# Application Guide

505-032

## HPM1 Heat Pump Master Controller

***Self-Contained Interoperable Controller Model UCP-1***

SUPERSEDES: December 9, 2013 EFFECTIVE: June 5, 2014

Plant ID: 001-4066

# *Table of Contents*

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505-032, Effective: June 5, 2014

# HPM1

The HPM1 is a self-contained microprocessor-based controller for liquid-to-liquid heat pumps. Applications include two pipe single tank, two pipe two tank, and four pipe two tank hydronic HVAC systems. The HPM1 communicates with multiple zone controller units to identify heat or cool demands. In response, it energizes up to three heat pump compressor stages and a single stage of supplemental heat. The HPM1 may communicate with a GHP ground source flow controller to deliver ground temperature liquid as efficiently as possible.

## Overview

The iWorx® HPM1 Heat Pump Master controller is a stand-alone microprocessor based controller for water to water heat pumps. The application includes water to water heat pumps (with reversing valve), a geothermal loop controller and a variety of hydronic zone controllers.

The HPM1 determines demand for hydronic heating and cooling via communication over a LON network with associated iWorx® zone controllers (like the BZU, DXU and FCU, etc). Digital inputs are provided to monitor Equipment Status (pump proof), High Pressure, Low Pressure, Heating Demand, and Cooling Demand. Analog inputs are provided for the Geothermal Loop Temperature, Load Loop Temperature, Heating and/or Cooling Tank Temperatures and Heat Pump Power Consumption.

The HPM1 incorporates digital outputs in the form of Triacs for up to three Heat Pump Stages, Emergency Heat (such as a fossil fuel boiler or resistive heating element), a Reversing Valve, and Circulator Pumps. An analog output is also provided to control a Modulating Heat Pump.

The controller is based on LonWorks® networking technology. The controller can be networked to a higher-level control system for monitoring and control applications.

## Features

- Two Stage (4 or 2 pipe systems with 2 tanks), Three Stage (2 pipe, 1 tank systems) or Modulating Heat Pump Control
- Demand Aggregation from Hydronic Controllers over a LON network
- Communication with Ground Source Pump Controller (GPH1) over a LON network
- Configurable for 4 or 2 pipe systems with 2 tanks, or 2 pipe systems with 1 tank
- Automatic or Manual heat/cool changeover
- Emergency Heating Output
- Configurable heating/cooling medium setpoints
- Automatic and Configurable Reversing valve control
- Equipment status input for safety interlocks or main plant synchronization
- Analog input to monitor Heat Pump power consumption
- LONWORKS interface to building automation systems and host products
- Automatic configuration with the LCI2
- Alarm/Event Reporting

# PURPOSE OF THIS GUIDE

The *iWorx® HPM1 Application Guide* provides application information for the HPM1 Controller.

The reader should understand basic HVAC concepts, intelligent environmental control automation, and basic LONWORKS networking and communications. This application manual is written for:

- Users who engineer control logic
- Users who set up hardware configuration
- Users who change hardware or control logic
- Technicians and field engineers

# REPRESENTATIONS AND WARRANTIES

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iWorx® products shall only be used for the applications identified in the product specifications and for no other purposes. For example, iWorx® products are not intended for use to support fire suppression systems, life support systems, critical care applications, commercial aviation, nuclear facilities or any other applications where product failure could lead to injury to person, loss of life, or catastrophic property damage and should not be used for such purposes.

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# APPLICABLE DOCUMENTATION

See the table below for additional documentation that may be applicable to this controller.

| Description | Audience | Purpose |
|---|---|---|
| *iWorx® LCI Application Guide*, Document No. 505-002 | – Application Engineers<br>– Installers<br>– Service Personnel<br>– Start-up Technicians<br>– End user | Provides instructions for setting up and using the iWorx® Local Control Interface. |
| http://www.iWorxWizard.com | – Application Engineers<br>– Wholesalers<br>– Contractors | An on-line configuration and submittal package generator based on user input. Automatically generates bill of materials, sequence of operations, flow diagrams, wiring diagrams, points and specifications. |
| Additional Documentation | *LonWorks FTT-10A Free Topology Transceiver User's Guide,* published by Echelon Corporation. It provides specifications and user instructions for the FTT-10A Free Topology Transceiver. See also: www.echelon.com/support/documentation/manuals/transceivers. | |



505-032, Effective: June 5, 2014

# INSTALLATION INSTRUCTIONS

## Installation Precautions

### General

**CAUTION:** This symbol is intended to alert the user to the presence of important installation and maintenance (servicing) instructions in the literature accompanying the equipment.

**CAUTION:** Risk of explosion if battery is replaced by an incorrect type. Contains lithium type battery; dispose of properly.

**WARNING:** Electrical shock hazard. Disconnect **ALL** power sources when installing or servicing this equipment to prevent electrical shock or equipment damage.

Make all wiring connections in accordance with these instructions and in accordance with pertinent national and local electrical codes. Use only copper conductors that are suitable for 167 °F (75 °C).

### Static Electricity

Static charges produce voltages that can damage this equipment. Follow these static electricity precautions when handling this equipment.

- Work in a static free area.
- Touch a known, securely grounded object to discharge any charge you may have accumulated.
- Use a wrist strap when handling printed circuit boards. The strap must be secured to earth ground.

### FCC Compliance

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference. This equipment can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment to a power source different from that to which the receiver is connected.
- Consult the equipment supplier or an experienced radio/TV technician for help.

You are cautioned that any changes or modifications to this equipment not expressly approved in these instructions could void your authority to operate this equipment in the United States.

### Equipment Location

Abide by all warnings regarding equipment location provided in this document. This equipment is suitable for indoor use only. Preferably, or as required by National Electrical Code, the unit is intended to be installed within an electrical control enclosure. Operate where ambient temperatures do not exceed 140 °F (60 °C) or fall below 32 °F (0 °C) and relative humidity does not exceed 90%, non-condensing.

If the equipment is to be installed outdoors, it must be contained within a protective enclosure that maintains internal temperature and humidity within the ranges specified for this equipment.

The equipment must be installed within 500 feet of all input peripherals (smoke detectors, sensors, etc.) that are connected to the equipment.

Avoid locations where corrosive fumes, excessive moisture, vibration or explosive vapors are present.

Avoid electrical noise interference. Do not install near large contactors, electrical machinery, or welding equipment.

## Selecting a Power Source

This equipment requires a UL recognized Class 2 external power source (not supplied) to operate. The controller power input requires a voltage of 24 Volts AC.

To calculate power source current requirements, add the power consumption of all peripheral devices to that of the controller.

The controller and sensor power supplies can use the same power source. If both are using the same power source, the loads must have EMF protection. This protection can be integral to the load, or installed in the 24 VAC wiring across the load's coil.

To provide necessary RFI and transient protection, the controller's ground (GND) pin (T40) must be connected to earth ground or the earth ground of the packaged unit's enclosure ground. Failure to properly ground the controller may cause it to exceed FCC limits. Excessive noise could also produce inaccurate sensor data. The power source must be capable of operating with this connection to ground.

## Installation

**Warning:** Electrical shock hazard. To prevent electrical shock or equipment damage, disconnect **ALL** power sources to controllers and loads before installing or servicing this equipment or modifying any wiring.

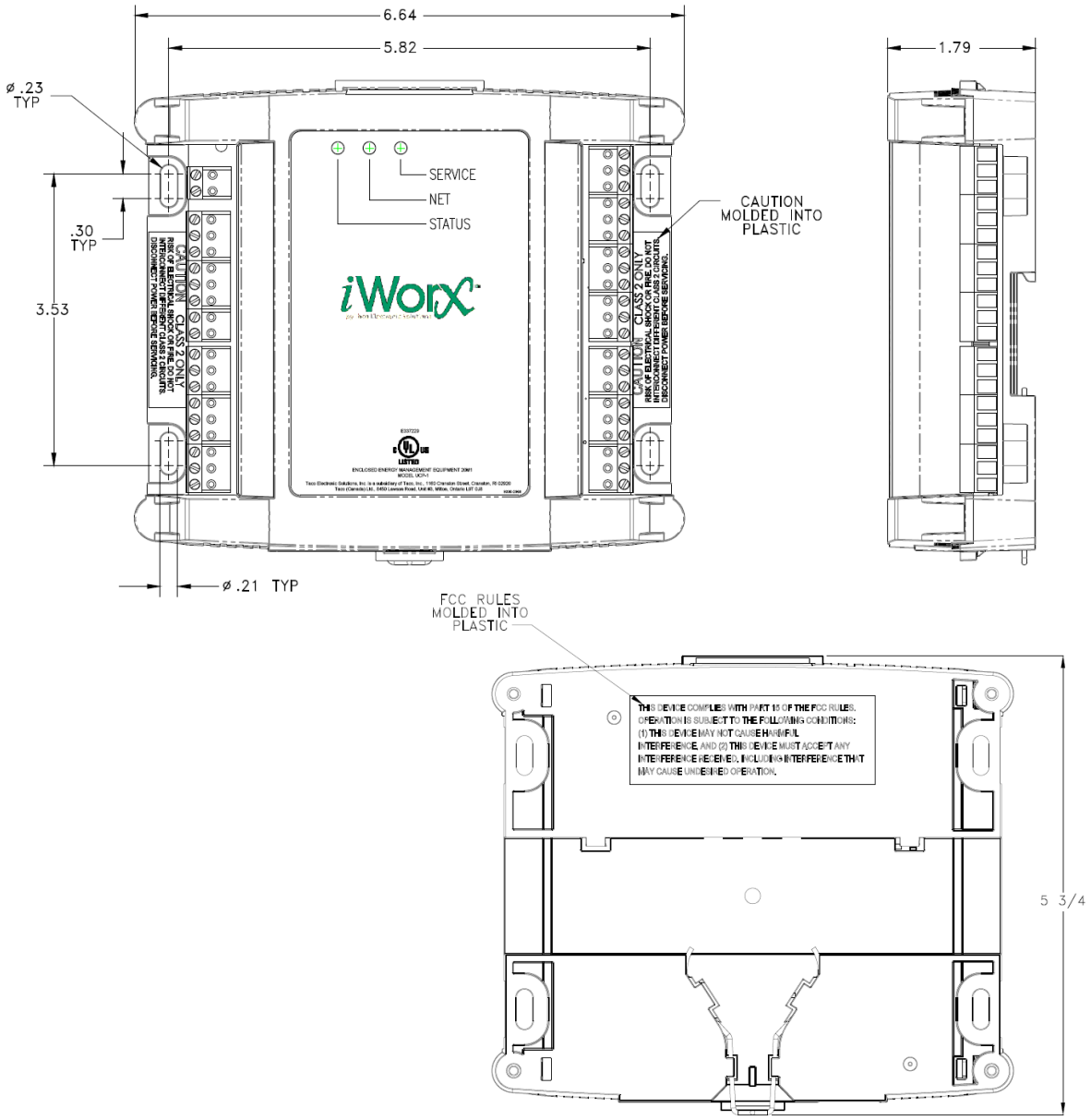
## Mounting the Device

1. Select a mounting location. Enclosure mounting is recommended.
2. Hold the controller on the panel you wish to mount it on. With a marker or pencil mark the mounting locations on the panel.
3. Using a small drill bit pre-drill the mounting holes.
4. Using two #6 pan head screws, mount the controller to the panel.
5. Wire the controller.



505-032, Effective: June 5, 2014

**Figure 1: Mounting Dimensions**




## Grounding the Device

The ground terminal (T40) must be securely connected to earth ground. Failure to properly ground this equipment will result in improper operation. Improper grounding may also increase the risk of electrical shock and may increase the possibility of interference with radio/TV reception.

For best performance, connect the power supply common terminal (T38) to the same external point as the ground terminal (T40).

## Power

**Requires:** 24VAC (20VAC to 28VAC), requires an external Class 2 supply

**Consumes:** 7.2W with no external loads, maximum limited by the Class 2 supply rating

# WIRING INFORMATION

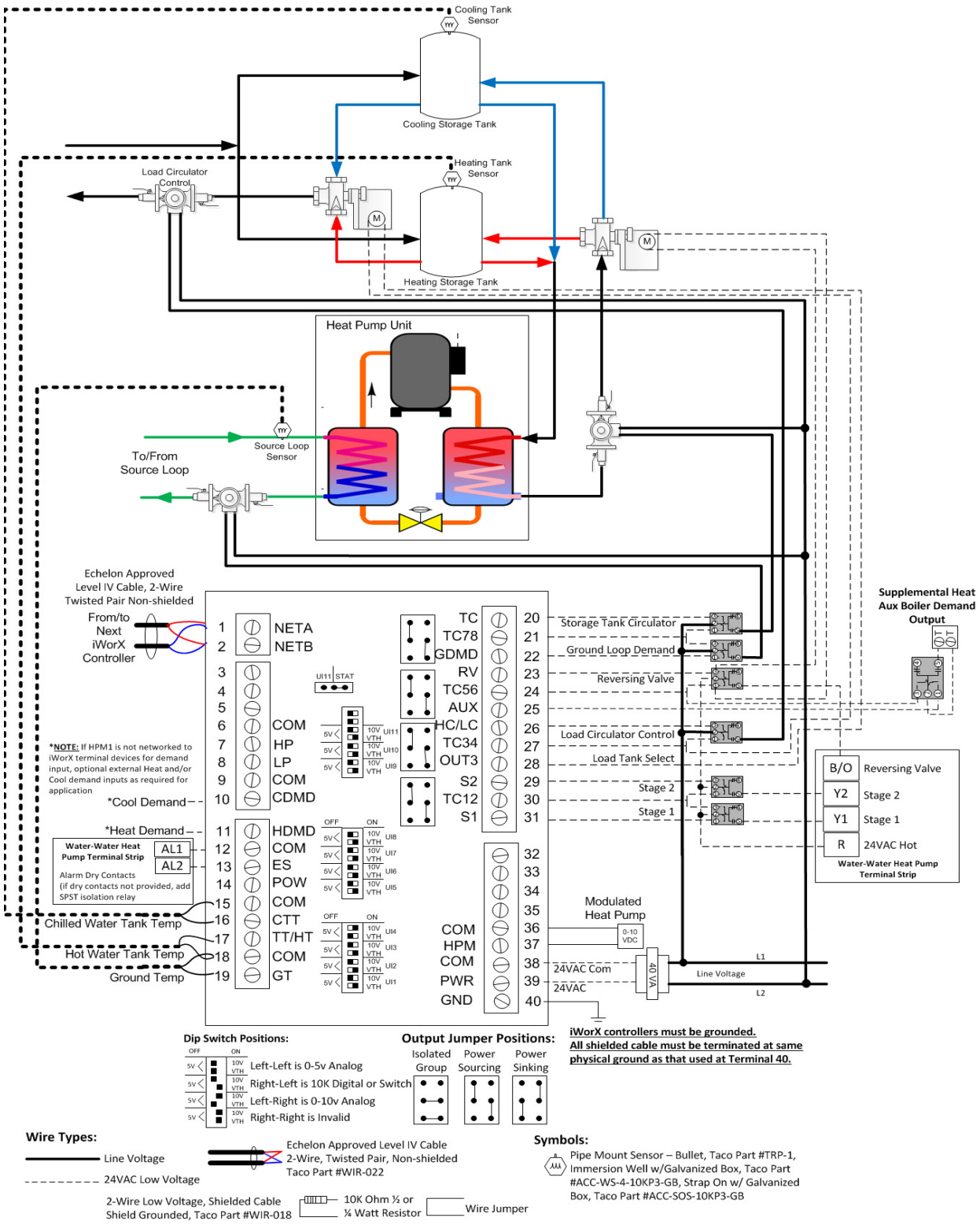
**WARNING**: Disconnect **ALL** power sources when installing or servicing this equipment to prevent electrical shock or equipment damage.

Example wiring diagrams are shown on the following pages.

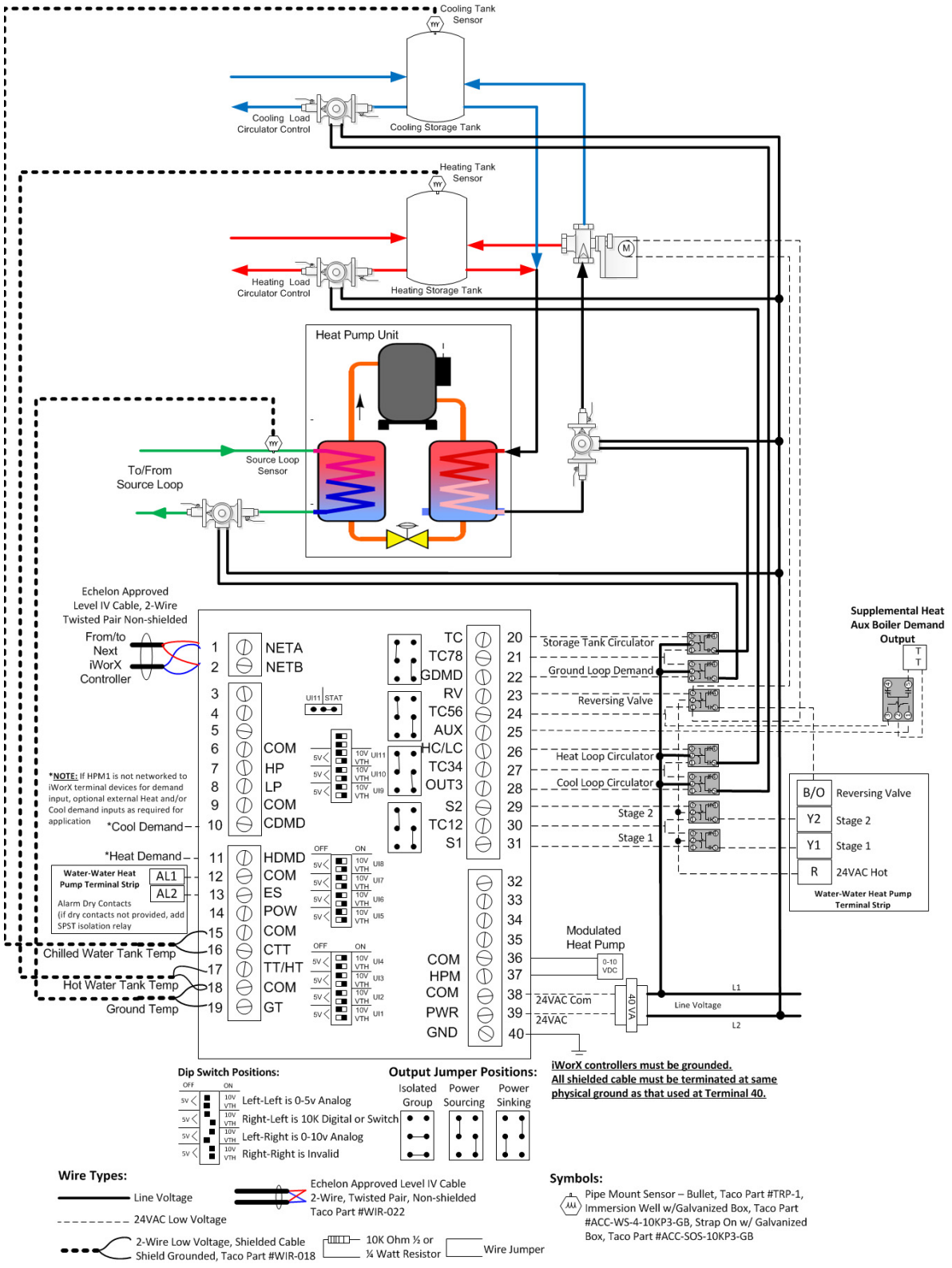


505-032, Effective: June 5, 2014

# HPM1 – Two-pipe Two Tank Application



# HPM1 – Four-pipe Two Tank Application






505-032, Effective: June 5, 2014

# HPM1 2-TANK SYSTEM SETUP

## 2-pipe, 2-tank or 4-pipe, 2-tank system

**Controls up to:**

- 1 ea. 2-Stage Water-to-Water Heat Pump,
- 2 ea. 1-Stage Water-to-Water Heat Pumps or 1 ea. 0-10VDC Modulating Water-to-Water Heat Pump and 1 ea. Auxiliary Boiler

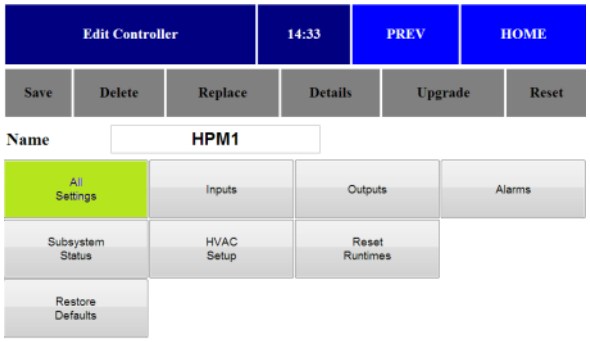
**Sensors Required:** Hot Water Tank Temp, Chilled Water Tank Temp, Ground Loop Water Temp

**Setup Instructions**

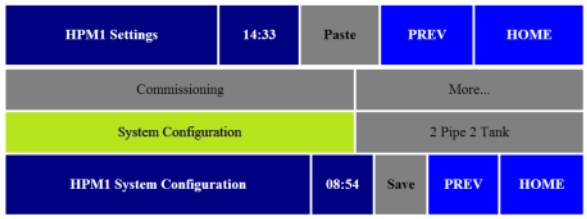
1. Press **Controllers** from main screen.

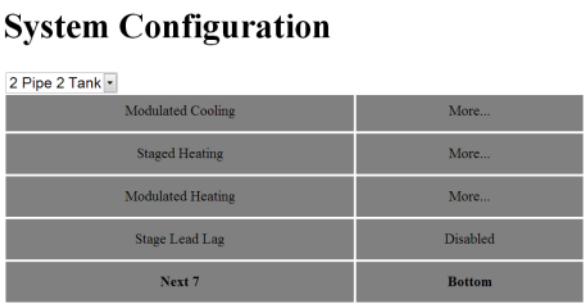

2. Select required HPM1 from controller list and press appropriate controller.


3. Press **All Settings**.



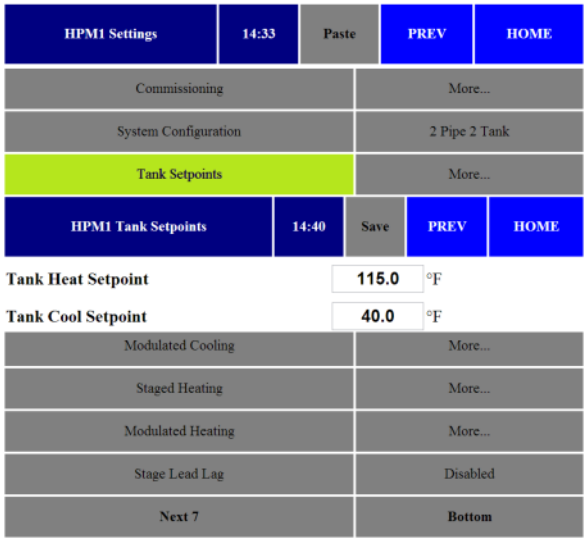

4. Press **System Configuration**.



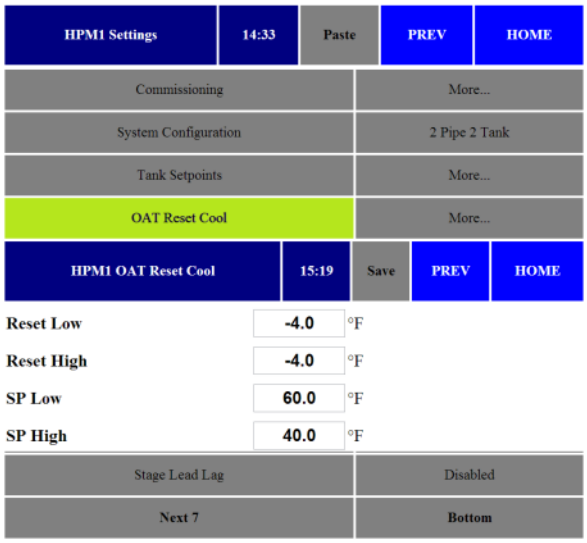




5. The *System Configuration* menu opens.
   a. Select “2 Pipe 2 Tank” or “4 Pipe 2 Tank.”
   b. Press **Save**.

6. Press **Tank Setpoints**.

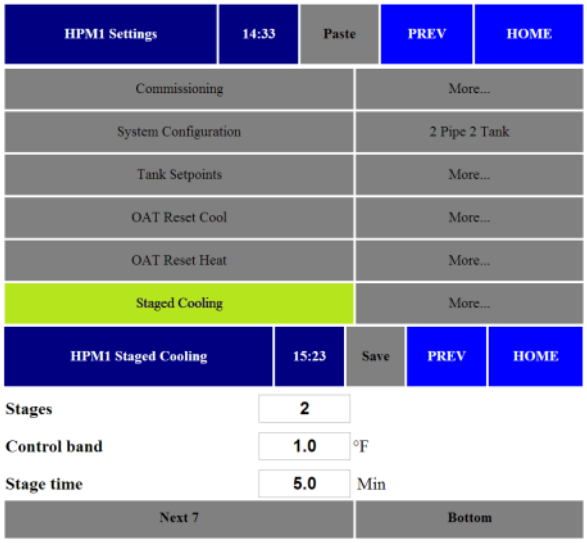



7. The *Tank Setpoints* menu opens.
   a. Specify **Tank Heat Setpoint** in degrees.
   b. Specify **Tank Cool Setpoint** in degrees.
   c. Press **Save**.
8. Press **OAT Reset Cool**.




9. The *OAT Reset Cool* menu opens.
   a. Specify **Reset Low** in degrees. The lowest cooling outdoor design temperature. (A setting of -4 disables the reset feature).
   b. Specify **Reset High** in degrees. The highest cooling outdoor design temperature. (A setting of -4 disables the reset feature).
   c. Specify **SP Low**, the lowest cooling supply water temperature in degrees.
   d. Specify **SP High**, the highest cooling supply temperature in degrees.
   e. Press **Save**.
10. Press **OAT Reset Heat**.

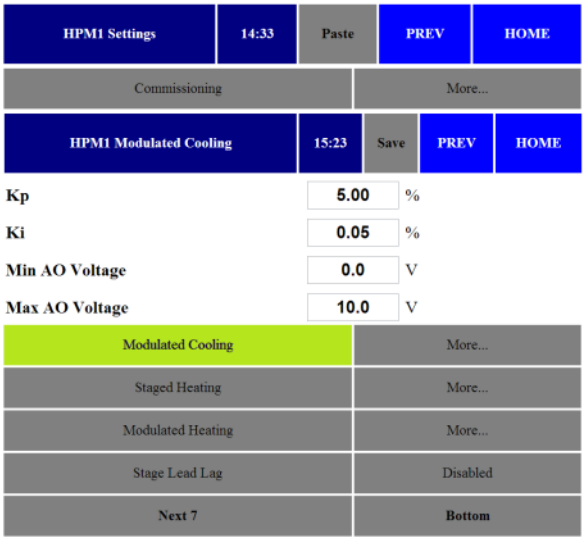

11. The *OAT Reset Heat* menu opens.
   a. Specify **Reset Low** in degrees. The lowest heating outdoor design temperature. (A setting of -4 disables the reset feature).
   b. Specify **Reset High** in degrees. The highest heating outdoor design temperature. (A setting of -4 disables the reset feature).
   c. Specify **SP Low**, the lowest heating supply water temperature in degrees.
   d. Specify **SP High**, the highest heating supply temperature in degrees.
   e. Press **Save**.
12. Press **Staged Cooling**.



13. The *Staged Cooling* menu opens.
    a. Specify number of **Stages** of equipment (0-2).
    b. Specify the stage **Control band** in degrees. Cannot be set to 0.
    c. Specify the **Stage time** in minutes. Cannot be set to 0.
    d. Press **Save**.

**OR**

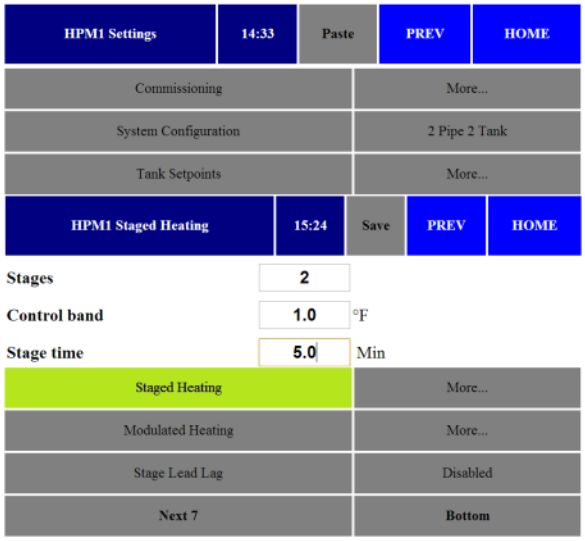
14. Press **Modulated Cooling**.




15. The *Modulated Cooling* menu opens.
    a. Specify **Min AO (Output) Voltage** (0-10VDC). 2.0 VDC Shown as example.
    b. Specify **Max AO (Output) Voltage** (0-10VDC). 10.0 VDC shown as example.
    c. Press **Save**.

    **NOTE:** DO NOT change factory KP/KI settings. Please review Factory KP/KI Setting White Paper #508-001.

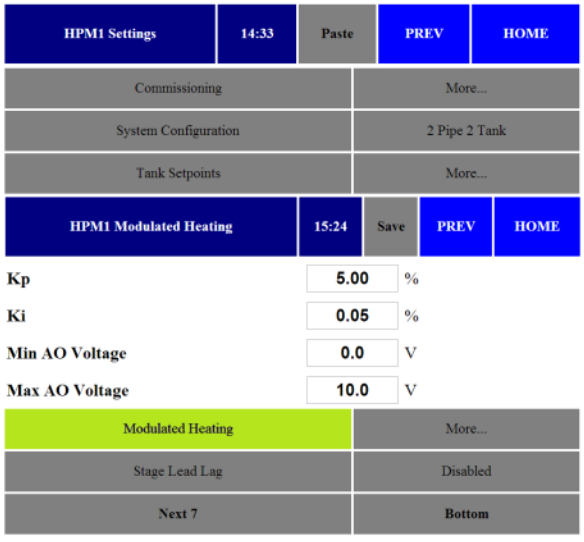
16. Press **Staged Heating**.




17. The *Staged Heating* menu opens.
    a. Specify number of **Stages** of equipment (0-2).
    b. Specify the stage **Control band** in degrees. Cannot be set to 0.
    c. Specify the **Stage time** in minutes. Cannot be set to 0.
    d. Press **Save**.

**OR**

18. Press **Modulated Heating**.

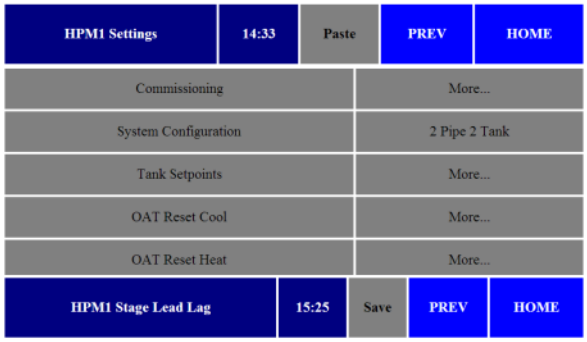


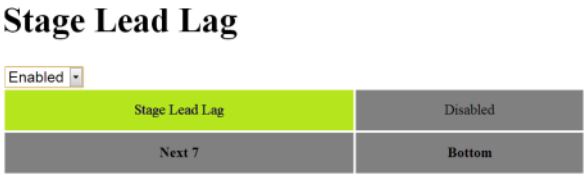

19. The *Modulated Heating* menu opens.
    a. Specify **Min AO (Output) Voltage** (0-10VDC). 2.0 VDC Shown as example.
    b. Specify **Max AO (Output) Voltage** (0-10VDC). 10.0 VDC shown as example.

c. Press **Save**.

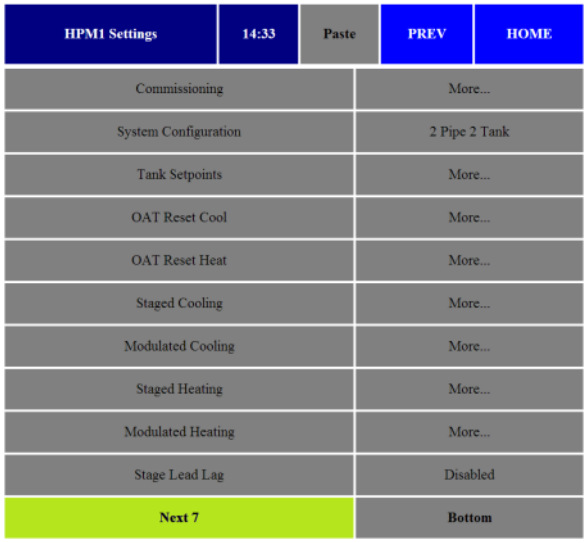
**NOTE:** DO NOT change factory KP/KI settings. Please review Factory KP/KI Setting White Paper #508-001.

20. Press **Stage Lead Lag**.




21. The *Stage Lead Lag* menu opens.
   a. Select “Enable” or “Disabled.”
   b. Press **Save**.
22. Press **Next 7**.



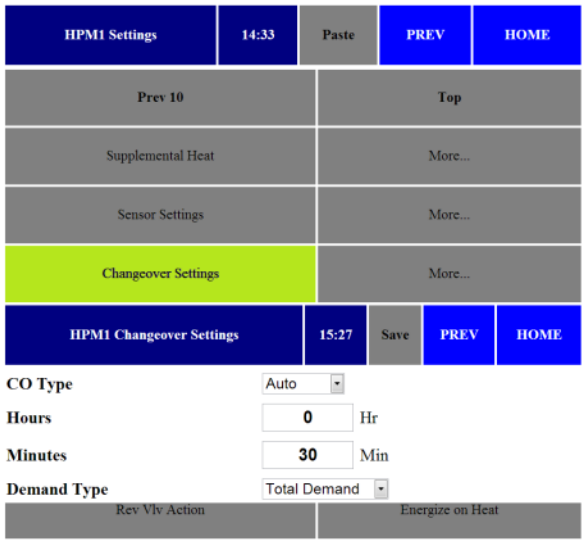

23. Press **Supplemental Heat**.


24. The *Supplemental Heat* menu opens.
   a. Specify the **Max Tank/Ground Diff**. in degrees. Temperature difference between the storage tank and its current setpoint that triggers supplemental heating or cooling. 0 disables.
   b. Specify **Tank/Ground Diff DB** in degrees. Rise above Max Tank/Source differential that will end supplemental heating.
   c. Specify **Min Ground Temp** in degrees. Source water temperature that triggers supplemental heating.
   d. Specify **Min Ground Temp DB** in degrees. Temperature rise above the water min temperature to end supplemental heating.
   e. Specify **Max TankSP Diff** in degrees. Difference between tank temperature and its setpoint that triggers supplemental heating.
   f. Press **Save**.

25. Press **Sensor Settings**.

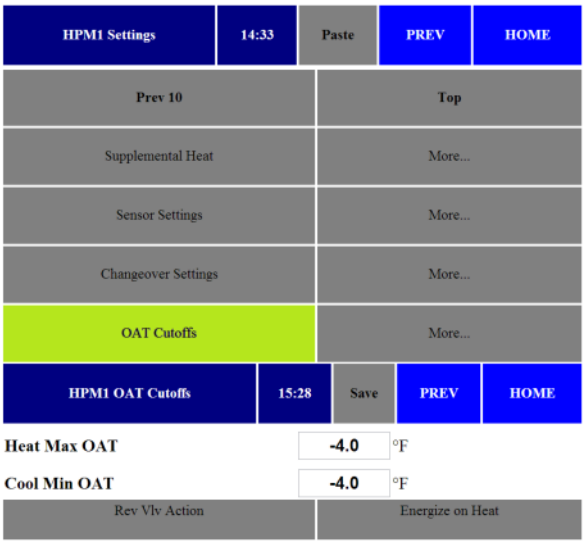

26. The *Sensor Settings* menu opens.
   a. Select **Ground Temp Sensor**:
      - VTS
      - Precon III (Standard Taco Sensors)
      - Precon II
   b. Select **Tank Temp Sensor**:
      - VTS
      - Precon III (Standard Taco Sensors)
      - Precon II
   c. Specify **Watts Full Scale**. The maximum power measured by the power transducer (optional input).
   d. Press **Save**.

27. Press **Changeover Settings**.



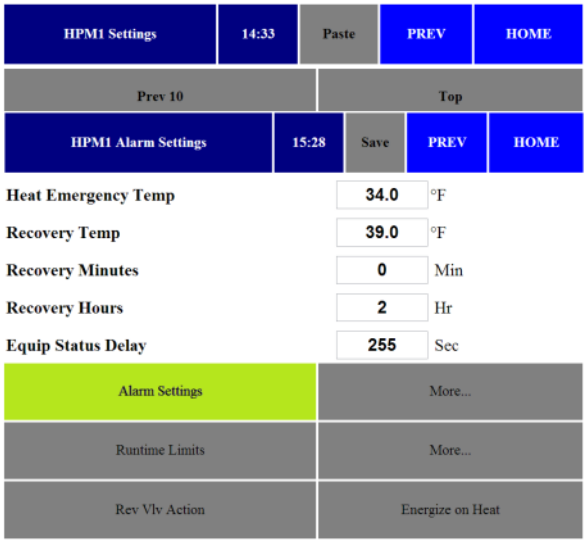

28. The *Changeover Settings* menu opens.
   a. Select **CO Type**:
      -Auto
      -Heat Only
      -Cool Only
   b. Specify **Hours** between changeover.
   c. Specify **Minutes** component of hours.
   d. Select **Demand Type**:
      -Total Demand
      -Zone Max
      -Reference Zone
      -Digital Input
   e. Press **Save**.

29. Press **OAT Cutoffs**.



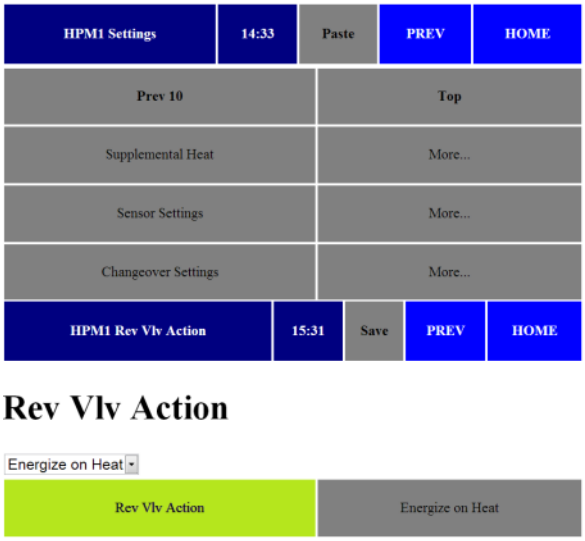

30. The **OAT Cutoffs** menu opens.
   a. Specify **Heat Max OAT** in degrees.
   b. Specify **Cool Min OAT** in degrees.
      **NOTE:** A setting of “-4.0” disables these settings.
   c. Press **Save**.

31. Press **Alarm Settings**.




32. The *Alarm Settings* menu opens.
    a. Select **Heat Emergency Temp** in degrees. The source water temperature that initiates the supplemental heating source.
    b. Select **Recovery Temp** in degrees. Source water temperature that allows for a recovery from emergency heating.
    c. Select **Recovery Minutes**. Period of time in which the controller attempts to recover from an emergency heating condition. **NOTE:** if both minutes and hours are set to zero, a user reset is required to recover from this alarm.
    d. Select **Recovery Hours**.
    e. Select **Equipment Status Delay** in seconds. Period of time the controller waits before declaring an Equipment status delay interval alarm after Source demand for the Equipment Status input to go low. A value of 255 disables this alarm.
    f. Press **Save**.

33. Press **Reversing Vlv Action**.



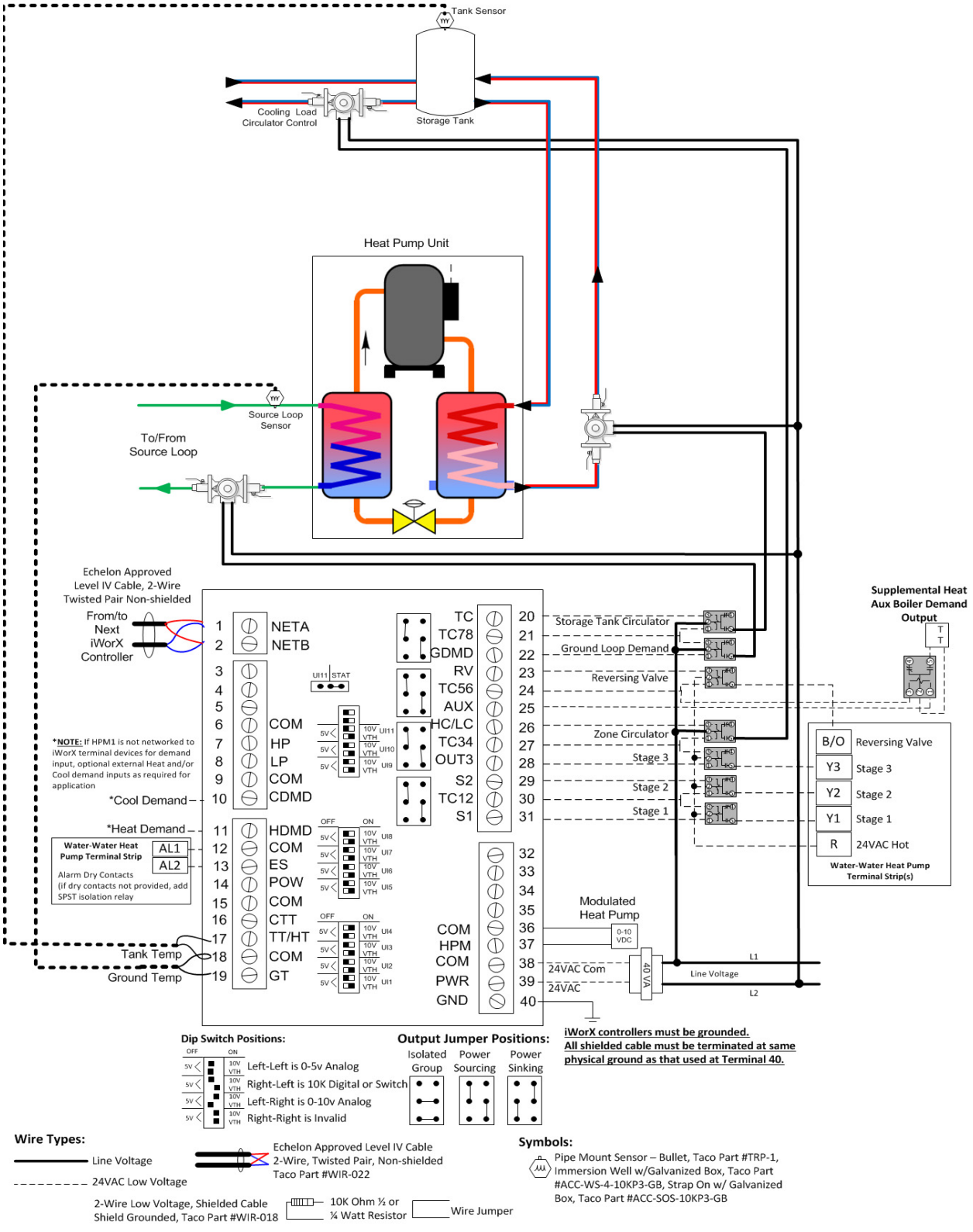

34. The **Reversing Vlv Action** menu opens.
    a. Select:
        - Energize on Heat
        - Energize on Cool

        **NOTE:** See WSHP equipment manufacturer requirements.
    a. Press **Save**.



505-032, Effective: June 5, 2014

# HPM1 – Two-pipe One Tank Application



# HPM1 1-TANK SYSTEM SETUP

## 2-pipe, 1-tank system

**Controls up to:**

- 1 ea. 3-Stage Water-to-Water Heat Pump,
- 3 ea. 1-Stage Water-to-Water Heat Pumps or 1 ea. 0-10VDC Modulating Water-to-Water Heat Pump and 1 ea. Auxiliary Boiler

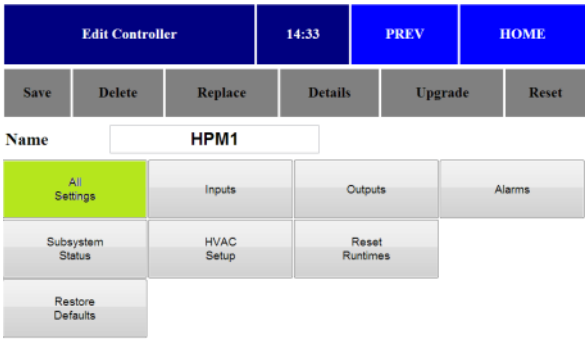
**Sensors Required:** Tank Temp, Ground Loop Water Temp

**Setup Instructions**

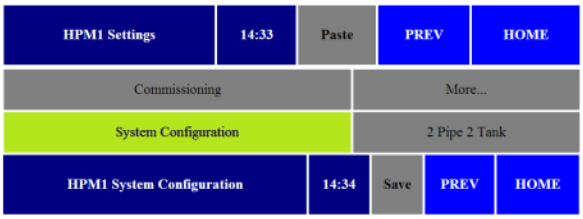
1. Press **Controllers** from main screen.

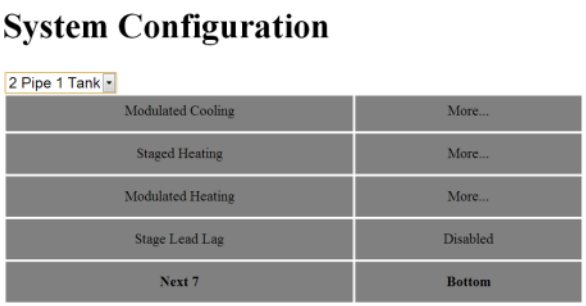

2. Select required HPM1 from controller list and press appropriate controller.


3. Press **All Settings**.




4. Press **System Configuration**.



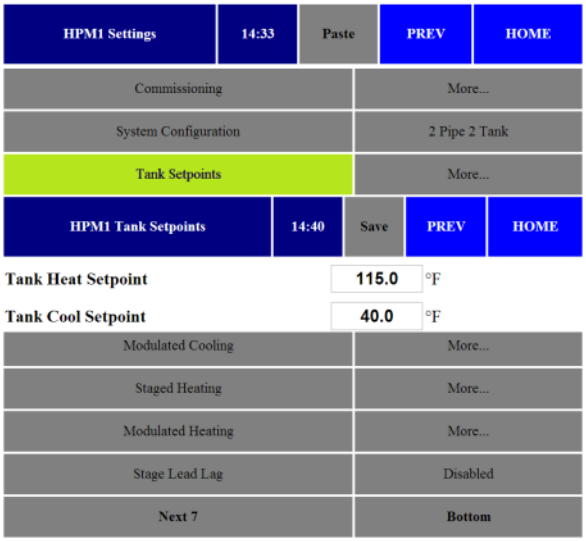




5. The *System Configuration* menu opens.
   a. Select “2 Pipe 1 Tank.”
   b. Press **Save**.

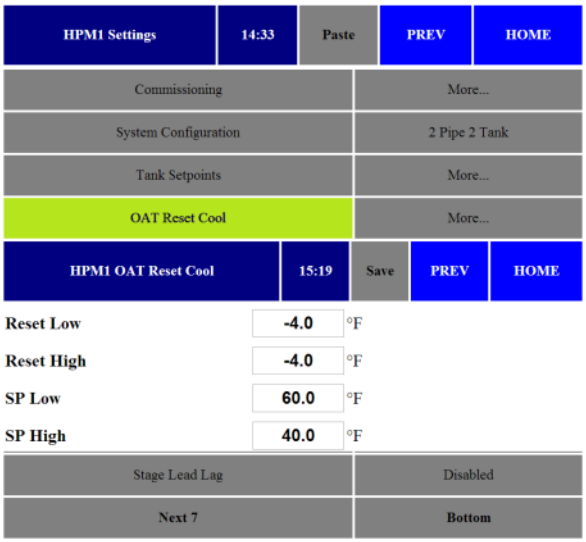


505-032, Effective: June 5, 2014

6. Press **Tank Setpoints**.

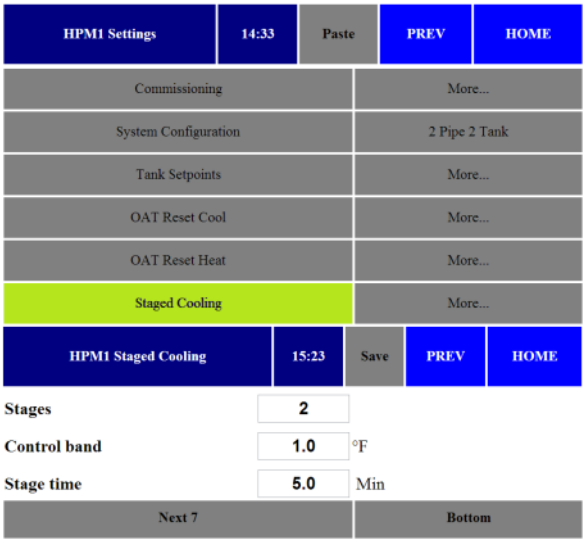



7. The *Tank Setpoints* menu opens.
   a. Specify **Tank Heat Setpoint** in degrees.
   b. Specify **Tank Cool Setpoint** in degrees.
   c. Press **Save**.
8. Press **OAT Reset Cool**.




9. The *OAT Reset Cool* menu opens.
   a. Specify **Reset Low** in degrees. The lowest cooling outdoor design temperature. (A setting of -4 disables the reset feature).
   b. Specify **Reset High** in degrees. The highest cooling outdoor design temperature. (A setting of -4 disables the reset feature).
   c. Specify **SP Low**, the lowest cooling supply water temperature in degrees.
   d. Specify **SP High**, the highest cooling supply temperature in degrees.
   e. Press **Save**.
10. Press **OAT Reset Heat**.

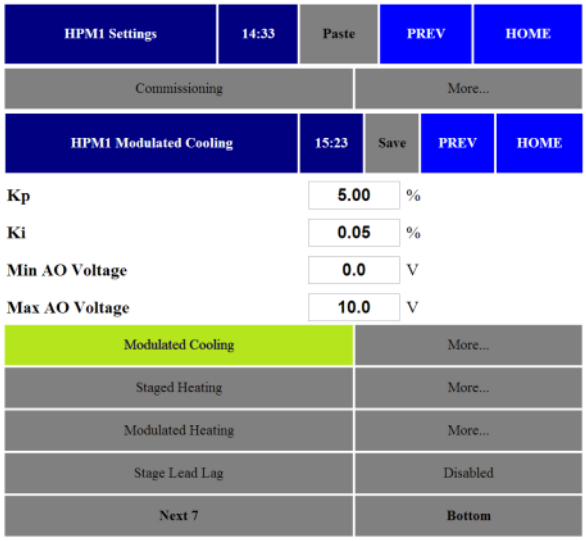

11. The *OAT Reset Heat* menu opens.
   a. Specify **Reset Low** in degrees. The lowest heating outdoor design temperature. (A setting of -4 disables the reset feature).
   b. Specify **Reset High** in degrees. The highest heating outdoor design temperature. (A setting of -4 disables the reset feature).
   c. Specify **SP Low**, the lowest heating supply water temperature in degrees.
   d. Specify **SP High**, the highest heating supply temperature in degrees.
   e. Press **Save**.
12. Press **Staged Cooling**.



13. The *Staged Cooling* menu opens.
    a. Specify number of **Stages** of equipment (0-3).
    b. Specify the stage **Control band** in degrees. Cannot be set to 0.
    c. Specify the **Stage time** in minutes. Cannot be set to 0.
    d. Press **Save**.

**OR**

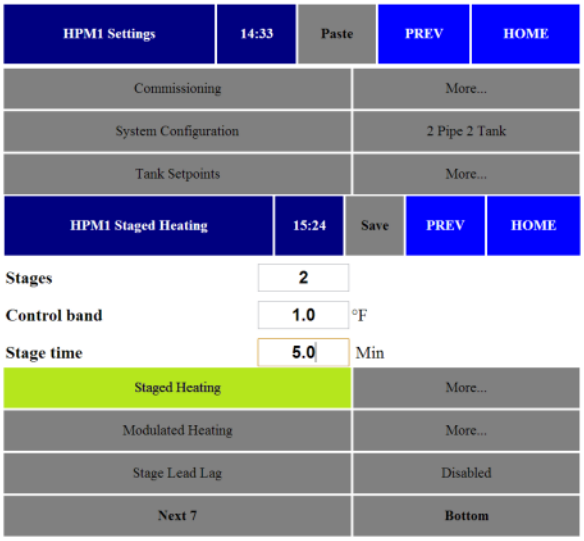
14. Press **Modulated Cooling**.




15. The *Modulated Cooling* menu opens.
    a. Specify **Min AO (Output) Voltage** (0-10VDC). 2.0 VDC Shown as example.
    b. Specify **Max AO (Output) Voltage** (0-10VDC). 10.0 VDC shown as example.
    c. Press **Save**.

    **NOTE:** DO NOT change factory KP/KI settings. Please review Factory KP/KI Setting White Paper #508-001.

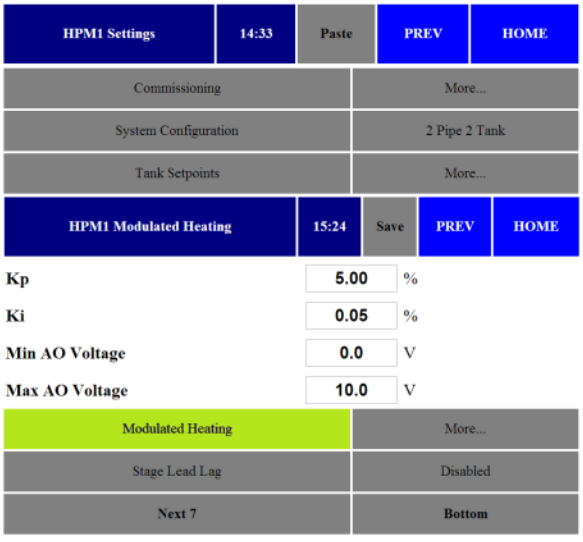
16. Press **Staged Heating**.




17. The *Staged Heating* menu opens.
    a. Specify number of **Stages** of equipment (0-3).
    b. Specify the stage **Control band** in degrees. Cannot be set to 0.
    c. Specify the **Stage time** in minutes. Cannot be set to 0.
    d. Press **Save**.

**OR**

18. Press **Modulated Heating**.




19. The *Modulated Heating* menu opens.
    a. Specify **Min AO (Output) Voltage** (0-10VDC). 2.0 VDC Shown as example.
    b. Specify **Max AO (Output) Voltage** (0-10VDC). 10.0 VDC shown as example.

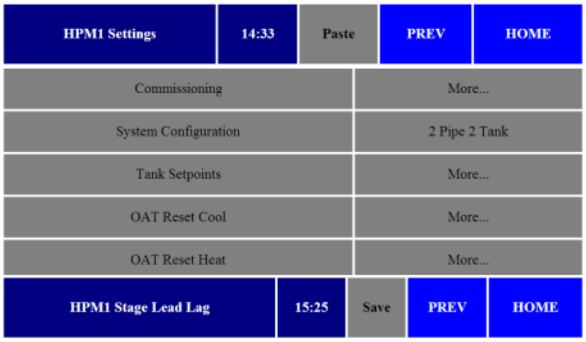


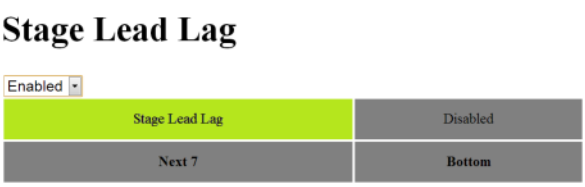
505-032, Effective: June 5, 2014

c. Press **Save**.

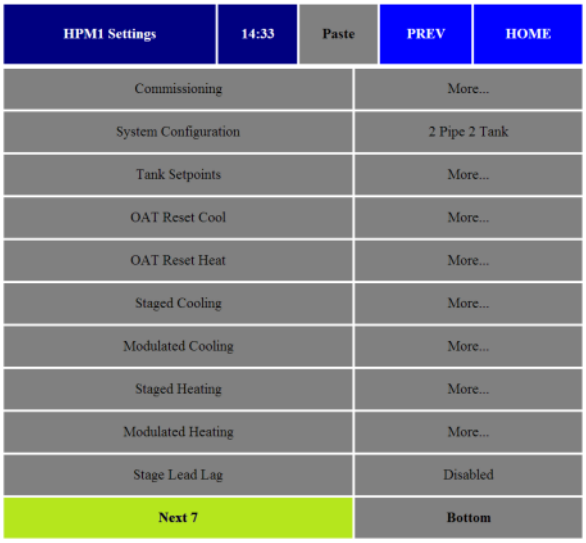
**NOTE:** DO NOT change factory KP/KI settings. Please review Factory KP/KI Setting White Paper #508-001.

20. Press **Stage Lead Lag**.




21. The *Stage Lead Lag* menu opens.
    a. Select “Enable” or “Disabled.”
    b. Press **Save**.
22. Press **Next 7**.

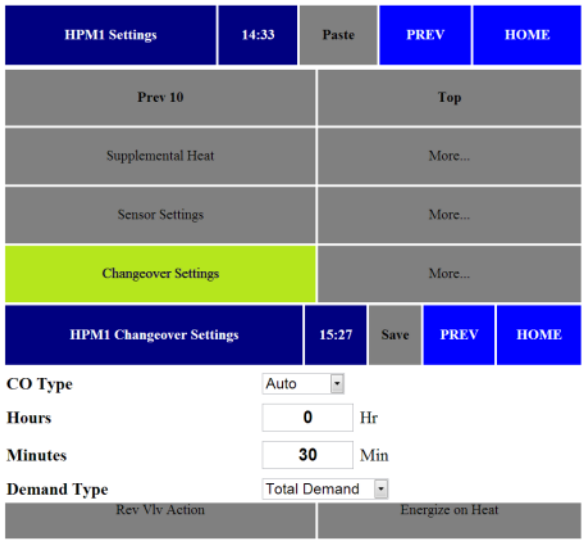



23. Press **Supplemental Heat**.

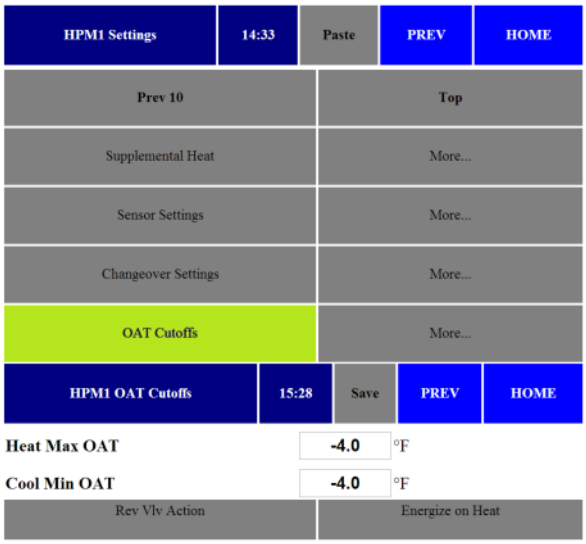

24. The *Supplemental Heat* menu opens.
    a. Specify the **Max Tank/Ground Diff**. in degrees. Temperature difference between the storage tank and its current setpoint that triggers supplemental heating or cooling. 0 disables.
    b. Specify **Tank/Ground Diff DB** in degrees. Rise above Max Tank/Source differential that will end supplemental heating.
    c. Specify **Min Ground Temp** in degrees. Source water temperature that triggers supplemental heating.
    d. Specify **Min Ground Temp DB** in degrees. Temperature rise above the water min temperature to end supplemental heating.
    e. Specify **Max TankSP Diff** in degrees. Difference between tank temperature and its setpoint that triggers supplemental heating.
    f. Press **Save**.

25. Press **Sensor Settings**.


26. The *Sensor Settings* menu opens.
   a. Select **Ground Temp Sensor**:
      - VTS
      - Precon III (Standard Taco Sensors)
      - Precon II
   b. Select **Tank Temp Sensor**:
      - VTS
      - Precon III (Standard Taco Sensors)
      - Precon II
   c. Specify **Watts Full Scale**. The maximum power measured by the power transducer (optional input).
   d. Press **Save**.
27. Press **Changeover Settings**.




28. The *Changeover Settings* menu opens.
   a. Select **CO Type**:
      -Auto
      -Heat Only
      -Cool Only
   b. Specify **Hours** between changeover.
   c. Specify **Minutes** component of hours.
   d. Select **Demand Type**:
      -Total Demand
      -Zone Max
      -Reference Zone
      -Digital Input
   e. Press **Save**.
29. Press **OAT Cutoffs**.

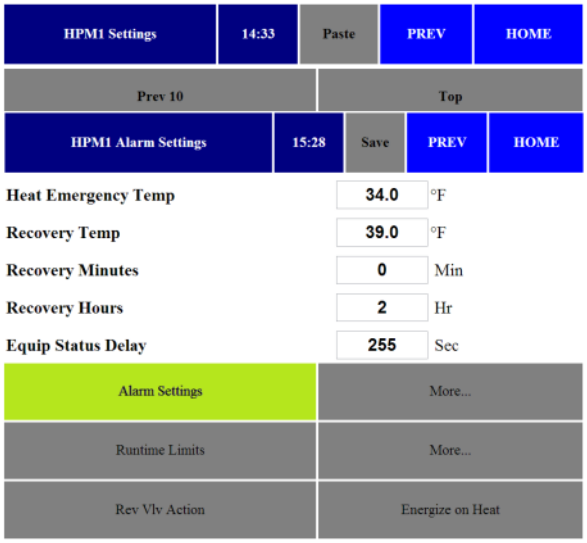



30. The **OAT Cutoffs** menu opens.
   a. Specify **Heat Max OAT** in degrees.
   b. Specify **Cool Min OAT** in degrees.
      **NOTE:** A setting of “-4.0” disables these settings.
   c. Press **Save**.



505-032, Effective: June 5, 2014

31. Press **Alarm Settings**.




32. The *Alarm Settings* menu opens.

a. Select **Heat Emergency Temp** in degrees. The source water temperature that initiates the supplemental heating source.

b. Select **Recovery Temp** in degrees. Source water temperature that allows for a recovery from emergency heating.

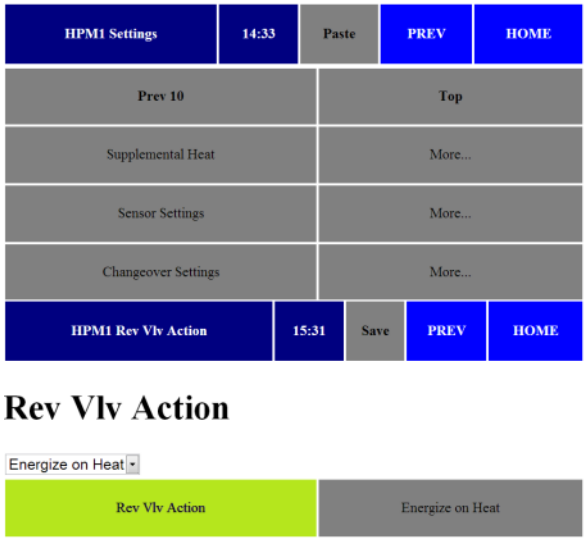
c. Select **Recovery Minutes**. Period of time in which the controller attempts to recover from an emergency heating condition. **NOTE:** if both minutes and hours are set to zero, a user reset is required to recover from this alarm.

d. Select **Recovery Hours**.

e. Select **Equipment Status Delay** in seconds. Period of time the controller waits before declaring an Equipment status delay interval alarm after Source demand for the Equipment Status input to go low. A value of 255 disables this alarm.

f. Press **Save**.

33. Press **Reversing Vlv Action**.




34. The **Reversing Vlv Action** menu opens.

a. Select:

- Energize on Heat
- Energize on Cool

**NOTE:** See WSHP equipment manufacturer requirements.

a. Press **Save**.

# ASSOCIATING THE HPM1 TO OTHER IWORX® MODULES ON THE NETWORK

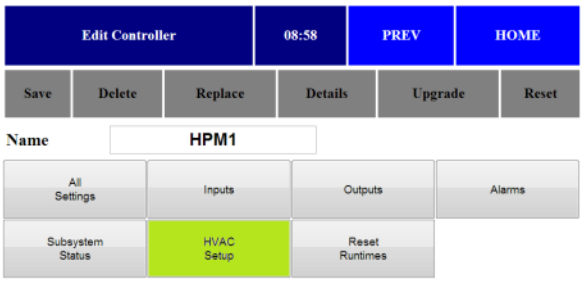
If the HPM1 is part of a network with the LCI2, it can be configured to be networked with other controllers. All other controllers utilizing the HPM1 for supply water should be associated.

**Setup Instructions**

1. Complete the setup procedure previously detailed.
2. Press **Controllers** from main screen.


3. Select required HPM1 from controller list and press appropriate controller.


4. Press **HVAC Setup**.




5. Press **Members**.


6. The **Members** menu opens.


7. The LCI identifies all appropriate members within the LCI's network of controllers.
8. Click on appropriate controller shown in gray (Not associated) to associate to the HPM1.
9. A successful association changes to RED and state MASTER: HPM1 (or HPM1 controller's current name).
10. Press **Save**.



505-032, Effective: June 5, 2014

# SPECIFICATIONS

## Electrical Inputs

**Ground Temperature, Tank Temperature, Heating Tank Temperature, Cooling Tank Temperature:** Precon Type III 10K thermistor or Taco VTS sensor

**Power Transducer:** 0 - 10 Volts DC

**Equipment Status, Heat Demand, Cool Demand, Low Pressure Alarm, High Pressure Alarm:** Dry Contact, 5 Volts DC Max

## Electrical Outputs

**Heat Pump Stage 1, Heat Pump Stage 2, Heat Pump Stage 3, Cooling Load Circulator, Tank Select, Heating Load Circulator, Load Circulator, Auxiliary Heat, Reversing Valve, Ground Demand, Tank Circulator:** 24 Volts AC, 1 Amp at 50 °C, 0.5 Amps at 60 °C, limited by Class 2 supply

**Modulated Heat Pump:** 0-10 Volts DC, 2K Ohm minimum

## Power

**Requires:** 24VAC (20VAC to 28VAC), requires an external Class 2 supply

**Consumes:** 7.2W with no external loads, maximum limited by the Class 2 supply rating

## Recommended Sensor Wire

**Maximum Length:** 500 feet (152 meters)

| Cable Type | Pairs | Details | Taco Catalog No. |
|---|---|---|---|
| 18AWG | 1 | Stranded Twisted Shielded Pair, Plenum | WIR-018 |

## Recommended LON Bus FTT-10A Network Wire

**Speed:** 78KBPS

**Max Volts:** 42.4 Volts DC

**Cabling:** Maximum node-to-node distance: 1312 feet (400 meters); Maximum total distance: 1640 feet (500 meters)

| Cable Type | Pairs | Details | Taco Catalog No. |
|---|---|---|---|
| Level 4 22AWG (0.65mm) | 1 | Unshielded, Plenum, U.L. Type CMP | WIR-022 |

## Mechanical

**Dimensions:** 5.55” (141mm) high, 6.54” (166 mm) wide, 1.75” deep (44 mm), ABS

**Controller Weight:** 0.70 pounds (0.32 kilograms)

**Shipping Weight:** 1.0 pounds (0.46 kilograms)

**Processor:** 3150 Neuron 10 MHz

**Flash:** 48 Kilobytes

**SRAM:** 8 Kilobytes

**Termination:** 0.197” (5.0 mm) Pluggable Terminal Blocks, 14-22 AWG

**Temperature:** 32 °F to 140 °F (0 °C to 60 °C)

**Humidity:** 0 to 90%, non-condensing

**UL Listed** for US and Canada, Energy Management Equipment PAZX and PAZX7

**FCC** Part 15 Class A compliant

# APPLICATION DESCRIPTION

The HPM1 is a heat pump master controller that manages multiple stages of heat pumps to respond to heating or cooling demands from multiple zones in a liquid based HVAC system. It communicates on LON network with up to 32 hydronic zone controller units, that operate Fan Coils, Radiant Heating Zones, Chilled Beam Ceilings, and other terminal units. The HPM1 operates heat pumps, circulators and auxiliary heating units (boilers or electric heaters) to respond to the demand for Heated or Chilled liquid from the zone controllers.

When actively heating or cooling a buffer tank, the HPM1 activates the Tank Circulator, which moves fluid from the heat pumps to the tank.

If the heat pump stages are insufficient to meet heating demand, the HPM1 activates a supplement heating element; usually a boiler or electric heater.

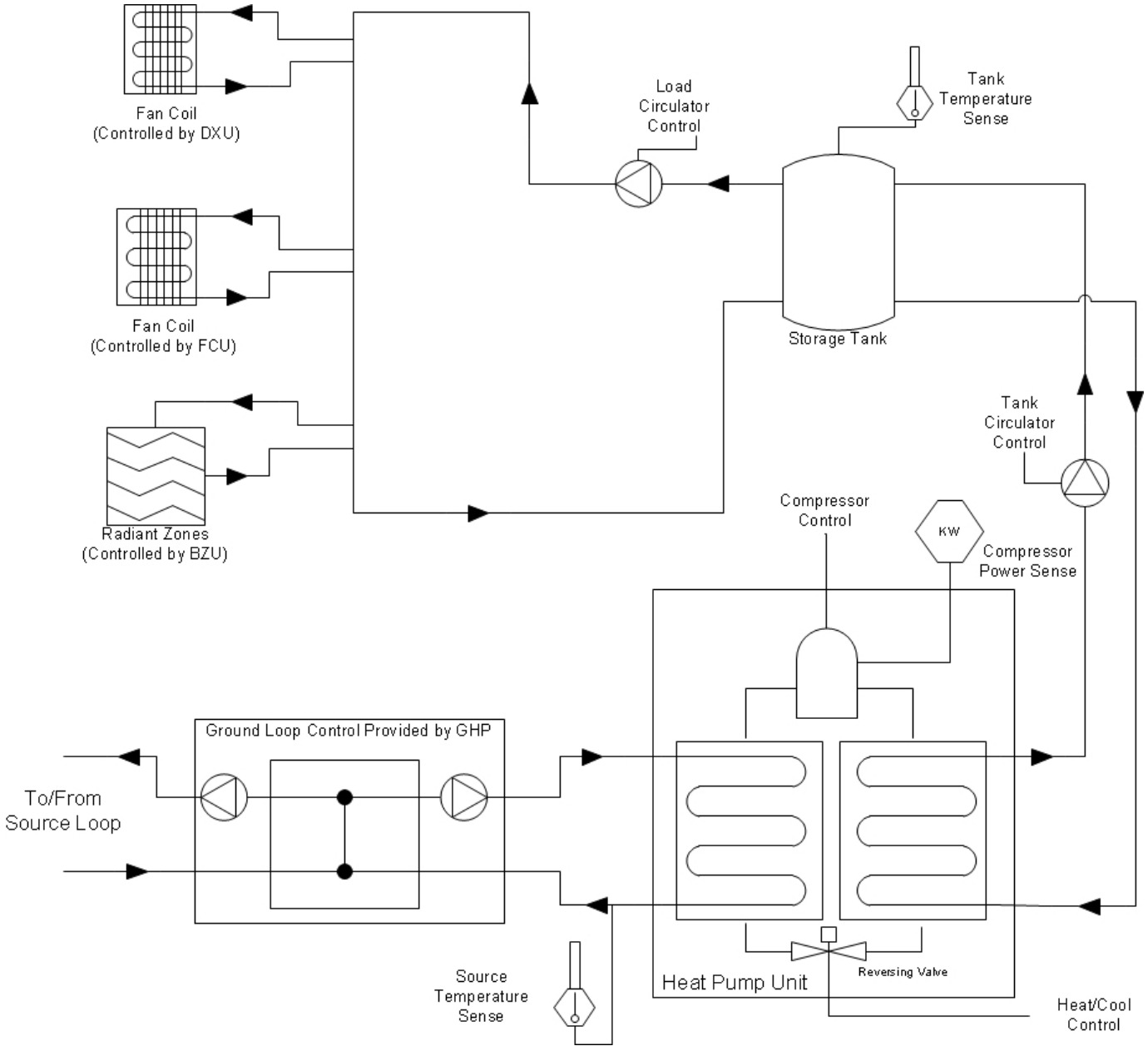
When the HPM1 requires ground water, it may either activate a geothermal circulator with one of its digital outputs or make a request on the network to an associated Geothermal Pump controller (GHP).

The HPM1 supports three different hydronic system configurations: Two Pipe Single Tank, Two Pipe Two Tank and Four Pipe Two Tank.



505-032, Effective: June 5, 2014

**Figure 2: HPM1 Two Pipe Single Tank Configuration**




In a Two Pipe, Single Tank system, a single supply loop runs to the associated zone controllers. It is fed from a single Buffer Tank. The supply loop may contain hot or cold water, based on the demand from the zone controllers. Note that this configuration means that at any given moment, only hot OR cold water may be supplied to the hydronic zones. Because there is a single buffer tank, there is a significant energy penalty when switching between Heating and Cooling as the heat pumps must change the temperature of all the water in the tank during the changeover.

When there is demand for heated or chilled water from the zone controllers (or from one of the hardwired digital demand inputs), the HPM1 will activate the Load Circulator to move water from the storage tank, through the load loop to the zones.

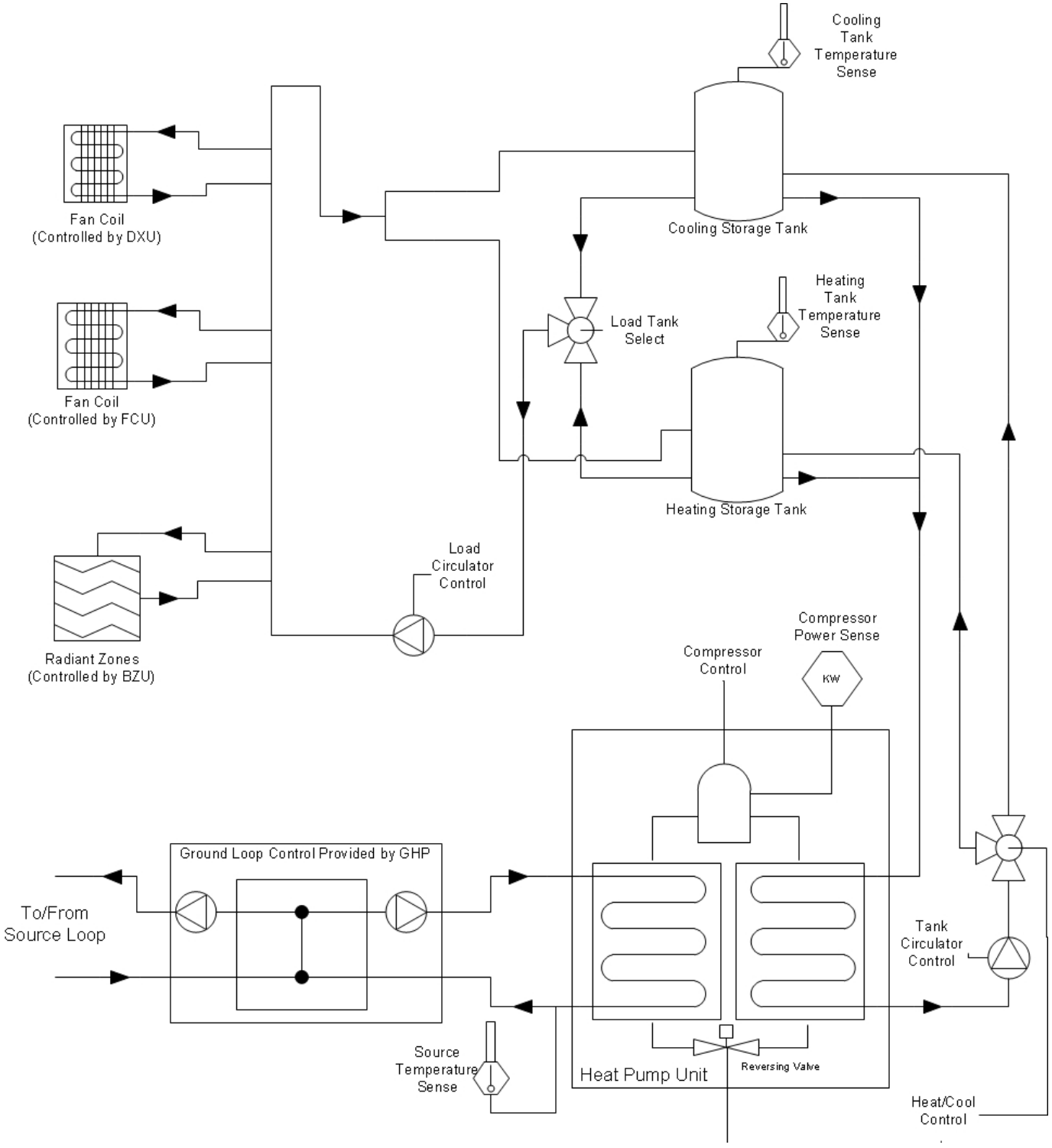
The HPM1 activates a heat pump to maintain the buffer tank's temperature setpoint. The buffer tank's temperature setpoint is determined by the demand from the zone controllers. When the zones require heating, the buffer tank is maintained at the heating setpoint. When zones require cooling, the buffer tank will use the cooling setpoint. Changeover between heating and cooling occurs when demand for the current mode is satisfied and a minimum changeover time has passed.

In this mode of operation, the HPM can stage on up to 3 heat pumps or control a modulating heat pump.



505-032, Effective: June 5, 2014

**Figure 3: HPM1 Two Pipe Two Tank Configuration**



In a Two Pipe, Two Tank system, a single supply loop runs to the associated zone controllers. It is fed from either a Hot Buffer Tank or a Cold Buffer Tank. The supply loop contains hot or cold water, based on the demand from the zone controllers. Note that this configuration means that at any given moment, only hot OR cold water may be supplied to the hydronic zones. The tankused to supply the load loop is determined by the Load Tank Select Output, which is assumed to control a three-way valve between the tanks and the load loop. Because there are separate buffer tanks for hot and cold water, there is a much smaller energy penalty when switching between Heating and Cooling, in comparison to a single buffer tank system.

When there is demand for heated or chilled water from the zone controllers (or from one of the hardwired digital demand inputs), the HPM1 will activate the Load Circulator to move water from one of the storage tanks, through the load loop to the zones.

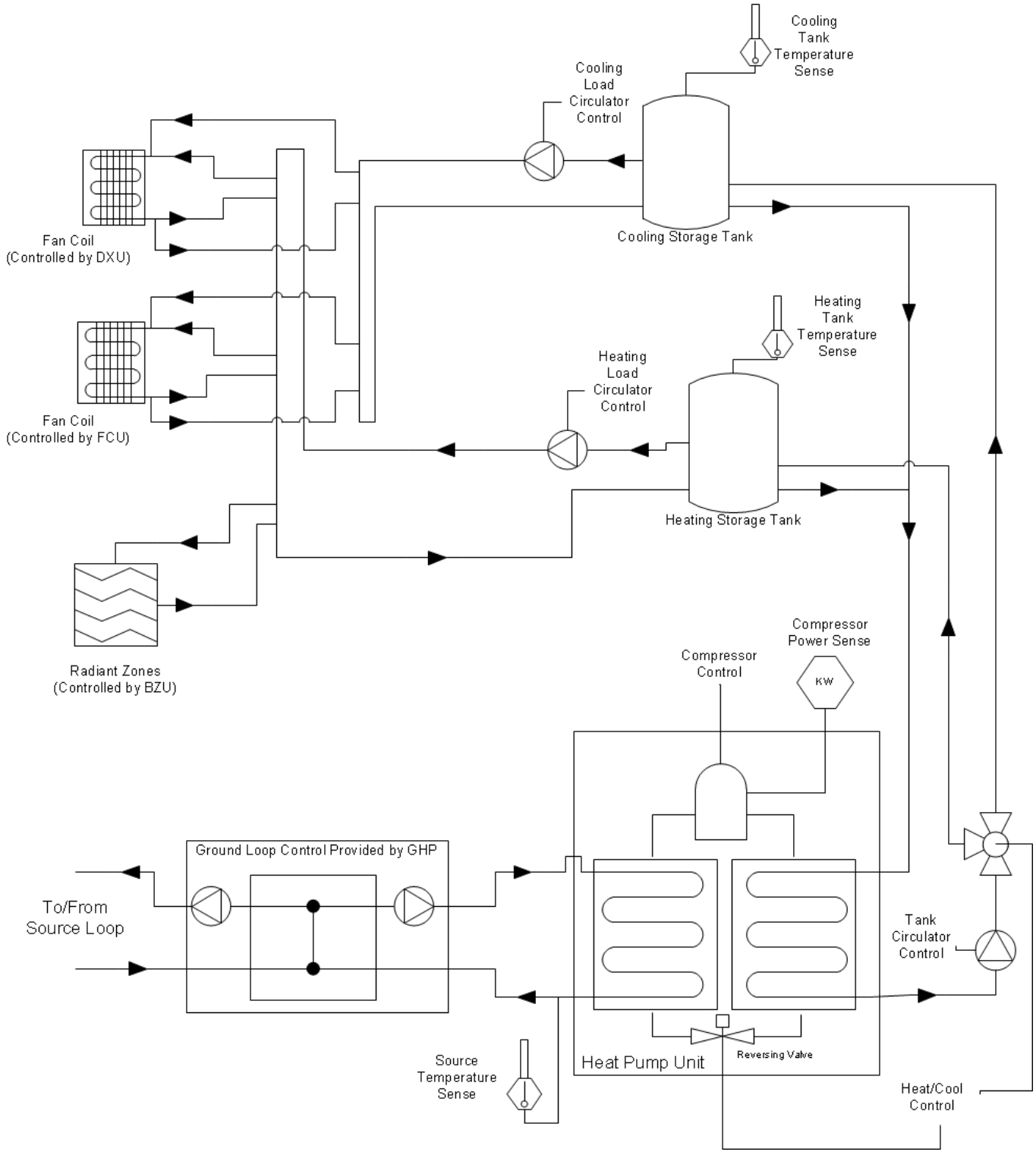
The HPM1 activates heat pump stages to maintain the buffer tanks' temperature setpoint. Since the Heat Pumps can only maintain one tank at a time, the HPM1 will finish moving the first tank's temperature to the setpoint before moving on to the other. A three-way valve is required between the heat pump and the buffer tanks so that the HPM1 may select which tank the heat pump is heating or cooling. This valve should be connected to the same output as the Heat Pump's reversing valve.

In this mode of operation, the HPM1 can stage on as many as 2 heat pumps or control a modulating heat pump.



505-032, Effective: June 5, 2014

**Figure 4: HPM1 Four Pipe Two Tank Configuration**



In a Four Pipe Two Tank system, separate Hot and Cold Load Loops are run to the associated zone controllers. Each of these Loops are fed from their own buffer tank. This configuration may supply hot and cold water simultaneously, based on demand from the hydronic zone controllers. When there is zone demand for hot water, the HPM1 activates the heating load loop circulator to move water from the hot buffer tank to the zones that require heat. When there is demand for cooling, the HPM1 activates the cooling load loop circulator which moves water from the cold buffer tank through the cooling load loop.

The HPM1 activates heat pump stages to maintain the buffer tanks' temperature setpoint. Since the heat pump can only maintain one tank at a time, the HPM1 will finish moving the first tank's temperature to the setpoint before moving on to the other. A three-way valve is required between the heat pump and the buffer tanks in order for the HPM1 to select which tank the heat pump is heating or cooling. This valve should be connected to the same output as the Heat Pump's reversing valve.

In this mode of operation, the HPM1 can stage on up to 2 heat pumps or control a modulating heat pump.

# SEQUENCE OF OPERATION

This section describes the detailed sequence of operation for the HPM1 control algorithms.

## Communication with Associated Zone Controllers

In addition to the HPM1's sensor inputs (thermistors, digital demand), the HPM1 uses information from its associated zone controllers to determine operation.

Each second, one zone controller is polled. The zone controller responds to the HPM1 with zone demand information. This interaction is repeated each second for each of the zone controllers. When all zone controllers have been polled, the sequence repeats.

For more information, see the section “HPM1 and Associated Controller Communications” on page 38.

## Operational Mode

The HPM1 operates in one of five operating modes: Primary Heating, Primary Cooling, Supplemental Heating, Emergency Heating, and Off. The operating mode determines whether warm water or cool water is supplied to the Storage Tank(s), and whether auxiliary heating elements are used.

The HPM1 determines the operational mode based on the temperature of the buffer tank(s) and sometimes the total zone demand supplied by the associated zone controllers. The operation of the load circulator(s) (and the Tank select valve in Two Pipe Two Tank Mode) is determined solely by zone demand.

### Determining Operation Mode

Different mechanical configurations have slightly different methods of determining the operation mode as described below.

### Mode Determination in a Two Tank System

In a Two Tank system, operating mode is determined solely on the temperature of the buffer tanks. First, the system checks which tank's temperature deviates the most from its setpoint. It brings that tank back to its setpoint, then moves on to the other. There is no changeover time between heating and cooling. For entry into supplemental and emergency heating, see the individual entries on those modes. If both tanks are at their setpoint, the mode switches off.

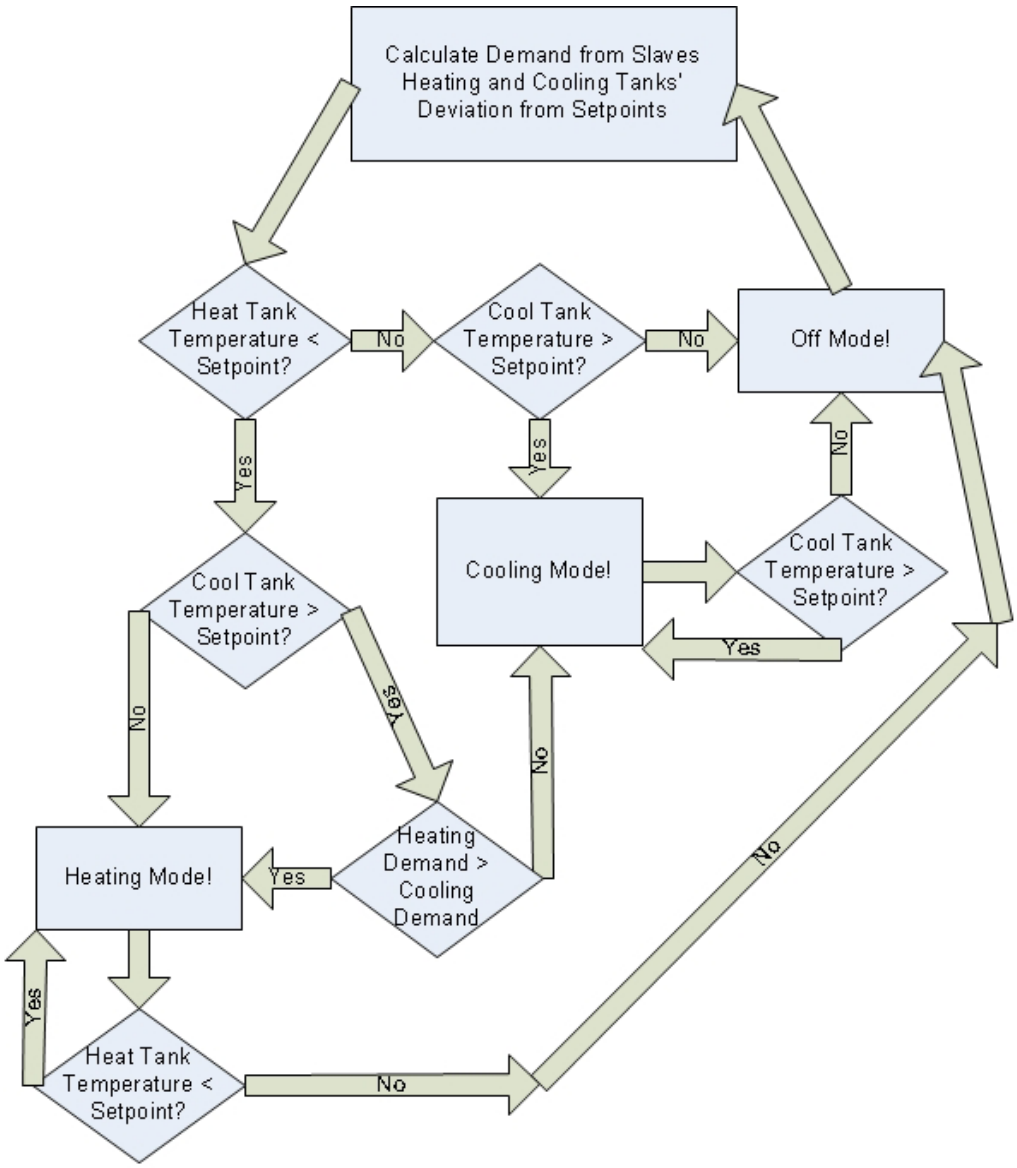
In a Two Pipe, Two Tank System, the load loop mode may be separate from the operational mode. It is determined by the total zone demand. On startup, the load loop will enter cooling if there is greater zone cooling demand. Otherwise it will enter heating. Once in a mode, the load loop will continue in that mode until all zone demand for that mode is met. Once demand for that mode is met it will switch to the other mode if such demand exists. Otherwise it will continue in the same mode.

In a Four Pipe, Two Tank System, there are two load loops, so the heating and cooling can happen simultaneously.



505-032, Effective: June 5, 2014

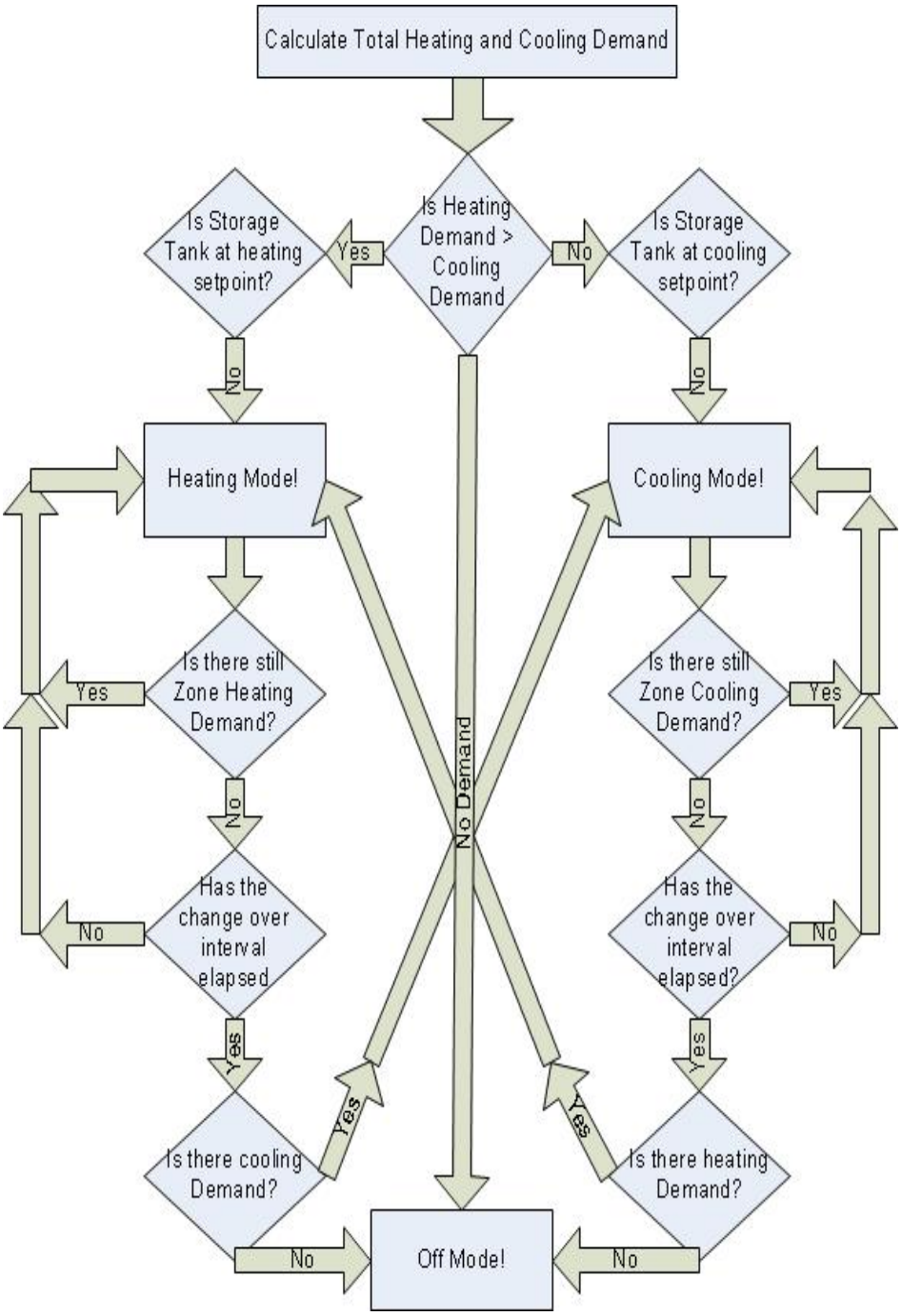
**Figure 5: HPM1 Mode Determination in a Two Tank Configuration**




## Mode Determination in a Single Tank System

In a Single Tank System, load loop mode will always match the HPM1's operational mode. First, the system calculates demand. If heating demand is greater, the HPM1 enter heating mode. If cooling demand is greater, then HPM1 enters cooling. Once in Heating or Cooling, the HPM1 will not exit that mode until all zone demand has been met AND a pre-defined changeover period has elapsed.

**Figure 6: HPM1 Mode Determination in a Single Tank Configuration**



## Overriding the Operational Mode

The heating mode may be disabled during warm weather by setting the outdoor air temperature heating lockout *Max OAT Heat*. If the OAT is above the heating lockout temperature, the primary heating mode is disabled and the controller can only be in the primary off or primary cooling modes. This feature requires that a controller that broadcasts the OAT, such as an ASM2 or other controller that broadcasts the OAT, has been installed on the network.

The cooling mode may be disabled during cold weather by setting the outdoor air temperature cooling lockout *Min OAT Cool*. If the OAT is below the cooling lockout temperature, the primary cooling mode is disabled and the controller can only be in the primary off or primary heating modes. This feature requires that a an ASM2 be installed on the network.

Alarm conditions (High Pressure, Low Pressure, Plant [also known as Pump Proof] or Low Geothermal Loop temperature) also override the operation mode. A Low Geothermal Loop temperature will override the mode if emergency heating. Other alarms cause the HPM1 to transition to Off.

## Occupancy Mode

The HPM does not use the occupancy data transmitted over the LON network, instead relying entirely on the demand data from associated controllers.

## Supplemental Heating

There are often situations in which the heating output of heat pumps is inadequate to meet the system's demand. During these situations, the HPM1 operates in Supplemental Heating mode. The heat pumps operate normally, but an additional auxiliary heating element is brought online to pick up the slack. The circulators all operate normally.

There are three ways to enter Supplemental Heating:

*Tank/Supply Maximum Differential* - This is a configuration variable that sets the maximum allowable difference between the Source loop water temperature and the Tank water temperature. Once this temperature difference has been exceeded, the HPM will enter auxiliary heating. The HPM1 re-enters primary heating after a programmable hysteretic temperature has been reached.

*Source Loop Temperature Supplemental Threshold* - This is a configuration variable that sets the minimum or maximum temperature for the heat transfer medium in the Source loop. If the Source loop temperature goes below the minimum source loop threshold, the unit enters Supplemental Heating. The HPM1 will re-enter primary heating after a programmable hysteretic temperature has been reached.

T*ank Setpoint Deviation Threshold* - This is a configuration variable that sets the maximum allowable deviation of the Storage Tank temperature from its heating setpoint. The HPM1 will re-enter primary heating after the tank setpoint temperature has been reached.

## Emergency Heating

Occasionally there are situations when the operation of heat pumps is undesirable or impossible. During these situations, the HPM1 operates in Emergency Heating. The heat pumps are turned off to allow the Source Loop time to recover. Auxiliary heating elements are activated. The Circulators operate normally.

Emergency heating is activated when the Source Loop Temperature falls below the *Source Loop Temperature Emergency Minimum Threshold*.

If Emergency Heating has been entered, the HPM1 does not attempt to re-enter normal modes of operation until it has been manually reset, or until after the *Emergency Minimum Recovery Interval* has elapsed. This setting is a configuration variable than can range from minutes to hours.

After the Emergency Minimum Interval has passed, the HPM1 enables source demand for 30 seconds to ensure an accurate measure of the Source Loop Temperature. If it has recovered to the *Emergency Mode Hysteresis Temperature,* the HPM1 will resume primary or supplemental operation as determined by conditions. If the *Source Loop Temperature* has not recovered, the HPM will try again after another Emergency Minimum Recovery interval has passed, and so on.

## Setpoint Calculations

The *Heating and Cooling Tank Liquid Temperature* setpoints are programmable. In a single tank system, the effective setpoint is calculated based on the current operating mode. The effective setpoint is set to the heating setpoint when the operational mode is in heating. It is set to the cooling setpoint when the operational mode is in cooling. In a two tank system, both tanks maintain their own setpoints.

### Outside Air Temperature Setpoint Reset Curve

If there is an ASM present on the network, the HPM1 may use an OAT reset curve to determine Tank setpoints.

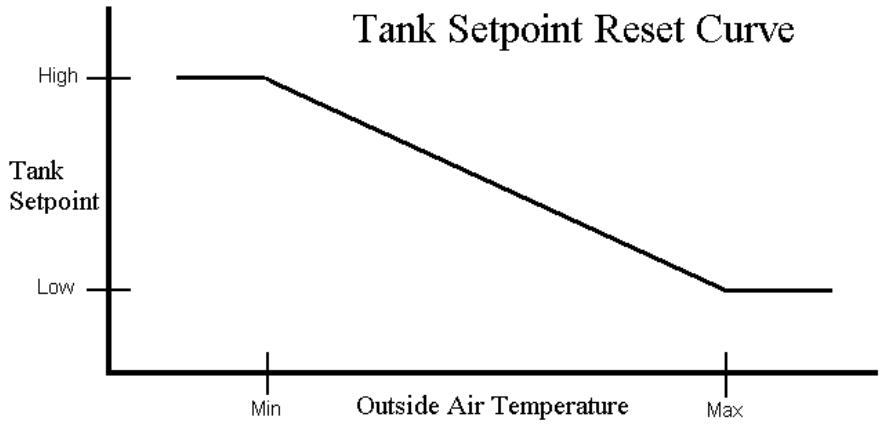
If the *OAT Setpoint Reset Curve* is enabled, the HPM1 keeps track of the Outside Air temperature. It adjusts the heating and cooling tank setpoints to compensate for hotter or colder outside temperatures.

If the OAT is less than the *OAT Minimum*, then the *Tank Setpoint High* is used. If the OAT is greater than the OAT Maximum, then the *Tank Setpoint Low* is used.

When the OAT is between the *OAT Maximum* and *Temperature Differential Minimum*, the *Supply Temperature Setpoint* is linearly interpolated between the *Supply Setpoint High* and *Supply Setpoint Low*.

When the *OAT Maximum* and *Minimum* are set to -4°F, the *OAT Setpoint Reset Curve* is disabled and the HPM1 operates with the usual heating and cooling supply air temperature setpoints.

**Figure 7: OAT Tank Setpoint Reset Curve**




## Heating Sequence

The controller provides support for up to 3 Heat Pump stages (2-pipe, 1-tank) during heating, or a single modulating 0-10V Heat Pump. The type of heating is selected with configuration variables.

### Staged Heating

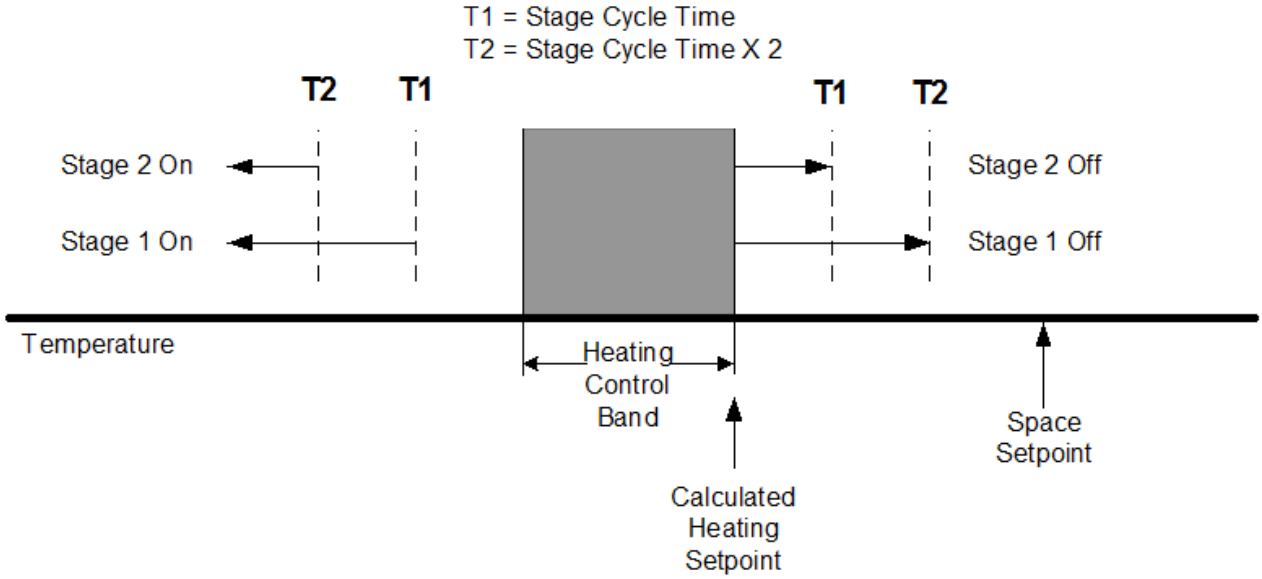
The heating sequence is initiated when the current operating mode calls for heat.


505-032, Effective: June 5, 2014

The heat pump stages are sequenced based on the supply temperature, the heating setpoint and the control band. When tank temperature remains below the control band for an additional time period, the next available stage is turned on. This cycle continues until all available stages have been energized.

After the tank temperature has risen above the heating setpoint, the first available stage is turned off. If the tank temperature remains above the heating setpoints for an additional time period, the next available stage is turned off. This cycle continues until all available stages have been de-energized. If the tank temperature rises above the heating setpoint plus control band, all of the stages immediately cycle off.

**Figure 8: Staged Heating for Two Stages**




### Heating with Modulated output

With modulated heating, the heat pump is controlled by a P+I control loop (Note that the 'loop' in this sense refers to a Proportional, Integral control loop, rather than a loop in the hydronic sense) based on the Storage Tank heating setpoint and the Storage tank temperature. The P+I control loop modulates the output to maintain a constant tank temperature.

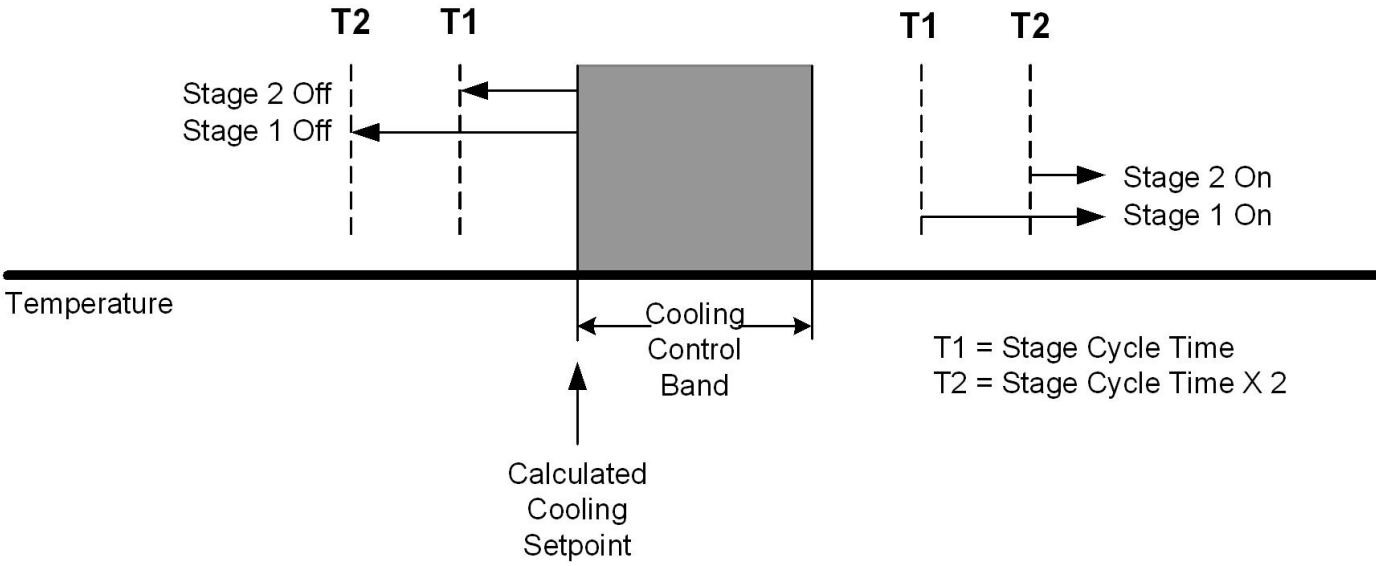
## Cooling Sequence

### Cooling Stages

The cooling sequence is initiated when the current operating mode calls for cooling. The Heat Pump stages are sequenced based on the Storage tank liquid temperature, the cooling setpoint and the control band. When buffer tank temperature rises above the cooling setpoint minus the control band, a stage is turned on. If buffer tank temperature remains above the control band for an additional time period, the next available stage is turned on. This cycle continues until all available stages have been energized.

After buffer tank temperature has dropped below the cooling setpoint, the first available stage is turned off. If buffer tank temperature remains below the cooling setpoint for an additional time-period, the next available stage is turned off. This cycle continues until all available stages have been de-energized. If buffer tank temperature drops below the cooling setpoint plus control band, all of the stages immediately cycle off.

**Figure 9: Staged Cooling for Two Stages**




### Cooling with modulated Output

With modulated cooling, the Heat Pump is controlled by a modulated P+I control loop (Note that the 'loop' in this sense refers to a Proportional, Integral control loop, rather than a loop in the hydronic sense) based on the cooling setpoint and the cooling buffer tank temperature. The P+I control loop modulates the output to maintain a constant buffer tank temperature. As the buffer tank temperature decreases below the cooling setpoint, the heat pump output is modulated lower. The heat pump output is modulated higher as the temperature increases above the cooling setpoint.

## Lead/Lag of Heat Pump Stages

When more than one heat pump stage is present, it may be preferable to rotate which stage is activated first to prevent more wear on any one stage than any other. It is also desirable to be able to disable this feature.

The HPM1 utilizes its real time clock to track the date. The HPM1 divides the current day of the month by the number of stages. If this division has no remainder, then the 1st stage is activated first. If the division has a remainder of 1, then the 2nd stage is activated first, and so on.

Subsequent stages are enabled in numerical order, wrapping back around to the first stage.

Lead/lag of stages is activated or deactivated with the Lead/Lag Enable configuration parameter.

## HPM1 and Associated Controller Communications

The HPM1 and its associated hydronic zone controllers transfer information at a frequency based on the number of associated zone controllers. The HPM1 polls a single associated zone controller once every second. If there are 4 associated controllers, it will communicate with all of them once every 4 seconds. Once every 5 seconds it will send a message to an associated zone controller containing information about the HPM1’s operational mode.

The following information is transferred to the HPM1 from the associated zone controller:

- Zone Mode (Heat/Cooling/ Off)

- Heating Output
- Cooling Output
- Local Alarm

The following information is transferred from the HPM1 to the associated zone controller:

- Alarm
- State of Load Loop for two state configurations

### Associating Zone Controllers

The zone controllers and the HPM1 must be associated to share information. To associate the zones to the HPM1, select the HPM1 from the LCI's list of controllers, tap **`HVAC Setup`** then **`Zone Members`**. A list of all zone controllers on the network with the designation "Included" or "Excluded" is displayed. To include a zone controller, tap the preferred controller in the list. It then shows as “Included” and the color changes to Red. After all the associations are complete, tap **`Save`** to send the information to all associated controllers.

## HPM and GHP Communications

HPM1 is capable of sending information on the heat pumps' energy consumption and demand for ground temperature water. The Taco Geothermal Pump controller (GHP) may use this data to provide Ground temperature water in the most efficient manner possible.

The HPM1 must be associated with the GHP to share information. See the GHP manual for a description of this process.

## Runtime Accumulations

The total runtime is accumulated for the heat pump, load loop circulator, heat load circulator, cool load circulator and tank circulator. The runtimes are used to indicate that maintenance is required on the equipment controlled by these outputs. The runtimes are reset by an operator or maintenance person once service has been performed.

## Heat Pump Power Consumption

The HPM1 is provided with an analog input to measure the amount of energy used by Heat Pump controllers. Taco can provide a power transducer that is compatible with this input. This input combined with Full Scale Power configuration parameter allows the HPM1 to calculate the instantaneous power consumed by the Heat Pump. This value will be integrated over time to calculate the watt hours of energy used. This information is transmitted to the GHP for COP and efficiency calculations.

# CONTROLLER IDENTIFICATION

Once the HPM1 is properly installed and recognized by the LCI, the LCI may be used to configure the settings of the controller. This section describes the commands available on the LCI for configuration of the HPM1, and the meanings and default values for controller parameters. For more information on using the LCI, see the *iWorx® LCI Application Guide.*

## Network Inputs

The HPM1 allows a network manager to write to Network Input Variables for the purpose of overriding the configuration, operation and outputs of the HPM1. The variables are listed below.

Values written to NVIs have absolute priority over any other controller operation.

• *nviOccCmd* overrides the occupancy as obtained from the thermostat. Writing to this variable will also be reflected in the controller's output of the occupancy mode. Note that this is NOT the occupancy sensor. The occupancy sensor hardware input (OCC) will still be displayed on the LCI based on its configuration.

• *nviResetRuntime* is a command to reset the fan, heating and cooling runtimes. If the value sent is 0, then no reset occurs; if the value sent is 1, then the runtimes are reset.

• *nviSysTime* is a time stamp to set the date and time. Writing to this variable will change the time on the device and will affect all time-related functions such as schedules.

• *nviOutOverride* is a structure (defined below) that overrides the hardware digital and analog outputs on the HPM1. These values allow the network controller to directly control the analog and digital outputs of the board. Additionally, the two floating setpoint outputs may be set directly.

> **NOTE:** the HPM1 makes no attempt to interpret the outputs; assigning meaningless outputs (such as setting a digital output in both the digOut array and the fpOut array, or assigning values to FAN1 and FAN2 but leaving FAN3 as 0xFF) will have unpredictable results.

## Network Variable Inputs (NVIs)

| Internal Variable Name | Format | Range | Description |
|---|---|---|---|
| nviOccCmd | SNVT_occupancy | 0=Occupied<br>1=Unoccupied<br>2=Bypass<br>3-Standby | Occupancy Command |
| nviResetRuntime | SNVT_lev_disc | 0=no reset<br>1=reset runtimes | Resets fan, heating, and cooling runtimes |
| nviSysTime | SNVT_time_stamp | Date/Time | System time |
| nviOutOverride | Structure | Structure | Output override |



505-032, Effective: June 5, 2014

### Output Override Structure (NVI)

| Name | Type/Range | Default | Description |
|---|---|---|---|
| digOut[8] | Unsigned Byte:<br>0=OFF<br>1=ON<br>0xFF=no override | 0xFF<br>0xFF<br>0xFF<br>0xFF<br>0xFF<br>0xFF<br>0xFF<br>0xFF | digOut[0] = TO1 (pin 31) C1<br>digOut[1] = TO2 (pin 29) C2<br>digOut[2] = TO3 (pin 28) H1<br>digOut[3] = TO4 (pin 26) H2<br>digOut[4] = TO5 (pin 25) FAN1<br>digOut[5] = TO6 (pin 23) FAN2<br>digOut[6] = TO7 (pin 22) FAN3<br>digOut[7] = TO8 (pin 20) DEH |
| aOut[4] | SNVT_lev_percent:<br>0% to 100%<br>32767=no override | 32767<br>32767<br>32767<br>32767 | aOut[0] = AO 0 (pin 37) HMOD<br>aOut[1] = AO 1 (pin 35) CMOD<br>aOut[2] = AO 2 (pin 34) FAN<br>aOut[3] = AO 3 (pin 32) DMPM |
| fpOut[4] | SNVT_lev_percent:<br>0% to 100%<br>32767=no override | 32767<br>32767<br>32767<br>32767 | fpOut[0] = TO1=FSP Op, TO2=FSP Cl<br>fpOut[1] = TO3=FSP Op, TO4=FSP Cl<br>fpOut[2] = unassigned<br>fpOut[3] = unassigned |

## Inputs

The Inputs screen displays the current values of the HPM1's inputs. These values cannot be changed.

| Input | Range | Description |
|---|---|---|
| Outside Temp | -30 to 230 °F (-34.4 to 110 °C) | The Outside Air Temperature as reported by the ASM2 controller |
| Instantaneous Power | 0 to 65535 watts | Instantaneous power measured by the controller |
| Ground Temperature | -30 to 230 °F (-34.4 to 110 °C) | Measured ground temperature |
| Tank/HW Tank Temp | -30 to 230 °F (-34.4 to 110 °C) | Tank temp in 2 pipe 1 tank configuration; HW Tank temperature in 2 tank applications |
| CW/Tank Temp | -30 to 230 °F (-34.4 to 110 °C) | Chilled water tank temperature in 2 tank applications |
| **Digital Inputs** | | |
| Equip Status | Normal/Alarm | Equipment status of the controlled heat pump |
| Heat Demand | Off/On | External heating demand status |
| Cool Demand | Off/On | External cooling demand status |
| Low Pressure Alarm | Normal/Alarm | Low Pressure Alarm status |
| High Pressure Alarm | Normal/Alarm | High Pressure Alarm status |

## Outputs

The Outputs screen displays the current values of the HPM1's outputs. These values cannot be changed.

| Output | Range | Description |
|---|---|---|
| **Unit Status** | | |
| Mode | Off, Heat, Cool, Emergency Heat | Mode of the controller |
| Output | 0 to 100% | % of the heat pump heating or cooling |
| In Alarm | No/Yes | |
| **Digital Outputs** | | |

| Output | Range | Description |
|---|---|---|
| Stage 1 | Off/On | Status of the stage 1 output |
| Stage 2 | Off/On | Status of the stage 2 output |
| Stage 3/TS/Cool Circ | Off/On | Status of the output; dependent on application mode |
| Load Circ/Heat Circ | Off/On | Status of the output; dependent on application mode |
| Aux Heat | Off/On | Status of the auxiliary heat output |
| Rev Valve | Off/On | Status of the reversing valve output |
| Ground | Off/On | Status of the ground enable output |
| Tank Circ | Off/On | Status of the tank circulator output |
| Reversing Valve | Cool/Heat | Mode of the reversing valve |
| **Runtimes** | | |
| Heat Pump | 0 to 65535 hours | Run hours for the heat pump |
| Load Circ | 0 to 65535 hours | Run hours for the load circulator |
| Heat Load Circ | 0 to 65535 hours | Run hours for the heating load circulator |
| Cool Load Circ | 0 to 65535 hours | Run hours for the cooling load circulator |
| Tank Circ | 0 to 65535 hours | Run hours for the tank circulator |
| Effective Tank SP | 34 to 190 °F (1.1 to 87.7 °C) | The calculated tank setpoint depending on the output mode of the controller |

# Configuration

This section describes the settings that can be modified.

## All Settings

This screen displays all of the controller's settings and provides access to edit all parameters from a single screen. Parameters that are structures are described in individual tables that follow.

| Setting | Range | Default | Description |
|---|---|---|---|
| Commissioning | Structure | N/A | Commissioning Overrides of HPM1's Outputs |
| System Configuration | Two Pipe Two Tank, Two Pipe One Tank, Four Pipe Two Tank | Two Pipe Two Tank | Describes the piping and tank configuration of the system |
| Tank Setpoints | Structure | N/A | Setpoint Settings |
| OAT Reset Cool | Structure | N/A | OAT Setpoint Reset Curve Cooling |
| OAT Reset Heat | Structure | N/A | OAT Setpoint Reset Curve Heating |
| Staged Cooling | Structure | N/A | Staged Cooling Settings |
| Modulated Cooling | Structure | N/A | Modulated Cooling Settings |
| Staged Heating | Structure | N/A | Staged Heating Settings |
| Modulated Heating | Structure | N/A | Modulated Heating Settings |
| Stage Lead Lag | Enabled, Disabled | Enabled | Describes whether Lead/Lag of heat pump stages is enabled |
| Supplemental Heat | Structure | N/A | Supplemental Heating Settings |
| Sensor Settings | Structure | N/A | Temperature and Power Sensor Settings |
| Changeover Settings | Structure | N/A | Settings relating to automatic changeover of heat/ool mode in Two Pipe One Tank systems |
| OAT Cutoffs | Structure | N/A | Provies entries for cutoff temperatures for heating and cooling |



505-032, Effective: June 5, 2014

| Setting | Range | Default | Description |
|---|---|---|---|
| Alarm Settings | Structure | N/A | All settings related to alarms |
| Runtime Limits | Structure | N/A | Runtime Limit Settings |
| Rev Vlv Action | Energized on Heat, Energized on Cool | Energized on Heat | Describes when the reversing valve output is energized |
| Alarm Enable | Structure | N/A | Allows the user to define the switch type |

## Commissioning

This screen displays settings related to commissioning the HPM1's outputs.

| Setting | Range | Default | Description |
|---|---|---|---|
| Enable Commissioning | Off, On | Off | Enables / disables commissioning |
| Stage 1 | Off, On | Off | Stage 1 override |
| Stage 2 | Off, On | Off | Stage 2 override |
| Stage 3/TS/Cool Circ | Off, On | Off | Stage 3/TS/Cool Circ override |
| Load Circ/heat Circ | Off, On | Off | Load Circ override |
| Aux Heat | Off, On | Off | Aux Heat override |
| Rev Valve | Off, On | Off | Rev Valve override |
| Ground | Off, On | Off | Ground Circ override |
| Tank Circ | Off, On | Off | Tank Circ override |
| Mod Output | 0% to 100% | 0% | Percent of full scale to override output (during commissioning) |

## Tank Setpoints

This screen displays settings related to the system's buffer tanks' heating and cooling setpoints.

| Setting | Range | Default | Description |
|---|---|---|---|
| Tank Heat Setpoint | 60 to 190 °F (15.5 to 87.8 °C) | 115 °F (46.1 °C) | Temperature Setpoint of the Storage tank during heating |
| Tank Cool Setpoint | 34 to 70 °F (21.1 to 5.56 °C) | 40 °F (4.4 °C) | Temperature Setpoint of the Storage tank during cooling |

## OAT Reset Cool

This screen displays settings related to modifying the cooling buffer tank's setpoint based on outdoor air temperature.

| Setting | Range | Default | Description |
|---|---|---|---|
| Reset Low | -20 to 122 °F (-28.9 to 50.0 °C) | -4.0 °F (-20.0 °C) | Low OAT for Cooling Tank Setpoint Reset Curve |
| Reset High | -20 to 50.0 °F (-28.9 to 48.9 °C) | -4.0 °F (-20.0 °C) | High OAT for Cooling Tank Setpoint Reset Curve |
| SP Low | 34 to 70 °F (1.1 to 21.1 °C) | 60 °F (15.6 °C) | Low Tank Setpoint for Cooling |
| SP High | 34 to 70 °F (1.1 to 21.1 °C) | 40 °F (4.44 °C) | High Tank Setpoint for Cooling |

## OAT Reset Heat

This screen displays settings related to modifying the heating buffer tank's setpoint based on outdoor air temperature.

| Setting | Range | Default | Description |
|---|---|---|---|
| Reset Low | -20 to 122 °F<br>(-28.9 to 50.0 °C) | -4.0 °F<br>(-20.0 °C) | Low OAT for Heating Tank Setpoint Reset Curve |
| Reset High | -20 to 122 °F<br>(-28.9 to 50.0 °C) | -4.0 °F<br>(-20.0 °C) | High OAT for Heating Tank Setpoint Reset Curve |
| SP Low | 60 to 190 °F<br>(15.5 to 87.8 °C) | 120 °F (48.9 °C) | Low Tank Setpoint for Heating |
| SP High | 60 to 190 °F<br>(15.5 to 87.8 °C) | 100 °F (37.8 °C) | High Tank Setpoint for Heating |

## Staged Cooling / Heating

This screen displays settings related to the activation of heat pump stages during cooling or heating.

| Setting | Range | Default | Description |
|---|---|---|---|
| Stages | 0-3 | 2 | Number of Stages controlled. Set to zero to disable staged cooling or heating. |
| Control Band | 0 to 10.0 °F<br>(0 to 5.55°C) | 1.0 °F<br>(0.55 °C) | Value used to modify the calculated setpoints to form the temperature range in which local cooling or heating is enabled. |
| Stage Time | 0 to 255 minutes | 5 minutes | The rate at which successive stages are sequenced. |

## Modulated Cooling / Heating

This screen displays settings related to the use of a modulated heat pump for cooling or heating.

| Setting | Range | Default | Description |
|---|---|---|---|
| Kp | 0.00 to 100.00 per °F | 5.00% | Proportional gain of the P+I control loop |
| Ki | 0.00 to 100.00% | 0.05% | Integral gain of the P+I control loop |
| Min AO Voltage | 0.0 to 10.0 Volts | 0.0 Volts | Maximum output voltage for modulated cooling or heating |
| Max AO Voltage | 0.0 to 10.0 Volts | 0.0 Volts | Maximum output voltage for modulated cooling or heating. If set to 0, Modulation is disabled. |

## Supplemental Heat

This screen displays settings related to the operation of supplemental heating.

| Setting | Range | Default | Description |
|---|---|---|---|
| Max Tank/Ground Diff | 0 to 120 °F<br>(0 to 66.7 °C) | 80 °F (44.4 °C) | Temperature difference between the Storage tank and its current setpoint that will trigger supplemental heating or cooling. 0 disables. |
| Tank/Ground Diff DB | 1 to 20 °F<br>(0.55 to 11.1°C) | 2 °F (1.11 °C) | Rise above Max tank/Source differential that will end supplemental heating |



505-032, Effective: June 5, 2014

| Setting | Range | Default | Description |
|---|---|---|---|
| Min Ground Temp | 0 to 45 °F<br>(-17.8 to 7.22 °C) | 38 °F (3.33 °C) | Source Liquid temperature that will trigger supplemental heating |
| Min Ground Temp DB | 1 to 20 °F<br>(0.55 to 11.1°C) | 2 °F (1.11 °C) | Temperature rise above the liquid min temperature to end supplemental heating |
| Max Tank SP Diff | 0 to 50 °F<br>(0.0 to 27.8°C) | 20 °F (11.11 °C) | Difference between tank temperature and it's setpoint that will trigger supplemental heating. |

### Sensor Settings

This screen displays settings related to the type of senors used by the HPM1.

| Setting | Range | Default | Description |
|---|---|---|---|
| Ground Temp Sensor | Precon III, Precon II, VTS | Precon III | Type of temperature sensor used to monitor Ground Source Liquid temperature |
| Tank Temp Sensor | Precon III, Precon II, VTS | Precon III | Type of temperature sensor used to monitor Storage Tank Liquid temperature |
| Watts Full Scale | 0 to 65535 Watts‘ | 100 W | Maximum power measured by the power transducer. |

### Changeover Settings

This screen displays settings related to the Changeover between heating and cooling modes in 2 Pipe 1 Tank systems.

| Setting | Range | Default | Description |
|---|---|---|---|
| CO Type | Auto, Heat Only, Cool Only | Auto | Whether to allow automatic mode transitions, or to lock unit into heating only or cooling only |
| Hours | 0 to 255 hours | 0 hours | See above (hours portion of the time interval). |
| Minutes | 0 to 59 minutes | 30 minutes | Minimum time between heating and cooling modes (minutes portion of the time interval) |
| Demand Type | Total Demand,<br>Zone Maximum,<br>Reference Zone,<br>Digital Input | Total Demand | Describes which method to use to changeover |

### OAT Cutoffs

This screen displays settings related to overriding heat pump operation in response to outdoor air temperature.

| Setting | Range | Default | Description |
|---|---|---|---|
| Heat Max OAT | -20 to 122 °F<br>(-28.9 to 50.0 °C) | -4.0 °F<br>(-20.0 °C) | Outside air temperature above which heating is disabled. -4 disables the cutoff. |
| Cool Max OAT | -20 to 122 °F<br>(-28.9 to50.0 °C) | -4.0 °F<br>(-20.0 °C) | Outside air temperature below which cooling is disabled. -4 disables the cutoff. |

## Alarm Settings

This screen displays settings related to response to alarm situations.

| Setting | Range | Default | Description |
|---|---|---|---|
| Heat Emergency Temp | 0.0 to 40.0 °F<br>(-17.8 to 4.4 °C) | 34 °F<br>(1.11 °C) | Source temperature that will trigger emergency heating |
| Recover Temp | 0.0 to 40.0 °F<br>(-17.8 to 4.4 °C) | 39.0 °F<br>(3.89 °C) | Source temperature that allows for a recovery from emergency heating |
| Recovery Minutes | 0 to 59 minutes | 0 minutes | Period of time in which the HPM1 will try to recover from an emergency heating condition. Note that if both minutes and hours are set to zero, a user reset is required to recover from this alarm. |
| Recovery Hours | 0 to 255 hours | 2 hours | See above (hours portion of the time interval). |
| Equip Status Delay | 0 to 255 minutes | 255 minutes | Period of time the HPM1 will wait before declaring an Equipment status delay interval alarm after Source demand for the Equipment Status input to go low. A value of 255 disables this alarm. |

## Runtime Limits

This screen displays settings related to runtime maintenance notifications for heat pump system components.

| Setting | Range | Default | Description |
|---|---|---|---|
| Heat Pump | 0 to 65535 hours | 1,000 hours | Runtime limit for Heat Pump operation after which a maintenance alarm is generated |
| Load Circ | 0 to 65535 hours | 10,000 hours | Runtime limit for Load Circulator operation after which a maintenance alarm is generated (Two Pipe Systems) |
| Heat Load Circ | 0 to 65535 hours | 10,000 hours | Runtime limit for Heat Load Circulator operation after which a maintenance alarm is generated (Four Pipe Systems) |
| Cool Load Circ | 0 to 65535 hours | 10,000 hours | Runtime limit for CoolLoop Circulator operation after which a maintenance alarm is generated (Four Pipe Systems) |
| Tank Circ | 0 to 65535 hours | 10,000 hours | Runtime limit for Tank Circulator operation after which a maintenance alarm is generated |

## Alarm Enable

Allows the user to define the switch inputs as either Open or Closed or to disable alarming.

| Setting | Range | Default | Description |
|---|---|---|---|
| Equip Status Polarity | Disabled,<br>Normally Open,<br>Normally Closed | Normally Open | Defines the type of switch and when to alarm. |
| Low Press Alm Polarity | Disabled,<br>Normally Open,<br>Normally Closed | Normally Closed | Defines the type of switch and when to alarm. |
| High Press Alm Polarity | Disabled,<br>Normally Open,<br>Normally Closed | Normally Closed | Defines the type of switch and when to alarm. |

## Alarms

The table below describes the alarms that the user may encounter and how to reset them.

| Alarm | Range | Alarm Trigger | Alarm Reset |
|---|---|---|---|
| Plant Synchronization/Equipment Status | Normal, Alarm | An input is provided on the HPM1 for external emergencies or synchronization. If this input is not shorted to ground within *Plant Sync Delay Interval* minutes after the Heat Pump activates, the HPM1 enters an alarm state. This feature is most commonly used as a 'pump proof' signal from the circulator providing the heat pump with water. If this input is not used it should be shorted (jumpered) to ground. | The cause of the emergency condition must be resolved. |
| Sensor Failure | Normal, Alarm | If the HPM1 measures an invalid voltage (shorted to power or ground, for example) on any of its analog inputs, it sends this alarm to the LCI. | The HPM1 attempts to operate as normal during this alarm. |
| Source Loop Liquid Temperature | Normal, Alarm | This alarm is generated when the HPM1 enters Emergency Heating mode. | See the Emergency Heating section for more detail on behavior in this alarm. |
| Maintenance | Normal, Alarm | Occurs when the heat pump or circulator operating hours have exceeded their Runtime limit. | The HPM1 attempts to operate as normal during this alarm. |
| Low Pressure | Normal, Alarm | This alarm is generated when the Low Pressure Alarm input is shorted to ground. During this alarm a 'low pressure alarm' message is sent to the LCI, the compressor is disabled, and the status LED turns red. Load circulators work as normal. There are two types of Low Pressure alarms: Soft and Hard. When the Low Pressure alarm condition is first detected, it is designated a soft alarm. | During a soft alarm, the HPM1 attempts to return to normal operation if the Low Pressure Alarm input is no longer shorted to ground. If a subsequent Low Pressure alarm is detected after 120 minutes have elapsed since the previous alarm, the alarm is again designated a soft alarm. When a low pressure alarm recurs with 120 minutes, it is designated a hard alarm. The HPM1 requires a hard reset to clear a hard low pressure alarm. |
| High Pressure | Normal, Alarm | This alarm is generated when the High Pressure Alarm input is shorted to ground. During this alarm a 'high pressure alarm' message is sent to the LCI, the compressor is disabled, and the status LED turns red. Load circulators work as normal. There are two types of High Pressure alarms: Soft and Hard. When the High Pressure alarm condition is first detected, it is designated a soft alarm. | During a soft alarm, the HPM1 attempts to return to normal operation if the Low Pressure Alarm input is no longer shorted to ground. If a subsequent High Pressure alarm is detected after 120 minutes have elapsed since the previous alarm, the alarm is again designated a soft alarm. When a High Pressure alarm recurs with 120 minutes, it is designated a hard alarm. The HPM1 requires a hard reset to clear a hard High Pressure alarm. |

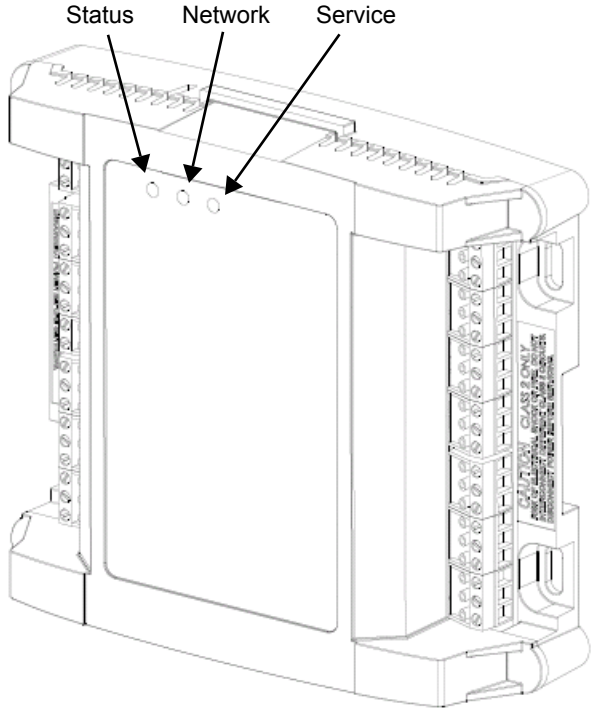
# TROUBLESHOOTING

## Diagnostic LEDs

The controller has 3 LED indicators. These indicators can aid in troubleshooting equipment operation problems. The following table lists the functions of the controller's LEDs in the order they appear from left to right on the unit.

| LED | Indication |
|---|---|
| Status | – Solid green when running and configured by an LCI (networking)<br>– Flashing green when running and NOT configured by an LCI (stand-alone)<br>– Solid red when a fault condition exists (control shut down)<br>– Blinking Red - the controller has a device failure<br>– Solid Amber - The controller has not received a LCI ping message in over 10 minutes and is part of a network. |
| Network | – Yellow while the controller is transmitting data onto the FTT-10A network<br>– Green when there is network activity<br>– Off when there is no network activity |
| Service | – Illuminated when the service pin is depressed or when a controller gets configured by the LCI. |

**Figure 10: HPM1 Controller LEDs**






505-032, Effective: June 5, 2014

# Troubleshooting Tips

The table below provides solution to some common problems you may encounter.

| Problem | Solution |
|---|---|
| Controller is not running and Status LED is not illuminated. | No power to controller. Verify the voltage on the controller's power connector (24 VAC). |
| How do I reset the controller? | The controller can be reset by the LCI, or you can cycle power to the controller. Refer to the LCI documentation for more information on resetting the controller using the LCI. |
| Can my iWorx® system contain multiple HPM1 controllers? | Yes, provided that you do not exceed the maximum number of controllers that can be handled by the Local Control Interface (LCI). |
| Readings fluctuate rapidly, sometimes by several degrees. | The controller is not properly grounded. The controller's ground (GND) pin (T40) must be connected to earth ground. |

## Getting Help

Components within an iWorx® controller, sensor, or power supply cannot be field repaired. If there is a problem with a unit, follow the steps below before contacting your local TES representative or TES technical service.

1. Make sure controllers, sensors, and power supplies are connected and communicating.
2. Record precise hardware setup indicating the following:

   Version numbers of application software.

   Device and/or firmware version number.

   A complete description of difficulties encountered.

**Notes:**

## LIMITED WARRANTY STATEMENT

Taco Electronic Solutions, Inc. (TES) will repair or replace without charge (at the company's option) any product or part which is proven defective under normal use within one (1) year from the date of start-up or one (1) year and six (6) months from date of shipment (whichever occurs first).

In order to obtain service under this warranty, it is the responsibility of the purchaser to promptly notify the local TES stocking distributor or TES in writing and promptly deliver the subject product or part, delivery prepaid, to the stocking distributor. For assistance on warranty returns, the purchaser may either contact the local TES stocking distributor or TES. If the subject product or part contains no defect as covered in this warranty, the purchaser will be billed for parts and labor charges in effect at time of factory examination and repair.

Any TES product or part not installed or operated in conformity with TES instructions or which has been subject to accident, disaster, neglect, misuse, misapplication, inadequate operating environment, repair, attempted repair, modification or alteration, or other abuse, will not be covered by this warranty.

TES products are not intended for use to support fire suppression systems, life support systems, critical care applications, commercial aviation, nuclear facilities or any other applications where product failure could lead to injury to person, loss of life, or catastrophic property damage and should not be sold for such purposes.

If in doubt as to whether a particular product is suitable for use with a TES product or part, or for any application restrictions, consult the applicable TES instruction sheets or in the U.S. contact TES at 401-942-8000 and in Canada contact Taco (Canada) Limited at 905-564-9422.

TES reserves the right to provide replacement products and parts which are substantially similar in design and functionally equivalent to the defective product or part. TES reserves the right to make changes in details of design, construction, or arrangement of materials of its products without notification.

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**TES WILL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL, INDIRECT OR CONSEQUENTIAL DAMAGES RESULTING FROM THE USE OF ITS PRODUCTS OR ANY INCIDENTAL COSTS OF REMOVING OR REPLACING DEFECTIVE PRODUCTS.**

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# CONTROLS MADE EASY®

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