An in-depth look at windows

Windows provide light, air and views. They also affect heating and cooling loads through several heat transfer mechanisms.

When choosing windows to reduce cooling loads, the goal is to control conduction and solar heat gain.

Conduction is the transfer of heat through materials (represented by the U-value). This is the rate of non-solar heat gain or loss from the entire window assembly. The lower the U-value, the greater the window's resistance to heat flow.

The Solar Heat Gain Coefficient (SHGC) measures how easily heat from direct sunlight passes through a window. It is a fraction between 0 and 1. The lower the number, the less solar heat the window transmits.

SHGC is dependent on the layers of glazing, and the glazing thickness, tints and dimensions. Another factor that affects SHGC is the presence of low-emissivity (low-e) coatings. There are two types:

- hard-coat increases the insulating capacity of the glass and is best used where solar gain is wanted
- soft-coat is a better choice where cooling loads dominate.

The Efficient Windows Collaborative (efficientwindows.org/energystar.php) has a comprehensive table of properties for windows by climate zone. Here is a summary of the U-factor and SHGC by climate zone.

	U-factor	SHGC
North (heating)	0.25-0.32	0.35-60
North/Central (mixed)	≤0.30	≤0.40
South/Central (mixed)	≤0.30	≤0.25
South (cooling)	≤0.40	≤0.25

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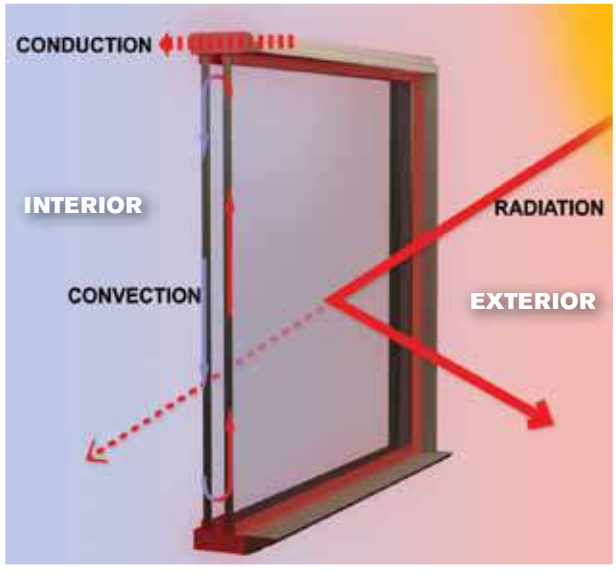

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Another property for window performance, Visible Transmittance (VT), indicates how much light passes through a window. Tints and reflective coatings that reduce SHGC can also reduce the VT dramatically. Spectrally selective low-E glass reduces solar heat gain without reducing visible transmittance.

An important part of designing to reduce solar gain is the angle of incidence: the angle at which solar radiation hits the glass. When the sun is high in the sky, more solar gain is reflected and the amount of solar radiation transmitted decreases.

Seasonal differences, orientation and latitude impact solar heat gain through windows: on a south-facing window in summer, when the sun's path takes it high in the sky, the angle of incidence at midday will be closer to perpendicular, and the amount of solar gain will be minimal. The angle of incidence on that same south-facing window at noon on a winter's day will be closer to the horizon, and so the amount of solar gain available will be higher. However, a west-facing window that sees only a small amount of winter gain will have significant solar gain in the summer over many hours due to the increasing angle of incidence as the sun moves on its long path to the horizon.

The best way to reduce overheating from south and west facing windows is to ensure good shading outside the building envelope – once the heat is inside the house, it must be dissipated. Shade can be provided by overhangs, awnings or by plantings where views are not crucial.

Minimize cooling loads

To minimize cooling loads, reduce solar gain by minimizing south-facing and maximizing north-facing windows. Ensure ratings are for whole-unit/total window vs. center-of-glass (COG) performance measurements.

Use windows with low SHGC and high VT for cooling climates (SHGC less than 0.4, VT greater than 0.6). Use tinted windows to reduce heat gain and control glare where VT is not crucial. In mixed and heating climates, use windows with low U-factor and low SHGC.