MICRO CONTROL SYSTEMS

5580 Enterprise Pkwy.
Fort Myers, FL 33905

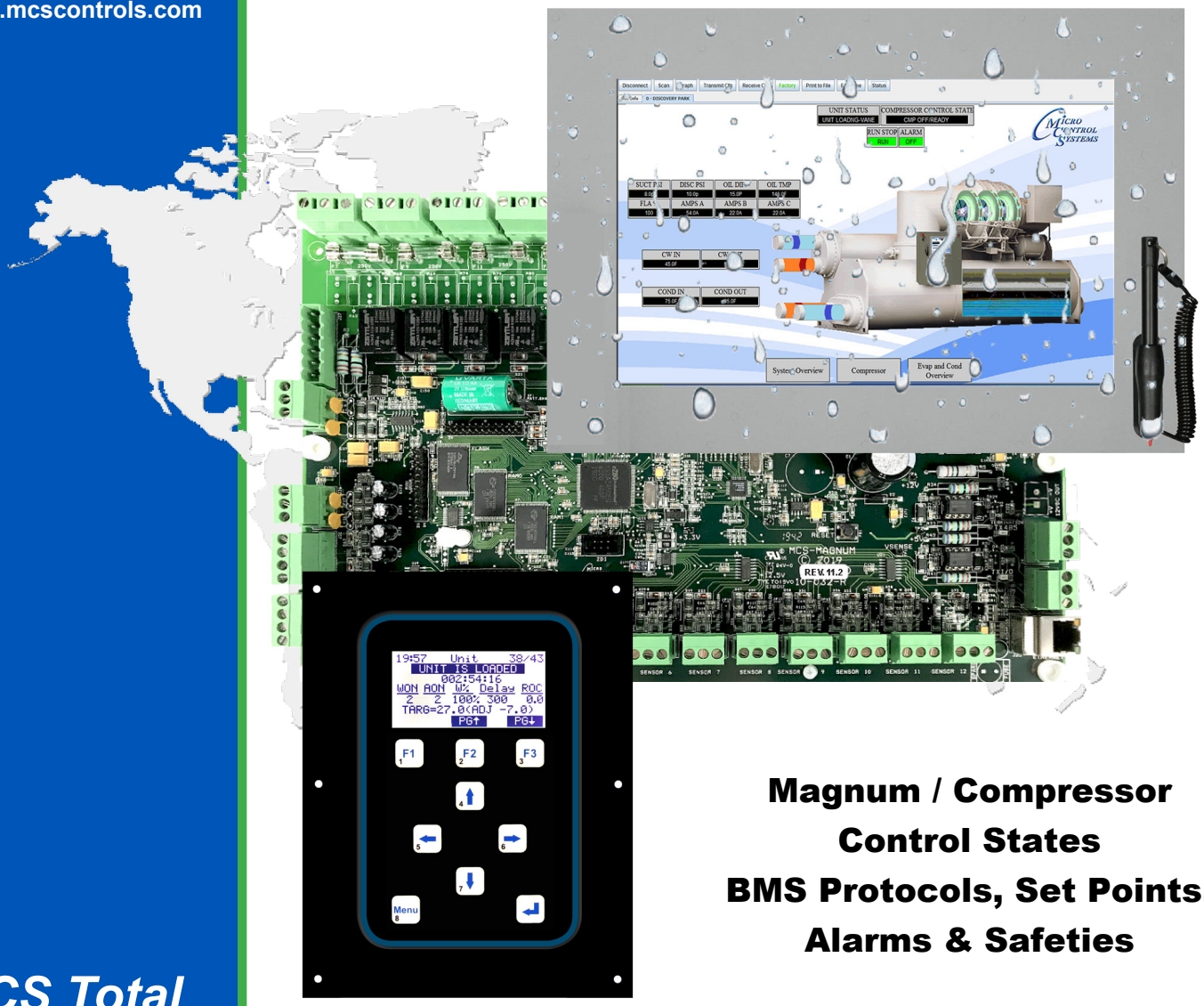
Office: 239-694-0089
Fax: 239-694-0031

www.mcscontrols.com

Magnum HVAC Version 17

Rev. 2.4.4 - REV-2026-06-24

View Changes made since last Version Release, see page 2



Magnum / Compressor
Control States
BMS Protocols, Set Points,
Alarms & Safeties

MCS Total Solution for all your Control Needs

RoHS Compliant

Energy Efficient and RoHS Compliant

HVAC Manual additions / changes since last revision:

Rev. 2.4.4 - Updated the state text “UNIT IS OFF/TEMP” to “UNIT OFF CTRL SI“

Rev. 2.4.3 - edition of the HVAC Manual contains a number of updates and additions since the last HVAC manual release 2.3.3.

1. Chapter 12.11 - Start Multiple compressors to turn on together
2. Chapter 13.2 and 13.2.1- Liquid Injection released to Rev 2.4.3

The MCS Commitment is to provide practical solutions for the industries needs and to be both a leader and partner in the effective use of microprocessor controls.

Micro Control Systems, Inc.
5580 Enterprise Parkway
Fort Myers, Florida 33905
PH:(239) 694-0089 FAX:(239) 694-0031
www.mcscontrols.com

Table of Contents

Chapter - 1. Introduction to the Magnum

About the Magnum

The Magnum controller is a microprocessor-based control system designed to provide complete control of many different types of compressors of both fixed and variable capacity, as well as many additional features. Supported control options include multiple liquid line solenoids, electronic expansion valves (EXVs), liquid injection, economizer, hot gas bypass, variable frequency drives for compressors (VFDs), digital scrolls, and many more.

Applications vary from control of a single compressor to complex multiple compressor systems.

In all applications, however, safety and operating efficiency is of primary importance.

The controller interface is made to be informative and meaningful, with built-in logic to prevent unsafe conditions from occurring. This helps reduce or even completely eliminate nuisance alarms.

Magnum Industrial Control Panels

Industrial Control Panels are available configured with many different options including a Keypad or a 15.4 Touchscreen installed with MCS-CONNECT using graphics designed for your controller.

Control Panels are available in three sizes, Small Panel, Medium Large Panel and Large Panel. Standard Panels are Nema rated Type 1 for inside installation and Nema rated Type 4 for installations for areas which may be regularly hosed down or are in very wet or oily conditions. The control panel provides protection from dust, dirt, oil and water.

Magnum Hardware Supported by Magnum V17 Software

The following MCS boards can be connected together through the MCS-I/O communications terminal block:

- MCS-Magnum (10 RO's, 12 SI's, 4 Digital SI's, and 4 AO's)
- MCS-RO-Base (10 RO's) and MCS-RO-EXT (10 RO's)
- MCS-SI-Base (16 SI and 4 AO) and MCS-SI-EXT (16 SI and 4 AO)

The versatility of the Magnum offers the user much flexibility in configuring the controls in an economical way. The limitation is not the number of boards but the total number of set points.

Software

HVAC V17–This software supports all types of compressors except centrifugal. It supports the configuration type 106 Chiller V17 CFG, as well as 109 Loop Control CFG. If this software is loaded into a Magnum with a different type of configuration file, an invalid configuration type message will be generated.

Magnum V17 Software Control Point Capacity

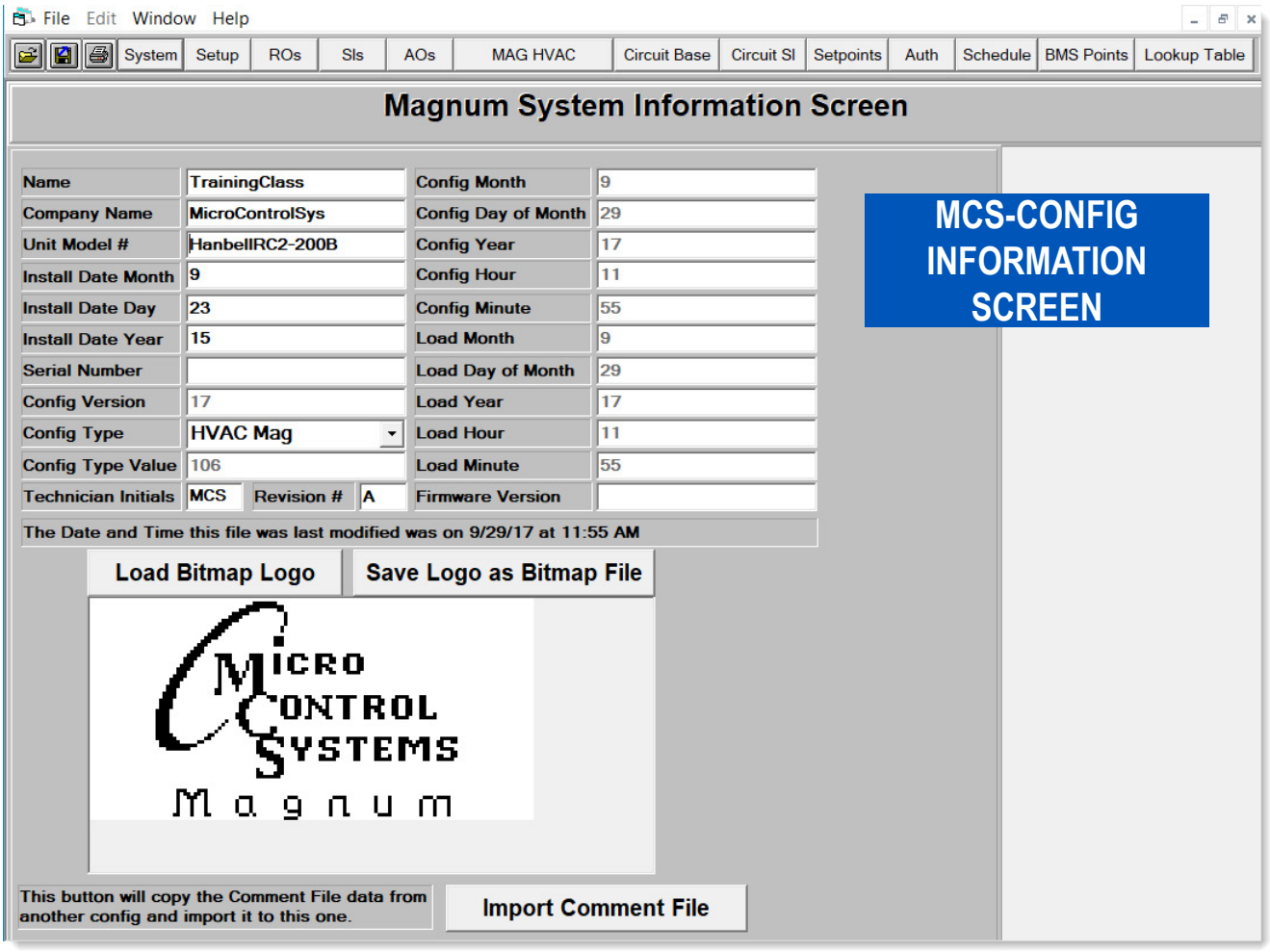
- Circuits (compressors) up to 20
- Steps per Compressor up to 4
- Relay Outputs up to 80
- Analog Outputs up to 28
- Sensor Inputs up to 112
- Setpoints 255
- Alarms 100

Chapter - 2. PC Software for the Magnum

2.1. MCS-Config

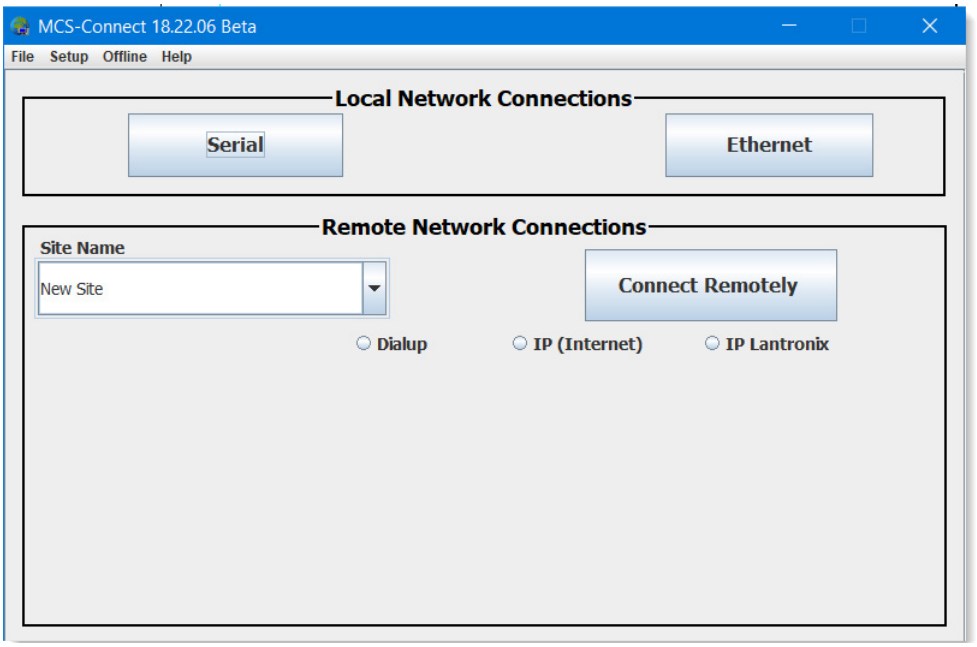
Provides the configuration file (.cfg), which includes the input/output points list, Setpoints, circuit information, etc., for all versions of software. This program is designed to assist and make the task of building the configuration file as simple as possible.

- Windows 7 or later operating system or
- Linux operating system
- Minimum 1GB of RAM
- Minimum 4GB Drive
- 14.4k baud modem or higher for remote
- Communications
- 1280 x 800 pixel or higher display

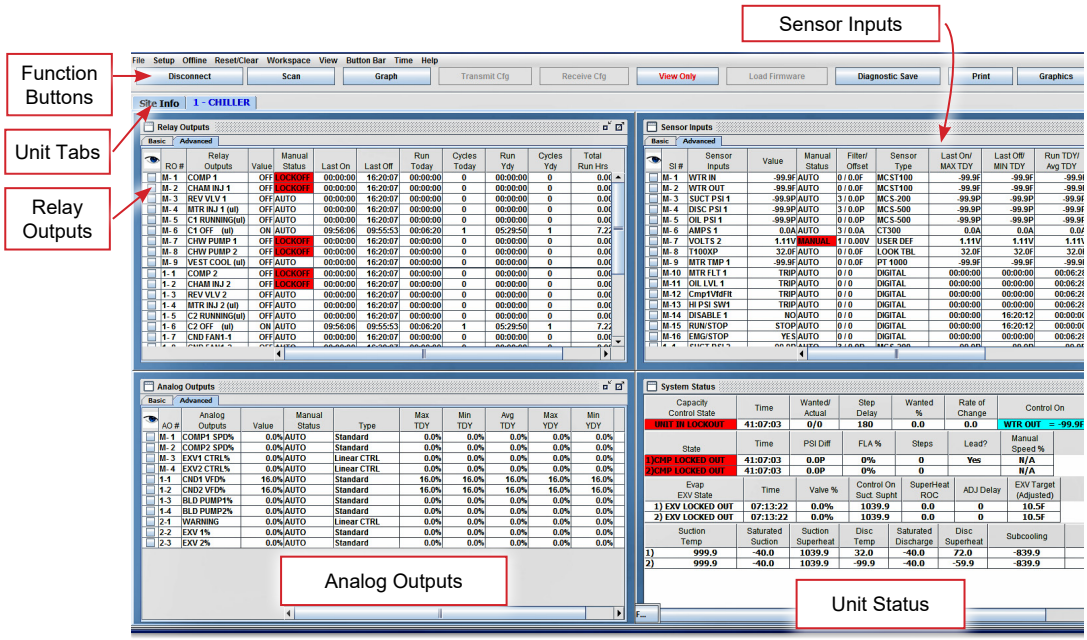


2.2. MCS-CONNECT

Provides both local and remote communications to the Magnum independent of software type. Local communications can be either through an RS485 or Ethernet connection. This program displays the status of the controller, and changes can be made to the system with proper authorization. Configuration files can be transmitted to or received from a Magnum unit. The Magnum automatically performs history logging and this program allows the data to be presented in a useful graph form.



2.2.1 HVAC STATUS Display (MCS-Connect)

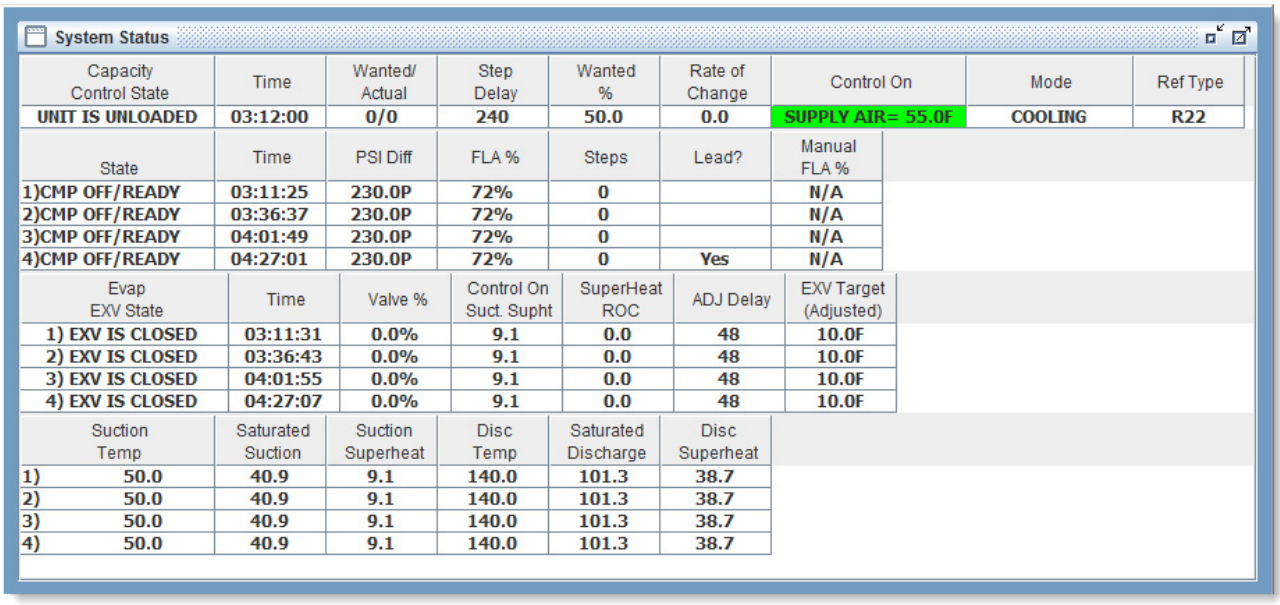


The screen shot above shows the following features:

- The top row of buttons provides function selection within MCS-Connect.
- The authorization level button is located in this row; it will automatically update to display the current authorization level. The example above is at a factory level authorization.
- Just below the top row of buttons, there is a row of tabs. The first is the Site Information screen which will show you details of all the Magnum controllers available to establish a connection, the remaining tabs allow you to access to each one respectively.

- There are four quadrants of information displayed for each Magnum controller, namely: Relay Outputs, Analog Outputs, Sensor Inputs, and Unit Status (with six sub-menus of Status, Alarms, Setpoints, Reset/Clear, Schedule, and Service). Note: these screens may not always be displayed in the same position; MCS-Connect will automatically adjust the screen arrangement for optimum display information.

The status of the Capacity Control States, Compressor Control States and EXV Control States can be viewed from MCS-Connect by clicking the “Status” screen in the Unit Status quadrant. The following screen will be displayed:



System Status

Capacity Control State	Time	Wanted/ Actual	Step Delay	Wanted %	Rate of Change	Control On	Mode	Ref Type
UNIT IS UNLOADED	03:12:00	0/0	240	50.0	0.0	SUPPLY AIR= 55.0F	COOLING	R22

State	Time	PSI Diff	FLA %	Steps	Lead?	Manual FLA %
1)CMP OFF/READY	03:11:25	230.0P	72%	0		N/A
2)CMP OFF/READY	03:36:37	230.0P	72%	0		N/A
3)CMP OFF/READY	04:01:49	230.0P	72%	0		N/A
4)CMP OFF/READY	04:27:01	230.0P	72%	0	Yes	N/A

Evap EXV State	Time	Valve %	Control On Suct. Supht	SuperHeat ROC	ADJ Delay	EXV Target (Adjusted)
1) EXV IS CLOSED	03:11:31	0.0%	9.1	0.0	48	10.0F
2) EXV IS CLOSED	03:36:43	0.0%	9.1	0.0	48	10.0F
3) EXV IS CLOSED	04:01:55	0.0%	9.1	0.0	48	10.0F
4) EXV IS CLOSED	04:27:07	0.0%	9.1	0.0	48	10.0F

	Suction Temp	Saturated Suction	Suction Superheat	Disc Temp	Saturated Discharge	Disc Superheat
1)	50.0	40.9	9.1	140.0	101.3	38.7
2)	50.0	40.9	9.1	140.0	101.3	38.7
3)	50.0	40.9	9.1	140.0	101.3	38.7
4)	50.0	40.9	9.1	140.0	101.3	38.7

System (unit) information is shown in the top section:

- **Capacity Control State**–State of chiller
- **Time**–Time spent in current state. If the state is UNIT IN POWER UP time will count down to zero.
- **Wanted / Actual**–Number of capacity steps Wanted On versus Actual On.
- **Step Delay** – Value that is counted down. The sensitivity and difference between the control sensor and control zone will determine the speed of the countdown. When this value reaches zero, the controller will determine if a change in the system capacity is required.
- **Wanted %–**Wanted slide percentage.
- **Rate Of Change** – Rate of Change of control sensor.
- **Control On–**The control sensor value. The name and the reading will be displayed, with color to indicate its relationship to the target Setpoint.
- Mode–The mode can be either COOLING or HEATING.

Compressor information (all active compressors will be displayed):

- **State–**Compressor number and state. The default Compressor number can be changed in MCS-Config with a 3 character entry in the “Comp Name/ID” column of the Circuit Base screen.
- **Time**–Time spent in current state. If the state is CMP ANTICYCLE time will count down to zero.
- **Oil Diff**–Oil differential pressure. It is calculated as follows:
  Semi hermetic screws.....Oil PSI–Suction PSI
  OR .....Discharge PSI–Suction PSI
  Open drive horizontal and Carlyle screw compressor ..Oil PSI–Discharge PSI
  Reciprocating compressors .....Oil PSI–Suction PSI
  All Others .....Oil PSI–Discharge PSI
- **FLA %**–Full Load Amps based on the compressor’s respective Setpoint. For screw compressors this calculation is based current operating conditions.
- **Steps**–Indicates number of steps associated with this compressor that are turned on.
- **Lead?**–YES will be displayed for the lead compressor.

Compressor Superheat information:

- **Suction Temp–**Compressor number and Suction Temperature, if available.
- **Saturated Suction**–Calculated Suction Saturated Temperature (R22, R134a, R407c, and R410a are supported).
- **Suction Superheat**–Calculated Suction Superheat, only available if both the Suction Temperature and the Suction Pressure are used. Suction Superheat = Suction Temperature–Suction Saturated Temperature.
- **Disc Temp**–Discharge Temperature, if available.
- **Saturated Discharge–**Calculated Discharge Saturated Temperature (R22, R134a, R407c, and R410a are supported).
- **Disc Superheat–**Discharge Superheat is available only if both the Discharge Temperature and the Discharge Pressure are used. Discharge Superheat = Discharge Temperature–Discharge Saturated Temperature.
- **Ref Type** – Refrigerant type used.
- CTRL LIFT – Control Lift = Saturated Discharge Temperature–Saturated Suction Temperature (OR) Turbine Input PSI (converted to temperature).

Compressor information (all active compressors will be displayed):

- State–Compressor number and state. The default Compressor number can be changed in MCS-Config with a 3 character entry in the “Comp Name/ID” column of the Circuit Base screen.
- Time–Time spent in current state. If the state is CMP ANTICYCLE time will count down to zero.
- Oil Diff–Oil differential pressure. It is calculated as follows:
- Centrifugal compressors: Oil Pressure – Pre-oil Filter Pressure
- FLA %–Full Load Amps based on the compressor’s respective Setpoint.
- Steps–Indicates number of steps associated with this compressor that are turned on.
- Lead?–YES will be displayed for the lead compressor.
- Staging – This field will display “VANES” for centrifugal compressors
- Lift Temp – If an Inlet Pressure sensor is specified in the configuration, then this value will equal Saturated Discharge Temperature – Inlet PSI (converted to temperature). If no Inlet Pressure sensor is present, this value will equal Saturated Discharge Temperature–Saturated Suction Temperature.
- Lift ROC’s – Current lift Rate Of Change/ Last lift Rate Of Change
- Amp/Lift Surges – This field is a counter for the number of amp and lift surges respectively.

2.3. Authorization Function

The authorization code is a special four-character code that enables access to the Magnum controller.

The code may consist of any valid alpha/numeric characters if the system is being accessed through MCS-Connect, however, the code must be numeric with values between 1 and 8 if it is to be entered through the Keypad/Display. Each Magnum can have up to 10 different authorization codes, with four levels of authorization which provide differing levels of functionality. The authorization code and the associated level cannot be viewed or changed through the Keypad/Display or MCS-Connect, but only when the configuration file is opened in MCS-Config. The authorization codes should be protected and remain confidential, or unauthorized personnel may gain access to the system and perhaps cause irreparable damage.

From the Keypad/Display the following changes can be made based upon the authorization level:

FUNCTION	VIEW	USER	SERVICE	SUPERVISOR	FACTORY	ADMIN
Sensor offsets	NO	NO	YES	YES	YES	YES
Sensor diagnostics	NO	NO	YES	YES	YES	YES
Clear alarm history	NO	NO	NO	NO	NO	YES
Clear point information	NO	NO	NO	NO	NO	YES
Date and time set	NO	YES	YES	YES	YES	YES
Day of week set	NO	YES	YES	YES	YES	YES
Change No Flow Lockout or shut down	NO	NO	NO	NO	YES	YES
Change rotate Yes or No	NO	NO	NO	NO	YES	YES
Change Manual/Auto settings	NO	NO	NO	YES	YES	YES
Change setpoint values	NO	*	*	*	YES	YES
Change operating schedules	NO	YES	YES	YES	YES	YES
Change holiday dates	NO	YES	YES	YES	YES	YES
Lockout Reset	NO	**	**	**	YES	YES
*** Change RS485 network settings	NO	NO	YES	YES	YES	YES
Change Ethernet network settings	NO	NO	YES	YES	YES	YES
Adjust Keypad/Display contrast	YES	YES	YES	YES	YES	YES
Transmit Software	NO	NO	YES	YES	YES	YES
Transmit/Receive Configuration	NO	NO	YES	YES	YES	YES

* Setpoints may have individual authorization levels; you must have the proper authorization to view or edit them.

**See the Setup screen of the configuration for authorization level(s) that are allowed unlimited resets per day. Authorization levels below ‘Auth Level Bypass’ are allowed only a limited number of resets. Authorization levels at and above ‘Auth Level Bypass’ are allowed unlimited lockout resets.

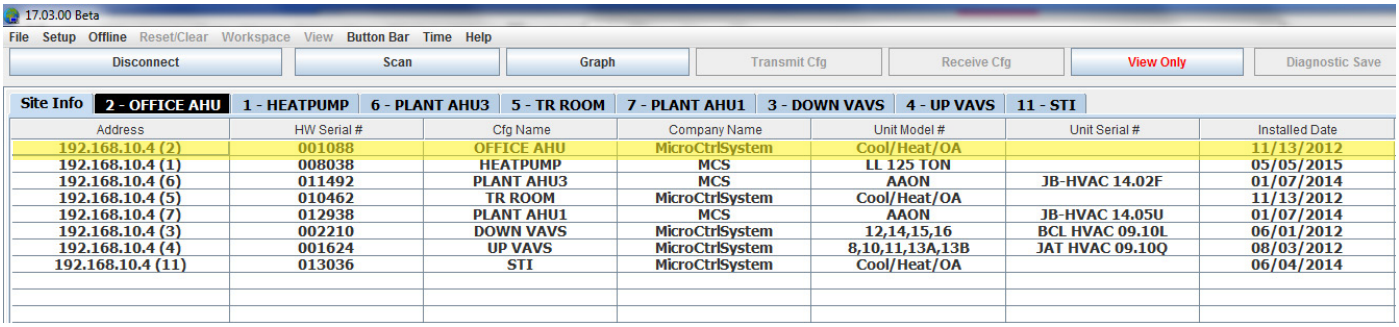
***Firmware Version 17.62M, ‘Change RS485 network settings - **SERVICE** or greater.’

To get authorized through the Keypad/Display do the following:

1. Press ‘Menu’
2. Using ↑ ↓, →, or ← keys, move cursor to ‘Passwords’

3. Press ↵key.
4. Enter 4 digit password and press ↵
5. The authorization will be displayed.
6. Press 'Menu' to make next selection.

To get authorized through MCS-Connect do the following:



Address	HW Serial #	Cfg Name	Company Name	Unit Model #	Unit Serial #	Installed Date
192.168.10.4 (2)	001088	OFFICE AHU	MicroCtrlSystem	Cool/Heat/OA		11/13/2012
192.168.10.4 (1)	008038	HEATPUMP	MCS	LL 125 TON		05/05/2015
192.168.10.4 (6)	011492	PLANT AHU3	MCS	AAON	JB-HVAC 14.02F	01/07/2014
192.168.10.4 (5)	010462	TR ROOM	MicroCtrlSystem	Cool/Heat/OA		11/13/2012
192.168.10.4 (7)	012938	PLANT AHU1	MCS	AAON	JB-HVAC 14.05U	01/07/2014
192.168.10.4 (3)	002210	DOWN VAVS	MicroCtrlSystem	12,14,15,16	BCL HVAC 09.10L	06/01/2012
192.168.10.4 (4)	001624	UP VAVS	MicroCtrlSystem	8,10,11,13A,13B	JAT HVAC 09.10Q	08/03/2012
192.168.10.4 (11)	013036	STI	MicroCtrlSystem	Cool/Heat/OA		06/04/2014

1. Click View Only on desired Magnum in the Site Information screen.
2. Click button.
3. Enter the 4 digit code into the pop-up box and click ok (or press the enter key).
4. Depending on the authorization level, the button will change to one of the following displays, indicating if the code was accepted or not.

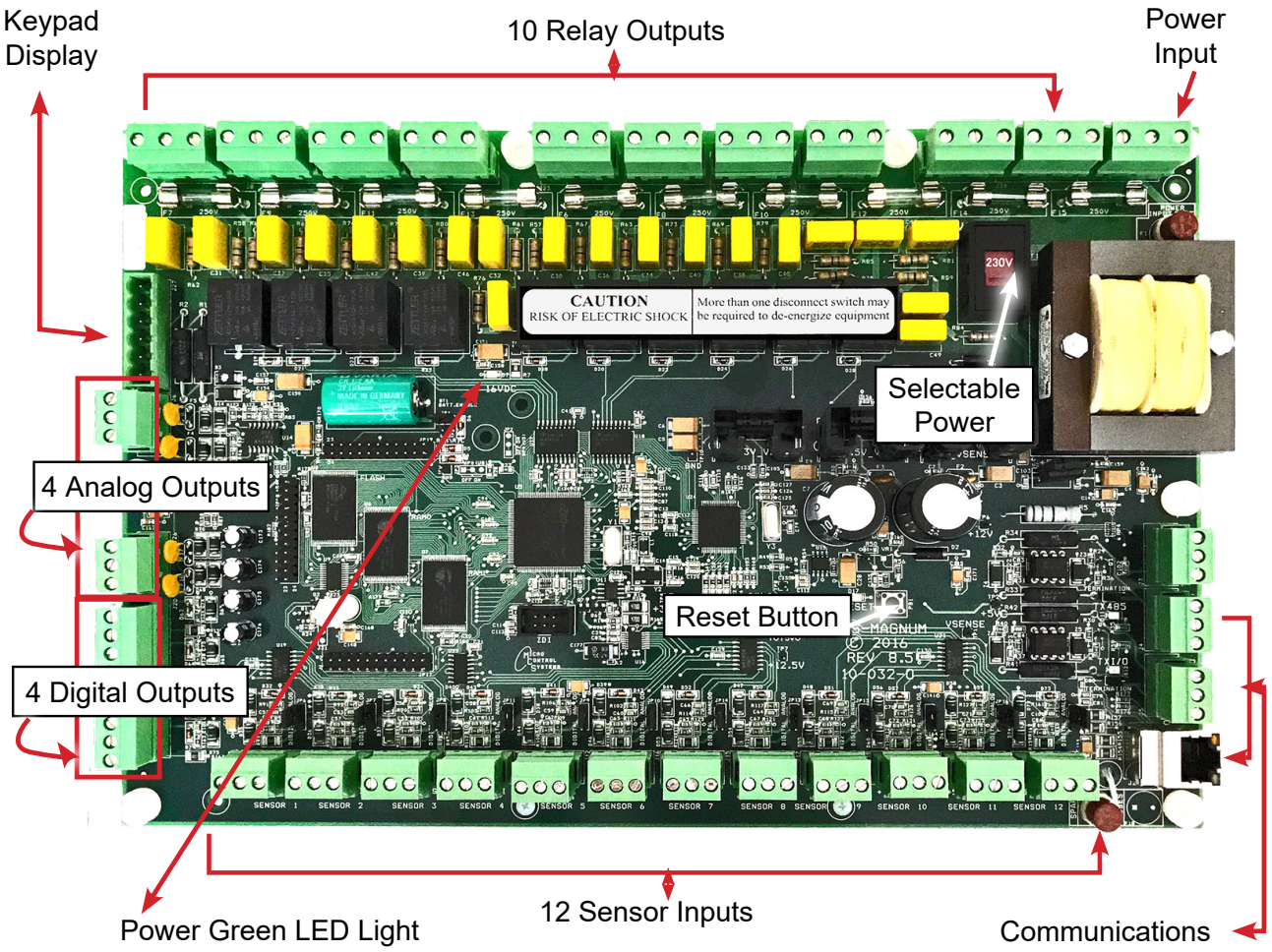
Chapter - 3. MCS-MAGNUM-N and Expansion Boards

3.1. MCS-Magnum Revision 9.1 (revised to 10.4, see next pages)

File No: E169780

RoHS Compliant

MCS-MAGNUM-N
115-230vac-Selectable Power



Controller Specifications

Dimensions ..... 12.0”w, 8.0”h, 2.0”d
Mounting Holes ..... Mounts on a backplane using eight #6 sheet metal screws
Operating Temperature ..... -40°F to +176°F (-40°C to +80°C)
Storage Temperature ..... -40°F to +176°F (-40°C to +80°C)
Microprocessor ..... Zilog eZ80 Acclaim! @ 50mhz
Sensor Inputs (SI) ..... 12 inputs 0-5vdc (10-bit A/D)
Digital Inputs ..... 4 inputs 0 or 5vdc only
Relay Outputs (RO) ..... 10 outputs 6.3amps @ 230vac
Analog Outputs (AO) ..... 4 outputs 0-10vdc
Printed Circuit Board ..... Six layer with separate power and ground planes

Input Power (Standard) ..... 115 or 230vac ±10% 50/60Hz
..... @ 77°F (25°C) ambient, 20VA max
(Voltage is field selectable)
MCS-I/O Comm Port ..... 1 @ 38,400 baud
RS-485 Comm Port ..... 1 @ 19,200 baud
Ethernet ..... 10/100 Mbps Ethernet
Real Time Clock ..... Battery backup
Power Detection ..... Automatic power fail reset

Options

-24 24vac input power ±10% 50/60Hz @ 77°F (25°C) ambient

MCS-MAGNUM HARDWARE REV. 9.1

- MCS-MAGNUM hardware has been modified and its new revision number is - 9.1
- Hardware modification - Ethernet PHY chip was replaced due to obsolescent of the old Ethernet PHY chip by the manufacturer.
- **NEW ETHERNET PHY CHIP REQUIRES NEW FIRMWARE TO FUNCTION.**

FOLLOWING FIRMWARE VERSIONS (OR GREATER) ARE REQUIRED FOR MAGNUM HARDWARE VERSION 9.1

V7:

HVAC	07.03-V
CENT	07.03-V
REFR	07.03-V

V9:

HVAC	09.14-P
CENT	09.14-P
REFR	09.14-P
RTUM	09.14-P
PAO	09.14-P
ACU	09.14-P

V16:

HVAC	16.11-G
CENT	16.11-G
REFR	16.11-G
RTUM	16.11-G
PAO	16.11-G
ACU	16.11-G

V17:

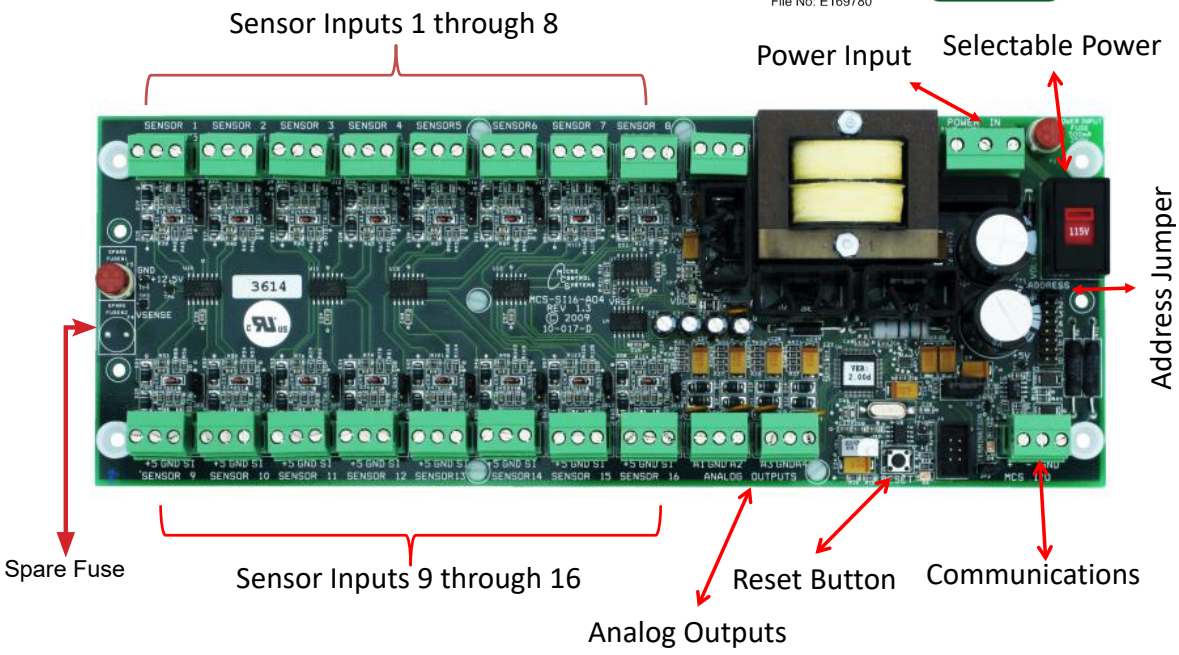
HVAC	17.26-A or greater
CENT	17.26-A or greater
REFR	
RTUM	17.26-A or greater
PAO	17.26-A or greater
ACU	17.26-A or greater

3.2. MCS-SI16-A04- Version 1.3

The MCS-SI16-AO4 provides a flexible and cost effective way to allow sensor input and analog output expansion for MCS MAGNUM and MicroMag controllers

Input Power (Standard) ..... 115 or 230vac ±10% 50/60Hz
Optional 24vac input power ±10% 50/60Hz

File No: E169780

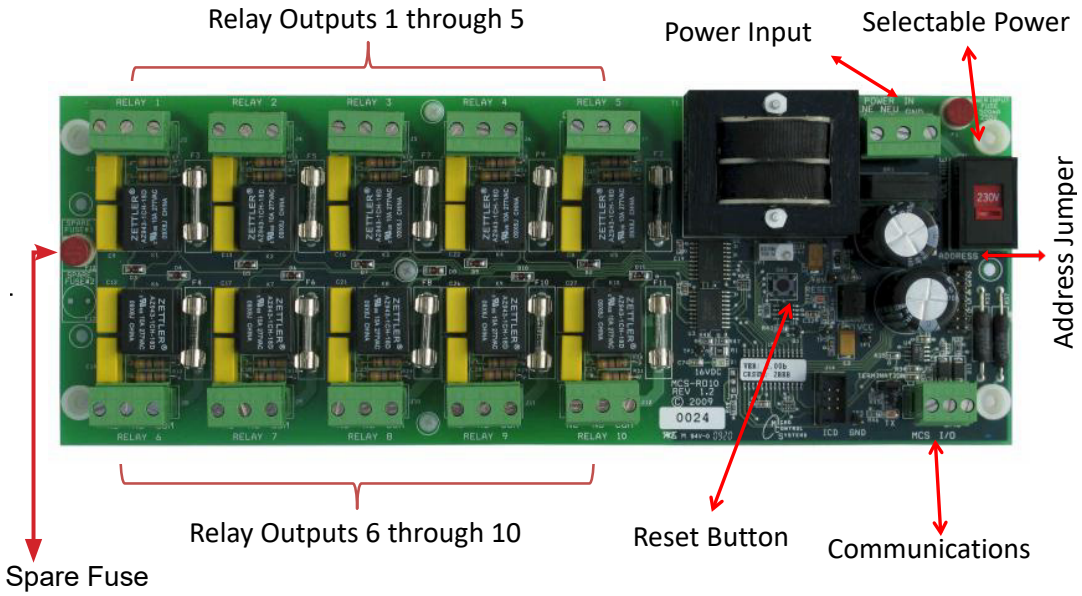


3.3. MCS-RO10 - Version 1.2

The MCS-RO10 provides a flexible and cost effective way to allow relay output expansion for MCS-MAGNUM and 1MicroMag controllers.

Input Power (Standard) ..... 115 or 230vac ±10% 50/60Hz
Optional 24vac input power ±10% 50/60Hz

File No: E169780

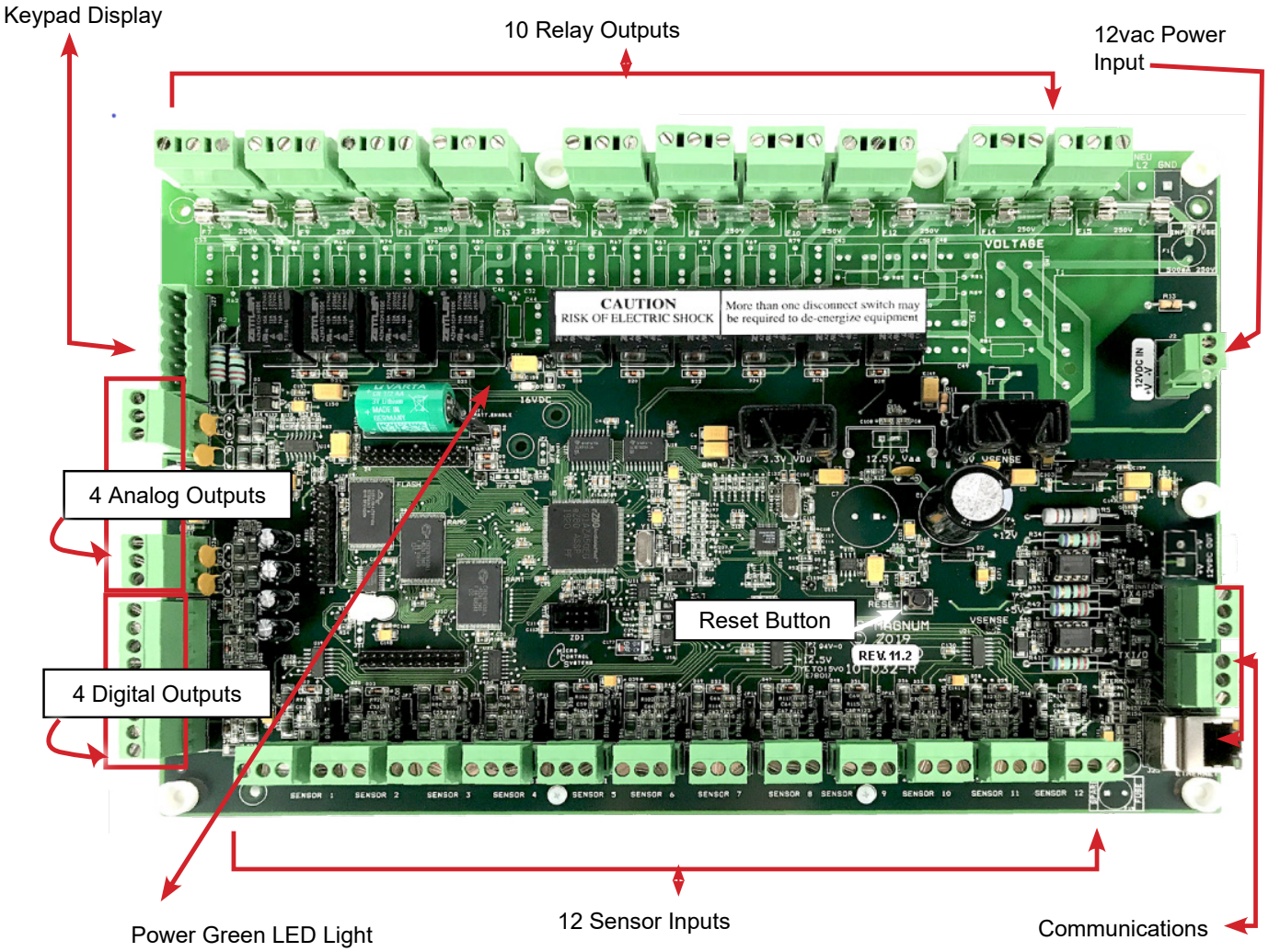


3.4. MCS-Magnum-N-12 Revision 11.1

Input Power (Standard) +12vdc power in board from 88 VAC to 264 VAC switching power supply

c UL us
File No: E169780

RoHS Compliant



3.4.1 Optional Single Output Power Supply

90W 12VDC Enclosed Switching Power Supply
Input Voltage: 88 VAC to 264 VAC
Output Voltage: 12 VDC @ 7.5 Amps
Input Current: 3 A / 115 AC
1.6 A / 230AC
Output Rated Current: 7.5 A
Size: 2.76” x 3.54” x 2.14 (W*H*D) (70*90*54.5mm)

3.5. MCS-IO-BASE and MCS-IO-EXT

The MCS-IO-BASE provides a flexible and cost effective way to allow relay output, sensor input and analog output expansion for MCS MAGNUM-N-12.

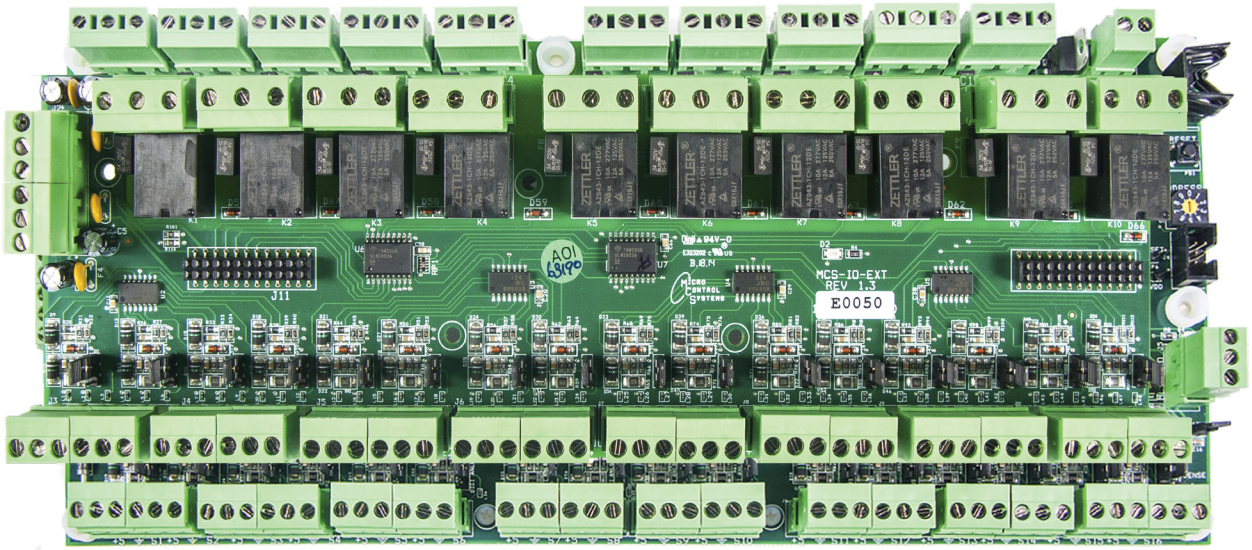
Using a Single Output Power Supply the MCS-IO can be used with 115-230 or 24 volt MCS-MAGNUM-N or MicroMag systems.

Using the stackable MCS-IO-EXT you can double the number of inputs and outputs in the same footprint in your control panel or mounted to a backplane.

Photo below shows MCS-IO-BASE and MCS-IO-EXT mounted in a stackable array.

c UL us
File No: E169780

RoHS Compliant



MCS-RO-BASE and MCS-RO-EXT

Dimensions	10.7”l, x 3.5”w, 2.50”h
MCS-IO-BASE	Mounts on a backplane using six #6 sheet metal screws
MCS-IO-EXT.	Mounts on top of the MCS-IO-BASE on top of the MCS-IO-BASE by 5 nylon standoffs and 2 stackers headers (included on MCS-IO-BASE)
Operating Temperature	-40°F to +158°F (-40°C to +70°C)
Operating Humidity	0-95% Non-Condensing
Storage Temperature	-40°F to +158°F (-40°C to +70°C)
Sensor Inputs	32 inputs 0-5vdc (total with MCS-IO-EXT)
Analog Output	20 outputs 5amps @ 230VAC (total with MCS-IO-EXT)
Printed Circuit Board	Four layer with separate power and ground planes
Input Power	Powered by MCS-IO-BASE Power
Power Detection	Automatic Power Fail Reset on MCS-IO-BASE

3.6. MCS-RO-BASE and MCS-RO-EXT

The MCS-RO-BASE provides a flexible and cost effective way to allow relay output expansion for MCS MAGNUM-N-12.

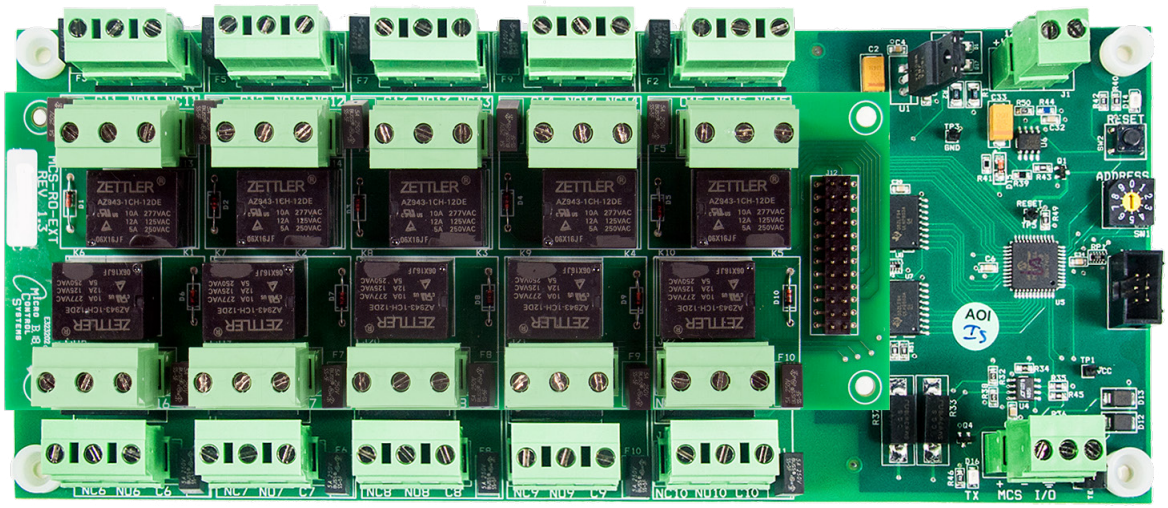
Using a Single Output Power Supply the MCS-RO can be used with 115-230 or 24 volt MCS-MAGNUM-N or MicroMag systems.

Using the stackable MCS-RO-EXT you can double the number of inputs and outputs in the same footprint in your control panel or mounted to a backplane.

MCS-RO-BASE and MCS-RO-EXT

c UL us
File No: E169780

RoHS Compliant



Dimensions .....9.5”l, 4.00”w, 2.50”h

MCS-RO-BASE.....Mounts on a backplane using four #6 sheet metal screws

MCS-RO-EXT .....Mounts on top of the MCS-RO-BASE by 4 nylon standoffs and a stacker header (included on MCS-RO-BASE)

Operating Temperature .....-40°F to +158°F (-40°C to +70°C)

Operating Humidity .....0-95% Non-Condensing

Storage Temperature. .....-40°F to +158°F (-40°C to +70°C)

Relay Outputs (RO) .....20 outputs 5amps @ 230VAC (total with MCS-RO-EXT)

Printed Circuit Board.....Four layer with separate power and ground planes

Input Power (Standard .....12VDC input power ±10% @ 77°F (25°C) ambient, 12VA max

MCS-I/0 Comm Port.....1 @ 38,400 Baud

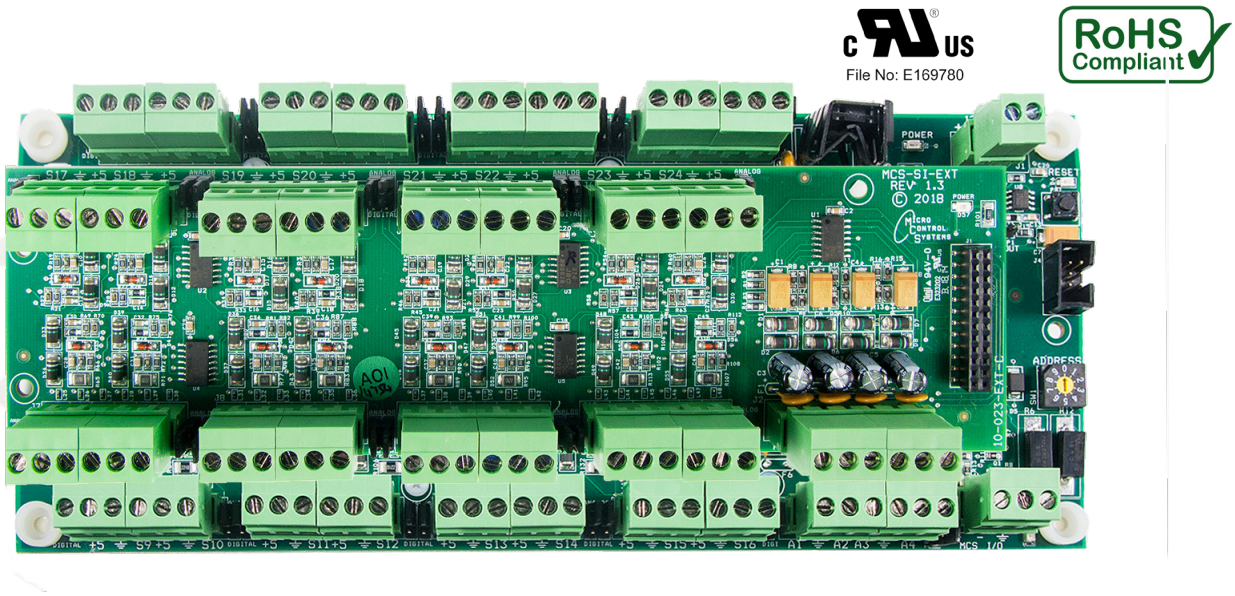
Power Detection.....Automatic power fail reset

3.7. MCS-SI-BASE and MCS-SI-EXT

The MCS-SI-BASE provides a flexible and cost effective way to allow sensor input expansion for MCS MAGNUM-N-12.

Using a Single Output Power Supply the MCS-SI can be used with 115-230 or 24 volt MCS-MAGNUM-N or MicroMag systems.

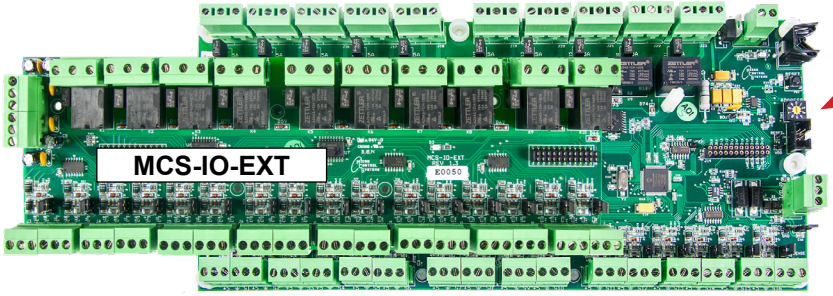
Using the stackable MCS-SI-EXT you can double the number of inputs and outputs in the same footprint in your control panel or mounted to a backplane.



Dimensions	8.7”l, x 2.50”w, x 2.50”h
MCS-SI-BASE	Mounts on a backplane using four #6 sheet metal screws
MCS-SI-EXT	Mounts on top of the MCS-SI-BASE by 4 nylon standoffs and stacker headers (included on MCS-SI-BASE)
Operating Temperature	-40°F to +158°F (-40°C to +70°C)
Operating Humidity	0-95% Non-Condensing
Storage Temperature	-40°F to +158°F (-40°C to +70°C)
Sensor Inputs	32 inputs 0-5vdc
Analog Outputs	16 outputs 0-10vdc
Printed Circuit Board	Four layer with separate power and ground planes
Input Power	Powered by MCS-SI-BASE Power
Power Detection	Automatic Power Fail - Reset on MCS-SI-BASE

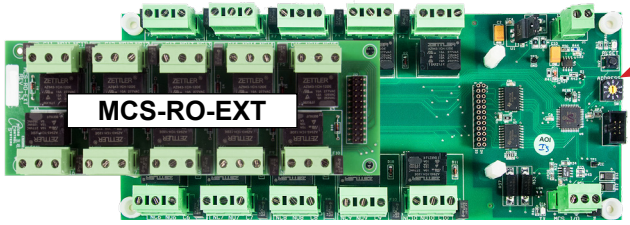
Theory for settings one MCS-IO-BASE plus extension boards

1. **Address settings for installing MCS-IO-BASE and MCS-IO-EXT expansion boards:**



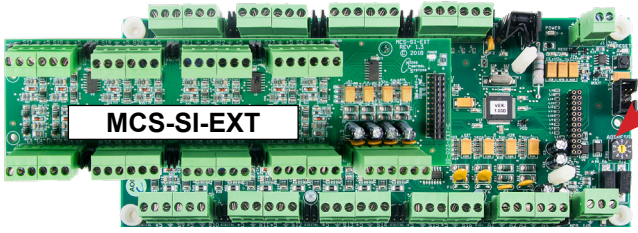
MCS-IO-Base - Set to #1
Mount a MCS-IO-EXT address automatically is assigned #2

2. **Adding MCS-RO-BASE, MCS-RO-EXT**



MCS-RO-Base - Set to #3
Mount a MCS-RO-EXT address automatically is assigned #4

3. **Adding MCS-SI-BASE, MCS-SI-EXT**

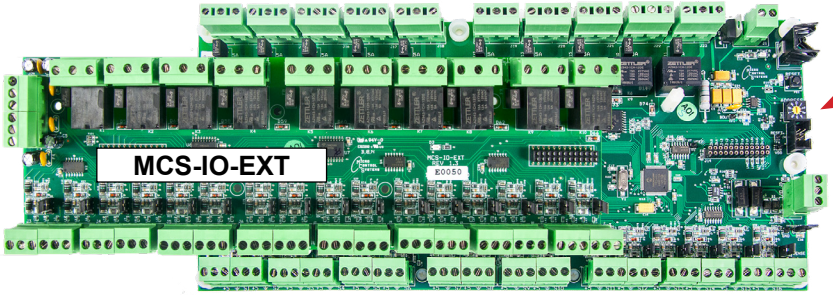


MCS-SI-Base - Set to #3
Mount a MCS-SI-EXT address automatically is assigned #4

SEE NEXT PAGE - ADDING A SECOND MCS-IO-BASE

Theory for settings two MCS-IO-BASE boards plus extension board

4. **Address settings for installing MCS-IO-BASE and MCS-IO-EXT expansion boards:**

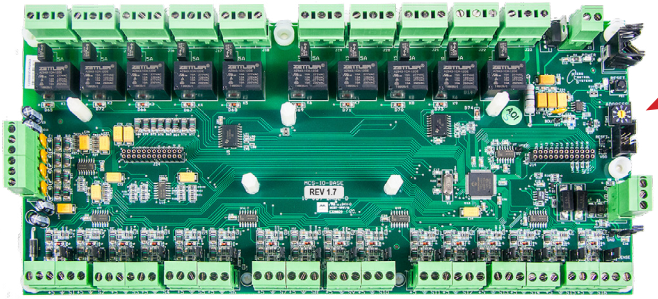


MCS-IO-Base - Set to #1

Mount a MCS-IO-EXT address automatically is assigned #2

MCS-IO-BASE #1

5. **Adding second MCS-IO-BASE**



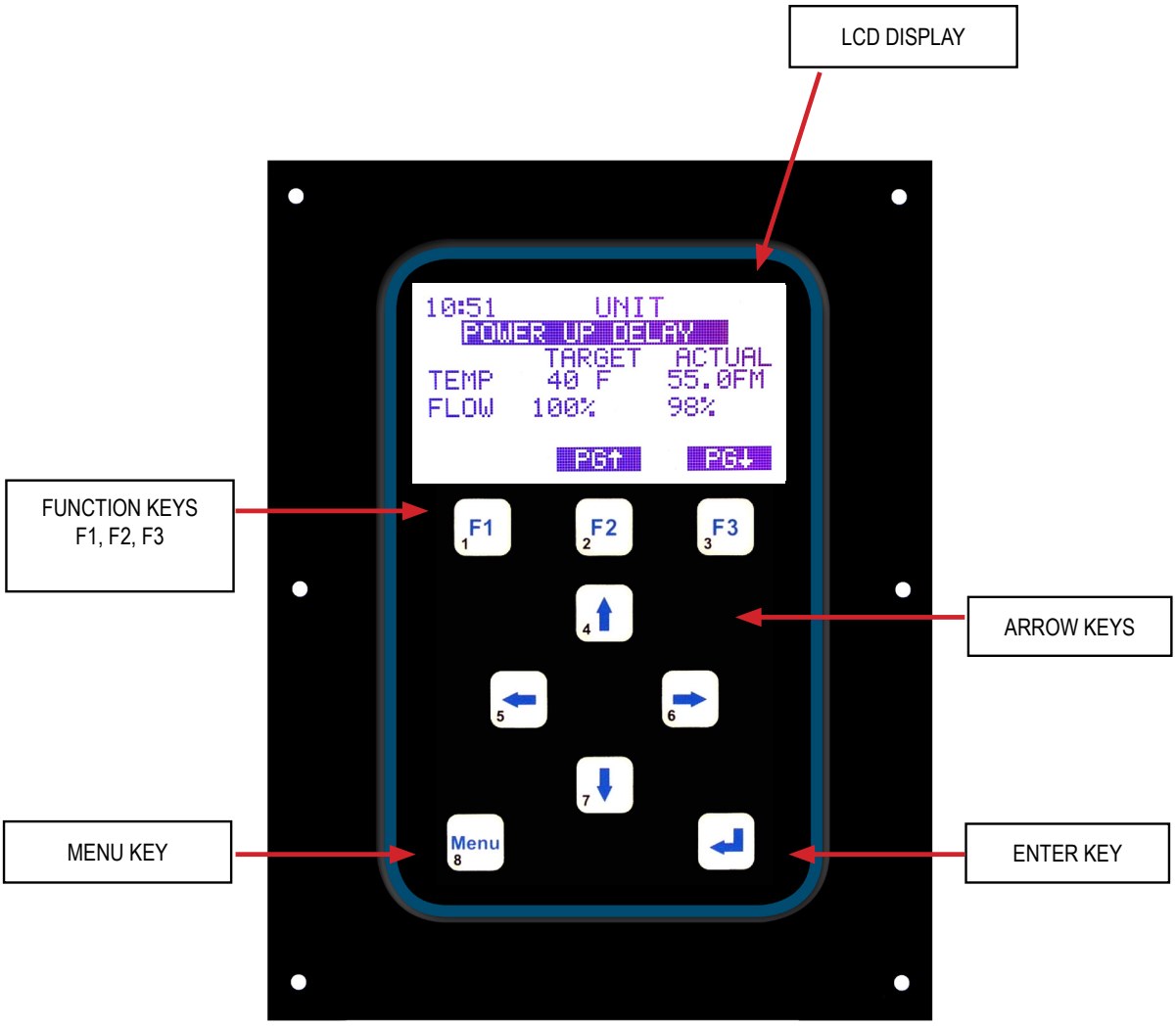
MCS-IO-Base - Set to #3

MCS-IO-BASE #2

Chapter - 4. MCS-MAGNUM DISPLAYS

4.1. MCS- MAGNUM KEYPAD - Keys and their functions

- LCD DISPLAY - displays current condition of controller. Pressing the Menu key, displays the 10 available Menu items.
- **FUNCTION KEYS** - F1, F2, F3 are used to Page Up and Page Down as shown below, F2 - PG↑(page up), F3 - PG↓(page down). Function keys are also used when an numerical digit is needed, F1 = 1, F2 = 2, F3 = 3.
- **ARROW KEYS** - ↓↑ ←→used to move between items on screen and also as numerical digits are needed.
- **ENTER KEY** ↵ - used to accept highlighed item on screen and to move to next screen.
- **MENU KEY** - used to move to main menu, also used as numerical digit 8.



CLICK HERE FOR MAGNUM KEYPAD MANUAL

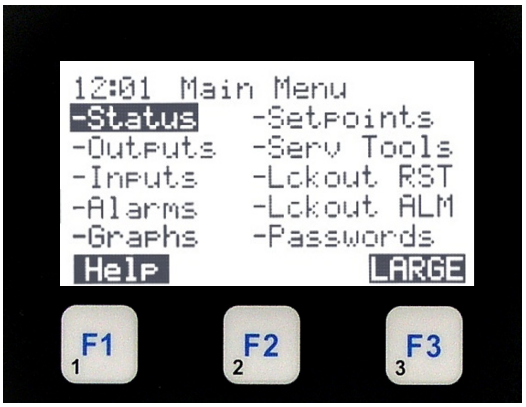
SCAN WITH PHONE FOR MAGNUM KEYPAD MANUAL

The following is an examination of all the information screens that can be accessed through both the Magnum keypad and MCS-Connect program.

4.1.1 Magnum Keypad and Display

4.1.1.1. Menu Screen

The main menu is accessed by pressing the “Menu” key.



Press ↵

Pressing the Menu Key- Status

- Results in displaying the 10 available Menu items. The highlight is on the Status display.
- To select any item use the ▲ ▼ ◄ ► arrow keys to position the highlight and press ↵ .
- To understand the options select F1 for help.
- To display the current Status Screens press the Enter Key.

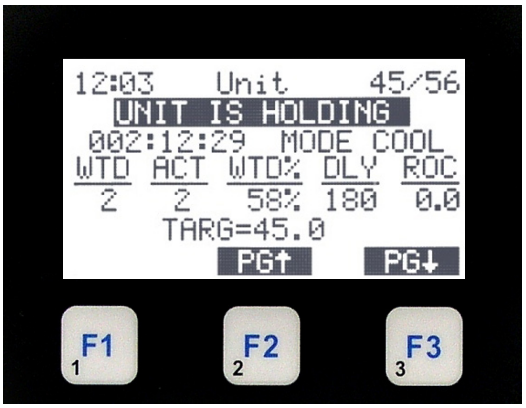
4.1.1.2. Introduction to Status Screens

When the status is selected a series of screens can be scrolled through which provide the status of the unit your are controlling.

If setup in your configuration file a series of scrolling screens will be displayed. Each screen is displayed for about 10 seconds and then moves to the next status screen. If you press enter on the Keypad, you can view that item. The scrolling will continue after 15 mintues if no button is pressed.

The current status of the unit and compressors is displayed by selecting the “Status” option from the “Menu” screen. This following screen will be displayed. By pressing the PG ⬆ or PG ⬇ function keys you will get additional information on each compressor.

4.1.1.3. UNIT STATUS (WTD/ACT)



Press F3 PG↓

Unit Status WTD/ACT

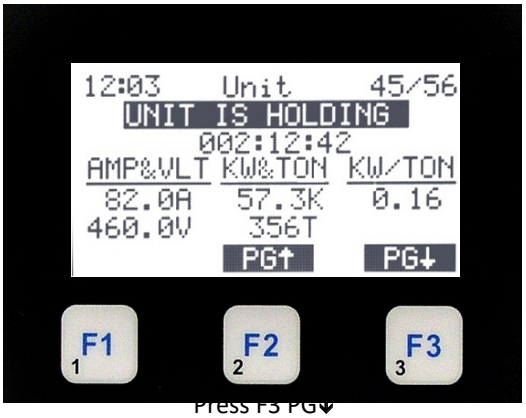
- On the top line right chiller out & chiller in is displayed rounded to a whole number.
- The second line shows system status.
- The third line shows mode & time in that mode.
- The next two lines show the following:

  -Steps wanted on -Steps actually on
  -Wanted capacity % -Integration delay
  -Rate of change.

- The next line shows the current target.

4.1.1.4. Unit Tonnage and KW Information

If tonnage/KW information is available the following screen is added to the status screens:



Press F3 PG↓

Unit Status KW/TON

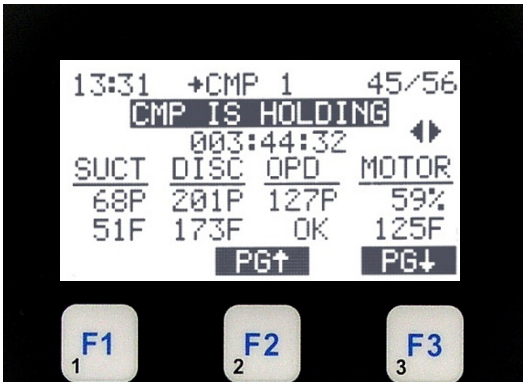
- On the top line right chiller out & chiller in is displayed rounded to a whole number.
- The second line shows Unit status.
- The third line shows time in that mode.
- The next two lines show the following:

  -Current amps -Current voltage
  -Current KW -Current tons
  -Current KW/Ton

- This information is only available if the sensors are provided.

The above screen is based upon flow of 230 GPM and power factor (PF) of 1. All other values in the calculation are displayed on the screen.

4.1.1.5. COMPRESSOR 1 STATUS (PSI & Temp)



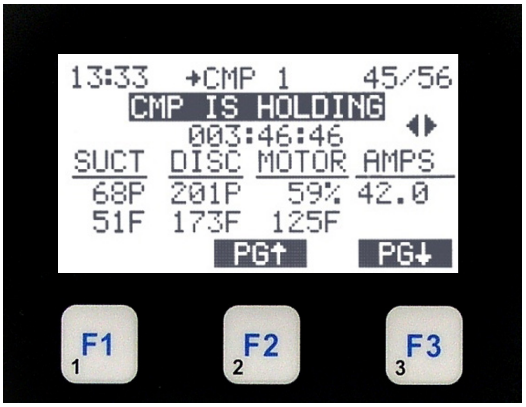
Press F3 PG↓

Compressor 1 PSI & Temp

- On the top line right chiller out & chiller in is displayed rounded to a whole number.
- The second line shows Circuit status.
- The third line shows time in that mode.
- The next two lines show the following:

  -Suct psi -Suct temp
  -Disc psi -Disc temp
  -Oil psi differential -Oil temp
  -Motor % -Motor temp

4.1.1.6. COMPRESSOR 1 STATUS (Pressures/AMPS)



Press F3 PG↓

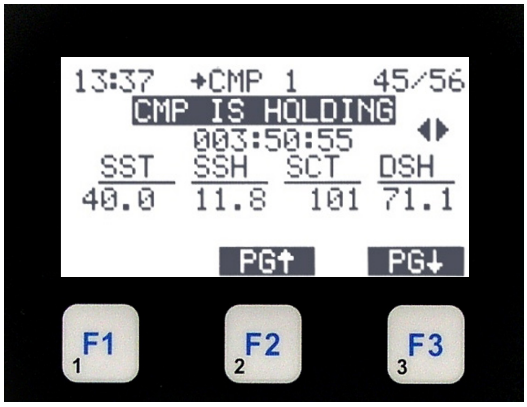
Compressor Pressures/AMPS

- On the top line right chiller out & chiller in is displayed rounded to a whole number.
- The second line shows Circuit status.
- The third line shows time in that mode.
- The next line shows the following:

  -Suct psi -Suct Temp
  -Disc psi -Disc Temp
  -Motor % -Motor Temp
  -AMPS

- The function keys F1 & F2 allow paging up or down.

4.1.1.7. COMPRESSOR 1 STATUS (Superheats)



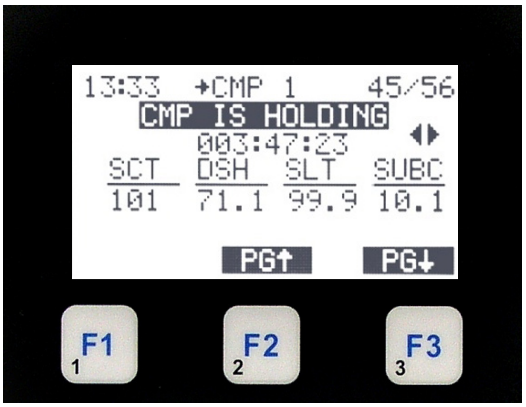
Press F3 PG↓

Compressor 1 Superheats

- On the top line right chiller out & chiller in is displayed rounded to a whole number.
- The second line shows Circuit status.
- The third line shows time in that mode.
- The next line shows the following:

  -Sat Suct Tmp -Sat Cond Tmp
  -Suct Superheat -Disc Superheat
- The function keys F1 & F2 allow paging up or down.

4.1.1.8. COMPRESSOR 1 STATUS (Superheats)



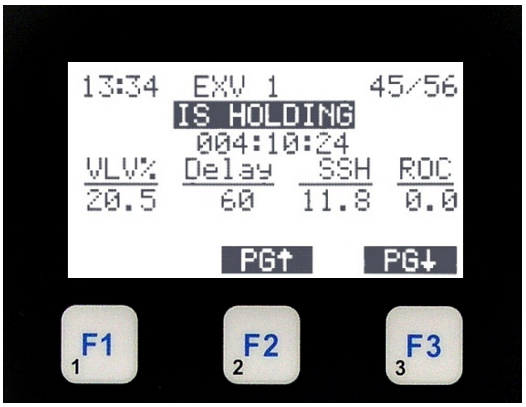
Press F3 PG↓

Compressor 1 Superheats

- On the top line right chiller out & chiller in is displayed rounded to a whole number.
- The second line shows Circuit status.
- The third line shows time in that mode.
- The next line shows the following:

  -Sat Suct Tmp -Sat Cond Tmp
  -DSH Tmp -Suct Superheat
- The function keys F1 & F2 allow paging up or down.

4.1.1.9. COMPRESSOR 1 STATUS EXV 1



Press F3 PG↓

Compressor 1 EXV or LLS

- On the top line right chiller out & chiller in is displayed rounded to a whole number.
- The line also shows EXV or LLS status.
- The third line shows time in that mode.
- The display shows information for the EXV or LLS for circuit 1. If EXV the information is as follows:

  -Valve % open -Delay till next chg
  -Curr Suct SH -Slope of SH

4.2. MCS TOUCHSCREENS

The MCS-TOUCHSCREENS were designed to simplify user access with the MCS-MAGNUM and MicroMag.

The Touchscreen is available in three sizes:

MCS-TOUCH 7'

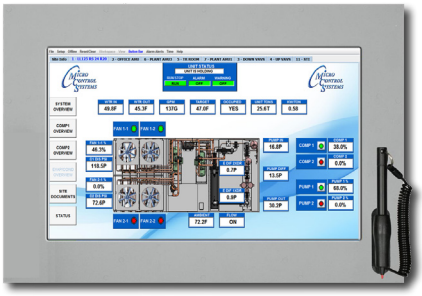
MCS-TOUCH 10.1"

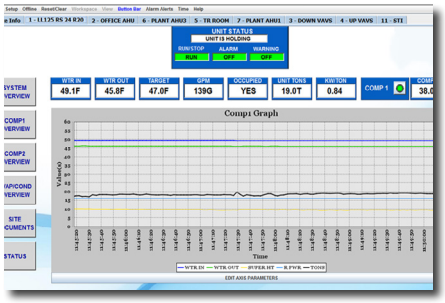
MCS-TOUCH 15.4"

MCS-CONNECT can be utilized to provide both graphics and service mode access for technicians.

Information and graphics on the MCS-TOUCH are shown on high resolution (1280x800) LCD display with LED back lighting, which guarantees long-life operation.

OEM'S using the MCS-GRAPHICS BUILDER* can customize the installation with multiple windows to monitor all aspects of your chiller.



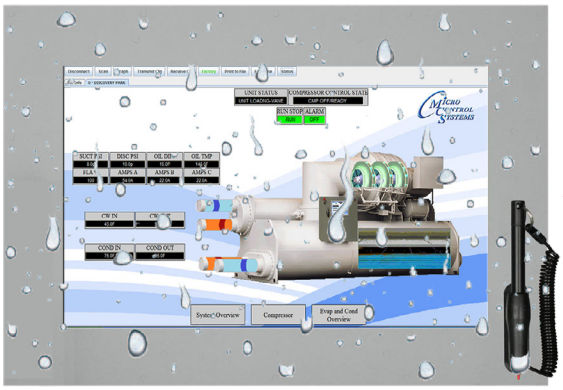


MCS also offers several different Industrial Control Panels to fit your installation needs. This includes upgrading to a New Magnum Industrial Control Panel which can hold the new Touch-15.4 screens.

Industrial Control Panels range in size from:

- Small Industrial Control Panel
- Medium Large Industrial Control Panel
- Large Industrial Control Panel
- Large Industrial Control Panel-NEMA4 - with 15.4 Touch which offers the installer a choice for indoor or outdoor installation where water or other harsh environments may exist.
- Remote 15.4 Panel with the Touchscreen is available with or without NEMA4.

*MCS GRAPHICS BUILDER IS LICENSED FOR OEM USE ONLY.



New Waterproof Silicone Seal for areas subject to weather, etc.

4.3. MCS-CONNECT and your Touchscreen

MCS-CONNECT is installed on every MCS-TOUCHSCREEN. Its purpose is to provide both local and remote communication for MCS Micro Controllers either by themselves or as part of a network.

MCS-CONNECT permits the user to monitor the status of the Micro Controller in real time and, with proper authorization, changes can be made to the system. In as fast as 10 seconds configuration files can be transmitted to or received from a MCS Micro Controller.

Another powerful feature of MCS-CONNECT is its ability to graph event history. Since MCS controllers automatically perform history logging, the user can select which inputs or outputs to graph and view the results either in REAL TIME or over a user selectable period of time.

MCS-TOUCHSCREENS come standard with custom display screens allowing users to acknowledge alarms, change set points and force points on selected screens. Transitioning from screen to screen is fast and easy by tapping the touch screen or using the stylus on the touchscreen.

PERFORMANCE MANAGEMENT

The MCS-TOUCHSCREEN display continuously captures data and provides trending capability for power and chiller performance, and chilled and condenser water parameters for precise energy management.

Chapter - 5. NETWORK CONNECTIONS

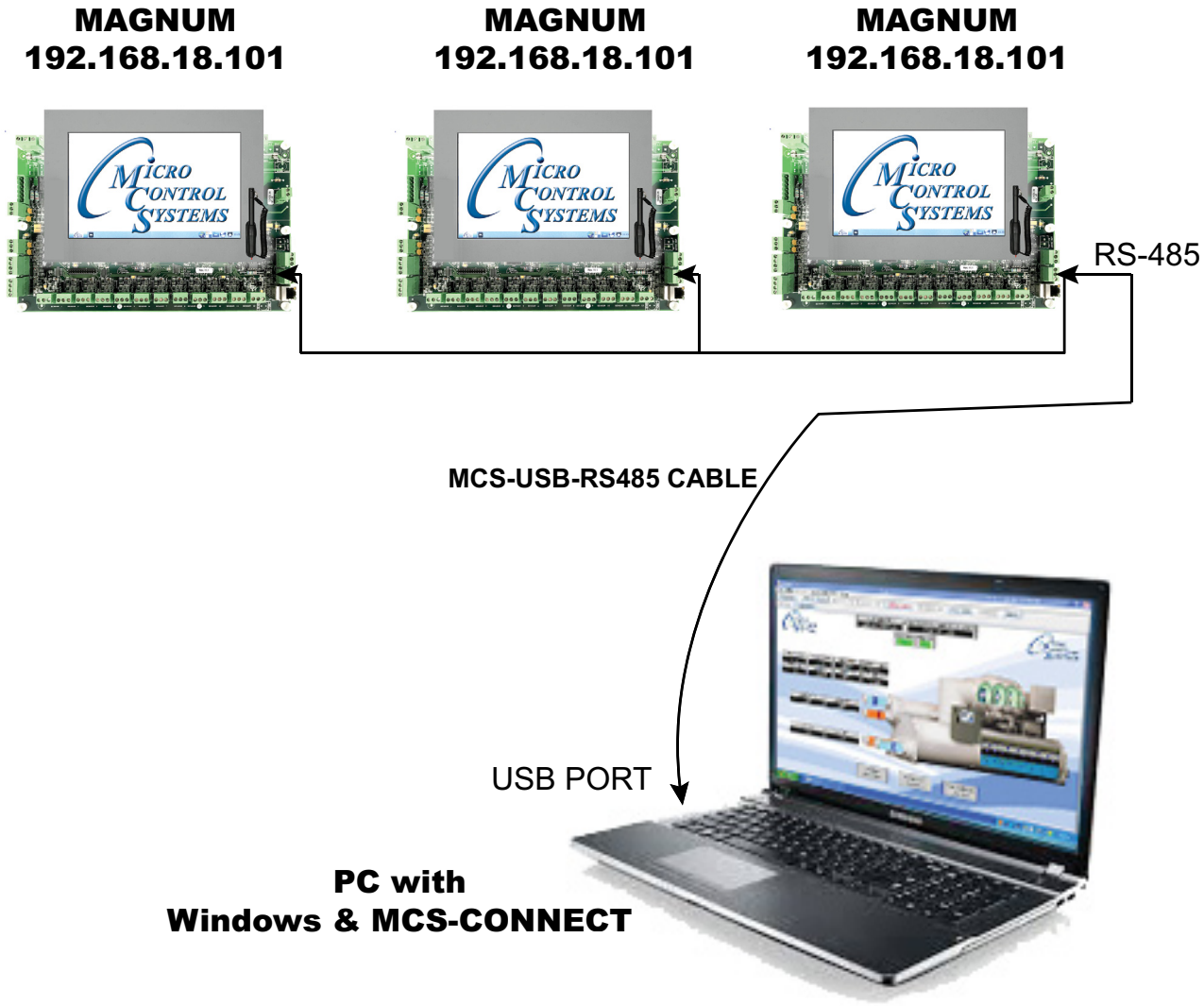
The next few pages show recommended network setups for communication to your controller using products from MCS.

5.1. MCS 485 Network

The MCS 485 Network can support up to 20 Magnums and their associated I/O boards.

Each Magnum in the network must be assigned a unique address in the configuration file. This address will be the key in establishing communications with the appropriate Magnum system. It can be viewed or changed from the LCD / key-pad of the unit with Factory authorization.

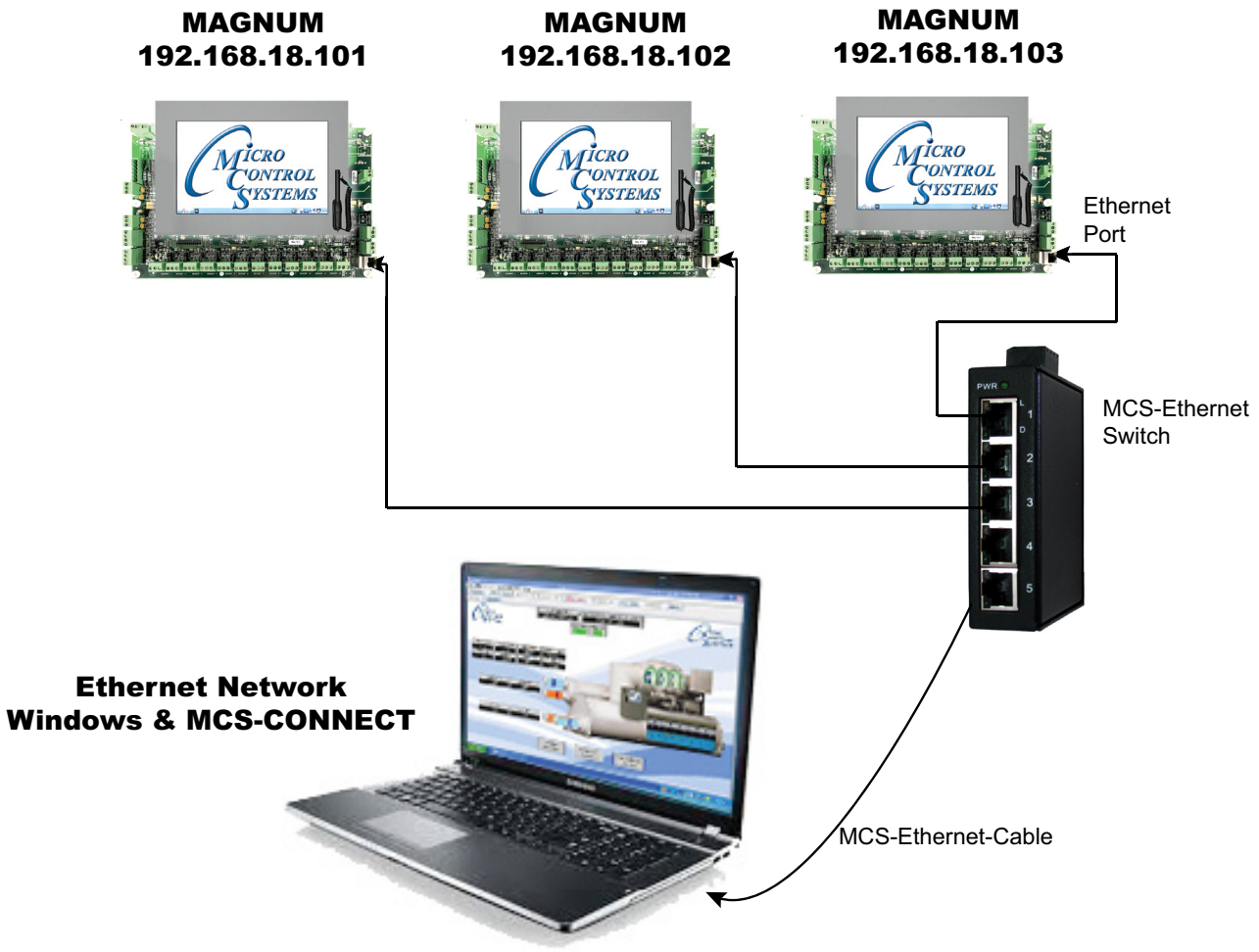
RS485 transmissions should not exceed 4000 feet without a repeater.



5.2. ETHERNET

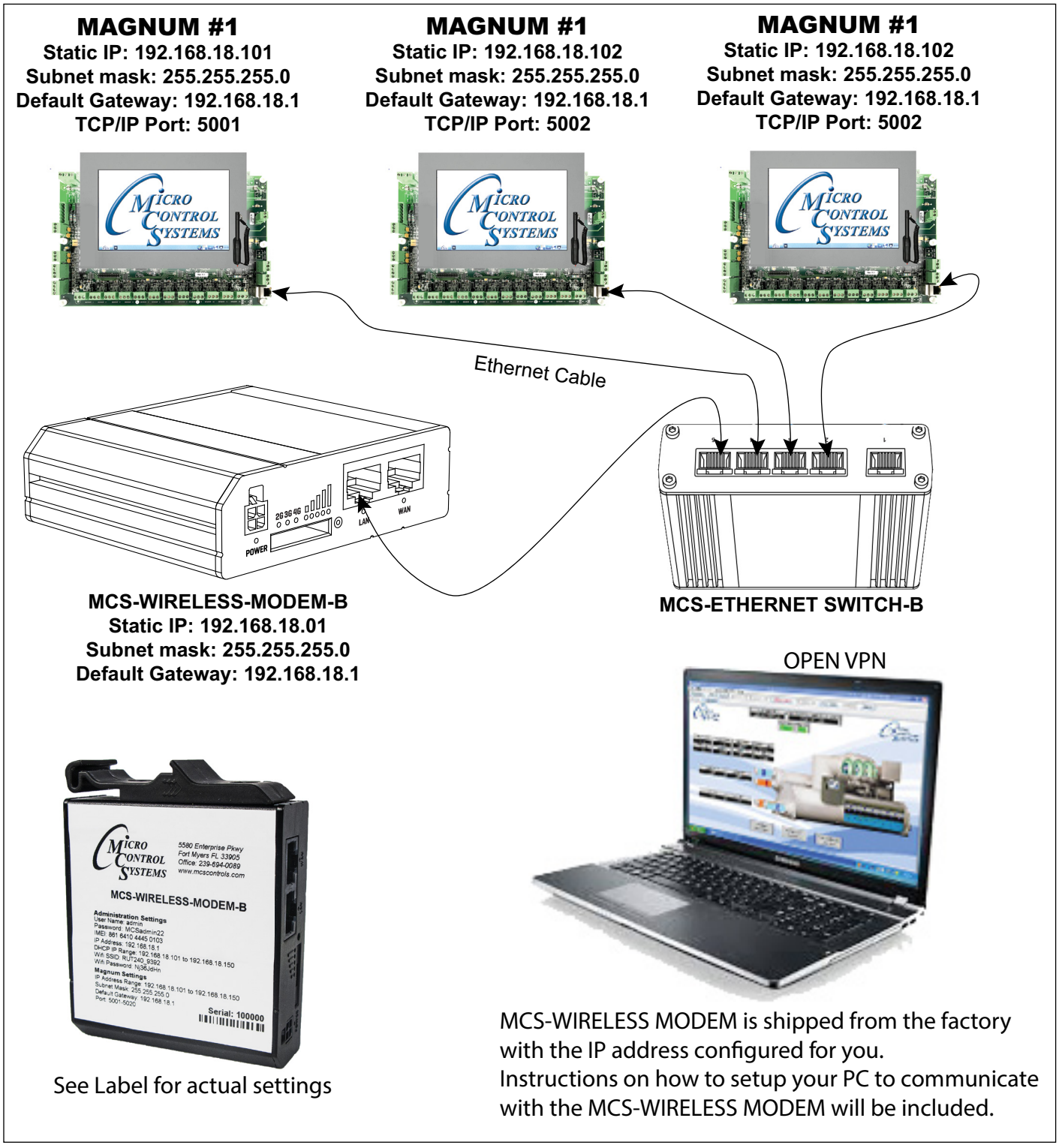
5.2.1 RJ45 using a Crossover Ethernet Cable

When connecting directly through the 10 MBPS Ethernet port on the Magnum from a PC it is necessary to use a crossover Ethernet cable.



5.3. Remote using Ethernet

When connecting directly through the 10 MBPS Ethernet port on the Magnum from a PC it is necessary to use a crossover Ethernet cable to the MCS-WIRELESS MODEM.



Chapter - 6. Magnum Control States

The Magnum controller is a state computer, that is, decisions are made based upon Set points, timers and Sensor Inputs, the controller moves from one state to another. The controller will change states to ensure the proper functioning of the chiller package.

As we review the various states, we must remember that a chiller package consists of a number of different parts or functions: the compressors and their related items such as unloaders hot gas bypasses, etc.; evaporator; and condensing functions.

Both the Capacity Control States and Compressor Control States are displayed in the Status screens on the Keypad Display. To view the state of the chiller, select the Status option from the menu on the Keypad. You can then view the entire status by using the page up / down function keys. The information can also be accessed through MCS-Connect under status screen by clicking on the CONTROL STATUS button.

Unit Control States (number)
Note: All User Logic points can now access the Unit Control State. The value accessed is the number listed in parenthesis in the following headings.

6.1. UNIT IN POWER UP (0)

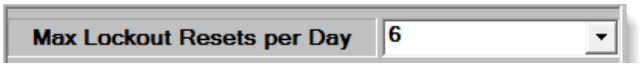
This state is entered when the Magnum is powered up or the system has been reset. The system will remain in this state for the time specified in Setpoint #23 “POWER DELAY” or for 60 seconds if not active. In this state all Relay Outputs are turned off. This time delay is to insure the microprocessor has stable power before starting the algorithm.

6.2. NO RUN- I/O LOST (2)

This state will be entered whenever the Magnum loses communications with any of the I/O boards that are connected through the MCS I/O network. When this state is entered the Magnum will generate an MCS I/O offline alarm, which identifies which I/O is offline and a lost I/O shutdown alarm which locks out the unit. Once locked out, if there are ten consecutive successful I/O reads the Magnum will reset and attempt to run. When this occurs a “LOST I/O RESTART” will be generated. Or, the lockout-reset key can be pressed to reset the Magnum, after the lost I/O has been corrected. This will generate a “LOCKOUT RESET.” In this state all RO’s except ALARM and OIL HEATER are turned OFF.

6.3. UNIT IN LOCKOUT (3)

This state is entered whenever a critical situation is encountered that could cause harm to the chiller package. Items such as freeze protect and emergency stop will force the system into this state. Lockouts can be reset without authorization from the keypad or MCS-Connect program; however if the lockout condition has not been corrected, the system will again be forced into the LOCKOUT state. In this state, all RO’s except ALARM and OIL HEATER (for screws with an oil pump) are turned OFF and placed in the “LOCKOUT” state. Note: If the Lockout Reset is pressed more than the programmed allowable number of times in one day the unit cannot be reset during the current day except through MCS-Connect and requires Factory authorization. This number is selected from a drop down menu under the Setup Information button, with a range of 2 to 12.
In Cent Firmware only, Close Vane RO will stay energized for 5 minutes after compressor lockout.



6.4. UNIT IS OFF (4)

This state is entered when the system has finished a STARTUP, DISABLE, LOCKOUT, or NO RUN- I/O LOST state. The chiller is now ready to move into an active state to meet the capacity required.

6.5. UNIT IS HOLDING (5)

This state is entered when one of three conditions exists:

1. The control sensor reading is being maintained with in the control zone.
2. Control sensor reading is above the control zone but the Rate of Change is less than the value in the (MAX ROC-, #27) Setpoint. This indicates that the temperature is decreasing toward the target at an acceptable speed. Therefore, no additional cooling is needed at this time.
3. The temperature is below the control zone but the Rate of Change is greater than the (MAX ROC+, #28) Setpoint.

This indicates that the temperature is increasing toward the target. Therefore, no reduction in cooling is needed at this time. This state indicates that there is no need to adjust the capacity of the chiller package. This state will end when more or less capacity is required.

4. Step Wanted Greater than Steps Turned On - When the controlling temp sensor is in the control zone and if step wanted on is greater than steps turned on, set steps wanted on equal to steps turned on. This logic is enabled by setting setpoint #25 TYPE column to a “TIME” type and TIME column to a value of 1.

6.6. UNIT UNLOADING (6) Only HVAC software

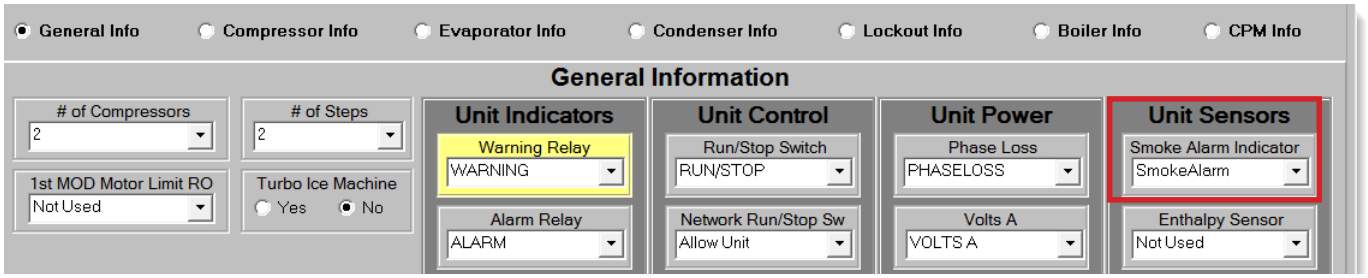
This state is entered when less capacity is required. Every second an adjustment is made to the step delay. When the delay reaches zero, the counter “steps wanted” on is decreased by 1.

6.7. UNIT IS LOADING (7) Only HVAC software

This state is entered when more capacity is required. Every second an adjustment is made to the step delay. When the delay reaches zero, the counter “steps wanted on” is increased by 1.

6.8. OFF-SMOKE ALARM (8)

This state is entered when a smoke alarm has been detected. In the MCS-Configuration file the Smoke Alarm Indicator must be selected in the General Information panel under the MAGNUM screen. When this sensor is trips, an error message “OFF-SMOKE ALARM” is generated and the unit state is changed. In this state all RO’s except ALARM and OIL HEATER are turned OFF.



6.9. RUN/STOP SW OFF (9)

This state is entered when the run stop switch is off, in the stop position. When the chiller is in this state, the individual compressor states if active are moved to the CMP IS OFF state through the normal states. One capacity STEP will be moved per second.

6.10. SCHEDULED OFF (10)

This state is entered when the schedule is calling for the package to be off. When the chiller is in this state, the individual compressor states if active are moved to the CMP IS OFF state through the normal states. One capacity STEP will be moved per second.

6.11. OFF- NO FLOW (11)

This state is entered when the evaporator flow switch is off. When the chiller is in this state, the individual compressor states if active are moved to the CMP IS OFF state through the normal states. One capacity STEP will be moved per second. If the NO FLOW Setpoint is active and set to Lockout the chiller will lockout on no flow.

6.12. AMBIENT OFF (13)

This state is entered when the ambient temperature falls below Setpoint #24 “LOW AMB OFF” or is above Setpoint #26 “HIGH AMB OFF”. The system will remain in this state until the ambient temperature if low rises 5.0°F (2.5°C) above the “LOW AMB OFF” Setpoint value or if high drops 5.0°F (2.5°C) below the “HIGH AMB OFF” Setpoint value. When the chiller is in this state, the individual compressor states if active are moved to the CMP IS OFF state through the normal staging function. One capacity STEP will be moved per second.

6.13. UNIT IS UNLOADED (15)

This state is entered when all of the systems available capacity steps are off. The package is providing no cooling capacity, as none is required. The system is ready to react to cooling needs.

6.14. UNIT IS LOADED (16)

This state is entered when all of the system's available capacity steps are on and the package is providing the maximum amount of cooling capacity.

6.15. OFF TMP-ICE MADE (17)

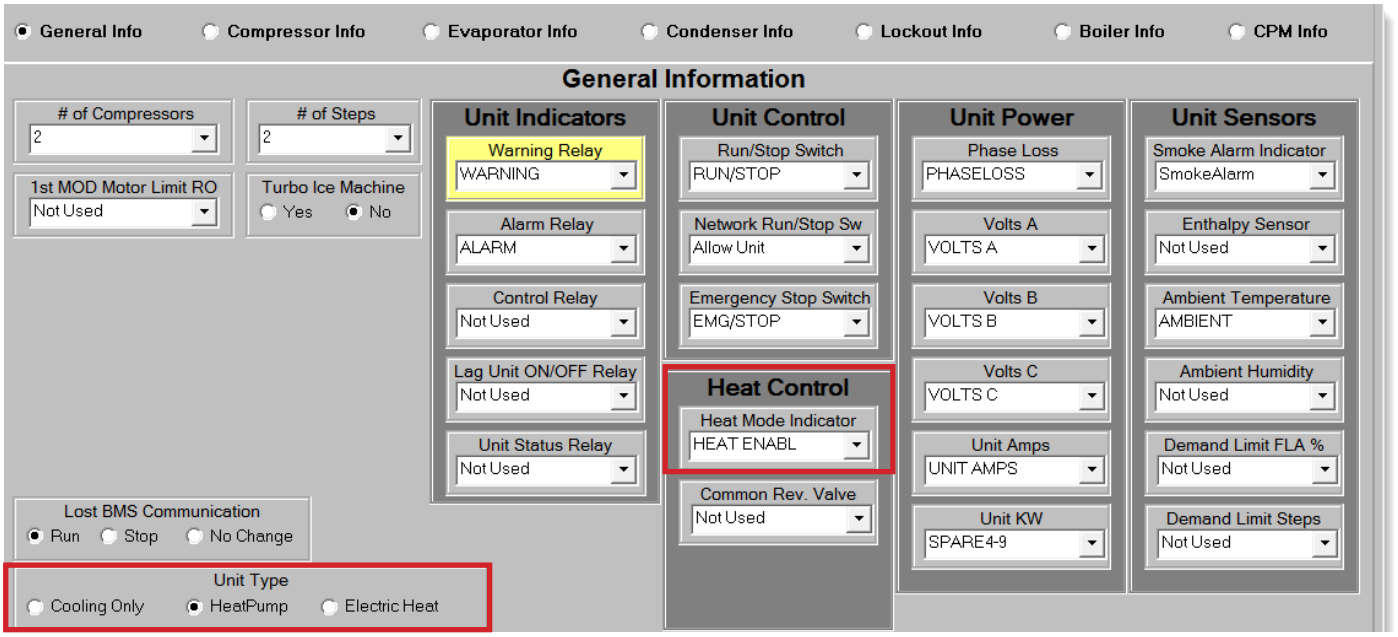
This state is only used in systems when the Ice Mode DI On/Off option has been selected. When the system is in the ICE MAKING mode and the control temperature sensor's temperature is less than the target temperature, set point #1, This state is entered. In this state the mode will remain ICE MAKING, all stages of cooling will be staged off and remain off until the ice making mode is exited. Refer to section on 'Ice Making Capabilities'.

6.16. ECONOMIZER ONLY (18)

This state is entered when mechanical cooling is off and the economizer has been specified in the MCS-Configuration setup and it is being used for cooling. Refer to section about Economizers.

6.17. SWITCHING MODES (19)

This state is entered when the unit is switching between cooling mode and heating mode. Only heat pump units or units with electric heat and a Sensor Input selects either the cooling or heating mode will enter this state. Select this information under the MAGNUM screen.



6.18. UNIT SMOKE UNLDG (20)

This state is entered when the system is unloading because a smoke alarm sensor has tripped. When this sensor is on, an error message "OFF-SMOKE ALARM" is generated and the unit state is changed.

6.19. UNIT OFF UNLDING (21)

This state is entered when the unit has been disabled. It will force a quick unload of the system.

6.20. UNIT DMD UNLDING (22)

This state is only entered when the demand limiting input has been selected. The demand limit sensor must be selected in the General Information panel under the MAGNUM screen and its type must be "485 Dmd Step". This input will indicate the maximum number of steps that the unit can run. If this value is less than the number of steps that are currently on, the unit will unload to meet this value.

6.21. UNIT HEAT UNLDING (23)

This state will be entered and will begin unloading the system if it is in heating mode and the control temperature is greater than the control temperature Setpoint plus Setpoint #164 "HP CTL ZONE +" and the system is not already fully unloaded.

6.22. UNLDING RUN CMP (24) Only with HVAC Software with TurboCor

This state is entered when a TurboCor compressor is being unloaded and the start stage is either unload or pump down that compressor prior to starting another compressor.

6.23. OPENING BYP VLV (25) Only with HVAC Software with TurboCor

This state is entered when a TurboCor compressor is being unloaded and the start stage is opening the bypass valve for that compressor prior to starting another compressor.

6.24. CMP RAMPING UP (26) Only with HVAC Software with TurboCor

This state is entered when a TurboCor compressor is being unloaded and the start stage is waiting for that compressor prior to starting another compressor.

6.25. CLOSING BYP VLV (27) Only with HVAC Software with TurboCor

This state is entered when a TurboCor compressor is being unloaded and the start stage is closing the bypass valve for that compressor prior to starting another compressor.

6.26. FACTORY STARTUP (28) Only with HVAC Software

A factory startup has been specified. The system cannot be commissioned until the proper authorization has been entered and the factory startup preformed.

6.27. MAXIMUM RUN TIME (29) Only with HVAC Software

The maximum run time option has been specified and a compressor run time has surpassed this limit. All functions will remain off unit the proper authorization has been entered.

6.28. ESTABLISHING COM (34) Only with HAVC Software

If the unit is to be part of the CPM network, this state will be sent to CPM Master controller while establishing communications.

6.29. RS-STARTING COMP (35) Only with HVAC Software

Used only if unit has the Rapid Start option active. In this state the system will turn on the number of compressors allowed in the rapid start.

6.30. RS-LOADING (36) Only with HVAC Software

Used only if unit has the Rapid Start option active. All compressors available for the Rapid Start option have been turned on, In this state the unit capacity will be increased as long as additional capacity is needed, once it is at its maximum an additional compressor if available will be turned on and the capacity will be set to its minimum value.

6.31. RS-HOLDING (37) Only with HVAC Software

Used only if unit has the Rapid Start option active. In this state the capacity will be not be increased as the control temperature and slope are within target.

6.32. UNIT OFF CTRL SI (38)

This state is only used if the low temperature option has been specified. Set point #151 is active and it is a TARGET type of set point. When the steps wanted is zero, no mechanical stages of cooling is on and the control temperature is below the off temperature this state will be entered. Once the control temperature is above this value the unit state will be loading.

Chapter - 7. Heat Recovery Logic

- HVAC only
- HVAC Firmware 17.60H4 or greater
- Config program 18.01O or later

7.1. Theory of Heat Recovery:

During cooling only operation, the chiller produces a controlled source of chilled water leaving the evaporator while dissipating heat through the condenser and ultimately to the environment. When there is a simultaneous need for chilled water and hot water, these chillers have the capability to operate in heat recovery mode. The recovered heat can be redirected for various heating applications, which saves energy while maintaining conditions.

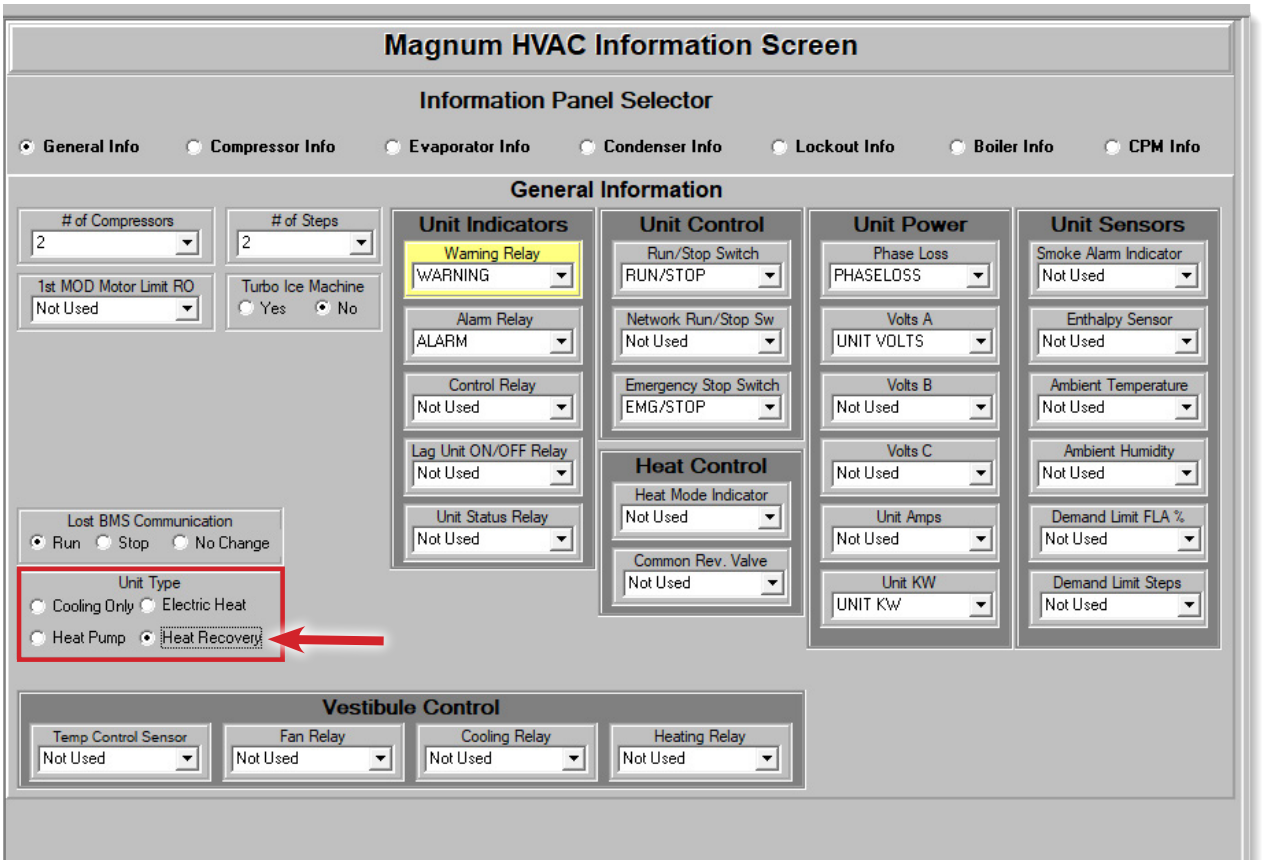
7.2. General Description for MCS-Magnum Heat Recovery:

Heat Recovery logic is a new MCS-Magnum control option for chillers. When this option is enabled the MCS-Magnum capacity control will dynamically select control mode Heat or Cooling for staging the unit. When in cooling mode the capacity control state logic will use the chilled water out sensor and setpoint #1 for staging the unit. When in Heating mode the capacity control state logic will use the condenser water out sensor and setpoint #163 for staging the unit.

The heat recovery logic allows chillers to switch between heating and cooling on the fly and works as follows.

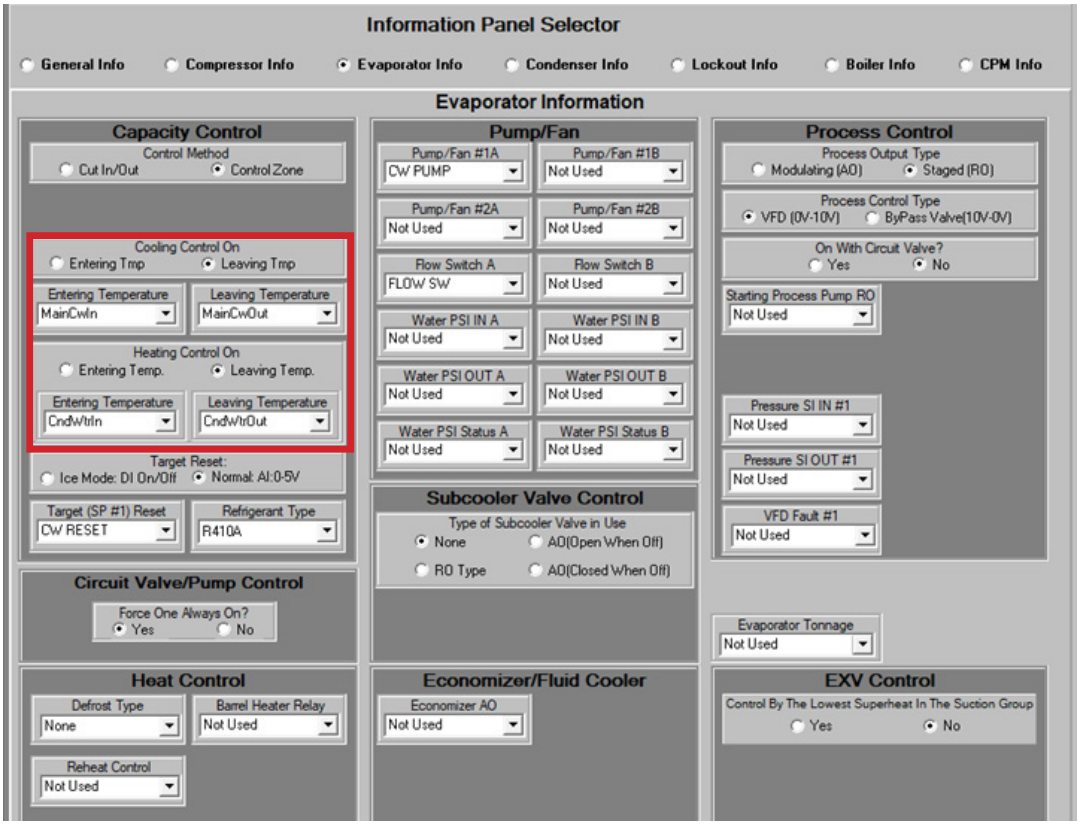
7.3. Unit Type – Heat Recovery

Heat Recovery needs to be selected in the general info page for the heat/cool automatic change overs to take effect.



7.4. Heating and Cooling Control Sensors

1. Under the evaporator info tab you'll be able to select your heating/cooling entering and leaving sensors and select which one you want to control on when in heating or cooling mode.



2. The mode will be decided based on the controlling sensor nearest to its target.

   If both heating and cooling are in their target zones, then we won't switch modes until heating or cooling needs to unload based on going outsides its control zone. Otherwise we control based on closest to target when each sensor requires loading of the unit.

   Setpoints 1-3 are used for cooling control target and zones

   Setpoints 163-165 are used for heating control target and zones

1	CW OUT TRGT	44	42	60	0.5	0	0	0	0	Active	...	TEMP	View Only	Setpoint
2	CTRL ZONE+	2	0.5	5	0.5	0	0	0	0	Active	...	TEMP	View Only	Setpoint
3	CTRL ZONE-	1	0.5	1	0.1	0	0	0	0	Active	...	TEMP	View Only	Setpoint

163	HP HEAT TARG	95	75	120	1	0	0	0	0	Active	...	TEMP	View Only	Setpoint
164	HP CTL ZONE+	2	0.5	3	0.5	0	0	0	0	Active	...	TEMP	View Only	Setpoint
165	HP CTL ZONE-	2	0.5	3	0.5	0	0	0	0	Active	...	TEMP	View Only	Setpoint

Chapter - 8. Compressor Control States (number)

All User Logic points can now access the Compressor Control State. The value accessed is the number listed in parenthesis in the following headings.

The action of the compressor control states may result in an increase or decrease in capacity. The Unit Control States may affect or change the Compressor Control States or supersede them altogether.

8.1. LOST IO LOCKED

This state is entered when the Capacity Control State is NO RUN- I/O LOST. Resetting the lockout will move the compressor to the CMP OFF/READY state.

8.2. CMP LOCKED OUT

This state is entered when the Capacity Control State is in UNIT IN LOCKOUT or a safety trip has occurred for this compressor (Examples of safety Setpoints include #77 “LOW SUCTION” and #81 “HI DISC PSI”). Lockouts can be reset without authorization from the keypad or MCS-Connect program, however if the condition causing the lockout has not been corrected, the compressor will again be forced into the LOCKOUT State.

8.3. SWITCHED OFF

This state is entered when the compressor is off due to the pump down switch being on or the compressor flow switch being off. In this state the compressor and all related points, including the liquid line solenoid are off. The compressor will not leave this state unless the pump down switch is turned off. If the pump down switch is turned off, the compressor state will be changed to the CMP OFF/READY state.

8.4. UNLD and PMPDWN

This state is entered when the pump down switch has been turned on or if this compressor is no longer Wanted On. The compressor remains on while the liquid line solenoid is closed. This state is active until the suction pressure reaches Setpoint #61 “PMP DWN OFF” or the time has exceeded Setpoint #62 “PMP DWN DELY”. The compressor will then move to the CMP ANTICYCE state.

8.5. CMP ANTICYCE

This state is entered when the UNLD and PMPDWN state has been completed. The compressor will stay in this state with all compressor points off for the period of time contained in Setpoint #59 “ACYC OFF-> ON” or Setpoint #63 “ACYC ON -> ON”, whichever is longer. The compressor will then move to the OFF state. NOTE: “ACYC ON -> ON” can be used to set the maximum number of compressor starts per hour.

8.6. CMP OFF/READY

This state is entered when no capacity is required from this compressor, or the last state was CMP ANTICYCE, LOST I/O LOCKED, or SWITCHED OFF. In this state the compressor is ready to provide capacity if needed. The compressor will remain in this state for a minimum of 60 seconds.

8.7. OIL PMP LUBING

Screw, centrifugal, and compressors with external oil pumps all use this state. This state is used to ensure proper oil flow prior to compressor startup. Options that affect this state are setup in Compressor Information button under the MAGNUM screen and in the Setpoints screen:

In this state the following Relay Outputs, if present, are set as follows:

1. Compressor relay(s) are OFF.
2. Oil pump is ON.

3. If suction group running is either 1 or 2 the hot gas solenoid is OFF.
4. Fast unloader is ON.
5. First 120 seconds or until the unload switch is ON the unloader is ON else it is OFF.
6. Loader is OFF.
7. VI increase and decrease are OFF.
8. Start unloader is OFF.
9. Low discharge superheat relay is OFF.
10. All liquid line solenoids are OFF.
11. Oil equalization relay is ON.
12. All unloaders are OFF if they are load type else they are ON.
13. All turbo ice relays are off.
14. Oil heater is controlled to maintain oil temperature

All of the following conditions must be met within the time allowed in Setpoint #41 "LUBE DELAY". If the compressor type is centrifugal an additional 10 seconds will be allowed for these conditions to be met.

1. Oil differential must be equal to or greater than the value in Setpoint #40 "LUBE OIL PSI". If this Setpoint is not active this test is bypassed.
2. Oil temperature must be equal to or greater than the calculated oil temperature target. If Setpoint #39 "LUBE OIL TEMP" is not active this test is bypassed. If the compressor type is centrifugal and the option to use the saturated temperature is indicated, then the value of the saturated temperature will be added to Setpoint #39 "LUBE OIL TEMP", else the value of Setpoint #39 will be used by itself as the calculated oil temperature target.
3. The compressor must be unloaded. If there is an unloaded indicator it must be on. If it is a centrifugal compressor, it is forced to stay in this state for minimum of 15 seconds. If the compressor has no unloaded indicator it must stay in this state for a minimum of 10 seconds less than Setpoint #41 "LUBE DELAY".

If all of these conditions are met within the allotted time, the compressor will move to another state.

If a fixed step compressor with an external oil pump the state will either be UNLOADED or LOADED, depending if there are multiple compressor steps.

If a variable step compressor, then the percentage wanted on will be checked. If it is less than Setpoint #31 "MIN SLIDE %", or option "Use Min FLA" has been selected, the percentage wanted will be set to the value in Setpoint #31 "MIN SLIDE %" and the state will be set to HOLDING.

Any associated EXV will be adjusted to allow for additional capacity.

If the compressor does not meet all of the conditions it will be LOCKED OUT and an error message will be generated indicating the reason for the failure: pressure, temperature or time.

8.8. NOT USED

8.9. CMP UNLOADED

For variable step compressors, this state occurs when the slide is fully unloaded (indicated by unloaded input or after the unloader is pulsed for 30 seconds with no change). For fixed step compressors, this state occurs when the compressor is on and fully unloaded. In this state the compressor is supplying its minimum cooling capacity.

8.10. CMP UNLD STEP1 Only HVAC Software

This state only applies for fixed step capacity compressors with a Hot Gas Bypass solenoid. In this state the Hot Gas Bypass solenoid is off and all unloaders in the compressor are on.

8.11. CMP UNLD STEP2 Only HVAC Software

This state only applies for fixed step compressors with two unloaders. This state occurs when the Hot Gas Bypass solenoid, if present, is off, the first unloader solenoid is off, and the second unloader solenoid is on.

8.12. CMP IS HOLDING

This state only applies for variable step compressors. In this state, the required refrigeration capacity of system is being met; no movement of the slide valve is required.

8.13. CMP IS LOADING Only HVAC Software

For variable step compressors, this state occurs when the load solenoid is being pulsed to increase the capacity of the compressor. The duration of the pulse is specified in the Setpoint #37 “LOAD PULSE” and the frequency of the pulse is determined by Setpoint #56 “PULSE DELAY”. The Setpoint “PULSE DELAY” should be a value of between 3 and 5 seconds to allow the amp sensor to reflect the change.

8.14. CMP IS UNLDING Only HVAC Software

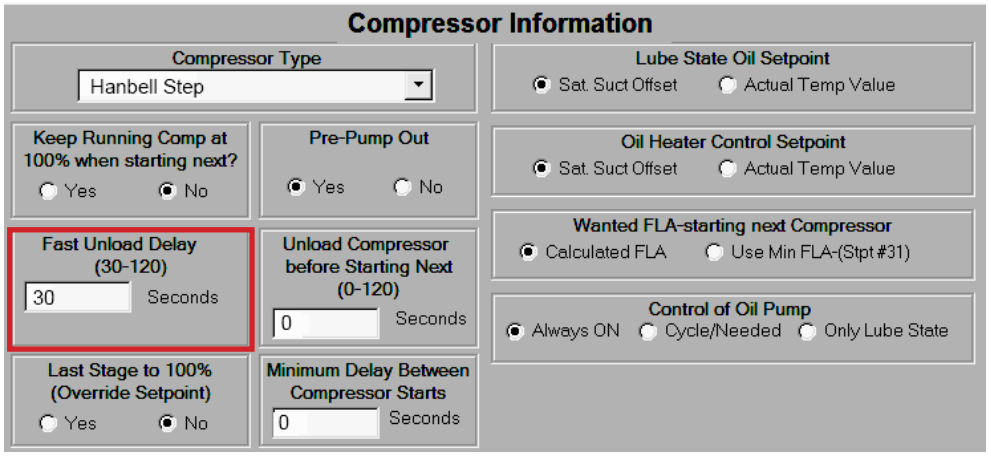
For variable step compressors, this state is when the unload solenoid is being pulsed to reduce the capacity of the compressor. The duration of the pulse is specified in Setpoint #38 “UNLOAD PULSE” and the frequency of the pulse is determined by Setpoint #56 “PULSE DELAY”. The Setpoint “PULSE DELAY” should be a value of between 3 and 5 seconds to allow the refrigerant to enter the chamber slowly enough to not cause oil foaming.

8.15. CMP IS RUNNING

For fixed capacity compressors only, this state occurs when the compressor is fully loaded. In this state, the compressor is providing the maximum amount of cooling capacity.

8.16. FAST UNLOADING

For screw compressors only, this state is entered when the compressor is turned on. All load solenoids will be turned off and all unload solenoids will be turned on to ensure the screw is fully unloaded. If an oil pump is included in the system it will be turned on during this state. The time in this state is set in the “Fast Unload Delay” cell under the Compressor Information button in the MAGNUM screen.



8.17. LO SUCT UNLOAD

Refer to Setpoints #77 “LOW SUCTION”; #78 “LO SUCT UNLD”; and #79 “LO SUCT RELD”.

For variable step compressors only. The capacity is being unloaded due to low suction pressure. The compressor will stay in this state until the suction pressure is above Setpoint #79 “LO SUCT RELD”. The system will then move to the LO SUCT HOLD state.

8.18. LO SUCT HOLD

Refer to Setpoints #77 “LOW SUCTION”; #78 “LO SUCT UNLD”; and #79 “LO SUCT RELD”.

Fixed step compressors–This state is entered when a fully loaded compressor that has more than one step is unloading due to low suction pressure. One step of capacity is turned off. The compressor will remain in this state for a minimum of five minutes before returning to the LOADED state if the low suction condition has been corrected.

Variable Step Compressors–Capacity is being held due to low suction pressure. Once the suction pressure returns to a normal operating level the compressor will return to its normal running state.

8.19. HI DISC UNLOAD

Refer to Setpoints #81 ”HI DISC PSI”; #82 “HI DISC UNLD”; #83 “HI DISC RELD”; #87 “HI DISC TMP”; #88 “HI DISC UNLD”; #89 “HI DISC RELD”, and #84 “LO DISC SHEAT”.

For variable step compressors only. The capacity is being unloaded due to a high discharge pressure, high discharge temperature, or low discharge superheat. The compressor will stay in this state until the pressure or temperature has dropped below the corresponding Setpoint. The system will then move to the HI DISC HOLD state.

8.20. HI DISC HOLD

Refer to Setpoints #81 ”HI DISC PSI”; #82 “HI DISC UNLD”; #83 “HI DISC RELD”; #87 “HI DISC TMP”; #88 “HI DISC UNLD”; and #89 “HI DISC RELD”.

Fixed Step Compressors–This state is entered when a fully loaded compressor that has more than one step is unloading due to high discharge pressure or temperature. One step of capacity will be turned off. The compressor will remain in this state for a minimum of five minutes before returning to the LOADED state if the high discharge condition has been corrected.

Variable Step Compressors–Capacity is being held due to high discharge temperature or pressure. Once the discharge returns to normal operating levels the compressor will return to its normal running state.

8.21. SAFETY TRIPPED

This state is entered when a safety trip occurs but a lockout is not generated. An alarm is generated but the system will automatically restart after the delay specified in the corresponding Setpoint. If a second trip occurs within the time specified in the Setpoint, the compressor will be placed in the CMP LOCKED OUT state.

8.22. LO TMP UNLOAD

The following two conditions can cause this state to be entered and the system to begin unloading:

1) The leaving liquid temperature is within 1.5°F of the Setpoint #111 “FREEZE “

2) The refrigerant temperature is less than Setpoint #155 “LO REF TMP” if this Setpoint is active.

8.23. LO TMP HOLD

Reload from the “LO TMP UNLOAD” occurs when the leaving liquid temperature is 3.0° F above Setpoint #111 “FREEZE “and the refrigerant temperature sensor, if present, is greater than Setpoint #155 “LO REF TMP” plus twice the value of Setpoint #156 “LO REF TMP”. Until this temperature is reached the system will remain in the LO TMP HOLD State.

8.24. HI AMP HOLD

Fixed step compressors–This state occurs when a fully loaded compressor experiences an abnormally high amp draw. Refer to Setpoints #171-190 for FLA per compressor (compressors 1-20 respectively) and #75 “HI AMPS %”. In this state, one step of capacity will be turned off. The compressor will remain in this state for a minimum of five minutes before returning to the LOADED state if the high amp draw condition has been corrected.

Variable Step Compressors–This state occurs after HI AMP UNLDING. It will remain in this state for the time specified in Setpoint #101 “SAFETY HOLD DELAY”. If the amp draw is less than the FLA Setpoint for this compressor, it will return to the normal operating state and the compressor will be able to load if necessary. In this state the compressor will not load but it can be unloaded if needed.

8.25. HI DIS TMP HLD

Refer to Setpoints #87 “HI DISC TMP”; #88 “HI DISC UNLD”; and #89 “HI DISC RELD”.

This state is entered when a fully loaded compressor that has more than one step encounters a high discharge temperature. One step of capacity will be turned off. The compressor will then remain in this state for a minimum of five minutes before returning to the LOADED state if the high discharge temperature has returned to normal.

8.26. CMP IS AT 40% Only HVAC Software

For Mitsubishi Screw compressors only. This compressor does not provide variable capacity but has two solenoids used to regulate the compressor capacity. This state occurs when the compressor is providing 40% capacity. In this state, the Relay Output to activate the 40% valve is turned on.

8.27. CMP IS AT 70% Only HVAC Software

For Mitsubishi Screw compressors only. This compressor does not provide variable capacity but has two solenoids used to regulate the compressor capacity. This state occurs when the compressor is providing 70% capacity. In this state, the Relay Output to activate the 70% valve is turned on.

8.28. HI WATER HOLD

When the compressor is running and Setpoint #86 “HI RETURN TEMP” is active, the Magnum will check for high water temperature. If the control temperature is greater than Setpoint #86 for the time specified the Magnum will place the compressor in this state. The system will be unable to load when in this state.

8.29. EXTRA 70% STEP Only HVAC Software

For Mitsubishi Screw compressors only. This compressor does not provide variable capacity but has two solenoids used to regulate the compressor capacity. This will move an extra step for this type of screw compressor.

8.30. OFF-LO OIL TMP

In this state the compressor is disabled. The oil temperature will be checked only if the compressor type is a centrifugal or screw.

Screw compressors – If the temperature is less than the value in Setpoint #39 “LUBE OIL TEMP” this state will be entered.

8.31. HI AMP UNLDING

For variable step compressors this state is entered when the amp draw is greater than the respective FLA Setpoint plus half the value in Setpoint #75, “HI AMPS”. This action is to prevent a high amps safety trip from occurring. Once the amp draw has been reduced the system state will change to HI AMP HOLD.

8.32. DEF PREPMP OUT Only HVAC Software

This state is only entered if the defrost type is any condition other than NONE. Hot gas will be used to perform the defrosting. This is selected in Compressor Information button under the MAGNUM screen. When a defrost cycle begins this state is entered and an alarm message is generated. The liquid line solenoid will be closed and the compressor will remain in this state and continue running until the suction pressure is less than Setpoint #61”PMP DWN OFF” or the time in this state is greater than Setpoint #62 “PMP DWN DELY”. The compressor will then move to the DEFROSTING state.

8.33. DEFROSTING (32) Only HVAC Software

Refer to DEF PREPMP OUT state. In this state the hot gas solenoid is opened. The compressor will remain in this state until both coil temperatures are greater than Setpoint #161 “DEF TERM TMP” or the time in this state is greater than the value in Setpoint #162 “DEF TERM DEL”. The compressor will then move to the DEF PUMP DOWN state.

8.34. DEF PUMP DOWN Only HVAC Software

Refer to DEFROSTING state. In this state the hot gas solenoid is closed. The compressor will remain in this state until the suction pressure is less than Setpoint #61”PMP DWN OFF” or the time in this state is greater than Setpoint #62 “PMP DWN DELY”. The compressor will then move to the CMP IS HOLDING state.

8.35. HI TEMP UNLOAD Only with HVAC Software

This state is only used when in Heating Mode. The system will unload if Setpoint #152 “HP OVERHEAT” is active and the leaving temperature is greater than the value in Setpoint #152 minus 15°F (8°C). The compressor will then move to the HI TEMP HOLD state when the temperature drops below the value in Setpoint #152 minus 30°F (16°C).

8.36. HI TEMP HOLD Only with HVAC Software

Refer to HI TEMP UNLOAD state. When the temperature drops below Setpoint #152 minus 45°F (24°C) the compressor will return to a normal state.

8.37. SCROLL STEP 1 Only with HVAC Software

Only used with special patterns for Trane Trio and Quad compressors. These compressors provide special staging as follows:
If Trane Trio then COMP C is on and COMP A and B are off.
If Trane Quad then COMP A is on and COMP B, C, and D are off.

8.38. SCROLL STEP 2 Only with HVAC Software

Only used with special patterns for Trane Trio and Quad compressors. These compressors provide special staging as follows:
If Trane Trio then COMP A and B are on and COMP C is off.

If Trane Quad then COMP C and D are on and COMP A and B are off.

8.39. SCROLL STEP 3 Only with HVAC Software

Only used with special patterns for Trane Trio and Quad compressors. These compressors provide special staging as follows:
If Trane Trio then COMP A, B, and C are on.
If Trane Quad then COMP B, C, and D are on and COMP A is off.

8.40. SCROLL STEP 4 Only with HVAC Software

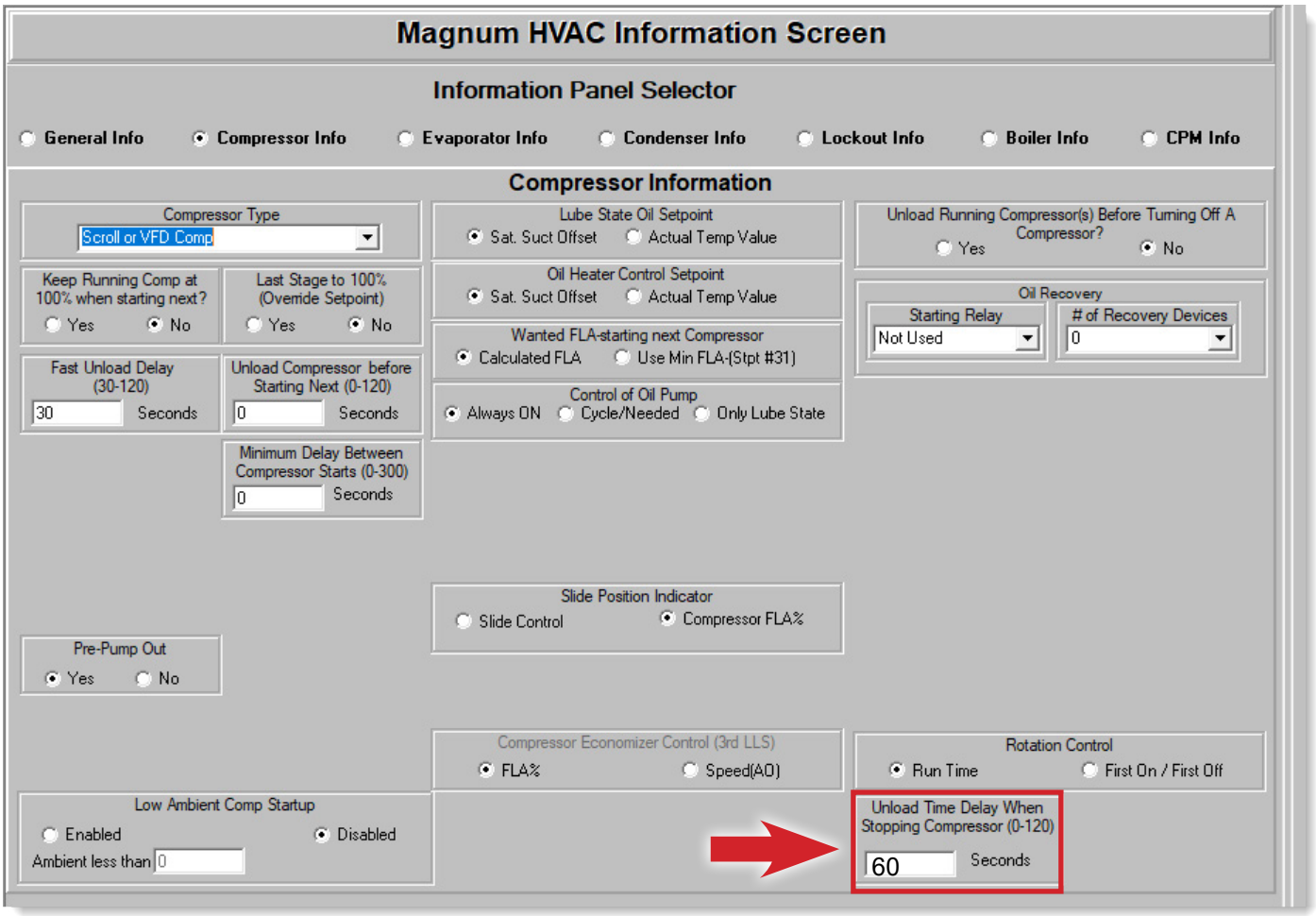
Only used with special patterns for Trane Quad compressors. These compressors provide special staging as follows:

If Trane Quad then COMP A, B, C, and D are on.

8.41. UNLOAD DELAY- RECIP/VFD COMPRESSORS

Firmware Version: 18.01Y or later

On the MAGNUM HVAC/RTU compressor screen, a new cell was added for setting the unload delay before pumpdown. If there's a value greater than "0" in this cell, the logic will enter the "Unload&PumpDown" state when calling for the compressor to shut down. In this state, it will wait the amount of time in that cell, before closing the LLS & or Closing the EXV to perform the normal pumpdown operation.



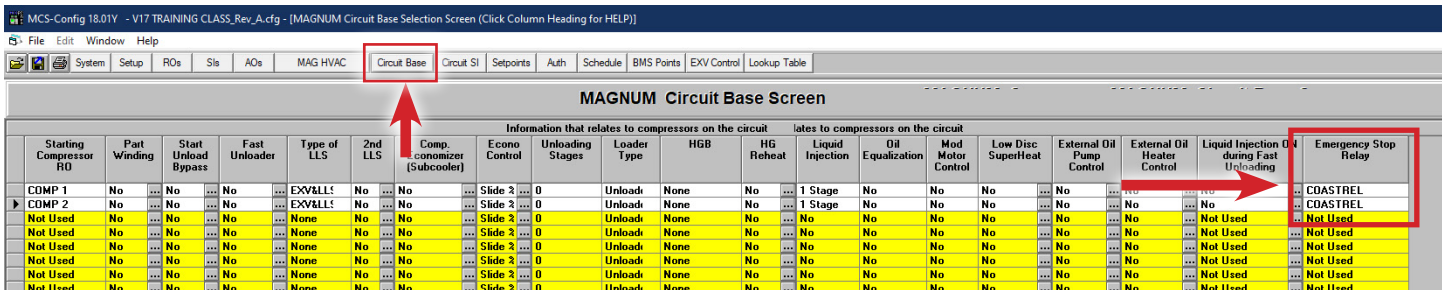
8.42. EMERGENCY STOP RELAY - CIRCUIT BASE

Firmware Version: 18.01Y or later

New logic for “Coast” relay on Bitzer VFD compressors has been added to the Circuit Base on HVAC/RTU firmware.

This allows the ability to point to a relay, that will be activated whenever that circuit is in alarm, OR the unit is in safety shutdown due to Phaseloss, Emg/Stop, etc.

Point to the relay as shown below in the Emergency Stop Relay box. (This relay is not a part of the compressor sequence and can be located on any wired point.)



8.43. Screw Compressor Oil Boost based on Load and Time

There are 3 setpoints that need to be set up in order to define the compressor load to activate the boost, the compressor load we’ll go to when in a boost, the time between boosts (when compressor load is below setpoint), and the time to remain in a boost.

Setpoint #30 needs to be a “Target” type, and we’ll use the “Low Zone” cell. This will define the compressor speed or FLA% for the compressor while running a boost.

Setpoint #31 needs to be a “Target” type, and we’ll use the “Low Zone” cell. This will define the compressor speed or FLA% that the compressor must be under, to call for a boost sequence.

#	Name	Value	Min	Max	Adjust Value	Time (SEC)	Max Time Allowed (SEC)	Lockout Delay (HRS)	Safety Down Time(MIN)	Active or Non-Active	Select Value: # decimals & print char	Level Of Auth. To Display	Type of Setpoint	Comments	SEC to Ignore Safety	Window to Ext. Safety Time(SEC)	Safety Time Extension (SEC)	High Zone	Low Zone	Setback
30	MAX SPD%	100	50	110	1	0	0	0	0	Active	HUMD or %	View Only	Target		—	—	—	0	100	0
31	MIN SPD%	50	40	80	1	30	30	0	0	Active	HUMD or %	View Only	Target		—	—	—	0	75	5

Setpoint #64 needs to be changed from “Minutes” to “DIGITAL/SW”, and made a “Target” type.

We’ll use the “Low Zone” cell to specify the time, in Minutes, that the compressor needs to be running for (below setpoint #31 “Low Zone” value) to call for a boost.

The “High Zone” cell will specify the time, in Seconds, that the compressor will remain in the boost sequence for.

#	Name	Value	Min	Max	Adjust Value	Time (SEC)	Max Time Allowed (SEC)	Lockout Delay (HRS)	Safety Down Time(MIN)	Active or Non-Active	Select Value: # decimals & print char	Level Of Auth. To Display	Type of Setpoint	Comments	SEC to Ignore Safety	Window to Ext. Safety Time(SEC)	Safety Time Extension (SEC)	High Zone	Low Zone	Setback
64	COMP MIN RUN	2	1	5	1	0	0	0	0	Active	DIGITAL/SW	View Only	Target		—	—	—	60	5	0

If the supply temp falls below the target setpoint – the low zone while in a boost sequence… compressors will begin to be cycled OFF until the supply temp rises back into the zone. Once a boost cycle is finished, the running compressors will be placed back to the running % that they were at before the boost occurred.

All safeties will still be in place while in boost. If a compressor trips, it will not affect the boost cycle of the other compressors.

Chapter - 9. SHARED VFD

HVAC 17.62M or later firmware

The following logic will utilize both unloaders and a VFD at the same time for capacity control

9.1. Compressor Modes

The compressor sequence must follow a predetermined sequence set by selecting Shared VFD for the compressor type. Typical sequence:

COMP
LLS
50% UNLOAD
75% UNLOAD
LIQUID INJ
STRT UNLD
CMP DOL
CMP EMG

The VFD inputs must be in this order:

VFD FAULT
VFD RUN
VFD AMPS

9.1.1 Compressor Modes

1. OFF – Compressor is off
2. VFD – Compressor is on VFD control
3. DOL – Direct Online – Compressor is locked in at 100% through a contactor
4. EMG – If VFD were to fault, all available compressors would run in emergency mode meaning DOL and step control only.

Setpoint #185

This setpoint defines the minimum and maximum wanted percentage for the VFD when the compressor slide is at 50% loaded. Value = Minimum % // Hi zone = Maximum %

Setpoint #186

This setpoint defines the minimum and maximum wanted percentage for the VFD when the compressor slide is at 75% loaded. Value = Minimum % // Hi zone = Maximum %

Setpoint #187

This setpoint defines the minimum and maximum wanted percentage for the VFD when the compressor slide is at 100% loaded. Value = Minimum % // Hi zone = Maximum %

9.1.2 Compressor Startup/Loading Sequence

1. Compressor starts in VFD mode
   a. All unloaders will be turned on and slide will be at 50% loaded.
   b. Compressor VFD speed will be set to setpoint #185 value field. The logic will look for a VFD proof input as well as the amps.
2. Compressor will modulate up to the maximum speed defined by setpoint #185 Hi zone.
3. Once compressor speed is at maximum and more capacity is required the following will occur.
   a. Compressor speed will be backed down to setpoint #186 value field. (This will be the new minimum speed value.)
   b. 50% unload solenoid will be turned off resulting in slide moving to 75% loaded.
4. Compressor will then begin to load up to the maximum wanted VFD percentage in setpoint #186 Hi zone.

5. Once the maximum VFD percentage is reached and more capacity is needed the following will occur.
   a. Compressor speed will be backed down to setpoint #187 value field. This will be the new minimum speed value.)
   b. 75% unload solenoid will be turned off resulting in the slide moving to 100% loaded.
6. Compressor will now continue to load up to the maximum VFD percentage of setpoint #187 Hi zone.
7. If the VFD is at the maximum wanted percentage the following will occur.
   a. The micro will energize the DOL contacts locking the compressor in at 100% and open the VFD contacts for that compressor. The logic will look for the DOL proof input before removing the VFD signal and moving to the next available compressor and this entire sequence would repeat.

9.1.3 VFD Fault/Emergency Mode

1. If the VFD Fault input comes on the VFD will be bypassed and the compressors will start using the Emergency Run output. The DOL proof will be verified and the compressors will now load using step control and turning on/off the 50% and 75% unloaders.

Chapter - 10. VFD Controlled Screw Compressors

10.1. INTRODUCTION

The MCS Magnum controller is designed to control Variable Frequency Drive (VFD) screw compressors. Its algorithm allows the user to define specific functions to maximize startup and running conditions. It handles all of the following:

1. Startup control
2. DX chiller barrel
3. DX remote coils
4. Flooded chiller barrel
5. Water cooled condenser
6. Air cooled condenser
7. Slide control for starting unloaded
8. EXV startup control
9. EXV Anticipatory loading
10. EXV low suction Anticipatory control

10.2. STARTUP CONTROL

When the compressor is started the state will be 'CMP IN STARTUP'. During this phase the compressor's Analog output will be placed at the percentage specified in the Config for startup and for the length of time specified. If the compressor has a slide valve it will be started unloaded. After a few seconds the slide is moved to the loaded position and all control is via the VFD. In the MCS Config the user can specify the following:

1. The starting frequency of the compressor which is via the compressor's Analog Output.
2. The length of time the compressor is to remain in 'CMP IN STARTUP' state.
3. The starting position of the Electric Expansion Valve (EXV).

10.3. OPERATING CONTROL

When the compressor completes the startup phase it enters normal operating controls. In the normal operating phase the primary function is to maintain the target based on the controlling sensor. (Usually this is Leaving Water Temperature.) To do this the following control functions occur:

1. The compressor Analog output will be adjusted to match the current wanted capacity percent.
2. The EXV position will be adjusted when the compressor speed is adjusted and depending on the current value of its superheat.
3. The compressor slide remains at 100% during normal operating control.

10.4. COMPRESSOR LOADING / UNLOADING

The standard MCS algorithm applies. However for the VFD controlled screw additional set point capabilities have been expanded as follows:

1. On a standard slide operated screw SP 32 'MAX ADJUST %' would usually be set to 4% to 5%. With the VFD it is typical to allow larger adjustments, when required, say to 10%. The loading/unloading algorithm can be set to increase/decrease slowly because the VFD allows exact positing of the capacity.
2. Controlling this adjustment is SP 56, 'COMP ADJ DELAY', which tells the Magnum the frequency to set. The EXV is adjusted at the same time allowing precise superheat control.

10.5. COMPRESSOR SHUTDOWN

Compressor shutdown is a function of the set point values setup at Config time. Normal function would be to shutoff the EXV and pump down based on set points. However if it's a flooded evaporator no pump down is done. When the compressor is off the MCS control system forces the slide vale to its minimum position so at the next start time the compressor is unloaded.

10.6. Screw Compressor with VFD

When using a VFD with a Hanbell Screw compressor the solenoid configuration will be to use the 25% or 33% depending on the model for the fast unloader. This solenoid will be energized at startup and shut down, to ensure the compressor is fully unloaded. The load solenoid will be replaced with a load cap. This allows oil to flow to the piston chamber continuously to load the slide. As soon as the fast unload solenoid is de-energized the slide will move to fully loaded. The compressor will stay fully loaded during the duration of running while the VFD will vary the HZ based on load demand.

Typically the VFD is setup for 0-10 VDC equals 0 hz-60 hz. Set point 30 is the MAX SPEED which equals 100% (60hz). Set point 31 is the MIN SPEED which equals 50% (30 hz). Our standard control logic based on the rate of change and the distance the control sensor is from the target set point is used within set points 25-34 and 56.

25	STEP SENSTIY	The decrements to the time delay between making changes in the control algorithm is based upon the difference between the target and control values. If the difference is greater than 10 the delay will be reduced by 10. If less the delay will be adjusted by the value of this set point. 1 is the fastest response, whereas higher numbers will mean a more gradual response.
26	STEP DELAY	Value: This is the time delay before making adjustments to the system capacity. Refer to set point #25 for how this delay is decremented. 'Time (sec)' field: If used, this will force a minimum time delay between any two compressor starts. This time delay is specified in the 'Minimum Delay Between Compressor Starts' box in the 'Cooling Info' panel under the MAG RTU screen.
27	MAX ROC -	Compares the control value rate of change. Maximum negative Rate of Change allowed before preventing the unit from loading. If the ROC is less than this value the capacity control state is set to HOLDING.
28	MAX ROC +	Compares the control value rate of change. Maximum positive Rate of Change allowed before preventing the unit from unloading. If the ROC is greater than this value the capacity control state is set to HOLDING.
29	ROC INTERV	Seconds between samples used for calculating the Rate of Change. (Maximum 60 seconds)
30	MAX FLA% or MAX SLIDE % or MAX CAPACITY% or MAX VFD %	Indicates the maximum amp draw, slide %, digital scroll load%, or speed allowed. Usually set to 100%, else compressors will load to the value of this Set point until all steps are on, then the system will load to 100%. 'Time (sec)' field: If non-zero, then force individual compressors to stay at maximum capacity when another compressor starts. This option is selected in in the 'Keep Running Comp at 100% when starting next?' box in the 'Compressor Information' panel under the MAGNUM screen. 'SEC to Ignore Safety' field (Fully Loaded Screw Compressor logic): If non-zero, turn on the load solenoid every 5 min for 5 seconds when fully loaded. If zero, then do not turn on solenoid for 5 seconds every 5 minutes. 'SEC to Ignore Safety' field (Holding Screw Compressor logic): If non-zero, turn on the load solenoid every 5 min for 5 seconds when holding. If zero, then do not turn on solenoid for 5 seconds every 5 minutes.
31	MIN FLA% or MIN SLIDE % or MIN CAPACITY% or MIN VFD %	Value: Indicates the minimum amp draw, slide %, digital scroll load%, or speed allowed (usually 40%). This is where the slide valve or VFD will be set when the compressor is turned on. This % is a function of actual amp draw relative to the FLA. 'Time (sec)' field: If used, this forces a time delay before unloading all running compressors before the next compressor is started. This time delay is specified in the 'Unload Compressor Before Starting Next' box in the 'Compressor Information' panel under the MAGNUM screen. Will Delay next compressor for this time after EVAP pump/valve is opened. Target: If this set point is setup as a target type the value in the night setback column will be added to the set point VALUE to allow safety unloading all the way down to this value. This replaces a hardcoded 20%. This is also utilized in conjunction with hotgas setpoints #4 and #5 on temperature.

32	MAX ADJUST %	Value of set point contains the maximum percentage change that can be made to the slide valve or VFD. 'Time (sec)' field: A zero indicates that the calculated FLA will be used; else the value in set point #31 will be used when starting the next compressor. This value is specified in the 'Wanted FLA starting next Compressor' box in the 'Cooling Info' panel under the MAG RTU screen.
33	MIN ADJUST %	Indicates the minimum percentage change that can be made to the slide valve or the VFD. For Fixed Step Compressors with adjustable speed AO's when returning to 100% after shutting down another compressor, this Set point will be the percent of adjustment along with Set point #56 "PULSE DELAY" which is the time frame between capacity adjustments.
34	SLIDE SENSITY	This controls the sensitivity of the adjustment made to the Wanted Percentage (adjustments are relative to the difference between the current control sensor and target). The larger the value the larger the adjustment (usually 1).

56	PULSE DELAY CMP RELOAD ADJ	Used with variable capacity screws. The number of seconds between load or unload pulses (Usually between 3 and 5. Allows load change to be checked before next pulse and eliminates oil foaming when unloading too fast). 'Time (sec)' field: If used, this is the fast unloading state time delay. This option is selected in the 'Fast Unload Delay' box in the 'Compressor Information' panel under the MAGNUM screen. For Fixed Step Compressors with adjustable speed AO's when returning to 100% after shutting down another compressor, this Set point will be the time frame between capacity adjustments along with Set point #33 "MIN ADJUST %" which is the percent of adjustment. IF Target Type: The high zone (pulse on time) and low zone (delay between pulses) will define the safety unloading logic as follows. The low zone timer is calculated from ON to ON. Example: hi zone =2, low zone =5. The unload solenoid will pulse ON for 2 seconds and be OFF for 3 seconds, ON for 2 seconds OFF for 3 seconds during safety unloading.

Chapter - 11. Relay Output Sequences

The sequence of Relay Outputs must be correctly matched to the particular type of compressor being controlled. Relays are required unless marked as optional. If a relay is optional and it is not used then its position is skipped and the following relays will be moved up. Compressor type selection as displayed in MCS-Config is shown within brackets.

11.1. Reciprocating Compressors (Recip Comp w/Oil) and (Recip Comp w/o Oil)

Compressor relay
Part winding compressor relay (OPTIONAL)
Liquid line solenoid
Unloader 1 (OPTIONAL)
Unloader 2 (OPTIONAL)
Unloader 3 (OPTIONAL)
Oil pump (OPTIONAL, ONLY USED WITH **Recip Comp w/Oil)**
Oil heater (OPTIONAL, ONLY USED WITH **Recip Comp w/Oil)**
Hot gas bypass (OPTIONAL)
Common Hot gas bypass (OPTIONAL)
Liquid injection (OPTIONAL)
Fast unloader (OPTIONAL)
Second liquid line solenoid (OPTIONAL)
Oil equalization (OPTIONAL)
Oil seal cooler (OPTIONAL)
VI increase valve % (OPTIONAL)
VI decrease valve % (OPTIONAL)
Start unloader bypass (OPTIONAL)
Low disc superheat (OPTIONAL)
Hot gas reheat off (OPTIONAL) If hot gas reheat all 3 hot gas relays are required.
Hot gas reheat on (OPTIONAL)
Hot gas reheat bleed (OPTIONAL)
Third liquid line solenoid (OPTIONAL)
Reversing valve (heat pump) (OPTIONAL)
Liquid injection #2 (OPTIONAL)
Mod motor (OPTIONAL)

11.2. Screw Compressor with Oil (Screw Comp w/Oil)

Compressor relay
Part winding compressor relay (OPTIONAL)
Loader
Unloader
Oil pump
Oil heater
Liquid line solenoid (OPTIONAL)
Hot gas bypass (OPTIONAL)
Common Hot gas bypass (OPTIONAL)
Liquid injection (OPTIONAL)
Fast unloader (OPTIONAL)
Second liquid line solenoid (OPTIONAL)
Oil equalization (OPTIONAL)
Oil seal cooler (OPTIONAL)
VI increase valve % (OPTIONAL)
VI decrease valve % (OPTIONAL)
Start unloader bypass (OPTIONAL)
Low disc superheat (OPTIONAL)
Hot gas reheat off (OPTIONAL) If hot gas reheat all 3 hot gas relays are required.

Hot gas reheat on (OPTIONAL)
Hot gas reheat bleed (OPTIONAL)
Third liquid line solenoid (OPTIONAL)
Reversing valve (heat pump) (OPTIONAL)
Liquid injection #2 (OPTIONAL)
Mod motor (OPTIONAL)

The sequence of Relay Outputs must be correctly matched to the particular type of compressor being controlled. Relays are required unless marked as optional. If a relay is optional and it is not used then its position is skipped and the following relays will be moved up. Compressor type selection as displayed in MCS-Config is shown within brackets.

11.3. Reciprocating Compressors (Recip Comp w/Oil) and (Recip Comp w/o Oil)

Compressor relay
Part winding compressor relay (OPTIONAL)
Liquid line solenoid
Unloader 1 (OPTIONAL)
Unloader 2 (OPTIONAL)
Unloader 3 (OPTIONAL)
Oil pump (OPTIONAL, ONLY USED WITH **Recip Comp w/Oil)**
Oil heater (OPTIONAL, ONLY USED WITH **Recip Comp w/Oil)**
Hot gas bypass (OPTIONAL)
Common Hot gas bypass (OPTIONAL)
Liquid injection (OPTIONAL)
Fast unloader (OPTIONAL)
Second liquid line solenoid (OPTIONAL)
Oil equalization (OPTIONAL)
Oil seal cooler (OPTIONAL)
VI increase valve % (OPTIONAL)
VI decrease valve % (OPTIONAL)
Start unloader bypass (OPTIONAL)
Low disc superheat (OPTIONAL)
Hot gas reheat off (OPTIONAL) If hot gas reheat all 3 hot gas relays are required.
Hot gas reheat on (OPTIONAL)
Hot gas reheat bleed (OPTIONAL)
Third liquid line solenoid (OPTIONAL)
Reversing valve (heat pump) (OPTIONAL)
Liquid injection #2 (OPTIONAL)
Mod motor (OPTIONAL)

11.4. Scroll Compressor (Scroll Comp)

Compressor relay
Part winding compressor relay (OPTIONAL)
Liquid line solenoid
Unloader 1 (OPTIONAL)
Unloader 2 (OPTIONAL)
Unloader 3 (OPTIONAL)
Oil pump
Oil heater
Hot gas bypass (OPTIONAL)
Common Hot gas bypass (OPTIONAL)
Liquid injection (OPTIONAL)
Fast unloader (OPTIONAL)
Second liquid line solenoid (OPTIONAL)
Oil equalization (OPTIONAL)
Oil seal cooler (OPTIONAL)

VI increase valve % (OPTIONAL)
VI decrease valve % (OPTIONAL)
Start unloader bypass (OPTIONAL)
Low disc superheat (OPTIONAL)
Hot gas reheat off (OPTIONAL) If hot gas reheat all 3 hot gas relays are required.
Hot gas reheat on (OPTIONAL)
Hot gas reheat bleed (OPTIONAL)
Third liquid line solenoid (OPTIONAL)
Reversing valve (heat pump) (OPTIONAL)
Liquid injection #2 (OPTIONAL)
Mod motor (OPTIONAL)

11.5. Hitachi Screw Compressor (Hitachi Screw Comp)

Compressor relay
Part winding compressor relay (OPTIONAL)
Loader
Unloader
Fast unloader
Oil pump (OPTIONAL)
Oil heater (OPTIONAL)
Liquid line solenoid (OPTIONAL)
Hot gas bypass (OPTIONAL)
Common Hot gas bypass (OPTIONAL)
Liquid injection (OPTIONAL)
Fast unloader (OPTIONAL)
Second liquid line solenoid (OPTIONAL)
Oil equalization (OPTIONAL)
Oil seal cooler (OPTIONAL)
VI increase valve % (OPTIONAL)
VI decrease valve % (OPTIONAL)
Start unloader bypass (OPTIONAL)
Low disc superheat (OPTIONAL)
Hot gas reheat off (OPTIONAL) If hot gas reheat all 3 hot gas relays are required.
Hot gas reheat on (OPTIONAL)
Hot gas reheat bleed (OPTIONAL)
Third liquid line solenoid (OPTIONAL)
Reversing valve (heat pump) (OPTIONAL)
Liquid injection #2 (OPTIONAL)
Mod motor (OPTIONAL)

11.6. Carlyle Screw (Carlyle Screw)

Compressor relay
Part winding compressor relay (OPTIONAL)
Liquid line solenoid
Hot gas bypass (OPTIONAL)
Common Hot gas bypass (OPTIONAL)
Liquid injection (OPTIONAL)
Fast unloader (OPTIONAL)
Second liquid line solenoid (OPTIONAL)
Oil equalization (OPTIONAL)
Oil seal cooler (OPTIONAL)
VI increase valve % (OPTIONAL)
VI decrease valve % (OPTIONAL)
Start unloader bypass (OPTIONAL)
Low disc superheat (OPTIONAL)
Hot gas reheat off (OPTIONAL) If hot gas reheat all 3 hot gas relays are required.
Hot gas reheat on (OPTIONAL)

Hot gas reheat bleed (OPTIONAL)
Third liquid line solenoid (OPTIONAL)
Reversing valve (heat pump) (OPTIONAL)
Liquid injection #2 (OPTIONAL)
Mod motor (OPTIONAL)

11.7. Hanbell Screw Compressor, McQuay Frame 4 Compressor, Bitzer Screw Compressor, Hartford Screw Compressor, and Fu Sheng Compressor (McQuay Frame 4), (Fu Sheng), (Hanbell-Load NO), (Bitzer Screw Comp), (Hartford Screw Comp), and (Hanbell-Load NC)

Compressor relay
Part winding compressor relay (OPTIONAL)
Loader
Unloader
Oil pump (OPTIONAL)
Oil heater (OPTIONAL)
Liquid line solenoid (OPTIONAL)
Hot gas bypass (OPTIONAL)
Common Hot gas bypass (OPTIONAL)
Liquid injection (OPTIONAL)
Fast unloader (OPTIONAL)
Second liquid line solenoid (OPTIONAL)
Oil equalization (OPTIONAL)
Oil seal cooler (OPTIONAL)
VI increase valve % (OPTIONAL)
VI decrease valve % (OPTIONAL)
Start unloader bypass (OPTIONAL)
Low disc superheat (OPTIONAL)
Hot gas reheat off (OPTIONAL) If hot gas reheat all 3 hot gas relays are required.
Hot gas reheat on (OPTIONAL)
Hot gas reheat bleed (OPTIONAL)
Third liquid line solenoid (OPTIONAL)
Reversing valve (heat pump) (OPTIONAL)
Liquid injection #2 (OPTIONAL)
Mod motor (OPTIONAL)

11.8. Hanbell-3 Solenoid (Hanbell-3 Solenoid [50-100%])

Compressor relay
Part winding compressor relay (OPTIONAL)
Loader
Unloader
Fast unloader
Oil pump (OPTIONAL)
Oil heater (OPTIONAL)
Liquid line solenoid (OPTIONAL)
Hot gas bypass (OPTIONAL)
Common Hot gas bypass (OPTIONAL)
Liquid injection (OPTIONAL)
Fast unloader (OPTIONAL)
Second liquid line solenoid (OPTIONAL)
Oil equalization (OPTIONAL)
Oil seal cooler (OPTIONAL)
VI increase valve % (OPTIONAL)
VI decrease valve % (OPTIONAL)
Start unloader bypass (OPTIONAL)
Low disc superheat (OPTIONAL)

Hot gas reheat off (OPTIONAL) If hot gas reheat all 3 hot gas relays are required.
Hot gas reheat on (OPTIONAL)
Hot gas reheat bleed (OPTIONAL)
Third liquid line solenoid (OPTIONAL)
Reversing valve (heat pump) (OPTIONAL)
Liquid injection #2 (OPTIONAL)
Mod motor (OPTIONAL)

11.9. Hanbell Fixed Step (Hanbell Step)

Compressor relay
Part winding compressor relay (OPTIONAL)
Unloader 1 (OPTIONAL)
Unloader 2 (OPTIONAL)
Unloader 3 (OPTIONAL)
Liquid line solenoid
Oil pump (OPTIONAL)
Oil heater (OPTIONAL)
Hot gas bypass (OPTIONAL)
Common Hot gas bypass (OPTIONAL)
Liquid injection (OPTIONAL)
Fast unloader (OPTIONAL)
Second liquid line solenoid (OPTIONAL)
Oil equalization (OPTIONAL)
Oil seal cooler (OPTIONAL)
VI increase valve % (OPTIONAL)
VI decrease valve % (OPTIONAL)
Start unloader bypass (OPTIONAL)
Low disc superheat (OPTIONAL)
Hot gas reheat off (OPTIONAL) If hot gas reheat all 3 hot gas relays are required.
Hot gas reheat on (OPTIONAL)
Hot gas reheat bleed (OPTIONAL)
Third liquid line solenoid (OPTIONAL)
Reversing valve (heat pump) (OPTIONAL)
Liquid injection #2 (OPTIONAL)
Mod motor (OPTIONAL)

11.10. Mitsubishi Screw (Mitsubishi Screw)

Compressor relay
Part winding compressor relay (OPTIONAL)
Fast unloader
40 % open
70 % open
Liquid line solenoid (OPTIONAL)
Hot gas bypass (OPTIONAL)
Common Hot gas bypass (OPTIONAL)
Liquid injection (OPTIONAL)
Fast unloader (OPTIONAL)
Second liquid line solenoid (OPTIONAL)
Oil equalization (OPTIONAL)
Oil seal cooler (OPTIONAL)
VI increase valve % (OPTIONAL)
VI decrease valve % (OPTIONAL)
Start unloader bypass (OPTIONAL)
Low disc superheat (OPTIONAL)
Hot gas reheat off (OPTIONAL) If hot gas reheat all 3 hot gas relays are required.
Hot gas reheat on (OPTIONAL)

Hot gas reheat bleed (OPTIONAL)
Third liquid line solenoid (OPTIONAL)
Reversing valve (heat pump) (OPTIONAL)
Liquid injection #2 (OPTIONAL)
Mod motor (OPTIONAL)

11.11. Trane Scroll with 3 Compressor Sets (Trane Trio)

Staging sequence			
	COMP A	**COMP B**	**COMP C**
Stage 1	OFF	OFF	ON
Stage 2	ON	ON	OFF
Stage 3	ON	ON	ON

Compressor relay for COMP A
Part winding compressor relay (OPTIONAL)
Liquid line solenoid
Compressor relay for COMP B
Compressor relay for COMP C
Hot gas bypass (OPTIONAL)
Common Hot gas bypass (OPTIONAL)
Liquid injection (OPTIONAL)
Fast unloader (OPTIONAL)
Second liquid line solenoid (OPTIONAL)
Oil equalization (OPTIONAL)
Oil seal cooler (OPTIONAL)
VI increase valve % (OPTIONAL)
VI decrease valve % (OPTIONAL)
Start unloader bypass (OPTIONAL)
Low disc superheat (OPTIONAL)
Hot gas reheat off (OPTIONAL) If hot gas reheat all 3 hot gas relays are required.
Hot gas reheat on (OPTIONAL)
Hot gas reheat bleed (OPTIONAL)
Third liquid line solenoid (OPTIONAL)
Reversing valve (heat pump) (OPTIONAL)
Liquid injection #2 (OPTIONAL)
Mod motor (OPTIONAL)

11.12. Trane Scroll with 4 Compressor Sets (Trane Quad)

Staging sequence				
	COMP A	**COMP B**	**COMP C**	**COMP D**
Stage 1	ON	OFF	OFF	OFF
Stage 2	OFF	OFF	ON	ON
Stage 3	OFF	ON	ON	ON
Stage 4	ON	ON	ON	ON

Compressor relay for COMP A

Part winding compressor relay (OPTIONAL)

Liquid line solenoid

Compressor relay for COMP B

Compressor relay for COMP C

Compressor relay for COMP D

Hot gas bypass (OPTIONAL)

Common Hot gas bypass (OPTIONAL)
Liquid injection (OPTIONAL)
Fast unloader (OPTIONAL)
Second liquid line solenoid (OPTIONAL)
Oil equalization (OPTIONAL)
Oil seal cooler (OPTIONAL)
VI increase valve % (OPTIONAL)
VI decrease valve % (OPTIONAL)
Start unloader bypass (OPTIONAL)
Low disc superheat (OPTIONAL)
Hot gas reheat off (OPTIONAL) If hot gas reheat all 3 hot gas relays are required.
Hot gas reheat on (OPTIONAL)
Hot gas reheat bleed (OPTIONAL)
Third liquid line solenoid (OPTIONAL)
Reversing valve (heat pump) (OPTIONAL)
Liquid injection #2 (OPTIONAL)
Mod motor (OPTIONAL)

Chapter - 12. Standard Control Options

The following options are specified in MCS-Config when building the configuration. These options are used to customize the system to meet the individual control requirements.

12.1. General Options

- Control method can be based upon the control zone or a voltage input indicating the number of stages to be on.
- The control temperature sensor can be either the returning or leaving sensor.
- Electronic expansion valves make dynamic adjustments based on capacity changes.
- Chilled water reset from the Building Management System (BMS).
- Condenser control maintaining sufficient discharge superheat for good oil separation.
- Evaporator pump control.
- Anti-cycle timers (OFF to ON and ON to ON).
- Maximum of 20 circuits per Magnum, with selectable compressor rotation.
- Warning RO (turned on for low suction unload, high discharge unload, etc.).
- Alarm RO (turned on whenever an alarm is generated).
- Optional auto rotation for compressors.
- Low and/or high ambient temperature shut down.

12.2. Magnum Control Zone Logic

The control strategy is designed to modulate the compressor(s) capacity to maintain the control sensor reading within the specified control zone. To accomplish this, the Magnum will constantly monitor the control value, its rate of change, and position in relationship to the control zone and make adjustments accordingly.

The strategies for a fixed step system, reciprocating compressor, reciprocating compressor with an inverter, variable (slide) step system, or a screw compressor are all slightly different. The variable step system allows for infinite variations of capacity while the fixed step system does not.

12.3. Common Definitions

12.3.1 Target

The control target is specified in Setpoint #1. This will be the base of developing the control zone.

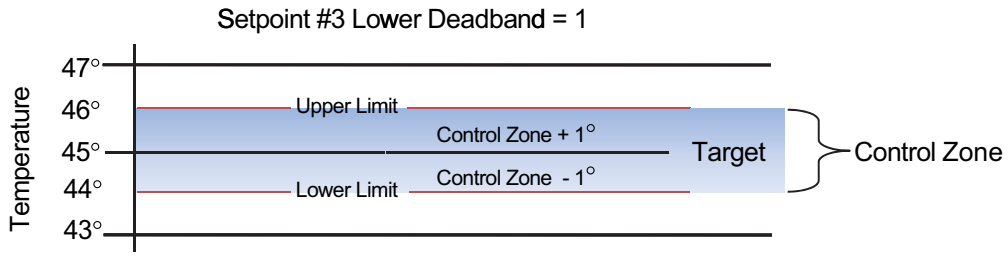
12.3.2 Control Zone

The control zone is developed by utilizing two more Setpoints to calculate the upper and lower limits. Setpoint #2 is added to the target to determine the deadband to the upper limit, and Setpoint #3 is subtracted from the target to determine the deadband to the lower limit.

Example: Setpoint #1 Target = 45

Setpoint #2 Upper Deadband = 1

Setpoint #3 Lower Deadband = 1



12.3.2.1. Control Sensor

This sensor has been specified in MCS-Config as providing the control value reading. It will normally be the entering temperature, leaving temperature, or suction pressure. The Setpoints must be adjusted according to the type of control measurement selected.

12.3.2.2. Control Input Rate of Change

The Rate of Change is how rapidly the control value changes over a set period of time. If the control value is increasing, the rate will be positive; if it is decreasing, the rate will be a negative value. How quickly the input is changing, its direction, and its distance from the control zone will all be used to determine how the Magnum will respond.

12.3.2.3. Step Delay and Sensitivity

The Magnum will not attempt to take action until the Step Delay counts down to zero. Setpoint #26 contains the initial value. The speed that the counter will decrement by is based on the control input rate of change and the sensitivity that has been specified in Setpoint #25. The purpose of the sensitivity value is to limit how quickly the Magnum reacts to changes indicated by the control sensor. The lower the value of this Setpoint, the faster the Magnum will react to changes of the control sensor.

12.3.2.4. Last step Temperature On

The purpose of this option is to keep the last step of mechanical cooling on until the control temperature is below the Temperature On value.

Set point #151 must be active to enable this option, refer to this set point.

If the safety time of this set point is zero then the value of this set point is used as the Temperature On value.

If the safety time of this set point is not zero then the value of this set point is used as a differential and is subtracted from the control temperature target to develop the Temperature On value.

In the above control zone example, if the set point #151's value is 43.0 and the safety time is zero, then the last stage will remain on until the control temperature is less than 43.0.

In the above control zone example, if the set point #151's value is 3.0 and the safety time is not zero, then the last stage will remain on until the control temperature is less than 42.0. (45.0 – 3.0 = 42.0).

12.3.2.5. Low temperature off

The purpose of this option is to keep the first step of mechanical cooling from being turned on until the control temperature is above the Low Temperature Off value. Note this is only checked when the wanted on steps are zero.

Set point #151 must be active and be a TARGET type of set point to enable this option, refer to this set point.

If the safety time of this set point is zero then the value of the Night Setback cell of this set point is used as the Low Temperature Off value.

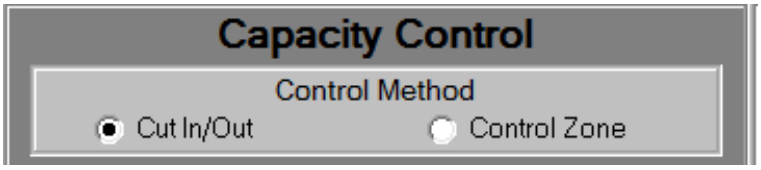
If the safety time of this set point is not zero then the value of the Night Setback cell of this set point is used as a differential and is added to the control temperature target to develop the Low Temperature Off value.

When the steps wanted on is zero and the control temperature is less than the Low Temperature Off value the unit state will be "UNIT OFF CTRL SI", refer to the Unit State section. The unit will remain in this state until the control temperature is above the Low Temperature Off value, at this point the state will be changed to loading and the delay counter will be counted down.

In the above control zone example, if the set point #151's Night Setback cell is 47.0 and the safety time is zero, then the first stage of cooling will remain off until the control temperature is greater than 47.0. State will be "UNIT OFF CTRL SI" and the delay counter will not be decremented.

12.4. Voltage Step Control Logic

An alternate control strategy is based on a variable voltage input to the Magnum board. The different stages of capacity will Cut In or Out depending on the voltage input. This option is selected in the MAGNUM screen under the Evaporator Info tab.



Setpoints #2-18 contain the Cut-In and Cut-Out voltage thresholds. The status screen has been changed

to show the actual voltage on the top line and to indicate voltage control on the bottom line. The step delay between adjustments is based on Setpoint #26 “STEP DELAY”.

Note: Liquid Injection and EXV logic are both disabled when this option is used.

12.5. Variable Capacity Control Method

12.5.1 Screw Compressor with slide piston

This option is specified in MCS-Config by selecting the compressor type in the Compressor Information Panel under the MAGNUM screen.

As stated in the previous section, the control strategy is designed to modulate the system capacity to maintain the control sensor reading within the specified control zone. The system capacity will be based upon the number of compressors that are Wanted On. When the first, or an additional compressor, is turned on the system capacity will be set to the calculated value. For the first compressor this will be the value of Setpoint #31 “MIN FLA %”. When additional compressors are brought on, their capacity is calculated to provide the same percentage of capacity prior to the change. The Magnum will adjust the required capacity between the calculated and the maximum value an as specified in Setpoint #30 “MAX FLA %”. All compressors that are on will be adjusted together to meet the system capacity.

When the maximum capacity value of the currently operating compressors has been reached, an additional compressor, if available, will be Wanted On. The number of compressors Wanted On will be increased by one and the system capacity will be set to the calculated value to maintain the same capacity as before the change and the sequence will begin again. Once all available compressors are on, their maximum will be 100% regardless of the value in Setpoint #30 “MAX FLA %”.

When the minimum calculated value has been reached, a compressor will be turned off. This will occur when the reduced number of compressors can achieve the same capacity at 90%. The number of compressors Wanted On will be decreased by one and the system capacity will be set to 90% and the sequence will begin again.

The compressor slide control is based upon the amps drawn by that compressor. For example, if Setpoint #31 “MIN FLA %” is set to 30%, that means 30% of the calculated full load amperage for that compressor.

Screw compressors with slide pistons that are turned on can either be loading (load solenoids are pulsed), unloading (unload solenoids are pulsed), or in a hold state (no action is taken). The state of each compressor reflects this action.

12.5.2 Compressor with a Variable Frequency Drive (VFD)

This option is specified in MCS-Config by selecting the Analog Output for the VFD in the “Compr Speed or Modulate Hot Gas AO” cell in the Circuit Base screen.

Select Output and Sensor Inputs per circuit									
Circuit # (reset button)	Alarm Relay	Comp Proof	Compr Speed or Modulate Hot Gas AO	Compressor speed fault	Slide Closed Indicator	Pump Down	EXV Output	Flow	Circuit Pump/Valve
1 ...	Not Used	Not Used	COMP1 SPD	Not Used	Not Used	DISABLE 1	Not Used	Not Used	Not Used

The Magnum will control the compressor speed in the same matter as the compressor slide. The same Set-points will be used. This allows a fixed staged compressor’s capacity to be varied. See section for Setpoints associated with variable capacity control logic.

12.5.3 Example of a system with 3 variable Step Compressors

(Example below assumes compressor 1 is the current lead compressor.)

STAGE 1

Compressor 1’s startup procedure has begun. Once on, the capacity will be adjusted from the minimum to the maximum. All other compressors will be off. The steps Wanted On / Actual On will be 1 / 1.

STAGE 2

Compressor 2’s startup procedure has begun. Once on, the system capacity will be changed to the calculated % and compressor 1 will be unloaded until it matches the calculated system capacity. Both compressors will be varied from the calculated to the maximum. All other compressors will be off. The steps Wanted On / Actual

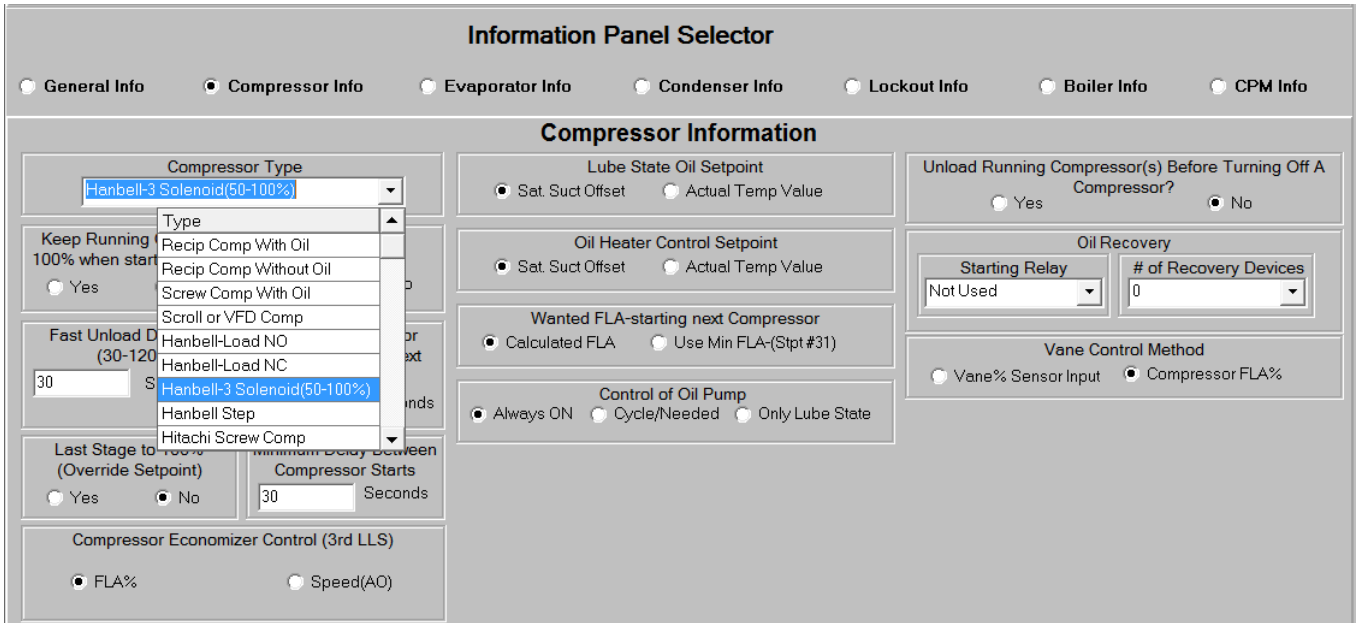
On will be 2 / 2. If the system capacity has been reduced to 45%, or the calculated % (whichever is larger) and less capacity is needed, a compressor will be turned off and the system capacity will be set to the 90% or the maximum and the system will return to Stage 1.

STAGE 3

Compressor 3's startup procedure has begun. Once on, the system capacity will be changed to the calculated % and compressors 1 and 2 will be unloaded until they equal the required capacity. All compressors will be varied from the calculated to 100%. The steps Wanted On / Actual On will be 3 / 3. If the system capacity has been reduced to 60%, and less capacity is needed, a compressor will be turned off and the system capacity will be set 90% and the system will return to Stage 2.

12.6. Compressor Types

The compressor type is selected from a drop down list in the Compressor Information panel on the MAGNUM screen.



- Reciprocating Compressor with Oil
- Reciprocating Compressor without Oil
- Hanbell-Load NO (load solenoid wired to normal open) Screw Compressor
- Hanbell-Load NC (load solenoid wired to normal close) Screw Compressor
- Hanbell- 3 Solenoid (50-100%) (not variable but 3 fixed step screw) Screw Compressor
- Hanbell- Step (fixed step) Screw Compressor
- Hitachi Screw Compressor
- Bitzer Screw Compressor
- Trane Quad
- Screw Compressor with Oil
- Scroll Compressor
- Hartford Screw Compressor
- Carlyle Screw Compressor
- Centrifugal Compressor
- Mitsubishi Screw Compressor
- TurboCor Compressor
- Trane Screw Compressor
- McQuay Frame 4
- Fu Sheng Compressor
- Trane Trio

The type of compressor will determine how the compressor is controlled and its particular Relay Output sequence.

12.7. Compressor Setup and Options

All setup information and option selection is completed in MCS-Config.

12.7.1 Compressor Information setup

In this screen under the MAGNUM screen, compressor type is selected from a drop down list. Additional information about the compressor and how it will be controlled is also provided in this section. Review all cells and input the proper information.

The type of compressor will determine how the compressor is controlled and its particular Relay Output sequence.

12.7.2 For additional fine tuning, four setpoints have been added to provide flexibility:

Setpoint #191, TEMP DIFF

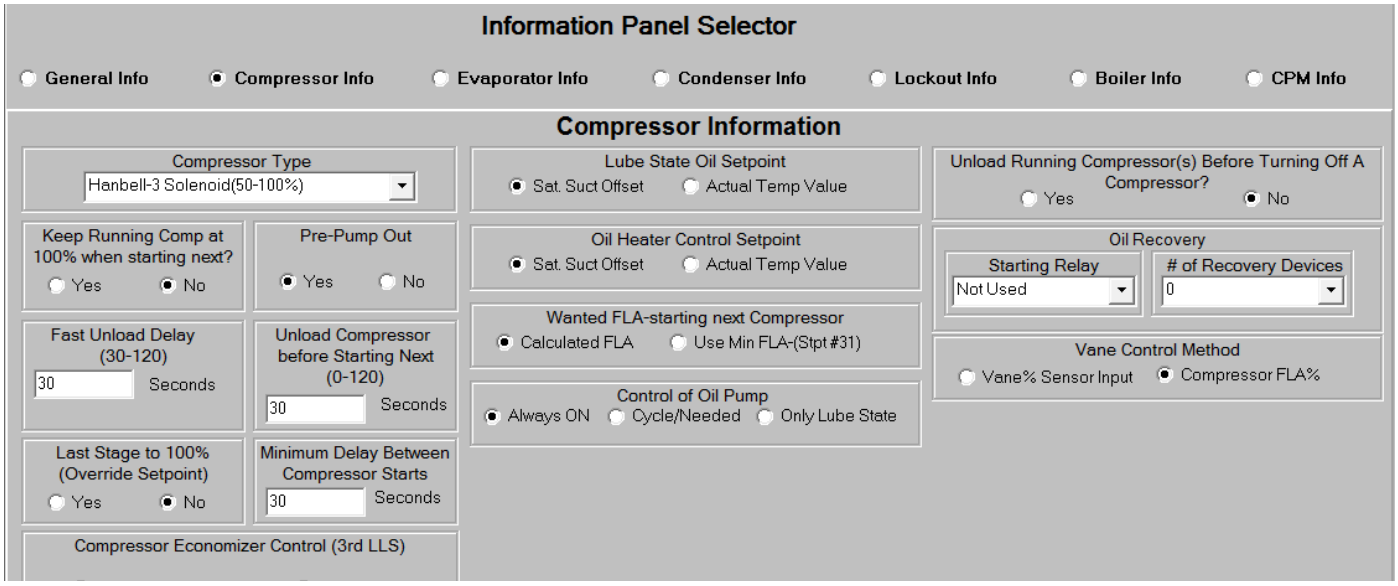
Setpoint #192, FRZ TEMP DIFF

Setpoint #193, CND H/L ZONE

Setpoint #194, CND 2ND ZONE

12.8. Compressor Setup and Options

All setup information and option selection is completed in MCS-Config.

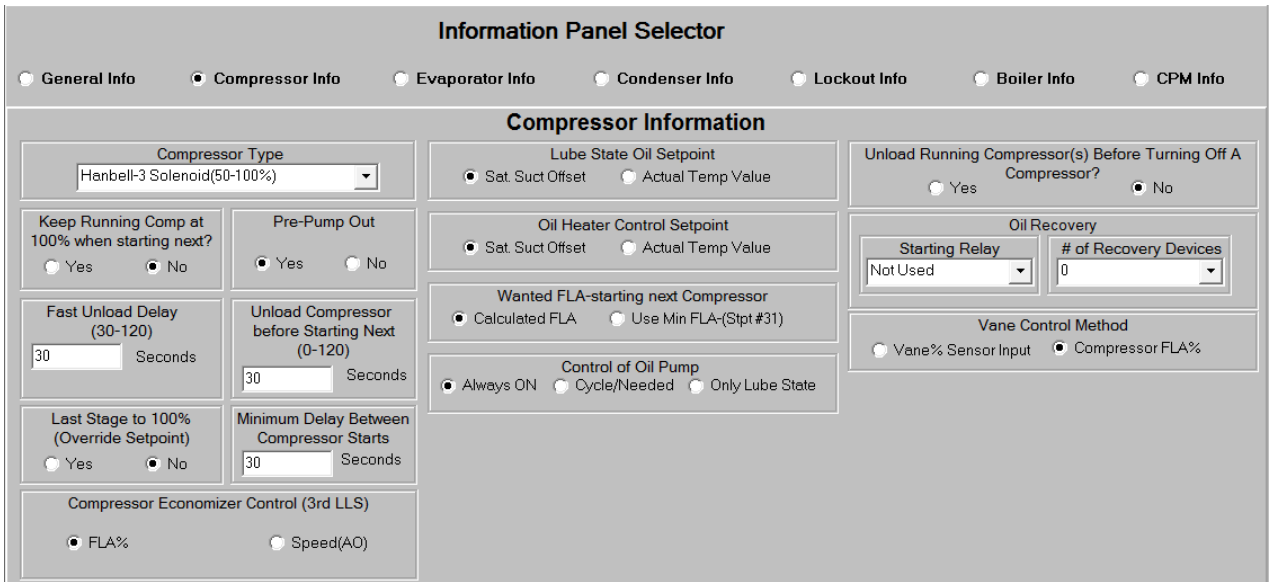


12.8.1 General Information

- A maximum of four steps per compressor is supported (compressor plus three additional steps of either compressors, unloaders, or hot gas bypass points). Note: Compressor safeties relate to a circuit. If multiple compressors are on a single circuit and a safety trips, all compressors on that circuit will be turned off (If hot gas bypass, refer to Hot Gas Bypass section).
- If the compressor has an across-the-line start, only one RO point will be allocated for the compressor. If the compressor has a part winding start, two RO points will be used. The first RO will be turned on and the second RO will turn on after Setpoint #73 has been fulfilled.
- Pump down will take place when the compressor is started and when turning off. Note: When the compressor is started the liquid line solenoid is not opened until the suction pressure drops below Setpoint #61 “PMP DWN OFF” or Setpoint #62 “PMP DWN DELY” is exceeded. A liquid line solenoid is required for the pump down to function correctly.
- Up to 3 liquid line solenoids and up to 2 EXV valves are supported for each circuit.

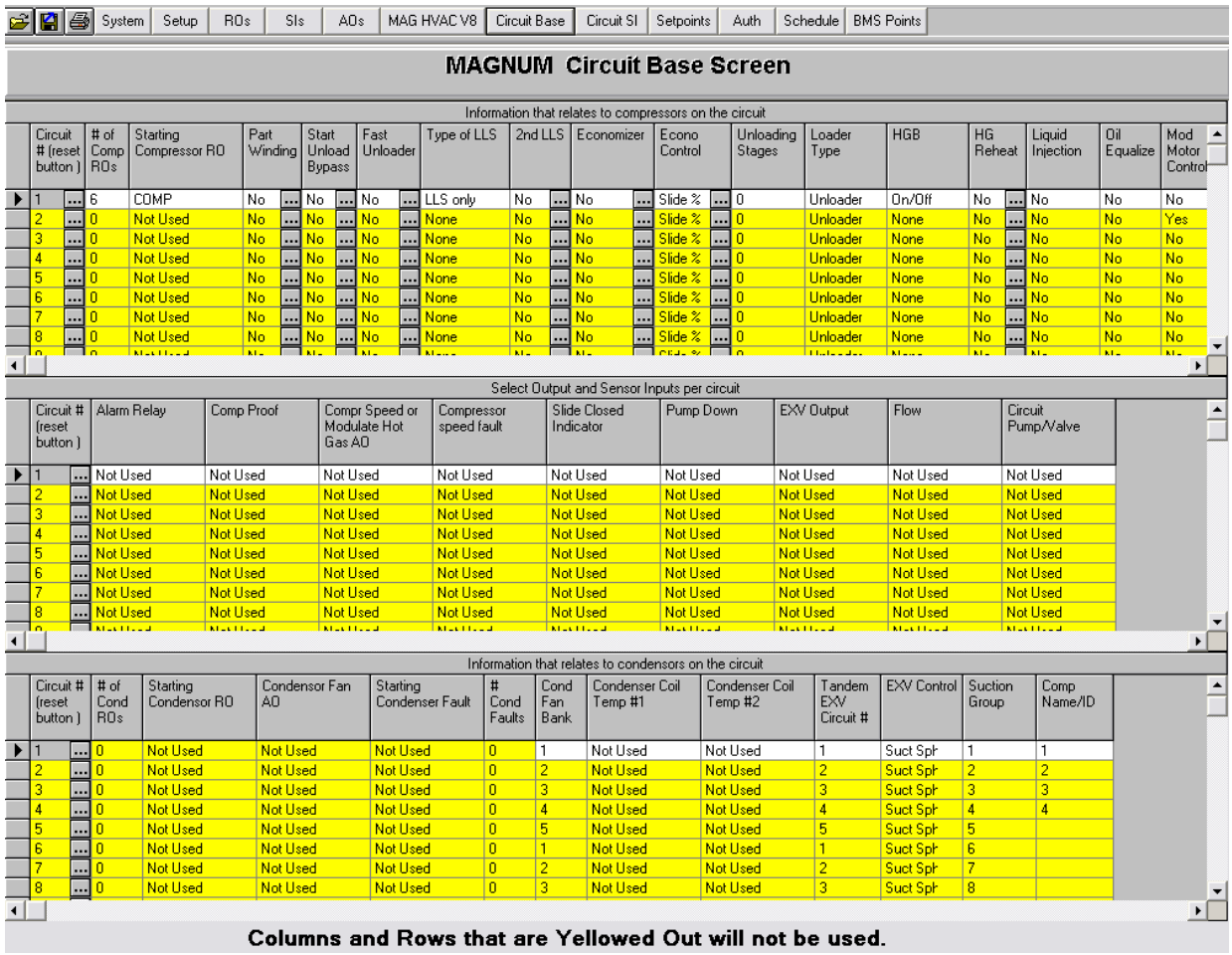
12.8.2 Compressor Information setup

In this screen under the MAGNUM screen, compressor type is selected from a drop down list. Additional information about the compressor and how it will be controlled is also provided in this section. Review all cells and input the proper information.



12.8.3 Circuit Base setup

Compressor information is provided per circuit in this section under the Circuit Base screen. Review all cells and input the proper information about the compressor.



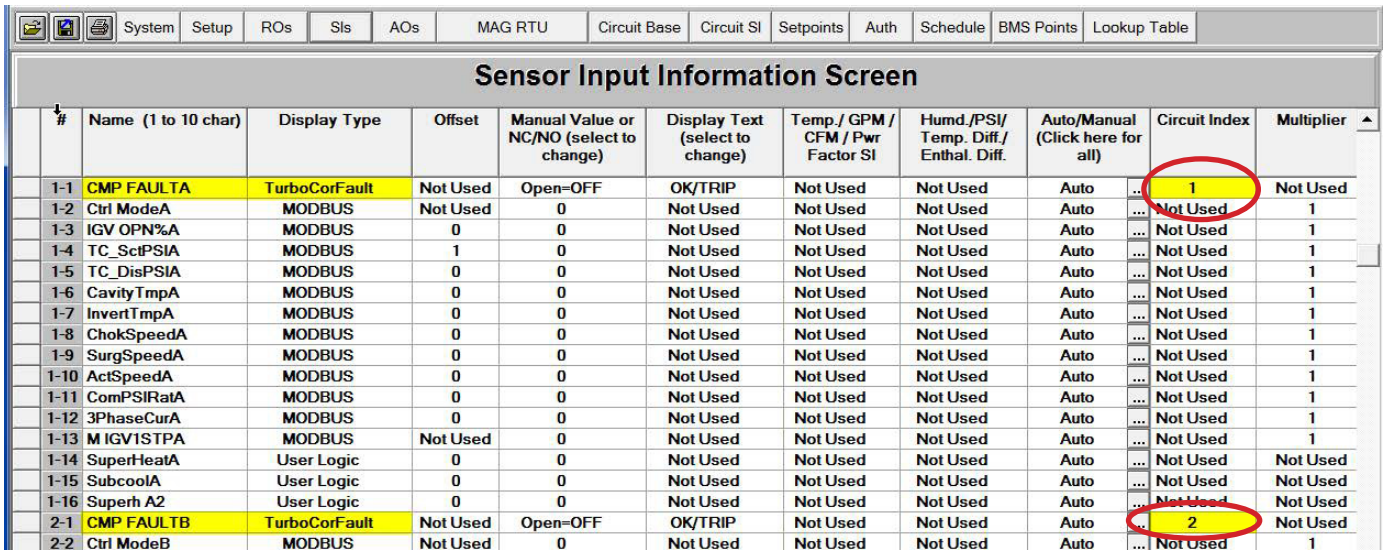
12.8.4 Modbus Fault Sensors

If using a MCS-MODBUS I/O to connect a slave to the MCS-MAGNUM for reading register alarms you need to setup the 'Sensor Input Information' **'CIRCUIT INDEX'** column to point to the circuit number the Modbus fault sensor belongs to.

The MCS-Magnum supports several special Modbus fault sensor types for reading multiple alarms from one Modbus register. The following are Modbus Fault sensor types:

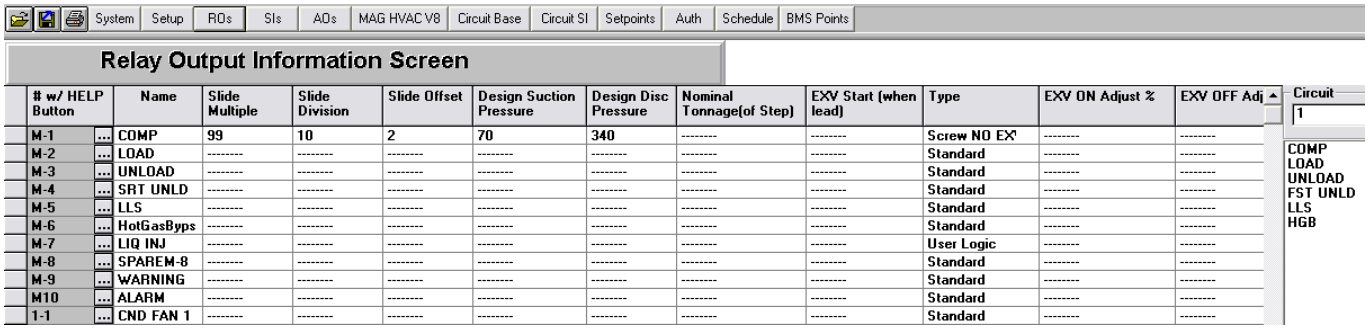
1. DBCENT1
2. DBCENT2
3. DBCENT3
4. DanFltHi
5. DanFltLo
6. DanFlt2Hi
7. DanFlt2Lo
8. DWarHi
9. DWarLo
10. DWar2Hi
11. DWar2Lo
12. BitFltHi
13. BitFltLo
14. RKNG F1
15. RKNG F2
16. RKNG F3
17. RKNG F4
18. TurboCorFault

See below example of a two comp turbocor config:



#	Name (1 to 10 char)	Display Type	Offset	Manual Value or NC/NO (select to change)	Display Text (select to change)	Temp./ GPM / CFM / Pwr Factor SI	Humd./PSI/ Temp. Diff./ Enthal. Diff.	Auto/Manual (Click here for all)	Circuit Index	Multiplier
1-1	CMP FAULTA	TurboCorFault	Not Used	Open=OFF	OK/TRIP	Not Used	Not Used	Auto	1	Not Used
1-2	Ctrl ModeA	MODBUS	Not Used	0	Not Used	Not Used	Not Used	Auto	Not Used	1
1-3	IGV OPN%A	MODBUS	0	0	Not Used	Not Used	Not Used	Auto	Not Used	1
1-4	TC_SctPSIA	MODBUS	1	0	Not Used	Not Used	Not Used	Auto	Not Used	1
1-5	TC_DisPSIA	MODBUS	0	0	Not Used	Not Used	Not Used	Auto	Not Used	1
1-6	CavityTmpA	MODBUS	0	0	Not Used	Not Used	Not Used	Auto	Not Used	1
1-7	InvertTmpA	MODBUS	0	0	Not Used	Not Used	Not Used	Auto	Not Used	1
1-8	ChokSpeedA	MODBUS	0	0	Not Used	Not Used	Not Used	Auto	Not Used	1
1-9	SurgSpeedA	MODBUS	0	0	Not Used	Not Used	Not Used	Auto	Not Used	1
1-10	ActSpeedA	MODBUS	0	0	Not Used	Not Used	Not Used	Auto	Not Used	1
1-11	ComPSIRatA	MODBUS	0	0	Not Used	Not Used	Not Used	Auto	Not Used	1
1-12	3PhaseCurA	MODBUS	0	0	Not Used	Not Used	Not Used	Auto	Not Used	1
1-13	M IGV1STPA	MODBUS	Not Used	0	Not Used	Not Used	Not Used	Auto	Not Used	1
1-14	SuperHeatA	User Logic	0	0	Not Used	Not Used	Not Used	Auto	Not Used	Not Used
1-15	SubcoolA	User Logic	0	0	Not Used	Not Used	Not Used	Auto	Not Used	Not Used
1-16	Superh A2	User Logic	0	0	Not Used	Not Used	Not Used	Auto	Not Used	Not Used
2-1	CMP FAULTB	TurboCorFault	Not Used	Open=OFF	OK/TRIP	Not Used	Not Used	Auto	2	Not Used
2-2	Ctrl ModeB	MODBUS	Not Used	0	Not Used	Not Used	Not Used	Auto	Not Used	1

12.9. Relay Output Information Screen setup



Relay Output Information Screen

System | Setup | ROs | SIs | AOs | MAG HVAC V8 | Circuit Base | Circuit SI | Setpoints | Auth | Schedule | BMS Points

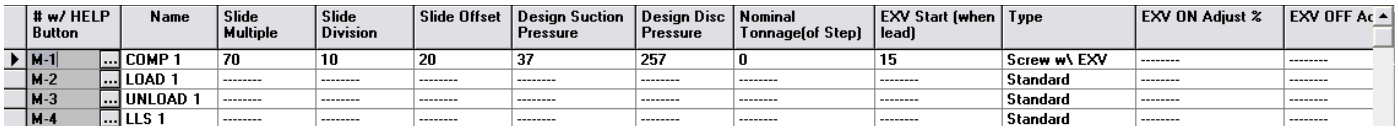
# w/ HELP Button	Name	Slide Multiple	Slide Division	Slide Offset	Design Suction Pressure	Design Disc Pressure	Nominal Tonnage(of Step)	EXV Start (when lead)	Type	EXV ON Adjust %	EXV OFF Adj
M-1	COMP	99	10	2	70	340	--------	--------	Screw NO EXV	--------	--------
M-2	LOAD	--------	--------	--------	--------	--------	--------	--------	Standard	--------	--------
M-3	UNLOAD	--------	--------	--------	--------	--------	--------	--------	Standard	--------	--------
M-4	SRT UNLD	--------	--------	--------	--------	--------	--------	--------	Standard	--------	--------
M-5	LLS	--------	--------	--------	--------	--------	--------	--------	Standard	--------	--------
M-6	HotGasByps	--------	--------	--------	--------	--------	--------	--------	Standard	--------	--------
M-7	LIQ INJ	--------	--------	--------	--------	--------	--------	--------	User Logic	--------	--------
M-8	SPAREM-8	--------	--------	--------	--------	--------	--------	--------	Standard	--------	--------
M-9	WARNING	--------	--------	--------	--------	--------	--------	--------	Standard	--------	--------
M10	ALARM	--------	--------	--------	--------	--------	--------	--------	Standard	--------	--------
1-1	CND FAN 1	--------	--------	--------	--------	--------	--------	--------	Standard	--------	--------

Circuit: 1

COMP
LOAD
UNLOAD
FST UNLD
LLS
HGB

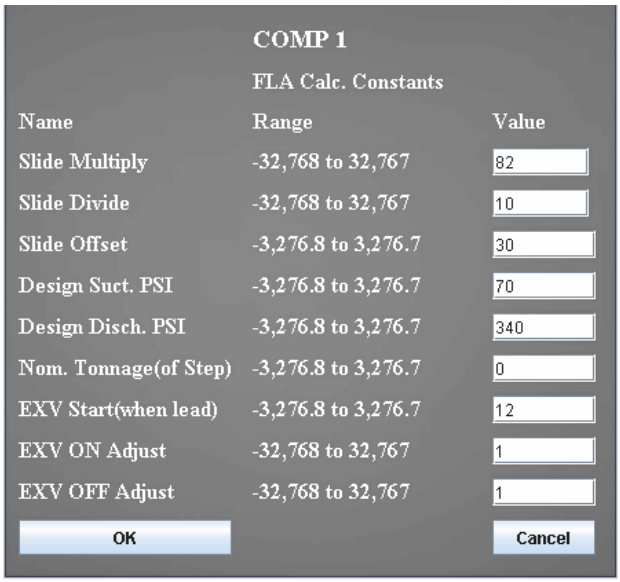
This screen relates to the above example. The compressor is a variable capacity compressor; therefore, the slide information must be provided, this is used in calculating the amp draw of the compressor. Note the 'Type' column, for COMP, the first compressor point, Screw NO EXV was selected from the drop down menu.

This screen is an example of a variable capacity, screw, and compressor with EXV valves. Note the Type column selection. The EXV data must be provided.



# w/ HELP Button	Name	Slide Multiple	Slide Division	Slide Offset	Design Suction Pressure	Design Disc Pressure	Nominal Tonnage(of Step)	EXV Start (when lead)	Type	EXV ON Adjust %	EXV OFF Ac
M-1	COMP 1	70	10	20	37	257	0	15	Screw w\ EXV	--------	--------
M-2	LOAD 1	--------	--------	--------	--------	--------	--------	--------	Standard	--------	--------
M-3	UNLOAD 1	--------	--------	--------	--------	--------	--------	--------	Standard	--------	--------
M-4	LLS 1	--------	--------	--------	--------	--------	--------	--------	Standard	--------	--------

This information can be viewed and changed, with proper authorization, from MCS Connect. By double clicking on the name field the following will be displayed.



COMP 1

FLA Calc. Constants

Name	Range	Value
Slide Multiply	-32,768 to 32,767	82
Slide Divide	-32,768 to 32,767	10
Slide Offset	-3,276.8 to 3,276.7	30
Design Suct. PSI	-3,276.8 to 3,276.7	70
Design Disch. PSI	-3,276.8 to 3,276.7	340
Nom. Tonnage(of Step)	-3,276.8 to 3,276.7	0
EXV Start(when lead)	-3,276.8 to 3,276.7	12
EXV ON Adjust	-32,768 to 32,767	1
EXV OFF Adjust	-32,768 to 32,767	1

OK | Cancel

12.10. Special Pattern for Scroll Compressors

Special patterns have been developed for Trane Scroll 3-D compressors. CENT 14.0 software and newer is required for this function. These patterns are for either a 3 or 4 scroll unit. They are specified by selecting either the Trane Trio or Trane Quad package in the Compressor Type selection under the MAGNUM screen. The sequencing will provide proper oil control for the Trane compressors.

The compressors set will be treated as one compressor. There will be one common suction pressure, suction temperature, discharge pressure, and discharge temperature sensor for the package. Each compressor will have an individual amperage sensor. These must be consecutive inputs.

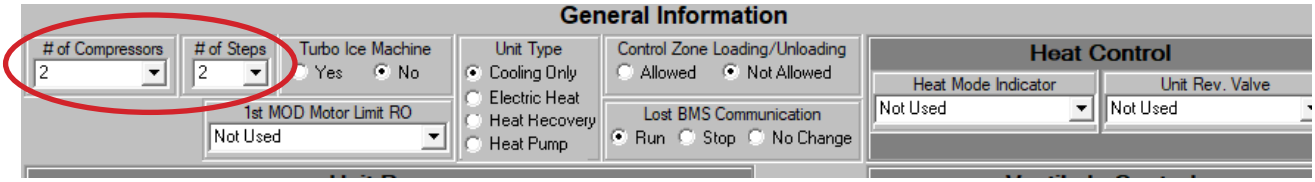
Chiller states have been allocated for these patterns: "SCROLL STEP 1" through "SCROLL STEP 4".

12.11. Start Multiple Compressors To Turn On Together

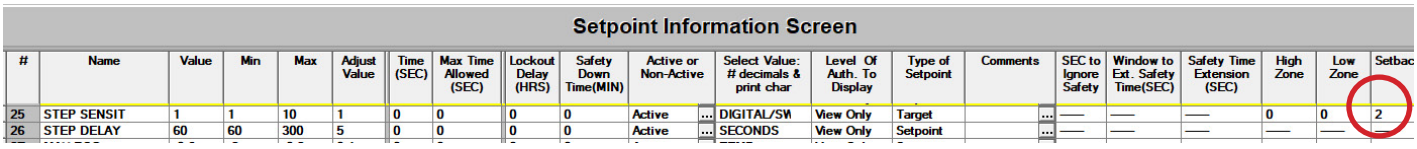
MAGSOFT HVAC V17.72F and higher needed.

In the Information Panel Selector screen, enter the number of Compressors and the number of steps needed in starting multiple HVAC compressors together.

- # of Compressors-Indicates number of compressors setup in information panel selector.
- # of Steps–Indicates number of steps associated with the # of compressors that are being turned on, 1 for each compressor.



You can enable/disable this option by changing the number in the Setback field of set point #25 (STEP SENSIT). Minimum value is 1 and the maximum value is the # of compressors in the information setup screen.

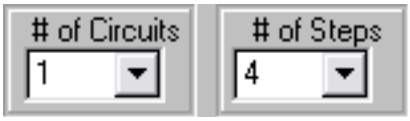


25	STEP SENSIT	If active the decrements to the time delay between making changes in the control algorithm is based upon the difference between the target and control values. If the difference is greater than 10 the delay will be reduced by 10. If less, the delay will be adjusted by the value of this set point. 1 is the fastest response, whereas higher numbers will mean a more gradual response. **Setback:** Minimum value is 1 and the maximum value is the # of compressors in the information setup screen.

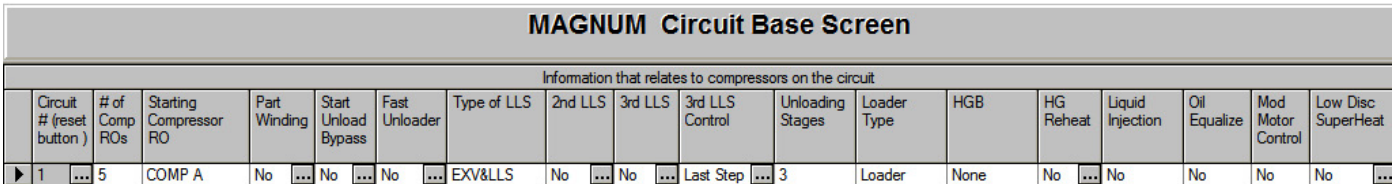
12.11.1 The following is a sample of the four-compressor setup:

Select compressor type:

# of Compressors and # of steps:



Set up compressor:



Set up Relay Outputs:

Relay Output Information Screen (Magnum)

# w/ HELP Button	Name	Slide Multiple	Slide Division	Slide Offset	Design Suction PSI	Design Disc PSI	Nominal Tonnage(of Step)	EXV Start (when lead)	EXV off Adj % Diff	Type
M-1	CND FAN	——	——	——	——	——	——	——	——	Standard
M-2	SYS PUMP	——	——	——	——	——	——	——	——	Standard
M-3	COMP A	——	——	——	——	——	15	12	——	Step w\ EXV
M-4	EEVENABL	——	——	——	——	——	——	——	——	Standard
M-5	COMP B	——	——	——	——	——	15	12	——	Step w\ EXV
M-6	COMP C	——	——	——	——	——	15	12	——	Step w\ EXV
M-7	SpareM-7	——	——	——	——	——	15	12	——	Step w\ EXV
M-8	SpareM-8	——	——	——	——	——	——	——	——	Standard
M-9	SpareM-9	——	——	——	——	——	——	——	——	Standard
M10	ALARM	——	——	——	——	——	——	——	——	Standard

12.11.2 Pattern of the four-compressor setup:

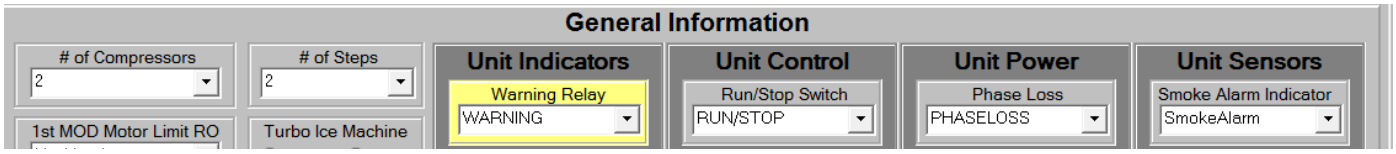
Staging sequence

Staging sequence				
	COMP A	COMP B	COMP C	COMP D
Stage 1	ON	OFF	OFF	OFF
Stage 2	OFF	OFF	ON	ON
Stage 3	OFF	ON	ON	ON
Stage 4	ON	ON	ON	ON

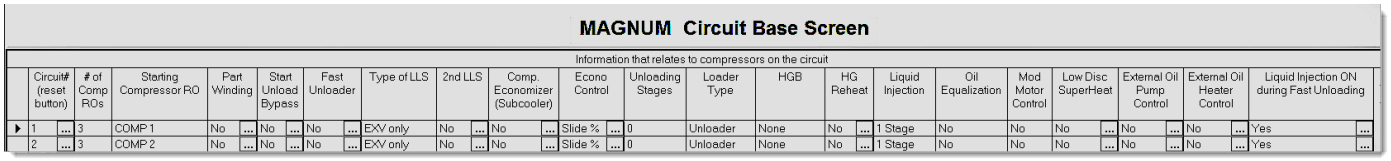
12.11.3 The three-compressor type will be setup as follows:

Select the compressor:

# of Compressors and # of steps:



Set up compressor:



Set up Relay Outputs:

Relay Output Information Screen (Magnum)

# w/ HELP Button	Name	Slide Multiple	Slide Division	Slide Offset	Design Suction PSI	Design Disc PSI	Nominal Tonnage(of Step)	EXV Start (when lead)	EXV off Adj % Diff	Type
M-1 ...	CND FAN	——	——	——	——	——	——	——	——	Standard
M-2 ...	SYS PUMP	——	——	——	——	——	——	——	——	Standard
M-3 ...	COMP A	——	——	——	——	——	15	12	——	Step w\ EXV
M-4 ...	EEVENABL	——	——	——	——	——	——	——	——	Standard
M-5 ...	COMP B	——	——	——	——	——	15	12	——	Step w\ EXV
M-6 ...	COMP C	——	——	——	——	——	15	12	——	Step w\ EXV
M-7 ...	SpareM-7	——	——	——	——	——	15	12	——	Step w\ EXV
M-8 ...	SpareM-8	——	——	——	——	——	——	——	——	Standard
M-9 ...	SpareM-9	——	——	——	——	——	——	——	——	Standard
M10 ...	ALARM	——	——	——	——	——	——	——	——	Standard

12.11.4 Pattern of the three-compressor setup:

Staging sequence			
	COMP A	COMP B	COMP C
Stage 1	OFF	OFF	ON
Stage 2	ON	ON	OFF
Stage 3	ON	ON	ON
Stage 4	ON	ON	ON

12.11.5 Safeties are the same for both compressor types

The standard unloading and holding logic has been incorporated with their compressor state names. When a step is unloaded it will go to the previous step pattern. For example if the compressor is in SCROLL STEP 3 and unloading is required the Relay Output for SCROLL STEP 2 will be used. The state name will reflect why the compressor has unloaded.

The unloading and holding can result from high discharge and low suction pressure and high discharge temperature.

Low and high amp drawn will be check for all compressors that are on. The standard amp safety checks will be made and if one occurs the compressor will be off on a safety or a lock out if the same safety reoccurs.

Note, the standard Setpoints are used for all safety checks, unloading, and holding functions.

12.12. Compressor Auto Rotation

The auto rotation option is selected by setting the value in set point #103, LEAD COMP to zero. If this value is not zero, it will contain the number of the lead circuit (compressor) and auto rotation is disabled. Note this setpoint can be manually changed to force a different compressor as the lead compressor or to enable auto rotation.

When this option is enabled, the system will rotate the compressors based upon the value in set point #104.

Setpoint Information Screen

#	Name	Value	Min	Max	Adjust Value	Time (SEC)	Max Time Allowed (SEC)	Lockout Delay (HRS)	Safety Down Time(MIN)	Active or Non-Active	Select Value: # decimals & print char	Level Of Auth. To Display	Type of Setpoint
103	LEAD COMP	0	0	2	1	1	1	0	0	Active ...	DIGITAL/SW	Superviso	Setpoint
104	CMP ROTATION	0	0	30	1	0	0	0	0	Active ...	DAYS	Superviso	Setpoint

CMP ROTATION.

If the value set point #104 is zero, rotation will occur with every complete capacity cycle and the next compressor will be selected as the lead compressor.

103	LEAD COMP	If type is Setpoint: Enables the user to specify the lead compressor. The value of this Setpoint will indicate the lead compressor. If zero, then auto rotation is enabled. 'Time (sec)' field: If non-zero, the compressor with the least amount of run time will become the lead upon rotation. If type is Target and the value is 0: Indicates that special rotation for dual barrel systems will be used. Refer to section on Custom Rotation.
104	COMP ROTATION	Specifies the number of days between rotations (Setpoint #103 must be set to zero to en- able auto rotation). If zero, then rotation will occur with every cycle.

If Setpoint # 104 is nonzero, the value is the number of days between rotations. At midnight the Magnum will check if it is time to rotate compressors. If yes, the Magnum will check the run hours on each compressor and select the one with the least amount of run hours to be the lead compressor.

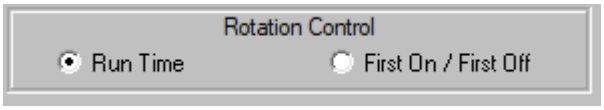
If Setpoint #104 is set up as an ALARM Setpoint type, a compressor rotation message will be generated each time a compressor is rotated.

Else, the value is the number of days between rotations. At midnight the system will check if it is time to rotate compressors. If yes, the system will check the run hours on each compressor and select the one with the least amount of run hours to be the lead compressor.

If set point #103 is set up as an ALARM type of set point, a compressor rotation message will be generated each time a compressor is rotated.

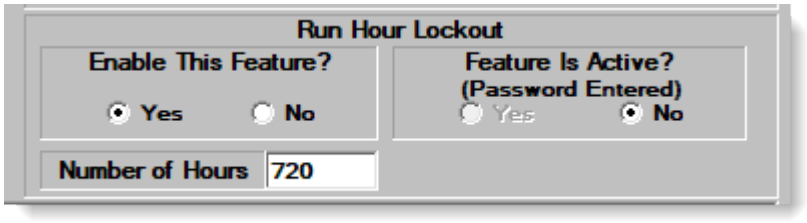
12.13. Expanded Compressor Rotation to Check for Maximum Run Time

In the Compressor Information panel of the Magnum HVAC screen in MCS-Config, there is a check box to select how compressors are to be rotated, based either on Run Time or First On/First Off.



12.14. Run Hour Lockout

In MCS CONFIG, in the Setup screen, select the option Run Hour Lockout Required. If enabled, then enter the number compressor run hours that must pass before the run hour lockout is triggered.



Run Hour Lockout- At midnight if any compressor has reached a set number of run hours, the unit will be disabled until an authorized service call is performed.

Function 2: (Compressor lockout based on run time hours)

If this option has been enabled, at midnight if any single compressor exceeds the number of run hours specified, the system will disable all compressors (circuits) and change the unit state to MAXIMUM RUN TIME. This test will only be made a midnight when new day logic is being executed. In

this state the Magnum will not enable normal operations and the only screen that will be available is the Passwords. If the Magnum is reset the chiller state will be MAXIMUM RUN TIME not UNIT IN POWER UP. Once the system state is MAXIMUM RUN TIME the system can be accessed from MCS-Connect but the system will not accept changes to the Relay Output states.

12.15. Custom Rotation

The requirement is to enable rotation only in the first barrel and do not turn ON any compressors associated with the second barrel until all compressors are ON in the first barrel. When decreasing refrigerant capacity, if any compressors in the second barrel are ON, they must first be turned OFF before turning OFF any compressors in the first barrel. Only first ON and first OFF lead rotation strategy can be used.

To activate this option Setpoint #103 “LEAD COMP” must be set up as follows:

Value:	0 (indicates auto rotation, must be 0)
Time (SEC):	0 (indicates first on first off, must be 0)
Select Value:	DIGITAL/SW
Type of Setpoint:	Target (must be Target type)
High Zone:	1 (this is the starting compressor following a reset; usually 1)
Low Zone:	1 (number to rotate, will default to 1)
Night Setback:	8 (number of compressors in the first barrel)

If the Value, Time, and Type cells are not set as indicated, normal rotation using Setpoints #103 “LEAD COMP” and #104 “COMP ROTATION” will be used.

The following examples have 16 compressors, dual barrels with 8 compressors in each. Barrel 1 has compressors 1 through 8 and 9 through 16 are in barrel 2. The wanted/actual ON will function as usual only the rotation and the sequence of turning on the compressors have been changed.

Example 1: Compressor 1 is the lead capacity calls for 4 circuits to be ON (wanted 4/ actual 4), then reduced to 0/0.

Compressors 1, 2, and 3, then 4 will be turned ON. As capacity is reduced, Compressor 1 will be turned OFF and the lead will be rotated to Compressor 2. Then Compressors 2, 3, and 4 will be turned OFF with the lead ending with Compressor 5.

Example 2: Compressor 5 is now the lead and capacity calls for 6 compressors to be ON (6/6) then reduce to 0/0.

Compressors 5, 6, 7, and 8, then 1 and 2 will be turned ON (6/6). As capacity is reduced, Compressors 5, 6, 7, and 8, then 1 and 2 will be turned OFF (0/0) and Compressor 3 will be the lead. Note, compressors in barrel 2 were not turned ON.

Example 3: Compressor 3 is now the lead and capacity calls for 12 compressors to be ON (12/12) then reduce to 0/0.

Compressors 3, 4, 5, 6, 7, and 8, then 1 and 2 will be turned ON (8/8). At this point all compressors in barrel 1 are ON, as more capacity is needed Compressors 9 through 16 will be used. Compressors 9, 10, 11, and 12 will be turned ON to reach 12/12. As capacity is reduced, Compressors 9 then 10, 11, and 12 will be turned OFF (8/8) at this point. Now, all compressors in barrel 2 are OFF and all compressors in barrel 1 can now be turned OFF if less capacity is needed. Compressor 3 followed by 4, 5, 6, 7, 8, and 1 then 2 will be turned OFF (0/0). At this point Compressor 3 is the lead compressor.

12.16. Compressor Anti-Cycle Logic

When a compressor is to be turned off, the Magnum software will make a calculation to determine the amount of time that the compressor will remain in an anti-cycle state. This calculation is based upon how long the compressor has been on and Setpoints #59 “ACYC OFF->ON” and #63 “ACYC ON->ON”.

If the value of Setpoint #63 minus the amount of time that the compressor has been on is greater than the value in Setpoint #59, the compressor will remain in the anti-cycle state for the period of time specified in Setpoint #63. Else the anti-cycle timer will be set to the value in Setpoint #59.

For example:

#59 (ANTI-CYC OFF) = 300 seconds

#63 (ANTI-CYC ON) = 600 seconds

If the compressor had been running for 3 minutes (180 seconds)

600 – 180 = 420 this is greater than Setpoint #59; therefore, the anti-cycle timer will be set to 600 seconds, the value of Setpoint #63.

If the compressor had been running for 12 minutes (720 seconds)

600 – 720 = -120 this is less than Setpoint #59; therefore, the anti-cycle timer will be set to 300 seconds, the value of Setpoint #59.

If the controller loses power, the length of time that the system was down will be taken into consideration when determining whether the compressor should be in an anti-cycle state and for how long.

12.17. Part Wind and Star Delta Starters

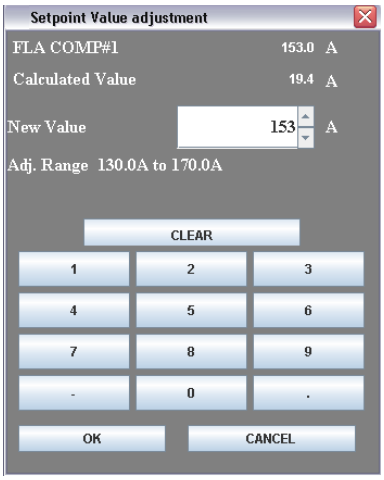
Both Part Winding and Star Delta starter types are supported by the Magnum software. This option is specified in the 'Part Winding' cell of the Circuit Base screen in MCS-Config and will require two successive Relay Output points. When this option is selected, make Setpoint #73 "STARTER DLAY" active. This Setpoint contains the delay in seconds or transition percentage before the second Relay Output is turned on. This delay is normally 1 second for part winding or 5 seconds for a star delta starter. If using the transition percentage option, after initial startup amp spike, the amps must fall below this percentage of the FLA for the second step to be turned on.

73	STARTER DLAY	This Setpoint controls the start of a compressor's second relay. If the 'Select Value: # decimals & print char' cell is set to 'HUMD or %' then logic is: If First Compressor Relay has been on longer than 2 seconds and the FLA% goes below the value of this setpoint or is still above the value but reaches the time value in the safety time field than turn on the second relay. (If the low zone field is zero use the hardcoded 2 seconds belay at start. If greater than zero use that valve). Setpoint Information Screen, if the **'Select Value: # decimals & print char'** cell is set to 'Seconds' then the Setpoints value is a time delay between the first and second relay's start. Used for part wind (typical value of 1) and star delta (typical value of 5) starter.

12.18. Full Load Amp (FLA) calculation and slide positioning

For variable capacity compressors the Magnum will calculate a FLA for each compressor and it will be stored in the FLA Setpoints (#171 to #190) for compressors 1 through 20 with every pass of the algorithm. The calculated FLA value will be displayed when viewing the respective compressor Setpoint through the Keypad/Display or MCS-Connect. The calculation is based upon the slide multiplier, divisor and offset values and then adjusted for the difference between the actual and design pressures for suction and discharge. This calculation is then used to determine the slide position by taking the actual amp draw divided the calculated FLA value. The load and unload solenoids will be used to match the compressor slide position with the wanted FLA.

If a FLA Setpoint is changed from MCS Connect both the original and calculated values are displayed in the following screen:



12.19. Chiller Barrel Heater

If a Chiller Barrel Heater is specified, it will be controlled based upon ambient temperature and Setpoint #134 "BARREL HEATER".

12.20. Hot Gas Bypass

Control of the Hot Gas Bypass function will depend on which Setpoints are made active/inactive. Refer to Setpoints #4-#7.

- Setpoints #4-#7 INACTIVE–If Setpoints #4-#7 are all inactive, then the HGB is enabled when the machine is unloaded to within 25% of the minimum slide percentage. The HGB is disabled when the machine rises above 30% of the minimum slide percentage. (These are just default values that can be overridden in the "Time(sec)" fields of Setpoints #4 and #5. The "Time(sec)" field of Setpoint #4 contains the minimum slide percentage offset to enable the HGB; the "Time(sec)" field of Setpoint #5 contains the minimum slide percentage offset to disable the HGB. For example, if Setpoint #4 "Time(sec)" field has a value of 10 and Setpoint #5's

is15, then the HGB will enable when the compressors FLA% is within 10% of Setpoint #31 “MIN FLA%” and will disable when FLA% goes above 15%.)

- Only Setpoints #4-#5 ACTIVE–The HGB is on when the machine is unloaded and the leaving liquid goes below the Cut In (Setpoint #4 “HGS TEMP ON”). HGB is turned off when the leaving liquid temperature goes above the Cut Out (Setpoint #5 “HGS TEMP OFF”) or the machine leaves the unloaded state.
- Only Setpoints #6-#7 ACTIVE- The HGB is on when the machine is unloaded and the suction pressure goes below the Cut In (Setpoint #6 “HGS PSI ON”). HGB is turned off when the suction pressure goes above the Cut Out (Setpoint #7 “HGS PSI OFF”) or the machine leaves the unloaded state.
- Setpoints #4-#7 ACTIVE–If both groups of Setpoints are active, then the HGB is on when the machine is unloaded and either the leaving liquid temperature or the suction pressure goes below the respective Cut In limit. The HGB goes off when the machine leaves the unloaded state or both the leaving liquid temperature and the suction pressure goes above the respective Cut Out limits.

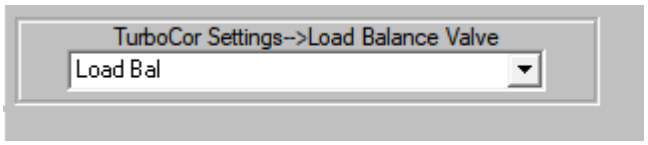
12.21. Chilled Water Reset

Chilled Water Reset (CWR) is a 0 to 5 volts dc Sensor Input (Display Type is TRGTRST) to the MCS micro-processor. The CWR follows the following rules using Setpoint #21 “MAX TRG RESET”:

1. If the input is 2.5 volts dc the CWR is zero.
2. At 0 vdc the CWR is a negative value equal to the Setpoint value.
3. At 5 vdc the CWR is a positive value equal to the value in the Setpoint.
4. For values in between 0 – 2.5 and 2.5 – 5.0 the CWR is a plus or minus value which is proportional to the Sensor Input voltage.

12.22. Turbocor Chillers - New Options:

12.22.1 Balancing Valve Control :



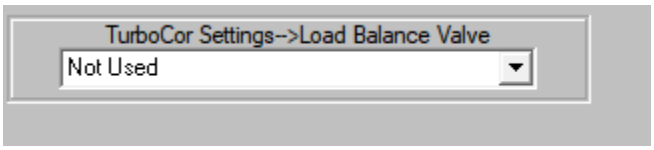
Staging Valve A0	Startup RPM
Not Used	Not Used
Not Used	Not Used
Not Used	Not Used
Not Used	Not Used

Startup (This is the same as existing logic)

i. Open valve to 100% when starting any compressor

ii. Keep valve open until the comp’s pressure ratio drops below STP value.

12.22.2 Stage valve control:



Staging Valve A0	Startup RPM
Stag BAL	StartRpm
Not Used	Not Used
Not Used	Not Used
Not Used	Not Used

Startup:

i. Open Stage valve to 100%

ii. Write StartSpeed(RPM)over Modbus register 42039

(Need Custom MCS-Modbus-IO CFG file) 2 AOs per CMP

	2-1	...	DEMAND%	Modbus	NO	... HUMD or %
	2-2	...	StartRpm	Modbus	NO	... RPM'S

If lead CMP use default starting speed from the cfg or Highest Actual speed from running compressors

Relay Output Information Screen

	EXV Load Adjust %	EXV Unld Adjust %	Comments	Starting Speed(RPM)
	——	——	...	10000

iii. Stay in the startup routine (Holding State) until the actual RPMs are greater than 0 and the Turbocor control state reads 0x0080 (RampingUp)

iv. Close Stage valve

Shutdown

i. Open Stage valve to 100%

ii. Keep valve open until actual RPMs are equal to 0

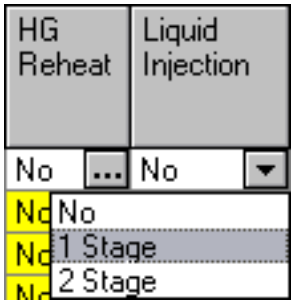
Chapter - 13. Oil Control Options

13.1. Oil Equalization Option

Oil equalization occurs with common suction/discharge systems. This feature allows for oil to equalize between compressors by opening a solenoid valve. The oil equalization occurs at compressor startup. Refer to section for Relay Output order and options. If this feature is specified in the Circuit Base screen, the micro will energize the Oil Equalization solenoid valve for 1 minute at compressor startup.

13.2. Liquid Injection Option

This option is specified in the Circuit Base screen:



1. Liquid Injection stage 1 logic built into the V17 MCS-Magnum : Comp has to be ON and
   - Stage 1 liquid injection is turned ON when:
     discharge temperature >= setpoint #8 value
     OR
     motor temperature > setpoint #216 value
     OR
     [Suction superheat > (setpoint #9 value x MULTIPLIER*) AND setpoint #8 is ACTIVE]
     *MULTIPLIER = setpoint #8 high zone value if setpoint #8 is Target Type, else use 3

   - Stage 1 liquid injection is turned OFF when:
     discharge temperature < [setpoint #8 value – setpoint #113 value]
     AND
     motor temperature < [setpoint #216 value – setpoint #216 safety time]
     AND
     [Suction superheat < (setpoint #9 value x MULTIPLIER*) OR setpoint #8 is INACTIVE]
     *MULTIPLIER = setpoint #8 low zone value if setpoint #8 is Target Type, else use 2

2. Liquid Injection stage 2 logic built into the V17 MCS-Magnum : Comp has to be ON and
   - Stage 2 liquid injection is turned ON when:
     (discharge temperature >= [setpoint #8 value + setpoint #191 value]
     OR
     motor temperature >= [setpoint #216 value + setpoint #191 value])
     AND
     Stage 1 Liquid Injection relay ON for more than X seconds, where X is define by setpoint #8 time value.

   - Stage 2 liquid injection is turned OFF when:
     discharge temperature < [setpoint #8 value – setpoint #113 value + setpoint #114 value]
     AND
     motor temperature < [setpoint #216 value – setpoint #216 safety time + setpoint #114 Value]

13.2.1 HARTFORD Compressor Liquid Injection Option

Applicable System:

- **V17.99.AC and Higher**
- **V19.01.B and Higher**

1. Liquid Injection Stage 1 logic

Comp must be ON when:

- Stage 1 liquid injection is turned ON when:

  Discharge temperature >=setpoint #8 value

  OR

  [Suction superheat > (setpoint #9 value x MULTIPLIER*) AND setpoint #8 is ACTIVE]

  *MULTIPLIER = setpoint #8 high zone value if setpoint # 8 is Target Type, else use 3

- Stage 1 liquid injection is turned OFF when:

  Discharge temperature < [setpoint #8 value -setpoint #113 value]

  AND

  [Suction superheat < (setpoint #9 value x MUTIPLIER*) OR setpoint #8 is INACTIVE]

  *MULTIPLIER = setpoint #8 low zone value if setpoint #8 is Target Type, else use 2

2. Liquid Injection stage logic

Comp has to be ON and

- Stage 2 liquid injection is turned ON when:

  *(discharge temperature >= setpoint #8 value + setpoint #191 value]

  OR

  Motor temperature >= [setpoint #216 value])

  AND

Stage 1 Liquid Injection relay ON for more than X seconds, where X is define by setpoint #8 time field.

- Stage 2 liquid injection is turned OFF when:

  discharge temperature < [setpoint #8 value – setpoint #113 value + setpoint #144 value]

  AND

  Motor temperature < [setpoint #216 value – setpoint #216 value safety time]

13.3. Oil Cooler Option

The oil cooler option can be enabled for compressors with oil. This feature requires an oil seal temperature sensor, a Relay Output to energize the oil cooler, and Setpoint #145 “OIL COOLER ON“ to be active. If the oil seal temperature is above Setpoint #145 for longer than the time specified, the oil cooler is energized until the temperature is 5° F below the Setpoint value. Refer to section for Relay Output order and options.

13.4. Oil Pump Control Option

The Magnum supports 3 different types of oil pump control. This option is selected in in the ‘Control of Oil Pump’ box in the ‘Compressor Information’ panel under the MAGNUM screen.

- **OIL PUMP ALWAYS ON** – The oil pump will start before the compressor to build up oil pressure and will always be on when the associated compressor is on. If the oil pressure drops below Setpoint #74 “OIL PUMP OFF”, then shut down the associated compressor and generate a LOW DIFFERENTIAL alarm. The oil pump will continue running after the compressor is turned off regardless of the reason, for the time specified in Setpoint #62 “PUMP DOWN DELAY”.
- **OIL PUMP CYCLES AS NEEDED** – After the compressor has been running for 2 minutes and when the differential pressure (discharge pressure minus suction pressure) is greater than Setpoint #74 “OIL PUMP OFF”, then the oil pump will be turned off. If the differential pressure drops 10 PSI below the value of Set-point #74, then the oil pump will be turned on again.

- **OIL PUMP LUBE ONLY** – After the compressor has been running for 2 minutes and when the differential pressure (discharge pressure minus the suction pressure) is greater than Setpoint #74 “OIL PUMP OFF”, then the oil pump will be turned off. If the differential pressure has not reached Setpoint #74 after 5 minutes, then shut down the associated compressor and generate a LOW DIFFERENTIAL alarm. If the differential pressure has been reached and the oil pump turned off, then if the differential pressure drops 5 psi below the value of Setpoint #74, shut down the associated compressor and generate a LOW DIFFERENTIAL alarm.

13.5. Oil Differential Calculation

For chillers with external oil pumps: Oil Differential = Oil Pressure–Discharge Pressure

For all others: Oil Differential = Oil Pressure–Suction Pressure

If an oil pressure sensor is not available, then discharge pressure can be used in place of it. This is set up in the Circuit SI screen of MCS-Config by selecting the discharge pressure sensor in the oil pressure sensor’s column.

13.6. On/Off Switches

The following digital inputs can affect the entire package or individual circuits:

- Flow switch – If OFF the system has no flow. The system will Lockout (if Setpoint #105 is active), or shut down (if Setpoint #105 is inactive).
- Pump down – If ON and the compressor is off, the compressor will not be allowed to start. If the compressor is on, the system moves to the Pump Down state to begin turning off the compressor(s) in normal steps.
- Run/Stop – If OFF the system will not run. If the system is running, the system turns all compressors off in normal steps (If a RUN/STOP and a Network RUN/STOP are both available they operate in series).
- Network Run/Stop – If OFF the system will not run. This input is provided by another system on the network. It functions in the same matter as the Run/Stop switch.
- Emergency Stop – If ON the system will be shut down immediately and will remain disabled until the switch is OFF.

13.7. MCS-Magnum Oil Recovery Logic Tandem Variable Speed & Fix Speed Scroll comps.

MCS-Magnum Firmware: HVAC 17.34B or greater is required

MCS-Connect version: 18.20.08 Beta or greater is required

MCS-Config version: 18.01G1 or greater is required

Config File Example: test only - 2 comp 1 circuit vs & fs_rev_01.cfg

13.7.1 Purpose:

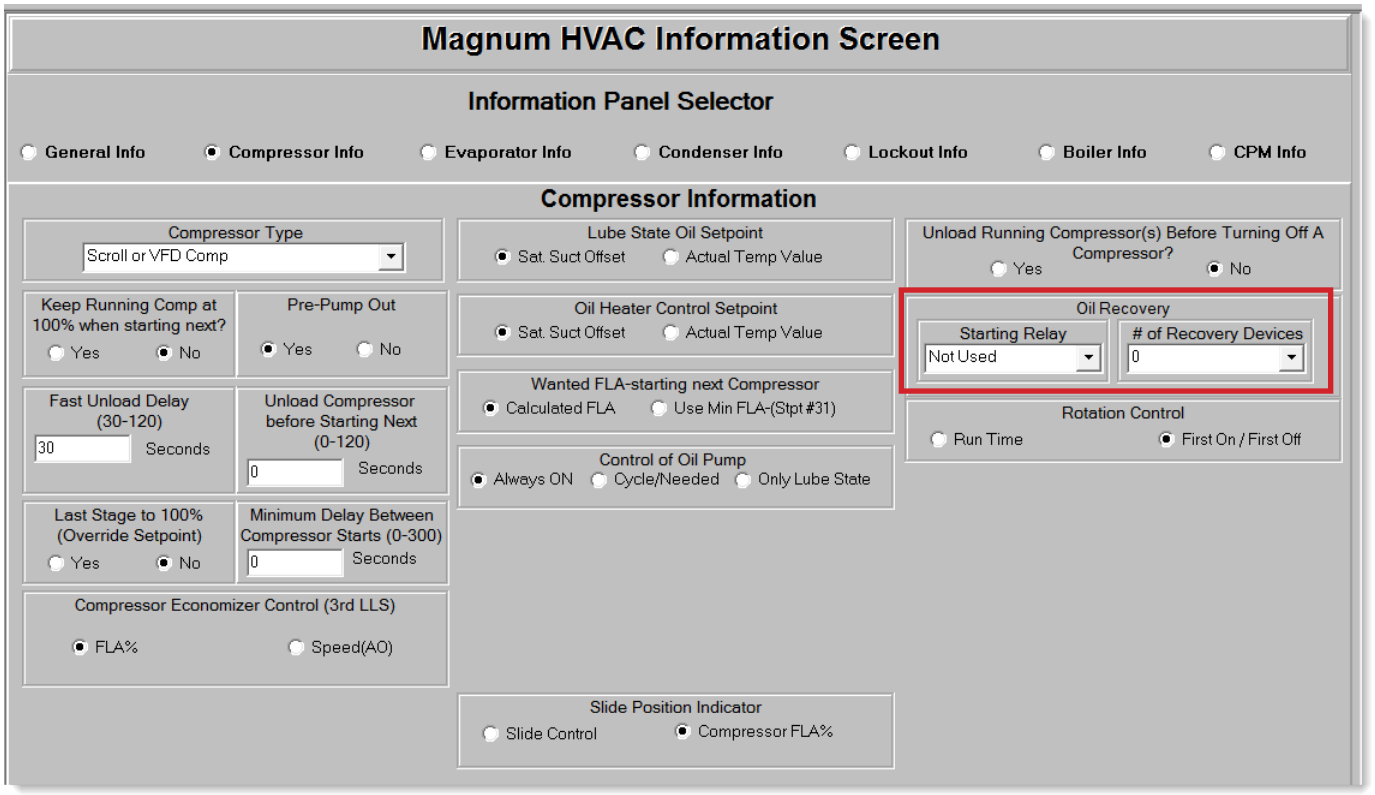
The purpose of the oil recovery logic is to return oil to the variable speed scroll compressor on a tandem refrigeration circuit where there is one variable speed compressor and one fix speed compressor. This logic only works for above compressor setup. No other compressor arrangement is supported, ie. screw compressors, reciprocating compressors, or more than 2 scroll compressors (trios, quads), etc.

If the variable speed compressor runs at low speed for a long period of time it possible the oil in the compressor sump will become too low. Too low of oil condition is indicated by the oil level switch in the variable speed compressor’s oil sump. When the variable speed compressor is running and the oil level switch indicates a low condition the MCS-Magnum will enter into the oil recovery logic to collect the oil back into the variable speed oil sump and avoid tripping the compressor on low oil level.

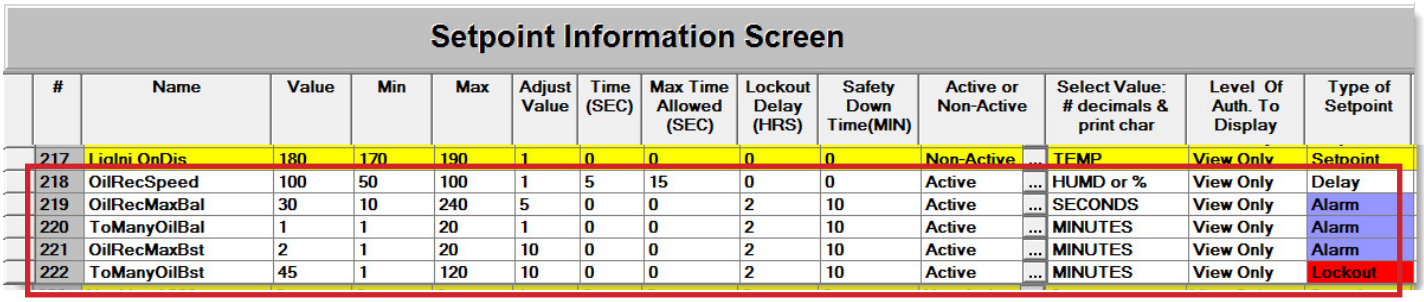
13.7.2 Requirements:

1. Tandem Scroll Compressors, one variable speed and the other fix speed.
2. Variable speed compressor must have an oil sump level switch.
3. MCS-Magnum Config must be setup as follows:

a. The special oil recovery logic must be disable – start relay field “Not USED” and # of recovery devices “0”.

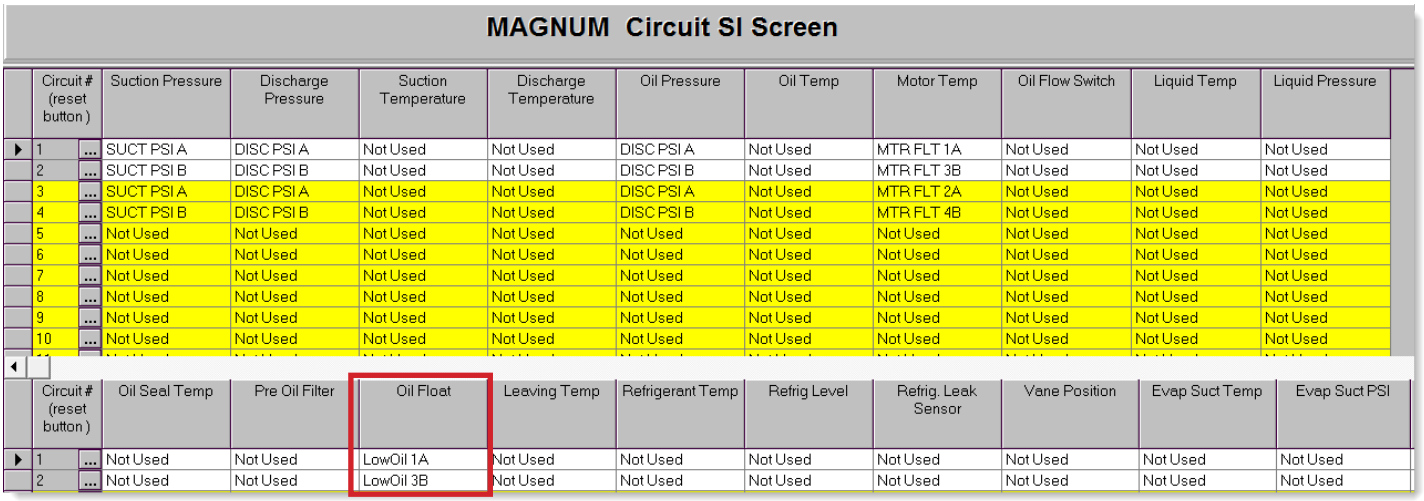


b. Setpoints #218 to #222 must be setup.



#	Name	Value	Min	Max	Adjust Value	Time (SEC)	Max Time Allowed (SEC)	Lockout Delay (HRS)	Safety Down Time(MIN)	Active or Non-Active	Select Value: # decimals & print char	Level Of Auth. To Display	Type of Setpoint
217	LiqInj OnDis	180	170	190	1	0	0	0	0	Non-Active	TEMP	View Only	Setpoint
218	OilRecSpeed	100	50	100	1	5	15	0	0	Active	HUMD or %	View Only	Delay
219	OilRecMaxBal	30	10	240	5	0	0	2	10	Active	SECONDS	View Only	Alarm
220	ToManyOilBal	1	1	20	1	0	0	2	10	Active	MINUTES	View Only	Alarm
221	OilRecMaxBst	2	1	20	10	0	0	2	10	Active	MINUTES	View Only	Alarm
222	ToManyOilBst	45	1	120	10	0	0	2	10	Active	MINUTES	View Only	Lockout

c. Variable Speed Compressor must be configured with Oil Level Switch sensor input.



Circuit # (reset button)	Suction Pressure	Discharge Pressure	Suction Temperature	Discharge Temperature	Oil Pressure	Oil Temp	Motor Temp	Oil Flow Switch	Liquid Temp	Liquid Pressure
1	SUCT PSI A	DISC PSI A	Not Used	Not Used	DISC PSI A	Not Used	MTR FLT 1A	Not Used	Not Used	Not Used
2	SUCT PSI B	DISC PSI B	Not Used	Not Used	DISC PSI B	Not Used	MTR FLT 3B	Not Used	Not Used	Not Used
3	SUCT PSI A	DISC PSI A	Not Used	Not Used	DISC PSI A	Not Used	MTR FLT 2A	Not Used	Not Used	Not Used
4	SUCT PSI B	DISC PSI B	Not Used	Not Used	DISC PSI B	Not Used	MTR FLT 4B	Not Used	Not Used	Not Used
5	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used
6	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used
7	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used
8	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used
9	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used
10	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used

Circuit # (reset button)	Oil Seal Temp	Pre Oil Filter	Oil Float	Leaving Temp	Refrigerant Temp	Refrig Level	Refrig. Leak Sensor	Vane Position	Evap Suct Temp	Evap Suct PSI
1	Not Used	Not Used	LowOil 1A	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used
2	Not Used	Not Used	LowOil 3B	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used

13.8. Primary/Secondary Tandem Scroll Option:

If Setpoint #218 TYPE field is setup as “DELAY”, then the Fix Speed compressor is only allowed to run if the variable speed compressor can run. If the speed compressor is locked out or disabled, the fix speed compressor will be force in the “VFD TANDEM OFF” state and not allowed to run. It is recommended to enable this option.

If setpoint #218 TYPE field is not a “DELAY” type, then the fixed speed compressor can run without the variable speed compressor.

13.8.1 Oil Recovery Logic:

The oil recovery logic has two modes, Balance and Boost.

13.8.2 Balance Mode:

In Balance mode the variable speed compressor speed is set to the value in setpoint #218 “OilRecSpeed” and the fix speed compressor stay off or is forced off. In this mode the variable speed compressor speed is increased to pull oil from the fixed speed compressor oil sump. The variable speed compressor state is set to “OIL REC SPD UP”. If the fixed compressor was running, it state is set to “OIL REC OFF”. If the fixed speed compressor is not running, it will stay in its current state.

The balance mode is entered when the oil level sensor input has tripped for X seconds. X is defined by the time field in setpoint #218. This indicate the level in the oil sump is low and we need to recovery the oil.

When entering the Balance mode, a check is performed to see if time since the last oil recovery action has been too short, indication an issue with the oil or system. If the time of Y (setpoint #222 value) since the boost mode occurred has not passed the compressors are locked out and the alarm “ToManyOilBst” (Too Many Oil Boost actions) is generated. If the time of X min (setpoint #220 value) since the last oil recovery balance mode occurred, the Balance mode is skip and logic goes right to the boost mode. If setpoint #220 is an alarm type, an alarm “ToManyOilBal” (Too Many Oil Balance Actions) is generated.

The balance mode is stopped when:

a. The oil level sensor input reads OK indicating oil has been recovery to the sump and level is good or,

b. Time delay specified in setpoint #219 “OilRecMaxBal” value field has been exceeded. If this condition occurs, the oil recovery logic goes to boost mode, or

c. Run/Stop or flow, etc. wants the unit off, or

d. Compressor safety trip occurs.

13.8.3 Boost Mode:

In Boost mode the variable speed compressor speed is set to the value in setpoint #218 “OilRecSpeed” and the fix speed compressor is forced on. In this mode both compressors are run to pull the oil back from the refrigeration circuit. Both compressor’s states are set to “OIL REC BOOST “.

The Boost mode is entered when the balance mode did not clear the low oil condition (balance mode max time delay excess before oil level sensor indicator good oil sump level).

The Boost Mode is stopped when:

a. The oil level sensor input reads OK indicating oil has been recovery to the sump and level is good or,

b. Time delay specified in setpoint #221 “OilRecMaxBst” value field has been exceeded. If this condition occurs, both compressors are locked out and an “OilRecMaxBst” alarm is generated, or

c. Run/Stop or flow, etc. wants the unit off, or

d. Compressor safety trip occurs.

13.9. Setpoint #139 Low Oil Level safety

With oil recovery logic active this setpoint will now be ignored IF a compressor with a VFD has an Oil level. The oil recovery logic will take over and control the compressor and lock it out if necessary.

If a compressor that is fixed speed (On/Off) with an oil level then setpoint #139 will be used to control the low oil level safety and ignore the oil recovery logic.

If all compressors in the config file are VFD compressors with oil levels and none of the fixed compressors have oil levels than please make setpoint #139 inactive as it serves no purpose.

13.9.1 Setpoint Descriptions Only

#218 – OilRecSpeed – HUMD or % - If setup as “Delay type” Fixed compressor cannot run without the vfd tandem. If not setup as a delay type the fixed compressor will be able to run without the vfd compressor being available.

Value – Speed in % to move the compressor to during an oil balance/boost

Time – Amount of time to wait in seconds after oil level is tripped before entering balance/boost

#219 – OilRecMaxBal – SECONDS - Alarm Type

Value – Max time allowed in seconds to stay in balance mode before moving onto Boost mode

#220 – ToManyOilBal – MINUTES – Alarm Type

Value – If an oil balance occurs twice within this time frame an alarm will be posted and the balance mode will be skipped and will be sent straight to a boost mode.

#221 – OilRecMaxBst – MINUTES – Alarm Type

Value – Max time allowed in minutes to stay in the boost mode before locking out that circuit on an alarm.

#222 – ToManyOilBst – MINUTES – Alarm Type

Value – If an oil boost occurs twice within this time frame an alarm will be posted and the circuit will be locked out.

13.10. Low Suction Unloading and Holding

This option is activated when Setpoint #78 “LO SUCT UNLD” is active. When suction pressure is below the calculated value of Setpoint #77 “LOW SUCTION“ plus Setpoint #78 “LO SUCT UNLD” for the time specified in the ‘Time (sec)’ field, the Magnum will turn on the WARNING Relay Output if specified in MCS-Config and take the following action:

- For fixed step compressors: The Magnum will turn off one step of capacity of the compressor(s) with low suction until all steps except one are unloaded. The circuit state will be LO SUCT HOLD. The compressor will remain in this state until the capacity control indicates that another step is to be unloaded or if the suction pressure has returned to normal after the time in Setpoint #101 “SAFETY HOLD DELAY” has passed.
- For variable step compressors: The Magnum will begin unloading the compressor(s) with low suction until the suction pressure rises above the calculated value. During this time the circuit state is LO SUCT UNLOAD. Once this pressure has been reached, the circuit state will be LO SUCT HOLD. The compressor will remain in this state until the capacity control indicates that another step is to be unloaded or if the suction pressure has returned to normal after the time in Setpoint #101 “SAFETY HOLD DELAY” has passed.

Normal suction pressure is defined as any value greater than Setpoint #77 “LOW SUCTION” plus Setpoint #79 “LO SUCT RELD”. Refer to Setpoints #78 and #79 for additional information.

13.11. High Discharge Pressure Unloading and Holding

This option is activated when the Setpoint #82 “HI DISC UNLD” is active. When the discharge pressure is above the calculated value of Setpoint #81 “HI DISC PSI” minus Setpoint #82 “HI DISC UNLD” for the time specified in the ‘Time (sec)’ field, the Magnum will turn on the WARNING Relay Output if specified in MCS-Config and take the following action:

- For fixed step compressors: The Magnum will turn off one step of capacity of the compressor(s) with high discharge until all steps except one are unloaded. The circuit state will be HI DISC HOLD. The compressor will remain in this state until the capacity control indicates that another step is to be unloaded or if the discharge pressure has returned to normal after the time in Setpoint #101 “SAFETY HOLD DELAY” has passed.
- For variable step compressors: The Magnum will begin unloading the compressor(s) with high discharge until the discharge pressure drops below the calculated value. During this time the circuit state is HI DISC

UNLOAD. Once this pressure has been reached, the circuit state will be HI DISC HOLD. The compressor will remain in this state until the capacity control indicates that another step is to be unloaded or if the discharge pressure has returned to normal after the time in Setpoint #101 “SAFETY HOLD DELAY” has passed.

Normal discharge pressure is defined as any value less than the calculated value of Setpoint #81 “HI DISC PSI” minus Setpoint #83 “HI DISC RELD” and greater than Setpoint #85 “LO DISC PSI”. Refer to Setpoints #82 and #83 for additional information.

13.12. High Discharge Temperature Unloading and Holding

This option is activated when the Setpoint #88 “DISC TMP UNLD” is active. When the discharge temperature is above the calculated value of Setpoint #87 “HI DISC TMP” minus Setpoint #88 “DISC TMP UNLD” for the time specified in the ‘Time (sec)’ field, the Magnum will turn on the WARNING Relay Output if specified in MCS-Config and take the following action:

- For fixed step compressors: The Magnum will turn off one step of capacity of the compressor(s) with high discharge temperature until all steps except one are unloaded. The circuit state will be HI DISC HOLD. The compressor will remain in this state until the capacity control indicates that another step is to be unloaded or if the discharge temperature has returned to normal after the time in Setpoint #101 “SAFETY HOLD DELAY” has passed.
- For variable step compressors: The Magnum will begin unloading the compressor(s) with high discharge temperature until the temperature drops below the calculated value. During this time the circuit state is HI DISC UNLOAD. Once this temperature has been reached, the circuit state will be HI DISC HOLD. The compressor will remain in that state until the capacity control indicates that less capacity is needed or if the discharge temperature has returned to normal after the time in Setpoint #101 “SAFETY HOLD DELAY” has passed.

Normal pressure is defined as any value less than the calculated value of Setpoint #87 “HI DISC TMP” minus Setpoint #89 “HI DISC RELD”. Refer to Setpoints #88 and #89 for additional information.

13.13. High Ampere Unloading and Holding

This option is activated when the Setpoint #75 “HI AMPS %” is active. Note: This option can only be active for fixed step compressors. When the amp draw is within one-half of the calculated HI AMP safety value, the Magnum will turn on the WARNING Relay Output if specified in MCS-Config and take the following action:

- For fixed step compressors: the Magnum will turn off one step of capacity associated with that compressor until that compressor is in an UNLOADED state that is all steps except one are unloaded. The circuit state will be HI AMP HOLD. The compressor will remain in that state until the capacity control indicates that another step is to be unloaded or if the amp draw has returned to normal after the time in Setpoint #101 “SAFETY HOLD DELAY” has passed.

13.14. Low Water Temperature Unloading and Holding

When the leaving liquid temperature is within 1.5° F (.8° C) of the freeze safety, the Magnum will turn on the WARNING Relay Output if specified in MCS-Config and take the following action:

- For fixed step compressors: The Magnum will turn off one step of capacity of the compressor(s) with low water temperature until all steps except one are unloaded. The circuit state will be LO TMP HOLD. The compressor will remain in that state until the capacity control indicates that another step is to be unloaded or if after 5 minutes the leaving liquid temperature has turned to normal.
- For variable step compressors: The Magnum will begin unloading the compressor(s) with low water temperature until the leaving liquid temperature rises above the calculated value. During this time the circuit state is LO TMP UNLOAD. Once the leaving liquid temperature rises above the calculated temperature the circuit state will change to LO TMP HOLD. The compressor will remain in that state until the capacity control indicates that less capacity is needed or if after 5 minutes the leaving liquid temperature has turned to normal.
- Turn Off All Running Compressors - Turn off all running compressors when the controlling sensor falls below setpoint #1 LOW ZONE column value. This feature is enabled if setpoint #1 TYPE column is set to “TARGET” type.

Normal leaving liquid temperature is defined as any value more than 3.0F (1.6C) above the freeze safety trip value.

13.15. Energy Efficient Compressor Staging

In a multi-screw system, it may be more efficient to run the screws at less than 100% capacity until all compressors have been turned on.

The following Setpoints are used to control the screw compressor staging:

- Setpoint #30 “MAX SLIDE %” contains the maximum slide percentage, based upon amp draw, before the system will bring on the next compressor.
- Setpoint #31 “MIN SLIDE %” contains the minimum slide percentage, based upon amp draw, before the system will reduce the number of compressors wanted on.

For example if “MAX SLIDE %” is 80% and the “MIN SLIDE %“ is 40%, the two-screw compressor system would be ramped up as follows:

The Lead compressor will be started at 40% and increased up to 80%. If more capacity is needed the next compressor will be started at 40% and the first compressor decreased to 40%. The two compressors will then have their slide positions changed together. Since there are only two compressors, they will be ramped together up to 100% if required. If both compressors are at 40% and less capacity is needed, one compressor will be turned off and the other increased to 80%.

If running compressors at 100% is not desired, then the “Last Stage to 100% (Override Setpoint)” cell in the Compressor Information panel of the MAGNUM screen should be set to ‘No’. Then the maximum capacity allowed will be the value in Setpoint #30. If ‘Yes’, then all compressors will load to the value in Setpoint #30 until all compressors are on, then they will load to 100% together.

13.16. Chilled Water Pump Control

The current Magnum software will support a chilled water pump plus a backup with rotation logic. These must be set up in MCS-Config. **Setpoint #105** and **Setpoint #106** are used with this control logic.

- If **Setpoint #105** “PUMP FAILURE” is **active**, flow is lost for the period of time contained in the ‘Time (sec)’ field, and only one pump is present, then the system will move to a LOCKED OUT state. If the system has two pumps and flow is lost, then the backup pump will start and the lead pump will be locked out. A Lockout Reset will be required to restart the system or to reactive a locked out pump.
- If **Setpoint #105** is **inactive** and the flow is lost, the system will move to the OFF- NO EVAP FLOW state. When flow is returned the system will automatically restart, no reset is required.

Setpoint #106 “LEAD PUMP” indicates whether the rotation option is active or which pump is the lead pump.

- If **Setpoint #106** is zero, then rotation of the pumps will occur whenever the lead pump is turned off. If no rotation has occurred during the current day, a forced rotation at midnight will occur. This forces at least one rotation per day.
- If **Setpoint #106** is non-zero, then rotation of the pumps is inactive and the value will specify the lead pump. This Setpoint can be changed in a live unit and the appropriate action will be taken.

13.16.1 Special Rotation for Chiller Pump Rotation

This feature is designed to rotate the chiller pumps at midnight with a minimum disruption to the flow.

- **Setpoint #238** must be active and contain the following information:
  Type: Delay Value: Not used Safety time: delay between states

- **Set point #106** must be active and contain the following information:

Type: Set point
Value: Number of days between rotation

At mid-night when rotation is required both chiller pumps will be on for the time in the safety time cell of set point #238. Once this time has elapsed, the current lead chiller pump will be turned off and the lead switched to the other chiller pump.

Prior to rotation the system will verify that the next chiller pump is available. That chiller pump's status must be AUTO and if a fault is specified it must be off or the rotation will not be made. Rotation is only checked a midnight. If the lead pump fails; normal rotation will occur to the next chiller pump.

13.16.2 Special Rotation For Process Pumps Rotation.

This feature is designed to rotate the process pumps at mid night with a minimum disruption to the flow.

Set point #239 must be active and contain the following information:

Select Value: HUMD or%
Type: Delay
Value: VFD setting of lead process pump during State 1
Safety time: delay between states 3o
MIN VFD Opening: setting of lead process pump during State 2 2.0
MAX VFD Opening: setting of next process pump during State 2 5:,

Set point #197 must be active and contain the following information:

Type: Set point
Value: Number of days between rotation 0

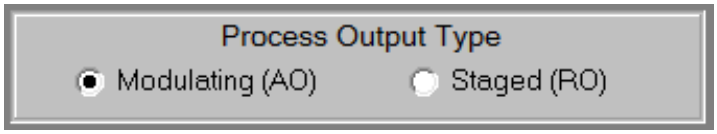
At mid-night when rotation is required the lead process pump's VFD will be set to Value of set point #239, this is state 1, the next process pump is off. The process pumps will be in state 1 for the time in the safety time cell of set point #239.

Once this time has elapsed, the current lead process pump's VFD will be set to the value in MIN VFD of set point #239 and the next process pump will be turned on and its VFD will be set to the value in MAX VFD of set point #239, this is state 2. The process pumps will be in state 2 for the time in the safety time cell of set point #239.
Once this time has elapsed, the current lead process pump's VFD will be set to 0 and the process pump turned off. The lead will be switched to the next process pump and normal process pump control will continue.

Prior to rotation the system will verify that the next process pump is available. That process pump's status must be AUTO and if a fault is specified it must be off or the rotation will not be made. Rotation is only checked a midnight. If the lead process pump fails; normal rotation will occur.

13.17. Process Pump (Heat Exchanger) Control

The Magnum software can support either variable or fixed stages of heat exchangers with up to two process pumps with rotation and control based upon pressure or temperature. This option is specified in the Evaporator Information panel in the MAG screen.



The pump information must be set up in the Evaporator Information Panel under the MAGNUM screen. The following information is required for each pump if used:

Pump Relay Output
Pump VFD Analog Output (if used)
VFD fault (if used)
Pressure Sensor Input (if used)
Pressure sensor output (if used)
Process temperature (if temperature control)

The following Setpoints are required:

#146 "PROC TARGET"
#147 "PROC ZONE"
#148 "PROC DELAY"

#149 “PROC MAX ROC”
#150 “Proc MinSpd%”
#197 “LEAD ProcPmp”
#198 “PROC PUMP FLT”
See Section on Setpoints for descriptions.

The process pump is on whenever the chilled water pump is on.

13.18. Control Power Relay (No Stop)

This feature provides the capability to interrupt the power supply to the system when a particular compressor continues to draw a specified amperage level when it is called to be OFF. A Relay Output, referred to as the control relay, must be wired so that no power reaches the compressors when it is switched OFF. The Relay Output must be selected in the ‘Control Relay’ cell of the General Information panel of MCS-Config and Setpoint #112 “NO STOP” must be active. The Magnum will continually monitor the amp draw of compressors that are called to be OFF. If the amp draw is greater than the FLA for that compressor multiplied by the percentage in Setpoint #112 “NO STOP” for the time specified in the ’Time (sec)’ field, then the control relay will turn OFF, a NO STOP alarm will be generated, and the system will be Locked Out.

13.19. Low and High Ambient Shutdown

The Magnum software supports both low and high ambient temperature shut downs. This option requires an ambient temperature sensor and one or both of Setpoints #24 “LOW AMB OFF” and #26 “HIGH AMB OFF”. The AMBIENT OFF state is entered when the ambient temperature falls below the Setpoint #24 or above Setpoint #26. The system will remain in this state until the ambient temperature rises 5.0F (2.5C) above Setpoint #24 value or drops 5.0F (2.5C) below Setpoint #25. When the chiller is in this state, the individual compressor states are changed to the CMP IS OFF state through the normal staging function.

13.20. Imperial, Metric, and Combined Unit sensor readings

The Magnum software supports Imperial, Metric, and Combined unit sensor readings. This setting is specified in the Setup screen of MCS-Config. All sensor values and all software-coded offsets are automatically converted to the option selected and displayed with the appropriate character. The following table contains the display character:

SENSOR READING	ENGLISH CHARACTER	METRIC CHARACTER	MIXED CHARACTER
Temperature	F	C	C
Pressure – Gage Reading	P	B	P
Pressure – Absolute Reading	p	b	p
Humidity	%	%	%
Digital or Switch			
Amp or CT	A	A	A
Voltage	V	V	V
Refrigeration Level	%	%	%

If the unit type is changed, MCS-Config will give you an option to automatically change the values of all items in the Setpoints to match the new type and will automatically adjust the display characters.

13.21. Warning and Alarm Relay Outputs

The Warning Relay Output will be turned on whenever the Magnum generates a warning message. These messages are:

- LOW REFR TEMP UNLOAD
- LOW SUCT PSI UNLOAD
- HIGH DISC TEMP UNLOAD
- LOW SUCT RELOAD
- LOW DISC RELOAD
- CICRUIT IS IN A SAFETY STATE

The system will continue to run since no safeties have tripped. The Warning Relay Output will also be turned on whenever a compressor is placed in a safety state.

The Alarm Relay Output will be turned on whenever the Magnum generates an alarm message. This indicates that a safety trip or Lockout has occurred.

13.22. Vi Port Control Logic (Open Drive Screw only)

The internal volume (Vi) of the open drive screw can be dynamically adjusted to achieve maximum efficiency modulating the Vi control solenoids. The duration of each solenoid pulse is contained in Setpoint #114 “Vi PULSE”.

The ratio of discharge pressure divided by suction pressure is calculated. This ratio is blocked between 50 and 22. The value of Setpoint #137 ”Vi DEADBAND” is added to and subtracted from this ratio to develop a control zone. The control zone will be recalculated based upon the time in Setpoint #138 ”Vi DELAY”. Refer to Setpoints #117, #118 and #119. The system will pulse the solenoids to keep the Vi reading within the calculated control zone.

13.23. Operating Schedules

Two operating schedules per each day of the week and 8 holidays are supported by the Magnum software. Each schedule contains a start and end time. If the time and day of the Magnum clock is within these limits then the schedule is true and the system will be allowed to run. If not, the system will be off due to schedule.

13.24. Mod-Motor Limit Control for Flooded Chiller

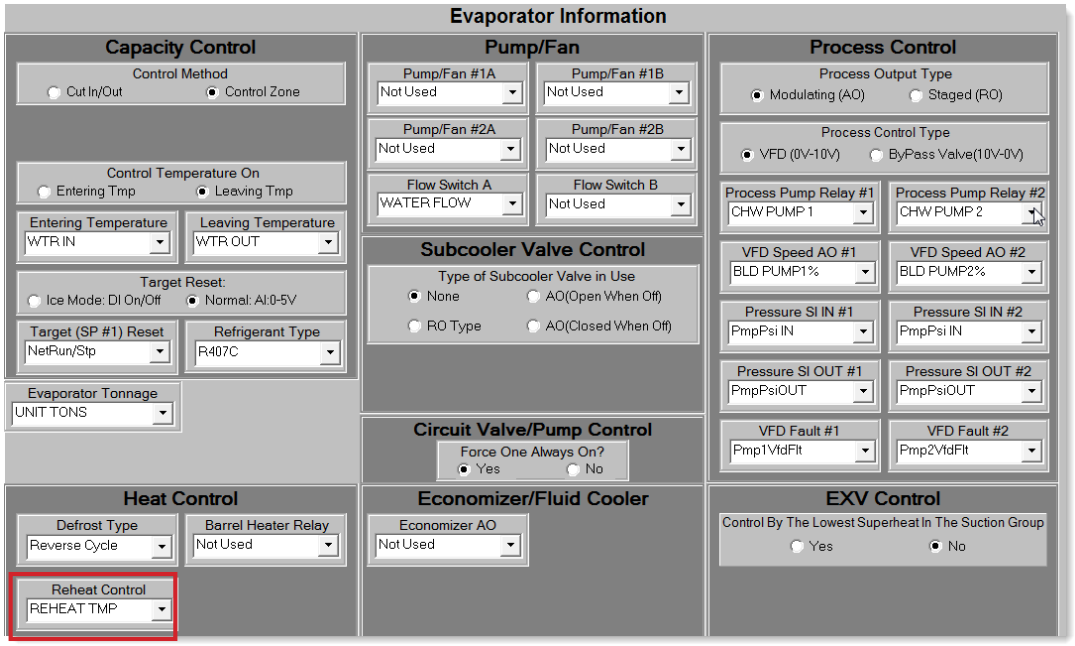
This option was added for Dunham-Bush flooded chillers. The Mod-Motor is a self-contained device that modulates a flooded chiller barrel level control valve based on a level sensor. The Magnum controls two Relay Outputs that change the limits on the movement of the Mod-Motor (The Relay Outputs change resistance to an input on the Mod-Motor). These Relay Outputs must be placed consecutively and specified in the General Information panel under the MAGNUM screen of MCS-Config.

- When one or less compressors are on, the first Mod-Motor Relay Output is turned on and the second Mod-Motor Relay Output is off.
- When 2 or more compressors are on, the first Mod-Motor Relay Output is turned off.
- The second Mod-Motor Relay Output will be turned on if the suction pressure is greater than 85.0 psi (5.8 bar) and the discharge suction pressure differential is less than 30.0 psi (2.0 bar), and the second Mod-Motor Relay Output will stay on as long as the suction pressure is greater than 80.0 psi (5.8 bar) and the discharge suction pressure differential is less than 35.0 psi (2.4 bar). If neither of the above is true, then the second Mod-Motor Relay Output will be turned off.

13.25. Hot Gas Reheat (Humidity) Control

The Hot Gas Reheat Control option is activated by selecting Yes in the ‘HGReheat’ cell in the Circuit Base Screen.

The hot gas control sensor is specified in the Evaporator Information panel of the MAGNUM screen. Select the input sensor that will be used to control the hot gas reheat function in the ‘Reheat Control’ cell.



When this option is selected the Reheat Relay Outputs must be setup as follows:

Relay Output Information Screen (Magnum V8)

# w/ HELP Button	Name	Slide Multiple	Slide Division	Slide Offset	Design Suctio Pressure
1-1	COMP	--------	--------	--------	--------
1-2	LOAD	--------	--------	--------	--------
1-3	UNLOAD	--------	--------	--------	--------
1-4	LLS	--------	--------	--------	--------
1-5	LIQ INJ	--------	--------	--------	--------
1-6	REHEAT	--------	--------	--------	--------
1-7	R-Hvalve	--------	--------	--------	--------
1-8	R-Hbleed	--------	--------	--------	--------

These Hot Gas Reheat relays are required and they must be placed in the proper sequence to work correctly.

The following Setpoints must be active: #129 “RH CUTIN”, #130 “RH CUTOUT ADJ”, #131 “RH START DLY”, #132 “RH BLEED DLY”, #133 “RH STAGE DLY”.(see Section full Setpoint descriptions).

Hot Gas Reheat sequence of operations:

(The names in the above example will be used to indicate the status of the relays: 1-6 REHEAT, 1-7 R-Hvalve, and 1-8 R-Hbleed)

Condition	1-6 REHEAT	1-7 R-Hvalve	1-8 R-Hbleed
The reheat state is OFF. The compressor is running and the RH TEMP is greater than Setpoint #129 plus #130.	ON	OFF	OFF
The reheat state is STARTING. The compressor is running and the RH TEMP is less than Setpoint #129. It will remain in this state until the time is greater than Setpoint #131, and then will move to the ON state.	ON	ON	ON
The reheat state is ON. The reheat will remain in this state until the reheat temperature is greater than Setpoint #129 plus #130. When the temperature is greater the state will be changed to BLEED.	OFF	ON	ON
The reheat state is BLEED. It will remain in this state until the time is greater than Setpoint #132, it will then move to the OFF state.	ON	OFF	ON

13.26. Extra Liquid Line Solenoid Control

2nd LLS	Economizer	Econo Control
Yes	Yes	Slide %
No	No	Slide %
No	No	Slide %

Second and third Liquid Line Solenoids (economizers) are supported and can be used for extra control. To specify, select the Circuit Base Screen:

The third solenoid (economizer) can be controlled either on the slide wanted percentage or as the last step on for that compressor (Refer to section 13 Setpoints #98 and #99). Liquid line solenoids 2 and 3 will be turned on and off as indicated in their Setpoints.

1. LLS#2 control logic built into V17 MCS-Magnum : Comp has to be ON and
   - LLS#2 Relay is turned ON when Comp FLA% >= Setpoint #98 value
   - LLS#2 Relay is turned OFF when Comp FLA% < Setpoint #98 value – Setpoint #98 Lockout Delay Value

2. Economizer/Subcooler/Vapor Injection(LLS #3 Option) logic built into V17 MCS-Magnum : Comp has to be ON and
   - LLS#3 Relay is turned ON when Comp FLA% >= Setpoint #99 value
   - LLS#3 Relay is turned OFF when Comp FLA% < Setpoint #99 value – Setpoint #99 Lockout Delay Value

13.27. Outside Air Economizer/Fluid Cooler with Analog

13.27.1 Output Control

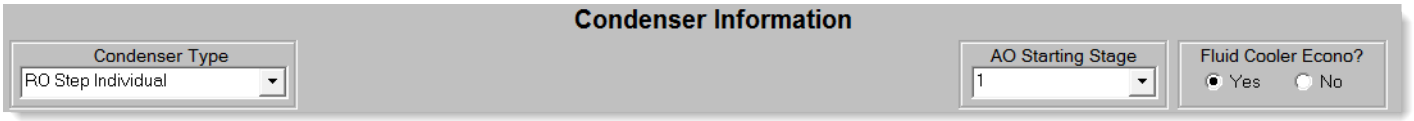
The purpose of an economizer/fluid cooler is to take advantage of any available free cooling so as to avoid the need of mechanical cooling. Several options can be specified in MCS-Config to accomplish this.

13.27.2 Economizer Set up

The analog valve that will be modulated is selected in the 'Economizer AO' cell in the Evaporator Information panel. In this example the name is 3 WAY VLV.

If the economizer/fluid cooler has separate fans (not associated with condensers) then answer yes in the 'Separate Economizer Fans?' cell. If Yes, then four additional cells will appear: 'Starting Economizer Fan' (select the first fan Relay Output), '# of Econ Fans' (specify the number of fan points), 'Starting Economizer Fault' (select the first fan fault, this is a Sensor Input), and '# of Econ Faults' (specify the number of faults)

In the above example there are two fans and two faults associated with the economizer/fluid cooler. If there is more than one fan they must be consecutive Relay Outputs. The same is true of the condenser faults.



The condenser fans can also be used to assist in the free cooling function when the system is not using mechanical cooling. To set this up in the condenser information grid, select "Fluid Cooler Econo" equals "Yes", else "No" if condenser fans are not used. All types of condensers can be used. The above example has individual fans per compressor. Whenever a compressor is running the control of its condenser fans will be based solely on the discharge pressure of that compressor, while the condenser fans of compressors that are not running will be controlled by the economizer function. If the type of condenser is common; if any compressor is on all of the fans will be controlled by the highest discharge pressure and not by the economizer function.

The following Setpoints must be set up: #107 "EcoDelayMech", #115 "EcoVFDfanDely", #119 "EcoOffsetON", #120 "Eco Stg Dely", #121 "Eco MIN VLV%", #122 "Eco MAX VLV%", #123 "Eco MAX ADJ", #124 "EcoVlvAdjDly", #125 "Eco StageDly", #126 "Eco MULTI", and #127 "Eco DIVIDE"

(Refer to Chapter 26 for Setpoint descriptions)

13.27.3 Sequence of Operation

The Economizer logic will be enabled whenever the ambient temperature meets the requirement as stated in Setpoint #119 "EcoOffsetON" (Ambient Temperature < Target Temperature–Setpoint #119). For example if the target is 45.0F and Setpoint #119 is 10.0F, then the ambient temperature must be less than 35.0F to enable the economizer function to begin.

If mechanical cooling has not been enabled (no steps are Wanted On or Actual On), when the economizer starts the Unit State will be ECONOMIZER ONLY. In this state mechanical cooling will not be started until the economizer function has reached its maximum capacity (Economizer valve is at maximum opening, all available fans are turned on, and the control temperature is still not in the target zone).

When the economizer logic starts, the Magnum will modulate the Analog Output to the economizer valve to maintain the control sensor reading within the target zone. The valve will be modulated between Setpoint #121"Eco MIN VLV%" and Setpoint #122 "Eco MAX VLV%" and will wait the time contained in Setpoint #124 "EcoVlvAdjDly" before making each adjustment to the valve opening.

- If control temperature is above the control target, Setpoints #1, and the control temperature rate of change is greater than the value of Setpoint #27 "MAX ROC-":

This indicates that the control temperature is too high and it is not approaching the target fast enough, therefore the valve opening must be increased if possible. The adjustment value will be the difference between the target (Setpoint #1) and the control sensor temperature multiplied by Setpoint #126 "Eco MULTI" and divided

by Setpoint #127 “Eco DIVIDE”. If the absolute adjustment is greater than the value of Setpoint #123 “Eco MAX ADJ”, then it will be limited to this value. The economizer valve opening will be increase by this value.

- If control temperature is below the economizer control zone (Setpoint #1–Setpoint #3) and the control temperature rate of change is less than the value of Setpoint #28 “MAX ROC+”:

  This indicates that the control temperature is too low and it is not approaching the target fast enough, therefore the valve opening must be decreased if possible. The adjustment value will be the difference between thetarget (Setpoint #1) and the control sensor temperature multiplied by Setpoint #126 “Eco MULTI” and divided by Setpoint #127 “Eco DIVIDE”. If the absolute adjustment is greater than the value of Setpoint #123 “Eco MAX ADJ”, then it will be limited to this value. The economizer valve opening will be decrease by this value.

- If control temperature is above the bottom of control zone (Setpoint #1–Setpoint #3) but less than the control target (Setpoint #1) no change to the economizer valve opening will be made.

Once the valve has reached its maximum opening (Setpoint #122), the Magnum will wait the time specified in Setpoint #125 “Eco StageDly” before checking if there are any fans associated with the economizer function. If there are the Magnum will stage the fans to maintain the control temperature with in the target zone. If a fan VFD is present, then this will be modulated in the same manner. The delay between VFD adjustments will be the value in Setpoint #115 “EcoVFDfanDely” if active, else Setpoint #124 will be used. Once all fans associated with the economizer function are on, the Magnum will check if any condenser fans can also be used. If yes, then these fans will then be staged to maintain the control temperature.

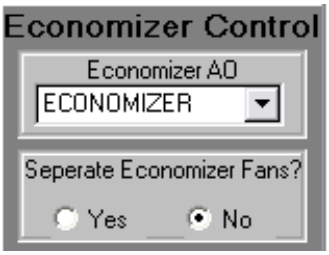
Once all the fans and/or VFD have been turned on and the control temperature is still greater than the control zone for the time specified in Setpoint #107 “EcoDelayMech” if active (else the time in Setpoint #125 “Eco StageDly” will be used) then mechanical cooling will be enabled.

- If the ambient temperature rises above the offset in Setpoint #119 during economizer cooling mode, then the economizer function will be terminated, its valve opening will be set to zero, and mechanical cooling will be enabled.
- If the control temperature is less than the target temperature (Setpoint #1) minus the 3 times value of Setpoint #3, then the economizer function will be terminated, its valve opening will be set to zero, and all fans will be turned off.
- If during mechanical cooling mode the ambient temperature drops below the offset in Setpoint #119, then the economizer function will begin. Note: the Unit State will not change, the economizer valve will be modulated as described above, fans directly associated with the economizer will be used, and no fans associated with the condensers will used.
- The control rate of change is always checked before an adjustment to the valve is made. The purpose is to not change the valve opening if the temperature is moving toward the target at an acceptable rate.

13.27.4 Outside Air Supply Economizer

If the purpose of the economizer is to provide outside air, then there will be no fans associated with the economizer and no condenser fans will be used. In this setup the economizer valve opening will never be less than the value of Setpoint #121 ”Eco MIN VLV%”. This is required to supply the minimum of outside air.

13.27.5 Mechanical Cooling Enabled

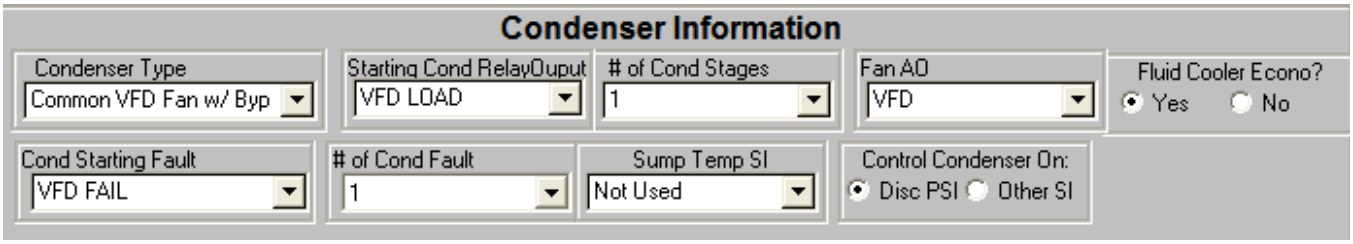


Once mechanical cooling has been enabled, the economizer will control only the individual compressor condenser fans of compressors that have not been started. The discharge pressure will control all others.

The percentage of the economizer valve opening will not be decreased. It will remain at its maximum setting until all stages of mechanical cooling are off.

13.27.6 Example: Fluid Cooler with VFD condenser fan

The economizer AO has been selected and there are no separate economizer fans.



The condenser type is common with VFD control and the Fluid Cooler Economizer option has been enabled. The VFD of the condenser fan will be controlled by the economizer function unless any compressor is running. If a compressor is running the VFD control will be based upon the highest discharge pressure.

Assume the following setup:

Setpoint #	Name	Value
1	SPPLY TRGT	44.0F
2	CTRL ZONE+	2.0F
3	CTRL ZONE-	1.0F
27	MAX ROC-	-.6F
28	MAX ROC+	.6F
54	CND MIN OPEN	20.0%
55	CND MAX OPEN	100.0%
107	ECON-MECHdly	240s
115	EconVFDdelay	45s
119	EcoOffsetON	10.0F
120	EconDelyFans	60s
121	EcoVlvMinVlv	0.0%
122	EcoVlvMaxVlv	100.0%
123	EcoVlvMaxAdj	5.0%

Conditions when the run/stop was set to RUN

Ambient temperature 30.0F

Control temperature 48.5F

The ambient temperature is less than 44.0 (Setpoint #1) – 10.0 (Setpoint #119) and no mechanical cooling steps are on; therefore, the Unit state will be ECONOMIZER ONLY and the economizer function will be enabled.

The AO M-1 “3 WAY VLV” will be opened to its minimum valve of 0% (Setpoint #121) and it will be modulated based upon the control temperature and the target (Setpoint #1). The first adjustment will be 48.5 – 44.0 = 4.5. This value will be adjusted by multiplier of 3 (Setpoint #126) and divided by 2 (Setpoint #127) to give an adjusted value of 6.7. This value is blocked; maximum allowed adjustment, by Setpoint #123 to allow an adjustment of 5.0%. The economizer valve opening will be increased by this amount if the temperature control rate of change is greater than the value of Setpoint #27.

The economizer function will wait 30 seconds (Setpoint #124) before determining the next adjustment. If the control temperature is now 47.3F; the following adjustment will be calculated.

47.3 – 44.0 = 3.3 x 3 / 2 = 4.9. Since this is less than 5.0 the valve will be open an additional 4.9% if the temperature control rate of change is greater than the value of Setpoint #27.

Each adjustment will be made after a delay of 30 seconds. If the control temperature is below the control target (Setpoint #1) and above the bottom the control zone (43.0F to 44.0F) there will be no change to valve opening.

If the control temperature drops below the control zone the valve opening will be reduced. For example if the control temperature is 42.6F then the following calculation will be made:

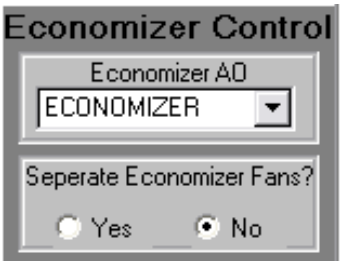
42.6 – 44.0 = 1.4 x 3 / 2 = 2.1. Since this is less than 5.0 the valve opening will be reduced an additional 2.1%.

When the valve reaches its maximum opening of 100.0% (Setpoint #122) the economizer function will use other fans if they are available. In this example there are no fans that are associated only with economizer but the VFD fan can now be used. At time delay of 120 seconds (Setpoint #125) be for the VFD will be modulated. Following this initial delay the VFD will be opened to its minimum opening, Setpoint #54 of 20%.

At this point the unit state is ECONOMIZER ONLY, economizer valve is at 100% and VFD will be modulated between its minimum (Setpoint #54) and it maximum (Setpoint #55). The delay between these adjustments will be 45 seconds (Setpoint #115).

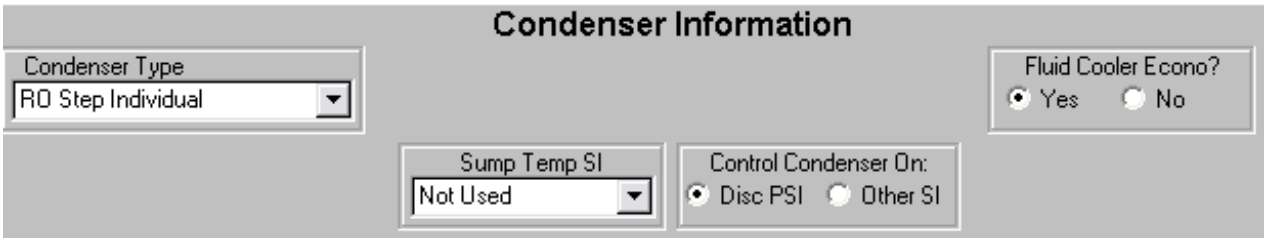
Once the VFD opening is equal to its maximum (Setpoint #55) there will be a delay of 240 seconds (Setpoint #107). At this time the unit state will be changed and mechanical cooling will be enabled.

13.27.7 Example: Fluid Cooler with condenser compressor fans



The economizer AO has been selected and there are no separate economizer fans.

The condenser type is RO Step Individual and the Fluid Cooler Economizer option has been enabled. The individual compressor condenser fans will be controlled by the economizer function unless a compressor is running. If a compressor is running, then the condenser fans associated with that compressor will be controlled based upon the discharge pressure of the compressor that is running.



Assume the following setup:

Setpoint #	Name	Value
1	SPPY TRGT	44.0F
2	CTRL ZONE+	2.0F
3	CTRL ZONE-	1.0F
27	MAX ROC-	-.6F
28	MAX ROC+	.6F
107	ECON-MECHdly	240s
115	EconVFDdelay	45s
119	EcoOffsetON	10.0F
120	EconDelyFans	60s
121	EcoVlvMinVlv	10.0%
122	EcoVlvMaxVlv	100.0%
123	EcoVlvMaxAdj	10.0%
124	EcoVlvDelay	30s
125	EcoVlvMaxDly	120s
126	EcoVlv Mul	2
127	EcoVlv Div	1

Analog output	Name
AO M-1	3 WAY VLV
AO M-2	VFD

Conditions when the run/stop was set to RUN

Ambient temperature 30.0F

Control temperature 49.7

The ambient temperature is less than 44.0 (Setpoint #1) – 10.0 (Setpoint #119) and no mechanical cooling steps are on, therefore the Unit state will be ECONOMIZER ONLY and the economizer function will be enabled.

The AO M-1 “ECONOMIZER” will be opened to its minimum valve of 10% (Setpoint #121) and it will be modulated based upon the control temperature and the target (Setpoint #1). The first adjustment will be 49.7 – 44.0 = 5.7. This value will be adjusted by multiplier of 2 (Setpoint #126) and divided by 1 (Setpoint #127) to give an adjusted value of 11.4. This value is blocked by the maximum allowed adjustment (Setpoint #123) to 10.0%. The economizer valve opening will be increased by this amount if the temperature control rate of change is greater than the value of Setpoint #27. With Setpoint #126 equal to 2 and #127 equal to 1, the valve will be adjusted by 2% for every degree difference from the target.

The economizer function will wait 30 seconds (Setpoint #124) before calculating the next adjustment. If the control temperature is now 47.3F the following adjustment will be made.

47.3 – 44.0 = 3.3 x 2 / 1 = 6.6. Since this is less than 10.0 the valve will be open an additional 6.6% if the temperature control rate of change is greater than the value of Setpoint #27.

Each adjustment will be made after a delay of 30 seconds. If the control temperature is below the control target (Setpoint #1) and above the bottom the control zone (43.0F to 44.0F) there will be no change to valve opening.

If the control temperature drops below the control zone the valve opening will be reduced. For example if the control temperature is 42.6F then the following calculation will be made:

42.6 – 44.0 = 1.4 x 2 / 1 = 2.8. Since this is less than 10.0 the valve opening will be reduced an additional 2.8%.

When the valve reaches its maximum opening of 100.0% (Setpoint #122) the economizer function will use other fans if they are available. In this example there are no fans that are associated only with economizer but the condenser fans can now be used. After the time delay of 120 seconds (Setpoint #125) the first condenser fan will be turned on (the first fan of the first compressor unless unavailable).

At this point the unit state is ECONOMIZER ONLY, the economizer valve is at 100%, and the compressor fans will be used to aid in the economizer cooling. The delay between starting the condenser fans will be 30 seconds (Setpoint #124). If all condenser fans are available and not manually turned off, the pattern of starting fans will be the first fan on compressor 1, after the delay then the first fan of compressor 2, after the delay then the second fan on compressor 1. This will continue until all available condenser fans have been turned on.

Once all of the condenser fans have been turned on there will be a delay of 240 seconds (Setpoint #107). At this time the Unit State will be changed and mechanical cooling will be enabled. When a compressor is running, its associated condenser fans will be controlled by the discharge pressure of the running compressors.

13.28. High Suction Superheat Safety

To add a high suction superheat safety, make Setpoint #203 “HiSuctSheat” active. If the suction superheat is greater than the value of this Setpoint for the ‘Time(sec)’ field, an alarm will be generated and the compressor will be shut down with a safety or Lockout state.

13.29. Low Temperature Safety and Unload (Low Saturated Suction Temperature)

The Magnum is set up to check for low refrigerant temperature safety and unload functions. To enable this test make Setpoint #155 “LO REF TMP” active and point to the sensor in the ‘Refrigeration Temp’ column of the Compressor SI grid in MCS-Config.

This safety will be checked only when the compressor is running. If the sensor value is less than Setpoint #155 for the ‘Time(sec)’ field, then an alarm message will be generated and the associated compressor will either be placed in a safety or Lockout state.

The Magnum will also determine if a low temperature condition occurs and to stop loading or unload if necessary. If the sensor value is less than the value of Setpoint #155 plus Setpoint #156 “LO REF UNLD”, then the compressor state will be LO TMP UNLOAD. Refer to state (21) .

By using the User Logic type sensor, we can test any value for a low condition. For example point the refrigerant temperature index to a User Logic sensor that picks up the saturated suction temperature for that compressor. Make Setpoint #155 active with the low temperature value that will trigger the safety and unload action and you have a low saturated suction temperature condition.

Chapter - 14. Using Lookup Tables

The purpose of Lookup tables is to provide additional capability for entering reference data for reading of sensors. Tables are handy, in that, you do not need to create separate configuration files for each change in the performance curve on a non linear sensor. The Magnum will look at the lookup table to get the right information for that sensor.

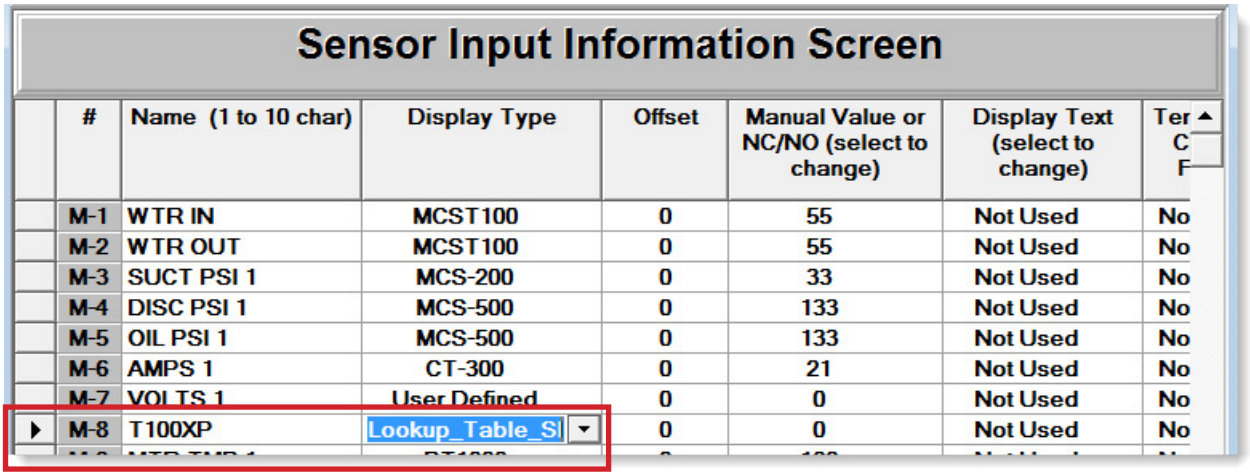
14.1. Lookup tables used with MCS-MAGNUM controls

In the sample below, we are using a Temperature sensor. The magnitude of the current is converted to a linear (0-5vdc) output signal which can be read as a standard analog input signal. The signal is used by MCS micro controllers for controlling some of the following:

1. For slide valve positioning on screw machines
2. For high amp motor overload protection
3. For verification of device on / off
4. For reading any temperature, voltage, or current sensors that has typical voltage input which ranges from 0 to 5 Vdc.
5. For reading non linear sensors that use a 4-20mA signal.

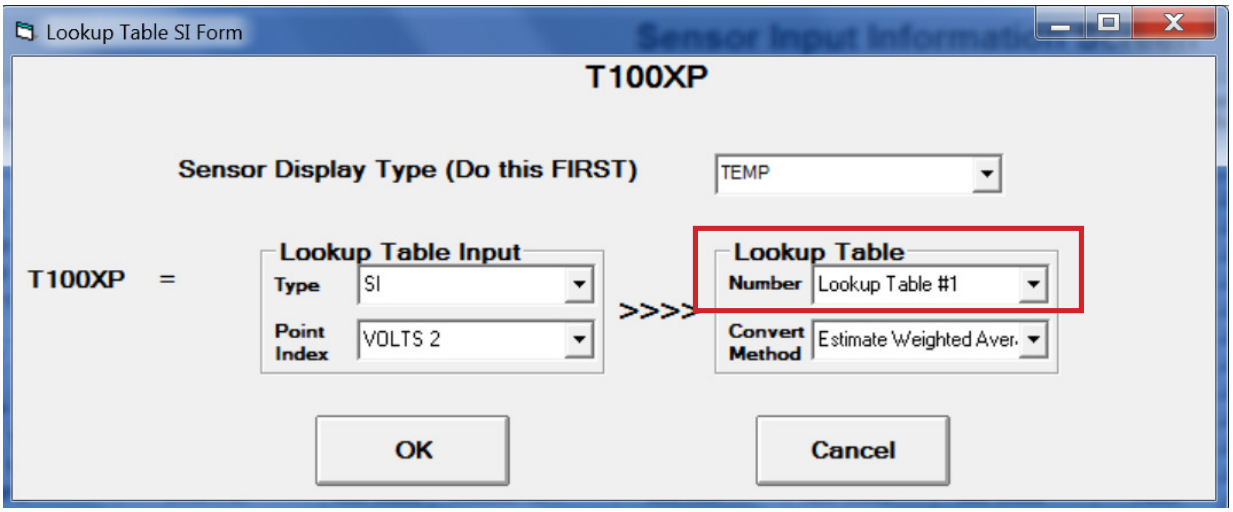
14.1.1 Setting up a Lookup table using MCS-CONFIG

1. Setup new temperature sensor in MCS-Config as shown in screen below.



Screen 1

2. Using the pull down icon, specified the Lookup table that you will be using for this sensor as shown in screen 2.

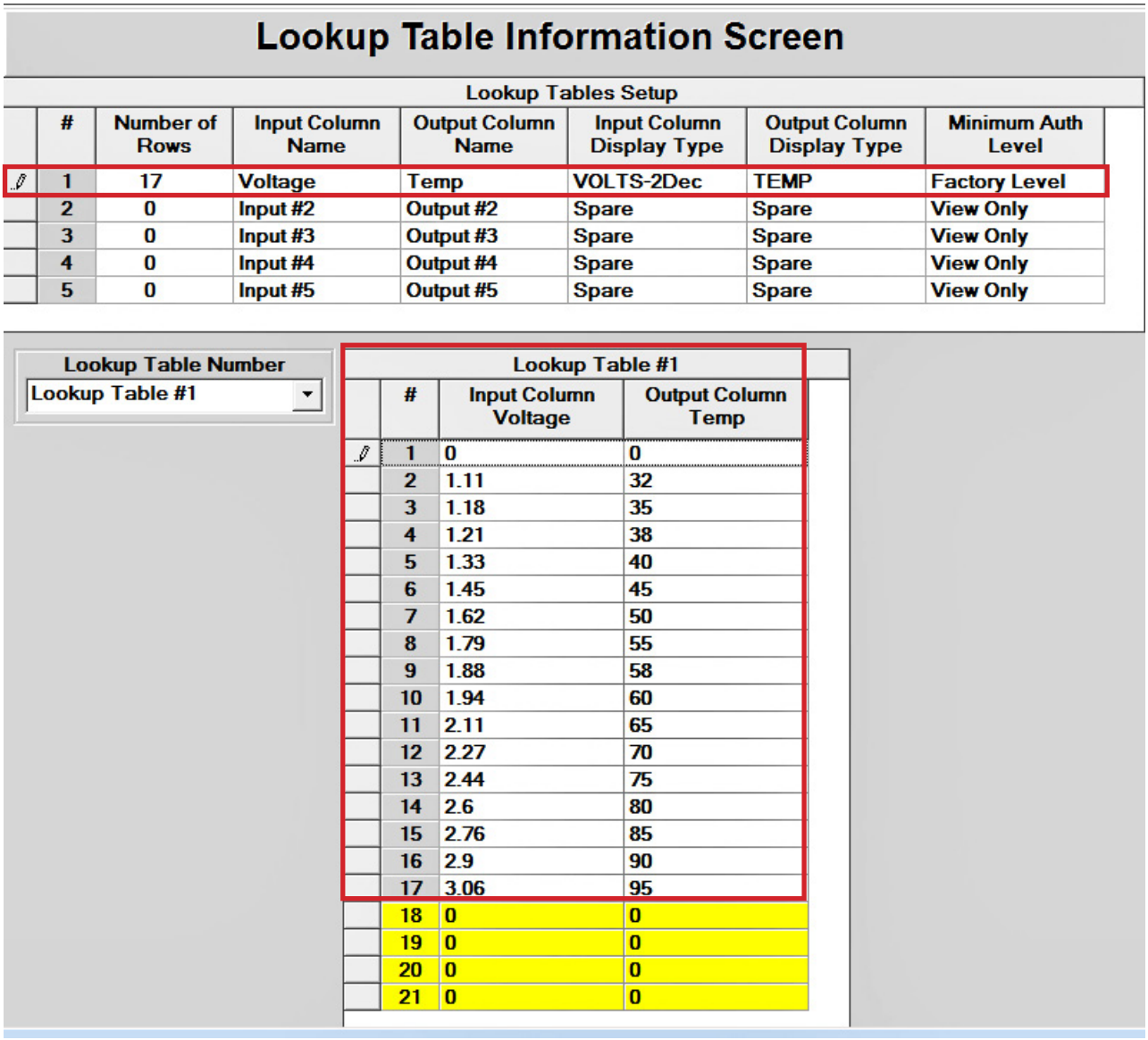


Screen 2

14.1.2 Setting up Lookup table #1 - see screen 3 below:

The sensor we have setup in this example is a temperature sensor. We are entering data into the lookup table using data from the manufacture of the sensor. In the sample table, we have used 17 rows for the data to give us a clear view of the temperature and voltage range of this sensor.

1. In column one, we have entered the number of rows we will use.
2. The second column we have entered Voltage as the Input
3. In the third column we have entered Temp as the output.
4. The fourth column we have shown Volts2 which will allow the example to have two decimal places for the voltage data.



Lookup Table Information Screen

Lookup Tables Setup

#	Number of Rows	Input Column Name	Output Column Name	Input Column Display Type	Output Column Display Type	Minimum Auth Level
1	17	Voltage	Temp	VOLTS-2Dec	TEMP	Factory Level
2	0	Input #2	Output #2	Spare	Spare	View Only
3	0	Input #3	Output #3	Spare	Spare	View Only
4	0	Input #4	Output #4	Spare	Spare	View Only
5	0	Input #5	Output #5	Spare	Spare	View Only

Lookup Table Number: Lookup Table #1

Lookup Table #1

#	Input Column Voltage	Output Column Temp
1	0	0
2	1.11	32
3	1.18	35
4	1.21	38
5	1.33	40
6	1.45	45
7	1.62	50
8	1.79	55
9	1.88	58
10	1.94	60
11	2.11	65
12	2.27	70
13	2.44	75
14	2.6	80
15	2.76	85
16	2.9	90
17	3.06	95
18	0	0
19	0	0
20	0	0
21	0	0

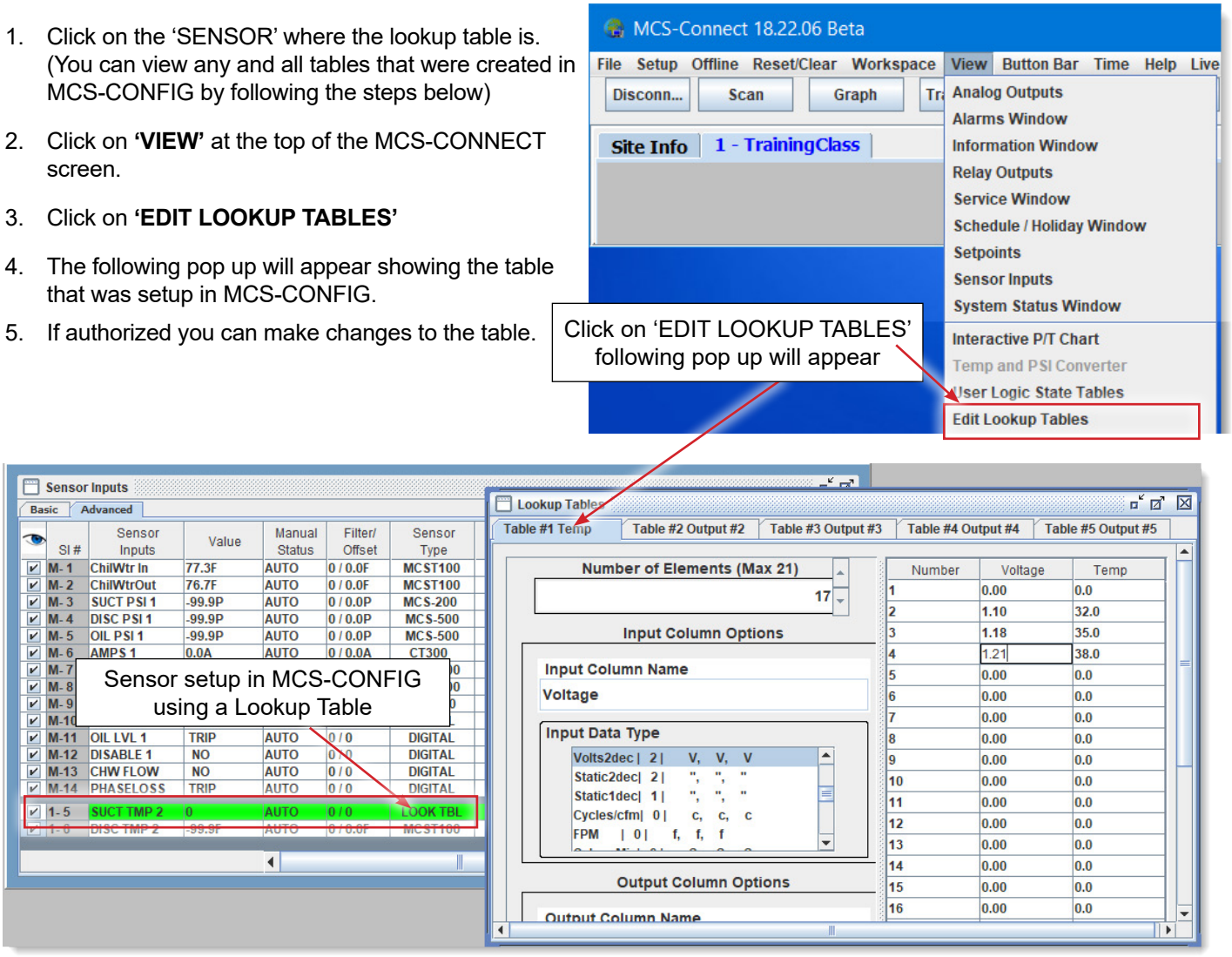
Screen 3

5. The last column shows the authorization level needed to make changes in MCS-Connect.

14.1.3 Viewing the Lookup Table in MCS-Connect

In MCS-Connect you can view the sensor example as shown in the screen below, viewing the same information that was setup in MCS-Config. The authorization was setup as 'FACTORY' in MCS-Config for this sensor example.

1. Click on the 'SENSOR' where the lookup table is. (You can view any and all tables that were created in MCS-CONFIG by following the steps below)
2. Click on **'VIEW'** at the top of the MCS-CONNECT screen.
3. Click on **'EDIT LOOKUP TABLES'**
4. The following pop up will appear showing the table that was setup in MCS-CONFIG.
5. If authorized you can make changes to the table.



14.1.3.1. Using as Control Temperature Sensor

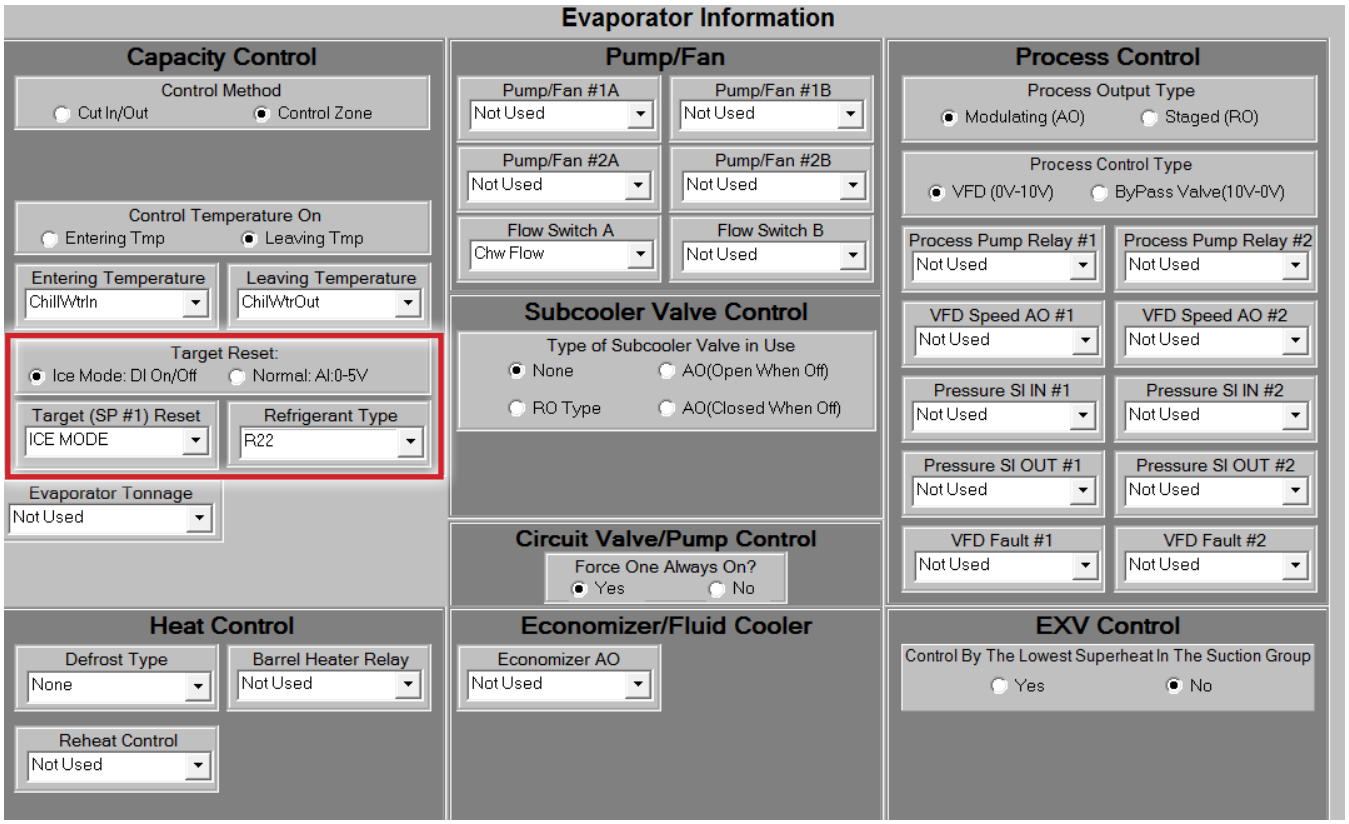
The example sensor has been specified in MCS-Config as providing the control value reading. It will normally be the entering temperature, leaving temperature, or suction pressure. The Setpoints must be adjusted according to the type of control measurement selected.

Chapter - 15. Ice Making Capabilities

The Magnum offers a number of different options to meet the requirements of providing ice for energy storage tanks. A system can be configured as a standard HVAC/R unit with the capability to adjust its cooling target or it can be configured as a pure ice making unit.

15.1. HVAC/R unit using the cooling target reset

This method is indicated by selecting the Ice Mode DI On/Off option and a sensor in the Target (SP #1) Reset cell in the Evaporator Info screen of the Information Panel Selector screen. The ice making mode will be entered based upon the sensor selected in the Target (SP #1) Reset cell.



15.1.1 Target (SP #1) Reset Sensor

This sensor will indicate when the system is to enter the ICE MAKING mode.

15.1.2 Reset Sensor Type 'Target Reset'

When this sensor A/D counts are less than 256, voltage of 1.25, ice mode is to be off, if greater than 768, voltage of 3.75, then ice mode is on else there is no change to the mode.

If this type of sensor is selected, the value of set point #21 will be the off set to set point #1. If set point #1 is 39.0F and the ice temperature target is to be 19.0F then the value of set point #21 must be -20.0F. When this sensor indicates that the ice mode should be entered, its value will be changed to the value of set point #21 & set point #1 will be reset by the value of set point #21, the unit mode will be ICE MAKING.

15.1.3 Reset Sensor Type 'Network Target Reset'

If this type of sensor is selected, its value will be the value received from Modbus address 201 from the network. Set point #21 is used as a high/low limit. The value must be greater than the negative value of set point #21 and less than the value of set point #21 else the value will be 0. This sensor will show this value. If the value of this sensor is not zero, the ice mode will be entered. The value of set point #1 will be reset by the value of this sensor, the unit mode will be ICE MAKING.

15.2. Ice Making Mode

When this mode is entered the unit mode will be changed to ICE MAKING, set point #1 will reflect the ice making target, and all steps of cooling will be staged on. The system will remain in this mode as long as the target reset sensor indicates ice making mode.

If the control temperature drops to the value of set point #1 or less, an information alarm, TMP OFF-ICE MADE, will be generated; all steps of cooling will be staged off; unit state will be OFF TMP-ICE MADE; and the unit mode will remain ICE MAKING. The system will remain in this state until the target reset sensor indicates that the ice making mode is to be terminated.

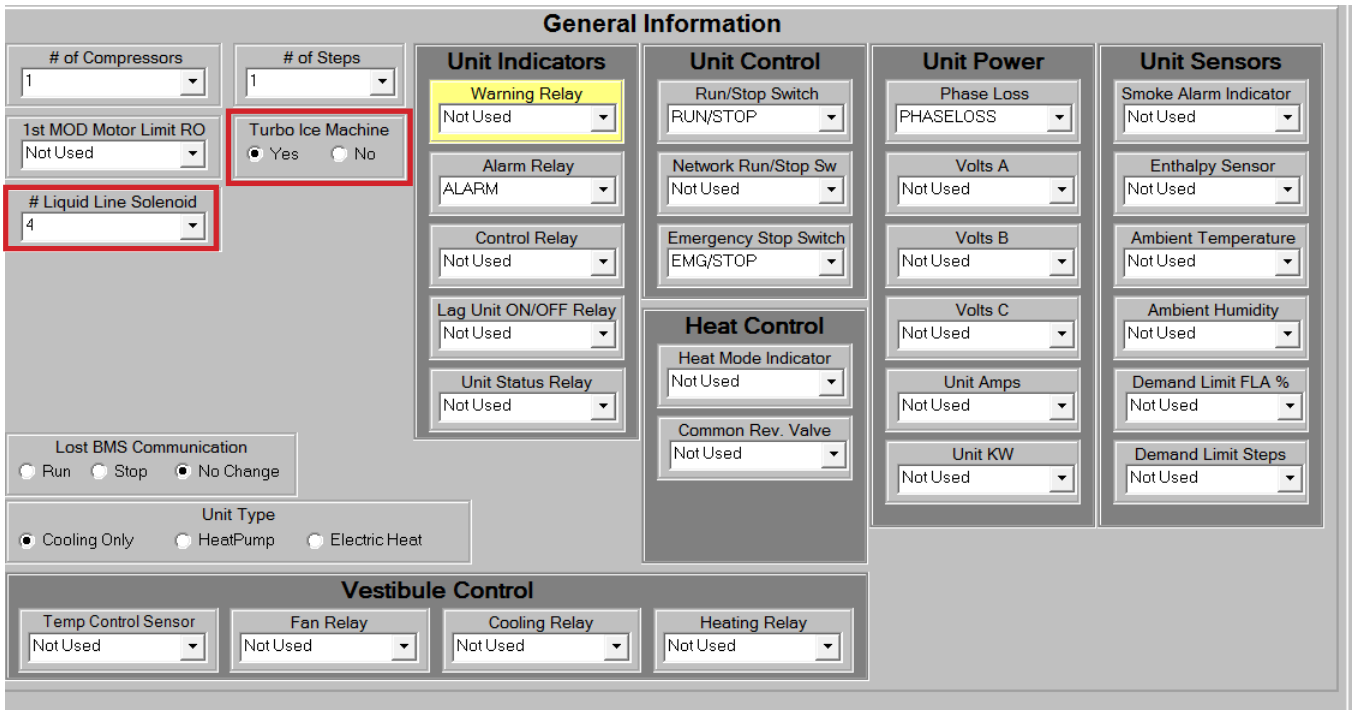
15.2.1 Terminating of ice making mode

Once the target reset sensor indicates that the ice making mode is to end; the mode will be changed to COOLING, the value of set point #1 will be restored to its cooling target, and the unit state will be to a normal state. At this point the system will function to provide cooling as needed.

15.3. System as a pure ice making unit, Turbo Ice Machine

This setup is used to specify a system that is designed to produce and provide a defrost function.

This method is indicated by selecting the Turbo Ice Machine option and the number of liquid line solenoids in the cell in the General Info screen of the Information Panel Selector screen.



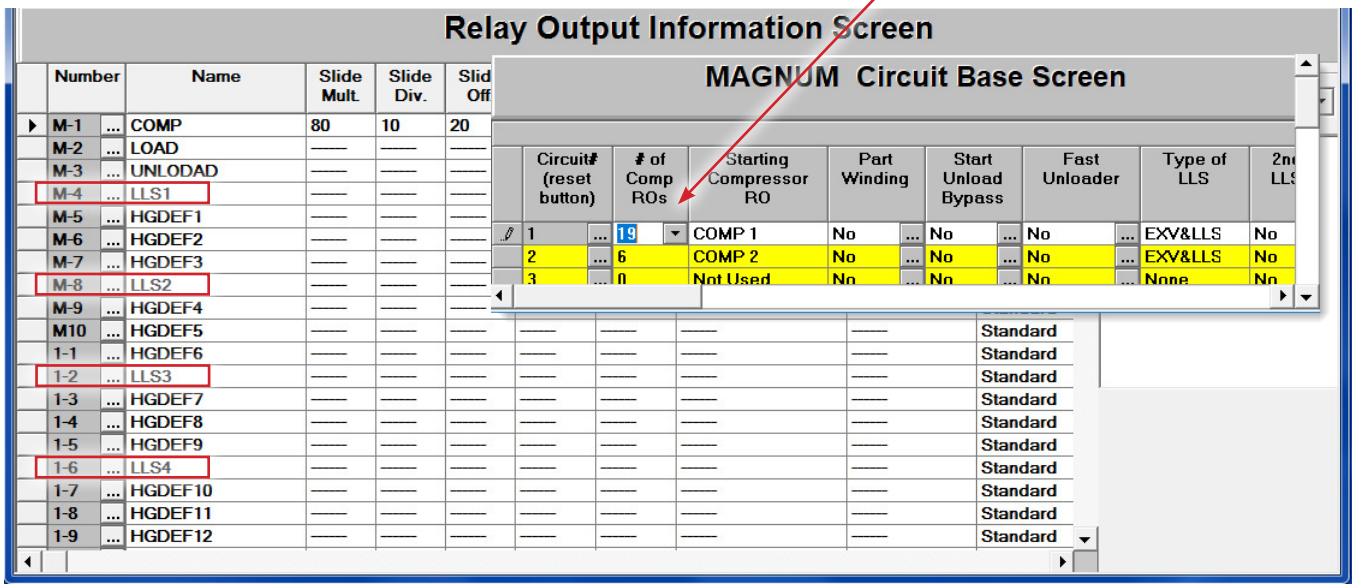
15.3.1 The # Liquid Line Solenoids

The number may be 1 thru 4 and indicates the number of groups of liquid line solenoids/hot gas defrost solenoids output relays.

Each group must consist of a liquid line solenoid and followed by three hot gas solenoid relays. The first group will follow the normal relay output sequence each additional group must follow the previous group.

The following is an example of relay outputs when 4 liquid line solenoids have been specified.

Note, in this example, in the Circuit Base grid the # of Comp RO's will be 19.

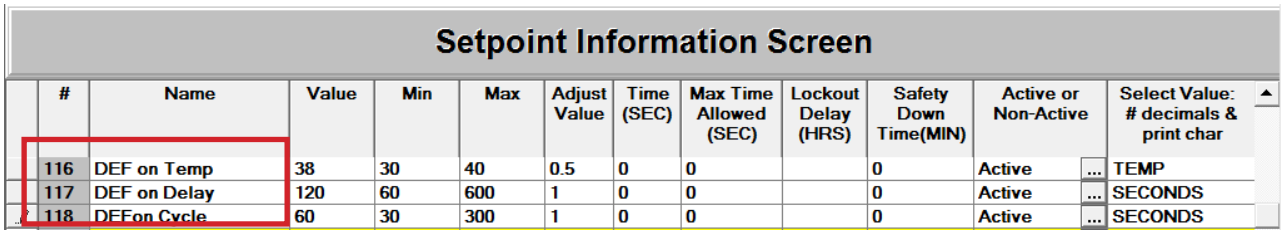


15.3.2 Required set points for defrost cycles

Setpoint #116, if the control sensor's temperature is less than or equal to this value, defrost cycles are required.

Setpoint #117, time that the system will wait before between defrost cycles.

Setpoint #118, time that each hot gas defrost relay will be on.



15.4. Turbo Ice Machine Operation

a) Capacity control

The unit capacity will be increased & decreased to meet the required target temperature in set point #1.

b) Non defrost cycle

When the system is not defrosting all liquid line solenoids will be ON and all hot gas solenoids will be OFF.

c) Defrost cycle initiated

A defrost cycle is required when the control sensor's temperature is less or equal to the value in set point #116, a delay of the value in set point #117 before the defrost cycle begins.

d) Defrost cycle

The defrost cycle will rotate through each group's hot gas solenoids and when all have been accessed then move to the next group.

Following table shows the relay status of a defrost group:

Relays	*1	*2	*3	*4	*5	*6	*7
Liquid Line Solenoid	ON	OFF	ON	OFF	ON	OFF	ON
Hot Gas Solenoid 1	OFF	ON	OFF	OFF	OFF	OFF	OFF
Hot Gas Solenoid 2	OFF	OFF	OFF	ON	OFF	OFF	OFF
Hot Gas Solenoid 3	OFF	OFF	OFF	OFF	OFF	ON	OFF

*1, status prior to defrost cycle.

*2, defrost cycle begins with first hot gas solenoid, state will remain for time in set point #118.

*3, delay between rotations to next hot gas solenoid, state will remain for time in set point #117.

*4, rotation to next hot gas solenoid, #2, state will remain for time in set point #118.

*5, delay between rotations to next hot gas solenoid, state will remain for time in set point #117.

*6, rotation to next hot gas solenoid, #3, state will remain for time in set point #118.

*7, all hot gas solenoids in this group have been accessed. Value of set point #117 will be the time delay before the next group begins a defrost cycle.

e) Terminating a defrost cycle

A defrost cycle will be terminated when the control sensor's temperature is greater or equal to the value in set point #116 plus .5. If another defrost cycle is initiated the cycle will begin where the previous defrost cycle ended.

Chapter - 16. Rapid Start

16.1. Purpose of Change

The purpose of this change is to add Rapid Start logic to MCS-Magnum HVAC Firmware. This logic will be used on process application where the chiller needs to provide cold water quickly after the unit has been off due to a power failure, run stop, unit lockout etc.. This new logic will change the capacity control stage from its normal control setpoints to new dynamic ROC staging logic. The required control temperatures rate of change to bring the control temperature with in the control zone target is developed. Cooling capacity will be added to maintain the needed rate of change. Once the control target zone has been entered the system will return to its normal control logic.

16.2. Existing Config Parameters

Suggest the POWER UP Delay set point #23, PowerUpDelay, have a low value 5-30 seconds depend on application.

16.3. New Config Parameters

The follow items are required to control the Rapid Start Dynamic ROC Loading:

1. Rapid Start Option Enabled
2. Rapid Start Time – this value defines the maximum time the chiller is allowed to be in the 'RS-ADJ CAPACITY?' state. When the unit is in this state it will increase the cooling capacity to maintain the needed control rate of change to get the control temperature with in the control zone. This time value is used in the calculation of the Rapid Start Dynamic ROC.
3. Rapid Start Delay – This is use as delay when unit state 'RS-ADJ CAPACITY?' between adjustments to the cooling capacity.
4. Rapid Start Adj% - this is used as the amount to increase the cooling capacity.
5. Rapid Start Compressors On – this value contains the number of compressor steps to turn when the unit is in the RS-STARTING COMP state.
6. Rapid Start Acceleration time – this is the time interval in seconds (1-60 only valid values) used to calculated the Rapid Start Dynamic Acceleration.
7. Rapid Start Maximum Acceleration – this is used as the maximum allowable acceleration value. The unit will not increase cooling capacity if the Rapid Start Dynamic Acceleration is less than this field. Note, this must be a negative value indicating a negative rate of change this show a decrease in the control temperature..

These parameters are contained in the following set points:

Set point #247, RS ComprTimers, target type of set point with no decimal places.

Value = Rapid Start Comps On (#5).

Time (SEC) = Delay between turning on compressors. (#5)

High Zone = Rapid Start Time. (#2)

Low Zone = Rapid Start Acceleration time. (#6)

Night Setback = Not used.

Set point #248, RS Adj/ROC, delay type of set point with 1 decimal place.

Value = Rapid Start Adj% (#4).

Time (SEC) = Delay between adjustments. (#3)

MIN VFD Opening = Not used.

MAX VFD Opening = Rapid Start Max Accel. (#7)

MAX Adjustment = Not used.

Set point #247 & Set point #248 both must be active to enable Rapid Start Option. (#1)

16.4. Calculated Values

Rapid Start Dynamic ROC – This value is calculated by taking the control target minus the current chilled water temperature divide by rapid start time. This value is calculated once at completion of the "RS-ADJ CAPACITY?" capacity states. This is the required rate of change of the control temperature to reduce the temperature to within the control zone within the time specified.

Rapid Start Dynamic Acceleration – This value is now fast the rate of change of the control temperature is changing.

16.5. Logic Requirements

1. If the Rapid Start Option is enable when both set points #247 and #248 are active and a power failure, computer reset or any other condition that causes the MCS-Magnum control logic to restart and the control temperature is above the top of the control zone the following occurs:

a. The normal capacity control staging logic is bypass until the chilled water out temperature is within the control zone or the time in Rapid Start has exceeded the Rapid Start time In place of the normal capacity control stage logic will be Rapid Start logic that will dynamically load the chiller to achieve control zone within a pre-defined amount of time..

b. After normal Power UP delay capacity control state, the capacity control state will go to "RS-STARTING COMP". All compressors that are available, status is either anti-cycle or off ready will be made ready to be turned on if needed. The first compressor turned on will be the lead compressors. All compressor safeties will be executed during the rapid start time.

c. In 'RS-STARTING COMP' state a comp will start right away after the power up delay state. Then based upon the time delay in set point #247 a compressor will be started until the number of comps on equals Rapid Start Comp On set point value. Once all the compressors required on are started we need to calculate the Rapid Start Dynamic ROC value and set the capacity control state RS-LOADING CAP'Y.

d. In 'RS-LOADING 'state the a decision will be made whenever the delay time in set point #248 has been exceeded to increase the unit's capacity If chilled water ROC is greater than the Rapid Start Dynamic value and Rapid Start Acceleration is greater than max acceleration set point value, the unit capacity will be increased by the value of set point #248. Once the capacity has reached its maximum, if another chiller is available it will be turned on and the capacity wanted will be changed to its minimum.

The delay counter will be reset in after a capacity change.

e. In 'RS-HOLDING 'state no additional capacity is needed at this time. When in this state the needed capacity will be checked with every pass of the algorithm.

f. Once the chilled water out temperature is inside the control zone or the rapid start time has been exceeded, the Rapid Start logic is disabled and normal capacity control logic takes over.

16.6. Modification to Magnum Status Screen

When the system is in a rapid start state the target line of the first screen of the Magnum Status display has been modified to show additional information about the rapid start. Also the delay counter is based upon the rapid start delay which is time of set point #248.

'RS-STARTING COMP'

X MAX COMP ON IN RS (X is the maximum number of compressors that will be turned on in this state)

In this state the system will turn on the number of compressors allowed in the rapid start.

'RS-LOADING'

ACC = -2.1 TRG = 2.0 (ACC is the actual change in the control temperature and TRG is the Rapid Start Dynamic ROC)

In this state the capacity will be increased, once it is at its maximum an additional compressor if available will be turned on and the capacity will be set to its minimum value.

'RS-HOLDING'

ACC = -2.1 TRG = 2.0 (ACC is the actual change in the control temperature and TRG is the Rapid Start Dynamic ROC)

In this state the capacity will be not be increased.

Example:

Set point #1 (target) = 47.4

Control temperature a start of R-S ADJ CAPACITY? State = 77.0

Set point #247

Value = 3, number of compressors to turn on during RS-STARTING COMP state

Time = 15S, delay between turning on the next compressor

HI zone = 600, number of seconds to bring the control temperature with control zone

LOW zone = 30, delay when calculating the Rapid Start Dynamic Acceleration

Set point #248

Value = 10.0%, adjustment to capacity (Wanted %) when more cooling is needed

Time = 20S, delay between making adjustments to capacity, this will only be reset if an adjustment is made.

MAX VFD = -2.0, maximum dynamic acceleration

Calculate Rapid Start Dynamic ROC at end of **RS-STARTING COMP** State = -1.5 (This is the rate of change that the rapid start logic will try to maintain by increasing or holding the cooling capacity.)

(The rate of change is a negative number; therefore -1.0 is greater than -1.5)

Example #1

If the control temperature rate of change is - 0.2 and the Rapid Start Dynamic Acceleration is -0.3.

State will be RS-LOADING, Cooling capacity will be increased by 10.0%, delay will be reset

(Control temperature rate of change is greater than the Rapid Start Dynamic ROC, temperature is not decrease fast enough and the acceleration is greater than the maximum, not exceeded it limit.)

Example #2

If the control temperature rate of change is –1.6 and the Rapid Start Dynamic Acceleration is -1.9.

State will be RS-HOLDING, Cooling capacity will remain constant, delay will not be reset

(Control temperature rate of change is greater than the Rapid Start Dynamic ROC, temperature is decrease fast enough and the acceleration is less than the maximum.)

Example #3

If the control temperature rate of change is –1.4 and the Rapid Start Dynamic Acceleration is -2.1.

State will be RS-HOLDING, Cooling capacity will remain constant, delay will not be reset

(Control temperature rate of change is greater than the Rapid Start Dynamic ROC, temperature is not decrease fast enough however the acceleration is less than the maximum, this indicates hold capacity as the rate of acceleration is moving fast enough at this time.

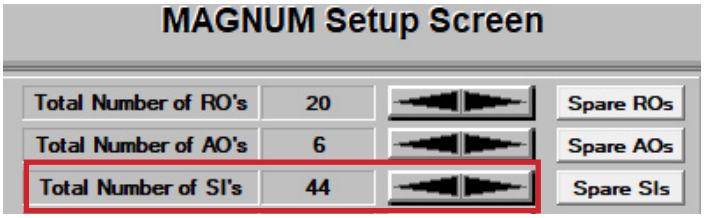
Chapter - 17. Setpoint Functions

17.1. Voltage Sensor Input

Up to three sensors that measure voltage input can be specified. If used, a safety condition based upon Setpoint #195 LOW VOLTAGE and Setpoint #196 HI VOLTAGE will be checked. If a safety trip occurs the unit will be placed in a safety hold state.

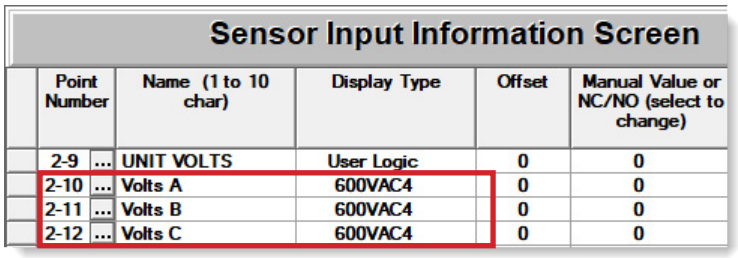
17.1.1 Set up the sensor type

1. Under **Setup** (MAGNUM Setup Screen) increase number of sensors(3) to add new sensors.

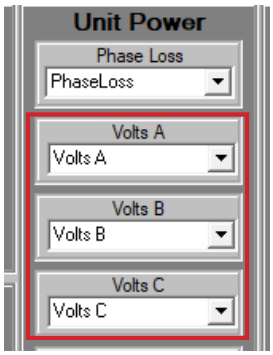


2. Under **SI's** (Sensor Input Info Screen, setup your sensors as shown,

	Name	Display Type
a.	Volts A	600VAC4
b.	Volts B	600VAC4
c.	Volts C	600VAC4

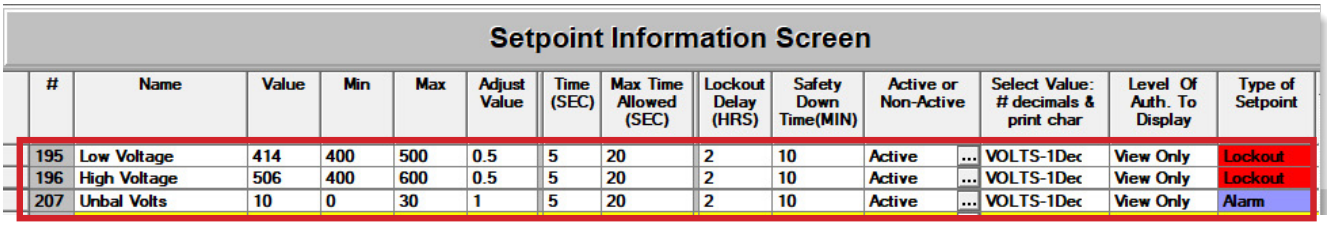


3. Point to the Sensors in the **MAG HVAC** (MAGNUM Setup Screen)



4. **Voltage Setjpoints**

Make setpoints #195, (Low Voltage setting), #196 (High Voltage setting).



195	LOW VOLTAGE	If active and the voltage of any one of the voltage sensors is less than the value of this Setpoint for the time specified in the safety time cell, then a Low Voltage alarm will be generated and the unit will be locked out.
196	HI VOLTAGE	If active and the voltage of any one of the voltage sensors is greater than the value of this Setpoint for the time specified in the safety time cell, then a Hi Voltage alarm will be generated and the unit will be locked out.

17.1.2 UNBALANCED Voltage Setpoint

Make setpoint #207 active.

Setpoint Information Screen

#	Name	Value	Min	Max	Adjust Value	Time (SEC)	Max Time Allowed (SEC)	Lockout Delay (HRS)	Safety Down Time(MIN)	Active or Non-Active	Select Value: # decimals & print char	Level Of Auth. To Display	Type of Setpoint
195	Low Voltage	414	400	500	0.5	5	20	2	10	Active ...	VOLTS-1Dec	View Only	Lockout
196	High Voltage	506	400	600	0.5	5	20	2	10	Active ...	VOLTS-1Dec	View Only	Lockout
207	Unbal Volts	10	0	30	1	5	20	2	10	Active ...	VOLTS-1Dec	View Only	Alarm

207	UNBAL VOLTS	If active, the average of the voltage sensors is calculated. Each individual voltage sensor is compared to this average and if the difference is greater than the value of this set-point, an alarm is generated and the unit is locked out. After the voltages have returned to normal an automatic lockout reset will occur after the delay in the Safety Down Time(MIN) field.

Example: Assuming Setpoint #207 value field is set to 10v

SI (Sensor Input)	Voltage Sensor Reading
Volts A	460v
Volts B	464v
Volts C	444v
Average Voltage Value	456v
Volts A differential from average = 4v Volts B differential from average = 8v Volts C differential from average = 12v	
In this example Volts C differential from the average voltage between all three legs of power exceeds our setpoint #207 value of 10 volts which would cause the unit to lockout on unbalanced voltage.	

17.2. Motor Amps

Up to three sensors that measure amperage input can be specified per circuit. If used a safety condition based upon Setpoints #75 HI AMPS and #76 LO AMPS, plus the associated Full Load Amps (FLA) for that circuit will be checked. If a safety trip occurs, that circuit will be placed in a safety hold state.

17.2.1 Add an Amp Imbalance Safety Test to the existing Amp Safeties.

All three Motor Amps (A, B, & C) sensors must be indicated and **setpoint #241** must be active and be setup as a normal safety and contain:

Type: Either Lockout or Alarm

Select Value: HUMD or %

Value: Maximum percentage of deviation

Time: Normal safety

Lockout Delay: Normal safety

Safety Down Time: Normal safety

This safety will be run every second when the compressor is on and the split winding relay is on if one exists (same requirement as other amp safeties).

The three amp sensor values will be totaled and averaged. If any of the amp sensors are more than the percentage of the value of **setpoint #241** difference from the average for more than the time specified in the time cell of **setpoint #241** the compressor will be tripped and the error message will be the name of **setpoint #241** plus the circuit number. The normal 2 trip logic will apply if the set point is a lockout type.

17.3. Custom display description of circuit

Instead of displaying the circuit number in the status screens of both the Magnum and MCS-Connect, up to 3 characters can be supplied using MCS-Config to replace the circuit number. For example, if 1-A is entered for circuit 1, then 1-A will be displayed in place of 1. This provides the user additional flexibility in describing a particular circuit.

17.4. User Logic RO Delay Before Off

A timer delay before turning off a relay has been added, providing the ability to keep a relay on for a period of time after the condition to turn it off is met.

17.5. Additional Information Messages

The messages generated when manually changing the status of a Relay Output or Sensor Input have been expanded. The messages now indicate which relay or sensor was changed and if the change was from AUTO to MANUAL or MANUAL to AUTO.

17.6. Pump Rotation

Pump rotation functionality has been added. This is specified with Setpoint #106 LEAD PUMP. If the Setpoint is active and its value is zero, then rotation will occur with each on/off cycle of the pump.

17.7. Process Pump Addition and Rotation

The number of process pumps has been expanded to two and rotation functionality has been added. This is specified with Setpoint #197 LEAD ProcPmp. If the Setpoint is active and its value is zero, then rotation will occur with each on/off cycle of the process pump.

17.8. MOP Control Option to EXV Logic

Maximum Operating Pressure (MOP) has been added to the EXV control logic. If Setpoint #199 MOP TARG PSI is active then MOP logic will be activated. Refer to section on Electronic Expansion Valve Control Logic.

17.9. Delta Temperature Evaporator

If Setpoint #202 DELTA TEMP EVP is active and the delta temperature across the evaporator is greater than the value of this Setpoint the unit will not increase wanted capacity.

17.10. Condenser Low Ambient

When a compressor is started its discharge pressure will be used as the controlling pressure for five minutes, enabling that compressor to build head pressure. However, if Setpoint #204 COND LOW AMB is active and there is an ambient temperature sensor reading less than this Setpoint, then this compressor's discharge pressure will remain in control for an additional time as specified in the "Time (sec)" field.

17.11. New Pressure Sensor Supported

Two pressure transducers developed by Huba Control designed refrigeration industry. These are the HB-350 and the HB-700.

17.12. Centrifugal Vane Control

Vane control now can be based on either a vane position or compressor amp draw Sensor Input.

17.13. External Centrifugal Purge Control

Support for the Trane Purifier Purge operation has been added. If Setpoint #163 Purge Target is active, it will activate this feature.

17.14. MCS Touch Screens Interface

The interface with the various touch screens has been expanded.

17.15. Sensor Averaging

Sensor inputs can now be averaged over a period of time, up to a maximum time of 30 seconds. This will enable sensor smoothing if it is needed. Note: At power up, the initial value of the Sensor Input will be counted as the sensor history for the number of seconds that has been selected as the averaging time (for example,

if the averaging time was selected at 5 seconds, the initial Sensor Input reading at startup will be counted as having already run at that value for 5 seconds previously).

17.16. Virtual Points Separated From Real Points

Virtual points are Sensor Inputs, Relay Outputs, or Analog Outputs that are not connected to an outside device, while a real point is connected with wiring from the input/output to an outside device (sensor, motor, etc.). By placing the virtual points after the real points they will not take up points on an actual hardware board. In the Setup section of MCS-Config the total number of points are specified and the number of Input/Output boards must now be specified. Only the number of I/O boards indicated will be accessed.

17.17. MDP to EXV Control Logic

Minimal (oil) Differential Psi (MDP) requires the following Setpoint #205 be active (Refer to Setpoint #205).
The EXV logic will forced the state to “EXV MDP CLOSE” when the all of the following conditions are true:

1. Setpoint #205 “MDP MIN OIL DIFF” is active,
2. The compressor oil differential pressure is less than Setpoint #205 value field,
3. The compressor has been running for less than X mins or X is equal to zero (where X is the value contained in Setpoint #205 “SEC to IGNORE SAFETY” field),
4. The compressor suction pressure is greater than or equal to (Setpoint #77 “LOW SUCTION” value plus Setpoint #79 “LO SUCT RELD” value).

In this state the EXV will be closed by the adjustment value in Setpoint #205 “Lockout Delay” field. If this value is positive the valve is closed, if this value is negative the valve will be opened.

The EXV logic will exit the “EXV MDP CLOSE” state and go to “EXV HOLDING” state when the any of the follow conditions are true:

1. The compressor oil differential pressure is greater than (Setpoint #205 value field plus Setpoint #205 Time field),
2. The compressor has been running for more than X mins and X is not equal to zero (where X is the value contained in Setpoint #205 “SEC to IGNORE SAFETY” field),
3. The compressor suction pressure is less than or equal to (Setpoint #77 “LOW SUCTION” value plus Setpoint #78 “LO SUCT ULLD” value).

17.18. Low Discharge Superheat Adjustment to EXV Logic

Setpoint #110 LOW REFRIGERANT LEVEL TARGET must be active.
If discharge superheat is less than Setpoint #84 LO DISC SUPERHEAT for 1/3 of its safety time and both discharge temperature and pressure sensors are active, then add the value of Setpoint #110 LOW REFRIGERANT LEVEL TARGET to Setpoint #9 EXV TARGET. This function takes precedence over the regular control zone logic.

17.19. Normal Condenser Discharge Control Bypass

Depending on what option was selected in MCS-Config, normal condenser control can either be based upon the compressor with the highest discharge pressure or on the pressure of the most recently started compressor. If control based on newly started compressor was selected then Setpoint #206 may be used to bypass this logic because of a high ambient temperature.
(Refer to Setpoint #206)

17.20. Test for Voltage Out of Balance

This test requires Setpoint #207 to be active. (Refer to Setpoint #207)
Only voltage sensors that are specified in the MAG V8 screen of MCS-Config will be included in the calculation.

17.21. Expanded Testing of Low and High Off

This test requires Setpoints #208 LOW SI OFF and #209 HI SI OFF to be active. (Refer to Setpoints #208 and #209)

17.22. Expanded Compressor Rotation to Check for Maximum Run Time

In the Compressor Information panel of the MAG V8 screen in MCS-Config, there is now a check box to select how compressors are to be rotated, based either on Run Time or First On/First Off.

17.23. New Option to test for Low Superheat on Suction or Discharge PSI

In the Circuit Base screen under the EXV Control column select “Disc Sph” to test discharge pressure or “Suct Sph” to test the suction pressure to determine low superheat.

17.24. New Large Character Screen Displaying Control Information

A new information screen has been added with large character size for ease of reading. This screen is accessed from the Main Menu of the Magnum Keypad by pressing the F3 key.

ACTUAL DISPLAY	*DESCRIPTION*
09:55 Control On OUT 48.1F IN 45.3F R22	HH:MM Heading First line is sensor that is the controlling sensor; either entering or leaving Second line is contains the other value The last line is the refrigerant type

If the “Scrolling Information” option has been selected from MCS-Config, this page will be included in the screen rotation.

17.25. Circuit Amp Value added to Circuit Status Screen

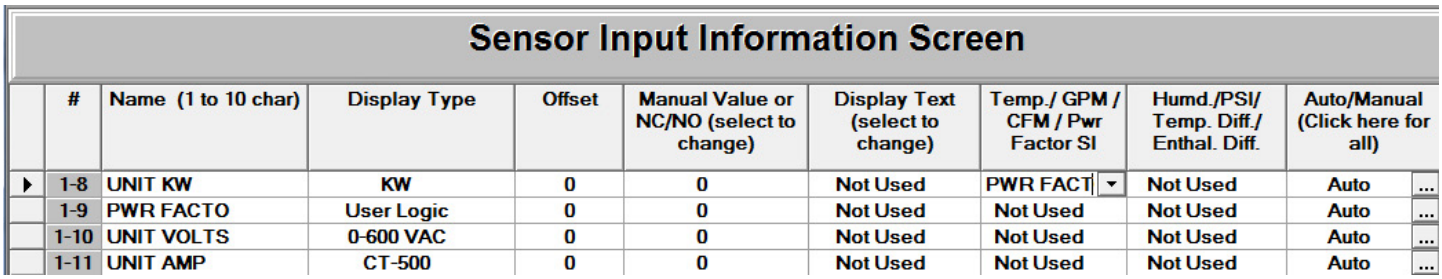
The amp value is now included in the first page of each compressor information screen. Use the right arrow button to access it.

17.26. Low Discharge Superheat Test to Economizer

Requires Setpoint #210 ECO LL3 D-SHT (Refer to Setpoint #210)

17.27. Tonnage and KW Information

17.27.1 KW Sensors



Sensor Input Information Screen

	#	Name (1 to 10 char)	Display Type	Offset	Manual Value or NC/NO (select to change)	Display Text (select to change)	Temp./ GPM / CFM / Pwr Factor SI	Humd./PSI/ Temp. Diff./ Enthal. Diff.	Auto/Manual (Click here for all)
▶	1-8	UNIT KW	KW	0	0	Not Used	PWR FACT	Not Used	Auto ...
	1-9	PWR FACTO	User Logic	0	0	Not Used	Not Used	Not Used	Auto ...
	1-10	UNIT VOLTS	0-600 VAC	0	0	Not Used	Not Used	Not Used	Auto ...
	1-11	UNIT AMP	CT-500	0	0	Not Used	Not Used	Not Used	Auto ...

Unit KW – virtual sensor that calculates the unit Kilowatt usage. The Power Factor (PF) sensor must be selected in the ‘Temp. / GPM / CFM / Pwr Factor SI’ cell.

Kw = Amps * Volts * Power Factor * Internal Constant of .00173

Power Factor – Virtual sensor tied to a Setpoint where a manual value of the unit’s power factor may be defined.

If not specified, a hardcoded value of .85 will be used.

Unit Volts – Voltage being supplied to the unit. This sensor can be an actual voltage sensor or virtual point that reads a static value from a Setpoint.

Unit Amps – Sensor reading the amperage of the entire unit. If no total unit amp sensor is specified, the software will automatically sum all the individual compressor amp sensors to approximate the unit amps.

17.27.2 Tonnage Sensors

Unit Tons – a virtual sensor that calculates the unit tonnage. The Unit Flow (GPM or CFM) sensor must be selected in the 'Temp. / GPM / CFM / Pwr Factor SI' cell, and the Enthalpy Differential or Temperature Differential sensor (air and water cooling systems respectively) must be selected in the 'Humd. SI / Temp. Diff. / Enthal. Diff.' cell. Also the correct values must be placed in the 'Multiplier' and 'Divisor' cells depending on the type of system; 45 and 10 respectively for air.

Tonnage for water (Fahrenheit) is calculated using a multiplier of 1 and divisor of 24 (refer to picture below).

Tonnage for water (Celsius) is calculated using a multiplier of 9 and divisor of 120.

*Tonnage (water Fahrenheit) = Flow (GPM) * 1 Temperature Differential / 24*

*Tonnage (water Celsius) = Flow (GPM) * 9 Temperature Differential / 120*

*Tonnage (air) = Flow (CFM) * Enthalpy Differential * 4.5*

Sensor Input Information Screen

#	Name (1 to 10 char)	Display Type	Offset	Manual Value or NC/NO (select to change)	Display Text (select to change)	Temp./ GPM / CFM / Pwr Factor SI	Humd./PSI/ Temp. Diff./ Enthal. Diff.	Auto/Manual (Click here for all)	Circuit Index	Multiplier	Divisor	Offset	Select Display Type
1-12	UNIT TONS	TONS	0	0	Not Used	UNIT GPM	TEMP DIFF	Auto ...	Not Used	1	24	Not Used	Not Used
1-13	UNIT GPM	User Defined	0	0	Not Used	Not Used	Not Used	Auto ...	Not Used	100	1025	28	FPM
1-14	TEMP DIFF	User Logic	0	0	Not Used	Not Used	Not Used	Auto ...	Not Used	Not Used	Not Used	Not Used	TEMP
1-15	WATER IN	MCST100	0	0	Not Used	Not Used	Not Used	Auto ...	Not Used	Not Used	Not Used	Not Used	Not Used
1-16	WATER OUT	MCST100	0	0	Not Used	Not Used	Not Used	Auto ...	Not Used	Not Used	Not Used	Not Used	Not Used

Unit Flow (GPM or CFM) – Gallons per minute (for water) or cubic feet per minute (for air). This can be an actual flow sensor or virtual point that reads a static value from a Setpoint. NOTE: It is essential for a correct calculation that this sensor must be configured so as to have no decimal places.

Water In and Out Temperatures – (Water only) Temperature sensors for Water In and Out.

Temperature Differential – (Water only) User logic that subtracts Water Out Temperature from Water In Temperature.

Temp Diff = Water In – Water Out

Supply and Return Humidity – (Air only) Humidity sensors for Return and Supply air.

Supply and Return Temperatures – (Air only) Temperature sensors for Return and Supply air.

Return Enthalpy – (Air only) Virtual sensor that calculates enthalpy for Return air. The Return Temperature sensor must be selected in the 'Temp. / GPM / CFM / Pwr Factor SI' cell and the Return Humidity sensor must be selected in the 'Humd. SI / Temp. Diff. / Enthal. Diff.' cell.

Supply Enthalpy – (Air only) Virtual sensor that calculates enthalpy for Supply air. The Supply Temperature sensor must be selected in the 'Temp. / GPM / CFM / Pwr Factor SI' cell and the Supply Humidity sensor must be selected in the 'Humd. SI / Temp. Diff. / Enthal. Diff.' cell.

Enthalpy Differential – (Air only) User logic that subtracts Supply Enthalpy from Return Enthalpy.

Enth Diff = Return Ent – Supply Ent

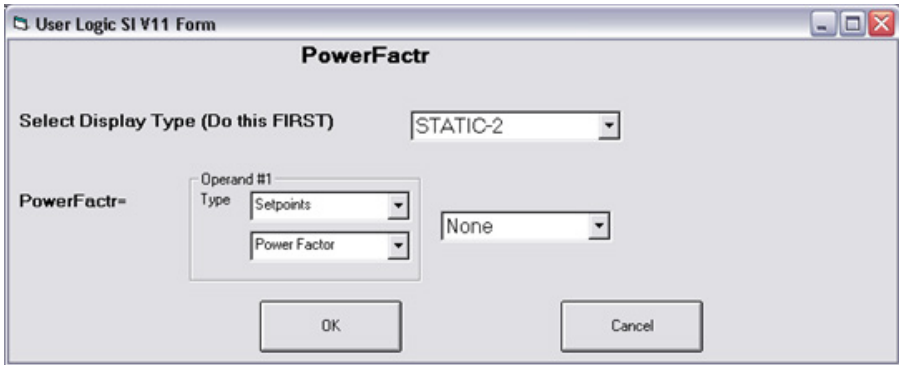
17.27.3 Configuring KW and Tonnage

To set up User Logic for Power Factor (or GPM, CFM, or Unit Volts if desired), first go to the Setpoints screen and scroll down to the very bottom. Starting at Setpoint #230 and working your way up, activate the number of Setpoints you will need. Give each point a descriptive name that will help you identify its function, such as the example below. Then input the value you would like that sensor to read, as well as a range that value may vary in and the interval at which you would like to adjust the value. Pay special note to the type of Setpoint selected (as in the example below) in the "Select Value: # decimals & print char" cell so that the values will read and calculate correctly.

Setpoint Information Screen

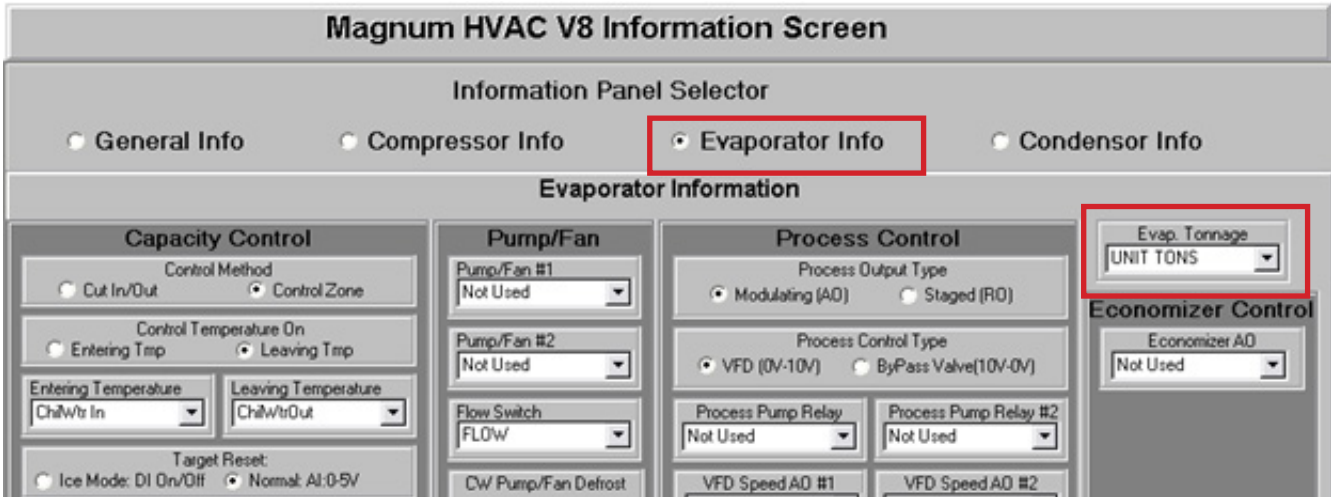
#	Name	Value	Min	Max	Adjust Value	Time (SEC)	Max Time Allowed (SEC)	Lockout Delay (HRS)	Safety Down Time(MIN)	Active or Non-Active	Select Value: # decimals & print char	Level Of Auth. To Display	Type of Setpoint	Comments
230	Power Factor	0.05	0	1	0.01	0	0	0	0	Active ...	STATIC-2De	View Only	Setpoint	...

Once your Setpoints have been defined, go back to the SI screen. Find the respective sensor you wish to tie to a Setpoint and select User Logic in the “Display Type” column. The “User Logic SI V11 Form” screen will pop up. First select the same Display Type as you did in the “Select Value: # decimals & print char” cell for the respective Setpoint. Next, select “Setpoints” in the first dropdown menu of the Operand #1 box, and select the respective Setpoint in the second dropdown menu. Finally, select “None” in the middle dropdown menu (Operators). An example User Logic displaying the value of a Setpoint is shown below:

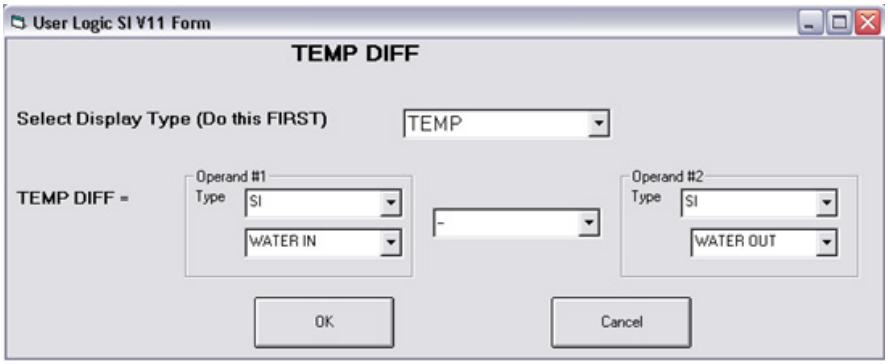


To set up the User logic for differential calculations, such as for Temperature Differential, first select User Logic as the Display Type for that particular sensor. Again the “User Logic SI V11 Form” screen will pop up. This time you will select the corresponding display type, as well as SI type for Operands #1 and #2. Then select Water In Temperature for Operand #1 and Water Out Temperature for Operand #2 and subtraction from the middle drop down menu (See picture below).

The Unit Tons value is selected in the “Evap. Tonnage” cell in the Evaporator Information panel under the MAG V8 screen.

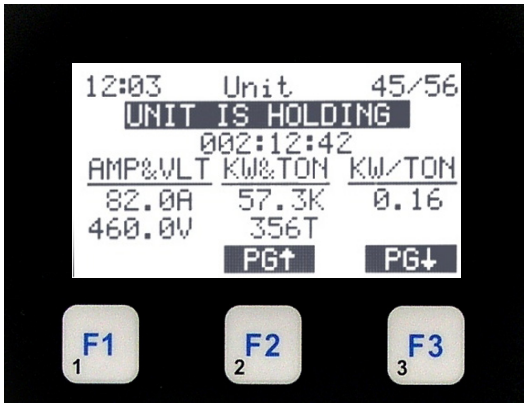


The Unit Volts sensor is selected in the “Volts A” cell in the General Information panel. The Unit Amps sensor is selected in the “Unit Amps” cell (If not used then the “Amps A” cell from each circuit in the Circuit SI screen will be totaled together to calculate the amps value). The Unit KW sensor is selected in the “Unit KW” cell.



The following screen has been added to the status screens in the keypad display to show Tonnage/KW information (if available):

ACTUAL DISPLAY *DESCRIPTION*



Unit Status KW/TON

- On the top line right chiller out & chiller in is displayed rounded to a whole number.
- The second line shows Unit status.
- The third line shows time in that mode.
- The next two lines show the following:

  -Current amps -Current voltage
  -Current KW -Current tons
  -Current KW/Ton

- This information is only available if the sensors are provided.

17.28. Oil Flow Safety

Requires Setpoint #211 if HVAC configuration type, Setpoint #214 if CENT (Refer to Setpoints #211 and #214).

17.29. RTC Access to User Logic

The real time clock (RTC) can now be accessed in the User Logic.