

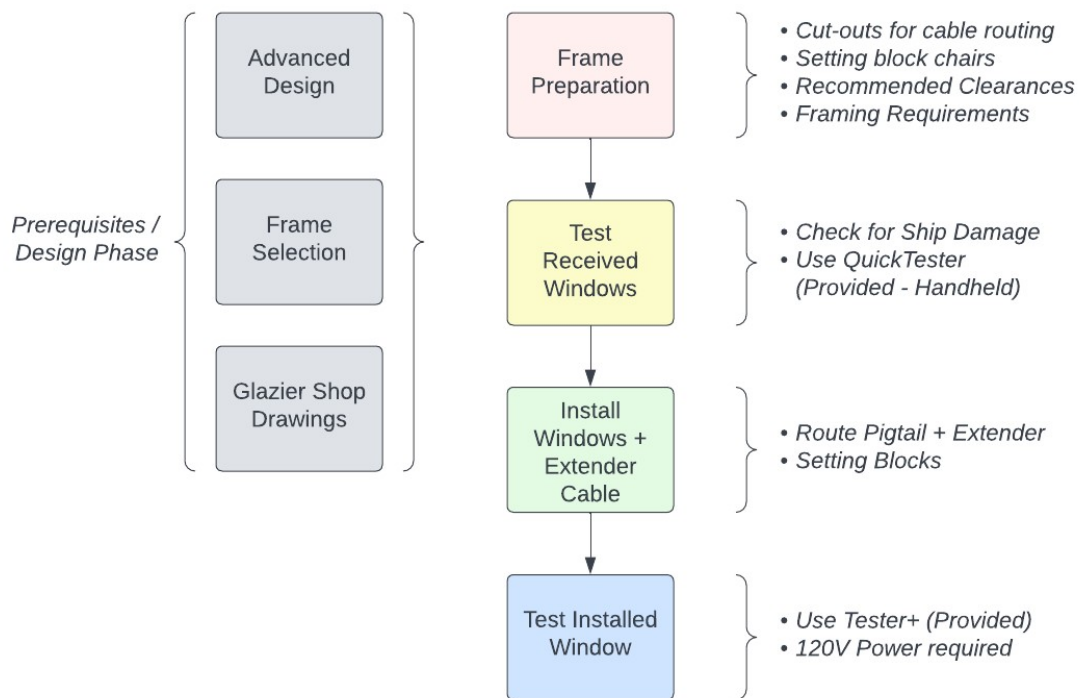
Viracon PLUS™ Smart Glass powered by HALIO® Glazing Guidelines

Viracon PLUS Smart Glass powered by HALIO is a laminated insulating glass unit (IGU). The outboard is a laminated electrochromic (EC) device. A pigtail is attached to the IGU to allow the unit to be connected to electricity once installed. The electrochromic device within the laminate is manufactured by HALIO. The laminated outboard glass and insulating glass unit configuration is fabricated by Viracon.

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High Level Installation Flow



Prerequisites / Design Phase

Prior to installation, the **Advanced Design** and the **Frame Selection** will inform the installation phase of the project. The output of this phase should be detailed drawings showing:

Frame Details + Design

Glazier Shop Drawings

Marked up with Pigtails + Extender Cables Placement

See Figures 1 and 2 for examples of the output of Advanced Design. These drawings will be available from HALIO to the Glazier prior to any window arrival and should inform the first installation step “Frame Preparation”

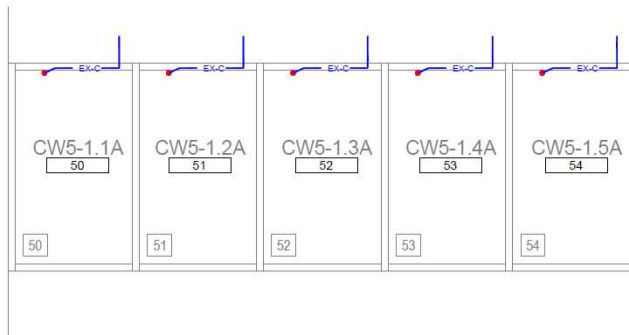
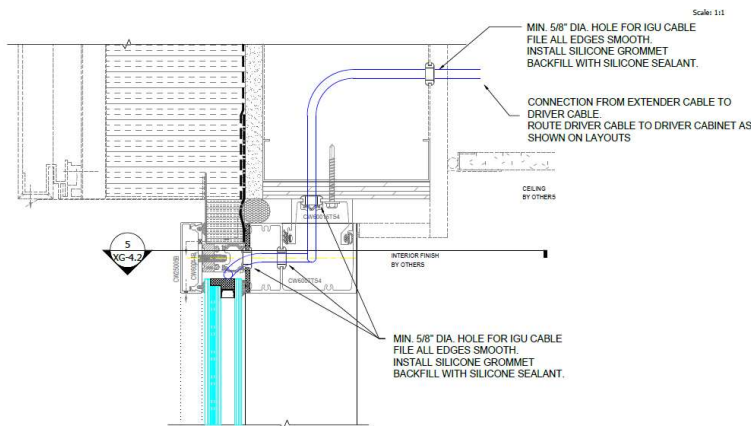


Figure 1: Elevation Drawing (Glazier Shops) showing Pigtail + Extender Cables



9 CW: HEAD DETAIL W VISION GLASS - CW4, CW5, CW5.1, CW5.2, CW5.3, 5.3B

Scale: 1:1

Figure 2: Detail Drawing (from Glazier Shops) showing Extender Routing

Frame Preparation

The first step for installation of Smart Glass is to prepare the Framing for the cable routing and glass installation.

Cable Preparation

Every Smart Glass window with HALIO is connected to driver electronics in a cabinet that is located up to 300 ft from the window. The cable chain from window to driver is typically:

- 1) Pigtail (attached directly to IGU)
- 2) Extender Cable (Connects from IGU to the 'dry side' of the building)
- 3) Driver Cable (Connects HALIO Driver to Extender Cable)

The Glazier's scope is proper installation, routing, attachment and testing of 1) and 2).

The Electrician's scope is proper connection and testing of 3).

During Frame Preparation, Advanced Design drawings are reviewed to identify location of holes needed for cable routing.

REQUIREMENT: All holes or slots must be 5/8" diameter minimum to accommodate the connector on the pigtail and extender cable

REQUIREMENT: All holes or slots must be deburred (filed until smooth)

REQUIREMENT: Grommets (nylon or silicone) must be installed on holes, backfilled with silicone. If the frame is cut with a slot, nylon split tubing or equivalent protection must be used to protect the cables from the edges of the slot. See **Appendix A** for grommet recommendations and examples of proper deburring tools.

In general, there are 3 options for Frame Preparation:

1. Cut a 7/8" hole and install a grommet with 5/8" inner diameter.
2. Cut a 5/8" hole and debur carefully. During window installation, a split grommet will be installed around the cabling.
3. Cut slots (if holes are not possible) and debur carefully. During window installation, split tubing will be used to protect the cabling.

See Figure 3 on the following page for example drawings showing location for holes

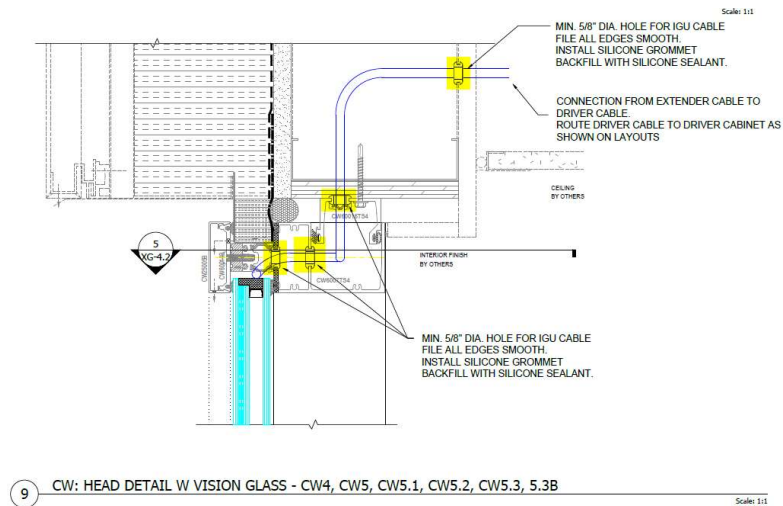


Figure 3: Example drawing with highlighted locations for holes

Setting Block Chairs

The Smart Glass IGU must be fully supported by appropriately sized support blocks per the latest GANA Glazing Manual guidelines. The Smart Glass IGU width is typically greater than standard 1", so for structural silicone glazing it is important to confirm the size of the support block chair.

REQUIREMENT: The support block and chair must fully support the Smart Glass IGU along its full length and width.

See Figure 4 for graphical representation of the requirements for Structural Silicone (SSG) support chairs. This will be discussed more in Section 3 (Window Installation)

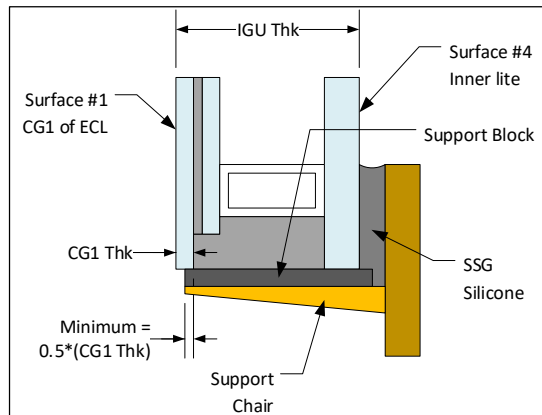


Figure 4: SSG Support Block Geometry

Specific details for Smart Glass Support Block Requirements are found in **Appendix B**

Recommended Clearances

- Edge clearance: 1/4"
- Face clearance: 3/16"
- Dimensional tolerance: +3/16", - 1/16"
- Thickness tolerance: $\pm 1/16$ "

Framing Requirements

The framing systems must provide continuous support to the Smart Glass IGUs to mitigate edge of glass deflection. Framing requirements:

- Deflection of the framing members under design loads must not exceed the length of the span divided by 175.
- Deflection of the horizontal sill member due to the weight of the glass should not exceed 1/8" nor should the deflection decrease the head clearance of the panel below by more than 25%.
- Twist of the horizontal sill member between the ends and center of each span, due to the weight of the glass, must be limited to one degree.
- Bow must not exceed 1/16" in any four-foot length of the framing.
- Squareness must be controlled to 1/8" difference in the lengths of the diagonals.
- Offset of adjoining members must not exceed 1/32" at the corners.

Additional glazing guidelines can be found at www.viracon.com/glazing-guidelines.

Test Received Windows

Once windows are received on site, they must be tested with the Quick Tester, a HALIO-provided custom tool. This tool is handheld and provides immediate feedback in the form of red/green LED's.

REQUIREMENT: All units must be tested using Quick Tester prior to installation

REQUIREMENT: All units must have pigtail caps attached unless actively being tested

See Figure 5 for an image of a Pigtail and Pigtail Cap. The cap screws onto the end of the pigtail. All units should arrive with Pigtail Cap already attached.



Figure 5: HALIO Pigtail (Capped) and Pigtail Cap

Upon unpacking each crate, every unit is tested using the Quick Tester (see Figure 6). The test flow chart should follow the chart shown in Figure 7 on the following page.



Figure 6: HALIO Quick Tester

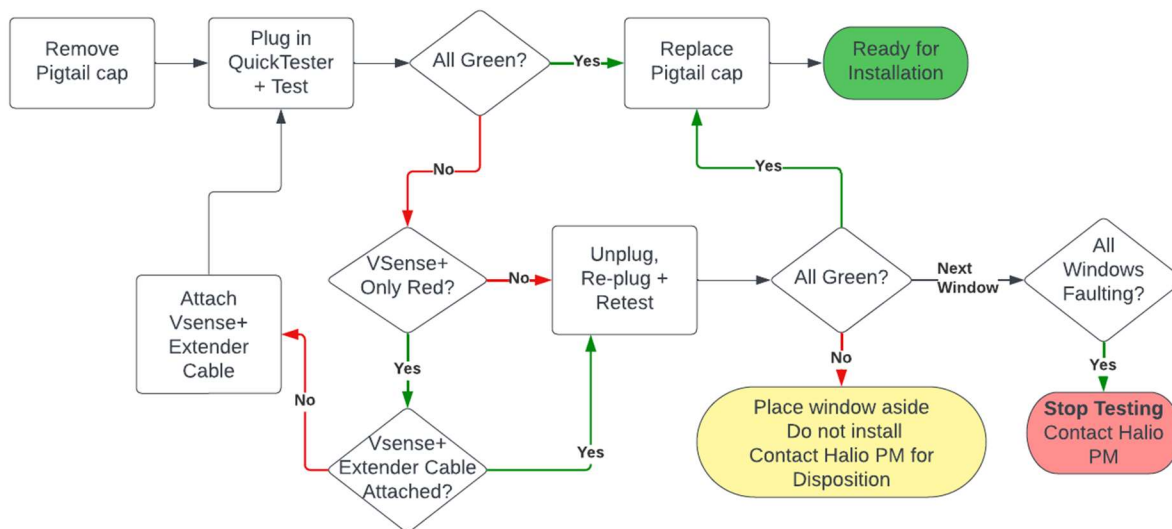


Figure 7: Quick Tester Test Flow

More details on the tester can be found in **Appendix C**, the QuickTester User Guide.

Install Windows + Extender Cable

Setting Blocks

Smart Glass IGUs must be fully supported by appropriately sized support blocks per the latest GANA Glazing Manual guidelines. The IGU width of the Smart Glass IGU is typically greater than standard 1", **so standard 1" width support blocks will not be acceptable.**

REQUIREMENT: The support block and chair must fully support the Smart Glass IGU along its full length and width.

Setting blocks must be:

- 100% silicone and 85±5 shore durometer hardness
- Located at ¼ points
- Size:
 - Support at least 50% of outermost substrate
 - 0.1" in length for each square foot of glass, but never less than 4"

Edge Blocks must be used for conventional glazing systems. Edge blocks must be:

- 100% silicone and 60 ±5 shore durometer hardness
- At least 4" long and located on vertical jamb opposite pigtail.
- 1/8" clearance between edge of glass and block

See Figure 8 for the setting block requirements for both Structural and Captured Framing

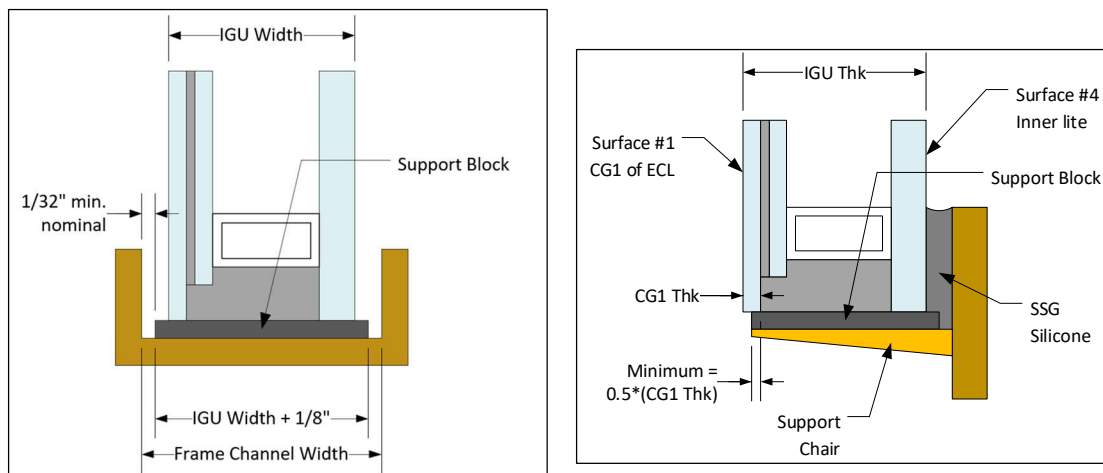


Figure 8: Support Block Requirements for Captured (left) and SSG (right) framing systems

Specific details for Smart Glass Support Block Requirements are found in **Appendix B**

Silicone Trimming

Because of the buried cable in the secondary seal of the Smart Glass IGU's, care must be taken when doing any silicone trimming. Smart Glass Pigtails typically come in two different types: "B-Exit" and "D-Exit". Also, depending on the orientation of the Smart Glass unit, the pigtail may exit on either of the top corners.

REQUIREMENT: Silicone trimming is NOT allowed in the area shown in Figure 9

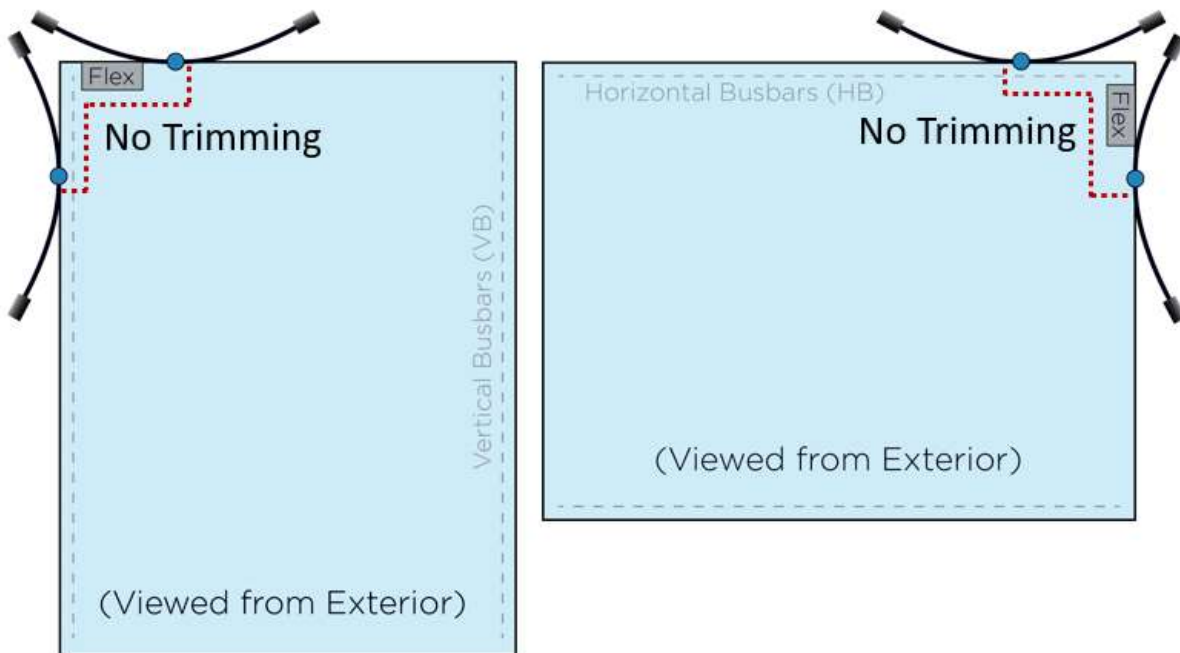


Figure 9: Location on window where Silicone Trimming is not allowed

Routing Pigtails + Extender Cables

REQUIREMENT: Grommets (nylon or silicone) must be installed on holes, backfilled with silicone. If the frame is cut with a slot, nylon split tubing or equivalent protection must be used to protect the cables from the edges of the slot. See **Appendix A** for grommet recommendations and examples.

After the window is installed, the cables must be set so that they are ready for connection to the electrochromic device cables. As noted above in Frame Preparation section, any holes or slots in the frame must be properly prepared so that the cables are protected through the frame sections. If grommets or protection were not installed during Frame Preparation, split grommets or nylon tubing must be installed at this time to protect the cable.

REQUIREMENT: All units must have waterproof caps attached unless actively being tested.

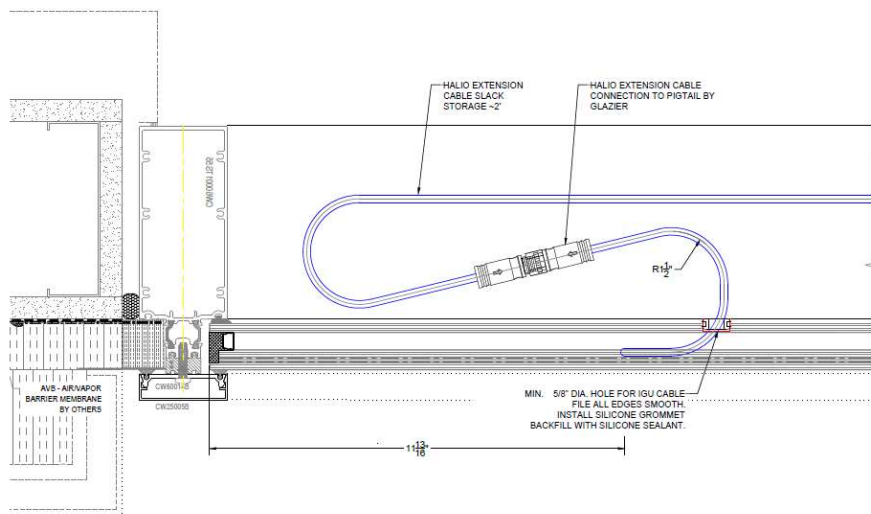
The pigtail cap should be moved from the pigtail to the extender cable after this connection is made so that all cable chains are still capped by the waterproof caps.

REQUIREMENT: PVC Extender Cables **cannot** be left in contact with IGU secondary seal after installation.

See Table 1 for list of Extender Cable SKU's that contain PVC (CMP or plenum rated) and are subject to this requirement. Also, see Figure 10 for design example where the extender cable is kept separate from the IGU seal.

Length	Jacket Material	
	B2CA (PVC-free)	CMP (plenum rated)
0.25 m (0.8 feet)	EG003	EH003
0.5 m (1.6 feet)	EG005	EH005
1 m (3.3 feet)	EG010	EH010
2 m (6.6 feet)	EG020	EH020
8 m (26')	EG080	EH080
15 m (49')	EG150	EH150
23 m (75')	EG230	EH230
30 m (98')	EG300	EH300

Table 1: List of Extender Cable SKU's that contain PVC



HORIZONTAL SECTION - VERTICAL MULLION CABLE EXIT

Figure 10: Example of design where Extender Cable is kept separate from IGU

Recommended Clearances + Framing Systems

Recommended Clearances:

- Edge clearance: 1/4"
- Face clearance: 3/16"
- Dimensional tolerance: +3/16", - 1/16"
- Thickness tolerance: $\pm 1/16"$

Glazing systems must have a positive wet seal or adequate weep system to prevent exposure to moisture. Repeated or prolonged exposure to moisture vapor or liquid water will lead to product failure and void product warranty.

The framing systems must provide continuous support to Smart Glass products to mitigate edge of glass deflection.

Framing requirements:

- Deflection of the framing members under design loads must not exceed the length of the span divided by 175.
- Deflection of the horizontal sill member due to the weight of the glass should not exceed 1/8" nor should the deflection decrease the head clearance of the panel below by more than 25%.
- Twist of the horizontal sill member between the ends and center of each span, due to the weight of the glass, must be limited to one degree.
- Bow must not exceed 1/16" in any four-foot length of the framing.
- Squareness must be controlled to 1/8" difference in the lengths of the diagonals.
- Offset of adjoining members must not exceed 1/32" at the corners.

Additional glazing guidelines can be found at www.viracon.com/glazing-guidelines/.

Test Installed Windows

After installation of Smart Glass IGUs, including all extender cable connections, the IGUs must be tested using the provided HALIO Tester+ tool. This tool will be provided by HALIO and shipment should be arranged with the HALIO Project Manager. Please assume a two-week lead time to receive the HALIO Tester+.

REQUIREMENT: HALIO Tester+ must be used after installation. This tool requires 120V power and each window sticker must be barcoded along with this testing.

The HALIO Tester+ tool contains two parts:

- Zebra Handheld Computer
 - This is the user interface and the tool used to record the FlexID barcode
- QC Tester + cables
 - This is the plug-in tester box which communicated wirelessly to the Zebra
 - It requires 120V power and connects to the window Pigtail (or Extender Cable)

See Figure 11 for image of the Tester+ contents. HALIO will provide additional extension cables for testing – these are commonly used to test units where the extender cable exits in the ceiling. In these cases, this additional extension cable is dropped to the floor where the Tester+ can connect to the cable. See Figure 12 on the following page for the typical steps for testing each window.



Figure 11: HALIO Tester+ Contents

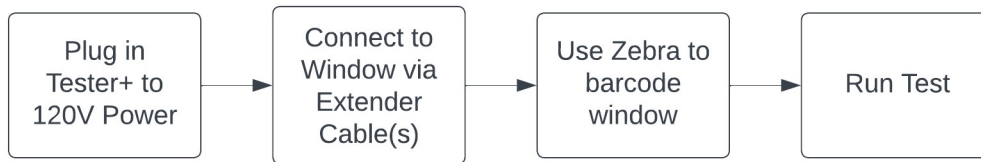


Figure 12: Tester Flow using HALIO Tester+

The Tester+ will return either PASS or FAIL depending on the results of the test. See Figure 13 for high level troubleshooting, and HALIO will provide additional training and detailed user guide prior to window installation.

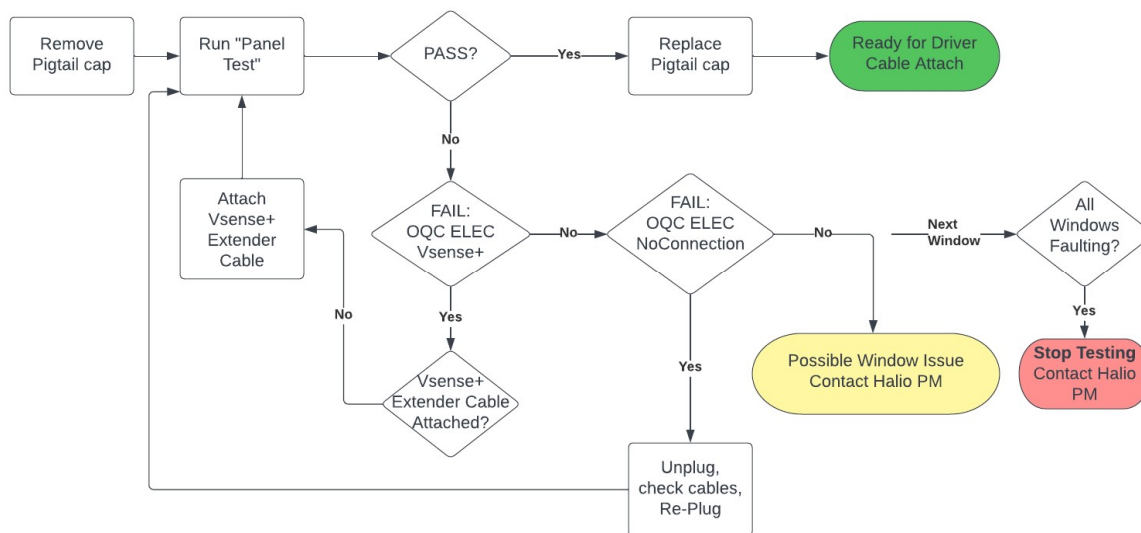


Figure 13: HALIO Tester+ Testing Flow Chart

Special Note: Unitized Systems

For unitized systems, this test will be performed twice – once at the unitizer after the installation of the Smart Glass units into the frame (and any extender cables) – and **again** after the unit is installed on the building. **The requirement for the Glazier is that this test is performed after the window has been installed in its final location with all cables attached.**

Appendix A – Grommet Recommendations and Examples:

Split Grommets: Heyco 2872-P or equivalent (Nylon 6/6 only)

Deburring tool: NOGA NG3003 Super Burr with E300 / S30 Scraper

Edge trim for slots: Panduit GE128-C or equivalent (Nylon 6/6)

*Note: Polyethylene NOT compatible with silicone sealants



Appendix B: Smart Glass IGU Support Block & Chairs Requirements

Requirements & Installation Guidelines for facades and Skylights

Overview

The purpose of this document is to outline the support block requirements for conventional and SSG Smart Glass window installations into facades and skylights to ensure the Smart Glass warranty remains valid and to prevent potential damage to the window. Failure to follow these requirements can result in loss of warranty coverage.

INSTALLATION WARNINGS:

⚠ WARNING
Smart Glass IGUs must be fully supported by appropriately sized support blocks per the latest GANA Glazing Manual guidelines.

⚠ WARNING
Incorrect support or material selection can result in non-warranty covered damage to the Smart Glass EC device and IGU.

⚠ WARNING
The support block itself must be fully supported underneath along its full length and width, and within the glass edge contact area from inner lite “surface 4” and the outer lite “surface 1” as shown in Figures 1 and 2.

IMPORTANT
It is important to verify systems incorporating support chairs (instead of full frame channels as in SSG) have had the chair sized to extend, along with the support block, out to a minimum of half the outer CG1 lite thickness. See Figure 2.

IMPORTANT
Support blocks must not be sized or positioned such that their long edge makes contact solely with the IGU silicone, creating the potential for being pushed into the silicone under vertical loading.

Material and Dimensional Requirements

The setting block material and properties must meet the following requirements for both facade and skylight installations:

Support Block - Frame Type Independent	
Material	Silicone
Durometer	85 ± 5 Shore A hardness
Length	4" minimum or 0.1"/sqft glass area (greater of)

Support Block Width – Captured Frame (Fig 1)		
IGU Width + 1/8"	≤ Width ≤	Frame Channel Width + 1/16"
Support Block Width – SSG Frame (Fig 2)		
IGU Width, inner lite is fully supported and outer EC lite (CG1) has minimum of half its thickness supported		≤ Width

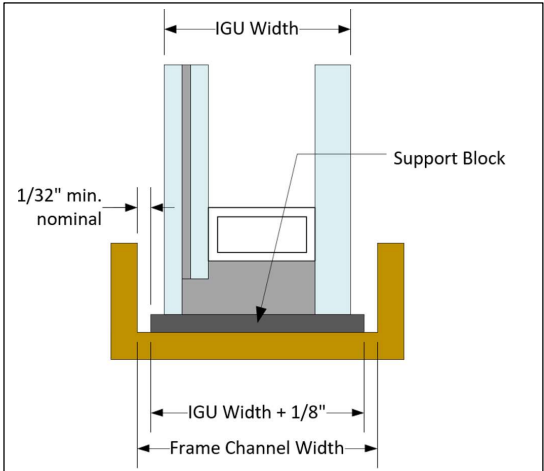


Figure 1 - Captured Framing Support Block Geometry

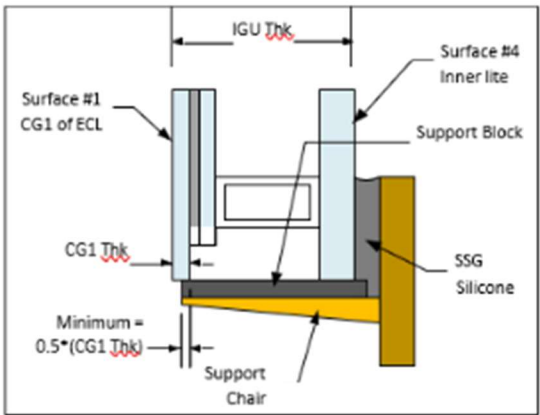


Figure 2 - SSG Support Block Geometry

Support Block Location

The positioning requirements of support blocks are the same for both facades and skylights.

- Preferred location - Quarter points ($1/4$) of the sill supporting frame (glass gravity base width) as shown in Figure 3.
- If necessary - one-eighth ($1/8$) points of the sill supporting frame (glass gravity base width), but not located less than 6 inches from vertical edge of glass to start of block as shown in Figure 4.

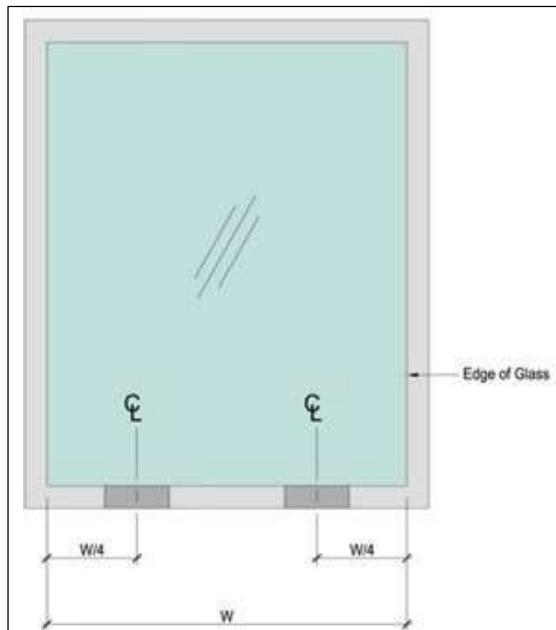


Figure 3 - Preferred Support Block Location

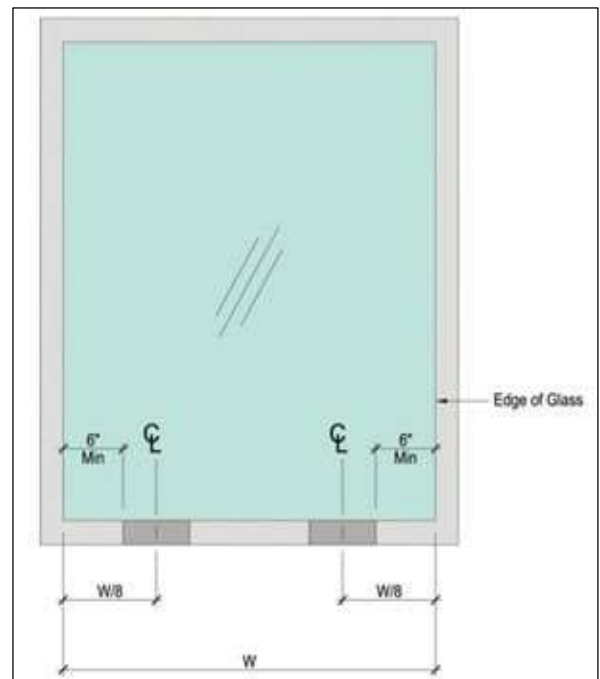


Figure 4 - Alternate Support Block Location

Spacer Blocks (Edge Blocking)

The following requirements apply to “anti-walking” blocks used to limit lateral movement of the glass caused by horizontal expansion/contraction, building sway and creep deflection in conventional dry glazed facades and skylights.

Material and Dimensional Requirements

The spacer block material and properties must meet the following requirements:

Spacer Block	
Material	Silicone
Durometer	60 ± 10 Shore A hardness
Thickness	1/8" minimum
Length	4" minimum – facades & skylights
Width	Same as support blocks, Figures 1 and 2

Spacer Block Location & Installation

- One per side located on "vertical" edges at furthest ¼-point from gravity edge as shown in Figure 5.
- Thickness of block sized to provide 3mm gap between edge of glass and surface of spacer block.
- Thickness of block sized to provide 3mm gap between edge of glass and surface of spacer block

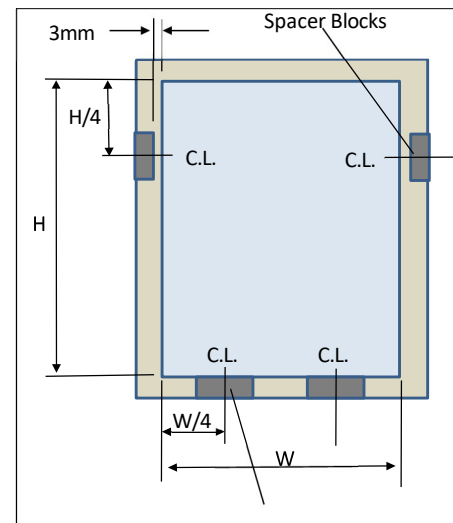


Figure 5 - Support and Spacer Block Locations

⚠ WARNING

IG must NOT be fully constrained within the frame with blocks on opposite sides creating zero clearance or an interference fit.

Appendix C: QuickTester User Guide

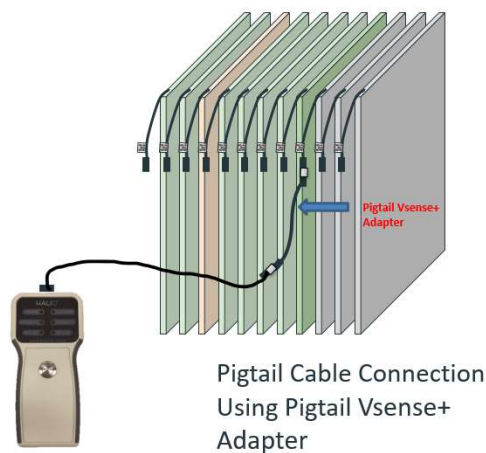
- Tool for quickly testing HALIO EC glass circuits
 - Enables faster IQC testing by manufacturing partners
 - Helps electricians verify cabling during installation
 - Assists provisioning partners troubleshooting wiring
- Fast, easy to use, and mobile
 - Tests connectivity of each HALIO EC circuit (Power, VSense+, Sequestration)
 - Provides instantaneous Pass/Fail LED Feedback
 - 9V Battery powered for easy use without AC power
 - No dependence on cloud connectivity
 - Suitable for tabletop, hand-held, or hanging using accessories
 - Adapter cables for pigtail or driver cable connections
- Simple & Low Cost
 - All circuit based, no firmware
 - Using off-the-shelf mechanicals
 - Expected cost <\$100 per unit



Components Included:

- QC Quick Tester
- 9V Battery
- Driver Cable Adapter
- Pigtail Cable Adapter
- Carrying Case
- Pigtail VSense+ Adapter





Basic Usage Steps

1. Remove Quick Tester from carrying case
2. Connect 9V battery and insert into battery tray on back of tester
3. Insert male adapter cable connector into female socket on Tester main body and tighten screws
4. Connect appropriate adapter cable to Smart Glass to be tested
 - Pigtail VSense+ Adapter > connects to the pigtail of the window being tested and to the Pigtail Adapter Cable
5. Push and hold Quick Tester button to test HALIO glass circuits
6. Review LED feedback for each circuit
 - All **GREEN** = PASS
 - 1+ **RED** = FAIL
7. Any failures require further troubleshooting and reporting using QC Tester Plus

Troubleshooting Guidelines

- Issue: VSense+ LED turns red (See image right)
 - Check to ensure the VSense+ Adapter cable is being used
- Issue: LEDs do not light up at all
 - Check the 9V battery and replace if depleted
- Issue: All LEDs always display red, indicating a failure
 - Confirm the tester cable is securely plugged into the QuickTester (and screws using the connector screws)
 - Confirm the tester cable is connected securely to the Smart Glass (via the M12 pigtail connector, or 8-position driver connector)
 - Confirm both testing cables are not connected as one extended cable
- Issue: Sometimes one of the LEDs switches between red and green with each button press
 - Ensure all cable connectors are secure between the Quick Tester and the Smart Glass
 - Ensure there is not an intermittent short based on changing positions of the cabling or connectors



- Confirm the battery is not low and replace if needed
- Any failures (1 or more red LEDs) must be further tested using the QC Tester Plus tool which provides more in-depth functional testing, error detection, and reporting.