

CHB2 Chilled Beam Ceiling Controller

Self-Contained Interoperable Controller Model UCP-1 for Software Version 2

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CHB2

The CHB2 Chilled Beam Ceiling Controller is a microprocessor-based controller for a dual coil operation. This application can operate one LoFlo® Blocks with heating and cooling switchover.

Overview

The CHB2 provides BTU energy monitoring for a Heating Loop and a Cooling Loop as well as measurement of Supply Water Temperature, Flow, and Return Water Temperature for each loop. Inputs for Supply Air Temperature, Indoor Air Quality, Occupancy, and Beam Temperature are provided. Space Temperature can be sensed by a two-wire serial interface to an iWorX TS300 series thermostat.

The controller incorporates digital outputs in the form of triacs for Fan Operation, two Heating Stages, two Cooling Stages, and a Dehumidifier. In addition, analog outputs are provided to control an analog Injection Signal as well as a modulated signal for a heating and cooling LoFlo® Block.

The CHB2 provides a Dehumidification output for an independent dehumidification unit.

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

Features

- Two stages of cooling
- Two stages of cooling with a selectable stage modulation
- Two stages of heating
- Two stages of heating with a selectable stage modulation
- Manual heat or cool operation or auto switch-over
- Injection/Mixing control with separate reset curves for heat and cool
- Optional dew point control
- Local or global fan setup
- Three speed fan for local fan control
- Dehumidification signal
- Optional BTU energy monitoring
- Optional Flow metering
- IAQ detection, configurable for digital or analog sensors
- P + I control of modulated heating and cooling
- P + I control of injection/mixing control of hot cool supply water
- Individual temperature setpoints for occupied/unoccupied heat and cool
- Supply Air and Duct Humidity monitoring
- Thermostat with space temperature, space humidity, setpoint adjust, fan override, occupancy override
- Local Occupancy override
- Commissioning mode for direct control
- LonWorks interface to building automation systems and host products
- Automatic configuration with the LCI2
- Supervisor control (JENE/Niagara)
- Alarm/Event reporting

PURPOSE OF THIS GUIDE

The *iWorx® CHB2 Application Guide* provides application information for the CHB2 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

This Document is subject to change from time to time at the sole discretion of Taco Electronic Solutions, Inc. All updates to the Document are available at www.taco-hvac.com. When installing this product, it is the reader's responsibility to ensure that the latest version of the Document is being used.

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
<i>iWorx® LCI Application Guide</i> , Document No. 505-002	– Application Engineers, Installers, Service Personnel, Start-up Technicians, End Users	Provides instructions for setting up and using the iWorx® Local Control Interface.
<i>iWorx® BLMC Application Guide</i> , Document No. 505-001	– Application Engineers, Installers, Service Personnel, Start-up Technicians, End Users	Provides instructions for setting up and using the iWorx® Boiler Control Module.
<i>iWorx® CCU2 Application Guide</i> , Document No. 505-022	– Application Engineers, Installers, Service Personnel, Start-up Technicians, End Users	Provides instructions for setting up and using the iWorx® Chiller Controller.
http://www.iWorxWizard.com	– Application Engineers – Wholesalers – 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	<i>LonWorks FTT-10A Free Topology Transceiver User's Guide</i> , 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 .	
Instruction Sheet LMB-LoFlo™ Mixing Block Document No. 102-415	– Application Engineers, Installers, Service Personnel, Start-up Technicians, End Users	Provides instructions for setting up and using the LMB with the iWorx® CHB

INSTALLATION INSTRUCTIONS

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.

BEFORE INSTALLING

About this Document

The instructions in this manual are for the CHB2 module which supports a CHB2.

Inspecting the Equipment

Inspect the shipping carton for damage. If damaged, notify the carrier immediately. Inspect the equipment for damage. Return damaged equipment to the supplier.

What is Not Included with this Equipment

- A power source for the equipment electronics and peripheral devices.
- Tools necessary to install, troubleshoot and service the equipment.
- The screws or DIN rail needed to mount the device.
- Peripheral devices, such as sensors, actuators, etc.
- Cabling, cabling raceway, and fittings necessary to connect this equipment to the power source, FTT-10A network and peripheral devices.

Equipment Location



Abide by all warnings regarding equipment location provided earlier in this document.

Optimally, the equipment should be installed within a secure enclosure.

If the equipment is to be installed outside, it must be contained within a protective enclosure. The enclosure must maintain 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.

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

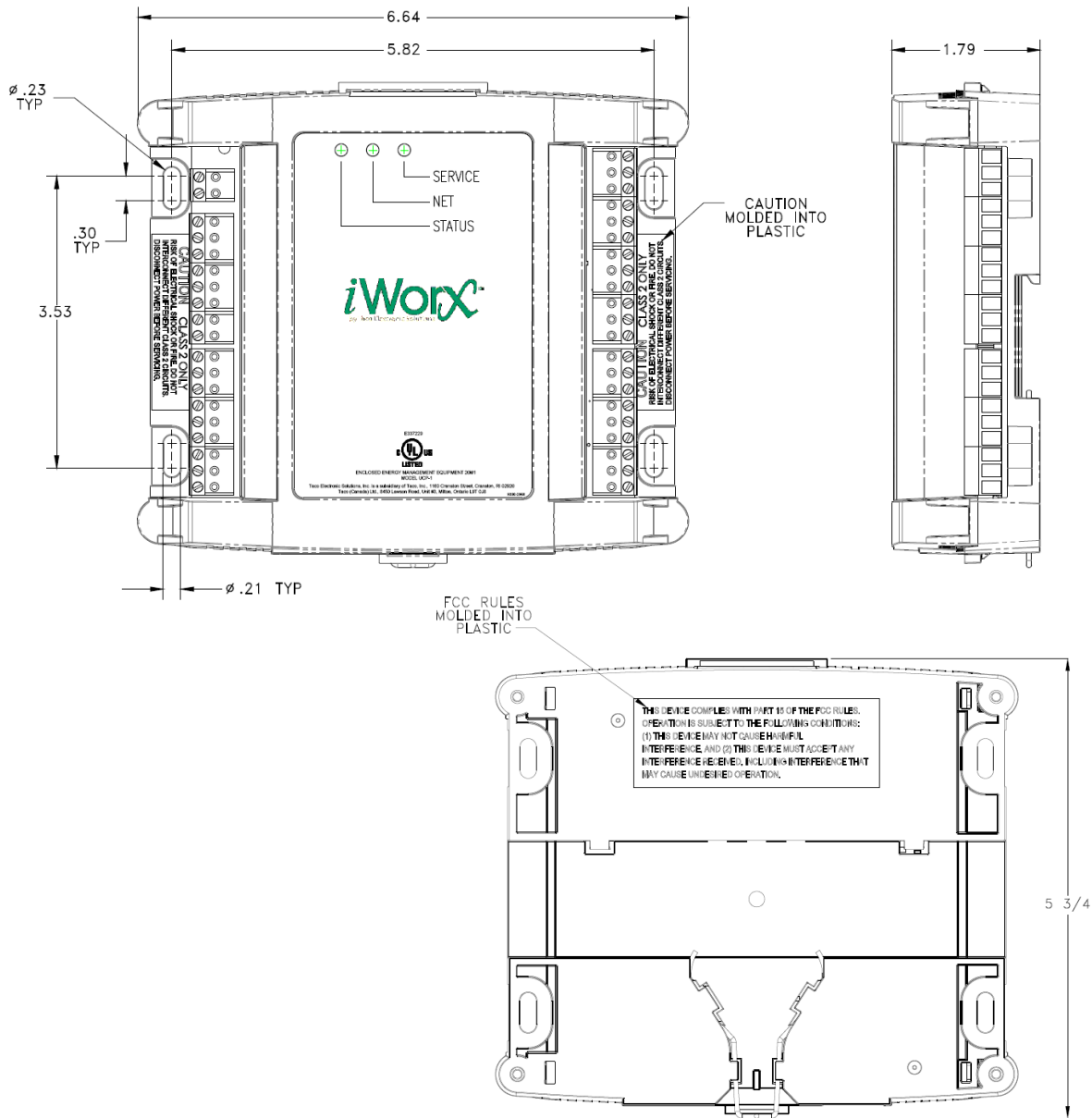


Warning: Electrical shock hazard. To prevent electrical shock or equipment damage, disconnect **ALL** power sources to controllers and loads before installing or servicing this equipment or modifying any wiring.

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 (See Routing Cabling to the Device).

Figure 1: Mounting Dimensions



Routing Cabling to the Device



Cabling used to connect the power source and cabling used to connect the FTT-10A network must remain separated within the control enclosure and wiring conduit.

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.



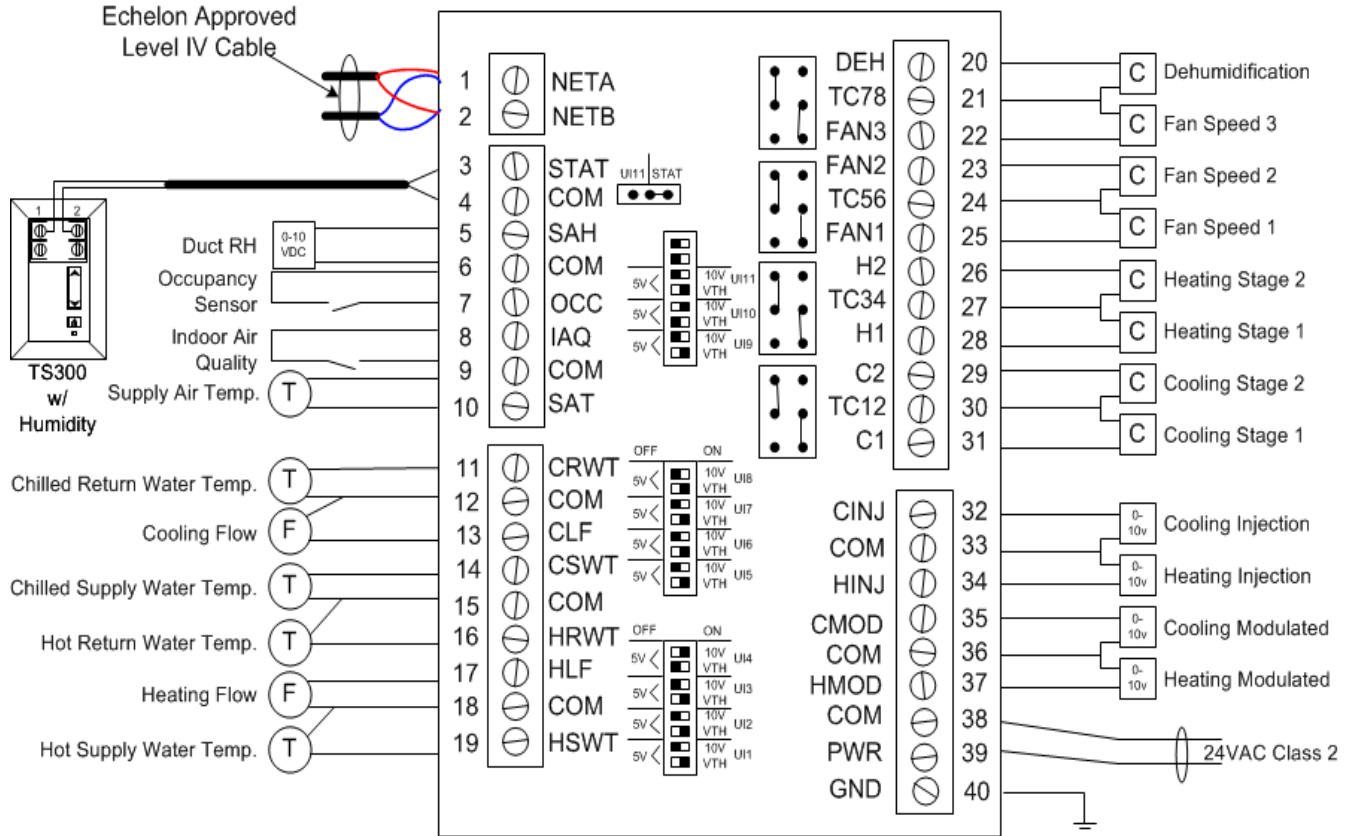
For best performance, connect the power supply common terminal (T38) to the same external point as the ground terminal (T40).

WIRING INFORMATION



WARNING: Terminals 4, 6, 9, 12, 15, and 18 are connected internally on all CHB2 controllers. Disconnect **ALL** power sources when installing or servicing this equipment to prevent electrical shock or equipment damage.

Figure 2: CHB2 Wiring Example - Power Sourcing



Symbols

- 10 K ohm Precon Type III thermistor
- 0-10VDC Flow Sensor
- 24VAC pilot relay or contactor coil
- 0-10 VDC signal

Output Jumper Positions

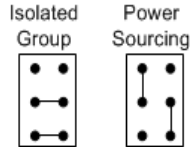
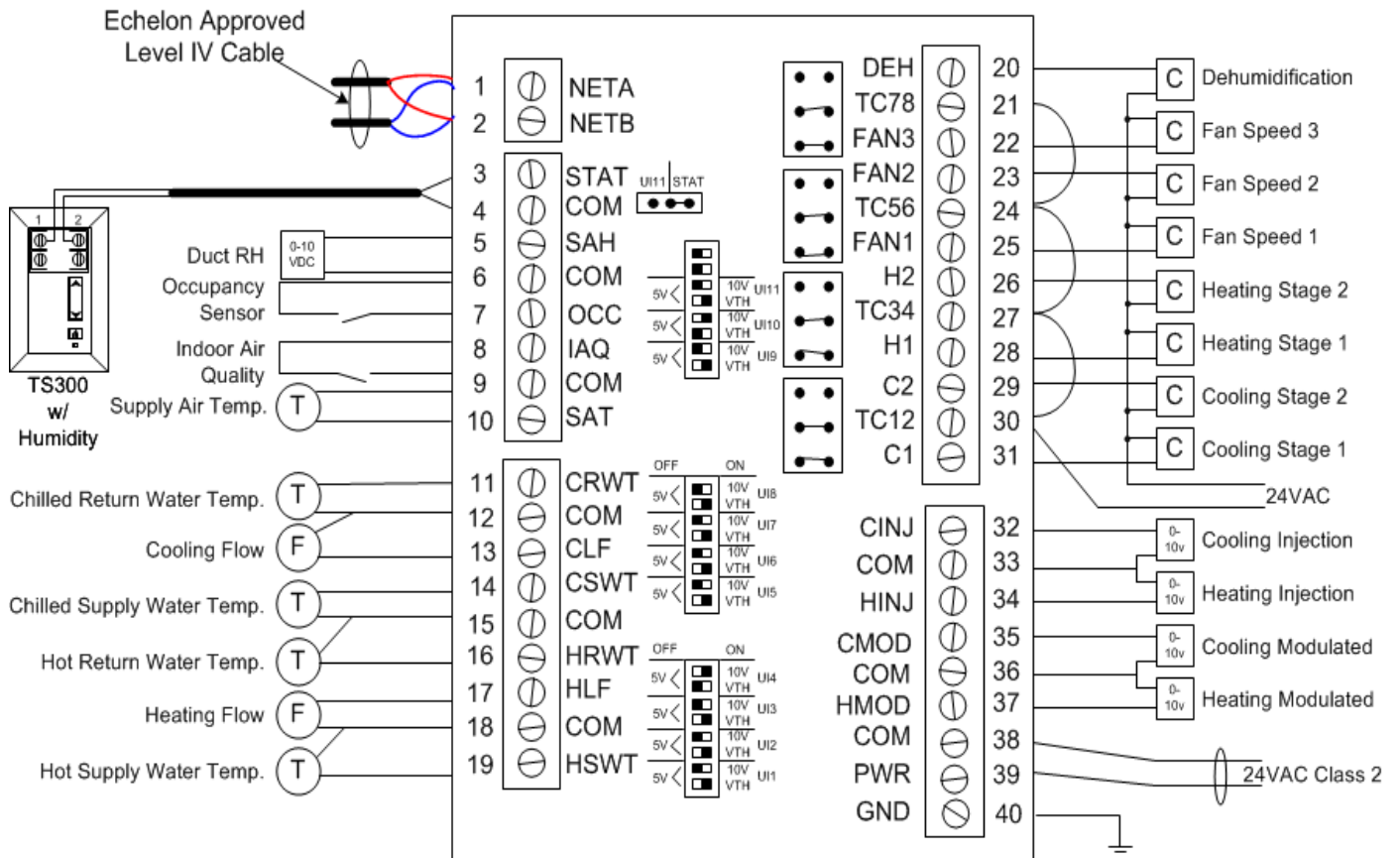


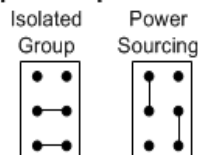
Figure 3: CHB2 Wiring Example - Power Isolated



Symbols

- 10 K ohm Precon Type III thermistor
- 0-10VDC Flow Sensor
- 24VAC pilot relay or contactor coil
- 0-10 VDC signal

Output Jumper Positions

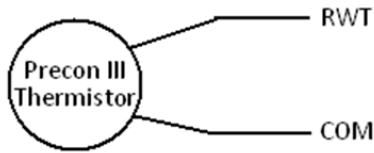


Connecting Input Devices

The figures below demonstrate typical sensor wiring.

Precon II or III sensors are wired as a standard thermistor. One terminal is connected to a common pin, the other to the RWT input. Jumpers for RWT lines using Precon II or III sensors must be configured for VTH input.

Figure 4: Typical Precon III Sensor Wiring



Hot Water Supply Temperature (HWST)

To connect the Hot Water Supply Temperature sensor to the unit, attach one wire from the sensor to HWST (T19) and the other wire to the adjacent common (T18). Depending on the type of sensor, the DIP switch settings must be changed. Please refer to the Wiring Information for the sensor types and the corresponding DIP switch settings.

Hot Water Flow (HWFL)

To connect the Hot Water Flow sensor to the unit, attach one wire from the sensor to HWFL (T17) and the other wire to the adjacent common (T18). The sensor must be of the 0-10 Volt type.

Hot Water Return Temperature (HWRT)

To connect the Hot Water Return Temperature sensor to the unit, attach one wire from the sensor to HWST (T16) and the other wire to the adjacent common (T15). Depending on the type of sensor, the DIP switch settings must be changed. Please refer to the Wiring Information for the sensor types and the corresponding DIP switch settings.

Cold Water Supply Temperature (CWST)

To connect the Cold Water Supply Temperature sensor to the unit, attach one wire from the sensor to HWST (T14) and the other wire to the adjacent common (T15). Depending on the type of sensor, the DIP switch settings must be changed. Please refer to the Wiring Information for the sensor types and the corresponding DIP switch settings.

Cold Water Flow (CFL)

To connect the Cold Water Flow sensor to the unit, attach one wire from the sensor to HWFL (T13) and the other wire to the adjacent common (T12). The sensor must be of the 0-10 Volt type.

Cold Water Return Temperature (CWRT)

To connect the Cold Water Return Temperature sensor to the unit, attach one wire from the sensor to HWST (T11) and the other wire to the adjacent common (T12). Depending on the type of sensor, the DIP switch settings must be changed. Please refer to the Wiring Information for the sensor types and the corresponding DIP switch settings.

Supply Air Temperature (SAT)

To connect the Supply Air thermistor to the unit, attach one wire from the sensor to SAT (T10) and the other wire to the adjacent common (T9). The thermistor used must be 10K Precon Type III.

Indoor Air Quality (IAQ)

To connect the IAQ switch to the digital input, attach one wire of the contact to IAQ (T8) and the other wire to the adjacent common (T9). This must be a dry contact normally open switch.

If the Indoor Air Quality sensor is an analog device, the sensor should be connected to the terminals mentioned above, but the dip switch settings must be changed to reflect a 0-10V input.

Occupancy (OCC)

To connect the Occupancy switch to the digital input, attach one wire of the contact to OCC (T7) and the other wire to the adjacent common (T6). This must be a dry contact normally open switch.

Supply Air RH (SAH)

To connect the Supply Air RH sensor to the unit, attach one wire from the sensor to SAH (T5) and the other wire to the adjacent common (T6). The dip switch settings must reflect a 0-10V input.

Connecting Output Devices

Heat Modulation (HMOD)

The heat modulation output can be set to 0-10 V max through the control logic. Connect the positive wire from the heating output to HMOD (T37) and the other wire to COM (T36). See preceding figures for details.

Cool Modulation (CMOD)

The cool modulation output can be set to 0-10 V max through the control logic. Connect the positive wire from the heating output to CMOD (T35) and the other wire to COM (T36). See preceding figures for details.

Heat Injection (HINJ)

The heat injection output can be set to 0-10 V max through the control logic. Connect the positive wire from the heating injection output to HMOD (T34) and the other wire to COM (T33). See preceding figures for details.

Cool Injection (CINJ)

The cool injection output can be set to 0-10 V max through the control logic. Connect the positive wire from the cooling injection output to CMOD (T32) and the other wire to COM (T33). See preceding figures for details.

Cooling Stage 1 (C1)

The cooling stage output must be connected to a 24 VAC pilot relay if the load is greater than 1 Amp. See preceding figures for details. If the load is less than 1 Amp, connect cooling stage 1 to C1 (31) and TC12 (30).

Cooling Stage 2 (C2)

The cooling stage output must be connected to a 24 VAC pilot relay if the load is greater than 1 Amp. See preceding figures for details. If the load is less than 1 Amp, connect cooling stage 2 to C2 (29) and TC12 (30).

Heating Stage 1 (H1)

The heating stage output must be connected to a 24 VAC pilot relay if the load is greater than 1 Amp. See preceding figures for details. If the load is less than 1 Amp, connect heating stage 1 to H1 (T28) and TC34 (27).

Heating Stage 2 (H2)

The heating stage output must be connected to a 24 VAC pilot relay if the load is greater than 1 Amp. See preceding figures for details. If the load is less than 1 Amp, connect heating stage 2 to H1 (T26) and TC34 (T27).

Fan Speed 1 (FAN1)

The fan speed 1 output must be connected to a 24 VAC pilot relay if the load is greater than 1 Amp. See preceding figures for details. If the load is less than 1 Amp, connect fan stage 1 to FAN1 (T25) and TC56 (24).

Fan Speed 2 (FAN2)

The fan speed 2 output must be connected to a 24 VAC pilot relay if the load is greater than 1 Amp. See preceding figures for details. If the load is less than 1 Amp, connect fan speed 2 to FAN2 (T23) and TC56 (T24).

Fan Speed 3 (FAN3)

The fan speed 3 output must be connected to a 24 VAC pilot relay if the load is greater than 1 Amp. See preceding figures for details. If the load is less than 1 Amp, connect the fan speed 3 to FAN3 (T22) and TC78 (T21).

Dehumidification (DEH)

The dehumidifier output must be connected to a 24 VAC pilot relay if the load is greater than 1 Amp. See preceding figures for details. If the load is less than 1 Amp, connect the dehumidifier to DEH (T20) and TC78 (T21).

Other Connections

Network (LON)

Network wiring must be twisted pair. One network wire must be connected to terminal NETA (T1) and the other network wire must be connected to terminal NETB (T2). Polarity is not an issue since an FTT-10A network is used for communications.

Power (PWR)

Connect one output wire from a 24 VAC power supply to PWR (T39) and the other output wire from the power supply to the adjacent common terminal (T38). T38 must be connected to earth ground.

Ground (GND)



Terminal GND (T40) must be 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 and TV reception.

SPECIFICATIONS

Electrical Inputs

Hot Water Supply Temperature, Hot Water Return Temperature, Cold Water Supply Temperature, Cold Water Return Temperature, Supply Air Temperature: Precon Type III 10K thermistor

Hot Water Flow, Cold Water Flow, Supply Air RH: 0 - 10 Volts DC

Occupancy: Dry Contact, Normally Open, 5 Volts DC Max

Indoor Air Quality: 0-10V or Dry Contact (configurable)

Electrical Outputs

Cooling Stage 1, Cooling Stage 2, Heating Stage 1, Heating Stage2, Fan Speed 1, Fan Speed 2, Fan Speed 3, Dehumidification: 24 Volts AC, 1 Amp at 50 °C, 0.5 Amps at 60 °C, limited by Class 2 supply

Heat Modulation, Cool Modulation, Heat Injection, Cool Injection: 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 CHB2 controller maintains the temperature of a space at defined setpoints. It also controls the supply water temperature according to a configurable reset curve. Curves for heating and cooling can be defined separately. The CHB2 works in conjunction with a LoFlo™ Mixing Block; Injection and Zone circulators are driven by the control algorithm.

Figure 5: Typical CHB2 With One Stage of Heating and Cooling

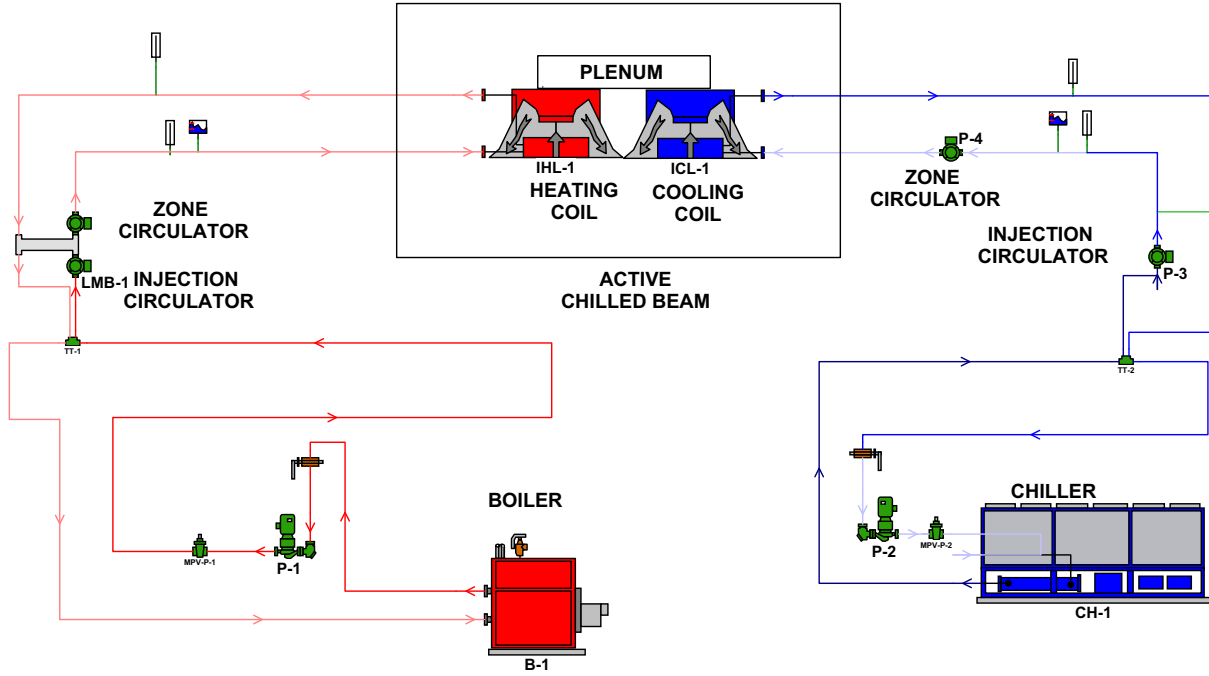
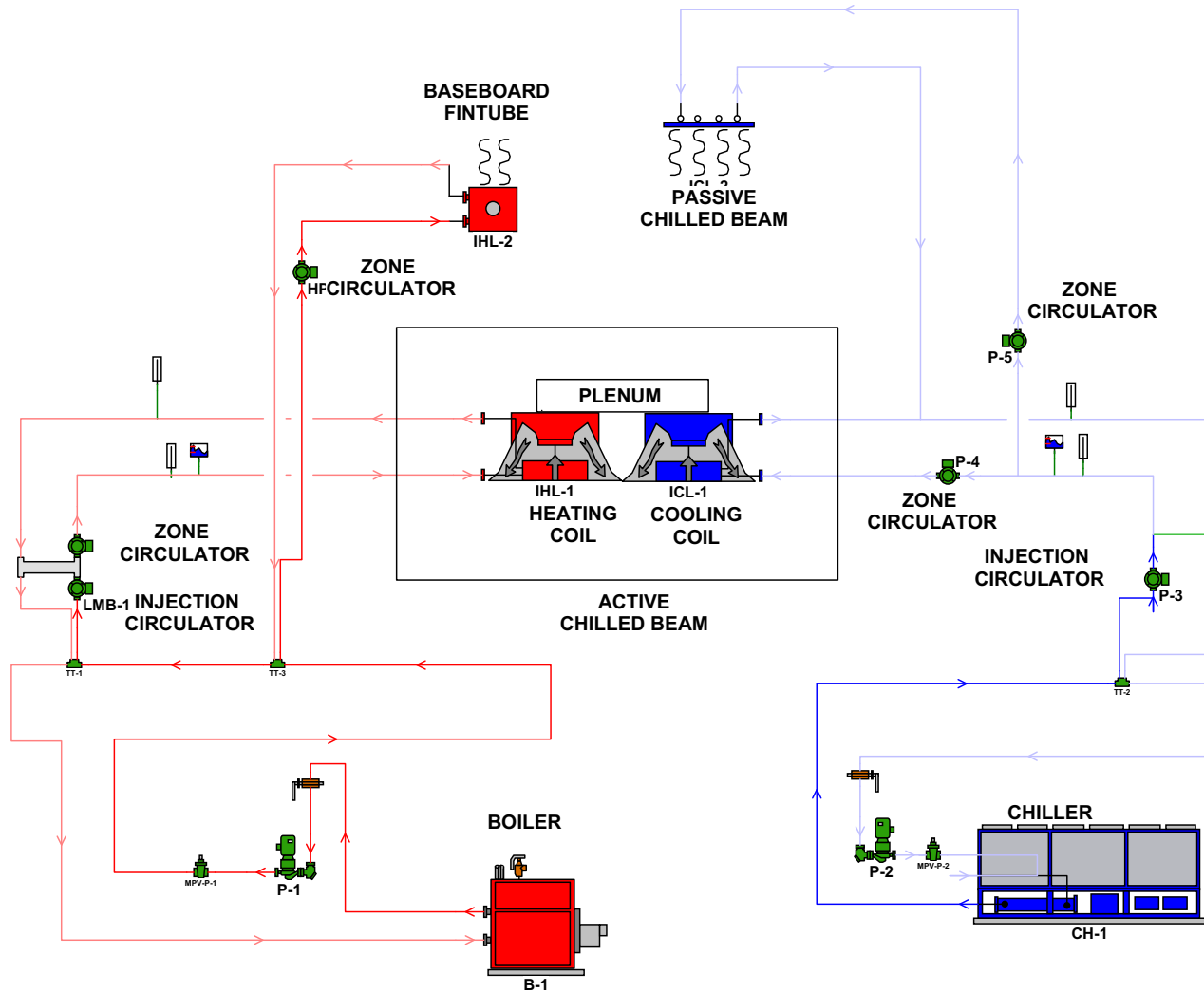


Figure 6: Typical CHB2 With Two Stages of Heating and Two Stages of Cooling



NOTE: Taco recommends operation of baseboard and passive chilled beam as stage two. The passive chilled beam needs to be piped after the LoFlo® block to make sure the cold supply water is dew point controlled.

The CHB2 can control heating only, cooling only, or heating and cooling Chilled Beam Ceilings. All control is based on the current space requirements as well as supply water temperature.

Room temperature control for two LoadMatch® or four-pipe, dual-coil configurations is achieved by discrete cooling and heating stages. The cooling or heating stages can be configured to modulate one stage.

Supply water control for heating and cooling is provided for an injection/mixing control.

The CHB2 controls the supply air fan locally or can be setup for global fan control. The fan is energized when there is a call for heating or cooling. During the occupied periods, the fan can be configured to run continuously in one of three speeds (digital outputs) configured from the LCI.

When cooling, the injection cooling output is calculated by a Proportional + Integral control loop based on the supply water temperature and the calculated cooling reset setpoint. As the temperature increases above the setpoint, the output is modulated to higher. As the temperature decreases below the setpoint, the output is modulated lower.

When in heating, the injection heating output is calculated by a Proportional + Integral control loop based on the supply water temperature and the calculated heating setpoint. As the temperature decreases below the setpoint, the output is modulated higher. As the temperature increases above the setpoint, the output is modulated lower.

Each controller interfaces to a local thermostat. Depending on the model, the thermostat includes a space temperature sensor, space humidity sensor, temperature setpoint adjustment, occupancy override and a fan speed selection.

The controller operates in one of two states: occupied or unoccupied. The LCI determines the active operating mode. The operating mode can be set by a supervisor system, which takes over precedence. The controller maintains the comfort level to a user-defined setpoint during the occupied period. The controller uses setup and setback values during the unoccupied period to maintain the space temperature. An optional backup schedule is provided to use when the LCI is not available.

The controller monitors the runtime of the fan, heating and cooling outputs. When the runtime of any of these exceeds a programmable limit, a maintenance alarm is reported to the LCI.

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

An indoor air quality input is provided. If an indoor air quality condition is indicated, the supply air fan is energized. If the condition remains active for a configurable period of time, an alarm is generated. The indoor air quality input may be a digital input or a 0-10V analog input. If the sensor is the analog type then the level that indicates the IAQ condition is configurable. A temperature reset function is available to maintain a comfort space temperature.

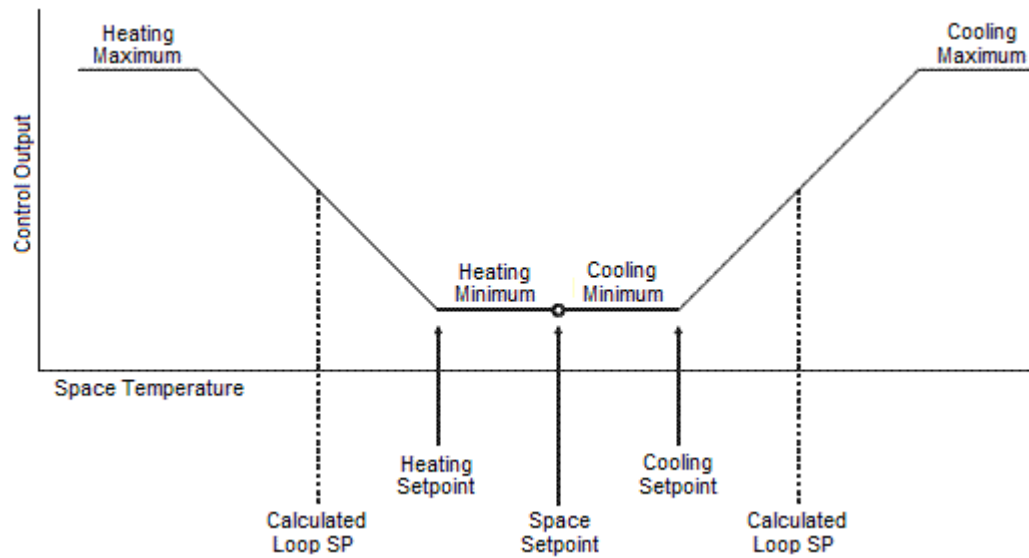
The controller monitors the supply and return temperatures as well as the flow in the system. The values are measured every second and an average is calculated every minute. The system then calculates an energy rate value in BTU/hr, a volume rate in GPM, a daily total heat consumption, a grand total heat consumption in BTU, and a daily total volume and grand total volume in gallons for each heating and cooling. It also generates a 31 day log, which can be retrieved with the LCI.

The controller's outputs can be manually changed through the LCI using the Commissioning configuration. The Fan can be set to one of three speeds. The Hot Water and Cold Water control outputs can be analog or staged. Analog output can control either modulating valves or pumps. When analog outputs are used, the corresponding digital outputs (enable) will turn ON if the analog outputs are greater than zero.

SEQUENCE OF OPERATION

This section describes the detailed sequence of operation for the CHB2 control algorithms.

Figure 7: Cooling and Heating Injection Control



Space Temperature Setpoint Operation

The space setpoint for the occupied and unoccupied modes are programmable values.

Setpoints in Occupied Mode

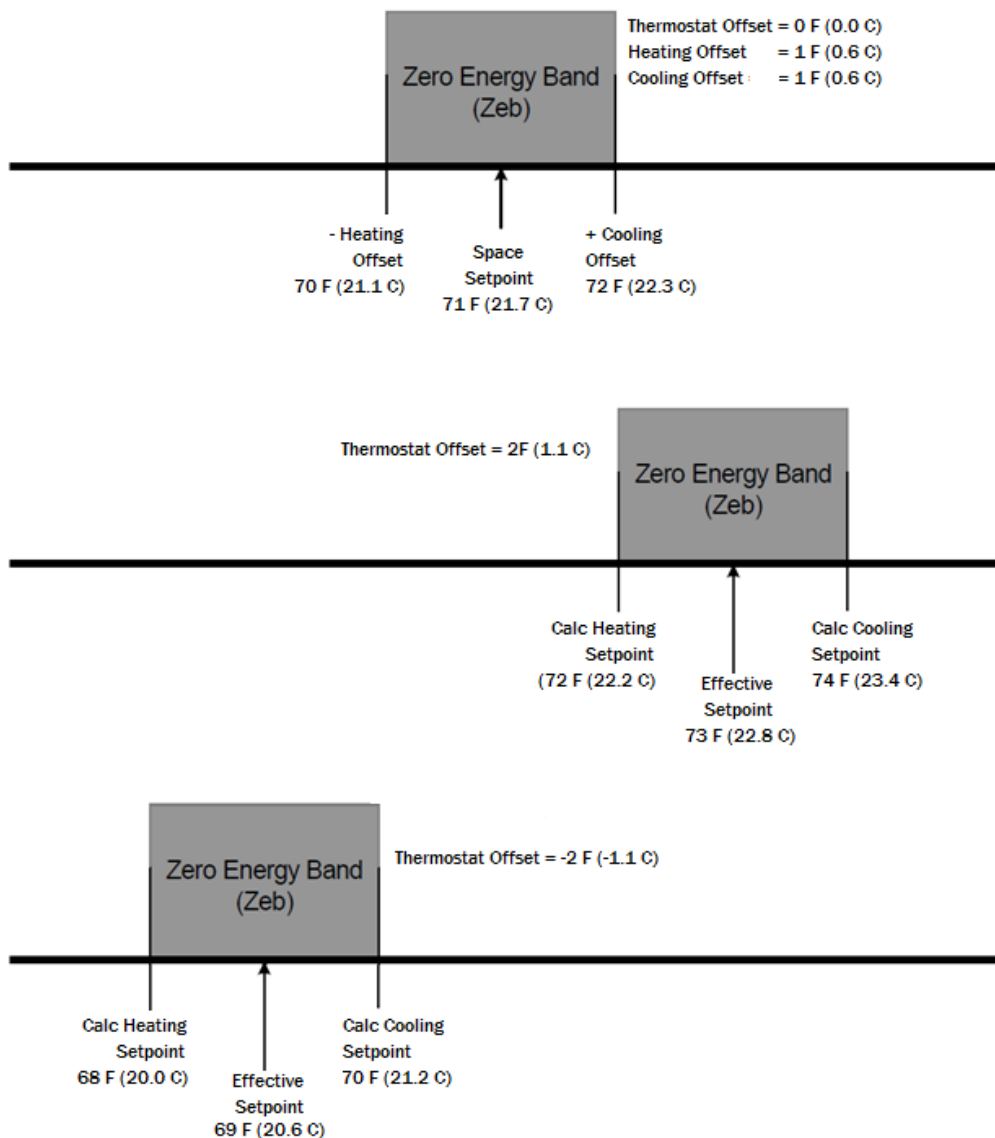
The heating and cooling setpoints for the occupied periods are programmable offsets from the space setpoint. The zero energy band (zeb) is the band between the heating and cooling setpoints where there is no heating or cooling demand.

The effective setpoint is a calculated value based on the space setpoint and the thermostat setpoint offset value. The thermostat setpoint offset is used to increase or decrease the space setpoint from the local thermostat in occupied mode only. The thermostat setpoint offset is limited to plus or minus the programmed setpoint adjustment limit. The thermostat setpoint offset affects the calculated heating and calculated cooling setpoints by an equal amount.

NOTE: The actual programmed heating and cooling setpoints are not changed by the thermostat setpoint offset; the offset is simply added to the programmed setpoints to derive the calculated values.

$$\begin{aligned} \text{CoolingSP} &= \text{SpaceSP} + \text{CoolingOffset} \\ \text{HeatingSP} &= \text{SpaceSp} - \text{HeatingOffset} \\ \text{ZebOcc} &= \text{CoolingSp} - \text{HeatingSp} \\ \text{EffectiveSetPoint} &= \text{SpaceSp} \pm \text{ThermostatSpOffset} \\ \text{CalcCoolingSp} &= \text{CoolingSp} \pm \text{ThermostatSpOffset} \\ \text{CalcHeatingSp} &= \text{HeatingSp} \pm \text{ThermostatSpOffset} \end{aligned}$$

Figure 8: Setpoint Adjustment (Occupied Mode)



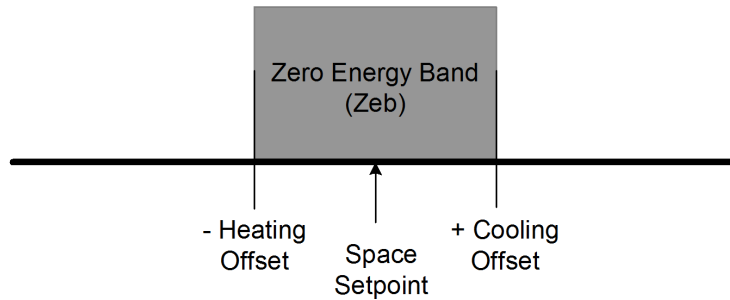
Setpoints in Unoccupied Mode

The heating and cooling setpoints for the unoccupied periods are directly programmable; they are not programmed as offsets. The zero energy band (ZEB) for unoccupied mode is calculated as the cooling setpoint minus the heating setpoint. The space setpoint for unoccupied mode can be calculated as the temperature that is halfway between the cooling setpoint and the heating setpoint, or midway into the zero energy band.

$$ZebUnocc = CoolingSp - HeatingSetPoint$$

$$SpaceSp = HeatingSp + ZebUnocc/2$$

Figure 9: Setpoint Adjustment (Unoccupied Mode)



Supply Water Setpoint Operation

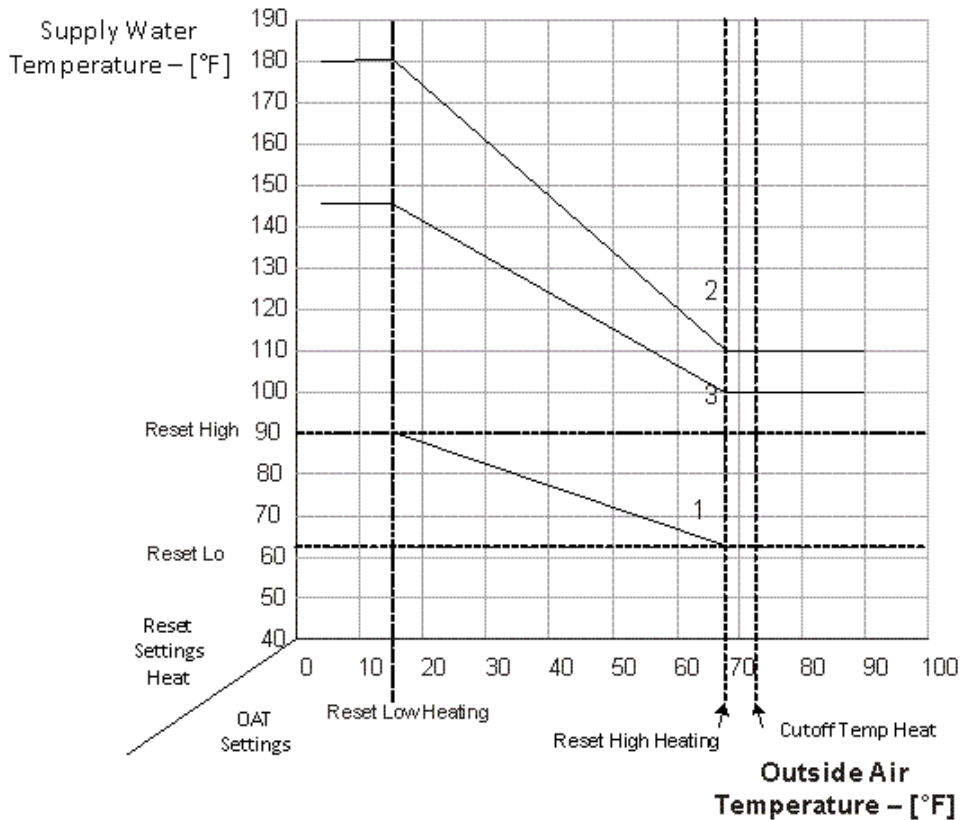
The Setpoint for the PI Loop is calculated as an Outdoor Reset Temperature.

Heating or Winter Mode

The loop control setpoint is determined by the loop reset curve, which compensates for changes in the heating load caused by varying outdoor air temperature (OAT).

An example is shown in Figure 10. As the Outside Air Temperature decreases, the loop supply setpoint is increased to compensate for the greater heating load. The slope of the loop reset curve is determined by the High and Low points of the reset curve for heating found in Reset Settings Heat. *OAT Settings : Reset Low* is the outdoor design heating temperature at which the Setpoint is Reset High, the highest temperature required in the loop for space heating. The lower end of the reset curve is defined by the Reset Low setpoint. The value of *OAT Settings : Cutoff Temp Heat* 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 Settings : ChangeOver* 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 and extra heating requirements. The *OAT Settings : Heating Cutoff* is subject to a 1 °F (0.55 °C) hysteresis.

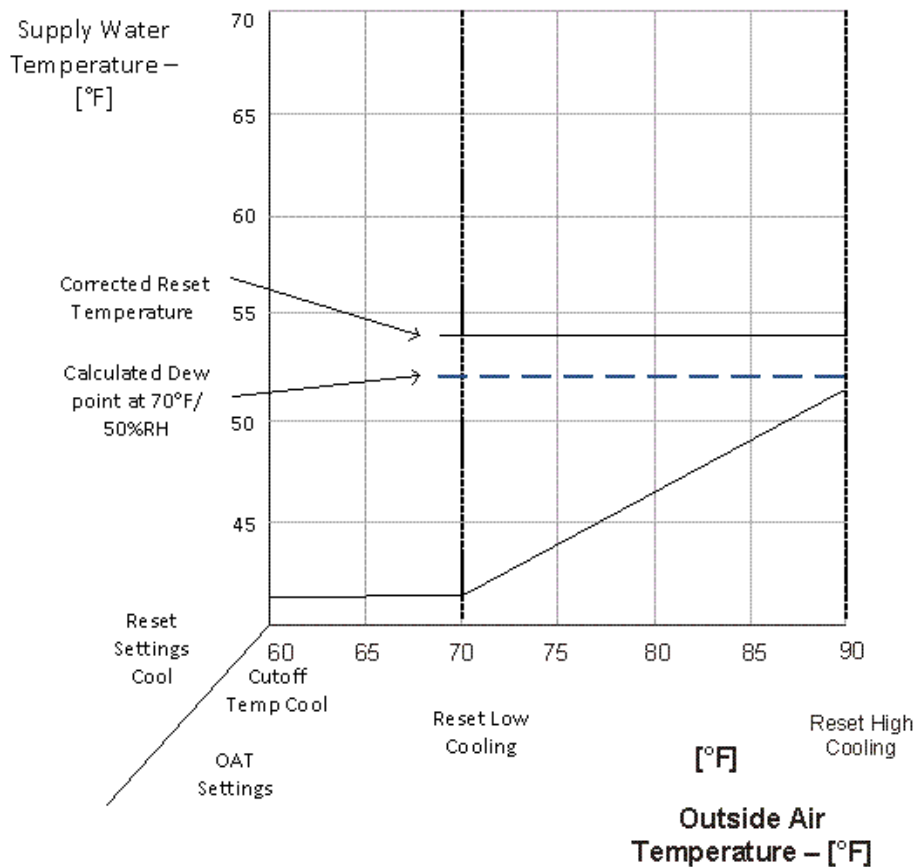
Figure 10: Outside Air Temp Reset Curve; Heating Season - Winter



Cooling or Summer Mode

In Cooling or Summer Mode the loop control setpoint is calculated in the same manner described for Heating or Winter Mode, except the Reset Curve for Cooling can have a different slope to accommodate the Humidity within the cooled environment (as shown in Figure 7). The Reset curve can be defined in *Reset Settings Cool*. The slope of the loop reset curve is determined by the *Reset High* and *Reset Low* of the reset curve for cooling found in *Reset Settings Cool*. The lower end of the reset curve is defined by the *Reset Low* setpoint and *OAT Settings : Reset High point*. The value of *OAT Settings : Cutoff Temp Cool* is the temperature below which space cooling demands are disabled.

Figure 11: Outside Air Temp Reset Curve; Heating Season - Summer



Dew Point Control

If *Reset Settings Cool : Enable DewPoint* is set to "On," the Dew Point Temperature is calculated and compared to the Supply Water Temperature. If the DewPoint Temperature is lower than the Supply Water Temperature, the *Eff Reset Setpoints* is adjusted by *DewPt Offset* to avoid dew point conditions.

In order to accurately calculate the dew point, the Stat needs to be equipped with a Humidity Sensor (TS302 or TS304). To compensate for humidity changes in the supply air coming from a DOA, an additional set of sensors can be placed. A Precon III Duct probe can be wired into the SAT input and a humidity sensor can be wired into the DRH input. Both sensor readings are used to calculate the correct dew point of the supply air. The controller calculates two dew points, one for the room and one for the duct. Whichever dew point is higher serves as a base dew point for the setpoint calculation.

A simplified formula for calculating dew point is:

$$DewPtTemp = DryBulbTemp - 9(100 - RH)/25$$

Rule of Thumb: For example, a relative humidity of 100% means dew point is the same as air temp. For 90% RH, dew point is 3 °F lower than air temperature. For every 10 percent lower Relative Humidity, dew point drops 3 °F.

Cooling Control

The calculated cooling loop setpoint is derived from the calculated cooling setpoint and the loop proportional gain:

$$\text{CalcCoolingLoopSp} = \text{CalcCoolingSp} + 1/(2Kp)$$

The analog cooling output is modulated by a Proportional + Integral (P+I) control loop based on the cooling loop setpoint and space temperature. The P+I control loop will modulate the output to maintain a constant space temperature. As the temperature increases above the cooling loop setpoint, the output is modulated higher. As the temperature decreases below the cooling loop setpoint, the output is modulated lower. When unoccupied mode is entered, the cooling setpoint is set up through a separate unoccupied cooling setpoint.

To prevent the integral component from becoming too large, there is anti-wind up reset protection. 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:

$$Kp = \text{Proportional Gain}$$

$$Ki = \text{Integral Gain}$$

$$\text{Error} = \text{SpaceTemp} - \text{CoolingLoopSp}$$

$$I = I + (Ki \times \text{Error})$$

$$\text{CoolOutput} = (Kp \times (\text{Error} + I)) + 50.00\%$$

Heating Control

The calculated heating loop setpoint is derived from the heating setpoint and the loop proportional gain:

$$\text{CalcHeatingLoopSp} = \text{CalcHeatingSp} - 1/(2Kp)$$

The analog heating output is modulated by a Proportional + Integral (P+I) control loop based on the heating loop setpoint and the space temperature. The P+I control loop will modulate the pump or valve to maintain a constant space temperature. As the temperature decreases below the heating loop setpoint, the output is modulated higher. As the temperature increases above the heating loop setpoint, the output is modulated lower. When unoccupied mode is entered, the heating loop setpoint is set back through a separate unoccupied heating setpoint.

To prevent the integral component from becoming too large, there is anti-wind up reset protection. 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:

$$Kp = \text{Proportional Gain}$$

$$Ki = \text{Integral Gain}$$

$$\text{Error} = \text{HeatingLoopSp} - \text{SpaceTemp}$$

$$I = I + (Ki \times \text{Error})$$

$$\text{HeatOutput} = (Kp \times (\text{Error} + I)) + 50.00\%$$

Staged Configuration

The controller can be configured for staging without modulation, stage 1 modulating or stage 2 modulating. Two stages for heating and two stages for cooling are available. The stages are sequenced based on the air temperature and air temperature setpoint.

Staging

When the air temperature rises above the cooling setpoint plus the control band, the first cooling stage is turned on. If the temperature remains above the control band for an additional configurable time period, *Stage Time*, the second stage is turned on. If the temperature falls below the control band, the second stage is not turned on. If the temperature falls below the setpoint, all cooling stages are turned off immediately.

When the air temperature falls below the heating setpoint minus the control band, the first heating stage is turned on. If the temperature remains below the control band for an additional configurable time period, the second stage is turned on. If the temperature rises above the control band, the second stage is not turned on. If the temperature rises above the setpoint, all heating stages are turned off immediately.

Staging with one modulating stage

When the *Staged Cooling : Modulating Stage* parameter is set to "Stage 1 Mod" or "Stage 2 Mod" the controller will modulate a 0-10V output in addition to the stage selected for modulation.

If Stage 1 was selected, the condition for changing to stage 2 changes from *Stage Time* to *Stage Modulation*. When the first stage turns on, the digital output is set and the modulating output ramps up. When the modulation reaches the value set in *Stage Modulation*, the second stage is turned on.

If Stage 2 is selected for Modulation, the *Stage Timer* is set to *Stage Time* and counted down. If the *Stage Timer* reaches 0, the second stage is turned on and starts modulating.

Modulated Configuration

Analog outputs may be used for modulating pumps or valves. Modulated outputs also have a corresponding digital output (enable) that is energized whenever the analog output is greater than zero.

Dehumidification

If the CHB2 Dew Point control is enabled and the supply temperature reaches the Dew Point, the Supply Water Temperature gets raised by a configurable offset above the Dew Point and a digital output gets turned on to signal to an external device the demand for Dehumidification.

Energy and Volume Monitoring

The CHB2 can monitor supply, return and flow of both hot and cold water. By default, *BTU Enable* is set to "Off" and the temperature sensors for the supply water temperature, *STemp Sensor*, and return water temperature, *RTemp Sensor*, in the *Heat/Cool Zone Settings* structure are set to "Precon III."

To enable BTU and Flow calculation and monitoring, the parameter *BTU Enable* must be set to "On."

From the supply, return and flow values, energy and volumetric information can be made available.

The controller reads the temperature and flow sensors once per second; the values are made available for the energy calculation.

Water Temperature Sensors

The water temperature sensor inputs can be configured for Precon III or Precon II type sensors. The controller reads the temperature sensors once per second; the values are made available for the energy calculation. The most common installation option is to install the sensor in the Supply Water position. For greatest accuracy in temperature readings and BTU measurement, use Precon sensors for both supply and return temperatures.

Water Flow Sensors

The flow sensor inputs are 0 to 10 Volt scaled inputs from VFS devices. Every second, the controller reads the flow sensors; the flow value is made available for the energy calculation.

Under normal circumstances, the flow sensor should be installed in the supply water pipe. For difficult installations, the position of the flow sensor can be configured for the return water pipe.

Energy and Consumption Monitoring

The CHB2 monitors the supply and return temperatures and the flow of water through the fan coil subsystem. The values are measured every second and an average is calculated every minute. The CHB2 calculates:

- energy rate value (BTU/Hr),
- volume rate (GPM),
- daily total heat consumption (BTU),
- grand total heat consumption (BTU),
- daily total volume,
- grand total volume (GAL).

The CHB2 uses the following formula to calculate the rate of heat energy flow:

$$q = (8.01 \times \rho \times cp) \times f \times (dT)$$

Where:

- q = the rate of heat energy flow (BTU/hr)
- rho = density (lb/ft³)
- cp = specific heat (Btu/lb/°F)
- f = flow rate (gpm)
- dT = temperature change of fluid (°F)
- 8.01 = units conversion factor

Fan Operation

The operation of the fan depends on the occupied state, the configured fan type, the demand (including dehumidification and IAQ conditions) and the configured fan speed.

The fan speed options are *Speed 1*, *Speed 2*, *Speed 3*, *Auto Speed*. The speeds refer to the three digital outputs that control the fan; *Auto Speed* directs the CHB2 to choose the speed (limited to *Fan Speed Count*) based on the demand.

In addition to the fan operation described here, fan outputs may be overridden during commissioning or by a LON network manager through the use of the nviOutOverride SNVT (see section 9).

Indoor Air Quality

An indoor air quality (IAQ) input is provided. The IAQ sensor can be a digital sensor providing an on/off signal or a configurable analog sensor.

Set up of the digital sensor requires only the *Delay* and *Temperature Reset* settings to be configured. An IAQ condition is said to exist if the digital IAQ input is *On*.

Set up of the analog sensor requires the settings *Deadband*, *Temperature Reset*, *Delay*, *Min*, *Max*, *Setpoint*, and *Offset* to be configured. An IAQ condition is said to exist if the analog IAQ sensor input exceeds the configured setpoint.

When an IAQ condition exists, the supply air fan is energized and the damper is opened immediately to supply fresh air to the space. The *Delay* setting determines the time delay to wait before signaling an IAQ Alarm. This delay affects the Alarm only; the fan and damper will operate without delay.

The controller has a temperature reset function for IAQ alarm operation. The temperature reset function allows the space temperature to rise above or drop below the calculated control setpoints by a configurable amount. This feature allows time for indoor air quality to improve. During IAQ Alarm operation, if the space temperature rises above or drops below the temperature reset limit, the controller will resume normal economizer control to maintain a comfort space temperature. Once the space temperature is brought within the calculated setpoints and an IAQ Alarm condition still exists, the controller will resume the IAQ mode of operation.

Thermostat

The space temperature value, setpoint adjustment, fan auto/on status (depending on the thermostat model), and occupancy override request are monitored by the thermostat and sent to the controller.

The controller will automatically detect a failure of the thermostat. When the thermostat fails, the valves will close, the fan will turn off, and control is disabled.

NOTE: The thermostat must be connected. The status LED on the controller will blink red if the thermostat is not connected. Once the controller begins receiving temperature data the status LED will turn green indicating normal operation.

When the thermostat is put into occupied mode for the purpose of changing the temperature setpoint settings, the amount of extended occupancy is accumulated. The extended occupancy time is accumulated in minutes and can be viewed from the LCI under *Thermostat Settings*. The extended occupancy time is backed up to non-volatile memory at 11:00 pm. The user can clear the accumulated extended occupancy from the LCI.

Local Backup Schedules

The LCI normally determines the operating mode. Local weekday and weekend backup schedules for situations when the LCI is not available may be configured. When the controller detects that the LCI is not available (after 10 minutes without communication), it resorts to the local backup schedules. If the local backup schedules are disabled, the controller defaults to the occupied mode.

Occupied and Unoccupied times determine the operating mode of the controller when it is running a backup schedule. By default, both the unoccupied and occupied times are set to zero, which disables the local backup schedule which causes the controller to default to the occupied mode of operation if it cannot communicate with the LCI.

Runtime Accumulations

The total runtime is accumulated for the heating, cooling, and fan outputs. The runtimes can be used to indicate that maintenance is required on the equipment controlled by these outputs. The runtime can be reset by an operator or maintenance person once servicing has been performed.

Commissioning

The CHB2 provides the ability to override normal operation through the LCI using the Commissioning mode. The Commissioning mode is accessed using the *Commissioning Mode* configuration structure.

When Commissioning mode is enabled, values in the Commissioning structure are used for outputs.

Commissioning Fan Outputs

The choices for fan outputs are:

Off: All fan outputs (FAN1, FAN2, FAN3) are de-energized.

Speed 1, 2, 3: The corresponding fan output (FAN1, FAN2 or FAN3) is energized.

Commissioning Cool and Heat Stages

There are two additional fields for *Heat Stage* and *Cool Stage*. These correspond to the digital outputs for cold and hot (C1,C2 and H1,H2). The output which number is placed into the field will be turned on. Setting the field to zero turns the output off.

Commissioning Cool and Heat Modulation

There are two additional fields for *Cool Modulation* and *Heat Modulation*. These correspond to the modulated outputs for cold and hot (CMOD and HMOD). Percentage values placed in these fields will be reflected on these analog outputs.

Commissioning Cool and Heat Injection

There are two additional fields for *Heat Injection* and *Cool Injection*. These correspond to the modulated outputs for cold and hot (HINJ and CINJ). Percentage values placed in these fields will be reflected on these analog outputs.

Alarms and Events

The controller will detect certain alarm conditions and send them to the LCI. The LCI must be used to configure the controller before this can occur.

Thermostat Failure

The controller automatically detects the presence of the local thermostat and monitors its status. If the thermostat fails to communicate with the controller, a Thermostat Failed Alarm is generated and the controller's status LED will turn red.

Maintenance Alarm

The controller provides a single programmable runtime limit for generating a runtime Maintenance Alarm. When the fan runtime exceeds this limit, a Maintenance Alarm is sent to the LCI.

Indoor Air Quality Alarm

The controller generates an IAQ alarm when the IAQ sensor detects inadequate indoor air quality.

Space Temperature Alarms

The controller generates high and low limit alarms for the space temperature. A programmable space temperature alarm limit offset may be configured. The temperature limits are calculated based on the control setpoints, alarm limit offset, and control band:

$$HighLimit = CalcCoolingSp + AlarmLimitOffset + CoolBand$$

$$LowLimit = CalcHeatingSp - AlarmLimitOffset - HeatBand$$

When the measured space temperature exceeds the high limit, a high limit alarm (Space Temperature High Limit Alarm) is generated. When the space temperature drops below the low limit, a low limit alarm is generated (Space Temperature Low Limit Alarm).

A return to normal alarm is generated when the space temperature is between the high and low limit (Space Temperature Return to Normal). To reduce / eliminate nuisance alarms, space temperature alarms are not reported for 30 minutes following after the controller switches between the unoccupied and occupied modes of operation.

Automatic Configuration

The CHB2 and 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 controller when the controller's service pin is pressed.

The controller's status light flashes green until the controller is configured and is 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.

The LCI also provides network supervision of the controller. The LCI periodically sends a "ping" message to the controller 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

Networking

The Controller can be used in conjunction with a BLM-series, HPM-series, and a CCU-series controller. The Network needs to be configured to associate the appropriate Boiler/Chiller and Chilled Beam Ceiling Controllers. This is accomplished by selecting the Master (Boiler/Chiller) controller and enabling the CHB2s found under the "Members" button.

CONTROLLER IDENTIFICATION

Once the CHB2 is properly installed and recognized by the 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 CHB2, 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 CHB2 allows a network manager to write to Network Input Variables for the purpose of overriding the configuration, operation and outputs of the CHB2. The variables are listed below and in Table 1 on page 27.

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

- *nviSpaceTemp* overrides the space temperature as obtained from the thermostat, sensor, or ASM module and is used by the controller for temperature control. Writing to this variable will also be reflected in the controller's output of the space temperature as displayed on the LCI.
- *nviSpaceHumidity* overrides the space humidity as obtained from the thermostat, sensor, or ASM module and is used by the controller for dehumidification control. Writing to this variable will also be reflected in the controller's output of the space temperature as displayed on the LCI.
- *nviSetpoint* overrides the setpoint as obtained from the thermostat, the LCI or from a pre-configured schedule. Writing to this variable will also be reflected in the controller's output of the effective setpoint as displayed on the LCI.
- *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 in Table 4 that overrides the hardware digital and analog outputs on the CHB2. 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.
- *nviApplicMode* is the Application Mode set by a supervisor. The Application will recognize HVAC_AUTO, HVAC_HEAT and HVAC_COOL and will disregard any other supervisor setting.
- *nviOAT* is the Outdoor Air Temperature measured somewhere else and transmitted to the CHB2 from a Supervisor like the LCI or a JENE.

NOTE: the CHB2 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.

Table 1: Network Variable Inputs (NVIs)

Internal Variable Name	Format	Range	Description
nviSpaceTemp	SNVT_temp_p	7 to 122°F (10 to 50°C)	Space temperature
nviSpaceHumidity	SNVT_lev_percent	0 to 100 percent	Space humidity
nviSetpoint	SNVT_temp_p	50 to 95°F (10 to 35°C)	Setpoint
nviOccCmd	SNVT_occupancy	0=Occupied 1=Unoccupied 2=Bypass 3=Standby -1=Nul	Occupancy Command

Internal Variable Name	Format	Range	Description
nviResetRuntime	SNVT_lev_disc	0=no reset 1=reset runtimes	Resets fan, heating, and cooling runtimes
nviSysTime	SNVT_time_stamp	Date/Time	System time
nviOutOverride	See Table 4	Structure	Output override
nviApplicMode	SNVT_hvac_mode	0=HVAC_AUTO, HVAC_HEAT, HVAC_COOL	ApplicationMode set by the supervisor. Overrides all internal settings.
nviOAT	SNVT_temp_p	-30 to 230°F (-34 to 110°C)	Outside air temperature
nviSATemp	SNVT_temp_p	-273 to 327°F (-169.4 to 163.9°C)	Supply Air Temperature
nviSARH	SNVT_lev_percent	0 to 100 %	Supply Air Humidity
nviZoneMode[0]	SNVT_hvac_mode	HVAC_AUTO, HVAC_HEAT, HVAC_COOL	HVAC mode for the Heat Loop
nviZoneMode[1]	SNVT_hvac_mode	HVAC_AUTO, HVAC_HEAT, HVAC_COOL	HVAC mode for the Cool Loop

Table 2: Output Override Structure (NVI)

Setting	Type/Range	Default	Description
digOut[8]	Unsigned Byte: 0=OFF 1=ON 0xFF=no override	0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF	digOut[0] = TO1 (pin 31) CS1 digOut[1] = TO2 (pin 29) CS2 digOut[2] = TO3 (pin 28) HS1 digOut[3] = TO4 (pin 26) HS2 digOut[4] = TO5 (pin 25) FAN1 digOut[5] = TO6 (pin 23) FAN2 digOut[6] = TO7 (pin 22) FAN3 digOut[7] = TO8 (pin 20) unassigned
aOut[4]	SNVT_lev_percent: 0% to 100% P_INVALID=no override	P_INVALID P_INVALID P_INVALID P_INVALID	aOut[0] = AO 0 (pin 37) HMOD aOut[1] = AO 1 (pin 35) CMOD aOut[2] = AO 2 (pin 34) FAN aOut[3] = AO 3 (pin 32) DMP
fpOut[4]	SNVT_lev_percent: 0% to 100% P_INVALID=no override	P_INVALID P_INVALID P_INVALID P_INVALID	fpOut[0] = TO1=FSP Op, TO2=FSP CI fpOut[1] = TO3=FSP Op, TO4=FSP CI fpOut[2] = not available fpOut[3] = not available

Inputs

Network Variable Outputs (NVOs) are parameters set by the controller to pass data to another device or network controller. The "output" nature of these variables refers to the fact that the data is sent out from the controller. Data is representing controller inputs or derived (calculated) values in the LCI.

Table 3: Inputs

Input	Range	Description
Outside Temp	-29 to 230°F (-34 to 110 °C)	Temperature reported by the OAT sensor.
Space Humidity	0 to 100%	(1% = 200) - Input from the thermostat
Space Temperature	-29 to 230°F (-34 to 110°C)	Input from the thermostat or network
Space DewPt Temp	-29 to 230°F (-34 to 110°C)	Calculated dew point temperature
IAQ	0 to 4000 ppm	Reading of the indoor air quality sensor when configured for analog input. This represents a hardware input.
Heating Loop	Structure	Heating Loop Sensor Readings
Cooling Loop	Structure	Cooling Loop Sensor Readings
Supply Air Temp	-29 to 230°F (-34 to 110°C)	Supply Air Temperature
Duct RH	0 to 100%	The Duct RH is used to measure the RH within the duct, allowing the dew point of the supply air to be calculated. Note: The SAT sensor must be populated.
IAQ	0 to 4000 ppm	Reading of the indoor air quality sensor when configured for analog input. This is a hardware input.
Occupancy Mode	Occupied, Unoccupied, Bypass	This is a calculated value.
Input Status	Structure	Lists all digital inputs (see table below)

Table 4: Heating/Cooling Loop Sensor Readings

Setting	Range	Description
Mode	Auto, Heat, Cool	Current Mode of the Loop
Supply Temp	-29 to 230°F (-34 to 110°C)	Supply Temp of the Loop
Return Temp	-29 to 230°F (-34 to 110°C)	Return Temp of the Loop
Flow Rate	0-3.4e38 GPM	Current Flow Rate
Energy Rate	0-3.4e35 KBTU/hr	Current Energy Rate

Table 5: Input Status

Setting	Range	Description
Occupancy Sensor	Off, On	Occupancy Sensor (OCC)
Indoor Air Quality	Normal, Alarm	Indoor Air Quality Alarm
Space Demand	Off, On	Calculated Demand for Space Control
Reset Demand	Off, On	Calculated Demand for Injection
Cutoff Heat	Off, On	WWSD or OAT Cutoff for heating
Cutoff Cool	Off, On	OAT Cutoff for cooling

Setting	Range	Description
BlrProtection	Off, On	Boiler Protection
Heat Stage Enabled	Off, On	Value is "True" if at least one stage is enabled
Heat Mod Enabled	Off, On	Value is "True" if one stage is configured to be modulating and the modulating output is active
Heat Inj Enabled	Off, On	Value is "True" if there is a demand and Injection control is active
Cool Stage Enabled	Off, On	Value is "True" if at least one stage is enabled
Cool Mod Enabled	Off, On	Value is "True" if one stage is configured to be modulating and the modulating output is active
Cool Inj Enabled	Off, On	Value is "True" if there is a demand and Injection control is active

Outputs

Network Variable Outputs (NVOs) are parameters set by the controller to pass data to another device or network controller. The "output" nature of these variables refers to the fact that the data is sent out from the controller. Data is representing controller outputs or derived (calculated) values in the LCI.

Table 6: Outputs

Output	Range	Description
Unit Status	Structure as defined in a following table	HVAC mode, alarm state, heating, cooling and fan outputs
Output Status	Structure as defined in a following table	Status of all the digital outputs.
Application Mode	0=Auto 1=Heat 3=Cool 6=Off	Application mode where Heat is "Winter Season" and Cool is "Summer Season".
Effective Setpoint	-29 to 230°F (-34 to 110°C)	Effective Setpoint. This value represents user input from various sources.
Eff ResetSetpt	-29 to 230°F (-34 to 110°C)	Effective Setpoint for the supply water temperature, calculated with the reset curve values
Heat Loop Data	Structure	BTU Meter Values for heating. These are calculated values.
Cool Loop Data	Structure	BTU Meter Values for cooling. These are calculated values.
Runtimes	Structure	Runtime structure

Table 7: Unit Status Structure

Output	Range	Description
Mode	0=Auto 1=Heat 3=Cool 9=Fan Only	HVAC mode of operation. This parameter provides real-time status of what the controller is actually doing
Heat Output	0 to 100%	Current Heat Output
Heat Inj Output	0 to 100%	Heat Output for LowFlow Injection Circulator
Cool Output	0 to 100%	Current Cool Output
Cool Inj Output	0 to 100%	Cool Output for LowFlow Injection Circulator
Fan Output	0 to 100%	Current Fan Output
In Alarm?	No, Yes	Is the unit in an alarm state?

Table 8: Output Status

Output	Range	Description
C1	Off, On	Cooling Stage 1
C2	Off, On	Cooling Stage 2
H1	Off, On	Heating Stage 1
H2	Off, On	Heating Stage 2
FAN1	Off, On	Fan Speed 1
FAN2	Off, On	Fan Speed 2
FAN3	Off, On	Fan Speed 3
Dehumid	Off, On	Dehumidification signal for third party dehumidifier

Table 9: Heat/Cool Loop Data (NVO)

Output	Range	Description
Daily Heating BTUs	0-3.4e35 KBTU	Reports BTUs used for Heating for the current day up to this minute
Life Heating BTUs	0-3.4e35 KBTU	Reports the BTUs for Heating since last reset
Daily Cooling BTUs	0-3.4e35 KBTU	Reports BTUs used for Cooling for the current day up to this minute
Life Cooling BTUs	0-3.4e35 KBTU	Reports the BTUs for Cooling since last reset
Daily Volume	0-3.4e38 G	Reports the Volume used for the current day up to this minute
Life Volume	0-3.4e38 G	Reports the Volume used since last reset

Table 10: Runtimes (NVO)

Output	Range	Description
Heating Runtime	0 to 65,535 hours	Runtime of the heating coil since last reset.
Cooling Runtime	0 to 65,535 hours	Runtime of the cooling coil since last reset.
Fan Runtime	0 to 65,535 hours	Runtime of the fan since last reset.

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. Some parameters (defaulted as Structure) will be described in individual tables below.

Setting	Range	Default	Description
Thermostat	Structure	N/A	Thermostat settings
Setpoints	Structure	N/A	Setpoint settings
Operating Mode	Auto, Winter, Summer	Auto	HVAC mode setting. When set to Auto, the controller determines the mode. In Summer mode only cooling is allowed, and in Winter mode, the controller observes only calls for 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

Setting	Range	Default	Description
Modulated Heating	Structure	N/A	Modulated Heating Settings
Fan Type	On, Auto	Auto	Fan Type
Fan Speed	Not used, Speed 1, Speed 2, Speed 3, Auto 1-3	Not used	Fan Speeds. "Not used" indicates that the system is ventilated by a DOAS or ERV. All other settings indicate an internal fan.
OAT Settings	Structure	N/A	Outside Air settings for reset curve
Reset Settings Heat	Structure	N/A	Supply water temperature settings for reset curve heating calculation
Reset Settings Cool	Structure		Supply water temperature settings for reset curve cooling calculation
Cool Inj Settings	Structure		Settings for the injection loop for the Low Flow cooling circulator
Heat Inj Settings	Structure		Settings for the injection loop for the Low Flow heating circulator
Runtime Limits	Structure		Runtimes for heating, cooling, fan
IAQ Mode	Digital, Analog	Digital	IAQ Mode configurable for digital or analog operation
IAQ Settings	Structure	N/A	IAQ settings for Setpoint, Deadband, and Temperature limits
IAQ Sensor	Structure	N/A	Settings for the IAQ sensor in analog mode
BTU Enable	Off, On	Off	Enables BTU calculations and logging
Heat Loop Settings	Structure		Heating Coil BTU meter settings
Cool Loop Settings	Structure		Cooling Coil BTU meter settings
Commissioning	Structure	N/A	Commissioning Overrides of CHB2's Outputs
Alarm Temp Offset	0 to 10°F (0 to 5.56°C)	5°F (2.66°C)	Temperature Offset before an alarm is generated
Alarm Enabled	No, Yes	No	Enables alarming
Backup Occ Time	24 hour	N/A	Backup Occupied time
Backup Uncc Time	24 hour	N/A	Backup Unoccupied time

Thermostat

This screen displays CHB2 settings related to this topic and allows access to all of these settings from a single screen.

Setting	Range	Default	Description
Type	SLink, Not Used	SLink	Thermostat Type
Occupancy extension	0 to 1000	60 min	Occupancy Extension (min)
Alarm temp offset	0 to 10°F (0 to 5.56°C)	5°F (2.66°C)	Space temperature alarm limit offset
Temperature offset	-10 to 10°F (-5.56 to 5.56°C)	0°F (0°C)	Space temperature offset
Ext Occ Accumulated			Accumulated extended occupancy time in hours - read from thermostat

Setpoints

This screen displays CHB2 settings related to this topic and allows access to all of these settings from a single screen.

Setting	Range	Default	Description
Setpoint	50 to 95 °F (10 to 35 °C)	71 °F (21.2 °C)	Setpoint for occupied time periods
Cooling offset	0 to 10°F (0 to 5.56°C)	1°F (0.6°C)	This value is added to Setpoint to calculate the cooling setpoint
Heating offset	0 to 10°F (0 to 5.56°C)	1°F (0.6°C)	This value is subtracted from Setpoint to calculate the heating setpoint
SP adjust limit	0 to 10°F (0 to 5.56°C)	2°F (1.2°C)	Maximum setpoint adjustment allowed during occupied periods
Unocc cooling	50 to 95 °F (10 to 35 °C)	82 °F (27.7 °C)	Cooling setpoint for unoccupied time periods
Unocc heating	50 to 95 °F (10 to 35 °C)	60 °F (15.5 °C)	Heating setpoint for unoccupied time periods

Staged Heating/Cooling

This screen displays CHB2 settings related to this topic and allows access to all of these settings from a single screen.

Setting	Range	Default	Description
Stages	0 to 2	1	Number of Stages controlled. Set to zero to disable staged heating or cooling
Control Band	0 to 10.0 °F (0 to 5.55°C)	1.0 °F (0.55 °C)	Value used to modify the calculated setpoints to form the temperature range in which local heating or cooling is enabled
Stage Time	0 to 255 minutes	5 minutes	The rate at which successive stages are sequenced
Stage Modulation	0 to 100%	90%	Percentage value, when the next stage gets turned on. This applies only if configured for Modulating stage = "Stage 1 Mod."
Modulating Stage	No Mod Stage, Stage 1 Mod, Stage 2 Mod	No Mod Stage	Determines which outputs are activated when a demand comes in. <i>No Mod Stage</i> defines pure staging. <i>Stage 1 Mod</i> or <i>Stage 2 Mod</i> define a mixed scenario, where one of the stages also drives an analog output.

Modulated Heating/Cooling

This screen displays CHB2 settings related to this topic and allows access to all of these settings from a single screen.

Setting	Range	Default	Description
Gain	-4 to 5	0	Speed - index into array of Kp and Ki control constants
On	0.00 to 100.00%	38.0%	Minimum output to turn on
Ramp up	0.00 to 20.00%	1.0%	Ramp up percent per second
Ramp down	0.00 to 20.00%	0.5%	Ramp down percent per second
Out min	0.0 to 10.0 Volts	0.0 Volts	Maximum output voltage for modulation
Out max	0.0 to 10.0 Volts	10.0 Volts	Maximum output voltage for modulation. If set to 0, Modulation is disabled.

OAT Settings

This screen displays CHB2 settings related to this topic and allows access to all of these settings from a single screen.

Setting	Range	Default	Description
Reset Low Heating	-31.9 to 50 °F (-34.5 to 10.0 °C)	15 °F (-9.4 °C)	Reset Temp Low in Heating Mode
Reset High Heating	41 to 122.0 °F (5 to 50 °C)	64 °F (17.7 °C)	Reset Temp High in Heating Mode
Cutoff Temp Heat	41 to 122.0 °F (5 to 50 °C)	90 °F (17.7 °C)	Cutoff Temperature when Heating gets deactivated
Reset Low Cooling	41 to 122.0 °F (5 to 50 °C)	66 °F (18.9 °C)	Reset Temp Low in Heating Mode
Reset High Cooling	41 to 122.0 °F (5 to 50 °C)	90 °F (32.2 °C)	Reset Temp High in Heating Mode
Cutoff Temp Cool	-4 to 122.0 °F (-20 to 50 °C)	46 °F (18.9 °C)	Cutoff Temperature when Heating gets deactivated. If set to -4 °F, the OATemp is ignored and cooling is enabled anytime.
Changeover	41 to 122.0 °F (5 to 50 °C)	65 °F (18.3 °C)	Temperature between heating and cooling
Offset	-10.0 to 10.0 °F (-5.6 to 5.6 °C)	0.0 °F (0.0 °C)	Offset for the OAT temperature sensor

Reset Settings Heat

This screen displays CHB2 settings related to this topic and allows access to all of these settings from a single screen.

Setting	Range	Default	Description
Reset Low	50 to 180 °F (10.0 to 82.2 °C)	95 °F (35.0 °C)	Reset Low Temperature for the supply water temperature for Heating
Reset High	50 to 180 °F (10.0 to 82.2 °C)	140.0 °F (60.0 °C)	Reset High Temperature for the supply water temperature for Heating
Boiler Pro	41 to 185 °F (5.0 to 85.0 °C)	42 °F (5.5 °C)	Boiler protection temperature

Reset Settings Cool

This screen displays CHB2 settings related to this topic and allows access to all of these settings from a single screen.

Setting	Range	Default	Description
Reset Low	50 to 180 °F (10.0 to 82.2 °C)	52.0 °F (11.1 °C)	Reset Low Temperature for the supply water temperature for Cooling
Reset High	50 to 180 °F (10.0 to 82.2 °C)	52.0 °F (11.1 °C)	Reset High Temperature for the supply water temperature for Cooling
Enable DewPt	Off, On	On	Dew Point control turned off or on
DewPt Offset	-10.0 to 10.0 °F (-5.6 to 5.6 °C)	5.0 °F (2.7 °C)	Offset that is added to the dewpoint and applied to the supply water temperature when the calculated supply water temperature is above dew point

Cool/Heat Inj Settings

This screen displays CHB2 settings related to this topic and allows access to all of these settings from a single screen.

Setting	Range	Default	Description
Gain	-4 to +5	-2	Spced - index into array of Kp and Ki control constants
On	0.00 to 100.00%	38.0%	Minimum output to turn on
Ramp up	0.00 to 20.00%	1.0%	Ramp up percent per second
Ramp down	0.00 to 20.00%	0.5%	Ramp down percent per second
Out min	0.0 to 10.0 Volts	0.0 Volts	Maximum output voltage for modulation
Out max	0.0 to 10.0 Volts	10.0 Volts	Maximum output voltage for modulation. If set to 0, Modulation is disabled.

Runtime Limits Settings

This screen displays CHB2 settings related to this topic and allows access to all of these settings from a single screen.

Setting	Range	Default	Description
Cooling	0 to 65535 hours	1,000 hours	Cooling coil runtime limit
Heating	0 to 65535 hours	1,000 hours	Heating coil runtime limit
Fan	0 to 65535 hours	1,000 hours	Fan runtime limit

IAQ Settings

This screen displays CHB2 settings related to this topic and allows access to all of these settings from a single screen.

Setting	Range	Default	Description
IAQ delay	0 to 1000 min	5 min	Delay after IAQ condition occurs before sending an alarm
Temp reset	0 to 15.0 °F (0 to 8.3 °C)	5 °F (2.8 °C)	To insure comfort temperature during IAQ alarm conditions
Deadband	0 to 400 ppm	100 ppm	Deadband around setpoint for hysteresis

IAQ Sensor

This screen displays CHB2 settings related to this topic and allows access to all of these settings from a single screen.

Setting	Range	Default	Description
Min	0 to 4000 ppm	0	Minimum of range
Max	0 to 4000 ppm	2000	Maximum of range
Setpoint	0 to 4000 ppm	1200	Setpoint
Offset	0 to 4000 ppm	0	Offset

Heat / Cool Loop Settings

This screen displays settings related to the heat zone or cool zone.

Settings	Range	Default	Description
Zone Type	BTU Zone, Flow only, Temp only, Disabled	BTU Zone	Determines, what Sensor readings are taken and what calculations are performed.
Zone Mode	Auto, Heat, Cool	Auto	HVAC mode can be set to Heat or Cool only. When set to Auto, the loop detects what mode it is currently in.
Meter Type	ACC-VFTS 4-1 (DN8) ACC-VFTS 10-1 (DN10) ACC-VFTS 20-1 (DN20) ACC-VFTS 40-1 (DN25) VFTS 1-20, VFTS 2-40, VFTS 5-100, VFTS 10-200, VFTS 20-400, Disable	VFTS 1-20	Flow Meter Type. If "Disable" is selected, BTU metering is disabled and supply and return temps are both read as indicated in the <i>Temp type</i> setting.
Media Ratio	100% WATER, EG-10 to EG-50 (in steps of 10%), PG-10 to PG-50 (in steps of 10%), TYCOFO_HTL	100% WATER	Water, or alcohol ratio.
Supply Sensor	Precon III, Precon II	Precon III	Temperature sensor used in the supply position. The default setting assumes NO BTU metering.
Return Sensor	Precon III, Precon II	Precon III	Temperature sensor used in the return position. The default setting assumes NO BTU metering.
Enable Logging	Off, On	Off	Determines if Logging is enabled
Reset Totals	No, Yes	No	When Reset is set to yes, the log is cleared and the momentary values are set to 0. The setting is then automatically set back to "No."

Commissioning

This screen displays settings that can be used during commissioning to override values from the system.

Setting	Range	Default	Description
Enable	Off On	On	Enable Commissioning
Fan speed	0=Not Used, 1=Speed 1, 2=Speed 2, 3=Speed 3	0=Not Used	Fan speed when commissioning. 0=Fan is Off. 1-3=Fan speed selected.
Heat Stage	0, 1, 2	0	Heat stage selected
Heat Modulation	0 to 100%	0%	Heat modulation analog output
Heat Injection	0 to 100%	0%	Heat injection analog output

Setting	Range	Default	Description
Cool Stage	0, 1, 2	0	Cool stage selected
Cool Modulation	0 to 100%	0%	Cool modulation analog output
Cool Injection	0 to 100%	0%	Cool injection analog output

Alarms

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

Alarm	Range	Alarm Trigger	Alarm Reset
Thermostat Failure	Normal, Alarm	Occurs when the thermostat fails to communicate with the controller for more than 10 minutes.	The alarm resets when communication is re-established.
Maintenance	Normal, Alarm	Occurs when the heat pump or circulator operating hours have exceeded their Runtime limit.	The CHB2 attempts to operate as normal during this alarm.
Indoor Air Quality (IAQ)	Normal, Alarm	IAQ condition has existed for a configurable period of time	The IAQ condition has cleared.
Space Temperature High Limit	Normal, Alarm	SpaceTemp >(CalcCoolingSp + CoolBand + AlarmLimitOffset)	Space temp returns back below the high limit.
Space Temperature Low Limit	Normal, Alarm	SpaceTemp <(CalcHeatingSp - HeatBand - AlarmLimitOffset)	Space temp returns back above the low limit.
Input 1 Short	Normal, Alarm	HW Supply Temp sensor input indicates a short circuit.	Equipment failure must be resolved.
Input 1 Open	Normal, Alarm	HW Supply Temp sensor input indicates an open circuit.	Equipment failure must be resolved.
Input 2 Short	Normal, Alarm	HW Flow sensor input indicates a short circuit.	Equipment failure must be resolved.
Input 2 Open	Normal, Alarm	HW Flow sensor input indicates an open circuit.	Equipment failure must be resolved.
Input 3 Short	Normal, Alarm	HW Return Temp sensor input indicates a short circuit.	Equipment failure must be resolved.
Input 3 Open	Normal, Alarm	HW Return Temp sensor input indicates an open circuit.	Equipment failure must be resolved.
Input 4 Short	Normal, Alarm	CW Supply Temp sensor input indicates a short circuit.	Equipment failure must be resolved.
Input 4 Open	Normal, Alarm	CW Supply Temp sensor input indicates an open circuit.	Equipment failure must be resolved.
Input 5 Short	Normal, Alarm	CW Flow sensor input indicates a short circuit.	Equipment failure must be resolved.
Input 5 Open	Normal, Alarm	CW Flow sensor input indicates an open circuit.	Equipment failure must be resolved.
Input 6 Short	Normal, Alarm	CW Return Temp sensor input indicates a short circuit.	Equipment failure must be resolved.
Input 6 Open	Normal, Alarm	CW Return Temp sensor input indicates an open circuit.	Equipment failure must be resolved.

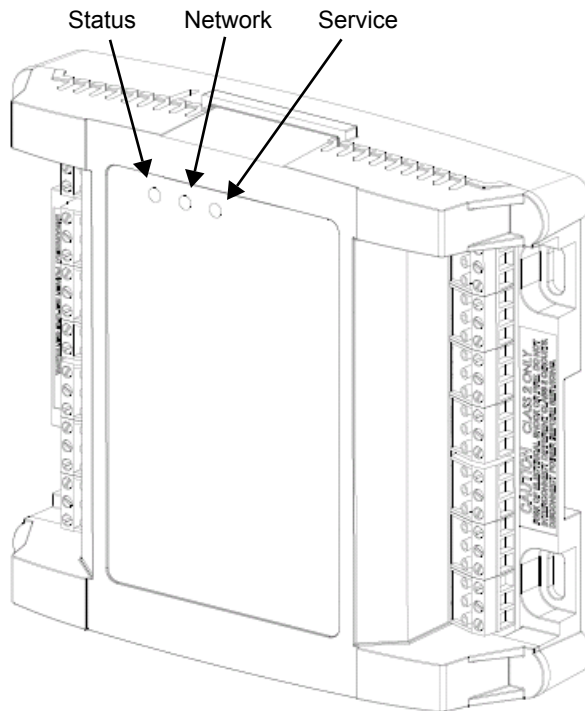
TROUBLESHOOTING

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	<ul style="list-style-type: none"> - Solid green when running and configured by an LCI (networking) - Flashing green when running and NOT configured by an LCI (stand-alone) - Solid red when a fault condition exists (control shut down) - Blinking Red - the controller has a device failure - Solid Amber - The controller has not received a LCI ping message in over 10 minutes and is part of a network.
Network	<ul style="list-style-type: none"> - 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
Service	<ul style="list-style-type: none"> - Illuminated when the service pin is depressed or when a controller gets configured by the LCI.

Figure 12: CHB2 Controller LEDs



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 CHB 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.
The input readings are unexpected.	Check if the DIP switch settings match the settings in the wiring sheet.
The airflow through the Chilled Beam Ceiling doesn't seem right.	Check if the VAV(I/D) is properly associated. The SLink Thermostat is shared between the CHB2 and the VAV; the Space Temp and the Space Setpoint need to match.
The Controller is calling for heat, but the Injection and the Modulation circulator for heating are not turning on.	a) Check if the controller is in Warm Weather Shut Down. b) Check if the application mode is set to AUTO and allows for heating and cooling.
In cooling mode with the option of Dew Point Control set to on, condensate buildup can be observed. The recorded cold water temp in the inputs page is above the calculated dew point.	a) Check if the DOAS or ERV unit delivering the pre-conditioned air is working properly. b) Is there a CSM1 installed and are the Supply Air Temperature and Supply Air Humidity Sensors properly installed?
Cooling is enabled and all readings indicate that the CHB2 is in a cooling mode, but the space temperature is rising instead.	Check the Chiller providing the chilled water

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 to desired devices.
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.

TES OFFERS THIS WARRANTY IN LIEU OF ALL OTHER EXPRESS WARRANTIES. ANY WARRANTY IMPLIED BY LAW INCLUDING

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