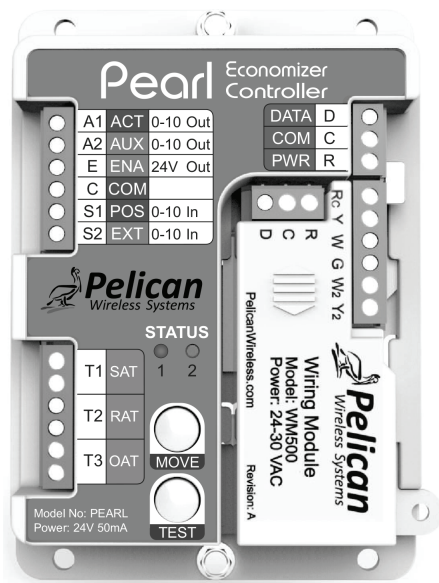




# Installation Guide

## PEARL Economizer Controller



Pelican Wireless Systems, 2655 Collier Canyon Rd. Livermore, CA 94551  
Phone: 888.512.0490  
Email: [support@pelicanwireless.com](mailto:support@pelicanwireless.com) Website: [www.PelicanWireless.com](http://www.PelicanWireless.com)

## Compatibility

The PEARL is an add-on accessory to the Pelican thermostat (TS200 or TS250). It provides inputs, outputs and logic that allow for intelligent economization and demand ventilation control.

The PEARL is designed to control most 24VAC HVAC systems, including: gas, electric, oil, heat pump, and forced air. It is also designed to control 0-10VDC variable speed fans and modulating economizer damper actuators.

## Caution

Failure to follow these instructions or improper installation, service, adjustments, maintenance, and/or use can result in personal injury, damage to personal property, and/or cause a hazardous and dangerous situation. Consult a qualified installer, distributor, or Pelican Wireless Systems for assistance or support. Follow all safety codes and regulations and all local and state building codes. Read instructions thoroughly and follow any warnings or notes.

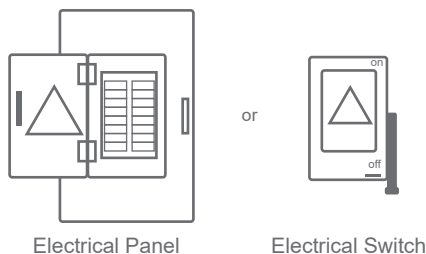
Disconnect power during the installation of this product. All wiring must conform to local and state codes and ordinances. The PEARL is designed to communicate with Pelican products only. This guide is designed to assist Pelican Certified Contractors on installing the PEARL for economizer damper control and/or demand control ventilation applications. For Certification assistance or other support questions contact Pelican Support at 888.512.0490.

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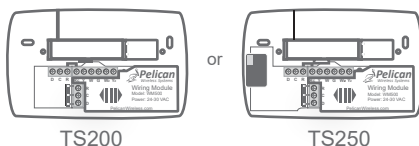
## 1. Switch off power

This will protect you, the HVAC equipment, and prevent electrical faults. This step is required for safety.



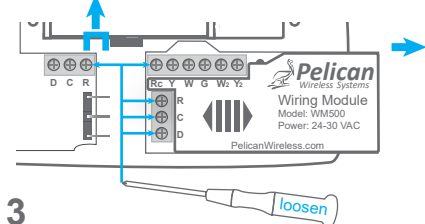
## 2. Remove the Pelican thermostat faceplate

Begin by removing the cover of your Pelican Thermostat (TS200 or TS250). To remove the cover, gently pull the thermostat faceplate away from the back plate.



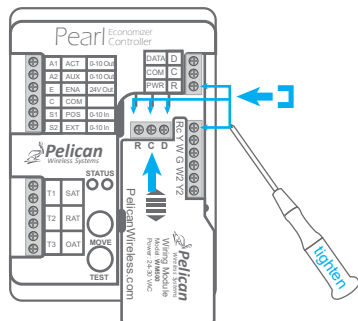
## 3. Remove the wire module (WM500) from the thermostat base

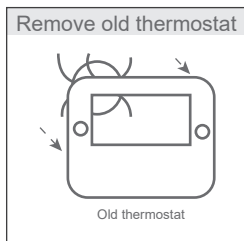
Loosen the R and Rc terminals to remove the jumper (save jumper). Loosen R, C, D terminals on WM500. Gently slide WM500 to the right to remove.



## 4. Insert the WM500 into the PEARL

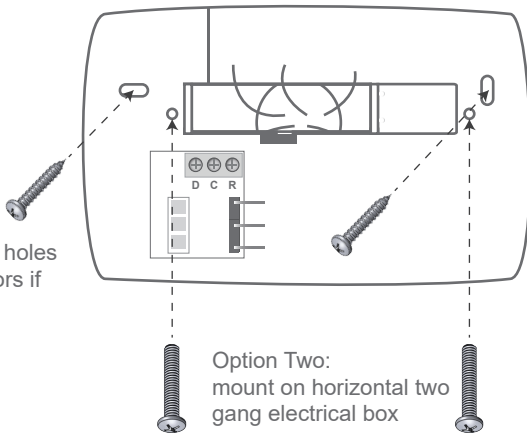
Gently push WM500 all the way into the PEARL. Install jumper between R and Rc and tighten. Tighten R, C, D terminals on WM500.





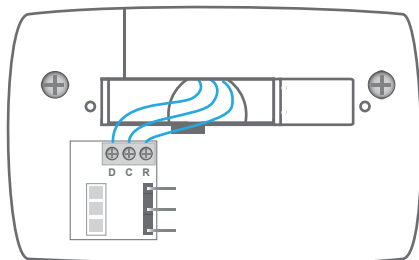
## 5. Mount thermostat sub-base onto the wall

Option One:  
standard mounting holes  
(use dry wall anchors if  
needed)



## 6. Connect 3 unique wires to D, C, and R terminals

Record which wires used for each terminal. These wires will connect to the same terminals at the PEARL.

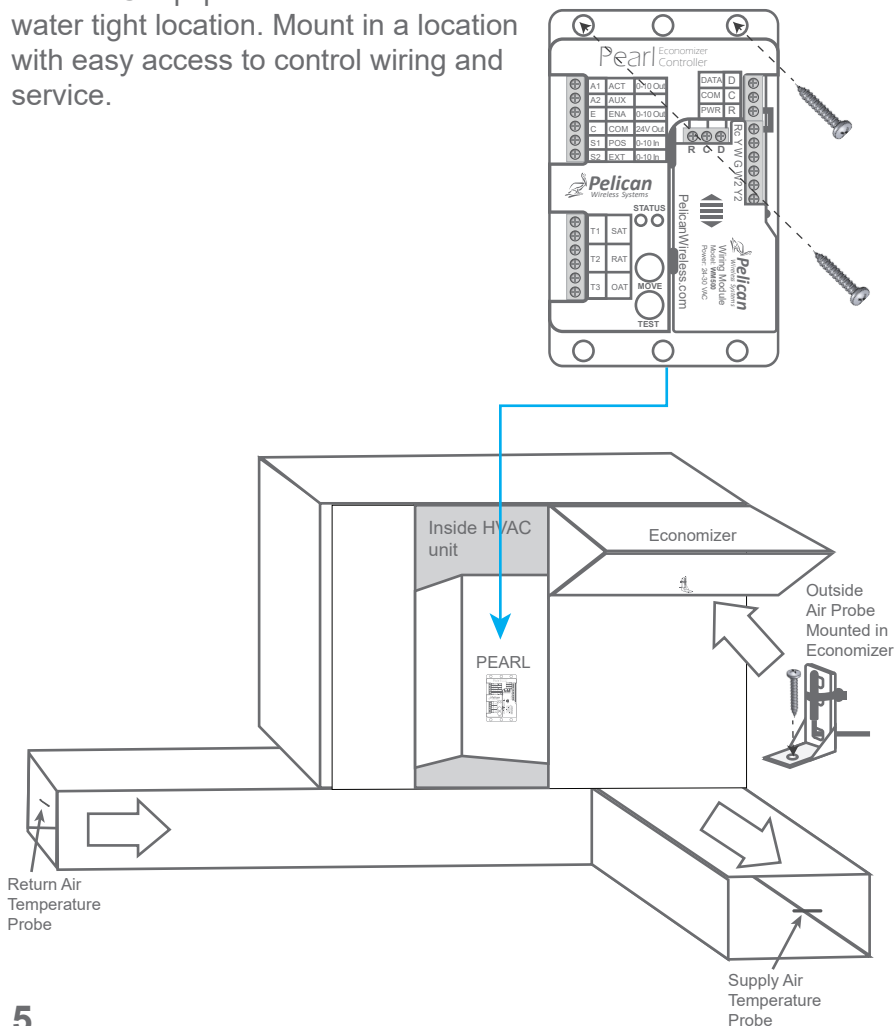


## 7. Attach thermostat faceplate

Line up the three pin male connector on the thermostat faceplate's electrical board with the three pin female connector on the thermostat sub-base. Gently press the thermostat front plate onto the mounted sub-base.

## 8. Install the PEARL inside the HVAC equipment

The PEARL should be mounted inside the HVAC equipment or enclosed in a water tight location. Mount in a location with easy access to control wiring and service.



Left-Top  
Terminal Block



### Conventional Control (Right Terminals)

DATA	D	⊕
COMMON	C	⊕
24VAC PWR	R	⊕
24VAC	Rc	⊕
COOL STAGE 1	Y	⊕
HEAT STAGE 1	W	⊕
FAN or 24V VFD ENABLE	G	⊕
HEAT STAGE 2	W2	⊕
COOL STAGE 2	Y2	⊕

### Heat Pump Control (Right Terminals)

DATA	D	⊕
COMMON	C	⊕
24VAC PWR	R	⊕
24VAC	Rc	⊕
COMPRESSOR STAGE 1	Y	⊕
REVERSING VALVE (O/B)	W	⊕
FAN or 24V VFD ENABLE	G	⊕
AUXILIARY HEAT	W2	⊕
COMPRESSOR STAGE 2	Y2	⊕

### Economizer and VFD Control (Left-Top Terminal Block)

⊕	A1	ECONOMIZER ACTUATOR (output)	0-10 Out
⊕	A2	VARIABLE FREQUENCY DRIVE (output)	0-10 Out
⊕	E	24VAC ENABLE OUTPUT	24V Out
⊕	C	COMMON	NEUTRAL
⊕	S1	ACTUATOR FEEDBACK (input)	0-10 In
⊕	S2	0-10VDC INPUT	0-10 In

### 10K Type II Temperature Probe Inputs (Left-Bottom Terminal Block)

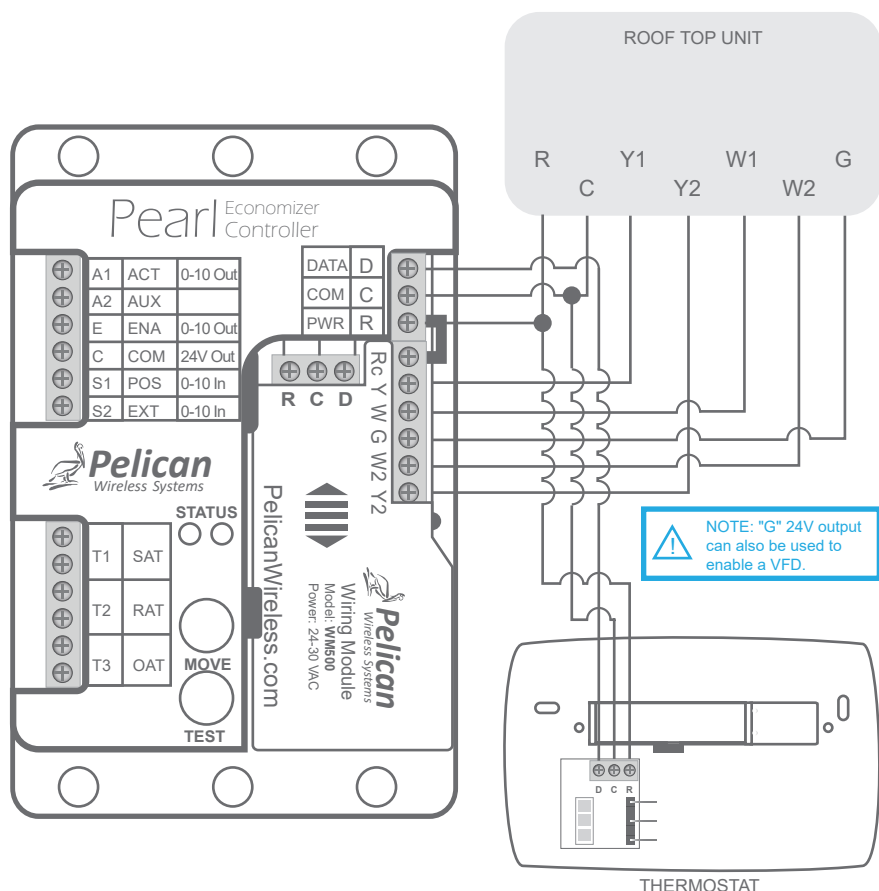
⊕	T1	SAT	SUPPLY TEMPERATURE
⊕	T2	RAT	RETURN TEMPERATURE
⊕	T3	OAT	OUTSIDE AIR TEMPERATURE



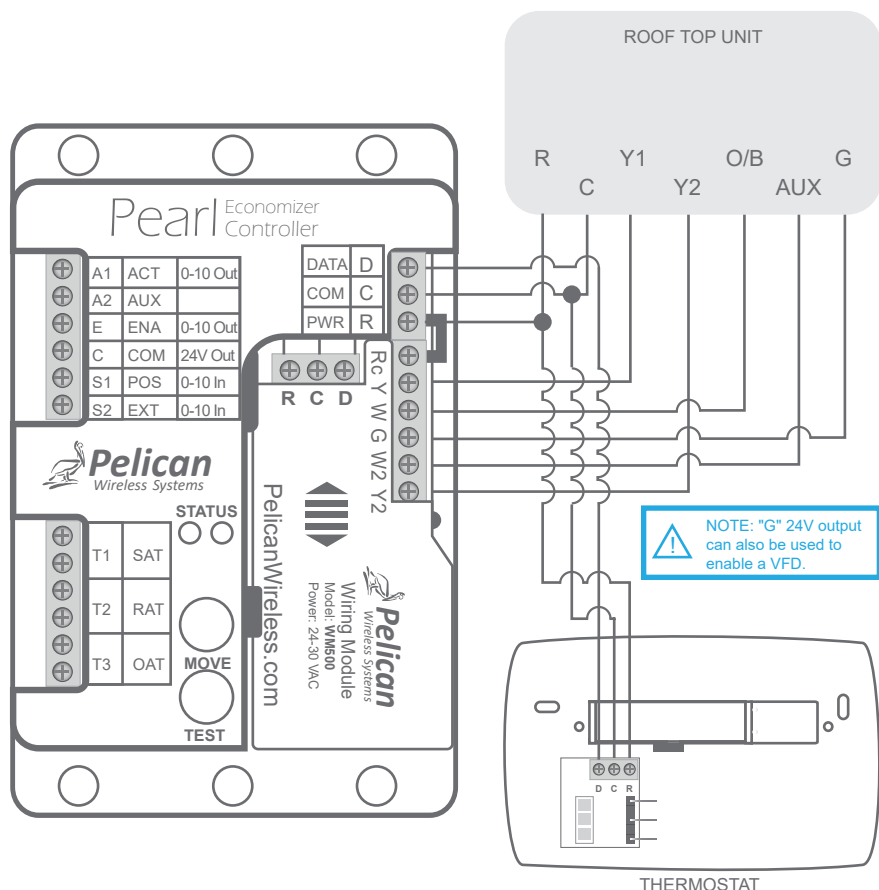
**CAUTION:** Do **NOT** connect 24V or any other electrical voltage to these terminals.



# Conventional Unit Wiring (Right Terminal Block)

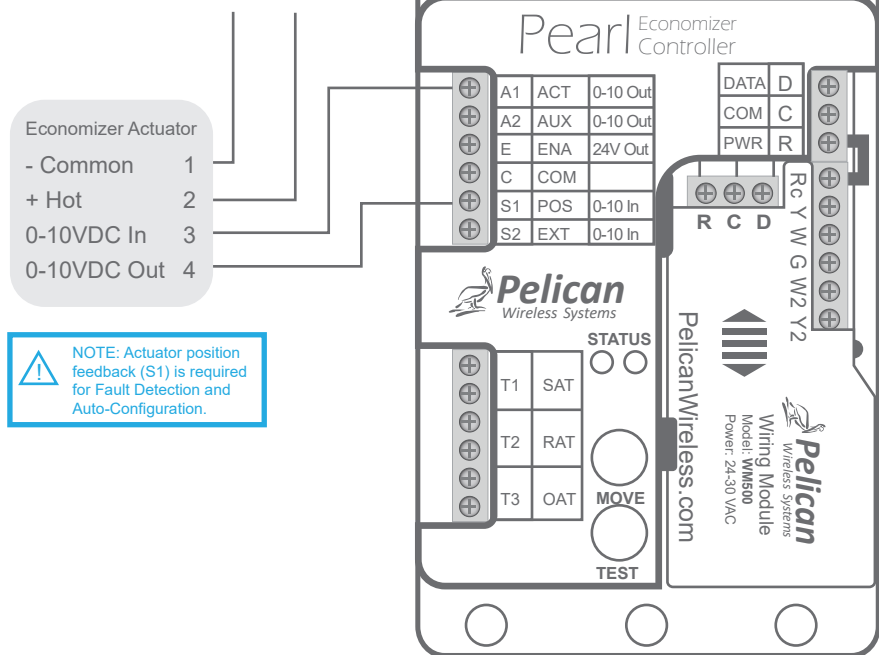


# Heat Pump Unit Wiring (Right Terminal Block)

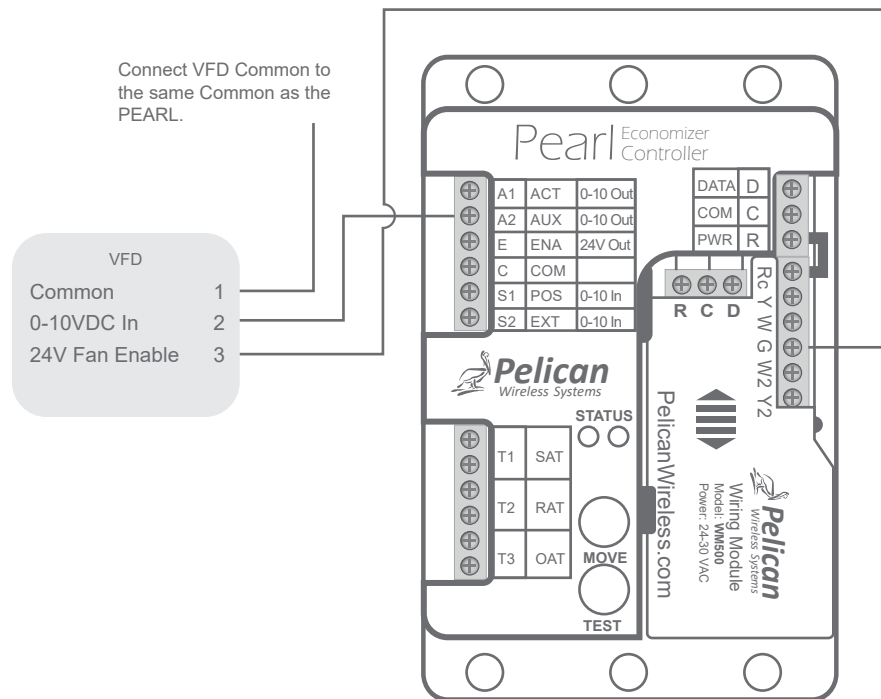


# Economizer Actuator Wiring (Left-Top Terminal Block)

Connect actuator power to the same 24VAC power source as the PEARL.

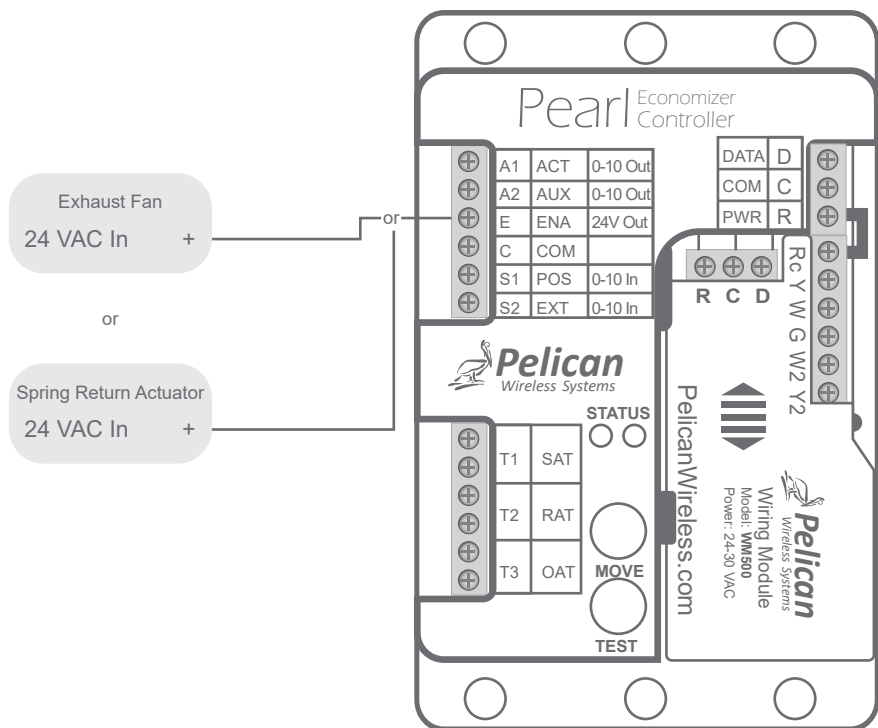


# Variable Frequency Drive (VFD) Wiring (Left-Top Terminal Block)



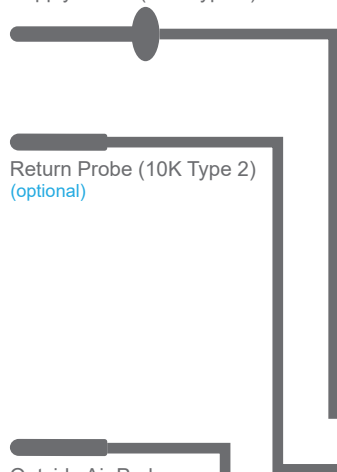
## 24VAC Economizer Enable Output (Left-Top Terminal Block)

The “E” terminal is energized whenever the Economizer or Demand Ventilation is active and can be used to control exhaust fans or auxiliary economizer equipment.



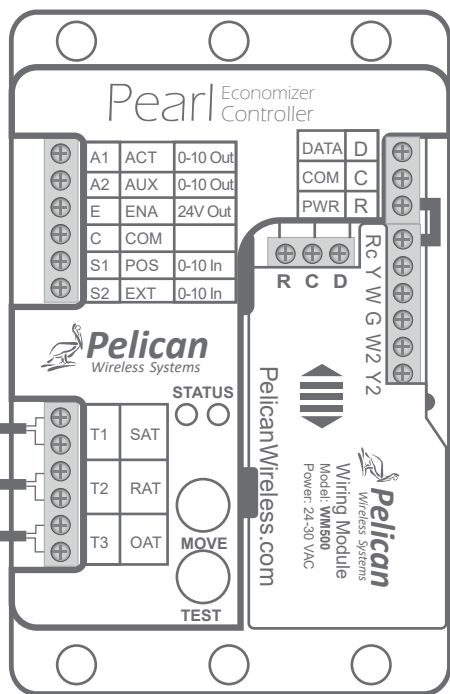
## 10K Type 2 Thermistor Wiring (Left-Bottom Terminal Block)

Supply Probe (10K Type 2)



Return Probe (10K Type 2)  
(optional)

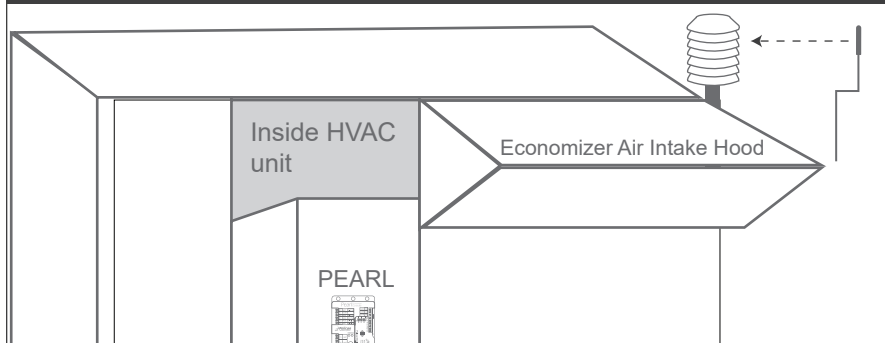
Outside Air Probe  
(10K Type 2)



**CAUTION:** The Outside Air Temperature Probe must be mounted outside in a weather resistant, sunshielded enclosure or inside the air intake hood mounted on the provided nylon mounting stand.

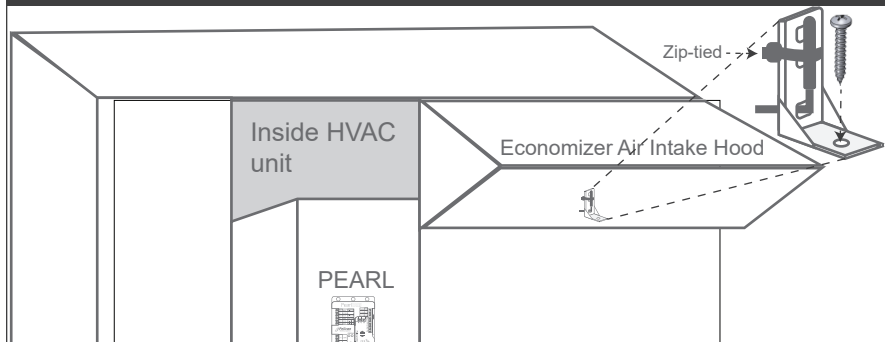
# Mounting Outside Air Probe

## Option 1) Install Outside Air Probe Inside PVC Enclosure



Mount outside air probe inside a weather resistant, sun shielded PVC enclosure directly outside of Air Intake Hood.

## Option 2) Install Outside Air Probe Inside the Air Intake Hood



Attach the outside air probe on the provided Nylon Mount. Place mount inside the air intake hood where sun and water will not affect temperature readings.

## Start Up

Restore power to the HVAC equipment.

The PEARL will need to be calibrated and configured to work with the HVAC system and must conform to local and state codes and ordinances. If being installed as part of a Utility program, the PEARL must be configured to meet all requirements for that program.

### IMPORTANT

*The PEARL must be correctly wired to the HVAC equipment and a Pelican thermostat following all instructions outlined in this install guide for the device to work properly.*

The PEARL comes with an **Automated One-Touch Calibration and Configuration** option. This configuration follows the sequence of operation beginning on page 21. Custom configuration adjustments can be made to the PEARL by logging into the Pelican Web Portal using any Internet Enabled Smart phone, Tablet, or PC.





















Completing the installation is accomplished in three steps detailed on the following pages. These steps are:

1. Verify Pearl Status Lights
2. Verify Actuator Movement
3. Perform Automated One-Touch Calibration and Configuration.

To perform these steps, the Pearl and Pelican Thermostat should be installed, all wiring should be complete, and power should be On for both devices.





# Status Lights During Normal Operation

	1 green light	2 red light
Normal Operation	 Solid	 Off
No Power <i>Check transformer and R, C connections.</i>	 Off	 Off
Connecting <i>PEARL is synchronizing with the thermostat.</i>	   Blinking	 Off
No Communication <i>PEARL is unable to communicate with thermostat. Verify R, C, D terminals are tightly screwed down at PEARL and thermostat. Check that the R, C, D wires match from PEARL to thermostat.</i>	 Off	   Blinking
Damper Position Error <i>Damper feedback is indicating incorrect position. Check damper, actuator and S1 (POS) signal.</i>	 Solid	 Solid
Supply Temperature Error <i>Unable to read the supply temperature probe. Check supply probe, wires, and terminal (T1).</i>	 Solid	 every 2 seconds 1 Blink
Outside Temperature Error <i>Unable to read the outside temperature probe. Check outside air probe, wires, and terminal (T3).</i>	 Solid	 every 2 seconds 3 Blinks
Resetting <i>24 VAC power has just been applied or losing power. Check transformer and R, C connections.</i>	 Flashing	 Off

## Testing the Actuator with the Move Button


Before configuring the PEARL, it is easy to test if the economizer actuator is correctly wired to the PEARL (A1) output terminal and to verify damper movement. When powered ON (A1) will output 2.0 VDC. This is the default and typically used as the closed damper position.

Pressing the MOVE button  will output the opposite voltage or 10.0 VDC. Status light 1 (green light) will begin flashing indicating the PEARL is moving the damper to the open position.

*Opening economizer damper* .....   
flashing

Pressing the MOVE button again will switch the output back to 2.0 VDC. Status light 2 (blue light) will begin flashing indicating the PEARL is moving the damper to the closed position.

*Closing economizer damper* .....   
flashing

The MOVE button  can be pressed as many times as required to test the actuator and damper movement. Flashing green always indicates the PEARL is outputting a high DC voltage or is opening the damper, flashing blue always indicates the PEARL is outputting a low DC voltage or is closing the damper.

## Automated One-Touch Configuration

The Automated One-Touch Configuration process is designed to program the PEARL based on feedback from the equipment the PEARL has been wired to. The automated configuration sequence can also be activated Online from a Smart phone, Tablet, or PC.

### IMPORTANT

*The PEARL must be correctly wired to the HVAC equipment and a Pelican thermostat following the directions in this installation guide for the Automated One-Touch Setup to complete. All devices must be powered ON and communicating for setup.*

To use the **Automated One-Touch Configuration** process you must have an economizer actuator with a position feedback output wired to the S1 terminal on the PEARL. At this time you will also want to set any manual actuator stops if required.


NOTE: The Automated One-Touch Configuration will program the PEARL following ASHRAE and California Title 24 CEC specifications for economization and demand control ventilation sequence of operations (pages 21). To modify the PEARL's configuration settings, you must program the PEARL through the Pelican Web Portal using an Internet Enabled Smart phone, Tablet, or PC.

## To begin Automated One-Touch Configuration:

**NOTE:** Each step can take 1 to 2 minutes to complete.



1. Switch power **ON** at breaker box or electrical switch.
2. The PEARL will power on. Status light 1 (green light) must be solid indicating **NORMAL OPERATION**.


Normal operation .....   
solid

3. Press the  button to start the Automated One-Touch Configuration. Status light 1 (green light) and Status light 2 (blue light) will begin slowly blinking.

Test started .....        
blinking                      blinking

4. After approximately 60 seconds Status light 2 (blue light) will begin flashing to indicate the PEARL is moving the damper to the **FULLY CLOSED** position.

Closing economizer damper .....       
flashing


If the economizer damper begins **OPENING** during Step 5 then press the  button to switch to closing the damper.

Switching damper direction .....       
flashing

Status light 2 (blue light) will begin flashing to indicate the PEARL is now correctly moving the damper to the **FULLY CLOSED** position.

Closing economizer damper .....       
flashing

5. 30 seconds after reaching **FULLY CLOSED**: Status light 1 (green light) will begin flashing to indicate the PEARL is moving the damper to the **FULLY OPEN** position.











Opening economizer damper .....       
flashing

6. If test is successful settings will be stored. Status light 1 will be solid green. Normal operation .....  solid

If any other light pattern is present, refer to the following section to determine the reason for the error. Correct the problem and then re-run the One-Touch Configuration.

# Trouble Shooting One-Touch Configuration

If status light 2 turns or flashes **RED** at anytime during or after the configuration sequence, follow this guide to identify the issue:

	1 green light	2 red light
<b>Unable to Test</b> <i>PEARL is unable to communicate with thermostat. Verify R, C, D terminals are tightly screwed down at the PEARL and thermostat. Check that the R, C, D wires match from PEARL to thermostat.</i>	 <b>Off</b>	 <b>Solid</b>
<b>No Communication</b> <i>PEARL is unable to communicate with thermostat. Verify R, C, D terminals are tightly screwed down at the PEARL and thermostat. Check that the R, C, D wires match from PEARL to thermostat.</i>	 <b>Off</b>	 <b>Blinking</b>
<b>Damper Error</b> <i>Damper feedback (S1) is receiving incorrect position. Check damper and actuator.</i>	 <b>Solid</b>	 <b>Solid</b>
<b>Supply Temperature Error</b> <i>Unable to read the supply temperature probe. Check supply probe, wires, and terminal (T1).</i>	 <b>Solid</b>	 <i>every 2 seconds</i> <b>1 Blink</b>
<b>Outside Temperature Error</b> <i>Unable to read the outside temperature probe. Check outside air probe, wires, and terminal (T3).</i>	 <b>Solid</b>	 <i>every 2 seconds</i> <b>3 Blinks</b>

# Sequence of Operation

## PEARL™ Economizer Controller

### Overview

The Pearl Economizer Controller provides automated control of HVAC Economizers and associated equipment. The controller has built-in logic to:

- Deliver cool outdoor air to reduce the need for mechanical cooling.
- Provide necessary ventilation in commercial buildings.
- Supply Demand-Controlled ventilation based on measured CO<sub>2</sub> levels in the conditioned space.
- Control a variable speed fan based on types of demand.

The sequence of operation for each of these functions works independently except for the overlap of damper position requested by each function. The overlapping requirements are arbitrated to provide the required outdoor air for each function.

## **Controller Inputs/Outputs**

### **HVAC Signals**

Y, Y2, G, W, W2, O/B 24VAC – Industry standard 24VAC signal outputs directly control up to 2 stages of Heat and 2 stages Cool for both Conventional and Heat Pump systems. Auxiliary and Emergency Heat are also supported.

### **Economizer Signals**

ACT 0-10 VDC Actuator Output – This signal modulates the damper actuator.

POS 0-10 VDC Actuator Position Input – This signal tracks damper position.

ENA 24 VAC Enable Output – This signal energizes when the Economizer is active and can be used to control exhaust fans or auxiliary economizer equipment.

### **Variable Speed Fan Signals**

AUX 0-10 VDC Speed Output – This signal adjusts the speed of the fan.

G 24 VAC fan start/stop signal.

### **Temperature Sensors**

SAT 10K type 2 input for Supply Temperature

RAT 10K type 2 input for Return Temperature

OAT 10K type 2 input for Outside Air Temperature

### **Supplied Accessories**

(3) 10K type 2 temperature sensors – 1% accuracy with 0.1 °F resolution

(1) Outside Air Sensor Mount – insulated intake hood mount

## **Thermostat Inputs**

Integrated Room Temperature Sensor: -20 °F – 128 °F with 0.1 °F resolution (Model TS200)

Integrated CO2 sensor: 0 – 2000 ppm +/- 50 ppm accuracy, 1 ppm resolution (Model TS250)

Integrated Humidity sensor: 0 – 100% RH (Model TS200H or TS250H)

## **Supplied Online Data**

Outside Relative Humidity - local humidity levels based on installation location zip code.

Barometric Pressure - local barometric pressure levels based on installation location zip code

## **Optional Accessories**

TA1 – wired sensor: -20 °F – 128 °F with 0.1 °F resolution or input for dry contact Occupancy sensor

RT1 – wireless remote sensors: -20 °F – 128 °F with 0.1 °F resolution

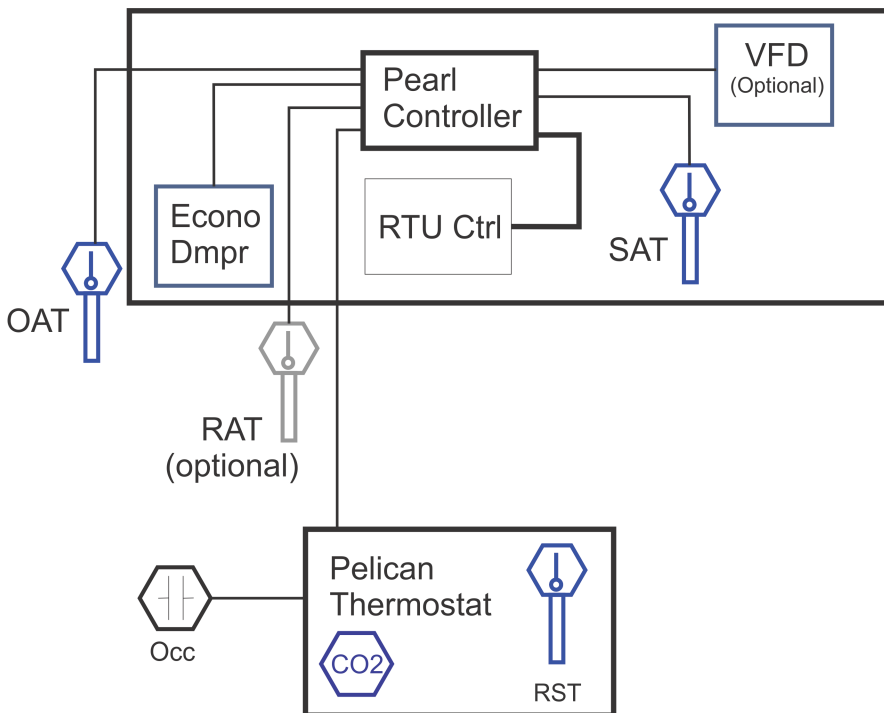
PRX1 - wireless input for dry contact Occupancy sensor



## Input/Output Wiring

All interconnect wiring for Thermostats, Pearl Controller, Optional Sensors, Actuators and HVAC signals can be done with standard 18 AWG solid thermostat wire or similar.

## Location of Components in an Economizer System.



## Configuration Parameters

Parameter	Range	Default
High Limit Temperature <i>Maximum outside temperature to allow active economization.</i>	Automatic or 30°F – 90°F	Automatic (blank)
Differential Limit <i>Economizer is only enabled if the outside temperature is at least this many degrees below the room space temperature.</i>	0°F – 6°F	2°F
Variable Damper <i>Set the damper to be Modulating (ON) or Open/Close (OFF).</i>	On / Off	On
Damper Voltage - Open <i>Set the output voltage for fully open damper.</i>	0.0 – 10.0 V	10.0 V
Damper Voltage - Closed <i>Set the output voltage for fully closed damper.</i>	0.0 – 10.0 V	2.0 V
Minimum Damper Position <i>Minimum damper percent open for ventilation.</i>	0 – 100%	10%
Track Damper Position <i>Use S1 analog input to track and verify economizer damper position.</i>	On / Off	On
Demand Ventilation <i>Adjust ventilation based on CO2 levels and high limit setting.</i>	On / Off	On
VFD Cooling Fan Speed <i>Fan speed to use during a cooling cycle.</i>	0 – 100%	100%
VFD Heating Fan Speed <i>Fan speed to use during a heating cycle.</i>	0 – 100%	100%
VFD Ventilation Fan Speed <i>Fan speed to use during a fan circulation or ventilation cycle.</i>	0 – 100%	50%

Parameter	Range	Default
<b>Input Sensor T1</b> <i>10K type 2 temperature sensor input, dry contact alarm input, or dry contact occupancy input.</i>	Temperature, Temp Monitor, Alarm, Occupancy	Supply Temperature
<b>Input Sensor T2</b> <i>10K type 2 temperature sensor input, dry contact alarm input, or dry contact occupancy input.</i>	Temperature, Temp Monitor, Alarm, Occupancy	Return Temperature
<b>Input Sensor T3</b> <i>10K type 2 temperature sensor input, dry contact alarm input, or dry contact occupancy input.</i>	Temperature, Temp Monitor, Alarm, Occupancy	Outside Temperature
<b>Fixed Enthalpy Limit</b> <i>Economizer is only enabled if the outside air enthalpy is below 28 Btu/lb or at higher elevations below the calculated enthalpy at 75°F and 50% relative humidity at that elevation.</i>	On / Off	Off

## Thermostat Control

Thermostat sequence of operation is outside the scope of this guide. However, the operation of the Pearl Economizer Controller is directly tied to the thermostat's decision to enable Heating, Cooling or Ventilation. These decisions are based on thermostat configuration, user set points, operating schedules, Demand Response signals, and Occupancy sensors which are all fully supported by Pelican thermostats. Setup and management of the thermostat and all economizer and ventilation functions are provided through an integrated Web-App.

## Economizer Control

The economizer sequence provides cool outside air to satisfy room cooling demand either by itself or in combination with mechanical cooling stages. The proprietary algorithm maximizes the use of free cooling and minimizes the use of mechanical cooling.

1. Configurable limits – High Temperature Limit, Minimum Temperature Differential, and Fixed Enthalpy Limit restrict the economizer from operating when set.
  - a. High Temperature Limit – If set, the economizer will be disabled if the outside temperature (**OAT**) exceeds this value. If left unset, the system will automatically adjust the high limit based on the room temperature.
  - b. Minimum Temperature Differential – The economizer will only be enabled if the outside temperature (**OAT**) is at least this many degrees below the room temperature. This should be configured based on the location's climate zone. The default is 2°F.

c. Fixed Enthalpy Limit – If enabled, the Economizer is only active if the outside air enthalpy is below 28 Btu/lb or at higher elevations below the calculated enthalpy at 75°F and 50% relative humidity at that elevation.

**2. Activation** – The economizer will be activated if the thermostat logic is calling for cooling and the conditions in item 1 are satisfied.

**3. The outside air damper modulates in the following modes:**

a. Outside temperature (**OAT**) is below room temperature and above target discharge temperature (55°F) – damper open 100%.

b. Outside temperature (**OAT**) is below Target Supply Temperature – damper will modulate to maintain Target Supply Temperature.

**4. Mechanical Cooling** – At the beginning of the cooling cycle, all mechanical cooling will be inhibited to give the economizer the opportunity to provide all necessary cooling. The system will monitor room temperature Rate-of-Change. If the rate of change is unacceptable, mechanical cooling will be engaged to “assist” with outside air cooling. The mechanical cooling will be staged up and down as necessary to meet space cooling demands.

**5. Ventilation coordination** – If Demand Ventilation is required (See next section Ventilation) the damper will modulate to meet demand for the subsystem requiring the most outside air.

## Economizer Faults

The controller continually monitors inputs to verify proper operation. When a fault is detected it will be displayed as a notification on the Web-App control console. In addition, the notification will be sent to an unlimited list of designated service personnel via email and Text Message.

1. Supply Temperature (**SAT**) – A fault will be generated if a failure of the supply temperature probe is detected.
2. Outside Air Temperature (**OAT**) – A fault will be generated if a failure of the outside air temperature probe is detected.
3. Room/Space Temperature - A fault will be generated if a failure of the room air temperature probe is detected.
4. Damper Position – A fault will be generated if a failure of the economizer damper is detected. Four different faults are detected and reported:
  - a. Not economizing – Damper is not opening when attempting to provide outside air.
  - b. Economizing when not needed – Damper is open when it should be closed.
  - c. Excess outdoor air – Damper is open more than it should be and won't close.
  - d. Not modulating – Damper will not modulate to the correct position.
5. Economizer not operational – A fault will be generated if a failure of the economizer controller or thermostat electronics is detected.

**6. Cool/Heat Failure** – A fault will be generated if the equipment is unable to heat or cool the conditioned space.

## Ventilation Control

The Pearl Economizer Controller supports multiple Ventilation modes depending on installed equipment and the desired ventilation strategy. These modes are:

- 1. Continuous Ventilation** – In this mode outside air is delivered continuously to the space. The thermostat schedule must be set for the Fan to be “On” during all scheduled set times. Whenever the fan is running, the economizer damper will be opened to the configured “Minimum Damper Position”.
- 2. Scheduled Occupied Ventilation** – Similar to item 1 above, the schedule is adjusted to only provide ventilation during scheduled hours of operation. For this mode, the schedule must have it's Fan set to “Auto” during non-occupied hours.
- 3. Temporary Reduction Ventilation** – The rate of outdoor air provided to a space may be reduced by setting an hourly “Fan Circulation Time” with the schedule Fan set to “Auto”. In this mode higher ventilation will be provided for the configured number of minutes each hour with no ventilation during the remaining portion of the hour. For California Title 24 compliance the average rate must be equal or greater than the required ventilation.
- 4. Occupant Sensor Ventilation** – If an occupancy sensor is installed, the schedule can be set to Fan “On” with Fan “Auto” during unoccupied times. In this mode the ventilation will only occur when people are present. A minimum hourly ventilation time will override this when “Fan Circulation Time” has been set.

To comply with California Title 24 the “Fan Circulation Time” must be set to a minimum of 30 minutes.

**5. Pre-occupancy Ventilation** – During the 1-hour period immediately before the building is normally occupied a schedule entry can be created with the Fan set to “On”. During this time ventilation will be delivered based on the “Minimum Damper Position”.

**6. Demand Ventilation** – The Pearl Economizer Controller will provide demand ventilation when installed with a Pelican thermostat which has an integrated CO2 sensor (Model TS250 or TS250H).

a. Activation – Ventilation will be provided when the CO2 level exceeds the CO2 set point (default = 800ppm). Ventilation will start by turning ON the Fan and opening the damper to the “Minimum Damper Position.”

b. Advanced Logic – If the CO2 level continues to increase above the CO2 set point, the damper will open further until reaching the Maximum Ventilation Position (default 100%) open at CO2 level of 1500ppm. The Damper position will be continuously modulated to maintain CO2 levels below 1000ppm.

c. Supply temperature restriction – The damper opening will be automatically restricted to limit Supply Temperature (**SAT**) to not exceed the active thermostat set point. *Note: Heat and Cool set points should be active to keep from over-heating or over-cooling the conditioned space due to ventilation from outside air.*



## Ventilation Faults

All of the Economizer Faults previously listed are also active for Ventilation. In addition, if the CO2 sensor fails, a fault will be generated and continuous ventilation will be provided during occupied hours.

## Variable Speed Fan

The Pearl Economizer Controller can control a Variable Speed Fan or Variable Frequency Drive (VFD).

1. Activation – This function is only active if the “Variable Speed Fan” configuration has been turned “On” and fan speeds have been configured through the management console.
2. Speed Control – Whenever the thermostat is calling for “Fan” the Fan Speed Control will be active. The control signal (**AUX**) is a 0-10 VDC output. Fan speeds are configured as percentages with 100% equal to 10.0 VDC and 0% equal to 0.0 VDC. The speed control will be set to the configured setting for the mode of operation (ie. Fan/Ventilation, Heat, Cool).
3. Fan Speed Enable – The Fan signal (**G**) can be used to enable the Variable Speed Drive Controller. It will be energized any time the system requires the Variable Speed Fan to be running.

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