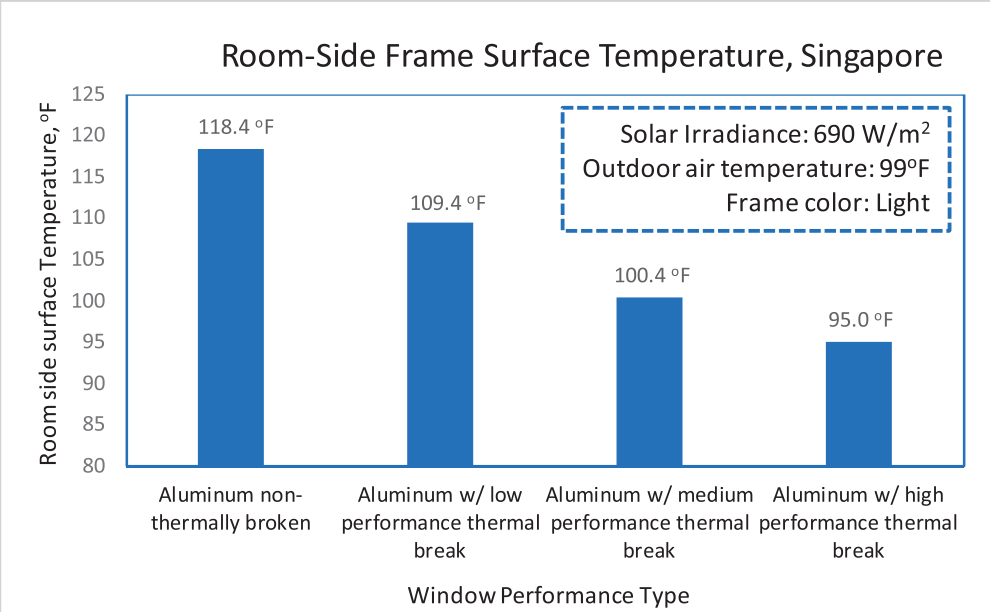
# Comfort Zone

## U-factor Matters – Even in Hot Climates

by Helen Sanders

It's commonly thought that window U-factor doesn't influence building performance significantly in hot climates and that solar heat gain dominates fenestration energy performance. The impact of U-factors generally is discounted in hot climates because energy efficiency losses due to thermal conduction decrease as the difference between outside and inside temperatures decrease. For example, if the temperature is the same inside a building as it is outside (say 70°F), then there is no temperature difference, and therefore no driving force for conductive heat flow either into, or out of, the building. In general, because the maximum temperature differences in hot climates are much lower (e.g. 110°F outside vs. 70°F inside) than the maximum difference in heating-dominated climates (-40°F outside vs. 70°F inside), the assumption is that U-factor performance is not so important. However, this assumption misses a key energy transfer mechanism associated with the opaque elements of the window: Solar absorption.




**The measured room-side frame temperatures for windows with a range of thermal performance installed in Singapore varied depending on the type of frame used.**

### Dark vs. Light

The opaque framing members on fenestration systems absorb solar heat from the sun, and as a result, can reach temperatures significantly higher than the outside air. The darker the frame, the more solar absorption, thus the hotter the frame becomes. Think of the difference you feel wearing a black shirt compared to a white one on a summer day. Solar absorption creates a much larger temperature difference between outside and inside than would be expected based on air temperatures alone.

If the frame is not thermally broken, heat will flow unhindered from the outside (hot) frame elements to the room-side (cool) frame elements. Not only will that result in higher cooling loads, it also will be thermally uncomfortable to sit next to the window because of the hot interior surfaces. The measured room-side frame temperatures for windows with a range of thermal performance (non-thermally broken to high-performance thermally-broken) as installed in Singapore are shown in the graph (above). The frames were light in color (so by no means a worst case for solar absorption), the outside temperature was 99°F and the solar irradiance was 690 W/m2. The room-side surface temperature of the non-thermally broken frame is an extremely high 118°F. A frame with a high-performance thermal break reduces the room-side surface temperature by more than 23°F, which can make a huge difference in both thermal comfort and cooling loads.

### Thermal Breaks

This means that the lower the U-factor of the frame, the lower the transfer of absorbed solar energy from outside to inside, and thus the lower the solar heat gain of the window. The solar heat gain of the frame therefore is proportional to its U-factor. Low solar heat gain windows can be achieved by having a low frame U-factor in combination with a low solar heat gain center of glass. Thermally breaking an aluminum frame can reduce the frame's solar heat gain coefficient by a factor of three.

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A similar rationale can be made for thermally breaking the edge of glass using warm-edge insulating-glass (IG) spacer systems. Thermally breaking the frame, but not the edge of glass, will result in heat flowing through the glass edge instead of the frame because heat finds the path of least resistance. This approach also will reduce the total solar heat gain performance of the window system.

Solar heat gain through the opaque elements of the window can be significant and is actually dependent on its U-factor. The take-away from this is that thermally broken frames and warm edge of glass solutions are needed in the desert and tropics as much as they’re needed in the wintry north. ■

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