Installation and Operation Guide

BAC-7301 and BAC-7301C Advanced Applications Controller for AHU Applications

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SECTION 1

About the BAC-7301

This section provides a general description of the KMC Controls BAC-7301 controller. It also introduces safety information. Review this material before installing or operating the controller.

The BAC-7301 and BAC-7301C are native BACnet, fully programmable controllers designed for small air handler units. Use these versatile controllers in stand-alone environments or networked to other BACnet devices. As part of a complete facilities management system, the BAC-7301 controllers provide precise monitoring and control of connected points.

◆ BACnet MS/TP compliant
◆ Automatically assigns the MAC address and the device instance
◆ Supplied with programming sequences for small air handler unit
◆ Easy to install, simple to configure, and intuitive to program
◆ Controls room temperature, humidity, fans, monitors refrigeration, lighting, and other building automation functions.

Specifications

Inputs

Universal inputs	4
Key features	Software selectable as analog, binary object or accumulator objects. Accumulator objects in one controller limited to three. Standard units of measure. NetSensor compatible Overvoltage input protection
Pull–up resistors	Switch select none or 10kΩ
Connector	Removable screw terminal block, wire size 14–22 AWG
Conversion	10–bit analog–to–digital conversion
Pulse Counting	Up to 16 Hz
Input range	0–5 volts DC
NetSensor	Compatible with models KMD–1161 and KMD–1181.

Outputs, Universal 3

Key features	Output short protection Programmable as an analog or binary object. Standard units of measure
Connector	Removable screw terminal block Wire size 14-22 AWG
Output voltage	0–10 volts DC analog 0–12 volts DC binary output range
Output current	100 mA per output

Outputs, Triac	1
Key features	Optically isolated triac output.
	Programmable as analog or binary object.
Connector	Removable screw terminal block
	Wire size 14-22 AWG
Output range	Maximum switching 30 volts AC at 1 ampere

Communications	
BACnet MS/TP	EIA–485 operating at rates up to 76.8 kilobaud.
	Removable screw terminal block.
	Automatic baud detection.
	Automatically assigns MAC addresses and device instance numbers
	Wire size 14–22 AWG
NetSensor	Compatible with models KMD–1161 and KMD–1181, Connects through RJ–12 connector.

Programmable features	
Control Basic	10 program areas
PID loop objects	4 loop objects
Value objects	40 analog and 40 binary
Time keeping	Real time clock with power backup for 72 hours (BAC-7301C only)
Supported objects	See PIC statement for supported BACnet objects

Schedules	
Schedule objects	8
Calendar objects	3

Trend objects	8 objects each of which can hold 256 samples

Alarms and events	
Intrinsic reporting	Supported for input, output, value, accumulator, trend and loop objects.
Notification class objects	8

Memory	Programs and program parameters are stored in nonvolatile memory.
	Auto restart on power failure

Application programs	KMC Controls supplies the BAC-7301 with programming sequences for small air handler units:
	◆ Air handler operation based on occupancy, night setback, proportional hot and chilled water valve control.
	◆ Economizer operation.
	◆ Freeze protection.

Regulatory	UL 916 Energy Management Equipment
	FCC Class B, Part 15, Subpart B
	BACnet Testing Laboratory listed
	CE compliant
	SASO PCP Registration KSA R-103263

Environmental limits

Operating	32 to 120° F (0 to 49° C)
Shipping	–40 to 140° F (–40 to 60° C)
Humidity	0–95% relative humidity (non-condensing)

Models

BAC-7301C	BACnet AHU controller with real-time clock
BAC-7301	BACnet AHU controller without real-time clock

Installation

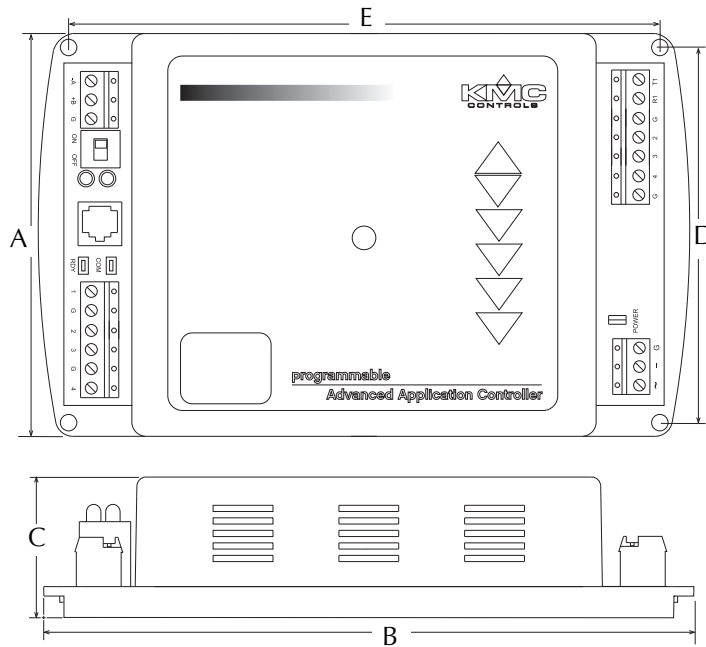|	
Supply voltage	24 volts AC (–15%, +20%), 50-60 Hz, 8 VA minimum, 15 VA maximum load, Class 2 only, non-supervised (all circuits, including supply voltage, are power limited circuits)
Weight	8.2 ounces (112 grams)
Case material	Flame retardant green and black plastic

Dimensions

Table 1-1 BAC-7301 Dimensions

A	B	C	D	E
4.36 in.	6.79 in.	1.42 in.	4.00 in.	6.00 in.
111 mm	172 mm	36 mm	102 mm	152 mm

Accessories

Power transformer

XEE-6111-40	Single-hub 120 volt transformer
XEE-6112-40	Dual-hub 120 volt transformer

Safety considerations

KMC Controls assumes the responsibility for providing you a safe product and safety guidelines during its use. Safety means protection to all individuals who install, operate, and service the equipment as well as protection of the equipment itself. To promote safety, we use hazard alert labeling in this manual. Follow the associated guidelines to avoid hazards.

⚠ Danger

Danger represents the most severe hazard alert. Bodily harm or death will occur if danger guidelines are not followed.

⚡ Warning

Warning represents hazards that could result in severe injury or death.

❗ Caution

Caution indicates potential personal injury or equipment or property damage if instructions are not followed.

✎ Note

Notes provide additional information that is important.

◹ Detail

Provides programing tips and shortcuts that may save time.

SECTION 2

Installing the controller

This section provides a brief overview of the BAC-7301 and the BAC-7301C Direct Digital Controllers. Review this material before you attempt to install the controller.

Mounting

Mount the controller inside of a metal enclosure. KMC Controls recommends using a UL-approved Enclosed Energy Management Equipment Panel such as a KMC model HCO–1034, HCO–1035 or HCO–1036. Insert #6 hardware through the four mounting holes on the top and bottom of the controller to securely fasten it to a flat surface. See _BAC-7301 Dimensions_ on page 6 for mounting hole locations and dimensions. To maintain RF emission specifications, use either shielded connecting cables or enclose all cables in conduit.

Connecting inputs

The BAC-7301 controller has four universal inputs. Each input can be configured to receive either analog or digital signals. By using the optional pull-up resistors, either passive or active devices may be connected to the inputs.

✎ **Note**

KMC supplied Control Basic programs assign input 1 (I1) to the space temperature sensor input. If the KMC programs are not in used or are modified, input 1 is available for other use. Inputs 2 and 3 are not assigned by KMC programs and are available as needed.

Pull–up resistors

For passive input signals, such as thermistors or switch contacts, use a pull-up resistor. For KMC thermistors and most other applications set the switch to the _On_ position. See Illustration 2-1 for the pull-up switch location.
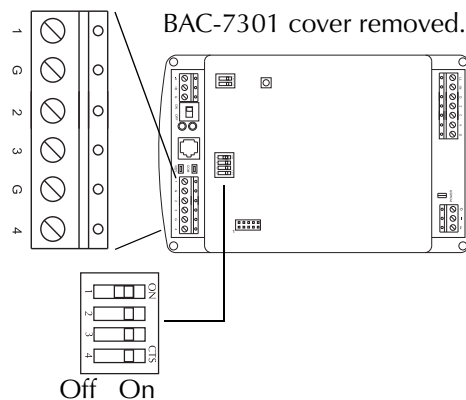

Illustration 2-1 Pull-up resistors and input terminals

4–20 mA inputs

To use a 4–20 current loop input, connect a 250 ohm resistor from an input to ground. The resistor will convert the current input to a voltage which can be read by the controller analog-to-digital converter. Set the pull-up switch to the *Off* position.

Ground terminals

Input ground terminals are located next to the input terminals. Up to two wires, size 14–22 AWG, can be clamped into each ground terminal. If more than two wires must be joined at a common point, use an external terminal strip to accommodate the additional wires.

Pulse inputs

Connect pulse inputs under the following conditions:

◆ If the pulse input is a passive input such as switch contacts, then place the input pull-up in the *On* position.

◆ If the pulse is an active voltage (up to a maximum of +5 volts DC), then place the input pull-up jumper in the *Off* position.

Connecting outputs

One triac and three universal outputs are available for output connections. The triac output is labeled as T1 and the Universal Outputs are labeled 2–4 on the output terminal block. Use the R1 terminal for the triac return only; connect the universal outputs to the common G terminal.
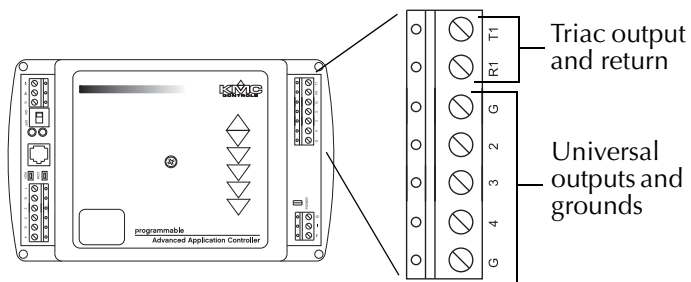

Illustration 2-2 Output terminals

Connecting to a NetSensor

The Network RJ–12 connector provides a connection port to a NetSensor model KMD–1161 or KMD–1181. Link the controller to a NetSensor with a KMC Controls approved cable up to 75 feet long. See the installation guide supplied with the NetSensor for complete NetSensor installation instructions.
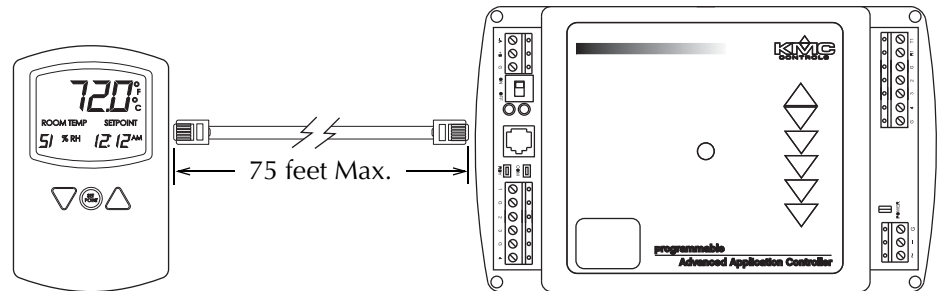

Illustration 2-3 Connection to a NetSensor

Connecting to an MS/TP network

Connections and wiring

Use the following principles when connecting a controller to an MS/TP network:

- ◆ Connect no more than 128 addressable BACnet devices to one MS/TP network. The devices can be any mix of controllers or routers.
- ◆ To prevent network traffic bottlenecks, limit the MS/TP network size to 60 controllers.
- ◆ Use 18 gauge, twisted pair, shielded cable with capacitance of no more than 50 picofarads per foot for all network wiring. Belden cable model #82760 meets the cable requirements.
- ◆ Connect the -*A* terminal in parallel with all other - terminals.
- ◆ Connect the +*B* terminal in parallel with all other + terminals.
- ◆ Connect the shields of the cable together at each controller. For KMC BACnet controllers use the *S* terminal.
- ◆ Connect the shield to an earth ground at one end only.
- ◆ Use a KMD–5575 BACnet MS/TP repeater between every 32 MS/TP devices or if the cable length will exceed 4000 feet (1220 meters). Use no more than seven repeaters per MS/TP network.
- ◆ Place a KMD–5567 surge surpressor in the cable where it exits a building.

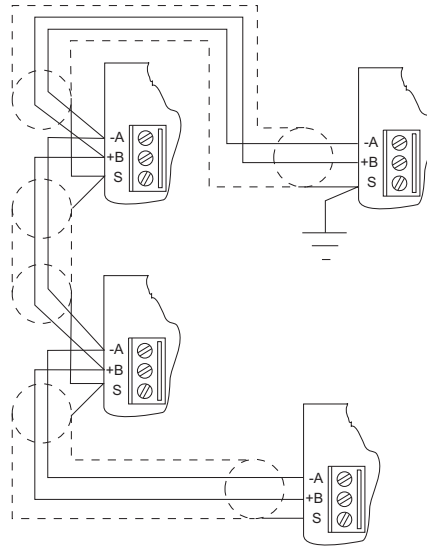See Application Note AN0404A, *Planning BACnet Networks* for addional information about installing controllers.

Illustration 2-4 MS/TP network wiring

✎ **Note**

The BAC-7301 EIA–485 terminals are labeled -*A*, +*B* and *S*. The *S* terminal is provided as a connecting point for the shield. The terminal is not connected to the ground of the controller. When connecting to controllers from other manufacturers, verify the shield connection is not connected to ground.

End of line termination switches

The controllers on the physical ends of the EIA-485 wiring segment must have end-of-line termination installed for proper network operation. Set the end-of-line termination to *On* using the *EOL* switches.
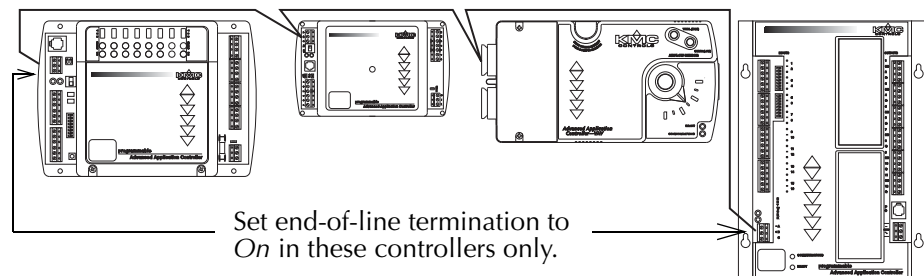

Set end-of-line termination to *On* in these controllers only.

Illustration 2-5 End of line termination

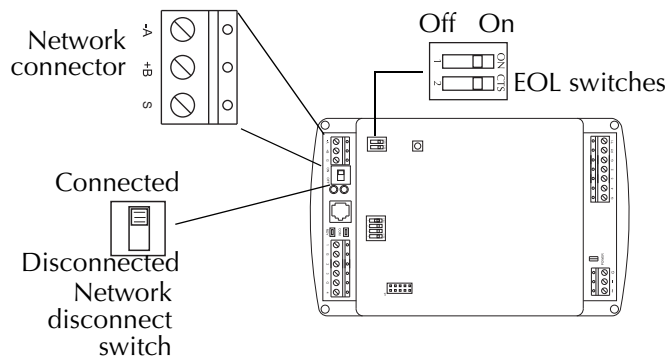Illustration 2-6 shows the position of the BAC–7001 End-of-Line switches associated with the EIA–485 inputs.

Illustration 2-6 Location of EOL switch

Connecting power   The controllers require an external, 24 volt, AC power source. Use the following guidelines when choosing and wiring transformers.

- ◆ Use a KMC Controls Class–2 transformer of the appropriate size to supply power to the controllers. KMC Controls recommends poweringPower only one controller from each transformer.
- ◆ When installing a controller in a system with other controllers, you may power multiple controllers with a single transformer as long as the total power drawn from the transformer does not exceed its rating and phasing is correct.
- ◆ If several controllers are mounted in the same cabinet, you can share a transformer between them provided the transformer *does not exceed* 100 VA or other regulatory requirements.
- ◆ Do not run 24 volt, AC power from within an enclosure to external controllers.

Connect the 24 volt AC power supply to the power terminal block on the lower right side of the controller near the power jumper. Connect the ground side of the transformer to the **–** or GND terminal and the AC phase to the **~** (phase) terminal. Power is applied to the controller when the transformer is plugged in and the power jumper is in place.
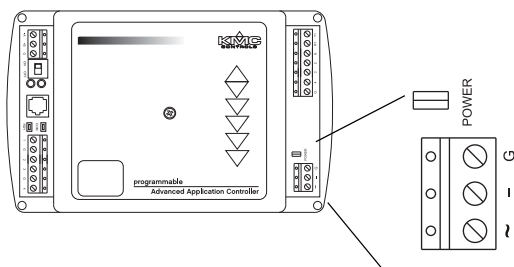

Illustration 2-7 Power terminal

Programming

Network configuration

For more information on installing, configuring, and programming HVAC system controllers, see the following documents available on the KMC Controls web site:

◆ *BACstage User's Guide to Installation and Getting Started* (902-019-62)
◆ *BAC-5000 Reference Guide* (902019-63)
◆ *TotalControl Reference Guide*
◆ Application Note AN0404A *Planning BACnet Networks*.
◆ *MS/TP Automatic MAC Addressing Installation Instructions*

Supplied applications programming

Refer to the KMC Digital Applications Manual for information on using the applications programs included with the controller.

SECTION 3

Operating the controller

This section provides a brief overview of the BAC-7301 and the BAC-7301C Direct Digital Controllers. Review this material before you attempt to install the controller.

Operation

Once configured, programmed and powered up, the controller requires very little user intervention.

Controls and Indicators

The following topics describe the controls and indicators found on the controller. Additional information for automatic addressing functions are described in the guide *MS/TP Automatic MAC Addressing Installation Instructions* that is available from the KMC Controls web site.
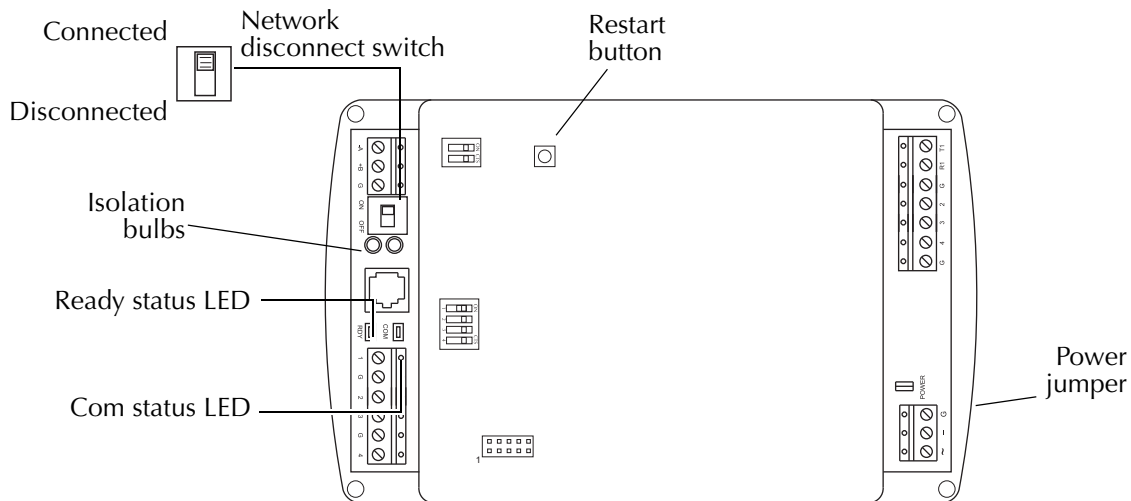

Illustration 3-1 Controls and indicators

Network disconnect switch

The network disconnect switch is located on the left side of the controller. Use this switch to enable or disable the MS/TP network connection. When the switch is ON the controller can communicate on the network; when it is OFF, the controller is isolated from the network.

Alternately, you may remove the isolation bulbs to isolate the controller from the network.

Ready LED

The green Ready LED indicates the state of the controller. This includes automatic addressing functions that are fully described in the guide *MS/TP Addressing For BACnet Controllers.*

Power up During controller initialization, the Ready LED is continuously illuminated for 5 to 20 seconds. Once initialization is complete, the Ready LED begins flashing to indicate normal operation.

Normal operation During normal operation, the Ready LED flashes a repeating pattern of one second on and then one second off.

Restart button acknowledge The restart button includes several functions for automatic addressing that are acknowledged with the Ready LED. When the restart button is pressed, the Ready LED illuminates continuously until either of the following take place:

- The restart button is released.
- The restart button time-out period is reached and a restart operation is complete. Restart button operations are listed in the following table.

Table 3-1 Ready LED patterns for restart button operations

Controller state	LED pattern
The controller is set as an automatic addressing anchor. The MAC in the controller is set to 3	A rapid repeating pattern of a short flash followed by a short pause.
The controller has sent the automatic addressing lock command to the network	Two short flashes followed by a long pause. The pattern repeats until the restart button is released.
No restart operation	Ready LED remains unlit until the restart button is released.

Communications (Com) LED

The yellow Communications LED indicates how the controller is communicating with other controllers on the network.

Sole master Repeating pattern of a long flash and a short pause that repeats once a second. It indicates that the controller has either generated the token or is a sole MS/TP master and has yet to establish communications with other MS/TP devices.

Token passing A short flash each time the token is passed. The frequency of the flash is an indication of how often the device receives the token.

Nomad patterns There are three Com LED patterns that indicate that the controller is an automatic addressing nomad controller that is receiving valid MS/TP traffic.

Table 3-2 Automatic addressing nomad patterns

Controller state	LED pattern
Lost nomad	A long flash
Wandering nomad	A long flash followed by three short flashes
Assigned nomad	Three short flashes followed by a long pause.

Error conditions for the LEDs

The two network isolation bulbs, located next to the network switch, serve three functions:

◆ Removing the bulbs opens the EIA-485 circuit and isolates the controller from the network.

◆ If one or both bulbs are lit, it indicates the network is improperly phased. This means that the ground potential of the controller is not the same as other controllers on the network.

◆ If the voltage or current on the network exceeds safe levels, the bulbs operate as fuses and may protect the controller from damage.

Isolation bulbs

The two network isolation bulbs, located next to the network switch, serve three functions:

◆ Removing the bulbs opens the EIA-485 circuit and isolates the controller from the network.

◆ If one or both bulbs are lit, it indicates the network is improperly phased. This means that the ground potential of the controller is not the same as other controllers on the network.

◆ If the voltage or current on the network exceeds safe levels, the bulbs operate as fuses and may protect the controller from damage.

Restoring factory settings

If the controller appears to be operating incorrectly, or is not responding to commands, you may need to reset or restart the controller. To perform a reset or restart, remove the cover to expose the red restart push-button and then use one of the following procedures.

To perform a reset or restart, locate the red restart push-button and then—in order—use one of the following procedures.

1. A warm start is the option least disruptive to the network and should be tried first.
2. If problems persist, then try a cold start.
3. If the problems continues, restoring the controller to factory settings may be required.

! Caution

Read all of the information in this section before proceeding!

✎ Note

Momentarily pushing the red reset button while the controller remains powered will have no effect on the controller.

Performing a warm start

A warm start changes the controller as follows:

◆ Restarts the controller's Control Basic programs.
◆ Leaves object values, configuration, and programming intact.

! Caution

In the unlikely event that the checksum test in RAM fails during the warm start, the controller will automatically perform a cold start. During a cold start, controller outputs may abruptly turn connected equipment on and off. To prevent equipment damage, turn connected equipment off or temporarily remove the output terminal blocks from the controller before performing a warm start.

Do either of the following to perform a warm start:

◆ Reinitialize the controller with either BACstage or TotalControl Design Studioa BACnet operator workstation.
◆ Remove the power jumper for a few seconds and then replace it.

Performing a cold start

Performing a cold start changes the controller as follows:

◆ Restarts the controller programs.
◆ Returns all object states to their initial factory settings until the controller programs update them.
◆ Leaves configuration and programming intact.

> **❗ Caution**
>
> Returning object values to their relinquished defaults during a cold start may abruptly turn connected equipment on or off. To prevent equipment damage, turn connected equipment off or temporarily remove the output terminal blocks from the controller before performing a warm start.

To perform a cold start:

1. While the controller is powered, press and hold the restart button.
2. Remove the power jumper.
3. Release the red button *before* replacing the power jumper.

> **✎ Note**
>
> A cold start performed by this method is the same as performing a cold start with BACstage or from TotalControl Design Studio.

Restoring to factory settings

Restoring a controller to factory settings changes the controller as follows:

◆ Removes all programming.
◆ Removes all configuration settings.
◆ Restores the controller to factory default settings.

> **❗ Caution**
>
> Resetting the controller erases all configuration and programming. After resetting to factory settings, you must configure and program the controller to establish normal communications and operation.

To reset the controller to factory settings.

1. If possible, use BACstage or TotalControl Design Studio to backup the controller.
2. Remove the power jumper.
3. Press and hold the red restart button.
4. Replace the power jumper while continuing to hold the restart button.
5. Restore configuration and programming with BACstage or TotalControl Design Studio.