LonWorks VAV Control Network Installation and Operation Manual

EMERSON™

026-1200 Rev 1

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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.

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), LonWorks 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 E2 Echelon Network and the RS485 Modbus Network (***Figure 1-1***).

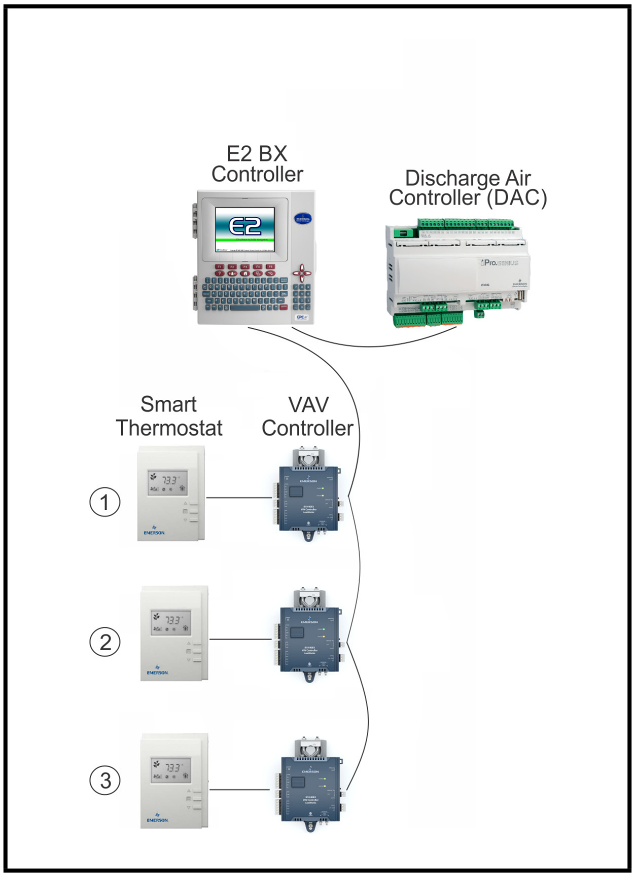


Figure 1-1 - *VAV Control Network - Daisy Chain*

1.1. LonWorks 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).

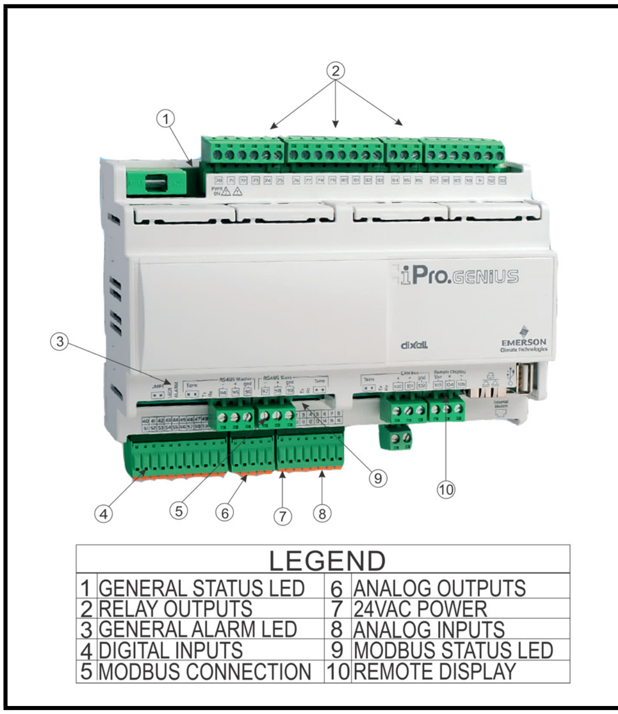


Figure 1-2 - *DAC*

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. LonWorks VAV (810-8003)

Figure 1-3 - *VAV Controller*

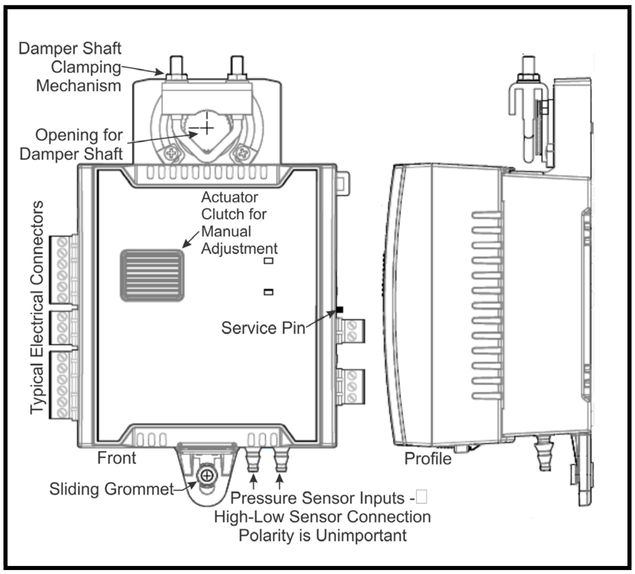


Figure 1-4 - *VAV Controller (Diagram)*

The LonWorks VAV is a programmable microprocessor-based controller designed to control any variable air volume box, including cooling, parallel and series fan, and cooling with reheat VAV boxes. The LonWorks VAV controller features various input types including resistance, voltage, and digital-based.

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

The controller uses the LonTalk® communication protocol and is LONMARK certified as an SCCVAV.

1.1.3. VAV Smart Thermostat (809-8002)

Figure 1-5 - *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.

1.1.4. 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 x 4” x 1-1/2” (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 1-1 *- DAC Kit Components*

1.1.5. LonWorks VAV Box Kit (810-8011)

VAV Box Kit Components	
Quantity	**Description**
1	LonWorks VAV Controller (810-8003)
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)
1	Insertion Probe (201-2009)

Table 1-2 *- 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.

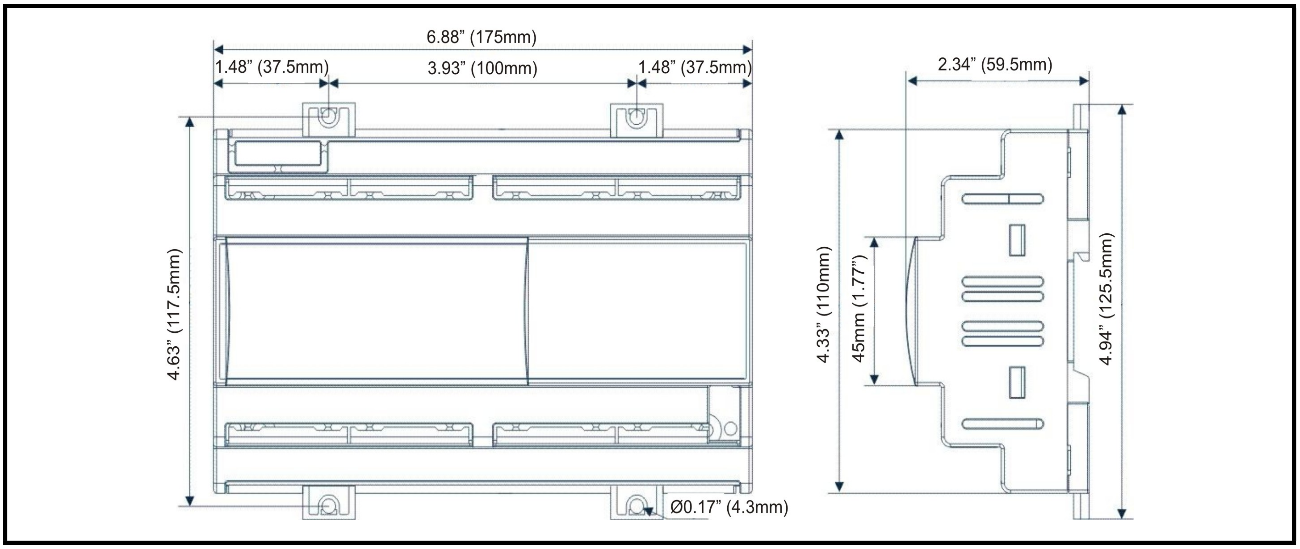


Figure 2-1 *- DIN Mounting*

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

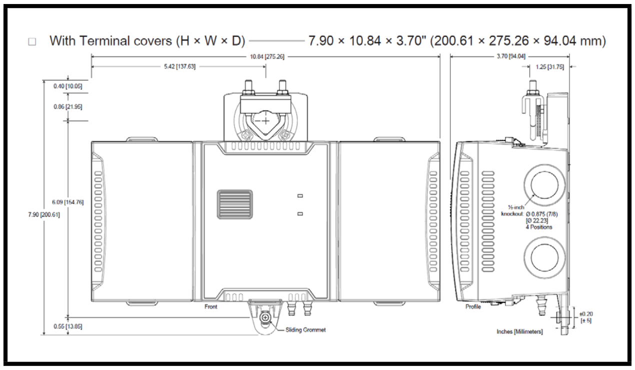


Figure 2-2 - VAV Controller Dimensions

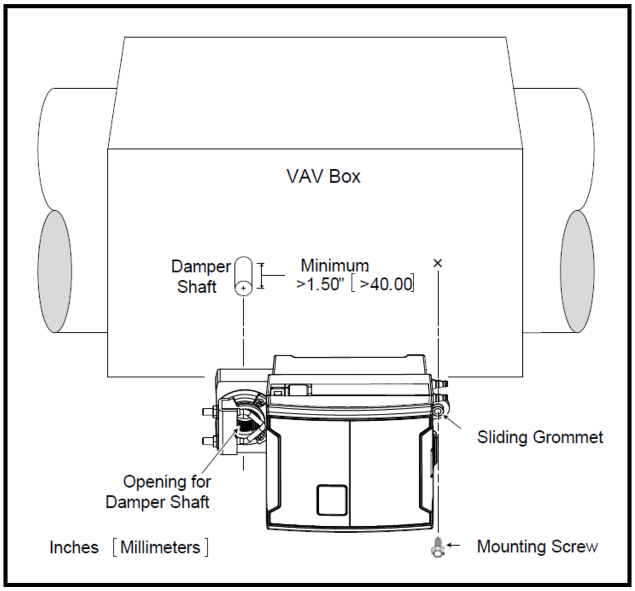


Figure 2-3 - VAV Damper Shaft Standard Mounting Diagram

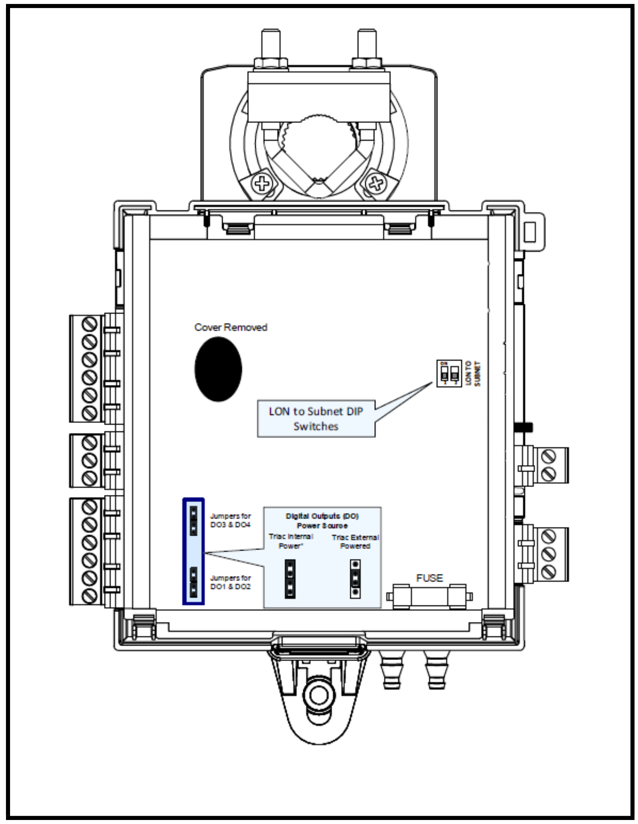


Figure 2-4 - VAV DIP Switch Configuration

The LonWorks VAV 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 LonWorks 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.

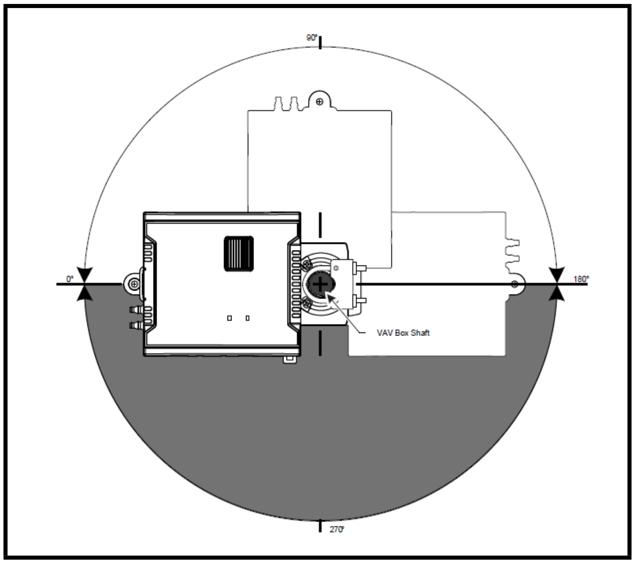


Figure 2-5 - *Mounting Position Angle Range*

1. The VAV 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*

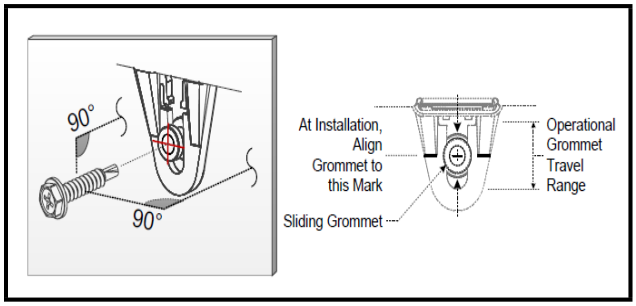


Figure 2-7 - *Supplied Mounting Hardware*

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.

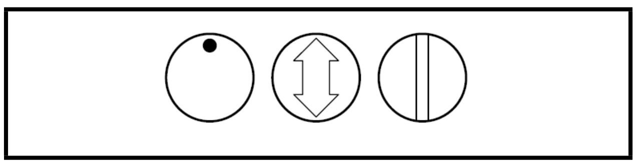


Figure 2-8 - *Typical Damper Shaft End Marking*

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” (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. LonWorks VAV Environmental Ratings

The LonWorks VAV 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

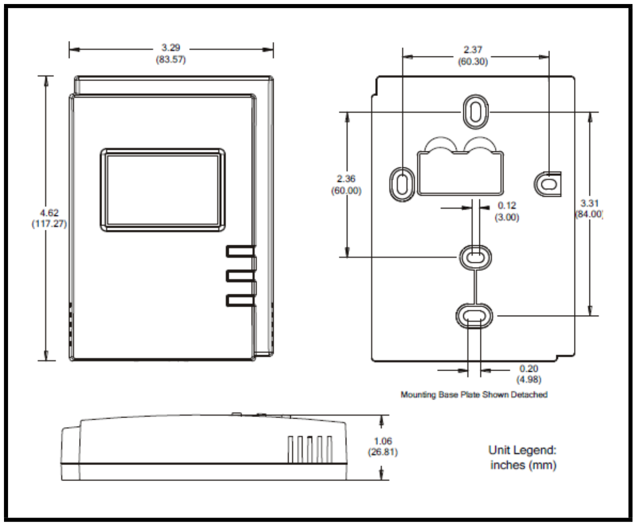


Figure 2-9 *- Smart Thermostat Dimensions*

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

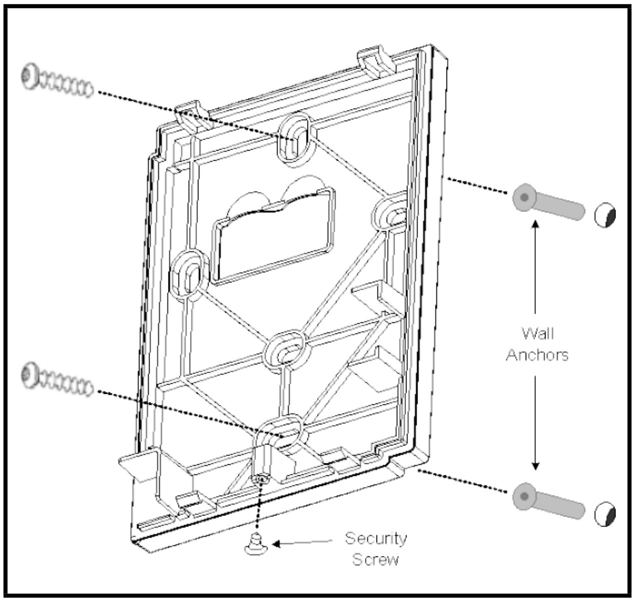


Figure 2-10 *- Smart Thermostat Mounting - Device Components*

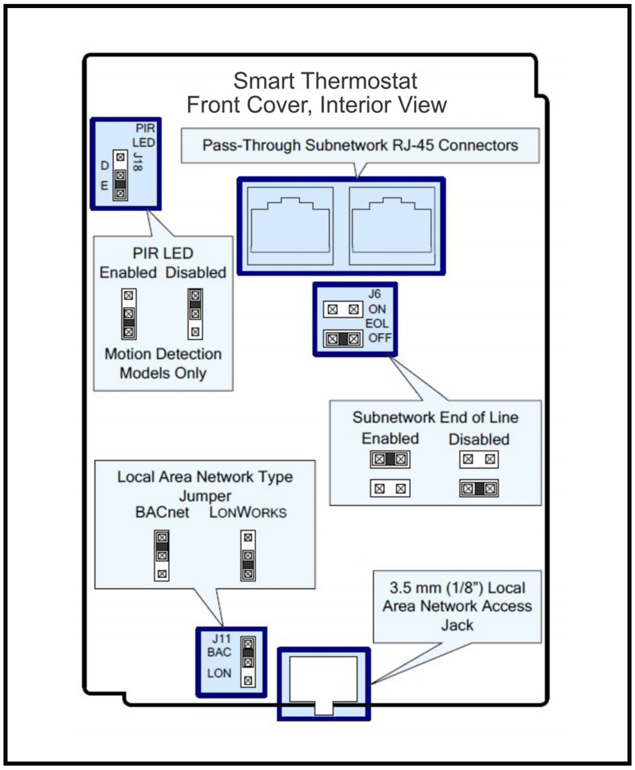


Figure 2-11 *- Connector and Jumper Locations*

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.

<u>*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.*</u>

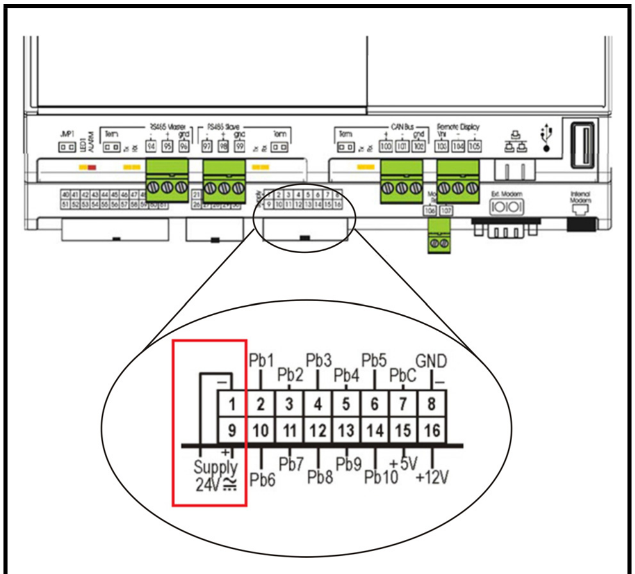


Figure 3-1 - *Non-Center-Tapped Transformer Wiring*

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; <u>*however, it is important NOT to exceed this maximum wire length or the controller will not operate correctly.*</u>

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 3-3 - *Power Wire Length*

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

3.2. LonWorks VAV

The LonWorks VAV 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 14 AWG 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***

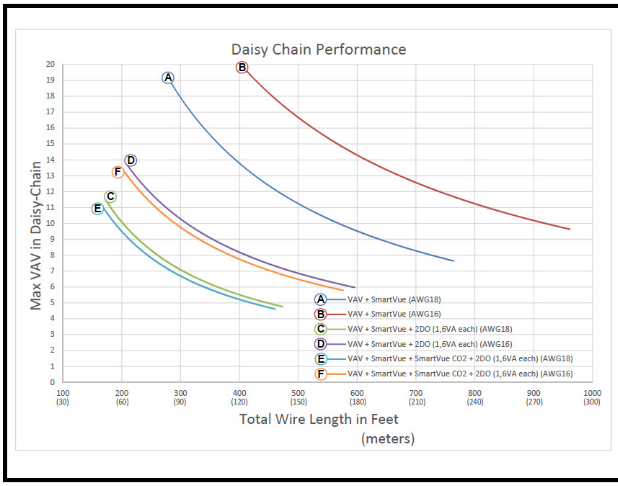


Figure 3-2 *- Maximum Number of VAV Devices on a Daisy-Chain at Evenly Spaced Intervals*

> ***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. The COM terminals of all controllers and peripherals should be connected to the same terminal on the secondary side of the transformer.

> ***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.***

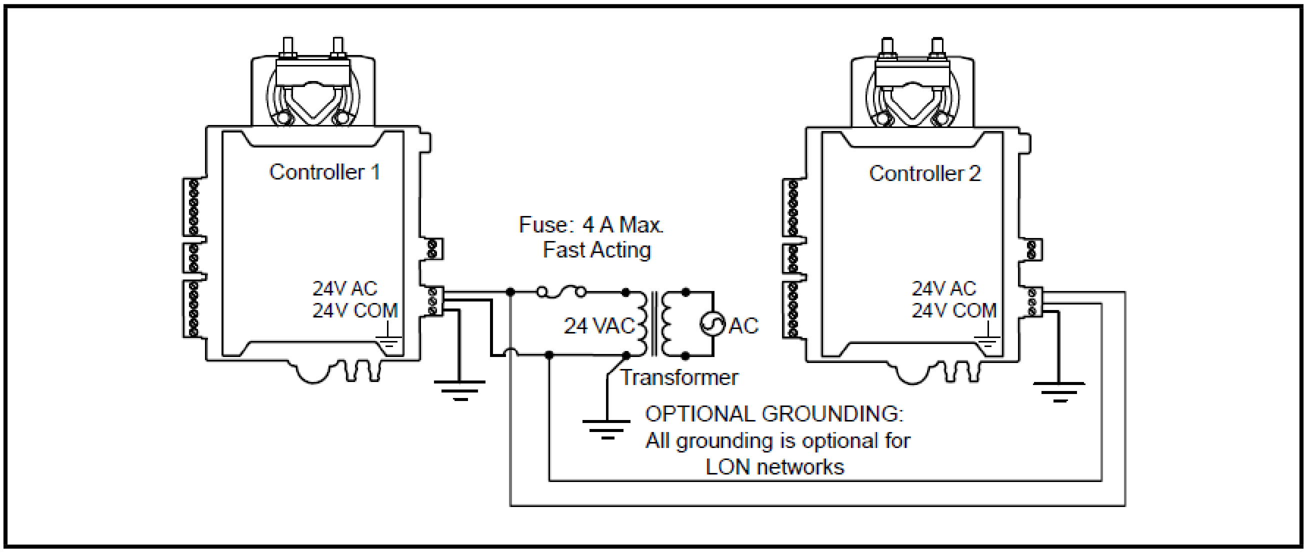


Figure 3-3 *- Power Wiring*

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.

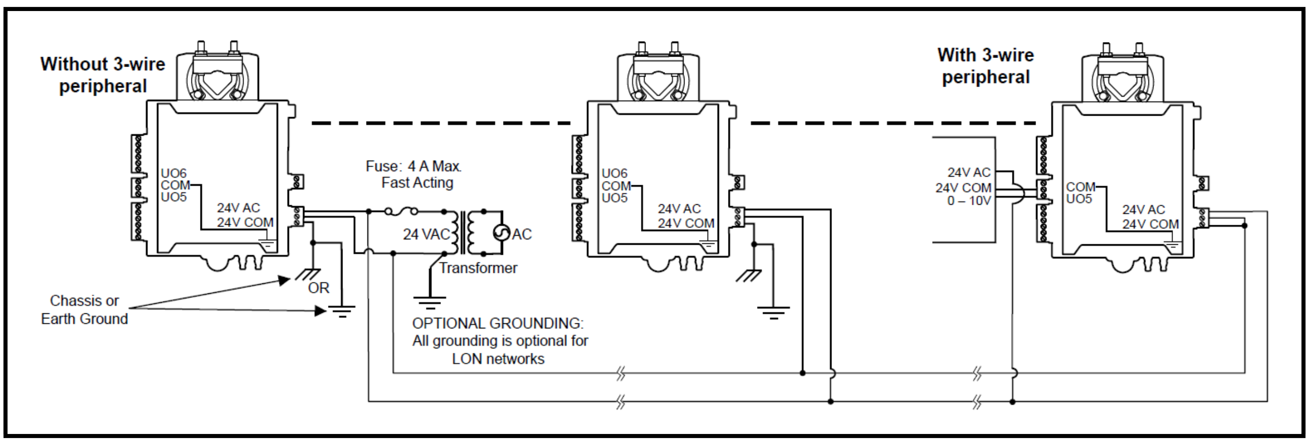


Figure 3-4 *- VAV Power Wiring with and Without 3-Wire Peripherals*

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
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*

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 LonWorks VAV Controller

The Lonworks VAV 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 18AWG 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.

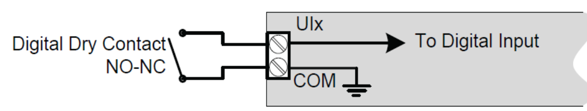
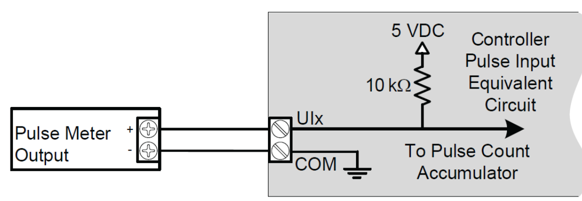
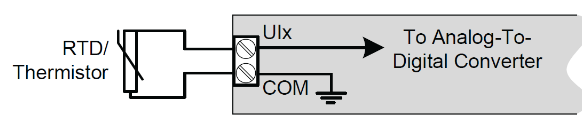
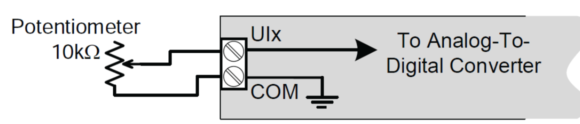
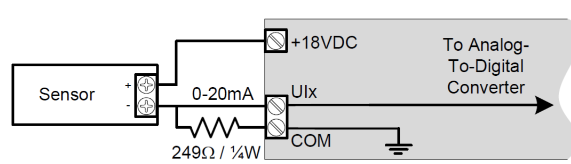
Sensor Input Type	Input Designation	Input Connection Diagram
• Dry Contact input. • Pulsed input	UIx	
• Pulse input used with a 2-wire sensor powered by its own power source – this input supports a maximum input frequency of 1Hz (500ms minimum ON/OFF). • Connect the pulse input according to the figure 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*

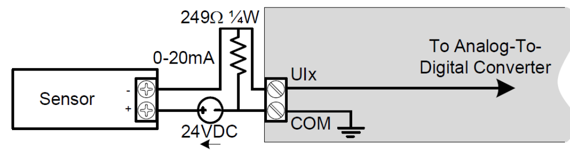
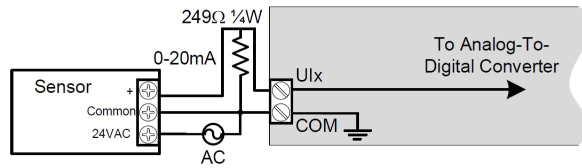
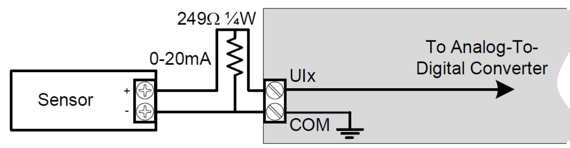
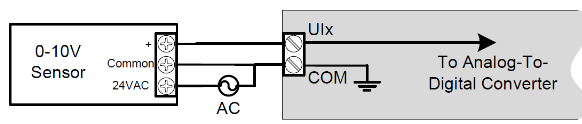
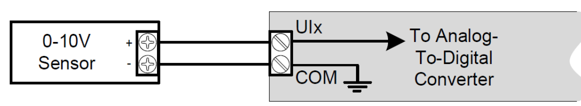
Sensor Input Type	Input Designation	Input Connection Diagram
• 0 to 20mA input used with a 2-wire, 0 to 20mA sensor powered by an external 24 AC/DC power supply. • Connect a 249Ω resistor between the UIx and COM terminals.	UIx	
• 0 to 20mA input used with a 3-wire, 0 to 20mA sensor powered by an external 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. To wire the sensor, connect a Cat5 cable between the sensor and the LonWorks VAV.

5 Output Wiring

5.1. DAC

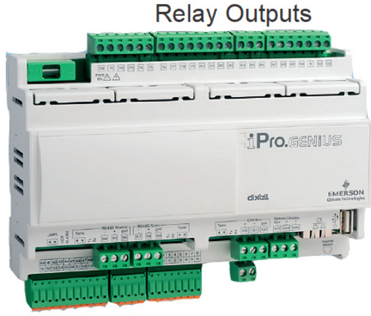


***Figure 5-1** - DAC Output Locations*

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 LonWorks 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) long, either a shielded or unshielded 18AWG 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.

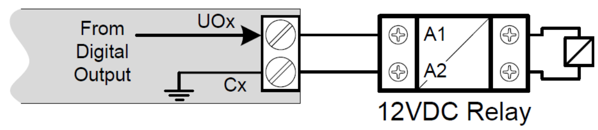
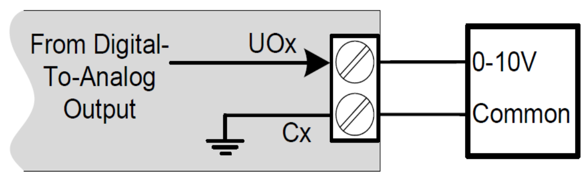
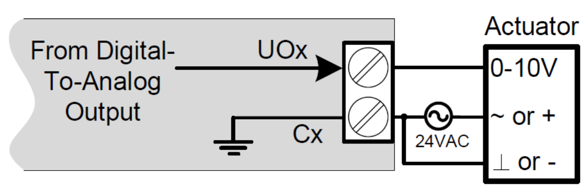
Control Output Type	Output Designation	Output Connection Diagram
• Discrete 0 or 12VDC digital, Pulse, or PWM output controlling a 12VDC relay.	UOx	
• 0 to 10VDC voltage output.	UOx	
• 0 to 10VDC voltage output controlling an analog actuator that is powered by an external 24VAC power source. • This output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

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

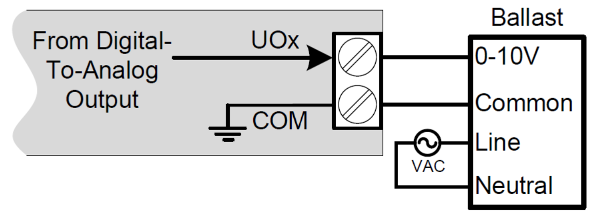
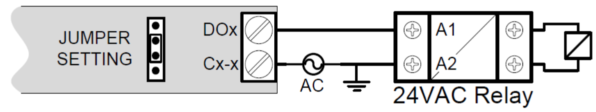
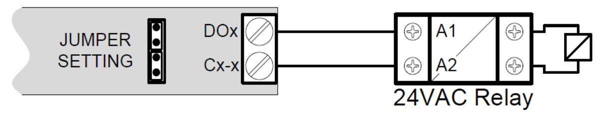
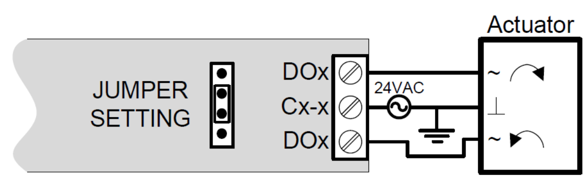
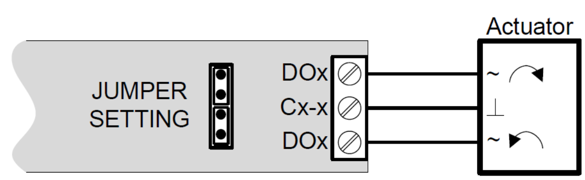
Control Output Type	Output Designation	Output Connection Diagram
• 1 to 10VDC voltage output controlling dimmable lighting ballasts that require a current sink output (pull-down). • This output can sink up to 2.5mA.	UOx	
• Discrete digital, Pulse, or PWM output: 24VAC externally-powered triac controlling 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 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.

6.1. 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.

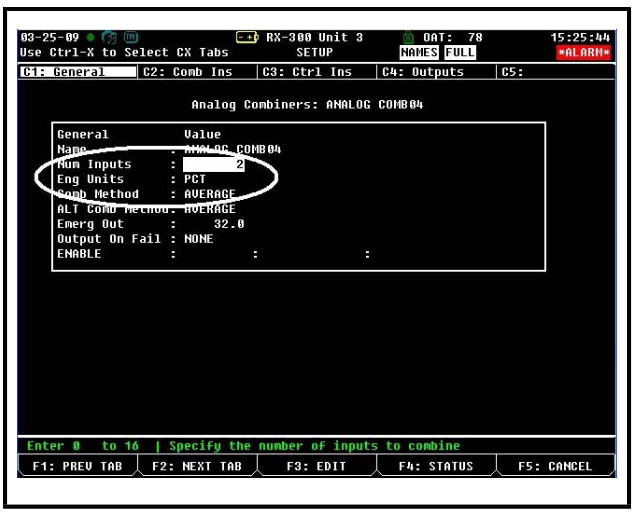


Figure 6-1 *- Analog Combiner General Setup Screen*

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.

6.2. 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.

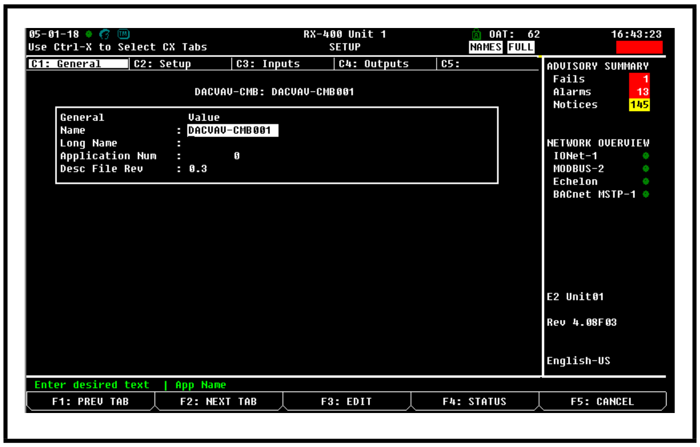


Figure 6-2 *- DAC-VAV Combiner General Setup Screen*

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.

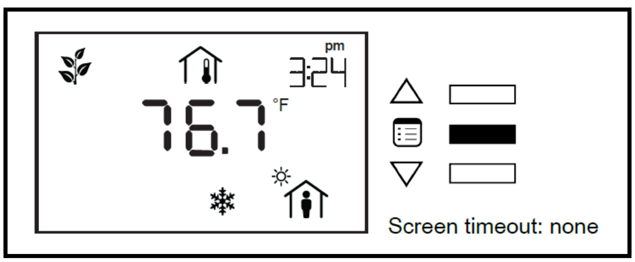
7 Smart Thermostat Screen-by-Screen Guide

7.1. Adjusting the Setpoints and Display Units

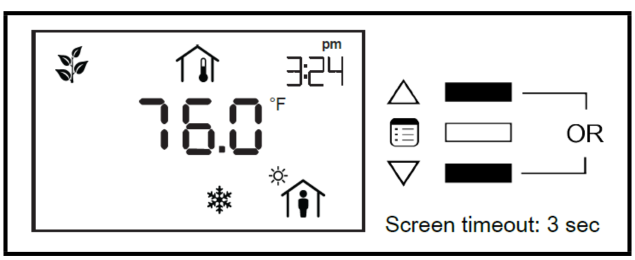
When a controller is in occupied or bypass mode, the active setpoint can be adjusted using the Smart Themostat's arrow keys. Alternatively, the heating and cooling setpoints can be adjusted from the sensor's User menu. The User menu also allows modifying the display units. The User menu is not password protected.

To enter into the User menu and make changes to the setpoints or display units:

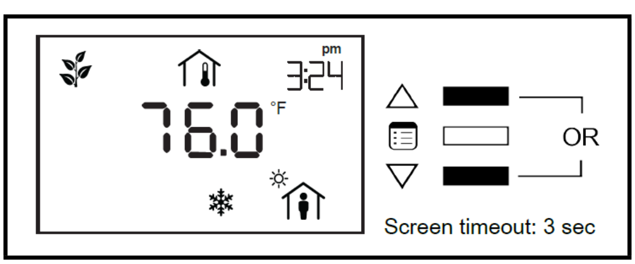
1. Press the **Menu** button once.



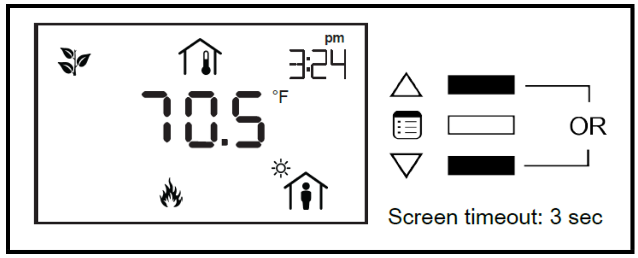
2. The cooling setpoint starts blinking. Use the arrow keys to increase or decrease the cooling setpoint.



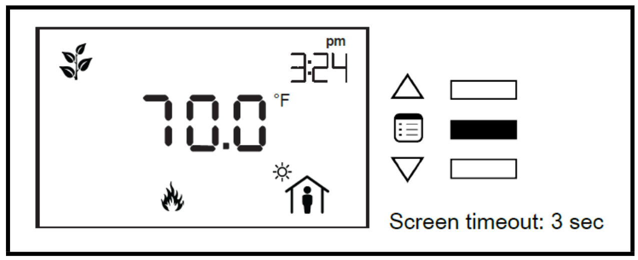
3. Press the **Menu** button to submit the new cooling setpoint.



4. The heating setpoint starts blinking. Use the arrow keys to increase or decrease the heating setpoint.

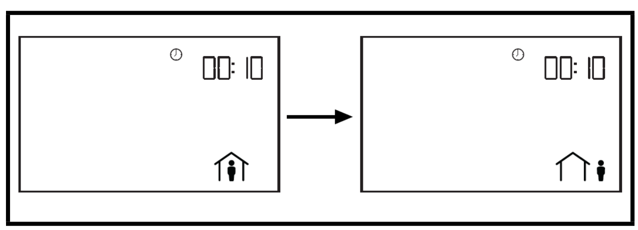


5. Press the **Menu** button to submit the new heating setpoint.

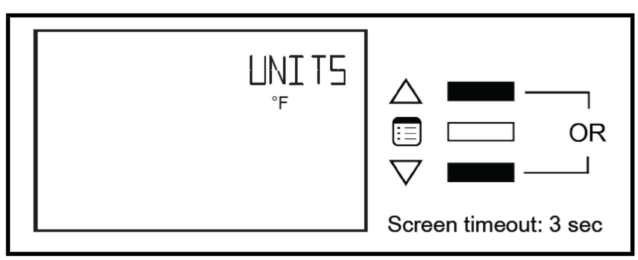


If the controller is in occupied mode, the Units submenu appears. Otherwise, the Bypass submenu appears with the option to manually end the bypass mode. After the Bypass submenu, the Units submenu appears.

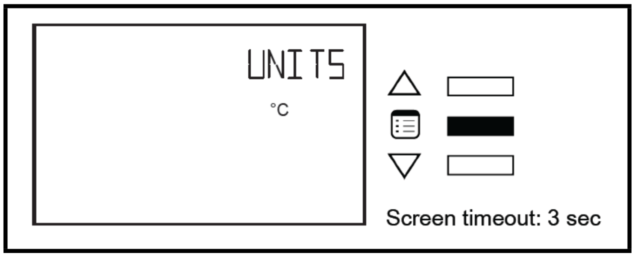
NOTE: To manually end the bypass mode, press on one of the arrow keys to modify the occupancy icon on the screen. Then press the Menu button.



6. Use the arrow keys to select the temperature display units.



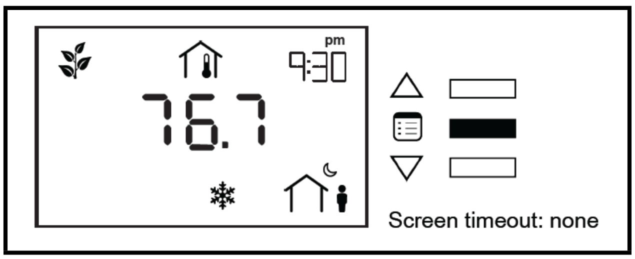
7. Press the **Menu** button to submit the selected display unit.



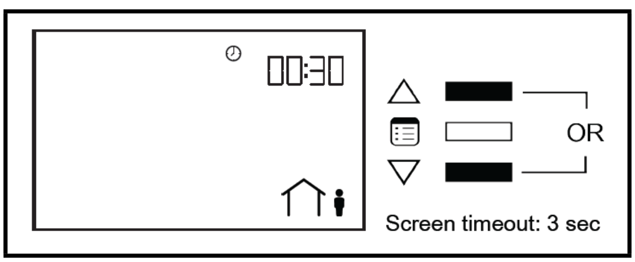
7.1.1. How to Put a Controller Into Bypass Mode

To change a controller's occupancy mode from standby or unoccupied to bypass mode:

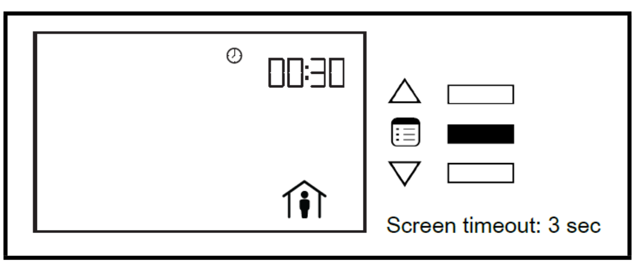
1. Press the **Menu** button once.



2. The Bypass submenu appears. Press on one of the arrow keys to modify the occupancy icon on the screen.



3. Press the **Menu** button.



The controller goes into bypass mode. When in bypass mode, the Smart Thermostat screen displays the current time and also the remaining bypass time.

7.2. Setting Up the Parameters and Calibrating the Sensor

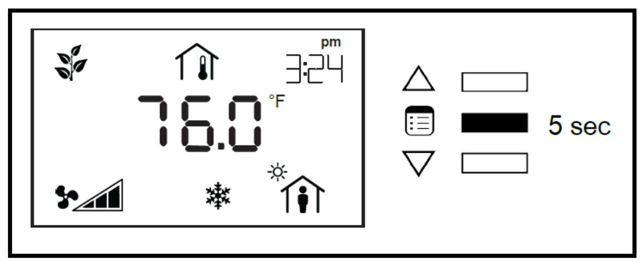
From the Smart Themostat's General Configuration submenu, the sensor's subnet ID can be set. In addition, other functions can be carried out such as calibrating the Smart Thermostat's space temperature and humidity sensor, verifying the Device ID and adjusting the screen contrast.

NOTE: This procedure also allows you to calibrate the humidity sensor if your Smart Thermostat is equipped with this option.

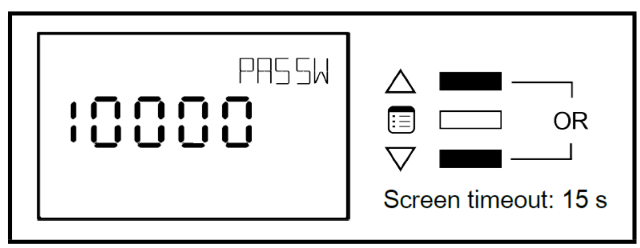
7.2.1. How to Enter the General Configuration Submenu

To enter the advanced menus:

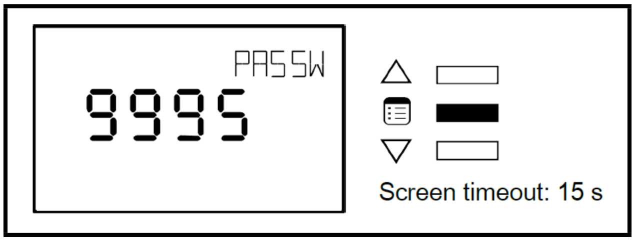
1. Hold the **Menu** button for five (5) seconds:



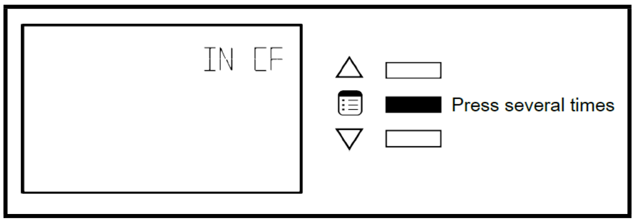
2. The password field will appear. Use the arrow keys to increase or decrease the displayed number until it matches the configured password.



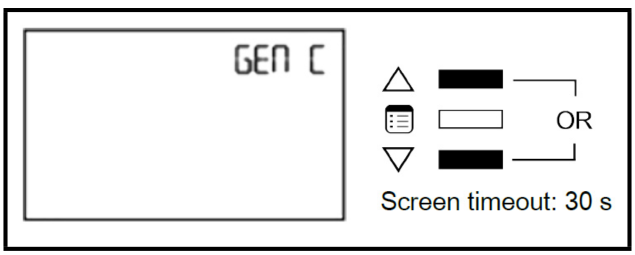
3. The default password is 9995. Press the **Menu** button to submit the password.



4. Once the correct password has been submitted, the advanced menu will display. Press the **Menu** button several times until **GEN CFG** appears on the display.

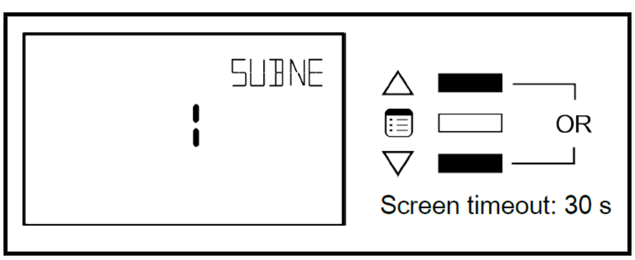


5. Press either of the arrow keys to enter the General Configuration submenu.

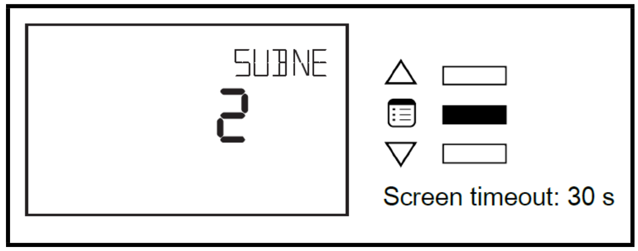


7.2.2. How to Enter the Sensor Subnet ID and View the Device ID

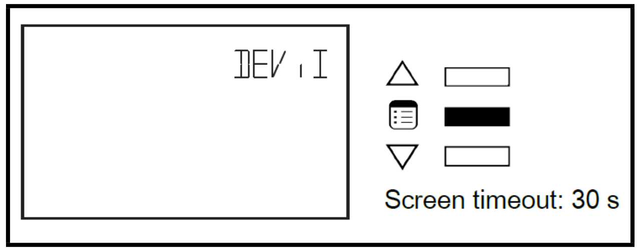
1. Press either of the arrow keys to choose the desired **Subnet ID** for the sensor.



2. Press the **Menu** button to submit the desired Subnet ID.



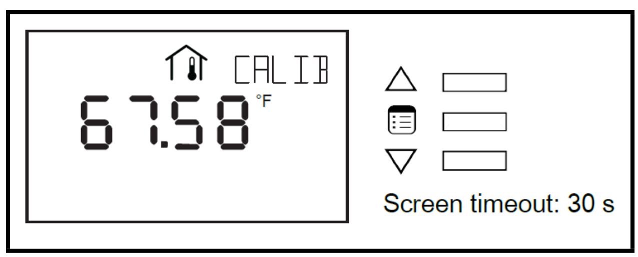
3. Upon selection, the **DEVICE ID** appears on the display. Press the **Menu** button once you have finished viewing the Device ID.



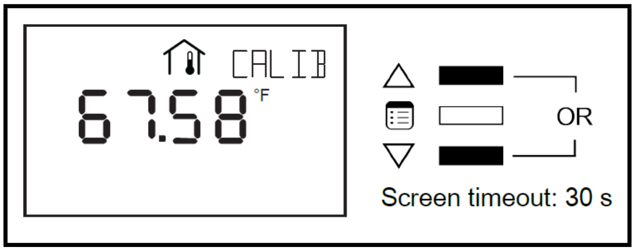
7.2.3. How to Calibrate the Sensor and Adjust the Screen Contrast

The General Configuration submenu also allows the calibration of the Smart Thermostat's space temperature sensor or humidity sensor (if equipped) and adjustment of the screen contrast. To perform these two functions:

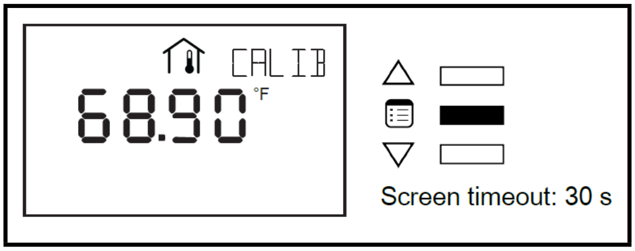
1. In the **GEN CFG** submenu, navigate to the Calibration parameter.



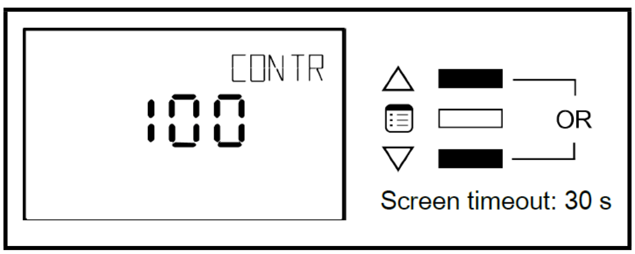
2. The screen displays the current indoor space temperature. Use the arrow keys to modify this reading to make it match that measured by the reference temperature sensor.



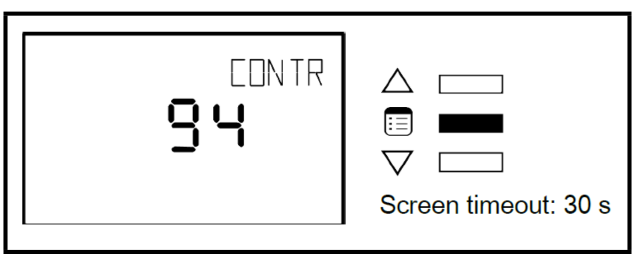
3. Press the **Menu** button to submit the calibrated temperature reading.



4. Once submitted, humidity sensor calibration will appear if the Smart Thermostat model is equipped with one. Otherwise Contrast parameter appears. Use the arrow keys to adjust the screen contrast.

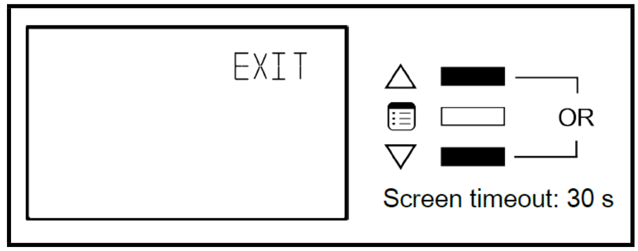


5. The Contrast parameter ranges from 0 to 100, where smaller values give a dimmer contrast than larger ones. Press the **Menu** button to submit the new contrast level. The screen contrast changes according to the new value submitted.



7.2.4. How to Exit the Submenu

1. Press the **Menu** button several times until the Exit screen appears. Then press either of the arrow keys.



2. Press and hold the **Menu** button for five (5) seconds.

7.3. Configuring the VAV

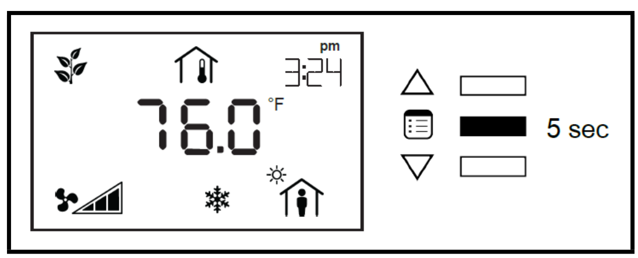
The VAV configuration parameters of an LonWorks VAV controller can be found in the VAV Configuration submenu of the Advanced menu. Through this submenu, various selections can be made, such as a controller's fan powered box type, number of duct heater reheat stages, and VVT operation mode.

The following instructions explain how to configure a controller's VAV parameters one by one. For instructions on how to configure them all at once using configuration codes, see ***Submitting New Configuration Codes using the VAV Smart Thermostat***.

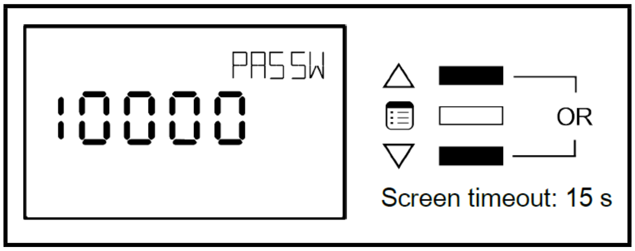
7.3.1. How to Enter the VAV Configuration Submenu and Select a Controller's VAV Parameters

To enter the advanced menus:

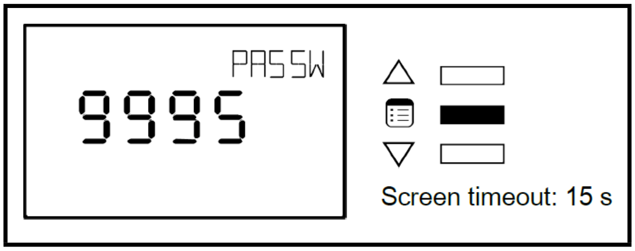
1. Hold the **Menu** button for five (5) seconds:



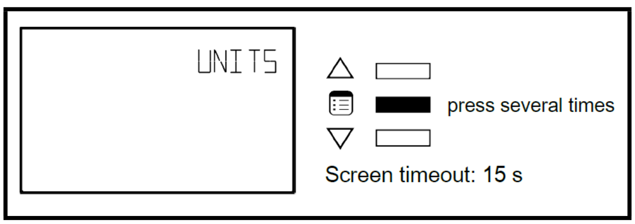
2. The password field will appear. Use the arrow keys to increase or decrease the displayed number until it matches the configured password.



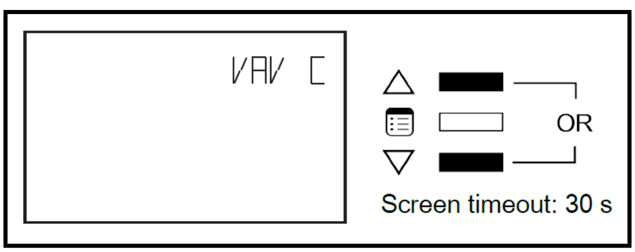
3. The default password is 9995. Press the **Menu** button to submit the password.



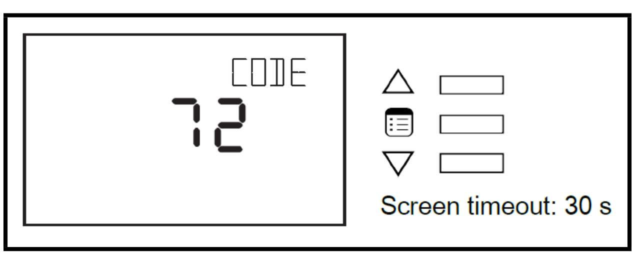
4. Once the correct password has been submitted, the advance menu will display.



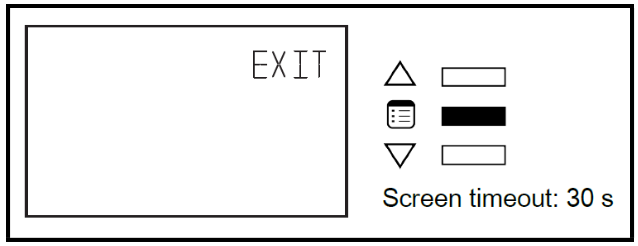
5. Press the **Menu** button several times until **VAV CFG** appears on the display.



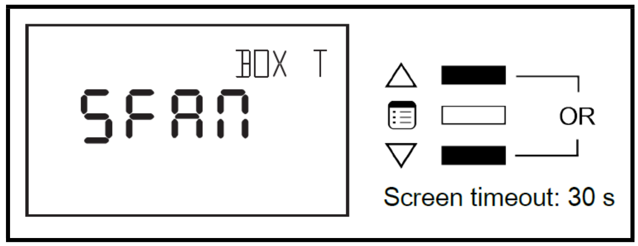
6. Once the VAV Configuration submenu has been entered, the Code parameter will appear.



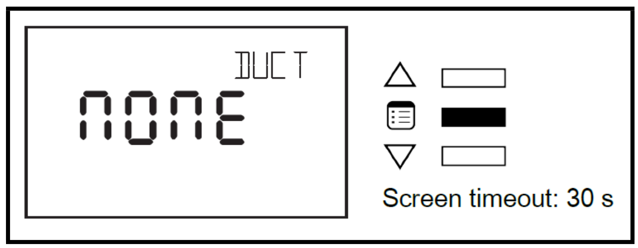
7. To scroll between the different parameters in the VAV Configuration submenu, press the **Menu** button.



8. To modify a parameter, use the arrow keys.



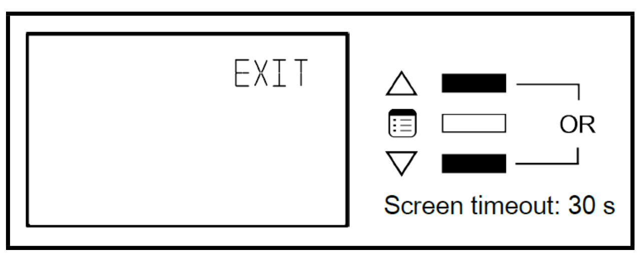
9. To submit a modified parameter, press the **Menu** button. The next VAV Configuration submenu parameter is displayed.



For more information refer to ***Table 7-1***.

7.3.2. How to Exit the Submenu

1. Press the **Menu** button several times until the Exit screen appears. Then press either of the arrow keys.



2. Press and hold the **Menu** button for five (5) seconds.

7.3.3. Configuration Parameters for VAV

Parameter		Valid Choices			Descriptions
CODE	VAV Box Code				VAV Box Configuration Code Entry
BOX TYPE	Box Type	0	SdUC	SDUC	Single Duct VAV
BOX TYPE	Box Type	1	SFAn	SFAN	Series Fan Single Duct VAV
BOX TYPE	Box Type	2	PFAn	PFAN	Parallel Fan Single Duct VAV
DUCT HT	Duct Heater Stages	0	nonE	NONE	No Duct Heater Reheat
DUCT HT	Duct Heater Stages	1	1 St	1 ST	Duct Heater Reheat on Heat Source 1
DUCT HT	Duct Heater Stages	2	2 St	2 St	Duct Heater Reheat on Heat Sources 1 & 2
DUCT HT	Duct Heater Stages	3	3 St	3 St	Duct Heater Reheat on Heat Sources 1, 2, & 3
HTPRIO	Heat Priority	0	dUCt	DUCT	Duct Heating 1st
HTPRIO	Heat Priority	1	PEri	PERI	Perimeter Heating 1st
HTPRIO	Heat Priority	2	bOtH	BOTH	Both Heating Simultaneously
DUAL MAX	Dual Maximum Flow Control	0	nO	NO	Box is not using Dual Maximum Control Settings
DUAL MAX	Dual Maximum Flow Control	1	YES	YES	Box is using Dual Maximum Control Settings
HWREHEAT	Hot Water Reheat	0	nO	NO	Duct Heater is not Hot Water Coil
HWREHEAT	Hot Water Reheat	1	YES	YES	Duct Heater Reheat by Hot Water Coil
VVTMODE	VVT Mode	0	nO	NO	Box is using Flow Input
VVTMODE	VVT Mode	1	YES	YES	Box is not Using Flow Input

Table 7-1 *- Configuration Parameters for VAV*

Parameter		Valid Choices			Descriptions
FLOATVLV	Floating Valve Drive Time		Edit	EDIT	
		0	95 S		95 seconds drive time
		1	125 S		125 seconds drive time
		2	150 S		150 seconds drive time
		3	25 S		25 seconds drive time
		4	30 S		30 seconds drive time
		5	50 S		50 seconds drive time
		6	60 S		60 seconds drive time
		7	Custom		Drive time controlled by CustomFloatTime
PWMVLV	Pule Width Modulation Valve Period	0	25.5	25.5	0.1 to 25.5 seconds
		1	5.2	5.2	0.1 to 5.2 seconds

Table 7-1 *- Configuration Parameters for VAV*

7.4. Setting Up Inputs

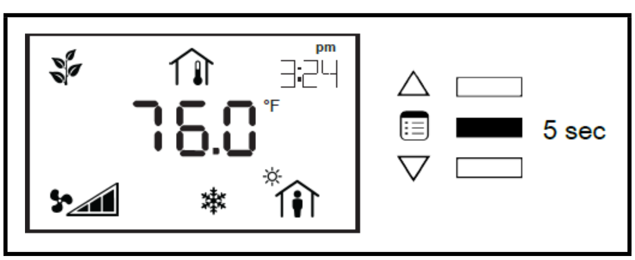
A controller's inputs can be configured through the Input Configuration submenu of the Advanced menu. LonWorks VAV has four (4) universal inputs.

The following procedures explains how to configure the inputs one by one. For instructions on how to configure them all at once using configuration codes, see ***Submitting New Configuration Codes using the VAV Smart Thermostat***.

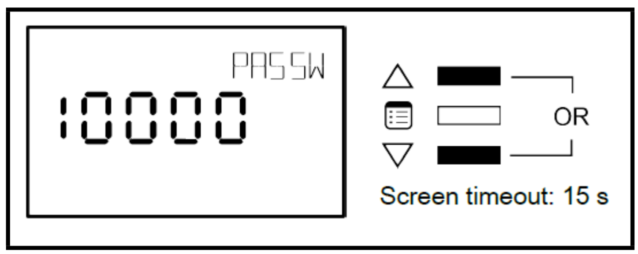
7.4.1. How to Enter the Input Configuration Submenu and Configure the Inputs

To enter the advanced menus:

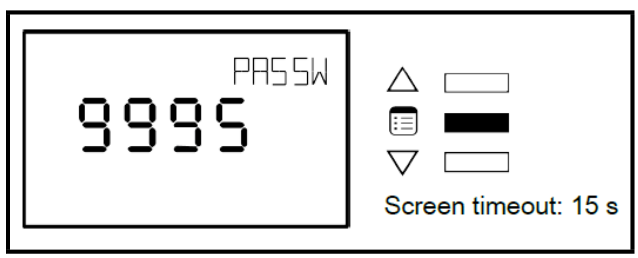
1. Hold the **Menu** button for five (5) seconds:



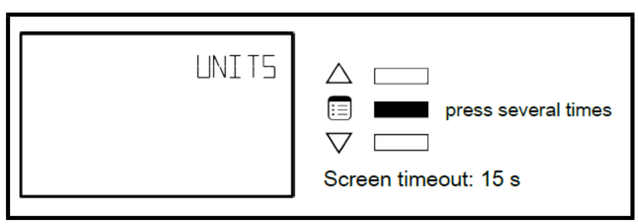
2. The password field will appear. Use the arrow keys to increase or decrease the displayed number until it matches the configured password.



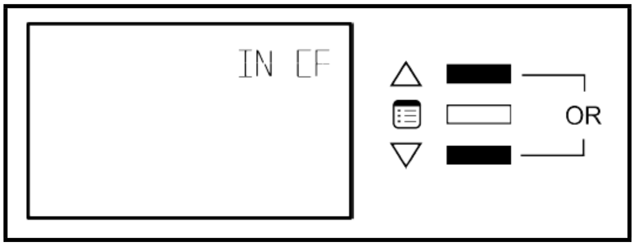
3. The default password is 9995. Press the **Menu** button to submit the password.



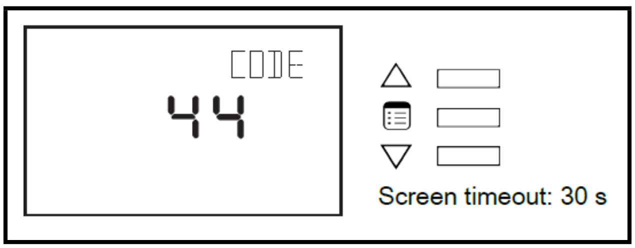
4. Once the correct password has been submitted, the advance menu will display.



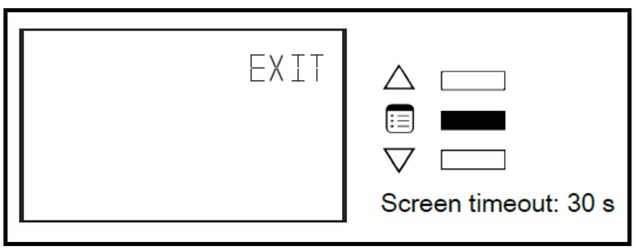
5. Press the **Menu** button several times until **IN CFG** appears on the display.



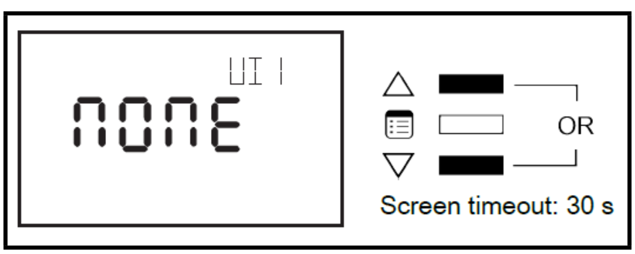
6. Press either of the arrow keys to enter the Input Configuration submenu. Once the Input Configuration submenu has been entered, the Code parameter will appear.



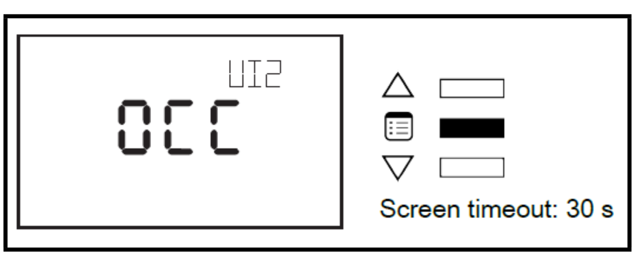
7. To scroll between the different parameters in the Input Configuration submenu, press the **Menu** button.



8. To modify a parameter, use the arrow keys.



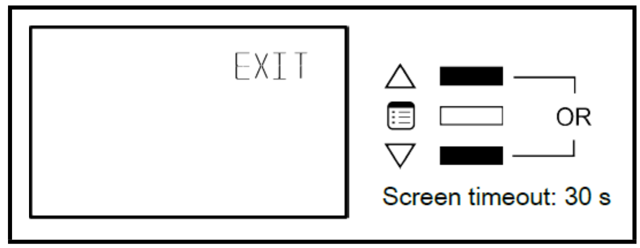
9. To submit a modified parameter, press the **Menu** button. The next Input Configuration submenu parameter is displayed.



There are between three to five parameters to be configured, depending on the controller model. The following table shows all the available input types for each controller input.

7.4.2. How to Exit the Submenu

1. Press the **Menu** button several times until the Exit screen appears. Then press either of the arrow keys.



2. Press and hold the **Menu** button for five (5) seconds.

7.4.3. Input Configuration for VAV

Input		Input Types			Descriptions
CODE	VAV Input Config Code				VAV Input Configuration Code Entry
UI1	Universal Input 1	0	nonE	NONE	Not Configured
		1	SPAC	SPAC	Room Temperature Sensor
		2	OCC	OCC	Occupancy Detection
		3	Cont	CONT	Window Contact
UI2	Universal Input 2	0	nonE	NONE	Not Configured
		1	dI SC	DISC	Discharge Air Temperature Sensor
		2	Cont	CONT	Window Contact
		3	OCC	OCC	Occupancy Detection
		4	SEtP	SETP	Room Temperature Setpoint Offset
UI3	Universal Input 3	0	nonE	NONE	Not Configured
		1	dI SC	DISC	Discharge Air Temperature Sensor
		2	OCC	OCC	Occupancy Detection
		3	Cont	CONT	Window Contact
		4	FAn	FAN	Fan Powered Box Status
UI4 CO2	Universal Input 4 CO2 Sensor	0	nonE	NONE	Not Configured
		1	4-20	4-20	4-20mA CO2 Sensor (0-2000 ppm)
		2	0-5	0-5	0-5V CO2 Sensor (0-2000 ppm)
COMS-ENS SP	Smart Thermostat User Setpoint Control	0	dUAL	DUAL	Cooling and Heating Setpoint via Smart Thermostat
		1	OFFS	OFFS	Room Temperature Setpoint Offset

Table 7-2 *- Input Configuration Parameters for VAV*

Input		Input Types			Descriptions
SENSORS TYPE	Discharge and Space Temp Sensors Type	0	10-2	10-2	Sensors are 10K Type II
		1	10-3	10-3	Sensors are 10K Type III
		2	1000	1000	Sensors are PT 1000
		3	NI 0C	NI0C	Sensors are NI 1000 @0°C
		4	NI 22	NI22	Sensors are NI 1000 @22°C

Table 7-2 *- Input Configuration Parameters for VAV*

7.5. Setting Up Outputs

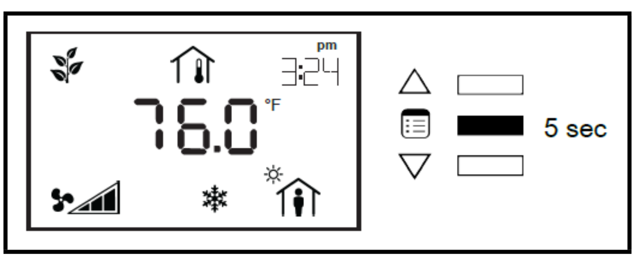
A controller's outputs can be configured through the Output Configuration submenu of the Advanced menu. LonWorks VAV have two (2) Universal Outputs and 4 Digital Outputs.

The following procedures explains how to configure the outputs one by one. For instructions on how to configure them all at once using configuration codes, see ***Submitting New Configuration Codes using the VAV Smart Thermostat***.

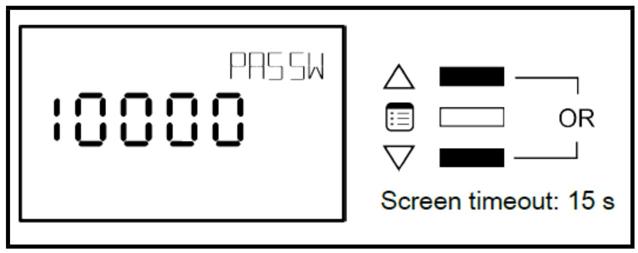
7.5.1. How to Enter the Output Configuration Submenu and Configure the Outputs

To enter the advanced menus:

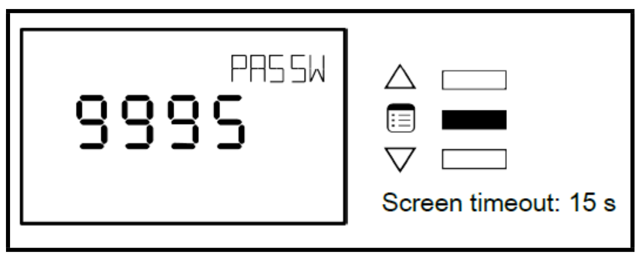
1. Hold the **Menu** button for five (5) seconds:



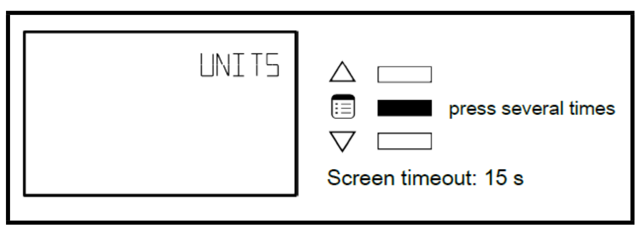
2. The password field will appear. Use the arrow keys to increase or decrease the displayed number until it matches the configured password.



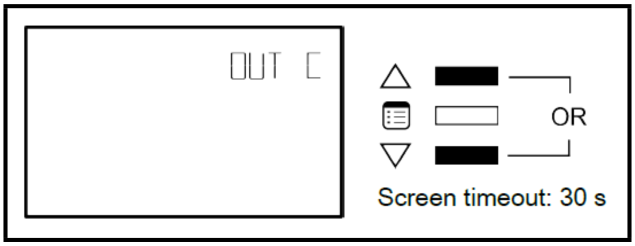
3. The default password is 9995. Press the **Menu** button to submit the password.



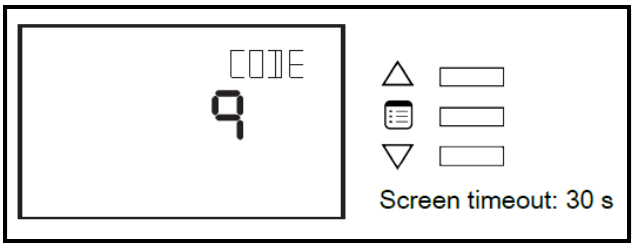
4. Once the correct password has been submitted, the advance menu will display.



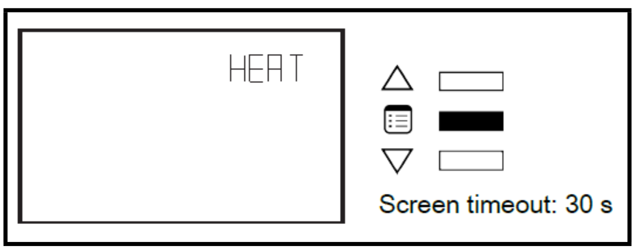
5. Press the **Menu** button several times until **OUT CFG** appears on the display.



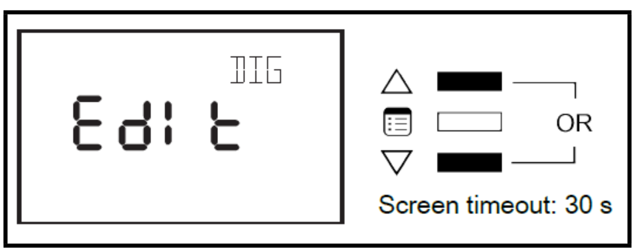
6. Press either of the arrow keys to enter the Output Configuration submenu. Once the Input Configuration submenu has been entered, the Code parameter will appear.



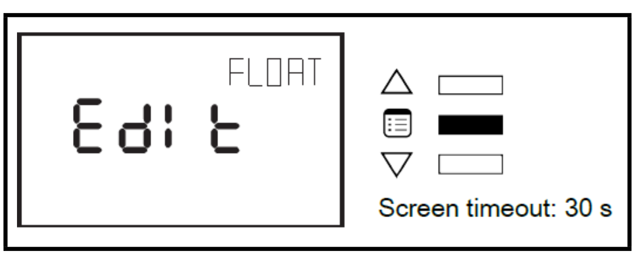
7. To scroll between the different parameters in the Output Configuration submenu, press the **Menu** button.



8. To modify a parameter, use the arrow keys.



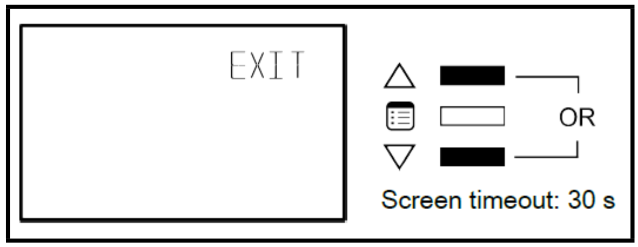
9. To submit a modified parameter, press the **Menu** button.



The first two or three parameters of the Output Configuration submenu allow the selection of the types of control signals used to drive the heating sources. The remaining parameters allow configuring the normally open or normally closed option for each heating source.

7.5.2. How to Exit the Submenu

1. Press the **Menu** button several times until the Exit screen appears. Then press either of the arrow keys.



2. Press and hold the **Menu** button for five (5) seconds.

7.5.3. Output Wiring (VAV)

Heat1 Type	Description
None	No Reheat
Pwm Triac	Modulating PWM on DO1 and AO5
Digital	Digital Reheat on DO1
Pwm Valve	PWM Valve on DO1
Thermal Valve	Thermal Valve on DO1
0-10V	Modulating 0-10V on AO5
2-10V	Modulating 2-10V on AO5
Floating Valve	Floating Valve on DO1 and DO2

Table 7-3 *- Heat 1 Configuration*

Heat2 Type	Heat1 Type			
	Heat 1 not configured	Heat 1 not floating	Heat 1 floating	Heat 1 Floating and Fan Powered Box
None	n/a			
Pmw Triac	Cannot configure	DO2 & AO6	DO3 & AO6	
Digital		DO2	DO3	
Pwm Valve				
Themal Valve				
0-10V		AO6		
2-10V		DO2 - Open	DO3 - Open	n/a
Floating Valve		DO3 - Close	DO4 - Close	n/a

Table 7-4 *- Heat 2 Configuration (Depends on Heat 1 Configuration)*

Heat3 Type	Heat1 and Heat2 Type			
	Heat 1 and Heat 2 not configured	Heat 1 and Heat 2 not floating	Heat 1 or Heat 2 floating	Heat 1 and Heat 2 floating
None	n/a			
Digital	Cannot configure	DO3	DO4	n/a
Pwm Triac				
Pwm Valve				
Thermal Valve				

Table 7-5 *- Heat 3 Configuration (Depends on Heat 1 and Heat 2 Configuration)*

For example, suppose Heat 1 Type is a floating valve, and both Heat 2 and Heat 3 Types are PWM Triac. In this case, Digital Outputs 1 and 2 of the controller are used to control Heat Source 1, Digital Output 3 or Analog Output 6 can be used to control Heat Source 2, and Digital Output 4 is used to control Heat Source 3.

In general, a heat type uses the next available digital output in sequence. For example, Heat 3 Type uses DO3 unless Heat 1 Type or Heat 2 Type is a floating valve, in which case DO4 is used instead of DO3.

7.6. Configuring the Flow Setpoints Parameters

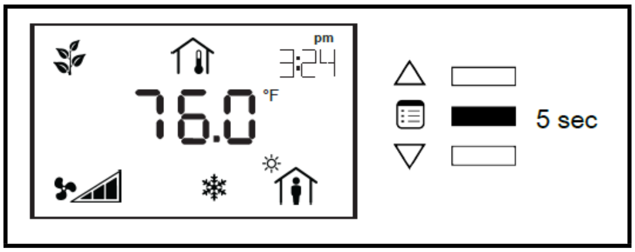
The flow setpoint parameters of the controller can be set in the Flow Setpoint submenu, which is part of the Advanced Menu of the Smart Thermostat.

7.6.1. How to Enter the Flow Setpoint Submenu and Configure a Parameter

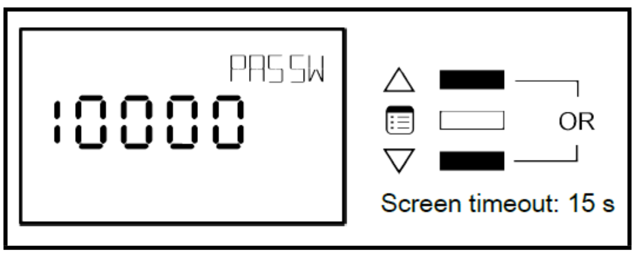
The Flow Setpoint submenu has several configurable parameters. To enter this submenu and configure a parameter:

To enter the advanced menus:

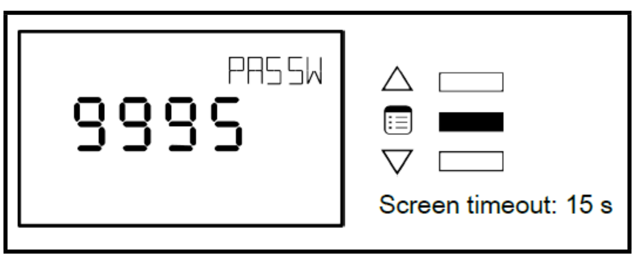
1. Hold the **Menu** button for five (5) seconds:



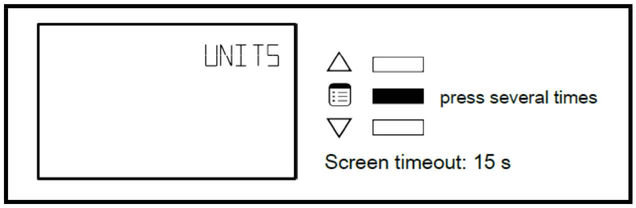
2. The password field will appear. Use the arrow keys to increase or decrease the displayed number until it matches the configured password.



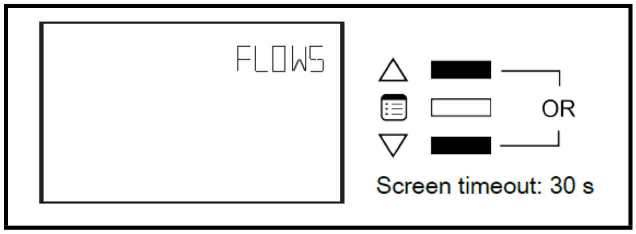
3. The default password is 9995. Press the **Menu** button to submit the password.



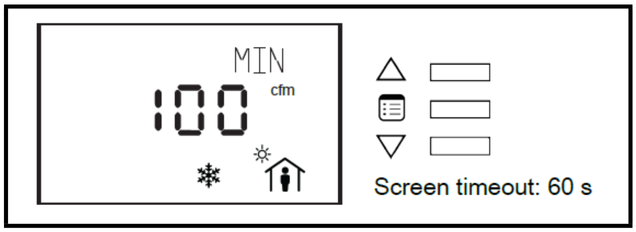
4. Once the correct password has been submitted, the advance menu will display.



5. Press the Menu button several times until the **FLOWSP** appears on the display.



6. The minimum flow (MIN) parameter appears.



7. To scroll between the different parameters in the Flow Setpoint submenu, press the **Menu** button.
8. To modify a parameter, use the arrow keys. To enter a new parameter value, press the **Menu** button.

The table below shows all the parameters under the Flow Setpoint submenu.

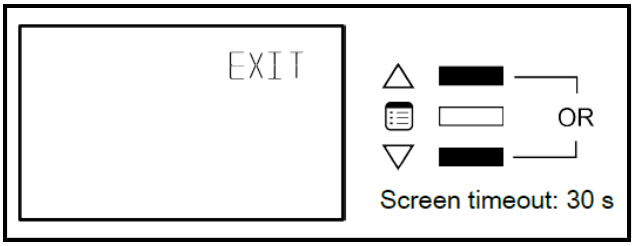
Parameter	Description	Screen Timeout
MIN	Minimum Flow	60 sec
MAX	Maximum Flow	60 sec
MINHT	Minimum Flow in Heating Mode	60 sec
MAXHT	Maximum Flow in Heating Mode	60 sec
STBY	Minimum Flow in Standby Mode	60 sec
UNOCC	Minimum Flow in Unoccupied Mode	60 sec
PFANFLOWSP*	Parallel Fan Flow Setpoint	60 sec

***Table 7-6** - Flow Setpoint Submenu Parameters*

**Applicable to a parallel fan powered VAV.*

7.6.2. How to Exit the Submenu

1. Press the **Menu** button several times until the Exit screen appears. Then press either of the arrow keys.



2. Press and hold the **Menu** button for five (5) seconds.

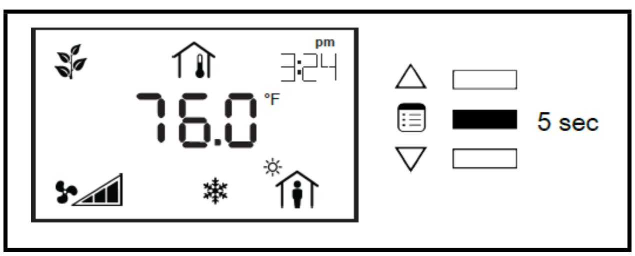
7.7. Performing VAV Airflow Balancing

The airflow balancing procedure can be carried out from the Balancing submenu, which is part of the Advanced Menu of the Smart Thermostat.

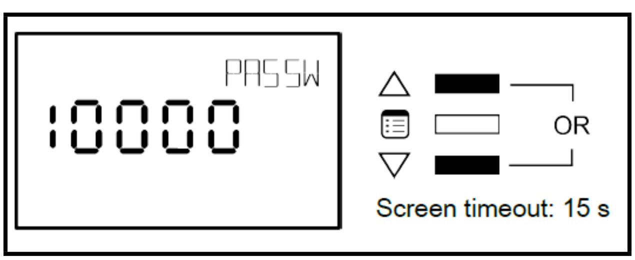
7.7.1. How to Enter the Balancing Submenu

To enter the advanced menus:

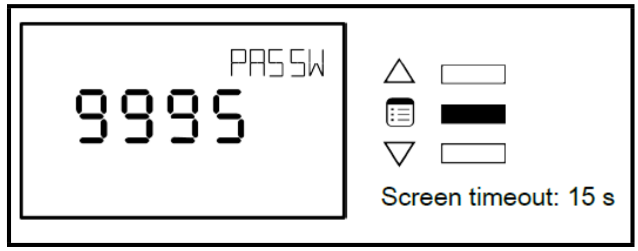
1. Hold the **Menu** button for five (5) seconds:



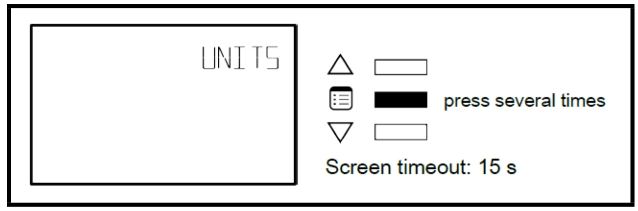
2. The password field will appear. Use the arrow keys to increase or decrease the displayed number until it matches the configured password.



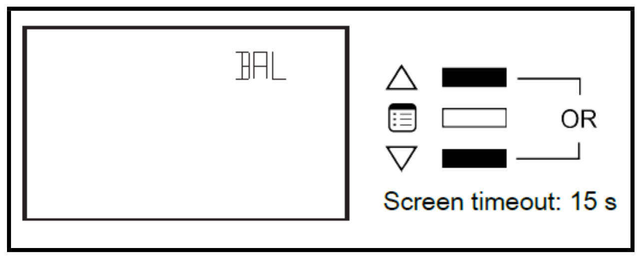
3. The default password is 9995. Press the **Menu** button to submit the password.



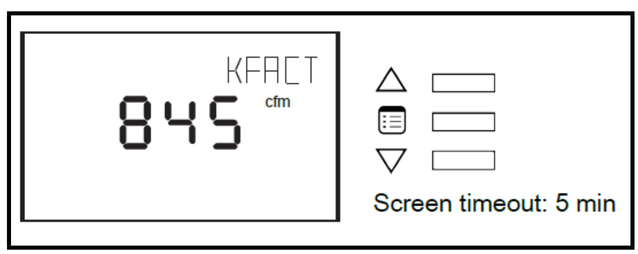
4. Once the correct password has been submitted, the advance menu will display. Press the **Menu** button to submit the selected display units type.



5. Press the **Menu** button several times until the **Balancing (BAL)** menu appears on the display.



6. Press either of the arrow keys to enter the Balancing submenu. Once the Balancing submenu has been entered, the K-Factor parameter will appear.

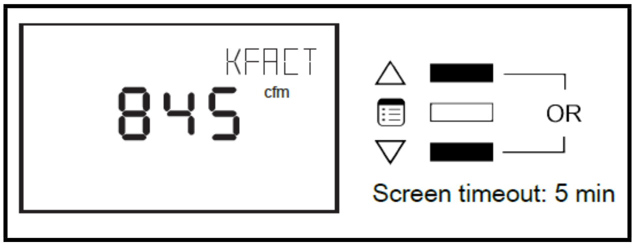


7.7.2. How to Perform Airflow Balancing

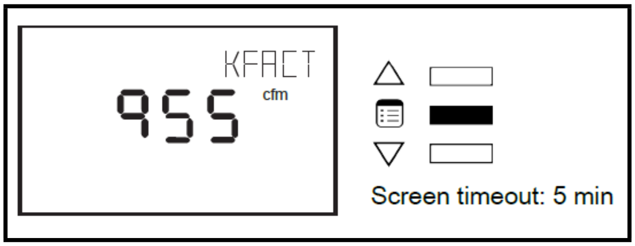
The K-Factor can be acquired from the VAV box manufacturer. The K-Factor in Imperial Units is: Airflow (in cfm) at 1" WC and Airflow (in cfm) at 1" WC in SI Units.

To perform the airflow balancing procedure:

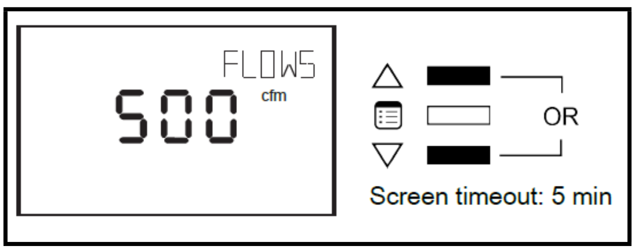
1. Use the arrow keys to enter the K-Factor.



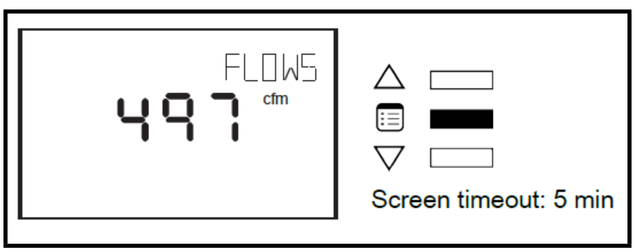
2. Press the **Menu** button to submit the K-Factor.



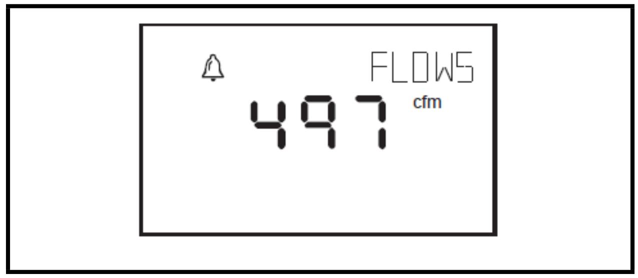
3. The Flow Setpoint parameter appears. Use the arrow keys to override the flow setpoint. Choose a relatively high setpoint.



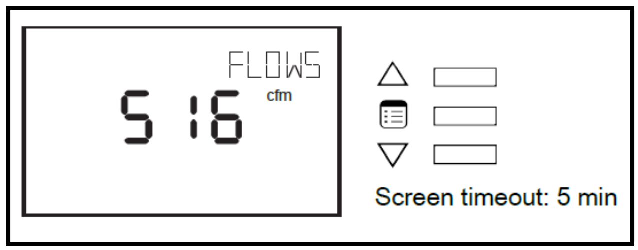
4. Press the **Menu** button to submit the new flow setpoint.



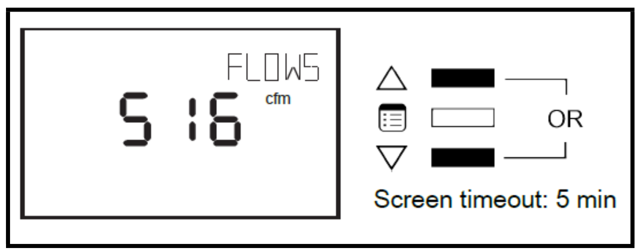
NOTE: When the flow setpoint is modified, the bell icon appears, indicating that this parameter has been overridden.



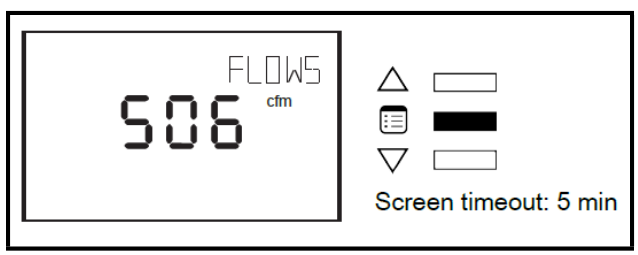
5. The Flow parameter appears. This parameter represents the airflow as measure by the controller. Monitor the Flow parameter until it stabilizes.



6. Using a flow hood, measure the actual airflow. Use the arrow keys to enter this measurement into the Flow parameter.

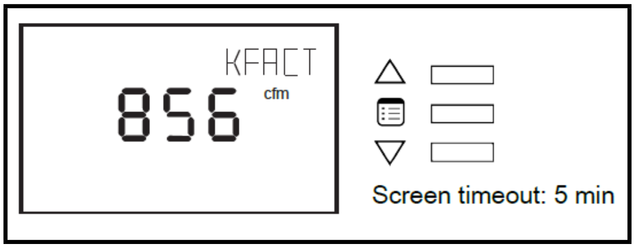


7. Press the **Menu** button to submit the actual airflow.



8. The Damper parameter appears. Note that at this point, the K-Factor gets adjusted based on the airflow value just entered.

9. Press the **Menu** button several times until the K-Factor parameter reappears. This value can be included in the balancing report.

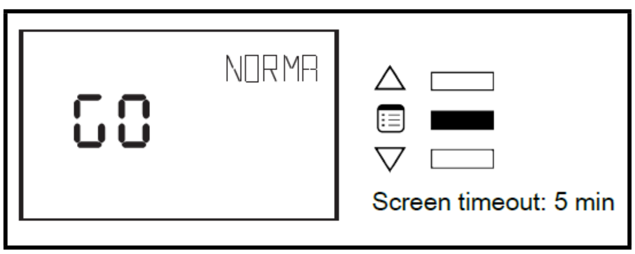


10. The LonWorks VAV controller is now balanced.

7.7.3. How to Perform Balancing Override

The balancing override setting can be selected from the Go submenu. Different values can be selected: normal, minimum flow, minimum flow heat, maximum flow, maximum flow heat, full open (damper), and full close (damper). This procedure can also be used to override the flow setpoint as shown in ***Section 7.7.2., How to Perform Airflow Balancing***.

1. Press the **Menu** button several times until the **GO** menu appears on the display.



2. Use the arrow keys to scroll through the Go menu options.
3. To select the desired option, press the **Menu** button to submit the new value.
4. To select the desired option, press the **Menu** button to submit the new value.

NOTE: When the balancing override position is modified, the bell icon appears, indicating that this parameter has been overridden.

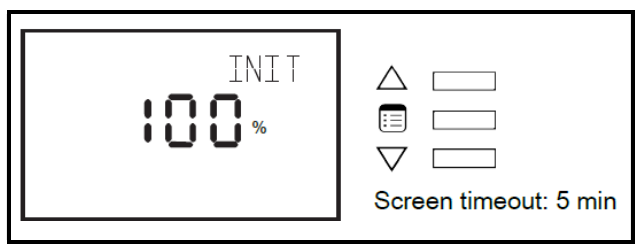
7.7.4. How to Initialize the Damper

If the mechanical stops on the actuator have been moved to limit the range of movement of the damper, then the damper must be initialized. Damper initialization resets the damper position and calculates the total number of steps between the stops.

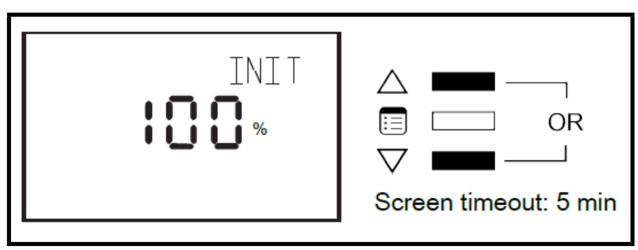
NOTE: The actuator mechanical stops should be moved only to limit damper movement from going under 0% or over 100%.

To initialize the damper using the Smart Thermostat:

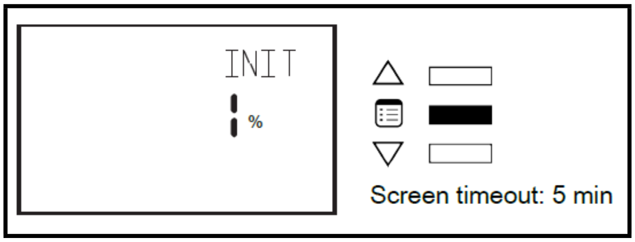
1. Navigate to the Initialize Damper parameter.



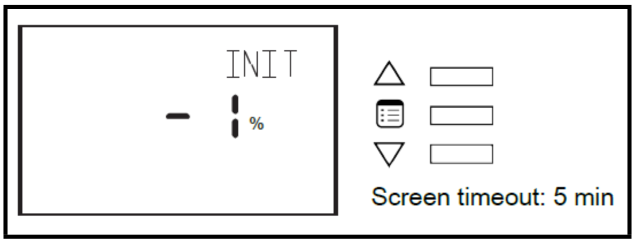
2. The screen displays the current damper position. Press one of the arrow keys to change the displayed value to 1.



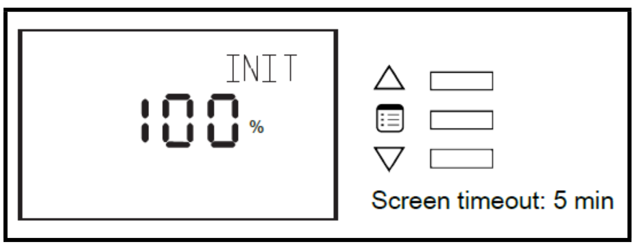
3. Press the **Menu** button.



4. The damper begins the initialization process. During this process, the screen displays -1.



5. After a few minutes, the screen redisplays the damper's current position.



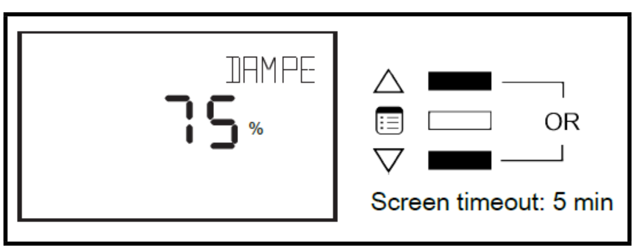
6. The damper is now initialized.

7.7.5. Other Functions in the Balancing Submenu

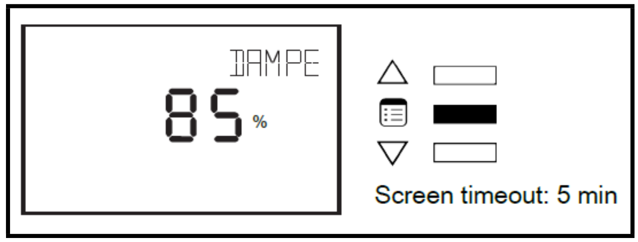
The Balancing submenu contains three other parameters that compliment those discussed above.

To override the damper position:

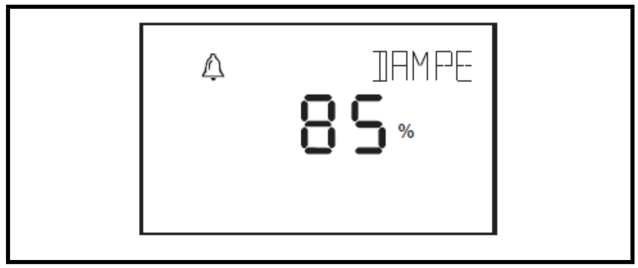
1. Navigate to the Damper parameter and then use the arrow keys to change the displayed value.



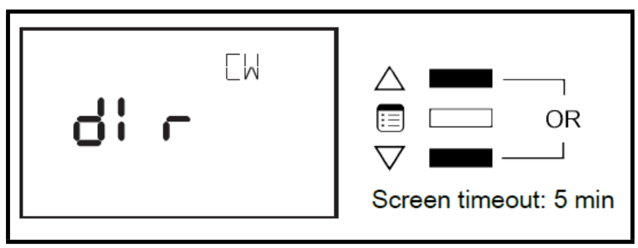
2. Press the **Menu** button to submit the new value.



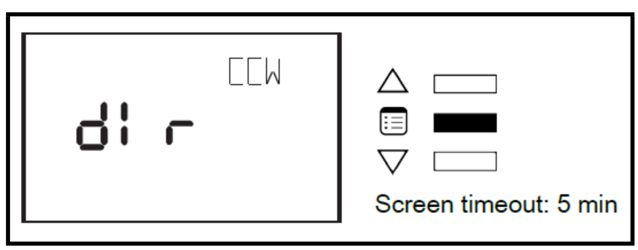
NOTE: When the damper position is modified, the icon appears, indicating that this parameter has been overridden.



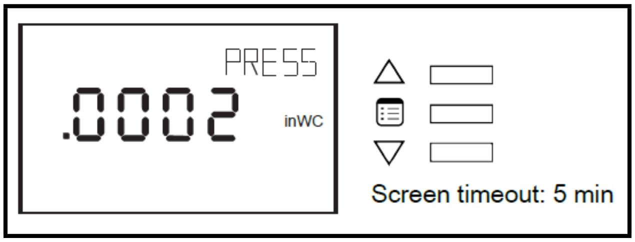
3. To change the direction in which the actuator rotates to open the damper, navigate to the Direction parameter (dir) and then use the arrow keys to change the rotation direction from clockwise to counter clockwise or vice versa.



4. Press the **Menu** button to submit the new rotation direction.



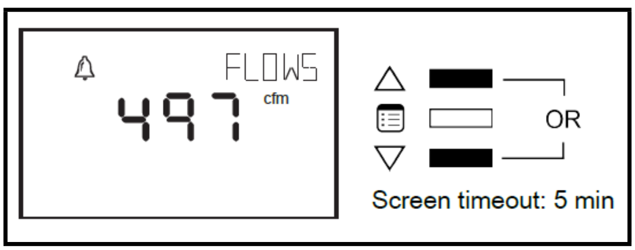
5. To view the current differential pressure reading, navigate to the **Pressure** parameter.



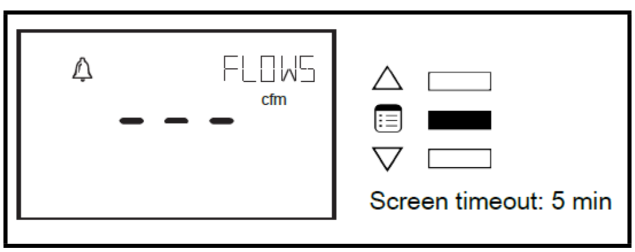
7.7.6. How to Release Overrides

The presence of the bell icon in the display screens of the Flow Setpoint or Damper parameters indicates that either of them is overridden. An override normally times out after two hours. However, it should be released manually when airflow balancing is complete. Also note that both the Flow Setpoint and Damper parameters cannot be overridden at the same time, so overriding one parameter automatically releases the other. To manually release an override.

1. Press and hold both arrow keys simultaneously.

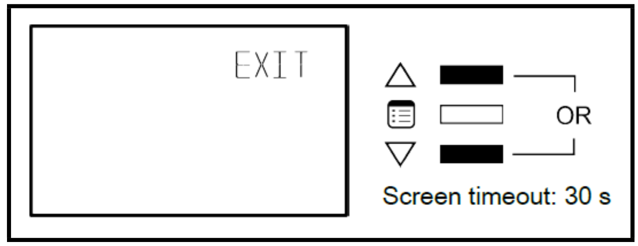


2. The screen displays three (3) dashes. Press the **Menu** button.



7.7.7. How to Exit the Submenu

1. Press the **Menu** button several times until the Exit screen appears. Then press either of the arrow keys.



2. Press and hold the **Menu** button for five (5) seconds.

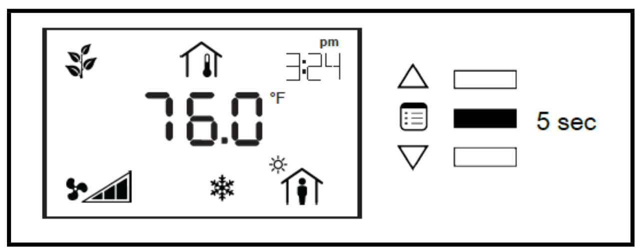
7.8. Performing Overrides

The Overrides submenu of the Smart Thermostat's Advanced menu allows performing damper overrides as well as output overrides. Output overrides range from 0 – 100% in increments of 1%. For digital outputs, any value different from 0 represents On.

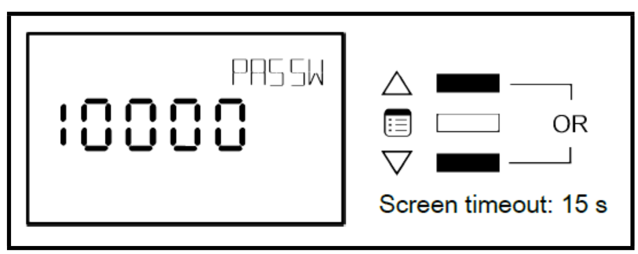
7.8.1. How to Perform an Override

To enter the advanced menus:

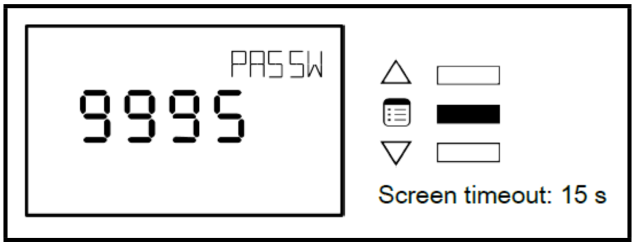
1. Hold the **Menu** button for five (5) seconds:



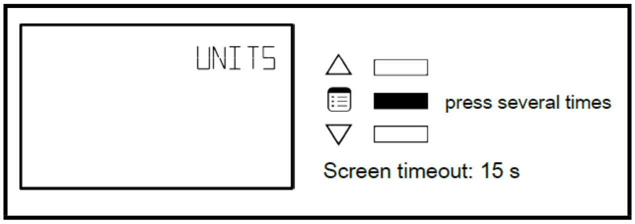
2. The password field will appear. Use the arrow keys to increase or decrease the displayed number until it matches the configured password.



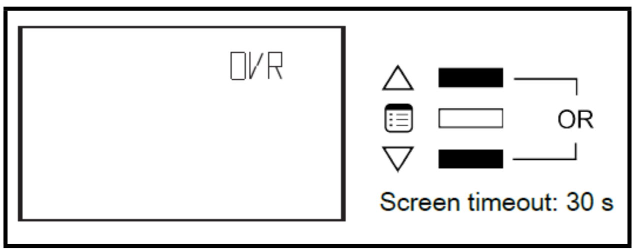
3. The default password is 9995. Press the **Menu** button to submit the password.



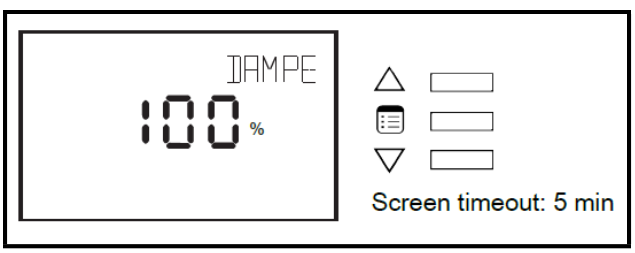
4. Once the correct password has been submitted, the advanced menu will display.



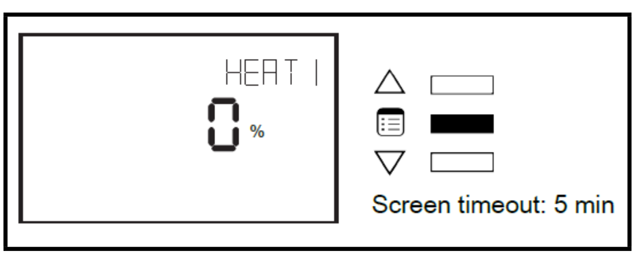
5. Press the **Menu** button several times until OVR appears on the display.



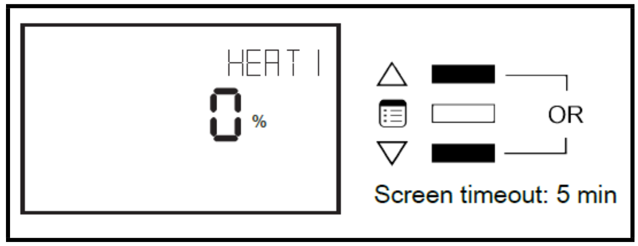
6. Press either of the arrow keys to enter the Overrides submenu. Once the Overrides submenu has been entered, the Damper parameter will appear.



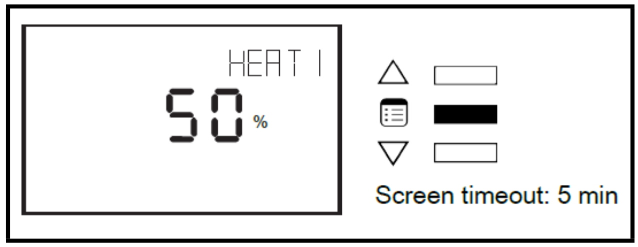
7. To scroll between the different parameters in the Overrides submenu, press the **Menu** button.



8. To override a parameter, use the arrow keys to modify the displayed percentage value.



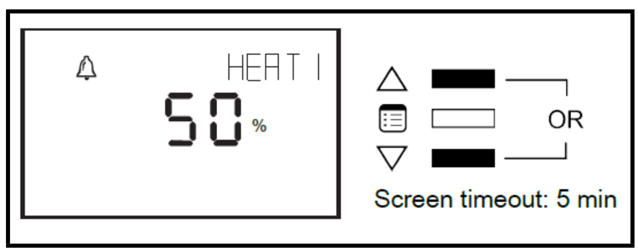
9. Press the **Menu** button to put the override into effect.



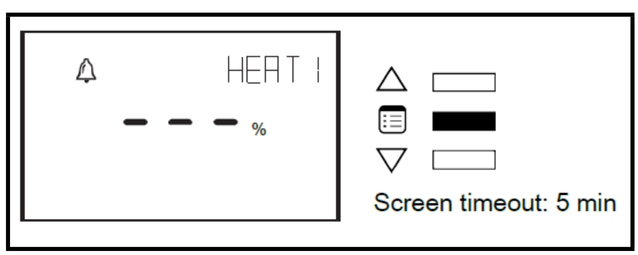
7.8.2. How to Release Overrides

The presence of the bell icon in the display screen of a parameter in the Overrides submenu indicates that it is overridden. An override normally times out after two hours. However, it should be released manually when there is no use for it anymore. To manually release an override:

1. Press and hold both arrow keys simultaneously.

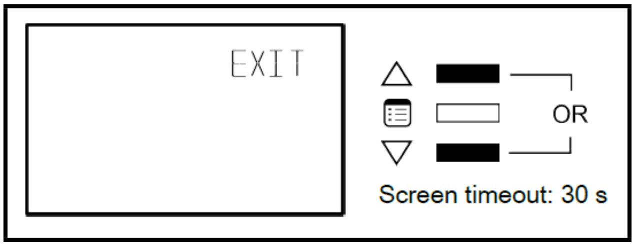


2. The screen displays three (3) dashes. Press the **Menu** button.



7.8.3. How to Exit the Submenu

1. Press the **Menu** button several times until the Exit screen appears. Then press either of the arrow keys.



2. Press and hold the **Menu** button for five (5) seconds.

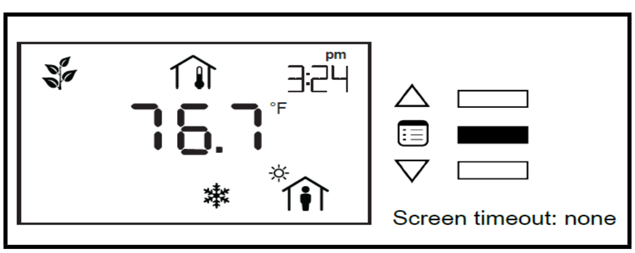
7.9. Commissioning LonWorks VAV-Series Controllers

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

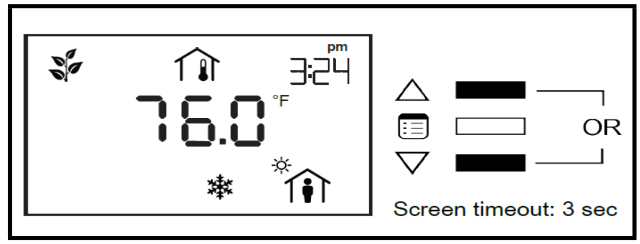
For LonWorks VAV Controllers, commissioning can be used to perform application selection if needed. Applications are pre-loaded programs that enable LonWorks VAV to control typical VAV box.

Set the connected controller's MAC Address as follows:

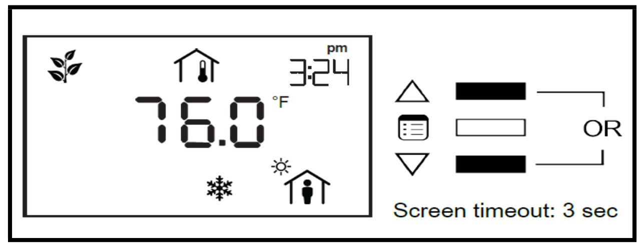
1. Connect the Smart Thermostat to the controller with a Cat 5e patch cable. Wait for the display to show the room temperature.
2. Press and hold the **Menu** button for five (5) seconds to enter the password menu. 1000 is shown on the display.



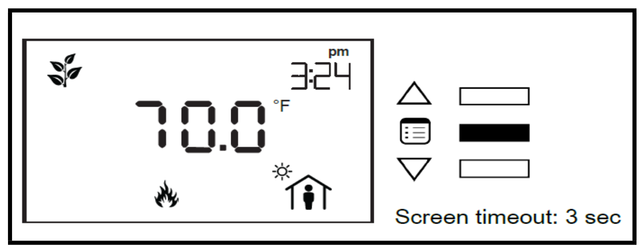
3. Use the down button to set the number to 9995 (this is the default password).



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 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**.

7.10. LonWorks Network Access from the Smart Thermostat

For commissioning and maintenance purposes, the LonWorks network is optionally available from the Smart Thermostat audio plug port. By setting the two (2) Net to Subnet Port Settings jumpers inside the LonWorks VAV to Enable will connect the main LonWorks network to the Smart Thermostat subnetwork Cat 5e cable.

WARNING: Only a limited number of controllers on a LonWorks network segment should have their Net to Subnet Port Settings jumpers enabled. Enabling too many Smart Thermostats with network access may cause network communication issues. If there are network communication problems, refer to Section 4.3., Smart Thermostat Wiring.

The Cat 5e cable length is restricted by the maximum allowable subnetwork bus length. The standard Net to Subnet Port Settings jumper setting is **Disable**.

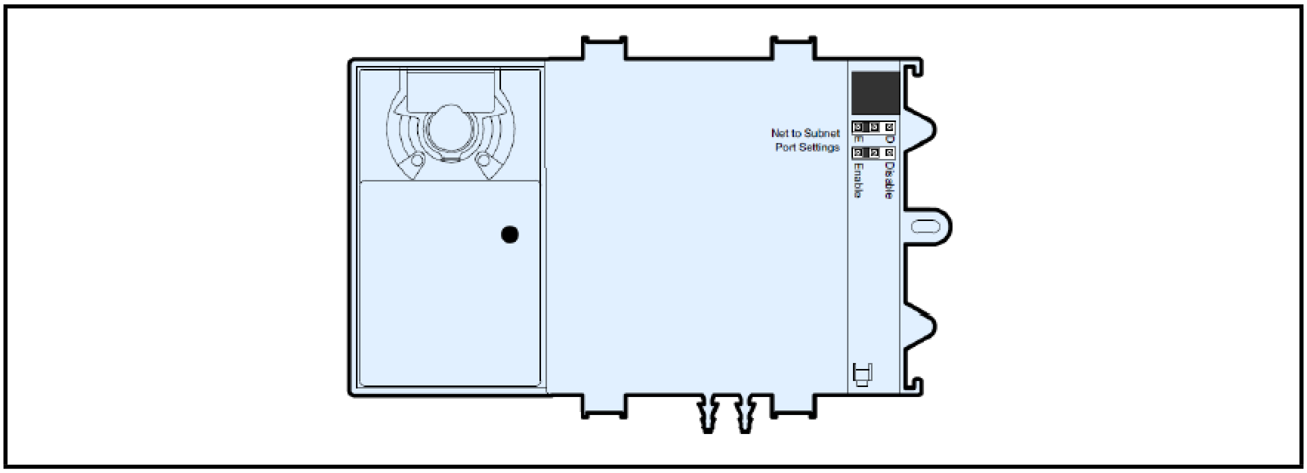


Figure 7-1 *- LonWorks VAV Controller: Net to Subnet Port Settings Jumpers*

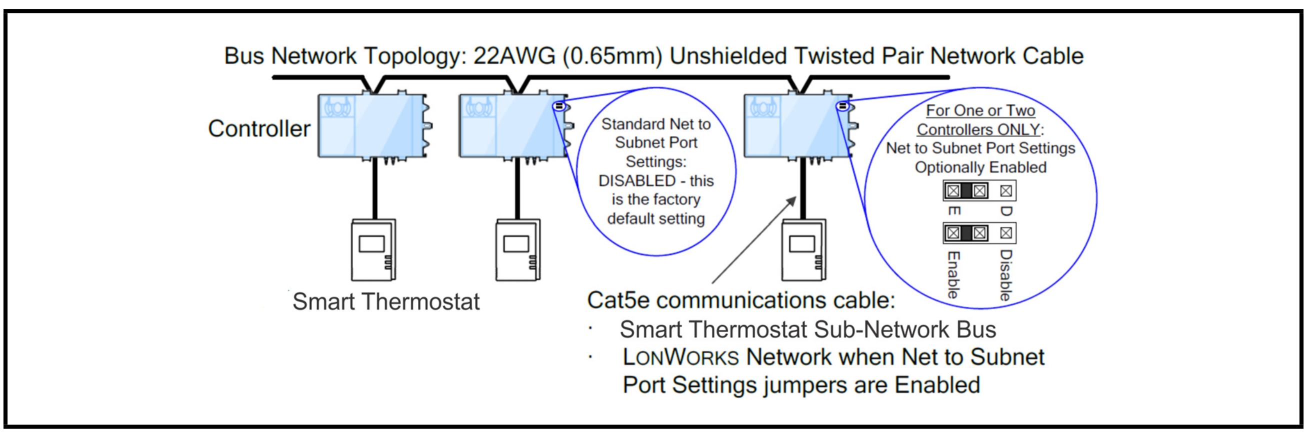


Figure 7-2 *- LonWorks Network: Bus Topology*

To temporarily access the LonWorks LAN for commissioning and maintenance purposes, connect a LonWorks network interface to the audio plug port located on the lower edge of the Smart Thermostat. Wire a standard 1/8 in. (3.5mm) three-conductor (stereo jack) or two-conductor (mono jack) as shown in ***Figure 7-3***.

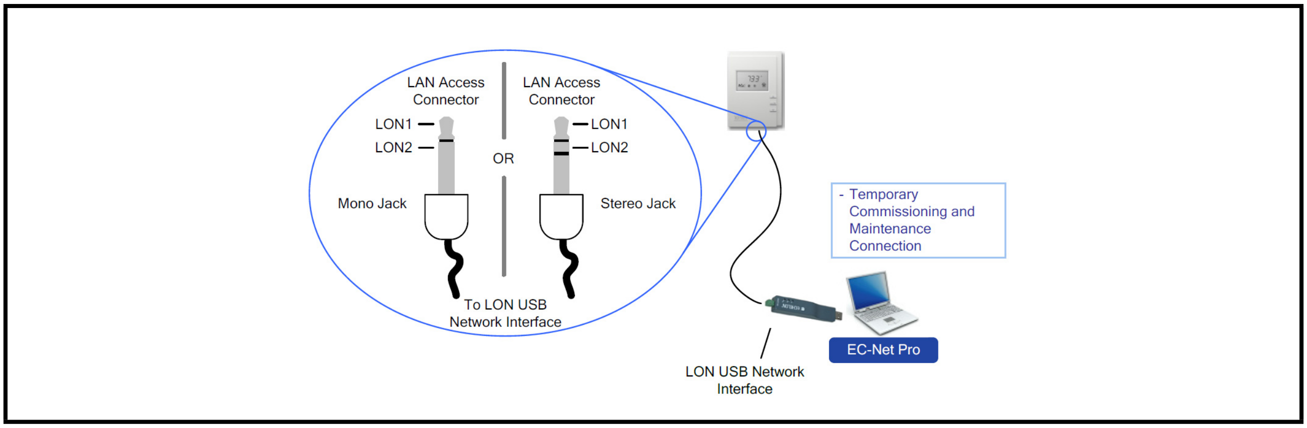


Figure 7-3 *- (3.5 mm) Stereo or Mono Jack Connection for a LONWORKS Network Interface*

8 Hardware Specifications

8.1. 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 8-1 *- 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 8-1 - *DAC Hardware Specifications*

8.2. LonWorks VAV

LonWorks 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 to 122°F (0 to 50°C) • **Storage Humidity**: -4 to 122°F (-20 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 8-2 *- LonWorks VAV Hardware Specifications*

8.3. 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 8-3 - *Smart Thermostat Hardware Specifications*

9 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.

9.1. 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.

9.2. 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 the LonWorks 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).
Too many VAV Smart Thermostat are providing network access.	Disable the Net to Subnet Port Settings jumpers on all controllers (for jumper locations, see ***Figure 2-7***). If communications are re-established, re-enable only a few VAV Smart Thermostat to have network access.
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 LonWorks Networks.
Wire type	Check that the wire type agrees with specifications.

Table 9-1- *LonWorks VAV Troubleshooting*

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.
Extra capacitance	Make sure that no extra capacitance is being connected to the network other than the standard FTT circuit and a maximum of a 3-meter stub (in bus topology).
Number of controllers on network segment exceeded	The number of controllers on a channel should never exceed to 64. Use a router or a repeater in accordance with specifications of the LonWorks Networks.
Network traffic	Query node statistics to check for errors. Use a LonWorks protocol analyzer to check network traffic.
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
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°.

***Table 9-1**- LonWorks VAV Troubleshooting*

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 LonWorks data bus.
TX LED not blinking	Data is not being transmitted onto the LonWorks 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 blink continuous: ■ ■ ■ ■ ■ ... (1s On, 1s Off, continuous)	The controller is not commissioned. Appropriate action: Commission the controller.
Long Long Long blink ■ ■ ■ (800ms On, 300ms Off, 800ms On, 300ms Off, 800ms On)	The controller is offline. Appropriate action: Set the controller Online
Long Short Short Short blink ■ ● ● ● (800ms On, 300ms Off, 150ms On, 300ms Off, 150ms On, 300ms Off, 150ms On)	The controller is in bypass mode. Appropriate action: Set the controller Online
Short Short Long blink ● ● ■ (150ms On, 300ms Off, 150ms On, 300ms Off, 800 ms On)	Poor-quality power; The device has browned-out: The voltage at the 24VAC and 24VCOM terminals has gone below the device's acceptable limit during power up.
Fast blink 12x: ●●●●●●●●●●●● (80ms On, 80ms Off, 12x)	Wink. The wink function is used to identify a device.

Table 9-1*- LonWorks VAV Troubleshooting*

9.3. Smart Thermostat Troubleshooting

<table>
<tr><th colspan="3">Smart Thermostat is blank and black light is off</th></tr>
<tr><td>Is the Smart Thermostat connected to the controller?</td><td colspan="2">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.</td></tr>
<tr><td>Is the power being supplied to the controller?</td><td colspan="2">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.</td></tr>
<tr><td>Is the cable connected to the controller and Smart Thermostat?</td><td colspan="2">Verify wiring.</td></tr>
<tr><th colspan="3">Smart Thermostat screen is blank and black light is on for about 30 to 45 seconds - Normal Operation</th></tr>
<tr><td>Firmware upgrade in progress</td><td colspan="2">Wait for the upgrade to complete. Do not disconnect the sensor from the controller as the upgrade will restart once it is completed.</td></tr>
<tr><th colspan="3">Device not communicating with controller</th></tr>
<tr><td>Is the address correctly set to a unique address?</td><td colspan="2">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.</td></tr>
<tr><td>Is the device too far from the controller?</td><td colspan="2">Verify the distance between the device and the controller. The wiring length is 600 ft (180 m).</td></tr>
<tr><td>Is there a configuration problem?</td><td colspan="2">Check the configuration of the sensor.</td></tr>
<tr><th colspan="3">Error Code interpretation</th></tr>
<tr><td>Clock icon flashing for 15 seconds.</td><td rowspan="3">Cannot communicate with controller.</td><td>Wait for the communication link to the controller to be established.</td></tr>
<tr><td rowspan="2">After 15 seconds: Flashing error code 1 with bell icon.</td><td>Verify wiring.</td></tr>
<tr><td>Verify that the Smart Thermostat’s Subnet IDs are unique for this controller.</td></tr>
<tr><td>Flashing error code 2 with bell icon.</td><td>Invalid configuration.</td><td>Resynchronized the code with the controller.</td></tr>
<tr><td>Flashing error code 3 with bell icon.</td><td>Smart Thermostat is not properly configured in the controller.</td><td>Check the configuration of the sensor.</td></tr>
</table>

Table 9-2 *- Smart Thermostat Troubleshooting*

Appendix A: Configuration Codes

Description

Configuring the preloaded applications of a LonWorks VAV controller can be easily done using configuration codes. Three different sets of configuration codes exist for the following three categories:

- VAV Configuration
- Input Configuration
- Output Configuration

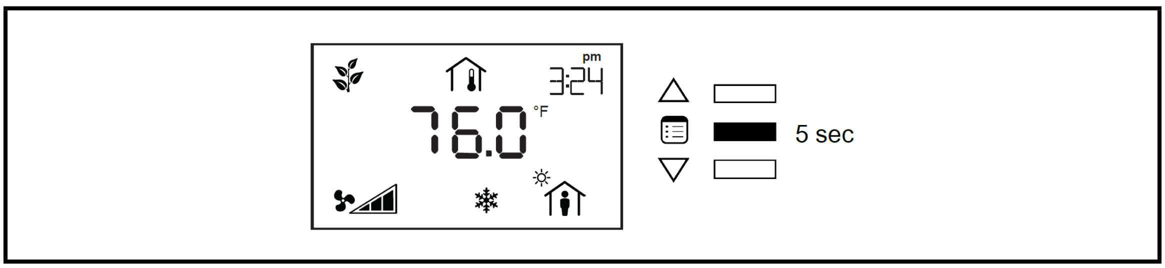
This chapter describes the use of codes in speeding up the configuration of LonWorks VAV controllers.

Submitting New Configuration Codes using the VAV Smart Thermostat

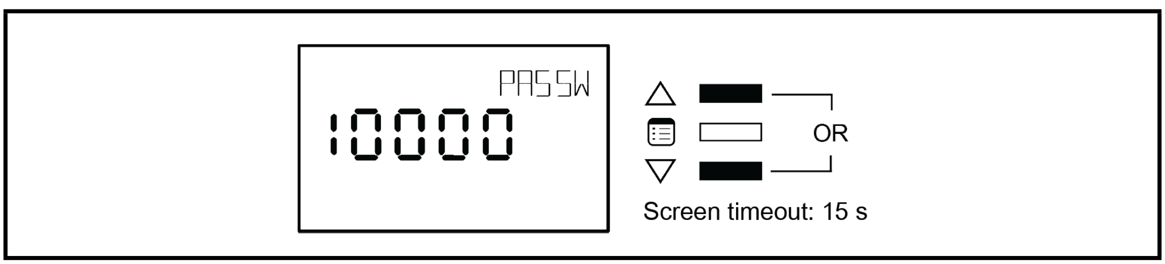
Using codes to configure a controller saves time, especially when working with large quantities. The following three submenus in the Smart Thermostat's Advanced menu, can be configured using codes:

How to Submit New Configuration Codes

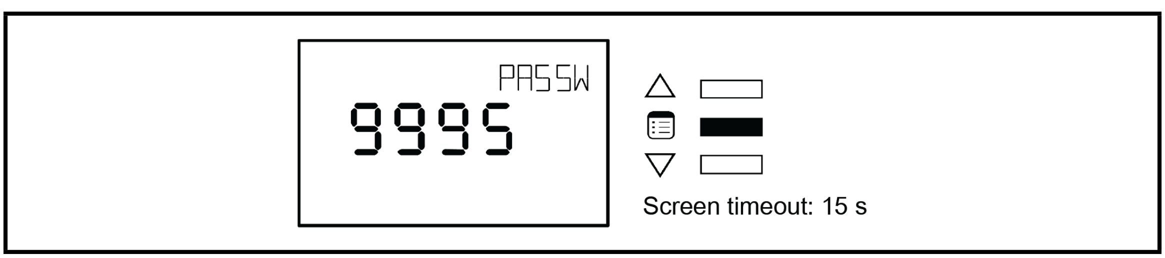
1. To enter the advanced menus, hold the **Menu** button for five (5) seconds:

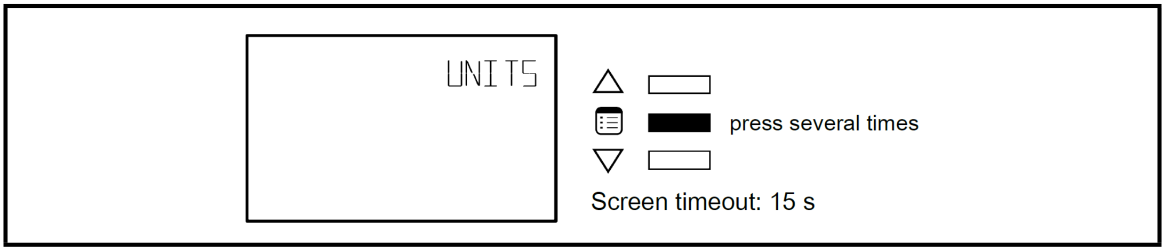


2. The password field will appear. Use the arrow keys to increase or decrease the displayed number until it matches the configured password.

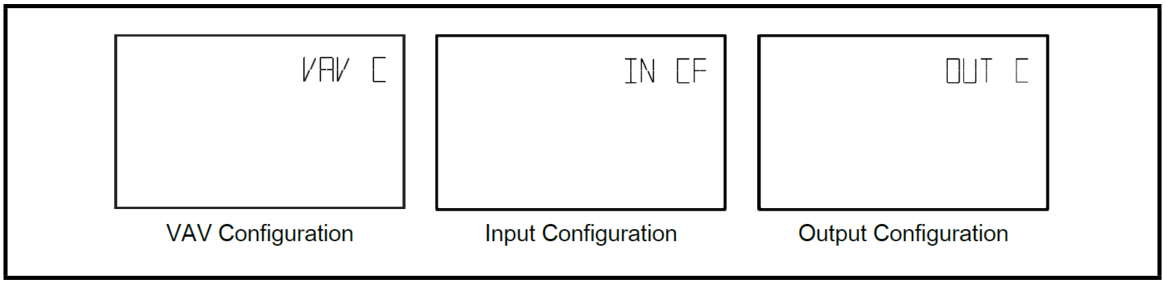


3. The default password is 9995. Press the **Menu** button to submit the password. Once the correct password has been submitted, the advanced menu will display.

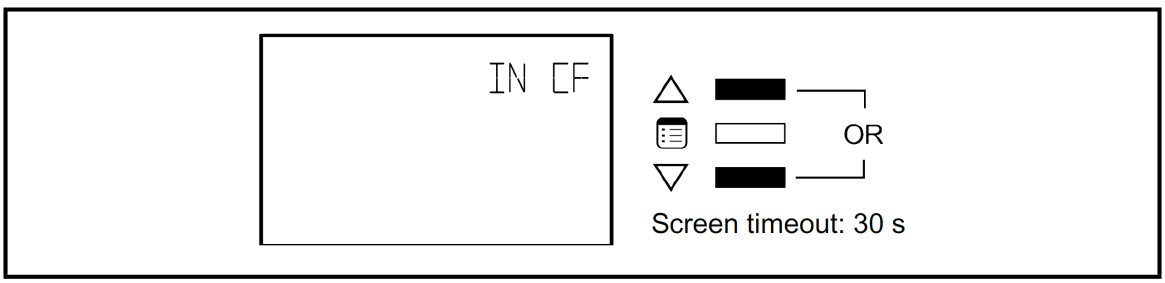




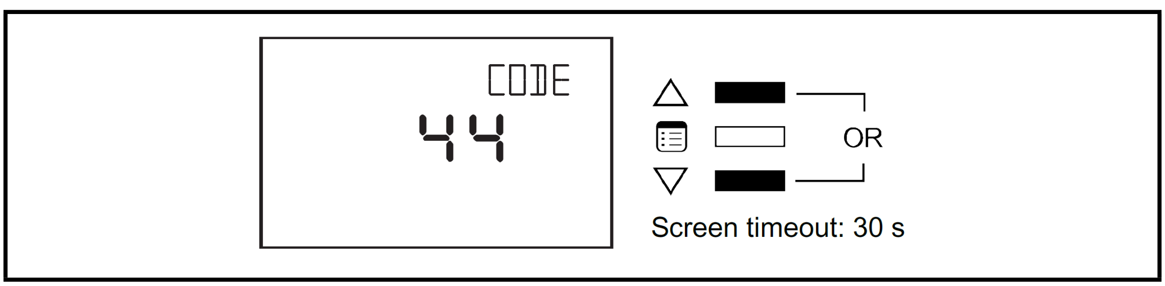
4. Press the **Menu** button several times until the desired submenu appears. Either one of the following submenus can be configured using a code.



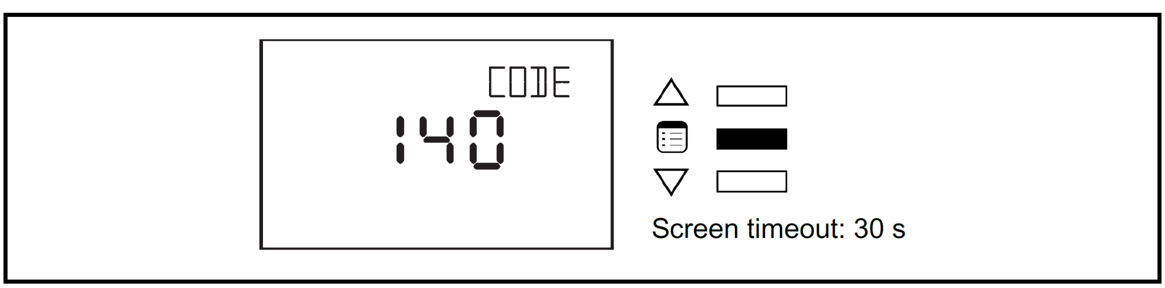
5. Press either of the arrow keys to enter the submenu.



6. The Code parameter will appear. Use the arrow keys to enter a configuration code.

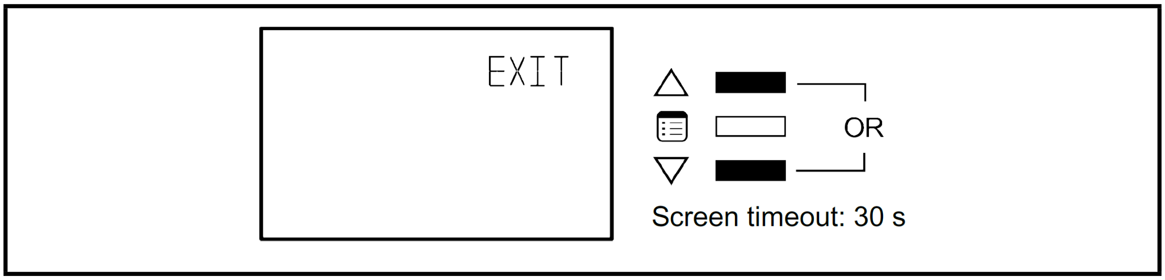


7. Press the **Menu** button to submit the new configuration code.



Exit the Submenu

1. Press the **Menu** button several times until the Exit screen appears. Then press either of the arrow keys.



2. Press and hold the **Menu** button for five (5) seconds.

LonWorks VAV 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 LonWorks VAV 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:

LonWorks VAV Configuration

Parameter	Binary Code	Default	Valid Choices		Descriptions
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
FLOATVLV	0	x	0	95 sec	95 sec drive time
	512		1	125 sec	125 sec drive time
	1024		2	150 sec	150 sec drive time
	1536		3	25 sec	25 sec drive time
	2048		4	30 sec	30 sec drive time
	2560		5	50 sec	50 sec drive time
	3072		6	60 sec	60 sec drive time
	3584		7	Custom	Drive time controlled by CustomFloatTime

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

	LonWorks VAV					
	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		0	NONE	Not Configured
		4		1	DISC	Discharge Air Temperature Sensor
		8		2	OCC	Occupancy Detection
		12		3	CONT	Window Contact
		16	x	4	SETP	Room Temperature Setpoint Offset
	UI3TYPE	0	x	0	NONE	Not Configured
		32		1	DISC	Discharge Air Temperature Sensor
		64		2	OCC	Occupancy Detection
		96		3	CONT	Window Contact
		128		4	FAN	Fan Powered Box Status
	UI4TYPE	0	x	1	NONE	Not Configured
		256		2	4-20	4-20mA CO2 Sensor (0-2000 ppm)
		512		3	0-5	0-5V CO2 Sensor (0-2000 ppm)
	COMSENS SP	0	x	0	DUAL	Cooling and Heating Setpoint via Smart Thermostat
		1024		1	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**				

LonWorks VAV

	Parameter	Binary Code	Default	Valid Choices		Descriptions and Output Wiring Details
Output Configuration	HEAT1	0		0	NONE	No Reheat
		1	x	1	DIG	Digital Reheat on DO1
		2		2	PWM TRIAC	Modulating PWM on DO1 and AO5
		3		3	PWM VLV	PWM Valve on DO1
		4		4	THERM VLV	Thermal Valve on DO1
		5		5	0-10V	Modulating 0-10V on AO5
		6		6	2-10V	Modulating 2-10V on AO5
		7		7	FLOAT VLV	Floating Valve (120 sec drive time) on DO1 and DO2
	HEAT2	0		0	NONE	No Reheat
		8	x	1	DIG	Digital Reheat on DO2 or DO3
		16		2	PWM TRIAC	Modulating PWM on (DO2 or DO3) and AO6
		24		3	PWM VLV	PWM Valve on DO2 or DO3
		32		4	THERM VLV	Thermal Valve on DO2 or DO3
		40		5	0-10V	Modulating 0-10V on AO6
		48		6	2-10V	Modulating 2-10V on AO6
		56		7	FLOAT VLV	Floating Valve on DO2 & DO3 or (DO3 and DO4)
	HEAT3	0	x	0	NONE	No Reheat
		64		1	DIG	Digital Reheat on DO3 or DO4
		128		2	PWM TRIAC	Modulating PWM on DO3 or DO4
		192		3	PWM VLV	PWM Valve on DO3 or DO4
		256		4	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 B: Sequence of Operation

OCCUPANCY CONTROL

The following table describes the variables that control occupancy.

Variable	Description
nviSchedule_1	Occupancy received from the network. If no update is received from the network for more than the network variable Max Receive Time (default = 600 sec), nviSchedule_1 will not be used to control nvoEffectOccup.
nviSystemToVav.Occupancy.current_state	Occupancy received from the network. If nviSchedule_1 is not bound then the system will use this network variable to control nvoEffectOccup. If no update is received from the network for more than the network variable Max Receive Time (default = 600 sec), nviSystemToVav.Occupancy.current_state will not be used to control nvoEffectOccup.
nviOccManCmd	Occupancy manual override received from the network. This variable has precedence over nviSchedule_1 and nviSystemToVav.Occupancy.current_state.
nvoEffectOccup	This variable is derived from the five variables listed above. The occupant can force the system into Bypass mode during unoccupied and standby modes via the room sensor. The override delay can be adjusted through nciConfig5.BypassTime. If none of the three above nvis are bound, nvoEffectOccup will default to occupied mode.
nvoVAVStatus1.OccupDetect	Current status from a motion detection sensor. When configured, nvoEffectOccup is set to standby mode when nviSchedule_1 or nviSystemToVav.Occupancy is in occupied mode. Once motion is detected nvoEffectOccup is set to occupied for the nciConfig5.HoldTime period.
nvoVAVStatus1.WindowContact	Current status of a window dry contact. When configured, nvoEffectOccup is set to unoccupied mode when the window is open regardless of the other occupancy variables.

The Smart Thermostat with occupancy detection (motion sensor) will have priority over any occupancy sensor input. For example, if inputs 1, 2, or 3 are configured for an occupancy sensor and there is also a Smart Thermostat sensor with occupancy detection, then nvoEffectOccup variable will only take into account the Smart Thermostat sensor.

The following table describes how the ComSensor with motion will interact.

Schedule	Occupancy	WindowContact	EffectOccup
Null	Unconfig	Off	Occupied
		On	Unoccupied
	Unoccupied	Off	Unoccupied
		On	Unoccupied
	Occupied	Off	Occupied
		On	Unoccupied
Occupied	Unconfig	Off	Occupied
		On	Unoccupied
	Occupied	Off	Occupied
		On	Unoccupied
	Unoccupied	Off	Standby
		On	Unoccupied
Standby	Unconfig	Off	Standby
		On	Unoccupied
	Occupied	Off	Occupied
		On	Unoccupied
	Unoccupied	Off	Standby
		On	Unoccupied
Unoccupied	Occupied	Off	Unoccupied
		On	Unoccupied
	Unoccupied	Off	Unoccupied
		On	Unoccupied
	Unconfig	Off	Unoccupied
		On	Unoccupied

SPACE TEMPERATURE SETPOINTS

The Space Temperature setpoints consist of six configuration setpoints, three network variables, and one setpoint adjustment variable. These setpoints are described in the following table:

<table>
<tr><th>Variable</th><th>Description</th></tr>
<tr><td>nciSetpoints.UnoccupiedCool</td><td>Cooling setpoint during unoccupied mode</td></tr>
<tr><td>nciSetpoints.StandbyCool</td><td>Cooling setpoint during standby mode</td></tr>
<tr><td>nciSetpoints.OccupiedCool</td><td>Cooling setpoint during occupied mode</td></tr>
<tr><td>nciSetpoints.OccupiedHeat</td><td>Heating setpoint during occupied mode</td></tr>
<tr><td>nciSetpoints.StandbyHeat</td><td>Heating setpoint during standby mode</td></tr>
<tr><td>nciSetpoints.UnoccupiedHeat</td><td>Heating setpoint during unoccupied mode</td></tr>
<tr><td>nviSetpoint</td><td>Network variable used to change occupied and standby setpoints via the network.</td></tr>
<tr><td>nviSystemToVav.SpaceSetpoint</td><td>Same as nviSetpoint, however when nviSetpoint is between 50°F(10°C) and 95°F(35°C) this network variable is not used.</td></tr>
<tr><td>nviSetPtOffset</td><td>Network variable used to shift the occupied and standby setpoints via the network. This variable is added to the effective Occupied and Standby setpoints.</td></tr>
<tr><td>SetpointOffset</td><td>The final setpoint offset is calculated based on the nviSetPtOffset, and the setpoint offset on hardware input 2 or the Smart Thermostat if configured.
• SetpointOffset = nviSetPtOffset + (Input 2 or Smart Thermostat setpoint offset)</td></tr>
<tr><td>nvoEffectCoolSP</td><td>The actual cooling setpoint is derived based on nvoEffectOccup, nciSetpoints, nviSetpoint and nviSetPtOffset
• abs_setpoint_offset = nviSetpoint - (nciSetpoints.OccupiedCool + nciSetpoints.OccupiedHeat)/2
When nvoEffectOccup equals occupied or bypass mode:
• nvoEffectCoolSP = nciSetpoints.OccupiedCool + abs_setpoint_offset + SetpointOffset
When nvoEffectOccup equals standby mode:
• nvoEffectCoolSP = nciSetpoints.StandbyCool + abs_setpoint_offset + SetpointOffset
When nvoEffectOccup equals unoccupied mode:
• nvoEffectCoolSP = nciSetpoints.UnoccupiedCool</td></tr>
</table>

Variable	Description
nvoEffectHeatSP	The actual heating setpoint is derived based on nvoEffectOccup, nciSetpoints, nviSetpoint and nviSetPtOffset. • abs_setpoint_offset = nviSetpoint - (nciSetpoints.OccupiedHeat + nciSetpoints.OccupiedHeat)/2 When nvoEffectOccup equals occupied or bypass mode: • nvoEffectHeatSP = nciSetpoints.OccupiedHeat + abs_setpoint_offset + SetpointOffset When nvoEffectOccup equals standby mode: • nvoEffectHeatSP = nciSetpoints.StandbyHeat + abs_setpoint_offset + SetpointOffset When nvoEffectOccup equals unoccupied mode: • nvoEffectHeatSP = nciSetpoints.UnoccupiedHeat
nvoEffectSetpt	The effective setpoint reflects nvoEffectCoolSP or nvoEffectHeatSP depending on nvoUnitStatus.mode.

The dc gfxApplications interface and the Smart Thermostat sensor can both be used to adjust the heating and cooling setpoints.

HVAC Modes

The following table describes the HVAC mode variables:

Variable	Description
nvoUnitStatus.mode	This variable is controlled by nviApplicMode. When nviApplicMode is set to Auto, nvoUnitStatus.mode reflects the room's actual terminal load.
nviApplicMode	This is the application mode received from the network. If no update is received from the network for more than the network variable Max Receive Time (default = 600 sec), nviApplicMode will be considered as Auto. The supported modes are: (-1)-Nul, (0)-Auto, (1)-Heat, (2)-Mrng Wrmup, (3)-Cool, (4)- Night Purge, (5)-Pre Cool, and (6)-Off.

Airflow Control and Calibration

Airflow Control

There are six (6) airflow configuration setpoint variables described in the following table:

Variable	Description
nciMinFlow	Absolute minimum flow setpoint during occupied mode
nciMaxFlow	Maximum flow setpoint during cooling mode
nciMinFlowHeat	Minimum flow setpoint when duct heater is active
nciMaxFlowHeat	Maximum flow setpoint during heating mode
nciMinFlowStby	Minimum flow setpoint during standby mode
nciMinFlowUnocc	Minimum flow setpoint during unoccupied mode

The actual flow setpoint, nvoEffectFlowSP, is calculated based on nciConfig1.BoxType and other control variables described in the subsections below.

Variable	Description
nviDuctInTemp	Using nviDuctInTemp and temperature setpoint average (nvoEffectCoolSP and nvoEffectHeatSP) the system evaluates whether the inlet temperature is suitable for cooling or heating the space. If nvoUnitStatus.mode is in morning warm up, the air is by default considered suitable for heating the space.
nviSystemToVav.DischargeTemp	Same as nviDuctInTemp however when nviDuctInTemp is between 32°F (0°C) and 212°F (100°C) this network variable is not used.

Single Duct VAV

The following sections describe the single duct VAV cooling and heating mode variables.

Cooling Mode

When the air is suitable for cooling the space, nvoEffectFlowSP varies between nciMinFlow and nciMaxFlow based on terminal load. Otherwise, when the air is too warm, nvoEffectFlowSP is by default equal to nciMinFlow.

When nvoEffectOccup is in unoccupied or standby mode, nciMinFlow is replaced by either nciMin- FlowUnocc or nciMinFlowStby.

Heating Mode

When the air is suitable for heating the space, nvoEffectFlowSP varies between nciMinFlow and nciMaxFlowHeat. Otherwise, when the air is too cold, nvoEffectFlowSP is by default equal to nciMinFlow. Regardless, when duct heating is required, nciMinFlow is replaced by the highest value between nciMinFlow and nciMinFlowHeat.

When nvoEffectOccup is in unoccupied or standby mode, nciMinFlow is replaced by either nciMin-FlowUnocc or nciMinFlowStby.

Variable	Description
nciConfig1.VvtMode	When this option is selected, nvoEffectFlowSP is converted into a percentage, which controls the damper without using a flow reading.
nciConfig1.DualMaximum*	In heating mode, nvoEffectFlowSP is controlled by the following method. The first 50 percent of the heating load adjusts the nvoDischTempSP between 55°F (13°C) and nciConfig5.MaxDischTempSp. The second 50 percent of the heating load adjusts the nvoEffectFlowSP between nciMinFlowHeat and nciMaxFlowHeat.

**The dual maximum option requires a discharge temperature sensor to be configured.*

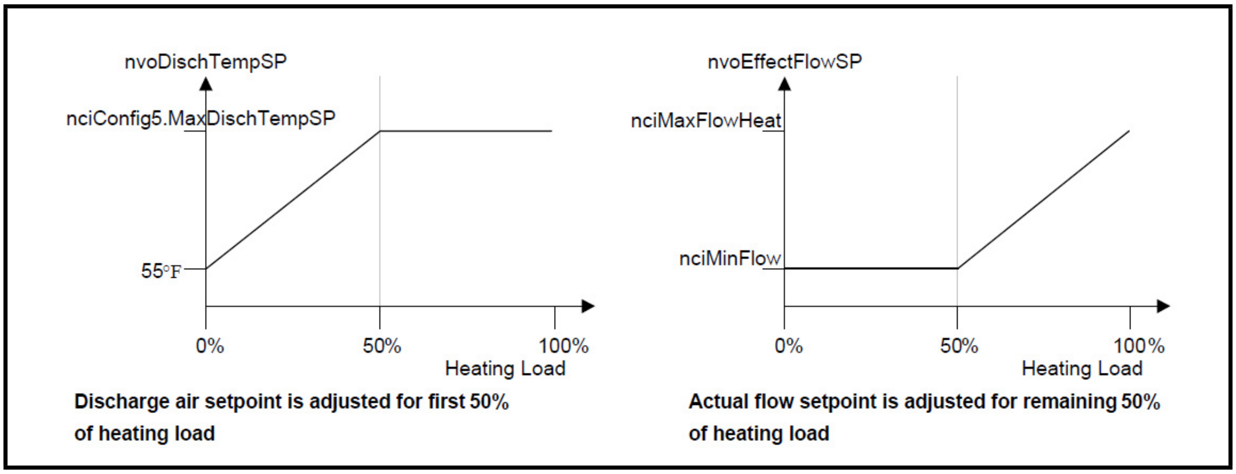


Figure B -1 *- Heating Control with the Dual Maximum Option*

Fan Powered VAV

The tables below describe the Fan Powered VAV cooling and heating mode variables.

Cooling Mode

When the air is suitable for cooling the space, nvoEffectFlowSP varies between nciMinFlow and nci- MaxFlow based on terminal load. Otherwise, when the air is too warm, nvoEffectFlowSP is by default equal to nciMinFlow.

When nvoEffectOccup is in unoccupied or standby mode, nciMinFlow and nciMinFlowHeat are replaced by either nciMinFlowUnocc or nciMinFlowStby.

Heating Mode

When the air is suitable for heating the space, nvoEffectFlowSP varies between nciMinFlowHeat and nciMaxFlowHeat. Otherwise, when the air is too cold, nvoEffectFlowSP is by default equal to nciMin-FlowHeat.

When nvoEffectOccup is in unoccupied or standby mode, nciMinFlow and nciMinFlowHeat are replaced by either nciMinFlowUnocc or nciMinFlowStby.

When nciConfig1.VvtMode option is selected, nvoEffectFlowSP is converted into a percentage, which controls the damper without using a flow reading.

Flow Tracking Operation

To use the flow tracking operation mode, two variables must be used. The nvoEffectFlowSP can be nviAirFlowSetpt and nciFlowOffset, described in the table below:

Variable	Description
nviAirFlowSetpt	When this network variable is between (0 l/s and 65534 l/s), the flow tracking operation mode is enabled.
nciFlowOffset	This network configuration input is added to the nviAirFlowSetpt to obtain the nvoEffectFlowSP.

HVAC Modes

The following table describes the HVAC mode variables:

Variable	Description
nvoUnitStatus.mode	This variable is controlled by nviApplicMode. When nviApplicMode is set to Auto, nvoUnitStatus.mode reflects the room's actual terminal load.
nviApplicMode	This is the application mode received from the network. If no update is received from the network for more than the network variable Max Receive Time (default = 600 sec), nviApplicMode will be considered as Auto. The supported modes are: (-1)-Nul, (0)-Auto, (1)-Heat, (2)-Mrng Wrmup, (3)-Cool, (4)-Night Purge, (5)-Pre Cool, and (6)-Off.

CO_2 Sensor

CO2 sensor priorities are as follows:

1. Smart Thermostat with CO2 sensor.
2. CO2 sensor configured on Input 4.

The Smart Thermostat with CO2 sensor will have priority configured on Input 4.

CO_2 Control

The CO2 is calculated by a PID loop. The PID loop is activated if the CO2 concentration value is valid (less or equal to 5000 ppm). In a PID configuration, the default value of the CO2Setpoint variable is 1000 ppm.
The PID output is multiplied by 2 in order to control the air flow in the first half of the PID loop (0-50%). As for the second half of the PID loop (50-100%), the NvoCO2Load (NVO16) should be read by the AHU to adjust the outdoor air damper. You can also use the maximum of all the PID loops to increase the minimum fresh air of the AHU supplying this area.

Air Flow Setpoint (AirFlowSP)

The Air Flow calculation depends on the CO2 load:

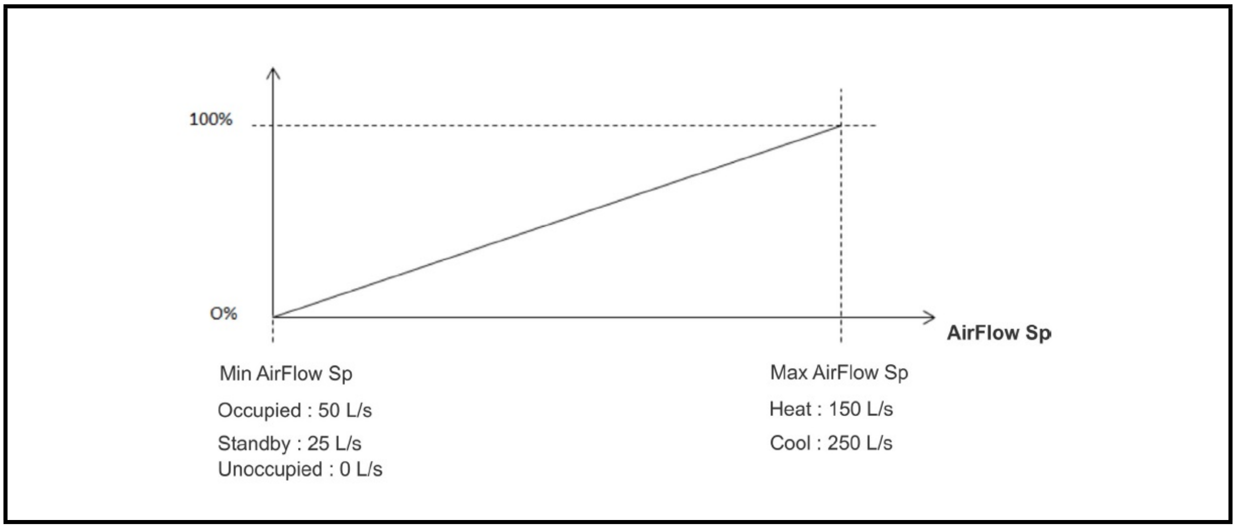


***Figure B -2** - Air Flow Setpoint Calculation*

For example, the AirFlow setpoint is directly linked to the NvoCO2Load (NVO16):

- If CO2Load is 0% then AirFlowSetpoint is equal to MinAirFlow Sp.
- If CO2Load is 65% then AirFlowSetpoint is equal to the following:

  ((MaxFlowSp - MinFlowSp) x 0.65) + MinFlowSp)

The AirFlow setpoint will be the maximum value between the air flow setpoint based on the space temperature and the CO2 flow setpoint.

CO2 Elevation Input

The Smart Thermostat with CO2 sensors are factory calibrated to accurately read CO2 concentration levels at sea level. The NumericConstant1 variable adjusts the CO2 concentration levels when the sensor is used in locations where the elevation is greater than 500ft (152m) above sea level. The Elevation input of the corresponding ComSensor block in ECgfxProgram must be set to the current location's elevation to obtain the most accurate readings.

Heat Control and Output Wiring

Heat Control

Depending on the controller model, up to three heating sources can be controlled. Configuration of these sources is done by the following variables:

- nciConfig3.Heat1Type
- nciConfig3.Heat2Type
- nciConfig3.Heat3Type

These variables allow the user to select the type of control signal used to drive the heating source. These variables must be configured in a specific order (i.e. nciConfig3.Heat1Type must be configured before nciConfig3.Heat2Type, and so on).

Each heat type has a normally open or normally closed configuration option, represented by the following variables:

- nciConfig3.Heat1_NO

- nciConfig3.Heat2_NO
- nciConfig3.Heat3_NO

Other relevant variables are described in the table below:

Variable	Description
nciConfig1.DuctHeatStgs	This variable determines the number of duct heaters that are installed. Duct heaters are always wired starting from nciConfig3.Heat1Type. If no duct heater or only perimeter heat is required, set this variable to “None”. All heat types configured greater than nciConfig1.DuctHeatStgs are considered perimeter heaters.
nciConfig5.MaxOatDuctHeat	Outside air temperature limit to disable the duct heater(s).
nciConfig5.MaxOatPerimHeat	Outside air temperature limit to disable the perimeter heater(s).
nciConfig1.HeatPriority	Determines which heating source is activated first. Options are duct heater, perimeter heat or simultaneous.
nciConfig1.HotWaterReheat	Determines if hot water reheat is used. When in use, the nciMinFlowHeat safeguard is ignored.

Shedding

Shedding is based on the following variables:

Variable	Description
nviShedding	Load shedding option. A value of zero percent disables this feature.
nviSystemToVav.Shedding	Same as nviShedding, however when nviShedding is between 0 and 100 percent, this network variable is not used.
nciConfig5.SheddingOnSetpoint	When set to true, the nvoEffectHeatSP and nvoEffectCoolSP will be adjusted based on their corresponding occupied and standby setpoints: • nvoEffectHeatSP adjustment = (nciSetpoints.StandbyHeat - nciSetpoints.OccupiedHeat) * nviShedding / 100 • nvoEffectCoolSP adjustment = (nciSetpoints.StandbyCool - nciSetpoints.OccupiedCool) * nviShedding / 100 When set to false, a shedding value between 0 and 100 percent attenuates the total heat demand of the system.
nciConfig5.SheddingEnable	When set to false, all shedding is disabled regardless of all other values.

Example:

Heating demand = 75%

Shedding = 20%

Max heating = 100% - 20% (shedding) = 80%

Output = 75% (heating demand) x 80% (max heating) = 60% (Scaled output based on required shedding)

Output Wiring

Wiring of outputs depends on heat type configuration.

Heat1Type	Heat1Type always outputs on DO1 and AO6. When using a floating valve, DO1 is used for opening the valve and DO2 is used for closing the valve. When the Pwm Triac option is used, DO1 and AO5 are used to control the heating source. If FanType (BV10) is configured for ECM, analog output (AO5) will not be used.
Heat2Type	Heat2Type always outputs on DO2 and AO6 unless Heat1Type is a floating valve, in which case the digital outputs are shifted (i.e. DO2 becomes DO3 and DO3 becomes DO4). When using a floating valve, DO2 is used for opening the valve and DO3 is used for closing the valve. When the Pwm Triac option is used, DO2 and AO6 are used to control the heating source. If FanType (BV10) is configured for ECM, analog output (AO6) won't be used.
Heat3Type	Heat3Type always outputs on DO3 unless Heat1Type or Heat2Type is a floating valve, in which case the digital output is shifted (i.e. DO3 becomes DO4). When both Heat1Type and Heat2Type are floating valves or when BoxType is a fan powered box and Heat1Type or Heat2type is a floating valve, Heat3Type cannot be configured. Note that when using the Pwm Triac option, no analog output is controlled.

Fan Control

Depending on the type of fan powered box, the fan is controlled based on one of two sequences.

- Series Fan
- Parallel Fan

Series Fan

The fan is started by the following conditions:

If the controller is configured for a Series Fan, any time the Occupancy mode of the controller is set to either Occupied or Standby, the fan runs continuously. The fan speed is set to Maximum Fan Speed when the state is Occupied and set to Minimum Fan Speed when the state is Standby. When the Occupancy state is Unoccupied, the fan starts and runs at minimum speed only on a call for heating. The fan starts when the Heating loop is greater than 10% and stops when the Heating loop is less than 1%.

- 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.

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

Parallel Fan

The fan is started by the following conditions:

If the controller is configured for a Parallel Fan, any time the Occupancy mode of the controller is set to either Occupied or Standby and there is a call for heating, the fan runs continuously. The fan starts when the Heating loop is greater than 10% and stops when the Heating loop is less than 1%. When the Occupancy state is Unoccupied or Standby, the fan starts and runs at minimum speed only on a call for heating. The fan starts when the Heating loop is greater than 10% and stops when the Heating loop is less than 0%.

- Duct heating is required.
- Main air flow is lower than nciPFanStartFlow during occupied or bypass period.

Note that for both types of fan powered boxes, the minimum on and minimum off delays prevent the fan from short cycling. Fan control always outputs on DO4.

VAV Performance Assessment Control Charts (VPACC)

The LonWorks VAV VPACC feature, which is embedded into the LonWorks VAV control sequences, provides a means of automatically detecting when the VAV is operating outside of its design parameters.

In a traditional sequence of operations, alarms are triggered when the value of a point stays outside the alarm limit for a defined period of time. The VPACC improves on this, since it has the capability to set off a warning condition automatically should the system be unstable or consistently too high or low, even if the alarm points are never reached.

Additional benefits of the VPACC:

- Identify failure or unstable control where standard alarming would fails
- Track equipment control over a long period of time
- Identify failure before occupant complaints
- Monitor system only when in occupied mode
- Increase building efficiency
- Reduce major equipment replacement and emergency equipment replacement
- No need to program alarm in EC-BOS or EC-Net Pro.

VPACC Functionality

The VPACC feature can detect and diagnose this unstable control by evaluating the frequency of errors over time and producing an alarm should the frequency exceed the established parameters. The VPACC fault detection alerts can be viewed from the dc gfxApplications graphics pages. The VPACC is available with all VAV controllers and is used in your custom VAV sequence using gfxApplications code library.

The VPACC will measure the following fault detections:

- Persistent High/Low Space Temperature
- Persistent High/Low Discharge Temperature
- Persistent High/Low Air Flow
- Unstable Air Flow

VPACC Parameters

- nciConfig6
  - EnableDelayVPACC
  - CUSUM_K_VPACC
  - SpaceTempStdErr
  - SpaceTempErrAlmSP
  - AirFlowStdE22
  - AirFlowErrAlmSP
  - DischTempStdErr
  - DischTempErrAlmSp
- nvoVavStatus3
- VPACCstatus
- SpaceTempPosErr
- SpaceTempNegErr
- AirFlowPosErr
- AirFlowNegErr
- AirFlowAbsErr
- DischTempPosErr
- DischTempNegErr

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