



**Windows as Renewable Energy Sources for Europe
Window Energy Data Network**

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www.windat.org

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WIS version 2.0.1 User Guide *Examples of windows as input for WIS¹*

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This document was produced within WinDat, with active contribution by the members of this European Thematic Network. See www.windat.org for more information.

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1. Introduction to WIS and WinDat

1.1 On WIS and WinDat

WIS is a European software tool for the calculation of the thermal and solar properties of commercial and innovative window systems on the basis of known component properties and thermal and solar/optical interactions between the components.

One of the unique elements in the software tool is the combination of glazings and shading devices, with the option of free or forced air circulation between the components. This makes the tool particularly suited to calculate the thermal and solar performance of complex windows and active facades.

WIS has built in algorithms based on international (CEN, ISO) standards, for internationally uniform product comparison, but WIS also contains advanced calculation routines for those components or conditions where no standards are available yet or current standards do not apply. In this way WIS hopes to contribute to the further international standardisation and harmonisation of product information.

The first version of the tool was available as the end product of a previous EU R&D Energy Programme: EU R&D project ‘Advanced Windows Information System (WIS)’, (1994-1996, coordination: TNO).

Since 1996 this version was in use and highly appreciated by many users from different professions. But it lacked mass penetration, mainly due to a fee being asked per license (to cover distribution and support costs) and a poorly populated database containing only a limited number of examples of products.

The kind of component data needed are for instance spectral data sets of the optical properties of the available commercial glazings in Europe, optical properties of shading devices (venetian blinds, roller blinds, ..) and scattering glazings, thermal properties of edge spacers (for sealed double glazings) and thermal properties of window frame profiles on the market.

To overcome these limitations TNO initiated in 2001 a European Thematic Network WinDat.

WinDat (“Windows as Renewable Energy Sources for Europe - Window Energy Data Network”, 2001-2004) is supported by DG for Energy and Transport of the European Commission.

The Networks membership comprises about 40 leading research and educational organisations, industries, consulting engineers and designers, including a strong representation in relevant international standardisation groups. Together, they represent all interested parties in Europe from research through development to manufacture and distribution (see also <http://www.windat.org>).

The main activities of the WINDAT Network are:

- support and guidance of the further development of WIS
- set up of WIS distribution without charge (e.g. via web site)
- validation the programmes algorithms
- set formats for the standardised input of component data
- organise population of the component databases with the data from commercial products and data from research
- set up of benchmark tests (also available for similar tools)
- create links to building simulation tools (ESP, Radiance, etc.)
- preparation of training courses and sets of examples
- set up of a user forum

One of the early achievements, summer 2002, was the agreement with all major flat glass producers in Europe, on a European procedure and format for the collation of optical properties of non-scattering glazings. This European database is compatible with a similar existing database in USA. Under this agreement series of data sets of commercially available glazings are currently being submitted as a first step towards populating the WIS database with comprehensive sets of certified component data. Simultaneously, similar formats are being developed for optical data from scattering glazings, plastics and solar shading products and thermal properties of frame profiles.

It is the wish of the WinDat consortium that WIS will be collectively supported and used in research, industry, standardisation, education and design throughout Europe to compare, select and promote innovative windows and window components for the optimum use of renewable energy (solar gains and daylight), highest energy savings (thermal insulation) and the best indoor comfort (solar shading, daylight quality).

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Web site: <http://www.windat.org>

1.2 On WinDat Work Package 4

WinDat WP 4 concerns "Training and Education".

The typical user of WIS can be divided in two main groups:

- Data provider: Manufacturers (window, frame, glazing, spacer, shading)
- Data user: Building designer (architect, engineer)

For each group a training concept has to be elaborated.

Part of the training concept is to create sets of examples.

This set of examples aims at the building designer (architect, engineer) who needs to know the main thermal and solar properties of a window consisting of combinations of glazing, shading device and/or frame.

1.3 About this document

This document succeeds the document called “*Examples of Windows as Input for WIS*”, the first public draft version, prepared for WIS2.0b, August 2003.

The changes in the underlying document compared to the previous document are marginal. The title has been changed to emphasize that the document guides the user with an explanation of each step to input/import component data and perform a calculation.

2. Selected components

2.1 Introduction

The following components as basis to construct a double glazing and window system have been selected:

Glass:

- Clear float glass
- Low emittance glazing
- Solar control glazing

Gasmix for glazing cavities:

- Air
- Argon

Shading:

- Venetian blind
- Shading fabric

Edge and frame:

- Metal edge
- Aluminium frame

The description of and reasons for selecting specific components, specific points of attention and outstanding actions are presented in the annex.

3. Instructions for WIS user (1): data sets

3.1 Introduction

This chapter plus next chapter, with instructions for the user, will be copied to a separate document (and/or on the web site) for the WIS user.

Introduction to the user:

WinDat Subgroup 4.4 deals with the creation of examples of windows: to prepare data sets of windows with the possible features of WIS (glazing, frame, blinds, vented cavities).

These examples are first result of their activities: first examples for WP4.4, for the target group of WIS data user: Building designer (architect, engineer).

The described data already in WIS database?

In the WIS version you have, the same data as described here may or may not be already loaded.

If they are already loaded you can go to a new record and load them again, if you want to get experience with the process.

3.2 Disclaimer

IMPORTANT:

Until further notice, the data provided in this chapter are only meant as illustrative examples and should not be used as the real data for the specified products or similar products.

3.3 Glazing

Some preliminary remarks:

Spectral data file structure:

The structure of the data files for the spectral data of non-scattering glazings is in accordance with a standard format agreed within the EU Thematic Network WinDat (<http://www.windat.org>).

A collaboration has been established between WinDat and LBNL Berkeley (Cal., USA) to come to a common international format for spectral data of non-scattering glazings.

Within that context the database for LBNL's Optics5 and Window5 programs has already been renamed "International Glazing Database (IGDB) (<http://windows.lbl.gov/materials/IGDB/default.htm>)".

As a result of the collaboration, the required formats for USA and Europe are already almost identical and the intention is to remove the remaining discrepancies in the coming period.

Explanation of coating code:

(to be added to the Pane Form in next version)

The coating code is set as combination of two letters AU or UC or etc.

The letters A, B, C, D, S, X denote the coating class.

The position of the letters in the combination corresponds to the orientation of the pane in the pane database:

The first letter in the combination corresponds to the outdoor facing side of the pane

The second letter in the combination corresponds to the indoor facing side of the pane

When the pane is placed in a transparent system and this orientation is not what you want it to be, you should check the checkbox "flipped" next to the coating code.

The letter U denotes that the surface of the glass is uncoated.

The coating class is explained in the list below:

Class A: The coated surface of the glass can be positioned on the outer or inner face of the building.

Class B: The coated glass can be used as monolithic glazing but the coated surface shall be on the inner face of the building.

Class C: The coated glass shall be used only in sealed multiple glazing units and the coated surface should be facing into the unit cavity.

Class D: The coated glass shall be incorporated into sealed units, with the coated surface facing into the unit cavity, as soon as they are coated. They are not available as monolithic glass.

Class S: The coated surface of the glass can be positioned on the outer or the inner face of the building but these types of coated glasses can only be used in specifically defined applications e.g. shop fronts.

Class X: The coated surface of the glass is of an unspecified type.

These types are shown in the transparent system form to check whether the pane needs to be flipped.

Selected examples:

Three glazing types are presented as examples:

- clear float glass
- low-emittance glazing
- solar control glazing

Type : clear float glass

Manufacturer: Interpane

Selected product: Ip_klar4

Explanation:

4 mm clear float; several combinations of float glass with low-e and solar control glazings are on the market.

WIS input data:

Thickness: 4 mm

Thermal conductivity: 1 W/(mK)

Emissivity: #1: 0.837; #2: 0.837

Spectral data files obtained from Interpane, adapted to EN 673 *).

Coating code: CU

File name: **ip_klar4.spc**

Incidence angle: 'near normal'

```
{ Units, Wavelength Units } SI nanometers
{ Thickness } 4 [in mm]
{ Conductivity } 1.0 [in W/(mK)]
{ IR Transmittance } TIR=0
{ Emissivity, front back } Emis= 0.84 0.84 [ft~#1, bk~#2]
}
{ Product Name: Float 4 mm}
{ Manufacturer: INTERPANE GLAS INDUSTRIE AG }
{ NFRC ID: 7194 }
{ Type: Monolithic }
{ Material: Glass }
{ Coating Name: N/A }
{ Coated Side: Neither }
{ Substrate Filename: N/A }
{ Film Filename: N/A }
{ Appearance: Clear }
{ Structure: }
{ Uses: }
{ Availability: }
280 0.0000 0.0000 0.0000 [wavel., transm., rfl#1, rfl#2]
290 0.0005 0.0280 0.0280 [etc.]
300 0.0040 0.0500 0.0500
310 0.0665 0.0480 0.0480
320 0.2645 0.0510 0.0510
330 0.5185 0.0605 0.0605
etc.
2470 0.8295 0.0908 0.0908
2480 0.8290 0.0909 0.0909
2490 0.8285 0.0909 0.0909
2500 0.8280 0.0910 0.0910
```

*) : emissivity: so called 'corrected emissivity' according to EN673, which is slightly different from the hemispherical emissivity (US: 'emittance') used for NFRC.

To be more precise: the emissivity for clear uncoated glazing according to EN673 is 0.837.

Type : low-emittance glazing

Manufacturer: Interpane

Selected product: Ip iplus neutral s

Explanation:

Example of state-of-the-art low-e glazing.

Combination: ipflo4 | 16 mm Argon | ip iplus neutral S (low-e coating on surface 3) is on the market as part of the product family: 'Interpane iplus neutral S' (selection of glass thicknesses and gas-filled cavity widths available under same family name)

WIS input data:

Thickness: 4 mm

Thermal conductivity: 1 W/(mK)

Emissivity: #1: 0.048; #2: 0.837

Spectral data files obtained from Interpane, adapted to EN 673 *).

Coating code: CU

Incidence angle: 'near normal'

File name: **ip_ipls.spc**

```
{ Units, Wavelength Units } SI nanometers
{ Thickness } 4 [in mm]
{ Conductivity } 1.0 [in W/(mK)]
{ IR Transmittance } TIR=0
{ Emissivity, front back } Emis= 0.048 0.84 [ft~#1,bk~#2]
}
{ Product Name: iplus neutral S }
{ Manufacturer: INTERPANE GLAS INDUSTRIE AG }
{ NFRC ID: 7110 }
{ Type: Coated }
{ Material: N/A }
{ Coating Name: 08002_1 }
{ Coated Side: Front } [front ~ surface #1]
{ Substrate Filename: ip080022.SPC }
{ Film Filename: N/A }
{ Appearance: Clear }
{ Structure: }
{ Uses: }
{ Availability: }
280 0.0006 0.1548 0.0491 [wavel., transm., rfl#1, rfl#2]
290 0.0004 0.1535 0.0482 [etc.]
300 0.0003 0.1555 0.0475
etc.
2470 0.0482 0.8903 0.7027
2480 0.0597 0.8851 0.7005
2490 0.0501 0.8852 0.6965
2500 0.0487 0.8710 0.6879
```

*) : emissivity: so called 'corrected emissivity' according to EN673, which is slightly different from the hemispherical emissivity (US: 'emittance') used for NFRC.

To be more precise: the emissivity for clear uncoated glazing according to EN673 is 0.837.

Type : solar control glazing

Manufacturer: Interpane

Selected product: ip6834ne

Explanation::

Example of state-of-the-art solar control glazing.

The combination: ip6834ne | 16 mm Argon | ipflo4 (solar control coating on surface 2) is on the market under family name: Interpane ipasol neutral 68/34

WIS input data:

Thickness: 6 mm

Thermal conductivity: 1 W/(mK)

Emissivity: #1: 0.837 #2: 0.025

Spectral data files obtained from Interpane, adapted to EN 673 *).

Coating code: UC

Incidence angle: 'near normal'

File name: **ip6834ne.spc**

```
{ Units, Wavelength Units } SI nanometers
{ Thickness } 6
{ Conductivity } 1.0
{ IR Transmittance } TIR=0
{ Emissivity, front back } Emis= 0.84 0.025
{
{ Product Name: ipasol neutral 68/34 }
{ Manufacturer: INTERPANE GLAS INDUSTRIE AG }
{ NFRC ID: 7115 }
{ Type: Coated }
{ Material: N/A }
{ Coating Name: 27800_1 }
{ Coated Side: back } [back ~ surface #2]
{ Substrate Filename: ip278002.SPC }
{ Film Filename: N/A }
{ Appearance: Clear }
{ Structure: }
{ Uses: }
{ Availability: }
280 0.00004 0.048967 0.30064
285 0.00005 0.048622 0.30228
290 0.00004 0.048289 0.30517
etc.
2485 0.00244 0.71609 0.96229
2490 0.00279 0.71461 0.96263
2495 0.00265 0.7127 0.9626
2500 0.00223 0.71098 0.96226
```

*) : emissivity: so called 'corrected emissivity' according to EN673, which is slightly different from the hemispherical emissivity (US: 'emittance') used for NFRC.

To be more precise: the emissivity for clear uncoated glazing according to EN673 is 0.837.

3.4 Gas mix in multiple glazing cavity

Type : air

Manufacturer:

Generic value

Selected product:

Air, according to EN 673

Explanation:

EN 673 gives the specifications for air; is already in WIS

WIS input data:

Available as standard data in WIS

Type : argon

Manufacturer:

Generic value

Selected product:

90% argon, 10% air, according to EN 673

Explanation:

EN 673 gives the specifications for argon and air and how to mix the properties; is already in WIS; combines well with suggested glazings

WIS input data:

Standard Argon data already in WIS

3.5 Shading

Type : Venetian blinds

Manufacturer:

Hunter Douglas Europe B.V.

Selected product:

25 mm wide slats, colour numbers 0150 and/or 7010 (grey, close to RAL 9006)

Explanation:

These are widely applied, whether or not in combination with a perforation (porosity 8% or 4%). We start with the non-perforated types.

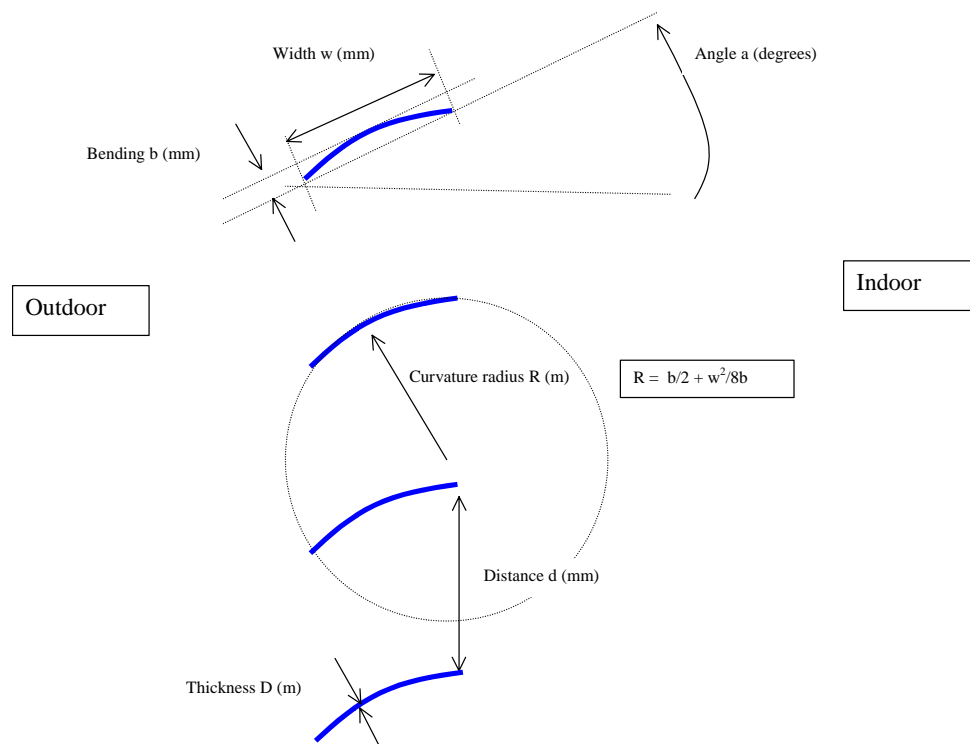
WIS input data:

Type HD 0150:

Type: horizontal lamella

Colour: white

Dimensions/definitions of slats



thickness D :	0.22 mm
width w :	50 mm
distance d :	42.5 mm
bending b :	4 mm per 50 mm

→curvature radius R 80 mm

slat angle: variable

Optical data:

Emissivity: 0.796

Spectral data file: measured at TNO

Incidence angle: 'near normal'

File name: **HD0150.spc**

```
Hunter Douglas  
venetian blind  
type: HD0150 (white)  
thickness:0.22 mm  
width: 50 mm  
distance: 42.5 mm  
curvature radius: 80 mm  
emissivity 0.796 0.796  
250, 0.0674, 0.0674 [wavelength, refl.#1, refl.#2]  
260, 0.0662, 0.0662  
270, 0.0655, 0.0655  
280, 0.0651, 0.0651  
290, 0.0643, 0.0643  
300, 0.0642, 0.0642  
310, 0.0636, 0.0636  
320, 0.0619, 0.0619  
330, 0.0599, 0.0599  
etc.  
...  
2410, 0.7017, 0.7017  
2420, 0.7070, 0.7070  
2430, 0.7085, 0.7085  
2440, 0.7183, 0.7183  
2450, 0.7098, 0.7098  
2460, 0.7094, 0.7094  
2470, 0.7155, 0.7155  
2480, 0.7195, 0.7195  
2490, 0.7183, 0.7183  
2500, 0.7201, 0.7201
```

Type: Shading fabric

Manufacturer:

Verosol Fabric B.V.

Selected products:

Flat fabric, neutral colour:

- type 816/000 (**grey, transparent**)
- type 812/000 (**grey, semi-transparent**).
- type 837/000 (**grey, opaque**).

Explanation:

Flat fabric, neutral colour is the predominant type used to characterise the optical properties.

Type 816/000 (transparent)

WIS input data:

Colour: grey; outdoor facing surface is aluminised
Type: metalised fabric for vertical blinds

Description: grey, transparent
Thickness: 0.23 mm
Thermal conductivity: 0.20 W/mK

Optical data:

Emissivity #1: 0.506
Emissivity #2: 0.802
IR transmittance = 0.079

Spectral data file: measured at TNO, including diffuse part of transmittance
(measured with cone half angle 6°)

Incidence angle: 'near normal'

File name: **VSL816.spc**

```
Verosol 816
source:          TNO July 2002
type:            metalised fabric for vertical blinds
description:     grey, transparent
thickness:       0.23 mm
th. conductivity: 0.20 W/mK
emissivity#1 =   0.506
emissivity#2 =   0.802
IR transmittance = 0.079
tr-spec: tr within cone half-angle 6 degrees
wl (nm) tr-total tr-spec   ref#1   ref#2
250  0.258961188 0.241525655 0.230961955 0.046572109
255  0.258995161 0.241086881 0.252609239 0.049180844
260  0.25960056  0.241138513 0.27899862  0.051058757
265  0.259962148 0.241408733 0.294425861 0.049579623
270  0.260974804 0.241418074 0.303013343 0.047118082
etc.
2475 0.280464653 0.207462596 0.43030568  0.254795277
2480 0.292357858 0.236518901 0.444150839 0.265302313
2485 0.294188689 0.235514326 0.454453701 0.279742769
2490 0.295278735 0.229266965 0.431334324 0.253186718
2495 0.300647017 0.243156053 0.451344578 0.279460783
2500 0.291262318 0.238318296 0.427436897 0.272179773
2505 0.287523855 0.221839304
2510 0.297495865 0.20200489
```

Type 812/000 (semi-transparent)

WIS input data:

Colour: grey; outdoor facing surface is aluminised
Type: metalised fabric for vertical blinds

Description: grey, semi-transparent
Thickness: 0.20 mm
Thermal conductivity: 0.20 W/mK

Optical data:
Emissivity #1: 0.351
Emissivity #2: 0.793
IR transmittance = 0.0

Spectral data file: measured at TNO, including diffuse part of transmittance
(measured with cone half angle 6°)

Incidence angle: 'near normal'

File name: **VSL812.spc**

```
Verosol 812
source:          TNO July 2002
type:            metalised fabric for vertical blinds
description:     grey, semi-transparent
thickness:       0.20 mm
th. conductivity: 0.20 W/mK
emissivity#1 =   0.351
emissivity#2 =   0.793
IR transmittance = 0.0
tr-spec: tr within cone half-angle 6 degrees
wl (nm) tr-total tr-spec   ref#1   ref#2
250    0.060112994 0.052342169 0.500017834 0.076696137
255    0.060525362 0.052263052 0.527519087 0.081924354
260    0.060701719 0.052199312 0.551046665 0.085571363
265    0.060860385 0.052301691 0.561167054 0.083442866
270    0.06103547  0.052124999 0.565489137 0.078234075
etc.
2460   0.095600748 0.056392331 0.682843436 0.309582541
2465   0.094358566 0.040211534 0.684196346 0.328005158
2470   0.085329296 0.045762093 0.682280247 0.340544925
2475   0.079837489 0.036960186 0.679204747 0.333336224
2480   0.090979644 0.040080072 0.686935994 0.338012892
2485   0.099651425 0.049280595 0.69521652  0.369308848
2490   0.096375612 0.040138769 0.698913643 0.353587088
2495   0.104423418 0.04080847  0.694368013 0.374401197
2500   0.086975768 0.054269213 0.686679407 0.363643597
2505   0.092080747 0.047269061
2510   0.102988449 0.056658951
```

3.6 Edge and frame

Type : aluminium spacer

Manufacturer:

Generic type

Selected product:

Aluminium edge according to EN 10077-1

Explanation:

Is default product value, according to EN 10077-1

WIS input data:

Already in WIS: table with PSI-values

Type : Aluminium frame

Manufacturer:

a) REYNAARS Aluminium N.V.

b) RC SYSTEM

Selected products:

a)

REYNAERS: CS68 aluminium profile system

Seven different sections, for different types of window parts

b)

RC System: one of four different types aluminium profile system: Confort 50, Avantis 55 (A55), Excellence 65 (Ex65) and Excellence 75 (ex75)

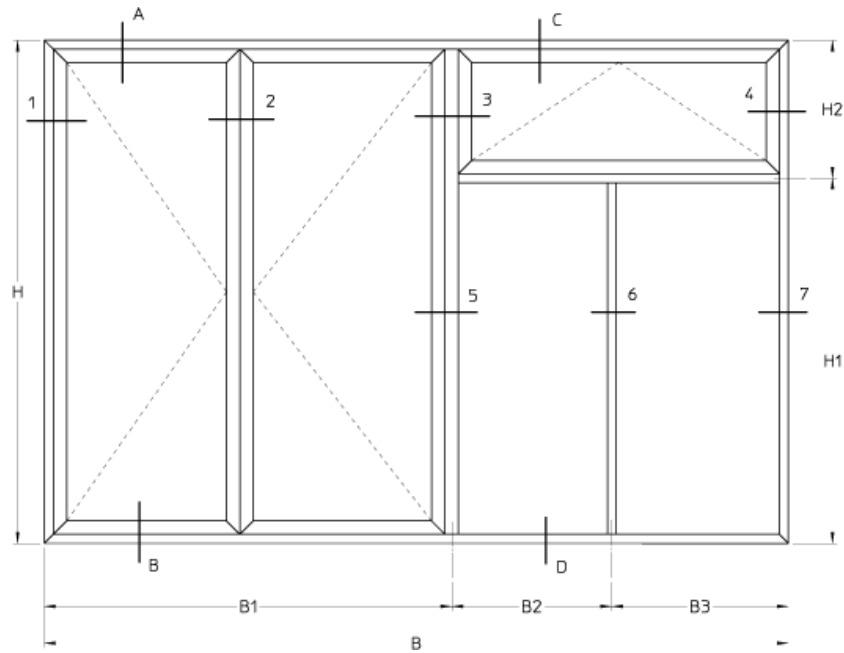
Each: seven different sections, for different types of window parts

Explanation:

Aluminium frames with thermal breaks

WIS input data:

Window configuration, with the different sections (1-7, A-D):



Each section requires a different subtype of frame.

For each system a detailed description is available

Per subtype, the following detailed data are also available for both systems:

- Cross sections
- Input/output of numerical calculations (Bisco/Kobru)
- Autocad files
- Calculated U-values
- Frame width

Example of detailed data:

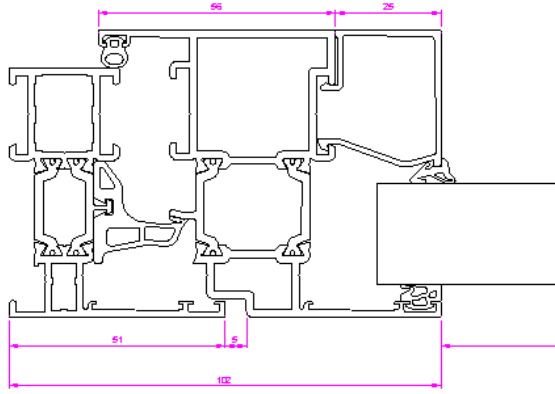
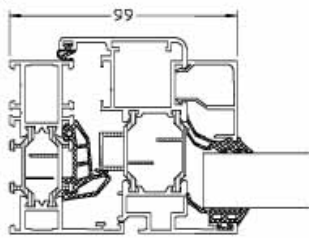
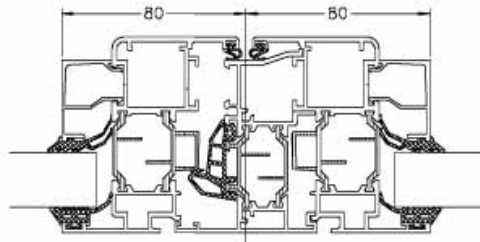


Fig.: Cross section Reynaers CS68-1

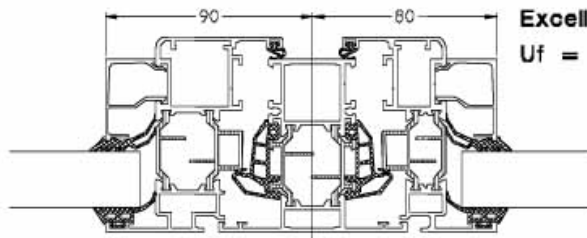
TECHNISCHE INFORMATIE File d:/db/rcs/kaaders/A4v



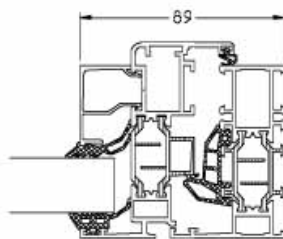
Excellence 75 - snede 1 :
Uf = 3.05 W/m2K



Excellence 75 - snede 2 :
Uf = 3.31 W/m2K



Excellence 75 - snede 3 :
Uf = 2.34 W/m2K



Excellence 75 - snede 4 :
Uf = 3.05 W/m2K



Tel.: 32-51-72 96 66
 Fax: 32-51-72 96 86

info



/db/rcs_w/test/physibel/ex10/u01-134-ex75

ex75

DATUM 18/12/01

Fig.: Few cross sections (plus U-values) of one of the RC System types.

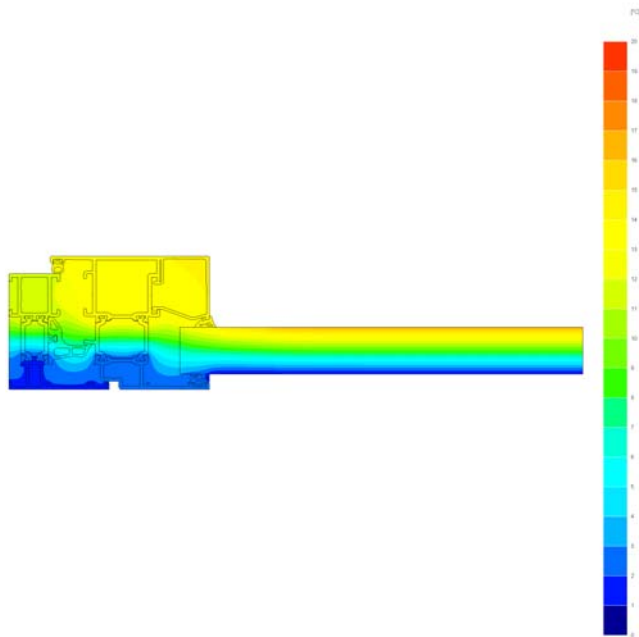


Fig.: Example of cross section with calculated temperature distribution

For the input of WIS we only need at the moment, per subtype:

- U-value
- Frame width

Data for Reynaers CS68:

Section	Profiles	Width (m)	U_f (W/m ² K)
1, A, B	005.0136.XX + 005.0192.XX	0.102	2.87
2	005.0115.XX + 2 x 005.0192.XX	0.170	2.89
3	005.0120.XX + 005.0192.XX + 005.0102.XX	0.178	2.87
4, C	005.0136.XX + 005.0102.XX	0.089	2.95
5	005.0120.XX + 005.0192.XX	0.140	2.79
6	005.0113.XX	0.076	2.51
7, D	005.0136.XX	0.051	2.80

Data for RC Systems, selected system: Excellence 75

Section	Profiles	Width (m)	U _f (W/m ² K)
1, A, B		0.099	3.05
2		0.160	3.31
3		0.170	2.34
4, C		0.089	3.05
5		0.131	3.14
6		0.072	3.47
7, D		0.050	3.64

WIS and combined window systems:

At the moment, WIS can only deal with one frame type per window system.

Also the CEN standard EN 10077-1 does not give rules for a window with different glazed parts in parallel.

The sensible way to work around this, is by calculating the weighted mean U-value for the frame, weighted according to the lengths of the different frame parts in the window.

However, currently, WIS calculates the frame area simply from window area and frame thickness, so still the frame area would not be in agreement with the real window. This could be worked around by calculating an effective frame thickness, but we prefer to leave the matter until the next version of WIS:

For the time being we restrict ourselves to a simple window geometry:

Window consisting of sections (referring to cross section numbers in figure above):

Bottom: section B

Top: section A

Sides: section 1

Width: 1.23 m

Height: 1.48 m

4. Instructions to user (2): how to load component data into WIS

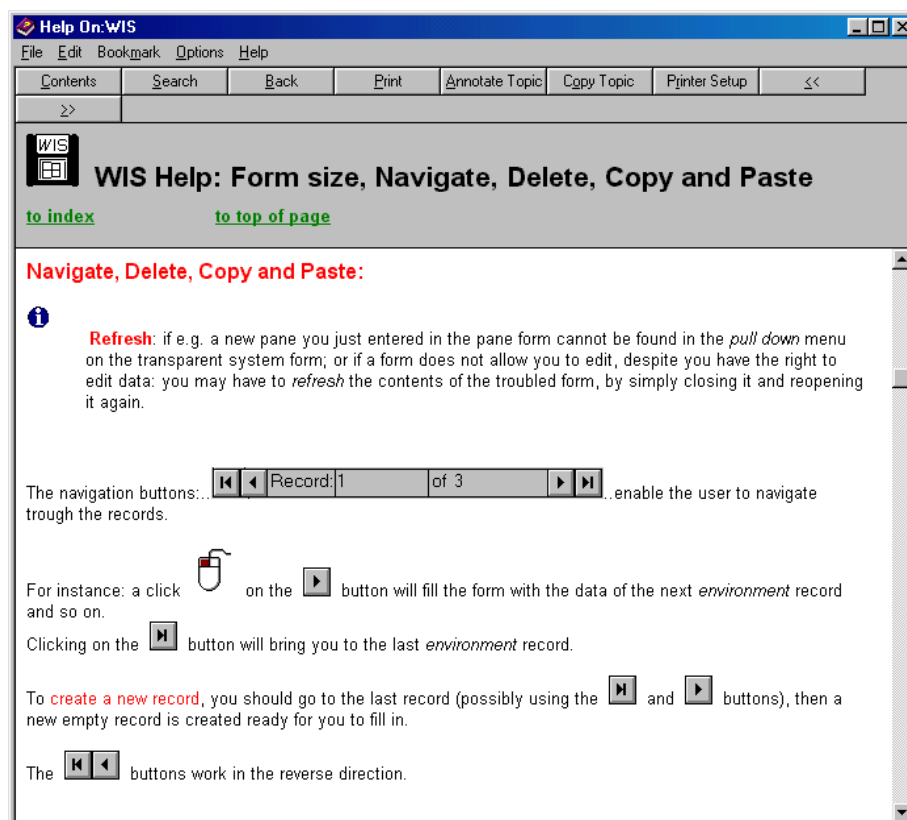
4.1 General instructions about browsing through the WIS forms

See “On line” Help Guide: press F1 or select Help in the menu.

You can use the on line Help Guide:

- Either as context sensitive help guide (help screens depend on which form you are working in)
- Or go to Index and select:
Records Manipulating:
Form size, Navigate, Delete, Copy and Paste

See illustration in next figure:

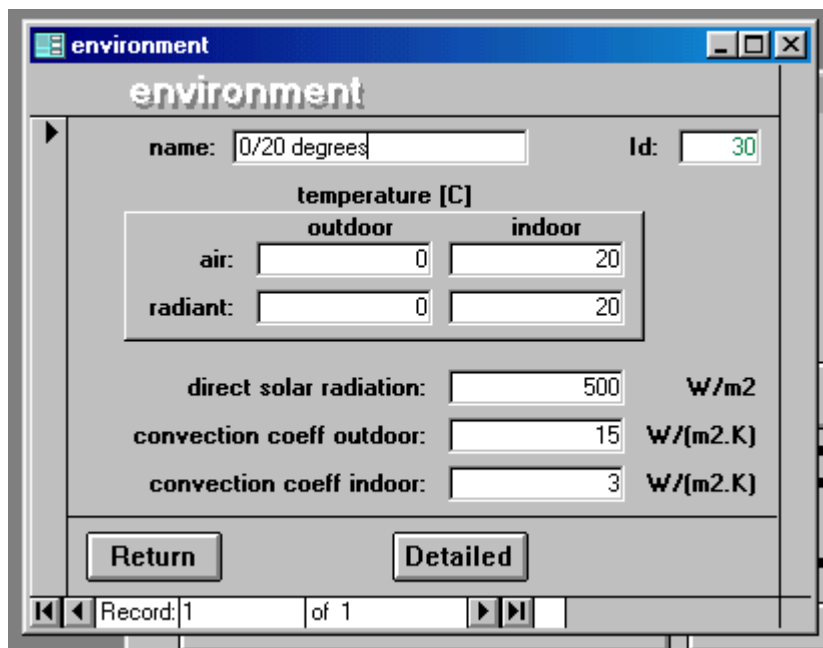


4.2 Load data Environment

Select button Environment.

Select a new Record (see previous section on how to navigate through the forms) or edit the existing record.

Complete as in the following example:



The screenshot shows a software window titled "environment" with a blue header bar. The main area is a form with the following fields and values:

- name:** 0/20 degrees
- Id:** 30
- temperature [C]** section:
 - outdoor** / **indoor** columns
 - air:** outdoor: 0, indoor: 20
 - radiant:** outdoor: 0, indoor: 20
- direct solar radiation:** 500 W/m²
- convection coeff outdoor:** 15 W/(m².K)
- convection coeff indoor:** 3 W/(m².K)

At the bottom of the form are two buttons: "Return" and "Detailed". Below the form is a navigation bar showing "Record: 1 of 1" with navigation arrows.

Press the Return button.

4.3 Load data Panes

4.3.1 First pane

Pane type: IP_klar_4 (float):

At the Main Form, press the Pane button.

On the Pane form:

Go to latest record or edit the current record (if not frozen).

Complete the input:

Name, thickness, th.conductivity, corrected emissivity 1 and 2; IR transmittance

Note: we used thermal conductivity = 1.0 W/(mK), being standard EN 673 value; actually, for the same reason, to be precise, we also choose emissivity = 0.837 instead of 0.84 for the uncoated surface.

Select type of pane options:

Select:

single pane (→ options for coated panes are no longer enabled)
spectral properties (this happens to be the default)

Result:

The screenshot shows the 'pane' software window with the following data and settings:

corrected emissivity ϵ [-]		transmittance [-]	
outdoor	indoor	outdoor	indoor
0.837	0.837	0.000	

	reflectance [-]		transmittance [-]		Ra
	outdoor	indoor	outdoor	indoor	
solar	0.000	0.000	0.000		0
visual	0.000	0.000	0.000		
UV	0.000	0.000	0.000		

Input fields: name: ip_klar_4 example, Pane id: 821, thickness: 4 mm, therm. conductivity: 1 W/(m.K)

Buttons: Input, Calculate, Output, Report, Return, Freeze

pane type: 3

Record: 61 of 61

NB: at input the blue fields contain still zeros; they are filled when calculate button is pressed.

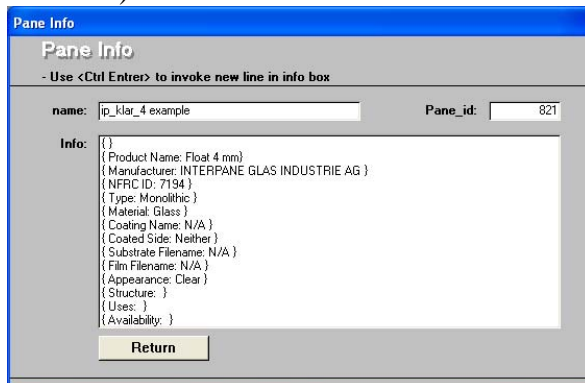
Insert the code for the coating: UU

See explanation of coating code in the beginning of this chapter.

Optional:

Press the Info button and add information (free text).

For instance: read the spectral file in Notepad and copy the header text of the spectral datafile to the clipboard (menu: edit/copy) and paste it into the info textbox (press “ctrl v”).



To import the spectral data:

Press the Input button.

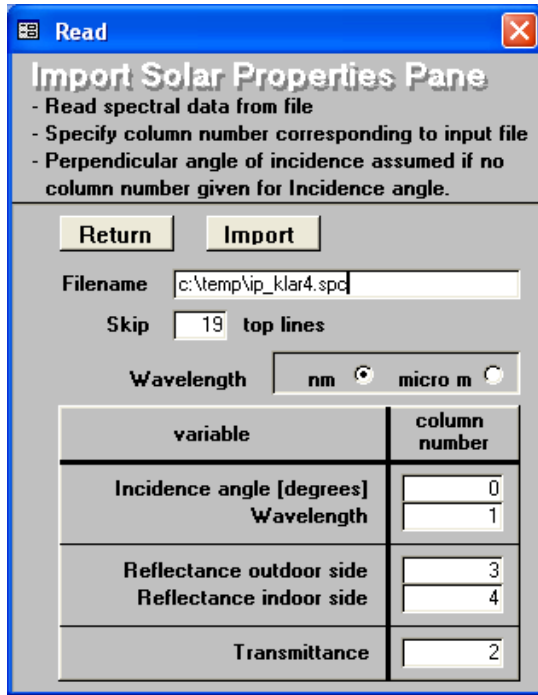
At the Import form which pops up: press again the Input button, because you want to import the data from a file.

Note: It is advised to copy the data files to a folder such as c:\temp, so as to avoid complications in case of too long path+filename.

Complete the form by filling in Filename (including path), number of header lines, unit for wavelength, incidence angle and in which columns the transmittance and reflectances are written.

Note that for the type ‘single pane’ the values for refl.1 and refl.2 are the same.

Result:

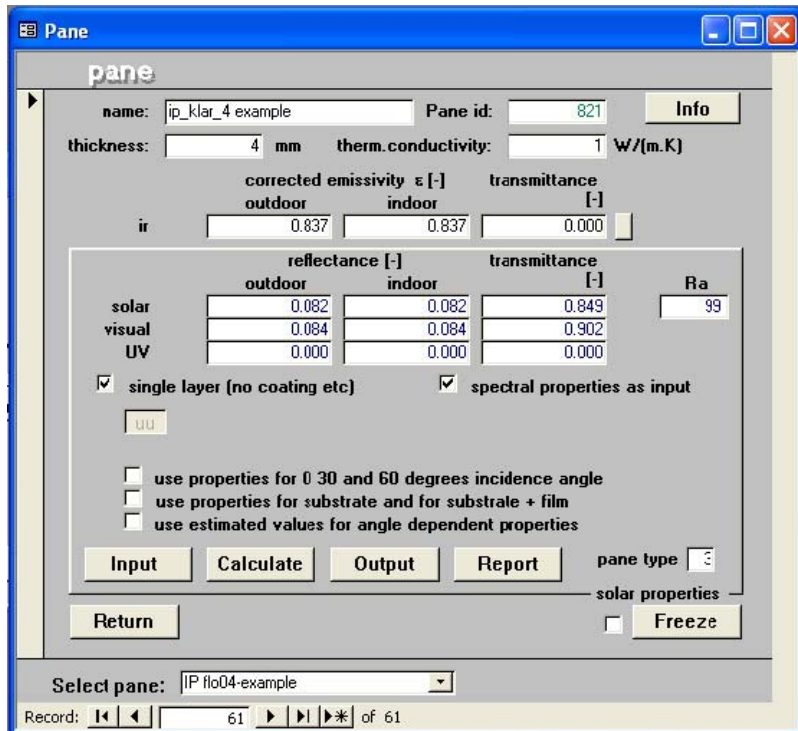


Press the Import button: the file is imported.
 Press OK and Return.

Press Calculate button to get or refresh the calculated optical properties of the pane.

Note: you may consider to press the Freeze button to protect the properties against editing.

Result:



4.3.2 Examine results

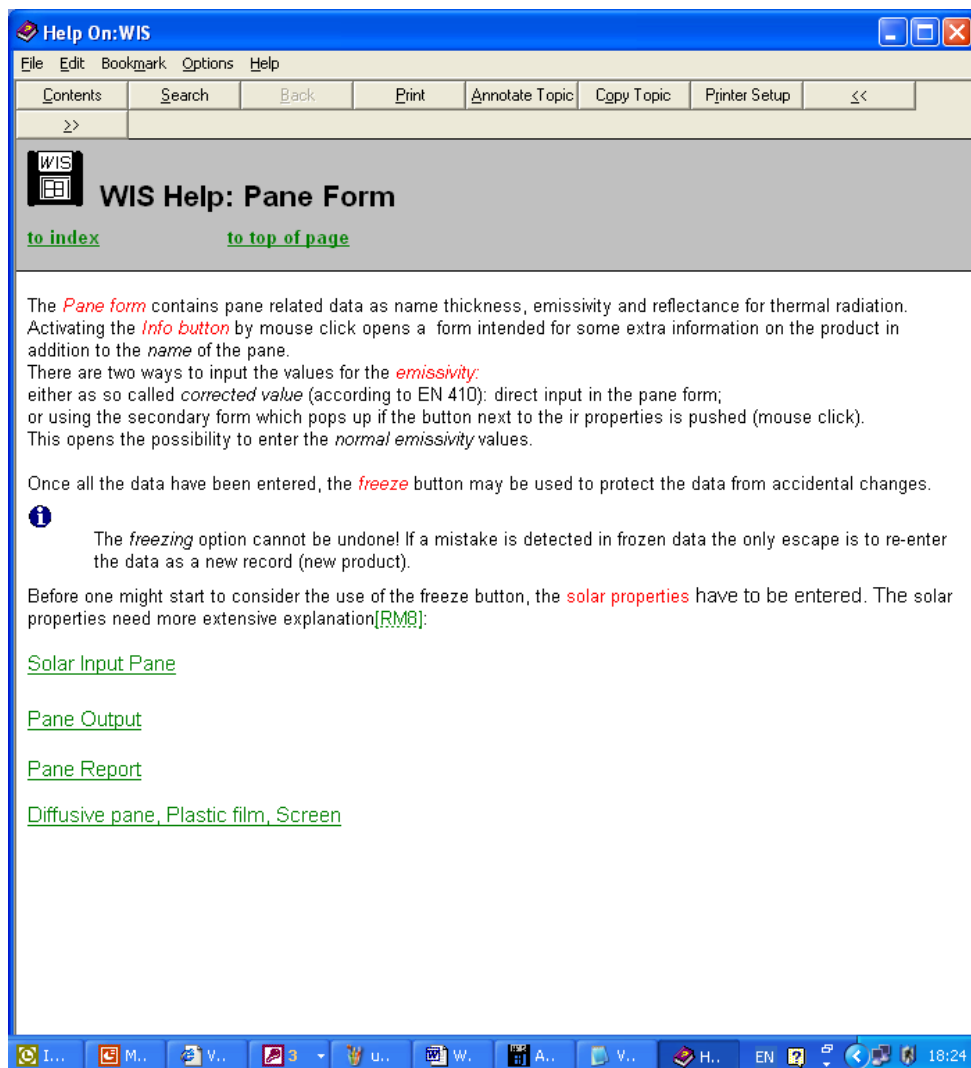
Press Output button to examine detailed results....

Press Report button to examine detailed results ...

4.3.3 Using WIS Help Guide

If you press F1 you get context related help.

Example:



4.3.4 Load second pane

Pane type: IP ipls (low emittance glazing):

Follow the same procedure as for the float glass, with difference:

Mind the low emissivity for the surface 1.

Fill in the coating code: CU (note: the C at second position means that the coating is at surface 2).

In this case it is not a single layer.

Note: you can press F1 to obtain detailed help on this form!

→ Check off the single layer option

Now, additional choices become visible.

Choose the option: “Use estimated values for angle dependent properties”.

Continue: import the spectral data; the procedure is similar to the previous pane.

After completing the input and pressing the Calculate button:

The screenshot shows the 'pane' software window with the following data:

corrected emissivity ϵ [-]		transmittance [-]
outdoor	indoor	
0.048	0.837	0.000

	reflectance [-]		transmittance [-]	Ra
	outdoor	indoor		
solar	0.247	0.209	0.632	99
visual	0.039	0.051	0.893	
UV	0.000	0.000	0.000	

Options checked: spectral properties as input, use estimated values for angle dependent properties.

Coating code: CU

Buttons: Input, Calculate, Output, Report, Return, Freeze

pane type: 7

Select pane: IP flo04-example

Record: 62 of 62

4.3.5 Examine results

Press Output button to examine detailed results....

Press Report button to examine detailed results ...

4.3.6 Load third pane

Pane type: IP 6834ne (solar control glazing):

Follow the same procedure as for the low emittance glass, with difference:

Mind the low emissivity for the surface #2.

Mind the thickness: 6 mm

Fill in the coating code: UC (note: the C at second position means that the coating is at surface #2).

Continue: import the spectral data; the procedure is similar to the previous pane.

After completing the input and pressing the Calculate button:

The screenshot shows the 'pane' software interface. The window title is 'pane'. The main area contains the following fields and controls:

- name:** ip 6834ne example
- Pane id:** 823
- Info** button
- thickness:** 6 mm
- therm. conductivity:** 1 W/(m.K)
- corrected emissivity ϵ [-]** table:

	outdoor	indoor
ir	0.837	0.025
- transmittance [-]** table:

	outdoor	indoor	Ra
solar	0.309	0.414	0.383
visual	0.050	0.039	0.748
UV	0.138	0.383	0.045
- single layer (no coating etc)
- spectral properties as input
- UC** (coating code)
- use properties for 0 30 and 60 degrees incidence angle
- use properties for substrate and for substrate + film
- use estimated values for angle dependent properties
- Input**, **Calculate**, **Output**, **Report** buttons
- pane type** 7
- solar properties** section with **Freeze** button
- Return** button
- Select pane:** ip 6834ne example
- Record: 63 of 63

4.3.7 Examine results

Press Output button to examine detailed results....

Press Report button to examine detailed results ...

4.4 Load data Shading

4.4.1 Load venetian blind; example: spectral data

Venetian blind type: Hunter Douglas venetian blind HD0150 (white)

At the Main Form, press the Shading button.

On the Shading form:

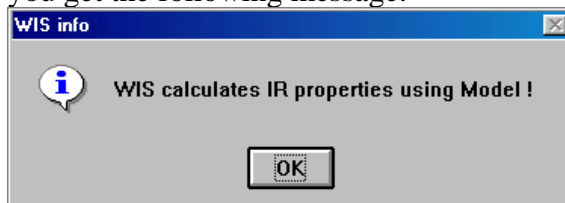
Go to latest record or edit the current record (if not frozen).

Complete the input:

Name, thickness, th.conductivity

Note: we used thermal conductivity = 99 W/(mK), just to indicate that it's highly conducting material; WIS calculates the thermal resistance from thickness divided by thermal conductance, which only has a true physical meaning in case of fully closed blinds.

Note: if you try to type in values for emissivity 1 and 2 and IR transmittance, you get the following message.



This is, because these properties are the calculated overall properties for the layer of slats (in certain position) with the openings between the slats.

Select the checkbox for: 'use spectral properties'.

Optional: press the Info button and add information (free text)

Result:

Solar Shading

Shading

name: id:

thickness: mm conduction: W/(m.K)

ir	IR emissivity [-]		IR transmittance [-]	
	outdoor	indoor	outdoor	indoor
<input type="text" value="0.000"/>	<input type="text" value="0.000"/>	<input type="text" value="0.000"/>	<input type="text" value="0.000"/>	<input type="text" value="0.000"/>

use spectral properties
 use direct input (not by model generated data)

solar properties

Record: 1 of 1

Next step:

Press the Model button to complete the input for the model which calculates the layer properties based on the slat properties and geometry.

Choose 'horizontal' (no effect yet, because option for 'vertical' slats is not yet activated in version 1.0).

Complete the other data.

Choose a slat angle, e.g. 45 degrees

Note: if the properties are frozen (see further on), the slat angle can still be changed.

Result:

Venetian blinds:

Note that (from WIS version 2.0.1) the previous description “distance” has been replaced by “**pitch**”: the distance between two slats.

The slat width is the shortest distance between the two edges of the slat (relevant for curved slats).

Note: for advanced options, see section 6.2.

To import the spectral data:

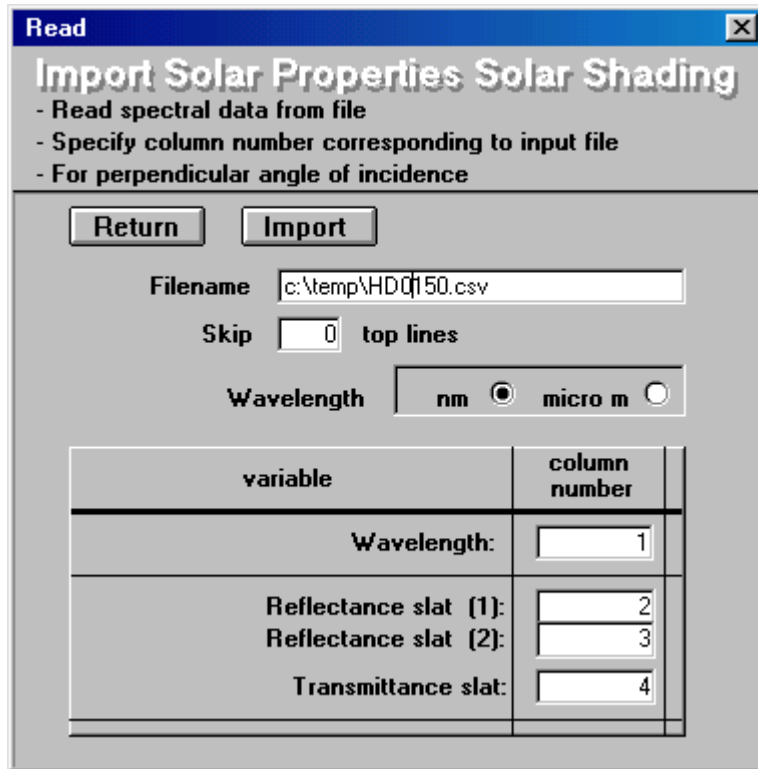
Press the Read Spectral data button.

At the import form which pops up: press again the Input button, because you want to import the data from a file.

Similar as for Panes: complete the form by filling in Filename (including path), number of header lines, unit for wavelength, incidence angle and in which columns the transmittance and reflectances are written.

Note: this particular spectral data file does not contain a column for transmittance; the transmittance is zero (opaque slats). For the column number of slat transmittance you can either type in column 4 (not existing) or column 0).

Result:



Press the Import button: the file is imported.

Press OK and Return and once more Return to arrive back at the Shading form.

Press Calculate button to get or refresh the calculated optical properties of the shading layer.

Note that if the slats are not fully closed the value for IR transmittance is not zero, 'even if' the slats are opaque: thermal radiation passes the layer via the openings between the slats and by reflection at the slats.

Note: you may consider to press the Freeze button to protect the properties against editing (except the slat angle).

4.4.2 Examine results

Press Output button to examine detailed results....

Press Report button to examine detailed results ...

4.4.3 Load non-spectral file shading (example: generic venetian blind)

Shade type: venetian blind, white

At the Main Form, press the Shading button.

On the Shading form:

Go to latest record or edit the current record (if not frozen).

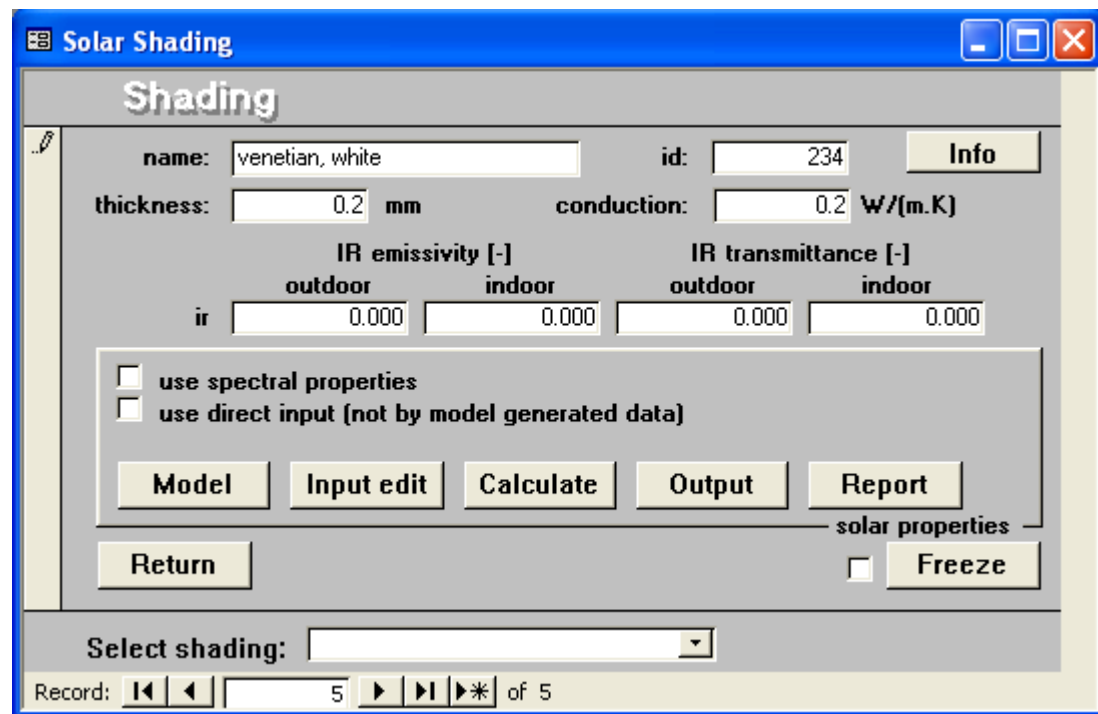
Complete the input:

Name, thickness, th.conductivity

Check off the checkbox for: 'use spectral properties', because we use in this case non-spectral input

Optional: press the Info button and add information (free text)

Result:



The screenshot shows the 'Solar Shading' software window with the 'Shading' form. The form contains the following fields and controls:

- name:** venetian, white
- id:** 234
- Info** button
- thickness:** 0.2 mm
- conduction:** 0.2 W/(m.K)
- IR emissivity [-]**
 - outdoor: 0.000
 - indoor: 0.000
- IR transmittance [-]**
 - outdoor: 0.000
 - indoor: 0.000
- use spectral properties
- use direct input (not by model generated data)
- Model** button
- Input edit** button
- Calculate** button
- Output** button
- Report** button
- Return** button
- solar properties** checkbox
- Freeze** checkbox
- Select shading:** dropdown menu
- Record:** navigation buttons (back, forward, search) and page number 5 of 5

Next step:

Press the Model button to complete the input for the model which calculates the layer properties based on the slat properties and geometry.

Result:

Shading model input form

Shading model

Horizontal: Vertical: id:

slat width (w) [mm]:
 slat distance (d) [mm]:
 slat angle (a) [degr]:

slat IR emissivity (1):
 slat IR emissivity (2):
 slat IR transmittance:

To import the optical data:

Press the Solar data button.

Complete the form.

Note that we leave the UV data empty, because of absence of data.

Result:

Shading model input form

Shading model solar

id:

slat solar reflectance (1):
 slat solar reflectance (2):
 slat solar transmittance:

slat light reflectance (1):
 slat light reflectance (2):
 slat light transmittance:

slat uv reflectance (1):
 slat uv reflectance (2):
 slat uv transmittance:

Press Return and once more Return to arrive back at the Shading form.

Press Calculate button to get or refresh the calculated optical properties of the shading layer.

Result:

The screenshot shows the 'Solar Shading' software window. The main panel is titled 'Shading' and contains the following fields and controls:

- name:** venetian, white
- id:** 234
- Info** button
- thickness:** 0.2 mm
- conduction:** 0.2 W/(m.K)
- IR emissivity [-]**
 - outdoor: 0.729
 - indoor: 0.729
- IR transmittance [-]**
 - outdoor: 0.227
 - indoor: 0.227
- Options: use spectral properties, use direct input (not by model generated data)
- Buttons: Model, Input edit, **Calculate**, Output, Report
- Buttons: Return, solar properties, Freeze
- Select shading:** venetian, white
- Record: 5 of 5

Note that the IR emissivity and transmittance are calculated as the resulting values for the shading as a layer (transmittance is between the slats and by (forward, single or multiple) reflection at the slats).

Note: you may consider to press the Freeze button to protect the properties against editing (except the slat angle).

4.4.4 Examine results

Press Output button to examine detailed results....

Press Report button to examine detailed results ...

4.4.5 Load spectral file shading (example: roller blind)

Shade type: Verosol 816/000, metalised roller blind, grey, transparent

At the Main Form, press the Shading button.

On the Shading form:

Go to latest record or edit the current record (if not frozen).

Complete the input:

Name, thickness, th.conductivity

Check the checkbox for: 'use spectral properties', because we use in this case spectral input

Because the current WIS version does not have a separate input for flat blinds, we use the model for slat type of blinds, with slat width equal to slat distance and slats fully closed (!! 90 degrees).

Result:

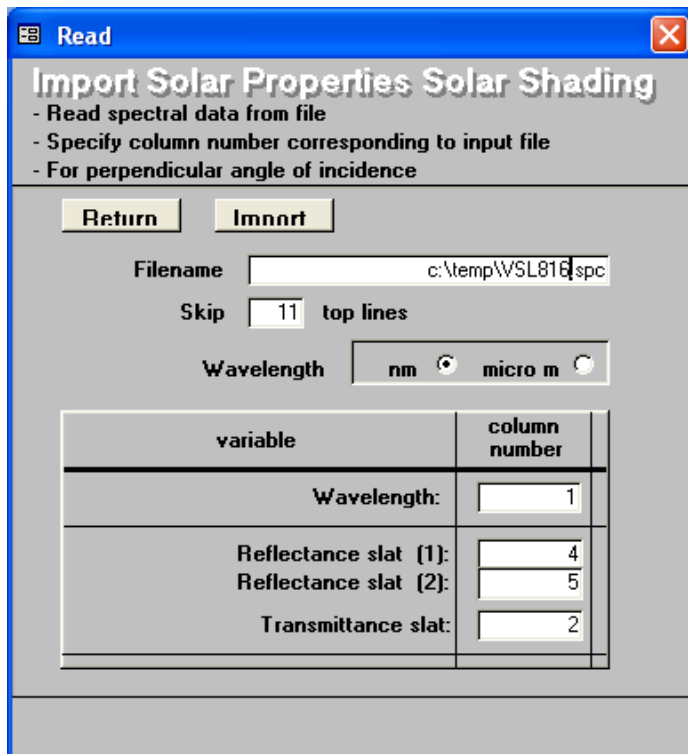
The screenshot shows a software window titled "Shading model input form". The window contains a "Shading model" section with the following controls:

- Horizontal: Vertical:
- id:
- slat width (w) [mm]:
- slat distance (d) [mm]:
- slat angle (a) [degr]:
- slat IR emissivity (1):
- slat IR emissivity (2):
- slat IR transmittance:

At the bottom of the form are three buttons: "Return", "Solar data", and "Read Spectral data". To the right of the input fields is a diagram of a roller blind with slats. The diagram is labeled with (1) for slat width, (2) for slat distance, 'a' for slat angle, and 'd' for slat distance. The diagram also shows "indoor side" and "outdoor side" with a red arrow pointing from outdoor to indoor.

Import the spectral data similar to the previous example with spectral data for shadings.

But note that the file contains an extra column which is not yet used in the current version of WIS: the diffuse part of the transmittance.

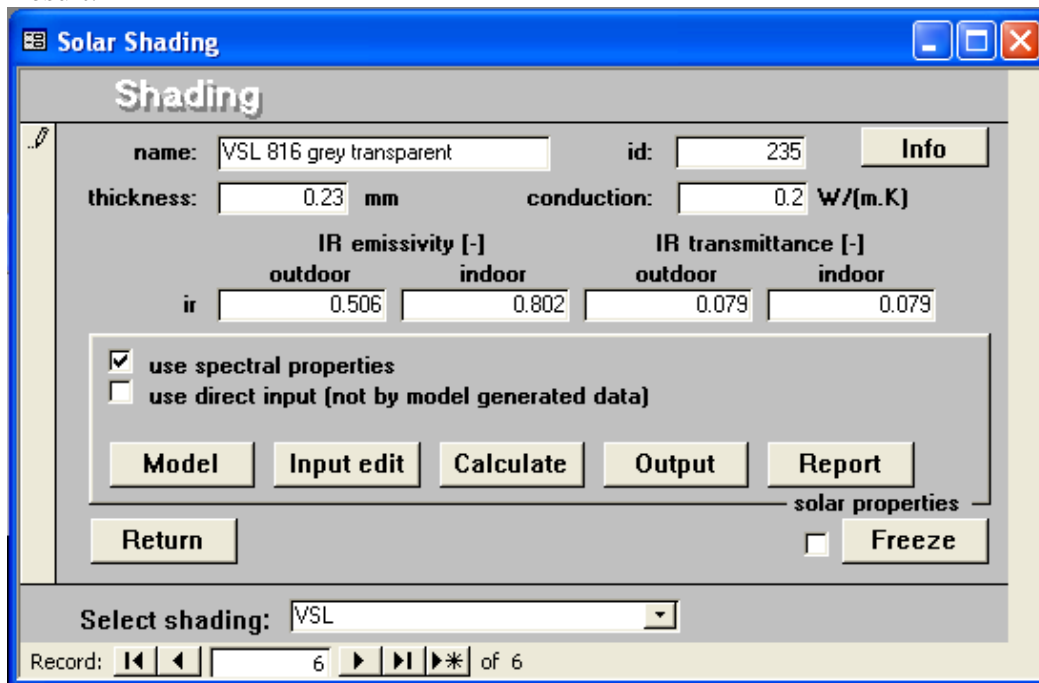


After returning to the main Shading Form and pressing the Calculate button:

Note that with the model with fully closed and precisely fitting slats (mimicking the roller blind) the values for IR emissivity and transmittance are the same as for the material, as could be expected.

Optional: press the Info button and add information (free text)

Result:



Note: you may consider to press the Freeze button to protect the properties against editing.

4.4.6 Examine results

Press Output button to examine detailed results....

Press Report button to examine detailed results ...

4.5 Construct data Gasmixes

4.5.1 Construct

Air:

At the Main Form, press the Gasmix button.

On the Gasmix form:

Go to latest record or edit the current record.

Complete the input:

- name of gasmix
- choose 'CEN-air' in the drop down menu of available gases:
- choose 100% for the record 'air'

Result:

The screenshot shows the 'Gas_mix' window with the following data:

	-10 oC	0 oC	10 oC	20 oC
Conduction [W/(m.K)]:	0.02336	0.02416	0.02496	0.02576
Dynamic Viscosity [kg/(m.s)]:	1.7E-05	1.7E-05	1.8E-05	1.8E-05
Density [Kg/m3]:	1.326	1.277	1.232	1.189
Cp [J/(kg.K)]:	1008	1008	1008	1008

Gases	
Gas name	percentage
cen_Air	100
*	0

Record: 1 of 5

Press Return button.

Argon (90%):

At the Main Form, press the Gasmix button.

On the Gasmix form:

Go to latest record or edit the current record.

Complete the input:

- name of gasmix
- first line under 'gas name': choose 'CEN-air' in the drop down menu of available gases
- choose 10% for the record 'air'
- Second line: choose 'CEN-argon', 90%

Result:

The screenshot shows the 'Gas_mix' software window. At the top, there is a 'Return' button, a 'Gasmix_id' field with the value '8', and a 'name' field with the value 'Air-Argon 10/90'. Below this is a table of properties for different temperatures: -10 oC, 0 oC, 10 oC, and 20 oC. The properties listed are Conduction [W/(m.K)], Dynamic Viscosity [kg/(m.s)], Density [Kg/m3], and Cp [J/(kg.K)].

	-10 oC	0 oC	10 oC	20 oC
Conduction [W/(m.K)]:	0.01659	0.01712	0.01765	0.01818
Dynamic Viscosity [kg/(m.s)]:	2.0E-05	2.1E-05	2.1E-05	2.2E-05
Density [Kg/m3]:	1.7787	1.6811	1.6523	1.5949
Cp [J/(kg.K)]:	567.9	567.9	567.9	567.9

Below the table is a section titled 'Gases' with a table listing gas names and their percentages:

Gas name	percentage
cen_Air	10
cen_Argon	90
*	0

At the bottom of the window, there are navigation buttons and a status bar showing 'Record: 2 of 5'.

Press Return button.

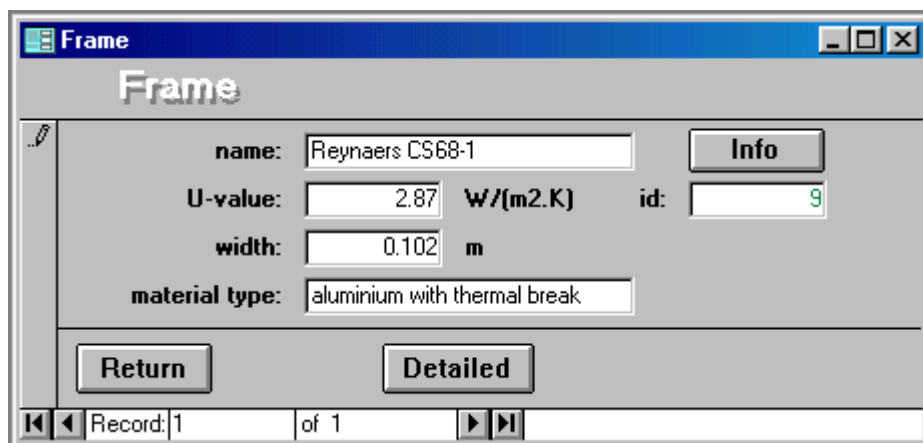
4.6 Load data Frame

At the Main Form, press the Frame button.
On the Frame form:
Go to latest record or edit the current record.

Complete the input:

- name of frame
- U-value
- Width
- Material type (for information only)

Result:

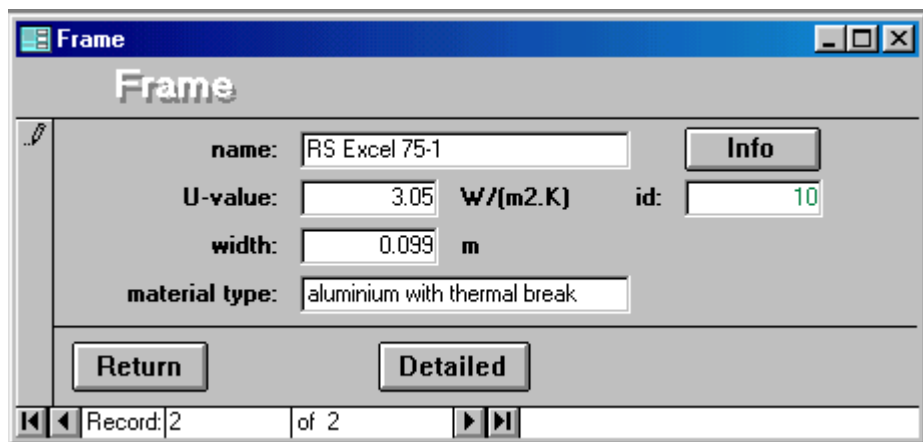


The screenshot shows a software window titled "Frame". The form contains the following fields and buttons:

- name:** Reynaers CS68-1
- U-value:** 2.87 W/(m2.K)
- width:** 0.102 m
- material type:** aluminium with thermal break
- id:** 9
- Buttons:** Info, Return, Detailed
- Footer:** Record: 1 of 1

Optional: press the Info button and add information (free text)

Select next record and complete the form for the next frame:



The screenshot shows the same "Frame" software window, but now displaying record 2. The form contains the following fields and buttons:

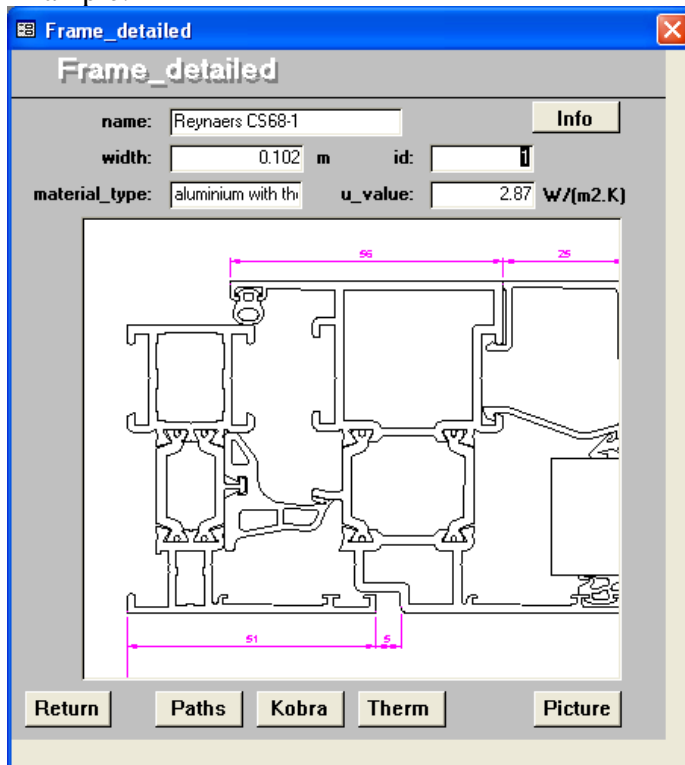
- name:** RS Excel 75-1
- U-value:** 3.05 W/(m2.K)
- width:** 0.099 m
- material type:** aluminium with thermal break
- id:** 10
- Buttons:** Info, Return, Detailed
- Footer:** Record: 2 of 2

Optional: press the Info button and add information (free text)

Optional:

Press the button “Detail”; click in the picture and paste (by pressing “cntrl v”) a picture from the clipboard.

Example:



Press Return to return to the WIS Main Form.

5. Instructions to user (3): How to construct a transparent system or a window system

5.1 Construct Transparent System

5.1.1 Construct example (1): sealed double glazing unit

At the Main Form, press the Transparent System button.

On the Transparent System form:

Go to latest record or edit the current record.

We'll start with constructing a double glazing system belonging to the family of Interpane iplus neutral S

Complete the input:

- Name: IP iplus nr S 4-16-4 (referring to the thicknesses of the glazings and gaps)
- Tilt angle
- Choose environment using the drop down menu

In the lower part ('Layers') of the form:

- Outer pane: first line, under 'Pane': choose 'IP klar4 example' in the drop down menu of available panes
- Gap: second line, under 'Gap': choose air/argon 10/90
- Type in: 16 mm for gap width
- Inner pane: third line, under 'Pane': choose 'IP ip ipls example' in the drop down menu of available panes

Because the second pane has the coating on surface 1 (the C, in the coating code CU, where U means uncoated), and surface 1 is now facing the cavity, we do **not** need to flip the coated pane.

Result:

Transparent_system

Transparent system

name:

tilt angle: id:

environment:

Results

U-value : W/(m²K)

solar factor (g) : -

solar direct transmittance : -

light transmittance : -

UV transmittance : -

f-value : -

col.rend.Index (Ra) : -

Layers

outdoor side

Type	Gap	width mm	Pane	width mm	code coating	flipped	Shading
			ip_klar_4 exam	4	uu	<input type="checkbox"/>	
	Air-Argon 10	16				<input type="checkbox"/>	
			ip iplus S exam	4	CU	<input type="checkbox"/>	
*						<input type="checkbox"/>	

indoor side

Select transparent system:

Record: of 10

No ventilation (sealed cavity).

Press the Calc button to get or refresh the calculated properties of the transparent system.

Result:

Transparent_system

Transparent system

name: IP iplus nr S 4-16-4
 tilt angle: 0 id: 72
 environment: 0/20 degrees
 Calc. Details Report
 Return Ventilation

Results

U-value : 1.15 W/(m2K)
 solar factor (g) : 0.64 -
 solar direct transmittance : 0.55 -
 light transmittance : 0.81 -
 UV transmittance : 0.00 -
 f-value : 0.85 -
 col.rend.Index (Ra) : 98 -

Layers outdoor side

Type	Gap	width mm	Pane	width mm	code coating	flipped	Shading
Pane			ip_klar_4 exam	4	uu	<input type="checkbox"/>	
Gap	Air-Argon 16	16				<input type="checkbox"/>	
Pane			ip iplus S exam	4	CU	<input type="checkbox"/>	
*						<input type="checkbox"/>	

indoor side

Select transparent system: IP iplus nr S 4-16-4
 Record: 10 of 10

5.1.2 Examine results

The main results are presented at the Form:

U-value, g-value (total solar energy transmittance), light transmittance, etc.

Note: the results on the Form are for normal incidence angle of the sun.

The report gives also results for other angles of incidence.

Press Details button to examine detailed results....

Press Report button to examine detailed results ...

5.1.3 Construct example (2): sealed double glazing unit with indoor venetian blind

At the Main Form, press the Transparent System button.

On the Transparent System form:

Go to latest record or edit the current record.

We'll now construct a clear double glazing system with two panes of float glass, with indoor venetian blind

Complete the input:

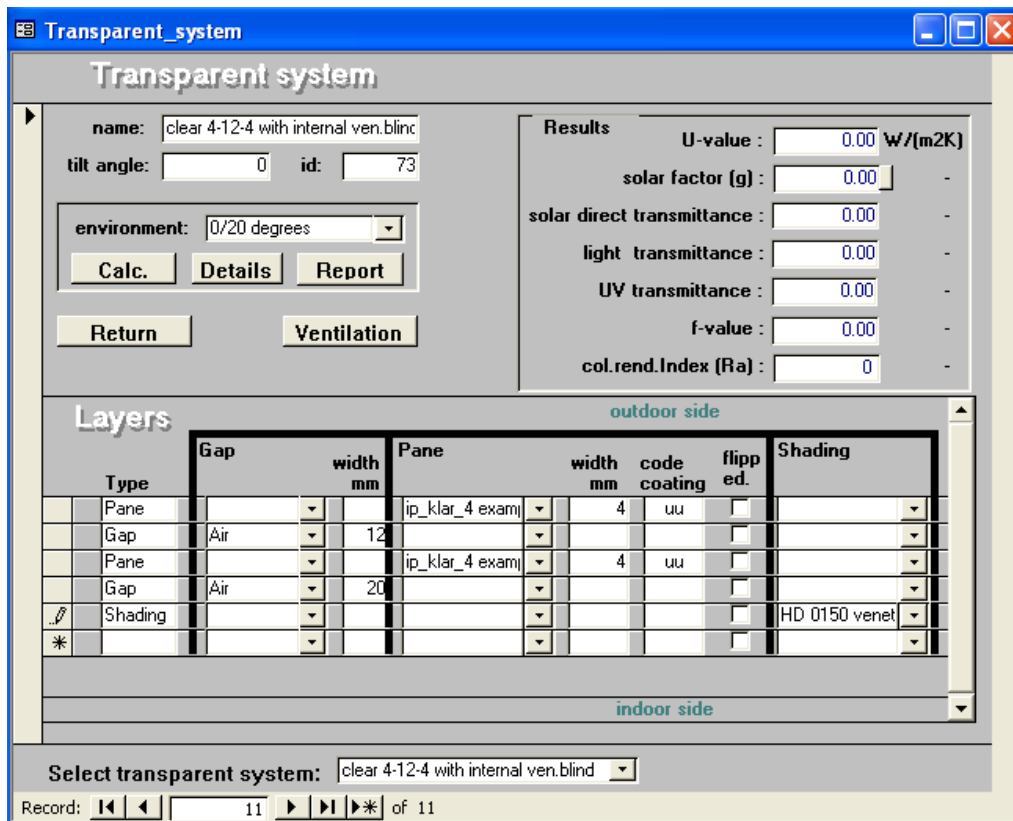
- Name: clear 4-12-4 with internal ven.blind (referring to the thicknesses of the glazings and gaps and blind)
- Tilt angle
- Choose environment using the drop down menu

In the lower part ('Layers') of the form:

- Outer pane: first line, under 'Pane': choose 'IP klar4 example' in the drop down menu of available panes
- Gap: second line, under 'Gap': choose air
- Type in: 12 mm for gap width
- Inner pane: third line, under 'Pane': choose 'IP klar4 example' in the drop down menu of available panes
- Gap: fourth line, under 'Gap': choose air
- Type in: 20 mm for gap width (which we assume to be the gap between pane and blind)
- Blind: fifth line, under 'Shading': choose 'HD0150' in the drop down menu of available shadings.

Note: because none of the panes has a coating, we don't have to bother whether or not the a pane has to be flipped or not.

Result:



Because there is air exchange between the double glazed unit and the blind, we have to specify ventilation:
Press the ventilation button.

The vented cavity is gap #4 (the fourth layer in the system).
Assume that we don't want to let WIS calculate the air flow rate based on natural (thermally driven) ventilation: we want to specify the flow rate ourselves.
Therefore we choose the option: 'forced ventilation'.

Note: consequently, we don't have to specify the opening sizes around the shading device

The ventilation is *from indoor to indoor* environment, so we check:

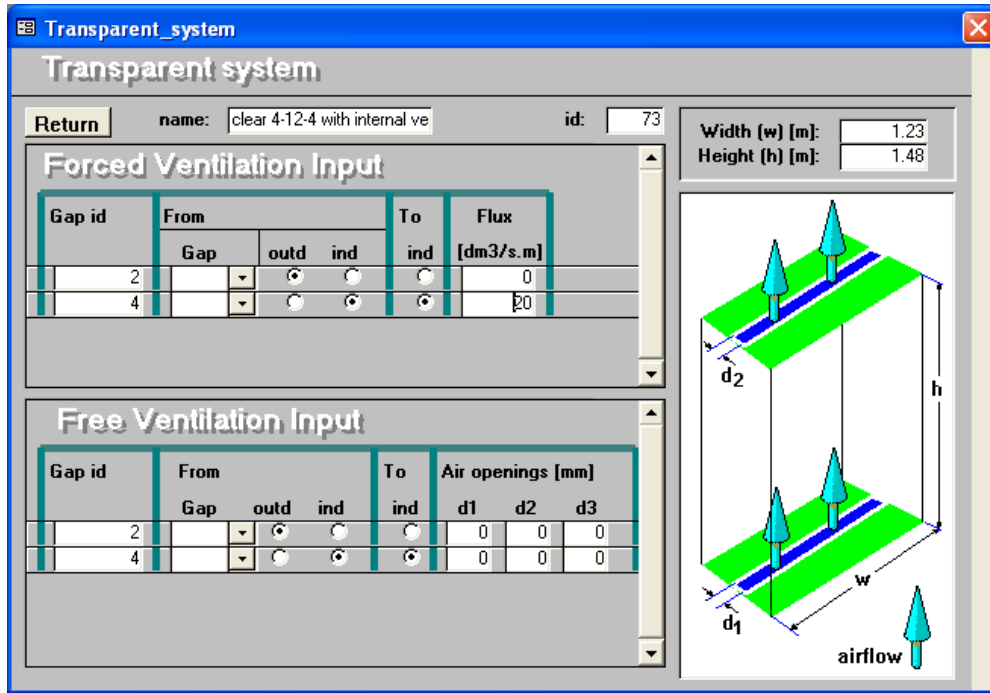
To indoor

From indoor

We assume a flow rate of 20 dm³/s (*!per m window width!*).

Don't forget to fill in the window height and width.

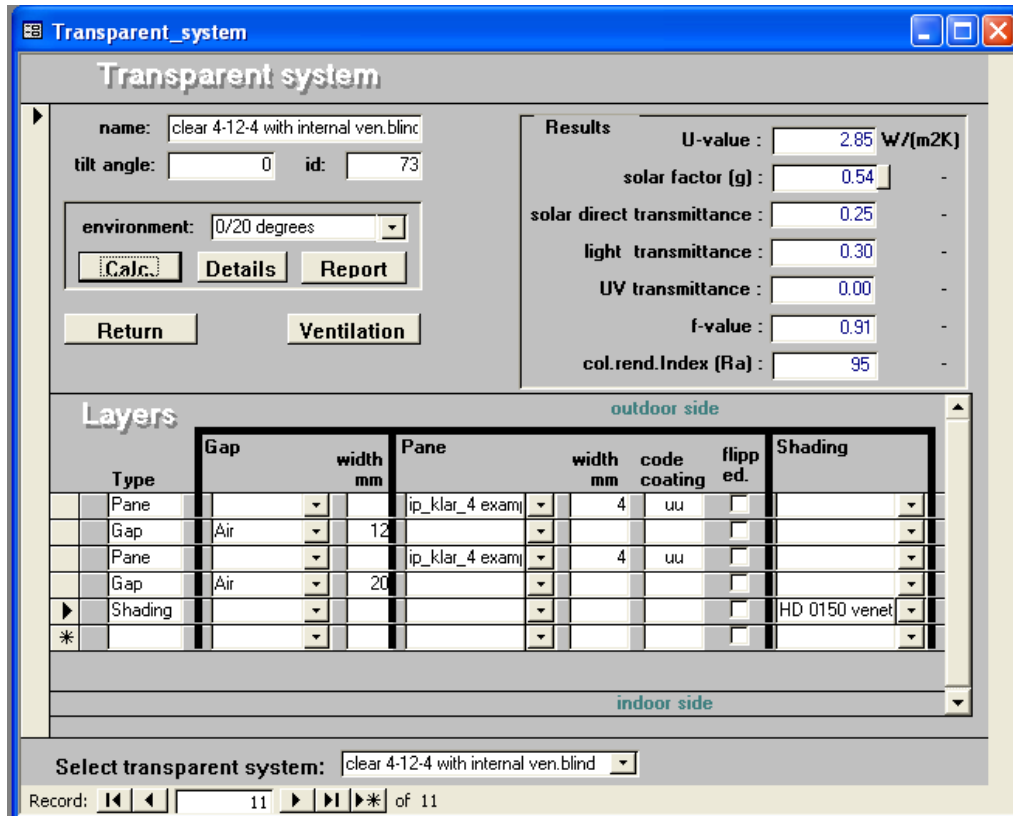
Result:



Press the Return button to return to the Transparent System form.

Press the Calculate button to get or refresh the calculated properties of the transparent system.

Result:



5.1.4 Examine results

Similar as in the previous example.

Don't forget to check whether the correct slat angle was chosen for the venetian blind; go to the Shading form to check –and change, if needed- the input.

Press Details button to examine detailed results....

Press Report button to examine detailed results ...

5.2 Construct Window System

5.2.1 Construct

At the Main Form, press the Window System button.

On the Window System form:

Go to latest record or edit the current record.

We'll now construct a high performance low e double glazing system with aluminium frame.

Complete the input:

- Name: high perf. low e dble glaz with alu frame
- Choose height and width
- Choose frame using the drop down menu
- Choose transparent system using the drop down menu
- Choose environment using the drop down menu

Finally: choose PSI-value for the glazing edge by pressing the selection button and selecting the appropriate value from the table which pops up.

The screenshot shows a dialog box titled "Linear thermal transmittance for metallic spacers [W/(m.K)]" with a sub-header "PSI". The "spacer type" is set to "alu or steel (draft EN ISO 10077-1 2003)". Below this is a table with columns for "Frame:" and three types of metal spacers: "Wood / Plastic", "Metal with thermal break", and "Metal without thermal break". The rows represent different glazing configurations. The values in the table are:

Frame:	Wood / Plastic	Metal with thermal break	Metal without thermal break
double or triple glazing uncoated glass, air or gas space	0.060	0.080	0.020
double glazing with low emissivity coating or triple glazing with two low emissivity coatings, air or gas space	0.080	0.110	0.050

A "Return" button is located at the bottom of the table. At the bottom of the dialog box, there is a "Record:" field with navigation icons and the text "1 of 3".

Note that these default values have been changed (increased) in anticipation of a modification of EN ISO 10077-1 (annex E).

Result, after pressing the Calculate button to get or refresh the calculated properties of the window system:

The screenshot shows a software window titled "Window_system" with a blue title bar. The main content area is divided into several sections:

- Name and ID:** "name: high perf. Low e dble glaz with alu frame" and "id: 1".
- Results Section:** A table of calculated values:

U-value:	1.91	W/(m2K)
area frame:	0.511	m2
area transparent system:	1.309	m2
perimeter length:	4.604	m
solar factor (g):	0.46	-
solar direct transmittance:	0.40	-
light transmittance:	0.58	-
UV transmittance:	0.00	-
- Buttons:** "Return", "Calc", and "Report" buttons are located below the results.
- Dimensions:** "height: 1.48 m" and "width: 1.23 m".
- Composition:** A table of input parameters:

Frame:	Reynaers CS6E	Select
PSI edge:	0.11	W/(m.K) Select
Transparent_syst:	IP iplus nr S 4-1	Select
Environment:	Te/Ti=0/20 de	Select
- Select window system:** A dropdown menu showing "high perf. Low e dble glaz with alu frame".
- Record navigation:** "Record: 1 of 2" with navigation icons.

Press Return to return to the WIS Main Form.

5.2.2 Examine results

See the main results on the Form.

Press Report button to examine detailed results ...

6. More features

6.1 CEN-only settings

Try the menu “Settings”, e.g. for the “CEN only” option (with the Settings Form open, press F1 for context related explanation from the WIS Help Guide).

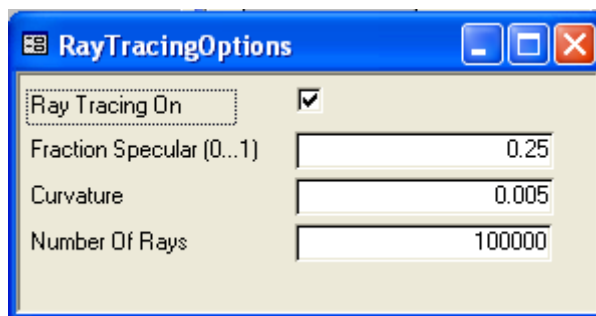
With this option all calculation cases or assumptions that are outside the scope of EN 673 and/or EN 410 are disabled.

6.2 Ray tracing option for slat types of solar shading devices

New in version 2.0.1, for advanced users

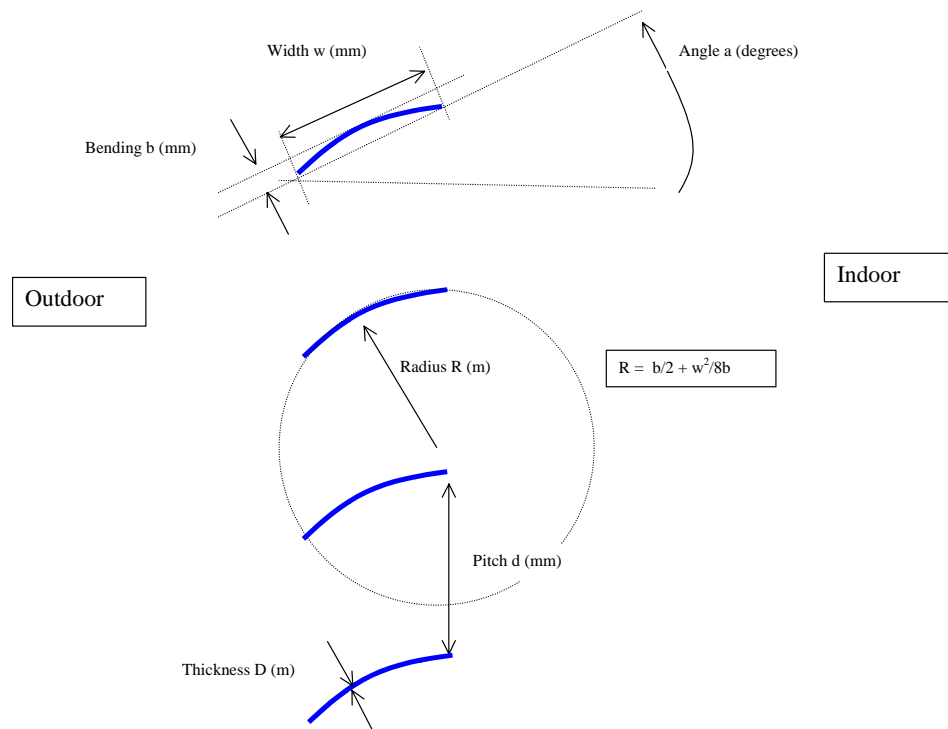
*** experimental version ***:

- Ray tracing option for slat types of shading devices: via the menu “Settings” or via the Shade Form.
 - Note: in case of spectral properties, the ray tracing calculation may take a few hours!



Fraction specular: the fraction of the solar and light reflectance that is specular (not diffuse as assumed for the normal option).

Curvature: the height of the slat in the middle, from base to top, in meters. A circular shape is assumed. For flat slats this value is zero (see illustration).



Example:

width w: 50 mm (→ Shading Form input: slat width: 50 mm)
pitch d: 42.5 mm (→ Shading Form input: slat pitch: 42.5 mm)
bending b: 4 mm per 50 mm (→ **ray tracing input: curvature: 0.004 m**)
→ radius R 0.080 m
thickness D: 0.2 mm (→ Shading Form input: slat thickness: 0.2 mm *!!))
slat angle: variable (e.g. 45 degrees) (→ Shading Form input)

*!!): note: only used for thermal conductance, not (yet) for solar optical properties!!

Number of rays: calculation parameter: the less rays are used for the calculation, the lower the accuracy (and calculation time). A typical value is 100 000 rays.

6.3 Latest information, frequently asked questions: go to web site

- Check the WinDat web site (www.windat.org) for the latest information (FAQ list, bugs, new releases, etc.)