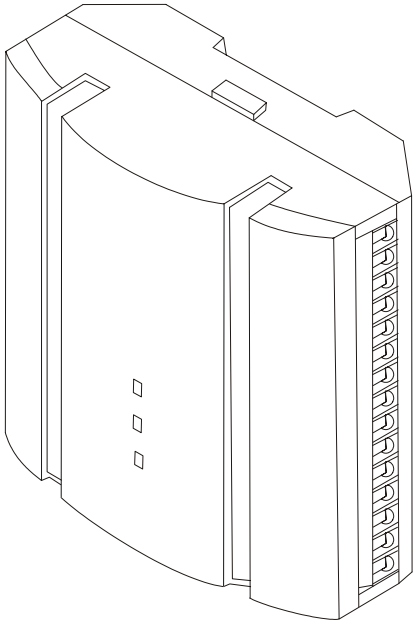
iWorX LHP-1 Application Manual

LHP-1



The iWorX LHP-1 is a self-contained, microprocessor-based controller for supervisory central liquid source heat pump central plant control applications. Applications include central plant controller applications with one cooling tower and one or two single-stage boilers. Applications may also include two water pumps configured for lead/lag or continuous operation.

Overview

Analog inputs are provided for measuring the temperatures of the boiler supply and tower return water, as well as the heat pump supply and return water. Digital inputs are provided for pump, fan, and boiler flow proof, as well as cooling tower basin level.

The LHP-1 incorporates digital outputs in the form of triacs to control the boilers, circulation pumps, tower spray pump, tower fan, tower damper, and tower sump/make-up water valve. In addition, analog outputs are provided to control a tower bypass valve and a variable speed tower fan.

The controller is based on the LonWorks® networking technology. The controller can be networked to a higher-level control system for monitoring and control applications, and provides heated or chilled water in response to demand from other controllers.

Features

- Modulated cooling tower bypass valve
- Modulated cooling tower fan
- Minimum on and off cycle timers for circulation pumps and boilers
- Runtime accumulation for boilers, pumps, and tower fans
- Lead/lag operation of circulation pumps and boilers
- Maximum of 60 zones (cooling/heating demand units)
- Proportional + Integral control of the modulated bypass valve
- Proportional + Integral control of a variable speed tower fan
- LonWorks interface to building automation systems
- OAT low limit protection
- Flow proof inputs
- Adjustable cooling tower setpoint
- Adjustable boiler (heat addition) setpoints
- User selectable analog or digital cooling tower fan
- Automatic configuration with the Local Control Interface (LCI)
- Alarm/Event reporting

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iWorX-LHP1-APP-100

Purpose of This Guide

The *iWorX LHP-1 Application Manual* provides application information for the LHP-1 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

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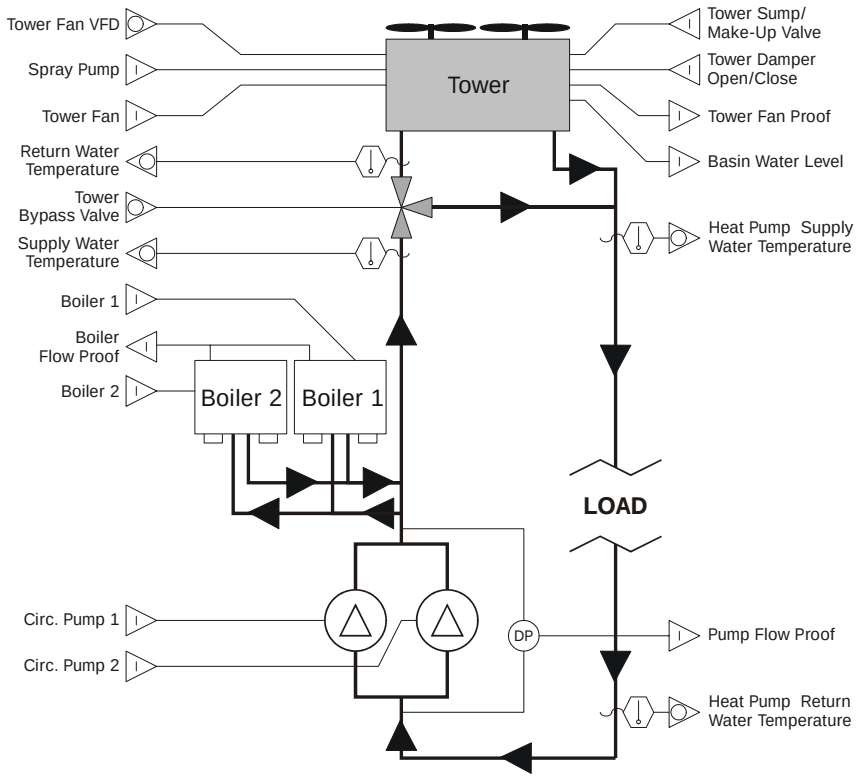
Applicable Documentation

Part Number	Description	Audience	Purpose
iWorX-LHP1-APP-100	iWorX LHP-1 Application Manual	– Application Engineers – Installers – Service Personnel – Start-up Technicians	Provides instructions for setting up and using the iWorX LHP-1 Controller.
iWorX-LCI1-USR-100	iWorX LCI User's Guide	– Application Engineers – Installers – Service Personnel – Start-up Technicians – End user	Provides instructions for setting up and using the iWorX Local Control Interface.
iWorX-HPU1-APP-100	iWorX HPU-1 Application Manual	– Application Engineers – Wholesalers – Contractors	These controllers may all operate in conjunction with the LHP-1. Application manuals provide specific application information about these controllers, including sequence of operation and configuration information.
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.		

Application Description

The LHP-1 liquid source heat pump controller is a stand-alone, microprocessor-based controller for supervisory central liquid source heat pump plant control applications with a cooling tower and one or two single-stage boilers. Two circulation pumps can be configured for lead/lag or continuous operation. For plant applications that utilize a cooling tower, the LHP-1 controls the tower bypass valve, fan (analog or digital control), a damper, and a spray pump. The controller also enables and disables one or two boilers.

Figure 1: LHP-1 loop with cooling tower and boiler



LHP-1 control starts only if there is sufficient cooling or heating demand. The LHP-1 operates in conjunction with up to 60 HPU-1 controllers that can require water. The demand is obtained by the LHP-1 from controllers (zones) that have been associated with the LHP-1 at the LCI user interface during system configuration. Water demand also occurs when the *Heat Pump Supply Temperature* is less than the *Lead Boiler* setpoint or greater than the *Tower Bypass Setpoint*, which triggers boiler or cooling tower activation respectively.

Initial control activates the circulation pump. Pump operation can be configured for continuous circulation or activation only with controller (zone) demand. An anti-cycle function provides configurable minimum On and Off times for the circulation pump. Only one pump is required for normal operation

The LHP-1 includes support for lead/lag operation of two circulation pumps. One of the pumps is designated to be the lead pump, with the lag pump only being required in the event of a lead pump failure. Each time the system is deactivated, the lead pump designation is transferred to the other pump. The lead pump designation is switched every twenty-four hours if the pumps are configured to run continuously.

When the system is activated, the lead circulation pump is started. If the circulation pump has been commanded on for at least 20 seconds and the circulation pump flow proof is off, an alarm is initiated and the lag pump is started. The lag pump also triggers an alarm if it has been commanded on for 20 seconds and flow proof is not established. If both pumps fail, all outputs are turned off and all con-

trol stops. Manual reset of the LHP-1 controller from the operator interface or by cycling power to the LHP-1 is required to restart control.

The position of the cooling tower bypass valve is calculated by a Proportional + Integral (P+I) control loop based on the *Heat Pump Water Supply Temperature* and the *Tower Water Bypass Setpoint*. The bypass valve control loop is activated 15 seconds after the pump flow proof has confirmed flow. As the temperature increases above the *Tower Water Bypass Setpoint*, the bypass valve is modulated open. The bypass valve is modulated closed as the water temperature decreases below the *Tower Water Bypass Setpoint*. The cooling tower bypass valve control loop can be set for direct- or reverse-acting operation.

The LHP-1 cooling tower consists of three stages of cooling. The discharge dampers, spray pump, and tower fan cycle in sequence to maintain loop water temperature. All temperatures are adjustable. Below the *Outside Air Cutoff Temperature*, the spray pump and makeup water valve are de-energized and remain de-energized until the *Outside Air Temperature* rises above the cutoff. After the makeup water valve is energized, the spray pump can be delayed for an adjustable time period to allow the sump to fill. Setting the *Spray Pump Delay* value to zero configures the system to use an external basin water level float switch to signal when the spray pump should be enabled.

When the tower fan is configured as variable speed, cooling tower fan speed is calculated using a P+I control loop based on the *Heat Pump Water Supply Temperature* and the *Tower VFD Fan Setpoint*. The fan speed control loop is activated 15 seconds after the cooling tower bypass valve has modulated to its 100% position (full flow through tower). As the temperature increases above the *Tower VFD Fan Setpoint*, the fan speed is increased. The fan speed is decreased as the water temperature decreases below the *Tower VFD Fan Setpoint*. The fan speed control loop can be set for direct- or reverse-acting operation.

The LHP-1 can activate one or two boilers for heat addition. The boilers are activated when the *Heat Pump Supply Water Temperature* drops below the *Lead Boiler On* or *Lag Boiler On* temperature setpoints. When the controller determines that boiler operation is required, it activates the circulation water pump (if the pump has not been configured to run continuously), and enables one or both boilers. Once enabled from the LHP-1 via digital outputs, the factory installed boiler controls (as provided by the boiler manufacturer) detect water loop water flow and activate the enabled boiler(s).

The LHP-1 provides low limit control. When the *Outside Air Temperature* (as sensed by an ASM controller on the system network) drops below the low limit setpoint, the circulation water pump energizes. The circulation water pump output de-energizes when the temperature rises 1 °F (0.55 °C) above the low limit setpoint (fixed at 35 °F, 1.66 °C).

The LHP-1 monitors the runtime of all pumps, boilers, and fans. When any one of the runtimes exceeds a programmable limit, a maintenance alarm is reported to the LCI.

When the loop temperature exceeds a programmable limit, a high limit alarm is reported to the LCI. When the loop temperature drops below a programmable limit, a low limit alarm is reported to the LCI. When the loop temperature returns to within the proper range, a return to normal is generated.

Sequence of Operation

This section describes the detailed sequence of operation for the LHP-1 control algorithms.

Control Activation

LHP-1 control starts only if there is sufficient cooling or heating demand. The LHP-1 operates in conjunction with up to 60 HPU-1 controllers that can require water. The demand is obtained by the LHP-1 from controllers (zones) that have been associated with the LHP-1 at the LCI user interface during system configuration. Water demand also occurs when the *Heat Pump Supply Temperature* is less than the *Lead Boiler Setpoint* or greater than the *Tower Bypass Setpoint*, which triggers boiler or cooling tower activation respectively.

Initial control activates the circulation pump. Pump operation can be configured for continuous circulation or activation only with controller (zone) demand. An anti-cycle function provides configurable minimum On and Off times for the circulation pump. Only one pump is required for normal operation

Circulation Pump Control

The LHP-1 includes support for lead/lag operation of two circulation pumps. One of the pumps is designated to be the lead pump, with the lag pump only being required in the event of a lead pump failure. Each time the system is deactivated, the lead pump designation is transferred to the other pump. The lead pump designation is switched every twenty-four hours if the pumps are configured to run continuously.

When the system is activated, the lead circulation pump is started. If the lead circulation pump has been commanded on for at least 20 seconds and the circulation pump flow proof is off, an alarm is initiated and the lag pump is started. The lag pump also triggers an alarm if it has been commanded on for 20 seconds and flow proof is not established. If both pumps fail, all outputs are turned off and all control stops. Manual reset of the LHP-1 controller from the operator interface or by cycling power to the LHP-1 is required to restart control.

Cooling Tower Bypass Valve Control

The position of the cooling tower bypass valve is calculated by a (P+I) control loop based on the *Heat Pump Water Supply Temperature* and the *Tower Bypass Setpoint*. The bypass valve control loop is activated 15 seconds after the pump flow proof has confirmed flow. As the temperature increases above the *Tower Bypass Setpoint*, the bypass valve is modulated open. The bypass valve is modulated closed as the water temperature decreases below the *Tower Bypass Setpoint*.

Anti-wind up reset protection prevents the integral component from becoming too large,. This protection clamps the integral value when all of the components add up to more than 100% or less than 0%. The following equations are used for P+I control:

The following equations are used for P+I control:

K_P = Proportional Gain
K_i = Integral Gain
Error = *HpSuppWtrTemp* - *TwrBypWtrSp*
I = *I* + (K_i x *Error*)
ValvePosition = (K_P x (*Error* + *I*)) + 50.00%

Cooling Tower Variable Speed Fan Control

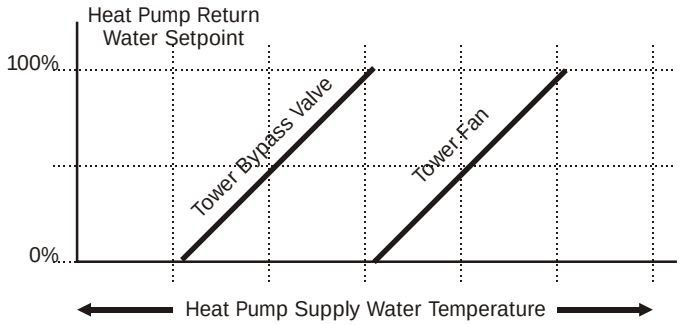
When the tower fan is configured as variable speed, cooling tower fan speed is calculated using a P+I control loop based on the *Heat Pump Water Supply Temperature* and the *Tower Fan VFD Setpoint*. The fan speed control loop is selectable for direct or reverse-acting operation.

Setpoint. The fan speed control loop is activated 15 seconds after the cooling tower bypass valve has modulated to its 100% position (full flow through tower). As the temperature increases above the *Tower Fan VFD Setpoint*, the fan speed is increased. The fan speed is decreased as the water temperature decreases below the *Tower Fan VFD Setpoint*. The fan speed control loop is selectable for direct or reverse-acting operation.

Anti-wind up reset protection prevents the integral component from becoming too large,. This protection clamps the integral value when all of the components add up to more than 100% or less than 0%. The following equations are used for P+I control:

K_P = Proportional Gain
K_i = Integral Gain
Error = *HpSuppWtrTemp* - *CtVfdFanSp*
I = *I* + (K_i x *Error*)
ValvePosition = (K_P x (*Error* + *I*)) + 50.00%

Figure 2: Cooling Tower Sequence



Cooling Tower Staging

The LHP-1 cooling tower consists of three stages of cooling. The discharge dampers, spray pump, and tower fan cycle in sequence to maintain loop water temperature. All “On” and “Off” temperatures and minimum off times are adjustable. “Off” temperature setpoints must be lower than their corresponding “On” setpoints. If an “Off” setpoint is incorrectly set to greater than it’s corresponding “On” setpoint, it is automatically set to 1 °F (0.55 °C) less than the “On” setpoint.

Below the *Outside Air Cutoff Temperature*, the spray pump and makeup water valve are de-energized and remain de-energized until the *Outside Air Temperature* rises above the cutoff. After the makeup water valve is energized, the spray pump can be delayed for an adjustable time period to allow the sump to fill. Setting the *Spray Pump Delay* value to zero configures the system to use an external basin water level float switch to signal when the spray pump should be enabled.

Boiler Activation

The LHP-1 can activate one or two boilers for heat addition. The boilers are activated when the *Heat Pump Supply Water Temperature* drops below the *Lead Boiler On* or *Lag Boiler On* temperature setpoints. When the controller determines that boiler operation is required, it activates the circulation water pump (if the pump has not been configured to run continuously), and enables one or both boilers. Once enabled from the LHP-1 via digital outputs, the factory installed boiler controls (as provided by the boiler manufacturer) detect water loop water flow and activate the enabled boiler(s).

With two boilers, one is designated the “lead boiler,” and the other boiler is designated the “lag boiler.” The lead boiler is always enabled first. The lag boiler is enabled as a second stage of heat addition, or in the event of a lead boiler failure. Each time the lead boiler is deactivated, the lead and lag designations are transposed. Both boilers share configurable minimum On and minimum Off times.

When the *Heat Pump Supply Water Temperature* drops below the *Lead Boiler On* setpoint, the lead boiler’s digital output is energized. If the *Heat Pump* Supply *Water Temperature* rises above the *Lead Boiler Off* setpoint, the lead boiler’s digital output is de-energized. If the *Heat Pump Supply Water Temperature* drops below the *Lag Boiler On* setpoint while the lead boiler is on, the lag boiler’s digital output is also energized. If the *Heat Pump Supply Water Temperature* rises above the *Lag Boiler Off* setpoint, the lag boiler’s digital output is de-energized.

“Off” temperature setpoints must be greater than their corresponding “On” setpoints. If an “Off” setpoint is incorrectly set to lower than it’s corresponding “On” setpoint, it is automatically set to 1 °F (0.55 °C) higher than the “On” setpoint.

If the lead boiler has been commanded on for at least 30 seconds and the boiler flow proof is off, an alarm is initiated, and the lag boiler is started. The lag boiler also triggers an alarm if it has been commanded on for 30 seconds and boiler flow proof is not established. If both boilers fail, LHP-1 boiler control stops and a dual boiler failure alarm occurs. Manual reset of the LHP-1 controller from the operator interface or by cycling power to the LHP-1 is required to restart control.

Low Limit Control

The LHP-1 provides low limit control. When the *Outside Air Temperature* (as sensed by an ASM controller on the system network) drops below the low limit setpoint, the circulation water pump energizes. The circulation water pump output de-energizes when the temperature rises 10 °F (5.55 °C) above the low limit setpoint (fixed at 40 °F, 4.42 °C).

Runtime Accumulations

The total runtime is accumulated for boiler 1, boiler 2, circulation pump 1, circulation pump 2, and the cooling tower fan. The runtimes can be used to indicate that maintenance is required on the equipment controlled by these outputs. An operator or maintenance personnel can reset the runtime once servicing has been performed. The runtimes are accumulated in non-volatile memory (NVRAM).

Alarms and Events

The controller detects certain alarm conditions and sends them to the LCI. Before this can occur, you must use the LCI to configure the controller.

Digital Input Alarms

The LHP-1 monitors the status of the digital inputs and generates alarms for the following events:

Boiler Flow Alarm

The LHP-1 generates alarms when a boiler has been started but boiler flow has not been achieved. If the lead boiler’s flow proof is off and it boiler has been commanded on for at least 30 seconds, an alarm is initiated and the lag boiler is started. The lag boiler also triggers an alarm if it has been commanded on for 30 seconds and boiler flow proof is not established. If both boilers fail, LHP-1 heat addition control stops and a dual boiler failure alarm occurs. Manual reset of the LHP-1 controller from the operator interface or by cycling power to the LHP-1 is required to restart control.

Circulation Pump (Flow) Alarms

The LHP-1 generates alarms when a pump has been started but flow has not been achieved. If pump flow proof is off and a pump has been commanded on for at least 20 seconds, an alarm is initiated and the lag pump is started. The lag pump also triggers an alarm if it has been commanded on for 20 seconds and pump flow proof is not established. If both pumps fail, LHP-1 control stops and a dual circulation water pump alarm occurs, requiring a manual reset of the LHP-1 controller from the operator interface or by cycling power to the LHP-1.

Tower Fan Failure Alarm

The LHP-1 generates an alarm when the tower fan has been started but fan proof has not been established. If the tower fan proof is off and a tower fan has been commanded on for at least 30 seconds, control of the fan stops, and a tower fan failure alarm is initiated. Restoring tower fan control requires a manual reset of the LHP-1 controller from the operator interface or by cycling power to the LHP-1.

Maintenance Alarm

A LHP-1 provides programmable run limits for generating runtime maintenance alarms. When the boiler runtime, pump runtime, or fan runtime exceeds these limits, a maintenance alarm is sent to the LCI.

Water Temperature Alarms

The LHP-1 generates high and low limit alarms for the monitored water temperatures. A programmable water temperature alarm limit offset is provided. The temperature limits are calculated based on the alarm limit setpoints and the alarm limit offset.

HighLimit = MaxWtrTemp + WtrTempLimit
LowLimit = MinWtrTemp - WtrTempLimit

When the measured water temperature exceeds the high limit, a high limit alarm is generated. When the water temperature drops below the low limit, a low limit alarm is generated. A return to normal is generated when the water temperature is between the high and low limit.

Automatic Configuration

The LHP-1 and iWorX Local Control Interface (LCI) use a self-configuring network management scheme requiring no external tools, binding, or LONWORKS knowledge. The LCI recognizes and configures the LHP-1 when the controller's service pin is pressed. The controller's status light flashes green until the controller is configured, and will be solid green after the controller is configured. Once the service pin has been pressed, no further action is required by the user; the controller is fully accessible to the LCI. Users may bind to SNVTs on the LHP-1 with LNS or other LONWORKS tools if they wish.

The LCI also provides network supervision of the LHP-1. The LCI periodically sends a "ping" message to the LHP-1, which elicits a response. If the response fails, an alarm is displayed on the LCI. The LCI also uses the "ping" message to refresh the occupancy mode and other system wide data.

LHP-1 Configuration

Once the LHP-1 is properly installed and recognized by the Local Control Interface (LCI), the LCI can be used to configure the settings of the controller. This section describes the commands available on the LCI for configuration of the LHP-1, and the meanings and default values for controller parameters. For more information on using the LCI, see the *iWorX LCI User's Guide.*

Setup

The Setup screen gives you access to controller settings.

Tower VFD Fan

This wizard enables you to view and set parameters directly related to control of the tower VFD fan. The maximum and minimum voltages for the fan output are shown on a line graph on the right of the screen. There are also a number of other setpoints listed below the graph.

Table 1: Tower VFD Fan settings

Table 2:

Setting	Range	Default	Description
Tower VFD Fan Setpoint	32.00 to 109.9 °F (0 to 43.3 °C)	89.9°F (32.2 °C)	Temperature setpoint for P+I control of the cooling tower fan.
Cooling Tower Fan Minimum	0.0 to 10.0 Volts	0.0 V	Minimum voltage of the cooling tower fan output.[a]
Cooling Tower Fan Maximum	0.0 to 10.0 Volts	10.0 V	Maximum voltage of the cooling tower fan output.[a]
Tower VFD Fan Kp	0.00 to 100.00% per degree of temperature	50.00%	Proportional gain for P+I control of the cooling tower fan.
Tower VFD Fan Ki	0.00 to 100.00%	0.05%	Integral gain for P+I control of the cooling tower fan.

a. To set the fan outputs for reverse action, exchange the minimum and maximum values.

Tower Bypass Valve

This wizard enables you to view and set parameters directly related to control of the tower bypass valve. The open and close voltages are shown on a line graph on the right of the screen. There are also a number of other setpoints listed below the graph.

Table 3: Tower Bypass Valve settings

Table 4:

Setting	Range	Default	Description
Tower Bypass Setpoint	32.00 to 109.9 °F (0 to 43.3 °C)	79.9 °F (26.6 °C)	Temperature setpoint for P+I control of the tower bypass valve.
Cooling Tower Valve Minimum	0.0 to 10.0 Volts	0.0 V	Minimum voltage of the cooling tower bypass valve output.[a]
Cooling Tower Valve Maximum	0.0 to 10.0 Volts	10.0 V	Maximum voltage of the cooling tower bypass valve output.[a]
Tower Bypass Kp	0.00 to 100.00% per degree of temperature	50.00%	Proportional gain for P+I control of the tower bypass valve.
Tower Bypass Ki	0.00 to 100.00%	0.05%	Integral gain for P+I control of the tower bypass valve.

a. To set the valve outputs for reverse action, exchange the minimum and maximum values.

Alarm Limits

This screen displays the setpoints that relate specifically to alarms.

Table 5: Alarm Limits settings

Table 6:

Setting	Range	Default	Description
Boiler Supply Temp. Minimum	32.00 to 140.00 °F (0.00 to 60.00 °C)	37.9 °F (3.3 °C)	Minimum supply temperature below which an alarm is generated.
Boiler Supply Temp. Maximum	32.00 to 140.00 °F (0.00 to 60.00 °C)	109.9 °F (43.3 °C)	Maximum supply temperature above which an alarm is generated.
Tower Return Temp. Minimum	32.00 to 140.00 °F (0.00 to 60.00 °C)	37.9 °F (3.3 °C)	Minimum return temperature below which an alarm is generated.
Tower Return Temp. Maximum	32.00 to 140.00 °F (0.00 to 60.00 °C)	109.9 °F (43.3 °C)	Maximum return temperature above which an alarm is generated.
Heat Pump Supply Minimum	32.00 to 140.00 °F (0.00 to 60.00 °C)	42.9 °F (6.1 °C)	Minimum heat pump supply below which an alarm is generated.
Heat Pump Supply Maximum	32.00 to 140.00 °F (0.00 to 60.00 °C)	109.9 °F (43.3 °C)	Maximum heat pump supply temperature above which an alarm is generated.
Heat Pump Return Minimum	32.00 to 140.00 °F (0.00 to 60.00 °C)	42.9 °F (6.1 °C)	Minimum heat pump return below which an alarm is generated.
Heat Pump Return Maximum	32.00 to 140.00 °F (0.00 to 60.00 °C)	109.9 °F (43.3 °C)	Maximum heat pump return temperature above which an alarm is generated.
Water Temperature Limit	0.00 to 10.00 °F (0.0 to 5.5 °C)	5.0 °F (2.7 °C)	Offset subtracted from the minimum water temperature setpoints to form the water temperature low limit alarm setpoint and added to the maximum water temperature setpoints to form the water temperature high limit setpoint.

Grouping Buttons

These three buttons enable you to configure which devices on the network are being supplied with water by the LHP-1.

Press **Add New Device** to see a list of available devices. Use the up and down arrow keys to select a device (use **Page Up** and **Page Down** if the list is longer than one screen), then press **Select** to move it to the list of devices in the LHP-1's group.

Press **Devices in Group** to see a list of devices that are currently in the LHP-1's group. If you wish to remove a device from this list, use the up and down arrow keys to select a device (use **Page Up** and **Page Down** if the list is longer than one screen), then press **Delete**.

Press **Send Grouping** to inform the LHP-1 which devices are associated with it.

List All Settings

This screen displays all setpoints used by the LHP-1 controller. Use the up and down arrow keys to select a value to change, then use **–** or **+** to increase or decrease the value (or utilize **USE KEYS** to directly enter the desired value). Press **Save** to save your changes or **Back** to return to the Setup screen.

Table 7: All LHP-1 Settings

Setting	Range	Default	Description
Tower Bypass Setpoint	32.00 to 109.9 °F (0 to 43.3 °C)	79.9 °F (26.6 °C)	Temperature setpoint for P+I control of the cooling tower bypass valve.
Tower VFD Fan Setpoint	32.00 to 109.9 °F (0 to 43.3 °C)	89.9 °F (32.2 °C)	Temperature setpoint for P+I control of the cooling tower fan.
Tower OAT Low Limit	0.00 to 50.00 °F (-17.78 to 10.00 °C)	39.9 °F (4.4 °C)	Outdoor air temperature below which low limit control of the cooling tower is enabled.
Tower Bypass Kp	0.00 to 100.00% per degree of temperature	50.00%	Proportional gain for P+I control of the tower bypass valve.
Tower Bypass Ki	0.00 to 100.00%	0.05%	Integral gain for P+I control of the tower bypass valve.
Tower VFD Fan Kp	0.00 to 100.00% per degree of temperature	50.00%	Proportional gain for P+I control of the cooling tower fan.
Tower VFD Fan Ki	0.00 to 100.00%	0.05%	Integral gain for P+I control of the cooling tower fan.
Boiler Minimum On	0 to 180 minutes	30 minutes	Minimum amount of time the boilers remain on.
Boiler Minimum Off	0 to 180 minutes	30 minutes	Minimum amount of time the boilers remain off.
Cooling Tower Valve Minimum	0.0 to 10.0 Volts	0.0 V	Minimum voltage of the cooling tower valve output.[a]
Cooling Tower Valve Maximum	0.0 to 10.0 Volts	10.0 V	Maximum voltage of the cooling tower valve output.[a]
Tower VFD Fan Minimum	0.0 to 10.0 Volts	0.0 V	Minimum voltage of the cooling tower fan VFD output.[a]
Tower VFD Fan Maximum	0.0 to 10.0 Volts	10.0 V	Maximum voltage of the cooling tower fan VFD output.[a]
Zone Limit	0 to 60	1	Number of zones that must signal demand to activate cooling mode,
Circulation Pump Mode	On Demand, Continuous	On Demand	Run the circulation pumps only when there is demand, or continuously.
Boiler Runtime Limit	0 to 65535 hours	1000 hours	Runtime limit for boilers after which a maintenance alarm is generated.
Fan Runtime Limit	0 to 65535 hours	1000 hours	Runtime limit for the cooling tower fan after which a maintenance alarm is generated.
Pump Runtime Limit	0 to 65535 hours	1000 hours	Runtime limit for the circulation pumps after which a maintenance alarm is generated.
Circulation OAT Low Limit	0.00 to 50.00 °F (-17.78 to 10.00 °C)	34.9 °F (1.6 °C)	Outdoor air temperature below which low limit control of the circulation pumps is enabled.
Tower Fan Mode	Staged Fan, VFD Fan	Staged Fan	Type of tower fan being controlled.

Table 7: All LHP-1 Settings (Continued)

Setting	Range	Default	Description
Spray Pump Delay	0 to 1000 minutes	30 minutes	Delay after the makeup water valve is energized before the spray pump is energized.
Circulation Pump Minimum On	0 to 180 minutes	30 minutes	Minimum amount of time the circulation pumps remain on.
Circulation Pump Minimum Off	0 to 180 minutes	30 minutes	Minimum amount of time the circulation pumps remain off.
Boiler Supply Temp. Minimum	32.00 to 140.00 °F (0.00 to 60.00 °C)	37.9 °F (3.3 °C)	Minimum boiler supply temperature below which an alarm is generated.
Boiler Supply Temp. Maximum	32.00 to 140.00 °F (0.00 to 60.00 °C)	109.9 °F (43.3 °C)	Maximum boiler supply temperature above which an alarm is generated.
Tower Return Temp. Minimum	32.00 to 140.00 °F (0.00 to 60.00 °C)	37.9 °F (3.3 °C)	Minimum tower return temperature below which an alarm is generated.
Tower Return Temp. Maximum	32.00 to 140.00 °F (0.00 to 60.00 °C)	109.9 °F (43.3 °C)	Maximum tower return temperature above which an alarm is generated.
Heat Pump Supply Minimum	32.00 to 140.00 °F (0.00 to 60.00 °C)	42.9 °F (6.1 °C)	Minimum heat pump supply temperature below which an alarm is generated.
Heat Pump Supply Maximum	32.00 to 140.00 °F (0.00 to 60.00 °C)	109.9 °F (43.3 °C)	Maximum heat pump supply temperature above which an alarm is generated.
Heat Pump Return Minimum	32.00 to 140.00 °F (0.00 to 60.00 °C)	42.9 °F (6.1 °C)	Minimum heat pump return temperature below which an alarm is generated.
Heat Pump Return Maximum	32.00 to 140.00 °F (0.00 to 60.00 °C)	109.9 °F (43.3 °C)	Maximum heat pump return temperature above which an alarm is generated.
Water Temperature Limit	0.00 to 10.00 °F (0.0 to 5.5 °C)	5.0 °F (2.7 °C)	Offset subtracted from the minimum water temperature setpoints to form the water temperature low limit alarm setpoint and added to the maximum water temperature setpoints to form the water temperature high limit setpoint.
Cooling Tower Setpoints			
– Damper On	32.0 to 140.0 °F (0.0 to 60 °C)	81.9 °F (27.7 °C)	Heat pump supply temperature above which the cooling tower damper is opened.
– Damper Off	32.0 to 140.0 °F (0.0 to 60 °C)	78.9 °F (26.1 °C)	Heat pump supply temperature below which the cooling tower damper is closed.
– Spray Pump On	32.0 to 140.0 °F (0.0 to 60 °C)	83.9 °F (28.8 °C)	Heat pump supply temperature above which the tower spray pump is enabled.
– Spray Pump Off	32.0 to 140.0 °F (0.0 to 60 °C)	80.9 °F (27.2 °C)	Heat pump supply temperature below which the tower spray pump is disabled.
– Fan On	32.0 to 140.0 °F (0.0 to 60 °C)	89.9 °F (32.2 °C)	Heat pump supply temperature above which the tower fan is enabled.

Table 7: All LHP-1 Settings (Continued)

Setting	Range	Default	Description
– Fan Off	32.0 to 140.0 °F (0.0 to 60 °C)	83.9 °F (28.8 °C)	Heat pump supply temperature below which the tower fan is disabled.
Boiler Setpoints			
– Lead Boiler On	32.00 to 140.0 °F (0 to 60.0 °C)	64.9 °F (18.33 °C)	HP supply temperature below which to enable the lead boiler.
– Lead Boiler Off	32.00 to 140.0 °F (0 to 60.0 °C)	69.9 °F (21.11 °C)	HP supply temperature above which to disable the lead boiler.
– Lag Boiler On	32.00 to 140.0 °F (0 to 60.0 °C)	59.9 °F (15.55 °C)	HP supply temperature below which to enable the lag boiler.
– Lag Boiler Off	32.00 to 140.0 °F (0 to 60.0 °C)	64.9 °F (18.33 °C)	HP supply temperature above which to disable the lag boiler.

a. to set the fan or valve outputs for reverse action, exchange the minimum and maximum values.

Inputs

The Inputs screen displays the current values of the LHP-1's inputs. These values cannot be changed.

Table 8: LHP-1 Inputs

Input	Range	Description
Outside Temperature	-22.00 to 122.00 °F (-30.00 to 50.00 °C)	Outside air temperature reported by an external temperature sensor over the network.
Pump Flow Proof	Off, On	Status of the PFP switch.
Cooling Tower Fan Proof	Off, On	Status of the TFP switch.
Basin Water Level Switch	Off, On	Status of the BWL switch
Boiler Flow Proof	Off, On	Status of the BFP switch.
Supply Temperature	-30.00 to 230.00 °F (-34.40 to 110.00 °C)	Temp. reported by BST sensor.
Return Temperature	-30.00 to 230.00 °F (-34.40 to 110.00 °C)	Temp. reported by TRT sensor.
Heat Pump Supply Temp.	-30.00 to 230.00 °F (-34.40 to 110.00 °C)	Temp. reported by HPST sensor.
Heat Pump Return Temp.	-30.00 to 230.00 °F (-34.40 to 110.00 °C)	Temp. reported by HPRT sensor.

Outputs

This screen displays the current values of the LHP-1's outputs. These values cannot be changed.

Table 9: LHP-1 Outputs

Output	Range	Description
Boiler 1	Off, On	State of the boiler 1 output.
Boiler 2	Off, On	State of the boiler 2 output.
Spray Pump	Off, On	State of the spray pump output.
Circulation Pump 1	Off, On	State of the circulation pump 1 output.
Circulation Pump 2	Off, On	State of the circulation pump 2 output.
Cooling Tower Fan	Off, On	State of the cooling tower fan output.
Damper	Off, On	State of the tower damper output.
Make Up Valve	Off, On	State of the tower sump/makeup valve output.
Cooling Tower Valve	0.00% to 100.00%	State of the tower bypass valve output.
Cooling Tower Fan	0.00% to 100.00%	State of the tower fan VFD output.
Mode	Off, Heating, Cooling	Current mode of the liquid source system.

This screen also displays the current state of each device in the LHP-1's group. Each device is displayed on its own line, and is identified as being off, in heating mode, or in cooling mode.

Runtimes/Limits

This screen shows all runtime totals and runtime limits for the LHP-1. To reset a runtime total to zero, use the up and down arrows to highlight the value, and then press **`Reset`**. To change a value, highlight it and press **`Select`**.

Table 10: LHP-1 Runtimes/Limits

Setting	Range	Default	Description
Boiler 1 Runtime	0 to 65535 hours	N/A	Current runtime total of boiler 1.
Boiler 2 Runtime	0 to 65535 hours	N/A	Current runtime total of boiler 2.
Boiler Runtime Limit	0 to 65535 hours	1000 hours	Runtime limit for boiler after which a maintenance alarm is generated.
Cooling Tower Fan Runtime	0 to 65535 hours	N/A	Current cooling tower fan runtime.
Fan Runtime Limit	0 to 65535 hours	1000 hours	Runtime limit for cooling tower fan after which a maintenance alarm is generated.
Pump 1 Runtime	0 to 65535 hours	N/A	Current runtime total of circulation pump 1.
Pump 2 Runtime	0 to 65535 hours	N/A	Current runtime total of circulation pump 2.
Pump Runtime Limit	0 to 65535 hours	1000 hours	Runtime limit for circulation pumps, after which a maintenance alarm is generated.

Troubleshooting

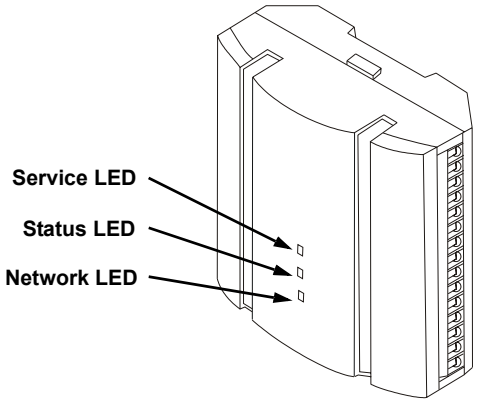
Diagnostic LEDs

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 top to bottom on the unit.

Table 11: Diagnostic LEDs

LED	Indication
Service	– Illuminated when the service pin is pushed
Status	– Solid green when running and configured by an LCI – Flashing green when running and NOT configured by an LCI – Solid red when a fault condition exists
Network	– Yellow while the controller is transmitting data onto the FTT-10A network – Green when there is network activity – Off when there is no network activity

Figure 3: Diagnostic LEDs



Troubleshooting Tips

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 LHP-1 controllers?

No, the system can only recognize one.

Thermistor readings fluctuate rapidly, sometimes by several degrees.

The controller is not properly grounded. The controller's ground (GND) pin (T28) must be connected to earth ground. Also ensure that the controller's digital inputs are dry contacts and that no voltage is being applied or switched to the inputs.

How do I associate my other controllers with the LHP-1?

Use the LHP-1's grouping mechanism, specifically **`Add New Device`** on the LHP-1 Setup screen of the LCI. Only HPU Series controllers may be associated with the LHP-1.

What is `Send Grouping` for, and when do I press it?

This button stores network information into the LHP-1 about the controllers in its group. Press this button when you have made any changes to the grouping.

What iWorX controllers can be part of a LHP-1's group?

Only HPU-1 controllers can be part of the LHP-1's group and demand cooling or heating from it.

Several controllers are requesting cooling or heating, but the circulation pump has not been enabled.

The "Zone Limit" setting may be set higher than the number of zones that are currently requesting cooling or heating. The circulation pump will not be enabled until the number of zones requesting cooling or heating is greater than the Zone Limit setting.

If the number of controllers requesting cooling or heating exceeds the Zone Limit setting, but the circulation pump is still not enabled, the outside air temperature may be less than the "Outdoor Air Temp. Lockout" setting.

I only have one circulation pump and/or boiler; how can I disable lead/lag operation?

The lead/lag function is built into the controller and cannot be disabled. However, you can wire both circulation pump outputs in parallel from the controller to the existing pump and the system will operate normally. Do the same for the boiler if the system only has one boiler.

The cooling tower staging does not follow the setpoints that are defined.

Verify that the Tower Bypass Setpoint is lower than the Cooling Tower Setpoints. Remember, staging will not occur until the tower bypass valve has reached the 100% open position. If staging is turning off before the defined OFF setpoints, the tower bypass valve is most likely not fully open.

Does the LHP-1 require a reset if a single pump fails?

No, only a dual pump failure requires a reset.

Under what conditions does the LHP-1 require a reset for normal operation.

There are three conditions that require a reset:

- Dual pump failure
- Tower fan failure
- Dual boiler failure