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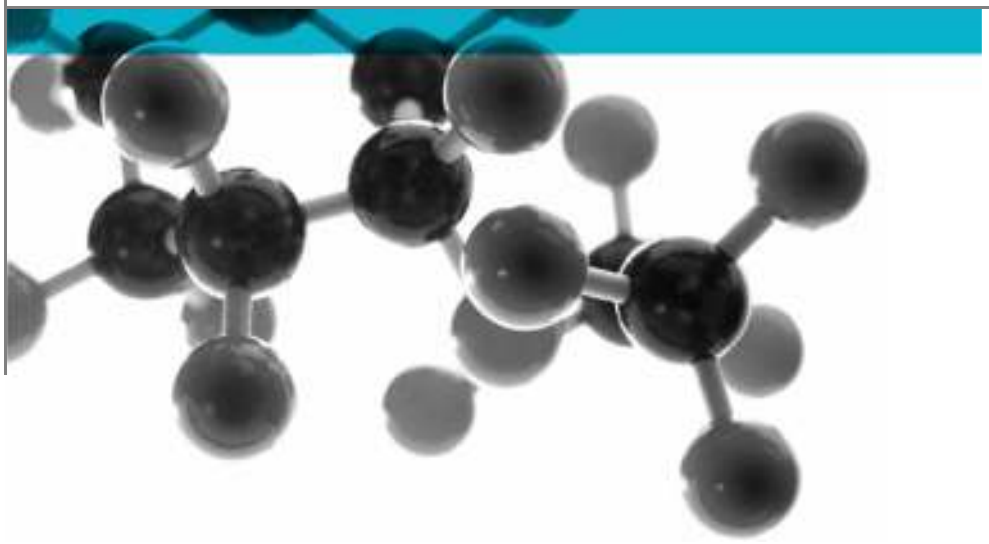
# BS EN ISO 10077-1:2006



**Calculation of: Door U Value**

**Thermal Performance of Windows, Doors & Shutters – Calculation of Thermal Transmittance**

A Report To:
Aluminios Cortizo S.A.U
Extramundi, S/N. 15910, Padrón (A Coruña), España

Document Reference:
WIL 389714

**Date:** 09/11/2017

**Copy: 1**

**Issue No.: 1**



Testing
Advising
Assuring

# CONCLUSIONS

Drawings of:
Manufacturer Aluminios Cortizo S.A.U
Product DeWall A1 / Cortizo Bifold
Model 3 Panel Slide Fold Door Set, Aluminium

Have been submitted for thermal performance calculation in accordance with BS EN ISO 10077-1:2006. By Christian Adams, a BFRC certified simulator (No. 125) of Exova (UK) Ltd, a UKAS accredited Testing Laboratory (No. 0621) and EC Notified Body number (No. 1104)

At Key Industrial Park, Fernside Rd, Willenhall, West Midlands, WV13 3YA.
Results and comments as detailed below:

| **Description** | **$U_D$ value W/(m$^2$.K)** |
|---|---|
| Doorset 1 – 36mm 4-12-4-12-4 e=0.05 pos 1,3 | **1.5** |
| Doorset 2 – 44mm 4-16-4-16-4 e=0.05 pos 1,3 | **1.4** |

** Performance assessed from Debar report WIL 376371*
No inferences can be made regarding performance against other requirements of this standard

# AUTHORISATION

Calculations performed by: Christian Adams, HSEQ Engineer
Assessment performed by: Mark West, Door & Window Laboratory Manager

Report issued by: Christian Adams, HSEQ Engineer

Signed 

Date 9th November 2017

For and on behalf of Exova (UK) Ltd

Report authorised by: Mark West, Door & Window Laboratory Manager

Signed 

Date 9th November 2017

For and on behalf of Exova (UK) Ltd

Report issued: 09 November 2017

UKAS TESTING
0621

NOTE.
Tests marked “Not UKAS Accredited” are not covered by the Laboratory UKAS accreditation schedule.

Tests marked NT were not tested
Tests marked NA are not applicable to the product on test.

Exova (UK) Ltd is an EC Notified Body Number 1104

**CONTENTS** **PAGE NO.**

# CALCULATION DETAILS

## CLIENT DETAILS

| | |
|---|---|
| Company name | Aluminios Cortizo S.A.U |
| Address | Extramundi,<br>S/N. 15910,<br>Padrón (A Coruña),<br>España |
| Contact | David Macía Arias |

## ORDER DETAILS

| | |
|---|---|
| Order number | DMA email 260917 |
| Dated | 26/09/2017 |

## PRODUCT DETAILS

| | |
|---|---|
| Product | DeWall A1 / Cortizo Bi-fold |
| Model | 3 Panel Slide Fold Door Set, Aluminium |
| Manufacturer | Debar Ltd / Cortizo |
| Material | Aluminium |

## CALCULATION DETAILS

| | |
|---|---|
| Specification | BS EN ISO 10077-1:2006 |
| Clauses | N/a |
| Calculation methods | BS EN ISO 10077-1:2006 Thermal performance of windows, doors & shutters – Calculation of thermal transmittance – Part 1: General<br>BS EN ISO 10077-2:2012 Thermal performance of windows, doors & shutters – Calculation of thermal transmittance – Part 2: Numerical method for frames<br>BS EN 673:2011 Glass in building – Determination of thermal transmittance (U-value) – Calculation method |
| Simulation software & spreadsheet versions used | Thermal transmittance models obtained by computer simulation using Therm Finite Element Simulator V5.2.14 provided by LBNL. Software validated in accordance with Annex D of BS EN ISO 10077-2.<br>Exova BS EN 673 Ug spreadsheet TR099 version 2 issue 7<br>Exova BS EN ISO 10077 doorset U-value spreadsheet |
| Other reports to be used in conjunction with this report | Exova Willenhall report for Debar WIL 376371 |

# PROCEDURE

**Introduction**

This report should be read in conjunction with the Standard BS EN ISO 10077-1:2006 Thermal performance of windows, doors and shutters – Calculation of thermal transmittance – Part 1: General, BS EN ISO 10077-2:2012 performance of windows, doors and shutters – Calculation of thermal resistance – Part 2: Numerical method for frames & BS EN 673:2011 Glass in building – Determination of thermal transmittance (U value) – Calculation method

Drawings in DXF format were submitted for calculation of thermal transmittance in accordance with BS EN ISO 10077-1.

**Instruction**

The calculations were conducted on the 18th – 21st November 2016 on behalf of Debar Ltd.

The assessment as conducted on the 26th September 2017 on behalf of Aluminios Cortizo S.A.U.

**Calculation method**

Calculation was carried out in accordance with Clause 5.4 of BS EN ISO 10077-1 using an area weighted average of $U_f$ and $U_g$ shown in equation 8, plus the edge effect of the glazing perimeter $\Psi_g$.

As per Clause 6 of BS EN ISO 10077-1 Input Data the thermal transmittance of the frame $U_f$ and the linear thermal transmittance of the glazing junction were carried out by simulation in accordance with Annex C of BS EN ISO 10077-2 using THERM finite element analysis software version 5.2.14 provided by LBNL. Simulations were produced both with the glazing in place, and the glazing replaced with an insulation panel of thermal conductivity 0.035.

Values used for the design thermal conductivity of materials in this calculation were taken from Annex A of BS EN ISO 10077-2:2012 unless specified otherwise, and are listed in Annex C of this report.

As such the result contained in this report is partly derived from tabulated values and should be considered indicative and not definitive.

# CONCLUSIONS

| | |
|---|---|
| **Evaluation against objective** | The sectional drawings of the doorsets as provided by the client were subjected to thermal performance calculations in accordance with BS EN ISO 10077-1 |
| **Observations & comments** | ** Performance assessed from Debar report WIL 376371* |

# LIMITATIONS

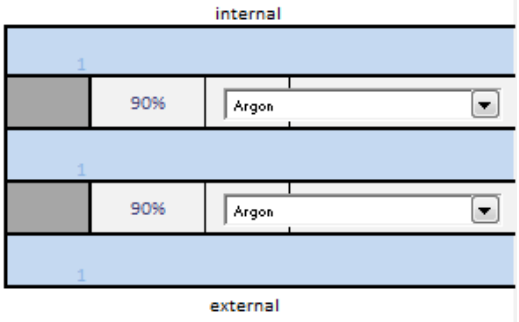
| | |
|---|---|
| **Limitations** | The results relate only to the behaviour of the specimens of the element of construction under the particular conditions of the calculation. They are not intended to be the sole criteria for assessing the potential performance of the element in use, nor do they reflect the actual behaviour in use. |
| **Range of assemblies covered by this report** | Table E.2 of BS EN 14351-1:2006 +A1:2010 states that the range of direct application (providing similar design) of doorset assemblies covered by this report is limited to the following:<br>▪ Doorsets with overall area ≤3.6m$^2$ for doorsets simulated at 1.23m x 2.18m.<br>▪ Doorsets with overall area >3.6m$^2$ for doorsets simulated at 2.0m x 2.18m<br><br>Height and width of simulated assemblies subject to a tolerance of ±25%. |
| **Uncertainty of Measurement** | The uncertainties of measurements calculated for a confidence level of 95% throughout these tests are within the limits of these tolerances.<br><br>The user and the simulation software have been validated in accordance with Annex D of BS EN ISO 10077-2:2012, giving the following accuracies:<br><br>▪ Thermal transmittance ± 5%<br>▪ Linear thermal transmittance ± 5% |

# ANNEX A: SIMULATION RESULTS & CALCULATIONS

**Doorset 1 - BS EN 673:2011 calculation for 4-12-4-12-4 Argon filled unit**
**4mm toughened / 12mm Argon fill / 4mm toughened / 12mm Argon fill / 4mm toughened**
**(ε=0.05 coating position 1 & 3)**

| | | | |
|---|---|---|---|
| Title: | Exova Warringtonfire Willenhall<br>BS EN 673 Thermal transmittance of triple glazing spreadsheet | | |
| Reference : | TR099 | | |
| Standard issue: | BS EN 673:2011 | | |
| Author: | Mark West | Client: | Debar Ltd |
| Version: | 2 issue 7 | Inclination of glazing: | Vertical |
| Issue date: | 2nd December 2015 | Calculation date: | 18th November 2016 |

| | thickness (mm) | ε normal | |
|---|---|---|---|
| internal pane ($d_i3$) = | 4 | 0.89 | uncoated |
| | | 0.89 | uncoated |
| air space 2 (s2) = | 12 | | |
| Centre pane ($d_i2$) = | 4 | 0.05 | |
| | | 0.89 | uncoated |
| air space 1 (s1) = | 12 | | |
| external pane ($d_i1$) = | 4 | 0.05 | |
| | | 0.89 | uncoated |
| $\Sigma d_i.r_i$ = | 0.012 | | |



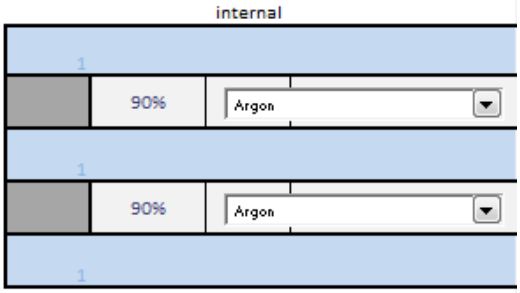

| Ug W/(m².K) | | Σ1/hs (m².K)/W | | λ eff s1 W/(m.K) | | λ eff s2 W/(m.K) |
|---|---|---|---|---|---|---|
| 0.763 | | 1.12941 | | 0.0213 | | 0.0213 |

** Performance assessed from Debar report WIL 376371*

## Doorset 2 - BS EN 673:2011 calculation for 4-16-4-16-4 Argon filled unit 4mm toughened / 16mm Argon fill / 4mm toughened / 16mm Argon fill / 4mm toughened (ε=0.05 coating position 1 & 3)

| | | | |
|---|---|---|---|
| Title: | Exova Warringtonfire Willenhall<br>BS EN 673 Thermal transmittance of triple glazing spreadsheet | | |
| Reference : | TR099 | | |
| Standard issue: | BS EN 673:2011 | | |
| Author: | Mark West | Client: | Debar Ltd |
| Version: | 2 issue 7 | Inclination of glazing: | Vertical |
| Issue date: | 2nd December 2015 | Calculation date: | 18th November 2016 |

| | thickness (mm) | ε normal | | |
|---|---|---|---|---|
| internal pane ($d_i3$) = | 4 | 0.89 | uncoated | |
| | | 0.89 | uncoated | |
| air space 2 (s2) = | 16 | | | |
| Centre pane ($d_i2$) = | 4 | 0.05 | | |
| | | 0.89 | uncoated | |
| air space 1 (s1) = | 16 | | | |
| external pane ($d_i1$) = | 4 | 0.05 | | |
| | | 0.89 | uncoated | |
| $\Sigma d_i.r_i$ = | 0.012 | | | |




| Ug W/(m².K) | | Σ1/hs (m².K)/W | | λ eff s1 W/(m.K) | | λ eff s2 W/(m.K) |
|---|---|---|---|---|---|---|
| 0.622 | | 1.42542 | | 0.0225 | | 0.0225 |

** Performance assessed from Debar report WIL 376371*

# Doorset 1 - ISO 10077-2:2012 calculation

| | | | |
|---|---|---|---|
| **Title:** | Exova Willenhall | **Carried out for :** | Debar Ltd |
| | U-value calculation for 3 pane bi-folding doorset | **Product :** | Bifold Doorset |
| **Reference:** | TR094_1 | **Model :** | 36mm |
| **Standard issue:** | BS EN ISO 10077-2:2012 | **Glazing config :** | 4-12-4-12 e=0.05 pos 1, 3 |
| **Author:** | Christian Adams | | |
| **Version:** | TR094_1 issue 3 | **Calculation date :** | 21st November 2016 |
| **Issue date:** | 20th June 2016 | **Carried out by :** | Christian Adams |

| Section detail | Lf2d | Up | bp | bf | Uf |
|---|---|---|---|---|---|
| Head | 0.5357 | 0.8343 | 0.1900 | 0.1010 | 3.7344 |
| Left jamb | 0.5133 | 0.8343 | 0.1900 | 0.1000 | 3.5478 |
| Right jamb | 0.5920 | 0.8343 | 0.1900 | 0.1100 | 3.9407 |
| Meeting stile 1 | 0.6475 | 0.8343 | 0.3800 | 0.1200 | 2.7538 |
| Meeting stile 2 | 0.6475 | 0.8343 | 0.3800 | 0.1200 | 2.7538 |
| Sill | 0.6132 | 0.8343 | 0.1900 | 0.1250 | 3.6374 |

U of insulating panel = 0.8343

Glass thickness = 0.0360 m

Centre pane U-value Ug = 0.7630

| Section detail | Lψ2d | Uf | bf | Ug | bd | ψi |
|---|---|---|---|---|---|---|
| Head | 0.5492 | 3.7344 | 0.1010 | 0.7630 | 0.1900 | 0.0271 |
| Left jamb | 0.5271 | 3.5478 | 0.1000 | 0.7630 | 0.1900 | 0.0274 |
| Right jamb | 0.6056 | 3.9407 | 0.1100 | 0.7630 | 0.1900 | 0.0272 |
| Meeting stile 1 | 0.6771 | 2.7538 | 0.1200 | 0.7630 | 0.3800 | 0.0567 |
| Meeting stile 2 | 0.6771 | 2.7538 | 0.1200 | 0.7630 | 0.3800 | 0.0567 |
| Sill | 0.6268 | 3.6374 | 0.1250 | 0.7630 | 0.1900 | 0.0272 |

Overall width = 2.5000 m

Overall height = 2.1800 m

Overall area $A_D$ = 5.450 m2

| Frame width bf | | |
|---|---|---|
| Head | 0.1010 | m |
| Left jamb | 0.1000 | m |
| Right jamb | 0.1100 | m |
| Meeting stile 1 | 0.1200 | m |
| Meeting stile 2 | 0.1200 | m |
| Sill | 0.1250 | m |

largest of the visible areas of both sides, to nearest mm

| Frame area | Af | Uf | Af.Uf |
|---|---|---|---|
| Head | 0.2419 | 3.7344 | 0.9033 |
| Left jamb | 0.2067 | 3.5478 | 0.7333 |
| Right jamb | 0.2274 | 3.9407 | 0.8960 |
| Meeting stile 1 | 0.2345 | 2.7538 | 0.6457 |
| Meeting stile 2 | 0.2345 | 2.7538 | 0.6457 |
| Sill | 0.2994 | 3.6374 | 1.0890 |
| Σaf= | 1.4443 | ΣAf.Uf= | 4.9130 |

| Panel length | lg | ψg | lg.ψg |
|---|---|---|---|
| Head | 2.0500 | 0.0271 | 0.0555 |
| Left jamb | 1.9540 | 0.0274 | 0.0534 |
| Right jamb | 1.9540 | 0.0272 | 0.0531 |
| Meeting stile 1 | 1.9540 | 0.0567 | 0.1108 |
| Meeting stile 2 | 1.9540 | 0.0567 | 0.1108 |
| Sill | 2.0500 | 0.0272 | 0.0557 |
| Σlg= | 11.9160 | Σlg.ψg = | 0.4392 |

| | Ag | Ug | Ag.Ug |
|---|---|---|---|
| Glass | 4.01 | 0.7630 | 3.0563 |

$$U_D = \frac{\Sigma Af \times Uf + \Sigma Ag \times Ug + \Sigma lg \times \psi g}{Ag + Ap + Af}$$

$$U_D = \frac{4.9130 + 3.0563 + 0.4392}{5.45}$$

$$U_D = 1.543 \ W / m^2 \cdot K$$

Reported Value **1.5** W / $m^2$·K (to 1 decimal place)

** Performance assessed from Debar report WIL 376371*

# Doorset 2 - ISO 10077-2:2012 calculation

| | | | |
|---|---|---|---|
| **Title:** | Exova Willenhall | **Carried out for :** | Debar Ltd |
| | U-value calculation for 3 pane bi-folding doorset | **Product :** | Bifold Doorset |
| **Reference:** | TR094_1 | **Model :** | 44mm |
| **Standard issue:** | BS EN ISO 10077-2:2012 | **Glazing config :** | 4-16-4-16 e=0.05 pos 1, 3 |
| **Author:** | Christian Adams | | |
| **Version:** | TR094_1 issue 3 | **Calculation date :** | 21st November 2016 |
| **Issue date:** | 20th June 2016 | **Carried out by :** | Christian Adams |

| Section detail | Lf2d | Up | bp | bf | Uf |
|---|---|---|---|---|---|
| Head | 0.5046 | 0.7007 | 0.1900 | 0.1010 | 3.6779 |
| Left jamb | 0.4829 | 0.7007 | 0.1900 | 0.1000 | 3.4977 |
| Right jamb | 0.5615 | 0.7007 | 0.1900 | 0.1100 | 3.8942 |
| Meeting stile 1 | 0.5915 | 0.7007 | 0.3800 | 0.1200 | 2.7103 |
| Meeting stile 2 | 0.5915 | 0.7007 | 0.3800 | 0.1200 | 2.7103 |
| Sill | 0.5825 | 0.7007 | 0.1900 | 0.1250 | 3.5949 |

U of insulating panel = 0.7007

Glass thickness = 0.0440 m

Centre pane U-value Ug = 0.6220

| Section detail | Lψ2d | Uf | bf | Ug | bd | ψi |
|---|---|---|---|---|---|---|
| Head | 0.5161 | 3.6779 | 0.1010 | 0.6220 | 0.1900 | 0.0265 |
| Left jamb | 0.4943 | 3.4977 | 0.1000 | 0.6220 | 0.1900 | 0.0264 |
| Right jamb | 0.5734 | 3.8942 | 0.1100 | 0.6220 | 0.1900 | 0.0269 |
| Meeting stile 1 | 0.6143 | 2.7103 | 0.1200 | 0.6220 | 0.3800 | 0.0527 |
| Meeting stile 2 | 0.6143 | 2.7103 | 0.1200 | 0.6220 | 0.3800 | 0.0527 |
| Sill | 0.5939 | 3.5949 | 0.1250 | 0.6220 | 0.1900 | 0.0264 |

Overall width = 2.5000 m

Overall height = 2.1800 m

Overall area $A_D$ = 5.450 m2

| Frame width bf | | |
|---|---|---|
| Head | 0.1010 | m |
| Left jamb | 0.1000 | m |
| Right jamb | 0.1100 | m |
| Meeting stile 1 | 0.1200 | m |
| Meeting stile 2 | 0.1200 | m |
| Sill | 0.1250 | m |

largest of the visible areas of both sides, to nearest mm

| Frame area | Af | Uf | Af.Uf |
|---|---|---|---|
| Head | 0.2419 | 3.6779 | 0.8897 |
| Left jamb | 0.2067 | 3.4977 | 0.7230 |
| Right jamb | 0.2274 | 3.8942 | 0.8854 |
| Meeting stile 1 | 0.2345 | 2.7103 | 0.6355 |
| Meeting stile 2 | 0.2345 | 2.7103 | 0.6355 |
| Sill | 0.2994 | 3.5949 | 1.0762 |
| Σaf= | 1.4443 | ΣAf.Uf= | 4.8453 |

| Panel length | lg | ψg | lg.ψg |
|---|---|---|---|
| Head | 2.0500 | 0.0265 | 0.0542 |
| Left jamb | 1.9540 | 0.0264 | 0.0515 |
| Right jamb | 1.9540 | 0.0269 | 0.0525 |
| Meeting stile 1 | 1.9540 | 0.0527 | 0.1030 |
| Meeting stile 2 | 1.9540 | 0.0527 | 0.1030 |
| Sill | 2.0500 | 0.0264 | 0.0540 |
| Σlg= | 11.9160 | Σlg.ψg = | 0.4182 |

| | Ag | Ug | Ag.Ug |
|---|---|---|---|
| Glass | 4.01 | 0.6220 | 2.4915 |

$$U_D = \frac{\Sigma Af \times Uf + \Sigma Ag \times Ug + \Sigma lg \times \psi g}{Ag + Ap + Af}$$

$$U_D = \frac{4.8453 + 2.4915 + 0.4182}{5.45}$$

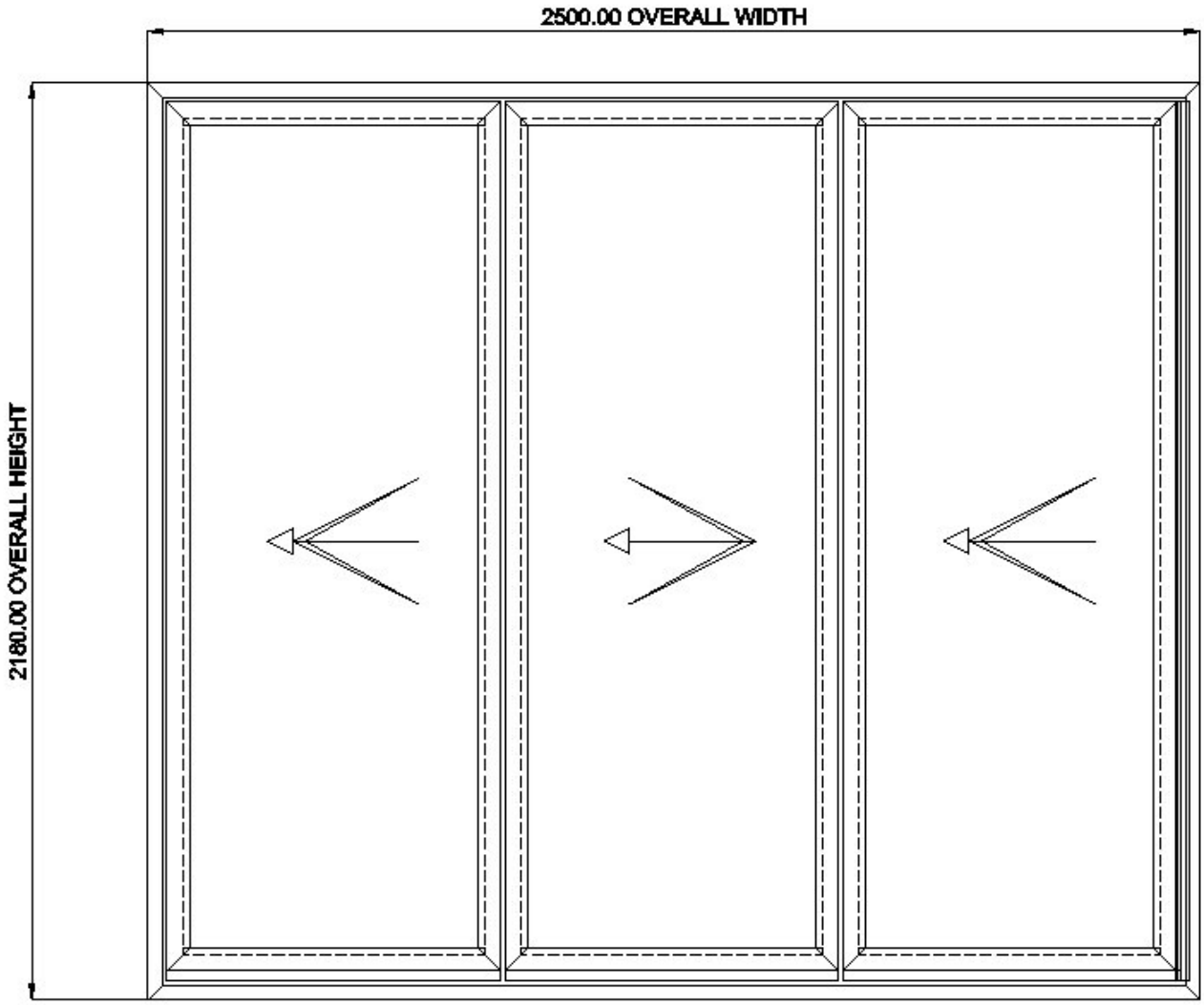
$$U_D = 1.423 \ W / m^2 \cdot K$$

Reported Value **1.4** W / $m^2$·K (to 1 decimal place)

** Performance assessed from Debar report WIL 376371*

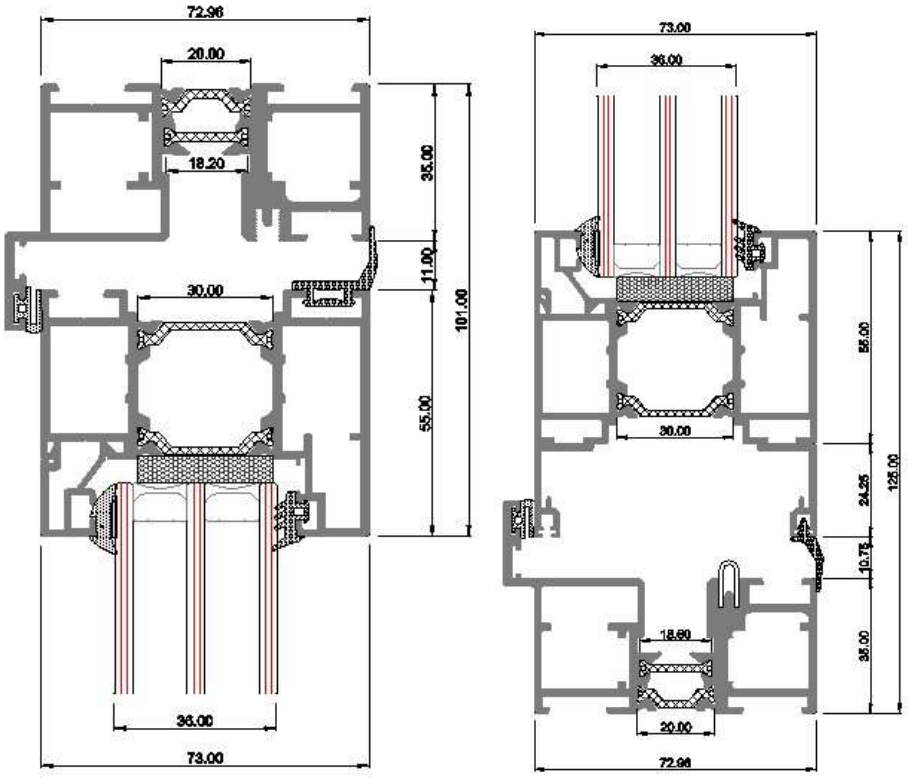
# ANNEX B: DOORSET DRAWINGS

**Doorset internal elevation**

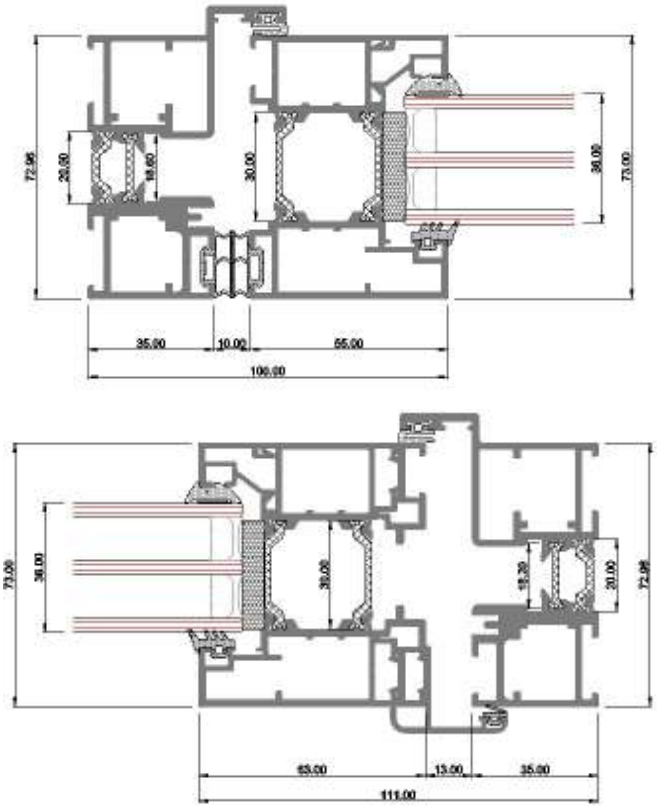



**Frame area $A_f$ = 1.44 m$^2$**

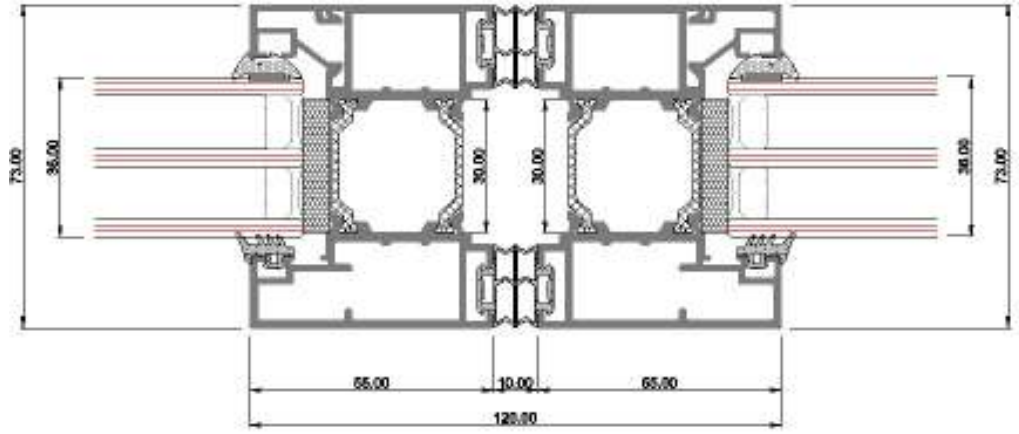
## Doorset 1 - head & sill section



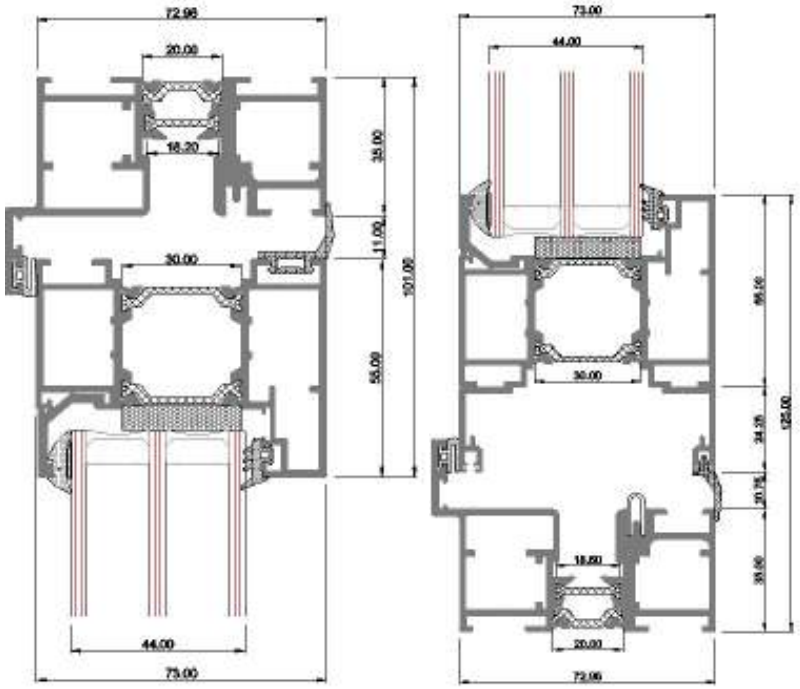

## Doorset 1 - hinge & lock jamb section



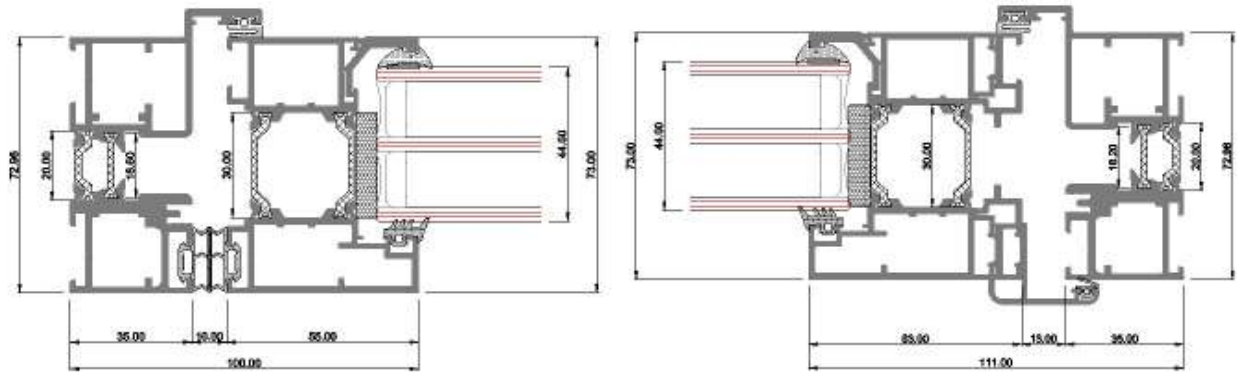
**Doorset 1 – meeting stile section**



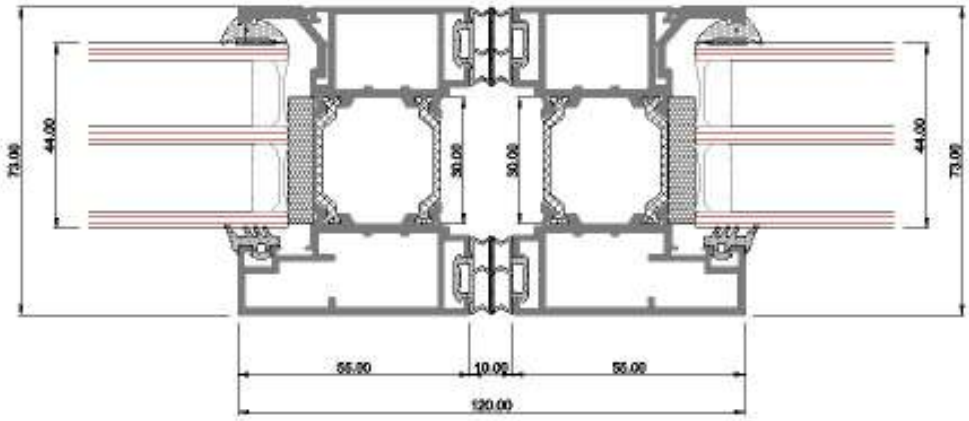

**Doorset 2 - head & sill section**



## Doorset 2 - hinge & lock jamb section




## Doorset 2 – meeting stile section



# ANNEX C: SOURCE DATA

**Materials used**

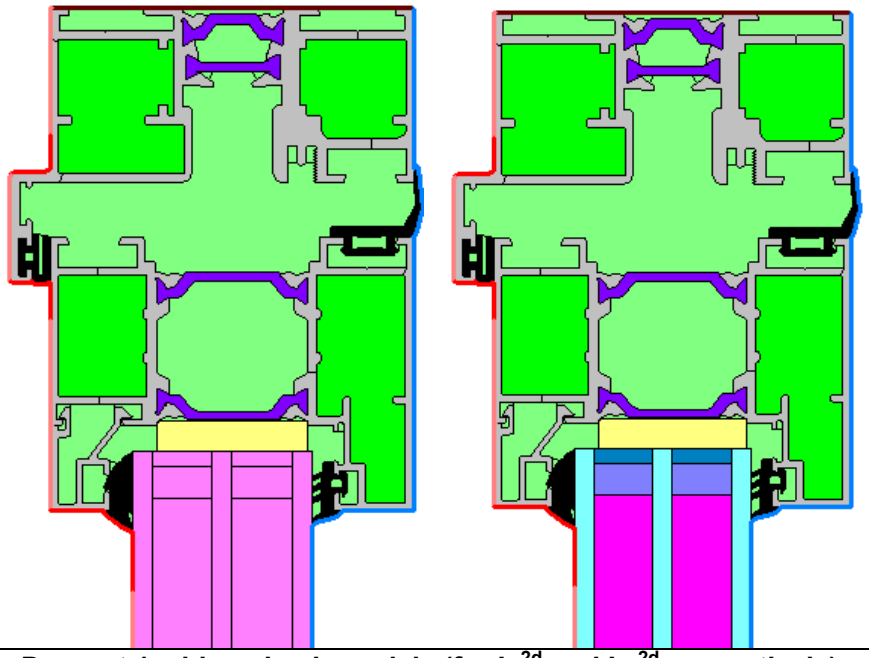
Design thermal conductivity of materials used in the simulation

| Material | | Conductivity (W/ m.K) | Emissivity | Source |
|---|---|---|---|---|
| Aluminium (painted)<br>*Frame* | | 160 | 0.9 | ISO 10077-2:2012 Table A.1 & A.4 |
| Stainless Steel (painted)<br>*Cill running track* | | 17 | 0.9 | ISO 10077-2:2012 Table A.1 & A.4 |
| Glass<br>*Infill panel* | | 1.0 | 0.9 | ISO 10077-2:2012 Table A.1 |
| Polysulphide<br>*Spacer bar secondary sealant* | | 0.40 | 0.9 | ISO 10077-2:2012 Table A.1 |
| Polyamide 6.6 25% glass fibre<br>*Frame thermal break* | | 0.30 | 0.9 | ISO 10077-2:2012 Table A.1 |
| EPDM<br>*Weatherseal and glazing gaskets* | | 0.25 | 0.9 | ISO 10077-2:2012 Table A.1 |
| Thermobar<br>*Spacer bar* | | 0.14 | 0.9 | BF Datasheet 27 – Rev Index 0 |
| Elastomeric foam<br>*Glazing tape* | | 0.05 | 0.9 | ISO 10077-2:2012 Table A.1 |

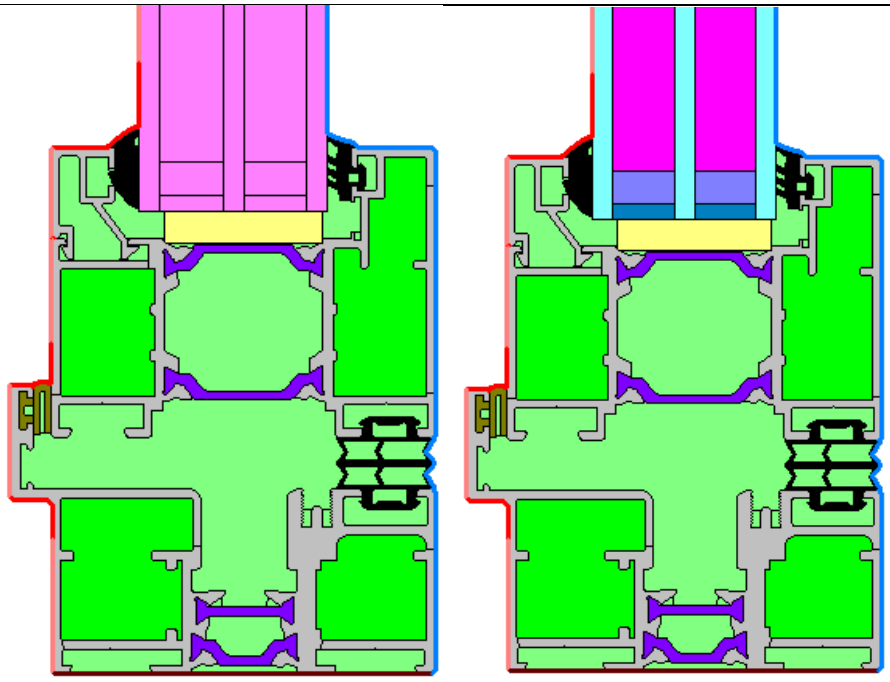
| Cavities | | Conductivity (W/ m.K) | Emissivity | Source |
|---|---|---|---|---|
| Unventilated cavity<br>Slightly ventilated cavity | | Various | | ISO 10077-2:2012 Clause 6 |
| λeff for 12mm cavity<br>4-**12**-4-12-4 air filled unit, internal pane 0.05 low-ε coating | | 0.0213 | 0.90 | By calculation according to BS EN 673:2011 |
| λeff for 16mm cavity<br>4-**16**-4-16-4 air filled unit, internal pane 0.05 low-ε coating | | 0.0225 | 0.90 | By calculation according to BS EN 673:2011 |

# ANNEX D: THERM MODELS

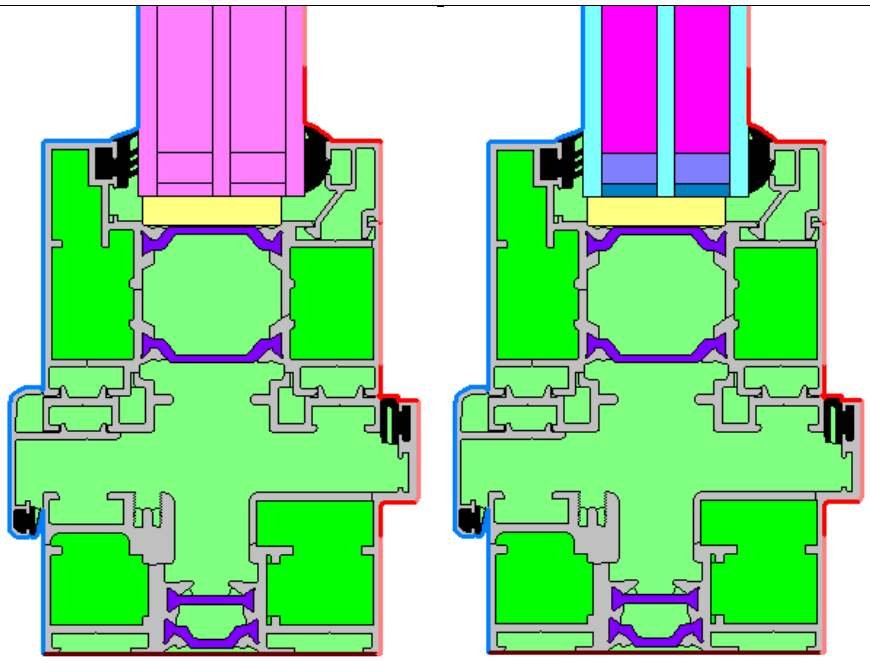
**Doorset 1 - head models (for $L_f^{2d}$ and $L_\psi^{2d}$ respectively)**



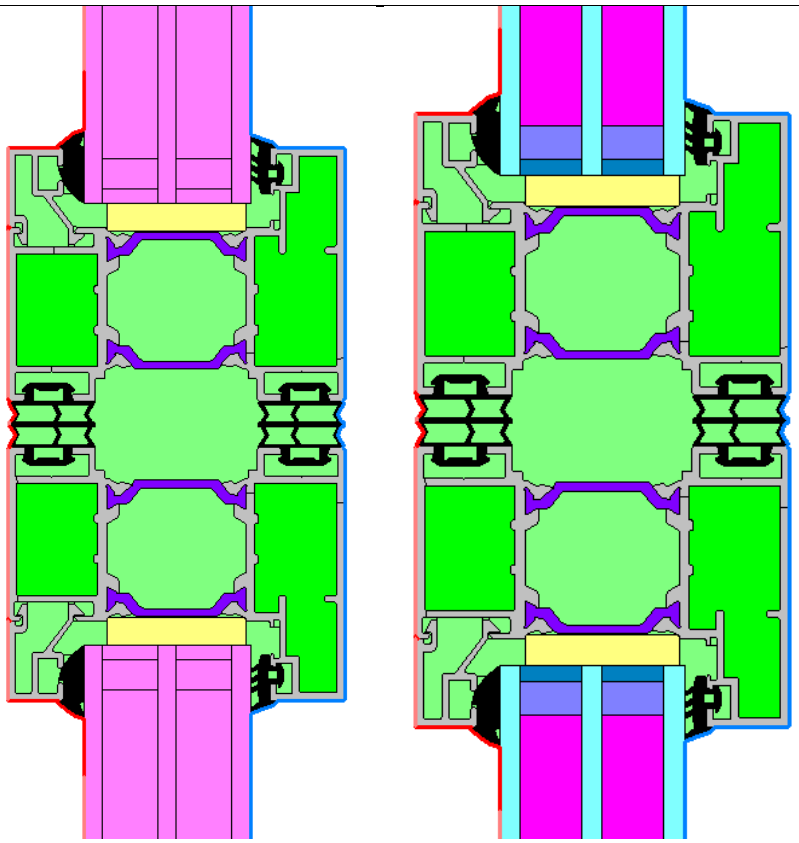
**Doorset 1 – hinge jamb models (for $L_f^{2d}$ and $L_\psi^{2d}$ respectively)**



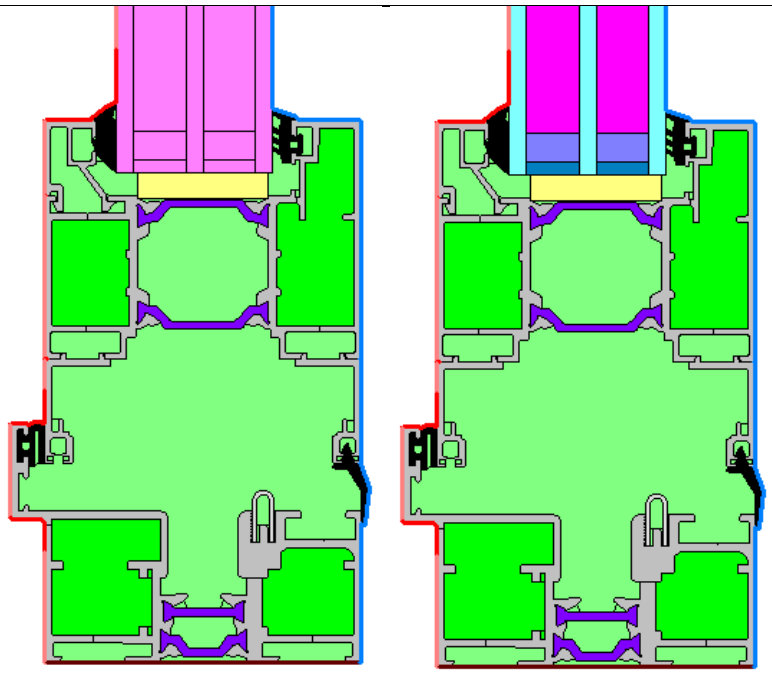
**Doorset 1 – locking jamb models (for $L_f^{2d}$ and $L_\psi^{2d}$ respectively)**



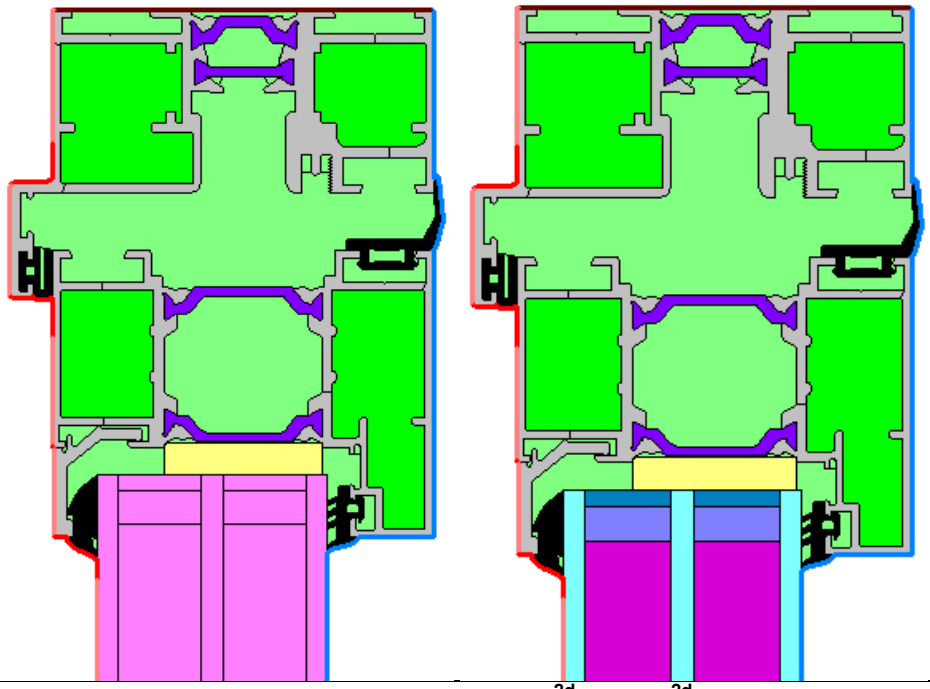
**Doorset 1 – meeting stile models (for $L_f^{2d}$ and $L_\psi^{2d}$ respectively)**



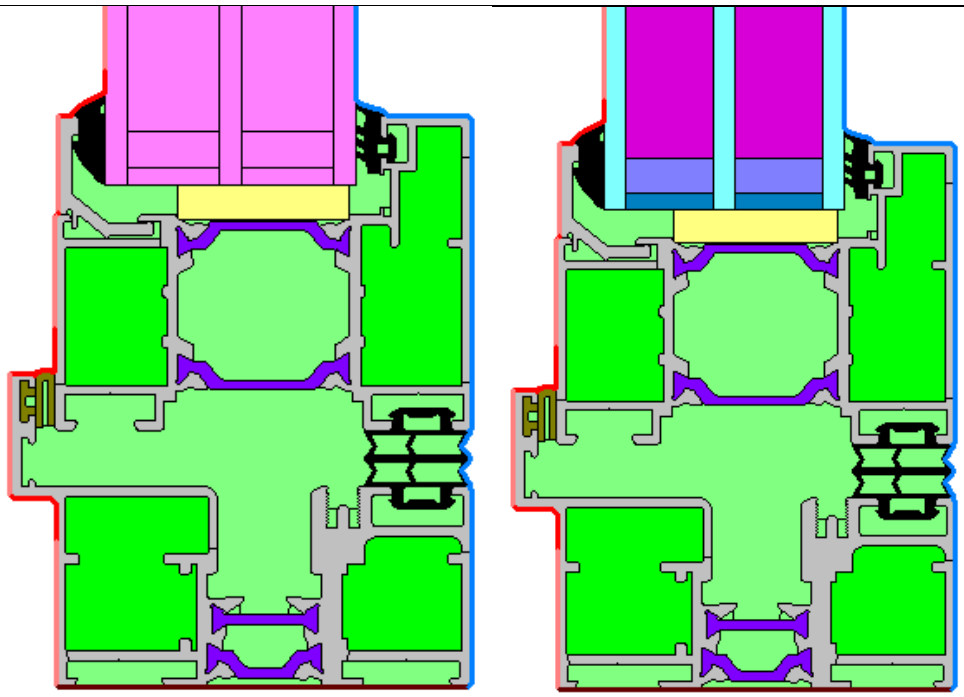
**Doorset 1 – cill models (for $L_f^{2d}$ and $L_\psi^{2d}$ respectively)**



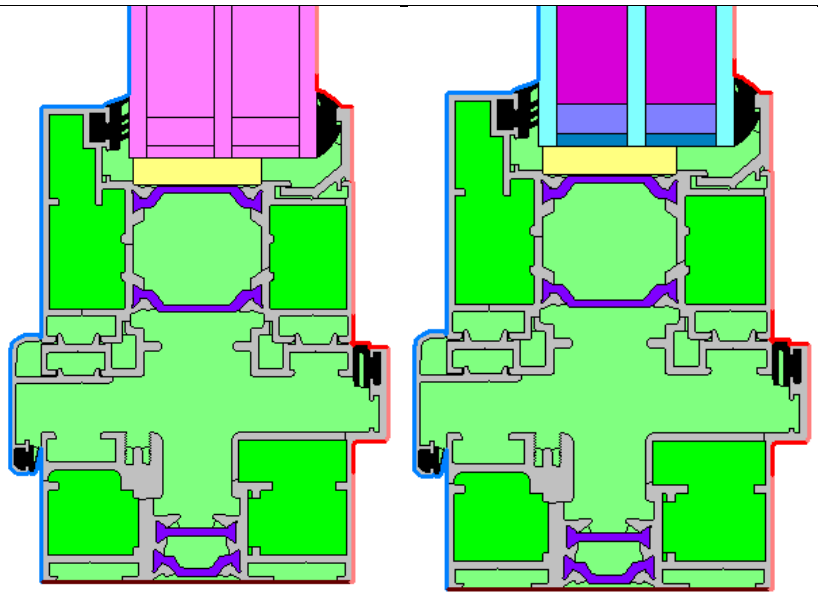
**Doorset 2 - head models (for $L_f^{2d}$ and $L_\psi^{2d}$ respectively)**



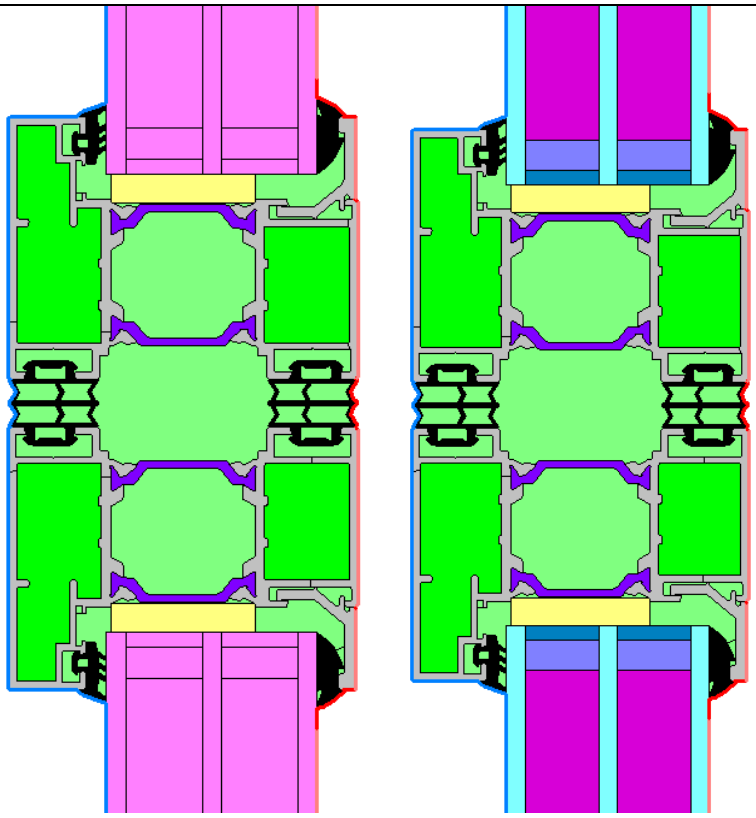
**Doorset 2 – hinge jamb models (for $L_f^{2d}$ and $L_\psi^{2d}$ respectively)**



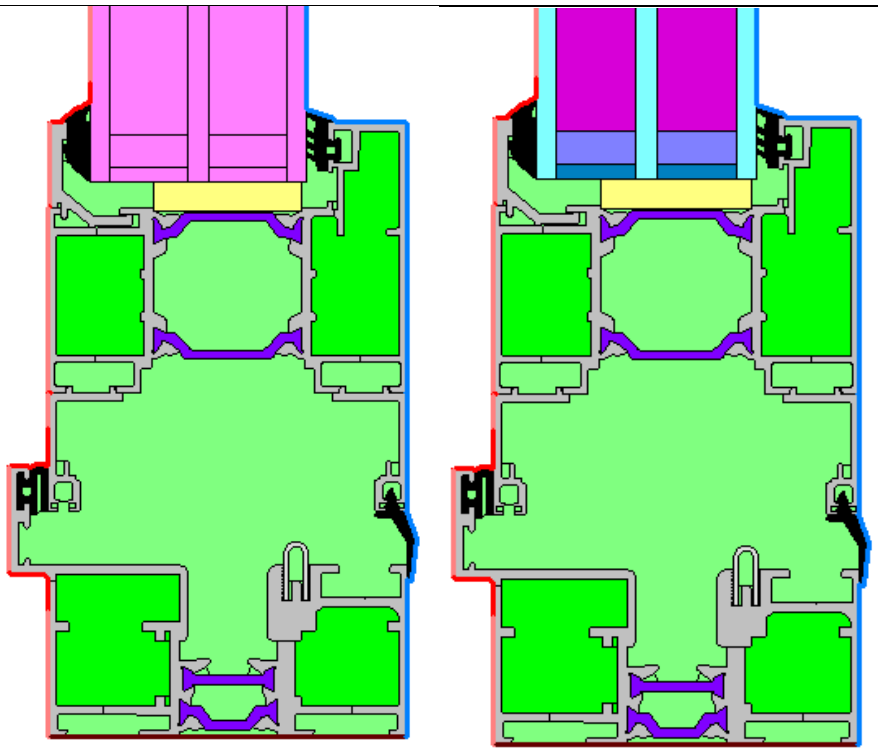
**Doorset 2 – locking jamb models (for $L_f^{2d}$ and $L_\psi^{2d}$ respectively)**



**Doorset 2 – meeting stile models (for $L_f^{2d}$ and $L_\psi^{2d}$ respectively)**



**Doorset 2 – cill models (for $L_f^{2d}$ and $L_\psi^{2d}$ respectively)**



# REVISION HISTORY

| | |
|---|---|
| **Issue No :** | **Re - Issue Date :** |
| **Revised By:** | **Approved By:** |
| **Reason for Revision:** | |

| | |
|---|---|
| **Issue No :** | **Re - Issue Date :** |
| **Revised By:** | **Approved By:** |
| **Reason for Revision:** | |

**END OF REPORT**