VAV with Variable Speed Fan and HW Reheat

Application Data Sheet

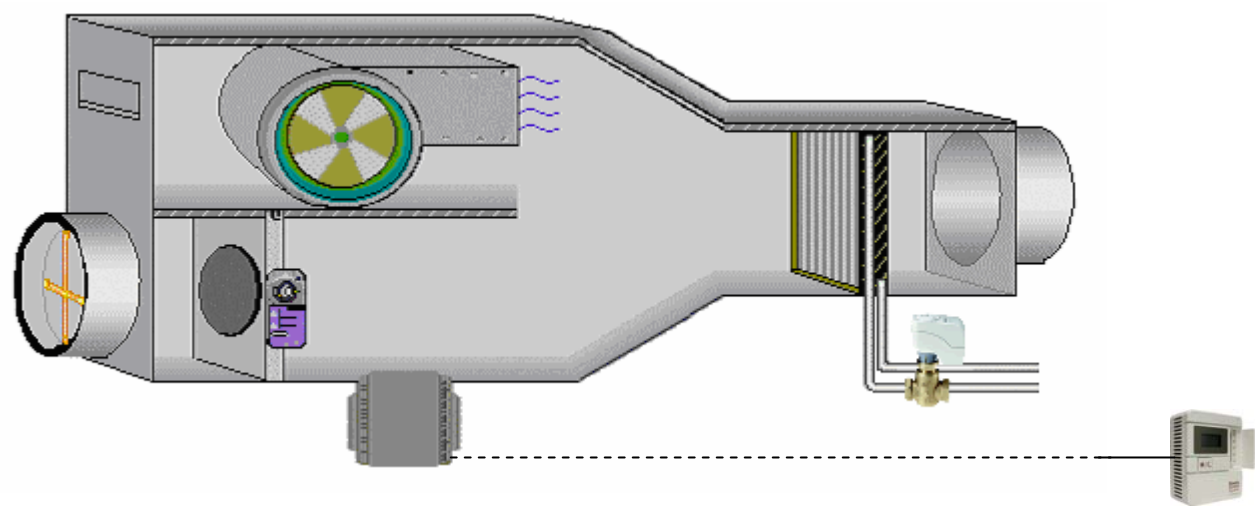


Figure 1. Variable Air Volume with Variable Speed Fan (VSF) with Hot Water Reheat

Features

- LONMARK compliant with space-comfort controller functional profile (8502)
- Adjusts terminal fan speed to match current loading conditions for the best combination of comfort and energy efficiency.
- Compatible with state-of-the-art electrically commutated (ECM) fan motors.
- Application control of zone lighting reduced installation costs and provides energy savings
- PID control minimizes offset and maintains tight set point control
- Standby mode enables energy savings during occupied hours for rooms that are not always used. When occupants are sensed the controller quickly responds to maintain comfort levels.
- Diversity control, through a demand limit input, maximizes comfort by maintaining even air distribution to all zones during morning warm-up or pre-cool operation.
- Conforms to the LONMARK interoperability guidelines, enabling information sharing with LONMARK products from other vendors.

Sequence of Operation

This application example describes the operation of the Predator VAV with Variable Speed Fan, hot water reheat and optional lighting control. The Predator monitors the room temperature, room setpoint, room override switch, and supply air flow. As the monitored conditions change, the control algorithm modulates the damper actuator, cycles and varies the fan speed, and modulates the reheat valve to maintain the specified room setpoints. If lighting control is installed, the zone will be illuminated according to the current operation mode of the Predator controller.

Occupied Control

Cooling Mode

The Predator Controller modulates the terminal box damper to regulate airflow between the "Cooling Flow Maximum" and "Cooling Flow Minimum" setpoints as required to maintain the "Occupied Cooling Setpoint" space temperature. Control is based on the occupied cooling setpoint and cooling demand PID loop, with the zone temperature supplied by the Predator Room Temperature Sensor. Flexible fan control configuration allows fan flow to vary with cooling demand.

Lighting is on.

Heating Mode

The Predator Controller modulates the terminal box damper to regulate airflow between the "Heating Flow Maximum" and "Heating Flow Minimum" setpoints as required to maintain the "Occupied Heating Setpoint" space temperature. Flexible fan control configuration allows fan flow to vary with heating demand. The reheat valve modulates as required to control the zone temperature. Control is based on the occupied heating setpoint and heating demand PID loop, with the zone temperature supplied by the Predator Room Temperature Sensor.
Lighting is on.

Standby Control

Spaces that are not occupied on a routine basis (conference rooms, etc.) can be placed into standby mode during normally scheduled occupancy times. This will save energy while still ensuring the comfort of the occupants.

Cooling Mode

The Predator Controller modulates the terminal box damper to regulate airflow between the "Cooling Flow Maximum" and "Standby Flow Minimum" values as required to maintain the "Standby Cooling Setpoint". Once occupancy is detected, control reverts to the Occupied Mode as detailed above.

Lighting is off.

Heating Mode

The Predator Controller modulates the terminal box damper to regulate airflow between the "Heating Flow Maximum" and "Standby Flow Minimum" values as required to maintain the "Standby Heating Setpoint". The terminal fan is on any time the airflow (as measured at the box inlet) is below the fan on setpoint, and off anytime the airflow is above the fan off setpoint, as defined by "FlowFanRq". The reheat valve modulates as required to control the zone temperature. Once occupancy is detected, control reverts to the Occupied Mode as detailed above.

Lighting is off.

Unoccupied Control

The Predator Controller modulates the terminal box damper as required to maintain the temperature setpoint. At low load, the flow will be controlled to the “Unoccupied Flow Minimum”. When this value is set to a non-zero number and the AHU is off, the damper will open in an attempt to achieve the minimum flow setpoint. If the value is set to zero, the controller will drive towards the closed position.

Cooling Mode

The “Unoccupied Cooling Setpoint” value can be programmed to maintain a maximum space temperature. When the unoccupied cooling setpoint is used, the Predator Controller modulates the terminal box damper to regulate airflow between the “Cooling Flow Maximum” and “Unoccupied Flow Minimum” values to maintain the “Unoccupied Cooling Setpoint” space temperature. If cooling is not needed, the controller will maintain airflow at the “Unoccupied Flow Minimum” setpoint. Flexible fan control configuration allows fan flow to vary with cooling demand.

Lighting is off.

Heating Mode

The “Unoccupied Heating Setpoint” value can be programmed to maintain a minimum space temperature. When the unoccupied heating setpoint is used, the Predator Controller modulates the terminal box damper to regulate airflow between the “Heating Flow Maximum” and “Unoccupied Flow Minimum” values. Flexible fan control configuration allows fan flow to vary with cooling demand. The reheat valve modulates as required to control the zone temperature at the “Unoccupied Heating Setpoint” space temperature. If heating is not needed, the controller will maintain airflow at the “Unoccupied Flow Minimum” setpoint.

Lighting is off.

Bypass (Override) Mode

If the Predator Controller is in the Unoccupied or Standby mode, it can be put into Bypass mode for a configurable period of time (“Bypass Time”). The placement of the controller into Bypass mode is triggered via the bypass button on the room sensor or system command. Once placed into Bypass mode the Predator Controller will operate as detailed in the occupied section above.

Morning Warmup

The Predator Controller operates maintain the occupied heating temperature setpoint. Operation of the terminal fan and the primary air flow control are configurable in the warm-up mode. Each may be individually applied or locked out. The reheat valve modulates as required to control the zone temperature at the occupied heating setpoint space temperature.

Systems that have been sized for normal operation may sometimes fall below the total maximum flow needs during morning warm-up (or pre-cool) operation. The demand limit input provides for stable start up. Selection of the appropriate percentage will allow all boxes to provide air flow to the space in equal proportions, thus eliminating starvation of zones.

Lighting is off.

Night Purge

The Predator Controller modulates the terminal box damper to regulate airflow between the occupied cooling maximum and minimum flow values as required to maintain the occupied cooling temperature setpoint. During night purge the AHU's cooling is disabled and cooler outside air is used to pre-cool the space.

Lighting is off.

Test

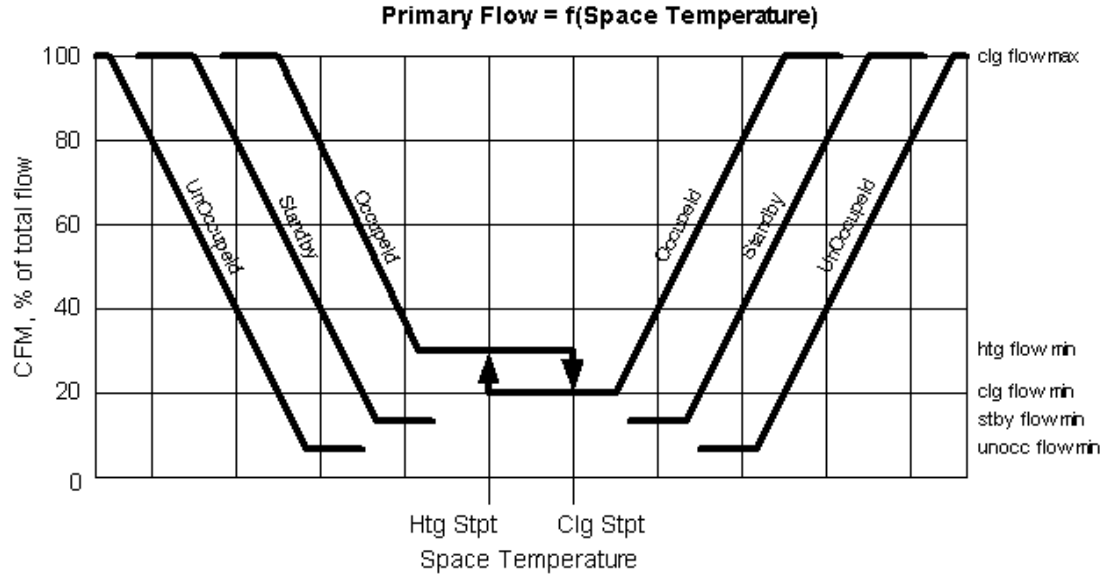
In the test mode, the controller will close the damper fully and recalibrate the airflow sensor. The terminal fan is commanded off. Once commanded to test mode, the controller remains in this mode (even if it is commanded to another mode) until the recalibration is complete. This process takes approximately two times the damper travel time as determined by the value of "UCPT_FlowDmprMtr" (see table 2).

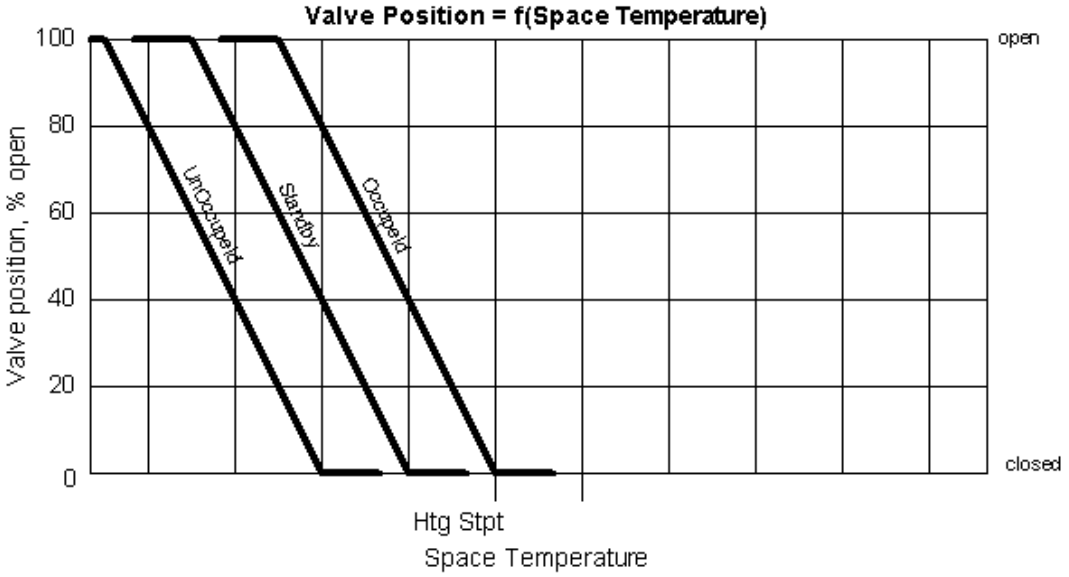
Off

In this mode, the damper will close fully and the terminal fan is off.

Lighting is off.

Control Sequence Diagram





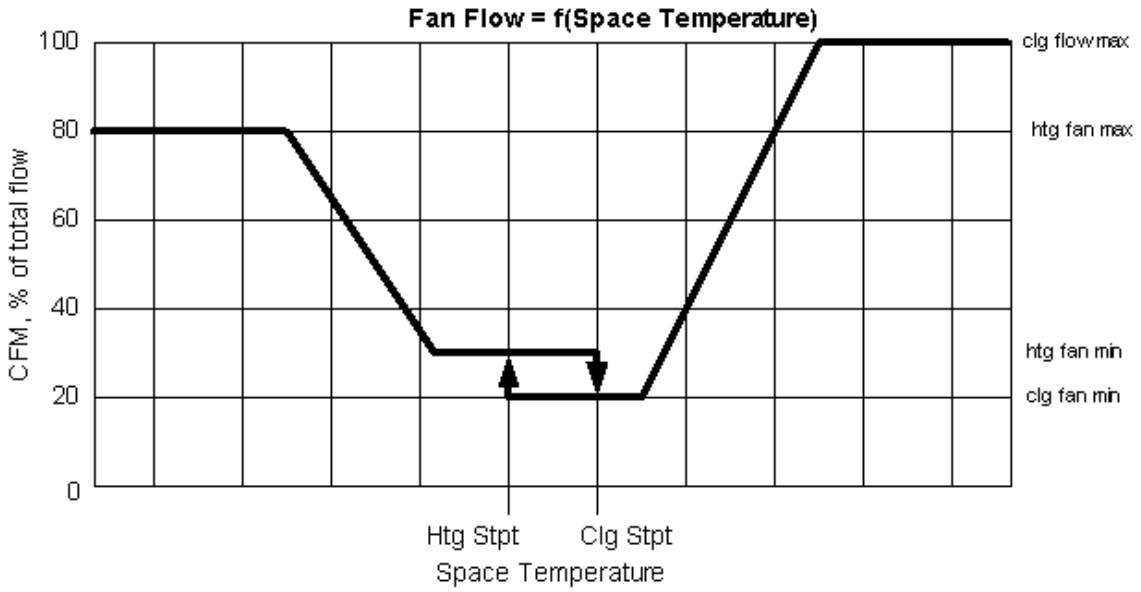


Figure 2. Control Sequence Diagram (Airflow).

Note: In the sequence of control section above there are numerous instances of text shown in quotes such as “Cooling Flow Maximum”. This is an indication of a configurable setting and you will find the text enclosed by the quotes in the column headed by the word “element” in the configuration table section of this document.

Occupancy Control

Occupancy Mode

The Predator controller defaults to the occupied mode of operation. Upon receipt of the 4-state LonMark occupancy override (nviOccManCmd), the controller will switch to the appropriate mode of operation. A brief summary of each mode follows below:

LonMark Occupancy State	Mode	Description
(0)	Occupied	Controller in Occupied mode and uses Occupied setpoints.
(1)	Unoccupied	Controller in Unoccupied mode and uses Unoccupied setpoints.
(2)	Bypass	Controller temporarily in Occupied mode and uses Occupied setpoints until the Bypass Time elapses. Controller then returns to previous occupancy state.
(3)	Standby	Controller in Standby mode and uses Standby setpoints.

If a LonMark compatible occupancy schedule input (nviOccSchedule) is used, the controller will use the modes and setpoints as shown above. This will allow the Predator controller to utilize the scheduling properties of other devices on the LonTalk Network.

The occupancy signal could also come from a time clock, wall switch, or occupancy sensor physically wired to one of the inputs of the Predator controller (see figure 3). This occupancy signal could then be shared with other controllers via the Lon Network.

Bypass Mode

If enabled (through UCPT StptDialEn) and the Bypass button on the Predator room sensor is pressed, the controller will be placed in the Bypass mode for the amount of time specified by the controller's configuration parameters (default 60 min. – see Table 2). If the button is subsequently pressed again prior to the expiration of the Bypass time, the timer will reset to the initial value and resume counting down.

Priorities of Occupancy Control

Occupancy overrides are prioritized as follows (listed from highest to lowest):

- Wall Switch Input – Typically a physically operated switch used by occupants of room.
- Operator Command – A valid occupied command sent from system operator.
- Bypass Button – Button on Talon room sensor, also utilized by occupants of room.
- Occupancy Sensor – Locally connected or signal via the network.
- Occupancy Schedule – Sent from network.

Optional Functions

Room Temperature Sensor Sharing

The Predator Room Temperature Sensor may share its value with other controllers on the LonTalk network via a network binding. This is most commonly done when multiple terminal units serve a room or area.

Duct Temperature Sensor

An optional duct temperature sensor may be connected to the Predator controller for the purpose of monitoring the source temperature. This is useful for functions such as morning warmup, when you want to be sure warm air is being provided to the box, or as an aid in troubleshooting space comfort problems.

Wall Switch

An optional maintained contact wall switch may be used to control the occupancy mode of a room. Rooms with variable occupancy (conference rooms, etc.) can use this device to control occupancy and the lights with one switch.

Occupancy Sensor

Another useful option is to utilize an occupancy sensor to control the occupancy mode of the Predator controller. The function of this device would be similar to the wall switch above, but an occupant entering the room would not perform any manual action to put the room into occupied mode. If the schedule is in the occupied mode and the occupancy sensor does not detect people in the room, the room will go into the standby mode enabling energy savings while maintaining occupant comfort.

Lighting Control Relay

The Predator controller can selectively operate with maintained contacts or pulsed contacts to switch lighting control relays. This is useful in those instances where lighting control is desired, but a lighting control panel with a LonTalk interface is either not present or not feasible.

Analog Damper Actuator

The standard application is setup to use a Siemens GDE or similar 3-point floating actuator for air volume control. Alternatively, A Siemens Open Air™ or similar damper actuator could be utilized if 0-10 VDC modulating control is desired.

Perimeter Heat

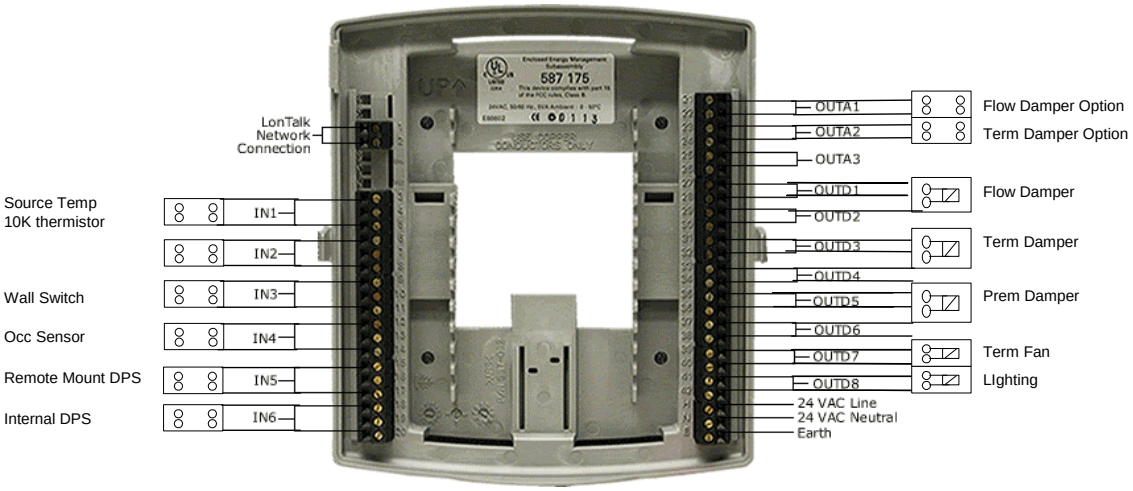
This application also supports the optional control of perimeter heat. The algorithm supports analog, 3-point floating, pulse width modulation, and on/off control of the perimeter heat. Perimeter heat operates independently of terminal airflow or the current state of the terminal fan.

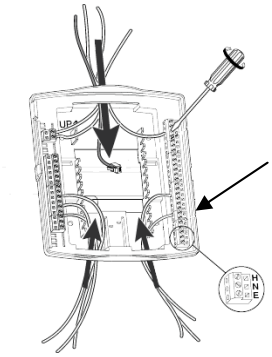
Hardware Map – VAV with VSF and hot water reheat

Termination Set	Parameter Set in	Element Name	I/O Type	Factory I/O Setting
StatTemp	inputs	statTemp	TEMP	SPACE_TEMP
StatSetpt		statSetpt		IN_UNUSED
StatOvrd		statOvrd	DI	STAT_SWITCH_DI
In1		in1	DI, TEMP	SOURCE_TEMP
In2		in2		IN_UNUSED
In3		in3	DI, PCT, TEMP	WALL_SWITCH_DI
In4		in4		OCC_SENSOR_DI
In5		in5		OFFBD_PRESSURE_PCT
In6		in6		ONBD_PRESSURE_PCT
OutA1	outputs	outA1	AO	FLOW_DMPR_AO
OutA2		outA2		TERM_FAN_AO
OutA3		outA3		NOT AVAILABLE
OutD1		outD1	DO, FLT_MTR	FLOW_DMPR_FLT_MTR
OutD2		outD2		FLOW_DMPR_FLT_MTR
OutD3		outD3		TRM_H_COIL_FLT_MTR
OutD4		outD4		TRM_H_COIL_FLT_MTR
OutD5		outD5		PERIM_H_COIL_FLT_MTR
OutD6		outD6		PERIM_H_COIL_FLT_MTR
OutD7		outD7		TRM_FAN_DO
OutD8		outD8		SPC_LIGHTS_DO

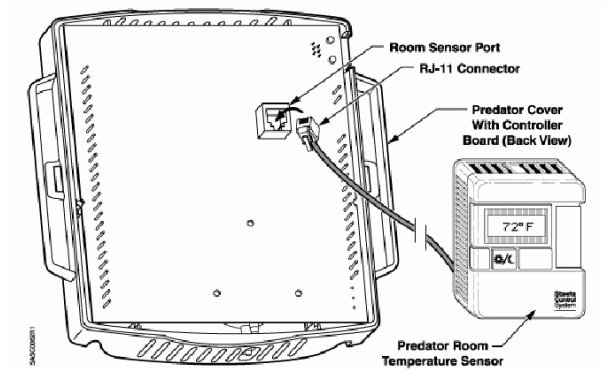
Table 1. Hardware Map

Wiring Diagram





Note: Route wiring from either the bottom opening when using a J-box or from the base sides as shown in the picture when flat or din rail mounting. The image above is for illustrative purposes only



RJ-11 6-Pin Connector from the Predator Room Temperature Sensor to the Controller.

Wiring Recommendations:

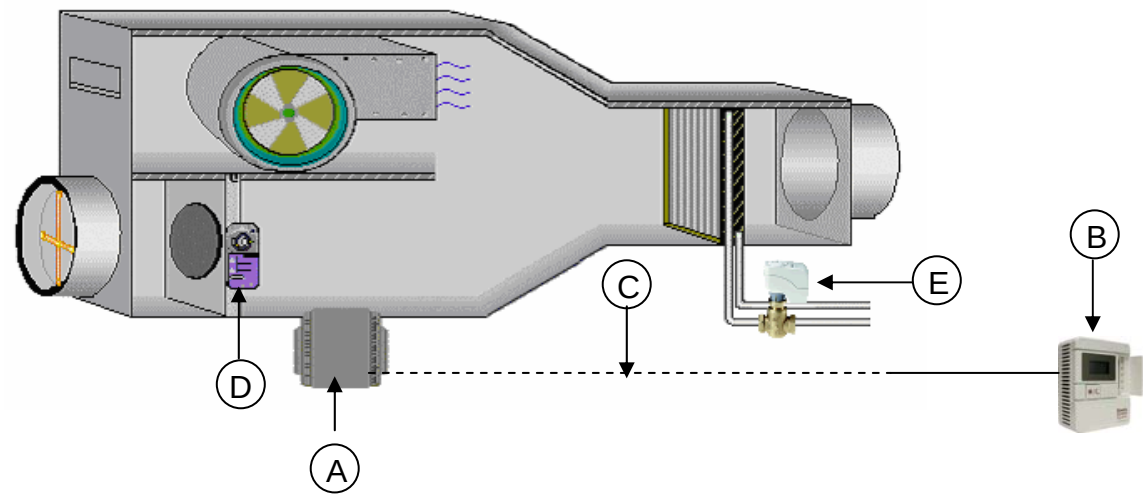
IN and AO:	20 to 22 AWG
DO:	18 to 22 AWG
Power:	16 to 18 AWG
LON Network:	22 AWG Level 4

Transformer Requirements:

Type: Class 2, 24 VAC, 50/60Hz

Figure 3. Predator Wiring Diagrams

Bill of Materials



Tag	Description	Product #
A	Predator VAV with Variable Speed Fan 5IN, 8DO, 2AO, 1DP, 1RTS Predator Full Point Wiring Base	588-511 587-175
B	Predator Room Sensors: Sensing Only Override Setpoint Temperature Display Setpoint and Override Override and Temperature Display Setpoint and Temperature Display Setpoint, Override, and Temperature Display Predator Room Sensors ***without*** Logo's: **No Logo** Sensing Only **No Logo** Setpoint **No Logo** Setpoint and Override **No Logo** Setpoint, Override, and Temperature Display Flush Mount Room Temp Sensor, 10K Thermistor, hardware connect Mylar Tabs – 20 pack (***covers RJ-11 – use w/ 4 conductor cables***)	 587-180 587-181 587-182 587-183(1) 587-184 587-185(1) 587-186(1) 587-187(1) 587-550B 587-552B 587-554B 587-557B(1) 536-994B 544-634B20
C	Predator Room Sensor 6-Conductor Plenum Rated Cables: 25 Foot 50 Foot 100 Foot Predator Room Sensor 4-Conductor ***(no network connection)*** Plenum Rated Cables: 25 Foot 50 Foot 100 Foot	 588-100A 588-100B 588-100C 588-101A 588-101B 588-101C
D	Floating damper actuator 44 lb. In.	GDE.131.P
E	Floating valve actuator	SSB81U
Not shown	Duct Temperature, Point – 4" probe, 10K Thermistor 40 to 150F Duct Temperature, Averaging – 24" flex, 10K Thermistor	587-691 587-694

Notes: (1) Sensor will display Fahrenheit or Celsius temperature

Configuration Tables

The application configuration tables below are for a typical VAV VSF with hot water reheat box. Items shown with an "X" in the desired settings column do not need to be changed from their factory defaults. JDE should be used to modify those items shown as optional or job specific.

Application Component	Configuration Item	Element	Factory Setting	Desired Setting
VAV / CV Core	UCPT_AirTermType		NO_FAN	Parallel_Fan
	UCPT_FlowVav	Enable	TRUE	X
		DmdAtMin	0%	X
		DmdAtMax	100%	X
	UCPT_HtgClgSwit	DmdDeadband	1%	Job Specific
		TmpDeadband	0.5 °C	Job Specific
		TimeDelay	3 min	Job Specific
	NciSetPnts	Occupied cooling setpoint	23.0 °C	Job Specific
		Standby cooling setpoint	25.0 °C	Job Specific
		Unoccupied cooling setpoint	28.0 °C	Job Specific
		Occupied heating setpoint	21.0 °C	Job Specific
		Standby heating setpoint	19.0 °C	Job Specific
		Unoccupied heating setpoint	16.0 °C	Job Specific
Fan Control	UCPT_FanCoefs	Coef0	0	§
		Coef1	0	§
		Coef2	0	§
		Coef3	0	§
		Coef4	0	§
		Coef5	0	§
	UCPT_fanWarmup		Modulate	Job Specific
	UCPT_htgDmdRanRq	PercentOn	110%	Job Specific[1]
		PercentOff	100%	Job Specific[1]
	UCPT_trmClgFan	Enable	False	Job Specific
		DmdAtMin	0%	Job Specific
		DmdAtMax	100%	Job Specific
	UCPT_trmHtgFan	Enable	False	Job Specific
		DmdAtMin	0%	Job Specific
		DmdAtMax	100%	Job Specific
	UCPT_nciMaxFanHtg		106 CFM	Job Specific
	UCPT_nciMaxFlowClg		2500 CFM	Job Specific
	UCPT_nciMaxFlowHtg		850 CFM	Job Specific
	UCPT_nciMinFanClg		0 CFM	Job Specific
	UCPT_nciMinFanHtg		0 CM	Job Specific
	UCPT_nciMinFlowClg		449 CFM	Job Specific
	UCPT_nciMinFlowHtg		600CFM	Job Specific
Space Temp Sensing	SCPT_bypassTime		60 minutes	Optional
	SCPT_statSwitchEn		FALSE	Optional
	UCPT_StptDialEn		FALSE	Optional
	UCPT_TempStptLim	MinTemp	19.0 °C	Job Specific
		MaxTemp	25.0 °C	Job Specific

Application Component	Configuration Item	Element	Factory Setting	Desired Setting
Damper Control	UCPT_FlowDmprMtr	TravelTime	90 sec	X
		Reverse	FALSE	X
	UCPT_FlowFanRq	PercentOn	110%	Job Specific
		PercentOff	100%	Job Specific
	UCPT_flowWarmup		OFF	Job Specific
Terminal Reheat	UCPT_hCoilFanRq	PercentOn	3%	X
		PercentOff	0%	X
	UCPT_hSstageCyc		10 min	N/A
	UCPT_htgSwitMeth		DEAD_BAND	N/A
	UCPT_numHStages		0	N/A
	UCPT_trmHtgCoil	Enable	FALSE	True
		DmdAtMin	0%	X
		DmdAtMax	100%	X
	UCPT_trmHtgEnrgy		ELECTRIC	Hot_Water
	UCPT_trmHtgMtr	TravelTime	125 sec	150 Sec*
		Reverse	FALSE	X
Perimeter Heat	UCPT_hstageCyc		10 min	X
	UCPT_htgSwitMeth		DEAD_BAND	X
	UCPT_perimHtgCoil	Enable	FALSE	X
		DmdAtMin	0 %	X
		DmdAtMax	100%	X
	UCPT_perimHtgMtr	TravelTime	125 sec	X
		Reverse	FALSE	X
	UCPT_numPerimStgs		0	X
Occupancy Control	UCPT_occSensorEn		FALSE	OPTIONAL
	UCPT_statSwitchEn		FALSE	Optional
	SCPT_bypassTime		60 minutes	Optional
	UCPT_wallSwitchEn		FALSE	Job Specific
Lighting Control	UCPT_lightsLag		10 minutes	Job Specific
Source Temp Sensing	UCPT_SourceTempLim	NeededToCool	18.0 °C	X
		NeededToHeat	25.0 °C	X
Spare Digital Output				
Spare Analog Output				
Spare Digital Reading				
Spare Analog Percent				

Table 2. Cooling Only VAV – Application Specific Parameters

* Assumes use of SSB Series Valve Actuator

§ Set to match characteristics of the fan

[1] Setting PercentOn to 110% and PercentOff to 100% disable the control feature.

Balancing Parameters

Configuration Parameter	Element	Factory Setting	Desired Setting
SCPT_ductArea		0.1000 m^2	Job Specific
ncimaxFlowClg	Cooling Flow Maximum	1180 L/s	Job Specific
ncimaxFlowHtg	Heating Flow Maximum	401 L/s	Job Specific
nciminFlowClg	Cooling Flow Minimum	212 L/s	Job Specific
nciminFlowHtg	Heating Flow Minimum	283 L/s	Job Specific
UCPT_minFlowStby	Standby Flow Minimum	212 L/s	Job Specific
UCPT_minFlowUnoc	Unoccupied Flow Minimum	165 L/s	Job Specific
nciPrOffset		0%	X
UCPT_sensConstVAV		1.000	Job Specific

Table 3. VAV VSF – Balancing Parameters

Tuning Parameters

Configuration Parameter	Element	Factory Setting	Desired Setting
UCPT_clgDmdCntr	Kr	36% /°C	X
	Ti	2000 sec	X
	Td	0 sec	X
UCPT_htgDmdCntr	Kr	18% /°C	X
	Ti	1000 sec	X
	Td	0 sec	X
UCPT_inStat	Stat Temp Offset	0 °C	X
	Stat Setpoint Offset	0 °C	X
UCPT_trmFlowCntr	Kr	0.25% /°C	X
	Ti	12 sec	X
	Td	0 sec	X

Table 4. Cooling Only VAV – Tuning Parameters

Control Mode Interaction Table – VAV with VSF and hot water reheat

	Heat		Warmup	Cool		PreCool Unocc	Off	Test	Emerg Heat Unocc	Fan Only
	Occ	Unocc	Unocc	Occ	Unocc					
Term Htg Coil	Heat Loop	Heat Loop	Heat Loop	Closed	Closed	Closed	Closed		Heat Loop	Closed
Perim Heat	Heat Loop	Heat Loop	Heat Loop	Closed	Closed	Closed	Closed		Heat Loop	Closed
Flow Dmpr	Heat Loop	Heat Loop	Heat Loop or Closed	Cool Loop	Cool Loop	Cool Loop	Closed	Closed	Heat Loop	Closed
Series Fan	On	Request	Request	On	Request	Request	Off	Off	Demand	On
Parallel Fan	Request	Request	Request	Request	Off	Off	Off	Off	Demand	On
Fan Speed	Heat Loop*	Heat Loop*	Heat Loop*	Cool Loop*	Cool Loop*	Cool Loop*	Off	Off	Heat Loop*	100%
Flow Limits	Htg Max Htg Min	Htg Max Unocc Min	Htg Max Unocc Min	Clg Max Clg Min	Clg Max Unocc Min	Clg Max Unocc Min	No Flow		Max Min	
Temp Stpt	Occ Heat	Unocc Heat	Occ Heat	Occ Cool	Unocc Cool	Occ Cool	N/A		Unocc	

* If the fan is turned off, the speed is set to zero.

Color Key: Red = OFF (not used); Green = Active (fixed in application); Yellow = Selectable (configurable)

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