the frame according to the standard UNE EN 10077-2:2012 “Thermal performance of windows, doors and shutters - Calculation of thermal transmittance - Part 2: Numerical method for frames.”

Determination of thermal transmittance coefficient U_w of the complete window according the standard UNE EN 10077-1:2010 “Thermal performance of windows, doors and shutters - Calculation of thermal transmittance - Part 1: General”.

4. OBJECTIVE.

The objective of this report is to thermally characterize the 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 temperature distributions resulting from the calculation will be elaborated.

In this report, a calculation of the complete window will be presented, including the glazing, taking into account the edge effect between the assembly of the frame and the sash and the glass itself.

5. CALCULATION HYPOTHESIS.

This simulation has been carried out using Flixo Professional software. This is a computer-based tool based on the finite element method to solve the two-dimensional heat transmittance equation. This computer tool has been tested using the examples proposed by the standard ISO 10077-2:2017.

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

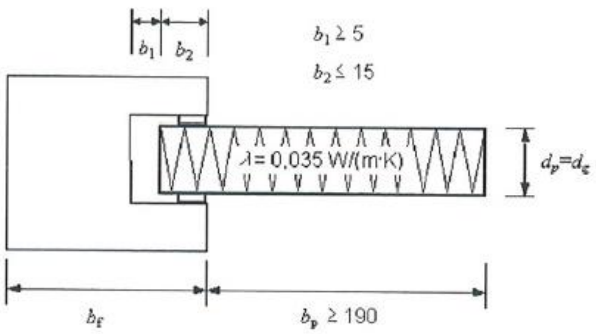
The standard ISO 10077-2:2012 establishes the procedure to calculate the thermal transmittance coefficients of the frame. This value is calculated for each section according to the following equation:

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

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 λ=0,035 W/m²K.
- 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 D of the standard UNE EN ISO 10077-2:2012. They are as follows:

Surface		**Normal surface resistance** (flat surface) *Rs (m²·K/W)*	**Increased surface resistance** (edges or unions between surfaces) *Rs (m²·K/W)*	**Temperature** *θ (ºC)*
A	Adiabatic	infinite	infinite	-
B	External	0.04	0.04	0
C	Internal	0.13	0.2	20

The previously calculated values, which are representative of the window sections, as well as the glazing transmittance value utilised, are used according to the guidelines from the standard UNE EN ISO 10077-1:2010 for the thermal transmittance calculation of the window as a whole.

6. SAMPLE DESCRIPTION.

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

The values of the thermal conductivity of the materials, λ, used in the calculations are obtained from the table D.2 of the standard:

Key	Material	Thermal conductivity, λ *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 [a]	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[b]
a Introduce a comment in the report about the superficial treatment, like coated or anodising, if the surface emissivity is ε_n = 0.85. b Equivalent thermal conductivity of the gas filling		

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)

The emissivity value used for all the materials is ε=0,9; except for the surfaces between polyamides where the value used is ε=0,1 according to the table A.4 of the standard EN ISO 10077-2:2012.

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

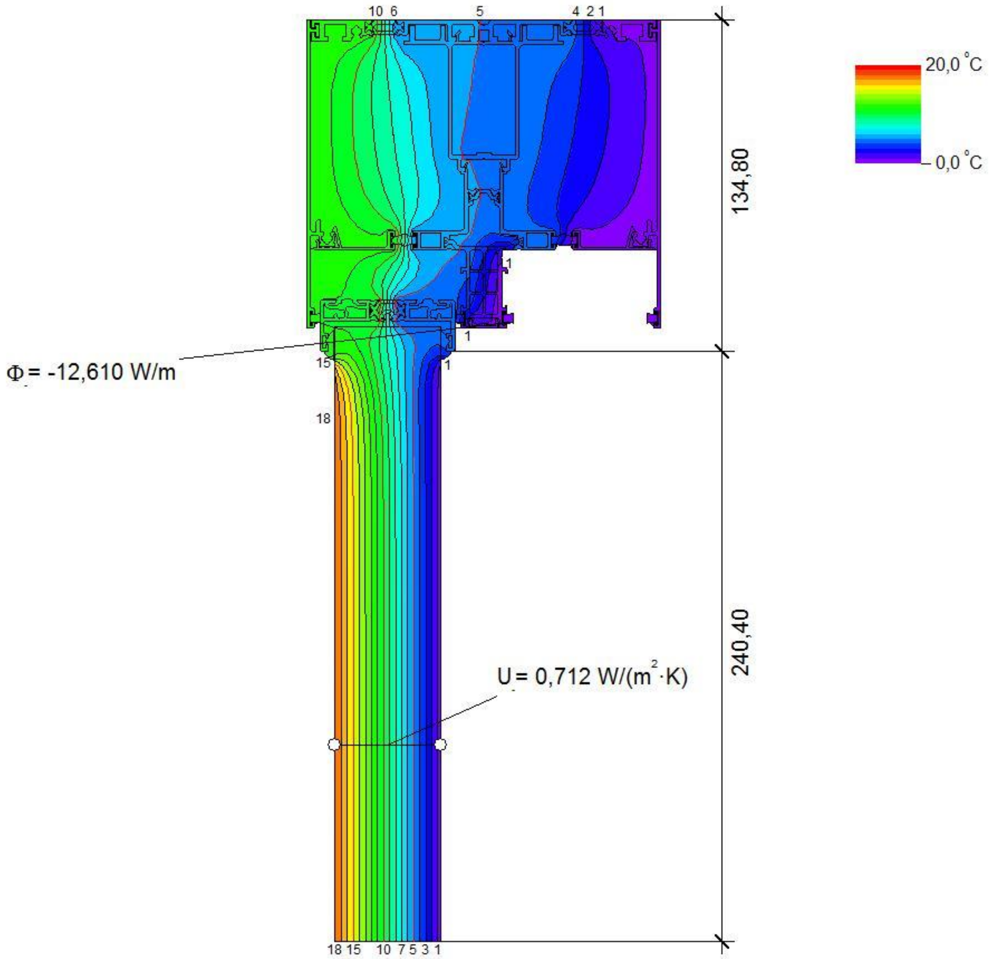
A double-sash window of 4000 x 3000 mm (width x height) was used for the calculation of the thermal transmittance coefficient of the entire window, U_w, as described in figure 1. The glass composition used was "6 Low E (12Ar) 6 (14 Ar) 8 Low E", with a thermal transmittance coefficient of U_g = 0,7 (W/m^{2}K), as described in detail in part 8.2.

For the purpose of this report, the differences between the manual and motorized versions are considered. In the annex 2 of this report other thermal characteristics of the glazing can be found.

7. CALCULATION OF SECTIONS.

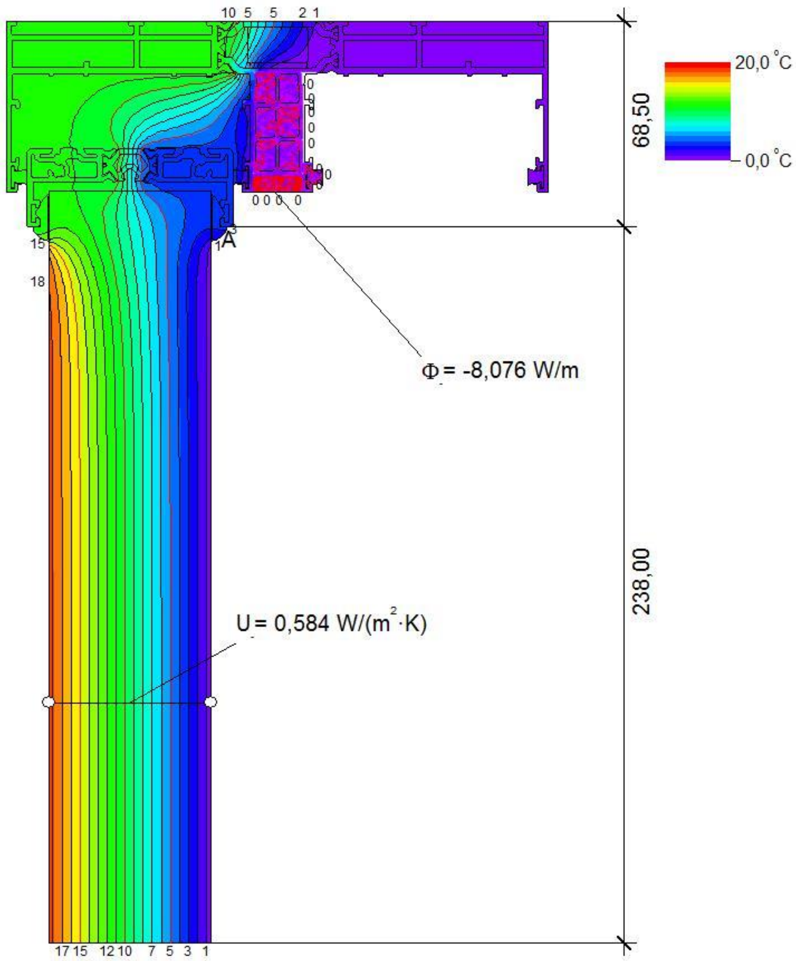
The sections calculated using the software Flixo Professional are described below:

Section 1a: (Motorised version)



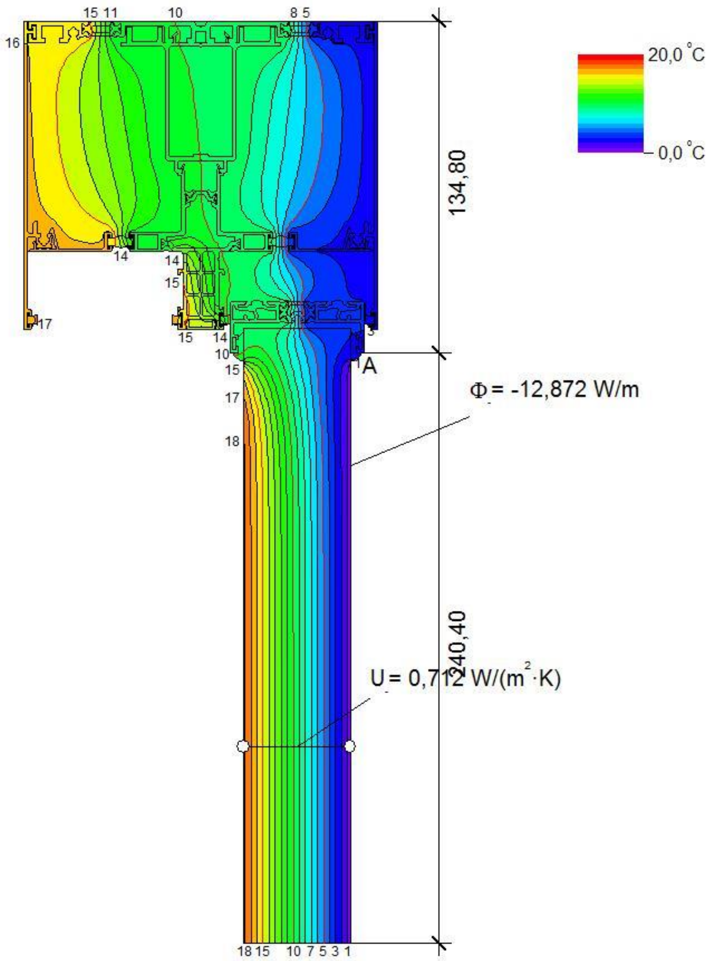
$$U_f = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{12,610}{20,000} - 0,712 \cdot 0,240}{0,135} = 3,41\ W/(m^2 \cdot K)$$

Section 1b: (Manual version)



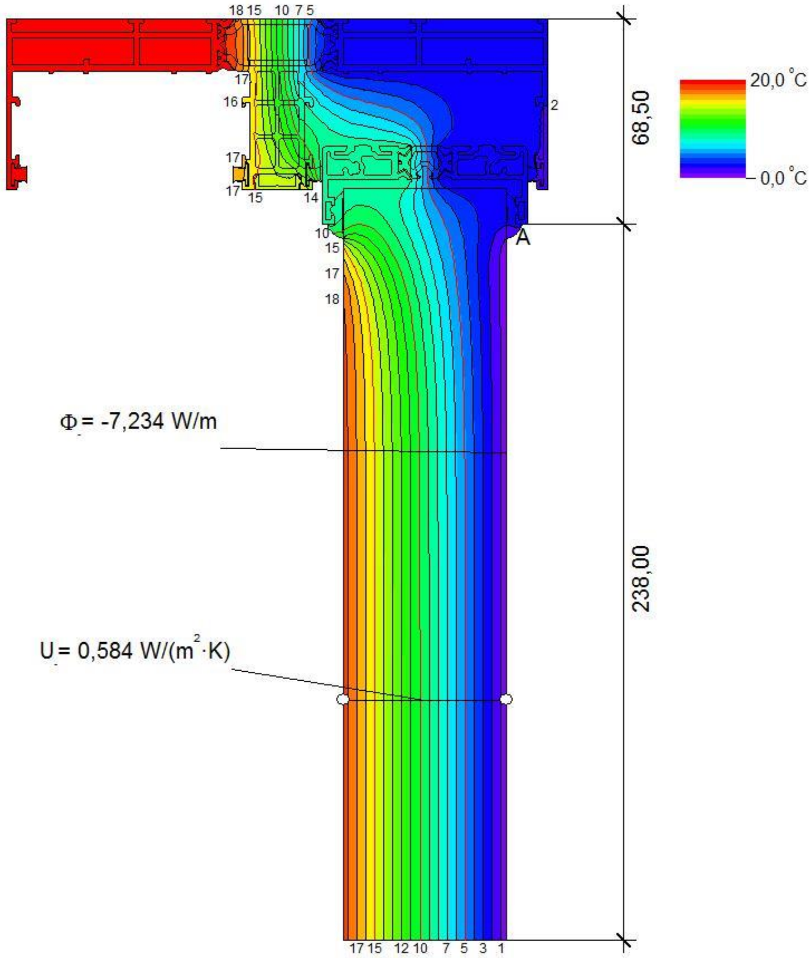
$$U_{fA} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{8,076}{20,000} - 0,584 \cdot 0,238}{0,069} = 3,87\ W/(m^2 \cdot K)$$

Section 2a: (Motorised version)



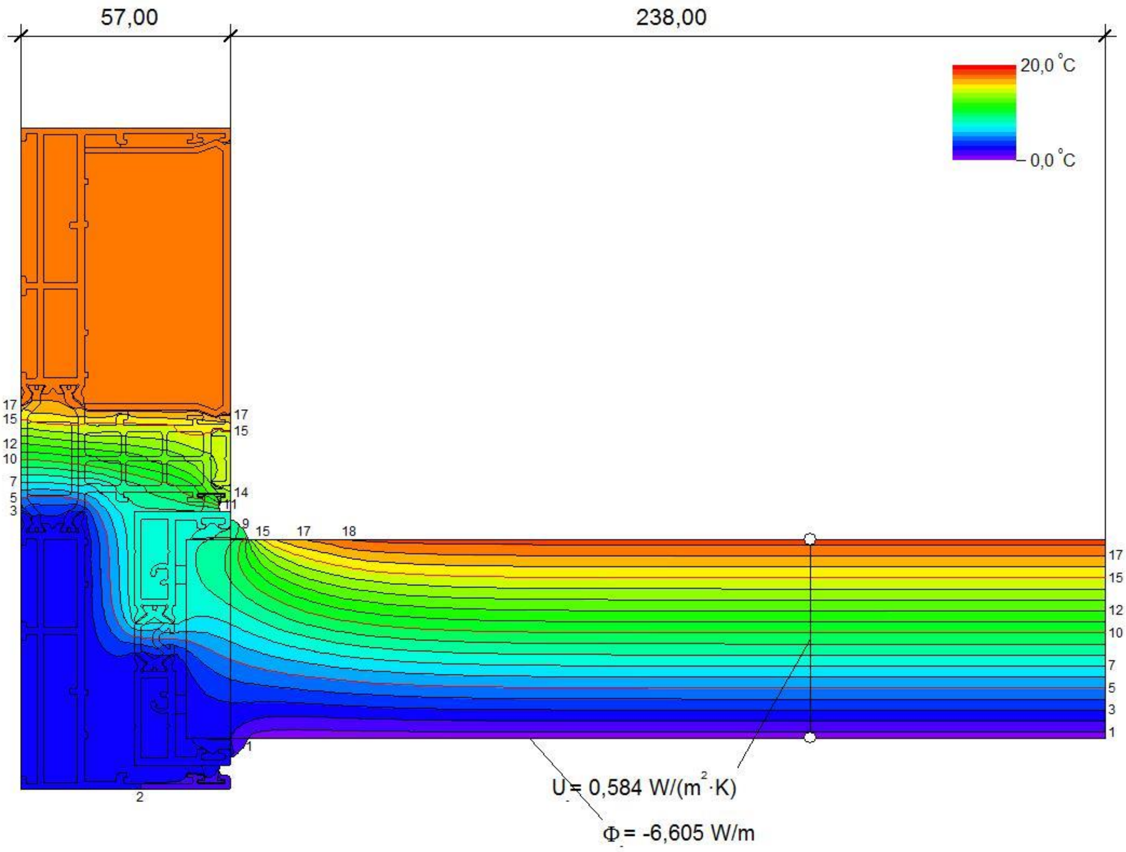
$$U_{fA} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{12,872}{20,000} - 0,712 \cdot 0,240}{0,135} = 3,50\ W/(m^2 \cdot K)$$

Section 2b: (Manual version)



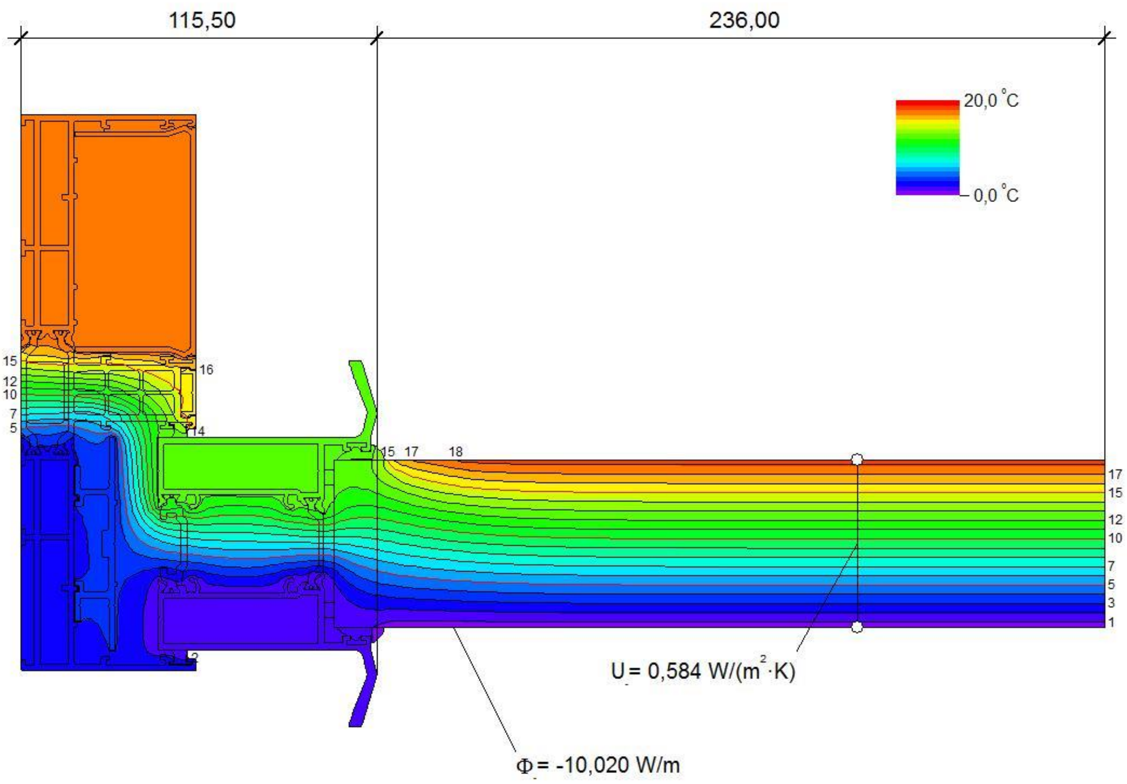
$$U_{fA} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{7,234}{20,000} - 0,584 \cdot 0,238}{0,069} = 3,25\ W/(m^2 \cdot K)$$

Section 3a: (Motorised version)



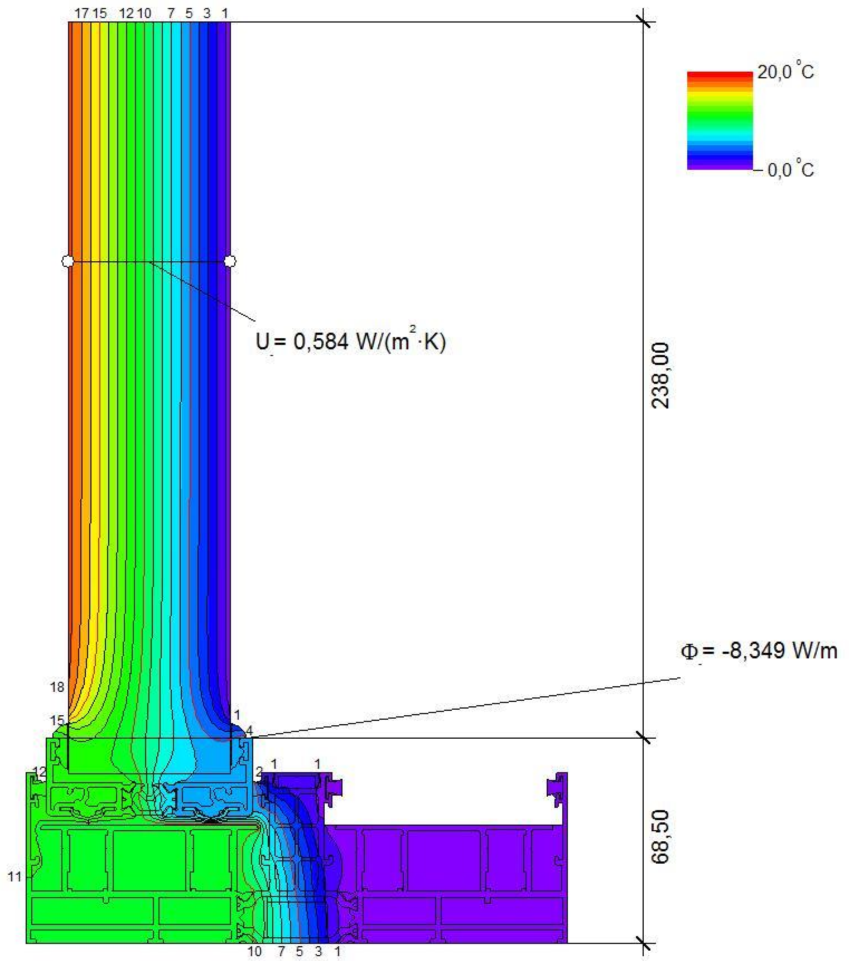
$$U_f = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{6,605}{20,000} - 0,584 \cdot 0,238}{0,057} = 3,36\ W/(m^2 \cdot K)$$

Section 3b: (Manual version)



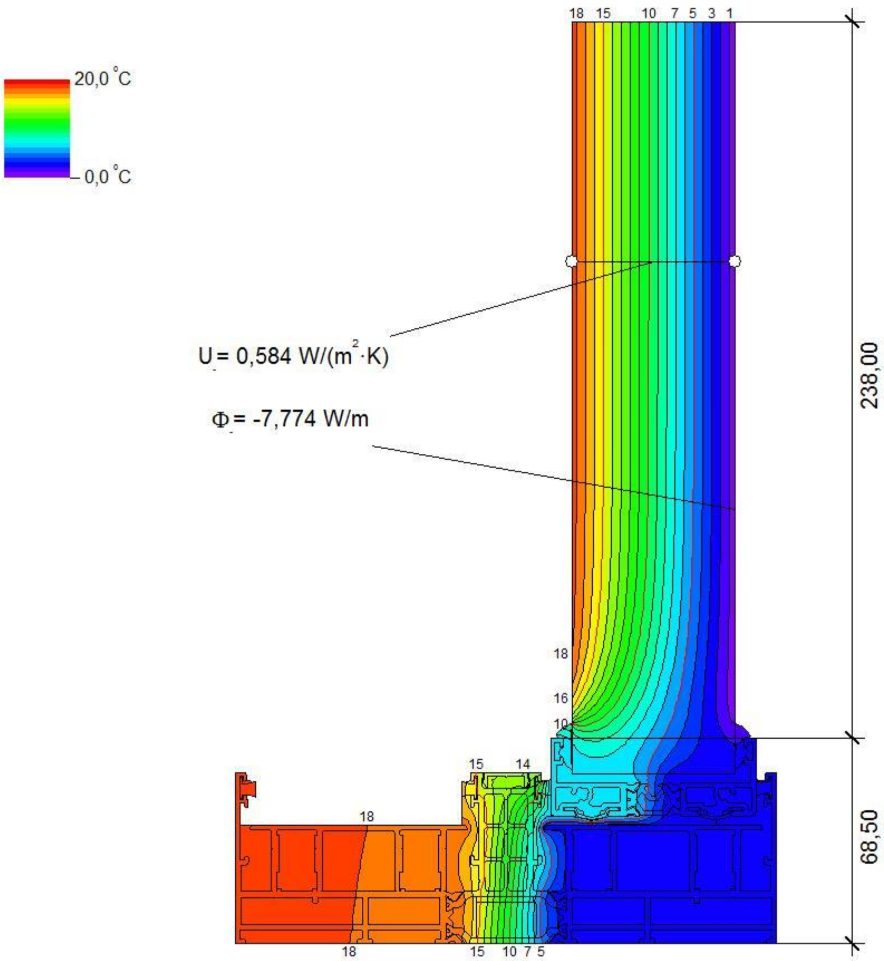
$$U_f = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{10{,}020}{20{,}000} - 0{,}584 \cdot 0{,}236}{0{,}116} = 3{,}14\ W/(m^2 \cdot K)$$

Section 4: (Manual or motorised version)



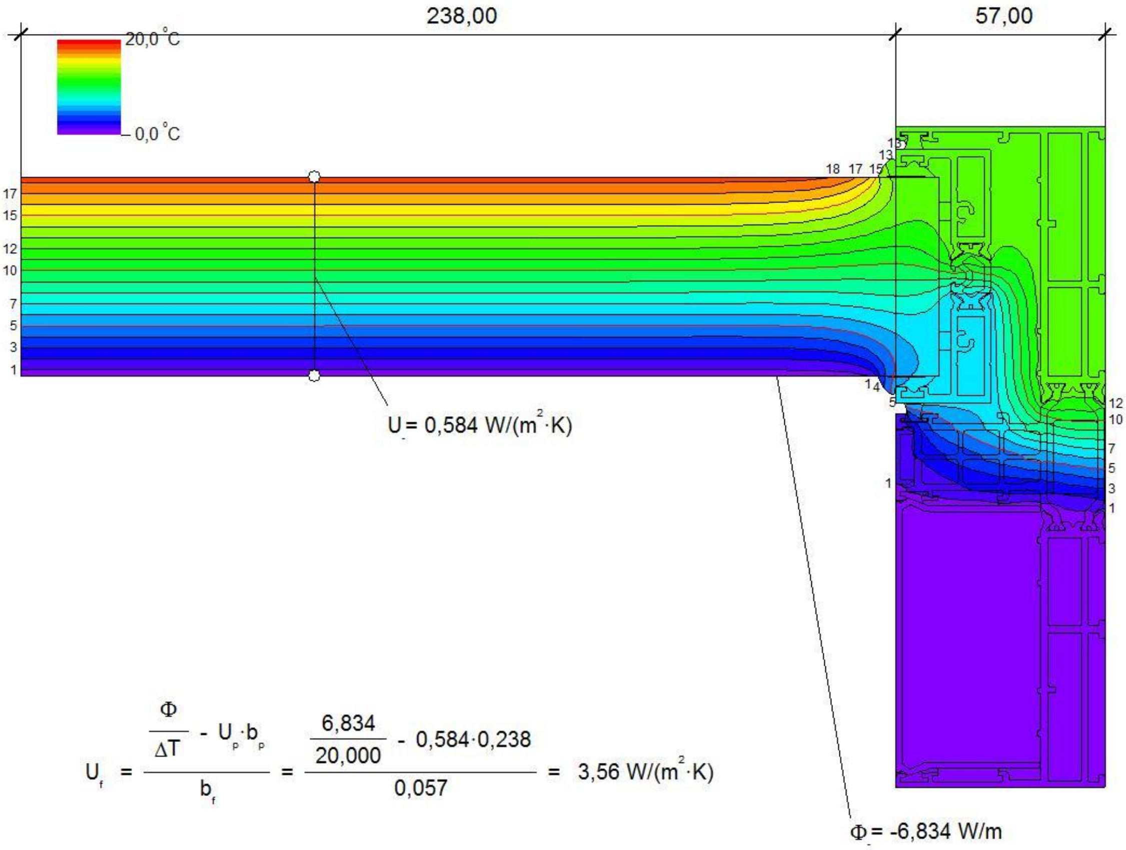
$$U_f = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{8,349}{20,000} - 0,584 \cdot 0,238}{0,069} = 4,07\ W/(m^2 \cdot K)$$

Section 5: (Manual or motorised version)



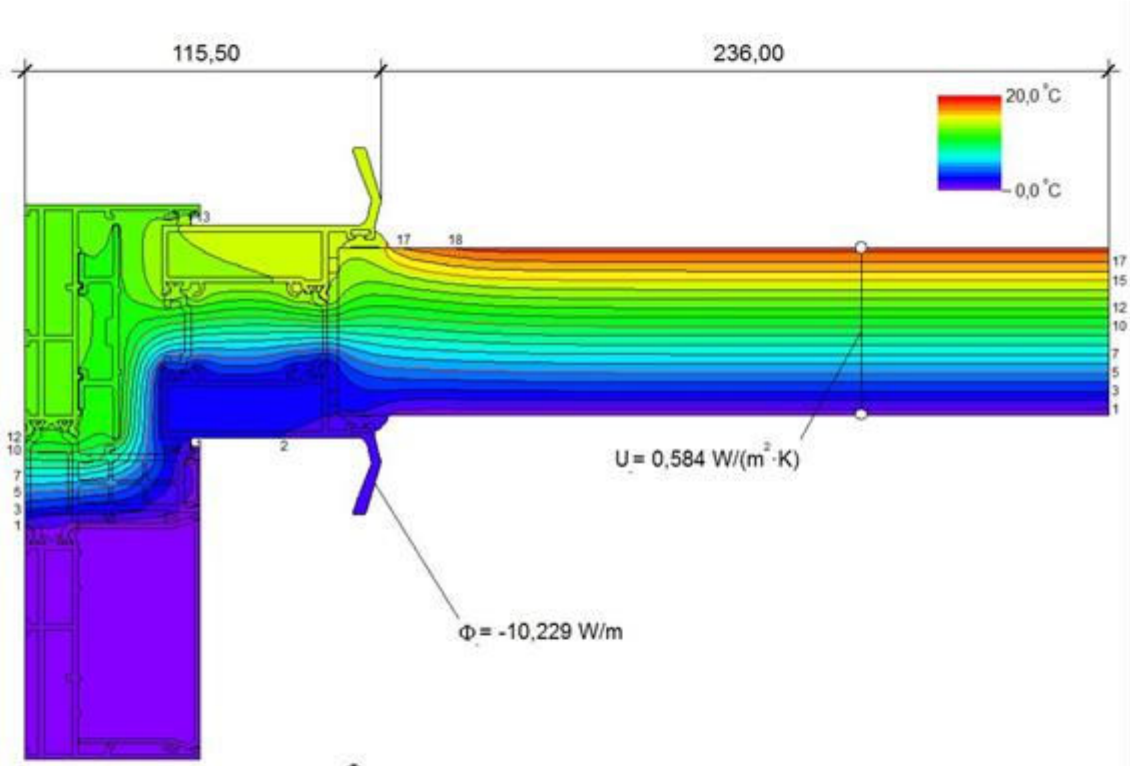
$$U_f = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{7{,}774}{20{,}000} - 0{,}584 \cdot 0{,}238}{0{,}069} = 3{,}65\ W/(m^2 \cdot K)$$

Section 6a: (Motorised version)



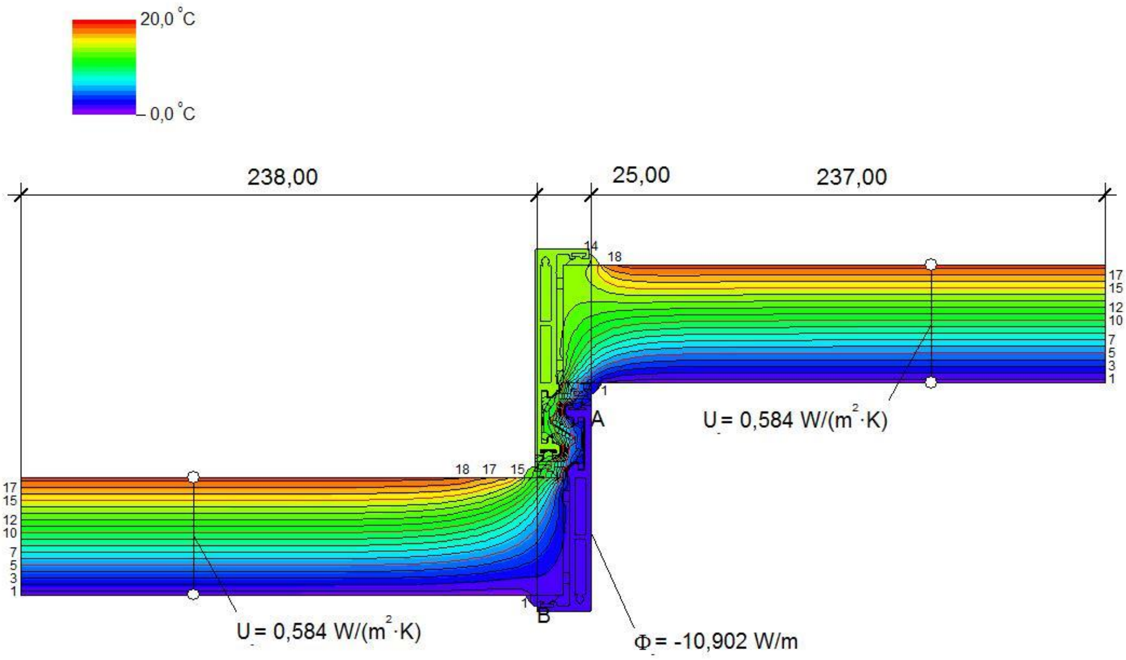
$$U_f = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{6,834}{20,000} - 0,584 \cdot 0,238}{0,057} = 3,56\ W/(m^2 \cdot K)$$

Section 6b: (Manual version)



$$U_f = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{10,229}{20,000} - 0,584 \cdot 0,236}{0,116} = 3,24\ W/(m^2 \cdot K)$$

Section 7: (Manual or motorised version)



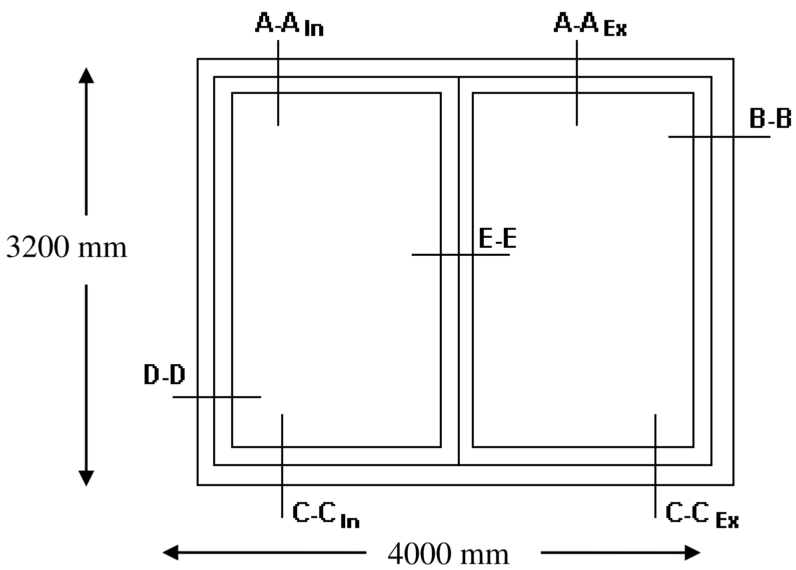
$$U_{fA,B} = \frac{\frac{\Phi}{\Delta T} - U_{p1} \cdot b_{p1} - U_{p2} \cdot b_{p2}}{b_f} = \frac{\frac{10,902}{20,000} - 0,584 \cdot 0,237 - 0,584 \cdot 0,238}{0,025} = 10,71\ W/(m^2 \cdot K)$$

8. RESULTS.

8.1 Thermal transmittance calculation of the frame.

TYPOLOGY	MOTORISED	MANUAL
RESULT:	**(W/m²K)**	**(W/m²K)**
Thermal transmittance Section A-A$_{int}$ Section 1	**3,4**	**3,9**
Thermal transmittance Section A-A$_{ext}$ Section 2	**3,5**	**3,3**
Thermal transmittance Section B-B Section 3	**3,4**	**3,1**
Thermal transmittance Section C-C$_{int}$ Section 4	**4,1**	**4,1**
Thermal transmittance Section C-C$_{ext}$ Section 5	**3,7**	**3,7**
Thermal transmittance Section D-D Section 6	**3,6**	**3,2**
Thermal transmittance Section E-E Section 7	**10,7**	**10,7**

The scheme of the window is attached below:



8.2 Thermal transmittance calculation of the glazing.

The glazing used for the calculation corresponds to one exterior floated clear glass of 6 mm coated with a low emissivity layer, a glazing cavity of 12 mm with argon and air in proportions 90% and 10% respectively, one intermediate floated clear glass of 6 mm, another glazing cavity of 12 mm with argon and air in proportions 90% and 10% respectively, and one interior floated clear glass of 6 mm coated with a low emissivity layer.

The thermal transmittance coefficient of that glazing composition is **U_g=0.7 W/m^{2}K.**

8.3 Thermal transmittance calculation of the window.

The thermal transmittance calculation of the complete window, U_w, is done according to the standard UNE-EN ISO 10077-1:2010, where:

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

A_g is the area corresponding to the glazing.
A_f is the area corresponding to each frame section described in previous points.
U_g is the thermal transmittance of the glazing described in previous points.
U_f is the thermal transmittance of each frame section described in previous points.
l_g is the visible perimeter of the glazing.
ψ_g is the linear thermal transmission coefficient of the glazing spacer bar or edge factor.

In this case, the values from the annex E.2. of the standard UNE-EN ISO 10077-1:2010 have been chosen as reference for the use of glazing bars with improved thermal performance, as detailed below:

Frame type	**Linear thermal transmittance for different types of glazing with improved thermal performance** ψ_g	
	Double or triple glazing uncoated glass air- or gass-filled	**Double[a] or triple[b] glazing low emissivity glass air- or gas-filld**
Wood or PVC	0.05	0.06
Metal with a thermal break	0.06	0.08
Metal without a thermal break	0.01	0.04
[a] One pane coated for double glazed. [b] Two panes coated for triple glazed.		

Therefore, the results of the calculations are:

Motorised version:

	Uf	Af	Ug	Ag	Ψg	lg	ΣU*A	(ΣU*A+Σψ*l)/(ΣA)
seccion A-A	3,4	0,27	-	-	-	-	0,92	1,15
seccion A-A'	3,5	0,27	-	-	-	-	0,94	
seccion B-B	3,4	0,16	-	-	-	-	0,54	
seccion C-C	4,1	0,14	-	-	-	-	0,56	
seccion C-C'	3,7	0,14	-	-	-	-	0,50	
seccion D-D	3,6	0,16	-	-	-	-	0,57	
seccion E-E	10,7	0,07	-	-	-	-	0,75	
Vidrio	-	-	0,7	10,80	-	-	7,56	
Ψ	-	-	-		0,08	18,91	1,51	
ΣA	-	1,20	-	10,80	-	-	13,84	
ΣAg+ΣAf	12,00							
Uw	**1,15**							

Manual version:

	Uf	Af	Ug	Ag	Ψg	lg	ΣU*A	(ΣU*A+Σψ*l)/(ΣA)
seccion A-A	3,9	0,14	-	-	-	-	0,53	1,16
seccion A-A'	3,3	0,14	-	-	-	-	0,45	
seccion B-B	3,1	0,33	-	-	-	-	1,04	
seccion C-C	4,1	0,14	-	-	-	-	0,56	
seccion C-C'	3,7	0,14	-	-	-	-	0,50	
seccion D-D	3,2	0,33	-	-	-	-	1,07	
seccion E-E	10,7	0,07	-	-	-	-	0,77	
Vidrio	-	-	0,7	10,72	-	-	7,50	
Ψ	-	-	-		0,08	18,94	1,52	
ΣA	-	1,28	-	10,72	-	-	13,93	
ΣAg+ΣAf	12,00							
Uw	**1,16**							

RESULT OF THE CALCULATION:

U_w=1,2 W/m²K.

David Macía Arias
Laboratory Director

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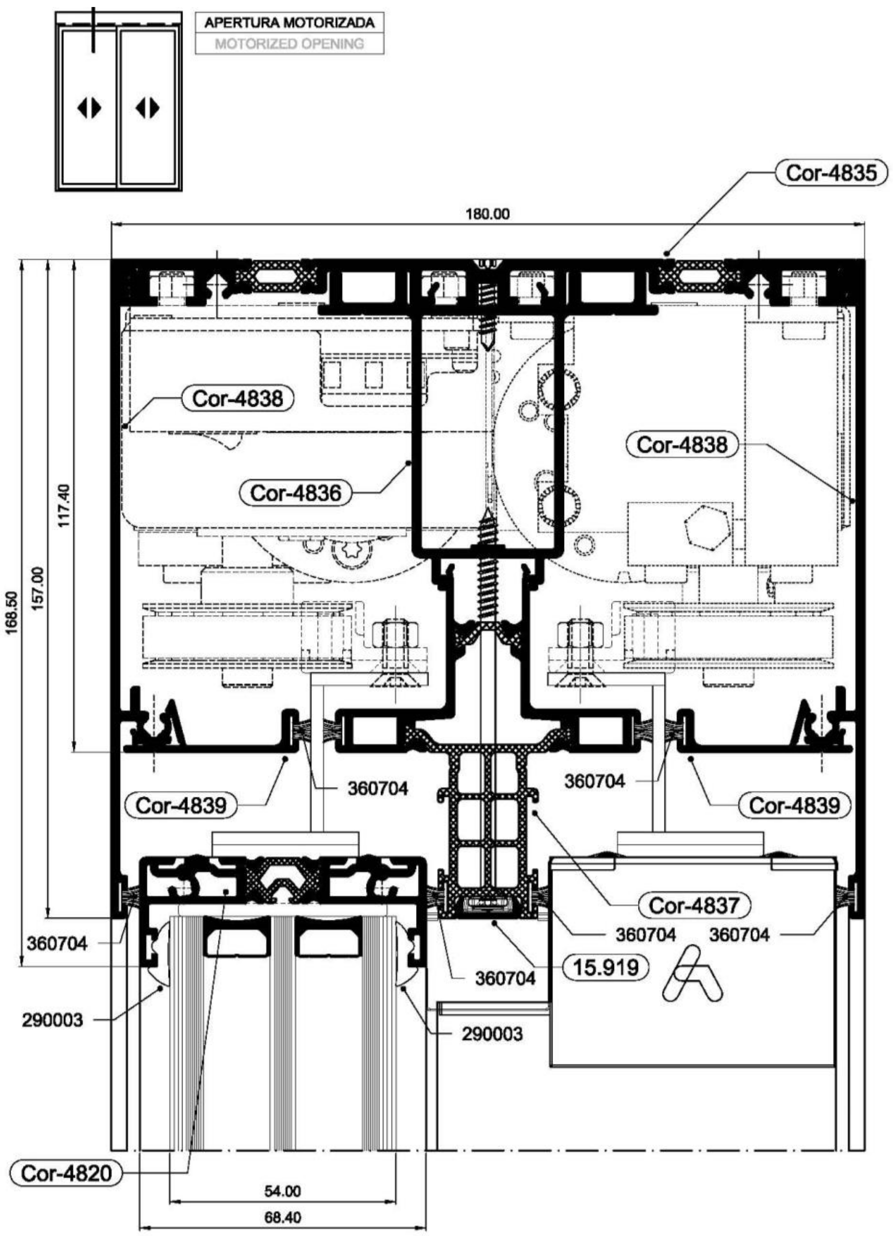
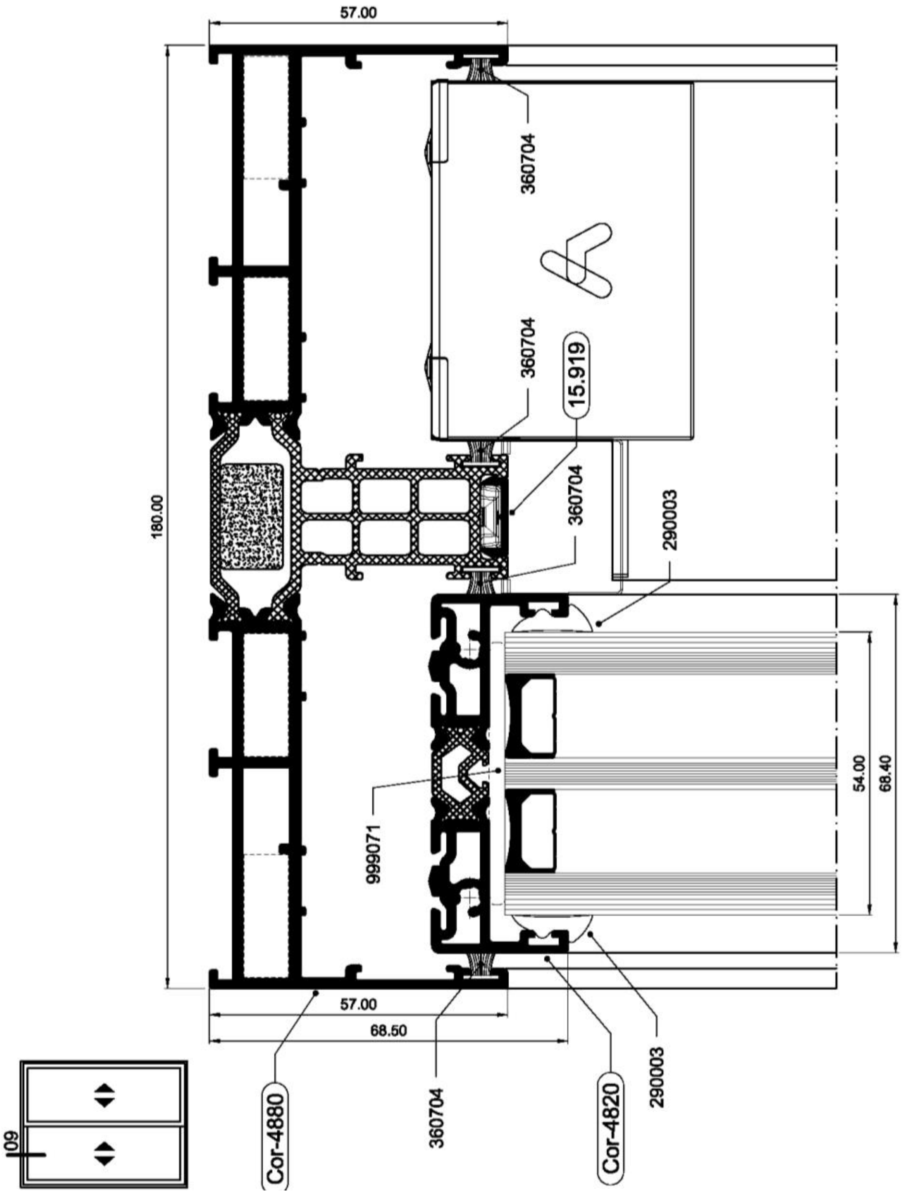
ANNEX 1. TECHNICAL DOCUMENTATION.

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

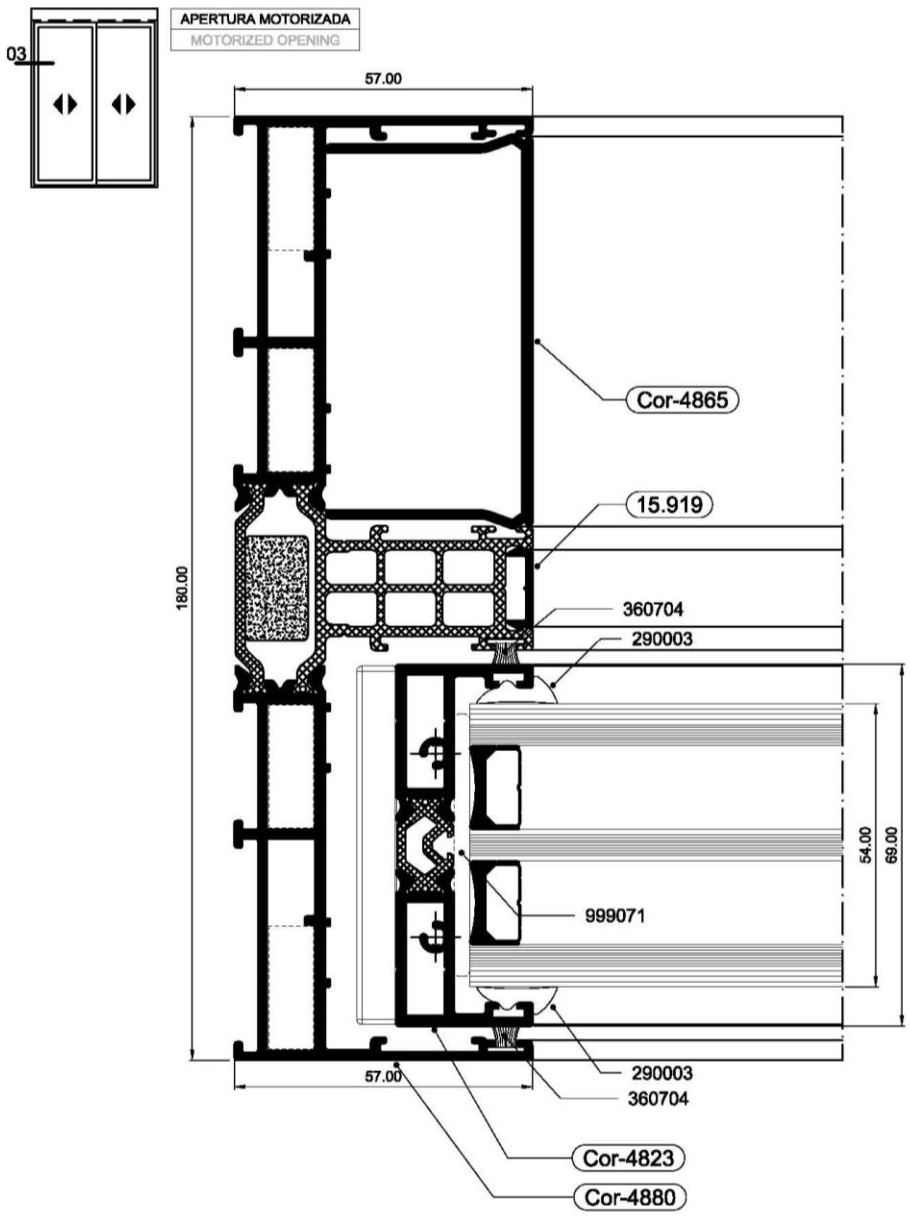
MOTORISED TOP SECTION



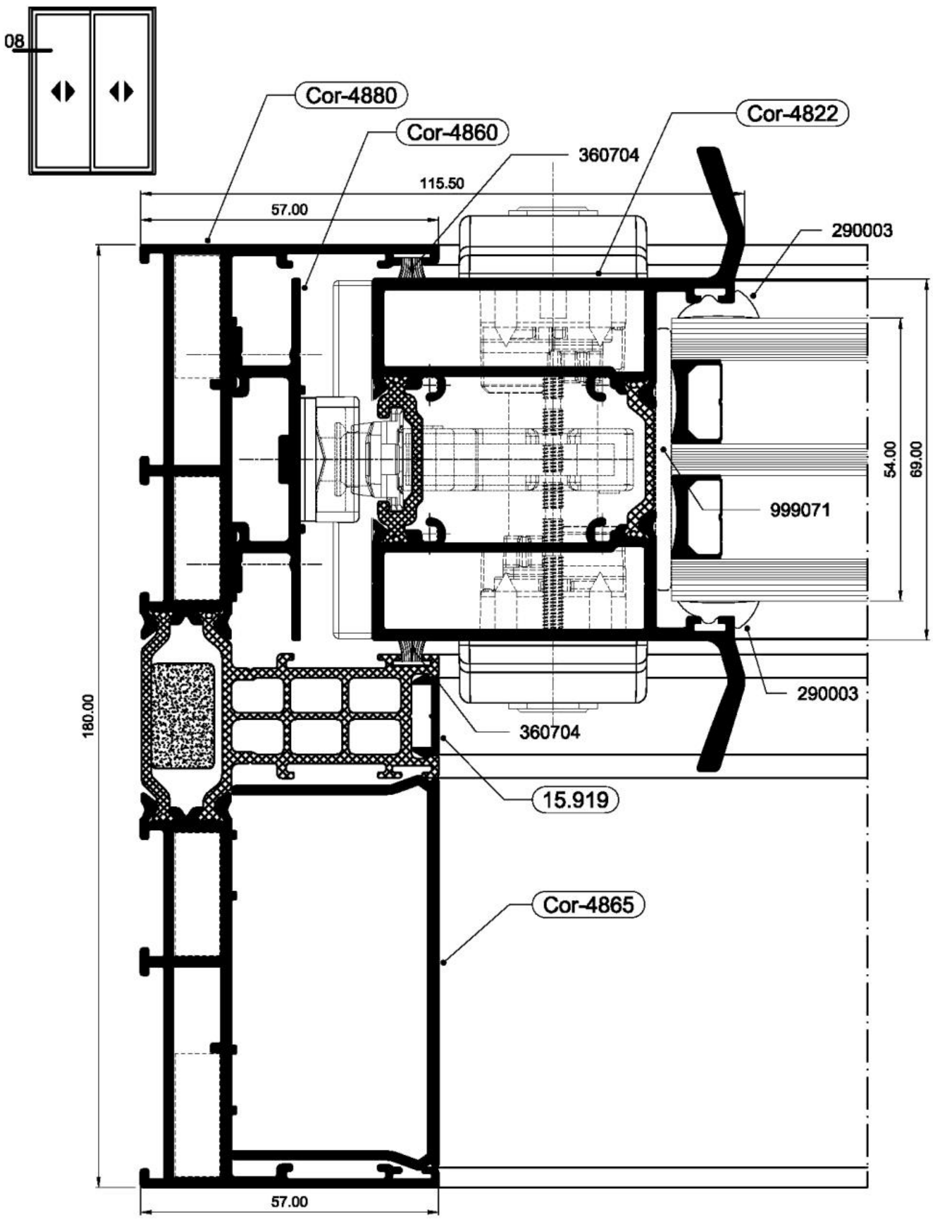
MANUAL TOP SECTION



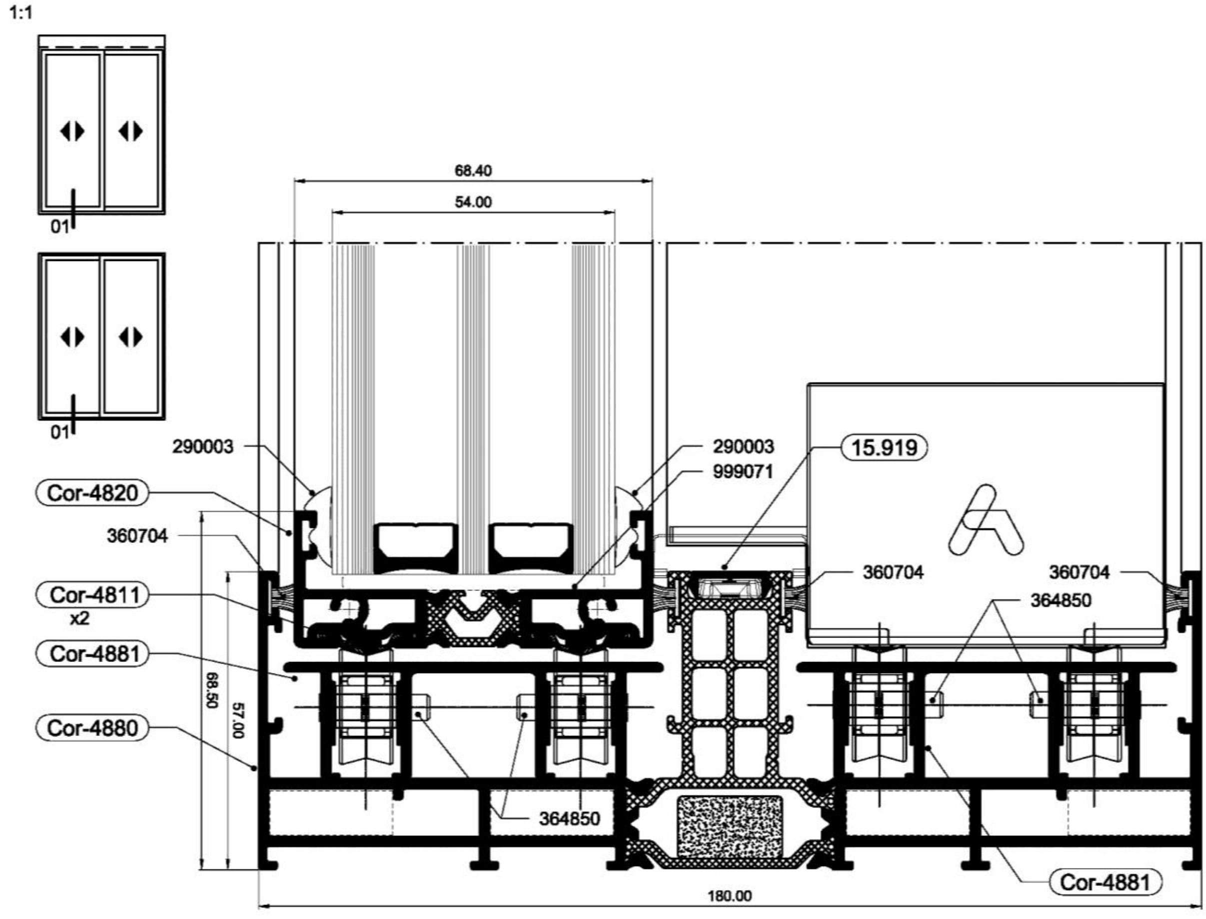
MOTORISED LATERAL SECTION



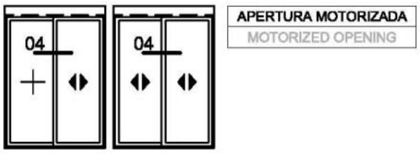
MANUAL LATERAL SECTION

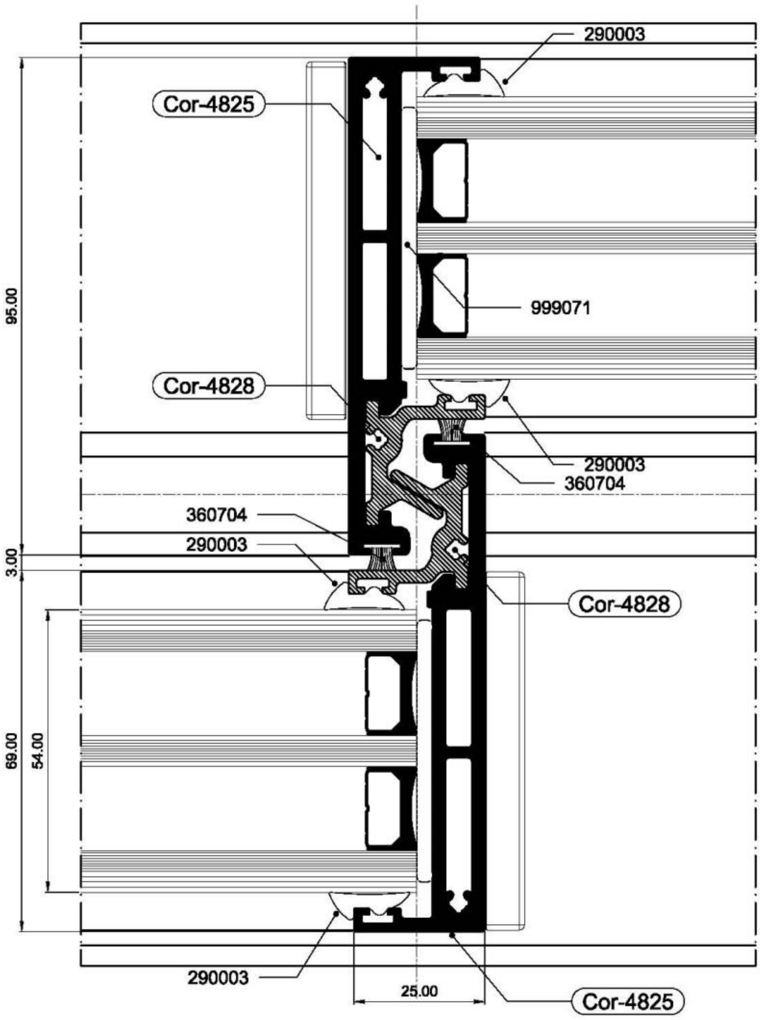


MOTORISED AND MANUAL BOTTOM SECTION



MOTORISED AND MANUAL CENTRAL SECTION





ANEXO 2. THERMAL TRANSMITTANCE CALCULATION OF THE WINDOW ACCORDING TO THE THERMAL TRANSMITTANCE OF THE GLAZING.

The following table relates the thermal transmission of the complete window U_W to the thermal transmission U_g of the chosen glazing for the characteristics described in this report

Typology	Motorised	Manual
Ug (W/m2K)	Uw* (W/m2K)	Uw* (W/m2K)
0,5	0,97	0,98
0,6	1,06	1,07
0,7	1,15	1,16
0,8	1,24	1,25
0,9	1,33	1,34
1	1,42	1,43
1,1	1,51	1,52
1,2	1,60	1,61
1,3	1,69	1,70
1,4	1,78	1,79
1,5	1,87	1,88
1,6	1,96	1,96
1,7	2,05	2,05
1,8	2,14	2,14
1,9	2,23	2,23
2	2,29	2,29
2,2	2,47	2,47
2,4	2,65	2,65
2,6	2,83	2,83
2,8	3,01	3,00
3	3,19	3,18

*The values indicated in the table correspond to a double-sash window whose characteristics are described previously, with total dimensions of 4000x3000 mm (width x height).
- For the calculation, it is considered that the glazings with the Ug value lower than 2 W/m^{2}K have at least one low emissivity pane coated, and the ones with values Ug ≥ 2 W/m^{2}K don't have any pane coated.
- The linear thermal transmittance was established for spacer glazing bars improved according to the Annex E.2 of the standard UNE EN 10077-1:2010.
- Any variation in the dimensions of the window or in the glazing typology can give rise to changes in the result.