

**DAIKIN**



## **CONTROL PANEL OPERATING MANUAL**

**AIR-COOLED SCREW CHILLER  
MICROTECH III CONTROLLER  
D – EOMAC00A04-10EN**

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Unit controllers are LONMARK certified with an optional LONWORKS communications module

# Introduction

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This manual provides setup, operating, troubleshooting and maintenance information for the DAIKIN Air Cooled Chillers 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 units with Software Version XXXXXXXX. 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.

**Minimum BSP Version:** 8.40

### 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.

## Operating Limits:

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- Maximum standby ambient temperature, 57°C
- Minimum operating ambient temperature (standard), 2°C
- Minimum operating ambient temperature (with optional low-ambient control), -20°C
- Leaving chilled water temperature, 4°C to 15°C
- Leaving chilled fluid temperatures (with anti-freeze), 3°C to -8°C. Unloading is not permitted with fluid leaving temperatures below -1°C.
- Operating Delta-T range, 4°C to 8°C
- Maximum operating inlet fluid temperature, 24°C
- Maximum non-operating inlet fluid temperature, 38°C

## Controller Features

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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.

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

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

Building Automation System (BAS) communication capability via LonTalk®, Modbus®, or BACnet® standard protocols for all BAS manufacturers.

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

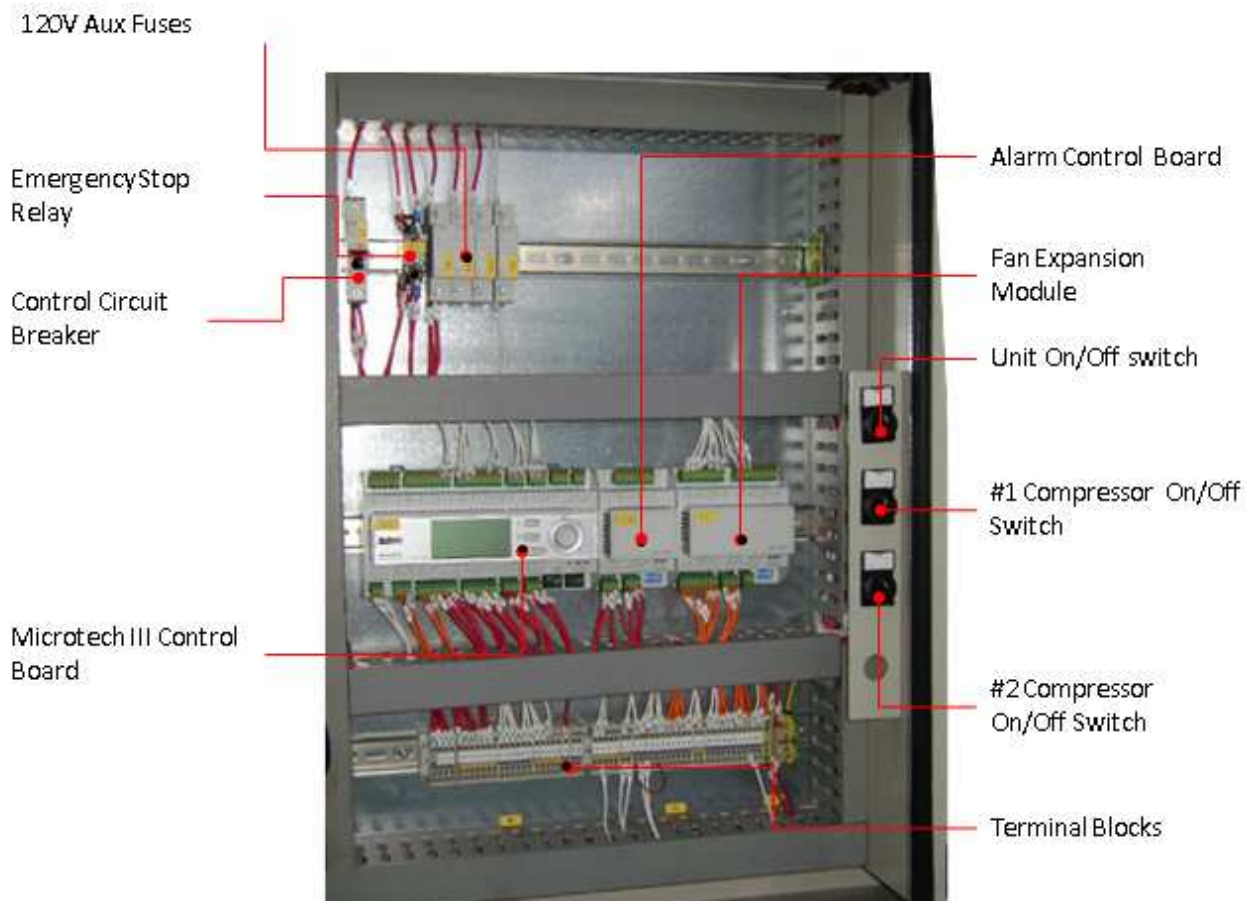
The MicroTech III control system consists of a microprocessor-based controller and a number of extension modules, which vary depending on the unit size and conformation. The control system provides the monitoring and control functions required for the controlled, efficient operation of the chiller.

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.

## Control Panel Layout

Figure 1, Control Panel Components



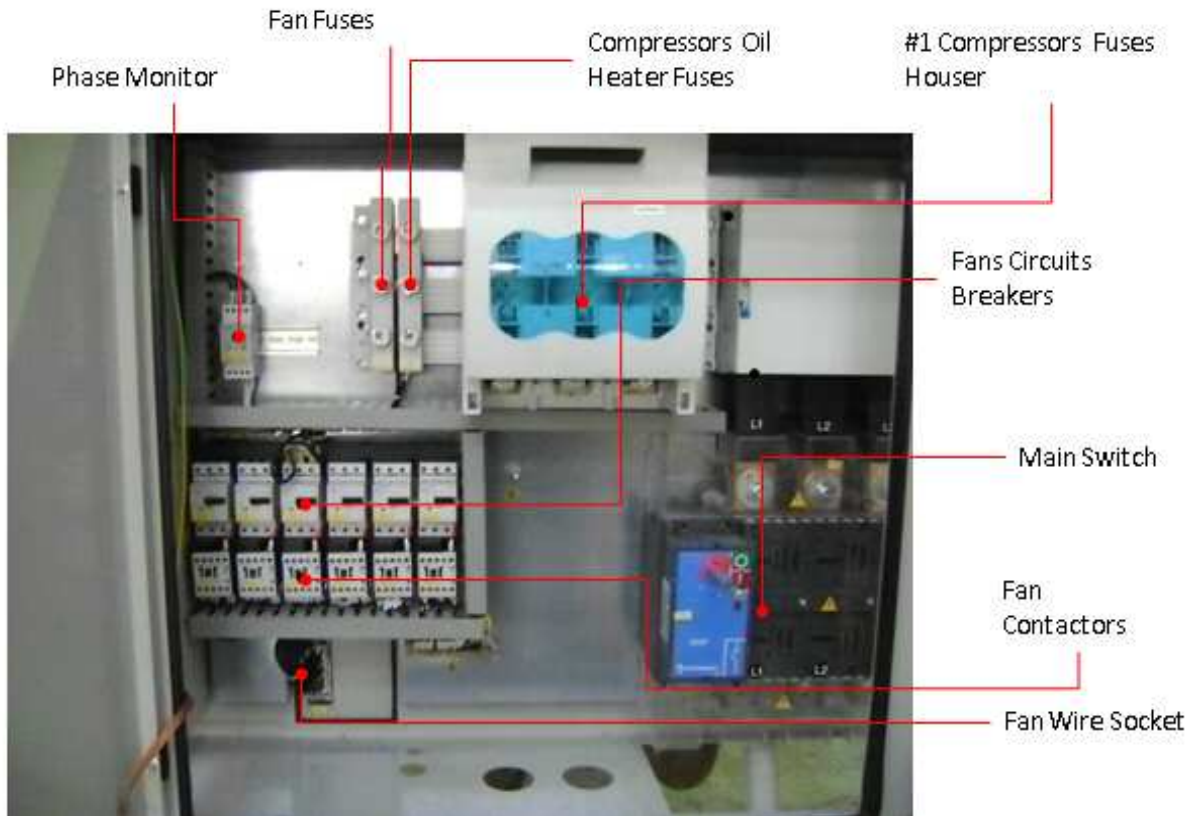
### NOTES:

1. The Emergency Switch Relay de-energizes circuit #1 #2 and #3 control power when activated, causing an immediate compressor and fan shutdown. The red emergency button switch is located on the bottom front of the control panel door.
2. The control power transformer is located in the power panel adjacent to the control panel.
3. Additional extension (aka extension) modules are located elsewhere on the chiller.

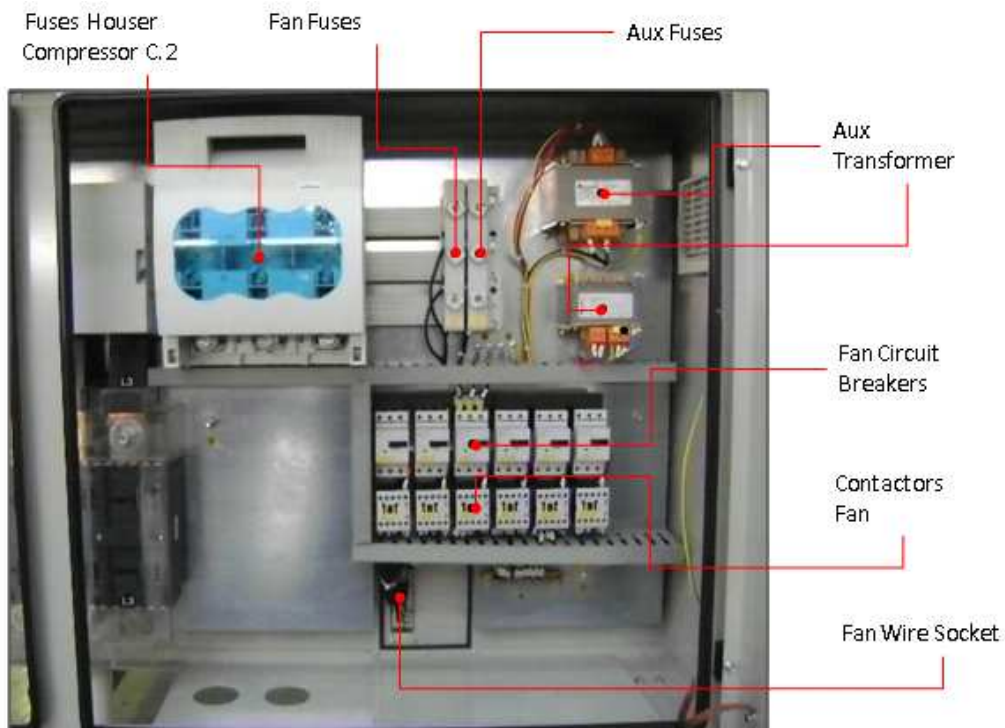
## Power Panel Layout

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

**Figure 2, Power Panel, Left Side**



**Figure 3, Power Panel, Right Side**



## Controller Description

### Hardware Structure

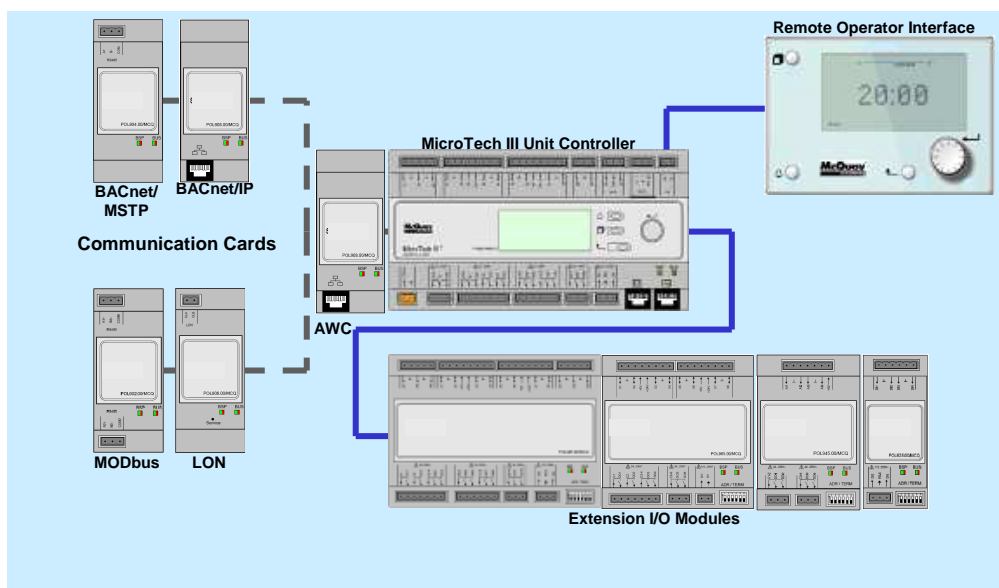
The MicroTech III control system for air cooled screw chillers consists of a main unit controller with a number of extension I/O modules attached depending on the chiller size and configuration.

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 air cooled screw chillers are not interchangeable with previous MicroTech II controllers.

*Figure 6, hardware structure*

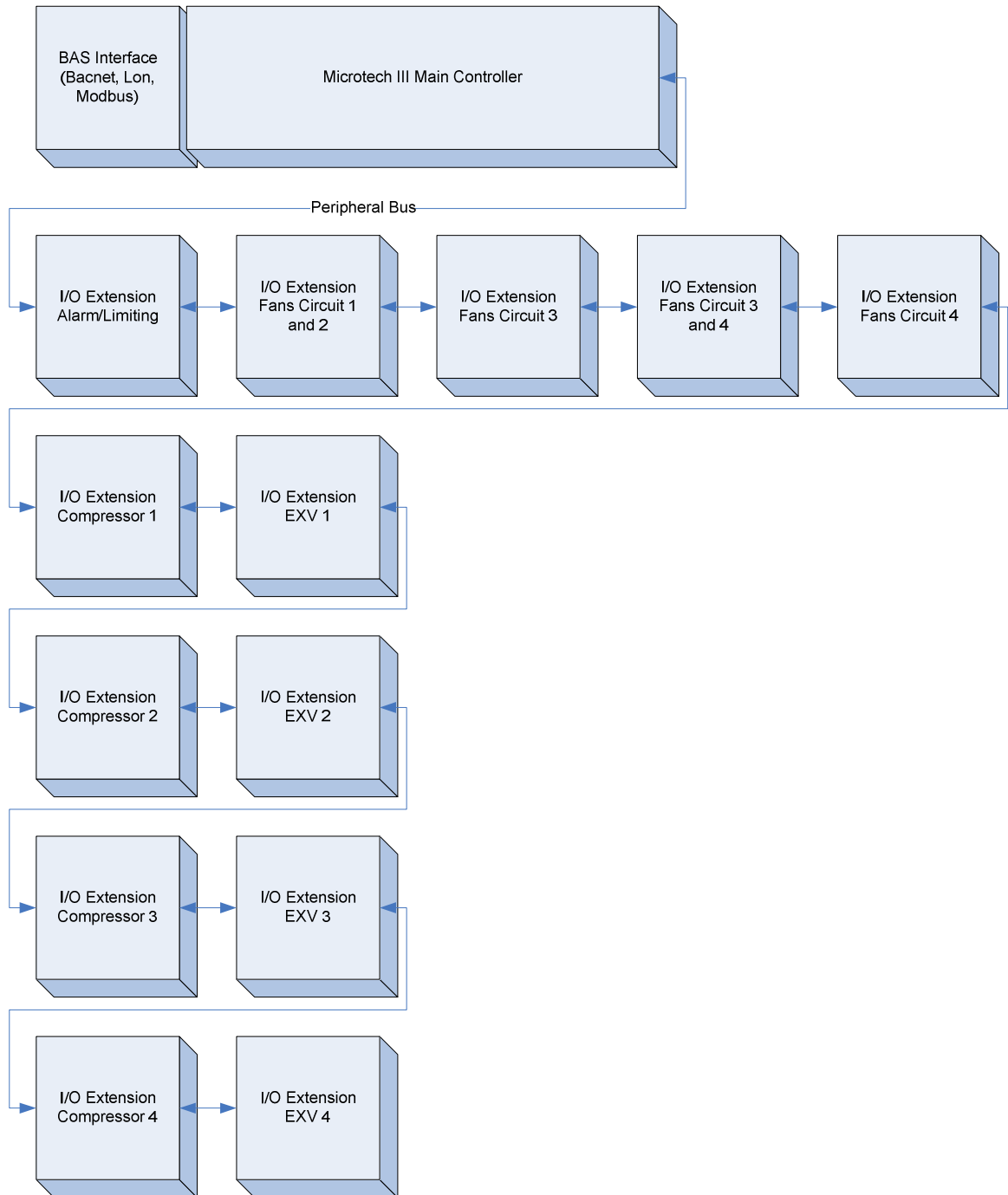


## System Architecture

The overall controls architecture uses the following:

- One Microtech III main controller
- I/O extension modules 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/<br>Extension Module | Siemens Part Number | Addresses | Usage  |
|---------------------------------|---------------------|-----------|--|
| Unit                            | POL687.70/MCQ       | n/a       | Used on all configurations   |
| Compressor #1                   | POL965.00/MCQ       | 2         | Used on all configurations   |
| EEXV #1                         | POL94U.00/MCQ       | 3         |  |
| Comp. #2                        | POL965.00/MCQ       | 4         |  |
| EEXV #2                         | POL94U.00/MCQ       | 5         |  |
| Alarm/Limit                     | POL965.00/MCQ       | 18        |  |
| Fans #1&2                       | POL945.00/MCQ       | 6         | Used when number of fans on circuit 1 is more than 6, number of fans on circuit 2 is more than 6, or unit has multipoint power |
| Comp. #3                        | POL965.00/MCQ       | 7         | Used when configured for 3   |
| EEXV #3                         | POL94U.00/MCQ       | 8         |  |
| Fans#3                          | POL945.00/MCQ       | 9         |  |
| Comp. #4                        | POL965.00/MCQ       | 10        | Used when configured for 4 circuits  |
| EEXV #4                         | POL94U.00/MCQ       | 11        |  |
| Fans #4                         | POL945.00/MCQ       | 12        |  |
| Fans #3&4                       | POL945.00/MCQ       | 13        | Used when number of fans on circuit 3 or 4 is more than 6  |
| Options                         | POL965.00/MCQ       | 19        | Used for Heat Recovery   |

## Communication modules

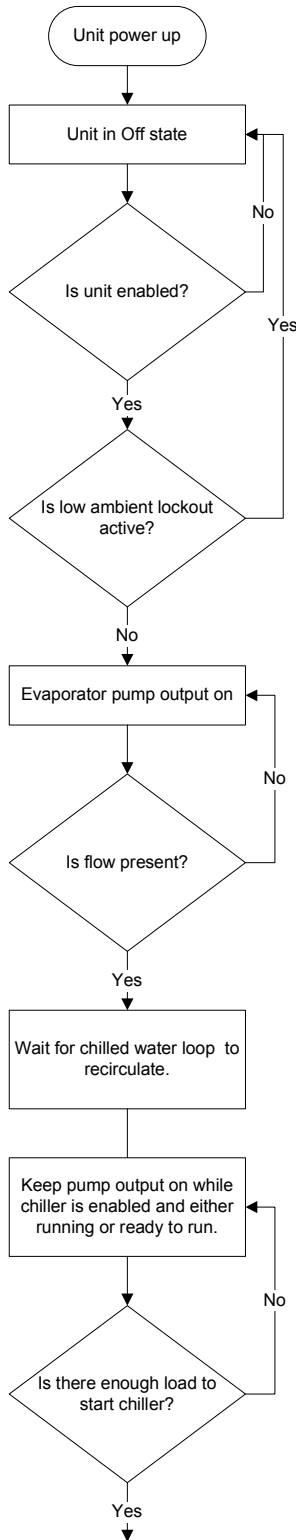
Any of the following modules can be connected directly to the left side of the main controller to allow a BAS interface to function.

| 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**.

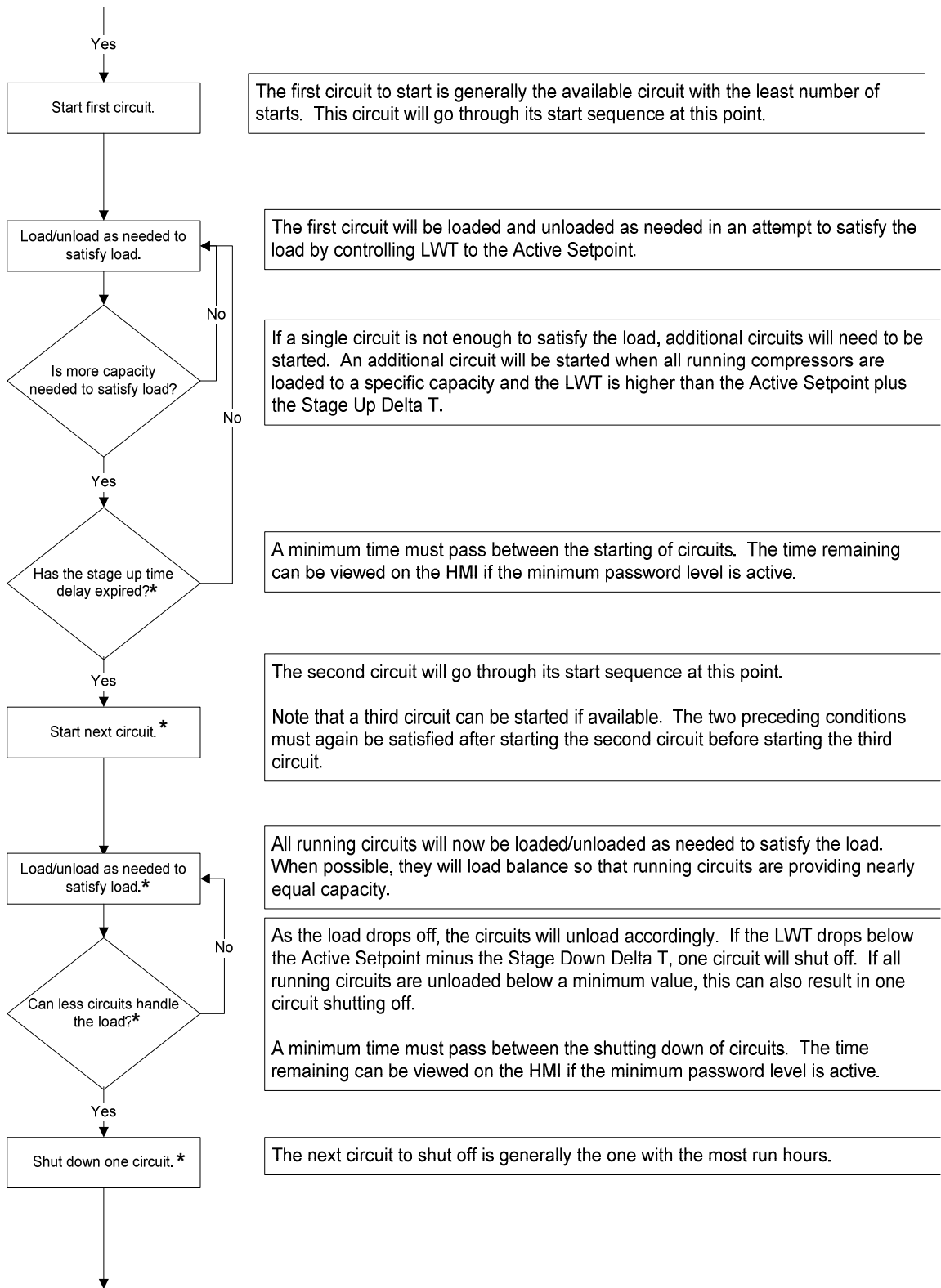
If the chiller is enabled, then the unit will be in the Auto state and the evaporator water pump output will be activated.

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**.

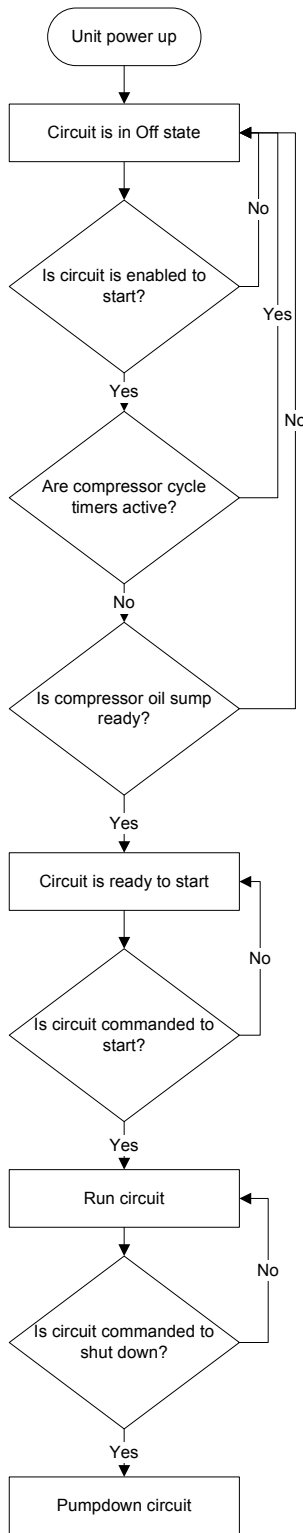
The chiller is now ready to start if enough load is present. If the LWT is not higher than the Active Setpoint plus the Start Up Delta T, the unit status will be **Auto:Wait for load**.

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 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

I/O for the unit control and for circuits one and two are found on CP1.  
The chiller may be equipped with one 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 | Evaporator #1 Leaving Water Temp (*) | NTC Thermister (10K@25°C) | -50°C – 120°C  |
| X1  | Evaporator #2 Leaving Water Temp (*) | NTC Thermister (10K@25°C) | -50°C – 120°C  |
| X2  | Outside Ambient Temperature          | NTC Thermister (10K@25°C) | -50°C – 120°C  |
| X4  | LWT Reset                            | 4-20 mA Current           | 1 to 23 mA     |

### Analog Outputs

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

### Digital Inputs

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

### Digital Outputs

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

## Extension I/O Compressor #1 to #3

### Analog Inputs

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

### Analog Outputs

| #          | Description | Output Signal | Range |
|------------|-------------|---------------|-------|
| Not Needed |             |               |       |

### Digital Inputs

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

### Digital Outputs

#### E:U. Configuration

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

## I/O EXV Circuit #1 to #3

### Analog Inputs

| #  | Description         | Signal Source            | Expected Range |
|----|---------------------|--------------------------|----------------|
| X2 | Suction Temperature | NTC Thermister 10K@25°C) | -50°C – 120°C  |

### Analog Outputs

| #          | Description | Output Signal | Range |
|------------|-------------|---------------|-------|
| Not Needed |             |               |       |

### Digital Inputs

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

### Digital Outputs

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

### Stepper Motor Output

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

## Extension I/O Fan Module Circuit #1 & 2

### Digital Inputs

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

### Digital Outputs

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

## Extension I/O Fan Module Circuit #3

### Digital Outputs

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

## Extension I/O Unit Alarm & Limiting

### Analog Inputs

| #  | Description                              | Signal Source            | Expected Range |
|----|--|--------------------------|----------------|
| X1 | Heat Recovery Entering Water Temperature | NTC Thermister 10K@25°C) | -50°C – 120°C  |
| X2 | Heat Recovery Leaving Water Temperature  | NTC Thermister 10K@25°C) | -50°C – 120°C  |

### Analog Outputs

| #          | Description | Output Signal | Range |
|------------|-------------|---------------|-------|
| Not Needed |             |               |       |

### Digital Inputs

| #  | Description               | Signal Off        | Signal On        |
|----|---------------------------|-------------------|------------------|
| X3 | Heat Recovery Mode Enable | Heat Recovery Off | Heat Recovery On |

### Digital Outputs

| #   | Description        | Output Off     | Output On     |
|-----|--------------------|----------------|---------------|
| DO1 | Heat Recovery Pump | Pump Off       | Pump On       |
| DO2 | Sub cooler #1      | Sub cooler Off | Sub cooler On |
| DO3 | Sub cooler #2      | Sub cooler Off | Sub cooler On |
| DO4 | Sub cooler #3      | Sub cooler Off | Sub cooler On |
| DO5 | Sub cooler #4      | Sub cooler Off | Sub cooler On |

## 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                     |
|------------------------|--------------|----|---------------------------|
|                        | Ft/Lb        | SI |                           |
| Unit                   |              |    |                           |
| Manufacturing Location | Not Selected |    | Not Selected, Europe, USA |

|  |          |            |   |
|--|----------|------------|---|
| Unit Enable                              | OFF      |            | OFF, ON   |
| Unit Type                                | Chiller  |            | MCU, Chiller  |
| Unit Status after Power Failure          | OFF      |            | OFF, ON   |
| Control source                           | Local    |            | Local, Network  |
| Available Modes                          | Cool     |            | COOL<br>COOL/w GLYCOL<br>COOL/ICE w GLYCOL<br>ICE<br>TEST |
| Cool LWT 1                               | 44 °F    | 7 °C       | See section 0   |
| Cool LWT 2                               | 44 °F    | 7 °C       | See section 0   |
| Heat Recovery LWT                        |          | 45°C       | /30 to 70 °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                                   |
| Heat Recovery Differential               |          | 3.0°C      | /2 to 5 °C  |
| Max Pulldown                             | 3 °F/min | 1,7 °C/min | 0.5-5.0 °F /min / 0,3 to 2,7 °C/min                       |
| Evap Recirc Timer                        | 30       |            | 0 to 300 seconds  |
| Evap Control                             | #1 Only  |            | #1 Only, #2 Only, Auto, #1 Primary, #2 Primary            |
| LWT Reset Type                           | NONE     |            | NONE, RETURN, 4-20mA, OAT                                 |
| Max Reset                                | 10 °F    | 5 °C       | 0 to 20 °F / 0 to 10 °C                                   |
| Start Reset Delta T                      | 10 °F    | 5 °C       | 0 to 20 °F / 0 to 10 °C                                   |
| Start Reset OAT                          | 75°F     | 23.8°C     | 50°F – 85°F / 10.0 – 29.4°C                               |
| Max Reset OAT                            | 60°F     | 15.5°C     | 50°F – 85°F / 10.0 – 29.4°C                               |
| Soft Load                                | Off      |            | Off, On   |
| Begin Capacity Limit                     | 40%      |            | 20-100%   |
| Soft Load Ramp                           | 20 min   |            | 1-60 minutes  |
| Demand Limit                             | Off      |            | Off, On   |
| Current Limit                            | Off      |            | Off, On   |
| Current @ 20mA                           | 800 Amp  |            | 0 to 2000 Amp = 4 to 20 mA                                |
| Current limit Set Point                  | 800 Amp  |            | 0 to 2000 Amp   |
| # of Circuits                            | 2        |            | 2-3-4   |
| Ice Time Delay                           | 12       |            | 1-23 hours  |

Continued next page.



| Description                      | Default      |           | Range                                 |
|----------------------------------|--------------|-----------|---------------------------------------|
|                                  | Ft/Lb        | SI        |                                       |
| <i>Unit</i>                      |              |           |                                       |
| Clear Ice Timer                  | No           |           | No, Yes                               |
| SSS Communication                | No           |           | No, Yes                               |
| PVM                              | Multi Point  |           | Single Point, Multi Point , None(SSS) |
| Noise Reduction                  | Disabled     |           | Disabled, Enabled                     |
| Noise Reduction Start Time       | 21:00        |           | 18:00 – 23:59                         |
| Noise Reduction End Time         | 6:00         |           | 5:00 – 9:59                           |
| Noise Reduction Condenser Offset | 10.0 °F      | 5 °C      | 0.0 to 25.0 °F                        |
| BAS Protocol                     | None         |           | None, BACnet, LonWorks, Modbus        |
| Ident number                     | 1            |           | 0-????                                |
| Baud Rate                        | 19200        |           | 1200,2400,4800,9600,19200             |
| Evap LWT sensor offset           | 0°F          | 0°C       | -5.0 to 5.0°C / -9.0 to 9.0°F         |
| Evap EWT sensor offset           | 0°F          | 0°C       | -5.0 to 5.0°C / -9.0 to 9.0°F         |
| OAT sensor offset                | 0°F          | 0°C       | -5.0 to 5.0°C / -9.0 to 9.0°F         |
| <b>Compressors-Global</b>        |              |           |                                       |
|                                  | <b>Ft/Lb</b> | <b>SI</b> |                                       |
| Start-start timer                | 20 min       |           | 15-60 minutes                         |
| Stop-start timer                 | 5 min        |           | 3-20 minutes                          |
| Pumpdown Pressure                | 14,3 PSI     | 100 kPa   | 10 to 40 PSI / 70 to 280 kPa          |
| Pumpdown Time Limit              | 120 sec      |           | 0 to 180 sec                          |
| Light Load Stg Dn Point          | 50%          |           | 20 to 50%                             |
| Load Stg Up Point                | 50%          |           | 50 to 100%                            |
| Stage Up Delay                   | 5 min        |           | 0 to 60 min                           |
| Stage Down Delay                 | 3 min        |           | 3 to 30 min                           |
| Stage Delay Clear                | No           |           | No, Yes                               |
| Max # Comps Running              | 4            |           | 1-4                                   |
| Sequence # Cir 1                 | 1            |           | 1-4                                   |
| Sequence # Cir 2                 | 1            |           | 1-4                                   |
| Sequence # Cir 3                 | 1            |           | 1-4                                   |
| Number of Pulses 10% to 50%      | 10           |           | 10 to 20                              |
| Slide Load Delay Minimum         | 30 seconds   |           | 10 to 60 seconds                      |
| Slide Load Delay Maximum         | 150 seconds  |           | 60 to 300 seconds                     |
| Slide Unload Delay Minimum       | 10 seconds   |           | 5 to 20 seconds                       |
| Slide Unload Delay Maximum       | 50 seconds   |           | 30 to 75 seconds                      |
| Liquid Injection Activation      | 185°F        | 85°C      | 75 to 90°C                            |
| Liquid Line Solenoid Valves      | No           |           | No, Yes                               |
| <b>Alarm Limits</b>              |              |           |                                       |
|                                  |              |           |                                       |
| Low Evap Pressure-Unload         | 23.2 PSI     | 160 kPa   | See section 0                         |
| Low Evap Pressure-Hold           | 27.5 PSI     | 190 kPa   | See section 0                         |
| Oil Press Delay                  | 30 sec       |           | 10-180 sec                            |

Continued next page.

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

The following set points exist individually for each circuit:

| Description  | Default                       |        | Range   | PW |
|--|-------------------------------|--------|---|----|
|  | Ft/Lb                         | SI     |   |    |
| Circuit mode   | Enable                        |        | Disable, enable, test   | S  |
| Compressor Size                                      | To be Verified                |        |   | M  |
| Heat Recovery Enable                                 | Disable                       |        | Disable, enable   | S  |
| Economizer   | Enable                        |        | Disable, enable   | M  |
| Capacity Control                                     | Auto                          |        | Auto, Manual  | S  |
| Manual Capacity                                      | <i>See note 1 below table</i> |        | 0 to 100%   | S  |
| Clear Cycle Timers                                   | No                            |        | No, yes   | M  |
| EXV control  | Auto                          |        | Auto, manual  | S  |
| EXV position   | <i>See note 2 below table</i> |        | <b>0% to 100%</b>   | S  |
| EXV model  | Danfoss ETS250                |        | ETS50, ETS100, ETS250, ETS400, E2VA, E2VP, E4V, E6V, E7V, SER, SEI25, Sex50-250, CUSTOM | S  |
| Oil Sump Check                                       | Enable                        |        | Enable, Disable   | S  |
| Service Pumpdown                                     | No                            |        | No, Yes   | S  |
| Evap pressure offset                                 | 0PSI                          | 0kPa   | -14.5 to 14.5 PSI / -100 to 100 kPa   | S  |
| Cond pressure offset                                 | 0PSI                          | 0kPa   | -14.5 to 14.5 PSI / -100 to 100 kPa   | S  |
| Oil pressure offset                                  | 0PSI                          | 0kPa   | -14.5 to 14.5 PSI / -100 to 100 kPa   | S  |
| Suction temp offset                                  | 0°F                           | 0°C    | -5.0 to 5.0 deg   | S  |
| Discharge temp offset                                | 0°F                           | 0°C    | -5.0 to 5.0 deg   | S  |
| <b>Fans</b>  |                               |        |   |    |
| Fan VFD enable                                       | On                            |        | Off, On   | M  |
| Number of fans                                       | 5                             |        | 5 to 12   | M  |
| Saturated Condenser Temp<br>Target Min               | 90 °F                         | 32°C   | 80.0-110.0 °F / 26.0 to 43.0 °C   | M  |
| Saturated Condenser Temp<br>Target Max               | 110 °F                        | 43°C   | 90.0-120.0 °F / 32.0 to 50 °C   | M  |
| Heat Recovery Saturated<br>Condenser Temp Target Min |                               | 50°C   | / 44 to 58 °C   | M  |
| Heat Recovery Saturated<br>Condenser Temp Target Max |                               | 56°C   | / 44 to 58 °C   | M  |
| Fan Stage Up Deadband 0                              | 5 °F                          | 2.5 °C | 1-20 °F / 1-10 °C   | M  |
| Fan Stage Up Deadband 1                              | 5 °F                          | 2.5 °C | 1-20 °F / 1-10 °C   | M  |
| Fan Stage Up Deadband 2                              | 8 °F                          | 4 °C   | 1-20 °F / 1-10 °C   | M  |
| Fan Stage Up Deadband 3                              | 10 °F                         | 5 °C   | 1-20 °F / 1-10 °C   | M  |
| Fan Stage Up Deadband 4                              | 8 °F                          | 4 °C   | 1-20 °F / 1-10 °C   | M  |
| Fan Stage Up Deadband 5                              | 8 °F                          | 4 °C   | 1-20 °F / 1-10 °C   | M  |

|                           |      |        |                   |   |
|---------------------------|------|--------|-------------------|---|
| Fan Stage Down Deadband 2 | 8 °F | 4 °C   | 1-25 °F / 1-13 °C | M |
| Fan Stage Down Deadband 3 | 7 °F | 3.5 °C | 1-25 °F / 1-13 °C | M |
| Fan Stage Down Deadband 4 | 6 °F | 3 °C   | 1-25 °F / 1-13 °C | M |
| Fan Stage Down Deadband 5 | 5 °F | 2.5 °C | 1-25 °F / 1-13 °C | M |
| Fan Stage Down Deadband 6 | 5 °F | 2.5 °C | 1-25 °F / 1-13 °C | M |
| VFD Max Speed             | 100% |        | 90 to 110%        | M |
| VFD Min Speed             | 25%  |        | 20 to 60%         | M |

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

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

### Auto Adjusted Ranges

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

#### Cool LWT 1 and Cool LWT 2

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

#### Evaporator Water Freeze

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

#### Low Evaporator Pressure - Hold

| Available Mode Selection | Range Imp.       | Range SI       |
|--------------------------|------------------|----------------|
| Without Glycol           | 28 to 45<br>PSIG | 195 to 310 kPa |
| With Glycol              | 0 to 45 PSIG     | 0 to 310 kPa   |

#### Low Evaporator Pressure - Unload

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

#### Low Ambient Lockout

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

### Dynamic Default Values

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

| Setpoint             | Default w/ VFD (°C) | Default w/o VFD (°C) |
|----------------------|---------------------|----------------------|
| Stage 0 On Deadband  | 2.5                 | 4                    |
| Stage 1 On Deadband  | 2.5                 | 5                    |
| Stage 2 On Deadband  | 4                   | 5.5                  |
| Stage 3 On Deadband  | 5                   | 6                    |
| Stage 4 On Deadband  | 4                   | 6.5                  |
| Stage 5 On Deadband  | 4                   | 6.5                  |
|                      |                     |                      |
| Stage 2 Off Deadband | 4                   | 10                   |
| Stage 3 Off Deadband | 3.5                 | 8                    |
| Stage 4 Off Deadband | 3                   | 5.5                  |
| Stage 5 Off Deadband | 2.5                 | 4                    |
| Stage 6 Off Deadband | 2.5                 | 4                    |

# Unit Functions

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## Calculations

### LWT Slope

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

### Pulldown Rate

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

## Unit Type

A unit can be configured as Chiller or MCU (motocondensing unit). When the unit is configured as MCU the EXV control logic and all the related variables and alarms are disabled,

## Unit Enable

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

Unit is enabled according to the following table.

**NOTE:** An x indicates that the value is ignored.

| Unit Switch | Control Source Set Point | Remote Switch Input | Unit Enable Set Point | BAS Request | Unit Enable |
|-------------|--------------------------|---------------------|-----------------------|-------------|-------------|
| Off         | x                        | x                   | x                     | x           | Off         |
| x           | x                        | x                   | Off                   | x           | Off         |
| x           | x                        | Off                 | x                     | x           | Off         |
| On          | Local                    | On                  | On                    | x           | On          |
| x           | Network                  | x                   | x                     | Off         | Off         |
| On          | Network                  | On                  | On                    | On          | On          |

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

When the controller is powered up, the Unit Enable Set Point will be initialized to 'off' if the Unit Status After Power Failure Set Point is set to 'off'.

## Unit Mode Selection

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

The Available Modes Set Point must only be changed when the unit switch is off. This is to avoid changing modes of operation inadvertently while the chiller is running.

Unit Mode is set according to the following table.  
**NOTE:** An “x” indicates that the value is ignored.

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

### Glycol Configuration

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

### Unit Control States

The unit will always be in one of three states:

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

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

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

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

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

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

- Unit is disabled via settings and/or inputs in section 0
- Low OAT Lockout is triggered

## Unit Status

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

| Enum | Status               | Conditions  |
|------|----------------------|---|
| 0    | Auto                 | Unit State = Auto   |
| 1    | Off:Ice Mode Timer   | Unit State = Off, Unit Mode = Ice, and Ice Delay = Active   |
| 2    | Off:OAT Lockout      | Unit State = Off and Low OAT Lockout is active  |
| 3    | Off:All Cir Disabled | Unit State = Off and all compressors unavailable  |
| 4    | Off:Emergency Stop   | Unit State = Off and Emergency Stop Input is open   |
| 5    | Off:Unit Alarm       | Unit State = Off and Unit Alarm active  |
| 6    | Off:Keypad Disable   | Unit State = Off and Unit Enable Set Point = Disable  |
| 7    | Off:Remote Switch    | Unit State = Off and Remote Switch is open  |
| 8    | Off:BAS Disable      | Unit State = Off, Control Source = Network, and BAS Enable = false                                |
| 9    | Off:Unit Switch      | Unit State = Off and Unit Switch = Disable  |
| 10   | Off:Test Mode        | Unit State = Off and Unit Mode = Test   |
| 11   | Auto:Noise Reduction | Unit State = Auto and Noise Reduction is active   |
| 12   | Auto:Wait for load   | Unit State = Auto, no circuits running, and LWT is less than the active set point + startup delta |
| 13   | Auto:Evap Recirc     | Unit State = Auto and Evaporator State = Start  |
| 14   | Auto:Wait for flow   | Unit State = Auto, Evaporator State = Start, and Flow Switch is open                              |
| 15   | Auto:Pumpdown        | Unit State = Pumpdown   |
| 16   | Auto:Max Pulldown    | Unit State = Auto, max pulldown rate has been met or exceeded                                     |
| 17   | Auto:Unit Cap Limit  | Unit State = Auto, unit capacity limit has been met or exceeded                                   |
| 18   | Auto:Current Limit   | Unit State = Auto, unit current limit has been met or exceeded                                    |

## Ice Mode Start Delay

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

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

## Evaporator Pump Control

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

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

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

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

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

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

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

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

### Pump Selection

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

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

### Primary/Standby Pump Staging

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

### Auto Control

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

### Noise Reduction

Noise Reduction is enabled only when the Noise Reduction set point is enable. Noise Reduction is in effect when enabled via the set point, the unit mode is cool, and the unit controller clock time is between the Noise Reduction start time and end time.

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

### Leaving Water Temperature (LWT) Reset

#### LWT Target

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

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

## Leaving Water Temperature (LWT) Reset

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

When the active reset increases, the Active LWT Target is changed at a rate of 0.1 degrees F every 10 seconds. When the active reset decreases, the Active LWT Target is changed all at once.

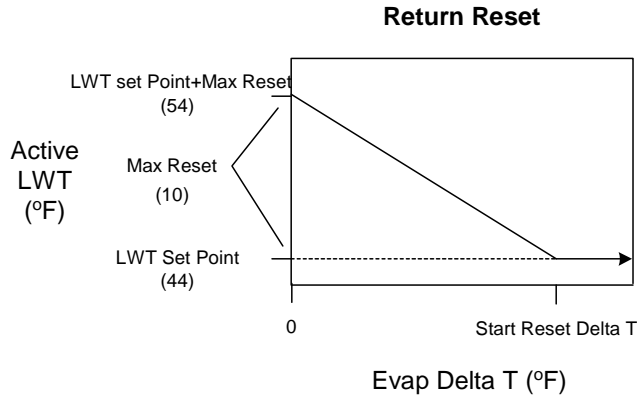
After resets are applied, the LWT target can never exceed a value of 60°F.

### Reset Type – None

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

### Reset Type – Return

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



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.

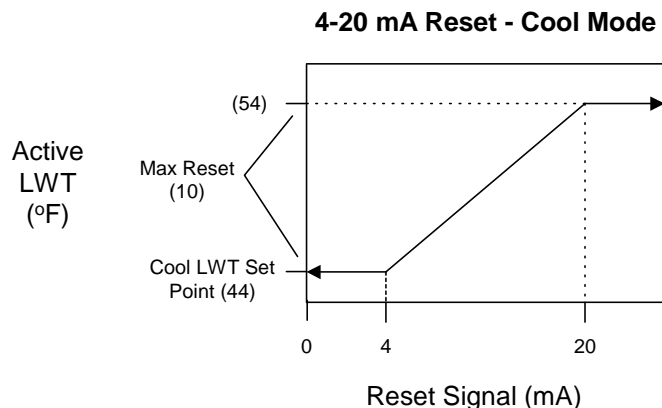
## 4-20 mA External Signal Reset

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.





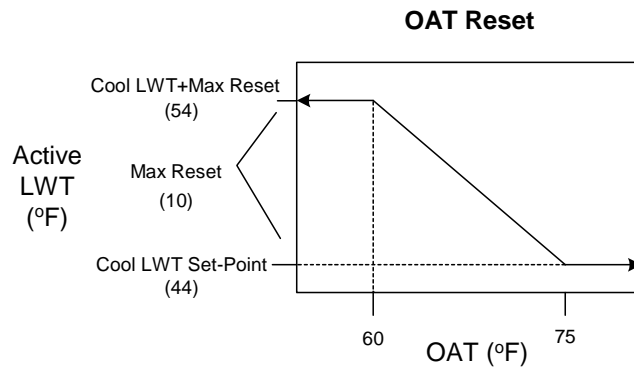
## Outside Air Temperature (OAT) Reset

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

Parameters used:

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

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



## Unit Capacity Control

Unit capacity control is performed as described in this section.

### Compressor Staging in Cool Mode

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

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

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

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

### Stage Up Delay

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

### Required Load For Stage Up

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

### Light Load Stage Down

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

### **Maximum Circuits Running**

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

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

### **Compressor Staging in Ice Mode**

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

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

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

### **Stage Up Delay**

A fixed stage up delay of one minute between compressor starts is used in this mode.

When at least one compressor is running, the other compressors will start as quickly as possible with respect to the stage up delay.

### **Staging Sequence**

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

### **Next To Start**

The next compressor to start must meet the following requirements:

Lowest sequence number of those compressors available to start

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

### **Next To Stop**

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

Lowest sequence number of the compressors that are running

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

### **Compressor Capacity Control In Cool Mode**

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

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

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

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

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

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

## Load/Unload Sequence

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

### Next To Load

The next compressor to load meets the following requirements:

Lowest capacity of the running compressors that can load up

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

### Next To Unload

The next compressor to unload must meet the following requirements:

Highest capacity of the running compressors

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

## Compressor Capacity Control In Ice Mode

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

## Unit Capacity Overrides

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

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

- For 2 circuit units, the deadband is 7%.
- For 3 circuit units, the deadband is 5%.
- For 4 circuit units, the deadband is 4%.

### Soft Load

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

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

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

### Demand Limit

The maximum unit capacity can be limited by a 4 to 20 mA signal on the Demand Limit analog input at the unit controller. This function is only enabled if the Demand Limit set point is set to ON.

As the signal varies from 4 mA up to 20 mA, the maximum unit capacity changes by steps of 1% from 100% to 0%. The unit capacity is adjusted as needed to meet this limit, except that the last running compressor cannot be turned off to meet a limit lower than the minimum unit capacity.

### **Network Limit**

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

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

### **Current Limit**

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

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

The current limit uses a deadband centered around the actual limit value, such that unit capacity increase is not allowed when current is within this deadband. If unit current is above the deadband, capacity is decreased until it is back within the deadband. The current limit deadband is 10% of the current limit.

### **Maximum LWT Pulldown Rate**

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

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

### **High Water Temperature Capacity Limit**

If the evaporator LWT exceeds 65°F, compressor load will be limited to a maximum of 75%. Compressors will unload to 75% or less if running at greater than 75% load when the LWT exceeds the limit. This feature is to keep the circuit running within the capacity of the condenser coil.

A dead-band placed below the limit set-point will be used to increase function stability. If the actual capacity is in the band, unit loading will be inhibited.

## **Heat Recovery**

When the Heat Recovery switch is set to Enable and at least one circuit has Heat Recovery option enabled Heat Recovery operations are initiated on the running circuits. The control will control the Heat Recovery heat exchanger leaving water temperature to the setpoint (50°C). When the Heat Recovery leaving water temperature exceeds the setpoint by a differential (3°C) the recovery function is disabled until the temperature drops below the setpoint.

Heat Recovery function is disabled if the Heat Recovery heat exchanger entering water temperature is below a minimum allowed value (25°C).

Three Heat Recovery states are possible:

- Off - Heat Recovery operations Off
- Start: Heat Recovery water is being recirculated
- Run: Heat Recovery is On

The Heat Recovery state is Off when one of the following is true:

- Heat Recovery Switch is set to Disable

- Heat Recovery option is not installed on at least one of the circuits available
- Heat Recovery entering water temperature is below the minimum allowed temperature
- Heat Recovery EWT sensor is out of range
- Heat Recovery LWT sensor is out of range

The Heat Recovery state is start if all of the following are true:

- Heat Recovery option is installed on any of the circuits available
- Heat Recovery entering water temperature is above the minimum allowed temperature
- Heat Recovery EWT sensor is in range
- Heat Recovery LWT sensor is in range
- Heat Recovery LWT is higher than Setpoint + Differential

The Heat Recovery state is Run if all of the following are true:

- Heat Recovery option is installed on at least one of the circuits available
- Heat Recovery entering water temperature is above the minimum allowed temperature
- Heat Recovery EWT sensor is in range
- Heat Recovery LWT sensor is in range
- Heat Recovery LWT is lower than Setpoint,

## Heat Recovery Pump

Two Heat Recovery Pump control states are possible for control the Heat Recovery Pump:

- Off - Pump Off.
- Run – Pump is on.

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

- Heat Recovery state is Off
- Heat Recovery EWT is higher than the Evap Freeze set point and Heat Recovery EWT sensor fault is not active
- Heat Recovery LWT is higher than the Evap Freeze set point and Heat Recovery LWT sensor fault is not active

The control state is Run when any of the following is true

- Heat Recovery state is Start or Run
- Heat Recovery EWT is lower than the Evap Freeze set point or Heat Recovery EWT sensor fault is active
- Heat Recovery LWT is lower than the Evap Freeze set point or Heat Recovery LWT sensor fault is active

# Circuit Functions

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## 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:

$$\text{Evaporator Approach} = \text{LWT} - \text{Evaporator Saturated Temperature}$$

### Suction Superheat

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

$$\text{Suction superheat} = \text{Suction Temperature} - \text{Evaporator Saturated Temperature}$$

### Discharge Superheat

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

$$\text{Discharge superheat} = \text{Discharge Temperature} - \text{Condenser Saturated Temperature}$$

### Oil Differential Pressure

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

$$\text{Oil Differential Pressure} = \text{Condenser Pressure} - \text{Oil Pressure}$$

### 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

$$\text{High Cond Hold Value} = \text{Max Saturated Condenser Value} - 2.78^{\circ}\text{C}$$

### High Saturated Condenser – Unload Value

$$\text{High Cond Unload Value} = \text{Max Saturated Condenser Value} - 1.67^{\circ}\text{C}$$

### 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.

### Heat Recovery Condenser Saturated Temperature Target

When Heat Recovery mode is enabled the condenser saturated temperature target is calculated in order to produce additional heat rejection at the condenser coils to heat the water to the desired temperature. To increase the efficiency of the chiller the target depends on the evaporator LWT so that the closer to the LWT setpoint the higher the amount of heat recovered to the water.

The target is limited to a range defined by the Heat Recovery Saturated Temperature Target min and max set points. These setpoints simply cut off the value to a working range, and this range can be limited to a single value if the two set points are set to the same value.

## Circuit Control Logic

### Circuit Availability

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

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

### Starting

The circuit will start if all these conditions are true:

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

### Circuit Startup Logic

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

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

### Low OAT Restart Logic

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

The restart counter is reset when a startup is successful, the Low OAT Restart alarm is triggered, or the unit time clock shows that a new day has started.

### Stopping

#### Normal Shutdown

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

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

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

- BAS Circuit Mode set point is set to Off

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

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

### Rapid Shutdown

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

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

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

## Circuit Status

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

| Enum | Status               | Conditions  |
|------|----------------------|---|
| 0    | Off:Ready            | Circuit is ready to start when needed.  |
| 1    | Off:Stage Up Delay   | Circuit is off and cannot start due to stage up delay.  |
| 2    | Off:Cycle Timer      | Circuit is off and cannot start due to active cycle timer.  |
| 3    | Off:Keypad Disable   | Circuit is off and cannot start due to keypad disable.  |
| 4    | Off:Circuit Switch   | Circuit is off and circuit switch is off.   |
| 5    | Off:Refr In Oil Sump | Circuit is off and Discharge Temperature – Oil Saturated Temperature at gas pressure $\leq 5^{\circ}\text{C}$ |
| 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.

### **Condenser Fan Control**

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

#### **Saturated Condenser Temperature Target**

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

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

#### **Heat Recovery Saturated Condenser Temperature Target**

When Heat Recovery operation is initiated the condenser temperature target is changed respect to normal operation. When the LWT Error changes between 2 and 8°C the

condenser temperature target is changed between Heat Recovery Saturated Condenser Temperature Max and Min respectively. This allows the circuit to recover more when the LWT is close to the temperature target.

**Fan Staging**

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

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

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

**Staging Up**

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

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

The Stage Up Error Step is added to Stage Up Accumulator. When Stage Up Error Accumulator exceeds a limit another stage is added.

Under specific conditions the Accumulator is reset to zero to avoid Accumulator saturation.

**Staging Down**

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

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

The Stage Down Error Step is added to Stage Down Accumulator. When the Stage Down Error exceeds a limit another stage of condenser fans is removed.

When one fan is running, a fixed point is used in place of a deadband. .

Under specific conditions the Accumulator is reset to zero to avoid Accumulator saturation.

**VFD**

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

**VFD State**

The VFD speed signal is always 0 when the fan stage is 0.

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

## Stage Up Compensation

In order to create a smoother transition when another fan is staged on, the VFD compensates by slowing down initially. This is accomplished by adding the new fan stage up deadband to the VFD target. The higher target causes the VFD logic to decrease fan speed. Then, every 5 seconds, 0.1°F is subtracted from the VFD target until it is equal to the saturated condenser temperature target set point. This will allow the VFD to slowly bring the saturated condenser temperature back down.

## EXV Control (for chiller units)

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 **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 **1.5 degrees F<sub>xxx</sub>** during stable operating conditions (stable water loop, static compressor capacity, and stable condensing temperature).

The target value is adjusted as needed to maintain discharge superheat within a range from **27 degrees F to 45 degrees F<sub>xxx</sub>**.

### Maximum Operating Pressures

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

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

Maximum operating pressure is **50.8 psi<sub>xxx</sub>**. 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.

### **Economizer Control**

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

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

### **Subcooler Control**

The subcooler is always activated when a circuit is in a run state and the economizer is not installed, to grant the proper compressor suction feeding during heat recovery operation if present.

### **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

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

### Signaling Alarms

The following actions will signal that an alarm has occurred:

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

### Clearing Alarms

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

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

An active password is not necessary to clear alarms.

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

### Remote Alarm Signal

The unit is configured to allow field wiring of a alarm devices. See **Errore. L'origine riferimento non è stata trovata.** on page **Errore. Il segnalibro non è definito.** for field wiring information.

## Description of Alarms

### Phase Volts Loss/GFP Fault

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

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

**Action Taken:** Rapid stop all circuits

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

### Evaporator Flow Loss

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

**Trigger:**

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

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

**Action Taken:** Rapid stop all circuits

**Reset:**

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

If active via trigger condition 1:

When the alarm occurs due to this trigger, it can auto reset the first two times each day, with the third occurrence being manual reset.

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

If active via trigger condition 2:

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

### **Evaporator Water Freeze Protect**

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

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

**Action Taken:** Rapid stop all circuits

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

### **Evaporator #1 Water Freeze Protect**

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

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

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

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

### **Evaporator #2 Water Freeze Protect**

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

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

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

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

### **Evaporator Water Temperatures Inverted**

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

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

**Action Taken:** Pumpdown stop on all circuits

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

### **Leaving Evaporator Water Temperature Sensor Fault**

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

**Trigger:** Sensor shorted or open

**Action Taken:** Rapid stop all circuits

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

### **Leaving Evaporator Water Temperature Sensor Fault #1**

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

**Trigger:** Sensor shorted or open

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

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

### **Leaving Evaporator Water Temperature Sensor Fault #2**

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

**Trigger:** Sensor shorted or open

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

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

### **AC Comm Failure**

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

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

**Action Taken:** Rapid stop of all running circuits.

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

### **Outdoor Air Temperature Sensor Fault**

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

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

**Action Taken:** Normal shutdown of all circuits.

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

### **External Alarm**

**Alarm description (as shown on screen):** External Alarm

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

**Action Taken:** Rapid stop of all circuits.

**Reset:** Auto clear when digital input is closed.

### **Emergency Stop Alarm**

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

**Trigger:** Emergency Stop input is open.

**Action Taken:** Rapid stop of all circuits.

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

## **Unit Events**

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

### **Entering Evaporator Water Temperature Sensor Fault**

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

**Trigger:** Sensor shorted or open

**Action Taken:** Return water reset cannot be used.



**Reset:** Auto reset when sensor is back in range.

## Unit Power Restore

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

**Trigger:** Unit controller is powered up.

**Action Taken:** none

**Reset:** none

## External Event

**Alarm description (as shown on screen):** External Event

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

**Action Taken:** None

**Reset:** Auto clear when digital input is closed.

## Low Ambient Lockout

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

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

**Action Taken:** Normal shutdown of all running circuits.

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

## Option Alarms

### Heat Recovery Water Freeze Protect

**Alarm description (as shown on screen):** HeatRecFrz

**Trigger:** Heat Recovery 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:** Heat Recovery is disabled, the Heat Recovery water pump contact is activated.

**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.

### Heat Recovery Leaving Water Temperature Sensor Fault

**Alarm description (as shown on screen):** HeatRecLwtSenf

**Trigger:** Sensor shorted or open

**Action Taken:** Heat Recovery is disabled.

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

### Option Comm Failure

**Alarm description (as shown on screen):** OptionExtFault

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

**Action Taken:** Heat Recovery is disabled.

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

## Option Events

### Heat Recovery Entering Water Temperature Sensor Fault

**Event description (as shown on screen):** HeatRecEwtSenf

**Trigger:** Sensor shorted or open

**Action Taken:** None.

**Reset:** Auto reset when sensor is back in range.

### **Low Heat Recovery Entering Water Temperature Lockout**

**Alarm description (as shown on screen):** HeatRecEwtLow

**Trigger:** The Heat Recovery EWT drops below the Heat Recovery lockout set point.

**Action Taken:** None.

**Reset:** The lockout will clear when Heat Recovery EWT rises to the lockout set point plus 0.5°C.

## **Circuit Stop Alarms**

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

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

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

### **Phase Volts Loss/GFP Fault**

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

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

**Action Taken:** Rapid stop circuits

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

### **Low Evaporator Pressure**

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

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

*Freeze error* = Low Evaporator Pressure Unload – Evaporator Pressure

*Freeze time* = 70 – 6.25 x freeze error, limited to a range of 20-70 seconds

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

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

**Action Taken:** Rapid stop circuit

**Reset:** This alarm can be cleared manually if the evaporator pressure is above –10 psi.

### **Low Pressure Start Fail**

**Alarm description (as shown on screen):** LowPressStartFail N

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

**Action Taken:** Rapid stop circuit

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

### **Mechanical Low Pressure Switch**

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

**Trigger:** Mechanical Low Pressure switch input is low

**Action Taken:** Rapid stop circuit

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

### High Condenser Pressure

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

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

**Action Taken:** Rapid stop circuit

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

### Low Pressure Ratio

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

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

**Action Taken:** Normal shutdown of circuit

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

### Mechanical High Pressure Switch

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

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

**Action Taken:** Rapid stop circuit

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

### High Discharge Temperature

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

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

**Action Taken:** Rapid stop circuit

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

### High Oil Pressure Difference

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

**Trigger:** Oil Pressure Differential > High Oil Pressure Differential set point for a time greater than Oil Pressure Differential Delay.

**Action Taken:** Rapid stop circuit

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

### Oil Level Switch

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

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

**Action Taken:** Rapid stop circuit

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

### Compressor Starter Fault

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

**Trigger:**

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

If PVM set point = Single Point or Multi Point: compressor has been running for at least 14 seconds and starter fault input is open

**Action Taken:** Rapid stop circuit

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

### High Motor Temperature

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

**Trigger:**

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

**Action Taken:** Rapid stop circuit

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

### Low OAT Restart Fault

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

**Trigger:** Circuit has failed three low OAT start attempts

**Action Taken:** Rapid stop circuit

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

### No Pressure Change After Start

**Alarm description (as shown on screen):** NoPressChgAtStrt N

**Trigger:** After start of compressor, at least a 1 psi drop in evaporator pressure OR 5 psi increase in condenser pressure has not occurred after 15 seconds

**Action Taken:** Rapid stop circuit

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

### No Pressure At Startup

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

**Trigger:** [Evap Pressure < 5 psi OR Cond Pressure < 5 psi] AND Compressor start requested AND circuit does not have a fan VFD

**Action Taken:** Rapid stop circuit

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

### CC Comm Failure N

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

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

**Action Taken:** Rapid stop of affected circuit

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

### FC Comm Failure Circuit 1/2

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

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

**Action Taken:** Rapid stop of circuit 1 and 2

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

### FC Comm Failure Circuit 3

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

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

**Action Taken:** Rapid stop of circuit 3

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

#### **FC Comm Failure Circuit 4**

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

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

**Action Taken:** Rapid stop of circuit 4

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

#### **FC Comm Failure Circuit 3/4**

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

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

**Action Taken:** Rapid stop of circuit 3 and 4

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

#### **EEXV Comm Failure N**

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

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

**Action Taken:** Rapid stop of affected circuit

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

#### **Evaporator Pressure Sensor Fault**

**Alarm description (as shown on screen):** EvapPressSensFault N

**Trigger:** Sensor shorted or open

**Action Taken:** Rapid stop circuit

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

#### **Condenser Pressure Sensor Fault**

**Alarm description (as shown on screen):** CondPressSensFault N

**Trigger:** Sensor shorted or open

**Action Taken:** Rapid stop circuit

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

#### **Oil Pressure Sensor Fault**

**Alarm description (as shown on screen):** OilPressSensFault N

**Trigger:** Sensor shorted or open

**Action Taken:** Normal shutdown of circuit

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

#### **Suction Temperature Sensor Fault**

**Alarm description (as shown on screen):** SuctTempSensFault N

**Trigger:** Sensor shorted or open

**Action Taken:** Normal shutdown of circuit

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

### **Discharge Temperature Sensor Fault**

**Alarm description (as shown on screen):** DiscTempSensFault N

**Trigger:** Sensor shorted or open

**Action Taken:** Normal shutdown of circuit

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

### **Motor Temperature Sensor Fault**

**Alarm description (as shown on screen):** MotorTempSensFault N

**Trigger:** Sensor shorted or open

**Action Taken:** Rapid stop circuit

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

## **Circuit Events**

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

### **Low Evaporator Pressure - Hold**

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

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

**Action Taken:** Inhibit loading.

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

### **Low Evaporator Pressure - Unload**

**Event description (as shown on screen):** EvapPressLowUnload N

**Trigger:** This event is not enabled until the circuit startup is complete and the unit mode is Cool. Then, while running, if evaporator pressure  $\leq$  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):** CondPressHigh Hold N

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

**Action Taken:** Inhibit loading.

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

### High Condenser Pressure - Unload

**Event description (as shown on screen):** CondPressHighUnloadN

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

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

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

### Failed Pumpdown

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

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

**Action Taken:** Shutdown circuit

**Reset:** N/A

### Power Loss While Running

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

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

**Action Taken:** N/A

**Reset:** N/A

### Alarm Logging

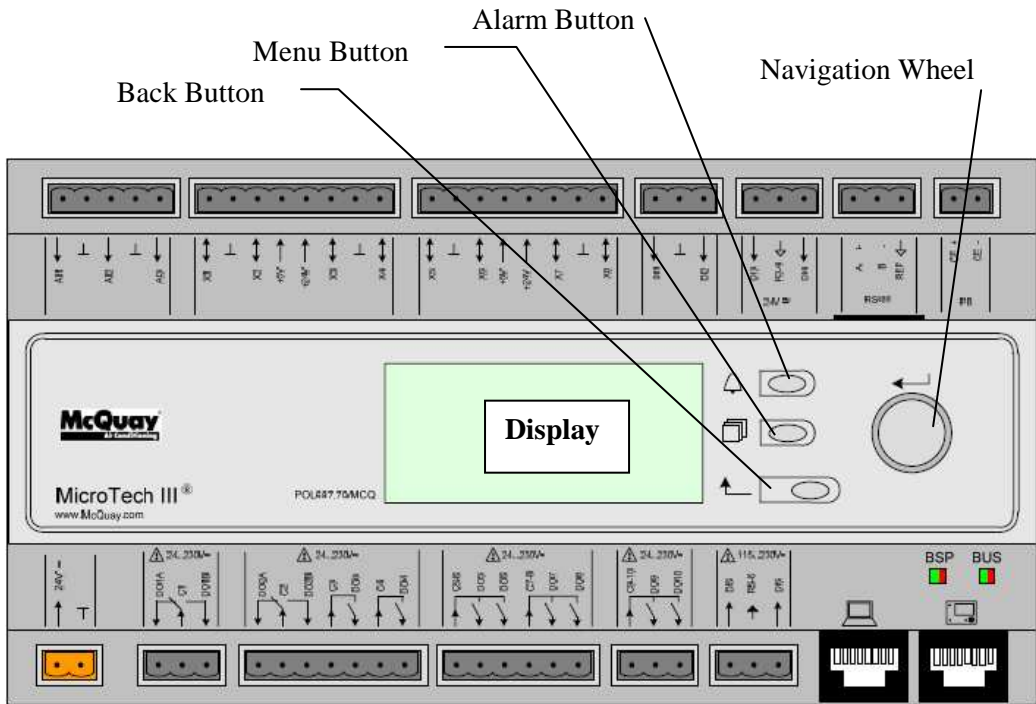
When an alarm occurs, the alarm type, date, and time are stored in the active alarm buffer corresponding to that alarm (viewed on the Alarm Active screens) also in the alarm history buffer (viewed on the Alarm Log screens). The active alarm buffers hold a record of all current alarms.

A separate alarm log stores the last 25 alarms to occur. When an alarm occurs, it is put into the first slot in the alarm log and all others are moved down one, dropping the last alarm. In the alarm log, the date and time the alarm occurred are stored, as well as a list of other parameters. These parameters include unit state, OAT, LWT, and EWT for all alarms. If the alarm is a circuit alarm, then the circuit state, refrigerant pressures and temperatures, EXV position, compressor load, number of fans on, and compressor run time are also stored.

# 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

|                    |                 |
|--------------------|-----------------|
| ◆6                 | View/Set Unit 3 |
| Status/Settings    | >               |
| Set Up             | >               |
| Temperature        | >               |
| Date/Time/Schedule | >               |

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 where it 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    |           | >      |
| Alarms                |           | >      |
| Scheduled Maintenance |           | >      |

**Figure 10, Password Entry Page**

|       |                |
|-------|----------------|
|       | Enter Password |
| Enter | ****           |

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.

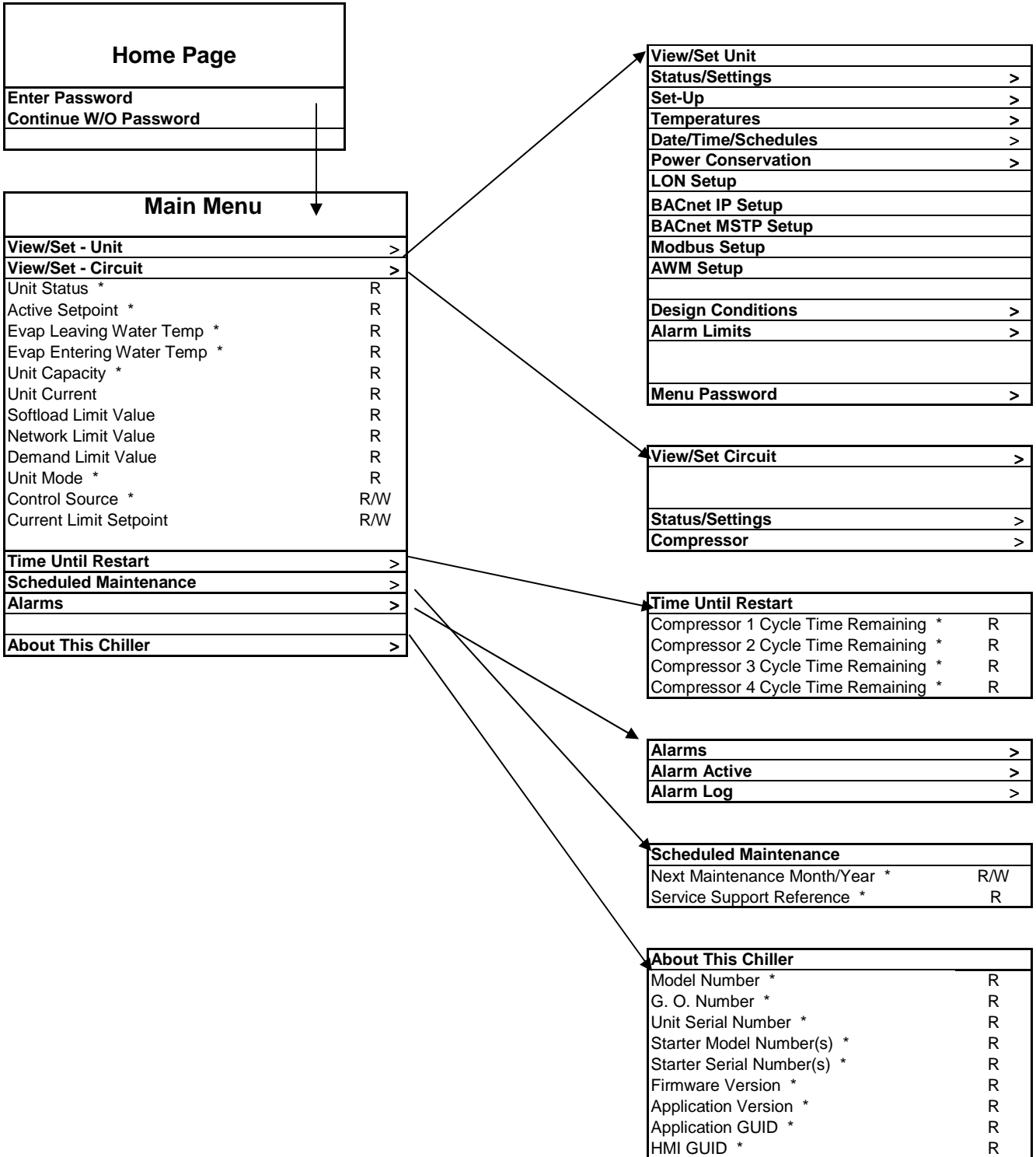
**Example 2; Change a Set point**, the chilled water set point for example. This parameter is designated as Cool LWT Set point 1 and is a unit set parameter. From the Main Menu select View/Set Unit. The arrow indicated that this is link to a further menu.

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.

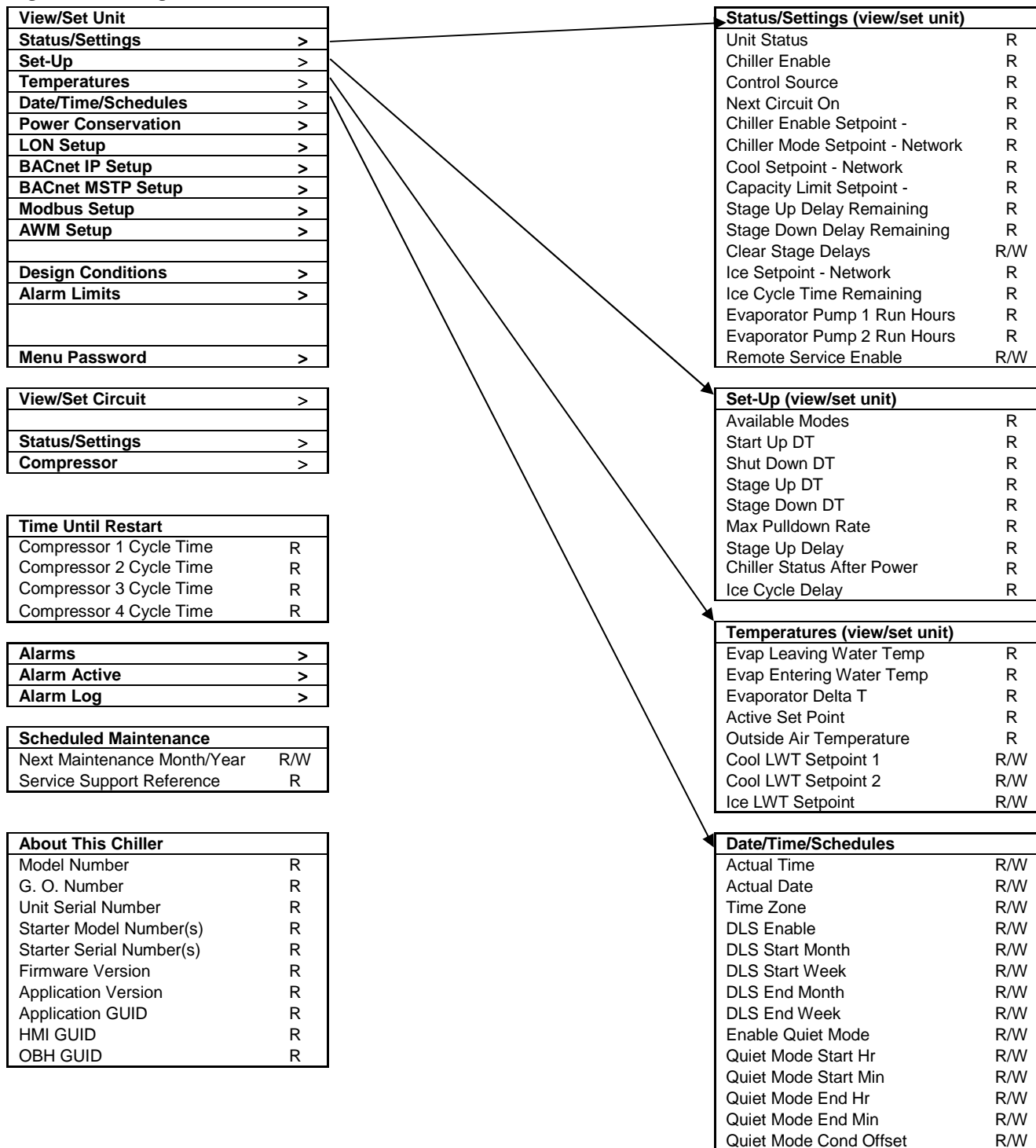
**Example 3; Clear an Alarm.** The presence of a new alarm is indicated with a Bell ringing on the top right of the display. If the Bell is frozen one or more alarm had been acknowledged but are still active. To view the Alarm menu from the Main Menu scroll down to the Alarms line or simply press the 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 13, Navigation, Part B

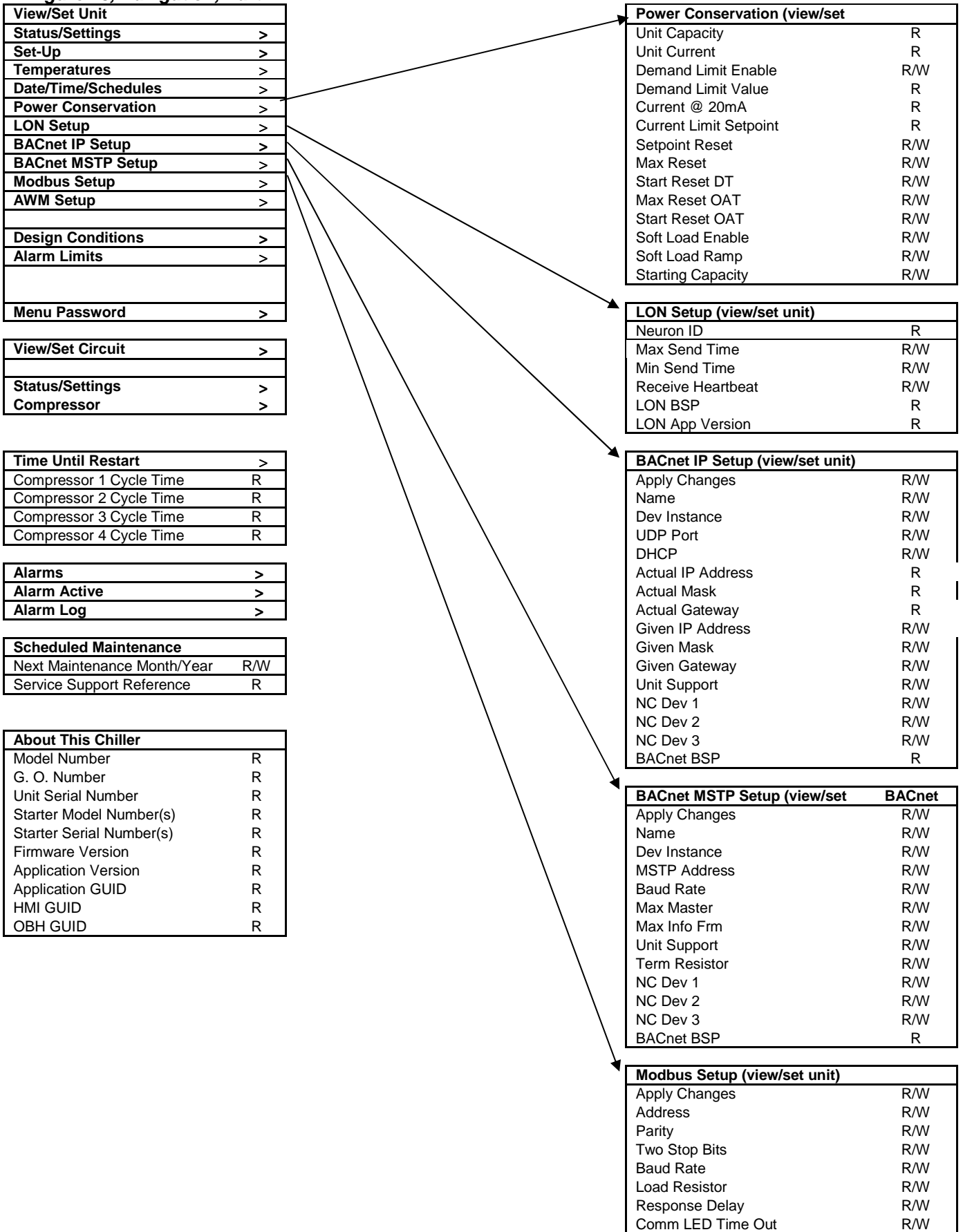
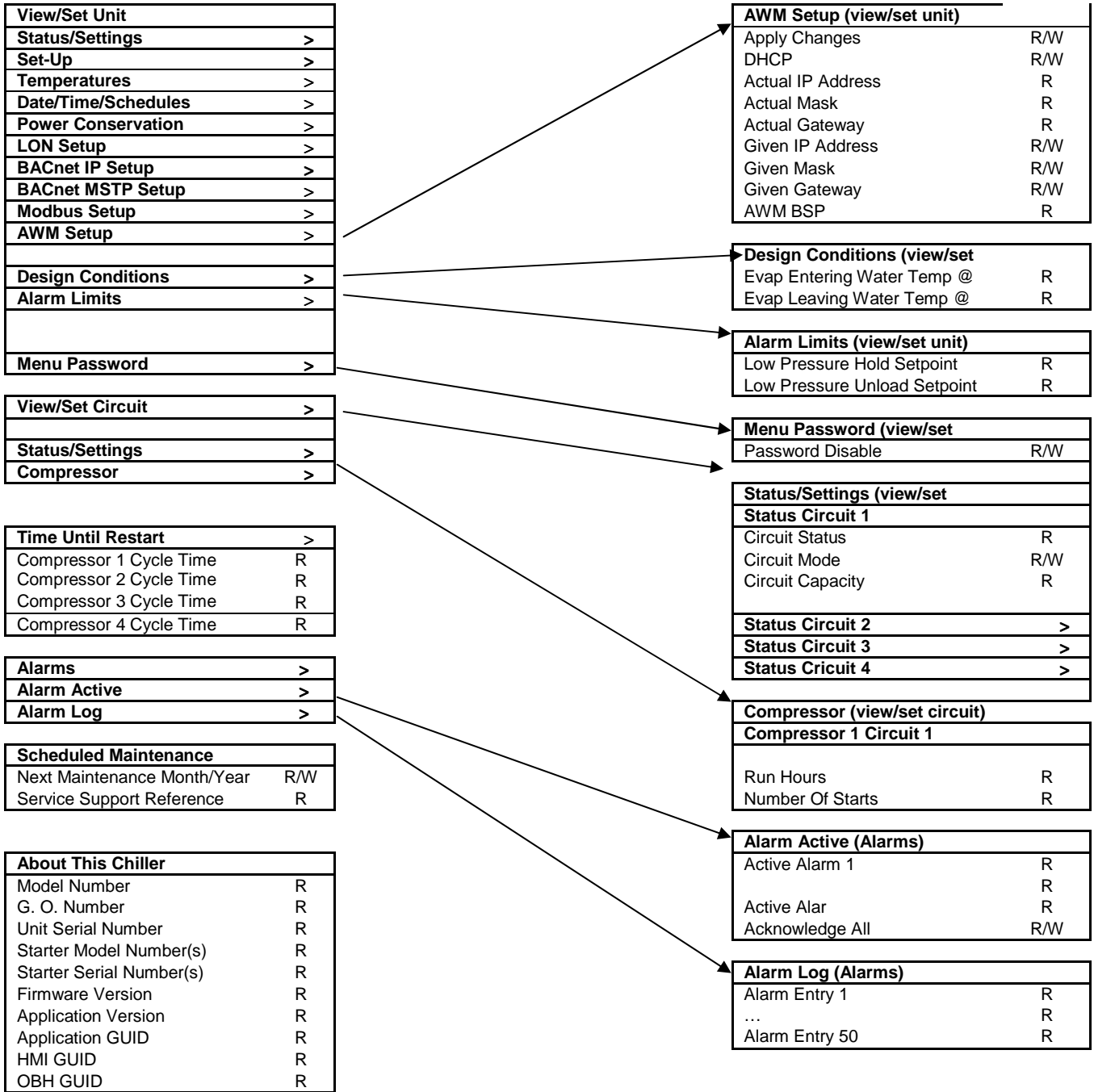


Figure 14, Navigation, Part C



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

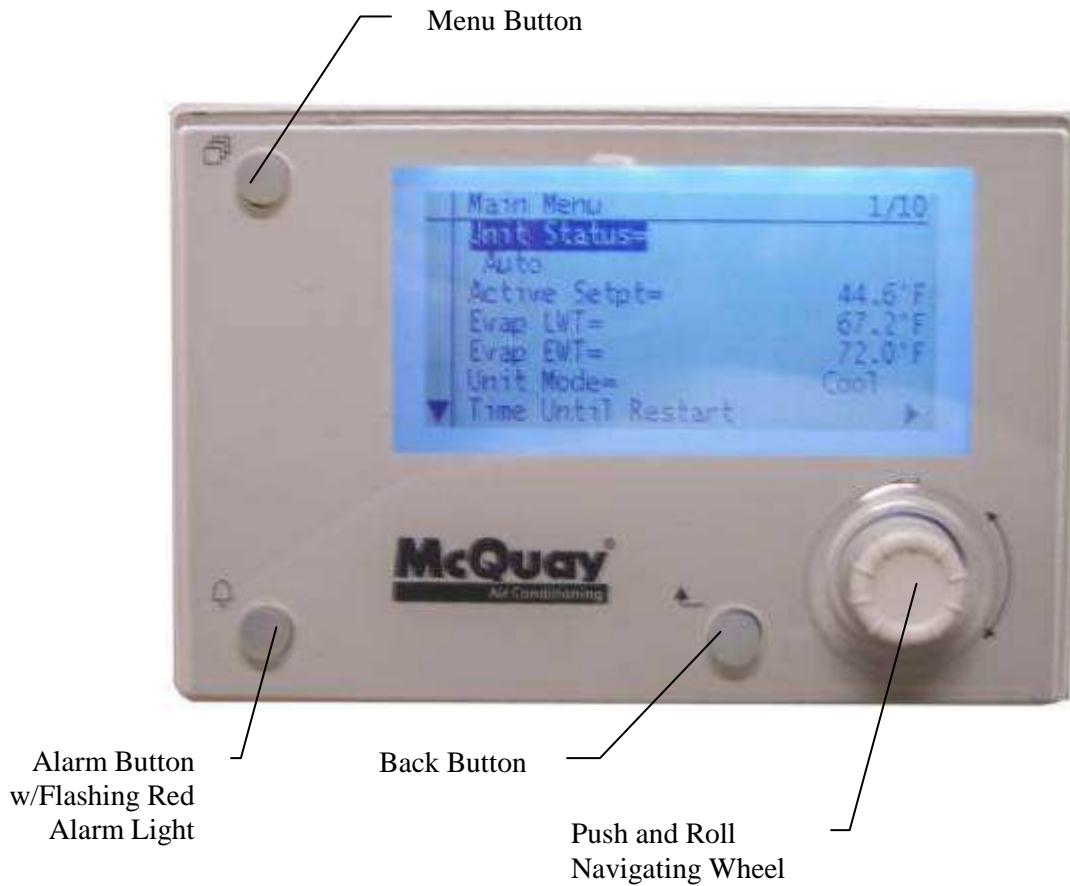
## Optional Remote User Interface

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 mm <sup>2</sup> |

### Display

|            |   |
|------------|---|
| LCD type   | FSTN  |
| Dimensions | 5.7 W x 3.8 H x 1.5 D inches (144 x 96 x 36 mm) |
| Resolution | Dot-matrix 96 X 208 pixels                      |
| Backlight  | Blue or white, user-configurable                |

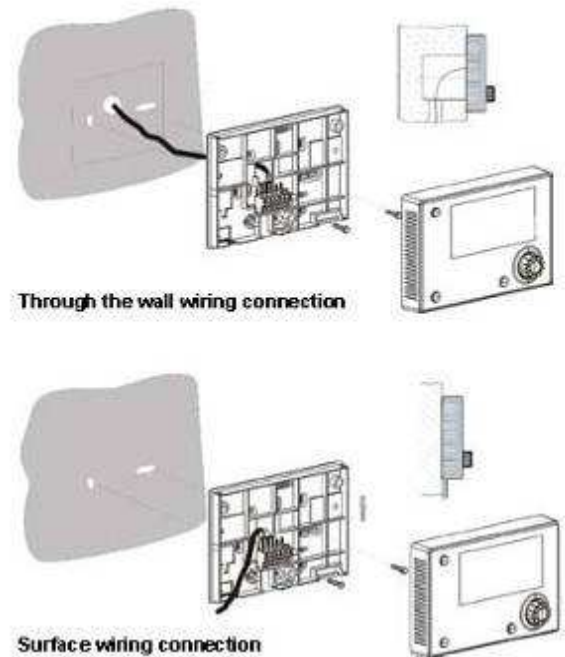
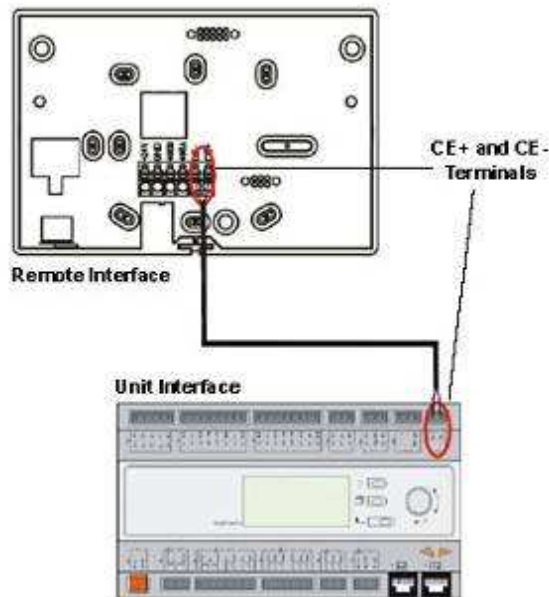
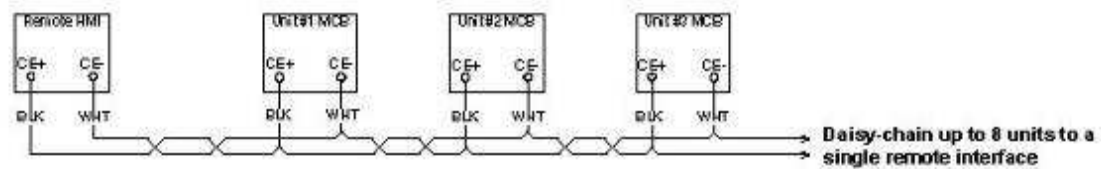
### Environmental Conditions

|                 |   |
|-----------------|---|
| 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



## 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 not 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 not 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  $\pm 10\%$  tolerance that is allowed. Voltage unbalance *between* phases must be within  $\pm 3\%$ .
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<br>°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

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Field wiring diagram is part of the air cooled screw chiller IOM. 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:**

| <b>BuS LED</b> | <b>Mode</b>   |
|----------------|---|
| 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**

| <b>BuS LED</b> | <b>Mode</b>  |
|----------------|--|
| 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

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## 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:

$$\text{Sat condenser temp target raw} = 0.833(\text{evaporator sat temp}) + 68.34$$

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

### Dead Band

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

### DIN

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

### Error

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

### Evaporator Approach

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

$$\text{Evaporator Approach} = \text{LWT} - \text{Evaporator Saturated Temperature}$$

See page 38 for more details

### Evap Recirc Timer

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

### EXV

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

### High Saturated Condenser – Hold Value

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

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

### **High Saturated Condenser – Unload Value**

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

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

### **Light Load Stg Dn Point**

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

### **Load Limit**

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

### **Load Balance**

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

### **Low Ambient Lockout**

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

### **Low Pressure Unload Setpoint**

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

### **Low Pressure Hold Setpoint**

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

### **Low/High Superheat Error**

The difference between actual evaporator superheat and the superheat target.

### **LWT**

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

### **LWT Error**

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

### **LWT Slope**

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

### **ms**

Milli-second

### **Maximum Saturated Condenser Temperature**

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

### **OAT**

Outside ambient air temperature

### **Offset**

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

### **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:

$$\text{Suction Superheat} = \text{Suction Temperature} - \text{Evaporator Saturated Temperature}$$

See page 38 for details.

### **Stage Up/Down Accumulator**

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

### **Stageup/Stagedown Delta-T**

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

### **Stage Up Delay**

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

### **Startup Delta-T**

Number of degrees above the LWT setpoint required to start the first compressor.

### **Stop Delta-T**

Number of degrees below the LWT setpoint required for the last compressor to stop.

### **VDC**

Volts, Direct current, sometimes noted as vdc.



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