

IGU Product Guide





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The SageGlass Story

SageGlass® helps create low-carbon buildings that enhance occupant wellness by delivering the world’s best smart windows. Smart windows tint and clear automatically, optimizing both light and thermal comfort in a space - no need for blinds or shades. With SageGlass smart windows, your buildings can feature a lot of windows without compromising energy efficiency and performance.



Occupant Wellness

Exposure to beautiful, natural light makes people happier, healthier, and more comfortable.



Sustainability

Block the sun on hot days, harness it on cool days. Cut energy use all year, helping environments inside and out.



Distinctive Design

A building should be as unique as its occupants. SageGlass products let you design without compromise.



Proven Technology

Decades of pioneering technology and experience make SageGlass the category leader and champion.

As the global leader in smart window technology, SageGlass has partnered with building owners, developers and architects on over 1,500 installations worldwide. Owned by Saint-Gobain, the world leader in light and sustainable construction, SageGlass is part of a group with over 350 years of building science and glass experience.

How Does SageGlass Work?

SageGlass is a dynamic, electrochromic glazing solution that integrates multiple components to deliver superior occupant comfort in the built environment. There are three primary components to SageGlass smart windows:

Insulating Glass Unit (IGU)

The SageGlass IGU contains the tintable, electrochromic coating. The IGU is shipped to the glazier/installer who installs it with the rest of the framing system. This guide will provide details about possible IGU configurations and customizations as well as system constraints.

Controls System Overview

Dynamic tinting is achieved by powering the glass with low-voltage electricity. The SageGlass team will work with you to integrate SageGlass Symphony® controls into your specific building design, including identifying the best wiring integration and locations for control panels.

System Intelligence

The SageGlass Maestro system automatically manages tinting based on indoor and outdoor inputs to support goals to optimize glare control, daylighting and thermal comfort. It adjusts in response to sunlight while allowing users to override or personalize settings through a mobile app, wall-mounted touch panel, or integration with the building management system.

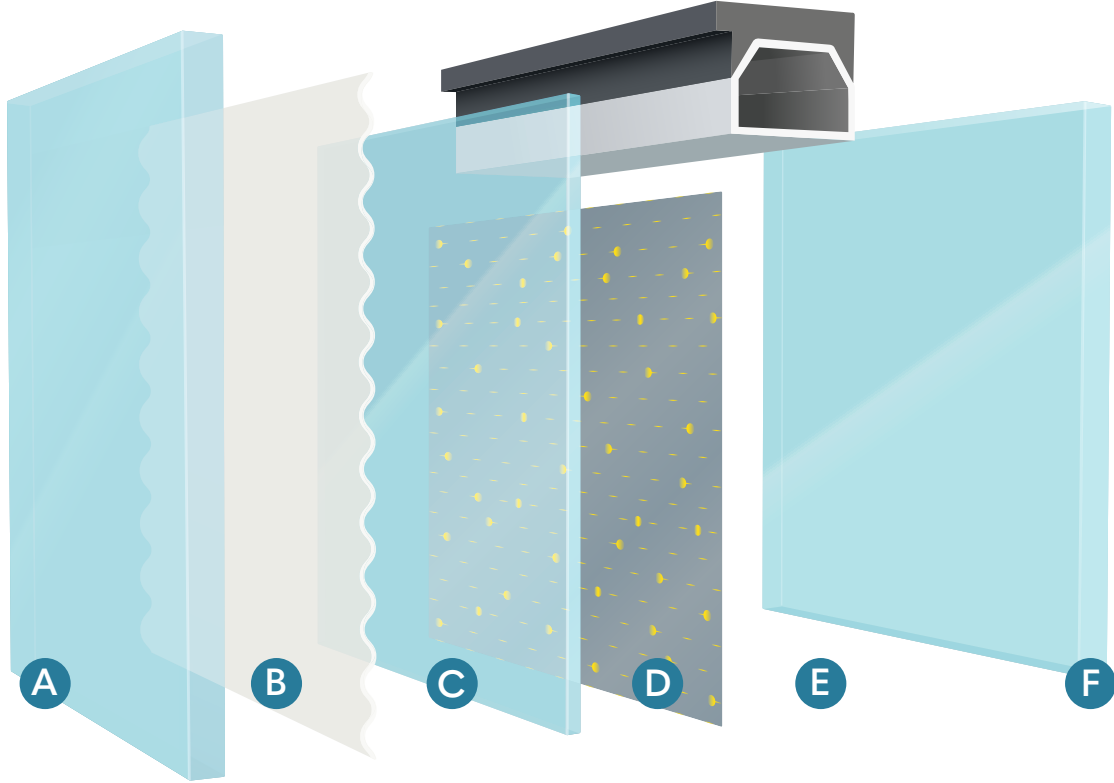


System Inputs

-  Rooftop Sky Sensor
-  Occupancy
-  Window Size
-  Time of Day
-  Building Orientation
-  Sun Angle
-  Sky Conditions

SageGlass IGU Configuration

SageGlass offers a variety of configurations including a range of coated substrates and interlayers. Below is the make-up of an IGU:



- A Outboard Lite**

The Outboard lite can be customized with different coatings and comes in different thicknesses based on project needs.
- B Interlayer**

An interlayer laminates the Outboard Lite to the EC Coated Lite.
- C EC Coated Lite**

Electrochromic layers are sputter coated onto 2.2 mm annealed glass.
- D EC Coating**

The electrochromic coating is comprised of multiple layers of metallic elements that can dynamically modulate the visible light transmittance (VLT) and solar heat gain coefficient (SHGC) of the glass by application of a small electrical charge.
- E Cavity**

The cavity is surrounded by a stainless steel warm edge spacer and industry standard PIB and silicone sealants. Air, Argon, or Krypton are used based on performance needs
- F Inboard Lite**

The inboard lite of the IGU can have additional low-e coatings and laminates based on project performance needs.

Summary of the IGU

A typical SageGlass IGU is a double-glazed or triple-glazed unit with an outboard laminate. A standard configuration involves a 6 mm (1/4") clear, heat-strengthened lite, which is laminated with an interlayer to a 2.2 mm (1/16") annealed lite with the proprietary SageGlass electrochromic coating on surface #4. A stainless-steel spacer separates this exterior pane from the inner lite. The space between is filled with air or performance-enhancing gas. The inboard lite is clear monolithic or laminated heat-treated glass. Every SageGlass IGU is built to adhere to ASTM standards.



Tint State	Clear	Light	Medium	Full
Light Transmission	60%	18%	6%	1%
Solar Heat Gain (SHGC)	0.41	0.16	0.11	0.09

IGU Details & Customizations: Exterior

Outboard Laminate: Exterior Lite

The exterior lite of the outboard laminate can be customized with the following options:

Color Options	Thickness Options	Coating Options
Clear	4 mm (5/32") 5 mm (3/16") 6 mm (1/4") 8 mm (5/16") 10 mm (3/8")	SR2.0 (standard offering with a crisp, uniform finish)
Clear	6 mm (1/4") 8 mm (5/16")	Saint-Gobain Bright Silver (for a reflective aesthetic)
Blue (Solar Blue)	6 mm (1/4")	
Bronze (OptiFloat)	6 mm (1/4")	
Gray (Crystal Gray)	6 mm (1/4")	
Gray (OptiFloat)	6 mm (1/4")	
Green (Azuria)	6 mm (1/4")	
Opti Gray	6 mm (1/4")	
Pacifica	6 mm (1/4")	
Parsol Green	6 mm (1/4")	
Solexia	6 mm (1/4")	

BirdWell™

A bird-friendly laser etched pattern can be applied to the exterior surface of the outboard lite. This pattern is a series of 5mm semi-transparent dots arranged in a 2" x 2" diamond pattern. It surpasses the American Bird Conservancy’s recommended requirements with a Threat Factor of 20, and is compatible with SR2 and Bright Silver coating options.

Interlayer

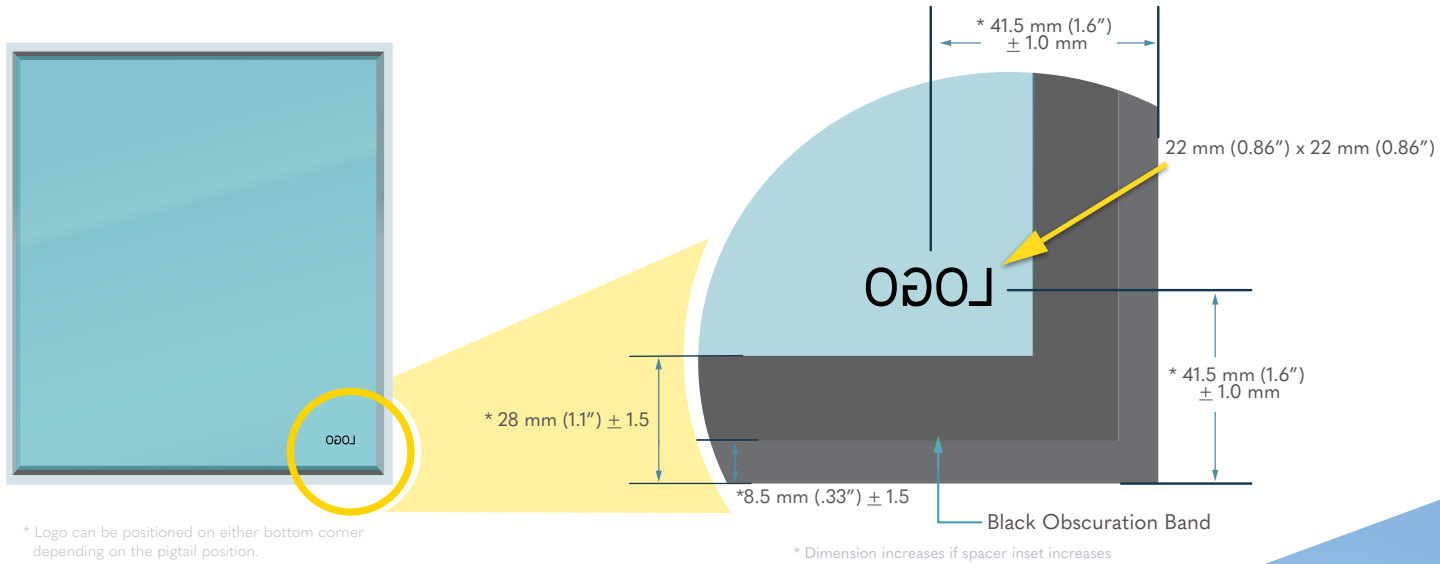
The outboard pane is laminated with an industry standard interlayer.

Outboard Laminate: Interior Lite

The interior lite of the outboard laminate is a 2.2 mm, annealed clear float glass, coated with the proprietary SageGlass electrochromic coating on surface #4. This high-performance coating allows the glass to tint and clear on demand. Layers of metallic elements are deposited on the glass and modify the visible light transmission (VLT) and solar heat gain coefficient (SHGC) of the glass, also offering low-emissivity properties.

Obscuration Band

A standard 19.5 mm (± 1.5 mm) black obscuration band is applied near the edge of the glass (on surface #2 in the IGU cross-section illustration). The obscuration band minimizes light trespassing through the gap between the framing/glazing system and the EC coating edge deletion. The obscuration band is printed on the glass, embedded into the laminate. It is more durable than alternatives such as tape, which can degrade with exposure to the elements. The location of the band may vary, depending on the spacer inset dimension (on a standard 8 mm spacer inset, the obscuration band starts 8.5 mm from the glass edge).



IGU Details & Customizations: Interior

Inboard Lites

SageGlass can be manufactured as double-glazed or triple-glazed units with either monolithic or laminated inboard lites. Clear float glass is used as the substrate for inboard lites, and is available in thicknesses of 4 mm, 5 mm, 6 mm, 8 mm or 10 mm. The middle lite of a triple glazed unit is available in 4 mm or 6 mm, clear glass substrates.

The inboard lites may be laminated with PVB (Clear, Acoustic PVB, Neutral Clear PVB) or SentryGlas™ interlayers. Interlayer thickness can range from 0.76 mm to 2.28 mm. The maximum thickness of the entire laminated inboard lite is 22 mm. More detailed rectangle rules are addressed later in this guide. For projects seeking a significantly more neutral appearance from the inside in the clear state, a laminate with a special PVB interlayer called Neutral Clear can be used in the inboard lite.

Maximum sizes for laminated panels are provided below. The thickness indicated refers to the thickness of each ply in the laminate. SageGlass can offer laminates with symmetric plies for the inboard laminate.

Thickness	Maximum Height	Maximum Width
4 mm (1/8")	2286 mm (90")	1219 mm (48")
5 mm (3/16")	2540 mm (100")	1524 mm (60")
6 mm (1/4")	3095 mm (121.8")	1828.8 mm (72")
8 mm (5/16")	3095 mm (121.8")	1828.8 mm (72")
10 mm (3/8")	3095 mm (121.8")	1828.8 mm (72")

Heat Treatments

Each of the SageGlass lites are heat-treated, except for the EC coated lite. Fully tempered glass is available upon request.

The maximum glass sizes vary, depending on the type of heat treatment:

For heat-strengthened glass/ fully tempered glass:

Thickness	Maximum Height	Maximum Width
4 mm (1/8")	1524 mm (<60")	1524 mm (60")
4 mm (1/8")	2743.2 mm (96")	1219 mm (48")
5 mm (3/16")	2743.2 mm (108")	1828.8 mm (72")
6 mm (1/4")	3095 mm (121.8")	1828.8 mm (72")
8 mm (5/16")	3095 mm (121.8")	1828.8 mm (72")
10 mm (3/8")	3095 mm (121.8")	1828.8 mm (72")

All heat-treated glass tends to have visual distortions, like roller waves, edge kinks, or overall bows. Reference the SageGlass Quality Guide for more information about the distortions due to heat treatment on the outboard lite. Typically, the glass unit is installed so any roller wave is horizontal, which helps minimize distortion. However, if the installed unit is wider than 2286 mm (90") and the exterior glass on the outboard lite is greater than 8 mm (5/16") thick, the unit will have a vertical roller wave.



Component Details & Customizations

Spacers

SageGlass IGUs use industry-leading, stainless-steel, warm-edge spacers, available in a black finish. The most commonly used spacers are 9.5 mm and 11.5 mm thick but other thickness options are available, including 10.5 mm, 13.5 mm, 15.5 mm and 19.5 mm. Depending on the local wind/snow load requirements and load-distribution needs of the project, the spacers might have deeper-than-standard insets, up to a maximum of 23 mm.

Gas Fill

Each IGU is filled with one of the following, depending on the product specifications:

- Air
- 90% Argon, 10% Air
- 90% Krypton, 10% Air

Desiccant

Each IGU spacer is filled with a blend of 3A molecular sieve and silica gel desiccant. SageGlass spacers are filled on all sides, while other IGU fabricators might fill only two sides.

Capillary Tubes

These can be provided for air-filled IGUs upon request based on installation or transportation altitude. They must be sealed before installation using the capillary tube sealing kit provided.

Edge Types/Finishing

Typical SageGlass edges are seamed. Chamfering (edge polish) is not available.

Primary Sealant

Between the glass panes and the spacer, SageGlass uses a black, Poly IsoButylene (PIB)-based sealant to maintain gas tightness and minimize moisture penetrating into the unit.

Secondary Sealant

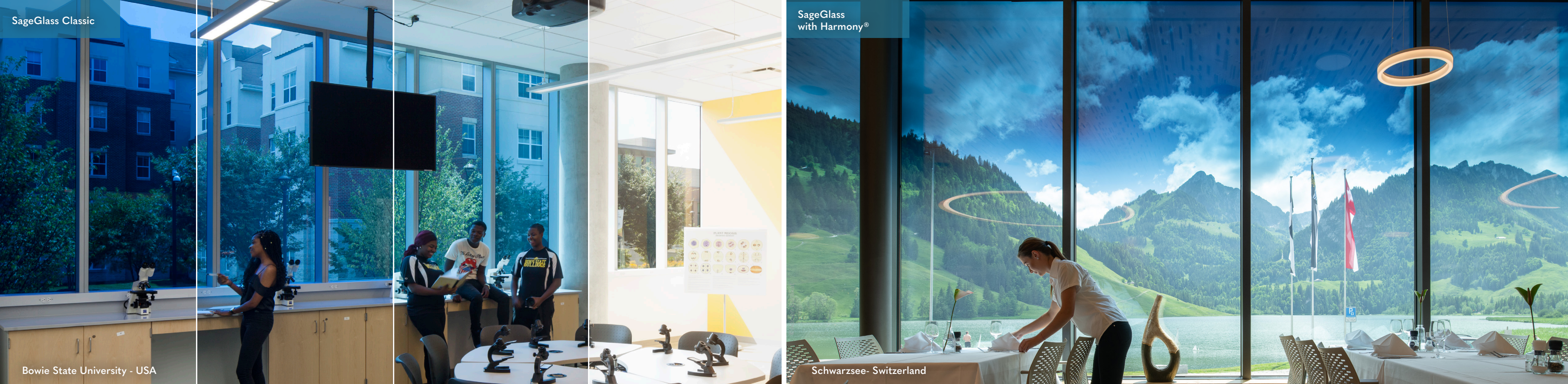
Secondary sealant is used to structurally adhere lites of glass to create the insulating glass unit. SageGlass uses Dow Corning 3363, a high-strength, two-part, black sealant. The two-part silicone is applied at the desired spacer inset (from 8 mm (5/16”) to 23 mm (15/16”) from the glass edge). Glaziers are required to confirm that other sealants and silicones used in the installation are compatible with the secondary sealant.

Pigtails

Each SageGlass IGU has a ‘pigtail’ that extends from the IGU. These pigtails connect to a frame cable, which leads to the control system. The pigtail is a multi-conductor, sheathed cable with a 2- or 4-pin wire connector. A standard length is 172 mm (6 ¾”). 500 mm (19 11/16”) and 1,500 mm (59”) are also available.

Bus Bar

The ceramic bar on the edge of the lite with the electrochromic coating, used to transfer electric charge into the coating (which enables tinting), is called a “bus bar.” The SageGlass tint configuration determines the number and configuration of bus bars.



SageGlass Tint Configurations

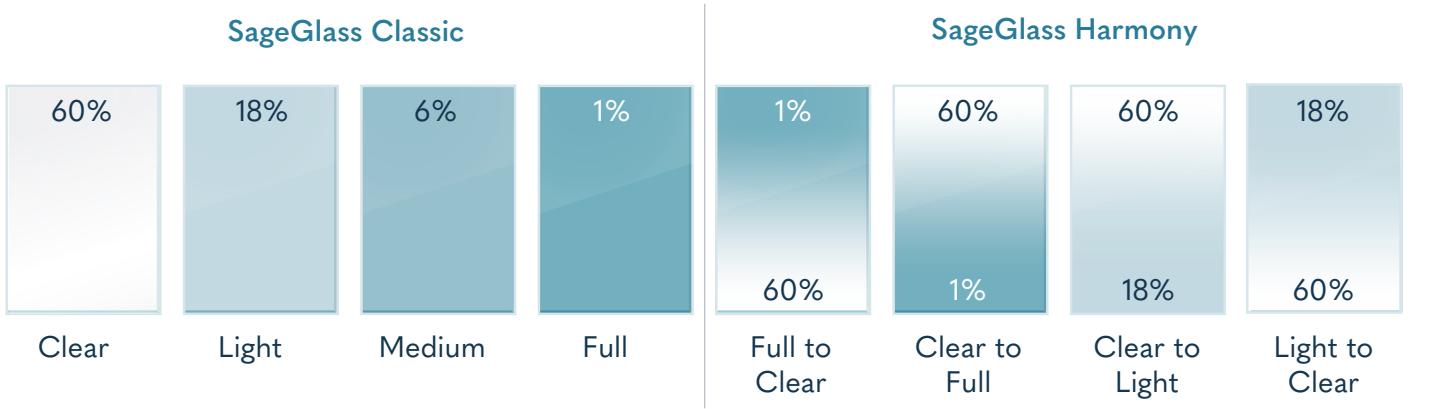
Customers will select a tint configuration for each SageGlass IGU. A Classic tint configuration offers uniform tinting in four states. The Harmony tint configuration enables an additional four gradient tint states.

The system is flexible to help accommodate your specific use case, while still managing heat, glare, and natural light automatically.

Typically, the product is configured by room and row level. Other parameters, such as elevation, building orientation, and geographic location are considered as well. These inputs are utilized to provide a more comfortable, energy-efficient space in your building.

Tint Configuration	Number of Tint States	Available Tints
Classic	4 Uniform States	Clear, Light, Medium, Full
Harmony	4 Uniform States 4 Gradient States	Clear, Light, Medium, Full, Full to Clear, Clear to Full, Light to Clear, Clear to Light

The diagram below indicates the visible light transmission (VLT) for each tint state (for example, the clear state allows 60% of visible light transmission; the light state allows 18%; and so on). VLT values may vary based on IGU glass selections.



The Classic tint configuration delivers uniform tinting across the entire IGU, in any one of the four tint states.

The Harmony tint configuration offers eight tint states including the four uniform states of Classic plus an additional four gradient tint states. Gradients are visible from both the interior and exterior of the building. Same-height IGUs should be used to ensure uniform patterns.

Harmony is best suited for windows, short facades and structural glazing systems. It is not recommended for skylights or applications with stacked electrochromic IGUs.

Designing Your SageGlass Project

Before your team begins designing a SageGlass IGU, you'll want to consider factors including:

- Need for daylight and views
- Energy efficiency
- Sustainability goals
- Safety
- Wind and snow loads
- Thermal stress
- Aesthetic goals

Manufacturing Boundaries

This table shows the minimum and maximum dimensions for SageGlass products. Find more details in Appendix A, including details on dimensional tolerances.

	Minimum	Maximum
Double Glazing	13.8" x 13.8" 350 mm x 350 mm	72" x 121.8" 1828 mm x 3095 mm
Triple Glazing	13.8" x 13.8" 350 mm x 350 mm	70.6" x 121.8" 1795 mm x 3095 mm
Shapes Bounding Box	13.8" x 13.8" 350 mm x 350 mm <i>A minimum bounding box should fit within the shape. Minimum shape side length 120 mm (4.72")</i>	59" x 116.9" 1498 mm x 2970 mm <i>Shape cannot exceed the maximum bounding box</i>
Harmony	Height of 63", 1600 mm	Same as a Double or Triple Glazing <i>Harmony is available in portrait orientation (H ≥ L) Recommended aspect ratio of 3:2 or greater</i>

When possible, avoid unique (one-off) panes of glass in your design to avoid costly add-ons that aren't an essential element of the design.

Shapes

SageGlass IGUs are available in a variety of shapes to enhance your building designs. Shape categories (rectangle, trapezoid, triangle, parallelogram, quadrilateral, and pentagon) are detailed in Appendix B. Check with the SageGlass team to confirm shape dimension availability.

Holes, Cut-outs, Radius shapes & Bent Glass

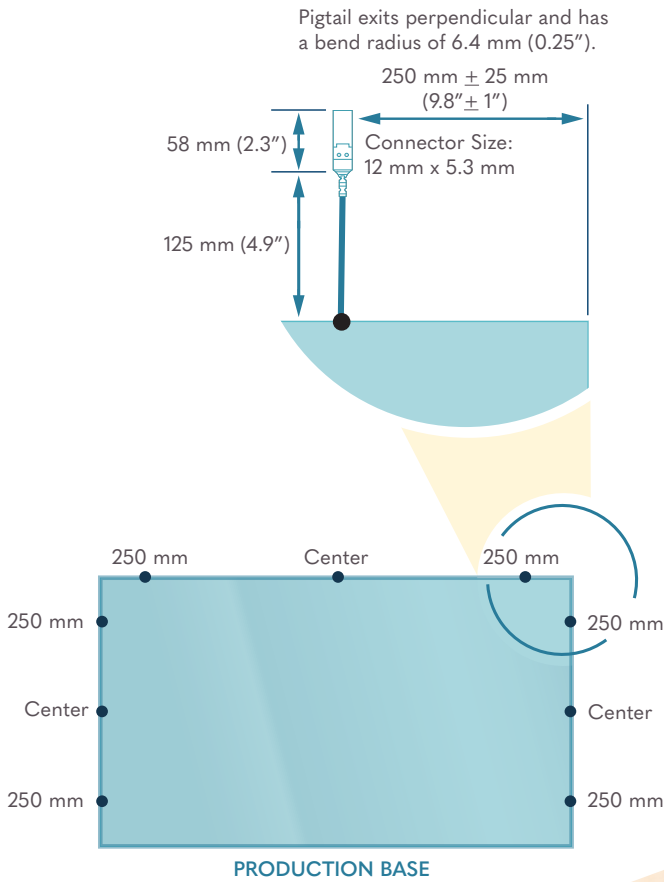
Holes, cut-outs, notches, radius shapes, and bent glass options are not offered in SageGlass IGUs. Other products cannot be included within the airspace.

Pigtail Locations & Connection

The pigtail and the frame cable connection are located within the glazing pocket. This pocket needs to be dry and protected from direct sunlight.

If the IGU side with the pigtail is less than 250 mm (9 13/16") and 500 mm (19 11/16"), the pigtail must be centered on that side. The minimum length of the side with the pigtail is 250 mm (9 13/16").

Pigtail cannot be located on installed base/production base/stepped sides. Recommended pigtail locations by shape are detailed in Appendix B.



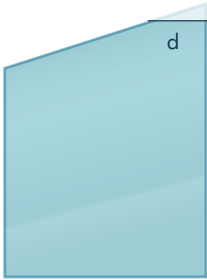
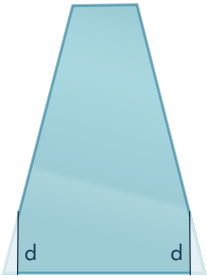
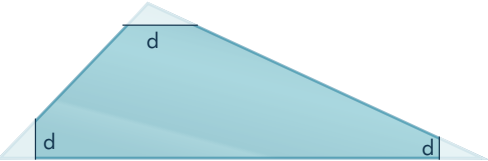
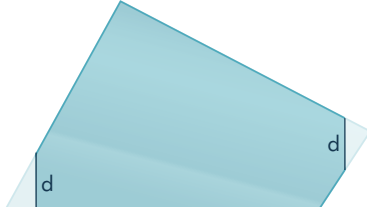
Product Specifications & Considerations

Steps & Offsets

Steps (or offsets) are only allowed on rectangle-shaped glass, and only allowed on the support lite. The maximum dimension for IGUs with steps is 1795 mm (70.6") x 3048 mm (120"). Steps must be greater than or equal to 14 mm (.55"), and less than or equal to 140 mm (5.51"). Up to two sides of the rectangle may have a step (but not both long sides). Pigtails cannot be provided on stepped sides.

Clipped Corners

In cases where shaped IGU's have corners with angles less than 65°, the corners will be "clipped" and replaced with a straight side. The guidelines for clipped corners are shown below. Dimensions for clipped corners must be provided at the time of order placement.

Shape	Rules & Constraints
 BOX TRAPEZOID	- Angles 30 to ≤ 35° will be clipped to a length (d) of 19.1 mm (0.75") - Angles > 35 to < 65° will be clipped to a length (d) of 9.5 mm (0.37")
 TRAPEZOID	
 TRIANGLE	
 QUADRILATERAL H=H1 only	

Performance of IGUs

See Appendix C for detailed performance data of SageGlass IGUs.

Structural Safety and Security

SageGlass electrochromic glass is a safety glazing that has been tested for both standard and heavy thickness classes. SageGlass performs third-party safety glazing testing in addition to regular in-house testing required by global certifications. The outboard laminate is always a safety glazing due to the SageGlass product design, and the inboard lite can be a safety glazing upon request.

Glass Temperature

When fully tinted, SageGlass panes have a temperature distribution similar to dark-tinted glass. While the edge temperature inside the framing members remain below 140° F (60° C), in certain sloped installations and certain locations, the maximum center-of-glass temperature may reach 167° F (75° C). In vertical applications, the temperature of SageGlass should not exceed the temperatures exhibited by highly absorbing spandrel glass (approximately 140° F or 60° C).

Thermal Stress Resistance

Similar to tinted static glass, temperature gradients occur from the frame edge to the center of the glass, resulting in thermal stress. Partial shading of the glass—where some portions of the pane are protected from the sun, while other areas receive intense sunlight—can make this stress worse. SageGlass provides excellent resistance to thermal stress with a wide margin of process capability. It also provides safety, enhanced security, and better acoustical performance. A thermal analysis is recommended when using the product in combination with external shading devices. SageGlass does not offer thermal analysis services.

Privacy Performance

Although SageGlass dynamic glass is not a privacy product, in its fully tinted state — in combination with a reflective coating — it does obscure the view to the inside of a building during the day. However, it does not achieve the opaqueness of privacy products, which are based on a different technology.

Hurricane and Wind-Borne Debris Protection

For projects that require glazing to protect against hurricane and wind-borne debris, the SageGlass outboard laminate is classified as a sacrificial lite with the inboard laminate providing the protection. The use of SageGlass as a material substitution may require a verification test or a certification of the substitution by a professional engineer.

Wires and Electrical Connections

Wiring Plans

You can consult SageGlass when developing frame drawings with wire routing. A standard wiring diagram is provided, which requires each IGU to be connected to a specified connector in the terminal box/control panel. To help ensure smooth start-up and troubleshooting, it's crucial that all components are installed according to the wiring diagram.

Wiring Protection

It is important to prevent damage to the wire sheathing, as it protects the wire from damage and corrosion. A flexible rubber grommet is provided with the frame cable to protect the cable sheathing at the penetration hole between the glazing pocket and the interior of the frame system. The sheathing must be protected at all points throughout the framing system. Similarly, the electrical circuit is protected from damage and corrosion in the interior of the IGU. There are two electrical connection points between the IGU pigtail and the electrical wiring internal to the IGU. The first connection is covered completely with silicone (from the IGU's secondary seal); the second connection is located inside the sealed gas-filled space and thus is also protected from moisture and corrosion.

Changes Over Time

Color variations are intrinsic to coated products. The SageGlass electrochromic coating experiences the same color variations as other standard coatings. The variations in the materials, in combination with variations in the process and age, lead to insulating glass unit color variations.



Schneider Electric, IntenCity - France



Bellavista Eye Clinic- Switzerland

Sustainability

SageGlass can support your project’s sustainability goals to help meet LEED, WELL, BREAM, MINERGIE, and most other global standards. SageGlass double- and triple-glazed units have Environment Product Declarations (EPDs) verified (Type 3) as well as Health Product Declaration (HPDs). The products also bear the Eurofins certification that confirms adherence to the requirements of the California Department of Public Health CA 01350.

SageGlass has worked hard to reduce our environmental footprint by reducing electricity consumption by 75% and natural gas by 60% per square meter of product, providing a pathway for Option 2 optimization. The full scope of improvements are detailed in the LCA optimization section of the EPD.

Saint-Gobain’s Sustainability Mission

As the world leader in light and sustainable construction, Saint-Gobain designs, manufactures, and distributes solutions that have a positive impact on well-being, quality of life and performance.

Architectural Specifications

The detailed specification for the SageGlass IGU can be obtained from Section 08 88 00, available at [sageglass.com](https://www.sageglass.com).

Shipping & Unloading

SageGlass ships the glass in standard A-frames and requires customers to follow the uncrating guidelines to safely unload the glass.

Façade Considerations

Structural Applications

When using SageGlass products in structural glazing (i.e. “butt” glazed) applications take caution to protect the pigtail and wiring that extends from one side of the insulating glass unit from environmental exposure. Where structural glazing is required, be sure the wire is properly protected from the environment. Ideally, wires are captured by framing. SageGlass requires a 4-side supported system. Where structural glazing is required, SageGlass must be notified at the time of order to ensure that the insulating glass unit construction is specified appropriately. SageGlass IGUs are not compatible with toggle-based glazing systems.

Spandrel Glass

Spandrel glass options are opaque glass panels on the façade of a building, often used to conceal structural building components such as columns, floor slabs, HVAC systems, vents, wiring, and plumbing. Spandrels are often used between rows of vision glass panels. Spandrel selection depends on the design team’s aesthetic intent.

Selecting spandrel glazing requires a few more considerations. An opaque spandrel glass will never exactly match the aesthetic of transparent vision glass because of the way light reflects from and transmits through the materials. A contrasting option can be used to highlight the vision glass panels.

Aesthetics

The aesthetic appearance of the glazing you select is an important aspect in your IGU and facade design. Two methods are recommended to evaluate the visual impact of your design: virtual/digital and physical mock-up.

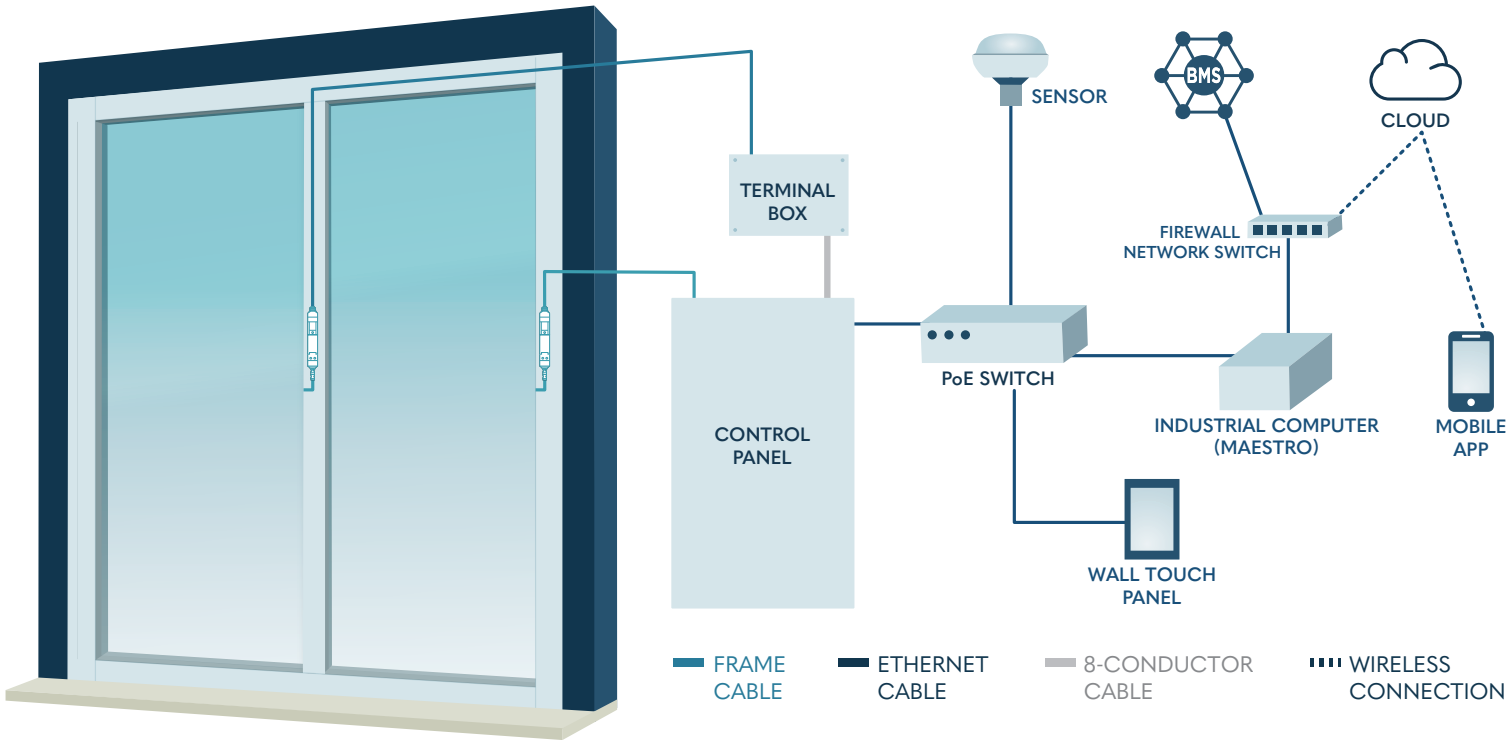
Upon request, SageGlass can provide a virtual/digital aesthetic mock-up to illustrate the impact of electrochromic glass on your building’s façade. This may entail superimposing the product’s appearance on an existing visual to help you visualize the product on the building. SageGlass also offers, for a fee, a service called GlassProLive, which requires the building’s model and some details of the surrounding elements in order to create a physico-realistic rendering of SageGlass on the façade.

Physical samples of solutions, typically 12” x 12” or 14” x 20”, can be provided. Additionally, to help evaluate dynamic glazing options from different manufacturers, full-sized panels with your project specifications can be provided for a fee. These can be installed in a life-sized mock-up for evaluation in a realistic outdoor environment.

SageGlass Symphony[®]

SageGlass Symphony: Control Components

SageGlass Symphony utilizes home-run AC power, along with Power over Ethernet (PoE), in a straight-forward system architecture familiar to almost all contractors. Below are the core system components, however there is flexibility on certain ones based on specific customer needs.



Control Panel

SageGlass IGUs route back to a window controller housed within a control panel. Below is a summary of control panel size and capacity.

	Control Panel Type	
	Small	Large
Window Controllers Supported	1	4
Number of Terminations	32	128
Number of SageGlass IGUs	16	64
Number of Harmony IGUs	8	32
Required Wall Space	1.6 ft ²	4.9 ft ²

Installation Information

The SageGlass system uses common electrical components and is easy to install. Your dedicated SageGlass Project Manager will provide end-to-end support by helping you navigate the order, installation, and start-up processes.

Installer Information

Rough-In Kit:

Frame Cables are delivered either prior to or during the construction of the framing system to facilitate the routing of cables.

Main Delivery:

The remaining balance of the system is delivered on-site for installation and connection at a later time in the construction phase.

Standard On-Site Division of Responsibility

Glazing Contractor

- Frame Cable Routing
- Frame Cable and IGU Circuit Testing (tester provided)
- Frame Cable Labeling (labels provided)
- IGU Installation
- Pigtail to Frame Cable Connection

Electrical Contractor

- Routing and testing Frame Cables
- Routing and labeling 8-Conductor Cables
- Routing and labeling Ethernet cables to system components
- Installation of Control Panels, Terminal Boxes, Wall Touch Panels, external sensors, PoE Switches, Firewall and Cell Modem

Frame Cable Distances

Max Length Frame Cable	Max Length 8-Conductor	Total Distance (IGU to Control Panel)
125'	N/A	125'
75'	200'	275'
50'	300'	350'

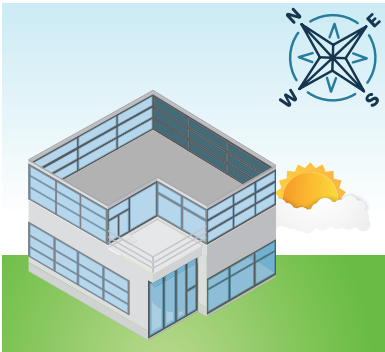
Cybersecurity and SageGlass

In today's connected world, security is top of mind. SageGlass can operate without any network connection, creating a secure ecosystem protected from external threats. Additionally, should you need the flexibility to interact with your system from anywhere in the world—or wish to enable SageGlass support to assist remotely—you can leverage an integrated connection to your existing network or an isolated connection using a cellular data plan.

SageGlass Operational System Overview

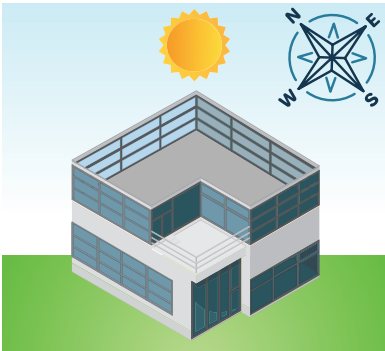
The SageGlass Controls System, or communications hub, operates the dynamic glass, providing intelligent tinting behavior in response to the sun to maximize occupant comfort, well-being and energy savings. The system is highly customizable to suit specific user preferences. With four (SageGlass Classic) or eight (SageGlass Harmony) tint states, the SageGlass system offers control when and where you want it and automation when you don't.

While every building is unique, below is a generalized representation of how your SageGlass system will behave over the course of a typical, sunny day. In areas with multiple rows of SageGlass, rows within a single room may differ in tint level throughout the day to maximize daylighting and reduce glare and heat.



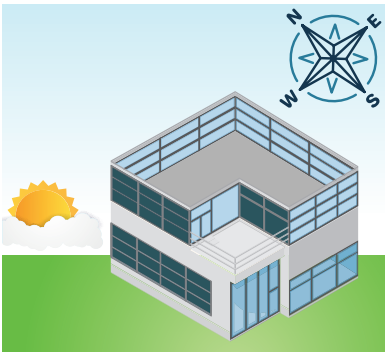
Sunrise

The sun's low position on the horizon can create significant glare on the east side of a building. SageGlass responds by fully tinting east-facing windows, while the rest of the building remains clear or in Light tint state to maximize daylight harvesting.



Afternoon

As the sun passes overhead, windows facing east, south and west respond based on real-time inputs and pre-defined automations. Typically, southern windows are set to Full tint to maximize glare and heat control, while the eastern and western windows are set to Light or Medium tint, allowing moderate glare and heat control.



Sunset

As the sun prepares to set, occupants seated near the west façade are subject to strong glare conditions. Typically, the west-facing windows will fully tint, while the rest of the building remains clear or in a light tint state to maximize daylight harvesting.

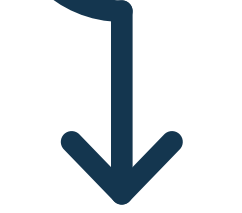
SageGlass Support

Incorporating smart windows into your next building project is made easier with our dedicated Field Operations team. They provide numerous support services to ensure everything runs smoothly, from specification all the way through occupancy.



Design

Field Operations works with the project team to develop a wiring and controls plan, tailored to specific customer needs. This provides all the details on the location of every system component.



Installation

Your dedicated Field Operations Project Manager will work with construction managers, glaziers and electricians to ensure everyone is on the same page about requirements, engaging in pre-construction meetings to align expectations.



Start-up

After the glass is installed and wired into the building, Field Operations will test every pane of glass, sensor, and SageGlass component. The goal is to ensure that every part of the SageGlass system functions properly, ensuring a smooth transition to building occupancy.



Tuning

Prior to occupancy, the Field Operations team provides tutorials to key parties to explain system operations. This training is tailored to specific customer needs. SageGlass continues to support customers post-occupancy to make system adjustments to suit occupant preferences.



Waves, Beaulac Hotel- Switzerland



Jean Singer & Cie SA- Switzerland

Appendix A: Manufacturing Boundaries & Dimension Rules

The SageGlass manufacturing process determines the extents (minimum and maximum dimensions; bounding box of geometry) of the glass units based on the configuration (For instance, double-glazed or triple-glazed units, Harmony® or Classic, and shape of the IGU).

IGU Rules

- Any angle must be $\geq 30^\circ$ and $\leq 150^\circ$
- If the installed width is greater than 2286 mm (90"), the roller wave will be vertical as installed
- Edge finish will be standard seamed
- Maximum IGU Thickness is 52 mm
- Maximum laminate thickness is 22 mm

Rectangle Rules:

- Maximum Length: 3095 mm (121.8"); other dimension must be:
 - ≤ 1828 mm (72") for Double Glazed Units
 - ≤ 1795 mm (70.7") for Triple Glazed Units
- Minimum Dimension: 350 mm (13.8")

Harmony Specific Rules:

- Rectangles only
- Minimum height: 1600 mm (63")
- Available in portrait orientation ($H \geq L$)
- Recommended aspect ratio of 3:2 or greater

Non-Rectangle Shapes Rules:

- Shape must be larger than a bounding box of 350 mm (13.8") x 350 mm (13.8")
- Shape must be smaller than a bounding box of 2970 mm (116.9") x 1498 mm (59")
- Minimum length of any side: ≥ 120 mm (4.72")
- Bounding box of all shapes defined by L x H

Dimensional Tolerances

The standard IGU length and width tolerance is ± 2 mm (0.08"). The tolerance increases to ± 3 mm (0.12") if a side is ≥ 1981 mm (78"), if a lite or laminate thickness is ≥ 8 mm (0.31"), or if it is a triple IGU.

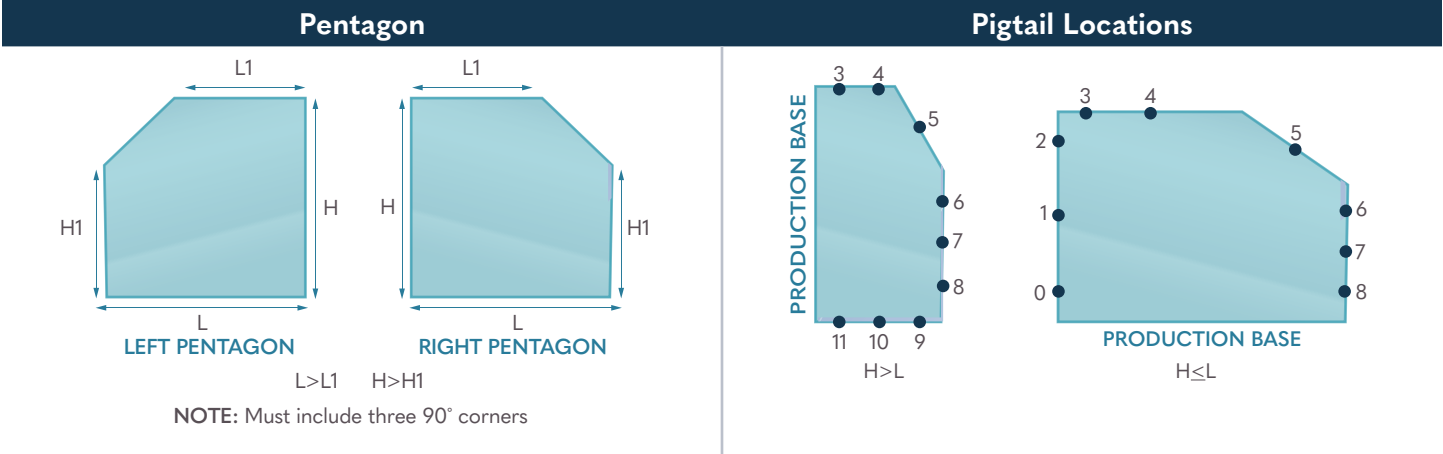
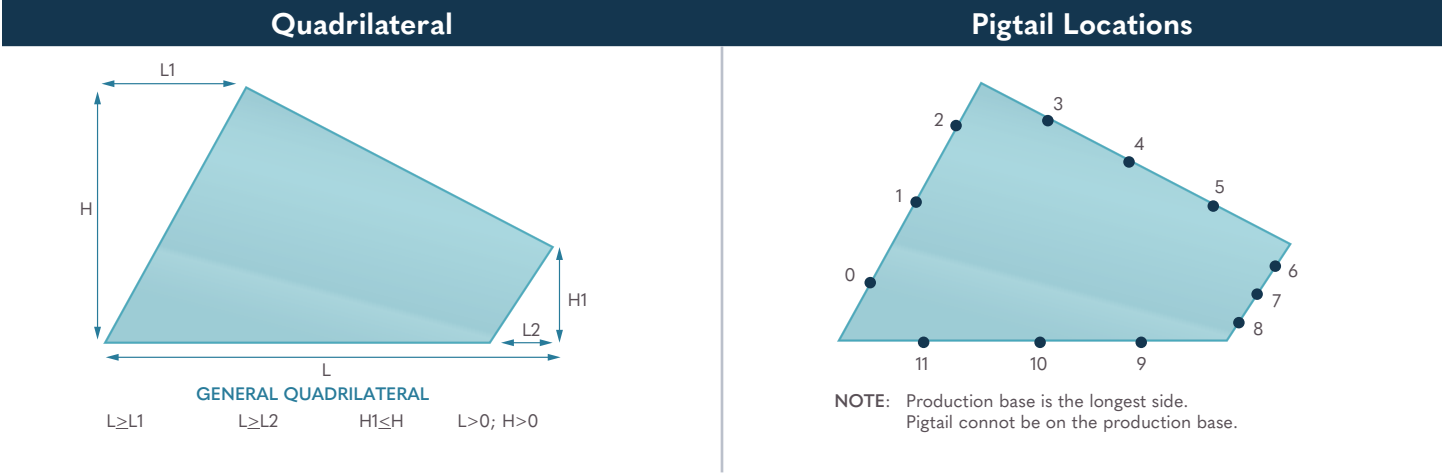
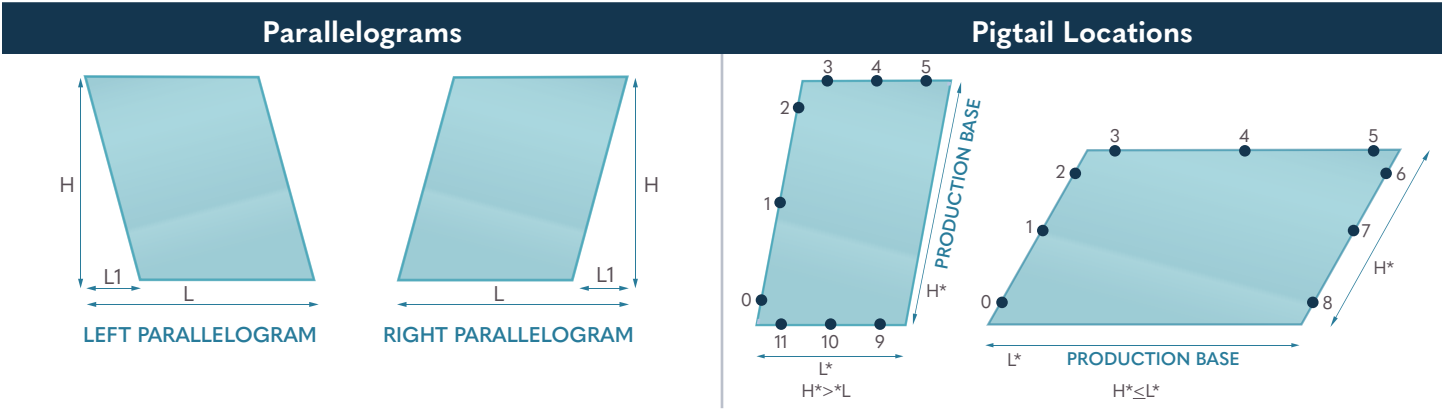
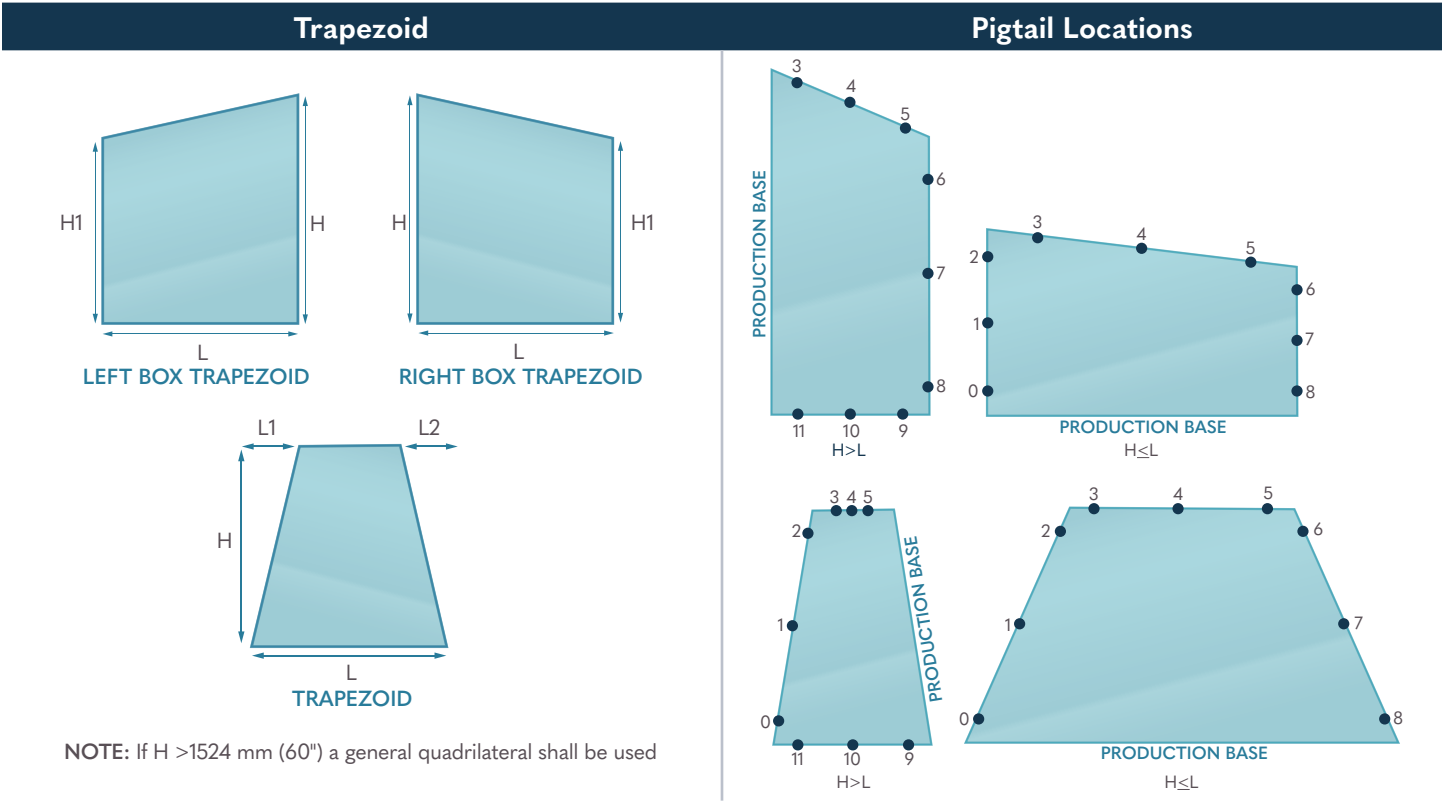
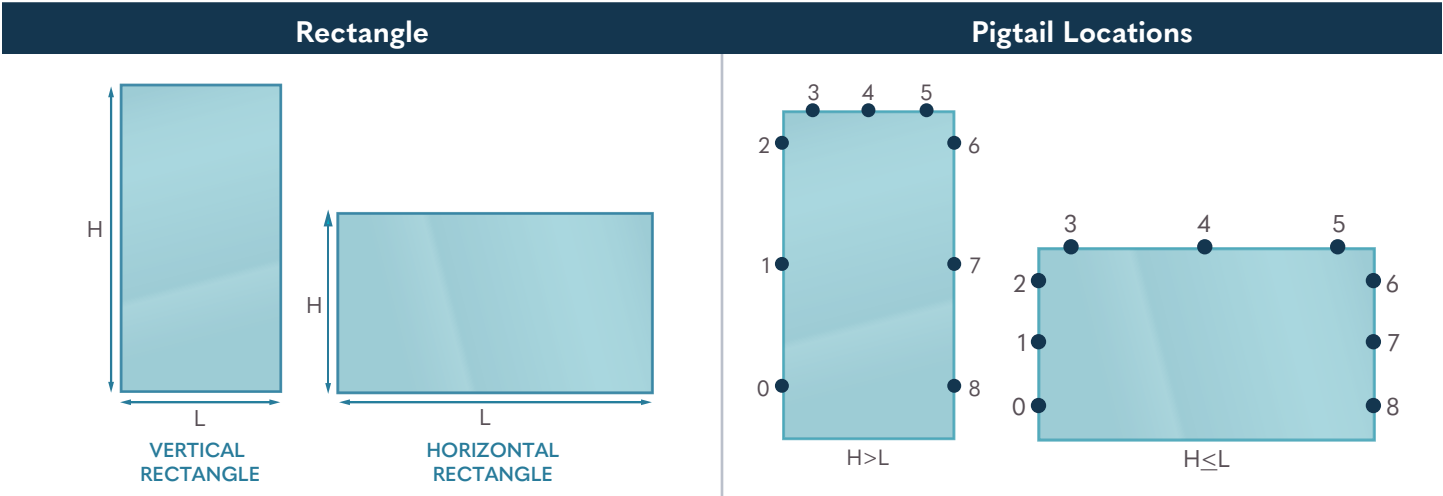
The thickness tolerance is ± 1 mm (0.04") for double IGU and ± 2 mm (0.08") for triple IGU.

Minimum and Maximum Dimensions

	Minimum	Maximum
Double Glazing	13.8" x 13.8" 350 mm x 350 mm	72" x 121.8" 1828 mm x 3095 mm
Triple Glazing	13.8" x 13.8" 350 mm x 350 mm	70.6" x 121.8" 1795 mm x 3095 mm
Shapes Bounding Box	13.8" x 13.8" 350 mm x 350 mm <i>A minimum bounding box should fit within the shape</i>	59" x 116.9" 1498 mm x 2970 mm <i>Shape cannot exceed the maximum bounding box</i>
Harmony	Height of 63", 1600 mm	Width of 72", 1828 mm <i>Harmony is available in portrait orientation ($H \geq L$)</i> <i>Recommended aspect ratio of 3:2 or greater</i>

Appendix B: Shape Dimensions & Pigtail Placements

Note: Views from exterior.
• Allowed Pigtail Locations.



Appendix C: IGU Performance

1" Standard DGU

Configuration	Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC Argon	U-Factor (BTU/hr ft²F) Argon	% Tuv	STC (dB)	OITC (dB)
6 mm Clear SR2.0 Coating 0.76 mm PVB 2.2 mm AN EC Coating 10 mm Cavity (Argon) 6 mm Clear	Clear State	60%	16%	15%	0.41	0.29	<1%	37	30
	Light Tint	18%	10%	10%	0.16				
	Medium Tint	6%	10%	9%	0.11				
	Full Tint	1%	11%	9%	0.09				

1" DGU with Bright Silver

Configuration	Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC Argon	U-Factor (BTU/hr ft²F) Argon	% Tuv	STC (dB)	OITC (dB)
6 mm Clear Bright Silver Coating 0.76 mm PVB 2.2 mm AN EC Coating 10 mm Cavity (Argon) 6 mm Clear	Clear State	57%	22%	18%	0.41	0.29	<1%	37	30
	Light Tint	20%	19%	11%	0.16				
	Medium Tint	5%	19%	9%	0.10				
	Full Tint	1%	18%	9%	0.09				

1" DGU with Crystal Gray

Configuration	Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC Argon	U-Factor (BTU/hr ft²F) Argon	% Tuv	STC (dB)	OITC (dB)
6 mm Crystal Gray 0.76 mm PVB 2.2 mm AN EC Coating 10 mm Cavity (Argon) 6 mm Clear	Clear State	46%	7%	11%	0.29	0.29	<1%	37	30
	Light Tint	19%	5%	9%	0.17				
	Medium Tint	6%	5%	9%	0.12				
	Full Tint	1%	5%	9%	0.10				

1" DGU with Low-E 180

Configuration	Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC Argon	U-Factor (BTU/hr ft²F) Argon	% Tuv	STC (dB)	OITC (dB)
6 mm Clear SR2.0 Coating 0.76 mm PVB 2.2 mm AN EC Coating 10 mm Cavity (Argon) Low-E 180 Coating 6 mm Clear	Clear State	58%	16%	15%	0.40	0.25	<1%	37	30
	Light Tint	17%	10%	10%	0.14				
	Medium Tint	5%	10%	10%	0.10				
	Full Tint	1%	11%	10%	0.08				

DGU with Krypton and Low-E 180

Configuration	Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC Krypton	U-Factor (BTU/hr ft²F) Krypton	% Tuv	STC (dB)	OITC (dB)
6 mm Clear SR2.0 Coating 0.76 mm PVB 2.2 mm AN EC Coating 10 mm Cavity (Krypton) Low-E 180 Coating 6 mm Clear	Clear State	58%	16%	15%	0.40	0.23	<1%	35	30
	Light Tint	17%	10%	10%	0.13				
	Medium Tint	5%	10%	10%	0.09				
	Full Tint	1%	11%	10%	0.07				

DGU with Inboard Laminate

Configuration	Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC Argon	U-Factor (BTU/hr ft²F) Argon	% Tuv	STC (dB)	OITC (dB)
6 mm Clear SR2.0 Coating 0.76 mm PVB 2.2 mm AN EC Coating 12 mm Cavity (Argon) 6 mm Clear 1.52 mm PVB 6 mm Clear	Clear State	58%	16%	14%	0.41	0.27	<1%	41	34
	Light Tint	17%	10%	9%	0.15				
	Medium Tint	5%	10%	9%	0.10				
	Full Tint	1%	11%	9%	0.09				

DGU with Acoustic Inboard Laminate

Configuration	Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC Argon	U-Factor (BTU/hr ft²F) Argon	% Tuv	STC (dB)	OITC (dB)
6 mm Clear SR2.0 Coating 0.76 mm PVB 2.2 mm AN EC Coating 12 mm Cavity (Argon) 6 mm Clear 1.52 mm Acoustic PVB 6 mm Clear	Clear State	58%	16%	14%	0.41	0.27	<1%	44	35
	Light Tint	17%	10%	9%	0.15				
	Medium Tint	5%	10%	9%	0.10				
	Full Tint	1%	11%	9%	0.09				

TGU with Krypton and Low-E 180

Configuration	Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC Krypton	U-Factor (BTU/hr ft²F) Krypton	% Tuv	STC (dB)	OITC (dB)
6 mm Clear SR2.0 Coating 0.76 mm PVB 2.2 mm AN EC Coating 12 mm Cavity (Krypton) 6 mm Clear 12 mm Cavity (Krypton) Low-E 180 Coating 6 mm Clear	Clear State	52%	19%	20%	0.34	0.12	<1%	40	31
	Light Tint	15%	11%	16%	0.10				
	Medium Tint	5%	10%	16%	0.06				
	Full Tint	1%	11%	16%	0.04				



Learn more at [SageGlass.com](https://www.sageglass.com)

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MALL OF AMERICA

Bloomington, Minnesota, USA

CASE STUDY

CHALLENGE

Mall of America is the nation's largest retail and entertainment destination. The 4.9 million square-foot complex attracts over 40 million of visitors annually for its shopping, dining, attractions and special events, the most of any mall in America. In May 2014, the Mall embarked on a \$325 million expansion — the most significant construction project since opening in 1992.

The expansion included a 342-room JW Marriott Hotel, an office tower, high-end retailers, new dining options, a tourist welcome center and large event space. In addition, the mall opened a grand entrance on the north side with an atrium and massive rotunda skylight to welcome incoming guests.

But with so much sunlight flooding in to the space from the large skylight above, the Mall had to find a way to control glare and solar heat gain to maintain guest comfort. Project designers wanted to avoid the use of shades and blinds, due to concerns about blocking natural daylight and diminishing the entrance's "wow" factor. These mechanical options would also be difficult to clean and maintain for such a large and elevated skylight installation.

"With SageGlass, we can control the amount of sun so that it is cool and comfortable in the mall, whether it is 9 degrees or 90 degrees outside."

Rich Hoge

Mall of America,
Vice President of Operations

Mall of America

Bloomington, Minnesota, USA

SageGlass®

SOLUTION

To maximize natural light infiltration and provide guests with a comfortable experience in all seasons, Mall of America chose to install electronically tintable SageGlass® glazing for the new rotunda skylight. SageGlass is dynamic glass that darkens or clears in response to sun movement throughout the day, deflecting solar heat and glare to reduce cooling costs and keep visitors comfortable.

The 3,500 square-foot SageGlass installation is composed of 300 individual SageGlass panes and operates automatically via light sensors. Tinting can also be controlled manually as needed for special events that require specific lighting conditions, such as a darkened room for an afternoon fashion show.

BENEFITS

With the help of SageGlass, Mall of America is now creating a memorable first impression for guests entering the complex through the new expansion. The north entrance atrium also provides a versatile and comfortable special events space.

Abundant natural light floods in from above throughout the day, but without the harsh glare and elevated interior temperatures that compromise comfort — and the increased energy bills. The space is comfortable for guests all hours of the day and it is easy to adjust the tint of the glass for special events in the large atrium.

“With SageGlass, we can control the amount of sun so that it is cool and comfortable in the mall, whether it is 9 degrees or 90 degrees outside,” Rich Hoge, Vice President of Operations for Mall of America. “We also benefit from energy savings without having to block daylight with blinds or shades. SageGlass was just the solution we were looking for to add a wow factor and yet solve the functional problem of too much sunlight.”



SageGlass transforms the indoor retail experience to optimize daylight and enhance the comfort of shoppers by preventing heat gain and glare. The skylight can be tinted via traditional switches, or the SageGlass mobile app, to create specific lighting effects and tint the glass as needed.

ARCHITECT: DLR Group

GLAZING CONTRACTOR: United Skys, Inc.

WHY SAGEGLASS?

The pioneer of the world's smartest electrochromic glass, SageGlass® is the ultimate connector between the built and natural environments. SageGlass tints on demand to optimize daylight, reduce glare and manage heat – all while maintaining unobstructed views of the outdoors. With SageGlass, architects and building owners can improve occupant comfort and reduce energy demand in buildings. As a wholly owned subsidiary of Saint-Gobain, SageGlass is backed by more than 350 years of building science expertise. Learn more at www.SageGlass.com or join SageGlass on Twitter, Facebook and LinkedIn.

sageglass.com / info@sageglass.com / 877.724.3321



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