Flashings shouldn't dam

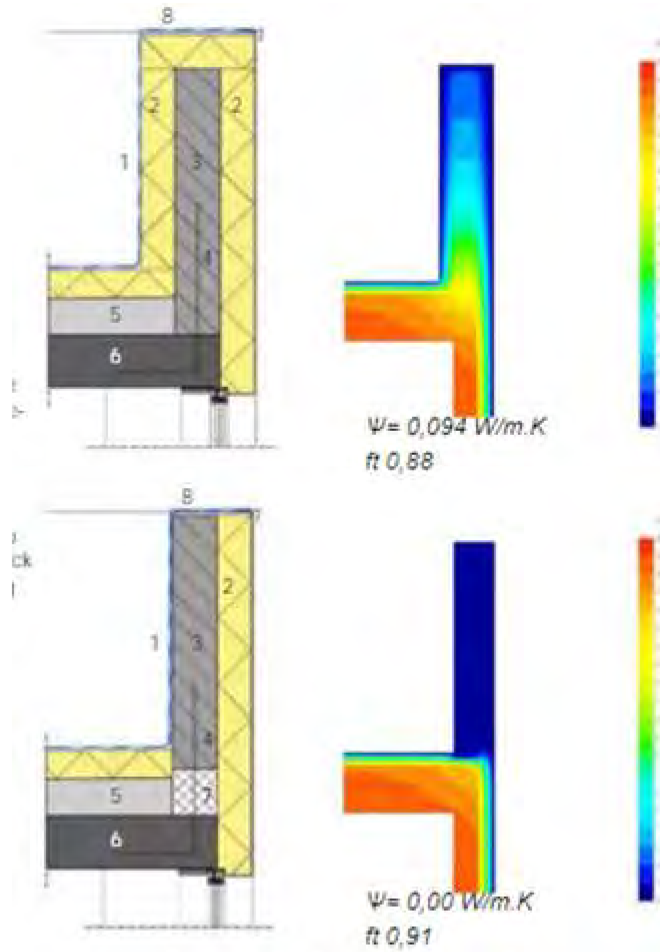
JLC, Harrison McCampbell, *Rethinking Window Flashing*

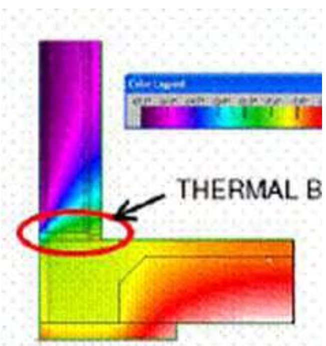
JLC, George Tsongas, *Sheathing Damage From Using Wide Impermeable Flashing*

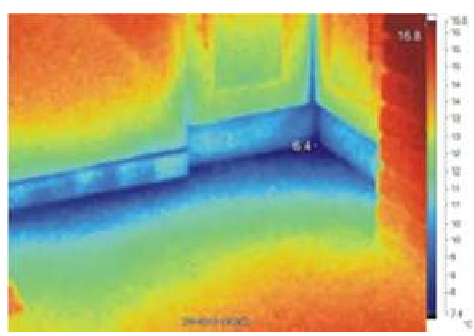
Thermal Control

Strong thermal control is based on:

- Continuous insulation layer
- Thermal bridge free joints and penetrations

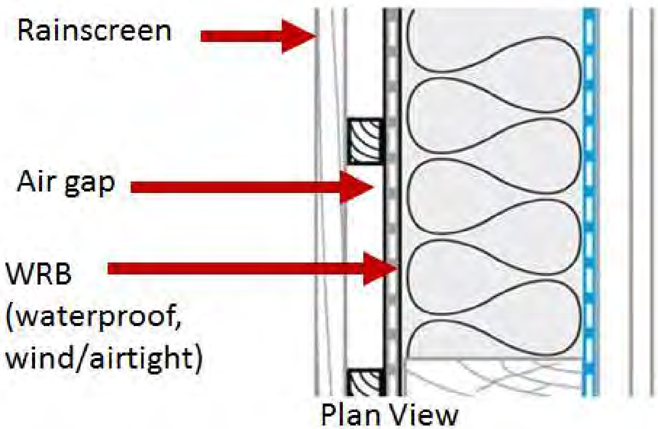


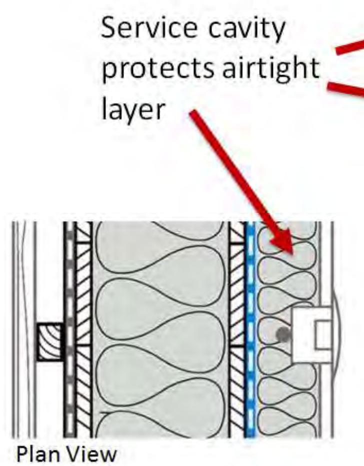




Integrated Penetrations

Protected Control Layers





Verified with blower door & repair

To deliver predictable high performance one must blower door enclosure, find leaks and repair.

High Performance Windows

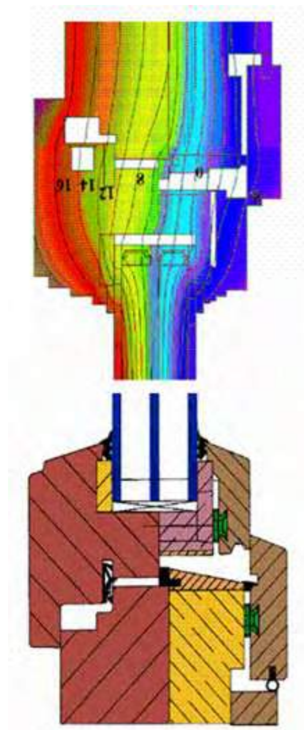
High Performance Windows

Properly installed high performance windows support enclosure performance.

Window performance:

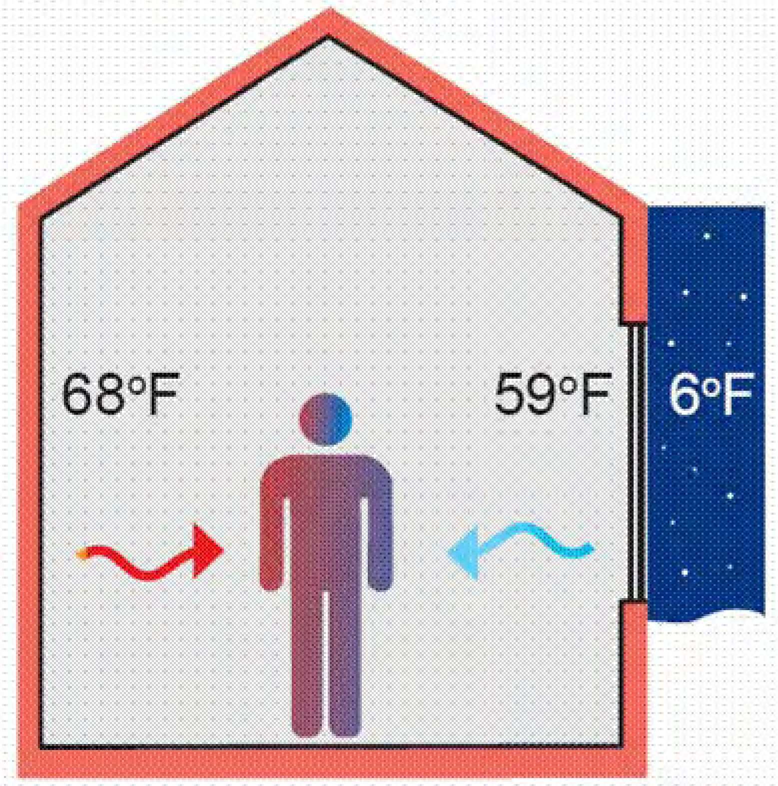
- airtightness
- glazing value
- frame value
- SHGC & VT
- shading - orientation - %

Optimized windows can improve the energy balance.



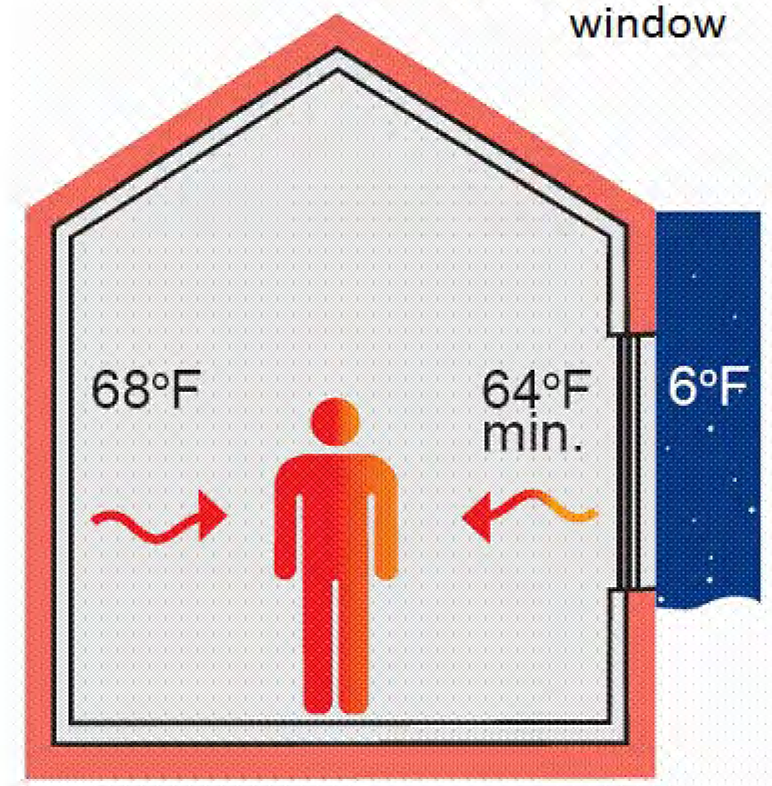
Uglass matters

Typical Double Glazing



discomfort

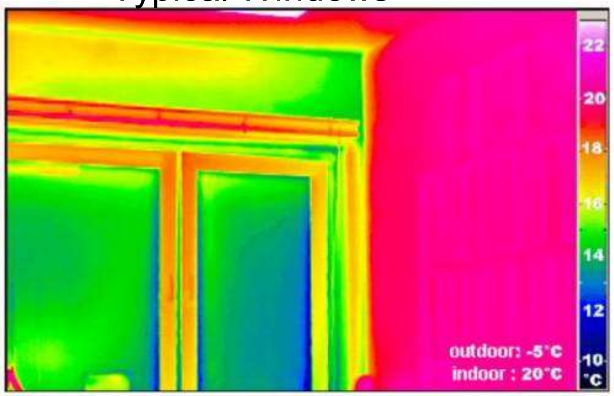
Triple glazed PH
window



comfort

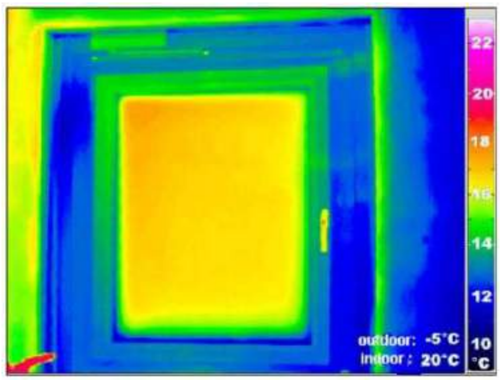
Frames and installs are weakest link

Typical Windows



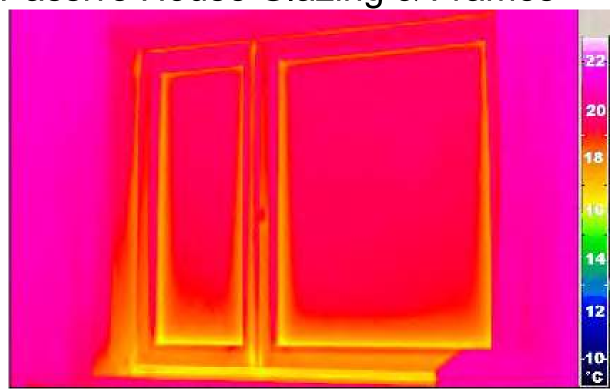
Poor glazing and frames

Improved Glazing



low e coatings

Passive House Glazing & Frames



Frames & connections are weak link

Passive House Institute

frames determine class…

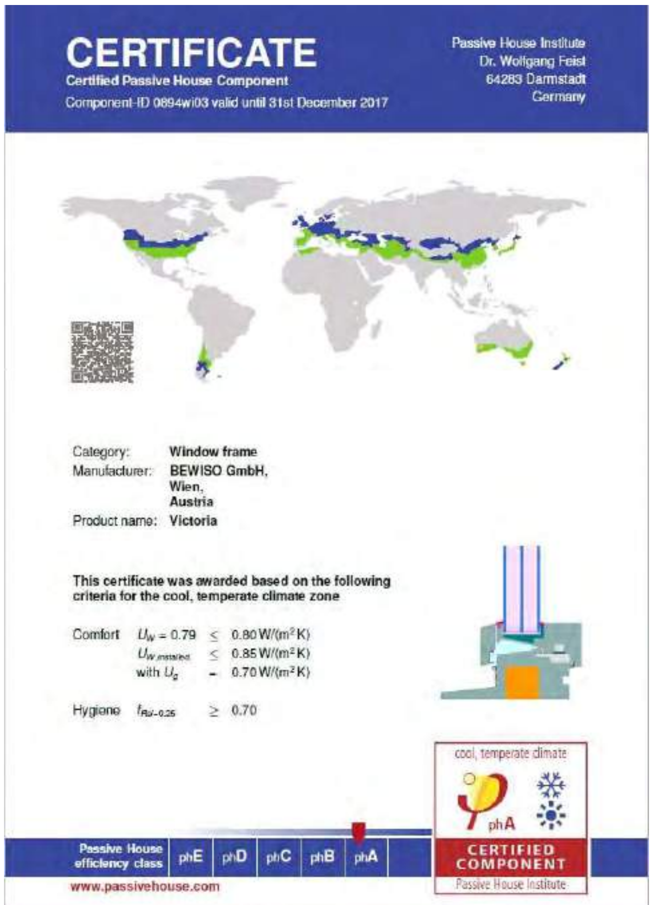


Table 1: Adequate certification criteria and U-values of the reference glazing

Climate zone	Hygiene criterion $f_{Rsi=0.25\ m^2K/W} \ge$	Component U-value[1] [W/(m²K)]	U-value installed [W/(m²K)]	Reference glazing [W/(m²K)] *
1 Arctic	0.80	0.40	0.45	0.35
2 Cold	0.75	0.60	0.65	0.52
3 Cool-temperate	0.70	0.80	0.85	0.70
4 Warm-temperate	0.65	1.00	1.05	0.90
5 Warm	0.55	1.20	1.25	1.10
6 Hot	None	1.20	1.25	1.10
7 Very hot	None	1.00	1.05	0.90

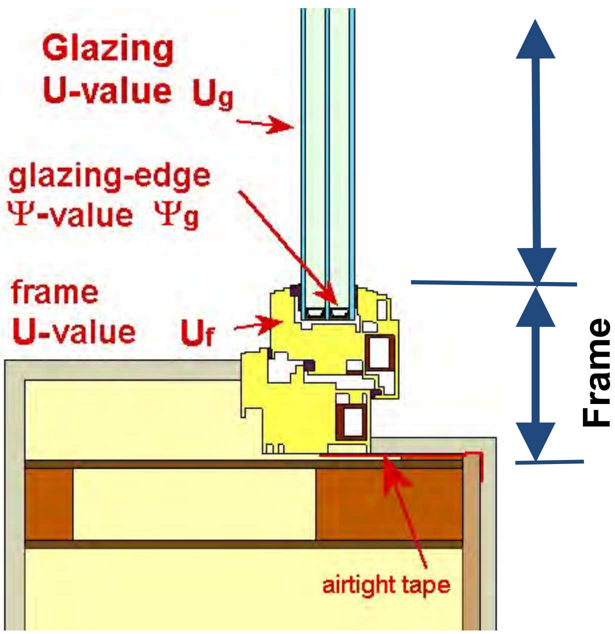
1 The following applies for inclined (45°) and horizontal (0°) components: the actual U_g value of the glazing used for the reference inclination, determined according to DIN EN 673, alternatively according to ISO 15099, should be used. The limit value in the installed state is the same as the limit value of the uninstalled component. The limit value of the component U-value for inclined building components compared to the limit value of the vertical component is increased by 0.10 W/(m²K), while that of the horizontal component is increased by 0.20 W/(m²K). Exception: in cool-temperate climates the limit value of the inclined component is increased by 0.20 W/(m²K), while that of the horizontal building component is increased by 0.30 W/(m²K).

Table 2: Passive House efficiency classes for transparent building components

Ψ_{opaque} [W/(mK)]	Passive House efficiency class	Description
≤ 0.065	phA+	Very advanced component
≤ 0.110	phA	Advanced component
≤ 0.155	phB	Basic component
≤ 0.200	phC	Certifiable component

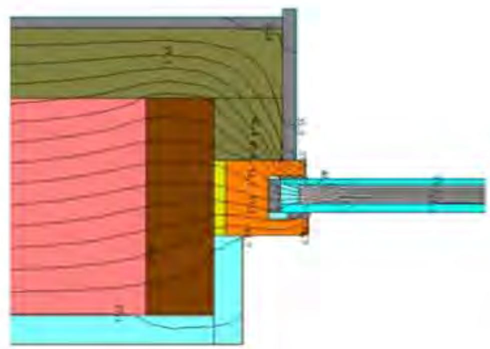
*Better glazing yields better overall window performance.

…and Uw-installed determine performance



And U_w – Installed:

Passive House Institute



- Interior Surface temp difference allowed = 4.2K max.
- θ_{op}K = operative temperature (average temp of interior room surfaces and interior air temperature.)
- θ_aK = (not clear to author at this time – requires PHI verification)

$$U_{w\text{-installed}} = \frac{(U_g{*}A_g) + (U_f{*}A_f) + (\psi_{edge}{*}L_g) + (\psi_{install}{*}L_f)}{A_w}$$

* This page PHI verified: Benjamin Krick 7.25.13.

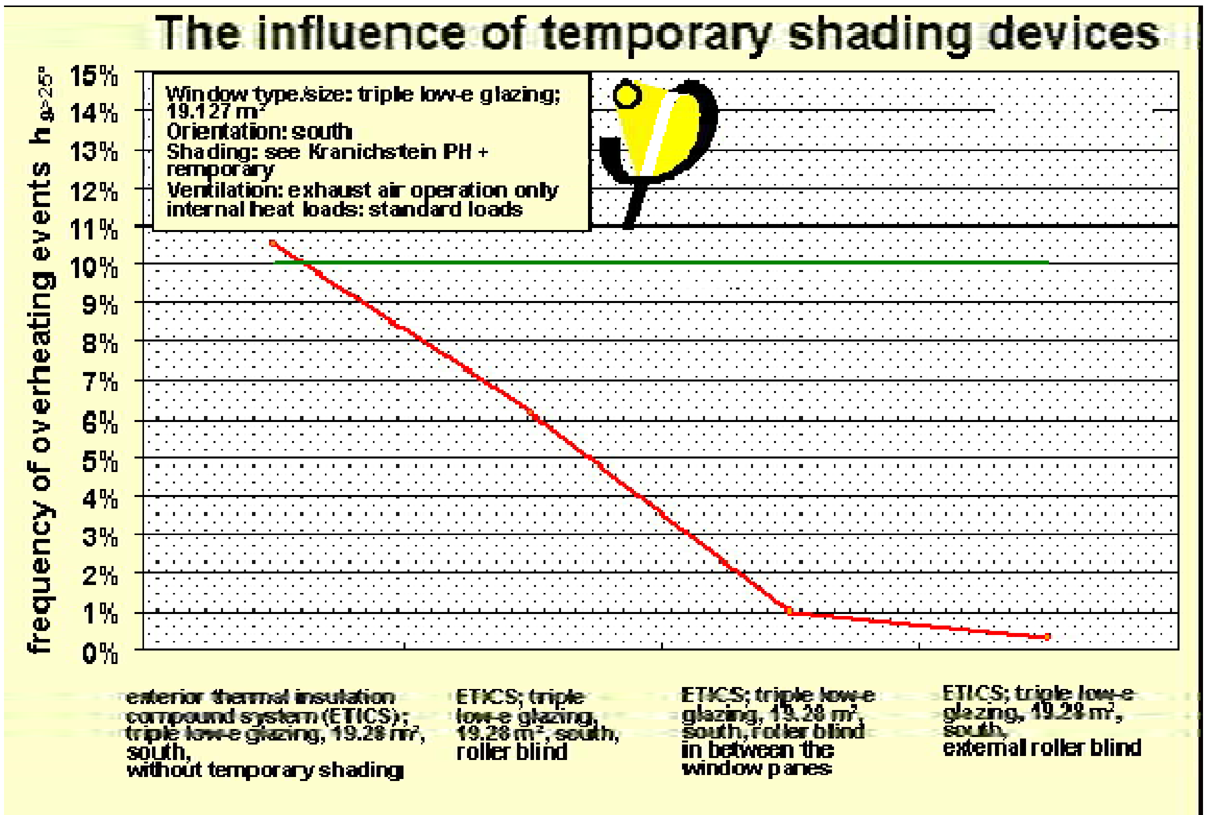
Solar Heat Gain Coefficient (SHGC)

The SHGC is the fraction of incident solar radiation admitted through a window, both directly transmitted and absorbed and subsequently released inward. SHGC is expressed as a number between 0 and 1. The lower a window's solar heat gain coefficient, the less solar heat it transmits.

In heating dominated climates a relatively high Solar Heat Gain Coefficient is beneficial when coupled with good shading control.

Shading is essential

….and is very effective



Skylights Energy Balance (heating)

Building Footprint: 200ft x 200ft
Skylights: 36 (38"x38" each)
Total glass area: 323 SF

Skylight	Thermal Bridge Free	Curb Insulation	Uglass BTU/hr.ft2°F	SHGC	Losses kBTU/yr	Solar Gains	Total Heat Gain or Loss	Total of heat loss/gain for building (%)
Double pane	No	None	0.24	30%	25935	11687	14248	212748 (7%)
Triple pane - conventional spacer	No	Non-Continuous	0.18	30%	23907	11053	12854	210114 (6%)
Triple pane - better spacer	Yes	Non-Continuous	0.18	30%	21907	11053	10854	208898 (5%)
Advanced component – low SHGC	Yes	4" Continuous	0.13	30%	10835	11032	**-197**	198079 **(0%)**
Advanced component – high SHGC	Yes	4" Continuous	0.13	**50%**	10835	18332	**-7497**	198079 **(-4%)**
Advanced component – high SHGC, shaded in summer	Yes	4" Continuous	0.13	**50%**	10835	18387	**-7552**	**191389 (-4%)**

Window Energy Balance (winter)

Climate:										81.8	
Window area orientation	Global radiation (cardinal points)	Shading	Dirt	Non-perpendicu-lar incident radiation	Glazing fraction	g-Value	Window U-Value	Glazing area	Average global radiation	Transmission losses	Heat gains solar radiation
maximum:	kWh/(m²a)	0.75	0.95	0.85			W/(m²K)	m²	kWh/(m²a)	kWh/a	kWh/a
North	123	0.76	0.95	0.85	0.664	0.50	0.82	12.63	131	1273	511
East	280	0.49	0.95	0.85	0.470	0.50	1.01	0.26	205	46	11
South	564	0.83	0.95	0.85	0.671	0.50	0.80	13.30	538	1293	2385
West	282	0.73	0.95	0.85	0.656	0.50	0.83	2.78	376	287	308
Horizontal	472	0.41	0.95	0.85	0.371	0.30	1.57	0.23	472	79	11
	Total or average value for all windows.					0.50	0.82	29.20		2977	3225

From PHPP9 – Heating and cooling tab

More useful winter gains than losses overall – with really good windows and installation details:

South facing windows are heating elements

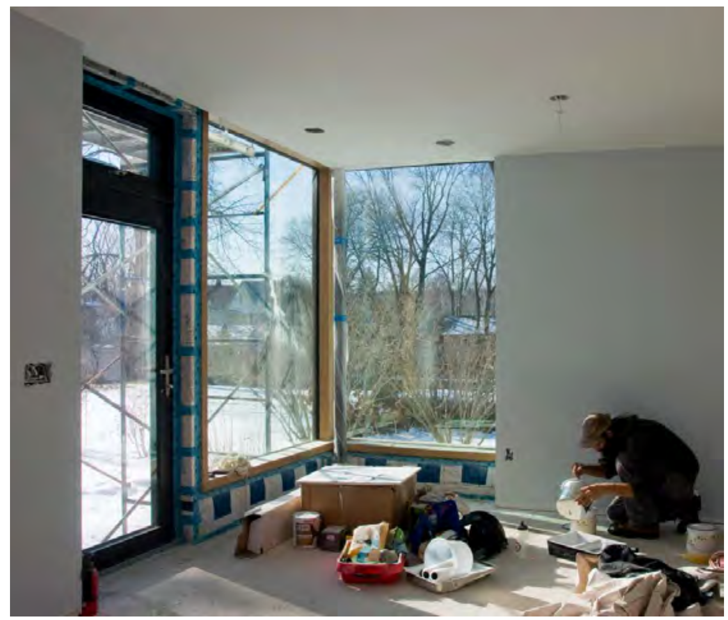
Short Break

The Installation Process

Window Installation Process

Design window placement for predictability and durability: CONTINUITY.

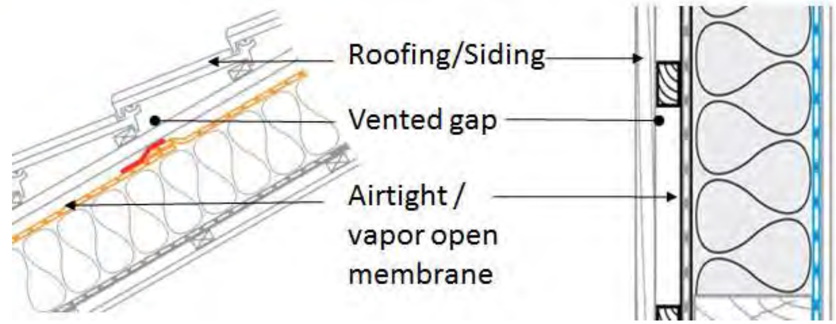
- Continuity of control layers.
- Simplicity of connections.
- Select compatible materials
- Sequencing Install
  - Exterior opening prep
  - Interior opening prep
  - Window placement
  - Connections
- Testing/Verification



Robert Swinburn Architect

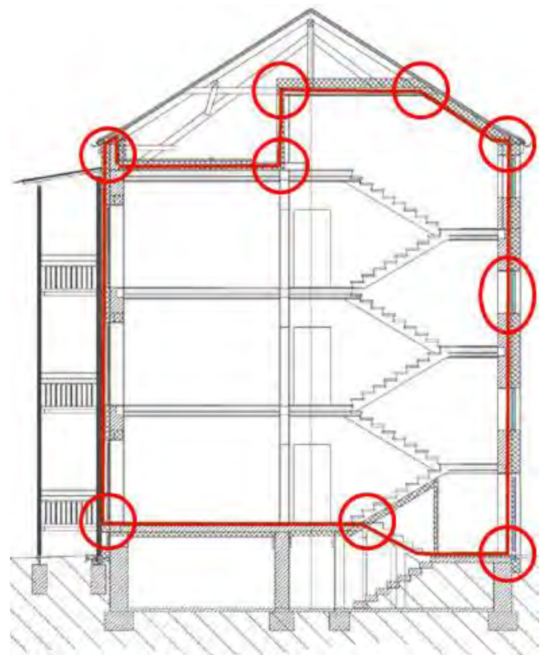
Design

- Continuity at Junctions
- Simplify Details
- Consider sequencing
- Integrate all penetrations
- Protection: back vented rainscreens & service cavities.

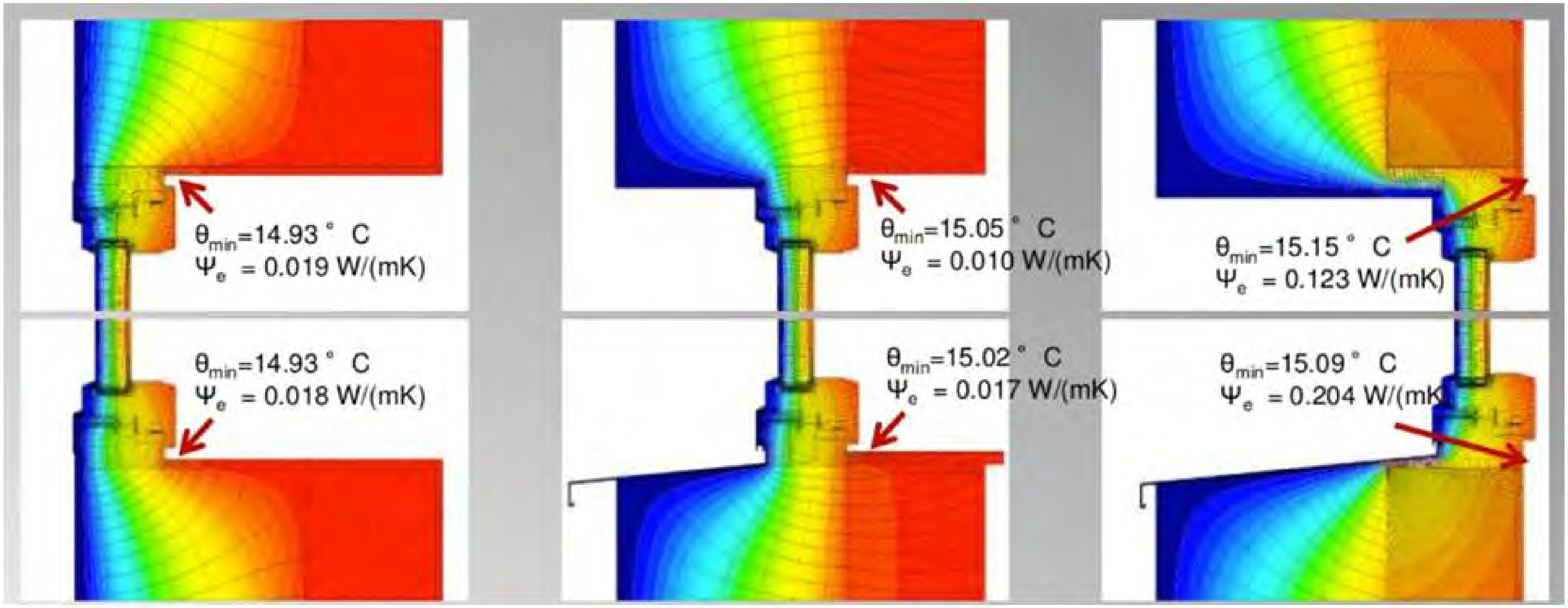


Step One

Step Two



Continuity: Window placement matters

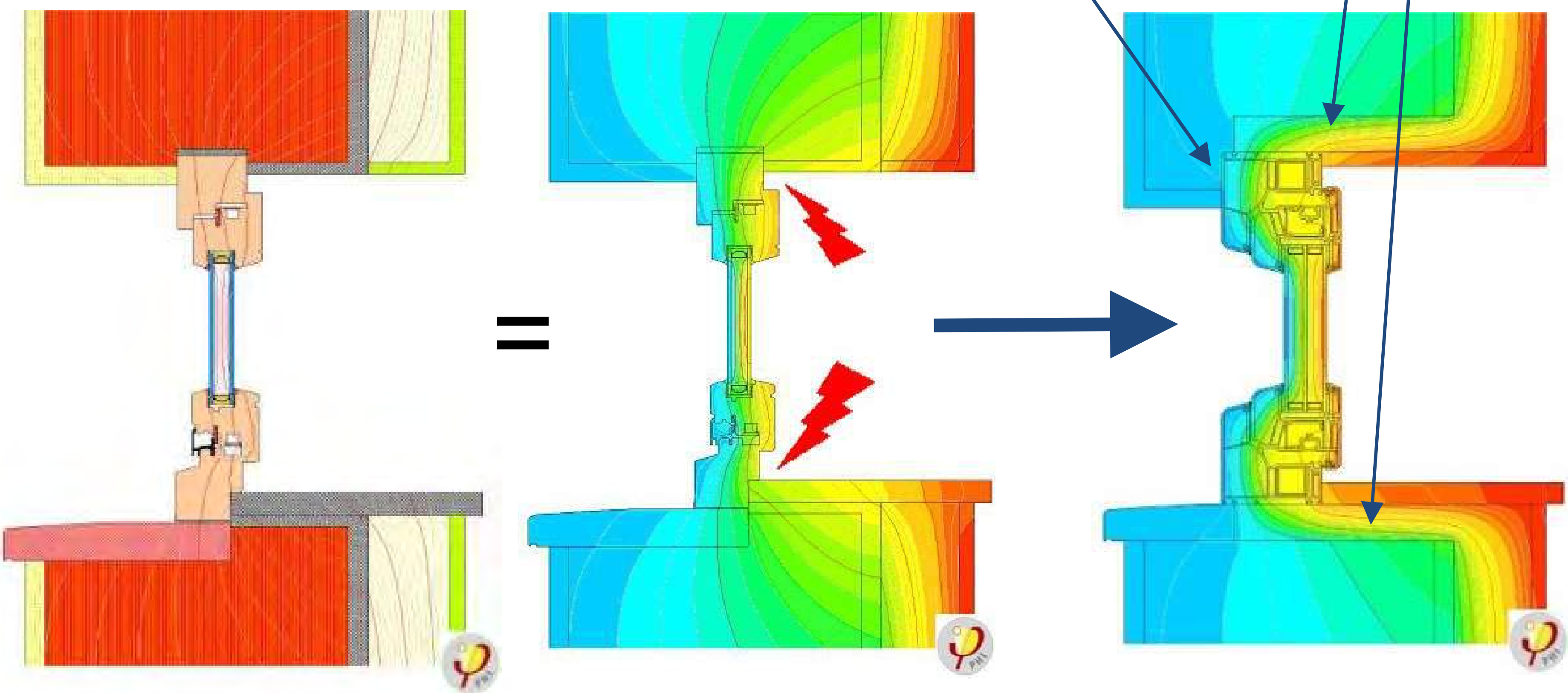


Uw installed = 0.151 BTU/h sf *F | Uw, installed=0.148 BTU/h sf *F | Uw, installed = 0.215 BTU/h sf *F

....bad to better

over insulate the face of frame at jambs & head if possible

insulation wraps structure to meet window

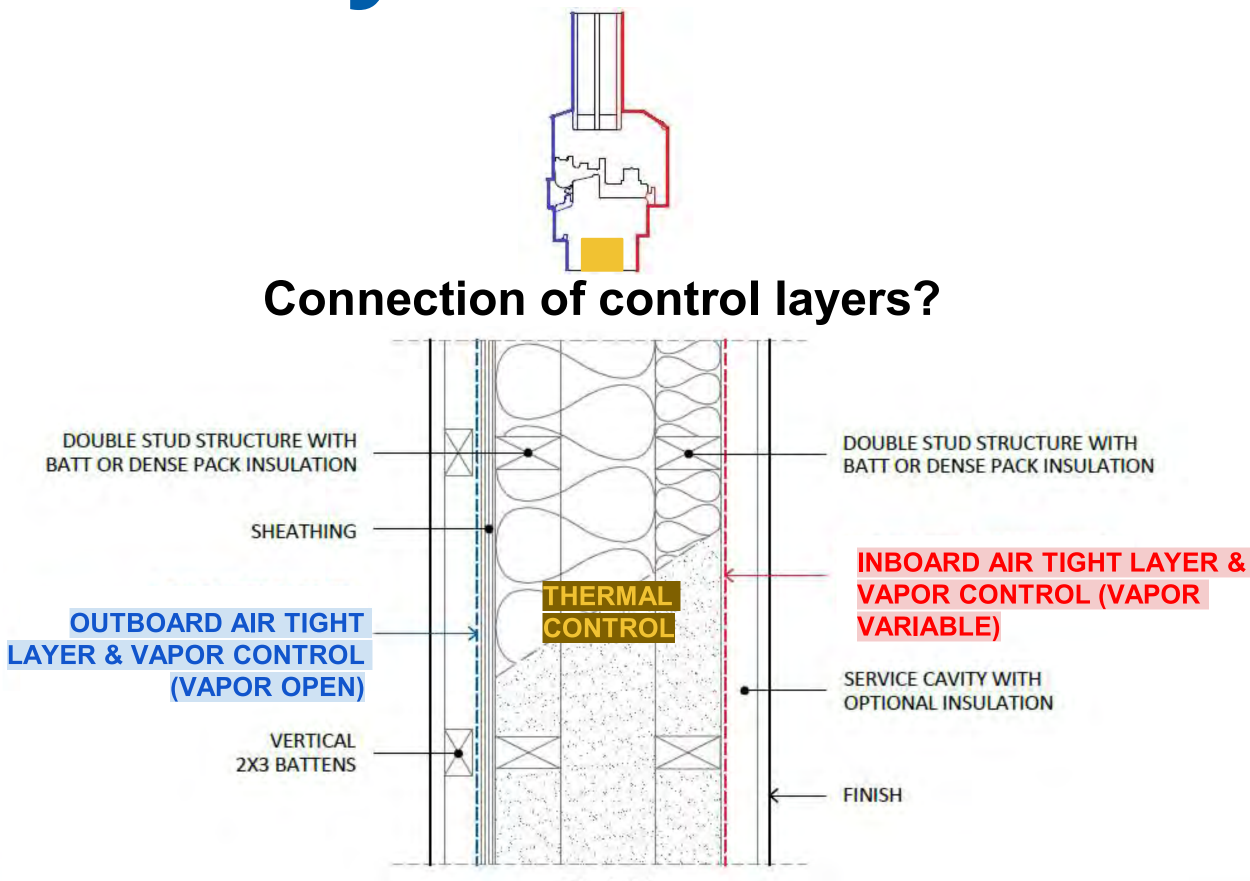


Bad

themography shows cold

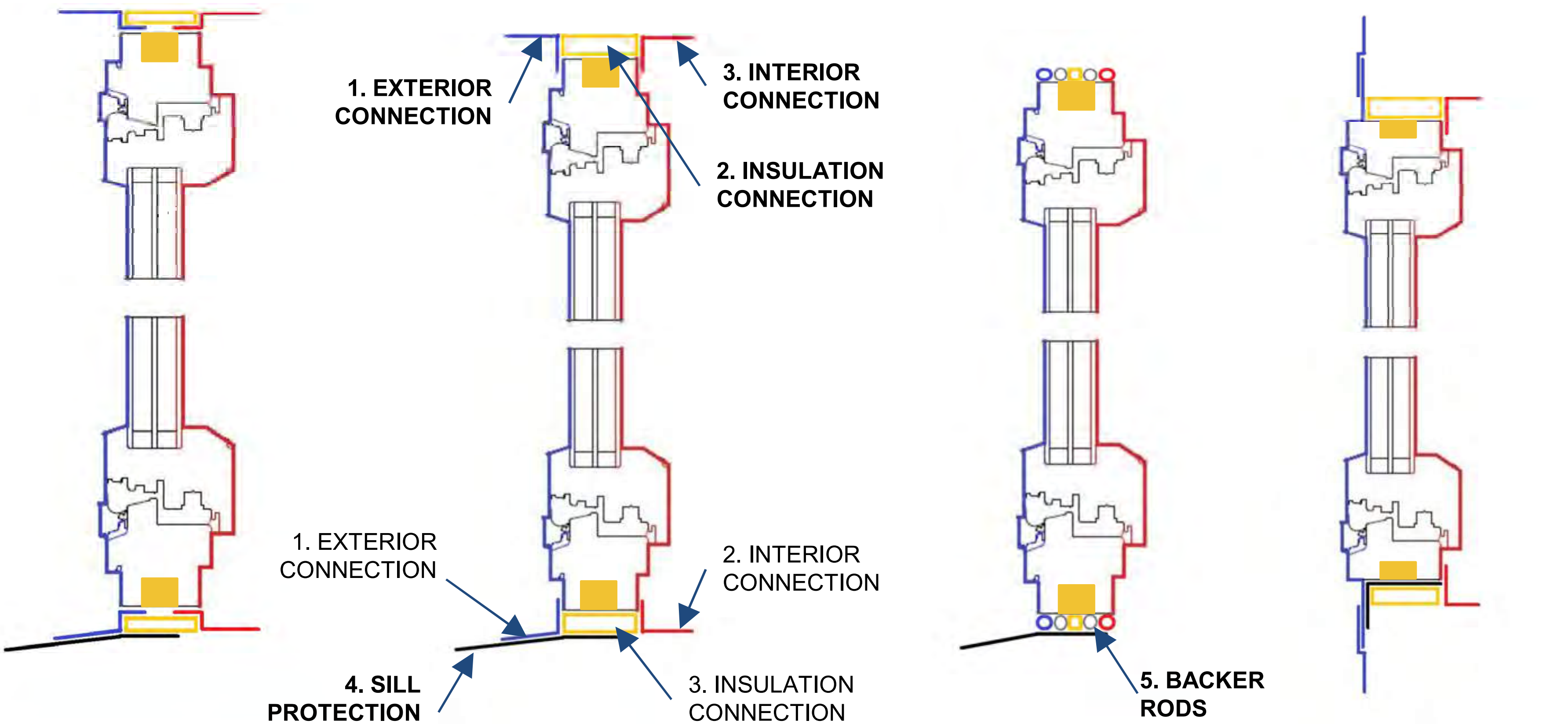
insulation connection warms locations

Design Connections for Continuity



Connection Continuity

ZERO REVEAL TAPE CONNECTIONS | **FACE TAPE CONNECTIONS** | **CAULK CONNECTIONS** | **FLANGE FRAME TAPE CONNECTIONS**



Connection Material Selections

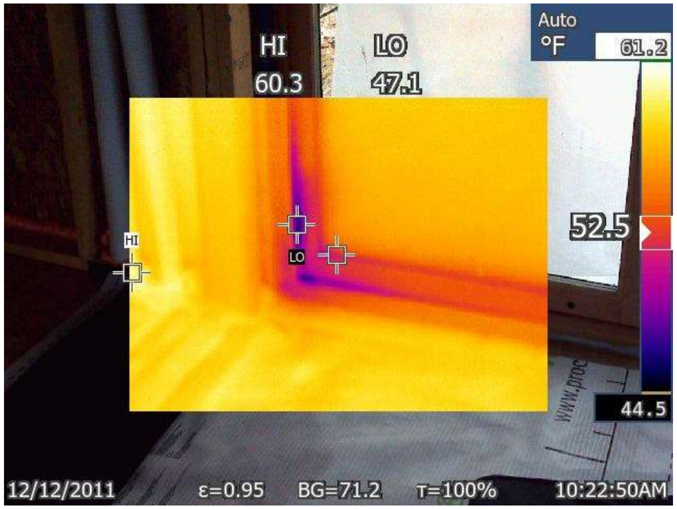
Airtightness & Vapor Control:
- Tapes
- Caulks
- Primers

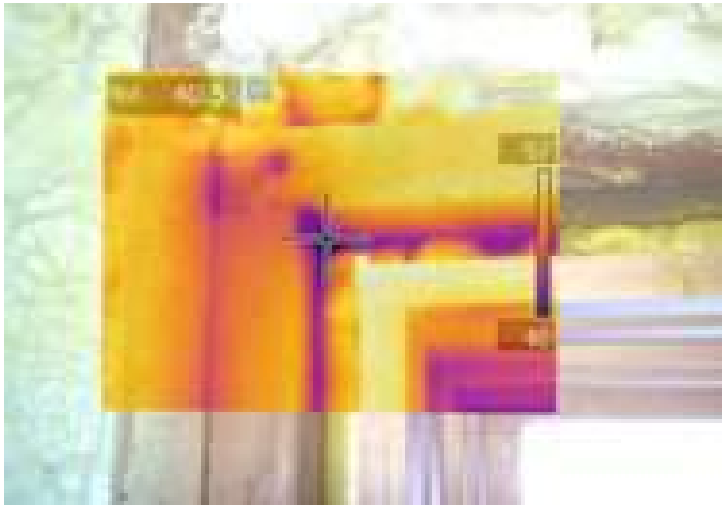


Insulation:
- Fibrous
  - fiberglass
  - mineral wool
  - sheeps' wool
- Foam?

Foam?

Foam does not provide airtightness.
Even when it looks good, it leaks.





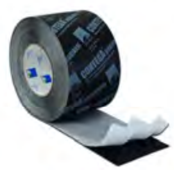
Tapes (Cold Climate)

PRESSFIX Tape Applicator

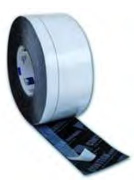
EXTERIOR ONLY

<u>**Sill tape**</u>: Vapor Closed Acrylic/Butyl ProClima EXTOSEAL ENCORS

Face Tape/Inside Corners: Vapor Open Fleece SOLID Acrylic split backing, ProClima CONTEGA Solido Exo (Zip Tape is vapor closed)



Zero Reveal Tape: Vapor Open Fleece, SOLID Acrylic, adhesive strip on reverse side, ProClima CONTEGA Solido Exo - D



EXTERIOR & INTERIOR

Flat Taping: Vapor permeable SIGA Wigluv, and SOLID Acriylic, ProClima TESCON Vana (3M 8067 is vapor retarding)

Inside Corners: Vapor Permeable SOLID Acrylic split backing, ProClima TESCON Profil

Pre-folded Inside Corners: Vapor Permeable, Acrylic, adhesive strip on reverse side, SIGA Fentrim IS 2 & ProClima TESCON Profect with SOLID Acrylic.

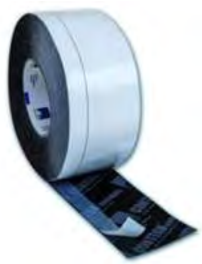
INTERIOR ONLY

Face Tape/Inside Corners: Vapor Retarding Fleece, SOLID Acrylic split backing, ProClima CONTEGA Solido SL

Pre-folded inside corners: Vapor Retarding Fleece, Acrylic pre-folded. SIGA, Fentrim IS 20

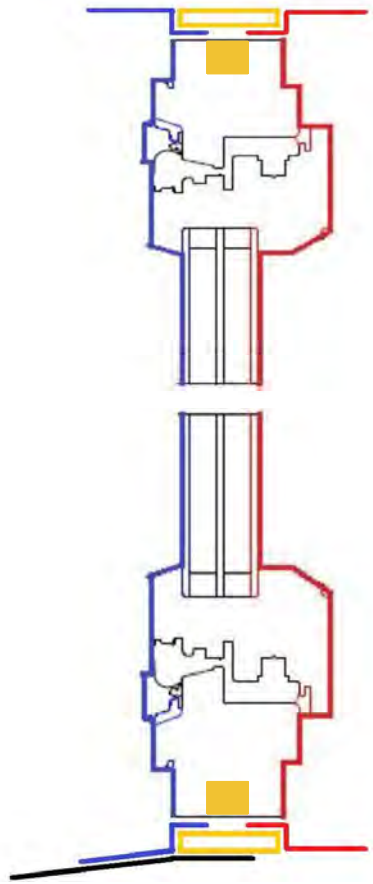
Zero Reveal Tape: Vapor Retarding Fleece, SOLID Acrylic, adhesive strip on reverse side ProClima CONTEGA Solido SL - D

Tapes for Zero Reveal:



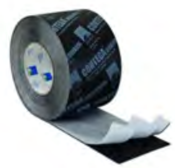
Exterior **Inside Corner Tape**: adhesive strip on reverse side at jambs, head & sill

Interior **Zero Reveal Tape**: adhesive strip on reverse side at jambs, head & sill



SILL TAPE: Extend 6” up jambs & approx 1” at wall face

Tapes for Face Connections:

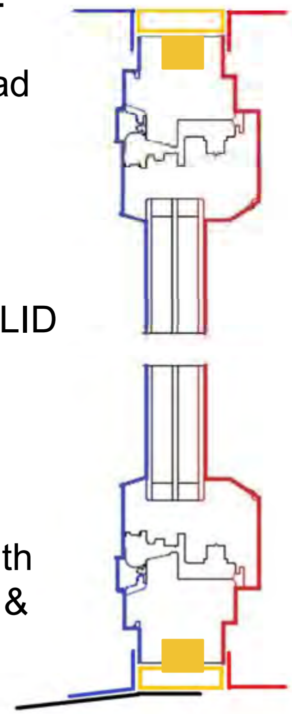


Exterior Option A:
Face Tape/Inside Corners: Vapor Open w/ split back SOLID Acrylic at jambs, head & sill

Exterior Option B:
Pre-folded inside Corner Tape: Vapor Permeable SOLID Acrylic at jambs, head & sill

Exterior Option C:
Inside Corner Tape: Vapor Permeable SOLID Acrylic with split backing at jambs, head & sill.

SILL TAPE: Extend 6” up jambs & approx 1” at wall face

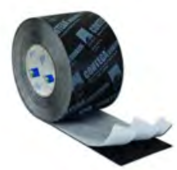


Interior Option A:
Face Tape/Inside Corners: Vapor Retarding SOLID Acrylic, w/split back at jambs, head & sill.

Interior Option B:
Pre-folded inside Corner Tape: Vapor Permeable SOLID Acrylic at jambs, head & sill.

Interior Option C:
Inside Corner Tape: Vapor Permeable SOLID Acrylic with split backing at jambs, head & sill.

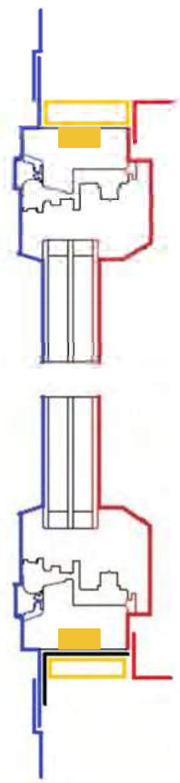
Tapes for Flange Connections:



Exterior Option A:
Face Tape/Inside Corners: Vapor Open w/ split back SOLID Acrylic at jambs, head & sill

Exterior Option B:
Flat Tape: Vapor Permeable SOLID Acrylic at jambs, head & sill.

Exterior **SILL TAPE**: Extend 6” up jambs & approx 1” at wall face



Interior Option A:
Face Tape/Inside Corners: Vapor Retarding SOLID Acrylic, w/split back at jambs, head & sill.

Interior Option B:
Inside Corner Tape: Vapor Permeable SOLID Acrylic with split backing at jambs, head & sill.

Interior Option C:
Pre-folded inside Corner Tape: Vapor Permeable SOLID Acrylic at jambs, head & sill.

Caulk connections?

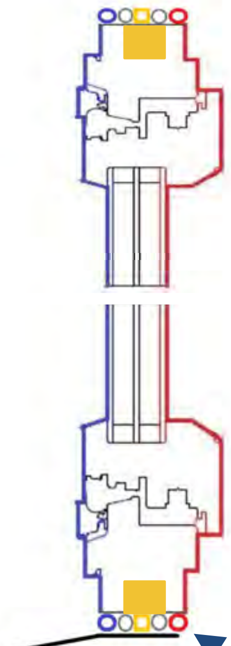
Joint Preparation

For joints less than one-half (½) inch wide, sealant depth should be equal to the width of the joint.

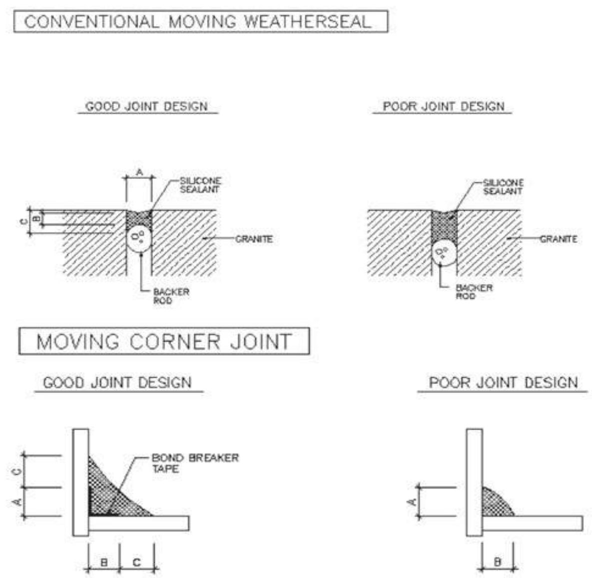
For joints ranging from one-half (½) to one (1) inch wide, sealant depth should be approximately one-half (½) the joint width.

In deep joints, control sealant depth by installing closed cell backer rod. The diameter of soft backer rod should be 25% greater than the joint width. Do not puncture backer rod.

Where joint depth does not permit use of a backer rod, install bond breaker tape to prevent three point bonding.



Be sure caulks are compatible with other materials. Choose appropriate caulks for interior and exterior usage.



Caulking at interior and exterior, at all four sides with backer rods