SageGlass
SAINT-GOBAIN

IGU Product Guide

SAINT-GOBAIN

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Glatt – Zurich

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 coating transforms its tint state. 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 processes a variety of indoor and outdoor inputs to address a project's specific goals such as occupant comfort, glare control, daylighting or energy reduction. It coordinates tinting behavior in response to the sun, maximizing 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 modes, the SageGlass system offers control when and how you want it, and automation when you don't.

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:
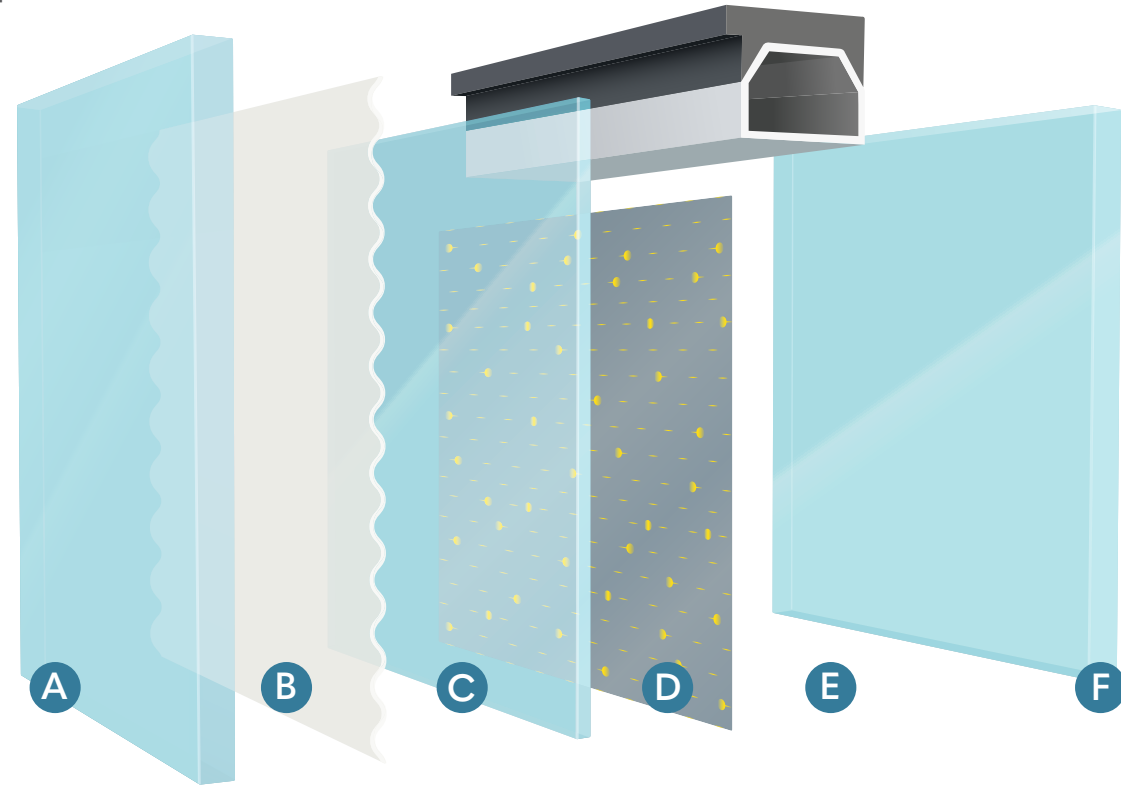
A Outboard Lite
The Outboard lite can be customized with different coatings and comes in different thicknesses based on project needs.

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 visual 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.

Interxion – France

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)
Green (Azuria)	6 mm (1/4")	
Blue (Solar Blue)	6 mm (1/4")	
Gray (Crystal Gray)	6 mm (1/4")	
Bronze (Pure Bronze)	6 mm (1/4")	
Pure Gray	6 mm (1/4")	

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 (or clear) on demand. Layers of metallic elements are deposited on the glass and modify the visual 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).

* 39.5 mm (1.6") ± 1.0 mm

22 mm (0.86") x 22 mm (0.86")

LOGO

* 39.5 mm (1.6") ± 1.0 mm

* 28 mm (1") ± 1.5

*8.5 mm (.33") ± 1.5 — Black Obscuration Band

* Logo can be positioned on either bottom corner depending on the pigtail position.

* Dimension increases if spacer inset increases

Tombola – UK
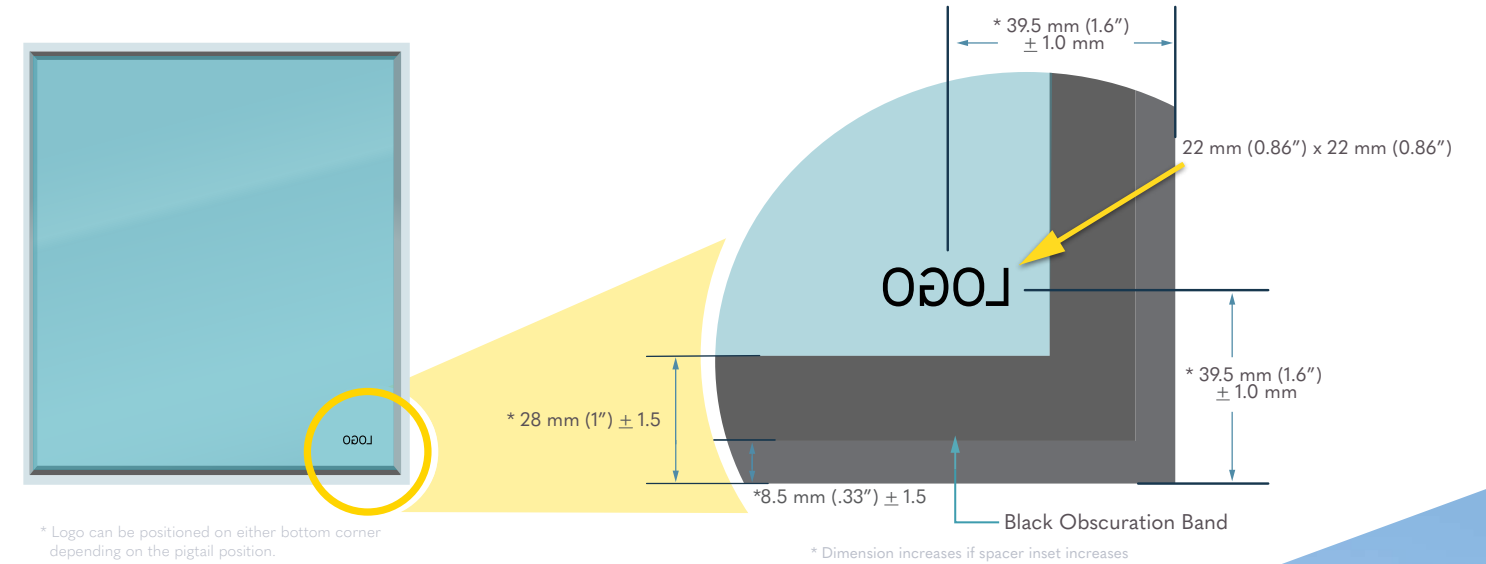
IGU Details & Customizations: Interior

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")	3048 mm (120")	1828.8 mm (72")
8 mm (5/16")	3048 mm (120")	1828.8 mm (72")
10 mm (3/8")	3048 mm (120")	1828.8 mm (72")

In addition to the electrochromic coating on the exterior lite, which already has low-emissivity properties, a performance coating (Low-E 180) can also be added on the interior lite (on surface #5 for double glazed, and on surface #7 for triple glazed).

SageGlass also offers the option of a ceramic fritting on surface #5 for double-glazed units or surface #7 for triple-glazed units. Consider the direction and orientation when you design a ceramic frit pattern. The final design must be validated by SageGlass before confirmation. Colored lites may not be used if ceramic fritting is required. All lites of the IGU must be clear substrates. Our current validated frit options on rectangular panels are:

- V-1085 Simulated Acid Etch
- V-1086 Simulated Sand Blast
- V-1087 Fog Gray
- V-1088 Sage Green
- V-1089 Blue Frost

- V-1090 Spice
- V-1091 Yellow Moon

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")	3048 mm (120")	1828.8 mm (72")
8 mm (5/16")	3048 mm (120")	1828.8 mm (72")
10 mm (3/8")	3048 mm (120")	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 black or mill finished options. 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 number and configuration of bus bars are based on which SageGlass product the project uses.

Nestlé - Switzerland

Bowie State University - USA

Schwarzsee- Switzerland

SageGlass Products & Tint Details

The SageGlass product portfolio includes SageGlass Classic, offering uniform tinting, and SageGlass Harmony, the world's only gradient tinting solution.

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.

Product	Number of Tint States	Available Tints
SageGlass Classic	4 Uniform States	Clear, Light, Medium, Full
SageGlass 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 visual light transmission (VLT) level of each tint state (for example, the clear state allows 60% of visual light transmission; the light state allows 18%; and so on). VLT values may vary based on IGU glass selections.

SageGlass Classic

Clear	Light	Medium	Full
60%	18%	6%	1%

SageGlass Harmony

Full to Clear	Clear to Full	Clear to Light	Light to Clear
1% / 60%	60% / 1%	60% / 18%	18% / 60%
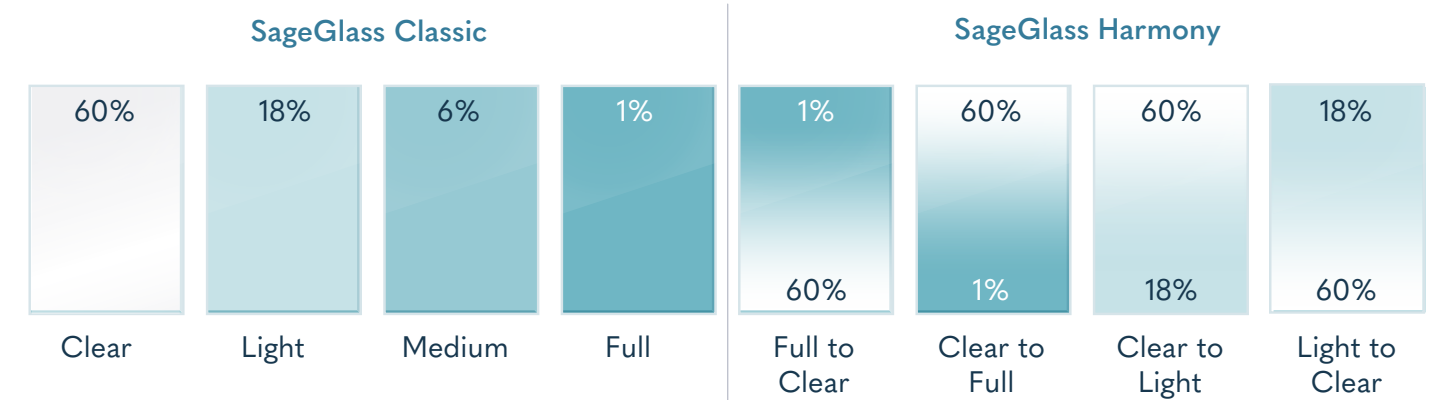
SageGlass Classic delivers uniform tinting across the entire IGU, in any one of the four tint states.

SageGlass Harmony offers eight tint states including four natural gradient tint states as well as four full-pane tint states. This feature is best used for vision glass areas. For spaces with stacked IGUs, a combination of Classic and Harmony can be leveraged to optimize daylight and glare management. Gradients are visible from both the interior and exterior of the building. Same-height IGUs should be used to ensure uniform patterns.

SageGlass Harmony is best suited for windows, short facades, and structural glazing systems and is not recommended for skylight applications.

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 *A minimum bounding box should fit within the shape.* *Minimum shape side length 120 mm (4.72")*	59" x 116.9" 1498 mm x 2970 mm *Shape cannot exceed the maximum bounding box*
Harmony	Height of 63", 1600 mm	Same as a Double or Triple Glazing *Harmony is available in portrait orientation (H ≥ L)* *Recommended aspect ratio of 3:2 or greater*

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.

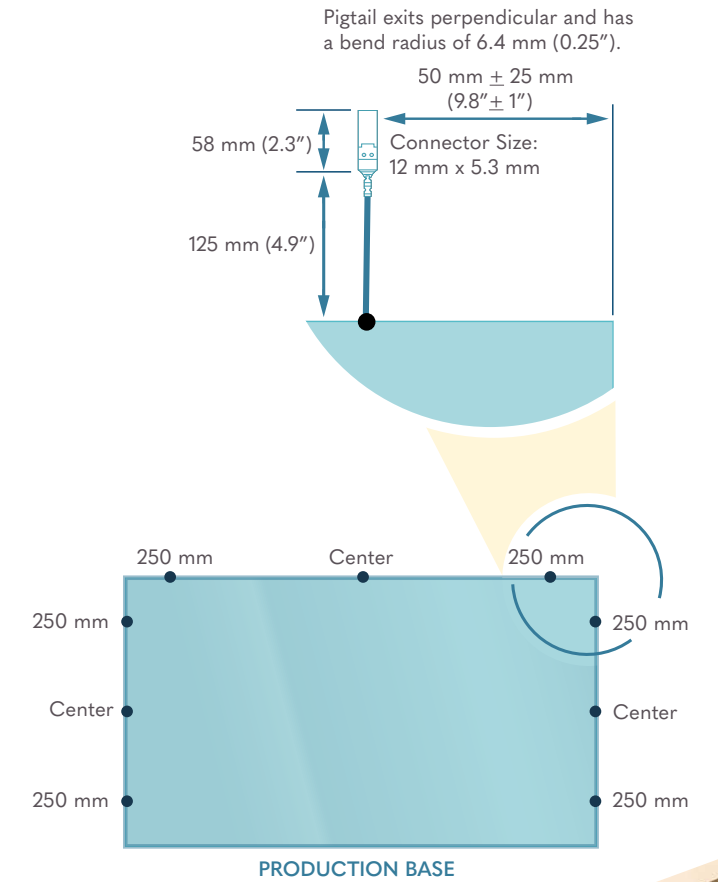## Holes, Cut-outs, Radius shapes & Bent Glass

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 installed on installed base/production base/stepped sides. For suggested pigtail locations refer to the adjacent diagram.

Pigtail exits perpendicular and has a bend radius of 6.4 mm (0.25").

50 mm ± 25 mm (9.8" ± 1")

58 mm (2.3")

Connector Size: 12 mm x 5.3 mm

125 mm (4.9")

250 mm — Center — 250 mm

250 mm / 250 mm

Center / Center
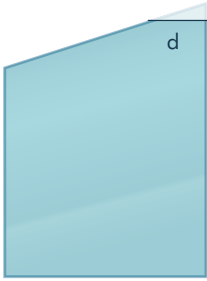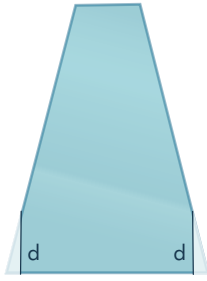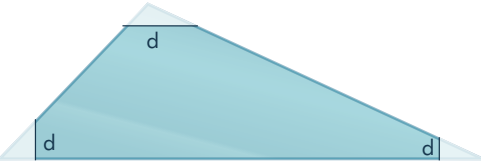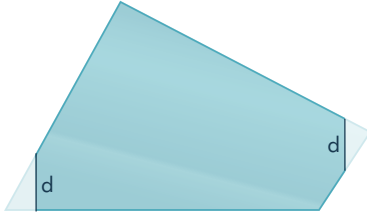
250 mm / 250 mm

PRODUCTION BASE

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. Silicone skim coating is an option available on step units.

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 TRAPEZOID TRIANGLE QUADRILATERAL H=H1 only	• 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")

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) and DECLARE labels. 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.

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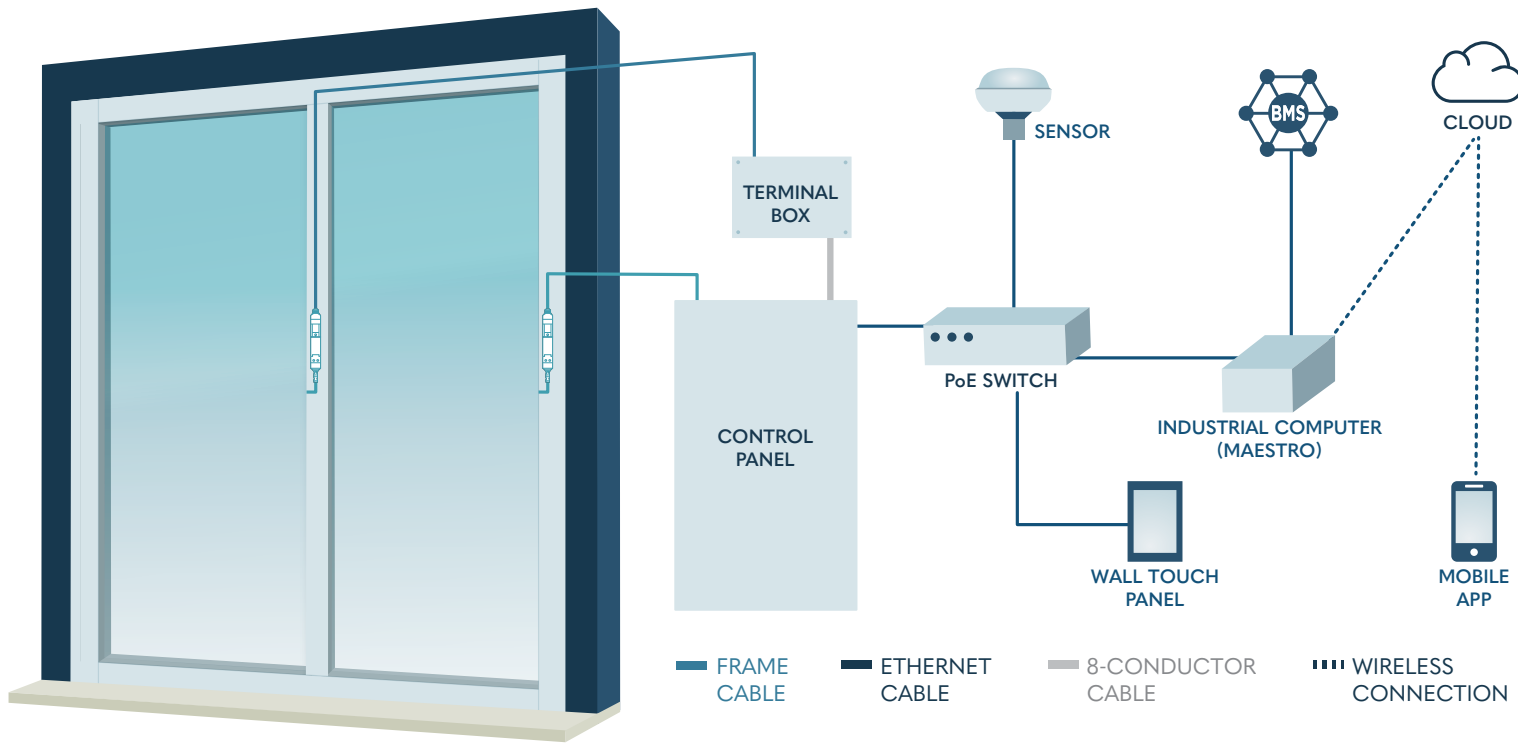
Physical samples of solutions, typically 12" x 12" for SageGlass Classic or 14" x 20" for SageGlass Harmony®, can be provided. Additionally, to help evaluate dynamic glazing options from different manufacturers, full-sized panels with your project specifications can be provided for a fee. These can be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

SageGlass Symphony®

SageGlass Symphony: Control Components

For greater context, this document also offers a short introduction to the SageGlass Symphony control components. For more details on the controls architecture, please contact a SageGlass representative.

The SageGlass IGU is controlled by a simple suite of control components, which may include terminal boxes, a wall touch panel, sensors, cables, and more. Detailed specifications of the control components are provided in the Specification Section 26 09 00. A snapshot of key design considerations is provided to assist with architectural space planning.

FRAME CABLE — ETHERNET CABLE — 8-CONDUCTOR CABLE — WIRELESS CONNECTION

Other Considerations for Installation

- Scope: PoE switches; industrial computer; ethernet switch.
- Components come with accessories for surface mounting.
- Consider installing in a standard 19" server rack; minimum 4U (not supplied by SageGlass).

Consider the distance from the IGU that is farthest from an electrical closet. If the distance is less than 125', no terminal box is needed. If between 125' and 350', a terminal box is needed. Installation is not possible if the distance is greater than 350'. SageGlass recommends a 50' buffer in addition to the direct distance between the IGU and the terminal box or the closet. The buffer allows for any routing requirements of the cable.

Wall Touch Panels

Wall Touch Panels can be used to control the SageGlass system and issue manual override commands. The panels are about the size of a light switch. They are best designed as a complementary component to the Symphony Mobile App, and allow users local control of rooms and floors.

Industrial Computer Needs

A standard BOM (Bill of Materials) includes an industrial computer with the SageGlass Maestro intelligence system installed; together, these are the "brains" of the system. Integration with Building Management Systems (BMS) is available, and uses a BACnet protocol. A Red Hat Package Manager is a preferred option.

Control Panel

Up to 16 SageGlass Classic IGUs can be supported by a small control panel, while a large control panel supports up to 64 IGUs. For SageGlass Harmony®, small control panels support up to 8 IGUs and large control panels support up to 32 IGUs. Panels are generally organized by floor and can be installed in any orientation. The total wall space required can be determined by assessing the number of IGUs per product type and determining the number of control panels that would be required.

Wall space required per control panel:

Size	Length	Width	Depth
Small	343 mm (13.5")	368 mm (14.5")	56 mm (2.2")
Large	914 mm (36")	445 mm (17.5")	107 mm (4.2")

SageGlass Symphony Mobile App

SageGlass® Classic

Waves, Beaulac Hotel- Switzerland

SageGlass Harmony®

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, SageGlass Harmony® or SageGlass Classic, and shape of the IGU).

IGU Rules
- Any angle must be ≥ 30° and ≤ 150°
- If the installed width is greater than 2286 mm (90"), the roller wave will be vertical as installed
- Edge finish will be standard seamed

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")

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

Product Specific Rules:
Harmony
- Rectangles only
- Minimum height: 1600 mm (63")
- Available in portrait orientation (H ≥ L)
- Recommended aspect ratio of 3:2 or greater

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 *A minimum bounding box should fit within the shape*	59" x 116.9" 1498 mm x 2970 mm *Shape cannot exceed the maximum bounding box*
Harmony	Height of 63", 1600 mm	Width of 72", 1828 mm *Harmony is available in portrait orientation (H ≥ L)* *Recommended aspect ratio of 3:2 or greater*

Appendix B:
Shape Dimensions & Pigtail Placements

Note: Views from exterior.
- Allowed Pigtail Locations.

Rectangle
VERTICAL RECTANGLE
HORIZONTAL RECTANGLE

Pigtail Locations
H>L
H≤L

Trapezoid
LEFT BOX TRAPEZOID
RIGHT BOX TRAPEZOID
TRAPEZOID

NOTE: If H >1524 mm (60") a general quadrilateral shall be used

Pigtail Locations
PRODUCTION BASE
H>L
PRODUCTION BASE
H≤L
PRODUCTION BASE
H>L
PRODUCTION BASE
H≤L

Triangle
L≥L1   L≥L2

Pigtail Locations
PRODUCTION BASE

Parallelograms
LEFT PARALLELOGRAM
RIGHT PARALLELOGRAM

Pigtail Locations
PRODUCTION BASE
L*
H*>*L
PRODUCTION BASE
L*
H*≤L*

Quadrilateral
GENERAL QUADRILATERAL
L≥L1   L≥L2   H1≤H   L>0; H>0

Pigtail Locations
NOTE: Production base is the longest side.
Pigtail connot be on the production base.

Pentagon
LEFT PENTAGON
RIGHT PENTAGON
L>L1   H>H1
NOTE: Must include three 90° corners

Pigtail Locations
PRODUCTION BASE
H>L
PRODUCTION BASE
H≤L

Appendix C: IGU Performance

Data is based on center of glass performance of representative factory production samples. Actual values may vary due to the production process and manufacturing tolerances. All tabulated data is based on NFRC methodology using the LBNL Window 7.8 software.

DGUs

6 mm Clear w/ SR2.0, 0.76 mm PVB interlayer, 2.2 mm SageGlass AN, EC2.0, 10.2 mm cavity, 6 mm Clear

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC	U-Factor (BTU/hr ft²F)	% Tuv	% Tdw-k	STC (dB)	OITC (dB)
				Argon	Argon			Argon	Argon
Clear State	60%	16%	15%	0.41	0.29	<1%	14%	37	30
Light Tint	18%	10%	10%	0.16	0.29	<1%	5%	37	30
Mid Tint	6%	10%	9%	0.11	0.29	<1%	2%	37	30
Full Tint	1%	11%	9%	0.09	0.29	<1%	<1%	37	30

6 mm Clear w/ Bright Silver, 0.76 mm PVB interlayer, 2.2 mm SageGlass AN, EC2.0, 10.2 mm cavity, 6 mm Clear

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC	U-Factor (BTU/hr ft²F)	% Tuv	% Tdw-k	STC (dB)	OITC (dB)
				Argon	Argon			Argon	Argon
Clear State	57%	22%	18%	0.41	0.29	<1%	13%	37	30
Light Tint	20%	19%	11%	0.16	0.29	<1%	6%	37	30
Mid Tint	5%	19%	9%	0.10	0.29	<1%	2%	37	30
Full Tint	1%	18%	9%	0.09	0.29	<1%	<1%	37	30

6 mm Clear, 0.76 mm PVB interlayer, 2.2 mm SageGlass AN, EC2.0, 10.2 mm cavity, 6 mm Clear

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC	U-Factor (BTU/hr ft²F)	% Tuv	% Tdw-k	STC (dB)	OITC (dB)
				Argon	Argon			Argon	Argon
Clear State	64%	11%	12%	0.44	0.29	<1%	16%	37	30
Light Tint	18%	6%	9%	0.16	0.29	<1%	6%	37	30
Mid Tint	6%	5%	9%	0.11	0.29	<1%	2%	37	30
Full Tint	1%	6%	9%	0.10	0.29	<1%	1%	37	30

6 mm OptiGray, 0.76 mm PVB interlayer, 2.2 mm SageGlass AN, EC2.0, 10.2 mm cavity, 6 mm Clear

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC	U-Factor (BTU/hr ft²F)	% Tuv	% Tdw-k	STC (dB)	OITC (dB)
				Argon	Argon			Argon	Argon
Clear State	45%	8%	11%	0.32	0.29	<1%	12%	37	30
Light Tint	12%	5%	9%	0.14	0.29	<1%	4%	37	30
Mid Tint	4%	5%	9%	0.11	0.29	<1%	2%	37	30
Full Tint	1%	5%	9%	0.10	0.29	<1%	1%	37	30

6 mm Bronze, 0.76 mm PVB interlayer, 2.2 mm SageGlass AN, EC2.0, 10.2 mm cavity, 6 mm Clear

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC	U-Factor (BTU/hr ft²F)	% Tuv	% Tdw-k	STC (dB)	OITC (dB)
				Argon	Argon			Argon	Argon
Clear State	39%	7%	11%	0.30	0.29	<1%	9%	37	30
Light Tint	10%	5%	9%	0.14	0.29	<1%	3%	37	30
Mid Tint	3%	5%	9%	0.11	0.29	<1%	1%	37	30
Full Tint	1%	5%	9%	0.10	0.29	<1%	<1%	37	30

DGUs with Inboard Laminate

6 mm Clear, 0.76 mm PVB interlayer, 2.2mm SageGlass AN, EC2.0, 12.2 mm cavity, 4 mm Clear, 1.52 mm Clear PVB, 4mm Clear

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC (Argon)	U-Factor (BTU/hr ft²F) (Argon)	% Tuv	% Tdw-k	STC (dB) (Argon)	OITC (dB) (Argon)
Clear State	63%	11%	12%	0.43	0.28	<1%	14%	37	30
Light Tint	18%	6%	9%	0.15	0.28	<1%	5%	37	30
Mid Tint	5%	5%	9%	0.11	0.28	<1%	2%	37	30
Full Tint	1%	6%	9%	0.09	0.28	<1%	1%	37	30

6 mm Clear, 0.76 mm PVB interlayer, 2.2 mm SageGlass AN, EC2.0, 10.2 mm cavity, 6 mm Clear, 1.52 mm Clear PVB, 6 mm Clear

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC (Argon)	U-Factor (BTU/hr ft²F) (Argon)	% Tuv	% Tdw-k	STC (dB) (Argon)	OITC (dB) (Argon)
Clear State	62%	11%	11%	0.43	0.28	<1%	14%	39	33
Light Tint	17%	6%	9%	0.16	0.28	<1%	5%	39	33
Mid Tint	5%	5%	9%	0.11	0.28	<1%	2%	39	33
Full Tint	1%	6%	9%	0.1	0.28	<1%	1%	39	33

6 mm Clear w/ SR2.0, 0.76 mm PVB interlayer, 2.2 mm SageGlass AN, EC2.0, 10.2 mm cavity, 6 mm Clear, 1.52 mm Clear PVB, 6 mm Clear

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC (Argon)	U-Factor (BTU/hr ft²F) (Argon)	% Tuv	% Tdw-k	STC (dB) (Argon)	OITC (dB) (Argon)
Clear State	58%	16%	14%	0.41	0.28	<1%	12%	39	33
Light Tint	17%	10%	9%	0.16	0.28	<1%	5%	39	33
Mid Tint	5%	10%	9%	0.11	0.28	<1%	2%	39	33
Full Tint	1%	11%	9%	0.09	0.28	<1%	<1%	39	33

6 mm Clear w/ Bright Silver, 0.76 mm PVB interlayer, 2.2 mm SageGlass AN, EC2.0, 10.2 mm cavity, 6 mm Clear, 1.52 mm Clear PVB, 6 mm Clear

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC (Argon)	U-Factor (BTU/hr ft²F) (Argon)	% Tuv	% Tdw-k	STC (dB) (Argon)	OITC (dB) (Argon)
Clear State	55%	22%	17%	0.40	0.28	<1%	11%	39	33
Light Tint	19%	19%	11%	0.16	0.28	<1%	5%	39	33
Mid Tint	5%	19%	9%	0.10	0.28	<1%	2%	39	33
Full Tint	1%	18%	9%	0.09	0.28	<1%	1%	39	33

8 mm Clear, 0.76 mm PVB interlayer, 2.2 mm SageGlass AN, EC2.0, 10.2 mm cavity, 6 mm Clear, 1.52 mm Clear PVB, 6 mm Clear

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC (Argon)	U-Factor (BTU/hr ft²F) (Argon)	% Tuv	% Tdw-k	STC (dB) (Argon)	OITC (dB) (Argon)
Clear State	61%	11%	11%	0.43	0.28	<1%	14%	39	33
Light Tint	17%	6%	9%	0.16	0.28	<1%	5%	39	33
Mid Tint	5%	5%	9%	0.11	0.28	<1%	2%	39	33
Full Tint	1%	6%	9%	0.10	0.28	<1%	1%	39	33

8 mm Clear w/ SR2.0, 0.76 mm PVB interlayer, 2.2 mm SageGlass AN, EC2.0, 11.2 mm cavity, 6 mm Clear, 1.52 mm Clear PVB, 6 mm Clear

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC (Argon)	U-Factor (BTU/hr ft²F) (Argon)	% Tuv	% Tdw-k	STC (dB) (Argon)	OITC (dB) (Argon)
Clear State	56%	16%	14%	0.40	0.27	<1%	12%	39	33
Light Tint	17%	10%	9%	0.15	0.27	<1%	4%	39	33
Mid Tint	5%	10%	9%	0.11	0.27	<1%	2%	39	33
Full Tint	1%	11%	9%	0.09	0.27	<1%	<1%	39	33

DGUs with LOW-E 180

6 mm Clear w/ SR2.0, 0.76 mm PVB interlayer, 2.2 mm SageGlass AN, EC2.0, 10.2 mm cavity, 6 mm Clear Low-E 180

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC	U-Factor (BTU/hr ft²F)	% Tuv	% Tdw-k	STC (dB)	OITC (dB)
				Argon	Argon			Argon	Argon
Clear State	58%	16%	15%	0.4	0.25	<1%	13%	37	30
Light Tint	17%	10%	10%	0.14	0.25	<1%	5%	37	30
Mid Tint	5%	10%	10%	0.1	0.25	<1%	2%	37	30
Full Tint	1%	11%	10%	0.08	0.25	<1%	<1%	37	30

6 mm Clear w/ SR2.0, 0.76 mm PVB interlayer, 2.2 mm SageGlass AN EC2.0, 10.2 mm cavity, 6 mm Clear, 1.52 mm Clear PVB, 6 mm Clear Low-E 180

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC	U-Factor (BTU/hr ft²F)	% Tuv	% Tdw-k	STC (dB)	OITC (dB)
				Argon	Argon			Argon	Argon
Clear State	56%	16%	14%	0.4	0.25	<1%	11%	39	33
Light Tint	16%	10%	10%	0.14	0.25	<1%	4%	39	33
Mid Tint	5%	10%	10%	0.1	0.25	<1%	2%	39	33
Full Tint	1%	11%	10%	0.08	0.25	<1%	<1%	39	33

6 mm Clear w/ Bright Silver, 0.76 mm PVB interlayer, 2.2 mm SageGlass AN EC2.0, 10.2 mm cavity, 6 mm Clear Low-E 180

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC	U-Factor (BTU/hr ft²F)	% Tuv	% Tdw-k	STC (dB)	OITC (dB)
				Argon	Argon			Argon	Argon
Clear State	55%	21%	18%	0.40	0.25	<1%	12%	37	30
Light Tint	19%	19%	12%	0.15	0.25	<1%	5%	37	30
Mid Tint	5%	19%	10%	0.09	0.25	<1%	2%	37	30
Full Tint	1%	18%	10%	.08	0.25	<1%	<1%	37	30

TGUs

4 mm Clear w/ SR2.0, 0.76 mm PVB interlayer, 2.2 mm SageGlass AN, EC2.0, 12.2 mm cavity, 6 mm Clear, 12.2 mm cavity, 6 mm Clear

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC	U-Factor (BTU/hr ft²F)	% Tuv	% Tdw-k	STC (dB)	OITC (dB)
				Argon	Argon			Argon	Argon
Clear State	55%	19%	20%	0.37	0.21	<1%	13%	36	27
Light Tint	16%	11%	16%	0.13	0.21	<1%	5%	36	27
Mid Tint	5%	10%	15%	0.09	0.21	<1%	2%	36	27
Full Tint	1%	11%	15%	0.07	0.21	<1%	1%	36	27

6 mm Clear w/ SR2.0, 0.76 mm PVB interlayer, 2.2 mm SageGlass AN, EC2.0, 10.2 mm cavity, 6 mm Clear, 10.2 mm cavity, 6 mm Clear

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC	U-Factor (BTU/hr ft²F)	% Tuv	% Tdw-k	STC (dB)	OITC (dB)
				Argon	Argon			Argon	Argon
Clear State	54%	19%	20%	0.37	0.22	<1%	13%	38	30
Light Tint	16%	11%	16%	0.13	0.22	<1%	5%	38	30
Mid Tint	5%	10%	15%	0.09	0.22	<1%	2%	38	30
Full Tint	1%	11%	15%	0.07	0.22	<1%	1%	38	30

TGUs with Inboard Laminate

6 mm Clear, 0.76 mm PVB interlayer, 2.2 mm SageGlass AN, EC2.0, 12.2 mm cavity, 6 mm Clear, 12.2 mm cavity,
6 mm Clear, 1.52 mm Clear PVB, 6 mm Clear

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC Argon	U-Factor (BTU/hr ft²F) Argon	% Tuv	% Tdw-k	STC (dB) Argon	OITC (dB) Argon
Clear State	55%	14%	17%	0.38	0.2	<1%	12%	43	34
Light Tint	15%	6%	15%	0.13	0.2	<1%	4%	43	34
Mid Tint	5%	5%	15%	0.09	0.2	<1%	2%	43	34
Full Tint	1%	6%	15%	0.07	0.2	<1%	1%	43	34

6 mm Clear w/ Bright Silver, 0.76 mm PVB interlayer, 2.2 mm SageGlass AN, EC2.0, 12.2 mm cavity, 6 mm Clear,
12.2 mm cavity, 6 mm Clear, 1.52 mm Clear PVB, 6 mm Clear

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC Argon	U-Factor (BTU/hr ft²F) Argon	% Tuv	% Tdw-k	STC (dB) Argon	OITC (dB) Argon
Clear State	50%	24%	21%	0.36	0.2	<1%	10%	43	34
Light Tint	17%	20%	16%	0.13	0.2	<1%	5%	43	34
Mid Tint	4%	19%	15%	0.08	0.2	<1%	2%	43	34
Full Tint	1%	18%	15%	0.07	0.2	<1%	1%	43	34

6 mm Clear w/ SR2.0, 0.76 mm PVB interlayer, 2.2 mm SageGlass AN, EC2.0, 12.2 mm cavity, 6 mm Clear, 12.2 mm
cavity, 6 mm Clear, 1.52 mm Neutral Clear PVB, 6 mm Clear

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC Argon	U-Factor (BTU/hr ft²F) Argon	% Tuv	% Tdw-k	STC (dB) Argon	OITC (dB) Argon
Clear State	45%	18%	15%	0.36	0.2	<1%	4%	43	34
Light Tint	13%	11%	12%	0.13	0.2	<1%	2%	43	34
Mid Tint	4%	10%	12%	0.09	0.2	<1%	<1%	43	34
Full Tint	1%	11%	12%	0.07	0.2	<1%	<1%	43	34

6 mm Clear w/ Bright Silver , 0.76 mm PVB interlayer, 2.2 mm SageGlass AN, EC2.0, 12.2 mm cavity, 6 mm Clear,
12.2 mm cavity, 6 mm Clear, 1.52 mm Neutral Clear PVB, 6 mm Clear

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC Argon	U-Factor (BTU/hr ft²F) Argon	% Tuv	% Tdw-k	STC (dB) Argon	OITC (dB) Argon
Clear State	42%	24%	17%	0.36	0.2	<1%	4%	43	34
Light Tint	15%	19%	13%	0.13	0.2	<1%	2%	43	34
Mid Tint	4%	19%	12%	0.08	0.2	<1%	<1%	43	34
Full Tint	1%	18%	12%	0.07	0.2	<1%	<1%	43	34

TGUs with Low-E 180

4 mm Clear w/ SR2.0, 0.76 mm PVB interlayer, 2.2 mm SageGlass AN, EC2.0, 12.2 mm cavity, 6 mm Clear, 12.2 mm
cavity, 6 mm Clear Low-E 180

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC Argon	U-Factor (BTU/hr ft²F) Argon	% Tuv	% Tdw-k	STC (dB) Argon	OITC (dB) Argon
Clear State	53%	19%	20%	0.35	0.14	<1%	12%	36	27
Light Tint	15%	11%	16%	0.11	0.14	<1%	4%	36	27
Mid Tint	5%	10%	16%	0.07	0.14	<1%	2%	36	27
Full Tint	1%	11%	16%	0.05	0.14	<1%	<1%	36	27

6 mm Clear w/ Bright Silver, 0.76 mm PVB interlayer, 2.2 mm SageGlass AN, EC2.0, 12.2 mm cavity, 6 mm Clear, 12.2
mm cavity, 6 mm Clear Low-E 180

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC Argon	U-Factor (BTU/hr ft²F) Argon	% Tuv	% Tdw-k	STC (dB) Argon	OITC (dB) Argon
Clear State	50%	24%	22%	0.35	0.14	<1%	10%	38	30
Light Tint	17%	20%	17%	0.12	0.14	<1%	5%	38	30
Mid Tint	4%	19%	16%	0.06	0.14	<1%	5%	38	30
Full Tint	1%	18%	16%	0.05	0.14	<1%	<1%	38	30

6 mm Clear w/ Bright Silver, 0.76 mm PVB interlayer, 2.2 mm SageGlass AN, EC2.0, 10.2 mm 90% Kr cavity, 6 mm
Clear, 90% Kr 10.2 mm cavity, 6 mm Clear Low-E 180

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC 90% Kr	U-Factor (BTU/hr ft²F) 90% Kr	% Tuv	% Tdw-k	STC (dB) 90% Kr	OITC (dB) 90% Kr
Clear State	50%	24%	22%	0.34	0.12	<1%	11%	37	30
Light Tint	17%	20%	17%	0.11	0.12	<1%	5%	37	30
Mid Tint	4%	19%	16%	0.05	0.12	<1%	2%	37	30
Full Tint	1%	18%	16%	0.04	0.12	<1%	<1%	37	30

6 mm Clear w/ SR2.0, 0.76 mm PVB interlayer, 2.2 mm SageGlass AN, EC2.0, 10.2 mm 90% Kr cavity, 6 mm Clear,
90% Kr 10.2 mm cavity, 6 mm Clear Low-E 180

Level of Tint	% Tvis	% Rf Ext.	% Rf Int.	SHGC 90% Kr	U-Factor (BTU/hr ft²F) 90% Kr	% Tuv	% Tdw-k	STC (dB) 90% Kr	OITC (dB) 90% Kr
Clear State	52%	19%	20%	0.35	0.12	<1%	12%	37	30
Light Tint	15%	11%	16%	0.10	0.12	<1%	4%	37	30
Mid Tint	5%	10%	16%	0.06	0.12	<1%	2%	37	30
Full Tint	1%	11%	16%	0.04	0.12	<1%	<1%	37	30

SageGlass
SAINT-GOBAIN
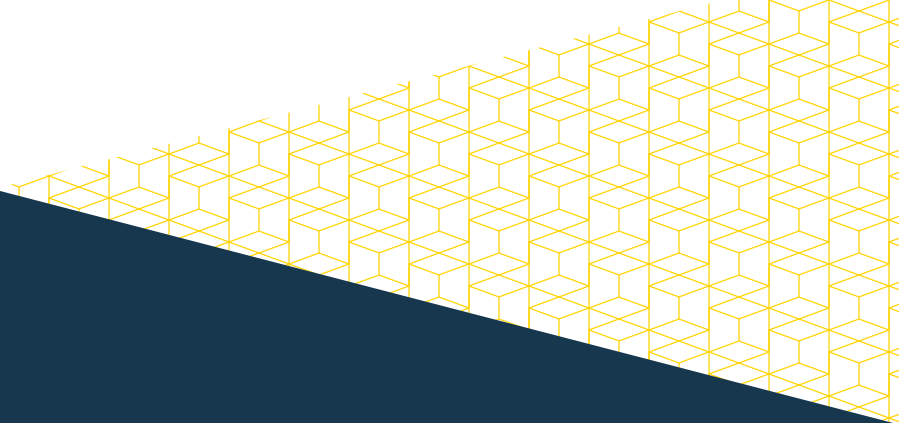
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