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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.
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1 Overview

Retail Solutions 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 Rooftop VAV controller, Single-duct VAV controllers (air damper control), and VAV Smart Thermostats 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 (Figure 1-1).
1.1. VAV Control Network Components

1.1.1. Rooftop VAV (RTU-L) Controller (810-8002)

The Rooftop VAV controller is a microprocessor-based discharge air controller designed to control any rooftop unit application. The Rooftop VAV controls up to 4 total stages of heating and cooling, VFD fan, humidification and dehumidification, economization, and more.

The Rooftop VAV comes with 6 pre-defined inputs and 7 pre-defined outputs. Inputs include static pressure, fan proof, outdoor, return, supply, and mixed temperature. 5 triac outputs (PWM or digital) include fan run, 0-10VDC economizer, 0-10VDC Fan, 2 cool, and 2 heat stages.

The Rooftop VAV controller’s role in the VAV Control Network is to coordinate all Single-duct controllers associated with the Rooftop VAV controller. The Single-duct VAV reports its terminal load back to the E2 controller, and the E2 sends the demand averaging back to its connected Rooftop VAV controller.

1.1.2. Single-duct VAV Controller (810-8000)

The Single-duct VAV controller is designed to control all aspects of a single zone or room, including heating and cooling, fans, duct heaters, and air dampers. The Single-duct VAV controller features 4 pre-defined temperature sensor inputs and 6 pre-defined outputs (4 digital and 2 universal).

Digital outputs are triacs rated at 0.75 amps, 24VAC. Universal outputs are either 0-10VDC, 0-12VDC, or PWM 20MA max.

The controller uses the LonWorks® network by Echelon® for communication with E2 BX Building and CX Controllers.
1.1.3. VAV Smart Thermostat (809-8000)

The VAV Smart Thermostat is an advanced LCD sensor specifically designed to interface with the Single-duct VAV controller. This device provides precision local temperature sensing and provides a variety of public functions that can be accessed by room occupants, as well as password-protected functions for technicians.

Occupants have access to a user-friendly interface for viewing environmental settings and adjusting them to their liking. Building occupants can also view occupancy status, space temperature, outside air temperature, and view the setpoint.

Maintenance personnel have access to a password-protected configuration mode that allows them to perform air balancing on a connected Single-duct VAV controller, view input and output values for the connected Single-duct VAV.

The VAV Smart Thermostat may either be mounted in a room or used by technicians as a hand-held air balancing tool.

1.1.4. AHU/Rooftop VAV controller Kit (810-8012)

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rooftop VAV Controller (810-8001)</td>
</tr>
<tr>
<td>1</td>
<td>Transformer (640-0056)</td>
</tr>
<tr>
<td>3</td>
<td>Return, Supply, and Mixed Temperature Sensors (201-2112)</td>
</tr>
<tr>
<td>1</td>
<td>Outdoor Air Temperature Sensor (501-1121)</td>
</tr>
<tr>
<td>1</td>
<td>Veris PXU LX05S Static Pressure Transducer</td>
</tr>
<tr>
<td>2</td>
<td>Kele A-302-K Pilot Tube</td>
</tr>
<tr>
<td>2</td>
<td>Kele A-345-K Flange</td>
</tr>
<tr>
<td>1</td>
<td>Kele RPS Cover</td>
</tr>
<tr>
<td>1</td>
<td>Single Gang Box</td>
</tr>
<tr>
<td>1</td>
<td>20’ – Kele T-101 Tubing</td>
</tr>
<tr>
<td>1</td>
<td>Kele B-376 T-barb</td>
</tr>
</tbody>
</table>

Table 1-1 - AHU/Rooftop VAV controller Kit Components
1.1.5. Single-duct VAV Box Kit (810-8010)

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Single-duct VAV Controller (810-8000)</td>
</tr>
<tr>
<td>1</td>
<td>VAV Smart Thermostat (809-8000)</td>
</tr>
<tr>
<td>1</td>
<td>Transformer (640-0056)</td>
</tr>
<tr>
<td>1</td>
<td>Flow Sensor (202-5005)</td>
</tr>
<tr>
<td></td>
<td>5.4 inch insertion</td>
</tr>
<tr>
<td>1</td>
<td>10’ Kele T-101 (Sample Tube)</td>
</tr>
</tbody>
</table>

*Table 1-2 - Single-duct VAV Kit Components*
2  Mounting

2.1. The Rooftop VAV Controller

The Rooftop VAV is designed to be mounted within or near the rooftop unit, either on a DIN rail or to a wall or panel using the mounting holes as shown in Figure 2-1.

2.1.1. Rooftop VAV Environmental Ratings

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

- Ambient temperature from 32°F to 158°F (0°C to 70°C).
- Relative humidity from 0-90% non-condensing.

![Figure 2-1 - Rooftop VAV Dimensions](image)

![Figure 2-2 - Single-duct VAV Controller Dimensions](image)

![Figure 2-3 - Single-duct VAV Damper Shaft Mounting Diagram](image)

2.2. The Single-duct VAV Controller

The Single-duct VAV Controller is designed to be mounted on a damper shaft, fastened either against the side of the air duct or in a panel. The integrated mounting brackets on the right side of the controller have a hole diameter of 0.2” (5 mm) and are designed to oppose shaft torque.

1. Mount the controller over the damper shaft, and use the controller mounting brackets to mark the location of any holes that need to be drilled.
2. Remove the controller and drill the necessary holes.
3. Clean the surface.

4. Re-mount the controller on the damper shaft, and fasten the controller using the appropriate screw types.

5. Ensure the damper shaft is at least 1.5” (4 cm) long to allow the damper bracket to fit securely around the damper shaft. If required, limit the maximum damper shaft rotation by modifying the position of the mechanical stops in 5° increments.

6. Connect the high and low pressure sensors with 1/4” (6.4 mm) outside diameter, 5/32” (4 mm) inside diameter flexible tubing.

   Allow for proper clearance of controller enclosure, wiring terminals and service pin for easy access, hardware configuration, and maintenance. Remember to record the Neuron® ID located on the side of the controller (in text and barcode format) for later commissioning.

   Ensure proper ventilation of controller and avoid areas where corroding, deteriorating or explosive vapors, fumes, or gases may be present. The controller must be oriented with the ventilation slots towards the top to permit proper heat dissipation.

2.2.1. Single-duct VAV Environmental Ratings

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

- Ambient temperature from 32°F to 158°F (0°C to 70°C).
- Relative humidity from 0-90% non-condensing.

2.3. The VAV Smart Thermostat

The VAV Smart Thermostat is designed to be mounted on a wall in the space controlled by its associated Single-duct VAV controller. Choose a location on the wall that is 4 to 6 feet above floor level that is away from any external source of heat, cool, humidity, or excess air flow.

2.3.1. VAV Smart Thermostat Mounting Conditions

The VAV 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.
2.3.2. VAV Smart Thermostat Mounting Steps

Before mounting, detach the VAV Smart Thermostat from the rear mounting plate by pushing down on the release tabs (4 total) on the top or bottom of the mounting plate. Use the holes in the mounting plate to fasten it to the wall, and use the large hole in the middle of the plate to run wiring through the wall to the VAV Smart Thermostat.

1. Make sure that the mounting surface is flat and clean.
2. Remove the security screw from the device (Figure 2-5).
3. 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.
4. Flip the printed circuit board over to access the mounting hole.
5. Pull all cables 6” (15.24 cm) out of the wall, and insert them through the central hole of the back plate.
6. 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.
7. Remove the back plate and drill holes in the wall if necessary.
8. Install anchors in the wall if necessary.
9. Screw the back plate onto the wall. Do not over tighten.
10. Strip each wire ¼” (6.35 mm) and insert each one according to the wiring diagrams shown in this document.
11. Gently push excess wiring back into the wall.
12. Flip the printed circuit board back into place.
13. When finished, re-attach the VAV Smart Thermostat front plate by snapping it into the mounting plate. Verify that it clips tightly into place.

2.3.3. VAV Smart Thermostat Environmental Ratings

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

- Ambient temperature from 32°F to 158°F (0°C to 70°C).
- Relative humidity from 0-90% non-condensing.

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

Figure 2-5 - VAV Smart Thermostat Mounting - Device Components

1. Make sure that the mounting surface is flat and clean.
2. Remove the security screw from the device (Figure 2-5).
3. 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.
4. Flip the printed circuit board over to access the mounting hole.
5. Pull all cables 6” (15.24 cm) out of the wall, and insert them through the central hole of the back plate.
6. 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
3 Powering

3.1. The Rooftop VAV and Single-duct VAV Controllers

The Rooftop VAV and Single-duct VAV controllers both require 24VAC ± 15%, Class 2 power from a non-center-tapped transformer. Table 3-1 lists all non-center-tapped transformers supplied by Retail Solutions.

<table>
<thead>
<tr>
<th>Xformer P/N</th>
<th>VA Rating</th>
<th>Primary Voltage</th>
<th>Center Tap?</th>
</tr>
</thead>
<tbody>
<tr>
<td>640-0041</td>
<td>50 VA</td>
<td>110 VAC</td>
<td>No</td>
</tr>
<tr>
<td>640-0042</td>
<td>50 VA</td>
<td>220 VAC</td>
<td>No</td>
</tr>
<tr>
<td>640-0056</td>
<td>56 VA</td>
<td>Multi-tap (120/208/240 VAC)</td>
<td>Yes</td>
</tr>
<tr>
<td>640-0050</td>
<td>75 VA</td>
<td>110 VAC</td>
<td>No</td>
</tr>
<tr>
<td>640-0045</td>
<td>75 VA</td>
<td>220 VAC</td>
<td>No</td>
</tr>
<tr>
<td>640-0080</td>
<td>80 VA</td>
<td>Multi-tap (120/208/240 VAC)</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 3-2 - Transformer Part Numbers

When using 640-0056 and 640-0080 multi-tap transformers, leave the center tap on the secondary side unconnected, as shown in Figure 3-1.

Maintain consistent polarity when connecting controllers and devices to the transformer. That is, the COM terminal of each controller and each peripheral should be connected to the same terminal on the secondary side of the transformer.

<table>
<thead>
<tr>
<th>Controller</th>
<th>Max Power Consumption (VA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rooftop VAV</td>
<td>18 VA</td>
</tr>
<tr>
<td>Single-duct VAV</td>
<td>10 VA</td>
</tr>
</tbody>
</table>

Table 3-2 - Controller VA Ratings

CAUTION: The controllers are half-wave rectified. Connecting two half-wave power supplies to the same transformer without maintaining polarity will cause a short circuit.

CAUTION: The COM terminals of the controller are internally wired to the 24V COM terminal of the power supply; therefore, if powering peripherals and controllers with the same transformer, it is essential to maintain polarity. Failure to do so will result in a short circuit and/or a damaged controller.

A transformer may power multiple Rooftop VAVs or Single-duct VAVs. Table 3-2 shows the maximum power consumption of the Rooftop VAV or Single-duct VAV controllers. To determine how many controllers may be powered by a single transformer, add together the VA ratings of each controller you wish to connect, and multiply by 1.3. If the resulting VA total is higher than the VA rating of the transformer, you will either need to use a larger transformer or power some of the controllers using a second transformer.
3.1.1. Wire Types and Maximum Distances

For powering Rooftop VAV and Single-duct VAV controllers, use two-conductor non-shielded cables for connecting between the transformer and the controllers. Shielded cable should not be used for power wiring. The center tap should be wired with the third conductor to earth ground at the transformer.

The wire length from the transformer and the number of boards connected to the same wire determines the type wire gauge used. In most cases, the distance between the controllers and the transformer that supplies power to them is not enough to be of concern. But it is very important not exceed this maximum wire length or the controllers will malfunction.

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

14 AWG:
Feet = \(0.40/(VA/24) \times 0.005\)

18 AWG:
Feet = \(0.40/(VA/24) \times 0.013\)

(\(VA\) is the total VA rating of the controllers)

For example, if you had an 80 VA load:
14 AWG: 24 ft. (rounded down)
18 AWG: 9 ft.
4  Input Wiring

4.1. The Rooftop VAV Controller

The Rooftop VAV has six (6) pre-configured inputs (labeled UI1 through UI6). The inputs support 10kΩ thermistors, 1kΩ Platinum RTDs, Platinum PT100s, digital dry contacts, and 0 to 10VDC inputs.

Wire the signal side of the sensor or input device to the appropriately numbered UI terminal as shown in Figure 4-1. Wire the other side to the COM terminal nearest to the UI terminal you are using (every two UI inputs shares a COM terminal).

![Figure 4-1 - Rooftop VAV Input Locations](image)

<table>
<thead>
<tr>
<th>Input Number</th>
<th>Input Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>UI1</td>
<td>Outside Temperature</td>
</tr>
<tr>
<td>2</td>
<td>COM</td>
<td>Common</td>
</tr>
<tr>
<td>3</td>
<td>UI2</td>
<td>Return Temperature</td>
</tr>
<tr>
<td>4</td>
<td>UI3</td>
<td>Supply Temperature</td>
</tr>
<tr>
<td>5</td>
<td>COM</td>
<td>Common</td>
</tr>
<tr>
<td>6</td>
<td>UI4</td>
<td>Mixed Air Temperature</td>
</tr>
<tr>
<td>7</td>
<td>UI5</td>
<td>Duct Pressure (INW)</td>
</tr>
<tr>
<td>8</td>
<td>COM</td>
<td>Common</td>
</tr>
<tr>
<td>9</td>
<td>UI6</td>
<td>Fan Proof</td>
</tr>
<tr>
<td>10</td>
<td>LON1</td>
<td>Echelon</td>
</tr>
<tr>
<td>11</td>
<td>LON2</td>
<td>Echelon</td>
</tr>
</tbody>
</table>

Table 4-1 - Rooftop VAV Inputs
4.1.2. Rooftop VAV Input Wiring

4.2. The Single-duct VAV Controller

The Single-duct has four pre-configured inputs (labeled UI1 through UI4). The inputs support 10kΩ thermistors, 1kΩ Platinum RTDs, Platinum PT100s, 10kΩ potentiometers, digital dry contacts, 4-20 mA current inputs, and 0-10VDC inputs.

Wire the signal side of the sensor or input device to the appropriately numbered UI terminal as shown in Figure 4-3. Wire the other side to the COM terminal. All four inputs share the same common terminal (COM).
4.2.1. Single-duct VAV Input Configuration

<table>
<thead>
<tr>
<th>Input Number</th>
<th>Input Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>LON2</td>
<td>Echelon</td>
</tr>
<tr>
<td>1</td>
<td>LON1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>SMRT -</td>
<td>Smart Thermostat</td>
</tr>
<tr>
<td>1</td>
<td>SMRT +</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>UI4</td>
<td>Temperature Monitoring (optional)</td>
</tr>
<tr>
<td>4</td>
<td>UI3</td>
<td>Temperature Monitoring (optional)</td>
</tr>
<tr>
<td>3</td>
<td>COM</td>
<td>Common for Temperature Sensors</td>
</tr>
<tr>
<td>2</td>
<td>UI2</td>
<td>Temperature Monitoring (optional)</td>
</tr>
<tr>
<td>1</td>
<td>UI1</td>
<td>Discharge Temp Sensor</td>
</tr>
</tbody>
</table>

Table 4-2 - Single-duct VAV Inputs

4.2.2. Single-duct VAV Input Wiring

![Diagram of Single-duct VAV Input Wiring]

Figure 4-4 - Single-duct VAV Input Wiring

Use Belden 8641 (or equiv.) for both the Smart Thermostat and Discharge Temperature Sensor
4.3. VAV Smart Thermostat Wiring

If a VAV Smart Thermostat is being used, connect the T1 and T2 terminals on the VAV Smart Thermostat circuit board sensor to the SMRT+ and SMRT- terminals on the Single-duct VAV, as shown in Figure 4-5. Use Belden 8641 cable or equivalent (two-conductor, shielded) to make the connection.

![Figure 4-5 - VAV Smart Thermostat Connection to Single-duct VAV](image-url)
### 4.3.1. Smart Thermostat Troubleshooting

<table>
<thead>
<tr>
<th>VAV Smart Thermostat Screen Is Blank</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Is the thermostat connected to the controller?</strong></td>
</tr>
<tr>
<td>Verify that the thermostat is connected to the controller and that no wires have come loose from the input terminals.</td>
</tr>
<tr>
<td><strong>Is power being supplied to the controller?</strong></td>
</tr>
<tr>
<td>Power may not be supplied from the controller. Check if the controller has power or if the controller’s internal fuses have blown or tripped.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Device Not Communicating With Controller</th>
</tr>
</thead>
<tbody>
<tr>
<td>**Is the polarity of the VAV Smart Thermostat connec-</td>
</tr>
<tr>
<td>tion to the controller incorrect?**</td>
</tr>
<tr>
<td>Verify that the device is wired to the controller with the correct polarity. T1 must be connected to SMRT+ and T2 to SMRT-.</td>
</tr>
<tr>
<td><strong>Is the device too far from the controller?</strong></td>
</tr>
<tr>
<td>Verify the distance between the device and the controller. The wiring length should be less than 50ft.</td>
</tr>
</tbody>
</table>

*Table 4-3 - VAV Smart Thermostat Troubleshooting*
5 Output Wiring

5.1. The Rooftop VAV Controller

The Rooftop VAV has seven (7) pre-configured outputs: five (5) digital outputs and two (2) universal outputs, the locations of which are shown in Figure 5-1.

Table 5-1 shows the maximum current ratings for the Rooftop VAV outputs.

<table>
<thead>
<tr>
<th>Rooftop VAV Controller Outputs</th>
<th>Output Ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Outputs (DO1-DO5)</td>
<td>Triac 24VAC, 1.0A max</td>
</tr>
<tr>
<td>Universal Outputs (UO6-UO7)</td>
<td>0 to 10VDC (linear/analog), 60mA max</td>
</tr>
</tbody>
</table>

5.1.1. Output Fusing

The universal outputs UO6 through UO7 are protected by an auto-reset fuse with a max current capacity defined by the following two points:

- 100 mA @ 68°F (20°C)
- 60 mA @ 140°F (60°C)
5.1.3. Rooftop VAV Output Wiring

The Single-duct VAV has six (6) outputs: four (4) digital outputs and two (2) universal outputs, the locations of which are shown in Figure 5-3. The function of each output comes pre-configured.

Each pair of digital outputs has a four-pin jumper that must be set with a jumper across the two center pins as shown in Figure 5-3 and Figure 5-4.
5.2.1. Universal Output Fusing

The universal outputs UO5 and UO6 are protected by an auto-reset fuse with a max current capacity defined by the following two points:

- 100 mA @ 68°F (20°C)
- 60 mA @ 140°F (60°C)

<table>
<thead>
<tr>
<th>Digital Outputs (DO1-DO4)</th>
<th>Universal Outputs (UO5-UO6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triac 24VAC, 0.75A max. External or internal power supply.</td>
<td>0 to 10VDC (linear/analog), digital 0 or 12VDC, PWM 20mA max. Maximum load 600Ω</td>
</tr>
</tbody>
</table>

Table 5-3 - Single-duct VAV Output Ratings

5.2.2. Single-duct VAV Output Configuration

<table>
<thead>
<tr>
<th>Single-duct VAV Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Number</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

Table 5-4 - Single-duct VAV Outputs

5.2.3. Single-duct VAV Output Wiring

Before power is applied to the outputs, verify that jumpers J11 and J12 for outputs DO1 - DO4 are jumpered on the middle pin.

CAUTION! If power is applied with the jumpers in the wrong position, damage to the board could result.

Figure 5-4 - Single-duct VAV Output Wiring
6  Echelon Network Wiring

The Echelon® LonWorks® network, commonly called “the Echelon network,” is a two-conductor network that interconnects E2s and other Echelon associated devices. All Echelon devices are wired together using the daisy-chain method of network structuring.

The Echelon network is used by the Rooftop VAV and Single-duct VAV controllers for two purposes: to communicate with each other (for demand averaging and other purposes), and to communicate with the E2 BX Building and CX Controllers.

Note: For more information about Echelon networks and the E2 controller, refer to the E2 User’s Guide (P/N 026-1610), available from Emerson Climate Technologies Retail Solutions.

6.1. Wiring Type

Retail Solutions specifies one type of cable for Echelon Network wiring. This cable type’s properties are listed in Table 6-1.

<table>
<thead>
<tr>
<th>Cable Type</th>
<th>Level 4, twisted pair, stranded, shielded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wire Diam./AWG</td>
<td>0.65mm/22AWG</td>
</tr>
<tr>
<td>Loop Resistance</td>
<td>106(ohms/km)</td>
</tr>
<tr>
<td>Capacitance</td>
<td>49(nF/km)</td>
</tr>
</tbody>
</table>

Table 6-1 - Echelon Network Cable Specifications

<table>
<thead>
<tr>
<th>Cable Type</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 pair, non-plenum</td>
<td>135-2300</td>
</tr>
<tr>
<td>1 pair, plenum</td>
<td>135-2301</td>
</tr>
</tbody>
</table>

Table 6-2 - Recommended Wiring

6.2. Echelon Network Structuring (Daisy-Chains)

Echelon devices are networked together into configurations called segments. A segment is a group of up to 64 Echelon devices that are connected together on an unbroken series of wires.

The recommended way of constructing an Echelon Network is called daisy-chaining. In the daisy-chain network configuration, devices are arranged by subnets, which consist of one E2 and all Echelon devices associated with the E2. All devices in a subnet are connected in an unbroken chain without branches or “star configurations” (see Figure 6-1).

If more than one E2 is present on-site and Echelon is being used as the E2 peer-to-peer network, all chains are connected so that the entire network forms a large unbroken chain. This allows for all devices in the Echelon Network to be hard wired together for trouble-free communication.
6.2.1. Maximum Number of Echelon Devices

A daisy-chained segment may contain no more than 63 total Echelon devices (also called “nodes”). If Echelon is being used as the E2 peer-to-peer network and the total number of Echelon devices on-site exceeds 63, routers will need to be used to separate subnets in between E2 controllers. Refer to P/N 026-1610, E2 User’s Guide, for more information on routers and using Echelon for peer-to-peer networking.

6.3. Echelon Wiring

Connect the Rooftop and Single-duct VAV controllers to the Echelon network segment using the two-terminal Echelon (LON) connector, as shown in Figure 6-2. Tie the shield wires together at each break in the cable, and connect the shields to a solid earth ground.

6.3.1. Device Termination

In a daisy-chain configuration, both ends of the network segment must be terminated. Terminate the E2 by setting jumper JP7 to the UP position, as shown in Figure 6-3. If a Rooftop VAV or Single-duct VAV controller is at the end of a LON network, use a 102-ohm “terminator block” at the end of the network segment (see Section 6.3.2., Using a Termination Block (P/N 535-2715) to Terminate a Daisy Chain).

All other E2s and Echelon devices that aren’t at the end of a daisy-chained network segment must be unterminated.
6.3.2. Using a Termination Block (P/N 535-2715) to Terminate a Daisy Chain

Some Echelon Network devices, notably TD3s, have no on-board means of terminating. For some other devices, it is inconvenient to use the jumpers supplied for termination (the CC-100/CS-100 case controllers, for example, require the enclosure to be removed to set the jumper).

To remedy these problems, Retail Solutions supplies termination blocks that can be wired to the end of an Echelon cable segment. This termination block uses the same three-pin connector as all other Echelon devices. Wire the two signal wires to the outside terminals, and connect the shield to the middle terminal (see Figure 6-4).

![Figure 6-3 - E2 Termination - Daisy Chain](image)

**Figure 6-4 - Placement and Wiring of the Termination Block**

### 6.3.3. Maximum Total Segment Length

The total amount of wire used to connect all E2s and associated controllers in a single segment (not including devices on the other side of routers) cannot be longer than 4592 feet (1400 meters). If the total length of cable used is longer than 4592 feet, a repeater will be required.

Repeaters boost signal strength and are only used in instances where a segment of 63 nodes or less uses more than 4592 feet of Echelon cable.

Refer to the *Router and Repeater Installation Guide (P/N 026-1605)*, for information about router and repeater placement.

**NOTE: The recommended termination procedure for all Echelon devices is the termination block.**
7 Open Echelon Device Connectivity

The Rooftop and Single-duct VAV controllers use the Open Echelon connectivity manager to communicate with the E2. E2s with Open Echelon devices must be ordered pre-configured from Retail Solutions. Open-Echelon licenses must be purchased and enabled on units, and are not transferable to other units without assistance from Retail Solutions. Call 770-425-2724 for technical assistance or your sales representative. Your sales representative will know to which devices your unit will connect.

7.1. Adding Rooftop and Single-duct VAV Controllers

Log into the controller and enter the desired number of Echelon devices to be added in the Connected I/O screen. From the Main Menu:

1. Press \[7\] (System Configuration)
2. Press \[7\] (Network Setup)
3. Press \[2\] (Connected I/O Boards and Controllers)

4. Navigate to the Open Echelon field under the Third Party Devices section of the Connected I/O screen and enter the number of Echelon devices to be added (recommended maximum number of devices is 25).

7.2. Commissioning the Rooftop and Single-duct VAV Controllers

Next, you must commission the Echelon device. Commissioning is done at the Controller Setup screen. If still on the Connected I/O screen, hit the back button to go back to the Network setup menu and press \[3\] (Controller Setup). Or, from the Main Menu:

1. Press \[7\] (System Configuration)
2. Press \[7\] (Network Setup)
3. Press \[3\] (Controller Setup)

Commission the device on the Connected I/O screen:

Highlight the “LonMark device” on the screen you wish to commission and press \[SET ADDRESS\]. There are two methods available for commissioning: by pressing the device’s service pin, or by entering the device’s unique Neuron ID.

Figure 7-1 - Connected I/O Screen (RX-400 Unit Shown)

Figure 7-2 - Controller Setup Screen (BX-400 Unit Shown)
7.2.1. Service Pin Commissioning

Commissioning by service pin involves pressing the service pin button on the device, which sends the device’s Neuron ID to the E2. The service pin locations for the Rooftop and Single-duct VAV controllers are shown in Figure 7-3. The devices must be powered and networked before service pin commissioning.

After pressing F4 (SET ADDRESS) on the Controller Setup screen (Figure 7-2) for the device you wish to commission:

1. From the Set Controller Address menu, select option 1 - Pressing Service Pin on Controller:

2. Enter a wait time in H:MM:SS. The Wait Time is the amount of time the E2 will listen for a service pin message on the network. Press Enter when ready.

3. The E2 will show the message Press “Service Pin” or plug in Hand Held Terminal on device. Press and hold for 5 seconds the service pin on the Rooftop and Single-duct VAV controller you are commissioning.

4. If the E2 received the service pin message, the E2 will complete the commissioning and binding process. You will see a progress bar on the screen as information is exchanged between the E2 and the Rooftop VAV or Single-duct VAV. If a service pin message was not received, an error message will be displayed. Check the network connections and retry commissioning.

7.2.2. Neuron ID Entry Commissioning

The Rooftop VAV and Single-duct VAV controllers will have a sticker on the enclosure showing the unit’s unique 12-character Neuron ID. You may commission a device by entering the device’s Neuron ID from the E2 front panel.

1. From the Set Controller Address menu, select option 2 - Entering Neuron ID(s) directly:

2. In the Neuron ID field, enter the 12-character Neuron ID.

3. Press Enter. If the E2 finds the device with the specified Neuron ID on the network, the E2 will complete the commissioning and binding process. You will see a progress bar on the screen as information is exchanged between the E2 and the Rooftop VAV or Single-duct VAV. If the device is not found, an error message will be displayed. Check the network connections and retry commissioning.

7.2.3. Troubleshooting

After commissioning has been completed, check to make sure the device has been added successfully.
From the Main Menu, select Configured Applications to open the Configured Applications list. If the device you have commissioned does not appear in this list, the Description File has failed to upload correctly onto the E2. An alarm of No Description File will be generated and can be found in the Alarm Advisory Log.

Call Retail Solutions at 770-425-2724 to contact your sales representative or technical assistance to obtain the Description File. Refer to the E2 License Key and Open Echelon Installation Technical Bulletin P/N 026-4118 for more information about uploading Description Files.

NOTE: The system is not fully commissioned until each Single-duct VAV device has been balanced and calibrated. If needed, an auto calibration can be programmed from the VAV Smart Thermostat, but all duct design needs to be programmed into the E2 (Section, E2 Setup for the Rooftop VAV Controller).

E2 Setup for the Rooftop VAV Controller

In the E2 controller, go to the Rooftop VAV Status screen. From the Main Menu, press 5, and select the desired LonMark device from the Configured Applications list and the status screen will open automatically.

7.3. Status Screen

The E2 Rooftop VAV Status screen displays different inputs and outputs for the Rooftop VAV application:
7.3.1. Inputs

**Active Setpoint** is the parameter that the device is using to maintain temperature. This value is the midpoint from the setpoints sent by the E2.

Duct Pressure, Fan Proof, Outdoor, Return, Supply, and Mixed Temperatures values are sent from the Rooftop VAV to the E2. Those sensors reside locally on the Rooftop VAV.

**Terminal Load** is the required percentage of cooling or heating that a Single-duct VAV controller requires. With multiple Single-duct VAV controllers, the average is calculated in the E2.

For example, -100% = full heating, 0 = no heating or cooling needed, 100% = full cooling.

For more information on Terminal Load calculation, see *Section 8, Terminal Load Calculation for Rooftop VAV Controller*.

7.3.2. Outputs

Fan Enable, Cool 1 and 2, Heat 1 and 2, Economizer, and VFD values are physical outputs on the Rooftop VAV and they reside locally on the Rooftop VAV. **Unit Mode** is the state in which the unit is working. Possible Unit Mode states are:

- HVAC COOL
- HVAC HEAT
- HVAC MRNG WRMUP
- HVAC NIGHT PURGE
- HVAC PRECOOL
- HVAC OFF
- HVAC EMERG HEAT

7.4. General Setup

Under General setup, the Rooftop VAV application **Name** can be set up. This is the only user-configurable parameter on this screen.

7.5. Setpoints Setup

The temperature and pressure setpoints are configured from this screen:

For more information on Terminal Load calculation, see *Section 8, Terminal Load Calculation for Rooftop VAV Controller*.

7.6. Inputs Setup

Set up all input information in the Inputs Setup screen that is communicated between the E2 and Rooftop VAV.
When any input data points are set up, the Max-Receive parameter should be configured (Figure 9-11). Max-Receive is the maximum amount of time the device waits for information before reverting to its internal default values.

7.7. Outputs Setup

Set up all output information in the Outputs Setup screen that is communicated between the E2 and Rooftop VAV.

When input and output pointers are set up, the Max-send and Min-send parameters need to have values configured. These parameters are pre-configured (Figure 9-11).

7.8. Averaging Setup

The E2 averages the Single-duct VAV controllers’ Terminal Load. This average should be connected to the Terminal Load input on the Rooftop VAV. Press F4 to set up the Controller, Application, and Output information for the Rooftop VAV.

The Averaging parameters weight the terminal load.

7.9. Miscellaneous Setup

Set up parameters such as heat and cool stages, bypass time, damper position, fan speed and more from this screen:
7.10. Alarms Setup

Set up values for alarming on this screen:

Static Pressure and CO2 alarms are available for user configuration. Static Pressure is an absolute value; CO2 uses an offset for the alarm. Alarm delay values are in seconds.

Figure 7-9 - Rooftop VAV Alarms

7.11. PID Setup

PID settings are available on this screen for temperature control and duct pressure for CO2 operation.

Figure 7-10 - PID Setup for Rooftop VAV

7.12. Advanced Parameter Setup

When an input pointer is set up on the Inputs tab, the Max-Receive parameter should be set up. Max-Receive is the maximum amount of time the device waits for information before reverting to its internal default values.

If the Max-Receive parameter is not set up, inputs are disabled. (The recommended setting is 600.) If a parameter is unused, enter zero (0) for the value.
8 Terminal Load Calculation for Rooftop VAV Controller

The Rooftop VAV controller determines whether to provide heating or cooling based on the terminal load indicated by the Single-duct VAV controllers. Since each Single-duct controller has its own unique terminal load, all of the Single-duct terminal loads must be combined to determine the average terminal load of the system. An Analog Combiner application can be used to calculate the average system terminal load for the Rooftop VAV to use.

8.1. Analog Combiner Setup: Calculate Terminal Load

In the E2 controller, add an Analog Combiner application.

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 Single-duct VAVs served by the Rooftop VAV.
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 Terminal Load outputs.
7. In Outputs setup (under the Outputs tab), connect the OUTPUT to the Terminal Load input on the Rooftop VAV application.

NOTE: The Analog Combiner can read up to 16 inputs, so up to 16 VAV units may be supported by a single Analog Combiner.
9 E2 Setup for the Single-duct VAV Controller

In the E2 controller, go to the Single-duct VAV Status screen. From the Main Menu, press \( F5 \), and select the desired LonMark device from the Configured Applications list and the status screen will open automatically.

9.1. Status Screen

The E2 Single-duct VAV Status screen displays selected inputs and outputs for the VAV application:

9.1.1. Inputs

Active and Flow setpoints are the parameters the Single-duct VAV controller uses for control. These values are provided from setpoints sent to the Single-duct VAV by the E2.

The Space Temp value is the temperature as read from the VAV Smart Thermostat. The HW Inputs are the local physical temperature inputs.

9.1.2. Outputs

Outputs are read-only feedback information received from the Single-duct VAV controller.

Press \( F5 \) for General setup.

9.2. General Setup

Under General setup, set the Single-duct VAV application Name. This is the only user-configurable parameter on this screen.

9.3. Temperature Setpoint Setup

All temperature and flow setpoints are user-configured from this screen, including the CO2 Setpoint. For CO2 operation, the sensor reading must come from the E2.
9.4. Inputs Setup

Set up all inputs desired to be communicated from the E2 to the Single-duct VAV from the Inputs setup screen.

When any input data points are set up, the Max-Receive parameters should be configured (Figure 9-11). Inputs are disabled if the Max-Receive parameters are left unconfigured. If a parameter is unused, enter zero (0) for the value.

Max-Receive is the maximum amount of time the device waits for information before reverting to its internal default values.

9.5. Outputs Setup

All outputs represent status information communicated from the Single-duct VAV to the E2. These outputs may be optionally connected to other applications in the E2.

When any outputs are set up, the Max-Send and Min-Send parameters should be configured with a value (Figure 9-12). Outputs are disabled if the Max-Send and Min-Send parameters are left unconfigured. If a parameter is unused, enter zero (0) for the value.

Terminal Load is the output that provides mode of operation to the Rooftop VAV controller. The E2 must be configured to calculate the Terminal Load Average of multiple Single-duct VAV controllers. For more information on Terminal Load calculation, see Section 8, Terminal Load Calculation for Rooftop VAV Controller.

9.6. Device Setup

Set up the Single-duct VAV controller from this screen by configuring Device Setup parameters such as duct cross-sectional area, gain, passwords, damper control, and more.
9.7. PID Setup

PID settings are available on this screen for temperature control and duct pressure for CO2 operation.

CO2 Limit is an absolute value. If the value exceeds the limit, an alarm is generated. Alarm delays are set in seconds.

9.8. Alarm Setup

Alarm parameters can be set for temperature, flow, and CO2 configuration. Both temperature and flow work as an offset alarm.

If temperature or flow readings are higher or lower than the active setpoint's maximum or minimum offset, an alarm is generated.
9.9. Override Setup

The damper override is a read-only output value from the Single-duct VAV device and is therefore not configurable from the Status screen. Configure the damper override from the Override Setup screen:

![Override Setup Diagram]

**Figure 9-10 - Override Setup**

From the **STATE OVR** parameter, press `F4` for the look up list and select **HVO_Position**.

Set the override percentage value in the **PERCENT OVR** field.

To revert back to default or normal control, change **STATE OVR** back to **HVO_OFF**.

9.10. Advanced Setup

When any input data points are set up, *(Figure 9-5)* the Max-Receive parameters should be configured.

![Advanced Setup Diagram]

**Figure 9-11 - Advanced Setup**

Max-Receive is the maximum amount of time the Single-duct VAV controller will wait to receive information from the E2 before reverting to its own internal default values.

Inputs are disabled if the Max-Receive parameters are left unconfigured. (The recommended setting is 600.) If a parameter is unused, enter zero (0) for the value.

9.10.1. Max-Send Parameter Setup

When any output data points are set up, *(Figure 9-5)* the Max-Send parameters should be configured.

Max-Send is the maximum amount of time the device will wait before sending status information to the E2. This information will be sent even if it hasn't changed since the last update.
9.10.2. Min-Send Parameter Setup

When any output data points are set up, (Figure 9-6) the Min-Send parameters should be configured.

Min-Send is the minimum amount of time the device will wait before it sends status information to the E2. This setting acts as a throttle to prevent rapidly changing status information from flooding the Echelon network. This parameter can be used to slow down network traffic.
10 VAV Smart Thermostat Programming

The VAV Smart Thermostat has a built-in thermistor for temperature sensing, a two-line / eight-character LCD display and five push buttons. The VAV Smart Thermostat measures the room temperature every 5 seconds, updates the value displayed on the LCD, and sends the temperature to the controller.

The VAV Smart Thermostat has a regular user mode for building occupants and a password-protected configuration mode that consists of a main configuration menu and three submenus (I/O display mode, flow configuration mode, and flow calibration mode). The menu hierarchy and the options available in each menu and submenu are illustrated in Figure 10-2.
10.1. Menu Hierarchy

Figure 10-2 - VAV Smart Thermostat Screen Hierarchy
10.2. Button Operation

10.2.1. Overview

The VAV Smart Thermostat has five push buttons that are scanned every 100ms to determine if a button has been pressed. You can perform a simple press-and-release of a button to scroll through menu items or to change displayed values one at a time. Alternatively, you can hold down a button to simulate repeated button presses, which is convenient when making changes to setpoints, adjusting the damper position, and more.

10.2.2. Timeouts

The VAV Smart Thermostat has a 5-second timeout in the regular user mode. The 5-second timer begins after each button release. Once it times out, it returns to the default display screen that typically displays the room temperature. The VAV Smart Thermostat has a 20-minute timeout in the password configuration mode. This longer timer provides sufficient time for an air balancing technician to perform various air balancing tasks, take readings, and enter data without timing out of the configuration mode.

10.2.3. Sampling Rate

The VAV Smart Thermostat stops sampling the room temperature while buttons are being pressed. The VAV Smart Thermostat waits five (5) seconds after the last button press to resume temperature sampling. In the configuration mode, even though the LCD screen does not timeout and return to the default temperature display screen for 20 minutes, it will begin sampling the temperature and sending the value to the controller five (5) seconds after the last button press.

10.3. Startup and Errors

Normally, the first time that the VAV Smart Thermostat is powered up (for example, connected to a Single-duct VAV from which it draws power), the text SENSOR INIT... will appear on the LCD. The VAV Smart Thermostat will also show this text after any power cycle of the Single-duct VAV signifying that it is able to communicate with the Single-duct VAV and that it is being initialized.

If there is a loss of communication between the VAV Smart Thermostat and the Single-duct VAV during regular operation, or if communication cannot be established on power-up, the text SENSOR COM FAIL will appear on the LCD. The VAV Smart Thermostat will periodically attempt to reestablish communication with the Single-duct VAV and display the text SENSOR RETRY! If communication cannot be established, the LCD will alternate between these two messages.

NOTE: If you encounter a communication problem, examine the wiring between the VAV Smart Thermostat and Single-duct VAV. Verify that the wires are properly inserted into the wire terminals and that you have not exceeded a wire length of 15 meters (50 feet). If the problem is not wiring related, connect another VAV Smart Thermostat to the Single-duct VAV to determine if the problem is with the original VAV Smart Thermostat or the Single-duct VAV, and contact Retail Solutions (770-425-2724) for RMA information.
10.4. User Mode

The User Mode is meant to be accessible by building occupants so that they can view temperatures, adjust the setpoint, and initiate an override. By default, the VAV Smart Thermostat will display the room temperature.

10.4.1. Button Functionality in User Mode

<table>
<thead>
<tr>
<th>Button</th>
<th>User-Mode Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUB MENU</td>
<td>Sub Menu is not used in User Mode</td>
</tr>
<tr>
<td>NEXT</td>
<td>Next is used to view the next available menu option</td>
</tr>
<tr>
<td>OVERRIDE</td>
<td>Override is used to put the Single-duct VAV into Override Mode. The occupancy state will change temporarily to BYPASS.</td>
</tr>
<tr>
<td></td>
<td>The down arrow is used to view and decrease the setpoint. Pressing the button once will display the setpoint. Pressing it a second time will decrease the temperature by 0.5 degrees. Holding down the button will decrement the value continuously until you release the button or until the lower limit is reached. (Permanent changes should be made from the E2 controller as they will override setpoints in the thermostat).</td>
</tr>
<tr>
<td></td>
<td>The up arrow is used to view and increase the setpoint. Pressing the button once will display the setpoint. Pressing it a second time will increase the temperature by 0.5 degrees. Holding down the button will increment the value continuously until you release the button or until the upper limit is reached.</td>
</tr>
</tbody>
</table>

Table 10-1 - Button Functionality in User Mode

10.4.2. LCD Text Definitions in User Mode

10.4.2.1. RoomTemp - Read Only

Displays the current room temperature and updates its value every 5 seconds. The room temperature is the default display screen for the VAV Smart Thermostat.

(The temperature is read from the onboard temperature sensor and written to nvoSpaceTemp SI Units: °C / US Units: °F).

10.4.2.2. Setpoint - Read-Only

Displays the current midrange setpoint. The midrange setpoint is the median value between the heating and cooling setpoints. Figure 10-4 illustrates the relation between the midrange setpoint and the heating/cooling setpoints. In this example, the range between the heating and cooling setpoints is 2°C and the midrange setpoint is 21°C.

<table>
<thead>
<tr>
<th>Heating Setpoint</th>
<th>Midrange Setpoint</th>
<th>Cooling Setpoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>20°C</td>
<td>21°C</td>
<td>22°C</td>
</tr>
</tbody>
</table>

Figure 10-4 - Midrange, Heating, and Cooling Setpoints

If the HVAC mode is in cooling, the effective setpoint (i.e., the actual setpoint) will be the cooling setpoint. Similarly, if the HVAC mode is in heating, the effective setpoint will be the heating setpoint.

If the Single-duct VAV has been set up for single room control, only then will the setpoint that was entered using the VAV Smart Thermostat (when in Occupied, Bypass or Standby Modes) is written to nvoEffectSetpt; however, nvoEffectSetpt will equal nviSetpoint if nviSetpoint has been assigned a value.

10.4.2.3. Cooling - Read-Only

If the HVAC is in Cooling Mode, the VAV Smart Thermostat will display the text Cooling followed by the cooling setpoint, which is the effective setpoint at the time.

(The HVAC mode is read from nvoUnitStatus.)

10.4.2.4. Heating - Read-Only

If the HVAC is in Heating Mode, the VAV Smart Thermostat will display the text Heating followed by the heating setpoint, which is the effective setpoint at the time.

(The HVAC mode is read from nvoUnitStatus.)
10.4.2.5. OccState - Read-Only

Shows the current occupancy status.

(The occupancy state is read from nvoOccState.)

10.4.2.6. Override - Read-Only

The VAV Smart Thermostat will display the text Override when the Override button is pressed, and nvoOccState will be set to OC_BYPASS.

(The controller will remain in bypass mode for the time period specified in SCPTbypassTime.)

10.4.2.7. OutdoorTemp - Read-Only

The outdoor temperature is only displayed if you have bound nviOutdoorTemp to a controller that can provide an outdoor temperature reading (SI Units: °C / US Units: °F).

10.5. Configuration Mode - Password Protected

The VAV Smart Thermostat Configuration Mode is protected by a password and is hidden from building occupants. The configuration mode provides building personnel with monitoring and air balancing options as illustrated in Figure 10-2.

10.5.1. Button Functionality in Configuration Modes

<table>
<thead>
<tr>
<th>Button</th>
<th>Configuration Mode Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUB MENU</td>
<td>Sub Menu is used to access three available submenus when the VAV Smart Thermostat displays the text Submenu that indicates it is possible to access a specific submenu. Sub Menu is also used to exit the configuration mode submenus and return you to the specific configuration mode submenu link that was chosen. When pressed simultaneously with Next, it exits the screen you are on and returns you to User Mode, RoomTemp screen.</td>
</tr>
<tr>
<td>NEXT</td>
<td>Next is used to view the next available menu option. When pressed simultaneously with Sub Menu, it exits the screen you are on and returns you to User Mode, RoomTemp screen.</td>
</tr>
<tr>
<td>OVERRIDE</td>
<td>Override is used as an “Enter” key on a keyboard. When you press this button, the value you have specified is sent to the controller.</td>
</tr>
<tr>
<td>The down arrow decreases the displayed parameter value.</td>
<td></td>
</tr>
<tr>
<td>The up arrow increases the displayed parameter value.</td>
<td></td>
</tr>
</tbody>
</table>

Table 10-2 - Button Functionality in Configuration Modes

10.5.2. Entering Configuration Mode

To access the password-protected Configuration Mode:

1. Hold the SUB MENU and the NEXT buttons simultaneously for approximately 10 seconds. Release the buttons when you see the display screen text change to Login 5000.

2. Use the arrow keys to increase or decrease the displayed number until it matches your configured password. By default, the password is 5001.
If you have previously changed the password and do not remember it, examine the value of ComPassword in the E2 controller under the Setup tab in the VAV application.

3. Press the button to submit the password that you entered.

If you have entered the correct password, the VAV Smart Thermostat will be in the Service Pin screen and display Srvc Pin. If you have entered an incorrect password, the VAV Smart Thermostat will display the text: Password Failed.

NOTE: I/O State, Flow Configuration, and Flow Calibration Submenus are accessed from special submenu links in the main Configuration Mode (Section 10.5.2., Entering Configuration Mode).

10.5.3. Exiting Configuration Mode

The VAV Smart Thermostat will automatically exit the configuration mode 20 minutes after the last button press.

To exit the Configuration Mode and Submenus manually, hold the and the buttons simultaneously for approximately 10 seconds. This will take you back to User Mode on the RoomTemp screen.

10.5.4. LCD Text Definitions for Configuration Mode

10.5.4.1. Srvc Pin - Editable

This menu is used to send a service pin message over the network. Setting the value to 1 and pressing the button is equivalent to pressing the service pin button on the controller.

For more information on commissioning, see Section 7.2., Commissioning the Rooftop and Single-duct VAV Controllers.

10.5.4.2. SI Units - Editable

This menu is used to specify the display units for temperature values. Setting the value to 0 will cause the VAV Smart Thermostat to display temperatures in US units (°F & CFM). Setting the value to 1 will cause the VAV Smart Thermostat to display SI units (°C & LPS).

(The value is written to the SmartSensorInSI field of UCPTvavOptions.)

10.5.4.3. Temp Cal - Editable

This menu is used to calibrate the temperature sensor. The arrow buttons can be used to increment or decrement the temperature calibration offset value by 0.1° per button press. The offset can be up to +/- 12.7°C or +/- 22.8°F.

(The value is written to UCPTcomInputCfg.Off set (SI Units: °C / US Units: °F)

10.5.4.4. IO State Submenu - Submenu Link

Pressing the button while you are in this menu will take you to the I/O State Configuration submenu (Section 10.5.5., I/O State Configuration Submenu - Display Text Definitions).

10.5.4.5. VAV Mode - Editable

This menu is used to specify whether you are using a VAV or VVT controller. This menu can also be used to put a VAV controller into VVT mode.

Setting the value to 0 will put the controller into VVT mode. Setting the value to 1 will put the controller into VAV mode.

(The value is written to the VVTmode field of the UCPTvavOptions.)

10.5.4.6. Flow Cfg Submenu - Submenu Link

Pressing the button while you are in this menu will take you to the flow configuration submenu (Section 10.5.6., Flow Configuration Submenu).

10.5.4.7. Flow Cal Submenu - Submenu Link

Pressing the button while you are in this menu will take you to the flow calibration submenu (Section 10.5.7., Flow Calibration Submenu).
10.5.5. I/O State Configuration Submenu - Display Text Definitions

10.5.5.1. Trm Load - Read-Only
Displays the controller’s terminal load. The terminal load value is read from \texttt{nvoTerminalLoad}.

10.5.5.2. Input N - Read-Only
Displays the value of hardware input \( N \) (where \( N \) is between 1 and 4).
(The value is read from \texttt{nvoHwInputN} where \( N \) is between 1 and 4).

10.5.5.3. Output N - Read-Only
Displays the value of hardware output \( N \) (where \( N \) is between 1 and 6). The value is read from the output value.
All values displayed in the I/O submenu are updated every 3 seconds.
To exit the I/O State Configuration Menu, press the \textbf{SUB MENU} button.

10.5.6. Flow Configuration Submenu

10.5.6.1. Min Flow - Editable
The minimum airflow that is to be maintained by the Single-duct VAV controller during normal operation. The flow setpoint only falls below the Minimum Flow if the \texttt{Use zero flow as min flow while Unoccupied} option is selected or if the flow setpoint is overridden.
Setting the Minimum Flow to zero means the damper can be fully closed in which case no fresh air will be supplied to the zone that the Single-duct VAV controls.
(The value entered in this field is written to \texttt{SCPTminFlow}. SI Units: LPS / US Units: CFM)

10.5.6.2. Max Flow - Editable
The maximum allowable airflow. The flow setpoint never exceeds this value unless overridden.
(The value entered in this field is written to \texttt{SCPTmaxFlow}. SI Units: LPS / US Units: CFM)

10.5.6.3. MinFlwHt - Editable
The minimum airflow that is to be maintained by the Single-duct VAV when duct heating is turned ON unless it is overridden. The Minimum Flow Heat option is provided to allow a higher minimum airflow which is sometimes required for duct heaters. If this flow value is not met, the duct heater will not turn ON.
(The value entered in this field is written to \texttt{SCPTminFlowHeat}. SI Units: LPS / US Units: CFM)

10.5.6.4. Nom Flow - Editable
The expected airflow when the damper is fully open. The nominal flow is used during precalibration. It is also used to determine the next damper movement. If you do not know the nominal flow you can leave it at zero.
(The value entered in this field is written to \texttt{SCPTnomAirFlow}.)

10.5.6.5. DmpDrTm - Editable
Used to specify the time that the damper will take to go from the fully closed position to the fully open position or vice-versa. Used only for built-in actuator. The damper drive time can be set to between 45 seconds and 150 seconds; however, it is recommended to use the default value of 95 seconds.
(The value entered in this field is written to \texttt{UCPTdamperDriveTime}.)

10.5.6.6. Open CCW - Editable
Used to specify the direction (clockwise or counter clockwise) in which the actuator rotates to open the damper. Set the value to 0 for clockwise or 1 for counter clockwise.
(A binary value representing the damper direction is written to the Damper CCW field of \texttt{UCPTvavOptions}.)

10.5.6.7. Area - Editable
This value is important only to perform a precalibration of the Single-duct VAV controller, without using a reference instrument.
(The value entered in this field is written to \texttt{SCPTductArea}. SI Units: cm² / US Units: in²)
10.5.6.8. PitotFct - Editable

A divider that is applied to the differential pressure reading. The Pitot Factor compensates for varying characteristics and flow effects in Single-duct VAV box equipment and pickup probes. It is recommended that you enter the Pitot Factor along with the Duct Area to ensure precise precalibration. Contact Retail Solutions (770-425-2724) for the Pitot Factor value if you do not have it.

(The value entered in this field is written to SCPTGainVAV.)

To exit the Flow Configuration Submenu, press the button and it will return you to the Configuration Mode Section 10.5., Configuration Mode - Password Protected.

10.5.7. Flow Calibration Submenu

10.5.7.1. Flow - Read-Only

The real-time air flow that is being supplied to the zone. The flow reading will only be available if the Single-duct VAV has been calibrated.

(The flow value is read from nvoAirFlow. SI Units: LPS / US Units: CFM)

10.5.7.2. RunNrmOp - Editable

Terminates calibration mode and puts the Single-duct VAV controller back into normal operation. Calibration Mode is activated as soon as you send a command from the flow calibration submenu, and ends automatically when the VAV Smart Thermostat returns to User Mode, or the RunNrmOp command is sent to the Single-duct VAV. While the controller is in Calibration Mode it will not respond to control demands.

10.5.7.3. GotoMinF - Editable

Only use this command if the Single-duct VAV is already calibrated. When this command is activated, the Single-duct VAV automatically maintains the minimum flow that was specified in the Min Flow screen of the Flow Configuration Submenu, (Section 10.5.6.) by adjusting the damper position. The Single-duct VAV will dynamically compensate for changes in air pressure to ensure that the minimum airflow is maintained. The Single-duct VAV will continue to maintain the minimum airflow until the RunNrmOp command is sent to the Single-duct VAV or you exit the password protected menu and return to the User Mode.

10.5.7.4. GotoMaxF - Editable

Only use this command if the Single-duct VAV is already calibrated. When this command is activated, the Single-duct VAV automatically maintains the maximum flow that was specified in the Max Flow screen of the Flow Configuration Submenu, (Section 10.5.6.) by adjusting the damper position. The Single-duct VAV will dynamically compensate for changes in air pressure to ensure that the maximum airflow is maintained.

The Single-duct VAV will continue to maintain the minimum airflow until the RunNrmOp command is sent to the Single-duct VAV, or you exit the password protected menu and return to the User Mode.

10.5.7.5. Dmp Cmd - Editable

Moves the damper to the position that you specify in this screen. The damper can open between 0% (fully closed) and 100% (fully open).

The damper will remain at the position you specify until the RunNrmOp command is sent to the Single-duct VAV or you exit the password protected menu and return to the User Mode.

10.5.7.6. Dmp Pos - Read-Only

Displays the current damper position (in %).

10.5.7.7. DifPress - Read-Only

Displays the current differential pressure reading. (SI Units: PA / US Units: WC)

10.5.7.8. CalLoVal - Editable

When you use this option, you can calibrate the Single-duct VAV based on an airflow that is close to the minimum flow that was specified in the Min Flow screen of the Flow Configuration Submenu, (Section 10.5.6.) sent by the E2 controller. Adjust the damper until your flow hood (capture hood) reading is close to the minimum flow. Enter the flow hood reading and press the button. This is faster than making micro adjustments to the damper as required when using the CalToMin option (refer to...
**Figure 10-5.**

**10.5.7.9. CalHiVal - Editable**

When you use this option, you can calibrate the Single-duct VAV based on an airflow that is close to the maximum flow that was specified in the **Max Flow** screen of the Flow Configuration Submenu (Section 10.5.6.) sent by the E2 controller. Adjust the damper until your flow hood reading is close to the maximum flow. Enter the flow hood reading then press the **Override** button. This is faster than making micro adjustments to the damper as required when using the **CalToMax** option (refer to **Figure 10-5**).

**10.5.7.10. High and Low Manual Calibration Example**

10.5.7.11. CalToMin - Editable

When you use this option, you can calibrate the Single-duct VAV to the exact airflow that was specified in the **Min Flow** screen of the Flow Configuration Submenu (Section 10.5.6.) sent by the E2 controller.

Adjust the damper until your flow hood reading is equal to the minimum flow, change the on-screen value from 0 to 1 then press the **Override** button.

10.5.7.12. CalToMax - Editable

When you use this option, you can calibrate the Single-duct VAV to the exact airflow that was specified in the **Max Flow** screen of the Flow Configuration Submenu (Section 10.5.6.) sent by the E2 controller.

Adjust the damper until your flow hood reading is equal to the maximum flow, change the on-screen value from 0 to 1, then press the **Override** button.

10.5.7.13. DoAutoCal - Editable

The Pitot Factor and duct area **must** be entered in the E2 in order for automatic calibration to be used.

Pitot Factor and duct area are used to calibrate a curve that defines the relationship between the airflow and differential pressure. The calibration is instantaneous.

10.5.7.14. NOT CALIBRAT - Read Only

Displayed if the Single-duct VAV has not been calibrated; however, if the Single-duct VAV has been calibrated it will show the calibration code that is stored in **nviCalibCode**.

**NOTE:** All Read-Only values are updated every 3 seconds. The values that can be changed by the VAV Smart Thermostat are read directly from the device in the Single-duct VAV Device Configuration window.

To exit the Flow Calibration Submenu, press the **button and it will return you to the Configuration Mode Section 10.5., Configuration Mode - Password Protected.**
11 Hardware Specifications

11.1. Rooftop VAV Controller

<table>
<thead>
<tr>
<th><strong>Rooftop VAV Specifications</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power</strong></td>
</tr>
<tr>
<td>Voltage: 24VAC; ±15%, 50/60HZ, Class 2</td>
</tr>
<tr>
<td>Protection: 1.35A auto-reset feature</td>
</tr>
<tr>
<td>Typical Consumption: 6VA</td>
</tr>
<tr>
<td>Maximum Consumption: 15VA</td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
</tr>
<tr>
<td>Operating Temperature: 32°F to 158°F (0°C to 70°C)</td>
</tr>
<tr>
<td>Storage Humidity: -4°F to 158°F (-20°C to 70°C)</td>
</tr>
<tr>
<td>Relative Humidity: 0 to 90% non-condensing</td>
</tr>
<tr>
<td><strong>General</strong></td>
</tr>
<tr>
<td>Standard: LonMark functional profile: Roof-top unit controller #8030</td>
</tr>
<tr>
<td>Processor: Neuron® 3150® 8 bits; 10MHZ</td>
</tr>
<tr>
<td>Memory: Non-volatile flash 64K (APB application &amp; configuration properties)</td>
</tr>
<tr>
<td>Communication: LonTalk protocol</td>
</tr>
<tr>
<td>Transceiver: FT-X1</td>
</tr>
<tr>
<td>Channel: TP/FT-10; 78Kbps</td>
</tr>
<tr>
<td>Status Indicator: Green LED: power status &amp; LON TX, Orange LED: service and LON TX</td>
</tr>
<tr>
<td>Communication Jack: LON audio jack mono 1/8” (3.5 mm)</td>
</tr>
<tr>
<td><strong>Enclosure</strong></td>
</tr>
<tr>
<td>Material: ABS PA-765A</td>
</tr>
<tr>
<td>Color: Blue casing &amp; gray connectors</td>
</tr>
<tr>
<td>Dimensions w/ screws: 5.7 x 4.7 x 2.0” (144.8 x 119.4 x 50.8 mm)</td>
</tr>
<tr>
<td>Shipping weight: 0.77lbs (0.35kg)</td>
</tr>
<tr>
<td>Installation: Direct din-rail mounting or wall mounting through mounting holes (see Figure 2-5)</td>
</tr>
</tbody>
</table>

*Table 11-1 - Rooftop VAV Hardware Specifications*
### Rooftop VAV Specifications

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Quantity: 6 (pre-configured)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input Types</strong></td>
<td>Universal (pre-configured)</td>
</tr>
<tr>
<td><strong>Voltage</strong></td>
<td>0-10VDC, Accuracy ±0.5%</td>
</tr>
<tr>
<td><strong>Current</strong></td>
<td>4-20mA with 249Ω external resistor (wired in parallel), accuracy ±0.5%</td>
</tr>
<tr>
<td><strong>Digital</strong></td>
<td>Dry contact</td>
</tr>
<tr>
<td><strong>Resistor</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Thermistor</strong></td>
<td>Type: 2, 3 10KΩ</td>
</tr>
<tr>
<td></td>
<td>Accuracy: ±0.9°F; (±0.5°C)</td>
</tr>
<tr>
<td></td>
<td>Range: -40°F to 257°F; (-40°C to 125°C)</td>
</tr>
<tr>
<td></td>
<td>Resolution: 0.18°F; (0.1°C)</td>
</tr>
<tr>
<td><strong>Potentiometer</strong></td>
<td>Translation table configurable on several points</td>
</tr>
<tr>
<td></td>
<td>Accuracy: ±0.5%</td>
</tr>
<tr>
<td><strong>Input Resolution</strong></td>
<td>12-bit analog / digital converter</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outputs</th>
<th>Quantity: 7 (pre-configured)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Digital</td>
<td>Triac 1.0A @ 24VAC External power supply</td>
</tr>
<tr>
<td>2 Universal</td>
<td>0-10VDC (linear), digital 0-12VDC (on/off) or PWM</td>
</tr>
<tr>
<td></td>
<td>PWM output; adjustable period from 2 seconds to 15 minutes</td>
</tr>
<tr>
<td></td>
<td>60mA max. @ 12VDC (140°F; 60°C)</td>
</tr>
<tr>
<td></td>
<td>Maximum load 200Ω</td>
</tr>
<tr>
<td><strong>Auto-reset fuse:</strong></td>
<td>60mA @ 140°F; 60°C</td>
</tr>
<tr>
<td></td>
<td>100mA @ 68°F; 20°C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Agency Approvals</th>
<th>UL Listed (CDN &amp; US): UL916 Energy management equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FCC: This device complies with FCC rules part 15, subpart B, class B</td>
</tr>
</tbody>
</table>

*Table 11-1 - Rooftop VAV Hardware Specifications*
## 11.2. Single-duct VAV Controller

### Single-duct VAV Specifications

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Quantity: 4 universal (pre-configured)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input Types</strong></td>
<td></td>
</tr>
<tr>
<td>- <strong>Digital:</strong> Dry contact</td>
<td></td>
</tr>
<tr>
<td>- <strong>Analog Voltage:</strong> 0-10VDC, Accuracy ±0.5%</td>
<td></td>
</tr>
<tr>
<td>- <strong>Analog Current:</strong> 4-20mA with 249Ω external resistor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Accuracy ±0.5%</td>
</tr>
<tr>
<td>- <strong>Resistor Support:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Thermistor:</strong> 100KΩ (PT100) 1KΩ (RTD 1K Type 85), 10KΩ (Type 2,3)</td>
</tr>
<tr>
<td></td>
<td>Range: -40°F to 302°F; (-40°C to 125°C)</td>
</tr>
<tr>
<td></td>
<td>Accuracy: ±0.9°F; (±0.5°C)</td>
</tr>
<tr>
<td></td>
<td>Resolution: 0.18°F; (0.1°C) (10KΩ to 100KΩ supported using translation table)</td>
</tr>
<tr>
<td></td>
<td><strong>Potentiometer:</strong> Linear 2-point setpoint adjustment</td>
</tr>
<tr>
<td></td>
<td>Min/Max linear configuration</td>
</tr>
<tr>
<td><strong>Differential:</strong></td>
<td>Range: 0-250 Pa (0-1” H₂O)</td>
</tr>
<tr>
<td><strong>Pressure Sensor:</strong></td>
<td>Resolution: 0.04 milli-inches H₂O</td>
</tr>
<tr>
<td>(Single-duct VAV model only):</td>
<td>Accuracy ±0.3% full scale</td>
</tr>
<tr>
<td><strong>Input Resolution:</strong></td>
<td>16-bit analog / digital converter</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outputs</th>
<th>Quantity: 6 Hardware (pre-configured)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 <strong>Digital:</strong></td>
<td>Triac 0.75Amp @ 24VAC</td>
</tr>
<tr>
<td></td>
<td>External or internal power supply</td>
</tr>
<tr>
<td>2 <strong>Universal:</strong></td>
<td>0-10VDC linear, digital 0-12VDC</td>
</tr>
<tr>
<td></td>
<td>(Analog / Digital) or PWM, 20mA max</td>
</tr>
<tr>
<td></td>
<td>maximum load 600Ω</td>
</tr>
<tr>
<td><strong>Output Resolution:</strong></td>
<td>10 bits digital / analog converter</td>
</tr>
</tbody>
</table>

### Power

| Voltage: 24VAC; ±15%, 50/60HZ, Class 2 |
| Protection: 3.0A removable fuse for triac when using the internal power supply |
| **Typical Consumption:** 18VA; Triac outputs (2 valves @ 4VA) and 2 outputs with 20mA load @12VDC |
| **Maximum Consumption:** 10VA (normal) or 85VA if internal power supply is used for triac (special application) |

*Table 11-2 - Single-duct VAV Hardware Specifications*
11.3. VAV Smart Thermostat

### Single-duct VAV Specifications

<table>
<thead>
<tr>
<th>Environmental</th>
<th>Operating Temperature: 32°F to 158°F (0°C to 70°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Storage Humidity: -4°F to 158°F (-20°C to 70°C)</td>
</tr>
<tr>
<td></td>
<td>Relative Humidity: 0 to 90% non-condensing</td>
</tr>
<tr>
<td>Agency Approvals</td>
<td>UL Listed (CDN &amp; US): UL916 Energy management equipment</td>
</tr>
<tr>
<td></td>
<td>FCC: This device complies with FCC rules part 15, subpart B, class B</td>
</tr>
</tbody>
</table>

### VAV Smart Thermostat Specifications

<table>
<thead>
<tr>
<th>General</th>
<th>CPU: PIC16C622</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Power Source: Externally powered 12VDC</td>
</tr>
<tr>
<td></td>
<td>LCD Display: 2 Lines, 8 Characters</td>
</tr>
<tr>
<td></td>
<td>Sensor: 10K NTC Thermistor</td>
</tr>
<tr>
<td></td>
<td>Range: 0°C to 70°C; 32°F to 158°F</td>
</tr>
<tr>
<td></td>
<td>Accuracy: ±0.2°F; ±0.36°F</td>
</tr>
<tr>
<td></td>
<td>Resolution: ±0.1°C; ±0.18°F</td>
</tr>
<tr>
<td>Communications</td>
<td>2400 baud serial communication over 2-wire interface.</td>
</tr>
<tr>
<td></td>
<td>Half duplex, 8-bit, no parity, 1 stop bit.</td>
</tr>
<tr>
<td></td>
<td>Protocol based on EIA-232.</td>
</tr>
<tr>
<td></td>
<td>Wiring: 50 feet max. (15 meters max.), 22 AWG unshielded, twisted pair stranded cable</td>
</tr>
<tr>
<td>Environmental</td>
<td>Operating Temperature: 0°C to 70°C; 32°F to 158°F</td>
</tr>
<tr>
<td></td>
<td>Storage Temperature: -20°C to 70°C; -4°F to 158°F</td>
</tr>
<tr>
<td></td>
<td>Relative Humidity: 0 to 90% Non-condensing</td>
</tr>
<tr>
<td>Enclosure</td>
<td>Material: ABS resin</td>
</tr>
<tr>
<td></td>
<td>Color: Off-white</td>
</tr>
<tr>
<td></td>
<td>Dimensions: 4.94” x 3.38” x 1.28” (124 x 85 x 32.5 mm)</td>
</tr>
<tr>
<td></td>
<td>Shipping weight: 0.4 lbs (0.18 kg)</td>
</tr>
<tr>
<td>Agency Approvals</td>
<td>UL Listed: UL873 Temperature Indicating &amp; Regulating Equipment (pending)</td>
</tr>
<tr>
<td></td>
<td>FCC: FCC part 15, subpart B, class B</td>
</tr>
</tbody>
</table>

Table 11-2 - Single-duct VAV Hardware Specifications

Table 11-3 - VAV Smart Thermostat Hardware Specifications
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