Figure 1. Heat Pump

Features

- LONMARK compliant with Space Comfort Controller Functional Profile (8503), enabling information sharing with LONMARK products from other vendors.

- Single-stage or multi-stage compressor with optional reversing valve control

- Outside air damper control based on mixed air or discharge air temperature with economizer

- Unit shut-down based upon low temperature, condensate overflow, and refrigeration alarms with network reset

- Source temperature sensing to disable cooling or heating compressors

- Configurable outside air temperature lockout of DX cooling and auxiliary and perimeter heat

- Optional fan status input, leaving source temperature sensing

- Maintained or pulsed lighting based on occupancy

Sequence of Operation

Occupied Control

Fan

The fan can be configured to operate continuously in occupied mode, or only when necessary to operate the compressors, auxiliary heat, or outside air damper. An optional fan status input can be used to ensure fan operation before allowing other equipment to operate.

Outside Air Damper

If the economizer is enabled, the optional outside air damper will modulate to maintain the mixed or discharge temperature at setpoint while maintaining a configurable minimum position. As the cooling demand changes, the control setpoint resets within a configurable range. If economizer is not enabled, the damper will go to minimum position.

In heating mode, the outside air damper maintains its minimum position.

Compressor Stages

The Predator can operate heat pumps that have separate inputs for heating and cooling compressors or those that have inputs for compressors and a reversing relay. Configurable minimum-on, minimum-off, and inter-stage periods are observed.

In cooling mode, if economizer is disabled or insufficient to meet room load, the cooling compressors will stage operate to meet room load.

In heating mode, the heating stages will be operated to meet room load.

Auxiliary/Perimeter

Optional auxiliary and perimeter heat can be configured to supply heating in addition to the compressor. In heating mode, auxiliary and perimeter heat operate according to room load.

Unoccupied Control

Fan

In unoccupied mode, the fan cycles on only as necessary to operate the compressors, auxiliary heat or the outside air damper.

Outside Air Damper

In unoccupied modes, the outside air damper operation is configurable. It can remain closed or operate when the economizer is enabled.

Compressor Stages

The Predator can operate heat pumps that have separate inputs for heating and cooling compressors or those that have inputs for compressors and a reversing relay. Configurable minimum-on, minimum-off, and inter-stage periods are observed.

In cooling mode, if economizer is disabled or insufficient to meet room load, the cooling compressors will stage operate to meet room load.

In heating mode, the heating stages will be operated to meet room load.

Auxiliary/Perimeter Heat

Optional auxiliary and perimeter heat can be configured to supply heating in addition to the compressor. In heating mode, auxiliary and perimeter heat operate according to room load.

Safety Shutdown

Low Temperature

A low temperature condition can be detected through a digital input or when the mixed temperature drops below a configurable limit. The OA damper closes and the fan shuts off. The optional auxiliary hot water coil valve opens fully; optional auxiliary staged heat is turned off. Perimeter heat continues to operate. The system may be configured to re-start automatically after the condition clears, or to remain shut down until a manual reset.

Other Safeties

The Predator can also shut down the heat pump if a condensate overflow or refrigeration alarm is detected. The Predator turns off the fan, closes the OA dampers and closes the coil valves. The Predator indicates an alarm condition over the network, and remains shut down until reset manually.

Off

In this mode, the compressors, auxiliary and perimeter heating coil valves/stages, and OA damper are closed and the fan is off.

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.

Special Features

Outside Air Temperature Equipment Lockouts

If the outside air temperature falls below a configurable limit, the cooling DX compressors can be disabled. If the temperature rises above a configurable temperature, the auxiliary and perimeter heat can be disabled.

Source Temperature Compressor Lockout

The Predator can monitor the source water temperature to determine suitability for cooling or heating. The minimum source temperature for heating and the maximum source temperature for cooling can be configured to disable the DX compressor when the limits are reached.

Random Start

The Predator can be configured with a maximum start delay. Whenever the controller is turned on, it will start randomly within the maximum start delay. This prevents all units from operating at once.

Optional Functions

Duct Temperature Sensor

An optional duct temperature sensor may be connected to the Predator for the purpose of monitoring he source temperature. This is useful for functions such as morning warm-up, when you want to be sure warm air is being provided to the space. It is also beneficial as a troubleshooting aid to determine space comfort issues.

Wall Switch

Space occupancy can be controlled via a maintained wall mounted switch. Rooms with varying occupancy schedules (i.e. conference rooms, etc.) can use this device to control occupancy and the lights with one switch.

Occupancy Sensor

An alternative method of controlling space occupancy is through an occupancy sensor. The function of this sensor is similar to the wall switch, but eliminates user intervention by automatically placing the room into occupancy mode when people are sensed in the space. Additionally, if the scheduled is currently in the occupancy mode and the occupancy sensor does not detect any people in the space, the room will go into an energy savings standby mode, while still maintaining comfort.

Lighting Control

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 and a lighting control panel with a LonTalk interface is either not present or not feasible.

Spare I/O

One spare digital input and one spare temperature input are available to monitor miscellaneous inputs. One spare analog output and one spare digital output are available to operate miscellaneous equipment.

Hardware Map – Heat Pump

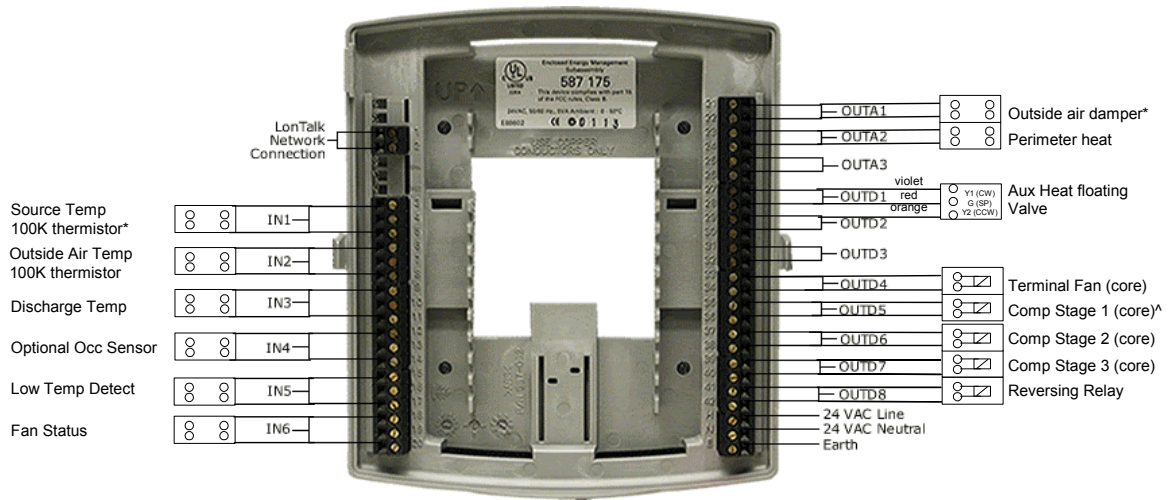| Termination Set	Parameter Set	Element Name	I/O Type	Factory I/O Setting
StatTemp	Inputs	statTemp	TEMP	spaceTemp
StatSetpt	Inputs	statSetpt	TEMP	spaceSetptTemp
StatOvrd	Inputs	statOvrd	DI	statSwitchDi
In1	Inputs	in1	DI, TEMP	dischTemp
In2	Inputs	in2	DI, TEMP	leavingSrcTemp
In3	Inputs	in3	DI, PCT, TEMP	fanStatusDi
In4	Inputs	in4	DI, PCT, TEMP	refrigAlarmDi
In5	Inputs	in5	DI, PCT, TEMP	occSensorDi
In6	Inputs	in6	DI, PCT, TEMP	condensateOvflwDi
OutA1	Outputs	outA1	AO	oADmprAo
OutA2	Outputs	outA2	AO	auxHCoilAo
OutA3	Outputs	outA3	AO	perimHCoilAo
OutD1	Outputs	outD1	DO, FLT_MTR	trmFamDo
OutD2	Outputs	outD2	DO, FLT_MTR	revRelayDo
OutD3	Outputs	outD3	DO, FLT_MTR	dxStage1Do
OutD4	Outputs	outD4	DO, FLT_MTR	dxStage2Do
OutD5	Outputs	outD5	DO, FLT_MTR	auxHCoilFltMtr
OutD6	Outputs	outD6	DO, FLT_MTR	auxHCoilFltMtr
OutD7	Outputs	outD7	DO, FLT_MTR	perimHCoilFltMtr
OutD8	Outputs	outD8	DO, FLT_MTR	perimHCoilFltMtr

In1 through In6 can be used for digital or analog inputs, as follows:
- In1 through In6 are dry contact inputs (with resistors)
- In1 and In2 also accept 100K ohm inputs
- In3, In4, In5, In6 also accept current (4-20 mA) and voltage (0-10 volt) inputs

OutA1, OutA2, and OutA3 are 0-10 volt outputs only

Table 1. Heat Pump Hardware Map

Wiring Diagram

LonTalk Network Connection

Source Temp 100K thermistor* — IN1
Outside Air Temp 100K thermistor — IN2
Discharge Temp — IN3
Optional Occ Sensor — IN4
Low Temp Detect — IN5
Fan Status — IN6

OUTA1 — Outside air damper*
OUTA2 — Perimeter heat
OUTA3
OUTD1 — violet Y1 (CW) / red G (SP) / orange Y2 (CCW) — Aux Heat floating Valve
OUTD2
OUTD3
OUTD4 — Terminal Fan (core)
OUTD5 — Comp Stage 1 (core)^
OUTD6 — Comp Stage 2 (core)
OUTD7 — Comp Stage 3 (core)
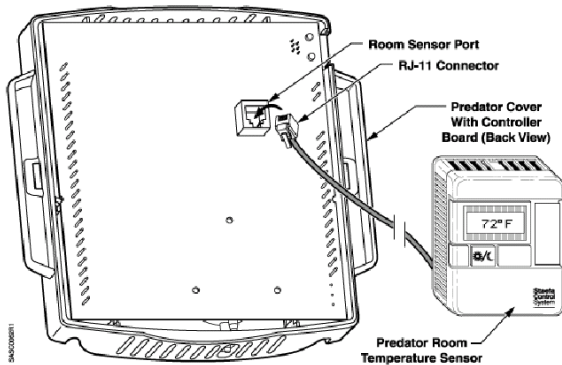OUTD8 — Reversing Relay
24 VAC Line
24 VAC Neutral
Earth

* All inputs can be used for the suggestions above or changed to any of the following:
- Entering source temperature
- Leaving source temperature
- Condensate overflow
- Refrigeration alarm
- Wall Switch override
- Mixed air temp

* Analog outputs can be used for the suggestions above and incorporate the following:
- Aux heat coil
- Spare AO

^ Digital outputs can be used for the suggestions or changed to add the following:
- Aux heat stages 1-3
- Compressor heat stages 1-3 (when no rev relay)
- OA floating damper
- OA 2 position damper
- Perimeter 1 stage of heat
- Perimeter floating heat valve
- Lights Maintained or pulse on/off
- Spare
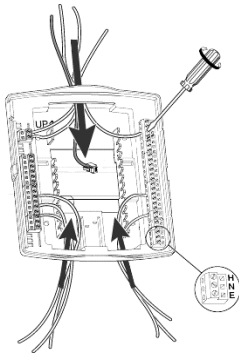
Note: Route wiring from either the bottom opening when using a J-box or from the base sides as shown in the picture when flat or din rail mounting. The image above is for illustrative purposes only

Room Sensor Port
RJ-11 Connector
Predator Cover With Controller Board (Back View)
72° F
Predator Room Temperature Sensor

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

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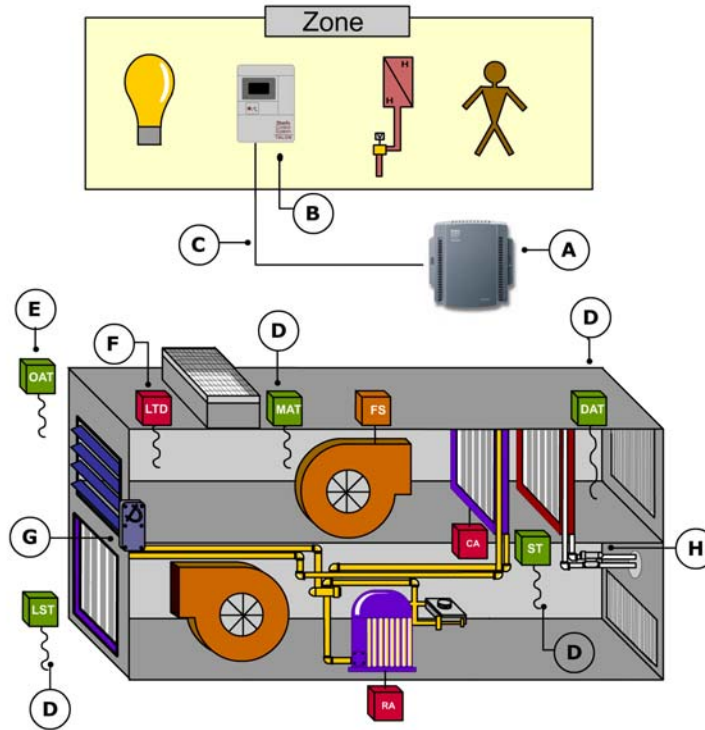
IN and AO:	20 to 22 AWG
DO:	18 to 22 AWG
Power:	16 to 18 AWG
LON Network:	22 AWG Level 4

Transformer Requirements:

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

Figure 3. Predator Wiring Diagrams

Bill of Materials

Tag	Description	Product #
A	Predator Heat Pump 4IN, 6DO, 1RTS	587-240
	Predator Reduced Point Wiring Base	587-170
	Predator Heat Pump 6IN, 8DO, 3AO, 1RTS	588-250
	Predator Full Point Wiring Base	587-175
B	Predator Room Sensors:	
	Sensing Only	587-180
	Override	587-181
	Setpoint	587-182
	Temperature Display	587-183
	Setpoint and Override	587-184
	Override and Temperature Display	587-185
	Setpoint and Temperature Display	587-186
	Setpoint, Override, and Temperature Display	587-187
	Predator Room Sensors *without* Logo's:	
	No Logo Sensing Only	587-550B
	No Logo Setpoint	587-552B
	No Logo Setpoint and Override	587-554B
	No Logo Setpoint, Override, and Temperature Display	587-557B
C	Predator Room Sensor 6-Conductor Plenum Rated Cables:	
	25 Foot	588-100A
	50 Foot	588-100B
	100 Foot	588-100C
	Predator Room Sensor 4-Conductor (no network connection) Plenum Rated Cables:	
	25 Foot	588-101A
	50 Foot	588-101B
	100 Foot	588-101C
D	Supply/Mixed/Source Air Temperature 100K thermistor 40 to 150F	535-741
Not shown	Water Pipe Temperature sensor	536-777
E	Outside Air Temperature 100K thermistor 0 to 120F	536-778
F	Low Temperature Detector	134-1510
G	Floating damper actuator 44 lb. In.	GDE.131.P
H	Floating valve actuator	SSB81U

Configuration Tables

The application configuration tables below are typical for a Heat Pump controller.

App Component	Configuration Parameter	Element	Factory Setting	Desired Setting
Heat Pump Core	htgClgSwit	dmdDeadband	1%	
		tmpDeadband	0.5 °C	
		timeDelay	6 min	
	maxStDelay	minutes	10 min	
	setPnts	Unoccupied cooling setpoint	82.4°F (28.0°C)	
		Standby cooling setpoint	77.0°F (25.0°C)	
		Occupied cooling setpoint	73.4°F (23.0°C)	
		Occupied heating setpoint	69.8°F (21.0°C)	
		Standby heating setpoint	66.2°F (19.0°C)	
		Unoccupied heating setpoint	60.8°F (16.0°C)	
Space Temp Sensing	statSwitchEn	UNVT_boolean	TRUE	
	stptDialEn	UNVT_boolean	FALSE	
	tempStptLim	minTemp	19.0 °C	
		maxTemp	25.0 °C	
Mixed Air Temperature Sensing	mixedLowLimEn		FALSE	
	mixedLLStpt	enable	39.20°F (4.00°C)	
		disable	46.40°F (8.00°C)	
	mixedLLDelay		15.0 sec	
Safeties	loTempLatch		FALSE	
Outdoor Air Damper Control	econDBand		1.0 °C	
	oACtrlDXOn		MODULATE	
	oACtrlSrc		MIXED	
	oACtrlStptRng	minTemp	53.60°F (12.00°C)	
		maxTemp	64.40°F (18.00°C)	
	OADFanReq	percentOn	3%	
		percentOff	0%	
	oADmpr2PosEn		FALSE	
	oaDmpr	enable	TRUE	
		dmdAtMin	0%	
		dmdAtMax	40%	
	oADmprMtr	travelTime	90 sec	
		reverse	FALSE	
	oADmprNPurg		MODULATE	
	oADmprPcool		MODULATE	
	oADmprUnocc		MODULATE	
	oADmprMin		10%	
Source State and Temp	hPSrcTemp	neededToCool	32.0 °C	
		neededToHeat	4.0 °C	

App Component	Configuration Parameter	Element	Factory Setting	Desired Setting
Fan Control	dxFanOffDly		10 sec	
	fanMinOn		2 min	
	fanOcc		ON	
	fanStatusEn		FALSE	
	fanStby		MODULATE	
	fanWrmup		ON	
	hCoilFanRq	percentOn	3%	
		percentOff	0%	
	htgFanDelay		10 min	
Terminal DX Heating and Cooling with Reversing Relay	dXClgLockout	enable	50.00°F (10.00°C)	
		disable	46.4°F (8.00°C)	
	dXFanOffDly		10 sec	
	dXMinOffTime		2 min	
	dXMinOnTime		2 min	
	dXStageDelay		3 min	
	numDXStages		1	
	revRelayEn		TRUE	
	trmClgCoil	enable	TRUE	
		dmdAtMin	50%	
		dmdAtMax	100%	
	trmHtgCoil	enable	TRUE	
		dmdAtMin	0%	
		dmdAtMax	100%	
Auxiliary Heat	auxHtgCoil	enable	FALSE	
		dmdAtMin	0%	
		dmdAtMax	100%	
	auxHtgMtr	travelTime	125 sec	
		reverse	FALSE	
	auxLockout	enable	20.0 °C	
		disable	22.0 °C	
	hStageCyc		10 min	
	numHStages		0	
Lighting Control	lightsLag			
Perimeter Heating	numPerimStgs		0	
	perimHUnocc		MODULATE	
	perimHWrmup		CYCLE	
	perimHtgCoil	enable	FALSE	
		dmdAtMin	0%	
		dmdAtMax	100%	
	perimHtgMtr	travelTime	125 sec	
		reverse	FALSE	
Occupancy Control	bypassTime		60 min	
	occSensorEn		FALSE	
	statSwitchEn		FALSE	
	wallSwitchEn		FALSE	
Spare Digital Output				
Spare Analog Output				
Spare Digital Reading				
Spare Analog Temp				

Control Mode Interaction Table

	Heat		Warmup	Cool		Night Purge	Pre-Cool	Off	Fan Only	Safeties
	Occ	Unocc		Occ	Unocc					
Trm DX Htg	Heat Loop	Heat Loop Cycle OFF	Heat Loop Cycle Max OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
Aux Htg Coil	Heat Loop	Heat Loop Cycle OFF	Heat Loop Cycle Max OFF	Closed	Closed	Closed	Closed	Closed	Closed	Max (HW) / OFF (elec)
Perim Heat	Heat Loop	Heat Loop Cycle Max OFF	Heat Loop Cycle Max OFF	Closed	Closed	Closed	Closed	Closed	Closed	Heat Loop
Fan	ON Demand	Demand	ON Demand	ON Demand	Demand	Demand	Demand	OFF	ON	OFF
OA Dmpr	Min	Closed	Closed	Cool Loop Min	Cool Loop Close	Cool Loop Max OFF	Cool Loop Max OFF	Closed	Closed	Closed
Trm DX Clg	OFF	OFF	OFF	Cool Loop	Cool Loop Cycle OFF	Cool Loop Cycle OFF	Cool Loop Cycle Max OFF	OFF	OFF	OFF

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