

MagLev Water-Cooled Chiller



Technical Manual

pCO² CONTROLLER USER MANUAL

CONTROLLER FOR “MagLev™”
WATER-COOLED CHILLER
for Version – MCTS_A01-SE

 **MULTISTACK®**

Introduction

The MagLev™ chiller is a modular water-cooled chiller system, composed of one or more modules and is controlled by a *master controller*, to provide chilled liquid to an external circuit. The modules interconnect through a common chilled water header system. Each module contains a semi-hermetic compressor with magnetic levitation technology, stainless steel-brazed plate heat exchangers, and other related control components. Each MagLev™ chiller system is operated by a microprocessor based controller that monitors the status of each refrigerant circuit and provides a signal to operate the compressors as required. The system monitors the leaving chilled water temperature (LCHWT) to determine the need for cooling to the external circuit.

Module Board

Each module has a *module board*, which sends information to the *master controller* regarding the temperatures, pressures, and activity of the module and is equipped with a semi-graphical LCD with backlight and six button keypad. The feedback from the *module board* reports the status of each module back to the *master controller*. The *module board* performs safety checks and alerts the *master controller* when something is wrong. Loss of communication with the *master controller* results in the shutting down of the module when in *Auto* mode. The screen at the *module board* will display information regarding that module and the compressor installed on that module. The *module board* communicates with the compressor in that module via the Modbus Protocol. This information is also passed to the Master Controller over the pLAN connection. Information, like Actual RPM, Desired RPM, Inverter Temperature, Critical Alarms, High Pressure, Low Pressure, etc. from the compressor, is available through this connection.

Master Controller

The *master controller* is equipped with a semi-graphical LCD with backlight and a six button keypad. These buttons aid the operator in setting [SYSTEM VARIABLES](#), checking fault conditions, monitoring the status of the chiller system, and monitoring the status of individual modules. The *master controller* is also the interface to remote, field-supplied, hardwire connections such as, Remote Start/Stop, flow switch inputs, customer alarm outputs, and CHILL WATER or LOAD LIMIT reset signals. There is also an optional communication link for connecting to a Building Automation System (BAS). This connection will allow the BAS to remotely monitor and control the chiller system. See *BAS Interface* on page 18.





MODULE BOARD





MASTER CONTROLLER

Controller Keys

 The **UP** arrow button is used to go back to the previous category on the screen or to increase the value of a digit in a numeric variable field.

 The **DOWN** arrow button is used to advance to the next category on the screen or to decrease the value of a digit in a numeric variable field.

 The **ENTER** button is used to make a selection from any of the menu screens in the program. It is also used to enter and exit *edit mode* while in the **SYSTEM VARIABLES** screens.

 The **ALARM** button is the menu for current system or module faults. When the backlight is red, it indicates that a fault has occurred.

Prg The **PROGRAM** button goes to the **MAIN MENU** from any screen in the program.

Esc The **ESCAPE** button goes to the previous screen or the *status screen*, if you are at the top of the **MAIN MENU**.



Controller Setup




Each board on the network must have a different address. The *master controller* has a set of 6 DIP switches used to set the address on the board. The DIP switches are set in binary code addressing, where the first slot is a value of 1, the second is a value of 2, the third is a value of 4, the fourth is a value of 8, the fifth is a value of 16, and the sixth is a value of 32. The following DIP switch would give an address of 30 to its controller. (The black square is the switch position.)

ON	<table border="1" style="border-collapse: collapse; text-align: center;"> <tr> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> </tr> <tr> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> </tr> <tr> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> </tr> <tr> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> </tr> <tr> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> </tr> <tr> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> <td style="width: 15px; height: 15px;"> </td> </tr> </table>																																					= 30

Switches	Value
ON	
2	= 2
3	= 4
4	= 8
5	= 16
	30

The module boards' address is set electronically by simultaneously pressing and holding the ALARM and UP arrow buttons while cycling power on. After a few seconds a screen configuration will appear, to modify the address, use the UP and DOWN arrow buttons to change the address value, and then press ENTER to confirm.

The following are the addressing parameters for setting up a MagLev chiller network:

-  MagLev Modules – 1 thru 8
-  Master Controller – 30
-  Remote LCD Display – 32

In setting up the network, the *master controller* must have an address of 30. The MagLev modules would start with module 1 and proceed numerically through module 8.



Manual/Off/Auto Switch

Each MagLev module has a *Manual/Off/Auto* switch. In *manual mode*, the loading of the compressor is done by the *module board*. The control is independent of the other modules and is based on the LCHW temperature of that module. When *auto mode* is selected, the staging of the compressors is handled by the *master controller*. The *master controller* will determine how many compressors need to be on in order to satisfy the load requirements. Control of the compressors is based on the system LCHW temperature when in *auto mode*. *Disabled mode* (off) selection disables the module and the compressor is not allowed to run.

Main Menu

The *MAIN MENU* displays the options the user can access in the program. Press the **Prg** button to get to the *MAIN MENU* and then use the **UP** and **DOWN** arrow buttons to scroll through the menu. The **ENTER** button allows displaying of the sub-menu that the greater than sign (>) is located beside. The *MAIN MENU* contains *ON/OFF CONTROL*, *STATUS*, *SYSTEM VARIABLES*, *FAULT REVIEW*, *LOAD PROFILE*, and *SECURITY*.

On/Off Control Screen

Upon power up, the initial screen will go through a 12 second delay before giving control to the user. The *ON/OFF CONTROL* screen will be the next screen displayed when the timer expires. This screen allows the user to command the chiller *on* or *off*. The display will read 'CHILLER OFF, PUSH ENTER TO START'. Pushing the **ENTER** button, will display a message of '30 SECONDS TO START!' and will change to 'CHILLER ON, PUSH ENTER TO STOP'. After the 30 second delay, the first compressor will turn on, if needed, and the display will change to the *status screen*. The last line of the ON/OFF control screen shows critical system faults such as *WAITING FOR CHW FLOW*, *REMOTE SRART/STOP*, and *POWER PHASE MONITOR*.

System Variables

Once power is connected to the *master controller*, the *SYSTEM VARIABLES* can be accessed. These variables determine how the chiller system will run and are assigned default values. For most installations, these values will provide optimum performance. However, special operating conditions may require different settings.

Use the **UP** or **DOWN** arrow buttons to locate the *SYSTEM VARIABLES* in the *MAIN MENU*. The greater than sign (>) is the cursor indicator. Press the **ENTER** button to enter the *SYSTEM VARIABLES MENU*. *Chiller Setup*, *Customer Resets*, *Temp Readings*, *Time and Date*, *BAS Interface*, and *Factory Setup* are located in the *SYSTEM VARIABLES MENU*. Press the **ENTER** button again to enter one of the sub-menus. To change the value of a variable, press the **ENTER** button. A blinking block cursor will appear in that system variables' value field indicating that the program is in *edit mode*. Use the **UP** or **DOWN** arrow buttons to change the value of the variable. To save the new setting, press the **ENTER** button, pressing the **Esc** button will not save the change. The cursor will move back to the upper left corner of the screen indicating that the program is no longer in *edit mode*. An asterisk (*) next to the variables indicates that the *SYSTEM VARIABLES* are **locked** and cannot be adjusted. For assistance on unlocking the *SYSTEM VARIABLES*, see *SECURITY* on page 16.

Chiller Setup (System Variables)

The following is a list of *SYSTEM VARIABLES* for the *mechanical cooling* modules:

1. **UPPER SETPOINT:** The designed entering chilled water temperature (ECHW – System sensor) at full load. The temperature drop across this chiller is based on flow rate. If the design temperature drop (ΔT) is 10°F across the chiller, then the UPPER SETPOINT should be 10°F above the LOWER SETPOINT.
2. **LOWER SETPOINT:** The desired leaving chilled water temperature (LCHW – System sensor). The LOWER SETPOINT would be the setpoint the chiller is controlling to if the VSP is set to 0%.
3. **VSP SETPOINT:** A percentage used to determine the *control setpoint*. Leaving the VSP at 0% would keep the *control setpoint* at the value of the LOWER SETPOINT. Raising the VSP would incorporate a chilled water reset scheme allowing the *control setpoint* to change depending on the ECHW Temperature. As the ECHW temperature approaches the LOWER SETPOINT value, the *control setpoint* will reset according to the VSP percentage. See Graph on page 7.
4. **OFFSET:** This value is not a selectable value; it is built into the program. The offset is figured in the program by subtracting the LOWER SETPOINT from the UPPER SETPOINT and then dividing the value by the number of modules. (Max is 3°) $((Upper - Lower) \div Modules)$ This value is used in starting compressors. The LCHW Temperature has to be at or above the LOWER SETPOINT plus the OFFSET to bring a compressor on.
5. **LOAD LIMIT:** A percentage used to limit the maximum system load. If this variable is set to 75% on a 4 compressor chiller, then only 3 of the 4 compressors would be available to run at any given time.
6. **CAPACITY LIMIT:** A percentage used to limit the maximum demand sent to a compressor at any given time. If this variable is set to 70%, then 70% demand is the maximum signal that can be sent to any of the compressors in the chiller system.
7. **T-DIFF (Time Difference):** The minimum time in seconds between increases in demand to a compressor on initial ramp up. This time should be set at or above the loop time of the chiller. The loop time is the time it takes for the water to make one pass through the entire CHW loop of the building.
8. **FAIL INDIC (Failure Indicator):** A percentage value which provides for an output signal to the Customer Alarm Relay whenever compressors of the indicated value have failed. A 0% setting will give an output signal after any failure within the system.
9. **MAN SETPOINT:** The desired LCHW temperature of that module when in Manual Mode.
10. **MAN OFFSET:** A value that, when added to the MAN SETPOINT, defines the point where the compressor will turn on; and, when subtracted from the MAN SETPOINT, defines the point where the compressor will turn off.
11. **LEAD COMP:** Determines which compressor is the first on. The first compressor off is the compressor that has run the longest in that particular cycle.
12. **NUM OF MODULES:** This is the number of MagLev modules that are in the chiller system.
13. **HP CUTOOUT:** The point where a high pressure fault occurs based on the high pressure reading returned from the compressor. This value is measured in psig. Note: Each module also has a mechanical high pressure switch with a manual reset.
14. **FLUSH TIME:** The time at which the DDRS-210A is energized.
15. **FLUSH DURATION:** The time in seconds telling how long the DDRS-210A is energized.
16. **INDEXING:** INDEXING can either be ON or OFF. If ON, the lead compressor advances by one every 24 hours at midnight. If OFF, the LEAD COMPRESSOR stays the same unless it is changed manually.

Standard Application

Program Version Format MCTS_A00-SE

System Variable Ranges & Default Settings

Mechanical Cooling

The following table defines all of the *SYSTEM VARIABLE* ranges and default values for MagLev modules with the standard program.

System Variable	Range	Default Value
UPPER SETPOINT	45°F to 80°F	55°F
LOWER SETPOINT	40°F to 70°F	45°F
VSP VALUE	0% to 80%	0%
LOAD LIMIT	0% to 100%	100%
CAPACITY LIMIT	0 % to 100%	100%
T-DIFF	15 to 200 sec	90 sec
FAIL INDIC	0% to 90%	0%
LEAD COMP.	1 to 8	1
NUM OF MODULES	1 to 8	1
HP CUTOUT	190 to 270 psig	200
FLUSH TIME	0 to 23 hrs and 0 to 59 min	12:00 (noon)
FLUSH DURATION	0 to 60 sec	20 sec
INDEXING	OFF or ON	ON

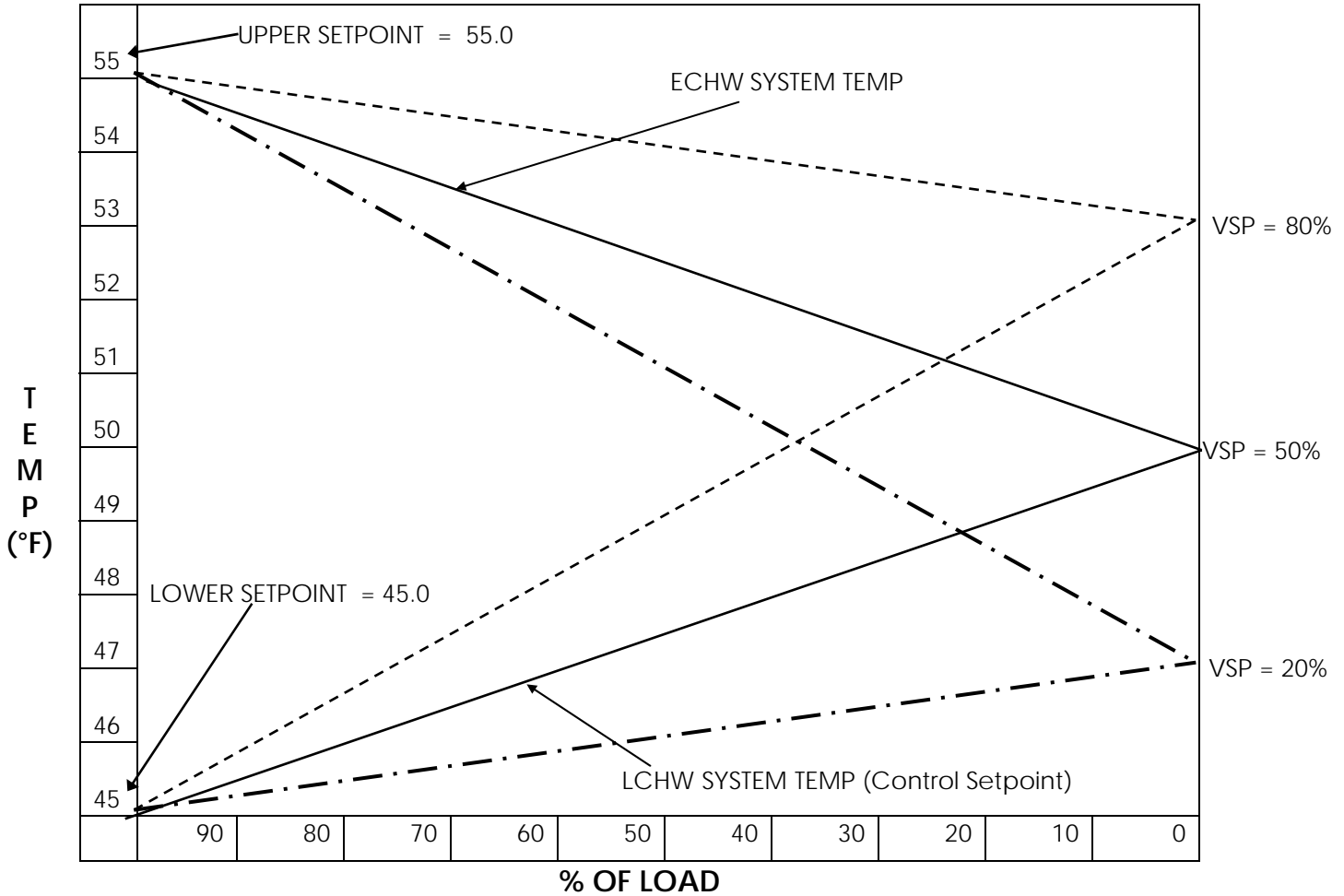
Standard Module Cutouts and Reset Points

Low Suction Temp	Cutout → 25°F	Reset @ 30°F
Low Leaving CHW	Cutout → 36°F	Reset @ 40°F
High Pressure	Cutout → HP Cutout Value	Reset below 175 psig

Auto Mode

Chilled Water Reset for Temperature Control

The following chart defines how the chilled water reset scheme operates when utilizing UPPER SETPOINT, LOWER SETPOINT, and VSP in the *SYSTEM VARIABLES*.



Example:

If the UPPER SETPOINT = 55°F; LOWER SETPOINT = 45°F; VSP = 50%; then the *no load* point would be 50°F. $[(\text{upper} - \text{lower}) * \text{vsp} \div 100 + \text{lower} = \text{no load}]$ In this example, if the ECHWT is at or above 55°F (upper setpoint) then the *control setpoint* would be 45°F. If the ECHWT is at or below 50°F (no load) then the *control setpoint* would be 50°F.

Note: The lower the VSP value selected will result in the most constant Leaving Chilled Water Temperature from the chiller.

Mechanical Cooling – Manual Mode

In *manual mode* operation, each module acts independently, depending on the sensor inputs to that module. The loading of the compressor is done by its module board. The control is based on the LCHW temperature of that module. The following are *SYSTEM VARIABLES* that are used in *manual mode* operation:

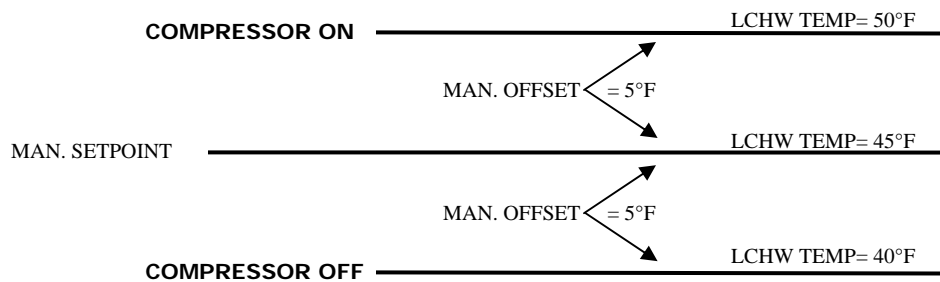
1. **MAN SETPOINT:** The LCHW temperature that the compressor will try to maintain.
2. **MAN OFFSET:** A value that, when added to the MAN SETPOINT, where the compressor will turn *on*; and, when subtracted from the MAN SETPOINT, the point where the compressor will turn *off*.



Caution: Operation of chiller in manual mode bypasses the flow protection and power phase monitor safeties. Operation of the chiller in this mode is not recommended for extended periods. Proper precautions must be made to prevent freezing of the heat exchangers.

Manual Mode Ranges and Default Settings

System Variable	Range	Default Value
MAN. SETPOINT	40°F to 70°F	45°F
MAN. OFFSET	0°F to 5°F	5°F



Master Controller Status Screens

System Screens

The main status screen displays information about the chiller system.

1. **CAPACITY:** A percentage of the chiller that is operating. It is calculated by adding the *demand* of each compressor (0-100%), and then dividing by the total number of compressors. This value will be displayed in the range of 0-100%. An asterisk (*) displayed next to capacity indicates that it is being controlled by an external source, either LOAD LIMIT or CHILL WATER RESET.
2. **DELAY:** A time in seconds between demand increases or compressor starts. A compressor should only turn on or ramp to a new demand if the delay time counter is at zero. This is determined by the system variable T-DIFF.
3. **FAULTS:** A value showing how many current faults are in the chiller system.
4. **ECHW:** The common Entering Chilled Water temperature to the chiller.
5. **LCHW:** The common Leaving Chilled Water temperature from the chiller.
6. **ECW:** The common Entering Condenser Water temperature to the chiller.
7. **LCW:** The common Leaving Condenser Water temperature from the chiller.

Press the **DOWN** arrow button once to display the next main status screen with system information.

1. **CONTROL SETPT:** The LCHW Temperature that the chiller is trying to maintain.
2. **LEAD COMP:** The compressor shown is the first on. The compressor that has the most run time in the cycle will be the first off.
3. **LOAD LIMIT:** A value to limit the max number of compressors available to run expressed in a percentage from 0 to 100. An asterisk (*) indicates the external LOAD LIMIT RESET signal is enabled.
4. **CHW OFFSET:** Shows the value of the customer CHW RESET signal from 0 to 10°F. This value is added to the UPPER and LOWER SETPOINTS. An asterisk (*) indicates the external CHW RESET signal is enabled.

Module Information Screens *(at the master controller)*

Press the **DOWN** arrow button while on the second main status screen to display information for the first MagLev module. The following information is available for each module in the chiller system:

1. **LCHW:** The Leaving Chilled Water temperature in the module, measured at the leaving of each evaporator coil.
2. **SUCT:** The Suction temperature in the module, located on the compressor suction line.
3. **COMP #:** This displays the status of the compressor, whether it is *on* or *off*, and tells which compressor number it is in the chiller system.
4. **Status Line:** The status line of the module displays general information about the condition of that particular module. If there is a fault condition in that module, then its condition will be displayed on this line.

Press the **DOWN** arrow button again to display screen #2 for the first module. Information on this screen is as follows:

1. **HP:** The High Pressure reading, in psig, based on the discharge pressure in the compressor of that module.
2. **LP:** The Low Pressure reading, in psig, based on the discharge pressure in the compressor of that module.
3. **RUN TIME:** This displays the total number of hours that the compressor has run. To reset the run hours, press and hold the **ALARM** and **DOWN** arrow buttons simultaneously on the screen of the module whose hours need to be reset. The SYSTEM VARIABLES must be unlocked to clear compressor run hours.

More detailed information about each compressor can be accessed by pressing the **ENTER** button to display screen #1 for Compressor #1 Info.

1. **DEMAND:** The demand input to the compressor expressed as a percentage from 0 to 100. The operating speed is directly related to the demand input.
2. **DEMAND TYPE:** The type of demand signal that the compressor is currently set up to receive. The demand signal for the MagLev application should read "MODBUS".
3. **COMPRESSOR STATUS:** Provides additional information from the compressor on the current status of the compressor.

Press the **DOWN** button to display screen #2 for Compressor #1 Info.

1. **ACT RPM:** The actual shaft speed of the compressor.
2. **DES RPM:** The requested shaft speed based on the control logic for each compressor. This value may be higher than the actual shaft speed.
3. **IGV POSITION:** The position of the Inlet Guide Vane expressed as a percentage from 0 to 110 (slightly beyond fully open).

Press the **DOWN** arrow button to display screen #3 for Compressor #1.

1. **LINE VOLTAGE:** The calculated three phase voltage going into the compressor
2. **LINE AMPS:** The calculated three phase current that the compressor is drawing from the mains.
3. **POWER KW:** The power consumption of the compressor measured in KW.
4. **INVERTER TEMP:** The temperature of the electronics that controls the compressor measured by the thermistor mounted under the IGBT inverter.

Press the **DOWN** arrow button to display screen #4 for Compressor #1 – Alarms.

1. **NON-CRIT:** Active non-critical alarms from the compressor. The non-critical alarms will allow the compressor to continue operation.
2. **CRITICAL:** Active critical alarms from the compressor. A critical alarm will not allow the compressor to operate.

Module Information Screens *(at the module board)*

1. **LCHW:** The Leaving Chilled Water temperature in the module, measured at the leaving of each evaporator coil.
2. **SUCT:** The Suction temperature in the module, measured on the compressor suction line.
3. **RPM:** The actual shaft speed of the compressor.
4. **TIMER:** This timer shows the countdown of the minimum off timer.
5. **STATUS LINE:** See item 4 on page 9 under Module Information Screens.

Press the **DOWN** button to display screen #2 for Compressor #1 Info.

1. **IGV POSITION:** The position of the Inlet Guide Vane expressed as a percentage from 0 to 110 (slightly beyond fully open).
2. **DEMAND:** The demand input to the compressor expressed as a percentage from 0 to 100. The operating speed is directly related to the demand input.
3. **CRITICAL:** Active critical alarms from the compressor. A critical alarm will not allow the compressor to operate.
4. **STATUS LINE:** See item 4 on page 9 under Module Information Screens.

Manual Mode Module Screens

NOTE: These screens are only accessible when the module is in *Manual Mode* of operation!

Press the **PRG** button when in *Manual Mode* to change the manual mode variables.

1. **MAN SETPOINT:** The LCHW temperature that the compressor will control to.
2. **MAN OFFSET:** A value that, when added to the MAN SETPOINT, where the compressor will turn *on*; and, when subtracted from the MAN SETPOINT, the point where the compressor will turn *off*.

Press the **ALARM** button when in *Manual Mode* to view and reset alarms in that module. The screen below is a sample of what the screen will look like.

```
*** MODULE #01 ***
**** ALARM ****
(ALARM HERE)
PRESS ENTER TO RESET
```

Inputs and Outputs

Master Controller Inputs

1. **Customer Chilled Water Reset Signal or Customer Load Limit Reset Signal:** A 0-10Volt, 0-20 mA, or 4-20 mA, customer supplied, **external** signal that shifts the UPPER and LOWER SETPOINTS from 0 to 10°F or allows the customer to change the LOAD LIMIT from 0 to 100%.
2. **Entering Condenser Water Sensor:** A NTC type sensor that measures the temperature of the condenser water entering the chiller.
3. **Leaving Condenser Water Sensor:** A NTC type sensor that measures the temperature of the condenser water leaving the chiller.
4. **Entering Chilled Water Sensor:** A NTC type sensor that measures the temperature of the system chilled water entering the chiller.
5. **Leaving Chilled Water Sensor:** A NTC type sensor that measures the temperature of the system chilled water leaving the chiller.
6. **EX1:** A customer supplied “Dry Contact” input that is required to be closed circuit to operate; open to stop operation. Requires a manual reset to resume operation. This input will create a fault.
7. **Remote Start/Stop:** An input that is a closed circuit to operate; open to stop operation. Automatic restart of the chiller. This input does NOT create a fault.
8. **Power Phase Monitor:** An input that is a closed circuit to operate; open to stop operation. Automatic restart returns the chiller to the previous *on/off* state of the chiller. This input will create a fault. The alarm light at the *master controller* will remain *on* until the fault is cleared.
9. **CHW Flow Switch:** An input that is a closed circuit to operate; open to stop operation. This circuit has a 4 second delay between the time it opens and when the system shuts down. Requires a reset and a restart to resume operation.
10. **CW Flow Switch:** An input that is a closed circuit to operate; open to stop operation. This circuit will allow the system to start when open. There is a 10 second delay on start-up before this circuit will shut the system down. This is to allow time for the condenser water pump to start with the first compressor and provide water flow stabilization. After the initial 10 second delay expires, then the fault only requires a 4 second delay between the time it opens and the time the system shuts down during normal operation. Requires a reset and a restart to resume operation.

Master Controller Outputs

1. **Customer Alarm Relay:** This is a 24V AC, 5VA max signal that can power a relay to trigger an alarm. The output is controlled by the failure indicator setting in the *SYSTEM VARIABLES*.
2. **Full Load Indicator Relay:** This is a 24V AC, 5VA max signal that can power a relay to show when the chiller system is at *full load*.
3. **Run Status Relay or Condenser Pump Relay:** This is a 24V AC, 5VA max signal that can power a small relay to control the condenser water pump. This output is energized anytime at least one compressor is running in the chiller.
4. **DDRS-210A Flush:** This is a 24V AC signal that can power a solenoid valve once a day for a preset amount of time. This signal works with the FLUSH TIME and FLUSH DURATION settings found in the *SYSTEM VARIABLES*.

Module Board Inputs

1. **Leaving Chilled Water Sensor:** A NTC type sensor that measures the temperature of the LCHW in the module.
2. **Compressor Status:** A contact closure on the compressor interface board that when closed indicates that the compressor is allowed to run. A compressor fault will occur when the status signal from the compressor is absent.

Module Board Outputs

1. **Compressor Start Signal:** A “Dry Contact” output wired to the compressor interface board used to control the starting of each compressor. The compressor start signal is connected to the interlock input of the compressor interface board. When the signal is not available, the compressor will ramp down to 0 RPM and de-levitate.

Faults

If a fault condition has occurred, the **ALARM** button will illuminate. To view the current fault(s), press the **ALARM** button. Use the **UP** and **DOWN** arrow and **ENTER** buttons to view and clear the fault(s). If the fault does not clear, then the fault is still current.

System Faults

If any of the following fault conditions occur, all compressors in the system will be turned off:

1. **EX1:** Customer Input – EX1 requires a reset at the *master controller*.
2. **Remote Start/Stop:** Customer Input – This condition does not log as a fault. This circuit operates like an on/off switch. If closed, the chiller is enabled. If open, the chiller is disabled and the compressors will be unable to run.
3. **Power Phase Monitor:** When the Power Phase Monitor input opens, the chiller is disabled until the input is closed again. There is no reset required at the *master controller* to resume operation, only to clear the alarm from the current fault log. Automatic restart returns the chiller to the previous *on/off* state of the chiller.
4. **CW Flow:** A signal from the condenser water flow switch that alerts the *master controller* of NO FLOW on the condenser side of the chiller and disables all modules in the chiller. This fault requires a manual reset and a restart at the *master controller*.
5. **CHW Flow:** A signal from the chilled water flow switch that alerts the *master controller* of NO FLOW on the evaporator side of the chiller and disables all modules in the chiller. If the flow switch opens and the chiller has not been commanded *on*, a warning will appear at the bottom of the *start/stop* screen, however, no fault will occur. This fault requires a manual reset and restart at the *master controller*.
6. **LOCHW Temp:** Low Leaving Chilled Water temperature. If the system LCHW falls below 36°F, all compressors will turn off. The water temperature must rise to 40°F before the fault can be cleared. This requires a manual reset and restart at the *master controller*.
7. **ECHW Sensor Failure:** The sensor for the system ECHW has either opened or shorted to the *master controller*. This fault requires resetting at the *master controller*.
8. **LCHW Sensor Failure:** The sensor for the system LCHW has either opened or shorted to the *master controller*. This fault requires resetting at the *master controller*.

9. **ECW Sensor Failure:** The sensor for the system ECW has either opened or shorted to the *master controller*. This fault does not affect the operation of the chiller.
10. **LCW Sensor Failure:** The sensor for the system LCW has either opened or shorted to the *master controller*. This fault does not affect the operation of the chiller.

Mechanical Cooling Module Faults

The following faults will only affect the module that they are associated with.

1. **High Pressure:** High Pressure Cutout. This high pressure fault can come from either the discharge pressure reading of the compressor or the HP switch being tripped. When the discharge pressure reading reaches the value of the HP CUTOOUT, a fault will occur, shutting down that compressor. The fault can be reset at the *master controller* after the high side pressure drops below 175 psig. If the High Pressure switch trips then, it requires resetting the HP switch at the module and clearing the fault at the *master controller* to resume operation. The fault will remain current until the HP switch is manually reset and the pressure is below 175 psig.
2. **LOSUCT:** Low Suction Temperature: This is measured by the module suction sensor. If during operation this temperature should drop below 25°F, the module's compressor will shut down. This requires resetting at the *master controller*, but only after the temperature has risen above 30°F. The system has to be *on* for this fault to occur.
3. **SUCT SENSOR FAILURE:** Suction Sensor Failure. This would occur if the suction line sensor reading is outside the range of the sensor. This fault requires resetting at the *master controller*.
4. **LOCHW TEMP:** Low Leaving Chilled Water Temperature: This is measured by the module LCHW temperature sensor. If the temperature falls below 36°F, the module's compressor will turn *off*. The temperature must rise to 40°F before the fault can be reset at the *master controller*.
5. **LCHW SENSOR FAILURE:** Leaving Chilled Water Sensor Failure: This would occur if the sensor opened or shorted to the *module board*. This fault requires resetting at the *master controller*.
6. **RPM DELAY:** When a module is in an RPM delay, it means that the compressor is not meeting the speed requirement for the demand signal that the *master controller* is sending to it. The delay can be active for a period of ten minutes. If the demand signal sent to the module increases, the timer will start over. As long as the ACT RPM of the compressor keeps up with the demand, then the RPM DELAY will not occur. If the timer reaches the 10 minute limit, then the compressor will be disabled and will restart after its minimum time off requirement is satisfied, if the compressor is needed.
7. **COMMUNICATIONS ERROR:** Communication errors can occur when the *master controller* is not properly communicating with the module boards in the chiller. This fault is an automatic reset. The alarm will still need to be cleared in the alarm screens; however, this will not hold back the operation of the module if the *master controller* begins communicating again.
8. **Non-Critical Alarms:** These alarms are from the compressor and will be displayed on the compressor alarm screen of the module. The non-critical alarms are warnings that the compressor is getting close to a critical alarm. The non-critical alarms will not stop the operation of the compressor, but slow down the motor. The following is a list of non-critical alarms that may be seen:
 - a. **NO WARNINGS:** No non-critical current alarms.
 - b. **INVERT TEMP:** High Inverter Temperature
 - c. **DCHRG TEMP:** High Discharge Temperature at the compressor flange.
 - d. **LOW PRESS:** Low Pressure at the compressor flange.
 - e. **HIGH PRESS:** High Pressure at the compressor flange.
 - f. **3 PH CRNT:** 3 Phase Over-Current - Excessive system load usually due to the compressor pumping liquid. This can be a result from low voltage.

- g. **CAVITY TEMP:** Shaft Cavity Temperature – Insufficient motor cooling.
 - h. **TEMP SENSOR:** Motor Winding
 - i. **COMP RATIO:** Total Compression Ratio – This fault will occur if the difference between the discharge pressure and suction pressure is outside the operational envelope of the compressor.
 - j. **SCR TEMP:** SCR Temperature – Increased temperature of the AC to DC voltage rectifier.
9. **Critical Alarms:** These alarms are from the compressor and will be displayed on the compressor alarm screen of the module and in the fault review when they occur. The critical alarms have exceeded the compressor’s alarm setting and will stop the operation of the compressor. The following is a list of critical alarms that may be seen:
- a. **NO WARNINGS:** No critical current alarms.
 - b. **INVERT TEMP:** High Inverter Temperature
 - c. **DCHRG TEMP:** High Discharge Temperature at the compressor flange.
 - d. **LOW PRESS:** Low Pressure at the compressor flange.
 - e. **HIGH PRESS:** High Pressure at the compressor flange. Note: A *High Pressure* alarm will lock out the compressor. The compressor will have to be powered down manually. Power must be cycled to the compressor (off for 3 minutes) to clear this alarm.
 - f. **3 PH CRNT:** 3 Phase Over-Current - Excessive system load usually due to the compressor pumping liquid. This can be a result from low voltage. Note: A *3 Phase Over-Current* alarm will lock out the compressor. Power must be cycled to the compressor (off for 3 minutes) to clear this alarm.
 - g. **CAVITY TEMP:** Shaft Cavity Temperature – Insufficient motor cooling.
 - h. **TEMP SENSOR:** Motor Winding
 - i. **COMP RATIO:** Total Compression Ratio – This fault will occur if the difference between the discharge pressure and suction pressure is outside the operational envelope of the compressor.
 - j. **BEARING MTR:** Bearing Motor (BMC) – Front or Rear radial displacement of the shaft.
 - k. **SCR TEMP:** SCR Temperature – Increased temperature of the AC to DC voltage rectifier.
 - l. **SYS LOCK OUT:** System Lock Out – If any combination of the alarms listed below occurs more than 3 times within 30 minutes, a *System Lock Out* occurs:
 - i. Inverter Temperature Alarm
 - ii. Cavity Temperature Alarm
 - iii. SCR Temperature Alarm

Fault Review

The FAULT REVIEW is a history of the faults that have occurred in the chiller system. The review holds up to 25 faults. The review can be found in the *MAIN MENU*. The faults are in order by the most recent to the oldest. Pushing the **UP** and **DOWN** arrow buttons allows scrolling through the faults. Pushing the **ENTER** button on a particular fault allows for viewing additional system information. Pushing **ENTER** again allows for viewing additional module information. The following is a sample of what the three screens contain:

FAULT 01 CURRENT COMMUNICATION ERROR MOD1 9/17 12:35 PRESS ENTER FOR MORE

Screen #1

FAULT 01 *SYS INFO* ECHW 00.0 ECW 000.0 LCHW 00.0 LCW 000.0 PRESS ENTER FOR MORE
--

Screen #2

FAULT 01 *MOD INFO* LCHW 00.0 HP = 000 SUCT 00.0 LP = 000
--

Screen #3

Screen one displays information about the fault. The status of the fault will be displayed as **CURRENT**, **RESET**, or **RECORD**. **CURRENT** means that the fault is still present, **RESET** means that the fault can be reset at the *master controller*, and **RECORD** means that the fault is part of the history for future reference. The date and time of the fault, the fault that occurred and where the fault occurred are also displayed on the first screen. On screen two, the system temperatures at the time the fault occurred are displayed. On screen

three, the module information is displayed that was current at the time of the fault. If the fault is a system fault the module information will display all zeros.

Clearing the faults from the FAULT REVIEW removes all the faults at once. Hold down the **Prg** and **UP** arrow buttons simultaneously for all faults to be removed from the FAULT REVIEW. When a message of **NO MORE ALARMS** appears on the screen, release the buttons.

Time and Date

The TIME AND DATE option is located in the *SYSTEM VARIABLES' MENU*. Press **ENTER** on the TIME AND DATE option. The time appears first and is displayed in 24 hour time. To change the time, press the **ENTER** button, putting the program into *edit mode*. The cursor is now in the *hour* field, use the **UP** and **DOWN** arrow buttons to change the *hour* to the correct time. Press the **ENTER** button again to move the cursor to the *minute* field to change it. Press the **ENTER** button one more time to set the TIME. Press the **Esc** button, at anytime, to abort the time change.

After setting the TIME, use the **DOWN** arrow button to move to the DATE screen. Press **ENTER** to move the cursor into the *month* field. Using the **UP** and **DOWN** arrow buttons, change the value to the current *month*. Press **ENTER** again to move the cursor to the *day* field, adjust the *day* accordingly. Press **ENTER** again to move to the *year* field, adjust the *year* accordingly. Press **ENTER** one more time to accept the DATE. Press the **Esc** button, at anytime, to abort the date change.

Customer Resets

CHILL WATER RESET (CHW) and LOAD LIMIT RESET are external inputs that are program selectable as 0-10Volt, 0-20 mA, or 4-20 mA. The customer can send a signal to change these values remotely. The CHW RESET will increase the UPPER and LOWER SETPOINTS in the chiller from 0 to 10 °F. The LOAD LIMIT RESET will allow the LOAD LIMIT of the chiller to be changed from 0 to 100%. There will be an asterisk (*) by the CHW OFFSET or the LOAD LIMIT values on the second system status screen, if they are enabled. The *CUSTOMER RESET* options are located in the *SYSTEM VARIABLES' MENU*. An asterisk (*) also appears next to CAPACITY on the *main status screen* when either reset is enabled. Press **ENTER** and use the **UP** and **DOWN** arrow buttons to enable the feature to be used. Both default to OFF, but when enabling the user must select the type of input being used. (0-10 Volt, 0-20 mA, or 4-20 mA)

Temperature Readings

The temperature readings default to Fahrenheit (°F). The readings may be set to display in Celsius (°C), by going to the *SYSTEM VARIABLES' MENU*. Press **ENTER** on TEMP. READINGS option. Press **ENTER** again to move the cursor into the field. Use the **UP** or **DOWN** arrow buttons to change the field from Fahrenheit to Celsius. Press **ENTER** again to accept the change.

Security

The security option in the *MAIN MENU* is used to lock the *SYSTEM VARIABLES*. The first screen tells whether the variables are **locked** or **unlocked**. Initially the screen will say 'SYSTEM VARIABLES UNLOCKED'. Press **ENTER** to change the status of the security. The cursor will be on the first letter of the password code. Enter a five letter password, using the **UP** and **DOWN** arrow buttons to change the letter and press **ENTER** to move to the next letter. After entering the last letter, the next screen is to accept the password or clear the password. Press **ENTER** again to set the password or **Esc** to clear the password. The screen will then display the status of the *SYSTEM VARIABLES* as LOCKED. An asterisk (*) is displayed within the *SYSTEM VARIABLES' MENU* in place of the greater than sign (>) as a cursor for the menu. If the asterisk is seen, the *SYSTEM VARIABLES* need to be **unlocked** before trying to make any changes to them.

If the password is forgotten, please call your Multistack Service Representative at 608-366-2400.

Board LED's

Five LED's are present on the *master controller* board. Two LED's are located at the bottom of the board, one yellow and one red. The yellow one indicates that the board is receiving power. The red one is an alarm LED that would indicate that something is wrong with the board internally. Three more LED's are located at the top of the board next to the DIP switches. These LED's indicate that the connection, address definition and pLan (network of the modules) are working correctly. The green and yellow LED's should be lit for the network to be working properly.

Four LED's are present on each *module board*. They are all located at the top of the board. One single yellow LED indicates that the board is receiving power. The other three LED's indicate that the connection, address definition and pLan (network of the modules) are working correctly. The green and yellow LED's should be lit for the network to be working properly.

Program Version

The program version is found by going to the *Main Menu* and pressing the **PRG** and **UP** arrow buttons simultaneously. A screen will appear that displays the version of the program in the controllers and the month and year the program was developed. The version will appear in a format similar to MCTS_A00-SE. When looking at the version, the forth position could vary between S, L, and B. The S stands for a Standard application, the L for a Low Ambient application, and the B for a Brine or Low Temperature application. Each of these programs may have different cutouts or temperature ranges available to the customer. The standard application *system variables* and cutouts are located on [page 6](#).

BAS Interface

The *master controller* is capable of tying into a building automation system. Modbus and BACnet are the two protocols that are currently available. First the *BAS INTERFACE* needs to be enabled. This is accomplished by going to the *SYSTEM VARIABLES Menu* and changing the enable point, under *BAS INTERFACE*, to *yes*. The enable defaults to *no*. This menu also has a variable to select which *Protocol* will be used. Select the appropriate *Protocol* for the job. BACnet is the default for this variable.

Modbus

Modbus requires that a RS485 card is installed into the pCO2 *Master Controller*. This card plugs into the serial port and communicates Modicon Modbus Protocol Rev. D. The Modbus protocol used is RTU type. The configuration is multipoint for RS-485. The data communication is asynchronous serial, 8 data bits, 2 stop bits, and no parity across an EIA-485 two-wire half-duplex connection. The minimum cable size recommended is an AWG20/22 two-wire twisted shielded cable. The pin wiring is GND, RX+/TX+, RX-/TX- and is stamped on the terminal connector. The customer can adjust the *Baud Rate* and the *Network Number*. These settings are found in the *SYSTEM VARIABLES Menu* under *BAS INTERFACE*. The *Baud Rate* defaults to 9600 bps and can be adjusted to 1200, 2400, 4800, 9600, or 19200 bps. The *Network Number* is the same as a slave address and defaults to 1. This number must be unique to the Modbus network. The range for the *Network Number* is from 1-200. See the MagLev Modbus Technical Manual for a table of Modbus registers.

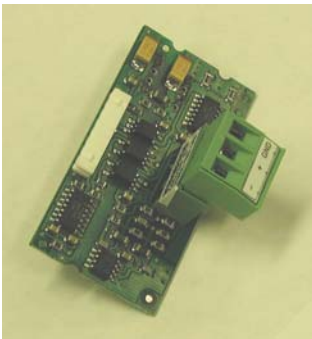


Figure 1 - RS485 Card

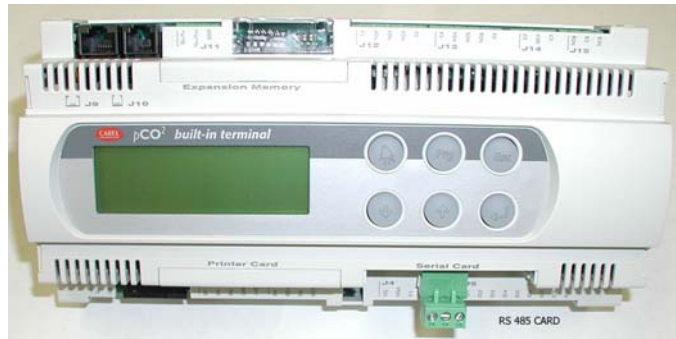


Figure 2 - pCO2 with RS485 Card

BACnet

BACnet requires that a pCO Web card is installed in to the pCO2 *Master Controller*. This card plugs into the serial port and communicates BACnet over Ethernet (ISO8802-2 or 8802-3) or BACnet over TCP/IP (Addenda A/Annex J). The recommended cable is shielded class 5, max 100mt. The *Baud Rate* has to be set and defaults to 19200. See the MagLev BACnet Technical Manual for a table of points and instructions on changing the IP Addressing scheme.



Figure 3 – pCO Web Card



Figure 4 - pCO2 with pCO Web Card

APPENDIX A

DEFINITION OF INPUTS AND OUTPUTS

TURBOCOR SE

MASTER CONTROL (UNIT WITH DISPLAY)

ANALOG INPUTS

- B1 CHW RESET OR LOAD LIMIT RESET (selectable)
- B2 ENTERING CONDENSER WATER SENSOR (ECW)
- B3 LEAVING CONDENSER WATER SENSOR (LCW)
- B4 ENTERING CHILL WATER SENSOR (ECHW)
- B5 LEAVING CHILL WATER SENSOR (LCHW)

DIGITAL INPUTS

- ID1 EX 1 INPUT
- ID2 REMOTE START / STOP
- ID3
- ID4 POWER PHASE MONITOR
- ID5 CHILL WATER FLOW SWITCH
- ID6 CONDENSER WATER FLOW SWITCH
- ID7
- ID8

ANALOG OUTPUTS

- Y1
- Y2
- Y3
- Y4

DIGITAL OUTPUTS (RELAY TYPE)

- NO1 CUSTOMER ALARM RELAY
- NO2 FULL LOAD RELAY
- NO3 RUN STATUS OR CONDENSER PUMP RELAY
- NO4 DDRS
- NO5
- NO6
- NO7
- NO8
- NC8

TURBOCOR SE MODULE BOARDS

ANALOG INPUTS

- B1
- B2
- B3
- B4 LEAVING CHILL WATER SENSOR (LCHW)

DIGITAL INPUTS

- ID1 MANUAL MODE
- ID2 AUTO MODE
- ID3 COMPRESSOR FAULT
- ID4
- ID5
- ID6

ANALOG OUTPUTS

- Y1
- Y2
- Y3

DIGITAL OUTPUTS (RELAY TYPE)

- NO1 LIQUID LINE SOLENOID VALVE
- NO2
- NO3 ALARM OUTPUT
- NO4 COMPRESSOR START SIGNAL (INTERLOCK)
- NO5 WATER SOLENOID VALVE
- NC5