F4-CV Series VAV Box Controllers Installation Guide

F4-CVM03050-0, F4-CVM03050-0P, F4-CVE03050-0P

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Application

The CV series controllers are designed for variable air volume (VAV) box applications. These controllers are fully programmable, using the Controller Configuration Tool (CCT), providing the flexibility to create custom control sequences.

CV series controllers feature an integral damper actuator, a digital Differential Pressure Transmitter (DPT) sensor, and a 32-bit microprocessor. The CVM03050-0P and CVE03050-0P models feature an integral potentiometer to sense actual VAV box damper position. For information on configuring an application with integrated actuator feedback, refer to the *CV Series Actuator Feedback Application Note (LIT-12013631)*.

CV series controllers also include an integral real-time clock, which enables the controllers to monitor and control schedules, calendars, and trends, and operate for extended periods of time as stand-alone controllers when offline from the Facility Explorer system network. These controllers connect easily to the wired and wireless network sensors for zone and discharge air temperature sensing. Their small package size facilitates quick field installation and efficient use of space without compromising control performance.

For CV series ordering information and accessories, refer to the *Facility Explorer CG, CV Series Equipment Controllers and XPM Expansion Modules Product Bulletin (LIT-12013225)*.

Communications protocols

CV series controllers can communicate using multiple communication protocols depending on model and configuration. The CVE controllers communicate using the BACnet® Secure Connect (BACnet/SC) or BACnet/IP communication protocol. CVM controllers communicate using the BACnet MS/TP, N2, or wireless communications protocols, with the addition of ZFR183x Pro Wireless Field Bus Routers. Equipment Controllers in BACnet/SC, BACnet/IP or BACnet MS/TP communication mode are BACnet network-compliant devices. The BACnet protocol is a standard for ANSI, ASHRAE, and the International Standards Organization (ISO) for building controls.

Controllers running in N2 mode can be used to maintain or modernize sites with installed legacy Johnson Controls® controllers. For installation and commissioning support, and tips for efficient and safe replacement, refer to the *Modernization Guide for Legacy N2 Controllers (LIT-12012005)* and the controller-specific documentation. For information about mapping N2 Objects in controllers with switchable communications protocols, refer to the *N2 Compatibility Options* chapter of the *Controller Tool Help (LIT-12011147)*.

To configure CVM controllers to communicate using the N2 communications protocol, see Configuring N2 communications (CVM models only). To configure CVM controllers to communicate using the wireless communications protocol, see Configuring wireless communications (CVM models only).

North American Emissions Compliance

North American Emissions Compliance

This equipment has been tested and found to comply with the limits for a Class A digital device pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when this equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area may cause harmful interference, in which case the users will be required to correct the interference at their own expense.

Canada

This Class (A) digital apparatus meets all the requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la Classe (A) respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

Installation

Observe the following guidelines when installing the controller:

- To minimize vibration and shock damage to the controller, transport the controller in the original container.
- Verify that all parts shipped with the controller.
- Do not drop the controller or subject it to physical shock.

Parts included

- One CVM/CVE controller with removable terminal blocks (Input/Output, Power, FC, and SA terminal blocks bus are removable)

  ⓘ **Note:** The FC terminal block is only available with the CVM model

- One F4-CV Pack Sheet (Part No. A163816VBD)
- One self-drilling No. 10 x 25 mm (1 in.) screw

Materials and special tools needed

- Small, straight-blade (1/8 in. or 3.0mm) or Phillips #1 screwdriver for securing wires in the terminal blocks
- 8 mm (5/16 in.) wrench or 10 mm (3/8 in.) 12-point socket to tighten the square coupler bolt
- Several shims or washers to mount the CVM/CVE
- Power screwdriver, 100 mm (4 in.) extension socket, punch, drill, and 3.5 mm (9/64 in.) drill bits to mount the controller
- Pliers to open and close the damper
- Required length of 3.97 mm (5/32 in.) ID pneumatic tubing and barbed fittings

Device diagram

The following figures display the physical features of the CVM/CVE controllers, and the accompanying table provides a description of the physical features and a reference to further information where required.

Figure 1: CVM03050 physical features

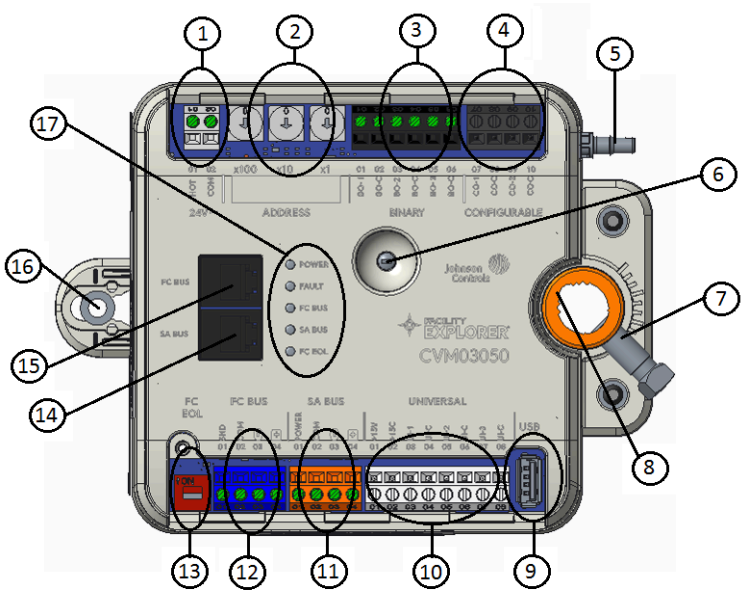


Figure 2: CVE03050 physical features

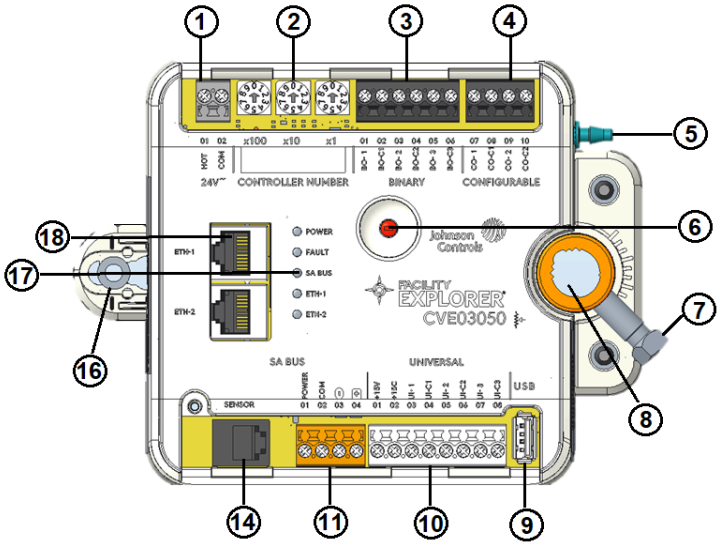


Table 1: CV series physical features

	Physical features: description and references
1	Supply Power Terminal Block: Gray terminals. See Supply power terminal block.
2	Rotary Switches: **CVM:** Decimal addressing. See Setting the device address on CVM models. **CVE:** Controller number. See Setting the controller number for CVE models
3	Binary Output (BO) Terminal Block: Black terminals. See Table 6.
4	Configurable Outputs (CO) Terminal Block: Black terminals. See Table 6.
5	Dual Port Fitting.
6	Manual Override Button. See Mounting.
7	Coupler Bolt
8	Controller Coupler. See Mounting.
9	Universal Inputs (UI) Terminal Block: White terminals. See Table 6.
10	Sensor Actuator (SA) Bus Terminal Block: Orange terminal. See SA Bus terminal block.
11 (CVM only)	Field Controller (FC) Bus Terminal Block: Blue terminal; may also be used for N2 connections, see FC Bus terminal block on CVM controllers.
12 (CVM only)	EOL (End-of-Line) Switch. See Setting the End-of-Line (EOL) switch (CVM models only).
13	Sensor (SA Bus) Port: RJ-12 6-Pin Modular Jack. See Sensor (SA Bus) Port.
14 (CVM only)	FC Bus Port: RJ-12 6-Pin Modular Jack. See FC Bus Port on CVM models.
15	Captive Spacer and Screw.
16	LED Status Indicators. See LED Table.
17 (CVE only)	Ethernet Ports: ETH-1 and ETH-2. See BACnet/SC or BACnet/IP Ethernet Network Topology for CVE controllers

Mounting

Observe the following guidelines when mounting a CVM/CVE controller:

- Ensure that the mounting surface can support the controller and any user-supplied enclosure.
- Mount the controller on a hard, even surface whenever possible.
- Use shims or washers to mount the controller securely and evenly on the mounting surface.

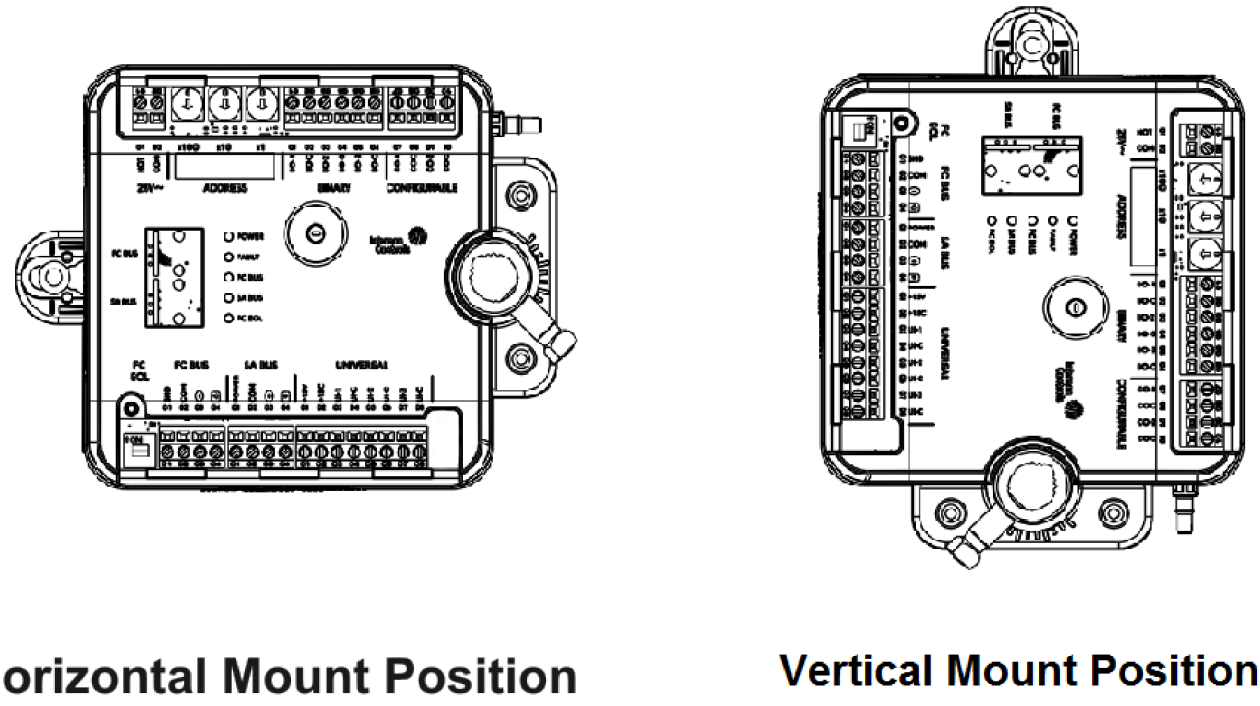
- Mount the controller in an area free of corrosive vapors that matches the ambient conditions specified in the Technical specifications section.
- Provide sufficient space around the controller for cable and wire connections and adequate ventilation through the controller (at least 50 mm [2 in.] on the top, bottom, sides, and front of the controllers).
- Do not mount the controller in areas where electromagnetic emissions from other devices or wiring can interfere with controller communication.
- Avoid mounting the controller on surfaces with excessive vibration.

Important: When the air supply to the VAV box is below 10°C (50°F), make sure that any condensation on the VAV box, particularly on the damper shaft, does not enter the controller electronics. Mount the controller vertically above the damper shaft to allow any shaft condensation to fall away from the controller. Additional measures may be required in some installations.

On panel or enclosure mount applications, observe these additional guidelines:

- Do not install the controller in an airtight enclosure.
- Mount the controller so that the enclosure walls do not obstruct cover removal or ventilation through the controller.
- Mount the controller so that the power transformer and other devices do not radiate excessive heat to the controller.

Figure 3: Controller mounting positions



To mount the CVM/CVE controllers, complete the following steps:

1. Set all the switches on the equipment controller to their known settings.
2. Place the controller in the proper mounting position on the damper shaft so that the wiring connections are easily accessible. Make sure the controller base is parallel to the VAV box (perpendicular to the damper shaft). If needed, use a spacer to offset tipping of the controller caused by the shaft bushings.

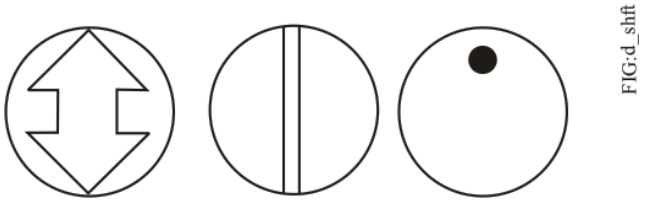
   Note: Use the alignment marks to center the captive spacer to ensure sufficient CVM/CVE movement in either direction.

3. Secure the self-drilling No.10 screw through the captive spacer with a power screwdriver and 100mm (4in.) extension socket. Otherwise, use a punch to mark the position of the shoulder washer, and then drill a hole into the VAV box using a 3.5mm (9/64in.) drill bit. Insert the mounting screw and tighten against the spacer.

   Important: Do not overtighten the screw, or the threads may strip. If mounting to the VAV box, make sure the screws do not interfere with damper blade movement.

4. Locate the damper position using the typical marking on the end of the damper shaft as shown in the figure below.

Figure 4: Typical damper end shaft icons



5. Note the direction, clockwise (CW) or counterclockwise (CCW), required to close the damper. Grasp the damper shaft firmly with pliers, and either manually close the damper for 90° boxes or manually open the damper for 45° or 60° boxes.
6. Push down and hold the **Manual Override** button and turn the controller coupler until it contacts the mechanical end-stop at either the full-closed (90° boxes) or full-open (45° and 60° boxes) position.
7. If the damper for a 90° box closes CCW, rotate the coupler to the CCW mechanical limit. If the damper for a 90° box closes CW, rotate the coupler to the CW mechanical limit. The open end-stop is automatically set for 90° boxes. For 45° and 60° boxes, you must provide hard stops at both full-closed and full-open damper positions. If you install the controller at the full-open position, the controller provides the open stop for 45° and 60° boxes. The closed damper seal provides the full-closed stop.

   Note: The integrated actuator has a stroke time of 60 seconds for 90° of travel with a 60Hz power source. The stroke time is the amount of time (in seconds) that it takes the actuator to move from the fully closed to fully opened position or from fully open to fully closed position. For proper operation, the actuator stroke time must be configured in the CCT application based on the actual time it takes the actuator to drive the damper. The default setting is 60 seconds (for 90° VAV boxes). For 45° and 60° VAV boxes, the actuator stroke time must be adjusted. Refer to *Controller Tool Help (LIT-12011147)* for instructions on setting the actuator stroke time in the application.

8. All models are compact in size and are easily installed on VAV boxes. The models can accommodate either a round shaft up to 13 mm in diameter or a 10 mm square shaft. Tighten the square coupler bolt to the shaft using an 8 mm (5/16 in.) wrench or 10 mm (3/8 in.) 12-point socket. Tighten to 10.5 to 11.5 N·m (95 to 105 lb·in).
9. Loop the pneumatic tubing (supplied by field personnel) to include a trap for condensation. Attach the needed length of tubing (supplied and installed by field personnel) to the dual port fitting on the controller and the other ends of the tubing to the pressure transducer in the VAV box application. For more information, see Attaching tubing to the dual port fitting.

   Note: The CVM/CVE uses a digital pressure sensor with bidirectional flow operation, which allows you to connect the high- and low-pressure DP tubes to either barbed fitting on the controller. You do not need to make a specific high- or low-side connection when you attach the tubing to the barbed fittings on the CVM/CVE.

10. Push the **Manual Override** button, and turn the actuator coupling manually to ensure that the actuator can rotate from full-closed to full-open positions without binding.
11. Complete the mounting by rotating the damper to the full-open position.

⚠ CAUTION

Risk of Property Damage.

Rotate the damper to the full-open position before starting the air handler. Failure to rotate the damper to the full-open position may result in damage to the VAV box or ductwork when the air handler is started.

⚠ ATTENTION

Risque de dégâts matériels.

Faire pivoter le registre pour le placer en position d'ouverture complète avant de démarrer l'unité de traitement d'air. Le non-respect de cette directive risque d'endommager le caisson de l'unité à volume d'air variable (VAV) ou le réseau de conduites au démarrage de l'unité de traitement d'air.

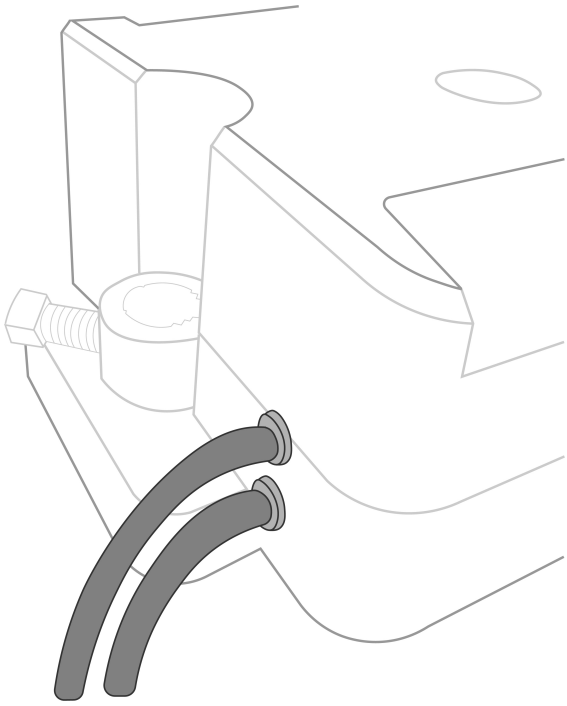
Attaching tubing to the dual port fitting

If you apply too much of an angle when attaching tubing to the dual port fitting on a CV series VAV box controller, the directional force can strain the unsupported base of the hose barbs and cause them to break from the device. To prevent damage to the dual port fitting:

1. Align the tubing so that it is perpendicular to the tip of the dual port fitting. See Figure 5.
2. Push the tubing directly over the dual port fitting. Do not apply force in any direction away from the dual port fitting, this strains the base of the hose barb.

   ➤ **Important:** Do not use tools to assist in attaching tubing to the dual port fitting. Using tools, such as pliers, to assist in attaching the tubing can increase the risk of breaking the dual port fitting if directional pressure is accidentally applied.
3. Continue pushing the tubing over the dual port fitting until the tubing stretches over the hose barb.

Figure 5: Applying tubing to the dual port fitting



Wiring

Observe the following guidelines when wiring a CVM/CVE controller:

⚠ CAUTION

Risk of Electric Shock.

Disconnect the power supply before making electrical connections to avoid electric shock.

⚠ ATTENTION

Risque de décharge électrique.

Débrancher l'alimentation avant de réaliser tout raccordement électrique afin d'éviter tout risque de décharge électrique.

- **Important:** Do not connect supply power to the controller before finishing wiring and checking all wiring connections. Short circuits or improperly connected wires can result in damage to the controller and void any warranty.
- **Important:** Do not exceed the controller electrical ratings. Exceeding controller electrical ratings can result in permanent damage to the controller and void any warranty.
- **Important:** Use copper conductors only. Make all wiring in accordance with local, national, and regional regulations.

- **Important:** Electrostatic discharge can damage controller components. Use proper electrostatic discharge precautions during installation, setup, and servicing to avoid damaging the controller.

For information on configuring and wiring a BACnet/SC or BACnet/IP network, refer to the *Facility Explorer IP Networks for BACnet/IP Controllers Configuration Guide (LIT-12012980)*. For detailed information about configuring and wiring an MS/TP Bus, FC Bus, or SA Bus, refer to the *FX MS/TP Communications Bus Technical Bulletin (LIT-12011670)*. For detailed information about wiring an N2 network, refer to the *N2 Communications Bus Technical Bulletin (LIT-636018)*.

Terminal blocks and bus ports

See Device diagram for terminal block and bus port locations on the CVM/CVE controllers. Observe the following guidelines when wiring a CVM/CVE controller.

Method for tightening terminal blocks

- **Important:** Remove power from the controller before beginning this procedure. Failure to de-energize the controller can result in equipment damage.
- **Important:** It is best practice to remove the terminal block from the pin headers on the unit before wiring the terminal blocks. See Removing a terminal block.

Do not use more force than is necessary when tightening the terminal block screws. To prevent applying excessive force when tightening the screws, apply the following steps:

1. Tighten the terminal screws until the screw is snug on the wire, and then tighten the screw an additional quarter (90°) to half (180°) turn.
2. Only use enough downward force necessary to keep the screwdriver bit engaged with the screw. Too much downward force while tightening the terminal screws can damage the terminal.

   If a terminal block exhibits any symptoms of damage, replace the terminal block. For detailed information about replacing terminal blocks, refer to the *Terminal Block Retrofit Installation Guide (LIT-12014622).* See the following table for replacement terminal block kits:

   Table 2: Terminal block replacement part numbers

Product code number	Description
ACC-TBKPWFCSA-1	Power, FC Bus, and SA Bus terminal block replacement kit for SNE, CG series, CV series, CC series, and XPM products. Kit includes 5 of each terminal block type. 15 terminal blocks in total. Power is grey, SA Bus is orange, FC Bus is blue, and all are unnumbered.
ACC-TBKIO234-1	Input and Output terminal block replacement kit for SNC, CG series, CV series, CC series, and XPM products. Kit includes 10 of each 2, 3, and 4 position Input and Output terminal blocks. 30 terminal blocks in total. All black and unnumbered.
ACC-TBKIO678-1	Input and Output terminal block replacement kit for SNC, CG series, CV series, CC series, and XPM products. Kit includes 5 of each 6, 7, and 8 position Input and Output terminal blocks. 15 terminal blocks in total. All black and unnumbered.

Input and Output terminal blocks

CV series controllers have removable input and output terminal blocks. The input terminals are located on the bottom of the controller and output terminal blocks are located on the top of the controller. For information about removing a terminal block, see Removing a terminal block. For more information about I/O terminal functions, requirements, and ratings, see Table 6.

BACnet/SC or BACnet/IP Ethernet Network Topology for CVE controllers

CVE controllers may be connected to a BACnet/SC or BACnet/IP building automation network in multiple ways: as daisy-chained devices, as part of a star (also called home run) type network, or as part of a ring network.

To daisy-chain CVE controllers, connect the controllers to the bus supervisor in a chain with the Ethernet cable connecting to the CVE at the ETH-1 or ETH-2 port, and connecting to the next device from the other port. Benefits of daisy-chained networks are that they require less physical wiring and new devices can be added easily to the network.

In a star network, each CVE controller is connected by Ethernet cable directly back to a main switch. This configuration reduces the possibility of network failure but requires more wiring to install.

A ring network is a chain of controllers virtually closed by a software component in an Ethernet switch. Not all switches support the ring topology. The dual-port controller from Johnson Controls supports Media Redundancy Protocol (MRP). With MRP, a ring of Ethernet devices can overcome any single communication failure, with a recovery time faster than a non-ring (daisy-chain or star) architecture.

For more information on network topologies for IP Controllers, see *Facility Explorer IP Networks for BACnet/IP Controllers Configuration Guide (LIT-12012980).*

FC Bus terminal block on CVM controllers

The FC Bus terminal block is a blue, removable, 4-pin terminal block that fits into a board-mounted pin header.

When connecting the CVM to the FC Bus, wire the bus terminal blocks on the controller and other FC Bus devices in a daisy-chain configuration using 3-wire twisted, shielded cable as shown in Figure 6. For more information about FC Bus terminal functions, requirements, and ratings, see Table 8.

Figure 6: FC Bus terminal block wiring

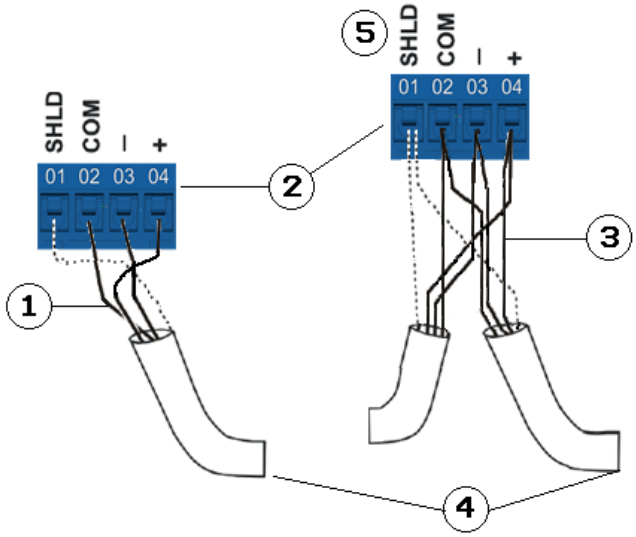


Table 3: FC Bus configuration

	Description
1	Wiring for a terminating device on the FC Bus
2	FC Bus terminal blocks
3	Wiring for a daisy-chained device on an FC Bus segment
4	Connects to the next device on the FC Bus
5	Isolated Shield connection terminal

Note: The Shield terminal (SHD) on the FC Bus terminal block is isolated and can be used to connect the cable shields on the bus (Figure 6).

SA Bus terminal block

The SA Bus terminal block is an orange, removable, 4-pin terminal block with +15 VDC that fits into a board-mounted pin header.

When connecting an SA Bus device to the controller, wire the SA Bus terminal block on the controller and other SA Bus devices in a daisy-chain configuration using 4-wire twisted, shielded cable as shown in Figure 7. For more information about SA Bus terminal functions, requirements, and ratings, see Table 8.

Figure 7: SA Bus terminal block wiring

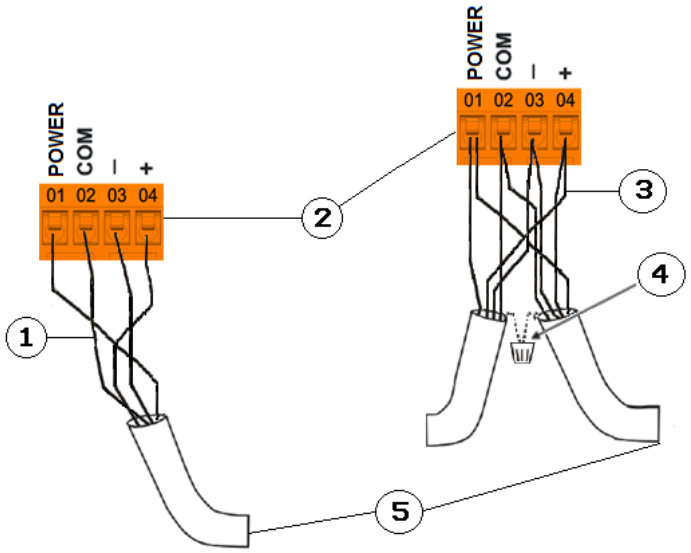


Table 4: SA Bus configuration

	Description
1	Wiring for a terminating device on SA Bus
2	SA Bus terminal blocks
3	Wiring for a daisy chained device on SA Bus
4	Cable shield connection **Note:** Connect the shields to ensure they are continuous the entire length with only one ground location.
5	Connects to the next device on the SA Bus

Note: Stranded, 4-wire (2 twisted pair) shielded cable. One twisted pair is the + and - leads. The second pair is COM and POWER.

Note: Do not use the modular SA Bus port and the terminal block SA Bus simultaneously. Only use one of these connections at a time.

Note: The CVM/CVE controller is the EOL for the SA Bus.

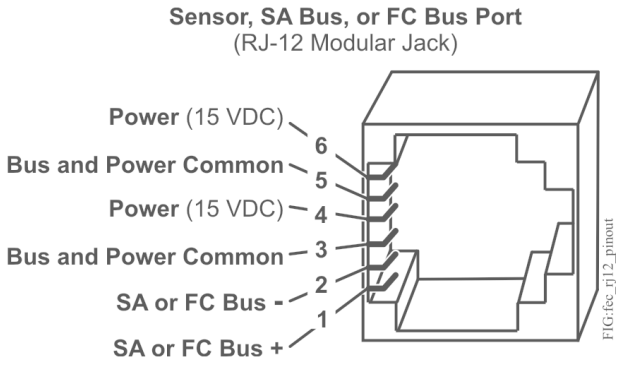
Sensor (SA Bus) Port

The Sensor (SA Bus) port is an RJ-12, 6-position modular jack that provides a connection for the Connected Workflow Wireless MS/TP Converter (CWCVT), Mobile Access Portal (MAP) Gateway, the VAV Balancing Tool, specified network sensors, or other SA Bus devices with RJ-12 plugs. A F4-DLK0350 or FX-DIS1710 Local Controller Display can also be connected to the SA Bus port.

Note: Do not use the modular SA Bus port and the terminal block SA Bus simultaneously. Only use one of these connections at a time.

The Sensor port is connected internally to the SA Bus terminal block. For more information about Sensor port functions, requirements, and ratings, see Communications bus and supply power terminal blocks, ratings, and requirements.

Figure 8: Pin number assignments for sensor, SA Bus, and FC Bus ports on Equipment Controllers



FC Bus Port on CVM models

The FC Bus port on the front of the controller is an RJ-12, 6-position modular jack that provides a connection for the CWCVT, MAP Gateway or the ZFR Pro Wireless Field Bus Router.

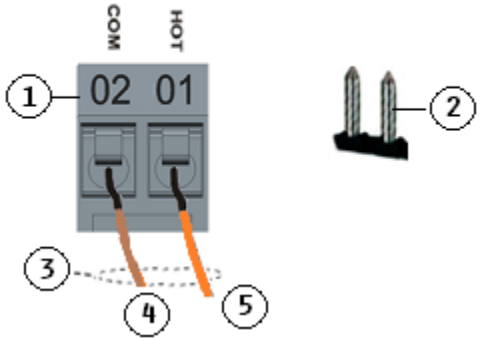
The FC Bus port is connected internally to the FC Bus terminal block. For more information about the FC Bus port functions, requirements, and ratings, see Communications bus and supply power terminal blocks, ratings, and requirements. The FC Bus port pin assignment is shown in Figure 8.

Supply power terminal block

The 24 VAC supply power terminal block is a gray, removable, 2-pin terminal block that fits into a board-mounted pin header on the upper left of the controller.

Wire the 24 VAC supply power wires from the transformer to the HOT and COM terminals on the terminal block as shown in Figure 9. For more information about Supply Power terminal functions, requirements, and ratings, see Table 8.

Figure 9: 24 VAC supply power terminal block wiring



Note: The order of the HOT and COM terminals on the CV series controllers is reversed from the order of the terminals on the CG series controllers.

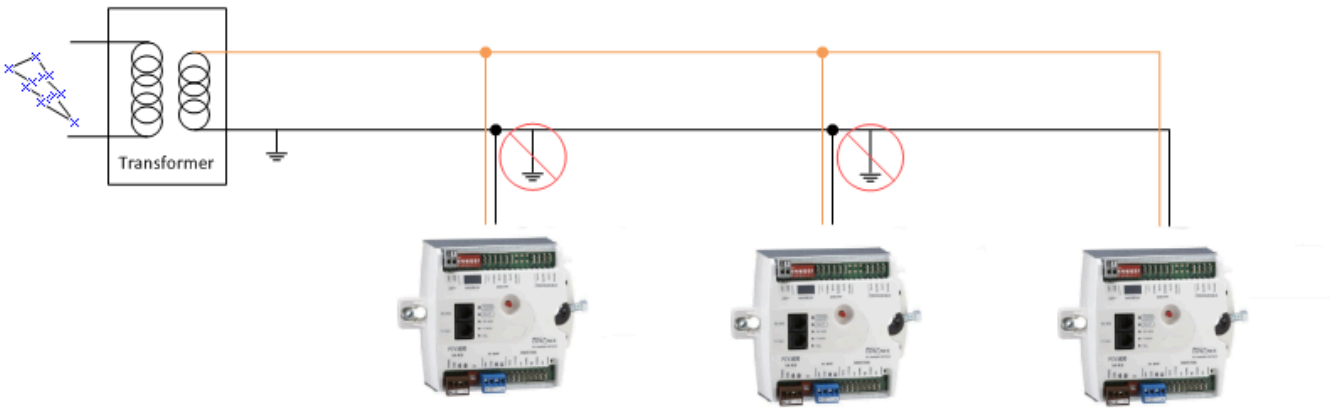
Table 5: Supply power terminal block wiring

	Description
1	Supply power terminal block
2	Supply power terminal header
3	Wires from Johnson Controls 24 VAC, class 2 power transformer
4	COM (Brown wire)
5	24 VAC (Orange wire)

Note: The supply power wire colors may be different on transformers from other manufacturers. Refer to the transformer manufacturer's instructions and the project installation drawings for wiring details.

Important: Connect 24 VAC supply power to the controller and all other network devices so that transformer phasing is uniform across the network devices. Powering network devices with uniform 24 VAC supply power phasing reduces noise, interference, and ground loop problems. The controller does not require an earth ground connection. However, when grounding the secondary of the 24 VAC transformer is required, only one connection to ground must be made near the transformer. See Figure 10.

Figure 10: Transformer grounding



⚠ CAUTION

Risk of Property Damage:

Do not apply power to the system before checking all wiring connections. Improper wiring of this terminal may cause a short circuit across the 24 VAC power supply. A short circuit may result in a tripped circuit breaker or blown fuse. If using a transformer with a built-in fuse, the transformer may need to be replaced.

⚠ ATTENTION

Risque de dommages matériels:

Ne mettez pas l'appareil sous tension avant d'avoir vérifié toutes les connexions du câblage. Le câblage inadéquat de cette borne peut causer un court-circuit sur l'alimentation électrique de 24 V c. Un court-circuit peut causer le déclenchement du disjoncteur ou le grillage d'un fusible. Si vous utilisez un transformateur avec un fusible intégré, vous pourriez devoir remplacer le transformateur.

To wire the controller, complete the following steps:

1. Terminate wiring according to the appropriate figure in Termination diagrams.
2. Wire network sensors and other devices to the SA Bus.
3. For the CVM model, wire the FC Bus in a daisy chain for MS/TP or N2. For CVE models, connect the controller to the BACnet/SC or BACnet/IP building automation network. See BACnet/SC or BACnet/IP Ethernet Network Topology for CVE controllers for details.
4. Ensure that the CVM03050 is assigned a device address and the CVE03050 is assigned a controller number, using the rotary switches. See Setting the device address on CVM models.
5. Connect the controller to 24 VAC, Class 2 power.

ⓘ **Note:** If you are using the CVM03050 controller with the Wireless Field Bus System, refer to the *WRG1830/FX-ZFR183x Pro Series Wireless Field Bus System Bulletin (LIT-12013553)*, or the *WNC1800/FX-ZFR182x Pro Series Wireless Field Bus System Bulletin (LIT-12012378)*.

Terminal wiring guidelines, functions, ratings, and requirements

This section provides further guidelines on input and output wiring, maximum cable length versus load current, and SA Bus and supply power wiring.

Input and Output wiring guidelines

Table 6 provides information and guidelines about the functions, ratings, and requirements for the controller input and output terminals, and Table 6 also references guidelines for determining proper wire sizes and cable lengths.

In addition to the wiring guidelines in Table 6, observe the following guidelines when wiring controller inputs and outputs:

- Run all low-voltage wiring and cables separate from high-voltage wiring.
- All input and output cables, regardless of wire size or number of wires, must consist of twisted, insulated, and stranded copper wires.
- Shielded cable is not required for input or output cables but is recommended for input and output cables that are exposed to high electromagnetic or radio frequency noise.
- Cable runs of less than 30 m (100 ft) often do not require an offset in the input/output software setup.
- Cable runs over 30 m (100 ft) often require an offset in the input/output software setup.

I/O terminal blocks, ratings and requirements

Table 6: I/O terminal blocks, functions, ratings, requirements, and cables

Terminal Block label	Terminal labels	Function, ratings, and requirements	To determine wire size and maximum cable length
UNIVERSAL (Inputs)	**+15 V**	**15 VDC Power Source** for active (3-wire) input devices connected to the Universal UI-n terminals. Provides 35 mA total current.	Same as (Universal) **UI-n**. **Note:** Use 3-wire cable for devices that source power from the +15 V terminal.
	UI-n	**Analog Input - Voltage Mode (0–10 VDC)** 10 VDC maximum input voltage Internal 75k ohm Pulldown	See Guideline A in Table 7.
		Analog Input - Resistive Mode (0–600k ohm) Internal 12 V, 15k ohm pull up Qualified Sensors: 0–2k potentiometer RTD (1k Nickel [Johnson Controls sensor] 1k Platinum, and A99B Silicon Temperature Sensor) Negative Temperature Coefficient (NTC) Sensor 10K Type L (10K Johnson Controls Type II is equivalent to Type L) or 2.252K Type II	See Guideline A in Table 7.
		Binary Input - Dry Contact Maintained Mode 1 second minimum pulse width Internal 12 V, 15k ohm pull up	See Guideline A in Table 7.
	UI-C or UI-Cn	**Universal Input Common** for all Universal IN terminals **Note:** All Universal UI-C/UI-Cn terminals are isolated from all other commons.	Same as (Universal) **UI-n**.
CONFIGURABLE (Outputs)	**CO-n**	**Analog Output - Voltage Mode (0–10 VDC)** 10 VDC maximum output voltage 10 mA maximum output current External 1k to 50k ohm load required **Note:** In instances where the input impedance load exceeds 100k ohm, install a 2k ohm resistor in parallel to the common and 0-10 VDC signal.	See Guideline A in Table 7.
		Binary Output 24 VAC Triac Connects CO-n to CO-C/CO-Cn when activated. External Power Source: 30 VAC maximum voltage to load 0.5 A maximum output current 1.3 A at 25% duty cycle 40 mA minimum load current	See Guideline C in Table 7.
	CO-C or CO-Cn	**Analog Output Signal Common**: All Configurable Outputs defined as Analog Outputs share a common, which is isolated from all other commons except the Binary Input common.	Same as (Configurable) **CO-n**.
		Binary Output Signal Common: All Configurable Outputs defined as Binary Outputs are isolated from all other commons, including other Configurable Output commons.	

Table 6: I/O terminal blocks, functions, ratings, requirements, and cables

Terminal Block label	Terminal labels	Function, ratings, and requirements	To determine wire size and maximum cable length
BINARY (Outputs)	**BO-n**	**Binary Output - 24 VAC Triac (Internal Power)** Sources internal 24 VAC power (24~ HOT)	See Guideline C in Table 7.
	BO-C or BO-Cn	**Binary Output - 24 VAC Triac (Internal Power)** Connects BO-C/BO-Cn to 24~COM when activated. Internal Power Source: 30 VAC maximum voltage to load 0.5 A maximum output current 1.3 A at 25% duty cycle 40 mA minimum load current	See Guideline C in Table 7.

Cable and wire length guidelines

Table 7 defines cable length guidelines for the various wire sizes that may be used for wiring low-voltage (<30 V) input and outputs. The required wire sizes and lengths for high-voltage (>30 V) Relay Outputs are determined by the load connected to the relay, and local, national or regional electrical codes.

Table 7: Cable length guidelines for recommended wire sizes

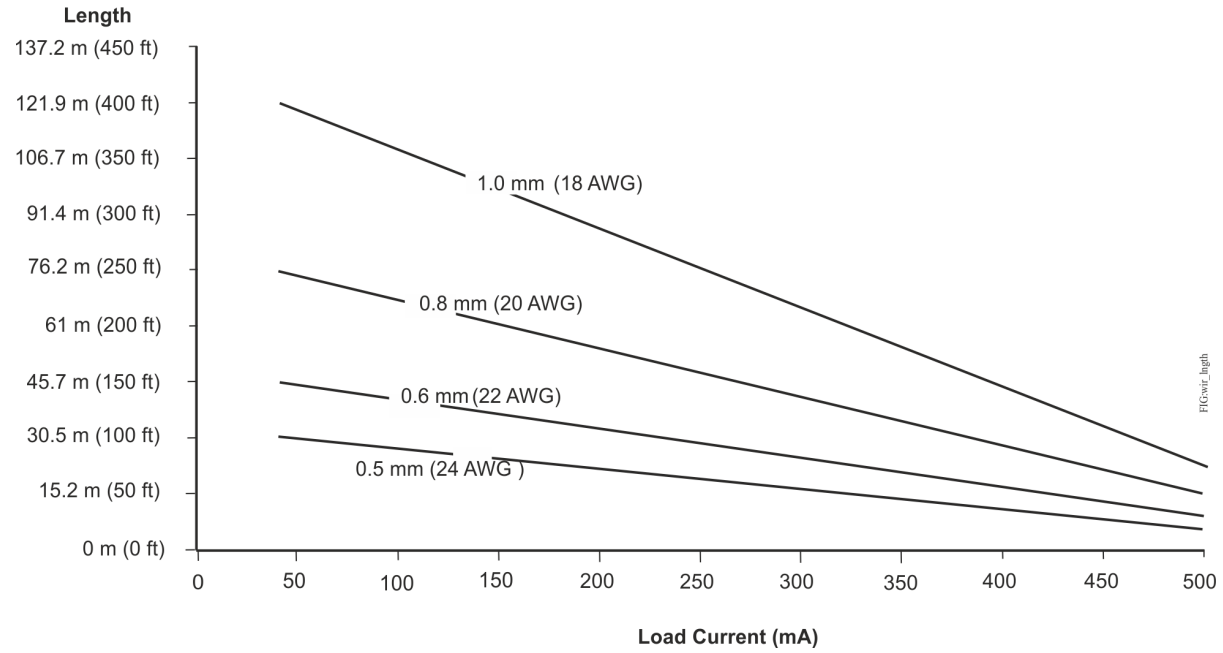
Guideline	Wire size/gauge and type	Maximum cable length and type	Assumptions
A	1.0 mm (18 AWG) stranded copper	457 m (1,500 ft) twisted wire	100 mV maximum voltage drop Depending on the cable length and the connected input or output device, you may have to define an offset in the setup software for the input or output point.
	0.8 mm (20 AWG) stranded copper 297 m (975 ft) twisted wire	297 m (975 ft) twisted wire	
	0.6 mm (22 AWG) stranded copper 183 m (600 ft) twisted wire	183 m (600 ft) twisted wire	
	0.5mm (24 AWG) stranded copper 107 m (350 ft) twisted wire	107 m (350 ft) twisted wire	
B	1.0 mm (18 AWG) stranded copper	229 m (750 ft) twisted wire	100 mV maximum voltage drop Depending on the cable length and the connected input or output device, you may have to define an offset in the setup software for the input or output point.
	0.8 mm (20 AWG) stranded copper 297 m (975 ft) twisted wire	137 m (450 ft) twisted wire	
	0.6 mm (22 AWG) stranded copper 183 m (600 ft) twisted wire	91 m (300 ft) twisted wire	
	0.5mm (24 AWG) stranded copper 107 m (350 ft) twisted wire	61 m (200 ft) twisted wire	
C	See figure labeled *Maximum Wire Length by Current and Wire Size* to select wire size/gauge. Use stranded copper wire.	See figure labeled *Maximum Wire Length by Current and Wire Size* to determine cable length. Use twisted wire cable.	N/A

Maximum cable length versus load current

Use the following figure to estimate the maximum cable length relative to the wire size and the load current (in mA) when wiring inputs and outputs.

Note: Figure 11 applies to low-voltage (<30 V) inputs and outputs only.

Figure 11: Maximum wire length for low-voltage (<30 V) Inputs and Outputs by current and wire size



Communications bus and supply power wiring guidelines

Table 8 provides information about terminal block functions, ratings, and requirements for the communication bus and supply power terminals. The table also provides wire size, cable type, and cable length guidelines for wiring the communication buses and supply power.

In addition to the guidelines in Table 8, observe these guidelines when wiring the FC Bus, SA Bus, or the 24 VAC supply power:

- Run **all** low-voltage wiring and cables separate from high-voltage wiring.
- All FC and SA Bus cables, regardless of wire size, must be twisted, insulated, stranded copper wire.
- Shielded cable is strongly recommended for all FC and SA Bus cables.

Communications bus and supply power terminal blocks, ratings, and requirements

Table 8: Communication bus and supply power terminal blocks, functions, ratings, requirements, and cables

Terminal block/Port label	Terminal labels	Function, electrical ratings/ Requirements	Recommended cable type
Ethernet (Ports) (CVE models)	**ETH-1 and ETH-2**	Connect to BACnet/SC or BACnet/IP Network	Ethernet ports; 10/100 Mbps; 8-pin RJ-45 connector
FC BUS (CVM models)[1]	**+** **-**	FC Bus Communications	0.6 mm (22 AWG) stranded, 3-wire twisted, shielded cable recommended
	COM	Signal Reference (Common) for bus communications	
	SHD	Isolated terminal	
FC BUS (Port) (CVM models)[1]	**FC BUS**	RJ-12 6-Position Modular Port provides FC Bus Communications. FC Bus provides 15 VDC Power for: • MAP Gateway • Wireless Field Bus Router	24 AWG 3-pair CAT 3 Cable <30.5m (100 ft)

Table 8: Communication bus and supply power terminal blocks, functions, ratings, requirements, and cables

Terminal block/Port label	Terminal labels	Function, electrical ratings/ Requirements	Recommended cable type
SA BUS[1]	**+** **-**	SA Bus Communications	0.6 mm (22 AWG) stranded, 4-wire (2 twisted-pairs), shielded cable recommended **Note:** The + and - wires are one twisted pair, and the COM and POWER wires are the second twisted pair.
	COM	SA Bus Signal Reference and 15 VDC Common	
	POWER	15 VDC Supply Power for Devices on the SA Bus	
SA BUS (Port)[1]	**SA BUS (CVM)** **Sensor (CVE)**	RJ-12 6-Position Modular Port provides SA Bus Communications. SA Bus provides 15 VDC Power for the following: • NS Series Sensors • MAP Gateway 4.2 or above • Wireless FX-ZFR-7860 Series One-to-One Wireless Receiver • F4-DLK0350 or FX-DIS1710 Local Controller Display • VAV Balancing Tool	24 AWG 3-pair CAT 3 Cable <30.5m (100 ft)
24V~	**HOT**	**24 VAC Power Supply - Hot** Supplies 20–30 VAC (Nominal 24VAC)	0.8 mm to 1.0 mm (20 to 18 AWG) 2-wire
	COM	**24 VAC Power Supply Common** The CVM models only isolate this terminal from the FC Bus common.	

1 The FC Bus and SA Bus wiring recommendations in this table are for MS/TP Bus communications at 38.4k baud.

Termination diagrams

A set of Johnson Controls termination diagrams provides details for wiring inputs and outputs to the controllers. See the figures in this section for the applicable termination diagrams.

Table 9: Termination details

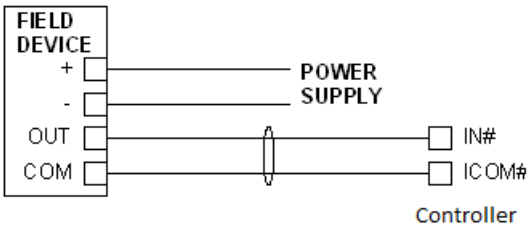
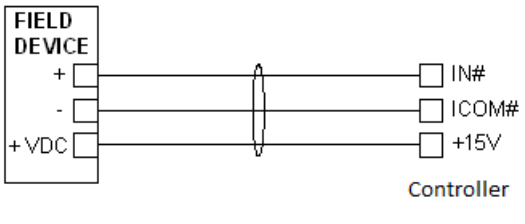
Type of Field Device	Type of Input/ Output	Termination diagrams
Voltage Input - External Source	UI	
Voltage Input - Internal Source	UI	

Table 9: Termination details

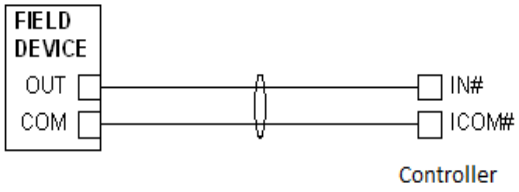
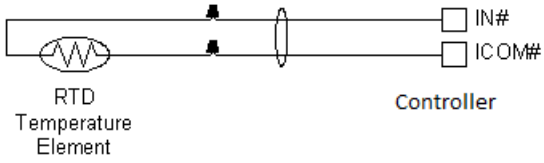
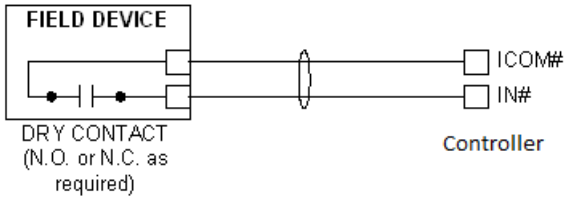
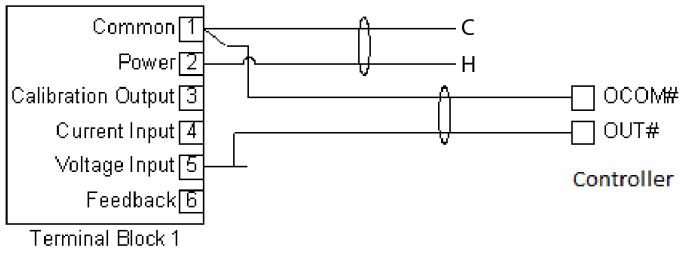
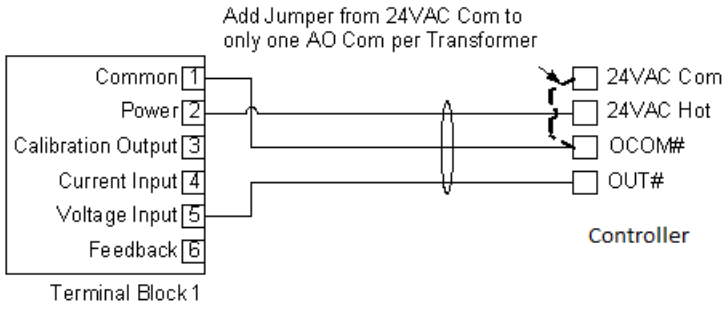
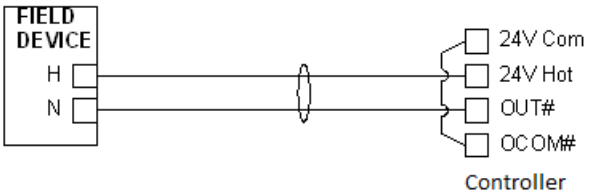
Type of Field Device	Type of Input/ Output	Termination diagrams
Voltage Input (Self-Powered)	UI	
Temperature Sensor	UI	
Dry Contact	UI	
0–10 VDC Output to Actuator (External Source)	CO	
0–10 VDC Output to Actuator (Internal Source)	CO	
24 VAC Triac Output (Switch Low, External Source)	CO	 ⓘ **Note:** Applies to CO4 and CO5.

Table 9: Termination details

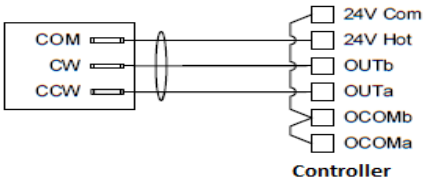
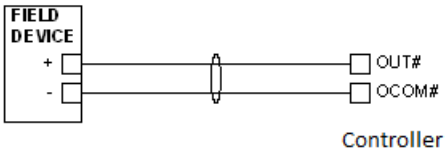
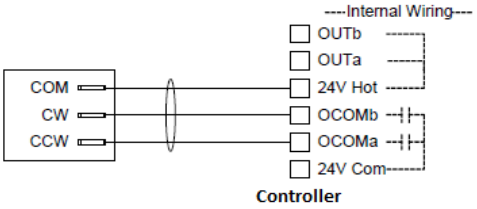
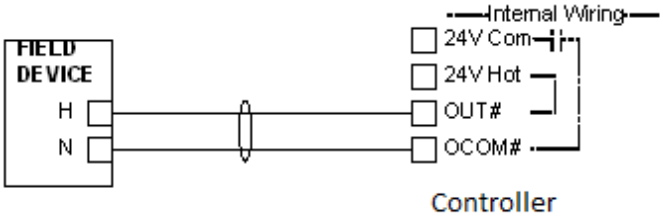
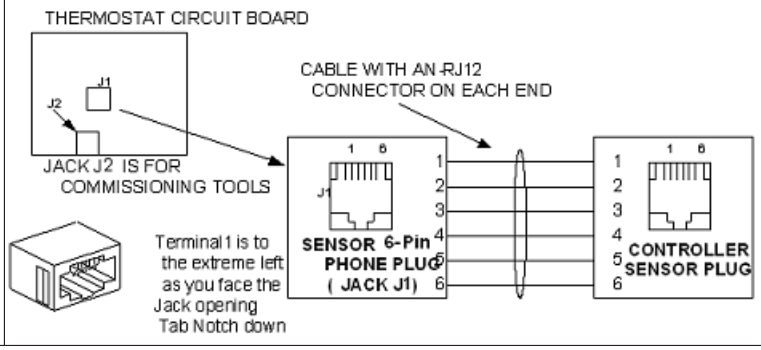
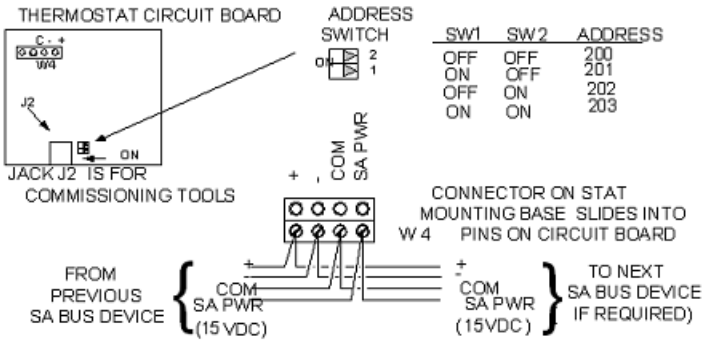
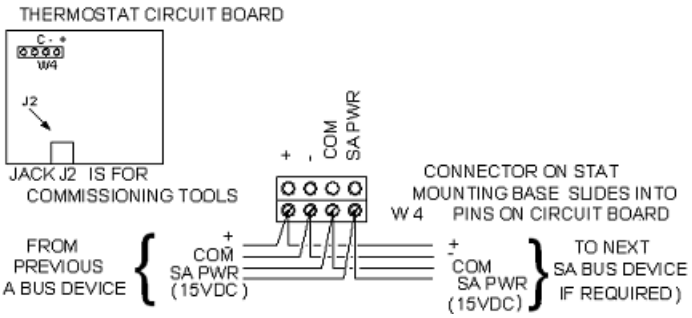
Type of Field Device	Type of Input/ Output	Termination diagrams
Incremental Control to Actuator (Switch Low, External Source)	CO	 ⓘ **Note:** Applies to CO4 and CO5.
Analog Output (Voltage)	CO	
Incremental Control to Actuator (Switch Low, Internally Sourced)	BO	 ⓘ **Note:** Applies to BO3, BO1, and BO2.
24 VAC Binary Output (Switch Low, Internally Sourced)	BO	
Network Stat with Phone Jack (Fixed Address = 199)	SA Bus	

Table 9: Termination details

Type of Field Device	Type of Input/ Output	Termination diagrams
Network Stat with Terminals Addressable	SA Bus	 **Note:** The above diagram is for the NS7000 series thermostats. For NS8000 network sensor addressing, refer to the *NS8000 Series Network Sensors Installation Guide (Part No. 24-11256-00007)*.
Network Stat with Terminals (Fixed Address = 199)	SA Bus	

Setup and adjustments

Important: Electrostatic discharge can damage controller components. Use proper electrostatic discharge precautions during installation, setup, and servicing to avoid damaging the controller.

Configuring N2 communications (CVM models only)

N2-capable controllers support the full range of possible N2 device addresses provided by the N2 protocol standard (1-254).

To configure a CVM controller to communicate using the N2 protocol, complete the following steps:

1. Disconnect the 24 VAC supply from the controller.
2. Set the address switches to the desired N2 address. For details about setting a device address, see Setting the device address on CVM models.
3. Reconnect the 24 VAC supply to the controller.
4. Using an SA Bus connection, download the firmware and controller application file configured for N2 to the controller.

Switching the communications protocol from N2 to MS/TP

For N2 sites that are converting to BACnet MS/TP, you can switch the communications protocol of N2-configured CVM controllers back to BACnet MS/TP.

To switch the CVM controller operating in N2 mode back into BACnet MS/TP mode, complete the following steps:

1. Disconnect the 24 VAC supply from the controller.

2. Set the address switches to the desired BACnet MS/TP address. For details about setting a device address, see Setting the device address on CVM models.
3. Reconnect the 24 VAC supply to the controller.
4. Using an SA Bus connection, download a controller application file configured for BACnet MS/TP to the controller.

Configuring wireless communications (CVM models only)

To configure a controller for use with the ZFR Pro Series Wireless Field Bus system, complete the following steps:

1. Disconnect the 24 VAC supply from the controller.
2. Wire the input/output terminals and SA Bus.
3. **Important:** Before the CVM controller is powered on, connect the ZFR Pro Wireless Field Bus Router to the FC Bus on the front of the controller. For more information, refer to the *ZFR1831 Pro Series Wireless Router Installation Guide (Part No. 24-11461-00004)*.
4. Ensure that the controller's rotary switches are set to the correct device address. For details about setting a device address, see Setting the device address on CVM models.
5. Reconnect the 24 VAC supply to the controller.

   For more information about the FX-ZFR 1800 Wireless Field Bus system, refer to the *FX-ZFR Series Wireless Field Bus System Bulletin (LIT-12011660)*. For more information on the FX-ZFR Pro Wireless Field Bus system, refer to the *WNC1800/FX-ZFR182x Pro Series Wireless Field Bus System Bulletin (LIT-12012378).*

Setting the device address on CVM models

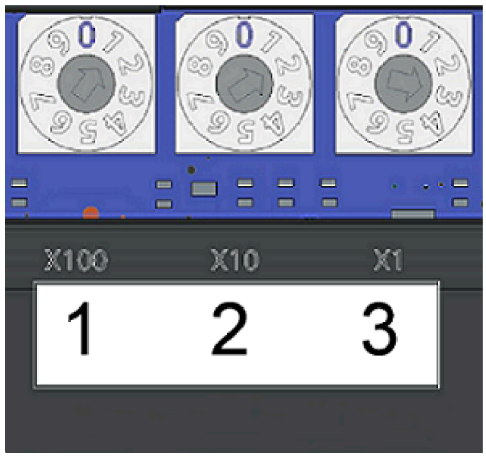
The CVM controllers are devices on MS/TP (FC or SA) Buses. Before you operate controllers on a bus, you **must** set a valid and unique device address for each controller on the bus.

The following table describes the valid rotary switch device addresses for communications bus applications.

FC Bus communication mode	Valid device address range
Wired MS/TP communication	4-127 ⓘ **Note:** Addresses 0-3 are reserved and not for use on equipment controllers.
ZFR Pro Wireless communication	4-127 ⓘ **Note:** Addresses 0-3 are reserved and not for use on equipment controllers.
N2 communication	1-253 ⓘ **Note:** Addresses 0, 254, and 255 are reserved and not for use on equipment controllers.

The device address is a decimal address set using three rotary switches located at the top of the controller. The numbers are ordered from left to right, 100s, 10s, and 1s as shown in Figure 12. In the following figure, the switches are set to 1 2 3, designating this controller's device address as 123.

Figure 12: Rotary switch block



The device address must match the device address defined in the Controller Configuration Tool (CCT) under **Define Hardware > Network Settings**.

To set the device addresses on controllers, complete the following steps:

1. Set a unique and sequential device address for each of the devices connected on the FC or SA, starting with device address 4.
2. To ensure the best bus performance, set sequential device addresses with no gaps in the device address range (4, 5, 6, 7, 8, 9, and so on). The devices do not need to be physically connected on the bus in their numerical device address order.
3. Write each controller's device address on the white label below the Device Address Rotary Switch Block on the controller's cover.

Setting the controller number for CVE models

The rotary switches on the CVE models are used to set the controller number. The controller number can be utilized to physically identify the controller and relate it to the building drawings. The factory default BACnet device ID is calculated from the value of the controller number added to 2000000. Each equipment controller on a BACnet/SC or BACnet/IP network must have a unique BACnet device ID on the subnet where it resides in order for proper identification and communication. To ensure a unique value, the BACnet device ID should be configured in CCT instead of relying on this default calculation. This step will be necessary on sites with more than 1000 devices as controller numbers will be duplicated.

The controller number is set using three rotary switches and may be numbered from 000 to 999. The numbers are ordered from left to right, 100s, 10s, and 1s.

In Figure 12, the switches are set to 1 2 3, designating this controller as controller number 123. The controller number can be written in the white squares provided so the controller number can be more easily seen from a distance.

Removing a terminal block

To remove a terminal block from the circuit board, complete the following steps:

ⓘ **Note:** You need a flat blade screwdriver to remove the terminal block.

1. To prevent any possibility of damage from an accidental short, **remove power from the controller**.
2. Underneath the terminal block, in the small gap between the bottom of the terminal block and the circuit board, insert the flat blade of the screwdriver.

3. To detach the left-hand side of the terminal block, position the flat blade underneath the terminal block to the left, and push down the screwdriver handle. When you do this, you are using the screwdriver as a lever to pry up the terminal block.
4. To detach the right-hand side of the terminal block, position the flat blade underneath the terminal block to the right, and push down the screwdriver handle.
5. If necessary, repeat steps 3 and 4 until the terminal block is removed.

Setting the End-of-Line (EOL) switch (CVM models only)

Each CVM controller has an EOL switch, which, when set to ON (up), sets the CVM controller as a terminating device on the bus. See Device diagram for the EOL switch location. The default EOL switch position is OFF (down).

Figure 13: End-of-Line Switch Positions



To set the EOL switch on a CVM controller, complete the following steps:

1. Determine the physical location of the controller on the FC Bus.
2. Determine if the controller must be set as a terminating device on the bus.

   ⓘ **Note:** For detailed information about EOL termination rules and EOL switch settings on FC Buses, refer to the *FX MS/TP Communications Bus Technical Bulletin (LIT-12011670)*.

3. If the controller is a terminating device on the FC Bus, set the EOL switch to ON. If the controller is not a terminating device on the bus, set the EOL switch to OFF.

When a controller is connected to power with its EOL switch set to ON, the amber EOL LED on the controller cover is illuminated.

Input and output wiring validation

The controllers ship with a cooling only, warm or cool adjust application loaded by default. You can use this default application to perform wiring verification using the MAP Gateway, F4-DLK0350, or the FX-DIS1710-0 local controller display.

To perform wiring validation, ensure that you set the rotary switches to the desired address or controller number and wire the input and output terminals. Apply power to the controller. The Fault LED behaves the same as it does during normal application load. When the Fault LED turns off, connect to the device with either a MAP Gateway, F4-DLK0350, or FX-DIS1710-0 Local Display to view the points in the controller.

Commissioning the controllers

To commission the controller, use the following procedure:

1. With the desired application loaded in the controller, commission the VAV Box. Refer to the *Controller Tool Help (LIT-12011147)*.
2. Perform airflow balancing on the VAV box. Refer to the *VAV Box Balancing Tool and Network Sensors Technical Bulletin (LIT-12011659)*.
3. Perform commissioning checkout procedures. Refer to the *Controller Tool Help (LIT-12011147)*.

You commission equipment controllers with the CCT software.

Commission controllers using the following connection types.

Connection Type	CVM	CVE
MAP 4.2+/BACnet Router	X	X
Supervisor Passthru[1]	X	X
CWCVT	X	X
Direct Ethernet		X

1 Engines need to be at release 9.0 or later.

These connection options require additional accessory hardware, refer to the accessories ordering table in the *Facility Explorer CG, CV Series Equipment Controllers and XPM Expansion Modules Product Bulletin (LIT-12013225)*.

Refer to the *Controller Tool Help (LIT-12011147)* and *Controller Provisioning with Tools* for detailed information about commissioning the controllers.

Firmware package file

The FX-FCP-0 equipment controller firmware package files are required for CCT to configure and commission the controllers. The firmware package files also allow you to upgrade an existing controller to the latest firmware release available for that controller.

The firmware package files are orderable separately; they are not included with CCT. They are obtained from the HVAC Navigator FX Community site, and are loaded and licensed on the computer/server that is running CCT.

For additional information about the firmware package files, refer to the *CCT Installation Instructions (LIT-12011259)*.

Setting a preloaded application

You can configure a CVM/CVE controller at firmware version 11.0 or lower to use one of 20 preloaded applications using the MAP Gateway release 5.1 or later. Refer to Table 10 for the list of preloaded applications. For instructions on setting a different preloaded application using the MAP Gateway, refer to the uLearn training video CVM Controllers with Configurable Applications.

The preloaded applications are not available in firmware version 12.0 or later. If a CVM or CVE running a preloaded needs to be upgraded to firmware version 12.0 or later, this can be accomplished following normal work flows. What began as a preloaded application, may be treated as any standard application moving forward. Using the desired CCT Release Mode, the application can be uploaded, upgraded, and then downloaded to the controller along with the firmware upgrade.

Table 10: Preloaded Standard Applications

Application Number	Application Name	Description	Units of Measurement
1	Imp_Cooling Only W/C Adj	Single Duct Cooling Only, Warm/Cool Adjust	Imperial
2	Imp_Cooling Only SP Adj	Single Duct Cooling Only, Setpoint Adjust	Imperial
3	Imp_Incr HW Reheat W/C Adj	Single Duct Incremental Hot Water Reheat, Warm/Cool Adjust	Imperial
4	Imp_Incr HW Reheat SP Adj	Single Duct Incremental Hot Water Reheat, Setpoint Adjust	Imperial
5	Imp_Elec Stg Reheat W/C Adj	Single Duct Electric Staged Reheat with 1, 2, or 3 Stages, Warm/Cool Adjust	Imperial

Table 10: Preloaded Standard Applications

Application Number	Application Name	Description	Units of Measurement
6	Imp_Elec Stg Reheat Series Fan W/C Adj	Single Duct Electric Staged Reheat with 1, 2, or 3 Stages, Single Speed Series Fan, Warm/Cool Adjust	Imperial
7	Imp_Elec Stg Reheat Series Fan SP Adj	Single Duct Electric Staged Reheat with 1, 2, or 3 Stages, Single Speed Series Fan, Setpoint Adjust	Imperial
8	Imp_Elec Stg Reheat Parallel Fan W/C Adj	Single Duct Electric Staged Reheat with 1, 2, or 3 Stages, Parallel Fan, Warm/Cool Adjust	Imperial
9	Imp_Elec Stg Reheat Parallel Fan SP Adj	Single Duct Electric Staged Reheat with 1, 2, or 3 Stages, Parallel Fan, Setpoint Adjust	Imperial
10	Imp_Incr HW Reheat Series Fan W/C Adj	Single Duct Incremental Hot Water Reheat, Single Speed Series Fan, Warm/Cool Adjust	Imperial
11	Imp_Incr HW Reheat Parallel Fan W/C Adj	Single Duct Incremental Hot Water Reheat, Parallel Fan, Warm/Cool Adjust	Imperial
12	Imp_SCR Elec/Prop HW Reheat W/C Adj	Single Duct SCR Electric Reheat/ Proportional Heating Valve, Warm/Cool Adjust	Imperial
13	Imp_SCR Elec/Prop HW RH Series Fan W/C	Single Duct SCR Electric Reheat/ Proportional Heating Valve, Single Speed Series Fan, Warm/Cool Adjust	Imperial
14	Imp_SCR Elec/Prop HW RH Parallel Fan W/C	Single Duct SCR Electric Reheat/ Proportional Heating Valve, Parallel Fan, Warm/Cool Adjust	Imperial
15	SI_Cooling Only W/C Adj	Single Duct Cooling Only, Warm/Cool Adjust	Metric
16	SI_Cooling Only SP Adj	Single Duct Cooling Only, Setpoint Adjust	Metric
17	SI_Incr HW Reheat W/C Adj	Single Duct Incremental Hot Water Reheat, Warm/Cool Adjust	Metric
18	SI_Elec Stg Reheat W/C Adj	Single Duct Electric Staged Reheat with 1, 2, or 3 Stages, Warm/Cool Adjust	Metric
19	SI_SCR Elec/Prop HW Reheat W/C Adj	Single Duct SCR Electric Reheat/ Proportional Heating Valve, Warm/Cool Adjust	Metric
20	SI_SCR Elec/Prop HW Reheat Series Fan W/C	Single Duct SCR Electric Reheat/ Proportional Heating Valve, Single Speed Series Fan, Warm/Cool Adjust	Metric

Note: Warm/Cool Adjust applications also support sensor only.

Note: These applications only support the NS8000 series sensors. Older netsensors are no longer supported.

Troubleshooting equipment controllers

Table 11 provides LED status indicator information for troubleshooting the controller. General troubleshooting provides some additional troubleshooting information for possible problems.

Note: If you experience short circuits in the 24 VAC power supply causing protective devices such as breakers or fuses to trip, make sure that the power connections on the controller are not reversed. The most common cause of this problem is when the 24 VAC power supply on the controller is reversed but not reversed on a connected secondary device.

LED status and states

Table 11: Status LEDs and description of LED states

LED label	LED color	Normal state	Descriptions of LED states
POWER	Green	On Steady	Off Steady = No power On Steady = Power is supplied by primary voltage
FAULT	Red	Off Steady	Blink - 2 Hz = Startup in progress, not ready for normal operation Two blinks, long pause = Controller powered on in default state. See . Rapid blink = SA Bus communications issue Off Steady = No faults On Steady = Device fault or no application loaded
FC BUS (CVM models)	Green	Blink - 2 Hz	Blink - 2 Hz = Data transmission (normal communication) Off Steady = No data transmission (auto baud in progress) On Steady = communication lost, waiting to join communication bus
SA BUS	Green	Blink - 2 Hz	Blink - 2 Hz = Data transmission (normal communication) Off Steady = No data transmission (N/A - auto baud not supported) On Steady = Communication lost; waiting to join communication bus
FC EOL (CVM models)	Amber	Off (except on terminating devices)	On Steady = EOL is active Off Steady = EOL is not active
ETH-1 (CVE models)	Green	Off	Off Steady = ETH-1 is not connected Blinking = ETH-1 connected and communicating
ETH-2 (CVE models)	Green	Off	Off Steady = ETH-2 is not connected Blinking = ETH-2 connected and communicating
FAULT and **SA BUS**	Red Green		Both blink six times in sequence = no valid firmware on the device (Applicable to CVE models only)

General troubleshooting

Table 12: Troubleshooting

Problem	Possible cause and correction	Verification
Controller is OFF. • Transformer has tripped: - Power is at Primary of Transformer, 0V at Secondary. • Breaker/Fuse has tripped: - Power is at Primary of Transformer, 24V at Secondary, 0V at Fuse/Breaker.	**Cause:** 1. Transformer is shorted. 2. 24 VAC powered sensor is not wired with the same polarity as the controller. 3. SA Bus device is not wired with the same polarity as the controller. **Correction:** 1. Ensure polarity of ~24 V COM / UI-C / + 15VC/SA BUS COM on the controller, auxiliary devices, and I/O is the same. 2. Ensure BO-1, BO-2, and BO-3 terminals of binary outputs are not connected to ~24 VAC COM, and verify that BO-C terminals are not connected to ~24 VAC HOT (these terminals are internally sourced). 3. Verify the short circuit has been resolved with an ohm-meter. 4. Reset the breaker/fuse or replace the transformer. ⓘ **Note:** When replacing the transformer, it is recommended to replace with a model that utilizes a resettable circuit breaker. A circuit breaker makes solving wiring problems easier.	1. Disconnect the Secondary of the 24 VAC transformer. 2. Use an ohm-meter to measure between ~24 V HOT and COM; there must be no short circuit. ⓘ **Note:** Some installations require the secondary of the transformer to be Earth Grounded. If this is the case, verify that the Earth Ground connection is valid and not shared between multiple pieces of equipment.
Configurable output - analog mode is invalid: 0–10 V output is set to 10–100%, but 0 V is at output terminals. **Output is in protection mode**, a state the analog portion of the configurable output goes into when it detects a wiring problem. The analog output is set to 0% regardless of the command whenever a wiring fault is detected.	**Cause:** There is a power polarity mismatch between the connected device and the configurable output. **Correction:** Ensure polarities of ~24 V COM/CO-C match and that the connected end device uses the same polarity.	1. Measure the output and verify that it matches the command. 2. Disconnect the connected device and verify the commanded value is present.
Configurable output - analog mode is invalid: 0–10V output has an undesirable offset of up to 1 V. **The Common Reference is incorrect.**	**Cause:** The CO-C terminal is not connected. **Correction:** Connect the CO-C terminal of the configurable output to the common of the connected end device.	1. Measure the output and verify that it matches the command. 2. Disconnect the connected device and verify the commanded value is present.

Accessories

The following table provides the product code number and description for the CV series accessories.

Table 13: CV series controller accessories (order separately)

Product code number	Description
XPM Series Expansion Modules	Refer to the *Facility Explorer CGx, CVx Equipment Controllers and XPM Expansion Modules Product Bulletin (LIT-12013225)* for a complete list of available XPM series expansion modules.
FX-PCX Series Expansion Input/Output Modules	Refer to the *FX-PC Series Programmable Controllers and Related Products Product Bulletin (LIT-12011657)* for a complete list of available FX-PCX Expansion I/O Modules.
TL-CCT-0	License enabling *Metasys* Controller Configuration Tool (CCT) software for one user
FX-FCP-0	License enabling Facility Explorer Equipment Controller Firmware Package Files required for CCT
TL-CWCVT-0	Communications converter that provides a temporary wireless connection between a host device and equipment controllers that support the BACnet MS/TP protocol.
F4-DLK0350-0	Local Controller Display, 3.5 in. (89 mm) color display with navigation keypad
NS-ATV7003-0	Handheld VAV Balancing Tool
NS Series Network Sensors	Refer to the *NS Series Network Sensors Product Bulletin (LIT-12011574)* for specific sensor model descriptions.
AS-CBLTSTAT-0	Cable adapter for connection to 8-pin TE-6700 Series sensors
NS-WALLPLATE-0	Network Sensor Wall Plate
WRZ Series Wireless Room Sensors	Refer to the *WRZ Series Wireless Room Sensors Product Bulletin (LIT-12000653)* for specific sensor model descriptions.
WRZ-7860-0	Receiver for One-to-One Wireless Room Sensing Systems - functions with WRZ Series Sensors room sensors. Refer to the *WRZ-7860 Receiver for One-to-One Wireless Room Sensing Product Bulletin (LIT-12011640)* for a list of available products.
WRZ-SST-120	Wireless System Survey Tool (for use with the lower power 10mW WRZ and WRZ-7860 systems) Refer to the *WRZ-SST-120 Wireless Sensing System Tool Installation Instructions (LIT-24-10563-55)* for usage instructions.
ZFR-HPSST-0	Wireless System Survey Tool. For use with the higher power WRG1830/ZFR183x System and lower power WRZ Sensors (10 mW). Refer to the *ZFR-HPSST-0 Wireless Sensing System Tool Installation Guide (Part No. 24-11461-00012)* for usage instructions.
WRG1830/ZFR183x Pro Wireless Field Bus System	For more information about products needed for wireless field bus installations and for a list of available products, refer to the *WRG1830/ZFR183x Pro Series Wireless Field Bus System Catalog Page (LIT-1901153)*.
ZFR-USBHA-0	ZFR USB Dongle provides a wireless connection through CCT to allow wireless commissioning of the wirelessly enabled CGM and CVM controllers. It also allows use of the ZFR Checkout Tool (ZCT) in CCT. ⓘ **Note:** The ZFR-USBHA-0 is not compatible with the WRG1830/ZFR183x Pro Series. ⓘ **Note:** The ZFR-USBHA-0 replaces the IA OEM DAUBI_2400 ZFR USB dongle. For additional information about the ZFR-USBHA-0 ZFR dongle, refer to the *ZCT Checkout Tool Help LIT-12012292* or the *WNC1800_ZFR182x Pro Series Wireless Field Bus System Technical Bulletin (LIT-12012356)*.
Y64T15-0	Transformer, 120/208/240 VAC Primary to 24 VAC Secondary, 92 VA, Foot Mount, 72.2 cm (30 in.), Primary Leads and 76.2 cm (30 in.) Secondary Leads, Class 2
Y65A13-0	Transformer, 120 VAC Primary to 24 VAC Secondary, 40 VA, Foot Mount (Y65AS), 20.32 cm (8 in.), Primary Leads and 76.2 cm (30 in.) Secondary Leads, Class 2
Y65T31-0	Transformer, 120/208/240 VAC Primary to 24 VAC Secondary, 40 VA, Foot Mount (Y65AR +), 20.32 cm (8 in.), Primary Leads and Secondary Screw Terminals, Class 2
Y65T42-0	Transformer, 120/208/240 VAC Primary to 24 VAC Secondary, 40 VA, Hub Mount (Y65SP +), 20.32 cm (8 in.), Primary Leads and Secondary Screw Terminals, Class 2

Table 13: CV series controller accessories (order separately)

Product code number	Description
ACC-TBKPWFCSA-0	Power, FC Bus, and SA Bus terminal block replacement kit for SNC, CGM, CGE, CVM, CVE, and XPM products. Kit includes 5 of each terminal block type. 15 terminal blocks in total.
ACC-TBKINOUT-0	Input and Output terminal block replacement kit for SNC, CGM, CGE, CVM, CVE, and XPM products. Kit includes 5 of each 2, 3, and 4 position Input and Output terminal blocks. 30 terminal blocks in total.
ACC-CVDPT-0R	Replacement barbed fittings and DPT sensor for CV series VAV controllers with Rev B boards, with date code starting from RY12106 to present.
MS-FIT100-0	The Field Inspection Tool (FIT) is a portable handheld device with a user interface that is used to test and troubleshoot the BACnet protocol MS/TP RS-485 communications bus that connects supervisory controllers and equipment controllers to field point interfaces. The FIT can be used to check out the wiring of the MS/TP RS-485 bus as well as verify proper communications of supervisory controllers and equipment controllers connected to the bus. The FIT can be used on both the FC Bus and SA Bus.
TL-BRTRP-0	Portable BACnet/IP to MS/TP Router
F4-CVACT-0R	Actuator Assembly Replacement Kit for use with F4-CV series controllers

Technical specifications

Table 14: CV Series controllers technical specifications

	Description
Power requirement	24 VAC (nominal, 20 VAC minimum/30 VAC maximum), 50/60 Hz, Power Supply Class 2 (North America), Safety Extra-Low Voltage (SELV) (Europe)
Power consumption	10 VA typical, 14 VA maximum ⓘ **Note:** The VA rating does not include any power supplied to the peripheral devices connected to three Outputs (BOs) or Configurable Outputs (COs), which can consume up to 12 VA for each BO or CO, for a possible total consumption of an additional 60 VA (maximum). There are 3 BO's and 2 CO's that can each draw 12VA for a total of 60VA additional power.
Power source	+15 VDC power source terminals provide 35 mA total current. Quantity 1 located in Universal IN terminals - for active (3-wire) input devices
Ambient conditions	**Operating:** 0°C to 50°C (32°F to 122°F) 10% to 90% RH noncondensing ⓘ **Note:** For UL 864 10th Edition/cUL applications, perating: 0°C to 49°C (32°F to 120°F) **Storage:** -40°C to 70°C (-40°F to 158°F) 5% to 95% RH noncondensing
Communications protocol	**F4-CVM models:** BACnet MS/TP; N2. Zigbee Wireless also supported (at FC Bus and for Sensors) with additional hardware. **F4-CVE03050-0P:** BACnet/SC; BACnet/IP
Controller number for Ethernet controllers	Set of three rotary switches used to set controller number between 000 and 999. See Setting the controller number for CVE models.
Device addressing for BACnet MS/TP	Decimal address set via three rotary switches; valid controller device addresses 4-127
Communications bus ⓘ **Note:** For more information refer to *FX MS/TP Communications Bus Technical Bulletin (LIT-12011670)*	**F4-CVM models:** BACnet MS/TP (default), N2 3-wire FC Bus between the supervisory controller and equipment controllers **F4-CVE models:** BACnet/IP (default), BACnet/SC Two Ethernet ports; 10/100 Mbps; 8-pin RJ-45 connector **F4-CVM and F4-CVE models:** 4-wire SA Bus between equipment controller, network sensors and other sensor/actuator devices, includes a lead to source 15 VDC supply power (from equipment controller) to bus devices
Processor	RX64M 32-bit Renesas microcontroller
Memory	16MB Flash Memory and 8MB SDRAM

Table 14: CV Series controllers technical specifications

	Description
Real-time clock backup power supply	Super capacitor maintains power to the onboard real-time clock for a minimum of 72 hours when supply power to the controller is disconnected.
Input and output capabilities	**3 - Universal Inputs**: Defined as 0–10 VDC, 0–600k ohms, or Binary Dry Contact **2 - Configurable Outputs:** Defined as 0-10 VDC or 24 VAC Triac BO **3 - Binary Outputs**: Defined as 24 VAC Triac (internal power source only)
Universal Input (UI) resolution/Configurable Output (CO) accuracy	**UI Analog Input Mode:** 15-bit resolution on UIs **CO Analog Output Mode:** 0–10 VDC ± 200 mV
Air pressure differential sensor	Range: -2 in. to 2 in. H2O **Performance Characteristics:** Typical Accuracy at ambient operating conditions: +/- 0.5 % in. H2O full scale Typical accuracy at zero (null) pressure is +/- 0.0006 in. H2O
Actuator rating	4 N·m (35 lb·in) minimum shaft length = 44 mm (1-3/4 in.) (if provided)
Terminations	**Inputs/Outputs**: Pluggable Screw Terminal **FC Bus, SA Bus, and Supply Power**: 4-Wire and 2-Wire Pluggable Screw Terminal Blocks **SA Bus Modular Ports**: RJ-12 6-Pin Modular Jacks ⓘ **Note:** The FC Bus Terminal and FC Bus Port are only available on the CVM models
Mounting	Mounts to damper shaft using single set screw and to duct with single mounting screw
Housing	**Enclosure material:** ABS and polycarbonate UL94 5VB; Self-extinguishing Protection Class: IP20 (IEC529)
Dimensions **(height x width x depth)**	165 mm x 125 mm x 73 mm (6.5 in. x 4.92 in. x 2.9 in.) **Center of Output Hub to Center of Captive Spacer:** 135 mm (5-5/16 in.)
Weight	0.69 kg (1.52 lb)
Compliance	**United States:** UL Listed, File E107041, CCN PAZX, UL 916, Energy Management Equipment. FCC Compliant to CFR47, Part 15, Subpart B, Class A. Suitable for Use in Other Environmental Air Space (Plenums) in Accordance with Section 300.22(C) of the National Electrical Code.
	Canada: UL Listed, File E107041, CCN PAZX7, CAN/CSA C22.2 No. 205, Signal Equipment. Industry Canada Compliant, ICES-003
CE	**Europe:** CE Mark – Johnson Controls declares that this product is in compliance with the essential requirements and other relevant provisions of the EMC Directive and RoHS Directive.
RCM	**Australia and New Zealand:** RCM Mark, Australia/NZ Emissions Compliant.
	BACnet International: Certification pending to BACnet Testing Laboratories™ (BTL) Protocol Revision 19 BACnet Advanced Application Controller (B-AAC), based on ANSI/ASHRAE 135-2020
UK CA	**United Kingdom:** Johnson Controls declares that this product is in compliance with Electromagnetic Compatibility Regulations, The Electrical Equipment (Safety) Regulations, and Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations.

The performance specifications are nominal and conform to acceptable industry standard. For application at conditions beyond these specifications, consult the local Johnson Controls office. Johnson Controls shall not be liable for damages resulting from misapplication or misuse of its products.

Repair information

If the controller fails to operate within its specifications, replace the controller. For a replacement controller, contact your Johnson Controls representative.

Product warranty

This product is covered by a limited warranty, details of which can be found at www.johnsoncontrols.com/buildingswarranty.

Patents

Patents: https://jcipat.com

Single point of contact

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