Single Fan VAV AHU
DX Cooling with Options

Application Data Sheet

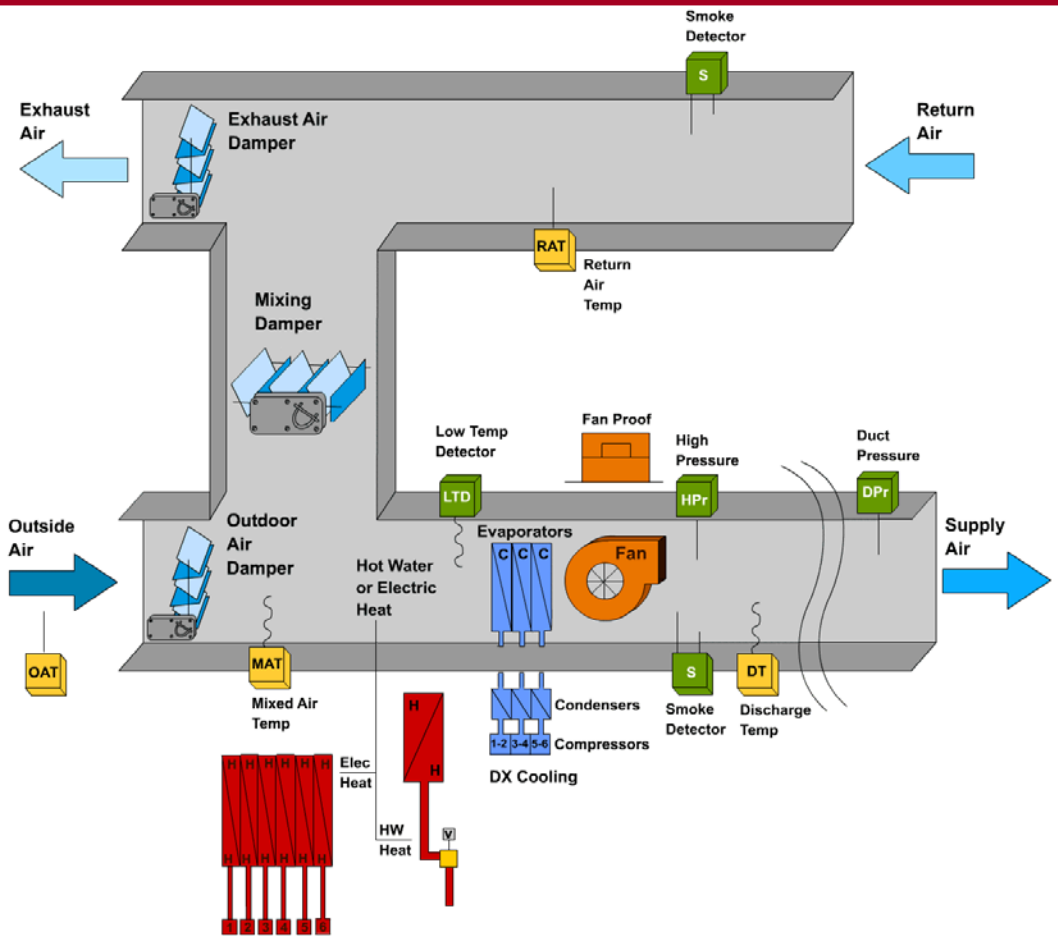


Figure 1. Single Fan DX VAV AHU with selectable hot water or electric heat and options

Features

- LONMARK compliant with Discharge Air Controller Functional Profile (8505)
- Economizer cycle driven by local dry bulb logic or network override
- Minimum ventilation setting responds to air quality input for demand controlled ventilation
- Multiple options for supply air temperature reset to optimize system performance
- Interoperates with LonMark zone controllers to coordinate occupancy and air conditioning functions
- Adaptive control of outdoor air dampers responds quickly and stably in any season
- PID control minimizes offset and maintains tighter set point control
- Conforms to the LONMARK interoperability guidelines, enabling information sharing with LONMARK products from other vendors.

Sequence of Operation

Occupied Control

General

The supply fan starts slowly and runs throughout the occupied mode. A PID control loop continually adjusts the fan capacity to maintain the duct static pressure at setpoint as loads vary in the zones. The duct pressure setpoint may be an adjustable constant, or may be varied automatically by another node to minimize energy consumption.

Ventilation Control Ventilation (DCV)

During occupied mode, the outdoor air damper opens to the design ventilation setting and stays open. When Demand Controlled Ventilation (DCV) is implemented, the ventilation setting may be automatically adjusted from internally in the Predator or by another node to a value appropriate for the demand. The Predator DCV function is adjustable, while the ventilation demand value comes from another node.

The supply air temperature setpoint may be adjusted manually or varied according to an adjustable built-in reset function.

Discharge Temperature Control

Hot Water Option
When free cooling is available, the heating coil valve, outdoor air damper, and stages of DX cooling operate sequence to maintain discharge air temperature setpoint. The outdoor air damper does not close beyond the current ventilation setting. When free cooling is unavailable, the outdoor air damper goes to the current ventilation setting; the heating coil valve modulates and stages of cooling operate in sequence to maintain discharge air temperature setpoint.

Staged Heat Option
When free cooling is available, the heat stages, outdoors air damper, and stages of cooling operate in sequence to maintain discharge air temperature setpoint. The outdoor air damper does not close beyond the current ventilation setting. When free cooling is unavailable, the outdoor air damper goes to the current ventilation setting; the heat stages and stages of cooling operate in sequence to maintain discharge air temperature setpoint.

Unoccupied Control

General

During unoccupied periods, the air handler is normally off. The outdoor damper is closed and the DX equipment is off. The optional hot water coil valve may be forced closed, or it may operate to maintain unit temperature above freezing. Optional staged heat stages are turned off.

The Predator may run the air handler intermittently to provide heating or cooling in response to demand from the associated unoccupied zone controllers.

Unoccupied Cooling Mode

The air handler starts in response to a cool or ***pre-cool*** command from the network or measured zone temperature above the unoccupied setpoint. The Predator modulates the supply fan capacity to maintain measured duct pressure at the duct static pressure setpoint. If free cooling is not available, the outdoor air damper closes fully. Mechanical cooling may be locked out during unoccupied periods.

Unoccupied Heating Mode

The air handler starts in response to a heat or ***warm-up*** command from the network or measured zone temperature below the unoccupied setpoint. The Predator modulates the supply fan capacity to maintain measured duct pressure at the duct static pressure setpoint. The hot water coil or staged heat is operated to maintain the supply air temperature at the heating setpoint. The stages of DX cooling are off and the outdoor air damper is closed.

Safety Shutdown

Low Temperature

If a Low Temperature is detected the OA damper closes and the fan shuts off. The stages of cooling are turned off. The optional hot water coil valve opens fully; optional staged heat is turned off. The system may be configured to re-start automatically after the condition clears, or to remain shut down until a manual reset.

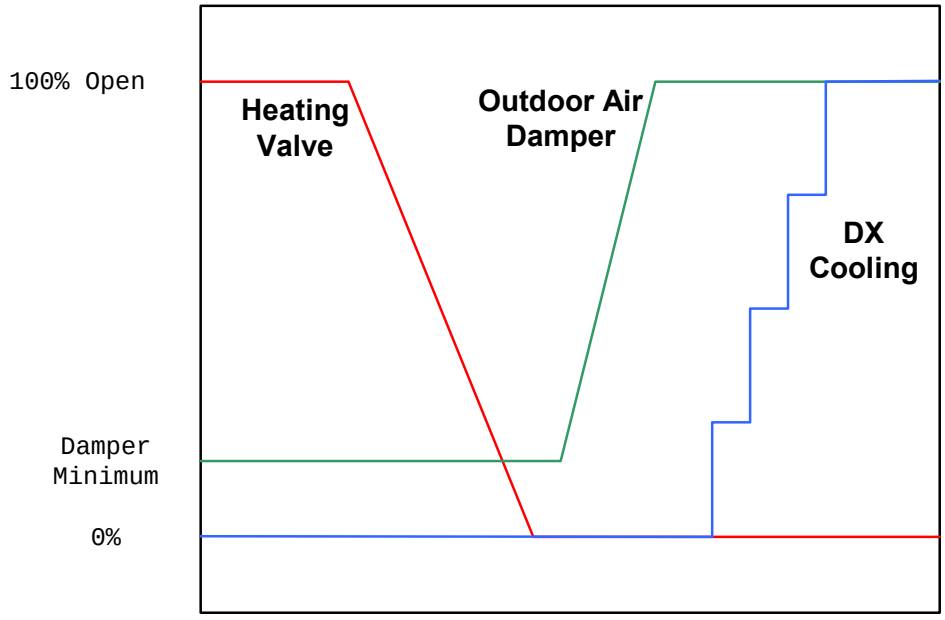
Other Safeties

Any number of other safety devices, such as smoke detectors or a high duct pressure switch, may be applied to shut the unit down. The Predator turns off the fan, closes the OA dampers, closes the hot water coil valve and turns off the cooling stages. The Predator indicates an alarm condition over the network, and remains shut down until reset manually.

Off

In this mode, the heating coil valve and OA damper are closed, and the cooling stages and fan are off.

Temperature Control Sequence Diagrams



The Predator sequences heating, cooling and outside air as needed to meet air contidioning load.

Special Features

System Level Occupancy Control

Occupancy for an air handler should be coordinated with occupancy for its respective zones. A site may employ more than one of the following interoperation mechanisms to accomplish system level coordination:

- The Predator Air Handler Controller may drive occupancy of the zones through bound network variables.
- The zone controllers may drive occupancy of the air handler so that it runs to meet their needs.
- Occupancy of the zones and air handler may both be driven in a coordinated way by another LonMark device.

The Predator responds to LonMark occupancy override (nviOccManCmd), allowing a building operator or technician to override the system from any LonMark compatible user interface.

The Predator responds to a LonMark compatible occupancy schedule input (nviOccSchedule). This allows the Predator to utilize the scheduling functions of other devices on the LonTalk Network.

The primary occupancy signal could also come from a time clock, wall switch, or occupancy sensor physically wired to one of the inputs of the Predator. This occupancy signal can then be shared with other controllers via the LonTalk Network.

Duct Pressure Reset

To comply with ASHRAE Standard 90.1, Energy Efficiency for Commercial Buildings, the Predator supports automatic duct pressure reset by accepting a variable setpoint. The dynamic setpoint may calculated according to any algorithm in another device, and transmitted over the network.

Supply Temperature Reset

The Predator can run an air handler as a classic constant-temperature VAV system, or it can dynamically adjust the supply temperature to adapt to loading conditions. The temperature may be reset using a built-in adjustable reset schedule, or calculated externally with a custom algorithm, and transmitted via the LonWorks network. The built-in reset schedules directly support the most popular approaches: reset based on space temperature, return temperature, outdoor temperature or a selected percentage demand signal from the zone controllers.

Demand Controlled Ventilation

The Predator can control ventilation by the industry standard approach, using an adjustable minimum OA damper opening or by a demand-controlled strategy that adjusts the OA intake according to IAQ measurements in the occupied spaces. The DCV lets an HVAC designer build the system for the maximum anticipated ventilation requirements, but operate the system more economical ventilation rates when the actual demand is lower.

Night Heating and Cooling

The Predator supports several heating and cooling options for unoccupied periods. Using zone temperature data that either comes from the directly connected zone sensor or delivered over the network, the controller can cycle the air handler to meet heating and cooling needs of the zones. This function requires no intervention from a supervisory node. If some other start/stop criteria is required, another node may implement that logic and command the air handler on and off during the unoccupied period.

In cold climates, to prevent mechanical equipment freeze up, there is a need to keep the air handler warm even when the fan is off. The Predator can cycle or modulate an optional hot water valve to keep the mixed air temperature (or discharge temperature) within a desired range while the fan is off.

The Predator can initiate a warm-up sequence for the zones. When the zone temperature and the outdoor temperature are both below adjustable limits and occupancy is due to start soon, the Predator switches to warm-up mode. It issues a network command for the zone controllers to put them in warm-up mode. The only inputs required are the zone temperature and the LonMark compatible schedule variable.

Adaptive Control of Outdoor Air Damper

Past history has proven that tuning for economizer control loops poses problems. For example, when it is particularly cold outside, a small damper movement can cause a big change in the mixed air temperature. The control loop is likely to overshoot or even oscillate which can cause big problems in the air-handling unit. To prevent oscillation, it is necessary to tune the loop specifically for the cold-weather case. Then when warmer weather arrives, the cold-weather tuning leads to sloppy control and an ineffective air conditioning system.

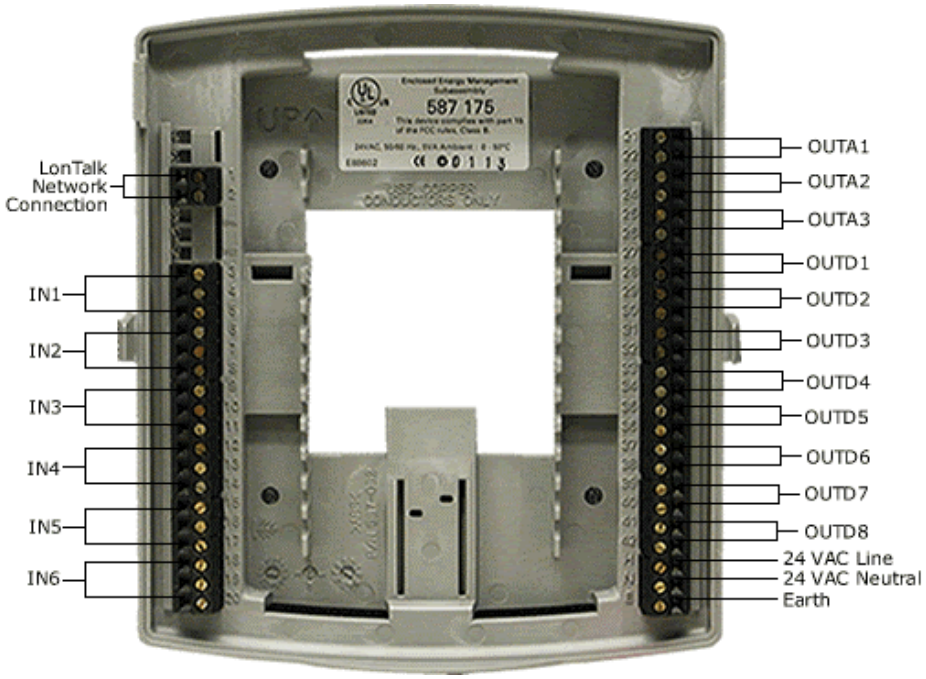
The Predator addresses this dilemma directly by automatically adjusting the economizer control loop tuning to suit the outdoor temperature. Without any attention or maintenance, the loop is always fast, stable and accurate, making the economizer truly economical.

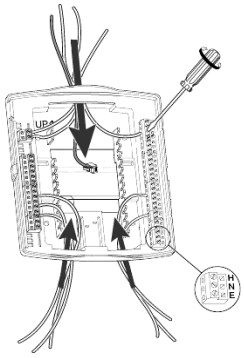
Hardware Map – VAV AHU

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	DISCH_TEMP
In2		in2		RETRN_TEMP
In3		in3	DI, PCT, TEMP	DUCT_PRESS
In4		in4		FAN_STATUS_DI
In5		in5		LOW_TEMP_DI
In6		in6		HI_PRESS_DI
OutA1	outputs	outA1	AO	SUP_FAN_CAP_AO
OutA2		outA2		OA_DMPR_AO
OutA3		outA3		HEAT_COIL_AO
OutD1		outD1	DO, FLT_MTR	SUP_FAN_DO
OutD2		outD2		OA_DAMPER_2POS_DO
OutD3		outD3		DX_STAGE1_DO
OutD4		outD4		DX_STAGE2_DO
OutD5		outD5		DX_STAGE3_DO
OutD6		outD6		DX_STAGE4_DO
OutD7		outD7		HEAT_STAGE1_DO
OutD8		outD8		HEAT_STAGE2_DO

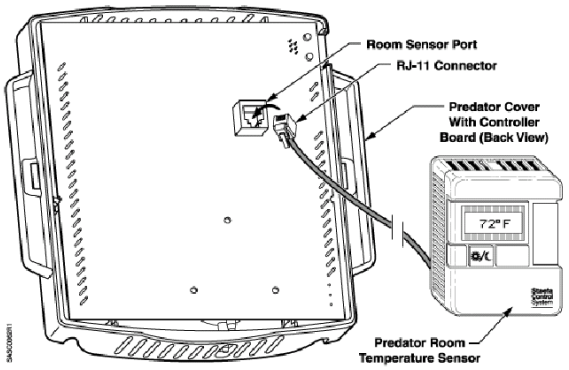
Table 1. Hardware Map

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:

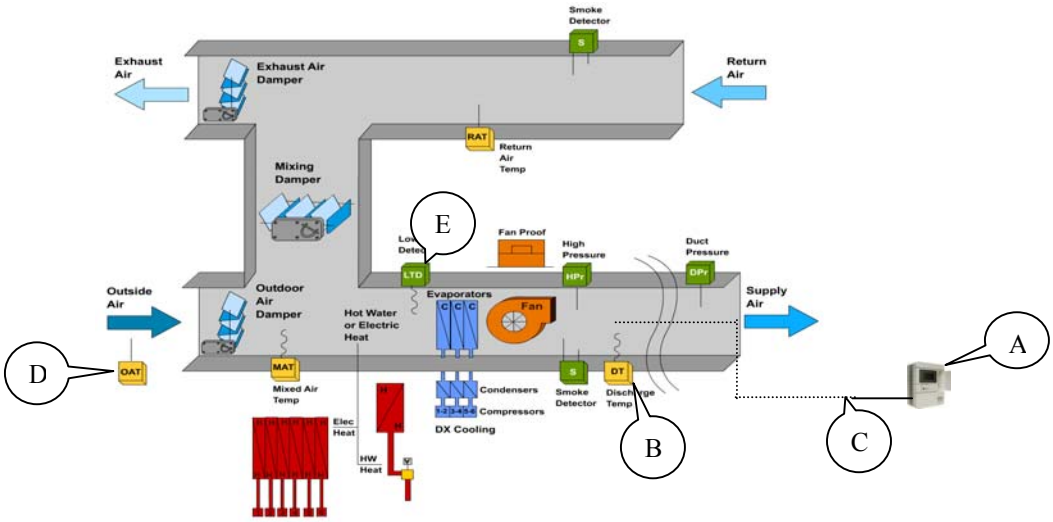
IN and AO:	20 to 22 AWG
DO:	18 to 22 AWG
Power:	16 to 18 AWG
LON Network:	22 AWG Level 4

Transformer Requirements:

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

Figure 3. Predator Wiring Diagrams

Bill of Materials



	Description	Product #
	Predator VAV AHU Controller 6IN 8DO 3AO	587-291
	Predator Full Point Wiring Base	587-175
A.	Predator Room Sensors:	
	Sensing Only	587-180
	Override	587-181
	Temperature Display	587-183(1)
	Override and Temperature Display	587-185(1)
	Notes: (1) Sensor will display Fahrenheit or Celsius temperature	
B.	Duct Sensor (100K thermistor)	535-741
C.	For Network communication: Predator 6-Conductor Room Sensor Cables:	
	25 Foot	588-100A
	50 Foot	588-100B
	100 Foot	588-100C
	- OR -	
	For non-network communications: Predator 4-Conductor Room Sensor Cables:	
	25 Foot	588-101A
	50 Foot	588-101B
	100 Foot	588-101C

Optional Accessories

D.	Outside Air Temperature Sensor	536-778
E.	Low Temperature Stat with auto reset	1341510

Configuration Tables

The application configuration tables below are typical for a VAV AHU controller.

Application Component	Variable Name	Element	Factory Setting
Small VAV Air Handler Core	hVACSeqDelay		5 minutes
	startDelay		0 minutes
	testTime		180 seconds
Cooling Coil CW	clgCoilMtr	TravelTime	125 seconds
		Reverse	False
	coolCoilCtl	Pb	50°F (10.0°C)
		Ti	300 seconds
		Td	0 seconds
	coolCoilEn		False
	coolDeadBand		0.90°F (0.50°C)
	coolLockout	Enable	32°F (0°C)
		Disable	14°F (-10°C)
Discharge Air Temp Sensing	dAClSP		59°F (15°C)
	dAHtSP		95°F (35°C)
	dAResetSrc		0
	maxDAClIn		68°F (20°C)
	maxDAClPct		0.0%
	maxDAClSP		68°F (20°C)
	maxDAHtIn		68°F (20°C)
	maxDAHtPct		100.0%
	maxDAHtSP		104°F (40°C)
	minDAClIn		68°F (20°C)
	minDAClPct		100.0%
	minDAClSP		59°F (15°C)
	minDAHtIn		68°F (20°C)
	minDAHtPct		0.0%
	minDAHtSP		50°F (10°C)
Duct Pressure Sensing	ductStatSP		250 Pa
	ductPresCtl	Pb	500 Pa
		Ti	20 seconds
		Td	0 seconds
	ductPresRange		498 Pa
DX Cooling	coolDeadBand		90°F (50°C)
	coolLockout	Enable	32°F (0°C)
		Disable	14°F (-10°C)
	dXMinOffTime		2 minutes
	dXMinOnTime		2 minutes
	numDXStages		0
	dXStageDelay		3 minutes
Fan Control	fanRampTime		15 seconds
	fanStatusEn		False

Application Component	Variable Name	Element	Factory Setting
Modulating Heat	heatCoilCtl	Pb	68°F (20°C)
		Ti	300 seconds
		Td	0 seconds
	heatCoilEn		False
	htgCoilMtr	TravelTime	125.0 seconds
		Reverse	FALSE
	heatDeadBand		0.90°F (0.50°C)
	heatLockout	Enable	68°F (20°C)
		Disable	71.6°F (22°C)
	heatUnit		Off
OA Damper Control with Mixed Air	econControl		Enabled
	econDBand		1.8°F (1°C)
	econRef	Source	SRC_RETURN_TEMP
		FixedTemp	68°F (20°C)
		Offset	35.6°F (2°C)
	oADmprCntr	Pb	95°F (35°C)
		Ti	200 seconds
		Td	0 seconds
	oAMinPos		0%
	oAReducedPos		0%
	oATempAdaptEn		Enable
	vDmdDesign		100%
	vDmdReduced		0.0%
Occupancy Control	bypassTime		60 minutes
	statSwitchEn		False
	setpoints	OccupiedClg	73°F (23°C)
		StandbyClg	77°F (25°C)
		UnoccupiedClg	82°F (28°C)
		OccupiedHtg	70°F (21°C)
		StandbyHtg	66°F (19°C)
		UnoccupiedHtg	61°F (16°C)
	unocDeadBand		3.6°F (2°C)
	warmupTrig	Duration	0 minutes
		OutTemp	50°F (10°C)
		InTemp	62°F (17°C)
Safeties	hiPressLatch		Enable
	loTempLatch		Enable
Staged Heat	heatDeadBand		0.90°F (0.50°C)
	heatLockout	Enable	68°F (20°C)
		Disable	71.6°F (22°C)
	htStageDelay		300 seconds
	numHStages		0

Control Mode Interaction Table

Device	Mode									
				Occupied		Unoccupied			Safety	
	Off	Fan Only	Starting (Fan Proof)	cool	heat	cool	Idle	heat	low temp	other safety
Fan	off	mod	mod	mod	mod	mod	off	mod	off	off
OA damper	close	close	close	mod	min	mod	close	close	close	close
DX	off	off	off	stage	off	mod	off	off	off	off
Stage heat	off	off	off	stage	stage	stage	off	stage	off	off
Heat valve	off	off	select	mod	mod	mod	select	mod	open	off

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

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