CONTROL PANEL OPERATING MANUAL

WATER-COOLED SCREW CHILLER

MICROTECH III CONTROLLER

D–EOMWC00A07-16EN

Table of Contents

Introduction

This manual provides setup, operating, troubleshooting and maintenance information for the DAIKIN Water Cooled Chillers listed below with 1, 2 and 3 circuits using Microtech III Controller.

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 EWWD G-EWLD G-EWWD I-EWLD I-EWWD J-EWLD J-EWWQ B units. The unit's software version number can be viewed by selecting the "About Chiller" menu item accessible without password. Then, pressing the MENU key will return to the Menu screen.

⚠ 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. Daikin disclaims any liability resulting from any interference or for the correction thereof.

Controller Operating Limits:

Operation (IEC 721-3-3):

- Temperature -40...+70 °C
- Restriction LCD -20… +60 °C
- Restriction Process-Bus -25….+70 °C
- Humidity < 90 % r.h (no condensation)
- Air pressure min. 700 hPa, corresponding to max. 3,000 m above sea level

Transport(IEC 721-3-2):

- Temperature -40...+70 °C
- Humidity < 95 % r.h (no condensation)
- Air pressure min. 260 hPa, corresponding to max. 10,000 m above sea level.

Controller Features

Readout of the following temperature and pressure readings:

- Entering and leaving chilled water temperature
- Saturated evaporator refrigerant temperature and pressure
- Saturated condenser refrigerant temperature and pressure
- Outside air temperature
- Suction 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.

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.

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

General Description

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

General Description

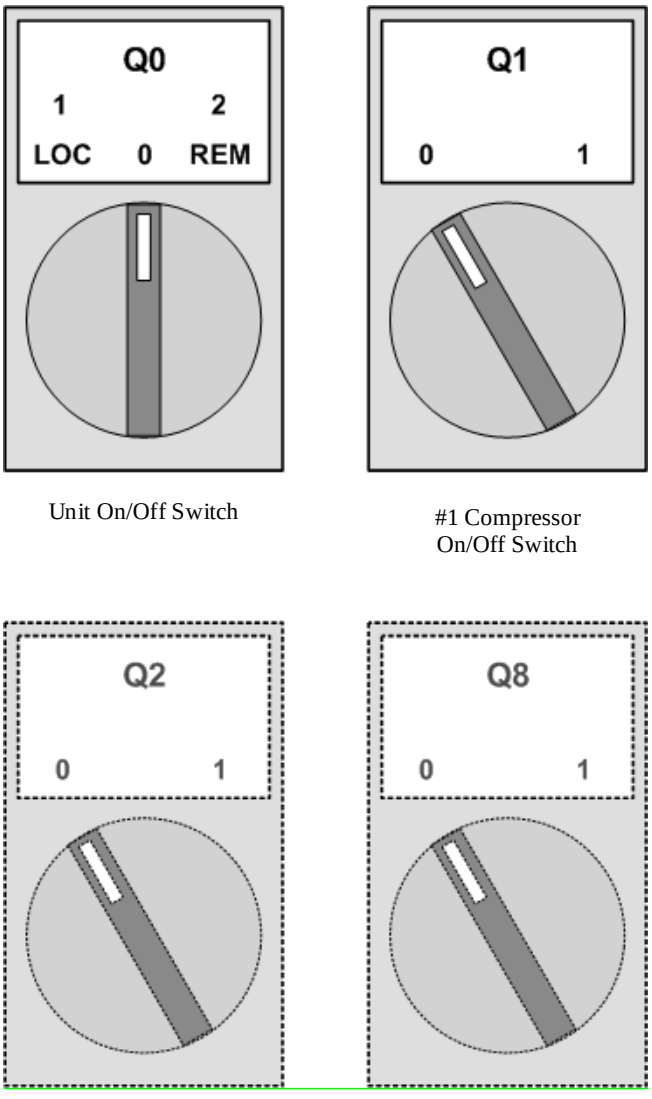
The MicroTech III control system consists of a microprocessor-based controller and a number of extension modules, which vary depending on the unit size and conformation. The control system provides the monitoring and control functions required for the controlled, efficient operation of the chiller.

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

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

Operation Commands Layout

Figure 1, Operation Commands



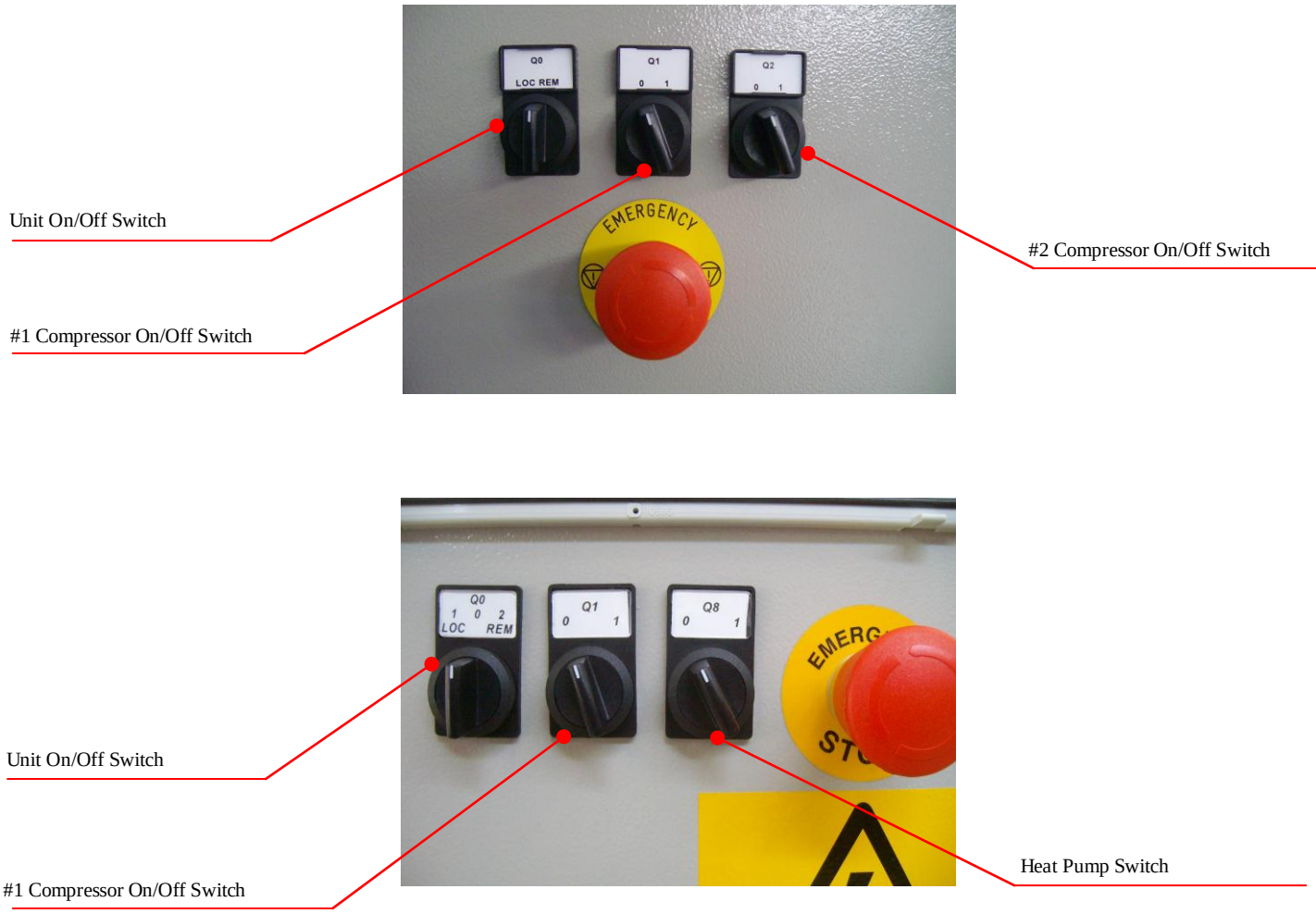
Unit On/Off Switch

#1 Compressor On/Off Switch

#2 Compressor On/Off Switch

Heat/Cool Switch

Figure 2, Operation Commands



Controller Description

Hardware Structure

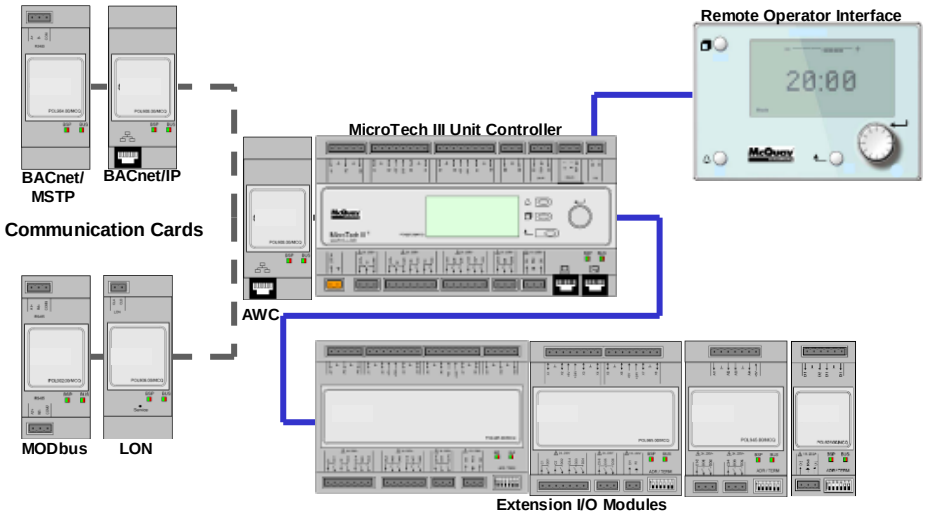
The MicroTech III control system for water cooled screw chillers consists of a main unit controller with a number of extension I/O modules attached depending on the chiller size and configuration.

Up to two optional BAS communication modules may be included on request.

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

The Advanced MicroTech III controllers used on water cooled screw chillers are not interchangeable with previous MicroTech II controllers.

Figure 3, hardware structure

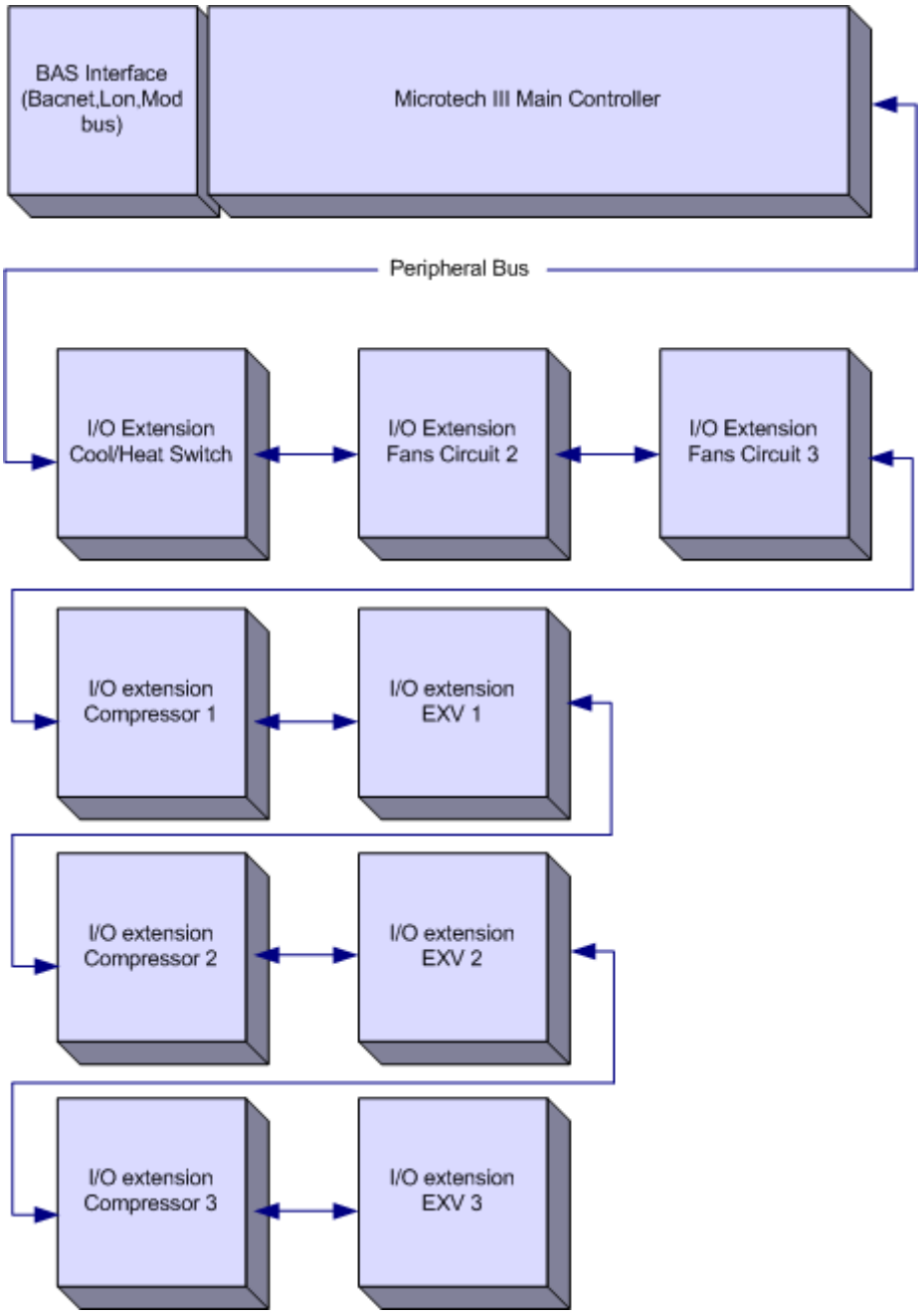


System Architecture

The overall controls architecture uses the following:

- One Microtech III main controller
- I/O extension modules as needed depending on the configuration of the unit
- Optional BAS interface as selected

Figure 4, System Architecture



Control network details

Peripheral Bus is used to connect I/O extensions to the main controller.

Controller/ Extension Module	Siemens Part Number	Address	Usage
Unit	POL687.70/MCQ	n/a	Used on all configurations
Comp. #1	POL965.00/MCQ	2	
EEXV #1	POL94U.00/MCQ	3	
Comp. #2	POL965.00/MCQ	4	Used when configured for 2
EEXV #2	POL94U.00/MCQ	5	
Fan#2	POL945.00/MCQ	6	
Comp. #3	POL965.00/MCQ	7	Used when configured for 3
EEXV #3	POL94U.00/MCQ	8	
Fan#3	POL945.00/MCQ	9	
HP	POL925.00/MCQ	25	Heat Pump Option

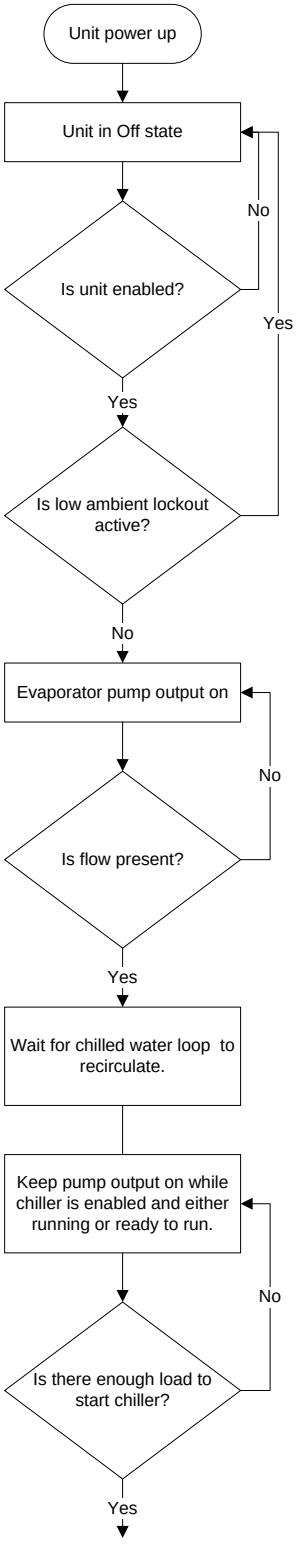
Communication modules

Any of the following modules can be connected directly to the left side of the main controller to allow a BAS interface to function.

Module	Siemens Part Number	Usage
BacNet/IP	POL908.00/MCQ	Optional
Lon	POL906.00/MCQ	Optional
Modbus	POL902.00/MCQ	Optional
BACnet/MSTP	POL904.00/MCQ	Optional

Sequence of Operation

Figure 5, Unit Sequence of Operation (see Figure 9 for circuit sequence of operation)



Chiller Sequence of Operation in Cool Mode

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

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

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

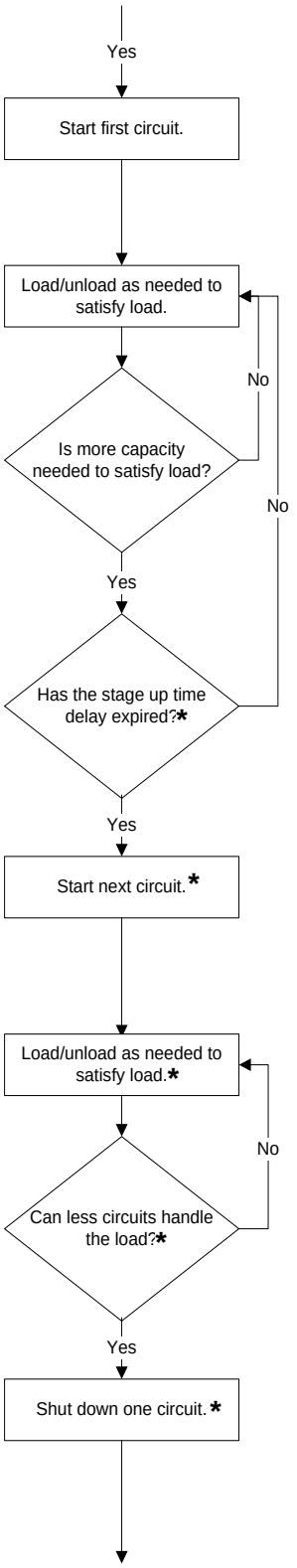
If the chiller is enabled, then the unit will be in the Auto state and the evaporator water pump output will be activated.

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

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

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

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



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

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

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

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

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

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

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

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

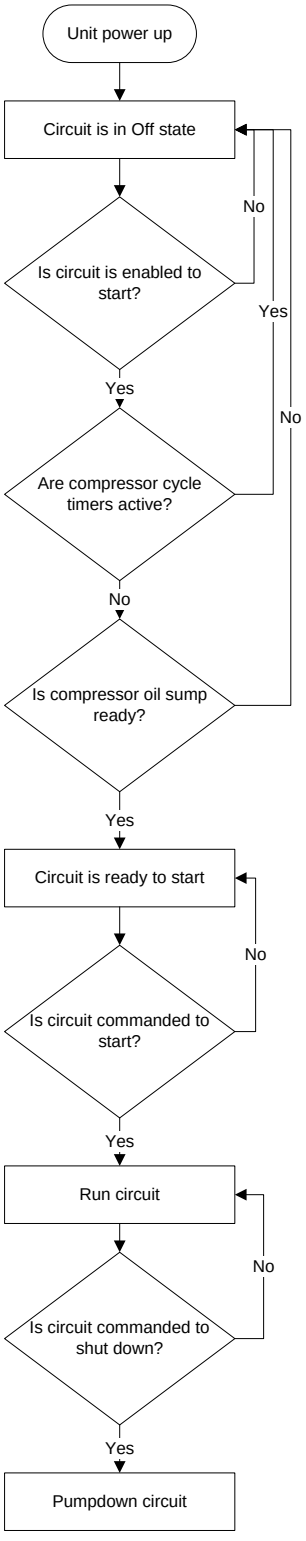
A minimum time must pass between the shutting down of circuits. The time remaining can be viewed on the HMI if the minimum password level is active.

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

*** The points highlighted are considered only in 2 or 3 circuits units**

Figure 6, Circuit Sequence of Operation

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**.**

Controller Operation

MicroTech III Inputs/Outputs

The chiller may be equipped with one up to 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	Condenser Entering Water Temp	NTC Thermister (10K@25°C)	-50°C – 120°C
X1	Condenser Leaving Water Temp	NTC Thermister (10K@25°C)	-50°C – 120°C
X4	LWT Reset	4-20 mA Current	1 to 23 mA
X7	Demand Limit	4-20 mA Current	1 to 23 mA
X8	Unit Current	4-20 mA Current	1 to 23 mA

Analog Outputs

#	Description	Output Signal	Range
X5	Condenser Pump VFD	0-10VDC	0 to 100% (1000 steps resolution)
X6	Condenser Bypass Valve	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	External Alarm	Remote off	Remote on
DI5	Unit Switch	Unit off	Unit on
DI6	Emergency Stop	Unit off/rapid stop	Unit on
X2	Current Limit Enable	Disabled	Enabled
X3	Condenser Flow Switch	No Flow	Flow

Digital Outputs

#	Description	Output OFF	Output ON
DO1	Evaporator Water Pump #1	Pump Off	Pump On
DO2	Unit Alarm	Alarm not Active	Alarm Active (Flashing= circuit alarm)
DO3	Cooling Tower Out 1	Fan Off	Fan On
DO4	Cooling Tower Out 2	Fan Off	Fan On
DO5	Cooling Tower Out 3	Fan Off	Fan On
DO6	Cooling Tower Out 4	Fan Off	Fan On
DO7			
DO8	Evaporator Water Pump #2	Pump Off	Pump On
DO9	Condenser Water Pump	Pump Off	Pump 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
X8	Circuit Switch	Circuit Off	Circuit On
DI1	High Pressure Switch	Fault	No fault

Digital Outputs

EU. Configuration

#	Description	Output Off	Output On
DO1	Start Compressor	Compressor Off	Compressor On
DO2	Circuit Alarm	Circuit Alarm Off	Circuit Alarm On
DO3	Load #2 Circuit	Load 2 Circuit Off	Load 2 Circuit On
DO4	Unload #2 Circuit / Liquid Injection	Unload 2 Circuit Off / Liquid Injection Off	Unload 2 Circuit On / Liquid Injection On
DO5	Load #1 Circuit	Load 1 Circuit Off	Load 1 Circuit On
DO6	Unload #1 Circuit	Unload 1 Circuit Off	Unload 1 Circuit On
X5	Turbo Slide	Turbo Slide Off	Turbo Slide On

I/O EXV Circuit #1 to #3

Analog Inputs

#	Description	Signal Source	Expected Range
X1	Evaporator Leaving Water Temp (*)	NTC Thermister 10K@25°C)	-50°C – 120°C
X2	Suction Temperature	NTC Thermister 10K@25°C)	-50°C – 120°C
X3			

Analog Outputs

#	Description	Output Signal	Range
Not Needed			

Digital Inputs

#	Description	Signal Off	Signal On
DI1	Evaporator Flow Switch (Circuit)	No Flow	Flow

Digital Outputs

#	Description	Output Off	Output On
DO1	Liquid Line Solenoid Valve	Liquid Line Solenoid Valve Off	Liquid Line Solenoid Valve On

Stepper Motor Output

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

Extension I/O Fan Module Circuit #2

Digital Outputs

#	Description	Output Off	Output On
DO1	Circuit #2 Fan Step #1 Fan Off Fan On	Fan Off	Fan On
DO2	Circuit #2 Fan Step #2 Fan Off Fan On	Fan Off	Fan On
DO3	Circuit #2 Fan Step #3 Fan Off Fan On	Fan Off	Fan On
DO4	Circuit #2 Fan Step #4 Fan Off Fan On	Fan Off	Fan On

Extension I/O Fan Module Circuit #3

Digital Outputs

#	Description	Output Off	Output On
DO1	Circuit #3 Fan Step #1 Fan Off Fan On	Fan Off	Fan On
DO2	Circuit #3 Fan Step #2 Fan Off Fan On	Fan Off	Fan On
DO3	Circuit #3 Fan Step #3 Fan Off Fan On	Fan Off	Fan On
DO4	Circuit #3 Fan Step #4 Fan Off Fan On	Fan Off	Fan On

Extension I/O Unit Heat Pump

Digital Inputs

#	Description	Signal Off	Signal On
DI1	Cool Heat Switch	Cooling Mode	Heating Mode

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	Disabled		Disabled, Enabled
Control source	Local		Local, Network
Available Modes	Cool		COOL COOL/w GLYCOL COOL/ICE w GLYCOL ICE w/GLYCOL HEAT/COOL HEAT/COOL w GLYCOL HEAT/ICE w GLYCOL TEST
Cool LWT 1	44 °F	7 °C	See section 0
Cool LWT 2	44 °F	7 °C	See section 0
Heat LWT 1	113°F	45 °C	§
Heat LWT 2	113 °F	45 °C	§
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
Max Pullup	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, 4-20mA, Return
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
Soft Load	Disable		Disable, Enable
Starting Capacity Limit	40%		20-100%
Soft Load Ramp	20 min		1-60 minutes
Demand Limit	Disable		Disable, Enable
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		1-2-3
Ice Cycle Delay	12		1-23 hours
Condenser Water Temp Setpoint	95 °F	35 °C	69,8 to 140 °F / 21 to 60 °C
Condensation Control value	Cond In		Cond In, Cond Out, Press
Condensation Analog Output type	None		None, Vfd, Bypass Valve
Tower 1 Setpoint	95 °F	35 °C	69,8 to 140 °F / 21 to 60 °C
Tower 2 Setpoint	98,6 °F	37 °C	69,8 to 140 °F / 21 to 60 °C
Tower 3 Setpoint	102,2 °F	39 °C	69,8 to 140 °F / 21 to 60 °C
Tower 4 Setpoint	105,8 °F	41 °C	69,8 to 140 °F / 21 to 60 °C
Tower 1 Differential	2.7 °F/1.5 °C		0,2 to 9 dF / 0,1 to 10 dK
Tower 2 Differential	2.7 °F/1.5 °C		0,2 to 9 dF / 0,1 to 10 dK
Tower 3 Differential	2.7 °F/1.5 °C		0,2 to 9 dF / 0,1 to 10 dK
Tower 4 Differential	2.7 °F/1.5 °C		0,2 to 9 dF / 0,1 to 10 dK
Vfd Min Speed	10%		0 to 100%

Description	Default		Range
Unit	Ft/Lb	SI	
Vfd Max Speed	100%		0 to 100%
Byp valve Min Opening	0%		0 to100%
Byp valve Max Opening	95%		0 to100%
Vfd/ Byp valve PID prop gain (kp)	10.0		0 to 50
Vfd/ Byp valve PID deriv time (Td)	1.0 s		0 to 180s
Vfd/ Byp valve PID integ time (Ti)	600.0 s		0 to 600s
Clear Ice Delay	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
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
Start-start timer	10 min		6-60 minutes
Compressor – Global	**Ft/Lb**	**SI**	
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	2		1-3
Sequence # Cir 1	1		1-4
Sequence # Cir 2	1		1-4
Sequence # Cir 3	1		1-4
Liquid Injection Activation	185°F	85°C	75 to 90°C
Liquid Line Solenoid Valves	Disable		Disable, Enable
Low Evap Pressure-Unload	23.2 PSI	160 kPa	See section 0
Low Evap Pressure-Hold	27.5 PSI	180 kPa	See section 0
High Oil Press Delay	30 sec		10-180 sec
High 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
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
Evap Recirculate Timeout	3 min		1 to 10 min

The following set points exist individually for each circuit:

Description	Default		Range
	Ft/Lb	SI	
Circuit mode	Enable		Disable, Enable, Test
Capacity Control	Auto		Auto, Manual
Capacity	0%		0 to 100%
Economizer En Cap	40%		40% to 75%
Clear Cycle Timers	Off		Off,On
EXV control	Auto		Auto, manual
EXV position	See note 2 below table		0% to 100%
Service Pumpdown	Off		Off,On
Evap pressure offset	0PSI	0kPa	-14.5 to 14.5 PSI /-100 to 100 kPa
Cond pressure offset	0PSI	0kPa	-14.5 to 14.5 PSI /-100 to 100 kPa
Oil pressure offset	0PSI	0kPa	-14.5 to 14.5 PSI /-100 to 100 kPa
Suction temp offset	0°F	0°C	-5.0 to 5.0 deg
Discharge temp offset	0°F	0°C	-5.0 to 5.0 deg

Fan 1 Setpoint	95 °F	35°C	69.8 to 140 °F / 21 to 60 °C
Fan 2 Setpoint	98,6 °F	37°C	69.8 to 140 °F / 21 to 60 °C
Fan 3 Setpoint	102,2 °F	39°C	69.8 to 140 °F / 21 to 60 °C
Fan 4 Setpoint	105,8 °F	41°C	69.8 to 140 °F / 21 to 60 °C
Fan 1 Differential	2.7 °F	1.5 °C	0.2 to 9 dF / 0.1 to 10 dK
Fan 2 Differential	2.7 °F	1.5 °C	0.2 to 9 dF / 0.1 to 10 dK
Fan 3 Differential	2.7 °F	1.5 °C	0.2 to 9 dF / 0.1 to 10 dK
Fan 4 Differential	2.7 °F	1.5 °C	0.2 to 9 dF / 0.1 to 10 dK
Vfd Min Speed	10%		0 to 45%
Vfd Max Speed	100%		55 to 100%
Vfd PID prop gain (kp)	10.0		0 to 50
Vfd PID deriv time (Td)	1.0 s		0 to 180s
Vfd PID integ time (Ti)	600.0 s		0 to 600s

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

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 for both evaporator and condenser.

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 Model

The unit model can be selected between the four available for this application. Depending on the model temperature ranges and refrigerant type are selected automatically.

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	HP Switch	BAS Request	Available Modes Set Point	Unit Mode
x	x	x	x	Cool	Cool
x	x	x	x	Cool w/Glycol	Cool
Local	Off	x	x	Cool/Ice w/Glycol	Cool
Local	On	x	x	Cool/Ice w/Glycol	Ice
Network	x	x	Cool	Cool/Ice w/Glycol	Cool
Network	x	x	Ice	Cool/Ice w/Glycol	Ice
x	x	x	x	Ice w/Glycol	Ice
Local	x	Off	x	Cool/Heat	Cool
Local	x	On	x	Cool/Heat	Heat
Network	x	x	Cool	Cool/Heat	Cool
Network	x	x	Heat	Cool/Heat	Heat
Local	Off	Off	x	Cool/Ice w/Glycol/ Heat	Cool
Local	On	Off	x	Cool/Ice w/Glycol/ Heat	Ice
Local	x	On	x	Cool w/Glycol/Heat	Cool
Local	x	On	x	Cool w/Glycol/Heat	Heat
Network	x	x	Cool	Cool/Ice w/Glycol/ Heat	Cool
Network	x	x	Ice	Cool/Ice w/Glycol/ Heat	Ice
Network	x	x	Heat	Cool/Ice w/Glycol/ Heat	Heat
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

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

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	-	-
3	Off:All Cir Disabled	Unit State = Off and all compressors unavailable
4	Off:Unit Alarm	Unit State = Off and Unit Alarm active
5	Off:Keypad Disable	Unit State = Off and Unit Enable Set Point = Disable
6	Off:Remote Switch	Unit State = Off and Remote Switch is open
7	Off:BAS Disable	Unit State = Off, Control Source = Network, and BAS Enable = false
8	Off:Unit Switch	Unit State = Off and Unit Switch = Disable
9	Off:Test Mode	Unit State = Off and Unit Mode = Test
10	Auto:Noise Reduction	Unit State = Auto and Noise Reduction is active
11	Auto:Wait for load	Unit State = Auto, no circuits running, and LWT is less than the active set point + startup delta
12	Auto:Evap Recirc	Unit State = Auto and Evaporator State = Start
13	Auto:Wait for flow	Unit State = Auto, Evaporator State = Start, and Flow Switch is open
14	Auto:Pumpdown	Unit State = Pumpdown
15	Auto:Max Pulldown	Unit State = Auto, max pulldown rate has been met or exceeded
16	Auto:Unit Cap Limit	Unit State = Auto, unit capacity limit has been met or exceeded
17	Auto:Current Limit	Unit State = Auto, unit current limit has been met or exceeded
18	Off:Config Changed, Reboot	Unit State = Off and Unit Enable Set Point = Disable
19	Off:Set Mfg Location	Unit State = Off and Unit Enable Set Point = Disable

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 ℃ and LWT sensor fault isn't active
- EWT is less than the Evap Freeze set point minus 0.6 ℃ 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.

Condenser Pump Control

There are three condenser pump control states for control of the condenser pump:

- Off
- Start – Pump is on, water loop is being recirculated
- Run – Pump is on, water loop has been recirculated

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

- Unit state is Off
- LWT is higher of Evap Freeze set point or LWT sensor fault is active
- EWT is higher of 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 lower than (Evap Freeze set point - 0.6 ℃) and LWT sensor fault is not active or EWT is lower than (Evap Freeze set point – 0.6 ℃) and EWT sensor fault is not active.

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

Condensation Control

Three condensation control modes are available:

- Cond In – the condensation control measure is the condenser entering water temperature
- Cond Out - the condensation control measure is the condenser leaving water temperature
- Pressure - the condensation control measure is the gas pressure referred to condenser saturated temperature

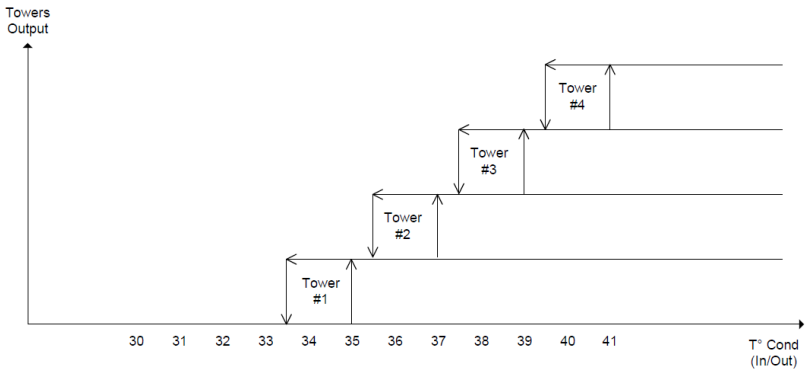
The Condenser control mode is determined by the Condensation Control Value set point.

Within these control modes, the application manages the outputs for the control of condensation devices:

- n.4 on/off signals, always available
- n.1 modulating 0-10V signal, whose availability is determined by the Condensation Analog Output type set point.

Cond In/Cond Out condensation control

If the Condensation Control Value Set Point is set to Cond In or Cond Out options, then Tower fan #1..4 control is enabled for the unit.
According to Tower fan #1..4 set point and differential default values listed in the Unit Set Points table, the following graph summarizes the activation and deactivation conditions for Towers fan.



The Tower fan # (# = 1..4) control states are:

- Off
- On

The Tower fan # control state is Off when any of the following are true:

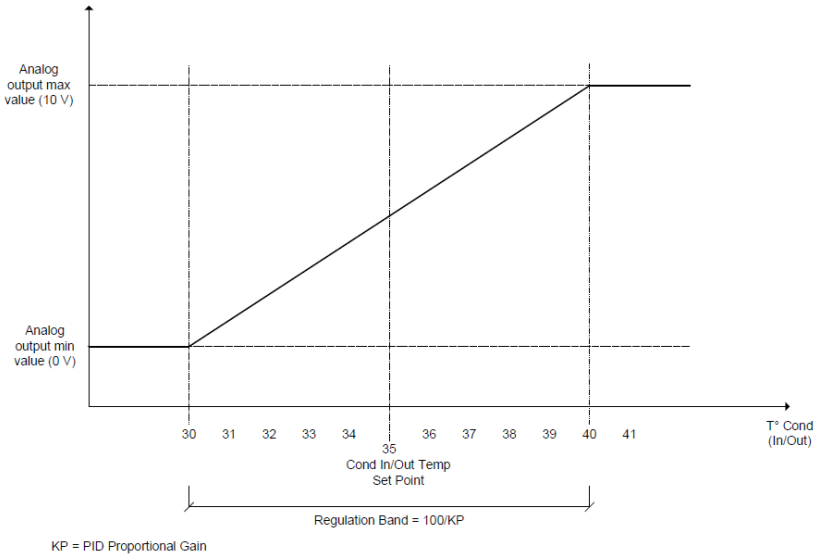
- Unit state is Off
- Tower fan # state is Off and EWT (Cond In) or LWT (Cond Out) is lower than Tower fan # Set point
- Tower fan # state is On and EWT (Cond In) or LWT (Cond Out) is lower than Tower fan # Set point – Tower fan # Diff.

The Tower fan # control state is On when all of the following are true:

- The unit state is auto

- EWT (Cond In) or LWT (Cond Out) is equal or higher than Tower fan # Set point

If the Condensation Control Value Set Point is set to Cond In or Cond Out options and Cond Aout type Set Point is set to Vfd or Byp Valve options, a 0-10V signal is also enabled for the unit to regulate a modulating condensation device by mean of a PID controller.
According to Vfd/Byp Valve default values listed in the Unit Set Points table, the following graph is an example of the modulating signal behavior in case of a control supposed to be purely proportional.



In this case, the analog output varies across the regulation band calculated as Condenser Water Temp Set Point ± 100/kp, where kp is the control proportional gain, and centered on the Condenser Water Temp Set Point.

Pressure condensation control

Refer to Circuit Functions.

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

Network	x	OFF	x	ICE w/Glycol	BAS Ice Set Point
Local	OFF	ON	X	HEAT	Heat Set Point 1
Local	ON	ON	X	HEAT	Heat Set Point 2
Network	X	x	HEAT	HEAT	BAS Heat Set Point

Leaving Water Temperature (LWT) Reset

The base LWT target may be reset if the unit is in Cool or Heat 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 **0.05 °C** (0.1°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 **15°C** (60°F).

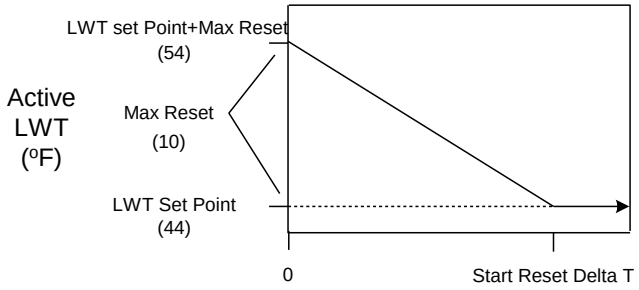
Reset Type – None

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

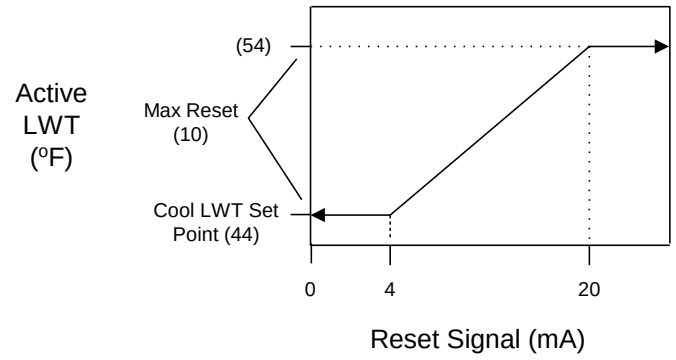
The Active Leaving Water variable is adjusted by the 4 to 20 mA reset analog input.

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



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.

Compressor Staging in Heat Mode

The first compressor on the unit is started when condenser LWT is lower than the target minus the Startup Delta T set point.

An additional compressor is started when condenser LWT is lower than the target minus the Stage Up Delta T set point.

When multiple compressors are running, one will shut down if condenser LWT is higher than the target plus the Stage Down Delta T set point.

The last compressor running will shut down when the condenser LWT is higher than the target plus 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 in Cool Mode

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.

Light Load Stage Down in Heat Mode

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 condenser LWT is greater than the target minus 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 **0.2 °C** (0.4 °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 **18 °C** (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.

Circuit Functions

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. Its value is 68.3°C basically but it can change when saturated evaporator temperature decreases below 0°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 to maintain the proper pressure ratio, to keep the compressor lubricated and to have the maximum circuit performances. The calculated target value is 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.

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:Oil Heating	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 12°C 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 (Asymmetric compressors)

This section applies to the following compressor models (asymmetric):

Model	Name plate
F3AS	HSA192
F3AL	HSA204
F3BS	HSA215
F3BL	HSA232
F4AS	HSA241
F4AL	HSA263

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.

Slide Control Solenoids (Symmetric compressors)

This section applies to the following compressor models (asymmetric):

Model	Name plate
F4221	HSA205
F4222	HSA220
F4223	HSA235
F4224	HSA243
F3216	HSA167
F3218	HSA179
F3220	HSA197
F3221	HSA203
F3118	HSA3118
F3120	HSA3120
F3121	HSA3121
F3122	HSA3122
F3123	HSA3123

The required capacity is achieved by controlling one modulating slide. The modulating slide can control 25% to 100% of the total compressor capacity, infinitely variable.

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

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.

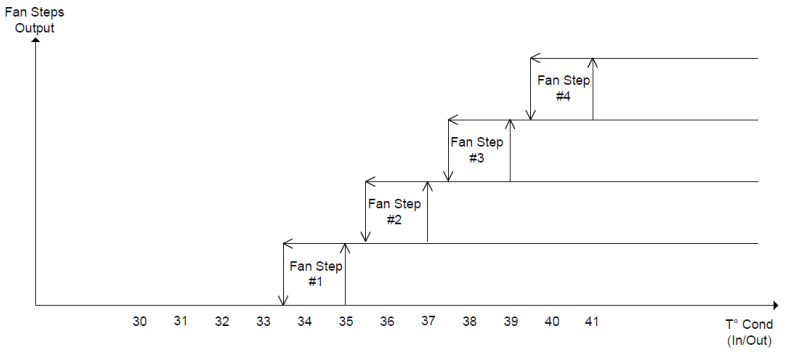
If the High Condenser Pressure Unload event is triggered, the compressor will begin reducing capacity.

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.

Pressure condensation control

If the Condensation Control Value Set Point is set to Press option, then Fan steps #1..4 control is enabled for each enabled circuit.
According to Fan steps set point and differential default values listed in the Circuit Set Points table, the following graph summarizes the activation and deactivation conditions for fan steps.



The Fan step# (# = 1..4) control states are:

- Off
- On

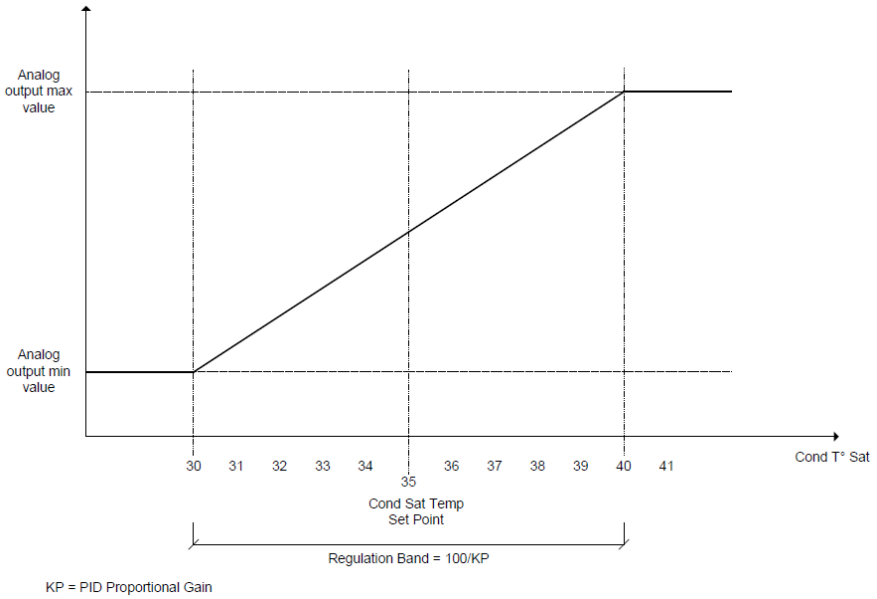
The Fan step # control state is Off when any of the following are true:

- Unit state is Off
- Fan step# state is Off and the Saturated Condenser Temperature corresponding to the current Condenser Pressure is lower than Fan step # Set point.
- Fan step # state is On the Saturated Condenser Temperature corresponding to the current Condenser Pressure is lower than Fan step# Set point – Fan step# Diff.

The Tower # control state is On when all of the following are true:

- The unit state is auto
- The Saturated Condenser Temperature corresponding to the current Condenser Pressure is equal or higher than Fan step# Set point

If the Condensation Control Value Set Point is set to Press option and Cond Aout type Set Point is set to Vfd option, a 0-10V signal is also enabled for the circuit to regulate a modulating condensation device by mean of a PID controller.
According to Vfd default values listed in the Circuit Set Points table, the following graph represents the modulating signal behavior in case of a control supposed to be purely proportional.



In this example, the analog output varies across the regulation band calculated as Condenser Saturated Temp Set Point ± 100/kp, where kp is the control proportional gain, and centered on the Condenser Saturated Temp Set Point.

EXV Control

The control is able to support different valve models from different vendors. When a model is selected, all the operational data for that valves are set including phase and hold currents, total steps, motor speed and extrasteps.

The EXV is moved at a rate which depends on the valve model, with a total range of 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 **20°C** (68 °F)

then a pressostatic (constant pressure) 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 in a pre-defined range

The EXV controls the suction superheat within **0.83**°C (1.5°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 **15°C** (27 °F) to **25 °C (**45°F).

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 **20°C (68°F)** at startup or if the pressure becomes higher than **350.2 kPa (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 **350.2 kPa (50.8 psi)**. It switches back to normal operation as soon as the suction superheat drops below a pre-defined value.

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.

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°C.

Alarms and Events

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 alarm devices. Refer to unit onboard documentation for field wiring information.

Description of Alarms

Phase Volts Loss/GFP Fault

Alarm description (as shown on screen): UnitOffPhaseVoltage

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): UnitOffEvapWaterFlow

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): UnitOffEvapWaterTmpLo

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 Water Temperatures Inverted in Cool Mode

Alarm description (as shown on screen): UnitOffEvpWTempInvrtd

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

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.

External Alarm

Alarm description (as shown on screen): UnitOffExternalAlarm

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

Action Taken: Pumpdown stop on all circuits.

Reset: Auto clear when digital input is closed.

Emergency Stop Alarm

Alarm description (as shown on screen): UnitOffEmergencyStop

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): UnitOffEvpEntWTemp

Trigger: Sensor shorted or open

Action Taken: Pumpdown stop on all circuits.

Reset: Auto reset when sensor is back in range.

Unit Power Restore

Event description (as shown on screen): UnitPowerRestore
Trigger: Unit controller is powered up.

Action Taken: none

Reset: none

External Event

Alarm description (as shown on screen): UnitExternalEvent

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

Action Taken: None

Reset: Auto clear when digital input is closed.

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): C# OffPhaseVoltage

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): Co#.LowEvPr

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): C# OffStrtFailEvpPr

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): C# Cmp1 OffMechPressLo

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): Co#.HighCondPr

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): C# Cmp1 OffPrRatioLo

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): C# Cmp1 OffMechPressHi

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

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): C# Disc Temp High

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): C# Cmp1 OffOilPrDiffHi

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): C# Cmp1 OffStarterFlt

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): C# Cmp1 OffMotorTempHi

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.

No Pressure Change After Start

Alarm description (as shown on screen): C# OffNoPressChgStart

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): C# OffNoPressAtStart

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

Alarm description (as shown on screen): C# OffCmpCtrlrComFail
Trigger: Communication with the I/O extension module has failed. Section 'Control network details' 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 2

Alarm description (as shown on screen): C2 OffFnCtlrComFail

Trigger: Condensation Control Value Set Point is set to Press option, Circuit 2 is enabled and communication with the I/O extension module has failed. Section 'Control network details' indicates the expected type of module and the address for the module.
Action Taken: Rapid stop of circuit 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): C3 OffFnCtlrComFail

Trigger: Condensation Control Value Set Point is set to Press option, Circuit 3 is enabled and communication with the I/O extension module has failed. Section 'Control network details' indicates the expected type of module and the address for the 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.

EEXV Comm Failure

Alarm description (as shown on screen): C# OffEXVCrtlrComFail

Trigger: Communication with the I/O extension module has failed. Section 'Control network details' 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.

Heat Pump Comm Failure

Alarm description (as shown on screen): HeatPCtrlrCommFail

Trigger: Heating mode is enabled and communication with the I/O extension module has failed. Section 'Control network details' indicates the expected type of module and the address for the module.
Action Taken: Pumpdown stop on all 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.

Evaporator Pressure Sensor Fault

Alarm description (as shown on screen): C# Cmp1 OffEvpPress

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): C# Cmp1 OffCndPress

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): C# Cmp1 OffOilFeedP

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): C# Cmp1 OffSuctTemp

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): C# Cmp1 OffDischTmp

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): C# Cmp1 OffMtrTempSen

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

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): C# UnloadEvapPress

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% (for Asymmetric compressors only).**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 + **2psixxx**). 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): C# InhbtLoadCndPr

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

Action Taken: Inhibit loading.

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

High Condenser Pressure - Unload

Event description (as shown on screen): C# UnloadCondPress
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^{o}F). The event is also reset if the unit mode is switched to Ice, or the circuit is no longer in the run state.

Failed Pumpdown

Event description (as shown on screen): C# FailedPumpdown

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): C# PwrLossRun

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

Action Taken: N/A

Reset: N/A

Alarm Logging

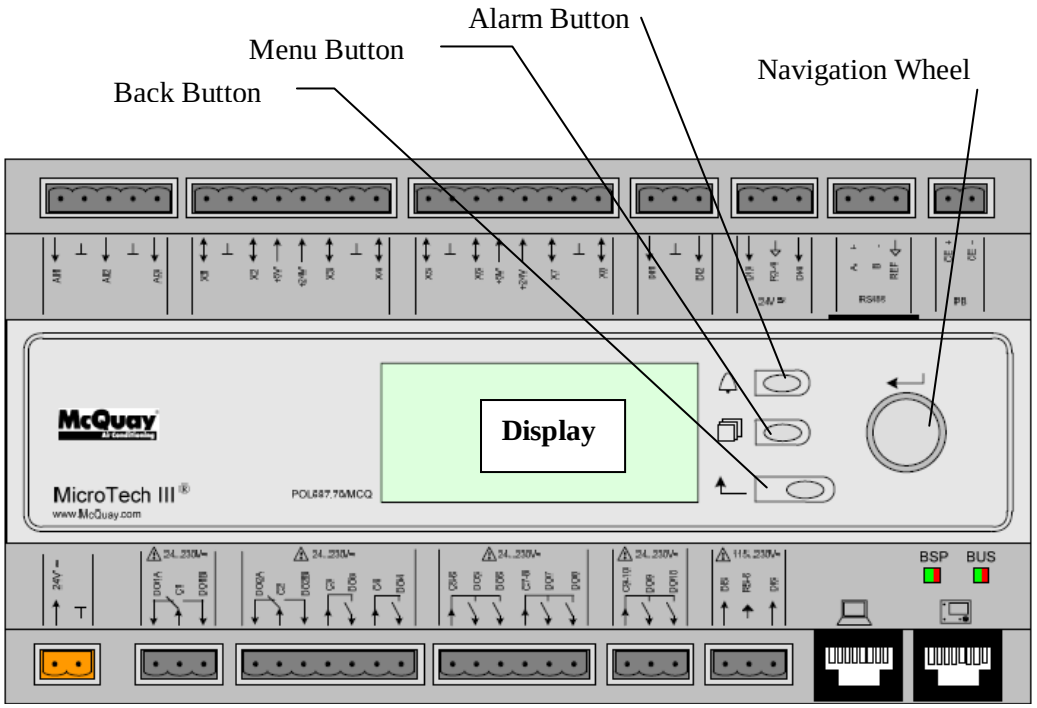
When an alarm occurs, the alarm type, date, and time are stored in the active alarm buffer corresponding to that alarm (viewed on the Alarm Active screens) also in the alarm history buffer (viewed on the Alarm Log screens). The active alarm buffers hold a record of all current alarms.

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, 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.

Using the Controller

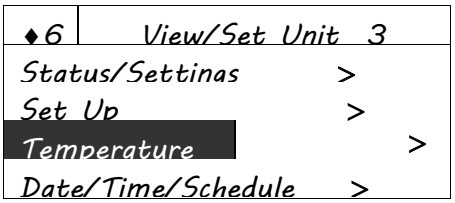
The Unit Controller Operation

Figure 7, 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 8, 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 eleven 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 and is cancelled if a new password is entered or the control powers down.

- Other basic information and links are shown on the Main Menu page for ease of usage and includes Active setpoint, Evaporator Leaving Water Temperature, etc. The About Chiller link connect to a page were is possible to see the software version.

Figure 9, Password Menu

Main Menu 1/11	
Enter Password	>
Unit Status=	
Auto	
Active Setpt=	xx·x°C
Evap LWT=	xx·x°C
Unit Capacity=	xxx·x%
Unit Mode=	Cool
Time Until Restart	>

Figure 10, 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 10.
- 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.

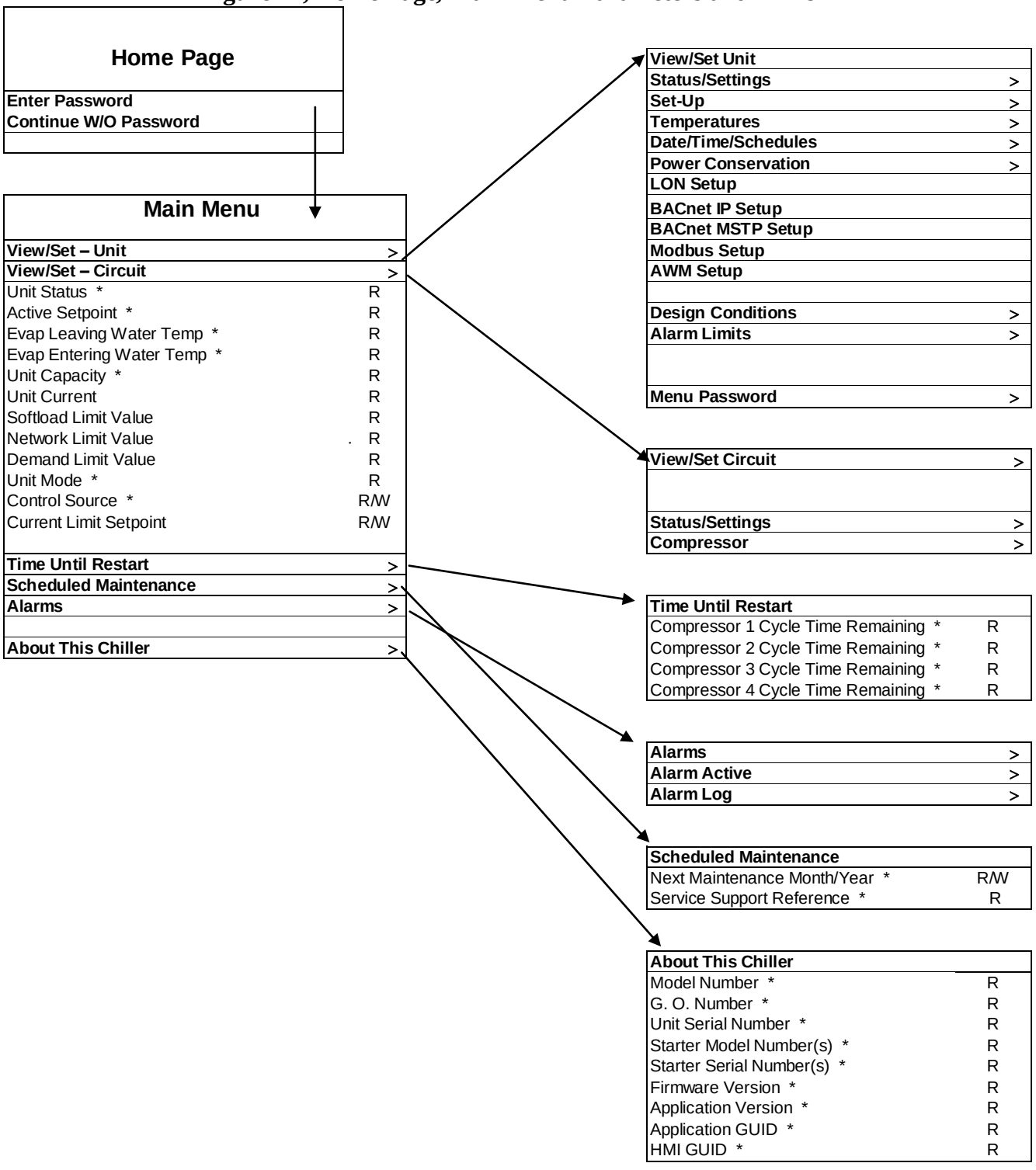
Rotate the wheel to scroll down to Control Source and read the result.

Example 2; Change a Set point, the chilled water set point for example. This parameter is designated as Cool LWT Set point 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 set points. Scroll down to Cool LWT 1 and press the wheel to jump to the item change page. Rotate the wheel to adjust the set point to the desired value. When this is done press the wheel again to confirm the new value. With the Back button it will be possible to jump back to the Temperatures menu where the new value will be displayed.

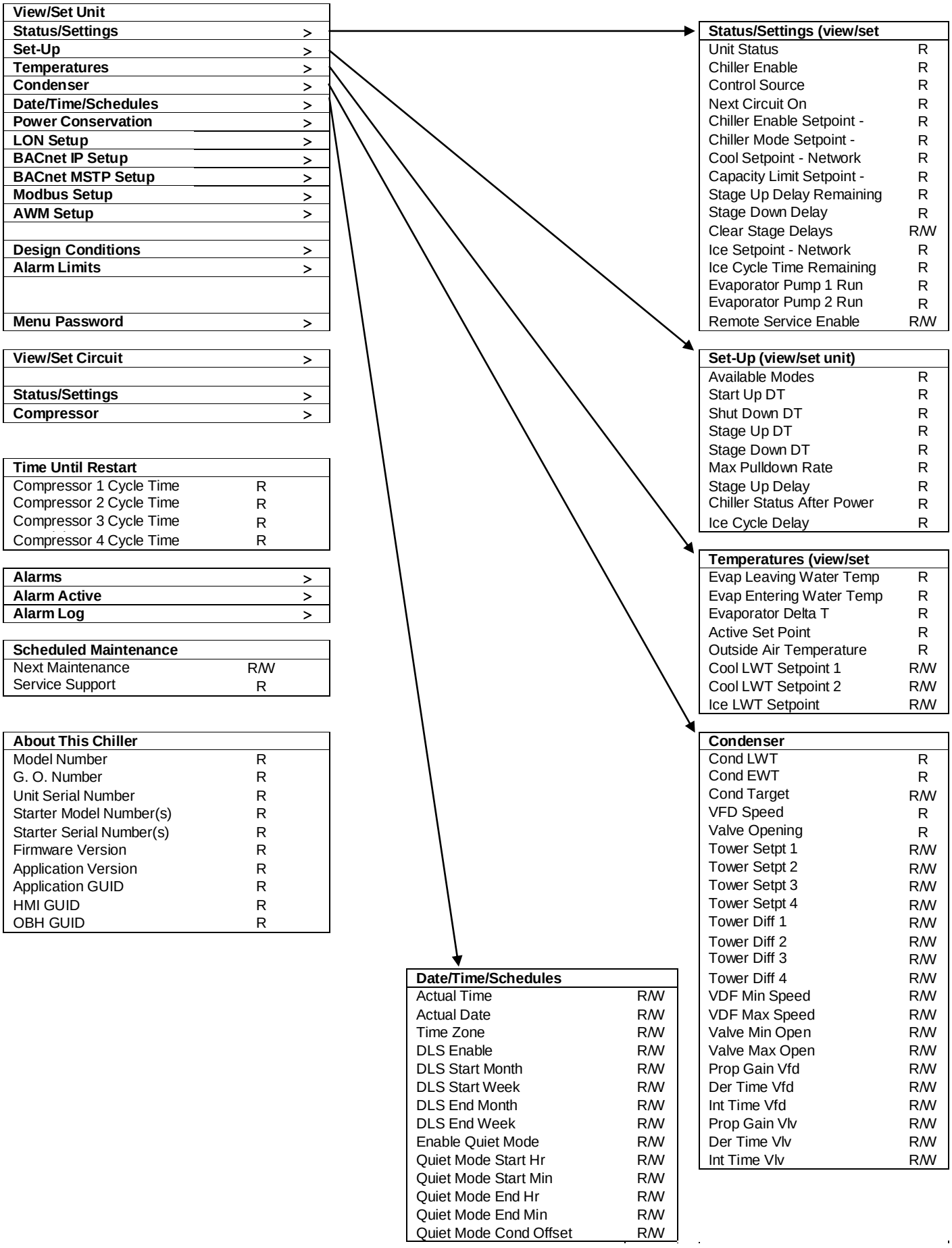
Example 3; Clear an Alarm,. The presence of a new alarm is indicated with a Bell ringing on the top right of the display. If the Bell is frozen one or more alarm had been acknowledged but are still active. To view the Alarm menu from the Main Menu scroll down to the Alarms line or simply press the Alarm button on the display. 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. When the Active Alarm list is entered scroll to the item AlmClr which is set to off by default. Change this value to on to acknowledge the alarms. If the alarms can be cleared then the alarm counter will display 0 otherwise it will display the number of alarm still active. When the alarms are acknowledged the Bell on the top right of the display will stop to ring if some of the alarms are still active or will disappear if all the alarms are cleared.

Figure 11, Home Page, Main Menu Parameters and Links



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

Figure 12, Navigation, Part A



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

Figure 2, Navigation, Part B

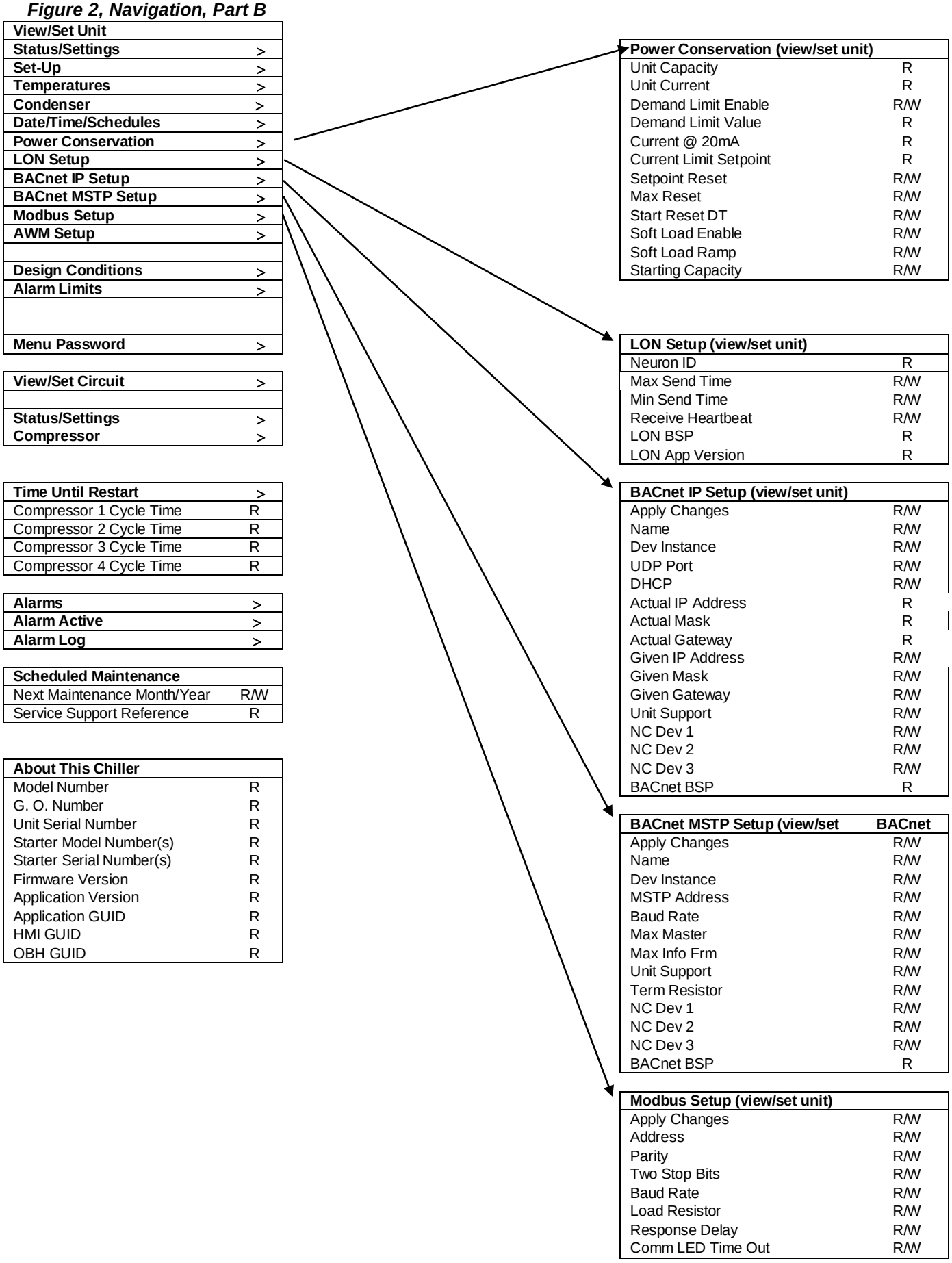
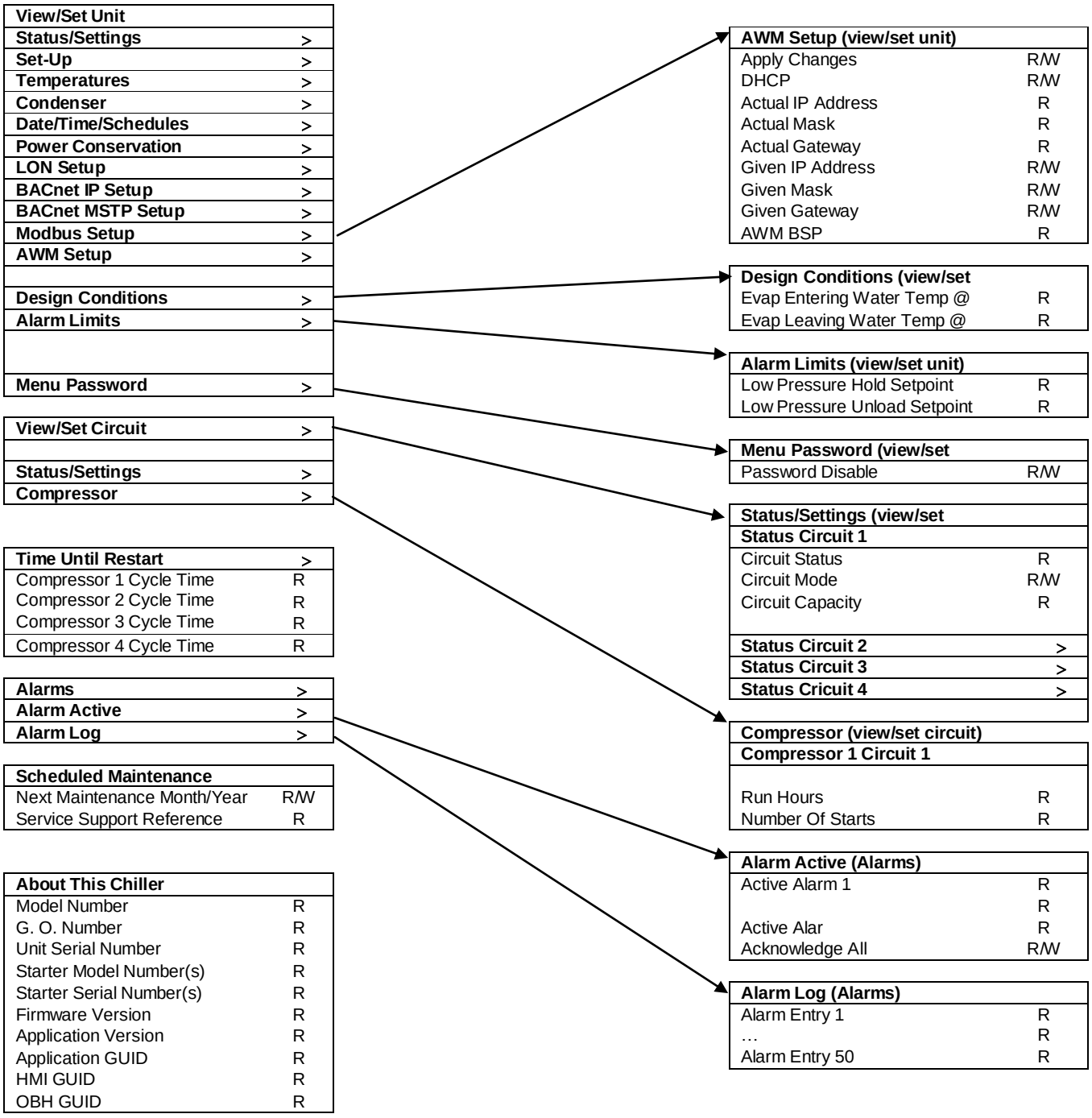


Figure 3, Navigation, Part C



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

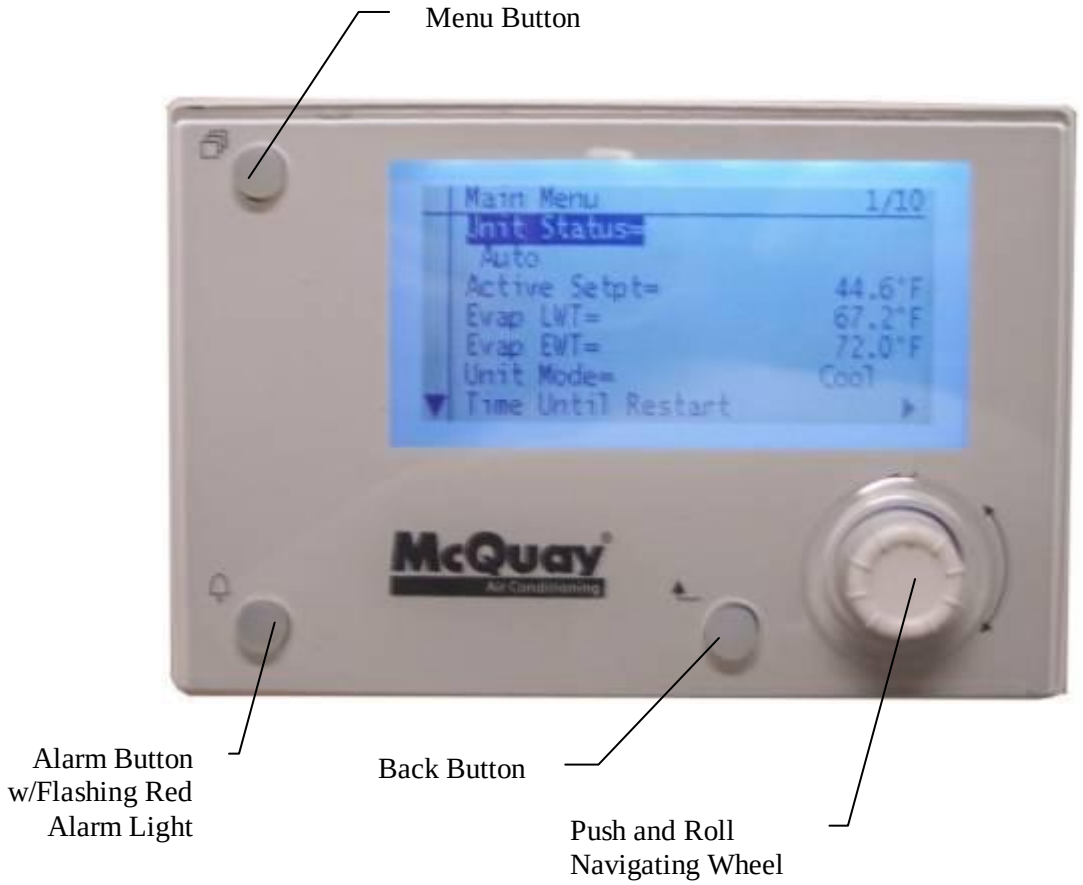
Optional Remote User Interface

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.

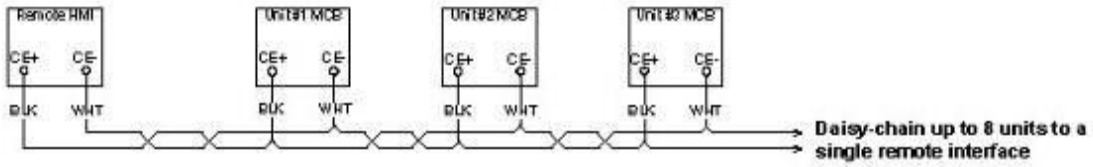


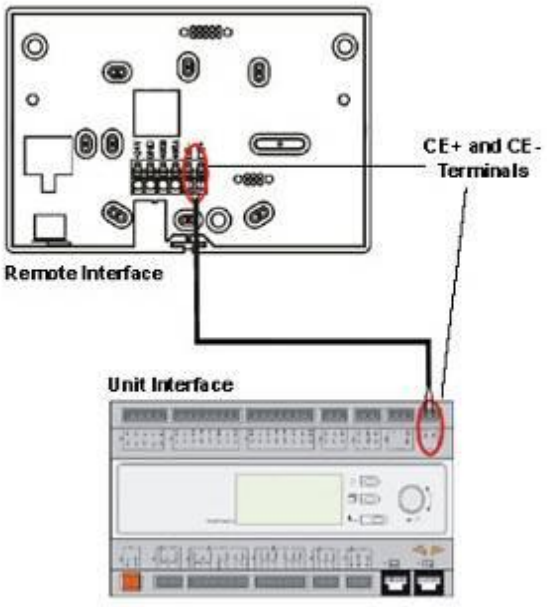
Technical Specifications

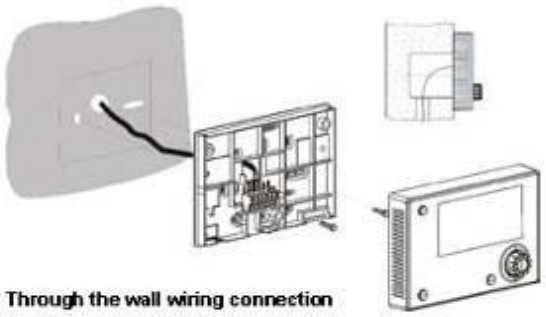
Interface		
Process Bus	Up to eight interfaces per remote	
Bus connection		CE+, CE-, not interchangeable
Terminal	2-screw connector	
Max. length	700 m	
Cable type	Twisted pair cable; 0.5...2.5 mm2	
Display		
LCD type	FSTN	
Dimensions	5.7 W x 3.8 H x 1.5 D inches (144 x 96 x 38 mm)	
Resolution	Dot-matrix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

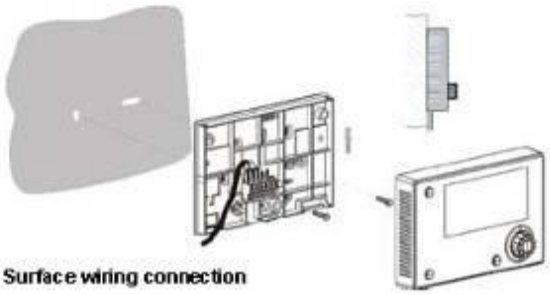
Cover Removal

Process Bus Wiring Connections






Through the wall wiring connection


Surface wiring connection

Start-up and Shutdown

NOTICE
Daikin 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

Field wiring diagram is generated for each unit and is part of the unit onboard documentation. Refer to this document for a complete explanation of the field wirings for this chillers.

Basic Control System Diagnostic

MicroTech III controller, extension modules and communication modules are equipped with two status LED (BSP and BUS) to indicate the operational status of the devices. The meaning of the two status LED is indicated below.

Controller LED

BSP LED	BUS LED	Mode
Solid Green	OFF	Application running
Solid Yellow	OFF	Application loaded but not running (*)
Solid Red	OFF	Hardware Error (*)
Flashing Yellow	OFF	Application not loaded (*)
Flashing Red	OFF	BSP Error (*)
Flashing Red/Green	OFF	Application/BSP update

(*) Contact Service.

Extension Module LED

BSP LED	BUS LED	Mode
Solid Green		BSP running
Solid Red		Hardware Error (*)
Flashing Red		BSP Error (*)
	Solid Green	Communication running, I/O working
	Solid Yellow	Communication running, parameter missing (*)
	Solid Red	Communication down (*)

(*) Contact Service.

Communication Module LED

BSP LED	Mode
Solid Green	BPS running, communication with controller
Solid Yellow	BSP running, no communication with controller (*)
Solid Red	Hardware Error (*)
Flashing Red	BSP Error (*)
Flashing Red/Green	Application/BSP update

(*) Contact Service.

BUS LED status vary depending on the module.

LON module:

BuS LED	Mode
Solid Green	Ready for Communication. (All Parameter loaded, Neuron configured). Doesn't indicate a communication with other devices.
Solid Yellow	Startup
Solid Red	No Communication to Neuron (internal error, could be solved by downloading a new LON application)
Flashing Yellow	Communication not possible to the Neuron. The Neuron must be configured and set online over the LON Tool.

Bacnet MSTP:

BuS LED	Mode
Solid Green	Ready for Communication. The BACnet Server is started. It doesn't indicate a active communication
Solid Yellow	Startup
Solid Red	BACnet Server down. Automatically a restart after 3 seconds are initiated.

Bacnet IP:

BuS LED	Mode
Solid Green	Ready for Communication. The BACnet Server is started. It doesn't indicate a active communication
Solid Yellow	Startup. The LED stays yellow until the module receives a IP Address, therefore a link must be established.
Solid Red	BACnet Server down. Automatic restart after 3 seconds is initiated.

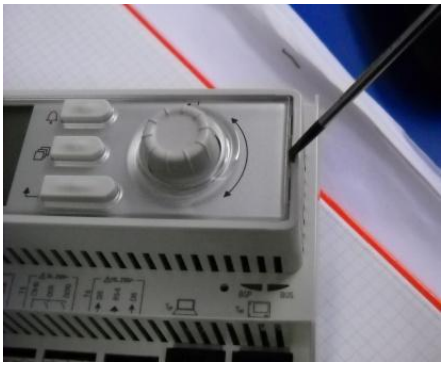
Modbus

BuS LED	Mode
Solid Green	All Communication running
Solid Yellow	Startup, or one configured channel not communicating to the Master.
Solid Red	All configured Communications down. Means no communication to the Master. The timeout can be configured. In case that the timeout is zero the timeout is disabled.

Controller maintenance

The controller requires to maintain the installed battery. Every two years it's required to replace the battery. Battery model is: BR2032 and it is produced by many different vendors.

To replace the battery remove the plastic cover of the controller display using a screw driver as shown in the following picture:



Be careful to avoid damages to the plastic cover. The new battery shall be placed in the proper battery holder which is highlighted in the following picture, respecting the polarities indicated into the holder itself.

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.

BSP

The BSP represents the operative system of the MicroTech III controller.

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 **6.5 °C** (44°F) and it has a dead band of ±1°C (± 2 °F), nothing will happen until the measured temperature is less than **5.5°C** (42°F) or more than **7.5°C** (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

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 – **2.7 °C** (5 °F)

This function prevents the compressor from loading whenever the pressure approaches within **2.7 °C** (5 °F) 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 – **1.6 °C** (3°F)

This function unloads the compressor whenever the pressure approaches within **1.6 °C** (3°F) 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 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 6.5 °C** (44°F) and the actual temperature of the water at a given moment is **7.5°C** (46°F), the LWT error is **+1°C** (+2°F).

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.

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.

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 screw compressors.

Suction Superheat

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

Suction Superheat = Suction Temperature – Evaporator Saturated Temperature

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.

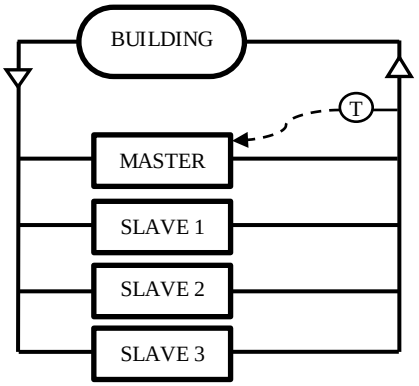
Master/Slave

In this section will be described the Master Slave (MS) control logic and all scenarios where this function can be applied. MS control consists in a common management of more chillers interconnected between them through the serial communication Konnex, where a chiller defined Master gets the control of all other chillers defined Slaves.

All schemes present in this section provide only a principle diagram of the hydraulic connection

Master Slave Overview

Master Slave function allows to control multi-chiller plant with a maximum of 4 chillers, 1 Master + 3 Slaves, connected in parallel in the water circuit. Temperature control is always performed on the base of the common leaving water temperature read by the Master chiller.



The MS function is able to manage individually several plants. The main difference that identifies every plant type is mainly in the number and in the connection method of the water pumps. The MS never can provide a speed modulation signal for one or more water pumps.

- **Plant 1 : Single Common Pump**

The simplest plant that Master Slave function can manage is composed by a single common pump installed on the water manifold that provided the water flow for all chillers of the network. The pump enable is obtained putting in parallel the enable contacts of the evaporator water pump of each chiller. First chiller enabled to start by the Master will activate the common pump. With this plant type all chillers are always crossed by the water flow even if they are still.

- **Plant 2 : Single Chiller Pump**

In the second plant type every chiller of the Master Slave network is equipped with a pump. The pump can be installed directly on the unit or in the pipe of the single chiller and it avoids the water flow in the evaporator if the chiller is in off state. Every pump will be commanded only by the chiller to which is connected.

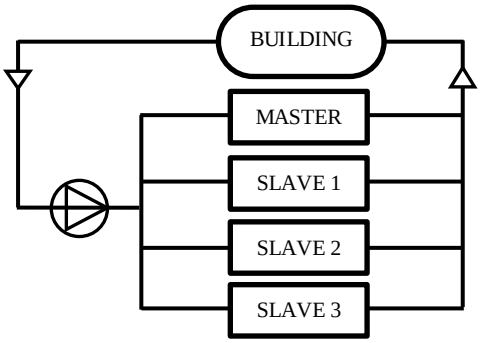
- **Plant 3 : Double Chiller Pump**

Third plant type is an extension of the previous plant. As standard every chiller can control two evaporator water pumps: primary and standby. This function is maintained also in Master Slave. Every pair of pumps is connected to the related chiller that will manage them rotation according to the local settings.

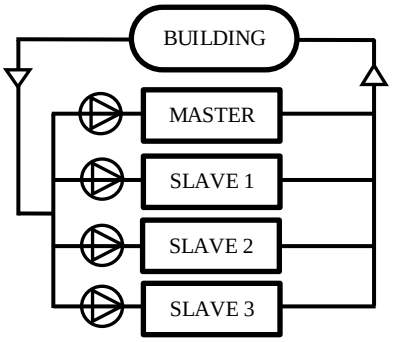
- **Plant 4. Chiller with sectioned evaporator**

In the last plant type every chiller has the evaporator sectioned by a two way valve that avoids the water flowing if the chiller is not running. The number of pumps and valves has to be the same of number of chillers, as every pump and every valve is associated to a specific chiller. Like in the Single Chiller Pump plant every chiller will enable its valve and its pump. No standby pump can be managed in this plant type.

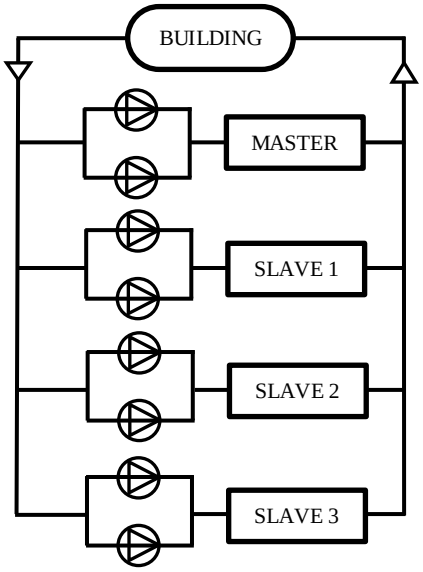
In this case it is advisable to connect the evaporator water pump enable provided by the chiller to the valve and consequently the feedback of total opening of the valve to the enable of the pump. In this way should be avoided all problems of over-pressure due to a simultaneous starting of the pump and of the valve



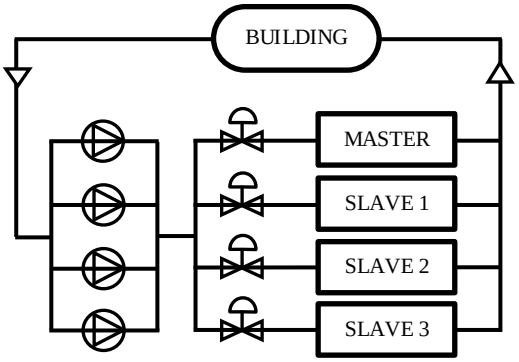
Single Common Pump



Single Chiller Pump



Double Chiller Pump



Chiller with sectioned evaporator

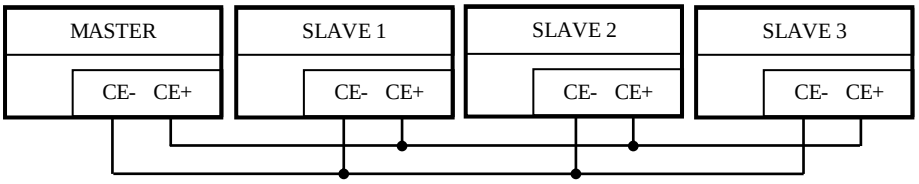
Electrical Connection

In the following section are reported all electrical connections necessary for the correct operation of the Master Slave function.

All schemes present in this section provide only a principle diagram of the electrical connection

Process Bus

The following diagram shows how have to be connected the chillers between them to establish the Master Slave Network. Starting from first chiller connect in parallel all terminals PB [CE+ / CE-] of each controllers, accessible on the customer terminal board. Refer to the table for the enumeration of the terminals.



Common leaving water temperature sensor

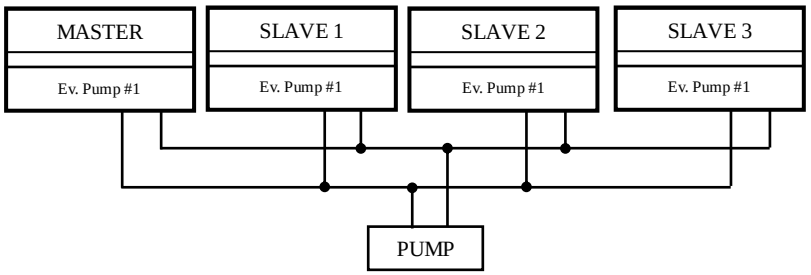
Common leaving water temperature sensor has to be connected to the chiller Master through the customer terminal block (Master/Slave Temperature Sensor). Refer to the table for the enumeration of the terminals.

Pumps Connection

Different types of pump connections are available depending on the plant type where the Master Slave function is used.

1. Single Common Pump

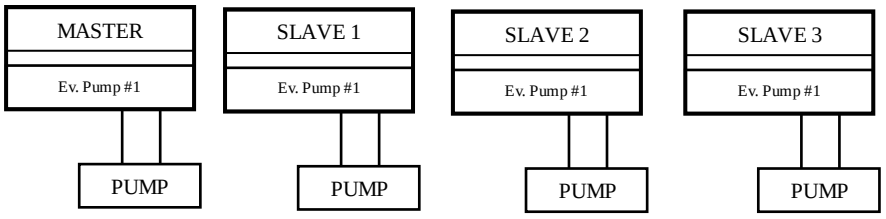
In the plant type Single Common Pump, where a unique pump provides all water flow, all enable pump contacts of each chiller have to be connected in parallel so that it is possible to provide a unique enabling contact for the common pump. The pump contact of each chiller is available on the customer terminal block (Evaporator Pump #1 start). Refer to the table for the enumeration of the terminals.



For the water cooled unit with water inversion, remember that in heat mode the user side pump is not the evaporator pump but the condenser pump. For this reason will be necessary use the terminal Condenser Pump #1 start to control the common pump

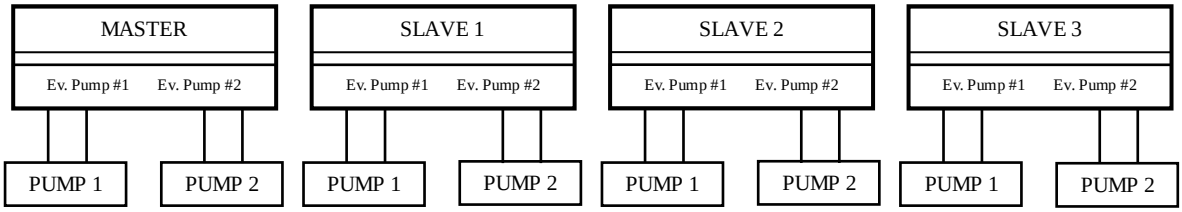
2. Single Chiller Pump

In the plant type Single Chiller Pump, every pump have to be connected to the related unit. The enabling contact is available on the customer terminal block (Evaporator Pump #1 start). Refer to the table for the enumeration of the terminals.



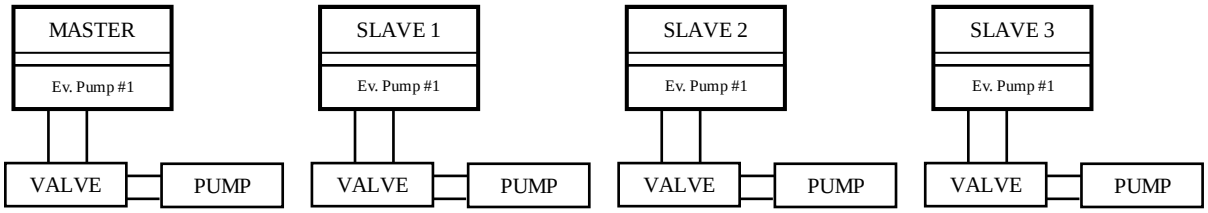
3. Double Chiller Pump

In the plant type Double Chiller Pump, every pair of pump have to be connected to the related chiller. The enabling contact are available in the customer terminal block (Evaporator Pump#1 start / Evaporator Pump#2 start). Refer to the table for the enumeration of the terminals.



4. Chiller with sectioned evaporator

In the plant where the evaporator is sectioned by a two way valve, connect the valve to the pump enable provided by the chiller and the pump to the total opening feedback of the valve. The enabling contact is available in the customer terminal block (Evaporator Pump#1 start). Refer to the table for the enumeration of the terminals.



Master Slave Operation

Master Slave configuration

The basic configuration of the Master Slave function requires the set of three parameters available in the unit configuration menu.

Setpoint/Sub-Menu	Default	Range	Description
M/S Address	Standalone	Standalone Master Slave 1 Slave 2 Slave 3	Define if the chiller works as standalone or if belongs to Master Slave network. Standalone: Current unit does not belong to the Master Slave network Master: Current unit is defined Master Slave 1: Current unit is defined Slave 1 Slave 2: Current unit is defined Slave 2. This address can be assigned only if the parameter **M/S Num Of Unit** = 3 or 4 Slave 3: Current unit is defined Slave 3. This address can be assigned only if the parameter **M/S Num Of Unit** = 4 Example: If in a network there are 3 chillers then them have to be addressed like : Master - Slave 1 - Slave 2. Any other addressing will generate a configuration alarm
M/S Num Of Unit	2	2,3,4	Indicate the number of chiller belonging to Master Slave network. This parameter have to be set only in the chiller Master, in all Slave units it can be let at default value as ignored.
M/S Sns Type	NTC10K	NTC10K, PT1000	Define the sensor type used to measure the common leaving water temperature. This parameter have to be set only in the

			chiller Master, in all Slave units it can be let at default value as ignored.

System enable

The startup and shutdown of all system can be performed applying the normal enabling commands (Local/Remote switch, HMI command, enable by Modbus/BACNet/Lon) to the master unit.

All other slaves unit maintain however their local enabling. When a slave is locally not enable, the master will consider it as not ready unit and will not send it starting commands.

Since that the master loses his its local enabling (used as system enable), it is present in the menu the parameter

Master Enable that allows to disable the Master. Disable the Master unit means that it will not use for the thermoregulation but it will continue to acquire the common leaving water temperature and it will continue to send the activation command to the slave units.

System setpoint

Temperature control in the MS is performed on the base of the common evaporator leaving water temperature respect the target value set in the Master chiller. This setpoint is global for all system and it is sent by the Master to all Slaves through the serial communication.

Like in the single chiller, every function to modify the target value (LWT Reset, Double setpoint, changes by Modbus/BACNet/Lon) can be applied to the Master to modify the global temperature target.

On the Slave chillers the parameter **Active Setpt** (refer to section) always will display the target received by the master except when the unit is in alarm communication or the function **Disconnect Mode** 0 is active.

System Operating Mode: Cool/Heat/Ice

All units belonging to the Master Slave network always have to work with same operating mode. Since that in all units the operating mode is local, master chiller does not send its operating mode, it is very important verify that the changeover Cool, Heat, Ice always will be performed in all unit.

For the water cooled chiller remember that the Master Slave cannot manage the Pursuit mode.

Operation with a communication alarm

All Slave units communicate through a serial communication with the Master unit. If during the normal functioning occurs a communication failure between Master and Slave the system continue to run with the followings behavior:

- The Slave unit that has lost the communication with the Master starts to operate as a Standalone unit following all local settings

- The Master unit detects that there is a communication error with a Slave and if present enable the Standby Chiller

If the Master unit loses the communication with all units of the network then all chiller will work in standalone mode

Master Slave Options

Chiller Priority

Startup and shutdown of each chiller is managed by the Master based on the conditions reported in the table below

Conditions	Next Chiller to start	Next Chiller to stop
1st	Highest priority	Lowest priority
2nd	Lowest number of starts	Lowest load
3rd	Lowest running hours	Highest running hours
4th	Lowest address	Highest number of starts
5th	-	Lowest address

First condition is related to the priority defined for each chiller. The priority default values are all 1, i.e. all unit have the same priority. A value of 1 indicates highest priority, a value of 4 indicates lowest priority. The priority values can be modified on the Master chiller (refer to section).

Standby Chiller

Master Slave function allows to define one of the chillers belonging to the network as standby chiller. The standby chiller is normally off and becomes operating only when one of the following conditions occurs:

1. At least one chiller is in alarm state.
2. At least one of the Slave chillers is in communication alarm with the Master chiller.
3. At least one chiller is not enabled.
4. The function Temperature Compensation is enabled and the water temperature setpoint is not reached with the system at full load.

In the following is explained step by step how to set all parameters changeable through the menu to configure the standby chiller according to the local requirements.

Step 1 : Selection of the standby chiller.

Setpoint/Sub-Menu	Default	Range	Description
Standby Chiller	No	No Auto Master Slave 1 Slave 2 Slave 3	**No** = There are not standby chiller in the Master Slave network **Auto** = One of the chillers of the Master Slave network will be always assigned as standby chiller. The rotation of the standby chiller will be performed according to the configuration set through the parameters **Rotation Type** and **Interval Time** **Maste**r = Master chiller is always set as standby chiller **Slave 1** = The Slave 1 chiller is always set as standby chiller

			Slave 2 = The Slave 2 chiller is always set as standby chiller **Slave 3** = The Slave 3 chiller is always set as standby chiller

Step 2 : Define rotation type of the standby chiller.

Define the rotation type of the standby chiller make sense only if the parameter **Standby Chiller** is set as **Auto**

Setpoint/Sub-Menu	Range	Description
Rotation Type	Time, Sequence	**Time** = The next Standby chiller will be the chiller with most running hours at the moment of the changeover **Sequence** = The next standby chiller will be the next according to the following sequences: - network with one slave: Master → Slave 1 → Master - network with tow slaves: Master → Slave 1 → Slave 2 → Master - network with three slaves: Master → Slave 1 → Slave 2 → Slave 3 → Master

Step 3 : Interval time for rotation of the Standby Chiller.

Define the interval time for rotation of the Standby Chiller make sense only if the parameter **Standby Chiller** is set as **Auto**

Setpoint/Sub-Menu	Default	Range	Description
Interval Time	7 Days	1…365	Define the interval time (expressed in day) for the rotation of the standby chiller.
Switch Time	00:00:00	00:00:00…23:59:59	Define the time within the day when will be performed the switch of the standby chiller

Step 4 : Enable of Temperature Compensation function

Choose if enable the temperature compensation function

Setpoint/Sub-Menu	Default	Range	Description
Tmp Cmp	No	No,Yes	**No** = The standby chiller becomes operating only in the following case: 1. At least one chiller is in alarm state. 2. At least one of the Slave chillers is in communication alarm with the Master chiller. 3. At least one chiller is not enabled. **Yes** = The standby chiller becomes operating in all previous cases and also if the all other chillers are running at the

			maximum capacity and the water temperature setpoint is not reached for at least a specific time defined by the parameter **Tmp Comp Time**
Tmp Comp Time	120 min	0…600	Time constant in which the system has to be at maximum capacity and the setpoint not reached before that the standby chiller will be enabled.

Step 5 : Reset

The reset command can be used to force the rotation of the standby chiller.

Setpoint/Sub-Menu	Default	Range	Description
Standby Reset	Off	Off, Reset	**Off** = No Action **Reset** = Force a rotation of the standby chiller and reset the timer for rotation

Disconnect Mode

For each unit belonging to the Master Slave is possible activate the function Disconnect Mode through the menu. This function allows to disconnect temporary the unit from the network and manage it like if this unit has been configured as Standalone.

- If a slave unit is in Disconnect mode then the master considers this unit as not available.
- If the master unit is in Disconnect mode then also all other slave units are forced to work in Disconnect mode.

This function can be used to easily perform maintenance operation of one or more chillers of the network.

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