

GGF Datasheet: Guide to the Calculation of Energy Ratings for Windows, Roof Windows & Doors

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Introduction

The energy rating of a window, roof window or doorset is an energy balance for the fenestration component in question. It takes into account both thermal losses and solar gains, and as such gives a more comprehensive measure of a fenestration product's energy performance than simply looking at U-value in isolation. Energy Ratings are only applicable to dwellings, or buildings that are substantially domestic in nature.

The rating figure determined by this method is the amount of energy that the fenestration product will lose (or gain) over the course of a 12-month period. Factors such as climatic variation, orientation and geographic location have all been assessed and averaged for the whole UK.

Energy rating is a means of comparing the energy performance of like products on a fair and equitable basis. It is not an indication of how a given product will perform in a single installation.

Performing an energy rating calculation will result in a product

being categorised into an energy-rating band (A ++ to G).

2. Scope

This GGF Datasheet provides an overview of the criteria by which various fenestration products are energy rated.

It should be noted that this document is intended for guidance purposes only. Ratings will only be acceptable for compliance with Building Regulations provided that they have been ratified and issued by a ratings organisation that operates a third-party quality management and inspection system.

Organisations such as the British Fenestration Rating Council will be able to provide further details if required.

This data sheet illustrates the methodology of energy rating for windows, roof windows (not applicable for rooflights), pedestrian access doorsets and patio, French and sliding / folding (bifold) doorsets.

2. Definitions and Applicable Standards

For the purpose of this GGF Data Sheet, the following definitions apply: -

Symbol	Definition	Unit
g_{glass}	The normal solar energy transmittance of the glazing unit as determined by BS EN 410.	-
g_{window}	$g_{\text{window}} = g_{\text{glass}} \times 0.9 \times \text{glass factor}$	-
glass factor	See individual guidance notes for details.	-
U	Thermal transmittance of the product	W/(m ² .K)
L ₅₀	Air leakage at 50 Pa	m ³ /(h.m ²)
Effective L ₅₀	L ₅₀ × 0.0165	W/(m ² .K)
Door	Entire doorset (leaf and frame)	-

Explanatory note: The value of 0.9 in the g_{window} calculation is an adjustment for solar transmittance from that at normal incidence to that at the average for all angles of incidence.

The value of 0.0165 within the Effective L₅₀ calculation, is



the factor to convert the air leakage rate to an equivalent heat loss taking into account the specific heat capacity of air at the appropriate temperature and pressure.

The standards referred to throughout this document are listed in Section 4 – Normative References.

3. Guidance Notes

3.1 Calculation of Window Energy Ratings

The Window Energy Rating (WER) is given by the following equation:

$$WER = A \times g_{\text{window}} - B \times (U_{\text{window}} + \text{Effective } L_{50})$$

Where, for UK climatic conditions, the following constants are defined:

- $A = 218.6$
- $B = 68.5$

In addition the following terms are defined as:

- $g_{\text{window}} = g_{\text{glass}} \times 0.9 \times \text{glass factor}$
- g_{glass} is the normal solar energy transmittance of the glazing unit as determined by BS EN 410.
- Glass factor is the fraction of the window that is transparent i.e. not frame or gasket.

NOTE: In the case of vertical sliding sash windows, the glass factor is calculated assuming that all but 35 mm of the fixed outer frame is fitted behind the window reveal (for the head and jamb sections only.) See Appendix A for detail.

- U_{window} is the window U-value for the standard size and configuration window as calculated according to EN ISO 10077 Parts 1+2. The size and configurations of the standard windows used for rating are shown in Figure A & B. The overall sizes of these standard windows are consistent with GGF Data Sheet 2.2.
- Alternatively, if hotbox test results according to BS EN ISO 12567-1 are available for the standard windows shown in Figure A & B, these results may be used for U_{window} in place of calculated results.

NOTE: For the purposes of determining WERs, the effects of Georgian bars and / or leaded lights are ignored.

- $\text{Effective } L_{50} = L_{50} \times 0.0165$
- L_{50} is the air leakage through the window in $\text{m}^3/(\text{h} \cdot \text{m}^2)$ at 50 Pa pressure difference based on testing to BS EN 1026 or BS 6375-1.

NOTE: L_{50} is the total air leakage for the standard window configuration divided by the window area. In cases where the positive and negative pressure test yields differing values, the average of the modulus of the two results shall be used.

The following rating bands define the window energy-rating label: -

Banding	Index Value		Index Value
A++	$\geq +20$	to	
A+	$< +20$	to	$\geq +10$
A	0	to	$< +10$
B	-10	to	< 0
C	-20	to	< -10
D	-30	to	< -20
E	-50	to	< -30

Energy Index = kWh / ($\text{m}^2 \cdot \text{yr}$)

Table 1: Window Energy Ratings (WER)

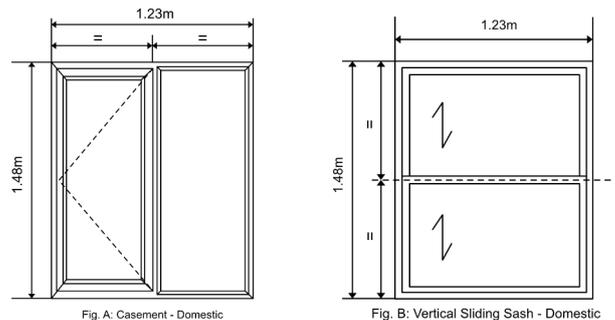


Fig. A & Fig. B: Standard window configurations and sizes for window energy rating calculations.

3.2 Calculation of Roof Window Energy Ratings

A roof window (as distinct from a rooflight) is a window which: -

- comprises an individual window-style frame glazed with a single insulating glass unit characteristic of windows installed in walls with regard to function, cleaning, maintenance and durability.
- is installed in the same orientation and in-plane with the surrounding roof at a minimum of 15 degrees pitch, weathered into the roof with an individual skirt or flashing.

Please note that energy rating index only applies to roof windows. Roof lights are not catered for.

The Roof Window Energy Rating (RWER) is given by the following equation: -

$$RWER = A \times g_{\text{window}} - B \times (U_{\text{window}} + \text{Effective } L_{50})$$

Where, for UK climatic conditions, the following constants are defined: -

- A = 218.6
- B = 68.5

In addition the following terms are defined as: -

- $g_{\text{window}} = g_{\text{glass}} \times 0.9 \times \text{glass factor}$
- g_{glass} is the normal solar energy transmittance of the glazing unit as determined by BS EN 410.
- glass factor is the fraction of the window that is transparent i.e. not frame or gasket.
- U_{window} is the window U-value for the standard size and configuration window as calculated according to EN ISO 10077 Parts 1+2.

The size and configuration of the standard window used for rating is shown in Figure C. The overall size of the standard roof window is consistent with GGF Datasheet 2.2.

Alternatively, if hotbox test results according to BS EN ISO 12567-1 are available for the standard windows shown in Figure C, these results may be used for U_{window} in place of calculated results.

NOTE: For the purposes of determining RWERs, the effects of Georgian bars and/or leaded lights are ignored.

$$\text{Effective } L_{50} = L_{50} \times 0.0165$$

L_{50} is the air leakage through the window in $\text{m}^3/(\text{h} \cdot \text{m}^2)$ at 50 Pa pressure difference based on testing to BS EN 1026 or BS 6375-1.

NOTE: L_{50} is the total air leakage for the standard window configuration divided by the window area. In cases where the positive and negative pressure test yields differing values the average of the modulus of the two results shall be used.

The following rating bands define the window energy-rating label: -

Banding	Index Value	RWER	Index Value
A		RWER	≥ 0
B	0 >	RWER	≥ -10
C	-10 >	RWER	≥ -20
D	-20 >	RWER	≥ -30
E	-30 >	RWER	≥ -50
F	-50 >	RWER	≥ -70
G	-70 >	RWER	

Energy Index = kWh / ($\text{m}^2 \cdot \text{yr}$)

Table 2: Roof Window Energy Rating (RWER)

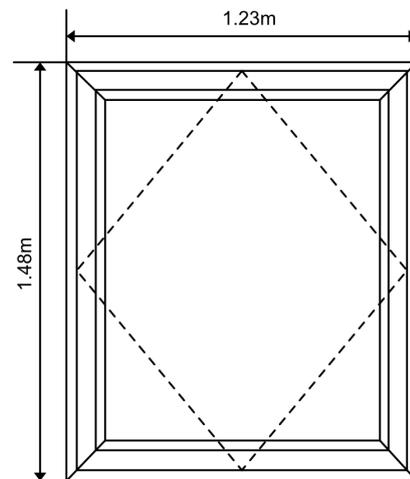


Fig. C: Standard configuration and size for roof window energy rating calculations.

NOTE

- 1) For the purposes of obtaining a RWER, the U_{window} and g_{window} are calculated with the window in the vertical plane. (For U-values of roof windows in service, refer to GGF Datasheet 2.2 for adjustment values).
- 2) Any configuration of hinge arrangement or a fixed light may be used for RWER purposes providing the air leakage test results are relevant.

3.3 Calculation of Doorset Energy Ratings – External Pedestrian Doors

The Doorset Energy Rating (DSER) is given by the following equation:

$$DSER = -B \times (U_{\text{door}} + \text{Effective } L_{50})$$

Where, for UK climatic conditions, the following constants are defined:

- B = 68.5

DSER for external pedestrian access doors are calculated based upon a door set size (including frame) of 1230 mm x 2180 mm, as referenced within BS EN 14351-1.

In addition the following terms are defined as: -

- U_{door} is the door U-value for the standard size and configuration doorset as calculated according to BS EN ISO 10077 Parts 1+2.

The size and configurations of the standard doors used for rating are shown in Figure 3.

Alternatively, if hotbox test results according to BS EN ISO 12567-1 are available for the standard doors shown in Figure 3, these results may be used for U_{door} in place of calculated results

NOTE: For the purposes of determining DSERs, the effects of Georgian bars and/or leaded lights are ignored.

- Effective $L_{50} = L_{50} \times 0.0165$
- L_{50} is the air leakage through the door in $m^3/(h.m^2)$ at 50 Pa pressure difference based on testing to BS EN 1026 or BS 6375-1.

NOTE: L_{50} is the total air leakage for the standard door configuration divided by the door area. In cases where the positive and negative pressure test yields differing values, the average of the modulus of the two results shall be used.

The following rating bands define the doorset energy-rating label: -

Banding	Index Value		Index Value
A++	≥ -70	to	
A+	-80	to	< -70
A	-90	to	< -80
B	-100	to	< -90
C	-110	to	< -100
D	-120	to	< -110
E	-130	to	< -120

Energy Index = $kWh / (m^2 \cdot yr)$

Table 3: Doorset Energy Rating (DSER - External Pedestrian Door)

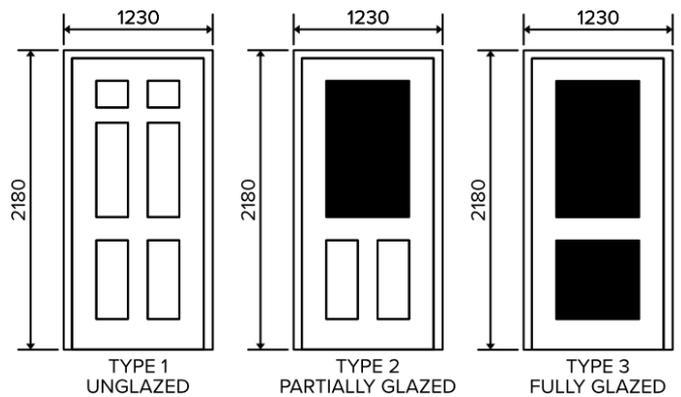


Figure 3: Categories of rated door types

These three door types cater for all material types, namely PVC-U, aluminium, timber, steel, and also for composite type doors.

The many different styles of doors actually offered in the marketplace are rated according to the above three types dependent on their glazed areas as follows: -

Glazed area $\leq 10\%$ - door set rated as type 1 - unglazed.

Glazed area $> 10\%$ but $\leq 30\%$ - door set rated as type 2 - Partially glazed.

Glazed area $> 30\%$ - door set rated as type 3 - Fully glazed.

Practically this means that **any** configuration of door with a glazed area of $\leq 10\%$ is rated as a type 1 door, **any** configuration of door with a glazed area between 10% and 30% is rated as a type 2 door, and **any** configuration of door with a glazed area of $> 30\%$ is rated as a type 3 door.

NOTES:

- The DSER applies to the door leaf and frame combination. It cannot be applied to a door leaf in isolation.
- The glazed area is expressed as a percentage of the door set (i.e. door leaf and frame combined).
- DSER does not take account of solar gain for external pedestrian doors (irrespective of % glazed area). The vast majority of this type of door have a glazed area of less than 60%, SAP 2012 does not take account of solar gain if the glazed area is less than 60% - refer to Table 6.1 and SAP 2012 for details).

3.4 Calculation of Doorset Energy Ratings – Patio, French and Sliding / Folding Doors

The Doorset Energy Rating (DSER) is given by the following equation: -

$$DSER = A \times g_{door} - B \times (U_{door} + \text{Effective } L_{50})$$

Where, for UK climatic conditions, the following constants are defined: -

- $A = 218.6$
- $B = 68.5$

NOTE: This equation is not applicable to external pedestrian doors, Section 4.3 applies. DSER for Patio and French doors are calculated using a two leaf configuration at a size of 2000 mm x 2180 mm – as per BS EN 14351-1.

Sliding / folding doors are calculated on a three leaf configuration (one hinged and two sliding) at size of 2500 mm x 2180 mm – this variation in configuration is to reflect the most commonly installed configuration for this type of door. The increase in size (whilst remaining within the upper tolerance of the size stated within BS EN 14351-1) ensures that this type of window is not penalised for its increased frame fraction when comparing with patio and French doors.

In addition the following terms are defined as:

- $g_{door} = g_{glass} \times 0.9 \times \text{glass factor}$.
- g_{glass} is the normal solar energy transmittance of the glazing unit as determined by BS EN 410.
- glass factor is the fraction of the door that is transparent i.e. not frame or gasket.

NOTE: When calculating the glass factor for sliding / folding doors, account should be taken of the fact that the sill is often rebated. If this is the case, the part of the frame below floor level is discounted for the purposes of determining glass factor. See Figure 4 for details.

- U_{door} is the door U-value for the standard size and configuration door as calculated according to BS EN ISO 10077 Parts 1+2. The size and configurations of the standard doors used for rating are shown in Figure 5.
- Alternatively, if hotbox test results according to BS EN ISO 12567-1 are available for the standard doors shown in Figure 5 these results may be used for U_{door} in place of calculated results

NOTE: For the purposes of determining DSERs, the effects of Georgian bars and / or leaded lights are ignored.)

- $\text{Effective } L_{50} = L_{50} \times 0.0165$
- L_{50} is the air leakage through the door in $\text{m}^3/(\text{h} \cdot \text{m}^2)$ at 50 Pa pressure difference based on testing to BS EN 1026

or BS 6375-1.

NOTE: L_{50} is the total air leakage for the standard door configuration divided by the door area. In cases where the positive and negative pressure test yields differing values, the average of the modulus of the two results shall be used.)

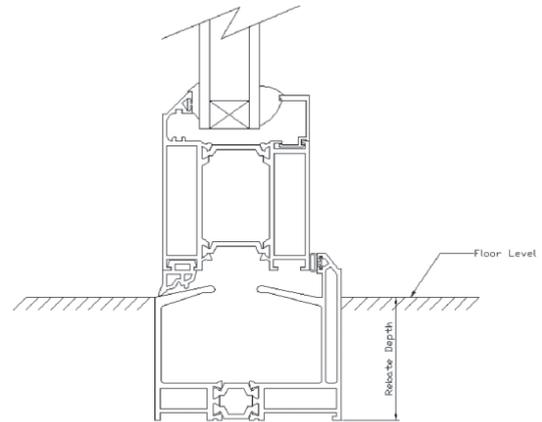


Figure 4: Sliding / folding door rebate detail

The following rating bands define the doorset energy-rating label:

Banding	Index Value	DSER	Index Value
A		DSER	≥ 0
B	$0 >$	DSER	≥ -10
C	$-10 >$	DSER	≥ -20
D	$-20 >$	DSER	≥ -30
E	$-30 >$	DSER	≥ -50
F	$-50 >$	DSER	≥ -70
G	$-70 >$	DSER	

Energy Index = $\text{kWh}/(\text{m}^2 \cdot \text{yr})$

Table 4: Doorset Energy Rating (DSER - French, Folding & Sliding)

NOTES:

Sliding patio doors are always rated with one 1 leaf fixed and one leaf sliding.

French doors are always rated without a mid-rail regardless of installed configuration.

The rating for a two-leaf French door cannot be used to cover a single leaf door installed as a pedestrian access door, irrespective of glass factor.

Sliding / folding doors are always rated in a 3 leaf configuration, with 2 leaves folding and one leaf single opening.

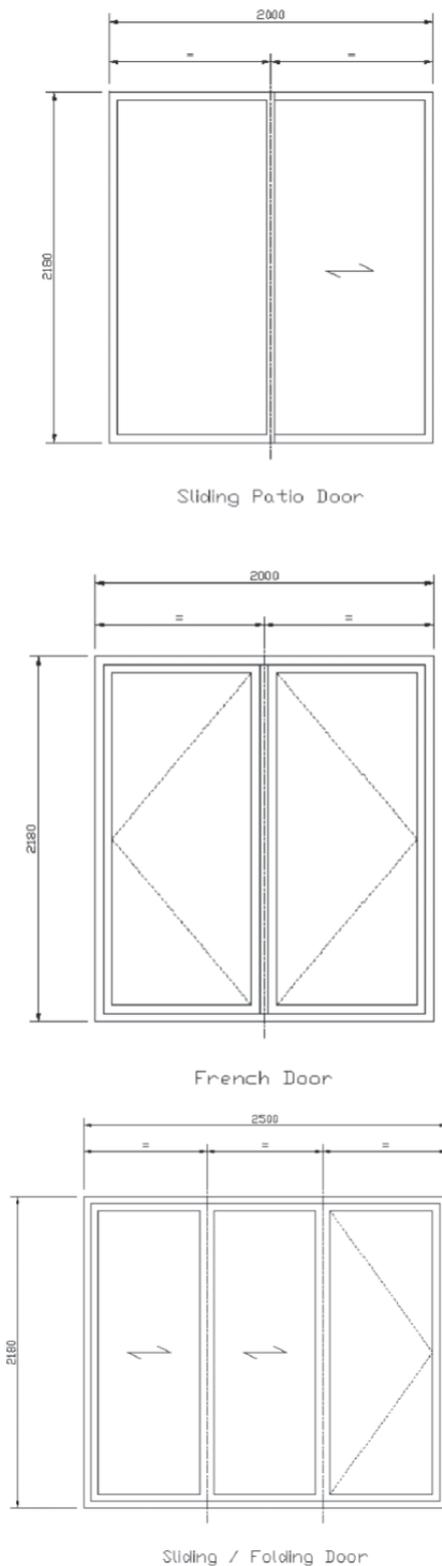


Figure 5: Standard door configurations and sizes for Doorset Energy Rating Calculations

Bibliography

GGF Datasheet 2.2 *Window & Door system U-Values: Provision of Certified Data (June 2020)*

BR443 *Conventions for U-value calculations, 2006 edition*

The Government's Standard Assessment Procedure for Energy Rating of Dwellings (SAP 2012)

BS EN ISO 10077-1:2017 *Thermal Performance of Windows, Doors and Shutters. Calculation of Thermal Transmittance. General*

BS EN ISO 10077-2:2017 *Thermal Performance of Windows, Doors and Shutters. Calculation of Thermal Transmittance. Numerical Method for Frames*

BS EN ISO 12567-1:2010 *Thermal Performance of Windows and Doors. Determination of Thermal Transmittance by Hot-Box Method. Complete Windows and Doors.*

BS EN 673:2011 *Glass in Buildings. Determination of Thermal Transmittance (U-value). Calculation Method*

BS EN 410:2011 *Glass in Building. Determination of Luminous and Solar Characteristics of Glazing*

BS EN 1026:2000 *Windows and Doors. Air Permeability. Test Method*

BS EN 6375-1:2009 *Performance of Windows and Doors. Classification for Weather Tightness and Guidance on Selection and Specification. Doorset Energy Rating calculations*

Appendix A

Calculation of glass factor for Vertical Sliding Sash Windows

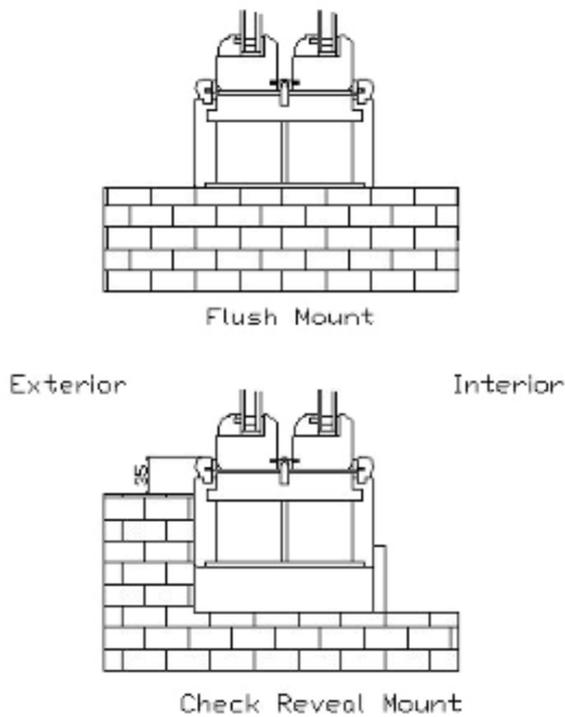


Figure 1: Flush mount and check reveal mount

When simulating VSS type windows, thermal simulations should be carried out with the frame flush mounted as shown in Figure 1 above. BS EN ISO 10077-2:2012 section 4.3 note 1 states, 'the interaction of the frame and the building structure is considered separately for the building as a whole. It is not part of the thermal transmittance of the frame section'. Therefore calculations of U-window must be undertaken with the window shown in the flush mounted position above.

However, when calculating the glass factor, the head and both jambs shall be assumed to be mounted behind a check reveal such that all but 35mm of the fixed outer frame is hidden behind the reveal, as this is representative of the typical installation method for this type of window. This effectively results in an increase in window size to leave just 35mm of fixed outer frame visible in the 1230mm x 1480 aperture when calculating g_{window} . See figure 2.

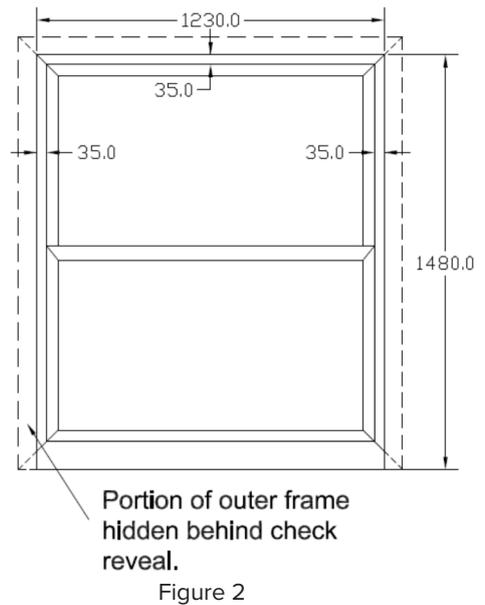


Figure 2