



HALIO[®]
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**Electrochromic Glass
BUYER'S GUIDE**

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Introduction

This buyer's guide gives an overview of the key characteristics to look for when considering electrochromic glass for your development. It answers the most commonly asked questions and provides you with the necessary information to make an educated decision and understand why Halio Smart Glass is the right choice.

Halio Smart Glass is the world's most advanced natural light management system. Designed to create comfortable and healthy indoor environments by eliminating glare and blocking solar heat, Halio windows deliver numerous ongoing benefits to building developers, owners, and occupants.

We're focused on advancing EC technologies, intelligence and controls that are designed to maximize daylight while mitigating glare; lower energy while increasing window area; and enable investments in real estate that support ESG – environment-sustainability-governance. Yet we ground our innovation with materials, processes and testing that have been tried and tested over decades.

This buyer's guide for electrochromic glass is organized in different chapters on the topics of product features, product specifications, manufacturing, design consideration, use (controls & automation), installation, longevity, quality & durability, test certifications, energy & environment, cost, and company. Your Halio representative is always available to answer any other questions you may have.



Contents

Click a topic to jump to the chapter.

[Introduction](#)

[Product Features](#)

[Product Specs](#)

[Manufacturing](#)

[Design Considerations](#)

[Use \(Controls & Automation\)](#)

[Installation](#)

[Longevity](#)

[Quality & Durability](#)

[Testing Certifications](#)

[Energy & Environment](#)

[Cost](#)

[Company](#)

Product Features

Electrochromic glass has a variable light transmission rate and solar heat gain coefficient. The specific product features are dependent on the technology and brand. Halio is next generation dynamic glass that looks like ordinary clear glass until it tints uniformly to block excessive solar heat and reduce glare, achieving its darkest shade within several minutes. Managing daylight with Halio improves occupant comfort while achieving the highest levels of energy efficiency. Additional product features include: High color rendering index in clear and tinted state providing accurate natural colors. Fast response time for immediate glare relief; combined with fast tinting speed and unlimited tint levels, this allows for maximal access to daylight. The Halio Cloud allows for manual or automated control as well as secure interaction with third-party devices and building automation systems.



PRODUCT FEATURES

QUESTION/TOPIC	HALIO SOLUTION	OTHER SOLUTIONS	RELATED INFO
COLOR			
What is the color performance or color rendering index of the EC glass?	Halio has the best color when clear, nearly the same as standard triple silver, low-e glass. It tints to shades of neutral gray. Halio's Color Rendering Index in clear state is 97 out of 100. After that, Halio CRI is >90 until 25% Tvis and remains above 80 through 12% Tvis. As a reference, indoor office lighting typically has a CRI of 80.	Other EC glass has inferior CRI, it has an observable yellowish hue when clear and bright blue when tinted.	Data Sheet
What is the Chroma value in the clear and tinted state?	Clear Chroma = 7.5 (lower is better). Tinted Chroma = 7.3	Clear Chroma = 13.0 (Sage)/Clear Chroma = 15.2 (View). Tinted Chroma = 10.2 (Sage)/Tinted Chroma = 9.3 (View)	Illustration
In what colors is the EC glass available?	Halio itself looks like traditional glass in its clear state and tints to neutral shades of cool gray. There are no other color options available, however, Halio can be laminated onto color glass, giving architects unprecedented design freedom.		
TINT UNIFORMITY			
Does the EC glass tint uniformly?	Yes. Halio EC glass tints uniformly across the entire window, making interior appearance uniform and beautiful.	Other EC technologies tints in a distracting, iris or lava lamp pattern from the outer edges in. With slow transitioning times, this makes interiors look unappealing during transition times.	
Why does tint uniformity matter?	Every shade between clear and dark is usable, giving you complete control over how much light to allow in. The unlimited tint options allow you to optimize Halio for glare and/or daylight in real-time, ensuring maximum comfort for the people inside.	The lack of uniformity is more obvious when tinting windows of various sizes. This patterned tinting is unnatural and makes the technology obvious and distracting.	

TINTING SPEED

What is the response time of the EC glass? Halio responds to automated or manual tint requests within 15 seconds. The combined rapid response and tint time makes it possible to keep up with rapid daylight level changes

Other EC glass doesn't respond in real-time to changes so it tints darker and stays tinted longer to hedge against glare.

How fast does the EC glass tint? Halio is the fastest electrochromic product available. Visible indication of switching is within 15 seconds. The glass tints from clear to full tint in under three minutes. In practice, most changes in tint levels are shorter steps between intermediate tint levels, which are achieved within a minute. Groups of windows are typically configured to switch at the same tint speed.

Other EC glass tints from clear to full tint in 15 -30 [Illustration](#) minutes.

Is tinting speed size dependent? The tinting speed is independent of window size for Halio. Facades or parts of it with various window sizes can be programmed to tint as one.

Tint time increases as window size increases. Windows are in tinted states longer than necessary.

Why does fast response time matter? Real-time response is critical to keeping up with rapidly changing cloud patterns. Halio delivers occupants more natural light during times of reduced glare, while providing superior glare mitigation when needed.

Why does tinting speed matter? Halio delivers occupants more natural light during times of reduced glare, while providing superior glare mitigation when needed. Halio is the only electrochromic product that tints fast enough to respond to changing daylight conditions in real-time, e.g., the sun coming out from behind the clouds.

Other electrochromic products cannot effectively respond to changing conditions. The risk of sudden glare requires other products to tint unnecessarily on overcast or partly cloudy days much of the time, resulting in unnecessarily dark spaces.

TINT LEVELS

How many tint levels does the EC glass have?

Halio offers infinite tint levels between fully clear and fully tinted, which results in always tinting to optimal level.

Other electrochromic technologies have tinting stops at 4 unevenly dispersed levels.

Why does unlimited tint levels matter?

Halio always tints to the exact level needed, not darker or lighter than necessary. Fast response time combined with unlimited tint levels delivers occupants more natural light during times of reduced glare, while providing superior glare mitigation when needed.

Because of slow switching speed, the glass will tint to a lower level than required and hedge against sudden glare.

[Research](#)
[Illustration](#)

How is the right tint level determined?

The algorithm prioritizes tinting for maximum natural light while still mitigating glare. After that, saving energy is prioritized.

Other electrochromics prioritize tinting for maximum glare mitigation. However, due to the low tinting speed, the glass doesn't have the flexibility to respond quickly to changing weather conditions. This results in over-tinted windows and gloomy occupant spaces.

Can the tinting experience be customized?

Halio's customization enables us to adjust the amount we tint, when we tint, what we clear to, how fast to clear, etc. If the customer desires to customize the tinting experience, Halio can adjust via remote configuration capabilities via the cloud. Halio's adjustments will have an impact due to our fast tint speed and unlimited tint level capability. Much more so than other electrochromics.

How much light does the EC glass block?

Halio tints from 65% to 1.7% Tvis for sun glare mitigation. Halio Black tints from 52% to 0.1% Tvis for complete sun glare elimination.

Sage & View tint to 1% Tvis

Product Specifications

Product specifications for Halio Glass and Halio Black Glass are listed in the table below based on the following IGU reference:

Color: Neutral
 Carrier Glass: 5mm
 Outboard Pane: 14.2mm: 5mm low iron, 1.52mm PVB, EC device, 1.52mm PVB, 5mm low iron
 Cavity: 10mm (3/8")
 Fill: 90% Argon
 Inboard Pane: 6mm clear with color-neutral low-e coating
 Overall Thickness: 30.2mm (1-3/16")

PRODUCT SPECIFICATIONS

PRODUCT SPECS	HALIO GLASS		HALIO BLACK GLASS		RELATED INFO
	CLEAR	FULLY TINTED	CLEAR	FULLY TINTED	
Visible Light Transmittance (Tvis)	61%	2%	52%	0.1%	
Solar Energy Transmittance (TSOL)	37%	1%	29%	0.04%	
UV Transmittance	<0.1%		<0.1%		
Exterior Reflectance	15%	6%	18%	6%	
Interior Reflectance	17%	12%	19%	12%	
Summer U-Factor Value	0.28		0.28		
Solar Heat Gain Coefficient (SHGC)	0.48	0.1	0.39	0.1	
Response Time	≤ 15 seconds		≤ 15 seconds		
Switching Time	≤ 3 minutes		≤ 3 minutes		
Number of Tint Level	Unlimited		Unlimited		
Privacy	No		Yes		
Blackout	No		No		

Manufacturing

The electrochromic Halio device is manufactured at the Halio factory in Miaoli, Taiwan. This Halio device is subsequently laminated in the IGU/LGU by a Halio certified fabrication partner, meaning Halio offers flexible IGU composition and high quality manufacturing of each step in the process. The production process of the electrochromic device is based on the flat panel display industry. That means inherently reliable, more efficient/high yield, and consistent high quality. Quality assurance and quality control are integrated throughout the production process, not only resulting in more efficient and superior manufacturing, but also guaranteeing that the products leaving the factory are superior and meeting Halio's high quality standards.



MANUFACTURING

QUESTION/TOPIC	HALIO SOLUTION	OTHER SOLUTIONS	RELATED INFO
What is the IGU composition?	Halio delivers an hermetically sealed EC device component ready to install into and IGU. IGU fabrication is done by certified third party fabricators for supply chain, glass and coating flexibility. A Halio EC IGU is manufactured on proven technology with the flexibility to use your trusted fabricators for glass and coatings option.	The EC device is integrated into the IGU through lamination and can fail if the IGU fails. The IGU is manufactured by the EC device supplier, making it sole-sourced and providing limiting glass and coatings options.	Data Sheet
What is the manufacturing time?	A more intricate manufacturing process for EC glass adds about 8 weeks compared to Low-E. Halio compenstates for this extra manufacturing time through close project collaboration with the customer team.	Other EC solutions have the same additional manufacturing time and processes to minimize supply interruptions.	Photo
What is the thickness of the IGU?	Variable thicknesses are possible depending on the IGU configuration. The typical IGU thickness is 1 3/16" for Halio and 1 5/16" for Halio Black.		Data Sheet
What is the production capacity per year in millions of square feet?	Approximately 4 millions square feet of capacity.		
How is the EC window manufactured?	Halio uses a slot dye manufacturing process, similar to the process used in the manufacturing of flat panel TVs (see illustration). This process creates a perfectly smooth conductive coating on high-quality, ultra-clear display glass.	Other suppliers use traditional glass manufacturing process to sputter the conductive coating onto the glass, leaving an uneven finish that scatters light and causes visible differences in uniformity when tinting (see illustration). Afterwards the EC device is laminated and sealed with tape, which can deteriorate and fail if the EC IGU seal fails.	Illustration

Next the Halio EC device is sealed, which not only improves reliability and enables the EC lite to operate even if the IGU fails, but also enables a variety of 3rd party Certified Fabricators to integrate Halio into EC IGUs. 3rd parties offer more glass, coating, and cost options for designers and architects.

The processes used by other EC manufacturers indicates that they produce the IGU in-house, limiting choice to designers of glass and coatings, as well as constraining capacity.

[Illustration](#)

What is the basis for the construction of Halio IGUs

ASTM E1300 “Standard Practice for Determining Load Resistance of Glass in Buildings”.

Design Considerations

Halio's manufacturing process is in sync with the supply chain, offering unparalleled design flexibility in IGU/LGU composition. Designing with Halio smart-tinting glass makes it easier for architects and designers to meet energy codes.



DESIGN CONSIDERATIONS

QUESTION/TOPIC

HALIO SOLUTION

OTHER SOLUTIONS

RELATED INFO

FACADE APPEARANCE

Can I determine the look by changing the IGU composition?

Halio EC device can be integrated into IGUs with a variety of glass and coating combinations.

Does the EC glass display “haze”?

Electrochromic products do not have haze. Other switchable products like SPD and LC glass have visible haze.

What exterior appearance flexibility does the product offer?

The standard IGU configuration has low iron glass and a neutral, single silver low-E coating. Due to flexible IGU configurations, Halio can incorporate tinted glass, low-E coatings, reflective coatings, colored laminates, ceramic frit pattern, etc. Also matching spandrel is an option. Halio offers the most flexibility in IGU composition by hermetically sealing the EC lite between two 0.5mm panes of glass with a PiB sealant. The resulting 1.2mm thick Halio Device can be laminated to carrier glass and built into an IGU by multiple manufacturers.

Other EC solutions are laminated unsealed on the carrier glass, and manufactured into an IGU by the EC manufacturer. They are also limited to the glass and coatings supported by the EC supplier and are typically blue tinted. [Illustration](#)

Can matching glass be provided for the facades or part of the facade that wouldn't use EC glazing? Is there a coating that can be used that matches the EC glass in clear state?

Currently we recommend Solarban 60 as a reasonable compliment to Halio (but not a match).

Can the EC glass provider deliver a building façade that has a silver reflective coating appearance?

Halio + AGC Stopsol Supersilver glass provides a silver reflective appearance. Stopsol has been in use for many years with hundreds of thousands of Sq Ft of installations. Due to our manufacturing process, we ensure that our glass looks significantly more uniform on your building than any other electrochromic glass provider. This is critical when using a silver coating on the glass.

To our knowledge, View has no solution. Sage will use Saint Gobain's Bright Silver.

Can you use the EC Glass in a frameless system?

No. The window frame is used to hide the required Halio System wiring.

No. The window frame is used to hide the required other system wiring.

GLASS PROPERTIES

Does the dynamic interlayer conflict with low-e coating?

Currently, we can't do a soft coating on surface #2. We can do a hard low-e on surface #2. The type of low-e coating we prefer works equally well on #2 or #3 (in fact it's sometimes referred to as a 3rd surface low-e coating).

What is the thermal expansion coefficient?

The outer IGU Halio pane has a coefficient of thermal expansion = 9×10^{-6} (/K). Halio panes are heat-strengthened or tempered.

What glass type is used?

Heat-strengthened low-iron glass.

SHAPES & SIZES

What sizes are available?

We provide standard sized panels of up to 120 3/8" x 59 3/8" (min size 23 15/16") of smart-tinting glass (IGU). We work closely with our customers to meet other size requirements.

[Data Sheet](#)

What shapes are available?

Only shapes with right angles are available (rectangles and squares).

[Data Sheet](#)

APPLICATIONS

Can the EC glass be used in doors or moveable walls? We have many installed doors using a power transfer hinge. We don't have a standard solution for moveable walls today.

GLARE

Can Halio provide privacy? Or do I still need blinds or shades? Halio Black is ideal for indoor designs of spaces wanted near-privacy without blinds. Halio smart-tinting glass is designed to maximize natural light, then mitigate glare for occupant comfort and energy savings. The Halio VLT ranges from 65% to 2%. Halio Black VLT ranges from 52% to 0.1%, at which point glare is completely eliminated, not just mitigated.

Other EC solutions are optimized to mitigate anticipated glare, resulting in over tinted spaces that are less optimal for occupants. Other EC solutions can reach 1%-1.7%, but still can't eliminate glare and may require shades or interior design use constraints.

ACOUSTICS

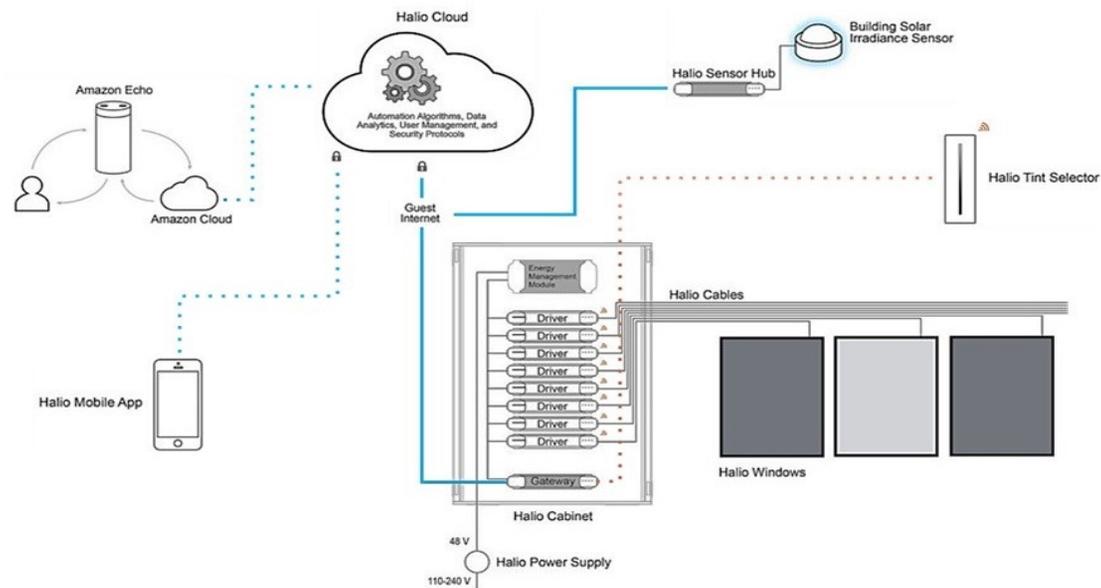
Does EC glass change the acoustic properties of the window? EC windows with Halio inside are quieter, improving acoustic comfort. Halio STC = 42 and OITC of 33. Other EC solutions have an STC of 32-35 [Illustration](#)
[Data Sheet](#)

What is the STC rating? Halio STC = 42 (higher is quieter). Halio OITC = 33. EC STC = 25-32. EC OITC = up to 30 [Data Sheet](#)

The Halio EC device provides additional sound reflection, making interiors quieter.

Use (Automation, Controls and Support)

This chapter answers questions pertaining to the use of Halio Glass. Halio Automation topics discuss the way in which Halio Glass operates; , Halio Controls reviews ways to automatically or manually control Halio Glass; and Halio Spectrum is the post-installation support framework that monitors, optimizes and updates installed solutions. These work together to setup, configure, manage, and control Halio over its lifetime.



USE (AUTOMATION, CONTROLS AND SUPPORT)

QUESTION/TOPIC	HALIO SOLUTION	OTHER SOLUTIONS	RELATED INFO
HALIO SYSTEM AUTOMATION			
What automation is possible with EC glass?	<p>Halio has sophisticated automation that enables real-time responsiveness to mitigate glare and maximize occupant comfort.</p> <p>The cloud-based architecture and advanced sensors enables real-time daylight and glare analysis.</p> <p>Halio includes :</p> <ul style="list-style-type: none">- Site context using obstruction maps tuned through commissioning is monitored for adjustments and issues. <p>Halio accounts for:</p> <ul style="list-style-type: none">- Current sun position relative to the building, using latitude, longitude, time of day, and time of year.- Real time weather and cloud cover, using our rooftop direct and diffuse irradiance sensor.- Neighboring buildings and other possible obstructions.- The distance sunlight shines into a building.- Solar Heat Gain, and impact on HVAC system.- Daylight, and impact on reducing electric lighting.	The automation of other solutions is hampered by less advanced photosensors and limited by the capability of the on-premise hardware and slow window response time.	Brochure

What are the benefits of an advanced automation system for EC glass?

Halio Automation puts people first by prioritizing maximum clear state time while mitigating glare. Changes are checked for every 30 seconds and responses are triggered in seconds to affect real-time tint adjustments. Halio mitigates direct and reflected sun glare. Halio delivers occupants more natural light during times of reduced glare, while providing superior glare mitigation when needed.

Other EC technologies prioritize mitigating glare, even if the glass is tinted too dark or for too long. Changes are based on weather forecasts and tinting changes are triggered in anticipation of what is needed at a future point in time.

How is glare mitigated?

Halio has direct sun glare -- mitigating visible light through the window.

Halio determines the sun position relative to the window and calculates the depth of light propagation into the building. The allowable propagation is set at commissioning. When the limit is reached, the level of tint is determined by Halio Automation, evaluating rooftop sensor data and sun position.

Halio Automation models the sun's positions to consider brightness, reflectance and position and tint levels are adjusted accordingly

What is the Halio fail safe state?

Halio can be configured to fail safe to a clear, tinted or "do nothing" state

Does the automation system use roof sensors?

Halio uses sensors to accurately read the sky condition. Halio uses a patented HDR camera / sensor, located on the roof, to measure global horizontal irradiance, diffuse horizontal radiance, and direct normal irradiance. We use this data on the brightness of the sun and sky to accurately interpret sky luminance and adjust tint levels.

The optical sensor that is used is not as sophisticated leading to less accurate reading of real-world conditions.

Can Automation be set to maximize daylight while reducing energy use?

Halio Automation for Max Daylight prioritizes daylight transmission to occupants, after glare mitigation.

Halio Automation for Energy Use prioritizes energy savings (cooling in summer and heating in winter) and sets window tint levels in a zone accordingly.

HALIO SYSTEM CONTROLS

Is control of the EC glass done through a cloud-based or cloud-connected system?

Halio is cloud-based. Control and computing is done in the cloud, which has specific benefits:

- Unlimited scalability – effective on small projects to the largest projects
- Extensive administrative control of user access and device access to site, location, window and changes.
- The fastest, most efficient computing hardware available is always deployed.
- Unlimited storage of historical and device usage data, used to optimize the overall system performance.
- Seamless and frequent deployment of new features and innovations via software updates.

Other solutions are cloud-connected with an on-premise server and VPNs for remote access. Control and computing is done on-premise.

Performance, scalability, ease of maintenance and upgrades, storage capacity, security, and integrations are all defined by the equipment that is on premise. [Illustration](#)

Performance is limited by the server and storage capacity of deployed, on-premise hardware.

Upgrade capability is limited and may not be uniformly deployed.

Customer IT teams may need to provide resources to secure and maintain the hardware.

Hardware obsolescence – much like other building infrastructure products with on-premise servers (HVAC, lighting), these servers become obsolete and can no longer run the latest software or run the latest security algorithms. This requires customers to upgrade the hardware servers in the future.

- Superior system reliability due to Cloud infrastructure.
- System and data security kept up-to-date with industry best in class technologies.
- Easy BMS/BAS Integration or future technology integration.

What initiates a call to tint?

Halio automatically reponds in real-time to changing light conditions, to occupant-initiated requests, or to programmed tint scenes.

Other solutions compensate for slow tint time by predicting, conservatively at the risk of sudden glare, when it must tint. The combination of tint time and predictive control means the windows are often unnecessarily tinted for hours at a time. [Illustration](#)

Do you offer manual control for daylight personalization?

Tint levels set by automation can be adjusted manually by occupants using the Halio in-room Tint Selector, the Halio Control Mobile App, or Alexa voice control.

View and Sage, which have 4 tint levels, can be manually controlled. [Illustration](#)

Manual adjustment allows for changes in window tint for atypical situations when more or less daylight is preferred. The manual adjustment is active for a configurable duration, after which it returns to normal automation.

HALIO SYSTEM SUPPORT

How is Halio supported after it has been installed and commissioned?

Halio Glass is supported by the Halio Spectrum(TM) Service

- Fully managed 24x7x365 by a customer care team that manages the system and user changes throughout the life of the system

Other solutions just offer standard technical support in response to failures. [Brochure](#)

- Unlimited access to a Halio system dashboard for real-time system status, performance data and operational mode changes.

- Unlimited licenses to the Halio Mobile Apps

- Pro-active Halio system device performance monitoring to detect and pre-empt potential failures and deploy corrective actions.

- The Halio Customer Care team can refine, adjust and improve programmed tint algorithms based on over-rides to glare

- Best in class hardware and software security

- Software update and bug fixes

- Annual on-site preventative maintenance

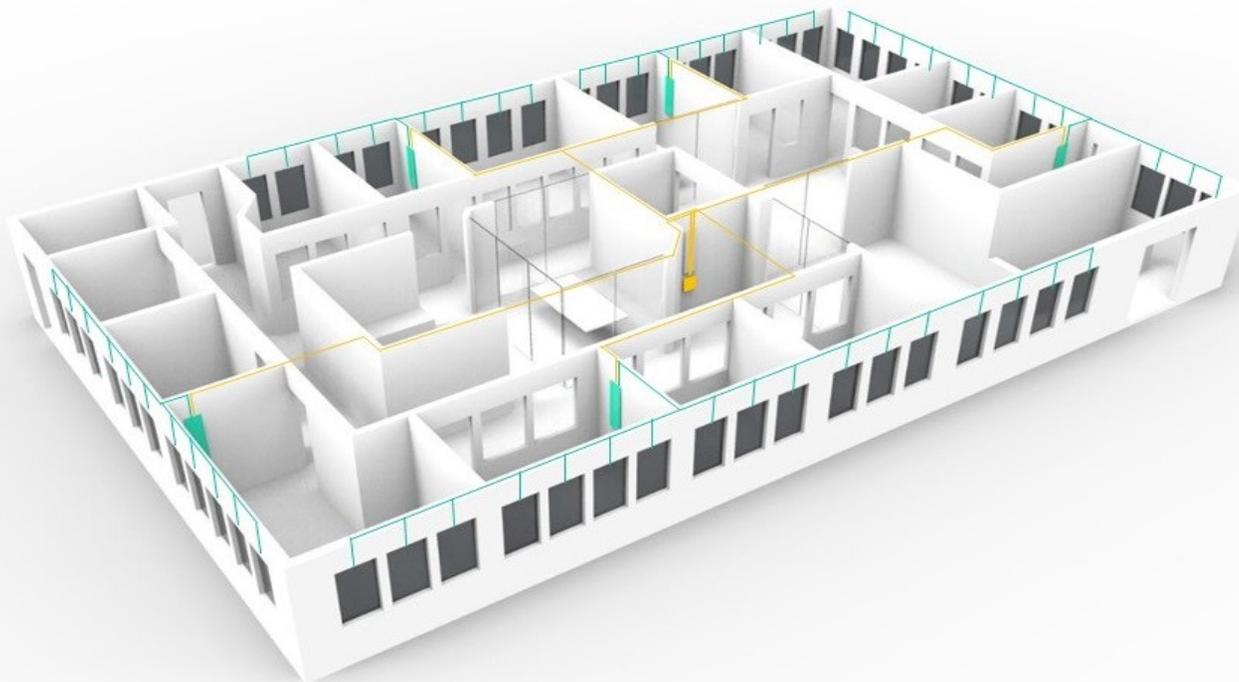
Is there remote monitoring of the glass?

All Halio windows are continuously monitored through their entire life for product health. Remote monitoring is included by leveraging building owner provided internet capacity to reach Halio's cloud environment. Halio offers a premium service after the first year to personalize and adjust settings.

Installation

Halio Glass is designed to be installed using the tools and practices that have been in place for decades for installation of standard Low-E windows, plus the additional installation of electronics for automation sensing and control of the EC windows. This section addresses questions that may arise from different installation trades including glaziers, electricians, system commissioners, and general contractors.

[Download complete Halio Installation Guide](#)



INSTALLATION

QUESTION/TOPIC

HALIO SOLUTION

OTHER SOLUTIONS

RELATED INFO

PROJECT MANAGEMENT

Project Implementation Process

Halio's Customer Success Team is responsible for ensuring the smooth planning and implementation of Halio projects. Prior to work commencement at the job site, the Customer Success Team engages all stakeholders to successfully define, design, develop and deploy your Halio System.

This includes the control, sensor and communications systems, product delivery, installation, testing, commissioning, training and cloud connectivity.

What is the size of the completed installations with Halio?

As of December 2020, Halio has been installed in facilities up to 200,000 sq ft of which up to 32,000 sq ft was Halio Glass.

ELECTRICAL INSTALLATION

Wiring System

The Halio System is powered by 120VAC/240VAC to 48VDC supplies.

Halio Tint Drivers receive 48VDC from the power supplies and connect to the Halio windows through a driver cable which provides power and analog signals.

The maximum length (distance) of the window driver cable is 300 feet.

Power Supply Routing through the Curtain Wall Unit

A Hario window has an IP67 waterproof connector and multiple exit locations. This provides flexibility in cable termination and routing on the "wet side" or "dry side" of the framing system.

Longevity

Halio is built to operate dependably over a period of decades, even in the event of IGU leakage. The development approach of the Halio System for longevity also dictated a cloud-based architecture that enables continuous upgrades, expansion, maintenance and security of the servers that power the Halio System.



LONGEVITY

QUESTION/TOPIC	HALIO SOLUTION	OTHER SOLUTIONS	RELATED INFO
Is the system architected to evolve and remain active over the life of the installation?	Yes. Halio's Command and Control reside in the cloud, where hardware and software is actively managed and updated. Installed Halio Glass is continuously monitored with accompanying analysis and support.		

Quality and Durability

Halio EC lites and IGUs are built on a decade of research, testing, and ongoing certification that ensure the product quality and durability. This section answers common questions regarding quality and durability.



QUALITY AND DURABILITY

QUESTION/TOPIC

HALIO SOLUTION

OTHER SOLUTIONS

RELATED INFO

QUALITY

What steps are taken to assure quality?

-- EC materials and compounds have been tested for durability and longevity in extreme conditions and passed.

-- IGU fabrication by certified third party fabricators guarantee expert quality for supply chain, glass and coating flexibility.

-- Quality assurance is taken at each step of the manufacturing process testing full-spectrum analysis, electrochromic properties, Tvis clear, Tvis tinted, the tint range curve, EC device charge, color, uniformity and switching speed.

Are the product and its materials designed, tested and certified for reliability?

We have built quality assurance into every step of our manufacturing process, ensuring the utmost in reliability. ASTM and accelerated outdoor weathering tests were performed.

[Illustration](#)

Does the system have a standard or extended warranty?

Our standard Halio Insulated Glass Unit (IGU) warranty is 10 years. The electronics of the Halio System are warranted for 5 years.

For a nominal fee, through Halio Worry Free Warranty, electronics are perpetually warranted, including parts and labor. Contact us for more details on the extended warranty.

[Brochure](#)

Was outdoor weather testing done on the EC products?

Halio has passed testing conducted by ATLAS Labs at their outdoor weathering test facility in Arizona. No degradation was evidenced in this testing to optics, color or appearance.

[Illustration](#)

What does the glass look like when broken by flying debris/projectiles?

Halio IGU is SGCC certified and is marked accordingly.

The outer lite of Halio is a laminate comprised of the Halio device sandwiched between two 1.52mm layers of PVB and two 5mm panes of heat-stengthened glass. In installations where most of the exerior panes are heat-strengthened Halio Glass, the impact resistance and breakage patterns match those typical of heat-strengthened glass.

When IGUs of other solutions fail, exposing the EC device to oxygen, the tinting capabililty is interrupted and results in a target or bullseye state (see illustration).

[Illustration of bullseye failure](#)

Cyber Security Penetration Testing

Halio hired a leading cyber securirty testing firm to perform security assessment to enumerate possible attack vectors, evaluate existing security controls, and provide recommendations for improvement.

Based on the evidence collected from the security assessment, Praetorian benchmarked the Halio System using an "Existing Vulnerability Measure" (EVM) formula. They rated the Halio system "EXCELLENT", earning an "A" grade.

Recurring testing is planned annually or when new software capabilities are added / changed substantially.

Thermal Expansion Coefficient

The outer pane of the Halio Smart-Tinting IGU has a coefficient of thermal expansion = 9×10^{-6} (/K).

Halio panes are heat-strengthened or tempered.

DURABILITY

Is the EC light durable?

Halio considers durability at every aspect of the device:

- Coatings that improve color in any state.

- Patented G-TCO electrodes provide improved robustness while delivering faster, uniform switching.

- use of in-line and offline manufacturing analytics via ASTM E2141.

- Operational monitoring from in-windows sensors to report operation to the cloud.

Has the EC glass passed ASTM 2141?

Yes. Halio Smart Glass passed the US Department of Energy’s National Renewable Energy Laboratories (NREL) testing procedures according to the ASTM E2141-06 test methodology required to meet the ASTM E2953 standard for electrochromic product durability.

Halio performed ASTM, outdoor weather testing and other accelerated testing for longevity and compliance with no evidence of degradation.

Halio also performed Outdoor Weathering Testing of the polymer film (static and accelerated the testing via Equatorial Mounts with Mirrors for Acceleration (EMMA) testing (5-fold increase in UV from Sun).

Other EC solutions have passed ASTM 2141 testing. We are unaware if View's new Gen 4 and Sage's new Harmony products are ASTM certified.

[Release](#)

Halio Glass is continuously monitored for performance and quality integrity.

Does the product contain organic components (chemistry) that can degrade?

Halio materials have been exhaustively tested over 10 years by Kinestral, the technology developer of Halio. Outdoor Weatherability Testing has also been performed by ATLAS Labs, including accelerated EMMA testing, and showed no degradation. Compliance and accelerated testing from ASTM 2141 also showed no degradation of failures.

No organic components are used.

Halio Smart Glass Testing Certifications

The information below summarizes quality and durability testing performed on Halio Glass.

TESTING CERTIFICATIONS

CATEGORY	TYPE	CERTIFICATION	STATUS
CERTIFICATIONS	IGU Certifications	Insulating Glass Certification Council certifications	Yes
		ASTM E2188 Standard Test Method for IGU Performance	Yes
		ASTM E2189 Standard Test Method for Testing Resistance to Fogging in IGUs	Yes
		ASTM E2190 Standard Specification for IGU Performance and Evaluation	Yes
	Laminated Glass Certifications	Safety Glazing Certification Council certifications	Yes
		Consumer Product Safety Commission 16 CFR 1201 Category II Federal Safety Standard for Architectural Glazing Materials	Yes
		ANSI Z97.1:2015 Safety Glazing Materials Used in Buildings – Safety Performance Specifications and Methods of Test	Yes
	Electrochromic Glass Certifications	ASTM E2141 Standard Test Method for Accelerated Aging of EC Devices in Sealed IGUs	Yes
		ASTM E2953 Standard Specification for Evaluating Accelerated Aging Performance of EC Devices in Sealed IGUs	Yes
	Component Materials Certifications	ASTM C1036 Standard Specification for Flat Glass	Yes
ASTM C1048 Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass		Yes	

ASTM C1172 Standard Specification for Laminated Architectural Flat Glass Yes

ASTM C1376 Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass

ELECTRICAL SAFETY

Safety Compliance	Installed Products meet NEC Standards compliance	Yes
	PS120 Cabinet complies to UL-50 Type 1 CSA Type 1 and NEMA Type 1 IEC 60529, IP20	Yes
	System Power Supplies Certified to UL60950-1	Yes

UL COMPLIANCE

Specification References	System is ETL certified under UL/CSA 60730. Driver and Energy Manager have been individually tested to specific specifications.	Yes
	ETL - UL/CSA 60730-1 T/R 8/13/19	Yes
	ETL - UL/CSA 60730-2-9 T/R 8/13/19	Yes
	UL/CSA 62133	Yes
	ETL - UL/CSA 62368-1 T/R 8/13/19	Yes
	UN38.3 T/R 4/23/19	Yes
	IEC 62133 T/R 5/15/19	Yes
	UL (MH63521) T/R 6-3-19	Yes
	The system power supply is certified to UL60950	Yes
Class 3 Plenum Rated Cabling, Communications Cable Plenum Rated	All Halio cabling is UL listed, meeting UL444 safety standard for multi-conductor communication cabling. CMP rated for NEC approved use in plenum spaces. Our Window cables and connector have an International Protection Rating of IP67 (waterproof).	Yes
CE Mark	Used only for European markets, but shows impact of using the 60730 specification	Yes, Europe
UL 61010 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use or equivalent	Halio worked with UL / ETL and selected a safety compliance path using UL/CSA 60730.	Not Applicable

UL 13 Standard for Power-Limited Circuit Cables or equivalent	Not Applicable
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ELECTROMAGNETIC COMPATIBILITY

Telecommunications Act 47 CFR Subpart B – Unintentional Radiators	Halio was designed for both commercial and residential applications Products to be compliant with the much stricter residential, CLASS B Criteria We comply with FCC Part 15, Subpart B; ICES-003, Issue 6 T/R 6-13-17	Yes
FCC 15.107:2020 Class B Specification for Conducted Limits	Halio was designed for both commercial and residential applications Products to be compliant with the much stricter residential, CLASS B Criteria We comply with FCC Part 15, Subpart B; ICES-003, Issue 6 T/R 6-13-18	Yes
FCC 15.109:2020 Class B Specification for Radiated Emission Limits	Halio was designed for both commercial and residential applications. We comply with FCC Part 15, Subpart B; ICES-003, Issue 6 T/R 6-13-18	
EMC Canada - RSS	Halio was designed for both commercial and residential applications. We comply with RSS-Gen Issue 5 (April 2018) RSS-247 Issue 2 (February 2017) T/R 6-14-18	Yes
EU - EMC Immunity - For CE Mark	Halio was designed for both commercial and residential applications for a world wide market. U EMC immunity is not required for the US market, but shows robustness to outside RF interference. We comply with EN 55024:2010+A1:2015 EN 61000-3-2:2014 EN 61000-3-3:2013 T/R 7-11-18	Yes, not required
EU - ERM - unintentional - For CE Mark	Halio was designed for both commercial and residential applications for a world wide market. EU unintentional is not required for the US market, but shows robustness of our products to be compliant with EU residential, CLASS B Criteria. We comply with EN 301 489-1 V1.9.2 (2011-09) as specified in EN 301 489-17 V2.2.1 (2012-09) T/R 7-6-18 CLASS B	Yes, not required

EU - EN - intentional radiators - For CE Mark	Halio was designed for both commercial and residential applications for a world wide market.	Yes, not required
	EU unintentional is not required for the US market, but shows robustness of our products to be compliant with EU residential, CLASS B Criteria. We comply with EN300 328V2.2.0 (2017-11) T/R 2-19-19, CLASS B	
US Electro Static Discharge - ESD EN 61000-4-2	This test is not required for sale, but establishes a test criteria especially useful for consumer electronics and interfaces end customers / occupants might often use. The Halio Tint selector passed this testing.	Not Required
FCC 15.109(g):2020 Class B Specification for Information Technology Equipment – Radio Disturbance Characteristics – Limits and Methods of Measurement (CISPR 22)	We test to the stricter CLASS B criteria. Reference to CISPR 22 is a European norm	Not Applicable

Energy and the Environment

The Halio System delivers energy savings and is environmentally friendly.



ENERGY AND THE ENVIRONMENT

QUESTION/TOPIC	HALIO SOLUTION	OTHER SOLUTIONS	RELATED INFO
What energy savings are attainable with EC technology?	5-20% Energy savings for office buildings with EC glass. Exact savings depend on building attributes and location.		Report Chart
How does Halio impact HVAC optimization/sizing?	<p>Halio contributes to incremental reductions in HVAC energy consumption by reducing solar heat gain. This may enable an optimization in the sizing and run times of the HVAC equipment.</p> <p>Since Halio can save more energy than other EC solutions, it may enable a greater reduction in HVAC equipment sizing.</p>	HVAC equipment sizing can be reduced based on 5-25% energy savings.	
What are the measurable sustainability aspects of the manufacturing process from start to finish?	<p>The environmental impact of Halio originates from:</p> <ul style="list-style-type: none"> -- Manufacturing, 70% -- Raw Materials (primarily glass), 29% -- Transport, 1% <p>Preliminary testing shows that the proprietary materials used in Halio Glass have a negligible impact on the environment. Halio is also LBC Red List Free.</p>		
Does the EC glass have a Health Product Declaration (HPD)?	Yes, declaration available online	Other suppliers have HPD.	Report
Does the EC glass have an	Yes.	Other suppliers have EPD.	Report

Environment Product Declaration (EPD)?

The EPD is a product-specific, type III EPD following the ISO 14025, EN 15804, and ISO 21930 standards, as well as the UL Part B PCR for Processed Glass.

This document contributes towards the LEED Building Design and Construction (BD+C) v4 and v4.1 credit for Building Product Disclosure and Optimization, Option 1.

Does the EC glass have a Red List Declare Label?

Yes, Halio is LBC Red List Free and the certificate is available online via the International Living Future Institute. View is Red List Compliant. The certificate is available online via the International Living Future Institute. [Report](#)

The Declare Label discloses the composition of the product to 100ppm (0.01%) and follows the Declare Manufacturer's Guide 2.0.

This document meets the requirements of Living Building Challenge and contributes towards the LEED BD+C v4 and v4.1 credit for Building Product Disclosure and Optimization – Material Ingredients, Option 1.

What is the dynamic solar heat gain coefficient of EC glass?

Halio has a dynamic solar heat gain coefficient (SHGC) from 0.39 to 0.08

Electrochromic Glass
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Cost

Ask your Haliao representative to estimate the cost and savings of your Haliao installation.



COST

QUESTION/TOPIC	HALIO SOLUTION	OTHER SOLUTIONS	RELATED INFO
What is included in a Haliao bid and DPR?	<ul style="list-style-type: none">-- Haliao IGU (Insulated Glass Units)-- Haliao Controls-- Haliao Cables-- Haliao Rooftop Photo Sensors-- Haliao Software Seat Licenses-- Haliao Project Management Support-- Haliao Design Guidance-- Haliao Implementation Guidance with Associated Trades-- Haliao System Provisioning-- Haliao System Commissioning-- Haliao Standard Warranty		
What is excluded from a Haliao bid?	<ul style="list-style-type: none">-- Rooftop mast components (typically provided by the GC or electrician)-- Internet cables to connect the Haliao Gateways to the facility internet-- Facility router to access the internet-- Fasteners or cable trays for cable runs between Haliao components-- Power supplies-- Electrical hardware/outlets to connect power to the Haliao System		

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About Halio, iNC.

Information about Halio, Inc.



ABOUT HALIO, INC.

QUESTION/TOPIC

HALIO SOLUTION

OTHER SOLUTIONS

RELATED INFO

Who is Halio?

Halio, Inc., formerly Kinestral Technologies, was founded in 2010 to conduct research, development, qualification, manufacturing and testing of Halio EC Lites and Halio Smart Glass IGUs.

The company also qualifies glass fabricators, glazier, and partners for the manufacturing of IGUs, windows, facades and interiors Powered by Halio.

Additionally, Halio's Works with Halio program certifies third party devices and systems that are integrated with the Halio System.

Halio provides technical support and resources for installations, whether from Halio or Halio partners.

Who manages Halio?

The current Halio executive team was assembled in 2020.

Is Halio public?

Halio is privately funded.

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