Application Note
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Variable Air Volume Modular Assembly (VMA) 1400 Series

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Using Variable Air Volume Modular Assembly (VMA) 1400 Series Applications

Introduction

The Variable Air Volume Modular Assembly (VMA) 1400 Series is an integrated module that includes a controller, differential pressure sensor, and actuator (except VMA1430 models, which are intended to be used with an external actuator).

Note: This document focuses on the VMA1410, 1420, and 1430 controllers. The VMA1400 Series also includes the VMA1440, which is used exclusively as part of the Metasys® Zoning Package. Refer to the *Metasys Zoning Package Product Bulletin (LIT-639050)* and the *Metasys Zoning Package Overview Technical Bulletin (LIT-639100)* for information on this specialized product.

This application note introduces the VMA controller and provides procedures for the creation, configuration, and commissioning of single duct and dual duct applications.

This document describes how to:

- create a VMA single duct application
- create a VMA dual duct application
- change the VMA parameter view
- configure a VMA application
- commission a VMA application
- test and balance a VMA single duct supply/exhaust application
- test and balance a VMA dual duct application

Key Concepts

VMA Controller

Description

The Variable Air Volume Modular Assembly (VMA) models VMA1410 and VMA1420 are integrated modules that include the controller, actuator, and differential pressure sensor. The VMA1430 includes the controller and differential pressure sensor and is designed for use with a floating/3-wire (incremental) external actuator or proportional external actuator. The VMA applications are developed using standard objects, assembly objects and application objects created by the Metasys system application basic programming language. These applications are built using Configuration Tools Release 7.00 or later, and are downloaded to the VMA. The VMA1430 is supported at Configuration Tools Release 7.02 or later.

Note: This document focuses on the VMA1410, 1420, and 1430 controllers. The VMA1400 Series also includes the VMA1440, which is used exclusively as part of the Metasys Zoning Package. Refer to the *Metasys Zoning Package Product Bulletin (LIT-639050)* and the *Metasys Zoning Package Overview Technical Bulletin (LIT-639100)* for information on this specialized product.

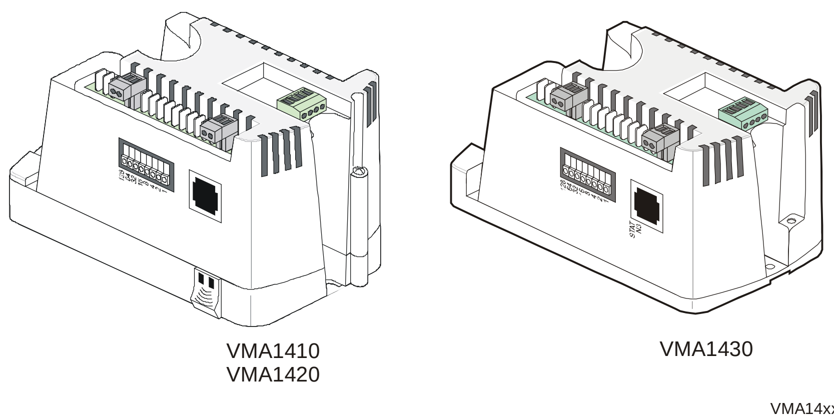

Figure 1: VMA Controller Models

VMA applications can only be used with the VMA. These applications cannot be downloaded to any other digital controllers, such as the Unitary (UNT), Variable Air Volume (VAV), or Air Handling Unit (AHU) controllers.

Integral Stepper Motor Actuator

The stepper motor damper actuator is an integral part of the VMA1410/1420. The stepper motor provides a fast and accurate method of controlling the damper actuator. At startup, the VMA is programmed to perform an autocalibration procedure. This procedure occurs on a variable time delay determined by the N2 address. Autocalibration corrects for pressure sensor drift and ensures the stepper is synchronized. As part of the initial autocalibration, the stroke time of the integral actuator is calculated based on the time required to move from the open end-stop to the closed end-stop. The stroke time should be roughly equal to one of the following:

- 30 seconds for 90 degree dampers
- 20 seconds for 60 degree dampers
- 15 seconds for 45 degree dampers

The VMA requires physical end-stops on both ends of rotation for correct operation.

During normal operation, the actuator position feedback provides position information and diagnostics that can indicate a stuck damper or slippage at the damper shaft connection. For the dual duct application, the VMA1420 with an integral actuator (if used) must be used on the cold deck damper.

External Damper Actuators

The VMA1420/30 can control external floating/3-wire (Position Adjust Output [PAO]) or proportional damper actuators in VAV boxes, such as Trane® company boxes. Two Binary Outputs (BOs) are used for each floating/3-wire (PAO) actuator. One Analog Output (AO) is used for each proportional actuator.

Note: External actuators require configuration of the stroke time attribute for the actuator to operate properly.

Revisions

Table 1 compares HVAC PRO software revisions and VMA application revisions. See the *Troubleshooting* section of this document for more information on VMA firmware revisions.

Table 1: Revisions

HVAC PRO Software Revision	VMA Application Revision	Description of Changes
7.00	2	Original Release
7.01	3	• Units attribute added for flow parameters. • State machine fixes to prevent stuck conditions: - VAV Box mode - Heating mode
7.02	4	• State machine fix to prevent Cooling state when a constant volume box (maximum flow is achieved during Satisfied state). • Autocalibration Duration is now calculated automatically. • Additional actuator support for flow control loop: - Floating/3-wire - Proportional • Users must set a new attribute for proportional actuators Stroke Time.
7.03	4	Application fix to correct error in pressure dependent operation
8.00	Single Duct – 4	Support added for TMZ Digital Room Sensor.
	Dual Duct – 1	Original release of dual duct application
8.01	Single Duct – 4	Supply exhaust application added to single duct application.
	Dual Duct – 2	Application fix to correct error with proportional band reset
8.03	Single Duct – 5	• State machines moved to sub-application to enable large supply/exhaust applications to download. • Optional minimum flow protection added for proportional (AO, Duration Adjust Output [DAO]) box heating outputs.
	Changes to both applications: Single Duct – 5 Dual Duct – 3	• Schedule attribute added to Occupancy Mode (ADI 78) for network command. If N2 communication fails, the Occupancy Mode Input is the default mode. See the *Key Concepts* section for complete description. • Setpoint threshold added to enable application to bypass state machine saturation timers when a large setpoint change occurs. • Configurable maximum damper positions added for pressure dependent mode. • Pattern Recognition Adaptive Control (PRAC) disabled for Proportional-Integral-Derivative (PID) control loops dependent on flow when Starved Box flag is True. • Min PID Prop Band limit added to provide a lower tuning limit for PRAC. • Sideloop PID Direct Acting parameter mapped (BD 171)

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HVAC PRO Software Revision (Cont.)	VMA Application Revision	Description of Changes
8.04	Single Duct - 5	Support for TE-7700.
	Changes to both applications: Single Duct – 5 Dual Duct – 3	TMZ setpoint allows wider ranges of 7 to 32°C (45 to 90°F). Note: The TMZ must be at firmware revision A08 or later to take advantage of this feature.
8.05	Single Duct – 5	• Support added for autocalibration using BO activated solenoid air valve that zeros the differential pressure across the velocity pressure sensor(s). • VAV Box Mode sequencing updated to ensure application remains in heating ,at minimum, for the PID low saturation time.

Related Documentation

Table 2 lists related VMA documentation.

Table 2: Related Documentation

For Information on This	Refer To
VMA Product Information	*Variable Air Volume Modular Assembly (VMA) 1400 Series Product Bulletin (LIT-635058)*
VMA Installation Information	*VAV Modular Assembly (VMA) 1410/1420 Installation Instructions (Part No. 24-8740-1)* - packed with VMA1410 and VMA1420 *VAV Modular Assembly (VMA) 1430 Installation Bulletin (Part No. 24-8986-18)* - packed with product
VMA Technical Information	*Variable Air Volume Modular Assembly (VMA)1400 Series Overview and Engineering Guidelines Technical Bulletin (LIT-6363120)*
	Mounting and Wiring Variable Air Volume Modular Assembly (VMA)1400 Series Controllers Technical Bulletin (LIT-6363125)
	Downloading and Commissioning the Variable Air Volume Modular Assembly (VMA)1400 Series Controllers Technical Bulletin (LIT-6363130)
	Troubleshooting Variable Air Volume Modular Assembly (VMA)1400 Series Controllers Technical Bulletin (LIT-6363135)
Commissioning Tool User Information	*HVAC PRO User's Guide*
Connecting the N2 Bus	*N2 Communications Bus Technical Bulletin (LIT-636018)*

Theory of Operation

VAV System

A VAV air handling system typically consists of a single air handling unit and multiple terminal units. Terminal units typically consist of a damper and flow sensing probe installed in an enclosure. VAV terminal units are also called VAV boxes. VAV systems are predominantly single duct, but about 15% are dual duct designs. In either case, the supply air temperature and static pressure of the air handling unit are controlled by an AHU controller, while each zone has its own VMA controller.

The air handling unit typically maintains a static pressure in the range of 125 to 375 Pa (0.5 to 1.5 inches w.c.) inside the longest run of duct away from the supply fan. This ensures that each VAV terminal unit has enough pressure at its inlet to deliver the maximum required flow of air into the space. The supply temperature is typically in the range of 7 to 16°C (45 to 60°F) for a single duct VAV system or the cold deck of a dual duct VAV system. The hot deck temperature of a dual duct VAV system is typically in the range of 29 to 49°C (85 to 120°F).

VAV systems are most easily understood by first considering a cooling only application. As the zone temperature increases, the VAV controller opens the VAV box damper to allow more cool air to reach the space. The volume of air required to maintain a particular zone temperature setpoint is dictated by the size of the space and the internal and external heat loads. In addition, since the size of the VAV box dictates its maximum cooling capacity, a VAV box's performance is dependent upon the mechanical engineer's correct box sizing for each zone.

Sometimes the size, and thus the capacity, of the VAV box may not match the zone loads. If the installed unit is too small, insufficient cooling results and audible noise may be emitted at high flow. If the installed unit is too large, proper control may be difficult to attain, since a small change in damper position causes a large change in airflow. Boxes can be oversized to allow for quieter operation or reserve cooling capacity at the expense of controllability. For a more in-depth explanation of VAV control, refer to the *Variable Air Volume Modular Assembly (VMA) 1400 Series Overview and Engineering Guidelines Technical Bulletin (LIT-6363120).*

Control Loops

Pressure Independent Control

In Cooling mode, the VMA employs cascaded control loops. The zone temperature control loop is achieved by using Proportional-Integral (PI) control loops with Pattern Recognition Adaptive Control (PRAC) to tune the controller. The output of the temperature loop is used to calculate the airflow setpoint between the minimum and maximum flow settings. This airflow setpoint is used by the flow control loop that is implemented using the Johnson Controls® patented Proportional-Adaptive (P-Adaptive) algorithm. The flow control loop allows the temperature control to be independent of duct static pressure.

Proportional-Integral-Derivative (PID)

The Heating, Ventilating, and Air Conditioning (HVAC) industry uses PID feedback control algorithms. The derivative portion is available in the VMA, but it is typically not used because it can amplify noise and lead to instability. Thus, PI algorithms are most commonly used in actual installations. PI control algorithms have two parameters that affect controller performance: proportional gain and integral time.

The HVAC controls' manufacturer typically uses default PI control parameters shipped with the controller. The default parameters may not be appropriate, and using them can lead to poor control performance. Also, many control loops require frequent re-tuning because HVAC systems have time-varying dynamics. These dynamics are caused by the inherent non-linear behavior of HVAC system components and the time-varying nature of the load disturbances. The loads for HVAC systems change with time or season.

Pattern Recognition Adaptive Control (PRAC)[1]

The VMA uses a Johnson Controls patented PRAC algorithm to tune its PI feedback loops. The PRAC algorithm automatically adjusts the proportional band and the integral time of a PI control loop based on patterns of the sensed values from the process variable, setpoint, and the output of a PID control loop. PRAC uses a measure of the system damping and response speed of the process output to characterize the closed loop response with respect to different setpoint changes and load disturbances, resulting in near-optimal closed loop control performance. PRAC automatically adjusts to different process noise levels, has minimal calculation and memory requirements, and is easily implemented.

Using PRAC reduces commissioning time for new control systems, eliminates operator time for re-tuning control loops and increases actuator life, as it reduces motor runtime.

PRAC is used to tune the zone temperature control loop in pressure independent applications. When two-position valves or electric heat is selected, PRAC is not loaded. PRAC is enabled or disabled via a software command. PRAC is disabled at saturation, upon an error, and during an override situation. If a derivative time value other than zero is detected in a PID control loop, PRAC does not attempt to tune the controller.

Starting with Application Revision 5 for single duct and Application Revision 3 for dual duct applications, PRAC is also disabled if the active PI does not have sufficient flow to maintain control (for example, Starved Box is True). This means that in single duct applications, the Cooling PID is disabled if Starved Box is True. Similarly, the Box Heating PID for single duct applications is disabled if Starved Box is True and there is no box fan active. In dual duct applications, the Energy Balance PID is disabled if either Starved Cold Deck or Starved Hot Deck is True.

[1] *Seem, J. E., "A New Pattern Recognition Adaptive Controller", 13th Triennial IFAC World Congress, The International Federation of Automatic Control, San Francisco, CA., Volume K on Adaptive Control, Session on Auto-tuning and Adaptation, Paper 3B-043, pp. 121-126, Pergamon, 1996.*

P-Adaptive Control[2]

The P-Adaptive flow control algorithm uses a patented fixed gain, proportional control loop with a self-adjusting deadband whose value is related to an estimate of the noise variance. The P-Adaptive control strategy is used in the secondary flow control loop for pressure independent applications. P-Adaptive control has the advantage of much tighter flow control without oscillation, because it dynamically adjusts the flow deadband, based on the turbulence (noise) measured on the pressure sensor. P-Adaptive does not require any tuning.

[2] *Federspiel, c., 1997. "Flow Control with Electric Actuators", International Journal of Heating, Ventilating, Air Conditioning, and Refrigeration Research, Vol. 3, No 3.*

Airflow Measurement

Airflow (supply flow) is calculated for the VMA using two parameters: the supply box area (area at the inlet of the box where the airflow pickup is located), and the flow pickup gain (supply pickup gain). *Appendix B: VAV Controller Flow Calculation Constants* (*LIT-6375185*) provides the flow pickup gain (supply pickup gain) or K-factor for most Original Equipment Manufacturer (OEM) boxes. With this information, the VMA calculates the airflow (supply flow) using the following equation:

$$\text{SupplyFlow} = \text{SupplyBoxArea} * \text{FlowCoefficient} * \sqrt{\frac{\text{SupplyDeltaP}}{\text{SupplyPickupGain}}}$$

Alternatively, if you know the supply flow and differential pressure (SupplyDeltaP), calculate the flow pickup gain (SupplyPickupGain) using the following equation:

$$\text{SupplyPickupGain} = \text{SupplyDeltaP} * \left(\frac{\text{FlowCoefficient} * \text{SupplyBoxArea}}{\text{SupplyFlow}}\right)^2$$

Note: Exhaust flow is calculated using the same equations.

SI (Metric) Units

SupplyFlow = airflow calculated in m^3/hr (liters/second in Canada)

SupplyDeltaP = differential pressure in Pascal (1 inch w.c. = 249 Pa)

FlowCoefficient = defaults to 4644 at sea level for airflow in m^3/hr or 1290 at sea level for airflow in liters per second (l/s)
(These values are a function of elevation.)

SupplyPickupGain = airflow pickup gain (dimensionless)

SupplyBoxArea = area in square meters

Inch-Pound Units

SupplyFlow = airflow calculated in cubic feet per minute (cfm)

SupplyDeltaP = differential pressure (inches w.c.)

FlowCoefficient = defaults to 4005 at sea level
(This value is a function of elevation.)

SupplyPickupGain = airflow pickup gain or K-factor (dimensionless)

SupplyBoxArea = area in square feet. Calculated from 3.1416 * r^2, where **r** is the inlet radius in feet.

The engineer or balancing contractor determines the minimum airflow necessary for adequate ventilation. Required minimum airflow is based primarily on the expected number of occupants in the room. The American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Standard 62 recommends 34 cubic meters per hour (20 cubic feet per minute [cfm]) of outdoor air per occupant for office space. Typically, zone airflow minimums are set between 10% and 20% of maximum flow. Boxes with heat may have higher minimum heating flow setpoints. Boxes with electric heating require a minimum airflow to avoid tripping the thermal overload protection.

Application Logic

The VMA operates in several modes. Some modes occur under normal operating conditions, and some are commanded only by a supervisory system. The VAV Box mode determines which PID control loops are active and controls VMA supervisory Command modes. The current Occupancy mode determines the current occupancy state. Velocity pressure status and zone temperature status determine the failsoft functioning of the VMA.

VAV Box Mode

The main mode control is the VAV Box mode. True digital logic is used to determine the active operating mode of the VMA. A state machine standard object integrates this logic with input and output functions. The operation of a state machine is clearly represented using a state diagram like that shown in Figure 2. This generic state diagram shows the general form taken by the VAV Box mode state machine in both the single duct and dual duct VMA applications.

State Diagram

The following is a brief explanation of how to read a state diagram. See Figure 2 for a state diagram illustration.

A circle represents a state, and its name is listed in the circle. The number in the circle corresponds to the state name in the enumeration set for the present value. A rectangle with a shaded header bar represents a super-state. A super-state allows related states to be grouped under one heading.

Only one state can be active at any one time. The active state is also the present value of the VAV Box mode. The present value can change two ways. The present value is a prioritized attribute and can be overridden to a new value. The present value is equal to the override value with the highest priority.

When no overrides are present, the active state can change via a transition (designated by an arc). Transitions may occur between both states and super-states. The arc points from the current state (or super-state) to the next state (or super-state). The next-state function is described on each arc. The next-state function must be True for the transition to occur. Any input not listed for a particular transition is a “don’t care” condition, meaning that transition can occur regardless of the current value of any input that is not listed.

If the transition leaves from a super-state, the transition can occur if any of the individual states within that super-state are active. If a transition goes to a super-state, then that super-state must have an entry state defined. This state is designated in the diagram by a large dot with an arrow pointing at the entry state. When more than one level of hierarchy is defined, a super-state may be defined as the entry state for a higher level super-state.

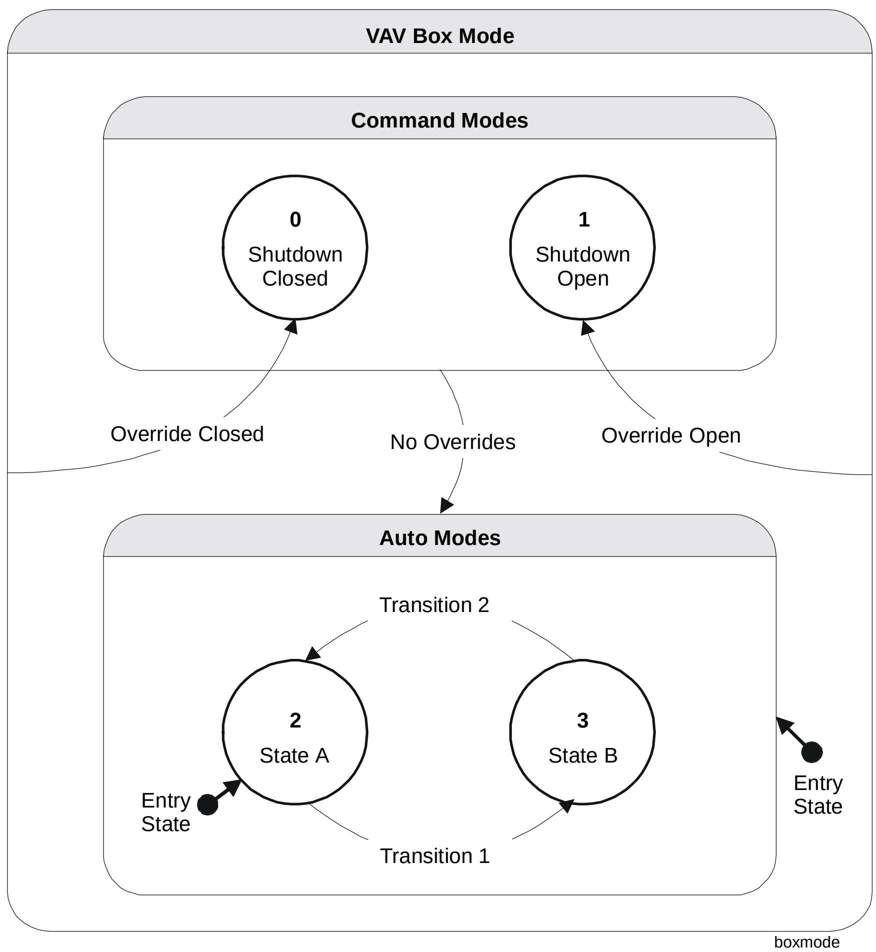

Figure 2: VAV Box Mode State Diagram

Autocalibration

Autocalibration first occurs after a reset of the controller. A reset is a cycle of the controller power which causes a refresh of the memory. A reset also occurs after an application download. During the first autocalibration, the integrated actuator fully opens and then fully closes to measure the stroke time. If needed, you can disable this autorange test by setting the Startup Autorange parameter to False. If you disable the autorange test, however, you must manually configure the stroke time for rotations other than 90 degrees (see the *Integral Stepper Motor Actuator* section under *Key Concepts* in this document for more information).

During normal autocalibration, the actuator closes during the actuator stroke time plus sensor settling time, and then the differential pressure sensor analog input offset adjusts to give a velocity pressure reading of zero. For the dual duct application, both pressure sensors autocalibrate at the same time.

For the single duct supply/exhaust application, when you also select an exhaust box, both pressure sensors autocalibrate at the same time. Due to the critical flow requirements of most supply/exhaust configurations, the autocalibration period default is set to zero to allow the user to manually command autocalibration (using the Autocal Req attribute) at a time when the zone is not occupied and the dampers are closed.

Starting with HVAC PRO 8.05 and later, another option is available for autocalibration using a BO to actuate a solenoid air valve when the sensor calibration is active instead of closing the damper. During autocalibration, the BO is set active for approximately 24 seconds (8 times the On Pulse Count. See *VMA Single Duct Parameters*). At the end of that time period, a new offset calculates for the Differential Pressure (dP) sensor(s). The flow controller is prevented from moving the damper actuator while the BO is active and for approximately 8 seconds after the BO deactivates. This allows the normal differential pressure signal to restore before returning control to the flow controller. For supply/exhaust applications, both pressure sensors autocalibrate at the same time. Dual duct applications do not currently support this feature.

Install the solenoid in an arrangement similar to Figure 3. When the solenoid air valve is active and the normally closed port opens to the common port, the low-pressure pickup port connects to both ports of the dP sensor so that the sensor receives a zero differential pressure.

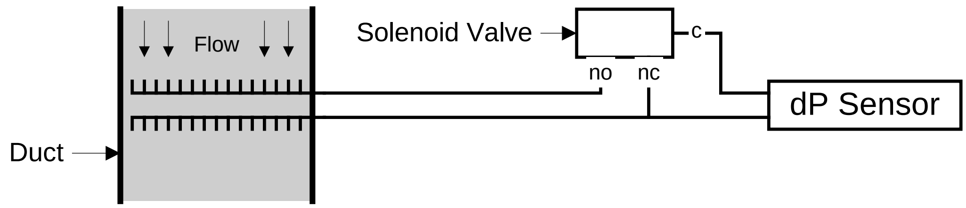

Figure 3: Solenoid Air Valve Installation

Note: The solenoid air valve must accommodate very low pressures (less than 1.5 inches w.c. [375 Pa]). It must not require higher pressures to properly seal or operate.

The VMA staggers autocalibration following reset so that several controllers do not autocalibrate at the same time. The autocalibration delay is a function of the restart delay. Subsequent autocalibration occurs based on the autocalibration period. The default period is two weeks for normal applications and zero (disabled) for supply exhaust applications. When using the BO option, configure the autocalibration period to that given in the job specification (typically a 3-hour period provides sufficient accuracy).

Note: If the resultant AI offset is large (greater than 1), verify the rotation of the VAV Box Damper using Box Flow Test with the AI offset reset to zero.

Occupancy Mode

Occupancy mode has three possible states: Occupied, Unoccupied, and Standby (Table 3). The state depends on the input received from binary inputs, such as window contact, occupancy sensor, or temporary occupancy button. Communications status with a supervisory system, and commands from a supervisory system to the Occupancy mode request, also affect the Occupancy mode.

Table 3: Occupancy Modes

Mode	Description
Occupied	When the mode is Occupied, the zone temperature and flow rate controls use the occupied setpoints.
Unoccupied	When the mode is Unoccupied, the zone temperature and flow rate controls use the unoccupied setpoints.
Standby	When the mode is Standby, the zone temperature control uses the standby temperature setpoints and the flow rate control uses the unoccupied setpoints.

Rules for Occupancy Mode

Occupancy mode is determined by the following set of rules. If the first rule does not apply, then the second rule is evaluated and so on down the list. Information content and quality are the principles upon which these rules are based. The following rules begin with the highest priority first and involve actions with the most information content, meaning the operator, occupant, or sensor is required to take an action.

Note: For TMZ Digital Room Sensors, refer to *Room Sensor with LCD Display (TMZ1600) Installation Instructions (LIT-6363110)* for differences in operation.

1. The Occupancy mode Present Value can be overridden. This action takes highest priority.
2. *Occupancy Button - Next mode (timed): Unocc - Standby - Occ:* Each press of the room sensor Occupancy button changes the Occupancy mode from its current state to the next Occupancy mode. For this option, the occupancy status rotation order is:
   a. Unoccupied (Light-Emitting Diode [LED] off)
   b. Standby (LED blinks)
   c. Occupied (LED on)
   d. Back to Unoccupied, then recycle through all three modes

   Each button press also restarts the occupancy timer, which is defaulted to 60 minutes. The Occupancy mode set by this Occupancy button is cleared when the occupancy timer expires.

Note: You must use a room sensor with an LED for this option.

3. *Occupancy Sensor - Occ button canceled when unocc sensed:* The Occupancy mode and the occupancy timer set by the Occupancy button in Rule 2 is cleared if the occupancy sensor goes from active to inactive.
4. *Occupancy Sensor - Occupied mode when occupancy sensed:* The Occupancy mode is set to Occupied if the occupancy sensor is active.
5. *Occupancy Button - Occupied Mode (timed):* Each press of the Occupancy button restarts the occupancy timer, which is defaulted to 60 minutes. The Occupancy mode is Occupied when set by an Occupancy button and is cleared when the temporary occupancy timer expires.
6. If the Schedule attribute is commanded to a value other than No Schedule, the Occupancy Mode is set to the Schedule value.
7. The Occupancy mode is set to the Input attribute.

Note: The TE-6700 or TE-7000 (Europe only) requires that the button be depressed for approximately 1.5 seconds to activate the Occupancy mode.

Temperature Setpoints

The VMA applications support highly flexible temperature setpoint configuration options. The single duct application uses the following equations to determine the actual heating and cooling setpoints. Depending on the flow setpoint configuration, the dual duct application uses either the following equations or an alternative method described in the *VMA Dual Duct Applications* topic later in this section:

Actual Heating Setpoint = Heating Setpoint + Remote Adjustment + Common Setpoint + Actual Heating Bias + Winter Compensation

Actual Cooling Setpoint = Cooling Setpoint + Remote Adjustment + Common Setpoint + Actual Cooling Bias + Summer Compensation

Note: The heating setpoint and the common setpoint are additive in the Actual Heating Setpoint calculation. To prevent the Actual Heating Setpoint from becoming a very large value, use either the common setpoint or the heating setpoint, not both. The same applies to the Actual Cooling Setpoint calculation.

Remote Adjustment

Connected to Analog Input 2, (AI2) this potentiometer input can be configured using the User-Defined Ohms linearization to be defined as a remote adjustment or remote setpoint. The default range for remote adjust is ± 3°C (±°5°F). The default range for remote setpoint is 12-28°C (65-85°F). If the remote setpoint is selected, the heating, cooling, and common setpoints should all be zero (see previous note). If the remote adjustment is unreliable at startup, the controller automatically uses the startup value. For remote adjustment, the default startup value is 0°. For remote setpoint, the default startup value is 21°C (70°F). If a reliable value is read and then the remote setpoint becomes unreliable, the controller uses the last reliable value received.

Common Setpoint

This setpoint provides the main supervisory setpoint if a single base setpoint is specified. The VMA defaults to this configuration. If a Remote Setpoint is used, the Common Setpoint defaults to zero. Otherwise, the default Common Setpoint is equal to 21°C (70°F).

Cooling and Heating Setpoint

These setpoints serve as the main supervisory setpoints if dual base setpoints are required. Because the VMA defaults to a single base setpoint configuration, these setpoints have default values of zero. If dual base setpoints are required, set the Common Setpoint to zero and the Heating and Cooling Setpoints to the desired values. For dual setpoints, select only those thermostats with warmer/cooler adjustments (see previous note).

Actual Cooling and Heating Bias

Setpoint configuration for each Occupancy mode is accomplished using the Actual Cooling Bias and Actual Heating Bias.

Summer and Winter Compensation

The summer and winter compensation allows the heating and cooling setpoints to be reset as a function of the outdoor air temperature. The outdoor temperature must be provided to the VMA by writing to the network variable Outdoor Air Temp. If this variable is not written, the summer and winter compensation are set equal to zero.

This method is sometimes used for units serving building entry areas (for example, lobbies and vestibules). The summer compensation is calculated by multiplying the difference that the Outdoor Air Temperature (OAT) is above the summer setpoint by the summer authority parameter. If the resultant value is greater than the summer change limit, the summer compensation is clamped at the limit. The winter compensation is calculated by multiplying the difference that the outdoor air temperature is below the winter setpoint (SP) by the winter authority parameter. If the resultant absolute value is greater than the winter change limit, the winter compensation is clamped at the limit. The summer and winter compensation parameters are then used in the setpoint calculation described earlier.

Summer Compensation = (OAT - SP) * Summer Authority

Winter Compensation = (Winter SP - OAT) * Winter Authority

Temperature Loop

Temperature status is the result of failsoft monitoring of the zone temperature analog input. It includes states described in Table 4.

Table 4: Temperature States

State	Description
Zone Temperature Reliable	This state indicates the zone temperature input is reliable, and normal zone temperature control is occurring.
Zone Temperature Unreliable	When the Zone Temp Unreliable state is active, the zone temperature input is unreliable, possibly due to an open wire. The outputs are overridden depending on the user failsoft selection. • Hold Outputs: The flow setpoints and any heating outputs are held at their last known good value. • Full Heating: The flow setpoint is held at the heating flow setpoint, and all heat is energized. This is to prevent water coil freeze up, but, over time, it may overheat the zone. • Full Cooling: The flow setpoint is held at the cooling maximum flow setpoint, and all heat is off.

IMPORTANT: Possible Zone Overheat or Overcool.
When the zone temperature sensor is unreliable, over time the zone likely overheats or overcools.

Flow Loop

Flow Loop is the result of failsoft monitoring of the supply delta pressure analog input. When the Flow Loop is reliable, it indicates the supply differential pressure is reliable, and normal flow control is occurring.

The Velocity Pressure (VP) Unreliable state indicates the supply differential pressure is unreliable. The VMA operates in a pressure dependent mode until the supply differential pressure is reliable. For the dual duct application, if either pressure sensor is unreliable, the controller operates in pressure-dependent mode.

Compute the required position of the damper for the single duct (supply only) application using the following equation:

$$\text{DamperPosition} = \left(\frac{\text{SupplySetpoint}}{\text{ClgMaxFlow}} \right) * \text{PDSupplyMaxPos}$$

For single duct applications, the supply setpoint is equal to the flow span output during the Cooling mode (see Figure 4) and the heating flow setpoint during the Heating modes.

For single duct supply/exhaust configurations, the damper positions are offset to aid the differential:

$$\text{SupplyDamperPos} = \left(\frac{\text{SupplySetpoint} - \text{Differential}}{\text{ClgMaxFlow}}\right) * \text{PDSupplyMaxPos}$$

$$\text{ExhaustDamperPos} = \left(\frac{\text{SupplySetpoint} + \text{Differential}}{\text{ClgMaxFlow}}\right) * \text{PDExhaustMaxPos}$$

The damper positions for the dual duct application are:

$$\text{ColdDeckDamperPosition} = \left(\frac{\text{ColdDeckSetpoint}}{\text{ColdDeckMaxFlow}}\right) * \text{PDColdDecMaxPos}$$

$$\text{HotDeckDamperPosition} = \left(\frac{\text{HotDeckSetpoint}}{\text{HotDeckMaxFlow}}\right) * \text{PDHotDeckMaxPos}$$

If the VP is unreliable, the setup attribute of the Stepper Motor Object (SMO) and PAO changes from Incremental (-100 to +100) to Positional damper command (0-100%) and controls in a pressure dependent mode.

Flow Setpoint Configuration

IAQ Minimum Flow Setpoints

The VMA applications are designed to comply with the ventilation rates for acceptable indoor air quality given in American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 62-1999. To meet these rates, the user must first provide some information. During commissioning, set the Occupancy parameter equal to the occupancy level of the zone served by the VMA controller. Occupancy level defaults to 0 people, which means this IAQ feature is disabled unless an occupancy level is provided. The user must also enter the outdoor air requirement value. The system default is the value for office space from Table 2 of Standard 62-1999, which is 10 L/s (20 cfm) per person.

Both single and dual duct applications have parameters that must be set by the supervisory system over the N2 bus to give the current percentage of outdoor air being brought into each deck at the main air handler. The single duct has a single parameter (OA Fraction), and the dual duct has two parameters (CD OA Percent and HD OA Percent). Use the design OA fraction/percentage if the air handler maintains that fraction/percentage. If the outdoor air included in each deck may be different or may vary in time, program the supervisory system to calculate the actual current fraction/percentage and set these parameters accordingly. Percent outdoor air is measured by the Metasys Ventilation Controller Application (MVCA) or another outdoor airflow measurement system. Percent outdoor air is not equal to the position of the outdoor air damper or the mixing damper, because airflow is not directly proportional to damper position. For more information on the MVCA, see the *Metasys Ventilation Controller (MVC-2000-1) Product Bulletin (LIT-653410)*.

The VMA application multiplies the occupancy level by the outdoor air requirement to determine the required ventilation rate (OA Flow Reqmnt). When the Occupancy Mode is Occupied, the minimum flow setpoints of the applications are adjusted based on this ventilation rate. When the Occupancy Mode is not Occupied, the minimum flow setpoints are calculated without adjusting for IAQ.

The single duct IAQ minimum flow is calculated using the following equation.

$$\text{IAQ Min Flow} = \text{OA Flow Reqmnt} * 100 / \text{OA Fraction}$$

For dual duct applications, the ventilation rate is met by the sum of the outdoor air in the hot and cold decks. If both decks have outdoor air available (Deck Available = True and OA Percent > 0.0), then the actual cold and hot deck minimum flow setpoints based on IAQ are calculated to share the outdoor air requirement across both decks taking into consideration the relative outdoor air content of each deck. The minimum IAQ flow for each deck is calculated using the following equations.

$$\text{CD IAQ Min Flow} = \frac{\text{OA Flow Reqmnt} * 100 * \text{CD OA Percent}}{\left(\text{CD OA Percent}^2 + \text{HD OA Percent}^2\right)}$$

$$\text{HD IAQ Min Flow} = \frac{\text{OA Flow Reqmnt} * 100 * \text{HD OA Percent}}{\left(\text{CD OA Percent}^2 + \text{HD OA Percent}^2\right)}$$

If only one deck has outdoor air available, the IAQ minimum flow for that deck is calculated by dividing the ventilation rate by the percent outdoor air of that deck (same as single duct). This IAQ strategy works with the existing VMA applications, is easy to alter, and optimizes energy usage by dealing with each zone independently.

VMA Single Duct Applications

Control Overview

Figure 4 shows the overall control diagram for the single duct application. The VMA application uses cascaded control loops to achieve pressure-independent control. During the Cooling mode, the Cool Loop uses a PID tuned by PRAC that produces an output from 0-100%. This output spans the minimum and maximum flow rate setpoints, and is calculated using the following equation:

$$\text{FlowSpanOutput} = \text{MinFlow} + (\text{MaxFlow} - \text{MinFlow}) * \frac{\text{PIPresValue}}{100}$$

The output of the flow rate span block is the flow setpoint for the Flow Loop. The flow loop uses the P-Adaptive flow controller to position the damper to maintain the current flow setpoint.

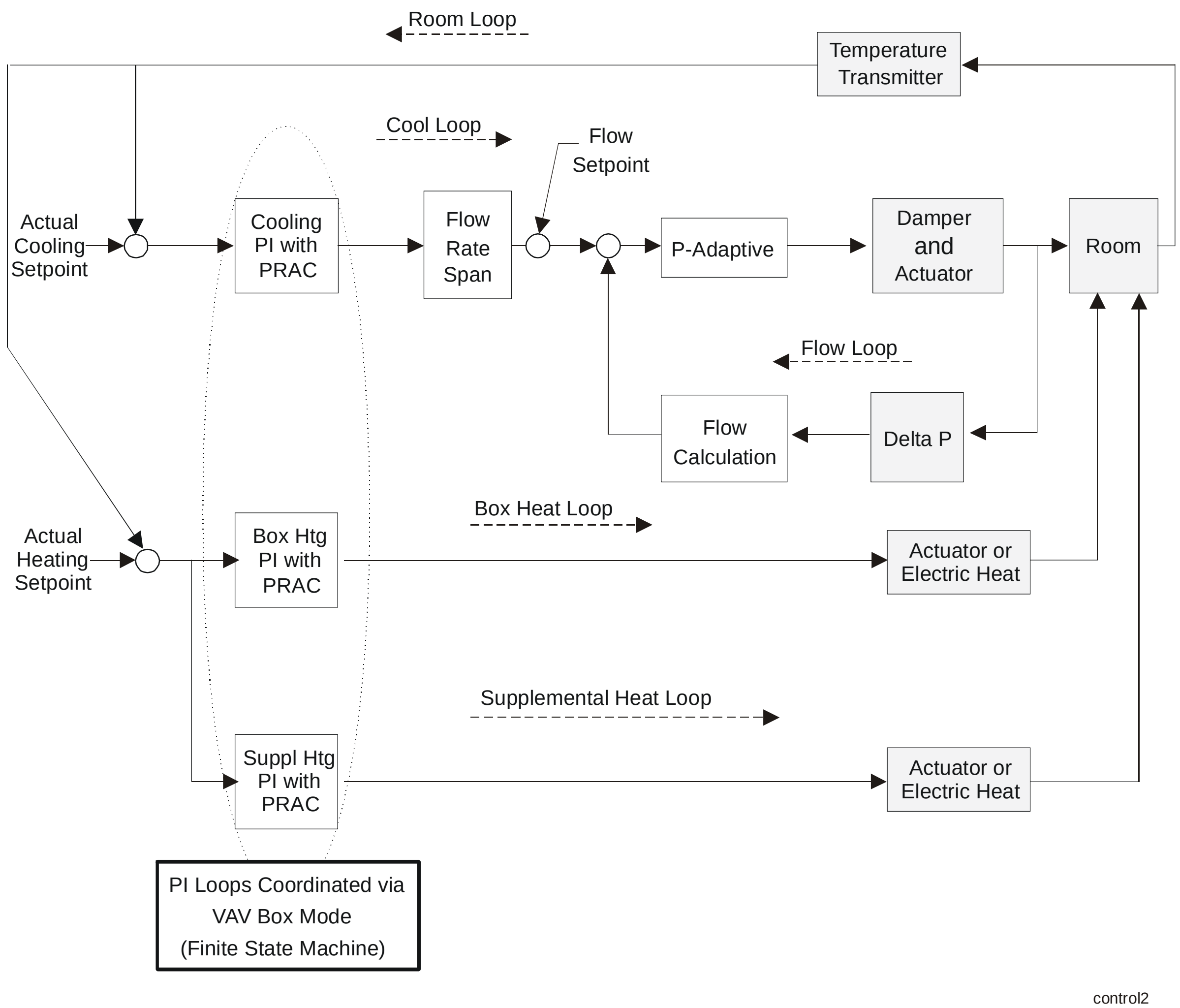

Figure 4: Control Diagram

Because the supply air is cool, the zone airflow increases when the zone temperature is above setpoint, and decreases when the zone temperature is below setpoint. To satisfy ventilation requirements, there is usually a minimum supply airflow.

For exterior zones, reheat coils are commonly installed at the VAV box. If the VAV box is at its minimum flow and additional heat is required to maintain the zone setpoint, a reheat coil is used. This is accomplished via the actuator or electric heat control logic shown in Figure 4. Additional supplemental heat (baseboard radiation) may also be sequenced.

Note: In this document, supplemental heat refers to heating devices not in the airstream of the VAV box (for example, baseboard and radiant panels).

For more details about the PID, PRAC, and P-Adaptive, see the *Control Loops* topic in the *Theory of Operation* section.

Supply Exhaust Option for Single Duct Applications

Some zones require flow control of both the supply and exhaust flow to prevent infiltration of contaminants into the zone (using positive pressure) or to prevent the contents of the zone from passing to surrounding zones (using negative pressure). The VMA Supply Exhaust application uses a flow differential to set the relationship between the supply and exhaust control loops. The exhaust setpoint tracks the sum of the supply flow setpoint and the current differential setpoint. For example, a flow differential less than zero provides a positive pressure.

The exhaust flow controller is active during all modes of control, including the command modes (Shutdown Open, Shutdown Closed, Low Limit). The exhaust setpoint continues to track the sum of the supply flow setpoint and the current differential setpoint. During Shutdown Closed or Low Limit, the supply setpoint is commanded to zero. Therefore, a positive differential (negative pressure) can be maintained during these modes if the exhaust fan remains running. A negative differential (positive pressure) requires supply flow and cannot be maintained during Shutdown Closed or Low Limit.

The VMA integrated actuator has a stroke time of 30 seconds for 90 degrees of travel. The stroke time for actual degrees of travel is calculated automatically by the application during the first autocalibration after restart. The stroke time for external actuators must be configured manually.

For floating/3-wire external actuators (position adjust output), the stroke time is an attribute of the output object and can be modified by double-clicking on the output in the Outputs screen in HVAC PRO software. For proportional external actuators (analog output), the stroke time is an attribute of the application and can be modified in the Parameters screen in HVAC PRO software under the corresponding Damper Actuator group (Supply or Exhaust).

The actual stroke time for the full-stroke rotation of the actuator should be the value configured for these outputs. The VMA supply exhaust application automatically compensates for actuators with different stroke times. If the stroke time of the supply damper actuator and the exhaust damper actuator are not equal, the application limits the rate at which the flow setpoints change to allow the controller to maintain the differential setpoint at all times.

VAV Box Mode for Single Duct Applications

The VAV Box mode determines which PID control loops are active, and controls VMA supervisory Command modes. Figure 5 shows the state diagram for the VAV Box mode. Within VAV Box mode are two main super-states: Command modes and Auto modes. The Command modes include Shutdown Open, Shutdown Closed, Warmup, Water System Flush, and Low Limit (Table 5).

Table 5: Command Modes

Mode	Description
Shutdown Open/Closed	Two shutdown options are available: Shutdown Open and Shutdown Closed. The VAV Box mode present value must be overridden to enter these states. The damper is commanded open during Shutdown Open mode to satisfy the occupied cooling maximum flow setpoint. During the Shutdown Closed mode, the damper position is 0% open. When either Shutdown mode is activated, all the analog and binary outputs are turned off, and the PID control loops are overridden to eliminate integration windup. If supply fans are off and no temperature control is required, it is best to use Shutdown Closed mode instead of de-energizing the Occupied mode during the unoccupied period.
Warmup	The Warmup mode assumes that warm air is being supplied by the air handling system to bring the space to normal occupied operating temperature. It is also referred to as central system warmup. During this mode, the VMA reverses its control action, with respect to the primary airflow setpoint, to control the zone temperature while the unit is supplying warm air. The Warmup mode uses the Cooling PID to modulate between the warmup minimum flow and the cooling maximum flow. Supplemental heating, if available, also is enabled during warmup. The Supplemental Heating PID controls simultaneously with the Cooling PID during Warmup mode to satisfy the actual heating setpoint. The user can choose to provide the supply temperature via network or Analog Input (AI). When the supply temperature is greater than the actual cooling setpoint by a fixed amount (the warmup differential), the present value transitions to Warmup and initiates the mode. Note: If the supply air temperature is measured locally with an AI, the sensor must be mounted upstream of any heating coils in the VAV box.
Water System Flush	This feature is typically used during the startup and commissioning of VMAs on a new job site for the flushing and balancing of building heating water systems. During this mode, the flow rate is modulated to maintain the cooling setpoint. The VAV Box mode present value can be commanded into this mode by setting the Water System Flush parameter (Command modes/Parameters window) equal to True. This feature affects incremental, proportional, and two-position normally open and normally closed box and supplemental heating outputs. This feature is not activated for devices configured with staged electric heat or for box heating AO or DAO outputs if Box Htg Elec Protect is True.
Low Limit	The Low Limit mode is typically used for applications serving zones with direct openings outside the building, including loading docks and offices with operable windows. During Low Limit mode, the box heating device is off, and the damper is closed. If the zone temperature drops below the low limit temperature setpoint, the supplemental heat is modulated to control zone temperature. This mode is activated by the low limit contact or by user override of the VAV Box mode. If supply fans are off, but heating is required via supplemental heating devices, it is best to use Low Limit mode instead of de-energizing the Occupied mode during the unoccupied period. For these cases, the low limit temperature setpoint should be set to the desired night setback temperature. If box heating is required during the unoccupied period, the supply fans should be turned on and the Occupancy mode set to Unoccupied.

The automatic control modes of the VMA are Cooling, Satisfied, and Heating (if present). The VMA automatically selects the mode required to heat or cool the space, as necessary. If the configuration of the controller is cooling only, or if the Heating Available parameter (Commissioning view) is false, then the state machine does not transition into heating. The Heating Available flag can be used to prevent the Heating modes from being entered when heating devices are physically present but currently unavailable (for example, the boiler is shut off for the summer).

When the present value of VAV Box mode is equal to Heating, the operation of the VMA is determined by the present value of the Heating mode state machine. Figure 6 shows the logic of the Heating mode on a separate state.

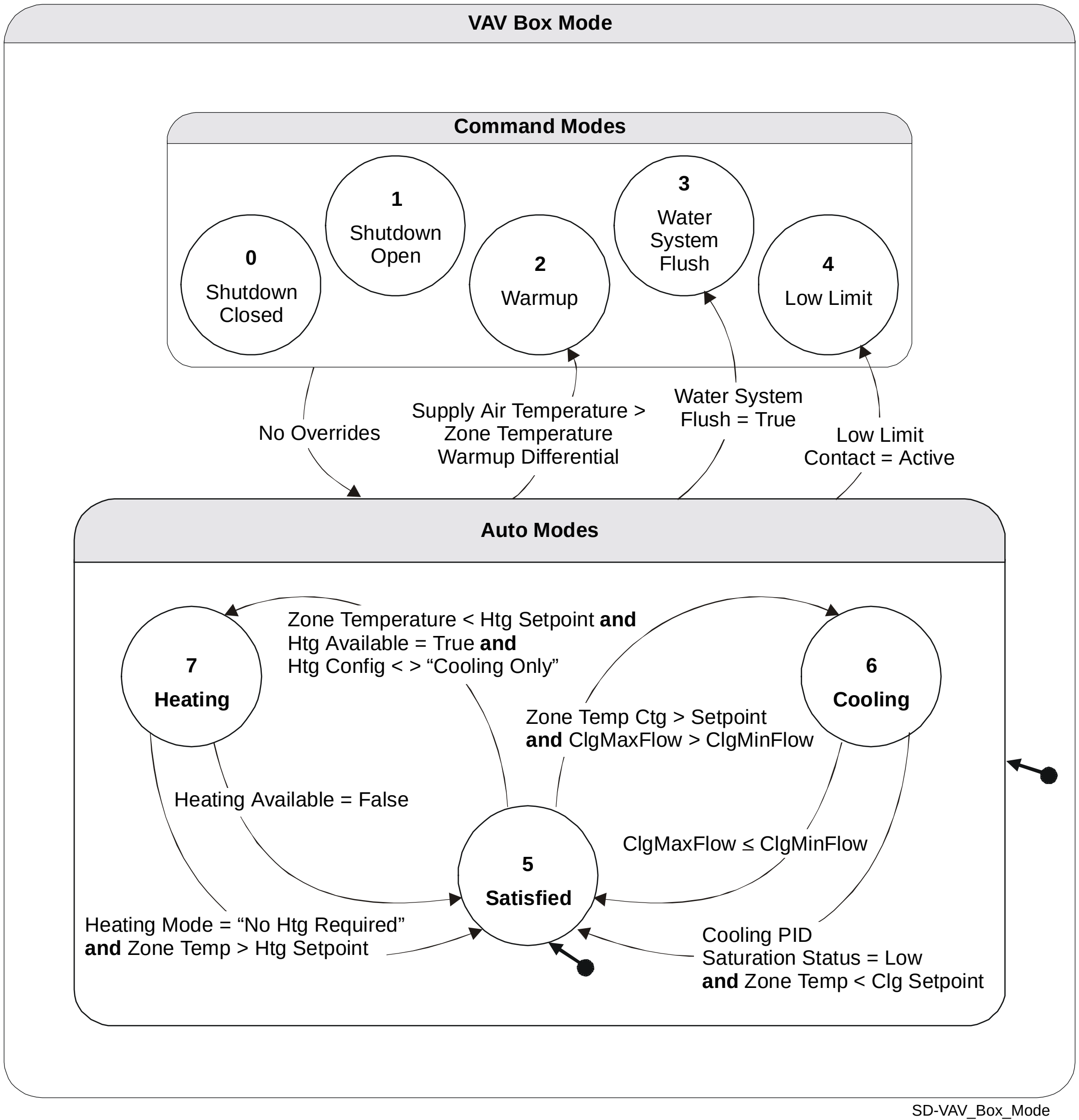

Figure 5: VMA Single Duct VAV Box Mode State Diagram

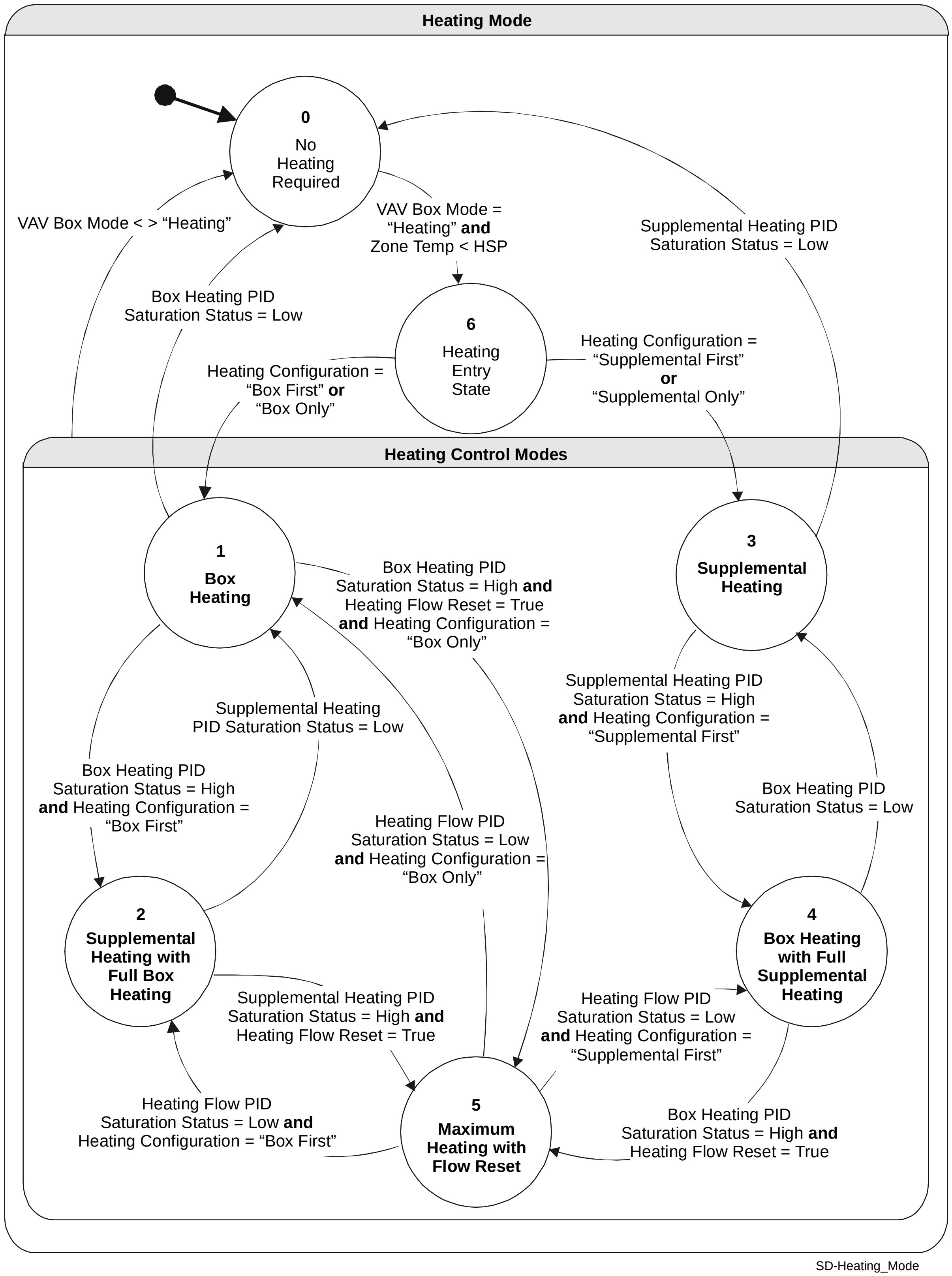

Figure 6: Heating Mode State Diagram

VMA Single Duct Parameters

The VMA has adjustable parameters, but most do not require changes. Changing parameters incorrectly may cause the controller to malfunction.

The *Attributes and Parameters* section describes all of the parameters shown in the main views as well as most of the attributes of the input and output sections.

If you are changing the flow units from the default created by HVAC PRO software, verify the Delta P sensor is still set up properly. If the setup attribute is changed, HVAC PRO software updates the Min Value, Max Value, and Units attributes based on the range chosen. HVAC PRO Release 7.00 and 7.01 set the Min Value to 0.0. The Min Value should be -24.9 Pa (-0.1 inches w.c.). HVAC PRO Release 7.02 and later sets this attribute to the correct value.

VMA Dual Duct Applications

Control Overview

Figure 7 shows the overall control diagram for the basic dual duct application. As with the single duct application, the dual duct application uses cascaded control loops to achieve pressure independent control. The primary control loop uses a PID tuned by PRAC that produces an output with units of heat transfer rate. This PID is termed Energy Balance PID, because the output indicates the current heat transfer referenced to an energy balance on the zone.

The heat transfer specified by the Energy Balance PID is used to calculate flow setpoints for the hot and cold decks. Individual flow control loops using the P-Adaptive flow controller command the hot and cold deck damper actuators to achieve the flow setpoints.

The supplemental heating output (if available) is controlled by a separate PID (tuned by PRAC for AO and PAO output types). The Energy Balance PID and Supplemental Heating PID are coordinated by the VAV Box mode finite state machine. For more details about the PID and PRAC, see the *Control Loops* topic in the *Theory of Operation* section earlier in this document.

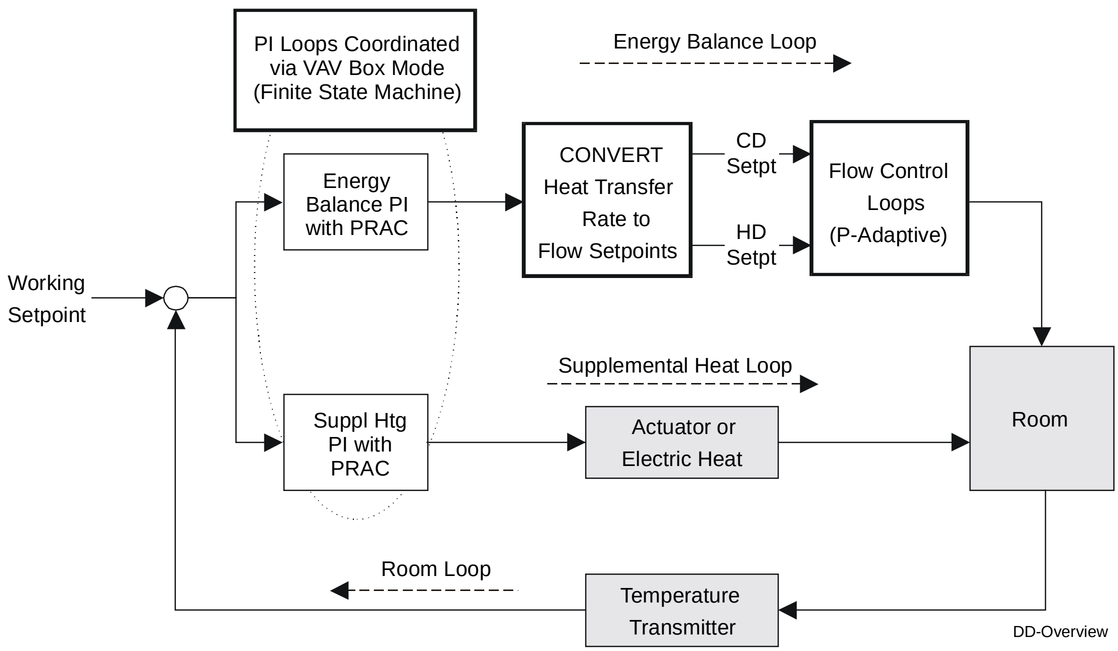

Figure 7: Basic Control Diagram for the VMA Dual Duct Application

Heat Transfer to Flow Setpoint Conversion for VMA Dual Duct Applications

The heat transfer rate specified by the Energy Balance PID is converted to hot and cold deck flow setpoints based on a heat transfer model of the dual duct box and an energy balance analysis on the zone. For steady state conditions with the zone temperature near setpoint, the heat transfer to the zone can be calculated using the following formula:

$$\dot{Q}_{zone} = Q_{convert} * [\dot{W}_{CD} * (T_{CD} - T_{zone,SP}) + \dot{W}_{HD} * (T_{HD} - T_{zone,SP})]$$

In this equation, W_{CD} and W_{HD} are the cold and hot deck volume flow rates. By this definition, the heat transfer is positive when the zone is being heated and negative when the zone is being cooled. The term $Q_{convert}$ is dependent on the flow and temperature measurement units and is used to convert the product of flow and temperature difference to heat transfer. Table 6 shows the values required for $Q_{convert}$.

Table 6: Heat Transfer Conversion Factor

Flow Units	Temperature Units	Q Convert
cfm	°F	1.08
M^3/hr	°C	1.1435
l/s	°C	4.119
cfm	°C	1.944

The heat transfer conversion requires a number of steps and various pieces of information. Figure 8 shows a data and calculation flow chart.

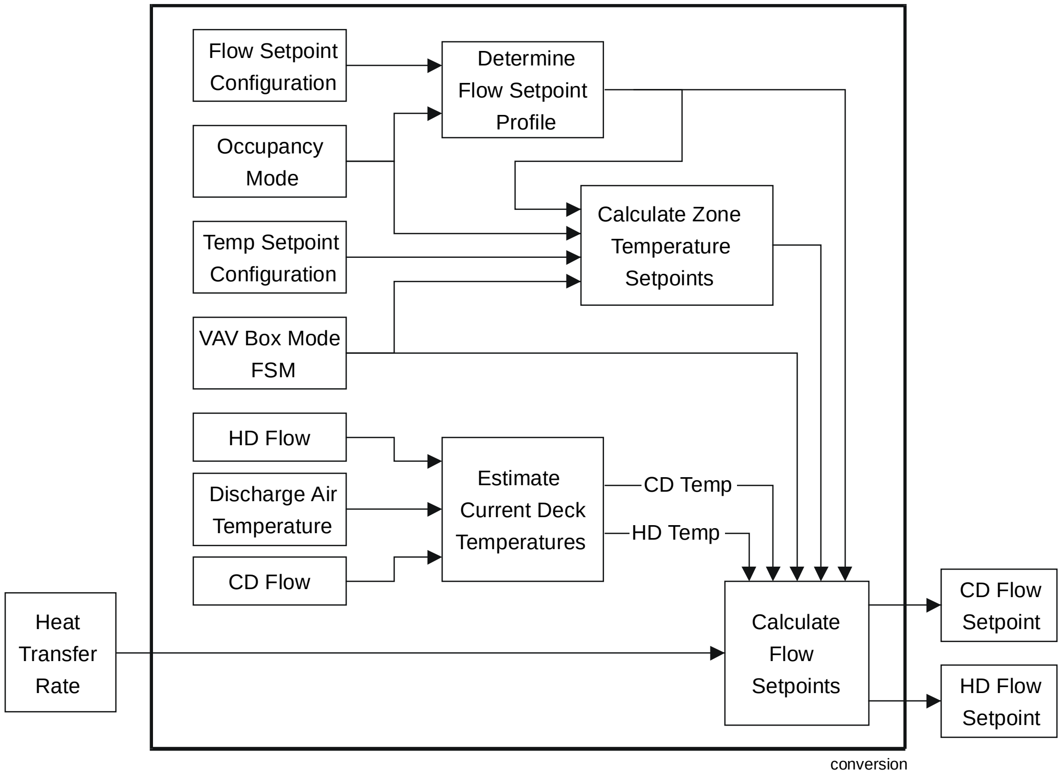

Figure 8: Conversion from Heat Transfer Rate to Flow Setpoints

The flow setpoint and temperature setpoint configurations are specified by the user for the Occupied and Unoccupied Occupancy modes. The current flow profile is calculated based on the active Occupancy mode. Depending on the flow profile, one of two temperature setpoint calculation methods is used to determine the cooling and heating temperature setpoints. The hot and cold deck temperatures are either estimated online by the controller based on the discharge air temperature or specified by the user. The flow setpoints are then calculated for each deck. Most of the elements shown in Figure 8 that are used in the flow setpoint calculation are described individually later in this section. The Occupancy mode calculation, as well as the basics of the temperature setpoint calculation, were previously described in this section.

Flow Control Loops

Figure 9 shows the flow control loops for the default dual duct application. If one of the velocity pressure (flow pickup) sensors is located on the mixed air duct, the total flow controller commands the damper actuator of the unmeasured flow based on maintaining the total flow setpoint. For more information on the P-Adaptive flow control algorithm, see the *Control Loops* topic in the *Theory of Operation* section.

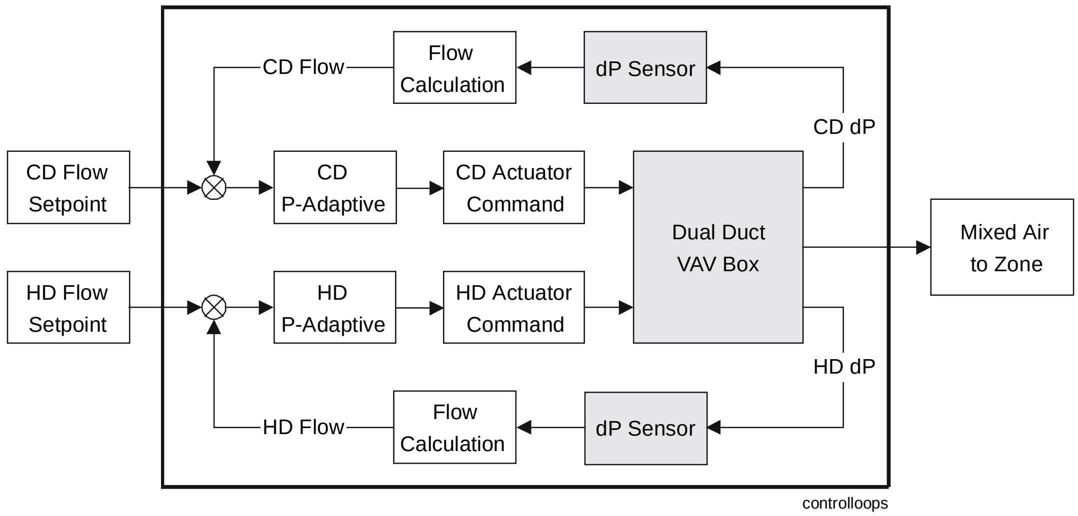

Figure 9: Flow Control Loops for the VMA Dual Duct Application

Flow Setpoint Configuration for VMA Dual Duct Applications

The general flow schedule for the Dual Duct application is defined using a set of basic configuration parameters. The internal parameters used to calculate the actual operating flow setpoints, however, vary depending on the values of several Boolean flags that designate special conditions and the specifications of Indoor Air Quality (IAQ) ventilation requirements.

Basic Flow Setpoint Parameters

The flow setpoint schedule for the VMA dual duct application is described by five basic configuration parameters:

1. Cooling Maximum Flow
2. Heating Maximum Flow
3. Box Minimum Flow (Occupied and Unoccupied)
4. Cold Deck Minimum Flow (Occupied and Unoccupied)
5. Hot Deck Minimum Flow (Occupied and Unoccupied)

The maximum flow setpoints specify the **total flow** for the VAV Box and do not vary with occupancy. The minimum flow setpoints are specified separately for the Occupied and Unoccupied Occupancy modes. The unoccupied flow setpoints are used when the Occupancy mode is either Standby or Unoccupied. Depending on the values of these five parameters, the flow schedule takes one of three basic forms: constant volume, variable volume with mixing (or blending), and variable volume without mixing.

To specify a constant volume flow schedule, the flow setpoints should be equal for the Cooling Maximum Flow, Heating Maximum Flow, and Box Minimum Flow. The sum of the Cold and Hot Deck Min Flow setpoints should be less than this maximum flow. Figure 10 shows an example of a flow schedule. Table 7 shows the flow setpoints for each of the example profiles.

Note: In Figures 10-12, the horizontal axis represents the range of output of the controller (between full heating at one end of the axis and full cooling at the other). Because PI Control is used, this axis does not have any direct correlation to temperature or proportional bands. The control range indices are used to allow simple representation of the flow setpoint configuration profile.

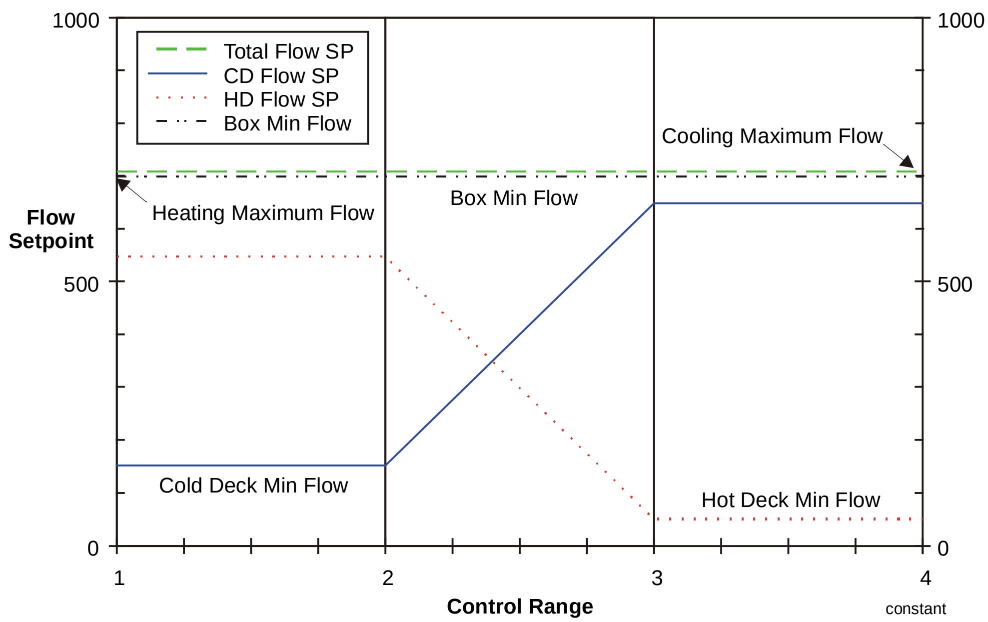

Figure 10: Example Constant Volume Profile

To specify a pressure independent flow schedule, the Box Minimum Flow should be less than the maximum flow setpoints for heating and cooling. The term mixing refers to simultaneous modulation of the cold and hot deck flow setpoints between the Cooling and Heating modes. For mixing to be enabled, the sum of the Cold and Hot Deck Min Flow setpoints must be less than the Box Minimum Flow setpoint. The consulting engineer sometimes specifies this type of flow schedule with mixing. Figure 11 shows an example of a variable volume flow schedule with mixing, and Figure 12 shows one without mixing.

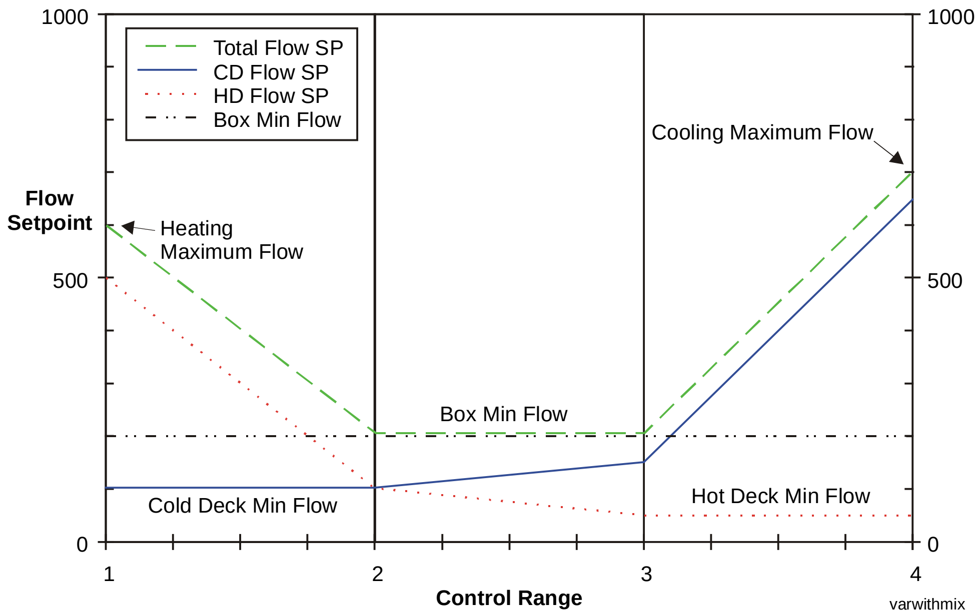

Figure 11: Example Variable Volume Profile with Mixing

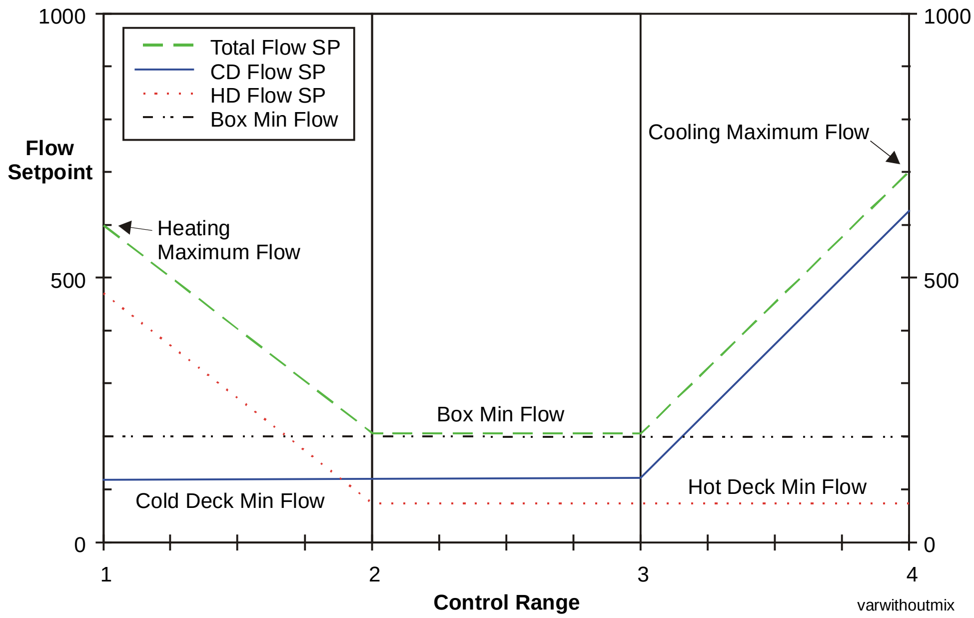

Figure 12: Example Variable Volume Profile without Mixing

Table 7: Flow Setpoints for Example Profiles

Profile	Heating Maximum	Cooling Maximum	Box Min Flow	Cold Deck Min Flow	Hot Deck Min Flow
Constant Volume	700	700	700	150	50
Variable Volume with Mixing	600	700	200	100	50
Variable Volume without Mixing	600	700	200	125	75

The basic flow setpoint configuration specified by the deck and total minimum and maximum flow setpoints is modified depending upon the availability of each deck, the status of the warmup, cooldown, and low limit flags, the IAQ requirements, and the discharge air temperature low limit.

Cold and Hot Deck Available

Two network variables are provided, called Cold Deck Available and Hot Deck Available, for the user to indicate the operational status of a particular deck. During the peak summer months, the hot deck may not be required and its supply fan turned off. When this situation occurs, the Hot Deck Available flag should be set to false. When a Deck Available flag is set to false, the flow setpoint for that deck is set to zero and the damper actuator is driven to the full closed end-stop.

When a single deck is available, the box minimum flow is set equal to the minimum flow of the available deck. The maximum total flow setpoint for the available deck is not affected.

Warmup and Cooldown Modes

In many buildings, the AHU supply fans are shut off during unoccupied periods. Prior to returning to occupancy, a warmup or cooldown period may be required to bring the system to normal occupied operating conditions. Two network variables are provided, called Warmup Req and Cooldown Req, to indicate that these modes are active.

During Warmup, the Hot Deck Min Flow is set equal to the Warmup HD Min. The cold deck flow setpoint is set equal to a constant value specified by the Warmup CD Flow. The energy balance PI adjusts the hot deck flow setpoint to maintain the actual heating setpoint. If the Warmup CD Flow is zero, the cold deck is treated as if the Cold Deck Available flag were set to false (damper forced closed).

During Cooldown, the supplemental heat is disabled; the Cold Deck Min Flow is set equal to the Cooldown CD Min. The hot deck flow setpoint is set equal to a constant value specified by the Cooldown HD Flow. The energy balance PI adjusts the cold deck flow setpoint to maintain the actual cooling setpoint. If the Cooldown HD Flow is zero, the hot deck is treated as if the Hot Deck Available flag were set to false (damper forced closed).

Low Limit Mode

The Low Limit mode is designed for systems that have operating windows or perhaps an outside door (such as a loading dock). To maintain stability of building pressurization and AHU operation, the supply air to these zones must be cut off when the window is opened. A closure contact on the window is connected to a binary input on the VMA. When the window is open (Binary Input [BI] is active), the cold deck and the hot deck are treated as if the Cold Deck Available and Hot Deck Available flags are both equal to false, forcing both dampers to close. The heating temperature setpoint is reset to the Low Limit Temp Setpt, which is defaulted to 4°C (40°F). The supplemental heating, if available, maintains the zone temperature to this setpoint. The lighting control is not affected.

A network variable is provided, called Low Limit Req, to allow the user to activate the Low Limit mode without having a BI contact. The user may choose to use Low Limit mode rather than Shutdown Closed if supplemental heating is available and the zone requires heating during Unoccupied periods. In this case, the Low Limit Temp Setpt should be adjusted to be the desired night setback temperature.
If lighting is controlled by the VMA, it must be turned off separately by changing the occupancy status to unoccupied.

Discharge Air Temperature Low Limit

Some dual duct applications use Cold Air Distribution. In these systems, the cold deck temperatures are colder than normal systems, often below 7°C (45°F). To prevent cold drafts at the zone, a minimum discharge air temperature can be specified using the Discharge Temp Limit setpoint. If the cold deck temperature is below and the hot deck temperature is above the Discharge Temp Limit, the percent hot deck flow is adjusted to maintain the discharge air temperature at or above the Discharge Temp Limit. The total flow setpoint is not affected.

Note: This limits the maximum cooling potential for a box and should be used only if specified by the consulting engineer.

Temperature Setpoint Configuration for VMA Dual Duct Applications

The VMA dual duct application supports the same temperature setpoint configuration options as the single duct application. These options are described in the *Temperature Setpoints* portion of the *Application Logic* topic earlier in this *Key Concepts* section. The calculation of the actual cooling and heating setpoints, however, depends on the active flow profile. For the variable volume without mixing flow profile, the actual cooling and heating setpoints are calculated separately using the formulas previously described in this section.

As shown in Figures 10-12, when both the hot and cold deck vary together (between control range 2-3), the dual duct application calculates a single temperature setpoint. This condition is True for both the constant volume (Figure 10) and variable volume with mixing (Figure 11) flow profiles. The single setpoint is calculated using the following formula.

Actual Cooling Setpoint = Common Setpoint + Remote Adjustment + (Cooling Setpoint + Heating Setpoint) / 2.0 + Actual Heating Bias + Actual Cooling Bias + Summer Compensation + Winter Compensation

Actual Heating Setpoint = Actual Cooling Setpoint

Therefore, for night setback to be active, the flow setpoints must **not** be configured to vary the flow between control range 2-3. The default unoccupied minimum flow setpoints (including box minimum) are set to zero so that the default application has separate heating and cooling setpoints during Unoccupied and Standby modes.

VAV Box Mode for Dual Duct Applications

The VAV Box mode determines which PID control loop is active and the control range across which the Energy Balance PID is spanned. It also controls VMA supervisory Command modes. Within VAV Box mode are two main super-states: Command modes and Auto modes. The Command modes include Shutdown Open and Shutdown Closed.

Table 8: Command Modes

Mode	Description
Shutdown Open/Closed	Two shutdown options are available: Shutdown Open and Shutdown Closed. The VAV Box mode present value must be overridden to enter these states. For the dual duct application, the hot and cold deck dampers are commanded open during Shutdown Open mode to satisfy 50% of the maximum heating and cooling flow setpoints, respectively. During the Shutdown Closed mode, the dampers are commanded fully closed. When either Shutdown mode is activated, all the analog and binary outputs are turned off, and the PID control loops are overridden to eliminate integration windup when the system is put back in control. If supply fans are off and no temperature control is required, it is best to use one of the Shutdown modes instead of de-energizing the Occupied mode during the unoccupied period.
Warmup, Cooldown, Low Limit	Warmup, Cooldown, and Low Limit are not modes within the Dual Duct VAV Box mode. Instead, these modes (activated by Boolean parameters) directly affect the flow setpoint calculations as described in the previous section.
Water System Flush	Water System Flush is not a mode within the Dual Duct VAV Box mode. Instead, this mode (activated by a Boolean parameter) indicates to the controller that the supplemental heating device is unavailable. Floating/3-wire, proportional, and 2-position normally open and normally closed outputs are commanded to the Flush Position when Water System Flush is active.

The VMA dual duct application has up to five automatic modes for control: Satisfied, Mixing, Cooling, Heating, and Supplemental Heating (Suppl Heating). Figure 13 shows the full state diagram for the VAV Box mode. Each of the transition paths between the Auto modes is designated by a letter and each path may have multiple transition conditions. Figures 14 and 15 show specific transition conditions for each configuration. Some transitions are used only when the application configuration changes (for example, constant volume during occupied and variable volume during unoccupied). Paths A-F in Figure 13 are examples of transitions that occur in these instances.

For single duct applications, the Heating and Cooling modes are fundamentally different processes because cooling involves modulating the airflow while heating involves modulating a heating device while maintaining a constant flow. Traditionally, dual duct applications have approached the modes in a similar manner.

For dual duct applications with a single temperature setpoint, however, the Heating and Cooling modes involve the same fundamental process of modulating airflow. Therefore, the VMA dual duct application operates in a limited set of the Auto modes depending on the flow and temperature setpoint configurations and the availability of supplemental heating, as is shown in Table 9. In this table, the control range index refers to the main break points as were shown in the example flow configurations (see Figures 10-12).

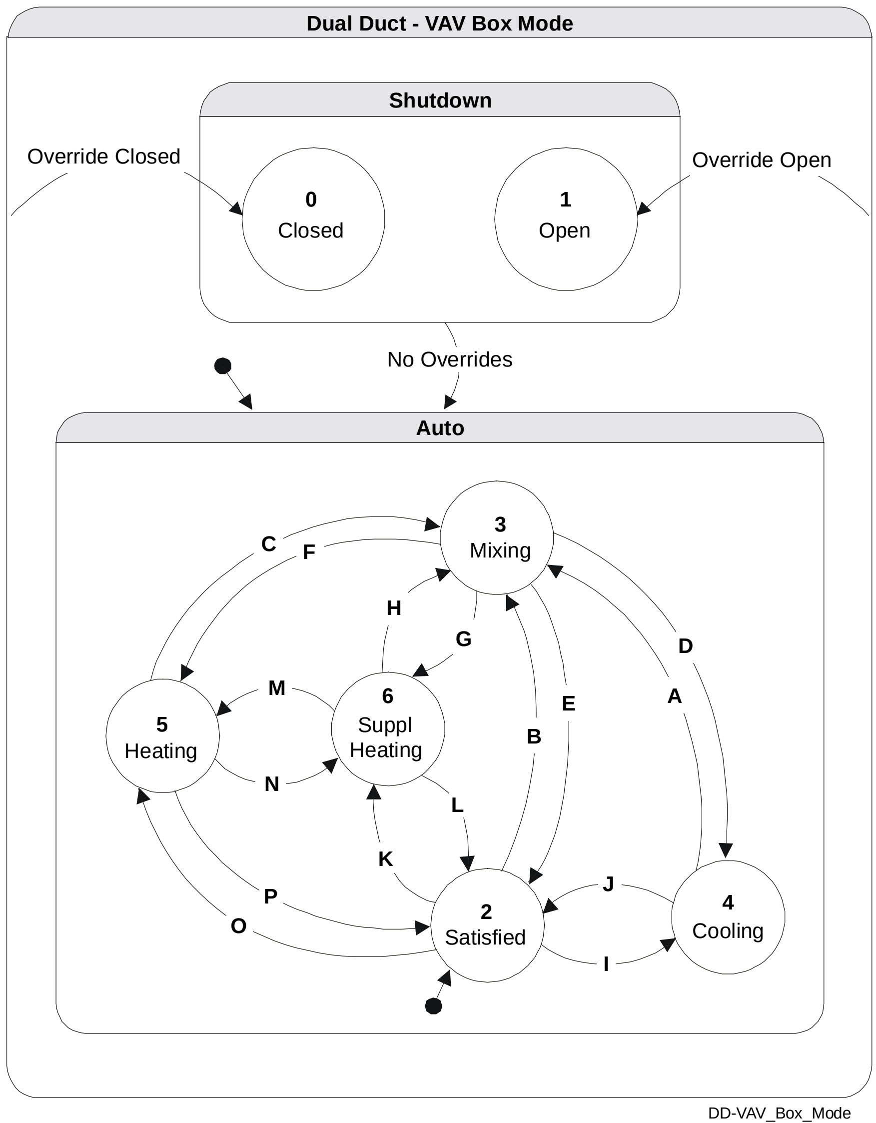

Figure 13: VMA Dual Duct VAV Box Mode State Diagram

Table 9: Active Modes for Application Configurations

Zone Temperature Setpoints	Supplemental Heating	Control Range Index 1 to 2	2	2 to 3	3 to 4
Single	**N/A**	Mixing	Mixing	Mixing	Mixing
Single	**Available**	Heating	Suppl Heating	Mixing	Mixing
Separate	**N/A**	Heating	Satisfied	Satisfied	Cooling
Separate	**Available**	Heating	Suppl Heating	Satisfied	Cooling

For configurations with a single temperature setpoint and no available supplemental heat, the VMA dual duct application operates in a single mode termed mixing. This includes applications that are required to have a single setpoint (see temperature setpoint description), as well as applications that have a single setpoint because the heating and cooling biases are set to zero.

For applications with supplemental heating available, the supplemental heating device is modulated before the hot deck flow is increased (corresponding to control index 2). Figure 14 shows the active Auto modes and transitions for this configuration.

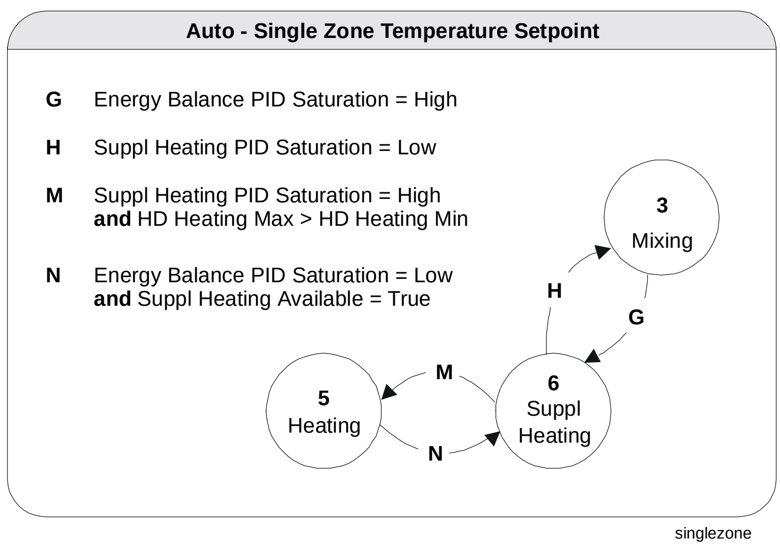

Figure 14: Auto Modes with Single Zone Temperature Setpoint

For configurations with separate heating and cooling setpoints, the control range is divided into Heating, Cooling, and Satisfied modes. The Supplemental Heating mode is also active if supplemental heating is available. Figure 15 shows the active Auto modes and transitions for these configurations. The application controls to the cooling setpoint in the Cooling mode and the heating setpoint in the Heating and Supplemental Heating modes. In the Satisfied mode, the flow setpoints are maintained at the minimum values until the zone temperature goes above or below the cooling or heating setpoint, respectively.

Note: In order for a VMA application to operate with dual setpoints, the flow configuration must have constant flow setpoints between control index 2-3. This requires the box minimum flow to be equal to the sum of the cold and hot deck minimum flows.

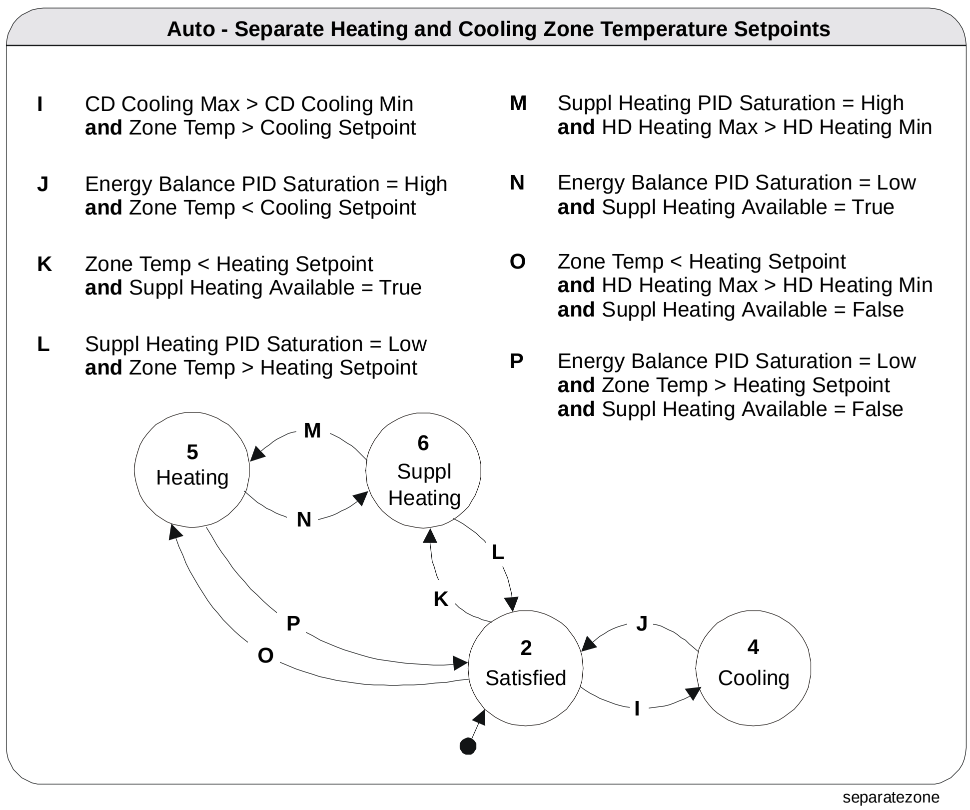

Figure 15: Auto Modes with Separate Zone Temperature Setpoints

Deck Temperatures for VMA Dual Duct Applications

The dual duct application uses the hot deck and cold deck air temperatures to translate the heat transfer output from the Energy Balance PID to individual flow setpoints for the hot and cold decks. The application supports two methods for specifying the deck temperatures.

If a discharge air temperature sensor is not installed, two network variables are provided, named Cold Deck Air Temp and Hot Deck Air Temp. These variables are configurable and can be set in the application to match an average value for the AHU deck temperature setpoint. They are also included in the mapping group and can be updated via network overrides to match the current sensed temperatures at the AHU. If a discharge air sensor is installed, the deck temperatures are estimated online by the controller.

When the deck temperatures are updated either via the network variables or via online estimation, the VMA dual duct application becomes a "deck temperature independent" controller in addition to being pressure independent. Normally, if the deck temperature were to change, the controller would be able to react only after the zone temperature was affected. With the knowledge of the deck temperatures, the controller reacts to prevent these changes from affecting the zone temperature.

Deck Temperature Estimation

The dual duct application uses recursive parameter estimation to determine the hot and cold deck temperatures from the mixed air temperature, hot deck flow rate, and cold deck flow rate. When the flow velocity at both sensors is sufficient to ensure accurate measurements, a Recursive Least-Squares (RLS) method is used. The minimum velocity is configured using the Min_dP_Velocity parameter. When one of the flows is below the minimum velocity, that deck temperature is held constant while the other temperature is updated using an exponentially weighted moving average.

The RLS method chosen combines covariance resetting, exponential forgetting, and conditional updating. Exponential forgetting allows the recursive parameter estimation to track slowly varying processes. In some dual-duct VAV boxes, the hot or cold deck temperatures may change abruptly. Covariance resetting allows the parameter estimation algorithm to track abrupt changes. Simulation studies were performed to determine an appropriate threshold for resetting the covariance matrix. Also, simulation studies were used to determine an initial value for the covariance matrix. Conditional updating prevents the recursive parameter estimation from becoming numerically unstable.

To obtain further information on this topic:

Lung, Lennart, and Torsten Soderström, c., 1983. Theory and Practice of Recursive Identification, The MIT Press, Cambridge, Massachusetts.

Åström, Karl Johan, and Bjorn Wittenmärk, c., 1995. Adaptive Control, Second Edition, Addison-Wesley Publishing Company.

VMA Dual Duct Parameters

The VMA has adjustable parameters, but most do not require changes from the default. Changing parameters incorrectly may cause the controller to malfunction.

The *Attributes and Parameters* section describes the parameters shown in the main views and most of the attributes of the input and output options.

VMA Diagnostics

Data Analysis and Compression

The VMA has the ability to collect data about its inputs, outputs, and internally calculated variables. Inside the VMA, Exponentially Weighted Moving Averages (EWMA) minimize memory requirements, reduce communication traffic, and provide an easy way to analyze collected data.

The most common method for representing a large amount of data with a single variable estimate is to calculate the mean (or average) of the data. Means are also useful because they smooth out random data fluctuations. When collecting data over a long period of time, it is desirable to give a higher weighting (level of importance) to the most recent data, since it represents current conditions more accurately than old data. An EWMA provides both of these characteristics. The general form used in the VMA is given below:

$$\hat{X}_k = \hat{X}_{k-1} + \lambda \left(X_k - \hat{X}_{k-1} \right)$$

where:

$\hat{X}_k$ = estimate of variable X at the current sample, k

$\hat{X}_{k-1}$ = the past estimate of X at sample, k-1

λ = is the forgetting factor or exponential smoothing constant, $0<\lambda<1$.

The value for λ is automatically computed, based on the type of data collected.

The VMA calculates four to eight EWMAs from the following input value categories:

1. absolute value of airflow setpoint minus airflow (for supply, exhaust, differential, and for each deck, if applicable)
2. absolute value of zone temperature setpoint minus zone temperature
3. airflow setpoint minus airflow (for supply, exhaust, differential, and for each deck, if applicable)

4. zone temperature setpoint minus zone temperature

The zone temperature and flow EWMA diagnostics turn off if any required analog inputs are unreliable, or if the mode is Shutdown Open or Closed. This prevents the diagnostics from becoming biased by non-representative data.

EWMAs from the third and fourth inputs in the list above can have either a positive or negative value:

- A negative value indicates either a warm zone or a flow higher than setpoint.
- A positive value indicates either a cool zone or a flow lower than setpoint.

The EWMAs can be used to detect faults within the VMA. For example, if the EWMA of absolute temperature error is large, the box may have a stuck heating valve or a blocked supply duct. EWMAs from several VAV boxes can be compared, using HVAC PRO software to easily identify boxes with poor relative performance.

Starved Box

The Starved Box diagnostic feature indicates when the VAV damper is open to 100% in the Occupied mode for 10 minutes. For single duct supply/exhaust applications, the starved status of both the supply and exhaust are calculated independently. For the dual duct application, the starved status of each deck is calculated separately (Starved Cold Deck and Starved Hot Deck). This point can be trended and viewed to diagnose a potential problem before the zone occupants complain of discomfort. If the output of the damper command is set to 100% for 10 minutes, the starved box saturation flag is on. Once the damper command drops below 100%, the flag is off.

When the Starved Box flag is True, the PRAC adaptive tuner is disabled for PIDs that require flow to maintain control of the zone. This means that in single duct applications, the Cooling PID is disabled if Starved Box is True. Similarly, the Box Heating PID for single duct applications is disabled if Starved Box is True and there is no box fan active. In dual duct applications, the Energy Balance PID is disabled if either Starved Cold Deck or Starved Hot Deck is true.

If the flag is on for an extensive period of time, use the following steps to diagnose the problem:

1. Check the static pressure near the box inlet to ensure that enough air is being delivered to the zone to meet maximum flow requirements.
2. Verify the VMA design flow setpoints are correct.
3. Check the damper linkage to ensure that the box is fully open.

4. Verify that the supply air temperature at the box inlet is correct.

Inadequate Cooling and Heating

The inadequate cooling and inadequate heating flags provide diagnostics that indicate whether the cooling or heating commands have saturated at 100% in an attempt to meet the current setpoint.

For the single duct application, inadequate cooling is True if the Occupancy mode is occupied, the VAV Box mode is cooling, and the Cooling PID is saturated high. However, if the zone temperature is unreliable or starved box is True, the inadequate cooling flag maintains its prior value. Inadequate heating is True if the Occupancy mode is occupied and the PID controlling the final heating stage saturates high. If the zone temperature is unreliable, the inadequate heating flag maintains its prior value.

For the dual duct application, inadequate cooling is True if the Occupancy mode is occupied, the VAV Box mode is cooling or mixing, and the Heat Balance PID is saturated at full cooling. If the zone temperature is unreliable or the cold deck is starved, the inadequate cooling flag maintains its prior value. Inadequate heating is True if the Occupancy mode is occupied, the VAV Box mode is heating or mixing, and the Heat Balance PID is saturated at full heating. If the zone temperature is unreliable or the hot deck is starved, the inadequate heating flag maintains its prior value.

Actuator Stall

On the VMA1410/1420, feedback to the microprocessor indicates when the integral stepper motor has stalled. The calculated damper position can be viewed in the SMO attribute list as Damper Output. If the stall is greater than 5% from the estimated stall position, the Reliability attribute indicates Stalled during Positioning.

Actuator Duty Cycle

The actuator duty cycle is an indicator of damper actuator usage. This diagnostic consists of controller runtime and actuator runtime. The controller runtime is the total amount of time the controller has been running since the application was downloaded. The actuator runtime is the total amount of time the damper motor has been pulsed to drive the actuator open or closed since the application was downloaded. These runtimes are continually updated and saved to permanent memory once per day. The actuator duty cycle is calculated as follows:

$$\text{ActuatorDutyCycle} = \frac{\text{ActuatorRuntime}}{\text{ControllerRuntime}} * 100\%$$

Moving Average Actuator Diagnostics

Two additional actuator diagnostics were added for the single duct application, starting with HVAC PRO Release 7.02. These diagnostics are also calculated for both actuators in the dual duct application and for the exhaust actuator if present.

The actuator diagnostics calculated include the moving average of the actuator duty cycle and hourly reversal rate. This moving average uses three samples weighted equally in the calculation and updated every 8 hours. The value of the moving average duty cycle indicates the average percent runtime for that actuator during the past 24 hours. The moving average reversal count indicates the average number of actuator reversals each hour during the past 24 hours. These diagnostics are calculated as follows:

$$\text{MovAvgDutyCycle} = \frac{\text{DeltaRuntime}}{24.0} * 100.0$$

$$\text{MovAvgReversals} = \frac{\text{DeltaReversals}}{24.0}$$

Note: The actuator runtime for the proportional damper actuator is estimated based on the stroke time parameter and the integrated changes of command. This estimate will be inaccurate if the stroke time parameter is incorrect or if the damper command is overridden without allowing the actuator to remain in sync. This potential inaccuracy affects both the moving average duty cycle diagnostics as well as the single duct actuator duty cycle.

Flow Test

A flow profile is performed for the single duct applications (without an exhaust box) at one or more VAV boxes using the VAV Box Flow Test function in HVAC PRO software. This test provides an automatic means of obtaining a damper position vs. flow plot. To quickly check if damper direction is correct, use Step Amount % = 50% and Settle Time (0-60 s) = 15 s. The flow should increase for 0-100%.
For additional information, refer to the *HVAC PRO User's Guide*.

Data Graphing

Data graphing allows you to graph up to three analog values in real time. The data graphing feature is available under the Commission menu in HVAC PRO software. Refer to the *HVAC PRO User's Guide* for further explanation of this feature.

Detailed Procedures

Creating a VMA Single Duct Application

To create a VMA single duct application:

1. On the Options menu, click Job Information.
2. Select either English or Metric units. Click OK.
3. On the File menu, click New.
4. In the Application Group drop-down list, click VAV Applications.
5. In the Application box, click VMA Single Duct.

Note: Refer to the *HVAC PRO User's Guide* for further explanation.

6. Answer the questions as they are presented. The sequence of questions and answers appears in Figures 16-19. An explanation of each question and answer appears following the figure in which the question is shown. The chosen answer for each question provides default parameter values. The user changes those values, when required.

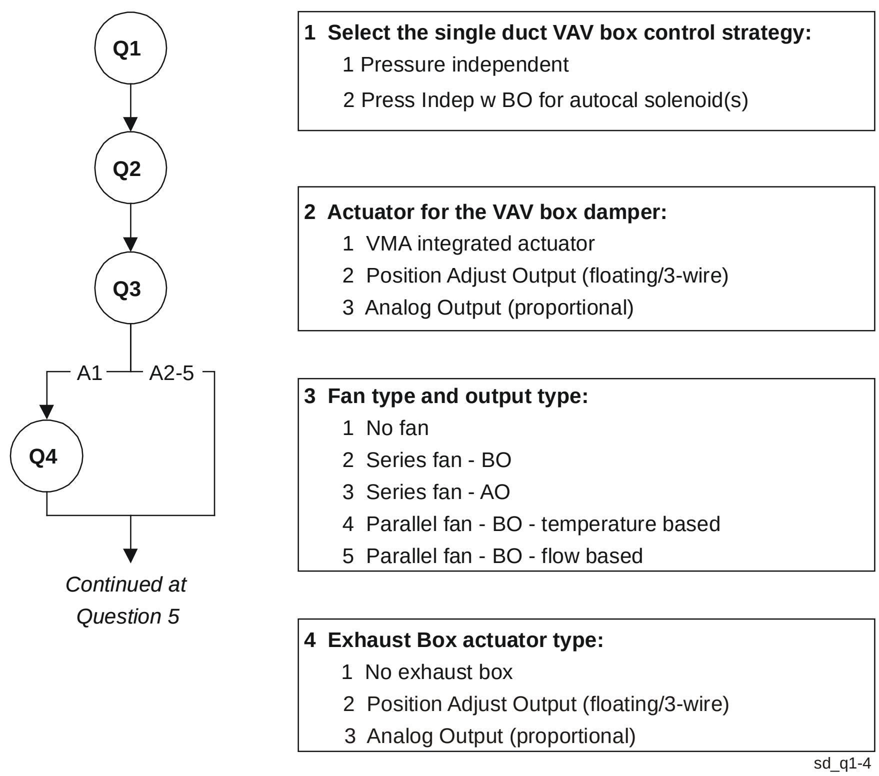

Figure 16: VMA Single Duct Basic Box Configuration Questions

Select the Single Duct VAV Box Control Strategy

Choose from the options in Table 10.

Table 10: Select the Single Duct VAV Box Control Strategy

Option	Description
Pressure Independent	A pressure independent application controls the VAV box supply flow, independent of the supply duct static pressure variations. The controller uses a P-adaptive control algorithm, along with a flow sensor, to modulate the supply damper to maintain the required flow setpoint. For further explanation of the point configuration, refer to the *Variable Air Volume Modular Assembly (VMA) 1400 Series Overview and Engineering Guidelines Technical Bulletin (LIT-6363120).*
Press Indep w BO for autocal solenoid(s)	This option allows autocalibration using BO activated solenoid air valve(s) that zeros the differential pressure across the velocity pressure sensor(s). It allows autocalibration to occur without closing the damper(s). For more information, refer to the *Autocalibration* topic in the *Application Logic* section of this document.

Actuator for the VAV Box Damper

Choose from the options in Table 11.

Table 11: Actuator for the VAV Box Damper

Option	Description
VMA Integrated Actuator	The VMA1410/1420 assembly has an integral actuator controlled by a Stepper Motor Object. For more information, see the SMO description in the *Input/Output Options* topic in the *Attributes and Parameters* section of this document.
Position Adjust Output (Floating/3-Wire) and Analog Output (Proportional)	The VMA1430 does not have an integrated stepper motor actuator. The VMA1420 and VMA1430 support an external, floating/3-wire (incremental) or proportional actuator. A pair of BOs or a single AO is used.

Fan Type and Output Type

A VAV box fan is installed either in series or in parallel with the box damper. In parallel fan powered terminal boxes, the fan runs intermittently to produce a flow of plenum air through the box, whenever needed. This occurs even if the box damper is fully closed to the primary air source. Series fans run continuously in the Occupied mode to improve the comfort of occupants by maintaining a constant airflow through the diffuser, providing a better mix of air regardless of the position of the supply air damper.

Choose from the options in Table 12.

Table 12: Fan Type and Output Type

Option	Description
No Fan	No points, parameters, or logic are assigned for this answer.
Series Fan - BO	The series fan remains off during Shutdown and Calibration modes and runs continuously during Occupied and Standby modes. During Unoccupied mode, the fan cycles on if heating is required. Prior to starting the fan, the damper is driven closed for the fan start delay time plus the damper stroke time to ensure that the fan is not rotating backwards. During warmup, the series fan cycles on if heating is required. A single BO is used.
Series Fan - AO	The series fan AO operates in the same manner as the BO option. The series fan AO uses a single Analog Output (AO) to provide a 0 to 10 VDC signal to a fan speed controller (S66 speed controller). The fan is set to a constant speed based on the Fan Speed Percent parameter. The fan operates at this constant speed setting whenever it runs. The VMA turns the fan off by setting this AO to 0 VDC.
Parallel Fan - BO - Temperature Based	When this option is selected, the parallel fan remains off during Shutdown and Calibration modes and cycles on whenever the Heating modes are active, regardless of Occupancy mode. If box heating is not chosen for this box, the temperature-based parallel fan is not turned on. A single BO is used.
Parallel Fan - BO - Flow Based	When this option is selected, the parallel fan remains off during Shutdown and Calibration modes and cycles on whenever the Heating modes are active during the Unoccupied mode. In addition, the parallel fan is cycled on during Standby and Occupied modes when the supply flow is less than the parallel fan minimum flow. A single BO is used.

Exhaust Box Actuator Type

Choose from the options in Table 13.

Table 13: Exhaust Box Actuator Type

Option	Description
No Exhaust Box	No points, parameters, or logic are assigned for this answer.
Floating/3-Wire (Incremental) and Proportional Actuator	The VMA1420/1430 support an external, floating/3-wire (incremental) or proportional actuator. A pair of BOs or a single AO is used. The VMA1430 does not have an integrated stepper motor actuator. The controller uses flow differential to set the relationship between the supply and exhaust control loops. The exhaust setpoint tracks the sum of the supply flow setpoint and the current differential setpoint. A flow differential less than zero provides a positive room pressure. You can select separate occupied and unoccupied differential setpoints. This allows you to change zone pressurization simply by changing occupancy modes. Note: The exhaust flow controller is active during all modes of control, including the command modes (Shutdown Open, Shutdown Closed, and Low Limit). The exhaust setpoint continues to track the sum of the supply flow setpoint and the current differential setpoint. During Shutdown Closed or Low Limit, the supply setpoint is commanded to zero. Therefore, a positive differential (negative pressure) can be maintained during these modes if the exhaust fan remains running. A negative differential (positive pressure) requires supply flow and cannot be maintained during Shutdown Closed or Low Limit.

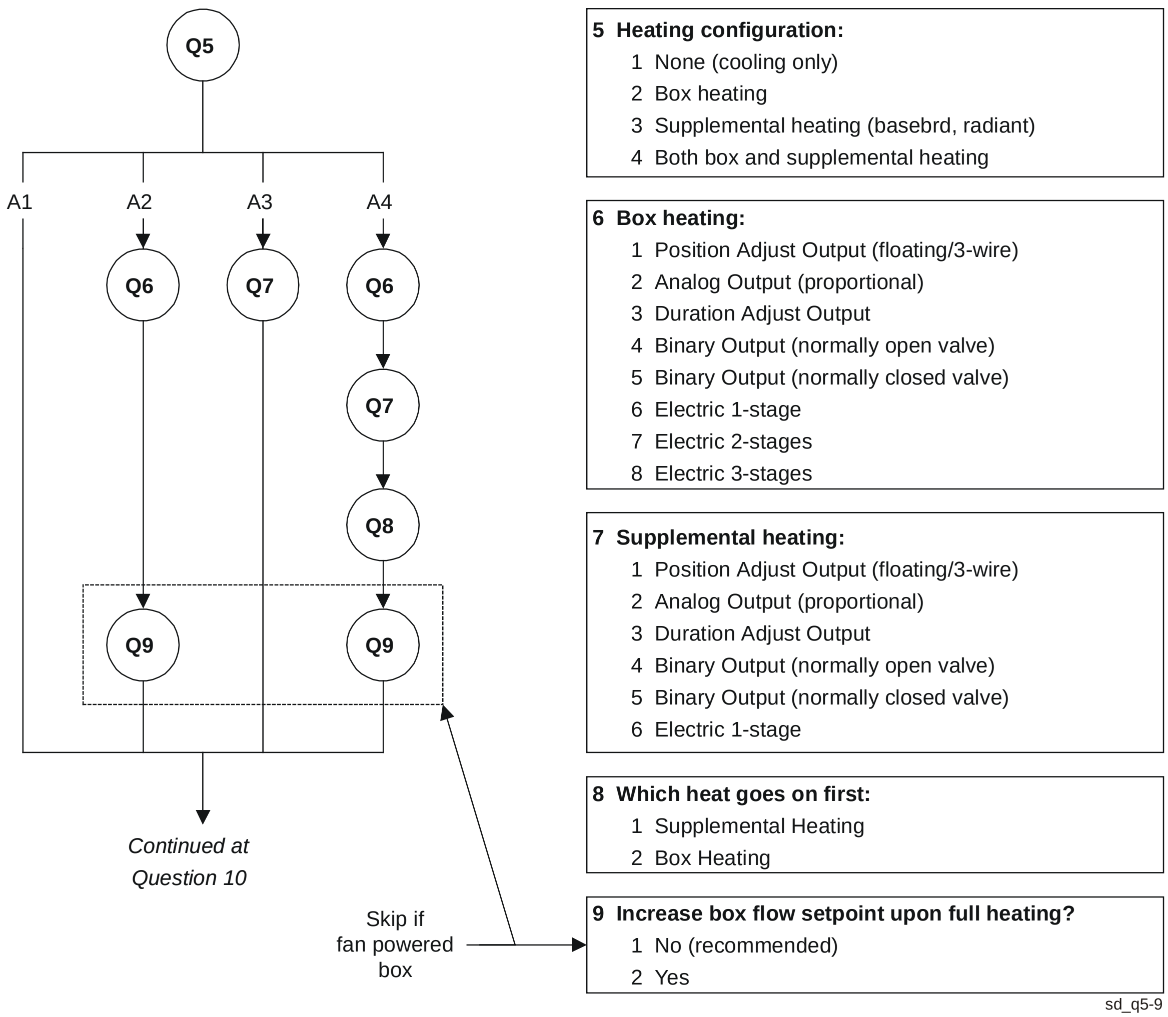

Figure 17: VMA Single Duct Heating Configuration Questions

Heating Configuration

Choose from the options in Table 14.

Table 14: Heating Configuration

Option	Description
None (cooling only)	No points, parameters, or logic are assigned for this answer.
Box Heating	This answer assigns points, parameters, and logic to support heating devices located at the VAV box.
Supplemental Heating (Baseboard, Radiant)	Choosing this answer assigns points, parameters, and logic to control supplemental heating sources (baseboard, or radiant panels, for example.) These types of heat are not dependent upon the supply airflow for proper operation.
Both Box and Supplemental Heating	This choice assigns points, parameters, and logic to control both a box mounted heating device and supplemental heating devices. The box and supplemental heating devices operate in the order specified by the user.

Box and Supplemental Heating

Choose from the options in Table 15.

Table 15: Box and Supplemental Heating

Option	Description
Position Adjust Output **Analog Output** **Duration Adjust Output**	These options load a Position Adjust Output, Analog Output, or Duration Adjust Output respectively, to control the heating device. Complete descriptions of these output types are given in the *Input/Output Options* topic in the *Attributes and Parameters* section of this document. For Application Revision 5 and greater (HVAC PRO software Release 8.03 and later), minimum flow protection is available for box heating Analog Output and Duration Adjust Output options. To activate this protection, configure the Box Htg Elec Protect attribute as True. The minimum flow protection operates in the same manner as described below for the staged electric devices.
Binary Output (Normally Open or Normally Closed Valve)	These options load a single binary output that is set up for a maintained output. The polarity for the normally open valve is Reverse, while the polarity for the normally closed valve is Normal. When the command is greater than the make limit, the BO present value is set to Active. When the command drops below the make limit by the heating differential, the BO present value is set to Inactive. The BO for the normally open valve is energized when the present value is Inactive (valve closed), and the BO for the normally closed valve is energized when the present value is Active (valve open). For more information, see the binary output description in the *Input/Output Options* topic in the *Attributes and Parameters* section of this document.
Electric 1-stage **Electric 2-stages** **Electric 3-stages**	The operation of the Electric Heat Sequencer output type is described in the *Input/Output Options* topic in the *Attributes and Parameters* section of this document. For box heating devices using electric heat, the application contains logic to avoid operating the electric heat with inadequate flow. Operation with inadequate airflow could cause thermal overload protection to trip. VAV box manufacturers typically provide a pressure switch to lock out electric heat in the absence of inlet static pressure. In pressure independent boxes, electric heating is enabled when the measured flow is greater than the box electric heating minimum flow parameter or a box fan is operating. Below this value, electric heat is disabled. To help prevent the box heating from becoming disabled when at minimum flow, set the Occupied Htg Flow and Unoccupied Htg Flow setpoints at least 25% higher than the Box Elec Htg Min Flo parameter.

Which Heat Goes on First

Choose from the options in Table 16.

Table 16: Which Heat Goes on First

Option	Description
Supplemental Heat	Points, parameters, and logic are assigned to cause the supplemental heating to be used prior to the box heating.
Box Heating	Points, parameters, and logic are assigned to cause the box heating to be used prior to the supplemental heating.

Increase Box Flow Setpoint upon Full Heating

Choose from the options in Table 17.

Table 17: Increase Box Flow Setpoint upon Full Heating

Option	Description
No (Recommended)	No points, parameters, or logic are assigned for this answer.
Yes	This answer assigns points, parameters, and logic to allow the heating flow setpoint to increase after all types of heating selected have reached their maximum value. In certain situations, additional heating can be achieved by allowing an increase in the airflow across the heating coil. Utilizing this feature significantly increases energy costs (due to reheating the cooler supply air) and is not recommended.

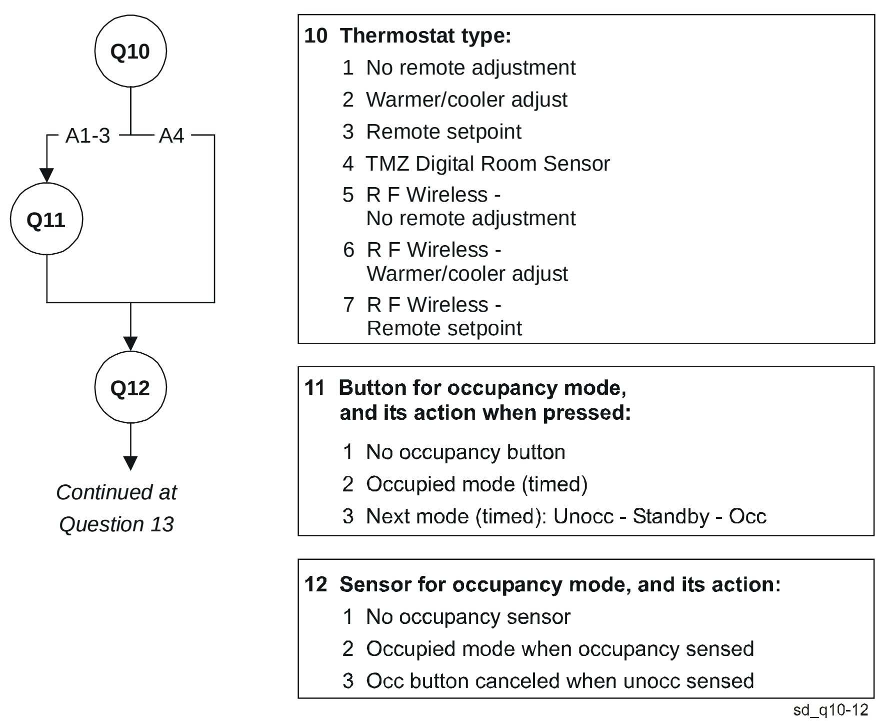

Figure 18: VMA Single Duct Thermostat and Occupancy Input Questions

Thermostat Type

The temperature setpoint calculation is described in detail in the *Key Concepts* section of this document. Choose from the options in Table 18.

Table 18: Thermostat Type

Option	Description
No Remote Adjustment	No remote setpoint adjustment is provided with this option.
Warmer/Cooler Adjust (±3°C, ±5°F)	This adds AI-2 with a default range of -3 to 3°C (-5 to 5°F). This can be scaled by the user. The warmer/cooler adjustment is active during all modes of operation (Occupied, Unoccupied, and Standby).
Remote Setpoint (12/28°C, 65/85°F)	This adds AI-2 with a default range of 12 to 28°C (65 to 85°F). This can be scaled by the user. The warmer/cooler adjustment is active during all modes of operation (Occupied, Unoccupied, and Standby).
TMZ Digital Room Sensor	This option adds the point, parameters, and logic to interface with the TMZ Digital Room Sensor. The TMZ includes an occupancy button that operates according to the Occupied mode (timed) option. For more information, see the *Room Sensor with LCD Display (TMZ1600) Installation Instructions (LIT-6363110)*.
RF Wireless – No Remote Adjustment	This option provides support for the TE-77xx Series RF Wireless Thermostats with no remote setpoint adjustment.
RF Wireless – Warmer/Cooler Adjust	This option provides support for the TE-77xx Series RF Wireless Thermostats that include a warmer/cooler setpoint. This adjustment has a default range of -3 to 3°C (-5 to 5°F) that can be scaled by the user. It is configured in the same manner as the hardware option (adjust AI-2 attributes) and is active in all modes of operation (Occupied, Unoccupied, and Standby).
RF Wireless – Remote Setpoint	This option provides support for the TE-77xx Series RF Wireless Thermostats that include a remote setpoint. This setpoint has a default range of 12 to 28°C (65 to 85°F) that can be scaled by the user. It is configured in the same manner as the hardware option (adjust AI-2 attributes) and is active in all modes of operation (Occupied, Unoccupied, and Standby).

Occupancy Button and Occupancy Sensor

The occupancy button and occupancy sensor options are described in the *Application Logic* topic in the *Key Concepts* section of this document. This section also shows the priority of the occupancy button and sensor inputs in the Occupancy mode calculation.

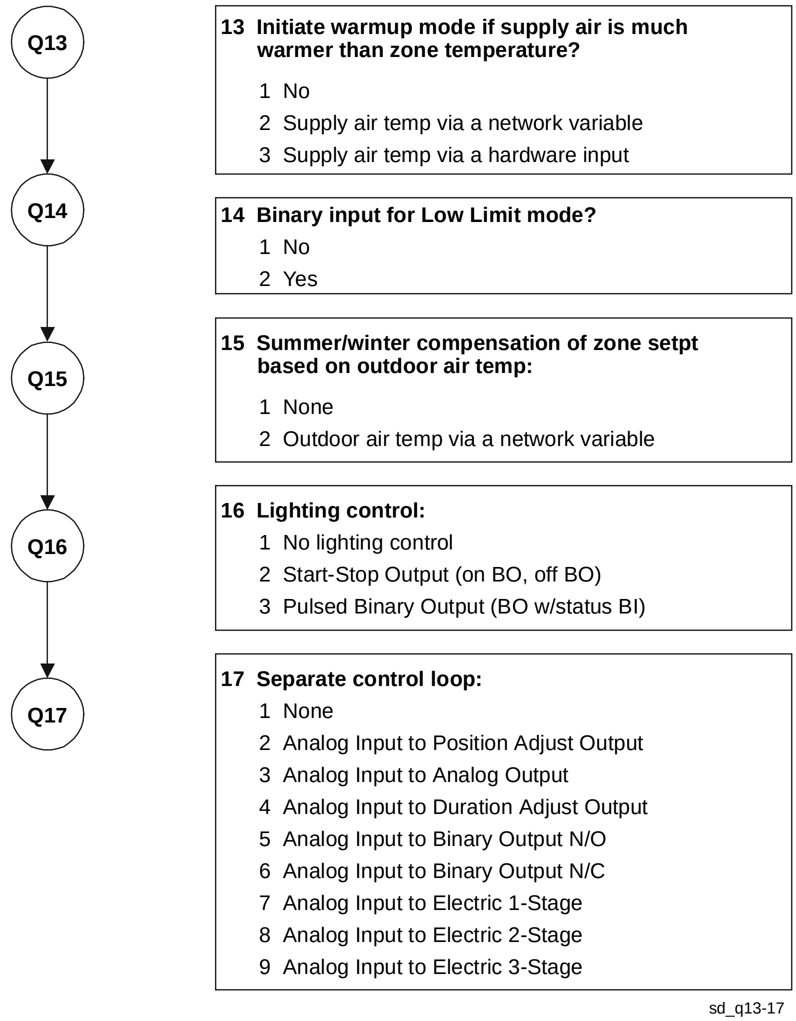

Figure 19: VMA Single Duct Additional Configuration Questions

Initiate Warmup Mode if Supply Air is Much Warmer than Zone Temperature

Choose from the options in Table 19.

Table 19: Initiate Warmup Mode if Supply Air is Much Warmer than Zone Temperature

Option	Description
No	No points, parameters, or logic are assigned for this answer. The Warmup mode for this application can be activated only by a user override of the VAV Box mode.
Supply Air Temp Via a Network Variable	This option loads a network variable to allow a supervisory system to provide the supply air temperature to the controller. If this temperature is greater than the zone cooling setpoint by the warmup differential, the Warmup mode is automatically activated. When the supply air temperature drops below the zone cooling setpoint, the controller reverts to normal operation.
Supply Air Temp Via a Hardware Input	This option loads an analog input to sense the supply air temperature. If this temperature is greater than the zone cooling setpoint by the warmup differential, the Warmup mode is automatically activated. When the supply air temperature drops below the zone cooling setpoint, the controller reverts to normal operation. Note: If the supply air temperature is measured locally with an AI, the sensor must be mounted upstream of any heating coils in the VAV box.

Binary Input for Low Limit Mode

Choose from the options in Table 20.

Table 20: Binary Input for Low Limit Mode

Option	Description
No	No points, parameters, or logic are assigned for this answer. The Low Limit mode for this application can be activated only by a user override of the VAV Box mode.
Yes	This choice assigns points, parameters, and logic to provide a low limit operation of supplemental heating. When a binary input, such as a window contact or overhead door switch, indicates Low Limit mode, the VAV box damper closes and all fans (if present) and box heating (if present) turn off. If the zone temperature drops below the low limit setpoint, the supplemental heat (if present) operates to maintain the zone temperature.

Summer/Winter Compensation of Zone Setpoint Based on Outdoor Air Temperature

Choose from the options in Table 21.

Table 21: Summer/Winter Compensation of Zone Setpoint Based on Outdoor Air Temperature

Option	Description
None	No points, parameters, or logic are assigned for this answer.
Outdoor Air Temp Via a Network Variable	Summer/winter compensation allows temperature setpoint reset based on outdoor air temperature. The complete temperature setpoint calculation, along with the contribution of the summer and winter compensation, is described in detail in the *Key Concepts* section.

Lighting Control

The lighting output turns the lights on when the controller is in the Occupied mode. When the controller transitions to the Unoccupied or Standby mode, the lights turn off for two seconds and then turn back on (blink). After the Light Shutoff Delay (user configurable with default of two minutes), the lights turn off completely. There are two types of lighting relays, start-stop output and pulsed binary output. Note that only three BOs are left on the VMA1430 for lights/heating, for example, when an incremental damper actuator is used.

Choose from the options in Table 22.

Table 22: Lighting Control

Option	Description
No Lighting Control	No points, parameters, or logic are assigned for this answer.
Start-Stop Output (on BO, off BO)	Points, parameters, and logic are assigned to provide a start-stop output to control a momentary lighting relay (GE RR-7EZ 24 V relay). Two triac outputs are used. The first (start) triac pulses on when lighting should be on and the second (stop) triac pulses on when lighting should be off.
Pulsed Binary Output (BO w/status BI)	This choice assigns points, parameters, and logic to control a pulse type lighting relay. One triac output is used. This relay type provides a feedback contact to indicate its output status and receives a pulse to change the state of the output (Touchplate/Microlite relay). The controller monitors the status of the feedback contact and issues the pulse when the requested command does not match the current relay feedback.

Separate Control Loop

This allows the user to add a single extra control loop to the controller. The default sideloop input is AI-3, a 0/16.5 V input scalable by the user. If temperature input is desired, the sideloop input can be moved to AI-4. The signal from the analog input becomes the process variable of a PID controller. For Position Adjust Output (PAO) and AO output types, PRAC is used to automatically tune the PI controller. The output of the PID provides the command to the output types that require a 0 to 100% signal (PAO, AO, DAO, Electric Heat Sequencer [EHS]). If the output type is the binary normally open or closed valve, the controller uses the sideloop make limit and sideloop differential to operate the valve. There are no point conditioning, interlocking, or Occupied mode provisions in this loop. PRAC does not run with EHS, DAO, or BOs. For more complete descriptions of the output types, see the *Input/Output Options* topic in the *Attributes and Parameters* section of this document.

Creating a VMA Dual Duct Application

To create a VMA dual duct application:

1. On the Action menu, click Job Information.
2. Select either English or Metric units. Click OK.
3. On the File menu, click New.
4. In the Application Group drop-down list, click VAV Applications.
5. In the Application box, click VMA Dual Duct.

Note: Refer to the *HVAC PRO User's Guide* for further explanation.

6. Answer the questions as they are presented. The sequence of question and answers appears in Figures 20-23. An explanation of each question and answer appears following the figure in which the question is shown. The chosen answer for each question provides default parameter values. The user changes those values when required.

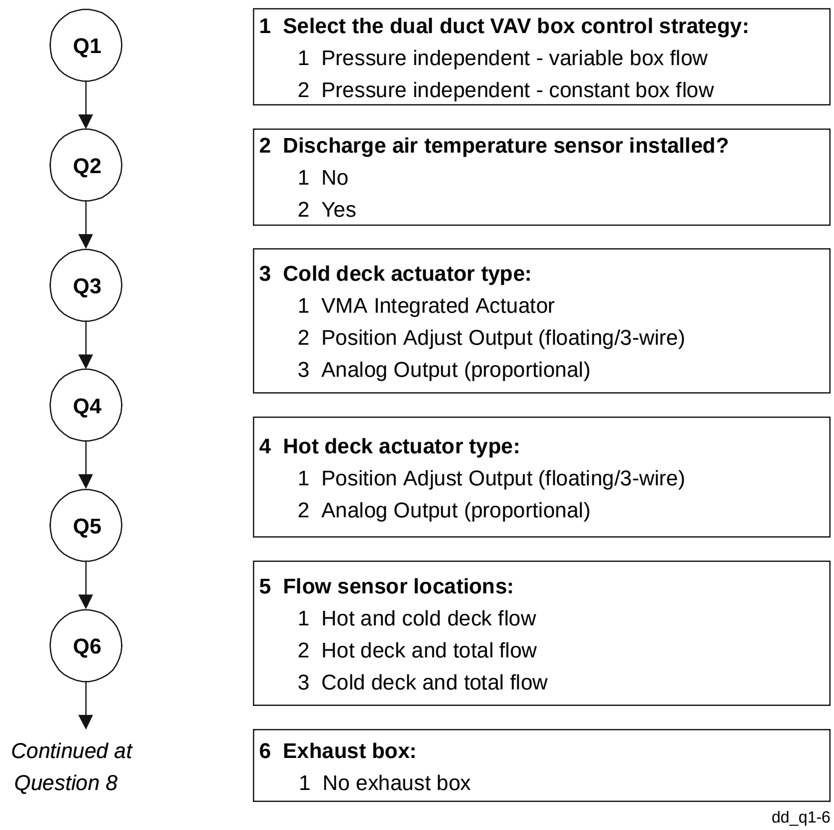

Figure 20: VMA Dual Duct Basic Box Configuration Questions

Select the Dual Duct VAV Box Control Strategy

The VMA dual duct application set includes only pressure independent applications. Two sets of default flow setpoint configuration parameters are provided, one for a VAV with mixing flow schedule and one for a constant volume flow schedule. Regardless of the default values chosen at this question, any flow setpoint configuration can be specified by changing the flow setpoint configuration parameters. The unoccupied minimum flow parameters have default values of zero for both options.

Discharge Air Temperature Sensor Installed

If a discharge air sensor is present, the application uses the measured discharge air temperature to estimate online the hot and cold deck temperatures. If a sensor is not installed, you can configure and/or command the hot and cold deck source temperature network variables to reflect the actual deck temperatures. The discharge temp limit is enabled whether or not a sensor is present, but the default for the limit has a value of 0°C (32°F).

Cold Deck Actuator Type

The VMA dual duct application supports three actuator types for the cold deck actuator. The VMA1420 has an integrated actuator. This actuator is a stepper motor that allows fast response with fine step resolution. If the integrated actuator is used, it must control the cold deck. Instead of the integrated actuator, a VMA1430 can be used with an external 3-wire (floating) actuator or proportional (analog output) actuator. For a more detailed description of the output types, see the *Input/Output Options* topic in the *Attributes and Parameters* section of this document.

Hot Deck Actuator Type

The VMA dual duct application supports an external 3-wire (floating) actuator or proportional (analog output) actuator for the hot deck damper. For a more detailed description of the output types, see the *Input/Output Options* topic in the *Attributes and Parameters* section of this document. An example wiring diagram for the external actuator and velocity pressures sensor is given in *Mounting and Wiring Variable Air Volume Modular Assembly (VMA) 1400 Series Controllers Technical Bulletin (LIT-6363125)*.

Flow Sensor Locations

The VAV box manufacturer can mount flow pickups on the hot and cold deck inlets upstream of the dampers. A flow pickup can also measure the total flow rate, but this must be installed by site personnel 5-10 duct diameters downstream of the mixing chamber to ensure a reliable reading and should be positioned to represent the average flow in the duct. Turbulence in the duct can cause airflow to shift.

The application allows the user to specify flow sensor inputs from any two of these three possible locations.

Exhaust Box

The current release of the VMA dual duct application does not support exhaust box control.

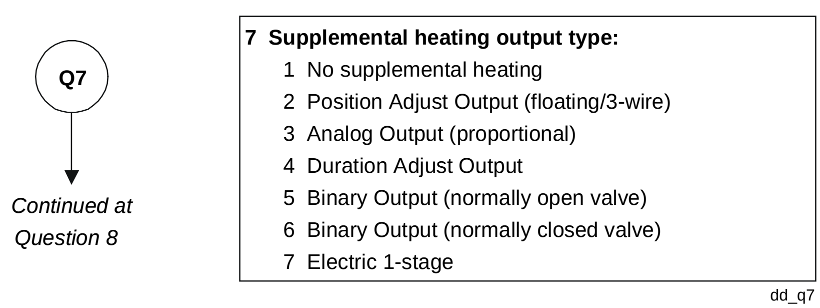

Figure 21: VMA Dual Duct Heating Configuration Question

Supplemental Heating Output Type

The supplemental heat (if present) is modulated before the hot deck.

Table 23: Supplemental Heating Output Type

Option	Description
No Supplemental Heating	No supplemental heating is assigned.
Position Adjust Output **Analog Output** **Duration Adjust Output** **Electric - 1 Stage**	These options load a Position Adjust Output, Analog Output, Duration Adjust Output, or one-stage Electric Heat Sequencer respectively, to control the heating device. Complete descriptions of these output types are given in the *Input/Output Options* topic in the *Attributes and Parameters* section of this document.
Binary Output (Normally Open Valve) **Binary Output (Normally Closed Valve)**	These options load a single binary output that is set up for a maintained output. The polarity for the normally open valve is Reverse, while the polarity for the normally closed valve is Normal. When the command is greater than the make limit, the BO present value is set to Active. When the command drops below the make limit by the heating differential, the BO present value is set to Inactive. The BO for the normally open valve is energized when the present value is Inactive (valve closed), and the BO for the normally closed valve is energized when the present value is Active (valve open). For more information, see the binary output description in the *Input/Output Options* topic in the *Attributes and Parameters* section of this document.

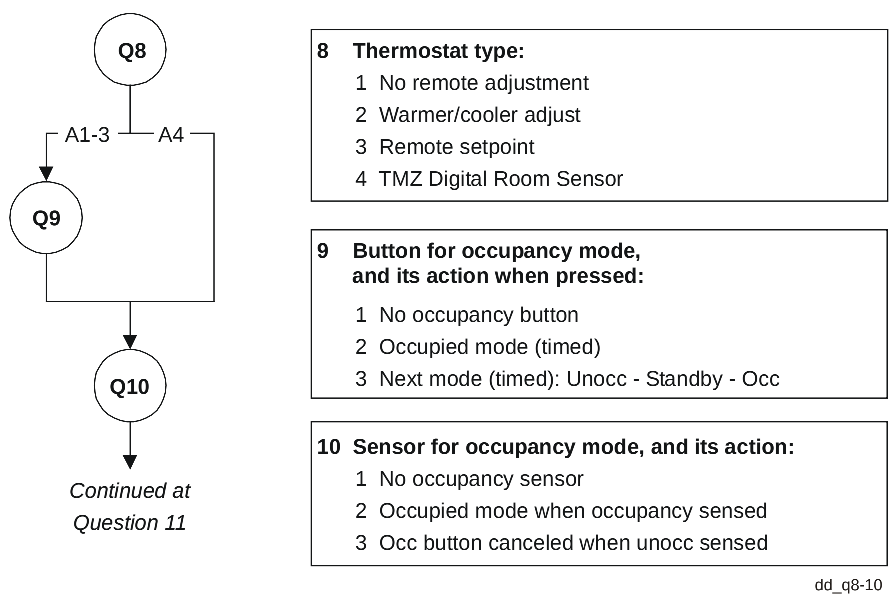

Figure 22: VMA Dual Duct Thermostat and Occupancy Input Questions

Thermostat Type

The temperature setpoint calculation for the dual duct application is described in the *Application Logic* and *VMA Dual Duct Applications* topics in the *Key Concepts* section of this document.

Choose from the options in Table 24.

Table 24: Thermostat Type

Option	Description
No Remote Adjustment	No remote setpoint adjustment is provided with this option.
Warmer/Cooler Adjust (+/-3°C, +/-5°F)	This adds AI-2 with a default range of -3 to 3°C (-5 to 5°F). This can be scaled by the user. The warmer/cooler adjustment is active during all modes of operation (Occupied, Unoccupied, and Standby).
Remote Setpoint (12-28°C, 65-85°F)	This adds AI-2 with a default range of 12 to 28°C (65 to 85°F). This can be scaled by the user. The warmer/cooler adjustment is active during all modes of operation (Occupied, Unoccupied, and Standby).
TMZ Digital Room Sensor	This option adds the point, parameters, and logic to interface with the TMZ Digital Room Sensor. The TMZ includes an occupancy button that operates according to the Occupied mode (timed) option. For more information, see *Room Sensor with LCD Display (TMZ1600) Installation Instructions (LIT-6363110)*.

Occupancy Button and Occupancy Sensor

The occupancy button and occupancy sensor options (Question 9 and Question 10 in Figure 22) are described in the *Key Concepts* section of this document. This section also shows the priority of the occupancy button and sensor inputs in the Occupancy mode calculation.

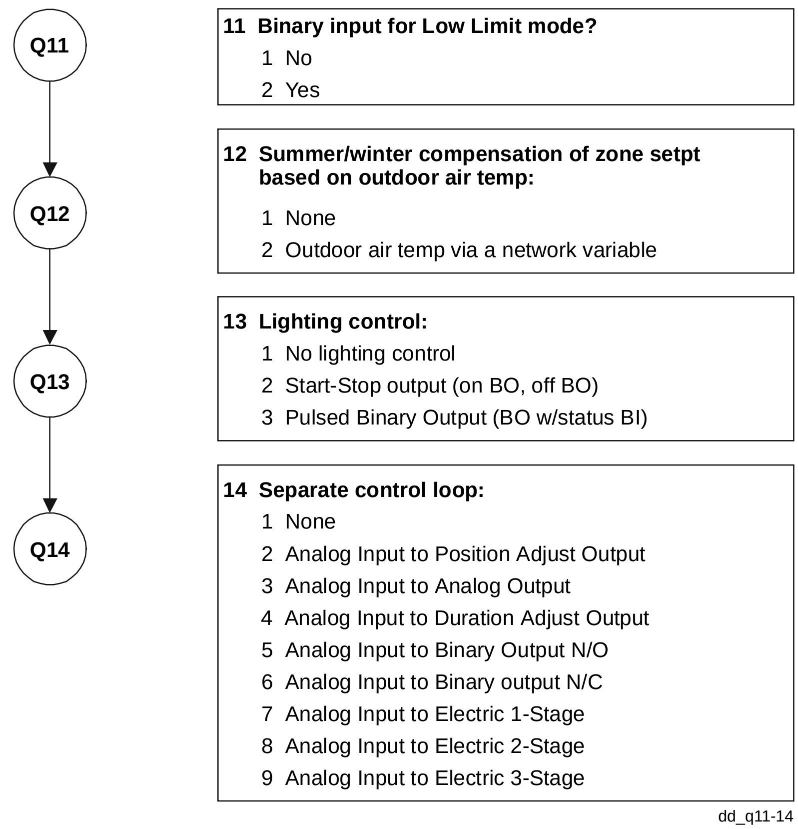

Figure 23: VMA Dual Duct Additional Configuration Questions

Binary Input for Low Limit Mode

Choose from the options in Table 25.

Table 25: Binary Input for Low Limit Mode

Option	Description
No	No points, parameters, or logic are assigned for this answer. The Low Limit mode for this application can be activated only by a user override of the Low Limit Req parameter.
Yes	This choice assigns points, parameters, and logic to provide a low limit operation of supplemental heating. When the application enters Low Limit mode, both VAV box dampers close. If the zone temperature drops below the low limit setpoint, the supplemental heat (if present) operates to maintain the zone temperature at this setpoint.

Summer/Winter Compensation of Zone Setpoint Based on Outdoor Air Temperature

Choose from the options in Table 26.

Table 26: Summer/Winter Compensation of Zone Setpoint Based on Outdoor Air Temperature

Option	Description
None	No points, parameters, or logic are assigned for this answer.
Outdoor Air Temp Via a Network Variable	Summer/winter compensation allows temperature setpoint reset based on outdoor air temperature. The complete temperature setpoint calculation, along with the contribution of the summer and winter compensation, is described in detail in the *Key Concepts* section.

Lighting Control

The lighting output turns the lights on when the controller is in the Occupied mode. When the controller transitions to the Unoccupied or Standby mode, the lights turn off for two seconds and then turn back on (blink). After the Light Shutoff Delay (user configurable with default of two minutes), the lights turn off completely. There are two types of lighting relays, start-stop output and pulsed binary output. Note that only one BO is left on the VMA1430 for lights/heating when two incremental damper actuators are used. Choose from the options in Table 27.

Table 27: Lighting Control

Option	Description
No Lighting Control	No points, parameters, or logic are assigned for this answer.
Start-Stop Output (on BO, off BO)	Points, parameters, and logic are assigned to provide a start-stop output to control a momentary lighting relay (GE RR-7 relay). Two triac outputs are used. The first (start) triac pulses on when lighting should be on and the second (stop) triac pulses on when lighting should be off.
Pulsed Binary Output (BO w/status BI)	This choice assigns points, parameters, and logic to control a pulse type lighting relay. This relay type provides a feedback contact to indicate its output status and receives a pulse to change the state of the output (Touchplate/Microlite relay). The controller monitors the status of the feedback contact and issues the pulse when the requested command does not match the current relay feedback.

Separate Control Loop

This allows the user to add a single extra control loop to the controller. The dual duct application uses AI-3 for the external flow sensor input. For this reason, only temperature based sideloops are supported using AI-4 (if discharge air sensor is not specified). The signal from the analog input becomes the process variable of a PID controller. For PAO and AO output types, PRAC is used to automatically tune the PI controller. The output of the PID provides the command to the output types that require a 0 to 100% signal (PAO, AO, DAO, and EHS). If the output type is the binary normally open or closed valve, the controller uses the sideloop make limit and sideloop differential to operate the valve. There are no point conditioning, interlocking, or Occupied mode provisions in this loop. PRAC does not run with EHS, DAO, or BOs. For more complete descriptions of the output types, see the *Input/Output Options* topic in the *Attributes and Parameters* section of this document.

Changing the VMA Parameter View

To change the VMA parameter view:

1. Open or create a VMA configuration file.
2. On the Options menu, click View.
3. Select the desired view from the four available options (Table 28).

Note: Select the view **before** the controller is commissioned. Once in Commissioning mode, the view cannot be changed until you exit Commissioning mode.

Table 28: VMA Parameter Views

View	Description
Configuration	Shows only configurable parameters. This view is recommended when modifying configuration files to match specifications.
Commissioning	Shows calculated values in addition to the configurable parameters. This view is recommended for use when commissioning a controller at a job site.
Test and Balance	Shows a small set of parameters and values useful to test and balance contractors.
Diagnostics	Shows the same information as the commissioning view plus additional attributes of the application. Values of the additional attributes are set by HVAC PRO software and should not be modified by the user. Due to the quantity of attributes in this view, updates are slow. Only use this view for serious application problems.

Configuring a VMA Application

To configure a VMA application:

1. Open or create a VMA application for the current VMA to be configured.
2. Check the inputs to ensure the configuration matches the installed sensor types and slot wiring.
3. Check the outputs to ensure the configuration matches any applicable actuators, valves, relays, and wiring. Review the action direction (direction to close or polarity) to ensure the controller configuration matches the installed hardware.
4. Check the temperature setpoints and biases and modify to match the job specifications.
5. Modify the flow setpoints and box flow configuration (area and pickup gain) to match the VAV box specifications.
6. Check the configuration parameters for any additional features (such as occupancy button or sensor, lighting, warmup) selected during the question and answer session and modify to ensure they meet any specified requirements.
7. Save the changes to the configuration file and download the new file to the VMA controller. Alternately, the values can be changed while commissioning the VMA controller and saved to the controller and filed when exiting the Commissioning mode.

Note: The *Attributes and Parameters* section describes all of the parameters shown in the main views as well as most of the attributes of the input and output options.

Commissioning a VMA Application

Note: These commissioning steps are meant to provide a guideline for some common tasks to perform during commissioning. This is **not** an exhaustive commissioning guide and does not provide all commissioning procedures required for a given job.

To commission a VMA application:

1. Open the file corresponding to the current VMA to be commissioned.
2. Change the parameter view to Commissioning.
3. On the Commission menu, click Current Configuration.
4. Check the inputs to ensure that reliable and reasonable values are being sensed by the controller.

5. Override the outputs and verify that the installed hardware actuates correctly. If a discharge air sensor is installed, the box heat operation can be verified by checking for temperature rise when the box heat is activated.
6. On the Action menu, click VAV Box Flow Test (single duct applications only). See the *Flow Test* topic in the *Key Concepts, VMA Diagnostics* section for more details.
7. On the Action menu, click Collect VAV Diagnostics. This tool scans the N2 trunk for VMA controllers and collects temperature, flow and actuator diagnostics for both single and dual duct configurations. Controllers with large errors should be examined more closely.

Testing and Balancing a VMA Single Duct Supply/Exhaust Application

This section describes a recommended test and balance procedure for balancing the VMA single duct supply/exhaust application using HVAC PRO software. The testing and balancing procedure reconciles the VMA flow measurements with the flow measurements of the balancer. The tools needed for this procedure include a calibrated flow measurement device suitable for the installed diffusers and a laptop computer connected to the VMA either through the Zone Bus or N2 Bus. For more information, see the *Testing and Receiving Data from Controllers* chapter of the *HVAC PRO User's Guide (LIT-63750416)*. Parameters are referenced using the following form: (Group Name) Parameter Name.

Startup

Start up the test and balancing session.

Note: Before starting, ensure that the Area and Flow Coefficient are correct for both the supply and exhaust decks. Also record the current Pickup Gain for each deck. These parameters can be found in the Supply Flow Config and Exhaust Flow Config parameter groups.

1. Start HVAC PRO software.
2. On the File menu, click Open.
3. Open the file corresponding to the current VMA to be balanced.
4. On the Options menu, click View > Test and Balance.

5. On the Commission menu, click Configuration in Controller.

Note: The pickup gains for the supply and exhaust decks can be calibrated at any desired flow setpoint or averaged for multiple flow setpoints. The exhaust flow setpoint always equals the supply flow setpoint plus the current exhaust differential, which is a function of the Occupancy mode. The steps required to calibrate at the minimum cooling flow, the maximum cooling flow, and the heating flow setpoints are given in the following sections.

Calibrate Pressure Sensor Offsets and Check for Leakage

To calibrate and check the system:

1. Issue an Autocalibration command. Override the parameter (Autocalibration) Autocal Req to True and then release.
2. Override (VAV Box mode) Present Value to Shutdown Closed. This keeps both dampers forced closed after the autocalibration is complete to allow for leakage check.
3. Measure airflow to determine leakage at full closed position. If amount of leakage is unacceptable, check damper actuators to ensure they are in the fully closed positions. If they are not fully closed, start again from Step 1.
4. Release the override on (VAV Box mode) Present Value.

Balance at Minimum Cooling Flow

To balance at minimum cooling flow:

1 Override (VAV Box mode) Present Value to Satisfied.

2. Wait for the VMA to reach the new flow setpoints.
3. Record the flow calculated by the VMA for the supply and exhaust flows and measure the actual flows with a hood.

Note: For each set of data, the pickup gain at the minimum flow is:

$$PickupGain_{MinFlow} = \left(\frac{MinFlow_{VMA}}{MinFlow_{Hood}} \right)^2 * PickupGain_{VMA}$$

4. Release the override on (VAV Box mode) Present Value.

Balance at Maximum Cooling Flow

1 Override (VAV Box mode) Present Value to Shutdown Open.
2. Wait for the VMA to reach the new flow setpoints.
3. Record the flow calculated by the VMA for the supply and exhaust flows and measure the actual flows with a hood.

Note: For each set of data, the pickup gain is:

$$\text{PickupGain}_{\text{MaxFlow}} = \left(\frac{\text{MaxFlow}_{\text{VMA}}}{\text{MaxFlow}_{\text{Hood}}}\right)^2 * \text{PickupGain}_{\text{VMA}}$$

4. Release the override on (VAV Box mode) Present Value.

Balance at Heating Flow

To balance at heating flow:

1. Override (VAV Box mode) Present Value to Heating.
2. Wait for the VMA to reach the new flow setpoints.
3. Record the flow calculated by the VMA for the supply and exhaust flows and measure the actual flows with a hood.

Note: For each set of data, the pickup gain is:

$$\text{PickupGain}_{\text{HtgFlow}} = \left(\frac{\text{HtgFlow}_{\text{VMA}}}{\text{HtgFlow}_{\text{Hood}}}\right)^2 * \text{PickupGain}_{\text{VMA}}$$

4. Release the overrides on (VAV Box mode) Present Value.

Finish

To finish testing and balancing:

1. Write the new pickup gain values for the supply and exhaust configurations (Supply Flow Config and Exhaust Flow Config groups).
2. Override the parameter (VAV Box mode) Present Value to Satisfied.
3. Wait 10 seconds and then release the override. This returns the application to the necessary automatic mode.
4. On the Commission menu, click Exit Commissioning Mode.
5. Click the Exit/Save Changes button.

Table 29: VMA Single Duct Supply/Exhaust Application Test and Balance Attributes Mapped to the Metasys Network

Attribute	Short Name	Long Name	Address
VAV Box Mode			
	BOXMODE	Present Value	ADI 67
Supply flow			
	FLOWAREA	Area	ADF 24
	PKUPGAIN	Pickup Gain	ADF 25
	FLOWCOEF	Flow Coefficient	ADF 26
	SUPFLOW	Process Variable	ADF 58
	SUPFLOSP	Setpoint	ADF 150
Exhaust Flow			
	EFLOAREA	Area	ADF 21
	EPKPGAIN	Pickup Gain	ADF 22
	EFLWCOEF	Flow Coefficient	ADF 23
	EXHFLOW	Process Variable	ADF 59
	EXHFLOSP	Setpoint	ADF 151
Autocalibration			
	ACREQ	Autocalibration Request	BD 168
	ACACT	Autocalibration Active	BD 66

Testing and Balancing a VMA Dual Duct Application

This section describes a recommended test and balance procedure for balancing the VMA dual duct application using HVAC PRO software. The tools needed for this procedure include a calibrated flow measurement device suitable for the installed diffusers and a laptop computer connected to the VMA either through the Zone Bus or N2 Bus. For more information, see the *Testing and Receiving Data from Controllers* chapter of the *HVAC PRO User's Guide (LIT-63750416)*. Parameters are referenced using the following form: (Group Name) Parameter Name.

For this description, parameters are found in the Parameter list box and are referenced with the group name in parentheses followed by the parameter name. The reference form is: (Group Name) Parameter Name.

Startup

To start up the testing and balancing session:

Note: Before starting, ensure that the Area and Flow Coefficient are correct for both the cold and hot decks. Also record the current Pickup Gain for each deck. These parameters can be found in the Cold Flow Config and Hot Flow Config parameter groups.

1 Start HVAC PRO software.

2. On the File menu, click Open.
3. Open the file corresponding to the current VMA to be balanced.
4. On the Options menu, click View > Test and Balance.
5. On the Commission menu, click Current Configuration.

Calibrate Pressure Sensor Offsets and Check for Leakage

To calibrate pressure sensor offsets and check for leakage:

1. Issue an Autocalibration command. Override the parameter (Autocalibration) Autocal Req to True and then release.
2. Force the dampers to remain shut. Override (VAV Box mode) Present Value to Shutdown Closed. This keeps both dampers forced closed after the autocalibration is complete to allow for leakage check.
3. Measure airflow to determine leakage at full closed position. If amount of leakage is unacceptable, check damper actuators to ensure they are in the fully closed positions.
4. Release the override on (VAV Box mode) Present Value.
5. Wait for autocalibration to complete (if not already finished). The parameter (Autocalibration) Autocal Active is True if the autocalibration is still active.

Balance Cold Deck

If a cold deck flow sensor is used, balance the cold deck as follows.

1. Override the parameter (Command modes) Hot Deck Available to False. This commands the hot deck damper fully closed.
2. Override (VAV Box mode) Present Value to Satisfied. This will keep PRAC from trying to tune during the balancing overrides.
3. Ensure that the (Cold Deck) Area and Flow Coefficient are correct for the cold deck. Also record the current Pickup Gain.
4. To balance at the minimum flow, override the parameter (Command modes) Cold Deck Percent to 0%. Wait for VMA to reach the new flow setpoint. Record the flow calculated by the VMA and measure the actual flow with a hood.
5. To balance at the maximum flow, override the parameter (Command modes) Cold Deck Percent to 100%. Wait for the VMA to reach the new flow setpoint. Record the flow calculated by the VMA and measure the actual flow with a hood.

Note: The new pickup gain can be calculated using the minimum or maximum flow data or both sets of data. For each set of data the pickup gain is:

$$PickupGain_{MinFlow} = \left(\frac{MinFlow_{VMA}}{MinFlow_{Hood}}\right)^2 * PickupGain_{VMA}$$

$$PickupGain_{MaxFlow} = \left(\frac{MaxFlow_{VMA}}{MaxFlow_{Hood}}\right)^2 * PickupGain_{VMA}$$

6. Replace the (Cold Deck) Pickup Gain with the value calculated for the minimum flow or maximum flow or an average of the two.
7. Release the overrides on (VAV Box mode) Present Value and (Command modes) Hot Deck Available and Cold Deck Percent.

Balance Hot Deck

If a hot deck flow sensor is used, balance the hot deck.

1. Override the parameter (Command modes) Cold Deck Available to False. This commands the hot deck damper fully closed.
2. Override (VAV Box mode) Present Value to Satisfied. This keeps PRAC from trying to tune during the balancing overrides.
3. Ensure that the (Hot Deck) Area and Flow Coefficient are correct for the hot deck. Also record the current Pickup Gain.
4. To balance at the minimum flow, override the parameter (Command modes) Hot Deck Percent to 0%. Wait for VMA to reach the new flow setpoint. Record the flow calculated by the VMA and measure the actual flow with a hood.
5. To balance at the maximum flow, override the parameter (Command modes) Hot Deck Percent to 100%. Wait for the VMA to reach the new flow setpoint. Record the flow calculated by the VMA and measure the actual flow with a hood.

Note: The new pickup gain can be calculated using the minimum or maximum flow data, or both sets of data. For each set of data the pickup gain is:

$$PickupGain_{MinFlow} = \left(\frac{MinFlow_{VMA}}{MinFlow_{Hood}}\right)^2 * PickupGain_{VMA}$$

$$PickupGain_{MaxFlow} = \left(\frac{MaxFlow_{VMA}}{MaxFlow_{Hood}}\right)^2 * PickupGain_{VMA}$$

6. Replace the (Hot Deck) Pickup Gain with the value calculated for the minimum flow or maximum flow or an average of the two.
7. Release the overrides on (VAV Box mode) Present Value and (Command modes) Cold Deck Available and Hot Deck Percent.

Balance Total Flow

If a total flow sensor is used, balance the total flow from the box.

1. Ensure that the (Total Flow) Area and Flow Coefficient are correct for the total flow pickup. Also record the current Pickup Gain.
2. To balance at the minimum flow, override (VAV Box mode) Present Value to Satisfied. Wait for VMA to reach the new flow setpoints. Record the flow calculated by the VMA and measure the actual flow with a hood. The total flow setpoint is equal to the box minimum flow, the hot deck flow setpoint is equal to the hot deck min flow, and the cold deck flow setpoint is equal to the difference between the box minimum flow and hot deck flow setpoints.
3. To balance the total flow with the cold deck at its maximum flow, override the parameters (Command modes) Cold Deck Percent to 100% and Hot Deck Percent to 0%. Wait for the VMA to reach the new flow setpoints. Record the flow calculated by the VMA and measure the actual flow with a hood.
4. To balance the total flow with the hot deck at its maximum flow, override the parameters (Command modes) Cold Deck Percent to 0% and Hot Deck Percent to 100%. Wait for the VMA to reach the new flow setpoints. Record the flow calculated by the VMA and measure the actual flow with a hood.

Note: The new (Total Flow) Pickup Gain can be calculated using any data. For each set of data the pickup gain is:

$$\text{PickupGain}_{\text{MinFlow}} = \left(\frac{\text{MinFlow}_{\text{VMA}}}{\text{MinFlow}_{\text{Hood}}} \right)^2 * \text{PickupGain}_{\text{VMA}}$$

$$\text{PickupGain}_{\text{C lg MaxFlow}} = \left(\frac{\text{C lg MaxFlow}_{\text{VMA}}}{\text{C lg MaxFlow}_{\text{Hood}}} \right)^2 * \text{PickupGain}_{\text{VMA}}$$

$$\text{PickupGain}_{\text{HtgMaxFlow}} = \left(\frac{\text{HtgMaxFlow}_{\text{VMA}}}{\text{HtgMaxFlow}_{\text{Hood}}} \right)^2 * \text{PickupGain}_{\text{VMA}}$$

5. Replace the (Total Flow) Pickup Gain with the value from that calculated for the box minimum flow, one of the maximum flows, or an average of the two or more.
6. Release the overrides on (VAV Box mode) Present Value and (Command modes) Cold Deck Percent and Hot Deck Percent.

Finish

To finish test and balancing:

1. Override the parameter (VAV Box mode) Present Value to Satisfied. Wait 10 seconds and then release the override. This returns the application to the necessary Automatic mode.
2. On the Commission menu, click Exit Commissioning Mode.
3. Click the Exit/Save Changes button.

Note: The test and balance application overrides also can be done via an Operator Workstation (OWS) if a second person is in communication with the person making the overrides on the OWS. Table 30 shows the mapping for the required parameters referenced in the previous sections. Figure 13 shows the VAV Box mode enumeration set.

Table 30: VMA Dual Duct Application Test and Balance Attributes Mapped to the Metasys Network

Attribute	Short Name	Long Name	Address
VAV Box Mode			
	BOXMODE	Present Value	ADI 67
Command Modes			
	CDAVAIL	Cold Deck Available	BD 75
	HDAVAIL	Hot Deck Available	BD 76
	CDPERCNT	Cold Deck Percent	ADF 71
	HDPERCNT	Hot Deck Percent	ADF 72
Cold Deck			
	CDAREA	Area	ADF 11
	CDPKUPGN	Pickup Gain	ADF 12
	CDFLCOEF	Flow Coefficient	ADF 13
	CDFLOSP	Setpoint	ADF 65
	CDFLOW	Cold Deck Flow	ADF 36
Hot Deck			
	HDAREA	Area	ADF 14
	HDPKUPGN	Pickup Gain	ADF 15
	HDFLCOEF	Flow Coefficient	ADF 16
	HDFLOSP	Setpoint	ADF 66
	HDFLOW	Hot Deck Flow	ADF 37
Total Flow			
	TOTAREA	Area	ADF 17
	TOTPKPGN	Pickup Gain	ADF 18
	TOTFCOEF	Flow Coefficient	ADF 19
	TOTFLOSP	Setpoint	ADF 67
	TOTFLOW	Total Deck Flow	ADF 38
Autocalibration			
	ACREQ	Autocal Request	BD 70
	ACACT	Autocal Active	BD 60

Troubleshooting

Table 31 describes known problems and their solutions.

Table 31: Troubleshooting VMA Controllers

Error/Condition	Problem	Solution
VMA Application Disappears after HVAC PRO Software Reports Download Complete	After HVAC PRO software completes a download, the VMA must still complete an internal archive. If the VMA is disconnected from 24 VAC power immediately after HVAC PRO software indicates that the application download is complete, the application is lost. This problem only pertains to HVAC PRO Release 7.01 or earlier.	Use one of the following methods to correct the problem: • Upgrade to HVAC PRO Release 7.02 or later, which is updated to report download complete after the VMA completes its internal archive (for single VMA downloads). • Allow the VMA to remain powered for an additional 60 seconds after HVAC PRO software indicates that the download is complete. • Select Controller Information from the Action menu and wait until device status indicates that the VMA is operational.
Heating Does Not Operate When File Upgrade is Performed with HVAC PRO Release 7.01	If HVAC PRO Release 7.01 is used to upgrade a VMA configuration file originally created in HVAC PRO Release 7.00, the VMA Box mode remains in Satisfied state and does not transition to Heating mode even when the zone temperature is less than the setpoint and the Heating Available parameter is True.	Use one of the following methods to correct the problem: • Use HVAC PRO Release 7.02 or later to open, save, and download the VMA configuration file. • Select Upgrade Controllers from the Upload menu in HVAC PRO Release 7.01 or later.
VMA Does Not Come Online	The VMA may be unable to communicate on the same N2 trunk as some third-party vendor devices because the VMA sends data other than American Standard Code for Information Interchange (ASCII) text. If this problem exists, the VMA does not come online when it is added to the N2 trunk where the vendor device is connected. If the vendor device is added to the N2 after the VMAs are online, the VMAs will go offline.	This is not necessarily a problem with the VMA; it may be a problem with the communication firmware of the vendor device. To determine whether this problem exists, disconnect all vendor devices and see if the VMA comes online. If so, contact the vendor to upgrade the firmware of the vendor device. The VTAC 7 and GV3000 drives from Reliance Electric are the only devices currently known to cause this problem, and they can be successfully upgraded by the manufacturer.
	N2 addresses of 254 and/or 255 have been used.	N2 addresses of 254 and 255 are reserved for VMA broadcast messages. Use only Addresses 1-253. See *Mounting and Wiring Variable Air Volume Modular Assembly (VMA) 1400 Series Controllers Technical Bulletin (LIT-6363125)* for more information.

Continued on next page . . .

Error/Condition (Cont.)	Problem	Solution
Incorrect Metric Value for Remote Setpoint (AI2)	The Metric default value for the Remote Setpoint (AI2) option for a VMA application is incorrect in HVAC PRO Release 7.02. The Metric Output Range High parameter is incorrectly defaulted to 18, and it should be 28. Note: User-Defined Ranges for the VMA were not available until HVAC PRO Release 7.02. This is only a problem for new VMA applications using the remote setpoint.	Workaround: 1. Manually adjust the Output High Range parameter for the Remote Setpoint AI2. The correct default values for the AI are shown in Table 32, although any combination of values is allowable. 2. Save the application. 3. Download and commission the VMA. Permanent Solution: Install Configuration Tools Release 7.03 and recreate the application (do not upgrade). Save and download.
No Damper Control when Supply Delta P (DP) Becomes Unreliable	In HVAC PRO Release 7.02, if the Supply Delta P (DP) analog input ever becomes unreliable, the VMA commands the damper to a fixed position and does not modulate the damper correctly.	Workaround: 1. Replace the existing file in the C:\Winpro\Modules directory with the corrected logic file (sdvmalg4.mod) available on *The Advisor*. 2. Upgrade all affected controllers. Note: The application revision does not change. Permanent Solution: 1. Install HVAC PRO Release 7.03. 2. Upgrade all affected controllers. Note: The application revision does not change.
Non-default Analog Outputs (AOs) and Binary Outputs (BOs) Incorrectly Upgraded	When using HVAC PRO Release 7.02 or earlier to upgrade VMA applications, non-default AOs and BOs are incorrectly upgraded. HVAC PRO software indicates the points are working correctly. The VMA is actually driving the default point with the commanded voltage (measured at the hardware). Using the default AO or BO number does not present the problem. It is only when the default AO or BO number is changed, for example AO-1 moved to AO-2.	Workaround: 1. Rebuild the application using the Question/Answer (Q/A) procedure and adjust the AO numbers. 2. Save and download the application to the affected controllers. Permanent Solution: 1. Install HVAC PRO Release 7.03. Use this release to upgrade VMA applications created in HVAC PRO Releases 7.00, 7.01, or 7.02. 2. If the application was upgraded using HVAC PRO Release 7.02, the only solution is to rebuild the application, save, and download.

Continued on next page . . .

Error/Condition (Cont.)	Problem	Solution
Incorrect DDL Code for Electric Heating Stage (EHS) Outputs	HVAC PRO Release 7.02 or earlier generates incorrect Data Definition Language (DDL) code for VMA applications with EHS outputs. This does not affect operation in the VMA but does result in incomplete information if the point is mapped. The point displays either `OFF` or `Stage` for the states. It should display `OFF`, `Stage1`, `Stage2`, or `Stage3`.	Workaround: Edit the .ddl file and manually add the stage numbers in the text field and delete the extra stages. The following are examples of the incorrect and correct .ddl for the EHS box heat parameters: Incorrect: CSMS "ADI140",Y,Y,"BOXHTG","Off",0,"Stage",1, "Stage ",2,"Stage ",3,"Stage ",4,"Stage",5, "Stage ",6,"Stage ",7,"Stage ",8 CSMS "ADI2",N,N,"BHACTSTG","Off",0,"Stage",1, "Stage ",2,"Stage ",3,"Stage ",4,"Stage",5, "Stage ",6,"Stage ",7,"Stage ",8 Correct: CSMS "ADI140",Y,Y,"BOXHTG","Off",0,"Stage1",1, "Stage2",2,"Stage3",3 CSMS "ADI2",N,N,"BHACTSTG","Off",0,"Stage1",1, "Stage2",2,"Stage3",3 Permanent Solution: 1. Install HVAC PRO Release 7.03. 2. Open the configuration files. 3. Save the file with the Generate .DDL box checked.
VMA Binary Inputs (BIs) and Binary Outputs (BOs) Are Offline	VMA BIs and BOs are offline to Metasys software Release 10.0 or earlier after commissioning with HVAC PRO Release 7.02. This is not an HVAC PRO software problem; it is a Metasys Operator Workstation (OWS) problem. The BIs and BOs, which are online to Metasys software prior to commissioning, go offline during commissioning, but never return to online after commissioning is completed. Other points mapped into the controller return to online.	Workaround: From Metasys software Release 9.01c or 10.0, override the points and release. This re-establishes communication and brings them online. Permanent Solution: Install a revision of Metasys software later than Release 10.0.

Continued on next page . . .

Error/Condition (Cont.)	Problem	Solution
Intermittent VMA Download Failures over Ethernet Networks	Intermittent communication errors are experienced while running HVAC PRO software on a Metasys OWS. The errors seem restricted to Ethernet N1 installations while doing VMA controller downloads. A possible cause is unusually high N1 Ethernet traffic.	Try to analyze source of N1 traffic. Try performing the operation (upload, download, and commission) during off-peak times of the day. There is no software solution currently available that addresses this specific problem.
VMA Download Failures over Dial-Up Networks	HVAC PRO Release 7.02 fails to download VMAs over a dial-up network. HVAC PRO software gets to 8% before a message box appears indicating the download failed. This may be caused by timing problems.	Avoid attempting to download a VMA over a dial-up network. Download directly through the N2 trunk.
Proportional Band Resets to Values That Are Too Large	For some configurations, when VMA1400 Series controllers exit a state in which no flow range is active (Satisfied or Shutdown mode), the proportional band may be reset to a very large value. When this occurs, the VMA operates sluggishly and does not accurately control the zone temperature. This problem occurs in HVAC PRO software releases prior to Release 8.01.	After updating HVAC PRO software to Release 8.01, upgrade current installations of VMA1400 controllers by clicking on Upgrade Controllers in the Upload menu in HVAC PRO software.
Single Duct Application Download Fails at about 25%	The Question and Answer paths for some Single Duct and Supply/Exhaust applications exceed the allowed file size. When this occurs, the download to the controller fails at about 25% complete. This occurs with VMA firmware C01 and HVAC PRO software Release 8.01.	Workaround: 1. Replace the existing file in the C:\Winpro\Modules directory with the corrected logic file (sdvmalg4.mod) available on *The Advisor*. 2. Upgrade all affected controllers. Permanent Solution: Upgrade to HVAC PRO software Release 8.03.
PRAC Tunes PID Proportional Band Very Small (Less Than 0.1)	Tuning error occurs when the VMA is not commanded to shutdown when the AHU is off. Other possible causes (if VMA is synchronized with AHU operation) are that the zone sensor time constant (either due to the room dynamics or the sensor placement) is very long or the controlled output is not responding correctly.	Upgrade to HVAC PRO software Version 8.03 (Single Duct Application Revision 5 and Dual Duct Application Revision 3). This software revision interlocks PRAC with the starved box flags to prevent tuning when supply air is not available. If PRAC still tunes the proportional band below the Min PID Prop Band (default value is 0.5°C [1.0°F]), the proportional band resets to five times the minimum value.

Continued on next page . . .

Error/Condition (Cont.)	Problem	Solution
TE-6700 LED Blinks when Occupancy Mode Is Not Standby	The LED on the TE-6700 sensor blinks when the VMA Occupancy Mode is not Standby.	Workaround: 1. Download the hpro802patch.zip file from the Configuration Tools Resource Page on *The Advisor*. Extract the files to a temporary directory. Replace the logic file in the C:\Winpro\Modules directory with the corrected logic file (sdvmalg4.mod). Replace the database files in the C:\Winpro\Data directory with the corrected database files (sdvmaqa4.dbt, sdvmpar4.dbf, sdvmpar4.ndx) 2. Upgrade all affected controllers. Permanent Solution: Upgrade to HVAC PRO software Release 8.03.
Write to Controller Fails	Error message appears, “Write to controller failed” when you attempt to change Analog Input User Range Attributes. For HVAC PRO 8.05 or later, during commissioning, the user can attempt to write to the Input Range Low, Input Range High, Output Range Low and Output Range High attributes of the Analog Inputs. Only VMA firmware Revisions C04 or later support this capability. Older versions do not allow the change which causes error.	Workaround: 1. Upload file from controller. 2. Change attributes and save. 3. Download updated file to controller. Permanent Solution: Upgrade VMA firmware to Revision C04 or later.
Parallel Fan Cycles On/Off as Zone Temp Hovers Around the Heating Setpoint	The heating sequencing was simplified in Application Revision 5 inadvertently allowing the VAV Box Mode to enter heating for only one application execution only when the zone temperature is below setpoint for one execution and above setpoint for the next execution.	The application was fixed at HVAC PRO 8.05, but the application revision was **not** changed. To update the application code, use HVAC PRO 8.05 or later.

Table 32: Default Values for Remote Setpoint AI

Parameter	Default Value	Description
Min Value	12C (65F)	Minimum reliable value allowed for the AI (does not affect the AI range)
Max Value	28C (85F)	Maximum reliable value allowed for the AI (does not affect the AI range)
Input Range Low	0	Low end for the input to the AI range equation
Input Range High	1660	High end for the input to the AI range equation
Output Range Low	12C (65F)	Low end for the output of the AI range equation
Output Range High	28C (85F)	High end for the output of the AI range equation

VMA Firmware Revisions

Table 33 shows the VMA firmware revision history. Each subsequent firmware version includes the features and fixes of the previous version plus any modifications listed. If you require any of these new capabilities, perform a Download > VMA Code operation using HVAC PRO software. Refer to the *Downloading Configurations and VMA Code* chapter of the *HVAC PRO User's Guide (LIT-63750404)*.

Table 33: VMA Firmware Revision History

HVAC PRO Revision	VMA Firmware Revision	Description of Changes
7.00	B04	Original Release
7.01	B04	Original Release
7.02	B12	Support added for User Range Ohms and User Range Volts input ranges for analog inputs. The Archive Memory increased to handle larger applications.
7.03	B15	When an AI has been set to User Range Ohms or Volts, the controller uses Input Range High and Low attributes to validate the input can handle the setup and/or select the correct auto ranging channel. For example, AI1 and AI4 have two internal ranges, each with a different input range that results in different resolutions. If the Input Range High/Low is set to 1200/800 ohms respectively, then the controller automatically chooses the channel with the smaller input range (higher resolution). The SMO damper controller now reduces the number of false Stalled During Positioning Reliability errors. This error makes the Output attribute unreliable and displays ????. The PAO object now correctly calculates/displays the Resync Remaining attribute. This only affects the value displayed in HVAC PRO software, not the control of the PAO. The Archive Memory increased to handle larger applications.
8.00	C00	No changes other than revision number. The revision change was made to be consistent with literature statements that the TMZ digital room sensor would be supported at VMA firmware revision C00.
8.01	C01	The operation of the Duration Adjust Output (DAO) modified to ensure that when the Present Value is greater than the Min Off Limit, the binary output remains on continuously. In some cases (with previous firmware), the binary output would turn off for a fraction of a second one time each period. This problem was most noticeable with very large applications (many options selected) when commissioning the controller.
8.03	C02	Added support for Remote Sensor Applications using the TMZ1600. The setpoint now cannot be changed from the TMZ1600 if it is overridden. Updated routine for calculating the Bytes Used value that is displayed in Device Info. Modified the method for overdriving a 3-wire proportional actuator. Added compatibility features for latest release of VMA Balancer Tool (VBT Version 2.0) Modified the Stepper Stall detection logic to reset the reliability on change of direction.
8.04	C03	TMZ software lockout retained on power cycle. Allows N30 ADJUST command of the Common Setpoint. Allows Occupancy Timer to be set to greater than 9 hours. Added COV message caching to improve N2 performance and reduce N2 Offline/retries.
8.05	C04	Analog Input attributes Input Range Low, Input Range High, Output Range Low, and Output Range High updated to allow modification after the application downloads to the controller. The user can change these attributes using either the AIM Spreadsheet Download tool or HVAC PRO 8.05 or later. Modified the Stepper (SMO) object so that its position (Output attribute) is no longer associated with the Reliability of the object.

Attributes and Parameters

Input/Output Options

The VMA applications support analog and binary inputs, analog and binary outputs, as well as some additional output types. The operation of these inputs and outputs may be different in the VMA and may have new features that were not available in previous controllers. For that reason, this section describes the basic operation of each of these input and output types and most of the attributes.

Analog Input

The analog input provides the main process information to the VMA, including temperature and velocity pressure measurements and occupant setpoint adjustment. The default attributes of this input are set up by the configuration tool, depending on the type of signal being measured. If the analog input is unreliable at startup, the controller automatically uses the startup value. If a reliable value is read and then the input becomes unreliable, the controller uses the last reliable value received. Table 34 describes the attributes for the analog input.

Note: Firmware Revision C00 or later is required to support all of the additional setup options for the AI ranges.

Table 34: Analog Input (AI) Attributes

Attribute Name	Description
Present Value	The current reading for the analog input
Reliability	The reliability of this analog input
Startup Value	The value used as a reliable output until the first reliable reading is received from the hardware
Units	The engineering units for this analog input
Min Value	This is the lowest value that will be reliable. This does not define the low end for the range equation.
Max Value	This is the highest value that will be reliable. This does not define the high end for the range equation.
Display Precision	This sets the number of decimals for display.
COV Increment	This is the amount the AI must change before a value is sent to any object that has signed up for the Present Value.
Setup	This attribute defines the ranging for the AI. The VMA has some restrictions on which ranges can be used on which analog input. AI-1, AI-2, and AI-4 support: Nickel F, Nickel C, Platinum F, Platinum C, NTC F, NTC C, Silicon F, Silicon C, Poten 65 to 85 F, Poten 12 to 28 C, Poten 55 to 85 F, Poten 13 to 30 C, Poten -5 to 5 F, Poten -3 to 3 K and User Range Ohms AI-3 supports: Percent RH, VDC 0 to 10, and User Range Volts AI-5 supports: DeltaP in w.c., DeltaP Pa, and User Range Volts
Offset	This is the offset to eliminate errors due to wiring or ADC offsets.
Anti-Spike	This enables or disables spike filtering for the analog input. The adaptive, anti-spike filter prevents a momentary spike in the signal from affecting the output of the controller. For a given sample, the signal is limited to a change no larger than the spike window. If the signal hits the edge of the spike window, the window opens exponentially larger during subsequent samples to allow real signal changes to pass. After the signal settles, the window closes exponentially back to the original spike window.
Spike Fraction	The amplitude of change that is clipped is called the spike window. *Spike Window = Spike Fraction * (Max Value – Min Value)*
Filter Order	This attribute chooses the filter type. None – no filtering. This is needed for flow control with P-Adaptive due to the adaptive noise band and extremely fast process speed. First – first order exponential filter that uses the Filter Weight to set its response. Second – second order butterworth filter that does exceptional low pass filtering and should be used for most applications. The process speed is used to set its response.
Filter Weight	This parameter sets the time constant of a first order filter.
Process Speed	This sets the second order filter for the speed of your process. Use Fast for processes that can change within a minute or less. Processes that respond slower should use Normal.
Input Range Low **Input Range High** **Output Range Low** **Output Range High**	If User Range Volts (AI-3 or AI-5 only) or User Range Ohms (AI-1, AI-2, or AI-4 only) is selected, the line equation for the user-defined input is defined using the four attributes Input Range Low, Input Range High, Output Range Low, and Output Range High. Input Range Low and High default to the ends of the typical input range (0-10 volts or 0-1660 ohms). The maximum measurable resistance for AI-1, AI-2, and AI-4 is 21,000 ohms, and the maximum voltages for AI-3 and AI-5 are 16.5 volts and 5.0 volts, respectively. Input Range Low must be less than Input Range High. To define a line equation with a negative slope, set Output Range High to a value less than Output Range Low.

Binary Input

The binary input provides digital feedback to the controller from sensors including the temporary occupancy button, occupancy sensor, and low limit contact. Table 35 describes the attributes for the binary input.

Table 35: Binary Input (BI) Attributes

Attribute Name	Description
Present Value	The current reading for the binary input
Polarity	Normal - Present Value is active based on a closed contact. Reverse - Present Value is active for an open contact.
Reliability	The reliability of this binary input
Startup Value	The value used as reliable until the first reliable reading is received from the hardware.
States Text	This attribute selects the units for this BI object.
Debounce	This is the debounce filter time for this BI object.

Analog Output

The analog output provides a proportional voltage output signal. Table 36 describes the attributes for the analog output.

Table 36: Analog Output (AO) Attributes

Attribute Name	Description
Present Value	The current command to the analog output
Output	The current command to the hardware in % of 0 to 10 volts DC
Reliability	The reliability of this analog output
Relinquish Default	The value used as a reliable output on startup until the first command is issued to this object. With a value of Null, no command is issued until the first command is received.
Units	The engineering units for this analog output
Min Value	This is the lowest value that is accepted at the input.
Max Value	This is the highest value that is accepted at the input.
Display Precision	This sets the number of decimals for display.
COV Increment	This is the amount the AI must change before a value is sent to any object that has signed up for the Present Value.
Setup	This attribute defines the output type for the AO. The VMA only supports voltage outputs at this time.
Deadband	This provides a deadband before the actual output changes.
Min Out Value **Max Out Value**	The Min Out Value and Max Out Value attributes define the output when the input is at Min Value and Max Value. In the VMA, the Present Value is always 0-100% coming from the PID, so the Min Out Value corresponds to the Output with an input signal of 0% and the Max Out Value corresponds to the Output with an input signal of 100%. For example, an EP-8000-2 at factory calibration, if you want 10 psi for the full closed position and 3 psi for the full open position; Min Out Value = 50% (5 VDC) Max Out Value = 15% (1.5 VDC)

Binary Output

The binary output is a 24 V output suitable for activating a relay, fan starter, or two-position heating device. Table 37 describes the attributes for the binary output.

Binary outputs are also to be used by other output types (described in the following sections) that provide special functionality. The slot of any BO reserved by these special output collections (PAO, DAO, EHS, Start Stop Output [SSO]) must be changed by modifying the slot attribute of the output collection.

Table 37: Binary Output (BO) Attributes

Attribute Name	Description
Present Value	The current command to the binary output
Output	The current command to the actual hardware
Polarity	Setup = Maintained: Normal - normally closed, Reverse - normally open Setup = Momentary: Normal - pulse on active, Reverse - pulse on inactive Setup = Pulse: no effect on output action
Reliability	The reliability of this binary output
Relinquish Default	The value used as a reliable output on startup until the first command is issued to this object. With a value of Hold, no command is issued until the first command is received.
States Text	The engineering units for this binary output
Setup	For QA configured BO, this has been set by the QA path and should not be changed. Momentary - for polarity = normal, BO issues pulse equal to Pulse Width when the Present Value changes to True or Active. Maintained - for polarity = normal, BO is active when Present Value is True or Active. Pulse - BO issues pulse equal to Pulse Width when the Present Value changes value.
Pulse Width	This is the width of the pulse when Momentary or Pulse is selected as Setup. When Maintained is selected, this is not used.
Heavy Equip Delay	This is the amount of time that elapses after this output is started before a second output could be started. This feature is not currently available.

Stepper Motor Object

The Stepper Motor Object (SMO) controls the VMA 1410/1420 integral actuator. This actuator is a stepper motor that allows fast response with fine step resolution (23,000). No BOs are used. The SMO output is set up for incremental commands. Incremental commands are accepted that drive the actuator open or closed (-100% to 100%). For example, a command of 10% more from its current position tells the actuator to open 10% from its current position, while a command of -10% tells the actuator to close 10% from its current position. An incremental command of 0% causes no change in actuator position. Typical commands from the flow controller are between -5% to 5%. Table 38 describes the attributes for the Stepper Motor Object.

Table 38: Stepper Motor Object (SMO) Attributes

Attribute Name	Description
Present Value	This is the current command to the integrated actuator.
Setup	This describes the object's response to commands. Incremental indicates the command contains direction and magnitude typically in the range -100 to 100%. Positional means the command is an absolute position in the range of 0 to 100%. This should be Incremental for the integral actuator. If the Delta P sensor becomes unreliable, the Flow Loop switches the actuator setup Positional.
Reliability	This is the reliability of this stepper motor object.
Relinquish Default	This is the value used as a reliable output on startup until the first command is issued to this object. With a value of Null, no command is issued until the first command is received.
COV Increment	This is the amount the attributes must change before a value is sent to any object that has signed up for the Present Value or Output.
Display Precision	This sets the number of decimals for display.
Deadband	This provides a deadband before the actual output changes.
Direction to Close	This defines the direction of actuator rotation when driven closed.
Startup Mode	This tells the actuator what it should do to determine the current Output on a startup. This has been setup by the QA path and should not be changed.
Resync Mode	This defines how the Stepper Motor Object should synchronize the Output.
Resync Period	This sets the time period to allow a resync of the output. Once resynched, the output does not resync again until this timer expires.
Resync Window	This sets the window for Positional mode.
Stroke Time	This is the integral actuators stroke time. Unless the initial autorange is disabled, the stroke time is calculated by the application during the startup autocalibration and should not be changed.
Output	This is the computed position of the actuator in %.

Position Adjust Output

The Position Adjust Output (PAO) performs floating control of 3-wire actuators using two triac (BO) outputs. With the correct stroke time entered, the duration and direction of travel is calculated to reposition the actuator based on the positional input. The open or close triac is commanded for the correct duration until the actuator position matches the input. The PAO can be set up to accept either incremental or positional commands. Table 39 describes the attributes for the PAO.

Table 39: Position Adjust Output (PAO) Attributes

Attribute Name	Description
COV Increment	This is the amount the attributes must change before a value is sent to any object that has signed up for the Present Value or Output.
Deadband	This provides a deadband before the actual output changes.
Display Precision	This sets the number of decimals for display.
Min Pulse Width	This is the minimum pulse issued if the actuator had stopped moving.
Polarity	Normal - Slot A defines the open BO, Slot B defines the close BO. Reverse - Slot B defines the open BO, Slot A defines the close BO.
Output	This is the computed position of the hardware in %.
Present Value	This is the current command to the position adjust output.
Reliability	This is the reliability of this position adjust output.
Relinquish Default	This is the value used as a reliable output on startup until the first command is issued to this object. With a value of Null, no command is issued until the first command is received.
Resync Amount	This is the maximum amount of movement in percent that the object overdrives in any Resync Period. The Resync Amount is reset whenever the actuator changes direction. This ensures that the actuator is able to fully return the valve or damper to its stop.
Resync Period	This sets the time period to allow a resync of the output. Once resynched, the output does not resync again until this timer expires. Starting with firmware revision C02 and Application Revision 5 for Single Duct applications and Application Revision 3 for Dual Duct applications, a Resync Period of zero indicates that the Resync Amount is not reset on a periodic basis, but only on change of direction. This is the new default setup based on information received from actuator manufacturers. Note: After upgrading the firmware to C02, the PAO objects in **existing** applications must **manually** have the Resync Period set to zero and the Resync Amount set to 100% to take advantage of this feature.
Reversal Delay	This is the amount of time the actuator stops before changing directions.
Setup	This describes the object's response to commands. Incremental indicates the command contains direction and magnitude typically in the range -100 to 100%. Positional means the command is an absolute position in the range of 0 to 100%. This was set by the QA and should not be changed.
Slot A	This is the first binary output used by this object. This attribute allows the slot of the reserved BO to be changed. See Polarity above for open/close definition.
Slot B	This is the second binary output used by this object. This attribute allows the slot of the reserved BO to be changed. See Polarity above for open/close definition.
Stroke Time	This is the actuator's stroke time used to calculate the binary output command duration.

Duration Adjust Output

The Duration Adjust Output provides proportional control using one triac (BO) output that is active (on) for the input percentage of the period. It is inactive (off) for the remainder of the period. When the input percentage is greater than the minimum off limit parameter, the output is turned on. When the input percentage is less than the minimum on limit parameter, the output is turned off. This would typically be used for solid-state electric heaters. Table 40 describes the attributes for the Duration Adjust Output.

Table 40: Duration Adjust Output (DAO) Attributes

Attribute Name	Description
Output	This is the percent of the period that the binary output is on.
Relinquish Default	This is the value used as a reliable output on startup until the first command is issued to this object.
Present Value	This is the current command to the duration adjust output.
Slot	This is the binary output used by this object. This attribute allows the slot of the reserved BO to be changed.
Reliability	This is the reliability of this duration adjust output.
COV Increment	This is the amount the attributes must change before a value is sent to any object that has signed up for the Present Value or Output.
Display Precision	This sets the number of decimals for display.
Period	This is the cycle time for the Duration Adjust Output. The on time is a percentage of this.
Deadband	This provides a deadband before the actual output changes.
Min Off Limit	When the Present Value is greater than or equal to the Min Off Limit, the binary output turns On continuously. Calculate the minimum off time as follows: Minimum BO off time = Period * (100 - Min Off Limit) / 100
Min On Limit	When the Present Value is less than or equal to the Min On Limit, the binary output turns Off continuously. The minimum time that the output turns on is as follows: Period * Min On Limit / 100

Electric Heat Sequencer

The Electric Heat Sequencer allows multiple BOs to be sequenced based on a single input command. When it is set up as proportional, it energizes the BOs when the heating command is greater than the corresponding make limit and de-energizes the BOs when it is less than the corresponding break limit. The make limits and break limits must be of an increasing value for each stage. The make limit must be larger than its corresponding break limit.

When the EHS is set up as integral, there is only one make limit and one break limit. The make limit must be greater than the break limit. In this setup, the first BO energizes after the make limit is exceeded by the heating command. The second BO energizes after the make limit is exceeded again and the interstage on delay has expired. The BOs are de-energized in reverse order. The second BO de-energizes after the heating command drops below the break limit. After the heating command drops below the break limit again and the interstage off delay expires, the first BO is de-energized.

The interstage delays apply to both integral and proportional setups. Table 41 describes the attributes of the Electric Heat Sequencer.

Table 41: Electric Heat Sequencer (EHS) Attributes

Attribute Name	Description
Present Value	This is the requested stage of the electric heat sequencer. The Present Value is an enumerated value calculated based on the Input and the Make and Break Limits. The Present Value can be overridden independent of the Input to command the electric heat sequencer to a particular stage.
Actual Stage	This is the current stage of the electric heat sequencer. The Actual Stage indicates which of the binary outputs are currently active. If the Instant All Off attribute is True, the Actual Stage is set to zero and all outputs are shut off. The Actual Stage may also not be equal to the Present Value if the Interstage On Delay or Interstage Off Delay for the Actual Stage has not been satisfied.
Input	This is the current command to the electric heat sequencer. This value from 0-100% comes from the Heating PID and is used to calculate the Present Value. When the Input exceeds the Make Limit, the next stage is started if the Interstage On Delay is satisfied. When the Input drops below the Break Limit, the last stage on is turned off if the Interstage Off Delay has been satisfied.
Instant All Off	When True, the electric heat sequencer turns all outputs off immediately.
Interstage Off Delay	This is the time that the previous stage must be off before another stage is turned off.
Interstage On Delay	This is the time that the previous stage must be on before another stage is turned on.
Number of Stages	This specifies the number of outputs. This has been set up by the QA path and should not be changed.
Output State	This array holds the current state of all binary outputs.
Reliability	This is the reliability of the electric heat sequencer.
Setup	Proportional - Each stage has its own make and break limits. Integrational - All stages have the same make and break limit. When the command exceeds the make limit, the next stage is started if the interstage on delay is satisfied. When the command drops below the break limit, the last stage on is turned off if the interstage off delay has been satisfied.
Slot	This is an array defining the binary output for each stage. This attribute allows the slot of the reserved BO to be changed.
Break Limit	This is the array of break limits for Proportional or the break limit for Integrational.
Make Limit	This is the array of make limits for Proportional or the make limit for Integrational.
States Text	This defines the units for the Present Value and Actual Stage attributes.
Output States Text	This defines the units for the Output State (on/off) array.

Start Stop Output

The start stop output is used to control a momentary lighting relay (GE RR-7 relay). Two triac (BO) outputs are used. The first (start) triac pulses on when lighting should be on and the second (stop) triac pulses on when lighting should be off. Table 42 lists and describes the SSO Attributes.

Table 42: Start Stop Output (SSO) Attributes

Attribute Name	Description
Present Value	This is the current command to the start - stop output.
Output	This is the current command to the actual hardware.
Polarity	Normal - Slot A defines the ON binary output. Reverse - Slot B defines the ON binary output.
Reliability	This is the reliability of this start - stop output.
Relinquish Default	This is the value used as a reliable output on startup until the first command is issued to this object. With a value of Hold, no command is issued until the first command is received.
States Text	This attribute selects the units for this object.
Slot A	This is the first binary output used by this object. This attribute allows the slot of the reserved BO to be changed. See Polarity above for ON command definition.
Slot B	This is the second binary output used by this object. This attribute allows the slot of the reserved BO to be changed. See Polarity above for ON command definition.
Heavy Equip Delay	This is the amount of time that elapses after this output is started before a second output could be started. This feature is not implemented.
Pulse Width	This is the width of the pulse issued when the Present Value changes.

VMA Single Duct Parameters

The VMA has adjustable parameters, but most do not require changes. Changing parameters may cause the controller to malfunction. We offer this guide to provide a reference for the application parameters used to configure VMA single duct application.

This topic has four groups of tables. Table 43 shows which parameters are in each of the main views. Tables 44-63 describe the parameters visible in the configuration view. Tables 64-89 describe the additional calculated values seen in the commissioning view. Finally, Table 91 lists the input/output object attributes mapped to the Metasys Network.

VMA Single Duct Main View Parameters

Table 43: VMA Single Duct Main View Parameters

VMA Parameters		Configuration	Commissioning	Test and Balance
VAV Box Mode				
	Present Value		X	X
Occupancy Mode				
	Input	X	X	X
	Schedule		X	X
	Present Value		X	X
Temp Setpoints				
	Actual Cooling Setpt		X	
	Actual Heating Setpt		X	
	Common Setpoint	X	X	
	Cooling Setpoint	X	X	
	Heating Setpoint	X	X	
	Low Limit Temp Setpt	X	X	
	Setpoint Threshold	X	X	
TMZ Setpoint Range				
	Low Setpoint Limit	X	X	
	High Setpoint Limit	X	X	
Temp Biases				
	Actual Cooling Bias		X	
	Actual Heating Bias		X	
	Occupied Clg Bias	X	X	
	Standby Clg Bias	X	X	
	Unoccupied Clg Bias	X	X	
	Occupied Htg Bias	X	X	
	Standby Htg Bias	X	X	
	Unoccupied Htg Bias	X	X	
Continued on next page . . .				

VMA Parameters (Cont.)		Configuration	Commissioning	Test and Balance
Temp Diagnostics				
	MovAvg ZT Err		X	
	MovAvg ABS ZT Err		X	
	Inadequate Cooling		X	
	Inadequate Heating		X	
Summer Winter Comp				
	Outdoor Air Temp		X	
	Summer Compensation		X	
	Winter Compensation		X	
	Summer Setpoint	X	X	
	Summer Authority	X	X	
	Summer Change Limit	X	X	
	Winter Setpoint	X	X	
	Winter Authority	X	X	
	Winter Change Limit	X	X	
Flow Status				
	Present Value		X	
	Process Variable		X	X
	Setpoint		X	X
Exhaust Flow Status				
	Present Value		X	
	Process Variable		X	X
	Setpoint		X	X
Flow Setpoints				
	Cooling Flow SP		X	
	Heating Flow SP		X	
	Exhaust Diff		X	
	Cooling Max Flow	X	X	X
	Occupied Clg Min	X	X	X
	Unoccupied Clg Min	X	X	X
	Occupied Htg Flow	X	X	X
	Unoccupied Htg Flow	X	X	X
	Heating Max Flow	X	X	X
	Occupied Htg Min	X	X	X
	Unoccupied Htg Min	X	X	X
	Occupied Exh Diff	X	X	X
	Unoccupied Exh Diff	X	X	X
	Warmup Min Flow	X	X	X
	Box Elec Htg Min Flo	X	X	X
	Box Elec Htg Protect	X	X	X
	Units	X	X	

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VMA Parameters (Cont.)		Configuration	Commissioning	Test and Balance
Flow Diagnostics				
	MovAvg Flow Err		X	
	MovAvg ABS Flow Err		X	
	Starved Box		X	
	MovAvg Exhst Err		X	
	MovAvg ABS Exhst Err		X	
	MovAvg Diff Err		X	
	MovAvg ABS Diff Err		X	
	Starved Exhaust Box		X	
	Units	X	X	
Indoor Air Quality				
	IAQ Min Flow		X	
	OA Fraction		X	
	Occupancy Level	X	X	
	Ventilation Reqmnt	X	X	
Supply Flow Config				
	Area	X	X	X
	Pickup Gain	X	X	X
	Flow Coefficient	X	X	X
	Pvar Units	X	X	
	Delta Vp	X	X	
	Min Delta Vp	X	X	
	Max Velocity	X	X	
Exhaust Flow Config				
	Area	X	X	X
	Pickup Gain	X	X	X
	Flow Coefficient	X	X	X
	Pvar Units	X	X	
	Delta Vp	X	X	
	Min Delta Vp	X	X	
	Max Velocity	X	X	
Supply Dpr Actuator				
	Reliability		X	
	Setup		X	
	Output		X	
	Present Value		X	
	Direction to Close	X	X	
	Polarity	X	X	
	Min Out Value	X	X	
	Max Out Value	X	X	
	Sply Dpr Stroke Time	X	X	
	PD Supply Max Pos	X	X	
	Startup Autorange	X	X	
	Autocal		X	

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VMA Parameters (Cont.)		Configuration	Commissioning	Test and Balance
Supply Dpr Actuator (Cont.)				
	Actuator Duty Cycle		X	
	MovAvg Sply Duty Cyc		X	
	MovAvg Sply Reversal		X	
Exhaust Dpr Actuator				
	Reliability		X	
	Setup		X	
	Output		X	
	Present Value		X	
	Polarity	X	X	
	Min Out Value	X	X	
	Max Out Value	X	X	
	Exh Dpr Stroke Time	X	X	
	PD Exhaust Max Pos	X	X	
	MovAvg Exh Duty Cyc		X	
	MovAvg Exh Reversals		X	
Command Modes				
	Heating Available		X	
	Water System Flush	X	X	
	Flush Position	X	X	
	Box Supply Temp		X	
	Warmup Differential	X	X	
	Temp Loop Failsoft	X	X	
Autocalibration				
	Autocal Period	X	X	
	Autocal Time		X	
	Autocal Req		X	X
	Autocal Active		X	X
	On Pulse Count	X	X	X
Occupancy Timer				
	Present Value		X	
	Time Remaining		X	
	Duration	X	X	
Lighting				
	Present Value		X	
	Light Shutoff Delay	X	X	
Fan Control				
	Parallel Fan Min Flo	X	X	X
	Fan Speed Percent	X	X	X
Cooling PID				
	Present Value		X	
	Process Variable		X	
	Setpoint		X	
	Saturation Status		X	
Continued on next page . . .				

VMA Parameters (Cont.)		Configuration	Commissioning	Test and Balance
Box Heating PID				
	Present Value		X	
	Process Variable		X	
	Setpoint		X	
	Saturation Status		X	
Box Heating Output				
	Object Type		X	
	Present Value		X	
	Actual Stage		X	
	Input		X	
	Output		X	
	Stroke Time	X	X	
	Polarity	X	X	
	Interstage Off Delay		X	
	Interstage On Delay		X	
	Make Limit		X	
	Break Limit		X	
	Min Off Limit		X	
	Min On Limit		X	
	Box Htg Make Lmt	X	X	
	Box Htg Diffrntl	X	X	
Suppl Heating PID				
	Present Value		X	
	Process Variable		X	
	Setpoint		X	
	Saturation Status		X	
Suppl Heating Output				
	Object Type		X	
	Present Value		X	
	Actual Stage		X	
	Input		X	
	Output		X	
	Stroke Time	X	X	
	Polarity	X	X	
	Interstage Off Delay		X	
	Interstage On Delay		X	
	Make Limit		X	
	Break Limit		X	
	Min Off Limit		X	
	Min On Limit		X	
	Suppl Htg Make Lmt	X	X	
	Suppl Htg Diffrntl	X	X	

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VMA Parameters (Cont.)		Configuration	Commissioning	Test and Balance
Heating Flow PID				
	Present Value		X	
	Process Variable		X	
	Setpoint		X	
	Saturation Status		X	
Sideloop PID				
	Present Value		X	
	Process Variable		X	
	Setpoint	X	X	
	Saturation Status		X	
	Offset	X	X	
	Deadband	X	X	
	Proportional Band	X	X	
	Integral Time	X	X	
	Self Tuning	X	X	
	Direct Acting	X	X	
	Period	X	X	
Sideloop Output				
	Object Type		X	
	Present Value		X	
	Actual Stage		X	
	Input		X	
	Output		X	
	Stroke Time	X	X	
	Polarity	X	X	
	Interstage Off Delay		X	
	Interstage On Delay		X	
	Make Limit		X	
	Break Limit		X	
	Min Off Limit		X	
	Min On Limit		X	
	Sideloop Make Limit	X	X	
	Sideloop Diffrntl	X	X	
RF Wireless Thermostat				
	Powerfail Diag	X	X	X

VMA Single Duct Configuration Parameters

Note: An address entry of **** indicates that this parameter is not mapped to an address.

Table 44: Occupancy Mode Parameters

Parameter Name	Address	Default	Description
Input	ADI 165	Occupied	0 - Unoccupied 1 - Standby 2 - Occupied See the *Key Concepts* section for complete description.

Table 45: Temperature Setpoints Parameters

Parameter Name	Address	Default	Description
Common Setpoint	ADF 197	21°C (70°F)	Primary supervisory zone temperature setpoint
Cooling Setpoint	ADF 189	0°C (0°F)	Zone temperature cooling setpoint (in place of common setpoint)
Heating Setpoint	ADF 193	0°C (0°F)	Zone temperature heating setpoint (in place of common setpoint)
Low Limit Temp Setpt	ADF 198	4°C (40°F)	Zone temperature setpoint during Low Limit mode
Setpoint Threshold	ADF 183	3°C (5°F)	Minimum temperature setpoint change required to bypass saturation timers between modes. If Cooling is active and the Actual Cooling Setpt increases by at least the Setpoint Threshold, the mode immediately switches to Satisfied. Similarly, if either Box Heating or Supplemental Heating is active and the Actual Heating Setpt decreases by at least the Setpoint Threshold, the mode immediately switches to Satisfied.

Table 46: TMZ Setpoint Range Parameters

Parameter Name	Address	Default	Description
Low Setpoint Limit	ADF 127	19°C (65°F)	TMZ low limit for Comfort Setpoint. The TMZ reads this parameter from the VMA and prevents the temperature setpoint from being adjusted below this value.
High Setpoint Limit	ADF 128	26°C (78°F)	TMZ high limit for Comfort Setpoint. The TMZ reads this parameter from the VMA and prevents the temperature setpoint from being adjusted above this value.

Table 47: Temperature Biases Parameters

Parameter Name	Address	Default	Description
Occupied Clg Bias	ADF 190	1°C (2°F)	Occupied mode cooling bias temperature
Standby Clg Bias	ADF 191	3°C (5°F)	Standby mode cooling bias temperature
Unoccupied Clg Bias	ADF 192	4°C (8°F)	Unoccupied mode cooling bias temperature
Occupied Htg Bias	ADF 194	-1°C (-2°F)	Occupied mode heating bias temperature
Standby Htg Bias	ADF 195	-4°C (-6°F)	Standby mode heating bias temperature
Unoccupied Htg Bias	ADF 196	-5°C (-10°F)	Unoccupied mode heating bias temperature

Table 48: Summer Winter Comp. Parameters

Parameter Name	Address	Default	Description
Summer Setpoint	****	26°C (79°F)	Outdoor air temperature above which summer compensation occurs
Summer Authority	****	0.2	Proportion of the change to setpoint to the difference between outdoor air temperature and summer setpoint
Summer Change Limit	****	5°C (9°F)	Maximum allowed setpoint change by summer compensation
Winter Setpoint	****	10°C (50°F)	Outdoor air temperature below which winter compensation occurs
Winter Authority	****	-0.1	Proportion of the change to setpoint to the difference between outdoor air temperature and winter setpoint
Winter Change Limit	****	3°C (6°F)	Maximum allowed setpoint change by winter compensation

Table 49: Flow Setpoints Parameters

Parameter Name	Address	Default	Description
Cooling Max Flow	ADF 163	850 m^3/hr (500 cfm)	Maximum cooling flow setpoint
Occupied Clg Min	ADF 164	170 m^3/hr (10 cfm)	Occupied mode cooling minimum flow setpoint
Unoccupied Clg Min	ADF 166	85 m^3/hr (50 cfm)	Unoccupied mode cooling minimum flow setpoint
Occupied Htg Flow*	ADF 165	340 m^3/hr (200 cfm)	Occupied mode heating flow setpoint
Unoccupied Htg Flow*	ADF 167	170 m^3/hr (100 cfm)	Unoccupied mode heating flow setpoint
Heating Max Flow*	ADF 161	850 m^3/hr (500 cfm)	Heating maximum flow (only w/ heating flow reset)
Occupied Htg Min*	ADF 165	340 m^3/hr (200 cfm)	Occupied mode heating flow setpoint (only w/ heating flow reset)
Unoccupied Htg Min*	ADF 167	170 m^3/hr (100 cfm)	Unoccupied mode heating flow setpoint (only w/ heating flow reset)
Occupied Exh Diff	ADF 206	340 m^3/hr (200 cfm)	Occupied mode exhaust differential setpoint
Unoccupied Exh Diff	ADF 207	170 m^3/hr (100 cfm)	Unoccupied mode exhaust differential setpoint
Warmup Min Flow	ADF 200	170 m^3/hr (100 cfm)	Minimum box flow during Warmup mode
Box Elec Htg Min Flow	ADF 162	128 m^3/hr (75 cfm)	Minimum flow requirement for EHS flow interlock, the actual heating flow setpoint must be somewhat greater so that minor flow deviations do not cause the electric heat to chatter.
Box Elec Htg Protect	BD 170	False	When True, the Box Elec Htg Protect enables minimum flow protection for Analog Output and Duration Adjust Output box heating devices.
Units	****	m^3/hr (cfm)	This allows change of the units for the above Parameters.

* Heating flow setpoints:

1 For VAV boxes with reheat but without fans, the heating flow setpoints must equal or be greater than (for cfm): 400 times the flow area in sq ft, or (for m^3/hr): 7315 times the flow area in m^3.

2 If the zone/box schedule from the HVAC design does not call out both heating maximum and minimum flow setpoints, the configuration question, “Increase box flow setpoint upon full heating?” must be answered “No”. If no heating flow setpoint is given in the HVAC design, then the Occupied Heating Flow setpoint should be set equal to the cooling minimum.

3 If the VAV box does not have a fan and heating is required in Unoccupied mode, then the Unoccupied Heating Flow should equal the Occupied Heating Flow.

Table 50: Indoor Air Quality Parameters

Parameter Name	Address	Default	Description
Occupancy Level	ADF 185	0 people	Normal zone occupancy level
Ventilation Reqmnt	****	34 m^3/hr (20 cfm)	Zone ventilation requirement per person

Table 51: Supply Flow Configuration Parameters

Parameter Name	Address	Default	Description
Area	ADF 24	0.0325 m^2 (0.35 ft^2)	Box inlet area. See the *Airflow Measurement* topic in the *Key Concepts, Theory of Operation* section of this document.
Pickup Gain	ADF 25	2.25 (2.25)	Airflow pickup gain
Flow Coefficient	ADF 26	4644 (4005)	Flow property (function of elevation) (Change metric value to 1290 to compute liters per second [l/s].)
Pvar Units	****	m^3/hr (cfm)	This attribute allows changes to the flow controller process variable's units.
Delta Vp	****	0.03194 Pa (1.282e-4 in. w.c.)	Change in velocity pressure for 1 bit A/D (0.03194 for liters per seconds [l/s])
Min Delta Vp	****	12.45 Pa (0.05 in. w.c.)	Minimum Vp for noise estimate (12.45 for liters per second [l/s])
Max Velocity	****	58522 m/hr (3200 ft/min)	Unit flow velocity (16243 for liters per second [l/s])

Table 52: Exhaust Flow Config Parameters

Parameter Name	Address	Default	Description
Area	ADF 21	0.0325 m^2 (0.35 ft^2)	Exhaust box inlet area. See the *Airflow Measurement* topic in the *Key Concepts, Theory of Operation* section of this document.
Pickup Gain	ADF 22	2.25 (2.25)	Airflow pickup gain
Flow Coefficient	ADF 23	4544 (2005)	Flow property (function of elevation) (Change metric value to 1290 to compute liters per second [l/s].)
Pvar Units	****	M^3/hr (cfm)	This attribute allows changes to the flow controller process variable's units.
Delta Vp	****	0.17003 Pa (6.8376e-4 in. w.c.)	Change in velocity pressure for 1 bit A/D [0.17003 Pa for liters per second (l/s)]
Min Delta Vp	****	12.45 Pa (0.05 in. w.c.)	Minimum Vp for noise estimate (12.45 for liters per second [l/s])
Max Velocity	****	58522 m/hr (3200 ft/min)	Unit flow velocity (1243 for liters per second [l/s])

Table 53: Supply Dpr Actuator Parameters

Parameter Name	Address	Default	Description
Direction to Close	****	Clockwise	Direction that the integrated actuator should turn to close damper
Polarity	****	Normal	For PAO output: 1st BO ON to open - normal; first BO ON to close - reverse
Min Out Value	****	0%	For analog output, % of 10 volts at 0% control
Max Out Value	****	100%	For analog output, % of 10 volts at 100% control
Sply Dpr Stroke Time	****	90 seconds	Stroke time for AO output
PD Supply Max Pos	ADF 181	100%	Maximum position for supply actuator during pressure dependent mode.
Startup Autorange	****	True	For integrated actuator, enables or disables automatic calibration of actuator stroke time based on measured stroke time. Normally occurs at first autocalibration.

Table 54: Exhaust Dpr Actuator

Parameter Name	Address	Default	Description
Polarity	****	Normal	For PAO output: First BO ON to open – normal; first BO ON to close - reverse
Min Out Value	****	0%	For analog output, % of 10 volts at 0% control
Max Out Value	****	100%	For analog output, % of 10 volts at 100% control
Exh Dpr Stroke Time	****	90 seconds	Stroke time for AO output
PD Exhaust Max Pos	ADF 182	100%	Maximum position for exhaust actuator during pressure dependent mode.

Table 55: Command Modes Parameters

Parameter Name	Address	Default	Description
Water System Flush	****	False	Flag to command VMA into Water Flush mode
Flush Position	****	100	Heating valve position during Water Flush mode
Warmup Differential	****	8°C (15°F)	Differential for supply air temperature to initiate warmup
Temp Loop Failsoft	****	Hold Outputs	Failsoft command when zone temperature AI is unreliable. See the *Temperature Loop* topic in the *Key Concepts, Application Logic* section of this document.

Table 56: Autocalibration Parameters

Parameter Name	Address	Default	Description
Autocal Period	****	336 hours	Autocalibration period (hours between subsequent autocalibrations)
On Pulse Count	ADF 170	3 seconds	For adjustment of the on-time for the BO solenoid air valve, depending on the time needed to equalize the dP pressure. The default value is sufficient for most installations. To verify sufficient settling time, compare the dP offset calculated during autocalibration once with the damper open and once when you override the damper closed.

Table 57: Occupancy Timer Parameter

Parameter Name	Address	Default	Description
Duration	****	60 minutes	Occupancy timer duration
Occupancy Override Time	ADF 85	60 minutes	Occupancy timer duration when mapped from the supervisory system

Table 58: Lighting Parameter

Parameter Name	Address	Default	Description
Light Shutoff Delay	ADF 180	2 minutes	Time between light blink and complete light shutoff when Occupancy mode transitions to unoccupied

Table 59: Fan Control Parameters

Parameter Name	Address	Default	Description
Parallel Fan Min Flo	ADF 177	$170 m^3/hr$ (100 cfm)	Flow-based parallel fan control parameter. If flow is below this setpoint, fan is turned on.
Fan Speed Percent	ADF 178	100%	Series fan analog output parameter. Sets AO signal (percent of 0-10 volts) to fan when on. Set by VAV terminal manufacturer or Test and Balance contractor.

Table 60: Box Heating Output Parameters

Parameter Name	Address	Default	Description
Stroke Time	****	60 seconds	Stroke time for PAO output
Polarity	****	Normal	For PAO output: 1st BO ON to open - normal; first BO ON to close - reverse
Polarity	****	Normal	For BO normally closed - normal; BO normally open - reverse
Box Htg Make Lmt	****	55%	For BO object, output is active when input is above this value.
Box Htg Differential	****	10%	For BO object, output changes from active to inactive when input falls below make limit by this value.

Table 61: Suppl Heating Output Parameters

Parameter Name	Address	Default	Description
Stroke Time	****	60 seconds	Stroke time for PAO output
Polarity	****	Normal	For PAO output: first BO ON to open - normal; first BO ON to close - reverse
Polarity	****	Normal	For BO normally closed - normal; BO normally open - reverse
Suppl Htg Make Lmt	****	55%	For BO object, output is active when input is above this value.
Suppl Htg Differential	****	10%	For BO object, output changes from active to inactive when input falls below make limit by this value.

Table 62: Sideloop PID Parameters

Parameter Name	Address	Default	Description
Setpoint	ADF 199	0	Current setpoint for the sideloop control algorithm
Offset	****	0	
Deadband	****	0	
Proportional Band	****	10	
Integral Time	****	300 seconds	
Self Tuning	****	-	Flag designating whether PRAC is used
Direct Acting	****	True	
Period	****	60 seconds	Time period between PID calculations

Table 63: Sideloop Output Parameters

Parameter Name	Address	Default	Description
Stroke Time	****	60 seconds	Stroke time for PAO output
Polarity	****	Normal	For PAO output
Polarity	****	-	BO normally closed - normal; BO normally open - reverse
Sideloop Make Lmt	****	55%	For BO object, output is active when input is above this value.
Sideloop Differential	****	10%	For BO object, output changes from active to inactive when input falls below make limit by this value.

VMA Single Duct Commissioning Parameters

Note: An address entry of **** indicates that this parameter is not mapped to an address.

Table 64: VAV Box Mode Parameters

Parameter Name	Address	Description
Present Value	ADI 67	Primary VMA control mode. Command modes: 0 = Shutdown Closed; 1 = Shutdown Open; 2 = Warmup; 3 = Water System Flush; 4 = Low Limit Auto modes: 5 = Satisfied; 6 = Cooling; 7 = Heating See the *Key Concepts* section for complete description.

Table 65: Occupancy Mode Parameters

Parameter Name	Address	Description
Schedule	ADI 78	0 – Unoccupied 1 – Standby 2 – Occupied 3 – No Schedule This parameter provides a non-archivable point for scheduling commands. If N2 communication fails, the Occupancy Mode Input becomes the default mode. See the *Key Concepts* section for a complete description.
Present Value	ADI 68	0 - Unoccupied 1 - Standby 2 - Occupied See the *Key Concepts* section for complete description.

Table 66: Heating Mode Parameters

Parameter Name	Address	Description
Present Value	ADI 69	Primary heating control mode. This point can be viewed from the diagnostic view. 0 = No Heating Required 1 = Box Heating 2 = Supplemental Heating with Full Box Heating 3 = Supplemental Heating 4 = Box Heating with Full Supplemental Heating 5 = Maximum Heating with Flow Reset See the *Key Concepts* section for complete description.

Table 67: Temperature Setpoints Parameters

Parameter Name	Address	Description
Actual Cooling Setpt	ADF 13	Actual Clg SP = Common SP + Remote Adjustment + Clg SP + Actual Clg Bias + Summer Compensation
Actual Heating Setpt	ADF 14	Actual Htg SP = Common SP + Remote Adjustment + Htg SP + Actual Htg Bias + Winter Compensation

Table 68: Temperature Biases Parameters

Parameter Name	Address	Description
Actual Cooling Bias	ADF 15	Actual Cooling Bias = specified cooling bias of the current Occupancy Mode Present Value
Actual Heating Bias	ADF 16	Actual Heating Bias = specified heating bias of current Occupancy Mode Present Value

Table 69: Temperature Diagnostics Parameters

Parameter Name	Address	Description
MovAvg ZT Err	ADF 6	Moving average of the error between the current zone temperature and the zone temperature setpoint
MovAvg ABS ZT Err	ADF 7	Moving average of the absolute value of the zone temperature error
Inadequate Cooling	BD 3	True when box is unable to maintain the zone at the cooling temperature setpoint and is not starved for flow
Inadequate Heating	BD 4	True when all available heat is at maximum, but the box is unable to maintain the zone at the heating setpoint

Table 70: Summer Winter Comp. Parameters

Parameter Name	Address	Description
Outdoor Air Temp	ADF 81	Outdoor air temperature value provided via network
Summer Compensation	ADF 17	Summer Comp. = min (Summer Change Limit, Summer Authority [SummerSP – OutdoorAir])
Winter Compensation	ADF 18	Winter Comp. = - min. (Winter Change Limit, Winter Authority [WinterSP - OutdoorAir])

Table 71: Flow Status Parameters

Parameter Name	Address	Description
Present Value	****	Output of the P-Adaptive control algorithm. See the *Key Concepts* section for more information.
Process Variable	ADF 58	Current flowrate being delivered by box
Setpoint	ADF 150	Current setpoint for box flow (based on Cooling or Heating Flow PIDs)

Table 72: Exhaust Flow Status

Parameter Name	Address	Description
Present Value	*****	Output of the P-Adaptive control algorithm. See the *Key Concepts* section for more information.
Process Variable	ADF 59	Current flowrate being removed by the exhaust box
Setpoint	ADF 151	Current setpoint for exhaust flow (based on the supply setpoint and the exhaust differential)

Table 73: Flow Setpoints Parameters

Parameter Name	Address	Description
Cooling Flow SP	****	Calculated based upon the Cooling PID output and the cooling min (based on occupancy) and max flow SPs
Exhaust Differential	****	Current exhaust differential based on Occupancy mode
Heating Flow SP	****	Normally equal to the heating flow setpoint corresponding to the current Occupancy mode

Table 74: Flow Diagnostics Parameters

Parameter Name	Address	Description
MovAvg Flow Err	ADF 8	Moving average of the error between the actual flow and the current flow setpoint
MovAvg ABS Flow Err	ADF 9	Moving average of the absolute value of the flow error
Starved Box	BD 55	True if the box is unable to maintain the flow setpoint (that is, damper remains saturated at 100% open)
MovAvg Exhst Err	ADF 43	Moving average of the error between the actual exhaust flow and the current exhaust flow setpoint
MovAvg ABS Exhst Err	ADF 44	Moving average of the absolute value of the exhaust flow error
MovAvg Diff Err	ADF 61	Moving average of the error between the actual exhaust differential and the current exhaust differential error
MovAvg ABS Diff Err	ADF 62	Moving average of the absolute value of the exhaust differential error
Starved Exhaust Box	BD54	True if the exhaust box is unable to maintain the flow setpoint (that is, damper remains saturated at 100% open)
Units	****	This attribute allows changes to the above attribute’s units.

Table 75: Indoor Air Quality Parameters

Parameter Name	Address	Description
IAQ Min Flow	****	IAQ Min Flow = Occupancy Level * Ventilation Requirement/OA Fraction
OA Fraction	ADF 80	Percent outdoor air included in supply. Value must be mapped via a network variable.

Table 76: Supply Damper Actuator Parameters

Parameter Name	Address	Description
Reliability	ADI 19	Reliability of the value or the reason for not being trustworthy if unreliable
Setup	****	Actuator type
Output	ADF 54	Estimated position (0-100%) of the damper actuator
Present Value	ADF 152	The current command to the actuator
Direction to Close	****	Direction that actuator should turn to close damper
Autocal	****	SMO calibration command
Actuator Duty Cycle	ADF 4	Time that the actuator runs as a percent of the controller run time
MovAvg Sply Duty Cyc	ADF 46	Moving average of the actuator duty cycle over the past 24 hours
MovAvg Sply Reversal	ADF 47	Moving average of the hourly reversals over the past 24 hours

Table 77: Exhaust Damper Actuator Parameters

Parameter Name	Address	Description
Reliability	ADI 18	Reliability of the value or the reason for not being trustworthy if unreliable
Setup	****	Actuator type
Output	ADF 60	Estimated position (0-100%) of the damper actuator
Present Value	ADF 153	The current command to the actuator
MovAvg Exh Duty Cyc	ADF 49	Moving average of the actuator duty cycle over the past 24 hours
MovAvg Exh Reversals	ADF 48	Moving average of the hourly reversals over the past 24 hours

Table 78: Command Modes Parameters

Parameter Name	Address	Description
Heating Available	BD 169	Used to specify when heating source is available (for example, boiler and hot water pumps on)
Box Supply Temp	ADF 82	Box supply temperature mapped via network variable (used instead of individual hardware input to VMA)

Table 79: Autocalibration Parameters

Parameter Name	Address	Description
Autocal Time	****	Current number of hours since most previous autocalibration
Autocal Req	BD 168	Flag used to request an autocalibration
Autocal Active	BD 66	Status of the autocalibration routine

Table 80: Occupancy Timer Parameters

Parameter Name	Address	Description
Present Value	BD 12	Status of the occupancy timer
Time Remaining	****	Time remaining in the current temporary occupancy period (if active)

Table 81: Lighting Parameters

Parameter Name	Address	Description
Present Value	ADI 65	Status of lighting control

Table 82: Cooling PID Parameters

Parameter Name	Address	Description
Present Value	ADF 70	Output of the PID control algorithm
Process Variable	****	Current zone temperature
Setpoint	****	Current zone temperature cooling setpoint
Saturation Status	****	Low (High) if output of PID remains 0.0 (100.0) for saturation time
	ADF 30*	Proportional band
	ADF 31*	Integral time

* This parameter can only be adjusted by PRAC. If mapped over the N2, it is a monitor only point.

Table 83: Box Heating PID Parameters

Parameter Name	Address	Description
Present Value	ADF 72	Output of the PID control algorithm
Process Variable	****	Current zone temperature
Setpoint	****	Current zone temperature heating setpoint
Saturation Status	****	Low (High) if output of PID remains 0.0 (100.0) for saturation time
	ADF 32*	Proportional band
	ADF 33*	Integral time

* This parameter can only be adjusted by PRAC. If mapped over the N2, it is a monitor only point.

Table 84: Box Heating Output Parameters

Parameter Name	Address	Description
Object Type	****	Standard output object type selected (for example, BO, PAO, AO, DAO, EHS)
Present Value	ADI or ADF 140	The current output command
Actual Stage	ADI 2	For an EHS object, the actual stages active (different from present value due to min flow and stage timing)
Input	ADF 50	Input signal from Box Heating PID output
Output	ADF 51	Estimated position of a PAO object
Interstage Off Delay	****	Delay between turning off subsequent EHS stages
Interstage On Delay	****	Delay between turning on subsequent EHS stages
Make Limit	****	Make limit (or limits) for EHS objects
Break Limit	****	Break limit (or limits) for EHS objects
Min Off Limit	****	Above this value, a DAO object remains on at 100%.
Min On Limit	****	Below this value, a DAO object remains off at 0%.
Box Htg Make Lmt	****	For BO object, output is active when input is above this value.

Table 85: Suppl Heating PID Parameters

Parameter Name	Address	Description
Present Value	ADF 73	Output of the PID control algorithm
Process Variable	****	Current zone temperature
Setpoint	****	Current zone temperature heating setpoint
Saturation Status	****	Low (High) if output of PID remains 0.0 (100.0) for saturation time

Table 86: Suppl Heating Output Parameters

Parameter Name	Address	Description
Object Type	****	Standard output object type selected (for example, BO, PAO, AO, DAO, EHS)
Present Value	ADI or ADF 141	The current output command
Actual Stage	ADI 6	For an EHS object, the actual stages active (different from present value due to min flow and stage timing)
Input	ADF 52	Input signal from Supplemental Heating PID output
Output	ADF 53	Estimated position of a PAO object
Interstage Off Delay	****	Delay between turning off subsequent EHS stages
Interstage On Delay	****	Delay between turning on subsequent EHS stages
Make Limit	****	Make limit (or limits) for EHS objects
Break Limit	****	Break limit (or limits) for EHS objects
Min Off Limit	****	Above this value, a DAO object remains on at 100%.
Min On Limit	****	Below this value, a DAO object remains off at 0%.

Table 87: Heating Flow PID Parameters

Parameter Name	Address	Description
Present Value	ADF 71	Output of the PID control algorithm. Changes flow setpoint during heating if heating flow reset is enabled.
Process Variable	****	Current zone temperature
Setpoint	****	Current zone temperature heating setpoint
Saturation Status	****	Low (High) if output of PID remains 0.0 (100.0) for saturation time

Table 88: Sideloop PID Parameters

Parameter Name	Address	Description
Present Value	****	Output of the PID control algorithm
Process Variable	****	Current value of the input sensor
Saturation Status	****	Low (High) if output of PID remains 0.0 (100.0) for saturation time

Table 89: Sideloop Output Parameters

Parameter Name	Address	Description
Object Type	****	Standard output object type selected (for example, BO, PAO, AO, DAO, EHS)
Present Value	ADI or ADF 142	The current output command
Actual Stage	ADI 31	For an EHS object, the actual stages active (different from present value due to min flow and stage timing)
Input	ADF 55	Input signal from Sideloop PID output
Output	ADF 56	Estimated position of a PAO object
Interstage Off Delay	****	Delay between turning off subsequent EHS stages
Interstage On Delay	****	Delay between turning on subsequent EHS stages
Make Limit	****	Make limit (or limits) for EHS objects
Break Limit	****	Break limit (or limits) for EHS objects
Min Off Limit	****	Above this value, a DAO object remains on at 100%.
Min On Limit	****	Below this value, a DAO object remains off at 0%.

Table 90: RF Wireless Thermostat

Parameter Name	Address	Description
Powerfail Diag	BD 180	TE7710 low battery indicator

VMA Single Duct Mapped Input/Output Attributes

The general characteristics of each of the input and output options available for use in VMA applications, as well as a detailed description of each of the viewable attributes, are given in the *Input/Output Options* topic in this section. Table 91 lists the attributes that are mapped to the Metasys Network for the inputs and outputs of the VMA single duct application.

Table 91: VMA Single Duct Application Input and Output Attributes Mapped to the Metasys Network

Attribute	Short Name	Long Name	Address
Zone Temperature (AI)			
	ZN-T	Present Value	AI n
	ZTREL	Reliability	ADI 20
Remote Adjust (AI)			
	W-C-ADJ	Present Value	AI n
	RAREL	Reliability	ADI 21
Remote Setpoint (AI)			
	REM-SET	Present Value	AI n
	RSREL	Reliability	ADI 22
Box Supply Temp (AI)			
	BOXS-T	Present Value	AI n
	BSTREL	Reliability	ADI 24
Supply Delta P (AI)			
	S-VP	Present Value	AI n
	DPREL	Reliability	ADI 23
Exhaust Delta P (AI)			
	E-VP	Present Value	AI n
	EDPREL	Reliability	ADI 26
Sideloop Input (AI)			
	SLAI	Present Value	AI n
	SLIREL	Reliability	ADI 25
Occupancy Button (BI)			
	TEMP-OCC	Present Value	BI n
	OCCCNREL	Reliability	ADI 10
Occupancy Sensor (BI)			
	OCC-S	Present Value	BI n
	OCCSNREL	Reliability	ADI 9
Low Limit Contact (BI)			
	LT-ALM	Present Value	BI n
	LLCNREL	Reliability	ADI 11
Continued on next page . . .			

Attribute (Cont.)	Short Name	Long Name	Address
Box Heating Cmd (PAO, AO, DAO, BO, EHS)			
	BOXHTG	Present Value (PAO, DAO)	ADF 140
	BOXHTG	Present Value (AO)	AO n
	BOXHTG-C	Present Value (BO)	BO n
	BOXHTG	Present Value (EHS)	ADI 140
	BHOUTPUT	Output (PAO, AO, DAO, EHS)	ADF 51
	BHOUTPUT	Output (BO)	ADI 51
	BHREL	Reliability	ADI 1
	BHACTSTG	Actual Stage (EHS)	ADI 2
	BHINPUT	Input (EHS)	ADF 50
	BHINSOFF	Instant All Off (EHS)	BD 41
Suppl Heating Cmd (PAO, AO, DAO, BO, EHS)			
	RADHTG	Present Value (PAO, DAO)	ADF 141
	RADHTG	Present Value (AO)	AO n
	RADHTG-C	Present Value (BO)	BO n
	RADHTG	Present Value (EHS)	ADI 141
	SHOUTPUT	Output (PAO, AO, DAO, EHS)	ADF 53
	SHOUTPUT	Output (BO)	ADI 53
	SHREL	Reliability	ADI 5
	SHACTSTG	Actual Stage (EHS)	ADI 6
	SHINPUT	Input (EHS)	ADF 52
	SHINSOFF	Instant All Off (EHS)	BD 43
Series Fan (AO, BO)			
	SER-FAN	Present Value (AO)	AO n
	SER-F-C	Present Value (BO)	BO n
	FANREL	Reliability	ADI 15
Parallel Fan (BO)			
	PAR-F-C	Present Value	BO n
	FANREL	Reliability	ADI 15
Damper Cmd (SMO, PAO, AO)			
	DMPRPV	Present Value (SMO, PAO)	ADF 152
	DPR-C	Present Value (AO)	AO n
	DMPRPOS	Output	ADF 54
	DMPRREL	Reliability	ADI 19
Exhaust Damper Cmd (PAO, AO)			
	EDPRPV	Present Value (PAO)	ADF 153
	EDPR-C	Present Value (AO)	AO n
	EDPRPOS	Output	ADF 60
	DDPRREL	Reliability	ADF 18
Lights			
	LTG-C	Present Value	ADI 65
	LGHTREL	Reliability (SSO)	ADI 16

Continued on next page . . .

Attribute (Cont.)	Short Name	Long Name	Address
Sideloop Cmd (PAO, AO, DAO, BO, EHS)			
	SLPAO, SLDAO	Present Value (PAO, DAO)	ADF 142
	SLAO, SLBO	Present Value (AO, BO)	AO n, BO n
	SLEHS	Present Value (EHS)	ADI 142
	SLOUTPUT	Output (PAO, AO, DAO, EHS)	ADF 56
	SLOUTPUT	Output (BO)	ADI 56
	SLCREL	Reliability	ADI 30
	SLACTSTG	Actual Stage (EHS)	ADI 31
	SLINPUT	Input (EHS)	ADI 55
	SLINSOFF	Instant All Off (EHS)	BD 45

VMA Dual Duct Parameters

The VMA has adjustable parameters, but most do not require changes. Changing parameters may cause the controller to malfunction. We offer this document to provide a reference for the application parameters used to configure VMA dual duct application.

This topic has four groups of tables. Table 92 shows which parameters are in each of the main views. Tables 93-114 describe the parameters visible in the configuration view. Tables 115-137 describe the additional calculated values seen in the commissioning view. Finally, Table 138 lists the input/output object attributes mapped to the Metasys Network.

VMA Dual Duct Main View Parameters

Table 92: VMA Dual Duct Main View Parameters

VMA Parameters		Configuration	Commissioning	Test and Balance
VAV Box Mode				
	Present Value		X	X
Occupancy Mode				
	Input	X	X	X
	Schedule		X	X
	Present Value		X	X
Command Modes				
	Cold Deck Available		X	X
	Hot Deck Available		X	X
	Cold Deck Percent			X
	Hot Deck Percent			X
	Warmup Req		X	X
	Cooldown Req		X	X
	Low Limit Req		X	X
	Suppl Htg Available		X	X
	Water System Flush	X	X	X
	Flush Position	X	X	
	Temp Loop Failsoft	X	X	
Temp Setpoints				
	Actual Cooling Setpt		X	
	Actual Heating Setpt		X	
	Common Setpoint	X	X	
	Cooling Setpoint	X	X	
	Heating Setpoint	X	X	
	Low Limit Temp Setpt	X	X	
	Discharge Temp Limit	X	X	
TMZ Setpoint Range				
	Low Setpoint Limit	X	X	
	High Setpoint Limit	X	X	
Temp Biases				
	Actual Cooling Bias		X	
	Actual Heating Bias		X	
	Occupied Clg Bias	X	X	
	Standby Clg Bias	X	X	
	Unoccupied Clg Bias	X	X	
	Occupied Htg Bias	X	X	
	Standby Htg Bias	X	X	
	Unoccupied Htg Bias	X	X	

Continued on next page . . .

VMA Parameters (Cont.)		Configuration	Commissioning	Test and Balance
Temp Diagnostics				
	MovAvg ZT Err		X	
	MovAvg ABS ZT Err		X	
	Inadequate Cooling		X	
	Inadequate Heating		X	
Summer Winter Comp				
	Outdoor Air Temp		X	
	Summer Compensation		X	
	Winter Compensation		X	
	Summer Setpoint	X	X	
	Summer Authority	X	X	
	Summer Change Limit	X	X	
	Winter Setpoint	X	X	
	Winter Authority	X	X	
	Winter Change Limit	X	X	
Deck Temperatures				
	Cold Deck Air Temp	X	X	
	Hot Deck Air Temp	X	X	
	Cold Deck Low Limit	X	X	
	Hot Deck High Limit	X	X	
	Min dP Velocity	X	X	
Cold Deck Status				
	Present Value		X	
	Cold Deck Flow		X	X
	Setpoint		X	X
Hot Deck Status				
	Present Value		X	
	Hot Deck Flow		X	X
	Setpoint		X	X
Total Flow Status				
	Present Value		X	
	Total Flow		X	X
	Setpoint		X	X
Continued on next page . . .				

VMA Parameters (Cont.)		Configuration	Commissioning	Test and Balance
Flow Setpoints				
	Cooling Max Flow	X	X	X
	Heating Max Flow	X	X	X
	Occ Box Min	X	X	X
	Occ Cold Deck Min	X	X	X
	Occ Hot Deck Min	X	X	X
	Unocc Box Min	X	X	X
	Unocc Cold Deck Min	X	X	X
	Unocc Hot Deck Min	X	X	X
	Warmup HD Min	X	X	X
	Warmup CD Flow	X	X	X
	Cooldown CD Min	X	X	X
	Cooldown HD Flow	X	X	X
Flow Units				
	Units	X	X	X
	Pvar Units	X	X	X
Indoor Air Quality				
	CD OA Percent		X	
	HD OA Percent		X	
	CD IAQ Min Flow		X	
	HD IAQ Min Flow		X	
	Occupancy Level	X	X	
	Ventilation Reqmnt	X	X	
Flow Diagnostics				
	MovAvg CD Err		X	
	MovAvg ABS CD Err		X	
	MovAvg HD Err		X	
	MovAvg ABS HD Err		X	
	MovAvg Total Err		X	
	MovAvg ABS Total Err		X	
	Starved Cold Deck		X	
	Starved Hot Deck		X	
Cold Deck Config				
	Area	X	X	X
	Pickup Gain	X	X	X
	Flow Coefficient	X	X	X
	Pvar Units	X	X	
	Delta Vp	X	X	
	Min Delta Vp	X	X	
	Max Velocity	X	X	

Continued on next page . . .

VMA Parameters (Cont.)		Configuration	Commissioning	Test and Balance
Hot Deck Config				
	Area	X	X	X
	Pickup Gain	X	X	X
	Flow Coefficient	X	X	X
	Pvar Units	X	X	
	Delta Vp	X	X	
	Min Delta Vp	X	X	
	Max Velocity	X	X	
Total Deck Config				
	Area	X	X	X
	Pickup Gain	X	X	X
	Flow Coefficient	X	X	X
	Pvar Units	X	X	
	Delta Vp	X	X	
	Min Delta Vp	X	X	
	Max Velocity	X	X	
Cold Deck Actuator				
	Reliability		X	
	Setup		X	
	Output		X	
	Present Value		X	
	Direction to Close	X	X	
	Polarity	X	X	
	Min Out Value	X	X	
	Max Out Value	X	X	
	Autocal		X	
	CD Stroke Time	X	X	
	Startup Autorange	X	X	
Hot Deck Actuator				
	Reliability		X	
	Setup		X	
	Output		X	
	Present Value		X	
	Direction to Close	X	X	
	Polarity	X	X	
	Min Out Value	X	X	
	Max Out Value	X	X	
	HD Stroke Time	X	X	

Continued on next page . . .

VMA Parameters (Cont.)		Configuration	Commissioning	Test and Balance
Actuator Diagnostics				
	MovAvg CD Reversals		X	
	MovAvg CD Duty Cycle		X	
	MovAvg HD Reversals		X	
	MovAvg HD Duty Cycle		X	
Autocalibration				
	Autocal Period	X	X	
	Autocal Time		X	
	Autocal Req		X	X
	Autocal Active		X	X
Occupancy Timer				
	Present Value		X	
	Time Remaining		X	
	Duration	X	X	
Lighting				
	Present Value		X	
	Light Shutoff Delay	X	X	
Energy Balance PID				
	Q Convert	X	X	
	Qdot Setpoint		X	
	Process Variable		X	
	Setpoint		X	
	High Limit		X	
	Present Value		X	
	Low Limit		X	
	Saturation Status		X	
Suppl Heating PID				
	Present Value		X	
	Process Variable		X	
	Setpoint		X	
	Saturation Status		X	
Continued on next page . . .				

VMA Parameters (Cont.)		Configuration	Commissioning	Test and Balance
Suppl Heating Output				
	Object Type		X	
	Present Value		X	
	Actual Stage		X	
	Input		X	
	Output		X	
	Stroke Time	X	X	
	Polarity	X	X	
	Interstage Off Delay		X	
	Interstage On Delay		X	
	Make Limit		X	
	Break Limit		X	
	Min Off Limit		X	
	Min On Limit		X	
	Suppl Htg Make Lmt	X	X	
	Suppl Htg Diffrntl	X	X	
Sideloop PID				
	Present Value		X	
	Process Variable		X	
	Setpoint	X	X	
	Saturation Status		X	
	Offset	X	X	
	Deadband	X	X	
	Proportional Band	X	X	
	Integral Time	X	X	
	Self Tuning	X	X	
	Direct Acting	X	X	
	Period	X	X	
Sideloop Output				
	Object Type		X	
	Present Value		X	
	Actual Stage		X	
	Input		X	
	Output		X	
	Stroke Time	X	X	
	Polarity	X	X	
	Interstage Off Delay		X	
	Interstage On Delay		X	
	Make Limit		X	
	Break Limit		X	
	Min Off Limit		X	
	Min On Limit		X	
	Sideloop Make Limit	X	X	
	Sideloop Diffrntl	X	X	

VMA Dual Duct Configuration Parameters

Note: An address entry of **** indicates that this parameter is not mapped to an address.

Table 93: Occupancy Mode Parameters

Parameter Name	Address	Default	Description
Input	ADI 165	Occupied	0 – Unoccupied 1 – Standby 2 – Occupied See the *Key Concepts* section for complete description.

Table 94: Command Modes Parameters

Parameter Name	Address	Default	Description
Water System Flush	****	False	Flag to command VMA into Water Flush mode
Flush Position	****	100	Heating valve position during Water Flush mode
Temp Loop Failsoft	****	Hold Outputs	Failsoft command when zone temperature AI is unreliable. See the *Temperature Loop* topic in the *Key Concepts, Application Logic* section of this document.

Table 95: Temperature Setpoints Parameters

Parameter Name	Address	Default	Description
Common Setpoint	ADF 197	21°C (70°F)	Primary supervisory zone temperature setpoint
Cooling Setpoint	ADF 189	0°C (0°F)	Zone temperature cooling setpoint (in place of common setpoint)
Heating Setpoint	ADF 193	0°C (0°F)	Zone temperature heating setpoint (in place of common setpoint)
Low Limit Temp Setpt	ADF 198	4°C (40°F)	Zone temperature setpoint during Low Limit mode
Discharge Temp Limit	ADF 188	0°C (32°F)	Minimum limit for discharge air temperature

Table 96: TMZ Setpoint Range Parameters

Parameter Name	Address	Default	Description
Low Setpoint Limit	ADF 127	19°C (65°F)	TMZ low limit for Comfort Setpoint. The TMZ reads this parameter from the VMA and prevents the temperature setpoint from being adjusted below this value.
High Setpoint Limit	ADF 128	26°C (78°F)	TMZ high limit for Comfort Setpoint. The TMZ reads this parameter from the VMA and prevents the temperature setpoint from being adjusted above this value.

Table 97: Temperature Biases Parameters

Parameter Name	Address	Default	Description
Occupied Clg Bias	ADF 190	0°C (0°F)	Occupied mode cooling bias temperature
Standby Clg Bias	ADF 191	2°C (4°F)	Standby mode cooling bias temperature
Unoccupied Clg Bias	ADF 192	4°C (8°F)	Unoccupied mode cooling bias temperature
Occupied Htg Bias	ADF 194	0°C (0°F)	Occupied mode heating bias temperature
Standby Htg Bias	ADF 195	-2°C (-4°F)	Standby mode heating bias temperature
Unoccupied Htg Bias	ADF 196	-4°C (-8°F)	Unoccupied mode heating bias temperature

Table 98: Summer Winter Comp. Parameters

Parameter Name	Address	Default	Description
Summer Setpoint	****	26°C (79°F)	Outdoor air temperature above which summer compensation occurs
Summer Authority	****	0.2	Proportion of the change to setpoint to the difference between outdoor air temperature and summer setpoint
Summer Change Limit	****	5°C (9°F)	Maximum allowed setpoint change by summer compensation
Winter Setpoint	****	10°C (50°F)	Outdoor air temperature below which winter compensation occurs
Winter Authority	****	-0.1	Proportion of the change to setpoint to the difference between outdoor air temperature and winter setpoint
Winter Change Limit	****	3°C (6°F)	Maximum allowed setpoint change by winter compensation

Table 99: Deck Temperatures Parameters

Parameter Name	Address	Default	Description
Cold Deck Air Temp	ADF 185	13°C (55°F)	Configured cold deck temperature (no D.A.T. sensor) or initial value for deck temperature estimate calculation (D.A.T. sensor)
Hot Deck Air Temp	ADF 186	32°C (90°F)	Configured hot deck temperature (no D.A.T. sensor) or initial value for deck temperature estimate calculation (D.A.T. sensor)
Cold Deck Low Limit	****	0°C (32°F)	Minimum limit for cold deck temperature estimate (D.A.T. sensor)
Hot Deck High Limit	****	60°C (140°F)	Maximum limit for hot deck temperature estimate (D.A.T. sensor)
Min dP Velocity	****	7300 m/hr (400 ft/min)	Minimum velocity for accurate dP measurement (2030 for liters per second [l/s])

Table 100: Flow Setpoints Parameters

Parameter Name	Address	Default	Description
Cooling Max Flow	ADF 161	850 m^3/hr (500 cfm)	Maximum box (total) flow when application is at full cooling, corresponding to control index 4
Heating Max Flow	ADF 162	850 m^3/hr (500 cfm)	Maximum box (total) flow when application is at full heating, corresponding to control index 1
Occ Box Min	ADF 163	850 m^3/hr (500 cfm)	Occupied minimum box (total) flow. For variable volume applications, the default is equal to 510 m^3/hr (300 cfm).
Occ Cold Deck Min	ADF 164	170 m^3/hr (100 cfm)	Occupied minimum cold deck (individual) flow setpoint
Occ Hot Deck Min	ADF 165	170 m^3/hr (100 cfm)	Occupied minimum hot deck (individual) flow setpoint
Unocc Box Min	ADF 168	0 m^3/hr (0 cfm)	Unoccupied minimum box (total) flow
Unocc Cold Deck Min	ADF 169	0 m^3/hr (0 cfm)	Unoccupied minimum cold deck (individual) flow setpoint
Unocc Hot Deck Min	ADF 170	0 m^3/hr (0 cfm)	Unoccupied minimum hot deck (individual) flow setpoint
Warmup HD Min	ADF 171	170 m^3/hr (100 cfm)	Minimum hot deck (individual) flow during Warmup mode
Warmup CD Flow	ADF 173	0 m^3/hr (0 cfm)	Constant flow setpoint for cold deck (individual) during Warmup mode
Cooldown CD Min	ADF 172	170 m^3/hr (100 cfm)	Minimum cold deck (individual) flow during Cooldown mode
Cooldown HD Flow	ADF 174	0 m^3/hr (0 cfm)	Constant flow setpoint for hot deck (individual) during Cooldown mode

Table 101: Flow Units Parameters

Parameter Name	Address	Default	Description
Units	****	m^3/hr (cfm)	This allows change of the display units for the flow setpoints.
Pvar Units	****	m^3/hr (cfm)	This allows change of the display units for the flow controllers.

Table 102: Indoor Air Quality Parameters

Parameter Name	Address	Default	Description
Occupancy Level	ADF 175	0 people	Normal zone occupancy level
Ventilation Reqmnt	****	34 m^3/hr (20 cfm)	Zone ventilation requirement per person

Table 103: Cold Deck Config Parameters

Parameter Name	Address	Default	Description
Area	ADF 11	0.0325 m^2 ($0.35 f^2$)	Box inlet area. See *Airflow Measurement* topic in the *Key Concepts, Theory of Operation* section.
Pickup Gain	ADF 12	2.25 (2.25)	Airflow pickup gain
Flow Coefficient	ADF 13	4644 (4005)	Flow property (function of elevation) (Change value to 1290 to compute liters per second [l/s].)
Pvar Units	****	m^3/hr (cfm)	This attribute allows changes to the flow controller process variable's units.
Delta Vp	****	0.031936 Pa (1.282e-4 in. w.c.)	Change in velocity pressure for 1 bit A/D (0.031936 for liters per seconds [l/s])
Min Delta Vp	****	12.45 Pa (0.05 in. w.c.)	Minimum Vp for noise estimate (12.45 for liters per second [l/s])
Max Velocity	****	58522 m/hr (3200 ft/min)	Unit flow velocity (16243 for liters per second [l/s])

Table 104: Hot Deck Config Parameters

Parameter Name	Address	Default	Description
Area	ADF 14	0.0325 m^2 ($0.35 ft^2$)	Box inlet area. See the *Airflow Measurement* topic in the *Key Concepts* section.
Pickup Gain	ADF 15	2.25 (2.25)	Airflow pickup gain
Flow Coefficient	ADF 16	4644 (4005)	Flow property (function of elevation) (Change value to 1290 to compute liters per second [l/s].)
Pvar Units	****	m^3/hr (cfm)	This attribute allows changes to the flow controller process variable's units.
Delta Vp	****	0.17003 Pa (6.8376e-4 in. w.c.)	Change in velocity pressure for 1 bit A/D [0.17003 for liters per seconds (l/s)]
Min Delta Vp	****	12.45 Pa (0.05 in. w.c.)	Minimum Vp for noise estimate (12.45 for liters per second [l/s])
Max Velocity	****	58522 m/hr (3200 ft/min)	Unit flow velocity (16243 for liters per second [l/s])

Table 105: Total Deck Config Parameters

Parameter Name	Address	Default	Description
Area	ADF 17	0.0325 ^{2} (0.35 f^{2})	Box inlet area. See the *Airflow Measurement* topic in the *Key Concepts* section.
Pickup Gain	ADF 18	2.25 (2.25)	Airflow pickup gain
Flow Coefficient	ADF 19	4644 (4005)	Flow property (function of elevation) (Change value to 1290 to compute liters per second [l/s].)
Pvar Units	****	m^{3}/hr (cfm)	This attribute allows changes to the flow controller process variable's units.
Delta Vp	****	****	Change in velocity pressure for 1 bit A/D. For internal total flow dP sensor paired with hot deck external sensor, default value is the same as for the cold deck. Otherwise, the default is the same as for the hot deck.
Min Delta Vp	****	12.45 Pa (0.05 in. w.c.)	Minimum Vp for noise estimate (12.45 for liters per second [l/s])
Max Velocity	****	58522 m/hr (3200 ft/min)	Unit flow velocity (16243 for liters per second [l/s])

Table 106: Cold Deck Actuator Parameters

Parameter Name	Address	Default	Description
Direction to Close	****	Clockwise	Direction that the integrated actuator should turn to close damper
Polarity	****	Normal	For PAO output: Normal - First BO ON to open; Reverse - First BO ON to close
Min Out Value	****	0%	For analog output, % of 10 volts at 0% control
Max Out Value	****	100%	For analog output, % of 10 volts at 100% control
CD Stroke Time	****	90 seconds	Stroke time for AO output
Startup Autorange	****	True	For integrated actuator, enables or disables automatic calibration of actuator stroke time based on measured stroke time. Normally occurs at first autocalibration.

Table 107: Hot Deck Actuator Parameters

Parameter Name	Address	Default	Description
Polarity	****	Normal	For PAO output: Normal - First BO ON to open; Reverse - First BO ON to close
Min Out Value	****	0%	For analog output, % of 10 volts at 0% control
Max Out Value	****	100%	For analog output, % of 10 volts at 100% control
HD Stroke Time	****	90 seconds	Stroke time for AO output

Table 108: Autocalibration Parameters

Parameter Name	Address	Default	Description
Autocal Period	****	336 hours	Autocalibration period (hours between subsequent autocalibrations)

Table 109: Occupancy Timer Parameter

Parameter Name	Address	Default	Description
Duration	****	60 minutes	Occupancy timer duration
Occupancy Override Time	ADF 85	60 minutes	Occupancy timer duration when mapped from the supervisory system

Table 110: Lighting Parameter

Parameter Name	Address	Default	Description
Light Shutoff Delay	ADF 180	2 minutes	Time between light blink and complete light shutoff when Occupancy mode transitions to unoccupied

Table 111: Energy Balance PID Parameter

Parameter Name	Address	Default	Description
Q Convert	****	1.1435 (1.08)	Conversion factor from product of temperature difference and flow (4.119 for l/s and °C, 1.944 for cfm and °C). See the *VMA Dual Duct Applications* topic in the *Key Concepts* section for more details.

Table 112: Suppl Heating Output Parameters

Parameter Name	Address	Default	Description
Stroke Time	****	60 seconds	Stroke time for PAO output
Polarity	****	Normal	For PAO output: first BO ON to open - normal; first BO ON to close - reverse
Polarity	****	Normal	For BO normally closed - normal; BO normally open - reverse
Suppl Htg Make Lmt	****	55%	For BO object, output is active when input is above this value.
Suppl Htg Differential	****	10%	For BO object, output changes from active to inactive when input falls below make limit by this value.

Table 113: Sideloop PID Parameters

Parameter Name	Address	Default	Description
Setpoint	ADF 199	0	Current setpoint for the sideloop control algorithm
Offset	****	0	
Deadband	****	0	
Proportional Band	****	10	
Integral Time	****	300 seconds	
Self Tuning	****	-	Flag designating whether PRAC is used
Direct Acting	****	True	
Period	****	60 seconds	Time period between PID calculations

Table 114: Sideloop Output Parameters

Parameter Name	Address	Default	Description
Stroke Time	****	60 seconds	Stroke time for PAO output
Polarity	****	Normal	For PAO output
Polarity	****	-	BO normally closed - normal; BO normally open - reverse
Sideloop Htg Make Lmt	****	55%	For BO object, output is active when input is above this value.
Sideloop Differential	****	10%	For BO object, output changes from active to inactive when input falls below make limit by this value.

VMA Dual Duct Commissioning Parameters

Note: An address entry of **** indicates that this parameter is not mapped to an address.

Table 115: VAV Box Mode Parameters

Parameter Name	Address	Description
Present Value	ADI 67	Primary VMA control mode. Command modes: 0 = Shutdown Closed 1= Shutdown Open Auto modes: 2 = Satisfied 3 = Mixing 4 = Cooling 5 = Heating 6 = Suppl Htg See the *Key Concepts* section for complete description.

Table 116: Occupancy Mode Parameters

Parameter Name	Address	Description
Schedule	ADI 78	0 - Unoccupied 1 - Standby 2 - Occupied 3 - No Schedule This parameter provides a non-archivable point for scheduling commands. If N2 communication fails, the Occupancy Mode Input becomes the default mode. See the *Key Concepts* section for a complete description.
Present Value	ADI 68	0 - Unoccupied 1 - Standby 2 - Occupied See the *Key Concepts* section for complete description.

Table 117: Command Modes Parameters

Parameter Name	Address	Description
Cold Deck Available	BD 75	Flag used to indicate whether the cold deck AHU is currently operating
Hot Deck Available	BD 76	Flag used to indicate whether the hot deck AHU is currently operating
Warmup Req	BD 72	Flag used to request Warmup mode
Cooldown Req	BD 71	Flag used to request Cooldown mode
Low Limit Req	BD 73	Flag used to request Low Limit mode
Suppl Htg Available	BD 77	Used to specify when supplemental heating source is available (for example, boiler and hot water pumps on)
Cold Deck Percent	ADF 71	Current cold deck flow setpoint as a percentage between the current cold deck minimum and cooling maximum flow setpoints. This point should be used in conjunction with the Hot Deck Percent parameter to command multiple slave controllers that condition a space with a single zone sensor and multiple VMA controllers. This parameter is visible only in Test and Balance View.
Hot Deck Percent	ADF 72	Current hot deck flow setpoint as a percentage between the current hot deck minimum and heating maximum flow setpoints. This point should be used in conjunction with the Cold Deck Percent parameter to command multiple slave controllers that condition a space with a single zone sensor and multiple VMA controllers. This parameter is visible only in Test and Balance View.

Table 118: Temperature Setpoints Parameters

Parameter Name	Address	Description
Actual Cooling Setpt	ADF 4	See the *Temperature Setpoint Configuration for VMA Dual Duct Applications* topic in the *Key Concepts* section for complete details.
Actual Heating Setpt	ADF 5	See the *Temperature Setpoint Configuration for VMA Dual Duct Applications* topic in the *Key Concepts* section for complete details.

Table 119: Temperature Biases Parameters

Parameter Name	Address	Description
Actual Cooling Bias	ADF 6	Actual Cooling Bias = specified cooling bias of current Occupancy mode
Actual Heating Bias	ADF 7	Actual Heating Bias = specified heating bias of current Occupancy mode

Table 120: Temperature Diagnostics Parameters

Parameter Name	Address	Description
MovAvg ZT Err	ADF 39	Moving average of the error between the current zone temperature and the zone temperature setpoint
MovAvg ABS ZT Err	ADF 40	Moving average of the absolute value of the zone temperature error
Inadequate Cooling	BD 3	True when box is unable to maintain the zone at the cooling temperature setpoint and is not starved for flow
Inadequate Heating	BD 4	True when all available heat is at maximum, but the box is unable to maintain the zone at the heating setpoint

Table 121: Summer Winter Comp. Parameters

Parameter Name	Address	Description
Outdoor Air Temp	ADF 81	Outdoor air temperature value provided via network
Summer Compensation	ADF 8	See *Summer and Winter Compensation* in the *Application Logic* topic in this document.
Winter Compensation	ADF 9	See *Summer and Winter Compensation* in the *Application Logic* topic in this document.

Table 122: Cold Deck Status Parameters

Parameter Name	Address	Description
Present Value	****	Output of the P-Adaptive control algorithm. See the *Key Concepts* section for more information.
Cold Deck Flow	ADF 36	Current flowrate being delivered by the cold deck
Setpoint	ADF 65	Current setpoint for the cold deck

Table 123: Hot Deck Status Parameters

Parameter Name	Address	Description
Present Value	****	Output of the P-Adaptive control algorithm. See the *Key Concepts* section for more information.
Hot Deck Flow	ADF 37	Current flowrate being delivered by the hot deck
Setpoint	ADF 66	Current setpoint for the hot deck

Table 124: Total Flow Status Parameters

Parameter Name	Address	Description
Present Value	****	Output of the P-Adaptive control algorithm. See the *Key Concepts* section for more information.
Total Flow	ADF 38	Current flowrate being delivered by the box (cold deck + hot deck)
Setpoint	ADF 67	Current setpoint for the box (cold deck + hot deck)

Table 125: Indoor Air Quality Parameters

Parameter Name	Address	Description
CD OA Percent	ADF 75	Percent outdoor air included in the cold deck supply. Value must be mapped via a network variable.
HD OA Percent	ADF 76	Percent outdoor air included in the hot deck supply. Value must be mapped via a network variable.
CD IAQ Min Flow	****	Minimum amount of cold deck air due to IAQ requirements
HD IAQ Min Flow	****	Minimum amount of hot deck air due to IAQ requirements

Table 126: Flow Diagnostics Parameters

Parameter Name	Address	Description
MovAvg CD Err	ADF 41	Moving average of the error between the cold deck flow and setpoint
MovAvg ABS CD Err	ADF 42	Moving average of the absolute value of the cold deck flow error
MovAvg HD Err	ADF 43	Moving average of the error between the hot deck flow and setpoint
MovAvg ABS HD Err	ADF 44	Moving average of the absolute value of the hot deck flow error
MovAvg Total Err	ADF 45	Moving average of the error between the total flow and setpoint
MovAvg ABS Total Err	ADF 46	Moving average of the absolute value of the total flow error
Starved Cold Deck	BD 50	True if the box is unable to maintain the cold deck flow setpoint (that is, damper remains saturated at 100% open)
Starved Hot Deck	BD 51	True if the box is unable to maintain the hot deck flow setpoint (that is, damper remains saturated at 100% open)

Table 127: Cold Deck Actuator Parameters

Parameter Name	Address	Description
Reliability	ADI 18	Reliability of the value or the reason for not being trustworthy if unreliable
Setup	****	Actuator type
Output	ADF 34	Estimated position (0-100%) of the damper actuator
Present Value	ADF 68	The current command to the actuator
Autocal	****	SMO calibration command

Table 128: Hot Deck Actuator Parameters

Parameter Name	Address	Description
Reliability	ADI 19	Reliability of the value or the reason for not being trustworthy if unreliable
Setup	****	Actuator type
Output	ADF 35	Estimated position (0-100%) of the damper actuator
Present Value	ADF 69	The current command to the actuator

Table 129: Actuator Diagnostics Parameters

Parameter Name	Address	Description
MovAvg CD Reversals	ADF 47	Moving average of the cold deck hourly reversals over the past 24 hours
MovAvg CD Duty Cycle	ADF 48	Moving average of the cold deck actuator duty cycle over the past 24 hours
MovAvg HD Reversals	ADF 49	Moving average of the hot deck hourly reversals over the past 24 hours
MovAvg HD Duty Cycle	ADF 50	Moving average of the hot deck actuator duty cycle over the past 24 hours

Table 130: Autocalibration Parameters

Parameter Name	Address	Description
Autocal Time	****	Current number of hours since most previous autocalibration
Autocal Req	BD 70	Flag used to request an autocalibration
Autocal Active	BD 60	Status of the autocalibration routine

Table 131: Occupancy Timer Parameters

Parameter Name	Address	Description
Present Value	BD 12	Status of the occupancy timer
Time Remaining	****	Time remaining in the current temporary occupancy period (if active)

Table 132: Lighting Parameters

Parameter Name	Address	Description
Present Value	ADI 65	Status of lighting control

Table 133: Energy Balance PID Parameters

Parameter Name	Address	Description
Qdot Setpoint	ADF 51	Current heat transfer setpoint (BTU/hr). This value is calculated by subtracting Qdot Offset from the PID Present Value.
Process Variable	****	Current zone temperature
Setpoint	****	Current zone temperature setpoint
Qdot Offset	****	Offset of PID Present Value to ensure High Limit is always > 0.0 (only visible in Diagnostic view).
High Limit	ADF 22	Maximum value for PID Present Value
Present Value	ADF 70	Current output of the PID
Low Limit	ADF 21	Minimum value for the PID Present Value
Saturation Status	****	Low (High) if output of PID remains 0.0 (100.0) for saturation time

Table 134: Suppl Heating PID Parameters

Parameter Name	Address	Description
Present Value	ADF 73	Output of the PID control algorithm
Process Variable	****	Current zone temperature
Setpoint	****	Current zone temperature heating setpoint
Saturation Status	****	Low (High) if output of PID remains 0.0 (100.0) for saturation time

Table 135: Suppl Heating Output Parameters

Parameter Name	Address	Description
Object Type	****	Standard output object type selected (for example, BO, PAO, AO, DAO, EHS)
Present Value	ADI or ADF 141	The current output command
Actual Stage	ADI 6	For an EHS object, the actual stages active (different from present value due to min flow and stage timing)
Input	ADF 28	Input signal from Supplemental Heating PID output
Output	ADF 29	Estimated position of a PAO object
Interstage Off Delay	****	Delay between turning off subsequent EHS stages
Interstage On Delay	****	Delay between turning on subsequent EHS stages
Make Limit	****	Make limit (or limits) for EHS objects
Break Limit	****	Break limit (or limits) for EHS objects
Min Off Limit	****	Above this value, a DAO object remains on at 100%.
Min On Limit	****	Below this value, a DAO object remains off at 0%.

Table 136: Sideloop PID Parameters

Parameter Name	Address	Description
Present Value	****	Output of the PID control algorithm
Process Variable	****	Current value of the input sensor
Saturation Status	****	Low (High) if output of PID remains 0.0 (100.0) for saturation time

Table 137: Sideloop Output Parameters

Parameter Name	Address	Description
Object Type	****	Standard output object type selected (for example, BO, PAO, AO, DAO, EHS)
Present Value	ADI or ADF 142	The current output command
Actual Stage	ADI 31	For an EHS object, the actual stages active (different than present value due to min flow and stage timing)
Input	ADF 32	Input signal from Sideloop PID output
Output	ADF 33	Estimated position of a PAO object
Interstage Off Delay	****	Delay between turning off subsequent EHS stages
Interstage On Delay	****	Delay between turning on subsequent EHS stages
Make Limit	****	Make limit (or limits) for EHS objects
Break Limit	****	Break limit (or limits) for EHS objects
Min Off Limit	****	Above this value, a DAO object remains on at 100%.
Min On Limit	****	Below this value, a DAO object remains off at 0%.

VMA Dual Duct Mapped Input/Output Attributes

The general characteristics of each of the input and output options available for use in VMA applications, as well as a detailed description of each of the viewable attributes, are given in the *Input/Output Options* topic in the *Attributes and Parameters* section of this document. A list of the attributes that are mapped to the Metasys Network for the inputs and outputs of the VMA application are shown in Table 138.

Table 138: VMA Dual Duct Application Input and Output Attributes Mapped to the Metasys Network

Attribute	Short Name	Long Name	Address
Zone Temperature (AI)			
	ZN-T	Present Value	AI n
	ZTREL	Reliability	ADI 20
Remote Adjust (AI)			
	W-C-ADJ	Present Value	AI n
	RAREL	Reliability	ADI 21
Remote Setpoint (AI)			
	REM-SET	Present Value	AI n
	RSREL	Reliability	ADI 22
Discharge Air Temp (AI)			
	DA-T	Present Value	AI n
	DATREL	Reliability	ADI 24
Cold Deck Delta P (AI)			
	CD-VP	Present Value	AI n
	CDDPREL	Reliability	ADI 26
Hot Deck Delta P (AI)			
	HD-VP	Present Value	AI n
	HDDPREL	Reliability	ADI 27
Total Flow Delta P (AI)			
	TOT-VP	Present Value	AI n
	TOTDPREL	Reliability	ADI 28
Sideloop Input (AI)			
	SLAI	Present Value	AI n
	SLIREL	Reliability	ADI 25
Occupancy Button (BI)			
	TEMP-OCC	Present Value	BI n
	OCCCNREL	Reliability	ADI 10
Occupancy Sensor (BI)			
	OCC-S	Present Value	BI n
	OCCSNREL	Reliability	ADI 9

Continued on next page . . .

Attribute (Cont.)	Short Name	Long Name	Address
Low Limit Contact (BI)			
	LT-ALM	Present Value	BI n
	LLCNREL	Reliability	ADI 11
Suppl Heating Cmd (PAO, AO, DAO, BO, EHS)			
	RADHTG	Present Value (PAO, DAO)	ADF 141
	RADHTG	Present Value (AO)	AO n
	RADHTG-C	Present Value (BO)	BO n
	RADHTG	Present Value (EHS)	ADI 141
	SHOUTPUT	Output (PAO, AO, DAO, EHS)	ADF 29
	SHOUTPUT	Output (BO)	ADI 29
	SHREL	Reliability	ADI 5
	SHACTSTG	Actual Stage (EHS)	ADI 6
	SHINPUT	Input (EHS)	ADF 28
	SHINSOFF	Instant All Off (EHS)	BD 43
Cold Deck Damper Cmd (SMO, PAO, AO)			
	CDDPRPV	Present Value (SMO, PAO)	ADF 68
	CD-DPR-C	Present Value (AO)	AO n
	CDDPRPOS	Output	ADF 34
	CDDPRREL	Reliability	ADI 18
Hot Deck Damper Cmd (PAO, AO)			
	HDDPRPV	Present Value (PAO)	ADF 69
	HD-DPR-C	Present Value (AO)	AO n
	HDDPRPOS	Output	ADF 35
	HDDPRREL	Reliability	ADI 19
Lights			
	LTG-C	Present Value	ADI 65
	LGHTREL	Reliability (SSO)	ADI 16
Sideloop Cmd (PAO, AO, DAO, BO, EHS)			
	SLPAO, SLDAO	Present Value (PAO, DAO)	ADF 142
	SLAO, SLBO	Present Value (AO, BO)	AO n, BO n
	SLEHS	Present Value (EHS)	ADI 142
	SLOUTPUT	Output (PAO, AO, DAO, EHS)	ADF 33
	SLOUTPUT	Output (BO)	ADI 33
	SLCREL	Reliability	ADI 30
	SLACTSTG	Actual Stage (EHS)	ADI 31
	SLINPUT	Input (EHS)	ADI 32
	SLINSOFF	Instant All Off (EHS)	BD 45

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