# **CR110 MANUAL**

### Pro Refrigeration, Inc





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# 1 Preface

This manual is intended to be used in conjunction with Pro Refrigeration's CR110 Refrigeration Controller.

This manual will guide you through the process of installing, configuring and troubleshooting your CR110 Refrigeration Controller.

**Note:** Check the following URL for the latest version of this manual and other Pro Refrigeration, Inc product documentation. http://www.prochiller.com/support

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Pro Refrigeration, Inc.

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LED CR14: CR14 is a communication indicator LED. The light will blink when it responds to an RS-485 Communications request.

Sensors 1-8: 0-5V Input Sensors. See Sensor Wiring for further information.

Power Surge Suppressor

8-PIN CR110 Communication Chip Commutation Surge Suppressor

14-PIN J7 Analog Output Control Chip

**EEPROM Chip:** The chip is loaded with latest version of CR110 controller software at factory.

LED's CR10-CR13: CR110 mode lights. See Modes Of Operation for further information

..... CR1

LED's CR1-CR9: CR110 output lights. See CR110 Output Status LED's for further information

**Fuses K1-K8:** 2AMP 130VAC output fuses. See replacement parts section for part number.

**J1:** Connect to 24V AC or DC Power Source.

**S2 Control Switch:** This switch controls the power and function of the CR110 card.

J13: This is the CR110's primary communication port.

AUX: The AUX port can be used as an additional communication port.

J7 (Analog Output): I->C = 4-20mA V->C = 0-10V

**J20:** Port J20 is used when programming the CR110 EEPROM chip.

J3:01-04 & J8:05-08: 120Volt analog outputs. See basic system wiring for further information

**C Ports:** Output power coming from external protection components.

**120/240:** Output power coming from neutral.



### **Basic Operation & Features**

The typical chiller application can consist of one to four compressors, each compressor controlled by a dedicated CR110 Control Card. The TPC touch screen Interface provides a local display and operator interface. The TPC is not needed for system operation it simply monitors, records and provides an operator interface.

All aspects of the CR-110 operation is based on providing the most efficient operation possible. The CR-110, looks at the difference between the coldest temperature sensor and the Set-point. It uses a PI loop to calculate an output signal from 0 to 100 percent. This signal is then used by multiple CR-110's to stage the liquid line solenoid valve and unloaders. The result is a very smooth and precise temperature control without short cycling the compressors. With the elimination of multiple dedicated set points controlling multiple cooling stages, the CR110 delivers a flexible set up with much tighter temperature variation and control.

On a multiple compressor system, each compressor utilizes two temperature sensors to detect both the Chilled Water Supply Temperature and Chilled Water Return Temperature. This provides a complete full redundant system. By default the controller will alternate lead compressors after 24 hours (adjustable) of compressor run time.

Each CR-110 monitors the compressor suction pressure, suction temperature, and discharge pressure. Any failure of sensors or exceeding temperature and pressure specifications will result in an alarm. An alarm mode will result in an automatic lead change to the next compressor and or back up compressor.

### **CR110 Quick Start**

### STEP 1

Verify that the main power to the system is OFF. This can be accomplished by confirming that the disconnect handle is in the OFF position



### STEP 2

Open the electrical panel and locate the Compressor Circuit Breakers





### STEP 3

Switch the compressor circuit breakers to the OFF position



### STEP 4

Locate the CR110 Cards



### STEP 5

Remove the cover from the CR110 Cards



### STEP 6

On the CR110 Card, locate the OFF-RUN-PD toggle switch



### STEP 7

Verify that the toggle switch is in the OFF position

### **STEP 8**

Turn the main power to the system ON by moving the disconnect handle to the ON position



### STEP 9

Using a volt-meter verify that the main power voltage matches that of the system voltage





### STEP 10

Turn the PROCESS PUMP switch to the ON position.



### STEP 11

Turn the STAGE switches to the ON position.



### STEP 12

Turn the CONTROLLER switch to the ON position.



STEP 13

Turn the CONTROLLER switch to the ON position.



### STEP 14

Verify that the temperatures and system pressures displayed on the controller interface panel are accurate.

### STEP 15

Adjust the system set point to 5°F higher then the current displayed temperature. Please reference your display manual for instructions on changing set point.

### STEP 16

Verify that the gauge pressures are approximately the same (+- 3-5psi) as those observed on the controller interface panel.

### STEP 17

Perform steps 12 - 15 for the remaining CR110 Cards.

### **STEP 18**

Turn the CR110 Cards toggle switch to the OFF position.



### **STEP 19**

Reset the low oil pressure controls for each compressor.



### STEP 20

Switch the compressor circuit breakers to the ON position.



### STEP 21

Place each CR-110 card in the RUN mode by switching the OFF-RUN-PD toggle switch to the RUN position



### STEP 22

To restore your system to normal, readjust the system set point to the appropriate setting and verify each stage is responding accordingly.

The CR110 Card is now in the RUN MODE and should operate on its own from this point forward according to cooling demand and system set point.



### **CR110 Basic Controls**

### **S2 Control Switch**

In keeping with the basic concept of simplicity, the actual active controls on the CR-110 is limited to one switch. This switch is labeled S2, and is located in the upper right hand corner of the circuit board, and is shown in the picture below. This is a multi-function switch, which has three positions.



•Pump Down: If the switch is in the up position, it will cause the compressor to go into pump down mode. It should pump down and shut off. This position is labeled 'PD' on the circuit board.

•Off: Center position is off. This shuts off power to the circuit board and effectively shuts down the system. Also placing the switch in the off position resets any alarm conditions which may exist.

•Run: Down position is RUN. This enables the system to run in a normal mode, and control the refrigeration system according to the profile the microprocessor is using.

•Test Mode: To enter Test Mode, move the switch from OFF to RUN then rapidly to PD. This will cause the CR-110 to go into a special 'Test Mode' for troubleshooting and initial set up options.





### **Modes Of Operation**

The CR110 has 16 different modes of operation. They are listed below with detail and their corresponding LED indication. The LED's referenced below are from left to right CR10, CR11, CR12, and CR13

#### Standby:



Standby occurs when Set-point is met. In Standby, the compressor should be pumped down and ready to start the refrigeration cycle.

#### **Refrigeration:**



Refrigeration mode occurs when the Cooling Demand reaches the pre-set temperature. This will occur when the PI loop adjusts the output above the Liquid Line Solenoid On percentage. In this mode, the liquid line solenoid is opened and the compressor will start as soon as the suction pressure rises to the Compressor On parameter.

#### Defrost:



Defrost mode occurs when a defrost cycle has been initiated. This initiation can occur from a number of sources, demand defrost, timed defrost or manual initiated defrost. The defrost mode applies to hot gas, electric, or air defrost.

#### Pump Down:



Pump Down mode occurs when the Refrigeration mode has ended, or the suction pressure rises above the turn on point in the standby mode. In the pump down mode, the liquid line valve is closed and the compressor pumps down to the suction shut off point.

#### Short Cycle:



Short Cycle mode is a safe guard that prevents the compressor from shutting down and then restart excessively. Typically the short cycle timer is set for a minimum of one minute.

#### Shutdown



Shutdown mode occurs when the S2 Control Switch on the CR110 is placed in the Pump Down position, or if the unit is remotely switched off. In Shutdown, the compressor will pump down if needed. A remote Shutdown can be over-ridden by switching the S2 switch on the controller to Off then back to Run.

#### Coil Dry



Coil Dry mode is activated after a hot gas defrost. Immediately after the defrost cycle, the liquid line solenoid is opened for a pre-set time, with the evaporator fans off. This will cause any moisture left in the evaporator coil to dry. The setting for the Coil dry is in seconds, and is normally set from 30 to 60 seconds. If this value is set to zero, the coil dry feature will be disabled.

#### High Head



High Head Alarm is activated when the discharge pressure exceeds a pre-set value. This is typically set 25 to 50 psi less than the mechanical high pressure switch. This alarm is activated instantaneously. When a High Head Alarm occurs, all outputs will shut off and the controller will lock out of any other mode. The alarm can be reset by using the S2 switch on the controller to power the unit off and then back to the run position or through the rest button on your display.

#### DP Sensor Fail



DP Sensor Fail mode is a failure of the discharge pressure sensor. This is a critical sensor, and will shut down all outputs immediately if a failure is detected. The failure could be caused by a number of things; broken wire, sensor plug or the sensor itself.

#### SP Sensor Fail



SP Sensor Fail mode is a failure of the suction pressure sensor. This is a critical sensor, and will shut down all outputs immediately if a failure is detected. The failure could be caused by a number of things; broken wire, sensor plug or the sensor itself.

#### Low Suction Alarm



Low Suction Alarm mode is active only in the Refrigeration mode. It has both a psi value for the suction pressure as well as an alarm timer associated with it. If the timer is set to zero, the alarm will be disabled. The low suction alarm point should be set somewhere above the low operator shut off point. This is a very valuable alarm and should be set accordingly. Use PT tables for freeze points.

#### External Alarm



External Alarm mode can be activated by a number of external devices. Oil pressure, high head pressure, phase monitor and compressor protection modules are some of the external devices that can be used to supervise the CR-110 controller. These devices provide power to the J8-05 terminal on the controller. If any one of these devices trip, all outputs will shut off and the 3 LED'S will start to blink. After 5 minutes the LED'S will come on steady and lock out in an alarm condition. If the external alarm is reset before the 5 minutes is up, then normal operation will be resumed.

#### Super Heat



The Super Heat window has a high and low setting, and a time delay. The CR-110 calculates the compressor Suction Super Heat continuously, and compares this setting to the alarm parameters. Most compressor manufacturers recommend the suction super heat run between 20 to 40 degrees F. The Super Heat window is active anytime the compressor is running. Setting the time delay to zero will disable this alarm.

#### **Temperature Sensor**



The Temperature Sensor Failure Alarm is activated when a controlling temperature sensor is found out of range. Example would be the Room Sensor when running in the Set-point mode.

#### Fan / Pump Failure



#### Program Error



If all the red LED'S are on, and the green LED is on, this indicates a Program Error and will prevent normal operation. If the flash memory has been reprogrammed, this condition will exist, and the operating profile will have to be loaded.

#### Normal Operation



Normal Operation is indicated by a blinking green LED on CR2.

#### **RS-485** Communications



The LED located on CR14 will blink when it responds to a RS-485 communications request transmitted over J13 or AUX.

#### CR110 Output Status LEDs

The CR110 has 9 120 volt analog outputs. They are listed below with their corresponding LED indication.

CR1	Condenser Fan 1
CR3	Condenser Fan 2
CR4	Condenser Fan 3
CR5	Liquid Line Solenoid / Cooling Demand
CR6	Circulation Pump (Pump off when light is on)
CR7	Compressor
CR8	Unloader 1 / Evaporator Fan
CR9	Unloader 2 / Defrost

**Note:** Output 4 when used in a chiller application is normally off. This is for fail safe conditions. When output 4 is off, the circulation pump should be running. When output 4 is on, the pump is in the off condition to save power.



### **Temperature Control**

The CR110 Refrigeration Controller utilizes a PI loop that operates by comparing the chilled water inlet set point and the coldest sensor.

Every time a PI Loop Math Calculation is performed the result is a new OUTPUT. The system uses this OUTPUT to control the following items:

#### • Liquid Line Solenoid Valve On/Off

#### Liquid Line Solenoid Valve is ON

Suction Pressure Increases
 Compressor Starts

#### Liquid Line Solenoid Valve is OFF

1. Suction Pressure Decrease

2. Compressor Stops

#### • Unloader Valve On/Off

#### LLS ON% Reached:

- 1. Cooling Demand is High
- 2. Cylinder Loads

#### LLS OFF% Reached:

- 1. Cooling Demand is Low
- 2. Cylinder Unloads

Each CR110 Refrigeration Controller card is supplied with it's own dedicated sensors providing 100% redundancy.

#### PI Loop Explained

The PI Loop formula is shown below with definations, details and examples.

#### NEW OUTPUT = OLD OUTPUT + P + I

#### • P (Default is 22):

+ P is positive when the coldest sensor reads above set point.

- P is negative when the coldest sensor reads below set point.

#### • I (Default is 5):

- + I is psoitive when the coldest sensor temperature is increasing.
- I is negative when the coldest sensor temperature is decreasing.

#### Example 1:

Old Output = 5% Set Point = 28 F Inlet = 27 F Oulet = 29 F Inlet Temperature Increasing New Output = 5 + (-22) + 5= 22

Example 2:

Old Output = 30%Set Point = 28 FInlet = 29 FOulet = 30 FInlet Temperature Decreasing New Output = 30 + 22 + (-5)= 47



**Note:** Output's 7 & 8 when used for Unloaders operate with reverse logic for fail safe operation. When the outputs are not lit the unloaders have the compressor cylinders loaded.

### **Basic System Wiring**

This section shows an overview of the typical system's installation wiring. The following assumes an Air-Cooled Pro Chiller operating CR110 V2.84 or grater. Below are some wiring examples. For exact wiring for your system please refer to your systems electrical schematics.

#### CR110 Power Wiring

Multiple cards may be powered from a single transformer. The control power must be common for each of the cards. Each card requires roughly 6VA of power.



#### Outputs 1-4

CF1: Condenser Fan 1

CF2: Condenser Fan 2

CF3: Condenser Fan 3

CP: Circulation Pump



#### Compressor Control

C1: Coompressor 1 LL1: Liquid Line Solenoid 1

UL1: Unloader 1

UL2: Unloader 2



#### **External Protection**

There are three devices that can remove 120V power to the CR110 card shutting down the system and sending the controller into an External Alarm they are shown below.







### **Sensor Wiring**

All temperature and pressure sensors, and current switches use a common 5 VDC.



#### Input Sensor Description

•0-500 PSI Discharge Pressure Transducer.

•0-100 PSI Suction Pressure Transducer.

•Compressor Suction Temperature Sensor.

•Process Temperature or Outside Ambient Air Temperature Sensor (OPTIONAL ITEM)

•0-100 PSI Oil Pressure Transducer (OPTIONAL ITEM)

•Circulation Pump/Evaporator Fan Proving Current Sensor

•Evaporator Glycol Inlet Temperature Sensor (Can be located in storage reservoir)

•Evaporator Glycol Outlet Temperature Sensor (Can be located in storage reservoir)



•Outside Ambient Air Temperature Sensor must be used for low ambient control option.

•Oil Pressure Transducer can be used to measure net oil pressure.

### **CR110** Communications Wiring

The inter-card communications is done on a 2-wire RS-485 buss with shield. There are simply 3 wires that run between all cards, connecting them in parallel. The communications baud rate is 9600. Below are some wiring examples. For exact wiring for your system please refer to your systems electrical schematics.



(Refer To Interface Manual)

#### Typical Wiring With RGX Communications





### **CR110 Default Parameters**

Below is a chart that contains the default CR110 parameters for Pro Chiller Systems with one to four compressors. For directions on setting these parameters please see the programming section of your interface manual.

PARAMETER	1 COMPRESSOR	2 COMPRESSOR	3 COMPRESSOR	4 COMPRESSOR
NETWORK	01	02	03 / 11	04 / 12
Setpoint	25 to 28	25 to 28	25 to 28	25 to 28
Low Suc	25	25	25	25
Low Suc T	2	2	2	2
Low SH Alarm	0	0	0	0
Hi SH Alarm	0	0	0	0
SH Time	0	0	0	0
Comp OFF	15	15	15	15
Comp ON	30	30	30	30
Short Cycle	240	240	240	240
Control Point	235	235	235	235
Fan Diff	20 or 10	20 or 10	20 or 10	20 or 10
HP Alarm	380	380	380	380
HP Unload	350	350	350	350
LLS OFF	1	1	1	1
LLS ON	50	25	15 / <mark>25</mark>	10 / <mark>25</mark>
UL1 OFF	40	20	10 / <mark>20</mark>	10 / <mark>20</mark>
ULLON	70	40	20 / 40	18 / <mark>40</mark>
UI 2 OFF	60	30	15 / <mark>30</mark>	15 / <mark>30</mark>
	80	50	30 / 50	25 / 50
	0	0	0	0
	0	0	0	0
	25	25	25	25
	23	23	23	23
	20	20	20	20
	20	20	20	20
D	22	22	22	22
	5	5	5	5
D	0	0	0	0
U	50	50	50	50
Main Diff	0	0	0	0
Output OffSet	0	50	33 / 50	25 / <mark>50</mark>
Low OSA	0 or 30	0 or 30	0 or 30	0 or 30
Pressure Transducer	0-100 (3)	0-100 (3)	0-100 (3)	0-100 (3)
Gas Type	R404A - (5)	R404A - (5)	R404A - (5)	R404A - (5)
System Mode	Fixed Head Pressure	Fixed Head Pressure	Fixed Head Pressure	Fixed Head Pressure
PID Mode	Cooling SP	Cooling SP	Cooling SP	Cooling SP
Temp Prohe Type	2250	2250	2250	2250
Tandem	NO	NO	NO	NO
Rotation	0	1440	1440	1440
	1	2	3/2	4/2
# 01 Comp	0 or 1 or 2	0 or 1 or 2	0 or 1 or 2	0 or 1 or 2
	25	25	25	25
	25	25	25	25
	2	2	2	2
On Inst	0	0	0	0
System Drop	200	200	200	200
Temp SP	25 to 28	25 to 28	25 to 28	25 to 28
Backup Diff	0	0	0	0
Filter	4	4	4	4



### **CR110 Troubleshooting**

PROBLEM	POSSIBLE CAUSES	POSSIBLE CORRECTIVE ACTION	
CR110 Card Lights Off & Card Will Not Operate	<ul> <li>24Volts not present on J1.</li> <li>Defective power surge protector (VR2)</li> <li>Defective or unprogrammed EEPROM chip</li> </ul>	<ul> <li>Check 24 VDC power supply if 120 volt input power is not present verify trans- former is operating properly.</li> <li>Remove power surge protector (VR2) &amp; contact Pro Refrigeration Technical Sup- port</li> <li>Call Pro Refrigeration technical support</li> </ul>	
CR110 Will Not Communicate With Interface	<ul> <li>RGX present &amp; not properly configured</li> <li>Defective Communication Chip</li> </ul>	<ul> <li>Consult RGX manual for proper configuration of the J6 &amp; J7 ports.</li> <li>Call Pro Refrigeration for replacement communication chip.</li> </ul>	
DP Sensor Fail SP Sensor Fail	<ul> <li>Loose wires on the pressure transducers.</li> <li>Sensor Failure</li> <li>Improper sensor installation.</li> <li>Sensor voltage is under .5vdc or above 4.5vdc</li> <li>Discharge</li> <li>Suction</li> </ul>	<ul> <li>Check the wires on Ch 1 &amp; Ch 2 on the sensor terminal strip on the CR-110. Check if the screws are loose or wires not in the terminal block.</li> <li>Replace the pressure transducer that is showing failed.</li> <li>Remove sensor and verify that the Schrader valve is working and installed properly.</li> <li>Use a DC volt meter and measure the voltage between the black and white wires. Black wire is negative. Measure on the top of the terminal block with wires connected.</li> </ul>	
TEMP SENSOR FAIL	<ul> <li>Loose wires on Ch 7 of the sensor terminal block on the CR-110.</li> <li>Sensor Failure Ch 7</li> <li>Sensor voltage is 0 or 5vdc</li> </ul>	<ul> <li>Check the wires on Ch 7 on the sensor terminal strip on the CR-110. Check if the screws are loose or wires not in the terminal block.</li> <li>Remove the wires from Ch 7 and measure the resistance of the sensor. Resistance should fall between 2k and 10k.</li> <li>Use a DC volt meter and measure the voltage between terminals on Ch 7 with wires connected. Measure on top of the terminal block. Voltage should not be close to zero or +5vdc.</li> </ul>	
EXTERNAL ALARM	<ul> <li>Compressor Power module tripped</li> <li>High Head Pressure Switch tripped</li> <li>Oil Pressure Switch tripped</li> <li>No control voltage between C and 120 or 240 terminal on CR-110.</li> </ul>	<ul> <li>Verify that compressor has power and power module has timed out.</li> <li>Check the High Head Pressure switch to see if it is tripped.</li> <li>Check the Oil pressure switch to see if it is tripped.</li> <li>Use an AC voltmeter to measure between the C and 240 or 120 depending on the control voltage being used. There should be the appropriate voltage present. If not, use 240 or 120 terminal to measure back on each of the external devices to find the problem.</li> </ul>	



PROBLEM	POSSIBLE CAUSES	POSSIBLE CORRECTIVE ACTION	
LOW SUCTION PRESSURE ALARM	<ul> <li>Alarm pressure setting incorrect</li> <li>Low refrigerant</li> <li>Evaporator iced up, low fluid or air flow.</li> <li>Evaporator Super Heat to High</li> </ul>	<ul> <li>Use PT chart to determine correct setting for gas type and temperature.</li> <li>Check circulation pump or evaporator fan for proper operation.</li> <li>Adjust expansion valve for proper opera- tion and adjustment.</li> </ul>	
SUPER HEAT ALARM	<ul> <li>Super Heat Alarm Window setting incorrect.</li> <li>Evaporator iced up, low fluid or air flow.</li> <li>Evaporator Super Heat to High or to Low.</li> </ul>	<ul> <li>Most compressor manufacturers suggest keeping the compressor super heat between 20 to 40 degrees. Check the settings and determine if the compressor is tripping on High or Low Super Heat.</li> <li>Check circulation pump or evaporator fan for proper flows.</li> <li>Verify proper operation of the evaporator expansion valves.</li> </ul>	
FAN OR CIRCULATION PUMP FAILURE	<ul> <li>Circulation pump or Fan control switch off.</li> <li>Circulation pump or Fan fuses blown.</li> <li>Defective motor.</li> <li>Bad current switch </li> </ul>	<ul> <li>Check control switch</li> <li>Check all fuses or circuit breakers for pump or fan.</li> <li>Check voltage and amp draw on motor</li> <li>With pump or fan running Ch 6 should be reading 0 vdc. Ch 6 will read 5 vdc if pump or fan is not running. Replace current switch if necessary.</li> </ul>	
COMPRESSOR WILL NOT RUN	<ul> <li>CR-110 Alarm for compressor</li> <li>Liquid line solenoid valve will not open.</li> <li>Compressor contactor not pulling in.</li> <li>Output 5 fuse blown</li> <li>CR10 K1</li> <li>K1</li> <li>CR30 K2</li> <li>CR40 K3</li> <li>CR50 K4</li> <li>CR60 K5</li> <li>CR70 K6</li> <li>CR80 K7</li> <li>CR90 K8</li> </ul>	<ul> <li>Check Display or CR-110 status leds for alarm condition.</li> <li>Check the output 6 led on the CR-110, if on, then check voltage on the liquid line solenoid. Replace if necessary.</li> <li>Check overloads on compressor contactor.</li> <li>Check the Compressor output led # 5, if the led is on, you should have voltage on the compressor mag. Replace the fuse if necessary. The fuse on outputs 3 or 4 could be used in a emergency.</li> </ul>	
CIRCULATION PUMP WILL NOT RUN	<ul> <li>System not calling for cooling.</li> <li>Pump fuses or overloads tripped</li> </ul>	<ul> <li>Check output reading on display. Reading must be greater than zero for circulation pump to run.</li> <li>Check pump overloads and fuses.</li> </ul>	



### **Replacement Parts**

The following is a list of replacement parts for the CR110 Refrigeration Controller. Call for pricing and availability.

Description	Part Number
CR110 Control Card	CR110-B
Suction Pressure Transducer (0-100psi)	P499RCP-101C
Discharge Pressure Transducer (0-500psi)	P499RCP-105C
Transducer Cable	WHA-P399-400C
Temperature Sensor	A4175-21
24VDC Power Supply	PS5R-SC24
Current Sensor Switch	RIBXKTF
Alarm Cable	J20-CC-ALARM-36
Power Surge Protector (VR2)	P6KE51CACT-ND
Communication Surge Protector (VR4)	P6KE6.8ACCCT-ND
Communication Chip (U2)	MAX483CPA
Output Fuses (K1-K8)	Z909-ND

### **CR110 Accessories**

The following is a list of accessories for the CR110. Call for pricing and availability.

Description	Part Number
G55 Grayscale Interface	G55-BW
G55 Color Interface	G55-CL
TS110 Touchscreen Interface	TS110
RGX Communication Gateway (Web Access)	105-1-755
5 Port 24V Ethernet Switch	MOX-EDS-205

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