

Thermal Transmittance (U-value) Test Report



Solar Energy Research
Institute of Singapore

Report number: CHB0056/S0032

Calorimeter Laboratory, SERIS

Client: **Inflector (Asia) Limited**

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Attention: Mr. Christopher Watson

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Client's reference: N/A

Report number: CHB0056/S0032

Test: Thermal transmittance (U-value) test

Specimen: A combined system consisting of an Inflector radiant barrier window insulator and a low-e coated double glazing unit (DGU)

Specimen ID: S0032

Result:

Thermal transmittance

U-value = 1.48 ± 0.14 W/(m² K)

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Signature:

Date of test: 30/11/2011

Date of report: 08/12/2011

1. Description of the Combined System

The objective of the test is to evaluate the thermal transmittance of the combined system, consisting of an Inflector radiant barrier window insulator specimen (hereafter referred to as “specimen”) and a low-e coated DGU (hereafter referred to as “DGU”). The specimen was installed as panel, with the silver side facing outdoor. Figure 1 shows a schematic representation of the combined system.

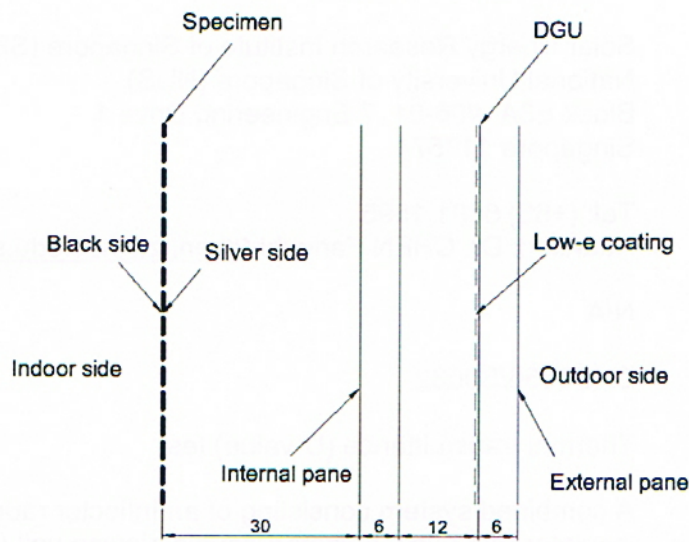


Figure 1. Schematic representation of the combined system consisting of the specimen and the DGU (unit of length: mm)

The specimen, as specified in the table below, was selected and delivered by the client. The original specimen is of trapezoidal shape, with constant width and one side slightly longer than the other.

Specimen ID	S0032
Date of receipt	10/11/2011
Product	Inflector radiant barrier window insulator
Total thickness	0.3 mm
Total width	1367 mm (constant)
Total length	1013 mm (shorter side), 1067 mm (longer side)

Thermal Transmittance (U-value) Test Report

Report number: CHB0056/S0032

Calorimeter Laboratory, SERIS

One side of the specimen is of silver color (Figure 2 left) and the other side of the specimen is of black color (Figure 2 middle). There are uniformly distributed small circular holes of the diameter approximately 1 mm over the entire specimen, except the 4 mm wide edge area (Figure 2 right). The hole grid is of rectangular pattern, with 6 holes for every 10 mm. The black side of the specimen is covered by a layer of thin transparent plastic film. The plastic film is continuous, i.e. without holes on it, and is not permeable to airflow. The specimen is flexible and allows a see-through view through it.

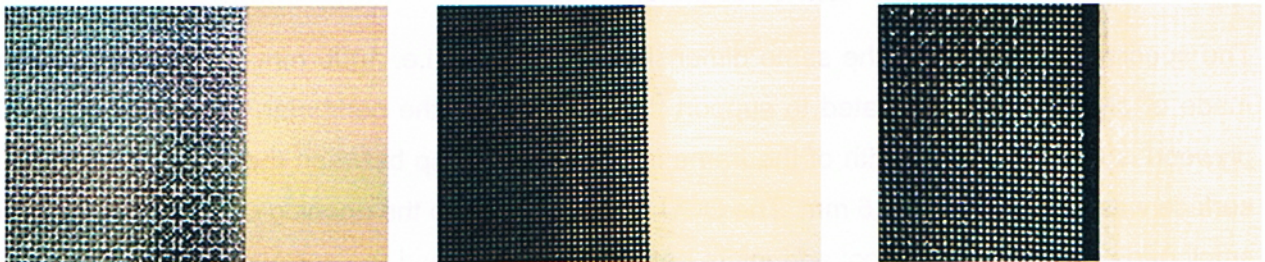


Figure 2. Detailed views of the specimens. Left: silver side of the specimen; middle: black side of the specimen; right: edge of the specimen

The DGU is an in-house sample provided by SERIS, with known thermal transmittance value. The table below lists the specification of the DGU.

Specimen ID	S0030
Product	DGU with low-e coating
Total thickness	24 mm
Total width	1000 mm
Total length	1000 mm
External pane type	6 mm thick clear tempered glass with low-e coating on the inner side
Internal pane type	6 mm thick clear tempered glass
Gas fill type	12 mm thick dry air
Thermal transmittance	1.88 ± 0.14 W/(m ² K), summer condition

According to the client's website information, the Inflector radiant barrier window insulator is to be used as window attachment for improved thermal insulation and solar heat gain control. The

Thermal Transmittance (U-value) Test Report

Report number: CHB0056/S0032

Calorimeter Laboratory, SERIS

window insulator can be installed as panel, roller blinds or vertical blinds on the indoor side of existing windows. In the summer, the silver side of the window insulator faces outdoor to reflect solar radiation back and achieve low solar gain; in the winter, the black side of the window insulator faces outdoor to absorb more solar radiation and achieve high solar gain. When installed as panel, the window insulator is usually attached onto the frame of the window by Velcro hooks, with a gap size of 20 mm – 40 mm between the window insulator and glass surface. The laboratory installation of the combined system simulates the summer operation mode of the window insulator and the window insulator was installed as panel.

The specimen was cut into the same dimension of the DGU, i.e. 1000 mm x 1000 mm. A frame made of plywood was fabricated to support the specimen at the perimeter. The thickness of the plywood is 6 mm and the width of the frame is 12 mm. The gap between the specimen and glass surface was adjusted to 30 ± 5 mm. The DGU was installed into the opening of surround panel with small gaps filled by cotton wool and joints between the DGU and the surround panel were further sealed by tape to ensure airtightness. The joints between the specimen and the surround panel are not airtight, but airflow is restricted as the gap between plywood frame and surround panel opening is very small (less than 2 mm). Figure 3 shows photos of the installation, taken before testing.



Figure 3. Photos of the installation. Left: view from outdoor side; middle: view from indoor side; right: zoom-in view of the gap between specimen and DGU (the specimen is on the left)

Thermal Transmittance (U-value) Test Report

Report number: CHB0056/S0032

Calorimeter Laboratory, SERIS



2. Test Procedure

2.1 Test Method

The measurement equipment and procedure are in compliance with ASTM C 1199 – 09e1.

Method	Standard test method for measuring the steady-state thermal transmittance of fenestration systems using hot box method
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Exception	N/A
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2.2 Test Apparatus

Calorimetric hot box was used in the measurement. Figure 4 shows the schematics of calorimetric hot box in thermal transmittance measurement mode. The specimen is mounted onto the opening of a well-insulated surround panel. Temperatures in room side and weather side are kept constant with a difference (refer to Section 2.3 for details). Air flow velocities, surface temperatures and emittances on both sides are controlled or monitored in order to maintain a desired surface heat transfer coefficient. Steady state heat flow through specimen due to temperature difference is measured to deduce the thermal transmittance value. The method defined in ASTM C 1199 is used for thermal transmittance calculation.

Test apparatus	Guarded hot box
Dimension of metered area	1.7 m (width) x 1.9 m (height)
Surround panel ID	SP001 (nominal opening size 1.0 m x 1.0 m)
Latest calibration date	CTS calibration: 18/07/2011 Wall loss calibration: 05/10/2011 Flanking loss calibration: 28/11/2011

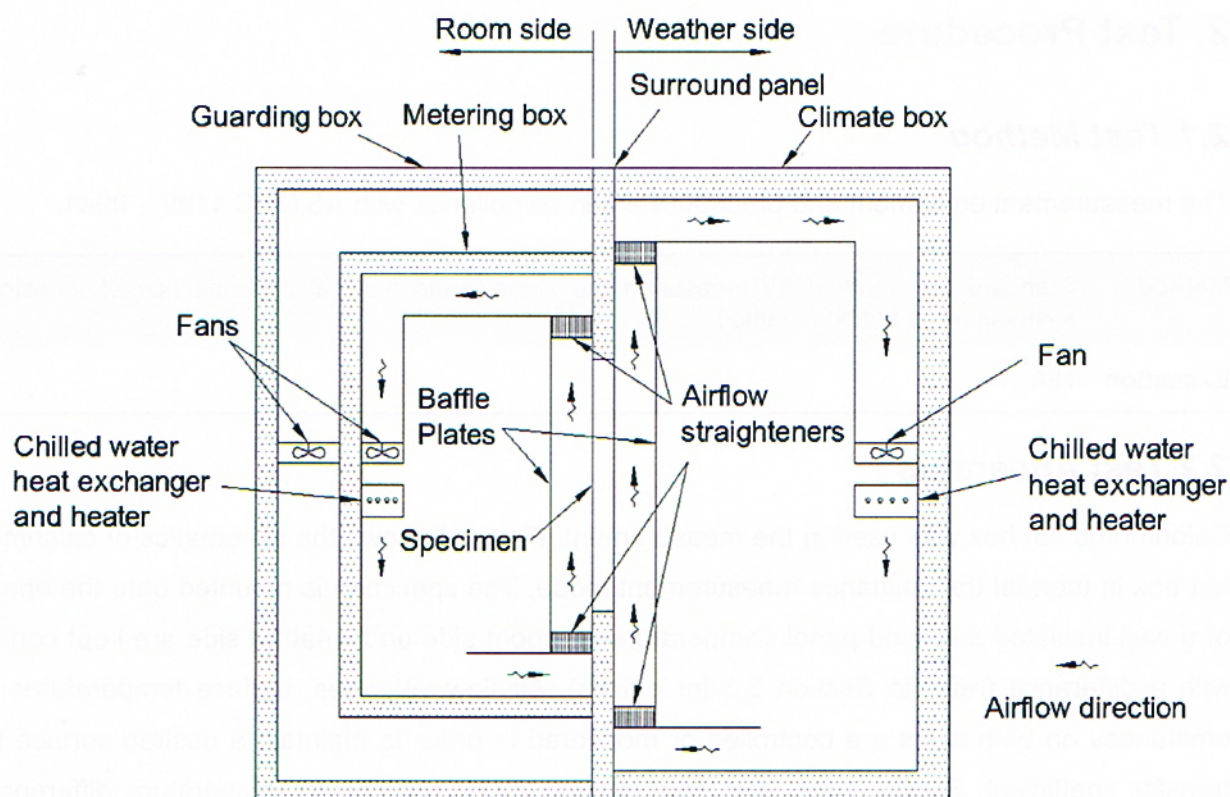


Figure 4. Schematics of the SERIS calorimetric hot box in thermal transmittance measurement mode

2.3 Boundary Conditions

The thermal transmittance test was carried out with summer environmental condition, as given in the table below.

Room side surface heat transfer coefficient	7.7 W/(m ² K) ± 5%
Weather side surface heat transfer coefficient	18 W/(m ² K) ± 10%
Room side airflow direction	Vertically upwards
Weather side airflow direction	Vertically upwards
Room side temperature	24 ± 0.025 °C
Weather side temperature	32 ± 0.025 °C

Thermal Transmittance (U-value) Test Report

Report number: CHB0056/S0032

Calorimeter Laboratory, SERIS



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3. Test Results

Date of test	30/11/2011
Test duration	11 hours
Operator	Mr. DU Hui, Laboratory Technologist
Laboratory ambient temperature	25.2 °C
Laboratory relative humidity	47 %
Laboratory barometric pressure	100344 Pa
Pressure differential across the specimen	Less than 10 Pa
Metering air temperature, $T_{Metering}$	24.0 °C
Climate air temperature, $T_{Climate}$	32.0 °C
Metering airflow velocity	0.3 m/s
Climate airflow velocity	2.8 m/s
Heat exchange with chilled water loops, $Q_{Chilled\ water}$	-81.93 W
Heat exchange with electrical devices, $Q_{Electrical\ devices}$	57.29 W
Metering box wall heat transfer, Q_{Wall}	4.90 W
Flanking heat transfer, $Q_{Flanking}$	3.48 W
Surround panel heat transfer, $Q_{Surround\ panel}$	4.42 W
Specimen heat transfer, $Q_{Specimen}$	11.84 W
Specimen area, $A_{Specimen}$	1.0000 m ²
Thermal transmittance (U-value), U	1.48 W/(m ² K)
Estimated uncertainty of thermal transmittance	± 0.14 W/(m ² K)

Note:

$$a) Q_{Specimen} = -(Q_{Chilled\ water} + Q_{Electrical\ devices} + Q_{Wall} + Q_{Flanking} + Q_{Surround\ panel});$$

Thermal Transmittance (U-value) Test Report

Report number: CHB0056/S0032

Calorimeter Laboratory, SERIS

$$b) U = \frac{Q_{\text{Specimen}}}{A_{\text{Specimen}} \times (T_{\text{Climate}} - T_{\text{Metering}})}$$

c) The estimated uncertainty is the expanded uncertainty estimated with a coverage factor of $k = 2$ and a level of confidence of approximately 95%.

4. Disclaimer, Limitation of Liability

The test method ASTM C 1199 does not include procedures to determine the heat flow due to either air movement through the specimen or solar radiation effects. As a consequence, the thermal transmittance results obtained do not reflect performances which may be expected from field installation due to not accounting for solar radiation, air leakage effects, and the thermal bridge effects that may occur due to the specific design and construction of the fenestration system opening. The latter can only be determined by in-situ measurements. Therefore, it should be recognized that the thermal transmittance results obtained from this test method are for ideal laboratory conditions and should only be used for fenestration product comparisons and as input to thermal performance analyses which also include solar, air leakage and thermal bridge effects.

The results stated in this test report only relate to the specimen tested. This test report shall not be reproduced, except in full, without the approval of the laboratory.

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