BACnet MS/TP and IP VAV Controller Installation and Operation Manual

EMERSON™

026-1221 Rev 3

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CE/FCC Compliance Notice Information

Class A compliance for VAV Control Network under CE Requirements. Meets Part 15 Subpart B requirements of the FCC Rules. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

UL Listed under UL916, file # E118489; UL873

READ ALL INSTRUCTIONS CAREFULLY

If the equipment is not used in the manner specified by the manufacturer, the protection provided by the equipment may be impaired.

NOTE TO INSTALLERS

It is recommended to read and review all documentation prior to installing the Emerson BACnet MS/TP and IP VAV.

CONTENTS

1 Overview

Emerson offers a VAV (variable-air volume) control option as part of the E2 line of facility controllers. The VAV Control Network provides a complete building energy control and conservation solution for HVAC systems using VAV components.

The VAV Control Network comprises the Discharge Air Controller (DAC), BACnet MS/TP VAV Controller, and VAV Smart Thermostat to supply a variable amount of conditioned airflow to different zones of a building. The VAV Smart Thermostat allows the user to view adjustments to environmental settings.

All controllers in the VAV Control Network communicate with the E2 BX Building and CX Controllers on the BACnet Network (***Figure 1-1***). VAV BACnet is now supported in Site Supervisor version 2.13 and above.

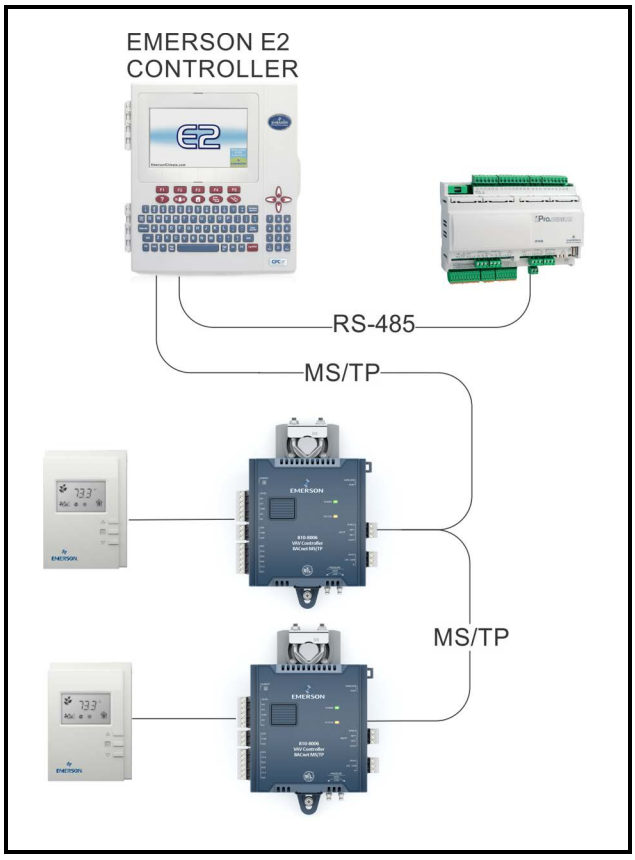


Figure 1-1 - *VAV Control Network - Daisy Chain*

1.1. VAV Control Network Components

1.1.1. Discharge Air Controller (DAC)

The Discharge Air Controller (DAC) (*P/N 818-9001*) is a packaged HVAC control board for use either as a standalone controller or in zone control applications using a Emerson E2 BX building control system. The DAC is capable of controlling heat and cool stages, fans, dehumidification devices, and economizers using on-board I/O and control algorithms, as well as monitor and interact with other building control systems and peripherals (such as smoke alarms and CO2 sensors).

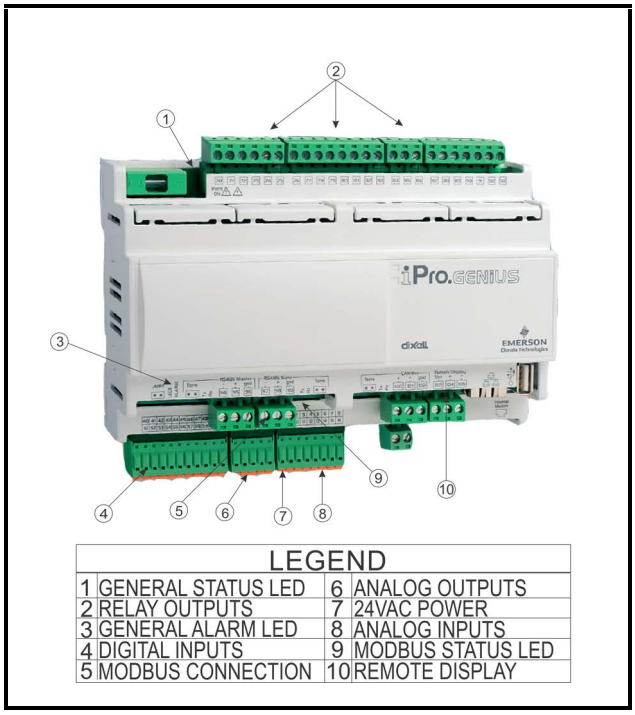


Figure 1-2 - *DAC*

The DAC supports local physical inputs and outputs and communicates with the E2 controller (version 3.00 and higher) via the RS485 MODBUS network.

The E2 will support a maximum of 32 instances of the DAC to be added to a BX-300 or CX-300. The E2 will support a maximum of 50 DAC devices on a BX-400 or CX-400.

The DAC supports 15 relay outputs, 6 analog outputs, 10 analog inputs, and 20 digital inputs.

1.1.2. BACnet MS/TP VAV Controller (810-8006)

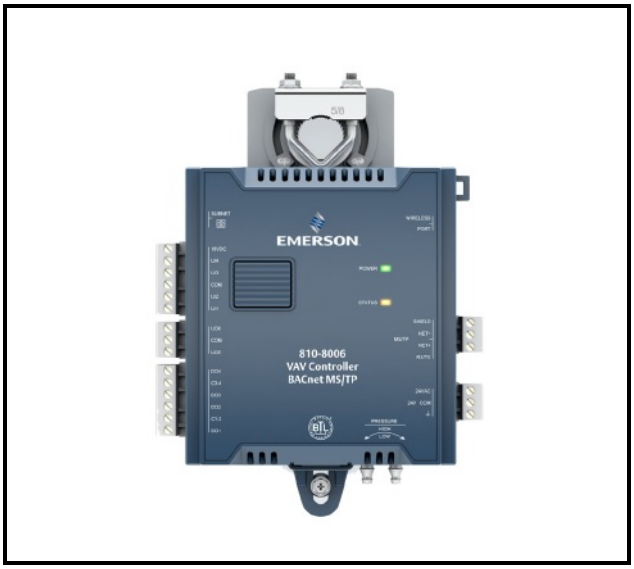


Figure 1-3 *- BACnet MS/TP VAV Controller*

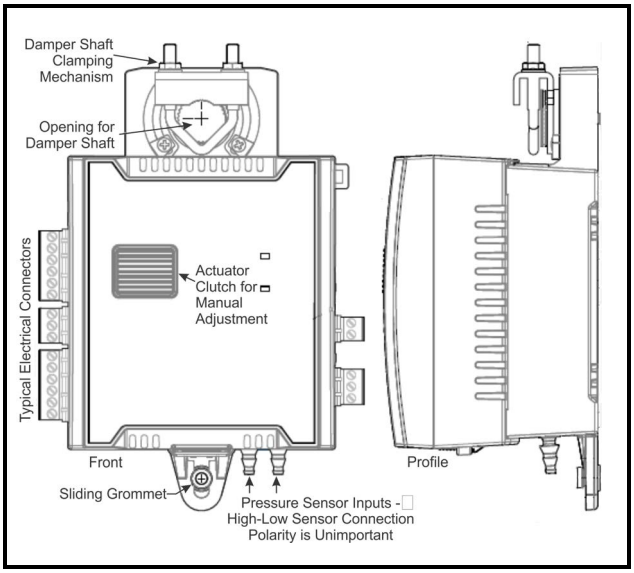


Figure 1-4 *- VAV Controller (Diagram)*

The VAV controller is designed to control and monitor various types of HVAC equipment such as baseboards, single and multi-stage duct heaters, fans, valves, and lights.

The VAV controller features 4 universal hardware inputs, 18 wireless inputs, 4 digital triac outputs, and 2 universal outputs.

The controller uses the BACnet® MS/TP LAN communication protocol and is BTL®-Listed as BACnet Application Specific Controllers (B-ASC).

1.1.3. BACnet IP VAV Controller (809-8004)

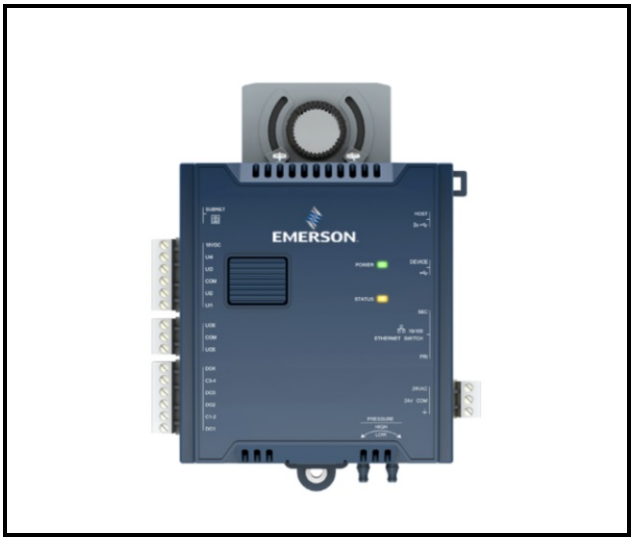


Figure 1-5 *- BACnet IP VAV Controller*

1.1.4. VAV Smart Thermostat (809-8002)

Figure 1-6 *- Smart Thermostat*

The Smart Thermostat is designed to interface with any VAV-Series controller to provide precision local temperature sensing, information display of system status, and a variety of control functions that can be

accessed by room occupants. The Smart Thermostat has a LCD display providing real-time access to temperature and other system information such as setpoint, occupancy status, and HVAC mode.

NOTE: Cat 5e network cable, 4 twisted pairs must be used to connect the VAV to the Smart Thermostat.

Occupants can view and adjust environmental settings to their liking, override the HVAC mode, and view and adjust the setpoint and fan speed for improved personal comfort.

A password-protected technician mode allows an installer to perform commissioning and troubleshooting. When connected with the VAV series, commissioning can start immediately after installation, as the sensor can be used as a hand-held tool to select the appropriate controller application for the type of HVAC equipment to be controlled and perform air balancing of the system without requiring an onsite controls engineer, and to troubleshoot the system.

The VAV Smart Thermostat is provided with mounting hardware with a separate sub-base for installation on dry wall or an electrical junction box.

1.1.5. BACnet MS/TP VAV Box Kit (810-8016)

BACnet MS/TP VAV Box Kit Components	
Quantity	**Description**
1	BACnet MS/TP VAV Controller (810-8006)
1	Smart Thermostat (809-8002)
1	Transformer (640-0056)
1	Flow Sensor (202-5005) 5.4-inch insertion
1	10-ft Kele T-101 (Sample Tube)

Table 1-1 *- BACnet MS/TP VAV Kit Components*

1.1.6. DAC Kit (810-8022)

DAC Kit Components	
Quantity	**Description**
1	DAC (810-9001)
2	Static pressure sensor Kele A-302-K (202-5001)
2	Static pressure sensor mounting kit (202-5003)
1	Static pressure sensor Kele RPS (202-5004)
1	Differential pressure transducer PXU-L-X (212-0075)
1	Pneumatic air supply fitting Kele B-376 (215-0014)
1	Utility Box 4”x4”x1-1/2” (302-1041)
1	Discharge Air Controller (DAC) IPG215D (818-9001)
3	12-inch temp probe, duct mount/walk-in 12-inch duct/walk-in temp sensor with box (201-2112)
20 feet	Pneumatic tubing Kele T-101 (270-0000)
1	10-ft Green temp Sensor Assembly (501-1121)
1	24V, 56VA, CT, 640-0043 Replacement 56VA 120/208/240V CT-CL2 (640-0056)

Table 1-2 *- DAC Kit Components*

1.1.7. BACnet IP VAV Box Kit (810-8015)

BACnet IP VAV Box Kit Components	
Quantity	**Description**
1	BACnet IP VAV Controller (810-8004)
1	Smart Thermostat (809-8002)
1	Transformer (640-0056)
1	Flow Sensor (202-5005) 5.4-inch insertion
1	10-ft Kele T-101 (Sample Tube)

Table 1-3 *- BACnet IP VAV Kit Components*

2 Mountings

2.1. DAC

The DAC is usually mounted by the HVAC equipment manufacturer. Therefore, the installer need only make the necessary connections between the boards and the site controller(s).

In some instances, an installer may be required to mount the DAC. There are no restrictions on the location of the DAC; however, the controller should be mounted in a location protected from moisture. Typically, mounting inside the electrical control panel of a package unit is acceptable. If there is no room to mount the controller inside the HVAC unit, it may be mounted inside a weatherproof enclosure on the outside of the unit.

The DAC uses a DIN mount installation.

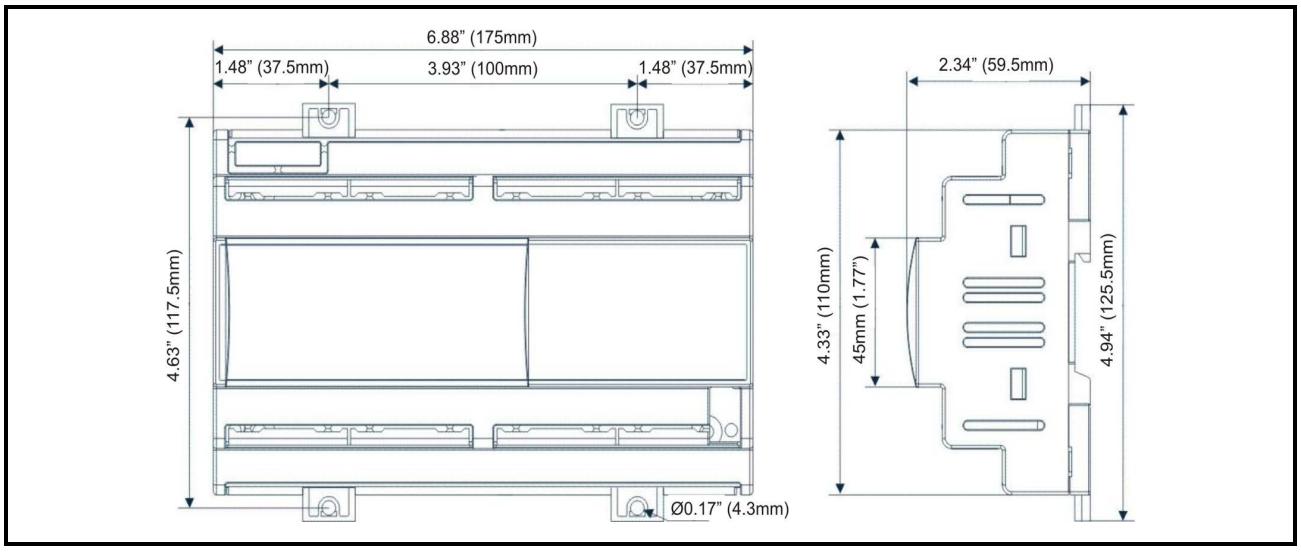


Figure 2-1 *- DIN Mounting*

Mount:	On a DIN rail (EN 50022, DIN 43880) Fastened with screws via the removable plastic flaps.
Material:	PC-ABS Thermoplastic
Self-extinguishing:	V0 (UL94)
Comparative Tracking Index (CTI):	300V
Color:	White

Table 2-1 *- DAC Enclosure Specifications*

2.1.1. DAC Environmental Ratings

The controller should be mounted in a location/environment that stays within a 20% to 85% relative humidity range (as specified by the label on the enclosure).

- Temperature from 50°F to 140°F (10°C to 60°C)
- Relative humidity from 20% to 85%.

2.2. VAV Controller

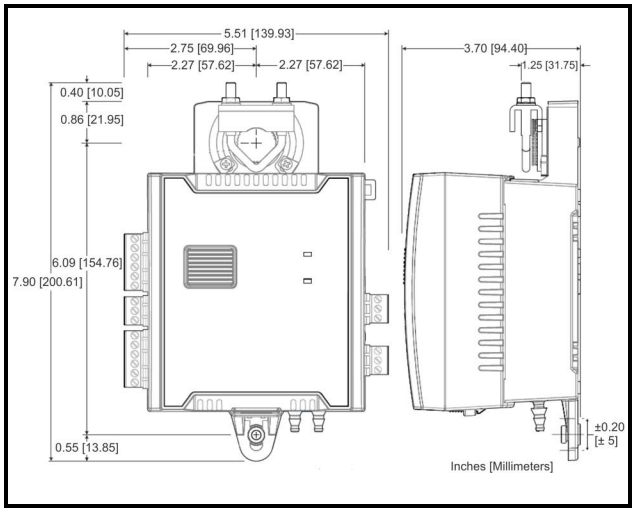


Figure 2-2 *- VAV Controller Dimensions*

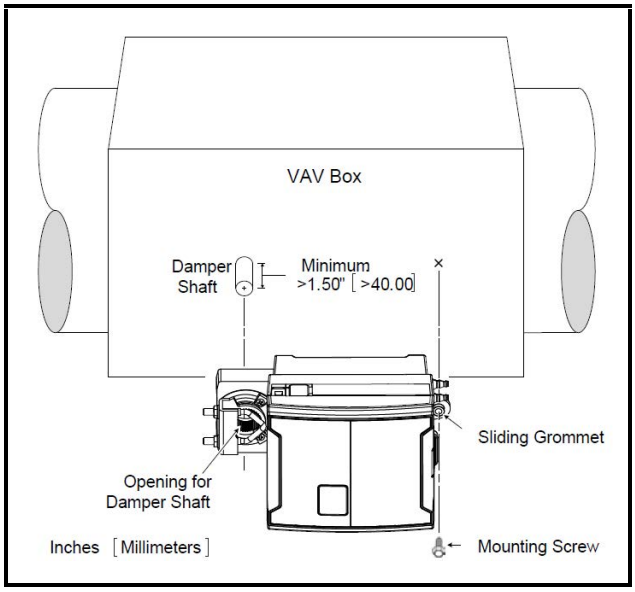


Figure 2-3 *- VAV Damper Shaft Standard Mounting Diagram*

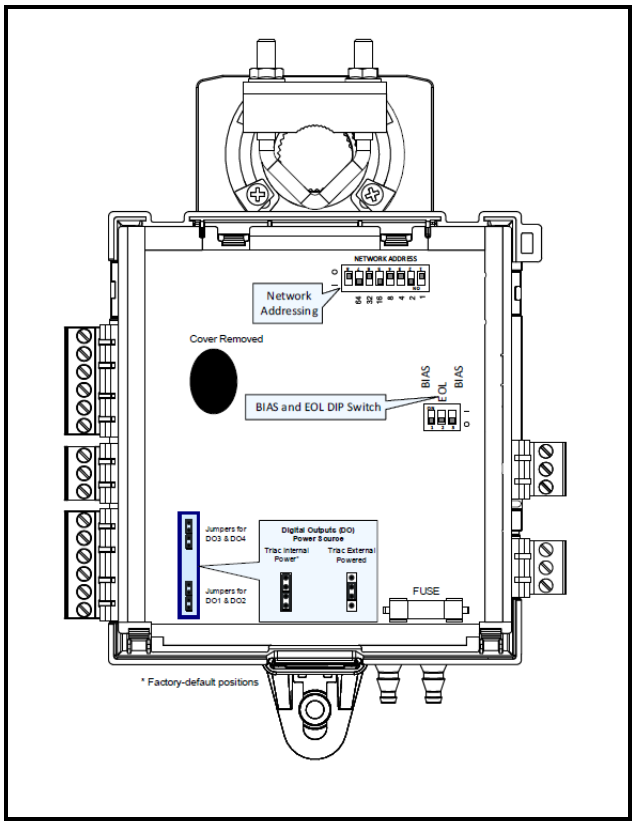


Figure 2-4 *- VAV DIP Switch Configuration*

The VAV Controller is designed to be mounted directly on an air duct or in a panel by using the integrated mounting collar and screw provided with the controller. This mounting arrangement is designed to oppose shaft torque applied to the damper shaft.

To prevent condensation on the VAV box's damper shaft from entering the controller's electronics, the controller's mounting orientation should be any position above the damper shaft (between 0° and 180°) so that any condensation from the damper shaft will fall away from the controller's electronics.

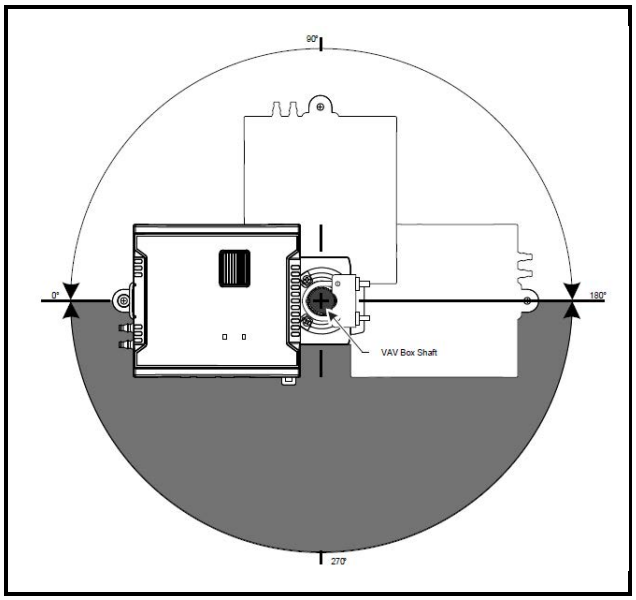


Figure 2-5 *- Mounting Position Angle Range*

1. The VAV controller comes with the sliding grommet pre-installed.
2. Orient the controller into position on to the damper shaft so that wiring connections are easily accessible. The controller must be fitted onto the shaft such that the base of the controller is parallel to the VAV box (perpendicular to the damper shaft). If the damper shaft has an external bushing that prevents the controller from being mounted flush to the side of the VAV box, use a spacer of the same thickness to compensate and to ensure the controller is at a right-angle to the shaft to prevent binding.
3. Screw the controller onto the VAV box through the controller's Sliding Grommet. The sliding grommet allows the controller to move back and forth when the VAV box's damper shaft is off center. Ensure to center the grommet along its travel range and ensure that the screw enters the VAV box at a right angle. Using a power screwdriver with a 6" extension (***Figure 2-6***), attach the controller to the VAV box with the 1" [25mm] screw provided with the controller (***Figure 2-7***) through the controller's sliding grommet as shown in ***Figure 2-3***. Otherwise, mark the positions for the screw on the VAV box with a punch and then drill a hole the into the VAV box. Then attach the controller to the VAV box with the 1" [25mm] screw provided with the controller.

Figure 2-6 *- Screwdriver shaft Extension*

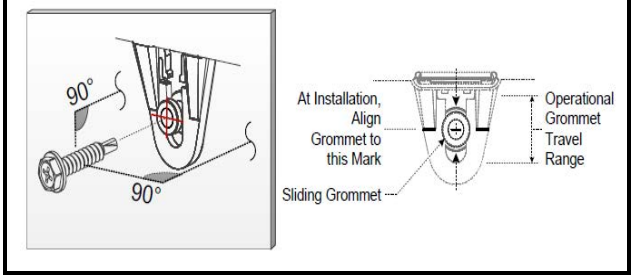


Figure 2-7 *- Supplied Mounting Hardware*

CAUTION: Avoid over-tightening the screw so as to not strip the threads. Make sure the screw does not pierce too far into the VAV box and interfere with damper blade movement.

4. Find the damper position by the marking typically found on the end of the damper shaft.

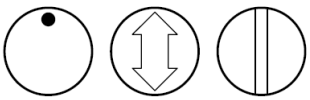


Figure 2-8 *- Typical Damper Shaft End Marking*

5. Determine the direction required to close the damper: Clockwise (CW) or Counterclockwise (CCW). Turn the damper shaft with a pair of pliers to fully close the damper for 90° boxes or fully open the damper for 45° or 60° boxes.
6. Press and hold down the Actuator Clutch for Manual Adjustment button (see ***Figure 1-4***), and turn the controller's shaft coupler until it touches the mechanical end-stop to either the fully closed position (90° boxes) or the fully open position (45° and 60° boxes).
7. For 90° VAV boxes: If the damper closes CCW, turn the coupler to the CCW mechanical stop limit. If the damper closes CW, turn the coupler to the CW mechanical stop limit. The open mechanical stop is factory preset for 90° boxes. For 45° and 60° VAV boxes: the mechanical stops must be set for both the fully closed and

fully open damper positions. By installing the controller at the fully open position, the controller provides the open mechanical stop for 45° and 60° boxes. The closed damper seal provides the fully closed stop.

8. Tighten the U-bolt clamp on the damper shaft using an 5/16 inch (8 mm) wrench or socket. Tighten the bolts between 100 and 130 lb-in (11 and 15 N-m).
9. Test for free damper shaft movement: Press and hold down the Actuator Clutch For Manual Adjustment button and manually turn the actuator coupling to be certain that the actuator can rotate from full closed to full open positions without binding.
10. Connect the VAV box's flow sensor tubing to the controller's Pressure Sensor Inputs. The connection is polarity-free (high-low ports are interchangeable). Create a condensation trap in the pneumatic tubing by forming it into a vertical loop.
11. Finalize the installation by rotating the damper to the full open position. See ***Figure 2-3***.

2.2.1. VAV Environmental Ratings

The VAV controller is designed to operate under the following environmental conditions:

- Operating temperature from 32°F to 122°F (0°C to 50°C).
- Storage temperature from -4°F to 122°F (-20°C to 50°C).
- Relative humidity from 0% to 90% non-condensing.
- Ingress Protection Rating of IP20.
- Nema Rating of 1.

2.3. Smart Thermostat

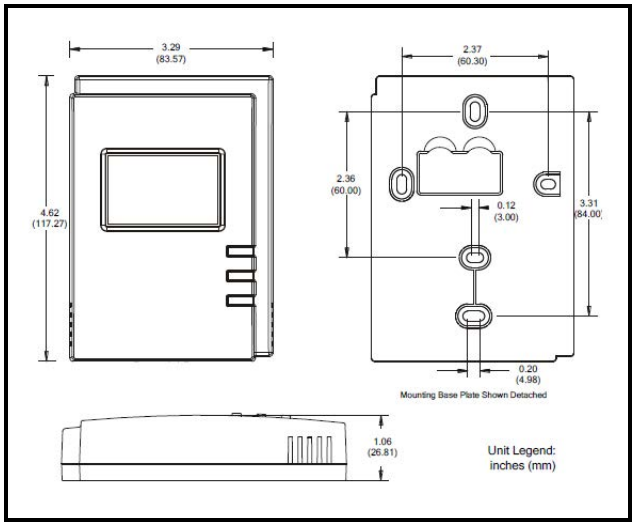


Figure 2-9 *- Smart Thermostat Dimensions*

The Smart Thermostat is designed to be mounted on a wall in the space controlled by its associated VAV controller.

2.3.1. Smart Thermostat Mounting Conditions

The Smart Thermostat has been designed for easy installation; however, certain conditions apply when choosing a suitable location for the device:

- The device should not be installed on an exterior wall.
- The device should not be installed near a heat source.
- The device should not be installed near an air discharge grill.
- The device should not be installed in a place where it can be affected by the sun.
- Install the device in an area that provides proper device ventilation.
- Nothing must restrict air circulation to the device.

CAUTION: The Smart Thermostat is not designed for outdoor use.

2.3.2. Smart Thermostat Mounting Steps

Mounting hardware with a separate sub-base is provided with the device for installation on dry wall or on an electrical junction box.

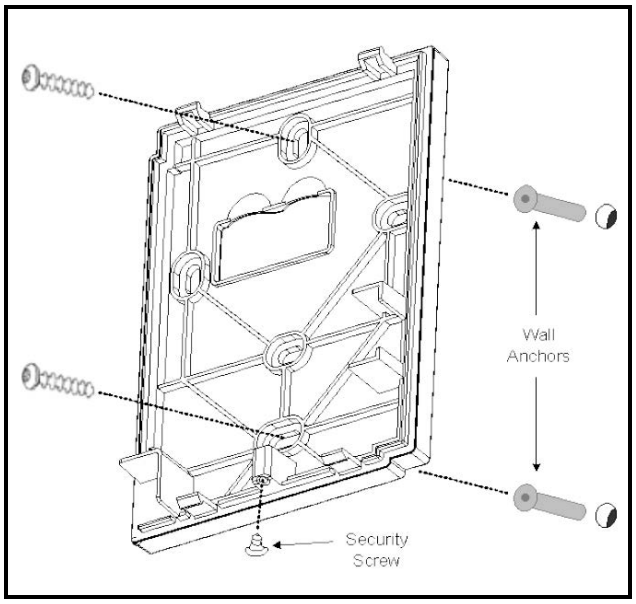


Figure 2-10 *- Smart Thermostat Mounting - Device Components*

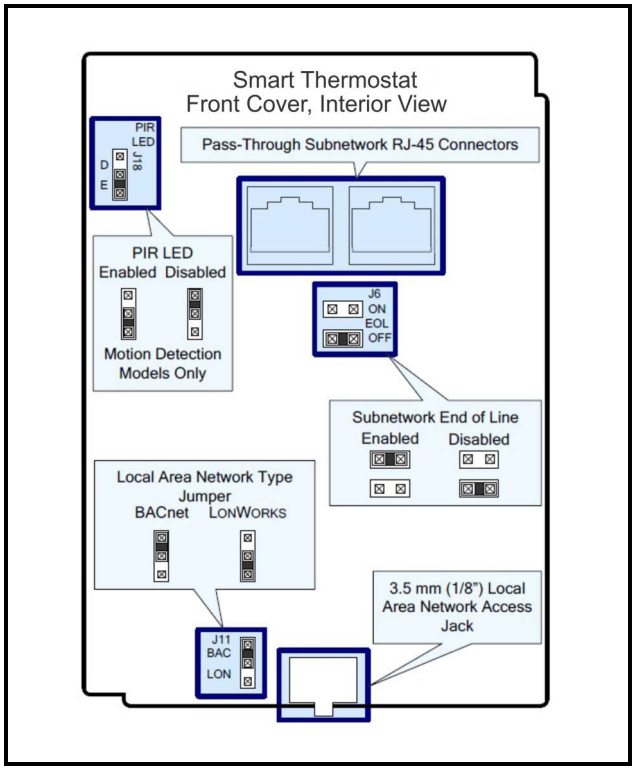


Figure 2-11 *- Connector and Jumper Locations*

1. Remove the security screw from the device (***Figure 2-10***).
2. Open the device by pressing in the two (2) tabs on the bottom of the device and pulling the bottom side of the front plate out.
3. Pull all cables 6” (15 cm) out of the wall, and insert them through the central hole of the back plate.
4. Align the back plate with the wall and mark the location of the two mounting holes on the wall. Make sure to orient the proper side of the back plate facing upwards.
5. Remove the back plate and drill holes in the wall if necessary.
6. Install anchors in the wall if necessary.
7. Make sure that the mounting surface is flat and clean.
8. Screw the back plate onto the wall. Do not over-tighten.
9. Plug the wire(s) into the connector(s).
10. Gently push excess wiring back into the wall.
11. Set any jumpers. See ***Figure 2-11***.
12. Reattach the front plate and make sure it clips tightly into place. Start by hooking the top in place, and then clip the bottom edge into place.
13. Install security screw.

2.3.3. Smart Thermostat Environmental Settings

The controller is designed to operate under the following environmental conditions:

- Operating temperature from 32°F to 122°F (0°C to 50°C).
- Storage temperature from -4°F to 122°F (-20°C to 50°C).
- Relative humidity from 0% to 90% non-condensing.

3 Powering

3.1. DAC

Emerson supplies a wide variety of 24VAC transformers with varying sizes without center taps. ***Figure 3-1*** shows the transformer sizes and are non-center-tapped.

The transformer used to power the DAC should have at least a 20VA rating. The DAC should not share a transformer with any other devices.

Transformer P/N	VA Rating	Primary Voltage
640-0041	50 VA	110 VAC
640-0042	50 VA	220 VAC

Table 3-1 - *Transformers Compatible with DAC*

The DACs can be powered by one of the 50VA non-center-tapped transformers listed in ***Figure 3-1***. ***Figure 3-1*** shows how to wire the transformers to the DAC boards.

Neither side of the secondary should be connected to ground. Also, do not connect the center tap (if provided on the transformer) to ground. The entire secondary of the transformer should be isolated from any ground.

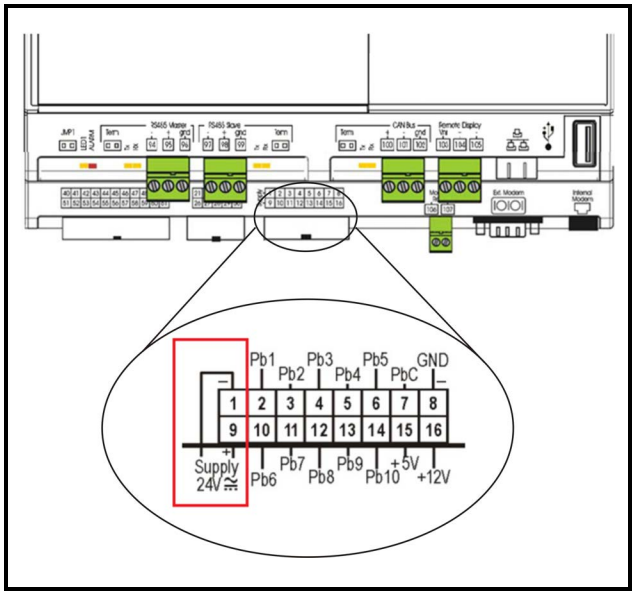


Figure 3-1 - *Non-Center-Tapped Transformer Wiring*

3.1.1. Wire Types and Maximum Distances

For powering I/O boards, use only the listed wire types in ***Figure 3-2***. Two-conductor non-shielded cables are the recommended wire for connecting the transformer to the DAC. Shielded cable should not be used for power wiring. The center tap should be left disconnected, if present on the transformer.

Power Wiring Types	
14 AWG	Belden 9495
18 AWG	Belden 9495

Table 3-2 - *Power Wiring Types*

The wire length from the transformer determines the type wire gauge used. In most cases, the distance between the DAC and the transformer that supplies power to it is not enough to be of concern; *however, it is important NOT to exceed this maximum wire length or the controller will not operate correctly.*

Use these formulas to determine if the wire gauge you are using fits within specification:

14 AWG:
Feet = 1920/VA
18 AWG:
Feet = 739/VA
(VA is the total VA rating of the controller)
For example, if you had an 80 VA load:
14 AWG: 24 ft.
18 AWG: 9 ft. (rounded down)

Table 3-1 - *Power Wire Lengths*

Sensors requiring 24VAC should not be powered from the same transformer powering the input board. *Any devices that will be connected to the DAC's inputs or outputs must be powered with a separate 24VAC transformer.*

3.2. VAV Controllers

The VAV controller requires 24VAC ± 15% from a Class 2 transformer.

WARNING! Use a Class 2 transformer only (rated at 100VA or less at 24VAC) to power the controller(s).

It is recommended to wire only one controller per 24VAC transformer. When calculating a controller's power consumption to size the 24VAC transformer, you must also add the external loads the controller is going to supply, including the power consumption of any connected subnet module.

If only one 24VAC transformer is available, determine the maximum number of daisy-chained VAVs that can be supplied on a single power cable supplied by a 100VA transformer, according to the controller's expected power consumption including external loads, the cable's wire gauge, and the total cable length from the following figure. Any installation condition that is outside of the parameters of the following graph should be avoided.

To maximize daisy-chaining performance, the transformer should be installed as close as possible to the first VAV. If this is not possible, then use 14AWG wire to power the first VAV, which can help reduce a voltage drop at the end of the daisy-chain.

WARNING! The recommended minimum peak input voltage is 27.2V

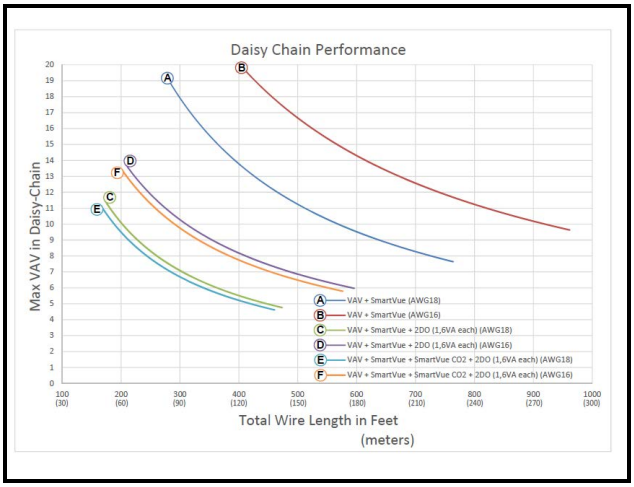


Figure 3-2 *- Maximum Number of VAV Devices on a Daisy-Chain at Evenly Spaced Intervals*

NOTE: Laboratory testing conditions for the above graph are as follows:

- ***Distance between each VAV is evenly spaced along the entire wire length.***
- ***Transformer specification: 100VA (120/24VAC)***
- ***Tested at room temperature with low-voltage line conditions: 108VAC (50Hz).***

3.2.1. Daisy-Chain Wiring

Use an external fuse on the 24VAC side (secondary side) of the transformer, as shown in ***Figure 3-3***, to protect all controllers against power line spikes.

Maintain consistent polarity when connecting controllers and devices to the transformer. One terminal on the secondary side of the transformer must be connected to the building's ground. All 24V COM terminals of all controllers and peripherals throughout the BACnet MS/TP network must be connected to the grounded transformer terminal as shown in ***Figure 3-3***. This ensures that the 24V COM terminals of all devices connected to any BACnet MS/TP bus in building are the same potential.

WARNING! A mechanical ground is unacceptable. Do not use pipe, conduit, or duct work for a ground. The power supply must have a dedicated ground wire that comes from the main electrical supply panel.

WARNING! Failure to maintain consistent polarity throughout the entire network will result in short circuit and/or damage to the controller.

WARNING! Connecting a peripheral or another controller to the same transformer without maintaining polarity between these devices will cause a short circuit.

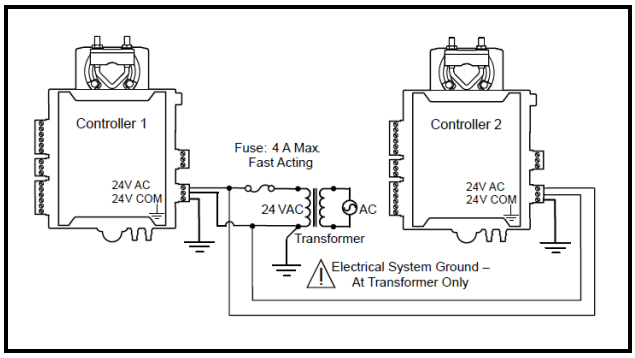


Figure 3-3 *- Power Wiring*

The following diagram shows the recommended wiring of the VAV Controller with and without a 3-wire peripheral. This configuration applies either to a daisy-chain configuration or configuration with separate transformers. Note that internally, the COM terminals are no longer connected to the 24VAC COM terminal but rather to the ground terminal.

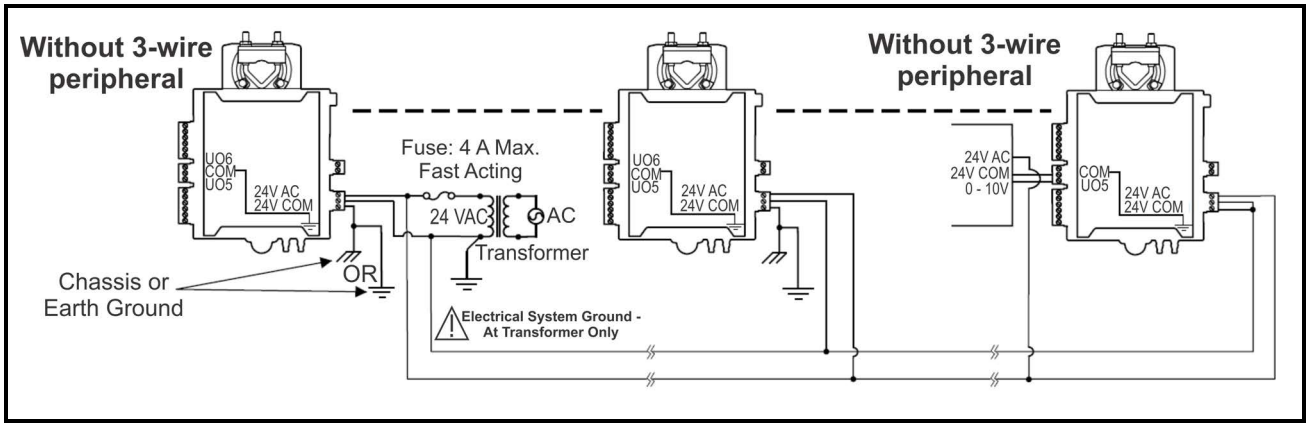


Figure 3-4 *- VAV Power Wiring with and Without 3-Wire Peripherals*

4 Input Wiring

4.1. DAC

Figure 4-1 *- DAC Input Locations*

The DAC will be able to use input data from either physical or network inputs. The DAC has connections to analog and digital sensors, transducers, switches, and other input types typically used in a rooftop HVAC unit application. The input type and function for each point must be programmed in the DAC software by the installer.

The DAC application will support the following analog inputs:

Analog Input	Type	Description
CO2 Level	Local or Network	Network CO2 Level
Duct Pressure	Physical	Local Duct Static Pressure Sensor
Inside Humidity	Local or Network	Network Inside Humidity
Mixed Air Temp	Physical	Local Mixed Air Temperature Sensor
OAH	Local or Network	Outside Humidity
OAT	Local or Network	Outside Air Temperature
Return Air Temp	Local	Local Return Air Temperature Sensor
Setpoint Reset (slider)	Local	Local Setpoint Reset Slider

Table 4-1 *- DAC Analog Inputs*

Analog Input	Type	Description
Space Temp (2)	Local	Local Space Temperature Sensor
Suction Pressure (2)	Local	Local Suction Pressure Sensor (used for Dehumidification control with Digital Scroll Compressors)
Supply Temp	Local	Local Supply Air Temperature (mandatory sensor - required for control)
Zone Temp	Network (DAC only)	Network Space Temperature
Auxiliary (2)	Local	Satellite Inputs used by E2

Table 4-1 *- DAC Analog Inputs*

The DAC will support the following digital inputs:

NOTE: The Digital Inputs of the DAC are pre-defined and cannot be changed.

Digital Input	Point Number	Description
Fan Proof	1	Local Fan Proof Sensor
Smoke Detector	2	Local Smoke Detector
Dirty Filter	3	Local Dirty Filter Sensor
Freeze Stat	4	Local Freeze Stat
Phase Loss	5	Local Phase Loss Sensor
VFD Alarm	6	Variable Frequency Drive Alarm
Exhaust Hood On	7	Local Exhaust Hood Sensor
Bypass to OCC	8	Local Occupancy Bypass Switch
Auxiliary A	9	Satellite Inputs used by E2
Auxiliary B	10	Satellite Inputs used by E2

Table 4-2 *- DAC Digital Inputs*

4.2. The VAV Controller

The VAV Controller input options must be properly configured to ensure correct input readings. ***Table 4-3*** shows the controller's available universal input designation. Inputs can be connected as follows.

CAUTION: Before connecting a sensor to the controller, refer to the installation guide of the equipment manufacturer.

NOTE: For a wire length less than 75' (23m) long, either a shielded or unshielded 18AG wire may be used. For a wire up to 200' (61m) long, a shielded 18AWG wire is recommended. The shield of the wire should be grounded on the controller side only and the shield length should be kept as short as possible.

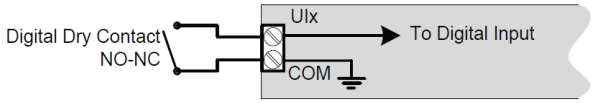
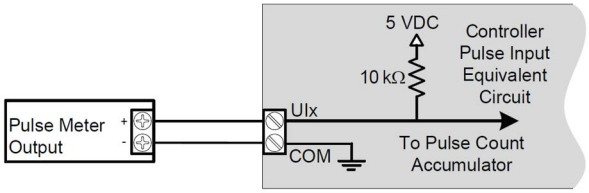
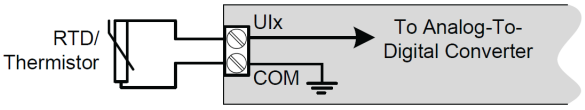
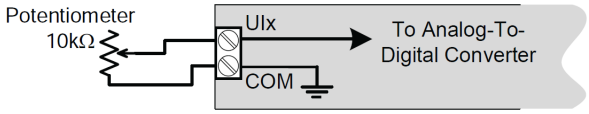
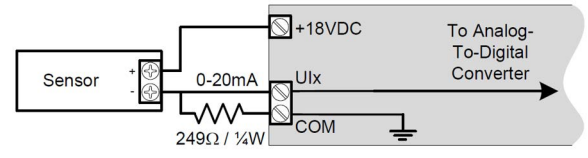
Sensor Input Type	Input Designation	Input Connection Diagram
• Dry Contact input. • Pulsed input	UIx	
• Pulse input used with a 2-wire sensor powered by its own power source – this input supports a maximum input frequency of 1Hz (500ms minimum ON/OFF). Connect the pulse input according to the figure for a pulse meter that can pull-down a +5VDC supply with a 10KΩ pull-up resistor (Internal supply type).	UIx	
• RTD input (for example, 1000Ω). • Thermistor Input (for example, 10kΩ type II and III).	UIx	
• Resistive input, maximum 350kΩ (for example, use with 10kΩ and 100kΩ potentiometers).	UIx	
• 0 to 20mA input used with a 2-wire, 0 to 20mA sensor powered by the controller's internal 18VDC power supply. • An on-board 18VDC power supply can provide the necessary power for 20mA current loop sensor operation. • Connect a 249Ω resistor between the UIx and COM terminals.	UIx	

Table 4-3 *VAV's Universal Input Designation*

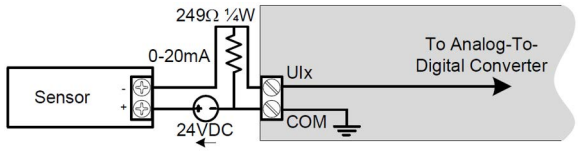
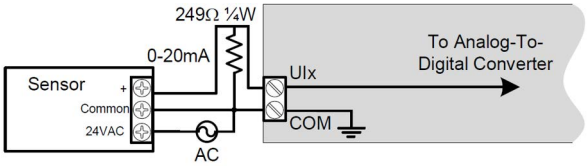
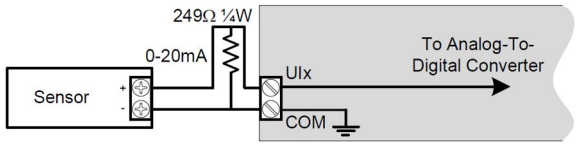
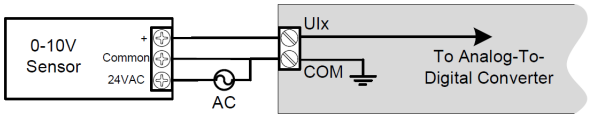
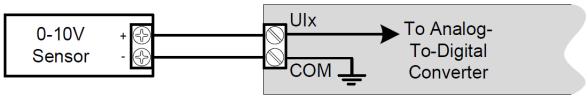
Sensor Input Type	Input Designation	Input Connection Diagram
• 0 to 20mA input used with a 2-wire, 0 to 20mA sensor powered by an external 24 AC/DC power supply. • Connect a 249Ω resistor between the UIx and COM terminals.	UIx	
• 0 to 20mA input used with a 3-wire, 0 to 20mA sensor powered by an external 24 AC/DC power supply. • Connect a 249Ω resistor between the UIx and COM terminals.	UIx	
• 0 to 20mA input used with a sensor powered by its own power source. • Connect a 249Ω resistor between the UIx and COM terminals.	UIx	
• Voltage input used with a 3-wire 0 to 10VDC or 0 to 5VDC sensor powered by an external 24 AC/DC power supply.	UIx	
• Voltage input used with a 0 to 10VDC or 0 to 5VDC sensor powered by its own power source.	UIx	

Table 4-3 *VAV's Universal Input Designation*

4.3. Smart Thermostat Wiring

WARNING! Turn off power before any kind of servicing.

The Smart Thermostat wiring must comply with national and local electrical codes.

4.3.1. Smart Thermostat Troubleshooting

Smart Thermostat is blank and black light is off		
Is the Smart Thermostat connected to the controller?	Verify that the Smart Thermostat is connected to the controller and that the patch cables are plugged into the connectors. Refer to ***Section 2.3.2., Smart Thermostat Mounting Steps*** for more information.	
Is the power being supplied to the controller?	There may be no power being supplied from the controller. Check if the controller has power or if the controller's internal fuses have blown or tripped.	
Is the cable connected to the controller and Smart Thermostat?	Verify wiring.	
Smart Thermostat screen is blank and black light is on for about 30 to 45 seconds - Normal Operation		
Firmware upgrade in progress	Wait for the upgrade to complete. Do not disconnect the sensor from the controller as the upgrade will restart once it is completed.	
Device not communicating with controller		
Is the address correctly set to a unique address?	Each Smart Thermostat must be set to a unique address for each controller. Connect the Smart Thermostat to the controller with a standard Cat 5e Ethernet patch cable fitted with RJ-45 connectors.	
Is the device too far from the controller?	Verify the distance between the device and the controller. The wiring length is 600 ft (180 m).	
Is there a configuration problem?	Check the configuration of the sensor.	
Error Code interpretation		
Clock icon flashing for 15 seconds.	Cannot communicate with controller.	Wait for the communication link to the controller to be established.
After 15 seconds: Flashing error code 1 with bell icon.		Verify wiring.
		Verify that the Smart Thermostat's Subnet IDs are unique for this controller.
Flashing error code 2 with bell icon.	Invalid configuration.	Resynchronized the code with the controller.
Flashing error code 3 with bell icon.	Smart Thermostat is not properly configured in the controller.	Check the configuration of the sensor.

Table 4-4 *- Smart Thermostat Troubleshooting*

5 Output Wiring

5.1. DAC

Figure 5-1 *- DAC Output Locations*

The DAC has 15 relay outputs for connection to all loads that are typically present for a rooftop unit. The relay output type and function for each point must be programmed in the DAC software by the installer.

The DAC supports the following relay outputs:

Relay Output	Description
Alarm Active	Alarm Active Output
Cool Stage 1-4	Cool Stage Output
Dehumidifier Digital	Dehumidification Active
Econ Enable	Economization Enabled
Fan Enable	Fan Enable
Primary Heat Stage 1-2	Primary Heat Stage Output
Secondary Heat Stage 1-2	Secondary Heat Stage Output
Reheat	Reheat Output
Reversing Valve	Heat Pump Reversing Valve Output
Auxiliary (2)	Satellite Outputs Controlled by E2

Table 5-1 *- DAC Relay Outputs*

The DAC supports the following analog outputs:

Analog Output	Description
Mod Fan (VS)	Modulating Fan
Mod Cool (2)	Modulating Cool Stages (including Digital Scroll compressors)
Mod Heat	Modulating Heat
Mod Outdoor Air Damper	Modulating Outdoor Air Damper
Mod Return Air Bypass	Modulating Return Air Bypass
Mod Return Air Damper	Modulating Return Air Damper
Mod VAV Bypass Damper	Modulating Variable Air Volume Bypass Damper
Supply Air SP Reset	Supply Air Setpoint Reset
Auxiliary (2)	Satellite Outputs Controlled by E2

Table 5-2 *- DAC Analog Outputs*

For both relay and analog outputs, the DAC will drive physical points as well as send the current output value over MODBUS to E2.

5.2. The VAV Controller

Output options must be properly configured to ensure correct output values. Outputs can be connected as follows.

CAUTION: Before connecting an output device (actuator, relay, etc.) to the controller, refer to the datasheet and installation guide of the equipment manufacturer.

NOTE: For a wire length less than 75' (23m) in length, either a shielded or unshielded 18AWG wire may be used.For a wire up to 200' (61m) in length, a shielded 18AWG wire is recommended. The shield of the wire should be grounded on the controller side only and the shield length should be kept as short as possible.

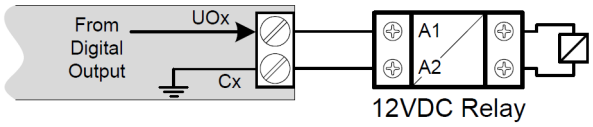
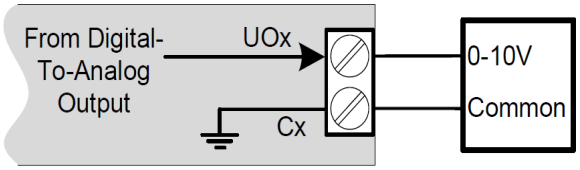
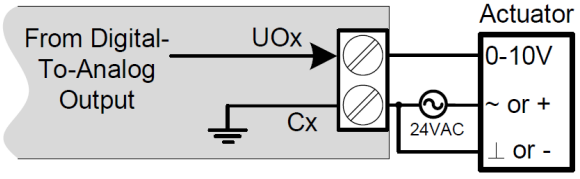
Control Output Type	Output Designation	Output Connection Diagram
Discrete 0 or 12VDC digital, Pulse, or PWM output controlling a 12VDC relay.	UOx	
0 to 10VDC voltage output.	UOx	
0 to 10VDC voltage output controlling an analog actuator that is powered by an external 24VAC power source. This output can source up to 20mA.	UOx	

Table 5-3 *VAV's Universal Input Designation*

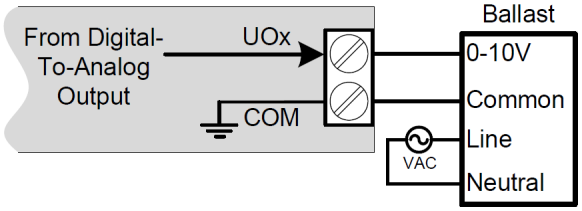
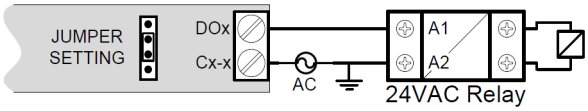
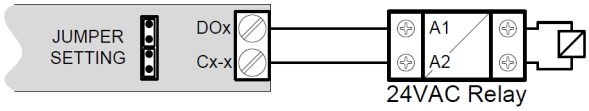
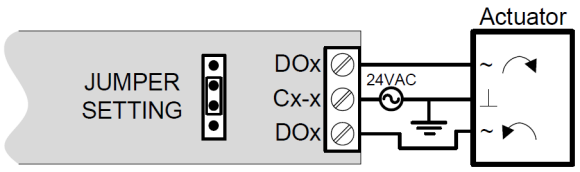
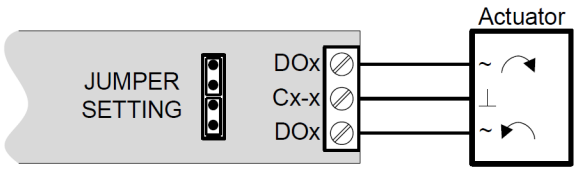
Control Output Type	Output Designation	Output Connection Diagram
• 1 to 10VDC voltage output controlling dimmable lighting ballasts that require a current sink output (pull-down). • This output can sink up to 2.5mA.	UOx	
• Discrete digital, Pulse, or PWM output: 24VAC externally-powered triac controlling a relay.* • Set the jumper according to ***Figure 2-11***.	DOx	
• Discrete digital, Pulse, or PWM output: 24VAC internally-powered triac controlling a relay.* • Set the jumper according to ***Figure 2-11***.	DOx	
• 24VAC externally-powered triac output controlling a floating actuator.* • Set the jumper according to ***Figure 2-11***.	DOx	
• 24VAC internally-powered triac output controlling a floating actuator.* • Set the jumper according to ***Figure 2-11***.	DOx	

Table 5-3 *VAV's Universal Input Designation*

NOTE: *The maximum output current for all triac outputs is 0.5A continuous or 1A @ 15% duty cycle for a 10-minute period.

6 E2 Setup for VAV

6.1. Installing the BACnet MS/TP VAV Controller

6.1.1. Uploading the Description File to the E2

1. From UltraSite, connect the E2 controller.
2. Right-click on the E2 symbol and select **Description File Upload**.
3. Browse the location of the description file and click **Upload**.
4. Reboot the controller.

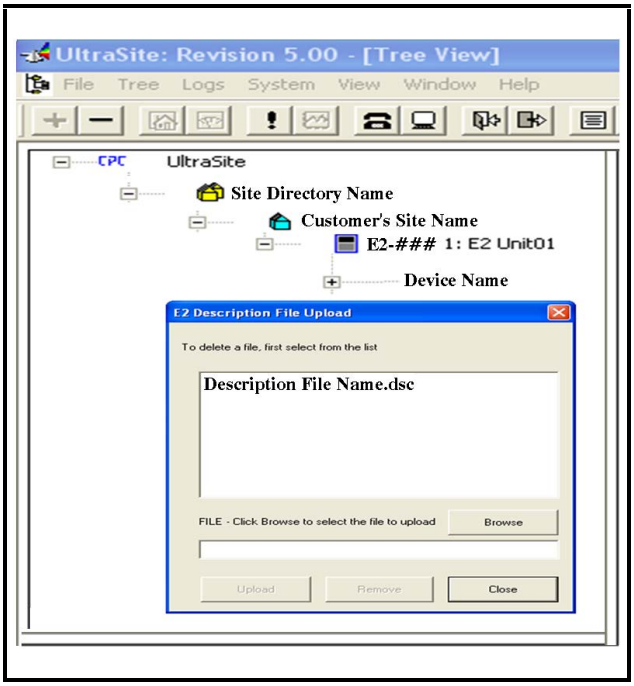


Figure 6-1 *- E2 Description File Upload*

6.1.2. Licensing Third-Party Device via E2

1. Log into the E2 controller.
2. From the front of the E2 or in Terminal Mode, select Menu then 7 & **(System Configuration)**, and 9 (**(License)**.
3. Press F1 to **Add Feature** and enter the license key.

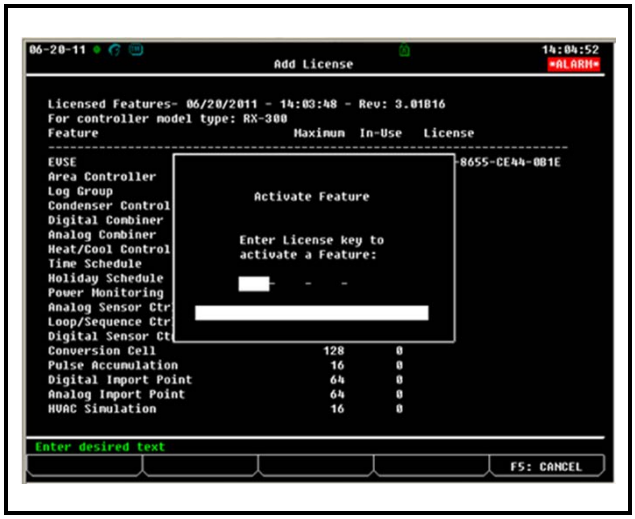


Figure 6-2 *- Adding License*

6.1.3. Adding Device to the E2 Controller

1. Press Menu then, 7 & **(System Configuration)**, and 2 @ **(Connected I/O Boards & Controllers)**.
2. Press F2 to move to **C4: Third Party** tab to see the device name. Enter the license count for the device and press the Home to save the changes.

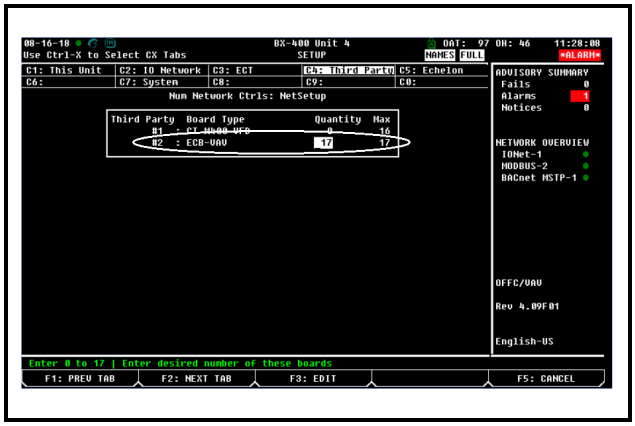


Figure 6-3 *- Adding Device to E2*

6.1.4. E2 BACnet MS/TP Setup

1. Log into the E2 controller.
2. Press Menu then, 7 & **(System Configuration)**, 3 # **(System Information)** and 1 ! **(General Controller Information)**.

3. Select F2 **(Next)** to move to **C8: BACnet** tab. Set this up to prevent conflict with installed modules. The following values are suggestions only.

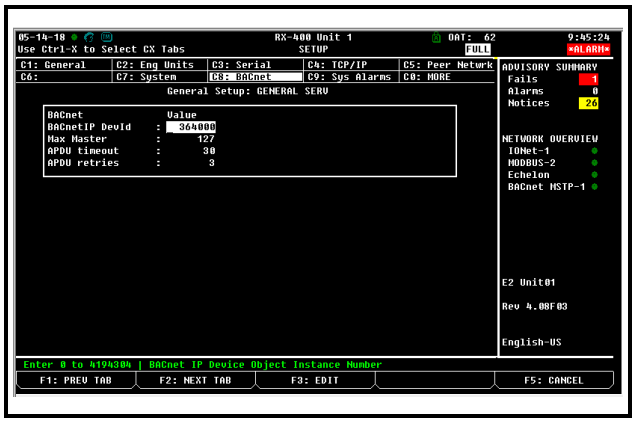


Figure 6-4 *- E2 and BACnet Setup*

6.1.5. Connecting the VAV to COM Port Setup as BACnet MS/TP

1. Log into the E2 controller.
2. Press Menu then, 7 **(System Configuration)**, 3 **(System Information)** and 1 **(General Controller Information)**.
3. Select F2 **(Next)** to move to **C3: Serial** tab. Set this up to prevent conflict with installed modules. The following values are suggestions only.
4. Make sure the baud rates match with this page and inside the device and that the device is connected to the correct COM port.

Note that the COM6 (or COM4) MSTP MAC is 127. This is user-configurable. Using 127 sets the E2E to the MAX number so devices can be addressed from 1 to 126.

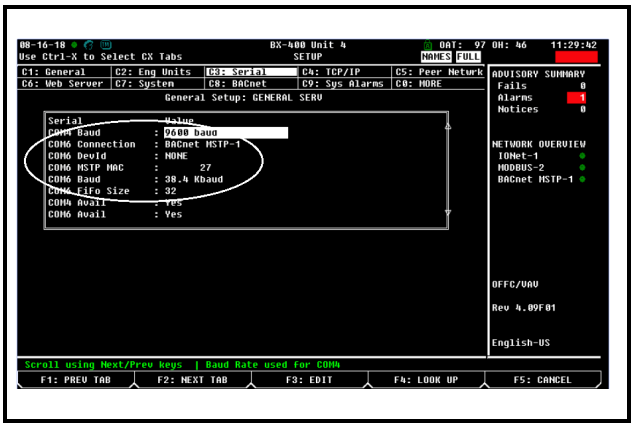


Figure 6-5 *- Connecting VAV to COM Port as BACnet MSTP*

6.1.6. Device Commissioning and BACnet MS/TP Network Selection

1. Log into the E2 controller.
2. Press Menu then, 7 **(System Configuration)**, 7 **(Network Setup)** and 1 **(Network Summary)**.
3. Highlight the device and press F4 **(Commission)** and select **BACnet MSTP** as the preferred network type when prompted.

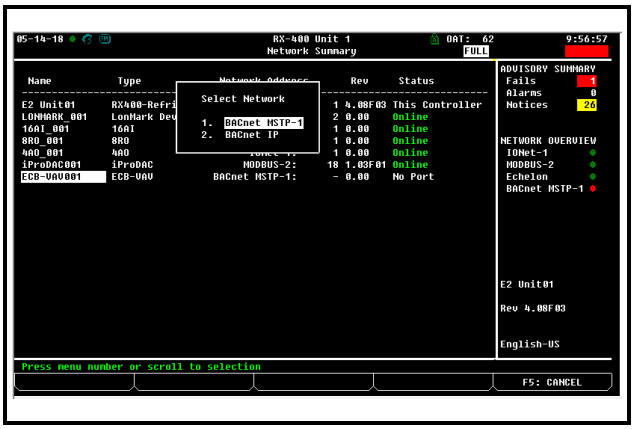


Figure 6-6 *- Device Commissioning*

4. Press Enter and the E2 controller will start scanning the BACnet network.

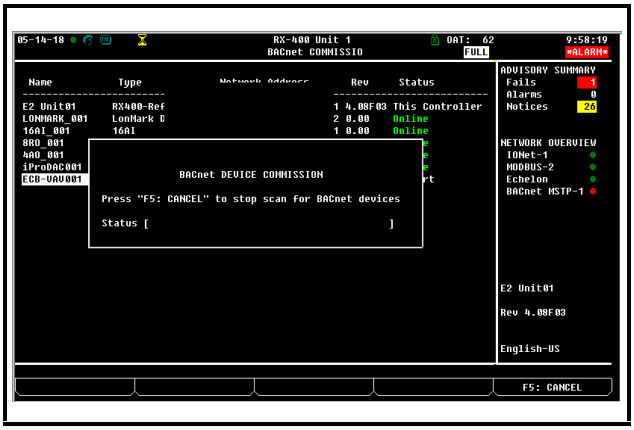


Figure 6-7 *- BACnet Device Commissioning*

5. When the scanning process has completed, a list of all the BACnet MSTP Devices on the Ethernet Network will be displayed. Verify the correct **Object Instance** and **MAC** address for the Third-party device on the example list as shown in ***Figure 6-8***. Then use the arrow keys to highlight the device and then press Enter to confirm.

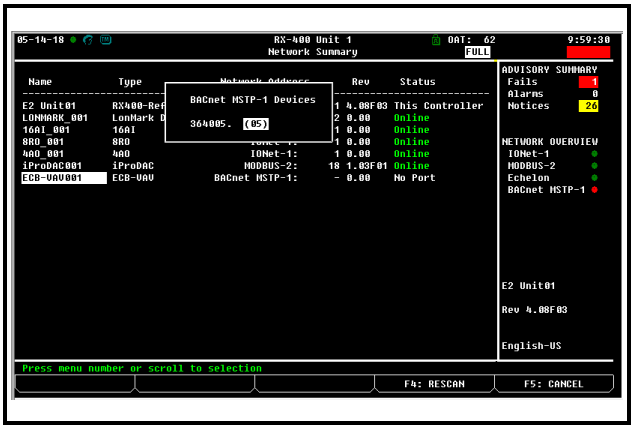


Figure 6-8 *- BACnet MSTP Device List*

6. Set the correct **Object ID#** of the Third-party device when prompted and press the Enter key.

*Note that the **BACnet Device Object ID** is now set for this device.*

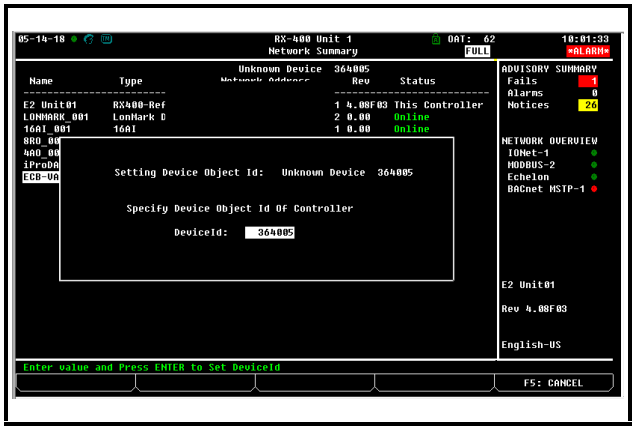


Figure 6-9 *- Setting the Device Object ID*

7. Press Enter to accept the **DeviceId**.
8. Press twice to return to the main **Network Summary** page. After a few seconds, the device will show as **Online** in green to confirm that the commissioning process has completed.

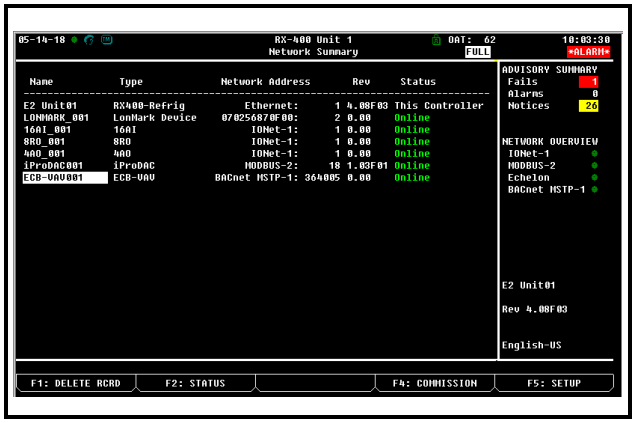


Figure 6-10 *- Network Summary Screen*

NOTE: Before Proceeding:

1. Install the DAC as per instructions in the 026-1221 manual. For more information on the DAC, reference the DAC manual 026-1727.

2. Install either an Open Flex or an Analog Combiner per instructions in Section 7.

6.2. Preliminary setting up the VAV

1. From the Network Summary screen, press F5 **(Setup)**. Change the Name and add a Long Name if desired.

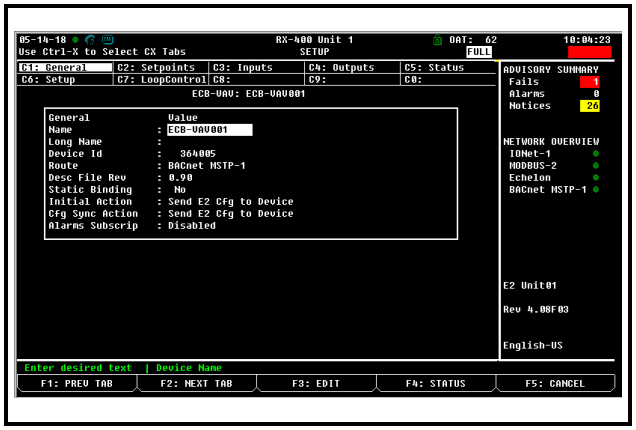


Figure 6-11 *- E2 Device Tab 1 - General*

2. Verify that all setpoints are as desired.

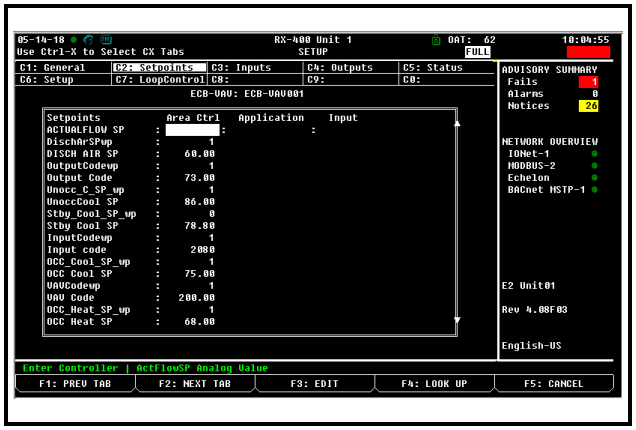


Figure 6-12 *- E2 Device Tab 2 - Setpoints*

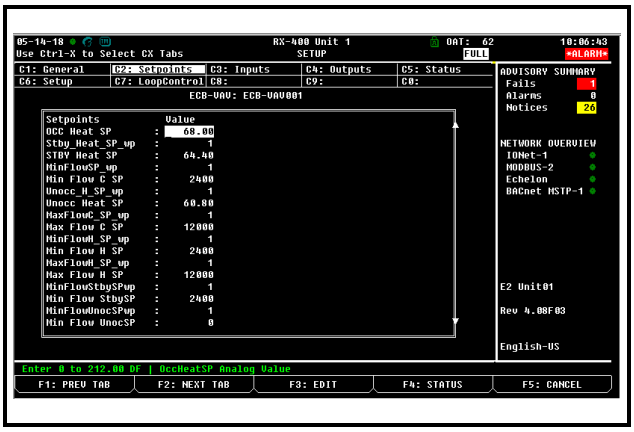


Figure 6-13 *- E2 Device Tab 2 - Setpoints (Page down)*

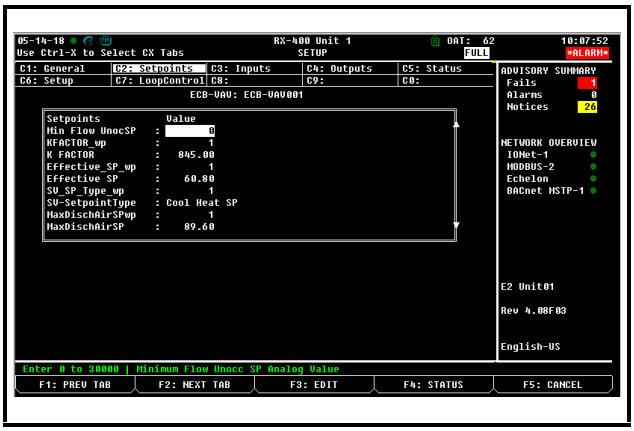


Figure 6-14 *- E2 Device Tab 2 - Setpoints (Page down)*

3. Point the **DUCT IN TEMP** to the **Supply Air Temp** of the installed DAC. Set up a Flex Combiner and point the **OCCUPANCY_CMD** to the correct AO output.

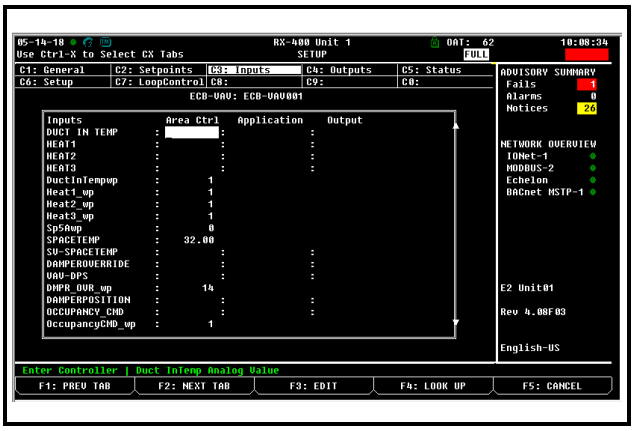


Figure 6-15 *- E2 Device Tab 3 - Inputs*

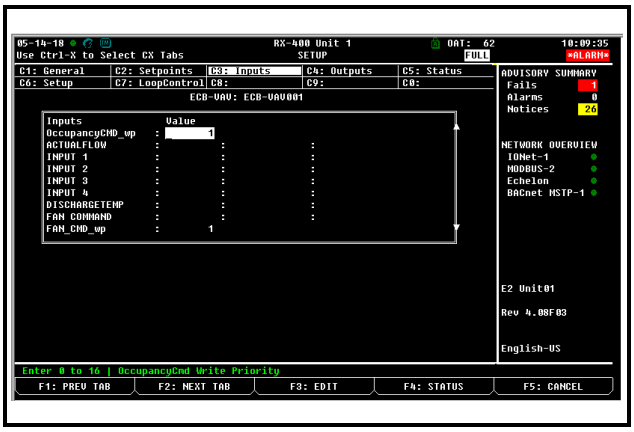


Figure 6-16 *- E2 Device Tab 3 - Inputs (Page down)*

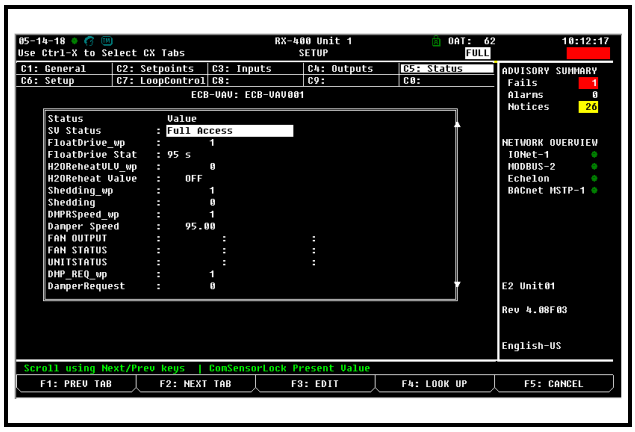


Figure 6-19 *- E2 Device Tab 5 - Status (Page down)*

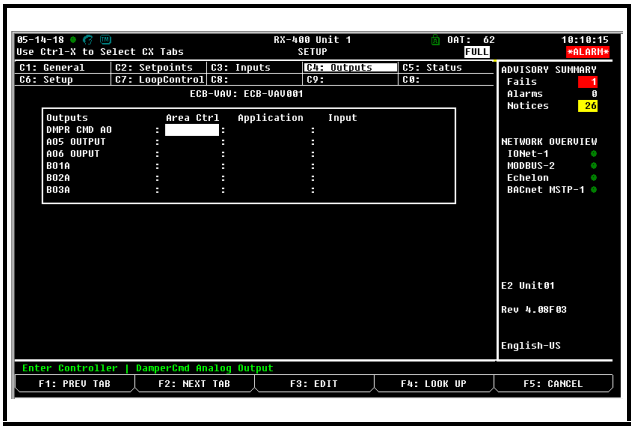


Figure 6-17 *- E2 Device Tab 4 - Outputs*

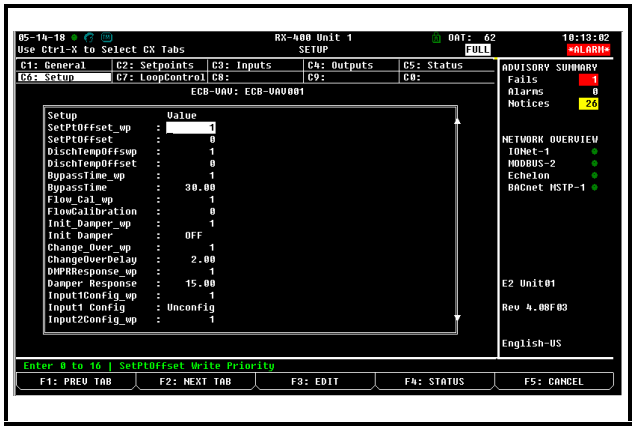


Figure 6-20 *- E2 Device Tab 6 - Setup*

4. Point the Terminal Load to the correct Unit in the Open Flex or Analog Flex Combiner created to average all VAV units Terminal Load values.

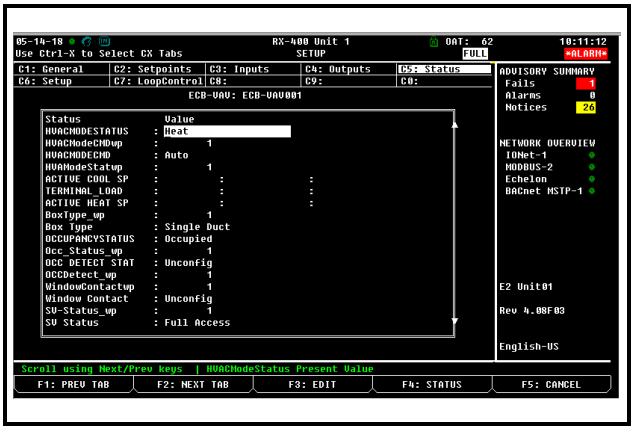


Figure 6-18 *- E2 Device Tab 5 - Status*

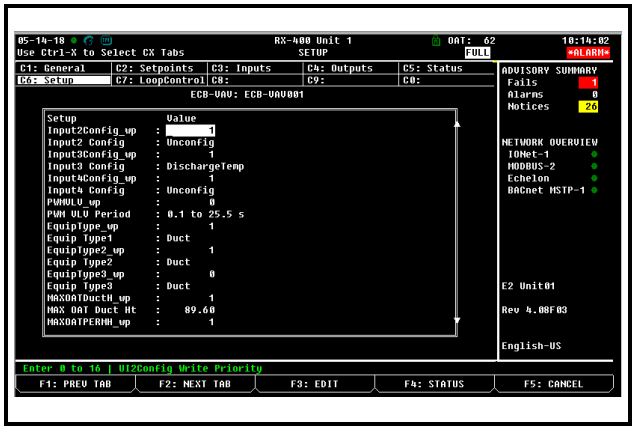


Figure 6-21 *- E2 Device Tab 6 - Setup (Page down)*

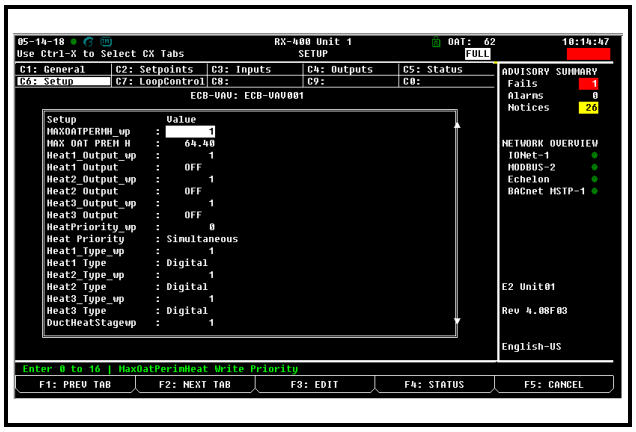


Figure 6-22 *- E2 Device Tab 6 - Setup (Page down)*

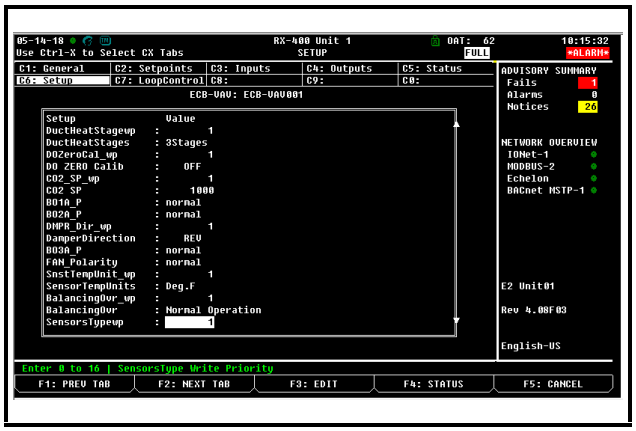


Figure 6-23 *- E2 Device Tab 6 - Setup (Page down)*

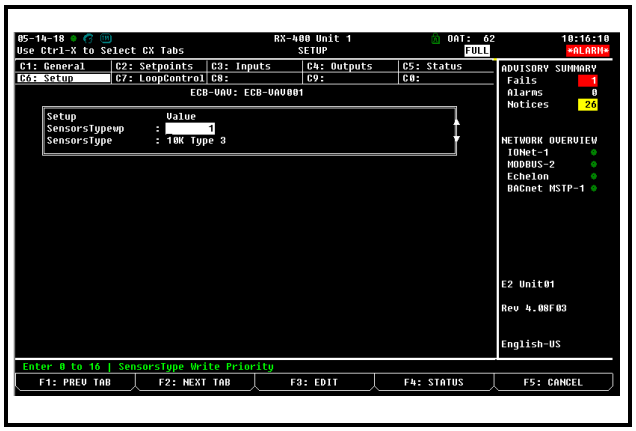


Figure 6-24 *- E2 Device Tab 6 - Setup (Page down)*

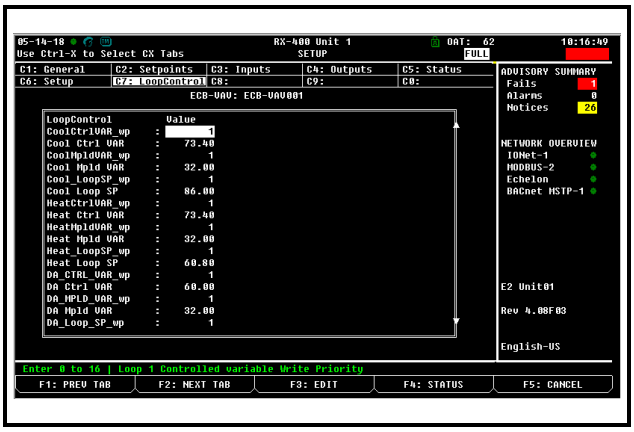


Figure 6-25 *- E2 Device Tab 7 - Loop Control*

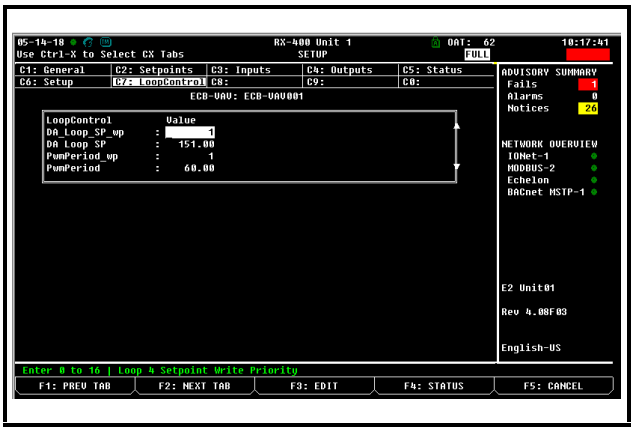


Figure 6-26 *- E2 Device Tab 7 - Loop Control (Page down)*

6.3. Installing the BACnet IP VAV Controller

6.3.1. Uploading the Description File to the E2

1. From UltraSite, connect the E2 controller.
2. Right-click on the E2 icon symbol and select **Description File Upload**.
3. Browse the location of the description file and click **Upload**.

4. Reboot the controller.

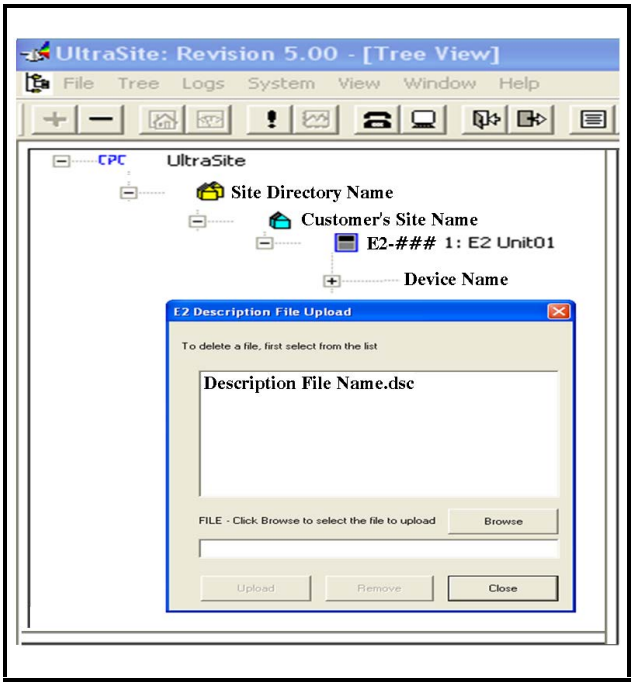


Figure 6-27 *- E2 Description File Upload*

6.3.2. Licensing Third-party Device via E2

1. Log into the E2 controller.
2. From the front of the E2 or in Terminal Mode, select Menu then 7 & **(System Configuration)**, and 9 (**(License)**.
3. Press F1 to **Add Feature** and enter the license key.

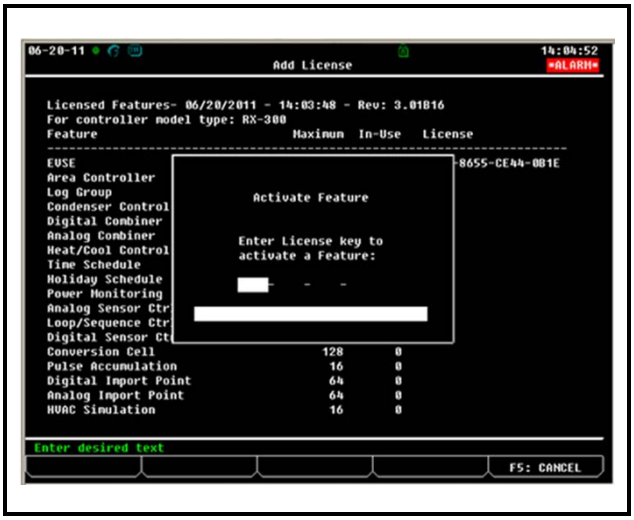


Figure 6-28 *- Adding License*

6.3.3. Adding Device to the E2 Controller

1. Press Menu then, 7 & **(System Configuration)**, and 2 @ **(Connected I/O Boards & Controllers)**.
2. Press F2 to move to **C4: Third Party** tab to see the device name. Enter the license count for the device and press the Home to save the changes.

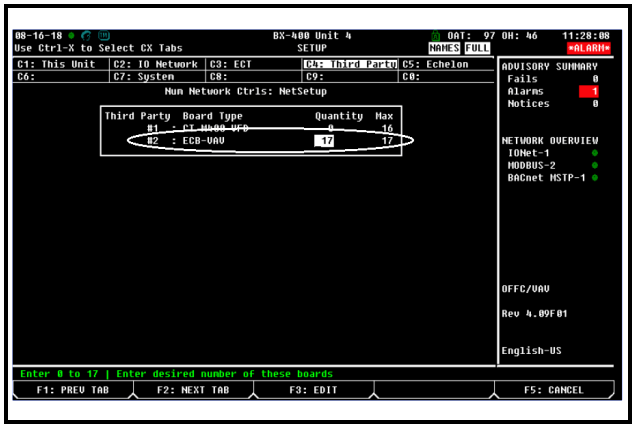


Figure 6-29 *- Adding Device to E2*

6.3.4. E2 BACnet IP Setup

1. Log into the E2 controller.
2. Press Menu then, 7 & **(System Configuration)**, 3 # **(System Information)** and 1 ! **(General Controller Information)**.
3. Select F2 **(Next)** to move to **C8: BACnet** tab. Set this up to prevent conflict with installed modules. The following values are suggestions only.

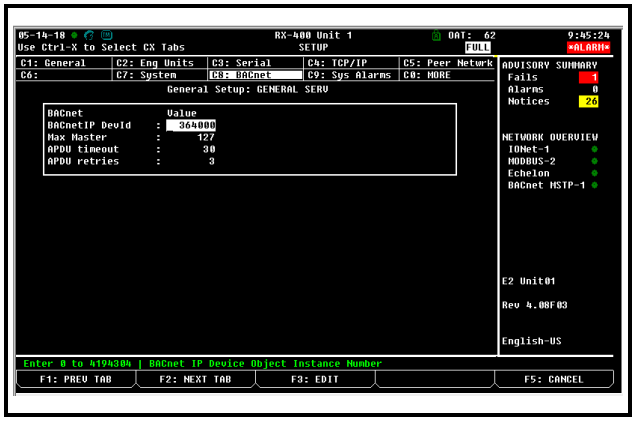


Figure 6-30 *- E2 and BACnet Setup*

6.3.5. Connecting the VAV to COM Port Setup as BACnet IP

1. Log into the E2 controller.
2. Press Menu then, & 7 **(System Configuration)**, # 3 **(System Information)** and ! 1 **(General Controller Information)**.
3. Select F2 **(Next)** to move to **C3: Serial** tab. Set this up to prevent conflict with installed modules. The following values are suggestions only.
4. Make sure the baud rates match with this page and inside the device and that the device is connected to the correct COM port.

Note that the COM6 (or COM4) MSTP MAC is 127. This is user-configurable. Using 127 sets the E2E to the MAX number so devices can be addressed from 1 to 126.

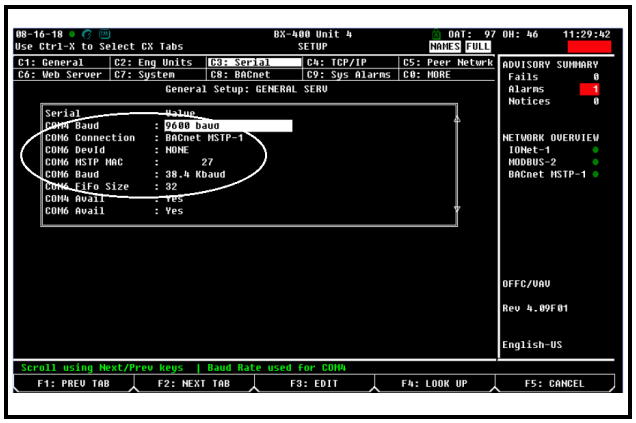


Figure 6-31 *- Connecting VAV to COM Port as BACnet MSTP*

6.3.6. Device Commissioning and BACnet IP Network Selection

1. Log into the E2 controller.
2. Press Menu then, & 7 **(System Configuration)**, & 7 **(Network Setup)** and ! 1 **(Network Summary)**.
3. Highlight the device and press F4 **(Commission)** and select **BACnet MSTP** as the preferred network type when prompted.

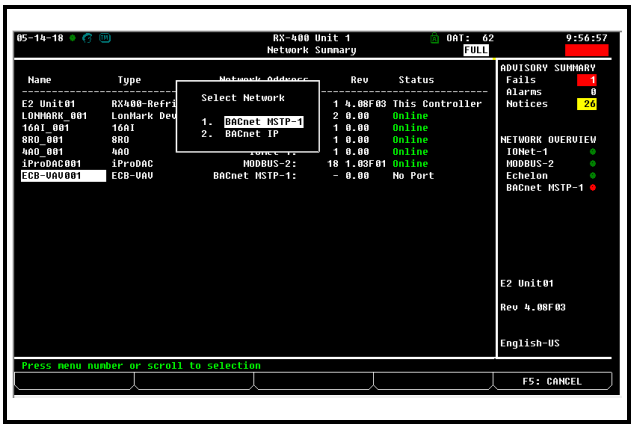


Figure 6-32 *- Device Commissioning*

4. Press Enter and the E2 controller will start scanning the BACnet network.
5. When the scanning process has completed, a list of all the BACnet MSTP Devices on the Ethernet Network will be dislayed. Verify the correct **Object Instance** and **MAC** address for the Third-party device on the example list as shown in ***Figure 6-8***. Then use the arrow keys to highlight the device and then press Enter to confirm.

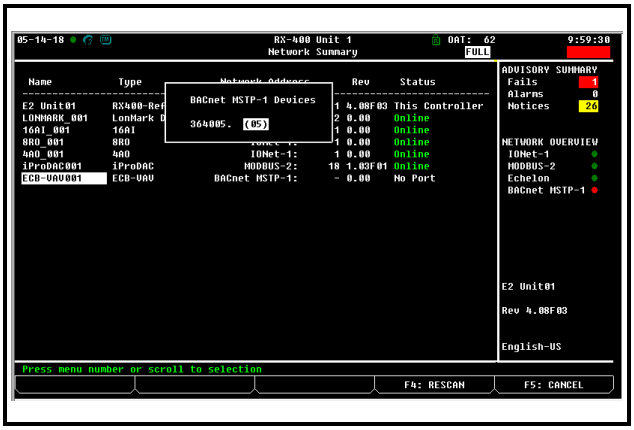


Figure 6-33 *- BACnet MSTP Device List*

6. Set the correct **Object ID#** of the Third-party device when prompted and press the Enter key.

*Note that the **BACnet Device Object ID** is now set for this device.*

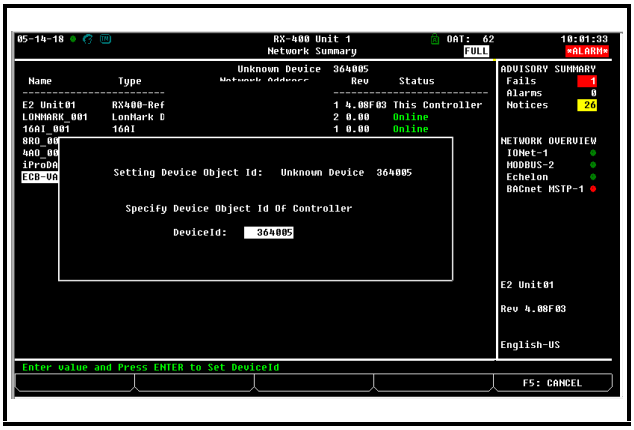


Figure 6-34 *- Setting the Device Object ID*

7. Press Enter to accept the **DeviceId**.
8. Press ESC twice to return to the main **Network Summary** page. After a few seconds, the device will show as **Online** in green to confirm that the commissioning process has completed.

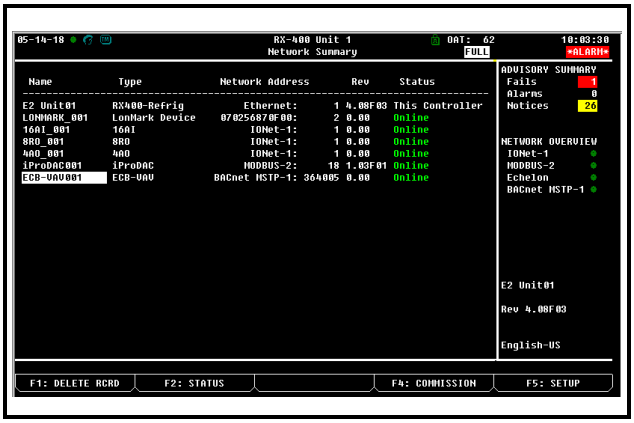


Figure 6-35 *- Network Summary Screen*

NOTE: Before Proceeding:

1. Install the DAC as per instructions in the 026-1221 manual. For more information on the DAC, reference the DAC manual 026-1727.

2. Install either an Open Flex or an Analog Combiner per instructions in Section 7.

6.4. Preliminary setting up the VAV

1. From the Network Summary screen, press F5 **(Setup)**. Change the Name and add a Long Name if desired.

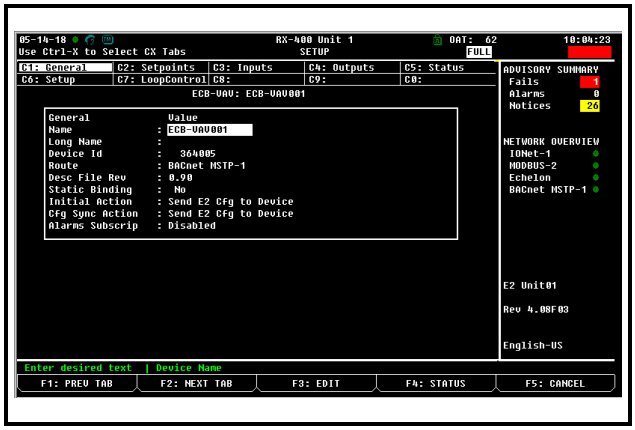


Figure 6-36 *- E2 Device Tab 1 - General*

2. Verify that all setpoints are as desired.

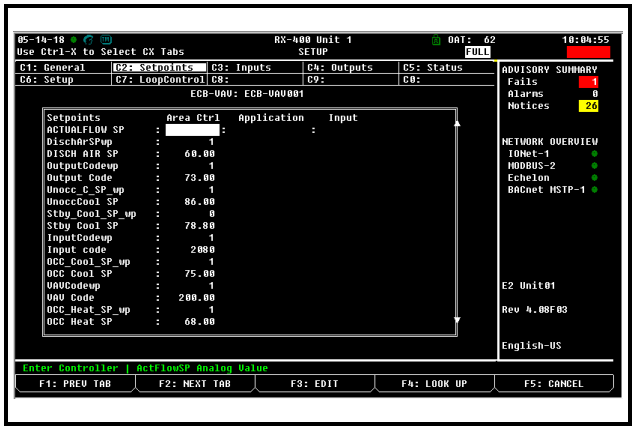


Figure 6-37 *- E2 Device Tab 2 - Setpoints*

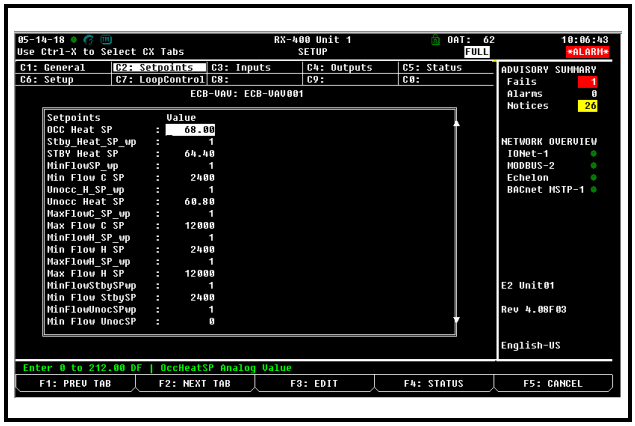


Figure 6-38 *- E2 Device Tab 2 - Setpoints (Page down)*

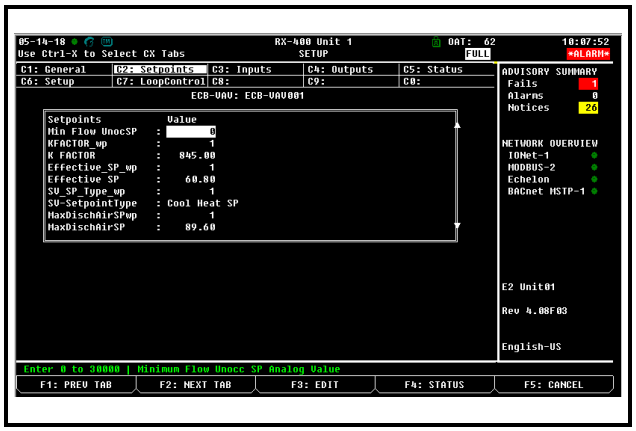


Figure 6-39 *- E2 Device Tab 2 - Setpoints (Page down)*

3. Point the **DUCT IN TEMP** to the S**upply Air Temp** of the installed DAC. Set up a Flex Combiner and point the **OCCUPANCY_CMD** to the correct AO output.

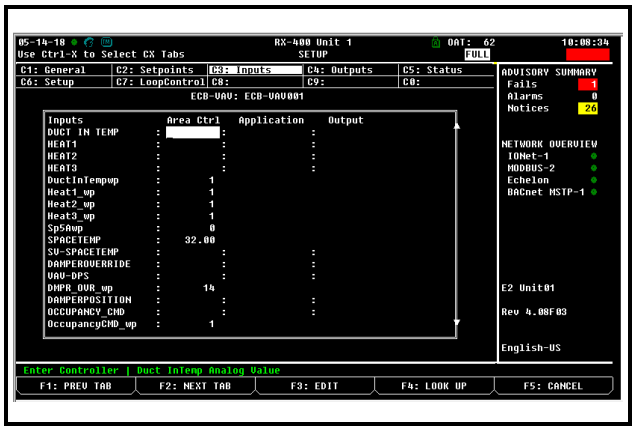


Figure 6-40 *- E2 Device Tab 3 - Inputs*

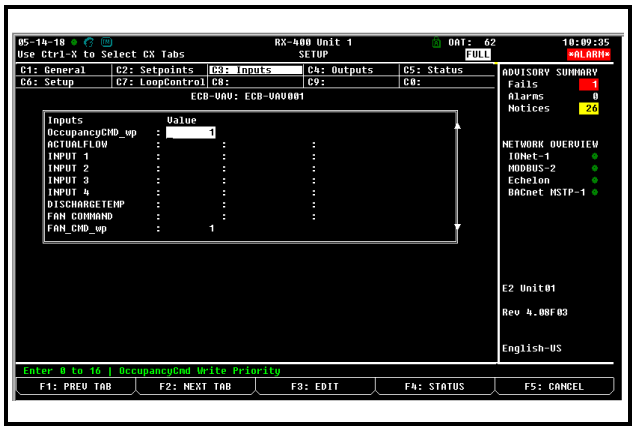


Figure 6-41 *- E2 Device Tab 3 - Inputs (Page down)*

4. Point the Terminal Load to the correct Unit in the Open Flex or Analog Flex Combiner created to average all VAV units Terminal Load values.

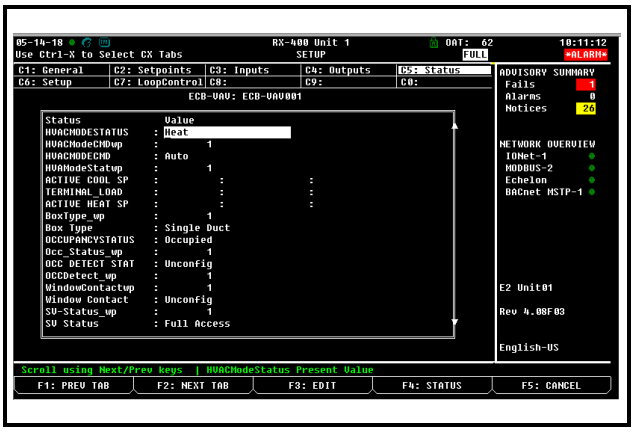


Figure 6-42 *- E2 Device Tab 5 - Status*

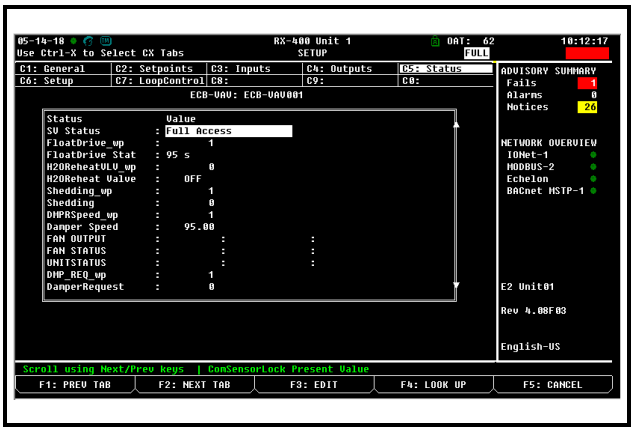


Figure 6-43 *- E2 Device Tab 5 - Status (Page down)*

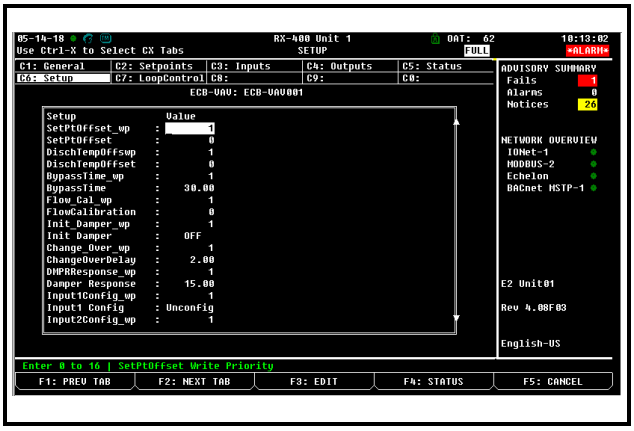


Figure 6-44 *- E2 Device Tab 6 - Setup*

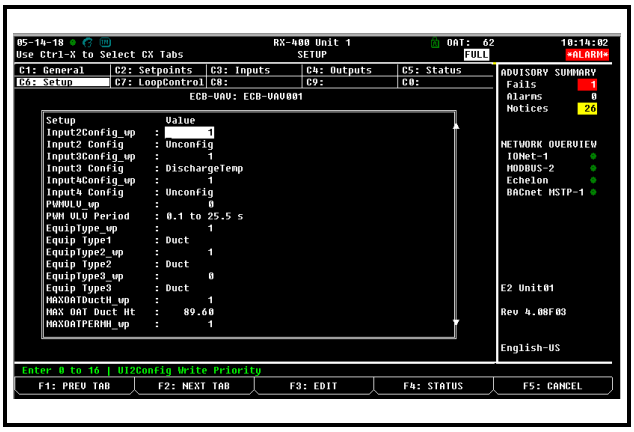


Figure 6-45 *- E2 Device Tab 6 - Setup (Page down)*

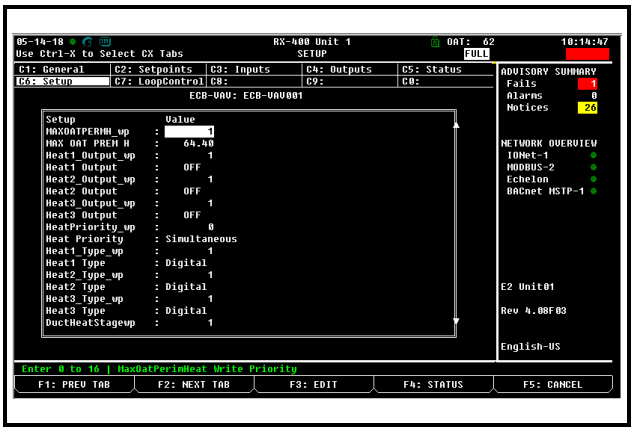


Figure 6-46 *- E2 Device Tab 6 - Setup (Page down)*

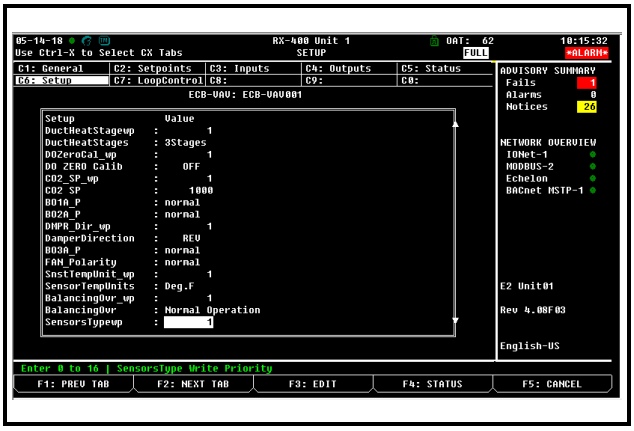


Figure 6-47 *- E2 Device Tab 6 - Setup (Page down)*

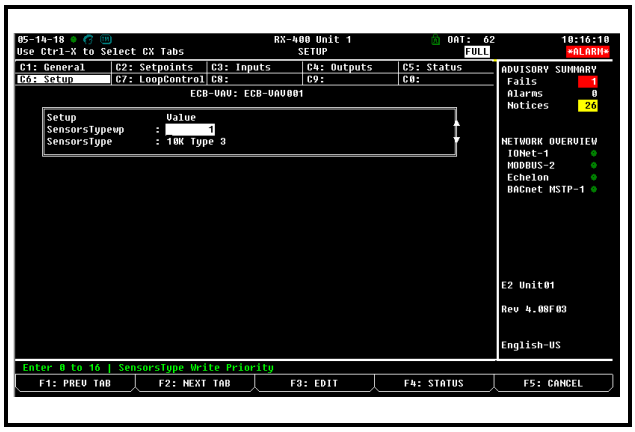


Figure 6-48 *- E2 Device Tab 6 - Setup (Page down)*

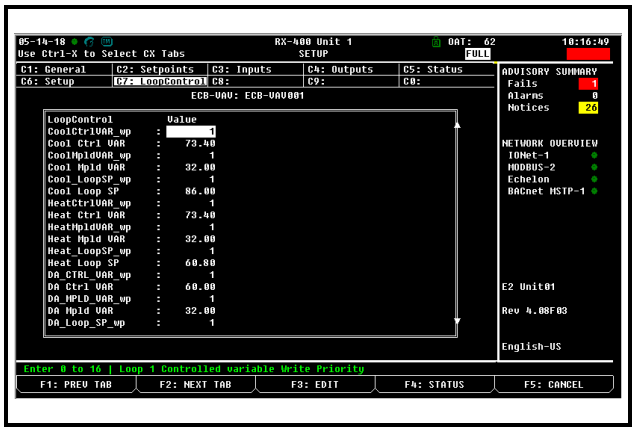


Figure 6-49 *- E2 Device Tab 7 - Loop Control*

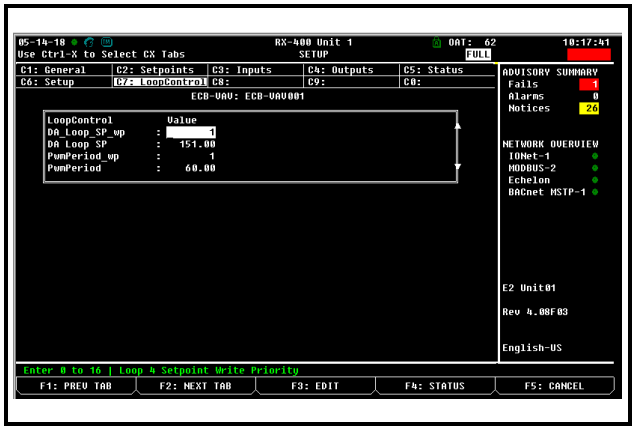


Figure 6-50 *- E2 Device Tab 7 - Loop Control (Page down)*

7 Terminal Load Calculation for DAC

The DAC controller determines whether to provide heating or cooling based on the terminal load indicated by the VAV controllers. Because each VAV controller has its own unique terminal load, all of the VAV terminal loads must be combined to determine the average terminal load of the system. To calculate the terminal load for the system, an Analog Combiner or DAC-VAV Combiner can be used.

7.1. Analog Combiner Setup: Calculate Terminal Load

In the E2 controller, add an Analog Combiner application.

1. From the Main Menu, press **6. Add/Delete Application** and then press **1. Add Application**. Choose **Analog Combiner** and add the desired number.
2. Press **Y** to go directly to the Analog Application setup.
3. In General setup, edit the Analog Combiner Application by setting the **Num Inputs** parameter to the number of VAVs served by the DAC.

***Figure 7-1** - Analog Combiner General Setup Screen*

NOTE: The Analog Combiner can handle up to 16 VAV units. The DAC-VAV Combiner can handle up to 32 units. Either the Analog Combiner or the DAC-VAV Combiner can be used if there are 16 or fewer VAV units installed.

4. Set **Eng Units** to **PCT**.
5. Set **Comb Method** to **AVERAGE** (default).
6. In Comb Ins setup (under the Comb Ins tab), connect the Analog Inputs to all of the associated VAV unit's Terminal Load outputs.
7. In Outputs setup (under the Outputs tab), connect the **OUTPUT** to the Terminal Load input on the DAC application.

7.2. DAC-VAV Combiner Setup: Calculate Terminal Load

In the E2 controller, add the DAC-VAV Combiner application.

1. Install the appropriate description file. Contact Emerson for license, file and installation guide.
2. From the Main Menu, press **6. Add/Delete Application** and then press **1. Add Application**. Choose DACVAV-CMB Combiner, press Enter and enter the desired number.

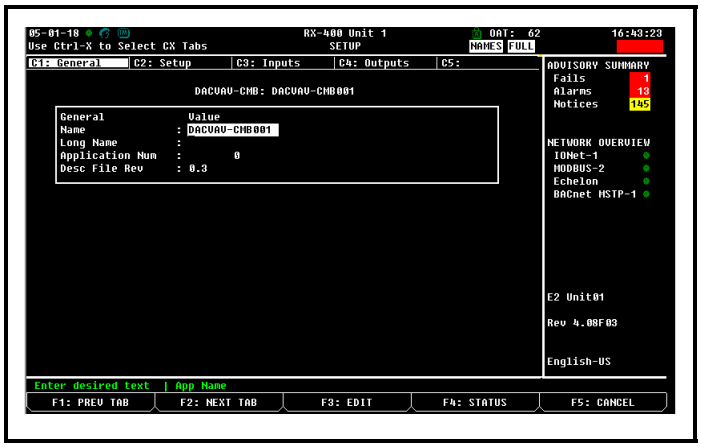


Figure 7-2 *- DAC-VAV Combiner General Setup Screen*

3. Press **Y** to go directly to the DAC-VAV Combiner Application setup.

4. Press F2 to tab to Setup. Enter 32 then F2 to tab to the Inputs tab. For each VAV above the installed number, enter "**NONE**" as the default value. Press F1 to return to the Setup tab. Change 32 to the number of actual units installed.

5. Press F2 to tab to the Inputs tab. For each VAV units installed, press F3, then select **1. Alternate I/O Formats** followed by **2. Area Ctrl: Application: Property**. Press F4 to look up the **Area Ctrl**, then press the right-arrow key followed by F4 to locate the corresponding unit and press Enter. Press the right-arrow key followed by F4, then highlight **TERMINAL_LOAD** and press Enter.

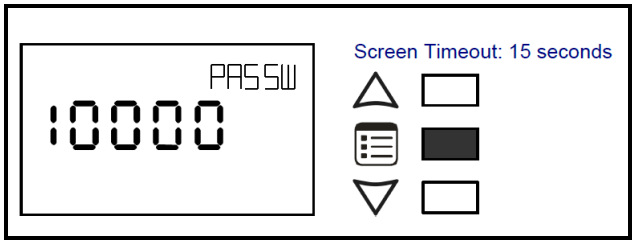
8 Smart Thermostat

8.1. Setting the Smart Thermostat Subnet ID

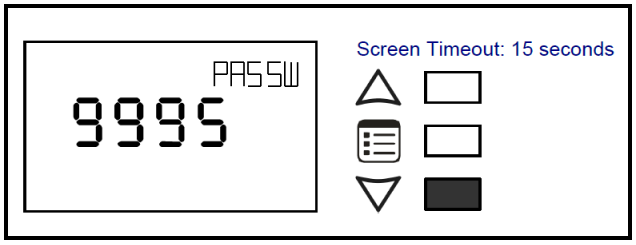
VAV series controllers can be commissioned with a Smart Thermostat by connecting it to the controller.

The default Subnet ID for the Smart Thermostat is 1. To commission an VAV Series controller, the sensor's Subnet ID must be set to 1. IF the sensor's Subnet ID has been set to another value (for example, the display flashes error code 1 with the bell icon when the sensor is connected to a controller for commissioning), change the Subnet ID to 1 as follows:

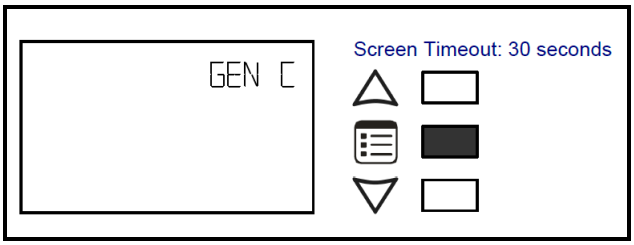
1. Connect the Smart Thermostat to the controller with a Cat 5e patch cable. Wait for the bell icon and the number 1 to flash on the display.
2. Press and hold the Menu button for five (5) seconds to enter the password menu. 1000 is shown on the display.



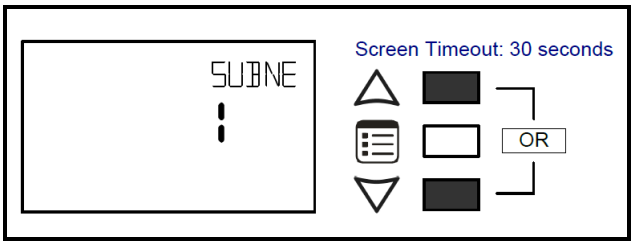
3. Press the down button to set the number to 9995 (this is the default password).



4. Press the Menu button to submit the password. Upon submitting the password, the GEN GCFG submenu appears on the display.



5. Press the down button once to enter the GEN CFG submenu.
6. Press the Menu button several times until SUBNET ID appears on the display. The current controller's Subnet ID is shown.



7. Use the up and down buttons to set the controller's Subnet ID to 1. Tip: Hold down either the up or down button to fast-advance the display value.
8. Press the Menu button once.
9. Press and hold the Menu button for five (5) seconds to exit the configuration menu.

The Smart Thermostat can now be used to go from one VAV series controller to the next for commissioning purposes.

8.2. Commissioning VAV-Series Controllers

When using the Smart Thermostat for commissioning VAV Series controllers, connect the Smart Thermostat to the controller with its Subnet ID set to 1.

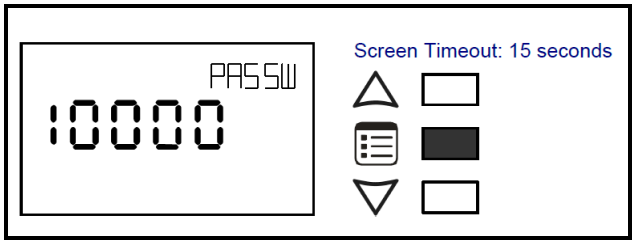
During commissioning, the sensor is used to set the controller's BACnet® MAC Address and to perform application selection if needed. Applications are pre-loaded programs that enable the VAV to control a

typical VAV box.

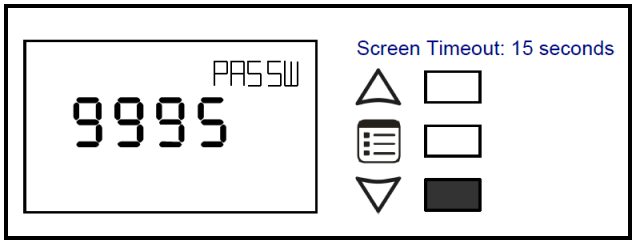
Set the connected controller's MAC Address as follows:

1. Connect the Smart Thermostat to the controller with a Cat 5e patch cable. Wait for the display to show the room temperature.

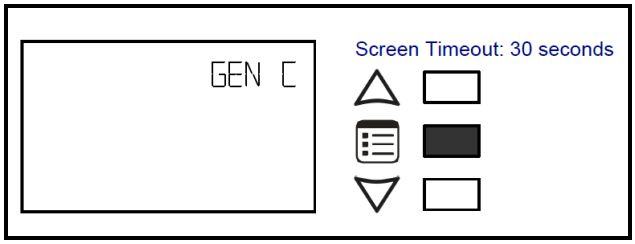
2. Press and hold the Menu button for five (5) seconds to enter the password menu. 1000 is shown on the display.



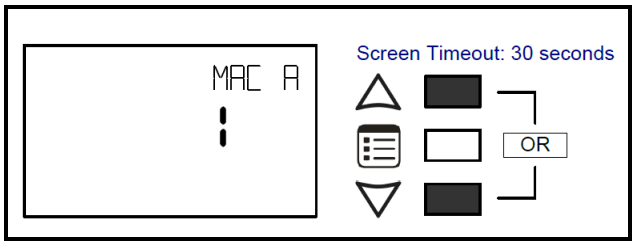
3. Use the down button to set the number to 9995 (this is the default password).



4. Press the Menu button to submit the password. Upon submitting the password, the GEN CFG submenu appears on the display.



5. Press the down button once to enter the GEN CFG submenu. The MAC ADDRESS menu is shown with the current controller's BACnet MAC Address.



6. Use the up and down buttons to set the controller's MAC Address. Only addresses from 1 to 127 are recommended to be used.

7. Press the Menu button once to apply the value.

8. Press and hold the Menu button for five (5) seconds to exit the configuration menu.

Once the controller's network is operational, the controller can be programmed with EC-gfxProgram. For each Smart Thermostat, set its Subnet ID number to the block number of its associated ComSensor block in EC-gfxProgram. This is done in the sensor's GEN CFG menu under SUBNET ID.

8.3. Setting the BAUD Rate (Optional - BACnet Controllers only)

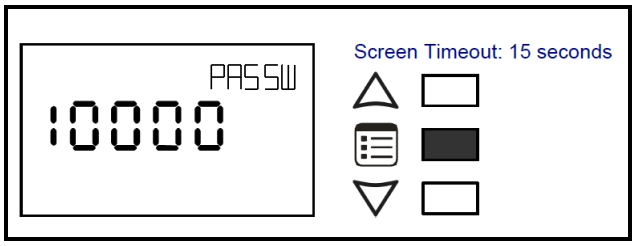
By default, the BAUD rate for the controller is set to automatically detect the current communication BAUD rate of the connected BACnet MS/TP network (AUTO). This is the preferred setting for a controller. However, at least one controller on the BACnet MS/TP network data bus must have its BAUD rate set. The preference is to set the building controller's BAUD rate (if present). Otherwise, set the BAUD rate on one controller that will set the BAUD rate for all other controllers (to act as the master for setting the BAUD rate).

CAUTION: When the Baud rate is set to AUTO, the controller cannot initiate any communication until it has detected the baud rate of the BACnet MS/TP network. If all controllers on the BACnet MS/TP network are set to AUTO, all controllers will not communicate.

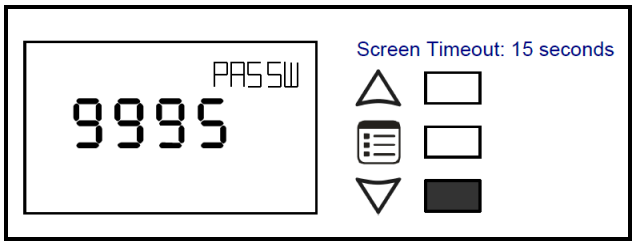
Set the connected controller's BAUD rate as follows:

1. Connect the Smart Thermostat sensor to the controller with a Cat 5e patch cable. Wait for the display to show the room temperature.

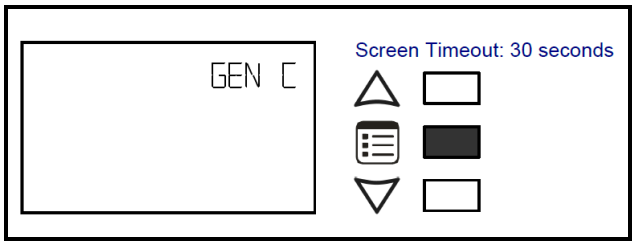
2. Press and hold the Menu button for five (5) seconds to enter the password menu. 10000 is shown on the display.



3. Use the down button to set the number to 9995 (this is the default password).

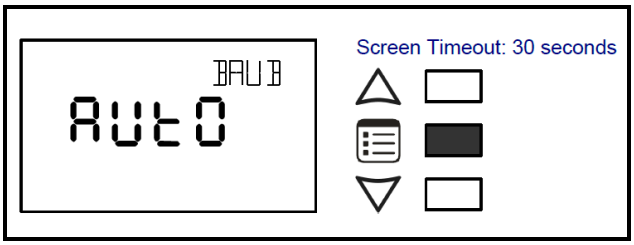


4. Press the Menu button to submit the password. Upon submitting the password, the GEN CFG submenu appears on the display.



5. Press the down button once to enter the GEN CFG submenu.

6. Use the Menu button several times until BAUD RATE appears on the display. The current controller's BAUD rate is shown.



7. Use the up and down buttons to set the controller's controller's Baud rate. The AUTO setting detects and uses the current baud rate being used by the BACnet MS/TP network.

8. Press the Menu button once to apply the value.

9. Press and hold the Menu button for five (5) seconds to exit the configuration menu.

8.4. Wireless Installation

When connected to a Wireless Receiver, controllers can receive input signals from a wide selection of wireless devices. Compatible wireless devices include temperature sensors, duct sensors, window/door contacts and light switches. These devices are easy to install, and can be mounted on a wide range of building materials.

8.4.1. Connecting the Wireless Receiver

The Wireless Receiver is connected to the controller using a 2-meter (6.5-ft) telephone cable with 4P4C modular connectors at both ends. Do not exceed this cable length. The Wireless Receiver's telephone socket is located inside the device. To locate it, open the Wireless Receiver by separating its front and back plates.

9 BACnet IP Controller

The BACnet IP Series Controller is a modular and scalable platform that is used to control a wide range of HVAC applications. It uses IP protocol to communicate on wired Ethernet network and Wi-Fi to communicate on wireless networks. It supports BACnet IP communication and is a listed BACnet Building Controller (B-BC). This controller consists of an automation and connectivity server, power supply, and I/O extension modules. This programmable connected system controller provides advanced functionality such as customizable control logic, Web-based design and visualization interface, logging, alarming, and scheduling.

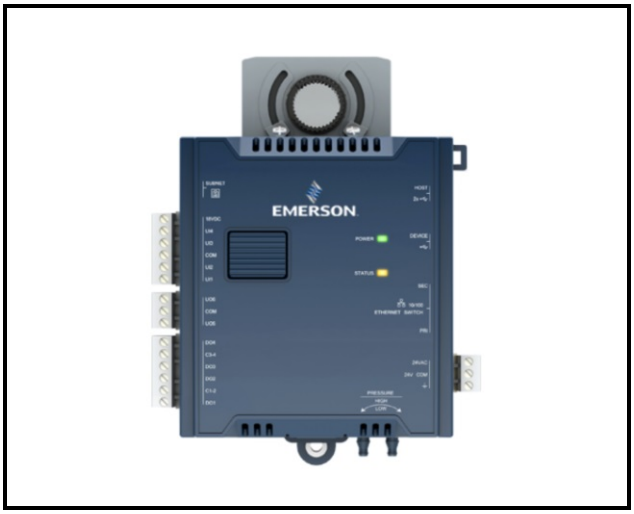


Figure 9-1 *- VAV BACnet IP Controller*

9.1. Internet Protocol

Internet Protocol (IP) is a part of a multi-layered suite that enables data communication. The following descriptions are an overview of the IP suite protocol layers used by IP devices:

- Physical layer (bits): This is the physical and device-to-device electrical connection layer otherwise known as Ethernet.
- Data Link layer: This layer implements the ability for two devices to exchange data with each other.
- Network layer: This layer implements the ability to connect multiple distinct networks with each other.
- Transport layer (segments): This layer provides end-to-end communication data stream connection between two or more devices through a variety of protocols.
- Session layer (data): This layer implements the protocol to open, close, and manage a session between applications such that a dialog can occur.
- Presentation layer: This layer implements the display of media such as images and graphics.
- Application layer: This layer implements the process-to-process communications protocol that includes among other services such as the BACnet IP protocol, programming, debugging, and WWW.

All of the above IP suite protocol layers must be fully functional for any two devices or controllers to communicate with each other.

9.2. IP Network Segmentation

For efficient network planning, normally the IP controllers will be assigned their own network/IP segment of an IP network or subnetwork. This can be done as shown in ***Figure 9-2***.

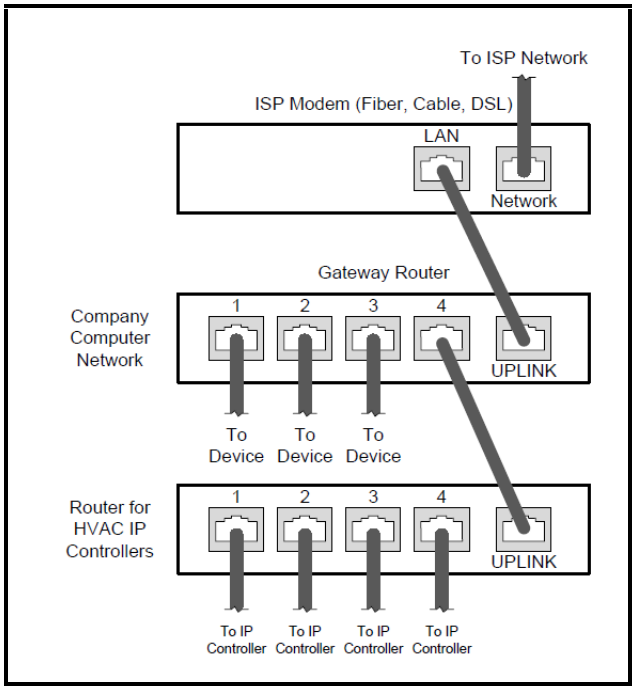


Figure 9-2 *- Network Segment for HVAC IP Controllers*

For certain wireless topologies, a wireless router can be used to connect BACnet IP. In this example, a wireless operator interface (laptop or tablet) can be used for commissioning as shown in ***Figure 9-3***. If the laptop has Soft EC-BOS^{AX} installed, it can be used to program BACnet series controllers connected to the RS-485 port of the Connected System

Controller.

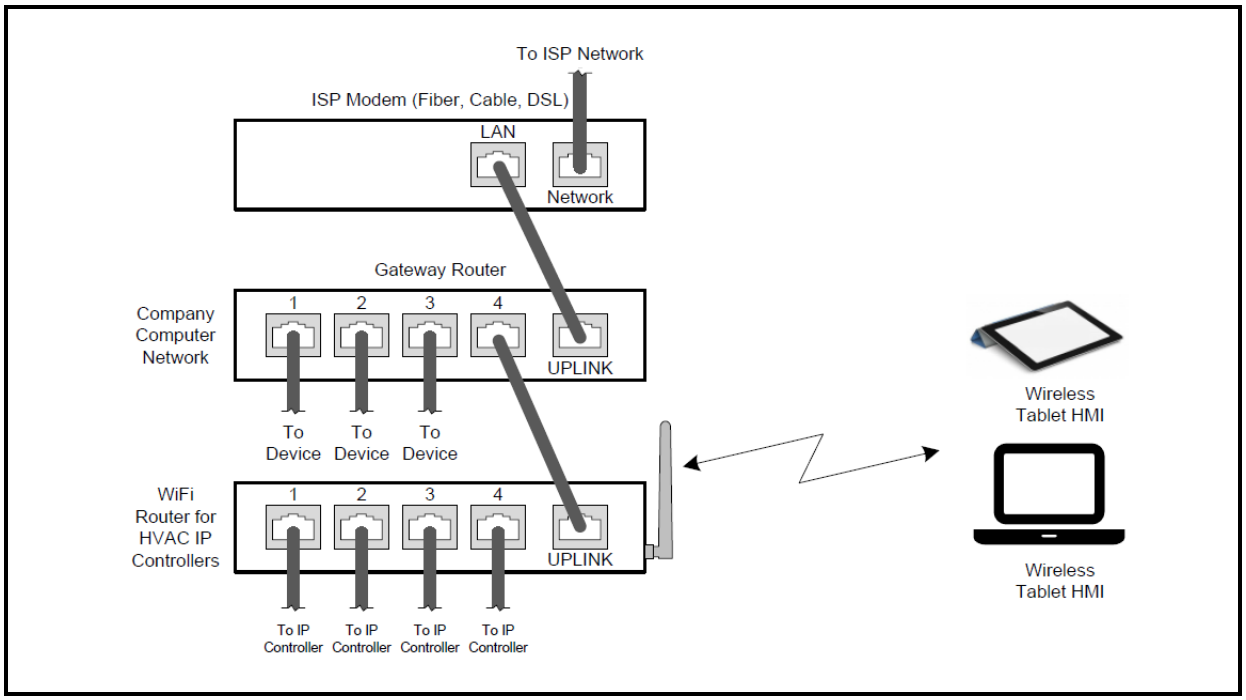


Figure 9-3 *- Network Segment for HVAC IP Controllers with a Wireless Access Point*

If a wireless router is unavailable or is out-of-range, an BACnet IP Wi-Fi adapter can be connected to a BACnet IP's USB port to add wireless connectivity.

9.3. Port Numbers

In an IP packet, a port number is an extension of the packet's IP address and completes the destination address for a communication session. By convention, the packet's port number is associated with a protocol used between software applications and is used to uniquely identify a communications endpoint for a specific application or process running on a computer. This allows a multitude of applications to share a single physical connection to the Internet while allowing distinct communication channels between different applications. Refer to ***Section 9.4., BACnet IP - IP Network Port Number and Protocols*** for the standard port numbers used by BACnet IP controllers.

Sometimes, two applications might use the same port number to communicate. To sort out this conflict, the following methods can be used:

- In the configuration of some applications, the port number can be changed from its default setting. Should you change it, you must also change it on the corresponding application also so that the port numbers will match.
- Routers have features such as port forwarding that can change an incoming packet's port number coming from the Wide Area Network (WAN) to another port number on the Local Area Network or vice versa.

9.4. BACnet IP - IP Network Port Number and Protocols

BACnet IP uses the following IP Network Protocols to communicate over IPv4 networks. The corresponding default in-bound port number is also shown in the table below.

Service	Default Port Number (Protocol)	Description	Where can this port number be changed?
SMTP	25 (TCP)	Outgoing Email server port number. This parameter is normally provided by your ISP or network administrator.	Refer to EC-gfxProgram User Guide, Resources Configuration
DNS	53 (TCP, UDP)	Domain Name Server URL lookup.	
DHCP	67 (UDP)	The router's DHCP service that allows a device to auto-configure a device's IP settings.	
HTTP	80 (TCP)	**EC-gfxProgram Debugging Values (REST service)**: After the control logic or code has been sent to the controller, a live debugger allows programmers to execute code, view input/output values, and troubleshoot errors in real-time. **ENVYSION**: The ENVYSION server presents system status, trending visualization, real-time equipment visualization, schedule configuration, alarm monitoring, and dashboard functions to a Web browser operator interface. **Web Configuration Interface**: This is the network configuration interface for wired and wireless IP network interfaces.	Check the system settings.
HTTPS	443 (TCP)	**Secure EC-gfxProgram Debugging Values (REST service)**: After the control logic or code has been sent to the controller, a live debugger allows programmers to execute code, view input/output values, and troubleshoot errors in real-time. **Secure ENVYSION**: The ENVYSION server presents system status, trending visualization, real-time equipment visualization, schedule configuration, alarm monitoring, and dashboard functions to a Web browser operator interface. **Secure Web Configuration Interface**: This is the network configuration interface for wired and wireless IP network interfaces.	
Radius Server	1812 (UDP)	**Authentication Port**: This is the port on which authentication requests are made.	
Radius Server	1813 (UDP)	**Accounting Port**: This is the port on which accounting requests are made. This is only used to receive accounting requests from other RADIUS servers.	
Radius Server	1814 (UDP)	**Proxy Port**: This is an internal port used to proxy requests between a local server and a remote server.	Check user management settings.
BACnet IP	47808 (UDP)	The BACnet over IP protocol.	Check BACnet settings.

9.5. BACnet IP Services that Require Internet Connectivity

In order to operate, the following outbound services are required:

- A working DNS.
- The default gateway/router to be configured.
- Internet connectivity.

The corresponding default out-bound port number is also shown in the table below.

Service	Default Port Number (Protocol)	Description
SMTP	25 (TCP)	Outgoing Email server port number.
Network Time Protocol (NTP)	25 (TCP)	Used to set the controller's real time clock.
DNS server	53 (UDP, TCP)	Used to provide URL name resolution. The controller by default uses an Internet DNS. If the local network has a DNS, set its IP address

9.6. Connecting the IP Network

There are two methods to connect a device to an IP network:

- Wired (Ethernet connection with the PRI and SEC ports).
- Wireless (when the BACnet IP Wi-Fi Adapter is connected to the controller).

9.7. Connecting the Network Cable to the BACnet MS/TP Controller

To connect controllers to an Ethernet network and discover them, see ***Section 9.8., Connecting to the BACnet IP Controller***.

9.8. Connecting to the BACnet IP Controller

When connecting to the controller for the first time, the goal is to gain access to the controller so that you can configure it to work in its future network environment. The controller must be connected to form a network.

The XpressNetwork Utility allows you to discover all BACnet IP Series controllers connected to an IP network's subnetwork and to perform a range of operations on many controllers at once: you can set each controller's Hostname and IP address, launch EC-gfxProgram to program the controller, or you can access the controller's Web interface. It is a software application that runs on a PC that is connected to the same subnetwork as the controllers.

BACnet IP Series Controller configuration can also be made through the controller's configuration Web interface that is accessed through the XpressNetwork Utility. This Web interface is used to set all the controller's configuration parameters including the controller's IP address according to your network planning. There are two networking methods to connect to a controller:

- Wired (Ethernet connection) with a PC.
- Wireless (when the BACnet IP Wi-Fi Adapter is connected to the controller) with a PC.

Once you have connected the controller(s) to a network, configure the controller.

9.8.1. Controller Identification

Controllers are uniquely identified on the network by their MAC address. This identifier is printed on a label located on the side of the controller and another is on the controller's box. Obtain a printed copy of the building's floor plan. During controller installation, peel the MAC address sticker off the controller's box and put it on the floorplan where the controller has been installed.

This MAC address is used as part of the controller's factory-default Wi-Fi access point name and its hostname.

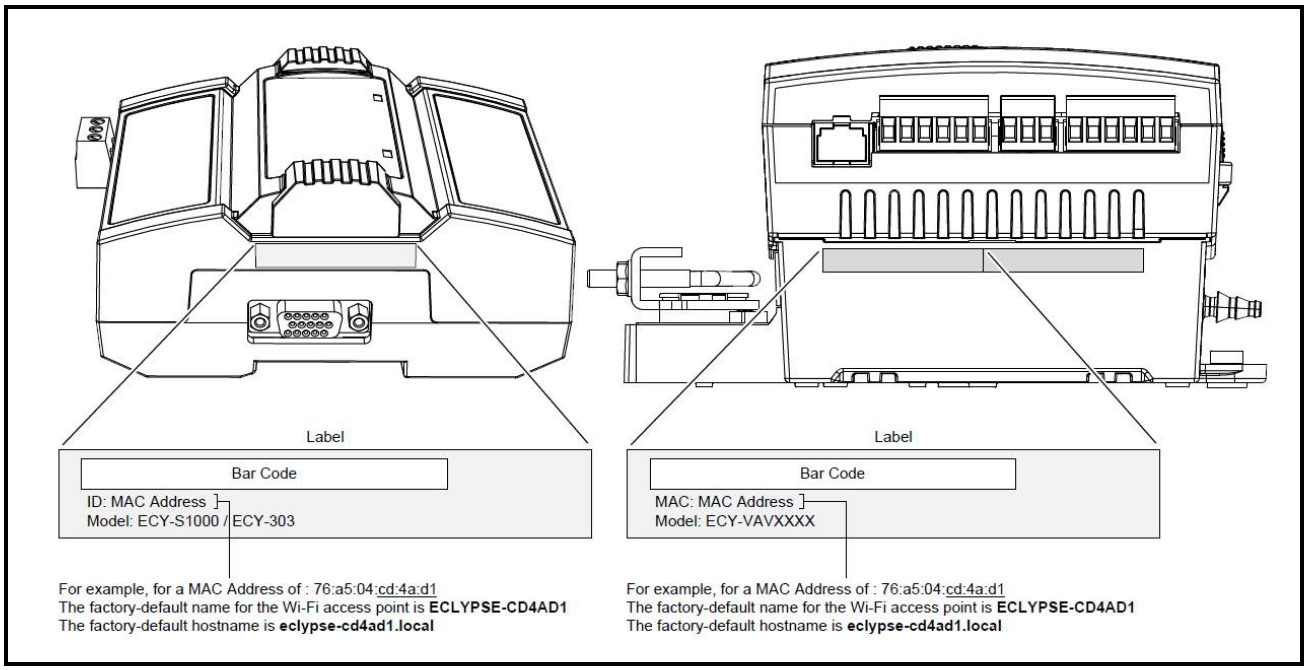


Figure 9-4 *- Finding the Controller's MAC Address*

9.9. Ethernet Network Connection

Depending on the controller model, the way the controller is connected to the network will change according to whether the controller is a Power over Ethernet (PoE) model or not.

- For non-PoE controller models, see ***Section 9.9.1., Network Connections for BACnet IP Series Controllers***.
- For the BACnet MS/TP-PoE controller, see ***Section 9.9.2., Network Connections for BACnet IP-PoE Model Controllers***.

9.9.1. Network Connections for BACnet IP Series Controllers

Connect the controller to the network as follows:

1. Connect your PC's network card to the controller's PRI Ethernet port using a Category 5e Ethernet cable.

   If you are commissioning more than one controller, connect the controllers and PC to a network switch. Two or more controllers can be connected to the network by daisy-chaining them together by using Cat 5e network Cables to connect the Ethernet Switch Sec(ondary) connector of one controller to the Ethernet Switch Pri(mary) connector of the next controller.

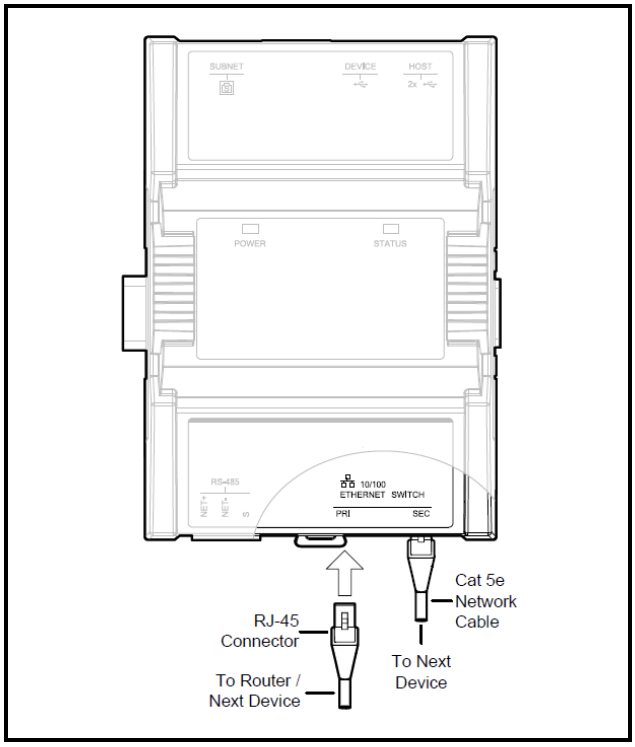


Figure 9-5 *- ECY-S1000 / ECY-303 Wired Network Connection: Cat 5e Cables with RJ-45 Connectors are used*

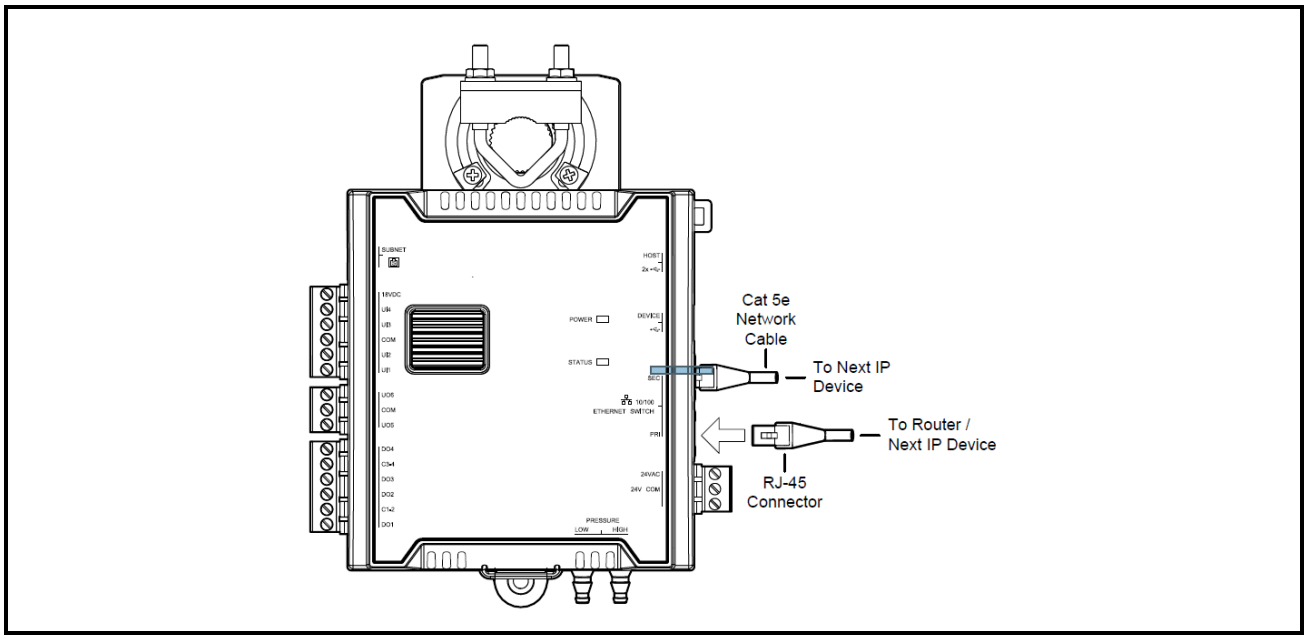


***Figure 9-6** - BACnet IP Wired Network Connection: Cat 5e Cables with RJ-45 Connectors are used*

2. Connect the power to the controller(s). See the controller's Hardware Installation Guide for instructions.

9.9.2. Network Connections for BACnet IP-PoE Model Controllers

The BACnet IP-PoE controller is powered through the Ethernet network cable by using a technique called Power over Ethernet (PoE). A single network cable provides both data and power to the controller. The BACnet IP-PoE Controller must be used with an IEEE 802.3at type 2 certified network switch that can supply 25.5 W at the powered device. Each of the switch's ports must be configured for static (hardware) power negotiation (*Data Link Layer Classification is not supported*).

Connect your PC's network card to the network PoE switch using a Category 5e Ethernet cable and then connect the controller ti the network PoE switch. mm m,

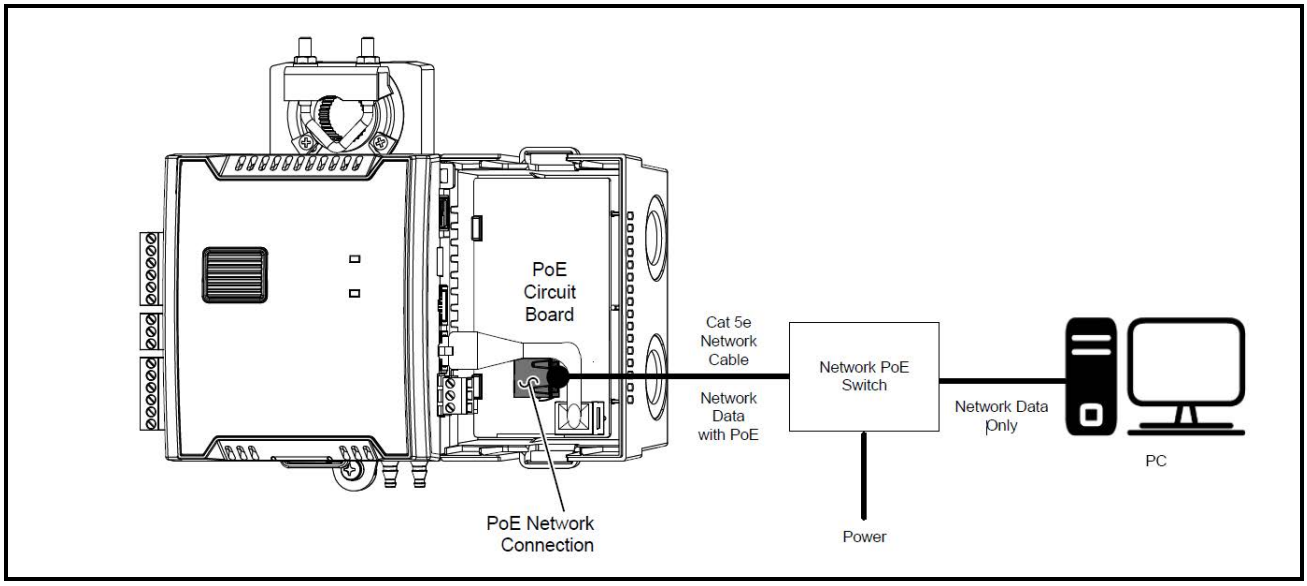


***Figure 9-7** - BACnet IP-PoE Wired Network Connection: Cat 5e Cables with RJ-45 Connectors Used*

The network connection to each PoE controller must go straight to the network PoE switch. Daisy-chaining controllers are not permitted. To remove power from an BACnet IP-PoE controller, disconnect the **PoE Network Connection** shown in ***Figure 9-7***.

9.10. Wi-Fi Network Connection

Once the BACnet IP Wi-Fi Adapter has been connected to a powered controller, a Wi-Fi hotspot becomes available that allows you to connect to the controller's configuration Web interface with your PC.

On your PC's wireless networks, look for an access point named BACnet IP-XXYYZZ where XXYYZZ are the last six (6) hexadecimal characters of the controller's MAC address. To find the controller's MAC address, see ***Section 9.8.1., Controller Identification***. The default password for the wireless network is: **eclypse1234**.

Either of the controller's two USB HOST ports can be used to connect the wireless adapter.

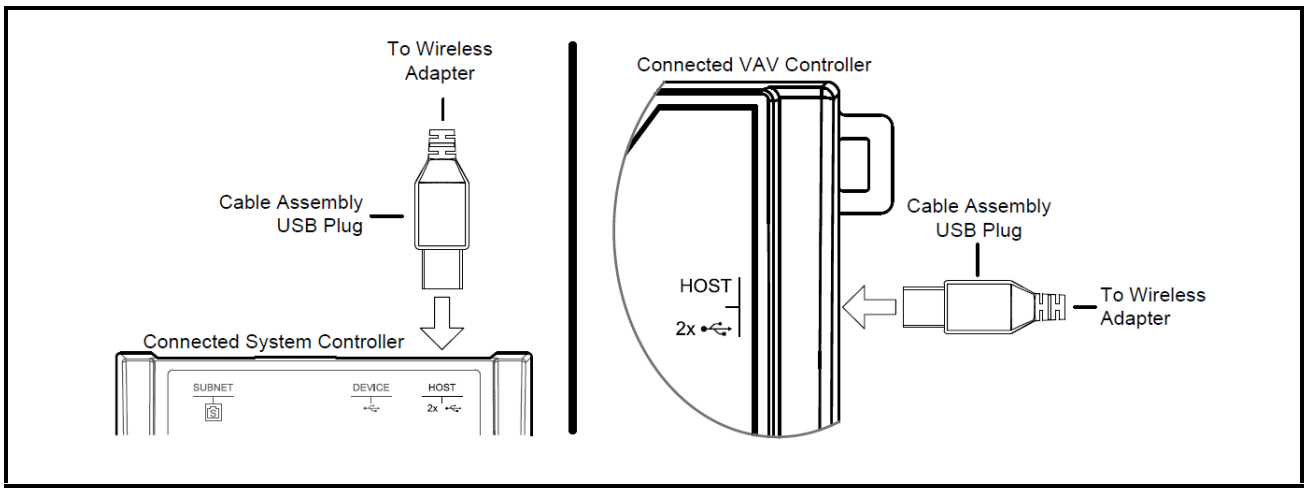


Figure 9-8 *- Connecting the Wireless Adapter to the Controller's USB Host Port*

9.11. Configuring the Controller

Any of the following methods can be used to connect to the controller's interface in order to configure it:

- Using the XpressNetwork Utility
- Using the controller's factory-default Hostname in the Web browser
- Using the controller's IP address in the Web browser

9.11.1. Using the Xpress Network Utility

The XpressNetwork Utility is a software application that runs on a PC that allows you to discover all BACnet IP Series controllers connected to an IP network's subnetwork or Wi-Fi network and to perform a range of operations on many controllers at once: you can set each controller's Hostname and IP address, launch EC-gfxProgram to program the controller, or you can access the controller's configuration Web interface.

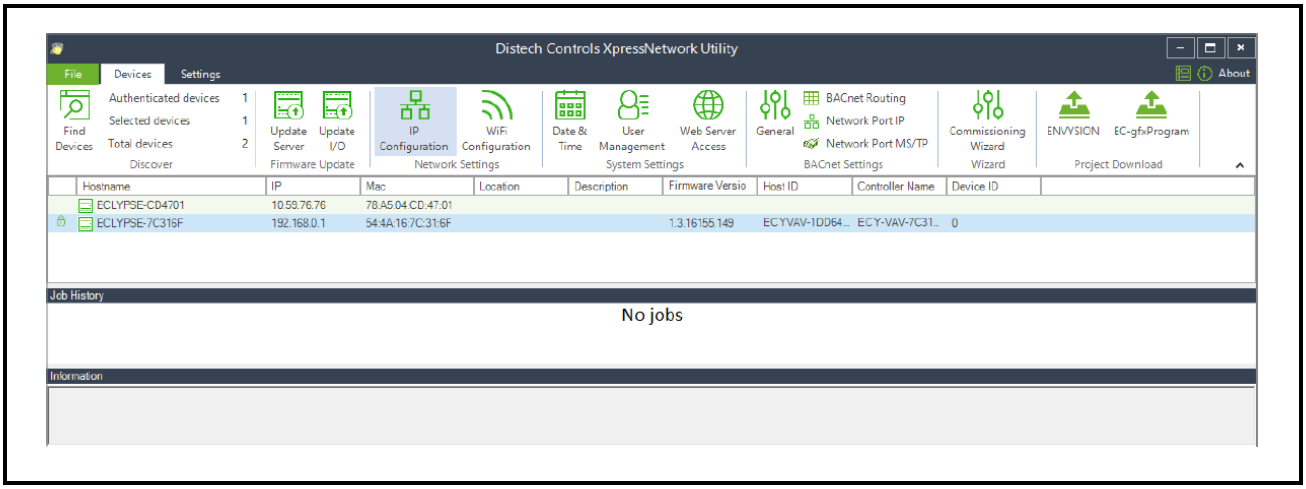


Figure 9-9 *- XpressNetwork Utility Discovers the Network-Connected Controllers*

9.11.2. Using the Controller's Factory-default Hostname in the Web Browser

Controllers have a factory-default hostname that you can use instead of an IP address to connect to it. The hostname can be used in a Web browser's address bar or in the EC-gfxProgram's Connect to screen. When installing the latest version of EC-gfxProgram and your PC does not have the Bonjour service installed, a link to install the Bonjour service is provided. The Bonjour service must be installed on your PC to allow your PC to discover controllers by their hostname.

If your PC is unable to resolve the controller's hostname, you must connect your PC to the controller through Ethernet or Wi-Fi so that your PC only sees the controller network. For example, in this case, your PC must be disconnected from all other networks such as a corporate network or the Internet. If necessary, temporarily disconnect your PC's network cable from its Ethernet port.

The controller's factory-default hostname is eclypse-xxxxxx.local where xxxxxx is the last six (6) characters of the MAC address printed on a sticker located on the side of the controller. See ***Section 9.8.1., Controller Identification*** for more information.

NOTE: Not all smart phones / mobile devices have the Bonjour service installed and thus cannot use the hostname mechanism.

9.11.2.1. First time Connection to an BACnet IP Controller

1. Open your Web browser.
2. In the Web browser's address bar, enter **https://eclypse-cd4ad1.local** and click **Go**.
3. Log into the controller. Then set the controller's configuration parameters in the controller's configuration Web interface.

9.11.3. Using the Controller's IP Address in the Web Browser

Connect to a controller though its IP address as follows:

For a Wi-Fi Network Connection

1. Open your Web browser.
2. In the Web browser's address bar, type **https://192.168.0.1** (the controller's factory-default wireless hotspot IP address) and click **Go**.
3. Log into the controller. Then set the controller's configuration parameters in the controller's configuration Web interface.

For an Ethernet Network Connection

You must know the controller's current IP address (from the DHCP server for example).

1. Open your Web browser.
2. In the Web browser's address bar enter the controller's IP address and click **Go**.
3. Login to the controller. Then set the controller's configuration parameters in the controller's configuration Web interface.

9.12. Connecting to the Controller's Configuration Web Interface

The BACnet IP Series Controller configuration can be made through the controller's configuration Web interface to set all the controller's configuration parameters including the controller's IP address according to your network planning.

At the first connection to an BACnet IP Controller you will be prompted to change the password to a strong password for the admin account to protect access to the controller.

It is important to create new user accounts with strong passwords to protect the controller from unauthorized access. Remove the factory default admin account as this is a commonly known security breach (only the password for this user account needs to be accessed).

In Network Settings, configure the controller's network parameters so that they are compatible with your network.

9.13. Configuring the BACnet IP Wi-Fi Adapter Wireless Networks

BACnet IP Wi-Fi Adapter supports a number of wireless network connection modes. This chapter describes how to configure a controller's wireless network.

9.13.1. Setting up a Wi-Fi Client Wireless Network

This connects the controller as a client of a Wi-Fi access point.

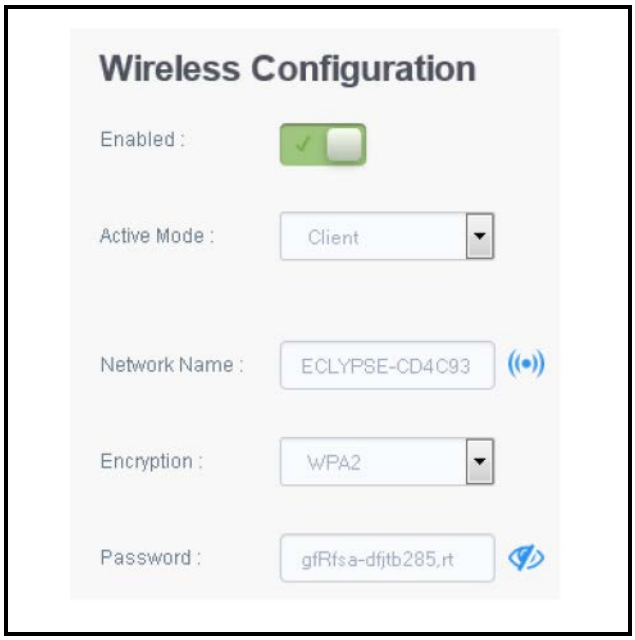


Figure 9-10 *- Client Wireless Network Settings*

Configure the controller's BACnet IP Wi-Fi adapter mode as a Wi-Fi client as follows:

1. Set **Enabled**.
2. Set the Active mode to **Client**.
3. Click  for the controller to search for available access points that are within range. The access points are listed on the right.

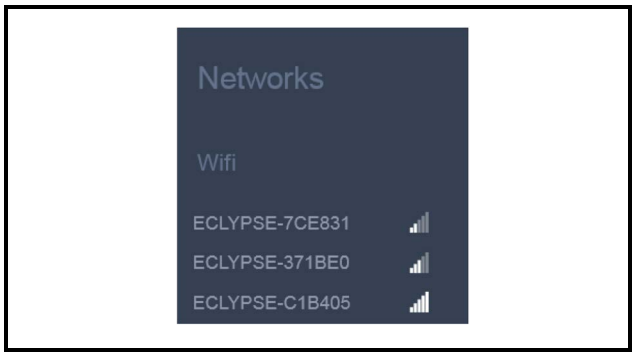


Figure 9-11 *- List of Available Access Points to Pair With*

4. Select an access point to pair with from the access point list. The Encryption mode is

provided by the access point.

5. Set the access point's authentication password in Password. This password is set in the access point's (or wireless router's) configuration.
6. Click **Apply**.

9.13.2. Setting up a Wi-Fi Access Point Wireless Network

This turns the controller into a Wi-Fi access point that other wireless clients can use for network access. This access point operates off of the same subnetwork and has the same IP connectivity that the controller has with its wired network connection. For example, if the controller's wired connection is to a network that has an active DHCP server, access point clients can also use this DHCP server to automatically configure their IP connection parameters.

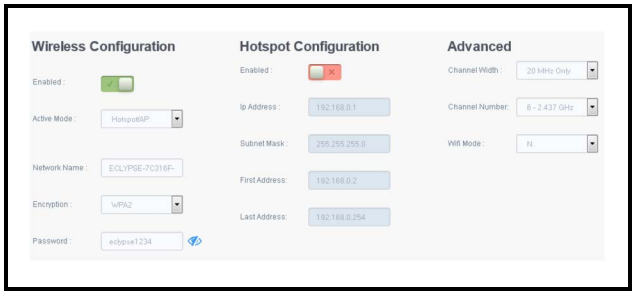


***Figure 9-12** - Access Point Wireless Network Settings*

Configure the controller's BACnet IP Wi-Fi adapter mode as a Wi-Fi access point as follows:

1. Under Wireless Configuration, set **Enabled**.
2. Set the Active mode to **Hotspot/AP**.
3. Set the name for this access point by which wireless clients will identify it in **Network Name**.
4. Set the encryption mode to be used by this access point in Encryption:
   - None: this option should be avoided as it does not provide any wireless security which allows any wireless client to access the LAN.
   - **WPA2**: select the Wi-Fi Protected Access II option to secure the Wi-Fi network with a password.
   - **WPA2 Enterprise**: Use this option if you are connecting to an enterprise network that has a working RADIUS authentication server. This RADIUS server provides user authentication.
5. Set the access point's authentication password in **Password**. This is the password wireless clients will need to know in order to connect to this access point.
6. Under Hotspot Configuration, disable **Enabled**.
7. Under **Advanced**, set the **Channel Width**, **Channel Number**, and **Wi-Fi Mode**.
8. Click **Apply**.
9. Under Advanced, set the Channel Width, Channel Number, and Wi-Fi Mode.

9.13.3. Setting up a Wi-Fi Hotspot Wireless Network

This turns the controller into a Wi-Fi hotspot with a router. This puts the hotspot into a separate subnetwork with a DHCP server to provide IP addresses to any connected device.

Wide area network (WAN) connectivity is through the wired connection. Though BACnet IP uses IP protocol to communicate, this hotspot acts as an IP router, it does not forward broadcast messages that are important in BACnet to identify services that are available within the BACnet internetwork.

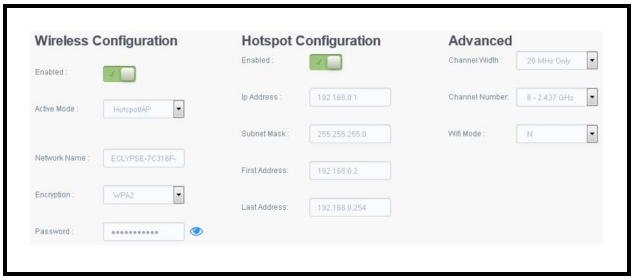


***Figure 9-13** - Hotspot Wireless Network Settings*

Configure the controller's BACnet IP Wi-Fi adapter mode as a Wi-Fi hotspot as follows:

1. Under Wireless Configuration, set **Enabled**.
2. Set the Active mode to **Hotspot/AP**.
3. Set the name for this access point by which wireless clients will identify it in **Network Name**.
4. Set the encryption mode to be used by this hotspot in Encryption:
   - None: this option should be avoided as it does not provide any wireless security that allows any wireless client to access the LAN.
   - **WPA2**: select the Wi-Fi Protected Access II option to secure the Wi-Fi network with a password.

- **WPA2 Enterprise**: Use this option if you are connecting to an enterprise network that has a working RADIUS authentication server. This RADIUS server provides user authentication.

5. Set the hotspot's authentication password in Password. This is the password wireless clients will need to know in order to connect to this hotspot.
6. Under Hotspot Configuration, set **Enabled**.
7. Set the hotspot's IP Address that wireless clients will connect to its IP Address. Ensure that this address is:
   - Not in the range of IP address set by First Address and Last Address.
   - Not the same as the IP address set under IP Configuration for the wired network.
8. Set the hotspot's subnet mask in Subnet Mask.
9. Set the hotspot's addressing range in First Address and Last Address. This defines the range of IP addresses to be made available for hotspot clients to use. The narrower the range, the fewer hotspot clients will be able to connect due to the lack of available IP addresses. For example, a range where First Address = 192.168.0.22 and Last Address = 192.168.0.26 will allow a maximum of five (5) clients to connect to the hotspot on a first-to-connect basis.
10. Under **Advanced**, set the **Channel Width**, **Channel Number**, and Wi-Fi Mode.
11. Click **Apply**.

9.13.4. Setting up a Wi-Fi Mesh Wireless Network

This feature is only available to Beta clients. This makes the controller a member of a Mesh network. This interface can auto-configure its IP parameters when the connected network has a DHCP server.

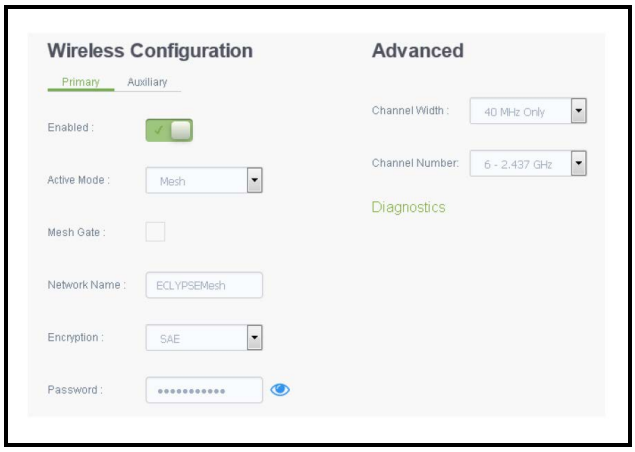


***Figure 9-14** - Mesh Wireless Network Settings*

Configure the controller's BACnet IP Wi-Fi adapter mode as a Wi-Fi Mesh as follows:

1. Under Wireless Configuration, set **Enabled**.
2. Set the Active mode to **Mesh**.
3. Set the Mesh Gate option when this controller has direct access to another non-Mesh network segment through a wired Ethernet connection that acts as a primary network interconnect. This increases the data rate between Mesh network nodes and other network segments. When this option is enabled, this Mesh node will broadcast to the other Mesh nodes at regular intervals that this Mesh node has the shortest path to other networks. Only one or two Mesh network nodes should have this option set as these broadcasts use wireless network bandwidth.
4. Set a network name for the Mesh network in Network Name. All Mesh network nodes must use the same network name to become a member of that Mesh network.
5. Set the encryption mode to **SAE** in **Encryption**. All Mesh network nodes must use the same encryption mode to become a member of that Mesh network.
6. Set the Mesh network's authentication password in Password. All Mesh network nodes use the same authentication password.
7. Under **Advanced**, set the **Channel Width**, **Channel Number**, and **Wi-Fi Mode**.
8. Click **Apply**.

9.13.4.1. Mesh Network Diagnostics

Click **Diagnostics** to see the currently connected neighboring Mesh network controllers and the corresponding connection receive signal strength and data rate. This information is used to troubleshoot a Mesh network. It is best that each controller has at least two Mesh network neighbors with a receive signal strength stronger than -70 dBm.

NOTE: Signal strength is measured in negative units where the stronger the signal, the closer it is to zero. A weaker signal strength will have a more negative number. For example, a receive signal strength of -35 dBm is much stronger than a receive signal strength of -70 dBm.

9.14. Resetting or Rebooting the Controller

The reset button is located between the RS-458 and Ethernet connectors on connected system controllers and underneath the cover on connected VAV controllers. Depending on the amount of time the reset button is held down, different actions are taken by the controller.

Hold Reset for	To
5 seconds	Restart / reboot the controller.
10 seconds	Reset both Ethernet and Wi-Fi IP addresses back to factory default settings.
20 seconds	Reset the controller to its factory default settings. User accounts (user names and passwords) will also be reset to the factory default settings and the controller's license and HTTPS security certificates will be cleared. If FIPS 140-2 mode has been enabled on the controller, this will turn FIPS 140-2 mode off.

IMPORTANT! Always back up the controller's license through the controller's Web interface before you hold the controller's reset button for 20 seconds. Once the controller reboots, you will have to install the license through the controller's Web interface. Click Export To PC to backup the controller's license to your PC. Click Import From PC to restore the controller's license file from your PC. After you hold the controller's reset button for 20 seconds, the controller's HTTPS security certificates will be regenerated. If you use HTTPS to connect to the controller, you will no longer be able to connect to the controller from any PC that was used in the past to connect to the controller unless you delete the old HTTPS security certificate from these PCs.

10 BACnet IP Controller Troubleshooting

Symptom	Possible Cause	Solution
Controller is powered but does not turn on.	Fuse has blown (for 24V controllers)	Disconnect the power. Check the fuse integrity. Reconnect the power.
	Power supply polarity	Verify that consistent polarity is maintained between all controllers and the transformer. Ensure that the COM terminal of each controller is connected to the same terminal on the secondary side of the transformer.
	The device has no power/poor-quality power (for 24V controllers)	Verify that the transformer used is powerful enough to supply all controllers.
Device does not communicate on the BACnet MS/TP network.	Absent or incorrect supply voltage (for 24V controllers)	1. Check the power supply voltage between 24VAC/DC and 24V COM pins and ensure that it is within acceptable limits (±15% for 24V controllers). 2. Check for tripped fused or circuit breaker.
	Overloaded power transformer (for 24V controllers)	Verify that the transformer used is powerful enough to supply all controllers.
	Network not wired properly	Double check that the wire connections are correct.
	Absent or incorrect network termination	Check the network termination(s).
	Max Master parameter	Configure the Max Master to the highest MAC Address of any device on the MS/TP data bus.
	There is another controller with the same MAC Address on the BACnet MS/TP data bus.	Each controller on a BACnet MS/TP data bus must have a unique MAC Address. Look at the MAC Address DIP switch on the faceplate of each controller. If it is set to 0 (all off), use the Smart Thermostat to check the MAC Address.
	There is another controller with the same Device ID on the BACnet intranetwork.	Each controller on a BACnet Intranetwork (the entire BACnet BAS network) must have a unique Device ID. Use an Allure series communicating sensor to check the Device ID of each controller.
	BACnet data bus polarity is reversed.	Ensure the polarity of the BACnet data bus is always the same on all devices.
	Cut or broken wire.	Isolate the location of the break and pull a new cable.
	The BACnet data bus has one or more devices with the same MAC Address.	Follow the recommended Numbering Scheme for MAC Addresses, Instance Numbers, and Network Numbers.
	The baud rate for all devices are set to AUTO.	At least one device must be set to a baud rate, usually the data bus master.
	The device is set to a MAC Address in the range of 128 to 255.	See if the STATUS LED on the device is showing a fault condition. This range is for slave devices that cannot initiate communication. All VAV devices are master devices and must have their MAC Address set accordingly.
	The maximum number of devices on a data bus segment has been exceeded.	Use a repeater to extend the BACnet data bus.
The STATUS LED is blinking.	The device has auto-diagnosed a fault condition	

Table 10-1 *- Troubleshooting BACnet IP Controller Symptoms*

Symptom	Possible Cause	Solution
Controller communicates well over a short network BACnet MS/TP network, but does not communicate on large network.	Network length	Check that the total wire length does not exceed the specifications of the Network Guide.
	Wire type	Check that the wire type matches the specification of the Network Guide.
	Network wiring problem	Double check that the wire connections are correct.
	Absent or incorrect network termination	Check the network termination(s). Incorrect or broken termination(s) will make the communication integrity dependent upon a controller's position on the network.
	Number of controllers on network segment exceeded	The number of controllers on a channel should never exceed 50. Use a router or a repeater.
	Max Master parameter	Configure the maximum number of master device on the MS/TP network in all devices to the controller's highest MAC address used on the MS/TP trunk.
Hardware input is not reading the correct value	Input wiring problem	Check that the wiring is correct according to the module's hardware installation manual and according to the peripheral device's manufacturer recommendations.
	Open circuit or short circuit	Using a voltmeter, check the voltage on the input terminal.
	Configuration problem	Using the controller configuration wizard, check the configuration of the input.
	Over-voltage or over-current at an input	An over-voltage or over-current at one input can affect the reading of other inputs. Respect the allowed voltage / current range limits of all inputs. Consult the appropriate datasheet for controller input range limits.
Hardware output is not operating correctly	Fuse has blown (Auto reset fuse, for 24V controllers)	Disconnect the power and outputs terminals. Then wait a few seconds to allow the auto-reset fuse to cool down. Check the power supply and the output wiring. Reconnect the power.
	Output wiring problem	Check that the wiring is correct according to the module's hardware installation manual and according to the peripheral device's manufacturer.
	Configuration problem	Check the configuration of the output.
	0-10V output, 24VAC powered actuator is not moving	Check the polarity of the 24VAC power supply connected to the actuator while connected to the controller. Reverse the 24VAC wire if necessary.

Table 10-1 *- Troubleshooting BACnet IP Controller Symptoms*

BACnet Device LED Interpretation	Description	Solution
RX LED not blinking	Data is not being received from the BACnet MS/TP data bus.	If there is no communication, see ***Table 10-1***.
TX LED not blinking	Data is not being transmitted onto the BACnet MS/TP data bus.	
POWER constant on	Power is available at the device. However this does not mean that the quality of supplied power is good.	
STATUS blinking	See ***Table 10-3***.	

Table 10-2 *- LED Fault Condition Interpretation for BACnet Devices*

Device STATUS LED blink patterns	Status	Description
One fast blink ●	Initialization	The device is starting up.
The STATUS LED is always OFF	No anomaly	Normal operation.

Table 10-3 *- Status LED Interpretation for Normal Operation with BACnet Devices*

Recommendation	Description
Properly terminate the BACnet MS/TP data bus.	EOL terminations must be enabled/installed at either end of the data bus only.
Avoid duplicate MAC Addresses.	Verify that no device has a duplicate MAC Address by checking the MAC Address DIP switch settings on all devices on the data bus, including segments connected by a repeater. If necessary, isolate devices from the data bus to narrow-down the number of devices that may be at fault.
All devices must be set to the same baud rate.	When all devices are set to AUTO baud rate, at least one device must be set to a baud rate, usually the data bus master.
The data bus is polarity sensitive.	Ensure that the polarity of all data bus wiring is consistent throughout the network.
Do not overload the data bus with Change of Value (COV) reporting.	COV reports create the most traffic on the BACnet MS/TP databus. Set the COV report rate to the largest value that provides acceptable performance. Only map COV reports for values that are necessary. For mapped analog points that are continuously changing, try increasing the COV increment on these points or set the COV minimum send time flag to true to send the value at a regular frequency.
Do not leave address holes in the device's MAC Address range.	Assign MAC Address to device starting at 3, up to 127. Do not skip addresses. Set the maximum MAC Address in the BACnet MS/TP Series Controller to the final MAC Address number actually installed. *Note: The physical sequence of the MAC Address of the devices on the data bus is unimportant: For example, the MAC Address of devices on the data bus can be 5, 7, 3, 4, 6, and 8.*
Only daisy-chained devices are acceptable.	Eliminate T-taps and star configurations. Use a router to connect a data bus spur.
Connect no more than five devices to a power supply transformer (for 24V controllers).	BACnet MS/TP devices require good power quality.

Table 10-4 *- Troubleshooting Recommendations*

11 Wi-Fi Network Troubleshooting Guide

Any wireless system consists of two or more Wi-Fi transceivers and a radio propagation path (Radio Path). Problems encountered can be any of the following:

Symptoms	Probable Causes	Corrective actions
Wi-Fi communications are non-existent or intermittent	Presence of a low power jammer	If the low power jammer is close to the transceiver antenna, move low power jammer (PC, telephone, etc.) at least 6.5 feet (2 m) away from transceiver antenna.
		Change the Wi-Fi channel on the router. Use a Wi-Fi surveying or Wi-Fi stumbling tool on a laptop computer to identify unused Wi-Fi channels that may provide a better interferenc free radio path.
		Move the BACnet IP Wi-Fi Adapter's position where it has a clear line of sight to the router.
		Move the wireless router's position. Try moving the router to the center of the room where it has a clear line of site to each wireless device.
	Presence of a high power jammer	Remove high power jammer if possible. If not, you will have to accept strong range reduction or add another wireless router closer to the controller(s).
		Use a wired Ethernet connection to the controller.
	Defective BACnet IP Wi-Fi Adapter	Exchange the wireless dongle with another BACnet IP Wi-Fi Adapter. If the dongle is found to be defective, replace the dongle.
	The maximum wireless operating range has been exceeded.	Add another wireless router closer to the controller(s).
	The controller has a known technical issue.	Upgrade the controller's firmware.
The BACnet IP Wi-Fi Adapter has been tested functional and there is no jammer in the field to interfere with the signal.	Radio signal path might be obstructed.	If a new screening or metal separation wall has been installed since the network was set up, try moving the receiver to see if the issue is corrected.
	Router may have a known technical issue.	Upgrade the router's firmware.

Table 11-1 *- Troubleshooting the BACnet IP Wi-Fi Adapter*

12 Hardware Specifications

12.1. DAC

DAC Specifications	
Power	**Voltage**: At least 20VA
	Protection: 1.35A auto-reset feature
	Typical Consumption: 6VA
	Maximum Consumption: 15VA
Environment	**Operating Temperature**: 50°F to 140°F (10°C to 60°C)
	Storage Humidity: -4°F to 158°F (-20°C to 70°C)
	Relative Humidity: 20 to 85%
General	**Standard**: LonMark functional profile: Roof-top unit controller #8030
	Processor: Neuron® 3150® 8 bits; 10MHZ
	Memory: Non-volatile flash 64K (APB application & configuration properties)
	Communication: LonTalk protocol
	Transceiver: FT-X1
	Channel: TP/FT-10; 78Kbps
	Status Indicator: Green LED: power status & LON TX, Orange LED: service and LON TX
	Communication Jack: LON audio jack mono 1/8" (3.5 mm)
Enclosure	**Material**: PC-ABS Thermoplastic
	Color: White
	Dimensions w/ screws: 5.7 x 4.7 x 2.0" (144.8 x 119.4 x 50.8 mm)
	Shipping weight: 0.77lbs (0.35kg)
	Installation: DIN mount installation (see ***Figure 2-1***)

Table 12-1 *- DAC Hardware Specifications*

DAC Specifications	
Inputs	**Quantity**: 6 (pre-configured)
	Input Types: Universal (pre-configured) • **Voltage**: 0-10VDC, Accuracy ±0.5% • **Current**: 4-20mA with 249Ω external resistor (wired in parallel), accuracy ±0.5% • **Digital**: Dry contact • **Resistor**: • ***Thermistor***: Type: 2,3 10KΩ Accuracy: ±0.9°F (±0.5°C) Range: -40°F to 257°F (-40°C to 125°C) Resolution: 0.18°F (0.1°C) • ***Potentiometer***: Translation table configurable on several points Accuracy: ±0.5%
Outputs	**Quantity**: 7 (pre-configured)
	5 Digital: Triac 1.0A @ 24VAC External power supply
	2 Universal: 0-10VDC (linear), digital 0-12VDC (on/off) or PWM PWM output; adjustable period from 2 seconds to 15 minutes 60mA max. @ 12VDC (140°F; 60°C) Maximum load 200Ω **Auto-reset fuse**: 60mA @ 140°F (60°C) 100mA @ 68°F (20°C)
Agency Approvals	**UL Listed (CDN & US)**: UL916 Energy management equipment **FCC**: This device complies with FCC rules part 15, subpart B, class B

Table 12-1 *- DAC Hardware Specifications*

12.2. VAV Controller

VAV Specifications	
Inputs	**Quantity**: 4 universal (software configurable)
	Input Types: • **Digital**: Dry contact • **Analog Voltage**: 24VAC/DC, Accuracy ±15%, Class 2 • **Analog Current**: 0-20mA with 249Ω external resistor wired in parallel • **Resistance/ Thermistor**: • ***Range***: 0 to 350KΩ • ***Supported Thermistor Types****:* Any which operates in 0 to 350KΩ range. • ***Pre-configured Temperature Sensor Types****:* • Thermistor: 10KΩ Type 2, 3 (10KΩ @ 77°F; 25°C) • Platinum: Pt1000 (1KΩ @ 32°F; 0°C) •Nickel: RTD Ni1000 (1KΩ @ 32°F; 0°C), RTD Ni1000 (1KΩ @ 69.8°F; 21°C)
	Differential Pressure Range: ±2.0 in. W.C. (±500 Pa)
	Pressure Sensor Accuracy: ±(0.2 Pa +3% of reading)
	Air Flow Accuracy: ±4.0% @ > 0.05 in. W.C. (12.5 Pa) ±1.5% once calibrated through air flow balancing @ > 0.05 in. W.C. (12.5 Pa)
	Input Resolution: 16-bit analog / digital converter
Outputs	**Quantity**: 6 Hardware (software configurable)
	4 Digital: • **Output Type**: 24VAC Triac • **Maximum Current per Output**: 0.5A continuous, 1A @ 15% duty cycle for a 10-minute period • **Power Source**: External or internal power supply (jumper selectable)
	2 Universal: • **Output Type**: Universal • **Output Resolution**: 10-bit digital to analog converter
Power	• **Voltage Range**: 24VAC/DC; ±15%; Class 2 • **Frequency Range**: 50/60Hz • **Protection**: Field-replaceable fuse • **Fuse Type**: 3.0A • **Power Consumption**: 4 VA typical plus all external loads2, 75 VA max. (including powered triac outputs)
Environmental	• **Operating Temperature**: 32°F to 122°F (0°C to 50°C) • **Storage Humidity**: -4°F to 122°F (-20°C to 50°C) • **Relative Humidity**: 0% to 90% non-condensing
Agency Approvals	**UL Listed (CDN & US)**: UL916 Energy management equipment **FCC**: This device complies with FCC rules part 15, subpart B, class B **CEC Appliance Database**: Appliance Efficiency Program

Table 12-2 *- DAC Hardware Specifications*

12.3. Smart Thermostat Specifications

Smart Thermostat Specifications	
General	**Power**: • **Voltage**: 12VDC maximum, Class 2 **Temperature Sensor**: • **Type**: 10KΩ NTC Thermistor • **Range**: 41°F to 104°F (5°C to 40°C) • **Accuracy**: ± 0.9°F (± 0.5°C) • **Resolution**: 0.18°F (0.1°C) **Humidity Sensor**: • **Accuracy**: ±3% • **Resolution**: 1%
Communications	• **Rate**: 38 400 bps • **Serial Communications**: RS-485 • **Wiring**: Cable length: 600 ft (180 m) maximum • **Cable Type**: T568B Cat 5e network cable, 4 twisted pairs • **Connectors**: • ***IN***: RJ-45 • ***OUT***: RJ-45 (pass-through for daisy chain connection to other room devices) • ***Network Access Jack***: 1/8 in. (3.5 mm) stereo plug connector •***Daisy-chaining***: Up to 12 Smart Thermostat
Environmental	• **Operating Temperature**: 32°F to 122°F (0°C to 50°C) • **Storage Humidity**: -4°F to 122°F (-20°C to 50°C) • **Relative Humidity**: 0% to 90% non-condensing
Enclosure	• **Material**: ABS • **Rating**: Plastic Housing, UL94-V1 • **Color**: White
Agency Approvals	**UL Listed (CDN & US)**: UL916 Energy management equipment **FCC**: This device complies with FCC rules part 15, subpart B, class B **CE:** • **Emission**: EN 61000-6-3:2007 2007; Generic standards for residential, commercial and light-industrial environments • **Immunity**: EN 61000-6-1:2007; Generic standards for residential, commercial and light-industrial environments

Table 12-3 *- Smart Thermostat Hardware Specifications*

13 Maintenance

WARNING! Unplug the device before any kind of servicing.

The device requires minimal maintenance, but it is important to take note of the following:

- If it is necessary to clean the outside of the device, use a dry cloth.
- Re-tighten terminal connector screws annually to ensure the wires remain securely attached.

13.1. Disposal

The Waste Electrical and Electronic Equipment (WEEE) Directive set out regulations for the recycling and disposal of products. The WEEE2002/96/EG Directive applies to standalone products, for example, products that can function entirely on their own and are not part of another system or piece of equipment.

For this reason, Emerson products are exempt from the WEEE Directive. Nevertheless, Emerson products are marked with WEEE symbol  , indicating devices are not to be thrown away in municipal waste. Products must be disposed at the end of their useful life according to local regulations and the WEEE Directive.

13.2. Troubleshooting Guide

Controller is powered but does not turn on	
Fuse has blown	Disconnect the power. Check the fuse integrity. Reconnect the power.
Power supply polarity	Verify that consistent polarity is maintained between all controllers and the transformer. Ensure that the 24V COM terminal of each controller is connected to the same terminal on the secondary side of the transformer. See ***Section 3, Powering***.
Controller cannot communicate on BACnet MS/TP Network	
Absent or incorrect supply voltage	1. Check power supply voltage between 24VAC ±15% and 24VCOM pins and ensure that it is within acceptable limits. 2. Check for tripped fuse or circuit breaker.
Overloaded power transformer	Verify that the transformer used is powerful enough to supply all controllers.
Network not wired properly	Double check that the wire connections are correct.
Absent or incorrect network termination	Check the network termination(s).
Max Master parameter	Configure the maximum number of master devices on the MS/TP network in all devices to the controller's highest MAC address used on the MS/TP trunk.
There is another controller with the same 5 MAC Address on the BACnet MS/TP data bus	Each controller on a BACnet MS/TP data bus must have a unique MAC Address. Look at the MAC Address DIP switch on the faceplate or under the cover of the controller. If it is set to 0 (all off), use the Smart Thermostat to check the MAC Address.
There is another controller with the same Device ID on the BACnet intranetwork.	Each controller on a BACnet Intranetwork (the entire BACnet BAS network) must have a unique Device ID. Use the Smart Thermostat to check the Device ID of each controller.

Table 13-1*- VAV Troubleshooting*

Controller communicates well over a short network, but does not communicate on large network	
Network length	Check that the total wire length does not exceed the specifications of the Network Guide.
Wire type	Check that the wire type agrees with specifications.
Network wiring problem	Double check that the wire connections are correct.
Absent or incorrect network termination	Check the network termination(s). Incorrect or broken termination(s) will make the communication integrity dependent upon a controller's position on the network.
Number of controllers on network segment exceeded	The number of controllers on a channel should never exceed 50. Use a router or a repeater in accordance with specifications.
Max Master parameter	Configure the maximum number of master devices on the MS/TP network in all devices to the controller's highest MAC address used on the MS/TP trunk.
There is another controller with the same MAC Address on the BACnet MS/TP data bus.	Each controller on a BACnet MS/TP data bus must have a unique MAC Address. Look at the MAC Address DIP switch on the faceplate or under the cover of the controller. If it is set to 0 (all off), use the Smart Thermostat to check the MAC Address.
There is another controller with the same Device ID on the BACnet Intranetwork	Each controller on a BACnet Intranetwork (the entire BACnet BAS network) must have a unique Device ID. Use the Smart Thermostat to check the Device ID of each controller.
Hardware input is not reading the correct value	
Input wiring problem	Check that the wiring is correct according to this manual and according to the peripheral device's manufacturer.
Configuration problem	Check the configuration of the input.
Over-voltage or over-current at an input	An over-voltage or over-current at one input can affect the reading of other inputs. Follow the allowed voltage / current range limits of all inputs.
Open circuit or short circuit	Using a voltmeter, check the voltage on the input terminal.
Hardware output is not operating correctly	
Fuse has blown (Auto reset fuse)	Disconnect the power and outputs terminals. Then wait a few seconds to allow the auto-reset fuse to cool down. Check the power supply and the output wiring. Reconnect the power.
Output wiring problem	Check that the wiring is correct according to this manual and according to the peripheral device's manufacturer.
Configuration problem	Check the configuration of the input.
0 to 10V output, 24VAC powered actuator is not moving.	Check the polarity of the 24VAC power supply connected to the actuator while connected to the controller. Reverse the 24VAC wire if necessary.
Wireless devices not working correctly	
Device not associated to controller	Check the configuration of the input.
Power discharge	1. Recharge the device with light (if solar-powered) or replace battery (if battery-powered). 2. Ensure sufficient light intensity (200lx for 4 hours/day).
Device too far from the Wireless Receiver	Reposition the device to be within the range of the Wireless Receiver.
Configuration problem	Using the device configuration plug-in wizard, check the configuration of the input.
Flow sensor is not giving proper readings	
Tubing connection problem	Ensure the tubing is installed properly and that the tubing is not bent.
Controller is not calibrated properly	Recalibrate the controller.

Table 13-1*- VAV Troubleshooting*

Damper is not opening or closing properly	
Mechanical stops not in proper position	Two mechanical stops must be positioned to stop the damper motion when it is completely closed and completely opened. The mechanical stops can be moved by increment of 5°.
Controller in Override	Set the Override to OFF in the wizard.
Rx/Tx LEDs	
RX LED not blinking	Data is not being received from the BACnet MS/TP data bus.
TX LED not blinking	Data is not being transmitted onto the BACnet MS/TP data bus.
Status LED– Normal Operation	
One fast blink 	Initialization: The device is starting up.
Fast blink continuous:  (150ms On, 150ms Off, continuous)	Firmware upgrade in progress. Controller operation is temporarily unavailable. The new firmware is being loaded into memory. This takes a few seconds. *Do not interrupt power to the device during this time*.
The Status LED is always OFF	The controller is operating normally.
Status LED blink patterns – Repeats every 2 seconds (highest priority shown first)	
Long Long Long blink  (800ms On, 300ms Off, 800ms On, 300ms Off, 800ms On)	The device has not received a BACnet token, and therefore cannot communicate on the network: Verify that the controller's MAC Address is unique on the BACnet MS/TP Data Bus – see Device Addressing. Make sure the controller's BAUD rate is the same as the BACnet MS/TP Data Bus BAUD rate (see Setting the BAUD Rate (optional). Verify that the Max Master is set high enough to include this controller's MAC Address.
Short Short Long blink  (150ms On, 300ms Off, 150ms On, 300ms Off, 800 ms On)	Poor-quality power; The device has experienced a brown-out: The voltage at the 24VAC and 24VCOM terminals has gone below the device's acceptable limit during power up.
Short Long blink  (150ms On, 300ms Off)	Invalid MAC address: The device's MAC address is set to zero (0) or is set to an address higher than the Max Master.

Table 13-1*- VAV Troubleshooting*

Appendix A: Flow Calibration (VAV Series)

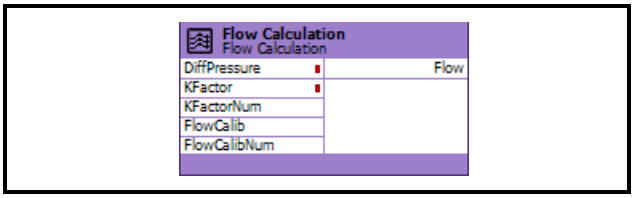


Figure A - 1 *- Flow Calibration*

Description

Used to calculate the airflow based on the differential pressure according to the following formula:

FLOW = Kfactor* sqrt(Differential Pressure)

Advanced configuration

Configure Ports, Show/Hide Ports

Related Blocks

Diff Pressure (VAV Series), VAV Differential Pressure

Input(s)

Port	Type	Range	Description
DiffPressure	Numeric	0 to 500Pa 0 to 2inches water column	Used to calculate the airflow based on the differential pressure. The input typically comes from the Diff Pressure (VAV Series) or VAV Differential Pressure Block.
KFactor	Numeric	0 to 3.4028×10^{38}	Sets the Kfactor provided by the VAV box / Pitot tube manufacturer. In imperial units, the Kfactor represents the airflow in CFM at 1 inch of water column. In SI (Metric units), the Kfactor represents the airflow in liter per second at 1 Pascal. When the Kfactor input is linked to an Analog Value block, the Flow Calculation block can assign the Kfactor it has calculated from the FlowCalib input to the Analog Value block.

Port	Type	Range	Description
KFactorNum	Numeric	0 to 100	When the Kfactor input is linked to an Analog Value block, it should be connected to the block's Number output. Doing so allows the Flow Calculation block to assign the Kfactor it has calculated from the FlowCalib input to the Analog Value block. See ***Figure A -2***.
FlowCalib	Numeric	3.4028×10^{38}	Used to calibrate the airflow reading. To use the flow calibration feature, see ***Figure A -2***. When this input equals 0, the block calculates the flow according to the following calculation: **FLOW = Kfactor* sqrt(Differential Pressure)** When this input is greater than 0, the airflow reading is calibrated according to the following calculation: **Kfactor = FlowCalib/sqrt(Differential Pressure)** The following is the typical calibration procedure: 1. Open the VAV box to the preferred position (typically 85%). 2. Use a capture hood/flow hoof to record the airflow that is passing through the VAV box. 3. Enter the measured air flow at this input.
FlowCalib Num	Numeric	0 to 100	When the FlowCalib input is linked to an Analog Value block, it must be connected to the block's Number output. Doing so allows the Flow Calculation block to reset the value in the Analog Value block to 0 once the flow calibration is complete. See ***Figure A -2***.

Output(s)

Port	Type	Range	Description
Flow	Numeric	0 to 3.4028×10^{38}	Actual airflow rate.

Block Properties

See Common block properties.

Flow Calculation block example:

If only Diff Pressure (VAV Series) / VAV Differential Pressure and Kfactor block inputs are linked, this block will output the flow. If you want to use the FlowCalib option, all block inputs must be linked and:

- The Kfactor input must be linked to an Analog Value block.
- The KfactorNum input must be linked to the Number port of the Analog Value block linked to the Kfactor input.
- The FlowCalib input must be linked to an Analog Value block.
- The FlowCalibNum input must be linked to the Number port of the Analog Value block linked to the FlowCalib input.

When the FlowCalib and Kfactor inputs are linked to Analog Value blocks, and the calibration is complete, the Flow Calculation block sets the value of the Analog Value block connected to the FlowCalib input to 0 and assigns the newly calculated Kfactor value to the Analog Value block linked to the Kfactor input.

To calibrate the Kfactor in the example below, set the FlowCalib Analog Value block to the measured air flow (measured with a flow hood).

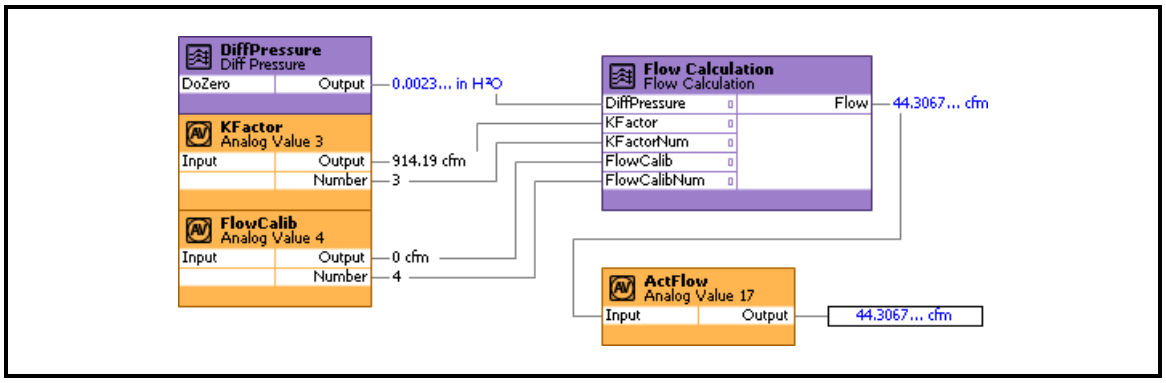


Figure A -2 *- Flow Calculation Block Example*

Appendix B: Setting up a Fan Powered Box and Operation

FAN CONTROL:

Depending on the type of fan powered box, the fan is controlled with the following sequence. Minimum on and minimum off delays prevent the fan from short cycling. Fan control always outputs on DO4.

Series Fan:

The fan is started by the following conditions:

- Occupancy is in occupied or bypass mode.
- Occupancy is in unoccupied or standby mode and duct heating is required.
- Occupancy is in unoccupied or standby mode where cooling is required and main air handling unit is active.

The damper actuator is closed before starting the fan to prevent the fan from running backwards.

The fan powered boxes have a minimum on and minimum off delays prevent the fan from short cycling.

Parallel Fan:

The fan is started by the following conditions:

- Duct heating is required.
- Main air flow is lower that PFanStartFlowSP (AV55) during occupied or bypass period.

Heating:

When the air is suitable for heating the space, ActFlowSP varies between MinFlowHeatSP and MaxFlowHeatSP. Otherwise, when the air is too cold, ActFlowSP is by default equal to MinFlowHeatSP.

When Occupancy Status is in unoccupied or standby mode, MinFlowSP and MinFlowHeatSP are replaced by either MinFlowUnoccSP or MinFlowStbySP.

The damper is controlled by DamperCmd and is based on the control variables described in the subsections below.

The system uses DuctInTemp (AV6) and the temperature setpoint average (ActCoolSP and ActHeatSP) to evaluate whether the inlet temperature is suitable for cooling or heating the space. If HVACModeStatus is in morning warm up, the air is by default considered suitable for heating the space.

Setting up the VAV using the Smart Thermostat

1. Access the Smart Thermostat.
2. Hold the middle button for five (5) seconds. When the value 10000 appears, change it to 9995 and press Enter.
3. Units - cfm (press Up or Down until you see cfm then press Enter.)
4. FLOWS - 100 min Cool, 600 max Cool, 100 min Heat, 400 max Heat, 0 stby, 0 unocc, 125 pfanflow min sp., exit
5. IN config - code= 32
6. Gen confg - MAC address= unit number,
   subnet= 1, baud rate= 38400, space temp cal, contrast= 100
7. No need to go into Bal (This is for the test and balance) or Ovr (This will allow you to override valve, heat, etc.).

Wiring

1. Verify Fan Output is wired to D04 and Fan Relay is wired on Terminals 2 and 5, not on 4 and 5.
2. Verify Heat SCR relay is wired to UO5 0 to 10 VDC.
3. D01 used for HEAT1, D02 used for HEAT2.

	VAV					
	Parameter	**Binary Code**	**Default**	**Valid Choices**		**Descriptions**
VAV Configuration	BOX TYPE	0	x	1	SDUC	Single Duct VAV
		1		2	SFAN	Series Fan Single Duct VAV
	DUCTHEATER	0		1	NONE	No Duct Heater Reheat
		192		4	3ST	Duct Heater Reheat on Heat Sources 1, 2, & 3
	HEATPRIO	0		1	DUCT	Duct Heating 1st
		4		2	PERI	Perimeter Heating 1st
	DUAL MAX	256		1	YES	Box is using Dual Maximum Control Settings
	HWREHEAT	32		1	YES	Duct Heater Reheat by Hot Water Coil
	VVTMODE	8192		1	YES	Box is not using Flow Input
	FLOATVLVPER	512		2	125 sec	125 sec drive time
		1024		3	150 sec	150 sec drive time
		1536		4	25 sec	25 sec drive time
		2048		5	30 sec	30 sec drive time
		2560		6	50 sec	50 sec drive time
		3072		7	60 sec	60 sec drive time
		3584		8	Custom	Drive time controlled by CustomFloatTime (AV64)
	PWMVLVPER	4096		2	5.2	0.1 to 5.2 sec
	DAMPERDIR	16		1	CCW	Damper Direction Counter Clockwise (CCW)
	Default VAV Code	**72**				

	VAV					
	Parameter	**Binary Code**	**Default**	**Valid Choices**		**Descriptions**
Input Configuration	UI1TYPE	1	x	2	SPAC	Room Temperature Sensor
		2		3	OCC	Occupancy Detection
		3		4	CONT	Window Contact
	UI2TYPE	4		2	DISC	Discharge Air Temperature Sensor
		8		3	OCC	Occupancy Detection
		12		4	CONT	Window Contact
		16	x	5	SETP	Room Temperature Setpoint Offset
	UI3TYPE	0	x	1	NONE	Not Configured
		64		3	OCC	Occupancy Detection
		96		4	CONT	Window Contact
		128		5	FAN	Fan Powered Box Status
	UI4TYPE	256		2	CO24	4-20mA CO2 Sensor (0-2000 ppm)
		512		3	CO25	0-5V CO2 Sensor (0-2000 ppm)
	COMSENS SP	1024		2	OFFS	Room Temperature Setpoint Offset
	SENSORS TYPE	2048		2	10-3	Sensors are 10K Type III
		4096		3	1000	Sensors are PT 1000
		6144		4	NI0C	Sensors are NI 1000 @0°C
		8192		5	NI22	Sensors are NI 1000 @22°C
	Default Input Code	**17**				

	VAV					
	Parameter	**Binary Code**	**Default**	**Valid Choices**		**Descriptions and Output Wiring Details**
Output Configuration	HEAT1	0		1	NONE	No Reheat
		2		3	PWM TRIAC	Modulating PWM on DO1 and AO5
		3		4	PWM VLV	PWM Valve on DO1
		4		5	THERM VLV	Thermal Valve on DO1
		6		7	2-10V	Modulating 2-10V on AO5
		7		8	FLOAT VLV	Floating Valve (120 sec drive time) on DO1 and DO2
	HEAT2	0		1	NONE	No Reheat
		16		3	PWM TRIAC	Modulating PWM on (DO2 or DO3) and AO6
		24		4	PWM VLV	PWM Valve on DO2 or DO3
		32		5	THERM VLV	Thermal Valve on DO2 or DO3
		40		6	0-10V	Modulating 0-10V on AO6
		48		7	2-10V	Modulating 2-10V on AO6
		56		8	FLOAT VLV	Floating Valve on DO2 & DO3 or (DO3 and DO4)
	HEAT3	64		2	DIG	Digital Reheat on DO3 or DO4
		128		3	PWM TRIAC	Modulating PWM on DO3 or DO4
		192		4	PWM VLV	PWM Valve on DO3 or DO4
		256		5	THERM VLV	Thermal Valve on DO3 or DO4
	HT1 NORM OPEN	512		1	YES	Heating1 Normally Open Valve
	HT2 NORM OPEN	1024		1	YES	Heating2 Normally Open Valve
	HT3 NORM OPEN	2048		1	YES	Heating3 Normally Open Valve
	Default Output Code	**9**				

Appendix C: BACnet MS/TP Tables of Configuration Codes

The configuration codes of each controller mode are presented in the tables below. An example is given in the table below illustrating how to calculate a configuration code based on the desired configuration parameters. For example, the BACnet MS/TP inputs will be configured to have the following characteristics:

Input	Binary Code	Description of Binary Code
Universal Input 1	1	Space Temperature
Universal Input 2	4	Discharge Air Temperature
Universal Input 3	64	Occupancy Detection
Universal Input 4	0	Not Configured
Communication Sensor Setpoint	0	Cooling and Heating Setpoint
Sensors Type	0	Sensors are 10K Type II

The total of the binary codes is 69, which is the code to enter in the Input Configuration submenu that results in the inputs above.

For a full list of all the configuration codes per controller mode, refer to the table below:

	BACnet MS/TP					
	Parameter	**Binary Code**	**Default**	**Valid Choices**		**Descriptions**
BACnet MS/TP Configuration	BOX TYPE	0	x	1	SDUC	Single Duct VAV
		1		2	SFAN	Series Fan Single Duct VAV
		2		3	PFAN	Parallel Fan Single Duct VAV
	DUCTHEATER	0		1	NONE	No Duct Heater Reheat
		64	x	2	1ST	Duct Heater Reheat on Heat Source 1
		128		3	2ST	Duct Heater Reheat on Heat Sources 1 & 2
		192		4	3ST	Duct Heater Reheat on Heat Sources 1, 2, & 3
	HEATPRIO	0		1	DUCT	Duct Heating 1st
		4		2	PERI	Perimeter Heating 1st
		8	x	3	BOTH	Both Heating Simultaneously
	DUAL MAX	0	x	0	NO	Box is not using Dual Maximum Control Settings
		256		1	YES	Box is using Dual Maximum Control Settings
	HWREHEAT	0	x	0	NO	Duct Heater is not Hot Water Coil
		32		1	YES	Duct Heater Reheat by Hot Water Coil
	VVTMODE	0	x	0	NO	Box is using Flow Input
		8192		1	YES	Box is not using Flow Input
	FLOATVLVPER	0	x	1	95 sec	95 sec drive time
		512		2	125 sec	125 sec drive time
		1024		3	150 sec	150 sec drive time
		1536		4	25 sec	25 sec drive time
		2048		5	30 sec	30 sec drive time
		2560		6	50 sec	50 sec drive time
		3072		7	60 sec	60 sec drive time
		3584		8	Custom	Drive time controlled by CustomFloatTime (AV64)

	BACnet MS/TP					
	Parameter	**Binary Code**	**Default**	**Valid Choices**		**Descriptions**
BACnet MS/TP Configuration	PWMVLVPER	0 4096	x	1 2	25.5 5.2	0.1 to 25.5 sec 0.1 to 5.2 sec
	DAMPERDIR	0 16	x	0 1	CW CCW	Damper Direction Clockwise (CW) Damper Direction Counter Clockwise (CCW)
	Default VAV Code	**72**				

	BACnet MS/TP					
	Parameter	**Binary Code**	**Default**	**Valid Choices**		**Descriptions**
Input Configuration	UI1TYPE	0		1	NONE	Not Configured
		1	x	2	SPAC	Room Temperature Sensor
		2		3	OCC	Occupancy Detection
		3		4	CONT	Window Contact
	UI2TYPE	0		1	NONE	Not Configured
		4		2	DISC	Discharge Air Temperature Sensor
		8		3	OCC	Occupancy Detection
		12		4	CONT	Window Contact
		16	x	5	SETP	Room Temperature Setpoint Offset
	UI3TYPE	0	x	1	NONE	Not Configured
		32		2	DISC	Discharge Air Temperature Sensor
		64		3	OCC	Occupancy Detection
		96		4	CONT	Window Contact
		128		5	FAN	Fan Powered Box Status
	UI4TYPE	0	x	1	NONE	Not Configured
		256		2	CO24	4-20mA CO2 Sensor (0-2000 ppm)
		512		3	CO25	0-5V CO2 Sensor (0-2000 ppm)
	COMSENS SP	0	x	1	DUAL	Cooling and Heating Setpoint via EC-Smart-Vue
		1024		2	OFFS	Room Temperature Setpoint Offset
	SENSORS TYPE	0	x	1	10-2	Sensors are 10K Type II
		2048		2	10-3	Sensors are 10K Type III
		4096		3	1000	Sensors are PT 1000
		6144		4	NI0C	Sensors are NI 1000 @0°C
		8192		5	NI22	Sensors are NI 1000 @22°C
	Default Input Code	**17**				

	BACnet MS/TP					
	Parameter	**Binary Code**	**Default**	**Valid Choices**		**Descriptions and Output Wiring Details**
Output Configuration	HEAT1	0		1	NONE	No Reheat
		1	x	2	DIG	Digital Reheat on DO1
		2		3	PWM TRIAC	Modulating PWM on DO1 and AO5
		3		4	PWM VLV	PWM Valve on DO1
		4		5	THERM VLV	Thermal Valve on DO1
		5		6	0-10V	Modulating 0-10V on AO5
		6		7	2-10V	Modulating 2-10V on AO5
		7		8	FLOAT VLV	Floating Valve (120 sec drive time) on DO1 and DO2
	HEAT2	0		1	NONE	No Reheat
		8	x	2	DIG	Digital Reheat on DO2 or DO3
		16		3	PWM TRIAC	Modulating PWM on (DO2 or DO3) and AO6
		24		4	PWM VLV	PWM Valve on DO2 or DO3
		32		5	THERM VLV	Thermal Valve on DO2 or DO3
		40		6	0-10V	Modulating 0-10V on AO6
		48		7	2-10V	Modulating 2-10V on AO6
		56		8	FLOAT VLV	Floating Valve on DO2 & DO3 or (DO3 and DO4)
	HEAT3	0	x	1	NONE	No Reheat
		64		2	DIG	Digital Reheat on DO3 or DO4
		128		3	PWM TRIAC	Modulating PWM on DO3 or DO4
		192		4	PWM VLV	PWM Valve on DO3 or DO4
		256		5	THERM VLV	Thermal Valve on DO3 or DO4
	HT1 NORM OPEN	0	x	0	NO	Heating1 Normally Close Valve
		512		1	YES	Heating1 Normally Open Valve
	HT2 NORM OPEN	0	x	0	NO	Heating2 Normally Close Valve
		1024		1	YES	Heating2 Normally Open Valve
	HT3 NORM OPEN	0	x	0	NO	Heating3 Normally Close Valve
		2048		1	YES	Heating3 Normally Open Valve
	Default Output Code	**9**				

Appendix D: BACnet IP Table of Configuration Codes

The configuration codes of each controller mode are presented in the tables below. An example is given in the table below illustrating how to calculate a configuration code based on the desired configuration parameters. For example, the BACnet IP inputs will be configured to have the following characteristics:

Input	Binary Code	Description of Binary Code
Universal Input 1	1	Space Temperature
Universal Input 2	4	Discharge Air Temperature
Universal Input 3	64	Occupancy Detection
Universal Input 4	0	Not Configured
Communication Sensor Setpoint	0	Cooling and Heating Setpoint
Sensors Type	0	Sensors are 10K Type II

The total of the binary codes is 69, which is the code to enter in the Input Configuration submenu that results in the inputs above.

For a full list of all the configuration codes per controller model, refer to the table below:

	BACnet IP					
	Parameter	Binary Code	Default	Valid Choices		Descriptions
BACnet IP Configuration	BOX TYPE	0	x	1	SDUC	Single Duct BACnet MS/TP
		1		2	SFAN	Series Fan Single Duct BACnet MS/TP
		2		3	PFAN	Parallel Fan Single Duct BACnet MS/TP

	BACnet IP					
	Parameter	**Binary Code**	**Default**	**Valid Choices**		**Descriptions**
BACnet IP Configuration	DUCTHEATER	0		1	NONE	No Duct Heater Reheat
		64	x	2	1ST	Duct Heater Reheat on Heat Source 1
		128		3	2ST	Duct Heater Reheat on Heat Sources 1 & 2
		192		4	3ST	Duct Heater Reheat on Heat Sources 1, 2, & 3
	HEATPRIO	0		1	DUCT	Duct Heating 1st
		4		2	PERI	Perimeter Heating 1st
		8	x	3	BOTH	Both Heating Simultaneously
	DUAL MAX	0	x	0	NO	Box is not using Dual Maximum Control Settings
		256		1	YES	Box is using Dual Maximum Control Settings
	HWREHEAT	0	x	0	NO	Duct Heater is not Hot Water Coil
		32		1	YES	Duct Heater Reheat by Hot Water Coil
	VVTMODE	0	x	0	NO	Box is using Flow Input
		8192		1	YES	Box is not ussing Flow Input
	FLOATVLVPER	0	x	1	95 sec	95 sec drive time
		512		2	125 sec	125 sec drive time
		1024		3	150 sec	150 sec drive time
		1536		4	25 sec	25 sec drive time
		2048		5	30 sec	30 sec drive time
		2560		6	50 sec	50 sec drive time
		3072		7	60 sec	60 sec drive time
		3584		8	Custom	Drive time controlled by CustomFloatTime (AV64)
	DAMPERDIR	0	x	0	CW	Damper Direction Clockwise (CW)
		16		1	CCW	Damper Direction Counter Clockwise (CCW)
	Default BACnet MS/TP Code	**72**				

	BACnet IP					
	Parameter	**Binary Code**	**Default**	**Valid Choices**		**Descriptions**
Input Configuration	UI1TYPE	0		1	NONE	Not Configured
		1	x	2	SPAC	Room Temperature Sensor
		2		3	OCC	Occupancy Detection
		3		4	CONT	Window Contact
	UI2TYPE	0		1	NONE	Not Configured
		4		2	DISC	Discharge Air Temperature Sensor
		8		3	OCC	Occupancy Detection
		12		4	CONT	Window Contact
		16	x	5	SETP	Room Temperature Setpoint Offset
	UI3TYPE	0	x	1	NONE	Not Configured
		32		2	DISC	Discharge Air Temperature Sensor
		64		3	OCC	Occupancy Detection
		96		4	CONT	Window Contact
		128		5	FAN	Fan Powered Box Status
	UI4TYPE	0	x	1	NONE	Not Configured
		256		2	CO24	4-20mA CO2 Sensor (0-2000 ppm)
		512		3	CO25	0-5V CO2 Sensor (0-2000 ppm)
	COMSENS SP	0	x	1	DUAL	Cooling and Heating Setpoint via EC-Smart-Vue
		1024		2	OFFS	Room Temperature Setpoint Offset
	SENSORS TYPE	0	x	1	10-2	Sensors are 10K Type II
		2048		2	10-3	Sensors are 10K Type III
		4096		3	1000	Sensors are PT 1000
		6144		4	NI0C	Sensors are NI 1000 @0°C
		8192		5	NI22	Sensors are NI 1000 @22°C
	Default Input Code	**17**				

	BACnet IP					
	Parameter	**Binary Code**	**Default**	**Valid Choices**		**Descriptions and Output Wiring Details**
Output Configuration	HEAT1	0		1	NONE	No Reheat
		1	x	2	DIG	Digital Reheat on DO1
		2		3	PWM TRIAC	Modulating PWM on DO1 and AO5
		3		4	RESERVED	RESERVED
		4		5	THERM VLV	Thermal Valve on DO1
		5		6	0-10V	Modulating 0-10V on AO5
		6		7	2-10V	Modulating 2-10V on AO5
		7		8	FLOAT VLV	Floating Valve (120 sec drive time) on DO1 and DO2
	HEAT2	0		1	NONE	No Reheat
		8	x	2	DIG	Digital Reheat on DO2 or DO3
		16		3	PWM TRIAC	Modulating PWM on (DO2 or DO3) and AO6
		24	-	4	RESERVED	RESERVED
		32		5	THERM VLV	Thermal Valve on DO2 or DO3
		40		6	0-10V	Modulating 0-10V on AO6
		48		7	2-10V	Modulating 2-10V on AO6
		56		8	FLOAT VLV	Floating Valve on DO2 & DO3 or (DO3 and DO4)
	HEAT3	0	x	1	NONE	No Reheat
		64		2	DIG	Digital Reheat on DO3 or DO4
		128		3	PWM TRIAC	Modulating PWM on DO3 or DO4
		192		4	RESERVED	RESERVED
		256		5	THERM VLV	Thermal Valve on DO3 or DO4
	HT1 NORM OPEN	0	x	0	NO	Heating1 Normally Close Valve
		512		1	YES	Heating1 Normally Open Valve
	HT2 NORM OPEN	0	x	0	NO	Heating2 Normally Close Valve
		1024		1	YES	Heating2 Normally Open Valve
	HT3 NORM OPEN	0	x	0	NO	Heating3 Normally Close Valve
		2048		1	YES	Heating3 Normally Open Valve
	Default Output Code	**9**				

	BACnet IP					
	Parameter	**Binary Code**	**Default**	**Valid Choices**		**Descriptions**
Input Configuration	UI1TYPE	0	x	1	NONE	Not Configured
		1		2	SPAC	Room Temperature Sensor
		2		3	OCC	Occupancy Detection
		3		4	CONT	Window Contact
	UI2TYPE	0	x	1	NONE	Not Configured
		4		2	DISC	Discharged Air Temperature Sensor
		8		3	OCC	Occupancy Detection
		12		4	CONT	Window Contact
		16		5	SETP	Room Temperature Setpoint Offset
	UI3TYPE	0	x	1	NONE	Not Configured
		32		2	DISC	Discharge Air Temperature Sensor
		64		3	OCC	Occupancy Detection
		96		4	CONT	Window Contact
		128		5	FAN	Fan Powered Box Status
	UI4TYPE	0	x	1	NONE	Not Configured
		256		2	CO24	4-20mA CO2 Sensor (0-2000 ppm)
		512		3	CO25	0-5V CO2 Sensor (0-2000 ppm)
	COMSENS SP	0	x	1	DUAL	Cooling and Heating Setpoint via EC-Smart-Vue
		1024		2	OFFS	Room Temperature Setpoint Offset
	SENSORS TYPE	0	x	1	10-2	Sensors are 10K Type II
		2048		2	10-3	Sensors are 10K Type III
		4096		3	1000	Sensors are PT 1000
		6144		4	NI0C	Sensors are NI 1000 @0°C
		8192		5	NI22	Sensors are NI 1000 @22°C
	Default Input Code	**17**				

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