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VAV Terminal Control Applications

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Using VAV Applications

Introduction

The Variable Air Volume (VAV) Controller is an electronic device for digital control of single duct, dual duct (for this release), fan powered, and supply/exhaust VAV terminal configurations. This bulletin provides an overview of the VAV Controller and includes procedures for creating single and dual duct applications.

Refer to the *Variable Air Volume Modular Assembly (VMA) 1400 Series Application Note (LIT-6375125)* for information on applications specific to the VAV Modular Assembly (VMA1400).

This bulletin describes how to:

- calculate user defined flow parameters for other non-linear sensors
- create a VAV single duct application
- create a VAV dual duct application

Key Concepts

Variable Air Volume (VAV) Controller

The Variable Air Volume (VAV) controller is an electronic device for digital control of single duct, dual duct, fan powered, and supply/exhaust VAV terminal configurations. Along with the control capability of the VAV box, the controller can also integrate the control of the room or zone baseboard heat and lighting logic. You may use the VAV as a standalone controller or connected to the Metasys® Network through a Network Control Module (NCM), Metasys Companion™/Facilitator™, or N30 Supervisory Controller.

When connected to the Metasys Network, the VAV provides all point and control information to the rest of the network. The devices communicate through the N2 Bus.

HVAC PRO™ Release 6.00 or later allows you to configure the Variable Air Volume controller with more ease, simplicity, and application flexibility than ever before. Refer to the *Getting Started on HVAC PRO* chapter of the *User's Guide to HVAC PRO (LIT-6375040)* for information on using the windows environment, general information pertaining to starting HVAC PRO, and hardware/software requirements.

HVAC PRO Release 6.00 or later allows a VAV controller application to be downloaded with one sideloop. A sideloop is a control loop where an input controls an unused output, in addition to the VAV controller's main strategy.

For example, you may want to control a humidifier based on return air humidity. Since the VAV controller does not offer a humidity loop, a sideloop could accomplish this task. This sideloop strategy could provide an occupied setpoint and an optional unoccupied setpoint. Moreover, you could disable the output (either from the On status of the controller's Shutdown mode or the Off status of a binary input interlock) in order to prevent the humidifier from operating when no air is flowing through the VAV box.

If more than one sideloop is required, HVAC PRO Release 5.10 or later allows downloading of a VAV terminal control configuration to a UNT11n-1.

The VAV controller cannot be downloaded as a point multiplexer. The unused points, however, can be user defined and used with a single sideloop.

For more detailed information on the operation of sideloops, see *Appendix A: Sideloop Applications (LIT-6375160).*

VAV System Operation Theory

VAV System

A VAV system maintains the air supply at a constant temperature while individual zone thermostats vary the flow of air to each space maintaining the desired zone temperature. This is unlike a constant volume system that maintains a constant volume of airflow to the space, but varies the temperature of the air stream in response to space temperature changes. 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 a Metasys Air Handling Unit (AHU) or DX-91x0 controller, while each zone has its own Metasys digital VAV controller.

Note: The DX-91x0 does not support HVAC PRO applications. Refer to the *System 9100 Technical Manual (FAN 636.4)* for more information on the DX-91x0.

The air handling system typically maintains about 1 inch W.C. static pressure inside the longest run of duct work 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. As each VAV box opens and closes in response to the temperature changes in the space, the static pressure in the air handling system changes. It is the job of the controller at the air handler to modulate the supply fan providing the needed amount of airflow to each VAV box by maintaining the static pressure setpoint.

VAV systems are most easily understood by first considering them as cooling applications. As the zone temperature increases and if the AHU is supplying cool air, the VAV controller opens the VAV box damper to allow more cool air to reach the space. The specific amount of air volume 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. If the installed unit is too small, insufficient cooling results and at high flow rates audible noise may be emitted. If the installed unit is too large, proper control may be difficult to attain since a small change in damper position causes an excessive change in airflow. Today, boxes may be oversized to allow for quiet operation or reserve cooling capacity.

Single Duct Systems

Many single duct systems are cooling only. When the zone temperature is below the setpoint, the damper is open only slightly to provide the minimum fresh air volume requirements.

In colder climates, exterior zones may require some form of heating. Staged electric heat, two position, or modulated hot water coil are used to heat the air entering the zone.

Dual Duct Systems

All dual duct systems have a separate hot deck and cold deck. Air supplied to the zone may be from the hot or cold deck. Within the comfort zone, the box may supply a blend of both decks.

VAV Terminal Unit

Commonly called a VAV box, this mechanical equipment modulates airflow to the space with the Johnson Controls VAV controller. It is a commercially manufactured box with a control damper, inlet and outlet connections, and options such as flow pickups, return air plenum inlet, heating coil, and fan. A dual duct box has inlets/control dampers for warm and cold air. The control damper is usually a butterfly type blade. The damper is controlled by rotating its shaft through a full stroke of either 90, 60, or 45 degrees, depending on the manufacturer. Box manufacturers rate their boxes for a range of air flow based on inlet size and 1 inch W.C. inlet duct static pressure.

Pressure Dependent

A VAV box control strategy where the amount of air delivered to the space is dependent upon the inlet duct static pressure, as well as control damper position. Pressure dependent control does not use a device to measure inlet pressure as a means to determine flow. The space temperature control loop directly positions the damper. Drawbacks to this system are that the effect of the damper position on space temperature is nonlinear, and the space temperature controller has no control over the actual airflow to the space. For example, if a number of boxes on a branch duct are closing, the resulting inlet pressure at the boxes remaining open increases, causing more air to flow into the spaces served. Thus, VAV box flow is dependent on duct static pressure.

Pressure Independent

An improved VAV box control strategy employs cascaded Proportional/Integral control loops. The zone temperature loop samples space temperature and resets the airflow setpoint between the minimum and maximum flow settings. This airflow setpoint is used by the airflow loop, which samples airflow via a Differential Pressure Transmitter (DPT) in the box inlet and modulates the damper to control the flow. Thus, the VAV box flow is independent of duct static pressure.

The engineering basis for this method of control is that the temperature of a space with a constant load is linearly proportional to the flow of conditioned air into the space. It also requires that the consulting engineer has accurately determined the required maximum and minimum flow for each space based on heating and cooling loads.

Airflow Measurement

Common flow measurement methods applicable to VAV terminal unit control are:

- differential pressure--based on the pressure difference created by the motion of air. A DPT senses the pressure difference across a multiple port airflow pickup, which typically amplifies the velocity pressure.
- thermal, (i.e., hot wire)--based on the rate of cooling, due to the flow of air over a hot body. Two basic types are in use: a single point duct insertion probe vs. a flow through device, which samples via the multiple port airflow pickup.

We recommend differential pressure sensing. Reasonable flow measurement accuracy can be obtained at velocities above 400 fpm (feet per minute) and down to perhaps 200 fpm. Given today’s technology, the temperature effect of the pressure sensor is by far the greatest contributor to error in indicated flow. Thus a pressure sensor having a minimal effect due to temperature and/or maintained at a relatively constant ambient temperature is desired. For example, using a 1.5 inch W.C. sensor with a temperature coefficient of offset of 0.06% of span per °F, a temperature variation of +/- 3 F° and an airflow pickup gain (or K-factor) of 2.78, the flow indication error due to temperature will be less than 5% at 400 fpm and 10% at 200 fpm. Also, since the largest effect is upon the sensor zero, this can be compensated for by an auto zero algorithm.

Although thermal types initially have better accuracy at low velocity, they sustain a shift in calibration over time as dirt is accumulated on the sensor. Additionally, hot wire insertion probes have the disadvantage of sensing at a single point in the air stream. Flow through types may use in line air filters, but as the filters become loaded with dirt, their pressure drop will increase causing an apparent sensor calibration shift. Further, this shift can affect both the sensor sensitivity and zero. A change in sensitivity cannot be compensated for by an auto zero algorithm, and requires verification at two or more points for recalibration.

Airflow Pickup

This device is usually located in the inlet of a pressure independent box to sample the airflow. The pickup may be a molded plastic cross shape or a pair of rings or straight sections of 1/4 inch diameter aluminum or copper tubing. Several examples are shown in Figure 1.

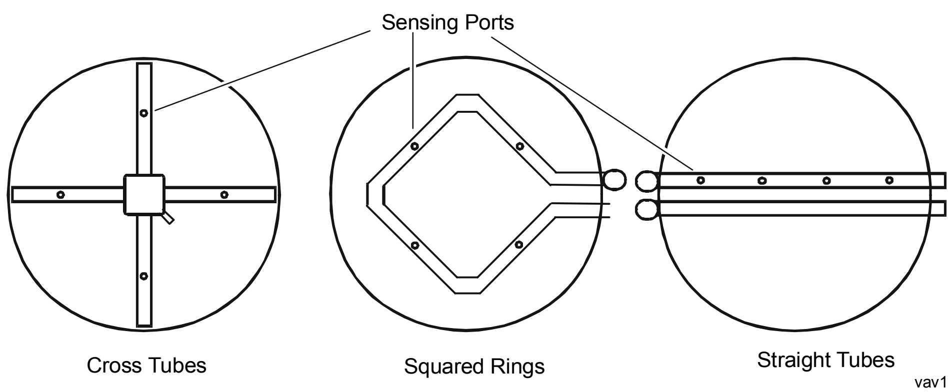

Figure 1: Common Flow Pickups as Viewed Looking into the Box Inlet

Functionally, the pickup consists of two manifolds having an equal number of symmetrically located ports. The high side manifold ports face upstream and the low side ports open downstream. Each manifold averages the samples from its multiple ports. These give a better indication of average pressure than a single port pickup can provide when the air velocity is not uniform across the duct area. Non-uniform velocity is common in VAV installations; typically caused by turns, other transitions, or sagging flex duct within three diameters upstream of the flow pickup. Among multiport devices, usually the cross and ring types perform better than straight tubes because the sensing ports are more distributed across the duct area.

What the Air Flow Pickup Measures

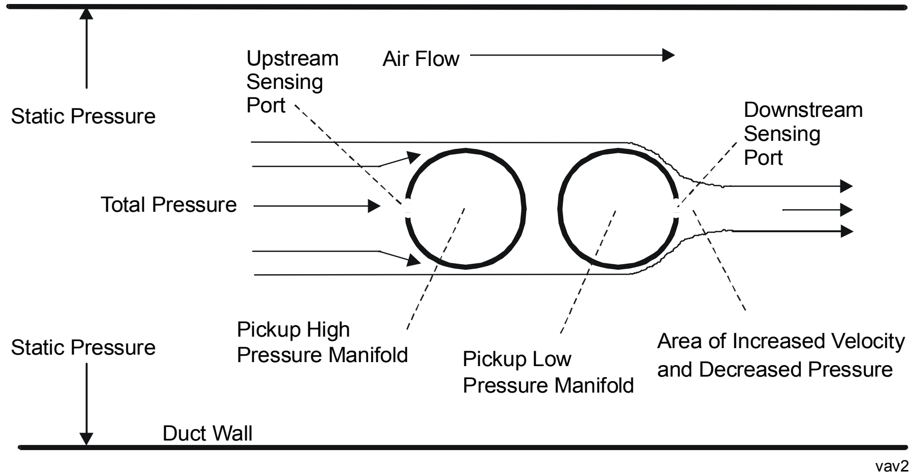

Figure 2: Interaction of the Pickup and Air Stream

Referencing Figure 2, the upstream ports are exposed to total pressure. In order to sense true static pressure, the pickup must have openings that are perpendicular to the direction of flow. Instead, the low pressure ports open downstream, and the passing air exerts a pull on these openings resulting in a pressure less than static.

Since velocity pressure equals total minus static pressures

$P_{velocity}=P_{total}-P_{static}$

and the differential pressure is total minus downstream pressures

$P_{differential}=P_{total}-P_{downstream}$

If downstream is less than static, then the pressure difference across the pickup must be greater than velocity pressure.

Thus, the velocity pressure is amplified by this effect. The amount of amplification or gain of the pickup is determined by its aerodynamic design and the flow characteristics of the box inlet, and varies among box manufacturers in the range of 1.5 to 3.5. This desirable amplification in pneumatic flow controllers provides the force necessary to displace diaphragms.

Flow Multiplier

Users of digital systems usually expect flow to be accurately calculated and displayed, thus the exact pickup gain (or K-factor) must be provided to the control algorithm. In VAV applications, we use the name Flow Multiplier for pickup gain. Velocity pressure is expressed as:

$$P_{velocity} = P_{differential} / \text{Flow Mult}$$

The equation for flow in English system units is:

$$\text{Flow} = \text{Area} * 4005 * \sqrt{P_{velocity}}$$

where flow is in cfm, area is in sq ft, and $P_{velocity}$ is in inches W.C.

Combining the two equations results in:

$$\text{Flow} = \text{Area} * 4005 * \sqrt{P_{differential} / \text{Flow Mult}}$$

Note: For metric equivalents of these equations (in l/s), see the *Airflow Calculations for Pressure Independent Applications* topic later in this section.

Flow Multipliers for most currently manufactured VAV boxes are listed in the *OEM Reference Manual (FAN 638)* and *Appendix B: VAV Controller Flow Calculation Constants (LIT-6375185)* in this manual. These gains are for use with dead ended devices like differential pressure transducers. As box designs change from time to time, and also because some controls companies specify flow pickups other than what is normally supplied by the box manufacturer, the published gains may not apply to existing boxes being retrofit with new controls. In these cases, or when using a flow through device like a hot wire sensor, contact the box manufacturer and calculate the correct pickup gain as shown below.

Instead of pickup gain, box manufacturers will provide a number that represents the flow in cfm at 1 inch W.C. differential pressure and combines the gain, inlet area, and the constant 4005. This number can also be estimated from the graph normally attached to the side of the VAV box. These graphs plot flow against differential pressure, although it is often incorrectly labeled velocity pressure. Calculate Flow Mult as follows.

$$\text{Flow Mult} = P_{differential} * \left(\frac{4005 * \text{Area}}{\text{Flow}} \right)^2$$

for flow in cfm, area in sq ft, and $P_{differential}$ in inches W.C.

During test and balance, the Flow Multiplier may be adjusted to match the controller flow indication with the balancer's reading. However, if the two readings differ by more than 20%, everyone is better served by investigating the cause of the difference.

Airflow Test and Balance Concerns

Pressure independent VAV control jobs frequently require an accuracy within 5-10% of actual flow and indicated flow. The balancing contractor must adjust and certify the flow rates specified by the consulting engineer. Sometimes the balancer's readings disagree with flow indicated by the VAV controller.

When airflow readings disagree, a problem may exist or some fact of the air delivery system may not be known or understood. There are margins for error in the measurement equipment used by the controller as well as that used by the balancer. Therefore, it is important that both contractors--controls and balancing--understand the equipment, techniques, and expectations of each other.

Factors Affecting Controller Flow Reading

Following is a list of some factors that may contribute to controller flow reading inaccuracy.

- Incorrect values entered into the controller for box area, flow multiplier (airflow pickup gain), or differential pressure input range.
- Auto Zero ran when the supply air fan was running and the VAV box damper was not tightly closed off. Failure to tightly close the box damper may be caused by damaged damper seal, bent damper blades, poorly designed dampers, or an actuator collar (or other linkage) which is not tightly locked to the damper shaft. The linkage may be set allowing the actuator to come to an internal travel stop before the damper fully closes. Any of these cause the incorrectly indicated differential pressure. The most reliable method to zero the differential pressure is to disconnect the high and low side tubing from the box pickup pressure taps, and command Auto Zero via the Commissioning mode of HVAC PRO.
- Error caused by differential pressure transducer drift since the most recent Auto Zero. This may be particularly noticeable during project startup when power is shut off in the evening, and ambient temperatures are not maintained. See the *Auto Zero* topic in this section.

- Error caused by turns or transitions in hard duct or sags in flexible duct within close proximity to the flow pickup. These conditions may result in non-uniform air velocity across the duct area at the flow pickup location. If this occurs, the velocity at the pickup sampling ports may not represent average air velocity. To complicate matters, the velocity profile may change at different flow rates. This may be indicated during air balance if flow is verified at both minimum and maximum. Calculate the pickup gain (Flow Mult) necessary for the controller indicated flows to match the balancing contractor's readings at both minimum and maximum. If the resulting flow multipliers are significantly different; i.e., by more than 10%, either the duct transition is causing a problem or the box is operating in a region of non-linear pickup behavior. To avoid problems caused by flow pickup proximity to transitions, ensure that there is a minimum of three duct diameters of straight, unrestricted duct upstream of the airflow pickup, unless otherwise stated by the box manufacturer. The flow profile problem can be corrected by installing turning vanes in the offending duct section or changing the duct configuration to provide greater separation between the transition and pickup, and by eliminating sags in flexible duct.

  The spiral pattern on the interior of flexible duct composed of wire reinforced plastic membrane may distort flow patterns and cause inaccurate flow indication. This effect can be avoided if a three diameter length of straight duct is connected between the flex duct and the box inlet.

- Extremely low air velocity--this condition may be caused by attempting to control at a very low flow, or it may be the result of an oversized box. The minimum velocity generally accepted to accurately and reliably control VAV box flow is 400 fpm.

- Airflow pickup problems--the pickup may be blocked, or partially blocked, by debris in the duct. Pickups could also have plugged ports or internal leaks between the high and low pressure sides of the sensor. Pickup performance may suffer when the device is not perpendicular to the duct walls.

- Differential pressure sensor calibrated without allowing one hour warmup.

Factors Affecting the Balancer's Flow Reading

The following factors may cause errors in the air balancer's flow reading:

- Flow hood accuracy is specified by the manufacturer and may be anywhere from +/- 5% of full scale to +/- 3% of reading on the better instruments.

  Periodically check flow hood calibration. Find out:

  – When was it last calibrated?

  – On what type of diffuser was it last calibrated?

  Calibrating the hood with one type of diffuser and then taking measurements on a different type of diffuser results in less accurate values.

- Multiple diffusers served by a single VAV box--when the flow hood is placed over one diffuser, the hood may present an restriction causing less flow from the measured diffuser and more flow from the others. In this case, the balancer's sum of the readings taken at all diffusers served by the box will be less than the actual flow.

- Error caused by slotted diffusers--a slotted diffuser is easy to visually identify as it normally consists of from one to three slots, each about one inch wide and two or more feet long. Tests show that hood readings of slotted diffusers may be as much as 40% erroneous. Perform airflow measurements for slotted diffusers using a velocity probe type of instrument rather than a hood. The diffuser manufacturer's literature will specify how to measure airflow and what instrument to use.

- Error caused by balancing damper proximity to diffuser--a balancing damper mounted directly to the diffuser may cause turbulent flow patterns entering the hood and result in erroneous hood indication.

- Use of a hood not matched to diffuser size--a balancing hood consists of a flow meter and a variety of hoods designed to fit different diffuser sizes. The flow meter can be interchanged among the hoods, but generally, the hood must completely cover the diffuser.

You may take two additional measurements to help find the cause of flow reading discrepancies:

- Verify the controller differential pressure reading with a high accuracy differential pressure meter.

- Perform a duct traverse as detailed in 1997 *ASHRAE Handbook Fundamentals*, Chapter 14, I-P Edition.

VAV Application Logic

A collection of logic modules has been created specifically for the VAV application. These logic modules fall into three categories:

- shared modules for both Single Duct and Dual Duct applications
- Single Duct application modules
- Dual Duct application modules

The modules are loaded into a downloadable program in the order shown below in Table 1. Each set of modules has options that are selected by the user during the Question and Answer session.

Table 1: User Selected Options

Module Name	Module Type		
	Shared Module	Single Duct Module	Dual Duct Modules
Shutdown Mode	X		
Power Fail Restart Mode	X		
Occupied/Unoccupied Mode	X		
Temporary Occupied Mode	X		
Boost	X		
Warmup Mode		X	X
Setpoint Calculation		X	X
Temperature Control Loops		X	X
Damper Control			
Pressure Independent		X	
Pressure Dependent without Feedback		X	
Pressure Dependent with Feedback		X	
Pressure Independent Cold Deck w/Pressure Independent Hot Deck			X
Constant Volume Separate Dampers			X
Constant Volume Linked Dampers			X
Single Duct Conversion			X
Ind. Cold Deck with Dep. Hot Deck			X
Fan Control		X	
Exhaust Box Control	X		
Baseboard Heat	X		
Box Heat Control		X	
Lighting Control	X		

Auto Zero	X	X

Shutdown

All VAV configurations have two shutdown options--Shutdown Box Open and Shutdown Box Closed.

When either Shutdown mode is enabled, all outputs to fans and heating are turned off. Integration timers are set to 0 to eliminate windup when the system is put back into control. Depending on the strategy selected, the damper is controlled as defined in Table 2.

Table 2: Damper Control During Shutdown

Duct Type	VAV Control Strategy	Box Open	Box Closed
Single Duct			
	Pressure Independent with and without User Defined Flow	*Occ Clg Max Flow Setpoint	0% Open
	Pressure Dependent	100% Open	0% Open
Dual Duct			
	Pressure Independent with and without User Defined Flow	HD = Occ HD - Htg. Max	0% Open
		CD = Occ CD - Clg. Max	0% Open
	CV Sep. Dampers with and without User Defined Flow and Discharge Air Reset	HD = Occ Flow Setpoint/2	0% Open
		CD = HD	0% Open
	CU Linked Damper	Occ Flow Setpoint	0% Open
	Single Duct Conversion	Occ Clg Max	0% Open
	Pressure Independent Cold Deck w/Dependent Hot Deck	HD = 100% open	0% Open
		CD = Occ CD Clg Max	0% Open
	Pressure Independent Discharge Air Reset	HD = Occ Htg Max	0% Open
		CD = Occ Clg Max	0% Open

* Occ Clg Max is Occupied Cooling Maximum.

Consider using Shutdown instead of de-energizing Occupied during the Unoccupied period if supply fans are off and no temperature control is required.

Power Fail Restart

This mode allows you to disable all outputs of the controller whenever it first receives power or resets. This is useful when you are using multiple controllers in a building, and you want to spread out the times when each controller energizes as part your energy management strategy. You may stagger the restart delay timers per zone, per floor, or per area.

Typically, a power fail restart delay is required on VAV boxes that have electric heat and/or fans. Power fail restart holds the controller in Shutdown Box Open mode for the time equal to the Restart Delay. Default parameters for this mode are shown in Table 3.

Table 3: Restart Delay Default Parameters

Restart Delay Parameters	Default Values
Restart Delay	1.0 minute
Restart Status	Off

When the value of the Restart Status parameters is On, a Restart is in progress.

Note: Regardless of the Power Fail Restart option, the controller drives incremental damper actuators full open and incremental valve actuators full closed for 1.5 times their individual stroke times following a controller reset. This is required to synchronize the incremental actuators with the controller.

Occupied/Unoccupied/Standby

All box configurations provide three sets of zone temperature setpoints. Occupied is the normal operating mode for occupant comfort, while Unoccupied is used when the zone is vacant.

Note: Use Unoccupied instead of Shutdown when supply air is available and/or some level of temperature control is required during the Unoccupied period.

Standby mode is entered into from Unoccupied. Standby can provide intermediate temperature setpoints. Standby is applicable to conference rooms and other intermittent use areas. An occupancy sensor, or the Temporary Occupancy feature, can be used to switch from Standby to Occupied.

Temporary Occupancy

Temporary Occupancy mode allows you to set the controller to Occupancy mode for a user-defined time period, then return to Unoccupied mode. During Temporary Occupancy mode, the controller maintains occupied temperature setpoints. For VAV applications, you may need to monitor the Occupied Status data point to turn on the central system or maintain records for tenant billing.

When you enable the Temporary Occupancy mode, Occ Ovrd time and Temp Occ Status Points are added to the parameter table. The timer starts when you release the Temporary Occupancy button. The timer restarts each time an occupant pushes the button. Default parameters for this mode are shown in Table 4.

Table 4: Temporary Occupancy Default Parameters

Temporary Occupancy Parameters	Default Values
Occ Ovrd Time	30.00 minutes
Temp Occ Status	Off

Table 5 describes the Temporary Occupancy mode in the TE-6400 and TMZ1600 room sensors.

Table 5: Room Sensor Functions in Temporary Occupancy Mode

Room Sensor	Description
TE-6400	The Temporary Occupancy pushbutton is built into the TE-6400 Zone Sensor. The button is wired in parallel to the zone temperature sensor. When pushed, it momentarily shorts out the zone sensor, which signals the controller to enable the Temporary Occupancy mode and sets Temp Occ Status and Occupied Status to on. Notes: Holding the TE-6400 Temporary Occupancy button in for more than 1.5 seconds initiates Failsoft and results in nuisance alarms at the Zone Terminal or the supervisory system because of zone sensor unreliability. You cannot cancel Temp Occ.
TMZ1600	When the Temporary Occupancy button is pressed during Unoccupied or Standby modes, the TMZ1600 instructs the controller to go into Temporary Occupancy Mode. When the TMZ1600 receives acknowledgment from the controller that it is in Temporary Occupancy mode, then the LCD Temporary Occupancy symbol will come on and the Occupied Comfort Setpoint will be enabled for the duration of the Temporary Occupancy time. If the controller does not sense an Occupied condition when the Occupancy timer expires, the controller will be released back to the previous mode (either Unoccupied or Standby). However, if the Temporary Occupancy button is pressed again during the Temporary Occupancy time period, and the controller does not sense an Occupied condition, it will return its previous mode (either Unoccupied or Standby). For more information on the TMZ1600, see the *Room Sensor with LCD Display (TMZ1600) Technical Bulletin (LIT-6363110)*. Notes: Boost mode is not used with the TMZ1600. The Temporary Occupancy button will not function if the Temporary Occupancy time in the controller has been overridden by an N2 device.

Boost

If you have not configured Temporary Occupancy mode in your application, you may configure the TE-6400 pushbutton for Boost mode. Boost mode allows you to quickly set the controller to full heating or cooling within an area. A popular application for Boost mode is a conference room where the number of people entering the room changes quickly, causing major load variations in the space.

The Boost pushbutton, which is the same pushbutton used for Temporary Occupancy, is built into the TE-6400 Zone Sensor. The button is wired in parallel to the zone temperature sensor. When pushed, it momentarily shorts out the zone sensor, which signals the controller to enable Boost mode and sets Boost Status to on.

Note: Holding the TE-6400 Zone Sensor button in for more than 1.5 seconds initiates Failsoft and results in nuisance alarms at the Zone Terminal or the operator workstation because of zone sensor unreliability.

When you enable Boost mode, Boost Ovrd time and Boost Status points are added to the parameter table. The timer starts when you release the zone sensor momentary button. The timer restarts each time an occupant pushes the button.

Note: Boost does not activate if the temperature is in the comfort zone between the heating and cooling setpoints as shown in Figure 3. Boost cancels when the Boost Ovrd time expires or the temperature falls into the comfort zone. Default parameters for this mode are shown in Table 6.

Table 6: Boost Default Parameters

Boost Parameters	Default Values
Boost Ovrd Time	5.00 minutes
Boost Status	Off

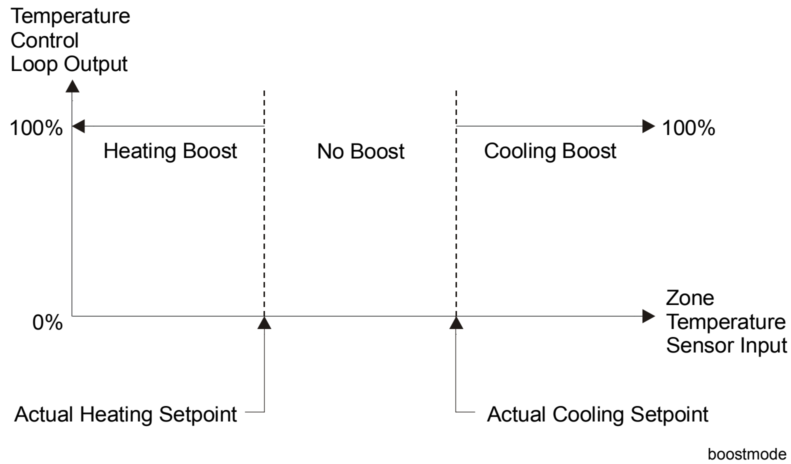

Figure 3: Control Sequence for Boost Mode

Warmup

A warmup cycle can be initiated by an N2 command or through a supply air temperature sensor per VAV box. The VAV controller must be in Unoccupied mode before warmup can be initiated.

The supply sensor can be configured to automatically initiate the Warmup mode if it senses that the supply air temperature is 5°F greater than the zone sensor.

During Warmup mode the central system supplies either return air or hot air to the zones to bring the building to occupied conditions. Zone temperature setpoints are set to their occupied values. Box heating and parallel fans are shut down. Baseboard heating is available.

Pressure independent zones have separate flow setpoints for Warmup.

For pressure dependent zones without actuator feedback, the controller positions the zone damper open until the zone temperature heating command is less than 1%.

Pressure dependent zones with actuator feedback have a separate damper position setpoint for Warmup.

Summer/Winter

Pressure dependent without feedback zones have a Summer/Winter mode to reverse controller action. In Summer mode, the actuator opens the zone damper on an increase in zone temperature within the cooling prop band from the minimum position to 100%. Once the zone temperature falls below the cooling setpoint, the damper is held at minimum position. In Winter mode, the reverse action takes effect. The actuator opens the damper on a decrease in zone temperature within the heating prop band.

Failsoft

In the event that a sensor becomes unreliable, Failsoft is a software controlled feature that causes controller outputs to go to a prescribed position to minimize discomfort in VAV applications.

- If the differential pressure sensor becomes unreliable, the damper drives to 100%. It is important to select the proper range for the differential pressure sensor. Oversized VAV boxes may cause an over-range reading, which causes Failsoft to lock the damper full open.
- If warmer/cooler adjust of the room sensor becomes unreliable, the reported value defaults to 0°F.
- If heating/cooling setpoints of the remote sensor become unreliable when in Occupied or Warmup, the controller uses Occ Htg Setpoint and Occ Clg Setpoint.
- If the setpoint of the remote sensor becomes unreliable when in Occupied or Warmup, the controller uses Occ Setpoint.
- If the room sensor becomes unreliable, the controller sets the box heat and baseboard heating commands to 0% for proportional only temperature control, or integrates them to 0% for proportional/integral zone control. The controller sets the flow setpoint to minimum for proportional only zones. For proportional/integral zones calling for cooling when the temperature sensor becomes unreliable, the present flow setpoint calculated from the flow reset schedule is held.

Starved Box--Flow Saturation Flag for Single Duct Systems

The Starved Box Point is a feature that warns when a zone calls for 100% flow in the Occupied mode for approximately 10 minutes. Starved box is included in all single duct control strategies. You can view and trend this data point at the network level to diagnose a potential problem before zone occupants actually complain of discomfort.

For the pressure independent strategy the flow saturation function analyzes the output of the proportional/integral control routine that controls the VAV box damper. When the Damper Command is equal to 100%, Starved Box is set to Yes. Once the Damper Command drops below 99%, Starved Box is set to No.

If you trend the saturation flag for a VAV box and find it to be on for extensive periods of time, you can diagnose the zone by following the steps below.

1. Check the damper linkage to ensure the box can fully open.
2. Check the static pressure near the box inlet to ensure that enough air is being delivered to the zone to maintain the maximum flow requirements.
3. Check the zone cooling setpoint to ensure that it is realistic in comparison to the conditioned air being delivered to the space.

Lighting Logic Interlock

Lighting logic interlock integrates lighting control as a start-stop output to control a momentary lighting relay (GE RR-7 relay). On a transition to Occupied or Temporary Occupied mode, the controller commands the lights on. On transition to Unoccupied mode, the lights blink two minutes before they turn off.

If you need to directly override the lighting circuit, issue either the on or off command through the *lights on* binary output.

Backup Daily Schedule

If you selected N2 Software Command as the Occupied mode source, this feature provides a backup schedule, maintains the controller's schedule.

If the network loses communication with the controller for more than ten minutes, the controller reverts to the backup daily schedule as established in the parameter table. Two parameters are used: Occupied Start Time and Occupied Stop Time.

Note: The software clock that operates inside the VAV controller is not battery backed. It resets to 00:00 whenever you apply power to the controller or the controller goes through a reset condition. The software time clock is synchronized to realtime when communicating with HVAC PRO Release 5.1 or later.

A permanently connected Zone Terminal (ZT) can also do time scheduling. If communication to the ZT fails, however, the controller remains in last mode commanded.

If you do not require a backup schedule, leave these two parameters at 00:00. Then, if the controller loses communication, it defaults to always occupied. Default parameters for this mode are shown in Table 7.

Table 7: Backup Daily Schedule Default Parameters

Backup Occupancy	Default Values
Occupied Command	Off
Occupied Start Time	00:00
Occupied Stop Time	00:00
Occupied Status	Off

Temperature Setpoint Options

The configuration Question and Answer tree segment in Figure 4 illustrates the selections available for zone temperature setpoints.

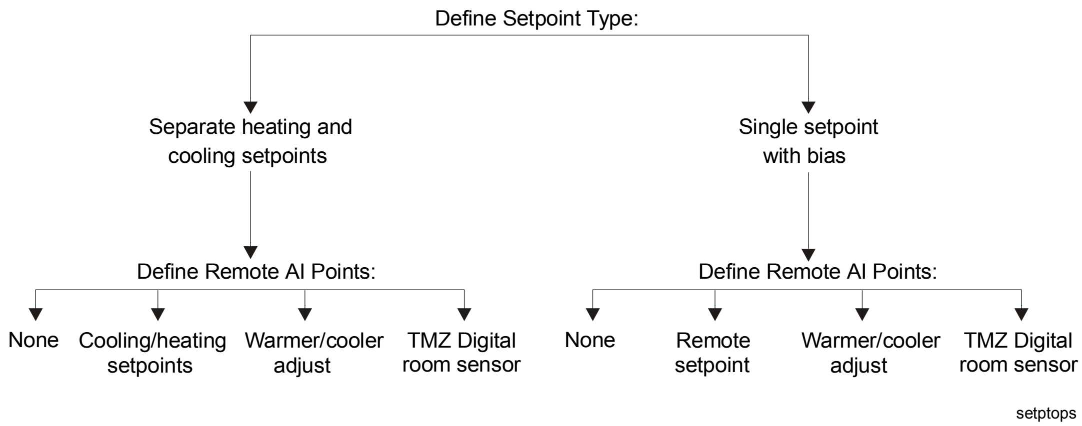

Figure 4: Temperature Setpoint Options

All VAV terminal control configurations use three sets (Occupied, Standby, and Unoccupied) of temperature setpoints for both heating and cooling.

Separate Heating and Cooling Setpoints

The Separate Heating and Cooling Setpoint option provides direct access to each of the six setpoints, but often this requires the user to remember to change both a heating and a cooling value. Since HVAC PRO Release 5.1, application logic prevents the heating loop setpoint from being higher than the cooling loop setpoint. If this is attempted, the Actual Heating Setpoint is forced to 0.3° less than the Actual Cooling Setpoint. This logic is not loaded in configurations built for the Revision A controllers due to memory constraints. See Table 8 for the separate setpoint default values.

Table 8: Separate Heating and Cooling Setpoint Defaults

Separate Heating/Cooling Setpoint Defaults	Values
Occupied Cooling Setpoint	22°C (72°F)
Standby Cooling Setpoint	23°C (74°F)
Unoccupied Cooling Setpoint	27°C (80°F)
Occupied Heating Setpoint	20°C (68°F)
Standby Heating Setpoint	19°C (66°F)
Unoccupied Heating Setpoint	17°C (62°F)
Actual Heating Setpoint	***
Actual Cooling Setpoint	***

*** Displays current controller value.

Single Setpoint with Bias

With Single Setpoint only one value must be changed to adjust the zone. Three setpoints and three biases provide flexibility. The Actual Heating Setpoint is calculated by subtracting the present mode's bias from the present mode's temperature setpoint. Similarly, the values are added to determine the Actual Cooling Setpoint. In this way the entire comfort band is effectively adjusted. Software logic prevents use of biases less than 0.15°, ensuring a minimum 0.3° comfort band between the Actual Heating and Actual Cooling Setpoints. Actual Heating and Actual Cooling Setpoints are read-only parameters that display the values presently used by the control loops. See Table 9 for the Single Setpoint default values.

Table 9: Single Setpoint with Biases

Mode	Setpoint Values	Setup/Bias Values	Resulting Actual Heating Setpoint	Resulting Actual Cooling Setpoint
Occupied	21°C (70°F)	1°C (2°F)	20°C (68°F)	22°C (72°F)
Standby	21°C (70°F)	2°C (4°F)	19°C (66°F)	23°C (74°F)
Unoccupied	22°C (71°F)	5°C (9°F)	17°C (62°F)	27°C (80°F)

Occupant Adjustments

There are three options for providing occupant adjustment of the heating and cooling setpoints of a variable air volume controller:

- The first option is to provide setpoints that are only adjustable over the N2 or through a Zone Terminal. There is no local adjustment hardware.
- The second option is to provide a TE-6400 with remote setpoints for use in Occupied mode. When separate heating and cooling setpoints are chosen, the TE-6400 provided will have a separate adjustment for heating and cooling setpoints. When single setpoint is used, the TE-6400 provided has a single remote setpoint. The default range is 18.3 to 29.4°C (65 to 85°F). This range can be modified from the AI Modify screen.
- The third option is to provide a TE-6400 Zone Sensor with a warmer/cooler setpoint adjustment. The warmer/cooler adjustment is active during all modes of operation (Occupied, Unoccupied, Standby, and Warmup). The default range provides +/-5°F adjustment from the setpoint. This +/-5°F range can be modified from the AI Input Modify screen.

Note: If any setpoint potentiometer becomes unreliable, the controller automatically uses the default values entered in the setpoint table.

Zone Temperature Loop Tuning Parameters

Default tuning parameter values are shown in Table 10. These are appropriate for typical zones and the TE-6400.

Table 10: Zone Temperature Defaults

Zone Temperatures Defaults	Values
Cooling Proportional Band	5.5°C (10°F)
Cooling Integration Time	1000 ticks*
Baseboard Proportional Band	-5.5°C (-10°F)**
Box Heat Proportional Band	-5.5°C (-10°F)
Heating Integration Time	1000 ticks*

* Ticks are a controller time interval equal to 1.5 seconds.

** If Baseboard mode is selected.

In addition, there are fixed 0.3° control deadbands below the Actual Heating Setpoint and above the Actual Cooling Setpoint. When the Zone temperature is within these deadbands, no proportional control action takes place, and integration, if used in the respective temperature loop, is held at its last value.

Even when there is no box heat, the Box Heating Proportional Band may require a valid value. It is used to calculate the flow setpoint for Warmup in Pressure Independent, to modulate the damper in Winter mode for Pressure Dependent without Feedback and to calculate position setpoint in Warmup for Pressure Dependent with Feedback.

The Heating Integration Time applies to both baseboard and box heat, if present in the application.

Flow Setpoint Options

Every effort has been made to keep I/O points and parameters the same as previous releases of HVAC PRO Release 4.0 or later, but because of changes to the flow control algorithm, you cannot override the calculated flow setpoints directly from the network. A new Supply Preset ADF (Analog Data Float) has been defined, which overrides the Supply Setpoint within the controller logic whenever the Supply Flow Override is enabled. See Table 11.

Table 11: Damper Control

Duct Type	Default	Value
Single Duct		
	Supply Preset	0.0
	Supply Flow Override	Disable
Dual Duct		
	Cold Dk Preset	0.0
	Cold Dk Override	Disable
	Hot Dk Preset	0.0
	Hot Dk Override	Disable

Note: The supply setpoint address has not changed from previous revisions. The Supply Preset is only necessary for applications that override the supply setpoint. Monitor only applications do not require any changes.

Airflow Calculations for Pressure Independent Applications

The VAV controller uses two key parameters in converting differential pressure inputs to airflow: Supply Box Area and Supply Multiplier. Both apply to any single or dual duct system with a pressure independent path.

The *OEM Technical Manual (FAN 638)* or *Appendix B: VAV Controller Flow Calculation Constants (LIT-6375185)* of this manual provides the flow multiplier (also known as K-constant or pickup gain) values for most OEM boxes. Also see the *Airflow Measurement* topic in this section for an explanation. For the purposes of this discussion, parameter names from the single duct supply box flow calculation are referenced. Exhaust box and dual duct flow calculations have similar but different parameters.

The controller uses the following equations to determine the airflow:

The displayed Delta P is reduced by 0.005 introduced by Auto Zero.

If Supply Delta P > 0.005, Supply Delta P = Supply Delta P - 0.005; or else, Supply Delta P = 0.0

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

Where:

Supply Flow = airflow calculated in cubic feet per minute (cfm)

Supply Delta P = differential pressure (inches W.C.)

Supply Multiplier (K) = airflow pickup gain

Flow Coefficient is fixed at 4005 in the following paths:

Single Duct - Pressure Independent

Dual Duct - Pressure Independent, Constant Volume with separate dampers, Constant Volume with linked dampers, Single Duct conversion, ind. cold deck with dep. hot deck, Pressure Independent (Disch Air Reset), and CV with separate dampers (Disch Air Reset)

In the following paths, Flow Coefficient is a parameter that is adjustable by the user:

Single Duct - Pressure Independent (User defined flow)

Dual Duct - Pressure Independent (User defined flow) and CV with separate dampers (User defined flow)

Supply Box Area = Area in square feet of inlet duct where the air flow pickup is located. Area may be calculated from 3.1416 * $(r)^2$ where r is the inlet radius in feet for circular inlets. See Table 12.

Table 12: Box Area Values for Common VAV Boxes

Size in Diameter	Square Feet*
4 Inches	0.087
6 Inches	0.196
8 Inches	0.349
10 Inches	0.545
12 Inches	0.785
14 Inches	1.068
16 Inches	1.396

* Assumes circular inlet with no constrictions

User Defined Flow

This feature extends support to a wide variety of flow sensors. Sensor types supported are:

- Differential pressure
- Linear velocity sensor
- Linear flow sensor
- Non-linear velocity and flow sensors which can be fit to a sixth or lower order polynomial equation

This flexibility is facilitated by the following additional, user adjustable parameters.

- Supply AZ Offset: prior to calculating flow, removes the 0.005 offset caused by Auto Zero
- Supply Ranging L0 through Supply Ranging L6: intercept and coefficients for polynomial Terms 1 through 6
- Supply Flow Coef.: coefficient for conversion of pressure to velocity, i.e., 4005 for flow in cfm and pressure in inches W.C., 1291 for flow in liters/s and pressure in Pascal's.
- Use Supply Area: when set to Yes (State 1), this binary flag causes the area parameter to be used as a multiplier in the flow equation.

The entire equation is:

$$\text{Supply Flow} = \text{Supply Box Area} * \text{Flow Coefficient} *$$

$$\sqrt{\frac{\text{Maximum(polynomial function(Supply Delta P} + \text{Supply AZ Offset), 0)}}{\text{Supply Multiplier}}}$$

Supply AZ Offset is defaulted to -0.005, and can be set to 0.0 if Auto Zero will not be used. The maximum function assures a positive value.

The Supply Ranging parameters default values disable polynomial curve fits and thus are appropriate for differential pressure, linear velocity, and linear flow sensors. L0 and L2 through L6 are set to a value of 0.000 and L1 is 1.000. This reduces the equation to:

$$\text{Supply Flow} = \text{Supply Box Area} * \text{Flow Coefficient} * \sqrt{\frac{\text{Maximum}((\text{Supply Delta P} + \text{Supply AZ Offset}), 0)}{\text{Supply Multiplier}}}$$

For a sensor having an output scaled in velocity or flow, zeroing the Flow Coefficient disables square root extraction, giving the following formula:

$$\text{Supply Flow} = \text{Supply Box Area} * \frac{\text{Maximum}((\text{Supply Delta P} + \text{Supply AZ Offset}), 0)}{\text{Supply Multiplier}}$$

Rename the analog input to something more appropriate such as Supply Velocity Input, along with unit and range changes required by the sensor. Set the Supply Multiplier to an initial value of 1.000.

For a linear flow sensor, also set the binary parameter, Use Supply Area to No (State 0), further reducing the formula to:

$$\text{Supply Flow} = \frac{\text{Maximum}((\text{Supply Delta P} + \text{Supply AZ Offset}), 0)}{\text{Supply Multiplier}}$$

Note: The Supply Box Area must be accurately defined even though not required for the flow equation because the area is used by HVAC PRO to calculate flow loop tuning values.

Table 13: User Defined Flow Parameter Values and Analog Input Definition for Various Flow Sensors

Parameter	Sensor Type					
	Delta Pressure/ (default)	**Linear Velocity**	**Linear Flow**	**Staefa FK-V32 Non-linear Velocity**	**Kreuter CEE-4841 Non-linear Velocity, Date Code < 9315**	**Kreuter CEE-4841 Non-linear Velocity, Date Code > 9315**
Supply AZ Offset	-0.005	-0.005	-0.005	0.695	-0.005	0.995
Supply Ranging L0*	0.0	0.0	0.0	0.0	0.0	0.0
Supply Ranging L1*	1.0	1.0	1.0	-475.32	120.3	28.309
Supply Ranging L2*	0.0	0.0	0.0	973.3	-45.699	-67.159
Supply Ranging L3*	0.0	0.0	0.0	-540.81	130.71	16.896
Supply Ranging L4*	0.0	0.0	0.0	151.23	-33.6	44.134
Supply Ranging L5*	0.0	0.0	0.0	-17.066	2.627	-13.764
Supply Ranging L6*	0.0	0.0	0.0	0.546	0.0	1.143
Supply Flow Coefficient	4005	0.0	0.0	0.0	0.0	0.0
Use Supply Area	Yes (State 1)	Yes (State 1)	No (State 0)	Yes (State 1)	Yes (State 1)	Yes (State 1)
Supply Multiplier	2.25**	1.0	1.0	1.0	1.0	1.0
AI: Suggested Name	Supply Delta P	Supply Velocity In	Supply Flow In	Supply Sensor Span Volts	Supply Sensor Volts	Supply Sensor Span Volts
AI: Sensor Type	Voltage	Voltage	Voltage	Voltage	Voltage	Voltage
AI: Units	In WG	fpm***	cfm***	VDC	VDC	VDC
AI: Filter Value	8	8	8	8	8	8
AI: Input Low	1.0	***	***	0.7	0.0	1.0
AI: Input High	5.0	***	***	6.0	5.0	5.0
AI: Output Low	0.0	***	***	0.0	0.0	0.0
AI: Output High	1.5	***	***	5.3	5.0	4.0

* Do not round the ranging coefficients for non-linear sensors because significant errors will result.

** Define per box or airflow pickup manufacturer specifications.

*** Define per sensor specifications.

User Defined Flow Parameters for Other Non-Linear Sensors

The procedure included in the *Detailed Procedures* section can be used to linearize most other sensors. A regression analysis of the sensor is required, which can be done using commercial spreadsheet or specific curve fitting programs, to fit the sensor to a 6th or lower order polynomial. The 6th order equation is:

$$Y = L6 * X^6 + L5 * X^5 + L4 * X^4 + L3 * X^3 + L2 * X^2 + L1 * X + L0$$

See the *Detailed Procedures* section for additional information.

Supply Multiplier English (IP) Calculation for Delta P Sensor

During balancing calculate the supply multiplier from the area, the flow hood cfm reading, and the controller Delta P indication as shown below. The displayed Delta P must be reduced by 0.005 introduced by Auto Zero.

If Supply Delta P > 0.005, Supply Delta P = Supply Delta P - 0.005; or else, Supply Delta P = 0.0

$$\text{Supply Multiplier} = (\text{Supply Delta P}) * \left(\frac{4005 * \text{Area}}{\text{FlowHood cfm}}\right)^2$$

Example:

The flow hood reading = 300 cfm

The Supply Delta P = 0.10 inches W.C.

The Area = 0.349 sq ft

$$\text{Supply Multiplier} = (0.10 - 0.005) * \left(\frac{4005 * 0.349}{300}\right)^2 = 2.06$$

Calculation results outside the range of 0.5 to 13 indicate likelihood of other problems. See the *Airflow Test and Balance Concerns* topic in this section.

Supply Multiplier Metric (SI) Calculation for Delta P Sensor

Two methods are available. The first (Fixed Flow Coefficient Method) is applicable to all pressure independent paths and adjusts Supply Multiplier to compensate for the fixed value (4005) flow coefficient. The second method (User Defined Flow Method) applies to User Defined Flow paths using Delta P sensors. These paths allow user definition of the flow coefficient.

1. Fixed Flow Coefficient Method

   Each variable can be converted to metric as shown below.

   Supply Delta P (pascals) = 248.84 ∗ Delta P (inches W.C.)

   Supply Area (sq meters) = 0.0929 ∗ Area (sq ft)

   Supply Flow (liters/sec) = 0.4720 ∗ flow hood reading (cfm)

   Example: Convert Supply Delta P AIs

   Use the Analog Input modify screen to change high output range for the Delta P sensor to readout in pascals as shown below.

   124.42 = 248.84 ∗ (0.5 inches W.C.) for 0.5 inch sensors

   373.26 = 248.84 ∗ 1.5 inches W.C.) for 1.5 inch sensors

The other two variables can be converted as shown below.

Example: Calculate Metric Supply Multiplier

Supply Delta P (pascals) = 248.84 ∗ (0.1) = 24.8

Supply Area (sq meters) = 0.0929 ∗ (0.349) = 0.0324

Supply Flow (liters/sec) = 0.4720 ∗ (300) = 141.6

$$\text{Supply Multiplier} = (\text{Supply Delta P} - 0.005) * \left(\frac{4005 * \text{Area}}{\text{Flow}}\right)^2$$

$$\text{Supply Multiplier} = (24.8 - 0.005) * \left(\frac{4005 * 0.0324}{141.6}\right)^2 = 20.8$$

Note: For this method, the Supply Multiplier typically falls between 14.25 and 33.25.

If the user selected one of the paths that allow user defined flow sensors (i.e., single duct - pressure independent user defined flow), the flow coefficient 4005 is user definable. Use the appropriate flow coefficient for your application.

2. User Defined Flow Method

This method is the same as that for the English calculation, except that all values can be ranged directly in metric system units.

$$\text{Supply Multiplier} = \text{Maximum}(\text{Supply Delta P} + \text{Supply AZ Offset}, 0) * \left(\frac{\text{Flow Coefficient} * \text{Area}}{\text{Flow Hood Reading}}\right)^2$$

The maximum function selects the greater of the two values, the sum of Supply Delta P and Supply AZ Offset or zero, to prevent a negative result.

Example:

The flow hood reading = 400 liters/s

The Supply Delta P = 210.0 Pascal's

The Area = 0.031 sq meters

The Flow Coefficient = 1291

The Supply AZ Offset = -0.005

$$\text{Supply Multiplier} = \text{Maximum}(210.0 - 0.005, 0) * \left(\frac{1291 * 0.031}{400.0}\right)^2$$

$$\text{Supply Multiplier} = 2.102$$

Results outside the range of 0.5 to 13 indicate the likelihood of other problems. See the *Airflow Test and Balance Concerns* topic in this section.

Supply Multiplier Calculation for Sensors Ranged in Velocity or Flow

In these applications, the Supply Multiplier has a nominal value of 1.0, and can be adjusted slightly to match controller flow indication with the reading obtained from a flow hood.

$$\text{Supply Multiplier} = \frac{\text{Supply Flow} * \text{present Supply Multiplier}}{\text{Flow Hood reading}}$$

Example:

The flow hood reading = 300 cfm

The Supply Flow = 320 cfm

The present Supply Multiplier = 1.0

$$\text{Supply Multiplier} = \frac{320 * 1.0}{300}$$

$$\text{Supply Multiplier} = 1.067$$

Airflow Control Settings

This section explains the key airflow parameters settings. Figure 5 illustrates the basic inputs, outputs, and parameters that surround the control logic.

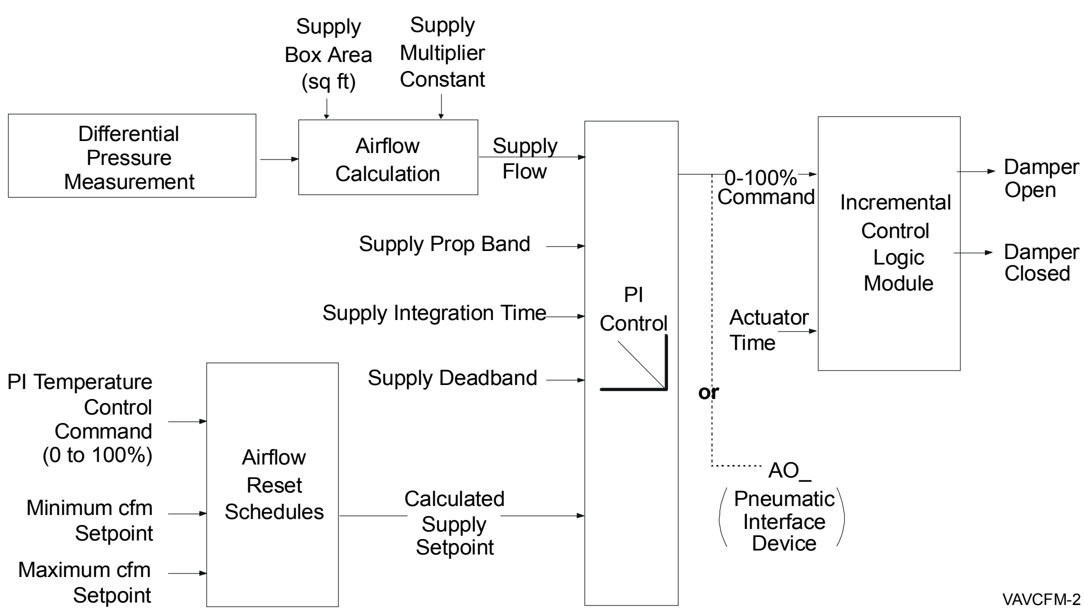

Figure 5: Pressure Independent Control Logic for the Damper Actuator

Minimum Airflow Parameter Adjustment

Usually the specifying engineer or balancing contractor determines the minimum airflow setpoint necessary to provide adequate ventilation. Many box control configurations provide multiple minimum setpoints. In addition to the cooling minimum airflow, boxes with heat and/or sequenced baseboard radiation have heating and/or baseboard minimum setpoints. Often all need to be set to the same value. Be sure to set each minimum flow setpoint appropriately as the defaults will not likely be correct for the zone.

Pressure independent minimum setpoints are expressed in the units of flow measurement.

Pressure dependent minimum setpoints are expressed in percent damper open.

Required minimum airflow is based primarily on the expected maximum number of occupants in the zone, the minimum amount of outside air contained in the supply air, building skin leakage and zone exhaust flow. ASHRAE Standard 62 recommends 20 cfm of outside air per occupant in commercial buildings. Typically, zone airflow minimums are between 10-50% of the maximum. When ventilation air is not required, such as during unoccupied periods, or when other sources exist, the minimum may be set to zero providing tight shutoff.

Flow Measurement Sensor Selection

For standard applications, use the 1.5 inch W.C. DPT-2000 series sensor. This provides resolution of 0.00024 inches W.C. for controlling at very low flows. For other sensor types, refer to the *Airflow Calculations for Pressure Independent Applications* topic in this section.

Damper Actuator Selection

Table 14 below shows the optimum incremental actuators chosen for good control depending on the controller version. Short stroke time may be required by specifications for smoke purge and this may dictate the controller and actuator selection.

Table 14: Optimum Incremental Actuators

Controller	Minimum Output Pulse (seconds)	EDA-2040 Stroke Time (minutes)	M9104 Stroke Time (minutes)
AS-VAV1xx-0 (2K, F/W < = AO3)	1.5	2	1.5
AS-VAV1xx-1 (8K, F/W > = DO2)	0.5	1	1.5

Selection of the proper stroke time for the damper actuator is critical for maintaining stable and accurate control. This is because damper positioning resolution is determined by dividing damper drive time by the minimum controller output pulse length. For example, a two minute actuator used with the AS-VAV1xx-0 provides output resolution of 80 steps if the total damper travel is 90°. However, 60 or more steps are needed, because in practice, control resolution is reduced by the following factors:

- Flow does not vary linearly with damper position.
- Some box dampers travel only 45 or 60°.
- When boxes are oversized, resolution is lost on the damper positioning unless duct static pressure is reduced.
- Differential pressure transducer ranges do not typically match the requirements of the zone under control or the mechanical system.

To control the damper position, the flow loop uses a proportional and integral algorithm. The proportional/integral control can be tuned to control any actuator that provides an end to end damper travel time of one minute or greater.

The controller internally multiplies the programmed stroke time of incremental actuators by 1.5 to provide overdrive to ensure end of travel is reached.

Incremental Output (Damper, Heat)

The controller uses two binary outputs to position the control device. The timing of these outputs is based on an operator specified stroke time. The controller uses the command to determine the required position of the device. Then the controller causes the appropriate output triac to energize for a percent of full stroke to achieve the required device position.

As the new command rises above the current command, the controller energizes the appropriate output to open the control device. As the new command decreases below the current command, the controller energizes the other output to close the control device. When the difference is within the step size of the incremental actuator, neither output energizes, leaving the device in its current position. That is, the change in the output command must be significant enough to cause the device to open or close to get some corrective action to take place.

The controller provides overdrive logic to ensure the position of the control device. When the output reaches 99%, the output drives 1.5 times the stroke time of the actuator to cause the device to reach its 100% position (stroke time plus 50%). The command must drop below 90% before the overdrive at 99% re-occurs. Whenever the output drops below 1%, the output will be driven for 1.5 times the stroke time to cause the device to reach its 0% position. The command must rise above 10% before overdrive at less than 1% will be repeated.

Upon controller reset, incremental outputs are driven for 1.5 times the programmed stroke time to synchronize the actuator and controller calculated positions. Heating values are driven closed. Dampers are driven open to avoid supply duct over-pressure conditions.

Pressure Independent Control Flow Loop Tuning Parameters

HVAC PRO automatically calculates new flow tuning parameters when an upgrade of an existing VAV is performed. Alternately, the user can force a calculation by selecting Recalculate Flow Tuning Parameters...in the Action menu.

Use Table 15 and the equations that follow to set the default tuning parameters for the Damper Control Flow Loop. Three different controller scenarios are described.

- VAV1xx-0 with an EDA-2040 Actuator
- VAV1xx-1 with an EDA-2040 Actuator or M9104 Actuator
- VAV1x1-x with an EP-8000 Transducer (high volume model)

The key difference between the VAV1xx-0 and the VAV1xx-1 is the minimum output pulse time for incremental actuators. The VAV1xx-0 has a minimum pulse time of 1.5 seconds and the VAV1xx-1 has a minimum pulse time of 0.5 seconds. The equations that follow were used to set the defaults based on the controller minimum pulse time and the different actuator stroke times available.

Flow Loop Tuning Process

The default tuning parameters found in Table 15 were established to ensure stable control. As a result, the defaults may provide a sluggish damper control loop in some cases. Normally, flow loop tuning is not required or recommended. If you feel it is necessary, the proposed process for increasing the responsiveness of the damper control loop is to adjust only the Supply Prop Band. A good starting point is to cut the Supply Prop Band in half and watch the performance of the loop.

Flow Loop Tuning Equations

Note: Stroke time used in the calculation must be in seconds, but programmed in the controller in minutes.

Supply Prop Band = -4520 ∗ Box Area

Supply Integ Time = 0.136 ∗ Stroke Time

For Incremental Damper Actuators:

High Supply Deadband = $\frac{12000 * SupplyArea}{StrokeTime}$ for VAV1xx-0 with EDA-2040

High Supply Deadband = $\frac{4000 * SupplyArea}{StrokeTime}$ for VAV1xx-1 with EDA-2040 or M9104

Low Supply Deadband = maximum (High Supply Deadband/2.5 or 120 * Supply Area)

Supply deadband should fall within the above limits based on resolution and noise level.

For Analog Damper Actuators:

Supply Deadband = 120 ∗ Supply Area for VAV1x1-x with EP-8000

Supply Deadband must be greater than this result based on noise level.

The user can select the constant HVAC PRO uses in the above noise calculation by choosing VAV Flow Deadband from the Action menu. Refer to the *Recalculating Flow Tuning Parameters* procedure in the *Testing and Receiving Data from Controllers* chapter of the *HVAC PRO User's Manual* in this manual for detailed information about this procedure.

Wide = 120 (default; for worst case process noise)
Medium = 84
Narrow = 48 (for typical process noise)

This sets the defaults for use when manually forcing a recalculation or when the calculation is performed during an upgrade.

Note: The tuning value will not change until Recalculate Flow Tuning Parameters is selected.

Table 15: Damper Control Flow Loop Tuning Parameters

Duct Diameter/ Supply Area	Damper Stroke Time (90 Deg)	Prop Supply Band	Supply Integ Time	VAV1xx-0 EDA-2040 or M9104 Supply Deadband	VAV1xx-1 EDA-2040 or M9104 Supply Deadband	VAV1x1-x EP-8000 Supply Deadband
4 inches	60 sec		8	17	10	10
0.087 sq ft	90 sec	-393	16	10	10	
	120 sec		16	10	10	10
	330 sec		45	10	10	10
6 inches	60 sec		8	39	24	24
0.196 sq ft	90 sec	-886	16	24	24	
	120 sec		16	24	24	24
	330 sec		45	24	24	24
8 inches	60 sec		8	69	42	42
0.349 sq ft	90 sec	-1577	16	42	42	
	120 sec		16	42	42	42
	330 sec		45	42	42	42
10 inches	60 sec		8	109	65	65
0.545 sq ft	90 sec	-2463	16	65	65	
	120 sec		16	65	65	65
	330 sec		45	65	65	65
12 inches	60 sec		8	157	94	94
0.785 sq ft	90 sec	-3548	16	94	94	
	120 sec		16	94	94	94
	330 sec		45	94	94	94
14 inches	60 sec		8	213	128	128
1.068 sq ft	90 sec	-4827	16	128	128	
	120 sec		16	128	128	128
	330 sec		45	128	128	128
16 inches	60 sec		8	279	167	167
1.396 sq ft	90 sec	-6309	16	167	167	
	120 sec		16	167	167	167
	330 sec		45	167	167	167

Exhaust Boxes

The controller uses flow differential to set the relationship between the supply and exhaust control loops (Figure 6). A flow differential greater than zero provides a negative room pressure. 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 modes.

For single duct applications, the exhaust setpoint tracks the sum of the supply flow and the differential setpoint. Dual Duct applications substitute total flow (hot deck and cold deck) for the supply flow.

Note: Shutdown does not directly affect the exhaust damper control loop. During shutdown the exhaust damper continues to track the supply flow.

Calculate the deadband, prop band, and integration time for the exhaust box using the formulas in the *Flow Loop Tuning Equations* topic in this section of the document.

Note: You should use one-half the value of the prop band found from the equation to ensure the exhaust box responds more quickly than the supply box.

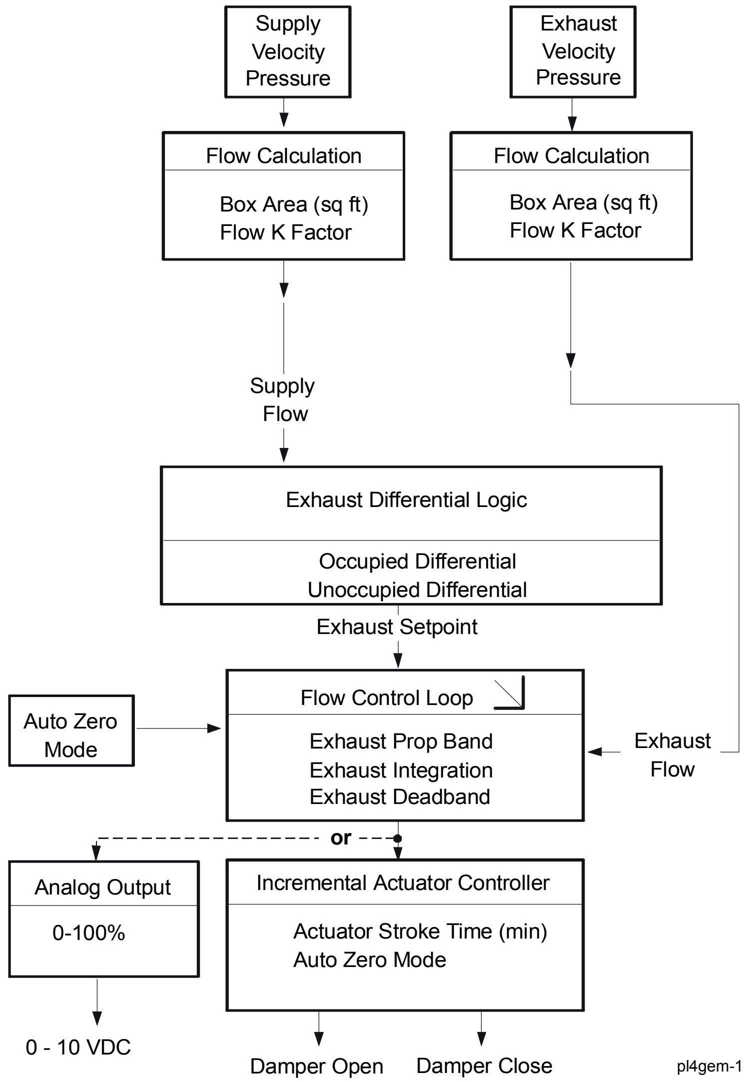

Figure 6: Exhaust Damper Control Logic

Auto Zero

Use the Auto Zero feature to calibrate the Delta P sensor, which is used to measure air flow. The points used for Auto Zero are shown in Table 16.

Table 16: Auto Zero Default Parameters

Auto Zero Parameter	Default Value
Auto Zero Enable	Enabled
Auto Zero Command	Off
Auto Zero Duration	6.5 minutes
Auto Zero Start Time	00:00 (Hr:Min)
Auto Zero Stop Time	00:00 (Hr:Min)
Auto Zero Status	Off

The controller performs the Auto Zero feature by overdriving the damper and valve actuators closed for the **Auto Zero Duration** (in minutes). During this time the **Auto Zero Status** value is On. When the dampers are fully closed, new values are calculated and stored into the AI offset table in the controller's nonvolatile memory for Delta P sensors.

Note: The Auto Zero duration must be set one minute longer than the longest stroke time of the incremental dampers and actuators to allow the Delta P sensor to settle.

Auto Zero sets the AI offset to produce a Delta P reading of 0.005 inches W.C. and prevent the Delta P value from going negative. This 0.005 inches W.C. is subtracted from the AI value before being passed to the flow calculation.

Trigger Conditions for Auto Zero

Activating Auto Zero while the controller is synchronizing incremental outputs causes improper Analog Input offsets to be computed.

The following conditions trigger Auto Zero.

- Override to On the Auto Zero Command
- Auto Zero Enable = Enable AND Start from controller-based Auto Zero Schedule
- Auto Zero Enable = Enable AND Delta P sensor goes negative
- Auto Zero Enable = Enable AND Flow < 1/3 Occupied Mode Cooling Maximum Flow Setpoint AND 24 hours have passed since last Auto Zero

The controller based schedule usually provides the best solution, ensuring flow sensors are zeroed once per day. Choose the Auto Zero trigger that best serves your application. If Auto Zero cannot be used, then an instrumentation quality pressure transducer may be required.

The controller may be triggered to begin the Auto Zero when:

- Command the Auto Zero Command point On.

  The Auto Zero command can be sent from the HVAC PRO, Companion/Facilitator, N30, GPL (Graphic Programming Language), Time Schedule, or PMI (Person-Machine Interface) operator command. This Auto Zero Command is useful for hospitals and laboratories that are always occupied and need to be scheduled from the Metasys headend. This method is also useful if the box dampers leak significantly because you can command Auto Zero when the supply fan is off.

- When Auto Zero Enable is set to Enable and any of the following occur:

  Start request from the controller-based Auto Zero schedule. The controller-based schedule can be programmed manually or automatically. To manually set this up, command the Auto Zero Start Time to the desired time, and Auto Zero Stop Time to one minute after the Start Time.

Note: You must save the configuration before proceeding.

The default time of 00:00 disables this controller-based scheduling.

To automatically program controller-based scheduling, use the HVAC PRO Upgrade feature to upgrade all VAV controllers on the N2 Bus. The upgrade feature applies an Auto Zero schedule with four different times between 01:00 a.m. and 01:46 a.m. to prevent all devices from auto zeroing at once.

Each controller upgraded in ascending address order is assigned the next higher schedule until the four times have been applied. Then the schedules are re-applied.

N2 Address	Start Time	Stop Time
1	01:00	01:01
2	01:15	01:16
3	01:30	01:31
4	01:45	01:46
5	01:00	01:01
6	01:15	01:16
7	01:30	01:31
...etc.		

Note: The controller time clock is set by Companion/Facilitator, NCM, or N30 when communication is established. Without a network, the time of the most recent reset is considered to be 00:00 hours, or midnight.

- Delta P sensor may become negative as a result of drifting.

Note: Previous releases of HVAC PRO configurations would also trigger when the Zone Temperature changed by more than 5 degrees.

- Flow is less than one-third of the Occupied mode cooling maximum flow setpoint and 24 hours have passed with the Auto Zero Enabled since the last Auto Zero.

Note: This method is useful when the main AHU is turned off during unoccupied times. Every day when the AHU turns off, the 24 hour timer expires and the flow goes to zero, the Auto Zero is triggered.

VAV Single Duct Applications

Pressure Independent Single Duct Control Logic (User Defined Flow)

Figure 8 illustrates the pressure independent control logic. The mode of operation generator selects which zone cooling and heating temperature setpoints are used during the selected mode of operation. The mode generator also selects which flow setpoint schedule supplies the flow proportional/integral loop during the Occupied, Unoccupied, Warmup, Standby, Shutdown, and Auto Zero modes.

The temperature control loop sequencer compares the zone temperature to the zone setpoint and produces a 0 to 100% output command. The output command feeds into the flow setpoint reset schedules to provide a supply flow setpoint during the Occupied, Unoccupied, and Warmup modes. The flow control loop compares the supply flow setpoint from the reset schedule to the actual flow calculated from the differential pressure input, and produces a 0 to 100% command to the damper.

The user defined flow path allows the user to define the flow sensor type and ranging. In addition to differential pressure measurement, this allows use of linear and non-linear sensors with outputs ranged in flow or velocity. The user must enter the appropriate constants for the sixth order polynomial to linearize the sensor. Then, the user enters the flow coefficient, box area, and indicates whether the box area should be used in the calculation. Box area is used to calculate flow loop tuning parameter values, so the area must be accurately entered, even when not required to calculate flow. Setting the flow coefficient to 0 (zero) disables square root extraction.

For more information regarding flow control parameter formulas, see previous topics in this document beginning with the *Flow Loop Tuning Equations* topic in this section.

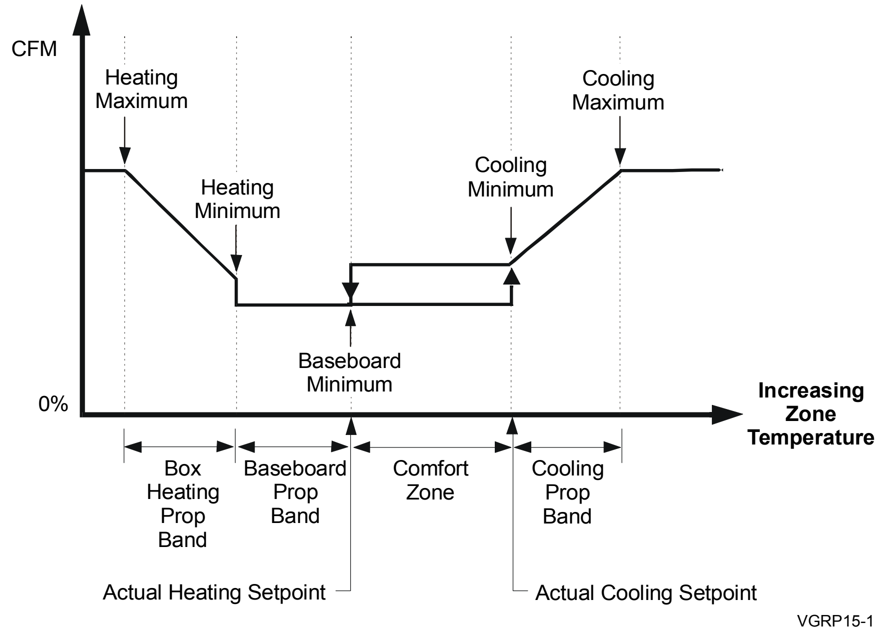

Figure 7: Pressure Independent Sequence

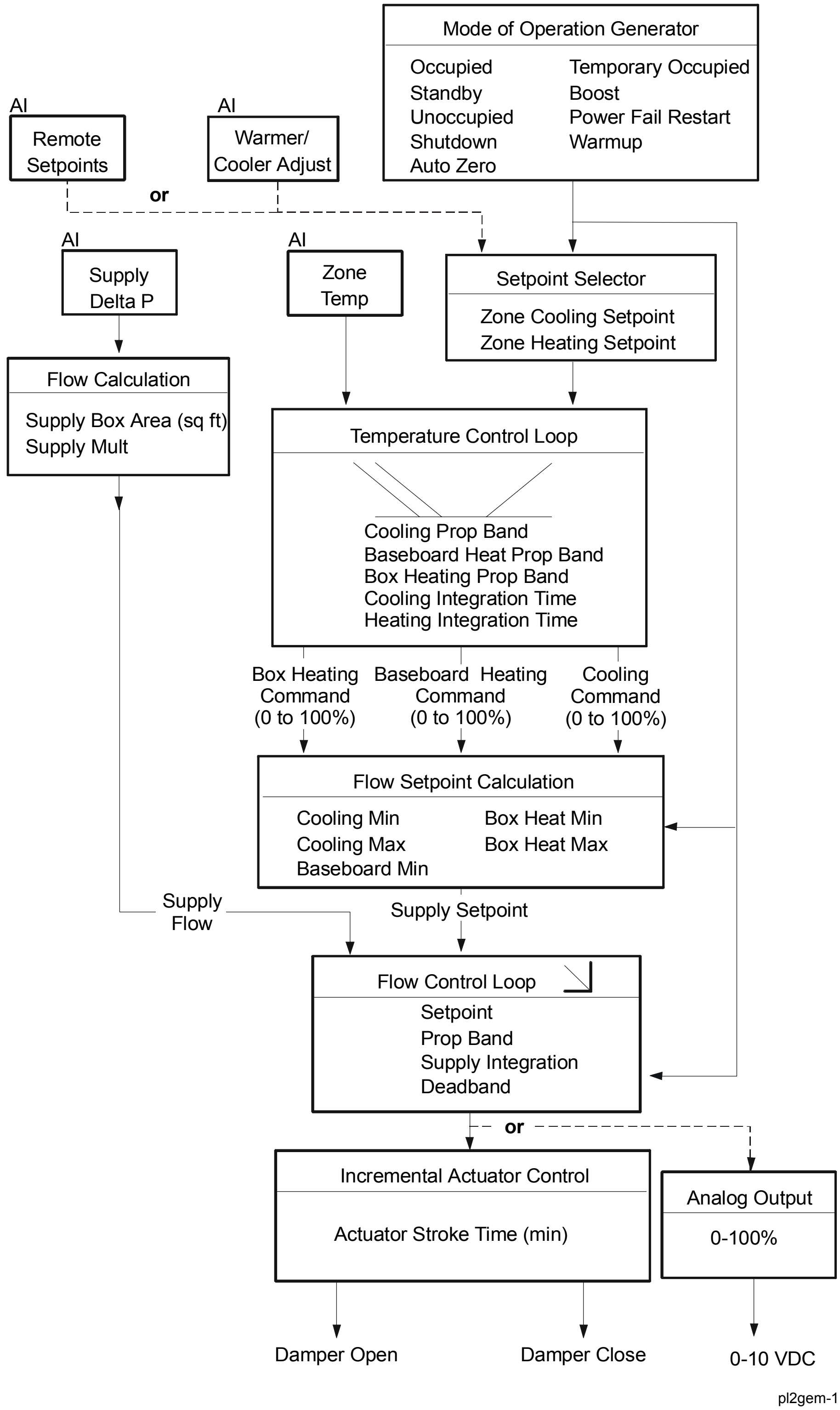

Figure 8: Pressure Independent Single Duct Control Logic

Pressure Dependent Single Duct Control Logic without Feedback

Figure 10 illustrates the pressure dependent control logic. The mode of operation generator selects which zone cooling and heating temperature setpoints are to be used by the temperature control loop during the selected mode of operation. The temperature control loop compares the zone temperature to the zone setpoint and produces a 0 to 100% output command to the damper actuator.

In Summer mode, the actuator opens the zone damper on an increase in zone temperature within the cooling prop band from the minimum position to 100%. Once the zone temperature falls below the cooling setpoint, the damper is held at minimum position. If you set up the system in Winter mode or Central System Warmup mode, the reverse action takes effect as shown in Figure 9.

The damper deadband adjustment, measured as damper open percentage, should not be set lower than 2% or greater than 10%. This deadband defines the minimum damper position increment in percent of stroke time.

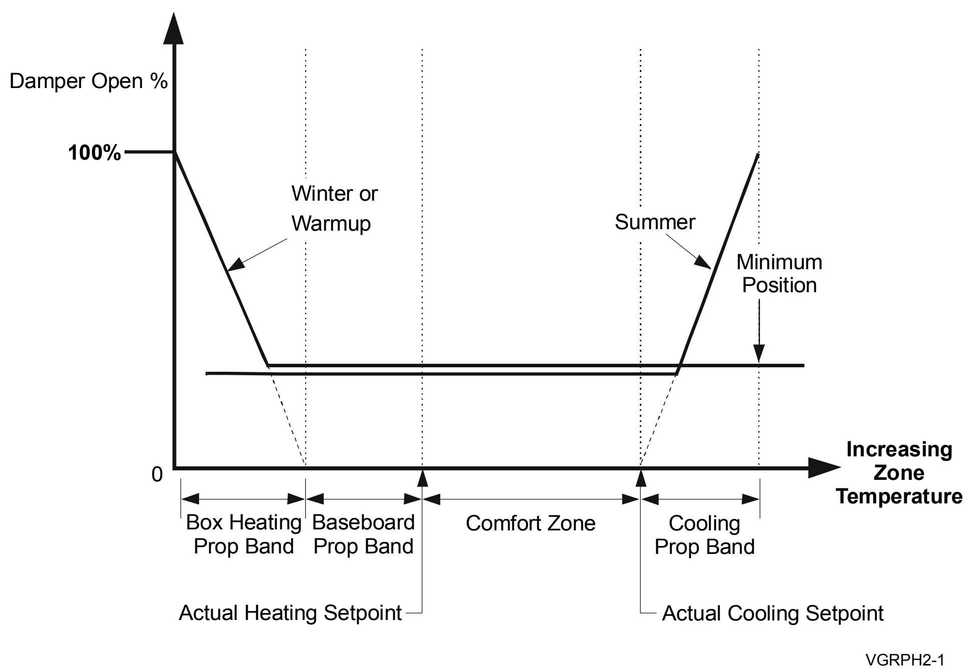

Figure 9: Control Sequence for Pressure Dependent Systems without Actuator Feedback

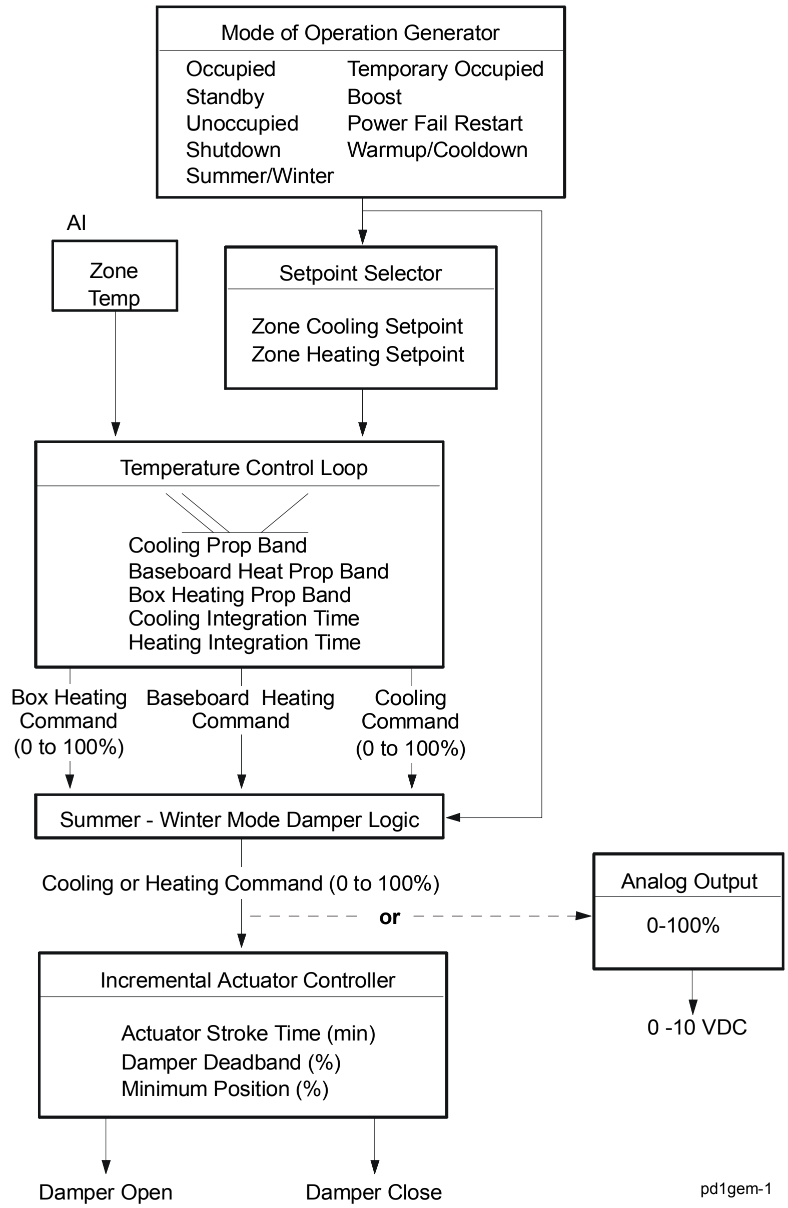

Figure 10: Pressure Dependent without Actuator Feedback Control Logic

Pressure Dependent Single Duct Control Logic with Feedback

Figure 12 illustrates pressure dependent with feedback control logic. The mode of operation generator selects which zone cooling and heating temperature setpoints are used during the selected mode of operation. The mode generator also selects which reset schedule supplies the incremental actuator controller during the Occupied, Unoccupied, and Central System Warmup modes.

The temperature control loop compares the zone temperature to the zone setpoint schedule and produces a 0 to 100% output command. The output command feeds into the reset schedule to provide a damper command during the Occupied, Unoccupied, and Central System Warmup modes. The damper command from the reset schedule is compared to the actual position feedback. Once the actual and damper commands are within the damper deadband, the actuator stops driving.

The damper deadband defaults to +/-2% of damper stroke. This means that once the incremental actuator controller falls into the deadband range, it will not drive the actuator until there is a 2% difference between the damper commanded position and the actuator feedback.

Notes: A 2K ohm feedback potentiometer on the damper actuator is recommended for the actuator position feedback.

When this strategy is used with an analog damper control output, position feedback is not used. See Figure 12.

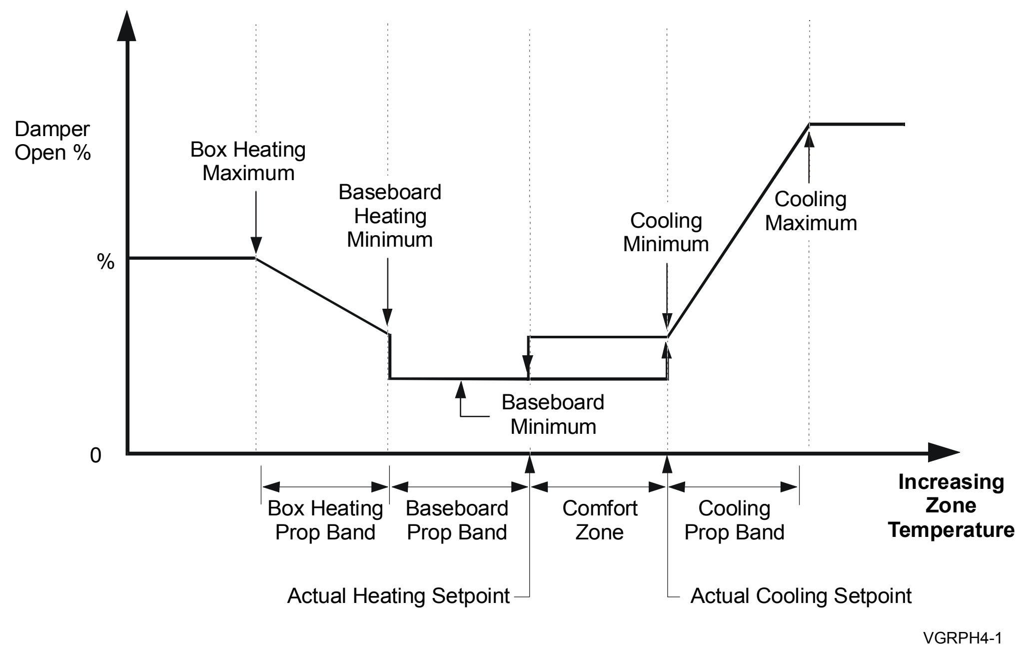

Figure 11: Control Sequence for Pressure Dependent Systems with Actuator Feedback

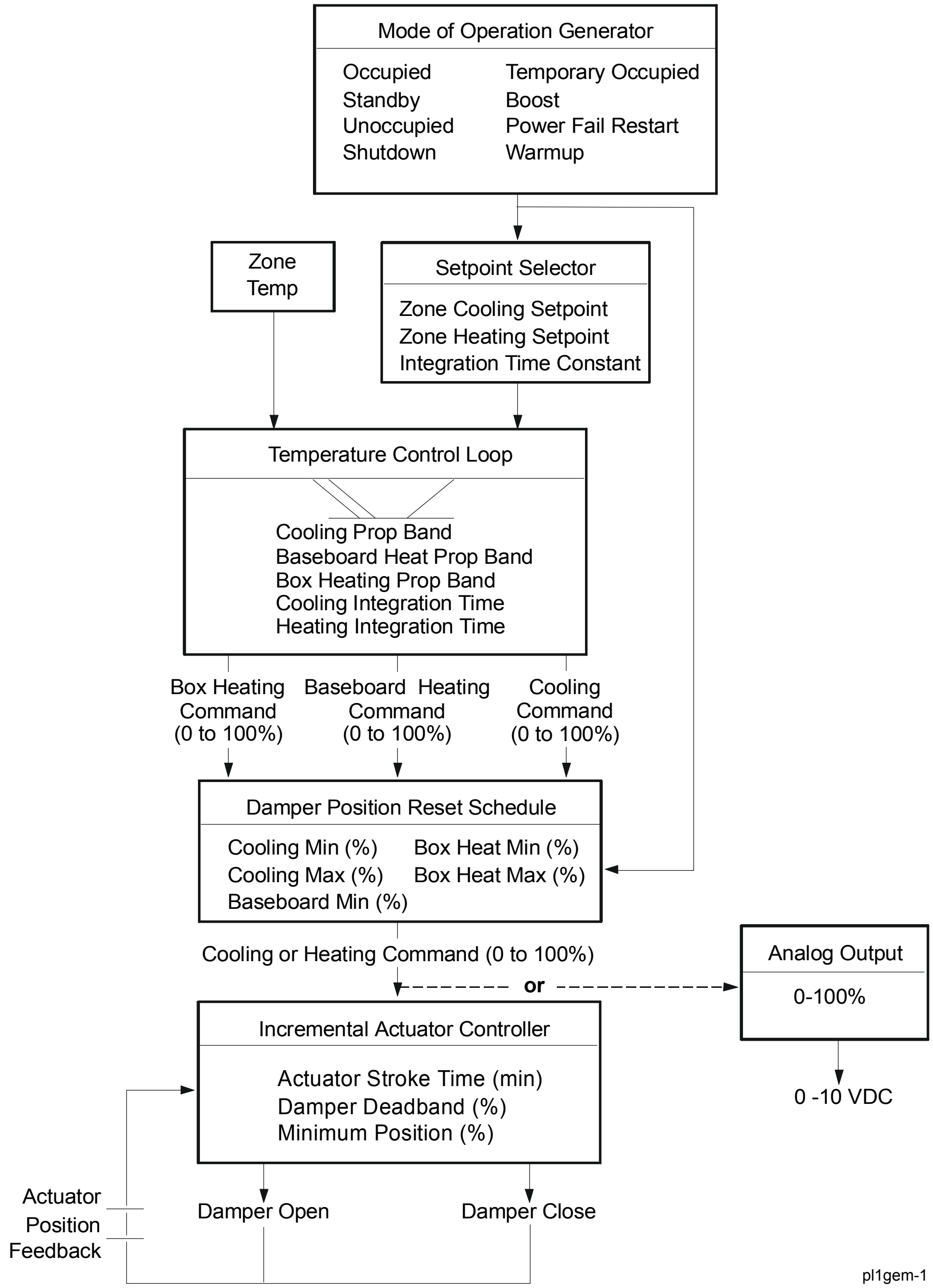

Figure 12: Pressure Dependent with Actuator Feedback Control Logic

Fan Operation

Small fans are used in some VAV boxes typically in conjunction with a heating coil. The fan serves two purposes.

- It produces a flow of plenum air through the heating coil even if the box damper is fully closed to the primary air source when heating is required.
- It improves occupant comfort by providing better mixing of the delivered air and room air by maintaining a constant airflow through the diffuser, regardless of the position of the box damper. That is, as the box damper closes, the fan pulls more air from the plenum.

VAV box fans are of two types as shown in Figure 13 and Figure 14 and as described in Table 17.

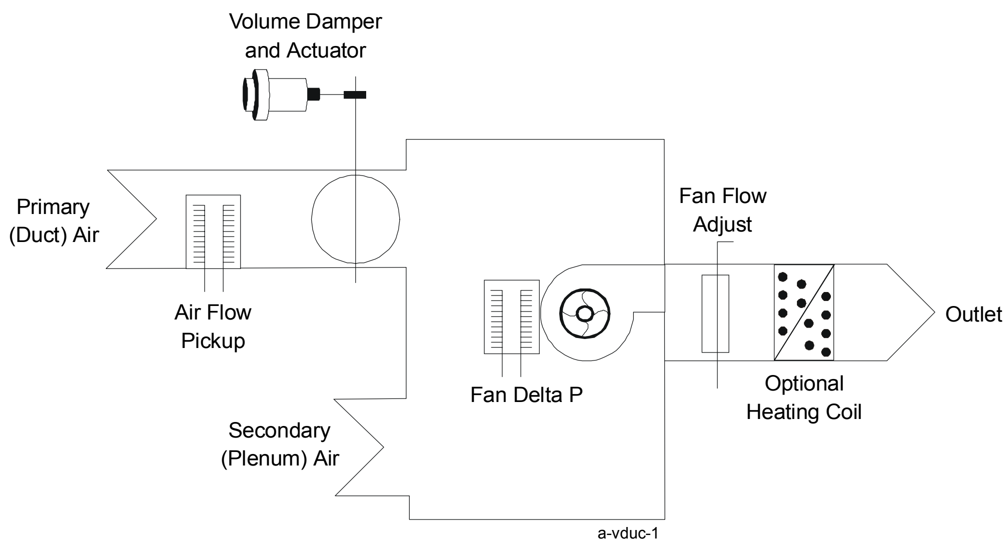

Figure 13: Single Duct VAV Box, Series Fan

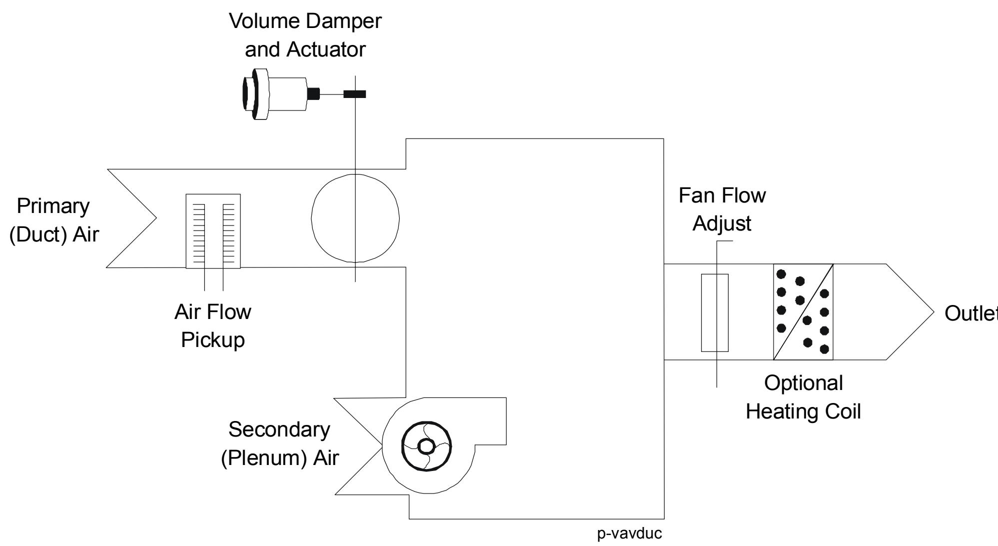

Figure 14: Single Duct VAV Box, Parallel Fan

Note: When used, the Fan Delta P pickup is attached to the fan inlet cone.

Table 17: Single Duct VAV Box Fan Types

Type	Description
Series Fan	The Series Fan is off during the Shutdown and Auto Zero modes. The fan is always on during the Occupied and Standby modes and is cycled on during the Unoccupied and Warmup modes when the zone requires heating. Before the fan is turned on, the damper is driven closed for the Auto Zero Duration time to ensure that the fan is not spinning backward. The on/off Series Fan is controlled by a single binary output with minimum On/Off timers that can be set in the BO Modify screen. The Proportional Series Fan uses a single analog output to the S66 speed controller. The S66 has built-in startup logic that sets the fan at 100% for five seconds. The VAV controller turns the fan on by setting the analog output to the Fan Speed % parameter value. The analog output is set to 0% to turn the fan Off. If you define the Series Fan without setpoints, the fan starts during unoccupied when the Htg Cmd > 1% and stops below 1%. If you define the Series Fan with setpoints (w/SP), then the fan starts when the Htg Cmd > Series Fan Setpt and stops when the Htg Cmd < Series Fan Setpt – Series Fan Differential. The Series Fan Setpt defaults to 1%, and the Series Fan Differential defaults to 0%. You must adjust these parameters to the required values.
Parallel Fan	The Parallel Fan is also referred to as fan assist. The fan is off during the Shutdown and Auto Zero modes. The Parallel/Temp Fan is cycled on when Warmup is inactive and the internal zone heating command is greater than the value of the Fan Start Setpoint parameter defaulted to 1%. The Parallel/Flow Fan is also cycled on during Occupied and Standby mode whenever the flow setpoint is below the Parallel Fan/Flow parameter value. The supply deadband is used as a differential to turn the fan off. Table 18 summarizes the relationship between the parallel and series fan types with the different modes of operation. If you define the Parallel Fan without setpoints, the fan starts during unoccupied when the Htg Cmd > 1% and stops below 1%. If you define the Parallel Fan with setpoints (w/SP), then the fan starts when the Htg Cmd > Fan Start Setpt and stops when the Htg Cmd < Fan Start Setpt – Parallel Fan Differential. The Parallel Fan Setpt defaults to 1%, and the Parallel Fan Differential defaults to 0%. You must adjust these parameters to the required values.

Table 18: Parallel and Series Fan Status per Mode of Operation

	Mode of Operation		
Fan Type	**Occupied and Standby**	**Unoccupied**	**Shutdown**
Parallel Fan/Temp	Cycled per Box* Heating Temperature Setpoints	Cycled at Unoccupied Box Heating Setpoint	Off
Parallel Fan/Flow	Cycled per Flow Setpoint	Cycled at Unoccupied Box Heating Setpoint	Off
Series Proportional	On	Cycled at Unoccupied Box Heating Setpoint	Off
Series On - Off	On	Cycled at Unoccupied Box Heating Setpoint	Off

* On when heating command is greater than Fan Start Setpoint.

Note: Fan and heat control outputs operate independently when overridden.

Box Heat

Box heat support includes incremental, proportional, two position valve actuators, and one to three stages of electric heat.

Electric heat control for non-fan powered boxes contains logic to avoid heat operation with inadequate airflow, which otherwise could trip electrical overload protection. Typically, VAV box manufacturers provide a pressure switch to lock out electric heat in the absence of inlet static pressure, but this does not ensure adequate airflow. The logic is provided for staged and 2-position heating options since both may control electric heat. The function provided depends on the main box strategy selected:

- In **pressure independent boxes**, box heat is enabled when the measured flow is greater than the presently selected heating minimum flow setpoint minus 1.25 times Supply Deadband. Box heat is disabled when the flow drops below the presently selected heating minimum flow setpoint minus 1.5 times Supply Deadband.

- In **pressure dependent with feedback boxes with incremental (binary) damper**, box heat is enabled when the measured actuator position is greater than the presently selected heating minimum position setpoint minus 1.25 times Damper Deadband. Box heat is disabled when the actuator position drops below the presently selected heating minimum position setpoint minus 1.5 times Damper Deadband.
- In **pressure dependent with feedback boxes with analog damper outputs**, there is no feedback. Since the analog output and corresponding actuator is proportional, feedback is not required. No additional logic is used to enable box heat in this application because damper position feedback is not provided and because analog actuators respond quickly.
- In **pressure dependent no feedback boxes**, box heat is delayed by an adjustable amount following a transition from Shutdown Box Closed. You should also use the Power Fail Restart logic with this strategy to delay the heat stages following a controller reset.

For single stage heat, the default minimum on time is 0 because hysteresis is established by the differential compare used to control the single stage. Heat is turned on when the Heating Command exceeds the Box Heat On Setpt and it is turned off when the Heating Command falls below one half the Box Heat On Setpt.

For two and three stage heating applications, the default minimum on time is 0.5 minutes. AS-VAV1xx-1 controllers contain logic to cancel the minimum on timer during Shutdown Box Closed and Auto Zero. In older (AS-VAV1xx-0) controllers, this needs to be changed to 0.0 to prevent the minimum on time from holding the heat on when there is no flow.

VAV Dual Duct Applications

Pressure Independent Decks (with and without User Defined Flow)

Figure 16 illustrates pressure independent control logic. The mode of operation generator selects which zone cooling and heating temperature setpoints are used during the selected mode of operation. The mode generator also selects which flow reset schedule supplies both the hot and cold deck damper actuator during the Occupied, Unoccupied, and Warmup modes.

The zone proportional/integral loop compares the zone temperature to the zone setpoint and produces 0 to 100% output commands. The output commands for heating and cooling feed into separate hot and cold deck reset schedules which provide flow setpoints.

The damper control uses prop band, integration time, deadband, and stroke time to modulate the damper and thus, maintain the flow setpoint. To calculate default values, see flow loop calculations in the *Flow Loop Tuning Equations* topic in this section.

The hot and cold deck flows reset between the zone heating and cooling setpoints. The cold deck is automatically reset between its minimum cooling flow setpoint and minimum heating flow setpoint. The hot deck is also automatically reset between its minimum heating flow setpoint and minimum cooling flow setpoint. This allows for smooth transitions of airflow as the zone temperature requirements switch between heating and cooling.

The user defined flow path allows the user to define the flow sensor type and ranging. In addition to differential pressure measurement, this allows use of linear and non-linear sensors with outputs ranged in flow or velocity. The user must enter the appropriate constants for the sixth order polynomial to linearize the sensor. Then, the user enters the flow coefficient, box area, and indicates whether the box area should be used in the calculation. Box area is used to calculate flow loop tuning parameter values, so the area must be accurately entered, even when not required to calculate flow. Setting the flow coefficient to 0 (zero) disables square root extraction.

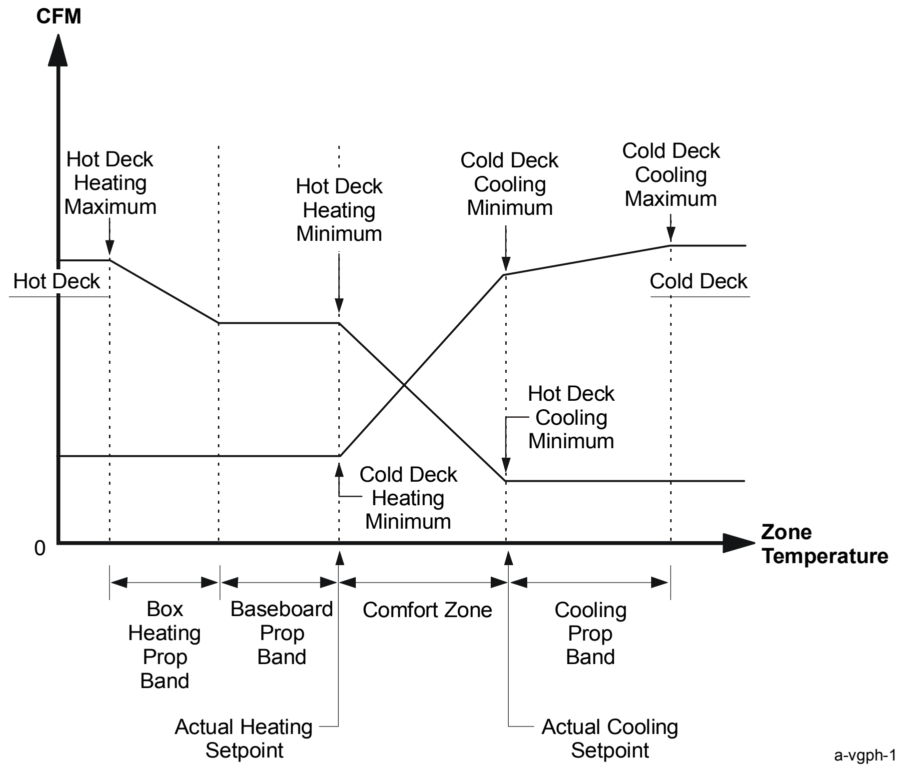

Figure 15: Control Sequence for Pressure Independent Hot and Cold Decks

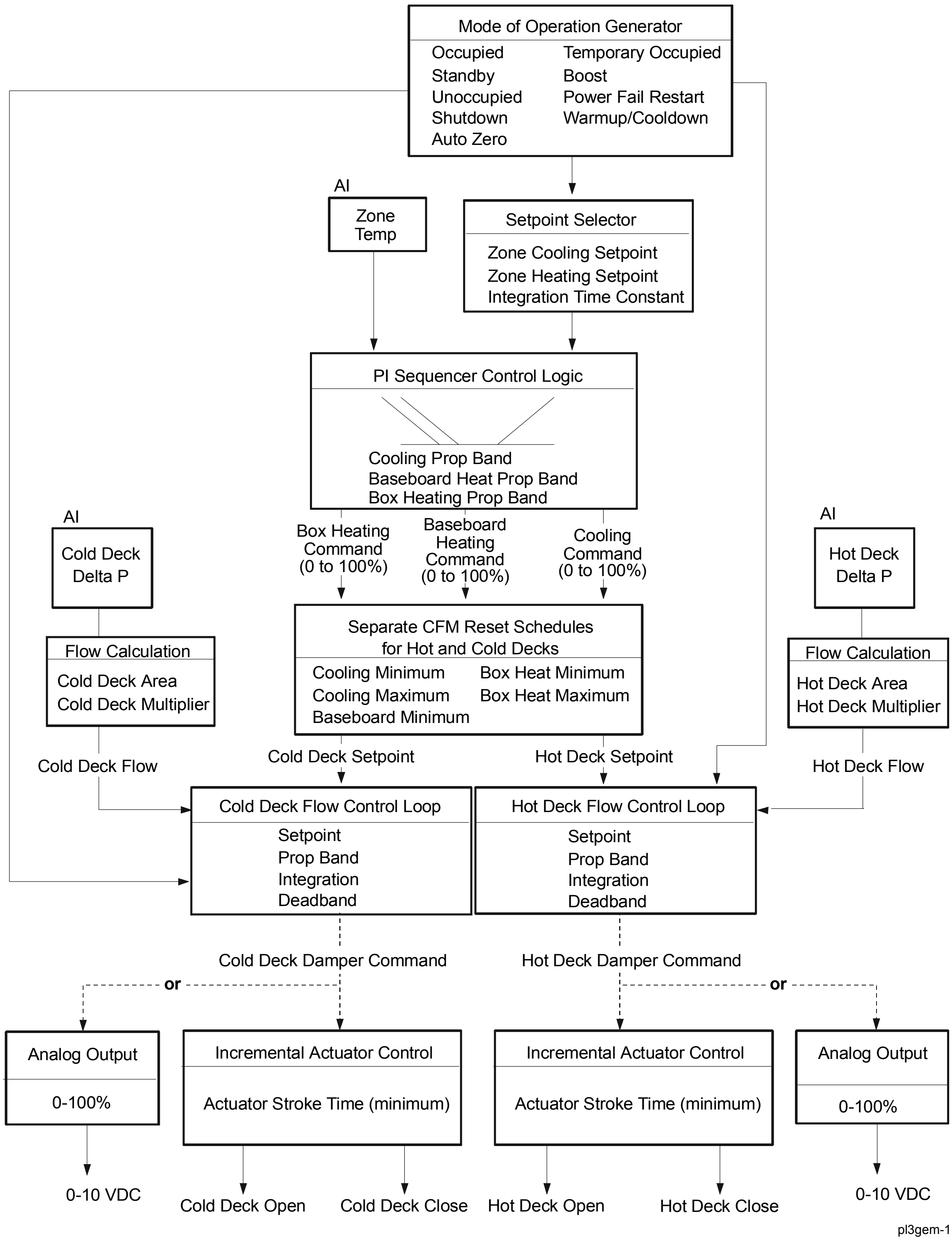

Figure 16: Dual Duct Pressure Independent/Separate Dampers Control Logic

Constant Volume Separate Dampers (with and without User Defined Flow)

The Separate Damper Constant Volume control strategy (Figure 17) uses two separate damper actuators to modulate the hot and cold deck respectively. The control algorithm controls the temperature in the zone and maintains a constant flow by proportionally resetting the hot and cold deck flow setpoints in response to the zone temperature. The zone heating and cooling setpoints set the zone temperature limits for full hot deck or cold deck flow. Whenever the zone temperature is between these limits, the hot and cold deck flow setpoints reset equally, but in opposite directions in response to the zone temperature change and thus, maintain a constant volume airflow. For example, a 500 cfm constant volume setpoint establishes a 0-500 cfm range for the hot and cold deck. Because of a certain zone temperature, the hot deck control point could be 300 cfm, which would dictate a 200 cfm control point for the cold deck. When the zone temperature is half way in-between the heating and cooling setpoint, the control point for the hot and cold decks would be 250 cfm each. This strategy does not provide minimum flow setpoints for either deck. For this capability, use the Pressure Independent strategy and set the flow setpoint appropriately.

The user defined flow path allows the user to define the flow sensor type and ranging. In addition to differential pressure measurement, this allows use of linear and non-linear sensors with outputs ranged in flow or velocity. The user must enter the appropriate constants for the sixth order polynomial to linearize the sensor. Then, the user enters the flow coefficient, box area, and indicates whether the box area should be used in the calculation. Box area is used to calculate flow loop tuning parameter values, so the area must be accurately entered, even when not required to calculate flow. Setting the flow coefficient to 0 (zero) disables square root extraction.

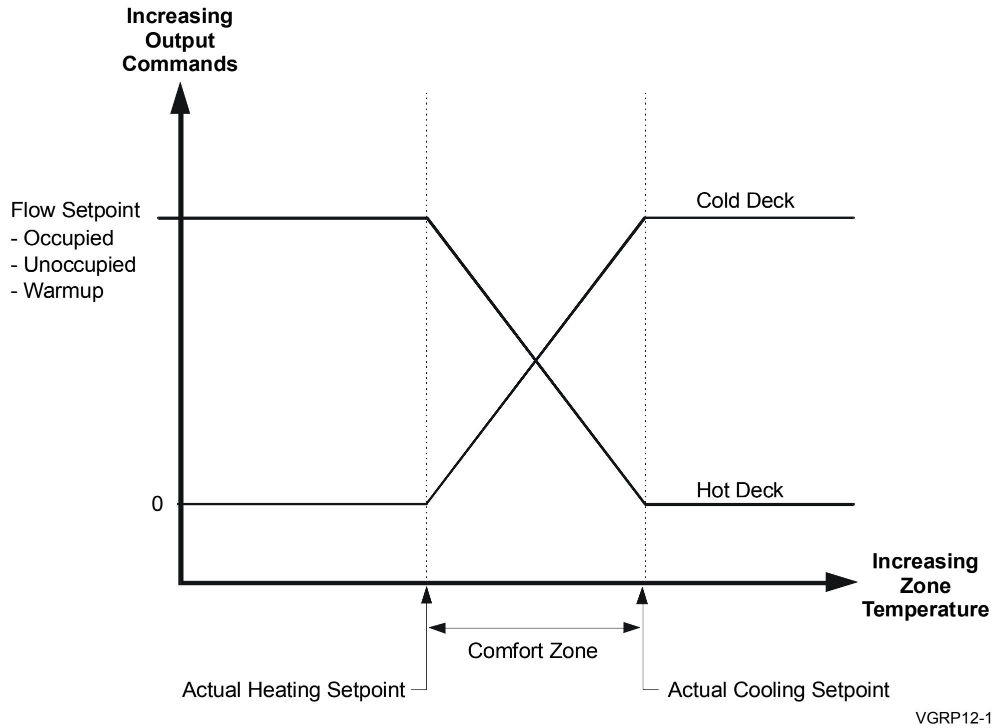

Figure 17: Control Sequence for Constant Volume Separate Dampers

Pressure Independent Discharge Air Reset (DAR) of Temperature and Flow

This strategy utilizes a terminal unit discharge air temperature sensor and flow and temperature reset schedules to provide tight zone control and stable discharge over a wide range of hot and cold deck supply air temperatures and space loads. The reset strategy is particularly well suited to cold air systems where the cold deck temperature may be less than the minimum desired air temperature delivered to the occupied space.

Baseboard radiation control may optionally be integrated to eliminate the effects of cold walls in exterior zones.

Proportional plus integral control is utilized in the zone temperature loop and in the individual hot and cold deck flow control loops. Control of discharge temperature and flow is provided by multi-variable control logic.

Maximum heating and cooling airflow setpoints are in terms of discharge flow. For example, if cooling design calls for 800 cfm of 42°F cold deck plus 200 cfm of 107°F hot deck in order to produce 1000 cfm of 55°F air flow to the space, the Maximum Cooling flow setpoint should be set to 1000 cfm. To meet ventilation requirements, a minimum air flow may be established on just one deck, on both decks or on discharge flow.

Although the hot and cold inlet locations are recommended, flow may be measured at any two of three locations: cold deck, hot deck, and discharge; the non-measured variable is internally calculated. Discharge flow measurement at low velocity may be less reliable unless the flow pickup is located at least three duct diameters downstream from the box outlet, making installation of the discharge flow pickup by the box manufacturer impractical.

Zone Control

Single setpoint provides for a zone temperature setpoint for each of the modes: Occupied, Unoccupied, and Standby. A bias is also provided for each of the three modes. In this configuration, the bias value establishes the zone control deadband. The deadband defines the range of zone temperatures above and below setpoint where no control action takes place, allowing the zone to float. Thus energy savings may be realized by using a larger bias during unoccupied periods, for example. The controller defines the deadband to be the zone setpoint +/- bias. For stable control and expected component life, a bias of at least 0.1 should be used. Internally, the control offset is set to 50%, so the control can function above and below setpoint.

Zone control loop tuning parameters for proportional band and integration time are available. The proportional band uses a positive value for direct action. The output from the zone control loop, or Zone Command is a value of 0 to 100%, which is used by the discharge temperature and flow reset schedules.

When baseboard control is included and heating is required, the radiation valve is sequenced prior to resetting the discharge flow from heating minimum to heating maximum, as shown in Figure 18. Tuning is facilitated by a proportional band (Basebd Prop Band), which must have a negative value to produce the reverse acting heating ramp. Also, the radiation control loop uses the zone integration time.

Discharge Temperature and Flow Reset

The zone proportional band is divided into three equal segments to reset the discharge temperature and flow. As shown in Figure 19, the outer segments are used to reset the discharge flow between the heating maximum and minimum, and the cooling maximum and minimum. In the inner one third called the comfort zone, flow is reset between the heating and cooling minimums. For configurations with radiation, the discharge flow setpoint is held constant while the radiation is modulated. Discharge temperature is reset in the comfort zone as shown in Figure 19.

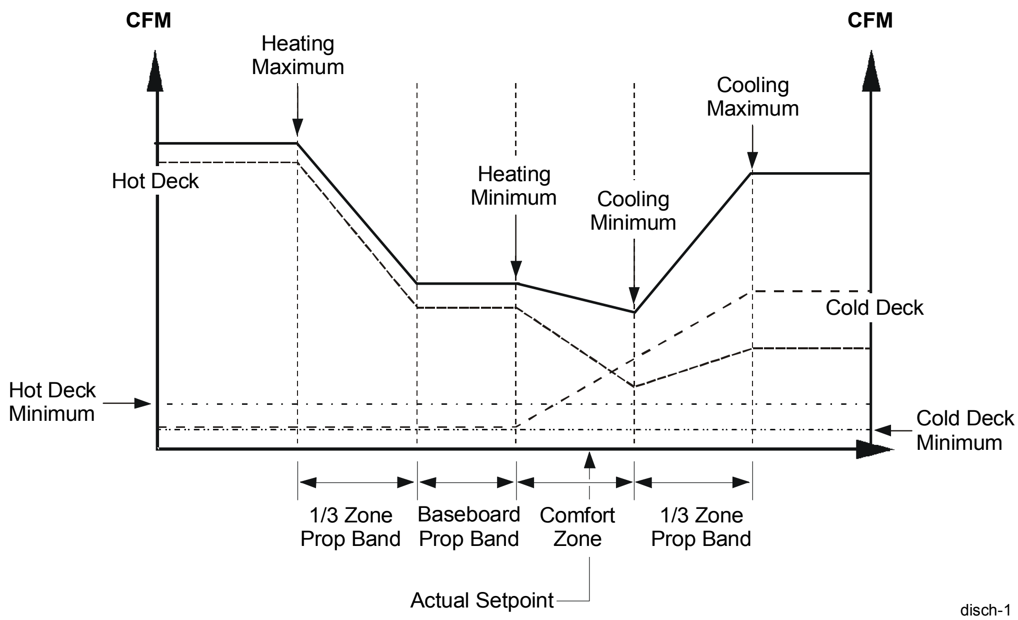

Figure 18: Discharge Flow Reset

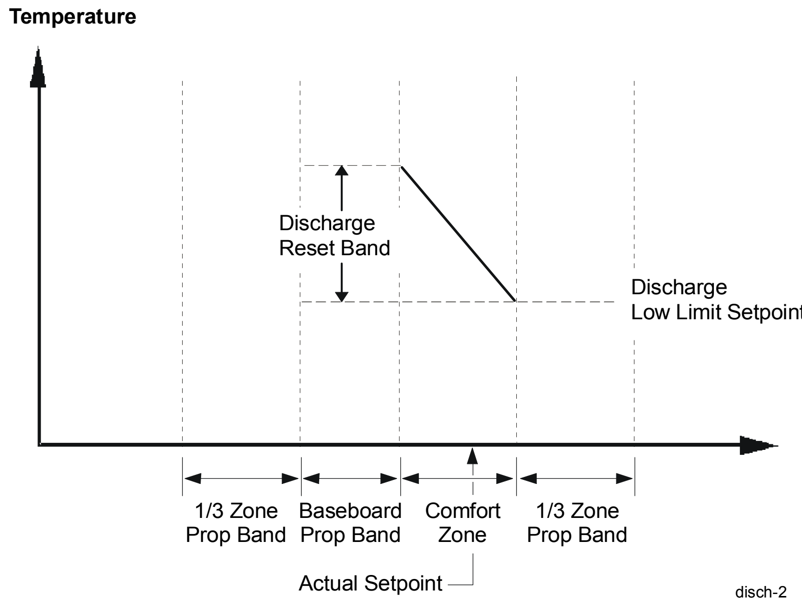

Figure 19: Discharge Temperature Reset

Integral Discharge Temperature Control

A deadband is utilized in discharge temperature control for stabilization. The default discharge temperature deadband is 2°F. Discharge temperature error is evaluated. This error is used to hold or slowly vary the percentage of cold deck from the calculated discharge flow setpoint (Actual Disch Flow Setpt), less any ventilation provided by the hot duct (HD Min Vent), to any minimum ventilation provided by the cold duct (CD Min Vent) in order to control discharge temperature. The cold duct flow setpoint is determined by multiplying the percentage by the Flow Span Range (Actual Disch Flow Setpt - HD Min Vent - CD Min Vent) and then adding that value to CD Min Vent. The hot duct flow setpoint is determined by subtracting the resultant cold duct flow setpoint from the Actual Disch Flow Setpoint. Overriding the cold deck via the preset does not affect the hot deck setpoint.

Discharge temperature is evaluated as shown in Table 19.

Table 19: Discharge Temperature

If This is True...	Do This
If the discharge temperature is greater than setpoint plus deadband	Increment % of CD
If the discharge temperature is within the setpoint +/- the deadband	Hold % of CD
If the discharge temperature is less than setpoint minus deadband	Decrement % of CD

The discharge temperature control loop can be tuned by adjusting the deadband (Disch Air Deadband) and an integration time parameter (DA Temperature Tuning). DA Temperature Tuning has a default value of 0.025, which provides a rate of change in the cold deck flow of 2% of the Flow Span Range each 1.5 seconds. The value for other rates can be calculated as:

$$\text{DA Temperature Tuning} = 0.05/\text{rate}\%$$

Hot and Cold Deck Flow Control Loops

Independent Proportional plus Integral control loops are utilized to position each deck damper. Proportional band, integration time, and deadband parameters are available to tune each deck. Recommended values based on deck inlet area and damper stroke can be found in other sections of the manual.

Constant Volume Separate Dampers Discharge Air Reset (DAR) of Temperature

This strategy utilizes a terminal unit discharge air temperature sensor and a temperature reset schedule to provide tight zone control and stable discharge over a wide range of hot and cold deck supply air temperatures and space loads. The reset strategy is particularly well suited to cold air systems where the cold deck temperature may be less than the minimum desired air temperature delivered to the occupied space.

Baseboard radiation control may optionally be integrated to eliminate the effects of cold walls in exterior zones.

Proportional plus integral control is utilized in the zone temperature loop and in the individual hot and cold deck flow control loops. Control of discharge temperature and flow is provided by multi-variable control logic.

Airflow setpoints are in terms of discharge flow. For example, if cooling design calls for 800 cfm of 42°F cold deck plus 200 cfm of 107°F hot deck in order to produce 1000 cfm of 55°F air flow to the space, the flow setpoint should be set to 1000 cfm. To meet ventilation requirements, a minimum air flow may be established on just one deck or on both decks.

Although the hot and cold inlet locations are recommended, flow may be measured at any two of three locations: cold deck, hot deck, and discharge. The non-measured variable is internally calculated. Discharge flow measurement at low velocity may be less reliable unless the flow pickup is located at least three duct diameters downstream from the box outlet, making installation of the discharge flow pickup by the box manufacturer impractical.

Zone Control

Single setpoint provides for a zone temperature setpoint for each of the modes: occupied, unoccupied, and standby. A bias is also provided for each of the three modes. In this configuration, the bias value establishes the zone control deadband. The deadband defines the range of zone temperatures above and below setpoint where no control action takes place, allowing the zone to float. Thus energy savings may be realized by using a larger bias during unoccupied periods, for example. The controller defines the deadband to be the zone setpoint +/- bias. For stable control and expected component life, a bias of at least 0.1 should be used. Internally, the control offset is set to 50%, so the control can function above and below setpoint.

Zone control loop tuning parameters for proportional band and integration time are available. The proportional band uses a positive value for direct action. The output from the zone control loop, or Zone Command is a value of 0 to 100%, which is used by the discharge temperature reset schedule.

When baseboard control is included and heating is required, the radiation valve is sequenced prior to resetting the discharge flow from heating minimum to heating maximum, as shown in Figure 22. Tuning is facilitated by a proportional band (Basebd Prop Band), which must have a negative value to produce the reverse acting heating ramp. Also, the radiation control loop uses the zone integration time.

Discharge Temperature Reset

Zone command values from 0 to 100% reset the discharge. The lower limit of the discharge temperature setpoint is set by the value of the Low Disch Setpt parameter, the upper limit is equal to the sum of the low limit plus the Disch Reset Band (Figure 20).

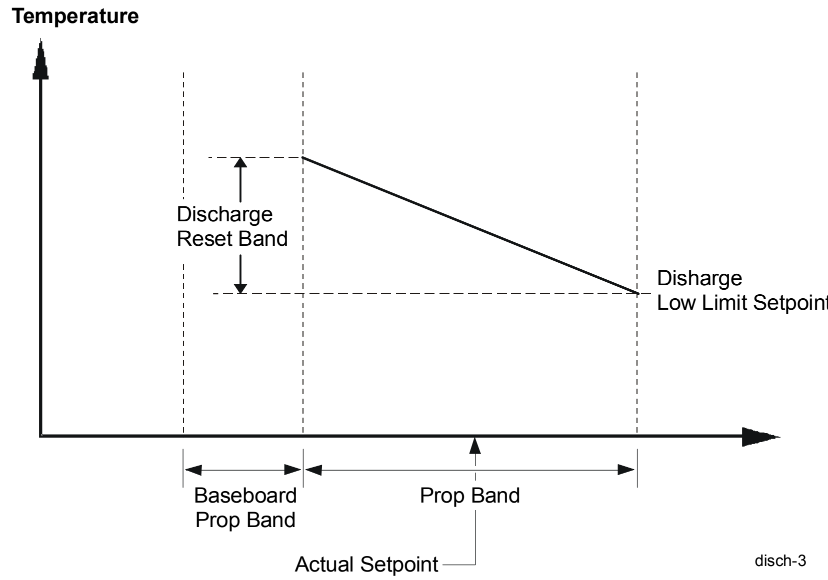

Figure 20: Discharge Temperature Reset

Integral Discharge Temperature Control

A deadband is utilized in discharge temperature control for stabilization. The default discharge temperature deadband is 2°F. Discharge temperature error is evaluated. This error is used to hold or slowly vary the percentage of cold deck from the calculated discharge flow setpoint (Actual Disch Flow Setpt), less any ventilation provided by the hot duct (HD Min Vent), to any minimum ventilation provided by the cold duct (CD Min Vent) in order to control discharge temperature. The cold duct flow setpoint is determined by multiplying the percentage by the Flow Span Range (Actual Disch Flow Setpt - HD Min Vent - CD Min Vent) and then adding that value to CD Min Vent. The hot duct flow setpoint is determined by subtracting the resultant cold duct flow setpoint from the Actual Disch Flow Setpoint. Overriding the cold deck via the preset does not affect the hot deck setpoint.

Discharge temperature is evaluated as shown in Table 20.

Table 20: Discharge Temperature

If This is True...	Do This
If the discharge temperature is greater than setpoint plus deadband	Increment % of CD
If the discharge temperature is within the setpoint +/- the deadband	Hold % of CD
If the discharge temperature is less than setpoint minus deadband	Decrement % of CD

The discharge temperature control loop can be tuned by adjusting the deadband (Disch Air Deadband) and an integration time parameter (DA Temperature Tuning). DA Temperature Tuning has a default value of 0.025, which provides a rate of change in the cold deck flow of 2% of the Flow Span Range each 1.5 seconds. The value for other rates can be calculated as:

$$\text{DA Temperature Tuning} = 0.05/\text{rate\%}$$

Hot and Cold Deck Flow Control Loops

Independent proportional plus integral control loops are utilized to position each deck damper. Proportional band, integration time, and deadband parameters are available to tune each deck. Recommended values based on deck inlet area and damper stroke can be found in other sections of the manual.

Constant Volume Linked Dampers

The hot and cold dampers are linked together and modulated by one actuator. These dampers modulate to maintain the temperature setpoint schedule per mode of operation. The second actuator throttles the box outlet to maintain the constant volume setpoint.

The hot and cold deck dampers are controlled with one actuator mechanically linked to each damper. The damper actuator is controlled directly from the zone temperature within the zone heating or cooling setpoints. These setpoints also establish the control limits. The VAV box opens to full heat when the zone temperature is at the heating setpoint and opens to full cooling when at the cooling setpoint. The linked dampers are proportionally modulated when the zone temperature is between the heating and cooling setpoints.

Baseboard heat can be added to the control strategy. The baseboard loop has its own tuning parameters and operates to satisfy the zone heating setpoint.

The volume damper flow loop maintains a constant volume setpoint utilizing proportional plus integral control. As the difference between actual flow and the volume setpoint becomes greater than the deadband, the actuator is commanded to operate in the proper direction. The actuator stops driving when the flow loop error is within the deadband.

The volume damper flow loop can be tuned through the adjustment of separate proportional band and integration time. Use the Pattern Recognition Adaptive Control (PRAC) automated tuning process within HVAC PRO to determine the proper tuning parameters for the control loop.

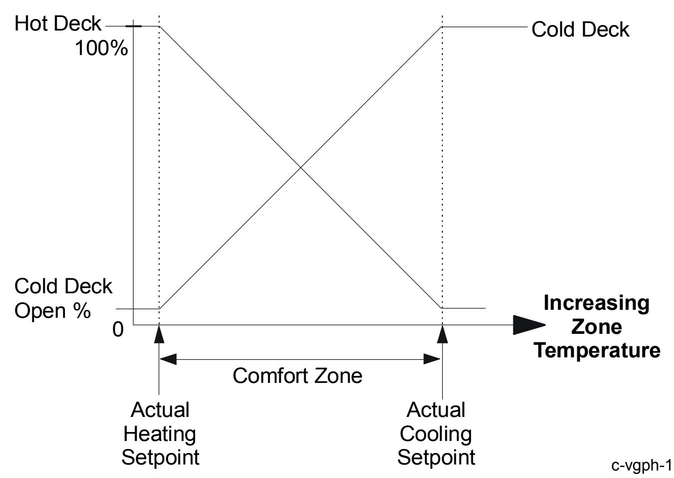

Figure 21: Hot/Cold Deck Control--Zone Damper

Dual-to-Single Duct Conversion

The conversion box has the same control sequence of operation as a standard pressure independent single duct sequence. The additional control loop process that is added is a binary output command that triggers at the heating setpoint. The BO energizes a V11 3-Way Air Valve.

If the controller is calling for heating, the V11 switches air to the existing pneumatic actuators on the dual duct box so that the hot deck is open and the cold deck is closed. Once the zone temperature is above the heating setpoint, the V11 reverses its action to open the cold deck and close the hot deck.

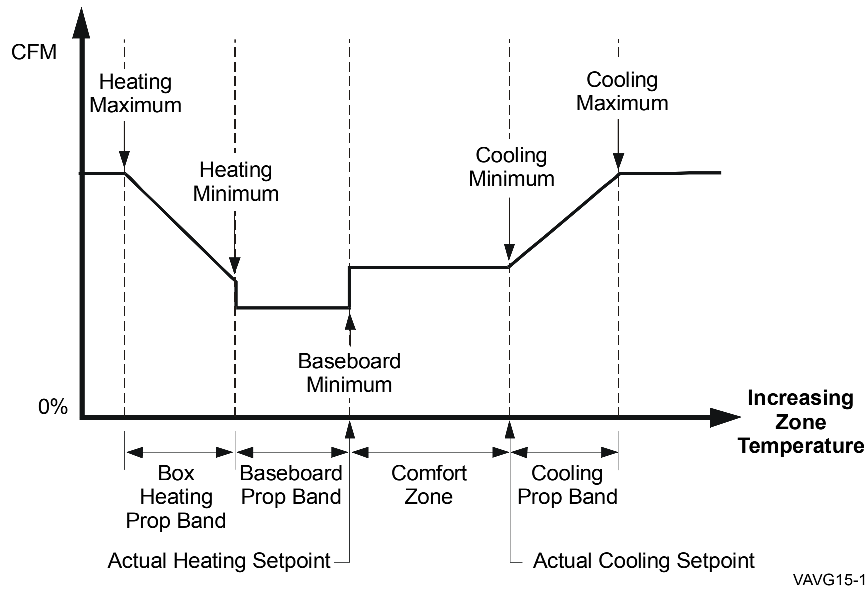

Figure 22: Control Sequence for Dual-to-Single Duct Conversion

Pressure Independent Cold Deck with Pressure Dependent Hot Deck

The pressure independent cold deck with pressure dependent hot deck control strategy accomplishes flow control of the cold deck and room control of the hot deck. Both are independent control loops controlled from a common zone temperature setpoint.

The cold deck operates between user defined minimum and maximum flow setpoints. As the zone temperature increases above the zone cooling setpoint, the cold deck resets between the minimum to the maximum flow setpoint.

Zone temperature directly controls the hot deck. As the zone temperature decreases below the zone setpoint and through the heating proportional band, a 0-100% hot deck damper command is generated. In addition, the control routine uses a hot deck minimum position expressed as 0-100% open. The minimum position value establishes a hot deck position that is maintained even during cold deck operation. Hot Deck Min Pos defaults to 2%. Increase this when the hot deck is the only source of outdoor air for ventilation.

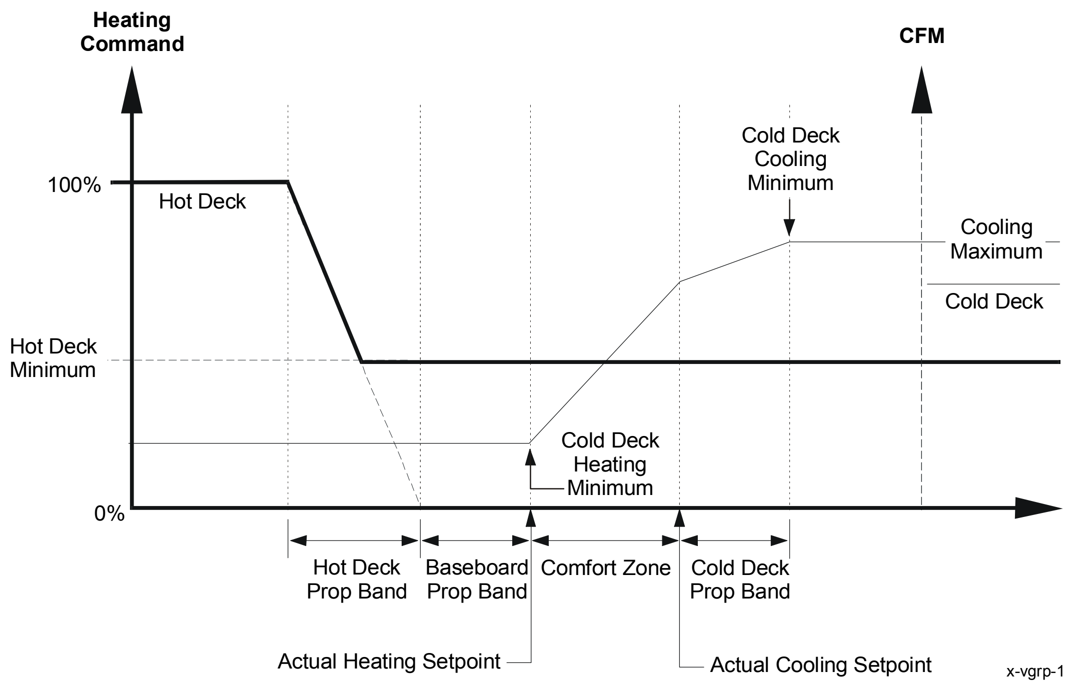

Figure 23: Pressure Independent Cold Deck with Pressure Dependent Hot Deck

Discharge Air Low Limit Logic

The discharge air sensor option can be used with the Pressure Independent or Constant Volume/Separate Damper Strategies. This discharge air sensor automatically maintains the low limit setting. The low limit logic may be required when the cold deck supply temperature uses 45 to 50°F air from an ice storage system.

The discharge air low limit automatically overrides the cold deck flow setpoint command and resets the hot deck volume to make up the difference.

The limiter utilizes proportional plus integral control.

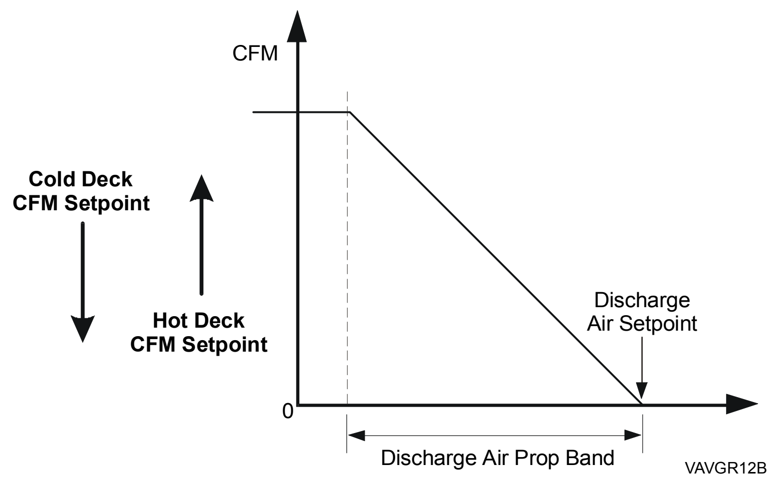

Figure 24: Discharge Air Low Limit Schedule

Water System Flush

Configurations that control water valves and that are targeted for VAV1xx-1 controllers include logic to simplify the processes of flushing and balancing building heating water systems. Incremental, proportional, and two position--normally open and normally closed--heating outputs are affected by this feature. Flush logic does not control multiple stage heating outputs, but does control single stage configurations since the HVAC PRO heating questions use the same answer for both single stage and two position normally closed valves.

Note: Do not activate this feature in configurations controlling single stage electric heat. If activated, single stage heat energizes and if an insufficient volume of air flows over the coil, overload protection is tripped. This may require replacement of fusible links.

This feature uses two configurable and adjustable parameters (Table 21). Water Flush, which is a binary data point, is used to select either the appropriate heating command or the value of an analog data point (Flush Position) to be sent to the heating output logic. When Water Flush has a value of one or enable, the Flush Position value is sent to the incremental, proportional, and two position heating control logic.

Table 21: Water System Flush Parameters

Group	Parameter	Address	Default
Water System Maintenance	Water Flush	BD-239	0 (Disable)
Water System Maintenance	Flush Position	ADF-239	100% Htg

Note: These parameters appear in all VAV configurations capable of controlling a heating valve, but due to memory constraints of older controllers, the associated logic is not loaded in VAV1xx-0 devices.

Flush has the highest priority and operates in all modes of controller operation.

Controller Diagnostics

HVAC PRO Release 5.10 or later provides three kinds of controller diagnostics. These diagnostics are operator selectable (or any combination thereof) during the Question and Answer session.

The three diagnostics are:

- Actuator Runtime
- Moving Average Flow Error
- Moving Average Zone Temperature Error

The logic for accomplishing these diagnostics is included as part of the controller download. As a result, the collection of these performance diagnostics continues until the controller is reset, either from the N2 Bus or by local power cycling.

Since these diagnostics are for determining controller performance and do not directly contribute to control strategy, they should be selected as memory permits in the VAVxxx-0 controllers. Sufficient memory for all diagnostics and control logic is available in the VAVxxx-1 controllers.

Actuator Runtime

This diagnostic consists of two parameters:

- Controller Runtime
- Actuator Runtime

The Controller Runtime is the total time the controller has been running in hours since the last reset. The Actuator Runtime is the total amount of time the incremental actuator has been pulsed open or closed since the last controller reset. The display is also in hours.

Duty Cycle

The incremental actuator Duty Cycle can be computed by dividing the actuator runtime by the controller runtime.

Single Duct

This diagnostic is available only in the pressure independent, incremental actuator path. See Figure 25 in this document to locate the diagnostic question. The parameters for single duct applications are grouped under VAV Box Diagnostics as seen in the Commissioning mode:

- Controller Runtime xxxxx Hrs
- Actuator Runtime xxxxx Hrs

Dual Duct

This diagnostic is available only in the pressure independent or constant volume, separate dampers, incremental actuator path. See Figure 28 in this document to locate the diagnostic question. The parameters for dual duct applications are grouped under VAV Box Diagnostics as seen in the Commissioning mode:

- Controller Runtime xxxxx Hrs
- Hot Dk Runtime xxxxx Hrs
- Cold Dk Runtime xxxxx Hrs

Moving Average Flow Error

This diagnostic indicates the flow error of the damper control loop in the VAV box. It is founded upon a published statistical process control equation **exponential weighted moving average**. The name has been shortened to **moving average**. The complete flow equation implemented is:

Moving Average $_{\textbf{(new)}}$ = ((| measured flow – flow setpoint | - moving average $_{(old)}$) ÷ **flow filter value**) + moving average $_{(old)}$

The **flow filter value** is a constant whose value has been set to 30 minutes. This parameter is not modifiable by the user. If a large moving average value persists over time, it is an indication of a malfunction in the damper control loop.

Single Duct

The Moving Average Flow Error is available in the single duct pressure independent, incremental actuator path. The following parameter shows up in the VAV Box Diagnostics group while in the Commissioning mode:

- Moving Avg Flow Error xxxx cfm

Dual Duct

The Moving Average Flow Error Diagnostic is also available for dual duct pressure independent or constant volume, separate dampers, incremental actuator applications. Under the VAV Box Diagnostics grouping, the following parameters display if this diagnostic is selected:

- Moving Avg CD Flow error xxxx cfm
- Moving Avg HD Flow error xxxx cfm

Note: Three possibilities in placing flow sensors on dual duct boxes include (1) separate cold and hot duct, (2) total and cold duct, and (3) total and hot duct. When either (2) or (3) are selected, one of the flow errors computes from the total even though the parameter implies calculation from each deck.

Conditions for Moving Average Flow Computing

There are situations during which this diagnostic will be suspended. They are when the:

- Delta P sensor is unreliable
- mode is not Occupied or Standby
- mode is in Shutdown Box Open or Close

Note: Because of memory constraints, the unreliable sensor check is included only in the VAVxxx-1 dual duct applications. It is always included with all single duct applications.

The respective single or dual duct diagnostic values stop changing if the Delta P sensors become unreliable. The diagnostics resumes automatically when the Delta P sensors are again reliable. The Delta P sensor indicates the standard unreliable value under the Analog Input grouping.

Moving Average Zone Temperature Error

This diagnostic indicates the zone temperature error of the space being controlled by the VAV box. It is founded upon a published statistical process control equation **exponential weighted moving average**. The name has been shortened to **moving average**. The equation supplied in Release 4.00 and 5.00 of HVAC PRO is not supported in Release 6.00. The equation provided below is supported in Release 6.00 and later. The complete zone temperature equation implemented is:

Moving Average $_{(new)}$= ((|measured temp - zone setpt| - moving average $_{(old)}$) ÷ **temperature filter value**) + moving average $_{(old)}$

The **temperature filter value** is a constant whose value is set to four hours. This parameter is not modifiable by the user. If a large value persists over time, it is an indication of a malfunction in the zone temperature control loop.

Single and Dual Duct Moving Average Zone Temp Error

The Moving Average Zone Temperature Error is available in the single duct, pressure independent; or dual duct, pressure independent constant volume, separate dampers, incremental actuator path. The following parameter shows up in the VAV Box Diagnostics group while in the Commissioning mode:

- Moving Avg Zone Temperature error xxxx Deg F

Conditions for Moving Average Zone Temperature Computing

There are situations during which this diagnostic will be suspended. They are when the:

- zone temperature sensor is unreliable
- mode is not Occupied or Standby
- mode is in Shutdown Box Open or Close

The Moving Average Zone Temperature Error stops changing if the zone temperature sensor becomes unreliable. The diagnostic resumes automatically when the sensor is again reliable. The zone sensor indicates the standard unreliable value under the Analog Input grouping.

Procedure Overview

Table 22: Using VAV Applications

To Do This	Follow These Steps:
Calculate User Defined Flow Parameters for Other Non-Linear Sensors	Range the input in units of the input signal (voltage). Determine if Auto Zero will be used to zero the sensor. If so, range the analog input to read 0 when flow is zero. Determine the Supply AZ Offset by subtracting 0.005 from the sensor offset voltage. Create a spreadsheet with two columns. Enter the analog input voltage in the left column and the required readout values in the right column. From the sensor manufacturer or test data, determine 12 or more points on the curve. When you have a sufficient number of data points, select the two columns and using Excel Chart Wizard, create an X-Y plot. Open the chart and select the points plotted. From the Insert menu, select Trendline. From the options that display, select the polynomial function and choose an order of 6. Mark the options which place the function and R^2 (correlation coefficient) on the chart. Click OK. Build the controller configuration. If the polynomial function result is in units of velocity, set Use Supply Area to Yes (State 1). Test the results in a controller with a real sensor in operating conditions against a reference measuring instrument of known accuracy.
Create a VAV Single Duct Application	From the File menu, select New. Select Application Group > VAV Applications. Select Application > Single Duct. Answer the questions as they are presented.
Create a VAV Dual Duct Application	From the File menu, select New. Select Application Group > VAV Applications. Select Application > Dual Duct. Answer the questions as they are presented.

Detailed Procedures

Calculating User Defined Flow Parameters for Other Non-Linear Sensors

Note: The following discussion reference functions of Microsoft® Excel Version 5.0 or later.

To calculate user defined flow parameters for other non-linear sensors:

1. Because the linearization is accomplished with process code, rather than within the analog input, range the input in units of the input signal which will generally be voltage. Determine if Auto Zero will be used to zero the sensor, which is recommended. If so, range the analog input to read 0 when flow is zero. For example, if the sensor output voltage range is 0.7 to 5.0 VDC for 0 to 4100 fpm, the AI could be ranged as follows:
    - Input Low = 0.7, Output Low = 0.0
    - Input High = 5.0, Output High = 4.3
    - Units = VDC (sensor voltage relative to the Input Low)
2. Determine the Supply AZ Offset by subtracting 0.005 from the sensor offset voltage.

    $$\text{Supply AZ Offset} = 0.7 - 0.005$$
    $$\text{Supply AZ Offset} = 0.695$$

3. Create a spreadsheet with two columns. Enter the analog input voltage in the left column and the required readout values (in units of fpm in this example) in the right column.
4. From the sensor manufacturer or test data, determine 12 or more points on the curve. Better results will be obtained with 20 to 30 points. For sensor curves having more than one knee, a greater number of points will be required. Select more points on the knee of the curve, and fewer points on the more linear portions. If the manufacturer did not supply a graph, plot the results so that you can see the knees.
5. When you have a sufficient number of data points, select the two columns and using Excel Chart Wizard, create an X-Y plot. Make sure that the first column is on the chart's X axis.
6. Open the chart and select the points plotted.

7. From the Insert menu, select Trendline. In Excel, this will cause options to be displayed. Select the polynomial function and choose an order of 6, which usually gives the best fit. Also, mark the options which place the function and R^2 (correlation coefficient) on the chart. Click on the OK button and the Trendline, polynomial function and R^2 value should be added to the plot.
8. The correlation coefficient is an indication of how well the function fits your data, a value of 1 indicates a perfect fit. However, if you did not provide enough data points, you may get a good R^2 value but not a function that accurately linearizes the sensor. To test this, find a few additional points on the curve and apply the function and compare the results.
9. Build the controller configuration. Normally square root extraction will not be required so the Flow Coefficient should be set to 0.0 and there will be no airflow pickup gain so the Supply Multiplier should be set to 1.0. Set the Supply Box Area to accurately reflect the duct are at the measuring point. If the polynomial function result is in units of velocity, set Use Supply Area to Yes (State 1).
10. Test the results in a controller with a real sensor in operating conditions against a reference measuring instrument of known accuracy.

Creating a VAV Single Duct Application

To create a VAV single duct application:

1. From the File menu, select New.
2. Select Application Group > VAV Applications.
3. Select Application > Single Duct.
4. Answer the questions as they are presented. The sequence of questions and answers is shown in Figure 25. See the *Key Concepts* section for more information on individual options within the question/answer path.

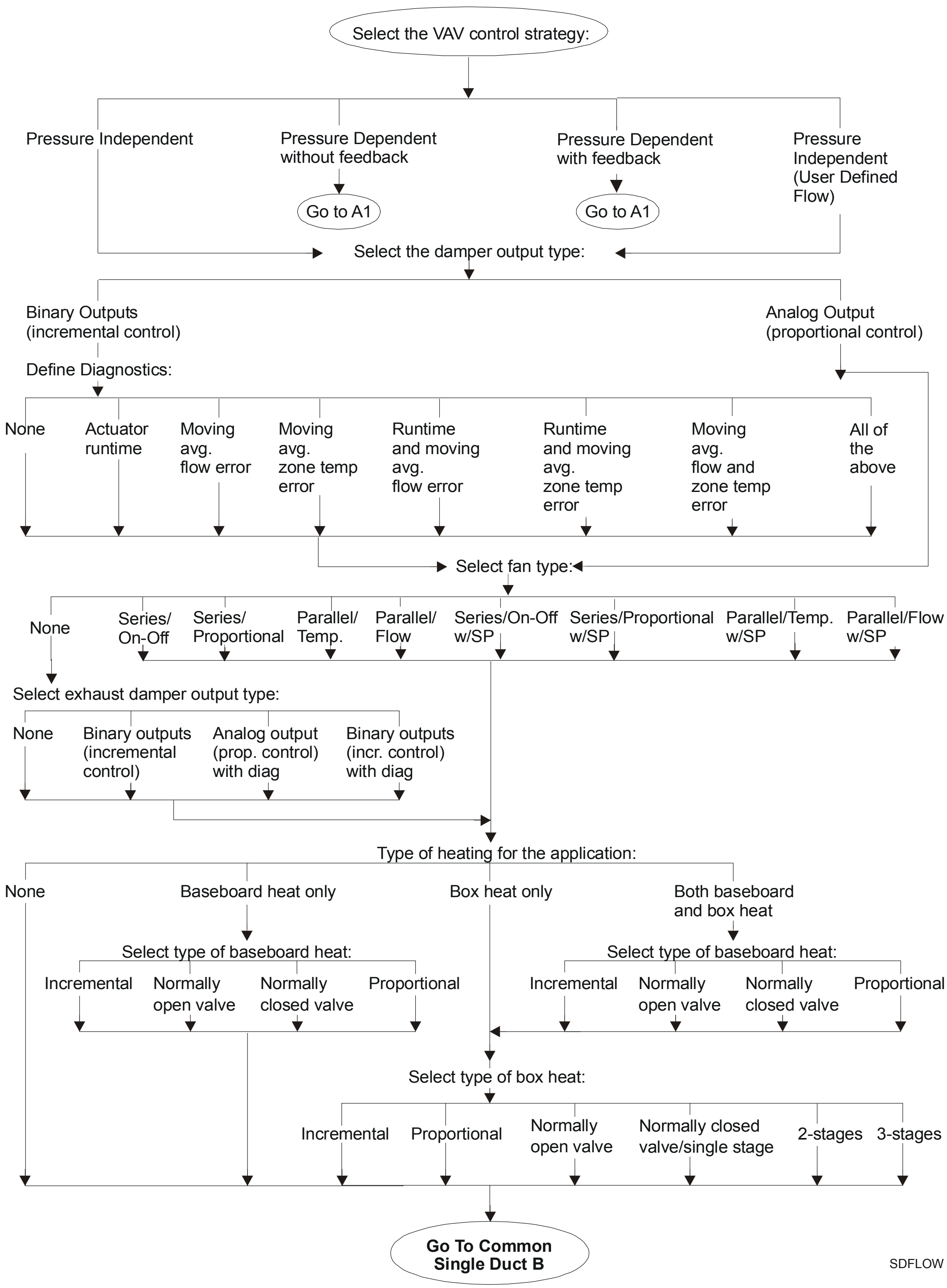

Figure 25: Single Duct Configuration Flowchart (Part I)

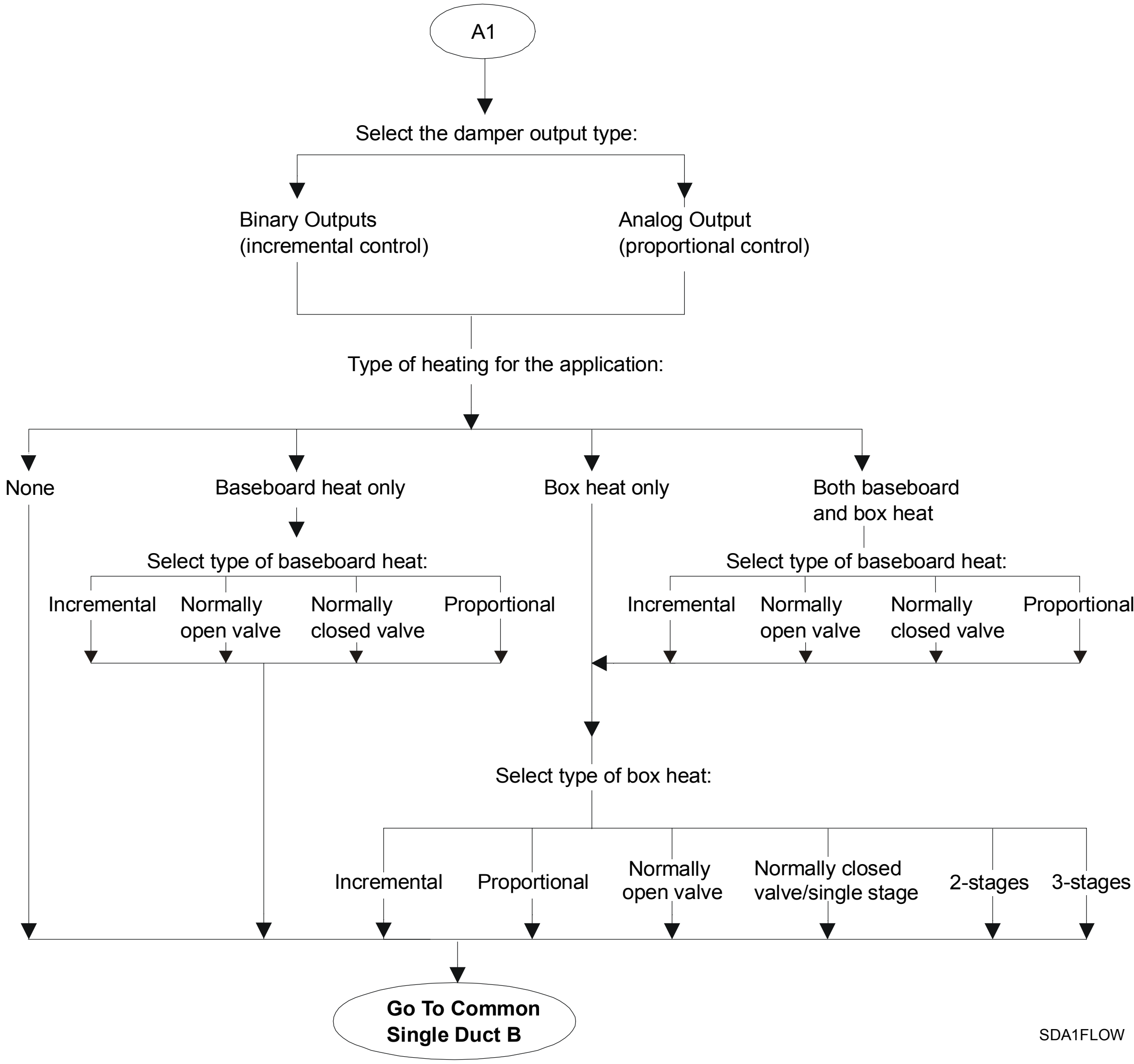

Figure 26: Single Duct Configuration Flowchart (Part II)

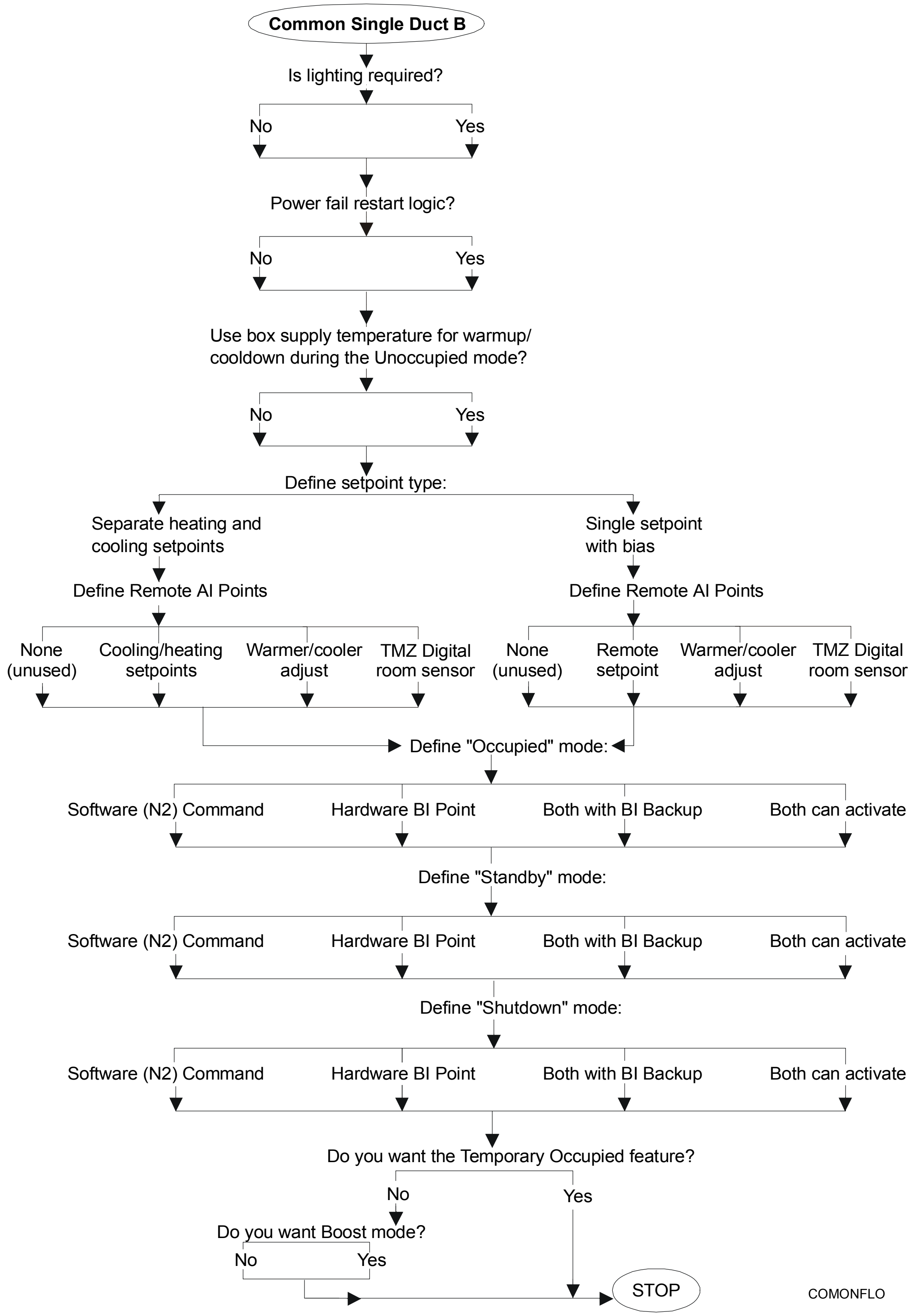

Figure 27: Single Duct Configuration Flowchart (Part III)

Creating a VAV Dual Duct Application

To create a VAV dual duct application:

1. From the File menu, select New.
2. Select Application Group > VAV Applications.
3. Select Application > Dual Duct.
4. Answer the questions as they are presented. The sequence of questions and answers is shown in Figure 28. See the *Key Concepts* section for more information on individual options within the question/answer path.

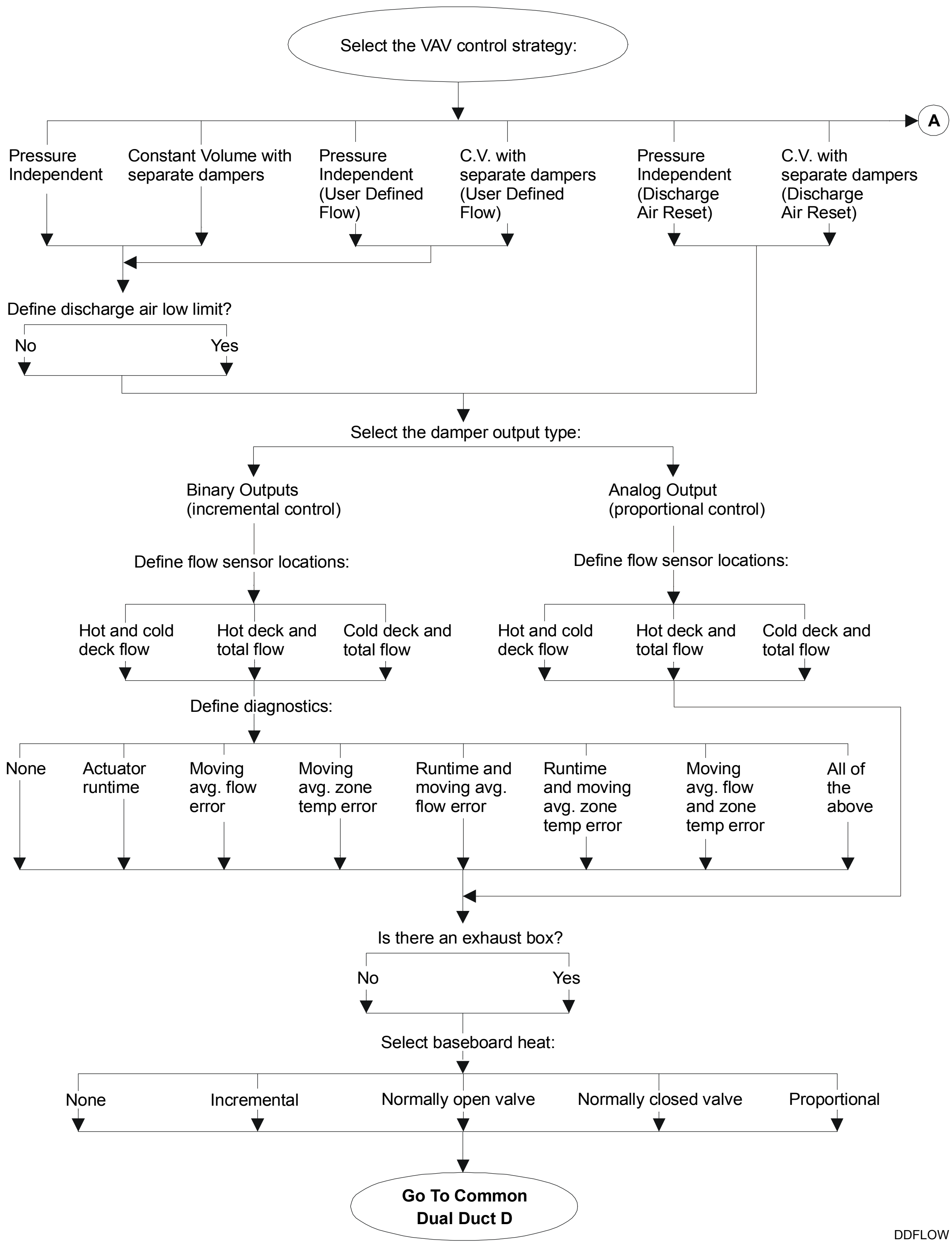

Figure 28: Dual Duct Configuration Flowchart (Part I)

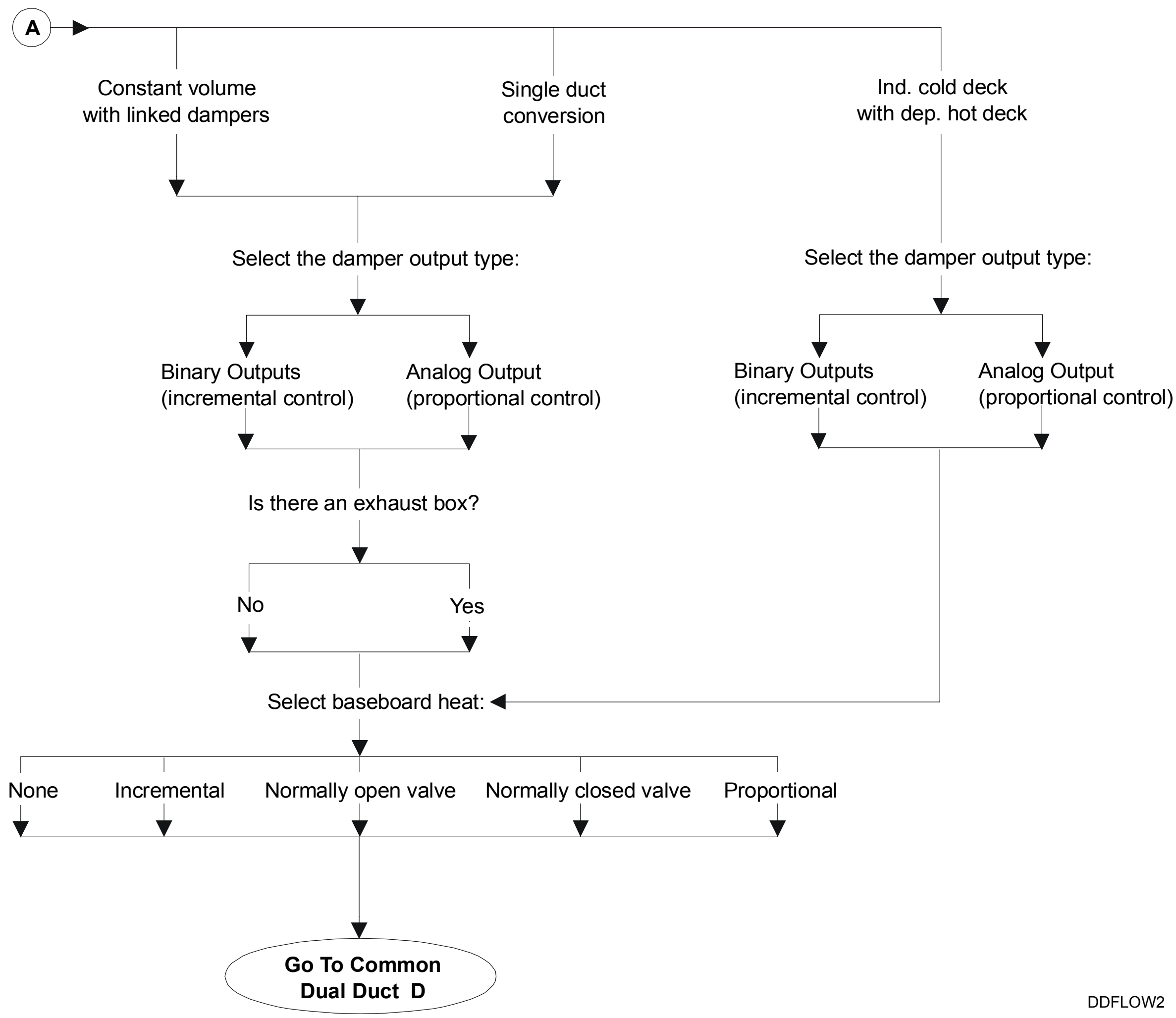

Figure 29: Dual Duct Configuration Flowchart (Part II)

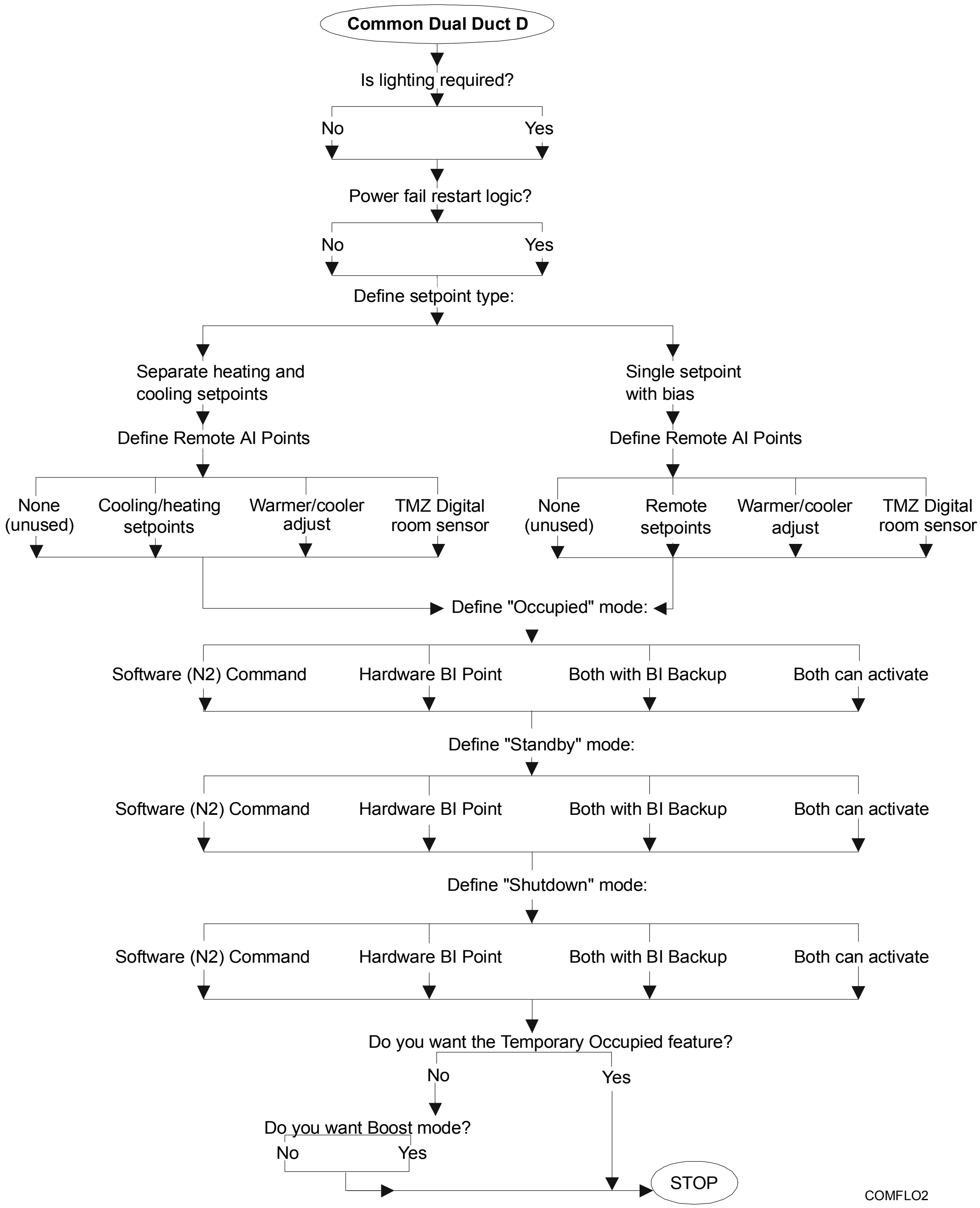

Figure 30: Dual Duct Configuration Flowchart (Part III)

Troubleshooting

The following are descriptions of known problems and their solutions.

Table 23: Troubleshooting VAV Controllers

Error/Condition	Problem	Solution
Second Occupancy Heating (Occ Htg) Setpoint When Using HVAC PRO Release 7.02	When building certain applications with HVAC PRO Release 7.02, a second (nuisance) Occ Htg Setpoint is loaded in the HVAC PRO parameters window. This only occurs when a user selects Separate Heating and Cooling Setpoints and answers the Remote Setpoint question with any of the following: • None • Cooling/Heating setpoints • Warmer/Cooler adjust This applies to any VAV Single Duct application or any of the following VAV Dual Duct applications: • pressure independent • constant volume with separate dampers • constant volume with linked dampers • single duct conversion • independent cold deck • dependent hot deck pressure independent (user defined flow) • constant volume with separate dampers (user defined flow)	Workarounds (use either): • When configuring or commissioning a VAV box with HVAC PRO, only adjust the top Occ Htg Setpoint. The second one in the list has no effect. • The corrected database files VAVHDWMD.DBF and VAVHDWMD.NDX are available on The Advisor. Replace the existing files in the C:\Winpro\Data directory. Upgrade the affected controllers. Note the application revision does not change. Permanent Solution: 1. Install HVAC PRO Release 7.03. 2. Upgrade the affected controllers. Note the application revision does not change.

Point Assignments and Parameters

Single Duct Default Point Assignments Summary

Table 24 shows the HVAC PRO default hardware point assignments and options for single duct configurations.

Table 24: Single Duct Default Point Assignments

Point Type	Point Index	Point Name	Description
Analog Inputs	AI 1	Zone Temp	Zone Temperature sensor--measured value
	AI 2	Cooling Setpoint	Cooling Setpoint potentiometer
		Warm/Cool Adjust	Warm/Cooling Adjust potentiometer
	AI 3	Heating Setpoint	Heating Setpoint potentiometer
	AI 4	Supply Delta P	Pressure Differential for Supply Flow calculation in Pressure Independent
		Actuator Pos	Actuator feedback in Pressure Dependent with Feedback
	AI 5	Exhaust Delta P	Pressure Differential for Exhaust Flow calculation
		Fan Delta P	Pressure Differential for Fan Flow calculation
	AI 6	Box Supply Temp	Box Supply Temperature Sensor for standalone Warmup in Pressure Dependent with Feedback and in Pressure Independent
Binary Inputs	BI 1	Occupied	Occupied/Unoccupied mode selection
	BI 2	Standby	Standby command
	BI 3	Shutdn Box Open	Shutdown mode with Box Open command
	BI 4	Shutdn Box Close	Shutdown mode with Box Close command
Analog Outputs	AO 1	Damper Command	Supply Flow Damper control
		Exhaust Command	Exhaust Damper control
	AO 1	Series Fan	Series Fan control
	AO 2	Box Heat	Box Heat control
Binary Outputs	BO 1	Lights On	Momentary output for lighting
	BO-2	Lights Off or BO-5, -6	Momentary output for lighting
	BO 1	Damper Open	Incremental control for Supply Flow Damper
	BO 2	Damper Close	Incremental control for Supply Flow Damper
	BO 3	Series Fan	On/Off control for Series Fan
		Parallel Fan	On/Off control for Parallel Fan
		Exhaust Open	Incremental control for Exhaust Damper
	BO 4	Exhaust Close	Incremental control for Exhaust Damper
		Baseboard Heat	On/Off control with Normally Open Valve
		Baseboard Heat	On/Off control with Normally Close Valve
		Htg Stage 1	3-Staged sequencing of Box Heat - Stage 1
	BO 5	Box Heat Open	Incremental control for Box Heat
		Htg Stage 1	2-Staged sequencing of Box Heat - Stage 1
		Htg Stage 2	3-Staged sequencing of Box Heat - Stage 2

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Point Type (Cont.)	Point Index	Point Name	Description
Binary Outputs (Cont.)	BO 6	Htg Stage 3	3-Staged sequencing of Box Heat - Stage 3
		Box Heat Close	Incremental control for Box Heat
		Box Heat	On/Off control with Normally Open Valve
		Box Heat	On/Off control with Normally Close Valve
		Htg Stage 2	2-Staged sequencing of Box Heat - Stage 2
	BO 7	Baseboard Open	Incremental control for Baseboard Heat
	BO 8	Baseboard Close	Incremental control for Baseboard Heat

Table 25: Single Duct Default Parameter Assignment and Related Features

Group	Parameters	Point Location	Default Value	Pressure Independent	Pressure Dependent w/ Feedback	Pressure Dependent w/o Feedback
Analog Input Configuration						
	Supply AZ Offset	ADF-190	-0.005	User Defined Flow		
	Supply Flow Coef.	ADF-213	4005	UDF		
	Supply Ranging L0	ADF-212	0.0	UDF		
	Supply Ranging L1	ADF-214	1.0	UDF		
	Supply Ranging L2	ADF-215	0.0	UDF		
	Supply Ranging L3	ADF-216	0.0	UDF		
	Supply Ranging L4	ADF-217	0.0	UDF		
	Supply Ranging L5	ADF-218	0.0	UDF		
	Supply Ranging L6	ADF-219	0.0	UDF		
	Use Supply Area	BDF-240	1 = Yes	UDF		
	Exhaust AZ Offset	ADF-191	-0.005	UDF		
	Exhaust Flow Coef.	ADF-220	4005	UDF		
	Exhaust Ranging L1	ADF-221	0.0	UDF		
	Exhaust Ranging L0	ADF-211	1.0	UDF		
	Exhaust Ranging L2	ADF-222	0.0	UDF		
	Exhaust Ranging L3	ADF-223	0.0	UDF		
	Exhaust Ranging L4	ADF-224	0.0	UDF		
	Exhaust Ranging L5	ADF-225	0.0	UDF		
	Exhaust Ranging L6	ADF-226	0.0	UDF		
	Use Exhaust Area	BDF-241	1 = Yes	UDF		
	Fan AZ Offset	ADF-191	-0.005	UDF		
	Fan Flow Coef.	ADF-220	4005	UDF		
	Fan Ranging L0	ADF-211	0.0	UDF		
	Fan Ranging L1	ADF-221	1.0	UDF		
	Fan Ranging L2	ADF-222	0.0	UDF		
	Fan Ranging L3	ADF-223	0.0	UDF		

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Group (Cont.)	Parameters	Point Location	Default Value	Pressure Independent	Pressure Dependent w/ Feedback	Pressure Dependent w/o Feedback
Analog Input Configuration (Cont.)						
	Fan Ranging L4	ADF-224	0.0	UDF		
	Fan Ranging L5	ADF-225	0.0	UDF		
	Fan Ranging L6	ADF-226	0.0	UDF		
	Use Fan Area	BDF-242	1 = Yes	UDF		
Auto Zero Configuration						
	Auto Zero Cmd	BD 226	0 (Off)	Used		
	Auto Zero Duration	ADF 188	6.5 Minutes	Used		
	Auto Zero Enable	BD 232	1 Enable	Used		
	Auto Zero Start Time	ID 227	00:00	Used		
	Auto Zero Status	BD 18	0 (Off)	Used		
	Auto Zero Stop Time	ID 228	00:00	Used		
Basebd Inc Valve						
	Basebd Command	AO 6	0.0%	Incremental Baseboard Heat	Incremental Baseboard Heat	Incremental Baseboard Heat
	Basebd Deadband	ADF 170	5.0%	Incremental Baseboard Heat	Incremental Baseboard Heat	Incremental Baseboard Heat
	Basebd Stroke Time	ADF 171	1.500 Minute	Incremental Baseboard Heat	Incremental Baseboard Heat	Incremental Baseboard Heat
Box Heat						
	Box Heat On Setpt	ADF 200	1% Htg	Box Heat, N.O., N.C., 1-Stage	Box Heat, N.O., N.C., 1-Stage	Box Heat, N.O., N.C., 1-Stage
	Box Ht Delay Time	ADF 201	1 Minute			Box Heat, N.O., N.C., 1- to 3-Stage
Box Heat Inc Valve						
	Box Ht Command	AO 7	0.0%	Incremental Box Heat	Incremental Box Heat	Incremental Box Heat
	Box Ht Deadband	ADF 172	5.0%	Incremental Box Heat	Incremental Box Heat	Incremental Box Heat
	Box Ht Stroke Time	ADF 173	1.50 Minute	Incremental Box Heat	Incremental Box Heat	Incremental Box Heat
Damper Control						
	Damper Command	AO 8	0.0%		Incremental Damper	Incremental Damper
	Damper Deadband	ADF 142	2.0%		Incremental Damper	Incremental Damper
	Minimum Pos	ADF 140	10.0%			Used

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Group (Cont.)	Parameters	Point Location	Default Value	Pressure Independent	Pressure Dependent w/ Feedback	Pressure Dependent w/o Feedback
Exh Box Configuration						
	Exh Damper Deadband	ADF 24	1.25%	Exhaust /w Incremental Damper		
	Exh Stroke Time	ADF 164	2.0 Minute	Exhaust /w Incremental Damper		
	Exhaust Box Area	ADF 166	0.35 sq ft	Exhaust		
	Exhaust Mult	ADF 167	2.25	Exhaust		
	Exhaust Velocity	ADF-27	Calculated	UDF		
Exhaust Box Setpoints						
	Unocc Exhaust Diff	ADF 169	200.0 cfm	Exhaust		
Exhaust Damper Control						
	Exhaust Command	AO 3	0.0%	Exhaust /w Incremental Damper		
	Exhaust Deadband	ADF 165	50.0 cfm	Exhaust		
	Exhaust Flow	ADF 17	0.0 cfm	Exhaust		
	Exhaust Integ Time	ADF 187	16.0	Exhaust		
	Exhaust Override	BD 235	0.0 (Disable)	Exhaust		
	Exhaust Prop Band	ADF 185	-800.0 cfm	Exhaust		
	Exhaust Setpt	ADF 235	0.0 cfm	Exhaust		
	Exhaust Setpt AO	AO 5	0.0 cfm	Exhaust		
Fan Configuration						
	Fan Velocity	ADF-27	Calculated	UDF		
Modes						
	Boost Ovrd Time	ADF 175	30.0 Minute	Boost Mode	Boost Mode	Boost Mode
	Boost Status	BD 15	0 (Off)	Boost Mode	Boost Mode	Boost Mode
	Occ Ovrd Time	ADF 174	30.0 Minute	Temporary Occupied Mode	Temporary Occupied Mode	Temporary Occupied Mode
	Occ Start Time	ADI 225	00:00 Hr:Mn	Occupied Mode	Occupied Mode	Occupied Mode
	Occ Stop Time	ADI 226	00:00 Hr:Mn	Occupied Mode	Occupied Mode	Occupied Mode
	Occupied Command	BD 227	1 (On)	Occupied Mode	Occupied Mode	Occupied Mode
	Occupied Status	BD 22	0 (Unocc)	Always	Always	Always
	Restart Delay	ADF184	1.0 Minute	Power Fail Restart	Power Fail Restart	Power Fail Restart

Continued on next page . . .

Group (Cont.)	Parameters	Point Location	Default Value	Pressure Independent	Pressure Dependent w/ Feedback	Pressure Dependent w/o Feedback
Modes (Cont.)						
	Restart Status	BD 21	0 (Off)	Power Fail Restart	Power Fail Restart	Power Fail Restart
	Shutdn Box Close Command	BD 230	0 (Off)	Shutdown	Shutdown	Shutdown
	Shutdn Box Open Command	BD 229	0 (Off)	Shutdown	Shutdown	Shutdown
	Shutdown Status	BD 23	0 (Off)	Shutdown	Shutdown	Shutdown
	Standby Command	BD 228	0 (Off)	Standby Mode	Standby Mode	Standby Mode
	Starved Box	BD 16	0 (No)	Always	Always	Always
	Summer/Winter	BD 231	0 (Summer)			Used
	Temp Occ Status	BD 14	0 (Off)	Temporary Occupied Mode	Temporary Occupied Mode	Temporary Occupied Mode
	Warmup Command	BD 225	0 (Off)	Always	Always	Always
	Warmup Status	BD 17	0 (Off)	Warmup	Warmup	Warmup
Occupied Damper Setpts						
	Occ Bsbd Min	ADF 147	100.0 cfm	Baseboard Heat, Both Heat		
	Occ Bsbd Min	ADF 147	20.0%		Baseboard Heat, Both Heat	
	Occ Clg Max	ADF 144	90.0%		Used	
	Occ Clg Max	ADF 144	500.0 cfm	Used		
	Occ Clg Min	ADF 143	20.0%		Used	
	Occ Clg Min	ADF 143	100.0 cfm	Used		
	Occ Htg Max	ADF 146	20.0%		Box Heat, Both Heat	
	Occ Htg Max	ADF 146	100.0 cfm	Box Heat, Both Heat		
	Occ Htg Min	ADF 145	20.0%		Box Heat, Both Heat	
	Occ Htg Min	ADF 145	100.0 cfm	Box Heat, Both Heat		
Parallel Fan / Flow						
	Parallel Fan Flow	ADF 163	0.0 cfm	Parallel Fan Flow		

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Group (Cont.)	Parameters	Point Location	Default Value	Pressure Independent	Pressure Dependent w/ Feedback	Pressure Dependent w/o Feedback
Parallel Fan / Temp						
	Fan Start Setpt	ADF 199	1% Htg	Parallel Fan Temp, Parallel Fan Flow, Parallel Fan Temp w/SP, Parallel Fan Flow w/SP		
	Fan Differential	ADF 198	0.0% Htg	Parallel Fan Temp w/SP, Parallel Fan Flow w/SP		
Proportional Series Fan						
	Fan Area	ADF 161	1.0 sq ft	Proportional Series Fan		
	Fan Flow	ADF 16	0.0 cfm	Proportional Series Fan		
	Fan Flow Mult	ADF 162	1.0	Proportional Series Fan		
	Fan Speed %	ADF 160	75.0%	Proportional Series Fan		
Series Fan						
	Series Fan Setpt	ADF 199	1% Htg	Series Fan / On-Off w/SP, Series Fan / Proportional w/SP		
	Series Fan Differential	ADF 198	0.0% Htg	Series Fan / On-Off w/SP, Series Fan / Proportional w/SP		
Staged Heat						
	Box Ht Command	AO 7	0.0%	Staged Box Heat	Staged Box Heat	Staged Box Heat
	Heat Stage 1 Percent	ADI 234	5%	Staged Box Heat	Staged Box Heat	Staged Box Heat
	Number of Heat Stages	BD 233	2	2-Staged Box Heat	2-Staged Box Heat	2-Staged Box Heat
	Number of Heat Stages	BD 233	3	3-Staged Box Heat	3-Staged Box Heat	3-Staged Box Heat
Supply Box Configuration						
	Damper Deadband	ADF 22	1.25%	Incremental Damper		
	Dmp Stroke Time	ADF 141	2.0 Minute	Incremental Damper		Incremental Damper
	Supply Box Area	ADF 158	0.35 sq ft	Used		
	Supply Mult	ADF 159	2.25	Used		
	Supply Velocity	ADF-26	Calculated	UDF		

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Group (Cont.)	Parameters	Point Location	Default Value	Pressure Independent	Pressure Dependent w/ Feedback	Pressure Dependent w/o Feedback
Supply Damper Control						
	cfm INTEG TERM	ADF 36	0.0 cfm	Used		
	DAMPER CMD	ADF 37	0.0 cfm			
	Damper Command	AO 4	0.0%	Incremental Damper		
	Damper Position	ADF 35	0.0%	Used		
	Supply Deadband	ADF 142	50.0 cfm	Used		
	Supply Flow	ADF 15	0.0 cfm	Used		
	Supply Integ Time	ADF 182	16.0	Used		
	Supply Override	BD 236	0.0 (Disable)	Used		
	Supply Prop Band	ADF 180	-1600.0 cfm	Used		
	Supply Setpt	ADF 236	0.0 cfm	Used		
	Supply Setpt	ADF 25	0.0 cfm			
	Supply Setpt AO	AO 8	0.0 cfm	Used		
TMZ Setpoint Range						
	Low Setpoint Limit	ADF 127	65°F	Applicable only if configured with TMZ Digital Room Sensor.	Applicable only if configured with TMZ Digital Room Sensor.	Applicable only if configured with TMZ Digital Room Sensor.
	High Setpoint Limit	ADF 128	78°F	Applicable only if configured with TMZ Digital Room Sensor.	Applicable only if configured with TMZ Digital Room Sensor.	Applicable only if configured with TMZ Digital Room Sensor.
Unocc Damper Setpts						
	Unocc Bsbd Min	ADF 152	0.0 cfm	Baseboard Heat, Both Heat		
	Unocc Bsbd Min	ADF 152	0.0%		Baseboard Heat, Both Heat	
	Unocc Clg Max	ADF 149	50.0%		Used	
	Unocc Clg Max	ADF 149	400.0 cfm	Used		
	Unocc Clg Min	ADF 148	0.0 cfm	Used		
	Unocc Clg Min	ADF 148	20.0%		Used	
	Unocc Htg Max	ADF 151	20.0%		Box Heat, Both Heat	
	Unocc Htg Max	ADF 151	100.0 cfm	Box Heat, Both Heat		
	Unocc Htg Min	ADF 150	20.0%		Box Heat, Both Heat	

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Group (Cont.)	Parameters	Point Location	Default Value	Pressure Independent	Pressure Dependent w/ Feedback	Pressure Dependent w/o Feedback
Unocc Damper Setpts (Cont.)						
	Unocc Htg Min	ADF 150	100.0 cfm	Box Heat, Both Heat		
VAV Box Diagnostics						
	Actuator Runtime	ADF 31	0.0 Hours	Actuator Runtime Diag.		
	Average Flow Error	ADF 33	0.0	Average Flow Error Diag.		
	Average Temp Error	ADF 32	0.0	Average Temp. Error Diag.		
	Controller Runtime	ADF 30	0.0 Hours	Actuator Runtime Diag.		
	Flow Filter Value	ADF 244	1200 Ticks	Moving Avg Flow Error		
	Zone Temp Filter Value	ADF 243	9600 Ticks	Moving Avg Zone Temp Error		
Warmup Damper Setpts						
	Warmup Bsbd Min	ADF 157	100.0 cfm	Baseboard Heat, Both Heat		
	Warmup Bsbd Min	ADF 157	20.0%		Baseboard Heat, Both Heat	
	Warmup Clg Max	ADF 154	100.0 cfm	Used		
	Warmup Clg Max	ADF 154	20.0%		Used	
	Warmup Clg Min	ADF 153	100.0 cfm	Used		
	Warmup Clg Min	ADF 153	20.0%		Used	
	Warmup Htg Max	ADF 156	90.0%		Box Heat, Both Heat	
	Warmup Htg Max	ADF 156	500.0 cfm	Box Heat, Both Heat		
	Warmup Htg Min	ADF 155	20.0%		Box Heat, Both Heat	
	Warmup Htg Min	ADF 155	100.0 cfm	Box Heat, Both Heat		
Water System Maintenance						
	Flush Position	ADF 239	100% Open	Baseboard or Box Heat, Incr., Prop, N.C., N.O.	Baseboard or Box Heat, Incr., Prop, N.C., N.O.	Baseboard or Box Heat, Incr., Prop, N.C., N.O.

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Group (Cont.)	Parameters	Point Location	Default Value	Pressure Independent	Pressure Dependent w/ Feedback	Pressure Dependent w/o Feedback
Water System Maintenance (Cont.)						
	Water Flush	BD 239	0 Disable	Baseboard or Box Heat, Incr., Prop, N.C., N.O.	Baseboard or Box Heat, Incr., Prop, N.C., N.O.	Baseboard or Box Heat, Incr., Prop, N.C., N.O.
Zone Cooling Setpoints						
	Actual Clg Setpt	ADF 21	0.0°F	Always	Always	Always
	CLG INTEG TERM	ADF 42	0.0%	Used		
	Clg Integ Time	ADF 133	1000.0	Always	Always	Always
	Clg Prop Band	ADF 132	10.0°F	Always	Always	Always
	COOLING PROP CMD	ADF 38	0.0%	Used		
	Occ Clg Setpt	ADF 129	72.0°F	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts
	Stby Clg Setpt	ADF 130	74.0°F	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts
	Unocc Clg Setpt	ADF 131	80.0°F	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts
Zone Heating Setpoints						
	Actual Htg Setpt	ADF 20	0.0°F	Always	Always	Always
	Basebd Prop Band	ADF 137	-10.0°F	Baseboard Heat, Both Heat	Baseboard Heat, Both Heat	Baseboard Heat, Both Heat
	Basebd Prop Band	ADF 177	0.0°F	No Heat, Box Heat	No Heat, Box Heat	No Heat, Box Heat
	BASEBD PROP CMD	ADF 40	0.0%	Baseboard Heat	Baseboard Heat	Baseboard Heat
	Box Ht Prop Band	ADF 138	-10.0°F	Baseboard Heat, Box Heat, Both Heat, Warmup	Baseboard Heat, Box Heat, Both Heat, Warmup	Baseboard Heat, Box Heat, Both Heat, Warmup, Winter
	Box Ht Prop Band	ADF 138	-2.0°F	No Heat, Warmup	No Heat, Warmup	No Heat, Warmup
	HEATING PROP CMD	ADF 39	0.0%	Used	Used	Used
	HTG INTEG TERM	ADF 41	0.0%	Used	Used	Used

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Group (Cont.)	Parameters	Point Location	Default Value	Pressure Independent	Pressure Dependent w/ Feedback	Pressure Dependent w/o Feedback
Zone Heating Setpoints (Cont.)						
	Htg Integ Time	ADF 139	1000.0	Baseboard Heat, Box Heat, and Both Heat	Baseboard Heat, Box Heat, and Both Heat	Baseboard Heat, Box Heat, and Both Heat
	Htg Integ Time	ADF 178	0.0	No Heat	No Heat	No Heat
	Occ Htg Setpt	ADF 134	68.0°F	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts
	Stby Htg Setpt	ADF 135	66.0°F	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts
	Unocc Htg Setpt	ADF 136	62.0°F	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts
Zone Setpoints						
	Occ Bias	ADF 134	2°F	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt
	Occ Setpt	ADF 129	70°F	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt
	Stby Bias	ADF 135	4°F	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt
	Stby Setpt	ADF 130	70°F	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt
	Unocc Bias	ADF 136	9°F	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt
	Unocc Setpt	ADF 131	71°F	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt

Dual Duct Default Point Assignments Summary

Table 26 shows the HVAC PRO hardware point assignments and options for dual duct configurations.

Table 26: Default Dual Duct I/O Assignments

Point Type	Point Index	Point Name	Description
Analog Inputs	AI 1	Zone Temp	Zone Temperature sensor - measured value
	AI 2	Cooling Setpoint	Cooling Setpoint potentiometer
		Warm/Cool Adjust	Warm/Cooling Adjust potentiometer
	AI 3	Heating Setpoint	Heating Setpoint potentiometer
	AI 4	Vol Dmp Delta P	Pressure Differential for total Air Flow calculation in Constant Volume
		Supply Delta P	Pressure Differential for Supply Air Flow calculation in Single Duct Conversion
		Cold Dk Delta P	Pressure Differential for Cold Deck Air Flow calculation in Pressure Independent
		Total Dk Delta P	Pressure Differential for Total Air Flow
	AI 5	Hot Dk Delta P	Pressure Differential for Hot Deck Air Flow calculation in Pressure Independent
	AI 6	Exhaust Delta P	Pressure Differential for Exhaust Flow calculation
		Dis Air Temp	Discharge Air Temperature sensor
Binary Inputs	BI 1	Occupied	Occupied/Unoccupied mode selection
	BI 2	Standby	Standby command
	BI 3	Shutdn Box Open	Shutdown mode with Box Open command
	BI 4	Shutdn Box Close	Shutdown mode with Box Close command
Analog Outputs	AO *	Cold Dk Damper Cmd	Cold Deck Damper control in Pressure Independent and Constant Volume Separate Dampers System
		Hot Dk Damper Cmd	Hot Deck Damper control in Pressure Independent and Constant Volume Separate Dampers System
		Vol Dmp Damper Cmd	Control for Damper controlling the total Air Flow in Constant Volume Linked Dampers System
		Zone Tmp Dmp Cmd	Linked Damper control in Constant Volume Linked Dampers System
		Damper Command	Damper control in Single Duct Conversion
		Exhaust Command	Exhaust Damper control

* A point index of zero causes HVAC PRO to assign the first available point.

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Point Type (Cont.)	Point Index	Point Name	Description
Binary Outputs	BO 0	Lights On	Momentary output for lighting
		Lights Off	Momentary output for lighting
	BO 1	Cold Dk Open	Incremental control for Cold Deck Damper in Pressure Independent and Constant Volume Separate Dampers System
		Damper Open	Incremental control for Damper in Single Duct Conversion
		Zn Tmp Dmp Open	Incremental control for Linked Dampers in Constant Volume Linked Dampers System
	BO 2	Cold Dk Close	Incremental control for Cold Deck Damper in Pressure Independent and Constant Volume Separate Dampers System
		Damper Close	Incremental control for Damper in Single Duct Conversion
		Zone Dmp Close	Incremental control for Linked Dampers in Constant Volume Linked Dampers System
	BO 3	Ht/Cl Changeover	Changeover control from heating to cooling and vice versa in Single Duct Conversion
		Hot Dk Open	Incremental control for Hot Deck Damper in Pressure Independent and Constant Volume Separate Dampers System
		Vol Dmp Open	Incremental control for Damper controlling the total Air Flow in Constant Volume Linked Dampers System
	BO 4	Hot Dk Close	Incremental control for Hot Deck Damper in Pressure Independent and Constant Volume Separate Dampers System
		Vol Dmp Close	Incremental control for Damper controlling the total Air Flow in Constant Volume Linked Dampers System
	BO 5	Exhaust Open	Incremental control for Exhaust Damper
	BO 6	Exhaust Close	Incremental control for Exhaust Damper
	BO 7	Basebd Open	Incremental control for Baseboard Heat
		Basebd Heat	On/Off control with Normally Open Valve
		Basebd Heat	On/Off control with Normally Close Valve
	BO 8	Basebd Close	Incremental control for Baseboard Heat

Note: In the above table (Table 26), the Point Names are repeated for different features due to the default assignments by HVAC PRO and based on the Question and Answer session. If the default location for a given feature is used by another feature, then HVAC PRO tries to assign the next available location for the given feature. If the default location for a given feature is zero, then HVAC PRO assigns the first unused location for the feature. A user can move the point locations to avoid the `No Target Device` warning. Please refer to the *HVAC PRO User's Manual* for a more detailed description of moving point locations.

Table 27: Default Dual Duct Parameter Assignments

Group	Para- meter	Point Location	Default Value	Pressure Indep	Constant Volume - Separate Dampers	Constant Volume - Linked Dampers	Single Duct Conver- sion	Indep Cold Deck w/ Dependent Hot Deck
Analog Input Config.								
	Hot Dk AZ Offset	ADF 209	-0.005	User Defined Flow	User Defined Flow			
	Hot Dk Flow Coef.	ADF 213	4005	UDF	UDF			
	HD Ranging L0	ADF 211	0.0	UDF	UDF			
	HD Ranging L1	ADF 214	1.0	UDF	UDF			
	HD Ranging L2	ADF 215	0.0	UDF	UDF			
	HD Ranging L3	ADF 216	0.0	UDF	UDF			
	HD Ranging L4	ADF 217	0.0	UDF	UDF			
	HD Ranging L5	ADF 218	0.0	UDF	UDF			
	HD Ranging L6	ADF 219	0.0	UDF	UDF			
	Use HD Area	BDF 233	1 = No	UDF	UDF			
	Cold Dk AZ Offset	ADF 234	-0.005	UDF	UDF			
	Cold Dk Flow Coef.	ADF 220	4005	UDF	UDF			
	CD Ranging L0	ADF 212	0.0	UDF	UDF			
	CD Ranging L1	ADF 221	1.0	UDF	UDF			
	CD Ranging L2	ADF 222	0.0	UDF	UDF			
	CD Ranging L3	ADF 223	0.0	UDF	UDF			
	CD Ranging L4	ADF 224	0.0	UDF	UDF			
	CD Ranging L5	ADF 225	0.0	UDF	UDF			
	CD Ranging L6	ADF 226	0.0	UDF	UDF			
	Use CD Area	BDF 234	1 = No	UDF	UDF			

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Group (Cont.)	Para-meter	Point Location	Default Value	Pressure Indep	Constant Volume - Separate Dampers	Constant Volume - Linked Dampers	Single Duct Conver-sion	Indep Cold Deck w/ Dependent Hot Deck
Analog Input Config. (Cont.)								
	Total Dk AZ Offset	ADF 235	-0.005	UDF	UDF			
	Total Dk Flow Coef.	ADF 213	4005	UDF	UDF			
	Total Ranging L0	ADF 211	0.0	UDF	UDF			
	Total Ranging L1	ADF 214	1.0	UDF	UDF			
	Total Ranging L2	ADF 215	0.0	UDF	UDF			
	Total Ranging L3	ADF 216	0.0	UDF	UDF			
	Total Ranging L4	ADF 217	0.0	UDF	UDF			
	Total Ranging L5	ADF 218	0.0	UDF	UDF			
	Total Ranging L6	ADF 219	0.0	UDF	UDF			
	Use Total Area	BDF 233	1 = No	UDF	UDF			
	Total Dk AZ Offset	ADF 235	-0.005	UDF	UDF			
	Total Dk Flow Coef.	ADF 220	4005	UDF	UDF			
	Total Ranging L0	ADF 212	0.0	UDF	UDF			
	Total Ranging L1	ADF 221	1.0	UDF	UDF			
	Total Ranging L2	ADF 222	0.0	UDF	UDF			
	Total Ranging L3	ADF 223	0.0	UDF	UDF			
	Total Ranging L4	ADF 224	0.0	UDF	UDF			
	Total Ranging L5	ADF 225	0.0	UDF	UDF			
	Total Ranging L6	ADF 226	0.0	UDF	UDF			
	Use Total Area	BDF 234	1 = No	UDF	UDF			
	Exhaust AZ Offset	ADF 240	-0.005	UDF	UDF			

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Group (Cont.)	Para-meter	Point Location	Default Value	Pressure Indep	Constant Volume - Separate Dampers	Constant Volume - Linked Dampers	Single Duct Conver-sion	Indep Cold Deck w/ Dependent Hot Deck
Analog Input Config. (Cont.)								
	Exhaust Flow Coef.	ADF 227	4005	UDF	UDF			
	Exhaust Ranging L0	ADF 210	0.0	UDF	UDF			
	Exhaust Ranging L1	ADF 228	1.0	UDF	UDF			
	Exhaust Ranging L2	ADF 229	0.0	UDF	UDF			
	Exhaust Ranging L3	ADF 230	0.0	UDF	UDF			
	Exhaust Ranging L4	ADF 231	0.0	UDF	UDF			
	Exhaust Ranging L5	ADF 232	0.0	UDF	UDF			
	Exhaust Ranging L6	ADF 233	0.0	UDF	UDF			
	Use Exhaust Area	BDF 241	1 = No	UDF	UDF			
Auto Zero Config.								
	Auto Zero Cmd	BD 226	0 Off	Always	Always	Always	Always	Always
	Auto Zero Enable	BD 232	1 Enable	Always	Always	Always	Always	Always
	Auto Zero Start Time	ADI 227	00:00 Hr:Mn	Used	Used	Used	Used	Used
	Auto Zero Status	BD 18	0 Off	Always	Always	Always	Always	Always
	Auto Zero Stop Time	ADI 228	00:00 Hr:Mn	Used	Used	Used	Used	Used
	Auto Zero Time Duration	ADF 188	6.5 Minute	Prop Damper	Prop Damper	Prop Damper	Prop Damper	Prop Damper
Basebd Inc Valve Setpts								
	Basebd Command	AO 6	0.0%	Baseboard Heat	Baseboard Heat	Baseboard Heat	Base-board Heat	Baseboard Heat
	Basebd Deadband	ADF 170	5.0%	Baseboard Heat	Baseboard Heat	Baseboard Heat	Base-board Heat	Baseboard Heat
	Basebd Stroke Time	ADF 171	2.0 Minute	Baseboard Heat	Baseboard Heat	Baseboard Heat	Base-board Heat	Baseboard Heat

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Group (Cont.)	Para-meter	Point Location	Default Value	Pressure Indep	Constant Volume - Separate Dampers	Constant Volume - Linked Dampers	Single Duct Conver-sion	Indep Cold Deck w/ Dependent Hot Deck
Box Flow Set Pts								
	Occ Cooling Max	ADF 144	500.000 cfm	DAR				
	Occ Cooling Minimum	ADF 143	100.000 cfm	DAR				
	Occ Heating Max	ADF 177	400.000 cfm	DAR				
	Unocc Cooling Max	ADF 149	200.000 cfm	DAR				
	Unocc Cooling Minimum	ADF 180	0.000 cfm	DAR				
	Unocc Heating Max	ADF 181	100.000 cfm	DAR				
	Warmup Cooling Max	ADF 154	400.000 cfm	DAR				
	Warmup Cooling Minimum	ADF 155	100.000 cfm	DAR				
	Warmup Heating Max	ADF 156	200.000 cfm	DAR				
	Occupied Flow Setpt	ADF 143	400.000 cfm		DAR			
	Unocc Flow Setpt	ADF 144	100.000 cfm		DAR			
	Warmup Flow Setpt	ADF 149	400.000 cfm		DAR			
	Warmup Heating Minimum	ADF 210	100.000 cfm	DAR				
	Unocc Heating Minimum	ADF 211	0.000 cfm	DAR				
	Occ Heating Minimum	ADF 212	100.000 cfm	DAR				

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Group (Cont.)	Para-meter	Point Location	Default Value	Pressure Indep	Constant Volume - Separate Dampers	Constant Volume - Linked Dampers	Single Duct Conver-sion	Indep Cold Deck w/ Dependent Hot Deck
Box Minimum Set Pts								
	Occ CD Min Vent	ADF 145	0.000 cfm	DAR	DAR			
	Occ HD Min Vent	ADF 179	0.000 cfm	DAR	DAR			
	Unocc CD Min Vent	ADF 150	0.000 cfm	DAR	DAR			
	Unocc HD Min Vent	ADF 183	0.000 cfm	DAR	DAR			
	Warmup CD Min Vent	ADF 152	0.000 cfm	DAR	DAR			
	Warmup HD Min Vent	ADF 153	0.000 cfm	DAR	DAR			
Cold Deck Config.								
	Cold Dk Box Area	ADF 158	0.35 sq ft	Cold Deck Flow Sensor	Cold Deck Flow Sensor			Damper Control
	Cold Dk Damper DB	ADF 22	5.0%	Inc. Damper - Cold Deck Flow Sensor	Inc. Damper - Cold Deck Flow Sensor			Incr Damper
	Cold Dk Mult	ADF 159	2.25	Cold Deck Flow Sensor	Cold Deck Flow Sensor			Damper Control
	Cold Dk Stroke Time	ADF 141	2.0 Min	Inc. Damper - Cold Deck Flow Sensor	Inc. Damper - Cold Deck Flow Sensor			Incr Damper
	Cold Dk Velocity	ADF 27	Calculated	UDF	UDF			
Cold Deck Damper Control								
	Cold Dk Damper Cmd	AO 4	0.0%	Prop Damper	Prop Damper			Incr Damper
	Cold Dk Deadband	ADF 142	50 cfm	Damper Control	Damper Control			Damper Control
	Cold Dk Flow	ADF 15	0.0 cfm	Damper Control	Damper Control			Damper Control
	Cold Dk Integ Time	ADF 192	16	Damper Control	Damper Control			Damper Control

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Group (Cont.)	Para-meter	Point Location	Default Value	Pressure Indep	Constant Volume - Separate Dampers	Constant Volume - Linked Dampers	Single Duct Conver-sion	Indep Cold Deck w/ Dependent Hot Deck
Cold Deck Damper Control (Cont.)								
	Cold Dk Override	BD 236	0.0 Disable	Damper Control	Damper Control			Damper Control
	Cold Dk Preset	ADF 236	0.0 cfm	Damper Control	Damper Control			Damper Control
	Cold Dk Prop Band	ADF 191	-1600 cfm	Damper Control	Damper Control			Damper Control
	Cold Dk Setpt	AO 8	0.0 cfm	Damper Control	Damper Control			Damper Control
Cold Deck Flow Setpts								
	Occ CD Clg Max	ADF 144	500.0 cfm	Used				Used
	Occ CD Clg Min	ADF 143	100.0 cfm	Used				Used
	Occ CD Htg Min	ADF 145	0.0 cfm	Used				Used
	Unocc CD Clg Max	ADF 149	400.0 cfm	Used				Used
	Unocc CD Clg Min	ADF 148	100.0 cfm	Used				Used
	Unocc CD Htg Min	ADF 150	0.0 cfm	Used				Used
Constant Volume Setpts								
	Occupied Flow Setpt	ADF 143	400.0 cfm		Used	Used		
	Unoccu-pied Flow Setpt	ADF 144	200.0 cfm		Used	Used		
	Warmup Flow Setpt	ADF 145	400.0 cfm		Used	Used		
Discharge Set Points								
	Actual Disch Setpt	ADF 36	Calculated	DAR	DAR			
	Low Disch Setpoint	ADF 172	55.0*F	DAR	DAR			
	Disch Reset Band	ADF 139	60.0*F	DAR	DAR			
	Disch Air Deadband	ADF 194	2.0*F	DAR	DAR			
	DA Tempera-ture Tuning	ADF 200	0.025	DAR	DAR			
	Actual Disch Flow Setpt	ADF 25	0.0 cfm	DAR	DAR			

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Group (Cont.)	Para-meter	Point Location	Default Value	Pressure Indep	Constant Volume - Separate Dampers	Constant Volume - Linked Dampers	Single Duct Conver-sion	Indep Cold Deck w/ Dependent Hot Deck
Exhaust Box Setpts								
	Occ Exhaust Diff	ADF 168	200.0 cfm	Exhaust Control	Exhaust Control	Exhaust Control	Exhaust Control	
	Unocc Exhaust Diff	ADF 169	200.0 cfm	Exhaust Control	Exhaust Control	Exhaust Control	Exhaust Control	
Exhaust Config.								
	Exh Damper Deadband	ADF 24	5.0%	Incremental Exhaust	Incremental Exhaust	Incremental Exhaust	Incre-mental Exhaust	
	Exh Stroke Time	ADF 164	2.0 Min	Incremental Exhaust	Incremental Exhaust	Incremental Exhaust	Incre-mental Exhaust	
	Exhaust Box Area	ADF 166	0.35 sq ft	Exhaust Control	Exhaust Control	Exhaust Control	Exhaust Control	
	Exhaust Mult	ADF 167	2.25	Exhaust Control	Exhaust Control	Exhaust Control	Exhaust Control	
	Exhaust Velocity	ADF 29	Calculated	UDF	UDF			
Exhaust Damper Control								
	Exhaust Command	AO 5	0.0%	Incremental Exhaust	Incremental Exhaust	Incremental Exhaust	Incre-mental Exhaust	
	Exhaust Deadband	ADF 165	50 cfm	Exhaust Control	Exhaust Control	Exhaust Control	Exhaust Control	
	Exhaust Flow	ADF 17	0.0 cfm	Exhaust Control	Exhaust Control	Exhaust Control	Exhaust Control	
	Exhaust Integ Time	ADF 204	16	Exhaust Control	Exhaust Control	Exhaust Control	Exhaust Control	
	Exhaust Override	BD 235	0.0 Disable	Exhaust Control	Exhaust Control	Exhaust Control	Exhaust Control	
	Exhaust Prop Band	ADF 203	-1600 cfm	Exhaust Control	Exhaust Control	Exhaust Control	Exhaust Control	
	Exhaust Setpt	AO 5	0.0 cfm	Exhaust Control	Exhaust Control	Exhaust Control	Exhaust Control	
	Exhaust Setpt	AO 5	0.0 cfm	Exhaust Control	Exhaust Control	Exhaust Control	Exhaust Control	

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Group (Cont.)	Para-meter	Point Location	Default Value	Pressure Indep	Constant Volume - Separate Dampers	Constant Volume - Linked Dampers	Single Duct Conver-sion	Indep Cold Deck w/ Dependent Hot Deck
Hot Deck Config.								
	Hot Dk Box Area	ADF 162	0.35 sq ft	Hot Deck Flow Sensor	Hot Deck Flow Sensor			
	Hot Dk Damper DB	ADF 23	5.0%	Inc. Damper - Hot Deck Flow Sensor	Inc. Damper - Hot Deck Flow Sensor			
	Hot Dk Mult	ADF 163	2.25	Hot Deck Flow Sensor	Hot Deck Flow Sensor			
	Hot Dk Stroke Time	ADF 160	2.0 Min	Inc. Damper - Hot Deck Flow Sensor	Inc. Damper - Hot Deck Flow Sensor			Incr Damper
	Hot Dk Stroke Time	ADF 160	2.0 Min					
	Hot Dk Velocity	ADF 26	Calculated	UDF	UDF			
Hot Deck Damper Control								
	Hot Deck Min Pos	ADF 140	2.0%					Damper Control
	Hot Dk Damper Cmd	AO 3	0.0%	Prop Damper	Prop Damper			Incr Damper
	Hot Dk Deadband	ADF 161	50 cfm	Damper Control	Damper Control			Incr Damper
	Hot Dk Flow	ADF 16	0.0 cfm	Damper Control	Damper Control			
	Hot Dk Integ Time	ADF 198	16	Damper Control	Damper Control			
	Hot Dk Override	BD 237	0.0 Disable	Damper Control	Damper Control			
	Hot Dk Preset	ADF 237	0.0 cfm	Damper Control	Damper Control			
	Hot Dk Prop Band	ADF 197	-1600 cfm	Damper Control	Damper Control			
	Hot Dk Setpt	AO 7	0.0 cfm	Damper Control	Damper Control			

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Group (Cont.)	Para-meter	Point Location	Default Value	Pressure Indep	Constant Volume - Separate Dampers	Constant Volume - Linked Dampers	Single Duct Conver-sion	Indep Cold Deck w/ Dependent Hot Deck
Hot Deck Flow Setpts								
	Occ HD Clg Min	ADF 179	0.0 cfm	Used				
	Occ HD Htg Max	ADF 177	500.0 cfm	Used				
	Occ HD Htg Min	ADF 176	100 cfm	Used				
	Unocc HD Clg Min	ADF 183	0.0 cfm	Used				
	Unocc HD Htg Max	ADF 181	300.0 cfm	Used				
	Unocc HD Htg Min	ADF 180	100.0 cfm	Used				
	Wrmup HD Clg Min	ADF 153	0.0 cfm	Used				
	Wrmup HD Htg Max	ADF 156	500.0 cfm	Used				
	Wrmup HD Htg Min	ADF 155	100.0 cfm	Used				
Low Limit Setpoints								
	Dis Air Deadband	ADF 194	1.0 °F	Discharge Air Low Limit	Discharge Air Low Limit			
	Dis Air Integ Time	ADF 193	200	Discharge Air Low Limit	Discharge Air Low Limit			
	Dis Air Low Limit	ADF 172	58.0°F	Discharge Air Low Limit	Discharge Air Low Limit			
	Dis Air Prop Band	ADF 173	-3.0°F	Discharge Air Low Limit	Discharge Air Low Limit			
Modes								
	Boost Ovrd Time	ADF 175	30.0 Minute	Boost Mode	Boost Mode	Boost Mode	Boost Mode	Boost Mode
	Boost Status	BD 15	0 Off	Boost Mode	Boost Mode	Boost Mode	Boost Mode	Boost Mode
	Occ Ovrd Time	ADF 174	30.0 Minute	Temporary Occupied Mode	Temporary Occupied Mode	Temporary Occupied Mode	Tempo-rary Occupied Mode	Temporary Occupied Mode
	Occ Start Time	ADI 225	00:00 Hr:Mn	Occupied Mode	Occupied Mode	Occupied Mode	Occupied Mode	Occupied Mode

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Group (Cont.)	Para-meter	Point Location	Default Value	Pressure Indep	Constant Volume - Separate Dampers	Constant Volume - Linked Dampers	Single Duct Conver-sion	Indep Cold Deck w/ Dependent Hot Deck
Modes (Cont.)								
	Occ Stop Time	ADI 226	00:00 Hr:Mn	Occupied Mode	Occupied Mode	Occupied Mode	Occupied Mode	Occupied Mode
	Occupied Command	BD 227	1 On	Occupied Mode	Occupied Mode	Occupied Mode	Occupied Mode	Occupied Mode
	Occupied Status	BD 22	0 Unocc	Always	Always	Always	Always	Always
	Restart Delay	ADF 184	1.0 Minute	Power Fail Restart	Power Fail Restart	Power Fail Restart	Power Fail Restart	Power Fail Restart
	Restart Status	BD 21	0 Off	Power Fail Restart	Power Fail Restart	Power Fail Restart	Power Fail Restart	Power Fail Restart
	Shutdn Box Close Command	BD 230	0 Off	Shutdown	Shutdown	Shutdown	Shut-down	Shutdown
	Shutdn Box Open Command	BD 229	0 Off	Shutdown	Shutdown	Shutdown	Shut-down	Shutdown
	Shutdown Status	BD 23	0 Off	Shutdown	Shutdown	Shutdown	Shut-down	Shutdown
	Standby Command	BD 228	0 Off	Standby	Standby	Standby	Standby	Standby
	Temp Occ Status	BD 14	0 Off	Temporary Occupied Mode	Temporary Occupied Mode	Temporary Occupied Mode	Tempo-rary Occupied Mode	Temporary Occupied Mode
	Warmup Command	BD 225	0 Off	Always	Always	Always	Always	Always
Occupied Damper Setpts								
	Occ Bbd Min	ADF 147	0.0 cfm				Used	
	Occ Clg Max	ADF 144	500.0 cfm				Used	
	Occ Clg Min	ADF 143	100.0 cfm				Used	
	Occ Htg Max	ADF 146	100.0 cfm				Used	
	Occ Htg Min	ADF 145	100.0 cfm				Used	

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Group (Cont.)	Para-meter	Point Location	Default Value	Pressure Indep	Constant Volume - Separate Dampers	Constant Volume - Linked Dampers	Single Duct Conver-sion	Indep Cold Deck w/ Dependent Hot Deck
Supply Box Config.								
	Damper Deadband	ADF 22	5.0%				Incre-mental Control	
	Dmp Stroke Time	ADF 141	2.0 Min				Incre-mental Control	
	Supply Box Area	ADF 158	0.35 sq ft				Damper Control	
	Supply Mult	ADF 159	2.25				Damper Control	
Supply Damper Control								
	Damper Command	AO 4	0.0%				Incr Damper	
	Supply Deadband	ADF 142	50 cfm				Damper Control	
	Supply Flow	ADF 15	0.0 cfm				Damper Control	
	Supply Integ Time	ADF 192	16				Damper Control	
	Supply Override	BD 236	0.0 Disable				Damper Control	
	Supply Preset	ADF 236	0.0 cfm				Damper Control	
	Supply Prop Band	ADF 191	-1600 cfm				Damper Control	
	Supply Setpt	AO 8	0.0 cfm				Damper Control	
TMZ Setpoint Range								
	Low Setpoint Limit	ADF 127	65°F	Applicable only if configured with TMZ Digital Room Sensor.	Applicable only if configured with TMZ Digital Room Sensor.	Applicable only if configured with TMZ Digital Room Sensor.	Applicable only if configured with TMZ Digital Room Sensor.	Applicable only if configured with TMZ Digital Room Sensor.
	High Setpoint Limit	ADF 128	78°F	Applicable only if configured with TMZ Digital Room Sensor.	Applicable only if configured with TMZ Digital Room Sensor.	Applicable only if configured with TMZ Digital Room Sensor.	Applicable only if configured with TMZ Digital Room Sensor.	Applicable only if configured with TMZ Digital Room Sensor.

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Group (Cont.)	Para-meter	Point Location	Default Value	Pressure Indep	Constant Volume - Separate Dampers	Constant Volume - Linked Dampers	Single Duct Conver-sion	Indep Cold Deck w/ Dependent Hot Deck
Total Dk Config.								
	Total Dk Box Area	ADF 158	0.35 sq ft	Total Deck Flow Sensor	Total Deck Flow Sensor			
	Total Dk Box Area	ADF 162	0.35 sq ft	Total Deck Flow Sensor	Total Deck Flow Sensor			
	Total Dk Flow	ADF 19	0.0 cfm	Total Deck Flow Sensor	Total Deck Flow Sensor			
	Total Dk Mult	ADF 159	2.25	Total Deck Flow Sensor	Total Deck Flow Sensor			
	Total Dk Mult	ADF 163	2.25	Total Deck Flow Sensor	Total Deck Flow Sensor			
	Total Velocity	ADF 28	Calculated	UDF	UDF			
Unocc Damper Setpts								
	Unocc Bbd Min	ADF 152	0.0 cfm				Used	
	Unocc Clg Max	ADF 149	400.0 cfm				Used	
	Unocc Clg Min	ADF 148	0.0 cfm				Used	
	Unocc Htg Max	ADF 151	100.0 cfm				Used	
	Unocc Htg Min	ADF 150	100.0 cfm				Used	
VAV Box Diagnostics								
	CD Filter Value	ADF 241	1200 Ticks	Moving Avg Flow Error	Moving Avg Flow Error			
	Cold Dk Flow Error	ADF 33	0.0 cfm	Average Flow Error Diag	Average Flow Error Diag			
	Cold Dk Runtime	ADF 31	0.0 Hours	Actuator Runtime Diag	Actuator Runtime Diag			
	Controller Runtime	ADF 30	0.0 Hours	Actuator Runtime Diag	Actuator Runtime Diag			
	HD Filter Value	ADF 242	1200 Ticks	Moving Avg Flow Error	Moving Avg Flow Error			

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Group (Cont.)	Para-meter	Point Location	Default Value	Pressure Indep	Constant Volume - Separate Dampers	Constant Volume - Linked Dampers	Single Duct Conver-sion	Indep Cold Deck w/ Dependent Hot Deck
VAV Box Diagnostics (Cont.)								
	Hot Dk Flow Error	ADF 35	0.0 cfm	Average Flow Error Diag	Average Flow Error Diag			
	Hot Dk Runtime	ADF 34	0.0 Hours	Actuator Runtime Diag	Actuator Runtime Diag			
	Temp Error	ADF 32	0.0°F	Average Temp Error Diag	Average Temp Error Diag			
	Zone Temp Filter Value	ADF 243	9600 Ticks	Moving Temp Error	Moving Temp Error			
Volume Damper Config								
	Vol Dmp Area	ADF 158	0.35 sq ft			Damper Control		
	Vol Dmp Damper DB	ADF 22	5.0%			Incr Damper		
	Vol Dmp Mult	ADF 159	2.25			Damper Control		
	Vol Dmp Stroke Time	ADF 141	2.0 Min			Incr Damper		
Volume Damper Control								
	Vol Dmp Damper Cmd	AO 4	0.0%			Incr Damper		
	Vol Dmp Deadband	ADF 142	50 cfm			Damper Control		
	Vol Dmp Flow	ADF 15	0.0 cfm			Damper Control		
	Vol Dmp Integ Time	ADF 192	16			Damper Control		
	Vol Dmp Override	BD 236	0.0 Disable			Damper Control		
	Vol Dmp Preset	ADF 236	0.0 cfm			Damper Control		
	Vol Dmp Prop Band	ADF 191	-1600 cfm			Damper Control		
	Vol Dmp Setpt	AO 8	0.0 cfm			Damper Control		

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Group (Cont.)	Para-meter	Point Location	Default Value	Pressure Indep	Constant Volume - Separate Dampers	Constant Volume - Linked Dampers	Single Duct Conver-sion	Indep Cold Deck w/ Dependent Hot Deck
Volume Damper Setpts								
	Occupied cfm	ADF 143	400.0 cfm			Used		
	Unoccu-pied cfm	ADF 144	200.0 cfm			Used		
	Warmup cfm	ADF 145	400.0 cfm			Used		
Warmup Damper Setpts								
	Warmup Bbd Min	ADF 157	100.0 cfm				Used	
	Warmup Clg Max	ADF 154	100.0 cfm				Used	
	Warmup Clg Min	ADF 153	100.0 cfm				Used	
	Warmup Htg Max	ADF 156	500.0 cfm				Used	
	Warmup Htg Min	ADF 155	100.0 cfm				Used	
Water System Maintenance								
	Flush Position	ADF 239	100.0% Open	Baseboard Heat, Incr, N.O., N.C.	Baseboard Heat, Incr, N.O., N.C.			
	Water Flush	BD 239	0 Disable	Baseboard Heat, Incr, N.O., N.C.	Baseboard Heat, Incr, N.O., N.C.			
Zone Cooling Setpoints								
	Actual Clg Setpt	ADF 21	0.0°F	Used	Used		Used	Used
	Clg Integ Time	ADF 133	1000	Used	Used		Used	Used
	Clg Integ Time	ADF 133	0			Used		
	Clg Prop Band	ADF 132	10°F	Used	Used		Used	Used
	Clg Prop Band	ADF 132	0°F			Used		
	Occ Clg Setpt	ADF 129	72.0°F	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts

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Group (Cont.)	Para-meter	Point Location	Default Value	Pressure Indep	Constant Volume - Separate Dampers	Constant Volume – Linked Dampers	Single Duct Conver-sion	Indep Cold Deck w/ Dependent Hot Deck
Zone Cooling Setpoints (Cont.)								
	Stby Clg Setpt	ADF 130	74.0°F	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts
	Unocc Clg Setpt	ADF 131	80.0°F	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts
Zone Heating Setpoints								
	Actual Htg Setpt	ADF 20	0.000°F	Used	Used	Baseboard Heat	Used	Used
	Basebd Prop Band	ADF 137	-10°F	Baseboard Heat	Baseboard Heat	Baseboard Heat	Base-board Heat	Baseboard Heat
	Basebd Prop Band	ADF 137	0°F					
	Htg Integ Time	ADF 139	1000	Used	Used	Baseboard Heat	Used	Used
	Htg Integ Time	ADF 139	0			Used		
	Htg Prop Band	ADF 138	-10°F	Used	Used	Baseboard Heat	Used	Used
	Htg Prop Band	ADF 138	0°F			Used		
	Occ Htg Setpt	ADF 134	68.000°F	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts
	Stby Htg Setpt	ADF 135	66.000°F	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts
	Unocc Htg Setpt	ADF 136	62.000°F	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts	Separate Heating and Cooling Setpts

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Group (Cont.)	Para-meter	Point Location	Default Value	Pressure Indep	Constant Volume - Separate Dampers	Constant Volume - Linked Dampers	Single Duct Conver-sion	Indep Cold Deck w/ Dependent Hot Deck
Zone Set Points								
	Actual Zone Setpt	ADF 21	Calculated	Disch Air Reset Only	DAR			
	Actual Zone Bias	ADF 20	Calculated	DAR	DAR			
	Zone Prop Band	ADF 132	10.0	DAR	DAR			
	Zone Integ Time	ADF 133	500 Ticks	DAR	DAR			
	Zone Dead-band	ADF 146	0.0*F	DAR	DAR			
	Occ Bias	ADF 134	2.0°F	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt
	Occ Setpt	ADF 129	70.0°F	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt
	Stby Bias	ADF 135	4.0°F	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt
	Stby Setpt	ADF 130	70.0°F	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt
	Unocc Bias	ADF 136	9.0°F	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt
	Unocc Setpt	ADF 131	71.0°F	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt	Single Zone Setpt
Zone Temp Damper Config								
	Zone Dmp Deadbd	ADF 161	5.0%			Used		
	Zone Dmp Stroke Time	ADF 160	2.0 Minute			Used		
Zone Temp Damper Control								
	Zone Tmp Dmp Cmd	AO 7	0.0%			Used		

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