Operating Manual

KOMAC00607-09EN

Date: **July 2009**

Supercedes: **None**

Control Panel

Air-Cooled Screw Chillers

AWS

50 Hertz

R-134a

CE

McQuay Air Conditioning

Table of Contents

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 McQuay AWS 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: This manual covers units with Software Version XXXXXXX The unit's software version number can be viewed by pressing the MENU and ENTER keys (the two right keys) simultaneously. Then, pressing the MENU key will return to the Menu screen.

BOOT Version: XXX

BIOS Version: XXX

⚠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, **55°C**
- Maximum operating ambient temperature is 46°C, 52°C for Premium Version
- Minimum operating ambient temperature (standard), 2°C
- Minimum operating ambient temperature (with optional low-ambient control), -18°C
- Leaving chilled water temperature, 4°C to 15°C
- Leaving chilled fluid temperatures (with anti-freeze), 3°C to -8°C. Unloading is not permitted with fluid leaving temperatures below -1°C.
- Operating Delta-T range, 4°C to 8°C
- Maximum operating inlet fluid temperature, 24°C
- Maximum non-operating inlet fluid temperature, 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 line, liquid line, 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. In addition, the operating conditions that existed just prior to an alarm shutdown can be recalled to aid in isolating the cause of the problem.

Twenty-five previous alarms and related operating conditions 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.

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

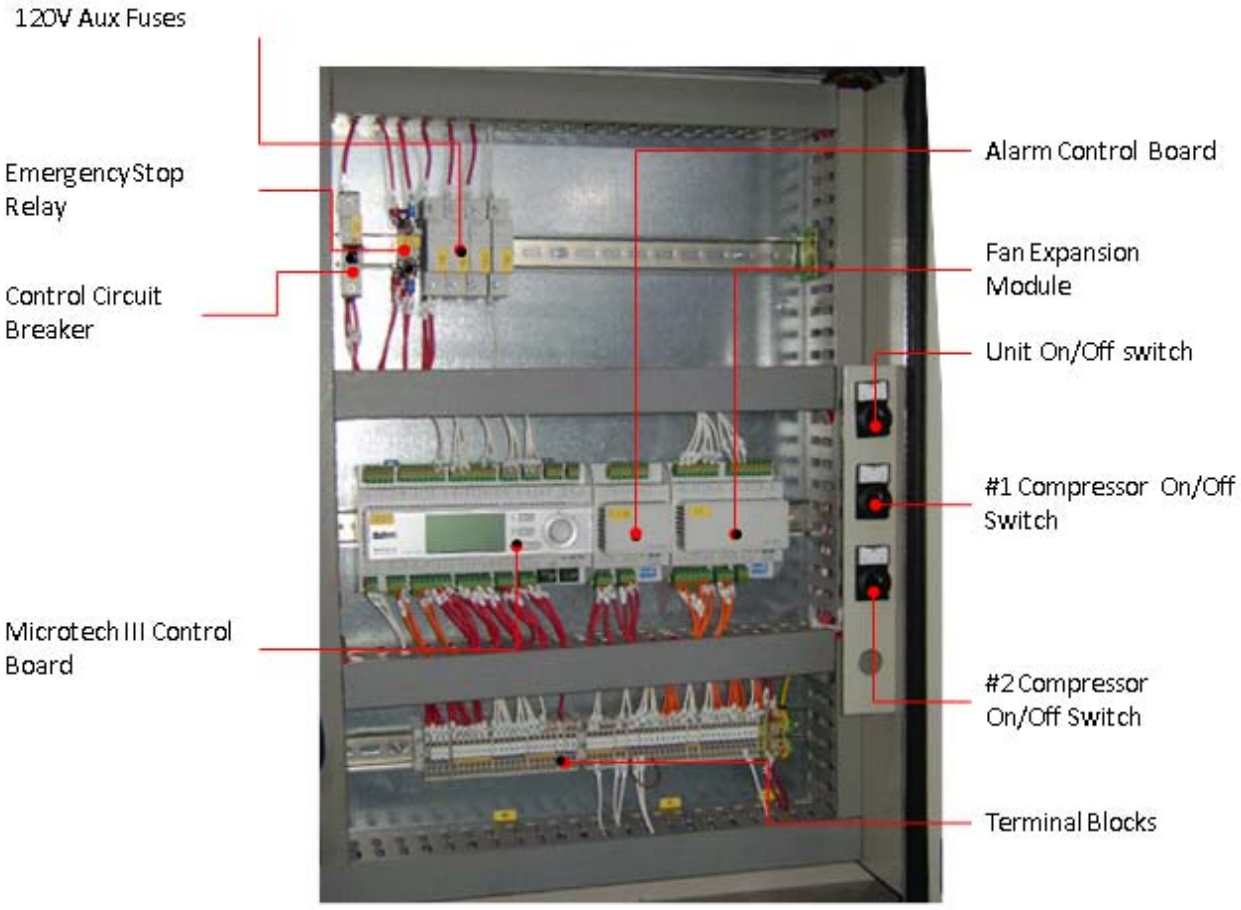
The MicroTech III control system consists of a microprocessor-based controller and a number of extension modules, which vary depending on the unit size and conformation. The control system provides the monitoring and control functions required for the controlled, efficient operation of the chiller.

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.

Control Panel Layout

Figure 1, Control Panel Components



NOTES:

1. The Emergency Switch Relay de-energizes circuit #1 #2 and #3 control power when activated, causing an immediate compressor and fan shutdown. The red emergency button switch is located on the bottom 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 extension) modules are located elsewhere on the chiller.

Power Panel Layout

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

Figure 2, Power Panel, Left Side

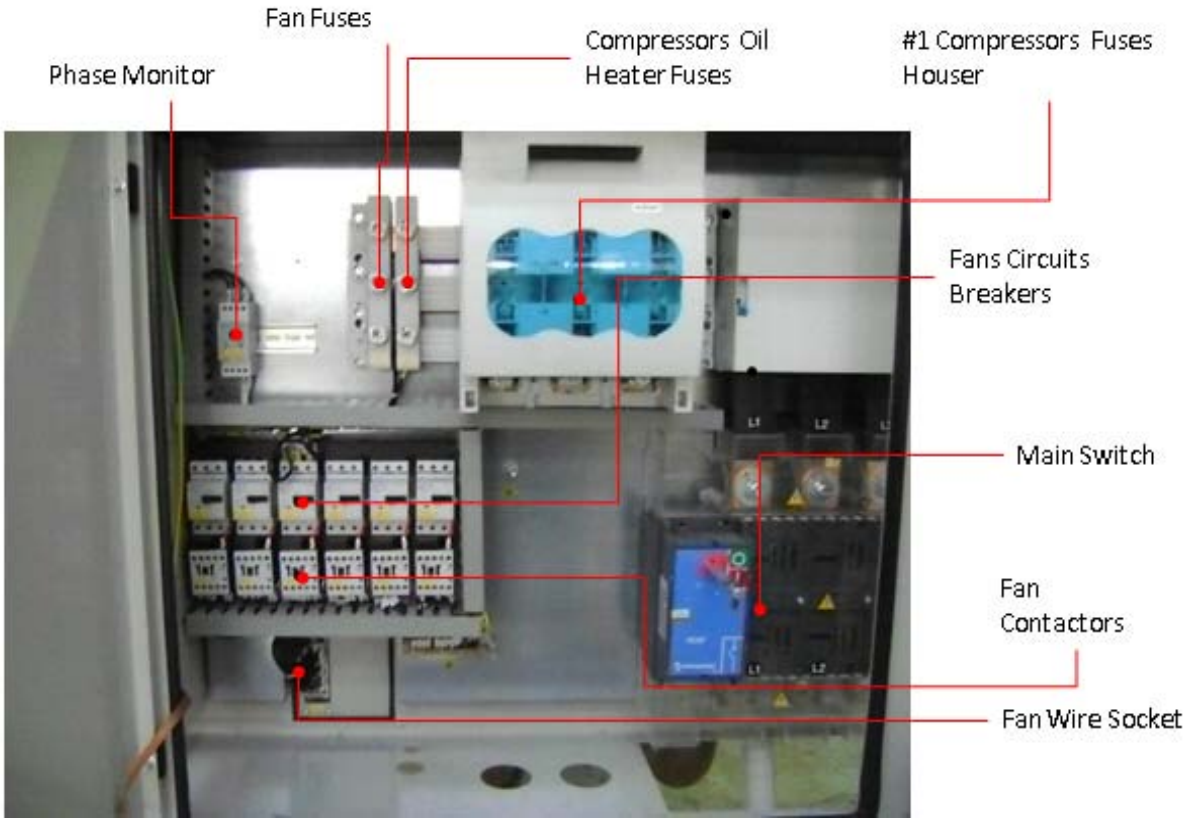
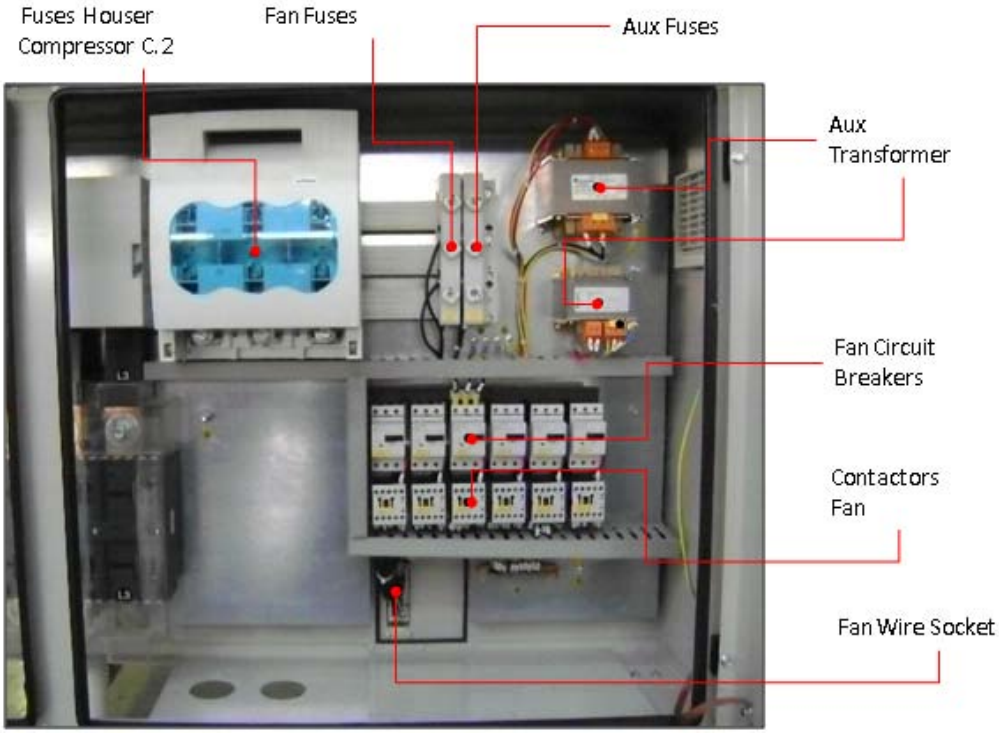


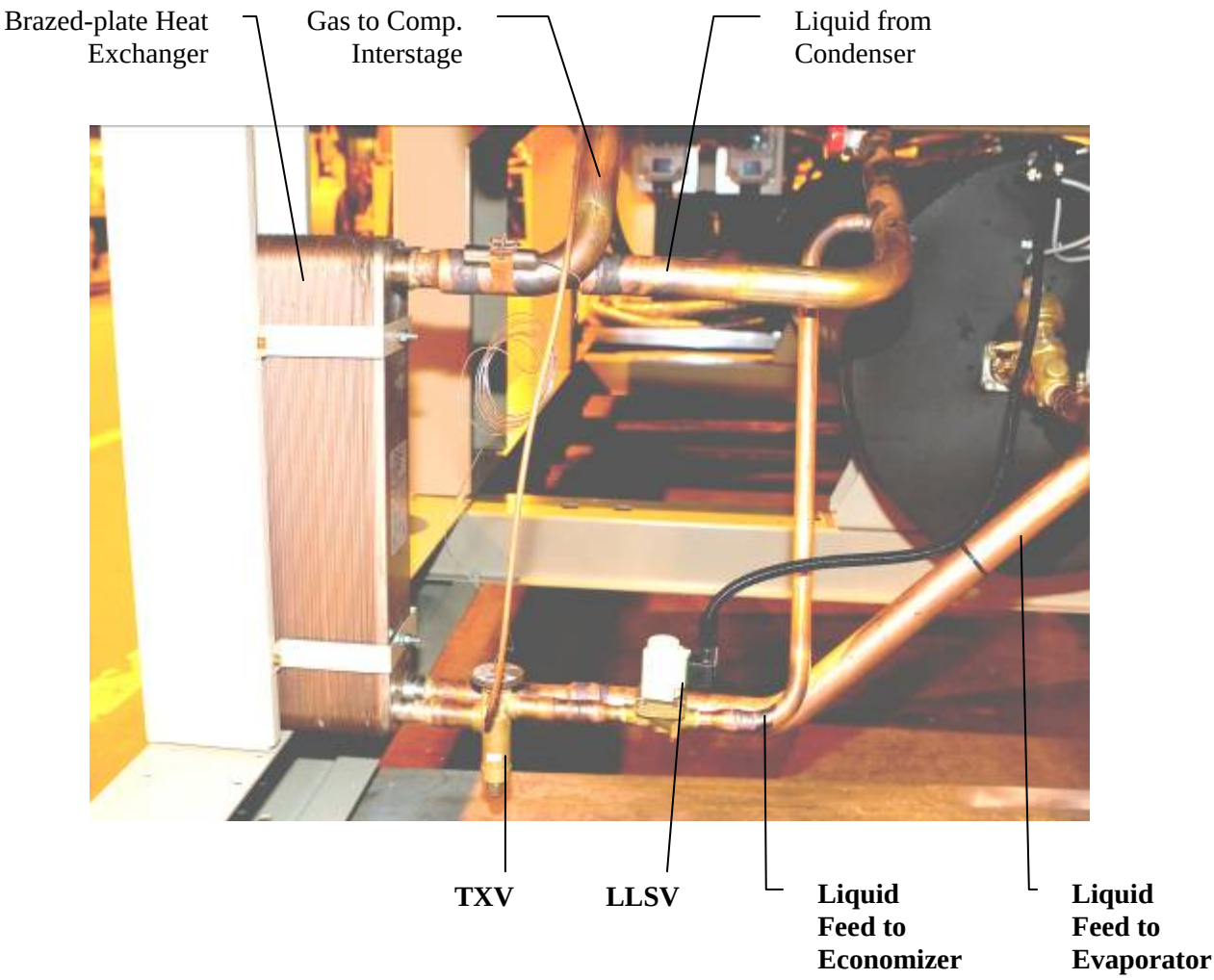
Figure 3, Power Panel, Right Side



Economizer Components

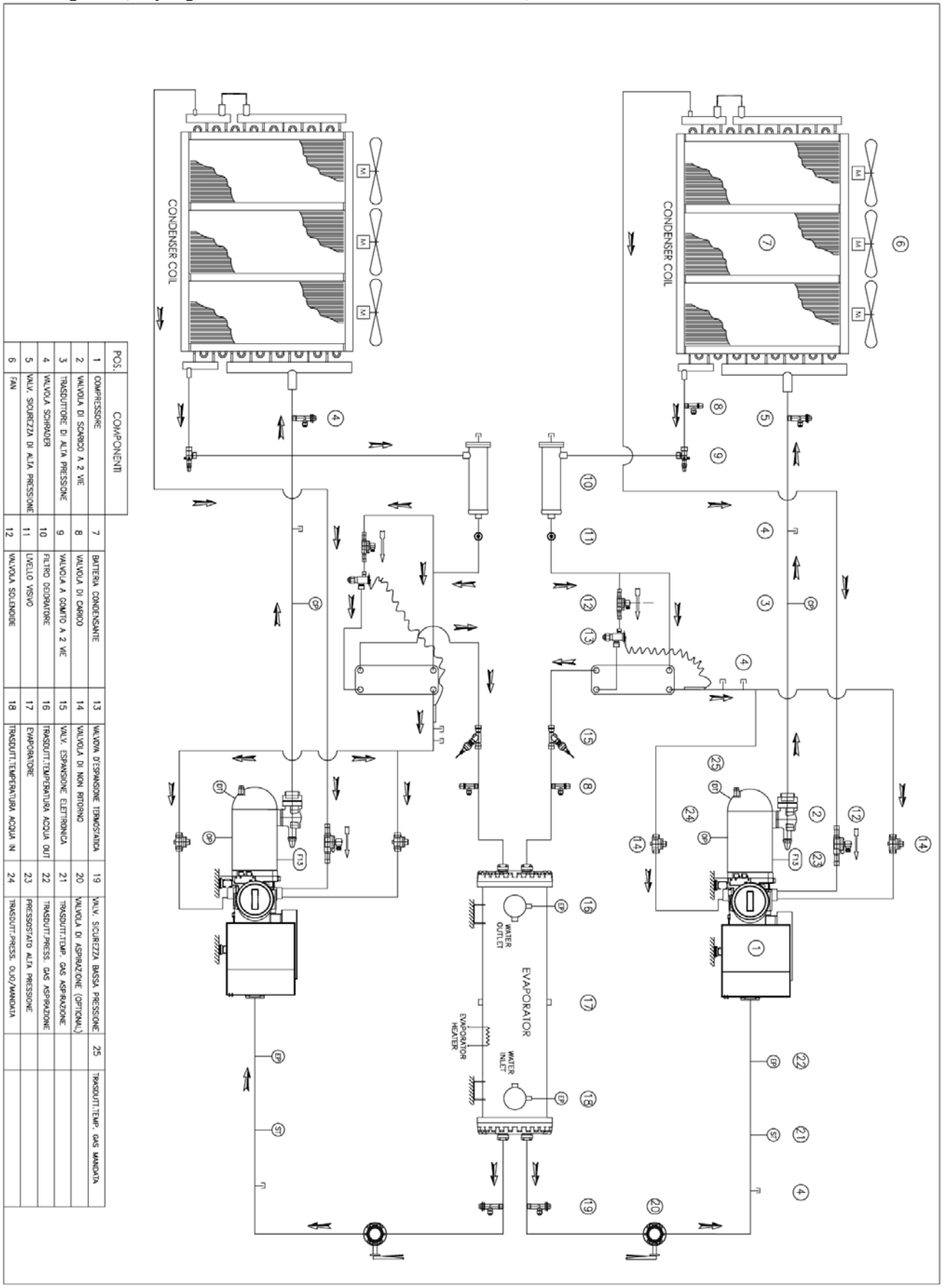
The chiller may or may not have economizers depending on design capacity requirements. An economizer is a well-proven device to increase a refrigerant circuit's capacity and to a lesser extent, its efficiency.

Figure 4, Economizer Components



Warm liquid from the condenser is feed 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 5, Piping Schematic with Economizer Circuit, One Circuit



POS.	COMPONENTI	POS.	COMPONENTI	POS.	COMPONENTI
1	COMPRESSORE	7	BATTERIA CONDENSANTE	13	VALVOLA D'ESPANSIONE TERMOSTATICA
2	VALVOLA DI SCARICO A 2 VIE	8	VALVOLA DI CARICO	14	VALVOLA DI NON RITORNO
3	TRASDUTTORE DI ALTA PRESSIONE	9	VALVOLA A GOMITO A 2 VIE	15	VALV. ESPANSIONE ELETTRONICA
4	VALVOLA SCHRADER	10	FILTRO DEIDRATORE	16	TRASDUTT.TEMPERATURA ACQUA OUT
5	VALV. SICUREZZA DI ALTA PRESSIONE	11	LIVELLO VISIVO	17	EVAPORATORE
6	FAN	12	VALVOLA SOLENOIDE	18	TRASDUTT.TEMPERATURA ACQUA IN

POS.	COMPONENTI
19	VALV. SICUREZZA BASSA PRESSIONE
20	VALVOLA DI ASPIRAZIONE (OPTIONAL)
21	TRASDUTT.TEMP. GAS ASPIRAZIONE
22	TRASDUTT.PRESS. GAS ASPIRAZIONE
23	PRESSOSTATO ALTA PRESSIONE
24	TRASDUTT.PRESS. OLIO/MANOMATA
25	TRASDUTT.TEMP. GAS MANDATA

Hardware Structure

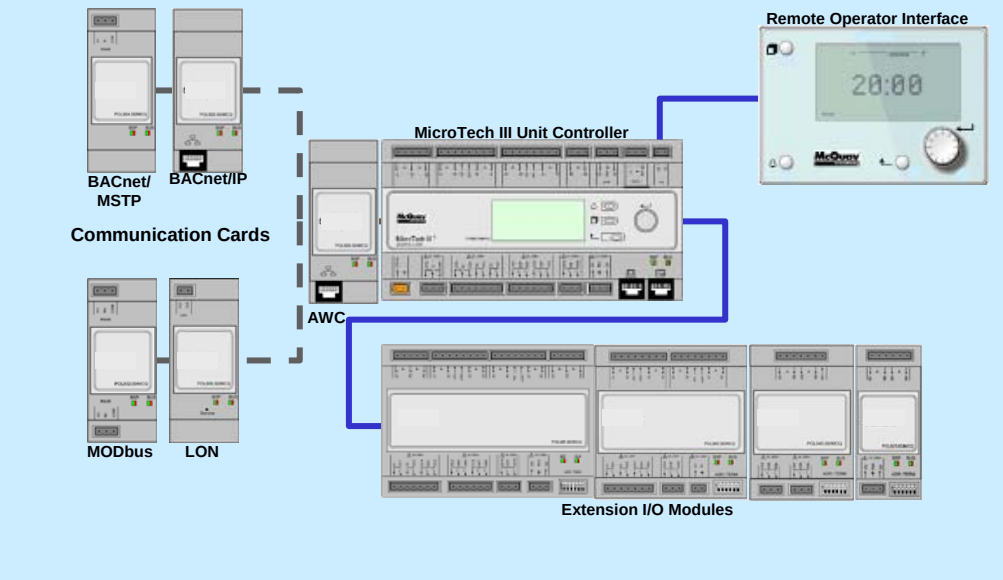
The MicroTech III control system for AWS chillers consists of a main unit controller with a number of extension I/O modules attached depending on the chiller size and configuration.

One of the optional BAS communication modules may be included.

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

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

Figure 6, hardware structure

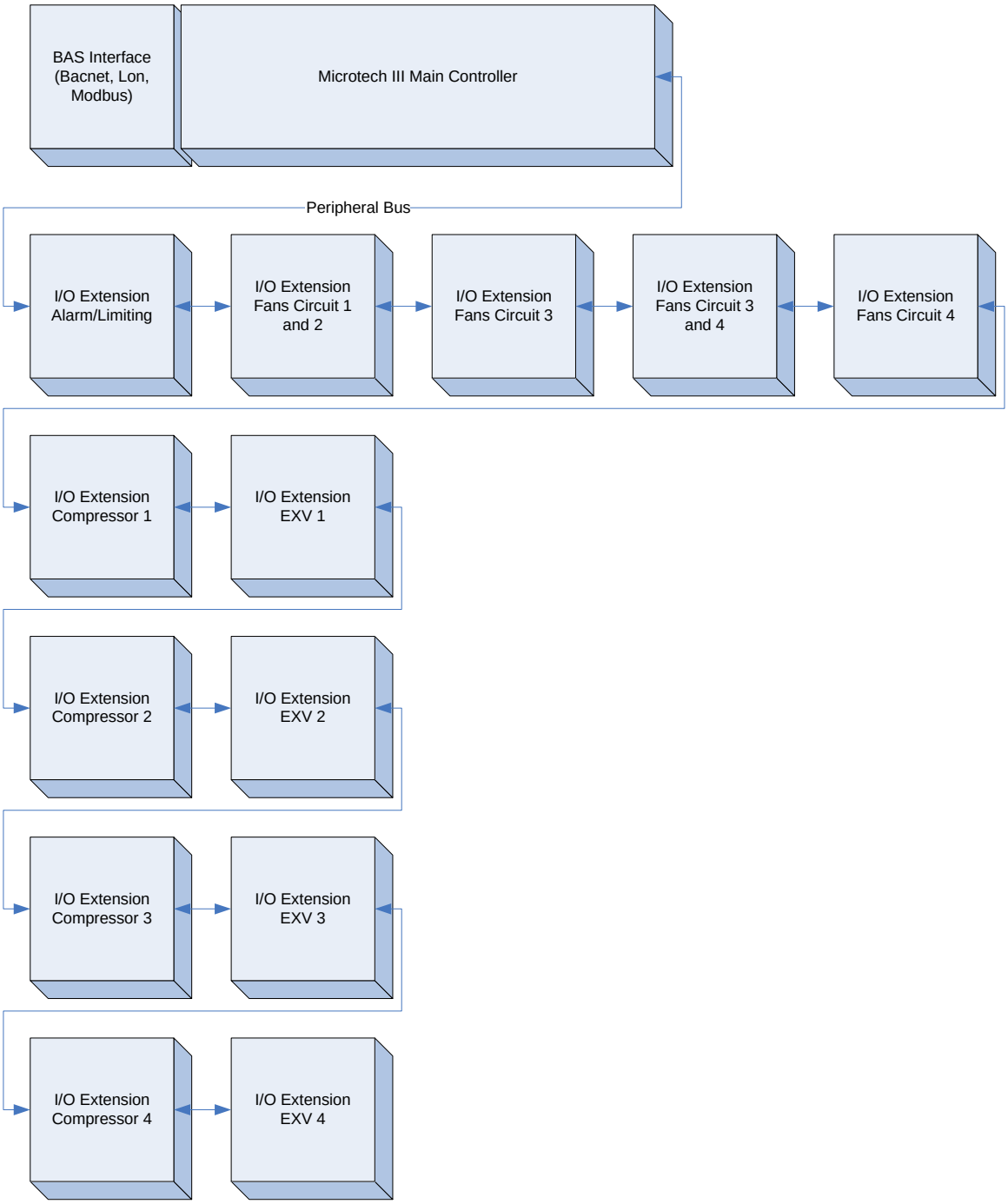


System Architecture

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

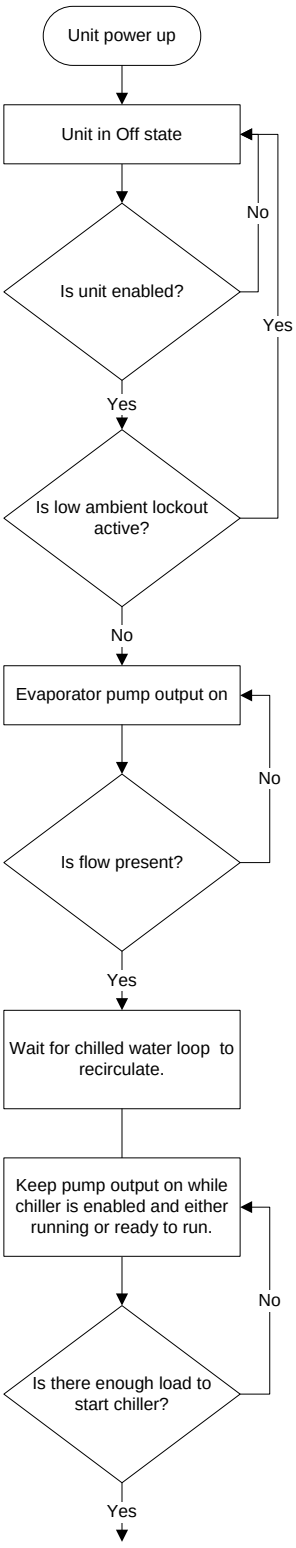
Figure 6, System Architecture



Sequence of Operation

Figure 7, Unit Sequence of Operation (see Figure 9 for circuit 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**.

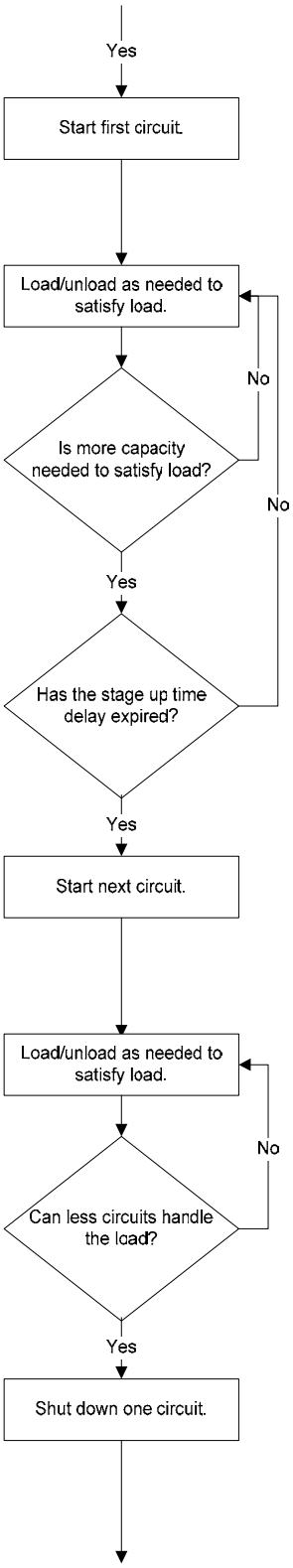
If the chiller is enabled, then the unit will be in the Auto state and the evaporator water pump output will be activated.

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.

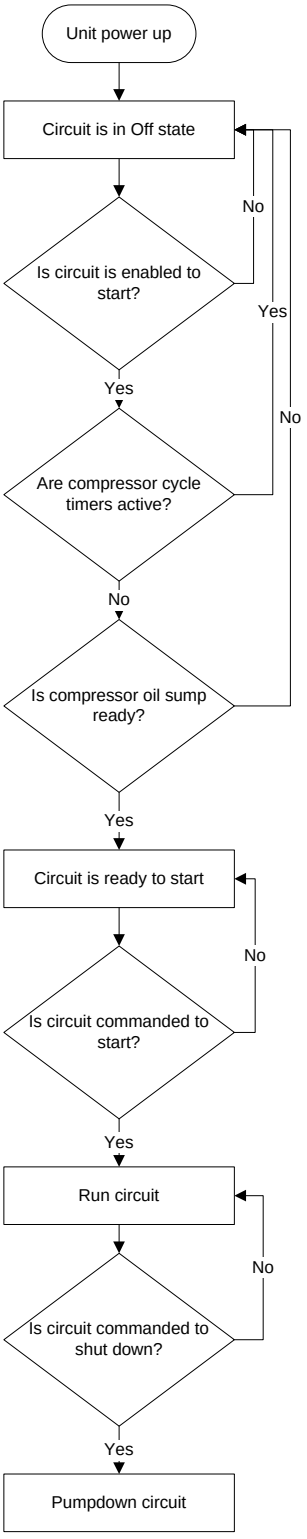
All running circuits will now be loaded/unloaded as needed to satisfy the load. When possible, they will load balance so that running circuits are providing nearly equal capacity.

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.

Figure 8, Circuit 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

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 Set Point/ 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

Extension I/O Compressor #1 to #3

Analog Inputs

#	Description	Signal Source	Expected Range
X1	Discharge Temperature	NTC Thermister (10K@25°C)	-50°C – 120°C
X2	Evaporator Pressure	Ratiometric (0,5-4,5 Vdc)	0 to 5 Vdc
X3	Oil Pressure	Ratiometric (0,5-4,5 Vdc)	0 to 5 Vdc
X4	Condenser Pressure	Ratiometric (0,5-4,5 Vdc)	0 to 5 Vdc
X7	Motor Protection	PTC Thermistor	n/a

Analog Outputs

#	Description	Output Signal	Range
Not Needed			

Digital Inputs

#	Description	Signal Off	Signal On
X6	Starter Fault	Fault	No fault
DI1	High Pressure Switch	Fault	No fault

Digital Outputs

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	Liquid Injection	Solenoid Closed	Solenoid Open
DO5	Modulating Slide Load	Solenoid Closed	Solenoid Open
DO6	Modulating Slide Unload	Solenoid Closed	Solenoid Open
X5	Spare		
X8	Spare		

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

Analog Outputs

#	Description	Output Signal	Range
Not Needed			

Digital Inputs

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

Digital Outputs

#	Description	Output Off	Output On
DO1	Liquid Line (optional)	Solenoid Closed	Solenoid Open (optional)

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 (POL)

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 set points is determined by the Global HMI (Human Machine Interface) Standard Specification.

Table 1, Setpoint Value and Range

Description	Default		Range
Unit	**Ft/Lb**	**SI**	
Manufacturing Location	Not Selected		Not Selected, Europe, USA
Unit Enable	OFF		OFF, ON
Unit Status after Power Failure	OFF		OFF, ON
Control source	Local		Local, Network
Available Modes	Cool		COOL COOL/w GLYCOL COOL/ICE w GLYCOL ICE TEST
Cool LWT 1	44 °F	7 °C	See section 0
Cool LWT 2	44 °F	7 °C	See section 0
Ice LWT	25 °F	-4 °C	20 to 38°F / -8 to 4 °C
Startup Delta T	5 °F	2,7 °C	0 to 10 °F / 0 to 5 °C
Shut Down Delta T	2.7 °F	1.5 °C	0 to 3 °F / 0 to 1,7 °C
Stage Up Delta T (between compressors)	2 °F	1 °C	0 to 3 °F / 0 to 1,7 °C
Stage Down Delta T (between compressors)	1 °F	0,5 °C	0 to 3 °F / 0 to 1,7 °C
Max Pulldown	3 °F/min	1,7 °C/min	0.5-5.0 °F /min / 0,3 to 2,7 °C/min
Evap Recirc Timer	30		0 to 300 seconds
Evap Control	#1 Only		#1 Only, #2 Only, Auto, #1 Primary, #2 Primary
LWT Reset Type	NONE		NONE, RETURN, 4-20mA, OAT
Max Reset	10 °F	5 °C	0 to 20 °F / 0 to 10 °C
Start Reset Delta T	10 °F	5 °C	0 to 20 °F / 0 to 10 °C
Start Reset OAT	75°F	23.8°C	50°F - 85°F / 10.0 – 29.4°C
Max Reset OAT	60°F	15.5°C	50°F - 85°F / 10.0 – 29.4°C
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 Limit	Off		Off, On
Current @ 20mA	800 Amp		0 to 2000 Amp = 4 to 20 mA
Current limit Set Point	800 Amp		0 to 2000 Amp
# of Circuits	2		2-3-4
Ice Time Delay	12		1-23 hours

Continued next page.

Description	Default		Range
Unit	**Ft/Lb**	**SI**	
Clear Ice Timer	No		No,Yes
SSS Communication	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 Condenser Offset	10.0 °F	5 °C	0.0 to 25.0 °F
BAS Protocol	None		None, BACnet, LonWorks, Modbus
Ident number	1		0-????
Baud Rate	19200		1200,2400,4800,9600,19200
Evap LWT sensor offset	0°F	0°C	-5.0 to 5.0°C / -9.0 to 9.0°F
Evap EWT sensor offset	0°F	0°C	-5.0 to 5.0°C / -9.0 to 9.0°F
OAT sensor offset	0°F	0°C	-5.0 to 5.0°C / -9.0 to 9.0°F
Compressors-Global	**Ft/Lb**	**SI**	
Start-start timer	20 min		15-60 minutes
Stop-start timer	5 min		3-20 minutes
Pumpdown Pressure	14,3 PSI	100 kPa	10 to 40 PSI / 70 to 280 kPa
Pumpdown Time Limit	120 sec		0 to 180 sec
Light Load Stg Dn Point	50%		20 to 50%
Load Stg Up Point	50%		50 to 100%
Stage Up Delay	5 min		0 to 60 min
Stage Down Delay	3 min		3 to 30 min
Stage Delay Clear	No		No, Yes
Max # Comps Running	4		1-4
Sequence # Cir 1	1		1-4
Sequence # Cir 2	1		1-4
Sequence # Cir 3	1		1-4
Number of Pulses 10% to 50%	10		10 to 20
Slide Load Delay Mininum	30 seconds		10 to 60 seconds
Slide Load Delay Maximum	150 seconds		60 to 300 seconds
Slide Unload Delay Minimum	10 seconds		5 to 20 seconds
Slide Unload Delay Maximum	50 seconds		30 to 75 seconds
Liquid Injection Activation	185°F	85°C	75 to 90°C
Liquid Line Solenoid Valves	No		No, Yes
Alarm Limits			
Low Evap Pressure-Unload	23.2 PSI	160 kPa	See section 0
Low Evap Pressure-Hold	27.5 PSI	190 kPa	See section 0
Oil Press Delay	30 sec		10-180 sec

Continued next page.

Description	Default		Range
Unit	**Ft/Lb**	**SI**	
Oil Press Differential	35 PSI	250 kPa	0-60 PSI / 0 to 415 kPa
Low Oil Level Delay	120 sec		10 to 180 sec
High Discharge Temperat.	230 °F	110 °C	150 to 230 °F / 65 to 110 °C
High Lift Pressure Delay	5 sec		0 to 30 sec
Low Pressure Ratio Delay	90 sec		30-300 sec
Start Time Limit	60 sec		20 to 180 sec
Evaporator Water Freeze	36 °F	2,2 °C	See section 0
Evaporator Flow Proof	15 sec		5 to 15 sec
Recirculate Timeout	3 min		1 to 10 min
Low Ambient Lockout Enable	Disable		Disable, Enable
Low Ambient Lockout	55 °F	12°C	See section 0

The following set points exist individually for each circuit:

Description	Default		Range	PW
	Ft/Lb	**SI**		
Circuit mode	Enable		Disable, enable, test	S
Compressor Size	To be Verified			M
Capacity Control	Auto		Auto, Manual	S
Manual Capacity	*See note 1 below table*		0 to 100%	S
Clear Cycle Timers	No		No, yes	M
EXV control	Auto		Auto, manual	S
EXV position	*See note 2 below table*		**0% to 100%**	S
Oil Sump Check	Enable		Enable, Disable	S
Service Pumpdown	No		No,Yes	S
Evap pressure offset	0PSI	0kPa	-14.5 to 14.5 PSI /-100 to 100 kPa	S
Cond pressure offset	0PSI	0kPa	-14.5 to 14.5 PSI /-100 to 100 kPa	S
Oil pressure offset	0PSI	0kPa	-14.5 to 14.5 PSI /-100 to 100 kPa	S
Suction temp offset	0°F	0°C	-5.0 to 5.0 deg	S
Discharge temp offset	0°F	0°C	-5.0 to 5.0 deg	S
Fans				
Fan VFD enable	On		Off, On	M
Number of fans	5		5 to 12	M
Saturated Condenser Temp Target Min	90 °F	32°C	80.0-110.0 °F / 26.0 to 43.0 °C	M
Saturated Condenser Temp Target Max	110 °F	43°C	90.0-120.0 °F / 32.0 to 50 °C	M
Fan Stage Up Deadband 0	5 °F	2.5 °C	1-20 °F / 1-10 °C	M
Fan Stage Up Deadband 1	5 °F	2.5 °C	1-20 °F / 1-10 °C	M
Fan Stage Up Deadband 2	8 °F	4 °C	1-20 °F / 1-10 °C	M
Fan Stage Up Deadband 3	10 °F	5 °C	1-20 °F / 1-10 °C	M
Fan Stage Up Deadband 4	8 °F	4 °C	1-20 °F / 1-10 °C	M
Fan Stage Up Deadband 5	8 °F	4 °C	1-20 °F / 1-10 °C	M
Fan Stage Down Deadband 2	8 °F	4 °C	1-25 °F / 1-13 °C	M
Fan Stage Down Deadband 3	7 °F	3.5 °C	1-25 °F / 1-13 °C	M
Fan Stage Down Deadband 4	6 °F	3 °C	1-25 °F / 1-13 °C	M
Fan Stage Down Deadband 5	5 °F	2.5 °C	1-25 °F / 1-13 °C	M
Fan Stage Down Deadband 6	5 °F	2.5 °C	1-25 °F / 1-13 °C	M
VFD Max Speed	100%		90 to 110%	M
VFD Min Speed	25%		20 to 60%	M

Note 1 – This value will follow the actual capacity while Capacity Control = Auto.
Note 2 – This value will follow the actual EXV position while EXV Control = Auto.

Auto Adjusted Ranges

Some settings have different ranges of adjustment based on other settings.

Cool LWT 1 and Cool LWT 2

Available Mode Selection	Range Imp.	Range SI
Without Glycol	40 to 60°F	4 to 15 °C
With Glycol	25 to 60°F	-4 to 15 °C

Evaporator Water Freeze

Available Mode Selection	Range Imp.	Range SI
Without Glycol	36 to 42°F	2 to 6 °C
With Glycol	0 to 42°F	-18 to 6 °C

Low Evaporator Pressure - Hold

Available Mode Selection	Range Imp.	Range SI
Without Glycol	28 to 45 PSIG	195 to 310 kPa
With Glycol	0 to 45 PSIG	0 to 310 kPa

Low Evaporator Pressure - Unload

Available Mode Selection	Range Imp.	Range SI
Without Glycol	26 to 45 Psig	180 to 310 kPa
With Glycol	0 to 45 Psig	0 to 410 kPa

Low Ambient Lockout

Fan VFD	Range Imp.	Range SI
= no for all circuits	35 to 60°F	2 to 15 °C
= yes on any circuit	-10 to 60°F	-23 to 15 °C

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:

VFD is Enabled	
Setpoint	**Default loaded (°F)**
Stage 2 On Deadband	5
Stage 3 On Deadband	8
Stage 4 On Deadband	10
Stage 5 On Deadband	8
Stage 6 On Deadband	8
Stage 7 On Deadband	8
Stage 8 On Deadband	8
Stage 2 Off Deadband	8
Stage 3 Off Deadband	7
Stage 4 Off Deadband	6
Stage 5 Off Deadband	5
Stage 6 Off Deadband	5
Stage 7 Off Deadband	5
Stage 8 Off Deadband	5

VFD is Disabled	
Setpoint	**Default loaded (°F)**
Stage 1 On Deadband	8
Stage 2 On Deadband	10
Stage 3 On Deadband	11
Stage 4 On Deadband	12
Stage 5 On Deadband	13
Stage 6 On Deadband	13
Stage 7 On Deadband	13
Stage 8 On Deadband	13
Stage 2 Off Deadband	20
Stage 3 Off Deadband	16
Stage 4 Off Deadband	11
Stage 5 Off Deadband	8
Stage 6 Off Deadband	8
Stage 7 Off Deadband	8
Stage 8 Off Deadband	8

Unit Functions

Calculations

LWT Slope

LWT slope is calculated such that the slope represents the change in LWT over a time frame of one minute with at least five samples per minute.

Pulldown Rate

The slope value calculated above will be a negative value as the water temperature is dropping. For use in some control functions, the negative slope is converted to a positive value by multiplying by –1.

Unit Enable

Enabling and disabling the chiller is accomplished using set points and inputs to the chiller. The unit switch, remote switch input, and Unit Enable Set Point 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.

Unit Switch	Control Source Set Point	Remote Switch Input	Unit Enable Set Point	BAS Request	Unit Enable
Off	x	x	x	x	Off
x	x	x	Off	x	Off
x	x	Off	x	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 Set Point will be initialized to ‘off’ if the Unit Status After Power Failure Set Point is set to ‘off’.

Unit Mode Selection

The operating mode of the unit is determined by setpoints and inputs to the chiller. The Available Modes Set Point determines what modes of operation can be used. This setpoint also determines whether the unit is configured for glycol use. The Control Source Set Point 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 Set Point 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.
NOTE: An "x" indicates that the value is ignored.

Control Source Set Point	Mode Input	BAS Request	Available Modes Set Point	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

Glycol Configuration

If the Available Modes Set Point 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 Set Point 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.

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

- A manual reset unit alarm is active
- All circuits are unavailable to start (cannot start even after any cycle timers have expired)
- The unit mode is ice, all circuits are off, and the ice mode delay is active

The unit will be in the Auto state if any of the following are true:

- Unit enabled based on settings and switches
- If unit mode is ice, the ice timer has expired
- No manual reset unit alarms are active
- At least one circuit is enabled and available to start
- Low OAT Lockout is not active

The unit will 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 0
- Low OAT Lockout is triggered

Unit Status

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

Enum	Status	Conditions
0	Auto	Unit State = Auto
1	Off:Ice Mode Timer	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:Emergency Stop	Unit State = Off and Emergency Stop Input is open
5	Off:Unit Alarm	Unit State = Off and Unit Alarm active
6	Off:Keypad Disable	Unit State = Off and Unit Enable Set Point = Disable
7	Off:Remote Switch	Unit State = Off and Remote Switch is open
8	Off:BAS Disable	Unit State = Off, Control Source = Network, and BAS Enable = false
9	Off:Unit Switch	Unit State = Off and Unit Switch = Disable
10	Off:Test Mode	Unit State = Off and Unit Mode = Test
11	Auto:Noise Reduction	Unit State = Auto and Noise Reduction is active
12	Auto:Wait for load	Unit State = Auto, no circuits running, and LWT is less than the active set point + startup delta
13	Auto:Evap Recirc	Unit State = Auto and Evaporator State = Start
14	Auto:Wait for flow	Unit State = Auto, Evaporator State = Start, and Flow Switch is open
15	Auto:Pumpdown	Unit State = Pumpdown
16	Auto:Max Pulldown	Unit State = Auto, max pulldown rate has been met or exceeded
17	Auto:Unit Cap Limit	Unit State = Auto, unit capacity limit has been met or exceeded
18	Auto:Current Limit	Unit State = Auto, unit current limit has been met or exceeded

Ice Mode Start 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 set point 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

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

- Off - No pump on.
- Start – Pump is on, water loop is being recirculated.
- Run – Pump is on, water loop has been recirculated.

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

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

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

- The unit state is auto
- LWT is less than the Evap Freeze set point minus 0.6 °C and LWT sensor fault isn’t active

- EWT is less than the Evap Freeze set point minus 0.6 °C and EWT sensor fault isn't active

The control state is Run when the flow switch input has been closed for a time greater than the Evaporator Recirculate set point.

Pump Selection

The pump output used is determined by the Evap Pump Control set point. 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 pump designated as primary will start first. If the evaporator state is start for a time greater than the recirculate timeout set point and there is no flow, then the primary pump will shut off and the standby pump will start. When the evaporator is in the run state, if flow is lost for more than half of the flow proof set point value, the primary pump will shut off and the standby pump will start. Once the standby pump is started, the flow loss alarm logic will apply if flow cannot be established in the evaporator start state, or if flow is lost in the evaporator run state.

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 enabled only when the Noise Reduction set point is enable. Noise Reduction is in effect when enabled via the set point, the unit mode is cool, and the unit controller clock time is between the Noise Reduction start time and end time.
When Noise Reduction is in effect, the Maximum Reset is applied to the cool LWT set point. 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:

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

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 set point.

When the active reset increases, the Active LWT Target is changed at a rate of 0.1 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.

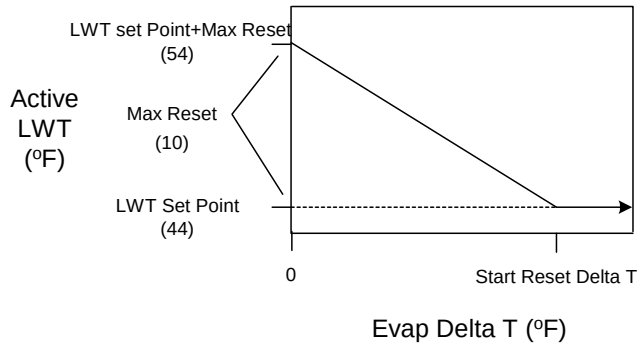
Reset Type – None

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

Reset Type – Return

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

Return Reset



The active set point is reset using the following parameters:

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

Reset varies from 0 to Max Reset set point 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

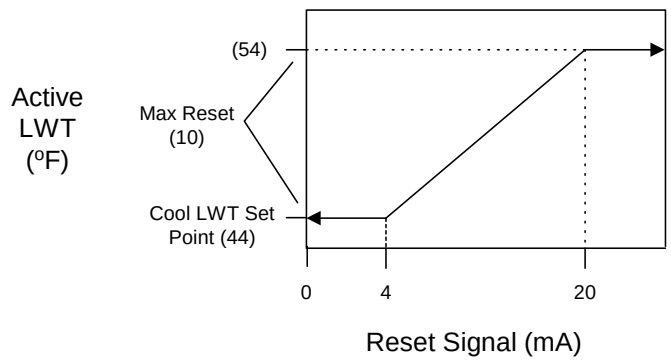
The Active Leaving Water variable is adjusted by the 4 to 20 mA reset analog input.

Parameters used:

1. Cool LWT set point
2. Max Reset set point
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 set point 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



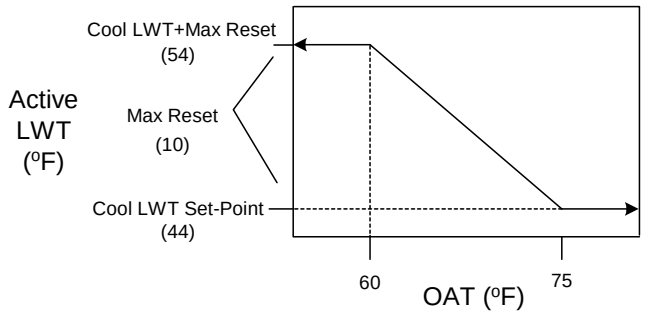
Outside Air Temperature (OAT) Reset

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

1. Cool LWT set point
2. Max Reset set point
3. OAT

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

OAT Reset



Unit Capacity Control

Unit capacity control is performed as described in this section.

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 set point.

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

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

The last compressor running will shut down when the evaporator LWT is lower than the target minus the Shut Down Delta T set point.

Stage Up Delay

A minimum amount of time will pass between compressors starting, which is defined by the Stage Up Delay set point. 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 set point, 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 set point and the evaporator LWT is less than the target plus the Stage Up Delta T set point. A minimum amount of time will pass between compressors stopping as a result of this logic, which is defined by the Stage Down Delay set point.

Maximum Circuits Running

If the number of compressors running is equal to the Max Circuits Running set point, 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 set point.

Compressor Staging in Ice Mode

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

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 set point.

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.

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 be the lowest numbered compressor

Compressor Capacity Control In Cool Mode

In Cool mode, evaporator LWT is controlled to within 0.4 degrees F of the target under constant flow conditions by controlling capacity of the individual compressors.

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 set point 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 highest sequence number of the compressors that are running
- if the sequence numbers are equal, it must have the least run hours
- if run hours are equal, it must have the most starts
- if starts are equal, it must be the highest 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 can be 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%.
- For 4 circuit units, the deadband is 4%.

Soft Load

Soft Loading is a configurable function used to ramp up the unit capacity over a given time. The set points 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 at the unit controller. This function is only enabled if the Demand Limit set point is set to ON.

As the signal varies from 4 mA up to 20 mA, the maximum unit capacity changes by steps of 1% from 100% to 0%. 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.

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 closed.

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 set point. 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 set point.

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 10% of the current limit.

Maximum LWT Pulldown Rate

The maximum rate at which the leaving water temperature can drop is limited by the Maximum Rate set point, only when the LWT is less than 60°F (15°C).

If the pulldown rate is too fast, the unit capacity is reduced until the rate is less than the Maximum Pulldown Rate set point.

High Water Temperature Capacity Limit

If the evaporator LWT exceeds 65°F, compressor load will be limited to a maximum of 75%. Compressors will unload to 75% or less if running at greater than 75% load when the LWT exceeds the limit. This feature is to keep the circuit running within the capacity of the condenser coil.
A dead-band placed below the limit set-point will be used to increase function stability. If the actual capacity is in the band, unit loading will be inhibited.

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 0.1 C for pressure inputs from 0 kPa to 2070kPa,
-within 0.2 C for pressure inputs from -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

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

Otherwise, Max Sat Cond Temp = 68.3°C

High Saturated Condenser – Hold Value

High Cond Hold Value = Max Saturated Condenser Value – 2.78°C

High Saturated Condenser – Unload Value

High Cond Unload Value = Max Saturated Condenser Value – 1.67°C

Condenser Saturated Temperature Target

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

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

This value is then limited to a range defined by the Condenser Saturated Temperature Target min and max set points. These set points simply cut off the value to a working range, and this range can be limited to a single value if the two set points 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 set point is set to Enable
- BAS Circuit Mode set point is set to Auto
- No cycle timers are active
- Discharge Temperature is at least 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 set point is set to Enable
- BAS Circuit Mode set point 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 set point, the startup is complete.

If the pressure does not rise above the unload set point and the circuit has been running longer than the Startup Time set point, 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 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, the Low OAT Restart alarm is triggered, or the unit time clock shows that a new day has started.

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 set point is set to Disable
- BAS Circuit Mode set point is set to Off

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

- Evaporator Pressure is less than the Pumpdown Pressure set point
- Service Pumpdown set point is set to Yes and Evaporator Pressure is less than 5 psi
- 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:

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:Keypad Disable	Circuit is off and cannot start due to keypad disable.
4	Off:Circuit Switch	Circuit is off and circuit switch is off.
5	Off:Refr In Oil Sump	Circuit is off and Discharge Temperature – Oil Saturated Temperature at gas pressure <= 5°C
6	Off:Alarm	Circuit is off and cannot start due to active circuit alarm.
7	Off:Test Mode	Circuit is in test mode.
8	EXV Preopen	Circuit is in preopen state.
9	Run:Pumpdown	Circuit is in pumpdown state.
10	Run:Normal	Circuit is in run state and running normally.
11	Run:Disc SH Low	Circuit is running and cannot load due to low discharge superheat.
12	Run:Evap Press Low	Circuit is running and cannot load due to low evaporator pressure.
13	Run:Cond Press High	Circuit is running and cannot load due to high condenser pressure.

Compressor Control

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

Cycle Timers

A minimum time between starts of the compressor and a minimum time between shutdown and start of the compressor will be enforced. The time values are set by global circuit set points.

These cycle timers are enforced even through cycling of power to the chiller.

These timers may be cleared via a setting on the controller.

Compressor Run Timer

When a compressor starts, a timer will start and run as long as the compressor runs. This timer is used in the alarm log.

Compressor Capacity Control

After starting, the compressor will be unloaded to the minimum physical capacity and no attempt to increase compressor capacity is made until the differential between evaporator pressure and oil pressure meets a minimum value.

After the minimum differential pressure is met, compressor capacity is controlled to 25%.

Compressor capacity will always be limited to a minimum of 25% while it is running, except for the time after compressor start when the differential pressure is being built and except when changes to capacity are performed as needed to meet unit capacity requirements (see unit capacity control section).

Capacity will not be increased above 25% until discharge superheat has been at least 22 degrees F for a time of at least 30 seconds.

Manual capacity control

The capacity of the compressor can be controlled manually. Manual capacity control is enabled via a set point with choices of auto or manual. Another set point allows setting the compressor capacity from 25% to 100%.

The compressor capacity is controlled to the manual capacity set point. Changes will be made at a rate equal to the maximum rate that allows stable circuit operation.

Capacity control reverts back to automatic control if either:

- the circuit shuts down for any reason
- capacity control has been set to manual for four hours

Slide Control Solenoids

The required capacity is achieved by controlling one modulating slide and one non-modulating slide. The modulating slide can control 10% to 50% of the total compressor capacity, infinitely variable. The non-modulating slide can control either 0% or 50% of the total compressor capacity.

Either the load or the unload solenoid for the non-modulating slide is on any time the compressor is running. For compressor capacity from 10% up to 50%, the non-modulating slide unload solenoid is on to keep that slide in the unloaded position. For capacity from 60% to 100%, the non-modulating slide load solenoid is on to keep that slide in the loaded position.

The modulating slide is moved by pulsing of the load and unload solenoids to achieve the required capacity.

An additional solenoid is controlled to assist in moving the modulating slide in certain conditions. This solenoid is activated when the pressure ratio (condenser pressure divided by evaporator pressure) is less than or equal to 1.2 for at least 5 seconds. It is deactivated when pressure ratio is more than 1.2.

Capacity Overrides – Limits of Operation

The following conditions override automatic capacity control when the chiller is in COOL mode. These overrides keep the circuit from entering a condition in which it is not designed to run.

Low Evaporator Pressure

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

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

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

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

High Condenser Pressure

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

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

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

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

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 condenser fan control logic attempts to control the saturated condenser temperature to a calculated target. A base condenser target is calculated based on evaporator saturated temperature. The equation is:

Base saturated condenser target = 5/6 (saturated evaporator temperature) + 68.33

This value is then limited to a maximum and minimum determined by the Condenser Target Maximum and Minimum set points. If these set points are both set to the same value, then the saturated condenser temperature target will be locked at that value.

Fan Staging

The fan stage is adjusted in steps of 1 fan. The only exception is to accommodate forced fan staging at compressor start.

Fan staging will accommodate anywhere from 5 to 12 fans according to the table below:

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

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 20 another stage is added.

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 Stage Down Error Delay seconds. When the Stage Down Error Accumulator is greater than the Stage Down Error Set Point 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, stage down error is accumulated.

When a stage down occurs or the saturated temperature rises back within the Stage Down dead band the Stage Down Error Accumulator is reset to zero. The accumulator is held at zero after startup until either the outside ambient temperature is less than or equal to 75°F, or the saturated condenser temperature is greater than the condenser target less the active stage down deadband.

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 5 seconds, 0.1°F 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.

Preopen Operation

The EXV control includes a preopen operation that is used only when the unit has optional liquid line solenoids. The unit is configured for use with or without liquid line solenoids via a set point.

When a circuit start is required, the EXV opens before the compressor starts. The preopen position is defined by a set point. The time allowed for this preopen operation is at least enough time for the EXV to open to the preopen position based on the programmed movement rate of the EXV.

Startup Operation

When the compressor starts (if no liquid line solenoid valve is installed), the EXV will start to open to an initial position that allows a safe start up. The value of LWT will determine if it is possible to enter the normal operation. If it is higher than 68°F then a pressostatic (constant pressure) 50.8 psi control will start to keep the compressor into the envelope. It goes in normal operation as soon as the suction superheat drops below a value equal to the suction superheat setpoint.

Normal Operation

Normal operation of the EXV is used when the circuit has completed startup operation of the EXV and is not in a slide transition conditions.

During normal operation, the EXV controls suction superheat to a target that can vary from 7.2 degrees F to 15.3 degrees F.

The EXV controls the suction superheat within 1.5 degrees F during stable operating conditions (stable water loop, static compressor capacity, and stable condensing temperature).

The target value is adjusted as needed to maintain discharge superheat within a range from 27 degrees F to 45 degrees F. As the discharge superheat approaches 27 degrees F, the suction superheat target is adjusted up. As the discharge superheat approaches 45 degrees F, the suction superheat target is adjusted down. The control will apply a 0.9 degrees F maximum reset every 5 minutes to the base target.

Maximum Operating Pressures

The EXV control maintains the evaporator pressure in the range defined by the maximum operating pressure.

If the leaving water temperature is higher than 68°F at startup or if the pressure becomes higher than 50.8 psi during normal operations, then a pressostatic (constant pressure) control will be started to keep the compressor in the envelope.

Maximum operating pressure is 50.8 psi. It switches back to normal operation as soon as the suction superheat drops below 7.2°F suction superheat.

Response to Compressor Capacity Change

The logic will consider transition from 50% to 60% and from 60% to 50% as special conditions. When a transition is entered the valve opening will change to adapt to the new capacity, this new calculated position will be kept for 60 seconds. The valve opening will be increased during 50% to 60% transition and decreased in 60% to 50% transition.
Purpose of this logic is to limit liquid flood back when changing from 50% to 60% if the capacity increases above 60% due to slides movement.

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 set point 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 goes back to the normal operations if possible or to pressure control to limit maximum operating pressure.

Transitions Between Control States

Whenever EXV control changes between Startup Operation, Normal Operation, or Manual Control, the transition is smoothed by gradually changing the EXV position rather than changing all at once. This transition prevents the circuit from becoming unstable and resulting in a shutdown due to alarm trip.

Economizer Control

The economizer is activated when a circuit is in a run state and capacity exceeds 95%.

It turns off when the load drops below 60% or the circuit is no longer in a run state.

Liquid Injection

Liquid injection is activated when the circuit is in a run state and the discharge temperature rises above the Liquid Injection Activation set point.

Liquid injection is turned off when the discharge temperature decreases below the activation set point by a differential of 10-degrees C.

Situations may arise that require some action from the chiller or that should be logged for future reference. A condition that requires a shutdown and/or lockout is an alarm. Alarms may cause a normal stop (with pumpdown) or a rapid stop. Most alarms require manual reset, but some reset automatically when the alarm condition is corrected. Other conditions can trigger what is known as an event, which may or may not cause the chiller to respond with a specific action in response. All alarms and events are logged.

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

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 alarm devices. See Figure 17 on page 58 for field wiring information.

Description of Alarms

Phase Volts Loss/GFP Fault

Alarm description (as shown on screen): Unit PVM/GFP Fault

Trigger: PVM set point is set to Single Point and PVM/GFP input is low

Action Taken: Rapid stop all circuits

Reset: Auto reset when PVM input is high or PVM set point does not equal single point for at least 5 seconds.

Evaporator Flow Loss

Alarm description (as shown on screen): Evap Water Flow Loss

Trigger:

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

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

Action Taken: Rapid stop all circuits

Reset:
This alarm can be cleared at any time manually via the keypad or via the BAS clear alarm signal.

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 always a manual reset alarm.

Evaporator Water Freeze Protect

Alarm description (as shown on screen): Evap Water Freeze

Trigger: Evaporator LWT or EWT drops below evaporator freeze protect set point. 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 keypad or via the BAS clear alarm signal, but only if the alarm trigger conditions no longer exist.

Evaporator #1 Water Freeze Protect

Alarm description (as shown on screen): Evap#1 Water Freeze

Trigger: Evaporator LWT read from Evaporator #1 LWT probe drops below evaporator freeze protect set point AND sensor fault is not active.

Action Taken: Rapid stop of circuits #1 and #2

Reset: This alarm can be cleared manually via the keypad or via the BAS clear alarm signal, but only if the alarm trigger conditions no longer exist.

Evaporator #2 Water Freeze Protect

Alarm description (as shown on screen): Evap#2 Water Freeze

Trigger: Evaporator LWT read from Evaporator #2 LWT probe drops below evaporator freeze protect set point AND sensor fault is not active

Action Taken: Rapid stop of circuits #3 and #4

Reset: This alarm can be cleared manually via the keypad or via the BAS clear alarm signal, but only if the alarm trigger conditions no longer exist.

Evaporator Water Temperatures Inverted

Alarm description (as shown on screen): Evap Water Inverted

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 seconds

Action Taken: Pumpdown stop on all circuits

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

Leaving Evaporator Water Temperature Sensor Fault

Alarm description (as shown on screen): Evap LWT Sens Fault

Trigger: Sensor shorted or open

Action Taken: Rapid stop all circuits

Reset: This alarm can be cleared manually via the keypad, but only if the sensor is back in range.

Leaving Evaporator Water Temperature Sensor Fault #1

Alarm description (as shown on screen): Evap LWT Sens#1 Fault

Trigger: Sensor shorted or open

Action Taken: Rapid stop of circuits 1 and 2

Reset: This alarm can be cleared manually via the keypad, but only if the sensor is back in range.

Leaving Evaporator Water Temperature Sensor Fault #2

Alarm description (as shown on screen): Evap LWT Sens#2 Fault

Trigger: Sensor shorted or open

Action Taken: Rapid stop of circuits 3 and 4

Reset: This alarm can be cleared manually via the keypad, but only if the sensor is back in range.

AC Comm Failure

Alarm description (as shown on screen): AC Comm. Fail

Trigger: Communication with the I/O extension module has failed. Section 3.1 indicates the expected type of module and the address for each module.

Action Taken: Rapid stop of all running circuits.

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

Outdoor Air Temperature Sensor Fault

Alarm description (as shown on screen): OAT Sensor Fault

Trigger: Sensor shorted or open and Low Ambient Lockout is enabled.

Action Taken: Normal shutdown of all circuits.

Reset: This alarm can be cleared manually via the keypad if the sensor is back in range or Low Ambient Lockout is disabled.

External Alarm

Alarm description (as shown on screen): External 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.

Emergency Stop Alarm

Alarm description (as shown on screen): Emergency Stop Switch

Trigger: Emergency Stop input is open.

Action Taken: Rapid stop of all circuits.

Reset: This alarm can be cleared manually via the keypad if the switch is closed.

Unit Events

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

Entering Evaporator Water Temperature Sensor Fault

Event description (as shown on screen): EWT Sensor Fail

Trigger: Sensor shorted or open

Action Taken: Return water reset cannot be used.

Reset: Auto reset when sensor is back in range.

Unit Power Restore

Event description (as shown on screen): Unit Power Restore

Trigger: Unit controller is powered up.

Action Taken: none

Reset: none

External Event

Alarm description (as shown on screen): External Event

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.

Low Ambient Lockout

Alarm description (as shown on screen): Low Ambient Lockout

Trigger: The OAT drops below the low ambient lockout set point and low ambient lockout is enabled.

Action Taken: Normal shutdown of all running circuits.

Reset: The lockout will clear when OAT rises to the lockout set point plus 2.5°C, or when low ambient lockout is disabled.

Circuit Stop Alarms

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.

Phase Volts Loss/GFP Fault

Alarm description (as shown on screen): PVM/GFP Fault N

Trigger: PVM input is low and PVM set point = Multi Point

Action Taken: Rapid stop circuits

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

Low Evaporator Pressure

Alarm description (as shown on screen): Evap Press Low N

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 set point, a timer starts. If this timer exceeds the freeze time, then a freezestat trip occurs. If the evaporator pressure rises to the unload set point 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: This alarm can be cleared manually if the evaporator pressure is above –10 psi.

Low Pressure Start Fail

Alarm description (as shown on screen): LowPressStartFail N

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

Action Taken: Rapid stop circuit

Reset: This alarm can be cleared manually via the Unit Controller keypad

Mechanical Low Pressure Switch

Alarm description (as shown on screen): Mech Low Pressure Sw N

Trigger: Mechanical Low Pressure switch input is low

Action Taken: Rapid stop circuit

Reset: This alarm can be cleared manually via the Unit Controller keypad if the MLP switch input is high.

High Condenser Pressure

Alarm description (as shown on screen): Cond Pressure High N

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

Action Taken: Rapid stop circuit

Reset: This alarm can be cleared manually via the Unit Controller keypad

Low Pressure Ratio

Alarm description (as shown on screen): Low Pressure Ratio N

Trigger: Pressure ratio < calculated limit for a time > Low Pressure Ratio Delay set point 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: alarm can be cleared manually via the Unit Controller keypad

Mechanical High Pressure Switch

Alarm description (as shown on screen): Mech High Pressure Sw N

Trigger: Mechanical High Pressure switch input is low AND Emergency Stop Alarm is not active.
(opening emergency stop switch kills power to MHP switches)

Action Taken: Rapid stop circuit

Reset: This alarm can be cleared manually via the Unit Controller keypad if the MHP switch input is high.

High Discharge Temperature

Alarm description (as shown on screen): Disc Temp High N

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

Action Taken: Rapid stop circuit

Reset: This alarm can be cleared manually via the Unit Controller keypad.

High Oil Pressure Difference

Alarm description (as shown on screen): Oil Pres Diff High N

Trigger: Oil Pressure Differential > High Oil Pressure Differential set point 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.

Oil Level Switch

Alarm description (as shown on screen): Oil Level Low N

Trigger: Oil level switch open for a time greater than Oil level switch Delay while compressor is in the Run state.

Action Taken: Rapid stop circuit

Reset: This alarm can be cleared manually via the Unit Controller keypad.

Compressor Starter Fault

Alarm description (as shown on screen): Starter Fault N

Trigger:
If PVM set point = None(SSS): any time starter fault input is open
If PVM set point = 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.

High Motor Temperature

Alarm description (as shown on screen): Motor Temp High

Trigger:
Input value for the motor temperature is 4500 ohms or higher.

Action Taken: Rapid stop circuit

Reset: This alarm can be cleared manually via the Unit Controller keypad after input value for motor temperature has been 200 ohms or less for at least 5 minutes.

Low OAT Restart Fault

Alarm description (as shown on screen): LowOATRestart Fail N

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.

No Pressure Change After Start

Alarm description (as shown on screen): NoPressChgAtStrt N

Trigger: After start of compressor, at least a 1 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.

No Pressure At Startup

Alarm description (as shown on screen): No Press At Start N

Trigger: [Evap Pressure < 5 psi OR Cond Pressure < 5 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.

CC Comm Failure N

Alarm description (as shown on screen): CC Comm. Fail N

Trigger: Communication with the I/O extension module has failed. Section 3.1 indicates the expected type of module and the address for each module.

Action Taken: Rapid stop of affected circuit

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

FC Comm Failure Circuit 1/2

Alarm description (as shown on screen): FC Comm Fail Cir 1/2

Trigger: [Circuit 1 or Circuit 2 Number of Fans > 6 OR PVM Config = Multi Point] and communication with the I/O extension module has failed. Section 3.1 indicates the expected type of module and the address for each module.
Action Taken: Rapid stop of circuit 1 and 2

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

FC Comm Failure Circuit 3

Alarm description (as shown on screen): FC Comm Fail Cir 3

Trigger: Number of Circuits set point is greater than 2 and communication with the I/O extension module has failed. Section 3.1 indicates the expected type of module and the address for each module.

Action Taken: Rapid stop of circuit 3

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

FC Comm Failure Circuit 4

Alarm description (as shown on screen): FC Comm. Fail Cir 4

Trigger: Number of Circuits set point is greater than 3 and communication with the I/O extension module has failed. Section 3.1 indicates the expected type of module and the address for each module.

Action Taken: Rapid stop of circuit 4

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

FC Comm Failure Circuit 3/4

Alarm description (as shown on screen): FC Comm. Fail Cir 3/4

Trigger: Circuit 3 or circuit 4 Number of Fans > 6, Number of circuits set point > 2, and and communication with the I/O extension module has failed. Section 3.1 indicates the expected type of module and the address for each module.

Action Taken: Rapid stop of circuit 3 and 4

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

EEXV Comm Failure N

Alarm description (as shown on screen): EEXV Comm. Fail N

Trigger: Communication with the I/O extension module has failed. Section 3.1 indicates the expected type of module and the address for each module. Alarm on Circuit #3 will be enabled if Number of Circuits set point > 2; alarm on Circuit #4 will be enabled if Number of Circuits set point > 3.

Action Taken: Rapid stop of affected circuit

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

Evaporator Pressure Sensor Fault

Alarm description (as shown on screen): EvapPressSensFault N

Trigger: Sensor shorted or open

Action Taken: Rapid stop circuit

Reset: This alarm can be cleared manually via the keypad, but only if the sensor is back in range.

Condenser Pressure Sensor Fault

Alarm description (as shown on screen): CondPressSensFault N

Trigger: Sensor shorted or open

Action Taken: Rapid stop circuit

Reset: This alarm can be cleared manually via the keypad, but only if the sensor is back in range.

Oil Pressure Sensor Fault

Alarm description (as shown on screen): OilPressSensFault N

Trigger: Sensor shorted or open

Action Taken: Normal shutdown of circuit

Reset: This alarm can be cleared manually via the keypad, but only if the sensor is back in range.

Suction Temperature Sensor Fault

Alarm description (as shown on screen): SuctTempSensFault N

Trigger: Sensor shorted or open

Action Taken: Normal shutdown of circuit

Reset: This alarm can be cleared manually via the keypad, but only if the sensor is back in range.

Discharge Temperature Sensor Fault

Alarm description (as shown on screen): DiscTempSensFault N

Trigger: Sensor shorted or open

Action Taken: Normal shutdown of circuit

Reset: This alarm can be cleared manually via the keypad, but only if the sensor is back in range.

Motor Temperature Sensor Fault

Alarm description (as shown on screen): MotorTempSensFault N

Trigger: Sensor shorted or open

Action Taken: Rapid stop circuit

Reset: This alarm can be cleared manually via the keypad, but only if the sensor is back in range.

Circuit Events

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.

Low Evaporator Pressure - Hold

Event description (as shown on screen): EvapPress Low Hold N

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 set point 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.

Low Evaporator Pressure - Unload

Event description (as shown on screen): EvapPressLowUnload N

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 set point 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 set point.

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.

High Condenser Pressure - Hold

Event description (as shown on screen): CondPressHigh Hold N

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°F). The event is also reset if the unit mode is switched to Ice, or the circuit is no longer in the run state.

High Condenser Pressure - Unload

Event description (as shown on screen): CondPressHighUnloadN

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 set point.

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

Failed Pumpdown

Event description (as shown on screen): Pumpdown Fail Cir N

Trigger: Circuit state = pumpdown for time > Pumpdown Time set point

Action Taken: Shutdown circuit

Reset: N/A

Power Loss While Running

Event description (as shown on screen): Run Power Loss Cir N

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

Action Taken: N/A

Reset: N/A

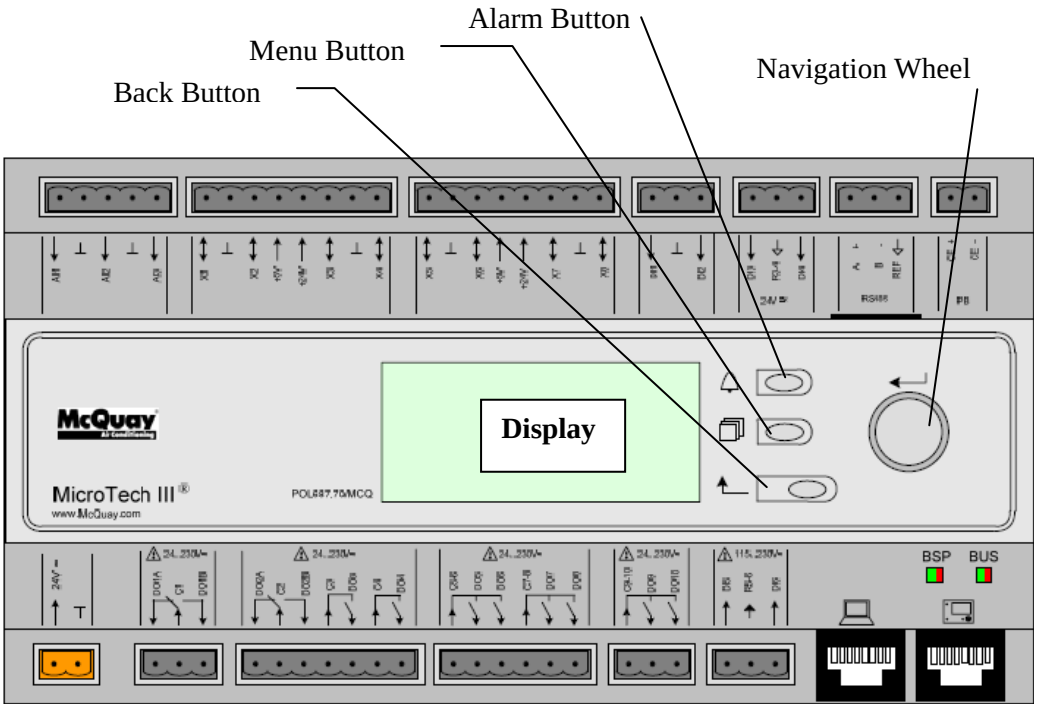
Alarm Logging

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. In the alarm log, the date and time the alarm occurred are stored, as well as a list of other parameters. These parameters include unit state, OAT, LWT, and EWT for all alarms. If the alarm is a circuit alarm, then the circuit state, refrigerant pressures and temperatures, EXV position, compressor load, number of fans on, and compressor run time are also stored.

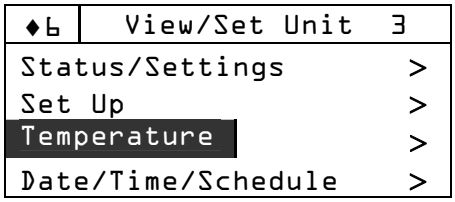
The Unit Controller Operation

Figure 9, 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 10, Typical Screen



Generally, each line 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. 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 page can contain status only information or include changeable data fields (setpoints). When a line contains status only information and the cursor is on that line, all but the value field of that line is highlighted, meaning the text is white with a black box around it. When the line contains a changeable value and the cursor is at that line, the entire line is highlighted.

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

The home screen has two lines:

- 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, adjustable up to 30 minutes, and is cancelled if a new password is entered or the control powers down.

- Continue W/O Password, which links to the Main Menu and allows access to a limited number of parameters (with asterisks) as shown in Figure 13 on page49.

Figure 11, Password Menu

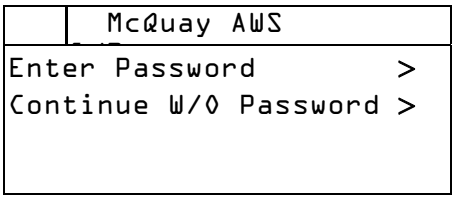
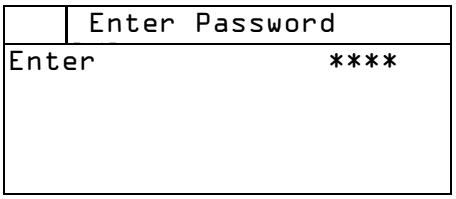


Figure 12, Password Entry Page



Entering an invalid password has the same effect as continuing without 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. It is changeable from 3 to 30 minutes via the Timer Settings menu in the Extended Menus.

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 12.
- 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 repeated 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.

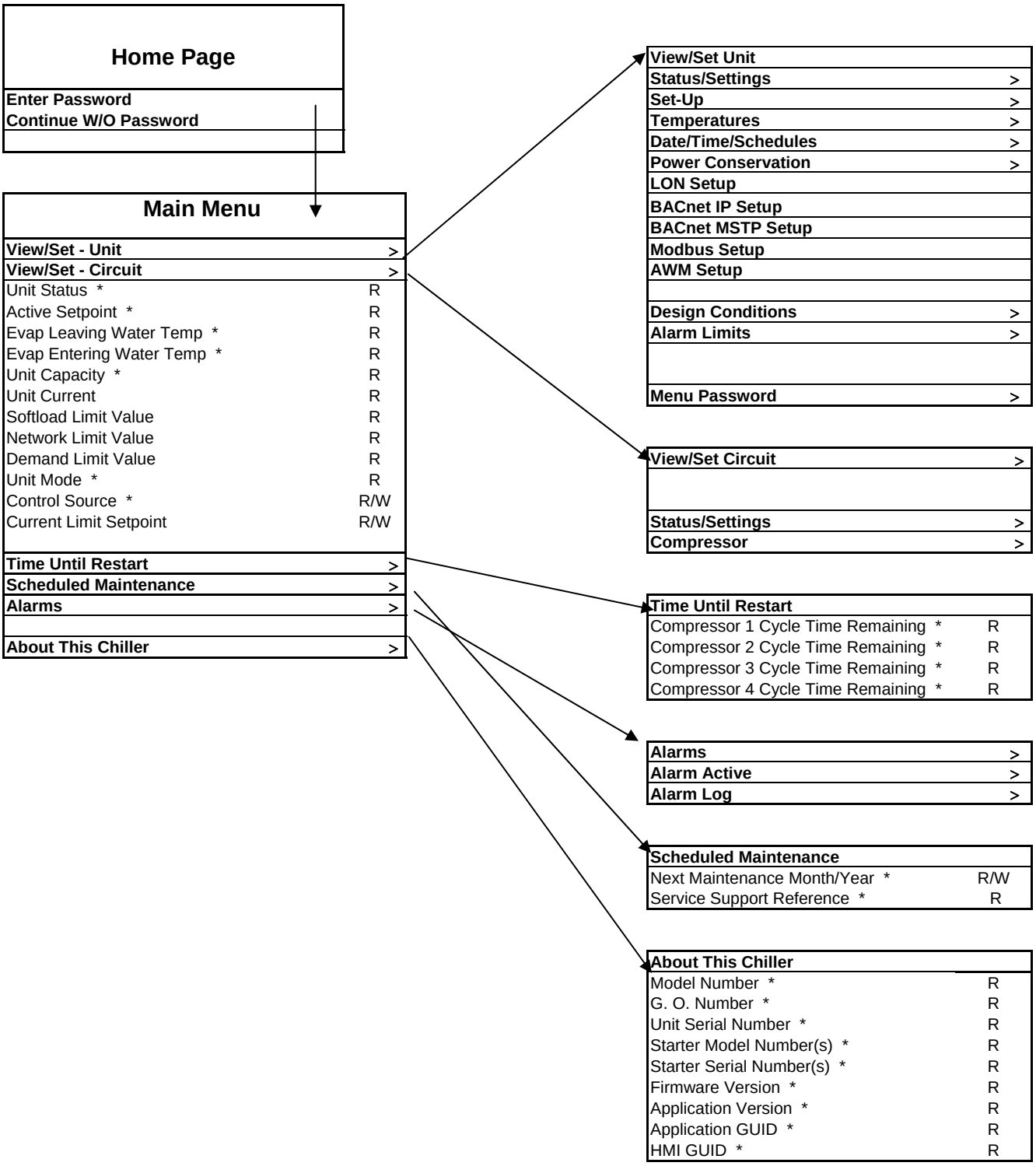
Rotate the wheel to scroll down to Control Source and read the result.

Example 2; Change a Setpoint, the chilled water setpoint for example. This parameter is designated as Cool LWT Setpoint 1 and is a unit set 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 six lines of temperatures setpoints. The first line is Evap LWT, XXXXX to do next—password expired??

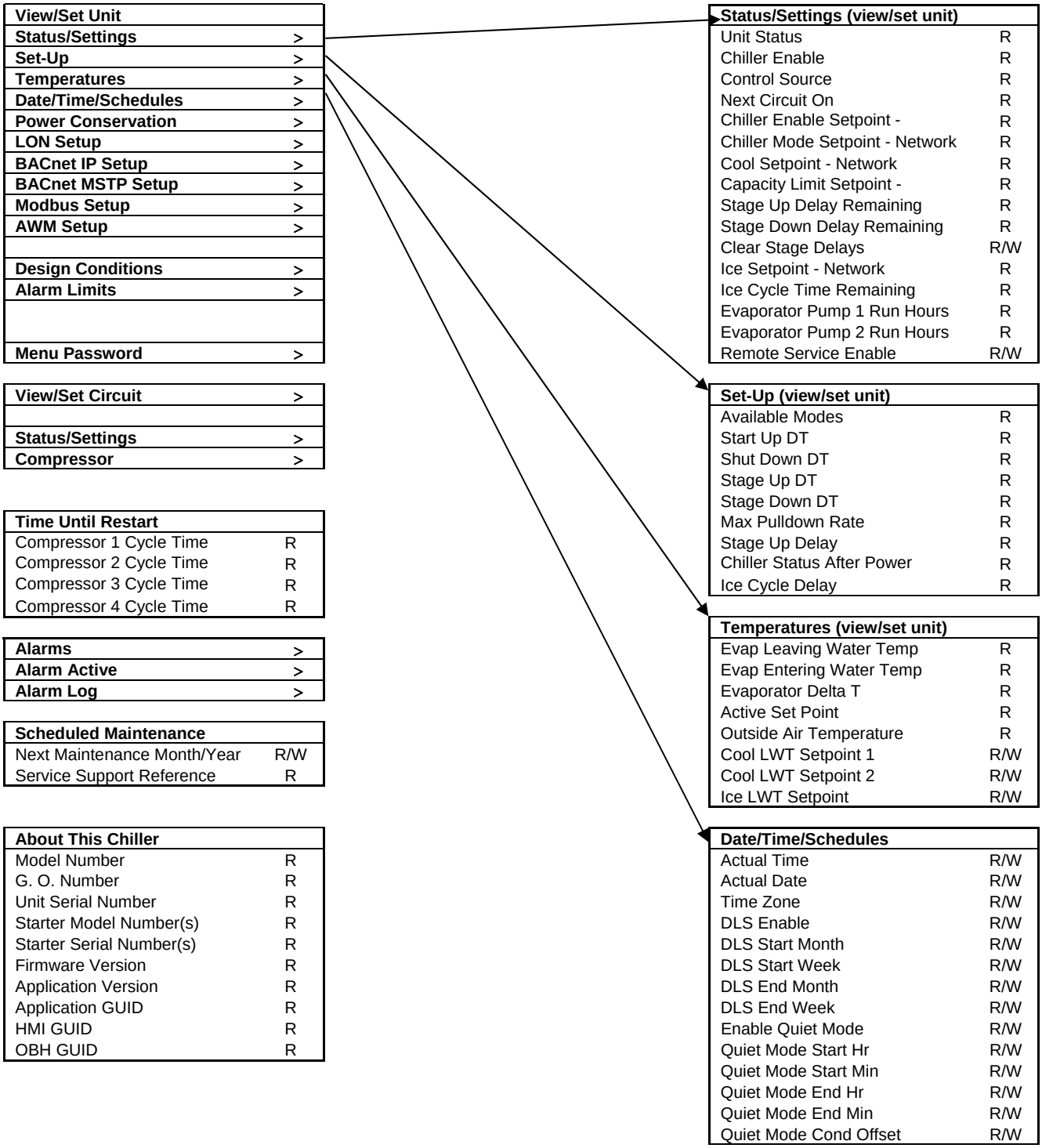
Example 3; Clear an Alarm,. HOW DO YOU KNOW THERE IS AN ALARM????. From the Main Menu scroll down to the Alarms line. Note the arrow indicating this line is a link. Press the wheel to jump to the next menu Alarms There are two lines here; Alarm Active and Alarm Log. Alarms are cleared from the Active Alarm link. Press the wheel to jump to the next screen

Figure 13, Home Page, Main Menu Parameters and Links



Note: Parameters with an "*" are available without entering a password.

Figure 14, Navigation, Part A



Note: Parameters with an "*" are available without entering a password.

Figure 15, Navigation, Part B

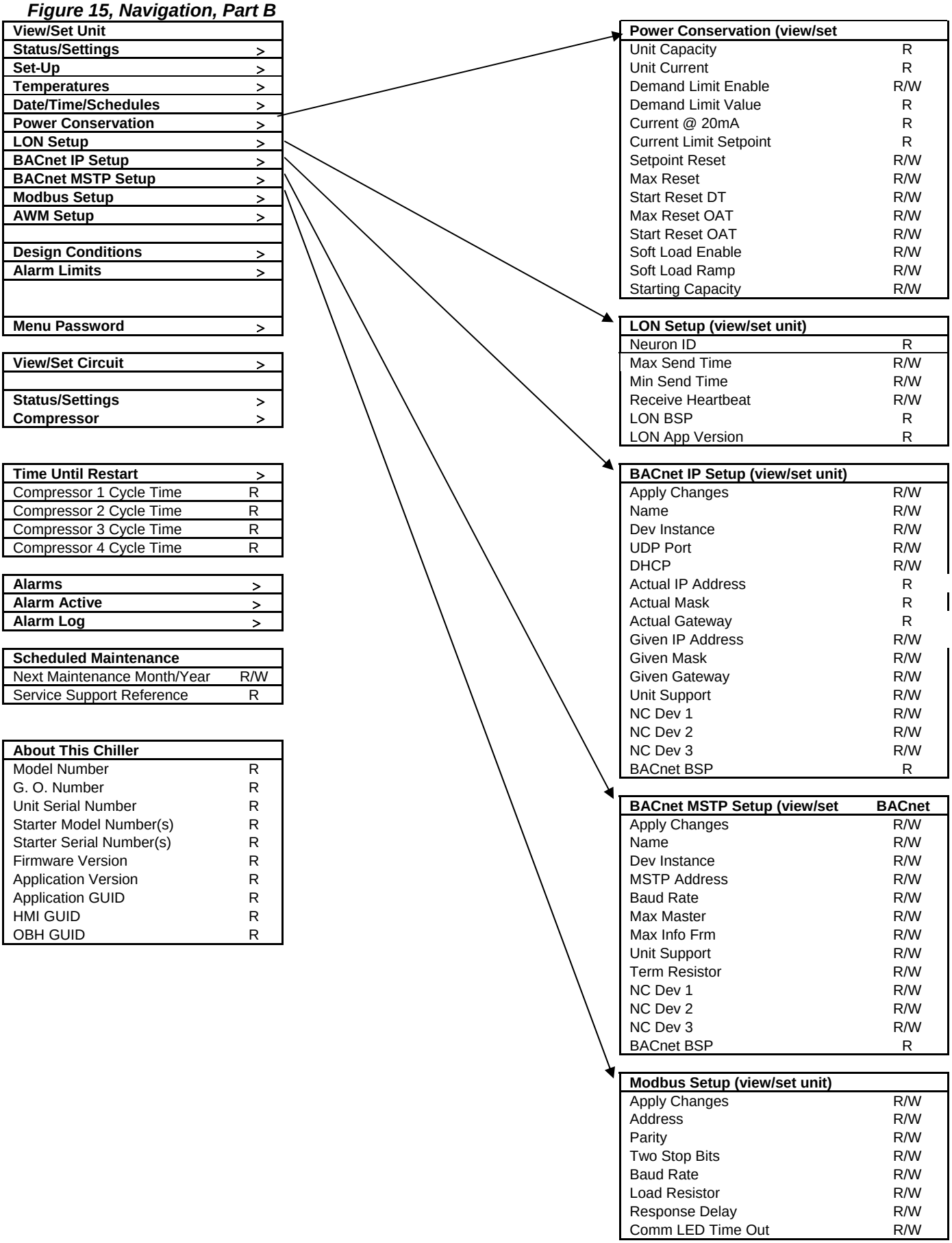
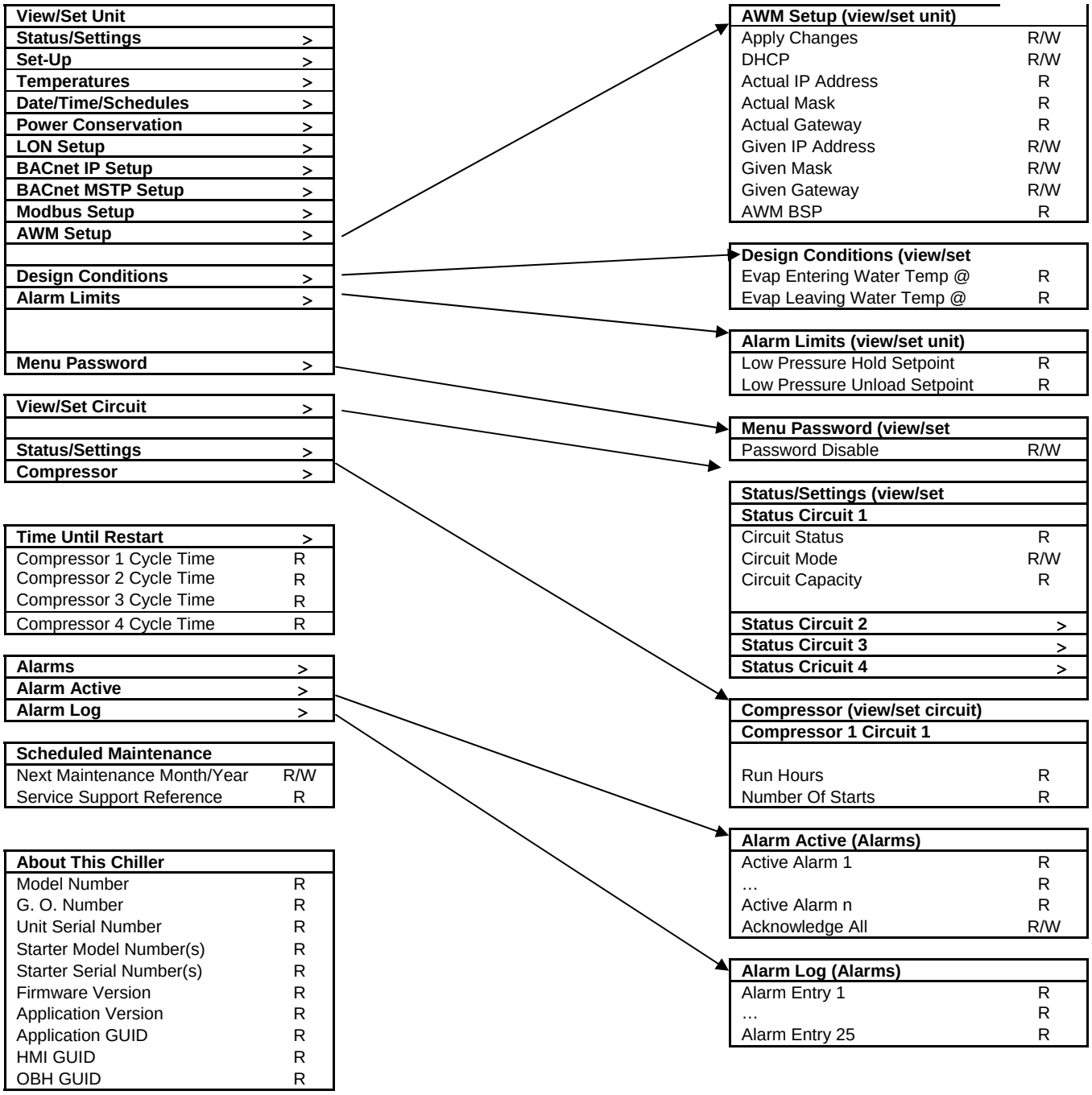


Figure 16, Navigation, Part C



Note: Parameters with an "*" are available without entering a password.

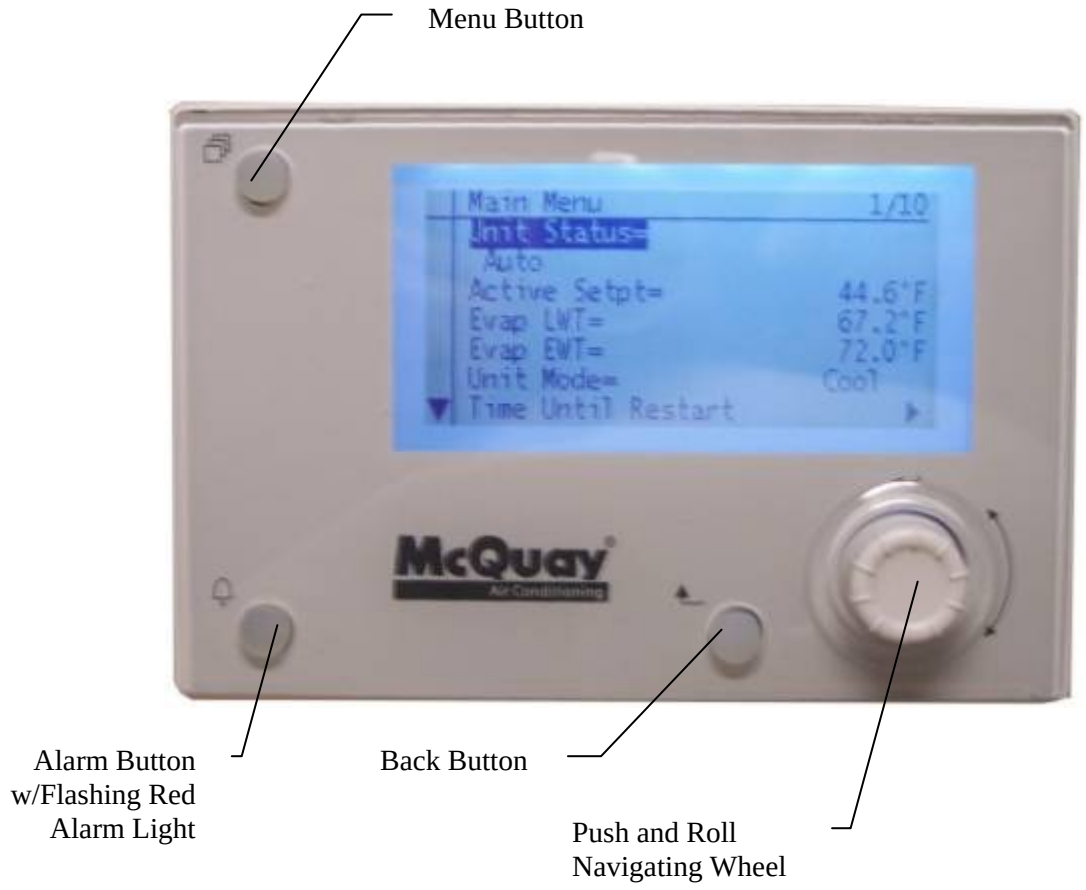
Optional Remote User Interface

The optional remote user interface is a remote control panel that mimics operation of the controller located on the unit. Up to eight AWS 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.

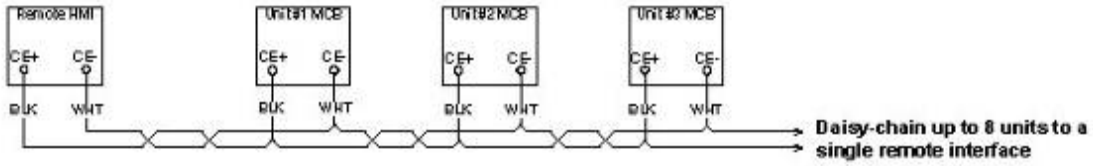


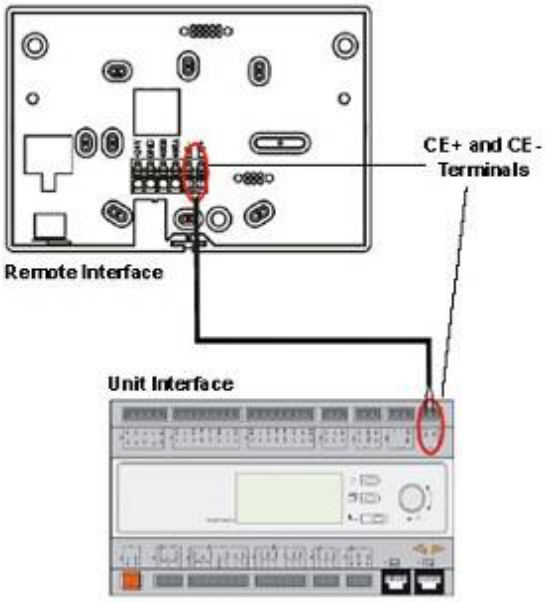
Technical Specifications

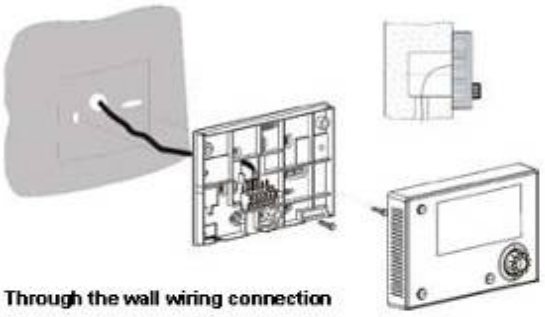
Interface		
Process Bus	Up to eight interfaces per remote	
Bus connection		CE+, CE-, not interchangeable
Terminal	2-screwconnector	
Max. length	700 m	
Cable type	Twisted pair cable; 0.5...2.5 mm2	
Display		
LCD type	FSTN	
Dimensions	5.7 W x 3.8 H x 1.5 D inches (144 x 96 x 38 mm)	
Resolution	Dot-matrix 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	

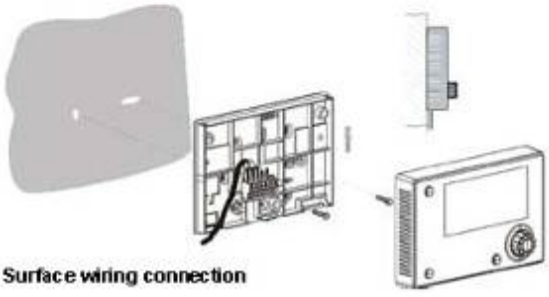
Cover Removal

Process Bus Wiring Connections






Through the wall wiring connection


Surface wiring connection

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.

⚠ 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, IMM AGSC-2.
8. The following table gives glycol concentrations required for freeze protection.

Table 2, Freeze Protection

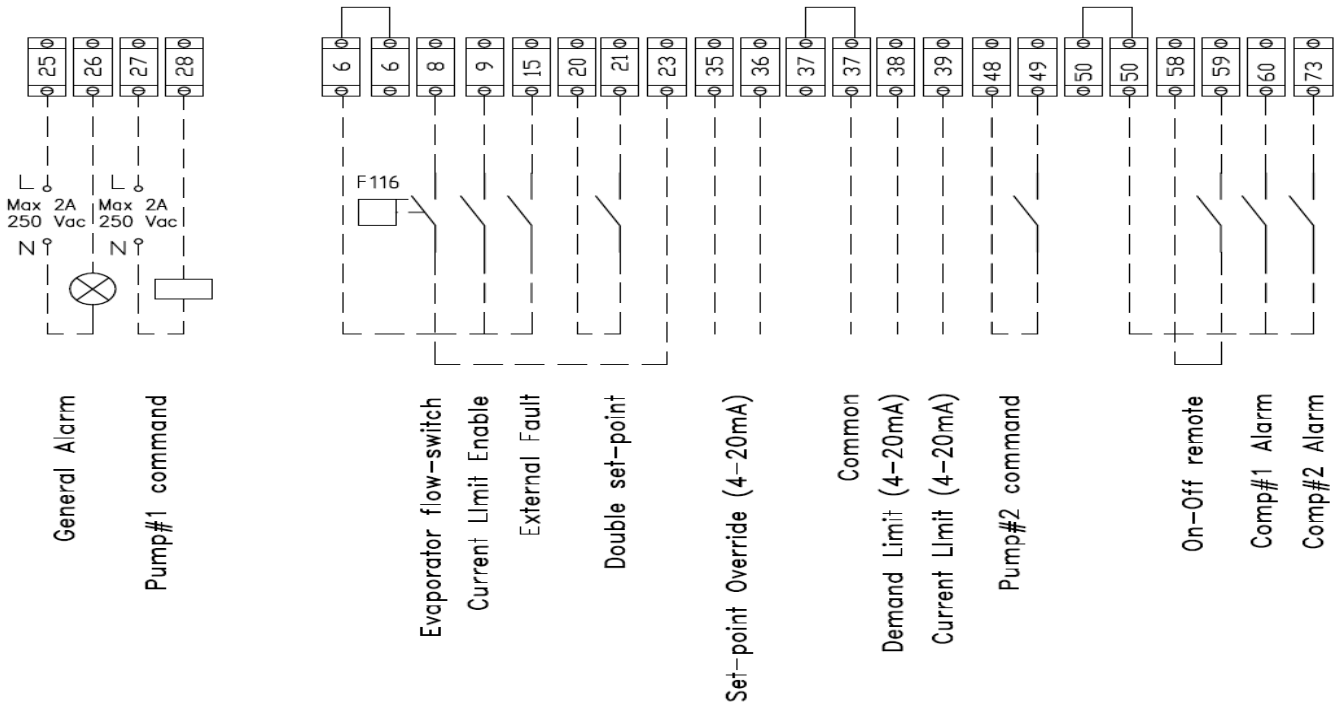
Temperature °F (°C)	Percent Volume Glycol Concentration Required			
	For Freeze Protection		For Burst Protection	
	Ethylene Glycol	Propylene Glycol	Ethylene Glycol	Propylene Glycol
20 (6.7)	16	18	11	12
10 (-12.2)	25	29	17	20
0 (-17.8)	33	36	22	24
-10 (-23.3)	39	42	26	28
-20 (-28.9)	44	46	30	30
-30 (-34.4)	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 17, Typical Field Wiring Diagram, Sheet 1



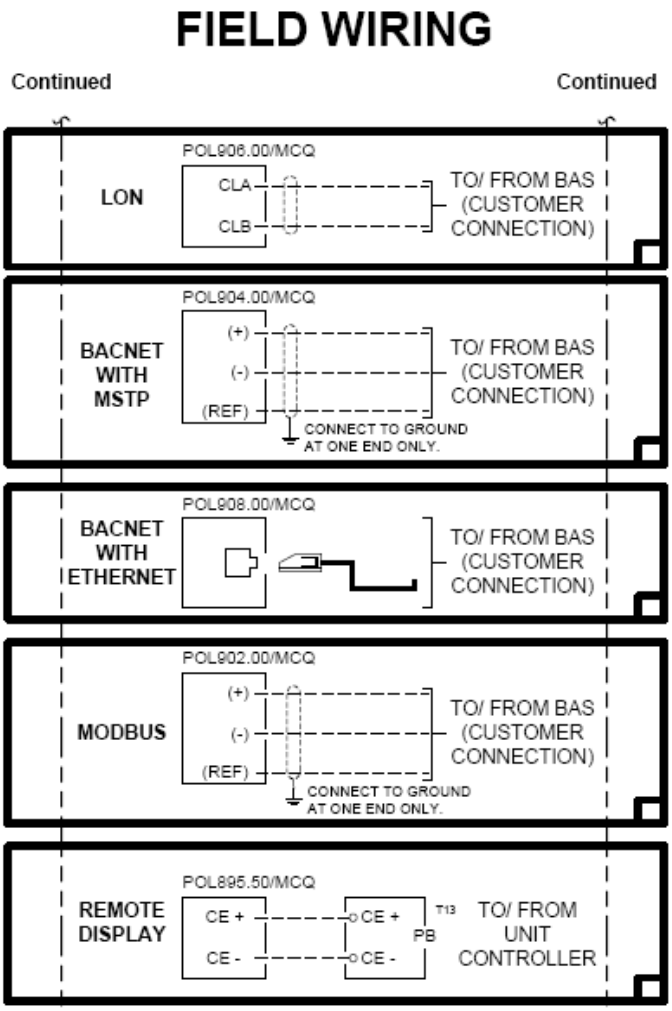
NOTE:

1 Compressor Alarm No. 3 applies to future product releases.

2 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.

3 Field wiring for optional BAS continued on next page.

Figure 17, Typical Field Wiring Diagram, Sheet 1



Note: 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 AWS 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.

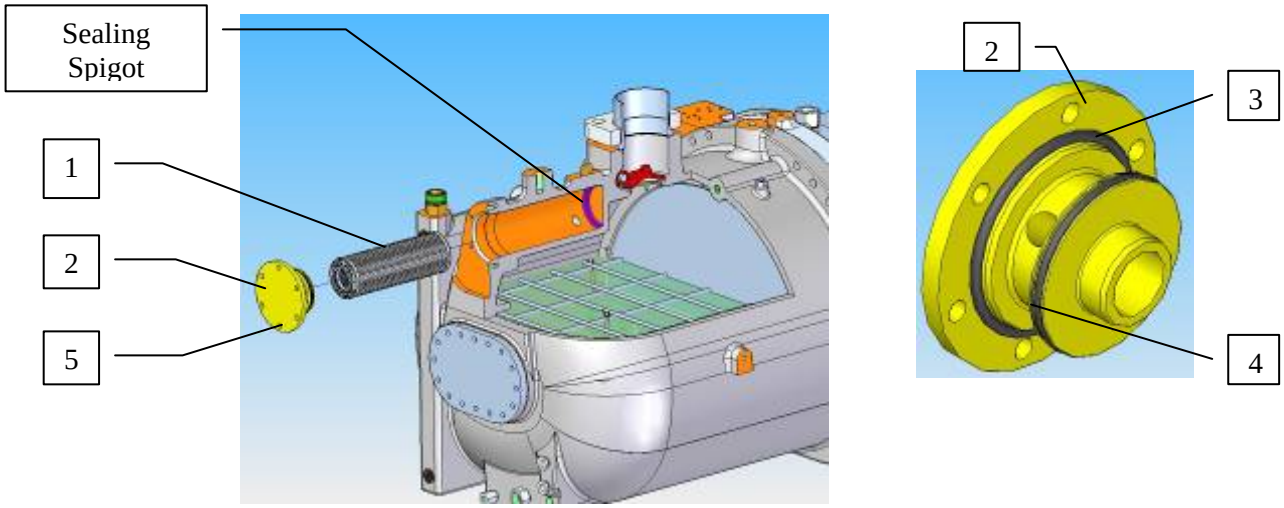
Oil Filter Removal and Renewal

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).



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

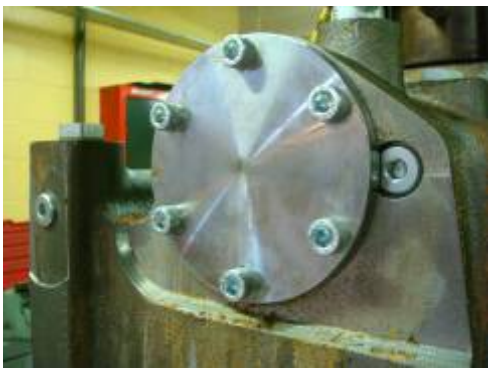
- Unscrew and remove two hex head side cover bolts 180° apart. Insert M8 guide studs into the vacant holes.
- Remove remaining bolts, remove oil filter housing cover.
- Pull the oil filter off of the spigot and withdraw the oil filter from the housing and clean.
- Clean oil filter housing cover plate.

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. 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.

Liquid Line Sight Glass

Observe the refrigerant sight glasses (one per circuit) 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 liquid line 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 McQuay AWS 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.

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			
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 he 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.