Application Guide

505-022-2

CCU2 Chiller Controller

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

SUPERSEDES: August 9, 2013

EFFECTIVE: December 20, 2014

Plant ID: 001-4016

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CCU2

The iWorx® CCU2 chiller controller is a stand-alone microprocessor based controller for supervisory central chiller control applications that utilize one air-cooled chiller or a water-cooled centrifugal chiller with cooling tower.

Overview

Analog inputs are provided for chiller water supply temperature, chiller water return temperature, condenser water supply temperature, and condenser water return temperature. Digital inputs are provided for chiller pump flow proof, condenser pump flow proof, a cooling water demand proof, and a chiller general alarm.

The CCU2 incorporates digital outputs in the form of triacs for chiller low limit status and the start and stop of the chiller and condenser pumps. In addition, three analog outputs are provided to control a modulated bypass valve, a variable speed fan, and set the adjustable setpoint of the chiller.

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

Features

- Adjustable chiller setpoint
- Modulated cooling tower bypass valve
- Modulated cooling tower fan
- Modulated chiller temperature output
- Minimum cycle timers for chiller On and Off
- Runtime accumulation for chiller, pumps, and fan
- Lead/Lag operation of water pumps
- Maximum of 60 cooling zones
- Proportional + Integral (P+I) control of the modulated bypass valve
- Proportional + Integral (P+I) control of a variable speed fan
- OAT low limit protection
- Flow proof inputs
- Chiller enable/demand input
- Chiller alarm input
- Automatic configuration with the LCI
- Alarm/Event reporting

PURPOSE OF THIS GUIDE

The *iWorx® CCU2 Application Guide* provides application information for the CCU2 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

Table 1: Applicable Documentation

Description	Audience	Purpose
iWorx® CCU2 Application Guide, Document No. 505-022-2 (this document)	– Application Engineers – Wholesalers – Contractors – Start-up Technicians – End user	Provides instructions for setting up and using the iWorx® CCU2 Controller.
iWorx® LCI Application Guide, Document No. 505-002	– Application Engineers – Installers – Service Personnel – Start-up Technicians – End user	Provides instructions for setting up and using the iWorx® Local Control Interface.
iWorx® DXU3 Application Guide, Document No. 505-004	– Application Engineers – Installers – Service Personnel – Start-up Technicians – End user	Provides instructions for setting up and using the iWorx® Controller.
iWorx® DXU4 Application Guide, Document No. 505-005	– Application Engineers – Installers – Service Personnel – Start-up Technicians – End user	Provides instructions for setting up and using the iWorx® DXU4 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	*LonWorks FTT-10A Free Topology Transceiver User's Guide,* published by Echelon Corporation. It provides specifications and user instructions for the FTT-10A Free Topology Transceiver. See also: www.echelon.com/support/documentation/manuals/transceivers.	

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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 CCU2 module, which supports one central plant consisting of one air-cooled chiller or one water-cooled chiller with cooling tower.

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).

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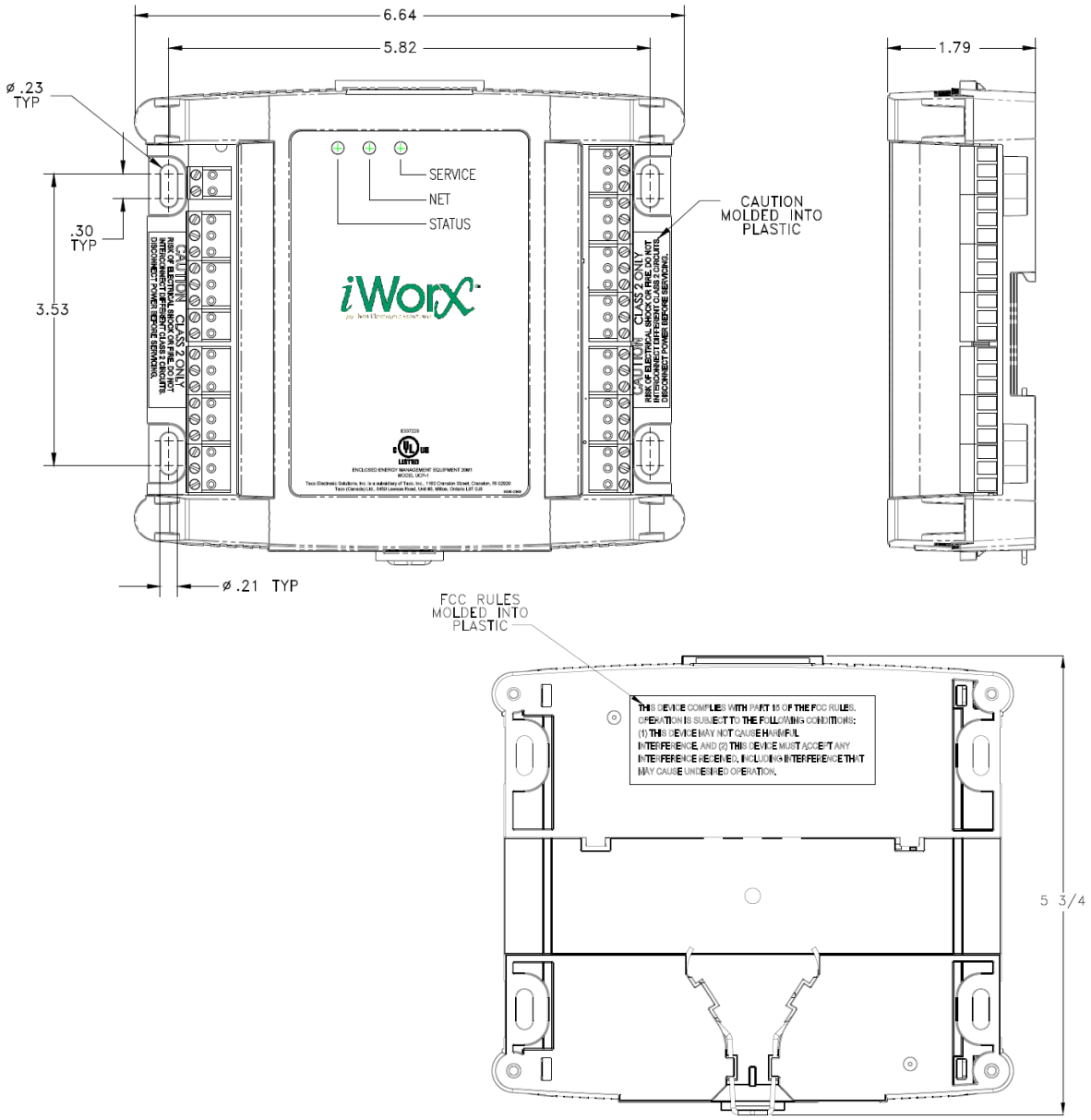
Figure 1: Mounting Dimensions



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

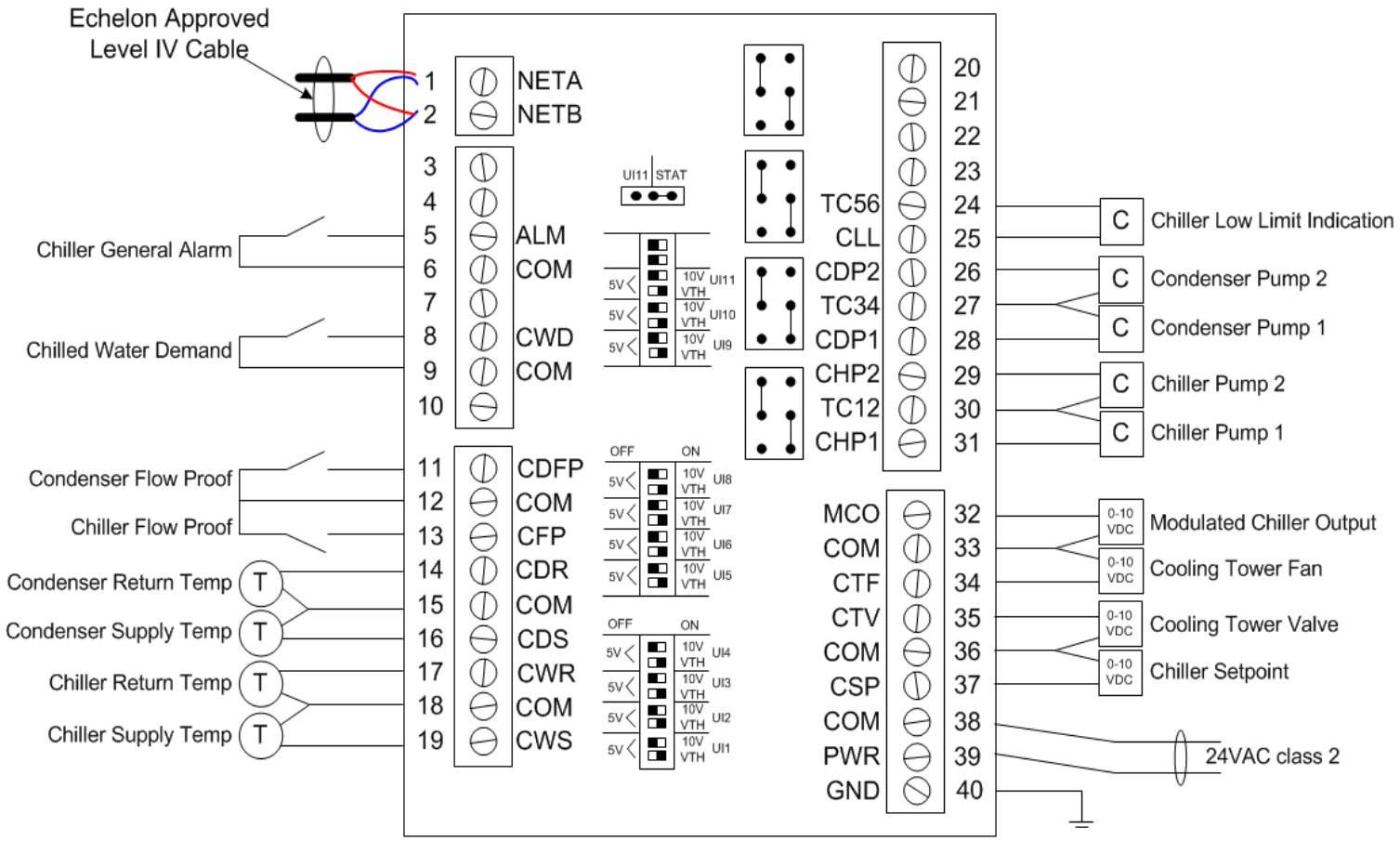
The ground terminal (T40) must be securely connected to earth ground. Failure to properly ground this equipment will result in improper operation. Improper grounding may also increase the risk of electrical shock and may increase the possibility of interference with radio/TV reception.

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, 18, 33, 36, and 38 are connected internally on all CCU2 controllers. Disconnect **ALL** power sources when installing or servicing this equipment to prevent electrical shock or equipment damage.

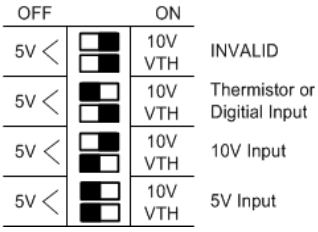
Figure 2: Wiring Diagram for Power Sourcing applications



Symbols

- T — 10 K ohm Precon Type III thermistor
- C — 24VAC pilot relay or contactor coil
- 0-10 VDC — 0-10 VDC signal

DIP Switches



Output Jumper Positions

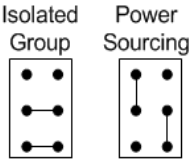


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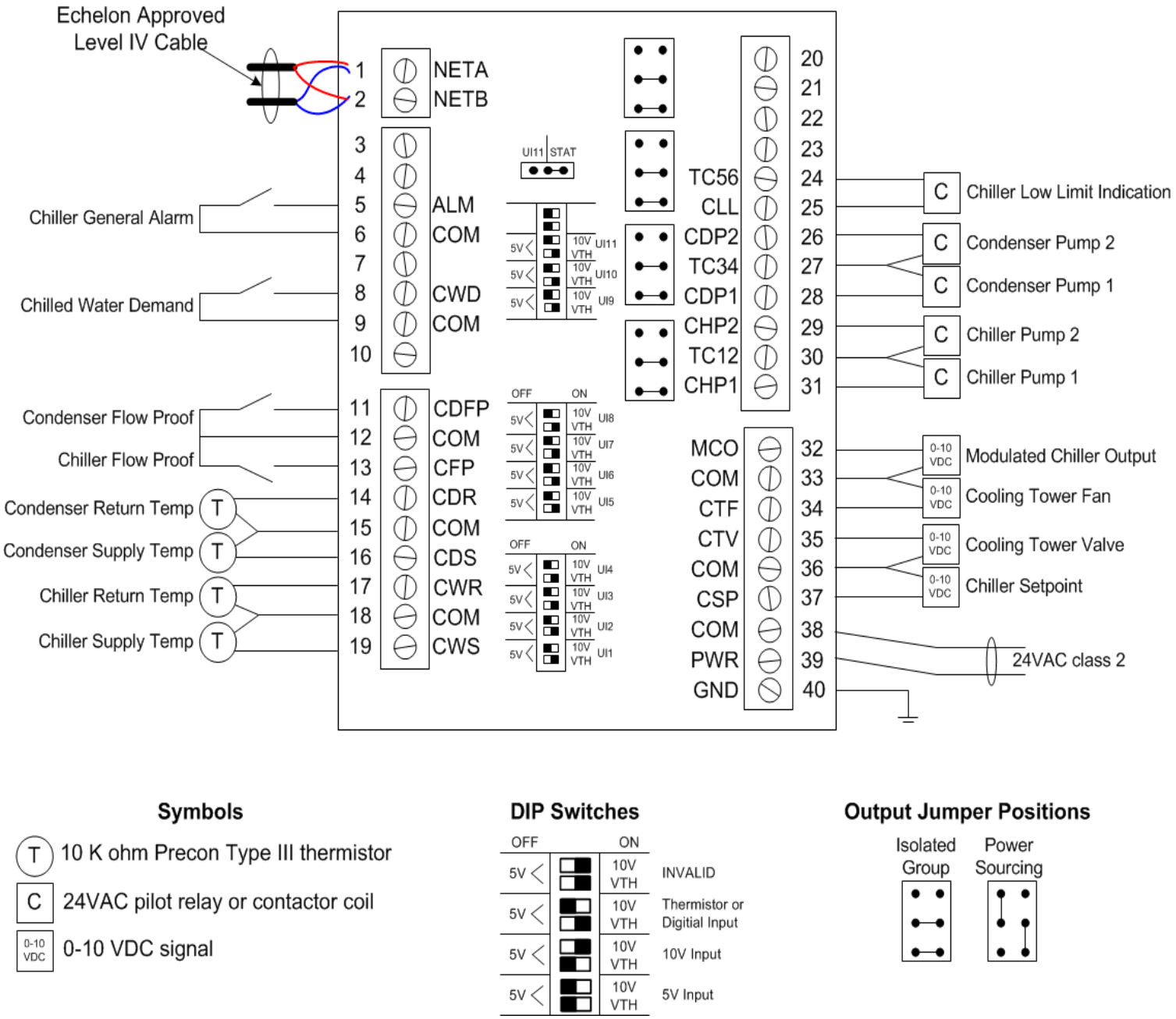
Figure 3: Wiring Diagram for Power Isolated applications



Symbols

T 10 K ohm Precon Type III thermistor

C 24VAC pilot relay or contactor coil

0-10 VDC 0-10 VDC signal

DIP Switches

Output Jumper Positions

Connecting Input Devices

Chiller Water Supply Temperature (CWS)

To connect the chiller water supply thermistor to the unit, attach one wire from the thermistor to CWS (T19) and the other wire to the adjacent common (T18). The thermistor used must be a 10K Precon Type III.

Chiller Water Return Temperature (CWR)

To connect the chiller water return thermistor to the unit, attach one wire from the thermistor to CWR (T17) and the other wire to the adjacent common (T18). The thermistor used must be a 10K Precon Type III.

Condenser Supply Temperature (CDS)

To connect the condenser water supply thermistor to the unit, attach one wire from the thermistor to CDS (T16) and the other wire to the adjacent common (T15). The thermistor used must be a 10K Precon Type III.

Condenser Return Temperature (CDR)

To connect the condenser water return thermistor to the unit, attach one wire from the thermistor to CDR (T14) and the other wire to the adjacent common (T15). The thermistor used must be a 10K Precon Type III.

Chiller Flow Proof (CFP)

To connect the chiller flow proof switch to the digital input, attach one wire of the contact to CFP (T13) and the other wire to the adjacent common (T12). This must be a dry contact, normally open switch which closes when flow is detected. If a flow proof switch is not installed, the terminals should be connected with a jumper wire.

Condenser Flow Proof (CDFP)

To connect the condenser flow proof switch to the digital input, attach one wire of the contact to CDFP (T11) and the other wire to the adjacent common (T12). This must be a dry contact, normally open switch which closes when flow is detected. If a flow proof switch is not installed, the terminals should be connected with a jumper wire.

Chiller General Alarm (ALM)

To connect the chiller's general alarm output to the digital input, attach one wire of the contact to ALM (T5) and the other wire to the adjacent common (T6). This output from the chiller must act as a dry contact, normally open switch.

Chilled Water Demand (CWD)

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

Connecting Output Devices

Chiller Pumps 1 & 2 (CHP1, CHP2)

The outputs for the pumps must be connected to 24 VAC pilot relays if the load is greater than 1 Amp for each pump. If the load is less than 1 Amp, connect pump 1 to CHP1 (T31) and TC12 (T30), and connect pump 2 to CHP2 (T29) and TC12 (T30).

Condenser Pumps 1 & 2 (CDP1, CDP2)

The outputs for the pumps must be connected to 24 VAC pilot relays if the load is greater than 1 Amp for each pump. If the load is less than 1 Amp, connect pump 1 to CDP1 (T28) and TC34 (T27), and connect pump 2 to CDP2 (T26) and TC34 (T27).

Chiller Low Limit (CLL)

The output for the chiller low limit interface must be connected to a 24 VAC pilot relays if the load is greater than 1 Amp. If the load is less than 1 Amp, connect the chiller's low limit input to CLL (T25) and TC56 (T24).

Chiller Setpoint Adjustment (CSP)

The chiller setpoint adjustment output can be set to 0-10 VDC max through the control logic. Connect the positive wire from the chiller's setpoint adjustment input to CSP (T37) and the other wire to the adjacent common (T36).

Cooling Tower Valve (CTV)

The cooling tower bypass valve output can be set to 0-10 VDC max through the control logic. Connect the positive wire from the valve actuator to CTV (T35) and the other wire to the adjacent common (T36).

Cooling Tower Fan (CTF)

The cooling tower fan output can be set to 0-10 VDC max through the control logic. Connect the positive wire from the fan actuator to CTF (T34) and the other wire to the adjacent common (T33).

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Modulated Chiller Output (MCO)

The modulated chiller output is set through control logic. Connect the positive wire to MCO (T32) and the other wire to the adjacent common (T33).

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).

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

Resolution: 10 bit

Chiller Supply Temperature, Chiller Return Temperature, Condenser Supply Temperature, Condenser Return Temperature: Precon Type III 10K thermistor

Chiller Alarm, Chilled Water Demand, Chiller Flow Proof, Condenser Flow Proof: Dry Contact, Normally Open, 5 Volts DC Max

Electrical Outputs

Chiller Pumps 1 & 2, Condenser Pumps 1 & 2, Chiller Low Limit: 24 Volts AC, 1A @ 50C, 0.5A @ 60C, limited by the Class 2 supply rating

Chiller Setpoint, Cooling Tower Valve, Cooling Tower Fan: 0-10 Volts DC, 2K Ohm minimum load, 8 bit resolution

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

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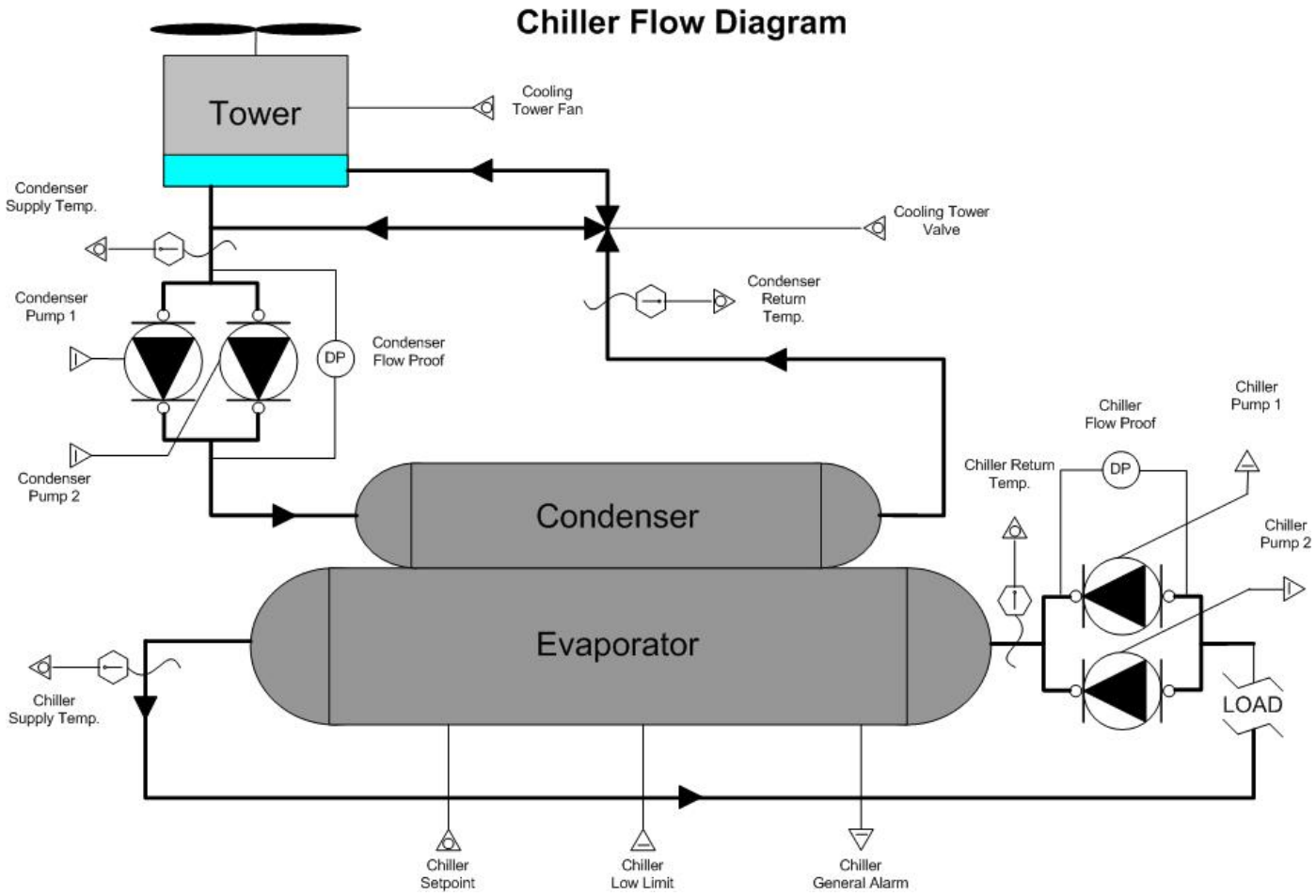
APPLICATION DESCRIPTION

The CCU2 chiller controller is a stand-alone microprocessor-based controller for supervisory control of central chiller applications that utilize either an air-cooled chiller or a water-cooled centrifugal chiller with a cooling tower. Two chilled water pumps are configured for lead/lag operation. The CCU2 provides setpoint adjustment control of the chiller by integrating to the factory mounted chiller controls with a 0-10 VDC setpoint control signal. For chilled water plant applications that utilize a cooling tower, the CCU2 controller provides control of the tower bypass valve and two cooling tower (condenser) pumps configured in a lead/lag configuration. Outputs are provided for control of the cooling tower bypass valve. Analog outputs are provided to support cooling tower applications with variable fan speed control.

Figure 4: CCU2 with Cooling Tower



CCU2 control starts only if there is a cooling water demand and the outside air temperature (OAT) is above the *OAT limits --> Cutoff temp*. The CCU2 operates in conjunction with up to 60 controllers that can require chilled water (FCU Series, DXU Series, HPU Series). The cooling water demand is obtained by the CCU2 from controllers that have been grouped with the CCU2 at the LCI user interface during initial configuration. *Cooling water demand* can also be communicated through a digital input switch, or through a demand for chiller activation from the LCI.

Initial chiller control activates a chiller pump. The factory-installed chiller controls, as provided by the chiller manufacturer, detect water flow in the chilled water loop and activate the chiller. An anti-cycle function provides configurable chiller minimum On and Off times.

The CCU2 includes support for two chilled water pumps, with only one pump required for normal operation. One of the pumps is designated the lead pump, with the lag pump only being required in the event of a lead pump alarm. Each time the chiller is deactivated, the lead pump designation is transferred to the other pump.

When the chiller is activated, the lead chiller pump is started. If the chiller pump has been commanded on for at least 20 seconds and the *Chiller Flow* proof is off, an alarm is initiated and the lag pump is started. The lag pump also triggers an alarm if it has been commanded on for 20 seconds and flow proof is not established. If both chiller pumps fail, all outputs are turned off, all control stops, and a dual pump failure alarm is generated. Manual reset of the CCU2 controller from the operator interface or by cycling power to the CCU2 is required to restart control.

The CCU2 also includes support for two condenser water pumps, with only one pump required for normal operation. One of the pumps is designated the lead pump, with the lag pump only being required in the event of a lead pump failure. Each time the system is deactivated, the lead pump designation is transferred to the other pump.

In a water-cooled chiller, when the chiller water pump is started the lead condenser pump is started also. If the condenser pump has been commanded on for at least 20 seconds and the condenser flow proof is off, an alarm is initiated and the lag pump is started. The lag pump also triggers an alarm if it has been commanded on for 20 seconds and flow proof is not established. If both condenser pumps fail, all outputs are turned off, all control stops, and a dual pump failure alarm is generated. Manual reset of the CCU2 controller from the operator interface or by cycling power to the CCU2 is required to restart control.

An analog output is provided for setpoint adjustment utilizing the factory-mounted chiller controls. The chiller setpoint adjust feature of the CCU2 enables the user to change the chiller water supply setpoint through the LCI.

The bypass valve position is calculated by a Proportional + Integral (P+I) control loop based on the condenser water return temperature and the condenser water setpoint. The bypass valve control loop is activated 15 seconds after the condenser water flow proof has confirmed flow. As the temperature increases above the condenser water setpoint, the bypass valve is modulated open. The bypass valve is modulated closed as the water temperature decreases below the condenser setpoint. The cooling tower bypass valve control loop is selectable for direct or reverse acting operation.

The cooling tower fan speed is calculated by a P+I control loop based on the condenser water return temperature and the cooling tower water setpoint. The fan speed control loop is activated 15 seconds after the cooling tower bypass valve has modulated to its 100% position (full flow through tower). As the temperature increases above the cooling tower water setpoint, the fan speed is increased. The fan speed is decreased as the water temperature decreases below the cooling tower setpoint. The fan speed control loop is selectable for direct or reverse acting operation.

The CCU2 provides low limit control. When the outside air temperature (OAT) drops below the low limit setpoint as sensed by an ASM controller on the system network, the chiller water pump energizes and the chiller low limit output is enabled. The chiller low limit output is interfaced to the factory supplied chiller controls to signal the chiller to not start in response to the chiller water pump operation during the low limit condition. The chiller water pump and chiller low limit output de-energizes when the temperature rises 1 °F above the low limit setpoint.

A digital input is provided on the CCU2 to monitor the status of the chiller's general alarm. An alarm is reported to the LCI when the chiller reports a general alarm condition.

The CCU2 monitors the runtime of all four pumps, the chiller, and the fan. When any one of the runtimes exceeds a programmable limit, a maintenance alarm is reported to the LCI.

When the water temperatures exceed a programmable limit, a high limit alarm is reported to the LCI. When the water temperature drops below a programmable limit, a low limit alarm is reported to the LCI. When the water temperature returns to the proper range, a return to normal is generated.

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SEQUENCE OF OPERATION

This section describes the detailed sequence of operation for the CCU2 control algorithms.

Chiller Activation

CCU2 control starts only if there is a cooling water demand and the OAT acquired from the network via an auxiliary sensor module (ASM) is above the *OAT limits -> Lockout temp*. The CCU2 operates in conjunction with up to 60 controllers that can require chilled water (FCU series, DXU series, HPU series). The cooling water demand is obtained by the CCU2 from controllers that have been associated with the CCU2 at the LCI user interface during configuration. The CCU2 polls each associated controller to determine if cooling has been requested.

Cooling water demand can also be communicated to the CCU2 through a digital input switch or a demand for chiller activation at the LCI. Activation through the digital input switch will not override an *OAT limits -> Lockout temp* condition. Activation through the LCI will override an *OAT limits -> Lockout temp* condition. Initial chiller control activates a chiller water pump. The factory installed chiller control, as provided by the chiller manufacturer, detects chiller water loop water flow and activates the chiller. An anti-cycle function provides configurable *Chiller settings --> Min On Time* and *Min Off Time*.

Chiller Setpoint Adjustment

The CCU2 provides setpoint adjustment control of the chiller by integrating to the factory mounted chiller controls with a 0-10 VDC setpoint control signal. The chiller setpoint adjustment provides the ability for the user to change the chilled water supply setpoint through the LCI. The chiller setpoint analog output has a user adjustable scaling range.

Chiller Pump Control

The CCU2 includes support for two chilled water pumps, with only one pump required for normal operation. One of the pumps is designated the lead pump, with the lag pump only being required in the event of a lead pump alarm. Each time the chiller is deactivated, the lead pump designation is transferred to the other pump.

When the system is activated, the lead chiller pump is started. If the chiller pump has been commanded on for at least 20 seconds and the chiller flow is off, an alarm is initiated and the lag pump is started. The lag pump also triggers an alarm if it has been commanded on for 20 seconds and flow proof is not established. If both chiller pumps fail, all outputs are turned off, all control stops, and a dual pump failure alarm is generated. Manual reset of the CCU2 controller from the operator interface or by cycling power to the CCU2 is required to restart control.

Condenser Pump Control

The CCU2 also includes support for two condenser water pumps, with only one pump required for normal operation. One of the pumps is designated to be the lead pump, with the lag pump only being required in the event of a lead pump failure. Each time the chiller is deactivated, the lead pump designation is transferred to the other pump.

When the chilled water pump is started, the lead condenser pump is started also. If the condenser pump has been commanded on for at least 20 seconds and the condenser flow is off, an alarm is initiated and the lag pump is started. The lag pump also triggers an alarm if it has been commanded on for 20 seconds and flow proof is not established. If both condenser pumps fail, all outputs are turned off, all control stops, and a dual pump failure alarm is generated. Manual reset of the CCU2 controller from the operator interface or by cycling power to the CCU2 is required to restart control.

Cooling Tower Bypass Valve Control

The cooling tower bypass valve is controlled when the CCU2 is configured for a water cooled chiller. The bypass valve position is calculated by a Proportional + Integral (P+I) control loop based on the condenser water return temperature and the condenser water setpoint. The bypass valve control loop is activated 15 seconds after the condenser water flow proof has confirmed flow.

As the temperature increases above the *All Settings -> Cool Tower Valve SP*, the bypass valve is modulated open. The bypass valve is modulated closed as the water temperature decreases below the *All Settings -> Cool Tower Valve SP*. The cooling tower bypass valve control loop is selectable for direct or reverse acting operation.

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:

K_P = Proportional Gain
K_i = Integral Gain
Error = Inputs --> Cond Rtn Temp - All Settings --> Cool Tower Valve SP
$I = I + (K_i \times Error)$
Outputs --> Cooling Tower Valve (%) = $(K_P \times (Error + I)) + 50.00\%$

The valve can be set for reverse action by exchanging the maximum and value settings during configuration. That is, if the default maximum of 10 Volts and default minimum of 0 Volts are being used for reverse action, set the minimum to 10 Volts and the maximum to 0 Volts.

Modulated Chiller Output

The modulated chiller output is controlled when the CCU2 *Mod Chiller* settings are configured. The default values for the settings keep the out put disabled. To enable the output, the *Max Output* must be greater than the *Min Output*. As the chiller supply temperature rises above the chiller setpoint, the modulated chiller output increases. Configurable *Ramp Up* and *Ramp Down* values limit the rate of increase and decrease. When the modulated chiller output transitions from 0 to a controlling value, the initial value is the configured "On" value.

Cooling Tower Variable Speed Fan Control

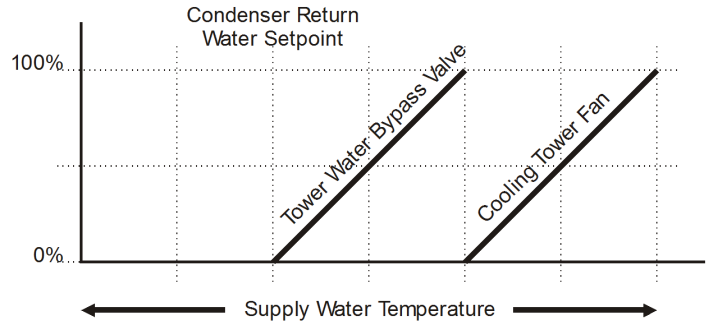
The cooling tower variable speed fan is controlled when the CCU2 is configured for a water cooled chiller. The cooling tower fan speed is calculated by a P+I control loop based on the condenser water return temperature and the cooling tower water setpoint. The fan speed control loop is activated 15 seconds after the cooling tower bypass valve has modulated to its 100% position (full flow through tower).

As the temperature increases above the cooling tower water setpoint, the fan speed is increased. The fan speed is decreased as the water temperature decreases below the *Chiller settings --> setpoint*. The fan speed control loop is selectable for direct or reverse acting operation.

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:

K_P = Proportional Gain
K_i = Integral Gain
Error = Inputs --> Cond Rtn Temp - All Settings --> Cool Tower Valve SP
$I = I + (K_i \times Error)$
Outputs --> Cooling Tower Fan (%) = $(K_P \times (Error + I)) + 50.00\%$

Figure 5: Cooling Tower Sequence



The valve can be set for reverse action by exchanging the maximum and value settings during configuration.

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Chiller Low Limit Control

The CCU2 provides low limit control. When the outside air temperature drops below the low limit setpoint as sensed by the ASM on the network, the CCU2 energizes the chiller low limit output and starts the chilled water pump. The chiller low limit output is interfaced to the factory supplied chiller controls to signal the chiller to not start in response to the chilled water pump operation in the low limit condition. The chilled water pump and chiller low limit output de-energizes when the temperature rises 1 °F above the low limit setpoint.

Chiller Alarm Status

The chiller alarm status input is monitored to determine if the chiller is operating properly. The input is used to indicate that an alarm occurred or maintenance is required on the chiller. The unit is not shut down due to a chiller alarm.

Runtime Accumulations

The total runtime is accumulated for the chiller at *HVAC Setup -> Runtimes and Limits -> chiller Runtime*, chiller pump 1 at *HVAC Setup -> Runtimes and Limits -> chlr Pump 1 Runtime*, chiller pump 2 at *HVAC Setup -> Runtimes and Limits -> chlr Pump 2 Runtime*, condenser pump 1 at *HVAC Setup -> Runtimes and Limits -> Cond Pump 1 Runtime*, condenser pump 2 at *HVAC Setup -> Runtimes and Limits -> Cond Pump 2 Runtime*, and fan at *HVAC Setup -> Runtimes and Limits -> Fan Runtime*. The runtimes can be used to indicate that maintenance is required on the equipment controlled by these outputs. An operator or maintenance personnel can reset the runtime once servicing has been performed. The runtimes are accumulated in non-volatile memory (NVRAM).

Alarms and Events

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

Digital Input Alarms

The CCU2 monitors the status of the digital inputs and generates alarms for the following events:

- *Inputs --> Chiller General Alarm*

Maintenance Alarm

A CCU2 provides programmable runtime limits for generating runtime maintenance alarms. When the *Runtime Limits -> chiller*, *Runtime Limits ->pump* or *Runtime Limits -> fan* exceeds these limits, a maintenance alarm is sent to the LCI.

Water Temperature Alarms

After a 1 minute delay following chiller startup, the CCU2 generates high and low limit alarms for the monitored water temperatures. A programmable water temperature alarm limit offset is provided. The temperature limits are calculated based on the alarm limit setpoints and the alarm limit offset.

Chiller Temp High Limit = Chiller Settings -> Max Water Temp + Water Temp Alarm Hys
Chiller Temp Low Limit = Chiller Settings -> Min Water Temp - Water Temp Alarm Hys

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

Pump Alarms

If the chiller pump has been commanded on for at least 20 seconds and the chiller flow proof is off, an alarm is initiated and the lag pump is started. The lag pump also triggers an alarm if it has been commanded on for 20 seconds and flow proof is not established. If both chiller pumps fail, all outputs are turned off, all control stops, and a dual pump failure alarm is generated. Manual reset of the CCU2 controller from the operator interface or by cycling power to the CCU2 is required to restart control.

If the condenser pump has been commanded on for at least 20 seconds and the condenser flow proof is off, an alarm is initiated and the lag pump is started. The lag pump also triggers an alarm if it has been commanded on for 20 seconds and flow proof is not established. If both condenser pumps fail, all outputs are turned off, all control stops, and a dual pump failure alarm is generated. Manual reset of the CCU2 controller from the operator interface or by cycling power to the CCU2 is required to restart control.

Automatic Configuration

The CCU2 and iWorx® Local Control Interface (LCI) use a self-configuring network management scheme requiring no external tools, binding, or LONWORKS knowledge. The LCI recognizes and configures the CCU2 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. Users may bind to SNVTs on the CCU2 with LNS or other LONWORKS tools *after* the CCU2 has been inserted into the LCI2 network.

The LCI also provides network supervision of the CCU2. The LCI periodically sends a "ping" message to the CCU2, 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 Controllers

Associations can only be done in a network with an LCI2 present. Please refer to the *iWorx® LCI2 Application Manual* for detailed instructions.

CCU2 can be associated and communicate with other controllers. CCU2 can receive the cooling demands form associated control.

Following is a list of the controllers that can be associated with the CCU2.

- DXU series
- HPU series
- FCU series

To associate a CCU2 to controllers, start from the LCI main screen; press *Controllers* and then select the CCU2. From within the CCU2, select *HVAC Setup* and then press the *Members* button. Once the members screen appears, a list of controllers that the CCU2 can be grouped to will be shown. Press the name of the controller to associate. The selected controller will turn "RED" color and "Associated" status will be displayed on the right side. To change the member status of a controller, just press that controller. It will toggle "Member" or "Non-Member" with each press. If a controller has been selected or deselected, you must press *Save* afterward to confirm the new setting.

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CONTROLLER IDENTIFICATION

Once the CCU2 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 CCU2, and the meanings and default values for controller parameters. For more information on using the LCI, see the *iWorx® LCI Application Guide.*

Inputs

The Inputs screen displays the current values of the CCU2's inputs. These values cannot be changed.

Input	Range	Description
Outside Temp	-30.00 to 230.00 °F (-34.4 to 110.00 °C)	Outside air temperature reported by an external temperature sensor over the network.
Chiller Flow	Off, On	Status of the CFP switch.
Condenser Flow	Off, On	Status of the CDFP switch.
Chlr General Alarm	Off, On	Status of the chiller's alarm output.
Cooling Water Demand	Off, On	Status of the CWD switch.
Chiller Supply Temp	-30.00 to 230.00 °F (-34.40 to 110.00 °C)	Temp. reported by CWS sensor.
Chiller Return Temp	-30.00 to 230.00 °F (-34.40 to 110.00 °C)	Temp. reported by CWR sensor.
Condenser Supply Temp.	-30.00 to 230.00 °F (-34.40 to 110.00 °C)	Temp. reported by CDS sensor.
Condenser Return Temp.	-30.00 to 230.00 °F (-34.40 to 110.00 °C)	Temp. reported by CDR sensor.
Occupancy Mode	Unocc, Occ	Indicates the current occupancy mode.

Outputs

This screen displays the current values of the CCU2's outputs. These values cannot be changed.

Output	Range	Description
Unit Status		
Mode	Off, Cooling	Current mode of the chiller system.
Mod Chiller Out	0.00% to 100.00)	Status of the modulated chiller output.
Cooling Tower Valve	0.00% to 100.00%	Status of the cooling tower valve output.
Cooling Tower Fan	0.00% to 100.00%	Status of the cooling tower fan output.
In Alarm?	On, Off	Current alarm status of the chiller.
Output Status		
Chiller Pump 1	Off, On	Status of chiller pump 1.
Chiller Pump 2	Off, On	Status of chiller pump 2.
Condenser Pump 1	Off, On	Status of condenser pump 1.
Condenser Pump 2	Off, On	Status of condenser pump 2.
Chiller Low Limit	Off, On	Status of the chiller low limit output.

All Settings

This screen displays all settings used by the CCU2 controller and provides access to edit all the parameters from a single screen.

Setting	Range	Default	Description
Chiller Enable	Auto, On	Auto	Auto: Chiller will follow the cooling demand set by other controllers. On: Chiller enabled regardless of cooling demand.
Cool Tower Valve SP	32 to 80.6 °F (0 to 27 °C)	45.0 °F (7.2 °C)	Valve Set Point
Cool Tower Valve	NA	Structure	Valve Settings
Cool Tower Fan SP	32 to 80.6 °F (0 to 27 °C)	50.0 °F (10.0 °C)	Fan Set Point
Cool Tower Fan	NA	Structure	Fan settings
Runtime Limits	NA	Structure	Runtime settings
OAT Limits	NA	Structure	OAT temp limit settings
Chiller Settings	NA	Structure	Chiller settings
Chlr Alm Temp Limits	NA	Structure	Chiller settings
Cond Alm Temp Limits	NA	Structure	Condenser settings
Water Temp Alarm Hys	0 to 10.0 °F (0 to 5.6 °C)	5.0 °F (2.8 °C)	Water temp alarm hysteresis
Zone Limit	0 to 60	1	Number of zones requiring cooling before the chiller is enabled
Mod Chiller	NA	Structure	Modulated Chiller Output settings

Cool Tower Valve

Enables the user to view and set parameters directly related to control of the cooling tower valve.

Setting	Range	Default	Description
Kp	0.00 to 100.00% per degree of temperature	50.00%	Proportional gain for P+I control of the cooling tower valve.
Ki	0.00 to 100.00%	0.05%	Integral gain for P+I control of the cooling tower valve.
Min AO Voltage	0.0 to 10.0 Volts	0.0 Volts	Minimum voltage of the cooling tower valve output.
Max AO voltage	0.0 to 10.0 Volts	10.0 Volts	Maximum voltage of the cooling tower valve output.

Cool Tower Fan

Enables the user to view and set parameters directly related to control of the cooling tower fan.

Setting	Range	Default	Description
Kp	0.00 to 100.00% per degree of temperature	50.00%	Proportional gain for P+I control of the cooling tower fan.
Ki	0.00 to 100.00%	0.05%	Integral gain for P+I control of the cooling tower fan.
Min AO voltage	0.0 to 10.0 Volts	0.0 Volts	Minimum voltage of the cooling tower fan output.
Max AO voltage	0.0 to 10.0 Volts	10.0 Volts	Maximum voltage of the cooling tower fan output.

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Runtime Limits

Enables the user to view and set parameters directly related to the runtime limits for maintenance alarms.

Setting	Range	Default	Description
Chiller	0 to 65535 hours	1000 hours	Chiller runtime after which a maintenance alarm is generated.
Fan	0 to 65535 hours	1000 hours	Cooling tower fan runtime after which a maintenance alarm is generated.
Pump	0 to 65535 hours	1000 hours	Total pump runtime after which a maintenance alarm is generated.

OAT Limits (Outside Temperature)

Enables the user to view and set parameters directly related to the outside temperature limits.

Setting	Range	Default	Description
Low Limit	-13.00 to 140.00 °F (-25.0 to 60.00 °C)	32.0 °F (0.0 °C)	Outdoor air temperature below which low limit control is enabled.
Cutoff Temp	-13.00 to 140.00 °F (-25.0 to 60.00 °C)	52.0 °F (11.1 °C)	Outdoor air temperature below which the chiller is disabled.

Chiller Settings

Enables the user to view and set parameters directly related to the chiller settings.

Setting	Range	Default	Description
Setpoint	32.00 to 80.60 °F (0 to 27.00 °C)	44.9 °F (7.2 °C)	Desired temperature of the chiller supply.
Type	Water, Air	Water	Type of chiller being controlled, water-cooled or air-cooled.
Min Supply Temp	32.00 to 80.60 °F (0.00 to 27.00 °C)	40 °F (4.4 °C)	Minimum chiller water temp
Max Supply Temp	32.00 to 80.60 °F (0.00 to 27.00 °C)	60 °F (15.6 °C)	Maximum chiller water temp
Min On Time	0 to 180 minutes	30 minutes	Minimum amount of time the chiller must remain on.
Min Off Time	0 to 180 minutes	30 minutes	Minimum amount of time the chiller must remain off.

Modulated Chiller Output Settings

Enables the user to view and set parameters directly related to the modulated chiller output.

Setting	Range	Default	Description
Gain	-4 to +5	0	Response speed relative to factory default; negative values are slower, positive values are faster.
On	0.0 to 100.0%	0.0%	Minimum output to turn on.
Ramp Up	0.0 to 20.0%	1.0%	Ramp up rate limit, percent per second.

Setting	Range	Default	Description
Ramp Down	0.0 to 20.0%	1.0%	Ramp down rate limit, percent per second.
Out Min	0 to 10 V	0 V	Minimum output value
Out Max	0 to 10 V	0 V	Maximum output value. Must be configured higher than *Out Min* to enable the modulated chiller output.

Chiller Alm Temp Limits (Chiller Temperature Limits for Alarm)

Enables the user to view and set parameters directly related to the chiller temperature alarm limits.

Setting	Range	Default	Description
Min Supply Temp	32.00 to 140.00 °F (0.00 to 60.00 °C)	43.0 °F (6.1 °C)	Chiller supply temperature below which an alarm is generated.
Max Supply Temp	32.00 to 140.00 °F (0.00 to 60.00 °C)	60.0 °F (15.56 °C)	Chiller supply temperature above which an alarm is generated.
Min Return Temp	32.00 to 140.00 °F (0.00 to 60.00 °C)	43.0 °F (6.1 °C)	Chiller return temperature below which an alarm is generated.
Max Return Temp	32.00 to 140.00 °F (0.00 to 60.00 °C)	60.0 °F (15.56 °C)	Chiller return temperature above which an alarm is generated.

Cond Alm Temp Limits (Condenser Temperature Limits for Alarm)

Enables the user to view and set parameters directly related to the condenser temperature alarm limits.

Setting	Range	Default	Description
Min Supply Temp	32.00 to 140.00 °F (0.00 to 60.00 °C)	43.0 °F (6.1 °C)	Condenser supply temperature below which an alarm is generated.
Max Supply Temp	32.00 to 140.00 °F (0.00 to 60.00 °C)	60.0 °F (15.56 °C)	Condenser supply temperature above which an alarm is generated.
Min Return Temp	32.00 to 140.00 °F (0.00 to 60.00 °C)	43.0 °F (6.1 °C)	Condenser return temperature below which an alarm is generated.
Max Return Temp	32.00 to 140.00 °F (0.00 to 60.00 °C)	60.0 °F (15.56 °C)	Condenser return temperature above which an alarm is generated.

Alarms

The table below describes the alarms you may encounter and how they are reset.

Alarm	Range	Alarm Trigger	Alarm Reset
Chil Sup High Temp Alarm	Normal, Alarm	If chiller water supply temperature is greater than *Chiller Supply Temperature Max* plus water temperature limits.	Automatic when chiller supply temperature returns to normal range.
Chil Sup Low Temp Alarm	Normal, Alarm	If chiller water supply temperature is less than *Chiller Supply Temperature Min* minus water temperature limits.	Automatic when chiller supply temperature returns to normal range.
Chil Ret High Temp Alarm	Normal, Alarm	If chiller water return temperature is greater than *Chiller Return Temperature Max* plus water temperature limits.	Automatic when chiller return temperature returns to normal range.

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Alarm	Range	Alarm Trigger	Alarm Reset
Chil Ret Low Temp Alarm	Normal, Alarm	If Chiller water return temperature is less than *Chiller Return Temperature Min* minus water temperature limits.	Automatic when chiller return temperature returns to normal range.
Cond Sup High Temp Alarm	Normal, Alarm	If Condenser water supply temperature is greater than *Condenser Supply Temperature Max* plus water temperature limits.	Automatic when condenser supply temperature returns to normal range.
Cond Sup Low Temp Alarm	Normal, Alarm	If Condenser water supply temperature is less than *Condenser Supply Temperature Min* minus water temperature limits.	Automatic when condenser supply temperature returns to normal range.
Cond Ret High Temp Alarm	Normal, Alarm	If Condenser water supply temperature is less than *Condenser Return Temperature Max* plus water temperature limits.	Automatic when condenser return temperature returns to normal range.
Cond Ret Low Temp Alarm	Normal, Alarm	If Condenser water supply temperature is less than *Condenser Return Temperature Min* minus water temperature limits.	Automatic when condenser return temperature returns to normal range.
Chiller Pump 1 Failed	Normal, Alarm	If chiller pump 1 fails.	Automatic unless there is a Dual Pump Failure; See Dual Pump Failure.
Chiller Pump 2 Failed	Normal, Alarm	If chiller pump 2fails.	Automatic unless there is a Dual Pump Failure; See Dual Pump Failure.
Condenser Pump 1 Failed	Normal, Alarm	If condenser pump 1 fails.	Automatic unless there is a Dual Pump Failure; See Dual Pump Failure.
Condenser Pump 2 Failed	Normal, Alarm	If condenser pump 2 fails.	Automatic unless there is a Dual Pump Failure; See Dual Pump Failure.
Dual Pump Failure	Normal, Alarm	If both pumps fail.	Reset the controller (power cycle).
Chiller Alarm	Normal, Alarm	This is a physical input received from the chiller.	Automatic when chiller returns to normal range.

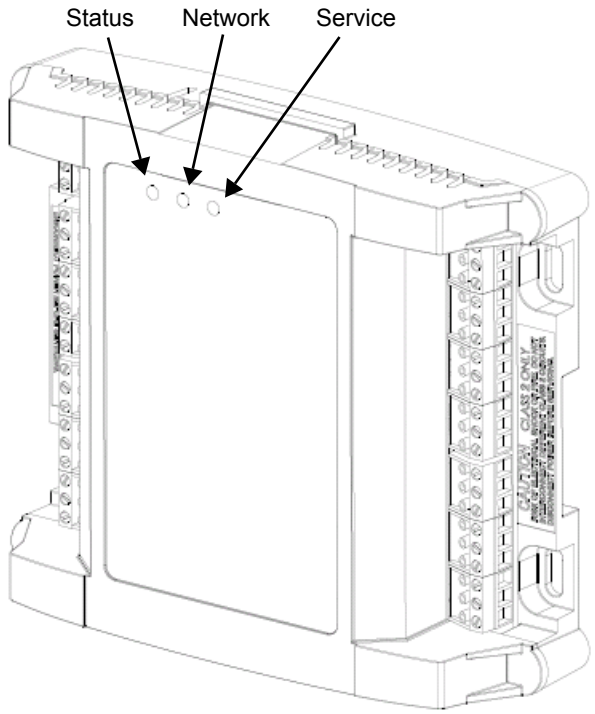
TROUBLESHOOTING

Diagnostic LEDs

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

LED	Indication
Status	– Solid green when running and configured by an LCI (networking) – 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	– 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	– Illuminated when the service pin is depressed or when a controller gets configured by the LCI.

Figure 6: CCU2 Controller LEDs



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Troubleshooting Tips

The following table provides tips on resolving common issues.

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 CCU2 controllers?	No, the system can only recognize one.
Thermistor readings fluctuate rapidly, sometimes by several degrees.	The controller may not be properly grounded. The controller's ground (GND) pin (T40) must be connected to earth ground. Also ensure that the controller's digital inputs are dry contacts and that no voltage is being applied or switched to the inputs.
How do I associate my other controllers with the CCU2?	Use the CCU2's grouping mechanism, specifically *HVAC Setup --> Members* on the CCU2 screen of the LCI.
What iWorx® controllers can be part of a CCU2's group?	Only FCU series, DXU series and HPU series controllers can be part of the CCU2's group and demand cooling from it.
Several controllers are requesting cooling, but the chiller and pumps have not been enabled.	The *Zone Limit* setting may be set higher than the number of zones that are currently requesting cooling. The chiller and pumps are not enabled until the number of zones requesting cooling is greater than the *Zone Limit* setting. If the number of controllers requesting cooling exceeds the *Zone Limit* setting, but the chiller is still not enabled, the outside air temperature may be less than the *Outdoor Air Temp. Lockout* setting.
I only have one chiller pump; how can I disable lead/lag operation?	The lead/lag function is built into the controller and cannot be disabled. However, you can wire both chiller pump outputs in parallel from the controller to the existing pump and expect normal system operation. The same can be done for the condenser pump outputs if you have only one condenser pump.
The LCI is reporting a dual pump failure. How do I know which pumps have failed?	Check the pump alarms that precede the dual pump failure alarm. These two alarms indicate which two pumps have failed, the chiller pumps or the condenser pumps.

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.

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Printed in the USA