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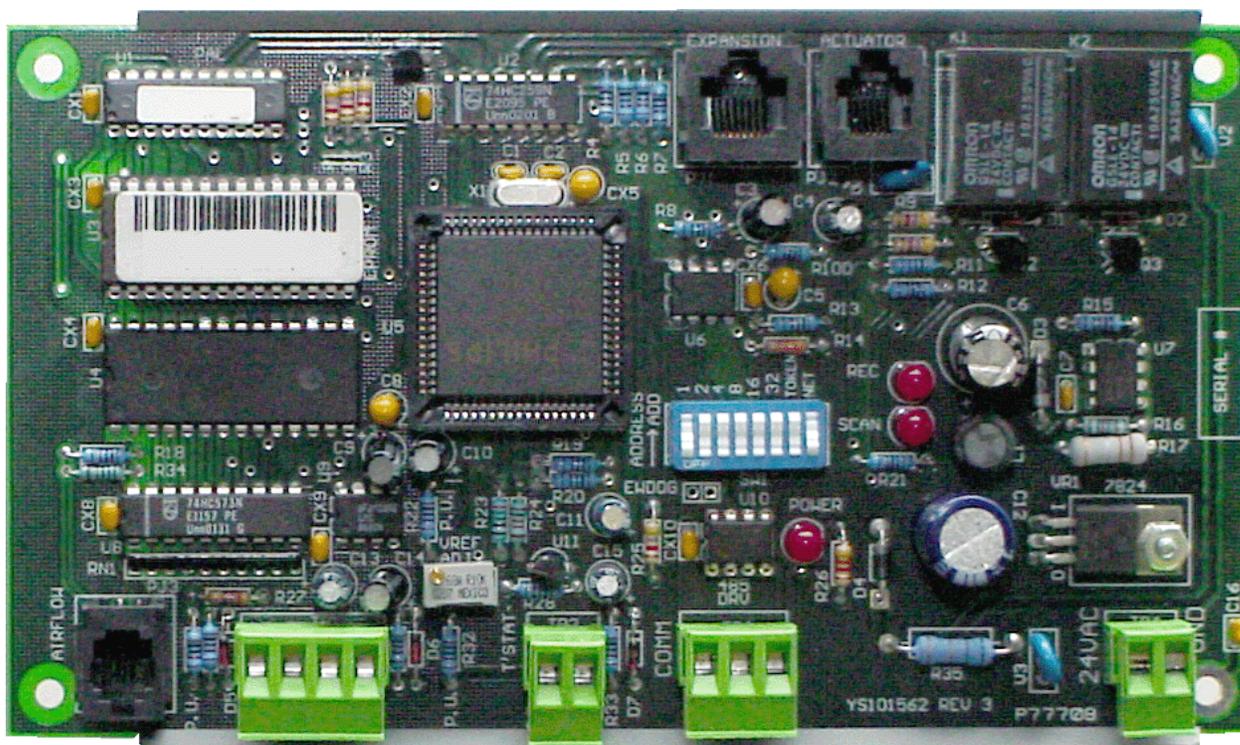
# WattMaster VAV

## Control Systems

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# VAVBOX Controller Technical Guide

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# Controller Overview

## Features

### VAVBOX Controller

This manual applies to the VAVBOX controller that is included in the following WattMaster products:

MG742-VAV	Pressure Dependent VAVBOX Kit For Terminal Units w/o Fan Electric or Hot Water Heat
MG744-VAV	Pressure Independent VAVBOX Kit For Terminal Units w/o Fan Electric or Hot Water Heat
MG742-03-VAV	Pressure Dependent VAVBOX Kit For Terminal Units or Fan Terminal Units With Electric or Hot Water Heat
MG744-03-VAV	Pressure Independent VAVBOX Kit For Terminal Units or Fan Terminal Units With Electric or Hot Water Heat

The VAVBOX Controller is used for controlling airflow and operation of VAV terminal units. It is a programmable digital controller, which allows for program setpoints to be stored in non-volatile memory. The controller is connected to a room sensor which monitors space temperature allowing the VAVBOX controller to modulate a damper in response to space temperature, duct temperature and airflow requirements in the controlled space.

The VAVBOX controller has three integral modular jacks for connection to the actuator, airflow sensor (for pressure independent applications), and relay or analog expansion boards, via modular cables. The controller has an on-board dip switch provided for board addressing.

The VAVBOX controller is provided with two relays for tri-state control of the damper actuator. All outputs and the relay common are electrically isolated from all other circuitry on the board. All relay outputs are supplied with transient suppression devices across each set of contacts to reduce EMI and arcing. The relay output contacts are rated for pilot duty control of a maximum of 2 Amps @ 24 VAC or 24 VDC. The actuator connects via a modular cable to the board and provides the VAVBOX controller with feedback monitoring for precise positioning of the actuator.

### OE322 Output Expansion Board

The OE322, 3 Relay with Analog Output Expansion board is used in conjunction with the VAVBOX Controller board to allow for control of VAV terminal units, including series and parallel fan terminal units with up to 2 stages of electric heat or modulating hot water heat. The OE322, 3 Relay with Analog Output Expansion board provides 3 relay outputs for pilot duty switching control, and 1 Analog output for control of a 0-10 V modulating hot water valve.

The OE322 Output Expansion board connects to the VAVBOX controller board by means of a modular cable provided with the expansion board. Power is supplied to the board by means of this modular cable. Screw terminals are provided for connection of field wiring to the relay and analog outputs.

The relay outputs are N.O. contacts with one common terminal. All outputs and the relay common are electrically isolated from all other circuitry on the board. All relay outputs are supplied with transient suppression devices across each set of contacts to reduce EMI and arcing. The relay output contacts are rated for pilot duty control of a maximum of 2 Amps @ 24 VAC or 24 VDC. The analog output provides a 0 – 10 VDC modulating signal output into a 1K ohm minimum load.

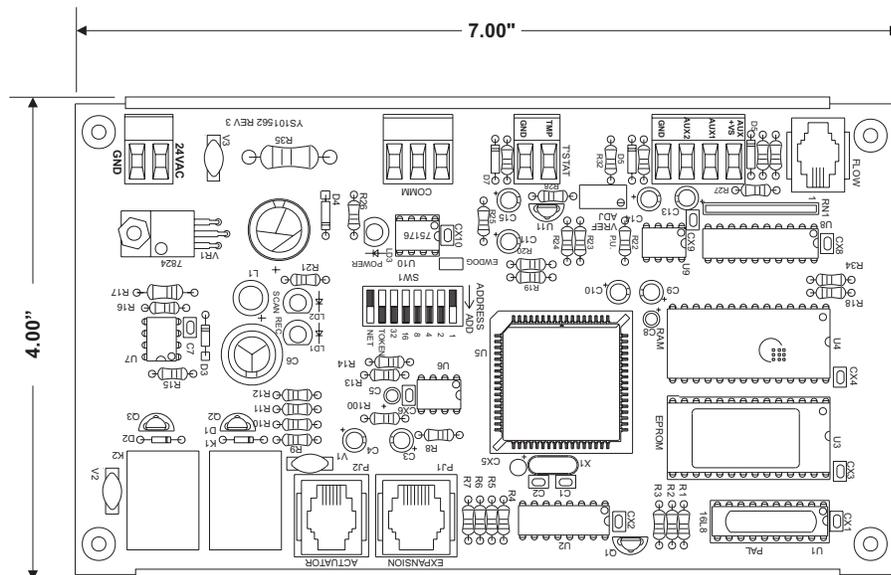


Figure 1: VAVBOX Controller Dimensions



## Controller Inputs and Outputs

### General

The following inputs and outputs are available on the VAVBOX controller and the OE322 Output Expansion Board that can be added by connecting it to the main controller board expansion port. For component locations of the inputs on the WMVAV Controller see **Figure 3**. For wiring of inputs and outputs see **Figure 4 thru 9**.

### VAVBOX Controller Analog Inputs:

#### Input #1: Space Temperature Sensor

The Room Sensor that reads space temperature is attached the TMP and GND terminals. If the Room Sensor with slide adjust option is used a third wire connects to terminal AUX1.

#### Input #2: Airflow Sensor

If the VAVBOX Controller is to be configured for pressure independent operation, you need to install the OE274 Airflow Sensor and connect the modular plug from the pressure sensor to this input. The pressure signal from the Airflow Sensor is used for CFM (airflow) calculations. If an OE274 Airflow Sensor is attached to this input, the VAVBOX controller will automatically detect this and switch to pressure independent operation. If the sensor is not attached or becomes defective, the controller automatically reverts to pressure dependent operation.

#### Input #3: Duct Air Temperature Sensor

The optional Duct Sensor is connected to terminals AUX2 and GND when it is used. If it is to be used as a Supply Air Sensor, it should be mounted in the supply duct close to the terminal unit where the VAVBOX controller is installed. This sensor can be used for monitoring purposes or in place of the Supply Air Temperature Broadcast from the WMVAV Controller. It can also be used as a Discharge Temperature Sensor. In this configuration the sensor should be mounted in the downstream ductwork close to the terminal unit where the VAVBOX controller is installed.

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**Note:** All temperature sensors must be Thermistor Type III which provide 77.0°F @ 10 K Ohms Resistance.

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### Other Controller Connections

#### Expansion Board Modular Connector

This modular connector is used to connect the optional OE322 Output Expansion Board to the VAVBOX controller. These boards are only required when electric or hot water heating and/or fan terminal control is required. The expansion boards are not required for cooling only terminal units.

#### Actuator Modular Connector

This modular connector is used to connect a modular cable from the VAVBOX controller to a tri-state actuator.

### Optional - Expansion Board Outputs

#### General

As previously outlined, the OE322 Relay Output Expansion board may be used for fan terminal and/or heating applications. The information that follows outlines the uses and capabilities of the OE322 Relay Output Expansion board's outputs.

#### Relay Output #1 - Fan Enable

The first expansion relay on the Output Expansion board is used for enabling the fan for Series or Parallel Fan Terminal Units.

#### Relay Output #2 - Heat 1

If you have at least one stage of terminal unit heating, this is the relay used to energize the 1st stage of heating. This heating stage can either be used with electric heat or On/Off hot water valve control. In a hot water system when the 1st stage of heat is initiated, relay output #2 would energize a 24 VAC N.C. hot water valve. See the **Electric Heat Staging for Relay Outputs #2 & #3** section that follows for complete electric heat staging information.

#### Relay Output #3 - Heat 2 & 3

This is the relay used to energize the 2nd stage of heating in a 2 stage electric heat system or the 2nd and 3rd stages of heating in a 3 stage electric heat system. See the **Electric Heat Staging for Relay Outputs #2 & #3** section that follows for complete electric heat staging information.

#### Electric Heat Staging for Relay Outputs #2 & #3

In an electric heat system when the 1st stage of heat is initiated, **relay output #2** would energize supplying power to the 24 VAC 1st stage electric heat contactor. In a 2 stage electric heat system when a 2nd stage of heat is required, **relay output #2** would remain energized maintaining power to the 24 VAC 1st stage electric heat contactor and **relay output #3** would also be energized supplying power to the 24 VAC 2nd stage electric heat contactor. For a 3 stage electric heat system a call for 1st stage heat would energize **relay output #2** only, supplying power to the 24 VAC 1st stage electric heat contactor. When a 2nd stage of heat is required, **relay output #2** would de-energize removing power to the 24 VAC 1st stage electric heat contactor and **relay output #3** would be energized supplying power to the 24 VAC 2nd stage and 3rd stage electric heat contactors. When the 3rd stage of heat is initiated, **relay output #3** would remain energized maintaining power to the 24 VAC 2nd stage and 3rd stage electric heat contactors and **relay output #2** would be re-energized supplying power to the 24 VAC 1st stage electric heat contactor. The electric heater stages should be of equal K.W. ratings for staging control to work properly.

#### Analog Output

If you are using hot water or steam heating via a modulating steam or hot water valve, this output can supply a 0-10 Volts DC signal for proportional control of the valve. It can also be used to control an SCR electric heat controller that accepts a 0-10 VDC control signal.

## Controller Inputs and Outputs

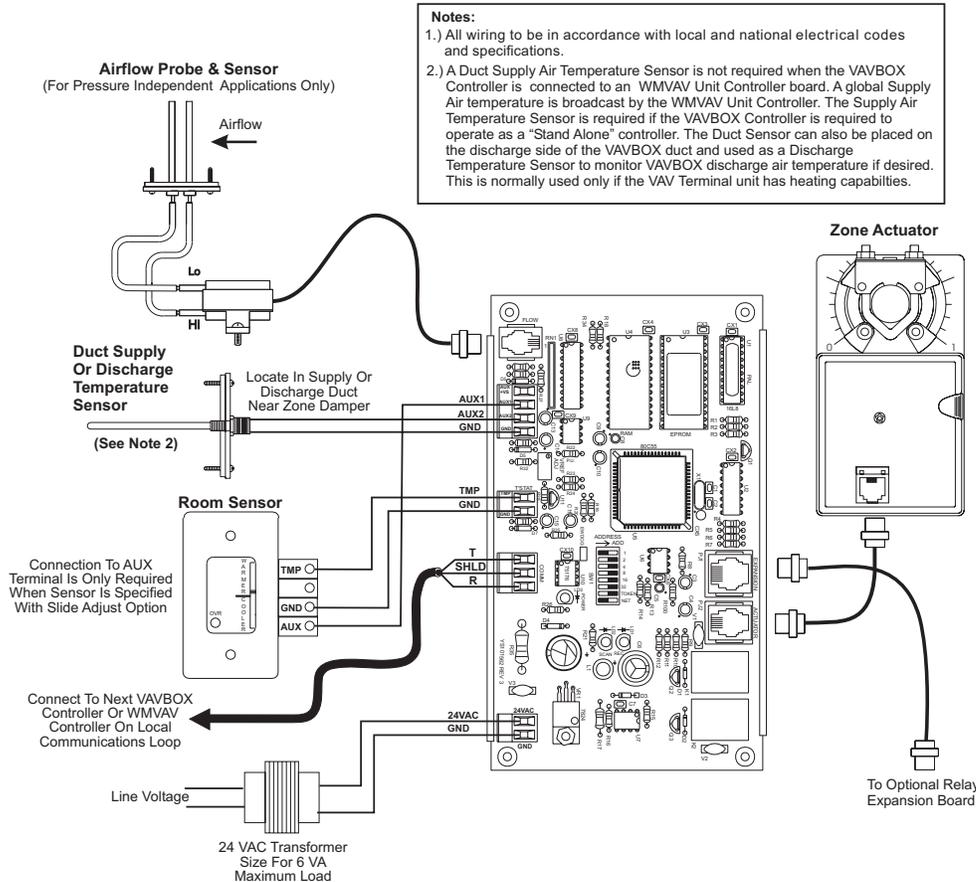


Figure 4: VAVBOX Controller Wiring

## Controller Installation & Wiring

### General

Correct wiring of the VAVBOX controller is the most important factor in the overall success of the controller installation process. The VAVBOX controller wiring has been simplified by the use of modular connectors and prefabricated modular cables.

### Controller Mounting

If the Round Zone Dampers were purchased from WattMaster, the controller and actuator are factory mounted and wired in the damper control enclosure. If your VAVBOX controllers are pressure independent, an airflow probe and pressure sensor will also be factory mounted and wired.

Most terminal unit manufacturers will offer the option of factory mounting the WattMaster controls in their terminal units for an additional charge. An installation worksheet and instructions are available for the WattMaster VAVBOX controller package which can be shipped with the VAVBOX control(s) to the terminal unit manufacturer to simplify third party factory mounting and wiring of the controller.

When the VAVBOX controller is to be field mounted, it is important to mount the controller in a location that is free from extreme high or low temperatures, moisture, dust and dirt. The VAVBOX controller board must be mounted within 10" of the damper actuator in order for the actuator cable to extend between the controller and the actuator.

Be careful not to damage the electronic components when mounting the controller. Remove the controller from its snap track mount. Mark the control enclosure base using the snap track as a template. Drill pilot holes in the enclosure base and secure the snap track to it using sheet metal screws. Do not allow metal shavings to fall onto the circuit board. Reattach the controller to the snap track. Mount the damper actuator to the damper shaft following the instructions supplied with the damper actuator.

### Important Wiring Considerations

Please carefully read and apply the following information when wiring the WMVAV controller. See Figure 4 for VAVBOX controller wiring diagram.

1. Size and wire the transformer per the instructions. Failure to size the transformer and/or wire the transformer correctly may cause the VAVBOX controllers to not operate erratically or not at all. See Figure 5 for wiring and transformer sizing information.
2. If a Duct Sensor is to be connected, the minimum wire size used should be 24 gauge.
3. Do not pry on the connectors when connecting or disconnecting the modular cables. Be sure to push in on the connector release clip and then pull straight up.

**24VAC Power - Transformer & Wire Sizing Considerations For VAVBOX Controllers**

Some installers like to use one large 24VAC transformer to power several devices. This is allowable as long as polarity is maintained to each device on the transformer circuit. **Warning: If polarity is not maintained, severe damage to the devices may result. WattMaster Controls recommends using a separate transformer for each device in order to eliminate the potential for damaging controllers due to incorrect polarity.** Using separate transformers also allows redundancy in case of a transformer failure. Instead of having 8 controllers inoperative because of a malfunctioning transformer you have only 1 controller off line. If the installer does decide to use a large transformer to supply power to several devices, the following transformer and wire sizing information is presented to help the installer correctly supply 24VAC power to the devices.

Following is a typical example to help the installer to correctly evaluate transformer and wiring designs.

Each VAVBOX Controller requires 6 VA @ 24VAC power. In the examples below we have a total of 10 VAV Controllers.

10 VAVBOX Controllers @ 6VA each..... 10 x 6VA =60VA.

The above calculation determines that our transformer will need to be sized for a minimum of 60VA if we are to use one transformer to power all the controllers. We will use a 75 VA transformer, as this is a readily available size that meets our VA load requirements.

Next we must determine the maximum length of run allowable for the wire gauge we wish to use in the installation. Each wire gauge below has a voltage drop per foot value we use to calculate total voltage drop.

18ga wire.....0.00054 = voltage drop per 1' length of wire  
 16ga wire.....0.00034 = voltage drop per 1' length of wire  
 14ga wire.....0.00021 = voltage drop per 1' length of wire

For our example we will use 18 gauge wire. WattMaster recommends 18 gauge as a minimum wire size for all power wiring.

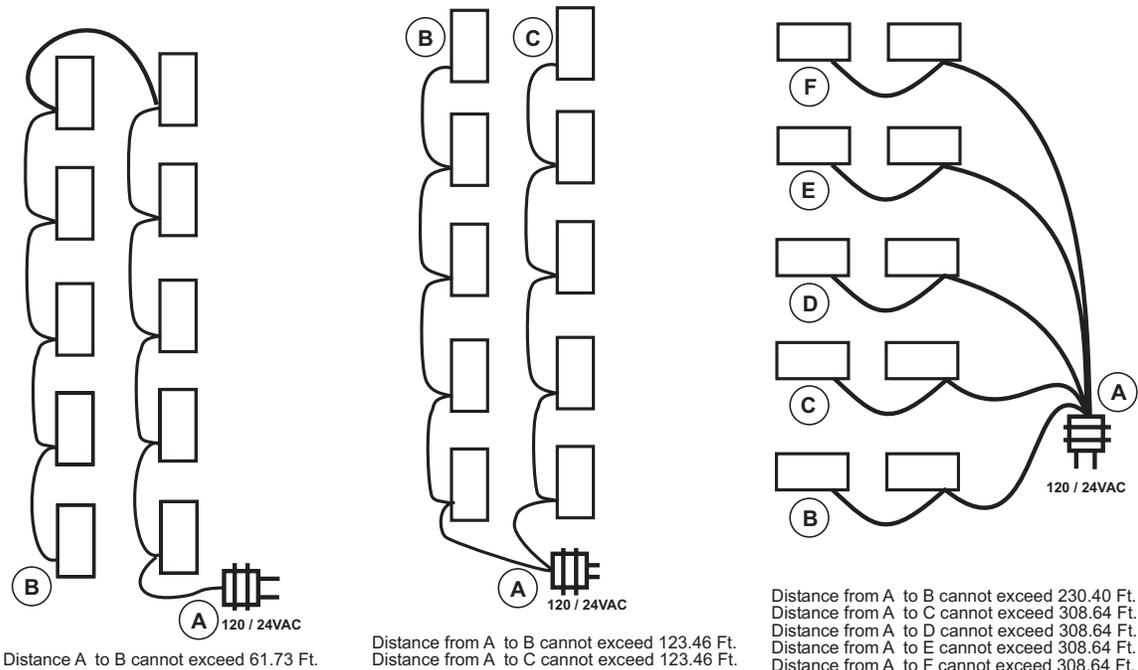
Next use the voltage drop per foot value for 18 gauge wire from the list above and multiply by the total VA load of the 10 controllers to be installed.

0.00054 (Voltage drop per foot for 18 gauge wire) x 60VA controller load = **0.0324** Volts/Ft.

WattMaster VAVBOX controllers will operate efficiently with a voltage drop no greater than 2 Volts. Divide the total allowable voltage drop of 2 Volts by the number you arrived at above and you have the maximum number of feet you can run the 18 gauge wire with an 75 VA transformer with no more than a 2 Volt drop at the farthest controller from the transformer.

$$\frac{2 \text{ (Volts total allowable voltage drop)}}{0.0324 \text{ (Voltage drop per 1 ft. @ 60VA load)}} = 61.73 \text{ feet}$$

Parallel circuiting of the wiring instead of wiring all 10 controllers in series allows for longer wire runs to be used with the same size wire (as shown in our examples below). It is often necessary for the installer to calculate and weigh the cost and installation advantages and disadvantages of wire size, transformer size, multiple transformers, circuiting, etc., when laying out an installation. No matter what layout scheme is decided upon, it is mandatory that the farthest controller on the circuit is supplied with a minimum of 22 Volts and that the polarity is maintained to all controllers connected to the transformer.



**Figure 5: WMVAV Controller Transformer Sizing**

**Transformer Sizing & Wiring**

Each VAVBOX controller requires 6 VA minimum at 24 VAC in order to function properly. Wiring and transformer information shown above is provided to help correctly size and layout wiring schemes for the VAVBOX controllers. As stated above, all wiring should be 18 Ga. minimum. Long runs may require heavier gauge wire to keep the volt-

age drop within the 2 volt maximum range. Please follow these guidelines.

**Warning:** If polarity between controllers is not maintained, severe damage to the controllers may result. WattMaster recommends using a separate transformer for each controller in order to eliminate the potential for damaging controllers due to incorrect polarity.

# Expansion Board Installation & Wiring

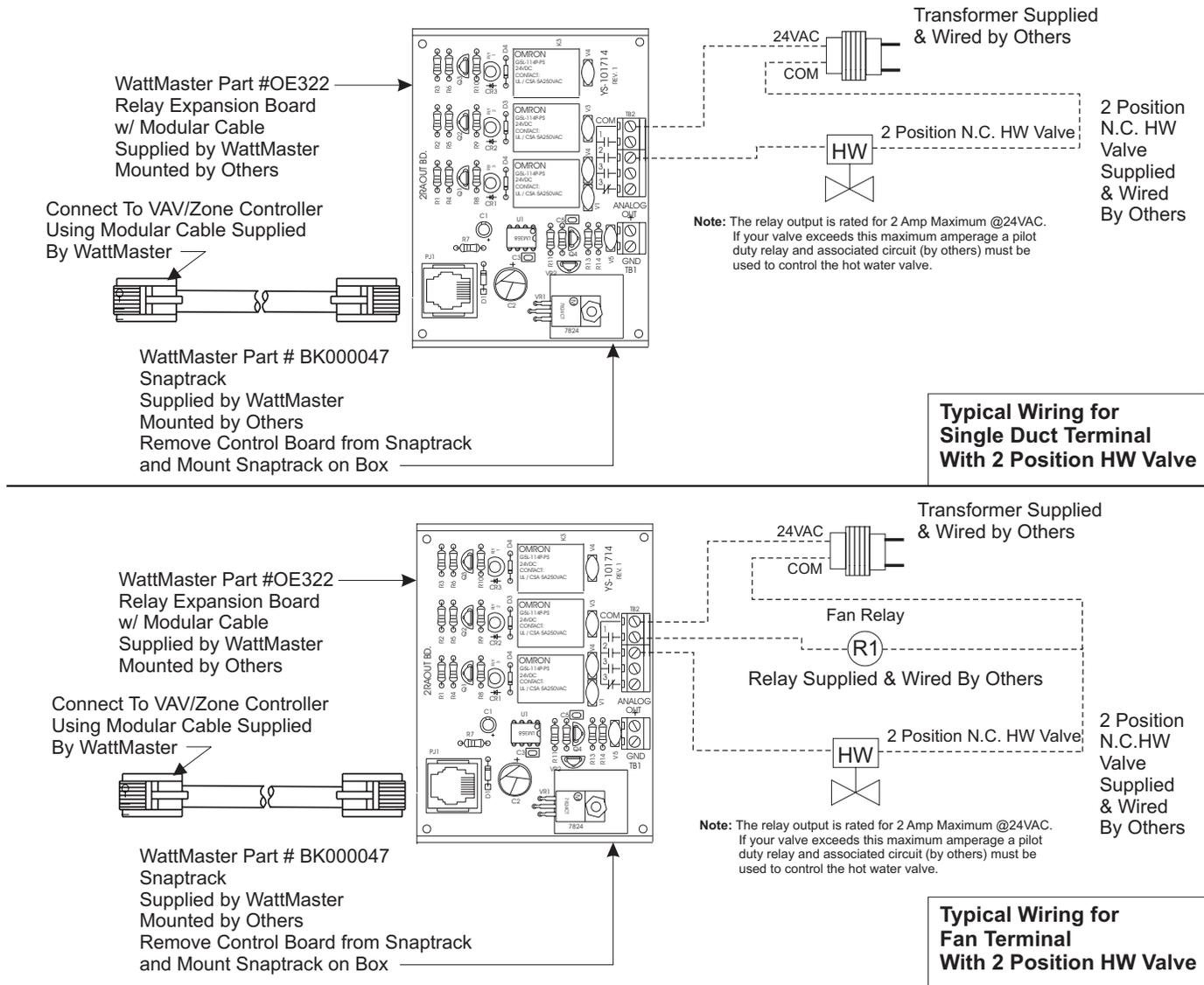


Figure 6: Expansion Board Wiring For Two Position Hot Water Heat Applications

## Wiring Considerations

Expansion boards are used to supply extra relays and/or analog outputs to control fan and heating functions for the VAVBOX controller.

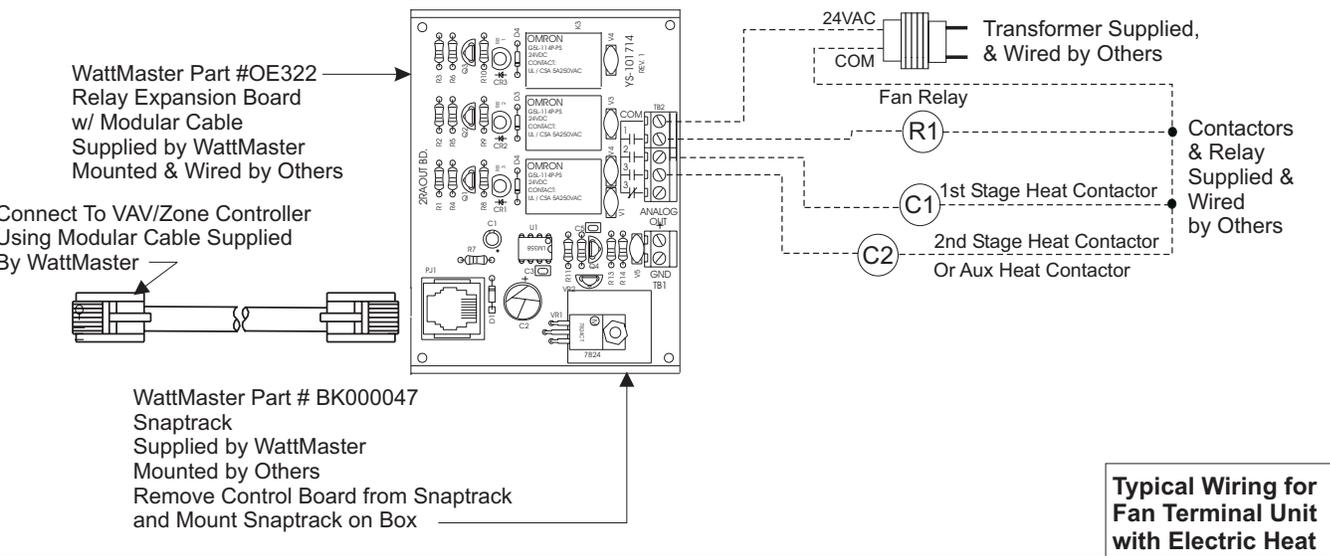
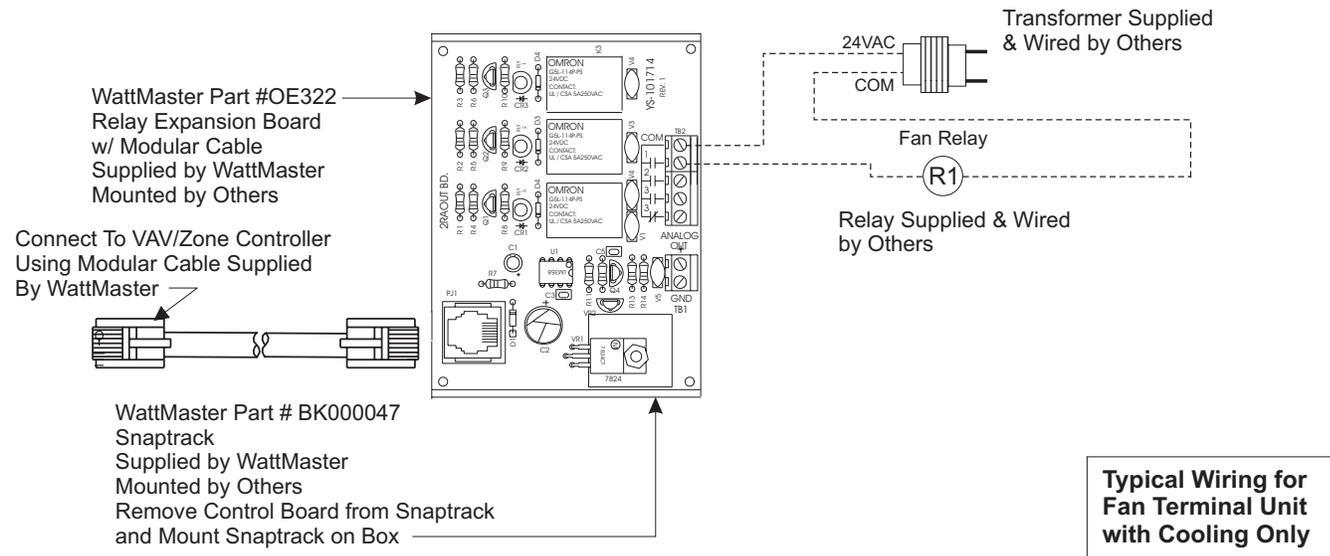
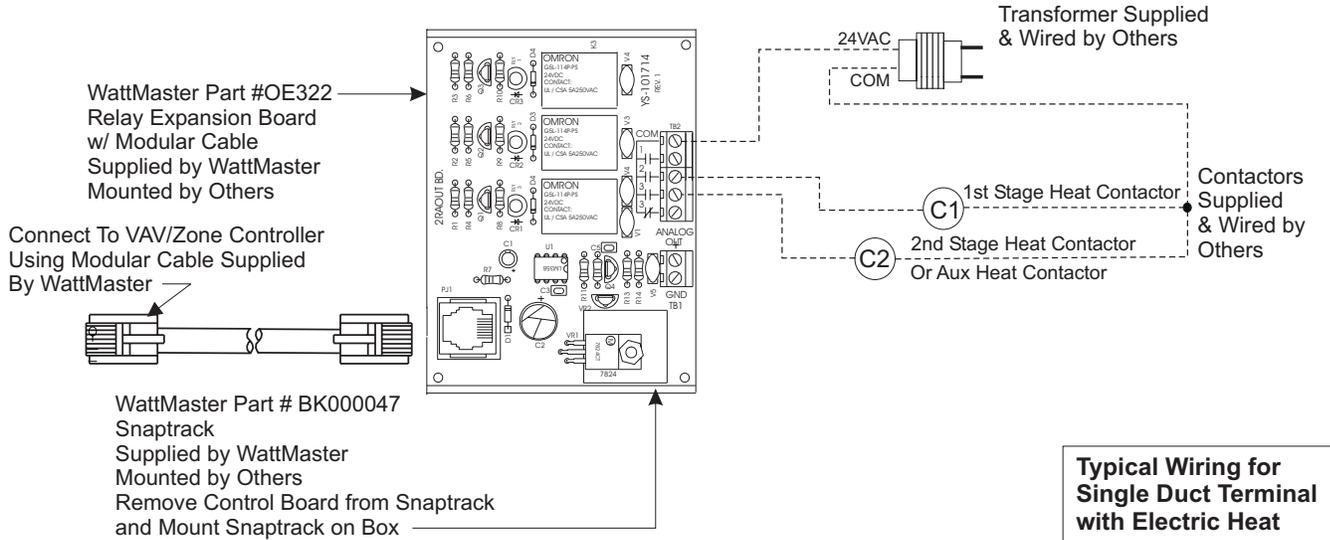
When Round VAVBOX Dampers or Rectangular VAVBOX Controller Kits are ordered from WattMaster, the OE322 Expansion board is shipped loose for field mounting by others.

Mounting of the OE322 Expansion Board is identical to the previously described mounting for the VAVBOX controller. Mount the Expansion board near the VAVBOX controller using the sheet metal screws provided. Be sure the mounting location is close enough so that the supplied modular cable will reach from the VAVBOX controller to the Expansion board.

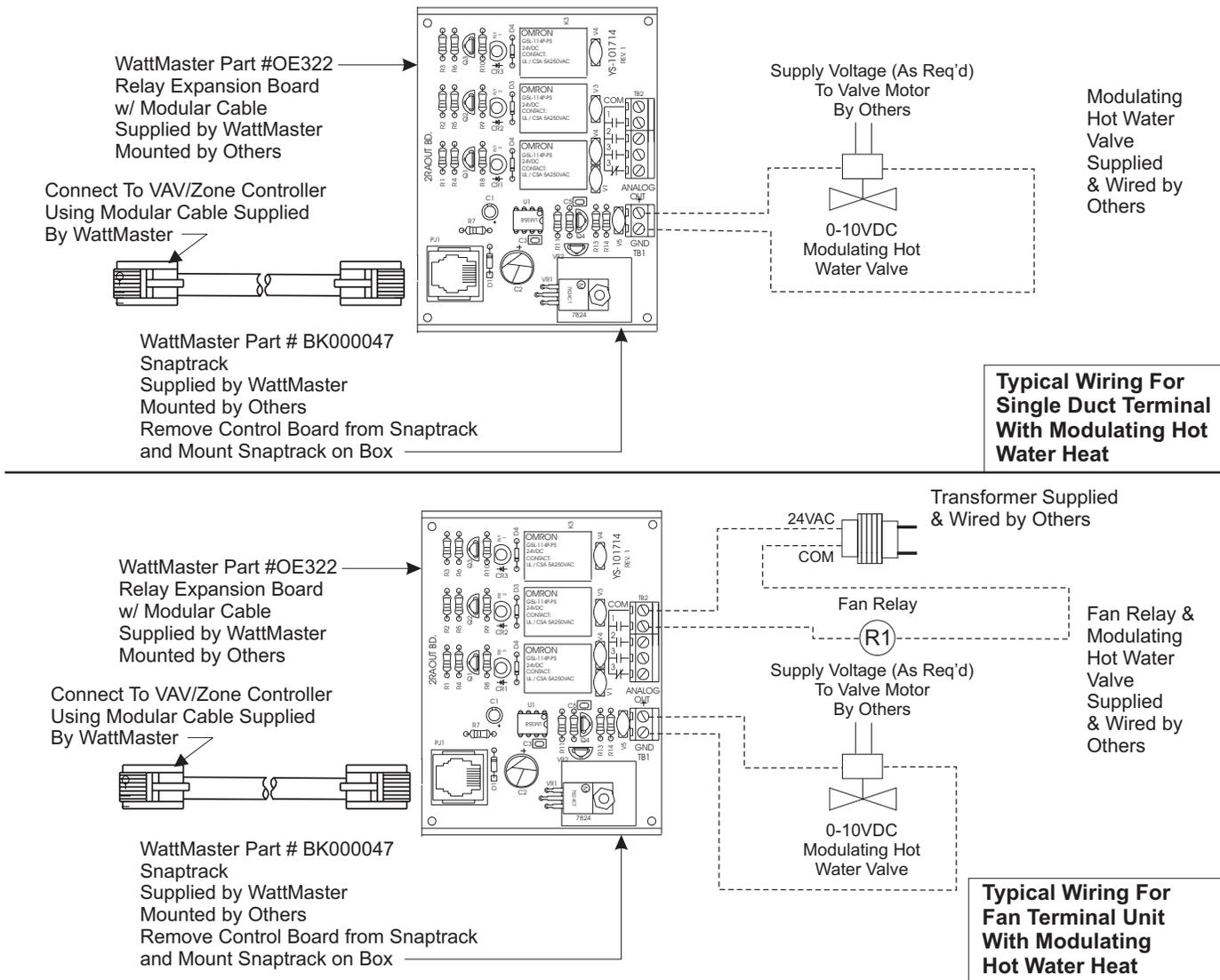
**Warning:** The 3 relay outputs available on the OE322 Output Expansion board are each rated for 2 Amps @ 24 VAC. If your device load exceeds these limits, a pilot duty relay (by others) must be used in the circuit.

The wiring consideration information previously outlined for the VAVBOX controller should be followed when wiring the OE322 Expansion Boards.

**Expansion Board Installation & Wiring**



**Figure 7: Expansion Board Wiring For Electric Heat Applications**



**Figure 8: Expansion Board Wiring For Modulating Hot Water Heat Applications**

## Start-up & Commissioning

### General

In order to have a trouble free start-up it is important to follow a few simple procedures. Before applying power for the first time it is very important to correctly address the controller and run through a few simple checks.

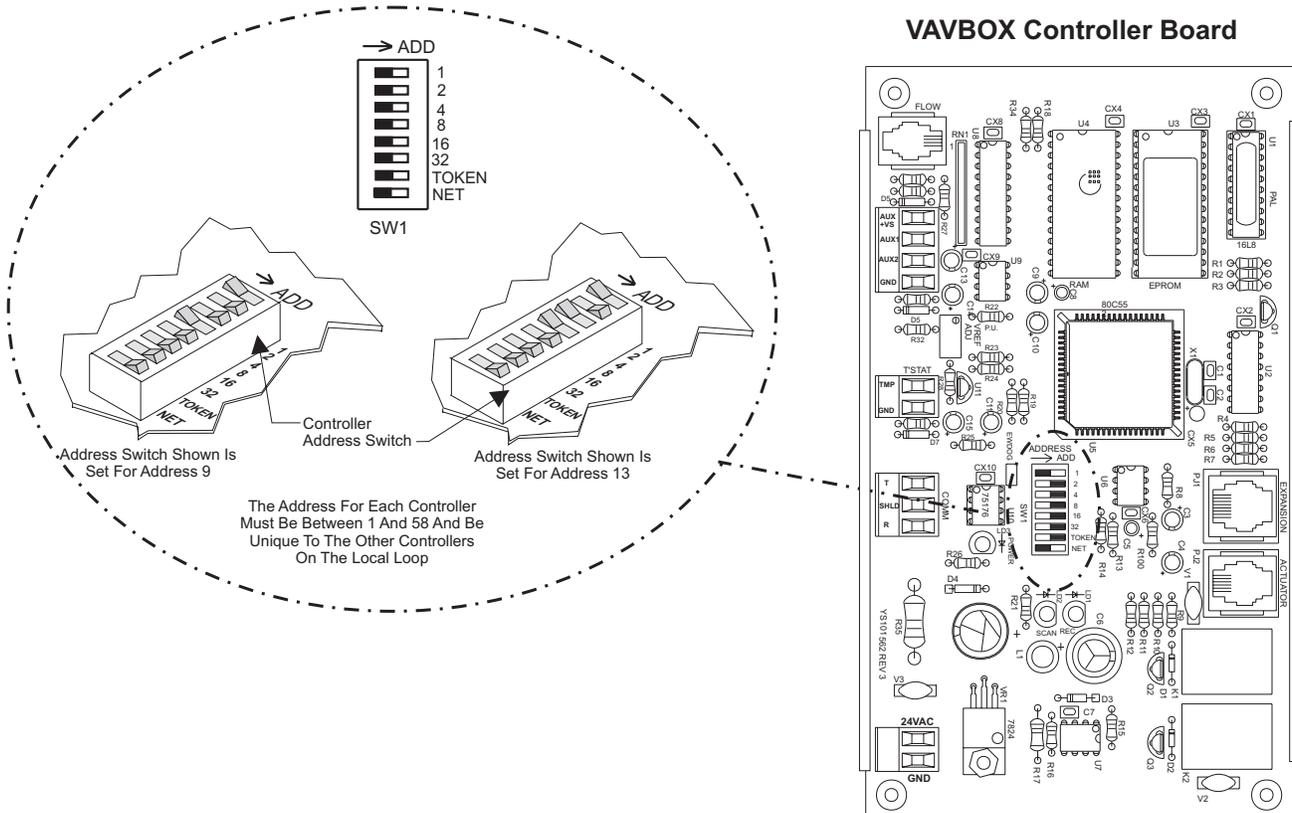
### Controller Addressing

All VAVBOX controllers are equipped with address switches. If the VAVBOX controller is to operate as a Stand Alone controller (not connected to any other HVAC unit or VAVBOX controllers) the controller address switch should be set for address 1. When the VAVBOX con-

troller is to be connected to other controllers on a communication loop, each VAVBOX controllers address switch must be set with a unique address between 1 and 58.

When programming the VAVBOX controller and asked to enter the Unit ID you would first enter the MiniLink loop address for the loop the controller is connected to and then enter the VAVBOX controllers address. See **Figure 10** for a diagram depicting address switch settings.

# Start-up & Commissioning



**Figure 9: Address Switch Setting**

For detailed information regarding communication wiring and connection for Interconnected and Networked systems, please see the Watt-Master WMVAV System Installation & Troubleshooting Guide.

## Power Wiring

One of the most important checks to make before powering up the system for the first time, is to confirm proper voltage and transformer sizing for the VAVBOX boards that are connected to it. Each VAVBOX controller requires 6 VA of power delivered to it at 24 VAC. See page 7 of this manual for complete wiring and transformer sizing information for the VAVBOX controller.

Check all connections to be sure they are tight with no loose wire strands hanging loose. Confirm that all sensors required for your system are mounted in the appropriate location and wired correctly to the VAVBOX controller. Check the actuator cable and be sure it is plugged in and secured to the modular connector on the actuator and the VAVBOX controller board modular connector. Be sure any expansion boards connected to the VAVBOX controller are also correctly wired per the expansion board wiring instructions on pages 8 through 102 of this manual.

After all the above wiring checks are complete, apply power to the first VAVBOX on the loop, that is connected to the WMVAV controller.

## Initialization

Upon applying power to the VAVBOX controller the following should occur:

On system power-up, the SCAN LED is extinguished for a few seconds and then the controller “flashes” its address switch setting. If the address switch were set to 7, you would see 7 flashes. After the address is finished, the LED will extinguish for another 5 seconds. At the conclusion of this 5-second delay, the LED will begin a continuous flashing while the Damper Feedback limits are calibrated. If the Damper is driving open, the LED will blink slowly. If the Damper is driving closed, the LED will blink fast. When the calibration is completed, the normal diagnostic flashes will commence. These diagnostic flashes are described later in this document. In addition, during the first few seconds of power-up, all default setpoints are initialized and all outputs are turned off.

a 30 second start-up delay to protect the fan and other components from short cycling during intermittent power conditions. If all inputs are operating correctly it will blink once every ten seconds.

## Programming The Controller

The next step is programming the controller for your specific requirements. In order to configure and program the VAVBOX controller you must have a central operators interface or a personal computer with the Prism computer front end software installed. Two different operators interfaces are available for programming of the VAVBOX controller. You may use either the *Modular Service Tool* or the *Modular System Manager* to access the *status* and *setpoints* of any VAVBOX controller or WMVAV controller on the systems communications loop. See the Operators Interface Technical Guide for VAVBOX controller programming information. If you are going to use a personal computer and the

Prism computer front end software, please see the WattMaster Prism Computer Front End Operations Manual. No matter which operators interface you use, it is recommended that you proceed with the programming and setup of the controller in the order that follows:

1. Configure The Controller For Your Application
2. Program The Controller Setpoints.
3. Review Controller Status Screens To Verify System Operation And Correct Controller Configuration

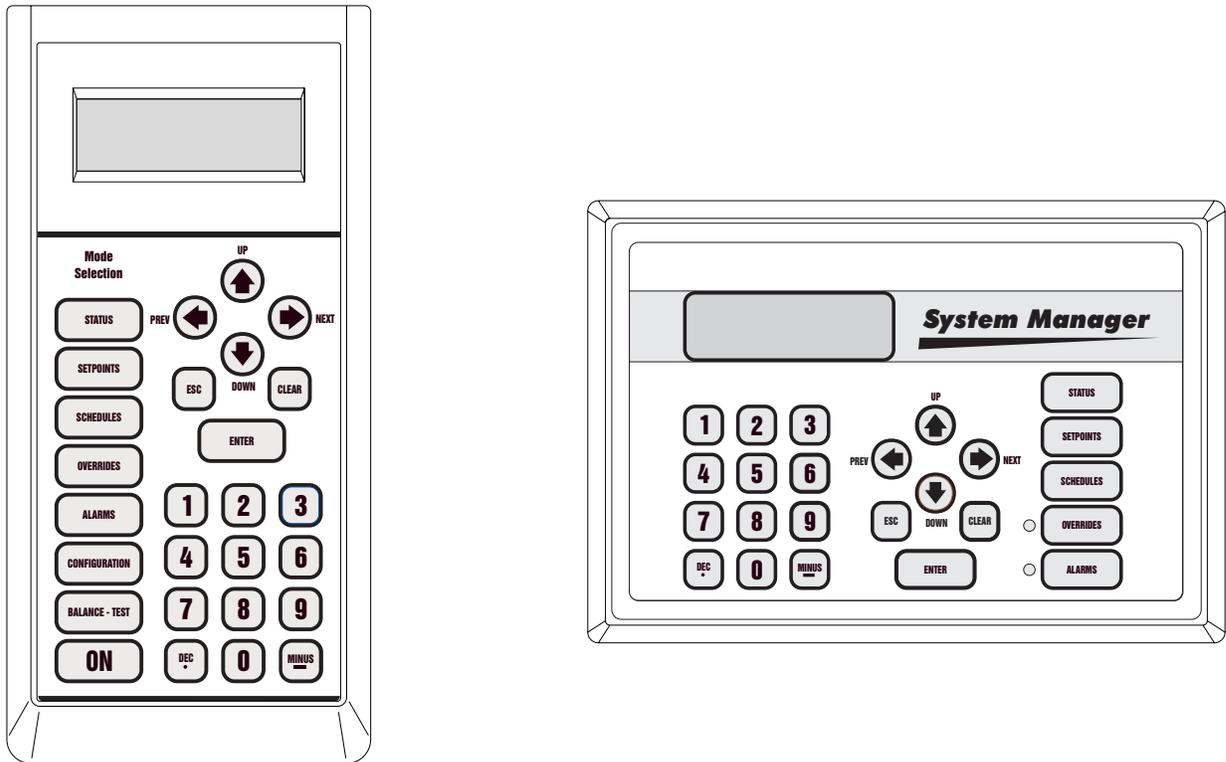


Figure 10: Operators Interfaces

## Sequence Of Operations

### Initialization

On system power-up, the SCAN LED is extinguished for a few seconds and then the controller “flashes” its address switch setting. If the address switch were set to 7, you would see 7 flashes. After the address is finished, the LED will extinguish for another 5 seconds. At the conclusion of this 5 second delay, the LED will begin a continuous flashing while the Damper Feedback limits are calibrated. If the Damper is driving open, the LED will blink slowly. If the Damper is driving closed, the LED will blink fast. When the calibration is completed, the normal diagnostic flashes will commence. These diagnostic flashes are described later in this document.

### VAVBOX Configuration & Setup

There are a few configuration selections available to the user, which can be used to tailor the software operation to match the mechanical equipment this controller is installed on. These are programmed using either the Modular System Manager, Modular Service Tool or a personal computer with Prism computer front end software installed. See the Operator Interfaces Technical Guide or the Prism Computer Front End Software manual for specific programming information.

#### General

Several options are available to configure the VAVBOX controller for the appropriate equipment it is installed on. All of these options can be set from the “Configuration” menu with the exception of “AHU Heat Call” which is set from the “Setpoints” menu. Again, please refer to the Operators Interface Technical Guide or the Prism Computer Front End Software manual for detailed programming information.

#### Box Control Method

Set this configuration item for the type of box the VAVBOX controller is used on. The options available are:

- 0 = Cooling Only Box (With Reheat if Required)
- 1 = Heating/Cooling Changeover Box
- 2 = Series Fan Powered Box With Reheat
- 3 = Parallel Fan Powered Box With Reheat

#### Damper Operating Mode

This allows the user to set the direction of rotation the damper moves when driving towards its full open position. The options available are:

- 0 = Direct Acting (Clockwise To Open Damper)
- 1 = Reverse Acting (Counterclockwise To Open Damper)

#### Pressure Independent Boxes - Airflow @ 1” W.C.

If this is a pressure independent box, this option allows you to calibrate the box CFM correctly using the box manufacturers “K” factor. Enter the correct “K” (CFM) factor for the inlet diameter of the box you are configuring.

#### Expansion Relays - Steps of Reheat

If the box has reheat supplied by an electric coil, this option must be set for the number of electric heating stages on the box. If the box has hot water heat with a 2 position hot water valve, set the number of stages to “1”. For hot water heat with a proportional hot water valve this must be set for “0”.

Options available are:

- 0 = No Staging
- 1 = 1 Stage of Reheat
- 2 = 2 Stages of Reheat
- 3 = 3 Stages of Reheat

#### Proportional Heating Signal

If the box has hot water reheat using a proportional hot water valve, set this option to match the voltage signal required by the hot water valve you are using. Options available are:

- 0 = 0-10 VDC Voltage Signal
- 1 = 2-10 VDC Voltage Signal

#### Allow Box Heat With AHU Heat

If the box you are using has reheat, configuring this setting to 1=Yes will allow the box heat to operate at the same time as the HVAC unit heat. Options available are:

- 0 = No
- 1 = Yes

#### Main Fan Status

If the VAVBOX controller is installed on a non-fan powered box that has reheat set this option to “Yes” in order to enable box reheat only when the HVAC unit fan is running. A full description of how this setting affects the various box types in the occupied and unoccupied modes is contained under the “Mode Sequence” heading that follows later in this manual. Options available are:

- 0 = No Heat can operate without fan
- 1 = Yes Heat cannot operate without fan

#### Push Button Override Group ID#

During Unoccupied Mode, all VAVBOX controllers with a corresponding **Group ID#** will resume Occupied operation whenever any of the VAVBOX controllers with the same **Group ID #** has its push-button depressed to initiate an override condition. This allows you to group zones in various areas of the building. For example, individual tenants with several offices could restore occupied mode for just their zones and not affect other zones in the building. If you don’t want a specific zone to be a part of any group, enter a ‘0’ for its Group ID #.

#### Dump Zone

If this VAVBOX controller is to be used as a “Dump Zone” set this configuration to 1=Yes. The dump zone is a controller without an actuator that is used to control a duct heater or auxiliary heat. Options available are:

- 0 = No
- 1 = Yes

#### AHU Heat Call

This setting is located under the “Setpoints” menu on screen #3. This is used only for the unoccupied mode. This temperature setpoint is used to allow auxiliary heat such as baseboard heaters to be energized in an attempt to satisfy the heating demand prior to initiating the HVAC unit Supply Air Heating mode.

# Sequence Of Operations

During unoccupied mode when the temperature in the space drops below the AHU Heat Call setpoint the VAVBOX controller sends a signal to the WMVAV controller to initiate the HVAC unit Supply Air Heating Mode. This setpoint temperature can be set higher or lower than the Space Heating setpoint.

## Scheduling

### Occupied/Unoccupied Mode

The VAVBOX Controller monitors the communications loop for its Occupied and Unoccupied mode of operation command. Either the WMVAV Controller or a special Optimal Start Scheduling device can transmit the Occupied command to the VAVBOX Controller. This requires the VAVBOX Controllers to all be connected to the system communication loop through their RS-485 connector and to be properly addressed for the command to be received.

### Push-button Override Operation

During unoccupied hours, the user can force the VAVBOX Controller and WMVAV Controller back to occupied operation by pressing the override button for a period of time less than 3 seconds. This initiates the override or resets the override timer back to zero during unoccupied hours of operation.

During Override operations, the user can cancel the override by pressing the override button for a period of time between 3 seconds and 10 seconds. This restores the normal unoccupied operation.

On larger installations with several terminal units, the VAVBOX Controllers can be configured into groups so that an override generated by one VAVBOX Controller can cause several other controllers to follow along and return to occupied mode for the programmed duration. Other VAVBOX Controllers not in the same group will simply maintain an unoccupied damper or airflow setting as set by the user.

Push-button overrides are broadcast continuously by the initiating VAVBOX Controller until the controller itself times out or the override is cancelled by the user. This broadcast forces the air handler to start its main fan and provide cooling or heating, if so configured. It will remain on until the override broadcast has not been detected for at least 2 consecutive minutes.

## Modes Of Operation

### General

There are 7 possible modes of operation for the HVAC Unit and the VAVBOX controller. These modes are determined by the supply air and/or space demand conditions. They are:

- Supply Air Vent Mode  
(Based on HVAC Unit SAT)
- Space Vent Mode  
(Based on VAVBOX Controller Space Temp.)
- Supply Air Cooling Mode  
(Based on HVAC Unit SAT)

- Space Cooling Mode  
(Based on VAVBOX Controller Space Temp.)
- Supply Air Heating Mode  
(Based on HVAC Unit SAT)
- Space Heating Mode  
(Based on VAVBOX Controller Space Temp.)
- Off Mode (Not displayed. See definition below)

The process of determining each mode is discussed below, but the actual operation of each mode is explained in the section that follows.

### Definitions Of Modes

#### VAVBOX Control Schemes

On all fan-powered and non-fan-powered terminal units, supply air modes and space demands are calculated the same. If the supply air rises 1 °F above the cooling setpoint, the supply air mode is heating. To cancel the supply air heating mode, the supply air temperature must fall below the cooling setpoint. If the supply air falls 1 °F below the heating setpoint, the supply air mode is cooling. To cancel the supply air cooling mode, the supply air temperature must rise above the heating setpoint. If the supply air is between the heating and cooling setpoints, it is considered vent mode.

#### Supply Air Vent Mode

This mode occurs when the Supply Air Temperature is between the heating and cooling setpoints.

#### Space Vent Mode

This mode occurs when the Space Temperature is between 0.5 °F below the Cooling Setpoint and 0.5 °F above the Heating Setpoint.

#### Supply Air Cooling Mode

This mode occurs when the Supply Air Temperature falls to 1.0 °F below the Space Heating Setpoint.

#### Space Cooling Mode

This mode occurs when the Space Temperature rises to 0.5 °F below the Space Cooling Setpoint.

#### Supply Air Heating Mode

This mode occurs when the Supply Air Temperature rises to 1.0 °F above the Space Cooling Setpoint.

#### Space Heating Mode

This mode occurs when the Space Temperature falls to 0.5 °F above the Space Heating Setpoint.

#### Off Mode

During unoccupied mode, the mode is considered "OFF" if the space temperature does not generate a heating mode or cooling mode based on the unoccupied heating & cooling setpoints.

## Damper Positions

The actual values for the minimum damper positions that are described in the following paragraphs can be user configured by changing the values in setpoint screens 5, 6 and 7 for the VAVBOX controller. These minimums are expressed in damper open percentages for pressure dependent terminal units or in CFM for pressure independent terminal units.

### Cooling Minimum

When the HVAC unit is in the Supply Air Cooling mode but the space does not require cooling, the VAVBOX damper will go to the Cooling Minimum position.

### Heating Minimum

When the HVAC unit is in the Supply Air Heating mode but the space does not require Heating, the VAVBOX damper will go to the Heating Minimum position.

### Vent Minimum

This is the position the VAVBOX damper will move to when the HVAC unit is in the Supply Air Vent mode.

### Nite/Reheat Minimum

This setpoint has two different functions depending on whether the HVAC unit is in Occupied or Unoccupied mode.

### Occupied Mode

If the VAVBOX controller is used on a non-fan-powered terminal unit that has reheat, the VAVBOX damper will move to the Nite/Reheat position whenever a Space Heating demand occurs and the HVAC unit is in Supply Air Cooling or Vent modes. When the HVAC unit is in Supply Air Heating mode the VAVBOX damper will modulate as required to maintain the Space Heating setpoint.

### Unoccupied Mode

When using non-fan powered terminal units, the VAVBOX damper will position itself in the Nite/Reheat minimum position. In order for fan powered terminal units to position the damper to the Nite/Reheat minimum position, the check for main fan status must be selected and the HVAC unit fan must be operating.

## Occupied Mode Sequences

### Space Vent Mode

This mode only applies to the Occupied Mode of operation. If the equipment is in the Unoccupied Mode, then a lack of heating or cooling demand would generate the **Off Mode**.

If the HVAC unit is in Supply Air Vent Mode, the user can adjust the damper position on pressure dependent terminal units and the airflow on pressure independent terminal units to provide a fixed amount of ventilation air into the space when there are no heating or cooling demands. During this time, the damper does not modulate on pressure dependent terminal units. On pressure independent terminal units, it only modulates to the extent required to maintain the vent minimum airflow setting.

If the VAVBOX Controller detects that the HVAC unit is in Supply Air Heating mode, indicating that the air handler has activated its heat, the heating airflow minimum will be substituted for the vent minimum position.

If the VAVBOX Controller detects that the HVAC unit is in Supply Air Cooling mode, indicating that the air handler has activated its cooling, the cooling airflow minimum will be substituted for the vent minimum position.

### Space Cooling Mode

Occupied Space Cooling mode is initiated by the temperature in the space rising to within 0.5 °F of the Occupied Cooling Setpoint.

If the HVAC unit is in the Supply Air Heating and another VAVBOX controller has a cooling demand, the damper/airflow for the VAVBOX controller requiring cooling will position itself to provide the heating minimum setpoint amount of air into the space. No modulation open will occur because the space does not want the warm air currently being supplied by the air handler.

When the HVAC unit is in the Supply Air Cooling mode, the damper is normally held at the minimum cooling position until the space temperature begins to rise above the cooling setpoint. As the space temperature rises to within 0.5 °F of the Occupied Cooling Setpoint, the damper/airflow calculation causes the air valve to open proportionally until the maximum setpoint is achieved at 3.5 °F above the setpoint. This is a 4 °F proportional window starting 0.5 °F below the cooling setpoint to 3.5 °F above the cooling setpoint.

The damper/airflow is never allowed to modulate outside the user adjusted minimum setpoint and the maximum setpoint. The maximum damper/airflow setpoint applies to heating and cooling modes of operation only. All of the modes have their own individual minimum setting.

### Series Flow Fan Terminals

If the VAVBOX Controller has been configured as a Series Fan Powered terminal unit, the series fan relay will activate and run the series box fan continuously anytime the HVAC unit fan is running.

In all cases, before the series box fan can be activated, the air damper is driven fully closed and held that way for 30 seconds to make sure the series box fan hasn't inadvertently started to spin backwards. Once the series box fan starts, it waits an additional 10 seconds to allow the fan to spin up before it starts to open the damper and introduce airflow from the HVAC unit fan.

### Parallel Flow Fan Terminals

During normal cooling or vent mode and adequate air supply, the parallel fan will be off. During the occupied cooling mode the fan will only activate if the damper/airflow is below a user defined low limit setting. This causes it to be used as a make-up air source. When the damper/airflow rises 15% above the low limit setpoint, the fan will be deactivated

## Sequence Of Operations

### Space Heating Mode

Occupied Space Heating mode is initiated by the temperature in the space falling to within 0.5 °F of the Occupied Heating Setpoint.

If the HVAC unit is in the Supply Air Cooling mode and another VAVBOX controller has a heating demand, the damper/airflow for the VAVBOX controller requiring heating will position itself to provide the Cooling Minimum amount of air into the space. No modulation open will occur because the space does not want the cold air currently being supplied by the air handler.

When the HVAC unit is in the Occupied Supply Air Heating mode, the damper will be held at the Heating Minimum position until the space temperature falls to within 0.5 °F of the Occupied Heating Setpoint. As the space temperature falls below the heating setpoint, the damper/airflow calculation causes the air valve to open proportionally until the maximum setpoint is achieved at 3.5 °F below the setpoint. This is a 4 °F proportional window starting 0.5 °F above the heating setpoint to 3.5 °F below the heating setpoint.

Two different configurations are available for the Occupied Space Heating mode. If the box is configured to allow reheat during Supply Air Heating mode, the reheat relays can be activated even when the HVAC unit is in the Supply Air Heating mode. If the box is configured not to allow reheat when the HVAC unit is in Supply Air Heating mode, the box heat relays will be de-energized when the HVAC unit is in Supply Air Heating mode. In either configuration, when the HVAC unit is in the Supply Air Heating mode, the damper will modulate open proportionally to the space demand. The proportional window for the space temperature is 0.5 °F above to 3.5 °F below the heating setpoint. This allows the space to take advantage of the warm supply air in the duct. See **Table 3: Relay Staging - Occupied Mode** for a complete layout of the various fan and heat relay staging points.

#### Series Flow Fan Terminals

If the VAVBOX Controller has been configured as a Series Fan Powered terminal unit, the series fan relay will activate and run the series box fan continuously anytime the HVAC unit fan is running.

In all cases, before the series box fan can be activated, the air damper is driven fully closed and held that way for 30 seconds to make sure the series box fan hasn't inadvertently started to spin backwards. Once the series box fan starts, it waits an additional 10 seconds to allow the fan to spin up before it starts to open the damper and introduce airflow from the HVAC unit fan.

#### Parallel Flow Fan Terminals

On parallel fan powered terminal units, the fan will run whenever Space Heating mode is active. At all other times, the fan will only activate if the damper/airflow is below a user defined low limit setting. This causes it to be used as a make-up air source. When the damper/airflow rises 15% above the low limit setpoint, the fan will be deactivated if there are no heating stages active, and no space demand exists.

The check for main fan status setting has no effect on the Parallel Fan box when in the occupied mode. The Parallel Fan will only be energized when in the Space Heating mode.

Box Fan Relay & Reheat Relay Staging Occupied Mode					
Relays Stage On At	Series Fan	Parallel Fan	Heat Stage 1	Heat Stage 2	Heat Stage 3
+0.5 °F Above Box Heat Setpoint	ON With HVAC Fan	X			
At Box Heat Setpoint			X		
-1.0 °F Below Box Heat Setpoint				X	
-2.0 °F Below Box Heat Setpoint					X
Relays Stage Off At	Series Fan	Parallel Fan	Heat Stage 1	Heat Stage 2	Heat Stage 3
+1.0 °F Above Box Heat Setpoint	OFF With HVAC Fan	X			
+1.0 °F Above Box Heat Setpoint			X		
At Box Heat Setpoint				X	
-1.0 °F Below Box Heat Setpoint					X

**Table 3: Relay Staging - Occupied Mode**

## Unoccupied Mode Sequences

### Space Vent Mode

This mode only applies to the Occupied Mode of operation. If the equipment is in the Unoccupied Mode, then a lack of heating or cooling demand would generate the **Off Mode**.

### Off Mode

This mode only applies to the Unoccupied Mode of operation. If the equipment is in the Unoccupied Mode, then a lack of heating or cooling demand would generate this mode. The VAVBOX controller will put the damper into the Night/Reheat minimum position if check main fan status has been selected. If check main fan status has not been selected the damper will be in the fully closed position.

### Space Cooling Mode

During unoccupied mode the HVAC unit is normally off. Unoccupied Space Cooling mode is initiated by the temperature in the space rising to within 0.5 °F of the Unoccupied Cooling Setpoint.

If the HVAC unit is in the Unoccupied Supply Air Heating mode because one or more of the VAVBOX controllers has a heating demand, and another VAVBOX controller has a cooling demand, the damper/airflow for the VAVBOX controller requiring cooling will position itself to provide the heating minimum setpoint amount of air into the space. No modulation open will occur because the space does not want the warm air currently being supplied by the air handler.

When the HVAC unit is in the Unoccupied Supply Air Cooling mode, the damper will be held at the Night/Reheat minimum position until the space temperature begins to rise above the cooling setpoint. As the space temperature rises to within 0.5 °F of the Unoccupied Cooling Setpoint, the damper/airflow calculation causes the air valve to open proportionally until the maximum setpoint is achieved at 3.5 °F above the setpoint. This is a 4 °F proportional window starting 0.5 °F below the cooling setpoint to 3.5 °F above the cooling setpoint.

The damper/airflow is never allowed to modulate outside the user adjusted minimum setpoint and the maximum setpoint. The maximum damper/airflow setpoint applies to heating and cooling modes of operation only. All of the modes have their own individual minimum setting.

### Series Flow Fan Terminals

If the VAVBOX Controller has been configured as a Series Fan Powered terminal unit and check for main status has been selected, the series fan relay will activate and run the series box fan continuously anytime the HVAC unit fan is running. The damper will be held at the Nite/Reheat minimum until the space temperature begins to rise above the cooling setpoint. If check for main fan status has not been selected, the series fan relay will activate and run the series box fan when in the Space Cooling mode. The damper will be in the fully closed position until the space temperature begins to rise above the cooling setpoint.

In all cases, before the series box fan can be activated, the air damper is driven fully closed and held that way for 30 seconds to make sure the series box fan hasn't inadvertently started to spin backwards. Once the series box fan starts, it waits an additional 10 seconds to allow the fan to spin up before it starts to open the damper and introduce airflow from the HVAC unit fan.

### Parallel Flow Fan Terminals

In the Unoccupied Cooling mode the parallel fan will be off whether check for main fan status has been selected or not. If check for main fan status has been selected the damper will be held at the Nite/Reheat minimum until the space temperature begins to rise above the cooling setpoint. If check for main fan status has not been selected the damper will be held in the fully closed position until the space temperature begins to rise above the cooling setpoint.

### Space Heating Mode

During unoccupied mode the HVAC unit is normally off. Unoccupied Space Heating mode is initiated by the temperature in the space falling to within 0.5 °F of the Unoccupied Space Heating Setpoint.

If the HVAC unit is in the Unoccupied Supply Air Cooling mode because one or more of the VAVBOX controllers has a cooling demand, and another VAVBOX controller has a heating demand, the damper/airflow for the VAVBOX controller requiring heating will position itself to provide the Night/Reheat setpoint amount of air into the space. No modulation open will occur because the space does not want the cold air currently being supplied by the air handler.

When the HVAC unit is in the Unoccupied Supply Air Heating mode, the damper will be held at the Night/Reheat minimum position until the space temperature begins to fall below the Unoccupied Heating Setpoint. As the space temperature falls to 0.5 °F below the Unoccupied Heating Setpoint, the damper/airflow calculation causes the air valve to open proportionally until the maximum setpoint is achieved at 3.5 °F below the setpoint. This is a 4 °F proportional window starting 0.5 °F above the heating setpoint to 3.5 °F below the heating setpoint.

As with the Occupied Mode of operation, two different configurations are available for the Unoccupied Space Heating mode. If the box is configured to allow reheat during Supply Air Heating mode, the reheat relays can be activated even when the HVAC unit is in the Supply Air Heating mode. If the box is configured not to allow reheat when the HVAC unit is in Supply Air Heating mode, the box heat relays will be de-energized when the HVAC unit is in Supply Air Heating mode. In either configuration, when the HVAC unit is in the Supply Air Heating mode, the damper will modulate open proportionally to the space demand. The proportional window for the space temperature is 0.5 °F above to 3.5 °F below the heating setpoint. This allows the space to take advantage of the warm supply air in the duct.

If check for main fan status is not selected and the VAVBOX terminal unit has auxiliary heat (baseboard heat etc.) that does not require the HVAC unit fan to operate, reheat can be used without the HVAC unit fan operating. If check for main fan status is selected, the reheat will only operate when the HVAC unit fan is operating.

The VAVBOX Controller can activate auxiliary heating relays if the relay expansion board has been connected and the correct number of heating stages (1,2 or 3) has been configured. During demands for heat, the first stage will activate whenever the space temperature drops below the heating setpoint. The second stage will activate if the space temperature falls 1.0 °F below the heating setpoint. The third stage will activate if the space temperature falls 2.0 °F below the heating setpoint. There is a two-minute delay between staging. This prevents stages from activating at the same time. Once a heating stage has been activated, it must remain on for at least one minute. Once it has been deactivated, it must remain off for at least two minutes. The third stage relay will deactivate when the space temperature rises to within 1.0 °F of the heating setpoint. The second stage relay will deactivate when the space temperature rises to the heating setpoint. The first stage relay will deactivate when the space temperature rises above the heating setpoint by 1.0 °F. See **Table 4: Relay Staging - Unoccupied Mode** for a complete layout of the various fan & heat relay staging points.

### Series Flow Fan Terminals

If the VAVBOX Controller has been configured as a Series Fan Powered terminal unit, the series fan will run continuously when the VAVBOX controller is in the Space Heating mode no matter whether check for main fan status has been selected or not. If the HVAC unit is in Supply Air Heating mode the damper will modulate to maintain the Space Heating Setpoint.

Any series fan terminal unit that has check for main fan status selected will also operate its series box fan anytime the HVAC unit controller is broadcasting that the HVAC unit fan is operating, regardless of whether it is calling for heat or not. The damper will be held at the closed position until the main fan status broadcast is received. Once the broadcast

## Sequence Of Operations

is received the damper will then move to its Nite/Reheat minimum position. If check for main fan status has not been selected, the series box fan will only activate and run when it is in Space Heating mode. When in Space Heating mode the damper will move to its Nite/Reheat minimum position. When in Supply Air Heating mode the damper will modulate to maintain the Unoccupied Heating setpoint.

In all cases, before the series box fan can be activated, the air damper is driven fully closed and held that way for 30 seconds to make sure the series box fan hasn't inadvertently started to spin backwards. Once the series box fan starts, it waits an additional 10 seconds to allow the fan to spin up before it starts to open the damper and introduce airflow from the HVAC unit fan.

Box Fan Relay & Reheat Relay Staging Unoccupied Mode					
Relays Stage On At	Series Fan	Parallel Fan	Heat Stage 1	Heat Stage 2	Heat Stage 3
+0.5 °F Above Box Heat Setpoint	X See Note 1	X			
At Box Heat Setpoint			X		
-1.0 °F Below Box Heat Setpoint				X	
-2.0 °F Below Box Heat Setpoint					X
Relays Stage Off At	Series Fan	Parallel Fan	Heat Stage 1	Heat Stage 2	Heat Stage 3
+1.0 °F Above Box Heat Setpoint	X See Note 1	X			
+1.0 °F Above Box Heat Setpoint			X		
At Box Heat Setpoint				X	
-1.0 °F Below Box Heat Setpoint					X

**Notes:**

1.) If check for main fan status is selected the series fan will activate anytime the HVAC unit fan is operating.

### Parallel Flow Fan Terminals

If the VAVBOX Controller has been configured as a Parallel Fan Powered terminal unit, the Parallel fan will run continuously when the VAVBOX controller is in the Space Heating mode no matter whether check for main fan status has been selected or not. At all other times, the fan will only activate if the damper/airflow is below a user defined low limit setting. This causes it to be used as a make-up air source. When the damper/airflow rises 15% above the low limit setpoint, the fan will be deactivated if there are no heating stages active, and no space demand exists.

If check for main fan status is selected the damper will remain in the closed position until the HVAC unit controller is broadcasting that the HVAC unit fan is operating, regardless of whether it is calling for heat or not. The damper will be held at the closed position until the main fan status broadcast is received. Once the broadcast is received the damper will then move to its Nite/Reheat minimum position. If check for main fan status has not been selected, the damper will stay in the closed position until Space Heating mode is initiated. When in Space Heating mode the damper will move to its Nite/Reheat minimum position. When in Supply Air Heating mode the damper will modulate to maintain the Unoccupied Heating setpoint.

### Damper Control

The damper position is calculated by the mode and demand from the space sensor. Included in this calculation is an Integral function. This prevents the damper/airflow from stagnating at a position somewhere above the setpoint because the supply air temperature or duct pressure isn't quite enough to satisfy the space at the currently calculated proportional position. The Integral causes the calculation to keep adding a small amount of the proportional error back into the damper/airflow position each time a new position is calculated. The amount the Integral adds back in is user adjustable. This value is presented as a number between 0.0 and 10.0. That means that if the integral is less than 1.0, you are adding a percentage, from 0 to 100% of the error back into the calculation. If you increase the Integral above 1.0, you are adding more than 100% back in.

With just proportional control, a 2 °F error would cause a 50% increase in damper/airflow if the Integral is not included. (2 °F is half of the 4 °F Proportional Window)

If you had set the Integral to 1.0, the calculation would add 2% to the current damper/airflow calculation each time. The calculation occurs once every 10 seconds, so it would take a little over 4 minutes to reach the programmed 100% maximum.

**Table 4: Relay Staging - Unoccupied Mode**

Example:

1. 50% Remaining / 2% Integral = 25 Moves to get to a 100% Maximum
2. 25 Moves times 10 seconds = 250 seconds or a little over 4 minutes to reach the 100% maximum damper/airflow position.

Of course different space temperature errors and different Integral values cause this calculation to operate slower or faster. It is up to the user to determine the optimum setting that provides the tightest temperature control without causing the damper to continue to hunt or modulate causing premature wear of the actuator gears and motor.

On pressure dependent terminal units, the damper position is maintained to within ± 3% of the calculated position. No attempt is made to position the damper exactly on the calculated position. This reduces wear and tear on the actuator gears and motors and the amount of airflow involved is not affected by that small amount of damper error.

On pressure independent terminal units, the airflow is maintained to within roughly 3% of the terminal unit size constant but no tighter than 16 CFM on the smallest terminal units. The actual control window is based on the formula:

Window = Terminal unit size X Square Root (1 / 750)

Where Terminal unit size refers to the total rated CFM of the terminal unit.

This sliding window allows the control to be much tighter on the smaller terminal units than can be achieved on the larger terminal units as far as CFM readings. On a large terminal unit, 25 CFM may not be noticeable but on a small terminal unit, 25 CFM may be more than the minimum airflow setting for the space.

If the pressure sensor is disconnected or fails on a pressure independent terminal unit, the controller automatically reverts to pressure dependent operation and generates an alarm to alert the user that a failure has occurred.

On either type of terminal unit, a space sensor failure will force the damper to position itself to the 50% position and it will not change until the sensor is repaired or replaced.

Tenant Override Logs

If you require tenant billing for push-button override usage, a MiniLink Polling Device must be installed on each local loop. The MiniLink Polling Device has the ability to track the amount of override time generated by each space sensor equipped with push-button override.

Storing and retrieving these logs requires a dedicated computer running the Prism front-end software program. No other method exists for retrieving these logs. That means that all of your units will be connected together on the communications loop and the loop will be terminated at a CommLink II device connected to an on-site computer.

Warning: This computer must be on 24 hours a day 7 days a week running the Prism software in order for tenant logging to be tracked.

The tenant logs are kept on the dedicated job site computer's hard drive. The only limitation to the number of logs stored is the capacity of the hard drive on the computer they are being logged too.

Note: For proper time and date stamping of the tenant log, you must configure the air handler to broadcast the time so that the VAVBOX Controllers can read it and use it in their tenant and trend logs.

Alarm Detection And Reporting

The VAVBOX controller continuously performs self diagnostics during normal operations to determine if any operating failures have occurred. These failures can be reported to the user in several ways, depending on the type of system and options installed by the user. If a System Manager or a Modular Service Tool is connected, the alarms will be reported on the Status Screens. If the Prism computer front end software is installed, the alarms will be reported on the main screen of the program and be logged to disk. If the remote communications option is installed, all alarms except the Damper Feedback Failure condition can initiate a callout to a pager to alert someone to the alarm condition. See the computer front end program operations manual for further information on this topic.

Internal Trend Logging

The VAVBOX controller continuously maintains an Internal Trend Log, which records a fixed set of values at an interval programmed by the user. These values can be retrieved only with the graphical front-end program. In order to utilize these logs, a computer with Prism front end software installed must be connected to the system.

There are 120 log positions available. Once the last (120th) position has been recorded, the log jumps back to the first position and begins overwriting the old data. This means the user is required to retrieve the logs at an interval that is shorter than the duration of the last 120 logs.

Shown below are some log intervals and the duration of 120 logs.

- 1 Minute Interval ..... 2 Hour Duration
- 15 Minute Interval ..... 30 Hour Duration
- 30 Minute Interval ..... 60 Hour Duration
- 60 Minute Interval ..... 120 Hour Duration

The fixed items in the log are listed below:

- Date
- Time

## Technical Guide

- Space Temperature
- Active Cooling Setpoint
- Active Heating Setpoint
- Supply Air Temperature
- Airflow on Pressure Independent Terminal Units
- Damper Position

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**Note:** For proper time and date stamping of the tenant log, you must configure WMVAV Controller to broadcast the time so that the VAVBOX controllers can read it and use it in their tenant and trend logs.

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**Caution:** These logs are subject to loss if a power outage occurs because there is no battery backed memory on the VAVBOX controllers.

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### Force Modes or Overrides

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The VAVBOX controller damper can be forced to one of several positions. These force modes aid the user during troubleshooting or air balancing, etc.

- Force Damper Full Open (Ignores Airflow Reading )
- Force Damper Full Closed (Ignores Airflow Reading )
- Force to Maximum Airflow/Damper Setpoint
- Force to Minimum Airflow/Damper Setpoint
- Force to Fixed Airflow/Damper Setpoint
- Force Damper to Re-Calibrate

The Force to Fixed Airflow/Damper mode also has a setpoint associated with it. This allows the user to provide a non-changing fixed amount of air into the space that doesn't affect the Minimum or Maximum setpoints. That means the user doesn't have to disturb the real minimum and maximum setpoints to achieve a nonstandard setting during their troubleshooting or air balancing modes.

The Force to Minimum mode uses the currently active minimum setting based on the Vent, Cooling or Heating modes. Whatever mode the VAVBOX controller is in, sets the minimum used by the force mode.

## Troubleshooting

### Using LED's To Verify Operation

The VAVBOX controller is equipped with LEDs that can be used as very powerful troubleshooting tools. The VAVBOX controller board has three LEDs. Two of these LEDs are used in troubleshooting. See **Figure 12** for the LED locations. The LEDs and their uses are as follows:

#### “REC”

This LED will light up to indicate system communications.

#### “PWR”

This LED will light up to indicate that 24 VAC power has been applied to the controller.

#### “SCAN”

This is the diagnostic blink code LED. It will light up and blink out diagnostic codes.

#### “SCAN”

##### Diagnostics LED

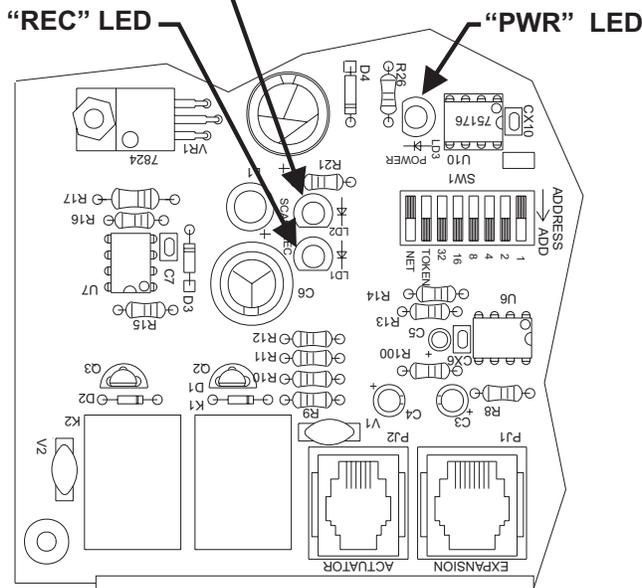


Figure 11: LED Locations

#### “REC” LED Operations

When the controller is communicating this LED will flicker. If it does not flicker check the MiniLink and/or CommLink that is connected to the Power/Comm board which connects to your VAVBOX controller and make sure the MiniLink and/or CommLink is powered up and properly connected to the Power/Comm board.

#### “PWR” LED Operations

When the WMVAV Controller is powered up the “PWR” LED should light up and stay on continuously. If it does not light up, check to be sure that the modular connector is connected to the board, that the con-

nections are tight and the tab is locked on the connector. Be sure power is connected and turned on to the Power/Comm board and that the modular cable connector is securely connected. If after making all these checks the “PWR” LED does not light up, the board is probably defective.

#### “SCAN” LED Operations

As previously described when the board is first powered up the LED will do the following:

- Flashes Once
- Off for 5 seconds
- SCAN LED blinks the board address (Address 14 = 14 blinks)
- 5 second pause
- 20 second time delay - LED blinks 20 times
- LED blinks slowly as damper moves towards the open position. The LED blinks fast as the damper moves towards the closed position.

After the above steps the status code is repeatedly blinked every 10 seconds to indicate controller status. The status blink codes are listed in the following table in order of priority.

LED Blinks This Number Of Times	Blink Code Description
1	Normal Operation. No Alarm Conditions Exist
2	Push-button Override Or Group Override Is Active
3	Communication Failure
4	Bad Airflow Sensor
5	Bad or Missing Space Sensor
6	Damper Failure
7	Damper Feedback Failure

Table 2: SCAN LED Blink Codes

Only the highest priority failure code will be shown. You must correct the highest priority alarm before other problems will be indicated.

If the “SCAN” LED does not operate as indicated above, first check the address switch setting. See Figure 10 for correct address switch setting procedures. If the address switch setting is correct and the “SCAN” LED still does not behave as indicated above contact Watt-Master Controls Technical support.

**Note:** Power to the controller being addressed must always be cycled after changing address switch settings in order for the changes to take effect.

## Troubleshooting

### Other Checks

#### Space Temperature Sensor

If the Space Temperature Sensor is not reading a valid temperature, first make sure that the Space Temperature Sensor is correctly wired and that the terminal connections are all tight. If the problem persists, try swapping the sensor with a known good Space Temperature Sensor. If that sensor works when connected to the VAVBOX controller board, you can assume you have a defective or damaged sensor.

#### Duct Air Temperature Sensor

If you suspect the Duct Air Temperature Sensor is not reading correctly, make sure the wiring terminal connections are tight and that any wiring splices are properly connected. You can check the operation of the Duct Air Temperature Sensor by measuring the resistance or voltage using a digital multimeter. Set the meter to DC Volts. Place the positive probe on the AIN terminal and the negative probe on the GND terminal. Read the DC Volts and find that voltage in **Table 3** on the following page. Read the temperature corresponding with that voltage and determine if this is close to the actual temperature the sensor is exposed to. If the temperature from the chart is different by more than a few degrees you probably have a defective or damaged sensor. You can also check the sensor resistance to determine correct operation. To read the resistance set the meter to Ohms. Unplug the sensor connector from the board and measure the resistance across the disconnected wires. This resistance should match the corresponding temperature from **Table 3** on the following page.

#### Airflow Sensor

If the Airflow Sensor seems to be reading incorrectly, first check the Airflow Sensor's modular cable connector and be sure it is firmly connected to its mating connector on the VAVBOX controller board.

Check the Airflow Sensor tubing connections at the airflow pickup tubes. The high pressure port of the sensor needs to be connected to the upstream pickup tube. The low pressure port of the sensor needs to be connected to the downstream pickup tube.

If none of the above procedures solves the problem, remove power from the VAVBOX controller. Shut down the HVAC unit supplying the duct that the VAVBOX damper is located on. Be sure that no airflow is present in the duct. Reapply power to the board and wait for the VAVBOX controller to run through its calibration sequence. Restart the HVAC unit and check the VAVBOX controller CFM readings. If the CFM reading still seems to be in error, you probably have a defective Airflow Sensor and will need to replace it.

#### Actuator

Check the Modular cable between the controller and the actuator. Be sure both ends of the cable are firmly connected to the mating connectors on the actuator and the VAVBOX controller board. Be sure the damper moves freely and is not bound. Do this by pressing the actuator clutch button and rotating the damper shaft in both directions to verify smooth operation. If binding is present fix the problem as required. Remove power from the VAVBOX controller. Reapply power and observe the damper rotation. If the actuator does not drive the damper in both directions, the actuator is probably defective or damaged. Another test that can be performed, is to swap cables with another known operating actuator to determine if the cable could be bad. If the problem goes away you have a defective cable that must be replaced. You can also try swapping a functioning actuator with the suspected defective actuator. If this solves the problem then the defective actuator will need to be replaced.

#### Expansion Board

If the Expansion Board does not seem to operate correctly, first make sure the modular cable between the Expansion Board and the VAVBOX controller is firmly connected at both ends. Be sure that the Expansion Board has been configured correctly. The expansion board must be configured using the Modular Service Tool, Modular System Manager or Prism computer front end software, for your application, before it will operate. You must configure it for the number of heat stages and if this is a fan terminal, whether it is a Series or Parallel Flow fan terminal. On a non fan terminal unit, when a call for heat is initiated the LED labeled RLY2 should light up. If the expansion board is configured as a fan terminal, on a call for the fan, the LED labeled RLY1 should light up. If the LEDs do not light up the Expansion Board is probably defective and must be replaced.

Temperature – Resistance – Voltage For Type III 10 K Ohm Thermistor Sensors								
Temp (°F)	Resistance (Ohms)	Voltage @ Input (VDC)	Temp (°F)	Resistance (Ohms)	Voltage @ Input (VDC)	Temp (°F)	Resistance (Ohms)	Voltage @ Input (VDC)
-10	93333	4.620	60	14681	3.042	86	8153	2.297
-5	80531	4.550	62	14014	2.985	88	7805	2.242
0	69822	4.474	64	13382	2.927	90	7472	2.187
5	60552	4.390	66	12758	2.867	95	6716	2.055
10	52500	4.297	68	12191	2.810	100	6047	1.927
15	45902	4.200	69	11906	2.780	105	5453	1.805
20	40147	4.095	70	11652	2.752	110	4923	1.687
25	35165	3.982	71	11379	2.722	115	4449	1.575
30	30805	3.862	72	11136	2.695	120	4030	1.469
35	27140	3.737	73	10878	2.665	125	3656	1.369
40	23874	3.605	74	10625	2.635	130	3317	1.274
45	21094	3.470	75	10398	2.607	135	3015	1.185
50	18655	3.330	76	10158	2.577	140	2743	1.101
52	17799	3.275	78	9711	2.520	145	2502	1.024
54	16956	3.217	80	9302	2.465	150	2288	0.952
56	16164	3.160	82	8893	2.407			
58	15385	3.100	84	8514	2.352			

**Thermistor Sensor Testing Instructions**

- 1.) Use the resistance column to check the thermistor sensor while disconnected from the controllers (not powered).
- 2.) Use the voltage column to check sensors while connected to powered controllers. Read voltage with meter set on DC volts. Place the “-” (minus) lead on GND terminal and the “+” (plus) lead on the sensor input terminal being investigated.

*If the voltage is above 5.08 VDC, then the sensor or wiring is “open.” If the voltage is less than 0.05 VDC, the sensor or wiring is shorted.*

**Table 3: Temperature Sensor - Voltage & Resistance for Type III Sensors**



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