

**Report in Accordance with  
BFRC Guidelines and Regulations**

**Product description:**

**Legend Intermediate Multi Chambered Outer Frame with Steel  
Reinforcing – “A” Rated**

**SYN-00121-19**

Client:	Synseal Extrusions Ltd
Project:	Synseal Legend A Rated
Project reference:	SYN-00121-19
Prepared By:	Ryan Shore
Issue date:	20 <sup>th</sup> October 2010

**Synseal Extrusions Ltd**

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Approved Simulator 088

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## 1 Introduction

The U values of the Legend window detailed below were commissioned by Andy Ball of Synseal Extrusions Ltd.

## 2 Validation of Program

The Therm 5.2 analysis software has been validated against proofs in Annex D (D1 to D10) of BS EN ISO 10077-2:2003.

## 3 Analysis Method

The frame profile results detailed below are provided by computer simulation using LBL software program THERM 5.2 and BFRC guidelines and regulations.

## 4 Summary of Results

A summary of results are detailed in the following sections. The details supplied for the analysis as well as all information required to verify the analysis can be found on the attached CD or is available on request from Synseal Extrusions Ltd.

### 4.1 Frame thermal transmittance (following the principles of BS EN ISO 10077-2)

Synseal Legend Intermediate Frame Profile	Frame Thermal Transmittance ( $U_f$ )
Fixed with Steel	1.3 W/(m <sup>2</sup> ·K)
Sash with Steel	1.6 W/(m <sup>2</sup> ·K)
Mullion with Steel	1.8 W/(m <sup>2</sup> ·K)

### 4.2 Linear thermal transmittance (following the principles of BS EN ISO 10077-2)

Synseal Legend Intermediate Frame Profile	Linear Thermal Transmittance ( $\psi$ )
Fixed with Steel	0.029 W/(m·K)
Sash with Steel	0.029 W/(m·K)
Mullion with Steel	0.058 W/(m·K)

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#### 4.3 Centre pane U-value of the glazing calculated in accordance with BS EN 673

Glazing Unit	Centre Pane U-Value ( $U_g$ )	Solar Energy Transmittance ( $g_{\perp}$ )
4-20-4 Low-E 0.05 uncorrected emissivity (Pilkington Optitherm S4+), 90% Argon 10% Air filled, Low Iron Outerpane (Pilkington Optiwhite) glazing unit with Swisspacer V (warm edge) spacer bar with butyl hot melt secondary seal to give 12mm spacer sight line.	1.2 W/(m <sup>2</sup> ·K)	0.74

#### 4.4 The thermal performance of the windows ( $U_w$ ) in accordance with BFRC guidelines and regulations

Synseal Legend Intermediate Frame Profile	Window U-value
Legend intermediate multi-chamber PVC-u frame with full steel reinforcement to system supplier specifications with 4-20-4 Low-E 0.05 uncorrected emissivity (Pilkington Optitherm S4+), 90% Argon 10% Air filled, Low Iron Outerpane (Pilkington Optiwhite) glazing unit with Swisspacer V (warm edge) spacer bar with butyl hot melt secondary seal to give 12mm spacer sight line.	1.44 W/(m <sup>2</sup> ·K)

#### 4.5 The effective $L_{50}$ in accordance with BFRC guidelines and regulations

Synseal Legend Intermediate Frame Profile	Effective $L_{50}$
Air permeability at 50Pa	0.00 W/(m <sup>2</sup> ·K)

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#### 4.6 Total solar energy transmittance (g) in accordance with EN410

Synseal Legend Intermediate Frame Profile	<b>g<sub>window</sub></b>
Legend intermediate multi-chamber PVC-u frame with full steel reinforcement to system supplier specifications with 4-20-4 Low-E 0.05 uncorrected emissivity (Pilkington Optitherm S4+), 90% Argon 10% Air filled, Low Iron Outerpane (Pilkington Optiwhite) glazing unit with Swisspacer V (warm edge) spacer bar with butyl hot melt secondary seal to give 12mm spacer sight line.	0.45

## 5 BFRC Rating

### 5.1 Synseal Legend Window System

Synseal Legend Intermediate Frame Profile	<b>Rating</b>
Legend intermediate multi-chamber PVC-u frame with full steel reinforcement to system supplier specifications with 4-20-4 Low-E 0.05 uncorrected emissivity (Pilkington Optitherm S4+), 90% Argon 10% Air filled, Low Iron Outerpane (Pilkington Optiwhite) glazing unit with Swisspacer V (warm edge) spacer bar with butyl hot melt secondary seal to give 12mm spacer sight line.	<p style="text-align: center;"><b>+0</b> (Rating Scale A)</p>

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## 6 Authorisation

Prepared By: Ryan Shore

Signature: *R. Shore*

Date: 20<sup>th</sup> October 2010

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## 7 Technical Specification

Profiles	Ref. No.	Material type / Manufacturers name	Dimensions (Height x Width)
<b>Outer Frame:</b>	5F5	Synseal - PVC-u	60mm x 70mm
<b>Casement Vent:</b>	5V2	Synseal - PVC-u	77mm x 70mm
<b>Transom/Mullion:</b>	5OL1	Synseal - PVC-u	72mm x 70mm
<b>Glazing Bead:</b>	5OJB28	Synseal - PVC-u	27mm x 15mm
<b>Joint type</b>	N/A	N/A	
<b>Joint Adhesives</b>	N/A	N/A	

Reinforcements	Ref. No.	Material type / Manufacturers name	Dimensions (Height x Width)
<b>Outer Frame:</b>	5RS-5F5	Synseal - Steel	20.5mm x 12mm
<b>Casement Vent:</b>	5RS-V2	Synseal - Steel	24.5mm x 33mm
<b>Transom/Mullion:</b>	5RS-FT1L	Synseal - Steel	13mm x 41.5mm

Weather Seals	Ref. No.	Material type / Manufacturers name	Continuous or joined at corners
<b>Outer Frame:</b>	N/A	Co-Extruded to bead - PVC-P	
<b>Casement Vent:</b>	N/A	Co-Extruded to bead - PVC-P	
<b>Transom/Mullion:</b>	N/A	Co-Extruded to bead - PVC-P	
<b>Glazing Bead:</b>	N/A	Co-Extruded to bead - PVC-P	

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Glazing Component	Specification	
<b>Overall Sealed Unit</b>	Thickness:	28mm
<b>Outer Pane</b>	Thickness:	4mm
	Manufacturer:	Pilkington
	Description:	Optiwhite (Low Iron)
<b>Inner Pane</b>	Thickness:	4mm
	Manufacturer:	Pilkington
	Description:	Optitherm S4+(Low-E 0.05)
<b>Spacer Bar</b>	Manufacturer:	Saint Gobain
	Description:	Swisspacer V (warm edge)
<b>Cavity</b>	Distance:	20mm
	Gas %:	Argon 90%, Air 10%
<b>Edge Seal</b>	Manufacturer:	N/A
	Description:	Butyl (isobutene) hot melt secondary seal to give 12mm sightline

#### Additional Notes:

Metallic reinforcement present in all profiles.

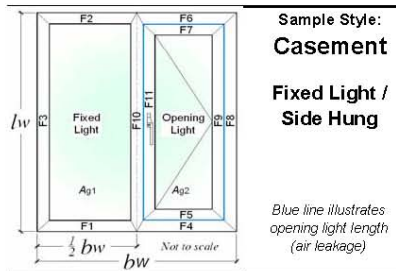
Multi-chambered outer frame profile.

The ovolo bead used for this simulation (5OJB28) has been determined as the "worst case" bead for this profile combination. Therefore it can be stated that use of the chamfered bead (5CJB28) will give the same result or marginally better.

Air leakage data is taken from BSI Test report ref: 261/005111/1 of 3 dated 17<sup>th</sup> July 2000 (data at 50Pa pressure = 0.13)

Solar heat gain figures are calculated from g-values supplied by the product manufacturer from EN 410 calculations for the glass units used in this simulation. The value used is 0.74

# BFRC Spreadsheet



Report Number: **SYN-00121-19** Issue No.21: 04/03/2009  
 Report Date: **20 October 2010**  
 Project Details: **Legend 5F5/5V2/5OL1, RS in all, 4/20/4 Optiwhite / Argon 90% / Pilkington S4+ / Swisspacer V**

**Input Values:**  
 Yellow input, green intermediary, blue finals X' DP is no. of decimal places to enter

Parameter	Symbol	Units
Total window height <b>ODP</b>	$i_w$	1480 mm
Total window width <b>ODP</b>	$b_w$	1230 mm

Nominal 4mm etc to <b>ODP</b> , others <b>1DP</b>		
<b>Glazing dimensions and properties:</b>		
Thickness of pane 1	4	mm
Pane 1/2 distance	20	mm
Gas fill (1/2)	Argon 90%	
Thickness of pane 2	4	mm
Complete next 3 cells for TG IGU		
Pane 2/3 distance		mm
Gas fill (2/3)		
Thickness of pane 3		mm
Glazing Trans - <b>3DP</b>	$U_g$	1.221 W/(m <sup>2</sup> K)
g-value - <b>2DP</b>	$g$	0.74

Frame dimensions:	(b <sub>f</sub> )	Without gasket	Gasket protrusion	With gasket	Total
		(mm)	(mm)	(mm)	
All frame values to nearest 0.5mm, gaskets to <b>1DP</b>	F1 fixed sill	60	0.0	60	109
	F2 fixed head	60	0.0	60	
	F3 fixed jamb	60	0.0	60	
F4 + F5 sash sill	F4 fixed sash sill	60	n/a	60	109
	F5 moving sash sill	49	0.0	49	
F6 + F7 sash head	F6 fixed sash head	60	n/a	60	109
	F7 moving sash head	49	0.0	49	
F8 + F9 sash jamb	F8 Fixed sash jamb	60	n/a	60	109
	F9 moving sash jamb	49	0.0	49	
F10 + F11 mullion	F10 fixed mullion	72	0.0	72	121
	F11 moving mullion	49	0.0	49	
Total gasket area				0	m <sup>2</sup>

Thermal transmittance of window from hot box test		
$U_w - 2DP$		W/(m <sup>2</sup> K)

Section	Length (m)	Width (m)	Area	
			No gasket (m <sup>2</sup> )	With gasket (m <sup>2</sup> )
Fixed Light	1.3600	0.5190	0.7058	0.7058
Opening light	1.2820	0.4210	0.5313	0.5313
Total glazing, A <sub>g</sub>			1.2371	1.2371
Frame	(m)	(m)	(m <sup>2</sup> )	(m <sup>2</sup> )
F1	0.6150	0.0600	0.0340	0.0340
F2	0.6150	0.0600	0.0340	0.0340
F3	1.4800	0.0600	0.0852	0.0852
F4	0.6150	0.0600	0.0340	0.0340
F5	0.5190	0.0490	0.0230	0.0230
F6	0.6150	0.0600	0.0340	0.0340
F7	0.5190	0.0490	0.0230	0.0230
F8	1.4800	0.0600	0.0852	0.0852
F9	1.3600	0.0490	0.0642	0.0642
F10	1.4800	0.0720	0.1022	0.1022
F11	1.3600	0.0490	0.0642	0.0642
Total Frame			0.5833	0.5833
Total Window, A <sub>w</sub>			1.8204	1.8204
Percentage fixed light glass area			38.77%	38.77%
Percentage opening light glass area			29.19%	29.19%
Percentage glass area (total)			67.96%	67.96%

Where a  $U_g$  value from hot box testing is available, no  $L_f^{2D}$  or  $L_w^{2D}$  values need to be entered

Frame conductance:	All L values to <b>4DP</b> . All b values to <b>ODP</b>			
	$L_f^{2D}$	$W/(m^2K)$	$b_g$ (mm)	$L_w^{2D}$
F1 fixed sill	0.2721	190	0.3374	190
F2 fixed head	0.2721	190	0.3374	190
F3 fixed jamb	0.2721	190	0.3374	190
F4 + F5 sash sill	0.3666	190	0.4319	190
F6 + F7 sash head	0.3666	190	0.4319	190
F8 + F9 sash jamb	0.3666	190	0.4319	190
F10 + F11 mullion	0.6044	380	0.7347	380

Frame:	$b_f$ (no gaskets)	$U_f$	Frame areas (no gaskets)	Heat flow	$\psi$	$l_g$	Heat flow
Section	(m)	(W/(m <sup>2</sup> K))	(m <sup>2</sup> )	(W/K)	(W/(m-K))	(m)	(W/K)
F1 fixed sill	0.0600	1.2704	0.0340	0.0432	0.0292	0.5190	0.0151
F2 fixed head	0.0600	1.2704	0.0340	0.0432	0.0292	0.5190	0.0151
F3 fixed jamb	0.0600	1.2704	0.0852	0.1082	0.0292	1.3600	0.0397
F4 + F5 sash sill	0.1090	1.5663	0.0571	0.0894	0.0292	0.4210	0.0123
F6 + F7 sash head	0.1090	1.5663	0.0571	0.0894	0.0292	0.4210	0.0123
F8 + F9 sash jamb	0.1090	1.5663	0.1494	0.2341	0.0292	1.2620	0.0368
F10 + F11 mullion	0.1210	1.7574	0.1665	0.2926	0.0581	1.3110	0.0761
Totals			0.5833	0.9000		Total	0.2075

Solar Factor, g-value:	$F_w$	0.9
	$g_w$	0.45

Air Leakage loss:		
Air leakage at 50 Pa per hour & per unit length of opening light (BS 6375-1) - <b>2DP</b>		
Opening light length	3.7580 m	Total air leakage 0.489 m <sup>3</sup> /h
$L_{50}$	0.27 m <sup>3</sup> /(m <sup>2</sup> ·h)	Heat loss = 0.0165 $L_{50}$ 0.00 W/(m <sup>2</sup> ·K)

$U_{window}$	$U_w$	1.44	W/(m <sup>2</sup> ·K)
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Other parameters needed for calculation, taken from simulations:  
 Panel thickness,  $d_p = d_g = 0.028$  m  
 $\lambda_p = 0.035$  W/(m·K)  $R_{se} = 0.04$  m<sup>2</sup>·K/W  $R_{sp} = 0.13$  m<sup>2</sup>·K/W  
 $R_p = 0.8000$  m<sup>2</sup>·K/W  $R_{tot} = 0.9700$  m<sup>2</sup>·K/W  $U_p = 1.0309$  W/(m<sup>2</sup>·K)

BFRC Rating kWh/(m <sup>2</sup> ·yr)	Label index	EWER Rating Scale	Window Rating
> 5	0	A	A
-10 to < 0		B	
-20 to < -10		C	
-30 to < -20		D	
-50 to < -30		E	
-70 to < -50		F	
< -70		G	

BFRC Rating =	218.6 $g_{window} - 68.5 \times (U_{window} + \text{Effective } L_{50}) =$	-0.27
Climate zone is:		UK
Thermal transmittance, W/(m <sup>2</sup> ·K)	$U_{window}$	1.4
Solar factor	$g_{window}$	0.45
Window air leakage heat loss, W/(m <sup>2</sup> ·K)	$L_{factor}$	0.00



Simulator Name: **Ryan Shore**

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## BS EN 673 Spreadsheet

Version 9 July 2010. Calculations according to BS EN 673:1998 (A1)

Number of spaces		1	
Glazing orientation		Vertical	
Resistivity panes	1	m-K/W	
Outside		90%	
		Gas	
		Argon	
Thickness (mm)	4.0	20	4.0
Normal emissivity	0.89	0.05	
$\sum d_i \cdot r_i$	0.008		
		Uncoated	

For uncoated surfaces input 0.89 for normal emissivity, which corresponds to a corrected emissivity of 0.837

Iteration number	U value		$\lambda_{eff}$	
	W/(m <sup>2</sup> ·K)	$\sum 1/h_s$ (m <sup>2</sup> ·K)/W	W/(mK)	$\Delta T$
1	1.221	0.64228	0.0311	15
2	1.221	0.64228	0.0311	15

### Thermal Conductance Values Used

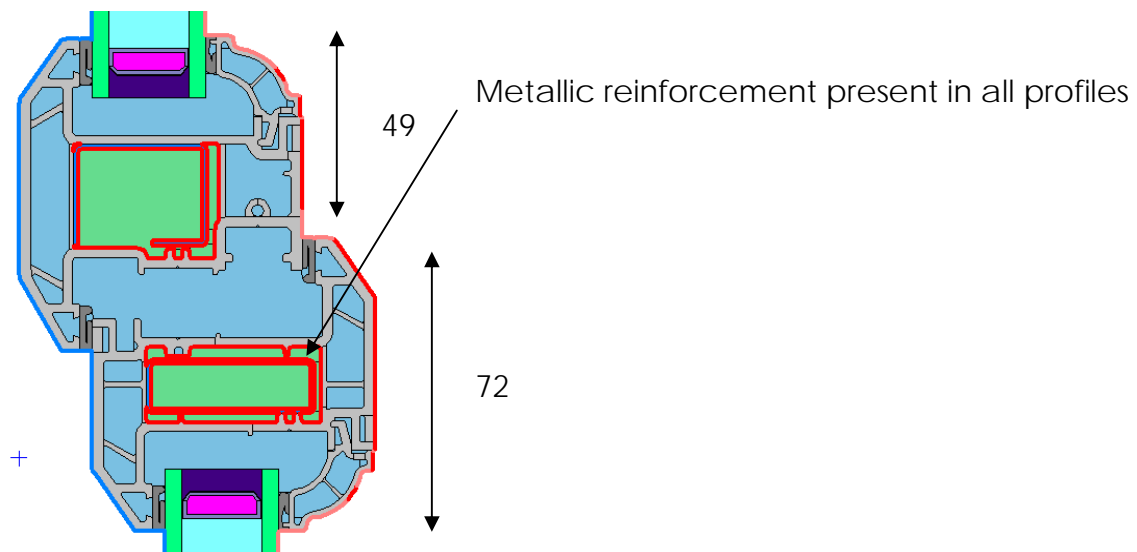
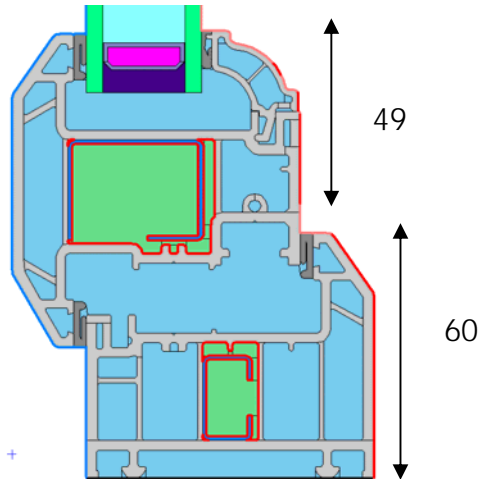
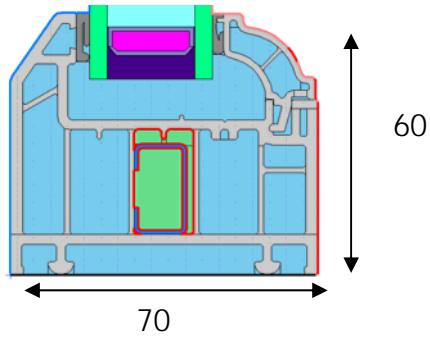
Material / Conductance (W/m.K)	Reference
PVC-u / 0.17	(Annex A BS EN ISO 10077-2)
PVC-P / 0.14	(Annex A BS EN ISO 10077-2)
EPDM / 0.25	(Annex A BS EN ISO 10077-2)
Butyl hot melt / 0.24	(Annex A BS EN ISO 10077-2)
Soda lime glass / 1.0	(Annex A BS EN ISO 10077-2)
Molecular Sieve / 0.1	(Annex A BS EN ISO 10077-2)
Polyisobutylene / 0.2	(Annex A BS EN ISO 10077-2)
Swisspacer Plastic / 0.16	SGG Manufacturers Data
Swisspacer Stainless Steel (15/12) / 1.25	SGG Manufacturers Data

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## Appendix

### Profile Drawings

(See Technical Specifications for dimensions)



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