thermoscientific

Standard Performance -86°C Ultra Low TemperatureFreezer

Suzhou Service Manual

321189H01-CN • Revision A • 03/11/2022

IMPORTANT Read this Service 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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Models

Brand / Model	Size	Voltages	Suffix	Unit Weight, Dimensions and Performance Data
Forma FDE Series	300 / 400 / 500 / 600	A / D / V / L	-ULTS	For more information on Unit Weight, Dimensions and Performance Data, visit www.thermofisher.com
Thermo Scientific TDE Series	300 / 400 / 500 / 600	A / D / V / L	-ULTS	For more information on Unit Weight, Dimensions and Performance Data, visit www.thermofisher.com

Part Number List

Part Number	Description
322227G14-CN	First Stage 115 V / 60 Hz Compressor Kit
322227G15-CN	First Stage 230 V / 60 Hz Compressor Kit
322227G16-CN	First Stage NT2180UV 230 V/ 50 Hz Compressor Kit
322227G18-CN	First Stage NTX2211U 230 V/ 50 Hz Compressor Kit
328115G01-CN	Start Gear Assembly 208-230 V / 60 Hz
328115G02-CN	Start Gear Assembly 115 V / 60 Hz
328115G03-CN	Start Gear Assembly NT2180UV 230 V / 50 Hz
TBD	Start Gear Assembly NTX211U 230 V / 50 Hz
322228G11-CN	Second Stage 115 V / 60 Hz Compressor Kit
322228G12-CN	Second Stage 208-230 V / 60 Hz Compressor Kit
322228G13-CN	Second Stage NT2180UV 230 V/ 50 Hz Compressor Kit
322228G15-CN	Second Stage NTX2211U 230 V/ 50 Hz Compressor Kit
329074G01-CN S	Cold Box Assembly
329451G01-CN	Condenser Assembly
329519H01-CN	Filter Drier, 1st stage -86° C
300367H01-CN	Accumulator, 2nd Stage -86°C - STP2
327005G01-CN	Condenser Fan Motor 208/230 V / 50-60 Hz
327005G02-CN	Condenser Fan Motor Assembly 115 V / 60 Hz
328285G02-CN	Deck Wiring Harness -86° C 300 / 400 / 230 V
328285G03-CN	Deck Wiring Harness -86° C 300 / 400 / 115 V
328285G04-CN	Deck Wiring Harness -86° C 500 / 600 / 230 V
328285G05-CN	Deck Wiring Harness -86° C 500 / 600 / 115 V

Part Number	Description
329653G01-CN S	Door Assembly 300 FDE / TDE, NMPA Units, Low End UI
329653G02-CN S	Door Assembly 400 FDE / TDE, NMPA Units, Low End UI
329653G03-CN S	Door Assembly 500 FDE / TDE, NMPA Units, Low End UI
329653G04-CN S	Door Assembly 600 FDE / TDE, NMPA Units, Low End UI
328206G01-CN S	Door Assembly 300 FDE / TDE, NMPA Units, High End UI
328206G02-CN S	Door Assembly 400 FDE / TDE, NMPA Units, High End UI
328206G03-CN S	Door Assembly 500 FDE / TDE, NMPA Units, High End UI
328206G04-CN S	Door Assembly 600 FDE / TDE, NMPA Units, High End UI
332005G01-CN S	Door Assembly 300 FDE / TDE, GP Units, Low End UI
332005G02-CN S	Door Assembly 400 FDE / TDE, GP Units, Low End UI
332005G03-CN S	Door Assembly 500 FDE / TDE, GP Units, Low End UI
332005G04-CN S	Door Assembly 600 FDE / TDE, GP Units, Low End UI
332005G21-CN S	Door Assembly 300 FDE / TDE, GP Units, High End UI
332005G22-CN S	Door Assembly 400 FDE / TDE, GP Units, High End UI
332005G23-CN S	Door Assembly 500 FDE / TDE, GP Units, High End UI
332005G24-CN S	Door Assembly 600 FDE / TDE, GP Units, High End UI
315351G01-CN S	Cam Latch Roller Strike Mount Assembly
328429G01-CN S	Front Grill Assembly 300 FDE / TDE
328429G02-CN S	Front Grill Assembly 400 FDE / TDE
328429G12-CN S	Front Grill Assembly 400 W / Recorder FDE / TDE
328429G03-CN S	Front Grill Assembly 500 FDE / TDE
328429G13-CN S	Front Grill Assembly 500 W / Recorder FDE / TDE
328429G04-CN S	Front Grill Assembly 600 FDE / TDE
328429G14-CN S	Front Grill Assembly 600 W / Recorder FDE / TDE
328427G01-CN S	Frame Grill Assembly 300 FDE / TDE
328427G02-CN S	Frame Grill Assembly 400 FDE / TDE
328427G03-CN S	Frame Grill Assembly 500 FDE / TDE
328427G04-CN S	Frame Grill Assembly 600 FDE / TDE
315329G05-CN	Hinge Assembly FDE / TDE

Part Number	Description
329405G01-CN	Relay Enclosure W/O BUS No Buck / Boost 230 V 60 Hz
329405G07-CN	Relay Enclosure W/O BUS Boost Only 115 V 60 Hz
329405G03-CN	Relay Enclosure W/O BUS No Buck / Boost 230 V 50 Hz
329405G04-CN	Relay Enclosure W/BUS No Buck / Boost 230 V 60 Hz
329405G08-CN	Relay Enclosure W/ BUS Boost Only 115 V 60 Hz
329405G06-CN	Relay Enclosure W/ BUS No Buck / Boost 230 V 50 Hz
329405G11-CN	NMPA w/o BUS 250 V /50 Hz RPS-160
329405G12-CN	NMPA w/BUS - 250 V /50 Hz - RPS-160
329405G13-CN	NMPA w/o BUS 250 V /50 Hz - RPS-160 - NTX
329405G14-CN	NMPA w/BUS 250 V /50 Hz -RPS-160 - NTX
315341G02-CN S	Power Supply Board RPS -160° C
315341G03-CN S	Power Supply Board RPS -120° C
329503G01-CN	UI Assembly FDE / TDE
329489H01-CN	UI Trim Bezel FDE / TDE
330108H01-CN	UI Trim Bezel Removal Tool
315206H01-CN	RTD Cabinet Sensor -86° C
33443G11-CN	Oil Separator Kit
315306H01-CN	Battery Bracket, LH
315306H02-CN	Battery Bracket, RH
332165H01-CN	Battery, Back Up System
332165H01-CN	Battery, Main System
315674G01-CN S	BUS, Pressure Equalization Vent Port
1517287H01-CN	Caster, 2"
315282H02-CN	Circuit Breaker Switch For 208/230 V 14 Amp Relay Enclosure
331025H01-CN	Door Magnet, Door and Bus Magnet

Part Number	Description
315096H06-CN	Gasket, Inner, Outer Door, 300
315096H01-CN	Gasket, Outer, Outer Door, 300
315096H07-CN	Gasket, Inner, Outer Door, 400
315096H02-CN	Gasket, Outer, Outer Door, 400
315096H08-CN	Gasket, Inner, Outer Door, 500
315096H03-CN	Gasket, Outer, Outer Door, 500
315096H09-CN	Gasket, Inner, Outer Door, 600
315096H04-CN	Gasket, Outer, Outer Door, 600
315018G01-CN	Inner Door, ASY, 300, 5 Door Single Speed
315018G02-CN	Inner Door, ASY, 400, 5 Door Single Speed
315018G03-CN	Inner Door, ASY, 500, 5 Door Single Speed
315018G04-CN	Inner Door, ASY, 600, 5 Door Single Speed
315018G06-CN	Inner Door, ASY, 300, 4 Door Single Speed
315018G07-CN	Inner Door, ASY, 400, 4 Door Single Speed
315018G08-CN	Inner Door, ASY, 500, 4 Door Single Speed
315018G09-CN	Inner Door, ASY, 600, 4 Door Single Speed
315538G01-CN	Inner Door, Hinge ASY, 5 Inner Doors
315538G02-CN	Inner Door, Hinge ASY, 4 Inner Doors
315362H01-CN	Pilaster, Shelf
316702H01-CN	Power Cord, 250 V, 50 Hz/16 amp
327197H06-CN	Power Cord, 100 V, 60 Hz/15 amp
430264-CN	Power Cord, 230 V, 60 Hz/16 amp
430263-CN	Power Cord, 125 V, 60 Hz/20 amp
316705H01-CN	Power Cord, 250V/16A, CHINA
316654H01-CN	Power Cord Retaining Bracket (SHORT)
316654H02-CN	Power Cord Retaining Bracket (LONG)
315229G01-CN S	Pressure Equalization Port Assembly

Part Number	Description
315019G01-CN	Shelf, Assembly, 300
315019G02-CN	Shelf, Assembly, 400
315019G03-CN	Shelf, Assembly, 500
315019G04-CN	Shelf, Assembly, 600
315672H01-CN	Remote Alarm Connector
UI34567H-CN	STP Factory Upgrade High End User Interface
315558G02-CN S	Right Side Panel
315559G02-CN S	Left Side Panel
328136G02-CN S	Rear Grill Assembly 400 / 500 / 600
328136G01-CN S	Rear Grill Assembly 300
315367H01-CN	RTD Probe Holder
322229G02-CN	2nd Stage Filter Drier Kit
329613H04-CN	TDE Door Handle
329613H02-CN	FDE Door Handle
329613H04-CN	Label, TDE Series
329613H02-CN	Label, FDE Series
327752H03-CN	Thermo Scientific Door Label
328046G03-CN S	FDE / TDE Door Handle
327994G01-CN	FDE / TDE Cam Latch Mount

Note: If unit is equipped with this Factory Upgrade refer to TSX Service Manual for UI Operations (TSX Service Manual part number 328390H01-CN).

Preface

Notices and Warnings

The following symbols are used in caution and warninginformational labels attached to the freezer:

	Caution, info
	Electrical Hazard
	Hot surface
	Cold surface
	Watch hands
	Protective conductor terminal
	Alternating current
	On
	Off
	On (control panel)
	Off (control panel)
	Stand-by (battery enabled)

	Earth ground

Warnings and Caution Symbols

Symbol	Warnings and Cautions
	**WARNING:** Caution, risk of fire. This unit is charged with hydrocarbon refrigerants.
	Electrical Hazard: Contains parts and assemblies susceptible to damage byElectrostatic Discharge (ESD). Potential electrical hazards. Only qualified persons should perform procedure associated with this symbol. Equipment being maintained or serviced must be turned off and locked off to prevent possibleinjury.
	**CAUTION:** All internal adjustments and maintenance must be performed by qualified service professional.

Material in this manual is for information purposes only. The contents and the product it describes are subject to change without notice. Thermo Fisher Scientific makes norepresentations of warranties with respect to this manual.

Always follow the safety suggestions listed below.

- Always wear the proper protective equipment (clothing,gloves, goggles, etc.).
- Always dissipate extreme cold or heat and wearprotective clothing.
- Always follow good hygiene practices.
- Each individual is responsible for his or her own safety.

Thermo Fisher Scientific Contact Information

If you need information or assistance on Thermo Fisher Scientific products, contact us between 9:00 am and 6:00 pm (GMT + 8) Monday through Saturday at:

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Our Service Support staff can supply technical information about proper setup, operation or troubleshooting of your equipment. We can fill your needs for spare or replacement parts or provide you with on-site service. We can also provide you with a quotation on our Extended Warranty for Thermo products.

Whatever Thermo products you need or use, we will be happyto discuss your applications. If you are experiencing technicalproblems, working together, we will help you locate the problem and chances are, correct it yourself or over the telephone without a service call.

When more extensive service is necessary, we will assist you with direct factory trained technicians or a qualified service organization for on-the-spot repair. If your service need is covered by the warranty, we will arrange for the unit to be repaired at our expense and to your satisfaction.

Regardless of your needs, our professional telephone technicians are available to assist you Monday through Saturday from 9:00 am to 6:00 pm (GMT + 8). If you wish to write, our mailing address is:

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Introduction

Description of STP Performance and Operation

The Single Speed Hydrocarbon -86° C Ultra Low Temperature (ULT) control system uses a touch screen user interface (UI) and a custom software package to allow setup,operation, monitoring, status alerts, data logging and diagnostic troubleshooting. Both typical user functions and special service functions are described in this manual.

Understanding the UI

The refrigeration system uses a dual compressor, cascade system with a heat exchange assembly or “heat exchange box” in the compressor deck to allow heat transfer from thesecond stage to the first stage system. The entire first stagerefrigeration system is located in the compressor deck with the cabinet containing only the second stage capillary and evaporator tubing.

The Hydrocarbon Single speed -86° C ULT has the following major systems:

- Control System
- Refrigeration System
- Cabinet Structure

The Control System has the following subsystems:

- Touch screen UI in the door
- Relay control box in the compressor deck
- Control and monitoring sensors in specific locations
- UI software

The Refrigeration System has the following subsystems ormajor components:

- High or first stage compressor
- Low or second stage compressor
- Oil Separator; second stage
- Condenser fan
- Heat exchange box in the compressor deck, includingfirst stage accumulator
- Diagnostic thermocouples in specific locations

The Cabinet structure has the following major components:

- Compressor deck assembly
- Cabinet structure with shelves
- Exterior door with gaskets and UI wiring harness

Data Label Location

The purpose of this service manual is to provide service dataand procedures to assist in troubleshooting and repairing theunit. The first step in that process is to correctly identify the specifications and features of the unit you are working on. Thefeatures and specifications are tied to the model number andserial number and these numbers should be recorded for all service events. Any contact with the manufacturer for technical support or parts will require both the model numberand the serial number.

The model and serial numbers for the STP Hydrocarbon freezers are printed on a data label attached to the freezer. The data plate is located on the left bottom side facing the cabinet on the latch side of the cabinet located near the frontside and next to the door.

Figure 1. -80° C Freezer

How to Read Serial Number Format

Freezers built in Suzhou, China have the following serialnumber format:

Current Serial Number Format

P	Numeric Plant Code (2 is the Suzhou Plant)
Z	Cabinet Size (3 = 300, 4 = 400, 5 = 500, 6 = 600)
T	Unit Type (C = low end UI, G = high end UI)
V	Voltage (D = 208V/60Hz, V = 220V/50Hz)
B	Brand (M = Forma, T = Thermo Scientific)
I	Interior (4 = 4 inner doors, 5 = 5 inner doors)
C	Cord (H = China)
OO	Option Code (01 = None, 73 = NMPA, 79 = HID)
YY	Two digit year
M	Month (1, 2…8, 9, A= Oct, B = Nov, C = Dec)
DD	Day (01 to 31)
SS	Serial Number – Unique to each unit (01 to 99)

Example:
Serial Number 26CVM4H0121A0412 is fora Forma brand, 4 shelf, 4 inner door 600V with no accessories, completed on December 04, 2021 with unique serial number 12.

Proper Use General Recommendations

- This unit is not a “rapid-freeze” device. Freezing large quantities of liquid or high-water content items will temporarily increase the chamber temperature and will cause the compressors to operate for a prolonged timeperiod.
- Avoid opening the door for extended time periods since chamber temperature air will escape rapidly. Also, keep the inner doors closed as much as possible. When roomair which is higher in humidity replaces chamber air, frostmay develop in the chamber more rapidly.

Proper Use General Recommendations

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Initial Loading

The initial loading instructions are located in the user manualand in the start-up screens when the unit is powered on.
Below are the instructions that will be seen in the user interface when going through the start-up screens when the unit is powered on.

- Allow the freezer to operate at the desired temperaturefor a minimum of 12 hours before loading.
- Load the freezer one shelf at a time beginning with the top shelf. After loading each shelf allow the freezer to recover to the desired set point before loading the next shelf. Repeat this process until the freezer is fully loaded.

Failure to follow these procedures or overloading the unit may cause undue stress on the compressors or jeopardize user product safety.

Operating Standards

The freezers described in this manual are classified for use as Category II environment. These units are designed to operateunder the following environmental conditions:

- Indoor use 10°C to 32°C (50ºF to 90ºF).
- Altitude up to 2000 m.
- Maximum relative humidity 60% for temperatures up to32º C (90º F).
- Main supply voltage fluctuations not to exceed 10% ofthe nominal voltage.

Installation

Do not exceed the electrical and temperature ratings printed on the data plate located on the lower left side of the unit.

Improper operation of the equipment could result in dangerous conditions. To preclude hazard and minimize risk, follow all instructionsand operate within the design limits noted on the data plate.

Location

- Install the unit in a level area free from vibration with a minimum of eight inches (20 cm) of space on the top andsides and six inches (15 cm) at the back. For further instructions on leveling cabinets, refer to **Leveling** section of this manual.
- Allow enough clearance so that door can swing open atleast 85 degrees.
- Do not position the equipment in direct sunlight or nearheating diffusers, radiators or other sources of heat.
- Ambient temperature range at the location must be15° C to 32º C (59° F to 90º F).

To allow for proper air flow, a minimum of eight inches of clearance space is required on the sides and top of the freezer and six inches at theback.

Wiring

- Connect the equipment to the correct power source.Incorrect voltage can result in severe damage to the equipment.

For personal safety and trouble-free operation this unit must be properly grounded before it is used. Failure to ground the equipment may cause personal injury or damage to the equipment.

- Always conform to the National Electrical Code and/orlocal codes.
- Do not connect the unit to overloaded power circuit.

Do not position the unit in a way that impedes access to the disconnecting device or circuit breaker in the back of the unit.

- Always connect the freezer to a dedicated (separate) circuit. Each freezer is equipped with a service cord andplug designed to connect it to a power outlet which delivers the correct voltage. Supply voltage must be within +10% or -10% of the freezer rated voltage.

Never cut the grounding prong from the service cord plug. If the prong is removed, the warranty is voided.

Leveling

- Ensure the floor is level. The unit must be level both frontto back and side to side.
- Be sure to set the brakes for units equipped with casters.

Super Insulated Cabinet Construction

- The cabinet walls have a vacuum insulation core encapsulated by a sealed film laminate and wrapped inMylar.
- Never drill holes in or near the cabinet walls. Drilling coulddamage the insulation and make the unit inoperable.

Door Operation

Upright freezer models are equipped with an advanced assembly specifically designed for ultra-low temperaturefreezers.

Features include:

- One-hand operation.
- A front-accessible lock.
- Hasps for a standard padlock to provide additionalsecurity.
- Durable construction for reliable operation and safeproduct storage.
- Optional controlled access to the freezer with ProximityAccess cards.
- Each model is equipped with a door ramp kit to addressdoor sag issues in the field.

When moving the freezer always grasp cabinet surfaces; never pull the freezer by the latch handle.

Opening the Door

1. Remove the padlock if installed.
2. Grasp the latch handle and pull it toward yourself until thelatch disengages from the cabinet strike.
3. Keep pulling by the latch handle to open the main door.

Closing the door

Note: The latch does not self-engage automatically when thedoor is closed. Follow the steps below to close the door andproperly engage the latch:

1. Grasp the latch handle (preferably with your left hand) and pull it toward yourself, rotating the latch into the openposition.
2. Move the freezer door into the closed position and gentlypush the handle away from you ensuring that the latch engages fully with the cabinet strike.
3. Keep applying gentle pressure to the latch handle untilthe latch is securely in closed position.
4. Insert the key and rotate counterclockwise to lock.
5. Replace the padlock as required.

Closing the door without ensuring the engages fully with the strike can result in substantial prying force. Forcing the door closed against obstructions may damage the door, the latch and threaten safe product storage.

Pressure Equalization Port

When an upright ultra-low temperature freezer door is opened, room temperature air rushes into the storage compartment. When the door is closed, the fixed volume of air is cooled rapidly. Pressure drops below atmospheric pressure resulting in a substantial vacuum. Re-entry into thecabinet is impossible until internal pressures are returned toatmospheric pressure. Without a pressure equalization mechanism, it can take, in extreme cases, several hours before the door can easily be reopened.

All upright models feature a port that provides vacuum relief after door openings. The pressure equalization port is locatedin the door behind the User Interface Touch Screen on the front of the freezer. Although the port is designed to self-defrost, excessive frost accumulation on the inner door could eventually restrict air flow. Therefore, periodically inspect the inner door and brush away any loose frost using astiff nylon brush.

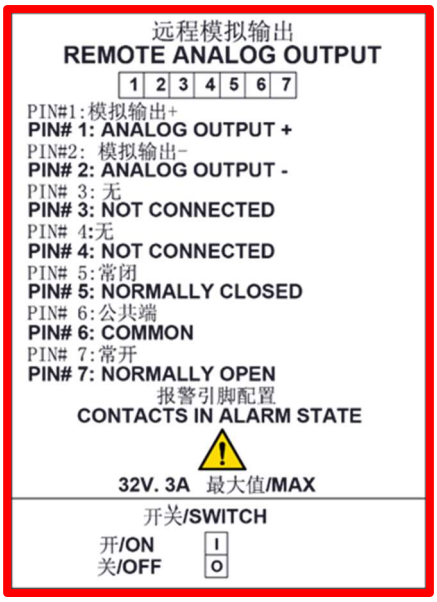
Remote Alarm Contacts

The remote alarm contacts are located behind the freezer above and to the left of the power switch. These are “dry contacts” or non-energized switches that change position in response to specified alarm conditions. After installing the wiring from the remote alarm to the connector, install the connector to the freezer micro board by plugging it into the receptacle provided.

When the unit is in the alarm condition:

- The rightmost pin (#7) is Open To Common;
- The second pin from the right (#6) is Common;
- The third pin from the right (#5) is Closed to Common.
- The contacts trip in the event of a power outage, hightemperature alarm or low temperature alarm.

Remote Analog



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

Safety Precautions

In this manual and on labels attached to this product, the words WARNING and CAUTION mean the following:

WARNING: A potentially hazardous situation which, if not avoided could result in serious injury or death.

CAUTION: A potentially hazardous situation which, if not avoided may result in minor or moderate injury or damage tothe equipment.

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

- Use this product only in the way described in the productliterature and in this manual.
- Before use, verify that this product is suitable for itsintended use.
- Do not modify system components especially thecontroller.
- Use OEM exact replacement equipment or parts.
- Before use, confirm that the product has not been alteredin any way.
- The unit must be properly grounded in conformity withnational and local electrical codes.
- Never connect the unit to overloaded power sources.
- Disconnect the unit from all power sources beforecleaning, troubleshooting or performing

Protective Conductor Statement

other maintenance on the product or its controls.

Remote Analog

The maximum limit of 10 mA shall not be exceeded testedaccording to Clause 5.5 (Measurement of protective conductor current) of EN 50676 or DIN VDE 0701-1 or DIN EN 50768 VDE 0701.

Protective Conductor Statement

Understanding the User Interface

Touch Screen User Interface

The message panel on the top of the UI indicates the freezerhealth status and the various alarm or warning states.

- Wrench – Generic service warning which corresponds toan intermittent flashing error code displayed on the UI.
- Door – Illuminates when the door is open for more than3 minutes.
- Heart – Health status for the freezer. A green heart indicates normal freezer operation. In an alarm state theheart icon will not be illuminated.
- Thermometer- Indicates when cabinet temperature exceeds either warm or cold alarm setpoints and anaudible alarm will occur.
- Snooze Bell – Only illuminated during an active alarm andhas been silenced by the user.
- Alarm Bell – Indicates visual and audible alarm that accompanies various alarm states. Pressing the alarm bell while in the alarm state will silence the alarm for 10minutes.

The control panel consist of 4 touch-point buttons located onthe right side of the display.

Plus – Increases the value of the selected setting.

Check Mark – Saves a change to the selected value.

Minus – Decreases the value of the selected setting.

Settings – Icon represents the various settings

including;

Warm Alarm value – Range of -40° C to within 5° C of setpoint.

Cold Alarm value – Range of -99° C to within 5° C of setpoint.

Offset value – Used for calibration. Range is -10° C to +10° C.Default is 0° C.

Setpoint Security – User set 3 digit numeric code that locks the UI Settings from being altered or changed without entering the specific code.

The control panel consist of 4 touch-point buttons located onthe right side of the display.

Touch Screen

The touch screen includes de-bounce to prevent a single press from being interpreted as multiple presses.

The touch screen accepts all presses that meet the hardware force requirement at a rate of up to 3 key presses per second.

The touch screen keyboard provides a visual, highlight providing feedback to the user that the key was pressed.

Figure 3. User Interface

The following table describes each screen in the User Interface.

User Interface		
Screen	**Secure Mode Login Required**	**Purpose**
Freezer Control Settings	Yes	Allows setup of various run parameters.
BUS Settings	Yes	Allows setup of an LN_2 or CO_2 backup system if installed.
Health Status	No (Read only without login)	Green Heart will go away if the freezer is in an alarm condition, replaced by Red alarm bell icon.
Service	Yes	The service mode entry screen with sub-screens that may only be accessed via a successful service account login. This screen has test functionality.

Figure 4. Setpoint security

In each case, press NEXT to move to the next prompt.

Note: If you are in doubt about whether any of the above installation requirements have been met, refer to the earlier parts of the Introduction to this manual to verify all of the above conditions have been met.

Start-Up and Operation

Initial Start-Up

To start the freezer, complete the following steps:

1. Plug the freezer into the power outlet.
2. Turn the power switch ON. You can find the switch inback of the freezer, on the bottom right.
3. Once the freezer is turned ON, the user interface will begin a start up procedure. Once ready for operation, thetemperature is displayed on the screen.

Selecting the Security Mode

The default setting is Full Access Mode in which all users haveaccess to all functions including changing freezer set points.

You can choose Secured mode to enable set point security. in Secured mode, If you wish to change the default, use the Settings button to change to Secured.

Note: If Setpoint Security Pass Code has been lost, you mustenter the “Service Password” for the day. This can be obtained from Knowledge Base or from Technical Support. Once entered display will unlocked, then the security mode pass code can be reset to “000” or a new pass code can beentered.

Home Screen

The Home Screen shown below is the screen displayed continuously during normal operation. This screen displays the current cabinet temperature and the Green Heart indicator as long as the freezer is in normal operation.

Figure 5. Home Screen

Accessing the Service Screen

Note: Only a user with Service Screen permission and asecure password will be admitted to the Service

1. Press up & down arrow in together for 5 seconds.
2. Display will show 000.
3. Enter Service Password of the day; only the 3 values.

If Service Mode is entered and the date/time are incorrect it will allow service personnel to update the UI to the current/correct date/time in the following format; yy, mm, dd,hr, min. At this time the Service Tech can transition from eachsetting using the check mark and use the up and down arrowkeys to change the values.

Time will be in 24 hour format.

4. UEr will be displayed, the UI is now in the Service Mode.
5. Once in the Service mode pressing the check mark will enter into the parameter settings and the Gear Icon willtransition to the next parameter.

Figure 6. Service Screen 1

Figure 7. Service Screen 2

Figure 8. Service Screen 3

Setting Temperature Set Points

User Interface Icons

The control panel consist of 4 touch-point buttons located on the right side of the display.

- Plus – Increases the value of the selected setting.
- Check Mark – Saves a change to the selected value.
- Minus – Decreases the value of the selected setting.
- Settings – Icon represents the various settings including;
  - Warm Alarm value – range of -40° C to within 5° C ofsetpoint.
  - Cold Alarm value – range of -99° C to within 5° C ofsetpoint.
  - Offset value – used for calibration. Range is -10° C to +10° C. Default is 0° C.
  - Setpoint Security – User sets 3 digit numeric codethat locks the UI Settings from being altered or changed without entering the specific code.
  - Backup system type (if backup system is installed) – Set the type to either LN_2 or CO_2 corresponding to the backup system that is installed.
  - Backup system setpoint (if backup system is installed) –This setpoint indicates the temperature atwhich the backup system will begin cooling the cabinet. It is recommended to set the backup systemsetpoint at a minimum of 10°C warmer than the control setpoint.

Control & Alarm Setpoints

Control Setpoint

When setting/changing the Control Setpoint

1. Press either the up or down arrow button.
3. Adjust by pressing + or - arrow buttons to desiredtemperature setpoint.
4. Select the check mark button Setpoint range for -86° C freezer = -50° C to -86° C to save the new control setpoint.

- Setpoint range for -86° C freezer = -50° C to -86° C.

Figure 9. Control Setpoint

Warm & Cold Alarm Setpoints

- Press the settings button, lower right corner, gear icon.
    - Warm alarm will be displayed, use the + or – arrowbuttons to adjust, setting will begin to flash.
- Press the check mark button to save the change.
    - Press the setting button twice to view or adjust the Cold alarm setting. Use the + or – arrow to adjust, setting will begin to flash.
- Press the check mark button to save the

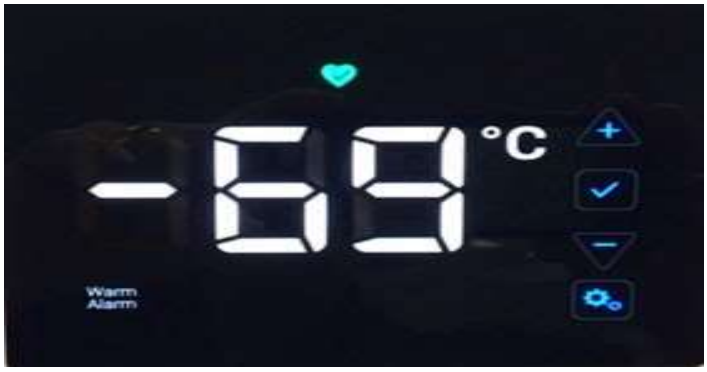


Figure 10. Warm & Cold Alarm Setpoints

Figure 11. Warm & Cold Alarm Setpoints 2

STP ULT Product Perspective

Sensors / On board Instrumentation

On-board Instrumentation			
Sensor	Location	Type	Detail
RTD 1	Cargo Area	RTD, 1000 Ohm	Back wall center, bottom compartment.
TC #1	First Stage Suction	T-type thermocouple	On suction tube at compressor.
TC #2	Condenser Air Inlet	T-type thermocouple	In air stream in front of condenser coil.
TC #3	Evaporator Inlet	T-type thermocouple	Evaporator inlet foamed in the cabinet
TC #4	Evaporator Outlet	T-type thermocouple	Evaporator outlet foamed in the cabinet
TC #6	Second Stage Suction	T-type thermocouple	Mounted on suction tube at compressor.
TC #7	Liquid Line	T-type thermocouple	Outlet line of the Condenser Coil
TC #8	First Stage Sump	T-type thermocouple	First stage compressor sump temperature
TC #9	Second Stage Sump	T-type thermocouple	Second stage compressor sump temperature
TC #10	BPHX	T-type thermocouple	Installed at the center of the BPHX. Two sensors installed; one for backup.

ULT Overview

1. A ULT is a long term storage device that cools a cargoarea to extremely cold temperatures. The primary purpose of the UI on a ULT is to:
    a. Accurately convey alarms, warnings and informational items to the end user visually andaudibly
    b. Process general user inputs/commands that changethe operation on the ULT (ex. set point change)
    c. Process user inputs for display information purposesto retrieve on board archives temperature and eventdata.

Software Distribution

The product functions with respect to software are divided into three primary sections:

a. Main Board software
b. Backup System (BUS) software
c. Display Board software

Functionality

Power Failure

In this case, the user interface will stay on (using battery power only) and an audible alarm will sound to indicate powerfailure.

Figure 12. Power Failure

Parameters

Adjustment Relationships

1. When the set point is adjusted, the warm and cold alarmsare verified to be >=10° C away from set point in the corresponding warm or cold direction. If they are not, each individual alarm is set to 10° C away from set point.If they are, no adjustment is required.
2. Warm and Cold Alarm set points may be set to a value 5° C away from set point in the corresponding warm orcold direction.

Non-Volatile Memory Usage

1. The UI Assembly/PCB restores all non-volatile set pointsfrom the Main System. The display shows blank information until the main supplies the parameter detail.
2. The following parameters are stored in Main System non-volatile memory. The UI ensures that the range andstep are appropriate when any of these parameters areadjusted via a screen, etc. A Restore System Defaults command resets these parameters to their default values.

Table 1. Parameters

Main Variables / Parameters	
Parameter	**Detail**
Set Point	Range: -50°C to -86°C Default: -80°C Step 1° C
Display Offset	Range: -10°C to +10°C Default: 0° C Step 1° C
Warm Alarm	Range: -40°C to (SP + 5°C) Default: -70° C Step: 1° C
Cold Alarm	Range: (SP -5° C) to -99° C Default: -90° C Step 1° C

Table 1. Parameters

Main Variables / Parameters	
Parameter	**Detail**
Time Delay	Range: 0.0 to 20.0 min Default: 0 min Step: 0.1 min Note: Rolls over at the limits
BUS Set Point	Range: 0 to -76° C (LN_2) and 0 to -65° C (CO_2) Default: -65° C (LN_2 and CO_2) Step: 1C
BUS Type	Range: LN_2 or CO_2 Default: LN_2
Mode	Normal Cycle/ Bottom Out

The following parameters are also stored in UI memory:

Table 2. UI/Display Variables/Parameters

Parameter	Detail
Date / Time	- (YYYY/MM/DD) US - Hour: 0 to 23 (24hr format) (step 1 hr) - Minutes: 0 to 59 (step 1 Min) Default: Last time saved from non-volatile. The factory will program prior to shipment.
Screen Intensity	10, 20, 30, 40, 50, 60, 70, 80, 90 and 100

Alarms

Audible Sound (Buzzer)

The following alarm sound is defined:

- Sound Level – 95 db @ 10 cm from the surface of buzzer.
- Frequency – Up to 3 K Hz with capability of interruptedtones.

Audible and Remote Alarm Contacts

The UI responds to alarm conditions as indicated from the main system. The following active alarms will activate the audible and remote alarms as follows:

Error Code	Description
E00	Undefined model
E01	Firmware Build Incompatible
E02	Control Probe Failure
E03	Heat Exchanger Probe Failure
E04	Power Failure
E05	Failure to Reach Setpoint
E06	BUS Battery - Low Voltage
E07	System Battery - Low Voltage
E08	Lost Communication Failure (Main to UI)
E09	Lost Communication Failure (BUS)
E10	Stuck Button
E11	Ambient Probe Failure
E12	System Battery Disconnected
E13	BUS Probe Failure
E14	BUS Battery Disconnected
F01	Unit in power failure and while trying to perform Software Upgrade. Not enough space to export data for Debug Logs. Files in TFS_FW are not there for the build .xml. Import configuration files not present to perform the import.
F03	Firmware incompatible when in Service USB mode (USB installed in UI). Once out of Service Mode & USB is removed the Error Code will go to E01.
F04	No space available on USB for general PUC or CSV configuration export.

Alarm Ring Back (Snooze)

- A muted active, audible alarm automatically rings back in10 minutes (default).
- A queued ring back automatically clears if the muted active alarm condition clears prior to the expiration of the10 minute timer and no additional active, audible capablealarm occurs prior to the original muted alarm clearing.
- A queued ring back remains if any active, audible capablealarm remains at the end of the default setting of
  10 minutes (it does not have to be the same active, audible alarm that was muted).

Figure 13. Alarm Ring Back (Snooze)

Warm Alarm

To test, press the plus (up arrow) and check mark buttons (square) simultaneously for 5 seconds to initiate the warm alarm test. During the warm alarm test, the actual cabinet temperature will not be displayed. The display temperature will increase. Once the display temperature reaches the warmalarm setpoint, the alarm is activated. After 5 seconds, the test will automatically end and the display will return to the actual cabinet temperature.

Figure 14. Warm Alarm Test

Home Screen

Figure 15. Home Screen

- The message panel on the top of the UI indicates the freezer health status and the various alarm or warningstates.
- Wrench – generic service warning corresponds to an intermittent flashing error code which is displayed on theUI.
- Door – illuminates when the door is open for morethan 3 minutes.
- Heart – health status for the freezer. A green heart indicates normal freezer operation. In an alarm state theheart icon will not be illuminated.
- Thermometer- indicates when cabinet exceeds either warm or cold alarm setpoint and an audible alarm will occur.
- Snooze Bell – only illuminated during an active alarm andhas been silenced by the user.
- Alarm Bell – indicates visual and audible alarm that accompanies various alarm states. Pressing the alarm bell while in the alarm state will silence the alarm for 10minutes
- The control panel consist of 4 touch-point buttonslocated on the right side of the display.
  - Plus – Increases the value of the selected setting.
  - Check Mark – Saves a change to the selected value.
  - Minus – Decreases the value of the selected setting.
  - Settings – Icon represents the various settingsincluding;
- Warm Alarm
- Cold Alarm
- Offset Value
- Setpoint Security

Backup System (BUS) SettingsScreen

To activate the backup system:

- Follow the instructions in **Setting Temperature SetPoints** to set temperature and alarm set points.
- Select the backup type and backup set point on the Backup Setting Screen which can be accessed throughthe Controls option in the Settings tab.
- Tap the Save button to save the changes made.

Operation: When the backup system is in operation, the parameters can be viewed and configured on the settingsscreen.

Once the backup system has been activated, it can be tested by pressing the Test button. The system will inject as long asthe button is being pressed.

The backup system can run for a minimum of 24 hours onbattery power.

On average, a backup system in operation uses 8 lbs. (3.6 Kg) to 10 lbs. (4.5 Kg) per hour of CO_2 or LN_2 at an ambient temperature of 25° C. This rate will vary depending on set point, load, ambient temperature and freezer size.

Screen Fields

Table 3. Screen Fields

Field	Min Value	Max Value	Default Value	Step
Backup Primary – LN_2	0	-76	-65	1
Backup Primary – CO_2	0	-65	-65	1

Service Screen

Figure 16. Service Screen

Entering the Service Mode

1. Press up & down arrow in together for 5 seconds.
2. Display will show “000”.
3. Enter Service Password of the day; only the 3 numericvalues.
    - If Service Mode is entered and the date/time are incorrect it will allow service personnel to update theUI to the current/correct date/time in the following format; yy, mm, dd, hr, min. At this time the Service Tech can transition from each setting using the checkmark and use the up and down arrow keys to change the values.
    - Time will be in 24-hour format.
4. “UEr” will be displayed, the UI is now in the ServiceMode.

- Once in the Service mode pressing the Check mark willenter the parameter settings and the Gear Icon will transition to the next parameter.

Parameter

- UEr - will show initially. Pressing check mark will show thefollowing using time delays (2 second transitions):

Note: None of these will flash as it can’t be changed).

- Build number (if NA it will show as ---). It will be a 3 digit number with first number is major and second two digits are minor. For example: 1.01 is 101.
- Kernel Version
- UI Version
- Main version
- Parameter table upper byte
- Parameter table lower byte

- EEr - will flash indicating it is a executable or changeableitem. When Check mark is pressed it will stop flashing and perform a restore to factory default.
- cYc - Cycle or Bottom Out Temp will show as flashing “cyc” or “bot”. When flashing pressing the “+” sign will change it to either of the modes and an enter will set it inthat mode. If changed press check mark to save.
- Tdy – Time delay restart. Pressing check mark will showtime delay value and it will start flashing indicating it can be changed. The first value will be minutes shown by flashing digits allowing user to chose from 1 to 20. Thenupon entering the minute value, it will show left digit with“s” and a value flashing from 00 to 60 allowing to set theseconds.
- Int - for intensity of display. It will show the current intensity and will have a value from 10 to 100 with increments of 10.

TC

Will allow service technician to see the live reading for any ofthe TC values and RAW RTD value. Pressing the “+” will advance to the next TC & then pressing the check mark display TC value. 01 -10 will be used to show TC1 through TC10.

00 is the Raw RTD temperature-Temperature of RTD withoutdisplay management applied.

- 01 = 1st stage suction temperature.
- 02 = Condenser air inlet temperature.
- 03 = Evaporator Inlet.
- 04 = Evaporator Outlet.
- 06 = 2nd stage suction temperature.
- 07 = Liquid Line.
- 08 = 1st stage compressor sump temperature.
- 09 = 2nd stage compressor sump temperature.
- 10 = Inter-stage Heat Exchanger temperature.
-

- Additional Evaporator (2nd stage) TC’s are available butnot monitored through the UI.

Figure 17. TC Values

rSr - Remote Serial

- Press check mark to enter into menu
- press plus + (up arrow) to advance through setting
- SFA - Smart Factory (factory use only)
- Bod - Modbus
- tCN - T-Command

Model Selection

The deciphering code example is as follows

- Where A is the voltage. Voltage can be either anA (115 V), D (208 V), V (230 V).
- 5 is thecontrol code for STP -86° C models.
- 0 is the size (0 is 300, 1 is 400, 2 is 500 and 3 is 600).

Regulatory Selection Codes

- Default value is R0 - Non Medical Device
- R1 value - Medical Device
- Heater mode (htr) - Adjust heater on %

IO – Diagnostic Test Mode

- All line voltage components will turn off when check markis pressed.
- Selection of “buc” buck, “bSt” boost, or “nor” normal shall be selected and will flash to allow the user to change. This will only be available if model is an A volt and not a D/V as those don’t have buck / boost. Oncecheck is pressed.
- FAn - will show on display solid for minimum of 10 seconds. Once 10 seconds expire the display will flash “FAn” allowing the service to transition to next state by clicking enter. Display will read 00, for one minute, this willallow the fan (1 condenser fan) and the HS compressor (1st stage) to start. Display will then read HS.

- HS - will show inter-stage Heat Exchanger temperature will flash alternately, allowing the user to transition to nextstate by pressing enter (check mark) which will bring on the LS compressor (2nd stage).
- LS – HX temperature will show solid for a period of 10seconds on display. Upon the delay expiring, “LS”, Inter-stage Heat Exchanger temperature and cabinet temperature will flash in rotation allowing the user to transition to next state by pressing enter (check mark).
- End - will show for 2 seconds then start flashing statingthe loads have been turned off and allowing the user toinitiate to the next state. The next state is end service which will reset the relay enclosure and start a count down of 45 seconds.
- If no activity for 30 minutes, the system will exit IO(diagnostic mode) and return to normal mode.

Note: The STP freezer is equipped with a door heater whichis operational 100% of the time.

Downloading Event Log andTemperature Logs

Steps to download temperature & event log data:

- Remove front display
- Loosen the top two screw & completely remove thebottom two screw holding UI in place.
- Carefully remove the UI from the door.
- Locate the USB ports on the UI board.
- Insert mini/ultra fit USB drive. The mini/ultra fit USB's must used due to restricted/limited space around theUSB ports.
- Enter the Service Password of the day, numeric valuesonly.
- Display flashes 00, using the + button, enter 02 if PUC files are needed or 03 if .CSV files are needed, then pressthe check mark. Enter 06 if Debug files are needed/ requested for troubleshooting.
- Enter 07 if Custom PUC is needed. Begin with entering year, example 2020 would be F20, then enter month, example March would be F03. Next select ending year, example 2020 would be T20 and ending month, exampleApril would be T04. "F" indicates the year and month from the beginning data points and "T" is to the end pointof the data.
- Enter 08 if Custom .CSV file is needed. Begin with entering year, example 2020 would be F20, then enter month, example March would be F03. Next select endingyear, example 2020 would be T20 and ending month, example April would be T04. "F" indicates the year and month from the beginning data points and "T" is to the end point of the data.
- Display will read 000 and then begin the 6 month download of the temperature & event logs in a PUC orCSV format, which ever was chosen in step 7. UI will automatically download 6 months.
- When completed the UI will flash 00, at this point you canremove the USB and reinstall the UI.

Figure 18. Event Log and Temperature Logs

Figure 19. Event Log and Temperature Logs

Software Update

Performing Software Update:

- Remove front display bezel.
- Loosen the top two screw & completely remove the bottom two screw holding UI in place.
- Carefully remove the UI from the door.
- Locate the USB ports on the UI board.
- Insert mini/ultra-fit USB drive loaded with Software Update files. The files can be downloaded from the Knowledge base as done previously with other ULTSeries freezers.
- The zip file should be extracted to the root of the USB, aspreviously done with other ULT Series freezers when upgrading software.
- Enter the Service Password of the day, numeric valuesonly.
- Display flashes 00, using the + button, enter 01, then press the check mark. At this point the UI will begin thetwo-step software update.
- After step one of the upgrade the system will rebootshowing "HIC" on the UI.
- Step two of upgrade will automatically begin, this step willtake approximately 10 mins to complete. Once completed the UI will begin a 45 second countdown to the second reboot of the system.
- When completed the UI will show "Ser" & 000, at this point you can remove the USB and reinstall the UI. Thesoftware upgrade is now complete.

Note: If the UI assemblies or the RE enclosure the correct model number will need to be selected (example A30) before software can be performed.

Routine Maintenance

CAUTION: De-energize all potential sources of energy tounit. Before cleaning the refrigeration system, lockout / tag-out de-energized control per OSHA Regulation.

Cleaning the Refrigeration System

Clean the condenser at least twice a year, depending on environmental conditions. The condenser is located behind the front grille. Use a vacuum or air hose to clean the fins of the condenser. Dust on the condenser fins slows the rate of heat dissipation and increases the operating temperature of the compressors (thereby decreasing their effective lives). A dirty condenser will reduce the overall performance of the refrigeration system in terms of recovery time and set point control accuracy; or may ultimately cause compressor failure.

The air filter should be cleaned or replaced twice a year depending on the environmental conditions. The filter is located behind the front grille. It can be replaced or washed using water and a mild detergent and then pressed betweentwo towels to dry.

Periodically clean any accumulated dirt from the compressorhousings and other refrigeration system parts. Compressorsand fan motors are permanently lubricated and do not requiremaintenance.

Freezer Unit Maintenance

Regularly remove the frost from the door gasket with a soft cloth. When the door is opened, the difference between the freezer's internal air and room ambient creates a very soft frost on the gasket of the door and the cabinet. If the door isclosed without removing the soft frost, on the next opening the soft frost melts and then turns to ice after the door is closed again. If this continues, ice builds up and that could keep the door from closing properly. Do not damage door gasket when removing frost.

Periodically check gaskets for punctures or tears. Leaks are indicated by a streak of frost at the point of gasket failure.

Replace the battery every two years for a consistent and dependable charge. Ensure to turn the unit off and disconnect it from the power source before attempting to replace the battery. If the freezer is not to be used for an extended length of time, the battery should be disconnected.

Defrost Chamber

The frost formed in the chamber is generally very soft and may be easily removed with a soft cloth. Do not use any typeof abrasive brushes. A complete defrosting may occasionallybe required (once a year or whenever ice buildup
reaches 3/8").

To completely defrost the chamber, follow the procedure below:

- Remove the product and place it in another freezer.
- Disconnect the freezer from the power source.
- Allow the freezer to stand with all doors open for at least 24 hours so that the interior and the foamed refrigeration system are warmed to ambient.
- Place towels on the cabinet floor. Keep the floor of thecabinet clear by removing water as it accumulates.
- Allow frost to melt and become loose from the interiorcabinet.
- To remove any odor, the interior can be washed with a solution of baking soda and warm water. The exterior canbe cleaned with any common household cleaning solution.
- After defrosting is complete, wipe interior chamber andgasket dry with a clean, dry and soft cloth.

Check Vacuum Entry Port

Visually inspect the Vacuum Entry Port weekly for frost. The Vacuum Entry Port is located in the door liner. Remove any frost with a soft bristle brush. The Vacuum Relief Assembly islocated in the door behind the UI and should only be servicedby a qualified service professional.

Door

Follow the steps below to adjust the hinges of a HC Ultra LowTemperature freezer:

1. Ensure the freezer cabinet is level from front to back andfrom left to right.
2. Install a bar clamps with 2" x 4" wooden blocks as shownin the photo below or the ratchet strap.

Figure 20. Door Adjustment 1

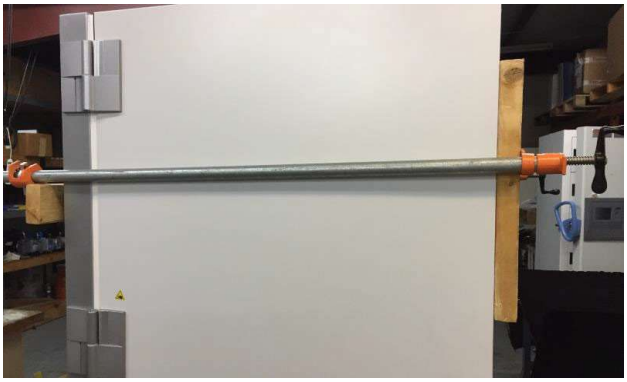


Figure 21. Door Adjustment 2

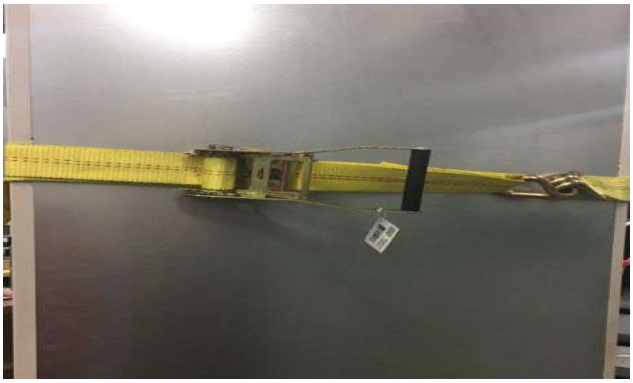


Figure 22. Door Adjustment 3

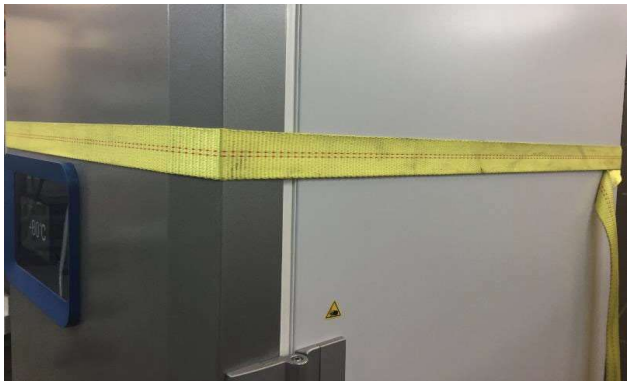


Figure 23. Door Adjustment 4

3. Loosen the mounting screws that hold the hinge to thedoor.

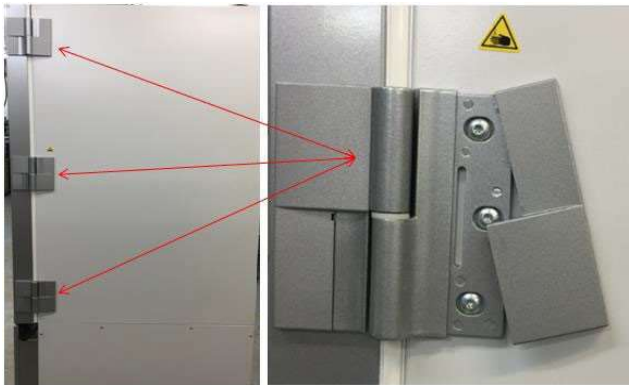


Figure 24. Door Adjustment 5

4. Align the door so that the top and latch edges are flushwith the cabinet.
5. Tighten the bar clamp, or ratchet strap to produce asecure gasket seal.

Sequence of Operation

Initial (Normal) Start-Up Sequence of Operation

1. Turn on power switch.
2. Condenser fan will start in low speed unless the ambientis higher than 25° C where the fan will run at high speed.
3. 1st stage compressor will energize and the micro board will monitor time and temperature of the heat exchange box.
4. The UI will initialize in approximately 30 seconds and await setup instructions while monitoring temperatureand run conditions.
5. After 10 minutes, if the heat exchange sensor has reached -35° C, the second stage compressor will start
6. If the heat exchange temperature does not reach -35° Cafter 5 minutes but colder than -25° C, the second stagecompressor will start.
7. When the second stage compressor starts the system will continue to run until the set point is reached and minimum on-time of 11 minutes from the second stagestarting has elapsed, at this point the system will cycle off.

Normal Cycling Sequence

1. When the control system senses a need for cooling the condenser fan will energize at low speed unless the ambient is higher than 25° C where the fan will run at highspeed.
2. After 10 seconds the 1st stage compressor will energizeand the control system will monitor time and the heat exchange box temperature.
3. After 90 seconds, if the heat exchange sensor hasreached -35° C, the second stage compressor willenergize.
4. If the heat exchange temperature does not reach -35° Cafter 5 minutes but colder than -25° C, the second stagecompressor will start.
5. When the second stage compressor starts the system will continue to run until the set point is reached and minimum on-time of 11 minutes from the second stagestarting has elapsed, at this point the system will cycle off.

Control Sensor Failure Sequence (E02)

1. When the control system senses a failed cabinet sensor itwill set an alarm in the UI, energize the remote alarm contacts, and go to 100% run mode.
2. The normal cycling sequence of operation will start.

Since the cabinet temperature cannot be monitored the system will continue to run 100% until the fault is corrected.

Heat Exchange Sensor Failure Sequence (E03)

1. When the control system senses a failed heat exchange sensor, it will set an alarm in the UI, but the remote alarm contacts will not change state.
2. When there is a call for cooling, the Normal Cycle Sequence of operation will be followed with the followingchange:
   a. After the first stage compressor has run for 5 minutesthe second stage compressor will energize.
   b. When the second stage compressor starts the system will continue to run until the set point isreached, at this point the system will cycle off.
3. This sequence of operation will continue until the heatexchange sensor fault is corrected.

Power Failure Sequence (E04)

In the event of a power failure User Interface will enter into “power down sequence” stating “Off, yes, or no” in the LCD.If the power failure last greater than 2 minutes the User Interface will sound the audible alarm, illuminate the alarm belland service wrench icons and show E04.

The audible alarm will sound and the remote alarm will be activated.

The power failure will be entered in the Event Log and theevent text will include the current system voltage and timedelay setting.

CAUTION: Do not press the shutdown button because ashutdown will disable the backup system.

Wait for power to be restored to the freezer and consult the event log for information concerning the power outage.

Troubleshooting

Troubleshooting and diagnostic analysis are generally considered the most challenging parts of the service profession. The information covered in this section of the manual is for trained and experienced cascade service personnel who are already familiar with good diagnostic practices and have the proper tools and test equipment to carry it out.

The following events are recorded and can be downloaded through the USB port as a PUC file or .CSV file:

- Event Log Types are used to classify an event log entryfor use by the fast filters.
    - Alarm, Battery, BUS, Door.
- Intelligent Text Entries:
    - All entries must reflect the Event Name as well as theEvent Field – Intelligent Text Detail requirements.

Event Log Entry

Table 4. Event Log Entry

Event Log Entry Detail		
Event Name	Event Type/Icon	Event Field – Intelligent Text Detail
BUS Battery Low	Alarm + BUS + Battery	System battery below the voltage threshold below 11 V DC.
Cold Alarm Active	Alarm	The event text includes the primary RTD temperature that first caused the alarm as communicated via the Main when the alarm is first sensed, cabinet set point and the status of each compressor (on/off).
Door Ajar	Alarm + Door	The event text includes door open greater than 3 minutes.
Extreme Ambient	Alarm	The event text includes the condenser air condenser air inlet temperature.
Power Failure Active	Alarm	The event text includes the current system voltage and time delay setting.
Power Failure recovered	Alarm	Power has been restored.
System Battery Low	Alarm + Battery	System battery below the voltage threshold.
UI/Main Lost Communications	Alarm	The event text includes the last valid RTD temperature.
Warm Alarm Active	Alarm	The event text includes the primary RTD temperature that first caused the alarm as communicated via the Main when the alarm is first sensed, cabinet set point and the status of each compressor (on/off).
Warm Alarm Recovered	Alarm	Warm Alarm recovered, freezer temperature has recovered from event.
BUS Set point Setting Change	User + BUS	The event text includes the user who made the change (secure mode only) and the to/from BUS set point.
BUS Type Change	User + BUS	The event text includes the user who made the change (secure mode only) and the to/from BUS type.
Cold Alarm Setting Change	User	The event text includes the user who made the change (secure mode only) and the to/from cold alarm set point.
Door Closed	Door	The event text includes the open duration.
Event Log Roll-over	General	The event text indicates the earliest date remaining in the event log.
Event Log Roll-over Warning	General	The event text estimates the number of events left.
Firmware Upgrade (Main / UI)	User	The event text includes the to / from version information.
Offset Setting Change	User	The event text includes the to / from offset.
Power Down	User	The event text includes date / time of the power down.
Set Point Setting Change	User	The event text includes the to / from set point.

Table 4. Event Log Entry

Event Log Entry Detail		
Event Name	Event Type/Icon	Event Field – Intelligent Text Detail
Temperature Log Roll-over	General	The event text estimates the number of temperature records left.
Temperature Log Roll-over Warning	General	The event text indicate if the log-off was a time out.
Voltage/Frequency Mismatch	General	The event text includes the measured voltage and frequency.
Warm Alarm Setting Change	User	The event text includes the to/from warm alarm set point.

The event log records any text included in the record based on the current Regional Settings language selection at the time of the event entry. Date/Time stamps will always be of the following format: MM-DD-YYYY 23:59:59 to facilitate sorting (note thatthe screen will display the date based on Regional Settings).

Boost Test

- Allow each boost state to be selected.
- Measure the line input voltage and the compensatedvoltage after making the mode change.

Boost transformers are called external transformers since they are external to the I/O Board are placed in the bottom side of the relay enclosure. The incoming AC voltage is routedto primary side of these transformers through the I/O Board. The secondary voltage from the external transformer(s) is theneither added in Phase for Boost or not used for Normal inputbased on the necessary mode of voltage operation needed for the compressors.

Table 5. Boost Test

	Buck-Boost Threshold			
	Boost In Out	Boost out	Buck In	Buck
115 V AC / 60 Hz	105	110	125	120

- Remote Alarm:
- The output of the remote alarm contacts can be checked / verified at the J2 connection of the Main Boardlocated on the end of the relay enclosure at the rear of the unit. The remote alarm contacts are pins 5, 6, and 7 of the J2 connector. Pin 5 is the Normally Closed contact,Pin 6 is Common, and Pin 7 is the normally open contact.Continuity can be checked from common to either the normally open or the normally closed contact to ensure the remote alarms contact state switches position duringan alarm occurrence.
- Sensor Readout:
- Show all TCs in dd.d C format update.
- Show all voltages in ddd.d V format.
- This sub-screen updates at least every 10 seconds(per sensor) to view current performance values.
- If the Cabinet RTD sensor reads out of range it can be checking the ohm value of the sensor and comparing thevalue to the 1000 ohm temperature vs. resistance scale provided in 1000 ohm RTD Resistance versus Temperature.
- If the Type “T” thermocouple sensors read out of range they can be verified by locating the appropriate sensor atthe J14 connector of the main board, which is located atthe rear of the relay enclosure box and checking the thermocouple using a type “T” temperature meter. See Temperature Sensors.
- Relay Enclosure Diagnostic LEDs.
- The Relay Enclosure Indicator LEDs are located on theside of the relay enclosure nearest the rear of the The LEDs are visible from the rear of the unit and do notrequire any panels to be removed for viewing. These indicators can help to troubleshoot possible issues occurring with the unit by visually providing the components' operating status. The Red indicators will show the compressor high pressure cut out status of both the first and second stage compressors along withthe status of the boost or normal electrical power beingsupplied to the unit. The Green LEDs show the status of the Fan, Comp 1 or Hi stage, Comp 2 or Low stage status as shown in the diagram below:

Figure 25. LED Indication

LED 1: Indicates Power is On

LED 2: Fan Power, On indicates fan in low speed, Offindicates fan is in high speed

LED 3: 1st Compressor on when illuminated

LED 4: 2nd Compressor on when illuminated

LED 5: Normal Power

LED 6: Boost

TransformerLED 7:

Normal Power

Note: LED’s 5, 6 & 7 will be on 115 V Models only, as 230 V Models do not have a Boost system.

Compressor Testing For Single Speed

This test presumes the compressor would not run during the Special UI Test Mode procedure, and that the High Voltage PCB was not the fault.

- Use a DMM to first check for opens and shorts at the compressor terminals. Be sure to disconnect the compressor wiring before testing to prevent back-feedingthrough a connected component.
- If the compressor shows normal internal Ohm readings and no shorts to ground, use a dedicated compressor testing device such as a hermetic analyzer or a “start cord” to see if the compressor will start and run. If possible, use the same power supply or receptacle that powers the freezer and look for a voltage drop during thetest. Even though the correct voltage may be measured at the wall outlet with a DMM, the inrush amperage of a compressor startup can draw the voltage so low that thecompressor has inadequate power and will not start and

may cause breakers to trip, or a related malfunction. A voltage drop of more than 10% below normal line should be corrected if the freezer is to operate properly for its expected life. Never leave a compressor running formore than a minute when conducting this test. See the note below regarding second stage compressor testing.

If the compressor will run using a compressor testing device, but will not run during the UI Test Mode or High Voltage PCB test, then one of the following is true:

- The High Voltage PCB has a fault and must be replaced.
- The wiring or connectors between the compressor andthe High Voltage PCB have a fault. Check for opens, shorts, or bad connections, and correct.

CAUTION: Due to the high pressure refrigerant used in the second stage, special care must be taken when testing this compressor. An otherwise good compressor may not start—or may cut out on overload—if started under high pressure. The system is designed to allow the second stage to start only after the first stage has cooled the interstage heatexchanger to < -30° C. There is usually no reason to test thesecond stage unless the first stage is already operating and cooling properly, so run the first stage for 5 minutes or until the internal heat exchange thermocouple is colder than
-30° C before starting the second stage compressor. Even then, do not run the second stage for longer than it takes to determine it will start and run.

Condenser Fan

This fan is powered from I/O PCB at connector J2. The condenser sensors are the two black wires connected to J2.

The two black wires and a green ground wire are the only three wires connected to J2. Test the fan first using the UIService Test

Troubleshooting the Printed Circuit Boards

The Main Board controls the basic functionality of the ULT.

- Implements multiple temperature sensor determinationcircuits.
- Provides control driving signals for the I/O board controlcircuit.
- Communicates status and logged information to theDisplay Assembly.
- Operates an external RS485 communication port to theuser.
- Operates and monitors correct operation of the ULTcompartment temperature via the I/O driving signals operating the unit compressors.
- Determines ULT operational conditions by evaluating thesensor inputs.
- Operates a Main and Backup System battery chargingand Battery Health monitoring circuit.
- Controls remote alarm activation, door switch positionmonitoring, and perimeter heater control.
- Outputs optional chart recorder information via 4-20 machart recorder circuits.

The Main Board is mounted inside an enclosure called theRelay Enclosure. Associated to the Main Board in the enclosure are the I/O Board, Voltage Compensation Transformer(s), a Switch Mode Power Supply and a circuitbreaker type OFF/ON switch.

The I/O board is mounted inside an enclosure called the RelayEnclosure. Associated to the I/O board in the enclosure are the Main Board, Voltage Compensation Transformers, a Switch Mode Power Supply and a circuit breaker type OFF/ON switch.

Additional functions of the I/O Boards are to provide advanced notice of loss of DC power through a decaying voltage detection system, provide direct feedback of compressor relay ON and OFF activity for advanced voltagephase application of relay activation and deactivation points,AC line voltage level detection, Zero Cross Detection, Line frequency detection, Mullion Heater and System Fan activation and deactivation.

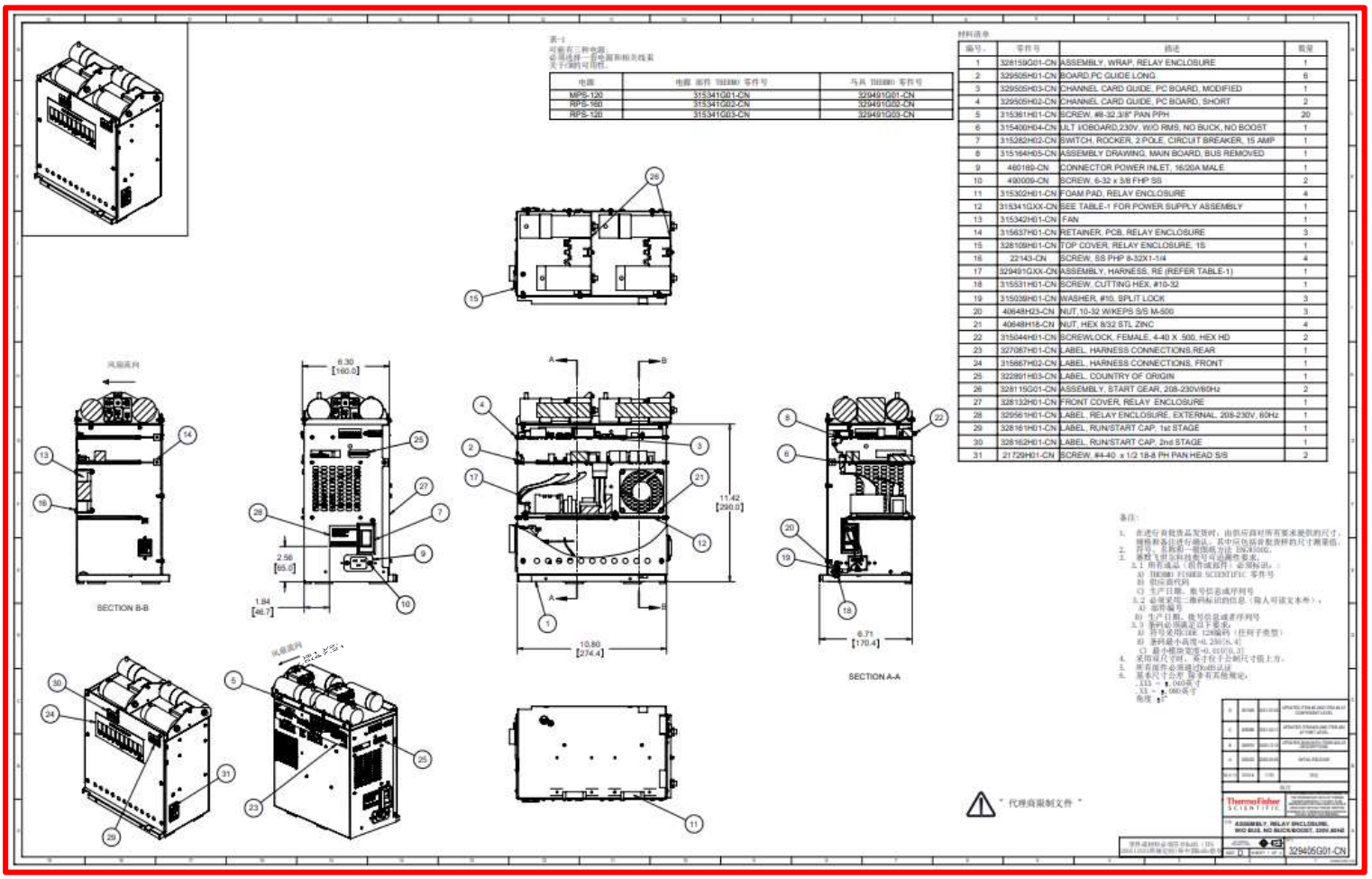
The signals and voltages needed to make the outlined functional operate are routed to/from the Main PCB processor via a Main to I/O board interconnect cable. Drive activation voltages are routed to the I/O board for execution by the I/O board.

All informational voltages and signals are returned to the Main PCB as feedback on a continuous basis to allow continuousupdating to the primary functions of compressor control andcompressor voltage optimization.

Testing Control Voltage /Electronic Components

See **Appendices** for Diagrams.

Relay Enclosure Component



编号	零件号	描述	数量
1	328159G01-CN	ASSEMBLY, WRAP, RELAY ENCLOSURE	1
2	329505H01-CN	BOARD,PC GUIDE LONG	6
3	329505H03-CN	CHANNEL CARD GUIDE, PC BOARD, MODIFIED	1
4	329505H02-CN	CHANNEL CARD GUIDE, PC BOARD, SHORT	2
5	315361H01-CN	SCREW, #8-32 3/8" PAN PPH	20
6	315400H04-CN	ULT I/OBOARD,230V, W/O RMS, NO BUCK, NO BOOST	1
7	315282H02-CN	SWITCH, ROCKER, 2 POLE, CIRCUIT BREAKER, 15 AMP	1
8	315164H05-CN	ASSEMBLY DRAWING, MAIN BOARD, BUS REMOVED	1
9	460189-CN	CONNECTOR POWER INLET, 16/20A MALE	1
10	490009-CN	SCREW, 6-32 x 3/8 FHP SS	2
11	315302H01-CN	FOAM PAD, RELAY ENCLOSURE	4
12	315341GXX-CN	SEE TABLE-1 FOR POWER SUPPLY ASSEMBLY	1
13	315342H01-CN	FAN	1
14	315637H01-CN	RETAINER, PCB, RELAY ENCLOSURE	3
15	328109H01-CN	TOP COVER, RELAY ENCLOSURE, 1S	1
16	22143-CN	SCREW, SS PHP 8-32X1-1/4	4
17	329491GXX-CN	ASSEMBLY, HARNESS, RE (REFER TABLE-1)	1
18	315531H01-CN	SCREW, CUTTING HEX, #10-32	1
19	315039H01-CN	WASHER, #10, SPLIT LOCK	3
20	40848H23-CN	NUT,10-32 W/KEPS S/S M-500	3
21	40848H18-CN	NUT, HEX 8/32 STL ZINC	4
22	315044H01-CN	SCREWLOCK, FEMALE, 4-40 X .500, HEX HD	2
23	327087H01-CN	LABEL, HARNESS CONNECTIONS,REAR	1
24	315867H02-CN	LABEL, HARNESS CONNECTIONS, FRONT	1
25	322891H03-CN	LABEL, COUNTRY OF ORIGIN	1
26	328115G01-CN	ASSEMBLY, START GEAR, 208-230V/60Hz	2
27	328132H01-CN	FRONT COVER, RELAY ENCLOSURE	1
28	329561H01-CN	LABEL, RELAY ENCLOSURE, EXTERNAL, 208-230V, 60Hz	1
29	328161H01-CN	LABEL, RUN/START CAP, 1st STAGE	1
30	328162H01-CN	LABEL, RUN/START CAP, 2nd STAGE	1
31	21729H01-CN	SCREW, #4-40 x 1/2 18-8 PH PAN HEAD S/S	2

Figure 26. Relay Enclosure

I/O Circuit

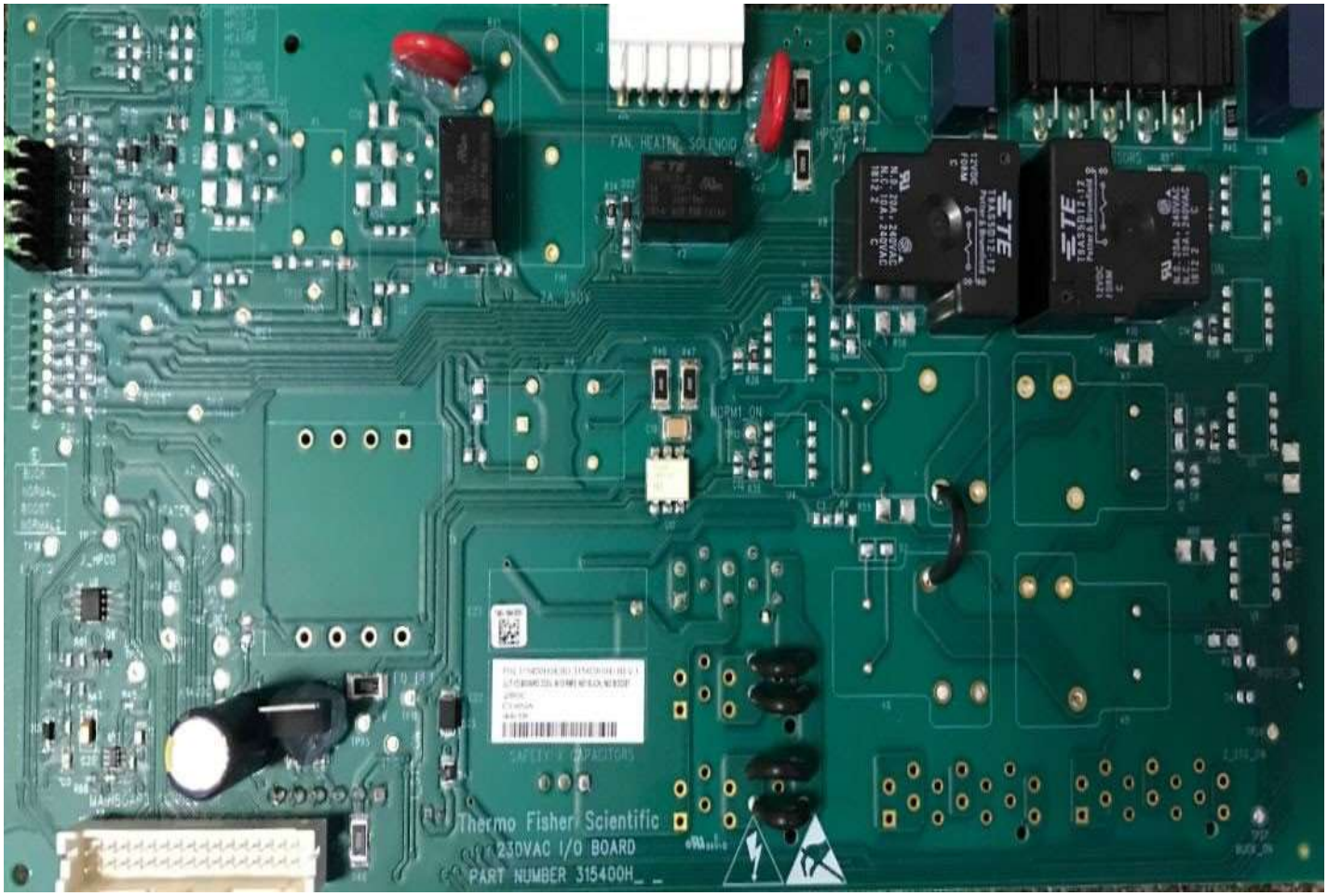


Figure 27. I/O Circuit Board

The I/O board accepts and routes the Mains AC voltages the compressors and fan. The main power connection to the entire ULT is routed through this board.

All informational voltages and signals are returned to the Main PCB as feedback on a continuous basis to allow continuousupdating to the primary functions of compressor control andcompressor voltage optimization.

Table 6. J3 Compressor Connector Grouped into 1 Connector

Pin #	Type	Connections
1A,1B	AC	Second Stage Line
2A,2B	AC	Second Stage Common
3A,3B	AC	Earth
4A,4B	AC	First Stage Common
5A,5B	AC	First Stage Line

Table 7. J2 Fan, Heater connections

Pin #	Type	Connections
1	AC	L1 Fan
2		Not used
3	AC	L1 Heater
4	AC	Not Used
5	AC	Not Used
6	Gnd	Earth
7	AC	LINE 2
8	AC	LINE 2
9	AC	LINE 2
10	AC	LINE 2
11	Gnd	Earth
12	Gnd	Earth

Table 8. P6 Mains Power IN Connector

Pin #	Type	Connections
1	AC	L1
2		NC
3	AC	L2

Table 9. P1 DC Power Connector from the External Power Module

Pin #	Type	Connections
1	DC Pwr	+14 V DC
2	DC Pwr	+14 V DC
3	DC Pwr	+14 V DC
4	DC GND	GND
5	DC GND	GND
6	DC GND	GND

Table 10. Primary Transformer connectors for 115 V systems

Pin #	Type	Connections
1	AC	Transformer_Pri_1 (Black)
2		No Connection
3	AC	Transformer_Pri_2 (White)
4		No Connection
5	AC	Transformer_Pri_5 (Black)
6		No Connection
7	AC	Transformer_Pri_6 (White)
8		No Connection

Table 11. Power Supply Board AC Output to the I/O Board

Pin #	Type	Connections
1	AC	LINE 2
2		No Connection
3	GND	Earth
4		No Connection
5	AC	LINE 1

Table 12. P7 Relay Enclosure DC Cooling Fan Connectors

Pin #	Type	Connections
1	DC Pwr	+12 V DC (Voltageacross Fan)
2	DC Gnd	GND

Table 13. P2 I/O Board - Main Board Connector

Pin #	Type	Connections
1	DC Pwr	+14 V DC
2	0-14 V DC	First Stage Compressor Drive
3	DC Pwr	+14 V DC
4	0-14 V DC	Second Stage Compressor Drive
5	DC Pwr	+14 V DC
6	TTL	Line Voltage Select
7	DC Pwr	+14 V DC
8	0-14 V DC	Tank Solenoid Drive
9		No Connection
10	0-14 V DC	Split Door Heater Drive
11	TTL	Wiggler Signal
12	0-14 V DC	Condenser Fan / S drive
13	DC Pwr	5 V
14	0-14 V DC	Buck Mode Drive
15		No Connection
16	0-14 V DC	Boost Mode Drive
17	TTL	Line Frequency / Zero Crossing Input
18	0-14 V DC	Normal Mode Drive_1
19	Analogue 5 V level	RMS Voltage Detect
20	0-14 V DC	Normal Mode Drive_2
21	TTL	First Stage Compressor Pressure Detection
22	TTL	Boost Relay on Detection
23	TTL	Second Stage Compressor Pressure Detection
24	TTL	Buck Relay on Detection
25		No Connection
26	TTL	Normal 1 Relay on Detection
27	Gnd	GND
28	TTL	Normal 2 Relay on Detection
29	Gnd	GND

Table 13. P2 I/O Board - Main Board Connector

Pin #	Type	Connections
30	TTL	First Stage Compressor Relay on Detection
31	Gnd	GND
32	TTL	Second Stage Compressor Relay on Detection
33	Gnd	GND
34	Analogue TTL Levels	115 / 230 V Detection

Power Supply Cooling Fan

This 12 V DC fan is connected to P7 on the I/O printed circuitboard. It should energize when the power switch/breaker is turned on. To verify board output to the fan harness check toensure the board is putting out approximately 12 V DC. If voltage is present and the cooling fan is not operational, replace the fan.

Main Circuit Board

The Main PCB is usually suspect when there is an error in thenormal sequence of operation, sensor readings, alarm response and error codes, or UI display. Refer to the electricalladder diagrams behind the manual for proper connections tothe micro PCB.

Note: If Main board is defective the whole Relay enclosure must be replaced and software upgrade performed.

Table 14. J8 Main Board to I/O Board Connector

Pin #	Type	Signal
1	Pwr	GND
2	TTL	115_230_DETECT
3	Pwr	GND
4	TTL	2ND_STAGE_ON
5	Pwr	GND
6	TTL	1ST_STAGE_ON
7	Pwr	GND
8	TTL	NORMAL2_ON

Table 14. J8 Main Board to I/O Board Connector

Pin #	Type	Signal
9		NC
10	TTL	NORMAL1_ON
11	TTL	2ND_STAGE_PRESSURE_OK
12	14 V / 0	BUCK_ON
13	TTL	1ST_STAGE_PRESSURE_OK
14	14V / 0	BOOST_ON
15	Analogue	RMS_VOLTAGE_DETECT
16	14V/0	NORMAL2
17	TTL	FREQUENCY_DETECT
18	14 V / 0	NORMAL1
19		NC
20	14 V / 0	BOOST
21	Analogue	AC_DETECT
22	14 V / 0	BUCK
23	TTL	WIGGLER
24	14 V / 0	FAN
25		NC
26	14 V / 0	HEATER
27	Pwr	14 V
28	14 V / 0	TANK_SOLENOID
29	Pwr	14 V
30	Analogue	COMPENSATED_OR_RAW_VOL
31	Pwr	14 V
32	14 V / 0	2ND_STAGE
33	Pwr	14 V
34	14 V / 0	1ST_STAGE

Table 15. J9 Main Board to Display Board Connector

Pin #	Signal	Pin #	Type	Signal	Pin #	Signal
1	14 V_UNREG	6		NC	11	NC
2	14 V_UNREG	7	TTL	RMT_ALARM_DISP	12	NC

Table 15. J9 Main Board to Display Board Connector

Pin #	Signal	Pin #	Type	Signal	Pin #	Signal
3	14 V_UNREG	8		NC	13	GND
4	14 V_HEATER	9	TTL	RS-485_A	14	GND
5	14 V_HEATER	10	TTL	RS-485_B	15	GND

Table 16. J18 Cabinet Main Cavity RTD Connector

Pin #	Type	Connections
1	Analogue	Precision Voltage / Constant Current
2	Analogue	Measurement
3	Analogue	Measurement
4	Analogue	GND

Table 17. J19 Optional RTD Connector

Pin #	Type	Connections
1	Analogue	Precision Voltage / Constant Current
2	Analogue	Measurement
3	Analogue	Measurement
4	Analogue	GND

Thermocouples – See **Temperature Sensors** of this manual.

Table 18. Backup System Connector

Pin #	Type	Signal	Pin #	Type	Signal
1	Analogue	PROBE_P	4	Analogue	PROBE_N
2	TTL	Tank Pressure	5	TTL	Tank Pressure
3	PWR	12 V_BUS (SOL OUT)	6	PWR	SOL_RTN

Table 19. J2 Remote Alarm Connector

Pin #	Type	Signal
1	Analogue Instrument 0-5 V	IOUT (4 mA- to -20 mA Analogue Output)
2		GND
3		NC
4		NC

Table 19. J2 Remote Alarm Connector

Pin #	Type	Signal
5	User Selected	NORM_CLOSE (Relay)
6	User Selected	COM (Relay)
7	User Selected	NORM_OPEN (Relay)

Table 20. J6 RS-485/232 External Communications Connector

Pin #	Type	Connections
2	TTL	TX
3	TTL	RX
5	PWR	DC Ground

Table 21. J3 Main Battery Connector

Pin #	Connections
1	+12 V
2	Return

Table 22. J4 Backup Battery Connector

Pin #	Connections
1	+12 V
2	Return

Table 23. J12 External Chart Recorder

Pin #	Connections
1	+14 V
2	Return

Table 24. J1 Perimeter Heater Connector

Pin #	Connections
1	+14 V
2	Return

Table 25. J16 Door Switch Connector

Pin #	Type	Connections
1	Logic	+3.3 V
2	Pwr	Return

Pin #	Type	Connections
1	Logic	+3.3 V
2	PWR	Return

Table 26. J11 Back UP System Programming Header

Pin #	Type	Connections
1	TTL	Master Clear
2	PWR	+5 V DC
3	PWR	DC Ground
4	TTL	Serial Data
5	TTL	Serial Clock
6	TTL	Internal

Table 27. Back UP System Control Connector

Pin #	Type	Connections
1	Analogue	RTD Probe +
2	Analogue	RTD Probe -
3	TTL	Reserve 1 (Pressure +)

Temperature

The touch screen freezer comes standard with 1 control/display RTD (1000 ohm), type-T thermocouples. Theoptional chart recorder RTD is 100 ohm.

Sensors should be tested at their typical operating temperatures for most reliable results, due to the influence ofexpansion and contraction. A sensor at room temperature may indicate proper operation, but then fail at very cold temperatures due to metal contraction. The TCs have the same plug configuration and can be plugged into any of the nine TC connections at J14 on the micro board. See Table 28for the correct TC location and colors.

Test the RTDs by measuring resistance at the connector andcomparing the resistance reading against the appropriate RTD chart in **Conversion and Reference Tables*** of this manual. Read the TCs using a type-T thermocouple meter. The cabinet sensor can be read from the main UI home screen. All the TCs can be read on the UI Sensor Summary screen.

Table 28. Temperature Sensors

Sensor	Location	Type	Main Board Location	Wire Color	Part Number
RTD	Back wall, Inside cabinet	RTD, 1000Ω, Red/White	J18	Red / White	315206H01-CN
TC #1	1st Stage Suction	TC, Type T, Stranded	J14	Brown	315204H01-CN
TC #2	Condenser Air Inlet	TC, Type T, Stranded	J14	Red	315204H02-CN
TC #3	Evaporator Inlet	TC, Type T, Stranded	J14	Orange	315204H03-CN
TC #4	Evaporator Outlet	TC, Type T, Stranded	J14	Yellow	315204H04-CN
TC #6	2nd Stage Suction	TC, Type T, Stranded	J14	Blue	315204H06-CN
TC #7	Liquid Line	TC, Type T, Stranded	J14	Violet	315204H07-CN
TC #8	1st Stage Compressor Sump	TC, Type T, Stranded	J14	Grey	315204H12-CN
TC #9	2nd Stage Compressor Sump	TC, Type T, Stranded	J14	White	315204H09-CN
TC #10	BPHX	TC, Type T, Stranded	J14	Black	315204H10-CN

Manifold Gauge Diagnostic Procedures in this

Using Built-In Thermocouples

All Touch Screen ultra-low temperature freezers are built withthermocouples (TCs) attached at strategic points inside the refrigeration system to aid in monitoring and diagnosing system performance without having to attach manifold gauges. The attachment of a manifold gauge set allows for possible loss of critical charge, entry of contaminants, and leaks. Attaching gauges is the final refrigeration diagnostic procedure, and is covered in Manifold Gauge Diagnostic Procedures, of this manual. This section deals with the identification of TCs and how to utilize them for diagnostic purposes to see if manifold gauges are needed.

TCs should be read with unit at a stable constant temperature, achieved in 100% run mode. To enter the 100%Run Mode.

Note: There are different types of thermocouples (TCs) for different applications and temperature ranges. The “T” type ismost accurate for cryogenic temperatures. Thermometers built for, or set to read, other types of thermocouples will giveyou an incorrect temperature reading when connected to a T-type TC. The most common misconception is that a “K” type thermometer will work “close enough”. This appears to be true at typical ambient room temperatures. Both K and T thermometer settings will read within 1 degree of each other at temperatures in the low 70s F. But a T-type thermocouple at -150°C will show -137°C on a K-type meter. As the temperature gets colder, the error gets larger. The major determining factor in refrigeration diagnostics is the verified cabinet temperature. If the cabinet will achieve and maintain the design temperature, it is unlikely there is a problem with the refrigeration system.

Due to the thermodynamic interdependency (heat transfer) between the first and second stages, it is possible for a performance problem with one stage to act like a performance problem with the other stage. Proper understanding and use of the thermocouples should allow accurate diagnosis of the location of the actual problem.

The first and second stages of a cascade system work as a team to remove heat from the freezer chamber's interior space. The second or Low Stage system extracts heat from the cabinet interior, and dumps that heat onto the first or HighStage system in the interstage heat exchanger. The first or High Stage then carries that heat to the fan-cooled condensercoil where the heat gets dumped into the room air. The second stage is totally dependent on a properly working firststage before the second stage can perform its job. Therefore,the first stage must always be diagnosed first, and repaired ifnecessary, before the second stage can be diagnosed.

The reverse is not true. The first stage may run just fine without the second stage, since without the second stage operating, the first stage has no heat load to carry. In fact, aweak first stage may appear to be running OK, until the

Note: TC 3 and 4 second stage evaporator inlet and stage. The result is that an inefficient first stage will overburden the second stage, making it appear that the second stage is having the problem.

A good understanding of the working relationship between the first and second stages is necessary to apply the thermocouple diagnostic procedures that follow.

First (High) Stage Efficiency Test

From the service screen enable only the first stage compressor, this will allow the first (High) stage to operate alone, without the second (Low) stage system running. TC #10, Heat Exchange Box thermocouple, should reach -35° Cto -45° C within ten minutes. If the heat exchange box thermocouple cannot achieve this temperature range within ten minutes, then suspect a problem and perform further testing as indicated. If TC #10 is unable to achieve temp as expected, then suspect a refrigerant leak, inefficient compressor, dirty condenser, failed condenser fan motor, a restriction, or too warm of an ambient room temperature (>90° F). If the heat exchange box TC cannot reach the indicated temperatures with the second stage not running, then the system probably needs repair. Connect a manifold gauge set and continue to diagnose the system. Refer to **Manifold Gauge Diagnostic Procedures** for further guidance.

- If the first stage appears to be running properly with the second stage kept off, energize the second (Low) stage compressor option in the service screen and allow it to start to complete the first stage diagnostics. Check the heat exchanger box thermocouple reading at this time toverify first stage cooling and that the second stage will start.
- Continue to monitor TC #10 when the second stagestarts, and watch for the following possibilities:
- If the first stage appeared to cool properly with the second stage off, then the Heat Exchange Box thermocouple will be cold enough to activate the secondstage refrigeration system. TC #10 will start to get warmer as the second stage dumps its heat load onto the first stage. If TC #10 gets too warm, suspect the issue is within the first (High) stage refrigeration system.
- The Heat Exchange Box sensor may warm by +10° C when the second (Low) stage starts. This may happen ina warm pull down at the beginning of run. If the second stage cycles off, the Heat Exchange Box sensor should cool back down and allow the second stage back on. The cycle may be repeated until the cabinet is cold enough to keep the second stage running.
- If the second stage keeps cycling on the Heat ExchangeBox thermocouple without the cabinet starting to cool, suspect a first stage refrigeration

Manifold Gauge Diagnostic Procedures in this problem and proceed to **what??? Text is missing.**

When in doubt, give the system more time.

- If TC #10 stays warm and the cabinet will not make or willnot maintain its design temperature from a warm pull down, then the first stage may need repair. A properly running first stage cannot be overburdened by a malfunctioning second stage, while a malfunctioning firststage can be overheated by a properly running second stage.
- If second stage appears to be running or cycling properly,set unit to Bottom Out Run Mode and allow to pull downfor 8 to 12 hours. A cabinet running at 100% should be at
-85° C or colder, and may reach into the -90s depending on room ambient.
- Despite some variation from the recommended TC readings, if the unit makes design temp or lower, and willcycle at design temp, it probably does not have a refrigeration problem. An oil logging problem (usually in the second stage) may go away after the cabinet has been warmed and restarted. See second stage diagnostics below for more on this problem.
- If the first stage appears to be running properly, or especially if it appears to be running colder than normal,but the unit will not make, or will not maintain, its designtemperature, then proceed to the second stage thermocouple diagnostics which follow.

Troubleshooting the Second (Low)Stage

Unlike the first stage TC tests, the second stage is diagnosedafter the cabinet has been running at 100% (Bottom Out RunMode) until a stabilized “bottom out” temperature has been achieved, usually 8 to 10 hours. The cabinet should be left undisturbed, with no door openings.

If TC #10 reflects acceptable Heat Exchange Box temperature, then energize the second stage compressor from the service screen. Place a T-type thermocouple insidethe cabinet to monitor center air temperature. Sometimes what appears to be a poor performing cabinet is really an inaccurate display temperature. Set the cabinet to run at Bottom Out and let the unit stabilize, then view all the TCs from the service screen of the User Interface (UI). Dependingon the actual cabinet temperature, TC #3 evaporator inlet thermocouple, along with TC #4 evaporator outlet thermocouple, usually have a ~T no greater than 3~F-5~F, and both should be colder than the display temperature. At the same time, TC #10 should show a warmer temperature than it did when the second stage compressor was kept off.This is due to the heat load from the second stage being dumped onto the first stage, which is the normal operation mode.

Note: TC 3 and 4 second stage evaporator inlet and are located on the compressor deck not visible through UI reading.

The following thermocouple temperature patterns will help in determining the most likely problem:

TC	Reading	Indication: No Problem Indicated
TC #10	-35 to -45° C	The TC is in a normal operating range. TC #10 are warmer than when the first stage is running without the second stage energized, showing that the first stage is receiving a heat load from the second stage, which is how the cascade system is supposed to work.
TC #3	-86 to -95° C	TC #3 is cold showing that the interstage condenser (Heat Exchanger) is working well. TC #4 is colder than TC #3, reflecting proper operation of the cascade system with a flooded evaporator.
TC #4	-86 to -95° C	The delta T between TC #3 and TC #4 is about 5 degrees F. If the door is opened, product loaded, or room ambient increases, the TC readings and delta T, along with the cabinet temp, may also increase until the system removes the added heat load. If the unit is cycling the readings will fluctuate, which is why stabilized Bottom Out mode is used for these readings.
Display Temp.	-86 to 95° C	Acceptable Bottom Out Temperature.
TC #10	-35 to -50° C	- First stage appears to be running normally or too cold. - There is little or no heat load coming from the second stage - This is the first indication that second stage is not working properly - TC #3 could be marginal or very cold, depending on how little refrigerant is actually moving through the evaporator TCs #3 and #4.

TC	Reading	Indication: No Problem Indicated
TC #3	-86 to -95° C	TC #3 shows a large heat load in the second stage, but it's not getting transferred to the first stage, indicating a lack of refrigerant flow. Four main reasons: (1) Leak, (2) Undercharge, (3) Lack of efficiency, (4) An obstruction to flow.
TC #4	-40 to -75° C	Manifold Gauge Diagnostics; second stage flow problems. Hint: If there's a leak, you will see temperatures continue to change and warm. If it's a bad pump or restriction, it will probably maintain.
Display Temp.	Unable to achieve set point	A steady or slightly fluctuating cabinet temperature.

Notes on Second Stage FlowProblems

An oil logging problem is a type of restriction, due to too muchrefrigerant oil getting to the cap tube and evaporator, and then becoming thick, or even solid, at these cold sections ofthe system. It can be caused by a large load of warm productplaced in the cabinet, lack of first stage performance, failed oilseparator, contamination build up over time, or failure to defrost the cabinet as needed. It can be constant or varying.This is because the oil logging gets worse as the cabinet cools, which causes the cabinet to warm, which thaws the oilallowing more flow and the cabinet will start to cool again, repeating the cycle. The cabinet temperature will vary around -55°C to -75°C over a period of a day or two, warming then cooling, then warming then cooling, continually. This cycle willnot continue if the problem is a leak, as in that case, the cabinet will get continually warmer. Defrosting the cabinet over a period of 48 hours, then restarting it might solve the problem. Back-flushing the system, replacing the oil separator, then recharging is the definite solution. Refer to **Manifold Gauge Diagnostic Procedures** for further symptoms using gauges.

A continuously increasing restriction can look like a leak, asthe restriction gets more severe. Refer to **Manifold GaugeDiagnostic Procedures** for further instructions before making this determination.

Manifold Gauge Procedures

When To Use Manifold Gauges

Eliminate all possible electrical/control and external problems first:

- Dirty filter, condenser, blocked air flow.
- Warm micro climates, adjacent heat loads.
- Intermittent relays and hot connections.
- Intermittent warm ambient; HVAC timing.

After the above have been eliminated, if the TCs still indicate a refrigeration problem, then it is time to connect the gauges.

First and Second Stage Gauge Diagnostics: leaks, inefficientcompressor, or restriction.

- Leak Suspected? First stage: operate on fan and compressor 1 in diagnostic mode to evaluate if TC #10 can achieve -35° C to -45° C. If not, proceed with leak check. To confirm on second stage, warm unit and checksoak pressure.
- Inefficient compressor? Pressures and amps won't change; discharge vs. suction pressures will be closer together than normal, may be equal if no pumping at all!Running amps may be lower than normal due to compressor not pumping. Suction and discharge gaugesmay equalize quickly on shutdown. First stage: remove charge and pressurize with nitrogen to 200 psig and watch gauge for loss of pressure.
- Restrictions may act like a leak. Both discharge and suction pressures will look lower than normal—especiallysuction. Shut down unit and look for slow or no gauge equalization. Despite acting like a leak, the soak pressurewill be normal in second stage, confirming there is no leak.

Second Stage Gauge Diagnostics: leaks.

- Allow unit to warm to room temperature (24 hours off, door open) and check the soak pressure. Should be about 10% to 20% below static charge pressure due tooil absorption.
- Soak pressure check does not work on the first stage unless the unit is almost empty; no liquid phase left. Liquid refrigerant will maintain a constant pressure until ithas all turned to vapor.
- Recover refrigerant from both stages.
- Attach two sets of gauges onto the first and second stage suction and discharge lines where they enter thecabinet.
- Pressurize one stage to 50 psig and the other stage to 200 psig with N2. Look for pressure loss from either side,

or pressures to equalize between the two systems time.

- Perform the same test on the condenser for first andsecond stage connections.

Troubleshooting the User Interface (UI)

If the UI assembly fails, the proper service procedure is to replace it. There are no serviceable components. Connectionto the UI is not required for the refrigeration system to operate. A fault in the UI may make the display go dark, but should not affect the cooling system. If the display is dark andthe freezer will not start, then a larger system problem shouldbe suspected, such as a short circuit in the Power PCB circuit.

The UI communication harness is foamed into the outer door,and can be replaced only by replacing the outer door.

Note: If replacing the UI assembly, and bypassing the door harness does not correct the UI display problem, the Relayenclosure should be replaced.

If the Micro PCB is suspected of causing display problems, proceed to the diagnostics for that board in Testing Control Voltage / Electronic Components of this manual. If all testingfails to pinpoint the problem, replace all suspect componentswith known good parts, particularly in urgent situations or distant locations.

The only definitive test is to substitute known good boards for the suspect boards. A critical or urgent repair should include changing both boards.

Calibration Range Information

UI Display Offset Calibration

Primary Offset: Used for calibration.
Range is -10° C to +10° C.

Default is 0.

Note to calibrators: Customers performing on-site temperature calibration may observe as much as a 2° C variation when an external probe is placed next to the freezercontrol probe. This variation is due to optimization of the control system to ensure temperature uniformity throughout the chamber.

1. Install a calibrated sensor into the top of the RTD bracketas indicated in the photo below.

Figure 28. Offset Calibration 1

2. Close inner and outer doors. Route calibrated sensorprobe wire as indicated in the figure:

Figure 29. Offset Calibration 2

3. Let unit stabilize at set point for a minimum of one hour.
4. Calculate the needed offset value.
5. From the Settings Screen shown below press the GearIcon then the Controls Icon.

Figure 30. Offset Calibration display

6. Now press the Temperature Offset Icon.
7. From the Temperature Offset Screen, press or scroll toselect the offset values.
8. From the Temperature Offset Screen, press the SaveIcon.
9. When the required offset value has been adjusted and saved, the new Setting Saved Icon will ask you to pressOK to save your changes.

Main Non-Volatile Variables / Parameters	
Parameter	**Detail**
Set Point	Range: -50 to -86° C Default: -80° C Step: 1C
Offset	Range: -10 to 10° C Default: 0° C Step: 1C
Warm Alarm	Range: -40C to (SP + 5C) Default: -70° C Step: 1C
Cold Alarm	Range: (SP -5° C) to -99° C Default: -90° C Step: 1C
Time Delay	Range: 0.0 to 20.0 min Default: 0 min Step: 5 sec increments Note: Rolls over at the limits

Main Non-Volatile Variables / Parameters	
Parameter	**Detail**
BUS Set Point	Range: 0°C to -76°C (LN_2) Range: 0°C to -65°C (CO_2)
BUS Type	LN_2 or CO_2

Instructions for Replacing Parts

Note: “First Stage” = “Low Stage;“Second Stage” = “High Stage”

Replacing the Door Gasket

Note: The new gasket will be wrinkled and folded when it isunpacked. Immerse the gasket in warm water until it becomes pliable. Lay the gasket flat and allow it to dry. Care should be taken not to stretch or tear the gasket duringhandling.

To replace the inner or outer door gasket on an upright UltraLow Temperature freezer, complete the procedure below.

1. Transfer product to another freezer of equal temperature.
2. Leave the unit set for the desired operating temperature,turn the unit breaker switch to the Power Off position, and disconnect the unit from the power source.
3. Remove the gaskets by pulling them straight out andaway from the door.
4. Align the corners. Press the retaining rib (corners first) ofthe new gasket into the groove in the door using a rubbermallet if necessary.

Note: The inner and outer gaskets are installed using thesame method shown above.

Note: It may be easier to remove the door and lay it on a flatsurface with the gasket side up. The door is heavy. Consider its size and weight. Additional help is recommended.

Adjusting the Door Latch

Note: only the roller mounting plate can be adjusted.

1. Loosen four T27 Torx socket screws.
2. Adjust roller mounting plate to provide 0.474 inch(12 mm) of door spacing from the cabinet.
3. Re tighten socket screws; factory torque spec is85 inch-pounds.

Replacing the Strike Plate and Roller

1. Unscrew the strike roller from the mounting platewith a T27 Torx Bit.
2. Install new roller in reverse operation.
3. The strike roller mounting plate is attached with fourT27 Torx socket screws.
4. Install new mounting plate in reverse of removal.The factory torque spec is 85 inch-pounds.

Replacing Cam Latch Handle

This procedure includes replacement of the key lock assembly.

1. Remove the 4 mm (5/32) Hex socket screw holding thehandle on the mounting pin.
2. If needed, remove the handle mounting plate byremoving the four T27 Torx screws.
3. Reinstall in reverse order of removal. Lubricate the handlemounting pin with white lithium grease or equivalent.

Replacing Door Hinges

Complete the procedure below to replace the door hinges.

1. Strap the door to the cabinet to prevent it from moving orfalling.

CAUTION: Ensure the door is secure. Replace only one hinge at a time.

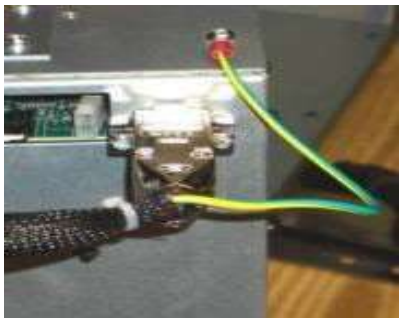


Figure 31. Door Hinges

Figure 32. Door Hinges replacement

2. Scribe the top and side locations of the current hinge forpositioning the new hinge.
3. Remove the screws securing the hinge to the cabinet. Discard the hinge. Retain the screws and any washers.
4. Install the new hinge and secure with the screws (andshims, if needed), as previously.
5. Adjust hinges.
6. Monitor unit for proper operation.

Replacing Interior Doors

The ULT freezer ships from the factory with a set of inner doors attached to a single hinge pin bracket extending the height of the cabinet. The inner doors slide onto the pins, andcan be replaced without tools or fasteners.

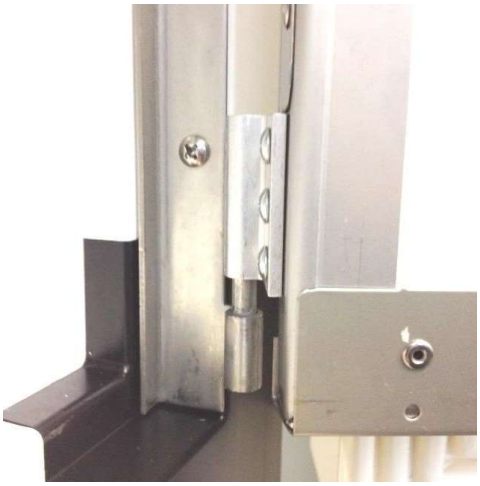


Figure 33. Interior Doors

If the hinge pin bracket on the cabinet needs to be replaced,transfer product to another freezer of equal temperature.

1. With the unit set at the desired operating temperature, turn the power/key switch to the Power Off position, anddisconnect the unit from the power source.
2. Remove the inner door by sliding it off of the hinge pins.
3. Remove the hinge pin bracket using a #2 Phillips screwbit, and install the new bracket in the reverse order.
4. Install the inner door, and then adjust the position of thehinge pin bracket to allow proper door clearance between the top and bottom of the cabinet opening.
5. Secure the hinge pin bracket in the correct position andreinstall the remaining inner doors.

Replacing Outer Door andChecking Seal

Complete the following steps to replace the outer door assembly and perform a seal check.

1. Transfer product to another freezer of equal temperature.
2. With the unit set for the desired operating temperature,turn the unit breaker switch to the Power Off position, and disconnect the unit from the power source.
3. Remove the User Interface panel. (See User InterfaceRemoval Procedure).
4. Remove User Interface harness by loosening two flathead screws from the rear of the relay enclosure.

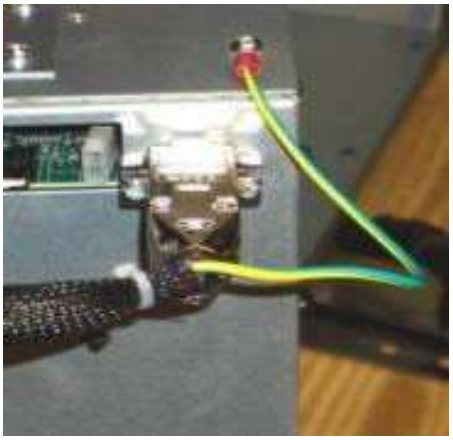


Figure 34. Replacing Outer Door

Note: The door is heavy. Be sure to have the necessary assistance available when removing and replacing. The hinge leaf that attaches to the door has round screw holes, so the door should be in very good alignment when it is re-installed. The slotted holes for adjustment are on the cabinet side.

1. Scribe the top and side of each hinge. Remove the threescrews from each hinge attached to the door.
2. Position the new door and secure in place withbar-clamps, or a ratchet strap. There should be 0.474inch (12 mm) clearance between hinge side of door and the cabinet.
3. Verify the gasket is smooth and flat. Make sure it

doesn’t roll or fold on the hinge side.

4. Secure hinges using the scribed lines for positioning, maintaining the 0.474 inch gap betweendoor and cabinet.
5. Verify good gasket sealing by testing that a slip of paperis held firmly when the door is closed.
6. Reinstall the UI assembly and restore the electricalconnections.
7. Reconnect to power source and check unit for properoperation.

Note: if the door needs to be adjusted, use bar clamps and boards or the ratchet straps.

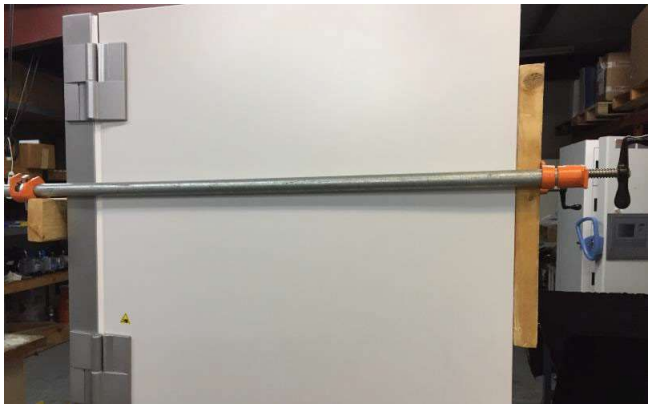


Figure 35. Outer door

Door Ramp

All doors are installed with the door ramp kit is to ensure thatthe freezer(s) does not experience door sag over the life of thefreezer. With the addition of the door ramp, we can reduce the possibility of door misalignment which can result in frost and ice buildup in the unit. The door ramp can also reduce thepossibility of handle and door lock alignment issues.

Figure 36. Door ramp

Replacing the Condenser

The condenser filter is in two parts, a door filter section and abottom strip filter under the condenser. For all models, the filter is a simple friction fit that is pressed into position. The filter door is hinged on all units.

To replace the grille filter, follow the steps below.

1. Open or remove the front grill panel.
2. Pull the filters loose from the grille door and thecondenser bottom.

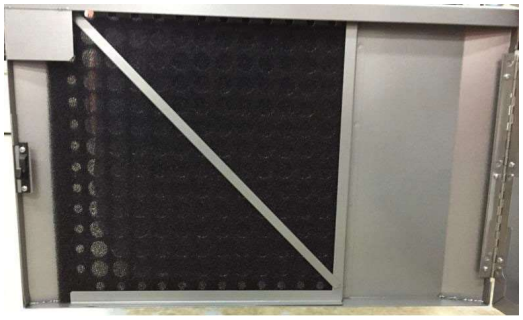


Figure 37. Condenser Filter

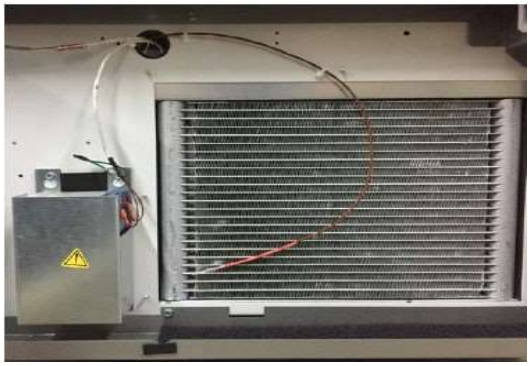


Figure 38. Condenser Filter

3. Wash with a mild soap and water. Press between twotowels to dry. Installation is the reverse of removal.
4. Close or secure the front grille, making sure the grilleattaches firmly.

Replacing Casters

Use the following steps to replace the casters on a ULT freezer.

WARNING: With product removed, the power switch on the unit must be turned off and the unit disconnected from the power source before starting this procedure.

CAUTION: Do not tilt the unit backward without blocking rear casters. The unit could roll, causing a personnel hazard.Ensure there is adequate assistance to prevent the unit fromtipping.

1. Raise the unit safely and adequately to allow removal ofthe caster mounting bolts.
2. Remove the four ½-inch hex head bolts that attach thecasters, 0.5 inch long.
3. Reinstall the new caster assembly using the same boltsremoved.
4. Lower the cabinet and test the casters for properfunction.

Description of ReplaceableElectrical Components

See Part Numbers In Appendix. Compressors are listed withrefrigeration components.

- User Interface Assembly
- Door reed switch
- Condenser fan; one
- Relay box as a unit; 115 V AC, 230 V AC. See part list inAppendix
- Micro PCB, inside relay box
- High Voltage PCB; inside relay box
- Switching Power PCB; inside relay box
- Switcher cooling fan; 12 V DC
- Boost Transformers; 1 for 115 V AC, 2 for 230 V AC
- Cabinet sensor; 1000 platinum RTD
- Power/Circuit Breaker Switch

Replacing Interior Cabinet SensorGroup

The interior cabinet group consists of the control/display, andwireless monitoring system sensor. It also includes the back-up and recorder sensors if these options are installed onthe freezer. The sensor shield is located at the bottom of theback wall inside of the cabinet.

CAUTION: High voltages may be present. Service should beperformed by qualified personnel only.

Note: The freezer must be at room temperature before beginning this procedure.

Complete the following procedure to replace

1. Turn the breaker switch to the “OFF” position anddisconnect the unit from the power source.
2. Remove the six screws securing the lower left side panelto access the electrical relay enclosure.
3. Unplug the red-white probe located in the control probesocket on the micro board.
4. Remove the Permagum from both sides (freezer compartment and compressor compartment) of the access hole and separate the control/ display sensorlead.
5. Pull the old control/display sensor out.
6. Install the new sensor. Install the Permagum on bothsides (freezer compartment and compressor compartments) to seal the access holes.
7. Install the control/display sensor in its mount on thesensor shield.
8. Install the screws securing sensor shield in the freezercompartment.

Figure 39. Interior Cabinet Sensor

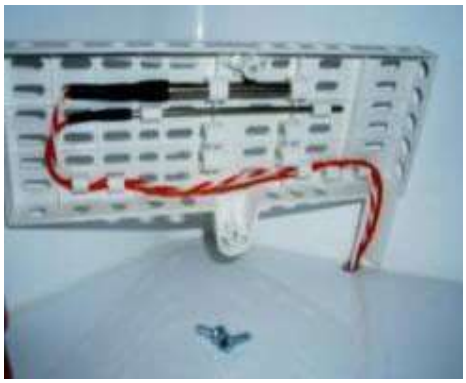


Figure 40. Interior Cabinet Sensor 1

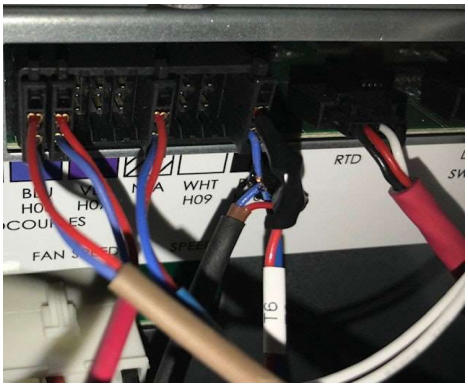


Figure 41. Interior Cabinet Sensor 2

Note: The recorder, back-up system, and wireless monitoringsensor will all be installed using the same cabinet access portand will be located behind the sensor shield. The replacementmethod of the control/display sensor should be followed for replacement of any additional sensors located behind the sensor shield.

Interior Cabinet Sensor Group:Non-Replaceable

Other interior sensors consist of the diagnostic thermocouples, which are located inside the foamed cabinetand cannot be replaced. The sensors which are not replaceable are listed below.

Evaporator Inlet #2 – TC #3

Evaporator Out #1 – TC #4

Heat Exchange Sensor – TC #10

Replacing Exterior CabinetSensor Group

The exterior cabinet group consists of the Ambient, Condenser, first stage suction, second stage suction and theheat exchange sensor.

Ambient Sensor Replacement

1. Open or Remove the front grill to access the ambient probe. The probe is located in front of the condenser asshown in the photo below.
2. Remove the rear compressor deck panel to gain access to the back of the electrical relay enclosure. The ambient sensor is TC #2 (315204H02) with the red band.

Figure 42. Replacing Exterior Cabinet Sensor Group

Figure 43. Replacing Exterior Cabinet Sensor Group 1

Replacing Other External Sensors

- 1st stage suction – TC #1, part number 315204H01, withBrown band.
- 2nd stage suction – TC #6, part number 315204H06,with Blue band.

1. Remove the rear compressor deck panel to gain accessto the back of the electrical relay enclosure.
2. Route a new sensor in the same path as the sensor beingreplaced.
3. Attached to micro board.

CAUTION: When working around the electrical relay box, make sure the unit is de-energized, disconnected from the power source, and the circuit breaker is locked and tagged out.

Turn the unit off with the switch and disconnect the power cord from the power source. If the unit is hard-wired to a power source, de-energize and tag-out the power disconnect to the unit. Refer to OSHA regulations 1910.147 regarding tagout and de-energizing potential electrical sources.

WARNING: High voltages may be present. Service should performed by qualified personnel only.

Replacing Heat ExchangerSensor

The heat exchange sensor is hermetically sealed in the heat exchange box, and cannot be replaced separately. In the event that both heat exchange sensors fail, the heat exchange box must be replaced. If the sensor failure is at theconnection to the micro board the connector or the wiring ofthe connector can be repaired or replaced.

CAUTION: When performing work inside the electrical junction box, make sure the unit is de-energized, disconnected from power, and the circuit breaker is locked and tagged out.

Replacing the Relay Enclosure

WARNING: High voltages may be present. Service should beperformed by qualified personnel only.

1. Disconnect freezer from power supply.
2. Label all wires before removing the relay enclosure. Referto the wiring and ladder diagrams in this manual.
3. Turn the unit breaker switch to the OFF position andensure the power cord is disconnected.
4. Remove the bottom left side panel by removing the (8)Phillips head screws to access the relay enclosure.
5. Remove the power cord retaining bracket.
6. Remove the two Phillips head screws from the rear of thecabinet and the two screws from the left hand side that are used to mount the relay enclosure in place.

Figure 44. Replacing the Relay Enclosure

Figure 45. Replacing the Relay Enclosure 1

7. Move the relay enclosure so that the back side of therelay enclosure is seen.
8. Label and remove all harnesses and connections on theback of the relay enclosure before removing from the compressor deck.
9. It is required to lift the rear of the relay enclosure abovethe caster bolts in order to remove the relay enclosure from the compressor deck area.

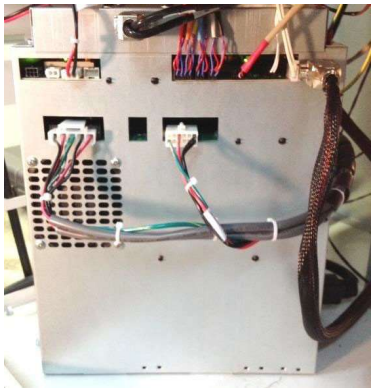


Figure 46. Replacing the Relay Enclosure 2

10. After replacing the relay enclosure, re-install all wiring,wiring connections, and unit panels.
11. Re-install power cord and retaining bracket.
12. Verify operation of the relay enclosure.
13. Software upgrade will need to be preformed.

Replacing the I/O

WARNING: High voltages may be present. Service should beperformed by qualified personnel only.

1. Disconnect unit from power supply.
2. Remove the eight screws securing the lower left sidepanel and remove the panel.
3. Turn the unit breaker switch to the OFF position andensure the power cord is disconnected.
4. Disconnect the battery.

Note: Always wear a personal grounding device when handling a printed circuit board.

5. Remove the screws from the relay enclosure cover togain access inside the relay enclosure.
6. Locate the I/O board inside the electrical relay enclosure.The I/O Board is mounted below the Main Board.
7. Label all wires before disconnecting. Refer to the wiringand ladder diagrams in this manual.
8. Remove any connections to the I/O board.
9. Remove the mounting device that secures the board, andthen gently pull the board out of the relay enclosure. If theboard is to be returned for evaluation, label the board with the model and serial number of the unit.
10. Install the new board. Secure the board mounting device.
11. Connect the connectors, as previously labeled.
12. Re-connect the battery.
13. Repower the unit and verify proper operation of theboard, then close all panels.

Replacing the Power SupplyBoard

Warning: High voltages may be present. Service should be performed by qualified personnel only.

1. Disconnect unit from power supply.
2. Remove the eight screws securing the lower left sidepanel and remove the panel.
3. Turn the unit breaker switch to the OFF position andensure the power cord is disconnected.
4. Disconnect the battery.

Note: Always wear a personal grounding device when handling a printed circuit board.

5. Remove the screws from the relay enclosure cover togain access inside the relay enclosure.
6. Remove the Main Board and I/O board to access power supply board.

7. Label all wires before disconnecting
8. Remove any connections to the I/O board.
9. Remove the four Phillips head mounting screws that secure the board, and then gently pull the board out ofthe relay enclosure.
10. Install the new board.
11. Secure the board mounting device.
12. Connect the connectors, as previously labeled.
13. Re-connect the battery.
14. Re-power the unit and verify proper operation of theboard then close all panels

Replacing the Relay Enclosure Cooling Fan

WARNING: High voltages may be present. Service should be performed by qualified personnel only.

1. Disconnect unit from power supply.
2. Turn the unit breaker switch to the OFF position andensure the power cord is disconnected.
3. Remove the bottom left side panel by removing the (8)Phillips head screws to access the relay enclosure.
4. Remove the power cord retaining bracket.
5. Remove the two Phillips head screws from the rear of thecabinet and two screws from the left hand side that are used to mount the relay enclosure in place.
6. Remove the screws to remove the relay enclosure coverto gain access to the components in the relay enclosure.
7. Label and Disconnect the transformer 1 and transformer2 connection to the I/O board.
8. Disconnect cooling fan two pin harness from the I/OBoard.

9. Remove the four lock nuts from the mounting bolts inside the relay enclosure.
10. Install new cooling fan, connecting the cooling fan harness to the pins labeled “fan” on the I/O board.
11. Re-connect the transformer pin connector(s) to the I/Oboard.
12. Re-install all panels and verify the operation of the coolingfan.

Replacing the UI Interface TouchScreen

The UI touch screen is replaced as a complete assembly.

WARNING: High voltages may be present. Service should beperformed by qualified personnel only.
WARNING: Always wear a personal grounding device whenhandling a printed circuit board.

1. Disconnect unit from the main power supply.
2. The entire outer plastic cover can be removed, by gentlypulling from the top of the cover or using the bezel removal tool part number 330108H01, then working yourway down the sides to pop the plastic fasteners from theUI frame.
3. Use care when removing the plastic covers not to damage the mounting posts that engage the key ways.

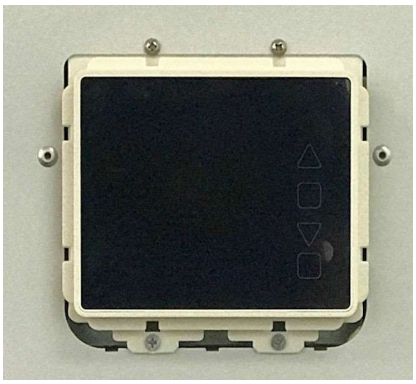


Figure 47. UI Interface Touch Screen

Figure 48. UI Interface

4. Remove 4 screws holding UI assembly in door, while holding the assembly in place. There are two pan headscrews and two countersunk screws that needs removed. The two countersunk head screws are at thebottom. Ensure to put the correct screws in the correctlocation while replacing.
5. Carefully tilt the UI assembly down from the cabinet, revealing the communication harness, PEP heater cable,and the grounding connection.
6. Disconnect the 3 connectors and remove the UIassembly. Replace with the new assembly and reconnect.
7. Remount the assembly in the door making sure all connecting harnesses have proper clearance to allowflush fit of the assembly.
8. Reattached the assembly and reinstall the plastic screwcovers.
9. Reconnect freezer to power and verify proper UIoperation.
10. Software upgrade will need to be performed.

Replacing the Display Harness

- The display harness is permanently foamed into the doorand is replaced by replacing the outer door. See **Replacing Outer Door and Checking Seal** for that procedure.
- Verify no other UI communication problem exists beforemaking this replacement. It is recommended that a UI harness (part number 315377H05) be used to test the system before replacing the door.
- For instructions on installing the UI into the replacementdoor see **Replacing the UI Interface Touch Screen**.

Replacing Alarm and BUS Battery

behind the filter door.

1. Label and disconnect the two red and black leads fromthe battery.
2. Remove the expired battery and recycle or discardaccording to proper procedures.
3. Install new battery. Red is the positive lead and black isthe negative.
4. Allow 4-6 days for the battery to fully charge. Monitor unitfor proper operation.

Figure 49. Alarm and BUS Battery

Replacing the Boost Transformer

Note: 115 volt units have two transformers for Boost.

WARNING: High voltages may be present. Service should beperformed by qualified personnel only.

1. Turn Off the power switch and disconnect the unit fromthe power source.
2. The transformers are located in the bottom of the relay box assembly. Remove the screws that secure the lowerleft side panel. Set the panel aside and disconnect the battery.
3. Remove the screws securing the relay box cover.
4. Locate the boost transformer in the bottom of the relayenclosure.
5. It is recommended to remove the boards and components above the transformers to allow clearaccess.

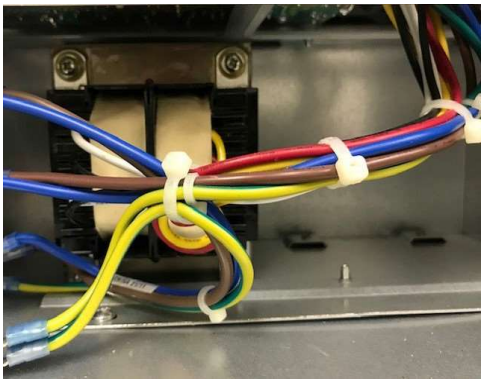


Figure 50. Boost Transformer

6. Label all wires removed.
7. Remove the mounting bolts securing the transformer to the enclosure, and recycle or discard according to properprocedure.
8. Install the new transformer by reversing this procedure,and reassemble the relay box components.
9. Replace the covers and test for proper operation.

Replacing the Condenser Fan

Complete the following procedure to replace a freezer condenser fan.

1. Turn the freezer off and disconnect it from the powersource.
2. Remove the right side panel. The condenser fan shouldbe accessible from this point.
3. Unplug the fan wiring from the wiring connector as seenin the picture below.
4. Using a ¼ inch socket or nut driver, remove the 4 hexhead screws holding the fan in place.
5. Install the replacement fan in reverse order of removal.

Figure 51. Condenser Fan

Replacing the

Description of -86° C ULT HC Freezer Replaceable Refrigeration Components

- Two Compressors may be replaced separately.
- Heat Exchange Box.
- Two filter driers may be replaced separately. The secondstage filter is enclosed in separate molded foam box. Thefirst stage filter drier is located just behind the front cutoutnext to the condenser.
- Second stage accumulator; flow through style, may beflushed and changed separately when needed.
- Oil separator on second stage.

Replacing the First Stage Compressor

1. Disconnect all power from the unit.

WARNING: Ensure that the freezer components have warmed to room temperature.

2. Remove the right side and back panels from the compressor deck. There are 8 screws on the right sidepanel and 7 screws holding the back panel in place.
3. Locate the first stage compressor on the right side facing the back of the cabinet just behind the first stage inverter.
4. Install a line tap on the process line and recover all refrigerant in an empty 50lb recovery tank. First stage willhave approximately 91 grams of R290 refrigerant in the system.

Figure 52. Replacing the Compressor

5. Remove the suction and discharge lines from the compressor. The suction line is at the top, and the discharge line at the bottom. The suction line has the Armaflex installation. Opposite the suction line at the topis the process tube.
6. Mark each wire and disconnect the wires from the compressor. Normally, there will be three wires hard-wired to the compressor. These wires will be identified asthe run, start and common terminals.

Note: Back flush the system any time a compressor replaced.

7. Remove the current first stage compressor by removingthe 4 compressor mounting bolts. Retain the mounting feet and shoulder bolts.

CAUTION: Cap off all remaining lines to prevent moisture contamination from migrating into the system.
CAUTION: The compressor weights approximately 60 Usecaution and employ proper lifting procedures when movingthe compressor.
CAUTION: Oxidation will form at the heated joint unless a low volume nitrogen flow is maintained. Such oxidation couldbreak free and cause a restriction.

8. Install the compressor rubber feet, remove and putshoulder bolts (4 each), and electrical wires to the terminals of the new compressor. Attach the new compressor to the freezer deck.
9. Install a new filter/drier and connect all copper lines.
10. Pressurize the system with dry nitrogen and leak-check. If no leaks are detected, start evacuation per instructions found in Flushing, Evacuation and Charging.

Note: Always use copper process lines directly to gauges and the vacuum pump.

11. Insulate the suction side from the compressor to thecabinet.
12. Charge the system after the system meets blank-offstandards per instructions found in **Flushing, Evacuation and Charging**.
13. Replace panels and return system to operation.

Replacing the Heat Exchange Box

Table 29. Heat Exchange Box

Parts Needed	Associated Procedures
Heat Exchange Box Assembly	Back flushing
Refrigerants (see data plate)	Brazing
See appendix for recommended tools	Triple Evacuation
	Refrigerant Charging

1. Disconnect all power from the unit. Remove the left and back side panels to access the compressor deck area.
2. Remove the vapor barrier panels to gain access to theheat exchange box.

3. Recover first and second stage charge from the refrigeration system. Disconnect the heat exchange sensor from the relay enclosure. Cut and label all linesleading to and from the heat exchange box.
4. Back flush the system if required. Place caps on all cut refrigeration lines until new heat exchange box is installedand ready to be brazed into place.
5. Remove 5/16 hex head mounting bolts from the base of the heat exchange box to remove it from the compressor deck area.

Figure 53. Heat Exchange Box

Figure 54. Heat Exchange Box 1

When the new heat exchange box is mounted in place

1. Re-insulate refrigeration lines.
2. Leak-check both first and second stage of therefrigeration system.
3. Evacuate the systems.
4. Recharge.
5. Verify Operation.

CAUTION: Cap off all remaining lines to prevent moisture contamination from migrating into the system.
CAUTION: Oxidation will form at the heated joint unless a low volume nitrogen flow is maintained. Such oxidation breaḳ free and cause a restriction.

Replacing the Second StageCompressor

Figure 55. Second Stage Compressor

Parts Needed	Associated Procedures
Compressor Service Kit (see parts list for correct stage and voltage)	Back flushing
Oil Sep (see **Part Number List**)	Brazing
Refrigerants (see data plate)	Triple Evacuation
See appendix for recommended tools.	Refrigerant Charging

WARNING: Ensure that the freezer has been warmed to room ambient temperature for a minimum of 24 hours.
1. Disconnect all power from the unit.
2. Remove the right side and back panels to access thecompressor deck area.
3. The second stage compressor is the one closest to the front as you face the compressor deck from the right sideof the freezer, and is connected to the oil separator.
4. Install a line tap on the process line, and recover allrefrigerant in accordance to state and federal EPA regulations.
5. After recovery of the refrigerant and to avoid pulling contaminants into the system, use dry nitrogen to break

the vacuum and bring the system to a low positive pressure.

6. Remove the wiring cover cap on the side of the compressor and see Fence Cover Disassembly of this manual on how to remove the inverter cable from the compressor. Note: For re-installation instructions seeElectrical Components Installation to Compressor. Remove the compressor connections. Inspect the wiringfor damage or burning, and repair or replace as needed.
7. Before cutting any tubing, determine which part of thetubing will be replaced or reused.
8. Also determine which brazing joints will be made on thebench and which will be made under the compressor deck.
9. Remove the suction, discharge, and oil return lines fromthe compressor.
10. Remove the four anchor bolts and remove thecompressor. (Save the mounting feet.)
11. Dump the compressor oil in a measuring container and determine the amount, color, and acidity of the oil. Noteyour findings in the service report.
12. If the unit is still under warranty return the compressor tothe factory for examination. Follow the factory instructions for securing and shipping the compressor.
13. Remove the old oil separator. Remove the attaching nutand washer from the bottom of the compressor deck using a 9/16 inch ratcheting wrench or equivalent. Cut the copper tubing as close to the oil separator as possible. The location of final cuts will be made during oilseparator installation.
14. Remove the old oil separator and dump the oil into a measuring container. Note the amount and color of the oilin the service record.
15. Remove the second stage filter/drier. Remove the smallermetal box on the back side of the heat exchange box containing the drier and molded foam insulation. Carefullyseparate the foam mold and reserve for re installation of the new drier.
16. Cut the drier tubing as close to the drier body as possible. Final cuts will be determined when installing thenew drier. Do not remove the heat exchange box.
17. Solvent flush (back flush) the second stage system perthe refrigeration diagram. The second stage may be flushed in sections or in one pass. The sections to be flushed are the heat exchange box, the capillary and evaporator tubing.
18. The cabinet section containing the cap tube and evaporator should be back flushed first to clear the capillary, then forward flushed final to allow all flushingliquid to flow out through the down-flow evaporator.
19. The heat exchange box can be flushed in either direction.
20. When solvent flushing is completed install the new system components.
21. Install the new filter/drier in the same position as the oldone so that the molded foam insulation can be reinstalled. The foam mold can be used as a pattern to help make the proper tubing bends.
22. After brazing in the new drier reinstall the molded insulation and the metal housing. Make certain the liquidline going up into the cabinet is also properly installed.
23. Install the new oil separator.
24. Install the new second stage compressor.
25. Leak-check the system.
26. Evacuate the system following the instructions found inFlushing, Evacuation and Charging section in manual.
27. Install suction line insulation near the completion of theevacuation process.
28. Charge the system following the instructions found inFlushing, Evacuation and Charging, Section 10.0 in manual.
29. Verify proper operation.

Note: Back flush the system any time a compressor is replaced. Flush the system following the instructions found in Flushing, Evacuation and Charging, Section 10.0 of this manual.

CAUTION: Cap off all remaining lines to prevent moisture contamination from migrating into the system.
CAUTION: The compressor weights approximately 30 pounds. Use caution and employ proper lifting procedures when moving the compressor.
CAUTION: Oxidation will form at the heated joint unless a low volume nitrogen flow is maintained. Such oxidation couldbreak free and cause a restriction.

30. Inspect the new oil separator to ensure that it is full andcontains the correct type of oil (500 mL of Zerol 150T). Plumb the oil separator with copper lengths equal to what was removed with the old oil separator, and installthe oil separator.
31. Connect all copper lines.
32. Pressurize the system with dry nitrogen and leak-check.If no leaks are detected, start evacuation (see **Flushing,Evacuation and Charging**).

Note: Always use copper lines directly to the gauges and vacuum pump. Ensure the suction lines are insulated. Insulatethe suction side from the compressor to the cabinet.

33. Charge the system after it meets blank-off standards (see **Flushing, Evacuation and Charging**).
34. Replace access panels and return freezer to operation.

Replacing the Oil Separator

Note: Always replace the oil separator when changing thesecond stage compressor.

1. Remove the eight screws that secure the lower right sidepanel. Set the panel aside. The oil separator is located next to the second stage compressor.
2. Cut the tubing as close to the brazed fitting on thecurrent oil separator as possible.
3. Remove the nut that secures the oil separator to the compressor base. The nut is located beneath the compressor base, (directly beneath the oil separator) andrequires a 9/16") wrench or 9/16") socket. Discard the oilseparator.
4. The new oil separator ships pre-charged with the correctamount of oil.
5. Align the separator so the tubing from the oil separatormatches the new oil separator.
6. Clean the tubing with emery cloth. Do not use steel woolor sandpaper. Make sure the piping is configured properly; inlet to inlet tube, outlet to outlet tube, etc.
7. Install and tighten the nut that secures the oil separator inplace.
8. Connect the tubing and braze the joints together.

Note: Always allow a low flow of nitrogen through the tubingwhile the brazing process is being performed.

9. Once the joints are brazed, wipe off any excess flux thatmay have accumulated on the joints.
10. Clean the freshly brazed joints with emery cloth.

Replacing the First Stage Drier

1. Recover the refrigerant charge from the system in accordance with current EPA and local regulations.
2. Remove the front grill to access the filter drier cut out. Remove the four screws as seen in figure 3 below, or if you prefer, remove the eight screws securing the left sidecompressor deck panel. This will provide access to the vapor barrier panel. These 17 screws can be removed to expose the first stage filter drier and accumulator, asseen in figures 1 and 2.

3. Use an emery cloth to clean the copper tubing on each side of the drier before the tube is cut. Do not use steel wool or sandpaper.
4. Cut and remove the old drier. Discard.
5. Install the new drier and check to make sure the arrow ispointing in the correct direction of flow. The arrow will bepointing down if the tubing has not been altered from thefactory design.
6. Always purge the tubing with nitrogen while brazing.
7. Once the joints are brazed, clean the joints with emerycloth.

Replacing the Second Stage Drier

Note:

- Recover the refrigerant charge from the system in accordance with current EPA and local regulations.
- When using a torch for de-soldering or brazing, be sureto employ shields as required to prevent the flame fromreaching other components that could be affected by heat.
- If the procedure is being performed in a facility, complywith any fire codes for the location and the facility.
- Always have a fire extinguisher available whenever usinga torch.

1. Remove the side panel and the rear grill to access the mounting screws and bolts of the second stage filter driermetal cover.

2. Remove the four 1/4” screws attaching the second stagefilter drier cover to the heat exchange box and the two 5/16” bolts mounting the cover the compressor deck.
3. insulation from the drier.
4. When the insulation has been removed, clean the tubingon both sides of the drier with an emery cloth. Clean brazed joints using an abrasive pad such as emery cloth.Do not use steel wool or sandpaper.

CAUTION: Measure the tubing to cut the refrigeration lines inthe appropriate area so that the tubing assembly will fit into the pre-formed two piece insulation of the filter drier.

5. Cut the tubing on each side of the drier.
6. Install the new drier ensuring that the length of the tubingis the same as what was removed.
7. Check to make sure the arrow is pointing in the correctdirection of flow.
8. Always purge the tubing with nitrogen while brazing.
9. Once the joints are brazed, clean the joints with emerycloth.
10. Evacuate, Leak Check and recharge.

Replacing the Condenser

Parts Needed	Associated Procedures
Condenser see parts list for correct stage and voltage	Back flushing
First and second stage filter drier (if not included with kit)	Brazing
Refrigerants (see data plate)	Triple Evacuation
See appendix for recommended tools.	Refrigerant Charging

1. Turn unit off. Disconnect unit from the power source.
2. Recover the refrigerant from first stage system.
3. Remove the front grille and locate the condenser.
4. Remove the right side panel to gain access to thecompressor deck.
5. Remove the condenser cover, by removing the screwsfrom around the condenser. This will allow you to gain access to the condenser and its tubing.
6. Remove any components obstructing the condenser removal, such as the ambient and condenser sensors.
7. Cut the condenser tubes inside the compressor deck area.

Figure 56. Condenser

Figure 57. Condenser replacement

8. Install the new condenser. Reconnect as previouslyremoved.
9. Re-install the ambient and condenser sensors.
10. Install grille.
11. Flush system if necessary.
12. Replace first stage filter drier.
13. Leak-check.
14. Evacuate.
15. Charge first stage system.

Note: Note: Back flush the system any time a compressor isreplaced.

CAUTION: Cap off all remaining lines to prevent moisture contamination from migrating into the system.
CAUTION: Oxidation will form at the heated joint unless a low volume nitrogen flow is maintained. Such oxidation couldbreak free and cause a restriction.

Replacing the Door

Required Tools

- Screw driver/cordless driver with #2 Phillips head.
- #1 Phillips head screw driver.

Turn the unit breaker switch to the OFF position and disconnect the power cord.

1. Open / Remove the filter door.
2. Remove the two #2 Phillips head screws from the doorswitch bracket. The bracket is located just above the condenser.
3. Remove the two #1 Phillips head screws from the doorswitch.

Figure 58. Door Switch

Figure 59. Door Switch 1

4. Replace Switch and re-install the door switch bracket.
5. Use an insulated splice connector to wire the new doorswitch, as shown below.

Note: Verify that the door switch magnet, located at the bottom of the door is aligned to the door switch.

6. Re-install / Close the filter door.
7. Verify the operation of the door switch.

Replacing the Power/CircuitBreaker

Required Tools

- Screw driver/cordless driver with #2 Phillips head.

Note: Turn the unit breaker switch to the OFF position and disconnect the power cord.

1. Remove the bottom left side panel by removing the (8)Phillips head screws to access the relay enclosure.
2. Remove the two Phillips head screws from the rear of thecabinet and two screws from the left hand side that are used to mount the relay enclosure in place.
3. Remove the (7) Phillips head screws that secure the relayenclosure cover. In the bottom of the relay enclosure youwill find the circuit breaker and wiring, label wires before removing them from the circuit breaker.

Figure 60. Power / Circuit Breaker

Figure 61. Power / Circuit Breaker 1

4. The circuit breaker is held in place by tabs at the top andbottom, Press the tabs and push the circuit breaker out of the relay enclosure.
5. Replace circuit breaker and wiring. Re-install all panelsand verify operation of the circuit breaker.

Flushing, Evacuation and Charging

Unlike previous ULT designs, the new HC freezers are designed without the need for an extra run of copper tubing around the door perimeter; this was called a halo pass and was used to help warm the door frame and prevent condensation issues in older models.

HC freezers do not have the heat exchanger installed in the bottom of the cabinet as older ULTs did—it has been movedinto the Heat Exchange Box installed on the compressor deckarea.

Note: The first stage accumulator has been moved from theprevious cold box design and now on the HC models, the accumulator is now located in the cold box and is now a copper flow-through type accumulator that allows it to be flushed.

The heat exchange box will come as a service part (refer to **Tool Lists**. You will need to order this part for any burned outcondition that may occur on the first stage system. Keep in mind that if you replace the heat exchange box, you will alsolose the refrigerant charge to the second stage system, whichwill require you to evacuate the second stage too and then reprocess per instructions below.

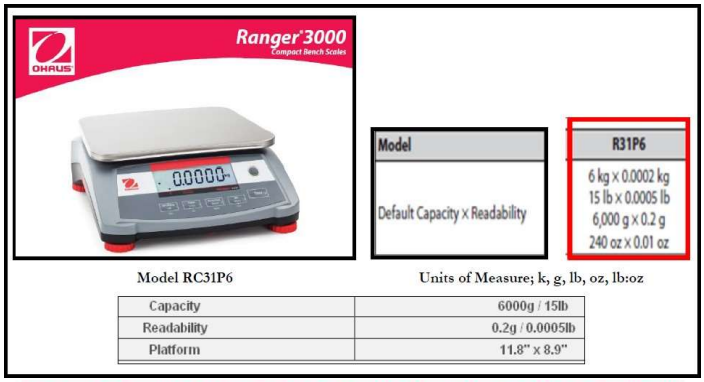
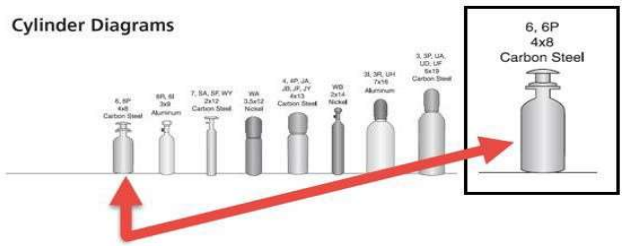


PHOTO	MODEL CODE	ITEM NR.	CAPACITY	READABILITY	PLATFORM	RE-CHARGE	VERIFICATION INTERVAL E	TEST WEIGHT
	RC31P1502	30031787	1.5kg (3lb)	0.05g (0.001lb)	300 x 225 mm	X	0.5g (0.01lb)	1.5kg, OIML F2 or ASTM Class 4
	RC31P3	30031788	3kg (6lb)	0.1g (0.002lb)	300 x 225 mm	X	1g (0.002lb)	3kg,OIML F2 or ASTM Class 4
	RC31P6	30031789	6kg (15lb)	0.2g (0.005lb)	300 x 225 mm	X	2g (0.005lb)	6kg,OIML F2 or ASTM Class 4



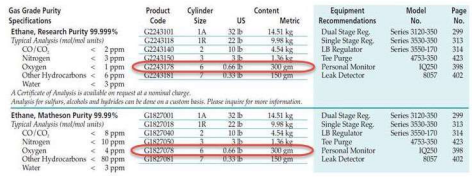
Equipment Required for Service

Standard Gases Cylinder Chart

Cylinder	Nominal Dimensions* Diameter x Length (in)	(cm)	Material of Construction	Tare Weight* lbs	kg	Water Capacity lbs	kg	Internal Volume cubic ft.	liters
6	4 x 8	10 x 20	Steel	3.9	2.0	2.1	0.9	0.03	0.94

Cylinder Specifications

Cylinder Size	Valve Outlet CGA No.	Pressure psig @ 70°F	Pressure kPa @ 21.1°C	Approximate Ship Weight lb	kg
1A	350	546	3,765	154	70
1R	350	546	3,765	70	32
2	350	546	3,765	74	34
3	350	546	3,765	32	15
6	350	546	3,765	5	2
7	350	546	3,765	6	3
LB	170	546	3,765	6	3



Gas Grade Purity Specifications	Product Code	Cylinder Size	Content US	Content Metric	Equipment Recommendations	Model No.	Page No.
Ethane, Research Purity 99.999%	G2243101	1A	32 lb	14.51 kg	Dual Stage Reg.	Series 3120-350	299
Typical Analysis (mol/mol units)	G2243118	1R	22 lb	9.98 kg	Single Stage Reg.	Series 3530-350	313
CO/CO_2 < 2 ppm	G2243140	2	10 lb	4.54 kg	LB Regulator	Series 3550-170	314
Nitrogen < 3 ppm	G2243150	3	3 lb	1.36 kg	Tee Purge	4753-350	423
Oxygen < 1 ppm	G2243178	6	0.66 lb	300 gm	Personal Monitor	IQ250	398
Other Hydrocarbons < 6 ppm	G2243181	7	0.33 lb	150 gm	Leak Detector	8057	402
Water < 3 ppm							
A Certificate of Analysis is available on request at a nominal charge.							
Analysis for sulfurs, alcohols and hydrides can be done on a custom basis. Please inquire for more information.							
Ethane, Matheson Purity 99.99%	G1827001	1A	32 lb	14.51 kg	Dual Stage Reg.	Series 3120-350	299
Typical Analysis (mol/mol units)	G1827018	1R	22 lb	9.98 kg	Single Stage Reg.	Series 3530-350	313
CO/CO_2 < 5 ppm	G1827040	2	10 lb	4.54 kg	LB Regulator	Series 3550-170	314
Nitrogen < 10 ppm	G1827050	3	3 lb	1.36 kg	Tee Purge	4753-350	423
Oxygen < 4 ppm	G1827078	6	0.66 lb	300 gm	Personal Monitor	IQ250	398
Other Hydrocarbons < 80 ppm	G1827081	7	0.33 lb	150 gm	Leak Detector	8057	402
Water < 3 ppm							

510 | 500 psi | -40 Degrees to 150 Degrees F | - | 30E816 | $41.05 /Each

CGA INLET CONNECTOR, CGA NUMBER 510

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First and Second Stage System Clean-Up/ Flushing Procedures

CAUTION: Do NOT use a torch to un-braze any refrigerationlines, you must recover or vent the refrigerant from the systemfirst. For your safety, follow the procedure below in detail.

Perform the following procedures when flushing, charging and evacuating your ultra low temperature freezer.

1. Follow the “Power Down” procedure, then turn the power off by turning the switch to the Off position located on the back of the cabinet left bottom just above the power cord and disconnect the battery.
2. Unplug the power cord from the wall receptacle. regulations regarding tag-out and de-energize thepotential electrical sources.
3. Locate the first stage system, and install refrigeration linetaps (follow manufacturers guideline to install the line tapor use the Quick Piercing Tool) on to the process tubes ofboth the high and low side of the compressor.

Note: The process lines are identified using RED tape or paint on the tubing, about 4 inches back from the tubing end. The process tubes are the 1/4 inch stubbed-off lines attached to the system.

Note: Do not pierce the process lines at this time.

CAUTION: When working with refrigerants, hand, eye andface protection is required. Liquid refrigerants are very coldand may cause burns. There is also a possibility of an acidcondition due to a compressor burn-out.

Note: The flushing agent nPentane and the refrigerants usedin both the first and second stage systems are hydrocarbon refrigerants and are FLAMMABLE, and must be recovered before any torch work can be done.

Note: Part number in this drawing are not orderable part numbers, you will need to order service kits.

Note: It is suggested that you place a Hydro-carbon leak detector on the floor around when you begin the recovery and flushing. This will alert you if there is a HC leak in the area youare working, for your protection.

4. Using Line Taps or the Piercing Tool, connect refrigeranthoses to the line taps and the refrigeration compound manifold. Note: if you are using the Quick Piercing tool, follow step 5 for this procedure. Recover the refrigerant charge from the system in accordance to state and federal EPA regulations. The process line will need to bepierced after connection of the hoses to the manifold gauges.
5. Using the Quick Piercing Tool or the Brass Line Tap: youwill need two of these piercing tools (displayed in the above tools or the brass line taps), for recovery, one for the suctions (low side) and one on the high side. Also, you will need an evacuated 50 pound recovery tank. Make sure that the tank is in a deep 25 to 30 inch vacuum.
6. Recovery to a Tank: using an evacuated recovery tank, valve closed; connect the hose from the Quick Piercing Tool, to the tank. Now, install the Quick Piercing Tool onthe “high side” process tube and pierce the process line.Open the tank valve and the refrigerant from the cabinetprocess tubes will now flow to the evacuated recovery tank. The tank, if in a deep vacuum, will take the entire refrigerant charge from the first stage system. If the refrigerant recovery is slow, you can add the recovery process, by placing the recovery tank in ice, which will reduce the tank pressure and speed up the recovery.

7. Recovery to the Outside: it is legal (per the EPA) to recover and vent the R290 and R170 to the outside if youare servicing a cabinet in a shop or dock location. You just need to ensure that there must be No Source of ignition with 3 m or (approximately 10 feet) of the systemor where you are venting.

8. After recovering the refrigerant, purge the system with anitrogen charge. Only a low system charge is required
(5 to 10 psig) for about a 10 minute flow, to ensure that allthe R290 has been removed/flushed from the system, before using a torch. You can vent the nitrogen to the outside, do not vent in a closed room area.

9. Clean the tubing with a sanding cloth, at the location ofthe planned tubing cut, as described below.

Note: Do not use steel wool or sandpaper. A synthetic abrasive pad is preferred to avoid getting grit into the system.

10. Cut the tubing on the discharge side close to the end of the tube that was attached to the compressor and cut the tubing on the suction side close to the end of the tube where it was attached to the compressor. Use quick-connect adaptor valves or process tube adaptors as shown in the tools pictured below, or braze copper lines with access ports, to attach the flushing tubes to the suction and discharge process lines (see drawing below).

11. 1st Stage Flush; reverse flow process: liquid flush entersthrough normal suction tube and flush returns through normal discharge tube.

12. Remove and discard the current refrigerant drier. Attachquick-connects, or braze a copper tube with a flare adapter/connector, to complete the refrigeration loop (asshown in above parts pictures) so the liquid flushing solvent can enter through the suction process line and return through the discharge process line as a liquid.

Note: Allowing the liquid flush agent (nPentane) to soak in thesystem for a minimum of 30 minutes will provide better resultsin the cleaning process prior to flushing it out of the system.

Note: It is not recommended to use RX11 or Qwik System Flush, but can be used. What is recommended is nPentane inliquid state. Caution: nPentane is a FLAMMABLE refrigerant.Ensure that you have enough liquid for a liquid-in and liquid- out flow using vapor nitrogen to push the liquid Pentane through the freezer refrigeration system (as shown in the drawing above).

Note: While back-flushing this process should be done in anopen location like a dock area. You will need to be in an openarea, with plenty of ventilation.

13. **IMPORTANT:** Connect the nPentane bottle to a tee fitting (using a short hose from the bottle). Remember, you will need an nPentane bottle that has a liquid siphoned tube. Install a TEE fitting at the end of the

about 16 oz/0.453 kilograms of liquid to the suction process tube. Now, turn off the nPentane valve (or have acheck valve installed in the line) so nitrogen pressure does not push into the nPentane bottle. With the Nitrogen on, set the regulator to about 150 psig. Let theNitrogen push the liquid nPentane into the system. hose(see nPentane photo above), so nitrogen can push the liquid nPentane through the system. With the nitrogen tank valve closed, open the nPentane valve and weigh in

7. Recovery to the Outside: it is legal (per the EPA) to recover and vent the R290 and R170 to the outside if youare servicing a cabinet in a shop or dock location. You just need to ensure that there must be No Source of ignition with 3 m or (approximately 10 feet) of the systemor where you are venting.
   set for about 30 minutes and then open the high side valve on the process tube to allow the liquid and nitrogengas pressure to push through the cabinet. Note: this should be vented to the outside, using a hose that will reach outside.
14. When flushing of the system is complete, always install anew filter drier, compressor (if required) and any other components or tubing as necessary.
15. For evacuation and charging information, refer to **Refrigerant Charge Procedures** in this manual.
16. Remove any lockout tags or devices installed earlier, andthen connect the power cord to the power source.

Second Stage SystemClean-Up/Flushing Procedure

Note: Do not pierce the line at this time. Follow line tap manufacturing instructions for installation and line piercing ofsystem.

1. Follow steps 1 through 5 from First and Second StageSystem Clean-Up/Flushing Procedures above.
2. Locate the second stage system (refer to the drawing below), and install line taps to the process tubes of boththe high and low side of the compressor. The process tubes are the 1/4 inch stubbed-off lines attached to the system.
3. Reverse flow process: liquid flush enters through normalsuction tube and flush returns through normal dischargetube.

WARNING: When working with refrigerants, hand, eye and face protection is required. Liquid refrigerants are very cold and may cause burns. There is also a possibility of an acid condition due to a compressor burn-out.
CAUTION: The models use hydrocarbon refrigerants and MUST be recovered and nitrogen flushed before using a torch.

4. Recover the refrigerant charge from the system in accordance to State and Federal EPA regulations. The line will need to be pierced after connection of the hosesto the manifold gauges.
5. Recovery to a Tank: using an evacuated recovery tank, valve closed; connect the hose from the Quick Piercing Tool, to the tank. Now, install the Quick

about 16 oz/0.453 kilograms of liquid to the suction process tube. Now, turn off the nPentane valve (or have acheck valve installed in the line) so nitrogen pressure does not push into the nPentane bottle. With the Nitrogen on, set the regulator to about 150 psig. Let theNitrogen push the liquid nPentane into the system.
Piercing Tool on

the “high side” process tube and pierce the process line.Open the tank valve and the refrigerant from the cabinetprocess tubes will now flow to the evacuated recovery tank. The tank, if in a deep vacuum, will take the entire refrigerant charge from the first stage system. If the refrigerant recovery is slow, you can add process, by placing the recovery tank in ice, which will reduce the tank pressure and speed up the recovery.

6. Recovery to the Outside: it is legal (per the EPA) to recover and vent the R290 and R170 to the outside if youare servicing a cabinet in a shop or dock location. You just need to ensure that there must be NO Source of ignition with 3 m or (approximately 10 feet) of the systemor where you are venting.
7. After recovering the refrigerant, purge the system with a nitrogen charge. Only a low system charge is required (20 to 30 psig) for about a 10 minute flow, to ensure thatall the R290 has been removed/flushed from the system,before using a torch. You can vent the nitrogen to the outside, do not vent in a closed room area.
8. Clean the tubing with a sanding cloth, at the plannedlocation of the cut.

Note: Do not use any type of steel wool or sandpaper. Emery cloth is preferred. When cutting the tubing, use proper tubing cutters.

9. Cut the tubing on the discharge side of the system, as close to the compressor as possible. Do the same on thesuction side.
10. Install a quick-connect, or braze a 1/4 copper line and use a flare adapter/connector, for ease of connection tothe flushing hoses.
11. Remove the oil separator and the filter drier. Use quick-connect fittings i.e. process tube adaptors or brazea line in place of the oil separator and drier to allow a continuous flushing loop entering at the suction line and exiting at the discharge line as seen in the following diagram:

Note: It is not recommended to use RX11 or Qwik System Flush (but can be used). What is recommended is nPentane inliquid state.

CAUTION: nPentane is a FLAMMABLE refrigerant. Ensure that you have enough liquid for a liquid-in and liquid-out flowusing vapor nitrogen to push the liquid nPentane through thefreezer.

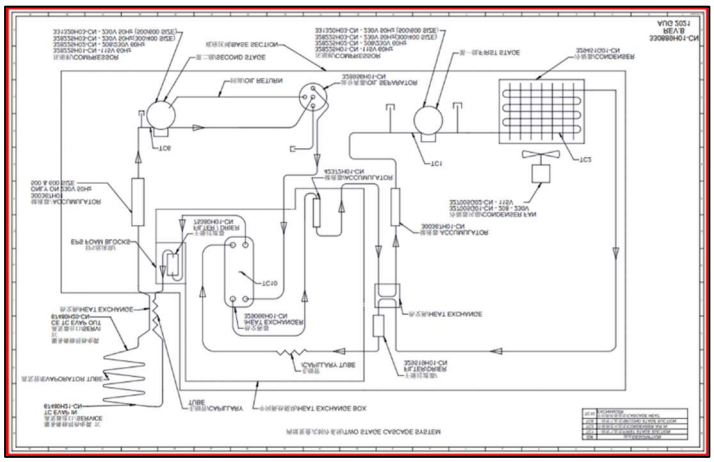


Figure 62. Refrigeration Diagram

12. During the flushing process, it is essential to keep a “liquid in” and “liquid out” flush. Use the shut-off valves on the end of the ¼" refrigerant hose to control the liquidflow.

CAUTION: While back-flushing, this process should be donein an open location, like a dock area. You will need to be in anopen area with plenty of ventilation.

13. **IMPORTANT**: Connect the nPentane bottle to a tee fitting to (using a short hose from the bottle) (Remember,you will need a nPentane bottle that has a liquid siphonedtube). Install a TEE fitting at the end of the hose (see nPentane photo above), so nitrogen can push the liquid nPentane through the system. With the nitrogen tank valve closed, open the nPentane valve and weigh in about 16 ounces /0.453 kilograms of liquid to the suctionprocess tube. Now, turn off the nPentane valve (or have acheck valve installed in the line) so nitrogen pressure does not push into the Pentane bottle. With the Nitrogenon, set the regulator to about 150 psig. Let the nitrogen push the liquid nPentane into the system. Let it sit for about 30 minutes and then open the high side valve on the process tube to allow the liquid and nitrogen gas pressure push through the cabinet. Note: this should bevented to the outside, using a hose that will reach outside.
14. Cleaning or flushing time depends on the recovery system used, the condition of the system being flushed,and the type of flushing solvent used.
15. When flushing of both sides of the system is complete, always install a new system liquid drier, (compressor if required) and any other components or tubing necessary.
16. To replace the drier and compressor, follow the procedures found in Instructions for 169 Replacing

the “high side” process tube and pierce the process line.Open the tank valve and the refrigerant from the cabinetprocess tubes will now flow to the evacuated recovery tank. The tank, if in a deep vacuum, will take the entire refrigerant charge from the first stage system. If the refrigerant recovery is slow, you can add Ṗarts.

17. For evacuation and charging information, refer to **Evacuation** in this manual.
18. Remove any lockout tags or devices installed earlier, andthen connect the power cord to the power source.
19. The system is now ready to run.

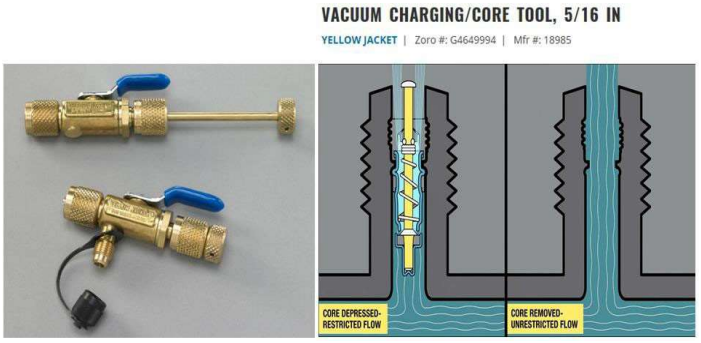
Evacuation

The process described presumes the system first has been back-flushed, has all necessary new components (compressor, heat exchange box, oil separator and filter/drier)with new dry refrigerant oil, and is properly sealed and leak- tested. A quick summary of the technique is to pull the systemdown to 1,500 microns, break the vacuum with a dry nitrogensweep and 10 minute low pressure Nitrogen soak, then evacuate to 500 microns, allow another nitrogen sweep and soak, then evacuate to <50 microns, then maintain a blank offof <200 microns for 20 minutes. The blank off goal is 400 microns for 20 minutes if components and oil are not replaced. The detailed method recommended is as follows:

Equipment Required

- Vacuum pump capable of achieving <40 microns of vacuum, plus clean vacuum pump oil. The size of thepump is not critical, as long as it will achieve <40 microns.
- Analog or digital vacuum gauge capable of measuring <50 microns in 10 micron increments or better. The typical manifold gauge cannot make this measurement.
- A clean 4-valve manifold gauge set, normally one reserved only for evacuation and charging procedures.The style of 4-valve manifold with a 5th access port willallow for adding the nitrogen sweep without disconnecting any of the copper evacuation lines.
- A source of clean dry nitrogen (N2).
- Copper tubing for connection of pump and micron gaugeto manifold. Use of rubber hoses for evacuation can delay or prevent achieving low evacuation levels. Quarterinch copper process lines with flared ends allow ready connection to most manifold gauge sets.
- Normal flaring tool and fittings will be needed to make thecopper tubing connections.





Triple Evacuation Method

1. Using the valves on the manifold gauge set; release thenitrogen leak test pressure almost down to 0 psig. A slight residual pressure is acceptable to keep air and moisture from entering the system.
2. Connect the vacuum pump to the gauge manifold at thedesired port, using copper tubing with flared connector fittings (preferably a double flare fitting).
3. Connect the micron gauge to the desired gauge manifoldport, using copper tubing with flared connector fittings. Ifthis port will also be used to introduce the nitrogen gas sweep, then a “T” fitting with valved access port needs tobe added so that the micron gauge can be isolated fromthe system during the nitrogen sweep. Otherwise, the micron gauge will have to be disconnected, and then reconnected for each nitrogen sweep, increasing the chance for a leak at this connection.
4. Once all connections have been made, the next step is totest the capacity of the vacuum pump and the micron gauge connections. Review proper vacuum pump operation, including the use of the isolation or blank-off valve, and the ballast valve, if so equipped.
5. With all valves closed, start the vacuum pump.
6. Open the vacuum pump isolation valve, if so equipped.
7. Open the vacuum pump ballast port, if so equipped, andallow the line leading up to the manifold to evacuate for aminute or two. All valves on the manifold should still be closed.
8. Open the manifold valve to the vacuum pump.
9. Open the manifold valve to the vacuum micron gauge.Keep the suction and discharge valves closed.
10. Turn on the micron gauge. Monitor the operation of thegauge and the ability of the pump to pull down toward the pump’s lower micron capacity as seen in the photobelow:

Figure 63. Triple Evacuation Method

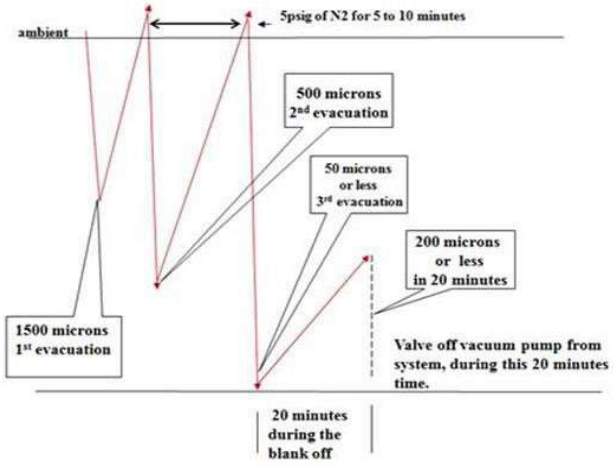
a. Close the vacuum pump ballast port to achieve maximum capacity. If the pump cannot pull down toward its lower limit, then a possible leak in the connections, contaminated vacuum pump oil, a micron gauge problem, or a manifold valve problemexists.

b. A vacuum fewer than 100 microns must be achievedat this step before proceeding. Pressure-test the connections and valves, change the pump oil, cleanor replace the micron gauge sensor, change gauge batteries, and do whatever else is needed to complete this step.

11. After the pump and gauge have passed the previousstep, it is time to evacuate the system.
12. Open the pump ballast port, if so equipped. The microngauge may show an increase or loss of vacuum. The micron gauge can be turned off or valve off at this time until a deep vacuum is expected, at a later time.
13. Open the manifold valves to the suction and discharge side of the system. Expect the micron gauge to rise to atmospheric pressure and the sound of the pump to change as the residual nitrogen left in the system passesthrough the vacuum pump.
14. Allow the pump to run for at least 10 or 15 minutes with the ballast valve open, and then check the vacuum on the micron gauge. When the micron gauge shows a valuebelow 5,000 microns, the ballast port can be closed. Failure to use the ballast port may cause the vacuum pump oil to become contaminated and require more frequent changing.
15. With the ballast valve closed, allow the system to pump down to <1500 microns. The evacuation will proceed more quickly and effectively if slight heat is provided to system components where feasible. Normal work lights placed next to compressors and oil separators should beadequate. If the cabinet evaporator is being evacuated, alight may be placed inside the cabinet, but the cabinet door must be left open or the interior will overheat and may be damaged, even with a small wattage bulb.
16. If the system will not pull down to 1,500 microns after several hours of evacuation, check for a leak, contamination in the system, dirty vacuum pump oil, or some type of failure of the evacuation equipment or connections. This is especially true if the system reachessome micron level and then hangs there for hours. The problem must be found and corrected, or evacuation cannot be accomplished. Regardless of other solutions, changing the vacuum pump oil is always recommended when evacuation appears slow or stalled.
17. When the system achieves 1,500 microns or less, close all the manifold valves. Allow the vacuum pump to run since it will be needed again shortly, but keep the manifold valve to the vacuum pump closed during the nitrogen purge process. Prepare to introduce the nitrogensweep by connecting the nitrogen supply to the 5th manifold access port, or valve system set up for this requirement. Disconnecting the micron gauge for this step will work, but is not ideal as it allows this connectionpoint to become a possible leak problem when evacuation continues.
18. Introduce a low pressure nitrogen sweep into the systemthrough the suction manifold valve while keeping the discharge valve closed, raising pressure to no more than5 or 10 psig. Watch for the pressure to increase on the discharge gauge, showing that the cap tube is allowing flow from the evaporator side to the condenser side of the system. If the pressures do not equalize in a few minutes, check for an obstructed cap tube, which will require flushing or replacing, if possible.
19. After pressures have equalized at the 5 or 10 psig level,allow the nitrogen to “soak” for approximately 10 to 20 minutes.
20. After a reasonable soak period, open the discharge manifold valve and release the nitrogen sweep down toapproximately 0 psig.
21. With the micron gauge still in place or reconnected, startthe evacuation procedure again as described in Step 5 above. It is good practice to retest connections and the vacuum pump capacity and micron gauge before opening the system, especially if any of the connections were disturbed during the nitrogen sweep process.
22. Once the vacuum pump and micron gauge show goodperformance, the open the manifold suction and discharge valves to restart the evacuation process. Remember to use the ballast port until the residual nitrogen sweep has been pulled out and the micron gauge shows a good rate of pull down, below 5,000 microns.
23. Allow the system to evacuate down to 500 microns. If thepull down process stalls below 1,500 microns, but above500 microns, check for contamination or a very small leak. In this case, it is best to change the vacuum pump oil and let the system pull down overnight. A residual

amount of contamination may be eliminated by overnightevacuation, but a leak will persist and must be corrected.

24. When the system pulls down to <500 microns, perform another nitrogen sweep as described in Step 18.
25. After completion of the second nitrogen sweep, restart Depending on how fast the system pulled down to 500 microns, it may be prudent to change the vacuum pumpoil at this point. Remember that the final goal of 50 microns cannot be achieved with contaminated vacuumpump oil.
26. Allow the system to run until the micron gauge shows 50 microns or less. If the system does not reach 50 microns after a reasonable time, at least within 24 hours, blank offthe system and see if 200 microns or less can be held for20 minutes.
27. If the system cannot hold a 200 micron blank off with new components and new dry refrigerant oil in the system, then change the vacuum pump oil and continuethe process until the 200 micron blank off can be achieved.
28. A system with reused components and refrigerant oil is considered dry, if a 400 micron blank off for 20 minutescan be achieved.
29. Once the blank off goal has been achieved, the system isready for refrigerant charging. If properly set up, the unit can be charged through the same access point that the nitrogen sweep was introduced. Follow the factory recommended charging procedure for the system beingserviced.



CAUTION: When working with refrigerants, hand, eye and face protection is required. Liquid refrigerants are very cold innature; therefore may cause burns. There may also be a possibility of an acid condition due to a compressor burnout.**CAUTION:** If charging both stages, always charge the second stage first to prevent cooling the interstage heat exchanger. A cold heat exchanger will cause the second stage static charge to be an overcharge, due to the loweredtemperature and pressure of the R170.
CAUTION: Do not leave Schrader valve core removal toolson the process tube after completion of the repair.

Refrigerant Charge

Model Specific Charging Notes

Follow the charging quantities for the model you have from the data plate and from Charge Table by Mass.

Be certain you use the correct charging tables for the unit being serviced.

CAUTION: All refrigerants used in these models are HYDROCARBON REFRIGERANTS and are FLAMMABLE.
Follow all safety procedures to ensure your safety.

General Safety

- The area must be well ventilated.
- There must be no source of ignition within 3 m or(approximately 10 feet) of the system.
- After Recovery of the HC refrigerant from the cabinet, youmust flush the system with nitrogen for a minimal time of10 minutes to ensure that the HC refrigerant has been push out of the system.
- HC Refrigerants can be released to the outside atmosphere, but again make sure that there is NO sourceof ignition near where you are venting.

The safe zone also applies around the vacuum pump, because it could discharge HC refrigerants to the atmosphere.

Charging First Stage

At this point the proper evacuation and micron blank offvalues should have been achieved.

- Weigh the 1st stage charge assembly bottle. Confirmweight matches factory weight listed on the chargingbottle, or the 400 gram R290 bottle.
- Connect the 1st stage charge bottle to the manifoldgauge.
- Leaving the vacuum hose on the gauge manifold vacuumport and still connected to the vacuum pump. Ensure that the high and low side hand valves on the gauge manifold are closed. Ensure that the valve on the R290 bottle is closed. With the vacuum pump running, open the gauge valve on the manifold to the hose connected tothe R290 bottle. This will vacuum any air from the hose.
- Now that the charging hose is evacuated, turn off the valve on the gauge manifold to the vacuum pump. Turnoff the vacuum pump.

Figure 64. Charging 1st Stage

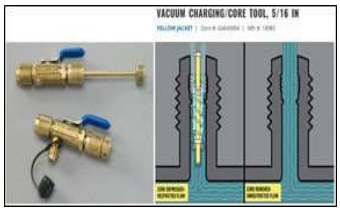
- Open the charge assembly bottle valve and open the suction line port of the digital manifold gauge to allow theunit vacuum to pull in the refrigerant charge until it equalizes.
- Then, plug in and turn the unit on, from the home screenenter the hidden service mode
- Once in the service mode enter the diagnostic mode and to run condenser fan and 1st stage compressor on high speeds.
- Allow the compressor to run for 10 minutes and ensure the heat exchange temperature is below -45° C. This willensure that the charge is being pulled into the 1st stage refrigeration system. Monitor the digital scales as the charge is being pulled into the system to the suggested grams in the chart on the next slide +/- 3 grams, per thedata plate or service manual charge amounts.
- Now, close the manifold gauge charging port anddisconnect the charge assembly bottle.
- Weigh bottle again to verify that correct charge amount +/-3 grams has been charged into the first stage system.
- Upon completion of the charging procedure, the systemis ready to test run.
- Watch the system pull down and record the pressure reading for future troubleshooting. The charge should notrequire adjustment, but can be adjusted, if necessary. After the system is operating satisfactorily, turn the system off and allow system pressure to equalize.

Table 30. STP II Suffix 83 and > mass charge table

Model - ULTS	1st Stage R290 (g)	2nd Stage R290 (g)	2nd Stage R170 (g)
300 A/D	79	11	79
300 V	78	11	92
400 A/D	79	11	85
400 V	78	11	92
500 A/D	79	11	91
500 V	75	11	95
600 A/D	79	11	92
600 V	81	11	100

Note: Hoses are not suggested for the Low and High side ofthe system. Copper tubing is suggested and digital gauge forthe accuracy.

Note: It is very important, that you pinch off, or seal the process tube adapters for the high side process line first (using the pinch off tools shown below. With the compressorrunning, open the manifold gauge high side and low side hand valves so the gas in the high side hose to the process tube is recovered through the manifold to the low side. It willpull into a vacuum or whatever the suction line pressure is. Now, close the high side valve and the low side valve. If you are using the type of Universal Line Service valves with the Schrader core, then the hose can be removed and the capstightened using wrenches.



Second Stage Charging

CAUTION: When working with refrigerants, hand, eye and face protection is required. Liquid refrigerants are very cold and can cause burns. The possibility of an acid condition due to a compressor burnout also exists. Note: both refrigerants in the second stage are hydrocarbon refrigerants and are FLAMMABLE.

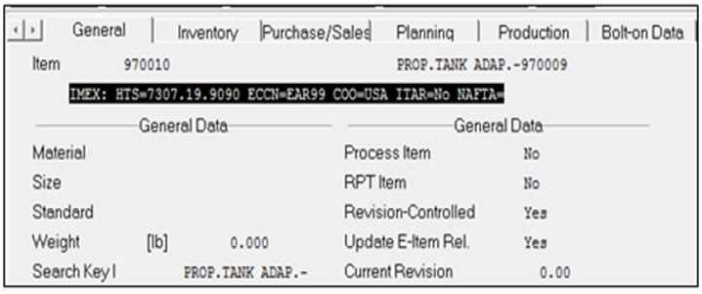
After the cabinet (second stage) has met the blank-off requirements in microns, the system is ready to charge the required refrigerant(s). A mixed refrigerant charge is used in second stage systems; for example, R290 and R170.

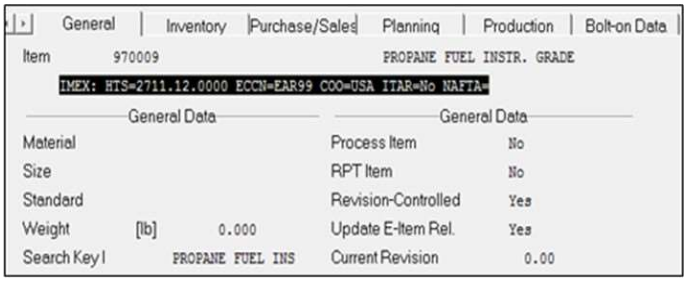
Note: R290 is high purity (99.2%) instrument grade propane. Using lesser grades of propane may cause system failure. Engineering suggested grade is 99.5% instrument grade
propane is preferred.

When charging a system using multiple refrigerants, charge the R290 (instrument grade propane) first, due to its low static pressure. Follow with the R170 refrigerant (Ethane).

Charging 2nd Stage by Mass

Model	2nd Stage R290 (Propane)	2nd Stage R170 (Ethane)
300 A/D	11g	79g
300 V	11g	92g
400 A/D	11g	85g
400V	11g	92g
500 A/D	11g	91g
500V	11g	95g
600 A/D	11g	92g
600 V	11g	100g





- With the vacuum pump still connected to the vacuum port on the (4 stage) digital manifold gauge, open the gauge valve, and turn on the vacuum pump. This will clear any air in the hose from the gauge to the R290 bottle.
- Close the charging port valve on the gauge manifold and turn off the vacuum pump.
- The R290 should be charged into the suction side from micron level value to appropriate mass charge value. The charge values are critical and a digital manifold gauge must be used to ensure the charge accuracy.
- Close all of the manifold valves and the R290 bottle.
- Weigh the R290 charging cylinder again to verify that the correct weight of R290 has been charged into the system.

- Disconnect R290 bottle and connect the R170
- With the vacuum pump still connected to the vacuum port on the (4 stage) gauge manifold, open the gauge valve, and turn on the vacuum pump. This will clear any air in the hose from the gauge to the R170 bottle.
- Open the R170 bottle and the charging port of the Manifold gauge
- Open the low and high side of the manifold gauge, bring the 2nd stage R170 mass charge to the appropriate level.
- Close the manifold gauge valve and then close the R170 bottle valve.
- Weigh the R170 charging cylinder again to verify that the correct weight in grams of R170 has been charged into the system.
- Now that you have completed the charging procedure, the system is ready to test run.
- Watch the system pull down. The charge should not have to be adjusted, but can be, if necessary. After the system isoperating satisfactorily.
- Do not start pull down test in BOT mode or by using diagnostic mode (BOT and Diagnostic mode high speeds run both the first and the second stage compressors at the maximum RPM values.)
- If charging both 1st and 2nd stage, ensure to charge the 2nd stage system first.

Diagrams, Drawings and Schematics

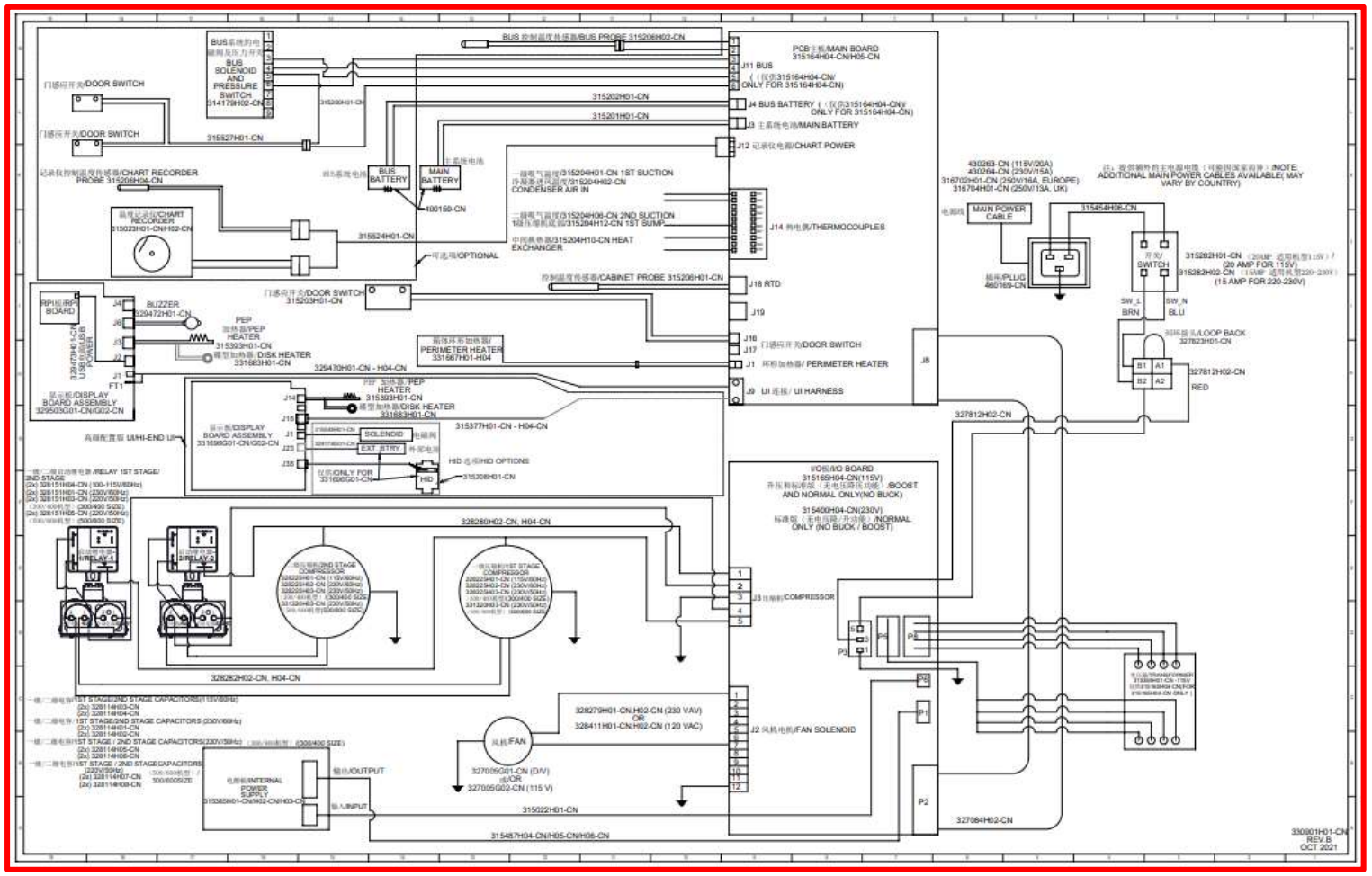


Figure 65. Electrical Diagram

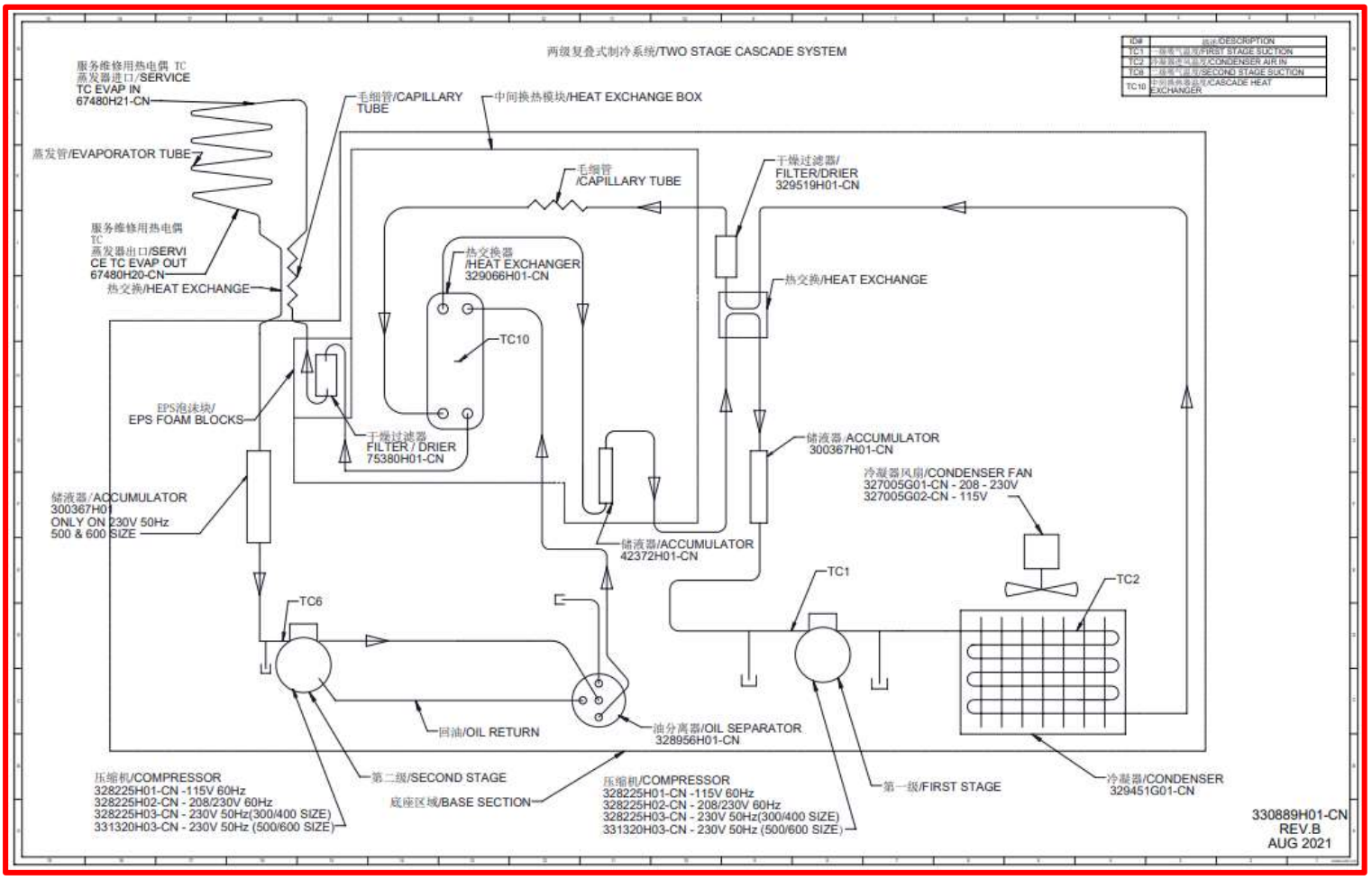


Figure 66. Refrigeration Diagram

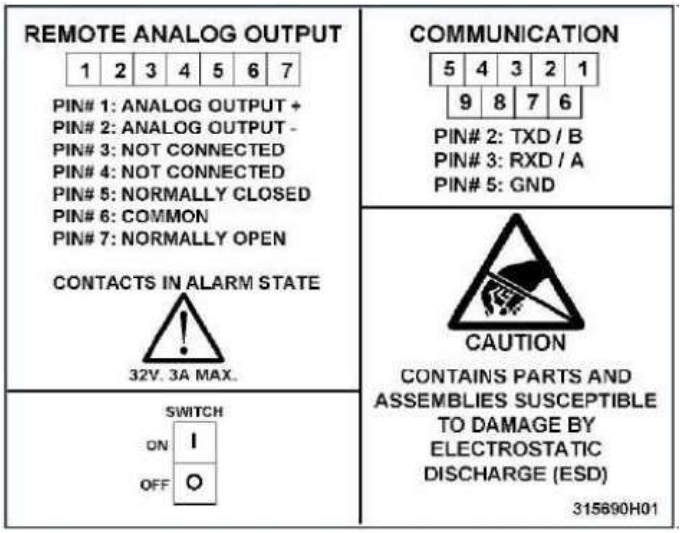
Conversion and Reference Tables*

Deg C	Deg	Deg F	Deg C	Deg	Deg F	Deg C	Deg	Deg F
-101.1	-150	-238.0	-48.9	-56	-68.8	-23.3	-10	14.0
-98.3	-145	-229.0	-48.3	-55	-67.0	-22.8	-9	15.8
-95.6	-140	-220.0	-47.8	-54	-65.2	-22.2	-8	17.6
-92.8	-135	-211.0	-47.2	-53	-63.4	-21.7	-7	19.4
-90.0	-130	-202.0	-46.7	-52	-61.6	-21.1	-6	21.2
-87.2	-125	-193.0	-46.1	-51	-59.8	-20.6	-5	23.0
-84.4	-120	-184.0	-45.6	-50	-58.0	-20.0	-4	24.8
-81.7	-115	-175.0	-45.0	-49	-56.2	-19.4	-3	26.6
-78.9	-110	-166.0	-44.4	-48	-54.4	-18.9	-2	28.4
-76.1	-105	-157.0	-43.9	-47	-52.6	-18.3	-1	30.2
-73.3	-100	-148.0	-43.3	-46	-50.8	-17.8	0	32.0
-70.6	-95	-139.0	-42.8	-45	-49.0	-17.2	1	33.8
-67.8	-90	-130.0	-42.2	-44	-47.2	-16.7	2	35.6
-67.2	-89	-128.2	-41.7	-43	-45.4	-16.1	3	37.4
-66.7	-88	-126.4	-41.1	-42	-43.6	-15.6	4	39.2
-66.1	-87	-124.6	-40.6	-41	-41.8	-15.0	5	41.0
-65.6	-86	-122.8	-40.0	-40	-40.0	-14.4	6	42.8
-65.0	-85	-121.0	-39.4	-39	-38.2	-13.9	7	44.6
-64.4	-84	-119.2	-38.9	-38	-36.4	-13.3	8	46.4
-63.9	-83	-117.4	-38.3	-37	-34.6	-12.8	9	48.2
-63.3	-82	-115.6	-37.8	-36	-32.8	-12.2	10	50.0
-62.8	-81	-113.8	-37.2	-35	-31.0	-11.7	11	51.8
-62.2	-80	-112.0	-36.7	-34	-29.2	-11.1	12	53.6
-61.7	-79	-110.2	-36.1	-33	-27.4	-10.6	13	55.4
-61.1	-78	-108.4	-35.6	-32	-25.6	-10.0	14	57.2
-60.6	-77	-106.6	-35.0	-31	-23.8	-9.4	15	59.0
-60.0	-76	-104.8	-34.4	-30	-22.0	-8.9	16	60.8
-59.4	-75	-103.0	-33.9	-29	-20.2	-8.3	17	62.6
-58.9	-74	-101.2	-33.3	-28	-18.4	-7.8	18	64.4
-58.3	-73	-99.4	-32.8	-27	-16.6	-7.2	19	66.2

Deg C	Deg	Deg F	Deg C	Deg	Deg F	Deg C	Deg	Deg F
-57.8	-72	-97.6	-32.2	-26	-14.8	-6.7	20	68.0
-57.2	-71	-95.8	-31.7	-25	-13.0	-6.1	21	69.8
-56.7	-70	-94.0	-31.1	-24	-11.2	-5.6	22	71.6
-56.1	-69	-92.2	-30.6	-23	-9.4	-5.0	23	73.4
-55.6	-68	-90.4	-30.0	-22	-7.6	-4.4	24	75.2
-55.0	-67	-88.6	-29.4	-21	-5.8	-3.9	25	77.0
-54.4	-66	-86.8	-28.9	-20	-4.0	-3.3	26	78.8
-53.9	-65	-85.0	-28.3	-19	-2.2	-2.8	27	80.6
-53.3	-64	-83.2	-27.8	-18	-0.4	-2.2	28	82.4
-52.8	-63	-81.4	-27.2	-17	1.4	-1.7	29	84.2
-52.2	-62	-79.6	-26.7	-16	3.2	-1.1	30	86.0
-51.7	-61	-77.8	-26.1	-15	5.0	-0.6	31	87.8
-51.1	-60	-76.0	-25.6	-14	6.8	0.0	32	89.6
-50.6	-59	-74.2	-25.0	-13	8.6	0.6	33	91.4
-50.0	-58	-72.4	-24.4	-12	10.4	1.1	34	93.2
-49.4	-57	-70.6	-23.9	-11	12.2	1.7	35	95.0

°C	Ohms	°C	Ohms	°C	Ohms	°C	Ohms
-100	602.60	-55	783.20	-10	960.90	35	1136.1
-99	606.70	-54	787.20	-9	964.80	36	1139.9
-98	610.70	-53	791.10	-8	968.70	37	1143.8
-97	614.80	-52	795.10	-7	972.60	38	1147.7
-96	618.70	-51	799.10	-6	976.50	39	1151.5
-95	622.90	-50	803.10	-5	980.40	40	1155.4
-94	626.90	-49	807.00	-4	984.40	41	1159.3
-93	631.00	-48	811.00	-3	988.30	42	1163.1
-92	635.00	-47	815.00	-2	992.20	43	1167.0
-91	639.10	-46	818.90	-1	996.10	44	1170.8
-90	643.00	-45	822.90	0	1000.00	45	1174.7
-89	647.00	-44	826.90	1	1003.90	46	1178.5
-88	651.10	-43	830.80	2	1007.80	47	1182.4
-87	655.10	-42	834.80	3	1011.70	48	1186.2

°C	Ohms	°C	Ohms	°C	Ohms	°C	Ohms
-86	659.10	-41	838.80	4	1015.60	49	1190.1
-85	663.10	-40	842.70	5	1019.50	50	1194.0
-84	667.20	-39	846.70	6	1023.40		
-83	671.20	-38	850.60	7	1027.30		
-82	675.20	-37	854.60	8	1031.20		
-81	679.20	-36	858.50	9	1035.10		
-80	683.30	-35	862.50	10	1039.00		
-79	687.30	-34	866.40	11	1042.90		
-78	691.30	-33	870.40	12	1046.80		
-77	695.30	-32	874.30	13	1050.70		
-76	699.30	-31	878.30	14	1054.60		
-75	703.30	-30	882.20	15	1058.50		
-74	707.30	-29	886.20	16	1062.40		
-73	711.30	-28	890.10	17	1066.3		
-72	715.30	-27	894.00	18	1070.2		
-71	719.30	-26	898.00	19	1074.0		
-70	723.30	-25	901.90	20	1077.9		
-69	727.30	-24	905.90	21	1081.8		
-68	731.30	-23	909.80	22	1085.7		
-67	735.30	-22	913.70	23	1089.6		
-66	739.30	-21	917.70	24	1093.5		
-65	743.30	-20	921.60	25	1097.3		
-64	747.30	-19	925.50	26	1101.2		
-63	751.30	-18	929.50	27	1105.1		
-62	755.30	-17	933.40	28	1109.0		
-61	759.30	-16	937.30	29	1112.8		
-60	763.30	-15	941.20	30	1116.7		
-59	767.30	-14	945.20	31	1120.6		
-58	771.30	-13	949.10	32	1124.5		
-57	775.20	-12	953.00	33	1128.3		
-56	779.20	-11	956.90	34	1132.2		



Temperature °C	Milliamp	4-20 mA / 250 W Ohmresistor (
-113	4.192	1.048
-112	4.288	1.072
-111	4.384	1.096
-110	4.480	1.120
-109	4.578	1.145
-108	4.676	1.169
-107	4.774	1.194
-106	4.872	1.218
-105	4.970	1.243
-104	5.066	1.267
-103	5.162	1.291
-102	5.285	1.315
-101	5.354	1.339
-100	5.450	1.363
-99	5.548	1.387
-98	5.642	1.412
-97	5.744	1.436
-96	5.842	1.461
-95	5.940	1.485
-94	6.036	1.509

Temperature °C	Milliamp	4-20 mA / 250 W Ohmresistor (
-93	6.132	1.533
-92	6.228	1.557
-91	6.324	1.581
-90	6.420	1.605
-89	6.518	1.630
-88	6.616	1.654
-87	6.714	1.679
-86	6.812	1.703
-85	6.910	1.728
-84	7.006	1.752
-83	7.102	1.776
-82	7.198	1.800
-81	7.294	1.824
-80	7.390	1.848
-79	7.488	1.872
-78	7.586	1.897
-77	7.684	1.921
-76	7.782	1.946
-75	7.880	1.970
-74	7.976	1.994
-73	8.072	2.018
-72	8.168	2.042
-71	8.264	2.066
-70	8.360	2.090
-69	8.458	2.115
-68	8.556	2.139
-67	8.654	2.164
-66	8.752	2.188
-65	8.850	2.213
-64	8.946	2.237
-63	9.042	2.261

Temperature °C	Milliamp	4-20 mA / 250 W Ohmresistor (
-62	9.138	2.285
-61	9.234	2.309
-60	9.330	2.333
-59	9.428	2.357
-58	9.526	2.382
-57	9.624	2.406
-56	9.722	2.431
-55	9.820	2.455
-54	9.916	2.479
-53	10.012	2.503
-52	10.108	2.527
-51	10.204	2.551
-50	10.300	2.575
-49	10.398	2.600
-48	10.496	2.624
-47	10.594	2.649
-46	10.692	2.673
-45	10.790	2.698
-44	10.886	2.722
-43	10.982	2.746
-42	11.078	2.770
-41	11.174	2.794
-40	11.270	2.818
-39	11.368	2.842
-38	11.466	2.867
-37	11.564	2.891
-36	11.662	2.916
-35	11.760	2.940
-34	11.856	2.964
-33	11.952	2.988
-32	12.048	3.012

Temperature °C	Milliamp	4-20 mA / 250 W Ohmresistor (
-31	12.144	3.036
-30	12.240	3.060
-29	12.338	3.085
-28	12.436	3.109
-27	12.534	3.134
-26	12.632	3.158
-25	12.730	3.183
-24	12.826	3.207
-23	12.922	3.231
-22	13.018	3.255
-21	13.114	3.279
-20	13.210	3.303
-19	13.308	3.327
-18	13.406	3.352
-17	13.504	3.376
-16	13.602	3.401
-15	13.700	3.425
-14	13.796	3.449
-13	13.892	3.473
-12	13.988	3.497
-11	14.084	3.521
-10	14.180	3.545
-9	14.278	3.570
-8	14.376	3.594
-7	14.474	3.619
-6	14.572	3.643
-5	14.670	3.668
-4	14.766	3.692
-3	14.862	3.716
-2	14.958	3.740
-1	15.054	3.764

Temperature °C	Milliamp	4-20 mA / 250 W Ohmresistor (
0	15.150	3.788
1	15.248	3.812
2	15.346	3.837
3	15.444	3.861
4	15.542	3.886
5	15.640	3.910
6	15.736	3.934
7	15.832	3.958
8	15.928	3.982
9	16.024	4.006
10	16.120	4.030
11	16.218	4.055
12	16.316	4.079
13	16.414	4.104
14	16.512	4.128
15	16.610	4.153
16	16.706	4.177
17	16.802	4.201
18	16.898	4.225
19	16.994	4.249
20	17.090	4.273
21	17.188	4.297
22	17.286	4.322
23	17.384	4.346
24	17.482	4.371
25	17.580	4.395
26	17.676	4.419
27	17.772	4.443
28	17.868	4.467
29	17.964	4.491
30	18.060	4.515

Temperature °C	Milliamp	4-20 mA / 250 W Ohmresistor (
31	18.158	4.540
32	18.256	4.564
33	18.354	4.589
34	18.452	4.613
35	18.550	4.638
36	18.646	4.662
37	18.742	4.686
38	18.838	4.710
39	18.934	4.734
40	19.030	4.758
41	19.128	4.782
42	19.226	4.807
43	19.324	4.831
44	19.422	4.856
45	19.520	4.880
46	19.616	4.904
47	19.712	4.928
48	19.808	4.952
49	19.904	4.976
50	20.000	5.000

Appendices

Appendix A: Modbus ASCII Parameter Table

Protocol	MODBUS ASCII
Baud Rate	2400bps to 57.6Kbps
Data Bits	7
Stop Bits	1
Partity	Even
Flow Control	None
Address	0 to 255

S.No	Parameter	Function Code	Address in hex	Size	Modbus Command	RE Response	Data	Data Type	Remarks
1	Cabinet Setpoint (C)	0x03	530	2	3a 31 39 30 33 **30 35 33 30** 30 30 30 32 41 44 0d 0a	3A 31 39 30 33 30 34 **46 46 46 46 46 43 45 30** 30 32 0D 0A	0xFFFFFCE0	int	Convert the data value into signed 2's complement and divide with 10,which gives the setpoint. Ex: Signed 2's complent of the 0xFFFFFCE0 is equal to -800. -800/10= -80. So the Setpoint is -80C.
2	Warm Alarm Setpoint (C)	0x03	538	2	3a 31 39 30 33 **30 35 33 38** 30 30 30 32 41 35 0d 0a	3A 31 39 30 33 30 34 **46 46 46 46 46 46 44 34 34** 39 44 0D 0A	0xFFFFFD44	int	Convert the data value into signed 2's complement and divide with 10,which gives the setpoint. Ex: Signed 2's complent of the 0xFFFFFD44 is equal to -700. -700/10= -70. So the WA Setpoint is -70 C.

S.No	Parameter	Function Code	Address in hex	Size	Modbus Command	RE Response	Data	Data Type	Remarks
3	Cold Alarm Setpoint (C)	0x03	53C	2	3a 31 39 30 33 **30 35 33 43** 30 30 30 32 41 31 0d 0a	3A 31 39 30 33 30 34 **46 46 46 46 46 43 37 43** 36 36 0D 0A	0xFFFFFC7C	int	Convert the data value into signed 2's complement and divide with 10, which gives the setpoint. Ex: Signed 2's complent of the 0xFFFFFC7C is equal to -900. -900/10=-90. So the CA Setpoint is -90C.
4	Smart Part number	0x03	570	2	3a 31 39 30 33 **30 35 37 30** 30 30 30 41 36 35 0d 0a	3A 31 39 30 33 32 34 **33 31 33 35 33 35 34 34 35 32 33 30 34 31 33 30 33 31 35 32 32 30 32 30 32 30 32 30 32 30 32 30 32 30 32 30 32 30 32 30 44** 30 0D 0A	155DR0A01R	string	All the remaining are spaces.
5	Product ID	0x03	598	2	3a 31 39 30 33 **30 35 39 38** 30 30 30 32 34 35 0d 0a	3A 31 39 30 33 30 34 **30 30 30 31 45 32 34 30** 42 39 0D 0A	0x001E240	uint	123456d would be encoded as 0x01E240.

S.No	Parameter	Function Code	Address in hex	Size	Modbus Command	RE Response	Data	Data Type	Remarks
6	Control Model	0x03	59C	1	3a 31 39 30 33 **30 35 39 43** 30 30 30 31 34 32 0d 0a	3A 31 39 30 33 30 32 **30 34** 44 45 0D 0A	0x04	uchar	**Note:** bits b4:b1 0000: PEEK Production Code (CNTRL 0) 0002: Variable Speed Compressor (CNTRL 2) 0003: Single Speed and Cascade System (CNTRL 3) 0004: Single Speed and Single Stage System (CNTRL 4) 0005: Single Speed and Cascade System (CNTRL 5)
7	Size	0x03	59D	1	3a 31 39 30 33 **30 35 39 44** 30 30 30 31 34 31 0d 0a	3A 31 39 30 33 30 32 **30 32** 45 30 0D 0A	0x02	uchar	5 units sizes 0 - 300, 1-400, 2-500, 3-600, 4-700
8	TC1	0x03	4C8	2	3a 31 39 30 33 **30 34 43 38** 30 30 30 32 31 36 0d 0a	3A 31 39 30 33 30 34 **34 31 42 34 33 31 39 31** 32 31 0D 0A	0x41B83191	Float	Convert the Float to decimal with below steps: 1. Open the link https://www.h-schmidt.net/FloatConverter/IEEE754.html 2. Paste the date in “Hexadecimal Representation” and press Enter. 3. The temp value is shown in “Decimal representation”

S.No	Parameter	Function Code	Address in hex	Size	Modbus Command	RE Response	Data	Data Type	Remarks
9	TC2	0x03	4CC	2	3a 31 39 30 33 **30 34 43 43** 30 30 30 32 31 32 0d 0a	3A 31 39 30 33 30 **34 34 31 42 42 34 34 45 34** 42 34 0D 0A	0x41BB48E4	Float	Convert the Float to decimal with below steps: 1. Open the link https://www.h-schmidt.net/FloatConverter/IEEE754.html 2. Paste the date in “Hexadecimal Representation” and press Enter. 3. The temp value is shown in “Decimal representation”
10	TC3	0x03	4D0	2	3a 31 39 30 33 **30 34 44 30** 30 30 30 32 30 45 0d 0a	3A 31 39 30 33 30 34 **34 31 42 42 30 43 41 43** 32 34 0D 0A	0x41BB0CAC	Float	Convert the Float to decimal with below steps: 1. Open the link https://www.h-schmidt.net/FloatConverter/IEEE754.html 2. Paste the date in “Hexadecimal Representation” and press Enter. 3. The temp value is shown in “Decimal representation”
11	TC4	0x03	4D4	2	3a 31 39 30 33 **30 34 44 34** 30 30 30 32 30 41 0d 0a	3A 31 39 30 33 30 34 **34 31 45 35 34 31 36 45** 43 37 0D 0A	0x41E5816E	Float	Convert the Float to decimal with below steps: 1. Open the link https://www.h-schmidt.net/FloatConverter/IEEE754.html 2. Paste the date in “Hexadecimal Representation” and press Enter. 3. The temp value is shown in “Decimal representation”

S.No	Parameter	Function Code	Address in hex	Size	Modbus Command	RE Response	Data	Data Type	Remarks
12	TC5	0x03	4D8	2	3a 31 39 30 33 **30 34 44 38** 30 30 30 32 30 36 0d 0a	3A 31 39 30 33 30 34 **43 32 46 45 30 30 30 30** 31 43 0D 0A	0xC2FE0000	Float	Convert the Float to decimal with below steps: 1. Open the link https://www.h-schmidt.net/FloatConverter/IEEE754.html 2. Paste the date in “Hexadecimal Representation” and press Enter. 3. The temp value is shown in “Decimal representation”
13	TC6	0x03	4DC	2	3a 31 39 30 33 **30 34 44 43** 30 30 30 32 30 32 0d 0a	3A 31 39 30 33 30 34 **43 32 46 45 30 30 30 30** 31 43 0D 0A	0xC2FE0000	Float	Convert the Float to decimal with below steps: 1. Open the link https://www.h-schmidt.net/FloatConverter/IEEE754.html 2. Paste the date in “Hexadecimal Representation” and press Enter. 3. The temp value is shown in “Decimal representation”
14	TC7	0x03	2.00E+00	2	3a 31 39 30 33 **30 34 45 30** 30 30 30 32 46 45 0d 0a	3A 31 39 30 33 30 34 **43 32 46 45 30 30 30 30** 31 43 0D 0A	0xC2FE0000	Float	Convert the Float to decimal with below steps: 1. Open the link https://www.h-schmidt.net/FloatConverter/IEEE754.html 2. Paste the date in “Hexadecimal Representation” and press Enter. 3. The temp value is shown in “Decimal representation”

S.No	Parameter	Function Code	Address in hex	Size	Modbus Command	RE Response	Data	Data Type	Remarks
15	TC8	0x03	4.00E+04	2	3a 31 39 30 33 **30 34 45 34** 30 30 30 32 46 41 0d 0a	3A 31 39 30 33 30 34 **34 31 42 43 43 44 39 46** 37 33 0D 0A	0x41BCCD9F	Float	Convert the Float to decimal with below steps: 1. Open the link https://www.h-schmidt.net/FloatConverter/IEEE754.html 2. Paste the date in “Hexadecimal Representation” and press Enter. 3. The temp value is shown in “Decimal representation”
16	TC9	0x03	4.00E+08	2	3a 31 39 30 33 **30 34 45 38** 30 30 30 32 46 36 0d 0a	3A 31 39 30 33 30 **34 34 31 42 45 32 34 41 31** 31 34 0D 0A	0x41BE28A1	Float	Convert the Float to decimal with below steps: 1. Open the link https://www.h-schmidt.net/FloatConverter/IEEE754.html 2. Paste the date in “Hexadecimal Representation” and press Enter. 3. The temp value is shown in “Decimal representation”
17	TC10	0x03	4EC	2	3a 31 39 30 33 **30 34 45 43** 30 30 30 32 46 32 0d 0a	3A 31 39 30 33 30 34 **34 31 42 45 32 43 37 45** 33 33 0D 0A	0x41BE2C7E	Float	Convert the Float to decimal with below steps: 1. Open the link https://www.h-schmidt.net/FloatConverter/IEEE754.html 2. Paste the date in “Hexadecimal Representation” and press Enter. 3. The temp value is shown in “Decimal representation”
18	UI RTD	0x03	500	2	3a 31 39 30 33 **30 35 30 30** 30 30 30 32 44 44 0d 0a	3A 31 39 30 33 30 34 **46 46 46 46 46 46 42 33** 32 43 0D 0A	0xFFFFFB2	int	Convert the data value into signed 2's complement which gives the data. Ex: Signed 2's complent of the 0xFFFFFB2 is equal to -78. So the UI RTD value is -78C.

S.No	Parameter	Function Code	Address in hex	Size	Modbus Command	RE Response	Data	Data Type	Remarks
19	Alarms	0x03	514	2	3a 31 39 30 33 **30 35 31 34** 30 30 30 32 43 39 0d 0a	3A 31 39 30 33 30 34 **30 30 30 30 30 34 30 32** 44 36 0D 0A	0x0 000 040 2	uint	1 = Active / 0 = Inactive b19 BUS Battery Disconnection, b18 System Battery Disconnection, b17 Water temperature, b16 Wrong Power, b15 Limp Mode, b14 TSXA Jumper/Pressure alarm, b13 Unused, b12 Clean filter Alarm, b11 Warm inter stage, b10 Buck boost ineffective, b9 BUS battery low, b8 SP attain, b7 Lifeguard, b6 Extreme Ambient, b5 System Battery Low, b4 Control Probe Fail, b3 Door Open, b2 Cold Alarm, b0 Power Failure Alarm

S.No	Parameter	Function Code	Address in hex	Size	Modbus Command	RE Response	Data	Data Type	Remarks
20	System Status	0x03	66F	1	3a 31 39 30 33 **30 36 36 46** 30 30 30 31 36 45 0d 0a	3A 31 39 30 33 30 32 **32 38** 42 41 0D 0A	0x28	uchar	b0 - init start, b1 - Power failure, b2 - Main - UI comm failure, b3 - Service Mode Active (unused before), b4 - main shutdown, b5 - BOT status (set only after entry to BOT), b6 - unused, b7 - Bus comm failure
21	RE status	0x03	670	2	3a 31 39 30 33 **30 36 37 30** 30 30 30 32 36 43 0d 0a	3A 31 39 30 33 30 34 **30 30 30 35 30 30 30 30** 44 37 0D 0A	0x0005 0000	ulint	b0 - Bus Solenoid Injection b1 - Bus Pressure switch b2 - No Wakeup message b3 - BB state change b4 - Compressor LV change b5 - Flash CRC change b6 - Short cycle active b7 - Dac Cmd data Corrupt b8 - Next Power up state b9 - Door1 Open b10- Door2 Open b11 - Hi Alarm test Active b12 - RD RSR Reg b13 - WC Pressure sense state b14 - DAC Over temp Fault b15 - DAC I out fault b16 - Main memory corrupt b17 - Back up memory corrupt
22	Build number	0x03	524	2	3a 31 39 30 33 **30 35 32 34** 30 30 30 32 42 39 0d 0a	3A 31 39 30 33 30 34 **30 30 30 30 30 44 30 31** 43 45 0D 0A	0x0000D001	uint	X/X/Minor/Major here the Build number is 1.13

S.No	Parameter	Function Code	Address in hex	Size	Modbus Command	RE Response	Data	Data Type	Remarks
23	Control Offset	0x03	534	2	3a 31 39 30 33 **30 35 33 34** 30 30 30 32 41 39 0d 0a	3A 31 39 30 33 30 34 **30 30 30 30 30 30 30 30** 44 43 0D 0A	0x0000000 0	int	Convert the data value into signed 2's complement and divide with 10,which gives the setpoint. Ex: Signed 2's complement of the 0xFFFFFCE0 is equal to -800. -800/10=-80.So the Setpoint is -80C.
24	Line Voltage	0x03	4F8	2	3a 31 39 30 33 **30 34 46 38** 30 30 30 32 45 36 0d 0a	3A 31 39 30 33 30 34 **30 30 30 30 30 45 34** 46 34 0D 0A	0x0000000E 4	uint	Convert hex to decimal gives the voltage. Ex. Here 0xE4 is equal to 228 V

Appendix B: Abbreviations and Acronyms

LED Status	LED Status Description
ASSY	Assembly
BOM	Bill Of Material
BOT	Bottom Out Temperature – the minimum temperature a unit can attain at full run conditions. If a load is present, the load must be allowed to attain temperature. Formally defined at the temperature the 1” region of the control probe attains 3 hours after being set to bottom out conditions from a -80 °C cycle conditions.
BPHX	Brazed Plate Heat Exchanger
BUS	Backup Up System – a secondary non-mechanical means to maintain cabinet temperatures in failure modes; available in LN_2 / CO_2 varieties. Also used to refer to logical electronics signal paths.
Comms	Communications
GUI	Graphical User Interface
HPCO	High Pressure Cut Outs – protective pressure switches that remove AC to compressor during over pressure conditions; available in manual and automatic reset when the extreme condition is no longer present
PCB	Printed Circuit Board – other variants are PCBA (printed circuit board assembly) and CCA (circuit card assembly)
PEP	Pressure Equalization Port - heated check valve allowing cabinet pressure to reach equilibrium with ambient pressure
PM	Preventative Maintenance
RTOS	Real Time Operating System
s/n	Serial Number
SI	Super Insulation – Inclusion of vacuum insulation panels in addition to foam
ULT	Ultra Low Temperature freezer
VSC	Variable Speed Compressor

Appendix C: LN2/CO2 Backup Systems

When you purchase a built-in CO_2 or LN_2 optional backup system for the freezer, backup control is integrated into themain user interface.

Note: Always purchase the cylinders that are equipped with siphon tubes for withdrawing liquid from the bottom of the cylinder. CO_2 cylinders must be kept at room temperature to function properly. LN_2 bottles are functional at any reasonable temperature.

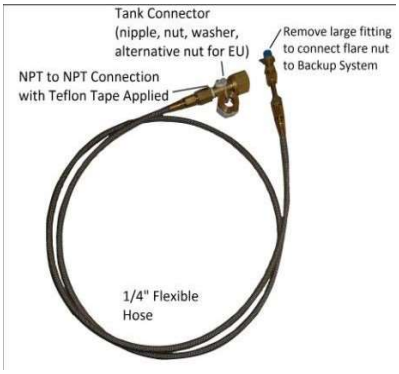
CO_2 and LN_2 Precautions

WARNING: If a CO_2 or LN_2 cylinder falls and a valve is knocked off, the cylinder becomes a deadly and completely unguided missile. Transport the cylinders in a hand truck or cart with secure chain ties for the cylinder. After cylinders areconnected to the equipment, securely attach them with chains to a solid, stationary object such as a building column.**WARNING:** CO_2 and LN_2 liquids are non-poisonous but are very cold and will burn unprotected skin. Always wear protective eye wear and clothing when changing cylinders or working on the piping systems attached to an active source of liquid refrigerant.
WARNING: The gases produced by evaporation of CO_2 or LN_2 are non-poisonous but displace the oxygen in a confined space and can cause asphyxiation. Do not store the cylindersin subsurface or enclosed areas.
CAUTION: When closing the cylinder valve, make sure that the injection solenoid is energized to allow all the liquid to bleed off instead of being trapped in the supply tubing. Failureto do this results in activation of the pressure relief device, which could damage the freezer and requires replacing if it isactivated.

CAUTION: For models ordered with factory installed built-in backup systems, the flow of liquid CO_2 or LN_2 will be discontinued if the door is opened during operation of the backup system. For units operated with free-standing, field installed type backup system, the flow of liquid CO_2 or LN_2 will be discontinued upon door opening only if the switch provided with the free-standing package is installed on the freezer.

Installation

Field installed systems are supplied with complete and operating instructions. If your system is factory installed,the freezer is shipped with a coiled length of tubing to connectthe freezer to the bottles:

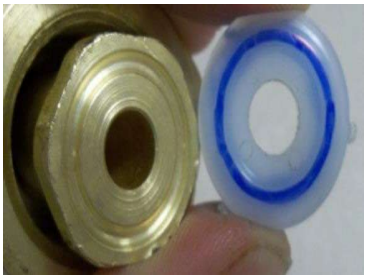


Note: Do not twist, torque or subject the flexible hose tosharp bends. Doing so may shorten the life of the hose.

CO_2 Supply Hose Installation Instruction

- Remove bulkhead fitting and tighten the ¼" compressionfitting to the BUS unit. Tighten hex nut 2 flats (approximately 120 degrees) past finger tight.
- Remove nipple from adapter (NPT Connection). Removecable tie to release alternative nut and washer. Ensure thecorrect nut fitting is supplied over the nipple (US or European).
- Add 2 wraps of Teflon tape clockwise to the 1/4" NPT fitting (on the nipple) when viewed from the threads. Tighten the NPT fittings approximately 2 turns from fingertight (approximately 720 degrees).

Note: The top of the nipple has a hex configuration, allowingfor use of a wrench when the nut is pulled down.



Note: The small raised area of washer fits into groove of nipple. The washer will feel snug when trying to shift side to side on nipple. The washers are designed for a limited numberof attachments/disconnections from the supply and may wearover time. If washer appears worn and causes CO_2 leakage, replace washer (P/N 45705H03).

Add washer to nipple inside of nut (unless CO_2 supply has a built in washer) as shown in the figures above. Wrench tightenthe supply nut to the supply bottle or building supply fitting.

LN_2 Supply Hose InstallationInstruction

Connect the ¼" flare fitting to the BUS unit, tightening the hex nut 2 flats (approximately 120 degrees) past finger tight. Wrench tighten the ½" fitting to the supply bottle or building supply fitting.

Start-Up

To activate the backup system, follow the instructions topower on the freezer.

1. Set temperature and alarm set points.
2. Enter the backup set point and backup type on the Backup Setting Screen, which you can bring up by pressing the Tank icon on the Freezer Settings screen.
3. 3. Press the check mark icon to confirm changes.
4. 4. Turn on the CO_2 or LN_2 supply.

Operation

When the backup system is in operation, you can view and reset parameters on the settings screen).

Once the backup system has been activated, you can test itby pressing the Test Injection button. The system will inject aslong as you keep pressing.

The backup system can run for a minimum of 24 hours onbattery power.

Appendix D: Codex Temperature Recorder

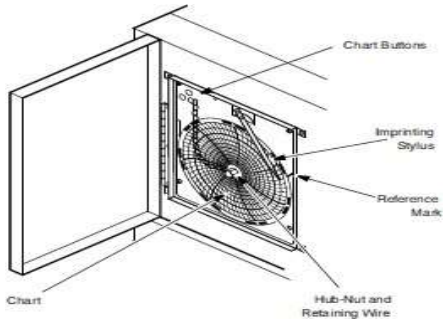
Setup and Operation

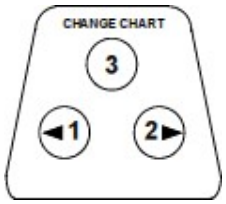
Panel-mounted six-inch seven-day recorders are available asoptions for all freezer models except for the smallest (300 boxcapacity) models.

To prepare the recorder to function properly, complete the following steps:

1. Open the recorder door to access the recorder.
2. Install clean chart paper; refer to **Changing the ChartPaper**.
3. Remove the plastic cap from the pen stylus and close therecorder door.

Recorder operation begins when the system is powered The recorder may not respond until the system reaches temperatures within the recorder's range.





CAUTION: Do not use sharp or pointed objects to depress the chart buttons. This may cause permanent damage to therecorder.

Changing the Chart Paper

To change the chart paper, complete the following steps:

1. Locate the pressure sensitive buttons at the front, upperleft of the recorder panel.
2. Press and hold the Change Chart button (#3) for onesecond. The pen will move off the scale.
3. Unscrew the center nut, remove the old chart paper, andinstall new chart paper. Carefully align the day and time with the reference mark (a small groove on the left side ofthe recorder panel).
4. Replace the center nut and hand tighten.
5. Press the Change Chart button again to resumetemperature recording.

Calibration Adjustment

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:

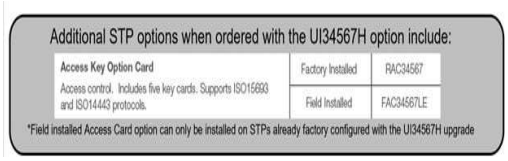
1. Run the unit continuously at the control set point temperature.

2. Continue steady operation for at least two hours provide adequate time for recorder response.
3. Measure cabinet center temperature with a calibratedtemperature monitor.
4. Compare the recorder temperature to the measuredcabinet temperature.

If necessary, adjust recorder by pressing the left (#1) and right(#2) chart buttons.

Note: The stylus does not begin to move until the button is held for five seconds.

Appendix E



- Easy to read temperature display from across the room.
- Green heart heath indicator.
- New UI guard designed to prevent liquid entry duringcleaning and sanitization.
- Five Touch Buttons: Settings Menu, +/- and Save, andAlarm Snooze.
- Setpoint Security, 3 digit code to secure freezer settingsfrom unwanted changes.
- Diagnostics Logs (Temperature/Event) for service only.

- Larger 7" screen.
- Easy to read temperature display from across the team.
- Green heart health indicator.
- UI guard prevents liquid entry during cleaning andsanitization.
- New front panel power button for user convenience.

Tool Lists

Service Tools

Table 31. Tools list

Tool	Comments
Vacuum Pump	Minimum size of 3 CFM
Recovery Machine	Liquid – Vapor type
Recovery Tank – 50 Lb	
Nitrogen Tank W/Regulator	
Torch Set	
Tubing Cutter	
Re-rounding Tool	
Pinch Off Pliers	
Flare Tool	
Thread Sealer	
Refrigeration Service Wrench	
Heat Shield	
Schrader Valve Service Tool	
T-type Thermocouple Thermometer	Must be “T-type” capable; Most Are Also “K” and “J” capable
Multi-Input Head	Recommended for reading several inputs without swapping leads; such as Omega HSW20-T or Tegam 8052
Refrigerant Leak Checking Equipment	
Soap Bubble Solution	
Electronic Detector	
Refrigerant Scale	
Digital Multi-Meter	Two recommended for simultaneous measurements or accessory use such as amp clamp. Ability to display 9.999 (“4 Digit” Display, Not “4000 Count”) or better recommended. Ability to read capacitors up to 1000uF; many expensive meters will not. Check before buying. Recommended: computer logging feature.

Tool	Comments
Digital Clamp-On Amp Meter	Must Have: Digital AC amp meter with 1 millisecond “inrush” current, not just “peak hold,” to capture inrush currents. Capable of reading down to 0.1 Amp (100 milli amps). Fluke, Amprobe, AEMC have such models. Should Have: AC/ DC amp meter as above. DC current milli amps useful for control circuits, heaters, and finding overloaded circuits. Recommended: In addition to the “must have” above, an extra unit of the style that plugs into a DMM, allowing full use of the DMM features such as Peak Hold, computer logging, etc. This unit allows amps to be measured under the cabinet while the meter is readableout in the open. Note: AC/DC capability must be a feature of the amp clamp accessory, not just the DMM.
Analog Amp Meter	Best for spotting variation in motor loads, and not dependent on batteries. Amprobe RS3 style or similar.
Process Tube Adaptors	
Piercing device Recovery Machine	For ¼ inch copper with hose fitting
Brazing Alloy	Required: AWS Specification BCuP-5 (15% Silphos) 1/16 inch stick form preferred. May Be Needed: AWS Specification BAg-24 flux-cored (Handy-Harmon Braze 505 recommended) or BAg-4 flux-cored (Handy-Harmon Braze403 recommended) or equivalent high-silver brazing alloy and black flux.
Clean Dry Nitrogen Gas	
Tank Cart Or Dolly	
Required: Suitable Regulator	Allowing Up To 200psig On Secondary Gauge For Pressure Testing
Desirable: Flow Meter/Regulator	For N2 Purge While Brazing Allowing 5 to 10SCFH (not per minute)
Vacuum Pump Oil	Requires changing at least once per rebuild
Micron Gauge	Analog or a good digital
Vacuum tight manifold gauge set; 4-valve style best or Two 3-valve style	4-valve style best or Two 3-valve style
Crimp Style Connectors For Terminal Ends Only	No Crimp-style Splice Connectors

Table 32. Personal Office Equipment

Tool	Comments
Computer	
Portable Printer, Fax, Scanner	
Digital Camera	
Compressor Tester (“Annie-type” Tester) Used for non-variable speed compressors.	Incredibly useful for quickly confirming or eliminating compressor failure problems. Also handy to supply metered and protected line voltage directly tocomponents for testing. Suggest Thermal Engineering model 12501 first, model 2001 second, or equivalent. Must Read And Keep The Instructions!
Decade Resistor Box	Perfect for emulating resistance type sensor inputs to check/verify control system operation. Range of 1 ohm to 11.1 megohm in 1-ohm increments most common. Recommend Elenco RS-500 or similar as most affordable. Alligator Clip Jumpers; size wire for both control and line voltages
Alligator Clip Jumpers	Size wire for both control and line voltages
Small forklift or equivalent	Shop or Depot only
Hoist	Shop or Depot only. for separating cabinet from compressor deck
3/8 inch eye bolts	approx. 1 inch thread length
Length of chain	Or lifting bar to connect to hoist hook
Caddy or worktable on wheels	
Heavy Duty work bench or stand	To hold compressor deck or entire unit, as appropriate
Additional work area	For tools and equipment; large work table can do both

Table 33. Unit Handling

Tool	Comments
3/8 inch eye bolts	Approx. 1 inch thread length
Caddy or worktable on wheels	
Heavy Duty work bench or stand	To hold compressor deck or entire unit, as appropriate
Additional work area	For tools and equipment; large work table can do both

Table 34. Flushing Supplies and Equipment

Tool	Comments
Typical dual valve Vapor/Liquid refrigerant	To hold a portion of the flushing agent if original source container is not to be used.
Second recovery cylinder	To capture the used flush for recycling or disposal.
Flushing Machine	Suitable refrigerant recovery machine for circulating the flushing material. Aliquid capable recovery machine is preferred.
Process Tube Adapters	For attaching flushing hoses to open end of ¼" and 3/8" copper lines ¼" and3/8" copper lines.
Typical Refrigerant Hoses	For connecting cylinders, circulating machine, process adapters, and hand valves. These hoses should be reserved for flushing use only, not charging.
Two hand valves, or two flush-reserved manifold gauge sets	For controlling entry and exit flow of flushing liquid.
Fabrication ¼" copper refrigeration tubing	
3/8" copper refrigeration tubing	
Tubing Cutters	

Table 35. Refrigerant Handling; Recovery and Charging Recovery

Tool	Comments
EPA Approved Recovery Cylinders; Industry Standard	Must be available for holding mixed refrigerants that are to be disposed of, not reused.
Hoses 4’ min lengths with quick connect fittings. ¼ inch.	Typical refrigerant industry standard for connecting equipment, tanks,manifold, etc.
Filters 052 size drier	
Charging Manifold Gauge Set	
Refrigerants	R290 (Instrument Grade) R170
Filters Driers 052 min size	To protect recovery machine, manifold, etc from contaminated refrigerant.
Refrigeration Hose Set (High Vacuum)	Preferred due to evacuation process, or two 3-hose sets per unit per stage.
Digital Charging Scales	Able to measure to 0.1 gram.
Filter/Driers (052 OK)	To pre filter refrigerant as charged.
Length (24 to 48 inches) of cap tube(approx. .028)	
Brazing	Oxygen Acetylene set.
Appropriate fitting, or pressure regulator,	To help control input of high pressure refrigerants (R508b).

Tool	Comments
Flushing Agent	R406a currently available R12 if available. If R406 is not available, Change to Qwik Flush. http://www.qwik.com
Sight Glass Devices	For the input and exit flushing hoses; to view liquid flow and dirt level

Table 36. Evacuation

Tool	Comments
¼" or 3/8 inch clean copper tubing	For evacuation
Incandescent Shop Light or Small Heater	To help warm compressor and/or cabinet
Solder	Rosin Core Solder; Get Extra Tube Of Rosin Flux

Table 37. General Supplies

Tool	Comments
Solvents	For cleaning and dissolving
For cleaning and dissolving	Blue and red strength
Silicone Caulk Compounds	For sealing and tubing protection
Cleaning Supplies	
Cleaning Solvent	
Abrasive cloth	For polishing copper surfaces and cleaning finished joints
Cleaning Rags	
Wet Rags	For protecting heat sensitive components
Proper NEC Rated Electrical Wire: 18 to 12 Gauge stranded;	Black, White, Red, Green minimum.

Alarm Troubleshooting

Table 41. Alarm Troubleshooting

Alarm	Cause	Diagnosis based
No Flow or Low Flow Alarm	If there is no water flow or flow too low for water temperature causing high condensing pressure. Recommended water flow range is minimum 0.5 GPM for less than 25C water inlet temp and above 25C water min 1GPM water flow.	When there is no water flow or very flow water flow and high stage discharge pressure reaches equal or higher than 305 PSIG +/- 10 BSIG this alarm is triggered based on pressure switch in refrigerant system.
Water temperature out of range	When water in temperature out of range either colder than 10° C or warmer than 33° C.	Read based on Water TC (TC5)- green TC.

Material Safety Data Sheet

Creation Date 14-May-2009 **Revision Date** 23-Sep-2009 **Revision Number** 1

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name n-Pentane

Cat No. P/1006/15; P/1006/17

Synonyms normal pentane.; n-Pentane; Amyl hydride

Recommended Use Laboratory chemicals

Company
Fisher Scientific Ltd Bishop
Meadow Rd
Loughborough, Leicestershire, Britain
LE115RG
Tel: 01509 231166

Emergency Telephone Number
Chemtrec US: (800) 424-9300
Chemtrec EU: (202) 483-7616

2. HAZARDS IDENTIFICATION

DANGER!

Emergency Overview

Extremely flammable liquid and vapor. Vapors may cause flash fire or explosion. May may cause central nervous system effects. May cause skin, eye, and respiratory tract irritation. Aspiration hazard if swallowed - can enter lungs and cause damage. Repeated exposure may cause skin dryness or cracking. Toxic to aquatic organisms, may cause long- term adverse effects in the aquatic environment.

Appearance Clear **Physical State** Liquid **odor** Petroleum like

Target Organs Central nervous system (CNS), Skin, Kidney

Potential Health Effects

Acute Effects
Principle Routes of Exposure

Eyes May cause irritation.
Skin May cause irritation. May be harmful in contact with skin. Repeated may cause skin dryness or cracking.
Inhalation May cause irritation of respiratory tract. Inhalation may cause central nervous effects. May be harmful if inhaled.
Ingestion May be harmful if swallowed. Aspiration hazard. Ingestion may cause irritation, nausea, vomiting and diarrhea.

Chronic Effects Repeated exposure may cause skin dryness or cracking. May cause adverse liver effects.

See Section 11 for additional Toxicological information.

Aggravated Medical Conditions Central nervous system disorders. Preexisting eye disorders. Skin disorders.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Haz/Non-haz

Component	CAS-No	Weight %
Pentane	109-66-0	95-100

4. FIRST AID MEASURES

Eye Contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Obtain medical attention.

Skin Contact Wash off immediately with plenty of water for at least 15 min. Get medical attention immediately if symptoms occur.

Inhalation Move to fresh air. If breathing is difficult, give oxygen. Do not use mouth-to-mouth resuscitation if victim ingested or inhaled the substance; induce artificial respiration with a respiratory medical device. Get medical attention immediately if symptoms occur.

Ingestion Do not induce vomiting. Call a physician or Poison Control Center immediately.

Notes to Physician Treat symptomatically.

5. FIRE-FIGHTING MEASURES

Flash Point -49°C / -56.2°F

Method No information available.

Autoignition Temperature 260°C / 500°F

Explosion Limits
Upper 7.8 vol %
Lower 1.5 vol %

Suitable Extinguishing Media CO_2, dry chemical, dry sand, alcohol-resistant foam. Cool closed containers exposed to fire with water spray.

Unsuitable Extinguishing Media Water may be ineffective. Do not use a solid water stream as it may scatter and spread fire.

Hazardous Combustion Products No information available.

Sensitivity to mechanical impact No information available.
Sensitivity to static discharge No information available.

Specific Hazards Arising from the Chemical
Extremely flammable. Risk of ignition. Containers may explode when heated. Vapors may form explosive mixtures with air. Vapors may travel to source of ignition and flash back.

Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. Thermal decomposition can lead to release of irritating gases and vapors.

NFPA **Health** 1 **Flammability** 4 **Instability** 0 **Physical hazards** N/A

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions Use personal protective equipment. Remove all sources of ignition. Take precautionary measures against static discharges.

Environmental Precautions Should not be released into the environment.

Methods for Containment and Clean Up Soak up with inert absorbent material. Keep in suitable and closed containers for disposal. Remove all sources of ignition. Use spark-proof tools and explosion-proof equipment.

7. HANDLING AND STORAGE

Handling Use only under a chemical fume hood. Wear personal protective equipment. Keep away from open flames, hot surfaces and sources of ignition. Use explosion-proof equipment. Use only non-sparking tools. Take precautionary measures against static discharges. Avoid contact with skin, eyes and clothing. Do not breathe vapors or spray mist.

Storage Keep containers tightly closed in a dry, cool and well-ventilated place. Keep away from heat and sources of ignition. Flammables area.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Measures Use only under a chemical fume hood. Ensure that eyewash stations and safety showers are close to the workstation location. Use explosion-proof electrical/ventilating/lighting/equipment.

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH
Pentane	TWA: 600 ppm	(Vacated) TWA: 1800 mg/m³ (Vacated) TWA: 600 ppm (Vacated)STEL: 750 ppm (Vacated) STEL: 2250 mg/m³ TWA: 2950 mg/m³ TWA: 1000 ppm	IDLH: 1500 ppm TWA: 120 ppm TWA: 350 mg/m³ Ceiling: 1800 mg/m³ Ceiling: 610 ppm

Component	Quebec	Mexico OEL (TWA)	Ontario TWAEV
Pentane	TWA: 120 ppm TWA: 350 mg/m³	TWA: 1800 mg/m³ TWA: 600 ppm STEL: 2250 mg/m³ STEL: 760 ppm	TWA: 1770 mg/m³ TWA: 600 ppm STEL: 750 ppm STEL: 2210 mg/m³

NIOSH IDLH: *Immediately Dangerous to Life or Health*

Personal Protective Equipment

Eye/face Protection Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin and body protection Wear appropriate protective gloves and clothing to prevent skin exposure.

Respiratory Protection Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State	Liquid
Appearance	Clear
odor	Petroleum distillates
Odor Threshold	No information available.
pH	No information available.
Vapor Pressure	573 mbar @ 20 °C
Vapor Density	2.5 (Air = 1.0)
Viscosity	0.25 mPa.s @ 20 °C
Boiling Point/Range	36°C / 96.8°F@ 760 mmHg
Melting Point/Range	-130°C / -202°F
Decomposition temperature °C	No information available.
Flash Point	-49°C / -56.2°F
Evaporation Rate	(Butyl Acetate = 1.0)
Specific Gravity	0.626
Solubility	Insoluble in water
log Pow	No data available
Molecular Weight	72.15
Molecular Formula	C5 H12

10. STABILITY AND REACTIVITY

Stability	Stable under normal conditions.
Conditions to Avoid	Incompatible products. Heat, flames and sparks.
Incompatible Materials	Strong oxidizing agents, Halogens
Hazardous Decomposition Products	Carbon monoxide (CO), Carbon dioxide (CO_2)
Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions .	None under normal processing..

11. TOXICOLOGICAL INFORMATION

Acute Toxicity

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Pentane	2000 mg/kg (Rat)	3000 mg/kg (Rabbit)	364 g/m³ (Rat) 4 h

Irritation	No information available.
Toxicologically Synergistic Products	No information available.

Chronic Toxicity

Carcinogenicity There are no known carcinogenic chemicals in this product

Sensitization No information available.

Mutagenic Effects No information available.

Reproductive Effects No information available.

Developmental Effects No information available.

Teratogenicity No information available.

Other Adverse Effects See actual entry in RTECS for complete information.

Endocrine Disruptor Information No information available

12. ECOLOGICAL INFORMATION

Ecotoxicity

. Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Pentane	Not listed	Not listed	Not listed	EC50 48 h 9.7 mg/L

Persistence and Degradability No information available

Bioaccumulation/ Accumulation No information available

Mobility .

Component	log Pow
Pentane	3.39

13. DISPOSAL CONSIDERATIONS

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemicalis classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. TRANSPORT INFORMATION

DOT

UN-No UN1265
Proper Shipping Name PENTANES
Hazard Class 3
Packing Group I

UN-No UN1265

14. TRANSPORT INFORMATION

TDG

Hazard Class 3
Packing Group I

IATA

UN-No UN1265
Proper Shipping Name PENTANES
Hazard Class 3
Packing Group II

IMDG/IMO

UN-No UN1265
Proper Shipping Name PENTANES
Hazard Class 3
Packing Group II

15. REGULATORY INFORMATION

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	CHINA	KECL
Pentane	T	X	-	203-692-4	-		X	X	X	X	KE-27968 X

Legend:
X - Listed
E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.
F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.
N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.
P - Indicates a commenced PMN substance
R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.
S - Indicates a substance that is identified in a proposed or final Significant New Use Rule
T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.
XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B).
Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.
Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b)

Component	TSCA 12(b)
Pentane	Section 4

SARA 313
Not applicable

SARA 311/312 Hazardous Categorization

Acute Health Hazard	Yes
Chronic Health Hazard	No
Fire Hazard	Yes
Sudden Release of Pressure Hazard	No
Reactive Hazard	No

Clean Water Act
Not applicable

Clean Air Act
Not applicable

OSHA
Not applicable

CERCLA
Not Applicable

California Proposition 65
This product does not contain any Proposition 65 chemicals.

State Right-to-Know

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Pentane	X	X	X	-	X

U.S. Department of Transportation
Reportable Quantity (RQ): N
DOT Marine Pollutant N
DOT Severe Marine Pollutant
N

U.S. Department of Homeland Security
This product contains the following DHS chemicals:

Component	DHS Chemical Facility Anti-Terrorism Standard
Pentane	7500 lb STQ

Other International Regulations

Mexico - Grade Severe risk, Grade 4

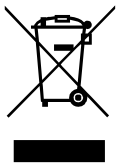
Canada

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.

WHMIS Hazard Class
B2 Flammable liquid

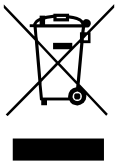
WEEE Compliance

Great Britain



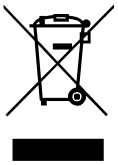
WEEE Compliance. This product is required to comply with the European Union's Waste Electrical &Electronic Equipment (WEEE) Directive 2012/19/EU. It is marked with the following symbol. Thermo Fisher Scientific has contracted with one or more recycling/disposal companies in each EU Member State, and this product should be disposed of or recycled through them. Further information on our compliance with these Directives, the recyclers in your country, and information on Thermo Scientificproducts which may assist the detection of substances subject to the RoHS Directive are available at www.thermofisher.com/WEEERoHS.

Deutschland



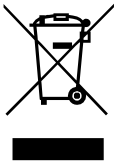
WEEE Konformittät. Dieses Produkt muss die EU Waste Electrical & Electronic Equipment (WEEE) Richtlinie 2012/19/EU erfüllen. Das Produkt ist durch folgendes Symbol gekennzeichnet. Thermo Fisher Scientific hat Vereinbarungen getroffen mit Verwertungs-/Entsorgungsanlagen in allen EU-Mit-gliederstaaten und dieses Produkt muss durch diese Firmen widerverwetet oder entsorgt werden. Mehr Informationen über die Einhaltung dieser Anweisungen durch Thermo Scientific, dieVerwerter und Hinweise die Ihnen nützlich sein können, die Thermo Fisher Scientific Produkte zu identizfizieren, die unter diese RoHS. Anweisungfallen, finden Sie unter www.thermofisher.com/WEEERoHS.

Italia



Conformità WEEE. Questo prodotto deve rispondere alla direttiva dell' Unione Europea 2012/19/EU in merito ai Rifiuti degli Apparecchi Elettrici ed Elettronici (WEEE). È marcato col seguente simbolo. Thermo Fischer Scientific ha stipulato contratti con una o diverse società di riciclaggio/smaltimento in ognuno degli Stati Membri Europei. Questo prodotto verrà smaltito o riciclato tramite queste medes-ime. Ulteriori informazioni sulla conformità di Thermo Fisher Scientific con queste Direttive, l'elenco delle ditte di riciclaggio nel Vostro paese e informazioni sui prodotti Thermo Scientific che possonoessere utili alla rilevazione di sostanze soggette alla Direttiva RoHS sono disponibili sul sito www.thermofisher.com/WEEERoHS.

France



Conformité WEEE. Ce produit doit être conforme à la directive euro-péenne (2012/19/EU) des Déchets d'Equipements Electriques et Electroniques (DEEE). Il est marqué par le symbole suivant. Thermo Fisher Scientific s'est associé avec une ou plusieurs compagnies de recyclage dans chaqueétat membre de l'union européenne et ce produit devraitêtre collecté ou recyclé par celles-ci. Davan-tage d'informations sur laconformité de Thermo Fisher Scientific à ces directives, les recycleurs dansvotre pays et les informations sur les produits Thermo Fisher Scientific qui peuvent aider le détection des substances sujettes à la directive RoHS sont disponibles sur www.thermofisher.com/ WEEERoHS.

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