IES VE guide for VELUX products

How to correctly insert VELUX products in IES VE program, focus on daylight and indoor climate simulation.



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Limitations

The guide provides information on how to model a VELUX window product in IES VE, given the available capabilities and limitations of the software and based on the latest software version available at the time of writing, namely VE 2019.

IES VE guide for VELUX

About

This document offers guidelines on the simulation of a sloped roof VELUX window in IES VE to carry out thermal, natural ventilation, air quality and daylight assessments.

IES VE is a software developed and licensed by Integrated Environmental Solutions Limited. It is a thermal simulation suite of integrated analysis tools for buildings, including whole building energy simulations and indoor climate analysis. The daylight calculation capability of the software is based on Radiance.

The guide focuses on how to model a sloped VELUX integra Roof Window in IES VE; it is not a general guide on how to use IES VE.

Slope Roof window

The modelling of a VELUX pivoting sloped Integra Roof Window in IES VE for thermal, natural ventilation, air quality and daylight assessments will be presented in the following sections.

The window characteristics are summarised in Table 1 and the modelling assumptions in Table 2.

Table 1, VELUX window characteristics

VELUX window characteristics	Values
General Properties	
Туре	Pivoting roof window GGL
Size	780mm x 1398mm (M08)
Insulating Glass Unit	59, Low energy
Frame percentage	36%
Thermal & solar properties	
Thermal transmittance of glass, Ug	1.1 W/(m²K)
Total window thermal transmittance, Uw	1.7 W/(m²K)
Total solar energy transmittance, g-value	0.60
Natural ventilation properties	
Opening area definition	Fully open position corresponds to 19.4 cm distance from bottom of frame to bottom of sash (refer to figur 5, page 9) 1
Free open area	0.27 m ²

Table 2, Modelling example assumptions

Modelling assumptions	
Natural ventilation control to avoid overheating	Open when Tair,in>24°C be- tween 07:00-20:00
Natural ventilation control for air quality	Open 10 mins morning and evening when Tair,out>0°C

¹ The opening area is based on VELUX Roof Window, GGL Integra V21. The area is the minimum value for all Integra VELUX Roof Windows. Manual (pivot and top hung) will have a higher opening area, but can use this value as a minimum opening area.

Modelling the sloped roof VELUX window in IES VE

Dynamic thermal simulation using Apache

Create a new project or open an existing one in IES VE. Once the geometry is complete (including all the windows), either through creating it in ModelIT or importing it using the IES interoperability, set up your model as usual, ensuring to include the location and climatic data, building fabric, thermal templates and energy systems.

To set up the sloped roof VELUX window go to the Apache module and open the Apache Construction Database Manager (APcdb). 2 In the <u>Glazed</u> tab add a new construction and set it to Roof Light under the Category column. Open the construction and give it an appropriate name in the <u>Descrip-</u> <u>tion</u> field.

Make sure to adjust the <u>Construction Layers</u> (figure 1) so that the window composition matches the construction.

Shading Device Solution		indow								1	ID: STD_RF	11	External	Inter
Net U-value (including frame): 1.7002 W/m ² ·K U-value (glass only): 1.1001 W/m ² ·K 3d Net R-value: 0.9990 m ³ K/W g-value (EN 410): 0.6002 Visible light normal transmittance: 0.79 faces Frame Shading Device Regulations UK Dwellings RadianceIES 3a Jutside Emissivity: 0.837 Resistance (m ³ K/W): 0.0400 Default Inside Instruction Layers (Outside to Inside): Resistance Magular Gas Convection Coefficient W/m ² ·K Resistance Outside Inside Inside Material Thickness Conductivity Angular Gas Convection Coefficient W/m ² ·K Transmittance Outside Inside Refractive Outside Inside// Emissivity Inside Inside Inside Emissivity Visib TD_RF01J Outer Pane 4.0 1.0600 Fresnel - - 0.0038 0.640 0.270 0.280 1.526 0.837 0.209 Yes wity 16.0 - - - 0.0038 0.6783 0.072 0.072 1.526 0.83	ormance: EN-ISO 🗸					3b								
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	avity TD_RF11] Inner Pane 2						3b							

Figure 1, APcdb Glazed construction – setting up the sloped roof VELUX window

Dynamic thermal simulation using Apache

- 3 The glazing properties of the VELUX product need to be reflected in the APcdb construction as figures 1 (on page 5) and figure 2 show, with each step highlighted in red.
- Edit the <u>Transmittance</u> of the outer pane to get the correct g-value, shown in the field g-value (EN 410). (figure 1)
- D To achieve the product's glass U-value edit the <u>Resistance</u> of the cavity. (figure 1)
- C Then go to the Frame tab (figure 2) and adjust the frame percentage (and <u>Absorptance</u> if known) as per the product specifications.

Edit the frame <u>Resistance</u> to get the specified frame U-value (if known) and total window U-value, shown in the field Net U-value (including frame). (figure 2) d Set the <u>Visible light normal transmittance</u> in the corresponding field (figure 1 or 2), in case you are planning to carry out Radiance calculations for a daylight assessment; the APcdb construction will be used in Radiance (see "Daylight calculations using RadianceIES").

Figure 2, APcdb Glazed construction, Frame tab – setting up the sloped roof VELUX window frame

cription: Velux 45deg win formance: EN-ISO V — Net U-value (including frame) Net R-value	dow 3c): 1.7002 V												
formance: EN-ISO Vet U-value (including frame) Net R-value	3c): 1.7002 V								I	D: STD_RF	11	External	Interr
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value: 0.76	70 W/m 2+K	Dec	istance: 0.221	4	DK AM	Tosido que	face area ratio	1.00					
Material	Thickness mm	Conductivity W/(m·K)	Angular Dependence	Gas	Convection Coefficient W/m²·K	Resistance m²K/W	Transmittance	Outside Reflectance	Inside Reflectance	Refractive Index	Outside Emissivity	Inside Emissivity	Visible Light Specified
					3	6		S		-			
STD_RF01] Outer Pane	4.0	1.0600	Fresnel	-	-	0.0038	0.640	0.270	0.280	1.526	0.837	0.209	Yes
STD_RF01] Outer Pane Cavity	4.0 16.0	1.0600 -	Fresnel -	-		0.0038	0.640 -	-	0.280	1.526	0.837	0.209	Yes -

- 4 To see the calculated values for the <u>Total shading coeffi</u> <u>cient</u>, open the <u>Derived Parameters</u> (figures 1 on page 5 and figure 3).
- 5 Once your VELUX construction is complete exit the APcdb dialogue and in the 3D model interface of Apache apply the construction to the appropriate windows, using the Assign constructions button.

You can do this by selecting the openings at room level (to apply the construction on all windows of the room) or at surface level (to apply the construction on specific windows of the room).

The VELUX window is now ready for use in thermal simulations

6 Click the ApacheSim (Dynamic Simulation) button in Apache to run a dynamic thermal analysis.

Enable the Suncast Link in the Apache Simulation window that will appear to allow for tracking direct beam radiation based on the model's geometry and click Simulate to run the analysis. Figure 3, APcdb Glazed construction - Derived parameters window

				Velux	45deg wir	ndow				
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nside surfi	ace resist	ance			0.100	0 m	²K∕W			
-value (B	S EN 410):			0.600	2				
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Natural ventilation using MacroFlo

- Once the set-up of the dynamic thermal simulation is complete, the opening of a VELUX window can be defined under the MacroFlo module of IES. By clicking on the <u>MacroFlo openings</u> database manager button the user can create a new <u>MacroFlo Opening Type</u> (figure 4). After giving the opening an appropriate name in the field <u>Description</u>, the <u>Opening Category</u> should be defined first, as this will dictate the available input options. For the example pivoting VELUX window the Window-centre hung category is appropriate. For details on the opening types please visit the IES help page on <u>MacroFlo Opening Types</u>.
- 2 The Exposure Type will define the wind pressure coefficients and needs to be selected based on the intended application of the window. In this example a semi-exposed roof >30deg is representative. For details on the exposure type characteristics and the calculation methods please refer to the MacroFlo Methods Manual and the Wind Pressure Coefficients section of the IES help page.

3 The <u>Openable Area %</u>, the <u>Max Angle Open[°]</u> and the <u>Proportions</u> of the window will define the <u>Equivalent orifice</u> area as a percentage of the gross opening area drawn in the model (figure 4).

As figure 6 (on page 9) explains, the <u>Openable Area %</u> is set to 85 % to account for the immovable frame of the window. The <u>Max Angle Open</u>° is calculated to 18.0° based on the given distance of 19.4 cm between the bottom of the frame and the bottom of the sash (figure 5, on page 9). (For Max angle Open for all Roof Window, (V21 & V22) and Flat Roof Window, see Appendix A, B and C).

The appropriate Length/Height <u>Proportions</u> is selected from the drop-down menu. Based on these inputs, the <u>Equivalent Orifice</u> Area calculated by IES is 24.7% of the gross window area (0.78 m x 1.398 m), which is equal to the 0.27 m2 free open area given in Table 1, on page 4.

Figure 4, MacroFlo Opening Types window - setting up the sloped roof VELUX window as an opening

XTRN0000 XTRN0001	External window opening Velux pivoting window	Reference ID X	TRN0001	
		Description V	elux pivoting window	1
		Exposure Type 08	3. semi-exposed roof >30deg	∼ ∍́ 2
		Opening Category W	'indow - centre hung	~ 1
		Openable Area	% 85.00	†
		Max Angle Ope	n ° 18.00	3
		Proportions	Length/Height = 1	~
		Equivalent orifi	ce 24.677 % of g	jross 🔶
		Crack Flow	0.150 I/(s·m·Pa^0.	6)
		Crack Length	0 % of opening	g perimeter
		Opening threshold	0.00 °C	5a
		Degree of Opening (Modulating Profile)	Velux window opening	~ 🕅 🔛 5
Add	Remove			

Natural ventilation using MacroFlo

4 The <u>Crack Flow</u> and <u>Crack Length</u> (figure 4, on page 8) represent the leakage properties of the crack around the opening. If these properties are known they can be inserted in the respective fields.

Alternatively the user can decide to account for the crackage of the windows when assigning the infiltration rate of the building in the Thermal templates. In that case, the crack length should be set to zero.

Typical values and further information on the crackage characteristics can be found in the Flow Characteristics of the IES help page. Figure 5, Pivoting sloped roof VELUX window opening characteristics



Figure 6, Pivoting sloped roof VELUX window sash and frame



Natural ventilation using MacroFlo

5 In order to set up the control of the opening the recommended way is to set up a Modulating profile and apply it in the <u>Degree of Opening</u> drop-down menu (figure 4, on page 8).

This way the user may select different control variables (e.g. temperature and/or CO^2 levels) and specific times to apply the control.

The <u>Opening Threshold</u> should be set to zero to ensure it does not override the modulating profile control. (Figure 4, on page 8)

Figure 7, shows the modulating profile applied for the sloped roof VELUX window based on the control assumption described in table 2, on page 4.

6 When all the inputs are defined click <u>OK</u> to close the <u>MacroFlo Opening Types</u> window and save. (figure 4, on page 4)

In the 3D geometry interface select the windows to which you would like to apply the VELUX opening type and assign the opening by clicking on the Assign Opening Types button, where you can replace the default opening assigned with the VELUX opening you just created.

7 Go to the Apache module and click on the ApacheSim (Dynamic Simulation button). Make sure to tick MacroFlo under Model Links in the Apache Simulation window that will open and click Simulate.

Figure 7, Example modulating profile for control of window opening

ofil	e Name:		ID:			
elu	ix window	v opening	DAY	/_0021	Modulating	O Absolute
ate	gories:	· · · · · · · · · · · · · · · · · · ·]			
Τ	Time	Value	1	1.00	* * * * * * *	1 1 1 1
	00:00	0.000	ne	0.90		
	07:00	0.000	val	0.80		
1	07:00	(to>0)	ing			
1	07:10	(to>0)	nat	0.70		
1	07:10	(ta>24)	log	0.60	· · · · · · · · · · · · · · · · · · ·	
1	20:00	(ta>24)	2	0.50		
1	20:00	(to>0)		0.40		
1	20:10	(to>0)		0.30		
1	20:10	0.000				
I	24:00	0.000		0.20		
				0.10	1-1-1-1-1-1-1-	
				0.00 00 02	04 06 08 10 12 14	16 18 20 22
					Time of	Day
	<u>ل</u>	🖌 👔 🛍 🛍 🖲 Metric 🔿 IP 💿 No units		Grid		
						Consul

Air quality

The available calculated variable for air quality assessments is the Room CO^2 concentration. Once the dynamic thermal model is set up, by running an ApacheSim (Dynamic Simulation) in Apache, IES will calculate the Room CO^2 concentration amongst its room output variables that can be reviewed in the VistaPro module when the simulation is complete.

The calculation will be based on the external CO^2 levels (assuming a fixed outside air concentration of 360 ppm), any air exchanges defined by MacroFlo or ApacheHVAC and the occupancy settings.

For more information on the calculation method please refer to the IES help page > Carbon Dioxide Balance section.

Daylight calculations using RadianceIES

The RadianceIES module supports both Climate Based Daylight Modelling under the Advanced calculation type as well as static daylight calculations, under the Luminance or Illuminance calculation types.

- Once the geometry (including all windows), location and climatic data are defined, go to the RadianceIES module to carry out a daylight calculation using the sloped roof VELUX window.
- 2 The next step is about defining the daylight properties of the VELUX glazing and the other model constructions. This is done using the APcdb menu, which can be accessed either through Apache or directly through.

<u>RadianceIES</u> by using the <u>Assign constructions</u> button. To define the glass Radiance properties follow the next steps. a In the 3D model interface select the windows to which you would like to apply the VELUX glazed construction. Click the <u>Assign constructions</u> button and in the window that will open (figure 8), click the <u>APcdb</u> button to create the VELUX window construction.

If you have already created a VELUX window construction in Apache and you now need to set its Radiance properties go directly to step 2c.

b In the Glazed tab add a new construction and set it to Roof Light under the Category column. Open the construction and give it an appropriate name in the Description field. (Figure 8)

Assign constructions				
	Select construct External wall Roof Skylight Internal floor/	ction category:		
	ID	Assigned Construction types	Show all Standard	EN-ISO U-value
	STD_RFLT	2013 Rooflight	Generic	2.300
	STD_RFL1	Velux 45deg window	Generic	1.700
	*	.3.		
	ID	Possible replacement construction types	Standard	U-value
	STD_RFLT	2013 Rooflight	Generic	2.300
	STD_RFL1	Velux 45deg window	Generic	1.700
	EXTW	External Window	Generic	6.176
	STD_RFL2	Velux 45deg window_no frame	Generic	1.100

Figure 8, RadianceIES Assign constructions window

12 . .

 \sim

C Within the Glazed construction APcdb window (figure 9), there are two ways to define the glass properties for the Radiance calculations.

The first option is to insert the <u>Visible light normal trans-</u> <u>mittance</u> and then go to the <u>RadianceIES</u> tab and <u>Glazed</u> <u>Surface</u> sub-tab of the construction and tick the box Derive from <u>Visible light normal transmittance</u> (figure 9). IES will calculate the transmissivity of the glass automatically.

Alternatively this can be done by using the <u>Calculate</u> <u>transmissivity</u> button, which will prompt you to insert the transmittance (i.e. visible light transmittance). (Figure 10, on page 14).

By clicking OK, IES will calculate the transmissivity.

- d To define the frame reflectance go to the <u>Frame</u> sub-tab of the <u>RadianceIES</u> tab of the <u>glazed</u> construction (figure 11, on page 14) and set the <u>Red</u>, <u>Blue</u> and <u>Green re-</u><u>flectance</u> to get the desired <u>Reflectance</u> (generic value of 0.80 used in example). Click <u>OK</u> to save and exit the dialogue.
- 3 By visiting the <u>Assign constructions</u> window now you will see the VELUX construction you created under <u>Possible replacement construction types</u> (figure 8, on page 12).
- A Apply the VELUX APcdb construction to the appropriate windows or skylights by using the <u>Replace</u> button and <u>Close</u>
- 4 Define the rest of the materials' reflectance properties in the RadianceIES tab of each APcdb construction element (i.e. walls, floor, roof, ceiling, etc), as you normally would.

ormance: EN-ISO			scription: Velux 45deg window ID: STD_RFL1							11	External	Inter	
	rformance: EN-ISO V												
Net U-value (including	frame): 1.7002 \	N/m²·K	U-value (glas	s only):	1.1001 W	//m²·K			2c				
Net F	R-value: 0.9090 r	m²K/W	g-value (E	N 410):	0.6002	v	isible light norma	al transmittan	ce: 0.79				
rfaces Frame Shad	ing Device Regulation	s UK Dwellings	RadianceIES	1									
Material Properties:	Derive from Visible	e light normal tr	ansmittance (T	vis) 👔	3 a			Ca	lculate Trans	missivity	Pre-d	efined Mate	rials
Туре	Red Tr	ansmissivity			Green Tran	smissivity		Blue Transmissivity				Colour	
Glass \vee	(.8607			0.86	607			0.8607		clear		
	· · · · · · · · · · · · · · · · · · ·												terials
Material	Thickness	Conductivity W/(m·K)	Angular Dependence	Gas	Convection Coefficient W/m ² ·K	Resistance m²K/W	Transmittance	Outside Reflectance	Inside Reflectance	Refractive Index	Outside Emissivity	Inside Emissivity	Visib Ligh Specif
Material	e 4.0	Conductivity W/(m·K) 1.0600	Angular Dependence Fresnel	Gas -	Convection Coefficient W/m²·K	Resistance m ² K/W 0.0038	Transmittance	Outside Reflectance 0.270	Inside Reflectance 0.280	Refractive Index 1.526	Outside Emissivity 0.837	Inside Emissivity 0.209	Visib Ligh Specif Yes
Material STD_RF01] Outer Pan avity	e 4.0 16.0	Conductivity W/(m·K) 1.0600	Angular Dependence Fresnel	Gas - -	Convection Coefficient W/m²·K	Resistance m ² K/W 0.0038 0.7615	Transmittance 0.640 -	Outside Reflectance 0.270 -	Inside Reflectance 0.280	Refractive Index 1.526	Outside Emissivity 0.837	Inside Emissivity 0.209	Visibl Ligh Specif Yes

Figure 9, APcdb glazed construction window RadianceIES tab – Glazed surface sub-tab

Figure 10, APcdb glazed construction window RadianceIES transmissivity calculation dialogue

Project Construction (Glazed: Roof Light) —								\Box \times						
Description:	Velux 45deg w	ndow								п	: STD_RF	11	External	Internal
Verformance: EN-ISO V														
Net U-value (including frame): 1.7002 W/m ² ·K U-value (glass only): 1.1001 W/m ² ·K														
Net R-value: 0.9090 m ² K/W g-value (EN 410): 0.6002 Visible light normal transmittance: 0.79														
Surfaces Fr	Surfaces Frame Shading Device Regulations UK Dwellings RadianceIES													
Material Properties: Derive from Visible light normal transmittance (Tvis)														
Ту	Type Red Transmissivity				Calculate Tran	smissivity		BI	ue Transmis	sivity		Colou	r	
Glass	~	0	.8607			Transmittance:	0.79			0.8607			clear	
Glazed Sur	Glazed Surface Frame Glazed Surface w/ Blind (sDA) Transmissivity: 0.8607													
Construction	1 Layers (Outside	to Inside):				2 с	Cancel			Sys	stem Materia	ils	Project Ma	terials
	Material	Thickness mm	Conductivity W/(m·K)	Angular Dependence	Gas	Coefficient W/m²·K	Resistance m²K/W	Transmittance	Outside Reflectance	Inside Reflectance	Refractive Index	Outside Emissivity	Inside Emissivity	Visible Light Specified
[STD_RF01] Outer Pane	4.0	1.0600	Fresnel	-	-	0.0038	0.640	0.270	0.280	1.526	0.837	0.209	Yes
Cavity		16.0	-	-	-	-	0.7615	-	-	-	-	-	-	-
[STD_RF11] Inner Pane	4.0	1.0600	Fresnel	-	-	0.0038	0.783	0.072	0.072	1.526	0.837	0.837	Yes
Copy Paste Insert Add Delete Flip Electrochromic More Data														
Condensation	n Analysis	Derived Parame	ters									1.1	ок	Cancel

Figure 11, APcdb glazed construction window RadianceIES tab - Frame sub-tab

Project Construction (Glazed: Roof Light)													
escription: Velux 45deg window ID: STD_RFL1 External Internal									Internal				
Performance: EN-ISO $$	Performance: EN-ISO V												
Net U-value (including frame): 1.7002 W/m²·K U-value (glass only): 1.1001 W/m²·K Net R-value: 0.9090 m²K/W g-value (EN 410): 0.6002 Visible light normal transmittance: 0.79													
Surfaces Frame Shading Device	Regulations	UK Dwellings	RadianceIES	20	4								
Material Properties:											Pre-d	efined Mate	erials
Type Red Re	eflectance	Green Ret	lectance	Blue Re	flectance	Reflect	ance	Specularity	y	Roughnes	s	Colou	r
Plastic V 0.4	3000	0.80	00	0.8	000	0.800	00	0.0000		0.0500			
Glazed Surface Frame Glazed S Construction Layers (Outside to Ins Material	Glazed Surface Frame Glazed Surface w/ Blind (sDA) Construction Layers (Outside to Inside): System Materials Project Materials Material Thickness Conductivity Angular Construction Resistance Total Configuration Gazef Surface Total Configuration								terials Visible Light				
			bependence		W/m²·K				Reneedance	Index	Liniositicy	2111001110	Specified
[STD_RF01] Outer Pane	4.0	1.0600	Fresnel	-	-	0.0038	0.640	0.270	0.280	1.526	0.837	0.209	Yes
[STD_RE11] Inner Pane	4.0	-	- Fresnel	-	-	0.0038	0.783	0.072	0.072	1.526	0.837	0.837	Yes
[S1D_RF-11] Inner Pane 4.0 1.0600 Presnel - - 0.0038 0.783 0.072 0.072 1.526 0.837 Ves Image: Copy Paste Insert Add Delete Flip Electrochromic Electrochromic More Data Condensation Analysis Derived Parameters OK Cancel													

Alternative route to edit the Radiance properties

You can also edit the Radiance properties of the model constructions using the <u>Surface Properties</u> tab on the bottom menu of Radiance (figure 12).

By scrolling down in the <u>Material surface properties</u> you will find all the surface types available in the model and you can double-click on any of them to amend their properties. You can then use the <u>Assign</u> button on the left hand-side to apply them in the model. Please note that you cannot create new surfaces through this utility.



Figure 12, RadianceIES Surface Properties tab

Daylight calculations using RadianceIES

5 In the RadianceIES menu go to <u>Simulation Options</u> and set up the <u>Working Plane, Maintenance Factor, Area of</u> <u>Interest, Ground Reflectance, Sky Resolution and Window Frames</u> under each respective tab (figure 13).

It is noted that the frame width will form part of the total window area drawn in the ModelIT geometry, i.e. the window area drawn must account for the frame.

6 According to the type of analysis the user wishes to simulate, the rest of the RadianceIES modelling inputs need to be defined as appropriate. In this example an illuminance simulation is described.

Once the Sky/Eye tab settings are set, Illuminance is selected under the Simulate tab. Choose the type of output you want to extract (e.g. working plane image). You can choose the simulation quality from the relevant drop down options.

When selecting Custom you will be prompted to customise the simulation settings. The simulation is commenced by clicking on the Simulate button.

For further details on the RadianceIES modelling inputs please visit the Radiance section of the IES help page and refer to the Notes & Design Tips for Upgrading pre-VE 2019 models, if relevant. Figure 13, Setting up Simulation Options for daylight calculations

Simulatio	n Options						×
Wo	rking Plane	Mainte	enance Factor			AOI S	nrinkage
Gro	und Reflectance	W	indow Frames	5		Sky Re	esolution
	🗹 Automati	cally Create	e Window F	rame	s		
							_
	Create Window	Frames using	g the given wid	dth.			
	Fram	e Width (m)	0.090				
						ОК	Акиро

Appendix A - VELUX product information

VELUX Roof Windows V22 (for all manual/ integra pivot and tophung)

Frame percentage	e VELUX roof wind	ows V22 (GGL,GGI	J, GPL,GPU etc.		
Size	External frame width	External frame height	Frame percent- age		
	[mm]	[mm]	[%]		
BK04	472	978	50		
СК01	550	698	51		
СК02	550	778	49		
СК04	550	978	46		
СК06	550	1178	44		
FK04	660	978	42		
FK06	660	1178	39		
FK08	660	1398	37		
MK27	780	624	47		
МК04	780	978	47		
МК06	780	1178	36		
MK08	780	1398	34		
МК10	780	1600	32		
MK12	780	1800	31		
РК25	942	550	48		
РК04	942	978	35		
РК06	942	1178	32		
РК08	942	1398	30		
РК10	942	1600	29		
SK06	1140	1178	30		
SK08	1140	1398	27		
SK10	1140	1600	26		
UK04	1140	978	31		
UK08	1140	1398	25		
UK10	1140	1600	24		

Free exit height, VELUX Roof Window								
Size	Window height	Free exit height	Max angle open					
	[mm]	[mm]	[degree]					
K02	778	38	7					
К04	978	198	28					
K06	1178	195	22					
K08	1398	194	18					
K10	1600	194	15					

Appendix B - VELUX product information

VELUX Roof Windows V21 (for all manual/ integra pivot and tophung)

Frame percentage VELUX roof windows V22 (GGL,GGU, GPL,GPU etc.								
Size	External frame width	External frame height	Frame percent- age					
	[mm]	[mm]	[%]					
C02	550	778	54					
C04	550	978	49					
C06	550	1178	46					
F04	660	978	45					
F06	660	1178	42					
F08	660	1398	40					
M04	780	978	42					
M06	780	1178	39					
M08	780	1398	36					
M10	780	1600	35					
P04	942	978	39					
P06	942	1178	36					
P08	942	1398	33					
P10	942	1600	31					
S06	1140	1178	33					
S08	1140	1398	31					
S10	1140	1600	29					
U04	1140	978	35					
U08	1140	1398	29					

Appendix C - VELUX product information

VELUX Flat Roof, CFP ISD

Frame percentage VELUX roof windows V22 (GGL,GGU, GPL,GPU etc.							
Size	External frame width	External frame height	Frame percent- age				
	[mm]	[mm]	[%]				
60060	790	790	70				
60090	790	1090	63				
80080	990	990	59				
90090	1090	1090	55				
90120	1090	1390	50				
100100	1190	1190	51				
100150	1190	1690	45				
120120	1390	1390	45				
150150	1690	1690	38				

Bringing light to life

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