

Cooling Only BAC-8001 BacNet DDC VAV Controller Installation Guide



Contents

Section 1

About the controllers

Specifications 5

Safety considerations 7

Section 2

Installing the controllers

Setting the rotation limits 9

Mounting 10

Connecting inputs 11

Connecting outputs 12

Connecting to sensors 12

Connecting to an MS/TP network 13

Connecting an airflow sensor 16

Connecting power 17

Application drawing 18

Section 3

Setting up VAV controllers

Network communications 19

Setting temperature setpoints 20

Setting airflow setpoints 21

Setting the VAV terminal unit parameters 21

Balancing airflow 21

SECTION 1

About the controllers

This section provides a description of the BacNet DDC BAC-8001 VAV controllers. It also introduces safety information. Review this material before installing or operating the controllers.

The BAC-8001 is native BACnet, direct digital controllers designed for VAV terminal units. An integrated actuator and the supplied programs make these ideal controllers for basic single-duct cooling and heating applications. Install these versatile controllers in stand-alone environments or networked to other BACnet devices. As part of a complete facilities management system, the BAC-8001 controller provides precise monitoring and control of connected points.

- ◆ BACnet MS/TP compliant
- ◆ Standard VAV control sequences are incorporated to provide pressure independent control of VAV unit
- ◆ On-board airflow sensor for use with a single or multi-point differential pressure measuring station or pitot tube.

Specifications

Analog inputs	All inputs are configured as analog objects
Active inputs	1
Passive inputs	3
Air flow sensor	1
Key features	Standard units of measure. Overvoltage input protection
Connector	Spade connectors, 0.25 inch
Conversion	12-bit analog-to-digital conversion
Input range	0-12 volts DC
Outputs, binary	2 for the internal actuator
Key features	
Conversion	12-bit analog-to-digital conversion
Connector	Spade connectors, 0.25 inch
Output range	Maximum switching 24 VAC at 3 amperes

Communications	
BACnet MS/TP	EIA-485 operating at rates up to 76.8 kilobaud. Removable screw terminal block. Wire size 12-24 AWG
Sensor jack	RJ-45 jack compatible with model STE-8000 and STE-6000 models with RJ-45 jacks
Supported objects	
Control Basic	See PIC statement for supported BACnet objects 5 program areas in BAC-8001 6 program areas in BAC-8201
PID loop objects	2
Value objects	60 analog, 32 binary, and 12 multistate
Memory	
	Programs and program parameters are stored in nonvolatile memory. Auto restart on power failure
Application programs	
	Titus Alpha Controls supplies models BAC-8001 and BAC-8201 with programming sequences for single-duct VAV applications.
	◆ Cooling and heating VAV ◆ Balancing ◆ UL 864 smoke controll (BAC-8201 only)
Air flow sensor features	
	Configured as BACnet analog input object. CMOS differential pressure 0-2 inches of water (0-500 Pa) measurement range. Internally linearized and temperature compensated. Span accuracy 4.5% of reading. Barbed connections for 1/4 FR tubing. Range dependent upon DP pickup, tubing size / length and connections.
Actuator specifications	
Torque	40 in-lb. (4.5 N•m)
Angular rotation	0 to 95° Adjustable end stops at 45° and 60° rotation
Motor timing, BAC-8001	90 sec./90° at 60 Hz 108 sec./90° at 50 Hz
Motor timing, BAC-8201	60sec./90° at 60 Hz 72 sec./90° at 50 Hz
Shaft size	Directly mounts on 3/8 to 5/8 inch (9.5 to 16 mm) round or 3/8 to 7/16 inch (9.5 to 11 mm) square damper shafts.

Regulatory	UL 916 Energy Management Equipment FCC Class B, Part 15, Subpart B BACnet Testing Laboratory listed as an application specific controller (ASC). UL 864 smoke controls (BAC-8201 only)
Installation	
Supply voltage	24 volts AC, -15%, +20% 5 VA
Weight	13.2 ounces (376 grams)
Case material	Flame retardant plastic
Environmental limits	
Operating	32 to 120° F (0 to 49° C)
Shipping	–40 to 140° F (–40 to 60° C)
Humidity	5–95% relative humidity (non-condensing)
Models	
BAC-8001	VAV controller with 90 second actuator and reheat
BAC-8201	VAV controller with 60 second actuator, reheat, and UL 864 smoke control application

Dimensions

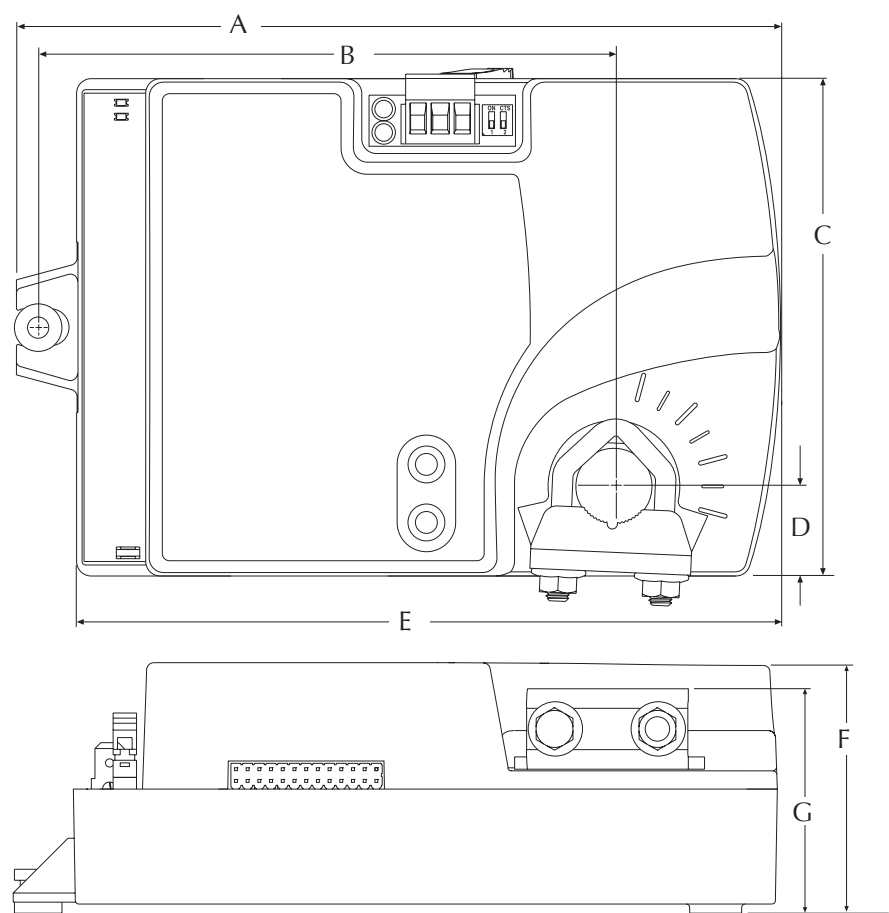


Table 1-1 BAC-8000 dimensions

A	B	C	D	E	F	G
6.53 in.	4.89 in.	4.25 in.	0.77 in.	6.00 in.	2.14 in.	1.92 in.
166 mm	124 mm	108 mm	19 mm	152 mm	54 mm	49 mm

Safety considerations

Titus 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 controllers

This section provides important instructions and guidelines for installing the BAC-8001 controller. Carefully review this information before installing the controllers.

Installing a VAV controller includes the following topics that are covered in this section.

- ◆ [*Setting the rotation limits on page 12*](#)
- ◆ [*Mounting on page 13*](#)
- ◆ [*Connecting inputs on page 14*](#)
- ◆ [*Connecting outputs on page 15*](#)
- ◆ [*Connecting to an MS/TP network on page 16*](#)
- ◆ [*Connecting an airflow sensor on page 19*](#)
- ◆ [*Connecting power on page 20*](#)

In addition to the topics, see the section [*Application drawing on page 21*](#).

Setting the rotation limits

Before mounting the controller, set the rotation limits with the supplied stop screw. Installing the stop screw limits the shaft rotation to either 45 or 60 degrees.



Caution

Before setting the rotation limits on the controller, refer to the damper position specifications in the VAV control box to which the controller will be attached. Setting rotation limits that do not match the VAV damper may result in improper operation or equipment damage.

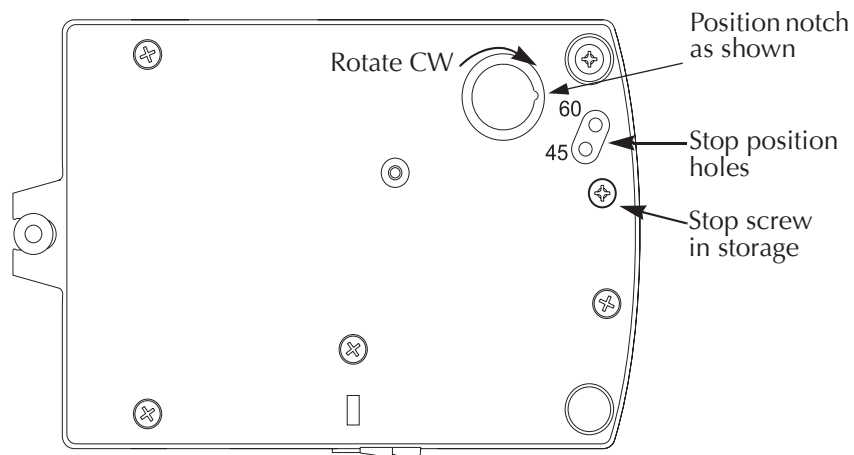


Illustration 2-1 Controller stop selections

To set the rotational limits:

1. Turn the controller over so you have access to the back.
2. Manually rotate the actuator fully clockwise as viewed from the back.
3. Remove the stop screw from its storage location and clean any debris from the threads.
4. Insert the screw into the correct stop position hole.
5. Tighten the screw only until the head touches the plastic in the bottom of the recess.

Mounting

Mount the controller inside of a metal enclosure. To maintain RF emissions specifications, use either shielded connecting cables or enclose all cables in conduit.

Mount the controller directly over the damper shaft. A minimum shaft length of 2.0 inch (51 mm) is required.



Note The controller is designed to directly mount to 3/8 to 5/8 inch (9.5 to 16mm) round or 3/8 to 7/16 (9.5 to 11mm) square damper shafts.

Mount the controller close enough to the pitot tubes to keep the tubing length to a minimum. In typical installations the controller's inputs and sensors are within 24 inches of each other.

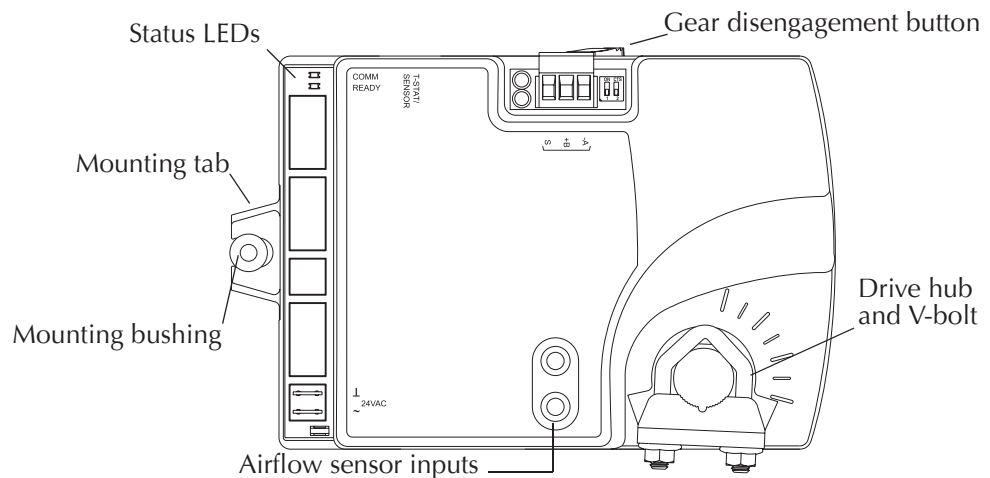


Illustration 2-2 Controls and indicators

Mount the controller as follows:

1. Loosen the nuts on the U-bolt until the shaft can fit through the collar.
2. Place the controller on the damper shaft in the approximate final position. Position the controller loosely against the mounting surface so that the mounting bushing can float freely in the mounting tab.
3. Center the mounting bushing in the slot of the mounting tab and secure it using a #8 self-tapping screw.
4. Manually position the damper in the full open position.
5. Adjust the drive hub as follows:
 - a. If the damper rotates counter clockwise to close, depress the gear disengagement button and rotate the drive hub to the full clockwise position then release the button.
 - b. If the damper rotates clockwise to close, depress the gear disengagement button and rotate the drive hub to the full counter clockwise position then release the button.
6. Lock the hub to the shaft by evenly tightening the V-bolt nuts to 30 to 35 in-lbs.

Connecting inputs

The BAC-8001 controller has preconfigured analog inputs to support the supplied programs. The inputs cannot be changed to binary or accumulator inputs. Only one input has an externally available physical terminal. All of the inputs are preconfigured for the application programs supplied in the controllers and are listed in Table 2-1.

Table 2-1 BAC-8001 and BAC-8201 input objects

Object	Function	Name	Unit	Location	Pull up
AI1	Discharge Air Temperature	DISCHARGE AIR	°F	Terminal block	10kΩ
AI2	Space Sensor	SPACE SENSOR	°F	RJ-45	10kΩ
AI3	Space Setpoint	SPACE SETPOINT	°F	RJ-45	10kΩ
AI4	Primary Duct Pressure	PRIMARY DUCT	wc	Internal airflow sensor	N/A
AI5	Primary Damper Position	PRIMARY POSITION	Volts	Internal damper position	N/A

Discharge air temperature Connect a 10kΩ, Type 3 thermistor temperature probe to the discharge air temperature input. The input includes the internal pull-up resistor. An STE-1405 sensor is suitable for this application. Follow the instructions supplied with the sensor for installation. See [Setting temperature setpoints on page 30](#) for setting up discharge air temperature limiting that requires this input sensor.

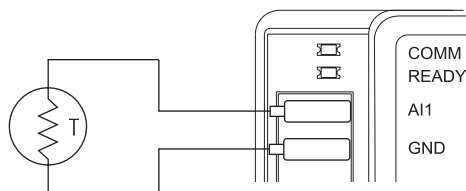


Illustration 2-3 Discharge air temperature

Space Temperature Input The space temperature input is connected only through the RJ-45 thermostat and sensor input jack. It is configured as an analog input for STE-6010, STE-6014, and STE-6017 sensors. If an STE-8000 sensor is connected to the controller, this input is ignored. See [Connecting to sensors on page 15](#).

Space Setpoint The space setpoint input is connected only through the RJ-45 thermostat and sensor input jack. It is configured for the setpoint dials on STE-6014 or STE-6017 sensors. If an STE-6010 or STE-8000 sensor is connected to the controller, this input is ignored. See [Connecting to sensors on page 15](#).

Primary Duct Pressure The primary duct pressure input is an internal measurement from the airflow sensor.

Primary Damper Position (BAC-8201 only) The primary damper position input is preconfigured as an analog input that represents the position of the internal damper.

Connecting
outputs

The BAC-8001 controller has two preconfigured outputs to support the supplied programs. The outputs are programmed run the integrated actuator in either a clockwise or counterclockwise direction. No external output connections are available.

Table 2-2 BAC-8001 output objects

Object	Function	Name	False value	True value	Default value	Type
BO1	Damper Clockwise	DAMPER CW	Neutral	Clockwise	Neutral	Internal
BO2	Damper Counter Clockwise	DAMPER CCW	Neutral	Counterclockwise	Neutral	Internal

Connecting to
sensors

Connect any of the following sensors to the RJ-45 thermostat and sensor jack.

- ◆ STE-8001
- ◆ STE-8201
- ◆ STE-6010
- ◆ STE-6014
- ◆ STE-6017

Link the controller to sensors with standard straight-through Ethernet cables up to 75 feet long. See the installation guide supplied with the sensors for complete sensor installation instructions.

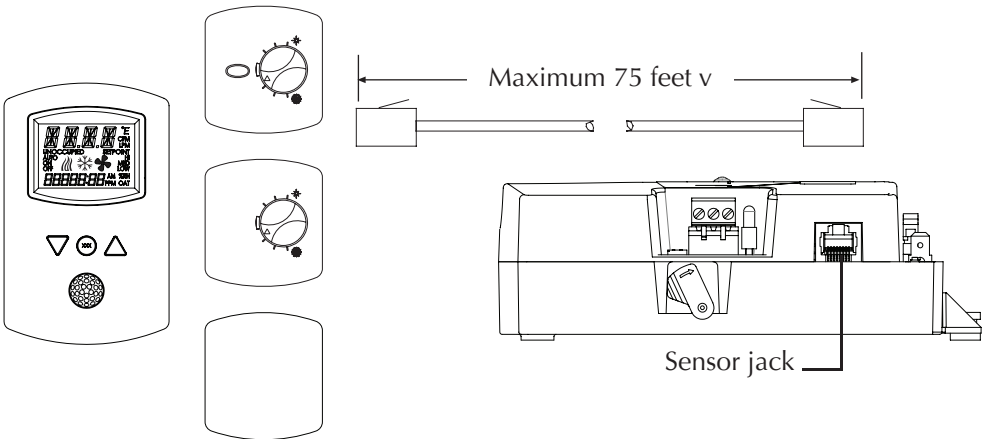


Illustration 2-4 Connecting to a sensor

No programming or configuration is required for the supported sensors. The controller is configured to automatically detect which type of sensor is connected to it.

Connecting to an MS/TP network

The BAC-8000 series controllers are BACnet MS/TP compliant controllers. Connect them only to a BACnet MS/TP network.

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

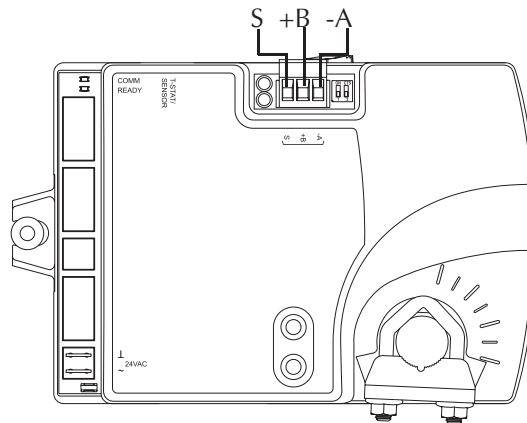
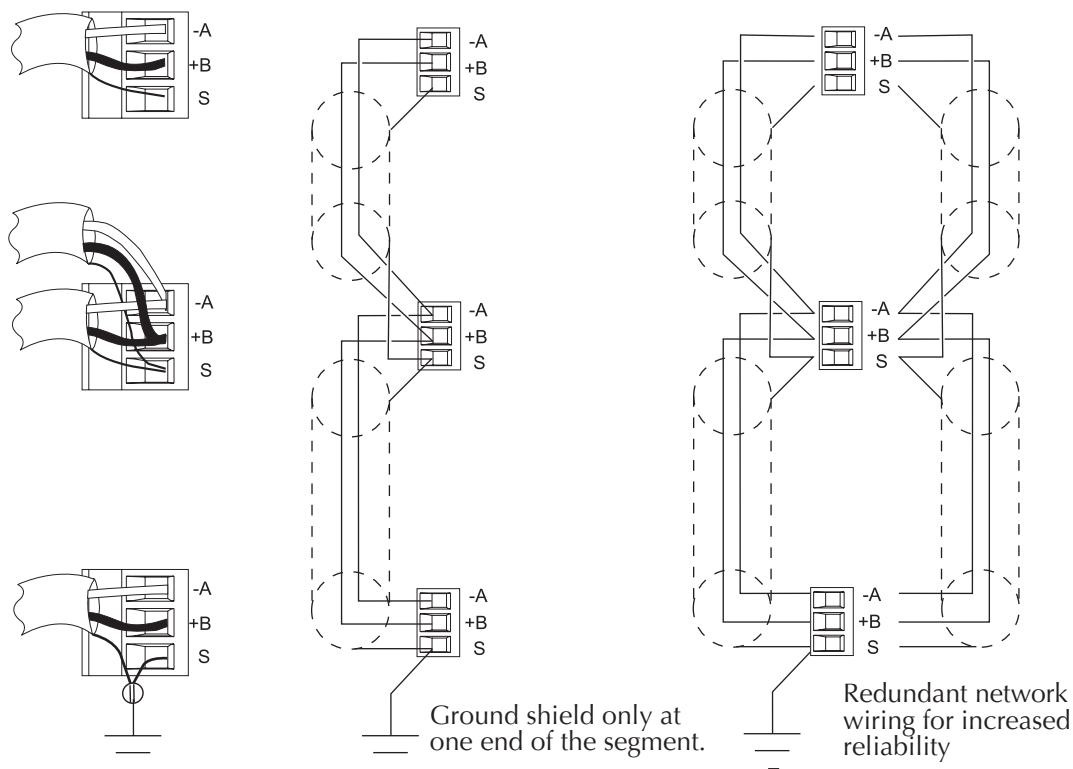


Illustration 2-5 MS/TP network connection

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 51 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 repeater between every 32 MS/TP devices or if the cable length will exceed 4000 feet (1220 meters). Use no more than four repeaters per MS/TP network.
- ◆ Place a KMD-5567 surge suppressor in the cable where it exits a building.

**Illustration 2-6 MS/TP network wiring****Note**

The MS/TP 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.

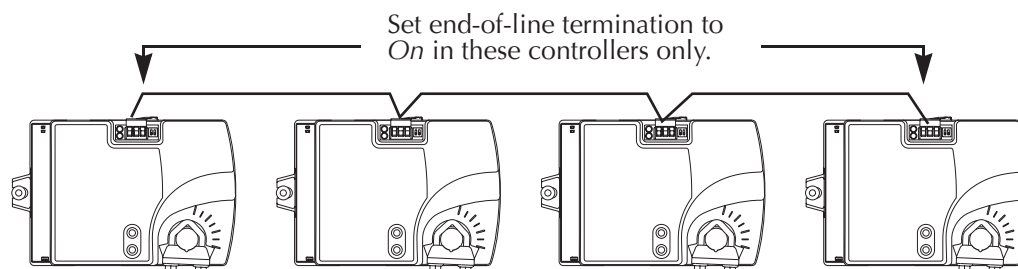


Illustration 2-7 End of line termination

Illustration 2-8 shows the position of the BAC-8000 End-of-Line switches associated with the MS/TP inputs.

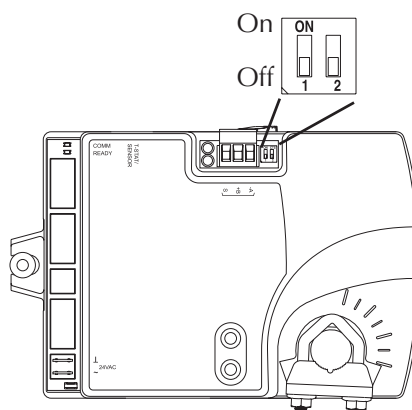


Illustration 2-8 Location of EOL switch

Connecting an airflow sensor

An airflow sensor is incorporated as one of the inputs to the controller. Remove the plugs and connect the tubing from the pitot assembly to the airflow sensor inputs next to the drive hub. (See Illustration 2-9). The airflow sensor is programmed as Input 4.

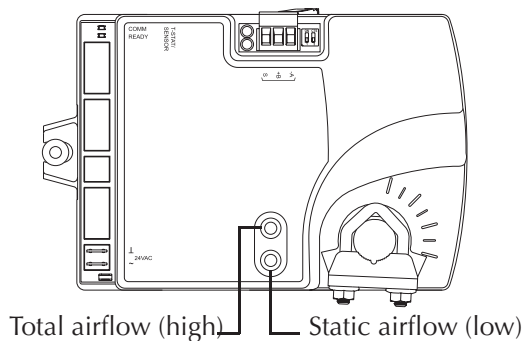


Illustration 2-9 Airflow sensor inputs

Connecting power

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

- ◆ Use a Titus Alpha Controls Class-2 transformer of the appropriate size to supply power to the controllers. Titus recommends powering only one controller from each transformer.
- ◆ Do not run 24 volt, AC power from within an enclosure to external controllers.

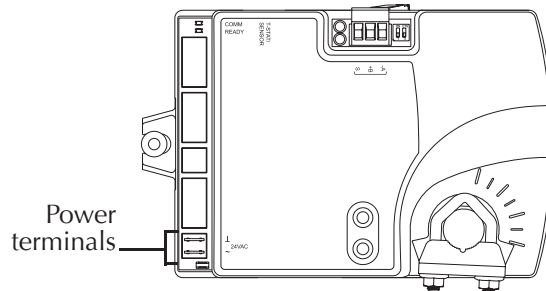


Illustration 2-10 Power terminals and jumper

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 ground terminal $\perp$ and the AC phase to the phase $\sim$ terminal. Power is applied to the controller when the transformer is powered.

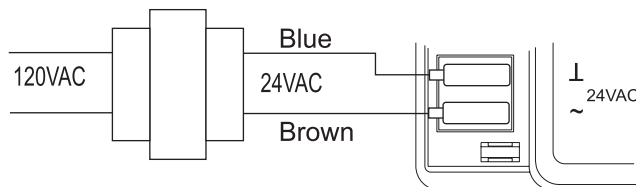


Illustration 2-11 Power connections

Application drawing

The BAC-8001 controller is configured by the manufacturer for single-duct cooling or heating VAV control. Connect the controller as shown in the illustration [BAC-8001 application on page 21](#).

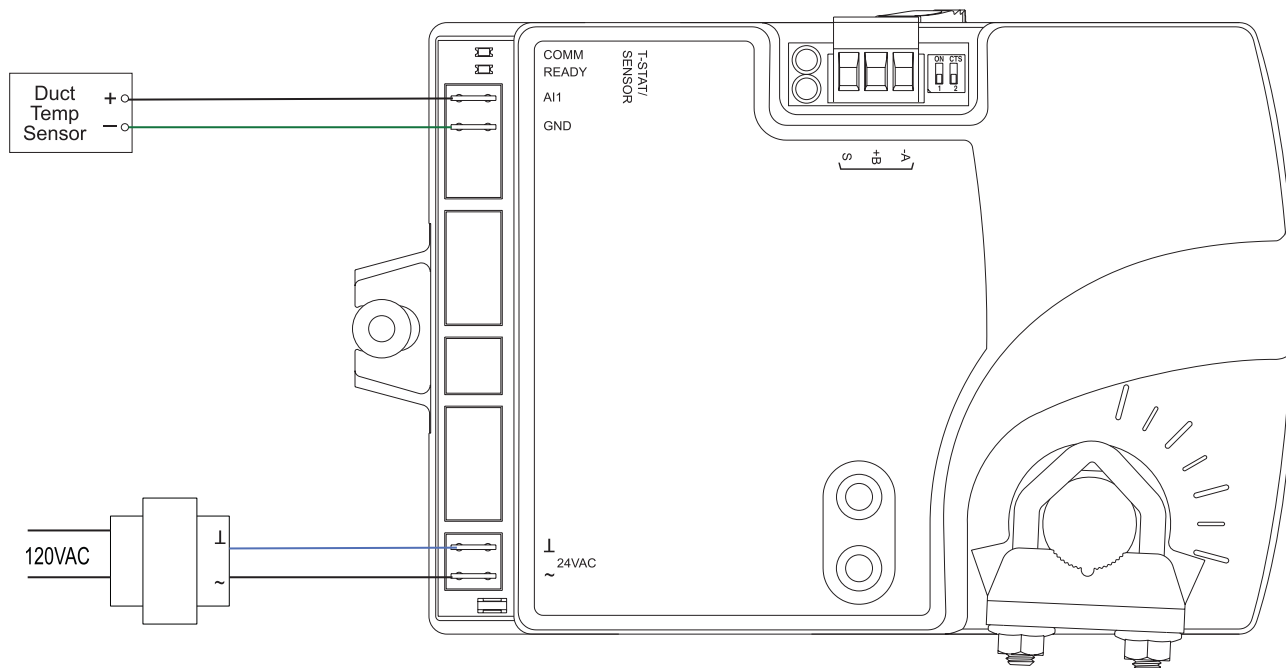


Illustration 2-12 BAC-8001 application

SECTION 3

Setting up VAV controllers

The topics in this section cover setting up the BAC-8001 controller for VAV operation. These are advanced topics for controls technicians and engineers.

The BAC-8001 VAV controller is set up by the manufacturer to operate as soon as they are connected to external equipment and power is applied. Installation and connection instructions are covered in the section [Installing the controllers on page 11](#).

Setting up the controllers may include setting BACnet objects with a BACnet Operator Workstation such as TotalControl. The objects may also be set up with an STE-8001 or STE-8201 sensor. The following topics are covered in this section.

- ◆ [Setting temperature setpoints on page 24](#)
- ◆ [Setting airflow setpoints on page 25](#)
- ◆ [Setting the VAV terminal unit parameters on page 25](#)
- ◆ [Network communications on page 23](#)



Caution

Change only the present values of the objects listed in this section. Changing any other objects or properties will result in improper operation.

Network communications

Before connecting the controller to a BACnet MS/TP network, configure the following network parameters with either a BACnet operator workstation or temporarily connecting an STE-8001 or STE-8201 to the controller.

Device instance—Set from 0 to 4,194,302. A device instance number must be unique across the BACnet internetwork.

Baud—Valid baud settings are 9600, 19200, 38400, and 76800.

MAC—Set from 0 to 127. Must be unique on the MS/TP network to which the controller is connected.

Setting temperature setpoints

The space temperature setpoints listed in Table 3-1, “Temperature setpoints,” on page 24 are used to control the controller VAV operation. The temperature setpoints have default values, but may be manipulated depending on which type of wall sensor is connected to the controller.

Occupied cooling and heating setpoints These setpoints are user controlled space setpoints that originate from an attached sensor. If no sensor is attached the values for these setpoints are manually entered by a controls technician.

Unoccupied cooling and heating setpoints The unoccupied setpoints are manually entered values to set the heating and cooling temperature when the space is unoccupied.

Minimum cooling setpoint A manually entered value to limit the occupied cooling setpoint regardless of the value entered by the user.

Maximum heating setpoint A manually entered value to limit the occupied heating setpoint regardless of the value entered by the user.

Minimum setpoint differential Sets the minimum temperature separation between occupied heating and cooling setpoints.

Standby differential This differential is added or subtracted from the occupied temperature setpoints to calculate the standby setpoints.

SAT changeover temperature Sets the supply air temperature at which the controller will change from heating to cooling. The changeover takes place when the supply air temperature is 2° above or below the discharge air temperature setpoint.

Table 3-1 Temperature setpoints

Object	Description	Name	Default
AV5	Occupied Cooling Setpoint	OCC CL STPT	74°F
AV6	Occupied Heating Setpoint	OCC HT SPT	70°F
AV7	Unoccupied Cooling Setpoint	UNOCC CL STPT	80°F
AV8	Unoccupied Heating Setpt	UNOCC HT STPT	64°F
AV9	Minimum Cooling Setpt	MIN CL STPT	70°F
AV10	Maximum Heating Setpoint	MAX HT STPT	76°F
AV11	Minimum Setpoint Differential	MIN STPT DIFF	4°F
AV12	Standby Differential	STBY DIFF	3°F
AV37	SAT Changeover Temp	SAT CHANGEOVER	75°F

Setting airflow setpoints

The airflow setpoints are limits for VAV unit operation. All values are entered by a controls technician.

Minimum and maximum cooling airflow Sets the airflow limits through the VAV unit when in the cooling mode.

Minimum and maximum heating airflow Sets the airflow limits through the VAV unit when in the heating mode.

Table 3-2 Airflow setpoints

Object	Description	Name	Defaults
AV13	Min Cooling Airflow	MIN COOL FLOW	0 CFM
AV14	Max Cooling Airflow	MAX COOL FLOW	400 CFM
AV15	Min Heating Airflow	MIN HEAT FLOW	0 CFM
AV16	Max Heating Airflow	MAX HEAT FLOW	400 CFM

Setting the VAV terminal unit parameters

Terminal unit parameters set basic operating parameters and enable options such as reheat and series or parallel fan operation.

Reheat Not available on model BAC-8001.

Damper direction to close Defines which direction the damper will turn to decrease airflow.

CCW—The actuator turns counterclockwise to close the damper.

CW—The actuator turns clockwise to close the damper.

Primary duct K-factor A property of the specific VAV unit and airflow sensor to which the primary controller is attached. This constant is supplied by the VAV unit manufacturer.

Fan operation Not available on models BAC-8001 or BAC-8201.

Balancing airflow

An airflow balancing program is included in BAC-8000 series controllers. See the manual *STE-8000 and STE-8201 Sensor Installation Guide* for balancing instructions.