



MBF-700

Refrigeration System

Installation, Operation and Service Manual

325152H01 Rev. E July 2015

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IMPORTANT Read this instruction manual. Failure to follow the instructions in this manual can result in damage to the unit, injury to operating personnel, and poor equipment performance.

CAUTION All internal adjustments and maintenance must be performed by qualified service personnel.

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Intended Use of the MBF-700 Refrigeration System

The MBF 700 described in this manual is a high performance unit which can be used for research and in situations that directly support medical applications. When the MBF-700 is used to support a medical application, it is an accessory to a medical device and is therefore considered as a medical device in its own right by the regulatory body (e.g. FDA).

This product is intended for use:

- As cold storage in research use.
- As a medical device for diagnostic use (storage of samples not intended to be re-introduced to the human body).
- As a medical device for blood component storage use and possible re-introduction to the human body.

Registration: This medical application is considered a Class I medical device by the FDA. This product is classified as product code – JRM, regulation number 862.2050 and is considered device class 1, 510(K) exempt.

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1 Specifications

1.1 Models The following MBF-700 models are described in this manual:

Model Number	Revision Level
MBF700LSAO-E	Rev. 20
MBF700LSAW-E	Rev. 20

1.2 Exterior Dimensions

Height	47.5 in (121 cm)
Width	121 in (307 cm)
Depth	35.3 in (90 cm)
Weight	1510 lbs (685 kg) – shipping weight 1790 lbs (812 kg)

1.3 Power Requirements

Frequency	60 Hz	50 Hz
Voltage	208/230	220
Phase	3	3
Amperage	24 A	38 A

1.4 LCO₂ Backup System

115 V, 120 V, 230 V available
Phase 1

1.5 Environmental Operating Conditions

Pollution Degree	2
Installation Category	II
Altitude	2000 m MSL (mean sea level)
Humidity	max 80% - non-condensing
Voltage Tolerance	±10%

1.6 Refrigerant Charge

Stage 1	R404a (50 oz)
Stage 2	R290 (1.5 oz), R508b (20.3 oz)

1.7 Oil Charge

Stage 1	50 oz POE RL32H
Stage 2	65 oz Alkyl Benzene Zerol

2 Safety Precautions

In this manual, the following symbols and conventions are used:



This symbol used alone indicates important operating instructions which reduce the risk of injury or poor performance of the unit.



CAUTION: This symbol, in the context of a CAUTION, indicates a potentially hazardous situation which if not avoided could result in minor to moderate injury or damage to the equipment.



WARNING: This symbol indicates situations where dangerous voltages exist and potential for electrical shock is present.



The snowflake symbol indicates extreme low temperatures and high risk of frostbite. Do not touch bare metal or samples with unprotected body parts.



This symbol indicates a need to use gloves during the indicated procedures. If performing decontamination procedures, use chemically resistant gloves. Use insulated gloves for handling samples and when using liquid nitrogen.



Before installing, using or maintaining this product, please be sure to read this manual and product warning labels carefully. Failure to follow these instructions may cause this product to malfunction, which could result in injury or damage.

Below are important safety precautions that apply to this product:



Use this product only in the way described in the product literature and in this manual. Before using it, verify that this product is suitable for its intended use. If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.



Do not modify system components, especially the controller. Use OEM exact replacement equipment or parts. Before use, confirm that the product has not been altered in any way.



WARNING: Your unit must be properly grounded in conformity with national and local electrical codes. Never connect the unit to overloaded power sources.



WARNING: Disconnect the unit from all power sources before cleaning, troubleshooting, or performing other maintenance on the product or its controls.

3 Unpacking

At delivery, examine the exterior for physical damage while the carrier's representative is present. If exterior damage is present, carefully unpack and inspect the unit and all accessories for damage.

If there is no exterior damage, unpack and inspect the equipment within five days of delivery. If you find any damage, keep the packing materials and immediately report the damage to the carrier. Do not return goods to the manufacturer without written authorization. When submitting a claim for shipping damage, request that the carrier inspect the shipping container and equipment.



CAUTION: Do not discard the sub lids. They are necessary for the operation of the unit.

4 General Description

This unit is a low temperature freezer designed to operate with a chamber temperature in the range of -65 to -80 °C (-85 to -112 °F) and in an ambient temperature range of 15 to 32 °C (59 to 89.6 °F).

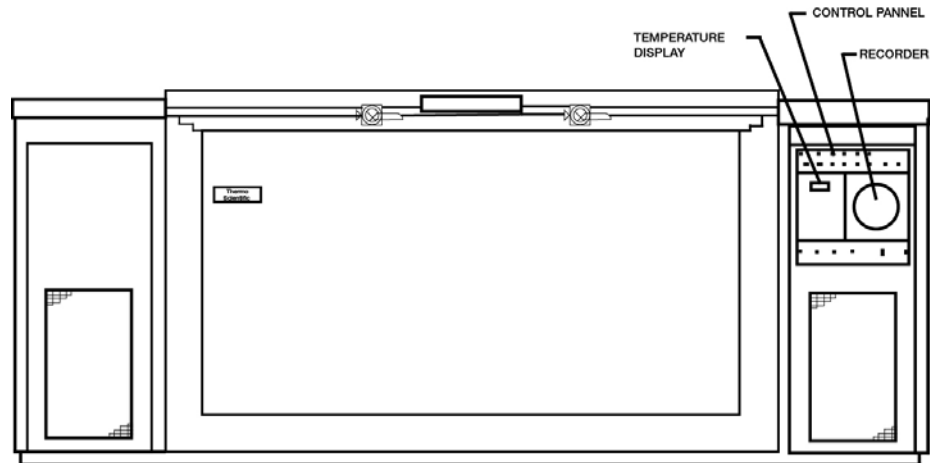


Figure 1. General Freezer Outline (refer to Figure 4 for control panel details)

The interior useable space is also rectangular. The four corners are covered. With insulating sub lids in place it measures 71” long (180.3 cm)x 35.37” high (89.9 cm) x 22.63” deep (57.5 cm). The interior volume is 32 Ft.(929 liters.)

The cabinet is insulated with nominal 5” of foamed-in-place polyurethane insulation.

The refrigeration system used in this freezer is a specially designed assembly using four hermetic motor compressors. This design is termed a “redundant cascade system” described in detail in Section 9.

Stainless steel storage racks for inventory control are available as an option and must be ordered separately.

4.1 Construction

The lid is held tightly closed by means of cam locks having provision for a user supplied padlock.

Durable corrosion protection is provided by an electrostatically applied epoxy fused powder coating over cold rolled steel.

To provide a redundant refrigeration system, the inner tank is double wrapped with copper tubing forming a dual circuit evaporator. In addition, each of these circuits has its own compressor, condenser and liquid refrigerant control (capillary tube). Each of the redundant systems will support full operation to maintain the storage temperature. When set to alternate between system “A” and system “B”, refrigeration is applied to the freezer chamber alternating between systems on each cycle.

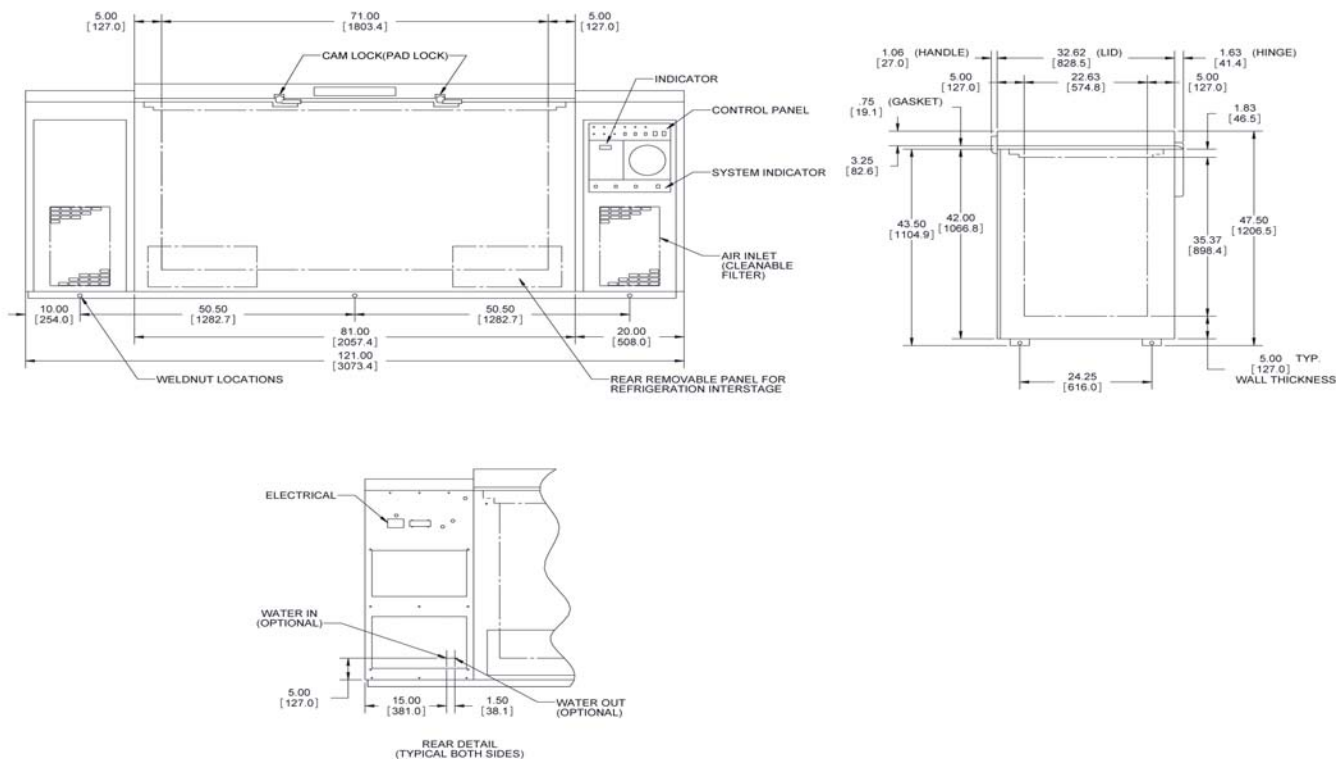


Figure 2. Cabinet Dimensional Drawing

4.2 Incoming Power Wiring

The illustration below shows the incoming power wiring and label:



Figure 3. Incoming Power Wiring

Note that the compressor is not rotation-specific. The contactor is wired as “L L L”.



WARNING: Only a licensed electrician is to make these connections.

5 Installation and Operation



WARNING: The MBF-700 is intended to be hard-wired upon installation. Use with quick-disconnect plugs is not approved. The unit must be installed with proper circuit breakers and overcurrent protection, and installation must be done by a licensed electrician in accordance with all applicable building codes and regulations.

Power conductors must be at least 10 AWG. Heavier wire may be required due to the specifics of a given installation or variations in applicable regulations. The circuit breaker must be located in close proximity to the equipment within easy reach of the operator, and must be clearly marked as the disconnect device for the equipment.



CAUTION: Do not attempt to operate this freezer until the following Installation Check List steps have been completed.

Note *Install with clearances of 6 inches at rear and 8 inches on sides.*

5.1 Installation Checklist

	Date	Initials
The freezer is in place.		
The freezer has been levelled.		
Check freezer data plate voltage.		
Check supply voltage is the same as data plate.		
Check that power panel circuit protection rating does not exceed that indicated on the data plate.		
Backup system has been installed (refer to Section 7) and LCO ₂ supply valve is Off.		
Facility monitoring system connected to freezer's remote alarm contacts (refer to Section 6.2).		
If unit uses a water-cooled condenser, water supply and discharge are connected in accordance with Section 6.1.		
No product loaded in freezer.		
Main building power panel breakers are On.		
Using key provided, turn the compressor key switch to ON.		

Set primary control set points. (refer to Appendix B).		
The frame heater switch (#8, Figure 4) is shipped from the factory in the OFF position. Turn frame heater switch ON only if the humidity is sufficiently high that it may cause frost on the strips.		
Turn LCO ₂ supply valve On after cabinet reaches.		

5.2 Responsibilities

Note *The following table define the Operator's responsibilities for reporting trouble symptoms on startup of the freezer and also observing its operation on an ongoing basis in order to prevent any mechanical or electrical failures that could result in loss of blood products.*

Frequency Of Task		Description Of Tasks, Observations & Record Keeping Requirements
Once on first start	a.	Time required for initial pulldown. If only partial loss of the refrigerant has occurred, the sign will be slow pulldown time required reaching -80 °C. Pulldown time should be 2.5 hours or less. If it is more than 2.5 hours, the technician must either determine the cause and the remedy therefore or IMMEDIATELY SHUT DOWN THE FREEZER until the problem can be diagnosed and remedied.
	b.	Carefully record the first few on-off periods with freezer empty, and then again loaded with product. Keep this record with the freezer at all times for future reference in troubleshooting.
	c.	If the installation is made in an air-conditioned area, there will not be much, if any, change in cycle. However, if the ambient temperature is subject to changes, make a record of cycle times at these various ambient temperatures.
Daily	d.	Listen for rattles. If refrigerant-carrying copper tubing is allowed to rub against other tubes or any object, a leak will very quickly occur resulting in loss of the refrigerant charge and cabinet temperature.
	e.	Watch the system operation indicator light. It should not be showing the same system always operating. For instance, when system A has been operating and shuts off, system B should start on the next control call for cooling.

Weekly	f.	Air-Cooled units only: clean the condenser air filter when its original jet-black color has changed. Attention to this detail will assure shortest running times and prolong the life of the freezer.
	g.	Make sure the lid closes without interference and that sub lids are always in place.
	h.	Ensure that the sub lids are in place.
	i.	Verify that the LCO ₂ vent is free of frost accumulation.
On Using	j.	Watch for lid gasket tears. Streaks of frost will collect inside the freezer at the precise location of the torn or cut gaskets.
	k.	Defrost the cabinet if frost or ice build-up exceeds 1/4" thickness: remove product, turn power key switch Off, leave unit open 48 hours, remove moisture, restart unit.

5.3 Control Panel

All controls are located at the right end of the cabinet. Refer to Appendix B for instructions on controller operation.

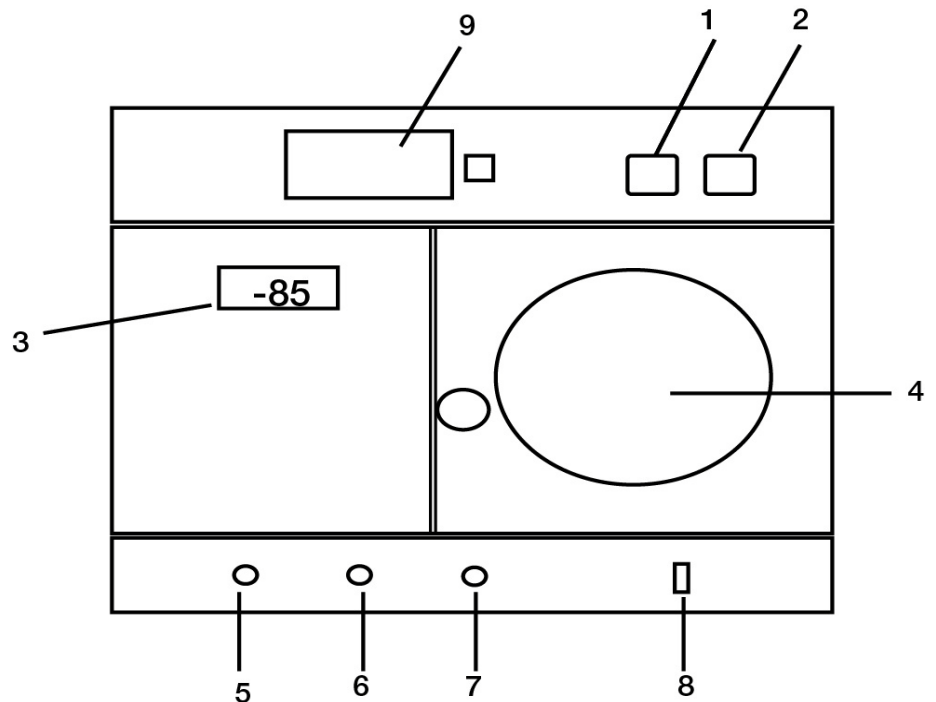


Figure 4. Control Panel Detail

1. Key-operated alarm ON/OFF switch. Turns on local audio alarm.
2. Key-operated compressor ON/OFF switch. Turns on power to compressors and control system.
3. Digital temperature indicator and primary control.
4. Temperature recorder, 7-day, 6" diameter.
5. System "B" indicator light. "ON" when system "B" 1st stage running.
6. Alternate system alarm indicator light. "ON" when auxiliary control causing both systems to operate.
7. System "A" indicator light. "ON" when system "A" 1st stage running.
8. Frame heater switch. Operates breaker strip condensate heater.
9. Battery meter. Displays state of battery charge when button is pressed.

5.4 Loading Instructions

The MBF-700 freezer is designed to be used for long-term storage and is not intended to be operated as a blast freezer. The unit has dual refrigeration systems primarily to provide redundant reliability in the event of a catastrophic failure of one side.

A secondary result of having dual refrigeration systems is that the unit also has a greater heat removal capacity than a conventional ULT freezer. This feature makes the MBF-700 more suitable for use with large product loads than a typical ULT; subject to the following loading recommendations.

Overloading the freezer beyond these recommendations can result in excessive temperatures and pressures which may be detrimental to unit life and reliability. For applications that will exceed these restrictions it is recommended that the user select and qualify a dedicated purpose-built blast freezer that will be suitable for the highest anticipated load.

The general requirements that apply to all loads are as follows:

- Upon initial startup the unit must be empty. Do not place any payload in the freezer until it is cycling at setpoint temperature.
- The maximum payload temperature is 32 °C.
- The maximum door opening time is 5 minutes.
- The load should be evenly distributed throughout the cabinet as much as is practical. For example, it is preferable to load in horizontal layers rather than vertical stacks.
- The unit must be permitted to cycle normally for at least one hour after the cabinet returns to the setpoint temperature before another load is placed inside. This ensures that the unit has made a complete recovery and prevents successive loads from combining to create an overload condition.

Additionally, the limits below must be followed depending on the nature of the payload:

- For **liquid** loads that will freeze solid inside the cabinet the maximum mass of an individual load is **30 kg of liquid plus 10 kg of solid material** such as bottles or racks.



CAUTION: Water-based solutions expand on freezing. Do not use glass containers, which may burst and present a cut or contamination hazard.

- For **solid** loads that will not change phase inside the cabinet the maximum mass of an individual load is **50 kg total**, including both the payload and any other material such as storage containers or racks.

Note that these are the maximum load sizes that the freezer can cool at one time, not the maximum storage limit of the freezer. For example, it is acceptable to have a total mass of 150 kg of solid material stored in the unit provided that this material was loaded in multiple operations with each discrete load not exceeding the 50 kg limit.

The cooling rate of the unit is determined by many variables including the thermal mass of the payload, its temperature at loading, the shape of the load, and how it is arranged in the freezer. The maximum safe recommendations above may not always result in optimum pulldown performance. For time-critical freezing operations it is recommended that the user independently test and validate their loading procedure to ensure satisfactory results.

6 Options and Accessories

6.1 Water-cooled Condensing Unit Connections

The MBF-700 can be purchased with air-cooled condenser, water-cooled condenser, or both. If purchased with water-cooled condensers, there are two water supply and two water discharge connections to be made at the rear of the cabinet if you wish to use the water cooling feature:



CAUTION: ONLY QUALIFIED REFRIGERATION TECHNICIANS ARE TO MAKE CONNECTIONS OR ADJUSTMENTS.

1. Locate the machine sections at each end of the freezer as you face the rear of the cabinet.
2. At the bottom of each machine section are two 1/2" O.D. NPT copper tubes stubbed out through the cabinet grille (refer to Figure 5). The outermost tubes are the COLD WATER INLET and the inner-most tube is the WATER OUTLET.

The four tubes terminate with 45° SAE flare nuts.



Note *If it is necessary to reship these units and water has been connected in the past, the lines must be blown clear with compressed air in order to preclude freezing and rupturing the water cooled condenser.*

There are normally three possible sources of cooling water for these freezers, and any one may be satisfactory used. They are:

1. City water supply, discharge water wasted to drain.
2. Chilled water from a building air conditioning chiller. In this case, the discharge water goes back to the chilled water loop and is recirculated.
3. Cooling tower water supply, discharge water goes back to the tower water loop.

Factory specification for maximum water supply temperature is 85 °F. The automatic water regulating valve allows use of any of these sources. Seasonal water temperature changes may require slight adjustment of the water regulating valve. The factory setting is 195 psig.

The Selector Ball Valve can be accessed by removing the end cover on each of the machine compartments.

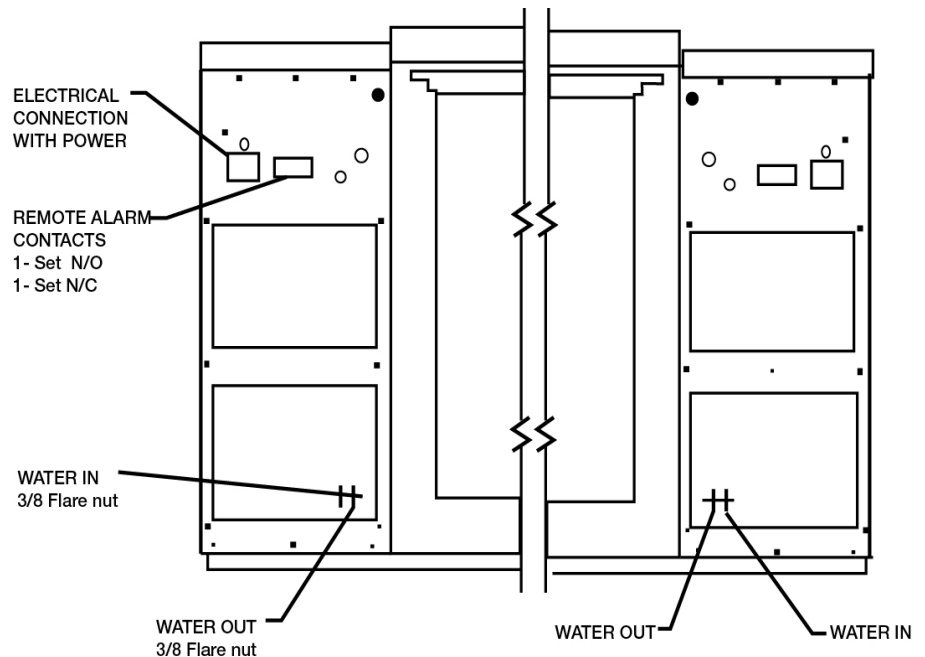
The valve may be identified by the square wrench flats on its top. The flow-indicating arrow will be perpendicular to the tubing when the valve is closed, and parallel to the tubing when the valve is open.



Note *Adjustment of the Selector Ball Valve is to be performed only by a qualified refrigeration technician.*

- For air cooling only, do not connect water and leave valve closed.
- For use with water cooling, connect water and open the valve.

To adjust the automatic water regulating valve for best operating economy, install a head pressure gauge; with the compressor operating, turn the adjusting stem (located on top of the valve) until a head pressure of 195 psig is measured. Clockwise rotation of the adjusting stem lowers the head pressure; counterclockwise rotation raises the head pressure.



Rear view of cabinet showing connections

Figure 5. Water-Cooled Condenser Connections

6.2 Installing the Remote Alarm Connector

The remote alarm contacts are located on the back of the freezer on the upper left side, as shown in Figure 5.

The pin configuration is shown in the figure below.



- 1:Open on Alarm
- 2:Common
- 3:Closed on Alarm

Figure 6. Remote Alarm Pin Configuration

The contacts will trip in the event of a power outage, high temperature alarm or low temperature alarm.

6.2.1 Storage Racks

These optional stainless steel accessory storage racks are useful for inventory control. The illustration at right shows the typical rack. It has folding handles at the top for easy removal from the freezer cabinet and a vertical retaining rod to keep the boxes in place. Each rack holds 16 boxes. A full set for the freezer would require thirty-four (34) #4027 racks.

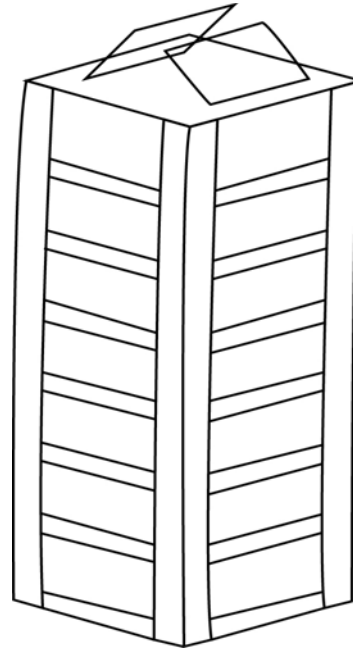


Figure 7. Accessory Storage Rack



Cold racks present a frostbite hazard. Do not handle with bare hands. Use insulated gloves.

7 Liquid CO₂ (LCO₂) Backup System

When connected to a user supplied siphon tank of liquid CO₂, the backup system will provide a source of backup refrigeration in case of power failure to the mechanical refrigeration equipment. The control assembly operates on 120 VAC, 1, 60 Hz. A backup battery supply is continuously charging for operation of the backup system during power failure.



WARNING: Liquid CO₂ back-up systems pose asphyxiation risk in confined spaces. Be sure area ventilation is sufficient. Oxygen level monitors may be required to ensure safe working environment.



WARNING: Use of a LCO₂ backup system requires adequate ventilation. CO₂ is a colorless gas which can impart a burning sensation to nose and eyes at high concentrations. Increased CO₂ levels can be a hazard to life via asphyxiation (suffocation).



Note *Be sure to use a liquid dispensing CO₂ tank which is fitted with a special dip tube.*

7.1 Installation

1. Place the LCO₂ control system on top of the System B mechanical section.
2. Connect the LCO₂ supply to the back of the control system.
3. Connect the LCO₂ distribution tube to the back of the unit.
4. Connect the LCO₂ temperature sensor to the Mate-N-Loc connector that hangs from the rear of System B mechanical section.
5. Connect the LCO₂ control system harness to the Mate-N-Loc connector that hangs from the rear of System B mechanical section.
6. The assembly of the LCO₂ to the cabinet is now complete.



Note *An LCO₂ supply must be provided by the customer. The supply pressure must be 900 – 1,000 psig.*

7. Uncoil the tubing from the control unit and connect to the LCO₂ tank or supply connection.
8. Turn on the LCO₂ valve.
9. Refer to the Backup System Owners Manual for operation instructions.



Note *LCO₂ backup systems are typically built with a relief valve set for 1,300 psig.*

7.2 LCO₂ Control System Battery Condition

The charge level light illuminates when the battery is below 80% of full charge. It is also possible that the charge level light will illuminate when the control system is dispensing LCO₂.

7.2.1 Placing LCO₂ control system in storage



CAUTION: Any rise in temperature will cause a rapid rise of pressure of liquid CO₂ trapped in the supply line. After turning off the LCO₂ supply, bleed the supply line by lowering the LCO₂ setpoint sufficiently to cause the LCO₂ solenoid to open. With the solenoid open, disconnect the supply line from the backup system control unit.

After disconnecting the LCO₂ supply line, set the LCO₂ control to +50 °C and plug the unit into the power supply. This will keep the battery charged and prevent the solenoid from operating.

7.3 Liquid CO₂ Backup Installed as Accessory #6100

This accessory, when connected to a user supplied siphon tank of liquid CO₂, will provide a source of backup refrigeration in case of power failure to the mechanical refrigeration equipment. The control assembly for this accessory operates over a range of 200 VAC to 240 VAC, 1, either 50 Hz or 60 Hz. There is a continuous charging battery backup power supply for operation of the accessory during power failure.

If installing from the accessory kit:

1. Place the LCO₂ control system on top of the System B mechanical section.
2. Place the LCO₂ control system on top of the freezer lid.
3. Locate the switch hole in the left hand side of the right hand machine compartment cover and remove the cover plate that was factory installed.
4. Remove the machine compartment cover by locating and removing the screws at the back and at front securing the cover to the housing.
5. Locate the lid switch in the accessory kit.
6. Locate the leads from the control unit with two-prong connector. Feed the leads through the hole provided in the back of the unit, route through machinery compartment to the left front and up through the second hole provided. Then feed the leads through the switch hole

provided in the machinery compartment cover and connect to the switch terminals. Snap the switch into the hole making sure that the curved side of the plunger is on the bottom side.

7. Replace the machinery compartment cover securing with the screws front and back.
8. Identify the LCO₂ discharge and control assembly mounted in the perforated housing.
9. Remove the coiled control bulb and the LCO₂ discharge tube from the housing, insert the bulb through the rear cabinet porthole and reassemble the bulb to the housing inside the cabinet. Mount the housing to the right inside wall of the cabinet using two of the three factory installed screws. Route the LCO₂ discharge tube through the porthole and, after loosening the screws securing the rear breaker strip, slide the discharge tube under the retainer strip and re-tighten the screws.
10. The assembly of the LCO₂ to the cabinet is now complete.



WARNING: An uninsulated LCO₂ supply cylinder with siphon tube must be provided by the customer. The siphon tube allows liquid CO₂ to be drawn from the cylinder. The supply pressure must be between 600 and 1050 psig. The supply temperature must be between 7 °C and 31 °C (45 °F and 88 °F). DO NOT INSTALL A PRESSURE REGULATOR BETWEEN THE CYLINDER AND THE CONTROL UNIT. *If you are unfamiliar with handling compressed gases, refer to a qualified service technician.*

11. Uncoil the tubing from the control unit and connect to the LCO₂ tank or supply connection.
12. Turn on the LCO₂ valve.
13. Adjust the temperature setpoint to the coldest position.
14. Connect the power cord of the control unit to the voltage source indicated on the unit serial plate.
15. Open and close the freezer lid to insure that the LCO₂ dispenses into the freezer when the lid is closed and does not dispense when the lid is open. If there is no discharge, check to see that the wires are fastened securely to the lid switch and that the switch plunger is actually depressed.



16. Set the temperature control at a minimum of 5 °C warmer than the operating temperature of the freezer but never colder than -70 °C. Setting colder than -70 °C will result in a continuous dispensing of the LCO₂ supply.

17. Make sure that the warm alarm setpoint is colder than the backup system setpoint.

LCO₂ Control System Battery Condition:

The charge level light comes ON when the battery is below 80% of full charge. It is also possible that the charge level light will come on when the control system is dispensing LCO₂.

When placing the control unit in storage, set the LCO₂ control to +50 °C and plug the unit into the power supply. This will keep the battery charge and prevent the solenoid from operating. The capillary tube leading from the control unit to the control bulb may be coiled up for storage but do not make coils any smaller than 4 inch diameter. There are two screws provided in the back of the control cabinet that match the slots in the back of the control bulb housing. Slip the slots in the housing under the screw heads and tighten. This will hold the housing and bulb securely to prevent damage.



CAUTION: Do not turn off the LCO₂ supply trapping liquid in the supply line. Any rise in temperature will cause a rapid rise of pressure that will rupture the protective disk in the control unit.

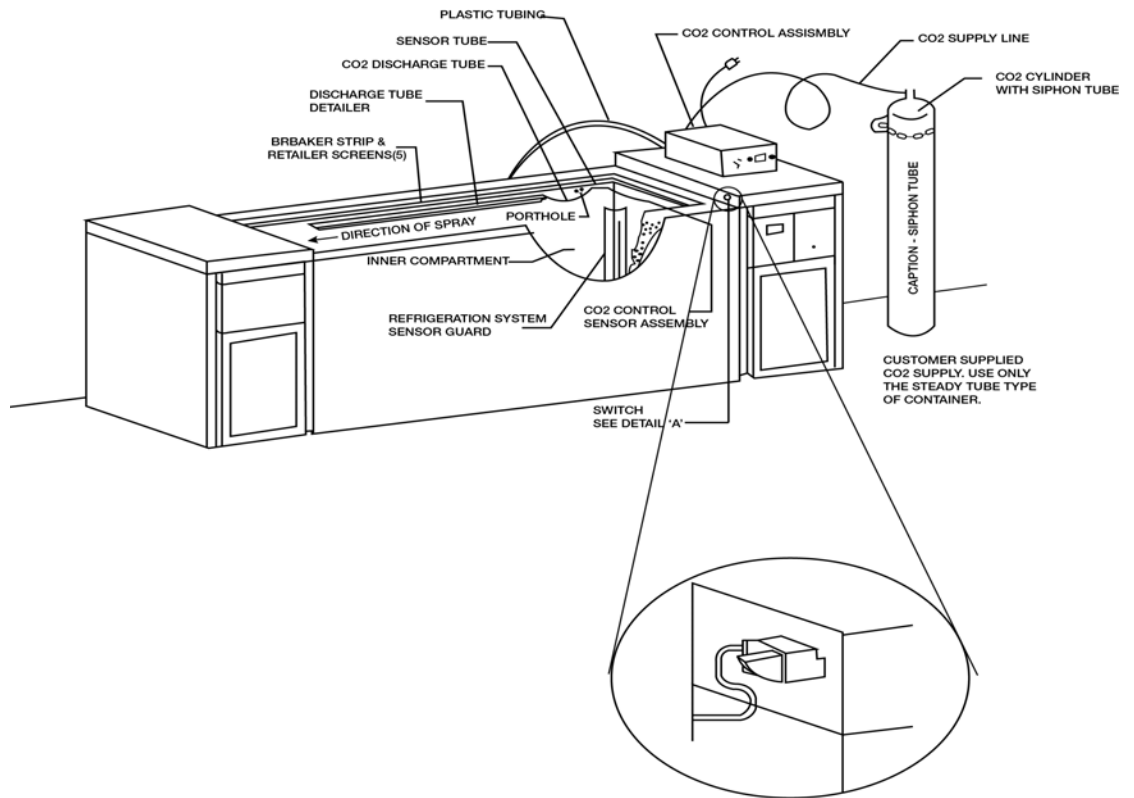


Figure 8. LCO₂ Backup System

8 Cobex 7-day Circular Chart Temperature Recorder

This product includes a manufacturer-installed electronic temperature recorder. These instructions are provided to assist with the initial set-up, operation and general maintenance of the recorder.

8.1 Setup and Operation

The recorder has been factory-installed, programmed, and calibrated for your new system. Operation will begin when the system is powered on. To prepare the recorder to function properly, you should perform the following steps:

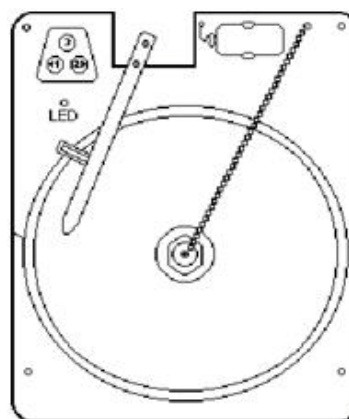
1. Review figure below to become familiar with recorder features.
2. Open recorder door to access recorder.
3. For back-up power, connect the 9 volt DC battery located at the recorder's upper right hand corner.
4. Install clean chart paper (refer to Section 8.2.2 below).
5. Remove plastic cap from pen stylus (ink or pressure sensitive) and close recorder door.



Note *Recorder may not respond until the system reaches temperatures within the recorder's range.*

This should complete operator setup. Additional information is provided for maintenance and troubleshooting as required.

8.2 Maintenance



CobexRecorder Face

Figure 9. Cobex Chart Recorder

8.2.1 Power Supply

The recorder normally operates with AC power when the system is operating. If AC power fails the LED indicator flashes to alert you to a power failure. The recorder will continue sensing cabinet temperature and the chart will continue turning for approximately 24 hours with back-up power provided by the 9 volt battery. Both the battery and main power are O.K. when the LED indicator glows continuously.

8.2.2 Changing Chart Paper

Locate the pressure sensitive buttons at the front, upper left of the recorder panel. Press and hold the change chart button (#3) for 1 second. Pen will move off scale. Unscrew center nut, remove old chart paper, and install new chart paper. Carefully align the day and time with the reference mark on the recorder panel. Replace center nut and hand tighten. Press the change chart button (#3) again to resume temperature recording.

8.2.3 Changing Marker Pen

For recorders having a marker pen rather than a stylus for pressure-sensitive paper, the pen provided is a fiber-tipped cartridge type, and is attached to the pen arm. As the pen ink supply runs out, the pen color will become lighter indicating the pen should be replaced. To install a new pen, loosen the (2) screws at the top of the arm. Slip the pen cartridge out and remove the “U” shaped clip tab from the pen. Discard the old pen. Insert the clip tab into a new pen and then re-fasten to the pen arm.

8.2.4 Changing Temperature Range Program

This recorder is capable of operating in multiple pre-programmed temperature ranges. The correct temperature range program was selected upon factory installation and is retained even during power interruptions. If the temperature range is wrong for any reason, it can be easily reprogrammed as follows:

- Press change chart button #3. Pen arm will move off scale, LED will glow continuously.
- Press and hold button #1 for 5 seconds. LED indicator will begin flashing.
- The number of flashes corresponds to the temperature range program as follows:

No. of Flashes	Temperature Range	Application	Option #
1	-40 to +25 °C	Refrigerators	6*83-7*
2	-115 to +50 °C	ULT's	6*83-6*
3	-200 to 0 °C	Cryogenic	6*83-5*
4	0 to +60 °C	Newer Units Only	

Change program to the “-115 °C to +50 °C” temperature range by using the left (#1) button to increase and the right (#2) button to decrease the number of flashes. Press the change chart button (#3) when the desired program is set. Pen will move to the outer edge of the chart for 5 seconds. After 5 seconds, the LED indicator will glow continuously and the pen arm will move to begin recording temperature.



Note *The pen does not begin to move until the button is held for 5 seconds.*

8.2.5 Calibration This recorder has been accurately calibrated at the factory and retains calibration even during power interruptions. If required, however, adjustments can be made as follows:

1. Run unit continuously at bottom-out temperature. Continue steady operation at least 30 minutes to provide adequate time for recorder response.
2. Measures cabinet center air temperature with a calibrated temperature monitor.
3. Compare recorder temperature to center air temperature. If necessary, adjust recorder by pressing the left (#1) and right (#2) chart buttons.

8.2.6 Cobex Recorder Troubleshooting Guide

<p>LED Flashing</p>	<p>Low Battery Replace with a FRESH 9v alkaline battery. Battery must be new.</p> <p>No AC Power</p> <ol style="list-style-type: none"> 1. Remove battery. 2. If LED goes out, then no power is getting to the unit. 3. Check power and transformer connections. Transformer secondary is approximately 15 VAC. 4. Be sure transformer is wired for proper voltage.
<p>LED Out or Unit "Dead"</p>	<p>Possible bad Board</p> <ol style="list-style-type: none"> 1. Remove battery. 2. Disconnect or turn off power. 3. Restore power. 4. Reconnect battery. 5. Return entire unit if not working. <p>Wrong Range</p> <ol style="list-style-type: none"> 1. Push #3 "Chart Change". 2. With pen off chart, hold #1 for 7 seconds. 3. Release. (Note: No range recall). 4. Green LED Flashes. 5. Push #1 or #2 to change: <ul style="list-style-type: none"> • 1 flash -40 to +25 °C • 2 flashes -115 to +50 °C • 3 flashes -200 to 0 °C • 4 flashes 0 to +60 °C (newer units only) 6. Push #3 again.

Not Calibrated	<p>If probe voltage is off by more than a factor of 2 then probe is faulty.</p> <ol style="list-style-type: none"> 1. Remove battery. 2. Disconnect or turn off power. 3. Restore power. 4. Reconnect battery.
Pen Goes to Center	<p>Wrong Range</p> <ol style="list-style-type: none"> 1. Momentarily depress button #3 (“Chart Change” button). 2. With pen off chart, hold #1 for 7 seconds. 3. Release. (Note: No range recall). 4. Green LED Flashes. 5. Momentarily depress #1 or #2 to change: <ul style="list-style-type: none"> • 1 flash -40 to +25 °C • 2 flashes -115 to +50 °C • 3 flashes -200 to 0 °C • 4 flashes 0 to +60 °C (newer units only) 6. Momentarily depress “Chart Change” button again. 7. Not calibrated (see below)

Not Calibrated	Calibrate Recorder
	<ol style="list-style-type: none"> 1. Push #3. Pen comes off chart. 2. Push #3 again. Pen stops briefly on returning to chart. Stopping point should be at edge of chart. If not perform the following: 3. Be sure pen arm is aligned with pen arm bracket. If not, loosen screws adjust. During stopping interval adjust pen arm using #1 and #2 to align pen arm with edge of chart. 4. Place probe in cold water for 5 min. Slow response. 5. Measure the water temperature with a thermometer. 6. Adjust calibration using #1 and #2 to make recorder read same temperature as thermometer. 7. Put probe back into solution. 8. Wait 5 minutes and adjust to cabinet temperature.
	Bad Probe
	<ol style="list-style-type: none"> 1. Check probe connections <ul style="list-style-type: none"> • Red wire connected to J6 pin 1 • Both black wires to J6 pin 2 2. Measure voltage across J6 approximate voltages are as follows: <ul style="list-style-type: none"> • -150 °C=35 mv • -85 °C = 7 5mv • -30 °C=100 mv • 3.5 °C=110 mv • 25 °C = 120 mv (ambient) • Probe open circuit 1.23 v (approximately) • Probe short circuit = 0.0 v (recorder possibly) faulty. Replace probe. If still 0.0v return/replace recorder. • >2.0 v = Replace recorder and probe. • If probe voltage is off by more than a factor of 2 then probe is faulty.

Pen Not Printing	<p>Chart Loose</p> <ol style="list-style-type: none"> 1. Tighten chart knob 2. Attempt to turn chart counter-clockwise 3. If chart turns then tighten knob more <p>No Pen Pressure</p> <ol style="list-style-type: none"> 1. Unscrew pen arm 2. Bend pen arm slightly downward 3. Reattach 4. Recalibrate (see “Not Calibrated”)
Pen Indicating Wrong Temp	<p>Not Calibrated</p> <p>Recalibrate (see “Not Calibrated”)</p> <p>Wrong Chart</p> <p>Be sure proper chart is used with selected range</p> <ul style="list-style-type: none"> • 1 Flash -40 to +25 °C • 2 Flashes -115 to +50 °C • 3 Flashes -200 to 0 °C • 4 Flashes 0 to +60 °C (newer units only)
Pen Will Not Come Completely Off Chart	<p>Pen Arm Displaced</p> <ol style="list-style-type: none"> 1. Unscrew pen arm 2. Align pen arm with pen arm bracket 3. Recalibrate (see “Not Calibrated”)

<p>Pen Arm Oscillating</p>	<p>Not Calibrated</p> <p>Recalibrate (see “Not Calibrated”)</p>
<p>No Recorded Line</p>	<p>No Pen Pressure</p> <ol style="list-style-type: none"> 1. Unscrew pen arm. 2. Bend pen arm slightly downward. 3. Reattach 4. Recalibrate (“Not Calibrated”). <p>Chart Loose</p> <ol style="list-style-type: none"> 1. Tighten chart knob. 2. Attempt to turn chart counter-clockwise. 3. If chart turns, tighten knob more.

9 Theory of Operation

9.1 Overview

The MBF-700 utilizes alternately-operating redundant refrigeration systems to maintain -80 °C while extending unit's life and providing safety in the event of a system failure. The electronic thermostat is backed up by an electromechanical thermostat in case of primary control failure. A liquid CO₂ (LCO₂) backup system provides safety in case of a catastrophic failure of both systems. An external alarm connection is provided in case of an alarm event: Loss of Power and Temperature Warm or Cold alarm.



Avoid contact with the cold equipment or samples, as their low temperature can cause freezing injuries.

9.2 Sequence of Operation

When the compressor key switch (Figure 3, key #5) is initially turned On, the digital display will illuminate and read actual cabinet temperature.



Note *It is normal for the top flange of the freezer cabinet to be warm during operation of the systems. This is particularly true when the chamber is first pulling down in temperature. Within six minutes from the time the compressor power key switch is energized, the red Backup Control alarm indicator will light and both first stage compressors will start.*

The first stage compressors will run until the first stage suction line pressure falls below the setpoint of the staging controller, at which time the switch contact points will close.

These points are connected electrically in the low stage control circuit, causing the low stage compressor to start. All four compressors will run continuously until cabinet temperature has dropped to the adjustable setting of the mechanical Backup Temperature Control setpoint. At this time, one cascade system will shut down and the second cascade system will continue operating until the electronic control setpoint is achieved. Typical pull down time from ambient to -80 °C is approximately 2.5 hours.



CAUTION: Do not add any product load to a warm cabinet.

After the freezer is down to operating temperature, time and record the “ON” and “OFF” cycles for the first few hours, noting the date, time of day and the ambient temperature existing during each cycle. Record this data in the front of this manual. This will provide a reference point for normal operation to aid in future diagnostics.

9.3 Systems Description

9.3.1 Refrigeration System

The MBF-700 is equipped with identical and redundant cascade refrigeration systems: System “A” and System “B”. Since each is capable of maintaining the proper operating temperature inside the freezer, the product load will be protected if one system should fail.

System “A” is located on the right-hand side and system “B” is located on the left. Both systems are two-stage, low temperature cascade systems designed to maintain the rated temperature of $-80\text{ }^{\circ}\text{C}$ individually. System “A” is located on the right end of the cabinet (behind the control panel) and System “B” is located on the left end of the cabinet.

During a normal cycling condition, a sequencing relay cycles first one system and then the other in order to equalize operating time on both systems. However, when the cabinet is abnormally warm (such as during start-up or temperature control failure), a backup mechanical temperature control will cause both systems to run.

The key components of the A and B systems are carefully selected to achieve the highest possible reliability of a mechanical freezer. The compressors are 1.5 HP industrial grade hermetic Bristols. These compressors have been thoroughly tested to give reliable service at ULT conditions. The condensers, interstage heat exchangers and evaporators on the high and low stages are designed to provide a reliable operation at an ambient of as high as $32\text{ }^{\circ}\text{C}$. A balancing operation of the stages combined with reliable components makes MBF freezers suitable for many difficult applications either in military or civilian fields.



Note *When loading the freezer, leave a minimum space of two inches (2”) between the under side of the freezer sub lids and the top of the topmost packages for proper air circulation*

9.3.2 Safety Devices

Both first and second stage compressors are protected by an internal pressure relief valve that will rapidly equalize the high and low sides of a given stage in the event of a pressure imbalance greater than -425 psig. Additionally, all compressors are equipped with internal Klixon-type electrical overloads that

will break the motor circuit in the event of an overcurrent or overtemperature condition. These two devices form a conservative application envelope that the compressors should operate in. Under normal conditions, the trip points are far from actual operating pressures. In the event of a trip, both devices will automatically reset to their normal operating mode once the triggering condition has been resolved.

A Staging Control Temperature Switch is connected to the suction side of the first stage. It is connected to the control side of the contactor for second stage. This prevents second stage from starting before first stage is able to support the thermal load. When the first stage suction pressure rises the second stage is de-energized to prevent a high head pressure condition on second stage.

High/Low Temperature Alarm

Through the main temperature control, both high and low process variable alarm settings can be made. Should the freezer temperature deviate beyond these settings, a relay will activate the master alarm circuitry and the control panel will display an alarm message.

In addition to the two refrigeration systems, redundancy is also incorporated into the control system. Two temperature control systems are included – the main and the back-up controls. The main control is an electronic Dixell controller that provides the primary refrigeration demand signal, as well as the high and low alarm setpoints. If the Primary control loses communication with its sensor probe, it defaults to a 100% run condition.

The back-up control is an electromechanical thermostat. This control should be set 10 °C warmer than the desired cabinet operating temperature. When this safety thermostat functions, it indicates that the second cascade system has been required to maintain proper temperature. This can be the result of a significant heat load added to the freezer or, it can mean that the system operating as primary at the time it occurred has a problem. If a failure occurs, the failed system may be switched off by selecting the functioning side on the rotary switch on top of the sequencing relay. This will prevent the relay from alternating sides, and the indicated side will run repeatedly.

9.3.3 Backup System

This fully independent system provides backup cooling in the event both mechanical refrigeration systems become inoperable, possibly due to a power loss. The system is designed to meter liquid CO₂ to the freezer compartment with the liquid flow controlled by a battery-supplied solenoid valve. The solenoid valve opens and closes in response to a closed-loop electronic control system that monitors the freezer temperature.

A built-in charger maintains the battery charge; the battery is capable of operating the backup system for approximately 24 hours, depending upon the age and condition of the battery. The temperature probe, which is a 100 ohm platinum RTD, is located on the right side of the freezer chamber. The liquid CO₂ distribution (supply) tube is located on the left side.

The liquid CO₂ control is designed to delay injection until the temperature has risen above the temperature setpoint. LCO₂ will then be injected to maintain the cabinet temperature at the desired setpoint. (Refer to the LCO₂ Operator's Manual for instructions on programming the temperature setpoints.

Liquid CO₂ may be supplied from a bulk tank or a Dewar. Recommended supply pressure is 900 to 1,000 psig. A compression fitting is provided for connection from the LCO₂ system to the LCO₂ supply.

A pressure relief vent is provided to relieve cabinet pressure in the event of LCO₂ deployment. A vent for the removal of nitrogen gas can be made. However, it is recommended that a direct connection not be made because of the possibility of restricting the vent with frost build-up if the room and "vent to" spaces are of differing atmospheric pressures and temperatures. A vacuum relief vent using a non-direct connection is recommended. In this manner, a venting system will not create a negative-pressure within the cabinet, nor can it force warm/humid air into the cabinet.

A mechanical lid position limit switch has been provided to ensure that the lid is fully closed before LCO₂ can be injected, to prevent injury to personnel.

9.3.4 Halo Passes

Two copper halo passes are installed on the inner wall around the flange of the freezer shell. Each of these halo passes is independently and directly connected to the discharge line of the first stage compressors of "A" and "B" refrigeration systems. The high discharge gas temperature from the compressors is thus utilized to raise the flange temperature above the local dew point to prevent any condensation from forming. When the unit is in operation, each halo pass can add approximately up to 60 Watts of heat for moisture removal in the flange area. The halo heat is only available when the unit operates.

Ample heat from both halo passes is provided to the flange to prevent frost accumulation. When the cabinet temperature drops below the auxiliary temperature control setting only one system ("A" or "B") will operate. Therefore, the flange is still kept dry even when the cabinet temperature is at ultra-cold condition.

9.4 Operation

9.4.1 Cascade Refrigeration System

Principle of a Low Stage in a Cascade Refrigeration System

A two stage cascade refrigeration system typically is comprised of two separate complete refrigeration circuits. They are normally referred to as high stage or first stage and low stage or second stage. While the two stages work separately, the heat transfer duty is carried from the low stage to the high stage via an interstage heat exchanger or cascade heat exchanger, then ultimately to the environment by an air-cooled or water-cooled condenser. In either stage, the basic elements are a compressor, a condenser, an expansion device, and an evaporator. The evaporator of low stage circuit is directly for removing heat from payload. In a storage type of freezer, an evaporator tubing is wrapped around the storage tank where the products are placed. As the liquid refrigerant boils within the tubing at a low temperature of about $-90\text{ }^{\circ}\text{C}$, it absorbs heat from the products. The condenser of the low stage is the high-pressure side of the interstage heat exchanger where low stage refrigerant is condensed to a high-pressure liquid at about $-40\text{ }^{\circ}\text{C}$. The expansion device, which may be a capillary tube or an expansion valve, regulates the refrigerant flow from the high condensing pressure to low evaporator pressure, hence producing an ultra lower temperature in the evaporator. A special refrigerant such as R508b is ideal to operate in the low stage because its characteristics fit well within the general capability of the low stage compressor and those of other related components. The second stage compressor compresses the refrigerant vapor for a high pressure condensing in the interstage heat exchanger.

Principle of a High Stage in a Cascade Refrigeration System

The cycle of refrigerant in compression, condensing, expansion, evaporating and compression again applies to the high stage of a cascade system. In this high stage, however, the evaporator is the low-pressure side of the interstage heat exchanger where evaporative refrigerant flows in an opposite direction from that of the condensing flow of the second stage. The evaporating temperature is lower than that of the second stage condensing temperature, therefore, second stage can transfer its the product heat to the first stage. With its condenser being water-cooled or air-cooled, the first stage passes the heat to the cooling media. Refrigerants such as R404a offer good performance attributes that are compatible with many components used in the first stage. As can be seen, both first and second stages operate together to remove heat from products in a chain or cascade fashion.

A reliable operation of the system stems not only from the good quality of each component, but also a well balance between the two stages to avoid extreme stresses.

9.4.2 Main Temperature Control

Under normal conditions, the main control system governs the operation of the freezer. If the main control system fails to operate, the backup system will take over operation of the freezer. With the main control system in operation, two distinct modes are available, Cycle Mode and Bypass Mode.

- **Cycle Mode:** This mode of operation alternates the usage of refrigeration systems “A” and “B” each time the main control cycles on. A sequencing relay is used to provide this functionality. This mode of operation will equalize operating time of both refrigeration systems and is the standard mode of operation for the MBF-700. In the case of a temperature excursion above the setpoint of the secondary controller, it will energize whichever side is **not** currently being controlled by the primary controller demand signal.
- **Bypass Mode:** In this mode of operation, one side of the unit is bypassed and will not be energized by the primary controller – all of its demand signals will go to the selected side. This mode can be selected by turning the rotary switch on top of the sequencing relay to indicate the side that is desired to run exclusively.
- **Off:** With the power key switch in the “Off” position the compressors will not energize.

The Primary Temperature Control does not directly cycle between sides, but provides a demand signal when the measured system temperature exceeds the setpoint plus hysteresis value. A digital display is provided to continuously show actual chamber temperature; the chamber temperature is measured with a 1000-ohm RTD.

The sequencing relay is located inside the upper machine compartment. It alternates the demand signal from the primary controller between side A and Side B, and also sends the demand signal from the secondary controller to the side that is currently idle. The alternating function can be disabled by selecting side A or B on the rotary switch on top of the relay.

9.4.3 MBF-700 Electronic Components

Power Supply: A power supply provides 12 VDC to drive the alarm circuit, battery charging circuit, and primary power relay. The nominal output voltage is 12.4 VDC, and can be adjusted via the dashpot on the top surface of the power supply.

Battery: The battery, a 12 V rechargeable gelled-electrolyte, lead-acid type, supplies power to the system upon loss of AC line power. This keeps the alarm circuits active in the event of a power or control failure. The current state of battery charge can be read by pressing the button next to the volt meter on the front panel display.

Alarm: The controller will detect and display high and low temperature alarms as per the programmed parameters. Additionally, the alarm circuit will activate in the event of a total loss of unit power. Alarm conditions are locally sounded by a solid-state audio alert. Additionally, a set of form C relay contacts are made to change state. These may be used to remotely indicate alarm conditions.

Alarm Outputs: Alarm conditions are indicated locally by a solid-state sonic device and remotely by Form c relay contacts. A maximum of 36 V 3 A should be applied to these contacts.

Display: Display of the temperature is integrated into the primary controller. Refer to Appendix B for details on controller operation.

9.4.4 Backup (Secondary) Temperature Control System

The electromechanical backup control system will take over control of the refrigeration systems if the main control system should fail to maintain the desired temperature.

In this mode of operation, the sequencing relay will respond to a demand signal from the secondary control by energizing the side of the system that is not currently being controlled by the primary controller. As these two demand signals are independent, it is possible for both systems to be running simultaneously with one driven by the primary controller and the other by the secondary controller. Control operation is transferred to the backup system simply as a result of a main control system failing to maintain a temperature colder than the backup control setpoint (typically 5 to 10 °C warmer than the desired operating temperature). Under normal operation the freezer will not warm up to the temperature at which the backup controller will engage. However, if the freezer lid is left open for extended periods or a large product load is placed inside the freezer, the backup control system may energize both refrigeration systems. Also note that when the freezer is first turned on at room temperature, the backup control system will be engaged. As the freezer cools beyond the setting of the backup control, operation of the freezer will transfer to the main control.

While the “On” cycles are fairly consistent, the off cycles will be very responsive to the density of product loading inside the cabinet and the ease of cabinet air circulation as well as ambient temperature. Off cycles can vary from 4 to 30 minutes. The system is protected against overloading through

the action of staging control in the electrical circuit of the second stage. However; prolonged overloaded operation will shorten the life of all refrigeration compressors; overloading should be avoided by loading pre-frozen product after the cabinet interior is at operating temperature.

When the secondary controller is engaged, the red “Backup Control” alarm light on the lower status indicator panel will be lit. When both systems operating have cooled the cabinet below the Backup Control’s setpoint, the Backup Control allows the Sequencing Relay to shut down one of the refrigeration systems and the Backup Control red warning light will be extinguished. The second system will continue to run until the cabinet temperature has lowered to the temperature control set point. At that time, the operating system will cycle off. Upon cabinet warm-up to the primary control setpoint, the “lead” system (as determined by the position of the sequencing relay contacts and indicated by the LED on top of the relay) will start. When the cabinet control setpoint is once again achieved, the sequencing relay will de-energize and will exchange the lead systems. The amber pilot lights on the lower status indicator panel indicate which system is in operation. The Backup Control thermostat has been provided to put both systems in operation if the cabinet temperature rises above its setpoint and to protect against failure of one refrigeration system or the primary controller.

10 Maintenance and Service

10.1 Cleaning the Freezer Surfaces

The inside and outside of the freezer are coated with a heat fused epoxy powder finish. It may be cleaned with any non-abrasive cleaner such as hand dish washing detergent. To prevent odors on the inside of the freezer after cleaning, it is recommended that, after cleaning with detergent, the entire surface be wiped with a clean cloth soaked with a solution of one-half (1/2) gallon of water and one-quarter (1/4) cup of baking soda.



It is recommended that rubber or chemically resistant gloves be worn during all cleaning and decontamination procedures.

10.2 Air Cooled Condensers

Because heavy traffic areas are dustier than others, a cleaning schedule for air-cooled condensers and filters is difficult to predict. A suggested schedule, however, is 6 months, which can be adjusted as needed. Access to the filters is gained by removing the three screws at the outboard edge of both front hinged panels and swinging them open. The filter will come out and can be washed with a mild detergent, rinsed and replaced. It is not necessary to dry the filter. The condenser coil itself may be vacuumed clean at the same time.

10.3 Compressor Oil Level

Lubricating oil is retained in the compressor sump. An oil pump at the bottom of the crankshaft picks up the oil and feeds it to the crankshaft. Centrifugal force then delivers oil under pressure to the bearings, crank pins, etc. THE UNIT MUST BE LEVEL. If the compressor is not vertical oil cannot reach the oil pump; this will result in bearing damage.

10.4 Fan Motors

One or more cooling fans are provided in the machine compartment of freezers, whether water-cooled or air-cooled. No oiling is necessary. During periodic maintenance, these fans should be checked for operation. If the compressors are running but any one of the fan motors is not, the inoperative one must be replaced.

10.5 Defrosting

Chest type freezers do not require defrosting more often than once every six months to a year unless they are subject to heavy usage. Frost will begin to build at first around the top of the inner liner and will decrease in proportion to the distance from the top. Frost or “snow” will be the most apparent accumulation and it may be removed with a plastic scraper. If any hard ice has developed, do not chip it using metallic objects.

Instead, remove all products stored in the freezer, turn the key “off”, unplug the unit, and allow it to warm up. When temperature has risen far enough, the ice can be readily dislodged.

To check gaskets for proper sealing, use a 2” x 6” piece of paper (a dollar bill is handy) closed between the gasket and the lid at 12” intervals around the perimeter of the lid. At each position, pull on the free end of the paper. A slight resistance should be felt. While performing this test, inspect the gasket for cuts or tears. An improperly sealing gasket must be replaced.

10.6 LCO₂ Vent

On a semi-annual or monthly basis (depending on frequency of lid opening), verify that the LCO₂ vent is free of dirt and frost/ice accumulation that might interfere with the venting function.

10.7 Storage

Before placing the freezer in storage, turn the key switch to Off, unplug the power cord, open the lid and allow the interior to warm up to ambient temperature. Dry out the interior. Prop the lid open at least 6" and secure in this position. If water cooling has been used, the water lines of BOTH water cooled condensers must be blown out to prevent freezing.

11 Troubleshooting

CAUTION: Only certified Refrigeration or Electronic Technicians should service the system



Note Before attempting to troubleshoot the unit, perform the following checks. Correct what is found wrong and re-evaluate the unit before continuing.

Before troubleshooting, verify that the main power is supplied to the freezer.

SYMPTOM	POSSIBLE CAUSE	TEST AND CORRECTION
Cabinet temperature colder than Control Setpoint.	<ol style="list-style-type: none"> 1. Control out of calibration. 2. Inoperative control. 3. Cabinet relay points fused. 4. Stuck Sequencing relay. 5. Stuck Backup Control. 6. Temperature sensor defective. 	<ol style="list-style-type: none"> 1. Recalibrate if necessary. 2. Replace control if necessary. 3. Replace relay if necessary. 4. Replace Sequencing Relay. 5. Replace Backup Control. 6. Replace temp sensor.
Displayed temperature does not match freezer temperature.	<ol style="list-style-type: none"> 1. Needs calibration. 2. Defective sensor. 	<ol style="list-style-type: none"> 1. Recalibrate per specified procedure. 2. Replace temp sensor.
Frost buildup on breaker strip.	Gasket not sealing properly.	Gasket wrinkled, worn or torn. Check retaining means and replace if necessary. Frost will accumulate at the point of an air leak. Check carefully in the area of any concentrated frost buildup.
No audio alarm at power fail or temperature fail.	<ol style="list-style-type: none"> 1. Defective wiring. 2. Defective alarm loudspeaker. 	<ol style="list-style-type: none"> 1. Check wiring between control board & panel. 2. Replace loudspeaker.
No remote alarm function.	Defective wiring.	Check wiring between control board & remote alarm terminal block.

Troubleshooting

<p>High Stage Compressor does not run</p>	<ol style="list-style-type: none"> 1. No power. 2. Low voltage. 3. Inoperative control. 4. Loose wiring at terminals. 5. Inoperative compressor contactor. 6. Open or grounded compressor windings. 7. Defective starting components. 8. Stuck compressor. 	<ol style="list-style-type: none"> 1. Check power source. If none, call qualified electrician. 2. Read supply voltage while unit is running. Reading must equal rated $\pm 10\%$. If the facility voltage fluctuates often, add the optional Voltage Safeguard accessory. 3. Jumper across contacts. If compressor starts but control is calling for closed contacts, replace control. 4. Inspect all electrical connections. 5. Start compressor using test cord or, momentarily, jumper contactor line terminals to load. 6. Disconnect compressor leads and read phase to phase ohms@0.8-2 at 77 °F + or -5%, and for any phase to ground. If electrical checks are OK, try to start by disconnecting and exchanging any two compressor power leads. 7. Replace starting components. 8. Install hard-start kit; if unsuccessful, replace compressor.
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<p>Low stage compressor does not run.</p>	<ol style="list-style-type: none"> 1. No power. 2. Inoperative controller, reverse acting pressure control, high pressure limit, or circuit relay. 3. Loose wiring at terminals. 4. Inoperative compressor contactor. 5. Low voltage. 6. Open or grounded compressor winding. 7. Stuck compressor. 8. Failed Staging Control. 9. Oil separator failed to return oil to the compressor. 10. Staging control not closing to trigger second stage compressor. 	<ol style="list-style-type: none"> 1. Check power supply. Refer problem to qualified electrician. 2. Check each component with high stage running and down to temperature. Replace defective control. 3. Inspect all electrical connections. Retighten as necessary. 4. Start compressor using test cord or, momentarily, jumper contactor line terminals to load. 5. Read supply voltage while unit is running. Reading must equal rated $\pm 10\%$. If the facility voltage fluctuates often, add the optional Voltage Safeguard accessory. 6. Disconnect compressor leads and read phase to phase ohms@0.8-2 and for any phase to ground. If electrical checks are OK, try to start by disconnecting and exchanging any two compressor power leads. 7. Install hard-start kit; if unsuccessful, replace compressor. 8. Replace Staging Control. 9. Replace oil separator. 10. Slowly adjust staging control in 5C increments until low stage
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Troubleshooting

<p>Unit runs but little or no refrigeration. On-cycles are getting longer.</p>	<ol style="list-style-type: none"> 1. Loss of refrigerant. 2. Compressor will not pump. 3. Restriction in low stage. 4. Inoperative high stage condenser fan. 5. Dirty insufficient air flow. 6. High room temperature. 7. Refrigerant leak. 8. Condenser fan blade is loose. 	<ol style="list-style-type: none"> 1. Check for the leak, repair, evacuate and recharge. 2. Install low-side gauge. If running pressure is no lower than starting pressure, replace compressor, evacuate and recharge. 3. Shut unit off and install low-side gauge. If high-side pressure appears on low-side gauge within 10 minutes, or no pressure buildup occurs, try disabling the high stage compressor and allow the low stage head pressure to build up to 275 psig. A sudden rise in low stage suction pressure will indicate that the restriction has cleared. If it does not, allow cabinet to warm up overnight and restart. If restriction still did not clear, isolate and back-flush the evaporator. 4. Check for fan blade obstruction. Replace fan motor if necessary. 5. Remove/clean condenser filter; ensure cabinet has a minimum of 6" clearance all around it. 6. Ensure room temperature is <90 °F (32.2 °C). 7. Refer to Charging procedures. 8. Adjust box height and tighten fan blade.
<p>Displayed temperature does not match freezer temperature.</p>	<ol style="list-style-type: none"> 1. Needs calibration. 2. Defective sensor. 	<ol style="list-style-type: none"> 1. Recalibrate per specified procedure. 2. Replace temp sensor.
<p>Frost buildup on breaker strip.</p>	<p>Gasket not sealing properly.</p>	<p>Gasket wrinkled, worn or torn. Check retaining means and replace if necessary. Frost will accumulate at the point of an air leak. Check carefully in the area of any concentrated frost buildup.</p>
<p>No audio alarm at power fail or temperature fail.</p>	<ol style="list-style-type: none"> 1. Defective wiring. 2. Defective alarm speaker. 	<ol style="list-style-type: none"> 1. Check wiring between control board & panel. 2. Replace alarm speaker.
<p>No remote alarm function.</p>	<ol style="list-style-type: none"> 1. Defective wiring. 2. Defective board component. 	<ol style="list-style-type: none"> 1. Check wiring between control board & remote alarm terminal block. 2. Replace control board.

<p>Unit runs continuously.</p>	<ol style="list-style-type: none"> 1. One or more sublids missing. Poor gasket seal. 2. Machine compartment fan not running. 3. Backup Control set too low. 4. Backup Control will not shut unit off—contacts stuck. 5. System undercharged. 6. System overcharged. 7. Non condensables in system. 8. Restriction. 9. Worn or inefficient compressor. 10. Wrong refrigerant installed. 11. Leaking needle valve in oil separator. 12. Wet insulation. 13. Defective control. 14. Defective temperature sensor 	<ol style="list-style-type: none"> 1. Replace missing sub lids. Replace lid gasket. 2. Check for fan blade obstruction. Replace fan motor if defective. 3. Check specifications for lowest design temperature. Reset control. 4. Replace Backup Control. 5. Check operating pressures. If low, shut down, warm up overnight and check soak pressure. 6. Recover, evacuate, and recharge as per data plate. 7. Check operating pressures and wattage. Wattage will be high and suction pressure low. Recover charge, evacuate and recharge. 8. Evacuate and flush system, replace drier and recharge. 9. Replace Compressor. 10. Evacuate and recharge following instructions in this manual. 11. Oil return line will be warm. Discharge pressure will be lower than normal, suction higher than normal. Suction gauge may fluctuate. Replace oil separator. 12. Replace insulation. 13. Replace control 14. Replace sensor.
<p>No Display</p>	<p>Defective control.</p>	<p>Replace control.</p>

All major failure modes are listed above. In cases where the particular fault is not listed, component level diagnostics must be performed. This may be accomplished using the parts list and component layout (refer to Appendix A).

12 Failure Analysis



CAUTION: Dangerous voltages can exist across capacitor terminals. Be familiar with electrical components and applicable testing procedures.

12.1 Contactors and Relays

The two possible failure modes of contactors and control relays are 1). a burned out coil, or 2). failed contact points. If the coil is burned out or electrically open, the device will not operate at all. If the points are burned out or failed mechanically, the relay will operate but the circuit will not close. In the case of a 3 phase motor contactor with only one faulty contact, the motor will attempt to start and may actually run if under light load but it will be “single phasing” and will quickly trip the overloads.

12.2 Compressor Motors, Three Phase

The quickest way to check a compressor motor is through the use of an ohmmeter to obtain the resistances of the three field windings. First, disconnect all leads from the motor terminals. Second, set the meter at the lowest scale and read the ohms from T1-T2, T1-T3 and T2-T3 terminals. The readings should be close to the same (within $\pm 10\%$). If the variance is greater than 10%, carefully check the refrigerant gas for “burned” odor. Any burned odor signals a winding breakdown and will require a compressor change. Also, a system cleanup is indicated. If not familiar with this procedure, consult the factory.

As part of the motor windings check, always read the resistance from windings to ground. It should be a high resistance, in the range of 100-130 megohms Confirm Value. Low readings indicate a beginning breakdown of the winding insulation. Readings that approach 1.0 to 2.0 megohms between any motor terminal to ground indicate that trouble is imminent. Some authorities use a hand cranked instrument called a Megger to obtain these readings. There is an instrument available, however, which gives more reliable readings than a Megger. This is the High Pot Tester. This meter gives a reading in milliamps reflecting the value of actual current leakage when a high potential is applied across windings to ground. Generally, the tester is set up to deliver 1,000 volts plus twice the nameplate voltage rating for the motor. The current leakage should be 5 to 10 milliamps or less.

12.3 Partial or Complete Loss of Refrigeration

If both compressors are inoperative, check to see if the unit’s electric service connections have loosened. Also check the breakers, fuses or other overload devices in the power circuit. Next, check to see if voltage is present at the compressor terminals. If the high stage compressor internal pressure relief valve or electrical overload has tripped, the condenser may be dirty or the condenser inlet air temperature may be above 90 °F. In the case of a water cooled condenser, the water supply may have been interrupted.

If the low stage compressor internal pressure relief valve or electrical overload has tripped, the high stage is not providing enough refrigeration for the cascade condenser and the trouble will be found in the high stage system. When cabinet temperature begins an unwanted rise, a shortage of refrigerant could be the cause. Allow the cabinet to warm up for at least 8 hours with the lid open, to assure thorough warming of the cascade condenser and the cabinet.

12.4 Checking Refrigerant Charge



CAUTION: At this point in the maintenance and service work, do not proceed further unless familiar with cascade refrigeration systems and are qualified to perform service work that involves opening either the high or low stage system to the atmosphere. The discussion following may seem elementary to some experienced refrigeration technicians, however, a review of correct service procedures is never wasted time.

12.5 Installing Gauges



CAUTION: Before installing or removing suction service gauges, always shut down the compressor and warm the valve so that moisture will not be drawn into a compressor operating in a vacuum. See below.



Note *When installing a gauge on the suction side of the system of either compressor of a unit that is down to operating temperature, always assume that both systems are operating on a vacuum on the low or suction side. Shut down the system for two or three minutes to let suction pressure rise above a vacuum.*

Since the high stage refrigerant is R-404a, the system pressures can stay the same even if a leak is present. If a leak is present in either stage, it will have to be found and repaired, a deep vacuum drawn on the system, and a recharge of refrigerant added.

12.6 Leak Testing, Repairing and Charging – an Overview



CAUTION: The following procedure assumes that there has not been a low side leak that has drawn air and moisture into the system. If this has happened, the low stage may be shut down on safety device, or the pressure reading on the low stage discharge gauge will be unusually high or in excess of normal pulldown pressures. The procedure to be followed in this instance involves evacuation and refrigerant drier replacement.

Install highside and lowside pressure gauges on both first and second stage systems.

LEAK TESTING

If it is impossible to find a leak with normal pressure present in the system, it will be necessary to back up the pressure with dry nitrogen. The nitrogen cylinder should be equipped with a pressure regulator and gauges. One gauge reads cylinder pressure and the other reads regulated pressure. When opening the main cylinder valve, it must be done carefully to avoid ruining the gauges. Barely crack the main cylinder valve until the cylinder pressure gauge reading stops rising and then the valve may be opened a full turn. Connect the regulator outlet port to the system to be leak checked and set the regulator to 150 psig by rotating the regulator “T”-handle clockwise until the outlet pressure gauge reads 150.



WARNING: Do not pressurize the system over 350 psig under any circumstances.



WARNING: Never use oxygen for pressurization or any other purpose in a refrigeration system. This is a highly dangerous practice and can result in a violent explosion.

The system is now ready to be leak checked. Only dry nitrogen is recommended to enhance pressure. Remember that there is now a mixture of nitrogen and refrigerant gas in the system. If the unit is restarted in this condition after leak checking is completed, the operating pressures will be extremely high resulting in trip of the safety devices. Be sure the system is evacuated and recharged by following the charging procedure outlined in this instruction. To test any freezer for leaks, an electronic leak detector is recommended. Turn on the leak detector and when it is warmed up, set it for highest sensitivity. Move the probe slowly around each component and fitting until an audible signal is heard. Stop and decrease the sensitivity

setting. Go back to the suspected leak site and attempt to pinpoint the exact location using leak detection soap. It is easier to obtain a good fix with minimum heating of a tubing joint if the exact location is known.

REPAIRING LEAKS

Copper tubing joints are made using “Phos Copper” solder which is a high temperature brazing alloy needing no flux and with good working characteristics. Leaks in these joints are usually caused by pinholes in the joint and can be repaired by heating the joint and adding extra brazing rod to the joint. It is not always necessary to add material so care should be exercised not to get too much brazing material into the joint.

Leaks occurring in components such as pressure controls or valves usually must be dealt with by replacing the offending component. Whenever a system has been opened for repair, it must be evacuated to a very low vacuum and the drier must be replaced. Always replace the drier with the same BRAND AND SIZE as originally supplied.

EVACUATION

A refrigeration system's worst enemy is air in the system, because all air contains moisture. It is quite simple to purge air from a system but eliminating moisture is more difficult. There has always been a tendency with technicians to open a system and not replace the drier after doing so.



Note *The filter-drier must ALWAYS be replaced whenever the refrigeration system has been opened to atmosphere.*

THE VACUUM PUMP

When evacuating a system, there is an initial flow of gases and moisture toward the vacuum pump but, as the vacuum becomes deeper (after a minute or two), the molecules of moisture-contaminating elements do not move toward the pump except by their random motion. Eventually they work their way to the pump intake by bouncing off the walls of confining vessels and tubing and neighboring molecules. For this reason, a means of speeding up the evacuation process called triple evacuation is used (refer to **EVACUATION PROCEDURE**).

Vacuum pump oil should be changed while it is still hot and after each evacuation job because it becomes contaminated during the process of evacuation. If the pump oil is contaminated, it will be apparent that the pump is not capable of the good deep vacuum of which it was previously capable. Also, remember that moisture in the pump oil is a mortal enemy of the finely machined surfaces inside the pump and it will not long tolerate careless use. It is good practice to change the pump oil after each use, using the dry oil recommended by the pump manufacturer. The pump should be put away in a clean, dry condition ready for the next job.

13 Repair Procedures



CAUTION: The following repair procedures are to be performed by qualified refrigeration technicians only.

13.1 Compressor Replacement



CAUTION: Because cabinet temperatures affect refrigerant pressures, never attempt to repair or charge a refrigeration system unless the freezer has been turned Off, unplugged, and left open for 48 hours.

CONNECT AND PURGE HOSES

1. Proper tools and equipment must be on hand to make a trouble free compressor replacement. Review the discussion covering the vacuum pump on page 51.



CAUTION: Preventing the entrance of air to the refrigeration system and its resultant contamination is vital to the success of any repair procedure that involves opening the system. Be sure to observe all current regulations prohibiting venting of refrigerants

2. Turn off all power to the freezer and unplug the power cord.
3. Locate the two 2nd (low) stage compressors (piped to the oil separators and occupy the lower compressor deck.) and the two 1st (high) stage compressors (piped to the condenser on the upper compressor deck).
4. Determine which compressor or compressors to replace.
5. Attach the gauge manifold to the suction and discharge process tubes via saddle valves.
6. Recover, and dispose of, the refrigerant charge in accordance with current regulations.
7. Go to Step 8, REMOVE THE COMPRESSOR.

REMOVE THE COMPRESSOR

8. Cut Suction, Discharge, and oil return lines to the failed compressor.
9. Remove the compressor mounting bolts.
10. Remove the cover from the electrical junction box on the side of the compressor. Label and disconnect the power leads.
11. Remove the compressor from the machine compartment.
12. Test a sample of the compressor oil. If non-acidic, backflush just the evaporator. (*see* BACKFLUSH PROCEDURE) If acidic, backflush the evaporator, condenser, and all of the tubing; the compressor, oil separator, and tubing that cannot be flushed **MUST** be replaced.

INSTALL THE NEW COMPRESSOR



CAUTION: Replacement compressors are pressurized with nitrogen and may only be installed by qualified refrigeration technicians.

13. Mount compressor on base and reinstall rubber feet and bolts.
14. Braze the suction, discharge, and oil return tubing to the new compressor.

EVACUATION

15. The gauge manifold should be still attached to the service or saddle valves; remove the center hose from the service cylinder of the appropriate refrigerant and attach it to the vacuum pump inlet. Open the manifold gauge handvalves.
16. Start the vacuum pump and run until the electronic vacuum gauge reads 50 microns or lower.

CHECK FOR LEAKS

17. Close the vacuum pump inlet valve, leaving the pump running and watch the electronic micron gauge carefully.



Note *The vacuum gauge must be installed between the compressor and the pump shut-off valve to perform this check.*

The gauge should not rise above 200 microns within 20 minutes. If it does, reopen the pump shut-off valve and allow the pump to evacuate the compressor for another 30 minutes. If the vacuum now holds longer, it indicates that there is still outgassing of nitrogen from the compressor oil. Repeat this process as many times as necessary to obtain the required vacuum and holding time.

BREAK THE VACUUM WITH REFRIGERANT

18. Close the gauge manifold handvalves and the vacuum pump shut off valve. Shut the pump off and change the center manifold hose to the service cylinder of the appropriate refrigerant. Purge the center hose for one or two seconds with gas from the service cylinder and then crack the cylinder valve and the manifold suction handvalve. Gas will flow into the compressor crankcase.
19. Remove gauge manifold and service valves that were used to charge the system.

This completes the installation of a replacement compressor.

13.2 Backflush Procedure

Because cabinet temperatures affect refrigerant pressures, never attempt to repair or charge a refrigeration system unless the freezer has been turned Off, unplugged, and left open for 48 hours.

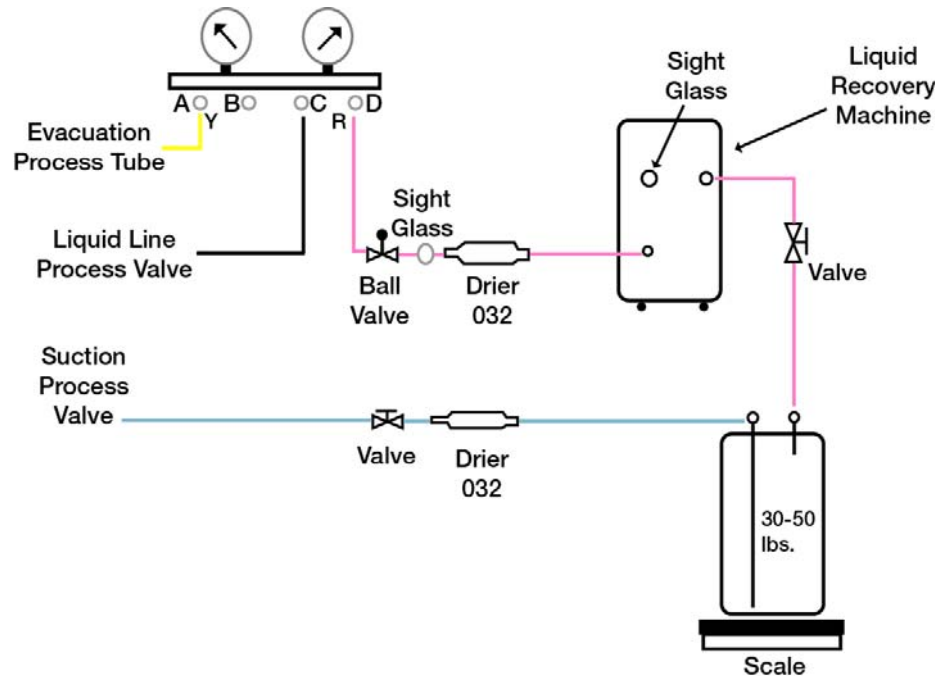


Figure 10. Backflush Connections

1. Two removable sheet panels in the back of the freezer provide access to the first stage expansion valves. This area also provides access points for backflushing the evaporators.
2. Disconnect power and allow the freezer to warm up with the lid open for at least 24 hours.
3. Recover the refrigerant and dispose of it in accordance with EPA regulations and guidelines.



WARNING: Be aware that the cylinder containing the reclaimed refrigerant will be at high pressure when it has warmed to room temperature. Use only a DOT approved 20 lb cylinder for the correct pressure. Refer to Figure 13, Refrigeration System Piping Diagram; item 9 is the Evaporator and is the first component to flush.

4. Use the tubing cutter to remove the drier (item 24) from this compartment; this will allow direct access to inlet end of the capillary tube, which will become the evaporator outlet when backflushing.

5. Cap the end of the tube that goes to the compressor, where the drier was connected.



CAUTION: If backflushing due to acid oil, replace the drier with a straight piece of copper tube. Remove the oil separator and connect the condenser inlet pipe to the *Liquid Line Process Valve* connection shown in Figure 10.



CAUTION: Use eye protection and gloves during the following procedure and whenever a possibility exists of being exposed to a direct spray of liquid solvent.

FLUSHING SOLVENT

It is illegal to discharge ozone depleting chemicals into the atmosphere. Any such discharges are punishable by large fines. Any solvents which are used primarily as refrigerants must be recovered and disposed of locally but also must be effective at moving Zerol oil out of the system; the factory recommendation is R406a or RX11.

For Units with Process Tubes

6. Cut the suction line 3" from the compressor and install a process tube adaptor; connect this to the *Suction Process Valve* connection shown in Figure 10.
7. Replace the oil separator on the lower machinery deck. Do not try to unsweat the entrance and exit tubes from the separator but, instead, cut the tubes at a convenient point. New oil separators are shipped from our factory with a proper oil charge and with tubing stubs squeezed shut and brazed to retain the oil. These stubs may be piped using copper fittings when installing.



Note *Always use a constant nitrogen purge when brazing or sweating joints at high temperature.*

8. Install a new drier in the access compartment.
9. Install new compressor as explained on page 43. Then evacuate and recharge the system using the following procedures.

13.3 Evacuation Procedure



Note *Due to the low temperatures of operation, removal of all moisture is critical to prevent restrictions due to ice formation. Adherence to these procedures is required.*

Required Equipment

1. Vacuum pump oil, 4 liters
2. Vacuum pump capable of pulling 50 microns
3. Dry Nitrogen
4. Gauge Manifold
5. Electronic Scales / Charging Tower

Procedure

1. Drain and refill the vacuum pump oil.
2. Connect the gauge manifold, micron gauge, dry nitrogen (N₂), shut-off valves, and service valves as shown in Figure 11(next page).
3. Shut off the nitrogen supply and the two gauge manifold valves.
4. Open the vacuum pump and micron gauge shut-off vales.
5. Turn on the vacuum pump and ensure that the micron gauge drops to below 200 microns. If not, check for leaks and/or replace the pump and/or gauge.
6. Open the two manifold valves and let the pump run to a vacuum of 1500 microns; shut off the pump.
7. Valve off the micron gauge and slowly bleed dry nitrogen into the system to a pressure of 5-10 psig.
8. Shut of the nitrogen and allow the nitrogen to absorb system moisture for 15-20 minutes, then vent.
9. Open the micron gauge shut-off and let the pump run to a vacuum of 500 microns; shut off the pump.



Note To achieve <200 microns, it may be necessary to replace the vacuum pump oil again during the 15-20 minute soak in the next step.

10. Valve off the micron gauge and slowly bleed dry nitrogen into the system to a pressure of 5-10 psig.
11. Shut of the nitrogen and allow the nitrogen to absorb system moisture for 15-20 minutes, then vent.
12. Open the micron gauge shut-off and let the pump run to a vacuum of 50 microns. Valve/shut off the pump and monitor the micron gauge during the next 10 minutes.
 - If gauge exceeds 200 microns in 10 minutes, tighten connections and repeat steps 10-11.
 - If gauge remains below 200 microns, valve off and remove micron gauge and vacuum pump. Charge system per the following procedures.

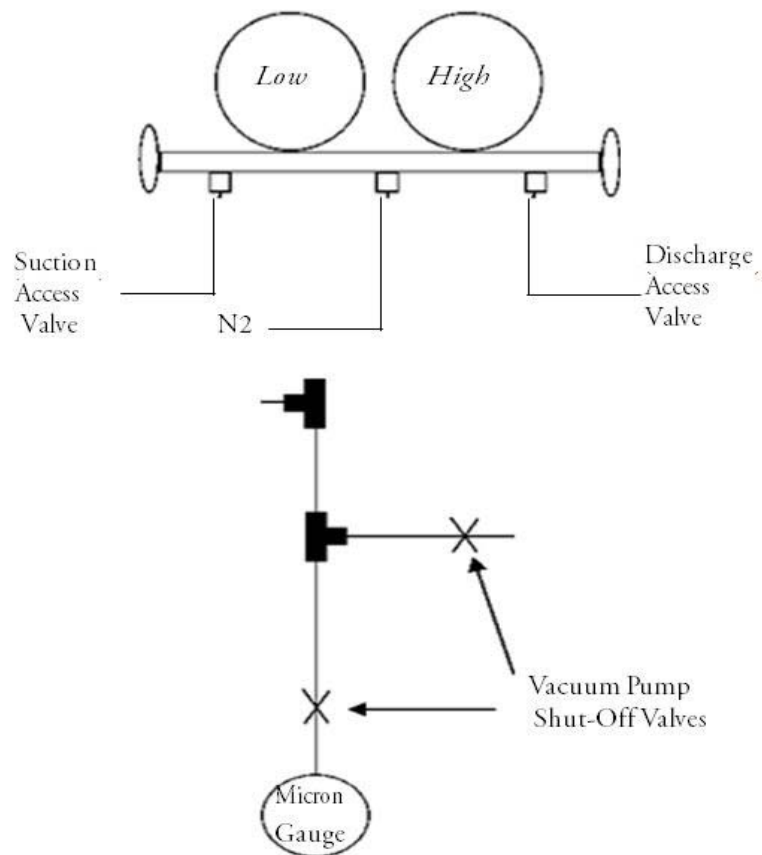


Figure 11. Evacuation and Recharge Process Connections

13.4 Charging Procedure

-- 1st (High) Stage



Note See Appendix A or the Unit Data Plate for the appropriate refrigerant charging data

Required Equipment:

1. Refrigerant(s)
2. Electronic Scales / Charging Tower
3. “T”-type Thermocouple Meter

Procedure

1. Replace the nitrogen tank with a charging bottle and scale.
2. Close the gauge manifold Low Pressure valve.
3. Weigh in the appropriate amount of refrigerant.
4. Disconnect the Staging Control so that the second stage cannot run.
5. Start the system and let it run for 15 minutes; measure / record thermocouple readings.
6. The Heat Exchange thermocouple should measure -35 °C to -46 °C. If not, adjust the TXV until the desired temperature is achieved.

13.5 Charging Procedure

-- 2nd (Low) Stage

Required Equipment:

1. Refrigerant(s)
2. Electronic Scale
3. “T”-type Thermocouple Meter

Procedure

1. Replace the nitrogen tank with a cylinder of R290.
2. Loosen the R290 supply hose at the gauge manifold; crack open the R290 tank valve and purge the hose for 2 seconds, then tighten the connection while purging.
3. Slowly open the gauge manifold High Pressure valve until the system pressure reaches appropriate pressure, close Manifold gauge. Or, weigh in the appropriate amount of refrigerant.
4. Replace the R290 cylinder with R508b.
5. Loosen the refrigerant supply hose at the gauge manifold; crack open the refrigerant tank valve and purge the hose for 2 seconds, then tighten the connection while purging.
6. Slowly open the gauge manifold High Pressure valve until the system pressure reaches appropriate pressure close manifold gauge. Or, weigh in the appropriate amount of refrigerant.
7. If the 1st (high) stage was charged, start the system and let it run for 15 minutes; measure / record thermocouple readings.
8. The Heat Exchange thermocouple should measure -35 °C to -46 °C. If not, adjust the TXV until the desired temperature is achieved.
9. Connect the 2nd (low) stage start relay if necessary, and allow the 2nd stage to start.
10. Allow the unit to run for three hours with a temperature setpoint of -95 °C.
11. Measure and record the temperature display and all thermocouple values.
12. Thermocouple #3 is on the evaporator inlet and should measure -87 °C or colder, if not verify operation of the 1st (high) stage system.
13. Thermocouples #4 and #5 are on the evaporator outlet and should be within 2 °C of each other, and should be within 3 °F to 6 °F of thermocouple #3. If not, adjust the charge by adding R508b.

14 Temperature Calibration

Required equipment

1. Celsius thermocouple meter capable of measuring the operating temperature of the unit at 0.1 °C accuracy.
2. Type “T” Thermocouple.

Cabinet Center Air Offset Calibration

1. Place temperature measuring device such as a thermocouple in the freezer at the approximate geometric center.
2. Allow the freezer temperature to pull down to its coldest possible temperature by setting the control setpoint to -95 °C and allowing the unit to run overnight.
3. Read the temperature of the added temperature measuring device.
4. Adjust Controller offset as per Appendix B.
5. Calibration is now complete. Return control setpoint to appropriate cycle temperature.

Table 1. Thermocouple Labeling and Location

Label	Location/Description
A	First Stage Heat Exchange Inlet/ in TXV compartment
B	First Stage Heat Exchange Outlet/ in TXV compartment
C	Second Stage Heat Exchange Inlet/ in TXV compartment
D	Second Stage Heat Exchange Outlet/ in TXV compartment
(2) Evap In	‘A’ Evap In is located in the ‘A’ side compressor deck area. ‘B’ Evap In is located in the ‘B’ side compressor deck area.
(2) Evap Out	‘A’ Evap Out is located in the ‘A’ side compressor deck area. ‘B’ Evap Out is located in the ‘B’ side compressor deck area.
(2) TXV	One for each ‘A’ and ‘B’ Side ‘TXV’ thermocouple is located in the txv compartment of each ‘A’ and ‘B’ side.

15 Warranty **Be sure to register your warranty online:**

www.thermoscientific.com/labwarranty

THERMO FISHER SCIENTIFIC USA FREEZER WARRANTY

The Warranty Period starts two weeks from the date your equipment is shipped from our facility. This allows for shipping time so the warranty will go into effect at approximately the same time your equipment is delivered. The warranty protection extends to any subsequent owner during the warranty period.

During the first two years of the warranty period, component parts proven to be non-conforming in materials or workmanship will be repaired or replaced at Thermo's expense, labor included. Installation and calibration are not covered by this warranty agreement. The Technical Services Department must be contacted for warranty determination and direction prior to any work being performed. Expendable items, i.e., glass, filters, pilot lights, light bulbs and door gaskets are excluded from this warranty.

Replacement or repair of component parts or equipment under this warranty shall not extend the warranty to either the equipment or to the component part beyond the original two year warranty period. The Technical Services Department must give prior approval for the return of any components or equipment.

THIS WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, WHETHER WRITTEN, ORAL, OR IMPLIED. NO WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE SHALL APPLY. Thermo shall not be liable for any indirect or consequential damages including, without limitation, damages relating to lost profits or loss of products.

Your local Thermo Scientific Sales Office is ready to help with comprehensive site preparation information before your equipment arrives. Printed instruction manuals carefully detail equipment installation, operation, and preventive maintenance.

If equipment service is required, please call your Technical Services Department at 1-800-438-4851 (USA and Canada). We're ready to answer your questions on equipment warranty, operation, maintenance, service, and special applications. Outside the USA, contact your local Thermo Scientific office or distributor for warranty information.

THERMO FISHER SCIENTIFIC FREEZER INTERNATIONAL WARRANTY

The Warranty Period starts two months from the date your equipment is shipped from our facility. This allows for shipping time so the warranty will go into effect at approximately the same time your equipment is delivered. The warranty protection extends to any subsequent owner during the warranty period. Dealers who stock our equipment are allowed an additional four months for delivery and installation, providing the warranty card is completed and returned to the Technical Services Department.

During the first two years of the warranty period, component parts proven to be non-conforming in materials or workmanship will be repaired or replaced at Thermo's expense, labor excluded. Installation and calibration are not covered by this warranty agreement. The Technical Services Department must be contacted for warranty determination and direction prior to any work being performed. Expendable items, i.e., glass, filters, pilot lights, light bulbs and door gaskets are excluded from this warranty.

Replacement or repair of component parts or equipment under this warranty shall not extend the warranty to either the equipment or to the component part beyond the original two year warranty period. The Technical Services Department must give prior approval for the return of any components or equipment.

THIS WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, WHETHER WRITTEN, ORAL, OR IMPLIED. NO WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE SHALL APPLY. Thermo shall not be liable for any indirect or consequential damages including, without limitation, damages relating to lost profits or loss of products.

Your local Thermo Scientific Sales Office is ready to help with comprehensive site preparation information before your equipment arrives. Printed instruction manuals carefully detail equipment installation, operation, and preventive maintenance.

If equipment service is required, please contact your local Thermo Scientific office or local distributor.

We're ready to answer your questions on equipment warranty, operation, maintenance, service, and special applications. Outside the USA, contact your local Thermo Scientific office or distributor for warranty information.

16 Appendix A

16.1 Refrigeration System Data

Unit Model No.: MBF-700		Serial No.:			
		HIGH STAGE		LOW STAGE	
COMPRESSOR Volts:208-230VAC		Bristol Model: L63A183DBD		Bristol Model: L63A133DBL	
OIL CHARGE	Compressor	50 oz of POE RL32 H		50 oz of Zerol 150T	
	Separator	N/A		15 oz of Zerol 150T	
		CUT OUT	CUT IN	CUT OUT	CUT IN
IPR Valve		~425 PSI	Auto	~425 PSI	Auto
LOW PRESSURE CONTROL		N/A	N/A	N/A	N/A
TX VALVE / CAPILLARY TUBE		Sporlan EFS-1/2-SZ		22' of .065"	

Charging Data	Refrigerant	June 2012 to Present
1 st Stage	R404a	50 oz
2 nd Stage	R290	1.5 oz
	R508b	20.3 oz

16.2 Service Parts List

PART NUMBER	DESCRIPTION	QTY
80337H01	Auxiliary Status Indicator Assembly	1
77039H02	Blade, Fan, 12", 3 Blade, 24 ° Pitch	2
326605G01	Stage 1 Compressor, Bristol L63A183DBD	2
326605G02	Stage 2 Compressor, Bristol L63A133DBL	2
314338G03	Service Accumulator Kit	1
304131H05	Condenser, Water Cooled, 1 ton flat-plate	2
80504H01	Contact, 230 VAC/30 A/3P (A1,A2,B 1,B2)	4
325058H01	Control, Reverse Acting, Encapsulated	2
45829G01	Temp Control Service Kit	1
314044H01	Control Sensor	1
325060H01	Primary Electronic Controller - Dixell	1
302543H01	Drier, Parker Special	4
75380H01	Drier, Sporlan# C-032s	4
65288H02	Plastic Fan Blade	2
69156H02	Fuse, 3.2A/250 VAC	2
325270H01	Fuse, Chart Recorder, 1/32 A	2
63017H12	Gasket, Inner, 31ls	1
63018H12	Gasket, Outer, 31ls	1
61833H01	Lid Hinge	5
49200H01	Light, Amber Indicator	2
49200H02	Light, Red Indicator	1
24738605	Motor, 14 W	2
77037H01	Motor, Fan 50 Watt, 230 vac/1 0/50-60 hz	2
81475H03	Oil Separator, Temprite	2
44569H10	Relay, 3PDT, 12 VDC, 10 A Contacts	1
44569H07	Relay, 3PDT/240 VAC	1
325055H01	Sequencing Relay	1
325056H01	Sequencing Relay socket, 8-pin	1
69070H02	Switch, Key	2

PART NUMBER	DESCRIPTION	QTY
327403H01	First stage suction accumulator	1
322598H01	Second stage suction accumulator	1
87812H04	Valve, Expansion	2
326647H01	Harness, Contactor-Compressor A1	1
326665H01	Harness, Compressor (A1 and B1)	2
326647H02	Harness, Contactor - Compressor A2	1
326647H03	Harness, Contactor - Compressor B1	1
326647H04	Harness, Contactor - Compressor B2	1
326516H01	12 V DC Relay	1

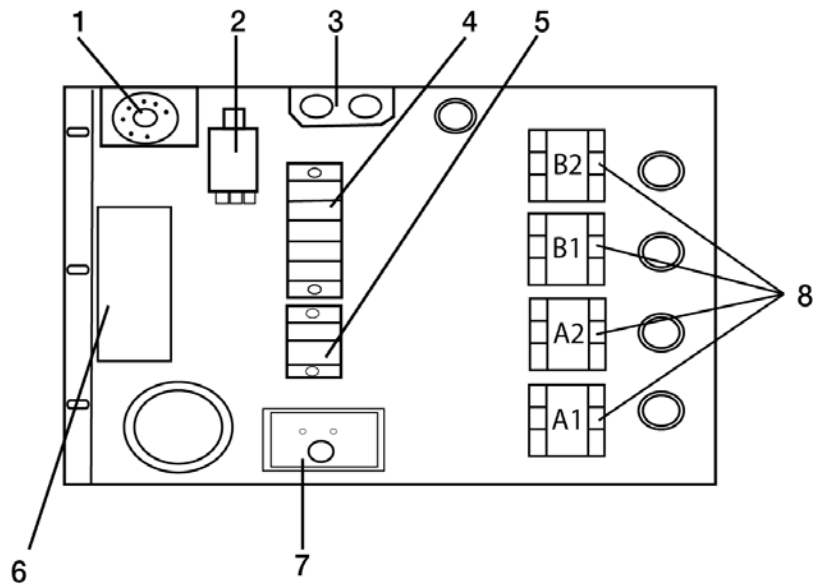


Figure 12. Junction Box

Table 2: JUNCTION BOX COMPONENT PARTS LIST

Item #	Description
1	Backup Temperature Control
2	Relay, 3PDT, 12 VAC
3	Fuse holder and fuses, 4A
4	Terminal Strip
5	Terminal Strip
6	12 VDC Power Supply
7	Sequencing Relay and Socket
8 (A1)	Contactor, System “A”, 1 st Stage
8 (A2)	Contactor, System “A”, 2 nd Stage
8 (B1)	Contactor, System “B”, 1 st Stage
8 (B2)	Contactor, System “B”, 2 nd Stage

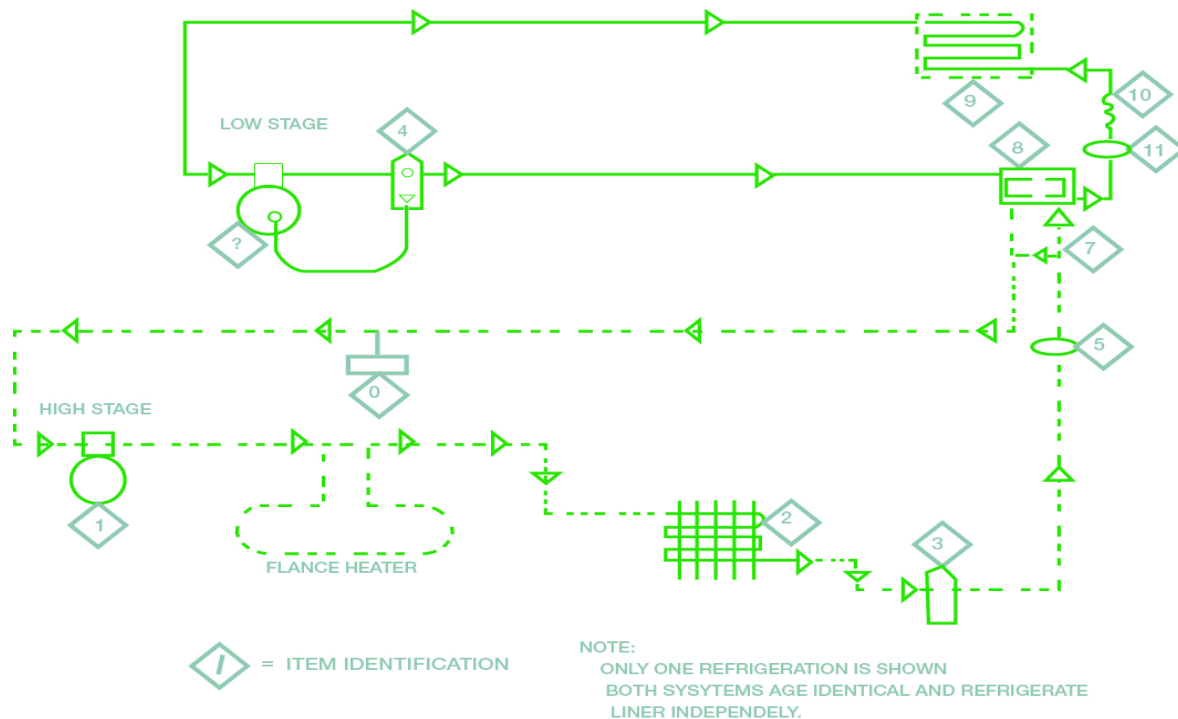


Figure 13. Refrigeration System Piping Diagram



Note Only one refrigeration system is shown. Both systems are identical and refrigerate cabinet independently.

Item #	Description
1	Compressor
2	Condenser
3	Receiver
4	Oil Separator
5	Filter Drier
6	Thermal Expansion Valve
7	Inter stage Condenser
8	Tank evaporator tubing
9	Capillary Tube
10	Filter-Drier

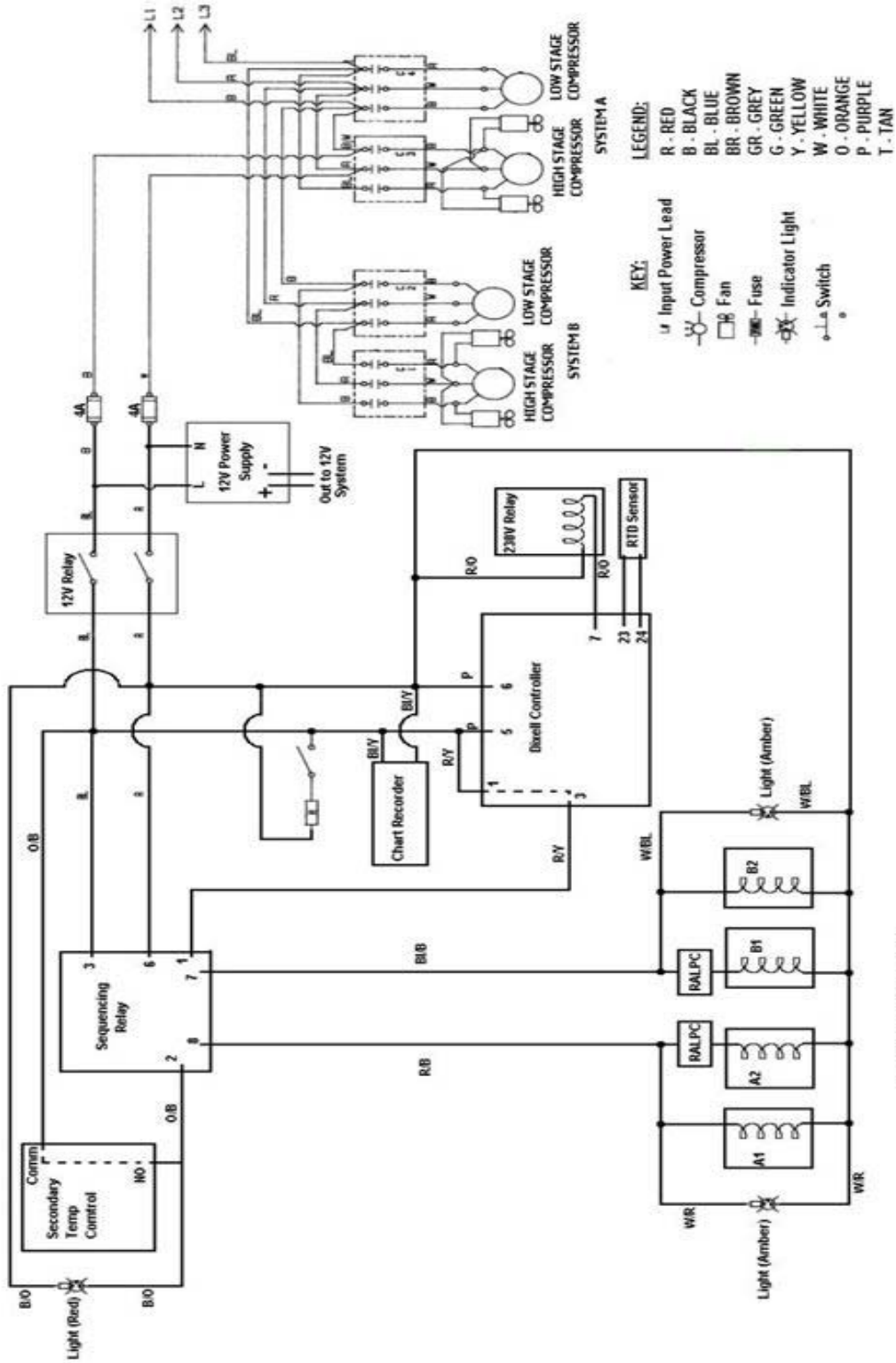
16.3 Temperature Conversion Table

The number in degrees, either Fahrenheit or Celsius, in the center column, refers to temperature. If converting Fahrenheit to Celsius, the equivalent temperature will be in the left column. If converting Celsius to Fahrenheit, the equivalent temperature will be in the right column.

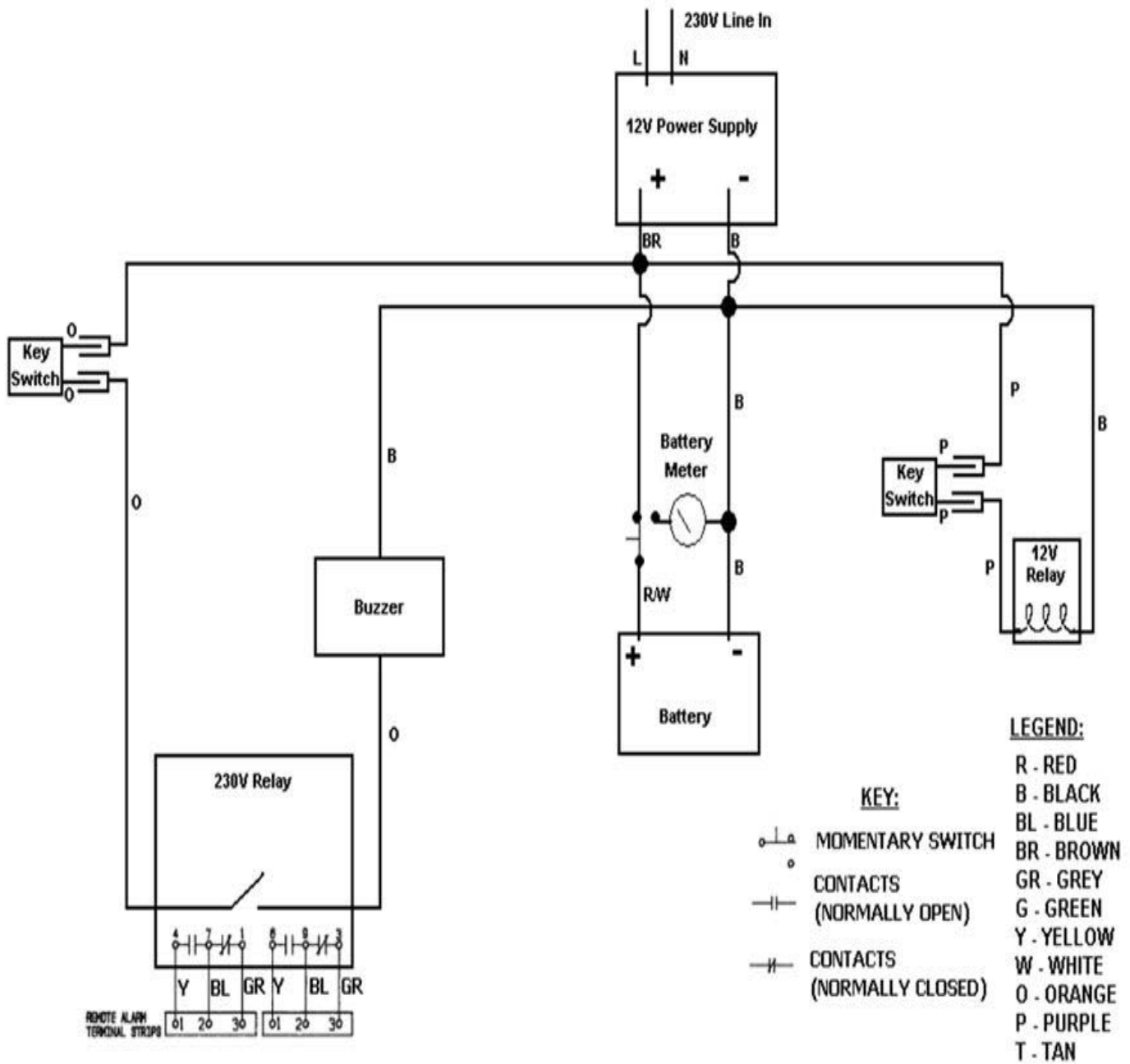
Table 3: Temperature Conversion Table

°C	BE	°F	°C	BE	°F	°C	BEG	°F
-101.1	-150	-238.0	-40.0	-40	-40.0	-17.8	0	32.0
-98.3	-145	-229.0	-39.4	-39	-38.2	-17.2	1	33.8
-95.6	-140	-220.0	-38.9	-38	-36.4	-16.7	2	35.6
-92.8	-135	-211.0	-38.3	-37	-34.6	-16.1	3	37.4
-90.0	-130	-202.0	-37.8	-36	-32.8	-15.6	4	39.2
-87.2	-125	-193.0	-37.2	-35	-31.0	-15.0	5	41.0
-84.4	-120	-184.0	-36.7	-34	-29.2	-14.4	6	42.8
-81.7	-115	-175.0	-36.1	-33	-27.4	-13.9	7	44.6
-78.9	-110	-166.0	-35.6	-32	-25.6	-13.3	8	46.4
-76.1	-105	-157.0	-35.0	-31	-23.8	-12.8	9	48.2
-73.3	-100	-148.0	-34.4	-30	-22.0	-12.2	10	50.0
-72.2	-98	-144.4	-33.9	-29	-20.2	-11.7	11	51.8
-71.1	-96	-140.8	-33.3	-28	-18.4	-11.1	12	53.6
-70.0	-94	-137.2	-32.8	-27	-16.6	-10.6	13	55.4
-68.9	-92	-133.6	-32.2	-26	-14.8	-10.0	14	57.2
-67.8	-90	-130.0	-31.7	-25	-13.0	-9.4	15	59.0
-66.7	-88	-126.4	-31.1	-24	-11.2	-8.9	16	60.8
-65.6	-86	-122.8	-30.6	-23	-9.4	-8.3	17	62.6
-64.4	-84	-119.2	-30.0	-22	-7.6	-7.8	18	64.4
-63.3	-82	-115.6	-29.4	-21	-5.8	-7.2	19	66.2
-62.2	-80	-112.0	-28.9	-20	-4.0	-6.7	20	68.0
-61.1	-78	-108.4	-28.3	-19	-2.2	-6.1	21	69.8
-60.0	-76	-104.8	-27.8	-18	-0.4	-5.6	22	71.6
-58.9	-74	-101.2	-27.2	-17	1.4	-5.0	23	73.4
-57.8	-72	-97.6	-26.7	-16	3.2	-4.4	24	75.2
-56.7	-70	-94.0	-26.1	-15	5.0	-3.9	25	77.0
-55.6	-68	-90.4	-25.6	-14	6.8	-3.3	26	78.8
-54.4	-66	-86.8	-25.0	-13	8.6	-2.8	27	80.6
-53.3	-64	-83.2	-24.4	-12	10.4	-2.2	28	82.4
-52.2	-62	-79.6	-23.9	-11	12.2	-1.7	29	84.2
-51.1	-60	-76.0	-23.3	-10	14.0	-1.1	30	86.0
-50.0	-58	-72.4	-22.8	-9	15.8	-0.6	31	87.8
-48.9	-56	-68.8	-22.2	-8	17.6	0.0	32	89.6
-47.8	-54	-65.2	-21.7	-7	19.4	0.6	33	91.4
-46.7	-52	-61.6	-21.1	-6	21.2	1.1	34	93.2
-45.6	-50	-58.0	-20.6	-5	23.0	1.7	35	95.0
-44.4	-48	-54.4	-20.0	-4	24.8	2.2	36	96.8
-43.3	-46	-50.8	-19.4	-3	26.6	2.8	37	98.6
-42.2	-44	-47.2	-18.9	-2	28.4	3.3	38	100.4
-41.1	-42	-43.6	-18.3	-1	30.2	3.9	39	102.2

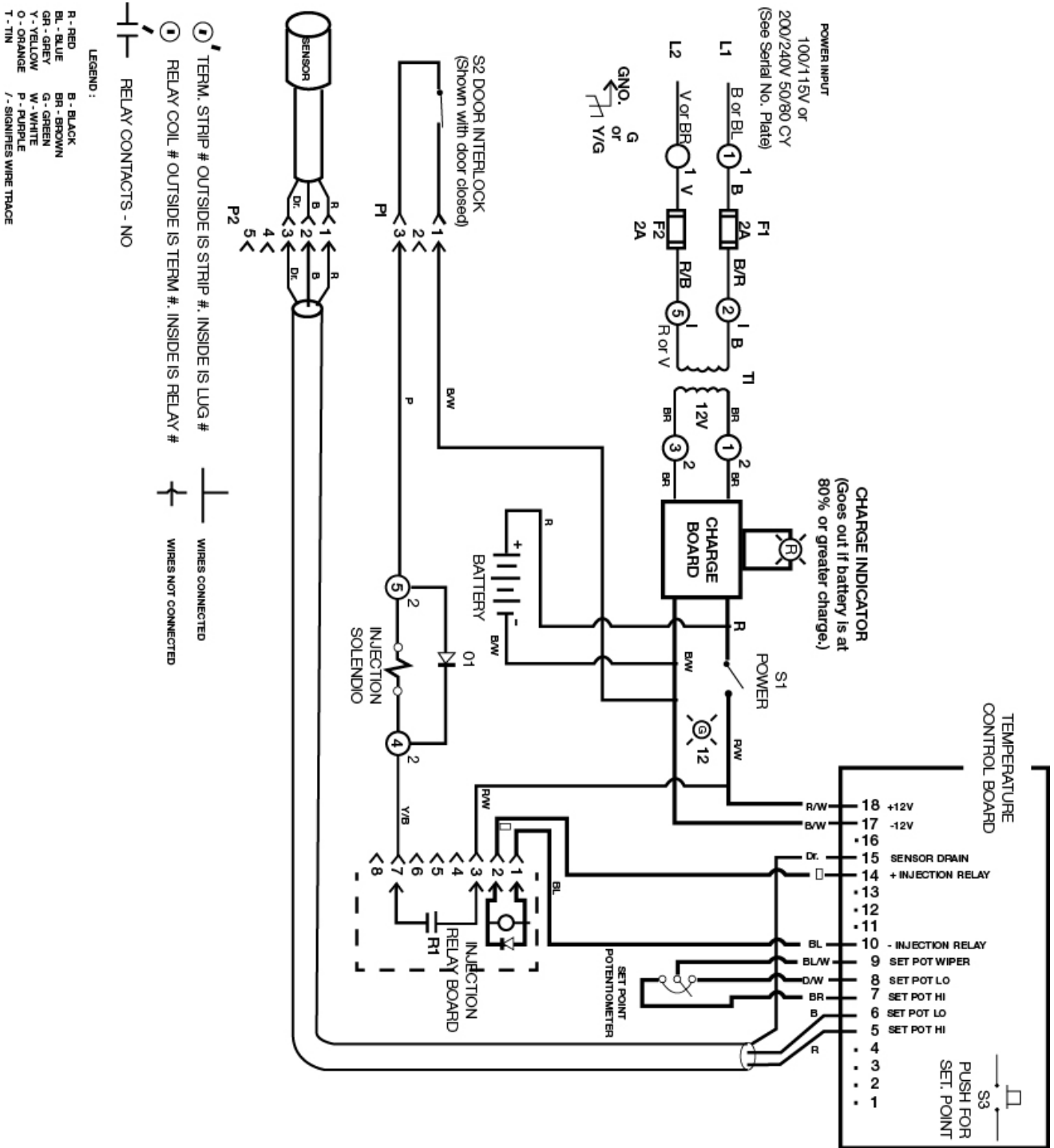
16.4 230 V Wiring Diagram



16.5 12 V Wiring Diagram



16.6 LCO₂ Backup System Electrical Schematic



17 Appendix B: Primary Controller

On the following pages are OEM instructions for the primary temperature controller, followed by a table of factory-set parameters and their default values.

18 Dixell Operating Manual

18.1 Introduction

18.1.1 General Warning

Please read the following safety precautions and warnings before using this manual:



CAUTION: This manual is part of the product and should be kept near the controller for easy and quick reference.

- The controller should not be used for purposes different from those described in this manual. It cannot be used as a safety device.
- Check the application limits before proceeding.



SAFETY PRECAUTIONS AND WARNINGS!

- Check that the supply voltage is correct before connecting the controller.
- Do not expose to water or moisture: use the controller only within the operating limits and avoid sudden temperature changes with high atmospheric humidity to prevent condensation from forming.
- Warning! Disconnect all electrical connections before performing any kind of maintenance.
- Fit the probe where it is not accessible by the end user. The controller must not be opened.
- In case of failure or faulty operation, send the controller back to the distributor or to Retail Solutions (see address) with a detailed description of the fault.
- Verify the maximum current that can be applied to each relay (see Section “Specifications”).
- Ensure that the wires for probes, loads, and the power supply are separated and far enough from each other, without crossing or intertwining.
- In case of applications in industrial environments, the use of main filters (our mod. FT1) in parallel with inductive loads could be useful.

18.2 Overview

18.2.1 General Description

Model XR35CX (32 mm x 74 mm) is a digital thermostat with off-cycle defrost, designed for refrigeration applications at normal temperature. It has two (2) relay outputs to control compressor and light (configurable). It can have a Real Time Clock (RTC) that allows programming of up to six (6) daily defrost cycles, divided into holidays and workdays. A “Day and Night” function with two different setpoints is fitted for energy savings.

It can also have up to four (4) NTC or PT1000 probe inputs: the first one for temperature control, the second one located on the evaporator to control the defrost termination temperature. One of the two digital inputs can operate as a third temperature probe. The fourth probe is used to signal the condenser temperature alarm or to display a temperature value.

The RS485 serial output enables the controller to be connected to a network line that is a MODBUSRTU compatible, such as the monitoring units of XWEB family. The Hot Key receptacle allows the controller to be programmed by means of the Hot Key programming keyboard.

The controller is fully configurable through special parameters that can be easily programmed through the keyboard.

18.2.2 Ordering Code

Table 4: Product Ordering Code

Device Name	Dixell Code	Emerson Code
XR35CX - 110 VAC	XR35CX -4C6F3B X0LG1MEUB4NA-000	318-6020
XR35CX - 230 VAC	XR35CX -5C6F3B X0LG1MEUB5NA-000	318-6021

18.3 Controlling Loads

18.3.1 Compressor

The regulation is performed according to the temperature measured by the thermostat probe with a positive differential from the setpoint: if the temperature increases and reaches setpoint plus the differential, the compressor is started and then turned OFF when the temperature reaches the setpoint value again.

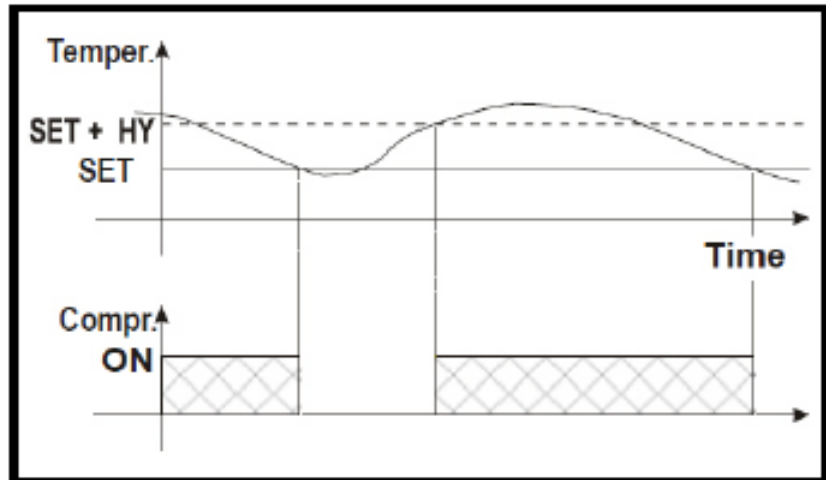


Figure 14. Compressor Temperature Regulation

In case of a fault in the thermostat probe, the start and stop of the compressor are timed through parameters **Con** and **CoF**.

18.3.2 Defrost With **oA1** *different from* **dEF** and **tdF = EL**, the controller performs a timed defrost, simply stopping the compressor.

With **oA1 = dEF**, two defrost modes are available through the **tdF** parameter: defrost through electrical heater (**tdF = EL**) and hot gas defrost (**tdF = in**); in this case, the second relay has to be set.

The defrost interval depends on the presence of the RTC (optional). If the RTC is present, it is controlled by means of parameter **EdF**:

- With **EdF = in**, the defrost is made every **IdF** time – standard way for controller without RTC.
- With **EdF = rtC**, the defrost is made in real time depending on the hours set in the parameters **Ld1...Ld6** on workdays and in **Sd1...Sd6** in holidays.

Other parameters are used to control defrost cycles: its maximum defrost duration (**MdF**) and two defrost modes: time or controlled by the evaporator's probe (**P2P**).

18.3.3 Second Relay Configuration (PAR. oA1; TERM. 1-7)

Depending on the kind of application, the function of the second relay (terminals 1-7) can be set through the **oA1** parameter.

Defrost Relay (oA1 = dEF)

With **oA1 = dEF**, the relay functions as a defrost relay. See **Section** “Defrost” for more details.

Light Relay

With **oA1 = Lig**, the relay operates as light.

18.3.4 Auxiliary Relay (oA1 = AUS)

Relay Activation by Digital Input (oA1 = AUS, i2F = AUS)

With **oA1 = AUS** and **i2F = AUS**, the relay 1-7 is switched ON and OFF by a digital input.

Auxiliary Thermostat

An anti-condensing heater with the possibility of switching it ON and OFF also by keyboard.

The function of the auxiliary relay can be configured by means of the following parameters:

- **ACH** - Kind of regulation for the auxiliary relay: **Ht**: heating; **CL**: cooling
- **SAA** - Setpoint for auxiliary relay
- **SHy** - Differential for auxiliary relay
- **ArP** - Probe for auxiliary relay
- **Sdd** - Auxiliary output OFF during defrost

Note Set *oA1 = AUS* and *ArP = nP* (no probe for auxiliary output). In this case the relay 1-7 can be activated only by digital input with *i1F* or *i2F = AUS*.

18.3.5 ON/OFF Relay (oA1 = onF)

In this case, the relay is activated when the controller is turned ON and deactivated when the controller is turned OFF.

18.3.6 Neutral Zone Regulation

With **oA1 = db**, relay 1-7 can control a heater element to perform a neutral zone action.

- **oA1** cut in = **SEt - Hy**
- **oA1** cut out = **SEt**

18.3.7 Alarm Relay

With **oA1 = ALr**, the relay 1-7 operates as an alarm relay. It is activated every time an alarm occurs.

Its status depends on the **tbA** parameter: if **tbA = y**, the relay is silenced by pressing any key.

If **tbA = n**, the alarm relay remains ON until the alarm condition recovers.

18.3.8 Night Blind Management during Energy Saving Cycles

With **oA1 = HES**, the relay 1-7 operates to manage the night blind: the relay is energized when the energy saving cycle is activated, by digital input, frontal button or RTC (optional).

18.4 Front Panel Commands



Figure 15. XR35CX Front Panel

18.4.1 Keys and Functions

Table 5 shows the keys that are found on the front panel of the XR35CX controller and their corresponding functions:

Table 5: XR35CX Front Panel Keys and Functions











Key	Function
SET	To display the target setpoint; in programming mode, it selects a parameter or confirms an operation.
	(DEF key) To start a manual defrost.
	(UP arrow key) To see the MAX stored temperature; in programming mode, it browses the parameter codes or increases the displayed value.
	(DOWN arrow key) To see the MIN stored temperature; in programming mode, it browses the parameter codes or decreases the displayed value.

Table 5: XR35CX Front Panel Keys and Functions

Key	Function
	Switches the controller OFF, if onF = oFF .
	Switches the light ON and OFF, if oA1 = Lig .
Key Combinations	
  + 	To lock and unlock the keyboard.
SET + 	To enter programming mode.
SET + 	To return to the room temperature display.

18.4.2 Use of LEDES Each LED function is described in *Table 6*:

Table 6: LEDES









LED	Mode	Function
	ON	Compressor enabled
	Flashing	Anti-short cycle delay enabled
	ON	Defrost enabled
	Flashing	Drip time in progress
	ON	An alarm is occurring
	ON	Continuous cycle is running
	ON	Energy saving enabled
	ON	Light ON
AUX	ON	Auxiliary relay ON

Table 6: LEDS

LED	Mode	Function
°C/°F	ON	Measurement unit
°C/°F	Flashing	Programming phase

18.5 MAX and MIN Temperature Memorization

18.5.1 How to See the MIN Temperature

1. Press and release the DOWN arrow key.
2. The **Lo** message will be displayed followed by the minimum temperature recorded.
3. By pressing the DOWN arrow key again or by waiting 5 seconds, the normal display will be restored

18.5.2 How to See the MAX Temperature

1. Press and release the UP arrow key.
2. The **Hi** message will be displayed followed by the maximum temperature recorded.
3. By pressing the UP arrow key again or by waiting 5 seconds, the normal display will be restored.

18.5.3 How to Reset MAX and MIN Temperature Recorded

1. Press and hold the SET key for more than 3 seconds while the maximum or minimum temperature is displayed. (**rSt** message will be displayed)
2. To confirm the operation, the **rSt** message starts blinking and the normal temperature will be displayed.

18.6 Main Functions

18.6.1 To Set the Current Time and Day (Only for Controllers with RTC)

When the controller is switched ON, it is necessary to program the time and day.

1. Enter the **Pr1** programming menu by pressing the SET + DOWN arrow keys combination for 3 seconds.
2. The **rtc** parameter displays. Press the SET key to enter the real time clock menu.
3. The **Hur** (hour) parameter displays.
4. Press the SET key and set current hour by pressing the UP and DOWN arrow keys, then press SET to confirm the value.
5. Repeat the steps on **Min** (minutes) and **dAy** (day) parameters.
6. To exit, press SET + UP arrow keys or wait for 15 seconds.

Note *This function setup is applicable only for controllers with RTC.*

18.6.2 How to See the Setpoint



1. Push and immediately release the SET key: the display will show the setpoint value.
2. Push and immediately release the SET key or wait for 5 seconds to display the probe value again.

18.6.3 How to Change the Setpoint

1. Push the SET key for more than 2 seconds to change the setpoint value.
2. The value of the setpoint will be displayed and the °C or °F LED starts blinking.
3. To change the setpoint value, push the UP or DOWN arrow keys within 10 seconds.
4. To memorize the new setpoint value, push the SET key again or wait 10 seconds.

18.6.4 How to Start a Manual Defrost



Push the **DEF** key for more than 2 seconds and a manual defrost will start.

18.6.5 How to Change a Parameter Value

To change the parameter's value operate as follows:

1. Enter the Programming mode by pressing the SET + DOWN arrow keys for 3 seconds (the °C or °F LED starts blinking).
2. Select the required parameter (refer to **Section** "Parameters", for the list of parameters). Press the SET key to display its value.
3. Use the UP or DOWN arrow keys to change its value.
4. Press SET to store the new value and move to the following parameter.
5. To exit, press SET + UP arrow keys or wait 15 seconds without pressing a key.

Note *The set value is stored even when the time-out expires and ends the procedure.*

18.6.6 The Hidden Menu

The Hidden Menu includes all the parameters of the controller.

How to Enter the Hidden Menu

1. Enter the Programming mode by pressing the SET + DOWN arrow keys for 3 seconds (the °C or °F LED starts blinking).
2. Immediately release the keys, then push the SET + DOWN arrow keys again for more than 7 seconds. The **Pr2** label will be displayed immediately followed by the **Hy** parameter. NOW YOU ARE IN THE HIDDEN MENU.
3. Select the required parameter. See **Section** "Parameters", for the list of parameters.
4. Press the SET key to display its value.
5. Use the UP or DOWN arrow keys to change its value.
6. Press SET to store the new value and move to the next parameter.

7. Press SET + DOWN arrow keys or wait for 15 seconds without pressing a key to exit.

Note *If a parameter is not present in Pr1, the noP message is displayed after 3 seconds. Keep the keys pressed until the Pr2 message is displayed.*

Note *The set value is stored even when the time-out expires and ends the procedure.*

How to Move a Parameter from the Hidden Menu to the First Level and Vice Versa

Each parameter present in the Hidden Menu can be removed or put into THE FIRST LEVEL (user level) by pressing SET + DOWN arrow keys.

In the Hidden Menu, when a parameter is present in First Level, the decimal point is visible.

18.6.7 How to Assign a MODBUS Address

1. Follow **Steps 1** and **2** of **Section** “How to Enter the Hidden Menu”, to access the Hidden Menu.
2. Select the **Adr** parameter.
3. Press SET to select.
4. Choose the address number using the arrow keys and press SET again to save.
5. Press the SET and UP arrow keys to exit.

18.6.8 How to Lock the Keyboard

1. Keep the UP and the DOWN arrow keys pressed for more than 3 seconds.
2. The **PoF** message will be displayed and the keyboard will be locked. At this point it will be possible to see the setpoint or the MAX or MIN temperature stored only.
3. If a key is pressed more than 3 seconds, the PoF message will be displayed.

18.6.9 To Unlock the Keyboard

To unlock the keyboard, press the UP and the DOWN arrow keys for more than 3 seconds until the **Pon** message displays.

18.6.10 The Continuous Cycle

When defrost is not in progress, it can be activated by pressing the UP arrow key for about 3 seconds. The compressor operates to maintain the **CCS** setpoint for the time set through the **CCt** parameter. The cycle can be terminated before the end of the set time by pressing the same activation key (UP arrow key) for 3 seconds.

18.6.11 The ON/OFF Function

With **onF = oFF**, pushing the **ON/OFF** key will turn the controller OFF. The **OFF** message is displayed. In this configuration, the regulation is disabled.

To switch the controller ON, push again the **ON/OFF** key.



WARNING: *Loads connected to the normally closed contacts of the relays are always supplied and under voltage, even if the controller is in stand-by mode.*

18.7 Parameters

Code	Parameter	Function
rtc	Real time clock menu (only for controller with RTC)	Sets the time and date and the defrost start time.
REGULATION		
Hy	Differential	(0.1 to 25.5 °C / 1 to 255 °F) Intervention differential for setpoint. Compressor Cut IN is Setpoint+ differential (Hy). Compressor Cut OUT is when the temperature reaches the setpoint.
LS	Minimum setpoint	(-100 °C to SEt / -148 °F to SEt) Sets the minimum value for the setpoint.
US	Maximum setpoint	(SEt to 110 °C / SEt to 230 °F) Sets the maximum value for the setpoint.
ot	Thermostat probe calibration	(-12.0 to 12.0 °C; -120 to 120 °F) Allows to adjust possible offset of the thermostat probe.
P2P	Evaporator probe presence	n = not present: the defrost stops by time y = present: the defrost stops by temperature
oE	Evaporator probe calibration	(-12.0 to 12.0 °C; -120 to 120 °F) Allows to adjust possible offset of the evaporator probe.
P3P	Third probe presence (P3)	n = not present: the terminals 18-20 operate as digital input y = present: the terminals 18-20 operate as third probe
o3	Third probe calibration (P3)	(-12.0 to 12.0 °C; -120 to 120 °F) Allows to adjust possible offset of the third probe.
P4P	Fourth probe presence	(n = not present, y = present)

Code	Parameter	Function
o4	Fourth probe calibration	(-12.0 to 12.0 °C) Allows to adjust possible offset of the fourth probe.
Ods	Outputs activation delay at start up	(0 to 255 min) This function is enabled at the initial start up of the controller and inhibits any output activation for the period of time set in the parameter.
Ac	Anti-short cycle delay	(0 to 50 min) Minimum interval between the compressor stop and the following restart.
rtr	Percentage of the second and first probe for regulation (0 to 100; 100 = P1 , 0 = P2)	Allows to set the regulation according to the percentage of the first and second probe, as for the following formula $(rtr(P1 - P2) / 100 + P2)$.
CCt	Compressor ON time during continuous cycle	(0.0 to 24.0 hr, res. 10 min) Allows to set the length of the continuous cycle: compressor stays ON without interruption for the CCt time. Can be used, for instance, when the room is filled with new products.
CCS	Setpoint for continuous cycle	(-100 to 150 °C) Sets the setpoint used during the continuous cycle.
Con	Compressor ON time with faulty probe	(0 to 255 min) Time during which the compressor is active in case of faulty thermostatprobe. With Con = 0, compressor is always OFF.
CoF	Compressor OFF time with faulty probe	(0 to 255 min) Time during which the compressor is OFF in case of faulty thermostat probe. With CoF = 0, compressor is always active.
CH	Type of action	CL = cooling; Ht = heating
DISPLAY		
CF	Temperature measurement unit	°C = Celsius; °F = Fahrenheit CAUTION! <i>When the measurement unit is changed, the setpoint and the values of the parameters Hy, LS, US, ot, ALU, and ALL have to be checked and modified if necessary.</i>
rES	Resolution (for °C)	(in = 1 °C; dE = 0.1 °C) Allows decimal point display.
Lod	Controller display	(P1 , P2 , P3 , P4 , SEt , dtr) Selects which probe is displayed by the controller: P1 = Thermostat probe P2 = Evaporator probe P3 = Third probe (only for model with this option enabled) P4 = Fourth probe SEt = setpoint dtr = percentage of visualization

Code	Parameter	Function
Red	X- REP display (optional)	(P1 , P2 , P3 , P4 , SEt , dtr) Selects which probe is displayed by X-REP: P1 = Thermostat probe P2 = Evaporator probe P3 = Third probe (only for model with this option enabled) P4 = Fourth probe SEt = setpoint dtr = percentage of visualization
dLy	Display delay	(0 to 20.0 min, res. 10 sec) When the temperature increases, the display is updated of 1 °C/ 1 °F after this time.
dtr	Percentage of the second and first probe for visualization when Lod = dtr (0 to 100; 100 = P1 , 0 = P2)	if Lod = dtr : Allows to set the visualization according to the percentage of the first and second probe, as for the following formula (dtr(P1 - P2)/100 + P2).
DEFROST		
EdF	Defrost mode (only for controller with RTC)	rtC = Real Time Clock mode: Defrost time follows Ld1 to Ld6 parameters on workdays and Sd1 to Sd6 on holidays. in = Interval mode: The defrost starts when the time Idf is expired.
tdF	Defrost type	EL = electric heater; in = hot gas
dFP	Probe selection for defrost termination	nP = no probe P1 = thermostat probe P2 = evaporator probe P3 = configurable probe P4 = probe on Hot Key plug
dtE	Defrost termination temperature	(-50 to 50 °C/ -58 to 122 °F) (Enabled only when EdF = Pb) Sets the temperature measured by the evaporator probe, which causes the end of defrost.
IdF	Interval between defrost cycles	(0 to 120 hr) Determines the time interval between the beginning of two defrost cycles.
MdF	Maximum duration for defrost	(0 to 255 min) When P2P = n , (not evaporator probe: timed defrost), it sets the defrost duration. When P2P = y (defrost end based on temperature), it sets the maximum duration for defrost.
dSd	Start defrost delay	(0 to 99 min) This is useful when different defrost start times are necessary to avoid overloading the plant.

Code	Parameter	Function
dFd	Temperature displayed during defrost	(rt = real temperature; it = temperature at defrost start; SEt = setpoint; dEF = dEF label)
dAd	MAX display delay after defrost	(0 to 255 min) Sets the maximum time between the end of defrost and the restarting of the real room temperature display.
Fdt	Drip time	(0 to 120 min) Time interval between reaching defrost termination temperature and the restoring of the controller's normal operation. This time allows the evaporator to eliminate water drops that might have formed due to defrost.
dPo	First defrost after start-up	(y = immediate; n = after the IdF time)
dAF	Defrost delay after continuous cycle	(0 to 23.5 hr) Time interval between the end of the fast freezing cycle and the following defrost related to it.
AUXILIARY THERMOSTAT CONFIGURATION (terms. 1-7) - oA1 = AUS		
ACH	Kind of regulation for auxiliary relay	Ht = heating; CL = cooling
SAA	Setpoint for auxiliary relay	(-100 to 110.0 °C; -148 to 230 °F) Defines the room temperature setpoint to switch auxiliary relay.
SHy	Differential for auxiliary output	(0.1 to 25.5 °C / 1 to 255 °F) Intervention differential for auxiliary output setpoint. With ACH = CL , AUX Cut in is SAA + SHy ; AUX Cut out is SAA . With ACH = Ht , AUX Cut in is SAA - SHy ; AUX Cut out is SAA .
ArP	Probe selection for auxiliary	nP = no probe, the auxiliary relay is switched only by the digital input P1 = Probe 1 (thermostat probe) P2 = Probe 2 (evaporator probe) P3 = Probe 3 (display probe) P4 = Probe 4
Sdd	Auxiliary relay OFF during defrost	n = the auxiliary relay operates during defrost; y = the auxiliary relay is switched OFF during defrost
ALARMS		
ALP	Probe selection for alarm	nP = no probe, the temperature alarms are disabled P1 = Probe 1 (Thermostat probe) P2 = Probe 2 (evaporator probe) P3 = Probe 3 (display probe) P4 = Fourth probe

Code	Parameter	Function
ALC	Temperature alarms configuration	(Ab ; rE) Ab = Absolute temperature: alarm temperature is given by the ALL or ALU values; rE = Temperature alarms are referred to the setpoint. Temperature alarm is enabled when the temperature exceeds the SEt + ALU or SEt - ALL values.
ALU	MAXIMUM temperature alarm	(ALL to 110 °C; ALL to 230 °F) When this temperature is reached, the alarm is enabled after the ALd delay time.
ALL	Minimum temperature alarm	(-100 °C to ALU ; -148 to ALU) When this temperature is reached, the alarm is enabled after the ALd delay time.
AFH	Differential for temperature alarm recovery	(0.1 to 25.5 °C; 1 to 45 °F) Intervention differential for recovery of temperature alarm.
ALd	Temperature alarm delay	(0 to 255 min) Time interval between the detection of an alarm condition and alarm signaling.
dAo	Exclusion of temperature alarm at startup	(from 0.0 min to 23.5 hr) Time interval between the detection of the temperature alarm condition after controller power ON and alarm signaling.
CONDENSER TEMPERATURE ALARM		
AP2	Probe selection for temperature alarm of condenser	nP = no probe P1 = thermostat probe P2 = evaporator probe P3 = configurable probe P4 = probe on Hot Key plug
AL2	Low temperature alarm of condenser	(-100 to 150 °C; -148 to 302 °F) When this temperature is reached the LA2 alarm is signaled, possibly after the Ad2 delay.
AU2	High temperature alarm of condenser	(-100 to 150 °C; -148 to 302 °F) When this temperature is reached the HA2 alarm is signaled, possibly after the Ad2 delay.
AH2	Differential for temperature condenser alarm recovery	(0.1 to 25.5 °C; 1 to 45 °F)
Ad2	Condenser temperature alarm delay	(0 to 255 min) Time interval between the detection of the condenser alarm condition and alarm signaling.
dA2	Condenser temperature alarm exclusion at start up	(from 0.0 min to 23.5 hr, res. 10 min)

Code	Parameter	Function
bLL	Compressor OFF with low temperature alarm of condenser	n = no: compressor keeps on working Y = yes: compressor is switched OFF until the alarm is present, in any case regulation restarts after Ac time at minimum
AC2	Compressor OFF with high temperature alarm of condenser	n = no: compressor keeps on working Y = yes: compressor is switched OFF till the alarm is present, in any case regulation restarts after Ac time at minimum
AUXILIARY RELAY		
tbA	Alarm relay silencing (with oA1 = ALr)	n = silencing disabled: alarm relay stays ON until alarm condition lasts y = silencing enabled: alarm relay is switched OFF by pressing a key during an alarm
oA1	Second relay configuration (1-7)	dEF = defrost; FAn : do not select it!; ALr : alarm; Lig : light; AUS : Auxiliary relay; onF : always ON with controller ON; db = neutral zone; CP2 = do not select it!; dEF2 : do not select it!; HES : night blind
AOP	Alarm relay polarity	Set if the alarm relay is open or closed when an alarm happens. CL = terminals 1-7 closed during an alarm oP = terminals 1-7 open during an alarm
DIGITAL INPUTS		
i1P	Digital input polarity (18-20)	oP = the digital input is activated by opening the contact CL = the digital input is activated by closing the contact
i1F	Digital input configuration (18-20)	dor = door switch function dEF = activation of a defrost cycle
i2P	2 nd digital input polarity (18-19)	oP = the digital input is activated by opening the contact CL = the digital input is activated by closing the contact
i2F	2 nd digital input polarity configuration (18-19)	EAL = external alarm: EA message is displayed; bAL = serious alarm; CA message is displayed; PAL = pressure switch alarm, CA message is displayed; dor = door switch function; dEF = activation of a defrost cycle; ES = energy saving; AUS = auxiliary relay activation with oA1 = AUS ; Htr = kind of action inversion (cooling – heating); FAn = fan; HdF = Holiday defrost (enable only with RTC); onF = to switch the controller OFF
did	With i2F = EAL or i2F = bAL : digital input alarm delay (18-20)	(0 to 255 min) Delay between the detection of the external alarm condition and its signaling.
	With i2F = PAL : time for pressure switch function	(0 to 255 min) Time interval to calculate the number of the pressure switch activation.
doA	Door open signaling delay	(0 to 255 min)

Code	Parameter	Function
nPS	Pressure switch number	(0 to 15) Number of activation of the pressure switch, during the did interval, before signaling the alarm event (i2F = PAL). If the nPS activation in the did time is reached, switch OFF and ON the controller to restart normal regulation.
Odc	Compressor status when open door	no ; FAn = normal; CPr , F_C = Compressor OFF
rrd	Outputs restart after doA alarm	no = outputs not affected by the doA alarm yES = outputs restart with the doA alarm
HES	Temperature increase during the Energy Saving cycle	(-30.0 °C to 30.0 °C) Sets the increasing value of the setpoint during the Energy Saving cycle.
TO SET CURRENT TIME AND WEEKLY HOLIDAYS (ONLY FOR MODELS WITH RTC)		
Hur	Current hour (0 to 23 hr)	Sets the current hour.
Min	Current minute (0 to 59 min)	Sets the current minute
dAY	Current day (Sun to SAT)	Sets the current day of the week.
Hd1	First weekly holiday (Sun to <i>not used</i>)	Sets the first day of the week which follows the holiday times. NOTE: Hd1 can be set also as <i>not used</i> value.
Hd2	Second weekly holiday (Sun to <i>not used</i>)	Sets the second day of the week which follows the holiday times. NOTE: Hd2 can be set also as <i>not used</i> value.
TO SET ENERGY SAVING TIMES (ONLY FOR MODELS WITH RTC)		
iLE	Energy Saving cycle start during workdays	(0 to 23 hr 50 min) During the Energy Saving cycle, the setpoint is increased by the value in HES so that the operation setpoint is SEt + HES .
dLE	Energy Saving cycle length during workdays	(0 to 24 hr 00 min) Sets the duration of the Energy Saving cycle on workdays.
iSE	Energy Saving cycle start on holidays. (0 to 23 hr 50 min)	
dSE	Energy Saving cycle length on holidays (0 to 24 hr 00 min)	
TO SET DEFROST TIMES (ONLY FOR MODELS WITH RTC)		
Ld1 to Ld6	Workday defrost start (0 to 23 hr 50 min)	These parameters set the beginning of the 6 programmable defrost cycles during workdays. (<i>e.g., When Ld2 = 12.4 the second defrost starts at 12:40 during workdays.</i>)

Code	Parameter	Function
Sd1 to Sd6	Holiday defrost start (0 to 23 hr 50 min)	These parameters set the beginning of the 6 programmable defrost cycles on holidays. (e.g., When Sd2 = 3.4 the second defrost starts at 3:40 on holidays.)
<i>NOTE: To disable a defrost cycle, set it to not used. (e.g., If Ld6 = not used, the sixth defrost cycle is disabled.)</i>		
OTHER PARAMETERS		
Adr	Serial address (1 to 244)	Identifies the controller address when connected to a MODBUS compatible monitoring system.
pbC	Type of probe	Allows to set the kind of probe used by the controller: Pt1 = Pt1000 probe ntc = NTC probe
onF	ON/OFF key enabling	not used = disabled oFF = enabled ES = not set it
dP1	Thermostat probe display	
dP2	Evaporator probe display	
dP3	Third probe display (optional)	
dP4	Fourth probe display	
rSE	Real setpoint	Shows the setpoint used during the energy saving cycle or during the continuous cycle.
rEL	Software release	For internal use only.
Ptb	Parameter table code	Read only

18.8 Digital Inputs

The first digital input 18-20 is enabled with **P3P = n**. With **P3P = n** and **i1F = i2F**, the second digital input is disabled. The free voltage digital inputs are programmable by the **i1F** and **i2F** parameters.

18.8.1 Generic Alarm (i2F=EAL)

As soon as the digital input is activated, the unit will wait for the **d1d** time delay before signaling the **EAL** alarm message. The outputs status do not change. The alarm stops just after the digital input is deactivated.

18.8.2 Serious Alarm Mode (i2F=bAL)

When the digital input is activated, the unit will wait for the **d1d** delay before signaling the CA alarm message. The relay outputs are switched OFF. The alarm will stop as soon as the digital input is deactivated.

- 18.8.3 Pressure Switch (i2F=PAL)** If the pressure switch has reached the number of activations (cycles) of the **nPS** parameter during the interval time set by the **did** parameter, the **CA** pressure alarm message will be displayed. The compressor and the regulation are stopped. When the digital input is ON, the compressor is always OFF. If the **nPS** activation in the **did** time is reached, switch the controller OFF and ON to restart normal regulation.
- 18.8.4 Door Switch Input (i1F or i2F=dor)** This input signals the door status and the corresponding relay output status through the **Odc** parameter: **no**, **Fan** = normal (any change); **CPr**; **F_C** = Compressor OFF.
- Since the door is opened, after the delay time set through the parameter **doA**, the door alarm is enabled, the display shows the message **dA** and *the regulation restarts is **rtr = yES***. The alarm stops as soon as the external digital input is disabled again. With the door open, the high and low temperature alarms are disabled.
- 18.8.5 Start Defrost (i1F or i2F=dEF)** If conditions are favorable for defrost, a defrost will be started. After the defrost is finished, the normal regulation will restart only if the digital input is disabled, otherwise the controller will wait until the **MdF** safety time is expired.
- 18.8.6 Switch the Auxiliary Relay (i2F=AUS)** With **oA1 = AUS**, the digital input switches the status of the auxiliary relay.
- 18.8.7 Inversion of the Kind of Action: Heating-Cooling (i2F=Htr)** This function enables the controller to invert the regulation of the controller: from cooling to heating and vice versa.
- 18.8.8 Energy Saving (i2F=ES)** The Energy Saving function allows you to change the setpoint value as the result of the **SEt + HES** (parameter) sum. This function is enabled until the digital input is activated.
- 18.8.9 Holiday Defrost (i2F=HdF) - Only for Models with RTC** This function enables the holiday defrost setting.
- 18.8.10 ON/OFF Function (i2F=onF)** Switches the controller ON and OFF.

18.8.11 Digital Inputs Polarity

The digital input polarity depends on the **i1P** and **i2P** parameters.

- **i1P** or **i2P** = **CL**: the input is activated by closing the contact.
- **i1P** or **i2P** = **oP**: the input is activated by opening the contact.

18.9 RS485 Serial Line (for Monitoring Systems)

The RS485 serial line allows you to connect the controller to a monitoring system MODBUS-RTU compatible, such as the X-WEB500/3000/300.

18.10 X-REP Output(Optional)

Optionally, an X-REP can be connected to the controller through the dedicated connector.

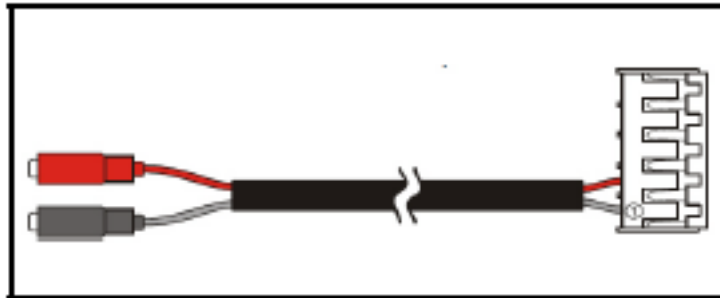


Figure 16. X-REP Output

To connect the X-REP to the controller, the following connectors must be used: CAB-51F(1m), CAB-52F(2m), and CAB-55F(5m).

18.11 Installation and Mounting

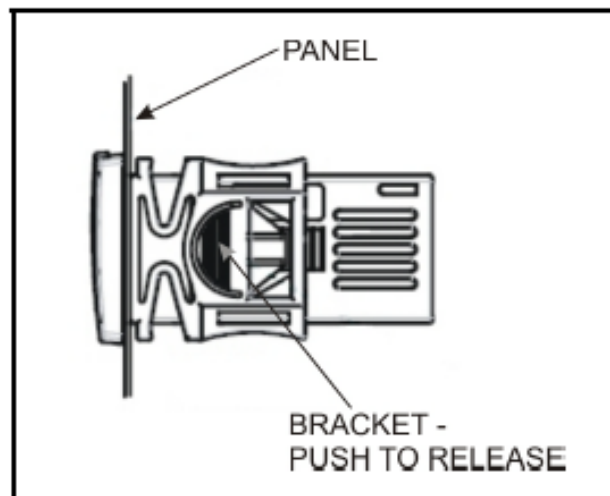


Figure 17. Installation and Mounting of XR35CX

The XR35CX controller should be mounted on a vertical panel, in a 29 x 71 mm hole, and secured using the special bracket supplied.

The temperature range allowed for correct operation is 0 to 60 °C. Avoid places subject to strong vibrations, corrosive gases, excessive dirt, or humidity. The same recommendations apply to probes. Allow air to circulate through the cooling holes.

18.12 Electrical Connections

The controller comes with a screw terminal block to connect cables with a cross section up to 2.5 mm². Before connecting cables, verify that the power supply complies with the controller's requirements. Separate the probe cables from the power supply cables, from the outputs and the power connections. *Do not exceed the maximum current allowed on each relay; in case of heavier loads, use a suitable external relay.*

18.12.1 Probe Connection

The probes should be mounted with the bulb upwards to prevent damages due to casual liquid infiltration. It is recommended that the thermostat probe be placed away from air streams to measure the average room temperature correctly. Place the defrost termination probe among the evaporator fans in the coldest place, (where most ice is formed) and far from heaters or from the warmest place during defrost, to prevent premature defrost termination.

18.13 How to Use the Hot Key

18.13.1 How to Program a Hot Key From the Controller (Upload)

1. Program one controller using the front keypad.
2. When the controller is ON, insert the Hot Key and push the UP arrow key; the **uPL** message appears followed by a flashing **End** LED.
3. Push the SET key and the **End** LED will stop flashing.
4. Turn OFF the controller, remove the Hot Key, then turn it ON again.

Note *The Err message is displayed in case of an error or failure in programming. In this case push the UP arrow key again if you want to restart the upload or remove the Hot Key to abort the operation.*

18.13.2 How to Program the Controller Using a Hot Key (Download)

1. Turn OFF the controller.
2. Insert a *programmed Hot Key into the 5-pin receptacle* and then turn the Controller ON.
3. Automatically, the parameter list of the Hot Key is downloaded into the controller memory; the **doL** message will blink followed by a flashing **End** LED.
4. After 10 seconds, the controller will restart working with the new parameters.
5. Remove the Hot Key.

Note *The Err message is displayed in case of an error or failure in programming. In this case, turn the unit OFF and then ON if you want to restart the download or remove the Hot Key to abort the operation.*

18.14 Alarm Signals

Table 7: Alarm Signals

Message	Cause	Outputs
P1	Room probe failure	Compressor output acc. to par. Con and COF
P2	Evaporator probe failure	Defrost end is timed
P3	Third probe failure	Outputs unchanged
P4	Fourth probe failure	Outputs unchanged
HA	Maximum temperature alarm	Outputs unchanged
LA	Minimum temperature alarm	Outputs unchanged.
HA2	Condenser high temperature	It depends on the Ac2 parameter
LA2	Condenser low temperature	It depends on the bLL parameter
dA	Door open	Compressor restarts
EA	External alarm	Output unchanged
CA	Serious external alarm (iIF = bAL)	All outputs OFF
CA	Pressure switch alarm (iIF = PAL)	All outputs OFF

Table 7: Alarm Signals

Message	Cause	Outputs
rtc	Real time clock alarm	Alarm output ON; Other outputs unchanged; Defrosts according to par. IdF Set real time clock has to be set
rtF	Real time clock board failure	Alarm output ON; Other outputs unchanged; Defrosts according to par. IdF Contact the service

18.14.1 Silencing Buzzer /Alarm Relay Output

If **tbA = y**, the buzzer and the relay are silenced by pressing any key.

If **tbA = n**, only the buzzer is silenced while the alarm relay is ON until the alarm condition recovers.

18.14.2 Alarm Recovery

Probe alarms **P1**, **P2**, **P3**, and **P4** start some seconds after the fault in the related probe; they automatically stop some seconds after the probe restarts normal operation. Check connections before replacing the probe.

Temperature alarms **HA**, **LA**, **HA2**, and **LA2** automatically stop as soon as the temperature returns to normal values.

Alarms **EA** and **CA** (with **i1F = bAL**) recover as soon as the digital input is disabled.

Alarm **CA** (with **i1F = PAL**) recovers only by *switching the controller OFF and ON*.

18.14.3 Other Messages

Table 8: Additional Display Messages

Message	Output
Pon	Keyboard unlocked
PoF	Keyboard locked

Table 8: Additional Display Messages

Message	Output
noP	In programming mode: No parameter is present in Pr1 .
	On the display or in dP2, dP3, dP4 : The selected probe is not enabled.

18.15 Specifications

Table 9: XR35CX Specifications

Housing	Self extinguishing ABS
Dimensions	Case: Front: 32 mm x 74 mm Depth: 60 mm
	Panel Mount: 71 mm x 29 mm panel cut-out
Protection	IP 20
	Frontal: IP65
Connections	Screw terminal block $\leq 2.5 \text{ mm}^2$ wiring
Power Supply (depending on the model)	24 VAC, $\pm 10\%$ 230 VAC, $\pm 10\%$, 50/60 Hz 110 VAC, $\pm 10\%$, 50/60 Hz
Power Absorption	34 VA max
Display	3 digits, red LED, 14.2 mm high
Inputs	Up to 4 NTC or PT1000 probes
	Digital: Free voltage contact
Relay outputs	Compressor: SPST 8(3) A, 250 VAC or SPST 16 A 250 VAC
	Aux: SPDT 8(3) A, 250 VAC
Data Storing	On the non-volatile memory (EEPROM)
Internal Clock Back-up	24 hours
Kind of Action	1B
Pollution Grade	2

Table 9: XR35CX Specifications

Software Class	A
Rated Impulsive Voltage	2500 V
Overvoltage Category	II
Temperature	Operating: 0 to 55 °C
	Storage: -30 to 85 °C
Relative Humidity	20 to 85% (no condensing)
Measuring and Regulation Range	NTC probe: -40 to 110 °C (-40 to 230 °F)
	PT1000 probe: -100 to 150 °C (-148 to 302 °F)
Resolution	0.1 °C or 1 °C or 1 °F (selectable)
Accuracy (ambient temp. 25°C)	±0.7 °C ±1 digit

18.16 Connections

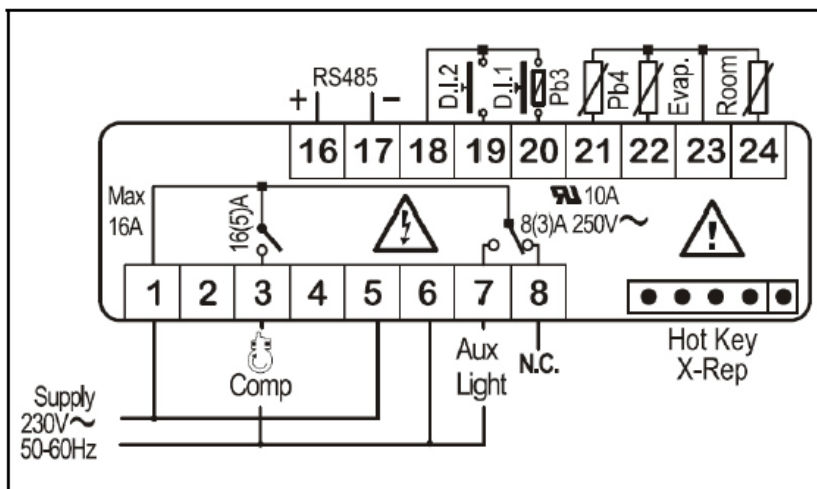


Figure 18. XR35CX Connections

- **Supply: 120 VAC or 24 VAC:** connect to terminals 5-6.
- The **X-REP** output is optional.

18.17 E2 MODBUS Network Wiring

- Connect the MODBUS Network to the RS485 Connector on the E2 PIB board (Belden 8641 recommended).
- Note to wire the RS485 +/- polarity at the E2 in the *reverse* of the XR35CX devices.
- Position the three termination jumpers to the UP (terminated) position to provide RS485 termination at the E2.
- Do not connect the shield of the MODBUS network to the E2 PIB center terminal. Instead, use a 100 ohm 1/2 watt resistor to connect the MODBUS cable shield to earth ground.
- At each XR35CX device, wire the MODBUS cable to the RS485 +/- terminals and connect the MODBUS shield to the pin 18 terminal. Terminate the end of the MODBUS network at the last XR35CX device on the daisy chain with the MODBUS termination block (*P/N 535-2711*), or by connecting a 150 ohm resistor between the MODBUS +/- terminals

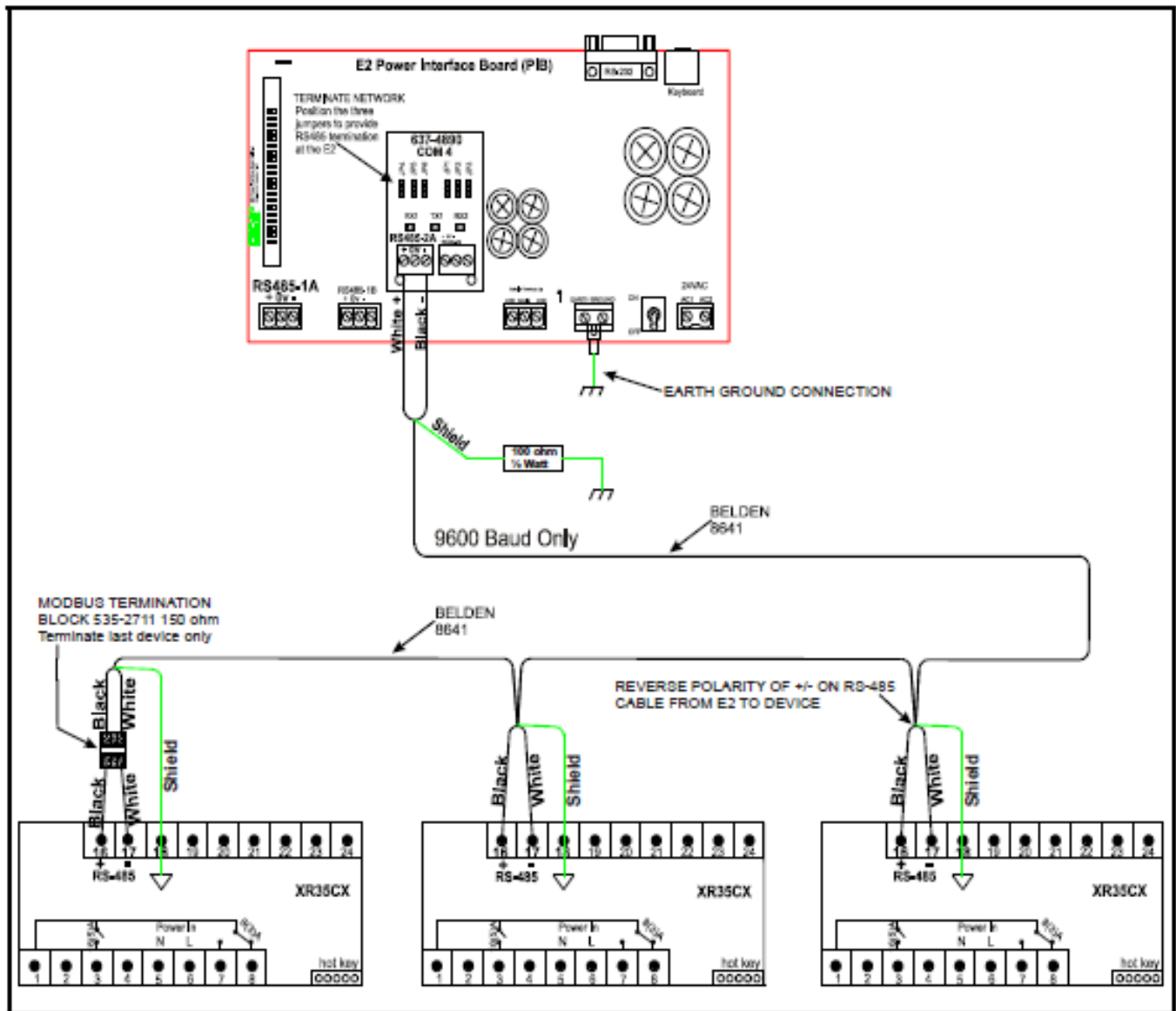






Figure 19. XR35CX to E2 MODBUS Network Wiring

18.18 ECT MODBUS Networking to E2s

Connecting a XR35CX controller to an E2 requires the E2 to be version 2.84 or above. Contact Retail Solutions for upgrade information if the controller is a version before 2.84.

An E2 has up to three COM ports that can be assigned for MODBUS communication: COM2, an RS485 port on the E2 power interface board, and COM4 and COM6, which are optional ports requiring expansion cards. COM4 is recommended for MODBUS connection of XR35CX units.

COM ports can only be used for one function; in other words, if COM2 is set up as the I/O network, you cannot connect MODBUS devices to COM2. Ensure your E2 is equipped with an RS485 COM Card

(P/N 637-4890) and configured in E2 General Services ( &  #  |  , **Serial** tab) to enable COM4 or an E2 Expansion COM Card (P/N 637-4871) to enable COM6.

Connect the MODBUS network cable to the three terminal connector on the COM port you wish to assign as MODBUS. Reverse polarity of +/- on RS485 cable from E2 to the device.

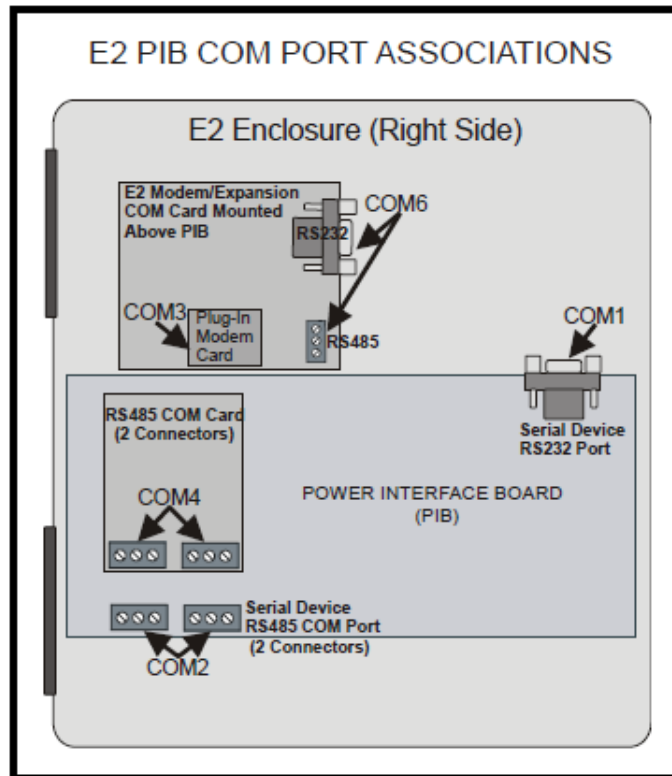


Figure 20. Location of E2 COM Ports

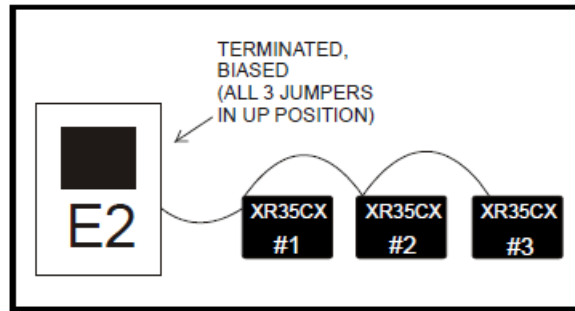


Figure 21. MODBUS Networking

18.18.1 E2 Setup of Devices

Set Up Network Ports

Before setting up a device, the port on the E2 that has the MODBUS cable connected must be set up as a MODBUS port.

1. Log in to the E2 with Level 4 access.
2. Press **Menu** followed by **& 7 # 3 !** - **General Controller Info**.
3. Press **Ctrl** + **# 3** to open the **Serial** tab of the General Controller Info setup screens:.

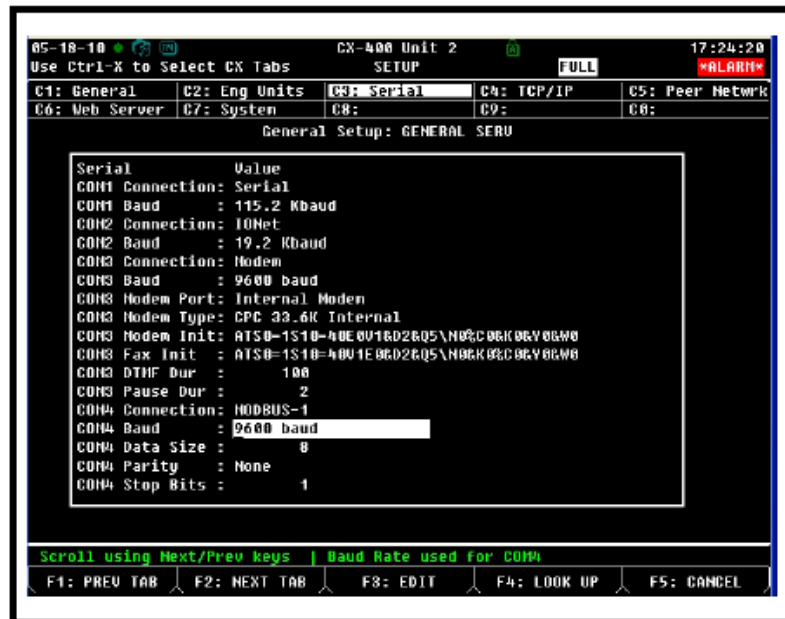




Figure 22. Serial Communications Manager Screen

4. This screen will have a “Connection” field for all COM ports on the E2. Highlight the COM port connection field that will be used for the device, and press **F4** - **LOOK UP**. From the list of network types, select **MODBUS**.
5. Four fields will become visible underneath the COM port connection field, which pertain to the way the device communicates:
 - **Baud** - Default setting is **19.2k**. The baud rate setting should be set to match the baud rate of the device (**9600**). (All devices connected to the same COM port should be set to the same baud rate.)
 - **Data Size** - Leave this field at the default value (**8**).
 - **Parity** - Leave this field at the default value (**None**).
 - **Stop Bits** - Leave this field at the default value (**1**).
6. Press  to save changes and exit.

Add and Connect the Device

To enable communications between E2 and the XR35CX units, the devices must be added and addressed in E2.

1. Log in to the E2 with Level 4 access.
2. Press  **& 7 & 7 @** - **Connected I/O Boards and controllers**.

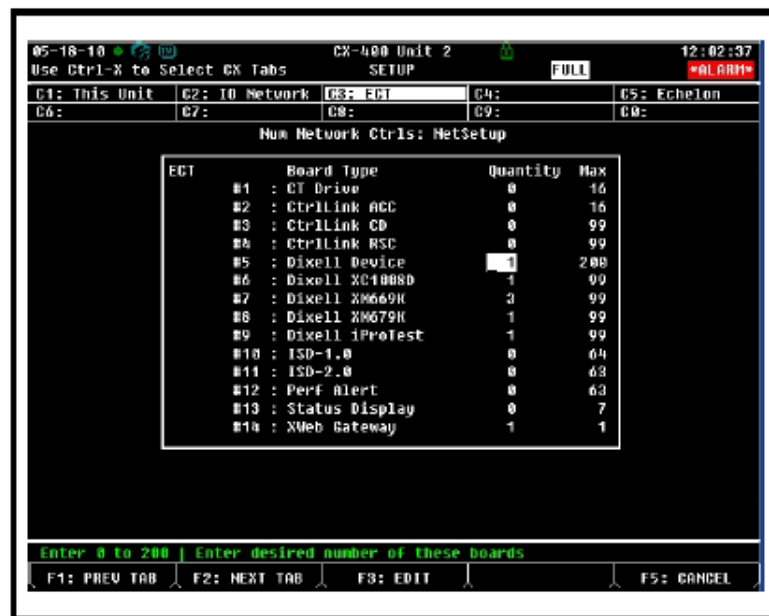






Figure 23. Num Network Ctrls: NetSetup Screen

3. In the *Num Network Ctrl*s: *NetSetup* screen, under the **ECT** tab, enter the number of devices in the **Quantity** field. (**Max** shows the maximum number of devices allowed on the network.)
4. Press  to return to the *Network Setup* menu, then select  - **Network Summary**.
5. Locate the units you added to the network list (press  and  to scroll through the list). If desired, enter a new name for each device in the **Name** field.

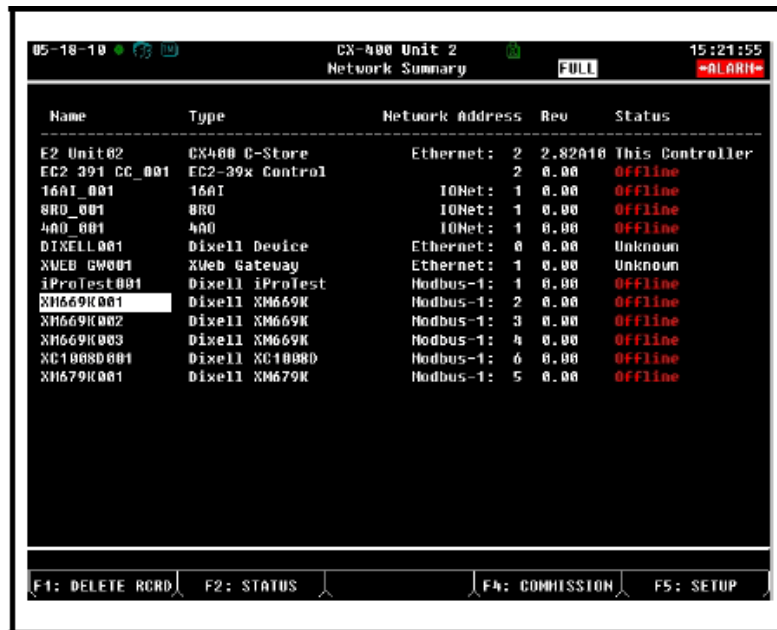




Figure 24. Network Summary Screen

6. By default, each device in the network list has a board number of 0. To set the address and begin communication, choose the device and press . In the list of MODBUS devices, choose the address number corresponding to the XR35CX address set up through the XR35CX front display, and press  to select it. A window will open where you can specify the address of the controller. If a network ID has already been selected, its name will be shown next to the network ID in this list. If the network ID you are trying to assign has already been used, you must set the address on this device to a different number that is not being used.

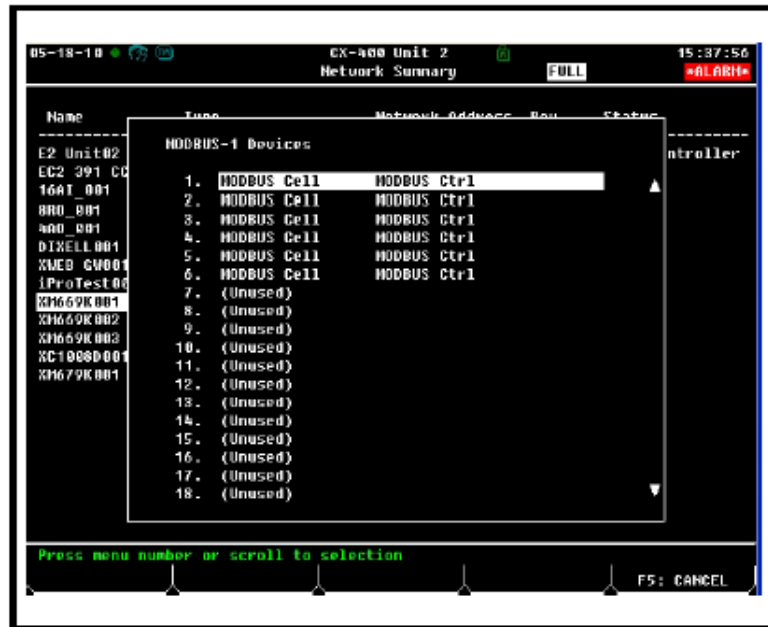




Figure 25. List of MODBUS Devices

7. Repeat **Steps 5** and **6** until each device has a name and address.
8. When finished, press  to return to the *NetworkSetup* menu, then press  - **Network Summary** (Figure 26). Locate the devices you set up, and look at each device's status in the **Status** field. You will see one of the following messages:
 - **Online** - The device is communicating normally.
 - **Offline** - The device is not communicating, has not been commissioned, is not functional, or is not powered up. Verify the device is powered up, wired correctly, and has the proper network address, baud rate, and parity.
 - **Unknown** - The device is not communicating or has not been commissioned. Verify the device is powered up, wired correctly, and has the proper network address, baud rate, and parity.
 - **No Port** - No port is set up in the E2 Serial Configuration Manager to be a MODBUS port.

- **Wrong FW Rev** - This message is likely caused by the device having a firmware version older than the minimum revision required by E2 for communication. Replace the device with a new one or a device that has the latest version of firmware on it.

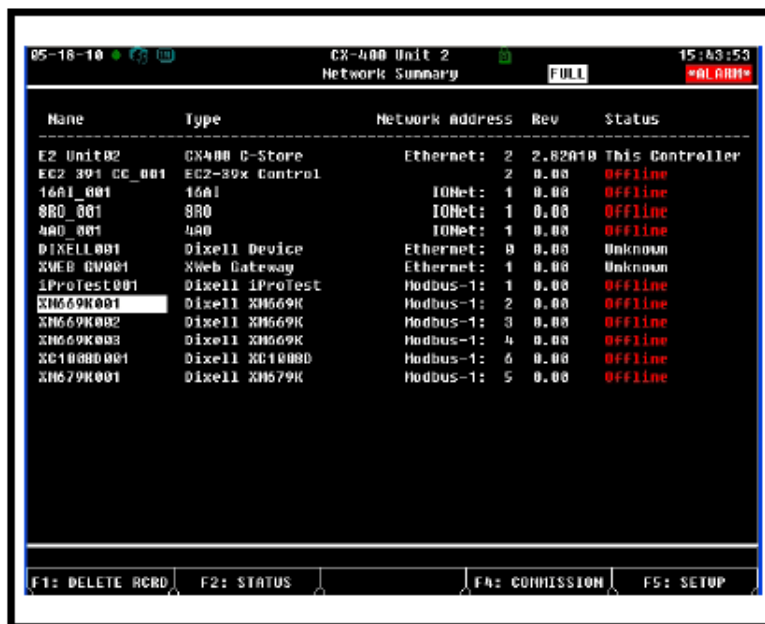


Figure 26. Network Summary Screen

18.18.2 Wiring Types

Retail Solutions specifies Belden #8761 shielded twisted pair cables for use as MODBUS wiring (or Belden #82761 and Belden #88761 for plenum installations). For MODBUS network wiring of XR35CX controllers to E2, Belden #8641 (*CPC P/N 135-8641*) is the recommended wire type to use.

If the recommended cable is not available in your area, be sure the wiring meets or exceeds the following specs:

Shielded?	Yes
Conductor Type	Twisted Pair
Gauge	18 - 24 AWG
Capacitance between signal wires	31 pF/ft or less (9.45 m) or less
Capacitance between signal and shield	59 pF/ft or less (17.98 m) or less
Maximum Length	4000 ft/18 to 22 AWG (1219.2 m) 2500 ft/24 AWG (762 m)
Nominal Impedance	120 ohm ± 50 ohm

18.18.3 MODBUS Termination Blocks

Because the XR35CX device has no on-board means of termination, use the MODBUS termination block (P/N 535-2711) for termination that can be wired to the end of the cable segment using the three-pin connector. Wire the two signal wires to the outside terminals, and connect the shield to pin 18, keeping the exposed shield wire length as short as possible (3 inches ideal maximum length).

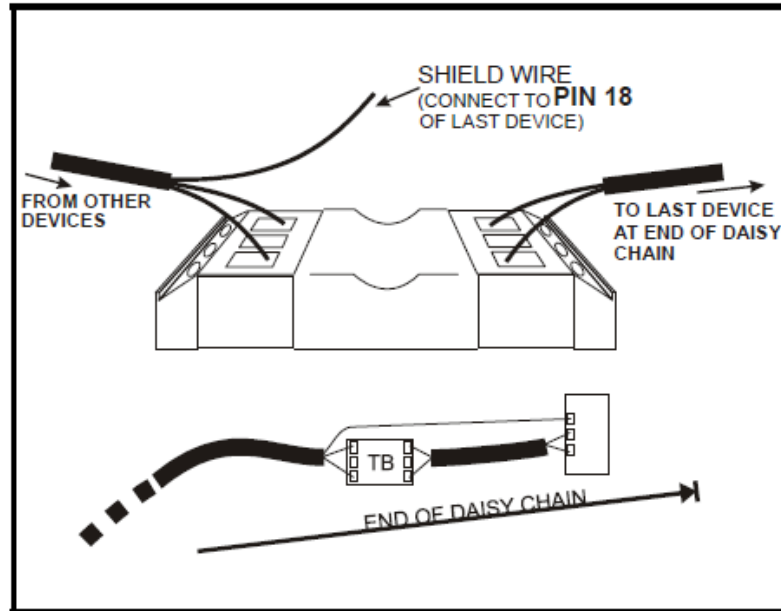


Figure 27. MODBUS Termination Block (P/N 535-2711)

18.19 Default Setting Values

Table 10: Default Setting Values (*Only for models with real time clock (RTC), 2 Only for XR35CX with X-REP output)

Label	Name	Range	Value	Level
SEt	Setpoint	LS to US	3.0	---
rtc*	Real time clock menu	---	---	Pr1
Hy	Differential	0.1 to 25.5 °C/ 1 to 255 °F	2.0	Pr1
LS	Minimum setpoint	-100 °C to SEt/-58 °F to SEt	-50.0	Pr2
US	Maximum setpoint	SEt to 110 °C/ SEt to 230 °F	110	Pr2
ot	Thermostat probe calibration	-12 to 12 °C /-120 to 120 °F	0.0	Pr1
P2P	Evaporator probe presence	n = not present; Y = present	Y	Pr1
oE	Evaporator probe calibration	-12 to 12 °C /-120 to 120 °F	0.0	Pr2

Table 10: Default Setting Values (*Only for models with real time clock (RTC), 2 Only for XR35CX with X-REP output)

Label	Name	Range	Value	Level
P3P	Third probe presence	n = not present; Y = present	n	Pr2
o3	Third probe calibration	-12 to 12 °C /-120 to 120 °F	0	Pr2
P4P	Fourth probe presence	n = not present; Y = present	n	Pr2
o4	Fourth probe calibration	-12 to 12 °C /-120 to 120 °F	0	Pr2
Ods	Outputs delay at start up	0 to 255 min	0	Pr2
Ac	Anti-short cycle delay	0 to 50 min	1	Pr1
rtr	P1-P2 percentage for regulation	0 to 100 (100 = P1 , 0 = P2)	100	Pr2
CCt	Continuous cycle duration	0.0 to 24.0 hr	0.0	Pr2
CCS	Setpoint for continuous cycle	(-100 to 150.0 °C) (-67 to 302 °F)	3	Pr2
Con	Compressor ON time with faulty probe	0 to 255 min	15	Pr2
CoF	Compressor OFF time with faulty probe	0 to 255 min	30	Pr2
CH	Kind of action	CL; Ht	CL	Pr1
CF	Temperature measurement unit	°C to °F	°C	Pr2
rES	Resolution	in = integer; dE = decimal point	dE	Pr1
Lod	Probe displayed	P1; P2	P1	Pr2
Red2	X-REP display	P1 – P2 – P3 – P4 – SEt – dtr	P1	Pr2
dLy	Display temperature delay	0 to 20.0 min (10 sec)	0.0	Pr2
dtr	P1-P2 percentage for display	1 to 99	50	Pr2
EdF*	Kind of interval for defrost	rtC to in	rtC	Pr2
tdF	Defrost type	EL = electrical heater; in = hot gas	EL	Pr2
dFP	Probe selection for defrost termination	nP; P1; P2; P3; P4	P2	Pr2
dtE	Defrost termination temperature	-50 to 50 °C	8.0	Pr1
IdF	Interval between defrost cycles	1 to 120 hr	8	Pr1
MdF	Maximum duration for defrost	0 to 255 min	20	Pr1
dSd	Start defrost delay	0 to 99 min	0	Pr2
dFd	Displaying during defrost	rt, it, SEt, dEF	it	Pr2
dAd	MAX display delay after defrost	0 to 255 min	30	Pr2
Fdt	Draining time	0 to 120 min	0	Pr2
dPo	First defrost after start-up	n = after IdF ; y = immediate	n	Pr2

Table 10: Default Setting Values (*Only for models with real time clock (RTC), 2 Only for XR35CX with X-REP output)

Label	Name	Range	Value	Level
dAF	Defrost delay after fast freezing	0 to 23 hr and 50'	0.0	Pr2
ACH	Kind of action for auxiliary relay	CL; Ht	CL	Pr2
SAA	Setpoint for auxiliary relay	-100 to 110 °C / -58 to 230 °F	0.0	Pr2
SHy	Differential for auxiliary relay	0.1 to 25.5 °C/ 1 to 255 °F	2.0	Pr2
ArP	Probe selection for auxiliary relay	nP/P1/P2/P3/P4	nP	Pr2
Sdd	Auxiliary relay operating during defrost	n to y	n	Pr2
ALP	Alarm probe selection	nP; P1; P2; P3; P4	P1	Pr2
ALC	Temperature alarms configuration	rE = related to set; Ab = absolute	Ab	Pr2
ALU	MAXIMUM temperature alarm	SEt to 110.0 °C; SEt to 230 °F	110.0	Pr1
ALL	Minimum temperature alarm	-100 °C to SEt / -58 °F to SEt	-50.0	Pr1
AFH	Differential for temperature alarm recovery	(0.1 °C to 25.5 °C)(1 °F to 45 °F)	2.0	Pr2
ALd	Temperature alarm delay	0 to 255 min	15	Pr2
dAo	Delay of temperature alarm at start up	0 to 23 hr and 50'	1.3	Pr2
AP2	Probe for temperature alarm of condenser	nP; P1; P2; P3; P4	P4	Pr2
AL2	Condenser for low temperature alarm	(-100 to 150 °C)(-67 to 302 °F)	-40	Pr2
AU2	Condenser for high temperature alarm	(-100 to 50 °C) (-67 to 302 °F)	110	Pr2
AH2	Differ. for condenser temperature alarm recovery	(0.1°C to 25.5°C) (1° to 45°F)	5	Pr2
Ad2	Condenser temperature alarm delay	0 to 254 (min), 255 = not used	15	Pr2
dA2	Delay of condenser temperature alarm at start up	0.0 to 23 hr 50'	1.3	Pr2
bLL	Compressor OFF for condenser low temperature alarm	n(0) - Y(1)	n	Pr2
AC2	Compressor OFF for condenser high temperature alarm	n(0) - Y(1)	n	Pr2
tbA	Alarm relay disabling	n = no y = yes	y	Pr2

Table 10: Default Setting Values (*Only for models with real time clock (RTC), 2 Only for XR35CX with X-REP output)

Label	Name	Range	Value	Level
oA1	Second relay configuration	ALr = alarm dEF = defrost Lig = Light AUS = AUX onF = always ON Fan = do not select it db = neutral zone cP2 = second compressor dF2 = do not select it HES = night blind	Lig	Pr2
AOP	Alarm relay polarity (oA1 = ALr)	oP ; CL	CL	Pr2
i1P	Digital input polarity (18-20)	oP = opening CL = closing	CL	Pr1
i1F	Digital input 1 configuration (18-20)	dor ; dEF	dor	Pr1
i2P	Digital input polarity (18-19)	oP = opening CL = closing	CL	Pr1
i2F	Digital input configuration (18-19)	EAL - bAL - PAL - dor - dEF - ES - AUS - Htr - FAn - HdF - onF	EAL	Pr2
did	Digital input alarm delay (18-20)	0 to 255 min	15	Pr2
doA	Door open alarm delay	0 to 255 min	15	Pr1
nPS	Number of activation of pressure switch	0 to 15	15	Pr2
Odc	Compress status when open door	no ; Fan ; CPr ; F_C	F-C	Pr2
rrd	Regulation restart with door open alarm	n – Y	y	Pr2
HES	Differential for Energy Saving	(-30 °C to 30 °C) (-54 °F to 54 °F)	0	Pr2
Hur*	Current hour	0 to 23	---	---
Min*	Current minute	0 to 59	---	Pr1
dAY*	Current day	Sun to Sat	---	Pr1
Hd1*	First weekly holiday	Sun to Sat – not used	not used	Pr1
Hd2*	Second weekly holiday	Sun to Sat – not used	not used	Pr1
iLE*	Energy Saving cycle start during workdays	0 to 23 hr 50 min	0.0	Pr1
dLE*	Energy Saving cycle length during workdays	0 to 24 hr 00 min	0	Pr1

Table 10: Default Setting Values (*Only for models with real time clock (RTC), 2 Only for XR35CX with X-REP output)

Label	Name	Range	Value	Level
iSE*	Energy Saving cycle start on holidays	0 to 23 hr 50 min	0.0	Pr1
dSE*	Energy Saving cycle length on holidays	0 to 24 hr 00 min	0	Pr1
Ld1*	1 st workdays defrost start	0 to 23 hr 50 min - not used	6.0	Pr1
Ld2*	2 nd workdays defrost start	0 to 23 hr 50 min - not used	13.0	Pr1
Ld3*	3 rd workdays defrost start	0 to 23 hr 50 min - not used	21.0	Pr1
Ld4*	4 th workdays defrost start	0 to 23 hr 50 min - not used	not used	Pr1
Ld5*	5 th workdays defrost start	0 to 23 hr 50 min - not used	not used	Pr1
Ld6*	6 th workdays defrost start	0 to 23 hr 50 min - not used	not used	Pr1
Sd1*	1 st holiday defrost start	0 to 23 hr 50 min - not used	6.0	Pr1
Sd2*	2 nd holiday defrost start	0 to 23 hr 50 min - not used	13.0	Pr1
Sd3*	3 rd holiday defrost start	0 to 23 hr 50 min - not used	21.0	Pr1
Sd4*	4 th holiday defrost start	0 to 23 hr 50 min - not used	not used	Pr1
Sd5*	5 th holiday defrost start	0 to 23 hr 50 min - not used	not used	Pr1
Sd6*	6 th holiday defrost start	0 to 23 hr 50 min - not used	not used	Pr1
Adr	Serial address	1 to 247	1	Pr2
pbC	Kind of probe	Pt1000; ntc	ntc	Pr2
onF	ON/OFF key enabling	not used, oFF, ES	not used	Pr2
dP1	Room probe display	---	---	Pr1
dP2	Evaporator probe display	---	---	Pr1
dP3	Third probe display	---	---	Pr1
dP4	Fourth probe display	---	---	Pr1
rSE	Real set	actual set	---	Pr2
rEL	Software release	---	2.6	Pr2
Ptb	Map code	---	---	Pr2

19 Dixell Parameter Table

Group	Parameter	Description	Factory Default	Minimum	Maximum	Unit
Regulation	Hy	Differential	2	0.1	25.5	°C
Regulation	LS	Minimum set point	-100	-100.0	3.0	°C
Regulation	US	Maximum set point	-60	3.0	150.0	°C
Probes	ot	Thermostat probe calibration	0	-12.0	12.0	°C
Probes	P2P	Evaporator probe presence	No			
Probes	oE	Evaporator probe calibration	0	-12.0	12.0	°C
Probes	P3P	Third probe presence	No			
Probes	o3	Third probe calibration	0	-12.0	12.0	°C
Probes	P4P	Fourth probe presence	No			
Probes	o4	Fourth probe calibration	0	-12.0	12.0	°C
Regulation	odS	Outputs delay at start up	0	0	255	min
Regulation	AC	Anti-short cycle delay	6	0	50	min
Regulation	rtr	P1-P2 percentage for regulation	100	0	100	
Regulation	CCt	Continuous cycle duration	24			ora
Regulation	CCS	Set point for continuous cycle	-100	-100.0	150.0	°C
Regulation	Con	Compressor ON time with faulty probe	255	0	255	min
Regulation	CoF	Compressor OFF time with faulty probe	0	0	255	min
Regulation	CH	Kind of action : heating cooling	CL			

Dixell Parameter Table

Group	Parameter	Description	Factory Default	Minimum	Maximum	Unit
Regulation	CF	Temperature measurement unit	°C			
Regulation	rES	Resolution	in			
Regulation	Lod	Probe displayed	P1			
Regulation	rEd	X-REP display	P1			
Regulation	dLy	Display temperature delay	0			min
Regulation	dtr	P1-P2 percentage for display	99	1	99	
Defrost	EdF	Defrost mode	in			
Defrost	tdF	Defrost type	EL			
Defrost	dFP	Probe selection for first defrost	nP			
Defrost	dtE	Defrost termination temperature first defrost	-55	-55.0	50.0	°C
Defrost	idF	Interval between defrost cycles	0	0	120	ora
Defrost	MdF	(Maximum) length for first defrost	0	0	255	min
Defrost	dSd	Start defrost delay	0	0	255	min
Defrost	dFd	Displaying during defrost	rt			
Defrost	dAd	Max display delay after defrost	0	0	255	min
Defrost	Fdt	Draining time	0	0	255	min
Defrost	dPo	First defrost after start-up	no			
Defrost	dAF	Defrost delay after fast freezing	23.5			ora
Auxiliary	ACH	Kind of action for auxiliary relay	cl			
Auxiliary	SAA	Set point for auxiliary relay	0	-100.0	150.0	°C

Group	Parameter	Description	Factory Default	Minimum	Maximum	Unit
Auxiliary	SHy	Differential for auxiliary relay	2	0.1	25.5	°C
Auxiliary	ArP	Probe selection for auxiliary relay	nP			
Auxiliary	Sdd	Auxiliary relay switched off during defrost	no			
Alarm	ALP	Probe selection for temperature alarms	P1			
Alarm	ALC	Temperature alarms configuration	rE			
Alarm	ALU	Maximum temperature alarm	10	-50.0	150.0	°C
Alarm	ALL	Minimum temperature alarm	-10	-100.0	110.0	°C
Alarm	AFH	Differential for temperature alarm recovery	0.1	0.1	25.5	°C
Alarm	ALd	Temperature alarm delay	0	0	255	min
Alarm	dAo	Delay of temperature alarm at start up	3			ora
Alarm	AP2	Probe selection for condenser temperature alarms	nP			
Alarm	AL2	Condenser low temperature alarm	-40	-100.0	150.0	°C
Alarm	AU2	Condenser high temperature alarm	150	-100.0	150.0	°C
Alarm	AH2	Differ. for condenser temp. alarm recovery	5	0.1	25.5	°C
Alarm	Ad2	Condenser temperature alarm delay	255	0	255	min
Alarm	dA2	Delay of condenser temper. alarm at start up	23.5			ora
Alarm	bLL	Compressor off for condenser low temperature alarm	no			
Alarm	AC2	Compressor off for condenser high temperature alarm	no			
Alarm	tbA	Alarm relay switched off by pushing a key	no			

Group	Parameter	Description	Factory Default	Minimum	Maximum	Unit
Configuration	oA1	First relay configuration	ALR			
Alarm	AOP	Alarm relay polarity	oP			
Digital inputs	i1P	Digital input 1 polarity	cl			
Digital inputs	i1F	Digital input 1 configuration	dor			
Digital inputs	i2P	Digital input 2 polarity	cl			
Digital inputs	i2F	Digital input 2 configuration	EAL			
Digital inputs	did	Digital input 2 alarm delay	15	0	255	min
Digital inputs	doA	Door alarm delay	15	0	255	min
Digital inputs	nPS	Number of activation of pressure switch	15	0	15	
Digital inputs	OdC	Compress and fan status when open door	no			
Alarm	rrd	Regulation restart with door open alarm	y			
Energy Saving	HES	Differential for Energy Saving	0	-30	30	°C
Other	Adr	Serial address	1	1	247	
Probes	PbC	Kind of probe	Pt1			
Configuration	OnF	On/off key configuration	Not Used			
Other	dP1	Probe 1 value	0			
Other	dP2	Probe 2 value	0			
Other	dP3	Probe 3 value	0			
Other	dP4	Probe 4 value	0			
Other	rSE	Real Set point (SET + ES + SETd)	0			

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