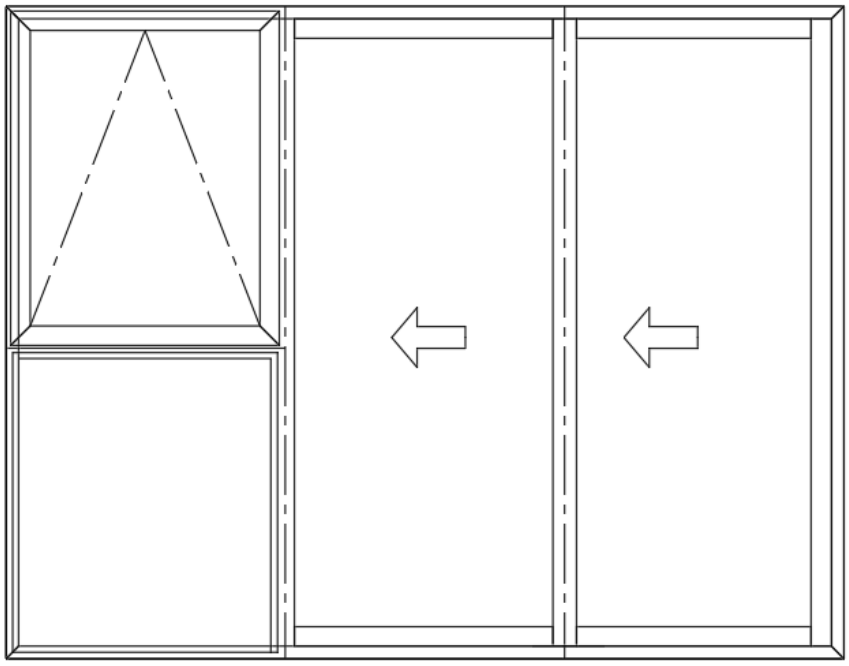
Thermally Broken Aluminium R-Value Calculation Report -Stacker Door

R-Value of Joinery Configurations



Document No: DEL591F-TAR-01, REV01

DATE	REVISION	DESCRIPTION	PREPARED BY	CHECKED BY
08-05-24	0	R Value of Joinery Configurations	Buddhi De Silva	Niño Barrera
17-05-24	1	R Value of Joinery Configurations	Buddhi De Silva	Niño Barrera

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1.0 Introduction

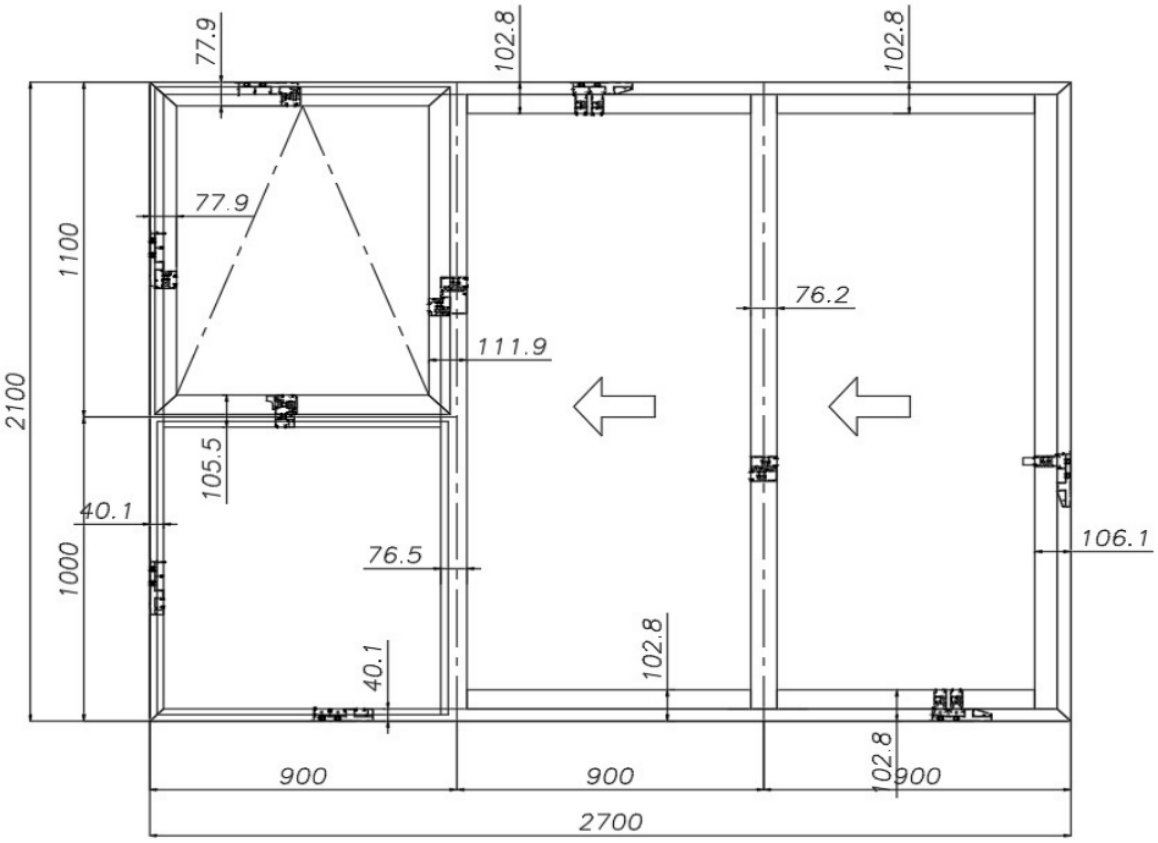
Design Engineers Ltd was engaged by Rangi Windows Ltd to calculate the R value of their sample joinery configurations. Thermal conductivity per ISO 10077-2.

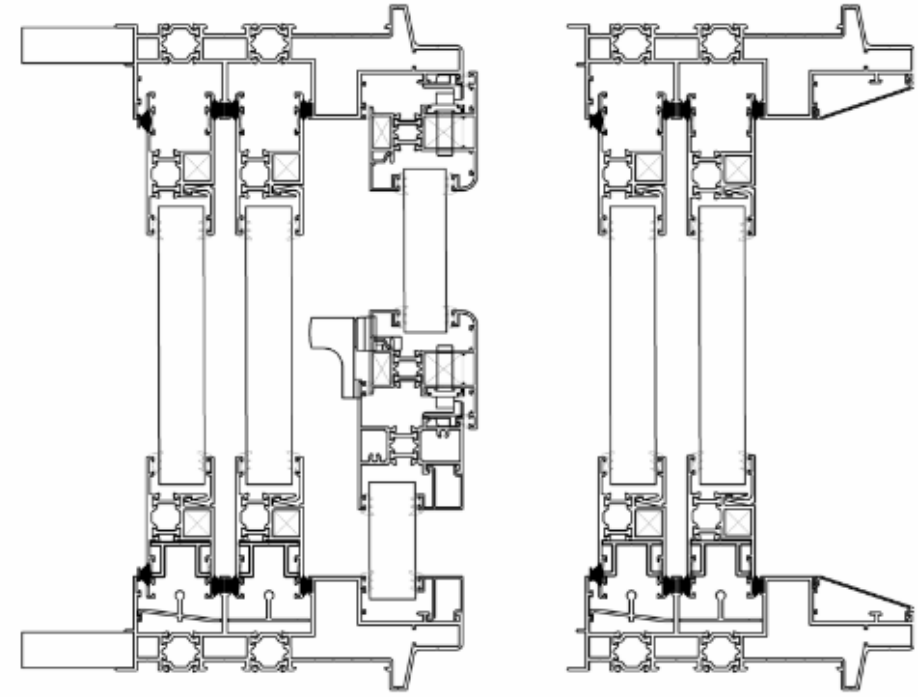
All R Value calculations are applicable to the size and configurations specified in Section 1.1 only.

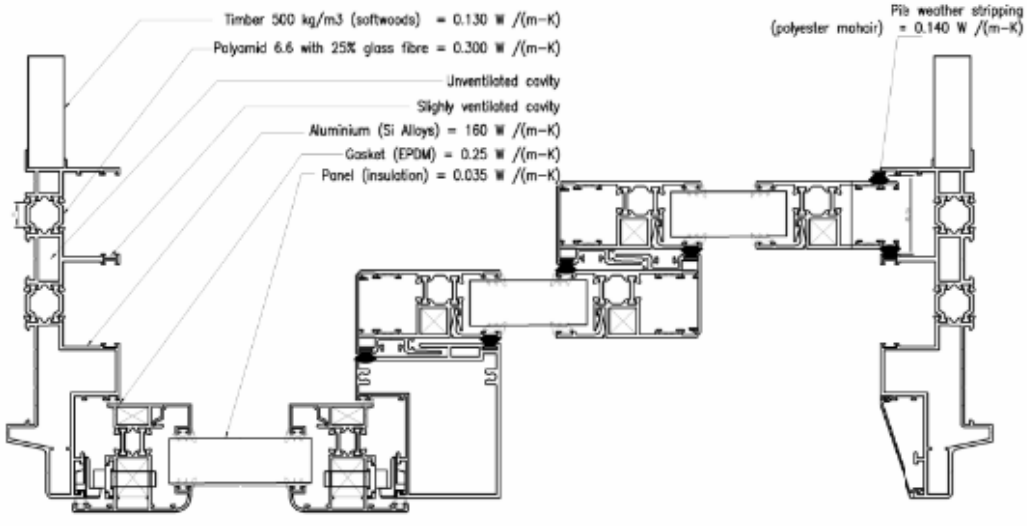
Glass Ug = 1.1 and thermally improved spacer is used as supplied by Client.

1.1 Elevations and Details

D1 – Fixed and Stacker Doors






Timber 500 kg/m3 (softwoods) = 0.130 W /(m-K)
Polyamid 6.6 with 25% glass fibre = 0.300 W /(m-K)
Unventilated cavity
Slightly ventilated cavity
Aluminium (Si Alloys) = 160 W /(m-K)
Gasket (EPDM) = 0.25 W /(m-K)
Panel (insulation) = 0.035 W /(m-K)
Pile weather stripping
(polyester mohair) = 0.140 W /(m-K)

1.2 Scope of Work

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

Joinery Type D1 = 2100mm height by 2700mm width, 1 fixed panel and 2 stacker door leaves.

1.3 Summary of Results

This report is focused on the R value calculation of the sample joinery configuration types 1-2.

	R-Value for Joinery Assembly - $m^2 \cdot K / W$
Joinery Type D1	**Using Aluminium Spacer**
Joinery Type D1 (Fixed + 2 stacker doors)	0.464

Aluminium spacer as per by ISO 10077-1.

See Appendix N for Calculations using Aluminium Spacer.

1.4 Material Thermal Conductivity

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

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

3. Panel (Glass) = 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)

5. Pile weather stripping (Polyester mohair) =0.14 W/ m-K (Reference ISO 10077-2)

6. Polyamide 6.6 with 25% glass fibre =0.300 W/ m-K (Reference ISO 10077-2)

1.5 Surface Resistance (For Walls)

1. Interior, normal, horizontal (R_{si})= 0.13 m^2-K /W (Reference ISO 10077-2)

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

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

1.6 Frame Cavities

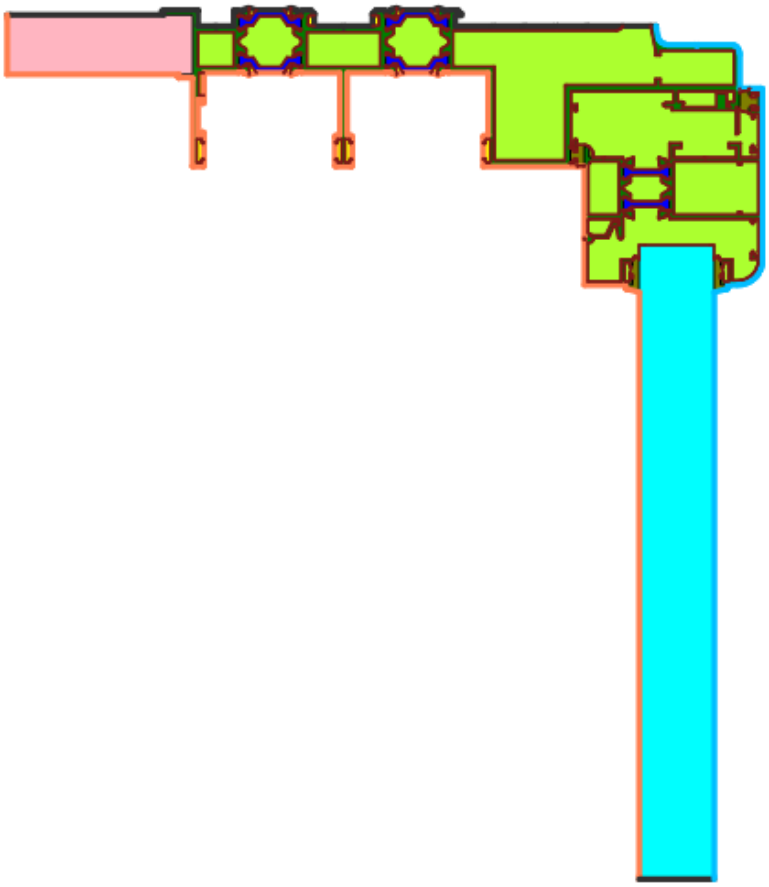
1.Unventilated air cavity (Reference ISO 10077-2)

2. Slightly Ventilated air cavity (Reference ISO 10077-2)

Appendix A – Sliding Door (Awing) Head

Title:Appendix A - SDoor Head 1--x.flx
Reference: Drawing :

Model 1

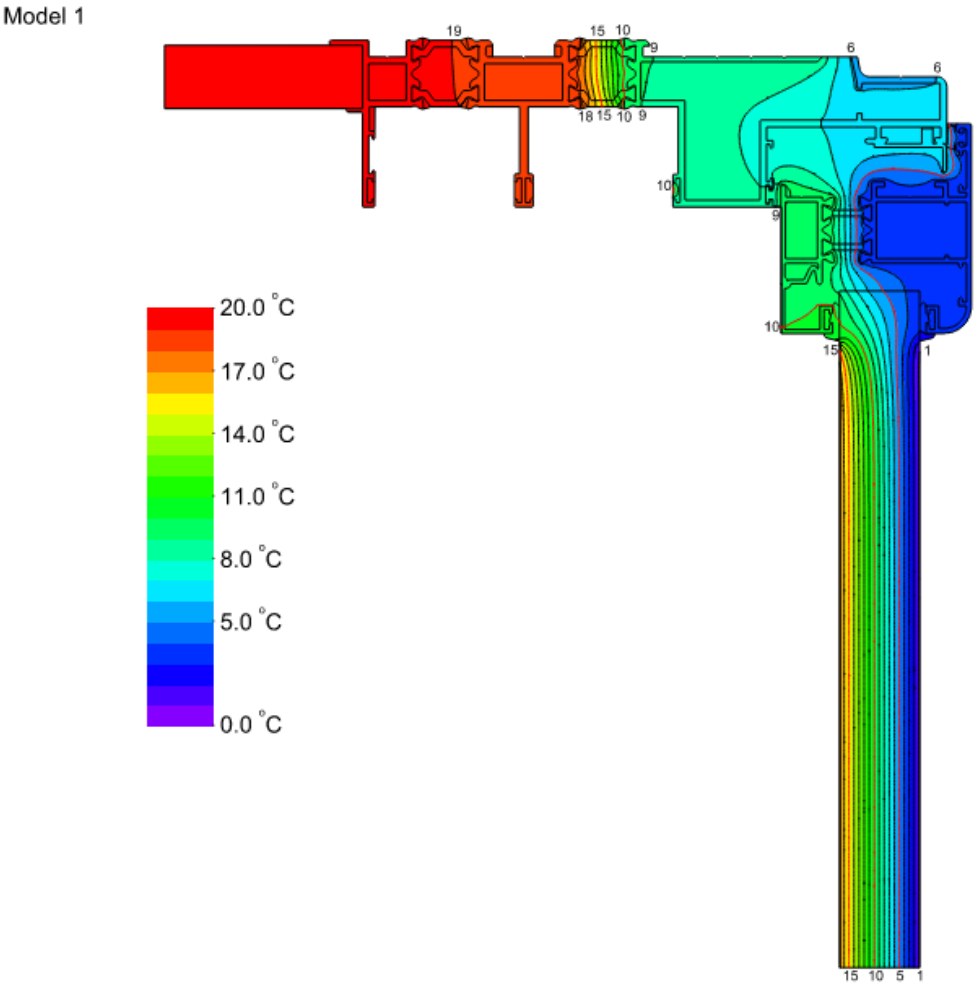


Material	λ[W/(m·K)]
DEL 591F_ Unventilated air cavity *	
DEL591F _EPDM (ethylene propylene diene monomer)	0.250
DEL591F_Aluminium (Si Alloys)	160.000
DEL591F_Panel	0.035
DEL591F_Polyamid 6.6 with 25% glass fibre	0.300
DEL591F_Slightly ventilated air cavity *	
DEL591F_Timber 500 kg/m3 (softwoods)	0.130

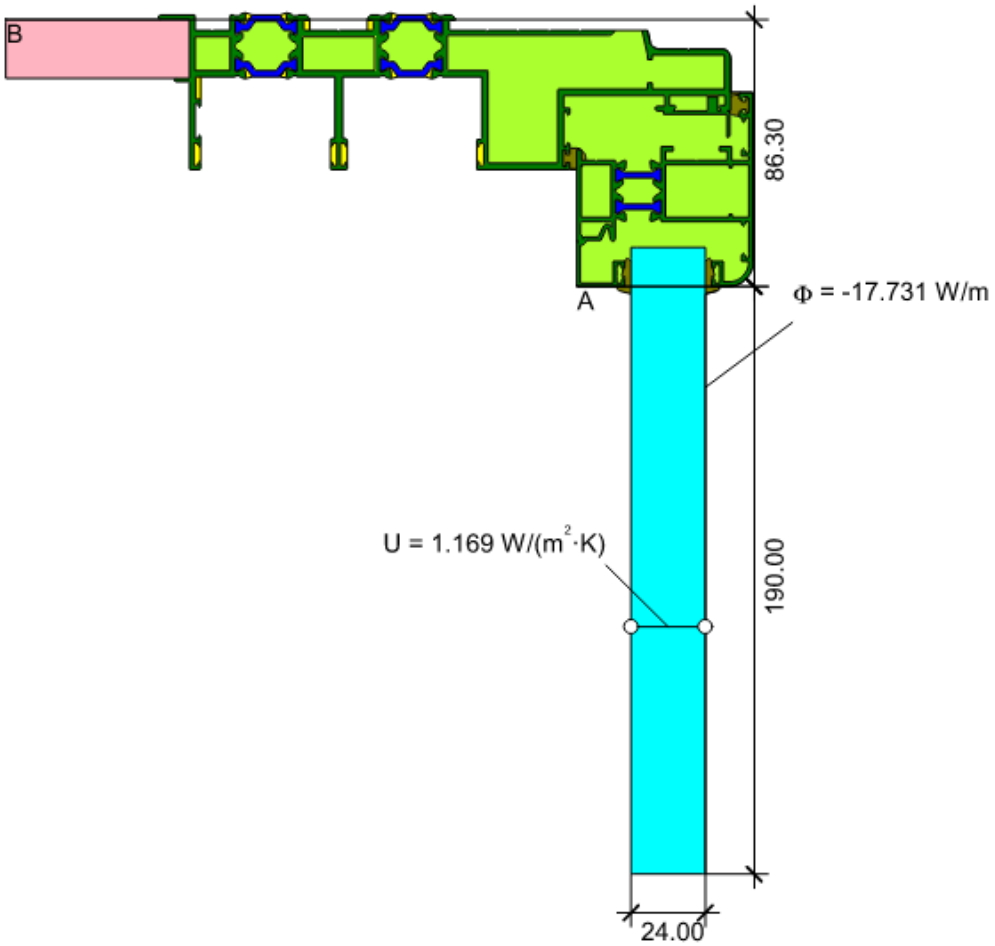
* EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
DEL591F_Exterior		0.000	0.040	
DEL591F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

Title:Appendix A - SDoor Head 1--x.flx
Reference: Drawing :



Model 1
Title:Appendix A - SDoor Head 1--x.flx
Reference: Drawing :

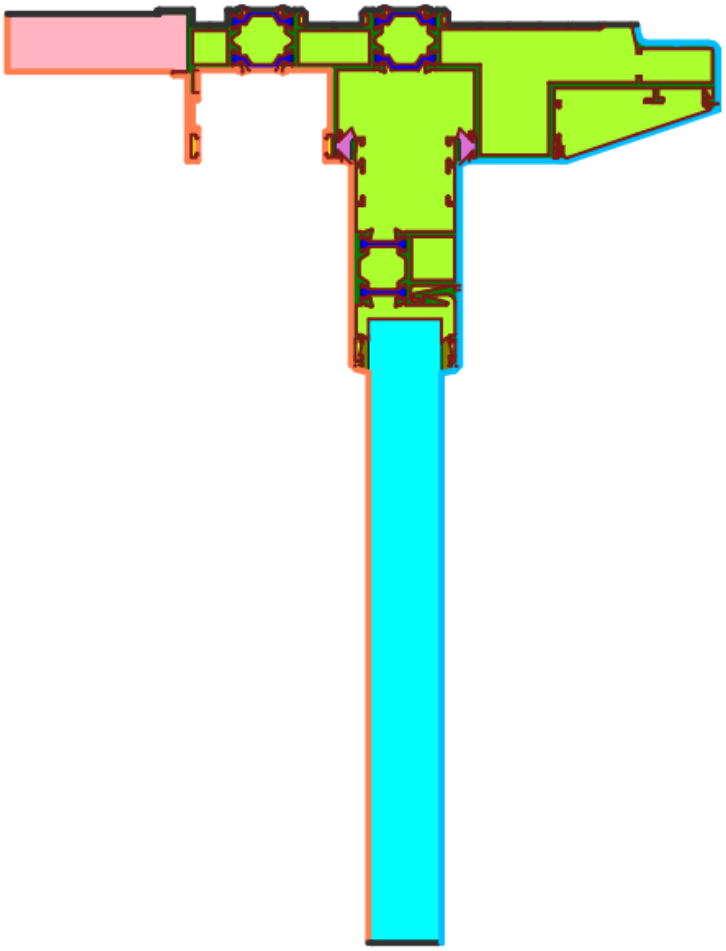


$$U_{f\,A,B} = \frac{\frac{17.731}{20.0} - 1.169 \cdot 0.19}{0.086} = 7.70\ \mathrm{W/(m^2 \cdot K)}$$

Appendix B – Sliding Door Head

Title:Appendix B - SDoor Head 2-x.flx
Reference: Drawing :

Model 1



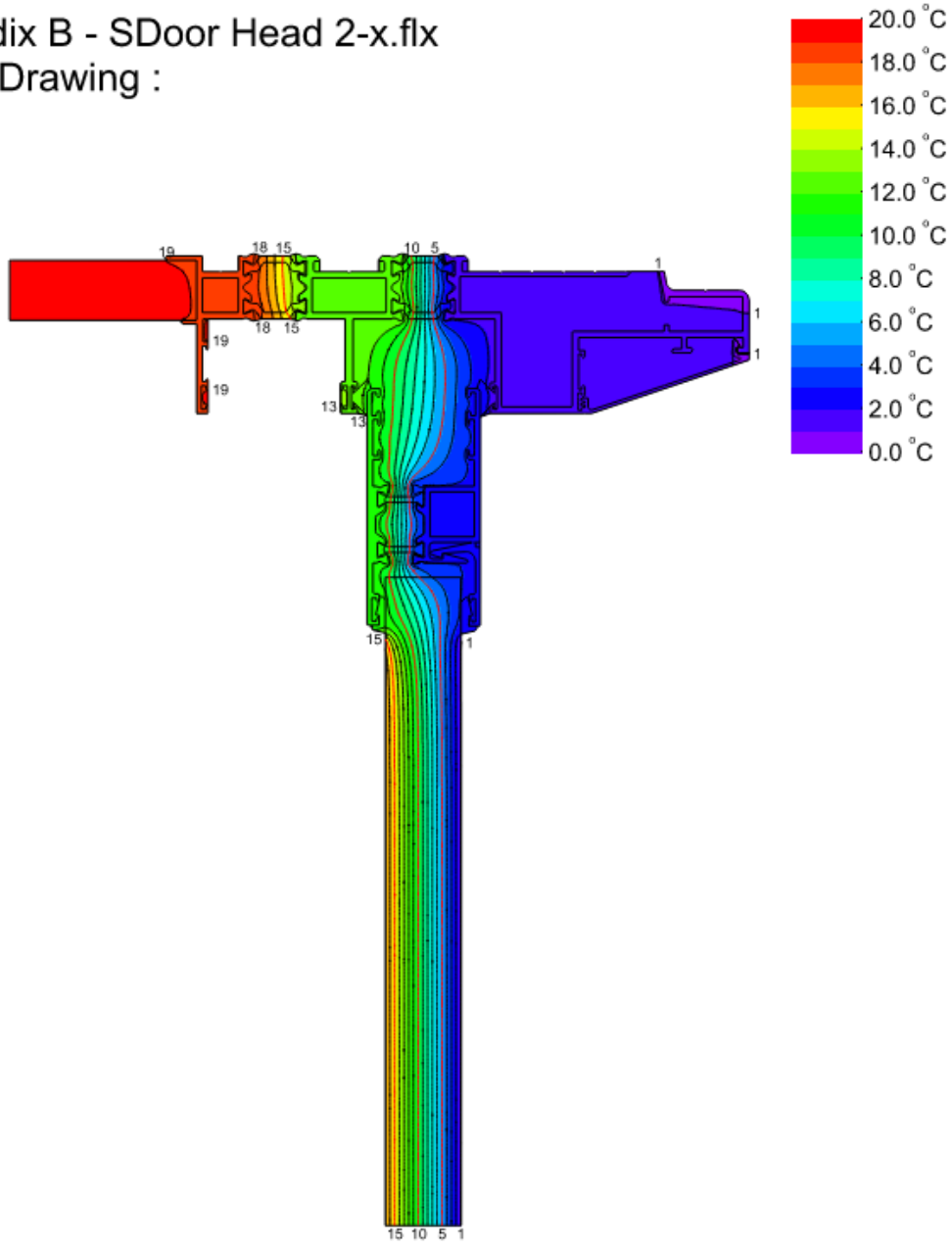
Material	λ[W/(m·K)]
DEL 591F_ Unventilated air cavity *	
DEL591F _EPDM (ethylene propylene diene monomer)	0.250
DEL591F_Aluminium (Si Alloys)	160.000
DEL591F_Panel	0.035
DEL591F_Polyamid 6.6 with 25% glass fibre	0.300
DEL591F_Slightly ventilated air cavity *	
DEL591F_Timber 500 kg/m3 (softwoods)	0.130
DEL591_Pile weather stripping (polyester mohair)	0.140

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

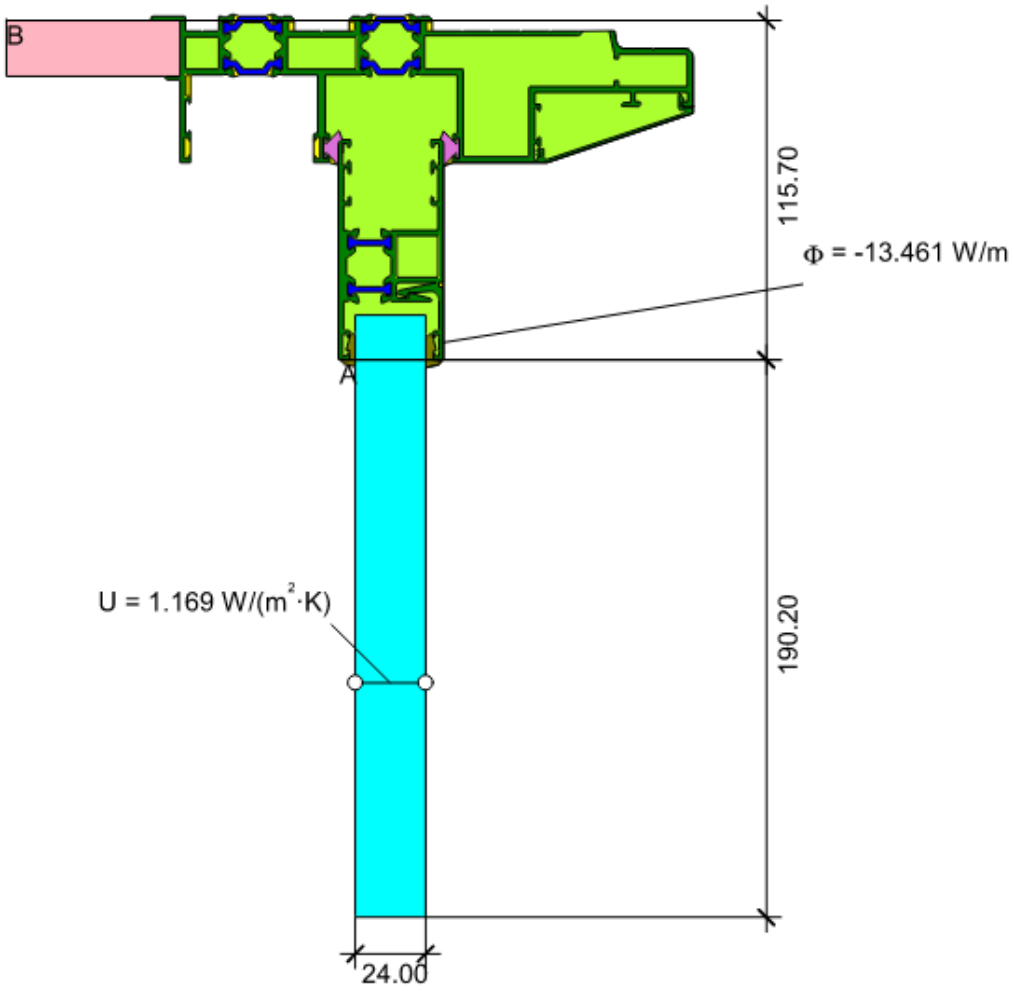
Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
DEL591F_Exterior		0.000	0.040	
DEL591F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

Title:Appendix B - SDoor Head 2-x.flx
Reference: Drawing :

Model 1



Model 1
Title:Appendix B - SDoor Head 2-x.flx
Reference: Drawing :

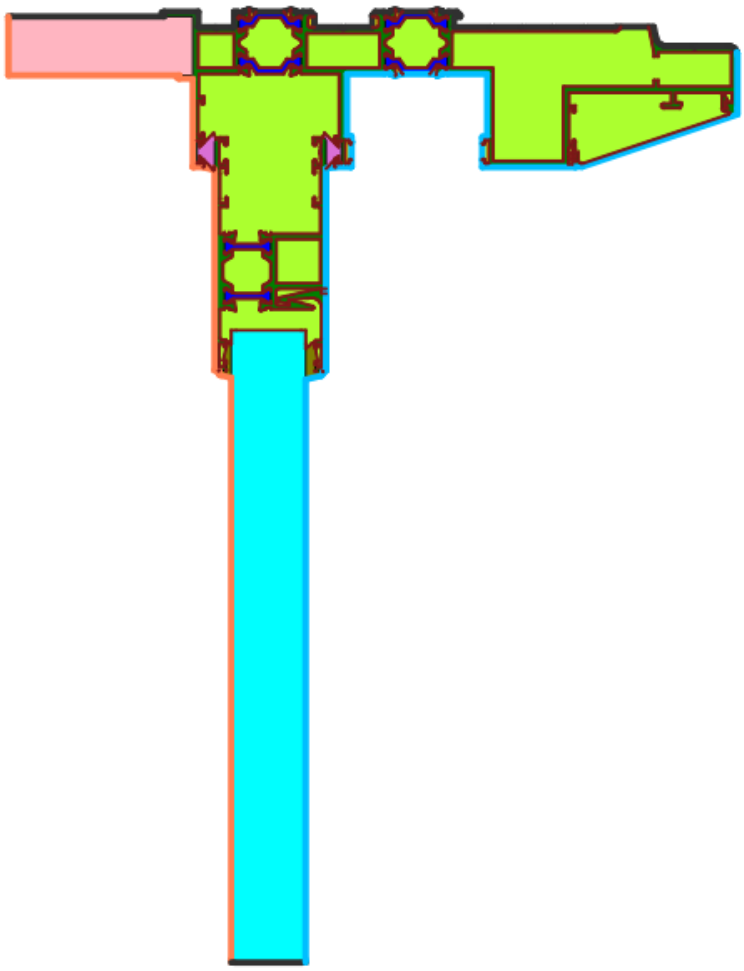


$$U_{f\,A,B} = \frac{\frac{13.461}{20.0} - 1.169 \cdot 0.19}{0.116} = 3.90\ \mathrm{W/(m^2 \cdot K)}$$

Appendix C– Sliding Door (Sliding) Head

Title:Appendix C - SDoor Head 3-x.flx
Reference: Drawing :

Model 1



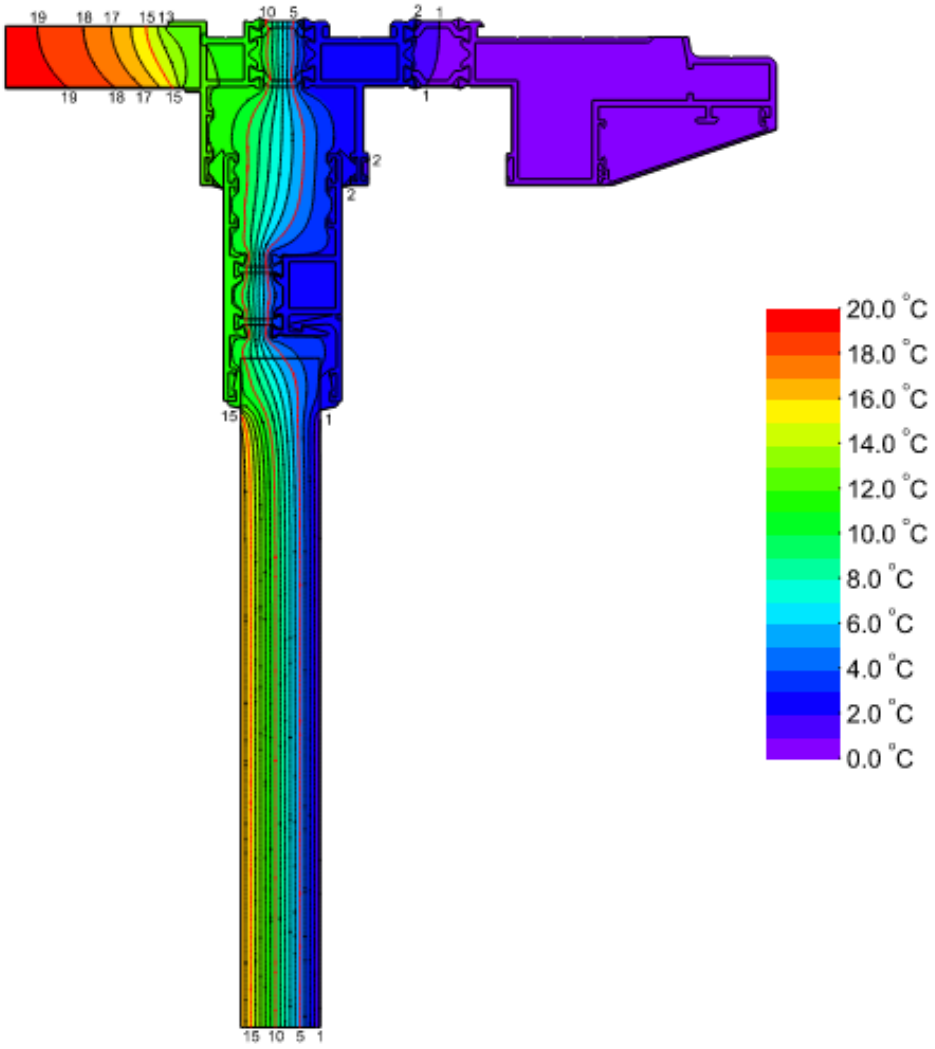
Material	λ[W/(m·K)]
DEL 591F_ Unventilated air cavity *	
DEL591F _EPDM (ethylene propylene diene monomer)	0.250
DEL591F_Aluminium (Si Alloys)	160.000
DEL591F_Panel	0.035
DEL591F_Polyamid 6.6 with 25% glass fibre	0.300
DEL591F_Slightly ventilated air cavity *	
DEL591F_Timber 500 kg/m3 (softwoods)	0.130
DEL591_Pile weather stripping (polyester mohair)	0.140

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

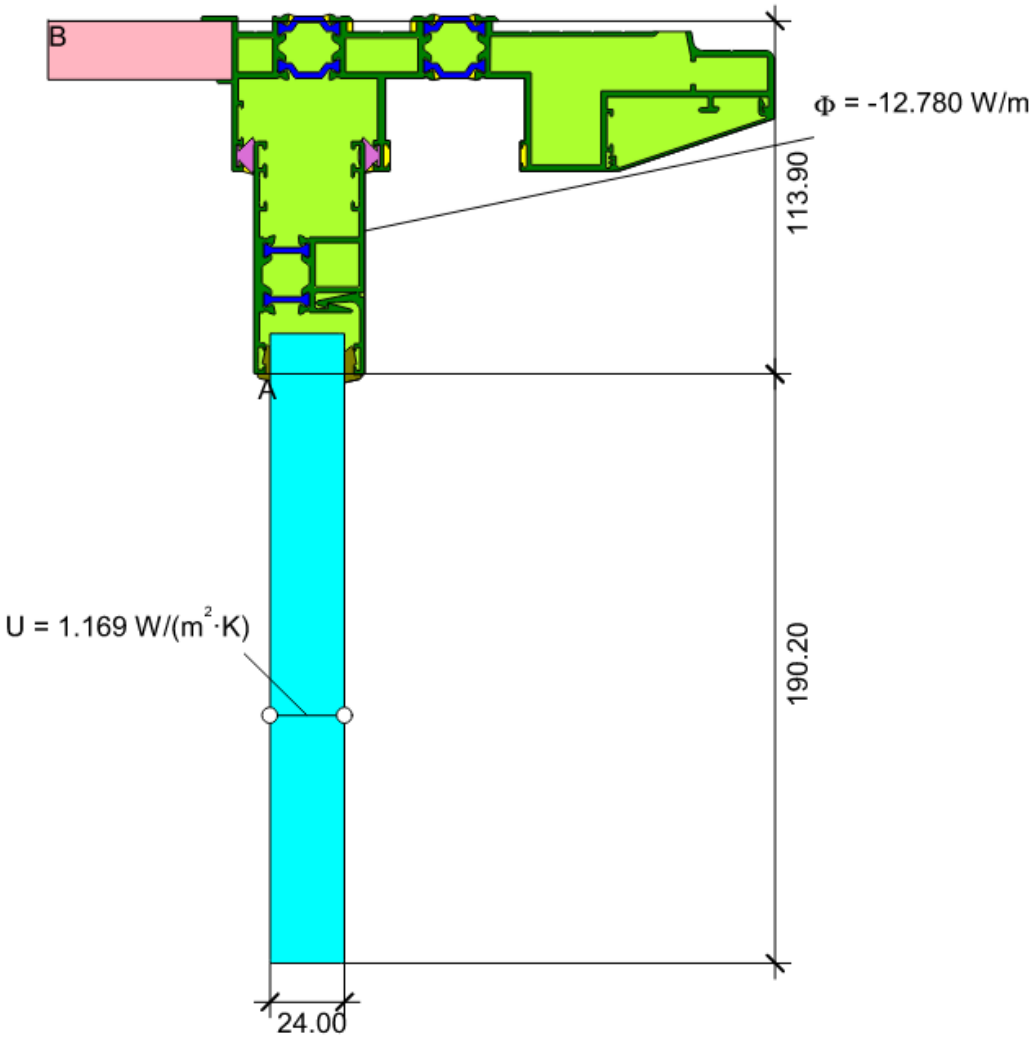
Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
DEL591F_Exterior		0.000	0.040	
DEL591F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

Title:Appendix C - SDoor Head 3-x.flx
Reference: Drawing :

Model 1



Model 1
Title:Appendix C - SDoor Head 3-x.flx
Reference: Drawing :

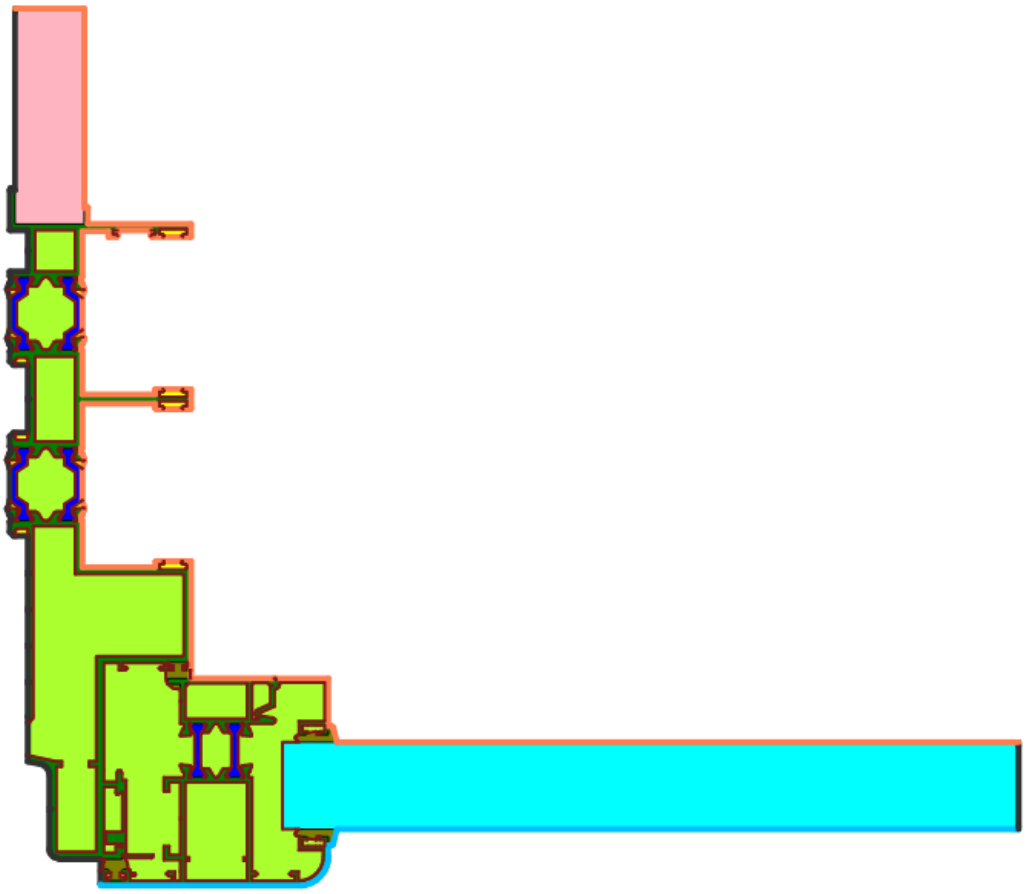


$$U_{f\,A,B} = \frac{\frac{12.78}{20.0} - 1.169 \cdot 0.19}{0.114} = 3.66\ W/(m^2 \cdot K)$$

Appendix D– Sliding Door Jamb Sash

Title:Appendix D - SDoor Jamb 1-x.flx
Reference: Drawing :

Model 1

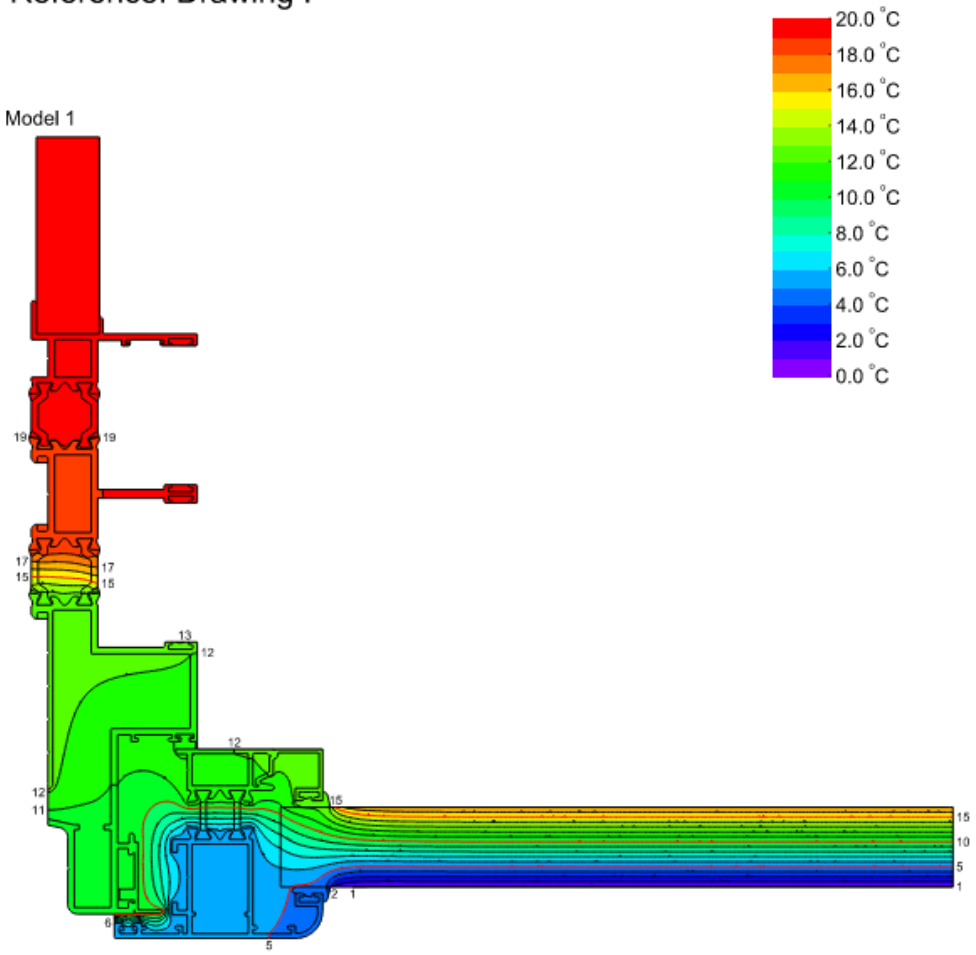


Material	λ[W/(m·K)]
DEL 591F_ Unventilated air cavity *	
DEL591F _EPDM (ethylene propylene diene monomer)	0.250
DEL591F_Aluminium (Si Alloys)	160.000
DEL591F_Panel	0.035
DEL591F_Polyamid 6.6 with 25% glass fibre	0.300
DEL591F_Slightly ventilated air cavity *	
DEL591F_Timber 500 kg/m3 (softwoods)	0.130

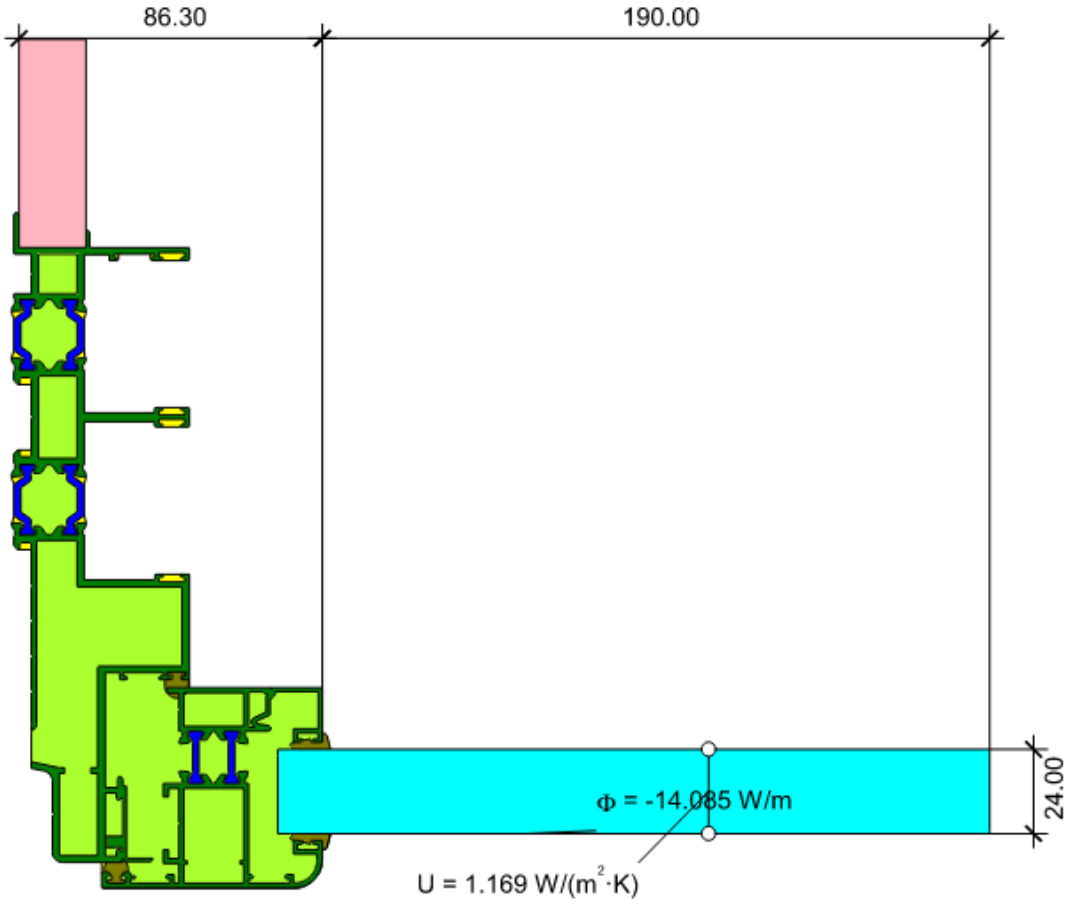
* EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
DEL591F_Exterior		0.000	0.040	
DEL591F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

Title:Appendix D - SDoor Jamb 1-x.flx
Reference: Drawing :



Model 1
Title:Appendix D - SDoor Jamb 1-x.flx
Reference: Drawing :

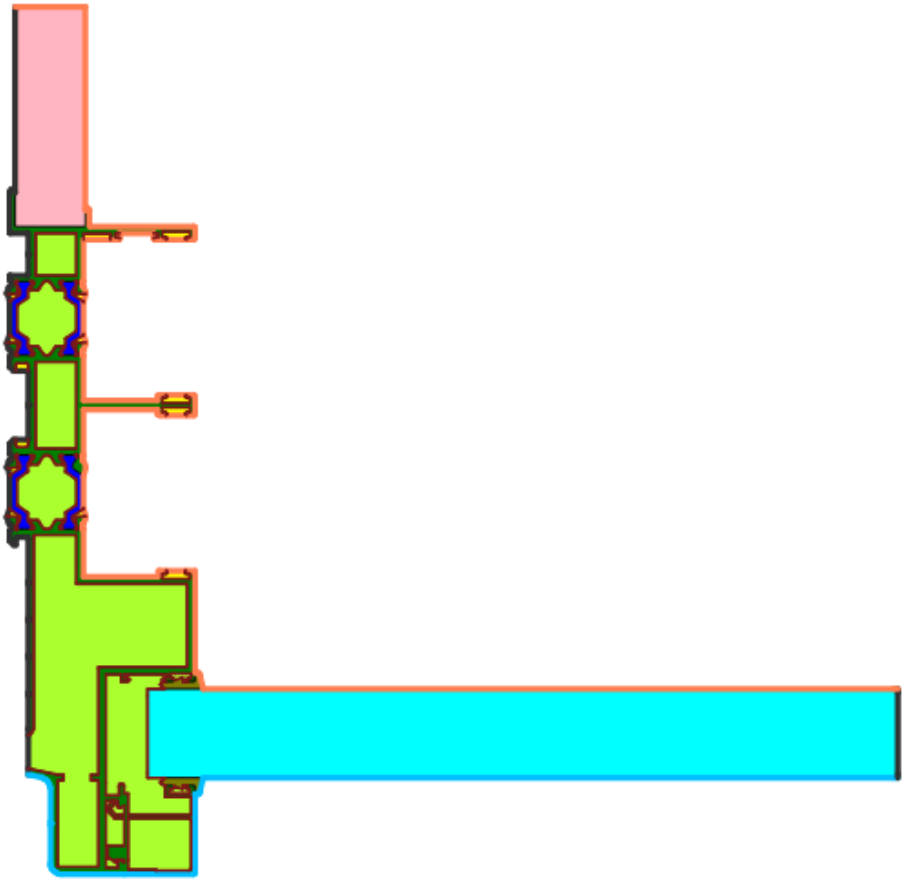


$$U_t = \frac{\frac{14.085}{20.0} - 1.169 \cdot 0.19}{0.086} = 5.59 \text{ W/(m}^2\text{·K)}$$

Appendix E – Sliding Door Jamb (Fixed)

Title:Appendix E - SDoor Jamb 2-x.flx
Reference: Drawing :

Model 1

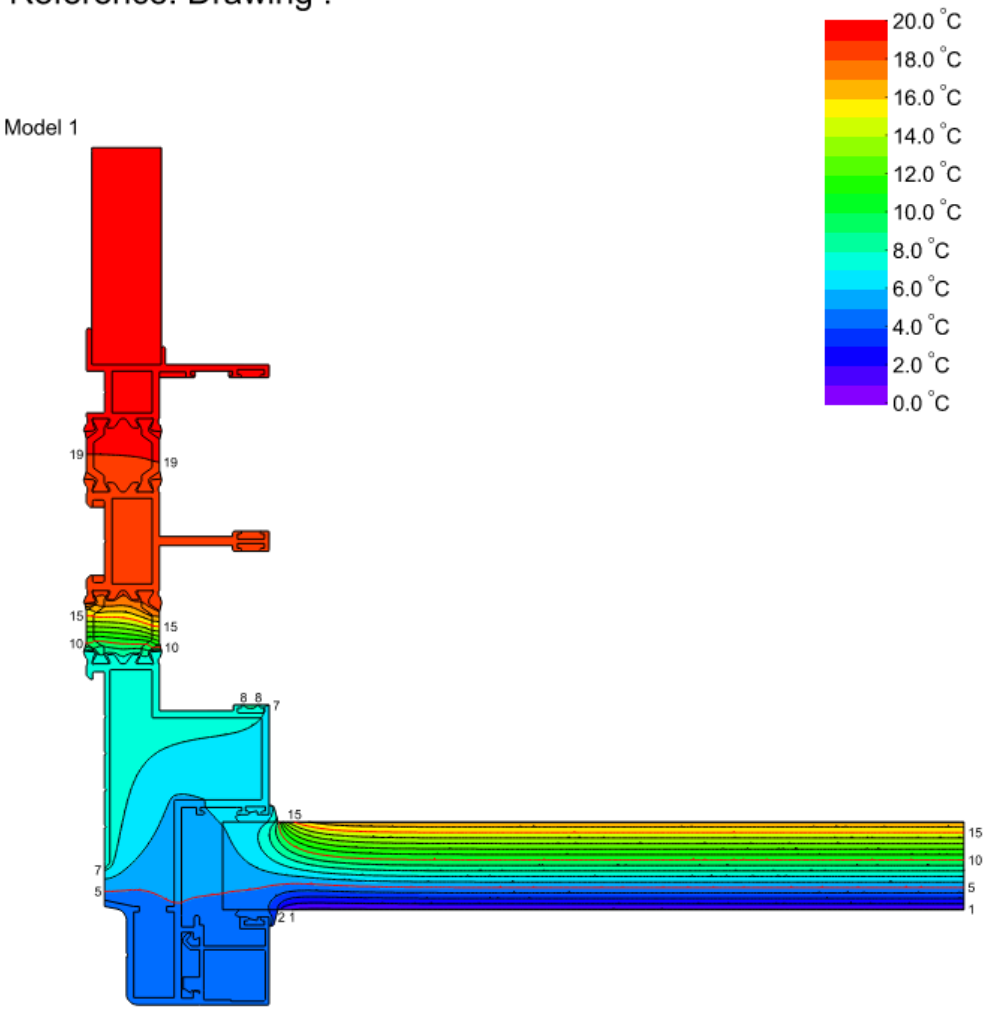


Material	λ[W/(m·K)]
DEL 591F_ Unventilated air cavity *	
DEL591F _EPDM (ethylene propylene diene monomer)	0.250
DEL591F_Aluminium (Si Alloys)	160.000
DEL591F_Panel	0.035
DEL591F_Polyamid 6.6 with 25% glass fibre	0.300
DEL591F_Slightly ventilated air cavity *	
DEL591F_Timber 500 kg/m3 (softwoods)	0.130

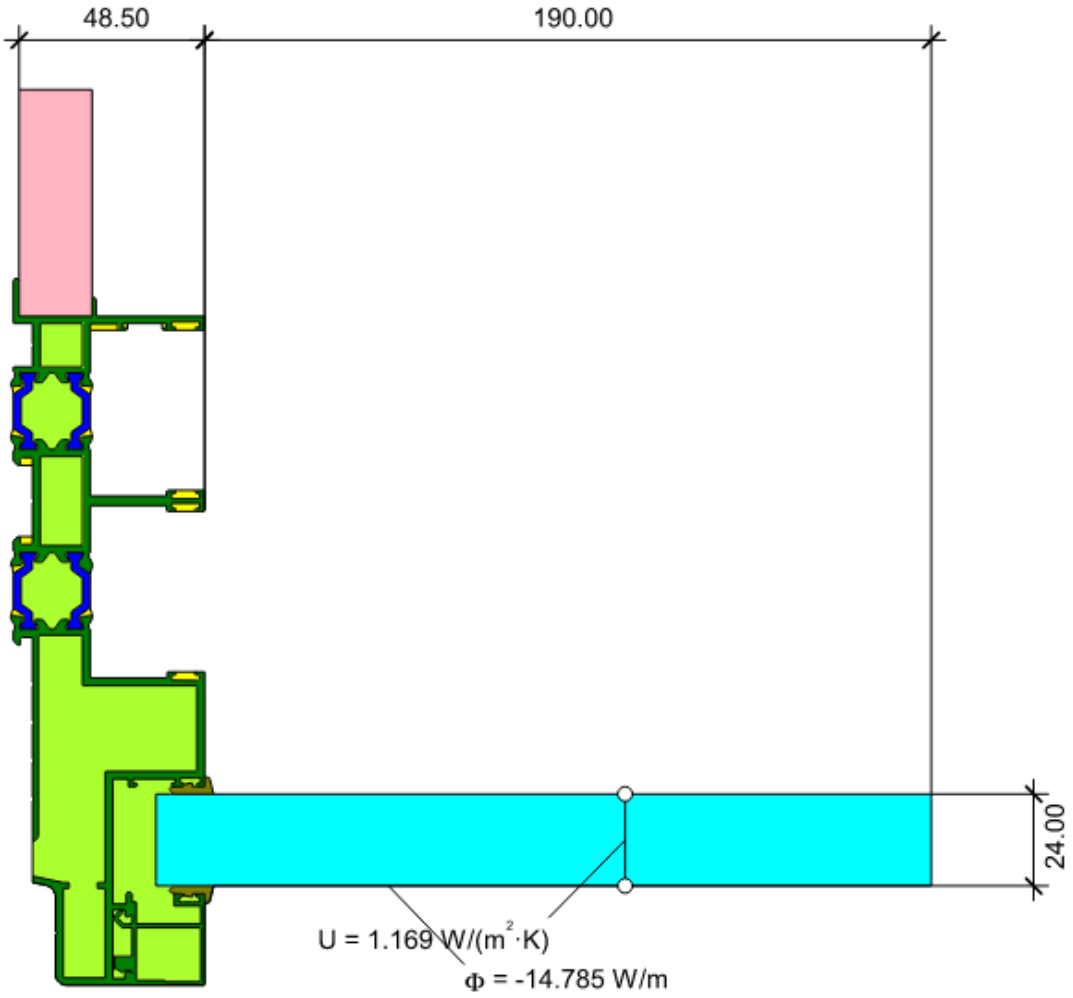
* EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
DEL591F_Exterior		0.000	0.040	
DEL591F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

Title:Appendix E - SDoor Jamb 2-x.flx
Reference: Drawing :



Model 1
Title:Appendix E - SDoor Jamb 2-x.flx
Reference: Drawing :

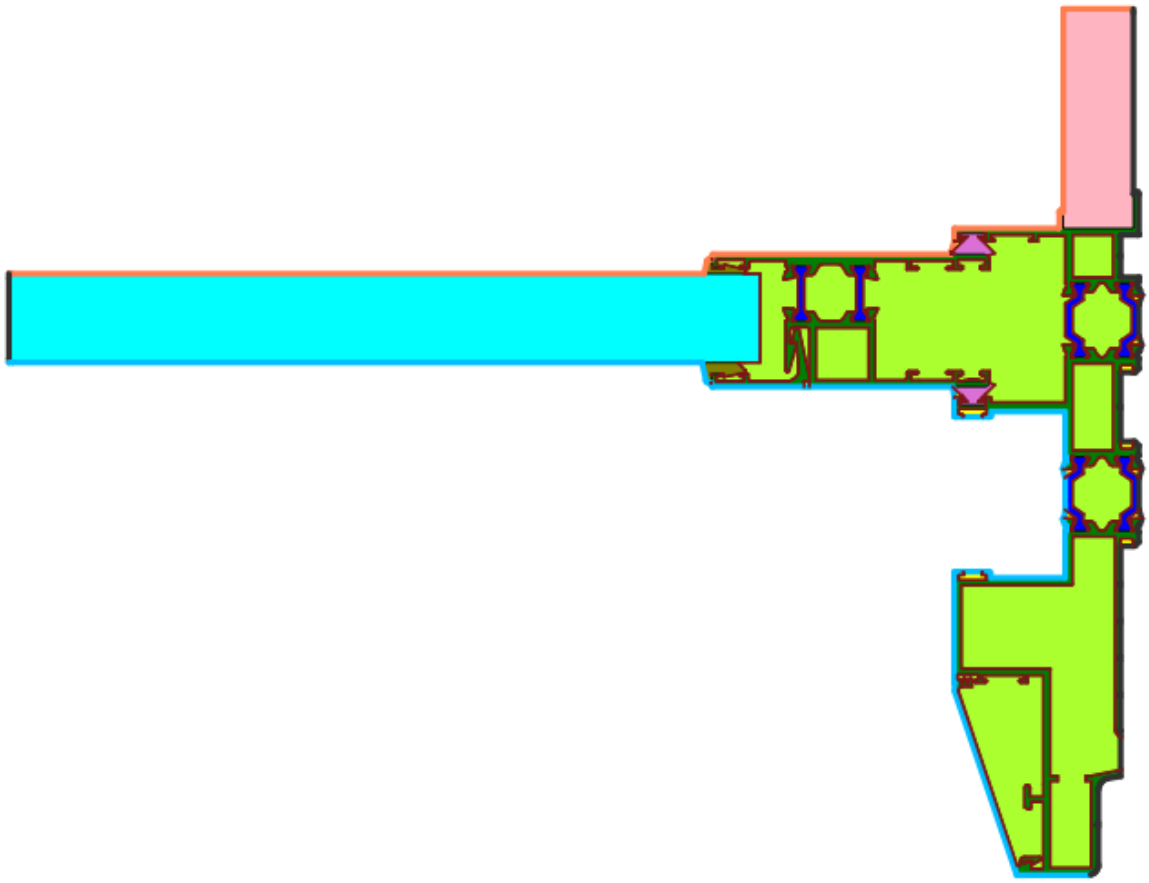


$$U_f = \frac{\frac{14.785}{20.0} - 1.169 \cdot 0.19}{0.049} = 10.7 \text{ W/(m}^2\text{·K)}$$

Appendix F– Sliding Door Jamb (Sliding)

Title:Appendix F - SDoor Jamb 3-x.flx
Reference: Drawing :

Model 1



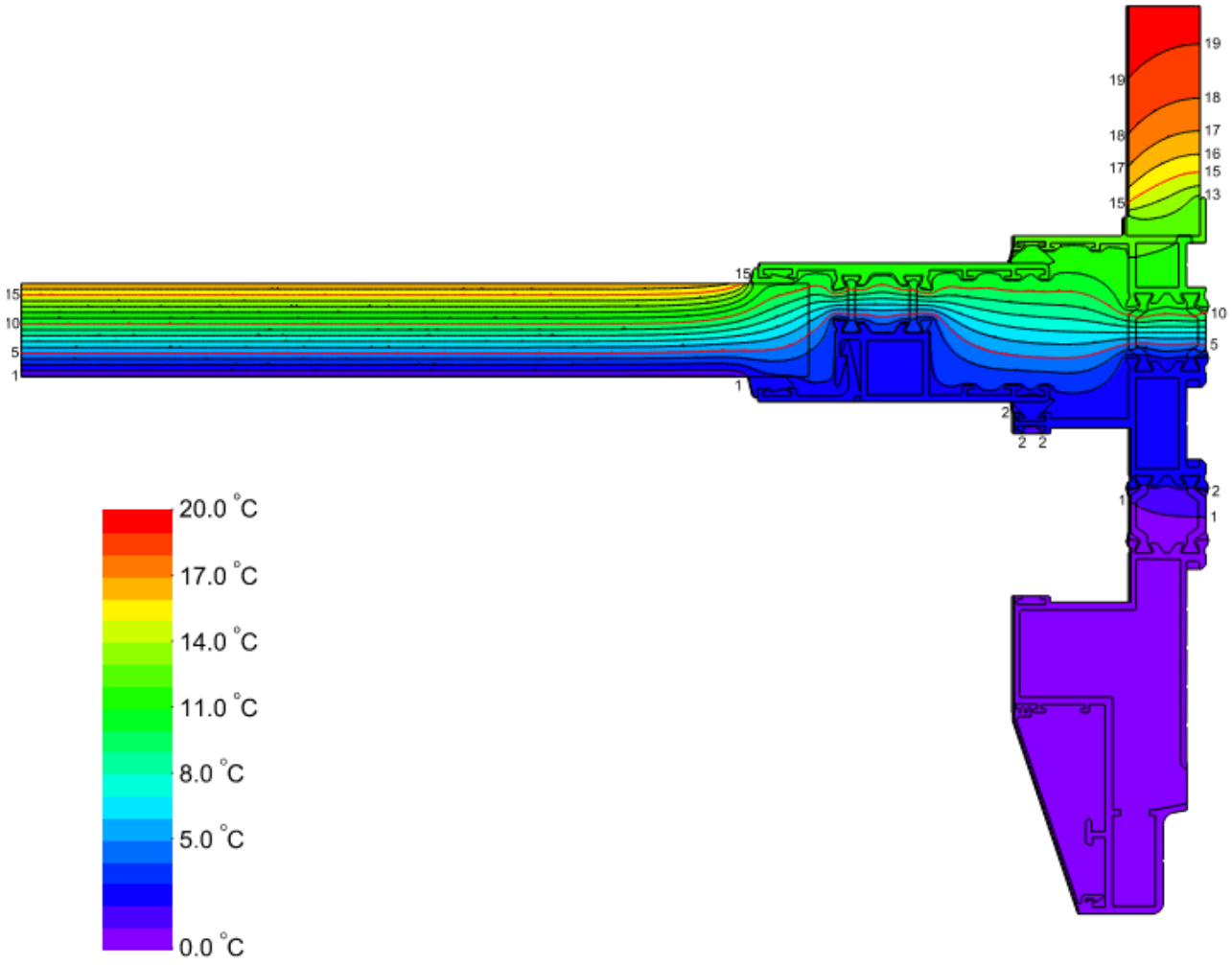
Material	λ[W/(m·K)]
DEL 591F_ Unventilated air cavity *	
DEL591F _EPDM (ethylene propylene diene monomer)	0.250
DEL591F_Aluminium (Si Alloys)	160.000
DEL591F_Panel	0.035
DEL591F_Polyamid 6.6 with 25% glass fibre	0.300
DEL591F_Slightly ventilated air cavity *	
DEL591F_Timber 500 kg/m3 (softwoods)	0.130
DEL591_Pile weather stripping (polyester mohair)	0.140

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

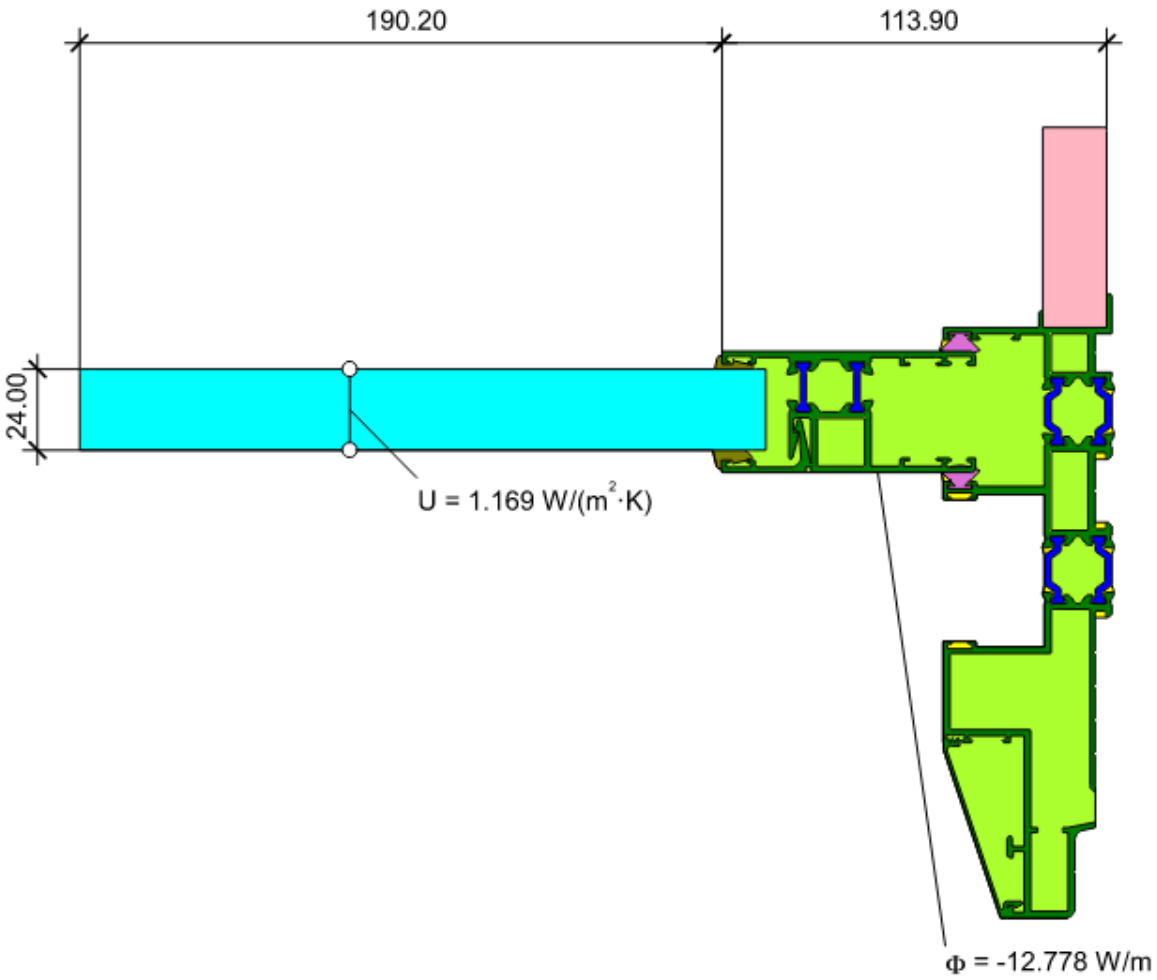
Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
DEL591F_Exterior		0.000	0.040	
DEL591F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

Title:Appendix F - SDoor Jamb 3-x.flx
Reference: Drawing :

Model 1



Model 1
Title:Appendix F - SDoor Jamb 3-x.flx
Reference: Drawing :

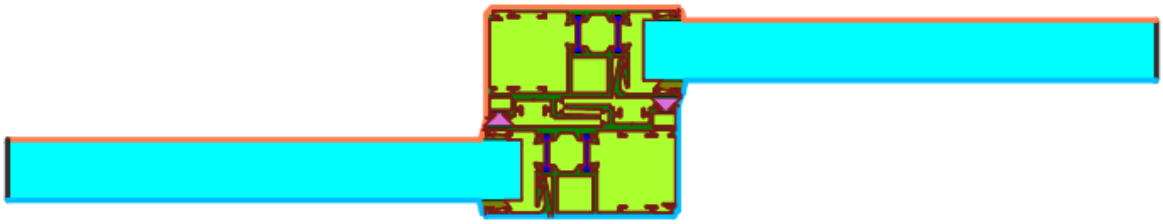


$$U_f = \frac{\frac{12.778}{20.0} - 1.169 \cdot 0.19}{0.114} = 3.66 \text{ W/(m}^2\text{·K)}$$

Appendix G– Sliding Door Stile

Title:Appendix G - SDoor Mullion 1-x.flx
Reference: Drawing :

Model 1



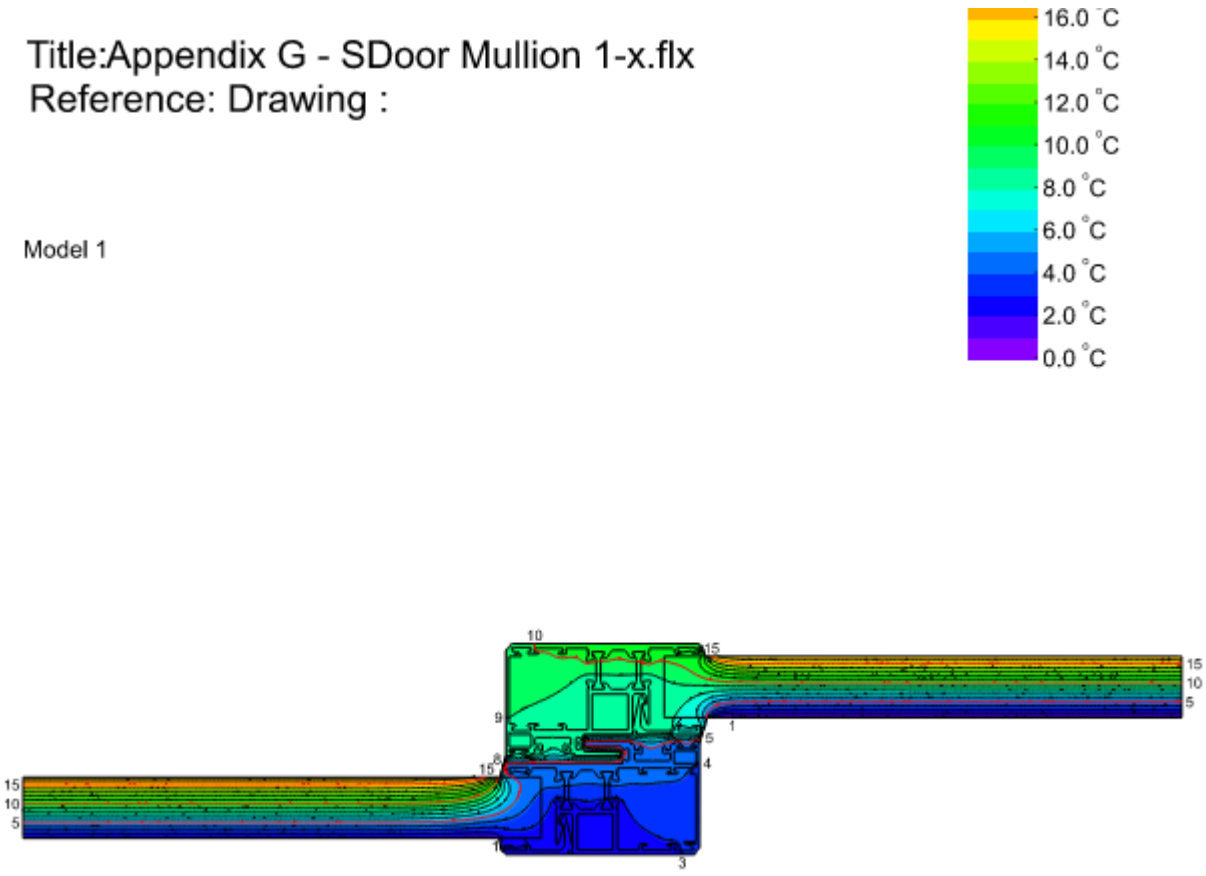
Material	λ[W/(m·K)]
DEL 591F_ Unventilated air cavity *	
DEL591F _EPDM (ethylene propylene diene monomer)	0.250
DEL591F_Aluminium (Si Alloys)	160.000
DEL591F_Panel	0.035
DEL591F_Polyamid 6.6 with 25% glass fibre	0.300
DEL591F_Slightly ventilated air cavity *	
DEL591_Pile weather stripping (polyester mohair)	0.140

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

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
DEL591F_Exterior		0.000	0.040	
DEL591F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

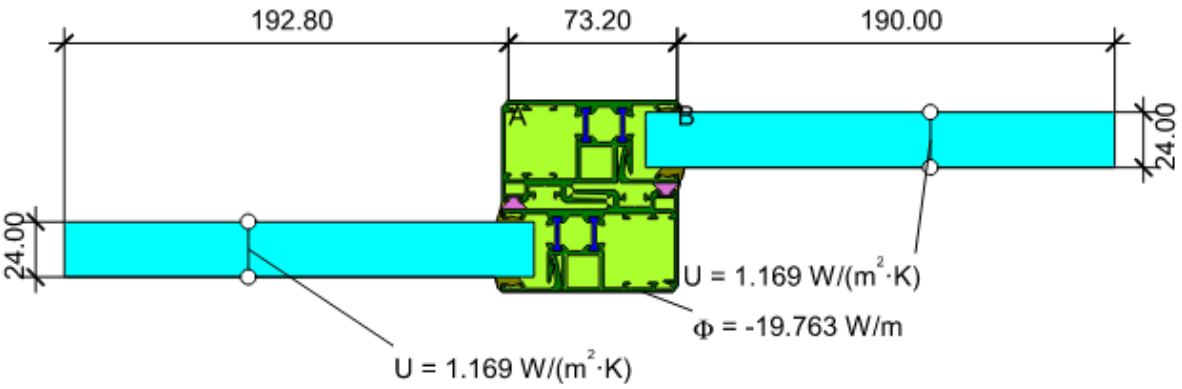
Title:Appendix G - SDoor Mullion 1-x.flx
Reference: Drawing :

Model 1



Model 1

Title:Appendix G - SDoor Mullion 1-x.flx
Reference: Drawing :



$$U_{f\,A,B} = \frac{\frac{19.763}{20.0} - 1.169 \cdot 0.193 - 1.169 \cdot 0.19}{0.073} = 7.39\ W/(m^2 \cdot K)$$

Appendix H– Sliding Door Transom (Awing & Fixed)

Title:Appendix H - SDoor Tansom 1--x.flx
Reference: Drawing :

Model 1

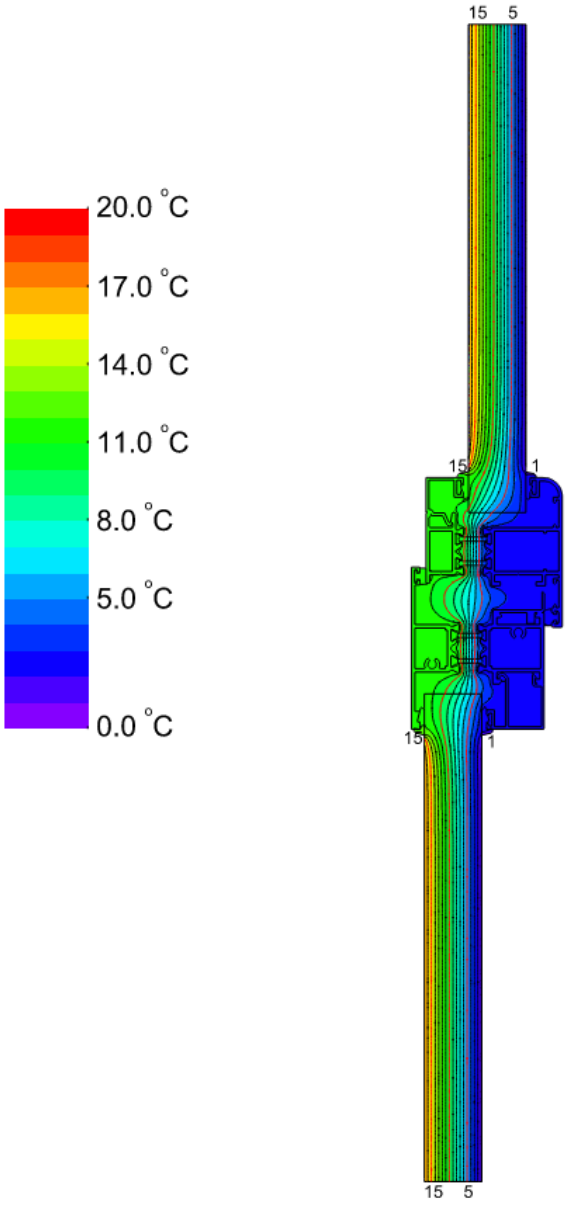
Material	λ[W/(m·K)]
DEL 591F_ Unventilated air cavity *	
DEL591F _EPDM (ethylene propylene diene monomer)	0.250
DEL591F_Aluminium (Si Alloys)	160.000
DEL591F_Panel	0.035
DEL591F_Polyamid 6.6 with 25% glass fibre	0.300
DEL591F_Slightly ventilated air cavity *	

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

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
DEL591F_Exterior		0.000	0.040	
DEL591F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

Title:Appendix H - SDoor Tansom 1--x.flx
Reference: Drawing :

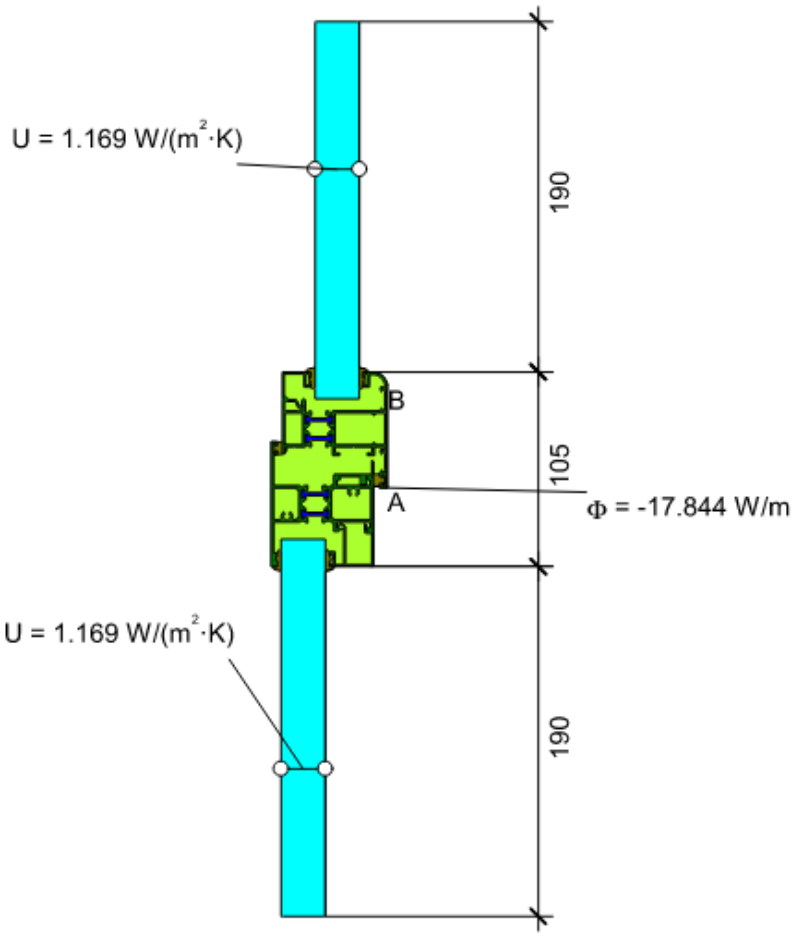
Model 1



Model 1

Title:Appendix H - SDoor Tansom 1--x.flx

Reference: Drawing :



$$U_{f\,A,B} = \frac{\frac{17.844}{20.0} - 1.169 \cdot 0.19 - 1.169 \cdot 0.19}{0.105} = 4.26\ W/(m^2 \cdot K)$$

Appendix I– Sliding Door Mullion (Sash)

Title:Appendix I - SDoor Sash 1--x.flx
Reference: Drawing :

Model 1

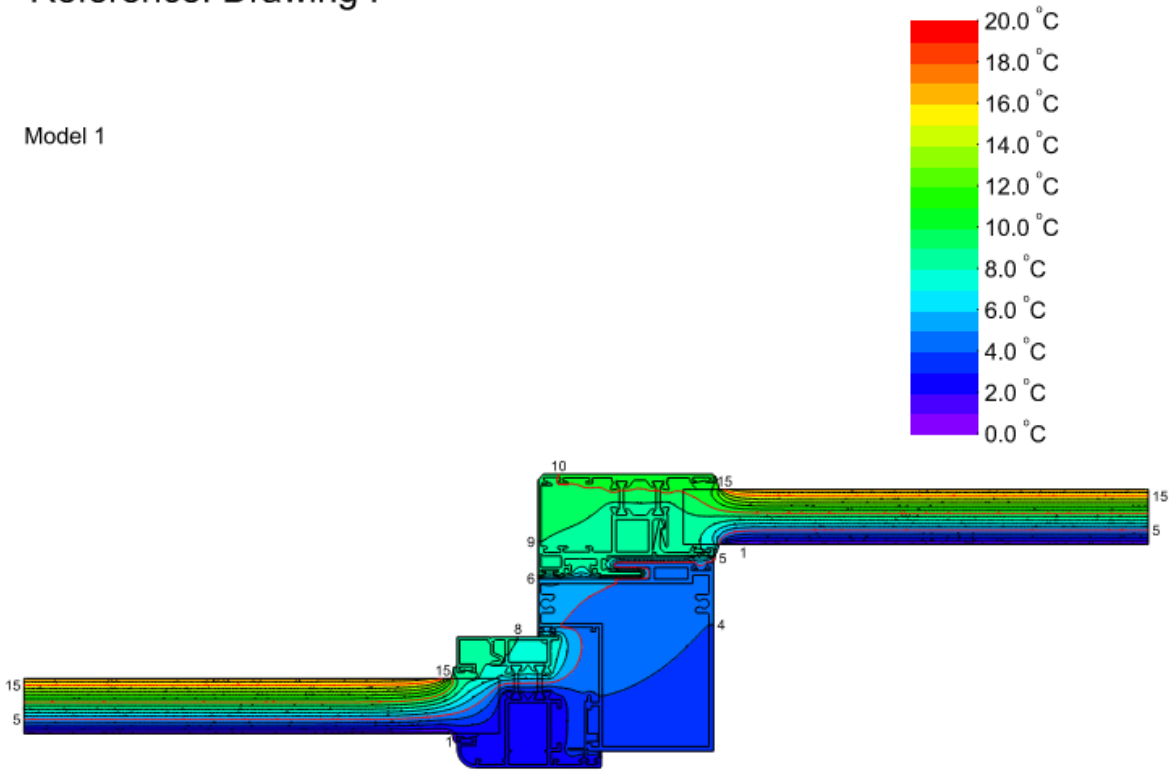
Material	λ[W/(m·K)]
DEL 591F_ Unventilated air cavity *	
DEL591F _EPDM (ethylene propylene diene monomer)	0.250
DEL591F_Aluminium (Si Alloys)	160.000
DEL591F_Panel	0.035
DEL591F_Polyamid 6.6 with 25% glass fibre	0.300
DEL591F_Slightly ventilated air cavity *	
DEL591_Pile weather stripping (polyester mohair)	0.140

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

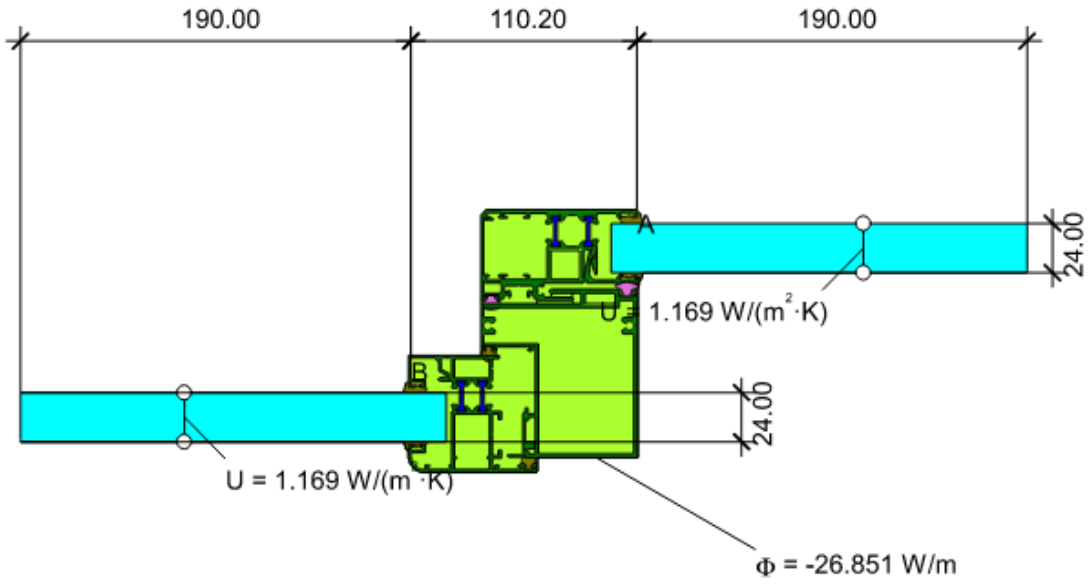
Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
DEL591F_Exterior		0.000	0.040	
DEL591F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

Title:Appendix I - SDoor Sash 1--x.flx
Reference: Drawing :

Model 1



Model 1
Title:Appendix I - SDoor Sash 1--x.flx
Reference: Drawing :



$$U_{fB,A} = \frac{\frac{26.851}{20.0} - 1.169 \cdot 0.19 - 1.169 \cdot 0.19}{0.11} = 8.15 \text{ W/(m}^2\text{·K)}$$

Appendix J– Sliding Door Sash

Title:Appendix J - SDoor Sash 2--x.flx
Reference: Drawing :

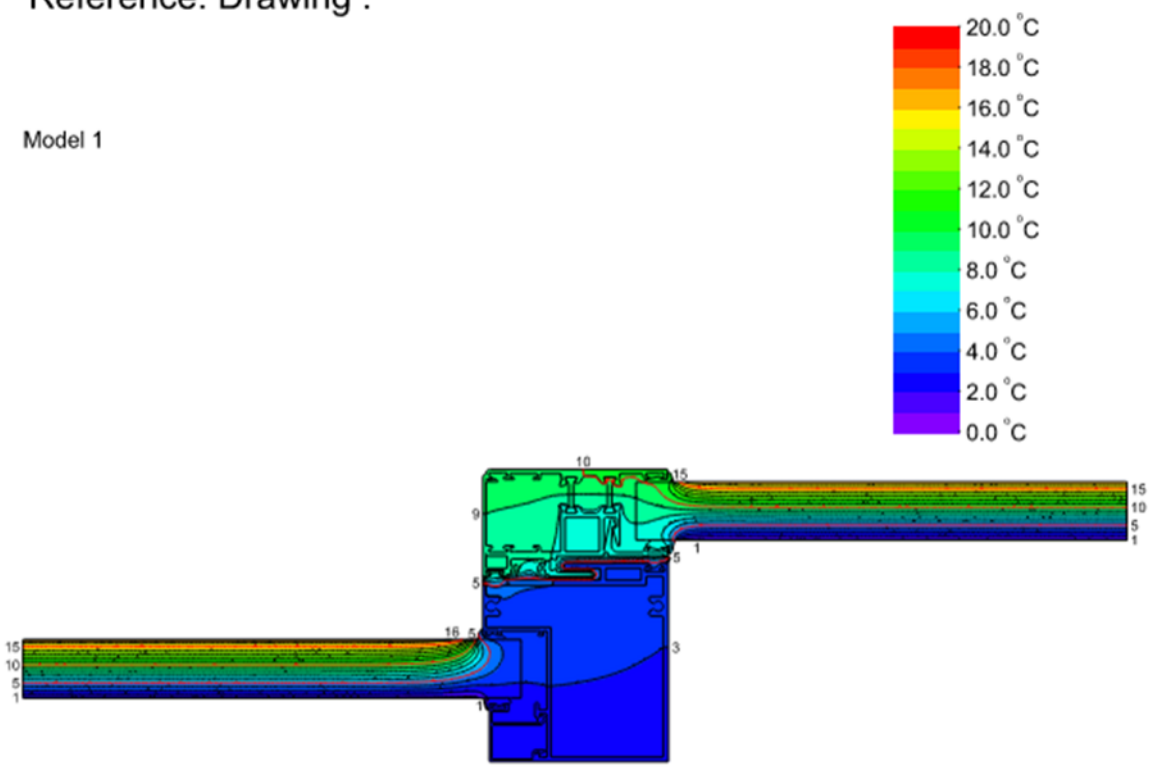
Model 1

Material	λ[W/(m·K)]
DEL 591F_ Unventilated air cavity *	
DEL591F _EPDM (ethylene propylene diene monomer)	0.250
DEL591F_Aluminium (Si Alloys)	160.000
DEL591F_Panel	0.035
DEL591F_Polyamid 6.6 with 25% glass fibre	0.300
DEL591F_Slightly ventilated air cavity *	
DEL591_Pile weather stripping (polyester mohair)	0.140

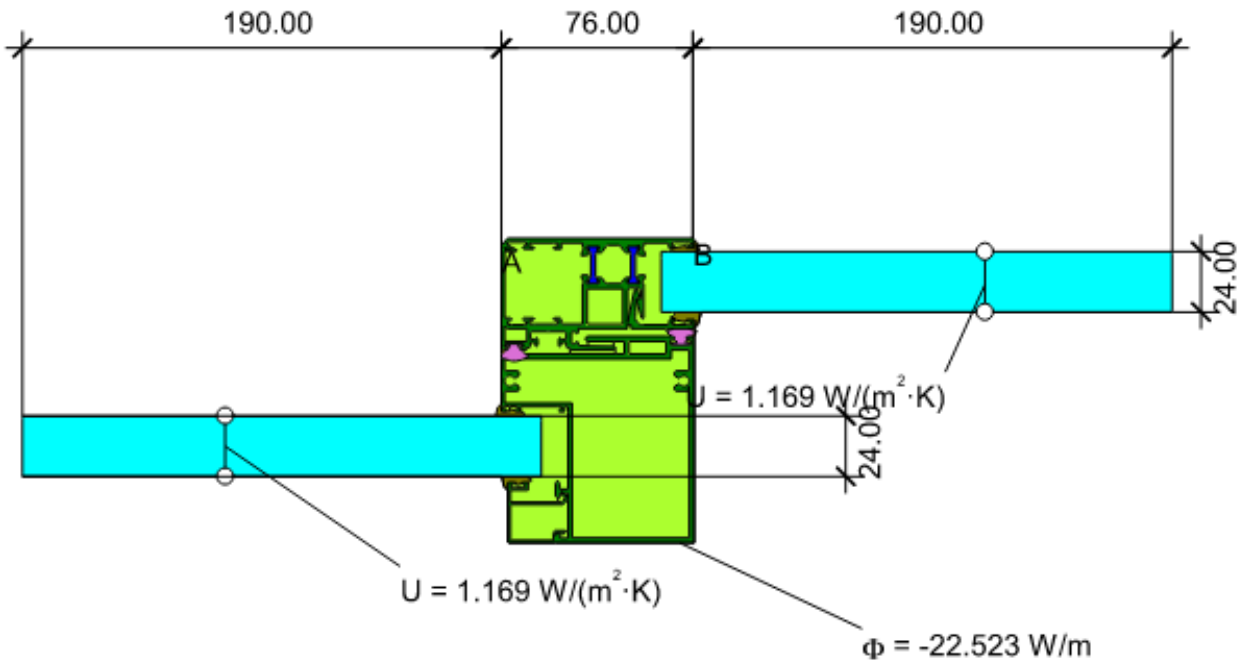
* EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
DEL591F_Exterior		0.000	0.040	
DEL591F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

Title:Appendix J - SDoor Sash 2--x.flx
Reference: Drawing :



Model 1
Title:Appendix J - SDoor Sash 2--x.flx
Reference: Drawing :

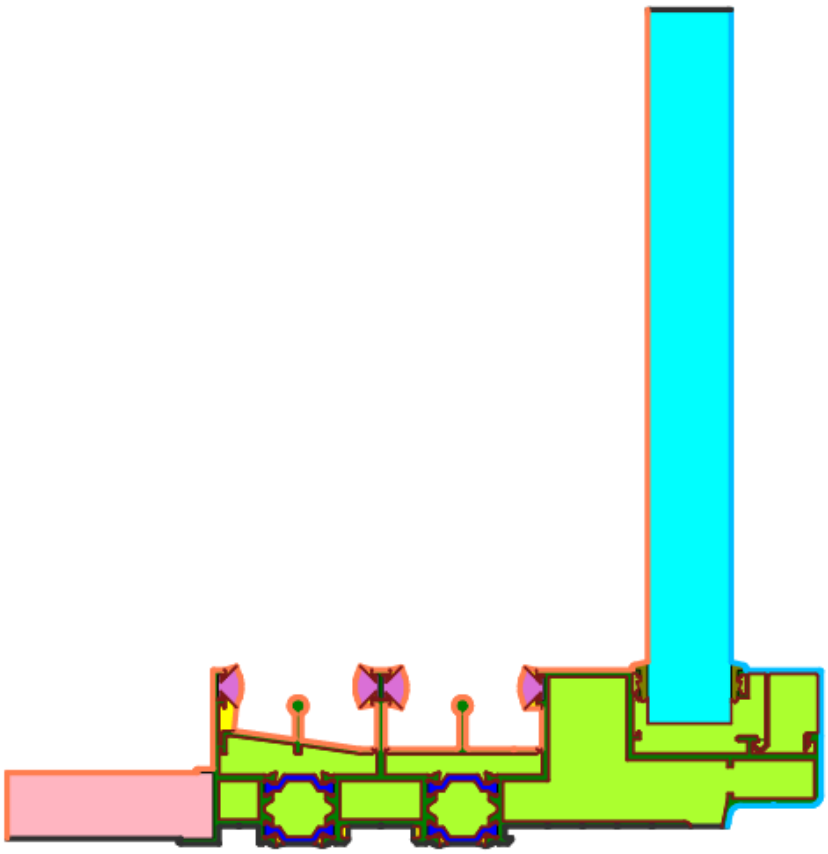


$$U_{rA,B} = \frac{\frac{22.523}{20.0} - 1.169 \cdot 0.19 - 1.169 \cdot 0.19}{0.076} = 8.97 \text{ W/(m}^2\text{·K)}$$

Appendix K– Sliding Door Sill (Fixed)

Title:Appendix K - SDoor Sill 1--x.flx
Reference: Drawing :

Model 1



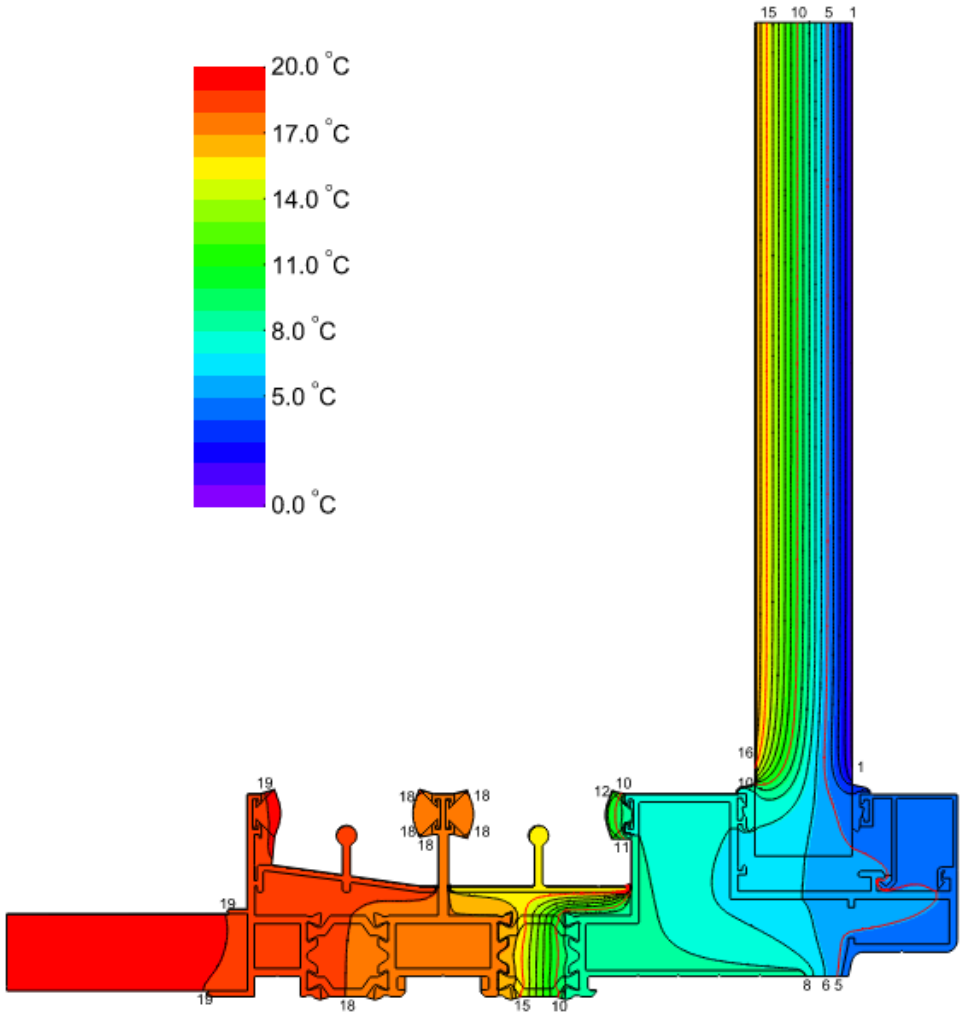
Material	λ[W/(m·K)]
DEL 591F_ Unventilated air cavity *	
DEL591F _EPDM (ethylene propylene diene monomer)	0.250
DEL591F_Aluminium (Si Alloys)	160.000
DEL591F_Panel	0.035
DEL591F_Polyamid 6.6 with 25% glass fibre	0.300
DEL591F_Slightly ventilated air cavity *	
DEL591F_Timber 500 kg/m3 (softwoods)	0.130
DEL591_Pile weather stripping (polyester mohair)	0.140

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

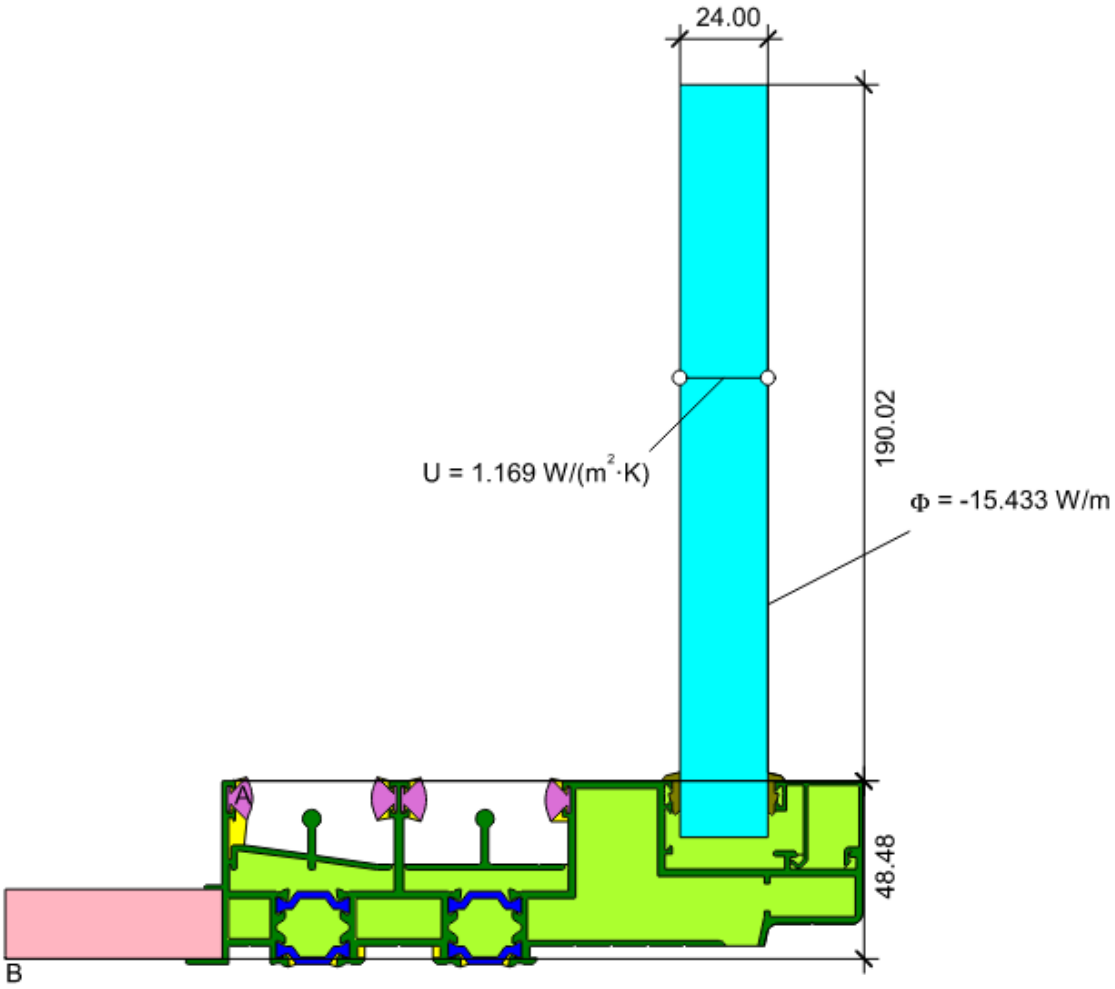
Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
DEL591F_Exterior		0.000	0.040	
DEL591F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

Title:Appendix K - SDoor Sill 1--x.flx
Reference: Drawing :

Model 1



Model 1
Title:Appendix K - SDoor Sill 1--x.flx
Reference: Drawing :

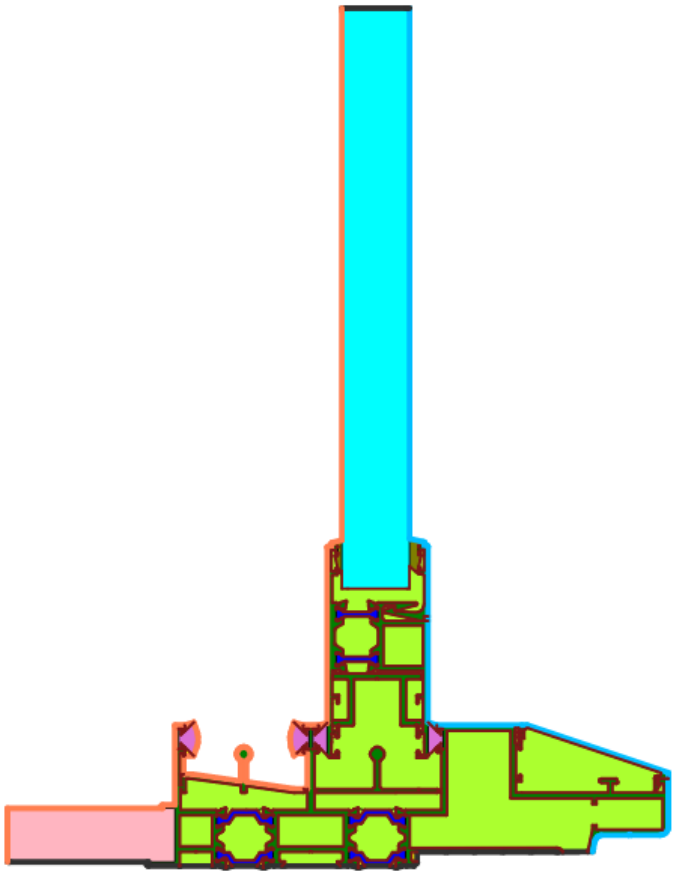


$$U_{f,A,B} = \frac{\frac{15.433}{20.0} - 1.169 \cdot 0.19}{0.048} = 11.3 \text{ W/(m}^2\text{·K)}$$

Appendix L– Sliding Door Sill

Title:Appendix L - SDoor Sill 2--x.flx
Reference: Drawing :

Model 1

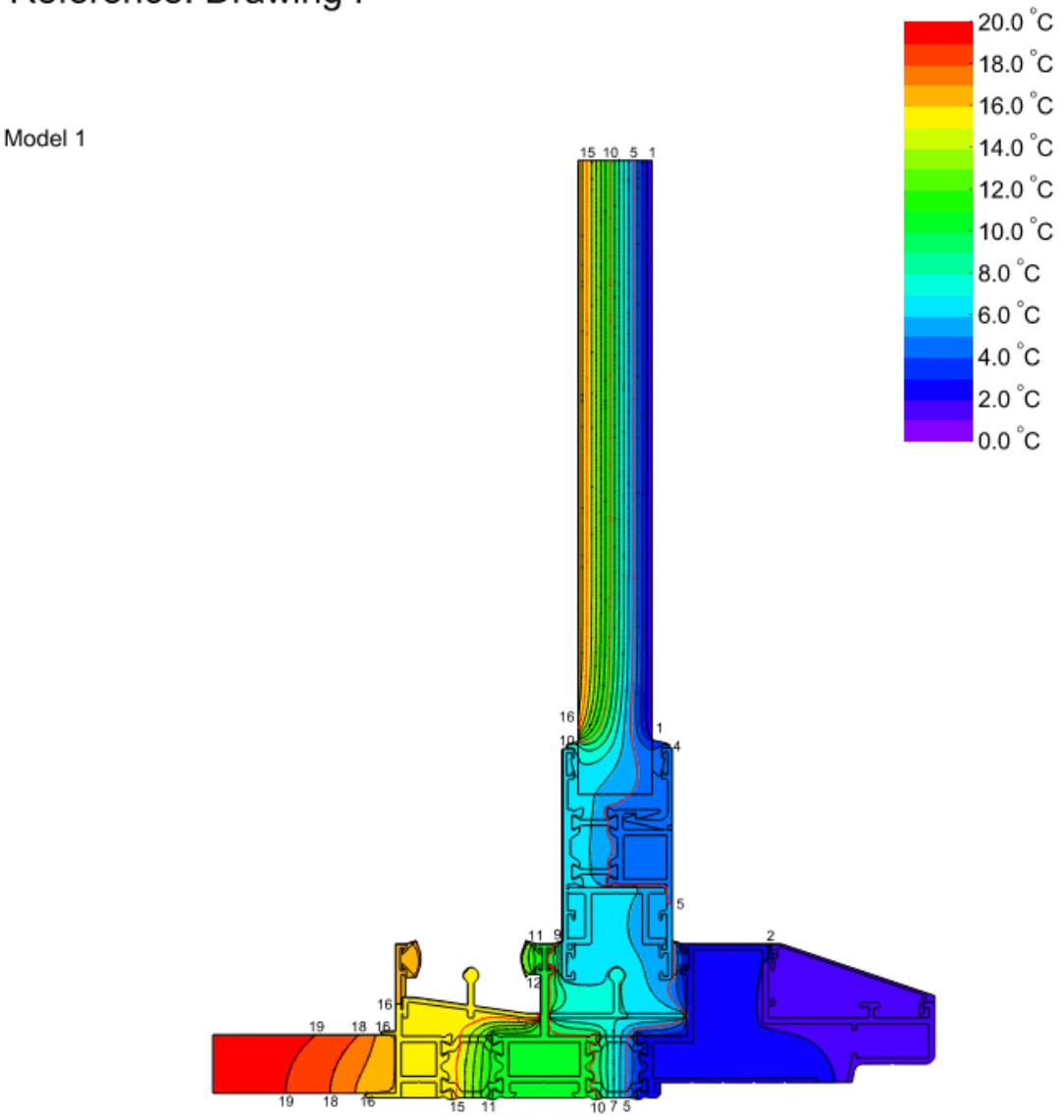


Material	λ[W/(m·K)]
DEL 591F_ Unventilated air cavity *	
DEL591F _EPDM (ethylene propylene diene monomer)	0.250
DEL591F_Aluminium (Si Alloys)	160.000
DEL591F_Panel	0.035
DEL591F_Polyamid 6.6 with 25% glass fibre	0.300
DEL591F_Slightly ventilated air cavity *	
DEL591F_Timber 500 kg/m3 (softwoods)	0.130
DEL591_Pile weather stripping (polyester mohair)	0.140

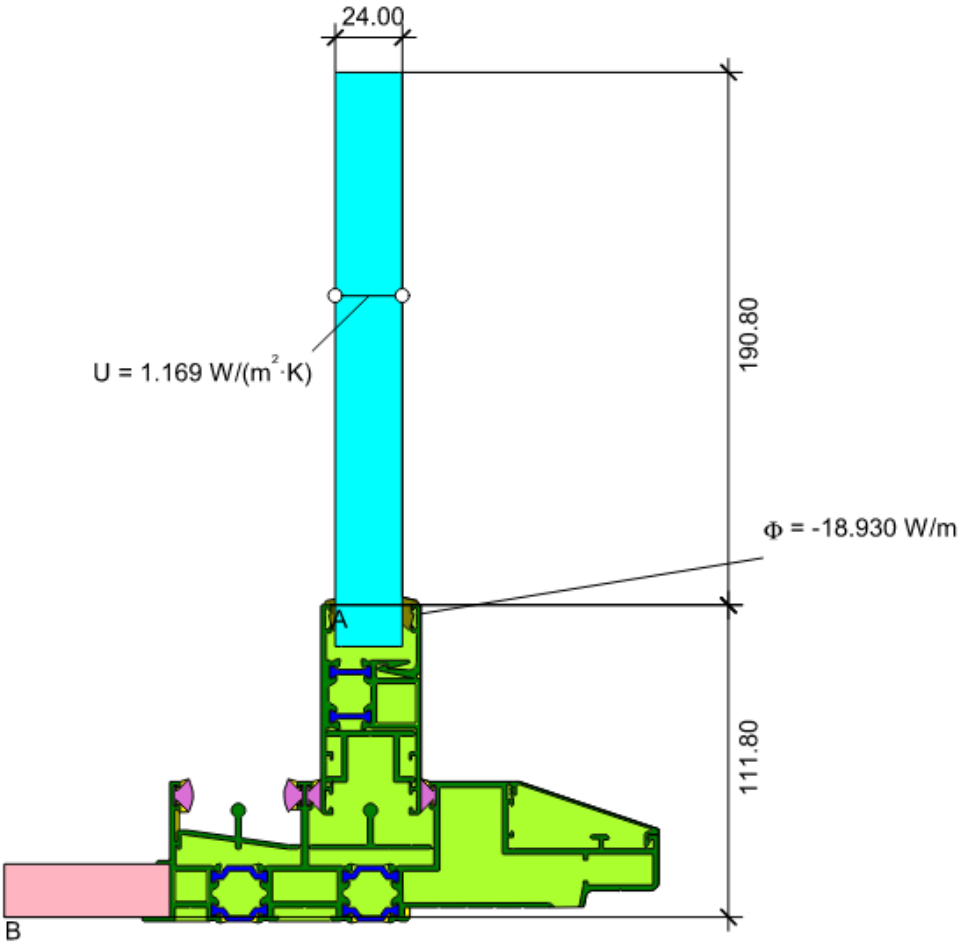
* EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
DEL591F_Exterior		0.000	0.040	
DEL591F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

Title:Appendix L - SDoor Sill 2--x.flx
Reference: Drawing :



Model 1
Title:Appendix L - SDoor Sill 2--x.flx
Reference: Drawing :

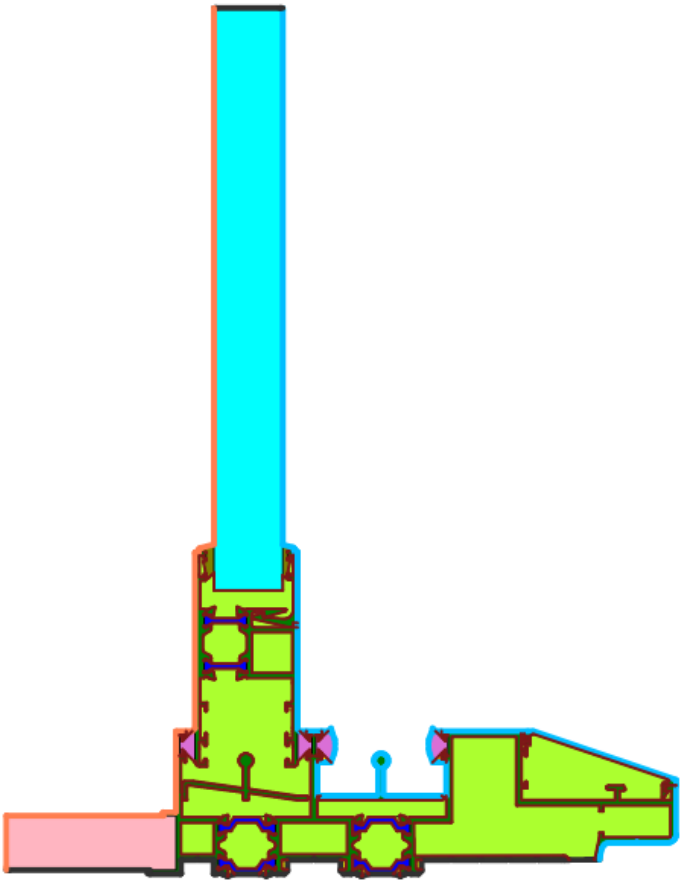


$$U_{f\,A,B} = \frac{\frac{18.93}{20.0} - 1.169 \cdot 0.191}{0.112} = 6.47\ W/(m^2 \cdot K)$$

Appendix M– Sliding Door Sill

Title:Appendix M - SDoor Sill 3--x.flx
Reference: Drawing :

Model 1

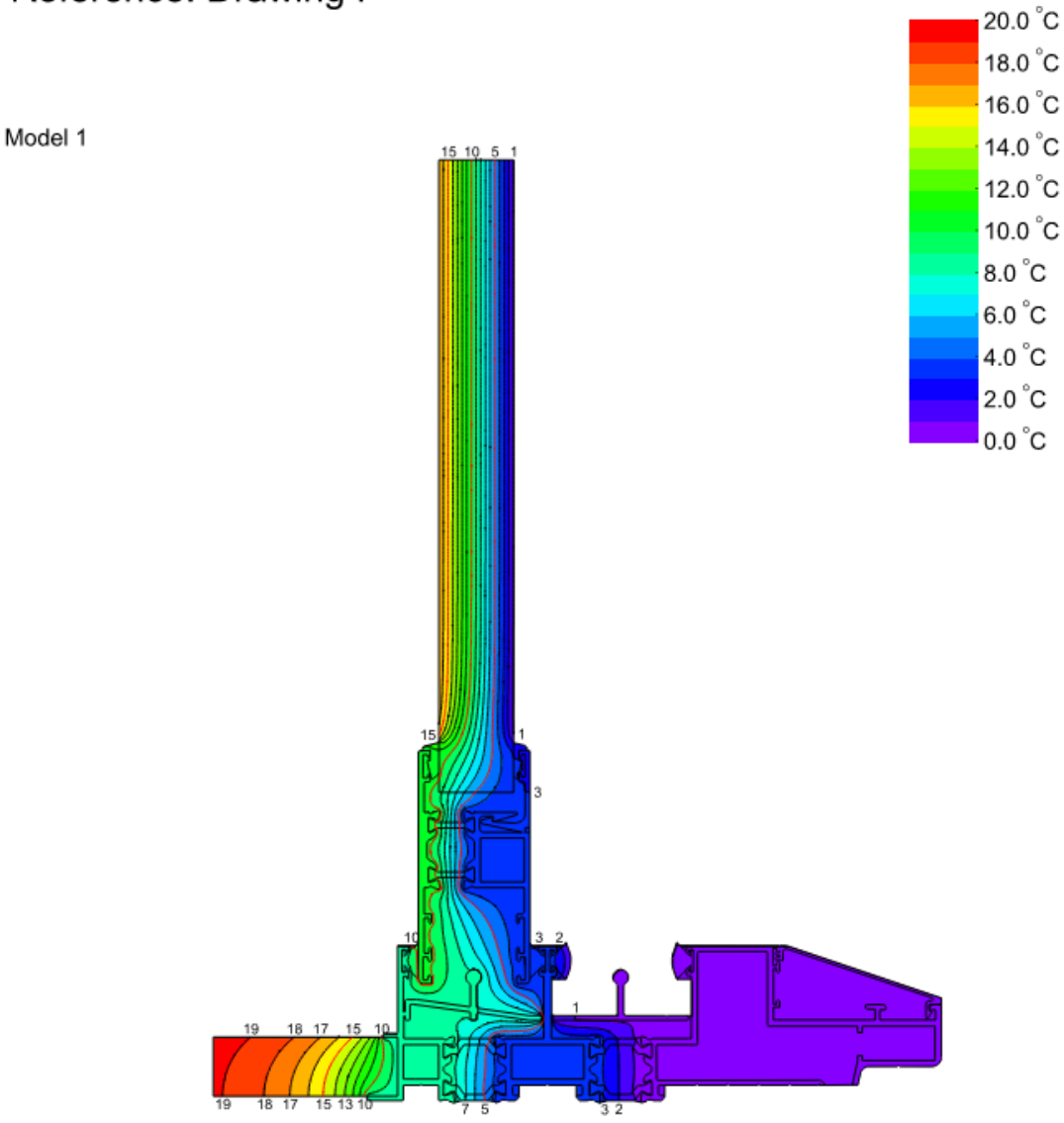


Material	λ[W/(m·K)]
DEL 591F_ Unventilated air cavity *	
DEL591F _EPDM (ethylene propylene diene monomer)	0.250
DEL591F_Aluminium (Si Alloys)	160.000
DEL591F_Panel	0.035
DEL591F_Polyamid 6.6 with 25% glass fibre	0.300
DEL591F_Slightly ventilated air cavity *	
DEL591F_Timber 500 kg/m3 (softwoods)	0.130
DEL591_Pile weather stripping (polyester mohair)	0.140

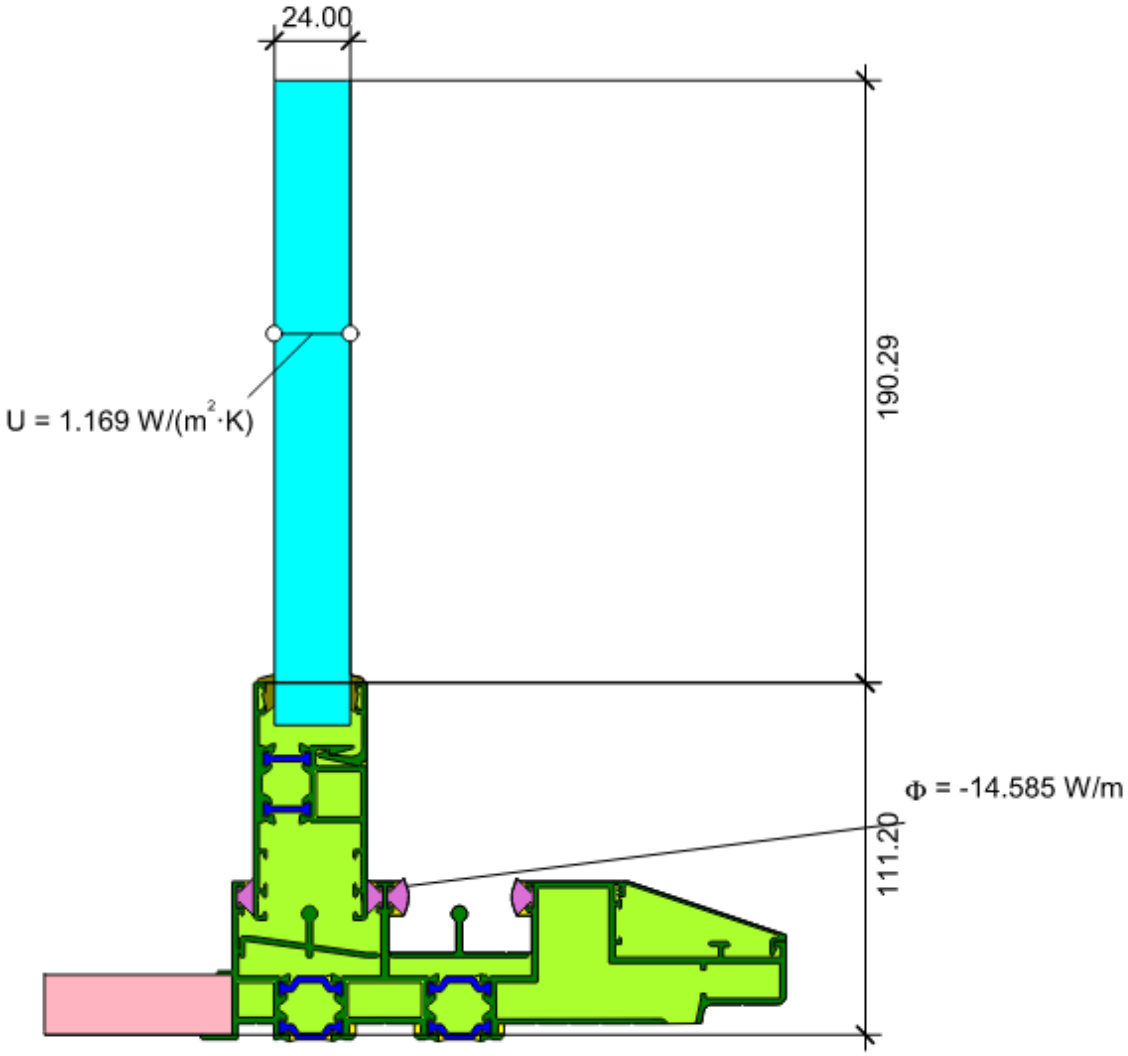
* EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
DEL591F_Exterior		0.000	0.040	
DEL591F_Interior, normal, horizontal		20.000	0.130	
Epsilon 0.9				0.900
Symmetry/Model section	0.000			

Title:Appendix M - SDoor Sill 3--x.flx
Reference: Drawing :



Model 1
Title:Appendix M - SDoor Sill 3--x.flx
Reference: Drawing :



$$U_f = \frac{\frac{14.585}{20.0} - 1.169 \cdot 0.19}{0.111} = 4.56 \text{ W/(m}^2\text{·K)}$$

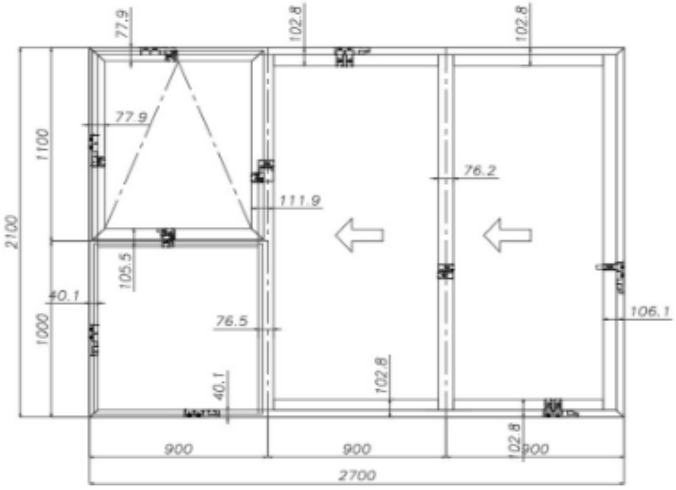
Appendix N – R-Value Calculation for Aluminium Joinery.

N.1 Joinery Type D1 - Fixed and 2 stacker door leaves

Job Name :	*Rangi Windows Ltd - System R Value*	**Job No:**	*DEL591F*
Reference :	*Awning and Stacker*	**Date:**	*16/05/24*
Glazing Type :	*Joinery*	**Engineer:**	*NB*
Spacer Type:	*Aluminium*		
Configuration Code:	*D1*	**Page :**	1

FRAME CONFIGURATION

Glazing Type→	Joinery	
Joinery Width Fixed =	0.9	m
Joinery Width Sliding =	1.8	m
Joinery Height =	2.1	m



Width of Projected Frame:

Head (Awning) =	0.0779	m
Head (Sliding) =	0.1028	m
Jamb (Fixed) =	0.04	m
Jamb (Sliding) =	0.1061	m
Sill (Fixed) =	0.04	m
Sill (Sliding) =	0.1028	m
Stile =	0.0762	m

U-Value of Frame:

Head (Awning) =	7.7	W/m2.K
Head (Sliding) =	3.78	W/m2.K
Jamb (Fixed) =	10.7	W/m2.K
Jamb (Sliding) =	3.66	W/m2.K
Sill (Fixed) =	11.3	W/m2.K
Sill (Sliding) =	5.515	W/m2.K
Stile =	7.39	W/m2.K

	Width	
Transom (awning fixed)	0.1055	m
Mullion+sash	0.1118	m
Jamb + sash	0.0779	m

U-Value of Transom

Transom (awning fixed)	4.26	W/m2.K
Mullion+sash	8.56	W/m2.K
Jamb + sash	5.59	W/m2.K

U-Value of Glazing, Ug =	1.1	W/m2.K	<= Client supplied value
Psi of Edge-of-Glass, Ψg =	0.08	W/m.K	For Thermally improved Spacer per ISO 10077-1

Glazing Area, Ag:	4.444	m2	*Exclude glass?*	NO
Length of Edge-of-Glass:	17.538	m		
U-Value of Frame, Uf	6.085	W/m2.K		
U-Value of Joinery, Uw	2.156	W/m2.K		
R-Value of Joinery, R	0.464	m2.K/W		