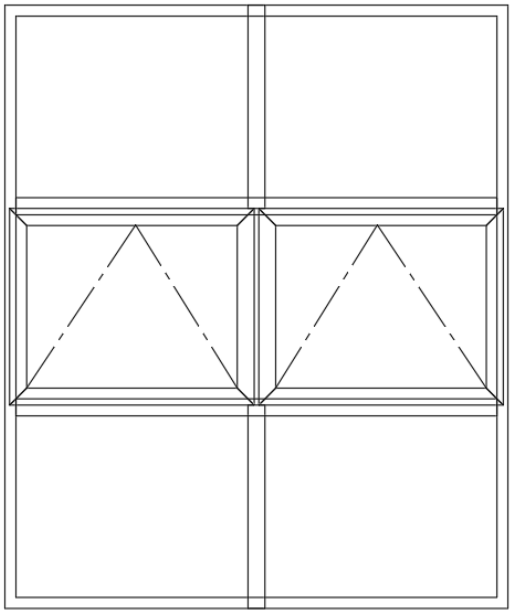
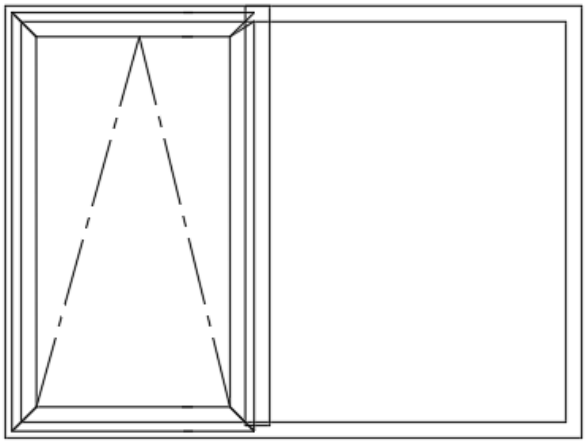
# Thermally Broken Aluminium R-Value Calculation Report -Window

## R-Value of Joinery Configurations





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| 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 |
| | | | | |
| | | | | |

## Table of Contents

## 1.0 Introduction

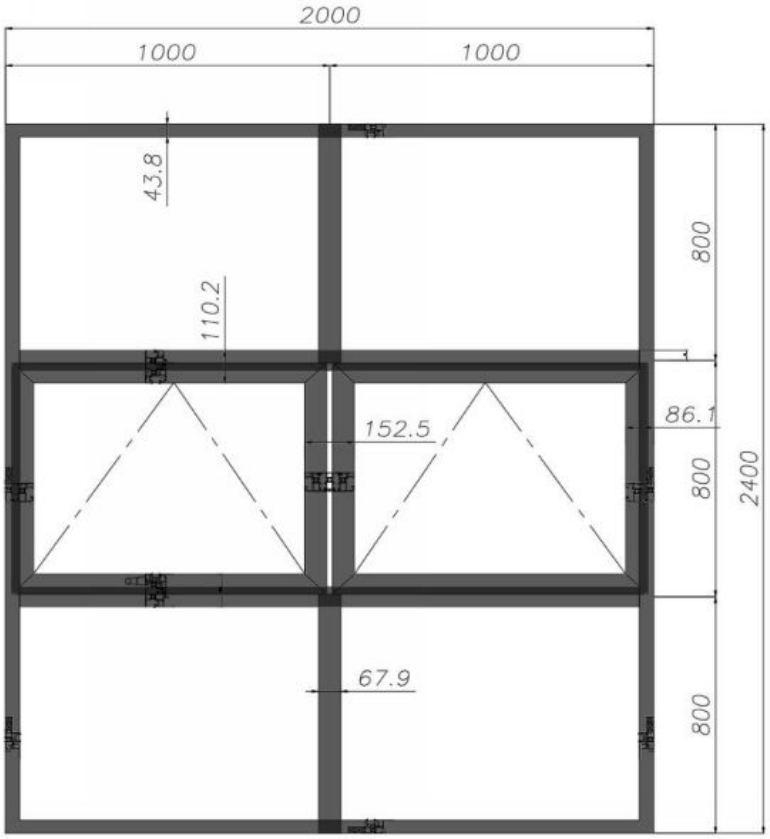
Design Engineers Ltd was engaged by Rangi Windows Ltd to calculate the R value of their sample joinery configurations. Thermal conductivity per ISO 10077-2.

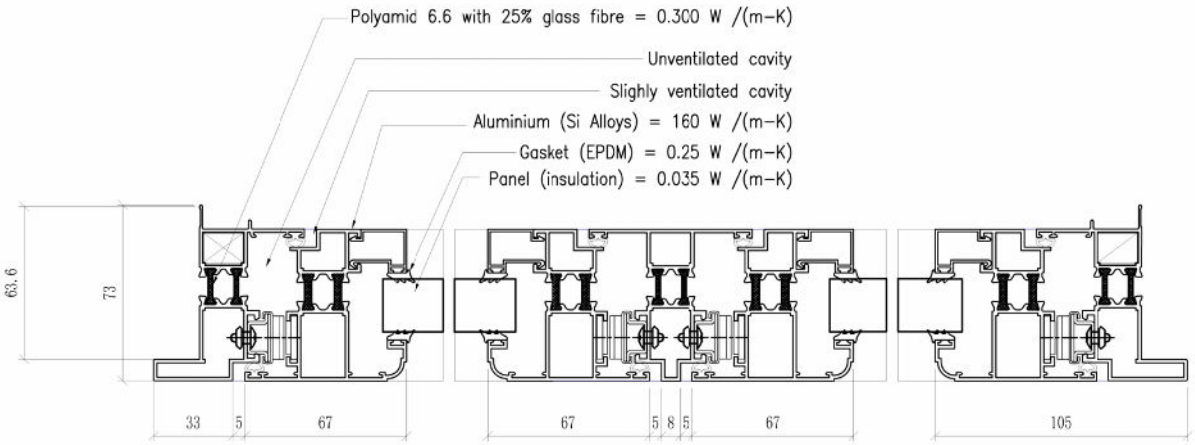
**All R Value calculations are applicable to the size and configurations specified in Section 1.1 only.**

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

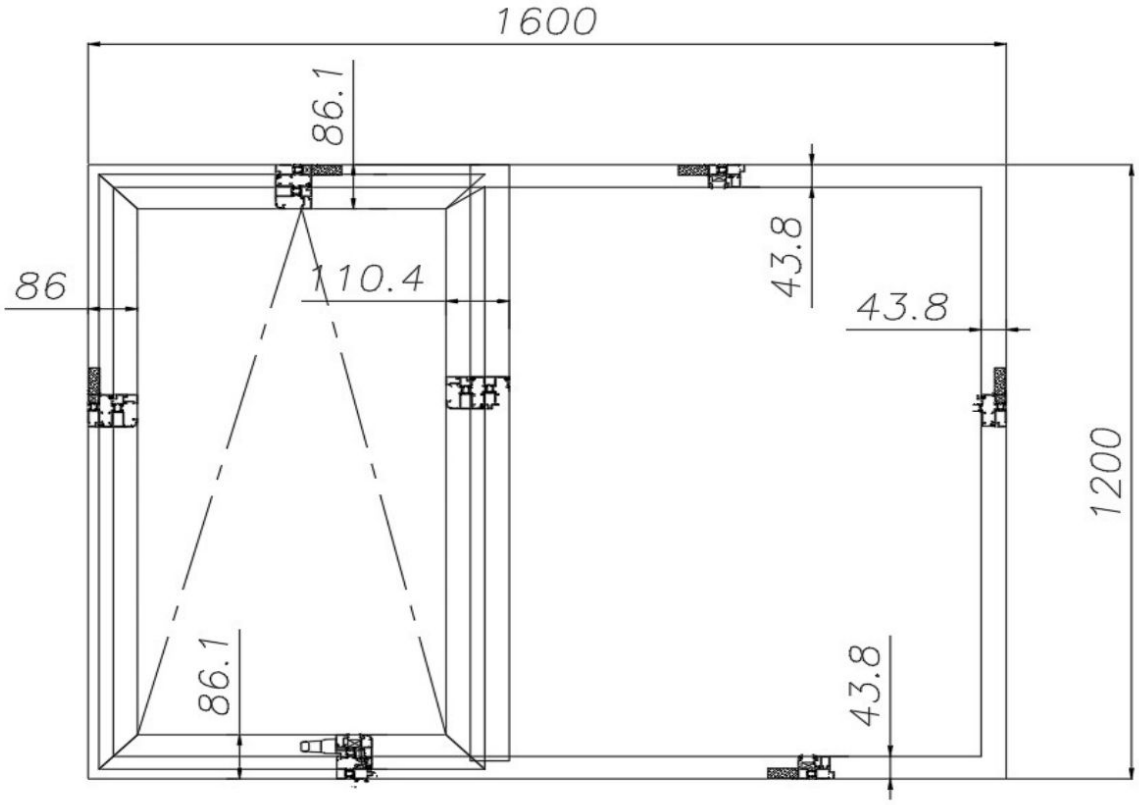
## 1.1 Elevations and Details

**W1 – Fixed and Awning Window**



**W2 – Fixed and Awning Window**



## 1.2 Scope of Work

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

**Joinery Type W1** = 2400mm height by 2000mm width, , 4 fixed panel + 2 awnings.

**Joinery Type W2** = 1200mm height by 1600mm width, 1 fixed panel with 1 awning.

## 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** | **Using Aluminium Spacer** |
| Joinery Type W1 | 0.479 |
| Joinery Type W2 | 0.473 |

These R Values are calculated using Glass Ug = 1.1 and a thermally improved spacer per ISO 10077-1.

## 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. Polyamide (with 25%) glass fiber) )= 0.300 W / m-K (for glass assembly, 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

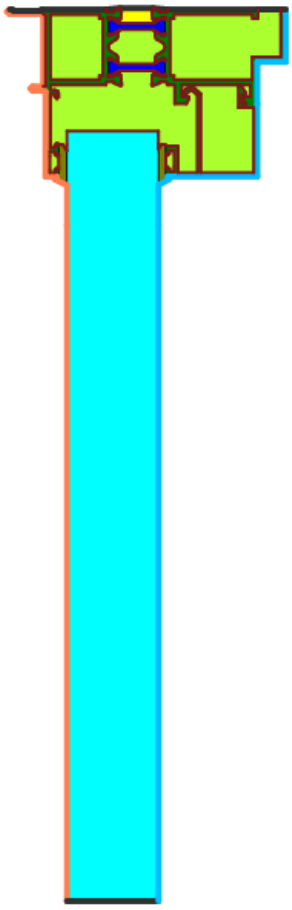
1. Unventilated air cavity (Reference ISO 10077-2)

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

## Appendix A.– Window Head

Title:Appendix A- Window Head.flx
Reference: Drawing :

Model 1



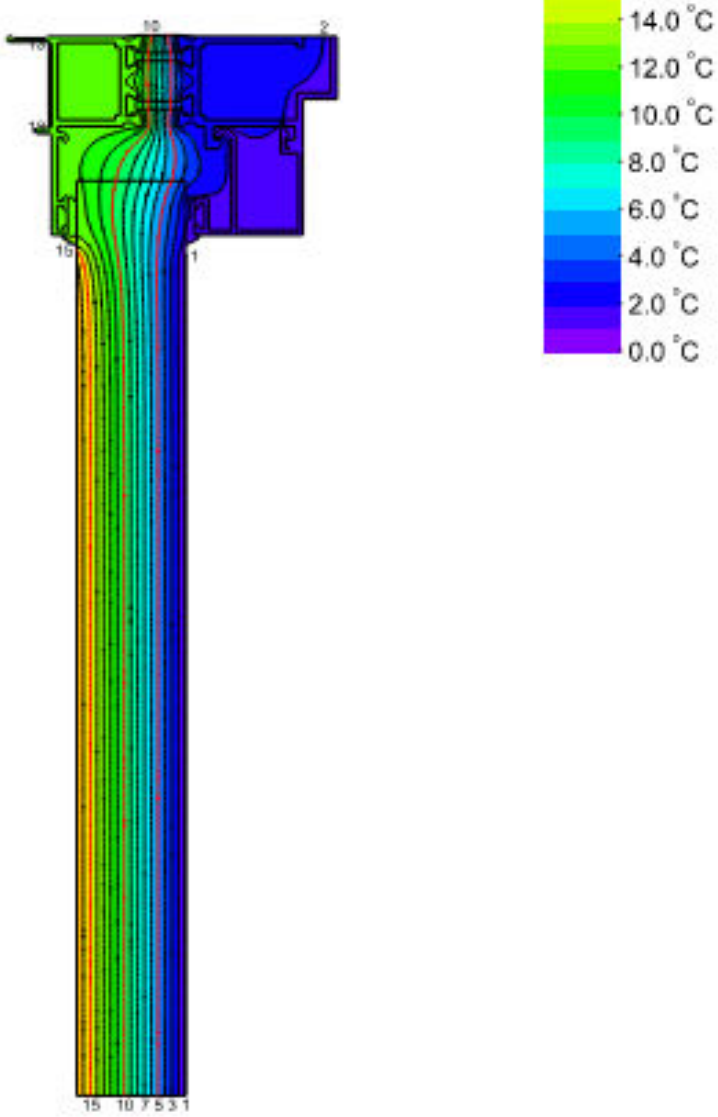
| Material | λ[W/(m·K)] |
|---|---|
| DEL 591F_ Unventilated air cavity * | |
| DEL591F _EPDM (ethylene propylene diene monomer) | 0.250 |
| DEL591F_Aluminium (Si Alloys) | 160.000 |
| DEL591F_Panel | 0.035 |
| DEL591F_Polyamid 6.6 with 25% glass fibre | 0.300 |
| DEL591F_Slightly ventilated air cavity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

* 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 A- Window Head.flx
Reference: Drawing :

Model 1



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

Title:Appendix B- Window Transom .flx
Reference: Drawing :

Model 1

U

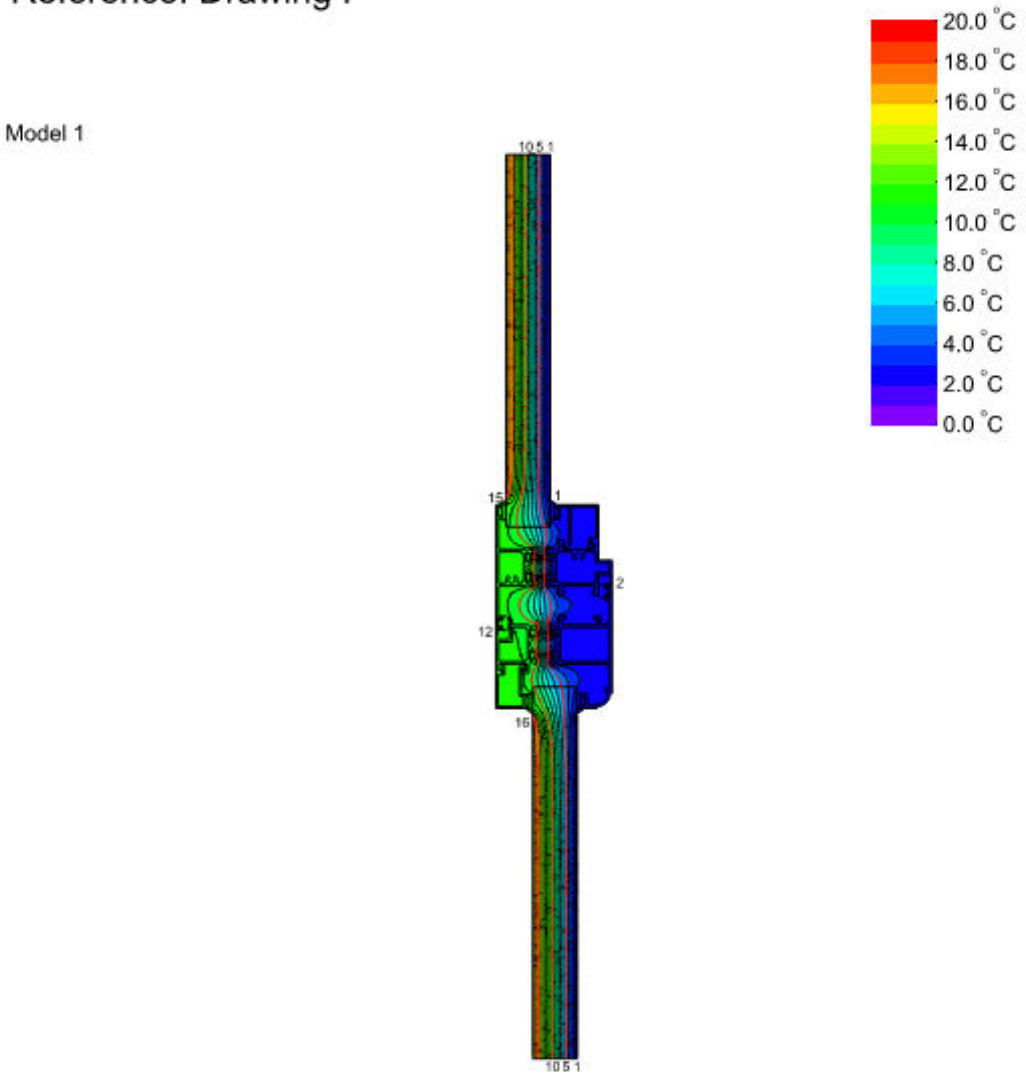
**Appendix B– Window Transom**

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

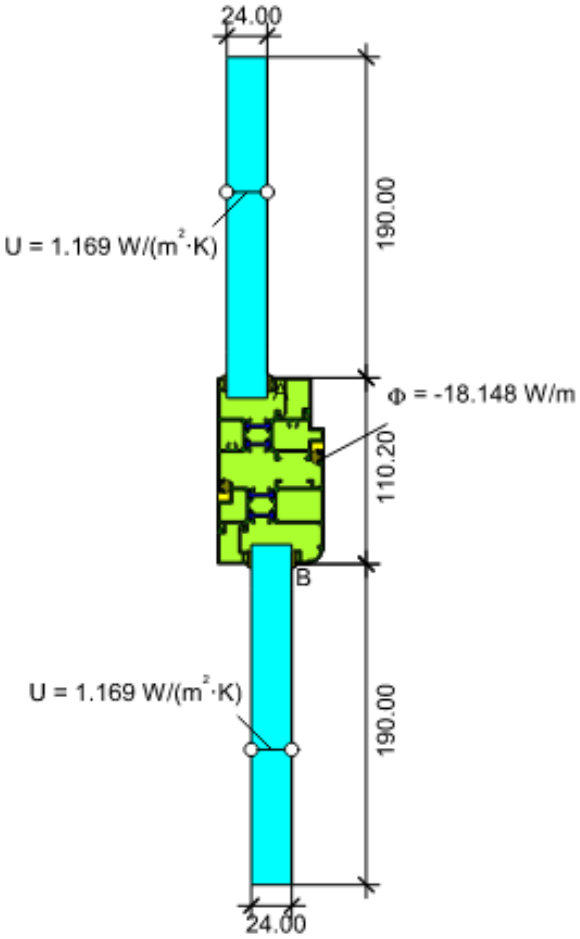
* EN ISO 10077-2:2017, 6.4.3/anisotrop

| 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 B- Window Transom .flx
Reference: Drawing :



Model 1
Title:Appendix B- Window Transom .flx
Reference: Drawing :

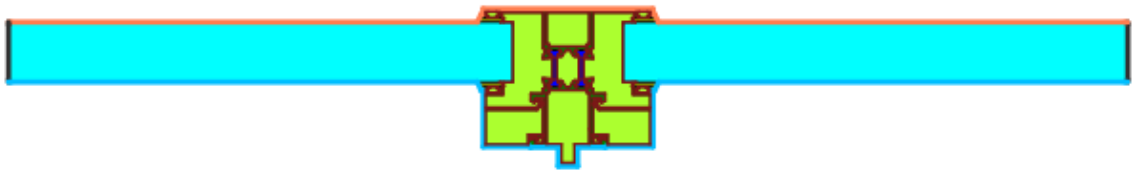



$$U_{tAB} = \frac{\frac{18.148}{20.0} - 1.169 \cdot 0.19 - 1.169 \cdot 0.19}{0.11} = 4.20 \text{ W/(m}^2\text{·K)}$$

## Appendix C– Window Mullion

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

Model 1

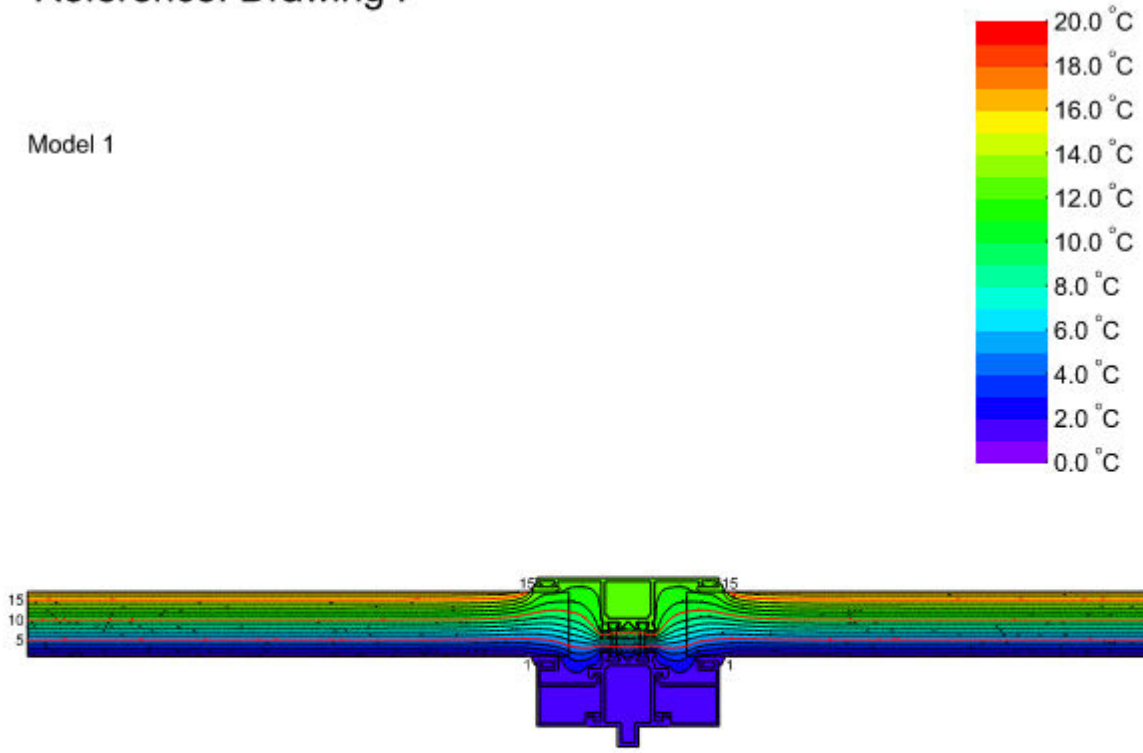


| Material | λ[W/(m·K)] |
|---|---|
| DEL 591F_ Unventilated air cavity * | |
| DEL591F _EPDM (ethylene propylene diene monomer) | 0.250 |
| DEL591F_Aluminium (Si Alloys) | 160.000 |
| DEL591F_Panel | 0.035 |
| DEL591F_Polyamid 6.6 with 25% glass fibre | 0.300 |
| * EN ISO 10077-2:2017, 6.4.3/anisotrop | |

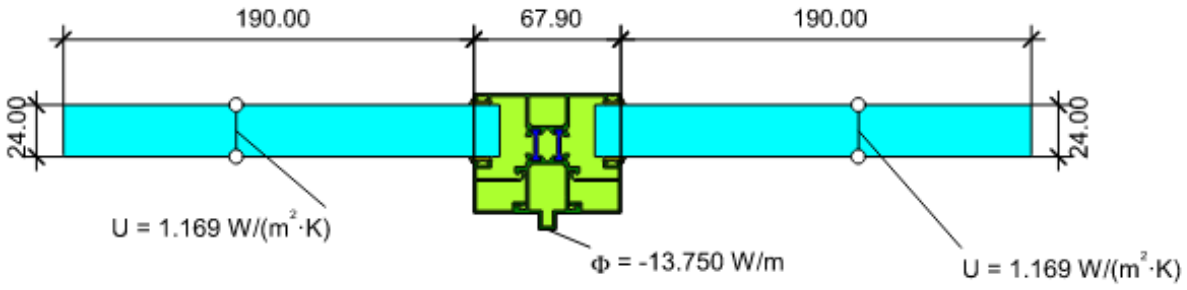
| Boundary Condition | q[W/m²] | θ[°C] | R[(m²·K)/W] | ε |
|---|---|---|---|---|
| DEL591F_Exterior | | 0.000 | 0.040 | |
| DEL591F_Interior, normal, horizontal | | 20.000 | 0.130 | |
| Epsilon 0.9 | | | | 0.900 |
| Symmetry/Model section | 0.000 | | | |

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

Model 1



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




$$U_f = \frac{\frac{13.75}{20.0} - 1.169 \cdot 0.19 - 1.169 \cdot 0.19}{0.068} = 3.58 \text{ W/(m}^2\text{·K)}$$

## Appendix D– Window Mullion 2

Title:Appendix D- Window Mullion 2.flx
Reference: Drawing :

Model 1

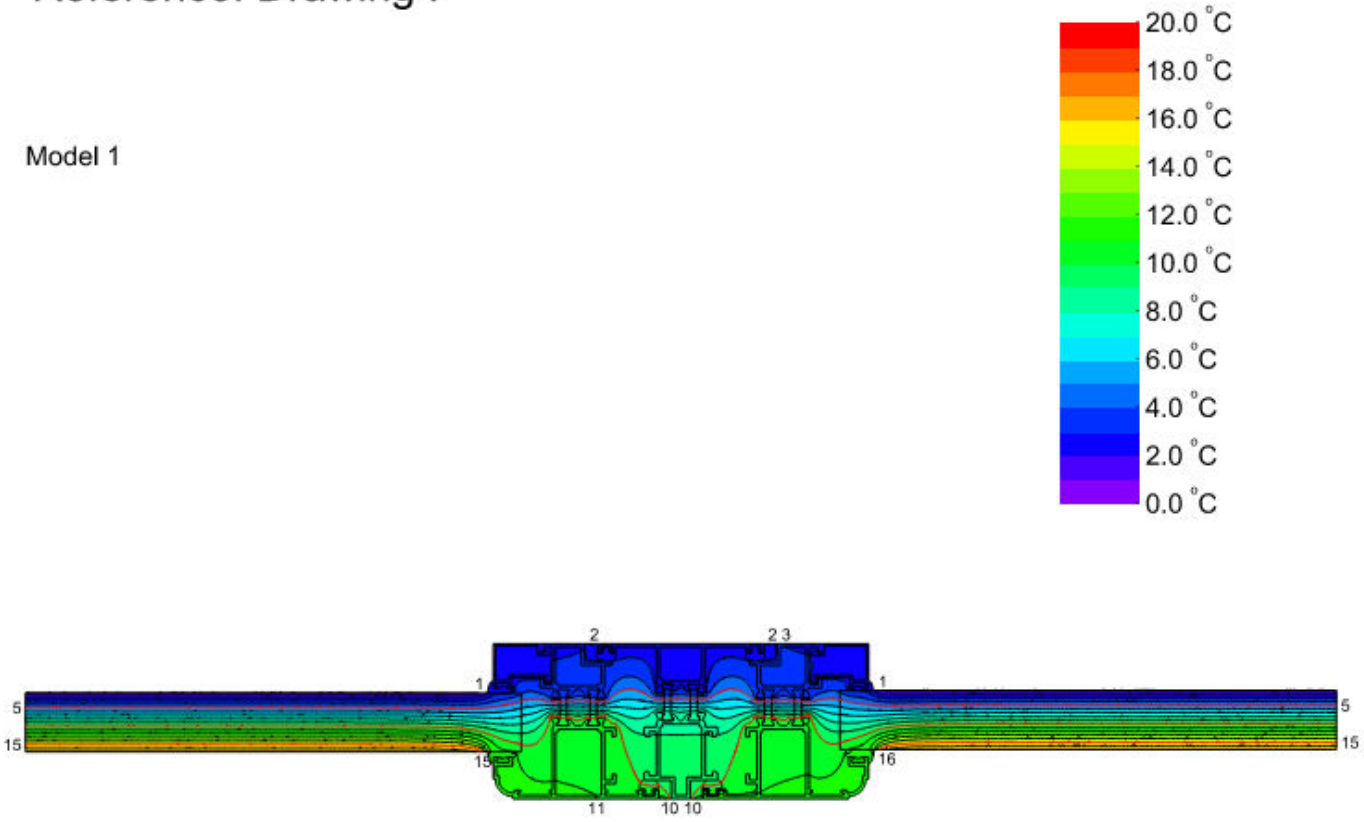
| Material | λ[W/(m·K)] |
|---|---|
| DEL 591F_ Unventilated air cavity * | |
| DEL591F _EPDM (ethylene propylene diene monomer) | 0.250 |
| DEL591F_Aluminium (Si Alloys) | 160.000 |
| DEL591F_Panel | 0.035 |
| DEL591F_Polyamid 6.6 with 25% glass fibre | 0.300 |
| DEL591F_Slightly ventilated air cavity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

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

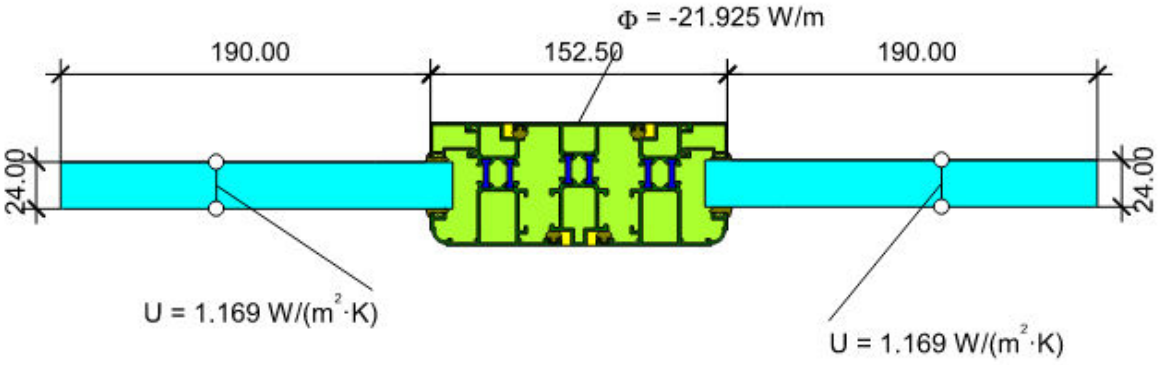
| Boundary Condition | q[W/m²] | θ[°C] | R[(m²·K)/W] | ε |
|---|---|---|---|---|
| DEL591F_Exterior | | 0.000 | 0.040 | |
| DEL591F_Interior, normal, horizontal | | 20.000 | 0.130 | |
| Epsilon 0.9 | | | | 0.900 |
| Symmetry/Model section | 0.000 | | | |

Title:Appendix D- Window Mullion 2.flx
Reference: Drawing :

Model 1



Model 1
Title:Appendix D- Window Mullion 2.flx
Reference: Drawing :




$$U_f = \frac{\frac{21.925}{20.0} - 1.169 \cdot 0.19 - 1.169 \cdot 0.19}{0.153} = 4.28 \text{ W/(m}^2\text{·K)}$$

## Appendix E– Window Mullion 3

Title:Appendix E- Window Mullion 3.flx
Reference: Drawing :

Model 1

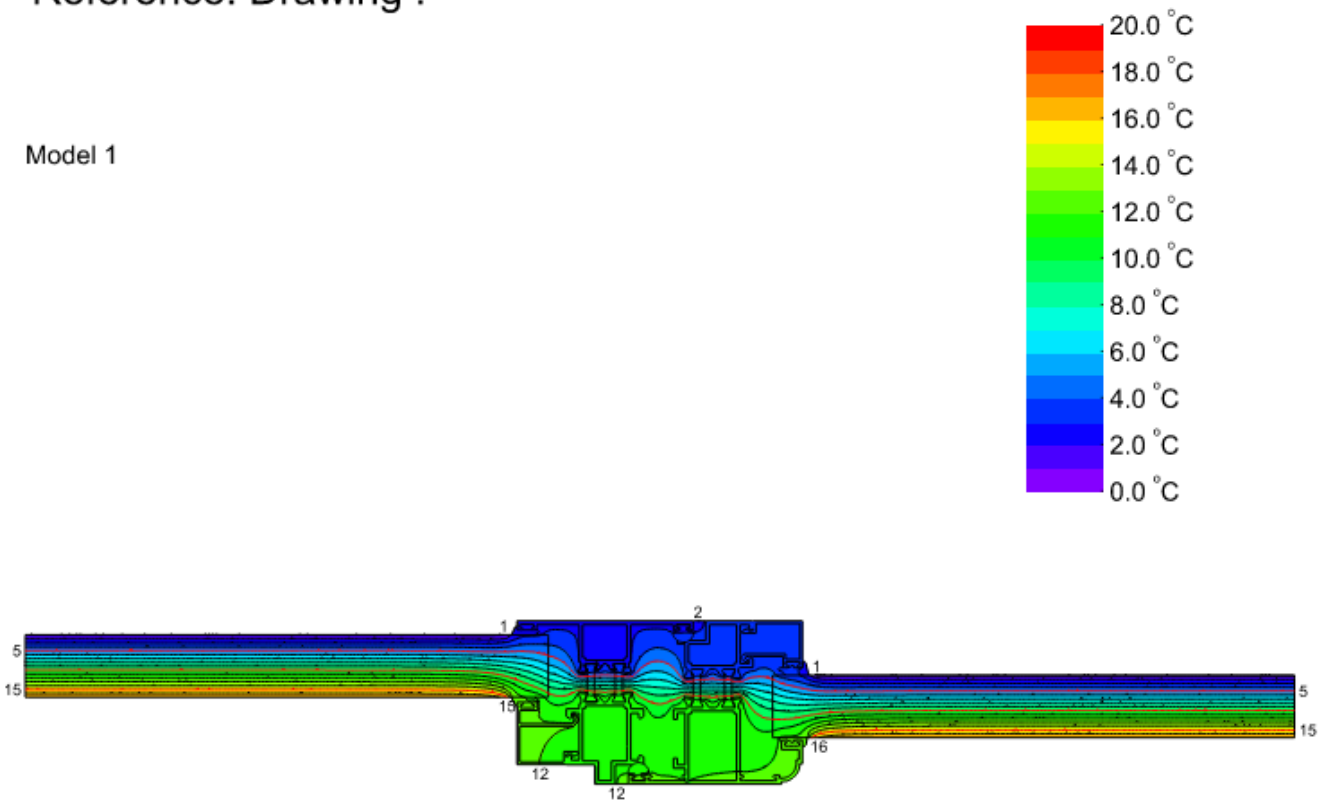
| Material | λ[W/(m·K)] |
|---|---|
| DEL 591F_ Unventilated air cavity * | |
| DEL591F _EPDM (ethylene propylene diene monomer) | 0.250 |
| DEL591F_Aluminium (Si Alloys) | 160.000 |
| DEL591F_Panel | 0.035 |
| DEL591F_Polyamid 6.6 with 25% glass fibre | 0.300 |
| DEL591F_Slightly ventilated air cavity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

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

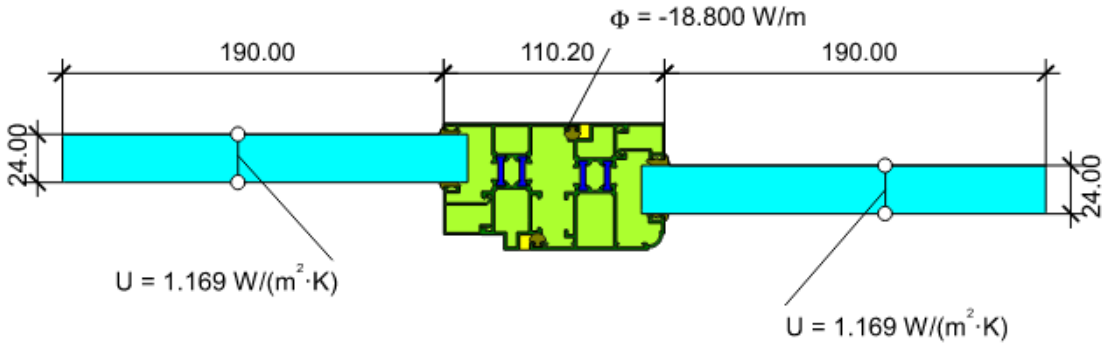
| Boundary Condition | q[W/m$^2$] | θ[°C] | R[(m$^2$·K)/W] | ε |
|---|---|---|---|---|
| DEL591F_Exterior | | 0.000 | 0.040 | |
| DEL591F_Interior, normal, horizontal | | 20.000 | 0.130 | |
| Epsilon 0.9 | | | | 0.900 |
| Symmetry/Model section | 0.000 | | | |

Title:Appendix E- Window Mullion 3.flx
Reference: Drawing :

Model 1



Title:Appendix E- Window Mullion 3.flx
Reference: Drawing :




$$U_f = \frac{\frac{18.8}{20.0} - 1.169 \cdot 0.19 - 1.169 \cdot 0.19}{0.11} = 4.50 \text{ W/(m}^2\text{·K)}$$

## Appendix F– Window Jamb

Title:Appendix F- Window Jamb.flx
Reference: Drawing :

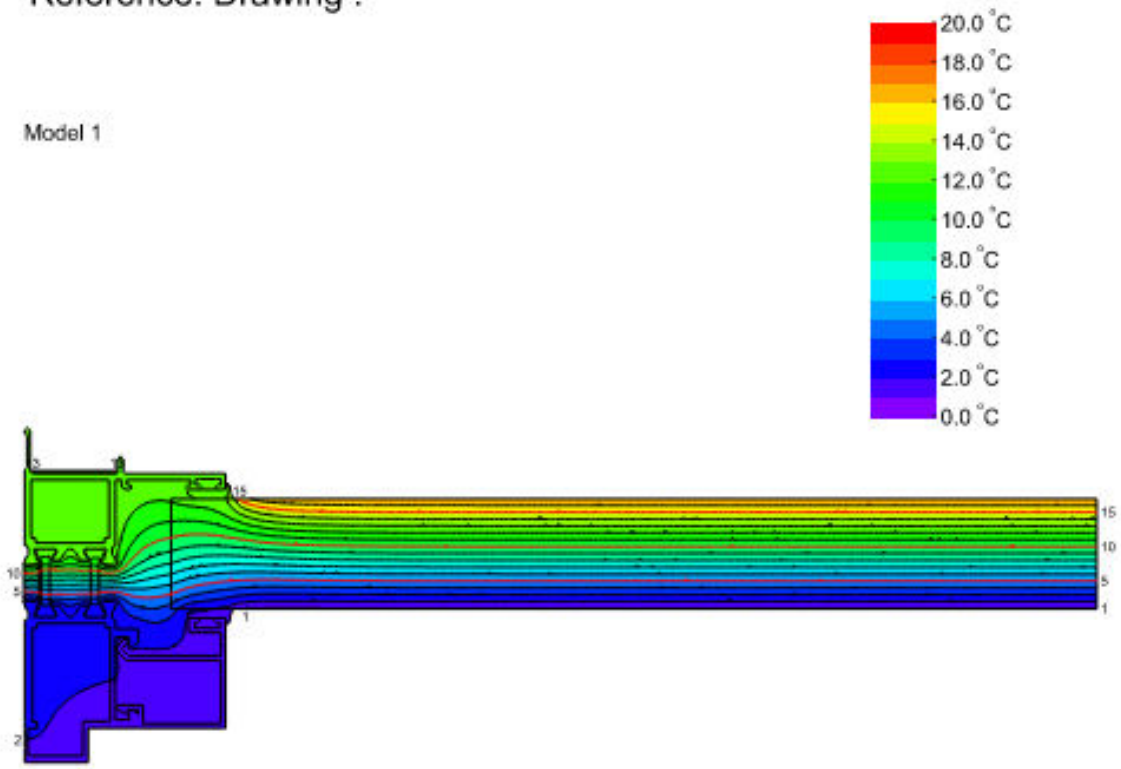
Model 1

| 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 * | |

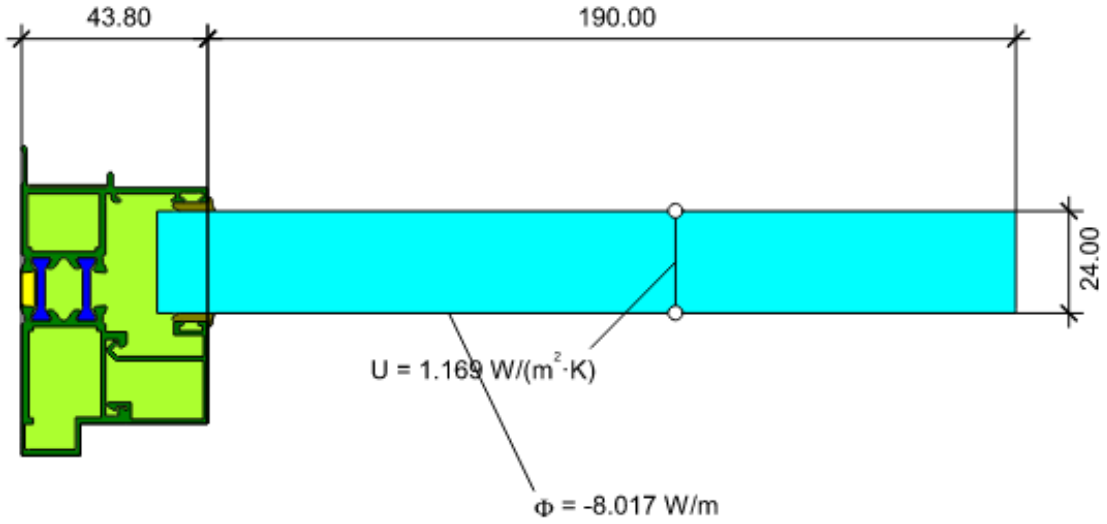
* EN ISO 10077-2:2017, 6.4.3/anisotrop

| 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 F- Window Jamb.flx
Reference: Drawing :



Model 1
Title:Appendix F- Window Jamb.flx
Reference: Drawing :




$$U_f = \frac{\frac{8.017}{20.0} - 1.169 \cdot 0.19}{0.044} = 4.08 \text{ W/(m}^2\text{·K)}$$

## Appendix G– Window Jamb 2

Title:Appendix G- Window Jamb2.flx
Reference: Drawing :

Model 1

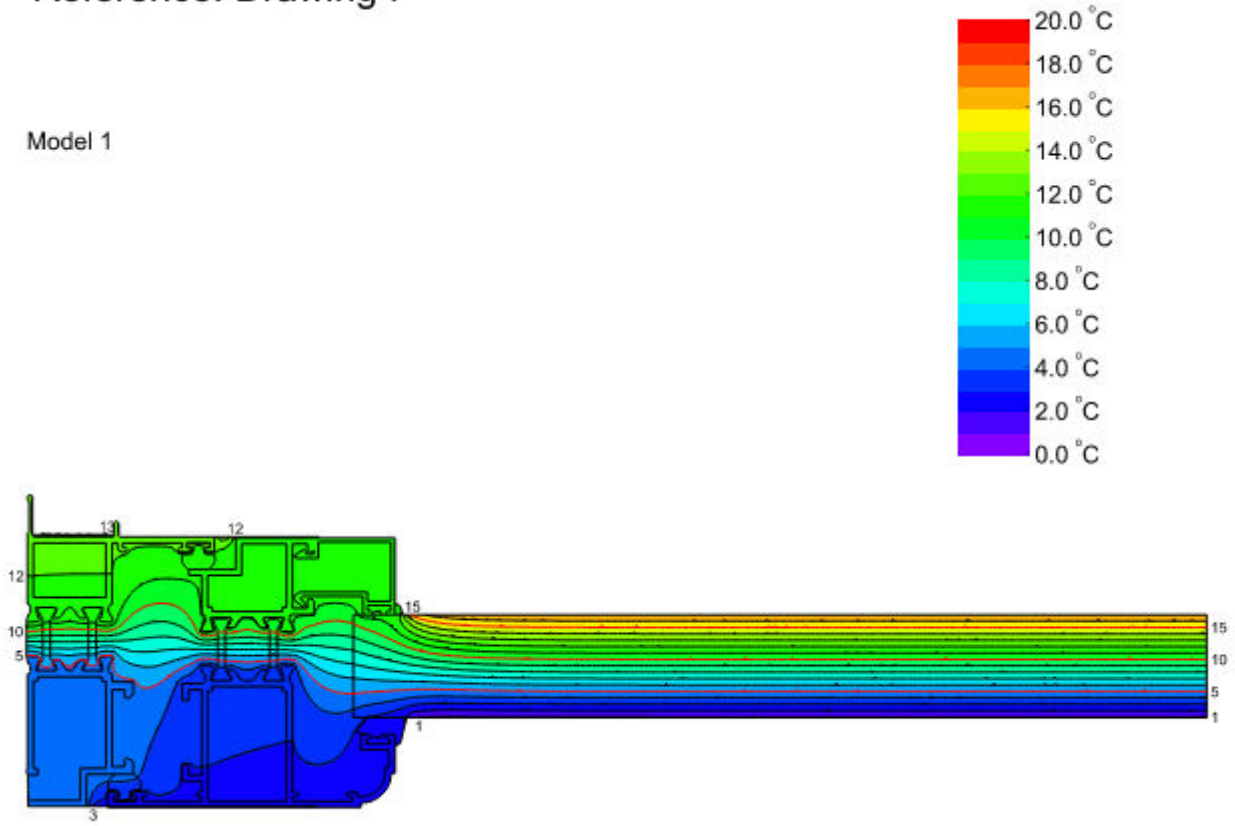
| Material | λ[W/(m·K)] |
|---|---|
| DEL 591F_ Unventilated air cavity * | |
| DEL591F _EPDM (ethylene propylene diene monomer) | 0.250 |
| DEL591F_Aluminium (Si Alloys) | 160.000 |
| DEL591F_Panel | 0.035 |
| DEL591F_Polyamid 6.6 with 25% glass fibre | 0.300 |
| DEL591F_Slightly ventilated air cavity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

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

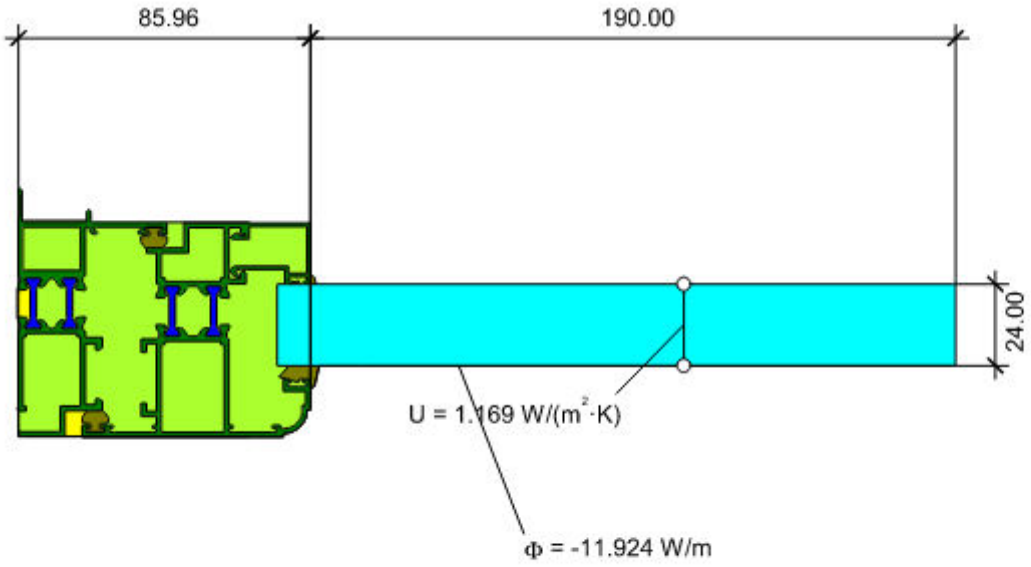
| Boundary Condition | q[W/m$^2$] | θ[°C] | R[(m$^2$·K)/W] | ε |
|---|---|---|---|---|
| DEL591F_Exterior | | 0.000 | 0.040 | |
| DEL591F_Interior, normal, horizontal | | 20.000 | 0.130 | |
| Epsilon 0.9 | | | | 0.900 |
| Symmetry/Model section | 0.000 | | | |

Title:Appendix G- Window Jamb2.flx
Reference: Drawing :

Model 1



Model 1
Title:Appendix G- Window Jamb2.flx
Reference: Drawing :



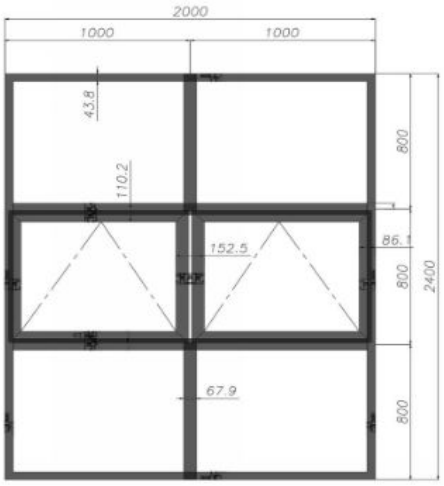

$$U_f = \frac{\frac{11.924}{20.0} - 1.169 \cdot 0.19}{0.086} = 4.35 \text{ W/(m}^2\text{·K)}$$

# Appendix H – R-Value Calculation for Aluminium Joinery.

## H.1 Joinery Type W1 - Fixed and Awning Window with 2 Sash

| | | | |
|---|---|---|---|
| **Job Name :** | *Rangi Windows Ltd - System R Value* | **Job No:** | *DEL591F* |
| **Reference :** | *Fixed and Awning Window* | **Date:** | *7/05/24* |
| **Glazing Type :** | *Window* | **Engineer:** | *NB* |
| **Spacer Type:** | *Aluminium* | | |
| **Configuration Code:** | *W1* | **Page :** | 1 |

**FRAME CONFIGURATION**




| Glazing Type→ | Window | |
|---|---|---|
| Window Width Fixed = | 1.000 | m |
| Window Width Fixed = | 1.000 | m |
| Window Height 1 = | 0.800 | m |
| Window Height 2 = | 0.800 | m |
| Window Height 3 = | 0.800 | m |

**Width of Projected Frame:**

| | | |
|---|---|---|
| Head (Fixed) = | 0.0438 | m |
| Jamb (Fixed) = | 0.0438 | m |
| Jamb (Sash) = | 0.0861 | m |
| Sill (Fixed) = | 0.0438 | m |
| Mullion = | 0.0679 | m |
| Mullion + sash = | 0.153 | m |
| Transom + sash = | 0.11 | m |

**U-Value of Frame:**

| | | | |
|---|---|---|---|
| Head (Fixed) = | 4.18 | W/m2.K | 3.77 |
| Jamb (Fixed) = | 4.18 | W/m2.K | 3.7 |
| Jamb (Sash) = | 4.36 | W/m2.K | 4.13 |
| Sill (Fixed) = | 4.18 | W/m2.K | 3.77 |
| Mullion = | 3.58 | W/m2.K | 3.58 |
| Mullion + sash = | 4.28 | W/m2.K | 4.28 |
| Transom + sash = | 4.2 | W/m2.K | 4.2 |

| | | | |
|---|---|---|---|
| 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 |

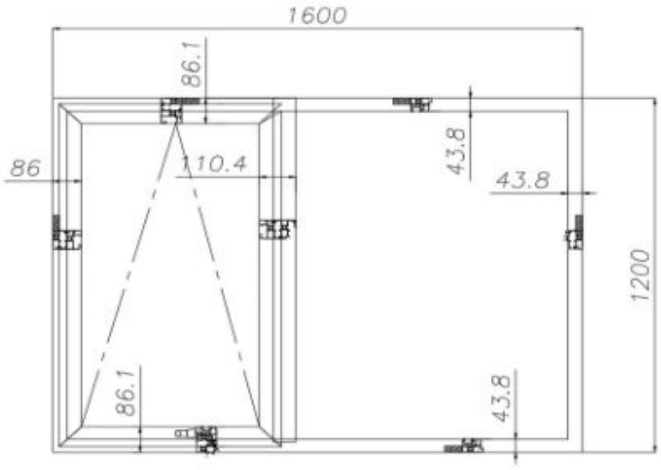
| | | | | |
|---|---|---|---|---|
| Glazing Area, Ag: | 3.749 | m2 | *Exclude glass?* | NO |
| Length of Edge-of-Glass: | 19.097 | m | | |
| U-Value of Frame, Uf | 4.166 | W/m2.K | | |
| U-Value of Window, Uw | 2.089 | W/m2.K | | |
| R-Value of Window, R | 0.479 | m2.K/W | | |

## H.2 Joinery Type W2 - Fixed and Awning Window with 1 Sash

| | | | |
|---|---|---|---|
| **Job Name :** | *Rangi Windows Ltd - System R Value* | **Job No:** | *DEL591F* |
| **Reference :** | *Fixed and Awning window* | **Date:** | *7/05/24* |
| **Glazing Type :** | *Window* | **Engineer:** | *NB* |
| **Spacer Type:** | *Aluminium* | | |
| **Configuration Code:** | *W2* | **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) = | 0.0438 | m |
| Head (Sash) = | 0.0861 | m |
| Jamb (Fixed) = | 0.0438 | m |
| Jamb (Sash) = | 0.0861 | m |
| Sill (Fixed) = | 0.0438 | m |
| Sill (Sash) = | 0.0861 | m |
| Mullion = | 0.11 | m |

**U-Value of Frame:**

| | | | |
|---|---|---|---|
| Head (Fixed) = | 3.77 | W/m2.K | 3.77 |
| Head (Sash) = | 4.13 | W/m2.K | 4.13 |
| Jamb (Fixed) = | 3.7 | W/m2.K | 3.7 |
| Jamb (Sash) = | 4.13 | W/m2.K | 4.13 |
| Sill (Fixed) = | 3.77 | W/m2.K | 3.77 |
| Sill (Sash) = | 4.13 | W/m2.K | 4.13 |
| Mullion = | 4.5 | W/m2.K | 4.5 |

| | | | |
|---|---|---|---|
| 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: | 1.461 | m2 | *Exlude glass?* | NO |
| Length of Edge-of-Glass: | 7.001 | m | | |
| U-Value of Frame, Uf | 4.121 | W/m2.K | | |
| U-Value of Window, Uw | 2.114 | W/m2.K | | |
| R-Value of Window, R | 0.473 | m2.K/W | | |