TRANE®

Confidential Engineering Bulletin

Tracer™ CH530 Chiller Controller for Centrifugal Water Chillers

CTV-PRB009-EN

Introduction

This bulletin provides information about the Tracer™ CH530 chiller controller as applied to CVHE, CVHF, and CVHG chillers.

It may also be used as a reference for standard and optional features and for specific data point communication.

By designing the third-generation unit controller with software and smart sensors (rather than hardware modules) at its core, Trane's controls engineers have provided Tracer CH530-equipped chillers with improved communication capabilities, accuracy, serviceability, and adaptability.

Contents

Advantages of Tracer CH530

Tracer CH530 allows the system designer to explore energy saving strategies and allows the CenTraVac™ chiller to be used in ways that were never thought possible.

Feedforward Adaptive Control
Feedforward is an open-loop, predictive control strategy designed to anticipate and compensate for load changes. It uses evaporator entering-water temperature as an indication of load change. This allows the controller to respond faster and maintain stable leaving-water temperatures.

Soft Loading
Tracer CH530 uses soft loading except during manual operation. Large adjustments due to load or setpoint changes are made gradually, preventing the compressor from cycling unnecessarily. It does this by internally filtering the setpoints to avoid reaching the differential-to-stop or the current limit. Soft loading applies to the leaving chilled-water temperature and current-limit setpoints.

Multi-Objective Limit Arbitration
There are many objectives that the controller must meet, but it cannot satisfy more than one objective at a time. Typically, the controller's primary objective is to maintain the evaporator leaving-water temperature.

Whenever Tracer CH530 senses that it can no longer meet its primary objective without triggering a protective shutdown, it focuses on the most critical secondary objective. When the secondary objective is no longer critical, the controller reverts to its primary objective.

Fast Restart
Tracer CH530 allows the CenTraVac to restart while the inlet guide vanes are closing and also during the postlube process. If the chiller shuts down on a nonlatching diagnostic, the diagnostic has 30–60 seconds to clear itself and initiate a fast restart. This includes momentary power losses.

Variable Water-Flow Compensation
Water-flow compensation is a new, optional, control feature for CenTraVac chillers. It is included with the water flow control (WPSR) option, along with water pressure-sensor transducers. Water-flow compensation allows the chiller to accommodate variable flow, even in combination with an Adaptive Frequency Drive™ (AFD). A more detailed discussion continues on page 18.

Adaptive Frequency Drive (AFD)
The combination of speed control and inlet guide-vane position is now optimized mathematically and controlled simultaneously. The increased performance of the microprocessor allows the chiller to operate longer at higher efficiency and with greater stability.

Revolutionary EarthWise Purge
Tracer CH530-equipped chillers feature a redesigned purge. The new purge includes an auto-regenerating carbon canister to return reclaimed refrigerant back to the chiller automatically. The EarthWise™ purge is more aggressive in auto-adaptive mode than its predecessor. Adaptive mode uses historical purge data to determine when to purge and for how long, keeping the chiller at peak efficiency.

Chiller-Tower Optimization
Tracer Summit™ chiller-tower optimization extends Adaptive Control™ to the rest of the chiller plant. Chiller-tower optimization is a unique control algorithm for managing the chiller and cooling-tower subsystem. It considers the chiller load and real-time ambient conditions, then optimizes the tower setpoint temperature to maximize the efficiency of the subsystem.

Variable-Primary Flow (VPF)
Chilled-water systems that vary the water flow through chiller evaporators have caught the attention of engineers, contractors, building owners, and operators. Varying the water flow reduces the energy consumed by pumps, while requiring no extra energy for the chiller. This strategy can be a significant source of energy savings, depending on the application.

Using the optional variable water-flow compensation, Tracer CH530 reliably accommodates variable evaporator water flow and virtually eliminates its effect on the chilled-water temperature.

VPF with an AFD
Previous controllers could not accommodate variable water flow in combination with variable-speed drives. Water-flow compensation reacts so quickly that this energy-saving combination is now possible.

34°F Leaving-Water Temperature
Another benefit of Feedforward Adaptive Control is the ability to operate the CenTraVac chiller at low leaving evaporator-water temperatures without the use of glycol.

Colder water is generally used in wide delta-T systems, reducing the pumping energy required and making it less expensive to deliver cooling capacity over long distances. For this reason, 34°F leaving-water temperatures are frequently used in district cooling applications, but can also be used in comfort cooling applications.

Consult CenTraVac marketing when making chiller two- or three-pass selections using 34°F to 36°F leaving-water temperatures. Adherence to standard installation procedures (e.g., strainer upstream of waterbox, waterbox temperature sensor) is important when implementing low leaving-water temperatures.

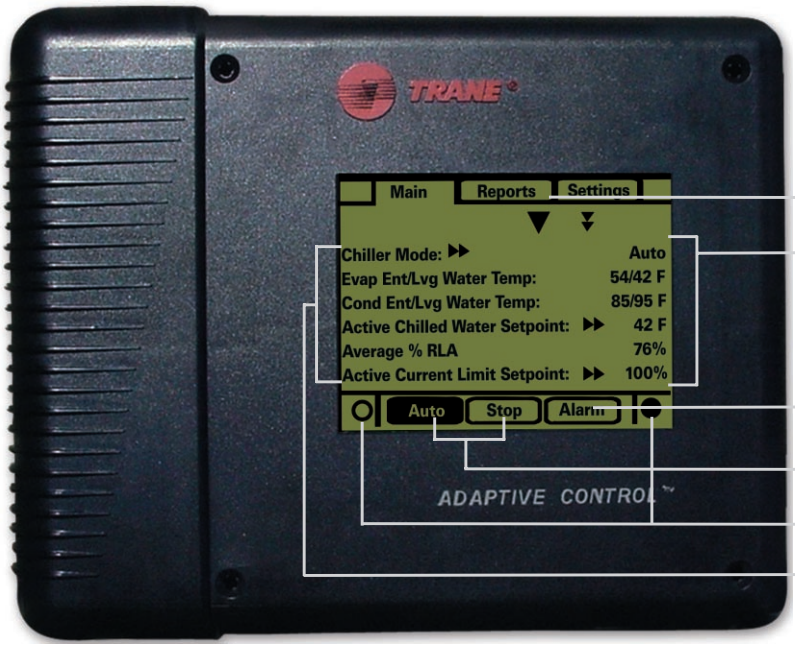
Operator Interfaces

DynaView Operator Interface

DynaView™ is the unit-mounted control panel and serves as the main processor and operator interface. It has a touch-sensitive overlay on a 4" wide by 3" high ¼ VGA display. Its weatherproof plastic enclosure is 9.75" wide, 8" high, and 1.6" deep. The panel enclosure is approximately 29" wide, 21½" high, and 8½" deep, with a hinged door that swings from right to left.

DynaView receives information from, and communicates commands to, the other devices on the chiller's communications link. DynaView performs the Leaving Chilled Water Temperature and Limit Control Algorithms, arbitrating capacity against any operating limit against which the chiller may find itself working.

- Auto/Stop commands
- Status (all subsystems)
- Setpoint adjustment (daily user points)
- 10 active diagnostics
- Mode overrides
- ASHRAE guideline and report



Touch sensitive screen provides information and navigation at the same time

Change setpoints and settings with touch screen commands

Displays chiller status and operating points. Touch for more information

If diagnostic exists, an alarm indicator will appear. Press for detail.

On and off buttons

Contrast Control

Extensive diagnostics customized to the chiller type installed—centrifugal, helical rotary, or absorption

Operator Interfaces

Serviceability

Previous Trane chiller controllers included a user interface that presented all chiller data necessary for both daily tasks and service or maintenance tasks. The amount of information presented on a limited display made a number of tasks difficult. A service technician's ability to assess and resolve chiller problems was hampered by the limited presentation of multiple pieces of chiller information.

Tracer CH530 adds a level of sophistication better served by a PC application that improves service technician effectiveness and minimizes chiller downtime. Tracer CH530 provides a user interface and main processor, DynaView, that is intended to serve only typical daily tasks. A portable, PC-based service tool, TechView, supports service and maintenance tasks.

The Tracer CH530 controller will be gradually applied to all Trane chillers. TechView will then serve as a common interface to all Trane chillers, and will customize itself based on the properties of the chiller with which it is communicating. Thus, the service technician learns only one service interface.

The panel bus is easy to troubleshoot using LED verification of sensors. Only the defective device is replaced. Captive screws ensure that the appropriate mounting hardware is available. TechView can communicate with individual devices or groups of devices.

TechView

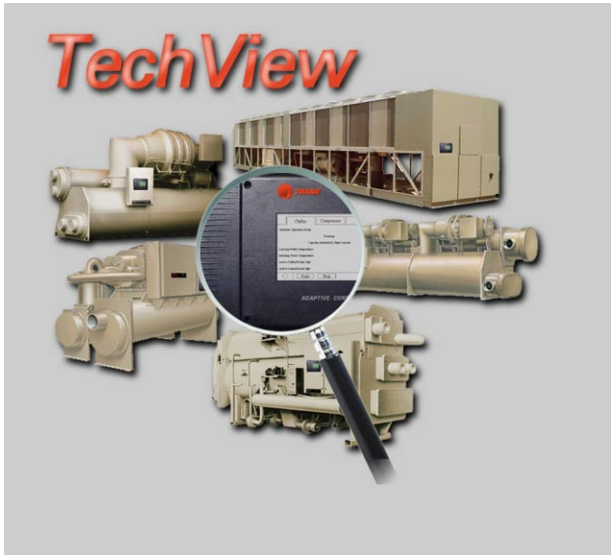
All chiller status, machine configuration settings, customizable limits, and up to 60 active or historic diagnostics are displayed through the service-tool software interface. Any PC that meets the system requirements may download the service interface software and Tracer CH530 updates from Trane's Web site at www.trane.com.

LEDs and their respective TechView indicators visually confirm the viability of each connected sensor, relay, and actuator.

TechView is designed to run on a customer's laptop, which connects to DynaView with a serial cable. DynaView's serial port is located behind a sliding door on the bottom of the DynaView enclosure. It uses a standard 9-pin male and 9-pin female RS-232 cable.

Hardware requirements for TechView:

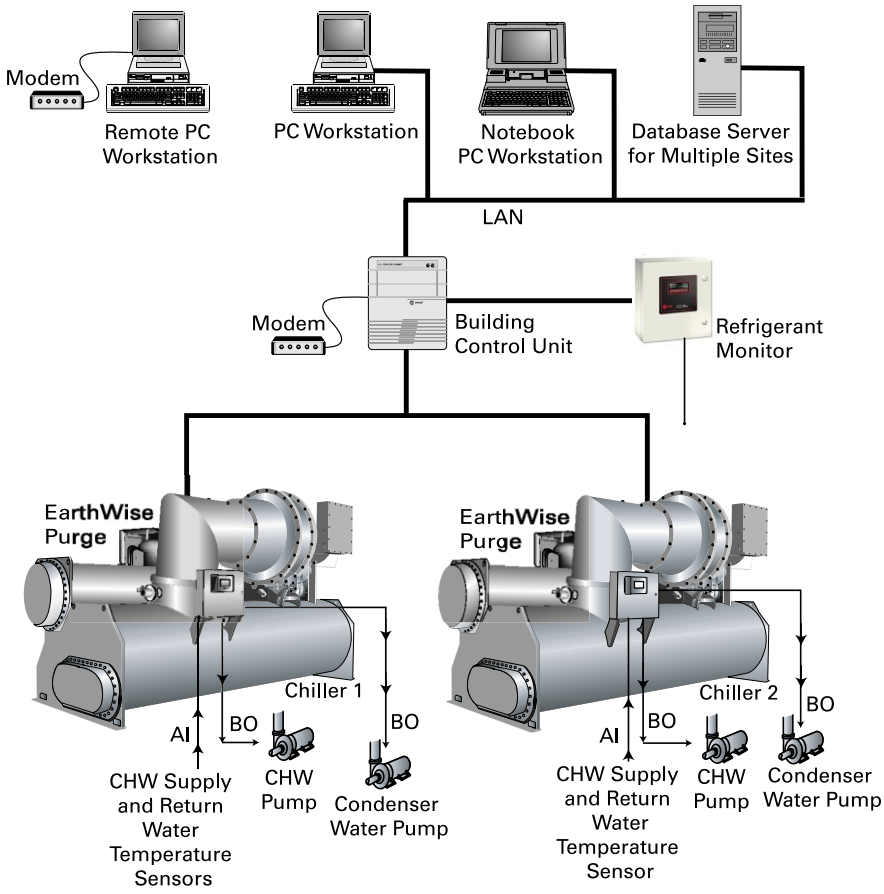
- Pentium II, III, or higher processor
- 128 MB RAM
- 1024x768 resolution
- CD-ROM
- 56 K modem
- 9-pin RS232 serial connection
- Windows® 95, 98, 2000



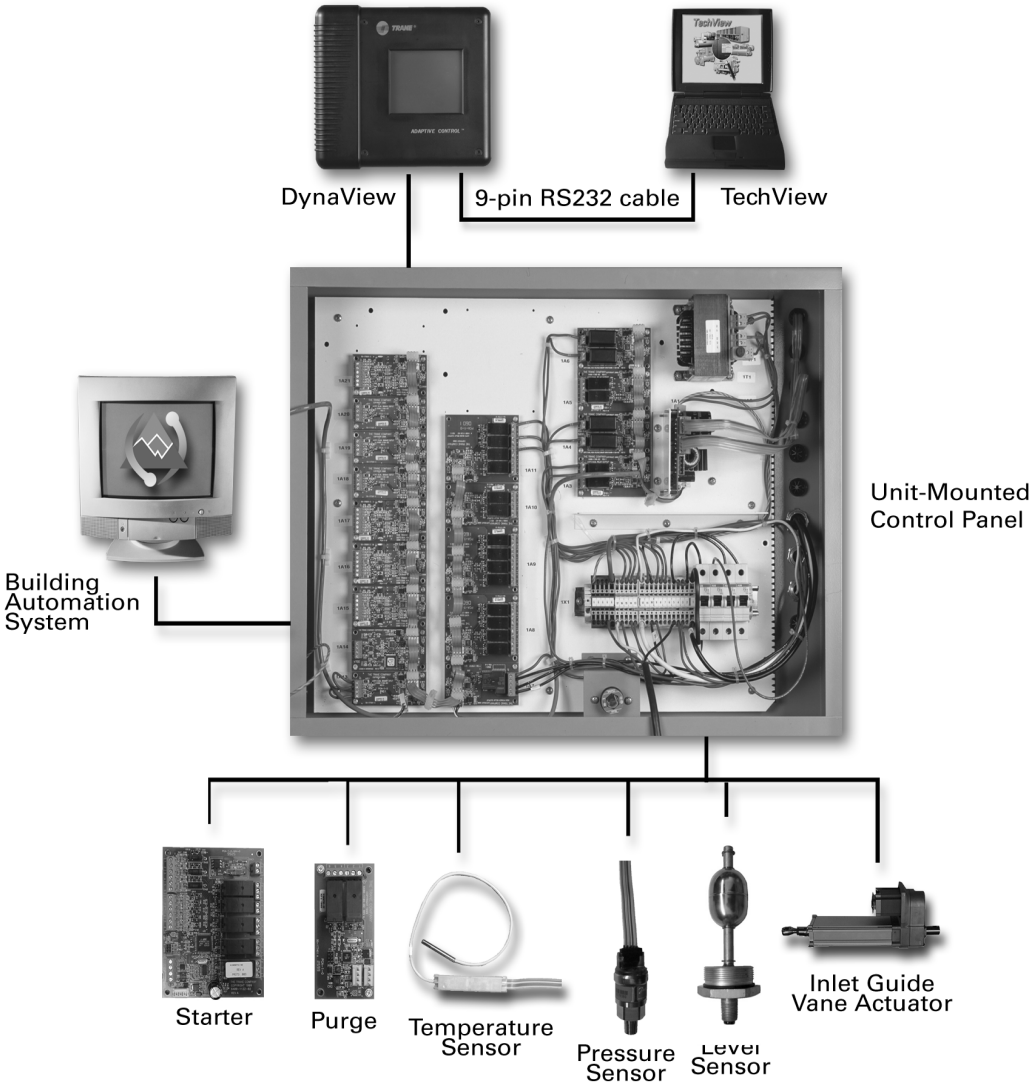
Architecture

Sample System

Tracer CH530's software-based architecture easily accommodates adding or changing features, function, or I/O to the platform. The devices are smaller and easier to replace. Tracer CH530 has a battery-backed real-time clock, which eliminates the need for a check-clock diagnostic.



Architecture



Binary and Analog I/O Termination Points

Binary Outputs from CH530	*Option*	*Module Termination*
Evaporator pump relay	standard	1A5-J2-4,6 for NO 1A5-J2-5,6 for NC
Condenser pump relay	standard	1A5-J2-1,3 for NO 1A5-J2-2,3 for NC
Compressor running relay	OPST	1A8-J2-10,12 for NO 1A8-J2-10,11 for NC
Alarm relay - machine manual reset	OPST	1A8-J2-7,9 for NO 1A8-J2-8,9 for NC
Alarm relay - machine auto reset	OPST	1A8-J2-1,3 for NO 1A8-J2-2,3 for NC
Limit warning relay	OPST	1A8-J2-4,6 for NO 1A8-J2-5,6 for NC

I/O Termination Points

Binary and Analog I/O Termination Points

Binary Outputs from CH530	*Option*	*Module Termination*
Evaporator pump relay	standard	1A5-J2-4,6 for NO 1A5-J2-5,6 for NC
Purge pump-out running relay	OPST	1A9-J2-10,12 for NO 1A9-J2-11,12 for NC
Purge alarm relay	OPST	1A9-J2-7,9 for NO 1A9-J2-8,9 for NC
Maximum capacity relay	OPST	1A9-J2-1,3 for NO 1A9-J2-2,3 for NC
Head relief request relay	OPST	1A9-J2-4,6 for NO 1A9-J2-5,6 for NC
Free cooling auxiliary relay	FRCL	1A11-J2-4,6 for NO 1A11-J2-5,6 for NC
Ice making status relay	EXOP	1A10-J2-4,6 for NO 1A10-J2-5,6 for NC

Binary Inputs to CH530	*Option*	*Module Termination*
Evaporator water flow switch	standard	1A6-J3-2
Condenser water flow switch	standard	1A6-J2-2
Chiller AUTO-STOP enable/disable	standard	1A13-J2-1,2
Chiller emergency STOP	standard	1A13-J2-3,4
Free cooling enable/disable	FRCL	1A20-J2-1,2
Ice building enable/disable	EXOP	1A19-J2-1,2
External base loading enable/disable	EXOP	1A18-J2-1,2
External hot-water control enable/disable	EXOP	1A18-J2-3,4

Analog Outputs from CH530	*Option*	*Module Termination*
Condenser pressure or differential press Cond P: 2 Vdc = 0 PSIA, 10 Vdc = high pressure cutout Differential P: 2-10 Vdc = cond rfgt press - evap rfgt press 2 Vdc: field settable; 10 Vdc: field settable	CDRP or GBAS	1A15-J2-4,6
Percent RLA output 2 Vdc = 0% RLA; 10 Vdc = 120% RLA	GBAS or CDRP	1A15-J2-1,3

Analog Inputs to CH530	*Option*	*Module Termination*
Wall-mounted refrigerant-specific monitor PPM: 4 mA = 0 PPM, 20 mA = 100 PPM or 1000 PPM	EXOP	1A17-J2-5,6
External Base Loading Setpoint	EXOP	1A17-J2-2,3
Chilled-water setpoint 2 Vdc/4 mA = 0°F, 10 Vdc/20 mA = 65°F	GBAS	1A16-J2-5,6
Current limit setpoint 2 Vdc/4 mA = 40% RLA, 10 Vdc/20 mA = 120% RLA	GBAS	1A16-J2-2,3

Accuracy

Each device (e.g., a sensor) is connected to its own microprocessor, which converts the sensor signal from analog to digital. The calibration of the conversion is specific to the type of sensor, providing better temperature accuracy and eliminating the need for matched sensor pairs.

Distributing logic to the sensors allows the main processor to focus on responding to changing conditions—in the load, the machine, its ancillary equipment, or its power supply.

Description	*Accuracy (+or-)*	*Range*	*Units*	*Location*
General purpose temperature sensor	.25 .50	–20 to 50 –40 to 120	°C	Chiller
High temperature (purge carbon regen. tank)	.25 .50	25 to 125 –40 to 232	°C	Purge
Motor RTD temperatures	8.3	TBD	°C	Chiller
Absolute oil/refrigerant pressure	TBD	0 to 50	PSIA	Chiller
Differential water pressure transducer	2.5%	0 to 30	PSID	Chiller
Water flow calculation	5% with calibration	0 to 15000	GPM	Chiller
Chiller tons calculation	15%	0 to 3000	Tons	Chiller
Motor current (single stage)	3.0 7.0 3.0 7.0 1.5 10	50 to 150 10 to 300 50 to 150 10 to 300 40 to 140 10 to 800	% RLA % RLA % RLA 	E-M Starter SSS AFD
Line voltage (600 Vac and less)	2.0% 2.0% 1.5% 10%	0 to 600 0 to 600 85% to 115% nom. 0 to 140% of nom.	LAC LAC 	E-M Sarter SSS AFD
Line voltage (greater than 600 Vac)				E-M Starter
Input power	5% 5% ~3% 20%	100 to 2,000 100 to 2,000 Accurate V, I range Outside accurate V, I range	kW kW kW 	E-M Starter SSS AFD
Load power factor	5% 5% TBD	–1.0 to 1.0 –1.0 to 1.0 TBD		E–M Starter SSS AFD

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Optional Communication

The display languages, navigation, units, and I/O are all software-configurable.

User-Selected Languages and Units
DynaView can store English plus two other languages at one time. Alternate languages are downloaded to the main processor from TechView. TechView Internet downloads include all available language capabilities.

DynaView is a touch-sensitive screen that uses dynamic navigation. The navigation automatically changes to the chosen language. Tracer CH530 displays all numerical values in I-P or SI units of measure.

Communication Protocols

Tracer CH530 has the ability to communicate using three different communications protocols, as well as generic BAS 2-10 Vdc or 4-20 mA.

For CenTraVac chillers, Tracer CH530 will initially use Comm4, with LonTalk® as an alternative in 2002. It can interface to building automation systems such as Tracer Summit. Tracer CH530 will accommodate new communications protocols with a board change and main-processor software update.

For example, suppose a chiller initially uses generic BAS I/O points to communicate with an external controller. Later, when the external controller can understand LonTalk, a LonTalk circuit board can be installed using TechView. New software downloaded from the Internet activates it.

Tracer Communications Interface (TRMM)
Integrating the Tracer CH530 chiller controller with a Tracer Summit building automation system is accomplished by selecting the optional Tracer Communication Interface module for Comm4.

Tracer CH530 for CenTraVac chillers does not support Comm3 for interfacing with Tracer 100.

Tracer Summit does not distinguish between a Tracer CH530 or a UCP2™ using Comm4.

When a Tracer Communication Interface is chosen, the following options are generally not required.

Operating Status (OPST)
This option includes the following relays:
- Compressor running relay
- MMR alarm relay (manual reset diagnostic)
- MAR alarm relay (automatic reset diagnostic)
- Limit warning relay
- Purge alarm relay
- Purge pump-out running relay
- Head relief request relay
- Maximum capacity relay

Condenser Refrigerant Pressure Output (CDRP)
Note: CDRP points included in GBAS option.
This option is generally used on chillers that will have cold starts (northern applications, daytime-only operation), or for plants where combined free cooling and regular cooling might take place, etc. It is specifically used in applications that might have trouble maintaining the 3-psid differential pressure between the evaporator and the condenser. It involves field engineering, wiring, and a setpoint controller for all chillers that want to activate this safety feature.
- % RLA output
- Condenser refrigerant pressure or differential pressure (cond P – evap P) output

Generic BAS (GBAS)
Note: CDRP points included in GBAS option.
The Generic BAS option essentially replaces the UCP2's primary Options Module control points.
- CDRP option package
- External chilled-water setpoint control
- External current-limit setpoint control

Standard Controls

Field Connection
The field-connected elements are involved in physically turning the chiller on or off. This involves ensuring that the chiller is not in an emergency or external stop condition, starting the pumps, and verifying that flow has been established. The optional, factory-supplied flow switch or a customer-supplied differential-pressure switch can be used to prove flow.
- External auto stop (enable/disable)
- Emergency stop
- Chilled-water flow contacts
- Condenser-water flow contacts
- Chilled-water pump relay
- Condenser-water pump relay

Heat Exchanger Control
Fundamental internal variables that are necessary to control the chiller are gathered and acted upon by the heat exchanger control function.
- High-pressure cutout
- Evaporator entering-water temperature
- Evaporator leaving-water temperature
- Condenser entering-water temperature
- Condenser leaving-water temperature
- Evaporator saturated-refrigerant temperature
- Condenser saturated-refrigerant temperature

Motor Control
This includes all functions that start, run, and stop the motor. The starter module provides the interface and control of Y-delta, across-the-line, primary reactor, autotransformer, and solid-state starters. Analog and binary signals are used to interface with the solid state starter.

An AFD output signal, included in the AFD option, controls the Adaptive Frequency drive. The motor control also provides protection to both the motor and the compressor.
- Starter module (all starters except AFD)
- Starter fault (all solid-state starters)
- Power supply
- Oil heater relay
- Oil and refrigerant pump relay with interlock
- Oil temperature
- Oil-sump pressure
- Oil-pump discharge pressure
- Compressor motor-winding temperatures

EarthWise Purge Control
The purge control function provides all the inputs and outputs to control the purge, optimizing both purge and chiller efficiency. The purge controller communicates with DynaView over the IPC3 bus communications link, uploading setpoints and downloading data and diagnostics.

Phase Voltage Sensors – 3ϕ
Includes factory-installed potential transformers in the starter for monitoring and displaying phase voltage and provides over/undervoltage protection. DynaView, TechView and Tracer Summit display the following:
- Compressor phase voltage (a-b, b-c, c-a)
- Kilowatts
- Power factor (uncorrected)

Chilled-Water Reset
(based on returned chilled-water temperature)

Chilled-water reset is often a practical means of reducing energy consumption during periods of the year when heating loads are high but cooling loads are reduced. Resetting the chilled-water temperature reduces the amount of work that the compressor must do by increasing the evaporator refrigerant pressure.

Chilled-water reset is also used in combination with the hot-water control. By resetting the chilled-water temperature upward, the compressor can generate a higher condenser pressure, resulting in higher leaving hot-water temperatures.

Hot-Water Control
In the hot-water mode, the chiller produces hot water as its primary objective, rather than chilled water. As an option, the Extended Operation (EXOP) package allows an external controller to enable, disable, and modulate this mode. It can be performed with or without a secondary condenser. See also Heat Recovery/Auxiliary Condenser (ACOS) option.

Ice-Making Control
For chillers that have been selected to allow for ice-making operation, the standard control package includes the ice-making mode. As an option, the Extended Operation (EXOP) package allows an external controller to enable, disable, and modulate this mode.

Optional Controls

Heat Recovery/Auxiliary Condenser (ACOS)

Includes a second condenser for the purpose of recovering heat that would normally be rejected to a cooling tower.

Also includes factory-installed sensors for the entering-and leaving-water temperatures. These temperatures are shown at the Tracer CH530 DynaView and TechView, and at Tracer Summit.

There are two ways to implement heat recovery: in hot-water control mode (get whatever incidental cooling is produced) or in cooling mode (get whatever incidental heating is produced.)

In hot-water control mode, the Hot Gas Bypass (HGBP) option is more-likely necessary. The Extended Operation (EXOP) option is relevant to ACOS only for external hot-water control, which includes enabling, disabling, and controlling the hot-water setpoint. These settings and the hot-water control mode are available internally as standard with Tracer CH530.

Hot-Gas Bypass (HGBP)

While the multi-stage CenTraVac design has excellent surge resistance, there are some applications where HGBP may be necessary to avoid excessive surging:

Heat recovery—elevated head pressure combined with low cooling load

Process or other applications where entering condenser-water temperature (ECWT) is independent of the cooling load

Customer preference—based on experience with a single-stage centrifugal chiller that is prone to surge without HGBP

HGBP is generally not needed in northern climates when ECWT varies with the load. TOPSS performs a stability check on all standard CTV chillers down to 25% load with constant ECWT. The chiller selection may be able to unload further; use the part-load, constant-condenser function of TOPSS to find out how far.

HGBP eliminates or reduces compressor cycling during periods of low or no load. It can be used for short or long periods of time, and allows the chiller to respond quickly to a load increase from the minimum capacity condition. It is sometimes used instead of an AFD when the chiller is oversized. HGBP can also be used in concert with the inlet guide vane control to reduce the settling time after a cooling-load adjustment.

The new compressor-discharge, refrigerant temperature-limit control makes HGBP more adaptable to different operating conditions. When a chiller is selected with the HGBP option, the discharge-refrigerant temperature sensor is included and factory-installed. This temperature and the HGBP hours of operation will be shown at DynaView and TechView, and at Tracer Summit.

Chilled-Water Reset (CWR)

(Based on ambient temp)

This option is an alternative to the standard chilled-water reset, which is based on the return chilled-water temperature.

It consists of ambient temperature sensors and related controls. The ambient temperature is displayed at the Tracer CH530 DynaView and TechView, and at Tracer Summit. The temperature sensor is shipped with the chiller for field installation.

Gas-Powered Chiller (GENR)

In today's climate of turbulent energy prices and availability, building owners look for solutions. The ability to run a chiller on either natural gas or electricity puts the owner in a stonger and more flexible position. Engine-driven chillers have the highest coefficients of performance of any natural-gas cooling system. Installations in many parts of the country demonstrate the engine-driven chiller's lower total operating costs.

There are two ways to couple a centrifugal chiller with a natural-gas engine—electrically and mechanically. By electrically coupling the chiller and the engine, the system designer has the flexibility to place the engine–generator in a remote location and isolate its sound from sound-sensitive areas.

The controls package is a custom control-interface that coordinates and protects the engine and the chiller.

Free Cooling (FRCL) Option

Free Cooling (FRCL)
Free Cooling (also known as Refrigerant Migration) is based on the principle that refrigerant migrates to the coldest area in the system. The CenTraVac's Free Cooling option converts the basic CenTraVac chiller to a simple heat exchanger by diverting refrigerant around the compressor. It does not provide control of the leaving chilled-water temperature.

If condenser water is available at a temperature lower than the required leaving chilled-water temperature, the operator manually switches to a Free Cooling cycle by enabling the Free Cooling mode in the DynaView Feature Settings group.

When the chiller operator initiates the Free Cooling mode, the compressor will shut down if running. The shutoff valves in the liquid and gas lines open the compressor bypass and the unit control logic prevents the compressor from energizing. Liquid refrigerant drains by gravity from the storage tank into the evaporator and floods the tube bundle. Since the temperature and pressure of the refrigerant in the evaporator are higher than in the condenser (due to the higher water temperature), the refrigerant vaporizes and travels to the condenser without assistance from the compressor. Cooling-tower water causes the refrigerant to condense and the cycle continues.

This cycle is sustained as long as a temperature differential exists between the condenser water and evaporator water. The actual cooling capacity provided by the Free Cooling cycle is determined by the difference between these temperatures and the consequent rate of refrigerant flow.

Several components must be factory-supplied or field-installed to equip the unit for Free Cooling operation:

- a refrigerant gas line with an electrically-actuated shutoff valve between the evaporator and condenser
- a liquid return line with an electrically-actuated shutoff valve between the condenser sump and the evaporator
- a liquid refrigerant storage vessel
- additional refrigerant

The Free Cooling option defines the basic chiller type, including factory-installed piping, valves, controls, and additional refrigerant. Free Cooling is not available with Heat Recovery or Auxiliary Condenser units or with the Hot-Gas Bypass option.

Extended Operation (EXOP) Option

Select the extended-operation package for chillers that require ice-building control, hot water control, and/or base-loading capabilities to be controlled externally. This package also includes a 4-20 mA or 0-10 Vdc analog input for a refrigerant monitor.

- External Ice-building control
- External Ice-building relay
- External base-loading control
- External base-loading relay
- External hot-water control relay
- Refrigerant monitor input

Base-Loading Control
This feature allows an external controller to directly modulate the capacity of the chiller. It is typically used in applications where virtually infinite sources of evaporator load and condenser capacity are available and it is desirable to control the loading of the chiller. Two examples are industrial process applications and cogeneration plants. Industrial process applications might use this feature to impose a specific load on the facility's electrical system. Cogeneration plants might use this feature to balance the system's heating, cooling, and electrical generation.

All chiller safeties and Adaptive Control functions are in full effect when Base Loading is enabled. If the chiller approaches full current, the evaporator temperature drops too low, or the condenser pressure rises too high, Tracer CH530's Adaptive Control logic limits the loading of the chiller to prevent the chiller from shutting down on a safety limit. These limits may prevent the chiller from reaching the load requested by the Base Loading signal.

An alternative and less radical approach to Base Loading indirectly controls chiller capacity. Artificially load the chiller by setting the chilled-water setpoint lower than it is capable of achieving. Then, modify the chiller's load by adjusting the current-limit setpoint. This approach provides greater safety and control stability because it leaves the chilled-water temperature-control logic in effect. The chilled-water temperature control responds more quickly to dramatic system changes and limits chiller loading prior to reaching an Adaptive Control limit.

Ice-Making Control
This feature allows an external controller to control the chiller in an ice-storage system. Ice storage is typically used in areas where high electrical-demand charges can be offset by shifting building energy use to off-peak (typically nighttime) hours.

While Tracer CH530 is capable of running the chiller in ice-making mode, installation savings and additional energy savings can be realized by using the Chiller Plant Control module of the Tracer building automation system. Chiller Plant Control anticipates how much ice needs to be made at night and operates the system accordingly. The controls are integrated with the chiller—two wires and preprogrammed software reduce field-installation cost and complex custom programming.

The CenTraVac chiller is uniquely suited for low-temperature applications like ice storage, because it provides multiple stages of compression. This allows the chiller to produce ice efficiently, while experiencing less stress than a single-stage compression chiller.

Hot-Water Control
This feature allows an external controller to enable/disable and modulate the hot-water control mode. Occasionally, CenTraVac chillers are used to provide heating as a primary mission. In this case the external controller or operator would select a hot-water temperature setpoint and the chiller capacity would be modulated to maintain the setpoint. Heating is the primary mission and cooling is a waste product or a secondary mission. This technique provides application flexibility, especially in multiple-chiller plants in conjunction with undersized heating plants.

The chiller uses only one condenser for hot-water control, whereas Heat Recovery uses a secondary condenser.

Refrigerant Monitor
The Extended Operation package allows for a refrigerant monitor to send a 4-20 mA signal to the DynaView display. It can be calibrated to correspond to either 0-100 ppm or 0-1,000 ppm concentration levels. The concentration level is displayed at DynaView, but the chiller will not take any action based on the input from the refrigerant monitor.

Alternatively, a refrigerant monitor can be connected to Tracer Summit, which has the ability to increase ventilation in the equipment room.

Water-Flow Control (WPSR)

Water-Flow Control (WPSR)
The Water-Flow Control option includes transducers for the differential evaporator-and condenser-water pressures (psid). Flow switches or some other means to prove flow are still required and must be field connected. One type of sensor handles all pressure ranges up to 300 psig.

The following data will be shown at the Tracer CH530 DynaView and TechView displays and at Tracer Summit.

- Evaporator and condenser differential water pressures (psid)
- Evaporator and condenser gpm
- Evaporator tons

Water-Flow Compensation
Tracer CH530 uses a patented, variable, water-flow compensation algorithm to maintain stable, precise capacity control. Water-flow compensation is a new control feature for CTV chillers that is available only if this option (WPSR) is installed.

It will automatically adjust capacity control to:

- Maintain control stability at low flow rates.
- Reject variable-flow disturbance.

If the water-pressure transducer fails and the flow switch continues to prove flow, water-flow compensation will be disabled and the design delta T will be used.

For applications designed to operate with variable-primary (VPF) water-flow, water-flow compensation allows the chiller to respond quickly to accelerating or decelerating water. By automatically adjusting the control gain, large changes in the water-flow rate can be tolerated. Data shown on Figure 2 demonstrates water-temperature control with flow compensation enabled. The chilled-water temperature remains stable, even when the water-flow rate drops 50 percent in 30 seconds.

Another benefit of water-flow compensation is disturbance rejection. Figure 3 shows the test results from step changes in water flow with increasing magnitudes. The leaving chilled-water temperature remains largely unaffected. Even the most severe change—dropping water flow 66 percent in 30 seconds—caused a small 1.5°F variation in chilled-water temperature.

It is unlikely that a chiller application would be making water-flow changes of this magnitude. The results demonstrate that the chiller is more than capable of supporting variable water-flow applications.

Variable Flow Stability

Figure 1 — Capacity Control without Flow Compensation

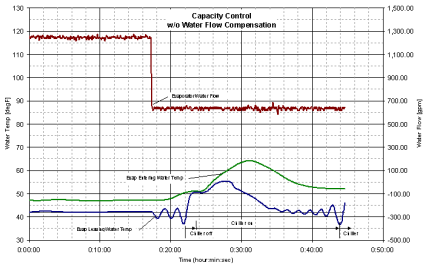


Figure 2 — Capacity Control with Flow Compensation

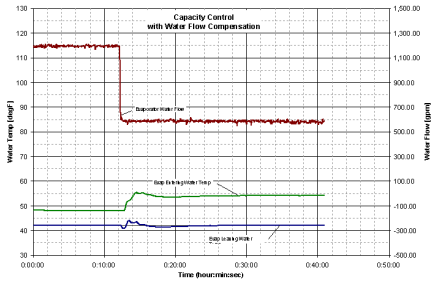
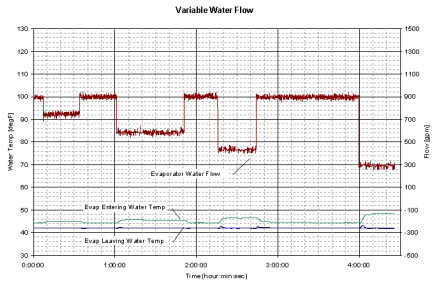


Figure 3 — Capacity Control with Flow Changes and Compensation



Adaptive Frequency Drive (AFD) Option

Simultaneously adjusts inlet guide vanes and speed to spend more hours at optimum efficiency
Upon startup, the chiller will start at a frequency that provides additional surge margin. The added surge margin will decay gradually, over 40 minutes, to the optimum speed. The extra surge margin is used to allow the chiller refrigerant pressures to stabilize.

AFD speed and IGV position are simultaneously adjusted to meet the dual requirements of water-temperature control and efficiency. Tracer CH530 adjusts speed unconditionally—it does not have to wait for water-temperature control to reach setpoint or for stable cooling load.

Tracer CH530 will adjust speed as needed to track changing load or water-loop conditions. At the same time, it adjusts the inlet guide vanes to prevent the water temperature from deviating from its setpoint. When the vanes are fully open, the compressor speed is controlling the water temperature. Reducing the chiller load or increasing the head conditions will cause the compressor to move toward a surge condition. When conditions are within the surge boundary, vanes and speed will modulate to control both surge margin and chiller capacity.

Mathematically optimizes inlet guide vanes and speed—no more "hunting" at surge boundary
Tracer CH530 will reduce speed until the surge pressure coefficient boundary is reached. Every 30 minutes, the AFD speed control will evaluate whether the boundary should be optimized. If optimization is required, the pressure-coefficient boundary will be raised until surge is detected. Upon surge, the boundary will be reset and surge recovery will occur. The decision to optimize is based on whether the vane position has changed by an amount greater than the optimization sensitivity since the last optimization was done. After the boundary is established, speed control will make adjustments to follow the boundary as conditions change.

Overcomes previous VFD limitations; instability is not an issue
- *Variable water-flow designs*—will work in conjunction with an AFD, provided the chiller control is Tracer CH530 with the flow-compensation control option installed. Chiller control with rapid water-flow variations and large turndown have been demonstrated with and without variable frequency drives.
- *Rapid changes in load*—Feedforward control improves chilled-water temperature response.
- *Short chilled-water loop*—Feedforward control cancels out the effect of short water loops.
- *Parallel chiller with poor control is causing temperature variations*—Tracer CH530 changes speed and adjusts cooling load at the same time. Even if there is a poorly controlled chiller in parallel, a CTV with Tracer CH530 will maintain excellent water-temperature control at the best efficiency.
- *Waiting for leaving temperature to exceed threshold*—Tracer CH530 reduces speed to the surge boundary based on the current differential operating pressure, making instantaneous corrections to speed and vane settings as conditions change.

CTV-PRB008-EN "Trane Adaptive Frequency Control for Centrifugal Water Chillers" provides deeper discussion of this option.

Standard Protections

Tracer CH530 uses proportional-integral-derivative (PID) control for all limits—there is no dead band. This removes oscillation above and below setpoints and extends the capabilities of the chiller.

Some of the standard protection features of the Tracer CH530 are described in this section. There are additional protection features not listed here.

High Condenser-Pressure Protection
Tracer CH530's condenser limit is a PID control that keeps the condenser pressure under a specified maximum pressure. There is no dead band—the chiller runs all the way up to 100 percent of the setpoint before reducing capacity using its Adaptive Control mode.

Starter-Contactor Failure Protection
Tracer CH530 controls the start and stop of the chiller through the starter. If the starter malfunctions and does not disconnect the compressor motor from the line when requested, Tracer CH530 will recognize the fault and attempt to protect the chiller by operating the evaporator-and condenser-water pumps and attempting to unload the compressor.

The chiller will protect itself, to the limits of its capabilities, from a starter failure that prevents the compressor motor from disconnecting from the line.

Loss of Water-Flow Protection
DynaView has an input that will accept a contact closure from a proof-of-flow device such as a flow switch or pressure switch. Customer wiring diagrams also suggest that the flow switch be wired in series with the chilled-water (condenser-water) pump starter's auxiliary contacts. When this input does not prove flow within a fixed time during the transition from Stop to Auto modes of the chiller, or if the flow is lost while the chiller is in the Auto mode of operation, the chiller will be inhibited from running by a nonlatching diagnostic.

Evaporator Limit Protection
Evaporator Limit is a PID control algorithm designed to prevent the chiller from tripping on its low refrigerant-temperature cutout. The machine may run up to the limit but not trip. Under these conditions the intended chilled-water setpoint may not be met, but the chiller will do as much as it can. The chiller will deliver as much cold water as possible even under adverse conditions.

Low Evaporator-Water Temperature
(Also known as Freeze Stat protection) Low evaporator-water temperature protection avoids water freezing in the evaporator by immediately shutting down the chiller and attempting to operate the chilled-water pump. This protection is somewhat redundant with the Evaporator Limit protection, and prevents freezing in the event of extreme errors in the evaporator-refrigerant temperature sensor.

The cutout setting should be based on the percentage of antifreeze used in the customer's water loop. The chiller's operation and maintenance documentation provides the necessary information for percent antifreeze and suggests leaving-water temperature-cutout settings for a given chilled-water temperature setpoint.

High-Vacuum Lockout Protection
The Tracer chiller controller inhibits a compressor start with a latching diagnostic whenever the evaporator pressure is less than or equal to 3.1 psia for R123. This protects the motor by locking out chiller operation while the unit is in a high vacuum, to prevent starting when the evaporator is in a high-vacuum state.

Standard Protections

Oil-Temperature Protection
Low oil temperature when the oil pump and/or compressor are running may be an indication of refrigerant diluting the oil. If the oil temperature is at or below the low oil-temperature setpoint, the compressor is shut down on a latching diagnostic and cannot be started. The diagnostic is reported at the user interface. The oil heater is energized in an attempt to raise the oil temperature above the low oil-temperature setpoint.

High oil-temperature protection is used to avoid overheating the oil and the bearings.

Low Differential Oil-Pressure Protection
Oil pressure is indicative of oil flow and active oil-pump operation. A significant drop in oil pressure indicates a failure of the oil pump, oil leakage, or other blockage in the oil-circuit.

The differential pressure during oil pump, compressor prelube mode should not fall below 12 psid. A failure on this parameter generates a shutdown diagnostic within 2 seconds of the differential pressure falling below 2/3 of the low differential oil pressure cutout.

When the compressor is running, the diagnostic is issued when the differential pressure falls below the cutout setpoint for more than

(cutout $\times$ 3) seconds.

Excessive Purge Detection
Pump-out activity is indicative of the amount of air leaking into the chiller refrigerant system. The operator should be informed when the air-leakage rate changes. Through this setpoint, the operator can indicate the expected leakage rate, and can be notified though a diagnostic if the rate is higher than expected.

Occasionally, when a service technician performs a mechanical repair on the chiller, an unusually high pump-out rate is expected for a certain period of time following the procedure. The service excessive pump-out override allows the technician to specify a time period for the purge system to rid the chiller of air in the system. This temporarily suspends excessive purge detection.

Phase-Unbalance Protection
Phase-unbalance protection is based on an average of the three phase-current inputs. The ultimate phase-unbalance trip point is 30 percent. In addition, the RLA of the motor is derated by resetting the active current-limit setpoint based on the current unbalance. The RLA derate protection can be disabled in the field-startup menu.

The following derates apply when the phase-unbalance limit is enabled:

10% unbalance = 100% RLA derate
15% unbalance = 90% RLA derate
20% unbalance = 85% RLA derate
25% unbalance = 80% RLA derate
30% unbalance = Shutdown

Phase-Loss Protection
Tracer CH530 will shut down the chiller if any of the three phase currents feeding the motor drop below 10 percent RLA. The shutdown will result in a latching phase-loss diagnostic. The time to trip is 1 second at minimum, 3 seconds maximum.

Phase Reversal/Rotation Protection
Tracer CH530 detects reverse phase rotation and provides a latching diagnostic when it is detected. The time to trip is 0.7 seconds for CTV. Phase-rotation protection can be disabled in TechView.

Standard Protections

Momentary Power Loss and Distribution Fault Protection
Three-phase momentary power loss (MPL) detection gives Tracer CH530 improved performance through many different power anomalies. MPLs of 2.5 cycles or longer will be detected and cause the unit to shut down. The unit will be disconnected from the line within 6 line cycles of detection. If enabled, MPL protection will be active any time the compressor is running. MPL is not active on reduced-voltage starters from the initial start signal through transition. The MPL diagnostic is an automatic reset diagnostic. MPL protection can be disabled in TechView.

An MPL has occurred when the motor no longer consumes power. An MPL may be caused by any drop or sag in the voltage that results in a change in the direction of power flow. Different operating conditions, motor loads, motor size, inlet guide vane (IGV) position, etc. may result in different levels at which this may occur. It is difficult to define an exact voltage sag or voltage level at which a particular motor will no longer consume power, but we are able to make some general statements concerning MPL protection:

The chiller will remain running under the following conditions:
- Line-voltage sag of 1.5 line cycles or less for any voltage magnitude sag
- Control-voltage sags of less than 3 line cycles for any magnitude sag
- Control-voltage sags of 40 percent or less for any amount of time
- Second-order or lower harmonic content on the line

The chiller may shut down under the following conditions:
- Line-voltage sags of 1.5 or more line cycles for voltage dips of 30 percent or more
- Control-voltage sags of 3 or more line cycles for voltage dips of 40 percent or more
- Third-order or higher harmonic content on the line

Current Overload Protection
The control panel will monitor the current drawn by each line of the motor and shut the chiller off when the highest of the three line currents exceeds the trip curve. A manual reset diagnostic describing the failure will be displayed. The current overload protection does not prohibit the chiller from reaching its full-load amperage.

The chiller protects itself from damage due to current overload during starting and running modes, but is allowed to reach full-load amps.

High Motor-Winding Temperature Protection
This function monitors the motor temperature and terminates chiller operation when the temperature is excessive. Tracer CH530 monitors each of the three winding-temperature sensors any time Tracer CH530 is powered up, and displays each of the temperatures at the service menu. Immediately prior to start, and while running, Tracer CH530 will generate a latching diagnostic if the winding temperature exceeds 265 +/- 5°F (129.4 +/- 2.8°C).

Surge Detection Protection
Surge detection is based on current fluctuations in one of three phases. The default detection criterion is 2 occurrences of RMS current change of 30 percent within 0.8 seconds in 60 $\pm$ 10 percent seconds.

With Tracer CH530, the detection criterion is adjustable.

Overvoltage and Undervoltage Protection
The unit will be shut down with an automatic reset if the line voltage is below or above 10 percent of nominal. Must trip = 15 percent of nominal. Time to trip = minimum of 1 minute, 10 seconds and maximum of 5 minutes, 20 seconds. Overvoltage and undervoltage protection can be disabled using TechView.

Power Factor and kW Measurement
Three-phase measurement of kW and unadjusted power factor yields higher accuracy during power imbalance conditions than with UCP2.

Short-Cycling Protection
Two selections exist, one based on motor-winding temperature and the other based on a start-to-start time.

Based on Motor-Winding Temperature:
If all three motor-winding temperatures are less than the 'Restart Inhibit Temperature' setpoint, the chiller will be allowed to proceed with prestart when there is need to cool.

If at least one of the three motor-winding temperatures is greater than or equal to the setpoint, but less than 265°F, the chiller will enter the restart-inhibit mode. The chiller will remain in this mode until all three motor-winding temperatures are less than the setpoint. After these temperatures drop below the setpoint, they will not be checked again in this sequence.

If at least one of the three motor-winding temperatures is 265°F or higher, a High Motor Winding Temp diagnostic will be called.

Based On Time:
This method uses a straight start-to-start timer to determine when to allow the next start.

A time-based restart inhibit-function is used if the Restart Inhibit Type is set to 'Time' or if the motor-winding temperatures are determined to be invalid.

A 'Restart Inhibit Start-to-Start Time' setpoint is used to set the desired start-to-start time.

There is no 'free' start on a power up at DynaView. The real-time clock is used to determine when the next start will be allowed, based on the previous start.

When the start is inhibited by the restart-inhibit function, the time remaining is displayed along with the restart-inhibit mode.

Enhanced Protection (EPRO) Option

The Optional Enhanced Protection Package includes sensors and transducers that enable the following protection features:

Enhanced Condenser-Limit Control
Includes factory-installed condenser-pressure transducer and interconnecting piping and wiring. Provides enhanced high-pressure cutout avoidance by energizing a relay to initiate head relief.

Note: This option is in addition to the standard high refrigerant-pressure safety contact.

Compressor-Discharge Refrigerant-Temperature Protection
Includes a factory-installed sensor and safety cutout on high compressor-discharge temperature. Allows Tracer CH530 to monitor compressor discharge temperature, which is displayed at DynaView, TechView, and Tracer Summit.

Note: When the chiller is selected with HGBP, this sensor and its associated protection are included.

Bearing-Oil Temperature Leaving Each Bearing
Optional factory-installed sensors allow high-temperature safety cutouts to monitor the leaving bearing-oil temperatures. Tracer CH530 and Tracer Summit display the temperatures.

The high bearing-temperature cutout is fixed at 180°F (82.2°C). If either bearing temperature violates the cutout, a latching diagnostic will be generated.

Monitored Points

This is a partial list of points that are monitored at DynaView and/or TechView. Please note that certain points require optional control packages, indicated by a three- or four-letter code.

Temperature	*Option*	*DynaView*	*TechView*
Evaporator approach temperature	Standard	Y	Y
Evaporator entering water temperature	Standard	Y	Y
Evaporator leaving water temperature	Standard	Y	Y
Condenser approach temperature	Standard	Y	Y
Condenser entering water temperature	Standard	Y	Y
Condenser leaving water temperature	Standard	Y	Y
Compressor motor winding temperature 1,2,3	Standard	Y	Y
Oil temperature (tank)	Standard	Y	Y
Saturated evaporator refrigerant temperature	Standard	Y	Y
Saturated condenser refrigerant temperature	Standard	Y	Y
Purge compressor suction temperature	Standard	Y	Y
Auxiliary/Heat Recovery entering temperature	Standard	Y	Y
Auxiliary/Heat Recovery leaving temperature	Standard	Y	Y
Discharge temperature	EPRO or HGBP	Y	Y
Bearing oil temperature 1,2	EPRO	Y	Y
Outdoor air temperature	CWR	Y	Y

Pressure	*Option*	*DynaView*	*TechView*
Evaporator refrigerant press (derived) psig	Standard	Y	Y
Condenser refrigerant press (derived) psig	Standard	Y	Y
Evaporator differential water press psid	WPSR	Y	Y
Condenser differential water press psid	WPSR	Y	Y
Oil tank press psig	Standard	Y	Y
Oil pump discharge press psig	Standard	Y	Y
Differential oil press (derived) psid	Standard	Y	Y
Condenser refrigerant press (transducer) psig	EPRO	Y	Y
Condenser refrigerant press output (0-10 Vdc)	CDRP	Y	Y

Control inputs	*Option*	*DynaView*	*TechView*
Setpoint source - Tracer (software point)	TRMM	Y	Y
Setpoint source - generic BAS (software point)	GBAS	Y	Y
Setpoint source - front panel	Standard	Y	Y
Chilled water reset based on return water temperature	Standard	Y	Y
Chilled water reset based on outdoor air temperature	CWR	Y	Y
Chilled water setpoint	GBAS	Y	Y
Current limit setpoint (% RLA)	GBAS	Y	Y
External chiller AUTO-STOP	Standard	Y	Y
External chiller emergency STOP	Standard	Y	Y
External free cooling enable/disable	FRCL	Y	Y
External ice building enable/disable	EXOP		

Chiller associated	*Option*	*DynaView*	*TechView*
HGBP hours	HGBP	Y	Y
Evaporator GPM (derived)	WPSR	Y	Y
Condenser GPM (derived)	WPSR	Y	Y
Tons - evaporator	WPSR	Y	Y

Monitored Points

Compressor associated	*Option*	*DynaView*	*TechView*
Compressor motor starts	Standard	Y	Y
Compressor motor running hours	Standard	Y	Y
Current, phase current	Standard	Y	Y
Voltage, L1, L2, L3	Standard	Y	Y
Compressor motor kW	Standard	Y	Y
Power factor	Standard	Y	Y
Compressor motor percent RLA by phase	Standard	Y	Y
Compressor motor percent RLA output (0-10 Vdc)	GBAS	NA	Y

AFD associated	*Option*	*DynaView*	*TechView*
% RLA L1, L2, L3	Standard	Y	Y
AFD bus voltage (Vdc)	AFD	N	Y
Frequency	AFD	Y	Y
AFD last diagnostic code	AFD	N	Y
AFD output power (kW)	AFD	N	Y
AFD (output/load) amps, L1, L2, L3	AFD	Y	Y
Speed	AFD	Y	Y
AFD transistor temperature	AFD	Y	Y
Variable speed settings and limits	AFD	N	Y
Input line kW	Standard	Y	Y
Input line voltage	Standard	Y	Y
Motor speed (Hz)	AFD	Y	Y
Motor speed (rpm)	AFD	Y	Y
Motor winding temps, 1, 2, 3	Standard	Y	Y

Refrigerant associated	*Option*	*DynaView*	*TechView*
Time until next purge run	Standard	Y	Y
Daily pump-out 24 hours	Standard	Y	Y
Average daily pump-out – 7 days	Standard	Y	Y
Daily pump-out limit/alarm	Standard	Y	Y
Chiller on – 7 days	Standard	Y	Y
Pump-out chiller on – 7 days	Standard	Y	Y
Pump-out chiller off – 7 days	Standard	Y	Y
Pump-out - life	Standard	Y	Y
Purge refrigerant compressor suction temperature	Standard	Y	Y
Purge liquid temperature	Standard	Y	Y
Purge carbon tank temperature	Standard	Y	Y
Purge alarm relay output	OPST	Y	Y

Binary outputs	*Option*	*DynaView*	*TechView*
Maximum capacity relay	OPST	Vane Position	Y
Evaporator pump relay	Standard	Operating Mode	Y
Condenser pump relay	Standard	Operating Mode	Y
Compressor running relay	OPST	Operating Mode	Y
Limit warning relay	OPST	Operating Mode	Y
Ice-making relay	EXOP	Operating Mode	Y
Head relief request relay	OPST	Operating Mode	Y
Free cooling auxiliary relay	FRCL	Operating Mode	Y
Alarm relay MMR, MAR	OPST	Alarm Display	Y
Purge alarm relay	OPST	Alarm Display	Y

Diagnostics

The following is a list of all the Tracer CTV CH530 diagnostics by major category.

Diagnostic Name
The exact text displayed in DynaView and TechView.

Severity
Immediate Shutdown means immediate shutdown of the affected portion
Normal Shutdown means normal or friendly shutdown of the affected portion
Warning means an Informational Note or Warning is generated.

Persistence
Latching means that the diagnostic and its effects must be manually reset. Nonlatching diagnostics can be either manually or automatically reset.

Starter Diagnostics

Diagnostic Name	*Severity*	*Persistence*
Starter Did Not Transition	Immediate Shutdown	Latching
Starter Did Not Fully Accelerate	Immediate Shutdown	Latching
Phase Reversal	Immediate Shutdown	Latching
Starter Dry Run Test	Immediate Shutdown	Latching
Phase Loss	Immediate Shutdown	Latching
Power Loss	Immediate Shutdown	Nonlatching
Momentary Power Loss	Immediate Shutdown	Nonlatching
Severe Current Unbalance	Normal Shutdown	Latching
Starter Fault Type I (definition varies with starter type)	Immediate Shutdown	Latching
Starter Fault Type II (definition varies with starter type)	Immediate Shutdown	Latching
Starter Fault Type III (definition varies with starter type)	Immediate Shutdown	Latching
Transition Complete Input Shorted	Immediate Shutdown	Latching
At Speed Input Shorted	Immediate Shutdown	Latching
Transition Complete Input Opened	Immediate Shutdown	Latching
At Speed Input Opened	Immediate Shutdown	Latching
Motor Current Overload	Immediate Shutdown	Latching
Compressor Did Not Accelerate: Shutdown	Immediate Shutdown	Latching
Cprsr Did Not Accelerate: Transition	Warning	Latching
Starter Contactor Interrupt Failure	Immediate Shutdown	Latching
Starter Module Memory Error Type 1	Warning	Latching
Starter Module Memory Error Type 2	Immediate Shutdown	Latching
Starter Comm Loss: Main Processor	Immediate Shutdown	Latching

Adaptive Frequency Drive Diagnostics

Diagnostic Name	*Severity*	*Persistence*
AFD Power Loss	Immediate Shutdown	Nonlatching
AFD Start Inhibited	Normal Shutdown	Nonlatching
AFD Motor Current Overload	Immediate Shutdown	Latching
AFD Motor Short	Immediate Shutdown	Latching
AFD Instantaneous Current Overload	Immediate Shutdown	Latching
AFD High Temperature	Immediate Shutdown	Latching
AFD Output Phase Loss	Immediate Shutdown	Latching
AFD Ground Fault	Immediate Shutdown	Latching
HPC/High AFD Heat Sink Water Pressure	Immediate Shutdown	Latching
AFD Communication Loss: Main Processor	Immediate Shutdown	Latching
AFD High Bus Voltage	Immediate Shutdown	Latching
AFD Control Board Memory Error Type 2	Immediate Shutdown	Latching
AFD General Failure	Immediate Shutdown	Latching
AFD Fatal Software Error	Immediate Shutdown	Latching
AFD I/O Board Failure	Immediate Shutdown	Latching
AFD Power Intfc Controller Board Failure	Immediate Shutdown	Latching
AFD Power Structure Board Failure	Immediate Shutdown	Latching
AFD DPI Communication Failure	Immediate Shutdown	Latching
AFD RS485 Board Memory Error Type 2	Immediate Shutdown	Latching

Diagnostics

Main Processor Defective Sensor or LLID Diagnostics

Diagnostic Name	*Severity*	*Persistence*
External Chilled/Hot Water Setpoint	Warning	Nonlatching
External Current Limit Setpoint	Warning	Nonlatching
Evaporator Entering Water Temp Sensor	Warning Normal Shutdown (Ice Building)	Latching Latching (Ice Building)
Evaporator Leaving Water Temp Sensor	Normal Shutdown	Latching
Condenser Entering Water Temp Sensor	Warning	Latching
Condenser Leaving Water Temp Sensor	Warning Normal Shutdown (Hot Water)	Latching
Evaporator Differential Water Pressure Transducer	Warning	Latching
Condenser Differential Water Pressure Transducer	Warning	Latching
Second Cond Entering Water Temp Sensor	Warning	Latching
Second Cond Leaving Water Temp Sensor	Warning	Latching
Evap Saturated Refrigerant Temp Sensor	Normal Shutdown	Latching
Cond Saturated Refrigerant Temp Sensor	Normal Shutdown	Latching
Purge Liquid Temperature Sensor	Normal Shutdown	Latching
Condenser Refrigerant Pressure Xdcr	Normal Shutdown	Latching
Oil Tank Temperature Sensor	Normal Shutdown	Latching
Oil Pump Discharge Pressure Transducer	Immediate Shutdown	Latching
Oil Tank Pressure Transducer	Immediate Shutdown	Latching
Motor Winding Temperature 1 Sensor	Normal Shutdown	Latching
Motor Winding Temperature 2 Sensor	Normal Shutdown	Latching
Motor Winding Temperature 3 Sensor	Normal Shutdown	Latching
Inboard Bearing Temperature Sensor	Normal Shutdown	Latching
Outboard Bearing Temperature Sensor	Normal Shutdown	Latching
Compressor Discharge Refrigerant Temperature Sensor	Normal Shutdown Warning (HGBP)	Latching
Outdoor Air Temperature Sensor	Warning	Nonlatching
Purge Cprsr Suction Rfgt Temp Sensor	Normal Shutdown	Latching
Purge Carbon Tank Temperature Sensor	Normal Shutdown	Latching
External Base Loading Setpoint	Warning	Nonlatching

Main Processor Purge Diagnostics

Diagnostic Name	*Severity*	*Persistence*
Purge Liquid Level Too High Warning	Normal Shutdown	Nonlatching
Purge Liquid Level Too High Continuously	Normal Shutdown	Latching
Purge Carbon Regen Temperature Too Low	Normal Shutdown	Latching
Purge Carbon Regen Temp Limit Exceeded	Normal Shutdown	Latching
Purge Regen Cooldown Temp Too High	Normal Shutdown	Latching
Purge Daily Pump-out Limit Exceeded	Normal Shutdown	Nonlatching
Purge Carbon Regen Temp Not Satisfied	Normal Shutdown	Latching

Diagnostics

Main Processor Unit-Level Diagnostics

Diagnostic Name	*Severity*	*Persistence*
Low Evaporator Refrigerant Temperature	Immediate Shutdown	Latching
High Oil Temperature	Immediate Shutdown	Latching
Low Evaporator Leaving Water Temp: Unit Off (Unit in auto but not starting or running)	Warning	Nonlatching
Low Evaporator Leaving Water Temp: Unit On (Unit Starting or Running)	Immediate Shutdown	Nonlatching
Evaporator Water Flow Overdue	Normal Shutdown	Nonlatching
Evaporator Water Flow Lost	Immediate Shutdown	Nonlatching
Condenser High Pressure Cutout	Immediate Shutdown	Latching
Emergency Stop	Immediate Shutdown	Latching
MP: Invalid Configuration	Immediate Shutdown	Latching
MP: Non-Volatile Memory Reformat	Warning	Latching
Check Clock	Warning	Latching
MP: Could not Store Starts and Hours	Warning	Latching
MP: Non-Volatile Block Test Error	Warning	Latching
MP: Reset Has Occurred	Warning	Latching
Extended Compressor Surge	Normal Shutdown	Latching Nonlatching (Ice Building)
Over Voltage	Normal Shutdown	Nonlatching
Under Voltage	Normal Shutdown	Nonlatching
Low Evaporator Water Flow	Warning	Nonlatching
Condenser Water Flow Overdue	Normal Shutdown	Nonlatching
Condenser Water Flow Lost	Normal Shutdown	Nonlatching
Free Cooling Actuators Not Open	Normal Shutdown	Latching
Free Cooling Actuators Not Open During FC	Normal Shutdown	Latching
Free Cooling Actuators Not Closed	Normal Shutdown	Latching
Free Cooling Actuators Unexpectedly Open	Immediate Shutdown	Latching
Unexpected Starter Shutdown	Normal Shutdown	Nonlatching
Starter Failed to Arm/Start	Normal Shutdown	Latching
Solid State Starter Fault	Immediate Shutdown	Latching
Low Differential Oil Pressure	Immediate Shutdown	Latching
Check Oil Filter	Warning	Latching
Oil Pressure Sensor Calibration	Normal Shutdown	Latching
High Vacuum Lockout	Immediate Shutdown	Latching
Low Oil Temperature	Immediate Shutdown	Latching
High Inboard Bearing Temperature	Immediate Shutdown	Latching
High Outboard Bearing Temperature	Immediate Shutdown	Latching
High Cprsr Discharge Rfgt Temperature	Normal Shutdown	Nonlatching
High Motor Winding Temperature 1	Immediate Shutdown	Latching
High Motor Winding Temperature 2	Immediate Shutdown	Latching
High Motor Winding Temperature 3	Immediate Shutdown	Latching
Unexpected Differential Oil Pressure	Immediate Shutdown	Latching
Differential Oil Pressure Overdue	Immediate Shutdown	Latching
BAS Failed to Begin Comm to Comm4 Board	Warning	Nonlatching
BAS Comm Lost with Comm4 Board	Warning	Nonlatching
Hot Gas Bypass Valve Closure Overdue	Normal Shutdown	Latching
Hot Gas Bypass Valve Unexpectedly Open	Normal Shutdown	Latching
Hot Gas Bypass Valve Opening Overdue	Warning	Latching
Refrigerant Monitor Input	Warning	Nonlatching

Diagnostics

Main Processor Communication Diagnostics

Diagnostic Name	*Severity*	*Persistence*
Excessive Loss of Communication	Immediate Shutdown	Latching
Comm Loss: External Auto/Stop	Normal Shutdown	Latching
Comm Loss: Emergency Stop	Normal Shutdown	Latching
Comm Loss: External Ice Building Command	Normal Shutdown	Latching
Comm Loss: Outdoor Air Temperature	Warning	Latching
Comm Loss: Evap Leaving Water Temp	Normal Shutdown	Latching
Comm Loss: Evap Entering Water Temp	Warning Normal Shutdown (Ice Building)	Latching Nonlatching (Ice Building)
Comm Loss: Condenser Leaving Water Temp	Warning Normal Shutdown (Hot Water)	Latching
Comm Loss: Condenser Entering Water Temp	Warning	Latching
Comm Loss: Sec Cond Leaving Water Temp	Warning	Nonlatching
Comm Loss: Sec Cond Entering Water Temp	Warning	Nonlatching
Comm Loss: Oil Tank Temperature	Normal Shutdown	Latching
Comm Loss: Ext Chilled/Hot Wtr Setpoint	Warning	Nonlatching
Comm Loss: Ext Current Limit Setpoint	Warning	Nonlatching
Comm Loss: Cond High Pressure Cutout	Normal Shutdown	Latching
Comm Loss: Evaporator Water Flow Switch	Immediate Shutdown	Latching
Comm Loss: Condenser Water Flow Switch	Normal Shutdown	Latching
Comm Loss: Evap Saturated Rfgt Temp	Immediate Shutdown	Latching
Comm Loss: Cond Saturated Rfgt Temp	Normal Shutdown	Latching
Comm Loss: Purge Liquid Temperature	Normal Shutdown	Latching
Comm Loss: Condenser Refrigerant Pressure	Normal Shutdown	Latching
Comm Loss: Oil Tank Pressure	Immediate Shutdown	Latching
Comm Loss: Oil Pump Discharge Pressure	Immediate Shutdown	Latching
Comm Loss: Evaporator Water Pump Relay	Warning	Latching
Comm Loss: Condenser Water Pump Relay	Warning	Latching
Comm Loss: Ice Building Relay	Normal Shutdown	Latching
Comm Loss: Starter	Immediate Shutdown	Latching
Comm Loss: Adaptive Frequency Drive	Immediate Shutdown	Latching
Comm Loss: Local BAS Comm4 Board	Warning	Nonlatching
Comm Loss: Compressor Running Relay	Warning	Latching
Comm Loss: Non-Wrn Latching Alarm Relay	Warning	Latching
Comm Loss: Non-Wrn Nonlatching Alm Relay	Warning	Latching
Comm Loss: Unit Purge Alarm Relay	Warning	Latching
Comm Loss: Limit Warning Relay	Warning	Latching
Comm Loss: Maximum Capacity Relay	Warning	Latching
Comm Loss: Head Relief Request Relay	Warning	Latching
Comm Loss: Evap Diff Water Pressure	Warning	Latching
Comm Loss: Cond Diff Water Pressure	Warning	Latching
Comm Loss: Cond Rfgt Pressure Output	Warning	Latching
Comm Loss: Compressor Motor % RLA Output	Warning	Latching
Comm Loss: Refrigerant Monitor Input	Warning	Latching
Comm Loss: External Free Cooling Command	Normal Shutdown	Latching
Comm Loss: Free Cool Actrs Closed Input	Immediate Shutdown	Latching
Comm Loss: Free Cool Liq Line Actuator Relay	Normal Shutdown	Latching
Comm Loss: Free Cool Gas Line Actuator Relay	Normal Shutdown	Latching
Comm Loss: Free Cooling Auxiliary Relay	Warning	Nonlatching

Diagnostics

Main Processor Communication Diagnostics

Diagnostic Name	*Severity*	*Persistence*
Comm Loss: Purge Cprsr Suction Rfgt Temp	Normal Shutdown	Latching
Comm Loss: Purge Carbon Tank Temperature	Normal Shutdown	Latching
Comm Loss: Purge Liquid Level Switch	Normal Shutdown	Latching
Comm Loss: Purge Chiller Cprsr Run Input	Normal Shutdown	Latching
Comm Loss: Purge Pump-out Relay	Normal Shutdown	Latching
Comm Loss: Purge Carbon Tank Heater Rly	Normal Shutdown	Latching
Comm Loss: Purge Regen Solenoid Relay	Normal Shutdown	Latching
Comm Loss: Purge Alarm Relay	Normal Shutdown	Latching
Comm Loss: Purge Pump-out Solenoid Output	Normal Shutdown	Latching
Comm Loss: Purge Exhaust Solenoid Output	Normal Shutdown	Latching
Comm Loss: Purge Condensing Unit Relay	Normal Shutdown	Latching
Comm Loss: Solid State Starter Fault	Immediate Shutdown	Latching
Comm Loss: PFCC Relay	Warning	Nonlatching
Comm Loss: Oil/Refrigerant Pump Relay	Immediate Shutdown	Latching
Comm Loss: Oil Tank Heater Relay	Warning	Nonlatching
Comm Loss: Motor Winding Temperature 1	Normal Shutdown	Latching
Comm Loss: Motor Winding Temperature 2	Normal Shutdown	Latching
Comm Loss: Motor Winding Temperature 3	Normal Shutdown	Latching
Comm Loss: Inboard Bearing Temperature	Normal Shutdown	Latching
Comm Loss: Outboard Bearing Temperature	Normal Shutdown	Latching
Comm Loss: Cprsr Discharge Rfgt Temp	Normal Shutdown Warning (HGBP)	Latching
Comm Loss: IGV First Stage Actuator	Normal Shutdown	Latching
Comm Loss: IGV Second Stage Actuator	Normal Shutdown	Latching
Comm Loss: Ext Base Loading Setpoint	Warning	Nonlatching
Comm Loss: Ext Base Loading Command	Warning	Nonlatching
Comm Loss: External Hot Water Command	Warning	Nonlatching
Comm Loss: Hot Gas Bypass Load Relay	Normal Shutdown	Latching
Comm Loss: Hot Gas Bypass Unload Relay	Normal Shutdown	Latching
Comm Loss: Hot Gas Bypass Actr Closed In	Normal Shutdown	Latching

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