

**Software Tool for
Hawaii State Energy Conservation Code
Area-Weighted Average Solar Heat Gain Coefficient
Template Instructions
July 2011**

Purpose of the Template

The template provides a method to calculate the area-weighted average SHGC as allowed by Sections 402.3.2 and 502.3.3 of IECC 2009, as amended.

Intent of the Template

The template approach recognizes the benefit of architectural shading and window screens in reducing solar heat gain through windows in Hawaii.

Genesis of the template approach

During the State Building Code Council meeting a written request to exempt jalousie windows from SHGC requirements was submitted. The subsequent discussion brought to light the SHGC exemptions being implemented in the Hawaiianized IECC that, when used with the area-weighted average SHGC approach of Section 402.3.2, would allow jalousie windows. A comment was made that it was not clear how to calculate the area-weighted average SHGC. Based on this discussion, the Chairman of the State Building Code Council requested that Howard Wiig of DBEDT develop a template to calculate the area-weighted average SHGC. Paul Norton of the National Renewable Energy Laboratory agreed to assist DBEDT with the template with the assistance of industry participants.

Exemptions and allowances included in the area-weighted average SHGC template

- North-facing windows are assigned a SHGC of 0.00.
 - Opaque louvered openings are assigned a SHGC of 0.00
 - Windows with a projection factor greater than or equal to 1.0 are assigned a SHGC of 0.00.
 - Windows with projection factors between 0.25 and 1.0 are credited through reduced SHGC weighting
 - Exterior screens are credited at their full SHGC
 - Interior screens are given 1/3 the credit of their full SHGC
 - The 15 sf exemption given in Sections 402.3.3 and 502.3.3 is included
-

Template Input Instructions

The template is designed to calculate the area-weighted average SHGC *for a specific existing home or new home design*. To provide credit for orientation, window shading and window screens, information on the area, SHGC, orientation, overhang, and screen of each window must be entered into the template. The template then calculates the area-weighted-average SHGC.

If a specific window package design does not meet the required SHGC, the template can be used to explore the effects of design changes on the weighted-average SHGC.

Information for each window in the home must be entered into one row in the template. This approach allows for a diversity of window types, overhangs, and screen configurations. The number of rows in a completed template should equal the number of windows in the home. The template is color coded as follows:

Green cells - Enter window information in these cells. This is mandatory information.

Yellow cells - Enter window information in these cells. This is optional information.

White cells - These cells are calculated and locked. Do not enter information.

Required Window Information

You will need to know the following information on each window to complete the template:

Mandatory information on each window:

- Orientation
- Height
- Width
- Glazing material
- SHGC

Optional information on each window:

- Overhang horizontal distance (if overhang is present)
- Overhang vertical distance (if overhang is present)
- Screen SHGC (if screen is present)
- Location of screen – interior or exterior (if screen is present)
- Percent of window covered by screen (if screen is present)

Step-by-Step Input Instructions for Entering One Window

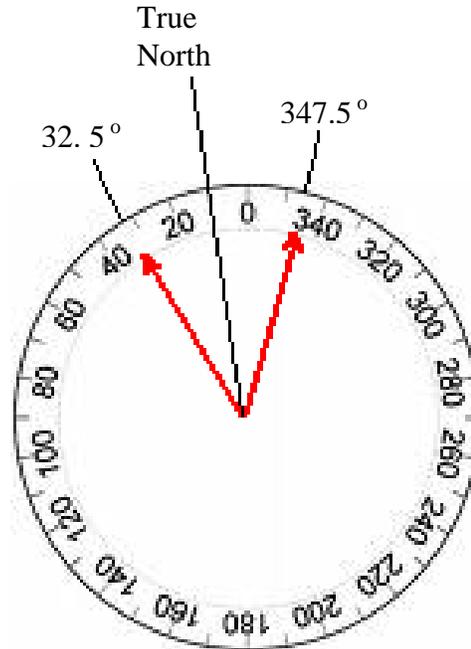
Column B: Orientation of Window

Click on a cell in column B and an arrow for a pull-down menu will appear. Choose the correct orientation for the window.

North-facing windows are exempt from the SHGC requirements. The north-facing window areas receive a weighting factor of 0.00 in the area-weighting average SHGC calculation. All other orientations receive a weighting factor of 1.00.

A north-facing window is defined as any window that faces within 22.5 degrees of true north. You can determine if a window qualifies as north-facing by using a compass. In Hawaii true north is 10 degree east of magnetic north (this is called the magnetic declination.) Therefore any window facing between 347.5 and 32.5 on the compass is

north facing. Stand with your back to the window and point directly away from the window. If the compass needle is between 347.5° and 32.5° as shown in the diagram below, then the window is considered to be north-facing.



Columns D and E: Height and Width

Enter the height and width of the window in inches in columns D and E.

You may round to the nearest inch. The height and width should include framed window area (not just the glass), because the framed area is included in the National Fenestration Rating Council (NFRC) SHGC rating of the window.

Column I: Glazing Material

Click on a cell in column I and an arrow for a pull-down menu will appear. Choose glass or opaque material for the window.

Because opaque louvered openings are considered windows, this column is used to determine if the window is glass or opaque material.

Column J: SHGC

Enter the rated NFRC SHGC rating of the window.

This information is contained on the NFRC sticker on new windows and is listed in window specifications from manufacturers for design purposes. For windows not tested by the NFRC, the default values listed Table 303.1.3(3) in the IECC 2009 shall be used.

Columns L and M: Shading Horizontal and Vertical Distances

If the window has an overhang, enter the horizontal distance A in column L and the vertical distance B in column M. If there is no overhang, leave these cells empty.

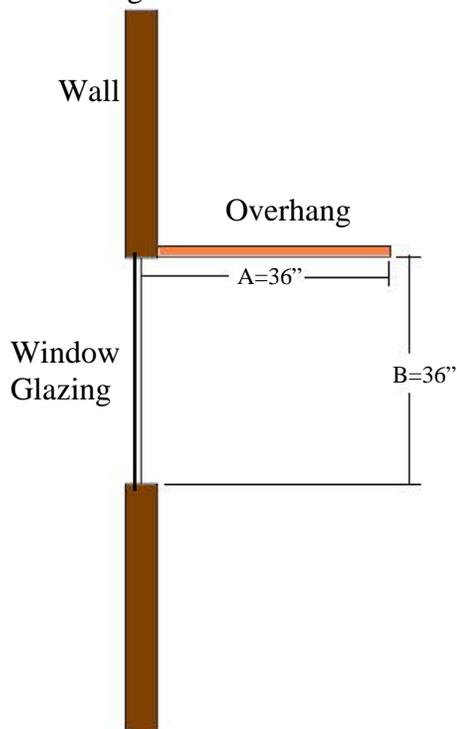
The horizontal distance A is defined as the “Distance measured horizontally from the furthest continuous extremity of any overhang, eave, or permanently attached shading device to the vertical surface of the glazing. Measured in inches.”

The vertical distance B is defined as the “Distance measured vertically from the bottom of the glazing to the underside of the overhang, eave, or permanently attached shading device. Measured in inches.”

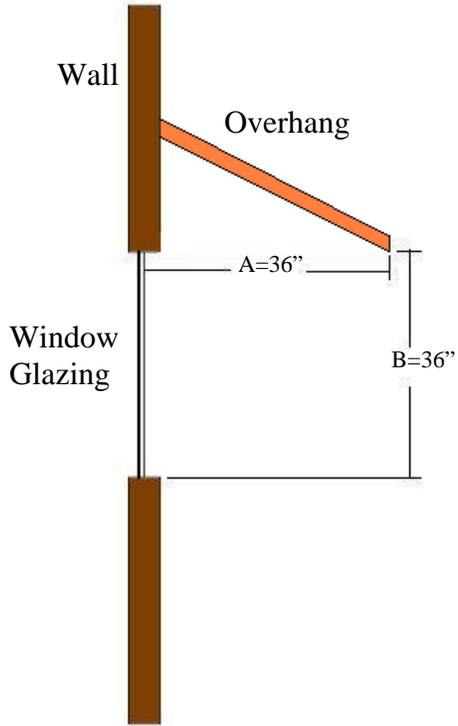
Measure directly to the glass (not the window frame) for these distances.

Some examples of A and B distance measurements for different overhang types are given below:

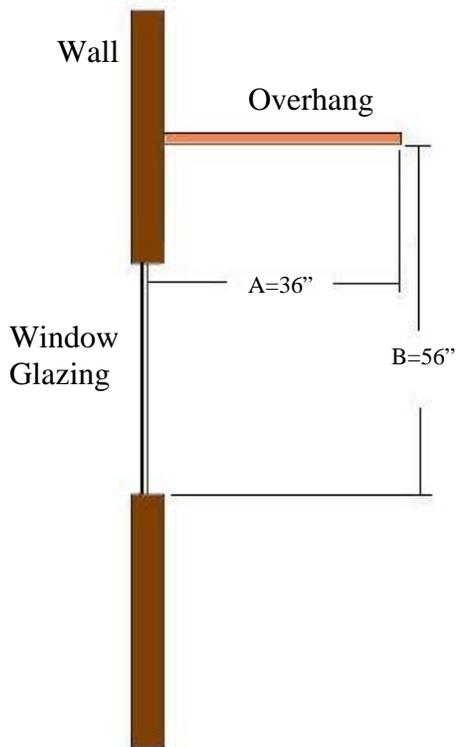
Simple Overhang



Sloped Overhang



Offset Overhang



Column P: Actual SHGC of Screen

If there is a screen on all or part of the window, enter the SHGC of the screen.

The SHGC of the screen should be available from the manufacturer. If the screen has not been rated, use a default value of 0.70.

Column Q: Interior/Exterior Screen

Click on a cell in column Q and an arrow for a pull-down menu will appear

If there is a screen on all or part of the window, choose whether the screen is exterior (outside the glass) or interior (inside the glass).

Column R: % of Window Covered by Screen

If there is a screen on all or part of the window, enter the percent of the window that is covered by the screen.

For example, if there is screen over half of the window glass, then enter 50%. If the screen covers the whole window, enter 100%. If there is no screen on the window, leave the default of 0% in this cell.

Column G: Exemptions Applied

Once the entries above have been entered for all windows, enter a total of 2160 in² (15 ft²) in column G.

IECC 2009 section 402.3.3 states that “up to 15 square feet of glazed fenestration per dwelling unit shall be permitted to be exempt from SHGC requirements...” Column G allows the template user to designate which window in the home will be used for the 15 ft² (2160 in²) exemption. Exempting the window(s) with the highest SHGC and least shading will minimize the weighted-average SHGC for the home.

The 2160 in² can be broken up and entered in different rows, as long as the area in any given row does not exceed the area of the window in that row and the sum of all areas entered in column G is equal to or less than 2160 in².

Explanation of Key Calculations

Column O: SHGC PF Multiplier

This column assigns a SHGC multiplier according to the projection factor of the window opening. The multiplier is assigned according to the table below. These multipliers are equivalent to the SHGC requirements for commercial buildings in IECC 2009 Table 502.3 with the exception that a PF equal or greater than one is assigned a SHGC multiplier of 0.00.

Projection Factor	SHGC multiplier
Equal or greater than 1.0	0.00
Equal or greater than 0.50 and less than 1.0	0.625
Equal or greater than 0.25 and less than 0.50	0.75
Less than 0.25	1.00

Column S: Effective SHGC of Screen

The SHGC of screens on the exterior of the windows are given full credit. However, some research indicates that screens on the interior of the windows is about 1/3 as effective as exterior screens¹. For exterior screens, the effective SHGC is calculated as:

$$\text{Effective SHGC for interior screens} = 1 - (1 - \text{SHGC})/3$$

Column T: Screen Multiplier

This column calculates the screen SHGC multiplier based on the effective SHGC of the screen and the percentage of the window covered by the screen.

$$\begin{aligned} \text{Screen multiplier} &= (\text{term for area covered by screen}) + (\text{term for uncovered area}) \\ &= (\text{Effective SHGC of screen} \times \% \text{ covered}) + (1 - \% \text{ covered}) \end{aligned}$$

Column U: Total Effective SHGC

The total effective SHGC is the actual window SHGC with all the multipliers applied:

$$\begin{aligned} \text{Total Effective SHGC} &= \text{Window SHGC} \times \text{Orientation multiplier} \times \text{Material multiplier} \\ &\times \text{PF multiplier} \times \text{Screen multiplier} \end{aligned}$$

Column V: Weighting

$$\begin{aligned} \text{The weighting for each window} &= \\ &\text{Window area after exemptions} \times \text{Total Effective SHGC} \end{aligned}$$

Weighted-Average SHGC

$$\text{The Weighted-Average SHGC} = \text{The sum of all weightings} / \text{total window area}$$

¹ Brugger, A. et.al., Measurement of the Solar Heat Gain Coefficient and U Value of Windows with Insect Screens, ASHRAE SE-99-15-04, 1999.