EMTX-IOM-3

Installation/Operation/Maintenance for DDC Chiller Sequencer

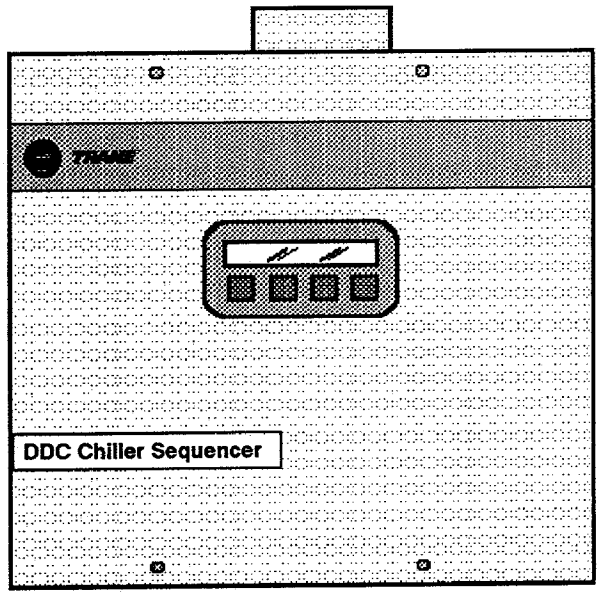
December 1990/Price: $10.00

DDC Chiller Sequencer

Part No. 4950-0360

Two-Chiller Sequencing Panel Used with ...

- Trane Air-Cooled Cold Generators® (Model CGAD, 20 through 60 Tons)
- Trane Water-Cooled Cold Generators (Model CGWD, 20 through 60 Tons)
- Trane Air-Cooled Compressor-Chillers (Model CCAD, 20 through 60 Tons)
- Trane Air-Cooled Rotary Chillers (130 through 400 Tons)
- Other Compatible Trane and Non-Trane Air or Water-Cooled Chillers



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Preface

This booklet describes the steps required to properly install a DDC Chiller Sequencer, part no. 4950-0360, for operation as a stand-alone sequencing panel for two chillers. Included are guidelines for proper panel application; specific instructions for panel mounting, wiring and setup; a discussion of system operation; and recommendations for panel maintenance and troubleshooting.

Where appropriate, cautionary statements are used to signal procedures or conditions that require particular attention. ***Warnings*** alert installing contractors and service personnel to potential hazards that could result in personal injury or death. If the risk of equipment damage exists, a ***caution*** is used.

Your personal safety and the proper operation of this system depend upon the strict observance of these precautions.

Library	Service Literature
Product Section	Electronic Systems and Controllers
Product	Building Automation Systems
Model	EMTX
Literature Type	Installation/Operation/Maintenance
Sequence	3
Date	December 1990
File No.	SV-ES-BAS-EMTX-IOM-3-1290
Supersedes	New

The Trane Company
3600 Pammel Creek Road
La Crosse, WI 54601-7599

Chiller Sequencer Specifications

Environment

- **Operating.** 32 F to 120 F, with 5% to 95% relative humidity, noncondensing.
- **Storage.** -50 F to 200 F, with 5% to 95% relative humidity, noncondensing. (A controlled storage environment is recommended.)

Cabinet

- **Type.** NEMA-1 enclosure for standard ambients; *not* suitable for outdoor exposed mounting.

  Enclosure includes factory-installed 24 VAC, 75 VA transformer to power chiller sequencer card. Transformer also provides an additional 35 VA to power external binary output load relays; a separate field-supplied 1.5-amp fuse must be provided for the external load.
- **Dimensions.** 14" high x 15.5" wide x 3.5" deep.
- **Weight.** 12 pounds.
- **Mounting.** Use four #10 fasteners to mount panel *indoors* on any flat horizontal or vertical surface (e.g., wall, ceiling or on controlled equipment).
- **Recommended Clearances.** 2" at left and right sides, 24" in front, and sufficient clearance above and below to make conduit connections.

Power Requirements

- **Nominal Rating.** 120 VAC; 50/60 Hz; 1.0 amp; nondedicated power source.
- **Voltage Utilization Range.** 98-132 VAC.

Inputs/Outputs

- **Analog Inputs (3).** Each accepts a -30 F to 220 F thermistor-type temperature sensor.
- **Binary Inputs (4).** Monitor isolated, ungrounded contacts; each input provides 12 VDC or 12 mA, minimum.
- **Analog Outputs (2).** Each output provides a continuous signal for a chiller setpoint input, capable of 0 to 10 VDC into a load impedance of 500 ohms or more, or 0 to 20 mA into a load impedance of 500 ohms or less.
- **Binary Outputs (6).** Relay contacts are Form C, NO/NC, and are rated for 24 VAC/VDC, 1 amp, 24 VA pilot duty.

LCD Display/Keypad

- **Display/Keypad.** Two-line by 20-character backlit liquid crystal display (LCD) read-out and four-button operator keypad. Display shows panel name, current time and date, and 32 point status items and/or setpoints. Interface operating ambient range is 30 F to 120 F.
- **RS-232 Interface.** *For use by factory personnel only.*

Application Considerations

Panel Overview

Trane's Chiller Sequencer is a dedicated chiller sequencing panel specifically designed to provide coordinated control of two parallel-piped chillers *plus* the associated chilled water pumps. Entries made at the front panel (see ***Panel Setup***, pp. 26-27) allow the operator to configure the Chiller Sequencer for either **basic** or **setpoint control** operation; the differences between these configurations are summarized in Table 1 on the facing page.

Note: *From this point on, references to "Chiller Sequencer" appearing in this manual apply to* ***both*** *operator-configured versions of the panel. "Basic Chiller Sequencer" and "Setpoint Control Chiller Sequencer" will be used to identify information pertaining only to one or the other of the panel configurations.*

Primarily intended for use with 20 through 60-ton Trane air or water-cooled chillers with 3-D™ Scroll compressors, the Chiller Sequencer's generic interface allows it to control virtually any Trane or non-Trane chiller that: *(a)* is equipped with a leaving water temperature controller, and *(b)* can be started and stopped via a contact closure.

Other chiller constraints are detailed later in this section; see *Panel Compatibility: Allowable Chiller Types* on the facing page.

Chiller Sequencer features are outlined below.

- **Hardware.** A NEMA-1 enclosure houses the Chiller Sequencer's processor/memory/ terminator card. A 24 VAC transformer with resettable secondary circuit breaker is factory-installed on top of the enclosure.

- **Inputs/Outputs.** All input/output (I/O) data is provided through direct-wired analog and binary circuits. The ***Input/Output Wiring*** section of this manual (pp. 17-22) details the specific inputs and outputs available.

  Note: *Sensors for monitoring system entering and leaving chilled water temperatures are included with the panel.*

- **Operator Interface.** A 20-character, backlit liquid crystal display (LCD) and four-button keypad allow the user to edit control values for system operation and monitor the status of 32 system parameters, including system and individual chiller status, and system supply and return water temperatures.

- **Software.** The Chiller Sequencer's control routines — including those for optional chilled water reset — are written in Process Control Language (PCL) and factory- downloaded to the processor card where they are stored permanently in nonvolatile (EEPROM) memory. Since nonvolatile memory is also used to store user-entered control settings, no battery back-up is needed. In the event of a power interruption, the Chiller Sequencer will resume normal operation as soon as power is restored.

Panel Compatibility

Allowable Chiller Types

The *Setpoint Control* entry — a binary parameter entered by the operator during setup — not only determines panel configuration (**basic** or **setpoint control**), but chiller compatibilty as well.

Basic Chiller Sequencer

Entering NO for the *Setpoint Control* parameter configures the Chiller Sequencer for **basic** operation. (See Table 1.) In this configuration, the panel can be used with virtually any chiller of any manufacture — as long as it can be started and stopped by a contact closure.

Since chilled water pump control is accomplished via contact closures, too, the Basic Chiller Sequencer can also accommodate other chiller control schemes that start and stop the chiller by starting and stopping the associated chilled water pump.

Setpoint Control Chiller Sequencer

If the Chiller Sequencer is configured for **setpoint control** operation (i.e., the *Setpoint Control* entry is YES; see Table 1), the panel uses a variable 2-10 VDC or 4-20 mA signal to adjust the chiller setpoint between 0 F and 65 F.

At present, the following Trane chillers, as shipped, are compatible with the Setpoint Control Chiller Sequencer interface — *provided* they are equipped with the *External Setpoint* option:

- Model CGAD Cold Generators® (air-cooled, 20 through 60 tons);
- Model CGWD Cold Generators (water-cooled, 20 through 60 tons);
- Model CCAD Compressor-Chillers (air-cooled, 20 through 60 tons);
- Model RTAA Series R™ Chillers (air-cooled, 130 through 400 tons); and,
- Gas Engine-Driven Chillers.

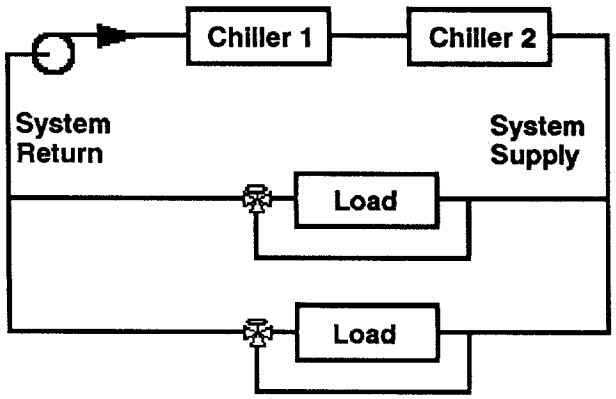
With field modifications, other Trane and non-Trane chillers can be controlled by a Setpoint Control Chiller Sequencer. The only requirements are that the chillers include their own leaving water temperature controllers and provide some means of varying the chilled water setpoint based on an analog input. In addition, each chiller's remote setpoint input must be adapted to accept the Setpoint Control Chiller Sequencer's 2-10 VDC or 4-20 mA output signal.

***Note:** It is possible to combine Setpoint Control Chiller Sequencer control of a chiller that does not*

Table 1
"Basic" vs. "Setpoint Control" Chiller Sequencer Operation

	BASIC CHILLER SEQUENCER ("Setpoint Control" = No)	SETPOINT CONTROL CHILLER SEQUENCER ("Setpoint Control" = Yes)
Control Functions Provided	• Chiller Sequencing • Chilled Water Pump Control • System Ice-Making Control	• Chiller Sequencing • Chilled Water Pump Control • System Chilled Water Reset • System Ice-Making Control
Trane Chiller Control Compatibility	• Requires *standard* chiller controls. • Is *not* compatible with chiller "Chilled Water Reset" option. • *Is* compatible with chiller "Relay," "Remote Display" and "Communications" options.	• Requires chiller controls with "External Setpoint/Chilled Water Reset" option. • Is compatible with chiller "Relay," "Remote Display" and "Communications" options.
Chiller Interface	• *Generic binary interface;* requires manual coordination between chiller sequencer and individual chiller setpoints.	• *Analog setpoint interface;* no manual chiller sequencer/chiller setpoint coordination required.

Figure 1
***Unacceptable* Chiller Piping Arrangement for Chiller Sequencer Control (Series-Piped System)**



include remote setpoint capability with one that does (e.g., as may be the case when a chiller is added to an existing facility). In this instance, the control limitations of the Basic Chiller Sequencer will apply to the chiller without remote setpoint control. For best results, the chiller without setpoint control should always be the lag chiller.

Allowable System Types

Chiller Sequencer panels are specifically designed to control chilled water systems with **two chillers** piped in a **parallel** arrangement. ***Series-piped chiller systems*** *like the example shown above in Figure 1* ***cannot be controlled by the Chiller Sequencer****, regardless of whether the panel is configured for basic or setpoint control operation.*

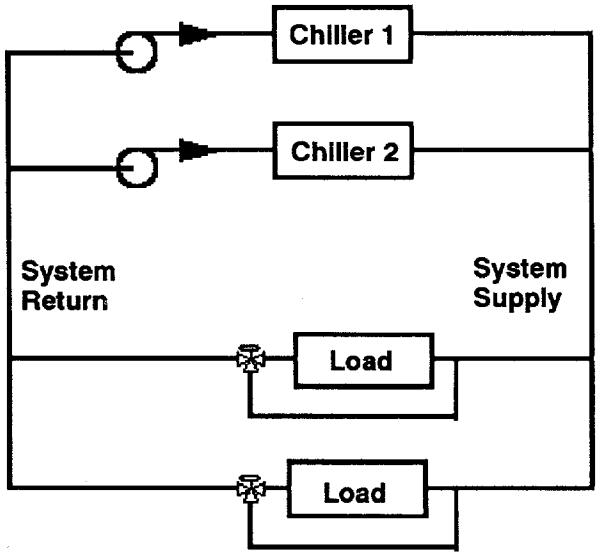
Three basic parallel chiller piping arrangements and an ice-making chiller system are described below.

One-Pump-per-Chiller System (Figure 2)

Each chiller in this system is provided with its own chilled water pump, and the pumps only run when the associated chiller is called to operate. Since the water flowing to the cooling loads only passes through the operating chiller(s), the system supply water temperature always equals the chiller setpoint. The quantity of water flowing to the loads varies as the lag chiller turns on and off.

Chillers piped in this arrangement can be controlled equally well by a Basic or Setpoint Control Chiller Sequencer. When enabled, the Chiller Sequencer starts the lead chilled water pump and enables the lead chiller; it then monitors system supply water temperature to determine when to start the lag chiller. With both chillers operating, the panel monitors the system ΔT to determine when the lag chiller should be stopped.

Figure 2
Parallel Piping Arrangement: One-Pump-per-Chiller System



Single-Pump Chiller System (Figure 3, p. 7)

A single pump provides chilled water flow for both of the chillers in this system. Whenever the pump is operating, water flows through both chillers — regardless of their operating status. When only one chiller is running, its leaving chilled water mixes with the unchilled water leaving the idle chiller; the result is a system supply water temperature that exceeds setpoint. To correct this, the operating chiller's setpoint must be lowered so that the combined water temperature of *both* chillers is at setpoint.

Though both Chiller Sequencer configurations (basic and setpoint control) can be applied to this system type, the Basic Chiller Sequencer is incapable of adjusting chiller setpoints; therefore, it cannot maintain a constant system supply water temperature. The Setpoint Control Chiller Sequencer addresses this by adjusting the setpoint

of the operating chiller so that the mix of chilled and unchilled water remains at the system setpoint.

Note: *Basic Chiller Sequencer control logic uses a modified lag chiller start routine so that the temperature of the mixed water does not start the lag chiller prematurely.*

Figure 3
Parallel Piping Arrangement:
Single-Pump Chiller System

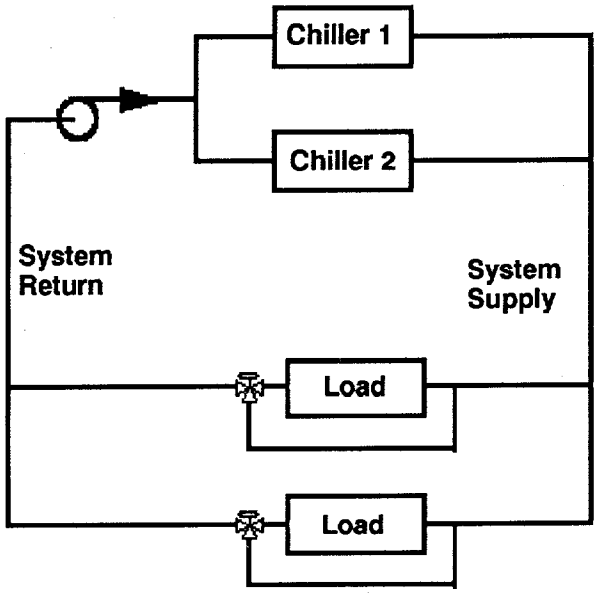
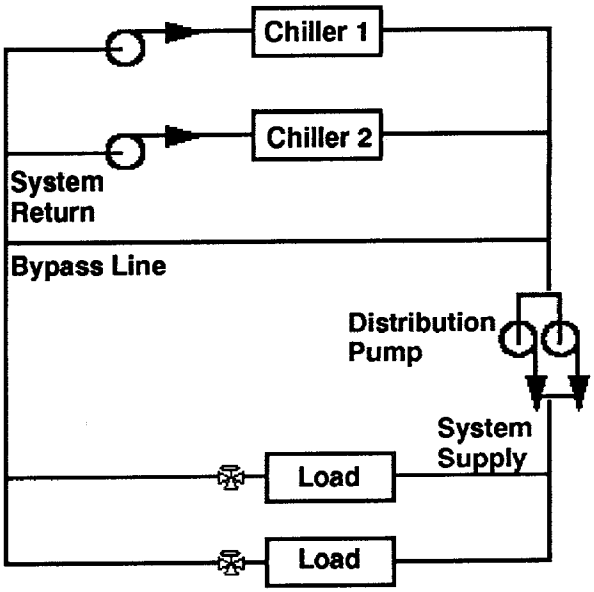


Figure 4
Parallel Piping Arrangement:
Decoupled Chiller System



Decoupled Chiller System (Figure 4)

Each of the chillers in the decoupled system shown in Figure 4 is served by a dedicated chilled water pump; one or more additional pumps, in turn, distribute a *variable* amount of chilled supply water to the loads.

When the chillers supply more chilled water than is needed to satisfy the cooling load, the excess supply water is shunted through a bypass ("decoupler") line to the system return pipe. Similarly, water is shunted from the return pipe to the supply pipe if the chillers furnish less chilled water than is needed to satisfy the load.

The Chiller Sequencer can be used in either of its operating configurations (basic **or** setpoint control) to control a decoupled chiller system. However, proper placement of the system supply and return water temperature sensors is critical – i.e., the supply sensor must be installed on the load side of the bypass, and the return sensor must be placed on the chiller side. For details, see *Sensor Installation* on pp. 10-13.

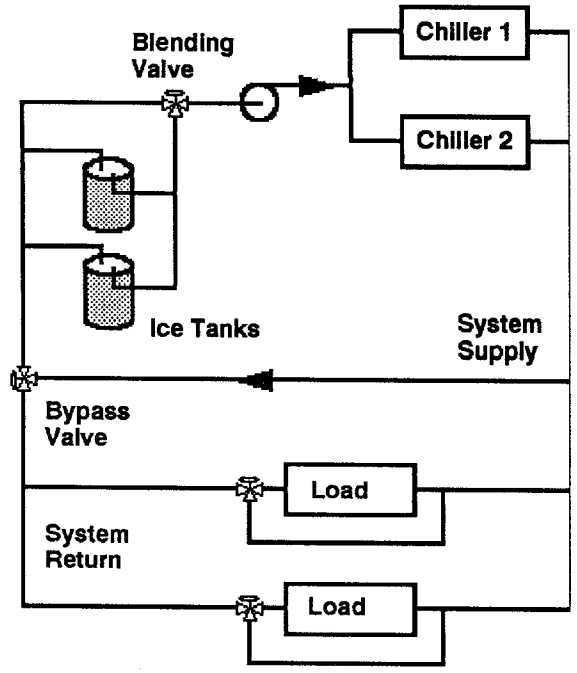
Ice-Making Chiller System (Figure 5, p. 8)

Ice storage systems typically require the chillers to run at a normal leaving fluid temperature (e.g., 40 F) for daytime operation, and at a low temperature (e.g., 20 F) during the ice-building mode. Ice storage controls must also monitor the ice-building process so that chiller and pump operation are terminated when ice-building is complete. The Setpoint Control Chiller Sequencer configuration includes an ice-making mode that simplifies control of chillers and pumps in ice storage systems; the Basic Chiller Sequencer configuration must rely on the chiller to signal completion of the ice mode.

CAUTION! Special unit-level controls are usually required at the chiller before it can be used in an ice storage system; therefore, the ice-making control option, if available, should be specified when the chiller is ordered. Chiller controls *not* specifically designed for ice-making may not be suitable for ice storage

applications, and may cause serious chiller damage if improperly applied in an ice storage system.

Figure 5
Parallel Piping Arrangement:
Typical Ice-Making Chiller System (See Note)



Note: This schematic illustrates just one of many piping arrangements that can be used for an ice-making chiller system.

Remote Displays

Available as an option for 20 through 60-ton Trane Cold Generators® and compressor-chillers with scroll compressors (Models CGAD, CGWD and CCAD), the remote display panel duplicates the chiller control panel's digital display, chilled water setpoint adjustment and auto/stop switch. While they are not incompatible, special operating considerations must be observed when the remote display panel and Chiller Sequencer are applied together:

- **Basic Chiller Sequencer Applications:** Remote display panels can be used as long as the setpoints entered for the chillers (at their front panels *or* remote panels) match the system setpoint entered at the Chiller Sequencer. Any chiller setpoint change made at a remote panel necessitates a similar manual setpoint change at the Basic Chiller Sequencer to assure proper system operation.

- **Setpoint Control Chiller Sequencer Applications:** Setpoints issued to the chillers from the remote display panel are given a higher priority than those from the Setpoint Control Chiller Sequencer. Consequently, chiller setpoints must not be changed from the remote panel when a Setpoint Control Chiller Sequencer is applied in the same system.

  Note: *To avoid accidental setpoint changes from the remote display panel, make sure that the chiller switch on both units is set at Auto/Local.*

Remote Alarm Annunciation

Only **system**-level failures are detected by the Chiller Sequencer. When such a condition exists, the panel opens a set of normally-closed contacts that can be used to remotely signal the failure. For additional information about customer connection points and the types of system failures detected, see the ***Input/Output Wiring*** and ***System Operation*** sections of this manual.

Note: *Though the Chiller Sequencer is unable to detect chiller-level failures, most chiller controls are offered with an alarm package option that can be used in conjunction with the Chiller Sequencer's alarm contacts.*

Mounting Panel Enclosure and Sensors

Inspection upon Receipt

The Chiller Sequencer and its documentation ship in the same carton, along with a matched pair of temperature sensors for monitoring system supply and return water temperature.

Note: *An accessory thermistor-type sensor (purchased separately) is required for Setpoint Control Chiller Sequencer applications performing ambient or zone temperature-based chilled water reset.*

Though all items are thoroughly inspected before leaving the factory, it is important to check them when they arrive at the jobsite to ensure that no shipping damage was incurred. Use the bill-of-lading to verify that all items are present.

If the jobsite inspection reveals damage or material shortage, make the appropriate notation on the carrier's delivery receipt. *File a claim with the carrier immediately,* specifying the extent and type of damage/shortage found; then notify the appropriate Trane sales office representative.

Jobsite Storage

Basic and Setpoint Control Chiller Sequencers are designed for indoor installation only. If the panel must be stored at the jobsite for a period of time before it is installed, make sure that it is placed indoors in a controlled environment. Acceptable storage temperatures range from -50 F to 200 F at a relative humidity of 5 to 95 percent (noncondensing).

Panel Location

Install the Chiller Sequencer indoors in a dustless, corrosive-free environment. When choosing a location, be sure to select one that provides security, is readily accessible for service personnel, and is close to the controlled equipment to minimize wiring costs.

While the panel is designed to operate at temperatures ranging from 30 F to 120 F and at relative humidities of 5 to 95 percent, noncondensing, *avoid extreme operating conditions* (including excessive vibration) whenever possible to extend the life of the panel's electronic components.

CAUTION! To prevent possible control malfunctions caused by interference, do not install the Chiller Sequencer near high- power radio signals, electrical switching gear, power buses, large motors or other sources of electrical noise.

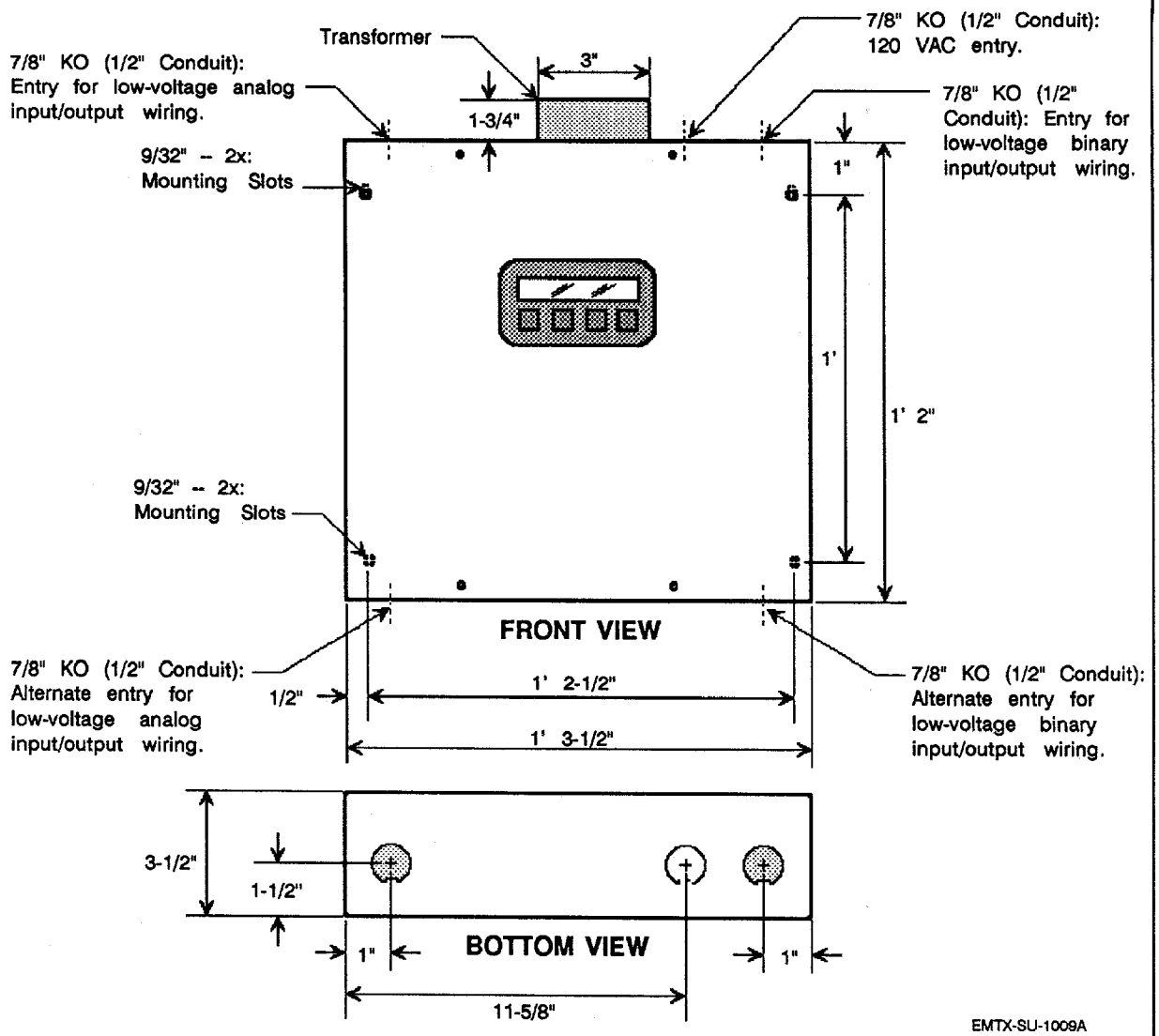
Panel Clearances

The Chiller Sequencer's NEMA-1 enclosure is approximately 14 inches high, 15.5 inches wide and 3.5 inches deep, and includes a removable front cover. Electrical access knockouts are provided at the top and bottom of the enclosure.

The panel can be secured to any *flat* horizontal or vertical surface. Once mounted, the Chiller Sequencer should be easily accessible for service. Provide at least 2 inches of clearance on the left and right sides of the panel, as well as enough space at the top and bottom of the enclosure to complete conduit connections. Ensure that at least 24 inches of clearance are available in front of the panel to accommodate panel wiring and maintenance.

Figure 6 (p. 10) illustrates Chiller Sequencer dimensions and electrical access locations.

Figure 6
Chiller Sequencer Dimensions and Electrical Access Locations



Panel Mounting

Four 9/32-inch holes are provided in the enclosure back panel for mounting. Use #10 mounting hardware (field-supplied) to secure the panel to the mounting surface. Panel dimensions and mounting hole locations are shown in Figure 6. Each Chiller Sequencer weighs approximately 12 pounds.

Note: *Though it is typically installed vertically, the Chiller Sequencer can be mounted on virtually any flat, stable horizontal surface if space is limited.*

Sensor Installation

System Supply/Return Water Sensors

A matched pair of chilled water temperature sensors ships with each Chiller Sequencer. Using these sensors to monitor system supply and return water temperatures, the Chiller Sequencer is able to make appropriate start/stop control decisions for the chillers. To assure proper sequencing operation, however, careful location and installation of the matched sensor pair is critical.

Figure 7
Typical System Chilled Water Temperature Sensor

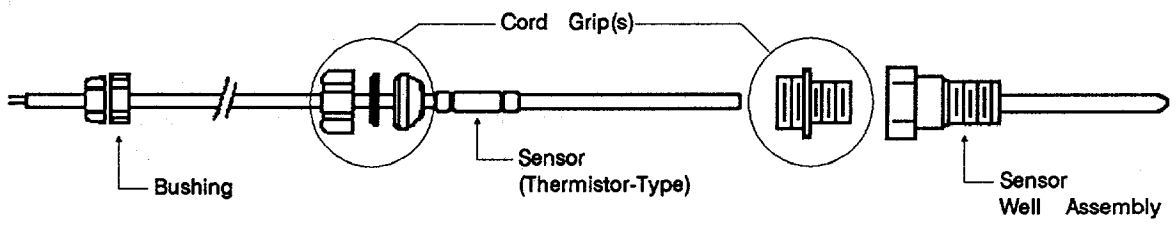


Figure 7 illustrates a typical system chilled water temperature sensor. This sensor (one of a matched pair) can be installed in the thermistor well provided, or fastened directly to the exterior of the system chilled water pipe. Regardless of the installation method used, be sure to select mounting locations that are appropriate for your piping arrangement and that provide representative system water temperature readings.

See Figure 8 (p. 12) for suggested sensor placement; for wiring recommendations and customer connection information, see **Input/Output Wiring** (pp. 17-18).

Surface-Mounting
To surface-mount the water temperature sensors on the exterior of the system chilled water piping:

1. Remove the paint and rust from the pipe surface; then use an emery cloth to expose bare metal.

2. Epoxy the sensor to the pipe surface with a heat-conductive adhesive. Use "Output High-Strength Adhesive" by Loc-Tite (part no. 00240), or its equivalent.

   Note: *Make sure that the sensor tip is in good thermal contact with the pipe, since this is where the temperature-sensitive thermistor is located.*

WARNING! "Loc-Tite" adhesive is an eye irritant, and may irritate sensitive skin. If adhesive comes in contact with skin, flush the affected area with water for 15 minutes and seek medical attention.

3. Wrap the sensor with Armaflex insulation.

Bulbwell Installation
To install the system chilled water temperature sensors in the bulbwells provided, be sure to:

1. Add thermastic paste to each bulbwell *before* inserting the sensor.

2. Verify that the sensor "bottoms out" at the base of the bulbwell.

Accessory Reset Sensor

Note: *An accessory thermistor-type sensor (purchased separately) is required to perform chilled water reset based on a temperature other than system return water. In addition, chilled water reset is only available if* (**a**) *the chiller controls include the "External Setpoint/Chilled Water Reset" option,* **and** (**b**) *the Chiller Sequencer is operator-configured for setpoint control operation (i.e., the "Setpoint Control" entry is YES).*

Installing this sensor allows a Setpoint Control Chiller Sequencer to perform chilled water reset based on a temperature other than return chilled water. Usually, changes in outside air or zone temperature are used to reset the system supply temperature.

Figures 9, 10 and 11 (p. 12) illustrate typical accessory reset sensors and offer installation suggestions. For wiring recommendations, see **Input/Output Wiring** (pp. 17-18).

Figure 8
Recommended Placement for System Chilled Water Temperature Sensors

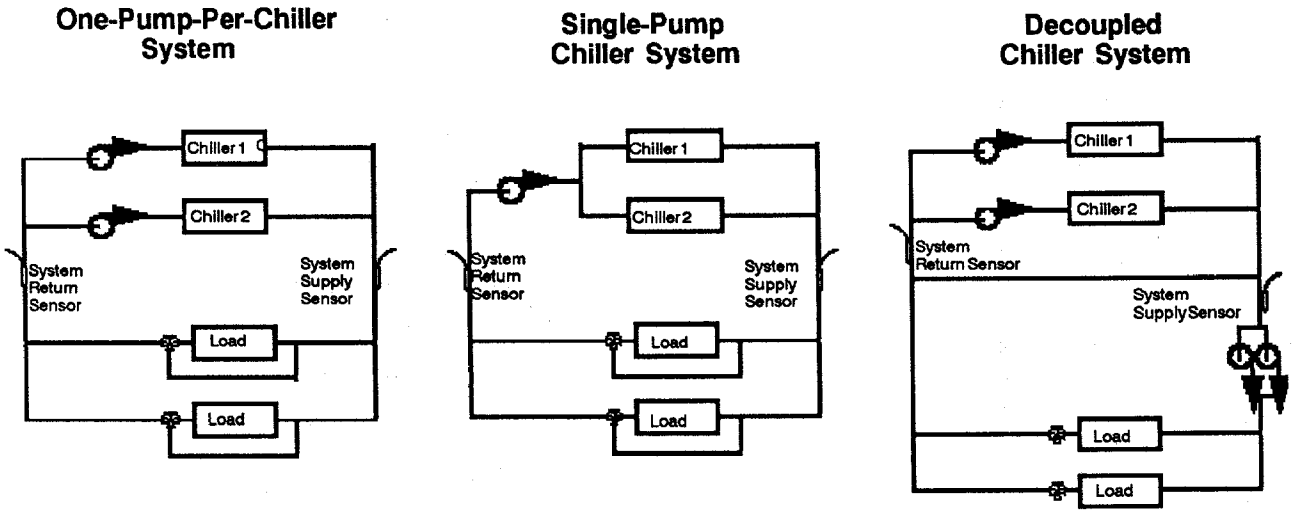
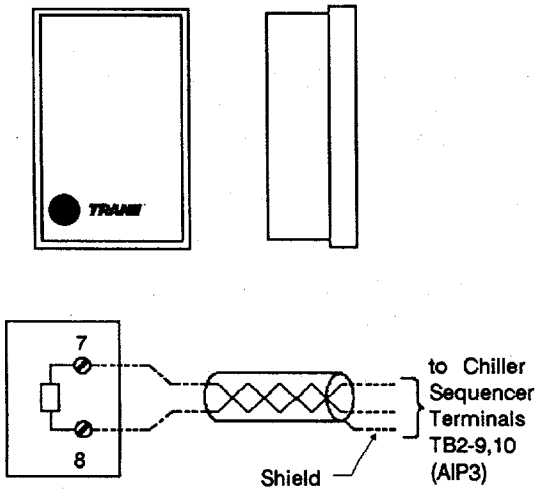


Figure 9
Accessory Zone Temperature Sensor (Order No. 4190-1041)

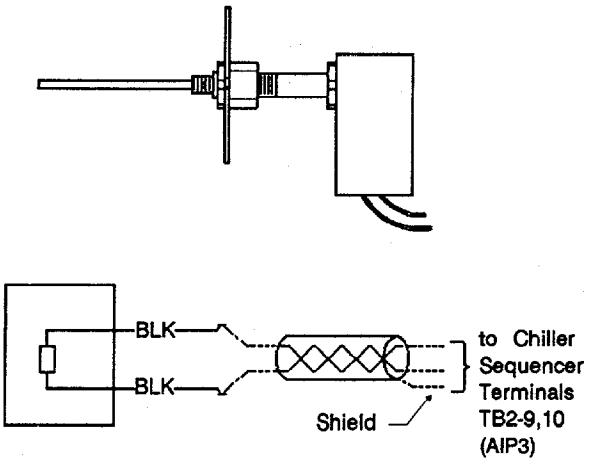


Installation Suggestions:

- Mount the sensor vertically on a standard 2" x 4" outlet box (field-supplied), or on a flat, nonconductive surface in a critical indoor zone.
- Position the sensor approx. 54" above the floor in a location with representative space temperature and air circulation.
- Do not mount the sensor behind doors, in corners or near duct openings, appliances, concealed pipes and chimneys, or unconditioned spaces.
- Wiring must be 18 AWG shielded twisted pair (Belden 8760 or equivalent); shield must be cut back and taped at sensor. See **Input/Output Wiring** later in this manual for further recommendations.

EMTX-SA-3000A

Figure 10
Accessory Duct Temperature Sensor
(Order No. 4190-1043)

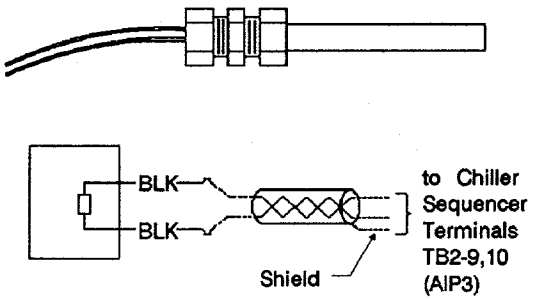


Installation Suggestions:

- Mount the sensor in the fresh air intake duct, at a point where the airstream is typical of the outdoor air temperature.
- Be sure to mount the sensor on a flat duct surface.
- Wiring must be 18 AWG shielded twisted pair (Belden 8760 or equivalent); shield must be cut back and taped at sensor. See **Input/Output Wiring** later in this manual for further recommendations.

EMTX-SA-3001A

Figure 11
Accessory Outside Air Temperature Sensor
(Order No. 4190-1044)



Installation Suggestions:

- Mount the sensor on a waterproof conduit box (field-supplied).
- Choose a mounting location on the north wall of the building that is shielded from direct sunlight, and that is not exposed to exhausts or other heat sources. **Do not install the sensor on the roof!**
- Wiring must be 18 AWG shielded twisted pair (Belden 8760 or equivalent); shield must be cut back and taped at sensor. See **Input/Output Wiring** later in this manual for further recommendations.

EMTX-SA-3002A

Power Supply Wiring

Note: *See Figure 6 (p. 10) for Chiller Sequencer knockout locations.*

WARNING! Before completing panel electrical connections, lock the supply power disconnect switch open to prevent injury or death due to electrical shock.

Circuit Requirements

To assure proper Chiller Sequencer operation, field-install the power supply circuit in compliance with these guidelines:

- Run a nondedicated line from a circuit breaker panel to the Chiller Sequencer.
- Three-wire, 60 Hertz, 1-amp service is required. Panel voltage utilization range is 98 to 132 VAC (120 VAC, nominal).
- Use 16 AWG copper wire and metal conduit.
- Do not run the panel's AC power supply circuit in the same conduit with input or output wiring!
- All field-installed wiring must comply with applicable NEC and local electrical codes.
- The secondary of the factory-installed 24 VAC transformer includes a resettable circuit breaker. If the panel transformer is used to power external binary output load relays, a separate fuse (1.5 amps, maximum) must be field-provided for the external load.

Panel Connections

Use the 7/8-inch knockout on the top right of the panel enclosure as the service entrance for the 120 VAC power supply. (Figure 6, p. 10, shows the conduit entry location.)

Connect the 120 VAC line to the power supply transformer at the top of the enclosure; that is, connect the 120V HOT and NEUTRAL wires to the appropriate transformer leads. Be sure to attach the ground wire to the chassis ground screw provided. See Figure 12 for field wiring connections.

CAUTION! A separate ground wire — *not NEUTRAL!* — must be run and connected to the Chiller Sequencer as part of the AC power connection. Failure to ground the panel in this manner may result in control malfunction or damage due to electrical noise or electrostatic discharge.

Preliminary Checkout and Power-Up

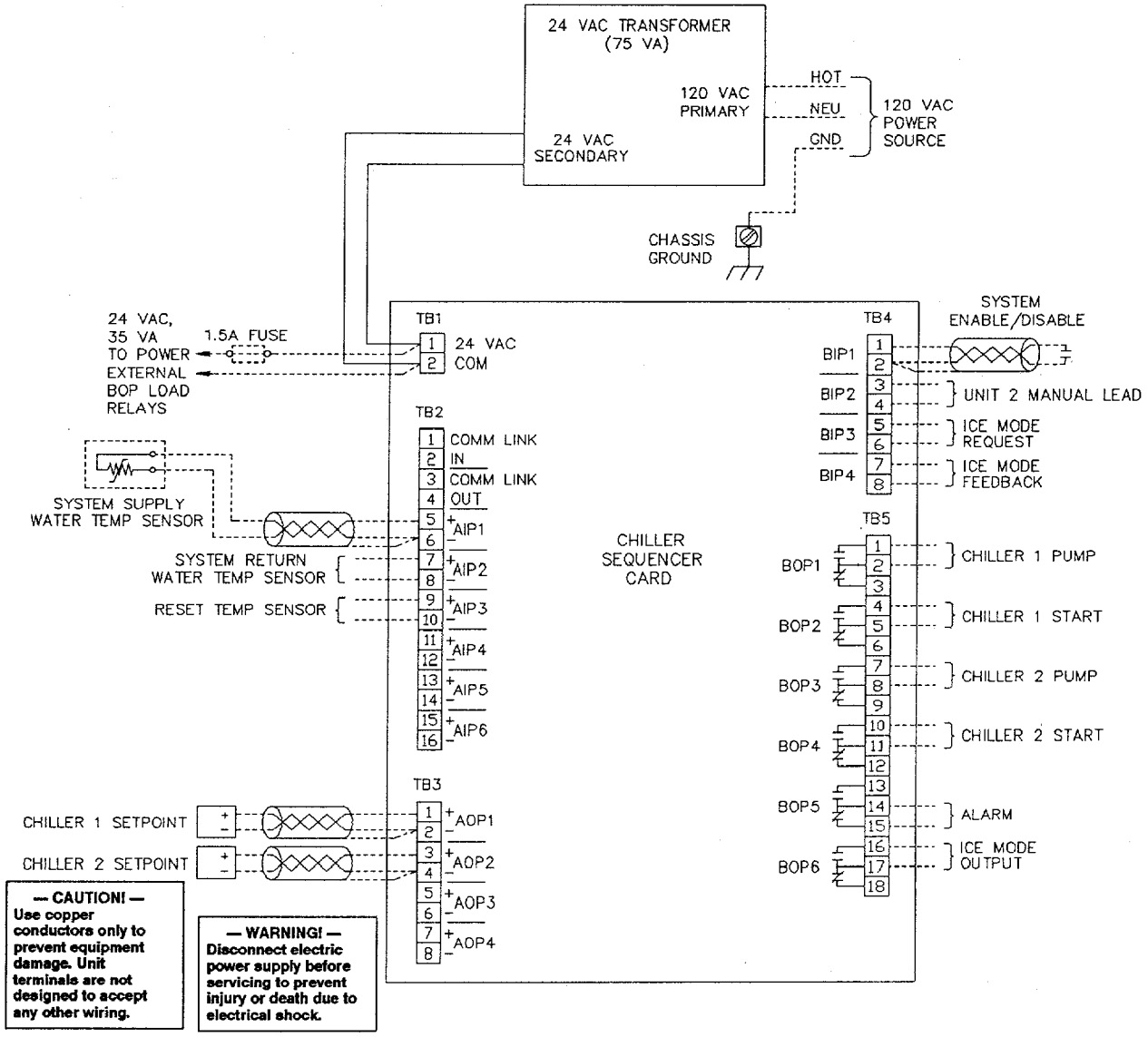
CAUTION! Make sure that the Chiller Sequencer ON/OFF switch (S1) is set at OFF until the following power supply check is completed. Improper voltages applied to the panel may damage its circuitry.

1. After completing the 120 VAC power connections at the Chiller Sequencer transformer *but before applying power to the panel,* verify that AC power switch S1 is set at OFF. (Switch S1 is located on the upper left-hand corner of the printed circuit board.)
2. Verify that all internal panel connections are secure and that the printed circuit board is properly seated.
3. Close the circuit breaker to energize the panel's power supply circuit. Check the voltage between Terminals TB1-1 and TB1-2; it should be 20 to 30 VAC.

WARNING! Use care when measurements must be made with power on to prevent injury or death due to electrical shock.

4. De-energize the panel power supply circuit by opening the circuit breaker.

Figure 12
Chiller Sequencer Customer Connections



Customer Note:

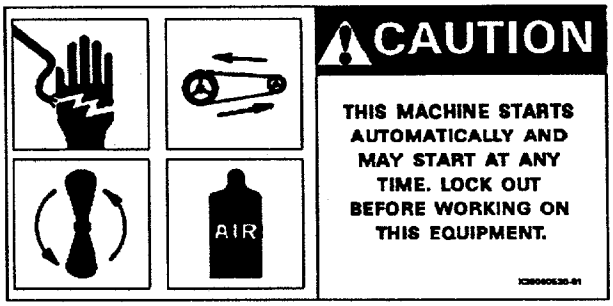
1. Components and wiring shown dashed are furnished and installed by customer.
2. All customer wiring must be in accordance with National Electric Codes and local codes.
3. The Chiller Sequencer requires a 120 VAC, 60 Hz, 1 amp nondedicated AC power source.
4. Binary input (BIP) wiring must be shielded, twisted pairs; recommended size is 18 ga. At input device, shield must be cut back and taped. At BIP terminals, shield must be connected to even-numbered terminal of the respective input. Maximum BIP wiring distance is 1000 feet.
5. Binary inputs must be isolated, ungrounded contacts.
6. Analog input (AIP) wiring must be shielded, twisted pairs; recommended size is 18 ga. At sensor, shield must be cut back and taped. At AIP terminals, shield must be connected to even-numbered terminal of the respective input. Maximum AIP wiring distance is 300 feet.
7. Analog inputs are resistance thermistor temperature sensors (-30 to 220 F).
8. Analog output (AOP) wiring must be shielded, twisted pairs; recommended size is 18 ga. At output device, shield must be cut back and taped. At AOP terminals, shield must be connected to even-numbered terminal of the respective input. Maximum AOP wiring distance is 300 feet.
9. Analog outputs provide a continuous signal for chiller setpoint inputs. Each analog output can provide 0 to 10 VDC into 500 ohms or greater load impedance or 0-20 mA into 500 ohms or less load impedance.
10. Binary output (BOP) relay contacts are rated 24 VAC/VDC, 1 amp, 24 VA pilot duty.
11. In addition to powering the Chiller Sequencer card, the 24 VAC (75 VA) transformer provides an additional 35 VA to power external binary output load relays. A separate 1.5-amp maximum fuse must be provided for the external load.
12. Analog inputs 4, 5 and 6 (AIP4, AIP5, AIP6) and analog outputs 3 and 4 (AOP3, AOP4) are not used.
13. The "Comm Link In" and "Comm Link Out" terminals are not used.
14. All customer connections on the Chiller Sequencer are #4 captive screw terminals with pressure plates, suitable for bare wire terminations.

EMTX-SW-2009A

Warning Labels

Warning labels (Form No. X39000530-01) ship with each Chiller Sequencer panel. Use them to alert operating, maintenance and service personnel to the potential hazards associated with automatically-controlled equipment. Before making any control wiring connections, place one or more labels (Figure 13) in conspicuous locations on each piece of equipment controlled by the Chiller Sequencer.

Figure 13
Warning Label (Form No. X39000530-01)



General I/O Circuit Requirements

Several binary and analog input/output (I/O) circuits must be hard-wired to the Chiller Sequencer to allow it to control chiller system operation. Adhere to these general guidelines when installing the I/O devices and completing the associated wiring:

- All binary and analog I/O wiring is low voltage, and must comply with NEC and local electrical codes. Metal conduit may be required.
- For all I/O wiring, use only shielded, twisted pair copper conductors (Belden 8760 or equivalent).
- Check all I/O wiring for stray AC or DC voltages, and for shorts to earth ground.
- Do *not* run I/O wires and AC power wires together in the same conduit or wire bundle.

CAUTION! Running I/O wires in the same conduit or wire bundle with any AC power wires may cause the Chiller Sequencer to malfunction due to electrical noise.

- At the **contact end** of each I/O circuit, isolate the shield from ground by cutting back and taping the foil shield and shield wire. At the **Chiller Sequencer**, connect the shield wire of each I/O circuit to the even-numbered terminal of the respective I/O.

Figure 12 (p. 15) illustrates typical panel field wiring connections; see Figure 6 (p. 10) for I/O wiring knockout locations. Additional recommendations follow for each I/O circuit type.

Binary Inputs

The Chiller Sequencer provides 12 VDC or 12 mA, minimum, for each binary input (BIP) circuit. As shown in Figure 14 and described below, up to three BIP circuits can be hard-wired to the Chiller Sequencer panel.

- **System Enable/Disable (BIP1).** Normally wired to a time clock, this input can be used to start and stop the chiller system from a remote location. If an ambient interlock is desired, this input can also be wired to a Manual/Off/Auto switch used in conjunction with a thermostat. Panel terminations are **TB4-1** and **TB4-2.**

  Note: *The time clock, Manual/Off/Auto switch and thermostat must be obtained locally.*

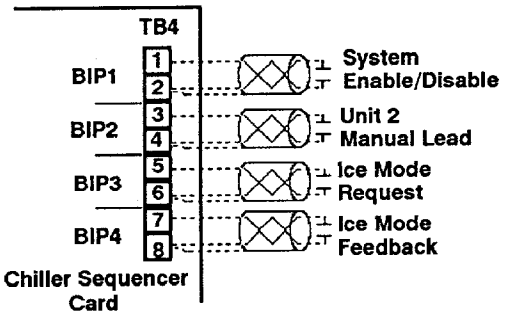
- **Chiller Lead/Lag (BIP2).** This input can be used to change chiller lead/lag designations when *manual* lead/lag control is selected. Open contacts designate Chiller 1 as lead; Chiller 2 is lead when the contacts are closed. Panel terminations are **TB4-3** and **TB4-4.**

- **Ice Mode Enable/Disable (BIP3).** Used on Reset Chiller Sequencers only, this input initiates ice making operation. Panel terminations are **TB4-5** and **TB4-6.**

All binary input devices hard-wired to the Chiller Sequencer must have isolated, ungrounded contacts. Route the BIP wiring from these devices into the panel through the 7/8-inch knockout at the top (or bottom) right of the enclosure. See Figure 6 (p. 10) for knockout locations.

Be sure to connect the bare shield wire to the appropriate even-numbered terminal; see Figure 14. Limit wire runs to 1,000 feet to avoid electrical noise interference.

Figure 14
Typical BIP Wiring



Note: BIP devices must have isolated, ungrounded contacts. Wiring must be 18 ga shielded, twisted pair; maximum wire run is 1000 ft. Cut back and tape shield at input device; at BIP terminals, connect shield to appropriate even-numbered terminal.

Analog Inputs

Each Chiller Sequencer is furnished with a matched pair of thermistor temperature sensors that enables it to monitor the supply and return temperatures of the system chilled water piping circuit. When provided with an accessory reset sensor (purchased separately), *Reset* Chiller Sequencers also monitor a zone or outdoor air temperature to perform chilled water reset.

Note: *Sensor installation and suggested accessory sensors are described on pp. 10-13.*

Route the analog input (AIP) wiring from the thermistors into the Chiller Sequencer through the 7/8-inch knockout at the top (or bottom) left of the enclosure. See Figure 6 (p. 10) for knockout locations.

Be sure to connect the bare shield wire to the appropriate even-numbered AIP terminal. Limit wire runs to 300 feet to avoid possible electrical noise interference.

Panel termination points for each of the analog inputs described below are shown in Figure 15.

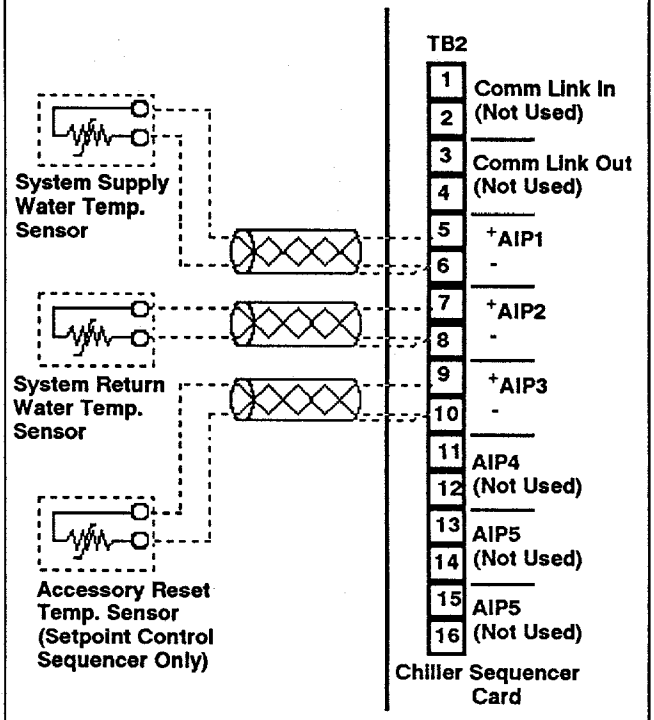
- **System Supply Water Sensor (AIP1).** Connect the leads of the sensor field-installed in the system supply water piping to terminals **TB2-5** and **TB2-6**. This input allows the Chiller Sequencer to monitor the chillers' *common* leaving water temperature, and is used to start and stop the chillers.

- **System Return Water Sensor (AIP2).** Connect the leads of the sensor field-installed in the system return water piping to terminals **TB2-7** and **TB2-8**. This input allows the Chiller Sequencer to monitor the system's *common* return water temperature, and is used to start and stop the chillers.

Note: *System supply and return water temperature inputs — AIP1 and AIP2 — are required for Chiller Sequencer operation.*

- **Reset Sensor (AIP3).** To perform chilled water reset based on a temperature other than return chilled water (i.e., usually outdoor air or zone), connect the leads of an accessory reset sensor to terminals **TB2-9** and **TB2-10**. *This sensor input is only applicable for Reset Chiller Sequencers.*

Figure 15
Typical AIP Wiring



Note: Analog inputs are resistance thermistor temperature sensors with a range of -30 to 220 F. Wiring must be 18 gauge shielded, twisted pair; maximum wire run is 300 feet. Cut back and tape shield at sensor; at AIP terminals, connect shield to even-numbered terminal.

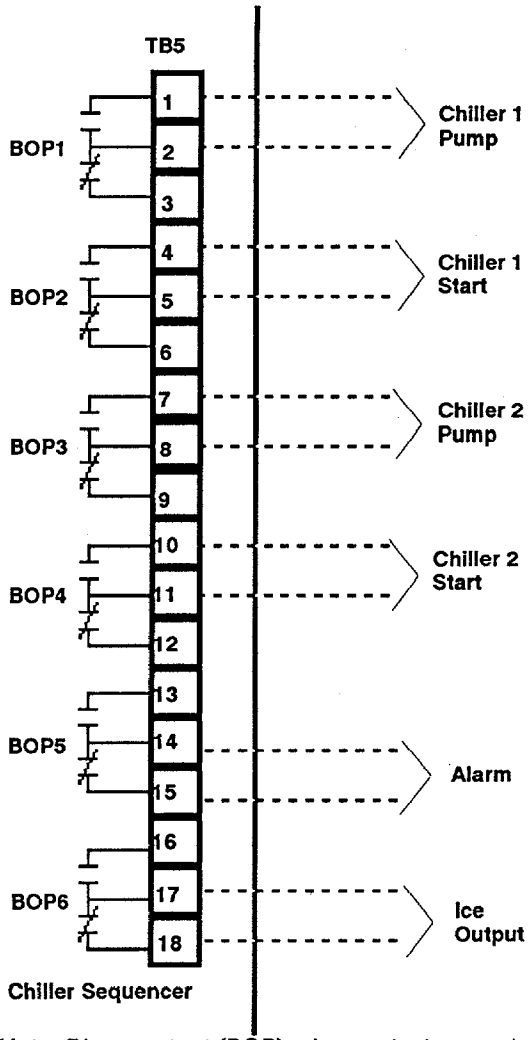
Binary Outputs

The Chiller Sequencer's binary output points (BOP's) provide individual chiller and pump start/stop control, an Ice Mode output, and an alarm output signal that can be used to trigger a field-supplied alarm device in the event of a system-level failure. (See *Failure Recovery/Alarm Annunciation*, p. 34.)

Each of the panel's six binary outputs consists of a set of Form C (normally-open/normally-closed) isolated, ungrounded contacts rated for 24 VAC/VDC, 1 amp, 24 VA pilot duty. To use these BOP's with control circuits requiring a higher voltage or amperage, use external pilot relays with 24 VAC coils to obtain the necessary contact ratings.

Note: *The Chiller Sequencer's 24 VAC transformer can be used to power external BOP relays, but a field-supplied 1.5-amp (maximum) fuse should be installed as separate protection for this 24 VAC circuit.*

Figure 16
Typical BOP Wiring



Note: Binary output (BOP) relay contacts are rated at 24 VAC/VDC, 1 amp, 24 VA pilot duty. Use only 18 gauge stranded, tinned, shielded, copper conductors to wire the BOP circuits.

Route all BOP wiring from the end devices into the panel through the 7/8-inch knockout at the top (or bottom) right of the enclosure. See Figure 6 (p. 10) for knockout locations.

Following is a brief description of each Chiller Sequencer binary output; see Figure 16 for field connections.

- **Chiller 1 Pump Control (BOP1).** Interface the *normally-open* contacts between terminals **TB5-1** and **TB5-2** to the pump's starter circuit to provide start/stop control.

- **Chiller 1 Enable/Disable (BOP2).** To enable or disable Chiller 1, interface the *normally-open* contacts between terminals **TB5-4** and **TB5-5** to that chiller's "External Auto/Stop" input.

- **Chiller 2 Pump Control (BOP3).** Interface the *normally-open* contacts between terminals **TB5-7** and **TB5-8** to the pump's starter circuit to provide start/stop control.

- **Chiller 2 Enable/Disable (BOP4).** To enable or disable Chiller 2, interface the *normally-open* contacts between terminals **TB5-10** and **TB5-11** to that chiller's "External Auto/Stop" input.

- **Alarm Output (BOP5).** To alarm system-level failures, wire the *normally-closed* contacts between terminals **TB5-14** and **TB5-15** to a field-supplied alarm annunciation device.

- **Ice Output (BOP6).** To initiate ice making, interface the normally open contacts between terminals **TB5-16** and **TB5-17** to any valves or ice inputs on the chiller controls required for ice making

  Note: *The Chiller Sequencer's alarm output does not alarm failures that occur at the chillers. If an individual chiller alarm function is required, an alarm package must be added to each chiller and hard-wired to BOP5 separately.*

  Note: *BOP1 through BOP6 will typically need an interface relay with higher voltage contacts (see note in Figure 16).*

Analog Outputs

Note: *The analog outputs described below are only used if the panel is operator-configured as a Setpoint Control Chiller Sequencer and the chillers are equipped with the external setpoint option. (Analog outputs are* ***not*** *used by Basic Chiller Sequencers.)*

Two analog outputs (AOP's) provide an analog setpoint interface between the Setpoint Control Chiller Sequencer and each chiller. Connecting these AOP's to the chillers as described below and shown in Figure 17 (p. 20) allows the panel to issue chilled water setpoints via a continuous 2 to 10 VDC **or** 4 to 20 mA signal.

- **Chiller 1 Setpoint (AOP1).** Terminations for this output circuit are terminals **TB3-1** and **TB3-2**, and Chiller 1's "External Chilled Water Setpoint" input. When properly wired, AOP1 will provide a continuous 2 to 10 VDC — or 4 to 20 mA — signal to control Chiller 1's leaving chilled water setpoint between 0 F and 65 F.

- **Chiller 2 Setpoint (AOP2).** If properly wired, this output issues a continuous 2 to 10 VDC — or 4 to 20 mA signal to control Chiller 2's leaving chilled water setpoint between 0 F and 65 F. Terminations for AOP2 are terminals **TB3-3** and **TB3-4** and Chiller 2's "External Chilled Water Setpoint" input.

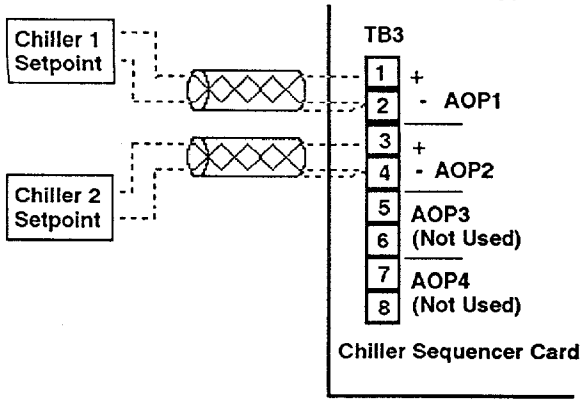
Note: *AOP signal type is determined by the position of jumper plugs J8 and J9 on the printed circuit board. See Table 3, p. 22, for jumper-position/signal -type correlations, and Figure 18, p. 21, for jumper plug locations.*

Note: *The chiller control panel will typically have a DIP switch that enables or disables the external setpoint input (refer to the literature supplied with the chiller for details).*

Route the AOP wiring from the chiller control panels into the Chiller Sequencer through the 7/8-inch knockout at the top (or bottom) left of the enclosure. (Figure 6, p. 10, illustrates knockout locations.)

Be sure to connect the bare shield wire and **negative** input lead to the appropriate even-numbered AOP terminal. Limit wire runs to 300 feet to avoid possible electrical noise interference.

Figure 17
Typical AOP Wiring
(Setpoint Control Chiller Sequencer Only)



Note: Analog outputs provide a continuous signal for chiller setpoint inputs; each AOP can provide 2-10 VDC into a load impedance of 500 ohms or greater or 4-20 mA into a load impedance of 500 ohms or less. Wiring must be 18 gauge shielded, twisted pair; maximum wire run is 300 ft. Cut back and tape shield at sensor; at AOP terminals, connect shield to appropriate even-numbered terminal.

Panel Checkout

PC Board Check

Several components on the Chiller Sequencer card provide the operator with helpful status information that can be used to verify that the board is functioning properly. These components are described below and illustrated in Figure 18.

- **On/Off Switch (S1).** This switch, located in the upper left quadrant of the pc board, can be used to interrupt 24 VAC power to the board and disable all Chiller Sequencer operation.

- **Relay Status LED's.** Six red LED's on the right-hand side of the pc board — **CR17**, **CR20**, **CR25**, **CR28**, **CR31**, and **CR34** — indicate the present status of the adjacent binary output relays. If the LED is lit, the corresponding relay is energized.

  Note: *BOP5 will be lit if the panel has not detected an alarm condition.*

- **Status/Diagnostic LED (CR10).** This LED, located in the upper right quadrant of the circuit board, flashes at regular intervals during normal operation. Service is required if CR10 either fails to light or is lit continuously.

Power-On Sequence

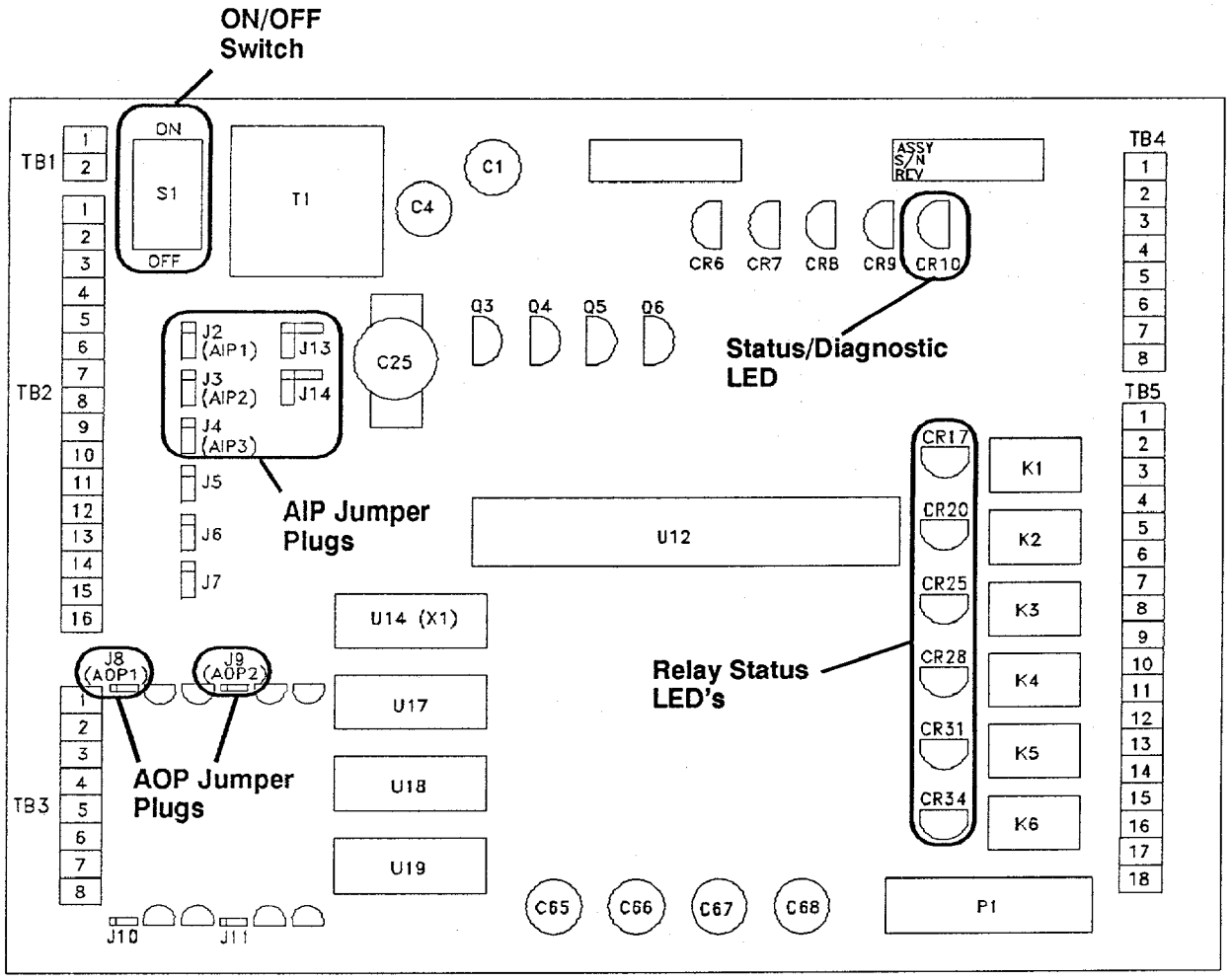
When power is turned on, status/diagnostic LED **CR10** will flash at a faster-than-normal rate during the board's self-diagnostic test. In addition, the **CR8** LED (located just to the left of CR10) will flash twice during the power-on sequence, and the binary output relays and associated LED's will remain off.

I/O Hardware Checkout

1. Remove power from the Chiller Sequencer and from all chillers and peripheral devices connected to it by opening the appropriate circuit breakers and/or disconnect switches.

WARNING! Before performing this I/O wiring check, lock all power supply disconnects open to prevent injury or death due to electrocution.

Figure 18
Chiller Sequencer Card (Partial Component Layout)



2. Check for stray AC or DC voltage between:

   a. each pair of terminals on TB2, TB3 and TB4.

   b. each TB2 terminal and the chassis. Then repeat this check for each TB3 and TB4 terminal.

   Voltage readings obtained in these checks should be less than 0.8 VAC or 0.1 VDC. (Stray voltages in excess of these values may cause the panel to malfunction.)

3. **AIP Check.** Check the resistance of each Chiller Sequencer sensor. To do this:

   a. Disconnect the sensor leads from TB2.

   b. Measure the temperature at the sensor with an accurate thermometer and record the reading observed.

   c. Measure the resistance through the sensor with a digital volt-ohmmeter and record the reading observed.

   d. Convert the recorded resistance value to a temperature using Table 2 (p. 22). Then verify that the temperature corresponding to this resistance value matches (i.e., within the

specified tolerance) the temperature recorded in Step 3b.

If the sensor resistance reading is out of range, replace the sensor.

e. Measure the resistance between each sensor lead and ground; readings obtained should be at least 1 megohm.

f. Reconnect the sensor leads to the appropriate TB2 terminals; refer to Figure 15 (p. 18).

4. **BIP Check.** Disconnect each of the Chiller Sequencer's binary input circuits from TB4; then use an ohmmeter to check the resistance through each pair of input leads.

   An *open* circuit should register a resistance exceeding 10,000 ohms, while a *closed* circuit should register a resistance of no more than 100 ohms.

   Reconnect each BIP circuit to the appropriate panel terminals once the resistance check is complete.

AIP/AOP Jumper Verification

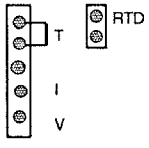
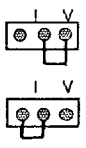
Jumper plugs configure each pair of Chiller Sequencer *analog* input and output terminals for the type of signal used. Use Table 3 to verify that these jumpers are properly positioned. (To determine plug locations, refer to Figure 18, p. 21)

Table 2
Temperature Sensor Resistance Data

Temperature	Sensor Resistance (Ohms)	Input Voltage (See Note)
0 F	87,511.8	3.71
10 F	63,769.6	3.47
20 F	46,919.9	3.18
30 F	34,839.4	2.88
40 F	26,221.1	2.56
50 F	19,995.2	2.25
60 F	15,333.0	1.95
70 F	11,888.8	1.67
80 F	9,297.6	1.42
90 F	7,330.5	1.20
100 F	5,824.3	1.01
110 F	4,661.6	0.84
120 F	3,756.9	0.70
130 F	3,051.0	0.59
140 F	2,493.6	0.49

Note: The acceptable tolerance range for the input voltage values shown here is Ö 0.25 volts with an analog meter.

Table 3
Configurations for AIP/AOP Jumper Plugs

Chiller Sequencer Analog I/O's	Jumper Plug	Signal Type	Required Plug Position
AIP1 (TB2-5,6)	J2, J13	Thermistor	
AIP2 (TB2-7,8)	J3, J14		
AIP3 (TB2-9,10)	J4		
AOP1 (TB3-1,2)	J8	2-10 VDC (500 ohm min. load) **or** 4-20 mA (500 ohm max. load)	
AOP2 (TB3-3,4)	J9		

Operator Interface

The liquid crystal display (LCD) and keypad on the front of the Chiller Sequencer allow the operator to display and adjust a variety of system operating parameters and setpoints.

As shown in Figure 19, this bracket-mounted interface is "windowed" into an opening in the panel enclosure cover. Cables with plug connectors link the keypad and display to the panel's printed circuit board.

Descriptions of available keypad functions and LCD read-outs follow.

Keypad Operation

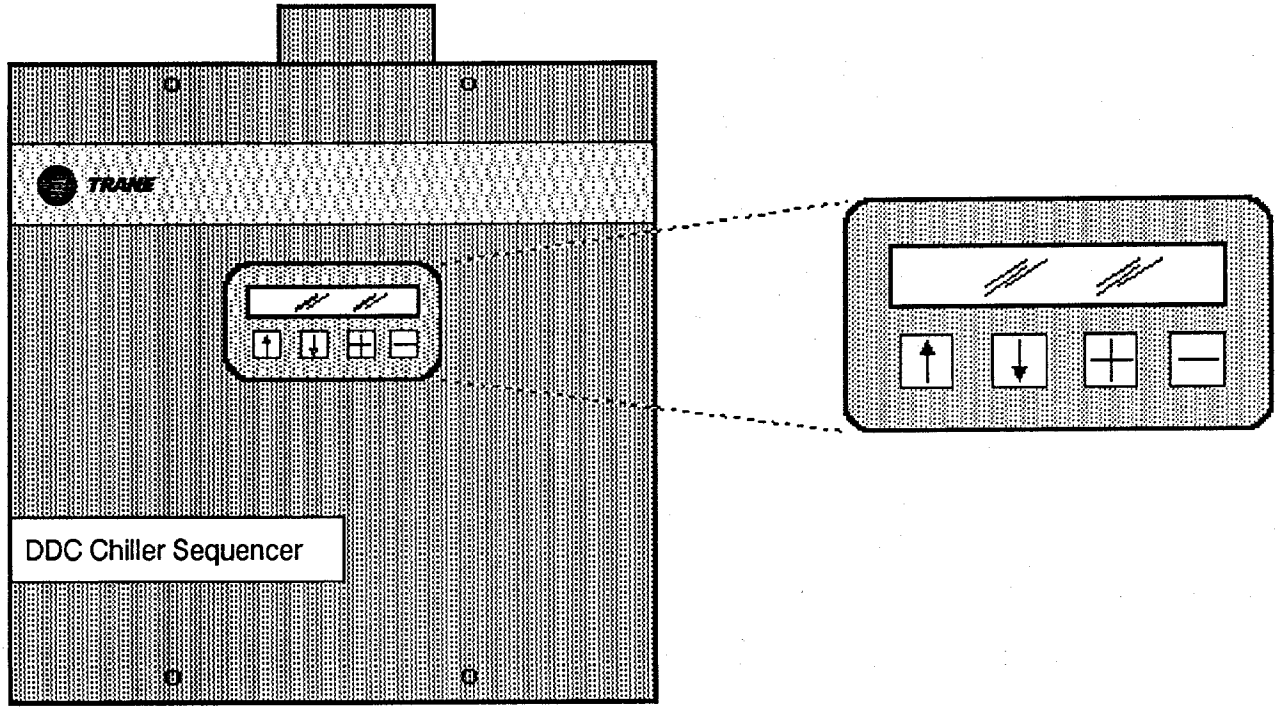
The Chiller Sequencer's four keypad buttons are arranged as shown in Figure 19. Pressing any of these buttons will turn on the display's backlighting. Once lit, the backlighting will remain on for approximately 5 minutes after the last key is pressed, then shut off automatically.

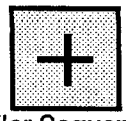
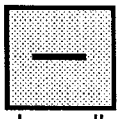
The ↑ and ↓ buttons on the panel's keypad allow the operator to scroll between Chiller Sequencer displays. Following is the display sequence; for additional details about these displays, see *LCD Read-outs* later in this section.

First:	*Date & Time*
Second:	*Chiller Sequencer Name & Status*
Next:	*Point Displays 1 to 32*

Chiller Sequencer displays are arranged in a continuous loop; that is, when the ↓ button is used to scroll past the last display, the first read-out — *Date and Time* — is automatically selected. By the same token, using the ↑ button to scroll past the first display automatically selects the last point display.

Figure 19
Operator Interface for Chiller Sequencer



The Chiller Sequencer's + and – keys allow the operator to change the control values entered on user-adjustable displays. When a **binary** parameter is displayed, press the + and – buttons to toggle between control states (i.e., Yes/No, Auto/Manual or Auto/Stop). When an adjustable **analog** parameter is displayed, use the + or – key to increase or decrease the control value. (Holding down either of these buttons changes the analog value more rapidly.)

Once displayed, the desired binary or analog control value is automatically stored in memory when the operator scrolls to the next parameter — or when no key is pressed for 5 seconds.

Note: *The + and – keys will not alter the displayed control value if the operator is not logged on, or if that parameter is not user-adjustable. A cursor (▒) will appear on all read-outs that accept operator entries. For log-on instructions, see the Log-On/Log-Off Procedures section on pag 25.*

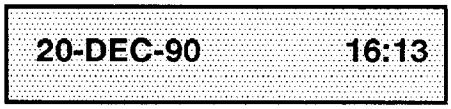
LCD Read-outs

The Chiller Sequencer's LCD displays 32 different read-outs that permit the operator to monitor the status — and change the control values — of various system operating parameters. These read-outs fall into three categories: *Date/Time*, *Name/Status* and *Binary/Analog Points*. Descriptions of each display type follow.

Read-outs can be viewed by using the ↑ and ↓ buttons to manually scroll forward or backward through through the displays. (The Chiller Sequencer does not include an automatic scroll function.) Once a read-out is selected, it remains on the display until a new one is selected. In the event of a power outage, the *Date/Time* read-out is displayed automatically when power is restored.

Dynamic data — i.e., analog values and binary states that appear on the point displays — are refreshed at least once every 5 seconds.

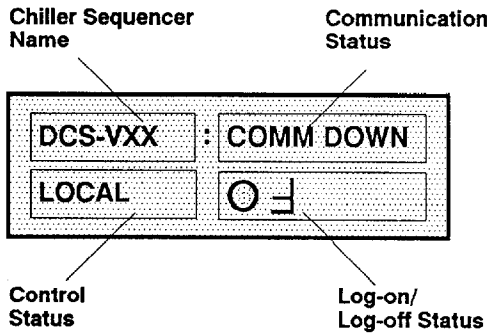
Date/Time Display



The *Date-and-Time* display (represented above) is the first of the Chiller Sequencer's read-outs, and is displayed automatically following a power interruption. To update the panel's calendar and 24-hour time clock:

1. Log on to the Chiller Sequencer. (See *Log-on/Log-off Procedures* on pp. 25-26.)
2. Use the ↑ and/or ↓ keys to scroll to the *Date-and-Time* display; then press the – key to move the cursor to the right side of the field to be changed.
3. Use the + key to change the information in that field.

Name/Status Display

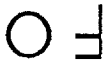


Consisting of four fields (shown above), this read-out provides an overview of the Chiller Sequencer's present status. The following information is displayed:

- **Chiller Sequencer Name.** The name that appears in this field is assigned at the factory and cannot be altered.
- **Communication Status.** This field indicates whether the panel is communicating with a Tracer® building automation system. *Since the Chiller Sequencer is* ***not*** *intended to be part of a Tracer system, the* ***Comm Down*** *message will always appear here.*

- **Control Status.** This field indicates the status of the Chiller Sequencer's automatic control routines. **Local** is typically displayed here, signifying that the control values stored in panel memory are in force. **Manual** will appear in this field if the operator manually disabled these routines by overriding all Chiller Sequencer outputs to their manual values.
- **Log-on/Log-off Status.** The "key" symbol displayed in this field indicates whether or not the operator logged into the Chiller Sequencer's operating system. When the "key" is intact, log-on was successfully completed; a "broken" key indicates that the operator logged off the system. Both key" symbols are shown below. (Log-on and log-off procedures are described later in this section.)

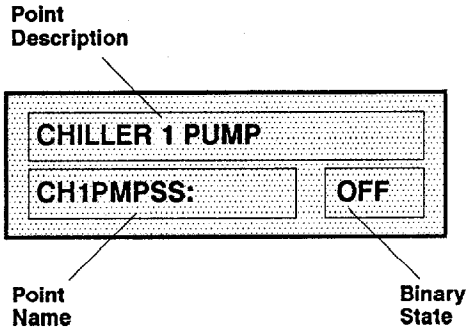
Log-on Symbol



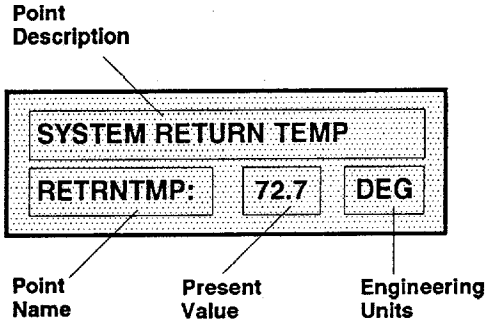
Log-off Symbol

Point Displays
In addition to the *Time/Date* and *Name/Status* displays, Chiller Sequencer read-outs include 32 point displays — one for each of its binary and analog parameters.

As shown below, displays for *binary* points consist of three fields: a description of the point, the point's name and the present binary status of that point.



Analog point displays (like the example shown below) are comprised of four fields: the description and name of the point, its present analog value, and the unit of measure used.



Note: *Displays with user-adjustable point settings include a blinking cursor that appears at the immediate right of the present control value. When logged on to the panel, the control value can be changed by pressing the + and – buttons on the keypad.*

Parameter Setup

The Chiller Sequencer keypad and LCD interface permit the operator to select desired control settings for a variety of binary and analog system operating parameters. Before any of these settings can be modified, however, the operator must first log on to the panel. Procedures for logging on and off the panel are outlined on p. 26. Recommended control settings and instructions for changing these values are also included in this section, along with a list of the Chiller Sequencer's user-adjustable parameters (Table 4, p. 27).

Log-on/Log-off Procedures

Control values for the Chiller Sequencer's user-adjustable parameters cannot be changed unless the operator first logs on to the panel. Log-on status

is verified — **and edited** — from the panel's *Name/Status* read-out. The "key" symbol in the lower right corner of that display (see p. 24) appears intact if the operator is presently logged on ... broken if logged off.

To Log On ...

1. Use the ↑ and ↓ keys to scroll to the Chiller Sequencer's *Name/Status* read-out.
2. Press the + and - keys to enter the four-character password (e.g., +, +, +, +).

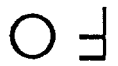
   ***Note:** If an error is made while entering the password, simply re-enter it.*

An intact key symbol (like the one at right) is displayed when log on is successful.

To Log Off ...

1. Use the ↑ and ↓ keys to scroll to the Chiller Sequencer's *Name/Status* read-out.
2. Press the – key once; then use the ↑ and ↓ keys to leave this display and return again.

A broken key symbol (like the one at right) is displayed when log off is complete.



Binary Settings

Of the 32 read-outs available at the Chiller Sequencer display (see Table 4), eight are user-adjustable **binary** control parameters:

SYS ENABLE COMMAND: This point should be "ENABLE" whenever it is desired that the system should be running (the **HARDENAB - BIP1** must also be closed for the system to run). To turn the system off from the LCD display, change this point to "DISABLE".

MANUAL CONTROL: This point must be "YES" before the **UNIT X MANUAL ON** entries can be active, allowing manual chiller selection. If this point is "NO", the **UNIT X MANUAL ON** entries will not be used.

UNIT 1 MANUAL ON: When **MANUAL CONTROL** is "YES", this point will directly control the outputs for Chiller Number 1. If MANUAL CONTROL is "NO", this point has no effect on system operation.

UNIT 2 MANUAL ON: When **MANUAL CONTROL** is "YES", this point will directly control the outputs for Chiller Number 2. If MANUAL CONTROL is "NO", this point has no effect on system operation.

MULTIPLE PUMP SYS: If the chillers have dedicated pumps, this entry should be "YES". If there is a single system pump, this entry should be "NO".

LEAD/LAG CONTROL: If the Chiller Sequencer is to automatically rotate the chiller every day, this entry should be "AUTO". If **UNIT 2 MANUAL LEAD** (BIP2) is to determine the lead chiller, this entry should be "MANUAL".

SETPOINT CONTROL: If the chiller sequencer has control of the setpoints on the chiller control panel through analog outputs 1 and 2, this entry should be "YES". If the chiller sequencer does not have control of the setpoints, this entry should be "NO".

RETURN WATER RESET: If the chiller sequencer is performing chilled water reset based on return water, this entry should be "YES". If the sequencer is performing chilled water reset based on analog input 3 (typically zone or ambient based), this entry should be "NO". If the chilled water reset function is not being used, this entry is not used.

Displays with adjustable control values can be identified by the blinking cursor that appears at the immediate right of the changeable value, as shown below:

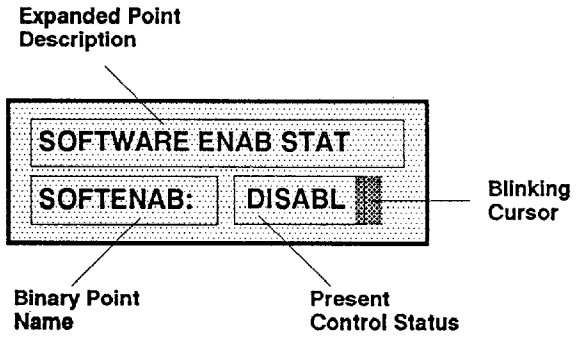


Table 4
Chiller Sequencer Setpoint/Status Displays
(In Order of Apperance)

Display Line	Point Name	Expanded Description	Desc/ Units	Adjust	Adjustment Limits	
					Low	High
1	HARDENAB	SYS ENABLE INPUT	2	NO	-	-
2	SOFTENAB	SYS ENABLE COMMAND	2	YES	-	-
3	ALARM	ALARM OUTPUT	5	NO	-	-
4	ACTIVESP	ACTIVE SYS SETPNT	0	NO	-	-
5	SUPLYTMP	SYSTEM SUPPLY TEMP	0	NO	-	-
6	RETRNTMP	SYSTEM RETURN TEMP	0	NO	-	-
7	RESETTMP	RESET TEMPERATURE	0	NO	-	-
8	SYSTEMSP	SYSTEM SETPOINT	0	YES	.0	65.0
9	CH1 LEAD	CHILLER 1 LEAD	4	NO	-	-
10	CH1SP	CHILLER SETPOINTS	0	NO	-	-
11	CH1PMPSS	CHILLER 1 PUMP	0	NO	-	-
12	CH1SS	CHILLER 1 START	0	NO	-	-
13	CH2PMPSS	CHILLER 2 PUMP	0	NO	-	-
14	CH2SS	CHILLER 2 START	0	NO	-	-
15	MANCTRL	MANUAL CONTROL	4	YES	-	-
16	CH1MANON	UNIT 1 MANUAL ON	4	YES	-	-
17	CH2MANON	UNIT 2 MANUAL ON	4	YES	-	-
18	MAN LEAD	LEAD/LAG CONTROL	3	YES	-	-
19	CH2 LEAD	UNIT 2 MANUAL LEAD	4	NO	-	-
20	ICEREQST	ICE MODE REQUEST	4	NO	-	-
21	ICEFDBK	ICE MODE FEEDBACK	0	NO	-	-
22	ICEOUTPT	ICE MODE OUTPUT	0	NO	-	-
23	MULTPMPS	MULTIPLE PUMP SYS	4	YES	-	-
24	CH1 %	UNIT 1 % OF SYSTEM	4	YES	1.0	99.0
25	DESDELTA	SYS DESIGN DELTA T	0	YES	4.0	20.0
26	ADD BAND	ADD CONTROL BAND	0	YES	.0	20.0
27	ADD TIME	ADD UNIT TIME	11	YES	1.0	99.0
28	SUB TIME	SUBTRACT UNIT TIME	11	YES	1.0	99.0
29	STPTCTRL	SETPOINT CONTROL	4	YES	-	-
30	RWRESET	RETURN WATER RESET	4	YES	-	-
31	RSTSTART	RESET START POINT	0	YES	.0	100.0
32	RESETRAT	RESET RATE	11	YES	.0	20.0

Note: Entering "YES" for the Setpoint Control (STPTCTRL) parameter configures the panel for setpoint control; entering "NO" configures the panel for basic operation (no reset).

Binary Descriptors: 0 = OFF/ON 1 = CLOSED/OPEN 2 = DISABL/ENABLE 3 = AUTO/MANUAL
4 = NO/YES 5 = NORMAL/ALARM 6 = UNOCC/OCCUPY 7 = SHUTDN/NORMAL
8 = HEAT/COOL

Analog Units: 0 = DEG 1 = PSI 2 = KW 3 = KWH 4 = PCT 5 = CFM
6 = AMP 7 = VOL 8 = HG 9 = IN 10 = RH 11 = Blank

To alter the control setting of an adjustable binary parameter:

1. Log on to the Chiller Sequencer. (If necessary, refer to the log-on instructions on page 26.)

2. Use the ↑ and/or ↓ keys to scroll to the desired binary point read-out. (A blinking cursor will appear at the right of the status descriptor — but only if log-on was successful.)

3. Press the + key (ENABLE, MANUAL, YES) or - key (DISABL, AUTO, NO) to select the desired control setting. The new setting is automatically stored in memory if no keys are pressed for five seconds, or upon scrolling to a different read-out.

Analog Settings

As shown in Table 4, Chiller Sequencer read-outs also include eight user-adjustable **analog** control parameters:

SYSTEM SETPOINT: This the system common leaving chilled water setpoint. This setpoint will be modified by the Chilled Water Reset function (if enabled).

UNIT 1 % OF SYSTEM: Enter the percentage of total system cooling capacity that Chiller 1 represents. For example, if Chiller 1 is a 40 ton unit and Chiller 2 is a 60 ton unit, the entry here is "40".

SYS DESIGN DELTA T: Enter the system design chilled water delta temperature (design return water temperature minus design supply water temperature) which is typically 10 degrees.

ADD CONTROL BAND: Enter the number of degrees that the Chiller Sequencer will use in the add equations before considering adding the lag chiller. Refer to the Lag Chiller Start/Stop section on page 32 for details.

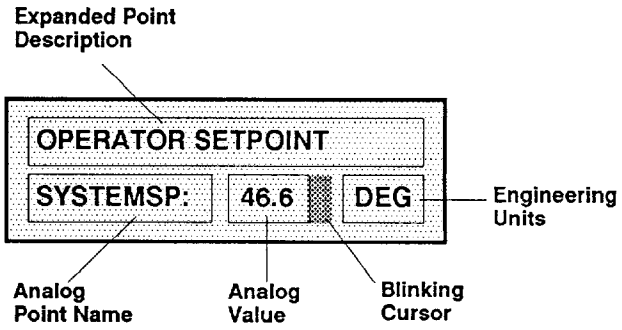
ADD UNIT TIME: Enter the amount of time that the add condition must exist continuously for the Chiller Sequencer to add the lag chiller. Refer to the Lag Chiller Start/Stop section on page 32 for details.

SUBTRACT UNIT TIME: Enter the amount of time that the subtract condition must exist continuously for the Chiller Sequencer to subtract the lag chiller. Refer to the Lag Chiller Start/Stop section on page 32 for details.

RESET START POINT: Enter the value at which ambient or zone based chilled water reset will be active. This entry is not used in a system using return water based reset, or no reset. Refer to the Chilled Water Reset section on page 30 for details.

RESET RATE: Enter the rate of reset used to calculate the Active Setpoint from the System Setpoint. Refer to the Chilled Water Reset section on page 30 for details.

Again, a blinking cursor will appear at the immediate right of the control value (as shown below) if the value can be changed.



To alter the value of an adjustable analog parameter:

1. Log on to the Chiller Sequencer. (If necessary, review the log-on instructions on p. 26.)

2. Use the ↑ and/or ↓ keys to scroll to the desired analog point read-out. (A blinking cursor will appear at the right of the analog value — but only if log-on was successful.)

3. Press the + key to increase the displayed analog value, or the - key to decrease it. (Holding down either of these keys will more rapidly change the displayed analog value.)

   The new analog control setting is automatically stored in memory if no keys are pressed for five seconds, or upon scrolling to a different read-out.

Chiller System Enable/Disable

The Chiller Sequencer's MANUAL CONTROL (MANCTRL) binary parameter permits the operator to choose between automatic or manual chiller system control.

Automatic control is selected by entering NO for the MANUAL CONTROL parameter. In this mode, the Chiller Sequencer decides when to operate the chiller system by checking three status points:

- **SYS ENABLE INPUT (HARDENAB)**, which reflects the present state of the hard-wired *Sys Enable Input*, BIP1. BIP1 permits automatic system on/off control from an external controller (e.g., time clock or building automation system).
- **SYS ENABLE COMMAND (SOFTENAB)**, which provides the operator with on/off control from the Chiller Sequencer keypad.
- **ICE MODE REQUEST (ICEREQST)**, which reflects the present state of the hard-wired *Ice Request Input*, BIP3.

The system will be enabled when BIP1 (HARDENAB) is closed, SOFTENAB is ENABLE, and BIP3 (ICEREQST) is open — the Chiller Sequencer operates the chillers automatically. Conversely, the panel initiates normal shutdown of the chillers and chilled water pumps if it detects that BIP1 is open **or** SOFTENAB is DISABL.

***Note:** Ice Mode operation overrides normal system operation. Therefore, if BIP3 — the "Ice Mode Request" input — is closed, ice-making operation may cause the chillers and pumps to run even if the "System Enable/Disable" input (BIP1) is open.*

Manual control is selected by entering YES for the MANUAL CONTROL parameter. In this mode, the operator commands the chillers on and off individually by changing the entries for the *Unit # Manual On* parameters (CH1MANON, CH2MANON). These parameter settings are overridden when the operator restores automatic control.

***Note:** To avoid unexpected chiller start-up or shutdown, check the individual chiller parameter settings and lead chiller state before switching the Chiller Sequencer from automatic to manual control.*

Scheduled Operation

While the Chiller Sequencer itself does not offer a scheduling function, this capability can be added in the field by connecting a field-supplied external time clock or building automation system to the panel's *System Enable/Disable* input (i.e., BIP1; identified as *SYS ENABLE INPUT* on the Chiller Sequencer display). With the addition of a field- supplied thermostat, ambient interlock is also available.

To manually override the system to "off," either: *(a)* use the Chiller Sequencer keypad to change the *SYS ENABLE COMMAND* parameter to DISABLE; or, *(b)* use a field-supplied Manual/Off/Auto switch wired into the BIP1 circuit.

Setpoint Control

Selecting YES for the MANUAL CONTROL parameter specifies the Chiller Sequencer's manual control mode, and prompts the panel to send both chillers the *System Setpoint* (SYSTEMSP) value entered at the keypad. If the chillers were in Chilled Water Reset when switched to manual, the setpoint will slowly approach the System Setpoint. Chiller Sequencer configuration — **basic** or **setpoint control** — determines how setpoint control is accomplished. Selecting "YES" for the SETPOINT CONTROL parameter specifies the Chiller Sequencer's Setpoint Control mode, while selecting "NO" specifies the Basic mode. Differences in operation are described below.

Basic Chiller Sequencer
When configured for basic operation, the Chiller Sequencer relies solely on contact closures to control the chillers. Consequently, any *System Setpoint* entered at the Sequencer keypad must also be set manually at both chiller control panels. Each chiller control panel is then expected to

maintain this setpoint within the operating limits allowed.

Note: *The Chiller Sequencer's "System Setpoint" must match the leaving chilled water setpoints at the chillers, or the panel will not sequence the chillers properly. Individual chiller setpoints must not be adjusted remotely — i.e., via a remote display panel or the chiller's "External Setpoint Input" — unless the change is coordinated with a manual setpoint change at the Basic Chiller Sequencer.*

Setpoint Control Chiller Sequencer
No manual setpoint coordination is required between the chillers and a Reset Chiller Sequencer. Instead, the *System Setpoint* value entered at the Chiller Sequencer is sent to the "External Setpoint Input" of each chiller via a 2-10 VDC or 4-20 mA signal. The Chiller Sequencer then modifies this setpoint as needed to provide chilled water reset; see *Chilled Water Reset*, p. 30, for details. The setpoint may also be modified for single pump systems with only one chiller operating. See the Single Pump Chiller Systems section on this page.

Each chiller control panel determines the range of setpoint values it will accept from the Reset Chiller Sequencer: minimum and maximum setpoint values are established by the chiller's Low Leaving Water Temperature Cutout setting and the "External Setpoint Input" end-of-range value (65 F), respectively.

In the event that the system supply or return water temperature sensor fails, the Chiller Sequencer resets both chiller setpoints to the *System Setpoint* value entered at the keypad.

Note: *Setpoints issued to the chillers from remote display panels receive higher priority than those sent by the Chiller Sequencer. Consequently, the chiller switch on* ***both*** *units should be set at AUTO/LOCAL to avoid accidental setpoint changes.*

Single-Pump Chiller Systems. When only the **lead** chiller is operating, the Setpoint Control Chiller Sequencer varies its chilled water setpoint to maintain a constant system supply water temperature. The formula used to determine the lead chiller's setpoint is as follows:

$$CHSP = \frac{[\,ACTIVESP - (RETRNTMP \times LAGCAP)\,]}{LEADCAP}$$

where:

CHSP	=	*Chiller Setpoint*
ACTIVESP	=	*Active System Setpoint*
LAGCAP	=	*Lag (Idle) Chiller's Percent of System Capacity*
LEADCAP	=	*Lead (Operating) Chiller's Percent of System Capacity*
RETRNTMP	=	*System Return Temperature (AIP2)*

If the **lag** chiller is enabled, the Chiller Sequencer sets **both** chiller setpoints equal to the *Active Sys Setpnt* (ACTIVESP).

Chilled Water Reset

(Setpoint Control Chiller Sequencers Only)

Note: *Because it has no control over chiller setpoints, a panel configured as a* ***Basic*** *Chiller Sequencer — i.e., "Setpoint Control" = NO — is unable to provide system-level chilled water reset (CWR). Furthermore, chilled water reset must not be installed at the chillers, since the Sequencer monitors system supply water temperature to determine when to start an additional chiller. If, for example, a chiller's CWR controls reset that unit's leaving water temperature upward, the Chiller Sequencer might bring the other chiller on-line in resonse to the increased system supply water temperature.*

Chiller Sequencer software includes a chilled water reset function that resets the system supply water setpoint *upward only* based on return water temperature. Alternatively, use of an accessory reset sensor (purchased separately) permits ambient or zone-based chilled water reset.

Regardless of the method of chilled water reset used, the following operator entries must be made at the Chiller Sequencer keypad to enable the chilled water reset function ...

- **Setpoint Control (STPTCTRL) Parameter:** Enter YES to configure the panel as a *Setpoint Control* Chiller Sequencer.
- **Return Water Reset (RWRESET) Parameter:** Enter YES to base reset on return water

temperature, or NO to base it on an accessory sensor input.

- **Reset Start Point (RSTSTART) Parameter:** If ambient or zone-based reset is used, enter the temperature at which chilled water reset is enabled; values ranging from 0.0 to 100.0 DEG (°F) are accepted.

  No entry is required here if reset is based on return water temperature. Instead, the *Reset Start Point* is calculated from the *System Setpoint* (SYSTEMSP) and *System Design Delta-T* (DESDELTA) entries, as shown below:

  RSTSTART = SYSTEMSP + DESDELTA

- **Reset Rate (RESETRAT) Parameter:** Enter a value between 0.0 and 20.0 to indicate the number of degrees of setpoint reset desired for each degree of temperature change.

Using this information, the Setpoint Control Chiller Sequencer solves the following equation *once each minute* to provide the appropriate amount of chilled water reset. To assure stable operation, setpoint changes are limited to 0.25 F per minute.

ACTIVESP =
SYSTEMSP + [RESETRAT x (RSTSTART – RESETTMP)]

where:

ACTIVESP	=	*Active Sys Setpnt*
SYSTEMSP	=	*System Setpoint*
RESETRAT	=	*Reset Rate*
RSTSTART	=	*Reset Start Point*
RESETTMP	=	*Reset Temperature (AIP1 or AIP2)*

The **maximum** temperature to which the system setpoint can be reset equals the values entered for the *System Setpoint* ***plus*** the *Sys Design Delta-T* parameters. The **minimum** setpoint permitted is the *System Setpoint* value; this value also becomes the *Active Sys setpnt* if the reset sensor fails.

Start/Stop Control

Pumps and Chillers

A pair of binary outputs is provided for each controlled chiller. The Chiller Sequencer uses one BOP to enable and disable the chiller, and the other to start and stop the associated chilled water pump. Pump control for single-pump chiller systems is accomplished by connecting the pump outputs for Chillers 1 and 2 (BOP1, BOP3) in parallel.

Whenever the Chiller Sequencer is enabled, the lead chiller pump output is on (closed); the lag chiller pump output is only on when the Sequencer selects the lag chiller for operation.

Upon selecting a chiller to start, the Chiller Sequencer simultaneously energizes the chiller and pump outputs for that unit. To safely control all types of chillers, the panel shuts down a chiller by disabling the **chiller** BOP one minute **before** disabling the associated **pump** BOP.

Note: *Trane CGAD installation instructions require field-installation of a time delay relay on the chilled water pump contactor. While use of this time delay with the delay imposed by the Chiller Sequencer is not required, the presence of both time delays will not adversely affect operation.*

Lead/Lag Control

An entry at the Chiller Sequencer keypad allows the operator to choose either automatic or manual chiller rotation. Selecting AUTO for the *Lead/Lag Control* parameter prompts the Sequencer to use its internal time clock to rotate the chillers. If MANUAL is selected, the panel's Unit 2 Manual Lead input (BIP2) determines which chiller is the lead.

To prevent rotation, select MANUAL rotation and do not change the state of the Unit 2 Manual Lead input (BIP2).

Automatic Rotation. A timing function within the Chiller Sequencer enables the panel to rotate the chillers automatically. Rotation occurs daily at midnight, and is not user-adjustable. Automatic chiller rotations are "forced" — i.e., they occur without waiting for system shutdown or load fluctuations. Some pump overlap is "built in" for

transitions from one sequence to another to prevent loss of chilled water supply on single-pump systems.

Manual Rotation. If manual lead/lag rotation is selected, the Chiller Sequencer looks at the status of its Unit 2 Manual Lead input (BIP2) to determine the rotation sequence. When BIP2 is **open**, Chiller **1** is **lead** and Chiller 2 is lag; this order is reversed when BIP2 is **closed** — i.e., Chiller **2** is **lead** and Chiller 1 is lag.

If the operator switches from manual to automatic rotation, the present operating sequence is maintained until midnight.

Lag Chiller Start/Stop

The Chiller Sequencer's control routine enables it to decide when to start and stop the lag chiller. User entries made at the panel keypad tailor this routine to accommodate various system types.

Among these user entries are *Add* and *Subtract* timing values that prevent the lag chiller from cycling due to brief fluctuations in water temperature. That is, before a start or stop is executed, the start or stop conditions defined by panel control logic must be met for the length of time established by the *Add* and *Subtract* timers.

These timers, which are individually adjustable from 1.0 to 99.0 minutes, are **reset to zero** whenever the Chiller Sequencer is **disabled** or operating in either the **manual** (MANCTRL = YES) or **ice-making** mode. (Resetting the timers to zero in these instances prevents the lag chiller from starting or stopping due to an existing "start" or "stop" command.)

Two other user entries that contribute to the Chiller Sequencer's start/stop logic are:

- **"Add" Control Band (ADD BAND)**, which can be set between 0.0 and 20.0 F, and is used to decide when to **start** the lag chiller; **and ...**
- **Unit 1 % of System (CH1 %)**, which sizes Chiller 1 as a percent — 0.0 to 99.0% — of total system capacity, and is used to decide when to **stop** the lag chiller.

Note: *If "Add" (start) and "Subtract" (stop) commands exist simultaneously, the panel acts on the "Add" command first to assure that the lag chiller continues operating in the event that the lag chiller fails.*

Lag chiller start/stop control logic for various system piping arrangements is described below.

Lag Chiller Start

The Chiller Sequencer issues a "start" signal to the lag chiller when the following equation is met continuously for the duration of the *Add* time period — **or** if the system return or supply water temperature sensor fails:

- **One-Pump-per-Chiller and Decoupled Systems, *plus* Single-Pump Systems with Setpoint Control Chiller Sequencers ...**

$$SUPLYTMP > ACTIVESP + ADD\ BAND$$

where:

SUPLYTMP = *Actual System Chilled Water Supply Temperature*
ACTIVESP = *Active System Setpoint*
ADD BAND = *"Add" Control Band Value (Operator-Entered)*

- **Single-Pump Systems with Basic Chiller Sequencers ...**

$$RETRNTMP > ACTIVESP + DESDELTA + ADD\ BAND$$

where:

RETRNTMP = *Actual System Return Chilled Water Temperature*
ACTIVESP = *Active System Setpoint*
DESDELTA = *System Design Delta-T Value (Operator-Entered)*
ADD BAND = *"Add" Control Band Value (Operator-Entered)*

Lag Chiller Stop

The Chiller Sequencer gives the lag chiller a "stop" signal when the following equation is met continuously for the duration of the *Subtract* time period.

SYSDELTA < DESDELTA x LEADCAP x 0.8

where:

SYSDELTA	=	*Actual System Return Chilled Water Temperature* **Minus** *Actual System Supply Chilled Water Temperature*
DESDELTA	=	*System Design Delta-T Value (Operator-Entered)*
LEADCAP	=	*Lead (Chiller's Percent of System Capacity*
0.8	=	*Coefficient that Prevents Lag Chiller from Short-Cycling*

Soft Loading

Chiller Sequencer control logic includes a *soft loading* strategy that prevents the **lag** chiller from starting unnecessarily when the system lowers the supply chilled water temperature to setpoint.

Soft loading is provided only during the first system start of the day, when the panel automatically sets the *Add* timer to twice the operator-entered *"Add" Unit Time* period.

Note: *The Chiller Sequencer's "Add" timer is always active and cannot be disabled.*

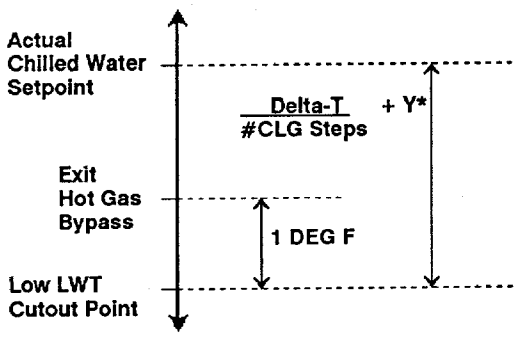
Ice Mode

When its *Ice Mode Request* input (BIP3) closes, the Chiller Sequencer enables both chillers and sends them leaving water setpoints of 0 F (if they are equipped with setpoint control). In addition, it closes the Ice Output contacts (BOP6) to accomodate chillers with ice mode inputs. The system then monitors the temperature registered by the system return water sensor (AIP2), and the Ice Feedback input (BIP4).

Though the Setpoint Control Chiller Sequencer gives the chillers an ice mode leaving water setpoint of 0 F, the **actual** setpoint enforced at each unit is determined by the chiller control panel's Low Leaving Water Temperature (LWT) Cutout point and the minimum differential that must be maintained between it and the unit's leaving chilled water setpoint. (Figure 20 illustrates the relationship between these chiller control values.) The **Low LWT Cutout** is user- adjustable, and **must be set low enough to assure that the chiller is always *fully* loaded during ice mode operation.**

CAUTION! Thermal expansion valves are unable to modulate effectively under part- load ice-making conditions. Consequently, liquid refrigerant slugging can occur, causing serious compressor damage.

Figure 20
Determining Actual Unit Chilled Water Setpoint (CGAD, CGWD, CCAD Chillers Only)



* Note:
Y = 2 for Chillers *without* Hot Gas Bypass
Y = 4 for Chillers *with* Hot Gas Bypass

The panel will interrupt chiller operation and shut down the chilled water pumps if any of the following events occur:

- the Sequencer's *Ice Mode Request* (BIP3) contacts reopen;
  or ...
- return water temperature drops below 27 F and remains there for 2 minutes;
  or ...
- return water temperature drops below 25 F and remains there for 10 seconds.
  or ...
- the Chiller Sequencer Ice Mode Feedback (BIP4) contacts open after ten minutes of ice making has elapsed.

Note: *Use the chillers' optional Compressor Running Relays to trigger other system events (e.g., valve position changes) that must be coordinated with ice mode termination. These relays will typically be used for the Ice Mode Feedback input as well.*

Once the Chiller Sequencer terminates ice mode operation, it will not allow the chillers to restart until the *Ice Mode Request* (BIP3) contacts open. In the event that the panel's power supply is interrupted while BIP3 is closed, ice mode operation resumes when power is restored (i.e., if BIP3 is still closed).

Ice mode operation overrides normal system operation — including the panel's *Sys Enable input*, BIP1. Only **manual** control (described on p. 29) takes precedence over ice mode operation.

Failure Recovery/ Alarm Annunciation

Upon detecting a **system**-level failure, the Chiller Sequencer energizes its alarm output (i.e. closes its normally-open BOP5 contacts) to signal a field-supplied alarm annunciation device installed remotely. Four conditions are recognized as system-level failures:

- System supply (AIP1) or return (AIP2) water temperature sensor value is either less than 0 F or greater than 100 F, indicating an open or shorted sensor.

  Note: *If this failure occurs, the Chiller Sequencer energizes both chillers as long as the system is enabled,* ***and*** *gives them each a setpoint equal to the* ***System Setpoint*** *(SYSTEMSP).*

- Loss of power to the Chiller Sequencer.

- Self-diagnosed failure of the Chiller Sequencer card.

- System supply water temperature exceeds setpoint by more than the operator-entered System Design Delta-T value *(i.e., SUPLYTMP > ACTIVESP + DESDELTA)* for an interval longer than the "Add" Unit Time value multiplied by six *(i.e., ADD TIME x 6)*.

Note: *Failure conditions occurring at the* ***chiller*** *level are* ***not*** *alarmed by the Chiller Sequencer. If individual chiller alarm functions are required, add an alarm package to each unit and separately hard-wire the alarm contacts to Chiller Sequencer alarm output BOP5.*

Though not triggered automatically, "failure recovery" *is* provided by Chiller Sequencer control logic in the event of a chiller failure. When the Sequencer "sees" the increase in system supply temperature that results when a chiller fails, it starts the lag chiller as soon as the *Add* timer expires. Once running, the lag chiller remains on — even if there are concurrent *Add* and *Subtract* commands. (Remember that *Add* commands receive priority; see *Lag Chiller Start/Stop* on p. 32.)

Failure of the lead chilled water pump in a **one-pump-per-chiller system** results in a loss of system chilled water flow. Considerable time may elapse before the supply water temperature rises enough to prompt start-up of the remaining chiller. Once the lag chiller starts, it cycles on and off based on the Chiller Sequencer's *Add* and *Subtract* timers.

Manual Control

When the MANUAL CONTROL parameter is changed to "YES", Chiller 1 will be controlled to the state of the UNIT 1 MANUAL ON setting, and Chiller 2 will be controlled to the state of the UNIT 2 MANUAL ON setting. The Chiller setpoints will be set equal to the SYSTEM SETPOINT. If the Ice Mode is active when the chillers are switched to Manual, the ice mode output will remain ON until normal ice mode termination conditions exist. Due to the high priority of Manual Control, caution must be used when changing the state of the chillers. Chillers will be enabled and disabled without regard to minimum ON/OFF timers. Pumps will go through a normal shutdown sequence for one minute after the chillers have been disabled. When the operator leaves the manual mode by changing the MANUAL CONTROL setting to "NO", the same precautions must be taken.

Panel Maintenance

At least **monthly** ...

- Verify that the panel's *Date/Time* display is accurate.
- Scroll through the Chiller Sequencer's LCD read-outs to verify that all user-adjustable parameters are set as desired.

Note: *None of the Chiller Sequencer's user-adjustable control values, including "Date/Time" entries, can be changed without first logging on to the panel. (See p. 26 for log-on instructions.)*

On an **annual** basis ...

- Check the panel's input/output wiring to verify that it is intact and that all connections are secure.
- Perform the panel checkout procedure described on pp. 20-22 to ensure that the Chiller Sequencer is functioning properly.

While the Chiller Sequencer itself requires little upkeep, it is important not to neglect the periodic maintenance of other equipment in the system — i.e., chillers, pumps, cooling tower, external time clock (if used), etc.

To promote trouble-free system operation, become familiar with the manufacturer's suggested equipment maintenance schedule and perform the recommended checks at the intervals advised.