Operating & Maintenance Manual

OMM 1123	
Group: **Chiller**	
Part Number: **OMM 1123**	Rev **00**
Date: **January 2012**	
Supercedes: **December 2011**	

Pathfinder™ Air-Cooled Chillers

AWS 170A/B through AWS 550A/B (Includes Models with Optional VFD)

60 Hertz

R-134a

Software Version: 2507500209 and 2507500210

DAIKIN McQUAY

Table of Contents

Modbus

Unit controllers are LONMARK certified with an optional LONWORKS communications module

Manufactured in an ISO Certified Facility

Introduction

This manual provides setup, operating, troubleshooting and maintenance information for the Daiken McQuay Pathfinder chillers.

HAZARD IDENTIFICATION INFORMATION

⚠ DANGER
Dangers indicate a hazardous situation which will result in death or serious injury if not avoided.

⚠ WARNING
Warnings indicate potentially hazardous situations, which can result in property damage, severe personal injury, or death if not avoided.

⚠ CAUTION
Cautions indicate potentially hazardous situations, which can result in personal injury or equipment damage if not avoided.

Software Version:

The unit software and BSP (Board Support Package) versions can be viewed using the keypad/display. From the Main Menu, turn the knob to the right until you reach the About Chiller menu and press Enter (the knob). The software version is displayed as "App Version =". Scroll down in this menu (turn knob to the right), the BSP version will also be displayed ("BSP Version=").

App Version 2507500210 for units with or without optional compressor VFDs or RapidRestore™. Version 2507500210 has certain operational revisions to the previous version but the information in this manual is unchanged.

⚠ WARNING
Electric shock hazard: can cause personal injury or equipment damage. This equipment must be properly grounded. Connections to, and service of, the MicroTech III control panel must be performed only by personnel who are knowledgeable in the operation of this equipment .

⚠ CAUTION
Static sensitive components. A static discharge while handling electronic circuit boards can cause damage to the components. Discharge any static electrical charge by touching the bare metal inside the control panel before performing any service work. Never unplug any cables, circuit board terminal blocks, or power plugs while power is applied to the panel.

NOTICE
This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with this instruction manual, can cause interference to radio communications. Operation of this equipment in a residential area can cause harmful interference, in which case the user will be required to correct the interference at the user's own expense. McQuay International Corporation disclaims any liability resulting from any interference or for the correction thereof.

Operating Limits:

- Maximum standby ambient temperature, 130°F (55°C)
- Maximum operating ambient temperature is 115°F (46°C), or 125°F (52°C) with the addition of the optional high ambient package
- Minimum operating ambient temperature (standard), 35°F (2°C)
- Minimum operating ambient temperature (with optional low-ambient control), 0°F (-18°C)
- Leaving chilled water temperature, 39.2°F to 59.0°F (4.0°C to 15.0°C)
- Leaving chilled fluid temperatures with glycol, 24.8°F to 59.0°F (-4.0°C to 15.0°C). Normal unloading.
- Leaving temperature in ICE mode, 17.6°F to 39.2°F (-8.0°C to 4°C). No unloading.
- Operating Delta-T range, 6°F to 16°F (3.3°C to 8.9°C)
- Maximum operating inlet fluid temperature, 76°F (24°C)
- Maximum non-operating inlet fluid temperature, 100°F (38°C)

Controller Features

Readout of the following temperature and pressure readings:

- Entering and leaving chilled water temperature
- Saturated evaporator refrigerant temperature and pressure
- Saturated condenser temperature and pressure
- Outside air temperature
- Suction and discharge line temperatures – calculated superheat for discharge and suction lines
- Oil pressure

Automatic control of primary and standby chilled water pumps. The control will start one of the pumps (based on lowest run-hours) when the unit is enabled to run (not necessarily running on a call for cooling) and when the water temperature reaches a point of freeze possibility.

Two levels of security protection against unauthorized changing of setpoints and other control parameters.

Warning and fault diagnostics to inform operators of warning and fault conditions in plain language. All events and alarms are time and date-stamped for identification of when the fault condition occurred.

Twenty-five previous alarms are available.

Remote input signals for chilled water reset, demand limiting, and unit enable.

Test mode allows the service technician to manually control the controllers' outputs and can be useful for system checkout.

Building Automation System (BAS) communication capability via LonTalk®, Modbus®, or BACnet® standard protocols for all BAS manufacturers-simplified with McQuay's Open Choices™ feature.

Pressure transducers for direct reading of system pressures. Preemptive control of low evaporator pressure conditions and high discharge temperature and pressure to take corrective action prior to a fault trip.

General Description

The control panel is located on the front of the unit at the compressor end. There are three doors. The control panel is behind to left-hand door. The power panel is behind the middle and right-hand doors.

General Description

The MicroTech III control system consists of a microprocessor-based controller and a number of extension modules, which vary depending on the unit size and conformation. The control system provides the monitoring and control functions required for the controlled, efficient operation of the chiller.

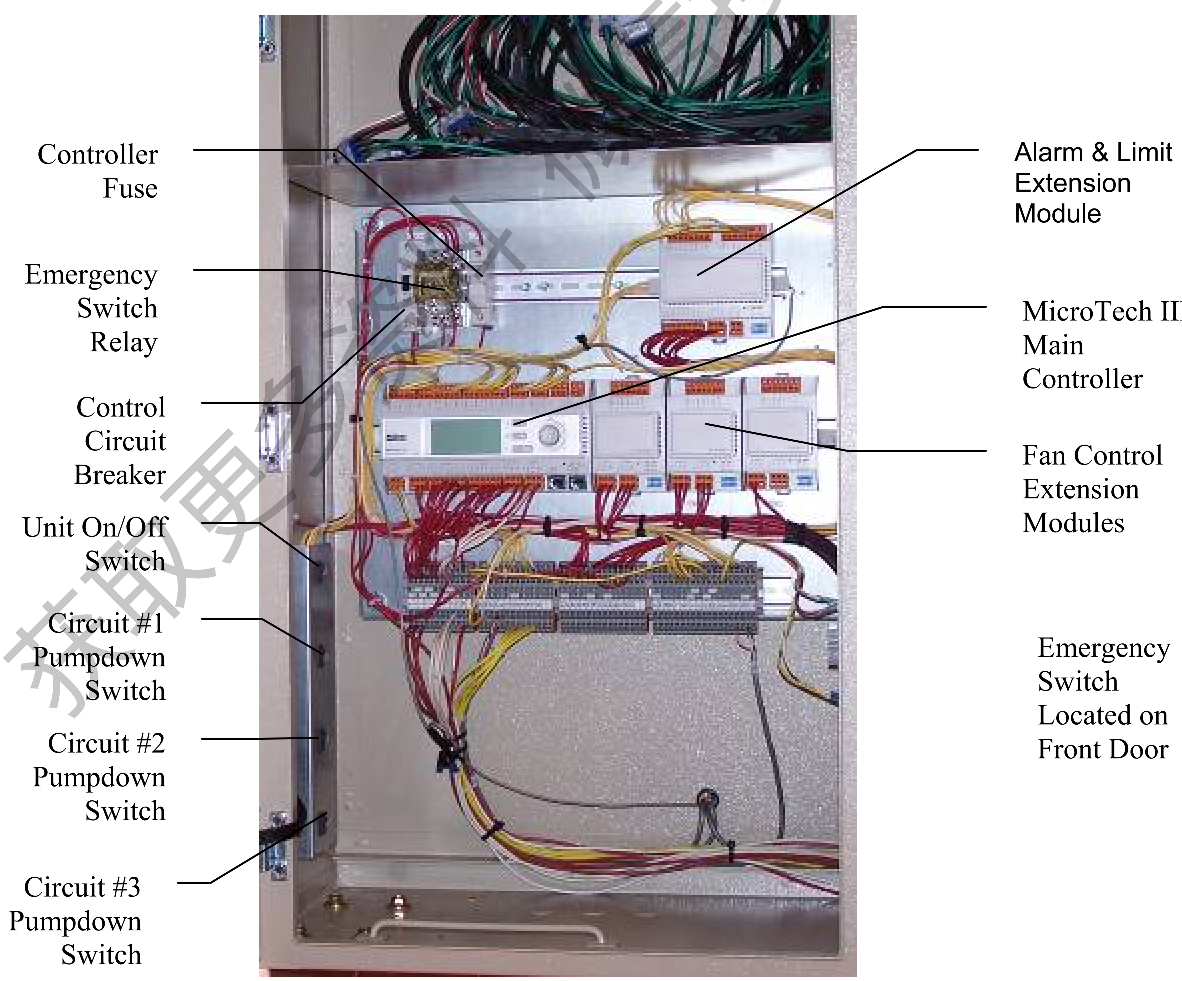
The operator can monitor all critical operating conditions by using the screen located on the main controller. In addition to providing all normal operating controls, the MicroTech III control system will take corrective action if the chiller is operating outside of its normal design conditions. If a fault condition develops, the controller will shut a compressor, or the entire unit, down and activate an alarm output.

The system is password protected and only allows access by authorized personnel. Except that some basic information is viewable and alarms can be cleared without a password. No settings can be changed.

Additional information about the Daikin McQuay Pathfinder Chiller is available in Catalog 600 and IM 997, which can be found on www.mcquay.com.

Control Panel Layout

Figure 1, Control Panel Components, Three-Circuit Unit, w/o VFD



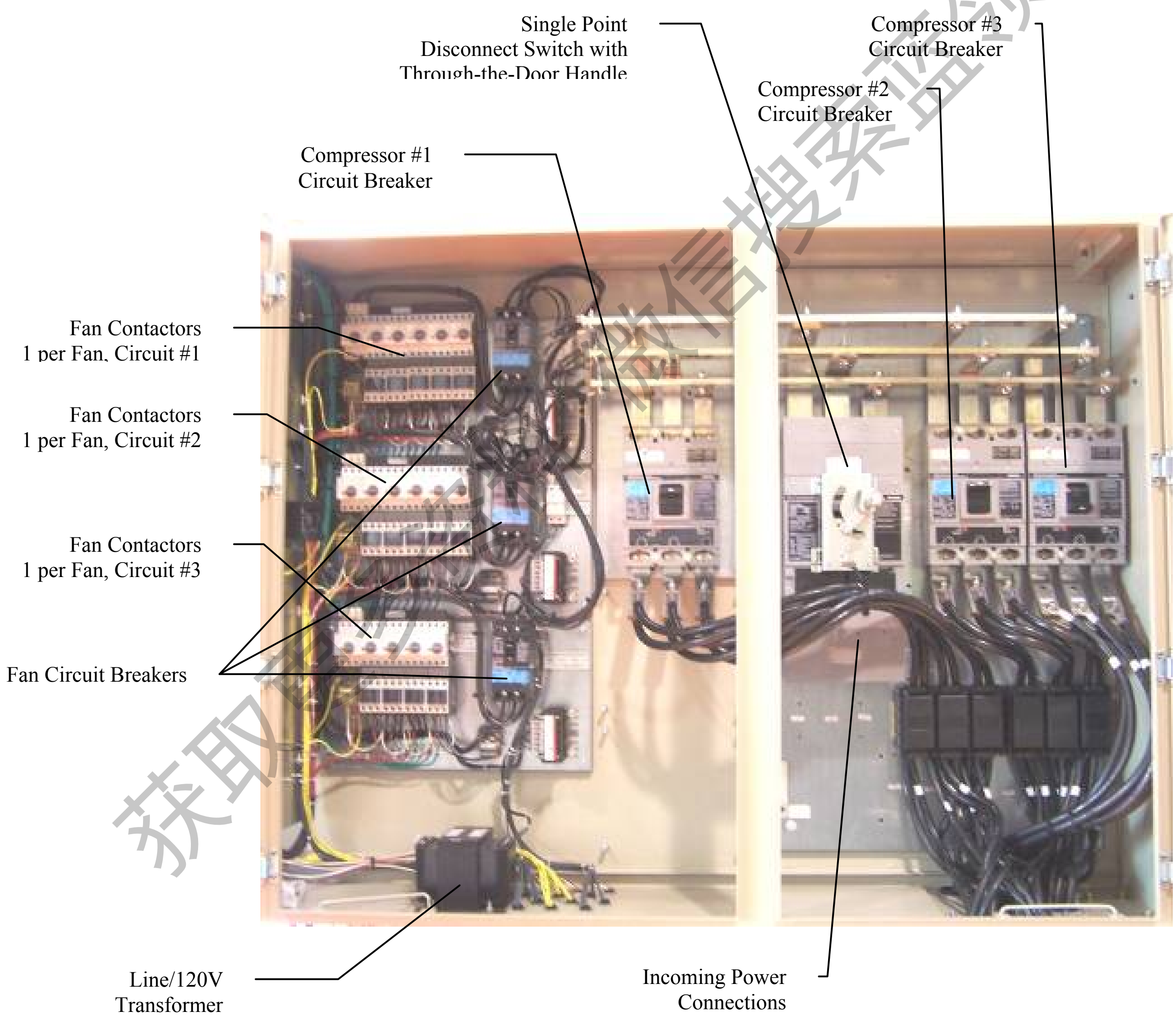
NOTES:

1. The Emergency Switch Relay de-energizes all circuit's control power when activated, causing an immediate compressor and fan shutdown. The red emergency button switch is located on the front of the control panel door.
2. The control power transformer is located in the power panel adjacent to the control panel.
3. Additional extension (aka expansion) modules are located elsewhere on the chiller.
4. See the VFD section for a description of the panel used with the VFD option as it is considerably different from the standard panel.

Power Panel Layout

The power panel is at the front of the unit, behind the two doors to the right.

Figure 2, Power Panel, Three-Circuit Units, w/o VFD

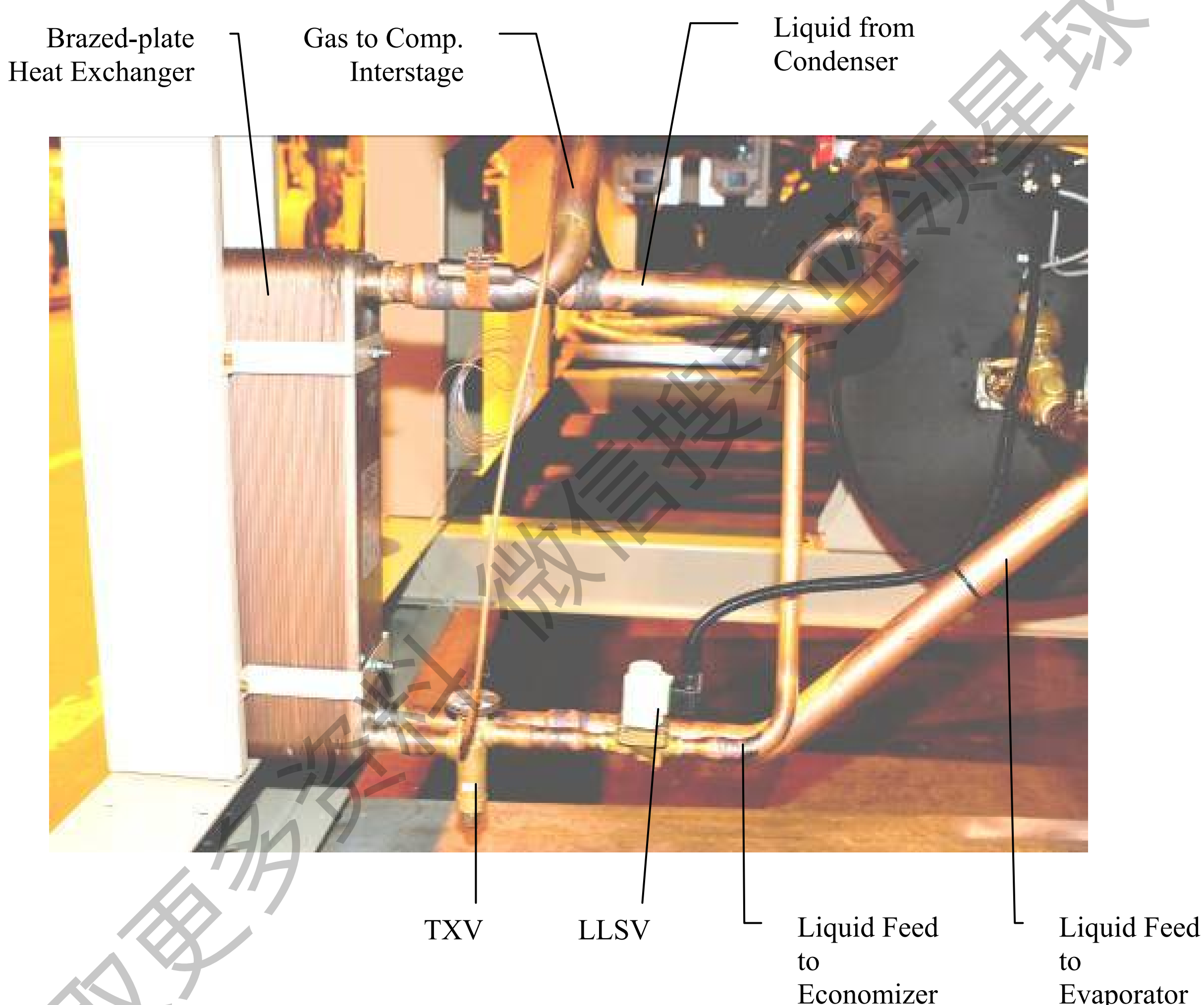


NOTE: See the VFD section of this manual for a description of the power used with the VFD option as it is considerably different from the standard panel.

Economizer Components

The chiller may or may not have economizers depending on design capacity requirements. An economizer is a well-proven device to increase a refrigerant circuit's capacity and efficiency.

Figure 3, Economizer Components



Warm liquid from the condenser is fed into the economizer where it is cooled by flashing off liquid also from the condenser. The flash gas is piped to a compressor interstage point. Lowering the liquid refrigerant temperature to the evaporator decreases its enthalpy (heat content) and results in a greater amount of heat absorption from the chilled water.

Figure 4, Piping Schematic with Economizer Circuit, One Circuit Shown

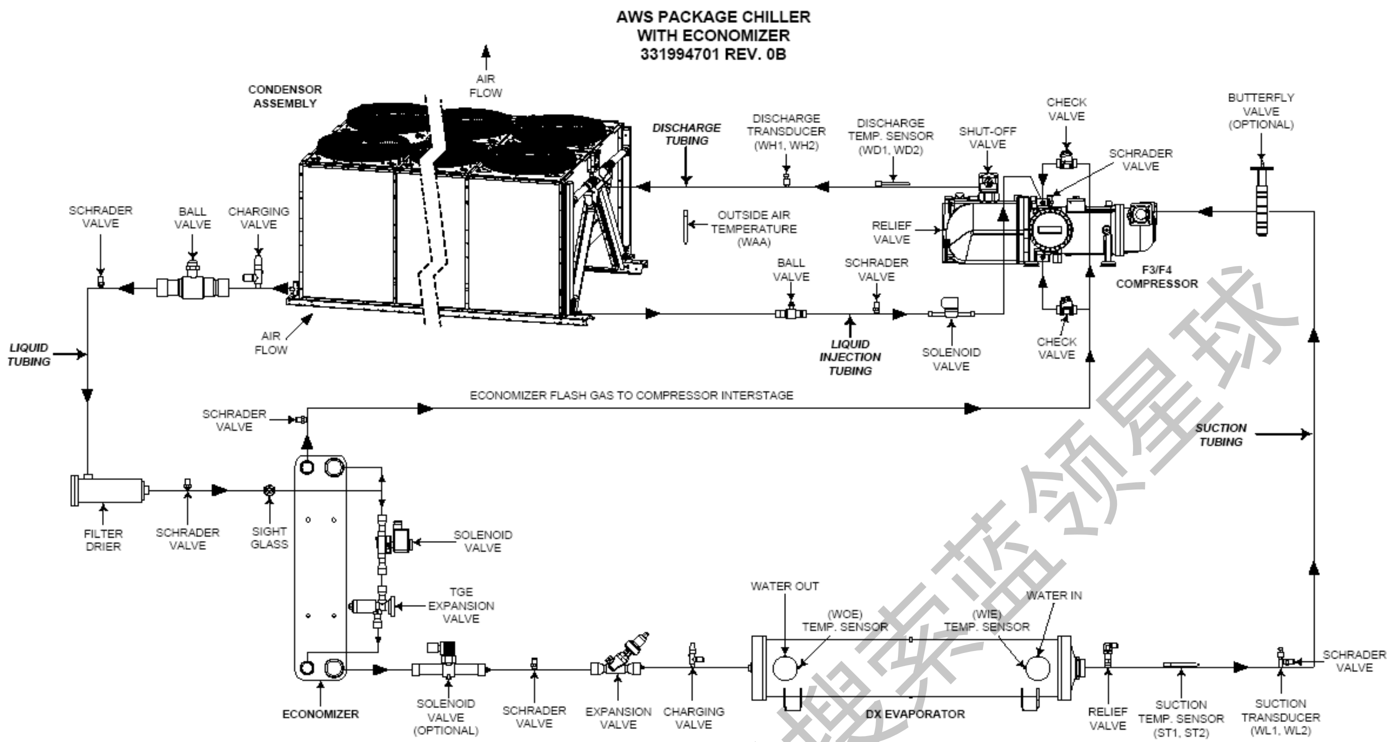
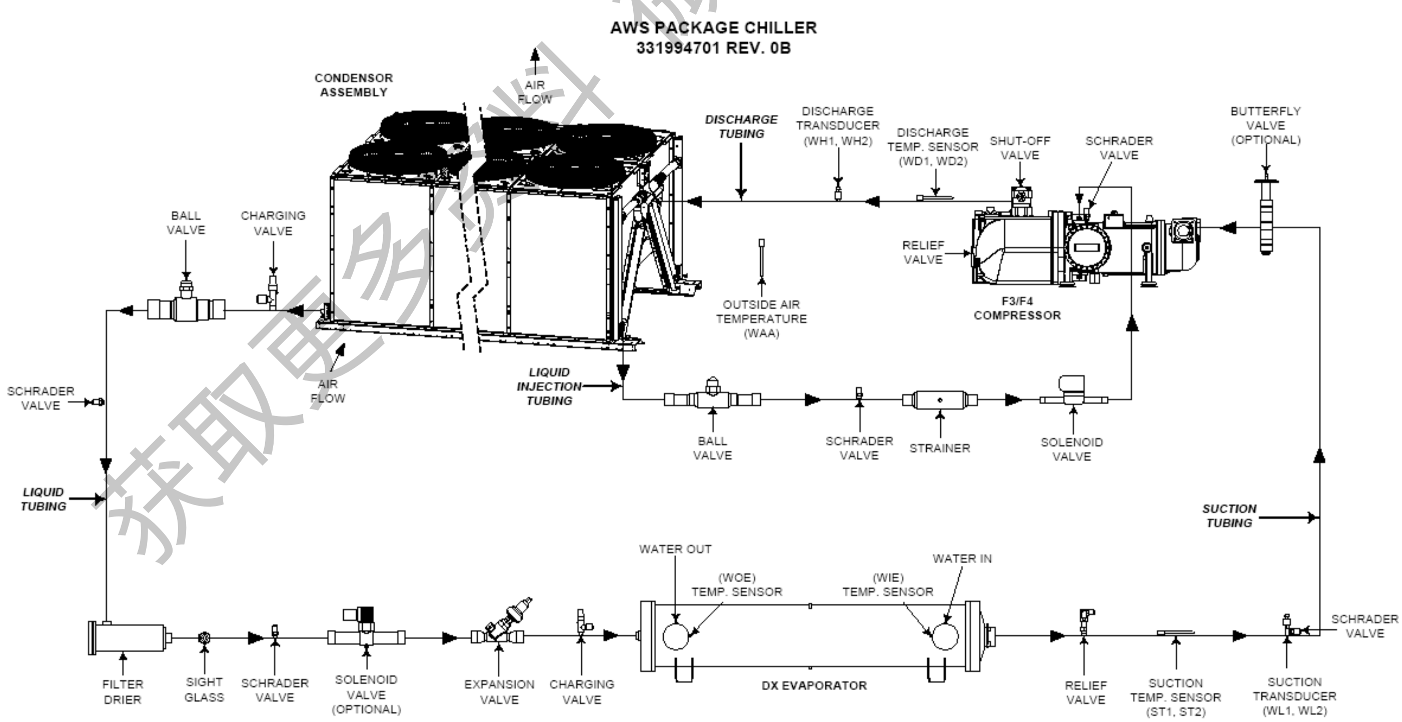


Figure 5, Piping Schematic without Economizer Circuit, One Circuit Shown



Controller Description

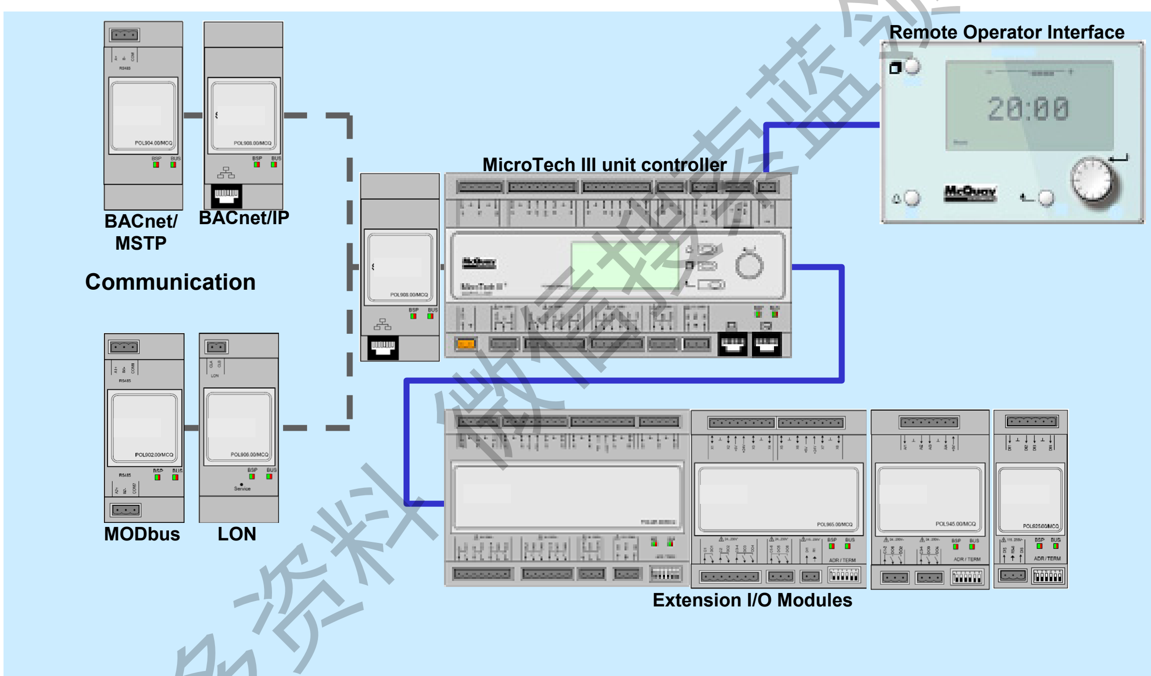
Hardware Structure

The MicroTech III control system for Pathfinder chillers consists of a main unit controller with a number of extension input/output I/O modules attached depending on the chiller size and configuration.

One of the optional BAS communication modules may be included.

An optional Remote Operator Interface panel may be included, connected with up to nine Pathfinder units.

The MicroTech III controllers used on Pathfinder chillers are not interchangeable with previous MicroTech II controllers.

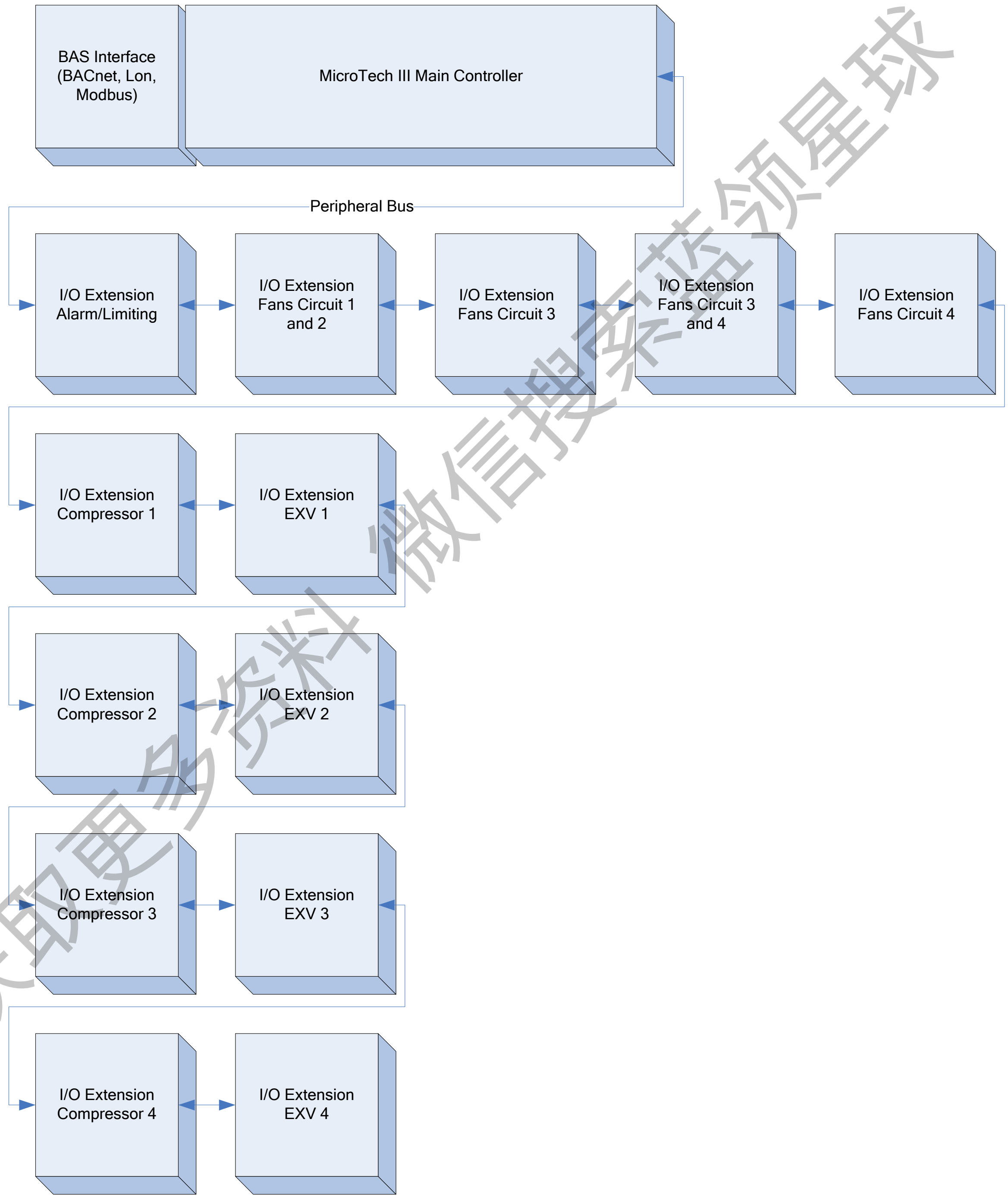


System Architecture

The overall controls architecture uses the following:

- One MicroTech III main controller
- I/O extension modules (sometimes referred to as "controllers") as needed depending on the configuration of the unit
- Optional BAS interface as selected

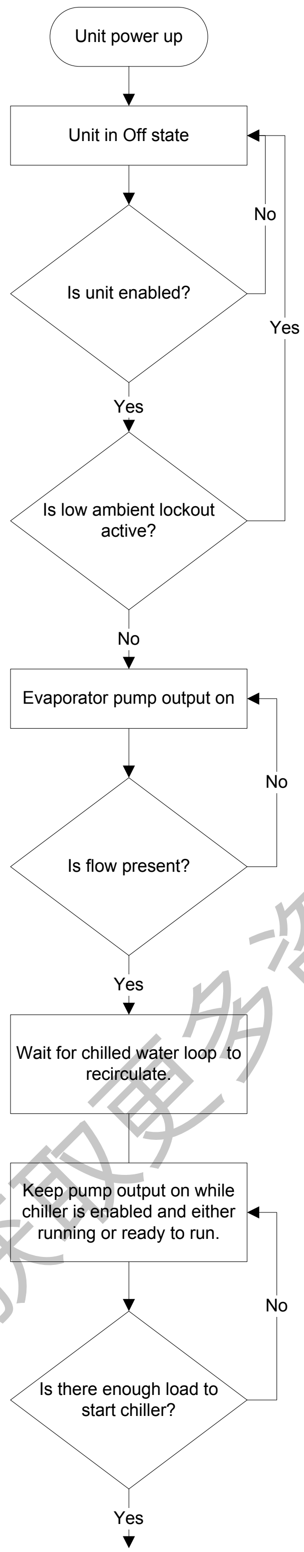
Figure 6, System Architecture



Sequence of Operation

Figure 7, <u>Unit</u> Sequence of Operation (see Figure 9 for <u>circuit</u> sequence of operation)

AWS Chiller Sequence of Operation in Cool Mode



The chiller may be disabled via the unit switch, the remote switch, the keypad enable setting, or the BAS network. In addition, the chiller will be disabled if all circuits are disabled, or if there is a unit alarm. If the chiller is disabled, the unit status display will reflect this and also show why it is disabled.

If the unit switch is off, the unit status will be **Off:Unit Switch**. If the chiller is disabled due to network command, the unit status will be **Off:BAS Disable**. When the remote switch is open, the unit status will be **Off:Remote Switch**. When a unit alarm is active, the unit status will be **Off:Unit Alarm**. In cases where no circuits are enabled, the unit status will be **Off:All Cir Disabled**. If the unit is disabled via the Chiller Enable set point, the unit status will be **Off:Keypad Disable**.

Low ambient lockout will prevent the chiller from starting even if it is otherwise enabled. When this lockout is active, the unit status will be **Off:Low OAT Lock**.

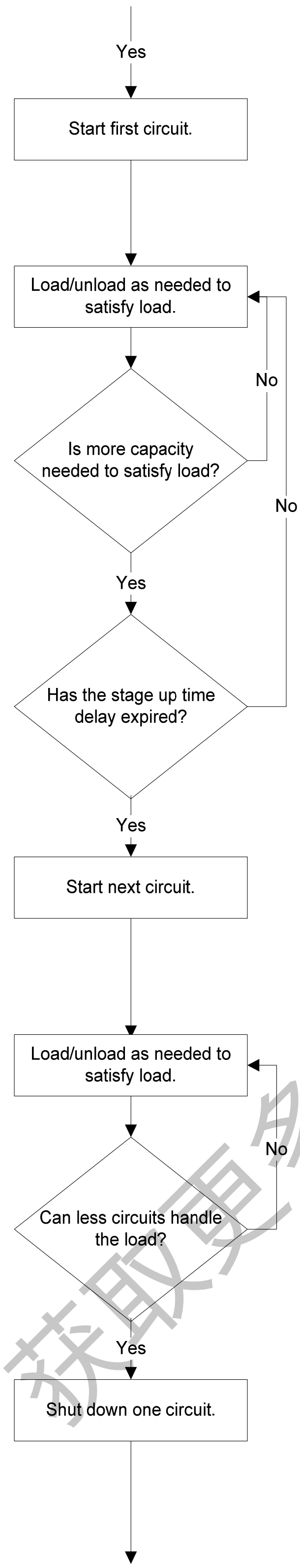
If the chiller is enabled, then the unit will be in the Auto state and the evaporator water pump output will be activated.

The chiller will then wait for the flow switch to close, during which time the unit status will be **Auto:Wait for flow**.

After establishing flow, the chiller will wait some time to allow the chilled water loop to recirculate for an accurate reading of the leaving water temperature. The unit status during this time is **Auto:Evap Recirc**.

The chiller is now ready to start if enough load is present. If the LWT is not higher than the Active Setpoint plus the Start Up Delta T, the unit status will be **Auto:Wait for load**.

If the LWT is higher than the Active Setpoint plus the Start Up Delta T, the unit status will be **Auto**. A circuit can start at this time.



The first circuit to start is generally the available circuit with the least number of starts. This circuit will go through its start sequence at this point.

The first circuit will be loaded and unloaded as needed in an attempt to satisfy the load by controlling LWT to the Active Setpoint.

If a single circuit is not enough to satisfy the load, additional circuits will need to be started. An additional circuit will be started when all running compressors are loaded to a specific capacity and the LWT is higher than the Active Setpoint plus the Stage Up Delta T.

A minimum time must pass between the starting of circuits. The time remaining can be viewed on the HMI if the minimum password level is active.

The second circuit will go through its start sequence at this point.

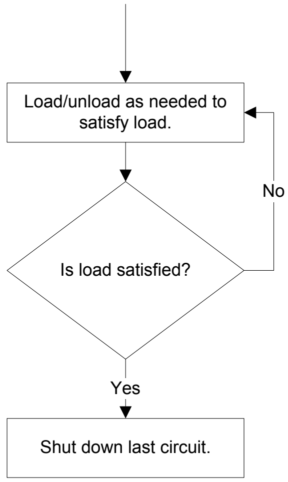
Note that a third circuit can be started if available. The two preceding conditions must again be satisfied after starting the second circuit before starting the third circuit.

All running circuits will now be loaded/unloaded as needed to satisfy the load. When possible, they will load balance so that running circuits are providing nearly equal capacity.

As the load drops off, the circuits will unload accordingly. If the LWT drops below the Active Setpoint minus the Stage Down Delta T, one circuit will shut off. If all running circuits are unloaded below a minimum value, this can also result in one circuit shutting off.

A minimum time must pass between the shutting down of circuits. The time remaining can be viewed on the HMI if the minimum password level is active.

The next circuit to shut off is generally the one with the most run hours.



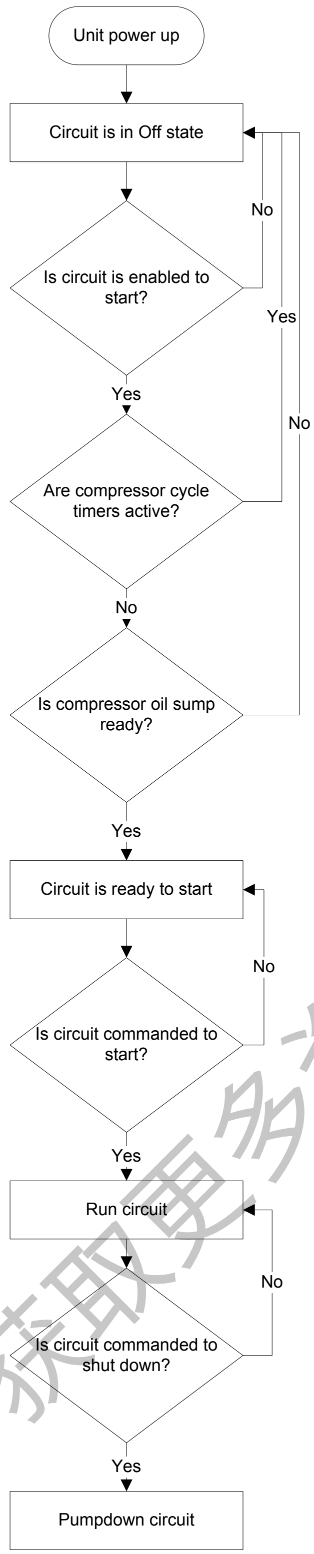
The remaining running circuit(s) will be loaded/unloaded as needed to satisfy the load.

When only one circuit is running, the load may drop off to the point where even minimum unit capacity is too much. The load has been satisfied when the LWT drops below the Active Setpoint minus the Shutdown Delta T. At this time the only running circuit can shut down.

The last circuit running now shuts down.

The unit should be ready to start again when the LWT gets high enough. Until that time, unit status will be **Auto:Wait for load**.

Figure 8, <u>Circuit</u> Sequence of Operation



AWS Sequence of Operation - Circuits

When the circuit is in the Off state the EXV is closed, compressor is off, and all fans are off.

The circuit must be enabled before it can run. It may be disabled for several reasons. When the circuit switch is off, the status will be **Off:Circuit Switch**. If the BAS has disabled the circuit, the status will be **Off:BAS Disable**. If the circuit has an active stop alarm then the status will be **Off:Cir Alarm**. If the circuit has been disabled via the circuit mode set point, the status will be **Off:Cir Mode Disable**.

A minimum time must pass between the previous start and stop of a compressor and the next start. If this time has not passed, a cycle timer will be active and the circuit status will be **Off:Cycle Timer**.

If the compressor is not ready due to refrigerant in the oil, the circuit cannot start. The circuit status will be **Off:Refr In Oil.**

If the compressor is ready to start when needed, the circuit status will be **Off:Ready**.

When the circuit begins to run, the compressor will be started and the EXV, fans, and other devices will be controlled as needed. The normal circuit status at this time will be **Run**.

When the circuit is commanded to shut down, a normal shut down of the circuit will be performed. The circuit status during this time will be **Run:Pumpdown**. After the shut down is completed, the circuit status will normally be **Off:Cycle Timer** initially**.**

MicroTech III Inputs/Outputs

I/O for the unit control and for circuits one and two are found on CP1.
The chiller may be equipped with two or three compressors.

Analog Inputs

#	Description	Signal Source	Expected Range
AI1	Evaporator Entering Water Temp	NTC Thermister (10K@25°C)	-50°C – 120°C
AI2	Evaporator Leaving Water Temp	NTC Thermister (10K@25°C)	-50°C – 120°C
AI3	Evaporator #1 Leaving Water Temp (*)	NTC Thermister (10K@25°C)	-50°C – 120°C
X1	Evaporator #2 Leaving Water Temp (*)	NTC Thermister (10K@25°C)	-50°C – 120°C
X2	Outside Ambient Temperature	NTC Thermister (10K@25°C)	-50°C – 120°C
X4	LWT Reset	4-20 mA Current	1 to 23 mA

*Evaporator #1 LWT and Evaporator #2 LWT will only be used when unit is configured with four circuits

Analog Outputs

#	Description	Output Signal	Range
X5	Fan VFD #1	0-10VDC	0 to 100% (1000 steps resolution)
X6	Fan VFD #2	0-10VDC	0 to 100% (1000 steps resolution)
X7	Fan VFD #3	0-10VDC	0 to 100% (1000 steps resolution)
X8	Fan VFD #4	0-10VDC	0 to 100% (1000 steps resolution)

Digital Inputs

#	Description	Signal Off	Signal On
DI1	Unit PVM	Fault	No Fault
DI2	Evaporator Flow Switch	No Flow	Flow
DI3	Double Setpoint/ Mode Switch	Cool mode	Ice mode
DI4	Remote Switch	Remote off	Remote on
DI5	Unit Switch	Unit off	Unit on
DI6	Emergency Stop	Unit off/rapid stop	Unit on

Digital Outputs

#	Description	Output OFF	Output ON
DO1	Evaporator Water Pump	Pump Off	Pump On
DO2	Unit Alarm	Alarm not Active	Alarm Active (Flashing= circuit alarm)
DO3	Circuit #1 Fan Step #1	Fan Off	Fan On
DO4	Circuit #1 Fan Step #2	Fan Off	Fan On
DO5	Circuit #1 Fan Step #3	Fan Off	Fan On
DO6	Circuit #1 Fan Step #4	Fan Off	Fan On
DO7	Circuit #2 Fan Step #1	Fan Off	Fan On
DO8	Circuit #2 Fan Step #2	Fan Off	Fan On
DO9	Circuit #2 Fan Step #3	Fan Off	Fan On
DO10	Circuit #2 Fan Step #4	Fan Off	Fan On

Expansion I/O Compressor #1 to #3

Analog Inputs

#	Description	Signal Source	Expected Range
X1	Discharge Temperature	NTC Thermister (10K@25°C)	-50°C – 125°C
X2	Evaporator Pressure	Ratiometric 0.5-4.5 Vdc	-100 kPa to 700 kPa
X3	Oil Pressure	Ratiometric 0.5-4.5 Vdc	0 kPa to 3000 kPa
X4	Condenser Pressure	Ratiometric 0.5-4.5 Vdc	0 kPa to 3000 kPa
X7	Motor Temperature	See note below	

Note: European chillers will have the PTC thermistor in the compressor motor connected to this input. X7 is configured as an NTC 10k input for European chillers.

Analog Outputs

#	Description	Output Signal	Range
Not Needed			

Digital Inputs

#	Description	Signal Off	Signal On
X6	Starter Fault	Fault	No fault
X7	Motor Protection	See note below	
DI1	High Pressure Switch	Fault	No fault

Note: US chillers will use the motor protection board connected to this input. X7 is configured as a digital input for US chillers.

Digital Outputs

Europe Configuration

#	Description	Output Off	Output On
DO1	Start Compressor	Compressor Off	Compressor On
DO2	Economizer	Solenoid Closed	Solenoid Open
DO3	Non-modulating Slide Load/Unload	Solenoid Closed	Solenoid Open
DO4	Liquid Injection	Solenoid Closed	Solenoid Open
DO5	Modulating Slide Load	Solenoid Closed	Solenoid Open
DO6	Modulating Slide Unload	Solenoid Closed	Solenoid Open
X5	Modulating Slide “turbo”	Solenoid Closed	Solenoid Open

U.S. Configuration

#	Description	Output Off	Output On
DO1	Start Compressor	Compressor Off	Compressor On
DO2	Economizer	Solenoid Closed	Solenoid Open
DO3	Non-modulating Slide Load	Solenoid Closed	Solenoid Open
DO4	Non-modulating Slide Unload	Solenoid Closed	Solenoid Open
DO5	Modulating Slide Load	Solenoid Closed	Solenoid Open
DO6	Modulating Slide Unload	Solenoid Closed	Solenoid Open
X5	Modulating Slide ‘Turbo’	Solenoid Closed	Solenoid Open
X8	Liquid Injection	Solenoid Closed	Solenoid Open

I/O EXV Circuit #1 to #3

Analog Inputs

#	Description	Signal Source	Expected Range
X2	Suction Temperature	NTC Thermister 10K@25°C)	-50°C – 120°C
X3	Slide Position	LVDT 4 to 20 mA	0% to 100%

Analog Outputs

#	Description	Output Signal	Range
Not Needed			

Digital Inputs

#	Description	Signal Off	Signal On
DI1	Low Pressure switch	Fault	No fault

Digital Outputs

#	Description	Output Off	Output On
DO1	Liquid Line	Solenoid Closed	Solenoid Open

Stepper Motor Output

#	Description
M1+	EXV Stepper Coil 1
M1-	
M2+	EXV Stepper Coil 2
M2-	

Extension I/O Fan Module Circuit #1 & 2

Digital Inputs

#	Description	Output Off	Output On
DI1	PVM/GFP Circuit #1	Fault	No fault
DI2	PVM/GFP Circuit #2	Fault	No fault

Digital Outputs

#	Description	Output Off	Output On
DO1	Circuit #1 Fan Step #5	Fan Off	Fan On
DO2	Circuit #1 Fan Step #6	Fan Off	Fan On
DO3	Circuit #2 Fan Step #5	Fan Off	Fan On
DO4	Circuit #2 Fan Step #6	Fan Off	Fan On

Extension I/O Fan Module Circuit #3

Digital Outputs

#	Description	Output Off	Output On
DO1	Circuit #3 Fan Step #5	Fan Off	Fan On
DO2	Circuit #3 Fan Step #6	Fan Off	Fan On

Extension I/O Unit Alarm & Limiting

Analog Inputs

#	Description	Signal Source	Range
X3	Demand Limit	4-20 mA	1 to 23 mA
X4	Unit Current	4-20 mA	1 to 23 mA

Analog Outputs

#	Description	Output Signal	Range
Not Needed			

Digital Inputs

#	Description	Signal Off	Signal On
X1	External Alarm/Event	External Device Failure	External Device OK
X2	Current Limit Enable	No Limiting	Limiting
X5	Circuit Switch #1	Circuit Off	Circuit On
X6	Circuit Switch #2	Circuit Off	Circuit On
X7	Circuit Switch #3	Circuit Off	Circuit On

Digital Outputs

#	Description	Output Off	Output On
DO1	Evaporator Water Pump #2	Pump Off	Pump On
DO2	Open		
DO3	Circuit #1 Alarm	No Alarm	Alarm
DO4	Circuit #2 Alarm	No Alarm	Alarm
DO5	Circuit #3 Alarm	No Alarm	Alarm

Setpoints

The following parameters are remembered during power off, are factory set to the **Default** value, and can be adjusted to any value in the **Range** column.

Read and write access to these setpoint is determined by the Global HMI (Human Machine Interface) Standard Specification.

Table 1, Setpoint Default and Range

Description	Default	Range
Unit		
Manufacturing Location	Not Selected	Not Selected, Europe, USA
Frequency	60 Hz	50, 60
Voltage	460 V	230, 380, 400, 460, 575
Unit Enable	Enable	Disable, Enable
Unit Status after Power Failure	Enable	Disable, Enable
Control source	Local	Local, Network
Available Modes	Cool	Cool, Cool w/Glycol Cool/Ice w/Glycol, Ice, Test
Cool LWT 1	7.0°C (44.6°F)	4.0°C to 15.0°C (39.2°F to 59.0°F)
Cool LWT 2	7.0°C (44.6°F)	4.0°C to 15.0°C (39.2°F to 59.0°F)
Cool LWT 1 with Glycol	7.0°C (44.6°F)	-4.0°C to 15.0°C (24.8°F to 59.0°F)
Cool LWT 2 with Glycol	7.0°C (44.6°F)	-4.0°C to 15.0°C (24.8°F to 59.0°F)
Ice LWT	-4.0°C (24.8°F)	-8.0°C to 4.0°C (17.6°F to 39.2°F)
Startup Delta T	2.7 deg C (4.9 deg F)	0 to 5.0 deg C (0 to 9.0 deg F)
Shut Down Delta T	1.5 deg C (2.7 deg F)	0 to 1.7 deg C (0 to 3.1 deg F)
Stage Up Delta T	0.5 deg C (0.9 deg F)	0 to 1.7 deg C (0 to 3.1 deg F)
Stage Down Delta T	0.7 deg C (1.3 deg F)	0 to 1.7 deg C (0 to 3.1 deg F)
Max Pulldown	1.7 deg C/min (3.1 deg F/min)	0.3 to 2.7 deg C/min (0.5 to 4.9 deg F/min)
Nominal Evap Delta T 2 Cir	5.6 deg C (10.1 deg F)	3.3 to 8.9 deg C (5.9 to 16.0 deg F)
Nominal Evap Delta T 3 Cir	5.6 deg C (10.1 deg F)	3.3 to 10 deg C (5.9 to 18.0 deg F)
Variable Evap Flow	No	No, Yes
Evap Recirc Timer	30 sec	0 to 300 seconds

Continued next page

.Description	Default	Range
Pump Control	#1 Only	#1 Only, #2 Only, Auto, #1 Primary, #2 Primary
LWT Reset Type	None	None, 4-20mA, OAT
Max Reset	5.0 deg C (9.0 deg F)	0 to 10.0 deg C (0 to 18.0 deg F)
Start Reset Delta T	5.0 deg C (9.0 deg F)	0 to 10.0 deg C (0 to 18.0 deg F)
Max Reset OAT	15.5°C (59.9°F)	10.0°C to 30.0°C (50°F to 86.0 °F)
Start Reset OAT	23.8°C (74.8°F)	10.0°C to 30.0°C (50°F to 86.0 °F)
Soft Load	Off	Off, On
Begin Capacity Limit	40%	20-100%
Soft Load Ramp	20 min	1-60 minutes
Demand Limit	Off	Off, On
Current @ 20mA	800 A	0 to 2000 A
Current limit Setpoint	800 A	0 to 2000 A
# of Circuits	2	2, 3
Ice Delay Timer	12 hrs	1-23 hours
Clear Ice Timer	No	No, Yes
PVM	Multi Point	Single Point, Multi Point , None(SSS)
Noise Reduction	Disabled	Disabled, Enabled
Noise Reduction Start Time	21:00	18:00 – 23:59
Noise Reduction End Time	6:00	5:00 – 9:59
Noise Reduction Offset	5.0 deg C (9.0 deg F)	0 to 14.0 deg C (0 to 25.2 deg F)
Evap LWT Sensor Offset	0 deg C (0 deg F)	-5.0 to 5.0 deg C (-9.0 to 9.0 deg F)
Evap EWT Sensor Offset	0 deg C (0 deg F)	-5.0 to 5.0 deg C (-9.0 to 9.0 deg F)
OAT Sensor Offset	0 deg C (0 deg F)	-5.0 to 5.0 deg C (-9.0 to 9.0 deg F)
Max Power Failure time	15 sec	15-180 sec
RapidRestore™	Disable	Enable, Disable (special software req'd)
Compressors-Global		
Start-start timer	20 min	15-60 minutes
Stop-start timer	5 min	3-20 minutes
Pumpdown Pressure	100 kPa (14.5 psi)	70 to 280 kPa (10.2 to 40.6 psi)
Pumpdown Time Limit	120 sec	0 to 180 sec
Light Load Stage Down	40%	26 to 50%
High Load Stage Up	80%	50 to 100%
Stage Up Time	5 min	0 to 60 min
Stage Down Time	3 min	3 to 30 min
Stage Delay Clear	No	No, Yes
Soft Load	Off	Off, On
Max # Comps Running	2	2,3
Sequence # Cir 1	1	1-3
Sequence # Cir 2	1	1-3
Sequence # Cir 3	1	1-3
Liquid Injection Activation	85.0°C (185.0°F)	80.0°C to 100.0°C (176.0°C to 212.0°F)
Liq. Line Solenoid Valves	No	No, Yes
Slide Position Sensors	Yes	No, Yes
Low Pressure-Unload	160 kPa (23 psi)	160 kPa to 310 kPa (23 psi to 48 psi)
Low Pressure-Hold	180 kPa (26 psi)	180 kPa to 310 kPa (26 psi to 48 psi)
Low Press-Unload w/ Glycol	160 kPa (23 psi)	0 kPa to 310 kPa (0 psi to 48 psi)
Low Press-Hold w/Glycol	180 kPa (26 psi)	0 kPa to 310 kPa (0 psi to 48 psi)
High Oil Press Diff Delay	30 sec	10-180 sec
High Oil Press Differential	250 kPa (36 psi)	0 to 415 kPa (0 to 60 psi)

Continued next page.

Description	Default	Range
Alarm Limits		
High Discharge Temperature	110.0°C (230.0°F)	65.0 to 110.0 °C (149.0 to 230.0°F)
Low discharge superheat	12°C (21.6°F)	10.0-15.0°C (18-27°F)
High Cond Pressure Delay	5 sec	0 to 30 sec
Low Pressure Ratio Delay	90 sec	0 to 180 sec
Start Time Limit	60 sec	20 to 180 sec
Evap. Water Freeze	2.2°C (36.0°F)	1.1°C to 6.0°C (34.0°F to 42.8°F)
Evap. Water Freeze w/ Glycol	2.2°C (36.0°F)	-18.0°C to 6.0°C (-0.4°F to 42.8°F)
Evaporator Flow Proof	15 sec	5 to 15 sec
Recirculate Timeout	3 min	1 to 10 min
Low OAT Lockout	12.0°C (53.6°F)	2.0°C to 15.0°C (35.6°F to 59.0°F)
Low OAT Lockout/with Fan VFD	12.0°C (53.6°F)	-23.0°C to 15.0°C (-9.4°F to 59.0°F)

The following setpoints exist individually for each circuit:

Description	Default	Range
Circuit mode	Enable	Disable, enable, test
Compressor Size for Non-VFD	HSA204	HSA192, HSA204, HSA215 HSA232, HSA241, HSA263
Compressor Size for VFD	HSV204	HSV204, HSV215 HSV232, HSV241, HSV263
Economizer (VFD Only)	With	With, Without
Capacity Control	Auto	Auto, Manual
Manual Capacity	See Note 1	0 to 100%
Clear Cycle Timers	No	No, Yes
EXV control	Auto	Auto, manual
Service Pumpdown	No	No, Yes
Economizer Enable Capacity (VFD Model Only)	40%	40 to 75%
Evap pressure Sensor offset	0 kPa (0 psi)	-100 to 100 kPa (-14.5 to 14.5 psi)
Cond pressure Sensor offset	0 kPa (0 psi)	-100 to 100 kPa (-14.5 to 14.5 psi)
Oil pressure Sensor Offset	0 kPa (0 psi)	-100 to 100 kPa (-14.5 to 14.5 psi)
Suction temp Sensor Offset	0 deg C (0 deg F)	-5.0 to 5.0 deg C (-9.0 to 9.0 deg F)
Discharge temp offset	0 deg C (0 deg F)	-5.0 to 5.0 deg C (-9.0 to 9.0 deg F)
Slide sensor mA @ minimum	4 mA	4 to 22 mA
Slide sensor mA @ maximum	20 mA	4 to 22 mA
Fans		
Fan VFD enable	Enable	Disable, Enable
Number of fans	5	5 to 12
Saturated Condenser Temp Target Min	32.0°C (89.6°F)	20.0°C to 50.0°C (68.0°F to 122.0°F)
Saturated Condenser Temp Target Max	43.0°C (109.4°F)	32.0°C to 50.0°C (89.6°F to 122.0°F)
Fan Stage 0 Up Deadband	2.5 deg C (4.5 deg F)	1.0 to 10.0 deg C (1.8 to 18 deg F)
Fan Stage 1 Up Deadband	2.5 deg C (4.5 deg F)	1.0 to 10.0 deg C (1.8 to 18 deg F)
Fan Stage 2 Up Deadband	4.0 deg C (7.2 deg F)	1.0 to 10.0 deg C (1.8 to 18 deg F)
Fan Stage 3 Up Deadband	5.0 deg C (9.0 deg F)	1.0 to 10.0 deg C (1.8 to 18 deg F)
Fan Stage 4 Up Deadband	4.0 deg C (7.2 deg F)	1.0 to 10.0 deg C (1.8 to 18 deg F)

Continued next page.

Description	Default	Range
Fan Stage 5 to 12 Up Deadband	4.0 deg C (7.2 deg F)	1.0 to 10.0 deg C (1.8 to 18 deg F)
Fan Stage 1 Down Deadband	10.0 deg C (18.0 deg F)	1.0 to 10.0 deg C (1.8 to 18 deg F)
Fan Stage 2 Down Deadband	4.0 deg C (7.2 deg F)	1.0 to 10.0 deg C (1.8 to 18 deg F)
Fan Stage 3 Down Deadband	3.5 deg C (6.3 deg F)	1.0 to 10.0 deg C (1.8 to 18 deg F)
Fan Stage 4 Down Deadband	3.0 deg C (5.4 deg F)	1.0 to 10.0 deg C (1.8 to 18 deg F)
Fan Stage 5 Down Deadband	2.5 deg C (4.5 deg F)	1.0 to 10.0 deg C (1.8 to 18 deg F)
Fan Stage 6 to 12 Down Deadband	2.5 deg C (4.5 deg F)	1.0 to 10.0 deg C (1.8 to 18 deg F)
Fan VFD Max Speed	100%	90 to 110%
Fan VFD Min Speed	25%	20 to 60%

Dynamic Default Values

The fan staging dead bands have different default values based on the VFD enable setpoint. When the VFD enable setpoint is changed, a set of default values for the fan staging dead bands is loaded as follows:

Fan VFD is Enabled	
Setpoint	**Default loaded (°F)**
Stage 0 On Deadband	4.5
Stage 1 On Deadband	4.5
Stage 2 On Deadband	7.2
Stage 3 On Deadband	9.0
Stage 4 On Deadband	7.2
Stage 5 On Deadband	7.2
Stage 2 Off Deadband	7.2
Stage 3 Off Deadband	6.3
Stage 4 Off Deadband	5.4
Stage 5 Off Deadband	4.5
Stage 6 Off Deadband	4.5

Fan VFD is Disabled	
Setpoint	**Default loaded (°F)**
Stage 0 On Deadband	7.2
Stage 1 On Deadband	9.0
Stage 2 On Deadband	9.9
Stage 3 On Deadband	10.8
Stage 4 On Deadband	11.7
Stage 5 On Deadband	11.7
Stage 2 Off Deadband	18
Stage 3 Off Deadband	14.4
Stage 4 Off Deadband	9.9
Stage 5 Off Deadband	7.2
Stage 6 Off Deadband	7.2

The low pressure settings have different default values based on the Manufacturing Location setpoint. When the manufacturing location is configured, the default values for these setting are loaded as shown below:

US Chiller	
Setpoint	**Default loaded**
Low Evap Press.Unload	160 kPa (23.2 psi)
Low Evap Press.-Hold	180 kPa (26.1 psi)

European Chiller	
Setpoint	**Default loaded**
Low Evap Press. Unload	160 kPa (23.2 psi)
Low Evap Pressure-Hold	180 kPa (26.1 psi)

Unit Functions

Calculations

EWT Slope

EWT slope is calculated such that the slope represents the change in EWT over a time frame of one minute.

Pulldown Rate

The slope value calculated above will be a negative value as the water temperature is dropping. A pulldown rate is calculated by inverting the slope value and limiting to a minimum value of 0°C/min.

Unit Availability

The unit is available to start if the following conditions are true:

1. Unit switch is closed
2. If unit mode is ice and the ice timer has timed out.
3. No unit alarms exist
4. Emergency stop input is closed
5. At least one circuit is enabled
6. Unit enable setpoint is Enable
7. If remote control is connected and remote unit switch is closed
8. If Control Source = Network, BAS Enable = True

Enabling and disabling the chiller is accomplished using setpoints and inputs to the chiller. The unit switch, remote switch input, and Unit Enable Setpoint all are required to be on for the unit to be enabled when the control source is set to local. The same is true if the control source is set to network, with the additional requirement that the BAS request must be on.

Unit is enabled according to the following table.
NOTE: An x indicates that the value is ignored.

Table 2, Enable Combinations

Unit Switch	Control Source Setpoint	Remote Switch Input	Unit Enable Setpoint	BAS Request	Unit Enable
Off	x	x	x	x	Off
x	x	Off	x	x	Off
x	x	x	Off	x	Off
On	Local	On	On	x	On
x	Network	x	x	Off	Off
On	Network	On	On	On	On

All of the methods for disabling the chiller, discussed in this section, will cause a normal shutdown (pumpdown) of any running circuits.

When the controller is powered up, the Unit Enable Setpoint will be initialized to 'Disable' if the Unit Enable Init Setpoint is set to 'Disable'.

.

Unit Mode Selection

The operating mode of the unit is determined by setpoints and inputs to the chiller. The Available Modes Setpoint determines what modes of operation can be used. This setpoint also determines whether the unit is configured for glycol use. The Control Source Setpoint determines where a command to change modes will come from. A digital input switches between cool mode and ice mode if they are available and the control source is set to local. The BAS mode request switches between cool mode and ice mode if they are both available and the control source is set to network.
The Available Modes Setpoint must only be changed when the unit switch is off. This is to avoid changing modes of operation inadvertently while the chiller is running.

Unit Mode is set according to the following table.

Table 3, Mode Combinations

Control Source Setpoint	Mode Input	BAS Request	Available Modes Setpoint	Unit Mode
x	x	x	Cool	Cool
x	x	x	Cool w/Glycol	Cool
Local	Off	x	Cool/Ice w/Glycol	Cool
Local	On	x	Cool/Ice w/Glycol	Ice
Network	x	Cool	Cool/Ice w/Glycol	Cool
Network	x	Ice	Cool/Ice w/Glycol	Ice
x	x	x	Ice w/Glycol	Ice
x	x	x	Test	Test

Notes

1. "x" Indicates that the value is ignored.
2. If the Available Modes Setpoint is set to an option 'w/Glycol', then glycol operation should be enabled for the unit. Glycol operation should only be disabled when the Available Modes Setpoint is set to 'Cool'.

Glycol Configuration

If the Available Modes Setpoint is set to an option w/Glycol, then glycol operation is enabled for the unit. Glycol operation must be disabled only when the Available Modes Setpoint is set to Cool.

Unit Control States

The unit will always be in one of three states:

- Off – Unit is not enabled to run.
- Auto – Unit is enabled to run.
- Pumpdown – Unit is doing a normal shutdown.

Off. The unit should be in the Off state if any of the following are true:

- A unit alarm is active
- All circuits are unavailable to start (cannot start even after cycle timers have expired)
- The unit mode is ice, all circuits are off, and the ice mode delay is active
- Manufacturing Location is not set
- Either manufacturing location or number of circuits have been changed and controller has not been rebooted

Auto. The unit should be in the Auto state if all of the following are true:

- Manufacturing location is set and controller has been rebooted
- Unit enabled based on settings and switches
- If unit mode is ice, the ice timer has expired
- No unit alarms are active
- At least one circuit is enabled and available to start

Pumpdown. The unit should be in Pumpdown until all running compressors finish pumping down if any of the following are true:

- Unit is disabled via settings and/or inputs in section Unit Availability.
- Unit pumpdown alarm is triggered

Unit Status

The displayed unit status is determined by the conditions in the following table:

Table 4, Unit Status

Enum	Status	Conditions
0	Auto	Unit State = Auto
1	Off: Ice Mode Tmr	Unit State = Off, Unit Mode = Ice, and Ice Delay = Active
2	Off: OAT Lockout	Unit State = Off and Low OAT Lockout is active
3	Off: All Cir Disabled	Unit State = Off and all compressors unavailable
4	Off: Unit Alarm	Unit State = Off and Unit Alarm active
5	Off: Keypad Disable	Unit State = Off and Unit Enable Setpoint = Disable
6	Off: Remote Sw	Unit State = Off and Remote Switch is open
7	Off: BAS Disable	Unit State = Off, Control Source = Network, and BAS Enable = false
8	Off: Unit Sw	Unit State = Off and Unit Switch = Disable
9	Off: Test Mode	Unit State = Off and Unit Mode = Test
10	Auto: Noise Reduction	Unit State = Auto and Noise Reduction is active
11	Auto: Wait for Load	Unit State = Auto, no circuits running, and LWT is less than the active setpoint + startup delta
12	Auto: Evap Recirc	Unit State = Auto and Evaporator State = Start
13	Auto: Wait for flow	Unit State = Auto, Evaporator State = Start, and Flow Switch is open
14	Auto: Pumpdn	Unit State = Pumpdown
15	Auto: Max Pulldn	Unit State = Auto, max pulldown rate has been met or exceeded
16	Auto: Unit Cap Limit	Unit State = Auto, unit capacity limit has been met or exceeded
17	Auto: Current Limit	Unit State = Auto, unit current limit has been met or exceeded
18	Off. Cfg Chg, Rst Ctlr	Unit configuration setpoint has changed, and reboot of controller is required
19	Off Mfg Loc Not Set	Mfg Location is not set

Ice Mode Start Delay

Compressor Staging in Ice Mode

The first compressor will start when evaporator LWT is higher than the target plus the Startup Delta T setpoint.

When at least one compressor is running, the other compressors will start only when evaporator LWT is higher than the target plus the Stage Up Delta T setpoint.

All compressors will be staged off when evaporator LWT is less than the target.

Stage Up Delay

A fixed stage up delay of one minute between compressor starts is used in this mode. When at least one compressor is running, the other compressors will start as quickly as possible with respect to the stage up delay.

An adjustable start-to-start ice delay timer will limit the frequency with which the chiller may start in Ice mode. The timer starts when the first compressor starts while the unit is in ice mode. While this timer is active, the chiller cannot restart in Ice mode. The time delay is user adjustable.

The ice delay timer may be manually cleared to force a restart in ice mode. A setpoint specifically for clearing the ice mode delay is available. In addition, cycling the power to the controller will clear the ice delay timer.

Evaporator Pump Control

State

Three evaporator pump control states for control of the evaporator pumps:

- Off - No pump on.
- Start – Pump is on, water loop is being recirculated. Recirc timer runnning
- Run – Pump is on, water loop has been recirculated. Recirc timer has timed out

Off The control state is Off when all of the following are true:

- Unit state is Off
- LWT is higher than the Evap Freeze setpoint or LWT sensor fault is active
- EWT is higher than the Evap Freeze setpoint or EWT sensor fault is active

Start. The control state is Start when any of the following are true:

- The unit state is auto
- LWT is less than the Evap Freeze setpoint and LWT sensor fault isn't active
- EWT is less than the Evap Freeze setpoint and EWT sensor fault isn't active

Run. The control state is Run when

- The flow switch input has been closed for a time greater than the Evaporator Recirculate setpoint.
- The flow switch fault is not active

Pump Selection

The pump output used is determined by the Evap Pump Control setpoint. This setting allows the following configurations:

- #1 only – Pump 1 will always be used
- #2 only – Pump 2 will always be used
- Auto – The primary pump is the one with the least run hours, the other is used as a backup
- #1 Primary – Pump 1 is used normally, with pump 2 as a backup
- #2 Primary – Pump 2 is used normally, with pump 1 as a backup

Primary/Standby Pump Staging

The standby pump will be on if either of the following are true:

- Pump state is Run and the flow switch is open for Evap Proof Time/2
- Pump start is start and Recirculate timeout has expired.

Auto Control

If auto pump control is selected, the primary/standby logic above is still used. When the evaporator is not in the run state, the run hours of the pumps will be compared. The pump with the least hours will be designated as the primary at this time.

Noise Reduction

Noise Reduction is an operating mode designed to reduce unit sound levels by decreasing compressor and fan operating time. It is used during the night when the cooling load is usually reduced and the ambient temperature is lower.

Noise Reduction always requires the Noise Reduction setpoint to be set to 'enable'. If it is set to 'disable', it will not activate for any reason.

Assuming this functionality is enabled, there are two ways it can become active:

- If the unit mode is cool, and the unit controller clock time is between the Noise Reduction start time and end time
- Control Source setpoint is set to network, and the BAS command is 'enable'

When Noise Reduction is active, the Maximum Reset is applied to the cool LWT setpoint. However, if any reset type is selected, that reset will continue to be used rather than the Maximum Reset. Also, the saturated condenser target for each circuit will be offset by the Noise Reduction Condenser Target Offset.

Leaving Water Temperature (LWT) Reset

LWT Target

The LWT Target varies based on settings and inputs and is selected as follows:

Table 5, Leaving Water Temperature Targets

Control Source Setpoint	Mode Input	BAS Request	Available Modes Setpoint	Base LWT Target
Local	OFF	X	COOL	Cool Setpoint 1
	ON	X		Cool Setpoint 2
Network	X	X		BAS Cool Setpoint
Local	OFF	X	COOL w/Glycol	Cool Setpoint 1
	ON	X		Cool Setpoint 2
Network	X	X		BAS Cool Setpoint
Local	OFF	x	COOL/ICE w/Glycol	Cool Setpoint 1
	ON	x		Ice Setpoint
Network	x	COOL		BAS Cool Setpoint
	x	ICE		BAS Ice Setpoint
Local	x	x	ICE w/Glycol	Ice Setpoint
Network	x	x		BAS Ice Setpoint

Leaving Water Temperature (LWT) Reset

The base LWT target may be reset if the unit is in Cool mode and it is configured for a reset. The type of reset to be used is determined by the LWT Reset Type setpoint.

When the active reset increases, the Active LWT Target is changed at a rate of 0.2 degrees F every 10 seconds. When the active reset decreases, the Active LWT Target is changed all at once.

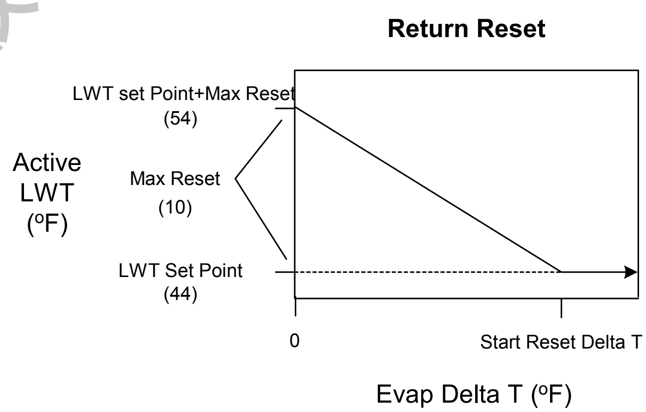
After resets are applied, the LWT target can never exceed a value of 60°F.

Reset Type – None

The Active Leaving Water variable is set equal to the current LWT setpoint.

Reset Type – Return Chilled Water

The Active Leaving Water variable is adjusted by the return water temperature.



The active setpoint is reset using the following parameters:

1. Cool LWT setpoint
2. Max Reset setpoint
3. Start Reset Delta T setpoint
4. Evap Delta T

Reset varies from 0 to Max Reset setpoint as the Evaporator EWT – LWT (Evap delta t) varies from the Start Reset Delta T set-point to 0.

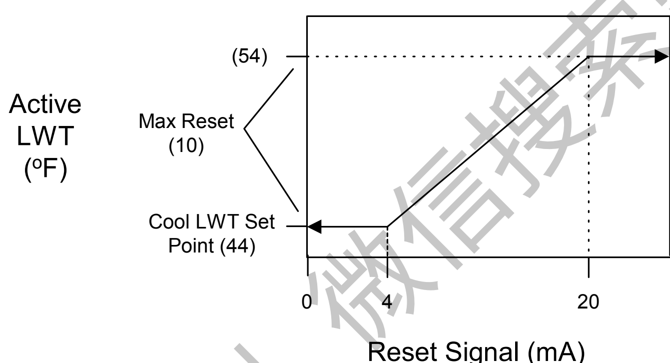
4-20 mA External Signal Reset

The Active Leaving Water variable is adjusted by the 4 to 20 mA reset analog input. Parameters used:

1. Cool LWT setpoint
2. Max Reset setpoint
3. LWT Reset signal

Reset is 0 if the reset signal is less than or equal to 4 mA. Reset is equal to the Max Reset Delta T setpoint if the reset signal equals or exceeds 20 mA. The amount of reset will vary linearly between these extremes if the reset signal is between 4 mA and 20 mA. An example of the operation of 4-20 reset in Cool mode follows.

4-20 mA Reset - Cool Mode



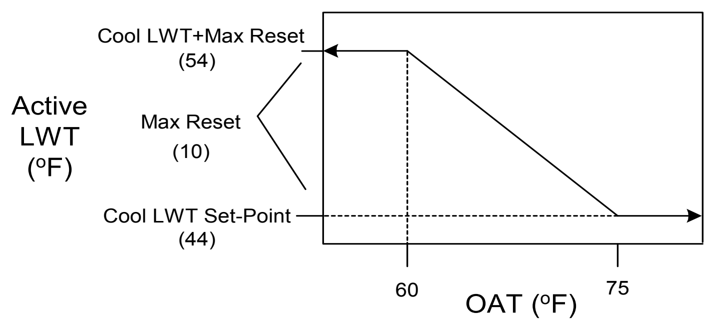
Outside Air Temperature (OAT) Reset

The Active Leaving Water variable is reset based on the outdoor ambient temperature. Parameters used:

1. Cool LWT setpoint
2. Max Reset setpoint
3. Start Reset OAT setpoint
4. Max Reset OAT setpoint
5. OAT

Reset is 0 if the outdoor ambient temperature is greater than Start Reset OAT setpoint. From Start Reset OAT setpoint down to Max Reset OAT the reset varies linearly from no reset to the max reset at Max Reset OAT setpoint. At ambient temperatures less than Max Reset OAT setpoint, reset is equal to the Max Reset setpoint.

OAT Reset



Unit Capacity Control

Compressor Staging in Cool Mode

The first compressor on the unit is started when evaporator LWT is higher than the target plus the Startup Delta T setpoint.

An additional compressor is started when Evaporator LWT is higher than the target plus the Stage Up Delta T setpoint.

When multiple compressors are running, one will shut down if evaporator LWT is lower than the target minus the Stage Down Delta T setpoint.

All running compressors will shut down when the evaporator LWT is lower than the target minus the Shut Down Delta T setpoint.

Stage Up Delay

A minimum amount of time will pass between compressors starting, which is defined by the Stage Up Delay setpoint. This delay will only apply when at least one compressor is running. If the first compressor starts and quickly fails on an alarm, another compressor will start without this minimum time passing.

Required Load for Stage Up

An additional compressor will not be started until all running compressors are at a capacity higher than the Load Stage Up setpoint, or running in a limited state.

Light Load Stage Down

When multiple compressors are running, one will shut down if all running compressors are at a capacity lower than the Load Stage Down setpoint and the evaporator LWT is less than the target plus the Stage Up Delta T setpoint. A minimum amount of time will pass between compressors stopping as a result of this logic, which is defined by the Stage Down Delay setpoint.

Light Load Shut Down

When the following conditions are met, the last compressor running on the chiller will be shut down:

- One compressor running
- Evaporator Delta T < 0.25*(Nominal Evap Delta T Setpoint/Number of Circuit Setpoint) for longer than five minutes
- Variable Evap Flow Setpoint = No

Maximum Circuits Running

If the number of compressors running is equal to the Max Circuits Running setpoint, no additional compressors will be started.

When multiple compressors are running, one will shut down if the number of compressors running is more than the Max Circuits Running setpoint.

Staging Sequence

This section defines which compressor is the next one to start or stop. In general, compressors with fewer starts will normally start first, and compressors with more run hours will normally stop first. Compressor staging sequence can also be determined by an operator defined sequence via setpoints.

Next To Start

The next compressor to start must meet the following requirements:

Lowest sequence number of those compressors available to start

- -if sequence numbers are equal, it must have the least starts
- -if starts are equal, it must have least run hours
- -if run hours are equal, it must be the lowest numbered compressor

Next To Stop

The next compressor to shut down must meet the following requirements:

Lowest sequence number of the compressors that are running

- -if sequence numbers are equal, it must have the most run hours
- -if run hours are equal, it must have the fewest starts
- -if starts are equal, it must be the lowest numbered compressor

Compressor Capacity Control in Cool Mode

In Cool mode, evaporator LWT is controlled to a temperature within a calculated variation range of the target under constant flow conditions by controlling capacity of the individual compressors. The allowed variation is plus or minus 4% of nominal evaporator delta t.

Compressors are loaded with a fixed step scheme. The rate of capacity adjustment is determined by the time between capacity changes. The farther away from the target, the faster compressors will be loaded or unloaded.

The logic projects ahead to avoid overshoot, such that the overshoot does not cause the unit to shut off due to evaporator LWT dropping below the target minus the Shutdown Delta T setpoint while there is still a load on the loop at least equal to the minimum unit capacity.

Capacity of the compressors is controlled so that when possible their capacities are balanced.

Circuits that are running in manual capacity control or running with active capacity limiting events are not considered in the capacity control logic.

The compressor capacities are adjusted one at a time while maintaining a capacity imbalance that does not exceed 12.5%.

Load/Unload Sequence

This section defines which compressor is the next one to load or unload.

Next To Load

The next compressor to load meets the following requirements:

Lowest capacity of the running compressors that can load up

- if capacities are equal, it must have the lowest sequence number of the compressors that are running
- if the sequence numbers are equal, it must have the least starts
- if run starts are equal, it must have the least hours
- if starts hours are equal, it must be the lowest numbered compressor

Next To Unload

The next compressor to unload must meet the following requirements:

Highest capacity of the running compressors

- if capacities are equal, it must have the lowest sequence number of the compressors that are running
- if sequence numbers are equal, it must have the most run hours
- if run hours are equal, it must have the least starts
- if starts are equal, it must be the lowest numbered compressor

Compressor Capacity Control in Ice Mode

In Ice mode, running compressors are loaded up simultaneously at the maximum possible rate that allows for stable operation of the individual circuits.

Unit Capacity Overrides

Unit capacity limits are used to limit total unit capacity in Cool mode only. Multiple limits may be active at any time, and the lowest limit is always used in the unit capacity control.

Soft load, demand limit, and network limit use a deadband around the actual limit value, such that unit capacity increase is not allowed within this deadband. If unit capacity is above the deadband, capacity is decreased until it is back within the deadband.

- For 2 circuit units, the deadband is 7%.
- For 3 circuit units, the deadband is 5%.

Soft Load

Soft Loading is a configurable function used to ramp up the unit capacity over a given time. The setpoint that control this function are:

- Soft Load – (ON/OFF)
- Begin Capacity Limit – (Unit %)
- Soft Load Ramp – (seconds)

The Soft Load Unit Limit increases linearly from the Begin Capacity Limit set-point to 100% over the amount of time specified by the Soft Load Ramp set-point. If the option is turned off, the soft load limit is set to 100%.

Demand Limit

The maximum unit capacity can be limited by a 4 to 20 mA signal on the Demand Limit analog input, usually from a BAS, on the unit controller. This function is only enabled if the Demand Limit setpoint is set to ON and the control is in the COOL mode.

As the signal varies from 4 mA up to 20 mA, the maximum unit capacity changes from 100% to 0%. The unit capacity shall be adjusted as needed to meet this limit, except that the last running compressor cannot be turned off to meet a limit lower than the minimum unit capacity.

Network Limit

The maximum unit capacity can be limited by a network signal. This function is only enabled if the unit control source is set to network. The signal will be received through the BAS interface on the unit controller.

As the signal varies from 0% up to 100%, the maximum unit capacity changes from 0% to 100%. The unit capacity is adjusted as needed to meet this limit, except that the last running compressor cannot be turned off to meet a limit lower than the minimum unit capacity.

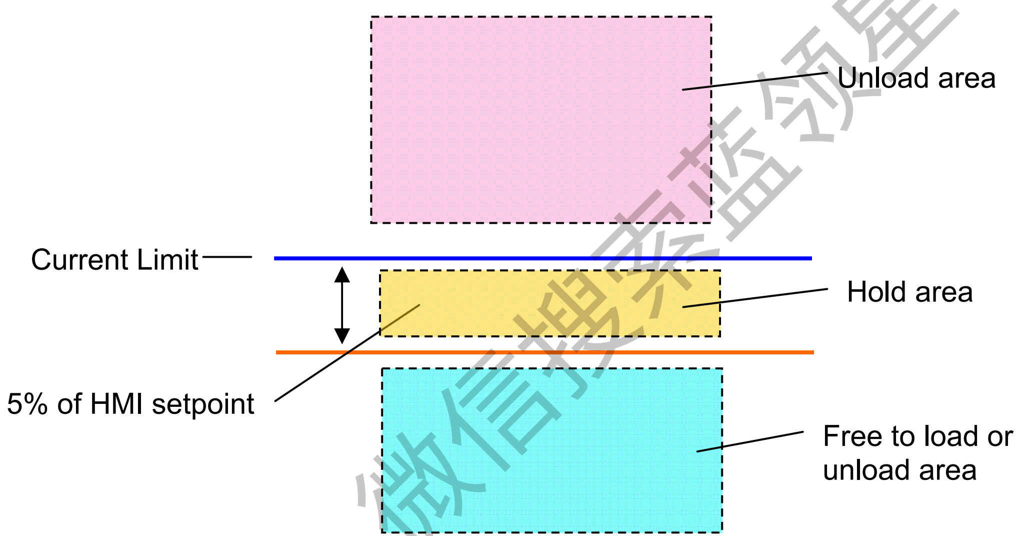
Current Limit

Current Limit control is enabled only when the current limit enable input is ON.

Unit current is calculated based on the 4-20 mA input that receives a signal from an external device. The current at 4 mA is assumed to be 0, and the current at 20 mA is defined by a setpoint. As the signal varies from 4 to 20 mA, the calculated unit current varies linearly from 0 amps to the amp value defined by the setpoint.

The current limit uses a deadband centered around the actual limit value, such that unit capacity increase is not allowed when current is within this deadband. If unit current is above the deadband, capacity is decreased until it is back within the deadband. The current limit deadband is 5% of the current limit.

Figure 9, Current Limit Operation



Maximum LWT Pulldown Rate

The maximum rate at which the leaving water temperature can drop is limited by the Maximum Rate setpoint, only when the LWT is less than 59°F (15°C).

If the pulldown rate is higher than the Maximum Pulldown Rate set point minus 0.1°C, the unit capacity should not be increased.

If the pulldown rate is higher than the Maximum Pulldown Rate set point plus 0.1°C, the unit capacity should be reduced until the rate is less than that value.

High Water Temperature Capacity Limit

If the evaporator LWT exceeds 77°F (25°C), compressor load will be limited to a maximum of 80%. Compressors will unload to 80% or less if running at greater than 80% load when the LWT exceeds the limit. This feature is to keep the circuit running within the capacity of the condenser coil.

Pumpdown

The circuit state should be Pump down when any of the following conditions are true.

1. Normal shut down alarm exists in Run state.
2. LWT error is less than Shut down delta T in case of 1 circuit running
3. LWT error is less than Stage down delta T in case of 2 circuit running
4. Unit state is Pumpdown
5. Circuit switch is Off

Cycle Timer

There is minimum time between compressor startup and shutdown. The time values are set by global circuit setpoints.

Start-to-start time is the time period from when a compressor starts until it starts again.

Stop-to-start is the time period from when a compressor stops until it restarts.

Table 6, Cycle Time Settings

Function	Default	Range	
		minimum	maximum
Start - Start time	20 min	15 min	60 min
Stop - Start time	5 min	3 min	20 min

Circuit Start-up Delta T, Shut-down Delta T

To avoid excessive ON/OFF compressor cycling when the capacity required is very low.

The first compressor on the unit will be started when evaporator LWT is higher than the LWT target plus the Startup Delta T setpoint.

An additional compressor will be started when evaporator LWT is higher than the target plus the Stage Up Delta T setpoint.

When multiple compressors are running, one will shut down if Evaporator LWT is lower than the target minus the Stage Down Delta T setpoint.

All running compressors will shut down when the evaporator LWT is lower than the target minus the Shut Down Delta T setpoint.

Circuit Pulldown Rate

The pulldown rate is established to control the capacity of the compressor so that it does not pull down the chilled water temperature too fast and overshoot the LWT target and to avoid excessive compressor cycling.

The maximum rate at which the leaving water temperature can drop is limited by the Maximum Rate setpoint, only when the LWT is less than 15°C (59°F).

If the pulldown rate is higher than the Maximum Pulldown Rate setpoint minus 0.1°C, the unit capacity will not be increased.

If the pulldown rate is higher than the Maximum Pulldown Rate setpoint plus 0.1°C, the unit capacity will be reduced until the rate is less than that value.

Non-VFD models

EWT slope is calculated such that the slope represents the estimated change in EWT over a time frame of one minute. This slope is used to determine the compressor capacity

VFD models

Compressor capacity is controlled by compressor speed and a sophisticated algorithm is used to determine rate.

Unit Capacity Control

Non-VFD models

An estimate of total unit capacity is needed for applying unit capacity limits. Unit capacity will be based on the estimated circuit capacities.

The unit capacity is the average of the estimated circuit capacities.

In Cool mode, evaporator LWT is controlled to a temperature within a calculated variation range of the target under constant flow conditions by controlling capacity of the individual compressors. The allowed variation is plus or minus 4% of nominal evaporator delta t.

Compressors are loaded with a fixed step scheme. The rate of capacity adjustment is determined by the time between capacity changes. The farther away from the target, the faster compressors will be loaded or unloaded.

The logic will project ahead to avoid overshoot, such that the overshoot does not cause the unit to shut off due to evaporator LWT dropping below the target minus the Shutdown Delta T setpoint while there is still a load on the loop at least equal to the minimum unit capacity.

Capacity of the compressors is controlled so that when possible their capacities are balanced.

Circuits that are running in manual capacity control or running with active capacity limiting events are not considered in the capacity control logic.

The compressor capacities are adjusted one at a time while maintaining a capacity imbalance that does not exceed 12.5%.

VFD models

The purpose of this logic is as follows.

- To avoid load/unload hunting.
- To reach LWT target at appropriate speed.
- To avoid unnecessary shut downs.
- To keep LWT within +/-0.1C of LWT target as possible.

Compressor capacity is controlled by compressor speed and a sophisticated algorithm is used to determine the rate considering the various parameters affecting capacity.

RapidRestore™ Option

The optional Rapid Restore feature provides a rapid restoration of unit maximum cooling capacity after a short power failure. It requires factory hardware and software changes from a standard unit. No action is required by the operator to activate this feature.

Rapid Restore requires the following conditions:

1. The power failure exists for 1 to 15 seconds
2. The unit and circuit switches are ON.
3. No unit or circuit alarms exist.
4. The unit has been running in the normal Run state (except backup unit).
5. The BAS Circuit Mode setpoint is set to Auto when the control source is Remote
6. In installations with a primary/standby arrangement, if the primary unit has a safety shutdown, the standby unit (powered up, waiting for an enable command from the BAS) will start and may take a longer to reach full load on its first start than a unit that has already been running.

If the power failure is less than one second, the chiller start will vary depending on a number of conditions, it may ride through the outage or it may restart in Rapid Restore mode or may remain off on a failure such as no chilled water pump operation.

If the power failure is more than 15 seconds, the unit will start based on the setting of the Stop-to-Start cycle timer (minimum setting of 3 minutes) and load per standard unit without Rapid Restore.

When Rapid Restore is active, the unit will restart within 30 seconds of power restoration.

Use with Backup Unit

Field supplied inputs to the units are required in the unusual case of a backup chiller being started after the power interruption rather than restarting the primary chiller. A field supplied control signal (normally a BAS) must turn off the Backup Chiller connection on the primary unit and turn on the Backup Chiller connection on the backup unit at the time of switching. See the Field Wiring Diagram for the Backup Chiller connection point (terminals 61 and 62).. The backup unit must experience the power failure in order to perform the rapid restore function.

The time to restore full load will vary depending on the compressor starter, type number of compressors and if it is a primary or backup unit as shown on the following table.

Table 1, Time to Full Load

Starter>	Y-Delta	Solid State	VFD
Standard Unit w/o Rapid Restore			
2-Circuit	21.6 min	21.6 min	18.8 min
3-Circuit	29.0 min	29.0 min	24.7 min
Primary Unit w/ Rapid Restore			
2-Circuit	4.9 min	7.3 min	5.9 min
3-Circuit	5.3 min	7.8 min	6.3 min
Backup Unit w/ Rapid Restore			
2-Circuit	7.3 min	7.3 min	5.9 min
3-Circuit	7.8 min	7.8 min	6.3 min

Software Settings

When this option is ordered, hardware is added and factory software changes are made to enable the feature.

- Slide position sensors must be enabled (set to Yes). The setting is located at "View/Set Unit-> Unit Configuration -> Slide Pos Sens="
- Liquid line solenoid must be enabled (set to Enable). The setting is loacted at "View/Set Unit-> Set-Up -> Liq Line SV="
- Rapid Restart must be enabled (set to Enable). The setting is loacted at "View/Set Unit ->Set-Up -> Rapid Restart="

Calculations

Refrigerant Saturated Temperature

Refrigerant saturated temperature is calculated from the pressure sensor readings for each circuit. A function provides the converted value of temperature to match values published data for R134a:

-within 0.18°F (0.1°C) for pressure inputs from 0 to 300 psi (0 to 2070kPa)

-within 0.36°F (0.2°C) for pressure inputs from -11.6 to 0 psi (80 kPa to 0 kPa)

Evaporator Approach

The evaporator approach is calculated for each circuit. The equation is as follows:

Evaporator Approach = LWT – Evaporator Saturated Temperature

Condenser Approach

The condenser approach is calculated for each circuit. The equation is as follows:

Condenser Approach = Condenser Saturated Temperature - OAT

Suction Superheat

Suction superheat is calculated for each circuit using the following equation:

Suction superheat = Suction Temperature – Evaporator Saturated Temperature

Discharge Superheat

Discharge superheat is calculated for each circuit using the following equation:

Discharge superheat = Discharge Temperature – Condenser Saturated Temperature

Oil Differential Pressure

Oil Differential Pressure is calculated for each circuit with this equation:

Oil Differential Pressure = Condenser Pressure - Oil Pressure

Maximum Saturated Condenser Temperature

The maximum saturated condenser temperature calculation is modeled after the compressor operational envelope.

If Sat Evap Temp < 32°F (0°C) then
Max Sat Cond Temp = 1.596(Sat Evap Temp) +155°F (68.3°C)

Otherwise, Max Sat Cond Temp = 155°F (68.3°C)

High Saturated Condenser – Hold Value

High Cond Hold Value = Max Saturated Condenser Value – 5°F (2.78°C)

High Saturated Condenser – Unload Value

High Cond Unload Value = Max Saturated Condenser Value – 3°F (1.67°C)

Condenser Saturated Temperature Target

The saturated condenser temperature target is calculated by using the following equation:

Sat condenser temp target raw = 0.8332(evaporator sat temp) + 95.0°F (35.0 °C)

This value is then limited to a range defined by the Condenser Saturated Temperature Target min and max setpoint. These setpoint simply cut off the value to a working range, and this range can be limited to a single value if the two setpoint are set to the same value.

Circuit Control Logic

Circuit Availability

A circuit is available to start if the following conditions are true:

- Circuit switch is closed
- No circuit alarms are active
- Circuit Mode setpoint is set to Enable
- BAS Circuit Mode setpoint is set to Auto
- No cycle timers are active
- Discharge Temperature is at least 9°F (5°C) higher than Oil Saturated Temperature

Starting

The circuit will start if all these conditions are true:

- Adequate pressure in the evaporator and condenser (see No Pressure At Start Alarm)
- Circuit Switch is closed
- Circuit Mode setpoint is set to Enable
- BAS Circuit Mode setpoint is set to Auto
- No cycle timers are active
- No alarms are active
- Staging logic requires this circuit to start
- Unit state is Auto
- Evaporator pump state is Run

Circuit Startup Logic

Circuit startup is the time period following the starting of the compressor on a circuit. During the startup, the low evaporator pressure alarm logic is ignored. When the compressor has been running at least 20 seconds and the evaporator pressure rises above the low evaporator pressure unload setpoint, the startup is complete.

If the pressure does not rise above the unload setpoint and the circuit has been running longer than the Startup Time setpoint, then the circuit is turned off and an alarm triggered. If the evaporator pressure drops below the absolute low pressure limit then the circuit is turned off and the same alarm triggered.

Low OAT Restart Logic

Low OAT restart logic allows multiple start attempts in low ambient conditions. If the condenser saturated temperature is less than 60°F (14.6°C) when the compressor starts, the startup is considered to be a ‘low OAT start’. If a low OAT start is not successful the circuit is shut down, but no alarm is triggered for the first two attempts of the day. If a third low OAT start attempt fails, then the circuit is shut down and the Low OAT Restart Alarm is triggered.

The restart counter is reset when a startup is successful or the Low OAT Restart alarm is triggered.

Stopping

Normal Shutdown

A normal shutdown requires the circuit to pumpdown before the compressor is turned off. This is done by closing the EXV, and closing the liquid line solenoid (if present) while the compressor is running.

The circuit will do a normal shutdown (pumpdown) if any of the following are true:

- Staging logic requires this circuit to stop
- Unit State is Pumpdown
- A pumpdown alarm occurs on the circuit
- Circuit switch is open
- Circuit Mode setpoint is set to Disable
- BAS Circuit Mode setpoint is set to Off

The normal shutdown is complete when any of the following are true:

- Evaporator Pressure is less than the Pumpdown Pressure setpoint
- Service Pumpdown setpoint is set to Yes and Evaporator Pressure is less than 5 psi (34.5 kPa)
- Circuit has been pumping down for longer than the Pumpdown Time Limit setpoint

Rapid Shutdown

A rapid shutdown requires the compressor to stop and the circuit to go to the Off state immediately.

The circuit will do a rapid shutdown if either of these conditions occurs at any time:

- Unit State is Off
- A rapid stop alarm occurs on the circuit

Circuit Status

The displayed circuit status is determined by the conditions in the following table:

Table 7, Circuit Status

Enum	Status	Conditions
0	Off:Ready	Circuit is ready to start when needed.
1	Off:Stage Up Delay	Circuit is off and cannot start due to stage up delay.
2	Off:Cycle Timer	Circuit is off and cannot start due to active cycle timer.
3	Off:BAS Disable	Circuit is off and cannot start due to BAS command.
4	Off:Keypad Disable	Circuit is off and cannot start due to keypad disable.
5	Off:Circuit Switch	Circuit is off and circuit switch is off.
6	Off:Refr In Oil Sump	Circuit is off and Discharge Temperature – Oil Saturated Temperature at gas pressure <= 5°C
7	Off:Alarm	Circuit is off and cannot start due to active circuit alarm.
8	Off:Test Mode	Circuit is in test mode.
9	EXV Preopen	Circuit is in preopen state.
10	Run:Pumpdown	Circuit is in pumpdown state.
11	Run:Normal	Circuit is in run state and running normally.
12	Run:Disch SH Low	Circuit is running and cannot load due to low discharge superheat.
13	Run:Evap Press Low	Circuit is running and cannot load due to low evaporator pressure.
14	Run:Cond Press High	Circuit is running and cannot load due to high condenser pressure.
15	Run: High LWT Limit	Circuit is running and cannot load due to high evaporator leaving water temperature.
16	Run: High VFD Amps	Circuit is running and cannot load due to high compressor VFD current output.
17	Off: Max Comp Starts	Circuit is off and cannot start due to four starts in the last hour. Remaining time displayed.

Compressor Control

The compressor runs only when the circuit is in a start, run or pumpdown state. The compressor will not be running any time the circuit is off or during preopening the EXV.

Compressor State

The compressor will always be in one of the following states

Name	Meaning
Off	Comp off.
Start	Comp in Start control.
Run	Comp in automatic or manual capacity control.
Pump down	Comp in shut down control.

Compressor Off

The control state will be Off when the circuit state is Off.

Compressor Start

The purpose of this logic is:

- To avoid the suction pressure dropping too much at start.
- To prohibit loading until circuit state is stable.

The control state should be Start up when the circuit state is Start. Start up is controlled by logic considering EXV preopen time, compressor start time, suction superheat and other parameters.

Capacity Control, Non-Compressor VFD Models

After starting, the compressor capacity target should be the minimum of 10%, and no attempt to increase compressor capacity should be made until the compressor has been running at least three minutes and the minimum discharge superheat has been established for at least 30 seconds. After this condition is met, the compressor capacity target shall move via steps to a minimum running capacity even if unit capacity control commands do not require the compressor to load up. This minimum running capacity target is 26% for European chillers and 25% for US chillers.

Once the compressor has been loaded to the minimum running capacity target, the capacity target shall always be at least equal to this value while the compressor is running.

Changes to the capacity target shall be performed as needed to meet unit capacity requirements based on load and unload commands (see unit capacity control section). For European chillers, the standard capacity target step is 4%, and for US chillers it is 5%.

A minimum time of 20 seconds should pass between capacity changes other than the capacity transitions from 50% to 60% or from 60% to 50%. For those capacity transitions, a minimum time of 30 seconds should pass before capacity is changed again.

Capacity Control, Compressor VFD Models

The control state is Capacity control when the circuit state is Run.

The purpose of this logic is as follows.

- To avoid the unnecessary shut down due to excessive loading.
- In the high LWT area, the loading should be faster.
- When the DSH is low, it could be an abnormal situation, so the loading should be limited.

Load control

Comp will Load when all the following is true.

- LWT error > Keep dead band
- EWT Pd Rate < EWT Pd Rate limit
- DSH > 12C for 30sec at least

Unload control

Compressor will Unload when any of the following conditions are true

- LWT error < minus Keep dead band
- HP > HP_unload
- LP < LP_unload
- EWT Pd Rate > EWT Pd Rate for unload
- Inverter over current unload

Manual capacity control

This function is only for use by authorized service personnel and a special password is requires for access.

Condenser Fan Control

The compressor must be running in order to stage fans on. All running fans will turn off when compressor goes to the Off state.

Saturated Condenser Temperature Target

The saturated condenser temperature target is calculated by first using the following equation:

Sat condenser temp target raw = 0.8332(suction sat temp) + 63.6℉ (35.0°C)

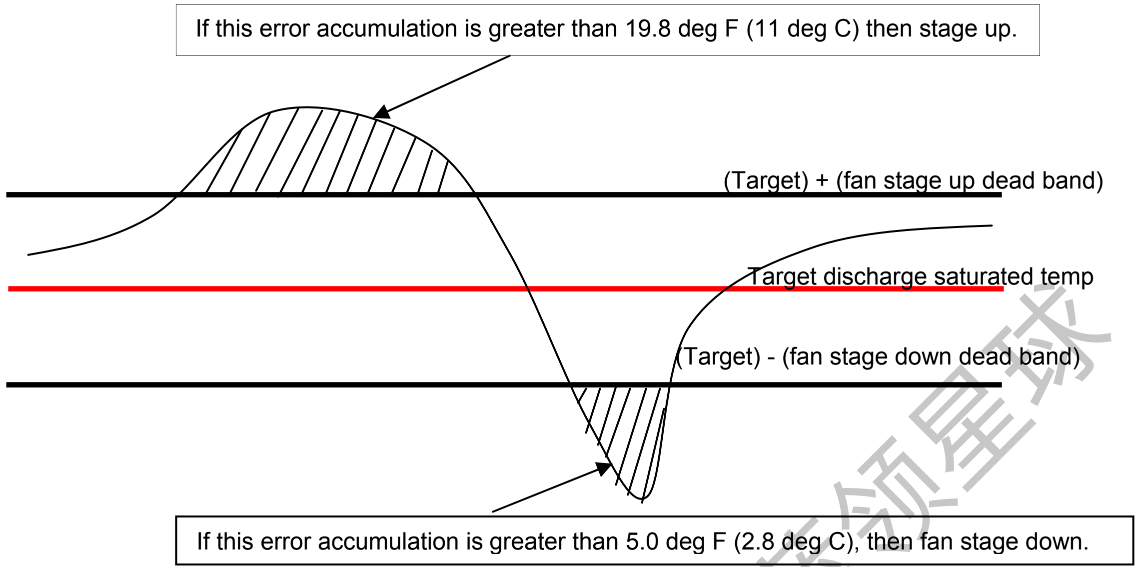
This value is then limited to a range defined by the Condenser Saturated Temperature Target min and max setpoint. These setpoint simply cut off the value to a working range, and this range can be limited to a single value if the two setpoint are set to the same value.

Fan Control without VFD

The fan stage is adjusted in steps of 1 fan. Fan staging will accommodate anywhere from 5 to 12 fans per circuit according to the following table:

Output Number						# of fans
1	2	3	4	5	6	
*	*	**	*			5
*	*	**	**			6
*	*	**	**	*		7
*	*	**	**	**		8
*	*	**	**	***		9
*	*	**	**	***	*	10
*	*	**	**	***	**	11
*	*	**	**	***	***	12

Figure 10, Fan Staging Up and Down



Referring to Figure 10, a fan will run normally when the saturated discharge temperature (equivalent to discharge pressure) is between the Target Temperature plus the stage up deadband and minus the stage down deadband.

If the saturated temperature exceeds the stage up or stage down setting, an error accumulation is calculated. The error accumulation takes into account how great the error is and its duration. Thusly, a small error can exist for a relatively long time and a large error for a relatively short time before a fan is staged on or off.

If the saturated temperature returns to within the deadband area, the error accumulation is cleared.

Staging Up

Six stage-up deadbands are used. Stages one through five use their respective dead bands. Stages six through twelve all use the sixth stage up dead band.

When the saturated condenser temperature is above the Target + the active deadband, a Stage Up error is accumulated.

Stage Up Error Step = Saturated Cond. temperature – (Target + Stage-Up deadband)

The Stage Up Error Step is added to Stage Up Accumulator once every 5 seconds, only if the Saturated Condenser Refrigerant Temperature is not falling. When Stage Up Error Accumulator is greater than 19.8°F (11°C) another stage is added.

If the circuit is configured to have a VFD on the first fan, then the first fan will turn on when condenser temperature is above the target.

When a stage up occurs or the saturated condenser temperature falls back within the Stage Up dead band the Stage Up Accumulator is reset to zero.

Staging Down

Five stage down dead bands are used. Stages two through five use their respective dead bands. Stages six through twelve all use the stage six dead band.

When the saturated condenser refrigerant temperature is below the Target – the active deadband, a Stage Down error is accumulated.

Stage Down Error Step = (Target - Stage Down dead band) - Saturated Condenser Refrigerant temperature

The Stage Down Error Step is added to Stage Down Accumulator once every 5-second Stage Down Error Delay seconds. When the Stage Down Error Accumulator is greater than 37°F (2.8°C) another stage of condenser fans is removed.

When one fan is running, a fixed point is used in place of a deadband. When the Saturated Condenser temperature drops below 70°F (21.1°C), stage down error is accumulated.

Fan Control with VFD

Condenser pressure trim control is accomplished using an optional VFD on the first fan. This VFD control varies the fan speed to drive the saturated condenser temperature to a target value. The target value is normally the same as the saturated condenser temperature target.

VFD State

The VFD speed signal is always 0 when the fan stage is 0.
When the fan stage is greater than 0, the VFD speed signal is enabled and controls the speed as needed.

Stage Up Compensation

In order to create a smoother transition when another fan is staged on, the VFD compensates by slowing down initially.

This is accomplished by adding the new fan stage up deadband to the VFD target. The higher target causes the VFD logic to decrease fan speed.

Then, every 2 seconds, 0.1°C is subtracted from the VFD target until it is equal to the saturated condenser temperature target set point.

This will allow the VFD to slowly bring the saturated condenser temperature back down.

EXV Control

The EXV is moved at a rate of 150 steps per second, with a total range of 3810 steps. Positioning is determined as described in the following sections, with adjustments made in increments of 0.1% of the total range.

Closed Position

When the EXV enters the closed state, it should be reinitialized to maintain accurate positioning.

If the unit is configured for use without liquid line solenoid valves, the EXV position is 0% any time the EXV is in a closed state.

If the unit is configured for use with liquid line solenoid valves, the EXV position will be 0% when the EXV initially enters the closed state, while it is reinitializing to the zero position. After the EXV position command has been 0% for a minute, the EXV will be moved to 5% (to prevent excessive pressure buildup between EXV and liquid line solenoid valve).

Preopen Operation

Preopen operation will vary depending on the unit configuration. The unit will be configured for use with or without liquid line solenoid valves via a setpoint.

Without Liquid Line Solenoid Valves

The EXV control will open the EXV to 5% for 5 seconds before the compressor is started.

With Liquid Line Solenoid Valves

If evaporator pressure is less than condenser pressure when a circuit start is required, the EXV control will preopen the EXV to 50% for 15 seconds. Otherwise, the preopen time will be 0 (position is already 5%).

Pressure Control Operation

In pressure control, the EXV is positioned to control the evaporator pressure. The pressure target varies based on evaporator LWT and discharge superheat values.

The base target is limited to a range from the low pressure inhibit setpoint plus 2 psi (14 kPa), up to 50.7 psi (350 kPa).

The pressure control target may be adjusted if the discharge superheat is not within an acceptable range. If the superheat is less than 21.6°F (12°C), the pressure target will be reduced. If the superheat is more than 39.6°F (22°C), the pressure target will be increased. The adjusted target is limited to a range from the low pressure inhibit setpoint plus 2 psi (14 kPa), up to 50.7 psi (350 kPa).

When the EXV transitions from superheat control to pressure control, the target will start at the current evaporator pressure value. The pressure target will then be decreased until reaching the normal calculated target, at a rate of 0.43 psi (3 kPa) per second. If the pressure at transition is less than the calculated target, then pressure control will start immediately with the calculated target.

When the EXV transition from preopen to pressure control, the target starts at the minimum and is held there for three minutes. After that time, the target is increased until it meets the calculated target, at a rate of 0.43 psi (3 kPa) per second.

The EXV should control the evaporator pressure to within 1.0 psi (7 kPa) of the target during stable operating conditions (stable water loop, static compressor capacity, and stable condensing temperature).

Superheat Control Operation

In superheat control, the EXV is positioned to control suction superheat. The superheat target varies linearly from 5 to 9.9 °F (2.8 to 5.5 °C) as discharge superheat changes from 30.6 to 21.6 °F (17 to 12 °C). This target is constantly updated, and averaged over a 10 second period.

When the EXV transitions to the superheat control state, the target will start at the current suction superheat value. This target will then be decreased 0.18°F (0.1°C) every five seconds until reaching the normal calculated target.

The EXV should control the suction superheat to within 1.5°F (0.8°C) of the target during stable operating conditions (stable water loop, static compressor capacity, and stable condensing temperature).

Control State Transitions

When the circuit is required to start, the EXV will go into the Preopen control state. After being in this state for the time period required, the EXV can transition to Pressure Control. The compressor will start at the same time that this occurs.

While the circuit is in a run state, the EXV will always be in either Pressure Control or Superheat Control.
The transition from Pressure Control to Superheat Control requires **all** of the following:

- Evap LWT <= 59.9°F (15.5°C)

- Suction Superheat >= suction superheat target
- EXV control state has been in pressure control and discharge superheat >= 12°C (21.6°F) for at least 3 minute
- Low Evap Pressure Unload alarm is not active

The transition from Superheat Control to Pressure Control will occur if **any** of the following conditions exist:

- Discharge Superheat < 12°C (21.6°F)
- Evap LWT > 17°C (62.6°F)

Any time the circuit is in the Off state or Pumpdown state, the EXV should be in the closed position.

Response to Compressor Capacity Change

The logic will consider transition from 50% to 60% and from 60% to 50% as special conditions. During this time, the EXV will operate in a way that prevents over-feeding or under-feeding the evaporator such that adequate superheats are maintained following the transition, no liquid ingestion by the compressor occurs, and no evaporator pressure dip causes low pressure alarms.

Minimum Operating Position

Whenever the compressor is running and the circuit is not pumping down, the EXV position is limited to a minimum of 5%.

Auto Control

When the EXV is in auto control and the EXV control state is either pressure control or superheat control, the position will be adjusted using a PID function. This function should control the pressure or superheat as outlined in the preceding sections.

The compressor size setting will adjust the proportional factor of the PID when in superheat control to allow for stable control of the superheat.

Manual Control

The EXV position can be set manually. Manual control can only be selected when the EXV state is Pressure or Superheat control. At any other time, the EXV control setpoint is forced to auto.

When EXV control is set to manual, the EXV position is equal to the manual EXV position setting. If set to manual when the circuit state transitions from run to another state, the control setting is automatically set back to auto. If EXV control is changed from manual back to auto while the circuit state remains run, the EXV state will go back to the normal operations if possible or to pressure control to limit maximum operating pressure.

Economizer Control

Non-VFD: The circuit economizer will be activated when the circuit is in a run state and the capacity exceeds 95%. It will turn back off when either the load drops below 80% or the circuit is no longer in a run state.

Compressor VFD: The economizer is on any time the circuit is running.

Liquid Injection

Liquid injection will be activated when the circuit is in a run state and the discharge temperature rises above the Liquid Injection Activation setpoint.

Liquid injection will be turned off when the discharge temperature decreases below the activation setpoint by a differential of 27°F (15°C).

Liquid Line Solenoid Valve

The liquid line solenoid valve output will be on any time the circuit is in the Start or Run state. It will be off when the circuit is in the Off, Preopen, or Pumpdown states.

Capacity Overrides – Limits of Operation

The following conditions will override automatic capacity control as described. These overrides keep the circuit from entering a condition in which it is not designed to run.

Low Evaporator Pressure

This limit is to be applied only when the chiller is operating in COOL mode.

If the Low Evaporator Pressure Hold alarm is triggered, the compressor will not be allowed to increase in capacity.

If the Low Evaporator Pressure Unload alarm is triggered, the compressor will begin reducing capacity.

The compressor will not be allowed to increase in capacity until the Low Evaporator Pressure Hold alarm has cleared.

See the Circuit Alarms section for details on triggering, reset, and unloading action.

High Condenser Pressure

This limit is to be applied only when the chiller is operating in COOL mode.

If the High Condenser Pressure Hold alarm is triggered, the compressor will not be allowed to increase capacity.

If the High Condenser Pressure Unload alarm is triggered, the compressor will begin reducing capacity.

The compressor will not be allowed to increase in capacity until the High Condenser Pressure Hold alarm has cleared.

See the Circuit Alarm section for details on triggering, reset, and unloading action.

High Water Temperature Capacity Limit

If the evaporator LWT is 25°C (77°F) or higher, compressor capacity will be limited to a maximum of 80%. Compressors should unload to 80% or less if running at greater than 80% capacity when the LWT exceeds 25°C (77°F).

Alarms and Events

Situations may arise that require some action from the chiller, or that should be logged for future reference. Alarms are classified in the following sections per the Global Chiller Protocol Standard using the Fault/Problem/Warning scheme.

When any Unit Fault Alarm is active, the alarm digital output will be turned on. If no Unit Fault Alarm is active, but any Circuit Fault Alarm is active, the alarm digital output will alternate five seconds on and five seconds off constantly. In addition, if a Circuit Fault Alarm is active, the circuit alarm output for that circuit will be turned on.

Signaling Alarms

The following actions will signal that an alarm has occurred:

1. The unit or a circuit will execute a rapid or pumpdown shutoff.
2. An alarm bell icon 🔔 will be displayed in the upper right-hand corner of all controller screens including the optional remote user interface panel's screens.
3. An optional field supplied and wired remote alarm device will be activated.

Clearing Alarms/Faults

Active alarms can be cleared through the keypad/display or a BAS network. Alarms are automatically cleared when controller power is cycled. Alarms are cleared only if the conditions required to initiate the alarm no longer exist. All alarms and groups of alarms can be cleared via the keypad or network via LON using nviClearAlarms and via BACnet using the ClearAlarms object.

To use the keypad, follow the Alarm links to the Alarms screen, which will show Active Alarms and Alarm Log. Select Active Alarm and press the wheel to view the Alarm List (list of current active alarms). They are in order of occurrence with the most recent on top. The second line on the screen shows Alm Cnt (number of alarms currently active) and the status of the alarm clear function. Off indicates that the Clear function is off and the alarm is not cleared. Press the wheel to go to the edit mode. The Alm Clr (alarm clear) parameter will be highlighted with OFF showing. To clear all alarms, rotate the wheel to select ON and enter it by pressing the wheel.

An active password is not necessary to clear alarms.

If the problem(s) causing the alarm have been corrected, the alarms will be cleared, disappear from the Active Alarm list and be posted in the Alarm Log. If not corrected, the On will immediately change back to OFF and the unit will remain in the alarm condition.

Remote Alarm Signal

The unit is configured to allow field wiring of a remote alarm device. See Figure 18 on page 72 for field wiring information.

Description of Alarms

Introduction

The alarms have the following conventions:

ALARM, any condition outside of normal operation requiring some action on the part of the control or information useful to the operator or to be logged for future reference

WARNING, an alarm indicating a condition that is not critical to safe unit operation, but is worthy of note and/or logging.

PROBLEM, a alarm that indicates operation off normal and requires some action by the control such as unloading a compressor.

FAULT, an alarm with consequences serious enough to require a compressor, a circuit, or entire unit to shutdown. The shutdown may be rapid, bypassing the pumpdown cycle, or controlled and incorporate the pumpdown cycle.

Alarm description conventions:

- C*n*Cmp*n* OffMechPressLo, the C*n* is the circuit number; the Cmp*n* is the compressor number.
- UnitOff EvapWaterFlow, UnitOff refers to the entire unit.

Alarm Listing

The alarms are listed alphabetically below showing their location

Unit Faults

<u>Alarm 1</u>, Evaporator Flow Loss

Alarm description (as shown on screen): UnitOffEvapWaterFlow

Trigger:

1: Evaporator Pump State = Run AND Evaporator Flow Digital Input = No Flow for time > Flow Proof Setpoint AND at least one compressor running

2: Evaporator Pump State = Start for time greater than Recirc Timeout Setpoint and all pumps have been tried

Action Taken: Rapid stop all circuits

Reset: This alarm can be cleared manually via the unit controller keypad or BAS command, if active via trigger condition 1:
When the alarm occurs due to this trigger, it can auto reset the first two times each day, with the third occurrence being manual reset.

For the auto reset occurrences, the alarm will reset automatically when the evaporator state is Run again. This means the alarm stays active while the unit waits for flow, then it goes through the recirculation process after flow is detected. Once the recirculation is complete, the evaporator goes to the Run state which will clear the alarm. After three occurrences, the count of occurrences is reset and the cycle starts over if the manual reset flow loss alarm is cleared.

If active via trigger condition 2:

If the flow loss alarm has occurred due to this trigger, it is a manual reset alarm.

<u>Alarm 2</u>, Evaporator Water Freeze Protect

Alarm description (as shown on screen): UnitOffEvapWaterTmpLo

Trigger: Evaporator LWT or EWT drops below evaporator freeze protect setpoint. If the sensor fault is active for either LWT or EWT, then that sensor value cannot trigger the alarm.

Action Taken: Rapid stop all circuits

Reset: This alarm can be cleared manually via the unit controller keypad if the alarm trigger conditions no longer exist.

<u>Alarm 3</u>, Evaporator Water Temperatures Inverted

Alarm description (as shown on screen): UnitOffEvpWTempInvrtd

Trigger: Evap EWT < Evap LWT - 1 deg C AND at least one circuit is running AND EWT sensor fault not active AND LWT sensor fault not active for 30 sec

Action Taken: Pumpdown stop on all circuits

Reset: This alarm can be cleared manually via the unit controller keypad or BAS command.

<u>Alarm 4</u>, Leaving Evaporator Water Temperature Sensor Fault

Alarm description (as shown on screen): UnitOffEvpLvgWTempSen

Trigger: Sensor shorted or open

Action Taken: Rapid stop all circuits

Reset: This alarm can be cleared manually via the unit controller keypad or BAS command if the sensor is back in range.

Alarm 5, Entering Evaporator Water Temperature Sensor Fault

Alarm description (as shown on screen: UnitOffEvpEntWTempSen
Trigger: Sensor shorted or open

Action Taken: Pumpdown stop of all circuits

Reset: This alarm can be cleared manually via the unit controller keypad or BAS command if the sensor is back in range.

Alarm 6, Outdoor Air Temperature Sensor Fault

Alarm description (as shown on screen): UnitOffAmbTempSen

Trigger: Sensor shorted or open

Action Taken: Normal shutdown of all circuits

Reset: This alarm can be cleared manually via the unit controller keypad or BAS command if the sensor is back in range.

Alarm 7, External Alarm

Alarm description (as shown on screen): UnitOffExternal Alarm

Trigger: External Alarm/Event input is open for at least 5 seconds and external fault input is configured as an alarm

Action Taken: Rapid stop of all circuits

Reset: Auto clear when digital input is closed

Alarm 8, Emergency Stop Alarm

Alarm description (as shown on screen): UnitOffEmergencyStop

Trigger: Emergency Stop input is low

Action Taken: Rapid stop of all circuits

Reset: Auto clear when digital input is high

Alarm 9, Primary Pump Failure Alarm

Alarm description (as shown on screen): UnitOffPriPumpFailAlarm

Trigger: Pump has been switched (only if pump is "Auto", '#1 or #2 Primary".

Action Taken: Alarm to BAS

Reset: Manual when condition cleared

Unit Warnings

The following unit events are logged in the warning log with a time stamp.

Alarm 10, Unit Power Restore

Alarm description (as shown on screen): UnitPowerRestore

Trigger: Unit controller is powered up

Action Taken: none

Reset: none

Alarm 11, External Event

Alarm description (as shown on screen): UnitExternalEvent

Trigger: External Alarm/Event input is open for at least 5 seconds and external fault is configured as an event

Action Taken: None

Reset: Auto clear when digital input is closed

Alarm 12, Bad Demand Limit Input

Alarm description (as shown on screen): BadDemandLimitInput

Trigger: Demand limit input out of range and demand limit is enabled. For this alarm out of range is considered to be a signal less than 3mA or more than 21mA

Action Taken: None

Reset: Auto clear when demand limit disabled or demand limit input back in range for 5 seconds

Alarm 13, Bad Setpoint Override Input

Alarm description (as shown on screen): BadSetptOverrideInput

Trigger: LWT reset input out of range and LWT reset = 4-20mA. For this alarm out of range is considered to be a signal less than 3mA or more than 21mA.

Action Taken: None

Reset: Auto clear when LWT reset is not 4-20mA or LWT reset input back in range for 5 seconds

Alarm 14, Low Ambient Lockout

Alarm description (as shown on screen): StartInhbtAmbTempLo

Trigger: The OAT drops below the low ambient lockout setpoint

Action Taken: Normal shutdown of all running circuits

Reset: The lockout clears when OAT rises to the lockout setpoint plus (4.5°F)

Circuit Faults

All circuit stop alarms require shutdown of the circuit on which they occur. Rapid stop alarms do not do a pumpdown before shutting off. All other alarms will do a pumpdown.

When one or more circuit alarms are active and no unit alarms are active, the alarm output will be switched on and off on 5 second intervals.

Alarm descriptions apply to all circuits, the circuit number is represented by '*n*' in the description.

Alarm 15, Phase Volts Loss/GFP Fault

Alarm description (as shown on screen): UnitOffPhaseVoltage or C*n*Off PhaseVoltage

Trigger: PVM input is low and PVM setpoint = Multi Point

Action Taken: Rapid stop unit or circuit

Reset: Auto reset when PVM input is high or PVM setpoint does not equal multi point for at least 5 seconds

Alarm 16, Low Evaporator Pressure

Alarm description (as shown on screen): C*n*Cmp*n*OffEvpPressLo

Trigger: [Freezestat trip AND Circuit State = Run] OR Evaporator Press < -10 psi Freezestat logic allows the circuit to run for varying times at low pressures. The lower the pressure, the shorter the time the compressor can run. This time is calculated as follows:

Freeze error = Low Evaporator Pressure Unload – Evaporator Pressure
Freeze time = 70 – 6.25 x freeze error, limited to a range of 20-70 seconds

When the evaporator pressure goes below the Low Evaporator Pressure Unload setpoint, a timer starts. If this timer exceeds the freeze time, then a freezestat trip occurs. If the evaporator pressure rises to the unload setpoint or higher, and the freeze time has not been exceeded, the timer will reset.

The alarm cannot trigger if the evaporator pressure sensor fault is active.

Action Taken: Rapid stop circuit

Reset: The alarm is cleared manually if the evaporator pressure is above 10 psi.

Alarm 17, Low Pressure Start Fail

Alarm description (as shown on screen): C*n*OffStrtFailEvpPrLo

Trigger: Circuit state = start for time greater than Startup Time setpoint.

Action Taken: Rapid stop circuit

Reset: This alarm can be cleared manually via the unit controller keypad or BAS command.

Alarm 18, High Condenser Pressure

Alarm description (as shown on screen): C*n*Cmp*n*OffCondPressHi

Trigger: Condenser Saturated Temperature > Max Saturated Condenser Value for time > High Cond Delay setpoint.

Action Taken: Rapid stop circuit

Reset: This alarm can be cleared manually via the unit controller keypad.

Alarm 19, Low Pressure Ratio

Alarm description (as shown on screen): C*n*Cmp*n*Off PrRatioLo

Trigger: Pressure ratio < calculated limit for a time > Low Pressure Ratio Delay setpoint after circuit startup has completed. The calculated limit will vary from 1.4 to 1.8 as the compressor's capacity varies from 25% to 100%.

Action Taken: Normal shutdown of circuit

Reset: This alarm can be cleared manually via the unit controller keypad or BAS command.

Alarm 20, Mechanical High Pressure (MHP) Switch

Alarm description (as shown on screen): C*n*Cmp*n*OffMechPressHi

Trigger: Mechanical High Pressure switch input is low AND Emergency Stop Alarm is not active. (Opening emergency stop switch kills power to MHP switches). Input must be off for one second before alarm is active.

Action Taken: Rapid stop circuit

Reset: This alarm can be cleared manually via the unit controller keypad if the MHP switch input is high

Alarm 21, High Discharge Temperature

Alarm description (as shown on screen): C*n*Cmp*n* OffDischTmpHi

Trigger: Discharge Temperature > High Discharge Temperature setpoint AND compressor is running. Alarm cannot trigger if temperature sensor fault is active

Action Taken: Rapid stop circuit

Reset: This alarm can be cleared manually via the unit controller keypad or BAS command

Alarm 22, High Oil Pressure Difference

Alarm description (as shown on screen): C*n*Cmp*n*OffOilPrDiffHi

Trigger: Oil Pressure Differential > High Oil Pressure Differential setpoint for a time greater than Oil Pressure Differential Delay

Action Taken: Rapid stop circuit

Reset: This alarm can be cleared manually via the unit controller keypad or BAS command

Alarm 23, Compressor Starter Fault

Alarm description (as shown on screen): C*n*Cmp*n*OffStarterFlt

Trigger:
If PVM setpoint = None(SSS): any time starter fault input is open
If PVM setpoint = Single Point or Multi Point: compressor has been running for at least 14 seconds and starter fault input is open

Action Taken: Rapid stop circuit

Reset: This alarm can be cleared manually via the unit controller keypad or BAS command.

Alarm 24, Compressor VFD Fault

Alarm description (as shown on screen): C*n*Cmp*n*OffVfdFault

Trigger: VFD is sending a fault status to controller via modbus communications

Action Taken: Shutdown compressor *n*

Reset: Lookup VFD alarm code to determine why the VFD is faulted. Clear alarm manually via the unit controller keypad after the VFD fault is fixed.

Alarm 25, High Motor Temperature

Alarm description (as shown on screen): C*n*Cmp*n*OffMotorTempHi
Trigger:
For European chillers - Input value for the motor temperature is 4500 ohms or higher or input is open

For US chillers - Motor Temperature input is open for two seconds delay

Action Taken: Rapid stop circuit

Reset:
For European chillers - This alarm can be cleared manually via the unit controller keypad after input value for motor temperature has been 300 ohms or less for at least 5 minutes.

For US Chillers - This alarm can be cleared manually via the unit controller keypad after Motor Protection input has been closed for at least 5 minutes.

Alarm 26, No Pressure Change After Start

Alarm description (as shown on screen): C*n*OffNoPressChgStart

Trigger: After start of compressor, at least a 3.6 psi drop in evaporator pressure OR 5 psi increase in condenser pressure has not occurred after 15 seconds

Action Taken: Rapid stop circuit

Reset: This alarm can be cleared manually via the unit controller keypad or BAS command.

Alarm 27, Low OAT Restart Fault

Alarm description (as shown on screen): C*n*Cmp*n*OffNbrRestarts

Trigger: Circuit has failed three low OAT start attempts

Action Taken: Rapid stop circuit
Reset: This alarm can be cleared manually via the unit controller keypad or BAS command.

Alarm 28, No Pressure At Startup

Alarm description (as shown on screen): C*n*OffNoPressAtStart

Trigger: Either Evap Pressure < 35 kPa (5.1 psi) OR Cond Pressure < 35 kPa (5.1 psi) AND Compressor start requested AND circuit does not have a fan VFD

Action Taken: Rapid stop circuit

Reset: This alarm can be cleared manually via the unit controller keypad or BAS command if Evap Pressure < 35 kPa (5.1 psi) and Cond Pressure < 35 kPa (5.1 psi), or circuit is configured for fan VFD.

Alarm 29, CC Comm Failure N Circuit Fault

Alarm description (as shown on screen): C*n*OffCmpCtrlrComFail or C*n*OffEXVCtrlrComFail

Trigger: Communication with the compressor or EXV I/O extension module has failed

Action Taken: Rapid stop of affected circuit

Reset: This alarm can be cleared manually via the unit controller keypad or BAS command when communication between main controller and the extension module is working for 5 seconds.

Alarm 30, Compressor VFD Overheat Fault - Shutdown

Alarm description (as shown on screen): C*n*Cmp*n*OffVfdTempHi

Trigger: VFD heat sink temperature has exceeded 248°F (120°C)

Action Taken: Shutdown compressor *n*

Reset: This alarm can be cleared manually via the unit controller keypad or BAS command if the VFD heat sink temperature is below the alarm setpoint.

Alarm 31, Comm Error with Compressor VFD - Shutdown

Alarm description (as shown on screen): C*n*Cmp*n*OffVfdCommFail

Trigger: The controller has failed a predetermined number of Modbus reads or writes with the VFD

Action Taken: Shutdown compressor *n*

Reset: This alarm can be cleared manually via the unit controller keypad or BAS command if communications is restored

Alarm 32, Current Overload Trip - Shutdown

Alarm description (as shown on screen): C*n*Cmp*n*OffCurrentHi

Trigger: VFD output current has exceeded 130% of the compressor RLA.

Action Taken: Shutdown compressor *n*

Reset: This alarm can be cleared manually via the unit controller keypad or BAS command.

Alarm 33, Evaporator Pressure Sensor Fault

Alarm description (as shown on screen): C*n*Cmp*n*OffEvpPress Sen

Trigger: When sensor is shorted or open, the alarm should be triggered, with the following exception. If the evaporator LWT is 30°C (86°F) or higher, the fault should not be triggered due to the input signal reading too high unless the circuit has been running for longer than 90 seconds

Action Taken: Rapid stop circuit

Reset: This alarm can be cleared manually via the unit controller keypad or BAS command if the sensor is back in range

Alarm 34, Condenser Pressure Sensor Fault

Alarm description (as shown on screen): C*n*Cmp*n*OffCondPressSen

Trigger: Sensor shorted or open

Action Taken: Rapid stop circuit

Reset: This alarm can be cleared manually via the unit controller keypad or BAS if the sensor is back in range.

Alarm 35, Oil Pressure Sensor Fault

Alarm description (as shown on screen): C*n*Cmp*n*OffOilFeedSen

Trigger: Sensor shorted or open

Action Taken: Normal shutdown of circuit

Reset: This alarm can be cleared manually via the unit controller keypad or BAS if the sensor is back in range.

Alarm 36, Suction Temperature Sensor Fault

Alarm description (as shown on screen): C*n*Cmp*n*OffSuctTempSen

Trigger: Sensor shorted or open. Sensor must be out of range for one second before alarm is active.

Action Taken: Normal shutdown of circuit

Reset: This alarm can be cleared manually via the unit controller keypad or BAS if the sensor is back in range.

Alarm 37, Discharge Temperature Sensor Fault

Alarm description (as shown on screen): C*n*Cmp*n*OffDishTmpSen

Trigger: Sensor shorted or open

Action Taken: Normal shutdown of circuit

Reset: This alarm can be cleared manually via the unit controller keypad or BAS if the sensor is back in range.

Alarm 38, Motor Temperature Sensor Fault

Alarm description (as shown on screen): C*n*Cmp*n*OffMtrTempSen

Trigger: Sensor shorted

Action Taken: Rapid stop circuit

Reset: This alarm can be cleared manually via the unit controller keypad or BAS if the sensor is back in range.

Alarm 39, Slide Position Sensor Fault

Alarm description (as shown on screen): C*n*Cmp*n*OffSlidePosSen

Trigger: Slide position input out of range and Slide Pos Sens= Yes. For this alarm out of range is considered to be a signal less than 1mA or more than 23mA.

Action Taken: Normal shutdown of circuit

Reset: This alarm can be cleared manually via the unit controller keypad or BAS command if the sensor is back in range.

Alarm 40, Low Discharge Superheat

Alarm description (as shown on screen): C*n*Cmp*n* OffLowDischSH

Trigger: Discharge superheat < 12°C (21.6°F) for 20 minutes

Action Taken: Normal shutdown of circuit

Reset: This alarm can be cleared manually via the unit controller keypad or BAS command.

Circuit Problems

The following events limit operation of the circuit in some way as described in the Action Taken column. The occurrence of a circuit event only affects the circuit on which it occurred. Circuit events are logged in the event log on the unit controller.

Alarm 41, Low Evaporator Pressure - Hold

Event description (as shown on screen): C*n*InhbtLoadEvpPrLo

Trigger: This event is not enabled until the circuit startup is complete and the unit mode is Cool. Then, while running, if evaporator pressure <= Low Evaporator Pressure Hold setpoint the event is triggered. The event is not to be triggered for 90 seconds following the capacity change of the compressor from 50% to 60%.

Action Taken: Inhibit loading.

Reset: While still running, the event will be reset if evaporator pressure > (Low Evaporator Pressure Hold SP + 2psi). The event is also reset if the unit mode is switched to Ice, or the circuit is no longer in the run state.

Alarm 42, Low Evaporator Pressure - Unload

Event description (as shown on screen): C*n*UnloadEvpPressLo

Trigger: This event is not enabled until the circuit startup is complete and the unit mode is Cool. Then, while running, if evaporator pressure <= Low Evaporator Pressure Unload setpoint the event is triggered. The event is not to be triggered for 90 seconds following the capacity change of the compressor from 50% to 60%.

Action Taken: Action Taken: Unload the compressor by decreasing the capacity by one step every 5 seconds until the evaporator pressure rises above the Low Evaporator Pressure Unload setpoint.

Reset: While still running, the event will be reset if evaporator pressure > (Low Evaporator Pressure Hold SP + 2psi). The event is also reset if the unit mode is switched to Ice, or the circuit is no longer in the run state.

Alarm 43, High Condenser Pressure - Hold

Event description (as shown on screen): C*n*InhbtLoadCndPrHi

Trigger: While the compressor is running and unit mode is Cool, if saturated condenser temperature >= High Saturated Condenser Hold Value, the event is triggered.

Action Taken: Inhibit loading

Reset: While still running, the event will be reset if saturated condenser temperature < (High Saturated Condenser Hold Value – 10^{o}F). The event is also reset if the unit mode is switched to Ice, or the circuit is no longer in the run state.

Alarm 44, High Condenser Pressure - Unload

Event description (as shown on screen): C*n*UnloadCndPressHi

Trigger: While the compressor is running and unit mode is Cool, if saturated condenser temperature >= High Saturated Condenser Unload Value, the event is triggered.

Action Taken: Unload the compressor by decreasing the capacity by one step every 5 seconds until the evaporator pressure rises above the High Condensing Pressure Unload setpoint.

Reset: While still running, the event will be reset if saturated condenser temperature < (High Saturated Condenser Unload Value – 10^{o}F). The event is also reset if the unit mode is switched to Ice, or the circuit is no longer in the run state.

Alarm 45, Compressor Motor Current High - Unload

Alarm description (as shown on screen): C*n*Cmp*n*UnloadAmpsHi

Trigger: VFD output amps exceeds unload setpoint

Action Taken: Unload compressor *n*

Reset: Automatically resets when the VFD output amps are below 116% of motor rated load amps for 5 seconds.

Alarm 46, Compressor Motor Current High – Inhibit Load

Alarm description (as shown on screen): C*n*Cmp*n*InhbtLdAmpsHi

Trigger: VFD output amps exceeds hold setpoint

Action Taken: Compressor *n* can not increase it's capacity (must hold at it's current capacity).

Reset: Automatically resets when the VFD output amps are below 116% of motor rated load amps for 10 seconds.

Alarm 47, Failed Pumpdown

Event description (as shown on screen): C*n*FailedPumpdown

Trigger: Circuit state = pumpdown for time > Pumpdown Time setpoint

Action Taken: Shutdown circuit

Reset: N/A

Alarm 48, Power Loss While Running

Event description (as shown on screen): CnPwrLossRun

Trigger: Circuit controller is powered up after losing power while compressor was running

Action Taken: N/A

Reset: N/A

Alarm Logging

When an alarm occurs, the alarm type, date, and time are stored in the active alarm buffer corresponding to that alarm (viewed on the Alarm Active screens) also in the alarm history buffer (viewed on the Alarm Log screens). The active alarm buffers hold a record of all current alarms.

A separate alarm log stores the last 25 alarms to occur. When an alarm occurs, it is put into the first slot in the alarm log and all others are moved down one, dropping the last alarm. The date and time the alarm occurred are stored in the alarm log.

Event Log

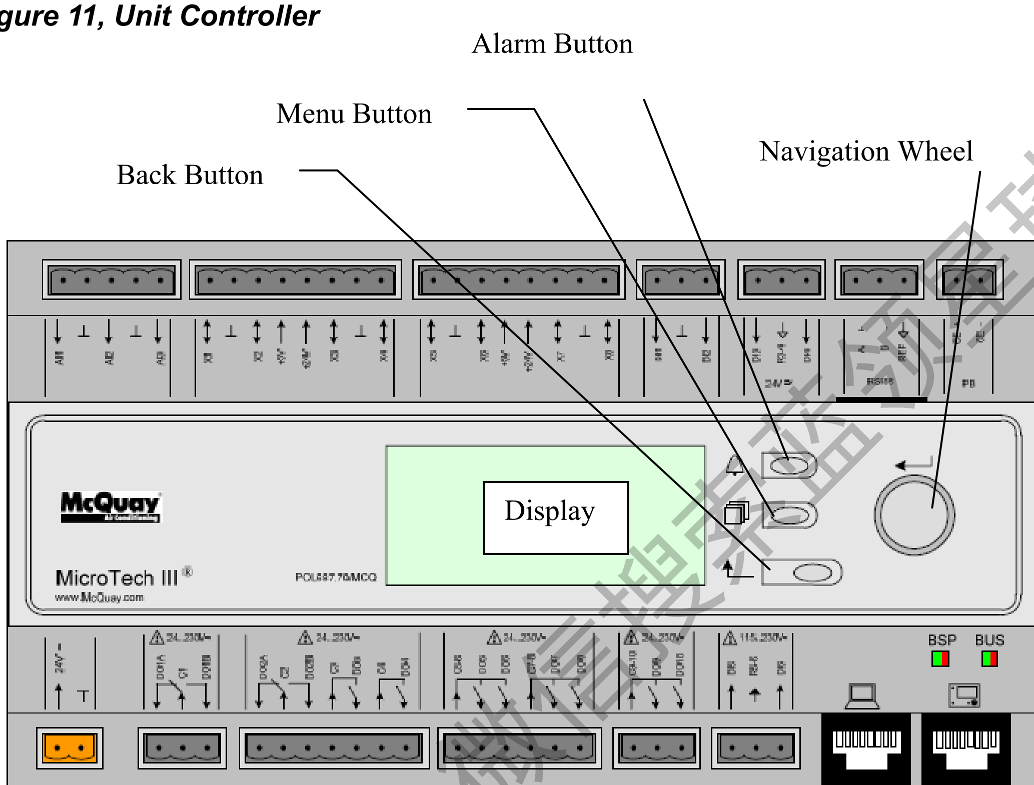
This menu is accessed through the alarm menu. It gives access to the event occurrence over a seven day period and the last occurrence with time and date for:

Unit Power Restore	Low Pressure Hold	Low Pressure Unload
High Pressure Hold	High Pressure Unload	High Current Hold
High Current Unload		

Using the Controller

The Unit Controller Operation

Figure 11, Unit Controller



The keypad/display consists of a 5-line by 22-character display, three buttons (keys) and a "push and roll" navigation wheel. There is an Alarm Button, Menu (Home) Button, and a Back Button. The wheel is used to navigate between lines on a screen (page) and to increase and decrease changeable values when editing. Pushing the wheel acts as an Enter Button and will jump from a link to the next set of parameters.

Figure 12, Typical Screen

```
♦6 |  View/Set Unit   3
Status/Settings       >
Set Up                >
Temperature           >
Date/Time/Schedule    >
```

Generally, each line on the display contains a menu title, a parameter (such as a value or a setpoint), or a link (which will have an arrow in the right of the line) to a further menu. The first line visible on each display includes the menu title and the line number to which the cursor is currently "pointing", in the above case 3, Temperature.

The left most position of the title line includes an "up" arrow ▲ to indicate there are lines (parameters) "above" the currently displayed line; and/or a "down" arrow ▼ to indicate there are lines (parameters) "below" the currently displayed items or an "up/down" arrow ♦ to indicate there are lines "above and below" the currently displayed line. The selected line is highlighted.

Each line on a screen can contain status-only information or include changeable data fields (setpoints).

When the cursor is on a line the highlights will look like this:

If line contains a changeable value- `Evaporator Delta T= 10.0F`

If the line contains status-only information- `Unit Status=          Run`

Or a line in a menu may be a link to further menus. This is often referred to as a jump line, meaning pushing the navigation wheel will cause a "jump" to a new menu. An arrow (>)is displayed to the far right of the line to indicate it is a "jump" line and the entire line is highlighted when the cursor is on that line.

NOTE - Only menus and items that are applicable to the specific unit configuration are displayed.

This manual includes information relative to the operator level of parameters; data and setpoints necessary for the every day operation of the chiller. There are more extensive menus available for the use of service technicians.

Navigating

When power is applied to the control circuit, the controller screen will be active and display the Home screen, which can also be accessed by pressing the Menu Button The navigating wheel is the only navigating device necessary, although the MENU, ALARM, and BACK buttons can provide shortcuts as explained later.

Passwords

Enter passwords from the Main Menu:

- Enter Password, links to the Entry screen, which is an editable screen So pressing the wheel goes to the edit mode where the password (5321) can be entered. The first (*) will be highlighted, rotate the wheel clockwise to the first number and set it by pressing the wheel. Repeat for the remaining three numbers.

  The password will time out after 10 minutes, and is cancelled if a new password is entered or the control powers down.

- Not entering a password allows access to a limited number of parameters (with asterisks) as shown in Figure 15 on page 61.

Figure 13, Password Menu

```
   Main Menu
Enter Password       >
Unit Status
Off: Unit Sw
ACTIVE SETPT     44.6°F
```

Figure 14, Password Entry Page

```
  Enter Password
Enter PW            ****
```

Entering an invalid password has the same effect as not entering a password.

Once a valid password has been entered, the controller allows further changes and access without requiring the user to enter a password until either the password timer expires or a different password is entered. The default value for this password timer is 10 minutes.

Navigation Mode

When the navigation wheel is turned clockwise, the cursor moves to the next line (down) on the page. When the wheel is turned counter-clockwise the cursor moves to the previous line (up) on the page. The faster the wheel is turned the faster the cursor moves. Pushing the wheel acts as an "Enter" button.

Three types of lines exist:

- Menu title, displayed in the first line as in Figure 14.
- Link (also called Jump) having an arrow (>) in the right of the line and used to link to the next menu.
- Parameters with a value or adjustable setpoint.

For example, "Time Until Restart" jumps from level 1 to level 2 and stops there.

When the Back Button is pressed the display reverts back to the previously displayed page. If the Back button is repeatedly pressed the display continues to revert one page back along the current navigation path until the "main menu" is reached.

When the Menu (Home) Button is pressed the display reverts to the "main page."

When the Alarm Button is depressed, the Alarm Lists menu is displayed.

Edit Mode

The Editing Mode is entered by pressing the navigation wheel while the cursor is pointing to a line containing an editable field. Once in the edit mode pressing the wheel again causes the editable field to be highlighted. Turning the wheel clockwise while the editable field is highlighted causes the value to be increased. Turning the wheel counter-clockwise while the editable field is highlighted causes the value to be decreased. The faster the wheel is turned the faster the value is increased or decreased. Pressing the wheel again cause the new value to be saved and the keypad/display to leave the edit mode and return to the navigation mode.

A parameter with an "R" is read only; it is giving a value or description of a condition. An "R/W indicates a read and/or write opportunity; a value can be read or changed (providing the proper password has been entered).

Example 1: **Check Status,** for example **-**is the unit being controlled locally or by an external network? We are looking for the Unit Control Source Since this a unit status parameter, start at Main Menu and select View/Set Unit and press the wheel to jump to the next set of menus. There will be an arrow at the right side of the box, indicating that a jump to the next level is required. Press the wheel to execute the jump.

You will arrive at the Status/ Settings link. There is an arrow indicating that this line is a link to a further menu. Press the wheel again to jump to the next menu, Unit Status/Settings.

Rotate the wheel to scroll down to Control Source and read the result.

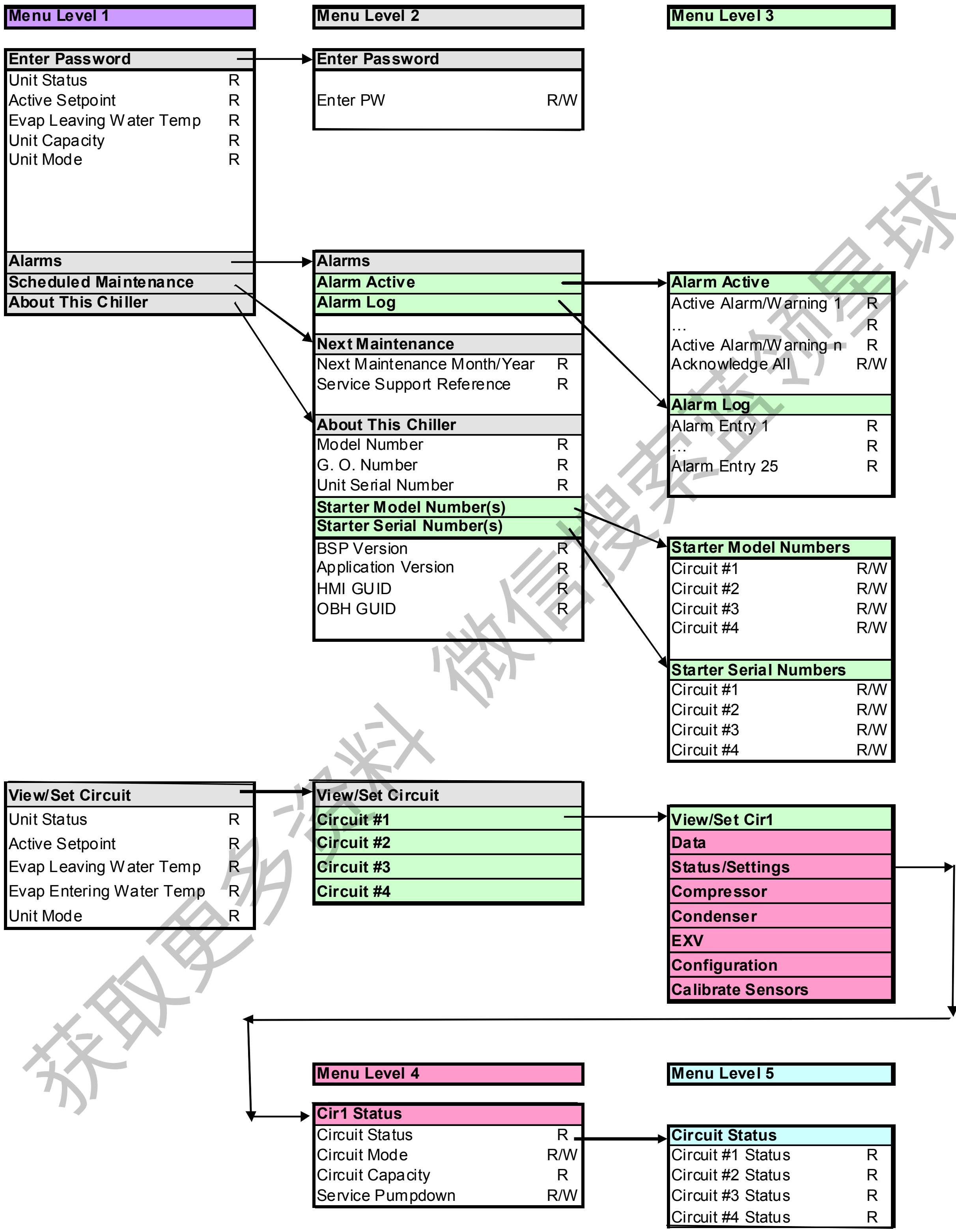
Example 2; Change a Setpoint, the chilled water setpoint for example. This parameter is designated as Cool LWT 1 setpoint and is a unit parameter. From the Main Menu select View/Set Unit. The arrow indicated that this is link to a further menu.

Press the wheel and jump to the next menu View/Set Unit and use the wheel to scroll down to Temperatures. This again has an arrow and is a link to a further menu. Press the wheel and jump to the Temperatures menu, which contains temperatures values and setpoints. The first line is Evap LWT, rotate wheel until Cool LWT 1 is highlighted. Press the wheel to enter edit mode. Rotate wheel until new setpoint is reached, then press wheel to accept the new value and exit edit mode.

Example 3; Clear an Alarm, from the Main Menu scroll down to the Alarms line. Note the arrow indicating this line is a link. Press the wheel to jump to the next menu Alarms There are two lines here; Alarm Active and Alarm Log. Alarms are cleared from the Active Alarm link. Press the wheel to jump to the next screen. With the first line highlighted, press the wheel to enter edit mode. Rotate wheel until AlmClr is set to On, then press wheel to clear the alarms.

Figure 15, HMI Keypad Navigation

Visable (w/o Password)



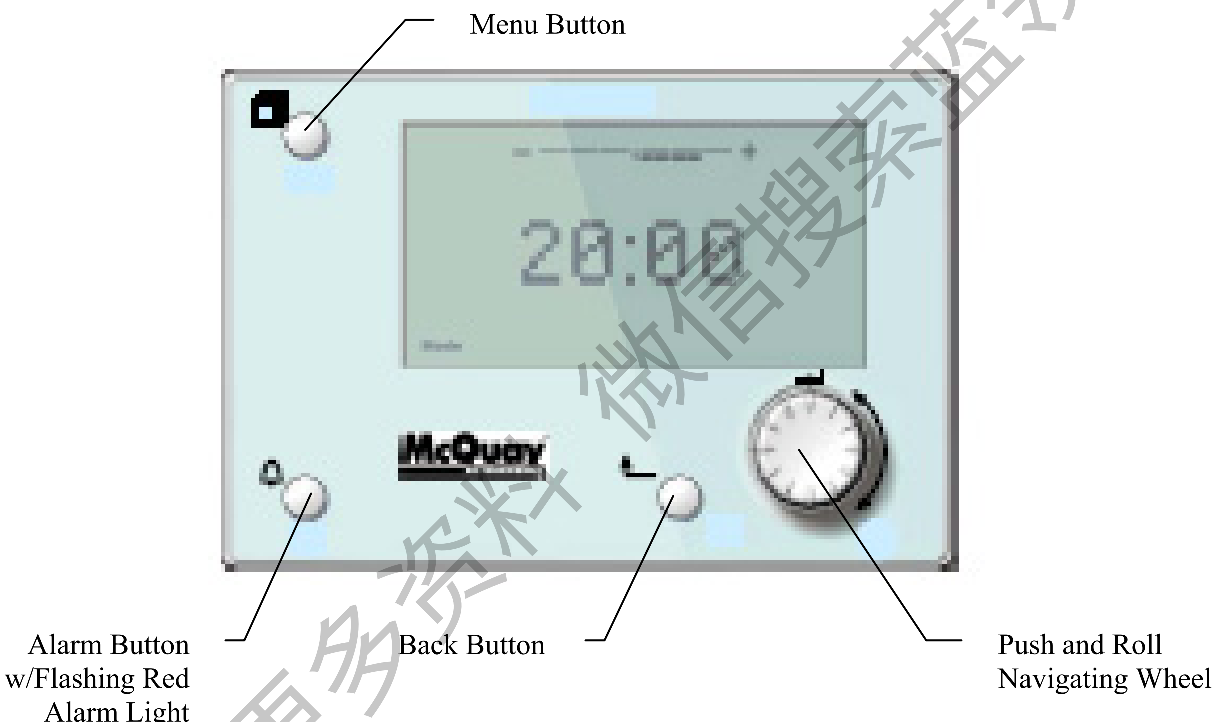
Optional Remote User Interface

The optional remote user interface is a remote control panel that mimics operation of the controller located on the unit. Up to eight Pathfinder units can be connected to it and selected on the screen. It provides HMI (Human Machine Interface) within a building, the building engineer's office for example, without going outdoors to the unit.

It can be ordered with the unit and shipped loose as a field installed option. It can also be ordered anytime after chiller shipment and mounted and wired on the job as explained on the following page. The remote panel is powered from the unit and no additional power supply is required.

All viewing and setpoint adjustments available on the unit controller are available on the remote panel. Navigation is identical to the unit controller as described in this manual.

The initial screen when the remote is turned on shows the units connected to it. Highlight the desired unit and press the wheel to access it. The remote will automatically show the units attached to it, no initial entry is required.

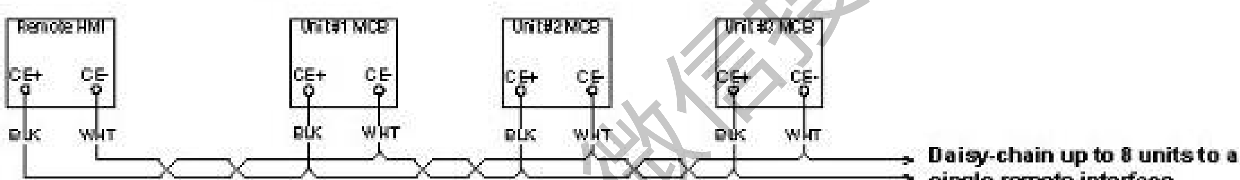


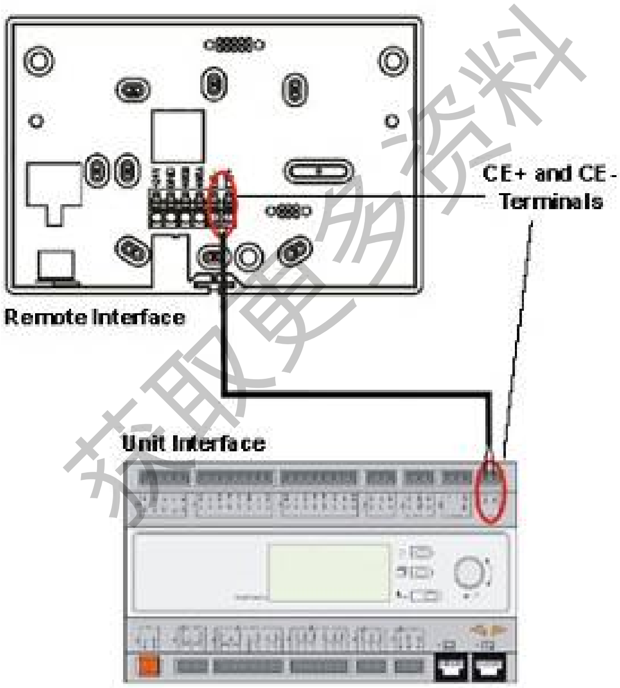
Technical Specifications

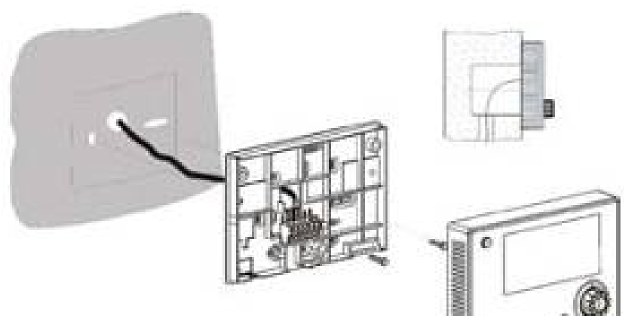
Interface	
Process Bus	Up to eight interfaces per remote
Bus connection	CE+, CE-, not interchangeable
Terminal	2-screw connector
Max. length	700 m
Cable type	Twisted pair cable; 0.5...2.5 mm2
Display	
LCD type	FSTN
Dimensions	5.7 W x 3.8 H x 1.5 D inches (144 x 96 x 38 mm)
Resolution	Dot-matrix 96 X 208 pixels
Backlight	Blue or white, user-configurable
Environmental Conditions	
Operation	IEC 721-3-3
Temperature	-40 to 70 °C
Restriction LCD	-20 to 60 °C
Humidity	<90% r.h. (no condensation)
Air pressure	Min. 700 hPa, corresponding to Max. 3,000 m above sea level

Cover Removal

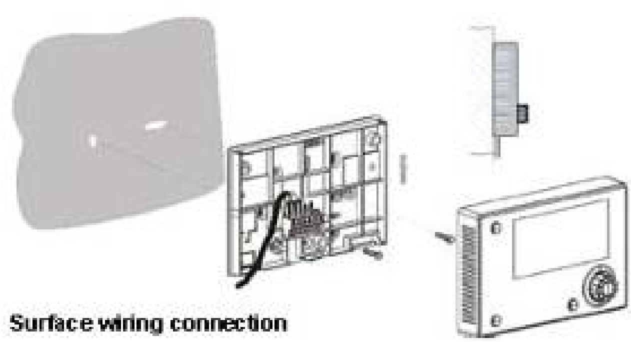
Process Bus Wiring Connections







Through the wall wiring connection



Surface wiring connection

Optional Compressor VFD

An optional variable frequency drive (VFD) for each unit compressor provides compressor speed reduction to the extent permissible by chiller load and discharge pressure requirements. The speed reduction provides significant energy savings over fixed-speed compressors.

The VFD has its own microprocessor controller that monitors VFD operation, provides safety shutdowns and sends data to the chiller controller.

VFD alarms and faults are handled the same as chiller related faults. See page 45 for information on viewing and clearing them.

⚠WARNING

Access to the VFD enclosure is by factory-trained technicians only. Unauthorized entry can result in property damage, severe personal injury, or death.

Faults and Minor Faults/Alarms

When the drive detects a fault:

- The VFD sends a message to the chiller controller regarding the fault
- The chiller controller displays a hexadecimal number code that identifies the specific VFD fault. Table 8 lists the fault codes.
- An alarm bell icon 🔔 will be displayed in the upper right-hand corner of all controller screens including the optional remote user interface panel's screens.
- The remote alarm circuit will be energized (wiring to a remote alarm device is optional)
- The drive output is interrupted and the compressor coasts to a stop.
- The drive is inoperable until the fault is corrected.

When the drive detects an alarm or minor fault:

- No message is sent to the chiller controller since no operator action is required.
- The drive continues running the compressor.

Clearing VFD Faults

VFD faults are cleared in the same manor as any chiller unit fault. See page 45 for instructions.

Navigating VFD Fault Codes

When a VFD fault condition is detected, the VFD hexadecimal fault code will appear on the chiller controller display (HMI) as a hexadecimal code, for example; 0002H. The faults that can be corrected by the operator without accessing the VFD interior are listed in Table 8. Note the fault code and contact McQuay Service if unsuccessful in clearing the listed faults or for assistance with unlisted faults.

Table 8, Fault Code, Causes and Possible Solutions

Hexa-decimal Code	VFD HMI Display	Fault Name, Cause	Possible Solutions
0083H	CPF02	A/D Conversion Error	Cycle power to drive (Note 1)
0095H	CPF20, CPF21	Control Circuit Error	Cycle power to drive (Note 1)
0097	CPF22	Hybrid IC Error	Cycle power to drive (Note 1)
0019H	dEv	Speed Deviation	Reduce compressor load

Table continued next page.

Hexa-decimal Code	VFD HMI Display	Fault Name,	Possible Solutions
001FH	Err	EEPROM Write Error	Cycle power to drive (Note 1)
0007H	oC	Overcurrent	Measure the current going to the compressor Determine if there is a sudden fluctuation in current Reduce load
0106H to 0107H	oFA03 to oFA06	Option Card Error	Cycle power to drive (Note 1)
0111H, 0112H	oFA10, oFA11	Option Card Error	Cycle power to drive (Note 1)
0131H to 0139H	oFA30 to oFA43	Option Card Error	Cycle power to drive (Note 1)
0205H to 0211H	oFb03 to oFb11	Option Card Error	Cycle power to drive (Note 1)
0212H to 0217H	oFb12 to oFb17	Option Card Error	Cycle power to drive (Note 1)
0231H to 0239H, 023AH to 023EH	oFb30 to oFb43	Option Card Error	Cycle power to drive (Note 1)
0305H, 0306H	oFC05, oFC06	Option Card Error	Cycle power to drive (Note 1)
0009H	oH	Heatsink Overheat	Verify ambient temperature within specification Remove any adjacent heat producing equipment Decrease load
000AH	oH1	Heatsink Overheat	Verify ambient temperature within specification Remove any adjacent heat producing equipment Decrease load
000BH	oL1	Motor Overload	Reduce load Check for power supply phase loss/fluctuation Check motor current against nameplate
000CH	oL2	Drive Overload	Reduce load Check for power supply phase loss/fluctuation
0008H	ov	Overvoltage DC Bus	Check motor wiring for ground faults Check input voltage
000FH	rr	Braking Transistor Failed	Cycle power to drive (Note 1)
0002H	Uv1	DC Bus Undervoltage	Check for loose power connections Check supply voltage Cycle power to drive (Note 1)
0003F	Uv2	Control Power Fault	Cycle power to drive (Note 1)
0004H	Uv3	Bypass Circuit Undervoltage	Cycle power to drive (Note 1)

Note

1. Depending on the fault type, the fault will shut down the circuit or entire unit.

   If a circuit is still running and on its own disconnect, it can be left running. Disconnect and then reconnect the faulted circuit.

   If a circuit is still running and there is a common disconnect for the unit, pump down the running circuit, disconnect and reconnect the entire unit.

VFD Changes from Non-VFD

Table 9, Setpoint Changes

Setpoint	VFD Units	Non-VFD Units
Light Load Stage Down	Default 35	Default 40
Stop Delta T	Default 1.5	Default 0.7
Stage Up Delta T	Default 0.5	Default 1.0
PVM Config	Default None	Default Single Point
Slide Position Sensor	Default No	Default Yes

Table 10, Logic Changes

Logic	VFD Units	Non-VFD Units
Requirements for staging a circuit on are different	If a calculated limit for pulldown rate is exceeded when LWT error is less than 10°C, no additional circuit can start.	Has the logic outlined in original SRS, without the additional logic shown at left for VFD chillers.
Method for generating load/unload commands is different.	A scaled limit on pulldown rate is used in combination with a scaled time delay between capacity changes based on LWT error.	An error accumulator using LWT error and loop pulldown rate are used. Time between capacity changes is determined by accumulator reaching limit and the time delays in individual circuits.
Pressure control target is different	Always controls to 350 kPa other than after transition from SSH control	Allows pressure target to vary in order to maintain DSH (12 to 22 °C)
Limits of SSH target are different	SSH target varies from 3.4 to 7.0 °C (as DSH varies from 18 to 12 °C)	SSH target varies from 2.8 to 5.5 °C (as DSH varies from 17 to 12 °C)
Triggers for transition from pressure control to SSH control are different.	Circuit running for 3 minutes and DSH >= 12 deg C for 1 minute or SSH < SSH target plus 1 degree C.	Low Pressure Unload not active and LWT <= 15.5°c and SSH >= SSH target and DSH >= 12°C for at least 3 minutes
Triggers for transition from SSH control to pressure control are different.	Evap Pressure > 350 kPa for 60 seconds	LWT > 17°C or DSH < 12°C

Control Panel

The control panel for VFD units is different from non-VFD units due to the space requirements of the drive. See Figure 16 and Figure 17 for component layout.

Figure 16, Upper Section of the VFD Control Panel Section

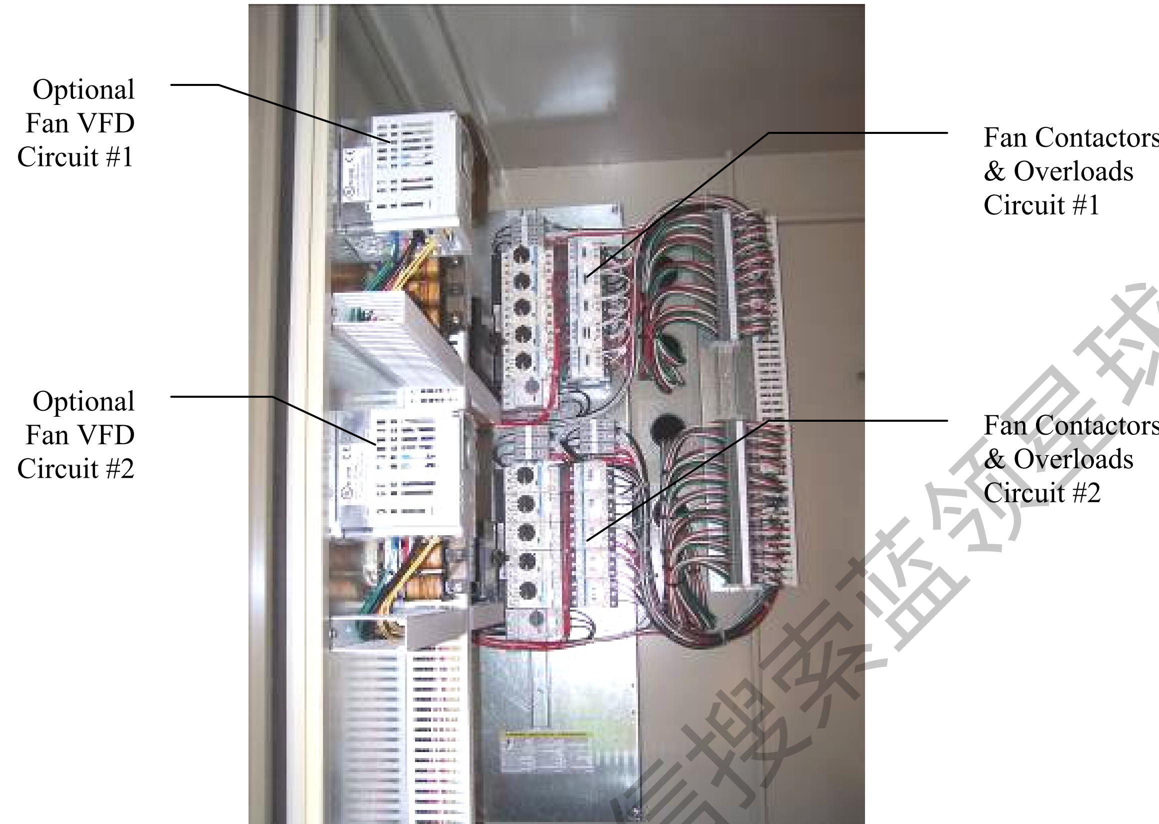
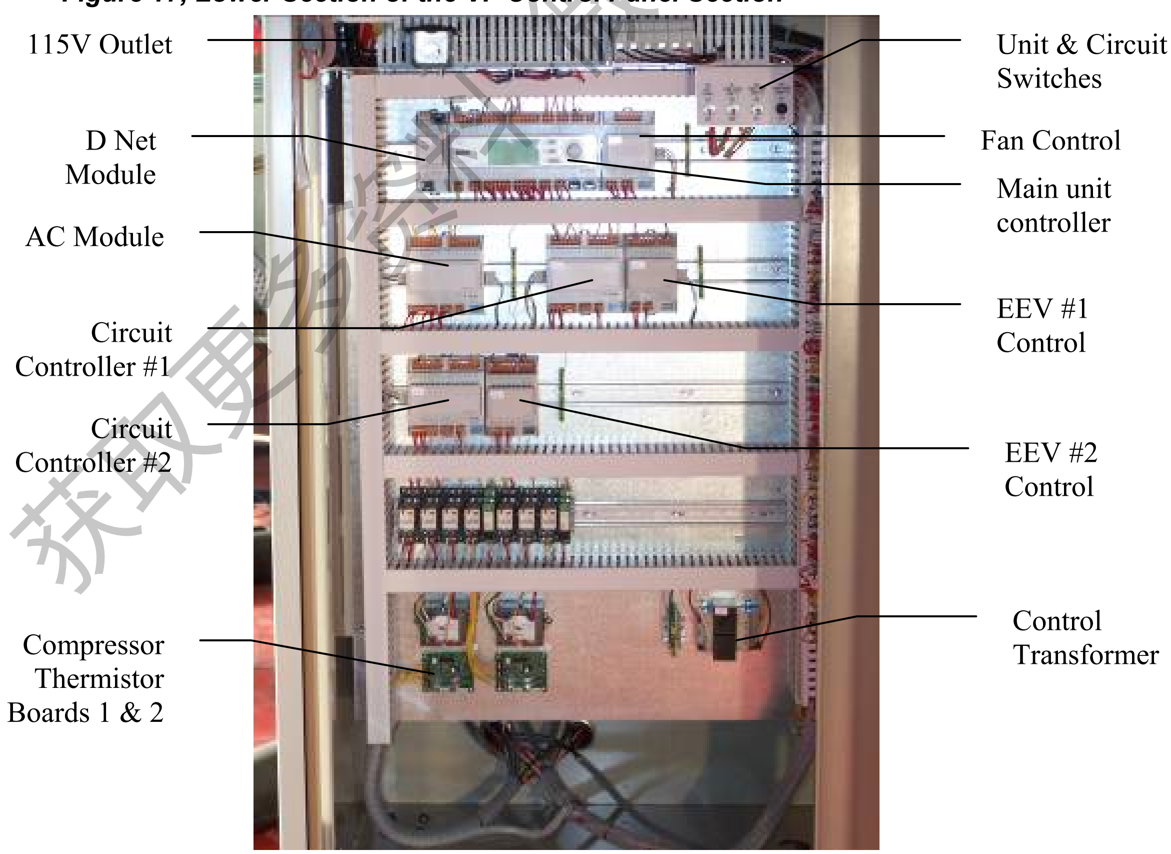


Figure 17, Lower Section of the VF Control Panel Section



Optional Power Factor Correction Capacitors

Optional power factor correction capacitors (PFCC) located in an electrical panel may have been ordered with the chiller. If so, there is one panel per compressor and they are mounted on the side base rail near the evaporator.

The panel has no moving parts and no routine maintenance is required. There is a fuse for each phase, each with a blown fuse indicator and associated red indicating light.

A fuse failure will cause a phase fault and the unit will experience a rapid shutdown from the Phase-Voltage Monitor for wye-delta starters or internally within solid state starters. Units with compressor VFDs will not normally have PFCCs.

Before replacing the fuse, the cause for failure must be determined and corrected. The chiller will not run with a blown circuit fuse.

⚠ WARNING
Disconnect power from the unit before opening the capacitor panel. After disconnecting, allow ten minutes for capacitor to discharge and check for no capacitor voltage with a voltmeter before attempting any service work.
Failure to do so can result in property damage, severe personal injury, or death.

Start-up and Shutdown

NOTICE
McQuay service personnel or factory authorized service agency must perform initial start-up in order to activate warranty.

⚠ CAUTION

Most relays and terminals in the unit control center are powered when S1 is closed and the control circuit disconnect is on. Therefore, do not close S1 until ready for start-up or the unit may start unintentionally and possibly cause equipment damage.

Seasonal Start-up

1. Double check that the discharge shutoff valve and the optional compressor suction butterfly valves are open.
2. Check that the manual liquid-line shutoff valves at the outlet of the subcooler coils and the oil separator oil return line shutoff valves are open.
3. Check the leaving chilled water temperature setpoint on the MicroTech III controller to be sure it is set at the desired chilled water temperature.
4. Start the auxiliary equipment for the installation by turning on the time clock, and/or remote on/off switch, and chilled water pump.
5. Check to see that pumpdown switches Q1 and Q2 (and Q3) are in the "Pumpdown and Stop" (open) position. Throw the S1 switch to the "auto" position.
6. Under the "Control Mode" menu of the keypad, place the unit into the automatic cool mode.
7. Start the system by moving pumpdown switch Q1 to the "auto" position.
8. Repeat step 7 for Q2 (and Q3).

Temporary Shutdown

Move pumpdown switches Q1 and Q2 to the "Pumpdown and Stop" position. After the compressors have pumped down, turn off the chilled water pump.

⚠ CAUTION

Do not turn the unit off using the "Override Stop" switch, without first moving Q1 and Q2 (and Q3) to the "Stop" position, unless it is an emergency, as this will prevent the unit from going through a proper shutdown/pumpdown sequence, resulting in possible equipment damage.

⚠ CAUTION

The unit has a one-time pumpdown operation. When Q1 and Q2 are in the "Pumpdown and Stop" position the unit will pump down once and not run again until the Q1 and Q2 switches are moved to the auto position. If Q1 and Q2 are in the auto position and the load has been satisfied, the unit will go into one-time pumpdown and will remain off until the MicroTech III control senses a call for cooling and starts the unit.

⚠ CAUTION

Water flow to the unit must not be interrupted before the compressors pump down to avoid freeze-up in the evaporator. Interruption will cause equipment damage.

⚠ CAUTION

If all power to the unit is turned off, the compressor heaters will become inoperable. Once power is resumed to the unit, the compressor and oil separator heaters must be energized a minimum of 12 hours before attempting to start the unit.

Failure to do so can damage the compressors due to excessive accumulation of liquid in the compressor.

Start-up After Temporary Shutdown

1. Insure that the compressor and oil separator heaters have been energized for at least 12 hours prior to starting the unit.
2. Start the chilled water pump.
3. With System switch Q0 in the "on" position, move pumpdown switches Q1 and Q2 to the "auto" position.
4. Observe the unit operation until the system has stabilized.

Extended (Seasonal) Shutdown

1. Move the Q1 and Q2 (and Q3) switches to the manual pumpdown position.
2. After the compressors have pumped down, turn off the chilled water pump.
3. Turn off all power to the unit and to the chilled water pump.
4. If fluid is left in the evaporator, confirm that the evaporator heaters are operational.
5. Move the emergency stop switch S1 to the "off" position.
6. Close the compressor discharge valve and the optional compressor suction valve (if so equipped) as well as the liquid line shutoff valves.
7. Tag all opened compressor disconnect switches to warn against start-up before opening the compressor suction valve and liquid line shutoff valves.
8. If glycol is <u>not</u> used in the system, drain all water from the unit evaporator and chilled water piping if the unit is to be shutdown during winter and temperatures below -20°F can be expected. The evaporator is equipped with heaters to help protect it down to -20°F. Chilled water piping must be protected with field-installed protection. Do not leave the vessels or piping open to the atmosphere over the shutdown period.
9. Do <u>not</u> apply power to the evaporator heaters if the system is drained of fluids as this can cause the heaters to burn out.

Start-up After Extended (Seasonal) Shutdown

1. With all electrical disconnects locked and tagged out, check all screw or lug-type electrical connections to be sure they are tight for good electrical contact.

⚠DANGER
LOCK AND TAG OUT ALL POWER SOURCES WHEN CHECKING CONNECTIONS. ELECTRICAL SHOCK WILL CAUSE SEVERE PERSONAL INJURY OR DEATH.

2. Check the voltage of the unit power supply and see that it is within the ±10% tolerance that is allowed. Voltage unbalance *between* phases must be within ±3%.
3. See that all auxiliary control equipment is operative and that an adequate cooling load is available for start-up.
4. Check all compressor flange connections for tightness to avoid refrigerant loss. Always replace valve seal caps.
5. Make sure system switch Q0 is in the "Stop" position and pumpdown switches Q1 and Q2 are set to "Pumpdown and Stop", throw the main power and control disconnect switches to "on." This will energize the crankcase heaters. Wait a minimum of 12 hours before starting up unit. Turn compressor circuit breakers to "off" position until ready to start unit.
6. Open the optional compressor suction butterfly as well as the liquid line shutoff valves, compressor discharge valves.
7. Vent the air from the evaporator water side as well as from the system piping. Open all water flow valves and start the chilled water pump. Check all piping for leaks and recheck for air in the system. Verify the correct flow rate by taking the pressure drop across the evaporator and checking the pressure drop curves in the installation manual, IM 997.
8. The following table gives glycol concentrations required for freeze protection.

Table 11, Freeze Protection

Temperature °F (°C)	Percent Volume Glycol Concentration Required			
	For Freeze Protection		For Burst Protection	
	Ethylene Glycol	Propylene Glycol	Ethylene Glycol	Propylene Glycol
20 (6.7)	16	18	11	12
10 (-12.2)	25	29	17	20
0 (-17.8)	33	36	22	24
-10 (-23.3)	39	42	26	28
-20 (-28.9)	44	46	30	30
-30 (-34.4)	48	50	30	33
-40 (-40.0)	52	54	30	35
-50 (-45.6)	56	57	30	35
-60 (-51.1)	60	60	30	35

Notes:

1. These figures are examples only and cannot be appropriate to every situation. Generally, for an extended margin of protection, select a temperature at least 10°F lower than the expected lowest ambient temperature. Inhibitor levels should be adjusted for solutions less than 25% glycol.
2. Glycol of less than 25% concentration is not recommended because of the potential for bacterial growth and loss of heat transfer efficiency.

Field Wiring Diagram

Figure 18, Typical Field Wiring Diagram (Sheet 1)

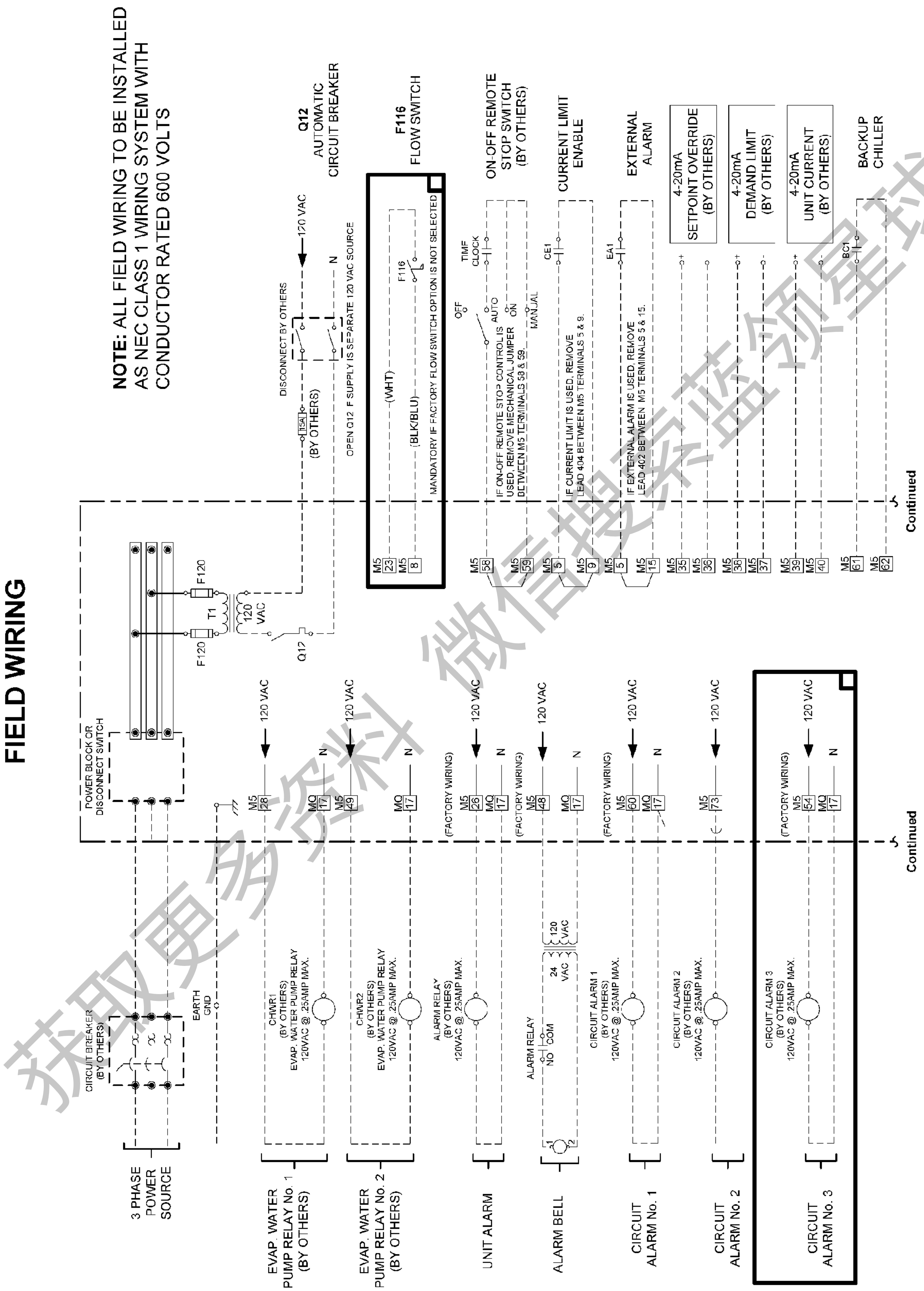
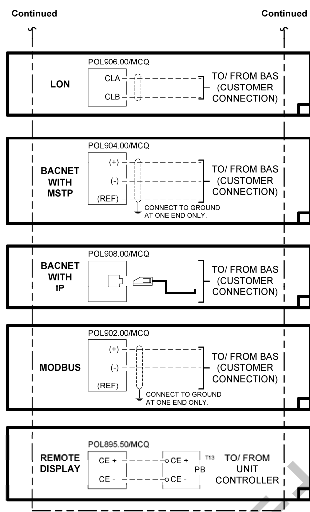


Figure 18, Typical Field Wiring Diagram (Sheet 2)

FIELD WIRING



NOTE:

1. The compressor alarms will not be energized by a unit fault, only the unit alarm will do so. Using the unit alarm and the circuit alarms will include all faults and also designate which compressor has an alarm.
2. Field wiring for optional BAS continued on next page.
3. The BAS interface modules and the remote display shown above are available as options.

System Maintenance

General

On initial start-up and periodically during operation, it will be necessary to perform certain routine service checks. Among these are checking the liquid line sight glasses, and the compressor oil level sight glass. In addition, check the MicroTech III controller temperature and pressure readings with gauges and thermometers to see that the unit has normal condensing and suction pressure and superheat and subcooling readings. A recommended maintenance schedule is located at the end of this section.

A Periodic Maintenance Log is located at the end of this manual. It is suggested that the log be copied and a report be completed on a regular basis. The log will serve as a useful tool for a service technician in the event service is required.

Initial start-up date, vibration readings, compressor megger readings and oil analysis information should be kept for reference base-line data.

Compressor Maintenance

The semi-hermetic compressor requires no yearly scheduled maintenance. Compressor vibration is an indicator of a possible problem requiring maintenance. It is recommended that the compressor be checked with a vibration analyzer at, or shortly after, start-up and again on an annual basis. The load should be maintained as closely as possible to the load of the original test. The initial vibration analyzer test provides a benchmark of the compressor, and when performed routinely, can give a warning of impending problems.

Lubrication

No routine lubrication is required on Pathfinder units. The fan motor bearings are permanently lubricated. No further lubrication is required. Excessive fan motor bearing noise is an indication of a potential bearing failure.

Compressor oil must be ICI RL68HB, McQuay Part Number 735030446 in a 1-gallon container. This is synthetic polyolester oil with anti-wear additives and is highly hygroscopic. Care must be taken to minimize exposure of the oil to air when charging oil into the system.

The oil charge is 6 gallons (23 liters) for all compressor sizes.

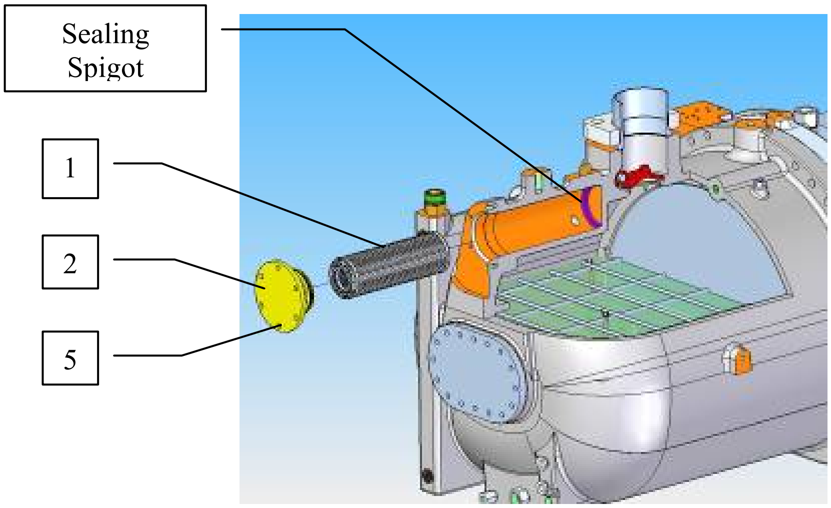
Oil Filter Removal and Renewal

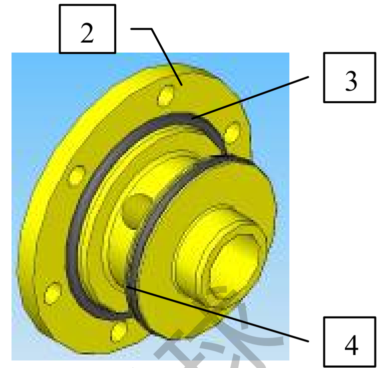
Fitting a New Oil Filter Element – Dismantling

Prior to this procedure, pump out the compressor; isolate the electrical supply to the control panels and compressor motor terminal.

⚠ WARNING

After the compressor has been pumped down and isolated, the oil contained inside the filter housing will remain hot enough to cause burns for some time afterwards. Always allow sufficient time for the oil to cool down so that it is cool enough not to be a danger when drained off (less than 35 °C is recommended). Severe injury from burns can result.





1	Oil Filter - 250mm
2	Oil Filter Housing Cover
3	O-Ring – 89.5x3
4	O-Ring – 76.1x3.4
5	M8 Bolts

- Unscrew and remove two hex head side cover bolts 180° apart. Insert M8 guide studs into the vacant holes.
- Remove remaining bolts, remove oil filter housing cover.
- Pull the oil filter off of the spigot and withdraw the oil filter from the housing and clean.
- Clean oil filter housing cover plate.

Fitting a New Oil Filter Element – Reassembly

Before assembly commences, remove any paint from joint faces. Inspect parts individually for damage, ensure they are completely clean before laying them out on a sheet of clean paper in a logical order ready for reassembly.

Use fresh refrigerant oil to lubricate parts during reassembly. New O-rings must be used.

- Insert new oil filter into the housing, ensuring the filter sits tightly on the sealing spigot.
- Replace the oil filter housing cover

Filter housing cover plate – 6xM8 Bolts

Removal of the filter housing cover

Remove filter and clean oil filter housing. Clean all other components. Replace the o-rings.

Electrical Terminals

⚠ DANGER

Electric equipment can cause electric shock which will cause severe personal injury or death. Turn off, lock out and tag all power before continuing with following service. Panels can have more than one power source.

⚠ CAUTION

Periodically check electrical terminals for tightness and tighten as required. Always use a back-up wrench when tightening electrical terminals.

Condensers

The condensers are air-cooled and constructed of 3/8" (9.5mm) OD internally finned copper tubes bonded in a staggered pattern into louvered aluminum fins. No maintenance is ordinarily required except the routine removal of dirt and debris from the outside surface of the fins. McQuay recommends the use of non-caustic, non-acidic, foaming coil cleaners available at most air conditioning supply outlets. Flush the coil from the inside out.

⚠ WARNING

Use caution when applying coil cleaners. They can contain potentially harmful chemicals. Wear breathing apparatus and protective clothing. Carefully follow the cleaner manufacturer's MSDS sheets. Thoroughly rinse all surfaces to remove any cleaner residue. Do not damage the fins during cleaning.

If the service technician has reason to believe that the refrigerant circuit contains noncondensables, recovery of the noncondensables will be required, strictly following Clean Air Act regulations governing refrigerant discharge to the atmosphere. The service Schrader valves are located on both vertical coil headers on both sides of the unit at the control box end of the coil. Access panels are located at the end of the condenser coil directly behind the control panel. Recover the noncondensables with the unit off, after shutdown of 15 minutes or longer, to allow air to collect at the top of the coil. Restart and run the unit for a brief period. If necessary, shut the unit off and repeat the procedure. Follow accepted environmentally sound practices when removing refrigerant from the unit.

Optional Compressor VFD

Inspection Area	Inspection Points	Corrective Action
General	Inspect equipment for discoloration from overheating or deterioration.	Replace damaged equipment as required.
	Inspect for dirt, foreign particles, or dust collection on components	Inspect door seal if so equipped. Use dry air to clear foreign matter
Conductors and Wiring	Inspect wiring and connections for discoloration, damage or heat stress.	Repair or replace damaged wire.
Terminals	Inspect terminals for loose, stripped, or damaged connections	Tighten loose screws and replace damaged screws or terminals.
Relays and Contactors	Inspect contactors and relay for excessive noise during operation	Check coil voltage for over or under voltage condition.
	Inspect coils for signs of overheating such as melted or cracked insulation.	Replace damaged removable relays, contactors or circuit board.

Liquid Line Sight Glass

Observe the refrigerant sight glasses weekly. A clear glass of liquid indicates that there is adequate refrigerant charge in the system to provide proper feed through the expansion valve.

Bubbling refrigerant in the sight glass, during stable run conditions, may indicate that there can be an electronic expansion valve (EXV) problem since the EXV regulates liquid subcooling. Refrigerant gas flashing in the sight glass could also indicate an excessive pressure drop in the liquid line, possibly due to a clogged filter-drier or a restriction elsewhere in the liquid line.

An element inside the sight glass indicates the moisture condition corresponding to a given element color. If the sight glass does not indicate a dry condition after about 12 hours of operation, the circuit should be pumped down and the filter-drier changed. An oil acid test is also recommended.

Do not use the sight glass on the EXV body for refrigerant charging. Its purpose is to view the position of the valve.

Lead-Lag

A feature on all Daikin McQuay Pathfinder air-cooled chillers is a system for alternating the sequence in which the compressors start to balance the number of starts and run hours. Lead-Lag of the refrigerant circuits is accomplished automatically through the MicroTech III controller. When in the auto mode, the circuit with the fewest number of starts will be started first. If all circuits are operating and a stage down in the number of operating compressors is required, the circuit with the most operating hours will cycle off first. The operator can override the MicroTech III controller, and manually select the lead circuit as circuit #1, #2 or #3.

Pump Operation

It is highly recommended that the chiller unit control the chilled water pump(s). The integral chiller control system has the capability to selectively start pump A or B or automatically alternate pump selection at each start and also has pump standby operation capability.

Failure to have the chiller control the pumps may cause the following problems:

1. If any device, other than the chiller, should try to start the chiller without first starting the pumps, the chiller will lock out on the no-flow alarm and require a manual reset to restart. This can be disruptive to the normal cooling process.
2. In areas where freeze-up is a concern, the chiller control senses the chilled water temperature and turns on an immersion heater in the evaporator. It also signals the chilled water pump to start ~~to~~ providing flow through the evaporator and additional protection against evaporator and outside pipe freeze-up . Other pump starting methods will not automatically provide this protection. Note: the owner/operator must be aware that when the water temperature falls below freezing temperatures it is imperative NOT to stop the pump(s) as immediate freeze-up can occur.

This method of freeze protection is only effective as long as the facility and the chiller have power. The only positive freeze protection during power failures is to drain the evaporator and blow out each tube or add the appropriate concentration of glycol to the system.

Preventative Maintenance Schedule

PREVENTATIVE MAINTENANCE SCHEDULE			
OPERATION	**WEEKLY**	**MONTHLY (Note 1)**	**ANNUAL (Note 2)**
General			
Complete unit log and review (Note 3)	X		
Inspect unit for loose or damaged components and visible leaks		X	
Inspect thermal insulation for integrity			X
Clean and paint as required			X
Electrical (* including the optional VFD)			
Sequence test controls *			X
Check contactors for pitting, replace as required *			X
Check terminals for tightness, tighten as necessary *			X
Clean control panel interior *			X
Clean control box fan filter (Note 7) *	X		
Visually inspect components for signs of overheating *		X	
Verify compressor and oil heater operation		X	
Megger compressor motor			X
Refrigeration/Lubricant			
Leak test		X	
Check liquid line sight glasses for clear flow	X		
Check compressor oil sight glass for correct level (lubricant charge)	X		
Check filter-drier pressure drop (see manual for spec)		X	
Check lubricant filter pressure drop (Note 6)		X	
Perform compressor vibration test			X
Perform oil analysis test on compressor oil			X
Condenser (air-cooled)			
Clean condenser coils (Note 4)			X
Check fan blades for tightness on shaft (Note 5)			X
Check fans for loose rivets and cracks, check motor brackets			X
Check coil fins for damage and straighten as necessary			X

Notes:

1. Monthly operations include all weekly operations.
2. Annual (or spring start-up) operations include all weekly and monthly operations.
3. Log readings can be taken daily for a higher level of unit observation.
4. Coil cleaning can be required more frequently in areas with a high level of airborne particles.
5. Be sure fan motors are electrically locked out.
6. Replace the filter if pressure drop exceeds 20 psi.
7. The weekly fan filter cleaning schedule can be modified to meet job conditions. It is important that the filter allows full air flow.

Appendix

Definitions

Active Setpoint

The active setpoint is the setting in effect at any given moment. This variation occurs on setpoints that can be altered during normal operation. Resetting the chilled water leaving temperature setpoint by one of several methods, such as return water temperature, is an example.

Active Capacity Limit

The active setpoint is the setting in effect at any given moment. Any one of several external inputs can limit a compressor's capacity below its maximum value.

Condenser Saturated Temperature Target

The saturated condenser temperature target is calculated by first using the following equation:

Sat condenser temp target raw = 0.833(evaporator sat temp) + 68.34

The "raw" value is the initial calculated value. This value is then limited to a range defined by the Condenser Saturated Temperature Target minimum and maximum setpoints. These setpoints simply cut off the value to a working range, and this range can be limited to a single value if the two setpoints are set to the same value.

Dead Band

The dead band is a range of values surrounding a setpoint such that a change in the variable occurring within the dead band range causes no action from the controller. For example, if a temperature setpoint is 44°F and it has a dead band of ± 2 degrees F, nothing will happen until the measured temperature is less than 42°F or more than 46°F.

DIN

Digital input, usually followed by a number designating the number of the input.

Error

In the context of this manual, "Error" is the difference between the actual value of a variable and the target setting or setpoint.

Evaporator Approach

The evaporator approach is calculated for each circuit. The equation is as follows:

Evaporator Approach = LWT – Evaporator Saturated Temperature

See page 38 for more details

Evap Recirc Timer

A timing function, with a 30-second default, that holds off any reading of chilled water for the duration of the timing setting. This delay allows the chilled water sensors (especially water temperatures) to take a more accurate reading of the chilled water system conditions.

EXV

Electronic expansion valve, used to control the flow of refrigerant to the evaporator, controlled by the circuit microprocessor.

High Saturated Condenser – Hold Value

High Cond Hold Value = Max Saturated Condenser Value – 5 degrees F

This function prevents the compressor from loading whenever the pressure approaches within 5 degrees of the maximum discharge pressure. The purpose is to keep the compressor online during periods of possibly temporary elevated pressures.

High Saturated Condenser – Unload Value

High Cond Unload Value = Max Saturated Condenser Value – 3 degrees F

This function unloads the compressor whenever the pressure approaches within 3 degrees of the maximum discharge pressure. The purpose is to keep the compressor online during periods of possibly temporary elevated pressures.

Light Load Stg Dn Point

The percent load point at which one of two operating compressors will shut off, transferring the unit load to the remaining compressor.

Load Limit

An external signal from the keypad, the BAS or a 4-20 ma signal that limits the compressor loading to a designated percent of full load. Frequently used to limit unit power input.

Load Balance

Load balance is a technique that equally distributes the total unit load among the running compressors on a unit or group of units.

Low Ambient Lockout

Prevents the unit from operating (or starting) at ambient temperatures below the setpoint.

Low Pressure Unload Setpoint

The psi evaporator pressure setting at which the controller will unload the compressor until a preset pressure is reached.

Low Pressure Hold Setpoint

The psi evaporator pressure setting at which the controller will not allow further compressor loading.

Low/High Superheat Error

The difference between actual evaporator superheat and the superheat target.

LWT

Leaving water temperature. The “water” is any fluid used in the chiller circuit.

LWT Error

Error in the controller context is the difference between the value of a variable and the setpoint. For example, if the LWT setpoint is 44°F and the actual temperature of the water at a given moment is 46°F, the LWT error is +2 degrees.

LWT Slope

The LWT slope is an indication of the trend of the water temperature. It is calculated by taking readings of the temperature every few seconds and subtracting them from the previous value, over a rolling one minute interval.

ms

Milli-second

Maximum Saturated Condenser Temperature

The maximum saturated condenser temperature allowed is calculated based on the compressor operational envelope.

OAT
Outside ambient air temperature

Offset
Offset is the difference between the actual value of a variable (such as temperature or pressure) and the reading shown on the microprocessor as a result of the sensor signal.

pLAN
Peco Local Area Network is the proprietary name of the network connecting the control elements.

Refrigerant Saturated Temperature
Refrigerant saturated temperature is calculated from the pressure sensor readings for each circuit. The pressure is fitted to an R-134a temperature/pressure curve to determine the saturated temperature.

Soft Load
Soft Loading is a configurable function used to ramp up the unit capacity over a given time period, usually used to influence building electrical demand by gradually loading the unit.

SP
Setpoint

SSS
Solid state starter as used on McQuay screw compressors.

Suction Superheat
Suction superheat is calculated for each circuit using the following equation:

Suction Superheat = Suction Temperature – Evaporator Saturated Temperature

See page 38 for details.

Stage Up/Down Accumulator
The accumulator can be thought of as a bank storing occurrences that indicate the need for an additional fan.

Stageup/Stagedown Delta-T
Staging is the act of starting or stopping a compressor or fan when another is still operating. Startup and Stop is the act of starting the first compressor or fan and stopping the last compressor or fan. The Delta-T is the “dead band” on either side of the setpoint in which no action is taken.

Stage Up Delay
The time delay from the start of the first compressor to the start of the second.

Startup Delta-T
Number of degrees above the LWT setpoint required to start the first compressor.

Stop Delta-T
Number of degrees below the LWT setpoint required for the last compressor to stop.

VDC
Volts, Direct current, sometimes noted as vdc.

McQuay Training and Development

Now that you have made an investment in modern, efficient McQuay equipment, its care should be a high priority. For training information on all McQuay HVAC products, please visit us at www.mcquay.com and click on Training, or call 540-248-9646 and ask for the Training Department.

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