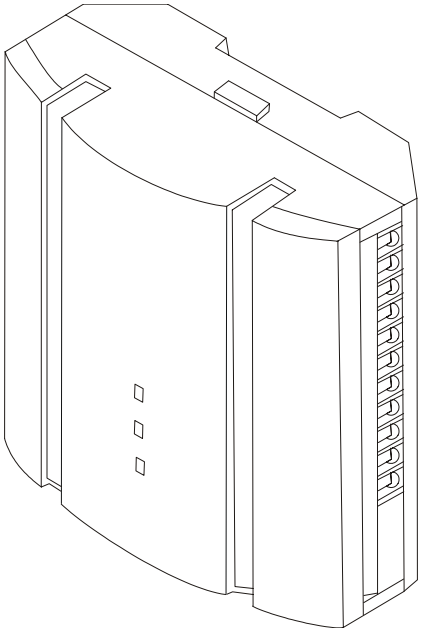
iWorX BLR-1
Application Manual

BLR-1



The BLR-1 boiler controller is a is a stand-alone microprocessor based controller for up to four single-stage boilers or two two-stage boilers. This application includes control of interior radiant heating and exterior snow melting systems.

Overview

Boiler stages and system pumps are controlled by digital outputs. An analog output is provided for controlling a 0-10 V or 2-10 V mixing valve or pump for a secondary loop.

Analog inputs are provided for measuring the temperature of the outside air, primary loop supply, primary loop return, secondary loop supply, and one zone. Digital inputs are provided for a snow melt switch, auxiliary demand, and a plant alarm.

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

Features

- Four stage proportional and integral (P+I) boiler control with low/high firing ability and outdoor reset
- Equal run-time rotation
- Snow melt control with slab temperature control
- Secondary loop proportional and integral mixing control with separate outdoor reset
- Support for optional iWorX BZU zone controllers
- Zone temperature feedback for automatic adjustment of primary and secondary water temperatures
- Auxiliary heating input for domestic hot water or supplementary heating
- Individual temperature setpoints for occupied and unoccupied zone heating
- 24-hour occupancy mode for around-the-clock operation
- Automatic heating shutoff in warm weather for energy savings
- Maintains primary loop temperature to protect non-condensing boilers
- Commissioning mode and manual overrides for troubleshooting and inspection
- Automatic configuration with a Local Control Interface (LCI) touchscreen
- Alarm/Event reporting
- LonWorks® network interface to integrate BLR-1 with other iWorX products

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Purpose of This Guide

The *iWorX BLR-1 Application Manual* provides application information for the BLR-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-BLR-INS-100	iWorX BLR Series Installation Instructions	– Application Engineers – Installers – Service Personnel – Start-up Technicians	Provides instructions for setting up and using the iWorX BLR-1 Controller.
iWorX-BZU1-APP-100	iWorX BZU-1 Application Manual	– Application Engineers – Wholesalers – Contractors	Provides specific application information about the BZU-1, including sequence of operation and configuration information.
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.
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 BLR-1 boiler controller maintains the boiler supply temperature based on several possible demand inputs including an integral zone control, networked zone controls, a snow melt sensor, and an auxiliary demand. It also maintains the temperature of a secondary loop by controlling an injection pump or mixing valve.

This product is not intended for safety or limiting functions.

Boiler Control

The boiler supply temperature is controlled by the four boiler outputs on the BLR-1. These are controlled in a step sequence as required by the demand. To even out run times, the boiler stages can be automatically rotated. Stages are rotated in pairs to accommodate low/high firing boilers. The primary loop setpoint is determined by the outdoor reset curve or auxiliary setpoint established during commissioning.

Zone Control

One indoor zone may be controlled directly by the BLR-1. The temperature of that zone is maintained by operating the zone pump, which supplies temperature-controlled water to the zone. The temperature of the water in the secondary loop is controlled by the injection pump / valve output of the BLR-1. The secondary loop setpoint is determined by a separate outdoor reset curve established during commissioning, and may also be influenced by the temperature of the zone itself.

The zone has both occupied and unoccupied setpoints. Occupancy is determined by the networked LCI, or it may be set to 24-hour occupancy. Whether occupied or not, the minimum boiler temperatures are maintained and its reset curve is followed throughout the heating season. When unoccupied, the secondary reset curve automatically shifts to supply water at a lower temperature.

Additional zones on the same secondary loop can be controlled in the same way with an optional iWorX BZU-1 zone controller.

Snow Melt

The BLR-1 can operate a snow melt system using a separate snow/ice detector switch. When the switch calls for heat, the BLR-1 operates the snow melt pump to deliver water from the boiler at a specified temperature. The BLR-1 can optionally maintain the slab within a specified temperature range by using the zone sensor as a slab sensor. Additional snow melt zones may be temperature-controlled using an optional BZU-1 Zone Controller.

Auxiliary Heat

The third type of demand satisfied by the BLR-1 is the auxiliary heating demand, which may be configured for either a setpoint demand or a reset demand. If configured as a setpoint demand, on a call for heat the boiler supply is maintained at the specified temperature. If configured as a reset demand, the boiler temperature is maintained according to its reset curve to provide energy-efficient heating.

Application Examples

The figures on the following pages represent possible applications for the BLR-1 controller. The application examples shown here all use a primary-secondary type of boiler piping that provides the same return temperature to each boiler and prevents circulation through unused boilers. A variety of heating loads are shown to demonstrate the variety of applications that can be controlled with the BLR-1. The commissioning options available allow for numerous piping and control configurations.

Note that these are generalized drawings. They may not be appropriate for some installations, and are not intended to show all piping components and detail. Relays are not shown for line voltage devices; for clarity, only the controlling signal is shown. Systems must be designed in accordance with basic hydronic principles as well as local and national codes. The system designer must ensure safety requirements and protection of the system components.

Single Zone Radiant & Simple Snow Melt System

Figure 1 on page 5 shows a basic system with 2 two-stage boilers, simple snow melt, a radiant zone, and a domestic hot water (DHW) system. The snow melt and DHW systems do not use the primary pump, so water is circulated only where needed. Additional heating loads can be added to the primary or secondary loop. The water temperature of the radiant zone is controlled by a mixing valve, with hot water supplied by the primary pump. In simple snow melt mode, the BLR-1 operates the snow melt pumps and supplies hot water from the boilers. Additional manual or automatic temperature controls for the snow melt loop may be required, such as the thermostatic mixing valve shown. The system designer must ensure proper supply temperatures and differentials for the particular application.

Table 1: Key Settings for Single Zone Radiant & Simple Snow Melt System

Aux. Htg. Reset	Off (use setpoint)
Aux. Heating Setpoint	Set appropriately for indirect DHW supply
Aux. Prim. Pump	Off
Aux. Zone Pump	Off
Occ. Zone Setpoint	Target room temperature for BLR-1 Zone when occupied
Unocc. Zone Setpoint	Target room temperature for BLR-1 Zone when unoccupied
Zone Temp. Effect	On
Snow Melt Primary Pump	Off
Snow Melt Temp. Control	Off
SMLT System	On

Multizone High-Temperature & Low-Temperature Radiant

Figure 2 on page 6 adds additional low-temperature radiant zones and high-temperature radiators controlled by two BZU-1 zone controllers. The low-temperature water in the secondary loop is controlled by an injection pump that is supplied by the primary pump. The high-temperature loads are also piped as a secondary loop, with the cooler return water going to the lower temperature circuits. The zones on each loop are controlled by a BZU-1 that operates the valves and communicates a heat demand to the BLR-1. Simple snow melt is also available in this configuration, but not shown. Additional controls may be used on the primary or secondary loop for indoor or snow melt applications.

Table 2: Key Settings for Multizone High-Temperature & Low-Temperature Radiant

Occ. Zone Setpoint	Target room temperature for BLR-1 Zone when occupied
Unocc. Zone Setpoint	Target room temperature for BLR-1 Zone when unoccupied
Zone Temp. Effect	On
Snow Melt Temp. Control	Off
SMLT System	Off

Figure 1: Single Zone Radiant & Simple Snow Melt System

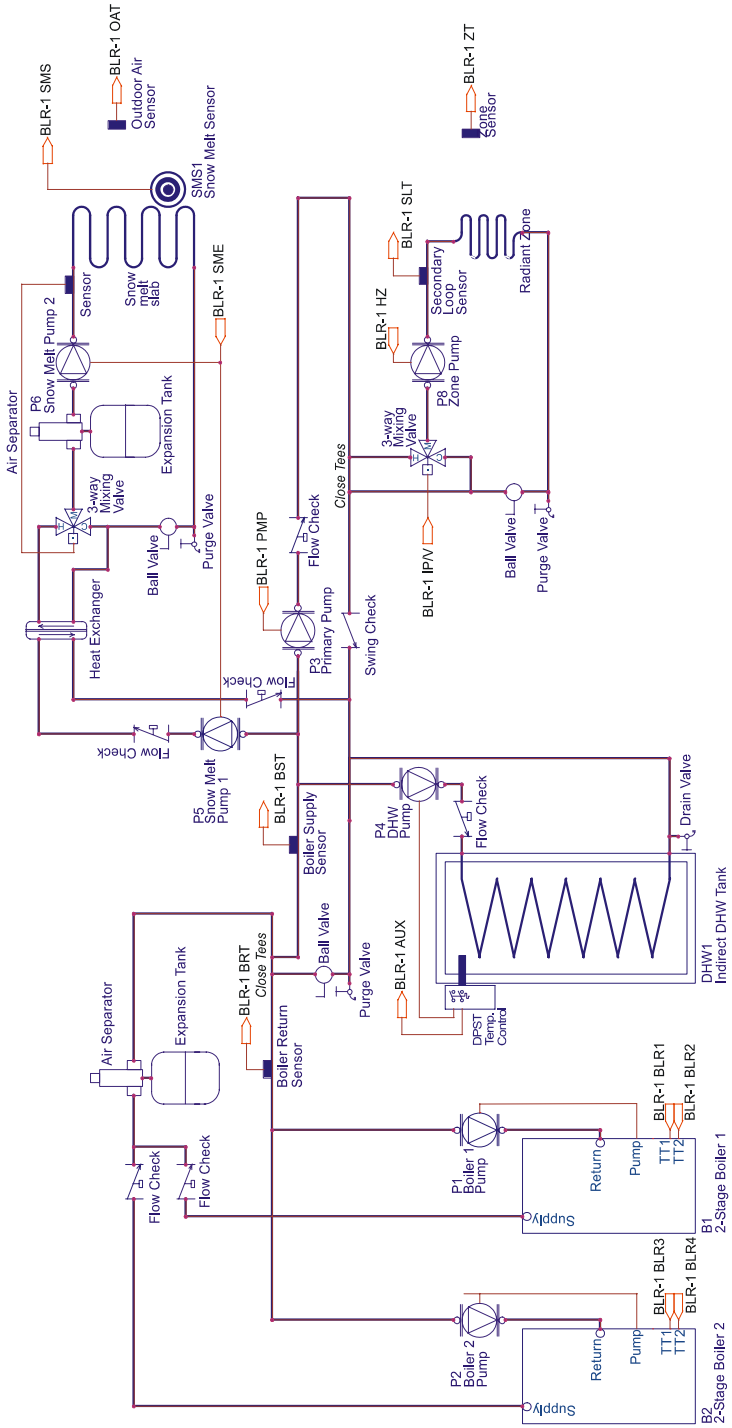
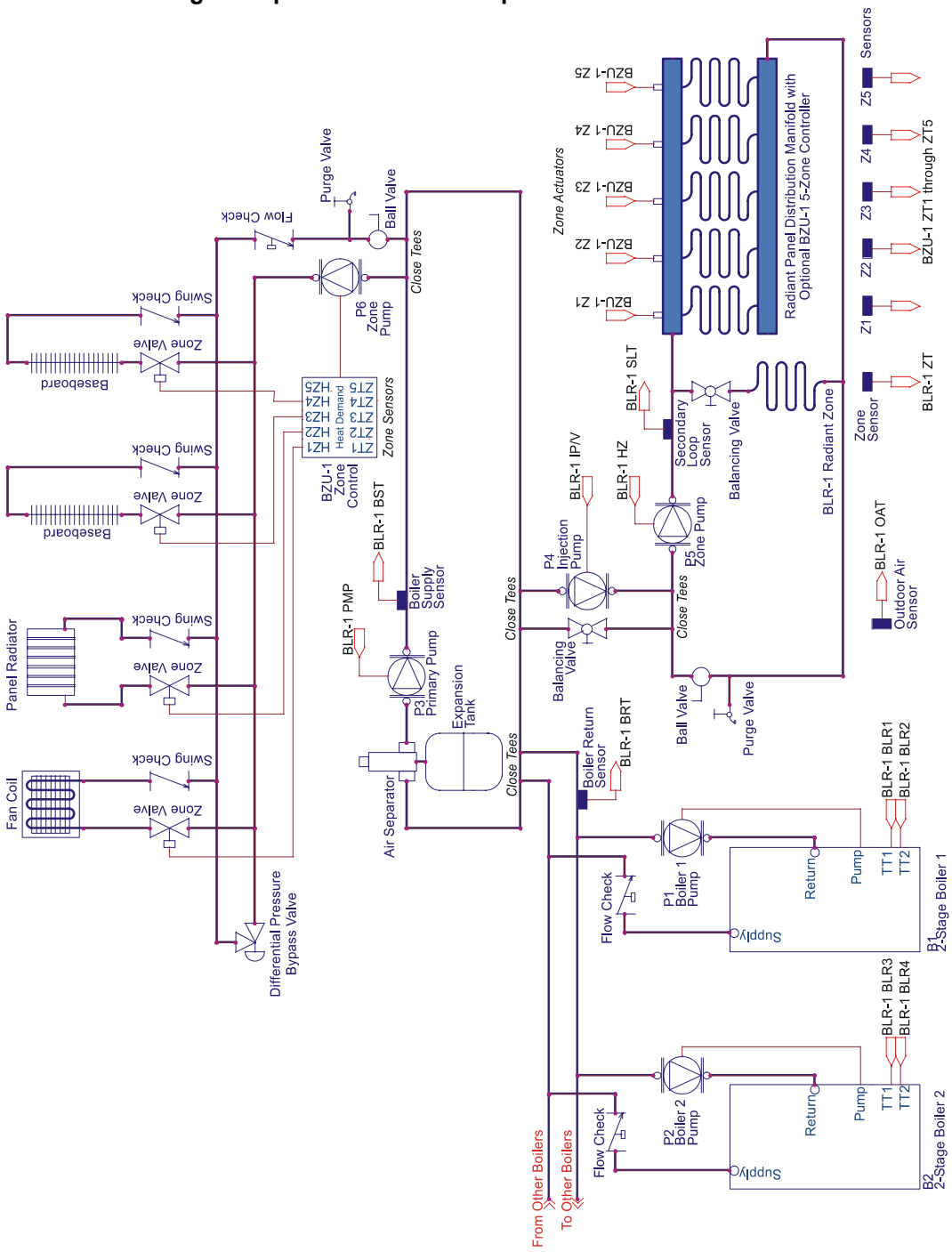


Figure 2: Multizone High-Temperature & Low-Temperature Radiant



NOTE: In this configuration, the BLR-1 Zone receives heat when any of the other zones are calling for heat, unless a thermostat-controlled zone valve is installed in the circuit.

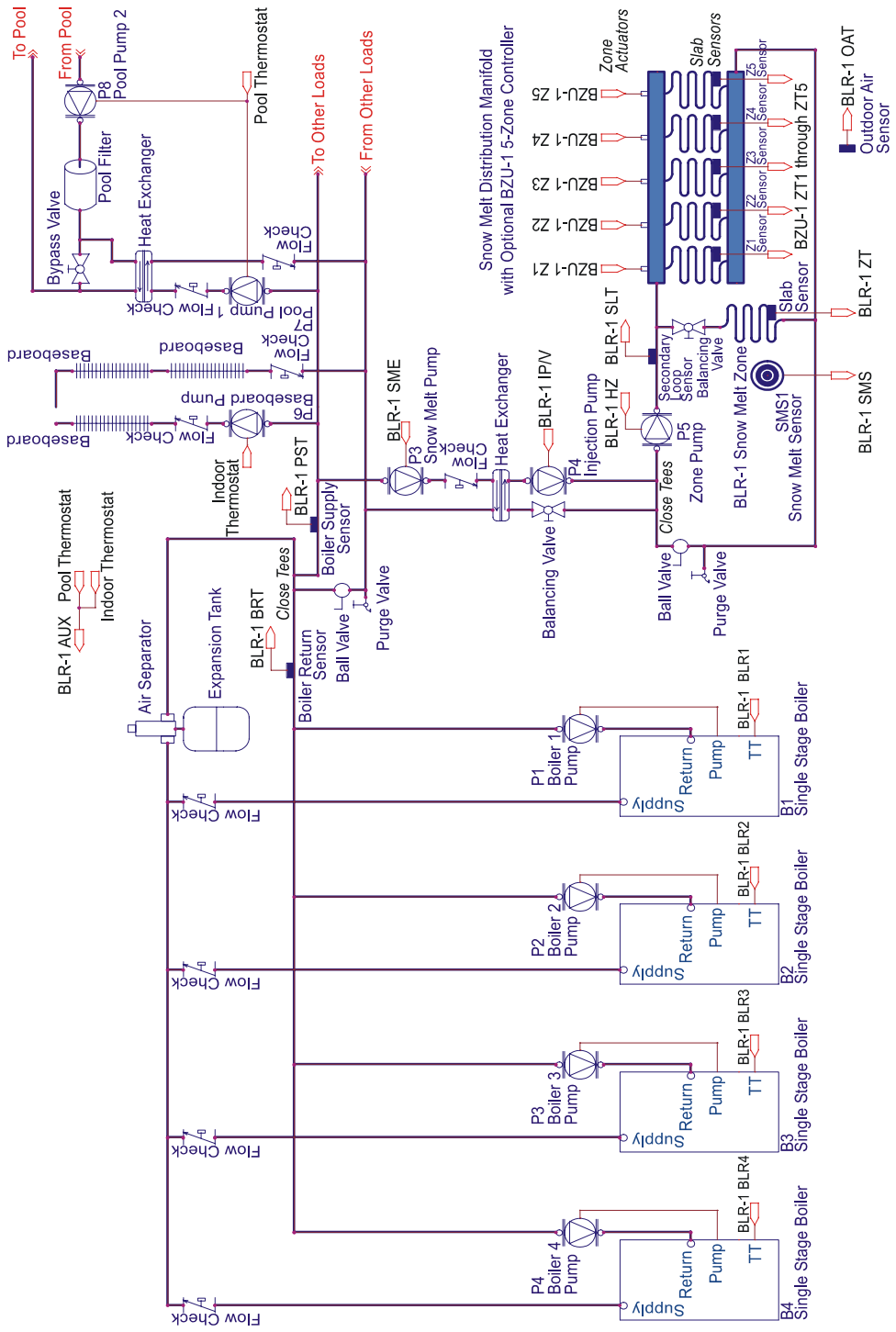
Multizone Snow Melt & Auxiliary Heat System

Figure 3 on page 8 shows a possible configuration for multi-zone snow melt with temperature control, as well as auxiliary loads such as baseboard and a pool heater. Four single-stage boilers are shown. A separate primary pump is not needed for this piping, since each load has its own supply pump at a common header that is piped as a secondary to the boiler loop. The thermostats for the auxiliary loads are wired in parallel (or use a zone control panel) to provide an auxiliary demand signal. The snow melt system is temperature controlled using an injection pump, so the zone control features are dedicated to snow melt and are not available for space heating.

Table 3: Key Settings for Multizone Snow Melt & Auxiliary Heat System

Aux. Htg. Reset	On or Off, depending on application
Aux. Heating Setpoint	If used, set appropriately for all aux. loads.
Aux. Prim. Pump	Off.
Aux. Zone Pump	Off
Occ. Zone Setpoint	Target slab temperature for melting
Unocc. Zone Setpoint	Target slab temperature for idling
Snow Melt Primary Pump	Off
Snow Melt Temp. Control	On
Zone Temp. Effect	On
SMLT System	On

Figure 3: Multizone Snow Melt & Auxiliary Heat System



NOTE: In this configuration, the BLR-1 Zone receives heat when any of the other zones are calling for heat, unless a thermostat-controlled zone valve is installed in the circuit.

Sequence of Operation

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

Boiler Staging Control

Stage Configuration Options

The BLR-1 controls up to four boiler stages. The boiler stages can be configured to control up to 4 single-stage boilers or 2 two-stage (low/high fire) boilers. Boilers or boiler stages are controlled from the BLR-1 with low voltage digital outputs BLR1, BLR2, BLR3, and BLR4. If configured for low/high fire boilers, outputs BLR1 and BLR2 are used for control of the low and high stages, respectively, of the first boiler. The low and high stages of the second boiler are controlled using outputs BLR3 and BLR4, respectively.

Sequencing

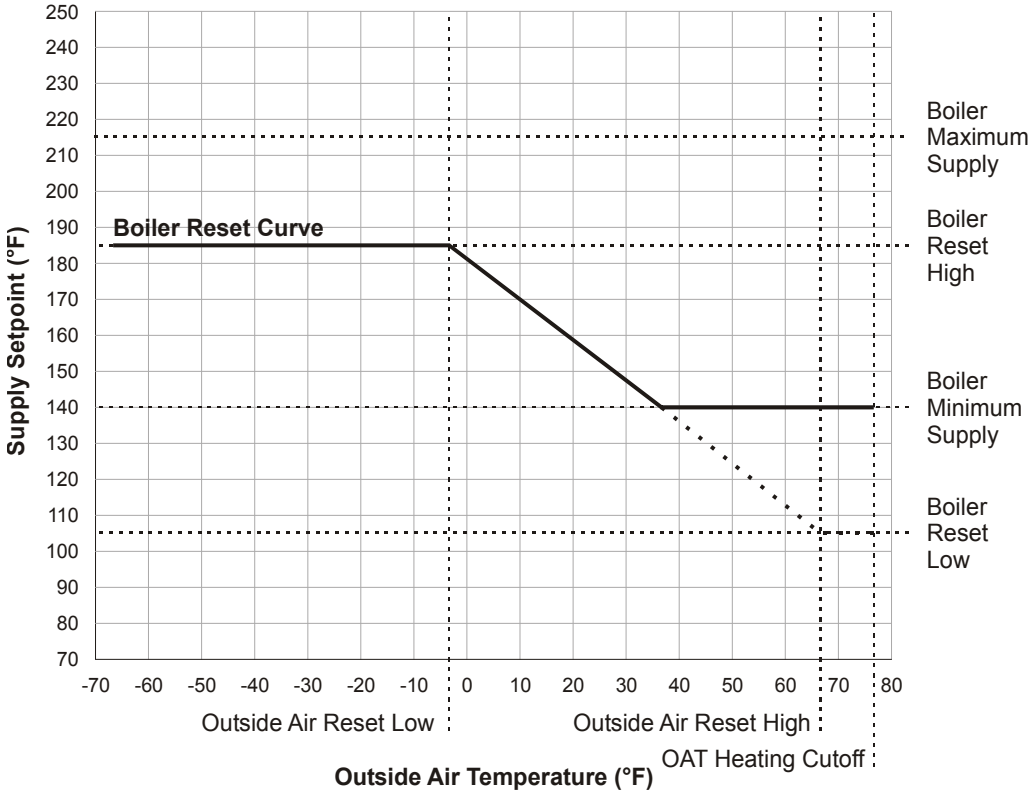
When there is a demand for heat, the boiler stages are operated in a sequence defined by parameters selected during commissioning. The default sequence fires the four stages in order (1,2,3,4) and turns them off in reverse order (4,3,2,1).

If the *Equal Run Time* option is selected, automatic lead/lag changeover of the boilers occurs when the number of runtime hours exceeds the *Rotate Time*. The rotation will always be such that outputs stage 1 and stage 2 will be energized in sequence and outputs stage 3 and stage 4 will energize in sequence. After the lead/lag period is exceeded the order will be stage 3 and stage 4 followed by stage 1 and stage 2. When the next *Rotate Time* period is exceeded the controller will return to the previous state of operation. In applications where multi-size boilers are used, or when three single stage boilers are used, lead/lag operation can be disabled through the LCI. If lead lag operation is desired in an application with two single-stage boilers, boiler control outputs stage 1 and stage 3 should be utilized.

Outdoor Compensated Boiler Supply Setpoint

When there is a zone demand or an auxiliary heat demand that is configured as a reset demand, the boiler setpoint is determined by the boiler reset curve, which compensates for changes in the heating load caused by varying outdoor air temperature (OAT). An example is shown in Figure 4. As outside air temperature decreases, the boiler supply setpoint is increased to compensate for the greater heating load. The slope of the boiler reset curve is determined by the start and stop points of the reset curve. *OAT Reset Low* is the outdoor design heating temperature at which the boiler setpoint is *Boiler Reset High*, the highest temperature required in the primary loop for space heating. The lower end of the reset curve is defined by the *Boiler Reset Low* setpoint and *OAT Reset High*. The actual setpoint is limited to temperatures that are between the *Maximum Boiler Supply* and *Minimum Boiler Supply* settings. The *OAT Heating Cutoff* is the temperature above which space heating demands are disabled (sometimes referred to as “Warm Weather Shutdown”). It may be higher or lower than *OAT Reset High* as determined by the application requirements. 65 °F (18 °C) may be a suitable cutoff for a building with good heat retention or other heat gains, while 75 °F (24 °C) may be more appropriate for a building with high heat loss or extra warmth requirements. The *OAT Heating Cutoff* is subject to a 5 °F (2.75 °C) hysteresis.

Figure 4: The Boiler Reset Curve



Setpoint Precedence

If there is a snow melt demand or an auxiliary demand that is configured as a setpoint demand, the boiler supply temperature will be controlled to the highest of the applicable setpoints. Thus the system must be designed so that any of the secondary systems can either tolerate the maximum boiler temperature, be mixed to the appropriate temperature, or be disabled when the temperature is too high. In addition, the boiler setpoint will be maintained at least 5 °F (3 °C) above the secondary loop setpoint when there is a zone demand.

Demand Calculation

Demand is calculated by a proportional and integral feedback algorithm according to the difference between the boiler loop temperature and the boiler setpoint. Differentials are determined automatically by the proportional and integral algorithm. Considering only the proportional control, the boilers will be staged on as shown.

Table 4: Boilers Staging On

Boiler Stage	Percentage Demand	Degrees Boiler Loop Temp. is Below Setpoint
1	39%	23.4 °F (13.0 °C)
2	60%	36.0 °F (20.0 °C)
3	80%	48.6 °F (27.0 °C)
4	99%	59.4 °F (33.0 °C)

Boiler stages are turned off as the temperature rises and the demand decreases. Note that the boiler stages are disabled at different points than they are enabled. The actual differential is again determined automatically by the proportional and integral loop.

Table 5: Boilers Staging Off

Boiler Stage	Percentage Demand	Degrees Boiler Loop Temp. is Below Setpoint
4	60%	36.0 °F (20.0 °C)
3	40%	23.4 °F (13.0 °C)
2	20%	12.6 °F (7.0 °C)
1	1%	0.6 °F (0.3 °C)

The gain and time values of the boiler demand proportional and integral control loop are preset to typical values but can be modified to match various system requirements.

Proportional Control Example

If the boiler loop setpoint is 158 °F (70 °C) and the actual boiler loop temperature reading is 104 °F (40 °C), then the difference is 54 °F (30 °C). This difference is multiplied by the *Boiler Proportional Gain* to yield the base demand for heating in the boiler loop. Using the default gain of 3 (per °C) yields a demand of 90%. According to Table 4, a 90% demand causes the first three boiler stages to be turned on (subject to the effects of integral, derivative and delays). When the temperature in the boiler loop is raised to 135 °F (57 °C), the demand is only 39% (13 °C below the setpoint, times 3) and the third boiler stage shuts down (again subject to the other control elements).

Integral Effect

Demand is influenced by adding to it a portion of the error (setpoint minus temperature) with every measurement. Properly set, the *Boiler Integral Time* will eliminate “droop” (drifting from the setpoint) that results from load variations. If set to 20 minutes or longer, it takes a more time to compensate for an offset. If set too short, the overcompensation may cause oscillations. (Setting it to zero disables the integral, however).

Boiler Protection

To minimize short cycling of the boilers on startup and during light or brief loads, there is a minimum cycle time of 1 minute. There is also a 1 minute delay between the firing of stages to allow one stage to warm up before the next stage is enabled.

To ensure that the temperature of the boiler loop supply or return does not drop below the manufacturer’s recommendations, the BLR-1 maintains the *Minimum Boiler Return* temperature while there is a demand. Loads are held off or reduced until the temperatures are high enough. In addition, while making automatic adjustments for heating demands, the primary loop is kept below the *Maximum Boiler Supply* temperature.

Purge Cycles

On an initial call for heat, the primary pump will be started 10 seconds before starting any boiler stages. This allows an accurate measurement of the primary loop temperature to determine the boiler demand. After the heating demand ceases and the boiler stages are all off, the primary loop pump remains on for one minute.

Radiant Zone Control

Zone Setpoints and Occupancy

There are two setpoints for the radiant zone. The *Occupied Zone Setpoint* and the *Unoccupied Zone Setpoint*. The zone setpoint temperatures have no effect on the *OAT heating cutoff* (Warm Weather Shutdown) temperature. Occupancy is determined by the LCI, and may be scheduled or set to 24-hour occupancy.

Outdoor Compensated Secondary Loop Setpoint

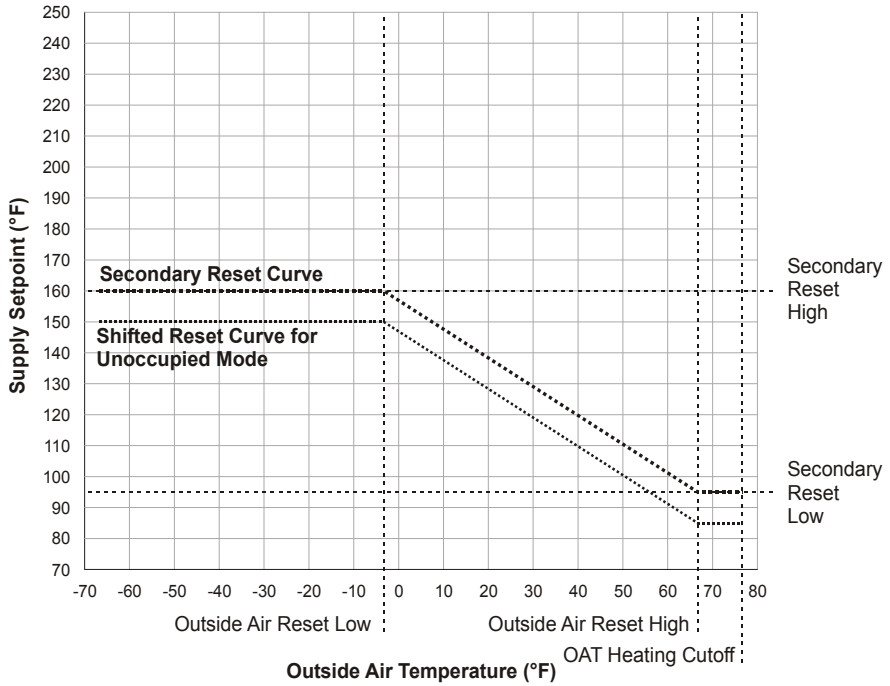
Occupied Mode Reset

The water temperature supplied to the radiant zone is controlled by the output to the injection pump / valve. The setpoint is determined by the secondary loop reset curve, which compensates for changes in the heating load with varying outdoor air temperature (OAT) (See Figure 5.) As outside air temperature decreases, the setpoint is increased to compensate for the greater heating load. The slope of the secondary reset curve is determined by the start and stop points of the reset curve. The same outdoor endpoints are used for both the boiler and the secondary loop. *OAT Reset Low* is the outdoor design heating temperature at which the secondary setpoint is *Secondary Reset High*, the highest temperature required in the secondary loop. The lower end of the reset curve is defined by the *Secondary Reset Low* setpoint and *OAT Reset High*. The *OAT Heating Cutoff* is the same as for the boiler reset.

Unoccupied Mode Reset Shift

During unoccupied periods, the reset curve is automatically shifted by the difference between the occupied and unoccupied zone setpoints. This results in a lower water temperature during the unoccupied period. The reset curve is demonstrated in Figure 5.

Figure 5: The Secondary Reset Curve



Zone Temperature Influence

This feature helps to compensate for infiltration and other varying factors. The temperatures of the zones influence the secondary loop setpoint by raising the setpoint 1.8 °F (1 °C) for each 10% of the maximum BLR or BZU zone demand. Zone demands depend on the proportional gain and integral settings of a particular zone. The proportional gain of the BLR-1 is fixed at 20. With the zone temperature 1.8 °F (1 °C) below setpoint, a proportional gain of 20 would result in a 20% demand and a 3.6 °F (2 °C) rise in the secondary loop setpoint. The proportional gain of the BZU-1 is modifiable. A BZU-1 proportional gain of 10, would result in only a 1.8 °F (1 °C) rise in the secondary loop setpoint. This compensated setpoint is not allowed to exceed the selected maximum temperature for the loop (Secondary Reset High). If the zone temperature exceeds its setpoint, the zone heat is turned off until the temperature drops below the 0.9 °F (0.5 °C) deadband.

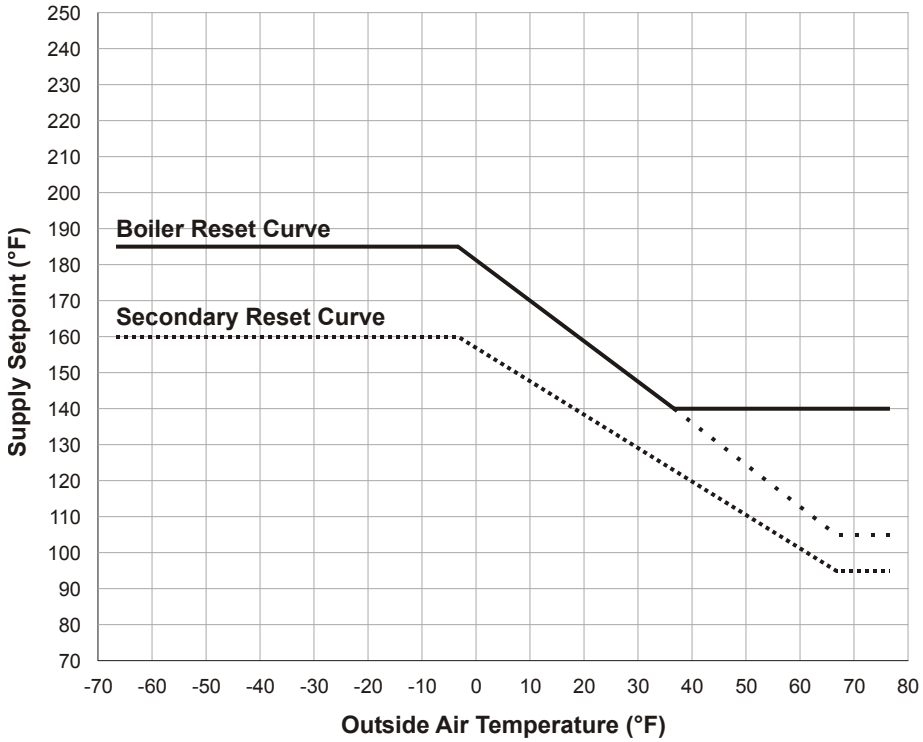
Combined Reset Curves

The combined boiler and secondary reset curves are shown in Figure 6. Note that the boiler reset temperatures should be set higher than the secondary reset temperatures to ensure adequate supply temperatures. The band between the two depends on the flow rates and temperature drops in the application. To account for the zone influence on the secondary reset curve, the primary (boiler) setpoint is adjusted as necessary to stay at least 5 °F (3 °C) above the secondary setpoint.

Manual Override

In the event that heating is temporarily required when the OAT is above the OAT heating cutoff, or when unoccupied, Heating Override may be turned on. This causes the control to operate as if there were a normal occupied demand.

Figure 6: Combined Reset Curves



Secondary Loop Control

Injection Pump / Valve Output

To maintain the proper secondary supply temperature for the radiant zone, the injection pump / valve output of the BLR-1 controls a mixing valve or injection pump. The output may be configured for 0-10 V or 2-10 V, which is suitable for many mixing valves and some injection pumps. The 2-10V signal may be easily converted to 4-20 mA by increasing the total load impedance to 500 Ω. Common line voltage circulators require a signal converter for proper pump speed control. Use only devices approved by the pump manufacturer. Some devices may require a full signal from the BLR-1 to start the pump at full speed. The *Injection Pump Start* option may be selected to provide a full 10 V signal for two seconds every time the pump is started.

Injection Pump / Valve Operation

The mixing device is controlled using a proportional and integral feedback loop. The output is enabled whenever a zone in the group has a demand of greater than 10%, which equates to the zone temperature being 0.9 °F (0.5 °C) below setpoint. When the demand is satisfied (<1%), the output is disabled.

Soft Start

When the difference between the current zone temperature and the secondary loop setpoint exceeds the *Soft Start Differential*, the water temperature controlled by the injection pump/valve is gradually increased to its target setpoint when there is demand. This feature reduces thermal shock to cold slabs, a particular risk with snow melt systems. It may also reduce expansion noises for indoor heating systems.

The initial supply temperature is the current zone temperature plus the *Soft Start Differential*, with a minimum supply temperature of 41 °F (5 °C). The warm up rate is controlled by the *Soft Start Rate*, which defines the number of degrees per minute of temperature increase. During soft start, the supply temperature is increased by a fraction of this rate every few seconds, to yield a smooth temperature increase over the course of the minute.

Soft start can be disabled by setting the *Soft Start Differential* and *Soft Start Rate* to their maximum values. Lower values provide the most gradual changes in water temperature

Zone Pump

Depending on the application requirements, the zone pump can be set to run continuously or only on demand. If the Continuous Circulation option is selected, the zone pump runs throughout the heating season regardless of occupancy. If the option is turned off, the pump will operate only when there is a heating demand from the BLR-1 zone of greater than 10%. When the demand is satisfied (<1%), the pump is turned off.

Boiler & Primary Pump Operation

When the zone demand is >10%, the primary pump will also be started to ensure that heat is available for the secondary loop. At the same time, the boiler setpoint will operate according to its reset curve.

Boiler Return Temperature Protection

To prevent excess cold water from being returned to the boiler, the BLR-1 limits the injection pump / valve output when the return temperature is near the *Minimum Boiler Return* setting. A proportional feedback begins limiting the injection pump / valve output when the return temperature is less than 9 °F (5 °C) above the minimum. If the return temperature falls below the minimum, the injection pump / valve output is disabled while the boiler recovers.

Snow & Ice Melt Control

The BLR-1 is capable of controlling snow and ice melting systems, and supplying those systems with hot water from the boilers. The snow melt features are disabled by default, and must be enabled by setting the *Snow Melt System* adjustment value to “On”. It can be disabled at any time by setting the value to “Off”.

Simple Snow Melt

A Snow Melt Sensor is required to monitor when there is a snow or ice condition. The sensor’s output state signals the controller when heat is required. If a demand is present and the outdoor temperature is above the *Snow Melt Cutoff* temperature, the boiler setpoint is set according to its reset curve, unless a higher setpoint exists. The snow melt pump runs for at least ten minutes. If the primary pump is enabled for snow melt, it runs for at least ten minutes at activation and runs for one additional minute after deactivation. (See “Purge Cycles” on page 12.)

Snow Melt with Temperature Control

To enhance the control and response time of the snow melt system, the slab temperature may be monitored by the zone sensor, and the supply temperature controlled by the injection pump / valve output. If the Snow Melt Temperature Control setting is on, all zone-related parameters, inputs and outputs are assigned to the snow melt system. The BLR-1 zone sensor is used as a slab temperature sensor. The secondary loop is used to supply the heated water according to its reset curve.

As long as the outdoor temperature is above the *Snow Melt Cutoff* temperature, the slab is maintained at the *Unoccupied Zone Setpoint* by operating the snow melt pump, zone pump and injection pump / valve output as needed. When the snow melt sensor calls for heat, the slab can then more quickly reach the *Occupied Zone Setpoint*, which is the targeted melting temperature. When using the secondary loop for snow melt, the “Soft Start” feature (described on page 14) is available for slab protection. The zone temperature influence shifts the secondary loop setpoint as described under “Radiant Zone Control” on page 12 which prevents excessive or inadequate heating.

The boiler is operated on demand according to its reset curve, unless a higher setpoint exists.

Primary Pump Operation

The piping for the snow melt system may or may not require primary pump operation to deliver hot water. The *Snow Melt Primary Pump* option should be turned on if the primary pump is used, and off if it is not used.

Manual Override

In the event that the snow melt switch does not call for heat when needed (due to localized drifting or moisture), the snow melt system may be manually enabled by selecting the *Snow Melt Override* setting. The control will operate as if there were a normal demand.

Auxiliary Heat Demand

Boiler Operation

The auxiliary heat input allows an external device to call for heat from the boilers. The auxiliary demand input may be used for domestic hot water (DHW), supplemental heat for radiant zones (baseboard, for example), or other special purpose systems such as pools or spas. When a demand is present, the boiler supply temperature may be controlled using one of two methods.

Selecting the *Auxiliary Heating Reset* option will cause the boiler supply temperature to be controlled to the boiler reset curve, which may be appropriate if the auxiliary input is used for supplemental zone heating. When using the *Auxiliary Heating Reset* option, the *OAT Heating Cutoff* disables demand just as it does for boiler reset (see “Outdoor Compensated Boiler Supply Setpoint” on page 10).

If the option is off, the boiler supply temperature is controlled to the *Auxiliary Heating Setpoint*. In either case, if another demand with a higher setpoint exists, the higher setpoint is used (see “Setpoint Precedence” on page 10).

Primary Pump Operation

The application may require the primary pump to deliver hot water to the auxiliary system. The Auxiliary Heating Primary Pump setting determines whether the primary pump comes on with an auxiliary demand. If this option is selected, the primary pump is turned on and off with the demand, which is appropriate if the auxiliary is piped as a secondary loop. For an auxiliary system piped in parallel with the primary, such as a DHW system might be, the option should be turned off.

Zone Pump Operation

The application may also require the zone pump to deliver hot water to the auxiliary system. The Auxiliary Heating Zone Pump setting determines whether the zone pump comes on with an auxiliary demand. If this option is selected, the zone pump is turned on and off with the demand. This may be used when the auxiliary demand comes from a zone relay panel that operates valves or pumps on the secondary loop.

Additional Features

Commissioning Switch

To allow simple commissioning, a single switch setting can be adjusted at the LCI. By setting the Commission Switch to “On”, all boiler and pump outputs will be turned on simultaneously. The boilers will be enabled to reach the *Max Boiler Supply* temperature, which may be adjusted for commissioning purposes. The injection pump / valve output is set to the *Injection Pump Commissioning Level* setting.

Sensor Fault Protection

If a temperature sensor is faulty or miswired, the resulting sensor fault could create readings that might result in heating being disabled or constantly enabled. In order to prevent these situations, the BLR-1 defaults to safer levels if it detects a sensor fault. The following table shows (for each sensor) the values that the controller will use if that sensor is shorted or open.

Table 6: Default Values for Sensor Readings

Sensor	If Shorted	If Open
Outside Air Temperature	32.0 °F (0.0 °C)	-60.0 °F (-51.0 °C)
Boiler Supply Temperature	239.0 °F (115.0 °C)	239.0 °F (115.0 °C)
Boiler Return Temperature	230.0 °F (110.0 °C)	-60.0 °F (-51.0 °C)
Secondary Loop Temperature	239.0 °F (115.0 °C)	239.0 °F (115.0 °C)
Zone Temperature	230.0 °F (110.0 °C)	-60.0 °F (-51.0 °C)

Alarms and Events

The controller will detect certain conditions and send them to the LCI as alarms. By default, only the Analog Input Out of Range generates an alarm. To enable the other alarms, they must be configured through the LCI on the “System Tuning” screen. These alarms are displayed and recorded for later access, but do not alter the system operation.

Auxiliary Heating Demand Alarm

The auxiliary heating demand input will trigger an alarm to indicate when there is an auxiliary heating demand. When demand ceases, the alarm is cleared.

Snow Melt Demand Alarm

The snow melt input will trigger an alarm to indicate when the snow melt switch is calling for heat. When the demand signal is removed, the alarm is cleared.

Plant Alarm

A digital input is utilized to monitor a common alarm from the plant. This may be derived from multiple sources such as a boiler lockout or pump trip. A dry contact is used to change the state of the BLR-1 input. When the alarm signal appears at the input, an alarm will be generated at the LCI. The alarm is cleared when the signal is removed.

Analog Input Out of Range

If the analog input from a thermistor is outside of the expected range of the thermistor (-60 °F to 23 0°F [-51 °C to 110 °C]), this alarm will be sent to the LCI. An alarm of this type is most likely due to a wiring fault causing the input to be shorted or open.

Controller Identification

The controller must be configured by the LCI in order to set the controller's schedules, change its set-points, etc. To allow the LCI to identify the BLR-1, controller's service pin must be pressed after the controller is installed and the LCI is active on the network. The controller's status light flashes green until it is configured, and will be solid green after it is configured.

BLR-1 Configuration

Once the BLR-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 BLR-1, and the meanings and suggested values for controller parameters. For more information on using the LCI, see the *iWorX LCI User's Guide.*

Overview

The Overview screen lists the major inputs and outputs of the BLR-1, and shows their current values. None of these values can be changed from this screen.

Table 7: Overview Fields

Field Name	Range	Description
Outside Air Temperature	-60.0 to 230.0 °F (-51.0 to 110.0 °C)	Temperature of the outside air.
Boiler Supply Temperature	-60.0 to 230.0 °F (-51.0 to 110.0 °C)	Temperature of the water in the boiler loop.
Boiler Return Temperature	-60.0 to 230.0 °F (-51.0 to 110.0 °C)	Temperature of the water in the boiler return.
Secondary Loop Temperature	-60.0 to 230.0 °F (-51.0 to 110.0 °C)	Temperature of the water in the secondary loop.
Zone Temperature	-60.0 to 230.0 °F (-51.0 to 110.0 °C)	Temperature of the radiant zone.
Injection Output	0.00% to 100.0%	Status of the output to injection pump or mixing valve.
Occupancy	Occupied, Unoccupied	Occupancy status of the zone according to schedule or override.
Boiler Demand	0.00% to 100.0%	Demand for boiler heat.
Boiler Setpoint	50.0 to 230.0 °F 10.0 to 110.0 °C)	Desired temperature in boiler loop.
Secondary Setpoint	50.0 to 230.0 °F 10.0 to 110.0 °C)	Desired temp. in secondary loop.
Zone Setpoint	5.0 to 230.0 °F (-15.0 to 110.0 °C)	Desired temp. of the radiant zone.
Sub Zone Demand	0 to 100%	Current demand from subzones.
Zone Pump	Off, On	Status of the zone pump.
Snow Melt Enable	Off, On	Status of the snow melt pump.
Primary Pump	Off, On	Status of the primary loop pump.
Boiler Stage 4	Off, On	Status of boiler stage 4.
Boiler Stage 3	Off, On	Status of boiler stage 3.
Boiler Stage 2	Off, On	Status of boiler stage 2.
Boiler Stage 1	Off, On	Status of boiler stage 1.

Adjustments

This screen lists adjustments that system managers may wish to modify at any time.

Table 8: Adjustment Fields

Field Name	Range	Default Value	Description
Constant Zone Circulation	Off, On	Off	Set to “On” to run the zone pump continuously when occupied during cold weather, “Off” to run on demand only.
Snow Melt Override	Off, On	Off	Set to “On” to enable snow melt heating regardless of snow melt switch status.
24 Hour Occupancy	Off, On	Off	If set to “On”, unoccupied setpoints are ignored and occupied setpoints are used 24 hours a day.
Heating Override	Off, On	Off	If set to “On”, heating is enabled regardless of outside air temperature or occupancy status.
Snow Melt System	Off, On	Off	Set to “On” to enable the Snow Melt function. “Off” disables all Snow Melt features.
Unoccupied Zone Setpoint	-60.0 to 203.0 °F (51.0 to 95.0 °C)	59.0 °F (15.0 °C)	Setpoint to maintain in the occupancy zone during unoccupied periods.
Occupied Zone Setpoint	32.0 to 203.0 °F (0.0 to 95.0 °C)	68.0 °F (20.0 °C)	Setpoint to maintain in the occupancy zone during occupied periods.

Commissioning

The commissioning screen lists the parameters that control the basic functionality of the BLR-1. These values are used primarily during commissioning of the system. Once these values are set to optimum levels, they should not need modification.

Table 9: Commissioning Fields

Field Name	Range	Default Value	Description
OAT Reset Low	-60 to 50 °F (-51 to 10 °C)	-4 °F (-20.0 °C)	Outside air temperature (cold) at or below which the water temperature is at its highest.
OAT Reset High	51 to 80 °F (11 to 27 °C)	68 °F (20 °C)	Outside air temperature (warm) at which the water temperature is at its lowest.
Boiler Reset High	123 to 230 °F (51 to 110 °C)	185 °F (85.0 °C)	Highest boiler temperature desired when it is cold outside.
Boiler Reset Low	68 to 122 °F (20 to 50 °C)	104 °F (40 °C)	Lowest boiler temperature desired when it is warm outside.
Secondary Reset High	123 to 230 °F (51 to 110 °C)	149 °F (65.0 °C)	Highest mixed temperature desired when it is cold outside.
Secondary Reset Low	68 to 122 °F (20 to 50 °C)	95 °F (35 °C)	Lowest mixed temperature desired when it is warm outside.
Snow Melt Primary Pump	Off, On	Off	If set to “On”, primary pump is enabled when there is snow melt demand.

Table 9: Commissioning Fields (Continued)

Field Name	Range	Default Value	Description
Auxiliary Heating Reset	Off, On	Off	If set to “On”, auxiliary demand uses the boiler reset curve instead of the Auxiliary Heating Setpoint.
Aux. Heating Zone Pump	Off, On	Off	Set to “On” to enable the secondary pump when there is an auxiliary heating demand.
Aux. Heating Primary Pump	Off, On	Off	Set to “On” to enable the primary pump when there is an auxiliary heating demand.
Snow Melt Temp. Control	Off, On	Off	Set to “On” to maintain the slab at an “idle” temperature.
2-10 Volt Select	Off, On	Off	Set to “On” for 2-10 V injection pump/valve output, “Off” for 0-10 V
Injection Pump Start	Off, On	Off	Set to “On” to always start the injection pump at full power for two seconds.
Commissioning Switch	Off, On	Off	Set to “On” to turn on all outputs simultaneously.
Zone Temperature Effect	Off, On	Off	Set to “On” to allow the zone demand to influence the reset temperatures.
Snow Melt Cutoff	-67 to 23 °F (-55 to -5 °C)	14 °F (-10 °C)	Outside temperature below which snow melt is disabled.
Aux. Heating Setpoint	77.0 to 203.0 °F (25.0 to 95.0 °C)	85.0 °F (185.0 °C)	Boiler supple setpoint to be maintained there is an auxiliary heating demand.
Injection Commissioning Level	0% to 100%	10%	Level at which to operate the injection pump/valve during commissioning.
Minimum Boiler Supply	50.0 to 140.0 °F (10.0 to 60.0 °C)	140 °F (60.0 °C)	Minimum temperature to be maintained at boiler supply at all times.
Maximum Boiler Supply	140.0 to 230.0 °F (60.0 to 110.0 °C)	203 °F (95 °C)	Maximum temperature allowed at boiler supply at any time.
Minimum Boiler Return	32.0 to 140.0 °F (0.0 to 60.0 °C)	131.0 °F (55.0 °C)	Minimum temperature to be maintained in the boiler return at all times.
Soft Start Rate	1.0 to 90.0 °F (0.5 to 50.0 °C)	18 °F (10 °C)	During Soft Start, number of degrees per minute the setpoint is increased.
Soft Start Differential	0.0 to 180.0 °F (0.0 to 100.0 °C)	18 °F (10 °C)	Soft Start is activated when difference between the current zone temp. and secondary loop temp. exceeds this value.
OAT Heating Cutoff	32 to 80 °F (0 to 27 °C)	68 °F (20 °C)	Outside temperature above which heating is disabled.

Digital Inputs

This screen reports the status of the controller's digital inputs. These values cannot be changed.

Table 10: Digital Input Fields

Field Name	Range	Description
Aux. Heating Demand	Off, On	Status of the auxiliary heating demand input.
Snow Melt Status	Off, On	Status of the snow melt sensor.
Plant Alarm	Off, On	Status of the plant alarm.

System Tuning

The System Tuning screen gives access to two sets of fields.

P+I Loops

These parameters control the proportional gain and integral time of the controller's proportional and integral (P+I) control loops. Increase a loop's gain if the system is not responsive enough to meet set-points in a reasonable time. Decrease the gain if the system seems to be erratic or unstable. Increase the integral times if the system is switching too quickly, and decrease them if it is reacting too slowly.

Table 11: P+I Loop Fields

Field Name	Range	Default Value	Description
Boiler Proportional Gain	0 to 20	3.0	Gain used in the P+I loop that controls the boiler stages.
Boiler Integral Time	0 to 1000 minutes	20 minutes	Response time of the Integral function for the secondary loop.
Injection Pump Proportional Gain	0 to 20	5.0	Gain used in the P+I loop that controls the injection pump / valve.
Injection Pump Integral Time	0 to 1000 minutes	5 minutes	Response time of the Integral function for the boiler loop.

The default settings are the result of research into optimal configurations. In almost every case, leave these settings at the default values. One exception would be if only two boiler stages are in use. In this case, increase the gain or the second boiler stage will only be enabled if there is an 80% demand.

Table 12: Suggested Settings for Specific Boiler Setups

	Boiler Proportional Gain	Boiler Integral Time
Four single-stage boilers	3	20
Two two-stage boilers	3	20
Two single-stage boilers	4	10

Sensors

These settings modify how the controller reacts to readings from the sensors that are connected to the controller. Offsets are added to sensor readings before any further processing is done by the controller. This is useful for system testing.

Table 13: Sensor Fields

Field Name	Range	Default Value	Description
Outside Air Temp. Offset	+/- 999	0.0 °F (0.0 °C)	Number of degrees to add to the outside air temperature readings.
Boiler Supply Temp. Offset	+/- 999	0.0 °F (0.0 °C)	Number of degrees to add to the boiler loop temperature readings.
Boiler Return Temp. Offset	+/- 999	0.0 °F (0.0 °C)	Number of degrees to add to the boiler return temperature readings.
Secondary Loop Temp. Offset	+/- 999	0.0 °F (0.0 °C)	Number of degrees to add to the secondary loop temp. readings.
Zone Temperature Offset	+/- 999	0.0 °F (0.0 °C)	Number of degrees to add to the zone temperature readings.
Auxiliary Heating Demand Alarming	Off, On	Off	Set to “On” to enable alarming for the auxiliary heating demand digital input.
Auxiliary Heating Demand Alarm Type	Normally Open, Normally Closed	Normally Open	Controller will report an alarm if the input is *not* in the selected state
Snow Melt Status Alarming	Off, On	Off	Set to “On” to enable alarming for the snow melt status digital input.
Snow Melt Status Alarm Type	Normally Open, Normally Closed	Normally Open	Controller will report an alarm if the input is *not* in the selected state
Plant Alarm Alarming	Off, On	Off	Set to “On” to enable alarming for the plant alarm digital input.
Plant Alarm Type	Normally Open, Normally Closed	Normally Open	Controller will report an alarm if the input is *not* in the selected state

Boiler Staging

The four boiler stages are shown as colored bars at the top of the screen. Inactive stages are represented by blue bars. Enabled stages are highlighted in red.

Table 14: Boiler Staging Fields

Field Name	Range	Default Value	Description
Boiler Supply Temperature	-60 to 230 °F (-51 to 110 °C)	(Not Editable)	Boiler supply water temperature.
Boiler Return Temperature	-60 to 230 °F (-51 to 110 °C)	(Not Editable)	Boiler return water temperature.
Boiler Rotate Time	0 to 1002 hours	500 hours	Hours of runtime between boiler rotations.
Equal Run Time	Yes, No	Yes	Set to “Yes” to enable automatic boiler rotation.
Lead Boiler Select	“Boiler 1, 2”, “Boiler 3, 4”	Boiler 1, 2	Manually select the leading boiler stages if *Equal Run Time* is disabled.
Boiler Demand	0 to 100%	(Not Editable)	Demand for boiler stages.

Troubleshooting

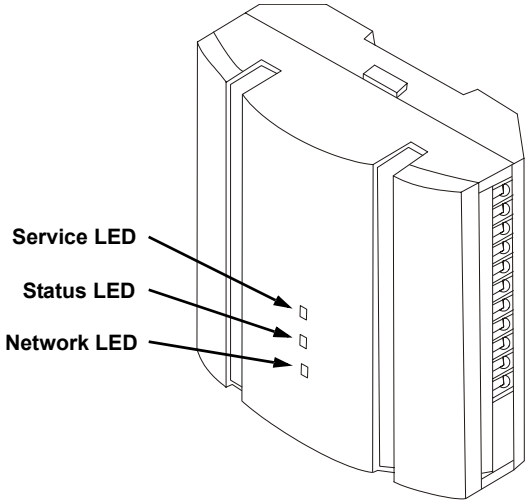
Diagnostic LEDs

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 15: Controller LED Indicators.

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
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 7: BLR-1 Controller 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.

A boiler or pump pilot relay will not come on even though the LCI indicates it is on.

Ensure that the controller and output pilot relay have been powered with 24 VAC and the output has been correctly wired to the coil of the pilot relay. Also ensure that the pilot relay has a 24 VAC coil.

There is a "Temperature Sensor Alarm" on the LCI.

The input is either shorted or open. Check the wiring for the indicated sensor.

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.