

view

DESIGN GUIDE

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1. Glossary

BoS (Balance of System) - All components that make up a View Dynamic Glass system other than the insulating glass units.

Busbar - A thin conductive metallic strip that runs along the two opposing edges of an Dynamic insulating glass unit.

Daylighting - The practice of orienting windows or other openings on a façade that brings in natural light to the space and provide effective internal lighting.

Drop Cable - the communication and power cable between the Window Controller and Trunk Line cable.

Electrochromic - A type of smart window technology that uses a solid state coating made up of nano-scale layers of metal oxides. A small electrical voltage moves ions between layers to change states.

HVAC - Heating, Ventilation & Air Conditioning system.

IGU (Insulating Glass Unit) - Two or more lites of glass spaced apart and hermetically sealed to form a single glazed unit with an air space between each lite.

IGU Array - A group of IGUs connected to the same Window Controller and controlled collectively.

IGU Cable - The communication and power cable between the Window Controller and IGU.

IGU Pigtail - The electrical wire hardwired to each IGU that provides the electrical voltage necessary to tint the glass.

LEED (Leadership in Energy and Environmental Design) - A voluntary, consensus-based, market-driven program that provides third-party verification of green buildings.

TEE - a "T" shaped connector that links two or more cables together.

Terminator - A cap connector placed at the two ends of the trunk line to "terminate" the power distribution.

Trunk Line - The primary cable that distributes power and communication to the Dynamic Glass system. Each IGU and Window Controller is branched back into the Trunk Line.

Window Controller - Local controller that provides the electrical voltage signal to each IGU.

WYE - A "Y" shaped connector that links two or more cables together.

Zone - Dynamic Glass windows that are controlled as a single group.

2. Overview

This guide will go through the steps to design a complete View Dynamic Glass system for a project. The architect, general contractor, glazier, window manufacturer and low voltage contractor should read this guide to understand the different design aspects and considerations when using View Dynamic Glass for their project. Responsibilities will vary by project type and scope.

View Dynamic Glass uses electrochromic technology to transition between clear and various tint states on demand, providing unprecedented control over the heat and glare. The design guidelines found in this manual will go through the key decisions necessary to design a proper View Dynamic Glass system.

View understands that incorporating a Dynamic Glass system into a building is a new process for most teams. Therefore View is dedicated to providing end-to-end support every step of the way. View encourages users to go through this guide and do their best in designing a system based on these guidelines. The View staff will gladly review drawings and provide redline inputs. If at any time further design assistance or additional information is needed, contact the assigned View Project Manager. If a Project Manager has not yet been assigned, email rfi@viewglass.com with your questions and we will get back to you quickly.

2.1. What is Dynamic Glass?

View Dynamic Glass represents a big step forward in building facade technology. With View Dynamic Glass, windows are no longer a static component in a building - it is a responsive façade solution for optimum solar control and occupant comfort.

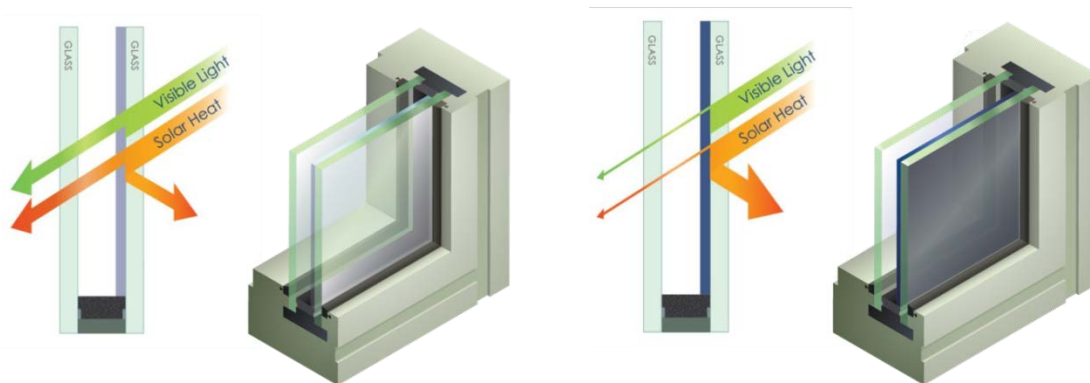


Figure 1 – Dynamic Glass in clear and tinted states

2.2. Benefits of Dynamic Glass

A BETTER VIEW. A stunning view blocked by blinds or marred by glare is not really a view at all. View Dynamic Glass allows you to look at—and be inspired by—your view 24 hours a day.

NATURAL LIGHT. The value of natural light to the human condition is well documented. With View's intelligent design, you can optimize the amount of daylight entering a building, 365 days a year.

OCCUPANT COMFORT. Everyone wants to sit next to a window – until it gets too hot or so bright you can't see. View's intelligent design manages this automatically, keeping inside conditions comfortable even when things outside are not.

INTELLIGENT CONTROL. Total control when and where you want it. View Dynamic Glass incorporates intelligent controls that automatically adjust the condition of the window for optimal daylighting, energy savings, or visual and thermal comfort. Manual adjustments can be made through a wall switch unit, web interface, or mobile application.

FREEDOM OF DESIGN. Designers and architects rejoice. With View Dynamic Glass, you no longer have to choose between expansive glass facades and increased HVAC and shading complexity. You are free to create innovative designs that maximize your vision while improving energy efficiency.

ENERGY EFFICIENCY. Heating, cooling, and lighting are substantial costs in a building. View Dynamic Glass is an energy-efficient product that drives down HVAC and lighting costs. Cooling peak load and energy consumption are significantly reduced, allowing downsizing of HVAC systems and cost savings in annual operating costs. Architects and owners can realize a major contribution to LEED certification with the use of View Dynamic Glass.

2.3. How Dynamic Glass Works

View Dynamic Glass is comprised of a solid-state coating with nano-layers of metal oxides deposited onto the glass. A small electrical voltage is applied that moves ions across the layers, allowing the glass to change states between clear and tint. View Dynamic Glass can be tinted to four tint levels. See the View IGU data sheet for the latest performance characteristics.

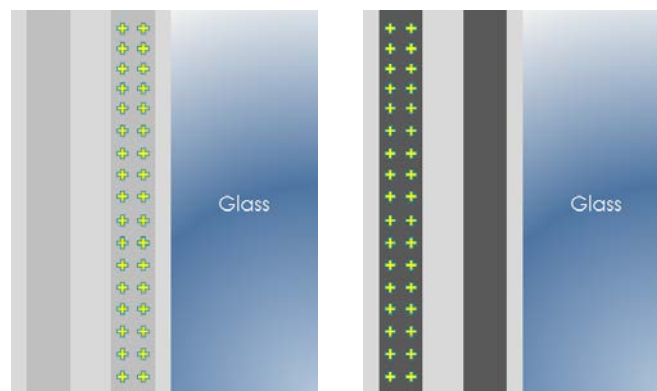


Figure 2 - How View Dynamic Glass Works

2.4. Insulating Glass Unit (IGU)

A standard View IGU consists of two clear tempered lites with an argon-filled space (triple-pane IGUs are also available). The electrochromic (EC) coating is typically deposited onto surface #2 of the outboard lite.

Low voltage DC electricity is conducted across the coating through two opposing busbars. A busbar is a thin conductive metallic strip that runs along the two opposing edges of an IGU. For rectangular

lites, the busbars run along the long edges of the IGU. For non-rectangular windows, contact View for busbar and IGU pigtail locations.

The distance between opposing busbars is referred to as the “busbar distance”. For rectangular IGUs, the busbar distance is equal to the short-edge dimension. This dimension is important to remember as it determines the applied voltage required to tint the IGU correctly. More relative to the reader, it also determines which IGUs can be connected to the same IGU (section 6.2).

View Dynamic Glass will exhibit a "theater curtain" effect during transition; the transition will begin along the long edges and gradually move towards the center. The transition duration depends on:

- i) The size of the window; the transition will take longer for larger windows, varying from 10 - 45min for temperatures $> 0^{\circ}\text{C}$
- ii) The ambient temperature; the transition time increases at sub-zero temperatures. View dynamic glass will effectively transition down to -10°C with the windows taking almost twice as long to transition at these temperatures.

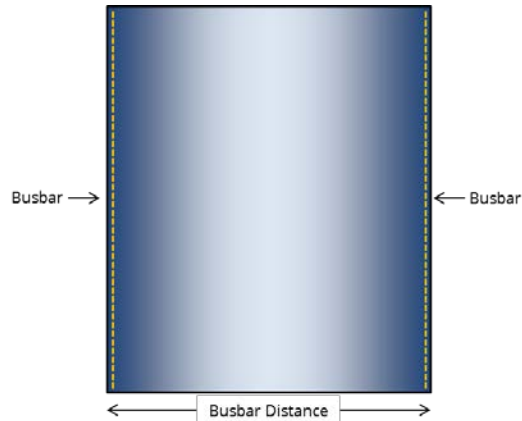


Figure 3 – IGU Busbars and Transition Direction

Each IGU contains a pre-terminated electrical “pigtail” cable that connects the IGU to the control network. This is how the IGU obtains the power and communication to tint on demand. This cable exits near one of the corners of the IGU and is connected to its corresponding Window Controller via an IGU cable. See the View IGU data sheet for exact locations and dimensions of the pigtail.

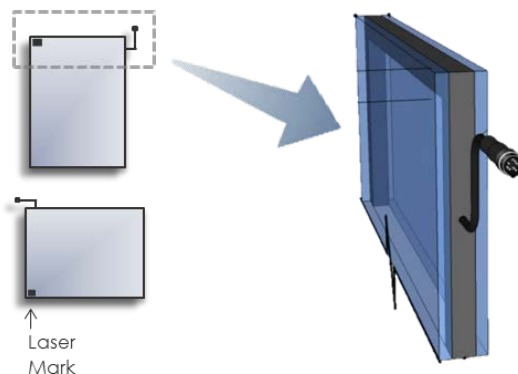


Figure 4 – IGU Pigtail

3. Controls Architecture/Components

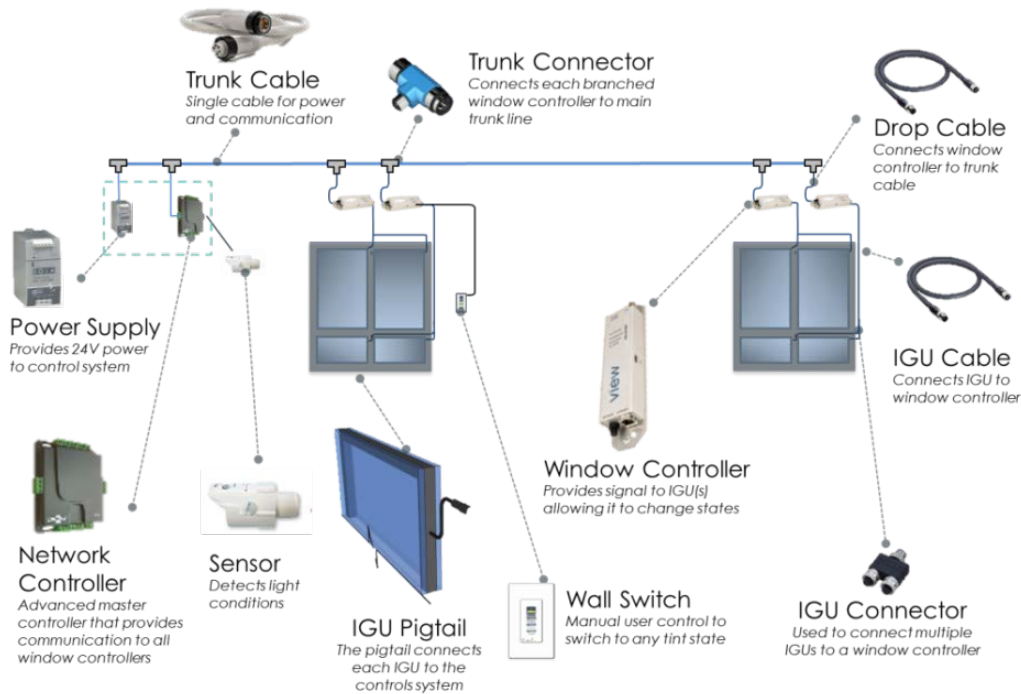


Figure 5 – BOS Architecture

This section describes the physical controls network that would typically be included in a View Dynamic Glass system. The hardware components other than the IGUs are referred to collectively as the Balance of System (BoS) components. These design guidelines provide a step-by-step process for determining BoS requirements.

3.1. The BoS has the following characteristics:

- a. The IGUs in the system are divided into IGU Arrays. An IGU Array consists of one or more IGUs connected to a single Window Controller
- b. The Window Controller sets the tint level of the IGU Array by providing a very specific small voltage/time profile. The selected tint level is commanded from a manual switch or the controls network
- c. A system will typically contain a single trunk line that provides both the power and communications backbone for the system
- d. Each Window Controller is connected to the trunk line by a tee and drop cable
- e. A Network Controller sends control data to multiple window controllers and is connected to a trunk line. This device sends control data to multiple Window Controllers.
- f. 24VDC power supplies are connected to the trunk line. Refer to section 3.2 on power supply sizing.

- g. Wall Switch – The wall switch is used to manually control the Dynamic Glass. The wall switch contains four LED buttons corresponding to the four tint states.
- h. Control boxes - typically contain a network controller, power supply, terminal blocks, circuit breaker, etc. and are placed in mechanical/utility closets.
- i. View Touch app - allows the end user to manually override and control the tint states of the Dynamic Glass via the View mobile application on an Apple iOS device. Zones, schedules and threshold programs can also be configured using the app.

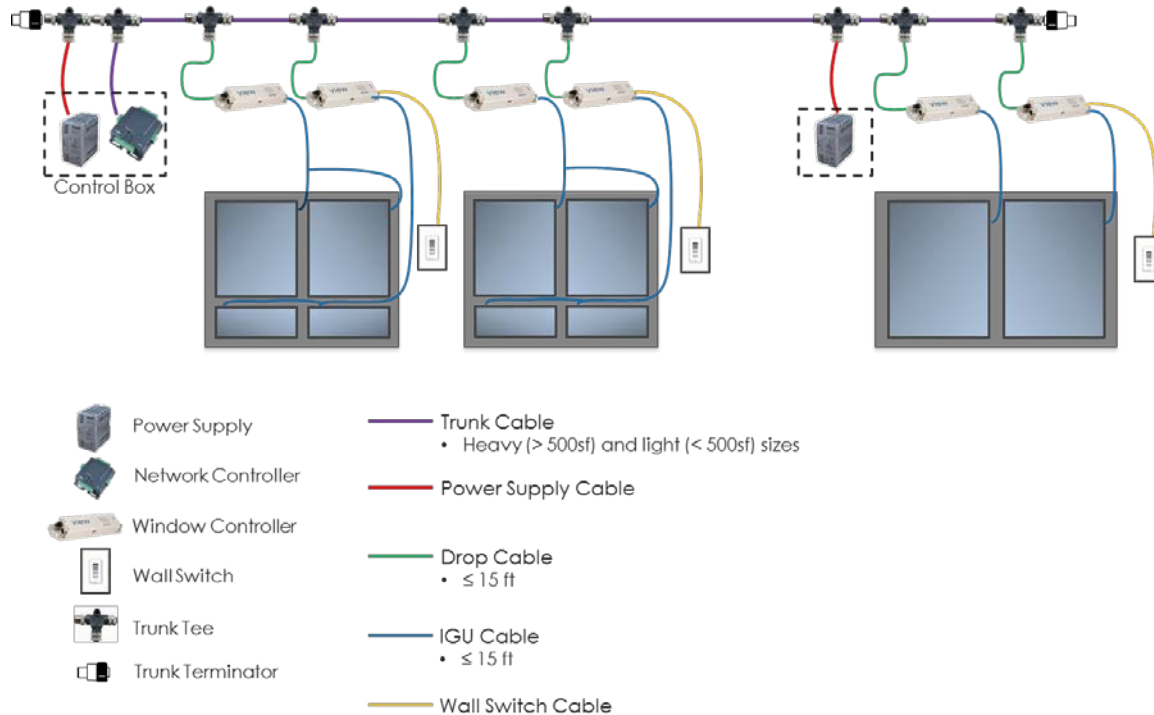


Figure 6 – BOS Design

3.2. Power Supply Sizing

Proper sizing is necessary of the power supplies that provide low voltage DC power to the View Dynamic Glass system. Follow these general guidelines as a preliminary calculation to determine the size and number of power supplies needed for a specific project and consult your View Project Manager at time of design.

- Rule of thumb: Every 60 sf of Dynamic Glass requires 10W of power
- For a 600 sf project, 100W of power is required. Add on 20% as a safety factor and you should have a 120W power supply.
- 240W is the largest power supply available. For projects that need more than 240W of power or are greater than 1,440 sf of Dynamic Glass, multiple power supplies are needed.



4. Design Process

The design process can be broken down into discrete steps. Generally these steps must be completed in the sequence of sections presented in this document. Some sections can be completed by different parties in the project design team but many require collaboration among the team.

Example of ownership worksheet. Each project may be different:

Project:	Example Office Project		
Assigned By:	J. Smith, Architect		
Section:	Owner:	Date:	
3. Design Process Ownership	General Contractor	2-Jan-14	
4. Controls Package	Architect	2-Jan-14	
5. Zoning	Architect	10-Jan-14	
6. Window Controllers Needed	Low Voltage Contractor	30-Jan-14	
7. Component Locations and Cable Routing	General Contractor	20-Feb-14	
8. Network Connectivity	General Contractor	20-Feb-14	

Figure 7 – Example of Design Process Ownership

5. Controls Packages

There are three controls packages available for a View Dynamic Glass System – the controls package determines what inputs are available to control the zones in the system.

5.1. Select

In the Select controls package, each zone is manually controlled using a wall switch or the optional View Touch app.

5.2. Sense

In the Sense controls package, zones are automatically controlled based on internal or external light levels using a light sensor. The Sense package can still include manual override capability using wall switches or the optional View Touch app.

5.3. Intelligence

In the Intelligence controls package, zones are automatically controlled based on the calculated position of the sun and characteristics of the zone. For instance, a lobby area may be biased more towards maximizing daylight than controlling glare when compared to an open cubicle area. A sunroom can have different parameters than a dining room. The Intelligence package may also include light sensors that adjust to local weather conditions. The Intelligence package can still include wall switches or the optional View Touch app.

6. Zoning

In a View Dynamic Glass system, each zone of IGUs can be controlled together, allowing, for example, different tint levels in different rooms or along different facades of a building.

Zones may be selected based on any number of design choices. Many design choices can be mixed and matched to create a completely customizable zoning scheme to maximize the tinting control benefits for a particular building. Some common considerations include:

6.1. Facades

Separate zones for the East, West, North and South facades. Through the course of a day and/or seasons, the sides of a building will experience a variety of different sunlight exposures based on the direction it faces, so it is common to separate the facades for tinting control.

6.2. Floors

Separate zones for each floor. Buildings with multiple floors may benefit from separating the tinting control zones from floor to floor.

6.3. Usage/Activities

Separate zones for special rooms/spaces. Based on occupancy and use, a building user may wish to have separate controls for tinting from room to room. A hospital with multiple patient rooms, a lobby, an office building with separate private offices, or even a private residence are all examples of cases that may benefit from some individual room tinting control.

6.4. Daylighting

A particular window elevation consisting of numerous lites from floor to ceiling may benefit from separating the top rows of lites from the bottom. This creates a daylighting row that allows sunlight in the top row while still having the remaining rows tinted to prevent glare or solar heat loss.

6.5. Manual Switching

Manual switching allows override control of an individual zone.

The zone assignments should be captured by annotating floor plans and elevation drawings. Each shown should be uniquely identified and given a meaningful name that will be recognizable to the occupants of the building. A zone schedule should also be created to include names, locations and hierarchy. This schedule will also be used to capture IGU arrays and Window Controller decisions in section 7 of this document.

VIEW DYNAMIC GLASS IGU SCHEDULE					
Zone Hierarchy	Zone Name	W.C.	Frame/Opening	IGU	MOS
1	All Building				
1.1	Northwest Elevation				
1.1.1	Northwest Elev. - 2nd Floor Daylight Zone	WC-1	A-1	IG-1	SW-1
			A-1	IG-2	
		WC-2	A-2	IG-3	
			A-2	IG-4	
		WC-3	A-3	IG-5	
			A-3	IG-6	
		WC-4	A-3	IG-7	
			A-3	IG-8	
		WC-4	A-4	IG-9	
			A-4	IG-10	
		WC-5	A-4	IG-11	
			A-4	IG-12	
		WC-5	A-5	IG-13	
			A-5	IG-14	
		A-6	IG-15		

Figure 8 – Zone, Window Controller and Window Schedule

7. Window Controllers Needed

Prerequisite:

- Zone, Window Controller and Window Schedule as shown in Figure 8.

To determine the number of Window Controllers required, several factors must be considered:

7.1. Zones

A Window Controller (WC) cannot control IGUs in separate zones. Each zone must have its own complete set of Window Controllers.

7.2. IGU Array

IGUs with similar busbar distances (contact View for tolerance limit) and in the same zone can be connected to the same window controller, creating an IGU array. An IGU array is a set of IGUs that are controlled by a single Window Controller.

7.3. IGU Square Footage

The maximum square footage of an IGU array controlled by a single Window Controller is 60 square feet. For large zones there can be multiple IGU arrays within a single zone.

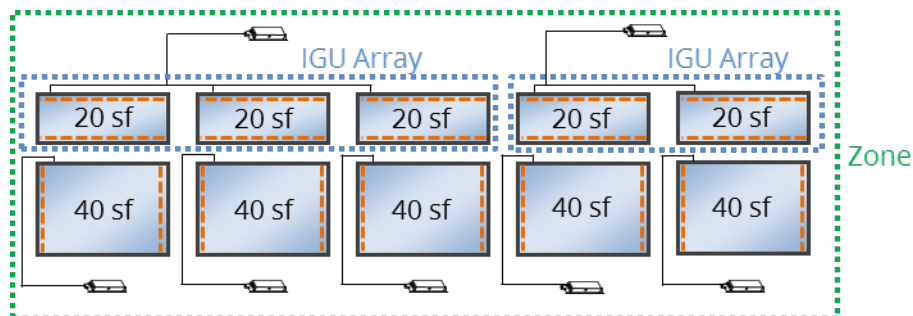


Figure 9 – IGU Arrays and Zones

7.4. Distance from IGU

A Window Controller must be located no further than a 15 foot cable length distance from the connected IGUs.

7.5. Distance from Trunk Line

A Window Controller must be located no further than a 15 foot cable length distance from the Trunk Line.

Decisions on Window Controller numbers and locations should be entered in the Zone, Window Controller and Window Schedule as shown in [Figure 8](#).

8. Component Locations and Cable Routing

This section provides guidance and considerations on the placement of BoS components and the routing of all BoS cabling.

Prerequisite:

- All previous steps should have been completed on at least a preliminary level prior to completing this section. However, conceptual locations can be evaluated without exact Zone and Window Controller information.

Costly surprises in the field can be avoided if design coordination meetings are scheduled early in the process. All of the impacted members of the construction team should be involved, including the Architect, General Contractor, Window Manufacturer, Glazier and Low Voltage Electrician. For instance, a decision to locate Window Controllers inside a glazing system mullion could have a significant impact on the scope of the glazier and electrician.

8.1. Location of Window Controllers

- A Window Controller provides a specific voltage signal to an IGU or IGU array. They will always be located between the Trunk Line and the IGUs.
- Window Controllers must be placed in an interior, insulated and accessible location. Although infrequent, access is required for programming, maintenance or troubleshooting and should be treated much like a florescent light ballast or LED lighting driver. See the Window Controller data sheet for specifications regarding component dimensions and operating temperature conditions.
- The Window Controller has cable connections on both sides. Therefore consideration must be given to the amount of space necessary to make the connections and the turn radius of the connected cables. The distances from IGU-to-Window Controller-to-Trunk Line is another key constraint. If this distance limitation cannot be met however, there are non-standard integration methods that can be used – consult with your View Project Manager.

- Decisions on locations of Window Controllers should be communicated to the entire design team and captured on the appropriate architectural or shop drawings.

Possible locations for a Window Controller include:

- inside a mullion behind a removable stop or access panel
- above a dropped ceiling grid; behind an architectural wall screen
- inside an enclosure
- in a stud bay accessed through a low voltage ring

8.2. Location of Power Supplies, Network Controller & Intelligence Controller

The 24VDC Power Supply, Network Controller and Intelligence Controller will typically be housed in a common control panel. The control panel size will vary depending on the size and complexity of the dynamic glass system and required components. View will design, procure, assemble and test these panels if engaged early enough in the project. The construction team merely needs to mount the panel, provide AC power and connect trunk, network and sensor cables. Refer to section 3.2 for power supply sizing.

These panels will typically be placed in an electrical, data, or low voltage closet. The location is driven by proximity to trunk line routing, ease of AC and network wiring and controlled access to appropriate personnel. In a multi-story installation, it is common for there to be a control panel for each floor.

8.3. Trunk Line Cables & Drop Cable Routing

Trunk Line and Drop Cables provide 24VDC and a communication buss to each Window Controller.

8.3.1. Trunk Line Cable

Pre-terminated Trunk Line cables are offered in two gauges, Light and Heavy, and come in various lengths. Reference the Trunk Cable specification sheets for details on available lengths, diameters, and associated connectors (tees, wyes, etc.). Select a Trunk Line gauge based on the power requirements of the installation. Generally, installations > 500 sf of Dynamic Glass require Heavy Trunk Cable. Use this as a preliminary baseline and consult with the View Project Manager during the design phase. The maximum distance for a single Trunk Line is 1,500 ft.

8.3.1. Drop Cable

Drop cables are used to connect a Window Controller to the Trunk Line. They come in various lengths up to 15 ft. Refer to the Drop Cable data sheet for more detailed information.

8.3.2. Connectors and Cable Routing

The individual Trunk Line cables run along the façade and are linked together by cable connectors. Refer to the connector data sheets to view the various Tees, Wyes, and Terminators available. The type of connector will be dependent on its need:

- Drop Tee - to connect a Window Controller to the Trunk Line via a Drop cable
- Tee or Wye - to extend the Trunk Line further along the façade, or branch multiple IGUs or Drop cables
- Terminator - to “terminate” the power at the end of the Trunk Line

Reference the Connector specification sheets for available Tees, Wyes, Terminators, etc.

The path for routing the Trunk Line should be optimized to provide easy distribution to each Window Controller. In many installations, the Trunk Line runs along the perimeter of the building since the Window Controllers are installed near the glass. Depending on the type of construction there are many options for routing, including:

- above a dropped ceiling grid
- in a residential crawl space or basement
- through surface wire mold or conduit

8.4. Window Controller to IGU Cable Routing

Prerequisites:

- Window Controller location
- Detailed drawings of window framing system
- Elevation drawings; wall and ceiling conditions if Window Controllers are located

Steps:

- Refer to the View IGU data sheet to determine the IGU Pigtail exit point on each IGU.
- Indicate on window elevation drawings the location of the IGU Pigtail (exit point is based on the orientation of each IGU).
- Determine the path from each IGU Pigtail exit point to the corresponding Window Controller. Refer to the View IGU Cable and Connector data sheets to determine appropriate lengths and connectors for that path.
- Wye connectors can be used to connect multiple IGUs (up to 60 sf) to a single Window Controller.
- The final connection between the IGU Cable and the IGU Pigtail is typically done in the glazing pocket. This allows replacement of the IGU in the event of breakage or malfunction with easy access to the IGU Pigtail. The IGU Cable path often runs from the dry side of the building to the wet side. The window manufacturer and/or glazier need to select this point and the method for sealing to ensure water and airtight envelope are maintained.
- Reference the IGU Cable data sheet for the hole size needed in the window framing to pass IGU Cables. Grommets must be placed in each hole to ensure the cable insulation is not cut or chafed by sharp edges. Examples of routing paths include inside mullions or glazing pockets.

If you need design assistance or additional information, contact your View Project Manager or email rfi@viewglass.com with your questions and we'll get back to you quickly.