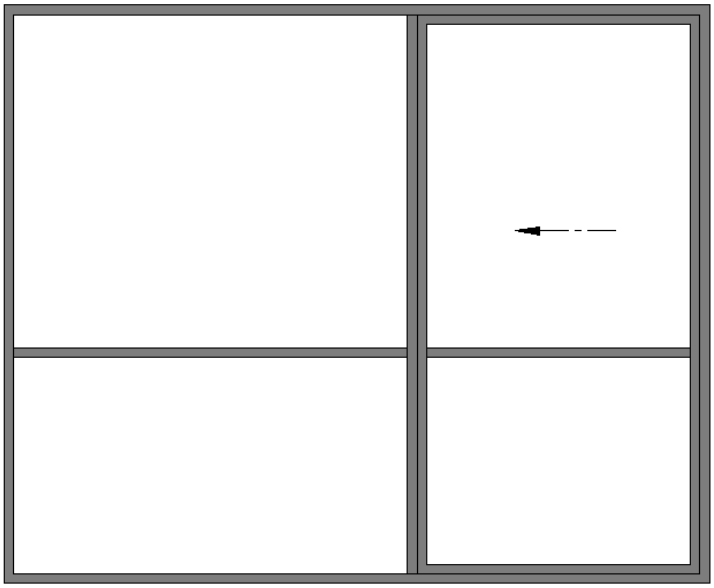
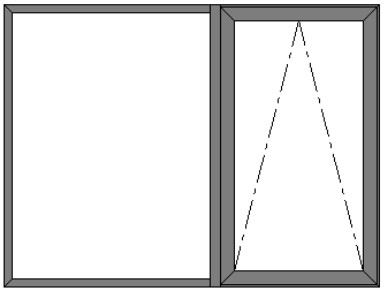
Thermal Assessment Report

R-Value of Joinery Configurations





Document No: DEL565F-TAR-01, REV1

DATE	REVISION	DESCRIPTION	PREPARED BY	CHECKED BY
15-04-24	0	R Value of Joinery Configurations	Buddhi De Silva	Niño Barrera
17-04-24	1	R Value of Joinery Configurations including glass	Buddhi De Silva	Niño Barrera

Table of Contents

1.0 Introduction

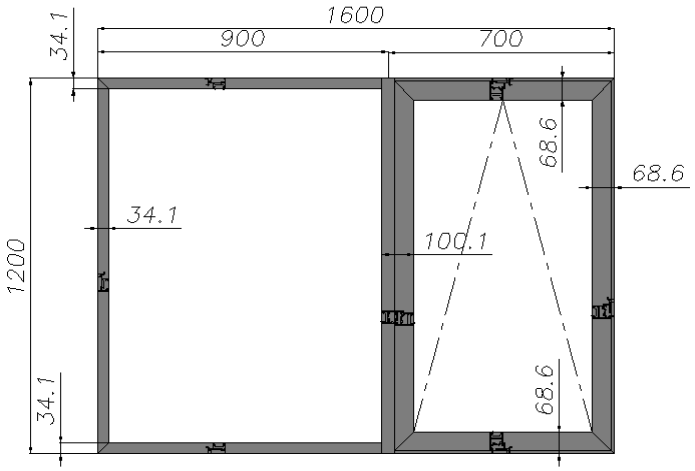
Design Engineers Ltd was engaged by Rangi Windows Ltd to calculate the R value of their sample joinery configurations. Thermal conductivity per ISO 10077-2.

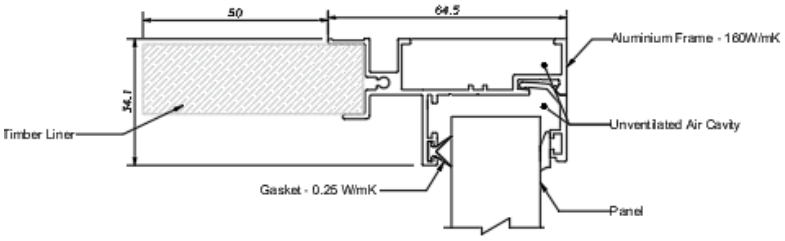
All R Value calculations are applicable to the size and configurations specified in Section 1.1 only.

Glass Ug is supplied by Client.

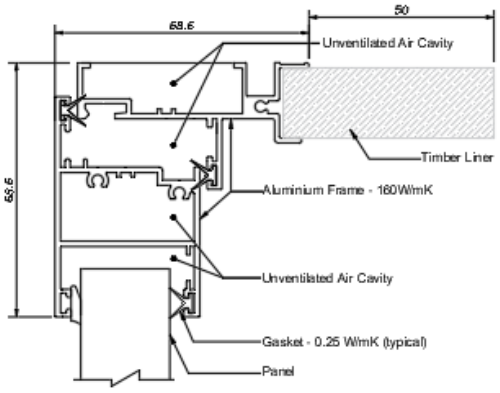
1.1 Elevations and Details

Joinery Configuration Type 1 – Fixed and Awning Window

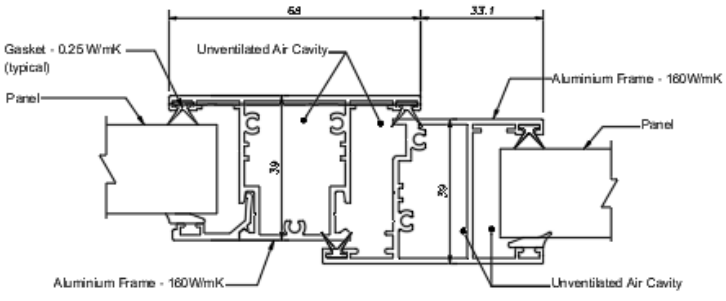




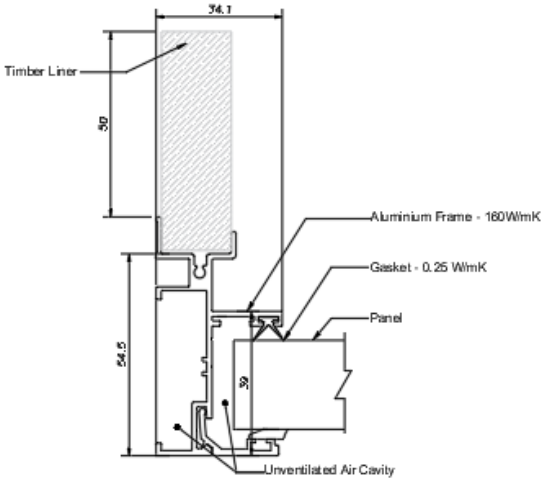
HEAD and SILL (Fixed) FRAME



HEAD and SILL (Sash) FRAME

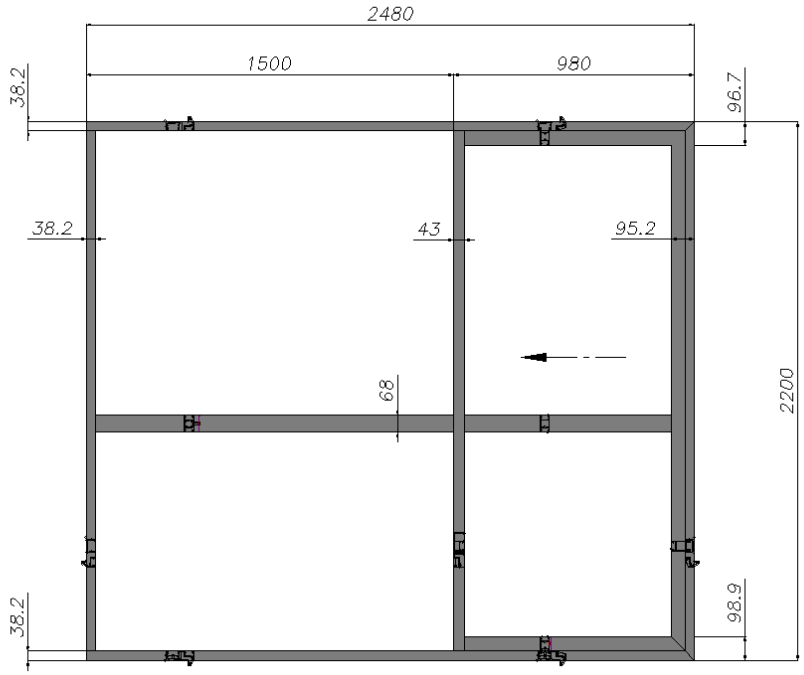


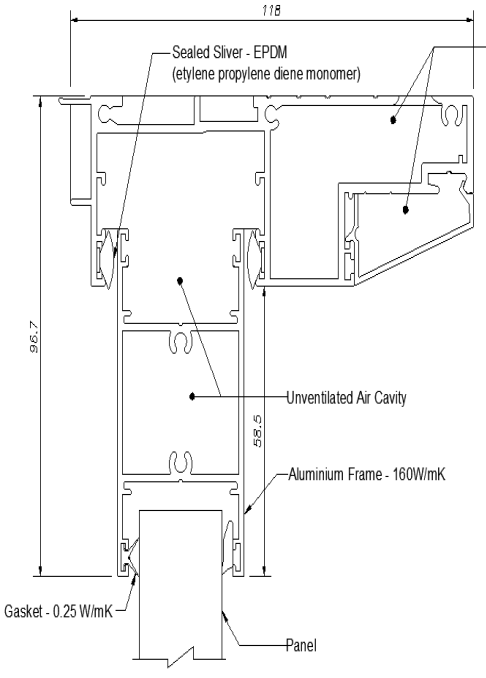
MULLION



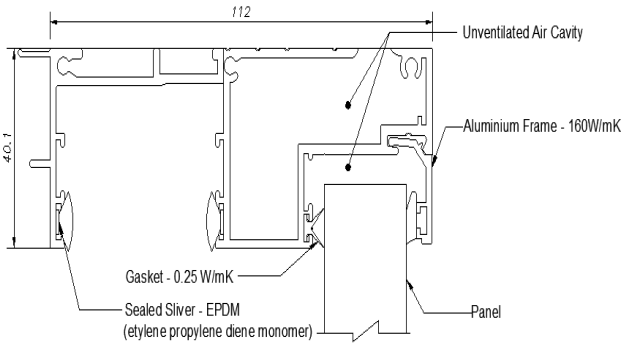
JAMB (Fixed) FRAME

Joinery Configuration Type 2 – Fixed and Sliding Door

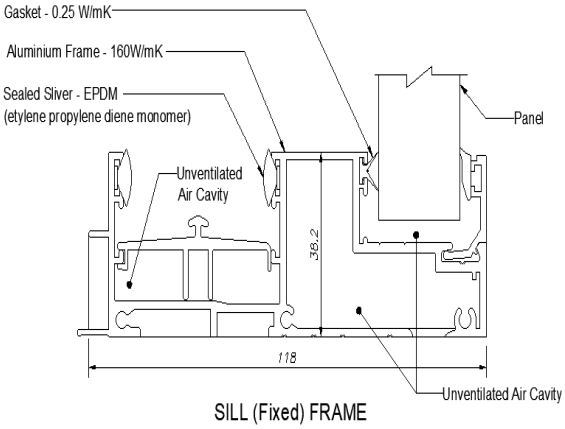




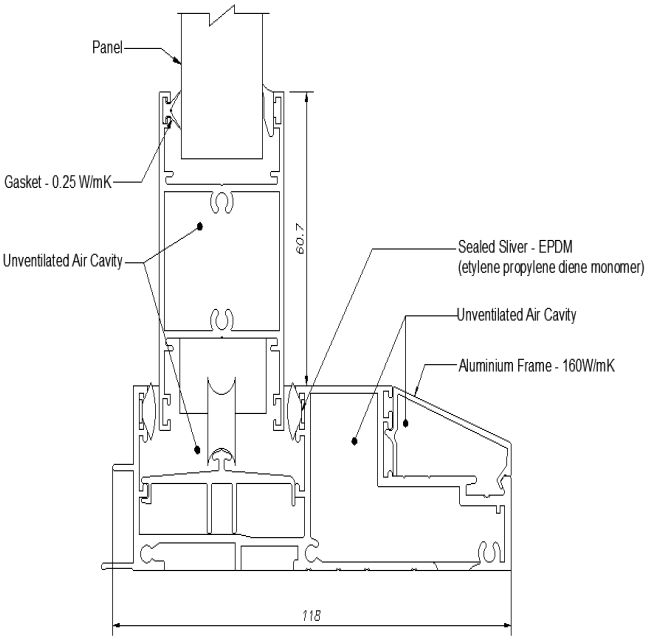
HEAD (Sash) FRAME



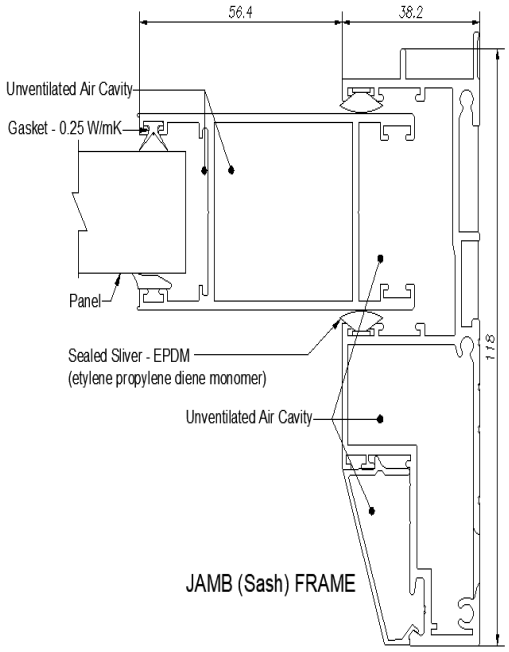
HEAD (Fixed) FRAME



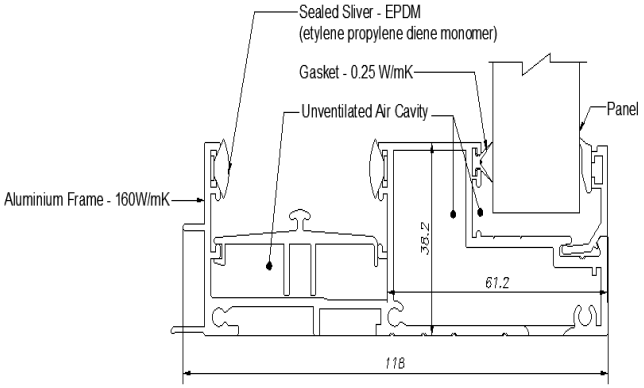
SILL (Fixed) FRAME



SILL (Sash) FRAME



JAMB (Sash) FRAME



JAMB (Fixed) FRAME

1.2 Scope of Work

This report is focused on the R value calculation of the joinery configuration types.

Joinery Type 1 = 1200mm height by 1600mm width, fixed panel with another open panel.

Joinery Type 2 = 2200mm height by 2480mm width, , fixed panel with another sliding panel.

1.3 Summary of Results

This report is focused on the R value calculation of the sample joinery configuration types 1-4.

	R-Value for Joinery Assembly - $m^2 \cdot K / W$
Joinery Type	**Using Aluminium Spacer**
Joinery Type 1 (Fixed + Awning window)	0.373
Joinery Type 2 (Fixed + Sliding door)	0.417

Aluminium spacer as per by ISO 10077-1.

See Appendix N for Calculations using Aluminium Spacer.

1.4 Material Thermal Conductivity

1. Aluminium profile = 160 W / m-K (Reference ISO 10077-2)

2. Gasket = 0.25 W / m-K (modelled as EPDM, Reference ISO 10077-2)

3. Panel = 0.035 W / m-K (for glass assembly, Reference ISO 10077-2)

4. Timber =0.13 W/ m-K (Timber liner (softwood), Reference ISO 10077-2

1.5 Surface Resistance (For Walls)

1. Internal Surface Resistance (R_{si})= 0.13 m^2-K /W (Reference ISO 10077-2)

2. External Surface Resistance (R_{se})= 0.04 m^2-K /W (Reference ISO 10077-2)

3. Adiabatic (Symmetry) Surface Resistance = 0.00 m^2-K /W

1.6 Frame Cavities

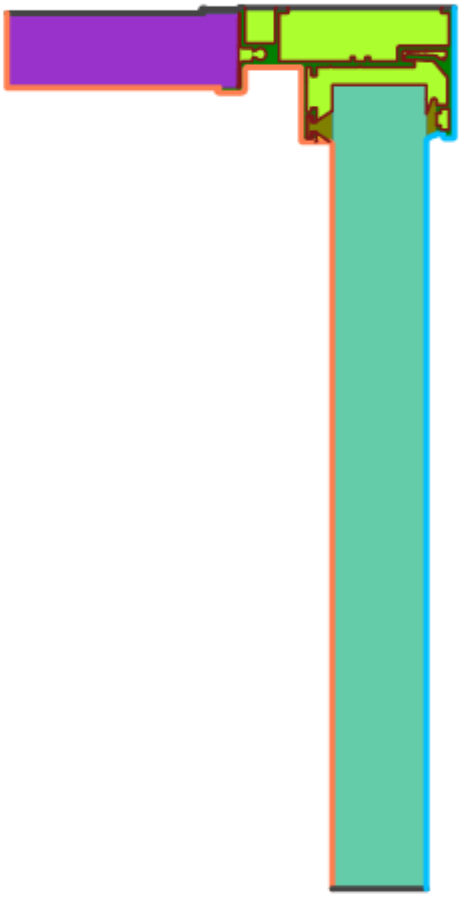
1. Frame Cavity CEN Simplified (Reference ISO 10077-2)

2. Frame Cavity CEN Slightly Ventilated (Reference ISO 10077-2)

Appendix A – Window Fixed Head

Title:Appendix A-Window Fixed Head R2.x
Reference: Drawing :

Model 1



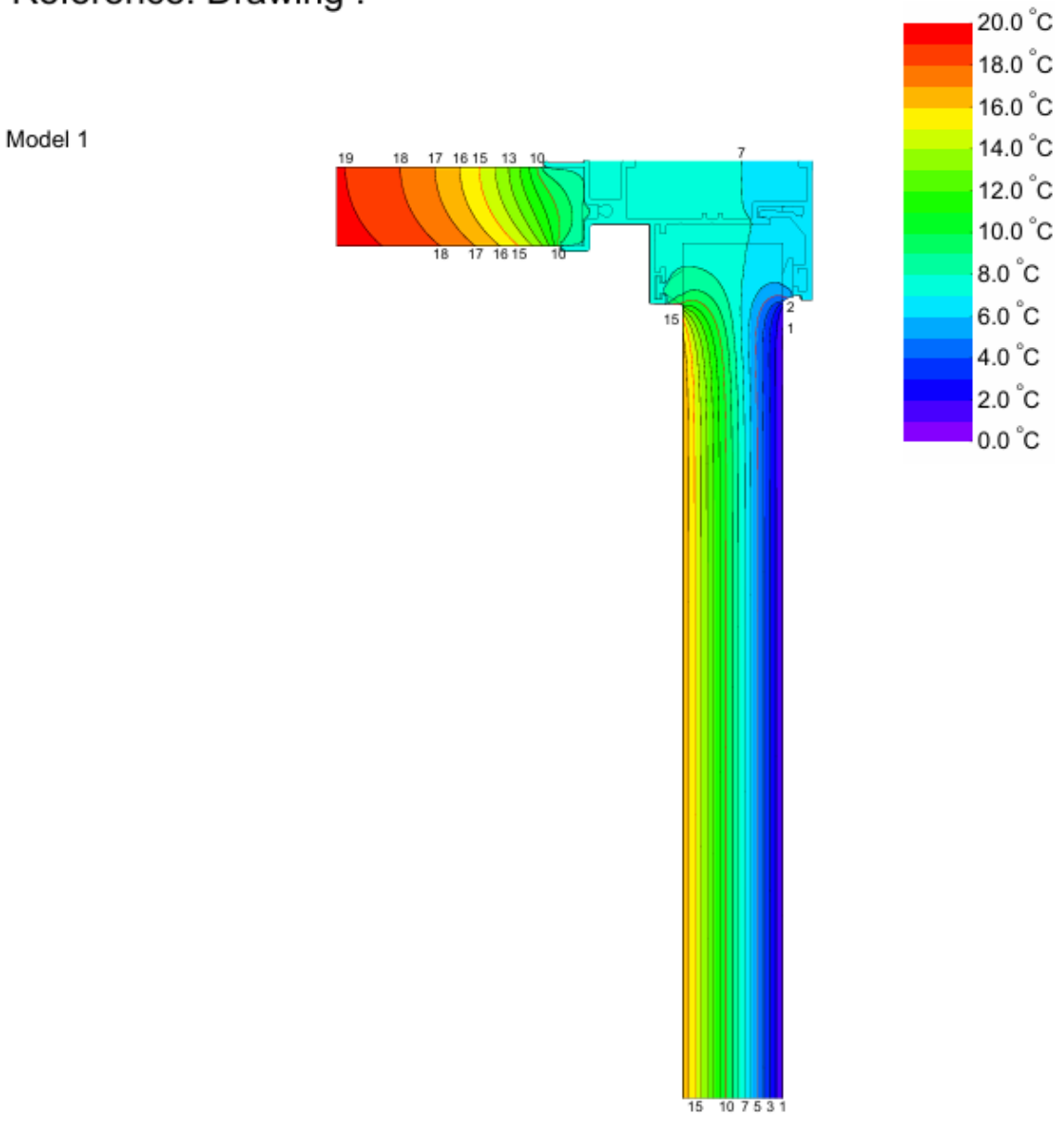
Material	λ[W/(m·K)]
DEL 565_ Unventilated air cavity *	
DEL565 _EPDM (ethylene propylene diene monomer)	0.250
DEL565_Aluminium (Si Alloys)	160.000
DEL565_Panel	0.035
DEL565_Slightly ventilated air cavity *	
DEL565_Timber Reveal	0.130

* EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
DEL565F_Exterior		0.000	0.040	
DEL565F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

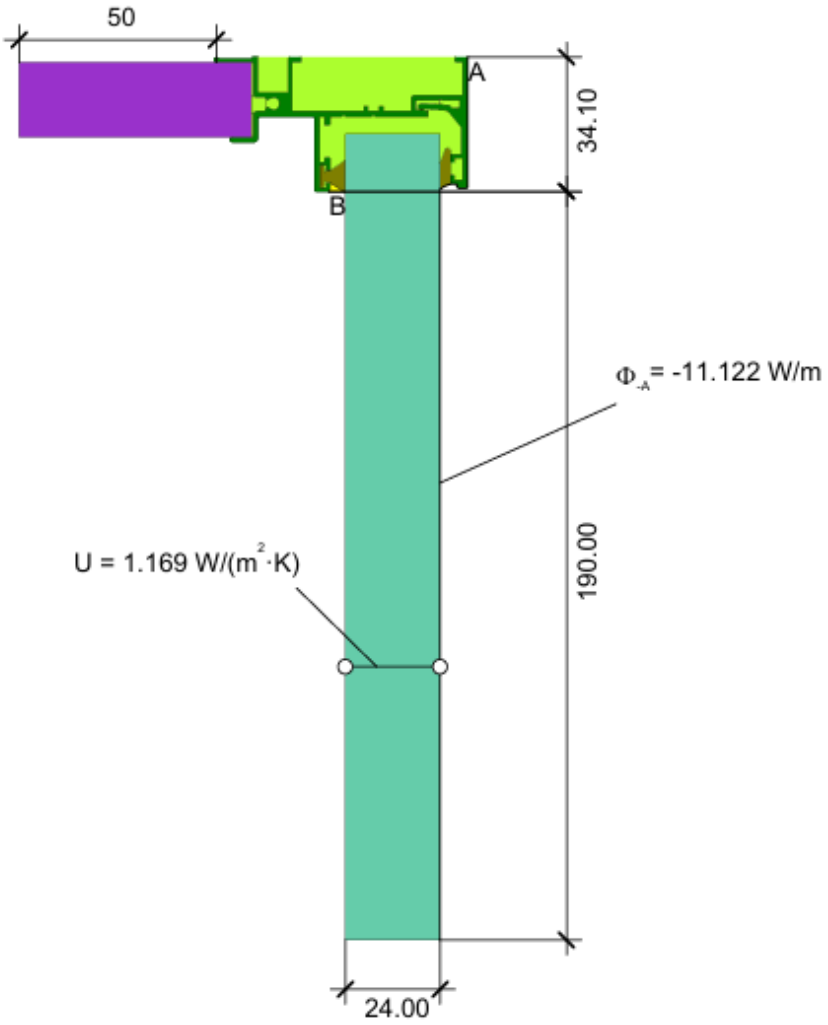
Title:Appendix A-Window Fixed Head R2.x
Reference: Drawing :

Model 1



Title:Appendix A-Window Fixed Head R2.x
Reference: Drawing :

Model 1



$$U_f = \frac{\frac{11.122}{20.0} - 1.169 \cdot 0.19}{0.034} = 9.80 \text{ W/(m}^2\text{·K)}$$

Appendix B – Window Fixed Jamb

Title:Appendix B - Window Fixed Jamb R2- x.flx
Reference: Drawing :

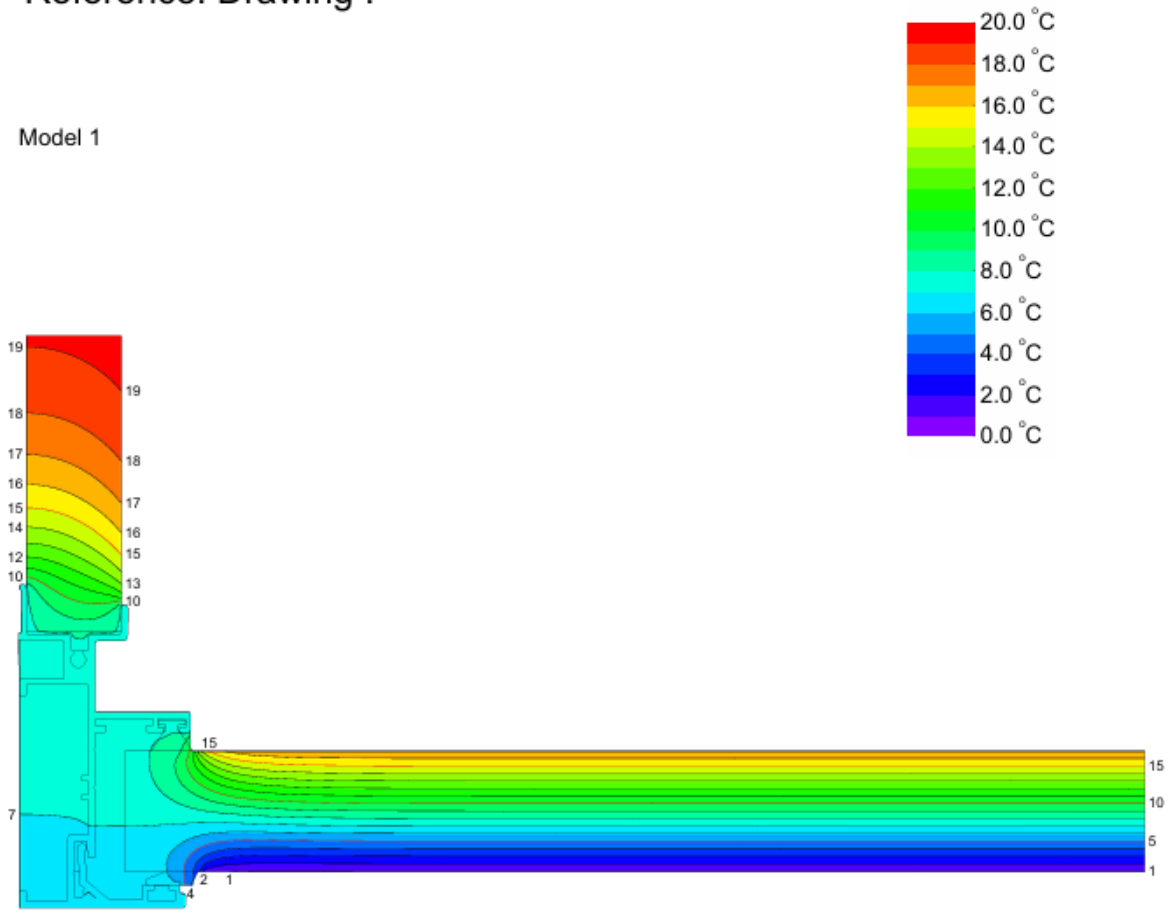
Model 1

Material	λ[W/(m·K)]
DEL 565_ Unventilated air cavity *	
DEL565 _EPDM (ethylene propylene diene monomer)	0.250
DEL565_Aluminium (Si Alloys)	160.000
DEL565_Panel	0.035
DEL565_Slightly ventilated air cavity *	
DEL565_Timber Reveal	0.130

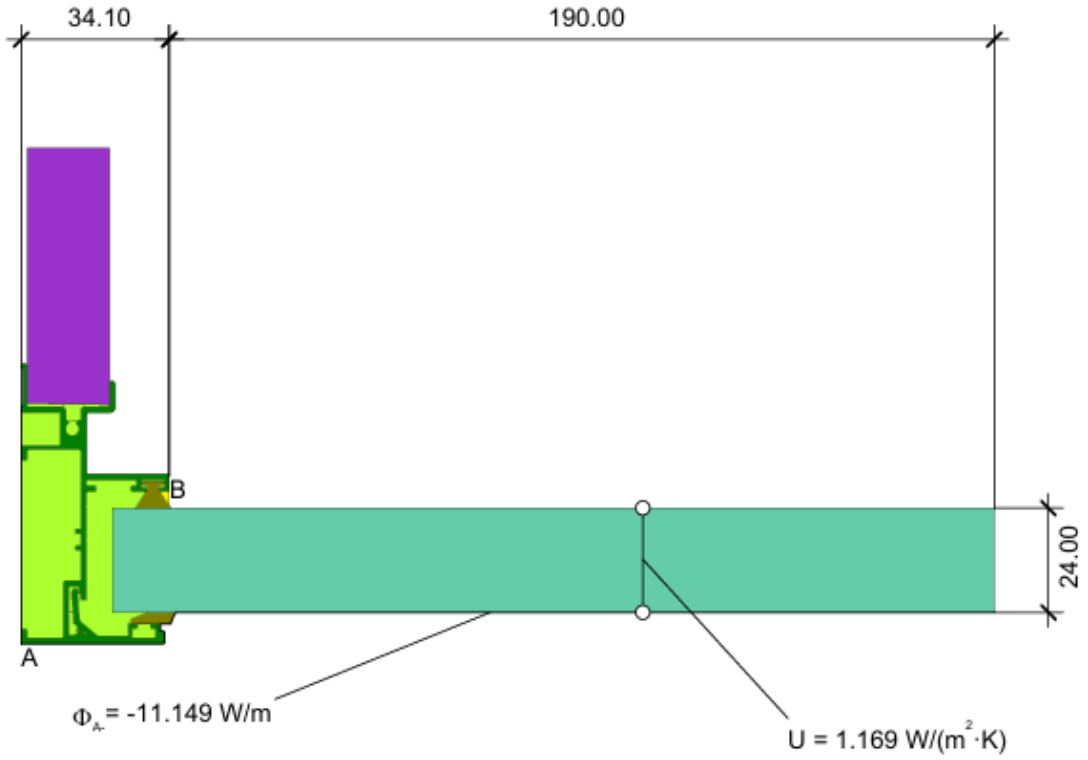
* EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
DEL565F_Exterior		0.000	0.040	
DEL565F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

Title:Appendix B - Window Fixed Jamb R2- x.flx
Reference: Drawing :



Title:Appendix B - Window Fixed Jamb R2- x.flx
Reference: Drawing :

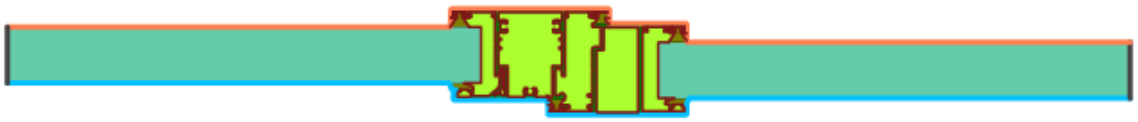


$$U_{fB,A} = \frac{\frac{11.149}{20.0} - 1.169 \cdot 0.19}{0.034} = 9.84 \text{ W/(m}^2\text{·K)}$$

Appendix C – Window Mullion

Title:Appendix C - Window Mullion R2- x.flx
Reference: Drawing :

Model 1



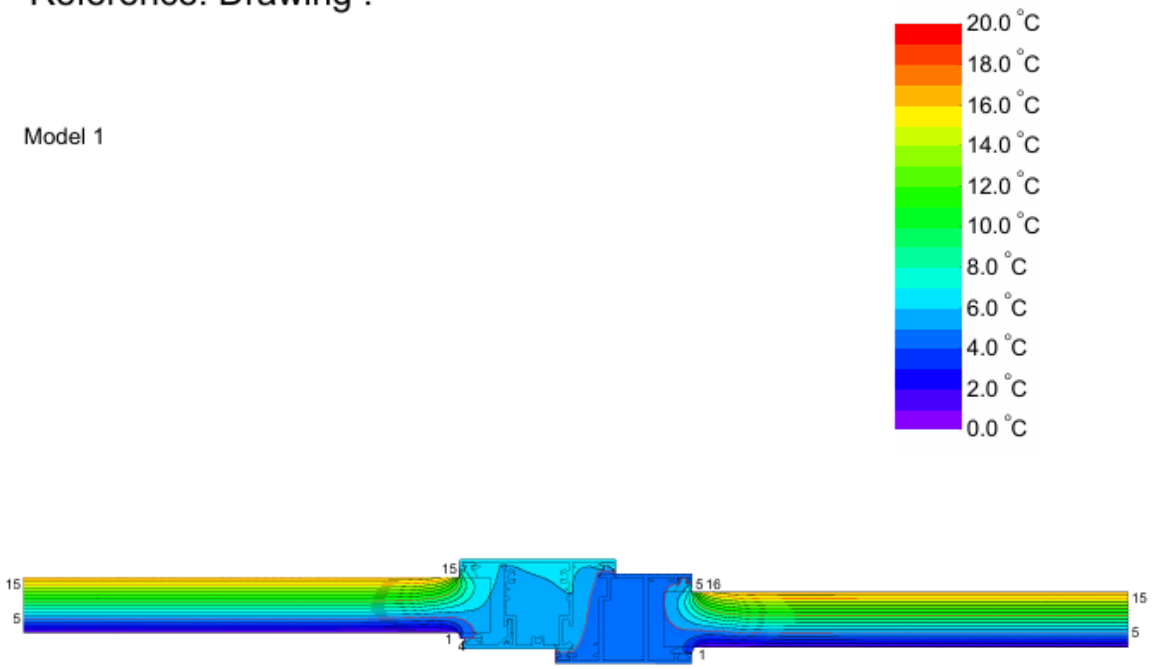
Material	λ[W/(m·K)]
DEL 565_ Unventilated air cavity *	
DEL565 _EPDM (ethylene propylene diene monomer)	0.250
DEL565_Aluminium (Si Alloys)	160.000
DEL565_Panel	0.035
DEL565_Slightly ventilated air cavity *	

* EN ISO 10077-2:2017, 6.4.3/anisotrop

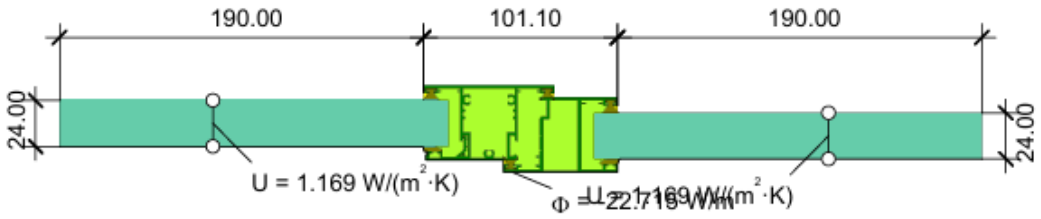
Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
DEL565F_Exterior		0.000	0.040	
DEL565F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

Title:Appendix C - Window Mullion R2- x.flx
Reference: Drawing :

Model 1



Model 1
Title: Appendix C - Window Mullion R2- x.flx
Reference: Drawing :

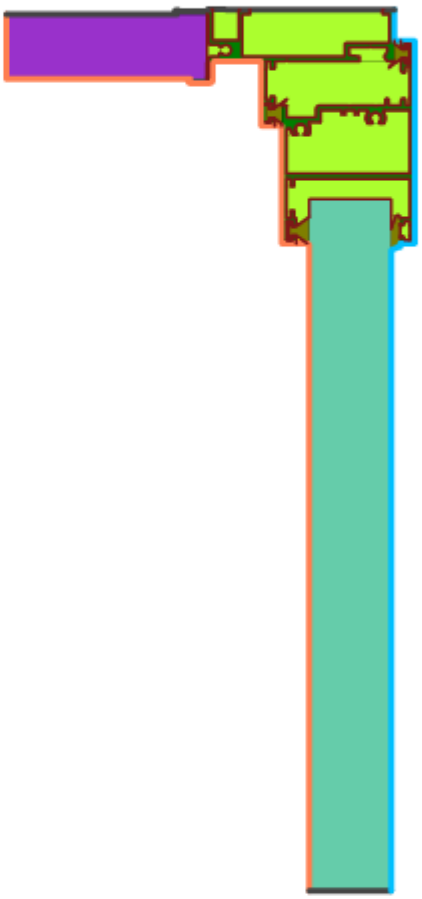


$$U_f = \frac{\frac{22.715}{20.0} - 1.169 \cdot 0.19 - 1.169 \cdot 0.19}{0.101} = 6.84 \text{ W/(m}^2\text{·K)}$$

Appendix D – Window Sash Head

Title:Appendix D - Window Sash Head R2- x.flx
Reference: Drawing :

Model 1



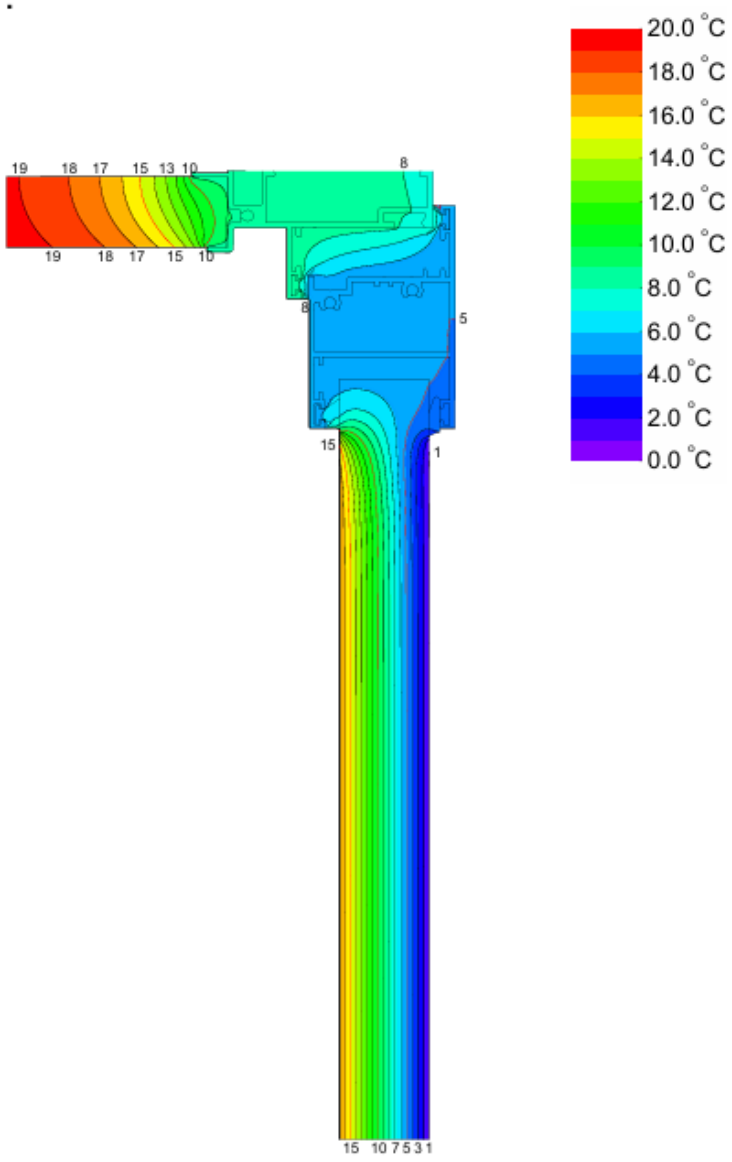
Material	λ[W/(m·K)]
DEL 565_ Unventilated air cavity *	
DEL565 _EPDM (ethylene propylene diene monomer)	0.250
DEL565_Aluminium (Si Alloys)	160.000
DEL565_Panel	0.035
DEL565_Slightly ventilated air cavity *	
DEL565_Timber Reveal	0.130

* EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
DEL565F_Exterior		0.000	0.040	
DEL565F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

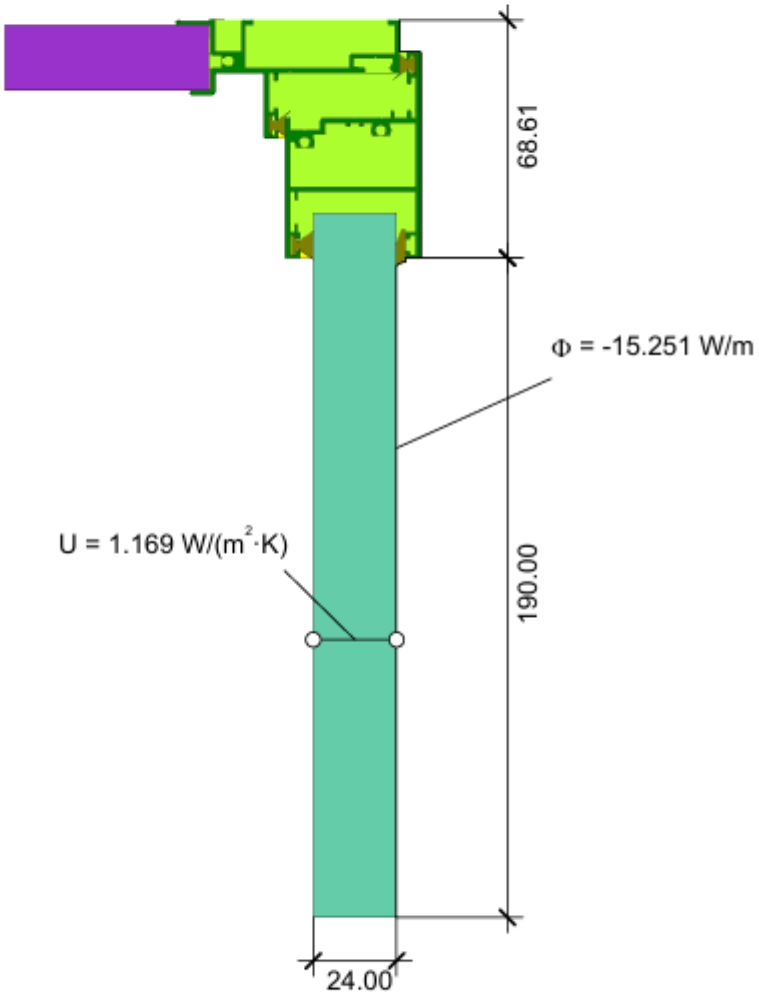
Title:Appendix D - Window Sash Head R2- x.flx
Reference: Drawing :

Model 1



Title:Appendix D - Window Sash Head R2- x.flx
Reference: Drawing :

Model 1



$$U_f = \frac{\frac{15.251}{20.0} - 1.169 \cdot 0.19}{0.069} = 7.88 \text{ W/(m}^2\text{·K)}$$

Appendix E – Window Sash Jamb

Title:Appendix E - Window Sash Jamb R2- x.flx
Reference: Drawing :

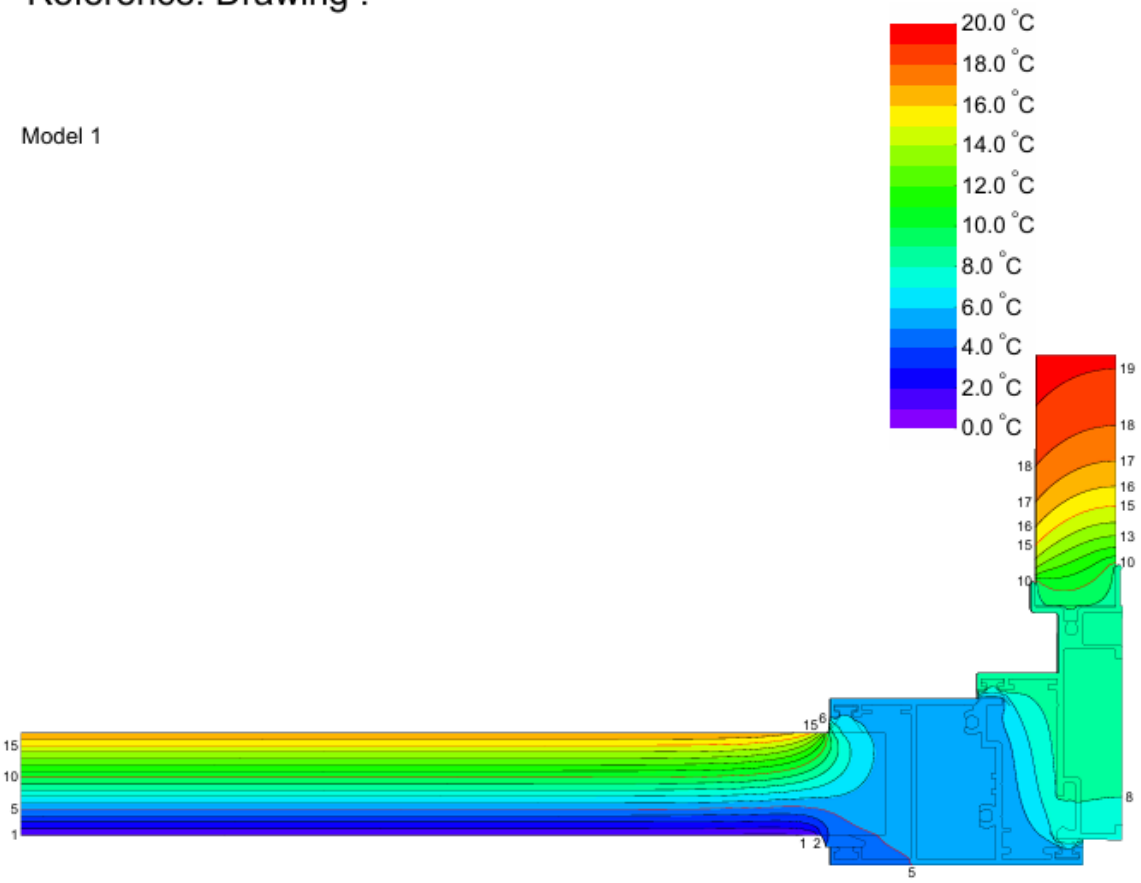
Model 1

Material	λ[W/(m·K)]
DEL 565_ Unventilated air cavity *	
DEL565 _EPDM (ethylene propylene diene monomer)	0.250
DEL565_Aluminium (Si Alloys)	160.000
DEL565_Panel	0.035
DEL565_Slightly ventilated air cavity *	
DEL565_Timber Reveal	0.130

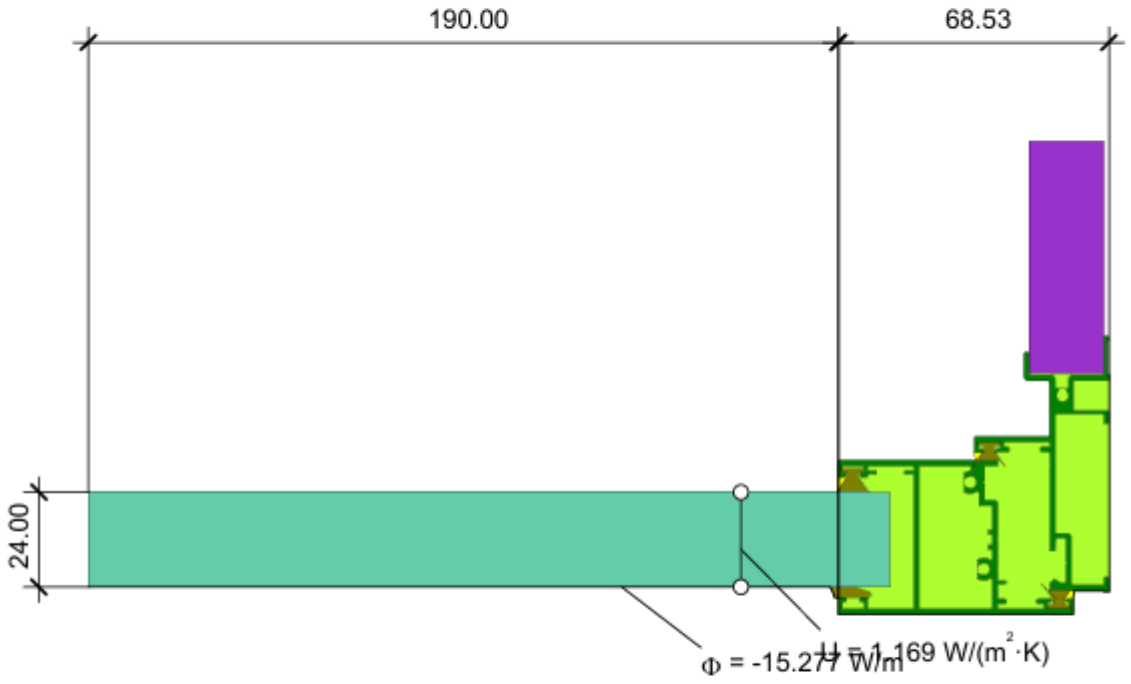
* EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
DEL565F_Exterior		0.000	0.040	
DEL565F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

Title:Appendix E - Window Sash Jamb R2- x.flx
Reference: Drawing :



Model 1
Title:Appendix E - Window Sash Jamb R2- x.flx
Reference: Drawing :

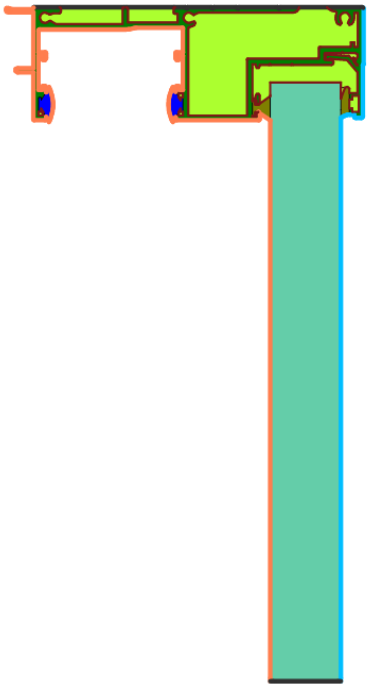


$$U_f = \frac{\frac{15.277}{20.0} - 1.169 \cdot 0.19}{0.069} = 7.91 \text{ W/(m}^2\text{·K)}$$

Appendix F – Sliding Door Fixed Head

Title:Appendix F - Sliding Door Fixed Head.flx
Reference: Drawing :

Model 1



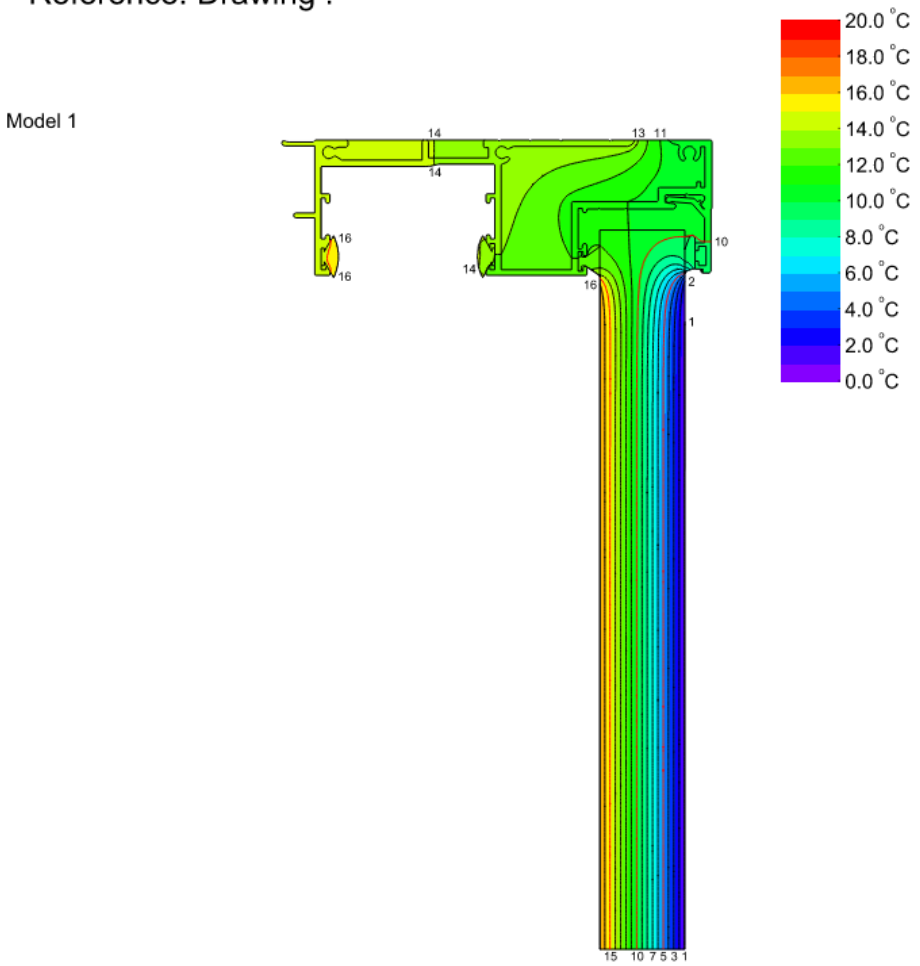
Material	λ[W/(m·K)]
DEL 565_ Unventilated air cavity *	
DEL565 _EPDM (ethylene propylene diene monomer)	0.250
DEL565F_Pile weather stripping (polyester mohair)	0.140
DEL565_Aluminium (Si Alloys)	160.000
DEL565_Panel	0.035

* EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m^2]	θ[°C]	R[(m^2·K)/W]	ε
DEL565F_Exterior		0.000	0.040	
DEL565F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

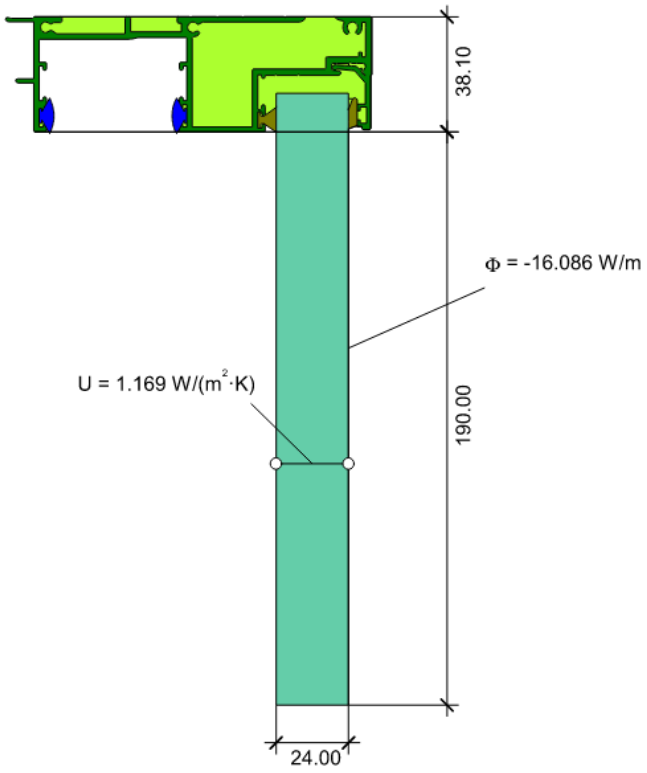
Title:Appendix F - Sliding Door Fixed Head.flx
Reference: Drawing :

Model 1



Title:Appendix F - Sliding Door Fixed Head.flx
Reference: Drawing :

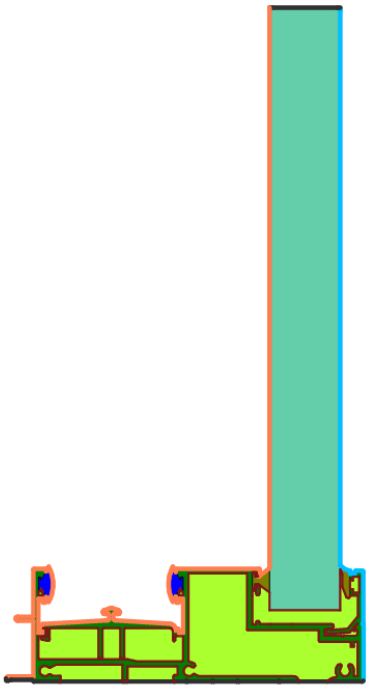
Model 1



$$U_f = \frac{\frac{16.086}{20.0} - 1.169 \cdot 0.19}{0.038} = 15.3 \text{ W/(m}^2\text{·K)}$$

Appendix G – Sliding Door Fixed Sill

Title:Appendix G - Sliding Door Fixed Sill.flx
Reference: Drawing :
Model 1



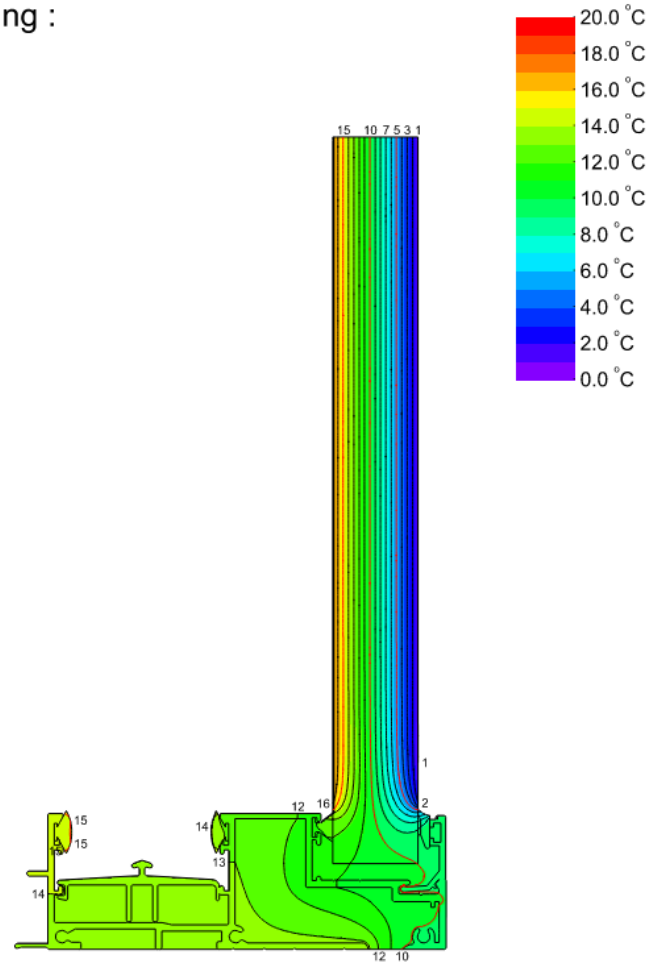
Material	λ[W/(m·K)]
DEL 565_ Unventilated air cavity *	
DEL565 _EPDM (ethylene propylene diene monomer)	0.250
DEL565_Aluminium (Si Alloys)	160.000
DEL565_Panel	0.035
DEL565_Pile weather stripping (polyester mohair)	0.140

* EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m^2]	θ[°C]	R[(m^2·K)/W]	ε
DEL565F_Exterior		0.000	0.040	
DEL565F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

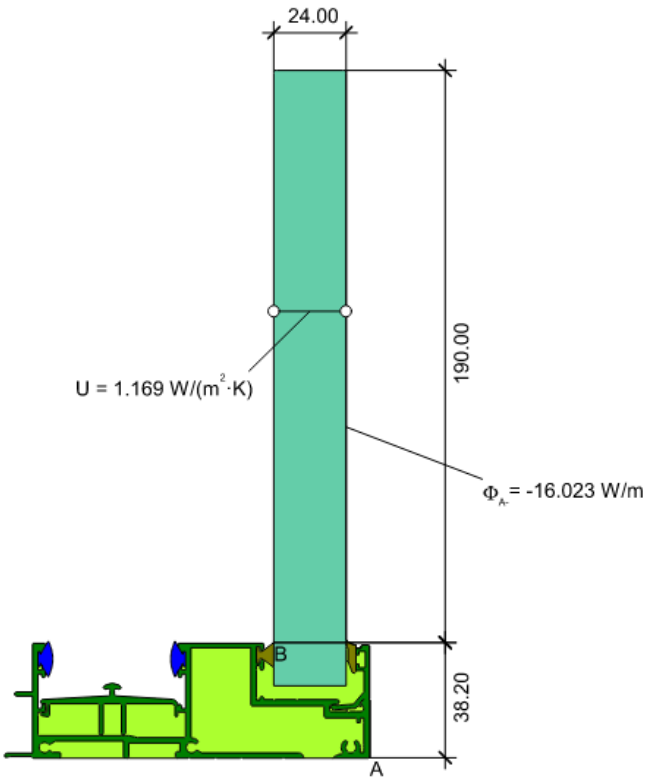
Title:Appendix G - Sliding Door Fixed Sill.flx
Reference: Drawing :

Model 1



Title:Appendix G - Sliding Door Fixed Sill.flx
Reference: Drawing :

Model 1



$$U_{f\,B,A} = \frac{\frac{16.023}{20.0} - 1.169 \cdot 0.19}{0.038} = 15.2\ W/(m^2 \cdot K)$$

Appendix H – Sliding Door Fixed Transom

Title:Appendix H - Sliding Door Fixed Transom.flx
Reference: Drawing :

Model 1

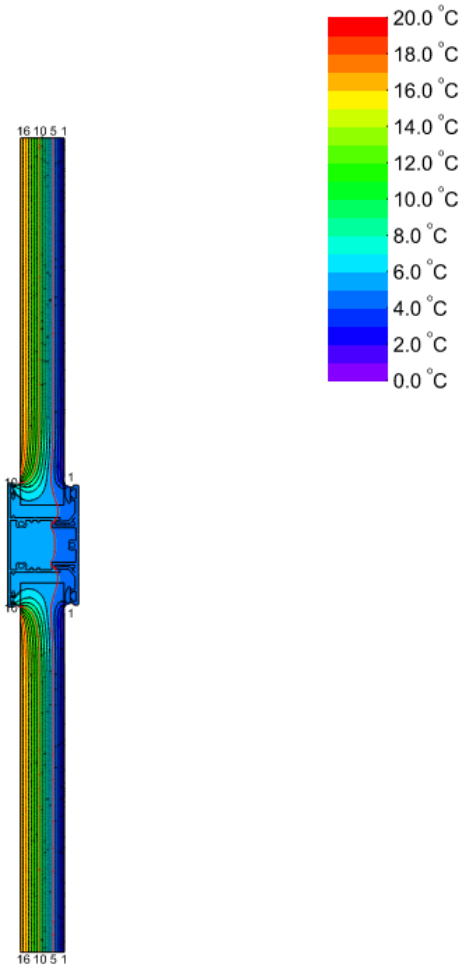
Material	λ[W/(m·K)]
DEL 565_ Unventilated air cavity *	
DEL565 _EPDM (ethylene propylene diene monomer)	0.250
DEL565_Aluminium (Si Alloys)	160.000
DEL565_Panel	0.035

* EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
DEL565F_Exterior		0.000	0.040	
DEL565F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

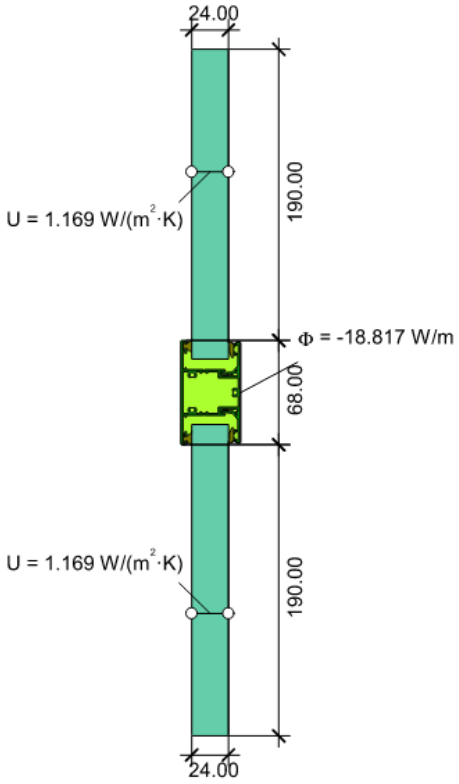
Title:Appendix H - Sliding Door Fixed Transom.flx
Reference: Drawing :

Model 1



Title:Appendix H - Sliding Door Fixed Transom.flx
Reference: Drawing :

Model 1

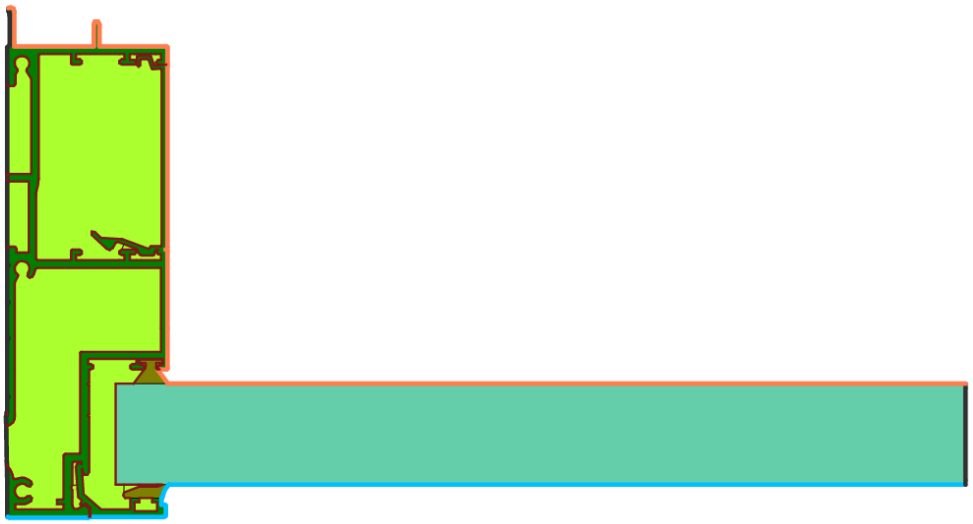


$$U_f = \frac{\frac{18.817}{20.0} - 1.169 \cdot 0.19 - 1.169 \cdot 0.19}{0.068} = 7.31 \text{ W/(m}^2\text{·K)}$$

Appendix I – Sliding Door Fixed Jamb

Title:Appendix I - Sliding Door Fixed Jamb.flx
Reference: Drawing :

Model 1

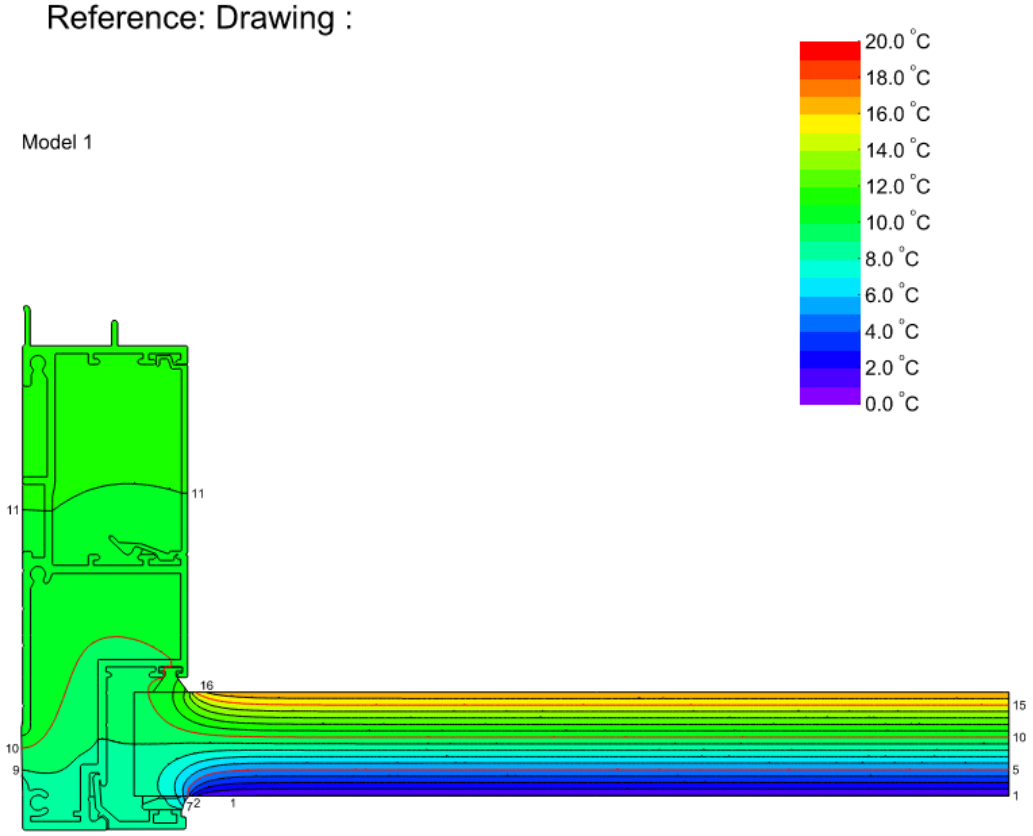


Material	λ[W/(m·K)]
DEL 565_ Unventilated air cavity *	
DEL565 _EPDM (ethylene propylene diene monomer)	0.250
DEL565_Aluminium (Si Alloys)	160.000
DEL565_Panel	0.035

* EN ISO 10077-2:2017, 6.4.3/anisotrop

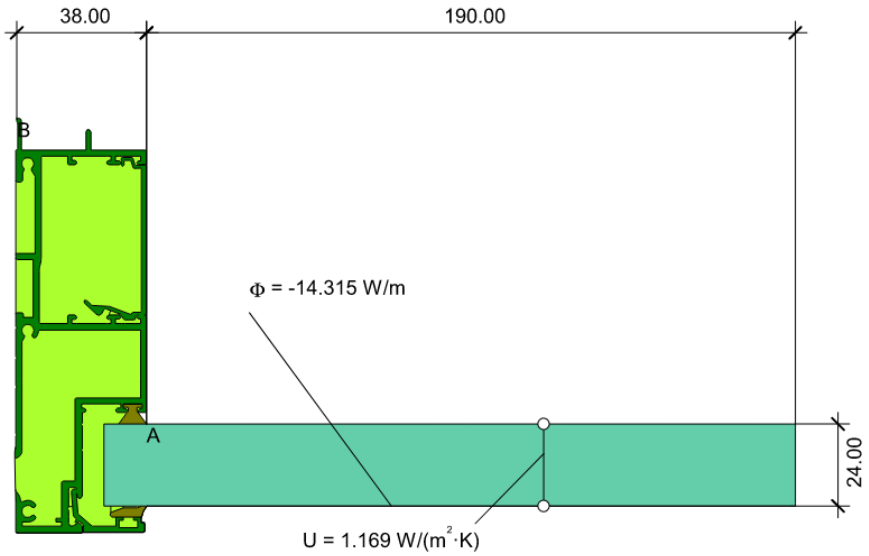
Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
DEL565F_Exterior		0.000	0.040	
DEL565F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

Title:Appendix I - Sliding Door Fixed Jamb.flx
Reference: Drawing :



Title:Appendix I - Sliding Door Fixed Jamb.flx
Reference: Drawing :

Model 1

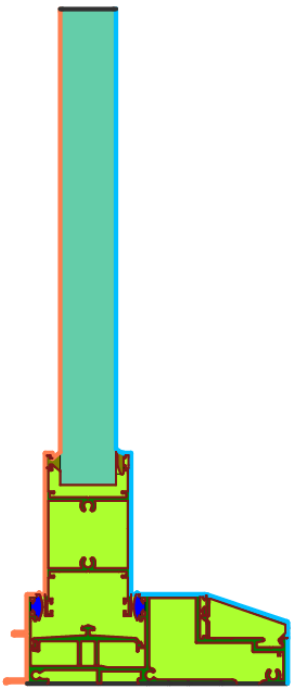


$$U_{fA,B} = \frac{\frac{14.315}{20.0} - 1.169 \cdot 0.19}{0.038} = 13.0 \text{ W/(m}^2\text{·K)}$$

Appendix J – Sliding Door Leaf Sill

Title:Appendix J - Sliding Door Leaf Sill.flx
Reference: Drawing :

Model 1



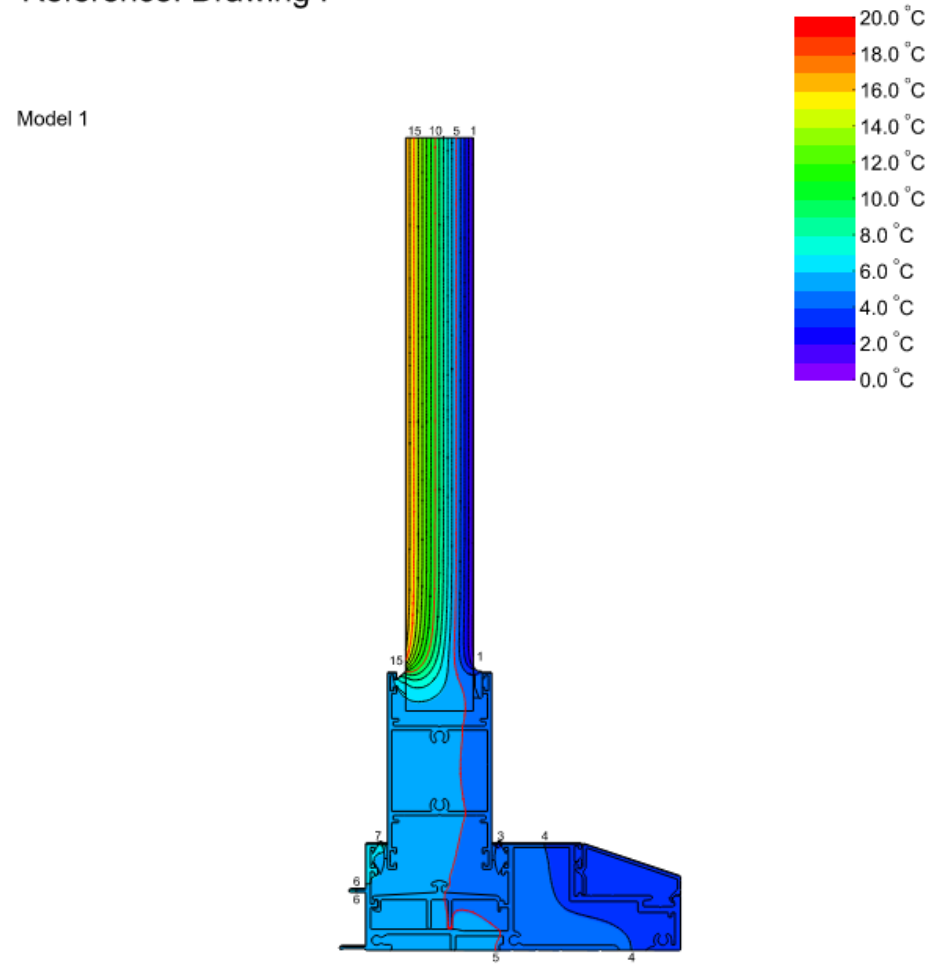
Material	λ[W/(m·K)]
DEL 565_ Unventilated air cavity *	
DEL565 _EPDM (ethylene propylene diene monomer)	0.250
DEL565_Aluminium (Si Alloys)	160.000
DEL565_Panel	0.035
DEL565_Pile weather stripping (polyester mohair)	0.140

* EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m^2]	θ[°C]	R[(m^2·K)/W]	ε
DEL565F_Exterior		0.000	0.040	
DEL565F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

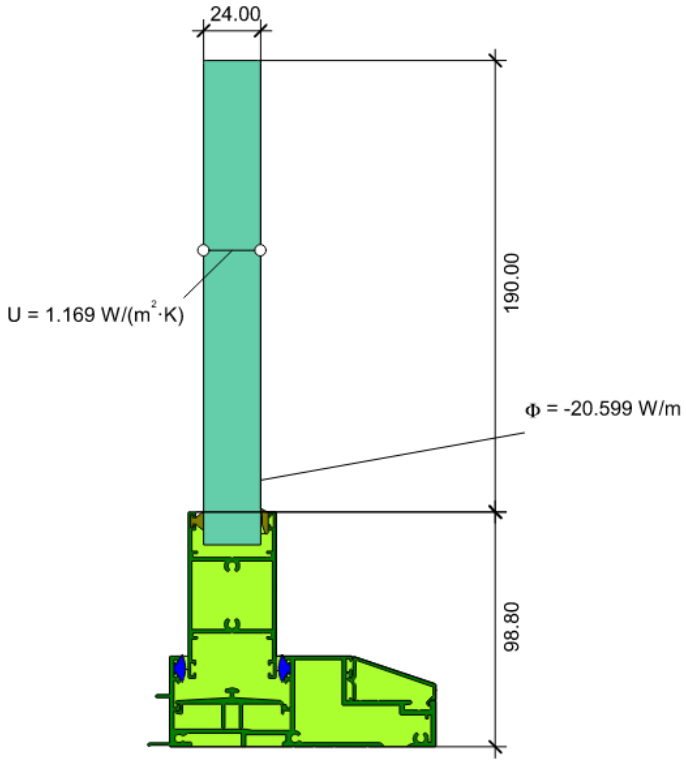
Title:Appendix J - Sliding Door Leaf Sill.flx
Reference: Drawing :

Model 1



Title:Appendix J - Sliding Door Leaf Sill.flx
Reference: Drawing :

Model 1

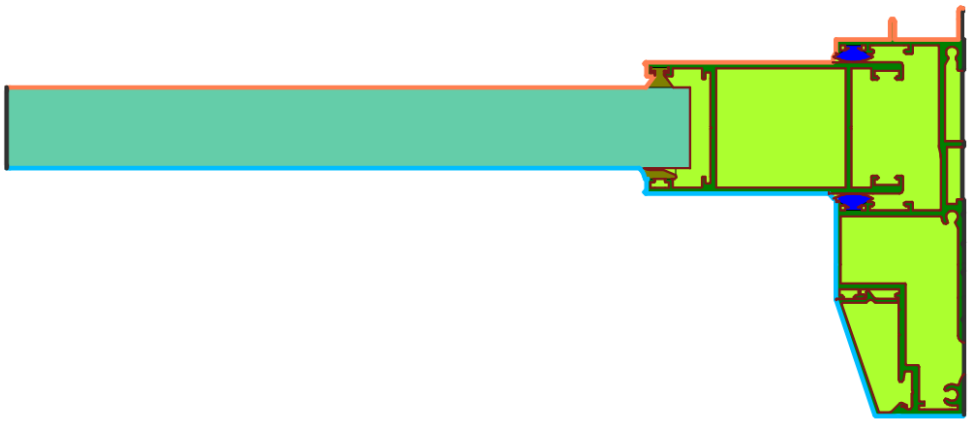


$$U_f = \frac{\frac{20.599}{20.0} - 1.169 \cdot 0.19}{0.099} = 8.18 \text{ W/(m}^2\text{·K)}$$

Appendix K – Sliding Door Leaf Jamb

Title:Appendix K - Sliding Door Leaf Jamb.flx
Reference: Drawing :

Model 1



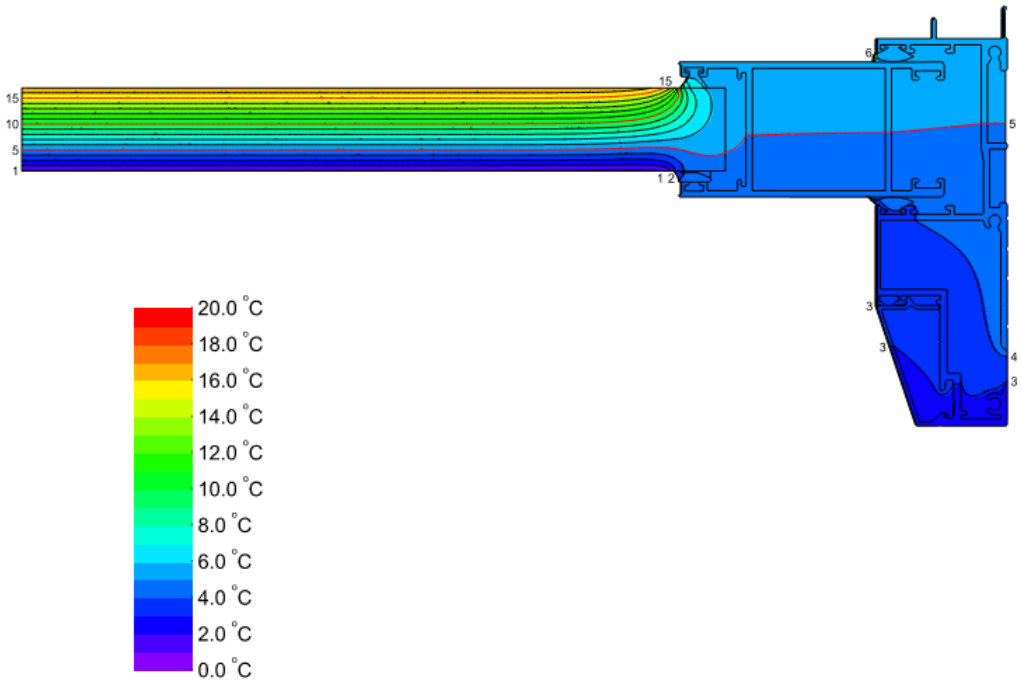
Material	λ[W/(m·K)]
DEL 565_ Unventilated air cavity *	
DEL565 _EPDM (ethylene propylene diene monomer)	0.250
DEL565_ Pile weather stripping (polyester mohair)	0.140
DEL565_Aluminium (Si Alloys)	160.000
DEL565_Panel	0.035

* EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m^2]	θ[°C]	R[(m^2·K)/W]	ε
DEL565F_Exterior		0.000	0.040	
DEL565F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

Title:Appendix K - Sliding Door Leaf Jamb.flx
Reference: Drawing :

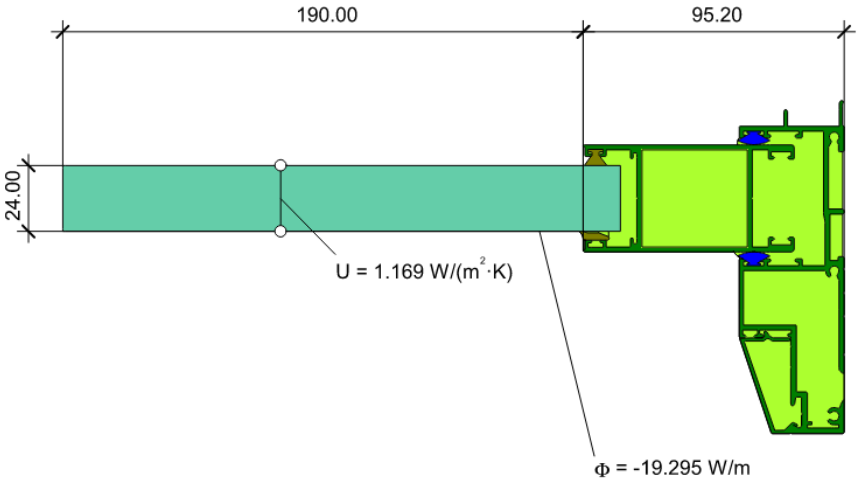
Model 1



PAGE 2 OF 3

Title:Appendix K - Sliding Door Leaf Jamb.flx
Reference: Drawing :

Model 1

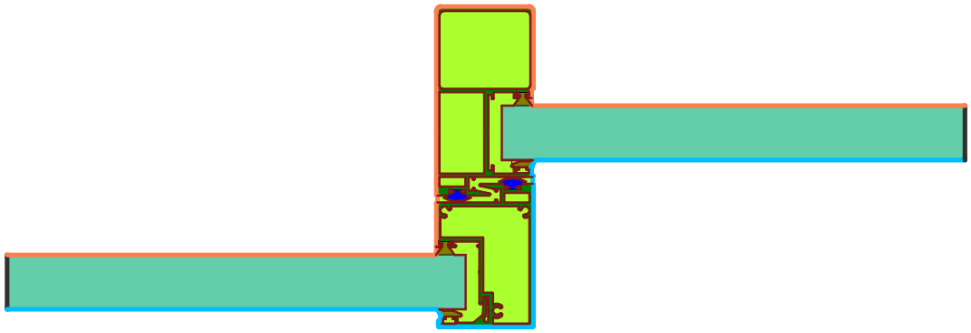


$$U_f = \frac{\frac{19.295}{20.0} - 1.169 \cdot 0.19}{0.095} = 7.80 \text{ W/(m}^2\text{·K)}$$

Appendix L – Sliding Door Stile

Title:Appendix L - Sliding Door Stile.flx
Reference: Drawing :

Model 1

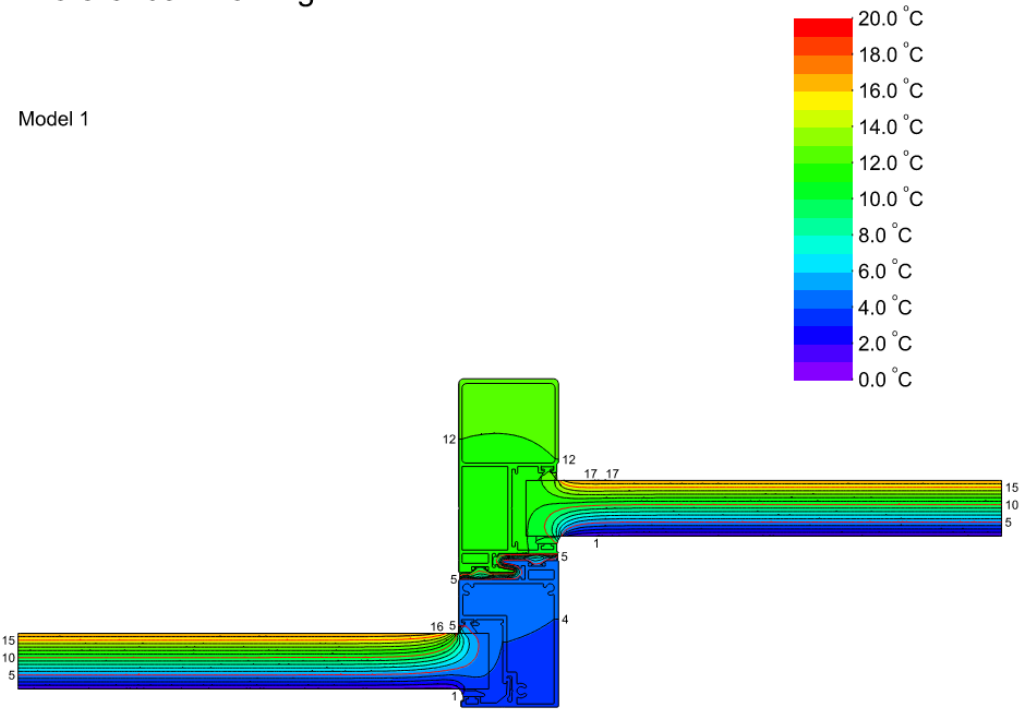


Material	λ[W/(m·K)]
DEL 565_ Unventilated air cavity *	
DEL565 _EPDM (ethylene propylene diene monomer)	0.250
DEL565_Aluminium (Si Alloys)	160.000
DEL565_Panel	0.035
DEL565_Pile weather stripping (polyester mohair)	0.140

* EN ISO 10077-2:2017, 6.4.3/anisotrop

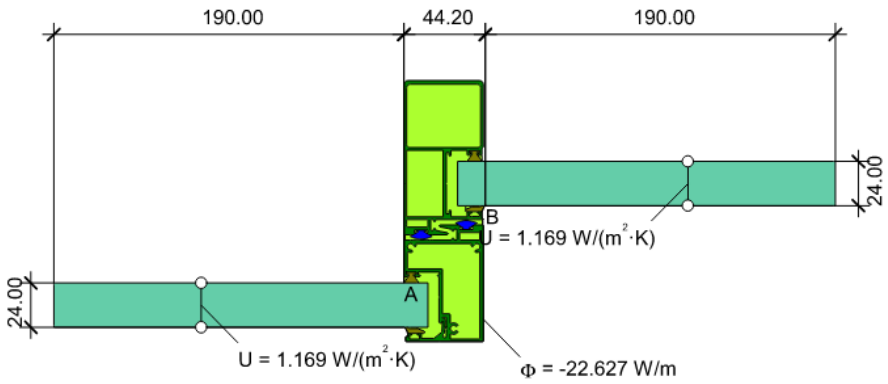
Boundary Condition	q[W/m^2]	θ[°C]	R[(m^2·K)/W]	ε
DEL565F_Exterior		0.000	0.040	
DEL565F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

Title:Appendix L - Sliding Door Stile.flx
Reference: Drawing :



Title:Appendix L - Sliding Door Stile.flx
Reference: Drawing :

Model 1

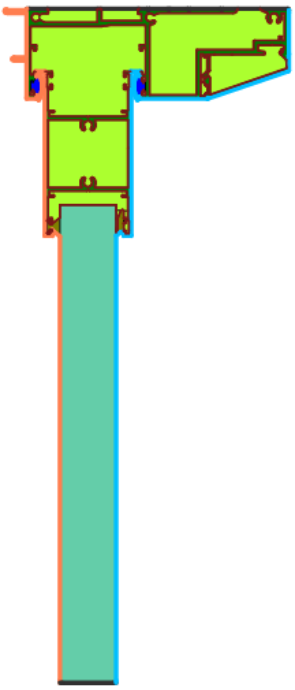


$$U_{f\,A,B} = \frac{\frac{22.627}{20.0} - 1.169 \cdot 0.19 - 1.169 \cdot 0.19}{0.044} = 15.5\ W/(m^2 \cdot K)$$

Appendix M – Sliding Door Leaf Head

Title:Appendix M- Sliding Door leaf head.flx
Reference: Drawing :

Model 1



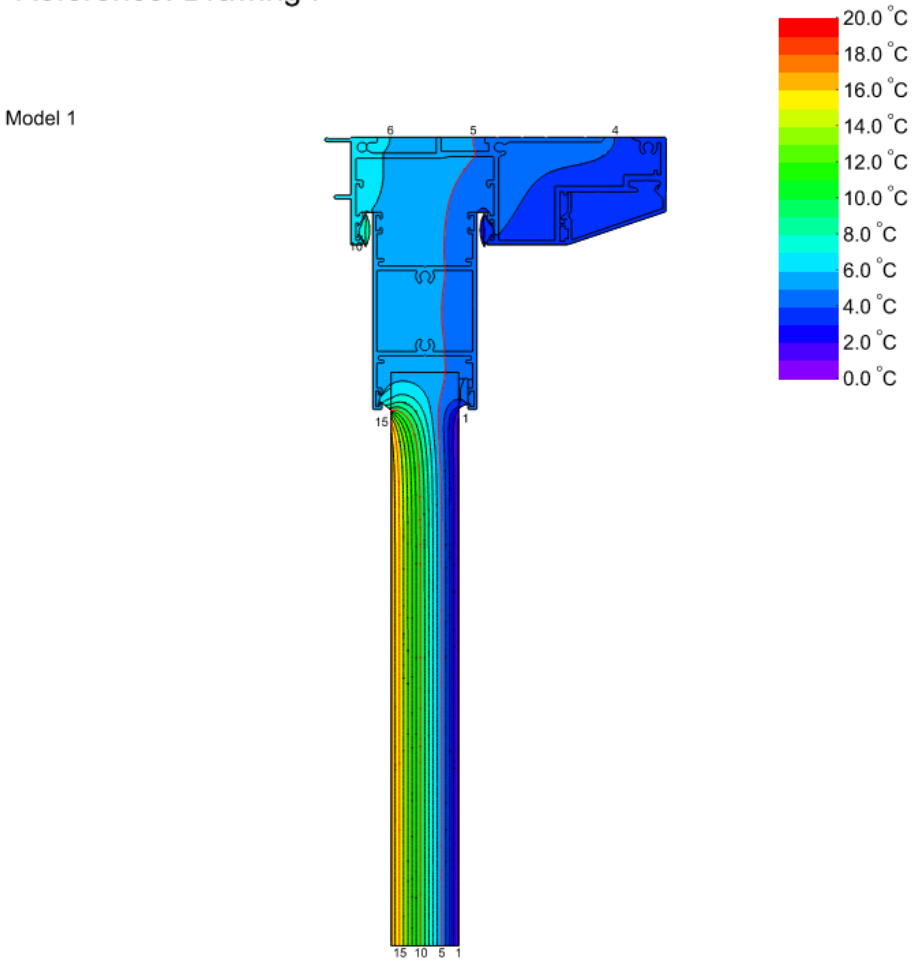
Material	λ[W/(m·K)]
DEL 565_ Unventilated air cavity *	
DEL565 _EPDM (ethylene propylene diene monomer)	0.250
DEL565_Aluminium (Si Alloys)	160.000
DEL565_Panel	0.035
DEL565_Pile weather stripping (polyester mohair)	0.140

* EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
DEL565F_Exterior		0.000	0.040	
DEL565F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

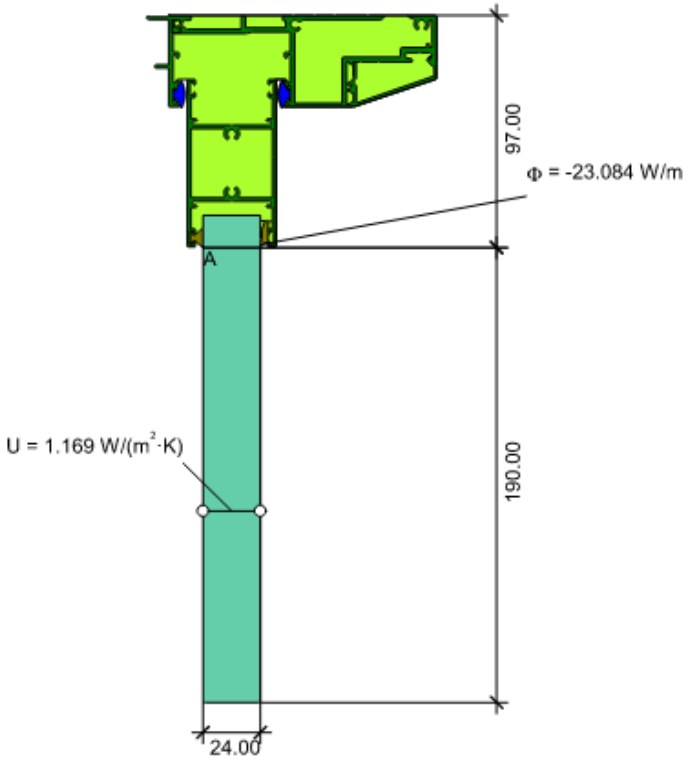
Title:Appendix M- Sliding Door leaf head.flx
Reference: Drawing :

Model 1



Title:Appendix M- Sliding Door leaf head.flx
Reference: Drawing :

Model 1



$$U_{fA,B} = \frac{\frac{23.084}{20.0} - 1.169 \cdot 0.19}{0.097} = 9.61 \text{ W/(m}^2\text{·K)}$$

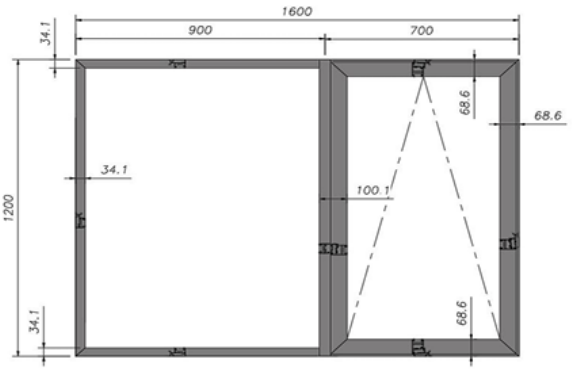
Appendix N – R-Value Calculation for Aluminium Joinery.

N.1 Joinery Type 1 - Fixed and Awning Window

Job Name :	*Rangi Windows Ltd - System R Value*	**Job No:**	*DEL565F*
Reference :	*Fixed and Awning window*	**Date:**	*17-04-24*
Glazing Type :	*Window*	**Engineer:**	*NB*
Spacer Type:	*Aluminium*		
Configuration Code:	*W1*	**Page :**	1

FRAME CONFIGURATION

Glazing Type→	Window	
Window Width Fixed =	0.900	m
Window Width Sash =	0.700	m
Window Height =	1.20	m



Width of Projected Frame:

Head (Fixed) =	0.034	m
Head (Sash) =	0.0686	m
Jamb (Fixed) =	0.034	m
Jamb (Sash) =	0.0686	m
Sill (Fixed) =	0.034	m
Sill (Sash) =	0.0686	m
Mullion =	0.1	m

U-Value of Frame:

Head (Fixed) =	9.8	W/m2.K
Head (Sash) =	7.88	W/m2.K
Jamb (Fixed) =	9.84	W/m2.K
Jamb (Sash) =	7.91	W/m2.K
Sill (Fixed) =	9.8	W/m2.K
Sill (Sash) =	8.03	W/m2.K
Mullion =	6.84	W/m2.K

U-Value of Glazing, Ug =	1.1	W/m2.K	<= Client supplied value
Psi of Edge-of-Glass, Ψg =	0.05	W/m.K	For Aluminium Spacer per ISO 10077-1

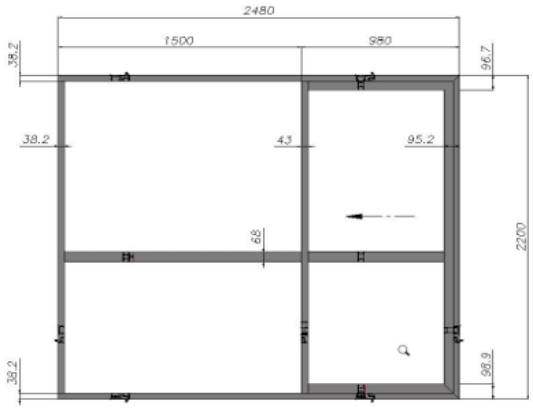
Glazing Area, Ag:	1.538	m2	*Exlude glass?*	NO
Length of Edge-of-Glass:	7.184	m		
U-Value of Frame, Uf	8.102	W/m2.K		
U-Value of Window, Uw	2.680	W/m2.K		
R-Value of Window, R	0.373	m2.K/W		

N.2 Joinery Type 2 - Fixed and Sliding Door

Job Name : *Rangi Windows Ltd - System R Value* **Job No:** *DEL565F*
Reference : *Fixed and Sliding Door* **Date:** *17-04-24*
Glazing Type : *Door* **Engineer:** *NB*
Spacer Type: *Aluminium*
Configuration Code: *D1* **Page :** 1

FRAME CONFIGURATION

Glazing Type→	Door	
Door Width Fixed =	1.500	m
Door Width Sliding =	0.980	m
Door Height =	2.20	m



Width of Projected Frame:

Head (Fixed) =	0.038	m
Head (Sliding) =	0.0987	m
Jamb (Fixed) =	0.038	m
Jamb (Sliding) =	0.095	m
Sill (Fixed) =	0.038	m
Sill (Sliding) =	0.0989	m
Stile =	0.044	m

U-Value of Frame:

Head (Fixed) =	15.3	W/m2.K
Head (Sliding) =	9.61	W/m2.K
Jamb (Fixed) =	13	W/m2.K
Jamb (Sliding) =	7.8	W/m2.K
Sill (Fixed) =	15.2	W/m2.K
Sill (Sliding) =	8.18	W/m2.K
Stile =	15.5	W/m2.K

Width of Transom

Transom (f)	0.068	m
Transom (s)	0.068	m

U-Value of Transom

Transom (f)	7.31	W/m2.K
Transom (s)	7.31	W/m2.K

U-Value of Glazing, Ug =	1.1	W/m2.K	<= Client supplied value
Psi of Edge-of-Glass, Ψg =	0.05	W/m.K	For Aluminium Spacer per ISO 10077-1

Glazing Area, Ag:	4.784	m2	*Exclude glass?*	NO
Length of Edge-of-Glass:	17.193	m		
U-Value of Frame, Uf	10.363	W/m2.K		
U-Value of Door, Uw	2.398	W/m2.K		
R-Value of Door, R	0.417	m2.K/W		