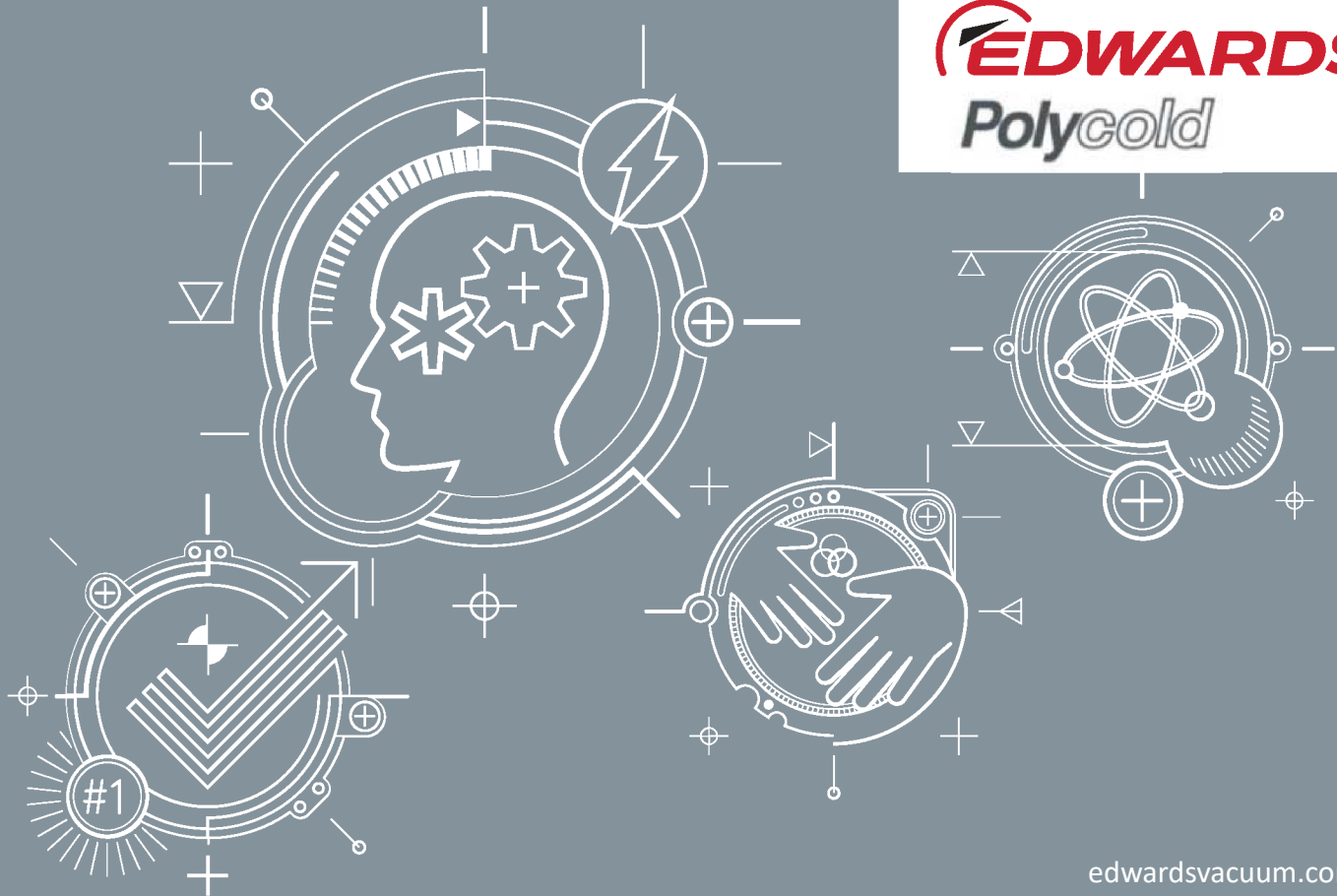




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MaxCool Cryochiller

INSTRUCTION MANUAL

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Reference document

Publication title	Publication No.	Link
Service procedure, zero line loss	185307	-
Service procedure, evacuation-recovery	185308	-
Service procedure, brazing specifications	185305	-
Installation procedure, caster option	185304	-
Profibus interface user manual	501937	https://4vac.io/6kcigl
Device net interface user manual	501936	https://4vac.io/k797i3
Profinet Interface User Manual	501938	https://4vac.io/df1bai
Ethercat interface user manual	501939	https://4vac.io/7h9obe
Ethernet host commands and configuration instruction manual	502039	https://4vac.io/6ms5ka
SDS, Inter-HFC, Non-flam refrigerant, Polycold system	502251	-
LULUBE 1032-LT SDS, POE, Solest oil	825103-00	-

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You must use this product as described in this manual. Read the manual before you install, operate, or maintain the product.

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1. Safety and compliance

For safe operation from the start, read these instructions carefully before you install or commission the equipment and keep them safe for future use. Read all the safety instructions in this section and the rest of this manual carefully and make sure that you obey these instructions.

The instruction manual is an important safety document that we often deliver digitally. It is your responsibility to keep the instruction manual available and visible while working with the equipment. Please download the digital version of the instruction manual for use on your device or print it if a device will not be available.

1.1 Definition of Warnings and Cautions

Important safety information is highlighted as warning and caution instructions which are defined as follows. Different symbols are used according to the type of hazard.

WARNING:

If you do not obey a warning, there is a risk of injury or death.

CAUTION:

If you do not obey a caution, there is a risk of minor injury, damage to equipment, related equipment or process.

NOTICE:

Information about properties or instructions for an action which, if ignored, will cause damage to the equipment.

We reserve the right to change the design and the stated data. The illustrations are not binding.

1.2 Safety symbols

The safety symbols on the products show the areas where care and attention is necessary.

The safety symbols that we use on the product or in the product documentation have the following meanings:

	Warning/Caution Risk of injury and/or damage to equipment. An appropriate safety instruction must be followed or a potential hazard exists.
	Warning - Dangerous voltage Risk of injury. Identifies possible sources of hazardous electrical shock.
	Warning - Flammable material Risk of fire. Identifies possible sources of flammable gases, liquids or materials.
	Warning - Heavy object Risk of injury or damage to equipment. Identifies a possible hazard from a heavy object.
	Warning - Hot surfaces Risk of injury. Identifies a surface capable of inflicting burns through contact.
	Warning - Risk of explosion Risk of injury or damage to equipment. Identifies a situation that could result in an explosion.
	Warning - Trip hazard Risk of injury. Identifies spilled liquids, trailing cords, pipes and other low-lying objects that may result in slipping, tripping or falling.
	Mandatory - Read the manual Failure to comply with this action may result in injury or damage to equipment.
	Warning - Use protective equipment Risk of injury. Use appropriate Personal Protective Equipment (PPE) when performing the task.
	Warning - Wear protective gloves Risk of injury. Wear appropriate protective gloves when performing the task.

1.3 Important safety information

1.3.1 General guidelines

WARNING: READ THE SAFETY CHAPTER



Failure to review the safety chapter and follow the safety warnings can result in death or serious injury.

- Do not perform installation, operation, or maintenance procedures until you have read and understood the safety information.
- Follow all applicable facility safety codes.
- Read and understand each procedure before performing it.

CAUTION: UNAUTHORISED SERVICE



Personal injury or damage to equipment may result if this product is operated or serviced by unauthorized personnel.

- Only qualified personnel are allowed to transport, assemble, operate, or maintain the product.
- Properly qualified personnel are those who have received certified training and have the proper qualifications for their jobs.

CAUTION: PROPER OPERATION



Improper use of the system may cause personal injury.

- Do not operate the system before it is properly installed.
- Do not modify connectors or cables.
- Do not operate the unit without all guards and safety devices in place.
- Do not install or operate the system if it has been dropped, damaged, or is malfunctioning.
- Do not use the system for any purpose other than as a Cryochiller or damage to the Cryochiller or the equipment to which it is connected may occur.

CAUTION: SEISMIC RESTRAINT



The use of the system in an earthquake prone environment may cause equipment damage or personal harm.

- The user is responsible for determining whether the product is used in an earthquake prone environment.
- The user is responsible for providing and installing the appropriate seismic restraints in accordance with local regulations.

If additional safety related upgrades or newly identified hazards associated with the system are identified, our technical support notifies the owner of record with a Technical Support Bulletin (TSB).

1.3.2 Mechanical hazards

WARNING: TIP HAZARD

This unit has a high centre of gravity and may tip when moved improperly or when left stationary with casters unlocked which may cause death or personal injury.

To avoid this hazard, follow these precautions:



- Read the user's manual before moving.
- For smooth hard floors, move by rolling slowly and avoid rapid acceleration and deceleration.
- Move only on smooth level surfaces that are free of gaps, grooves, or debris.
- For uneven or soft floors, move using optional hoist rings with overhead lift.
- Do not use casters to move up and down ramps.
- Apply force below centre line when moving by hand.
- Lock two front casters when not moving.

WARNING: EYE BOLT HAZARD

This unit is equipped with lift rings that when used improperly may fail and cause death or serious personal injury.

To avoid this hazard, follow these precautions:



- Lift with 4 straps that each have a minimum strength as required by local regulations but not less than the weight of the lifted item.
- Length for each strap between the lift ring bolt and the lifting point must be greater than 736 mm (29 inches).
- The angle between the sling strap and horizontal at each lift ring must be greater than 45°.
- Strength of lift device must be greater than 4 times weight of unit being lifted.

CAUTION: TRIP HAZARD



Trip hazard which may cause personal injury exists if the facilities connections such as power and communications cables, gas and vacuum lines, for the compressor are not properly routed.

- Route facilities connections and communication cables out of the way where there is no travel and they do not cause trip hazards.

CAUTION: HEAVY OBJECT



The cryochiller weighs a minimum of 533 kg (1175 lb) up to a maximum of 544 kg (1200 lb).

Failure to take the proper precautions before moving this unit could result in personal injury.

- Follow appropriate methods for moving heavy equipment.

1.3.3 Electrical hazards

WARNING: ELECTRICAL INSTALLATION HAZARD

Improper electrical connection or improper handling of the power can cause electrical shock resulting in death or serious injury and can cause fire and damage to the equipment.



- Make sure that a proper ground is provided from the power connection and confirm the equipment is properly grounded.
- Use proper power and proper electrical connections in accordance with the appropriate electrical code.
- Do not allow cables to be walked on or become wet.
- Turn off power before connecting or disconnecting cables.
- Allow only a qualified electrical installer to perform electrical work on the cryochiller in accordance with local codes.

WARNING: ELECTRICAL HAZARD

Contact with energised equipment can cause electric shock and result in death or serious injury.



- All electrical energy supplied to the cryochiller must be disconnected from the system according to the facilities lockout/ tagout procedure before performing service or maintenance.
- Lockout/Tagout device is provided for use when high voltage box cover is in place.
- Lockout/Tagout must be provided at the input power source if the high voltage box cover is removed.
- Only a qualified electrician or electrical technician is allowed to open the cryochiller and troubleshoot electrical problems.

The cryochiller is a hazardous voltage device. It requires a user installed slow blow circuit breaker that meets, or exceeds, the minimum SCCR rating specified by SEMI S2. See [Electrical](#) on page 51.

The proper precautions for operating and servicing electrical equipment must be observed.

1.3.4 Thermal hazards

WARNING: EXTREME TEMPERATURE

Contact with hot or cold surfaces can cause death or serious injury from burns or frostbite.



- Do not operate the product without all covers in place.
- Wait 90 minutes after performing the appropriate Lockout/Tagout procedures before removing covers.
- Do not touch thermal probes until they reach +10 °C (50 °F).
- Do not touch components that show signs of frost. Wait for them to defrost or use insulated gloves or appropriate protective equipment.
- Do not touch any uninsulated part of the refrigerant circuit when the unit is operating.

This includes:

- Solenoids
- Hand Valves
- Uninsulated parts of the refrigerant line
- Uninsulated parts of the feedthrough
- Cryosurface

CAUTION: COLD THERMAL HAZARD



Moving or repositioning the refrigerant line when cold may result in crimping of the gas lines and insulation may crack and cause minor or moderate injury along with hazardous refrigerant discharge.

- Do not attempt to move or position the refrigerant line.

The condenser and compressor inside the cryochiller present thermal hazards.

1.3.5 Chemical hazards

WARNING: ASPHYXIATION HAZARD



The blend of refrigerant used in the cryochiller is non-flammable and non-toxic. However, as with any gas, death or serious injury due to asphyxiation could occur if concentrated gas is inhaled.

- Service the cryochiller in a well ventilated area as specified by ASHRAE-15 and EN-378.

CAUTION: CHEMICAL HAZARD



Opening the refrigerant circuit or changing valve settings without following the instructions in this manual could result in release of refrigerant gas that is considered to be a greenhouse gas.

- Avoid release of greenhouse gas to the environment.
- Keep the gas line couplings aligned when making or breaking coupling connections to prevent leaks due to sharp bends.
- Review this manual before performing any procedure including routine operation.

The cryochiller is supplied with two overpressure relief valves. In the unlikely event that the relief valves release refrigerant gas, the gas must vent to the atmosphere in a well vented area that meets the minimum room size requirements as specified in ASHRAE-15 and EN-378.

United States and other federal laws require a certified refrigeration technician (Type 2, High Pressure) to perform any procedure that could release refrigerant into the atmosphere. These procedures include the following:

- Installing the cryochiller
- Inspecting procedures
- Disconnecting the refrigerant lines
- Troubleshooting procedures
- Repairing
- Disposing of the unit or charged components

1.3.6 High pressure gas hazard

CAUTION: HIGH PRESSURE GAS



Use of high pressure gas or compressed air during cleaning may cause flying debris.

- Wear personal protection equipment such as safety glasses if using high pressure gas for cleaning,
- Follow safety guidelines for cleaning with high pressure gas as specified by the facility.

1.3.7 Fire and explosion hazard



WARNING: FIRE HAZARD

Cleaning fluids such as isopropyl alcohol may cause fire if used on hot parts.

- Allow the system to cool before using cleaning fluids.



CAUTION: HIGH PRESSURE REFRIGERANT

In the unlikely event that the system develops a refrigerant leak inside an enclosed chamber, it is possible that a high pressure event could occur which may result in equipment damage or personal injury.

- The vacuum chamber must have a pressure-relief valve to avoid an over-pressure condition.

The system does not have any direct fire or explosion hazard.

1.4 Safety labels and safety label identification

Safety labels are placed on the cryochiller to identify hazards. Identification labels provide information about the product. This section describes each label and identifies its location.

 Note:

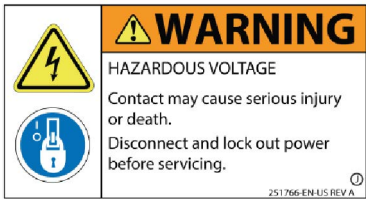
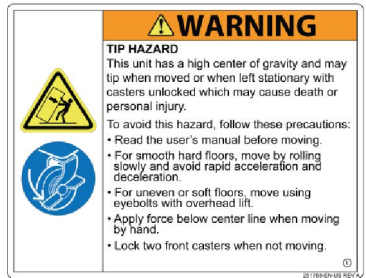
Do not change or remove the safety labels or equipment identification labels.

1.4.1 Label identification and location

Table: Labels used on the system lists the labels that are affixed to the system. These labels alert personnel to hazards on or within the product and provide information about the product.

Figure: Locations of labels on the front side of the system, standard through *Figure: Locations of labels on the back side of the system, front access* show the location of each label. To replace a lost or damaged label call our Technical Support.

Table 1 Labels used on the system

	Hazard: Hazardous voltage Part number: 251766 Quantity: 2 Location: (1) On inside and (1) on outside of inner control unit cover below circuit breaker view port. Possible injuries: Electrical shock or burn How to avoid the hazard: Turn off power and lock out before servicing.
	Hazard: Heavy object Part number: 251767 Quantity: 1 Location: On compressor body Possible injuries: Muscle strain or back injury How to avoid the hazard: Use lifting aids and proper lifting techniques.
	Hazard: Tip (On units with Caster option installed) Part number: 251768 Quantity: 2 Location: Front and back lower panels. Only on units with caster option Possible injuries: Crush How to avoid the hazard: Push from below the midpoint of the height. Lock casters when not moving. Move only on level surfaces. Do not use casters to move up and down ramps. Move at slow speed with slow acceleration/deceleration Move on smooth floors free of gaps, grooves, or debris

	Hazard: Extreme temperatures (hot and cold) Part number: 251737 Quantity: 3 Locations: (1) Lower right front cover. (1) Lower rear cover, (1) Inner valve cover panel on inside of unit. Possible injuries: Burns or frostbite injuries. How to avoid the hazard: Do not touch exposed piping. Allow to come to ambient temperature before servicing.
---	--

GE/16636/A

Unit nameplate label, abbreviated

Part number: 501902

Quantity: 1

Location: Outside lower right front cover

Contains part number, serial number



EDWARDS

POLYCOLD SYSTEMS

EDWARDS VACUUM, LLC.

6416 INDUCON DRIVE, SANBORN, NY 13132
+1 800-FOR-GUTS +1 (800) 367-4887
+1 (800) 848-9800
WWW.EDWARDSVACUUM.COM

**TEMPERATURE DESIGNATION
CRYOCHILLER UNIT**

PART NUMBER: "POLYCOLD MODEL PART NUMBER"
DESCRIPTION: "POLYCOLD MODEL DESCRIPTION
FROM ORACLE"
SERIAL #: "XXXXXXXXXX"
MANUFACTURING DATE: "DAY MONTH YEAR"

DESIGN PRESSURES (PS)

"COMPRESSOR LOW (SUCTION) SIDE: XXX psi (XXX BARI)"
"SYSTEM LOW (SUCTION) SIDE: XXX psi (XXX BARI)"
"SYSTEM HIGH (DISCHARGE) SIDE: XXX psi (XXX BARI)"
"SECONDARY COOLANT CIRCUIT: XXX psi (XXX BARI)"

"TEST PRESSURES (PT)"

"COMPRESSOR LOW (SUCTION) SIDE: XXX psi (XXX BARI)"
"SYSTEM LOW (SUCTION) SIDE: XXX psi (XXX BARI)"
"SYSTEM HIGH (DISCHARGE) SIDE: XXX psi (XXX BARI)"

**AMBIENT OPERATING
TEMPERATURE (TO)**

MINIMUM: "XXX" F (XX "C)"
MAXIMUM: "XXX" F (XX "C)"

"PED 2014/68/EU"

CATEGORY "XXX"



"XXXX"



ELECTRICAL

NOMINAL VOLTAGE: "XXX-X-XX"
LOCKED ROTOR AMPS: (LRA): "XXX"
MAXIMUM CONTINUOUS CURRENT (MCC, Amps): "XXX.X"
POWER AT MCC (kW): "XXX.X"
RATED LOAD AMPS (RLA): "XX.X"
POWER AT RLA (kW): "XX.X"
MAXIMUM FUSE SIZE (Amps): "XX"
"PROTECTION CLASS (IP): XX"
"SHORT CIRCUIT CURRENT RATING (kA): "XX"



**MUST BE INSTALLED AND SERVICED BY
QUALIFIED ELECTRICAL PERSONNEL.**

**"THIS UNIT CAN OPERATE SAFELY AT THE
CONDITIONS BELOW WITH PROPER SETTINGS
OF THE TRANSFORMER TAPS."**

NOMINAL VOLTAGE- PHASE-FREQUENCY	ACCEPTABLE VOLTAGE RANGE
"Nominal Voltage 1"	"Acceptable Voltage 1"
"Nominal Voltage 2"	"Acceptable Voltage 2"
"Nominal Voltage 3"	"Acceptable Voltage 3"
"Nominal Voltage 4"	"Acceptable Voltage 4"
"Nominal Voltage 5"	"Acceptable Voltage 5"

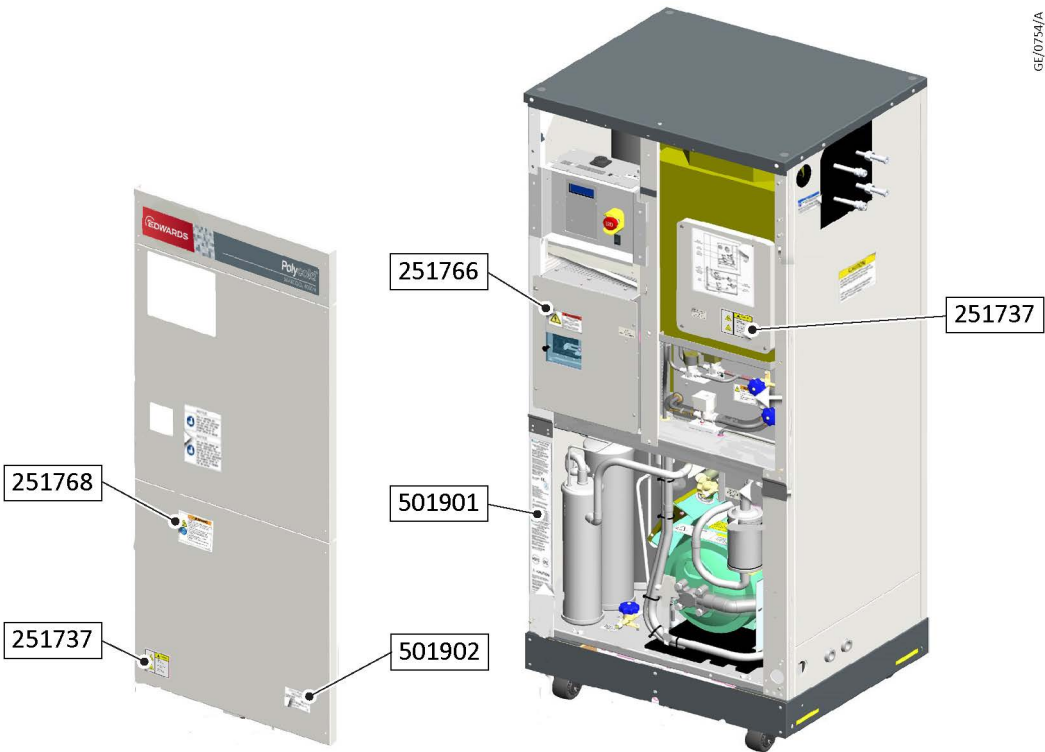
Nameplate label

Part Number: 501901 (left or top section)

Quantity: 1 (2 label set)

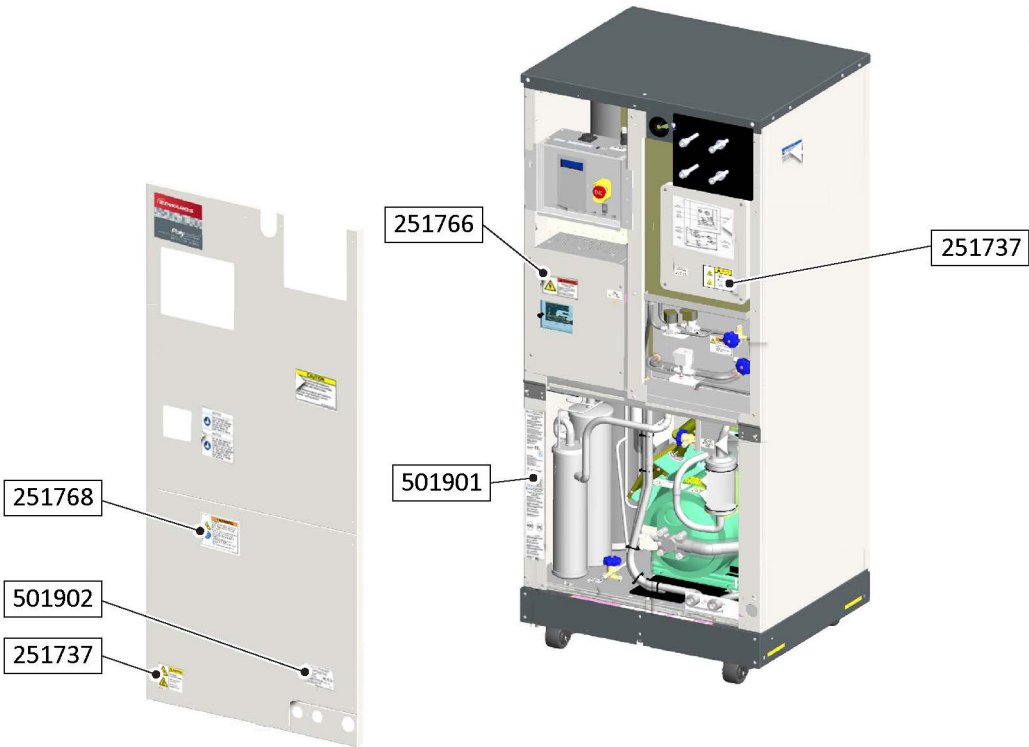
Location: Inside on lower left frame of compressor area contains part number, serial number, and specification information

Figure 1 Locations of safety labels on the front side of the system, standard



GE/0754/A

Figure 2 Locations of safety labels on the front side of the system, front access



GE/0755/A

Figure 3 Locations of safety labels on the back side of the system, standard



Figure 4 Locations of safety labels on the back side of the system, front access



1.5 Safety and operational interlocks

Safety interlocks protect personal safety. Operational interlocks protect the cryochiller. Additional interlocks may be added to the cryochiller by the user. For additional information, see [Compressor safety chain](#) on page 161.

The cryochiller contains the interlocks listed in [Table: Interlocks on the system](#) and shown in [Figure: Location of safety interlocks on the system, standard](#) (for MaxCool Standard) and [Figure: Location of safety interlocks on the system, front access](#) (for MaxCool with Front Access).



WARNING: HAZARDOUS VOLTAGE

Overriding interlocks can cause electrical hazards. Direct contact with hazardous voltage will cause death or serious injury.

- Do not defeat, modify, or disable any of the unit's safety interlocks.

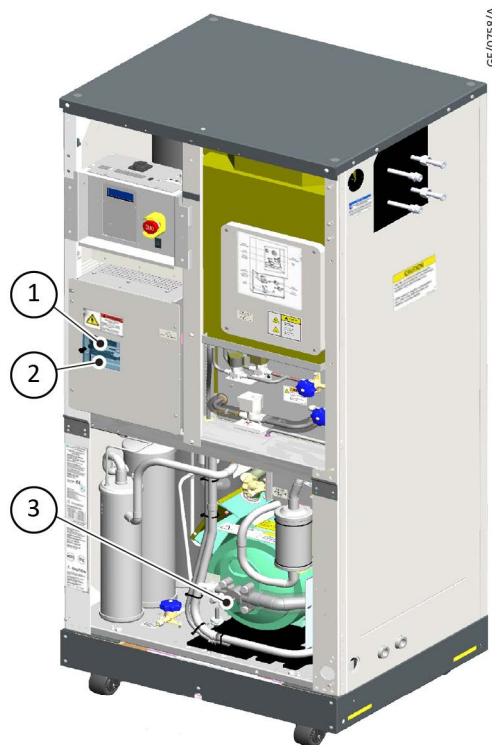
Note:

The user may choose to add an Emergency Off (EMO) circuit to the cryochiller and is accountable for that EMO circuit.

Table 2 Interlocks on the system

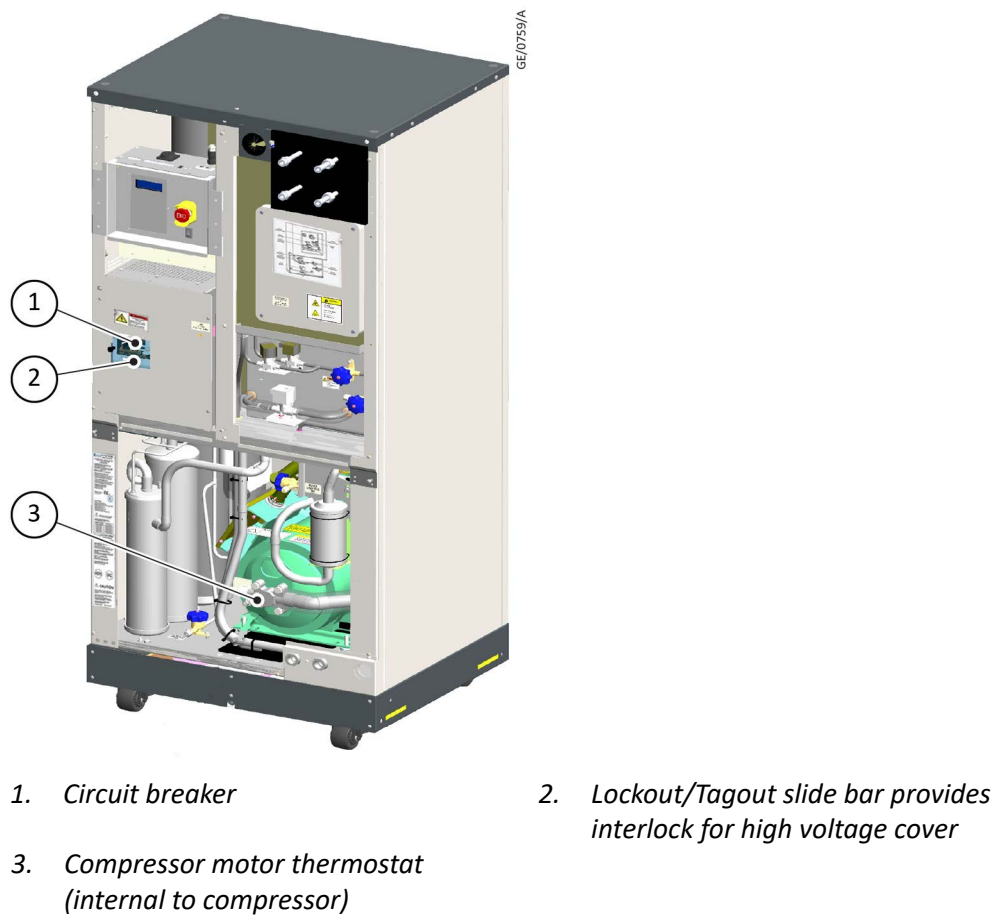
Interlock	Function
Circuit breakers	Protective devices that prevent current overload of the compressor motor or control system. Circuit breakers require manual reset
High voltage interlock	The Lockout/Tagout slide bar must be moved to the lockout/tagout position with the primary circuit breaker in the OFF position in order to remove the cover to the high voltage box and access the interior of the high voltage assembly.
Over pressure relief valve	A pressure relief valve vents refrigerant gas when the refrigerant circuit pressure exceeds the set point of the valve. Causes a controlled-release of excess pressure for the refrigerant in a manner that avoids an over pressure event. Valve closes when pressure is reduced to the valve set point
Compressor motor thermostat	Detects when the temperature of the compressor on the cryochiller exceeds a safe temperature and shuts off power to the compressor motor. The thermostat automatically resets when the temperature of the compressor motor thermostat falls to a safe level.

Figure 5 Location of safety interlocks on the system, standard



1. *Circuit breaker*
2. *Lockout/Tagout slide bar provides interlock for high voltage cover*
3. *Compressor motor thermostat (internal to compressor)*

Figure 6 Location of safety interlocks on the system, front access



1.6 Environmental information

Note:

The cryochiller contains fluorinated greenhouse gases covered by the Kyoto Protocol.

1.6.1 Global Warming Potential (GWP)

FC 517/2014: Item: XXXXXX

DE: Dieses Produkt enthält fluorierte Treibhausgase
X,XX kg, Gewicht, X,XX mt, CO2-Äquivalent.

EN: This product contains fluorinated greenhouse gases
X,XX kg, by weight, X,XX mt, CO2 equivalent.

ES: Este producto contiene gases fluorados de efecto invernadero
X,XX kg, de peso, X,XX mt, CO2 equivalente.

FR: Ce produit contient des gaz à effet de serre fluorés
X,XX kg, en poids, X,XX mt, CO2 équivalent.

IT: Questo prodotto contiene gas fluorurati ad effetto serra
X,XX kg, di peso, X,XX mt, CO2 equivalente.

Refrigerants:
XXXX.....XXXX

XXXX
X XX X

1.6.2 Refrigerant gas recycling and disposal



CAUTION: REFRIGERANT GAS

A qualified refrigeration technician is required to remove the refrigerant from the cryochiller.

- When working with refrigerant gases, follow all facility and local regulatory environmental procedures regarding the storage, handling, and disposal of the gases.
- Refer to the refrigerant Safety Data Sheets (SDS).

1.6.3 Hazardous materials

Make sure that the product has been properly decontaminated before performing any service. Follow the facility's decontamination procedures.

Follow all facility and local regulatory procedures for the disposal of hazardous materials. If the components are charged with refrigerant, refer to the Safety Data Sheets (SDS) for each refrigerant.

1.7 Safety Data Sheets - SDS

The cryochiller contains refrigerants that are a proprietary mixture of different gases. The actual blend may vary depending on the application. All of the blends of refrigerant gases are non-flammable and non-toxic.

A single Safety Data Sheet set for the different blends of gases is described in the SDS. The compressor in the cryochiller contains lubrication oil which may be considered a hazardous substance. The SDS contains the information for the POE Solest LT-32 oil.

2. Introduction

2.1 Using this manual



WARNING: READ THE SAFETY CHAPTER

The system contains high voltages and other hazards which, if not properly handled, may result in death or serious injury. Only trained and qualified personnel should work on the system. Do not perform installation, operation, or maintenance procedures on the system unless you have read and understood the information in the Safety chapter of this manual.

This product is intended for use by industrial customers and should be serviced only by us or our trained representatives. The manuals and related materials are provided in English at no charge and are intended for use by experienced technicians. It is the responsibility of the user to obtain and assure the accuracy of any needed translations of manuals. If you require assistance contact our service department

This manual provides information for a wide variety of system configurations. Some of the features that are shown are optional and may not be installed on your system.

There may be additional installation, maintenance, troubleshooting, and repair information in other manuals which may affect the settings or operation of the system. When integrated into a system, the cryochiller may be set to system specifications. Before adjusting or changing settings, consult the appropriate system documentation.

All documents that are referenced in this manual refer to documents of the latest revision as of the publication date of this manual. Our technical support issues Technical Support Bulletins (TSBs) to notify the owners of record of any field retrofits.

Pressures are stated as gauge (i.e., psig) not absolute. Psig is pounds per square inch gauge and kPa is Kilopascals gauge.

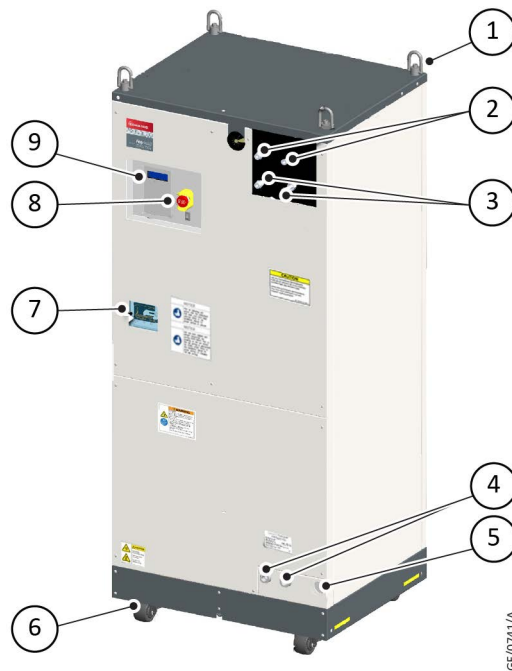
- $\text{kPa} = 6.895 \times \text{Psig}$
- $\text{bar} = \text{Psig} \div 14.5$

2.2 System illustration

Figure 7 Illustration of system standard



- | | |
|---|--|
| 1. Lifting rings (optional) | 2. Circuit 1 refrigerant lines feed 1 (left), return 1 (right) |
| 3. Circuit 2 refrigerant lines feed 2 (left), return 2 (right) (optional) | 4. Water in/out |
| 5. Power in | 6. Casters (optional) |
| 7. Circuit breaker | 8. EMO switch (optional) |
| 9. HMI display and keypad | |

Figure 8 Illustration of system with optional front access

- | | |
|---|--|
| 1. Lifting rings (optional) | 2. Circuit 1 refrigerant lines feed 1 (left), return 1 (right) |
| 3. Circuit 2 refrigerant lines feed 2 (left), return 2 (right) (optional) | 4. Water in/out |
| 5. Power in | 6. Casters (optional) |
| 7. Circuit breaker | 8. EMO switch (optional) |
| 9. HMI display and keypad | |

GE/0741/A

2.3 System summary

2.3.1 Definitions

Refrigeration unit

The device that compresses, cools, and pumps the refrigerant through the refrigerant line and cryosurface.

Refrigerant line

Typically an insulated bundle that contains feed and return hoses that transfer refrigerant between the refrigeration unit and the cryosurface.

Cryosurface

The cold element that is installed in the customer's vacuum chamber. Cryosurfaces are usually shaped as a coil to capture water vapour or as a baffle to capture backstreaming oil.

2.3.2 About the cryochiller

The cryochiller is a closed loop cryogenic refrigeration system with many applications. It is frequently used to capture water vapour and other condensable substances by

freezing them onto a cold surface such as a cryocoil (Meissner trap) or chevron baffle. This Cryochiller is also used to cool and heat objects such as electrostatic chucks used in semiconductor wafer processing.

The cryochiller consists of a refrigeration unit, refrigerant line set, and a cryosurface with cryogenic feedthrough. The refrigeration unit can pump cold or hot refrigerant in a continuous loop through the refrigerant lines and cryosurface. The innovative cryogenic refrigeration process in the cryochiller uses patented refrigerant mixtures and patented control processes developed by us.

Some configurations include advanced controls that reduce power consumption. Models are available that control two independent circuits, providing greater design flexibility for vacuum systems such as two cryocoils or one cryocoil and one cryobaffle. All models include both local and remote operation.

Standard features of cryochiller are:

- Ethernet
- USB
- Side access

Optional features can be selected to add advanced performance and remote communications features that enhance productivity and add convenience. Some of these optional features include:

- Sound attenuation
- Compliance with SEMI S2 and F47 standards including EMO
- Profinet
- EtherCAT
- DeviceNet
- 24 V remote interface
- Lifting rings
- Casters

2.3.3 Cryochiller models

The cryochiller is manufactured in different models and configurations to fit a variety of applications. [Table: System models and descriptions](#) shows the currently manufactured cryochiller model numbers and their description. Contact our vacuum sales for optional configurations.

Table 3 System models and descriptions

Configuration	Description
MaxCool 4000H	Optimized for maximum water vapour cryopumping speed and maximum vacuum process throughput (formerly XC8800 HC).
MaxCool 2500L	Optimized for low temperatures for minimum water vapour partial pressure and maximum vacuum process quality for specialty applications (formerly XC8800 MT).
MaxCool 2200	Optimized for water vapour cryopumping, and fast cycle times improved process throughput for medium sized vacuum tools.
MaxCool 1500	Optimized for water vapour cryopumping in small, lower-power applications.

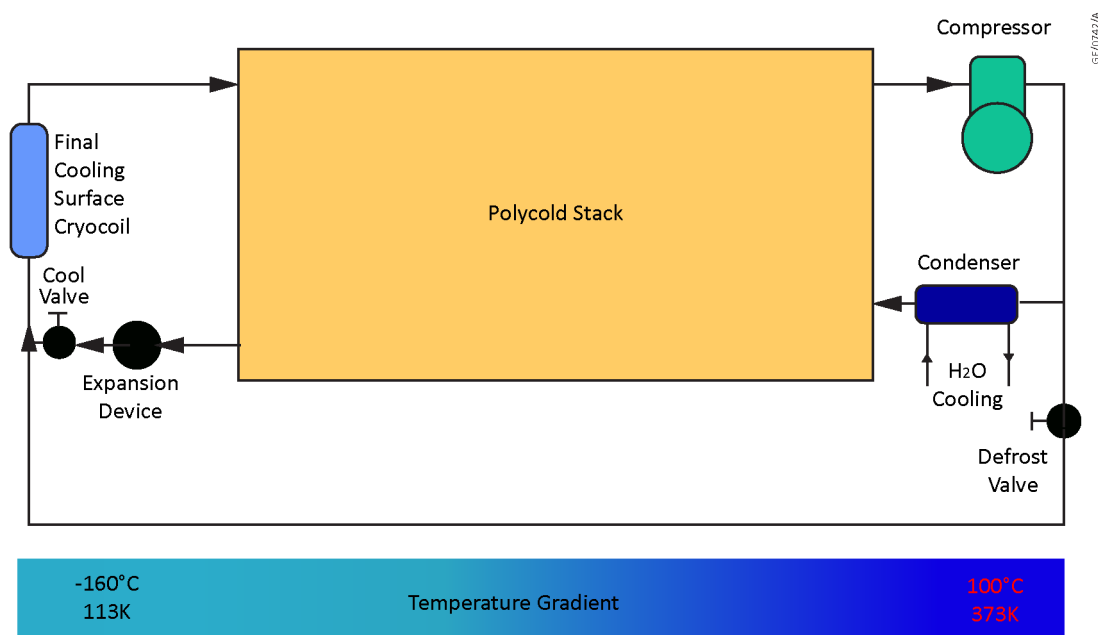
2.4 Theory of operation

The cryochiller employs a patented non-flammable HCFC-free refrigerant mixture in an auto-cascade refrigeration cycle (ARC) cooling process to provide operating temperatures from -80 °C to -150 °C.

This process, which is thermodynamically more efficient than a multistage cascade refrigeration process, combines all of its refrigerants into a single multi-component stream circulated by one compressor.

The advantages of the mixed refrigerant ARC cooling process are reduced system complexity, more favourable operating conditions, lower maintenance, and greater reliability.

Figure 9 Refrigeration flow diagram



2.4.1 Water vapour capturing in high vacuum systems

Water vapour can be up to 95% of the residual gas in high-vacuum chambers and is typically the most reactive contaminant in such systems. The exceptionally high water vapour pumping speed provided by the Cryochiller greatly increases product throughput and produces higher film quality, better adhesion, and more reproducible deposition.

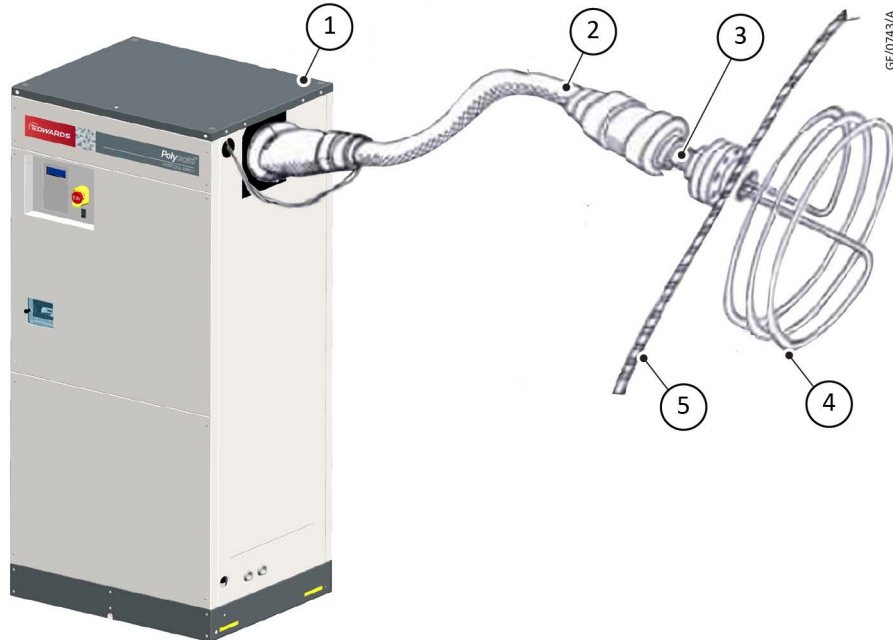
When capturing water vapour in high vacuum systems, the cryosurface is normally a coil. A rapid interchange between the cold and defrost states frees up valuable cycle time and increases product throughput.

As the vacuum chamber begins the pump down sequence, the pre-programmed cryochiller can exit the Standby mode and quickly cool the cryocoil, providing much higher pumping speeds than traditional vacuum pumps and significantly reducing chamber pump down time.

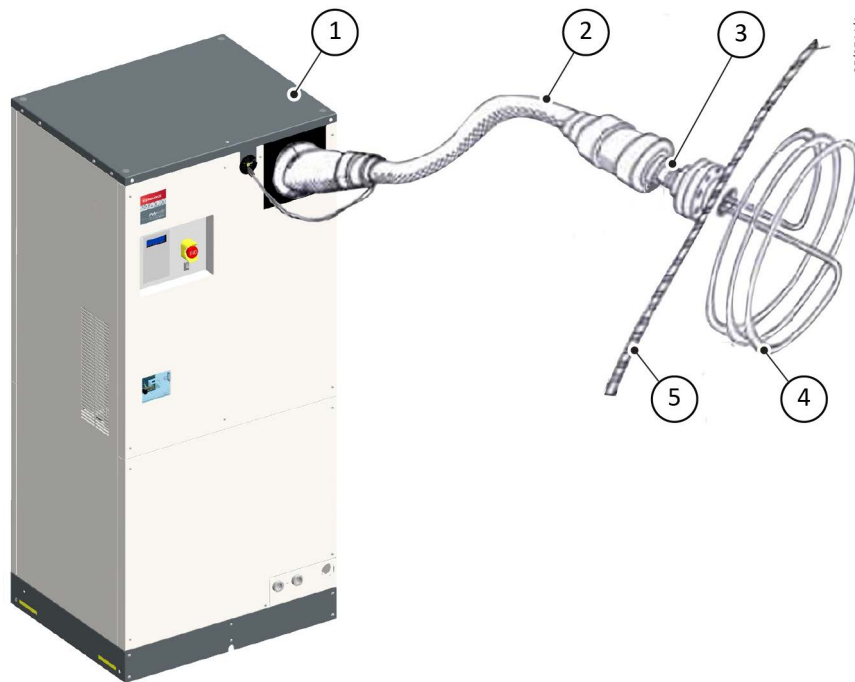
During the deposition process, the cryochiller remains in the Cool mode to greatly reduce water vapour contamination and increase product yield. During chamber venting, the cryochiller quickly heats the cryocoil to defrost and sublime the captured water vapour.

In this application, the cryocoil can be mounted directly in the vacuum chamber so conductance is not limited by ports, manifolds, valves and baffles. The cryocoil is easy to install and can be adapted to fit any system. It does not need a high vacuum valve. See [Figure: System used for water vapour capture, standard](#) and [Figure: System used for water vapour capture, front access](#).

Figure 10 System used for water vapour capture, standard



- | | |
|-----------------------------------|---------------------|
| 1. Cryochiller refrigeration unit | 2. Refrigerant line |
| 3. Cryogenic feedthrough | 4. Cryosurface |
| 5. Vacuum chamber wall | |

Figure 11 System used for water vapour capture, front access

- | | |
|-----------------------------------|---------------------|
| 1. Cryochiller refrigeration unit | 2. Refrigerant line |
| 3. Cryogenic feedthrough | 4. Cryosurface |
| 5. Vacuum chamber wall | |

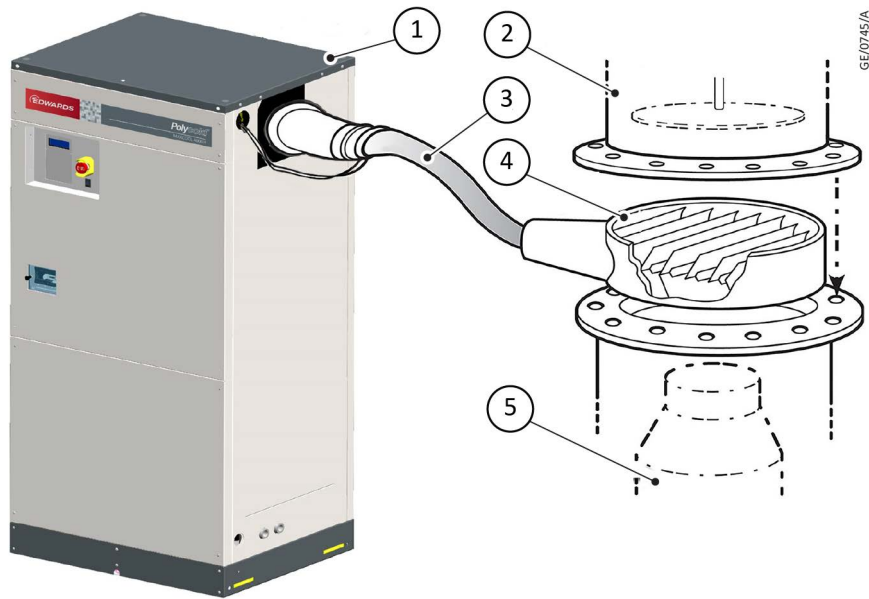
2.4.2 Minimise oil backstreaming from diffusion pumps

Backstreaming can occur when oil diffusion pumps are used in high vacuum systems. Hot oil vapour from a diffusion pump can migrate into the vacuum chamber and contaminate the system.

An optically-opaque cryogenic chevron baffle that is cooled by the cryochiller is placed over the diffusion pump to greatly reduce oil contamination due to backstreaming. This baffle also provides additional water vapour pumping speed to the vacuum tool. This greatly improves vacuum system cleanliness and leads to greater product quality and yield. Quick cooling and defrosting is not typically required for such an application because the cold cryobaffle remains isolated behind a high vacuum valve whenever the chamber is vented to atmosphere. See [Figure: System used with optically opaque baffle to minimise oil backstreaming, standard](#) and [Figure: System used with optically opaque baffle to minimise oil backstreaming, front access](#).

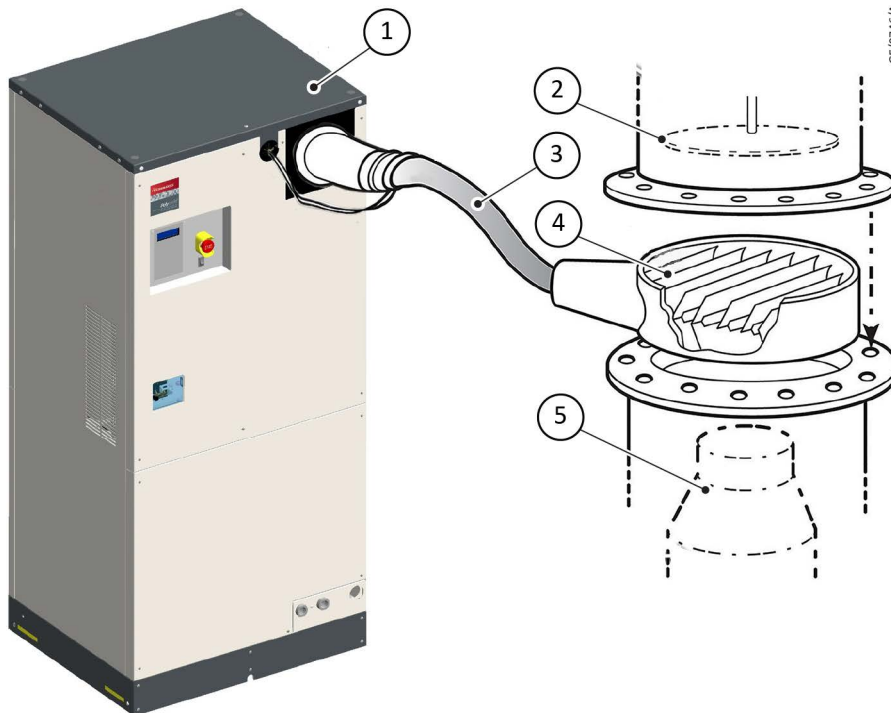
Optically transparent cryobaffles are also available from us. These baffles are appropriate for increased water vapour pumping speed in turbomolecular pump applications.

Figure 12 System used with optically opaque baffle to minimise oil backstreaming, standard



- | | |
|------------------------------|----------------------|
| 1. System refrigeration unit | 2. High vacuum valve |
| 3. Refrigerant line | 4. Cryobaffle |
| 5. Oil diffusion pump | |

Figure 13 System used with optically opaque baffle to minimise oil backstreaming, front access



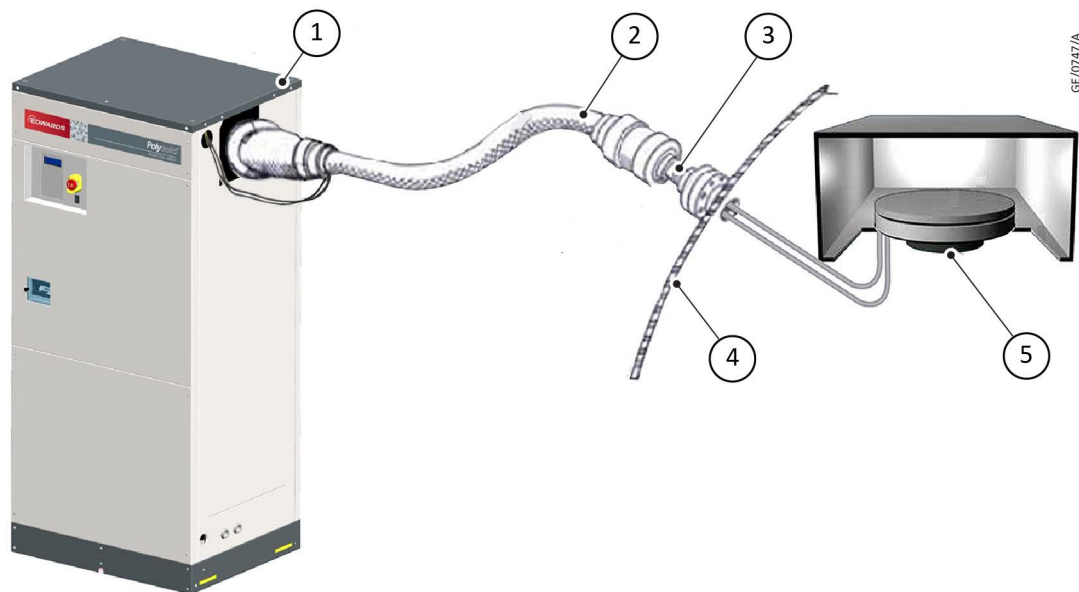
- | | |
|-----------------------------------|----------------------|
| 1. Cryochiller refrigeration unit | 2. High vacuum valve |
| 3. Refrigerant line | 4. Cryobaffle |
| 5. Oil diffusion pump | |

2.4.3 Heat removal

The cryochiller is also used in applications requiring high power cooling to temperature as low as -150 °C.

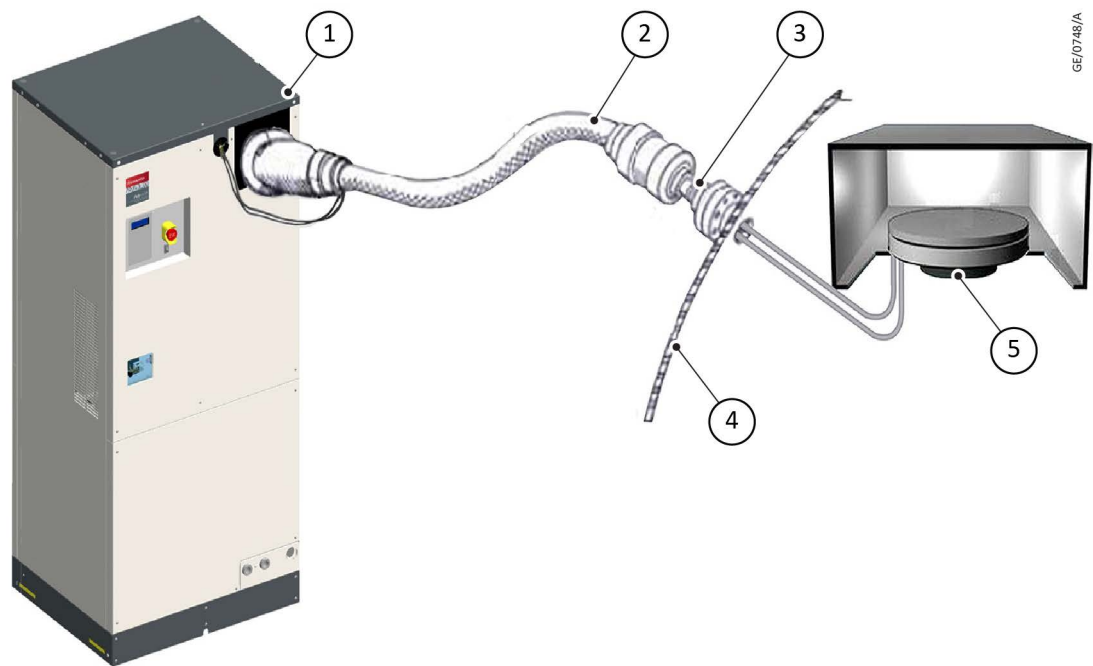
There are a wide variety of heat removal applications, but two notable examples include the cooling of external heat exchangers that chill a gas or a liquid and the cooling of refrigerant-cooled chucks that control the temperature of semiconductor wafers and other substrates during a manufacturing process in a vacuum. See [Figure: System used for heat removal, standard](#) and [Figure: System used for heat removal, front access](#).

Figure 14 System used for heat removal, standard



- | | |
|-----------------------------------|---------------------|
| 1. Cryochiller refrigeration unit | 2. Refrigerant line |
| 3. Feedthrough | 4. Chamber wall |
| 5. Cold plate | |

Figure 15 System used for heat removal, front access



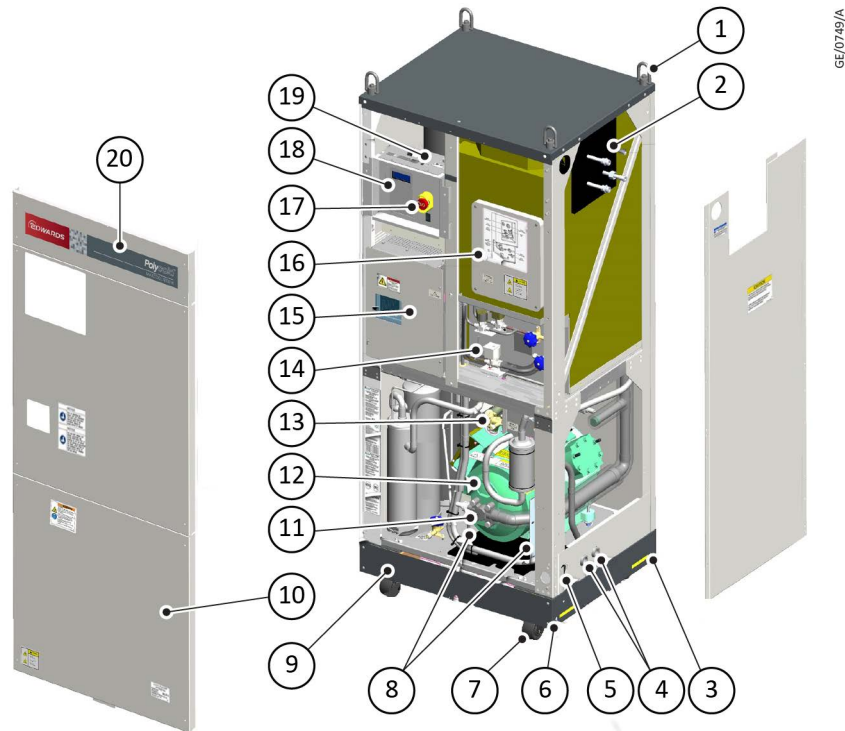
- | | |
|-----------------------------------|---------------------|
| 1. Cryochiller refrigeration unit | 2. Refrigerant line |
| 3. Feedthrough | 4. Chamber wall |
| 5. Cold plate | |

2.5 Cryochiller components

Cryochiller components are shown along with all optional components. Optional components must be selected when the system is ordered.

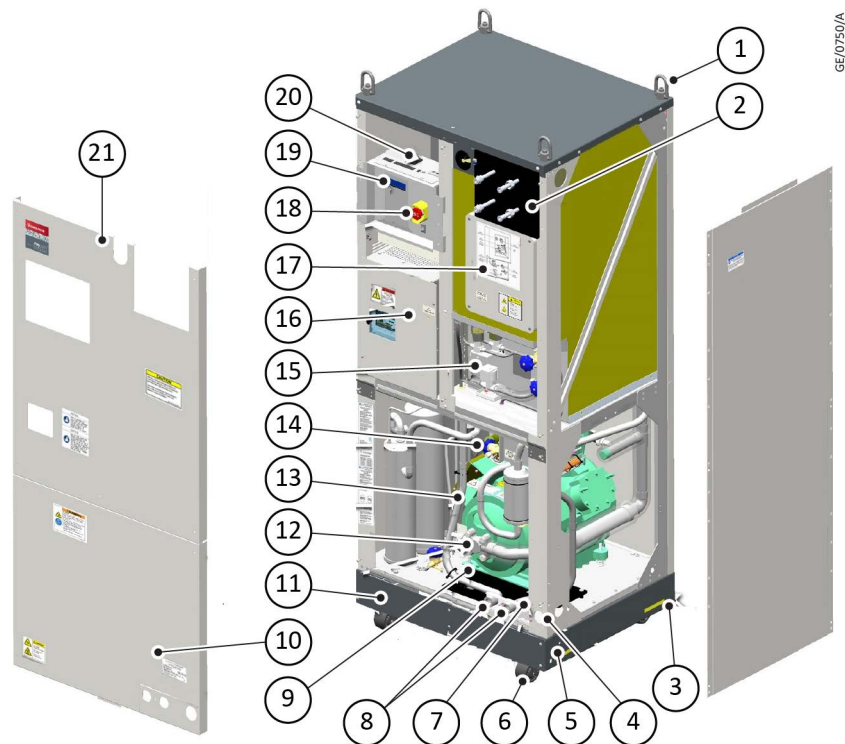
2.5.1 Cryochiller views

Figure 16 System exploded view, standard



- | | |
|---|--|
| 1. Lifting rings (x4, optional) | 2. Feed / return lines (optional second circuit shown) |
| 3. Back seismic anchor points (x2) | 4. Water supply and return connections |
| 5. Power inlet | 6. Front seismic anchor points (x2) |
| 7. Casters (x4, optional) | 8. Compressor shipping hold down nuts (x4) |
| 9. Removable kick plate for pallet jack access | 10. Bottom panels (optional sound attenuation) |
| 11. Suction service valve | 12. Compressor (optional power management) |
| 13. Discharge / recharge valve | 14. Warm valves |
| 15. High voltage box cover and circuit breaker access (optional SEMI F47) | 16. Cold valve box |
| 17. EMO (optional) | 18. Human Machine Interface - HMI - area |
| 19. 24 V remote interface (optional) | 20. Thermocouple access panel |

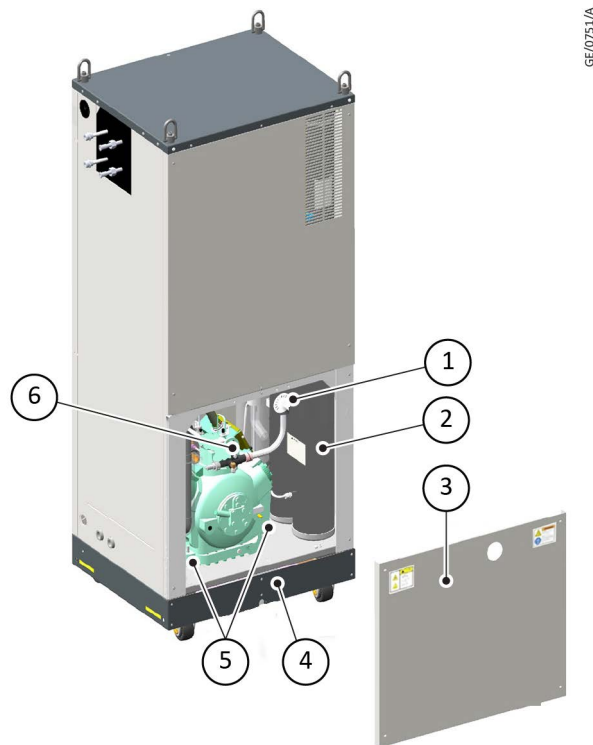
Figure 17 System exploded view, front access



GE/0750/A

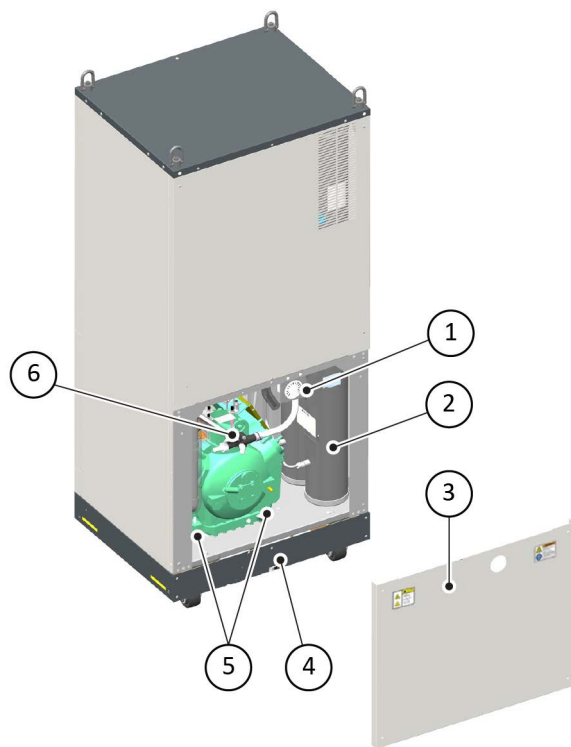
- | | |
|---|---|
| 1. Lifting rings (x4, optional) | 2. Feed / return lines (optional second circuit shown) |
| 3. Back seismic anchor points (x2) | 4. Power inlet |
| 5. Front seismic anchor points (x2) | 6. Casters (x4, optional) |
| 7. Compressor shipping hold down nuts (x4) | 8. Water supply and return connections |
| 9. Compressor shipping hold down nuts (x4) | 10. Bottom panels (optional sound attenuation) |
| 11. Removable kick plate for pallet jack access | 12. Suction service valve |
| 13. Compressor (optional power management) | 14. Discharge / recharge valve |
| 15. Warm valves | 16. High voltage box cover and circuit breaker access (optional SEMI F47) |
| 17. Cold valve box | 18. EMO (optional) |
| 19. Human Machine Interface - HMI - area | 20. 24 V remote interface (optional) |
| 21. Front access panel | |

Figure 18 System compressor view, standard



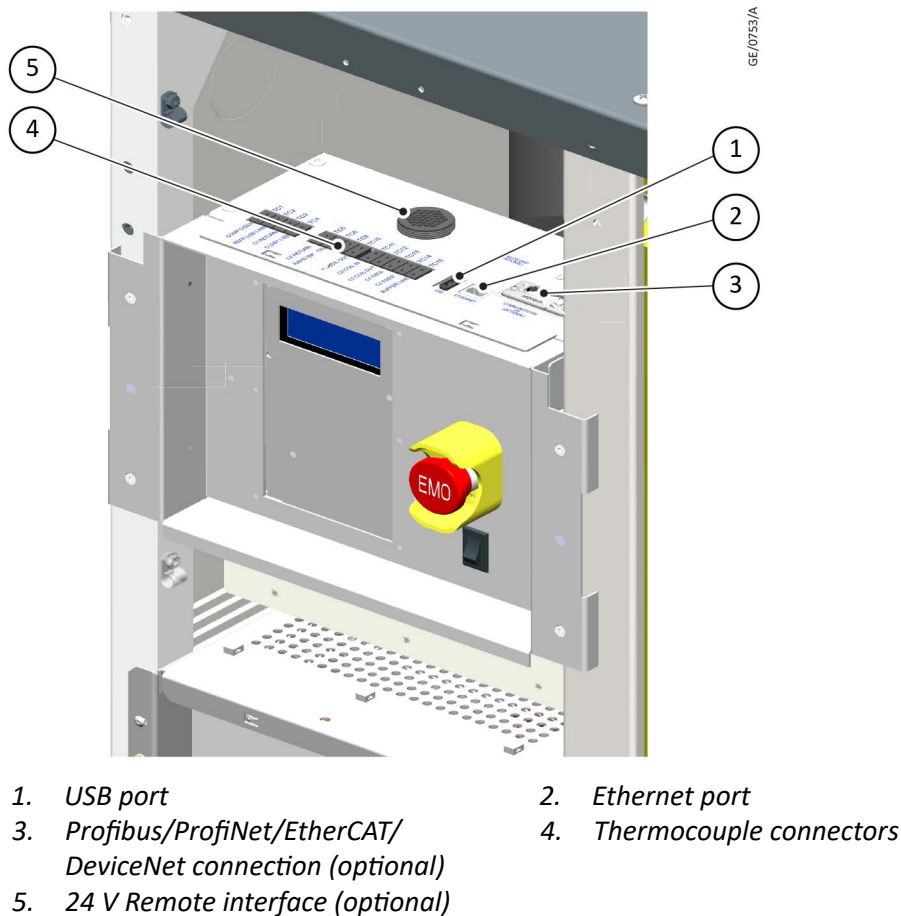
- | | |
|--|---|
| 1. <i>Pressure gauge</i> | 2. <i>Expansion tanks</i> |
| 3. <i>Bottom panels (optional sound attenuation)</i> | 4. <i>Removable kick plate for pallet jack access</i> |
| 5. <i>Compressor shipping hold down nuts (x4)</i> | 6. <i>Discharge service valve</i> |

Figure 19 System compressor view, front access



GE/0752/A

- | | |
|--|---|
| 1. <i>Pressure gauge</i> | 2. <i>Expansion tanks</i> |
| 3. <i>Bottom panels (optional sound attenuation)</i> | 4. <i>Removable kick plate for pallet jack access</i> |
| 5. <i>Compressor shipping hold down nuts (x4)</i> | 6. <i>Discharge service valve</i> |

Figure 20 Low voltage section

2.5.2 Limitations

This product must be serviced only by us or our trained representatives. If you require assistance, contact our service department.

2.6 Lifting rings (optional)



WARNING: LOAD SHIFT HAZARD

When lifting the system using straps and rings, the straps may shift slightly due to the offset centre of gravity and may cause death or severe injury. Ensure that the area beneath the hoist is clear of personnel and equipment when lifting the unit.



WARNING: HEAVY OBJECT HAZARD

Electrical Equipment Safety guideline IEC61010-1 and UL61010-1 Cl.7.5.3 require that the lifting slings have a safety factor (SF) of at least 4 times the weight of the load. Other standards have different safety factors. Use a lifting device and slings rated according to local regulations but not less than 2132 kg (4700 lb).



WARNING: HEAVY EQUIPMENT

This unit can weigh up to 1300 lbs (590 kg). This unit may fall when moved improperly which may cause serious injury or death.

To avoid this hazard, follow these precautions:

- Read the user's manual before moving.
- Use all four hoist rings with overhead lift equipment rated for use with this load with an adequate safety factor.
- Lift with more than 45° from horizontal.

Optional lifting rings may be installed on the top four corners of the cryochiller refrigeration units to aid in lifting and moving.

When using a sling to lift the unit by the lift rings, observe the following:

- The strength of the lifting device must be greater than 4 times the weight of the unit being lifted.
- Lift with 4 straps that each have a minimum strength as required by local regulations but not less than the weight of the item being lifted.
- The length for each strap between the lift ring bolt and the lifting point must be greater than 736 mm (29 inches).
- The angle between the sling strap and horizontal at each lift ring must be greater than 45°.

Figure 21 System with lifting rings, standard



- | | |
|--|--|
| 1. Strength of lift device greater than 4 times weight of unit | 2. Strength of each strap greater than full weight of unit |
| 3. Angle of strap greater than 45° | 4. Length of each strap greater than 736 mm (29 inch) |

Figure 22 System with lifting rings, front access



- | | |
|---|---|
| 1. <i>Strength of lift device greater than 4 times weight of unit</i> | 2. <i>Strength of each strap greater than full weight of unit</i> |
| 3. <i>Angle of strap greater than 45°</i> | 4. <i>Length of each strap greater than 736 mm (29 inch)</i> |

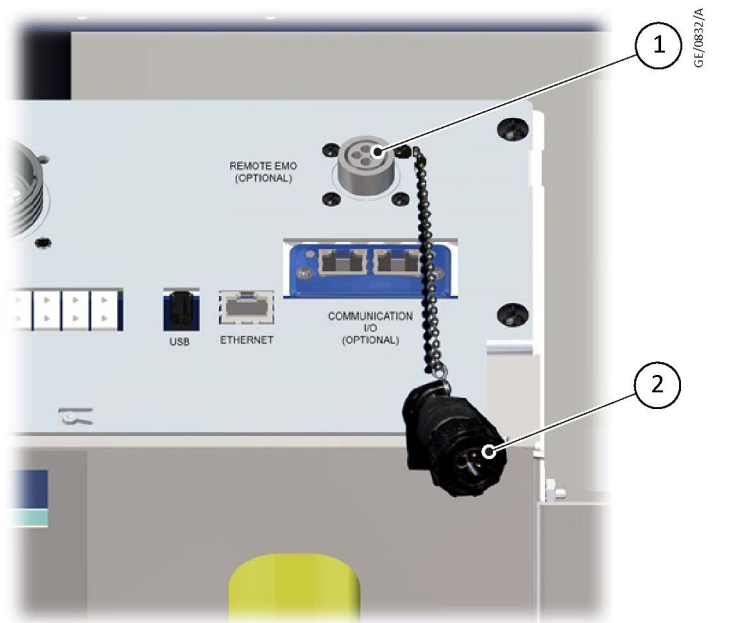
2.7 Remote EMO (optional)

The optional remote EMO connection allows for a 4-pin remote EMO control and remote EMO status connection at remote EMO on the Interface panel.

The remote EMO status and remote EMO control connections allow for monitoring the status of the compressor contactor and controlling the power to the compressor contactor.

If you do not use the remote EMO, install the EMO jumper to operate the compressor.

Figure 23 Remote EMO connector



1. Remote EMO connector 2. EMO jumper

2.7.1 EMO status

Pins 1 and 2 of remote EMO connector allow a remote device to sense the status of the cryochiller EMO circuit.

- Open circuit between this pair of contacts indicates that the compressor contactor is off or open.
- Closed circuit between this contact pair indicates that the compressor contactor is on and the compressor is probably running.

2.7.2 EMO remote control

Pins 3 and 4 of remote EMO connector allow a remote device to interrupt the power to the coil of the contactor which controls the power to the compressor motor. Pins 3 and 4 are in series with the power to the compressor motor contactor relay.

- When pins 3 and 4 are open, the circuit to the compressor contactor is open. The compressor cannot operate until this pair is closed. These pins directly interrupt the wiring of the power circuit that controls the contactor.
- When pins 3 and 4 are closed, the circuit to the compressor contactor is closed. This allows the compressor contactor to be turned on by the compressor on/off switch on the cryochiller.

Pins 3 and 4 must be wired to a switch or a set of relay contacts or must be jumpered using the EMO jumper connector.

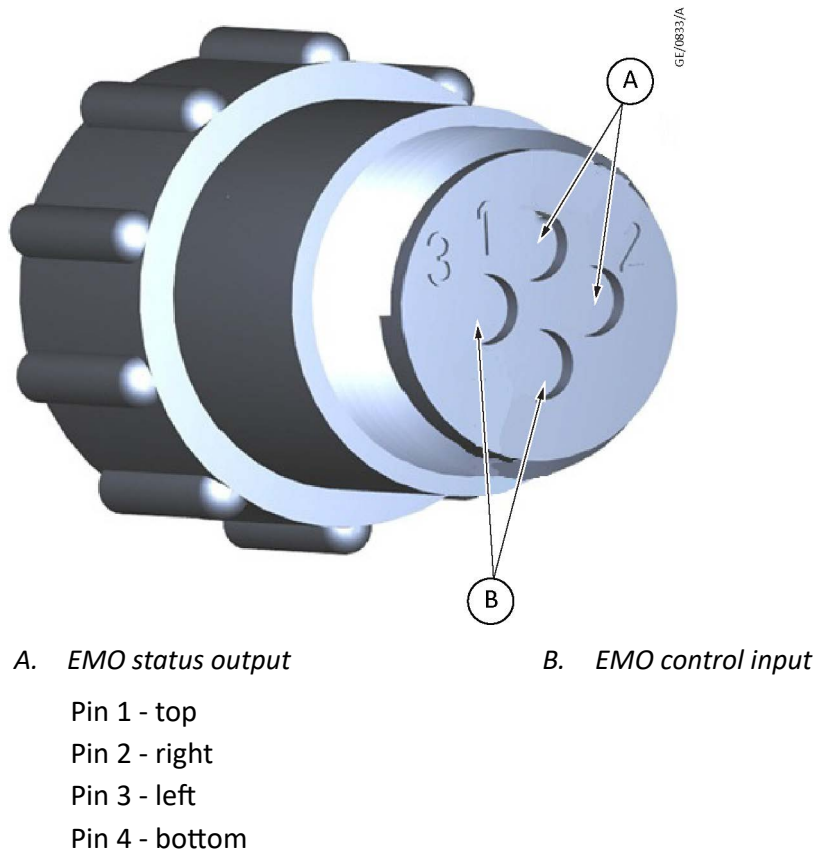
2.7.3 Remote EMO connector wiring

System EMO connection	4-pin connector (female pins)
Cable connector	4-pin cable connector (male pins) (Amp CPC-11-206429-1)

Cable terminal pins	Four crimp-tail style male pins for 16 to 18AWG wire size.
Cable size	16AWG wire required for pins 3 and 4 16 to 18AWG for pins 1 and 2 Cable must be less than 15 m (50 feet).
EMO status connection (output)	Pins 1 and 2 give dry contact switch closure output signal to remote device to monitor compressor contactor on/off. Closed = contactor on. Open = contactor off
EMO control connection (input)	Pins 3 and 4 interrupt the compressor contactor circuit. Switch set or relay contact pair or jumper wire is required for compressor contactor to turn on. Closed = contactor enabled. Open = contactor disabled

To construct the EMO remote cable connection follow these steps.

- Select a cable that meets the 16AWG size requirements for pins 3 and 4.
- Strip the cable conductors as required for the male crimp terminals.
- Crimp a male terminal onto each conductor in accordance with best practises.
- Place the connector back shell onto the cable.
- Insert the conductor male terminals into the wire side of the connector. See [Figure: Remote EMO connector - wire side view](#).
- Thread the connector back shell onto the connector body and tighten firmly.
- Install the cable clamp to the back shell and tighten so that the cable clamp firmly holds the cable. Check for proper cable restraint. Adjust the cable clamp as required.

Figure 24 Remote EMO connector - wire side view

2.8 Seismic restraints (optional)

The cryochiller is provided with four seismic anchor points for mounting seismic restraints. Two anchor points are located on the left and two on the right side of the frame. See [Table: Seismic bracket mount specifications](#) for dimensions.

Seismic bracket design and construction is the responsibility of the facility where the cryochiller is installed.

Table 4 *Seismic bracket mount specifications*

Item	Description
Mounting hole size	Two 9/16 inch (14.28 mm) through holes on the left side and on the right side of the bottom frame
Mounting hole height	With casters - 4 inches above floor Without casters - 1 inch above floor / bottom of frame
Mounting hole separation	23.5 inches between centres
Fasteners on system	Up to 1/2 inch (M12) hardware including backing flat washers against the inside cryochiller frame
Fasteners on floor	As specified by facility and local regulations
Working load	1800 pounds or greater to comply with SEMI S2

3. Technical data

3.1 Physical specifications

Table 5 Physical specifications

Parameter	MaxCool 4000H	MaxCool 2500L	MaxCool 2200	MaxCool 1500
Width - mm (inch)	813 (32)	813 (32)	813 (32)	813 (32)
Depth - mm (inch)	663 (26.1)	663 (26.1)	663 (26.1)	663 (26.1)
Height - mm (inch) (without castors or lifting hooks)	1791 (70.5)	1791 (70.5)	1791 (70.5)	1791 (70.5)
Minimum room volume, ft ³ (per ASHRAE 15)	740	830	540	540
Minimum room volume, m ³ (per EN 378-1)	25	25	20	20
Weight kg (lb)	533 (1175)	544 (1200)	453 (1000)	453 (1000)
Shipping weight kg (lb)	567 (1250)	578 (1275)	487 (1075)	487 (1075)
Cooling water connection	3/4 NPT Female	3/4 NPT Female	3/4 NPT Female	3/4 NPT Female
Maximum operating sound level, dB(A)	78	78	72	72
Maximum operating sound level with sound attenuation option dB (A)	69	69	64	64

 Note:

All units have cold elements that may be decoupled from the refrigerant lines.

Maximum angle of inclination for shipping or handling all units is 45°. When moving units using pallet jack or optional casters must be moved on level floors only.

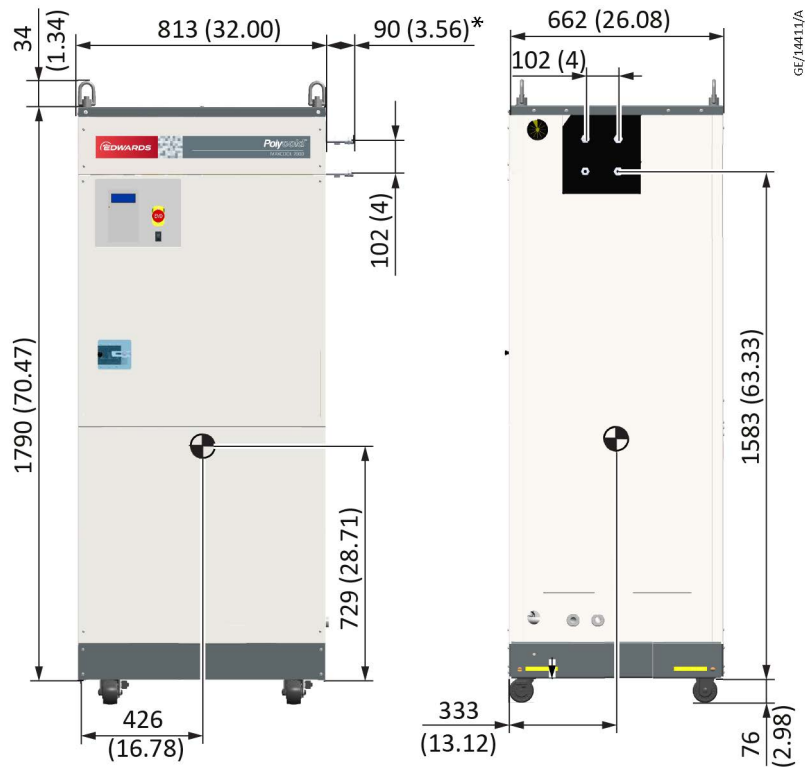
All specifications are for the standard product configuration. Specifications can vary for customised configurations.

Sound measurements were made on each side of the unit at a distance of 1.0 m (39 inch) and at a height of 1.6 m (63 inch). Measurements taken from each side of the unit did not vary significantly. Measurements will vary with the acoustics of the environment.

3.1.1 Dimensions

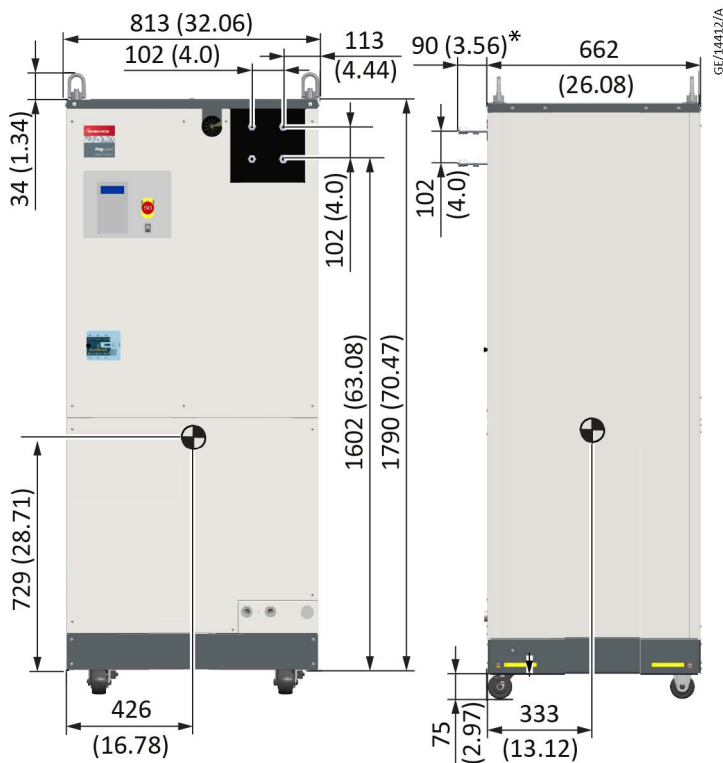
Standard dimensions are mm (inches) based on a standard unit. For a unit with casters, increase vertical dimension by 76.2 mm (3 inches). For a unit with lift hooks folded down, increase vertical dimension by 34 mm (1.34 inches).

Figure 25 Refrigeration unit dimensions for MaxCool 4000H and 2500L, standard

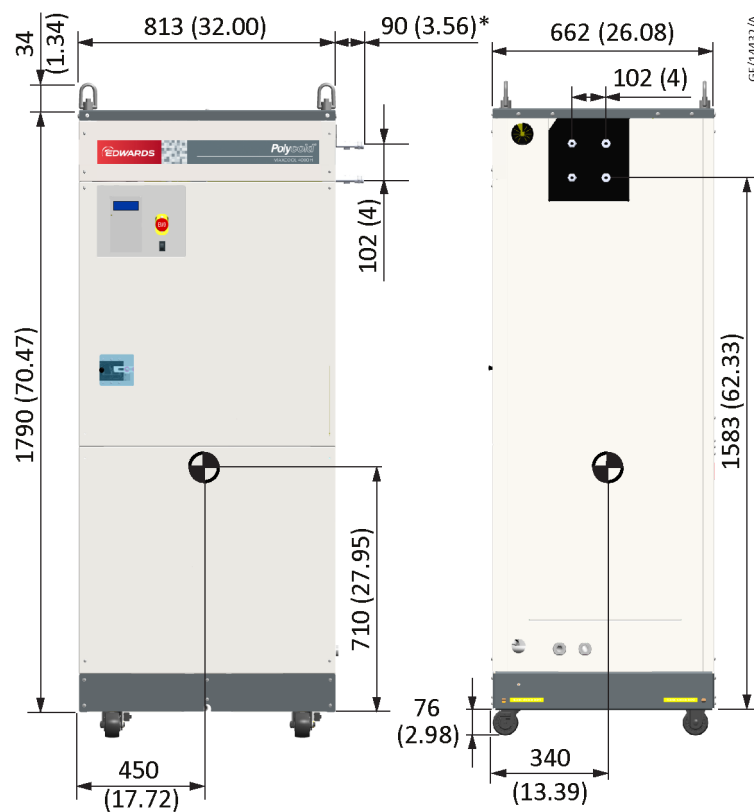


* 90 (3.56) for units with Parker compatible fittings & 105 (4.13) for units with VCR compatible fittings

Figure 26 Refrigeration unit dimensions for MaxCool 4000H and 2500L, front access



* 90 (3.56) for units with Parker compatible fittings & 105 (4.13) for units with VCR compatible fittings

Figure 27 Refrigeration unit dimensions for MaxCool 2200 & 1500 standard

* 90 (3.56) for units with Parker compatible fittings & 105 (4.13) for units with VCR compatible fittings

3.2 Electrical

Table 6 Power consumption under typical conditions (cooling water temperature 25 °C and power frequency 60 Hz):

Parameter	MaxCool 4000H	MaxCool 2500L	MaxCool 2200	MaxCool 1500
Maximum power input	19.2 kW	19.2 kW	11.7 kW	11.7 kW
Typical power input at maximum rated load	14 kW	11 kW	8.6 kW	7.8 kW
Typical power input with cool and low load	8.0 kW at 0 to 300 watts	8.0 kW at 0 to 300 watts	5kW at 0 to 150 watts	5kW at 0 to 150 watts
Typical standby power	8.0 kW	8.0 kW	4.5 kW	4.5 kW

Table 7 For units with power management option enabled

Parameter	MaxCool 4000H	MaxCool 2500L
Power management cool at 2/3 maximum rated load	14 kW	14.9 kW
Power management cool with no load	9.2 kW	12.4 kW
Power management in standby	10 kW	9.9 kW

Table 8 MaxCool 4000H, 2500L, 2200 and 1500 cryochiller electrical characteristics:

Compressor voltage range	Transformer tap setting	Common nominal voltages worldwide (voltage-phase- frequency)	Voltage range
200-230 V a.c.	200-3-50/60	200-3-50 202-3-60 208-3-60	180-222 - 50 Hz 182-229 - 60 Hz
	230-3-60	230-3-60	207-230 - 50 Hz 207-253 - 60 Hz
380-480 V a.c.	380-3-50	380-3-50	342-418 - 50 Hz
	400-3-50	400-3-50 415-3-50	360-440 - 50 Hz
	460-3-60	440-3-60 460-3-60	414-506 - 60 Hz
	480-3-60	480-3-60	432-528 - 60 Hz

3.2.1 Electrical protection requirements - MaxCool 4000H, 2500L, 2200 and 1500

Table 9 MaxCool 4000H and 2500L cryochiller electrical protection requirements

Transformer Tap Setting and ID Label	RLA Amps	MCC Amps	LRA Amps	Fuse Size Amps	Power Input kVA
200-3-50/60	57.1	89	266	80	19.78
230-3-50/60	49.7	89	266	70	19.78
380-3-50	24.1	31	114	35	15.86
400-3-50	22.9	31	114	30	15.86
460-3-50/60	19.9	31	114	25	15.83
480-3-60	19.1	31	114	25	15.86

Table 10 MaxCool 2200 and 1500 cryochiller electrical protection requirements

Transformer tap setting and ID label	RLA Amps	MCC Amps	LRA Amps	Fuse size Amps	Power input kVA
200-3-50/60	35.0	44	160	60	12.1
230-3-50/60	30.4	44	160	60	12.1
380-3-50	17.9	22	80	25	11.8
400-3-50	17.0	22	80	25	11.8
460-3-50/60	14.8	22	80	25	11.8
480-3-60	14.1	22	80	25	11.8

This specification is for unit operating with rated load and voltage range. All voltages are nominal +10%/-10%, unless otherwise stated.

3.2.2 Electrical specification notes

- The Cryochiller is shipped with transformer tap settings for the voltage specified on the system label. If the voltage is outside of the specified range, the transformer taps must be changed.

- 24 V transformers on systems capable of 230 to 480 V power input may be configured in the field to the actual voltage. Refer to [Change transformer tap settings](#) on page 84.
- RLA = Rated Load Amps is the current drawn by the compressor at a rated load. It may also be referred to as the maximum full load amps.
- A Bussman FRS-R dual element, current limiting fuse or equivalent is recommended to protect the cryochiller power circuit.
- Actual protection must comply with local codes.
- "Worst Case low Volts" refers to the lowest amount of voltage available. Power fluctuates by 10%, so the lowest voltage amount would be 90% of the nominal voltage.
- MCC = Maximum Continuous Current of the compressor motor.
- LRA = Locked Rotor Amps. This refers to the current that the compressor motor uses when the compressor is not able to rotate because the rotors are locked.
- Gould TRS, Littelfuse FLSR, MCA, minimum circuit ampacity, should be at least 125% RLA. This value is to assist the site electrician in determining the dimensions of the electrical system.
- Compressors are provided with over current and over temperature protection which comply with UL and NEC definitions of inherent thermal protection.

kVA = (Test Volts) X (RLA) X (1.732/1000).

kW = (kVA) X Power Factor.

3.3 Performance specifications

[Table: Typical performance specifications](#) lists the performance specifications for the cryochiller product family.

For additional information, contact us.

Table 11 Typical performance specifications

Performance	MaxCool 4000H	MaxCool 2500L	MaxCool 2200	MaxCool 1500
Maximum load (Watts at warmest average temperature)	4,000 at -98 °C	2,500 at -120 °C	2,200 at -105 °C	1,500 at -118 °C
Common cryocoil surface areas (m ²)	1.5 to 3.0	1.0 to 2.0	0.5 to 1.5	0.3 to 0.7
Extreme pumping speed, water vapor (l/s) (See note 2)	447,000 3.0m ² cryocoil	298,000 2.0m ² cryocoil	223,500 1.5m ² cryocoil	104,300 0.7m ² cryocoil
Typical cryocoil surface area (m ²)	2.2	1.4	1.1	0.5
Typical pumping speed, water vapor (l/s) (See note 2)	327,800 2.2m ² cryocoil	208,600 1.4m ² cryocoil	163,900 1.1m ² cryocoil	74,500 0.5m ² cryocoil
Typical ultimate operating pressure (torr) (See note 3)	6E-8 2.2m ² cryocoil	8E-10 1.4m ² cryocoil	8E-10 1.1m ² cryocoil	9E-10 0.5m ² cryocoil

Performance	MaxCool 4000H	MaxCool 2500L	MaxCool 2200	MaxCool 1500
Typical ultimate operating pressure (mbar) (see note 3)	8E-8 2.2m ² cryocoil	1E-9 1.4m ² cryocoil	1E-9 1.1m ² cryocoil	1E-9 0.5m ² cryocoil
Maximum pump start pressure (atm) (See note 4)	1.0	1.0	1.0	1.0

 Notes:

1. Standard conditions for performance testing:
 - Cryocoil environment at 25 °C.
 - Recommend cryocoils and line lengths.
 - Cooling water temperature between 25 °C and 28 °C.
 - Operation at 60 Hz.
2. Larger cryocoils may give greater pumping speeds and can be used in some applications. Contact your sales representative or our applications engineer for details.
3. Standard cryocoil at 25% of maximum pumping speed.
4. Recommended cryopump start pressure is near normal crossover. Mechanical roughing pumps and blowers are generally more effective for moisture above 1 torr.
5. Estimated time depending upon cryocoil mass and refrigerant line.
6. Units were tested in a manufacturing environment while under maximum load in the Cool mode.
7. Operation at 50 Hz results in warming of the cryocoil temperatures by 3 to 5 °C.
8. Operation of warmer cooling water temperatures results in a reduction of maximum load rating and warms cryocoil temperatures by about 4 °C for a 10 °C increase in cooling water temperature.

4. Installation preparation

The refrigeration unit should be installed in an environment that meets the following conditions:

- Indoors.
- Above ground.
- Well ventilated area. Room size must meet minimum requirements of ASHRAE-15 and EN-378. See [Install a refrigeration unit to meet ASHRAE requirements](#) on page 68.
- Room temperature of 4 - 40 °C (40 - 104 °F).
- Relative humidity of 20 - 80%, non-condensing.

The cryochiller must remain vertical while operating. The refrigeration unit is not gravity sensitive and may be placed at any elevation relative to the cryosurface.

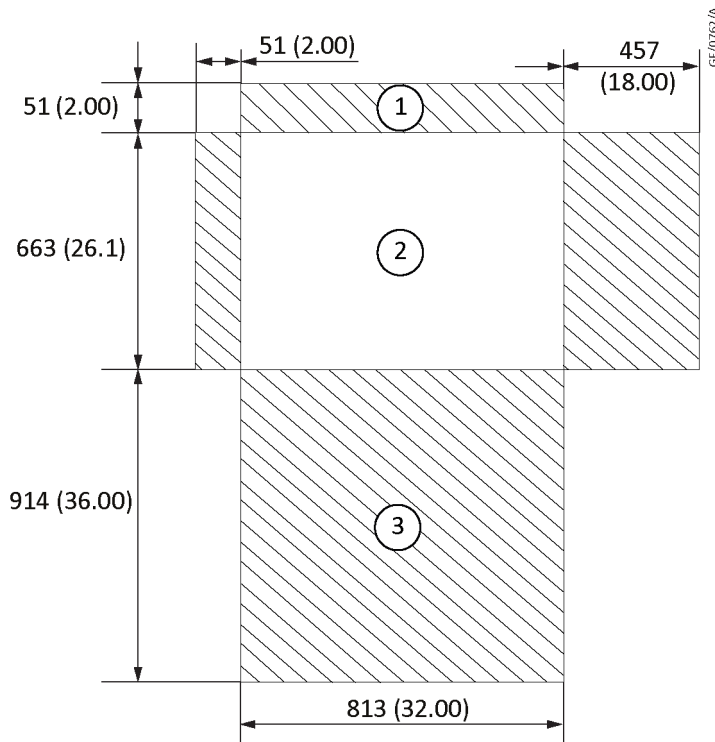
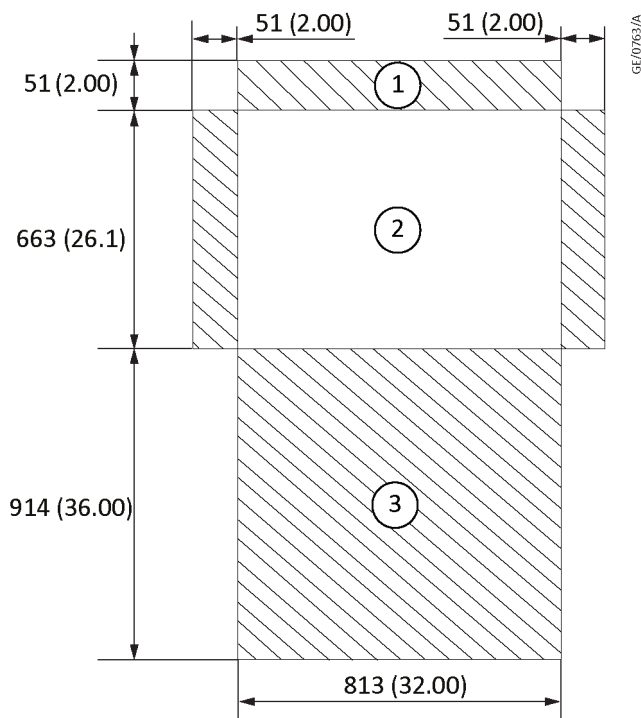
Note:

It is normal for the exterior of one end of the MaxCool compressor to get very cold. In certain environments, ambient humidity may collect on this cold surface. This is normal. A drain hose is provided if the customer wishes to actively manage this condensed moisture.

4.1 Access

During operation, the cryochiller requires 51 mm (2 inches) of clear area at the back of the cryochiller and 914 mm (36 inches) at the front for both standard and front access configurations. See [Figure: Minimum clearances, standard](#) and [Figure: Minimum clearances, front access](#).

- This clearance is required for access to switches, settings, air circulation, and safety reasons.
- For service and maintenance, it is recommended that the unit is installed with as much clear service access as the facility will allow.
- Routine service is performed from the front.
- Major compressor service requires a minimum of 36 inches of rear clearance.
- Units that are seismic anchored require a minimum of 914 mm (36 inches) of rear service access.
- Units that have the caster option require 51 mm (2 inches) of side clearance for gripping the unit.
- Multiple units with the optional 'front access' configuration may be placed side by side as long as the rear clearance is provided.
- Multiple units placed facing each other require 914 mm (36 inches) front service access.

Figure 28 Minimum clearances, standard**Figure 29** Minimum clearances, front access

4.2 Cryocoils and refrigerant lines

Refrigerant lines should be kept to a minimum length. Any line over 6 m (20 ft) should be reviewed by our applications engineer. Longer refrigerant lines delay the start of cryopumping and the time to complete the defrost cycle. They also add to the total heat load on the cryochiller and impact the coldest achievable temperatures at the cryocoil.

The heat gain through the insulation on the combined feed and return refrigerant line set is 8 Watts/ft (25 Watts/m).

The cryocoils must be specified and sized for the process. Contact us for assistance in selecting the proper cryocoil.

Total cryocoil surface area for dual circuit models must be divided between the two circuits. Larger cryocoils may give faster pumping speeds and can be used in some applications. However, if the heat load is too great, the cryopump becomes less efficient and may be shut off by a protective device.

Table 12 Typical cryocoils and refrigerant lines for MaxCool

Cryocoils and refrigerant lines	Single circuit				Dual circuit			
	MaxCool 4000H	MaxCool 2500L	MaxCool 2200	MaxCool 1500	MaxCool 4000H	MaxCool 2500L	MaxCool 2200	MaxCool 1500
Design pressure, Bar (psig)	31 (450)				31 (450)			
Test pressure, Bar (psig)	44.4 (644)				44.4 (644)			
Temperature range	+150 °C to -160 °C				+150 °C to -160 °C			
Typical cryocoil surface area m ² (ft ²) - per circuit	2.2 (23.7)	1.4 (15.1)	1.1 (11.8)	0.5 (5.4)	1.1 (11.8)	0.7 (7.5)	0.55 (5.9)	0.25 (2.7)
Typical cryocoil tube length - m (ft) - per circuit	43.8 (144.7)	27.9 (92.1)	27.9 (92.1)	13.3 (41.1)	21.9 (72.4)	18.6 (57.6)	14.6 (45.2)	6.6 (20.6)
Typical cryocoil tube outer diameter - mm (inch)	16 (5/8)			12 (1/2)	16 (5/8)	12 (1/2)		
Typical line length -m (ft) - per circuit*	2.4 (8)				2.4 (8)			
Feed line tube outer diameter - mm (inch)	10 (3/8)		10 (3/8) [or 8 (5/16)]	8 (5/16)	10 (3/8)	8 (5/16)		
Return line tube outer diameter - mm (inch)	16 (5/8)		16 (5/8) [or 12 (1/2)]	12 (1/2)	16 (5/8)	12 (1/2)		

* Other refrigerant line lengths and cryocoils may be possible, depending upon performance requirements.

 Note:

The tubing for the refrigerant lines and cryocoil must be dried prior to installation. We do not warranty refrigerant contamination.

Perform the strength test with dry compressed nitrogen using the appropriate safety precautions.

After testing, backfill with dry nitrogen and cap the assembly.

Hydrostatic pressure testing is not recommended because it introduces significant amounts of water.

Lines or cryocoils that are hydrostatically tested must be drained of water and baked out at 80 °C for at least 12 hours under a dry nitrogen purge. A calibrated hygrometer should then be used to verify that water vapour concentration is less than 50 ppm at atmospheric pressure (i.e. dewpoint less than -48 °C) at the end of the bake out process.

4.3 Feedthrough

Feedthrough must be selected to match the requirements of the process.

Feedthrough is used to provide feed and return refrigerant to and from the system cryosurface through the vacuum chamber wall.

One single feedthrough typically incorporates both feed and return lines for the cryosurface.

Our typical feedthrough used with the system has a 50 mm (2.0 inch) diameter barrel that fits into the vacuum chamber wall.

P/N 409054-XX has copper tubing. P/N 409053-XX has stainless steel tubing.

Additional feedthrough models are also available from us, including single-pass feedthrough for 25 mm (1 inch) diameter holes. A total of two such single-pass feedthroughs are required for each cryocoil.

 Note:

Our feedthrough is designed to be installed from the inside of the vacuum chamber. This permits removal of the cryosurface when cleaning or servicing the vacuum chamber.

Parameter	Specification
Number	228 [57 mm (2.25 inches) ID X 3 mm (0.125 inch) section]
Material	Buna-nitrile
Surface	66 mm (2.60 inches) Surface roughness not to exceed 0.81 micron (32 micro inch 0.000032 inch) Must be flat, clean, and free of scratches or deposits.

Figure 30 Two-inch Feedthrough with port requirements

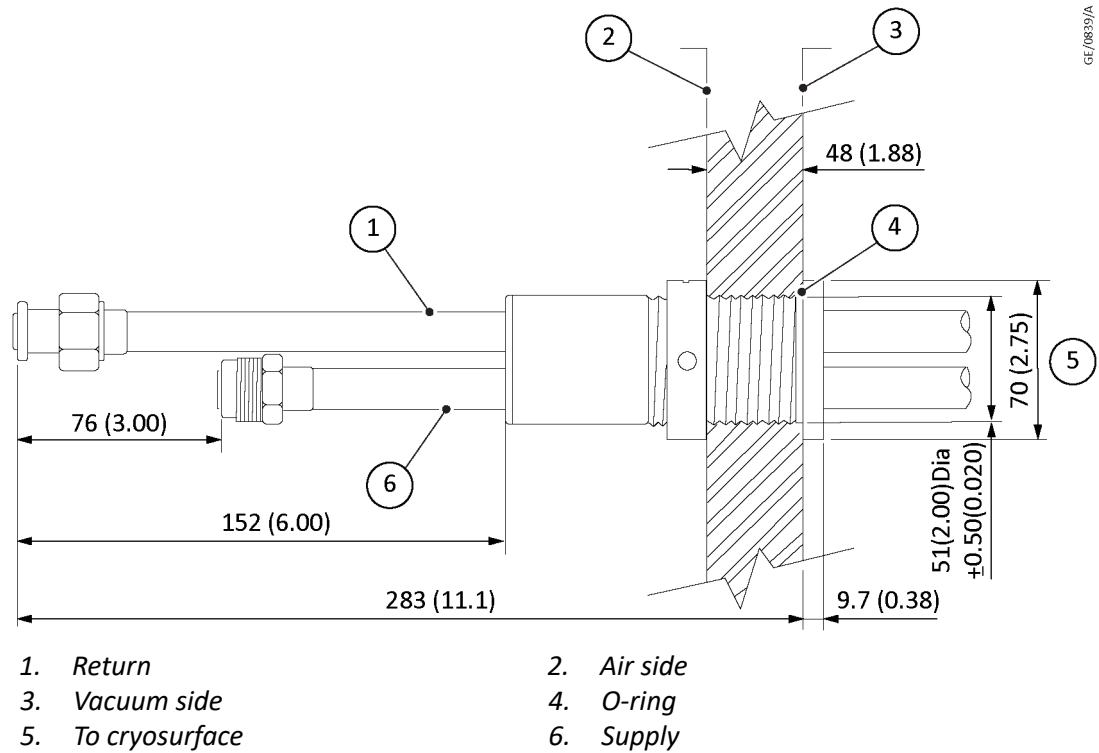


Figure 31 Close-up detail of feedthrough connection

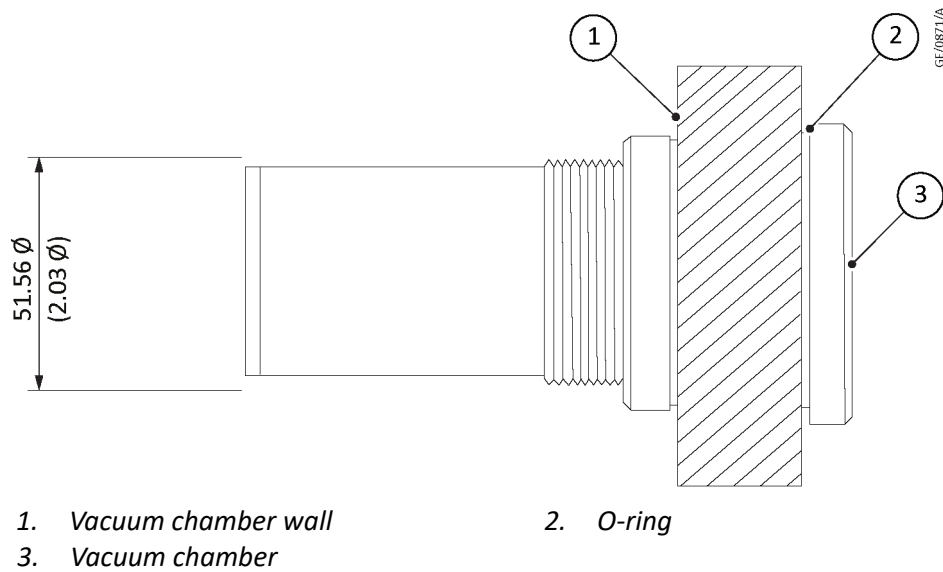
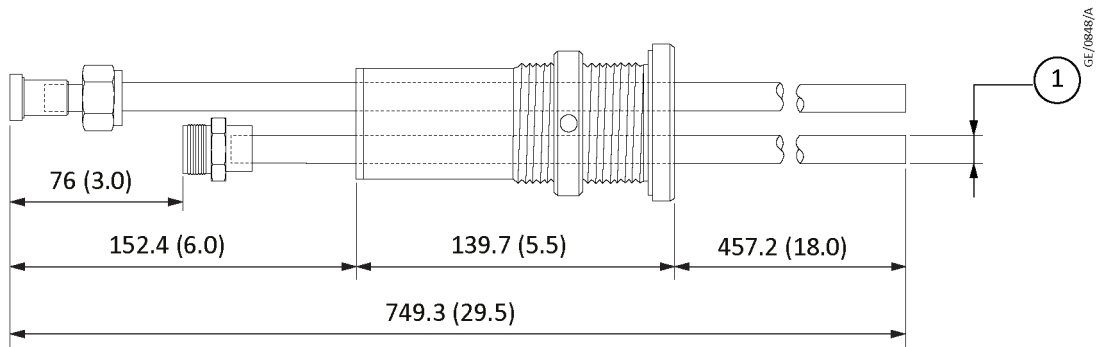
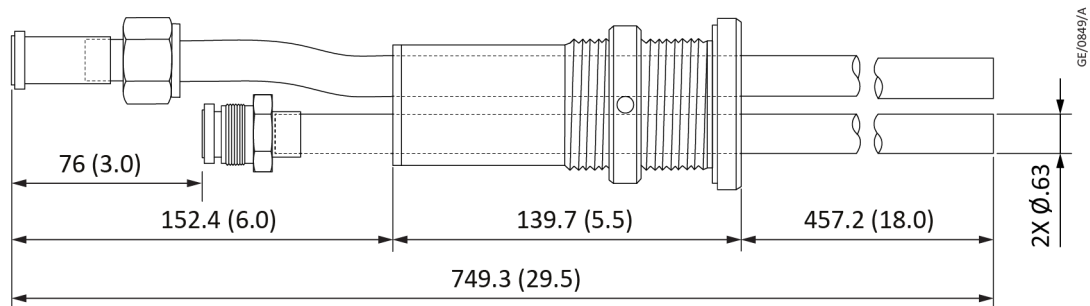
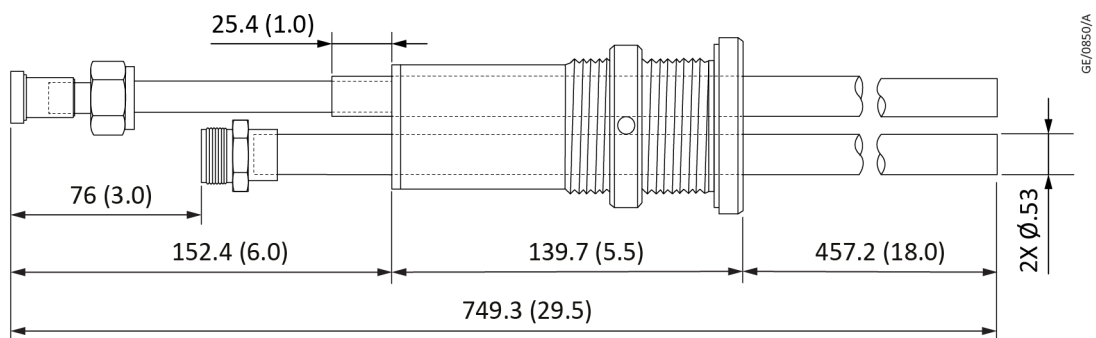


Figure 32 Feedthrough version -2 and -03**Figure 33** Feedthrough version -04**Figure 34** Feedthrough version -05

4.4 Balance pressure

Table 13 Balance pressures for cryochiller refrigeration units

Refrigeration unit	Balance pressure in bar (psig)
MaxCool 4000H	12.4 - 15.9 (180 - 230)
MaxCool 2500L	14.5 - 17.2 (210 - 250)
MaxCool 2200	11.4 - 13.4 (165 - 195)
MaxCool 1500	11.4 - 13.4 (165 - 195)

Note:

These pressures are for the refrigeration units only. The balance pressure may drop 0.3 - 1.8 bar (5-20 psig) after installing the refrigerant line and cryosurface and opening the isolation valves.

Balance Pressure refers to the pressure of the unit when it is turned off and warmed up to room temperature. Balance Pressure can be out of specification due to low room temperature of 20° C to 25° C and gauge reading variation. It is the balance of pressure on the suction and the discharge side of the compressor. When the compressor is running, the unit creates a pressure difference between the suction and discharge sides of the compressor.

4.5 Refrigerants in the MaxCool unit

This product does not contain R-22 or any CFC's or HCFC's and is in accordance with U.S. EPA law and EC2037/2000 and EC1005/2009.

All refrigerant used in our products have significant GWP values. Users and service providers should ensure that refrigerant is not released to the environment at any time. The refrigerant should be reclaimed and either recycled or destroyed in accordance with international regulations and the current best industry practices.

Calculations of the GWP for the cryochiller refrigerant blends, as shown in [Table: GWP values for system refrigerants](#), were calculated in accordance with the European Union's EC Regulation No 517/2014 on certain fluorinated greenhouse gases.

Table 14 GWP values for cryochiller refrigerants

Model	Refrigerants used in the blend (see product I.D. label for amounts)	Total CO ₂ equivalent (metric tons)	GWP value
MaxCool 4000H	R-245fa, R-125, R-23, R-14, Argon	55	6414
MaxCool 2500L	R-245fa, R-125, R-23, R-14, Argon	56	6123
MaxCool 2200	R-245fa, R-125, R-23, R-14, Argon	35.32	5560
MaxCool 1500	R-245fa, R-125, R-23, R-14, Argon	35.32	5560

4.6 Cooling water

Cooling water should be clean. We recommend filtering cooling water if it is very dirty or has abrasives in it. Any chemical impurities in the cooling water must be compatible with copper.

The cooling water supplied to the Cryochiller must meet temperature, flow, and purity requirements.

- Cooling water temperature must be between 13 - 38 °C (55 - 100 °F).
- Minimum flow rates and water temperatures are shown in [Table: Water flow and inlet water temperature](#).
- Purity requirements are shown in [Table: Water purity properties](#).

Minimum water flow rates are based on requirements to effectively remove heat from the cryochiller and to reduce risk for scale and corrosion of the condenser. Flow rates below the published minimum required flow rate can result in scale and corrosion since the risk for these conditions increases with lower water flow rates and higher outlet water temperatures.

Condenser failures or unit performance issues that occur on units operating at water flow rates lower than the minimum required flow rate are not covered by warranty.

Allow for cooling water temperature rise during the summer months.

Cooling water recommendations:

- Install a user-supplied filter that can be quickly purged of accumulated sediment by purging water from the filter, or install two parallel redundant user-supplied water filters with individual input and output shut off valves to allow for continuous operation during maintenance by diverting water to the opposite filter.
- Install a water flow rate meter in the input water line to monitor water flow.

Table 15 Water flow and inlet water temperature

Refrigeration unit	Water inlet temperature °C (°F)	Minimum required flow rate L/min (gpm)	Maximum allowable flow rate L/min (gpm)	Internal pressure drop kPa (Psi)	Pressure drop in supply line kPa/m (Psi/ft)	Heat rejection kW (Btu/Hour)
MaxCool 4000H	13 (55) - Minimum*	15.1 (4.0)	145 (38.3)	13.6 (2.0)	No data	23.2 (79.232)
	18 (65)	18.2 (4.8)		19.3 (2.8)		
	24 (75)	27.3 (7.2)		43.4 (6.3)		
	29 (85)	54.1 (14.3)		171 (24.8)	3.4 (0.15)	
	38 (100) - Maximum**					
MaxCool 2500L	13 (55) - Minimum*	15.1 (4.0)	145 (38.3)	13.6 (2.0)	No data	21.7 (74.109)
	18 (65)	18.2 (4.8)		19.3 (2.8)		
	24 (75)	27.3 (7.2)		43.4 (6.3)		
	29 (85)	54.1 (14.3)		171 (24.8)	3.4 (0.15)	
	38 (100) - Maximum**					
MaxCool 2200	13 (55) - Minimum*	6.8 (1.8)	72.5 (19.2)	3.4 (1.5)	No data	10.3 (35.104)
	18 (65)	9.1 (2.4)		5.5 (0.8)		
	24 (75)	13.6 (3.6)		12.4 (1.8)		
	29 (85)	27.6 (7.3)		52.4 (7.6)	2.5 (0.11)	
	38 (100) - Maximum**					
MaxCool 1500	13 (55) - Minimum*	6.8 (1.8)	72.5 (19.2)	3.4 (1.5)	No data	10.3 (35.104)
	18 (65)	9.1 (2.4)		5.5 (0.8)		
	24 (75)	13.6 (3.6)		12.4 (1.8)		
	29 (85)	27.6 (7.3)		52.4 (7.6)	2.5 (0.11)	
	38 (100) - Maximum**					

* More cooling capacity can be achieved, but compressor icing may occur at this condition.

** Rated load may not be achieved at this condition.

Note:

Pressure Drop values assume a 3/4 inch (20 mm) standard pipe size. Maximum working pressure of the unit's cooling water circuit is 1380 kPa (200 psig).

4.6.1 Recommended water purity properties

The following table provides general water purity guidelines.

Table 16 Water purity properties

Water property	Recommended level	Explanation
Microbiological control	< 10,000 CF (Colony Forming Units)	Higher microbiological levels can result in build up of biofilm, which causes poor heat transfer and copper pitting corrosion.
pH	7.0 - 8.7	Lower levels increase corrosion risk. Higher levels increase scale formation and precipitation.
Calcium Carbonate	< 75 ppm	Levels higher than 75 ppm increase the chance of scaling.
Electrical resistivity	2,000 - 100,000 Ω - cm	Resistivity is the inverse of Conductivity. Higher resistivity above 100,000 Ω - cm can result in copper corrosion.

Note:

Water conditioning may be required for applications not meeting these requirements. Additional parameters appear in [Table: Additional cooling water quality parameters](#).

Table 17 Additional cooling water quality parameters

Water property	Recommended level	Explanation
Total hardness (°dH)	3.9 - 8.4°dH (70 - 150 ppm)	Maintain recommended levels to reduce scaling Scaling affects heat transfer and can lead to crevice corrosion. Values below 100 ppm are strongly recommended as there is a higher risk for scale above 5.6°dH (100 ppm). This assumes the majority of hardness is due to calcium carbonate, CaCO ₃)
Alkalinity (HCO ₃)	70 - 250 ppm	Low levels cause copper corrosion, dissolution and release into water. High levels can cause increased chance of scaling. The alkalinity of interest is "methyl orange" alkalinity or "m alkalinity"
Electrical conductivity	10 - 600 iS/cm	Conductivity above the recommended level indicates a high concentration of ionic substances which results in high dissolved solids and potential for particles and scale.
Particle size	< 100 microns	Larger particles can clog heat exchanger passages.

Water property	Recommended level	Explanation
Chlorides (Cl^-)	< 100 ppm	Higher levels can cause pitting corrosion.
Free chlorine (Cl_2)	< 0.5 ppm	Higher levels accelerates copper leaching by oxidation and dissolution of the metal surface.
Hydrogen sulfide (H_2S)	< 0.05 ppm	Higher levels can lead to corrosion, pitting, and copper fatigue.
Free (aggressive) Carbon dioxide (CO_2)	< 5 ppm	Higher levels can indicate oxidation of metals.
Nitrate (NO_3^-)	< 100 ppm	Nitrate ions help to inhibit corrosion, similar to Sulphate (SO_4^{2-}) Higher levels increase the risk of copper pitting corrosion.
Iron (Fe)	< 0.3 ppm	Higher levels can increase the risk of galvanic corrosion.
Aluminium (Al)	< 0.2 ppm	Higher levels can increase the risk of galvanic corrosion.
Manganese	< 0.5 ppm	Higher levels can increase the risk of galvanic corrosion.
Silica	< 50 ppm	
Total Copper (Cu)	< 0.3 ppm	Higher levels can increase the risk of galvanic corrosion.
$\text{HCO}_3^- / \text{SO}_4^{2-}$	> 1 ppm	Lower levels below 1 ppm add risk of copper pitting
Turbidity	< 5 FTU	Higher turbidity levels are signs of high levels of micro-organisms. Clean water is less likely to form deposits.
Ammonium (NH_4^+)	< 2 ppm	Higher levels increase the risk of copper corrosion.
Sulphate (SO_4^{2-})	< 100 ppm	Levels higher than 100 ppm increase the risk of copper pitting corrosion.

5. Installation

WARNING: GENERAL HAZARD



Failure to review the Safety chapter and follow the safety warnings can result in death or serious injury.

- Do not attempt to perform installation, operation, or maintenance procedures on the cryochiller until you have read and understood the information in the Safety chapter.
- Read and understand each procedure before performing the procedure.

This chapter assumes that the user has completed the specification, design, and component selection process. Refer to the Introduction and Specification chapters for design and specification information.

When using this chapter follow the recommendations below.

- Read and become familiar with the safety chapter.
- Read the specifications chapter and ensure the site and system components are suitable for the installation location.
- Read this chapter and be familiar with the steps required to install the unit.
- Be aware of all safety issues associated with the materials and refrigerants contained in the cryochiller.
- Read the section titled "Installation Considerations" and decide on how each of these issues will be handled.
- Confirm the availability of certified refrigeration specialists that may be required for some procedures.
- Arrange for a qualified electrician or electrical installer to perform electrical power installation.
- Follow the installation checklist to guide you through the installation.

5.1 Installation overview

Before starting the installation, review the items in this section to confirm that the installation location meets the requirements of the Cryochiller and that the proper components have been selected and are available to perform the installation.

5.1.1 Component description

Confirm that each of the main components of the cryochiller are available for installation.

- Refrigeration unit
- Refrigerant line
- Cryosurface; one of two types:
 - Coil - for water vapour cryotrapping
 - Baffle - usually used to minimise oil back streaming
- Cryogenic feedthrough, which routes the refrigerant lines through the vacuum chamber wall

5.1.2 Install a refrigeration unit to meet ASHRAE requirements

The following information helps to comply with ANSI / ASHRAE 15-1994 "Safety Code for Mechanical Refrigeration".

- ANSI is for the American National Standards Institute.
- ASHRAE is for the American Society of Heating, Refrigeration, and Air Conditioning Engineers.

Normally, the manufacturer provides the type and amount of refrigerant used in the refrigeration unit. However, we consider their mixtures of refrigerants to be proprietary. Therefore, the following information complies with the above standards.

- The amount of refrigerant mixture, the minimum room size, and the refrigerant safety group classification are included next to the refrigeration unit's nameplate. The nameplate is located on the frame under the lower left front panel or above the water connection panel, lower right front panel.
- We determined the refrigerant safety group classification of the refrigerant mixture by evaluating the safety group classifications of the individual components. This evaluation used ANSI / ASHRAE- 34 and EN 378.1 as a guide.
- The cryochiller is a "direct (refrigeration) system". It is only intended to be installed above ground in an industrial environment.
- To comply with the Safety Code for Mechanical Refrigeration, ANSI/ASHRAE15-2007, the units should be located in a room no smaller than listed.
- If the minimum room size indicated on the nameplate is not obtainable, the refrigeration unit must be installed in a "refrigerating machinery room". Consult local or national building codes for machinery room requirements.
- See section 9.7.8 of ANSI / ASHRAE 15-1994 for location requirements.
- Only A1 refrigerants are used on MaxCool systems. According to ASHRAE 15 and EN 378, it is permissible for the pressure relief valves to vent into the equipment cabinet. This assumes the unit is installed above ground and in a room that meets the minimum room volume.

Table 18 Pressure relief venting requirements

Refrigeration unit	Recommended discharge capacity (lb air / min)	
	ANSI / ASHRAE 15	EN 378
MaxCool 4000H	2.58	1.58
MaxCool 2500L	2.37	1.47
MaxCool 2200	2.56	1.56
MaxCool 1500	2.56	1.56

The discharge capacity recommended by us is based on actual relief requirements from the refrigeration system as assessed by these standards. The pressure relief devices on the refrigeration unit are oversized. Discharge capacities based on the pressure relief devices are 23.9 pounds of air per minute.

5.2 Inspect and unpack the system

Item	Description
Electrical category	Type 1 - Equipment is fully de-energised
Tools	Standard tool kit and unpacking tools Overhead crane or forklift truck capable of lifting the Cryochiller

WARNING: GENERAL HAZARD



The cryochiller presents hazards that may cause death or personal injury.

- Review this manual before performing any procedure. This includes routine operation of the cryochiller.
- Know the information in the safety chapter.
- Review the SDSs that are associated with this tool.

WARNING: HIGH PRESSURE RUPTURE



If a high pressure circuit is ruptured, such as a refrigerant circuit, equipment damage could occur. Cuts and eye injury from flying objects could result in death or serious injury.

- Inspect the refrigerant circuit and entire unit before performing any installation procedures.

WARNING: HEAVY OBJECT - LIFT / TIP OVER



Cryochiller refrigeration unit weighs a minimum of 533 kg (1175 lb) and up to 544 kg (1200 lb). Failure to properly lift or move this device may result in death or serious injury.

- Use proper lifting devices and techniques when moving the cryochiller.

1. Carefully inspect all surfaces of the shipping containers for signs of damage or stress. Note that there may be more than one shipping container.
2. If the container has signs of damage:
 - Record the damage and notify the carrier immediately.
 - Assess the damage to the shipping container with the carrier.
 - Determine if the cryochiller is damaged.
 - If the cryochiller is damaged, stop the procedure.
 - Do not install a damaged unit.
 - Notify us of the damage to the unit.
 - Arrange with the carrier and us to repair the damage or replace the unit. Refer to [Service](#) on page 213.
 - If there is no damage, continue this procedure.
3. Remove strapping and fasteners that hold the cardboard enclosure to the palette. Examine the contents for damage. Report any damage that is discovered.
4. Remove the lower braces from the palette that block the base frame of the Cryochiller.

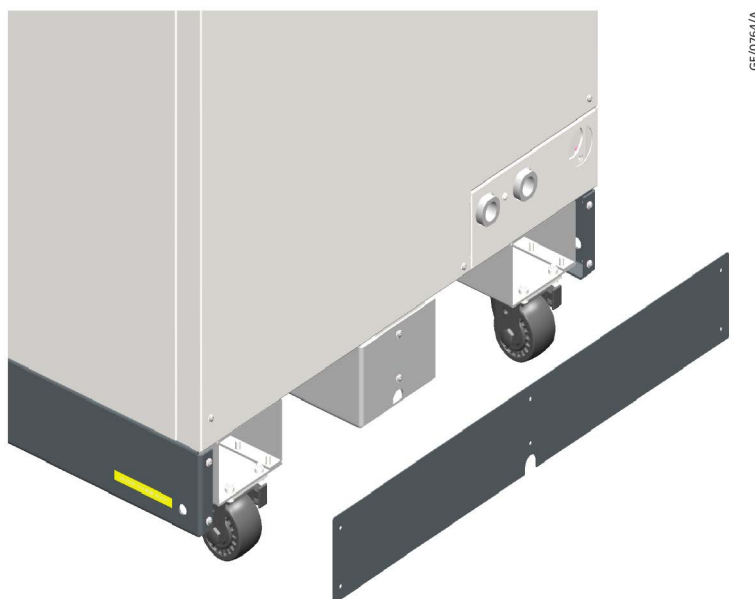
5. Remove the front and rear bottom panels from the Cryochiller.
6. Locate and remove the bolts that hold the Cryochiller to the palette.
7. Save the bolts, palette, shipping materials, and the shipping containers that are in re-usable condition to ship the cryochiller to another location, as required.
8. If a spare parts kit was shipped with the unit, remove the front panel of the refrigeration unit to retrieve the spare parts kit and the manual. Verify that all of the parts were shipped with the unit.
9. Record the balance pressure by performing the following steps:
 - a. Locate the pressure gauge on the rear of the refrigeration unit. When the compressor is turned OFF and at room temperature, the pressure gauge reading is the balance pressure.
 - b. Read the balance pressure on the pressure gauge. The pressure should be within the ranges shown on the balance pressure table, [Balance pressure](#).
 - c. Record the balance pressure in the space in Task 1 on [Table: Installation checklist](#).
 - d. If the equipment has recently been moved from an area where the temperature differs greatly from the installation area, allow the components 24 hours to stabilise to the new room temperature before reading the balance pressure and verifying correct charge pressure.
 - e. If the pressure is not within the listed range, contact our nearest service centre.

 Note:

If the system is exposed to extreme cold during shipping, the balance pressure is reduced due to the increased condensation of the refrigerant mixture. Refrigerant may take up to 48 hours at room temperature to achieve normal balance pressure and for the pressure gauge to display the proper reading.

10. Go to the [Table: Installation checklist](#). Initial and date this task.

Figure 35 Bottom panels



5.3 Move to location

Item	Description
Electrical category	Type 1 - Equipment is fully de-energised
Tools	Lift device to lift, move, and place the unit -see warning - Heavy object below # 2 Phillips screwdriver Two 9/16 inch wrenches

 Note:

*If the unit includes the Lifting Ring option, refer to [Lifting rings \(optional\)](#) on page 43. If the unit includes casters, refer to 185304, *Install Procedure, Caster Option*.*

WARNING: HEAVY OBJECT



The refrigeration unit weighs more than 522 kg (1150 lb). Failure to properly lift this device may result in death or serious injury.

- Use a fork lift or crane when lifting or moving the compressor unit.
- If using lift ring option, refer to [Lifting rings \(optional\)](#) on page 43.

WARNING: HIGH PRESSURE RUPTURE



If a high pressure circuit is ruptured, such as a refrigerant circuit, equipment damage could occur. Cuts and eye injury from flying objects could result in death or serious injury.

- Wear appropriate personal protective equipment when working on or around the system.

1. Check the location where the Cryochiller is to be placed.
Refer to [Figure: System refrigeration unit dimensions, standard](#) (for MaxCool standard),
[Figure: System refrigeration unit dimensions, front access](#) (For MaxCool with front access),
[Figure: Minimum clearances, standard](#) and
[Figure: Minimum clearances, front access](#) for placement and spacing requirements.
2. Follow the placement recommendations below.
 - Place the unit in an area where routing and connecting the water and electrical power will not pose a personnel or equipment hazard.
 - Place the refrigeration unit as close as possible to where the cryosurface will be installed.
 - Position the refrigeration unit for ease of maintenance and connection of facilities and refrigerant lines.
 - Place the refrigeration unit indoors and above ground.
 - Place the refrigeration unit in a well-ventilated area.
 - Place the refrigeration unit in an environment where the temperature is between 40 ° - 104 °F (4 ° - 40 °C).
 - Placement of the unit may be at any elevation relative to the cryosurface. The cryopumping system is not gravity-sensitive.

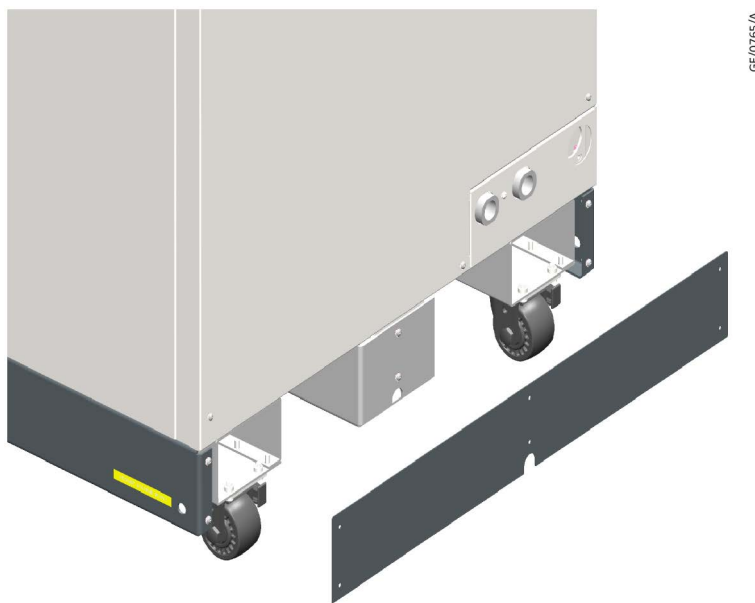
Note:

If using a fork lift or pallet jack, make sure the forks extend fully through the frame of the system and completely support both sides of the frame.

Lifting the unit with a forklift or pallet jack without having the forks or jack fully extended through the Cryochiller frame will damage the frame and void the warranty.

3. Use a forklift or pallet jack or an appropriate lift device to lift the refrigeration unit. When using a forklift or pallet jack, remove both the front and back bottom panels to access the slots for the forks. See [Figure: Bottom panels for fork lift access](#). Place the forks of the forklift or pallet jack fully through the frame of the Cryochiller so that they extend out the back side of the unit and are in position to lift the Cryochiller by both sides. Carefully lift the unit and confirm that it is being lifted by both sides.
4. Keep the Cryochiller vertical while it is being moved.
5. Place the refrigeration unit at the desired location.
6. Go to the [Table: Installation checklist](#). Initial and date this task.

Figure 36 Bottom panels for fork lift access



5.4 Remove the compressor hold-down nuts

Item	Description
Electrical Category	Type 1 - Equipment is fully de-energised
Tools	# 2 Phillips screwdriver Two 9/16 inch wrenches

1. Use a Phillips-head screwdriver to remove the 4 screws that attach the front lower panel on the system and remove the panel.
2. Use a Phillips-head screw driver to remove the 5 screws that attach the rear lower panel on the system and remove the panels. See [Figure: Rear lower panel access screws, standard](#) (for MaxCool Standard) and

Figure: Rear lower panel access screws, front access (for MaxCool with Front Access).

3. If an optional spare parts kit was ordered, it will be behind the lower front panel of the unit. Remove the spare parts kit and verify that all of the parts were shipped with the unit.
4. Locate the compressor in the bottom of the refrigeration unit. See *Figure: system with panels removed showing compressor location, standard* (for MaxCool Standard) and *Figure: system with panels removed showing compressor location, front access* (for MaxCool with Front Access).
5. Locate the four hold-down nut locations on the compressor. See *Figure: Hold-down nuts (2 of 4 shown)*.
6. Use two 9/16 inch wrenches to remove the two hold down nuts on each corner of the compressor.
 - Place one wrench on the lower nut and the other wrench on the upper nut.
 - Hold the lower nut and loosen then remove the upper nut from the bolt.
 - Loosen and remove the lower nut.
7. Repeat the procedure to remove the remaining three sets of hold-down nuts.
8. Save the hold-down nuts for future use when moving or shipping the refrigeration unit. Recommended: Place nuts on cable tie and secure to compressor.
9. Go to the *Table: Installation checklist*. Initial and date this task.

Figure 37 System with panels removed showing compressor location, standard

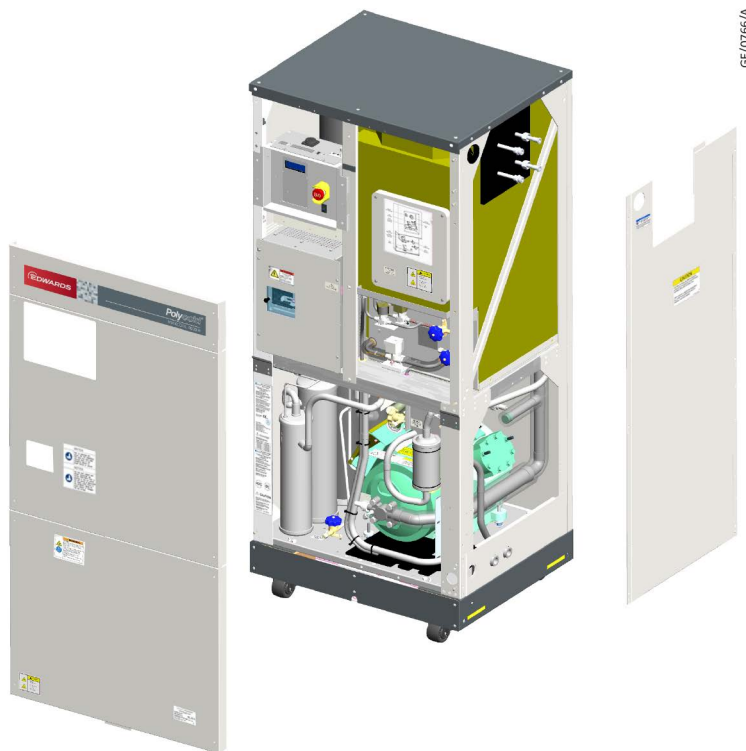


Figure 38 Rear lower panel access screws, standard

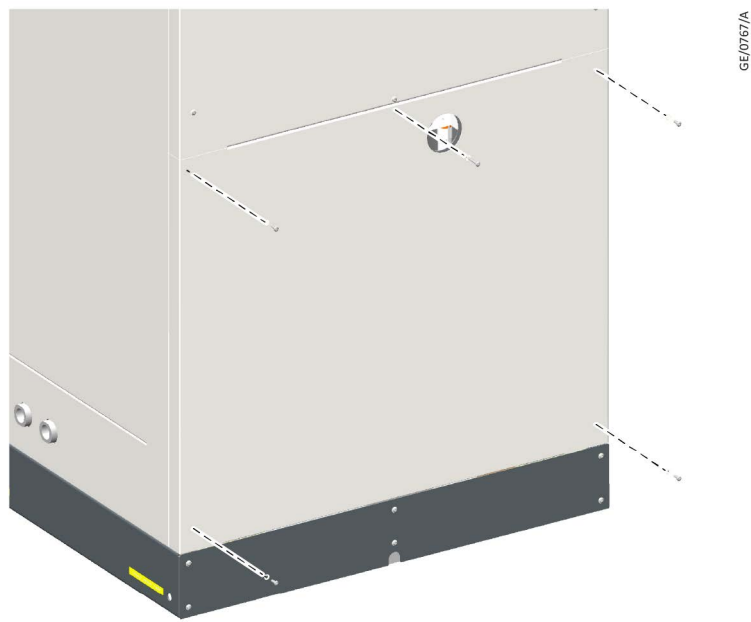


Figure 39 System with panels removed showing compressor location, front access

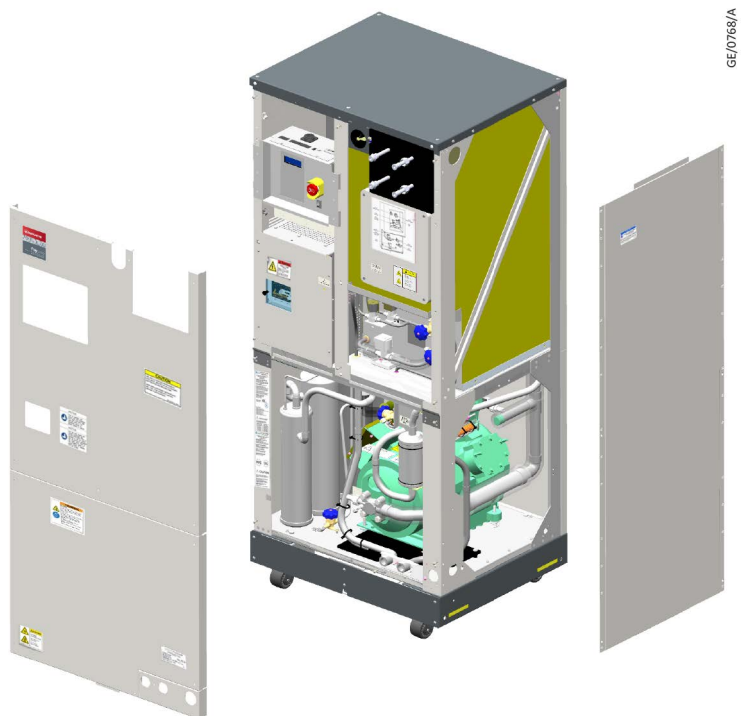
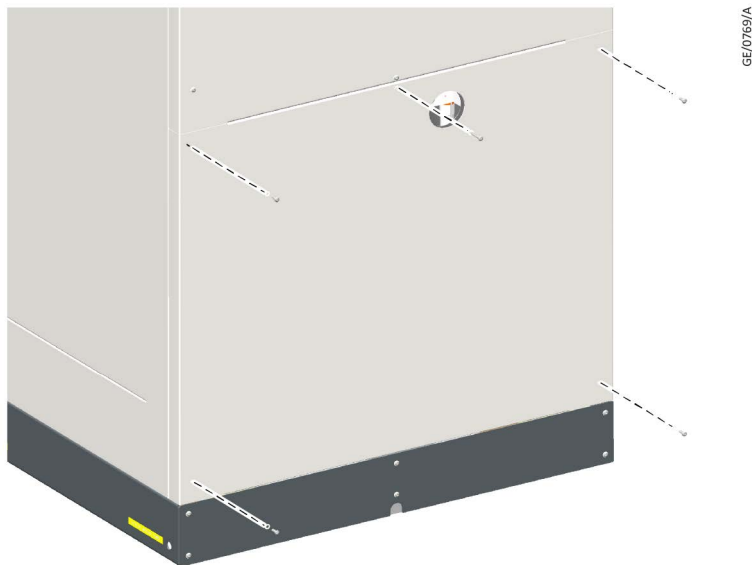
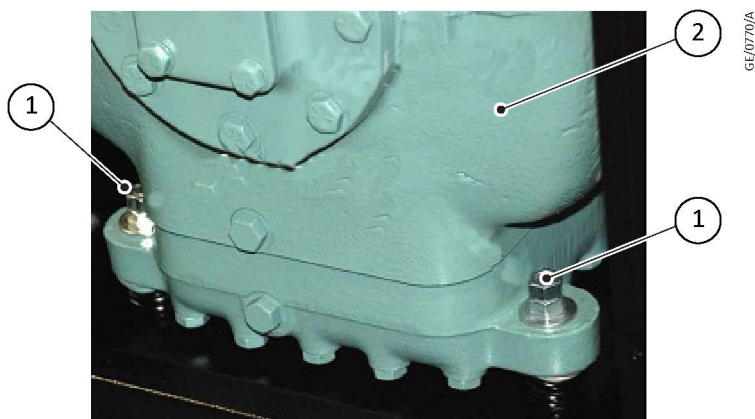


Figure 40 Rear lower panel access screws, front access**Figure 41** Hold-down nuts (2 of 4 shown)

1. Hold-down nuts

2. Compressor

5.5 Connect the cooling water

Item	Description
Electrical category	Type 1 - Equipment is fully de-energised
Tools	Pipe wrenches
Materials	Fabricated water lines from 3/4 inch (20 mm) standard pipe or equivalent with compatible fittings. 3/4 inch female NPT fittings. Thread sealant such as Teflon tape

Note:

Water should be filtered for contaminants and copper reducing microbes.

We recommend filtration to 100 microns and microbiological controls be put in place in order to supply clean and safe cooling water to your product.

Failure to provide water of proper specification may void the system warranty.

 Note:

If the system is turned on before cooling water has been connected, damage to the equipment can occur.

Verify that cooling water has been connected before turning on power to the unit.

1. Make sure that the water supply for the system refrigeration unit meets the specifications in [Cooling water](#) on page 63.
Optional:
Install pressure gauges on the water lines at the refrigeration unit in order to measure the pressure drop within the refrigeration unit. This will help you adjust the water flow for optimum operation of the system. It will also aid you in troubleshooting if there are water cooling problems. See [Figure: Redundant water circuits in supply line, optional](#).
It is also recommended to install two parallel input water lines including valves, water filters, and flow meters. This allows switching water lines and avoiding equipment shutdown during scheduled maintenance. See [Figure: Redundant water circuits in supply line, optional](#).

 Note:

If using rotameter-type flow meters, their inherent restriction may reduce the actual flow rate delivered to the refrigeration unit.

2. Route the supply and drain water lines to the In and Out water fittings on the lower right side of the system.
IN water port is on the right.
OUT water port is on the left .
See [Figure: Location of water ports, standard](#) (for MaxCool standard) and [Figure: Location of water ports, front access](#) (for MaxCool front access).
3. Apply two wraps of water-grade teflon tape or apply water sealant paste to the threads of all of the male fittings that connect to the In and Out water ports on the refrigeration unit.
4. Connect the supply water line to the IN water port on the right side. Connect the drain water line to the OUT water port on the left side.
5. Tighten each water line finger tight until the water line gasket contacts the fitting and then tighten 2 to 3 additional full turns. The number of turns required to tighten the fittings is affected by the thickness of the tape or sealant that has been applied to the threads.
6. Turn the supply and return water lines on. Check for leaks. If water leakage is found, tighten the leaking fitting an additional 1/4 turn. If water continues to leak at the connection, turn off the supply and return water lines, disconnect the fittings and check for the cause of the leak.
7. When the water connections are installed, tested, and do not leak, go to the [Table: Installation checklist](#). Initial and date this task.

Figure 42 Redundant water circuits in supply line, optional

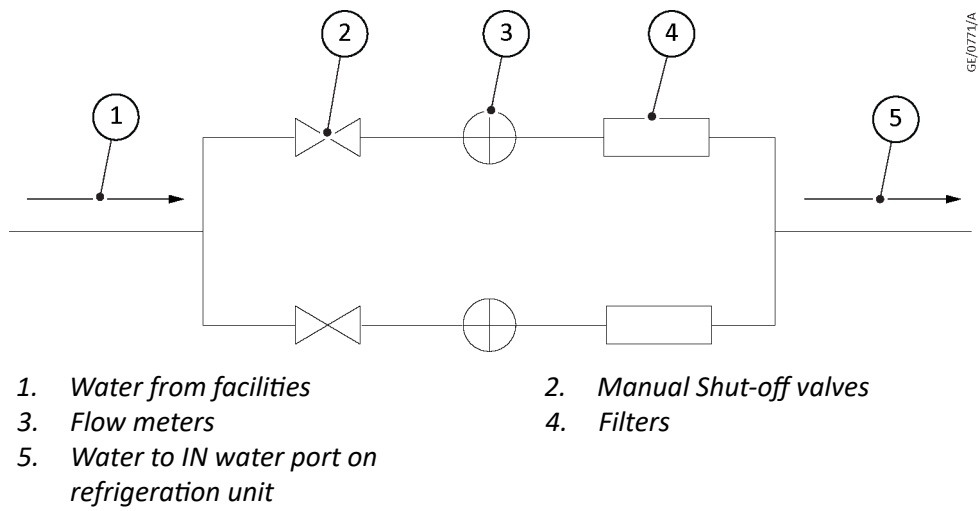


Figure 43 Location of water ports, standard

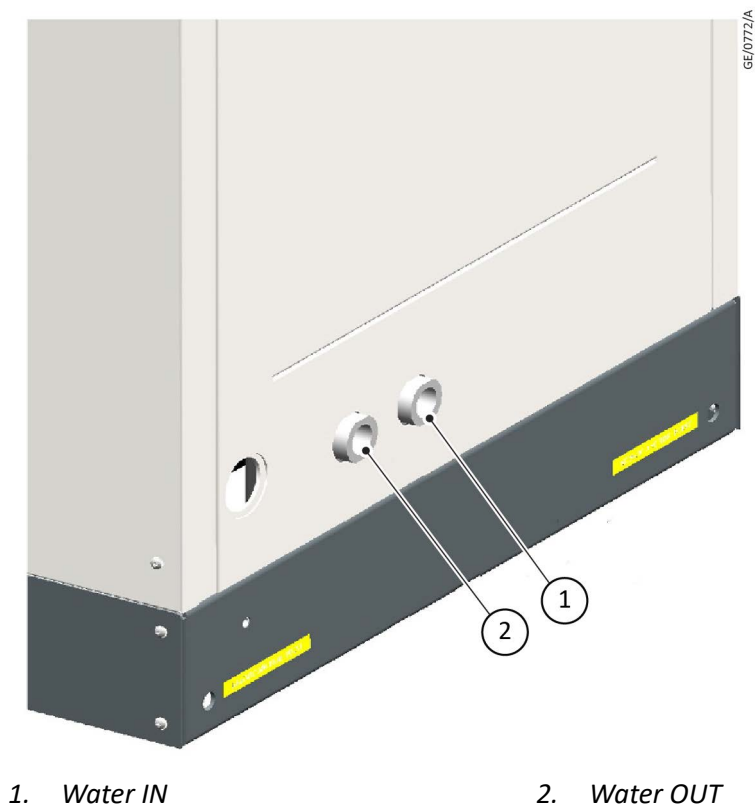
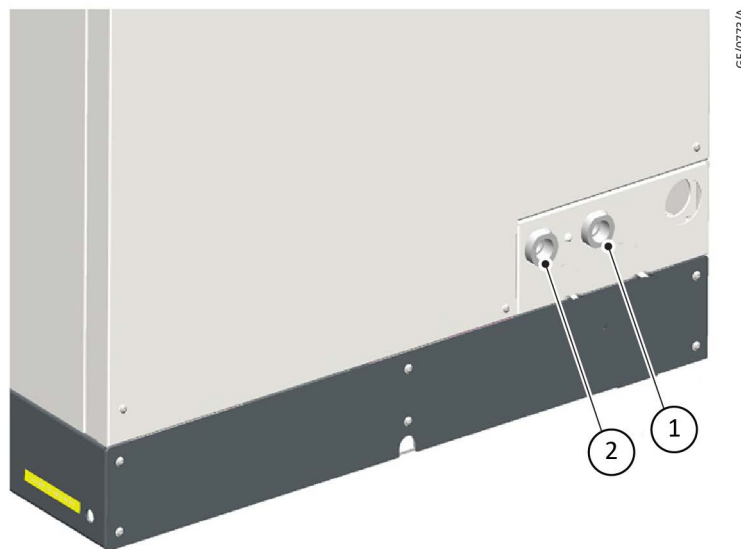


Figure 44 Location of water ports, front access

1. Water IN

2. Water OUT

5.6 Connect electrical power



WARNING: HAZARDOUS VOLTAGE

Risk of injury. Contact with energised equipment may cause electric shock and result in death or serious injury.

- Only a qualified electrician or electrical installer is allowed to install the power to the system.

Electrical power connections must be performed by a qualified electrician or electrical installer and must meet local electrical codes.

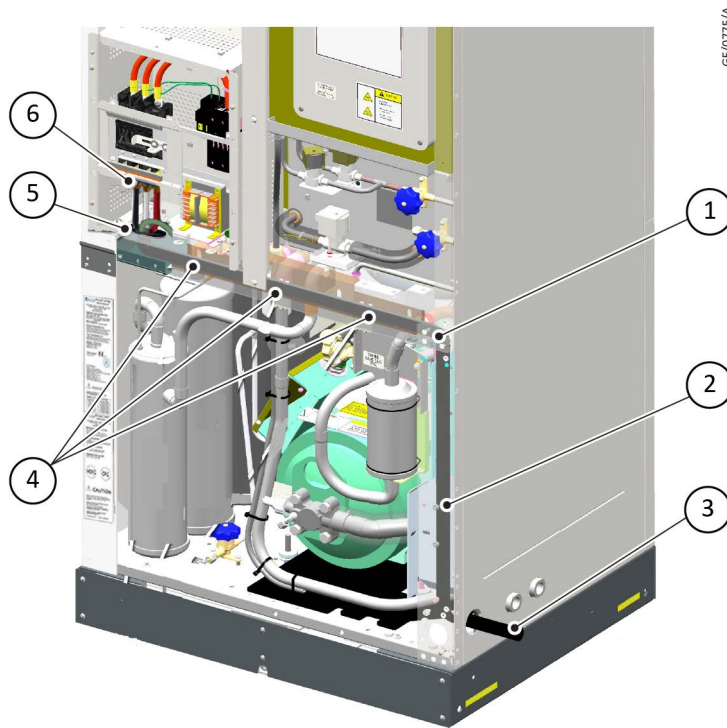
Item	Description
Electrical Category	Type 1 - Equipment is fully de-energised
Tools	Torque Wrench for 3.9 to 4.5 Nm (35 to 40 lb in) range ... or equivalent for electrical terminal connections
Materials	4-Conductor power cable that meets local electrical code for the voltage and amperage of the unit. See table in Electrical protection requirements - MaxCool 4000H, 2500L, 2200 and 1500 on page 52. Connector for power cord to facilities power connection. Cable Strain Relief or Conduit Connector for 49.2 mm (1.94 inch) power access hole 1/4 inch ring lugs.

- The location of power input to the system is on the lower right corner of the front of the unit. There is a 49.2 mm (1.94 inch) clearance hole in the outer skin and a 42.1 mm (1.656 inch) mounting hole on the frame for mounting an appropriate sized strain relief or conduit connector. Strain Relief Example: "OZ-Gedney KC-125T Flexible Conduit Connector".
- Route the 4 conductor cable or individual wires through the connection, up the right front leg, above the cable tray that is attached to the bottom of the shelf

that separates the compressor area from the valve area, and then up to the circuit breaker area.

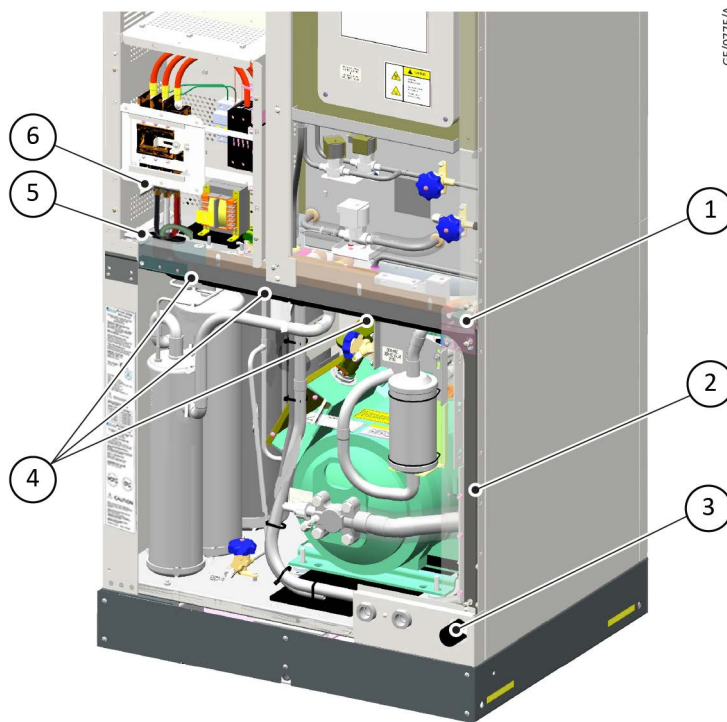
3. Confirm that the protective grommet or strain relief is in place in the opening below CB1.
4. When using larger cables, the three screws that hold the front edge of the upper cable track may be removed and the track lowered to provide greater access. When completed, replace the three screws.
5. If the input power cable is too large to route through the cable tracks or existing cable is too short, use the terminal block accessory and wiring kit, p/n 181500. If using a 4-conductor cable that is too stiff to bend in the cable tracks, remove the outer jacket from the cable after it passes through the strain relief. Alternatively, use terminal block accessory and wiring kit, p/n 181500.
6. Attach 1/4 inch ring lugs to each conductor on the input power cable.
7. Remove the finger guard from CB1 and CB2 as required.
8. Connect the three phase lines of the input power cable to the lower terminals / input side of CB1 using the provided screws and washers (optional) in the stack sequence shown in [Figure: Terminal washer stack sequence](#).
9. Tighten each 1/4-20 (M6) terminal screw to 3.9 to 4.5 Nm (35 to 40 lb in).
10. Connect the ground line of the power cable to the ground stud using the hardware provided in the fastener sequence. Follow the stack sequence below as shown in [Figure: Ground washer stack sequence](#).
 - External star washer
 - Terminal lug
 - Flat washer - (optional)
 - Lock washer - (optional)
 - 1/4-20 (M6) Nut
11. Tighten the 1/4-20 (M6) ground nut to 4.5 to 5.1 Nm (40 to 45 lb in).
12. After the power cable is fully connected, secure the power cable to the track using cable ties. Holes are provided in the cable track for inserting the cable ties.
13. Check the input voltage and compare to the voltage specified on the system label. Adjust the tap settings, if required, to accommodate the actual input voltage. See [Input power transformers](#).

Figure 45 Power cable routing, standard



- | | |
|--|---|
| 1. Cable or wires run in track below shelf | 2. Cable or wires run behind front frame |
| 3. Cable connector to customer provided strain relief. Conduit connects to customer provide conduit connection | 4. Cable track screws (x3) |
| 5. Confirm protective grommet is in place | 6. Cable or wires run up to circuit breaker |

Figure 46 Power cable routing, front access



- | | |
|--|---|
| 1. Cable or wires run in track below shelf | 2. Cable or wires run behind front frame |
| 3. Cable connector to customer provided strain relief. Conduit connects to customer provide conduit connection | 4. Cable track screws (x3) |
| 5. Confirm protective grommet is in place | 6. Cable or wires run up to circuit breaker |

Figure 47 Input connections to CB1

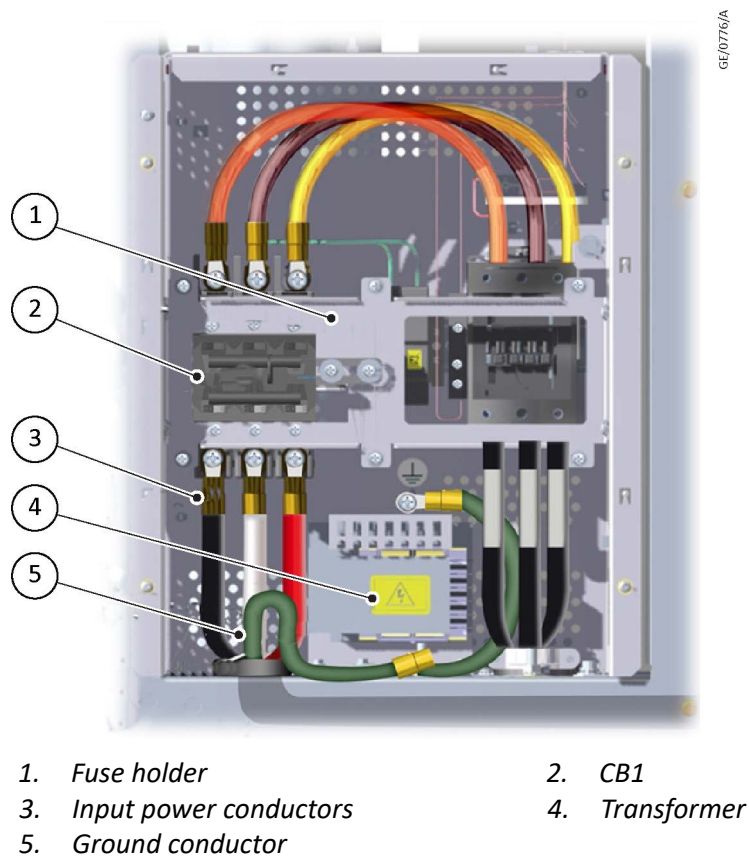


Figure 48 Terminal washer stack sequence

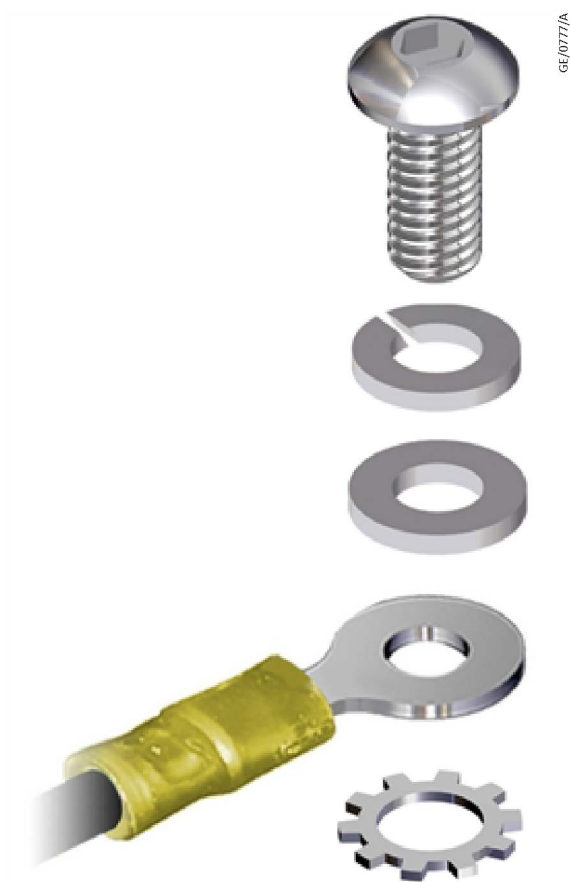


Figure 49 Ground washer stack sequence



5.6.1 Input power transformers

Note:

Unit has been shipped with default transformer tap setting (200 V/400 V). Prior to powering on the unit ensure the tap setting is appropriate for facility power. Refer to the installation manual for proper method of changing the tap setting.

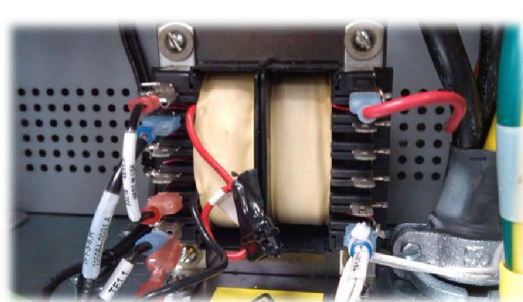
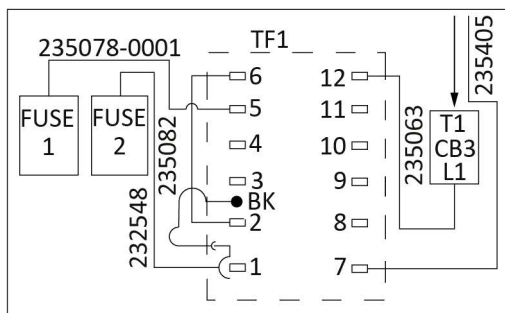
The system has 175 V transformer installed by default. Refer to [Figure: Input connections to CB1](#), the system is set to a specific input voltage of 200/400 V at the factory by transformer tap settings. These tap settings must be adjusted in the field as required to accommodate the actual voltage at the installation site.

- Available tap settings are: 200 V, 230 V, 380 V, 400 V, 460 V and 480 V.
- Tap setting label (Removable after tap setting). Location: front Middle panel.

5.6.2 Change transformer tap settings

1. Check the input voltage.
2. Check the transformer tap settings. Refer to the tap setting sticker on the transformer on [Figure: Tap settings for 200 volt transformers](#) to [Figure: Tap settings for 480 volt transformers](#).
3. Rewire the transformer tap settings as required. Refer to the table in [Electrical protection requirements - MaxCool 4000H, 2500L, 2200 and 1500](#) on page 52 for tap settings for your compressor and voltage.
 - Remove the protective cover
 - Change the input wiring and jumper settings as required
 - Replace the protective cover
4. Go to the [Table: Installation checklist](#). Initial and date this task.

Figure 50 Tap settings for 200 volt transformers



GE/0751A

Figure 51 Tap settings for 230 volt transformers

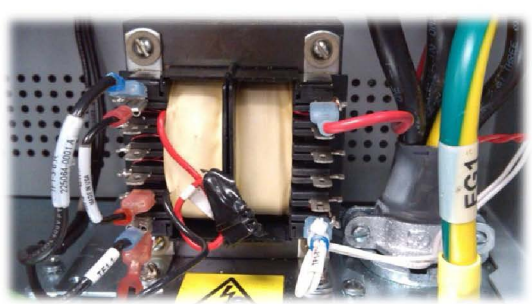
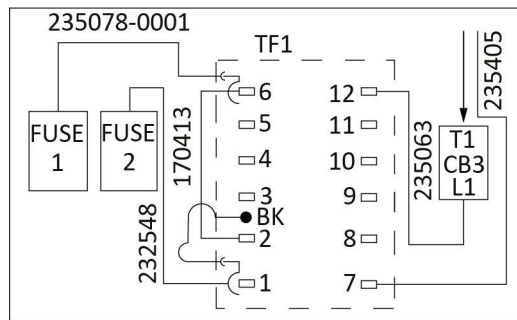


Figure 52 Tap settings for 380 volt transformers

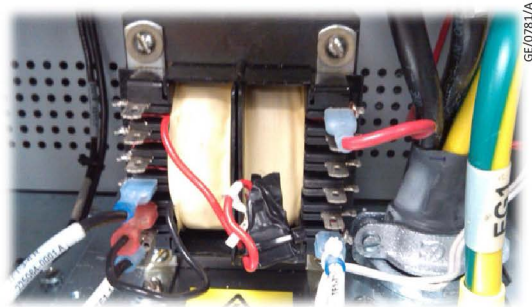
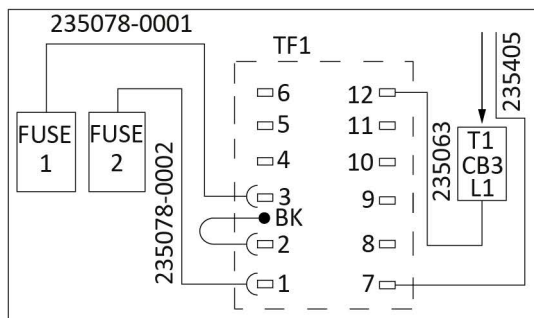


Figure 53 Tap settings for 400 volt transformers

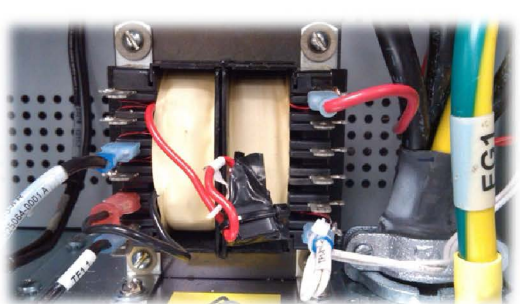
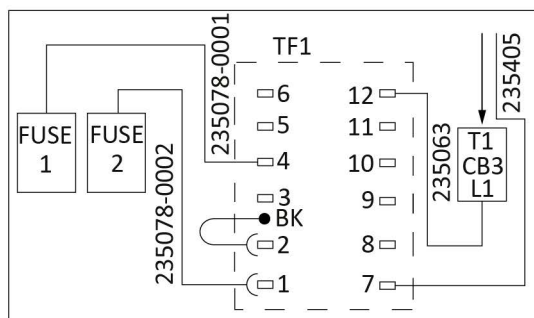


Figure 54 Tap settings for 460 volt transformers

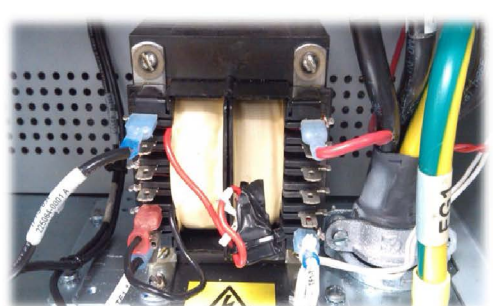
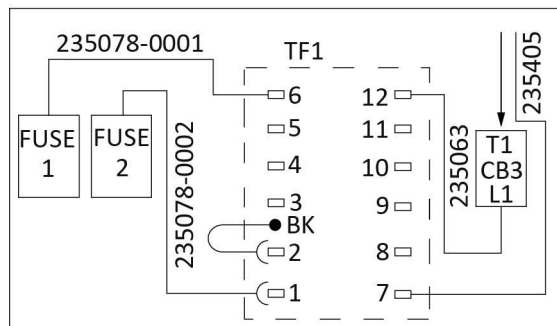
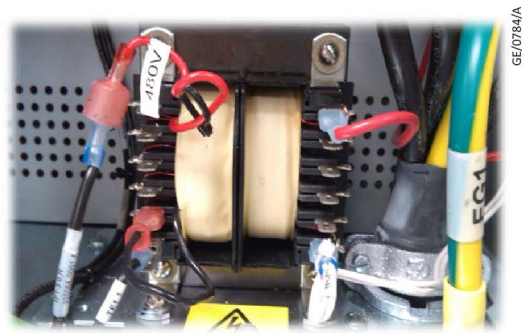
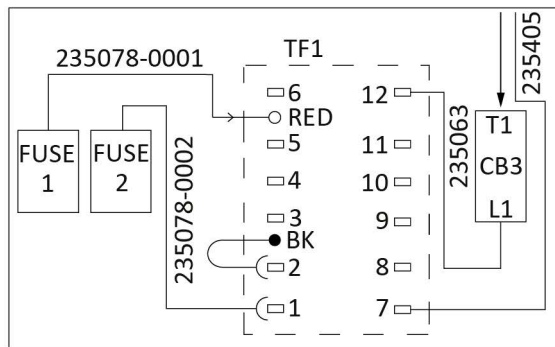


Figure 55 Tap settings for 480 volt transformers

GE/0784/A

5.7 Install the cryosurface

Item	Description
Electrical Category	Type 1 - Equipment is fully de-energised
Tools	2.5 inch Spanner wrench, p/n 810030-07, for the nut on feed-through connection
Materials	High-vacuum grease - must have an appropriate low vapour pressure (for optional use on the feed-through's) O-ring, as required

CAUTION: HIGH WORKING PRESSURE



The refrigeration unit's working pressure may exceed the cryosurface's working pressure which may damage the vacuum system components and may result in equipment damage and personal injury.

- Do not use reservoir type cryosurfaces.
- Do not connect the refrigeration unit to a cryosurface without first verifying that the cryosurface meets specifications.

This section describes how to install the cryocoil or cryobaffle, and refrigerant lines. If these items are not already selected, then follow the recommendations below.

- Refer to [System summary](#) on page 31 and [Cryocoils and refrigerant lines](#) on page 56 for cryosurface information.
- Contact us for more information.

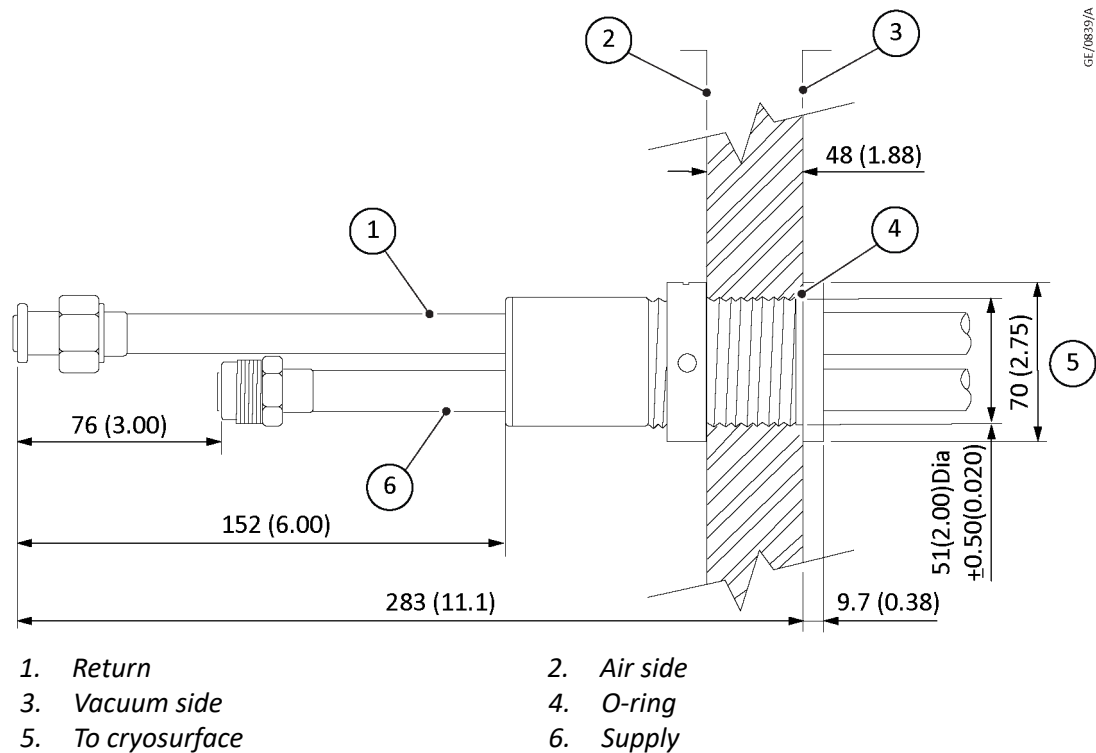
Note:

This task assumes that both a cryosurface and a standard 50 mm (2 inch) feedthrough from us are being installed. If a cryobaffle or cryocoil and feed-through has been custom-fabricated by a source other than us, verify that the part meets the specifications in the section Specifications and Site Requirements, [Cryocoils and refrigerant lines](#) on page 56.

The feed-through on the systems Cryocoil is designed to be installed from the inside of a vacuum chamber. This allows removal of the cryosurface when cleaning or servicing the vacuum chamber.

5.7.1 Install the feed-through and Cryocoil

1. Inspect the feed-through port thickness, hole diameter, and sealing surface. Make sure that the feed-through port is compatible with the feed-through.
2. Clean the inner and outer surfaces of the feed-through port on the vacuum chamber wall where the cryosurface feed-through is to be installed.
3. Inspect and clean the O-ring groove and O-ring in the inner flange of the feed-through.
4. Insert the O-ring into the O-ring groove in the inner flange.
5. From the inside of the vacuum chamber, insert the feed-through into the feed-through port.
6. Tighten the feed-through nut finger-tight and position the cryosurface. If the cryosurface has fasteners, secure them at this time. See [Figure: Typical feed-through](#).
7. Verify that no moving parts will hit the cryosurface. Make sure the cryosurface does not touch the vacuum chamber wall or anything in the vacuum chamber. The cryosurface must be at least 16 mm (5/8 inch) away from the vacuum chamber wall to prevent ice bridging. Greater distances are better.
8. Hold the feed-through in place and tighten the nut with the spanner wrench included with the cryosurface assembly. Make certain the nut is tight. If the nut is loose, the O-ring will tend to lift from the vacuum chamber wall when under vacuum.
9. Install a heat radiation shield if the cryocoil is in direct view of a source of heat greater than 50 °C. Position the shield between the cryocoil and the heat source. The shield should be as close as possible to the heat source and as far away as possible from the cryocoil. The cryocoil traps molecules best when it has maximum view of the vacuum chamber.
10. Check the vacuum chamber for leaks. If any leaks are found, correct them before proceeding.
11. Go to the [Table: Installation checklist](#). Initial and date this task.

Figure 56 Two-inch Feedthrough with port requirements

5.7.2 Install a cryobaffle

1. If you are installing our "CB" type cryobaffle, carefully centre it between the flange bolt holes to assure a good O-ring seal.
2. Verify that no moving parts will hit the cryosurface.
3. Make sure the cryosurface does not touch the vacuum chamber wall or anything else in the vacuum chamber. The cryosurface should be at least 16 mm (5/8 inch) away from the vacuum chamber wall to prevent ice bridging. Note that greater distances are better.
4. Install a heat radiation shield if the cryobaffle is in direct view of a source of heat greater than 50 °C. Position the shield between the cryobaffle and the heat source. The shield should be as close as possible to the heat source and as far away as possible from the cryobaffle. The cryobaffle traps molecules best when it has maximum view of the vacuum chamber.
5. Check the vacuum chamber for leaks. If any leaks are found, correct them before proceeding.
6. Go to [Table: Installation checklist](#). Initial and date this task.

5.8 Install the refrigerant lines

Note:

This procedure assumes that refrigerant lines from our systems are being installed.

If installing any refrigerant lines not made by us, verify that the refrigerant lines meet the required specifications.

Contact us for assistance.

Note:

This section assumes both refrigerant circuits are connected at the same time.

It is possible to connect only one refrigerant circuit of a dual circuit system.

When connecting the second refrigerant circuit, the refrigerant mixture must be fully drawn back into the unit.

Contact our customer support for more information.

Item	Description
Electrical category	Type 1 - Equipment is fully de-energised
Tools	Torque wrench (optional)
For Parker UltraSeal Style Couplings (standard)	Silver-plated stainless steel O-rings 1 inch open end wrench 15/16 inch open end wrench
For Cajon VCR Style Couplings (optional)	Silver-plated stainless steel gaskets or unplated nickel gaskets 1-3/16 inch open end wrench 1-1/16 inch open end wrench

5.8.1 Attach thermocouples to the feed and return lines



CAUTION: GENERAL HAZARD

Risk of damage to equipment. Make sure not to nick the thermocouple conductor. The wire may break with future vibration and can result in damage to the equipment.



CAUTION: FALSE THERMOCOUPLE READING

Risk of damage to equipment. Be careful when attaching thermocouples to the feed and return lines. Do not overheat the flux. Do not melt or cut the plastic insulation on the thermocouple wire. It may create false readings and can result in damage to the equipment.

1. Remove 1/2 inch (13 mm) of insulation from one end of the thermocouple wires.
2. Twist the two wires together. Apply flux and pre-tin the twisted wires. Remove the flux residue with a wet rag while it is still hot.
3. Use sand paper to remove oxidation from the copper tube. Apply flux to the tube. Position the thermocouple wire so that the first twist of wire (nearest the insulation) is against the tube. Solder the wire twist to the copper tube. Remove the flux residue with a wet rag while the joint is still hot.

Note:

Make certain the wire twist closest to the insulation is in contact with the copper tube. It is the first twist of wire closest to the insulation that senses and determines the temperature reading.

4. Wrap the thermocouple wire tightly around the tube 3-4 times. Allow enough thermocouple wire to run along the refrigerant line to the unit, plus an additional 4 feet (1.2 m) to reach the terminal blocks inside the low voltage box.

5.8.2 Guidelines for refrigerant lines

CAUTION: O-RING REMOVAL TOOL USAGE



The O-ring removal tool is intended for use during the installation procedure only. Do not use the same O-ring removal tool to install multiple units, as this could cause wear and tear. Always visually inspect an O-ring removal tool for signs of wear before use.

A worn-out O-ring removal tool will not function properly and can lead to fitting damage and refrigerant leaks.

- Improper connection of the couplings is a common source of leaks. Internal leaks can damage the equipment.
- Use a new O-ring or gasket each time the coupling is assembled.
- Do not use grease when assembling the couplings. Grease can contaminate the cryopump and can mask a leak during the leak-checking procedures. Additionally, the coupling will leak when the grease gets brittle at cryogenic temperatures.
- Do not scratch or dent the sealing surfaces of the couplings.
- Always use the O-ring removal tool to remove an O-ring from the Parker UltraSeal compatible couplings.
- An installation kit (800200-XXX) is available from us to support refrigerant line installation. Refrigerant lines (440119-XX and 440140-XX) are available from us.

Note:

Use of unauthorised or non-standard couplings voids your warranty.

Improper use, incorrect installation, over-tightening, or damaged O-rings in couplings will void your warranty.

Note:

The O-ring removal tool requires lubrication. Use dry lubricant only.

Always clean couplings after using the lubricated tool.

Note:

Refrigerant lines should only be bent once.

Re-bending a refrigerant line can cause "work hardening", fractures and refrigerant line failure.

5.8.3 Route and install the refrigerant lines

1. Use the following considerations to plan the route of the refrigerant line between the cryosurface and the top of the refrigeration unit:
 - The refrigerant line should not be a hindrance or hazard to the movement of personnel.

- The refrigerant line should not hinder access to, or the maintenance of any equipment.
- Provide at least 32 mm (1-1/4 inches) wall thickness of insulation around the feed and return lines. If the insulation and system are not completely sealed and airtight, water vapour from the air will accumulate on some of the surfaces and create ice on the refrigerant lines.
- Support the line at mid-length and at three-foot intervals. Ensure that the line supports do not crush the insulation covering the lines. Use supports that are at least 100 mm (4 inches) wide.
- Do not allow the lines to be vibrated by the application.
- Bend the refrigerant line so that the couplings are even at the point of connection to the refrigeration unit. The feed and return lines should have the same bend radius. The brand or type of tape, hangers, clamps, or cradles depends on what is available and acceptable at the installation site. We recommend using a continuous line length from the refrigerant unit to cryocool feed-through. We do not recommend or warranty the use of intermediate fittings. If your line design has an intermediate set of fittings between the unit and chamber feed-through, we recommend eliminating these fittings and brazing the tubes together. If brazing the lines cannot be done, use only approved fittings and support the tubing within 300 mm (12 inches) of each side of the intermediate fitting. See [Figure: Minimum refrigerant line bend radius](#).

 Note:

The feed lines are made of soft refrigeration copper and have a minimum bend radius of 300 mm (12 inches). Feed lines are only suitable to be bent once to fit the planned layout.

2. Inspect the sealing surfaces of the couplings for the following:
 - Dirt and foreign material
 - Scratches
 - Dents
3. Clean the sealing surfaces of the couplings.
If the sealing surfaces are scratched or dented, contact our service department.

 Note:

Parker UltraSeal compatible couplings are standard on all systems.

4. Connect the refrigerant line to the cryosurface first, if possible.
Finger-tighten the refrigerant line couplings to the feed-through couplings.
5. Remove the upper-right front panel of the refrigeration unit.
6. Locate the isolation valve box which is the box just below the refrigerant line couplings.
7. Remove the upper right panel on the front of the system to expose the valve box.
8. Locate the hand valves in the isolation valve box.
Hand valves are the manually operated valves (these may look different than the ones in the figures).
A unit may have up to 4 hand valves, depending on the configuration.

See [Figure: Cold valve box showing hand valves with red and blue handles](#) for valve locations.

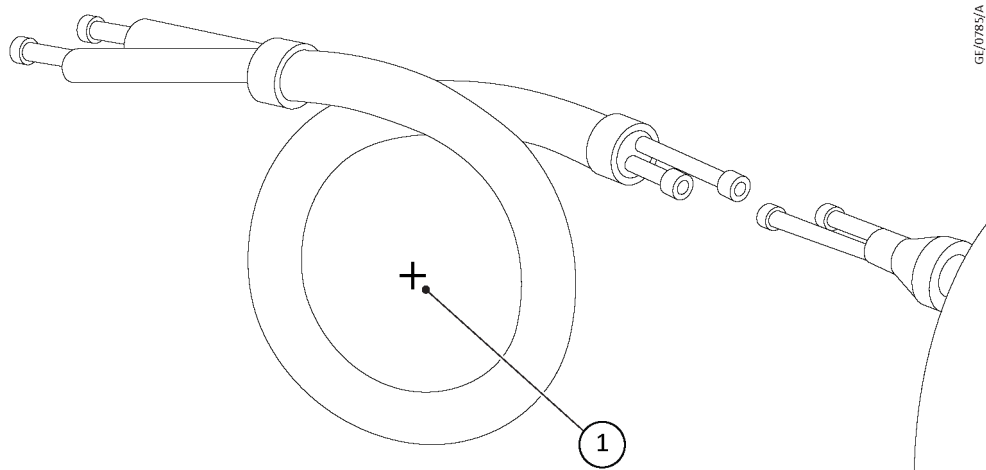
9. Close each of the hand valves by turning them clockwise until they are firmly closed.

 Note:

The isolation valves are used to hold the refrigerant mixture in the refrigeration unit during shipping or whenever the cryosurface or refrigerant line is disconnected. These valves cannot be operated when they are at cryogenic temperatures.

10. Locate the refrigerant feed and return fittings on the upper right corner of the front of the 44 refrigeration unit.
Remove the brass blank-off fittings from the feed and return lines using the following procedure. See [Figure: System refrigerant lines with standard Parker UltraSeal fittings, standard](#) (for MaxCool standard) and [Figure: System refrigerant lines with standard Parker UltraSeal fittings, front access](#) (for MaxCool with front access).
 - a. Use one wrench to hold the fitting on the refrigerant line steady.
 - b. Use a second wrench to carefully loosen the blank-off fitting from the refrigerant line.
 - c. Slowly remove the blank-off fittings from the feed and return couplings while listening for refrigerant leakage.
 - A brief hiss of refrigerant gas leakage is OK.
 - Continuous escape of refrigerant is NOT OK. Quickly reinstall the blank-off fittings and make certain the isolation valves are closed.
11. Save the blank-off fittings and store them with the unit for reinstallation if the refrigerant lines are disconnected. See [Figure: Blank off fittings](#).
12. Bend the refrigerant line so that the couplings are even when they get to the mating couplings on the refrigeration unit. Commonly, the feed and return lines should have the same bend radius.
13. Loosely fasten all couplings on the refrigerant line.
14. Check the line for stress or misalignment between couplings. Resolve line stress or misalignment before going to the next step.
15. Go to the installation procedures for either the Parker UltraSeal or Cajon VCR couplings.

Figure 57 Minimum refrigerant line bend radius



1. *Minimum bend radius*

Figure 58 Cold valve box showing hand valves with red and blue handles

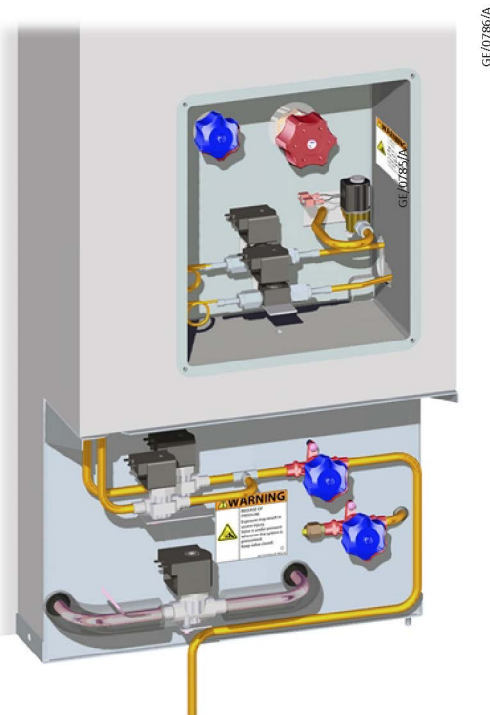


Figure 59 Cold valve box showing hand valves with red and blue handles (MaxCool 1500 & 2200)



Figure 60 System refrigerant lines with standard Parker UltraSeal fittings, standard

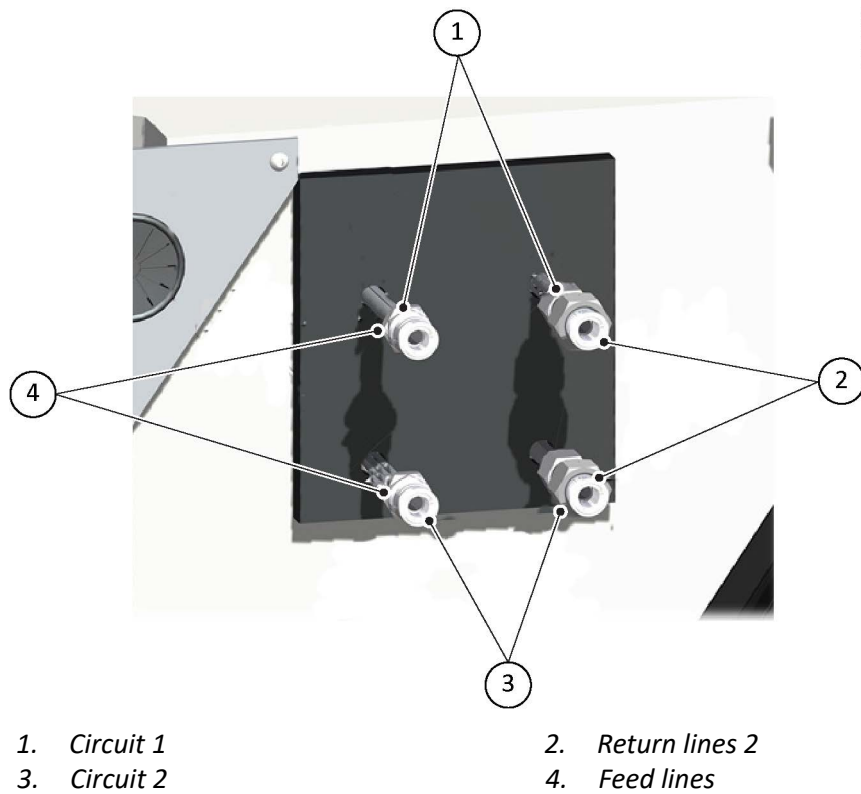
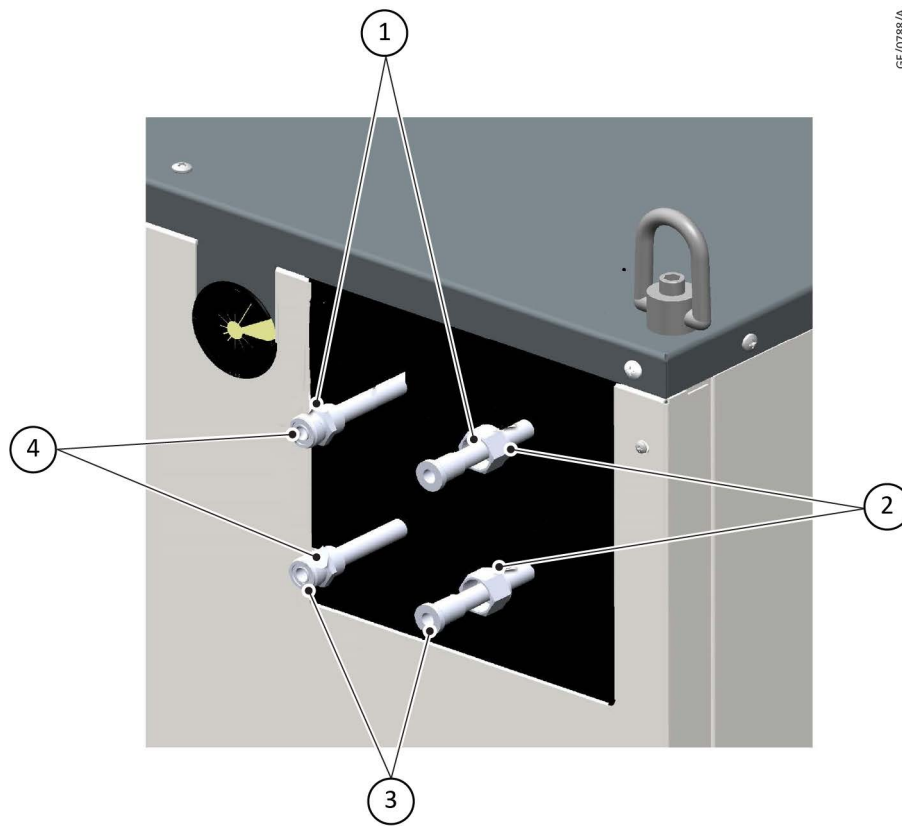
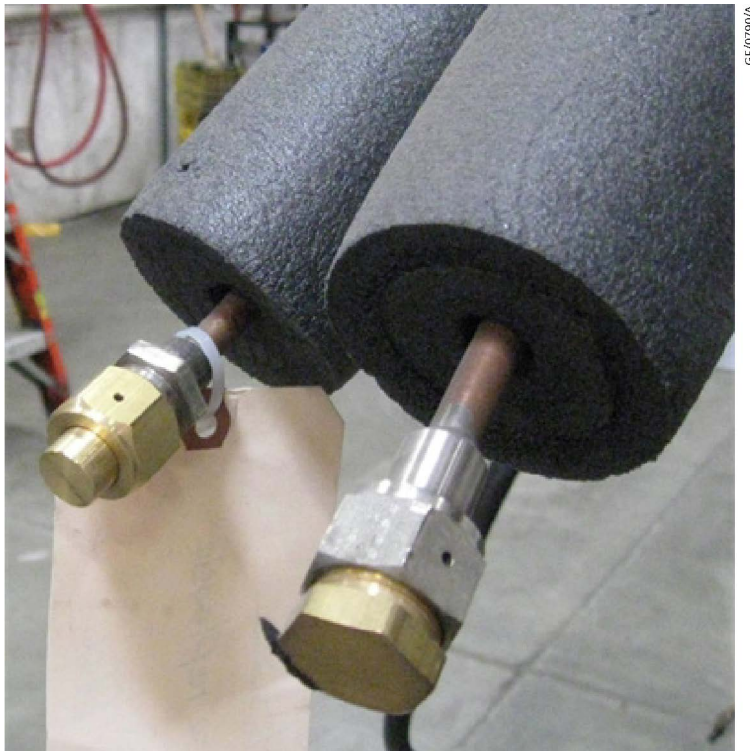


Figure 61 System refrigerant lines with standard Parker UltraSeal fittings, front Access



- | | |
|--------------|-------------------|
| 1. Circuit 1 | 2. Return lines 2 |
| 3. Circuit 2 | 4. Feed lines |

Figure 62 Blank off fittings



1. Insert a new O-ring into the male coupling's groove.

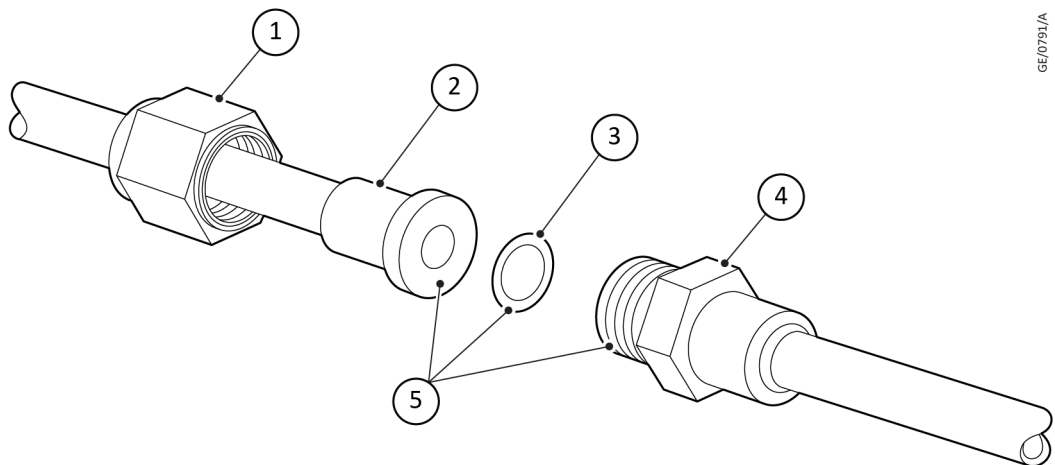
2. Place the gland against the O-ring and male coupling. Make sure the O-ring does not drop out of the groove.
3. Slide the nut forward and finger-tighten the coupling.
4. Use two wrenches to tighten the coupling. Keep the male coupling stationary with the 15/16 inch wrench and tighten the nut with the 1 inch wrench. Each wrench must have a length of at least 12 inches (300 mm).
5. Tighten the nut to no less than 1/4 turn until the resistance increases sharply and no further tightening occurs. The metal o-ring will be crushed into the o-ring groove. Tighten each coupling to 54 - 80 Nm (40 - 60 lb ft).

 Note:

The Parker fittings are coupled and sealed based on mechanical displacement of the threaded parts, which results in compression at the sealing surface. Torque values are provided for customers requiring a measurable value.

6. Go to the [Table: Installation checklist](#). Initial and date this task.

Figure 63 Parker UltraSeal compatible coupling



- | | |
|---|------------------|
| 1. Female nut | 2. Gland |
| 3. Silver plated stainless steel o-ring | 4. Male coupling |
| 5. Sealing surfaces | |

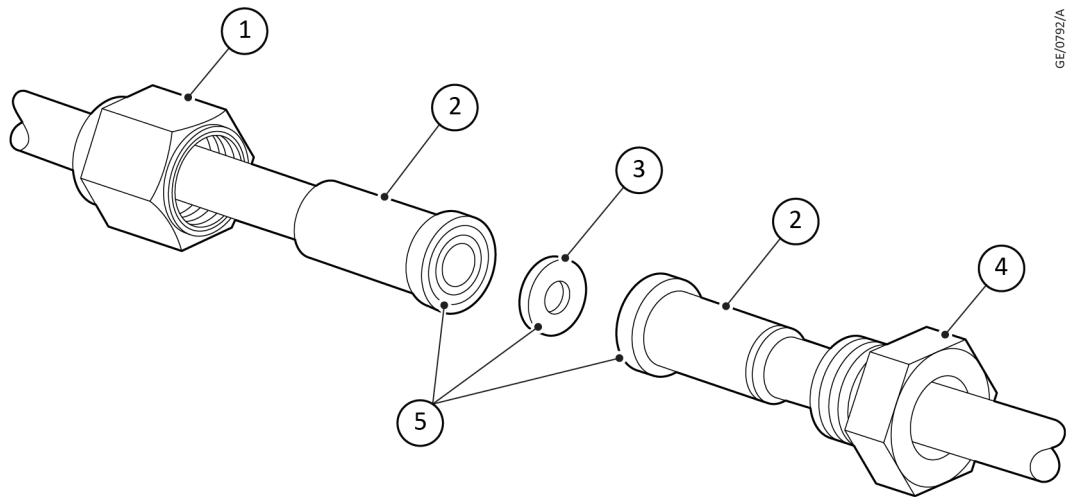
5.8.4 Install Cajon VCR couplings (optional fitting)

1. Place a new gasket into the female nut.
2. Assemble the components and finger-tighten the coupling.
3. Use both wrenches to tighten each coupling no less than 1/4 turn until the resistance increases sharply and no further tightening occurs, approximately 54 - 80 Nm (40 - 60 pound-foot).

 Note:

The Cajon fittings are coupled and sealed based on mechanical displacement of the threaded parts, which results in compression at the sealing surface. Torque values are provided for customers requiring a measurable value.

4. Go to [Table: Installation checklist](#). Initial and date this task.

Figure 64 Cajon VCR coupling

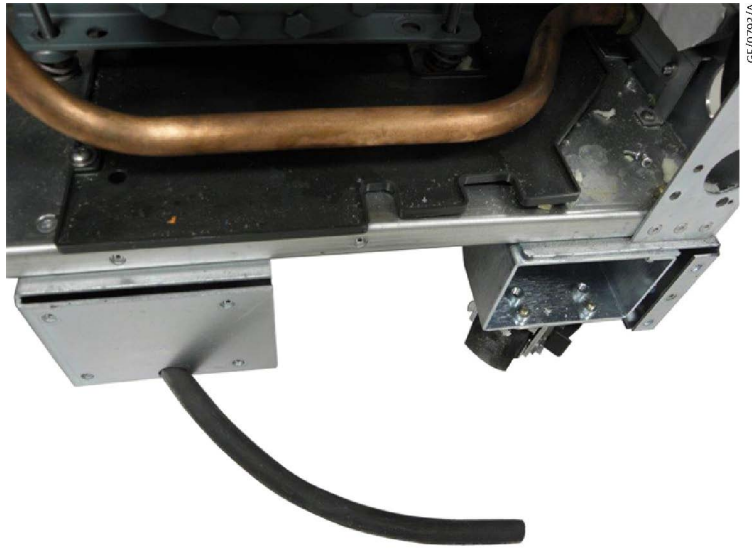
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- | | |
|--|------------------|
| 1. Female nut | 2. Gland |
| 3. Silver plated stainless steel gasket
or unplated nickel gasket | 4. Male coupling |
| 5. Sealing surfaces | |

5.9 Route condensate drain tube

Item	Description
Electrical Category	Type 1 - Equipment is fully de-energised
Tools	Standard hand tools
Material	5/16 inch ID tubing Length is dependent on facility drain location Condensate pump kit (provided by customer)

1. Locate the condensate drain tube. It is visible from the base of the unit and is visible when the front skirt and rear skirt are removed. See [Figure: Condensate drain tube](#).
2. Determine if the drain tube should be routed to the front or to the rear of the unit.
3. When the drain hose is in its final position, check the hose for kinks and adjust as required.
4. Route the tubing to a facility waste water drain or to the input line of a condensate pump.
5. Go to the [Table: Installation checklist](#). Initial and date this task.

Figure 65 Condensate drain tube

5.10 Install seismic restraints (optional)

The cryochiller is provided with four seismic anchor points for mounting seismic restraints. Two anchor points are located on the left and on the right side of the frame. See [Table: Seismic bracket mount specifications](#) for dimensions.

Seismic bracket design and construction is the responsibility of the facility where the cryochiller is installed.

1. Confirm that the cryochiller is in its final position and adequate access for operation and service is provided.
2. Secure the seismic brackets to the cryochiller using 1/2 inch (12 mm) hardware. Use flat washers for backing against the inside frame. Use lock washers as appropriate.
3. Secure the seismic brackets to the floor using appropriate hardware as required by the bracket design and facility or local regulations.
4. Tighten all hardware to appropriate torque specifications.
5. Go to the installation checklist refer to [Table: Installation checklist](#). Initial and date this task.

5.11 Check the refrigerant line and cryosurface for leaks

Item	Description
Electrical category	Type 1 - Equipment is fully de-energised
	Cylinder of refrigerant gas R-134a Cylinder of dry nitrogen gas (very low dew point of -80 °C) with a regulator Service manifold gauge set with three hoses (manifold) Electronic halogen leak detector with a leak sensitivity of at least 0.40 ounces (11 g) per year Leak detector soap Inspection mirror 1/4 inch ratchet valve wrench 7/16 inch open-end wrench 9/16 inch open-end wrench 5/8 inch open-end wrench 15/16 inch open-end wrench 1 inch deep socket or open end or crow foot wrench 1 1/16 inch deep socket or open end wrench 1 5/16 inch deep socket or open end wrench Adjustable wrenches as required
Reference documents	Service procedure, zero line loss, p/n 185307 Service procedure, evacuation-recovery, p/n 185308 Service procedure, brazing specifications, p/n 185305



WARNING: CHEMICAL HAZARD

Failure to have a qualified refrigeration technician to do all refrigeration work could result in system damage or personal injury.

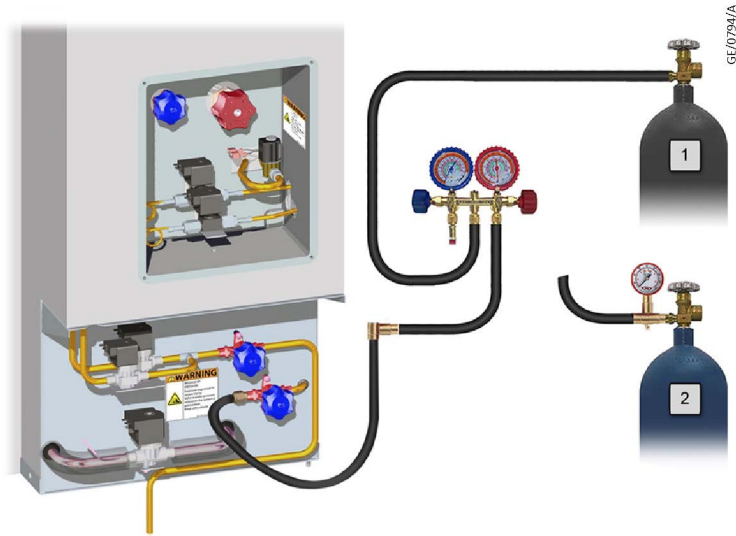
- Contact a qualified refrigeration technician to perform all refrigerant work.

5.11.1 About leak check

The leaked gas used must be dry with a dew point of -80 °C or less.

Be aware of false positives created by the armaflex insulation around the line set. The factory installed tube insulation and flat insulation can produce false positives with some leak check sensors.

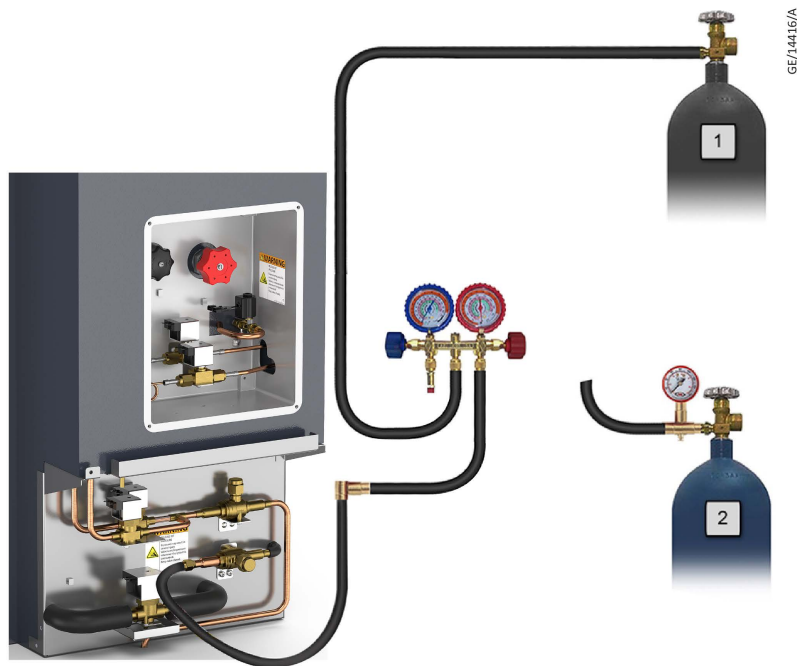
Figure 66 Leak check - add "trace" refrigerant



1. Refrigerant gas R134a

2. Dry nitrogen gas

Figure 67 Leak check - add "trace" refrigerant (MaxCool 1500 & 2200)



1. Refrigerant gas R134a

2. Dry nitrogen gas

5.11.2 Leak check procedure

WARNING: CHEMICAL HAZARD



The blend of refrigerants used in the system is non flammable and non toxic.

- However, as with any gas, asphyxiation could occur if concentrated refrigerant gas is inhaled.
- Service the system in a well ventilated area.
- Never add refrigerant to a unit with a leak. Locate and repair any leaks prior to adding refrigerant or re-charging.

Refer to [Figure: Leak check - add "trace" refrigerant](#) and [Figure: Leak check - pressurize with nitrogen](#), and follow the following steps:

1. Make sure the valves on the manifold are closed.
2. Connect the manifold's suction (low pressure) hose to the evacuation valve inside the valve box.
3. Open the evacuation valve.
4. Connect the refrigerant cylinder to the centre port of the manifold.
5. Open the suction valve on the manifold and pressurise the refrigerant line and cryosurface to 70 - 140 kPa (10 - 20 psig). This adds refrigerant trace gas to the system.
6. When the refrigerant line is pressurised, close the suction valve and disconnect the refrigerant cylinder.

Note:

Improper pressurisation can damage refrigerant lines or system components.

Do not pressurise the refrigerant line and cryosurface above 3100 kPa (450 psig) with the cryosurface attached to the system. The pressure relief valve may leak if it is activated.

7. Connect the nitrogen cylinder to the centre port of the manifold. See [Figure: Leak check - Pressurize with nitrogen](#).
8. Open the suction valve and increase the pressure in the refrigerant line and cryosurface to 1030 kPa (150 psig).
9. Close the valve on the nitrogen cylinder.
10. Use a halogen leak detector to check each connection in the refrigerant circuits. This includes the Parker UltraSeal compatible or Cajon VCR couplings, the Evacuation Valve, and all brazed joints. The couplings have two small access holes on each nut to help find leaks. Cover the lower access hole with a finger and put the sensor at the higher hole. See [Figure: Leak-checking couplings](#).

Note:

If there is a large leak and the source cannot be pinpointed without activating the leak detector, open the manifold's suction valve until the pressure drops to about 345 kPa (50 psig). This should allow detection of the source of the leak.

11. If the pressure in the manifold has decreased below 1030 kPa (150 psig), use leak detector soap and an inspection mirror to locate the source of the leak.

12. If a leak is found, correct the leak using one of the steps below and retest:
 - To correct a leak on a Parker UltraSeal compatible or Cajon VCR coupling, follow the steps in [Correct a leak in a Parker UltraSeal compatible or Cajon VCR coupling](#) on page 103.
 - To correct a leak on a brazed joint or a valve, contact us for assistance.
13. If no leaks are found, verify the manifold pressure is still 1030 kPa (150 psig).
14. If the pressure in the manifold stays at 1030 kPa (150 psig), follow these steps:
 - a. Close the valves on the manifold.
 - b. Disconnect the equipment from the manifold, but leave the manifold connected to the evacuation valve on the refrigeration unit.
15. Go to the [Table: Installation checklist](#). Initial and date this task.

Figure 68 Leak check - pressurize with nitrogen

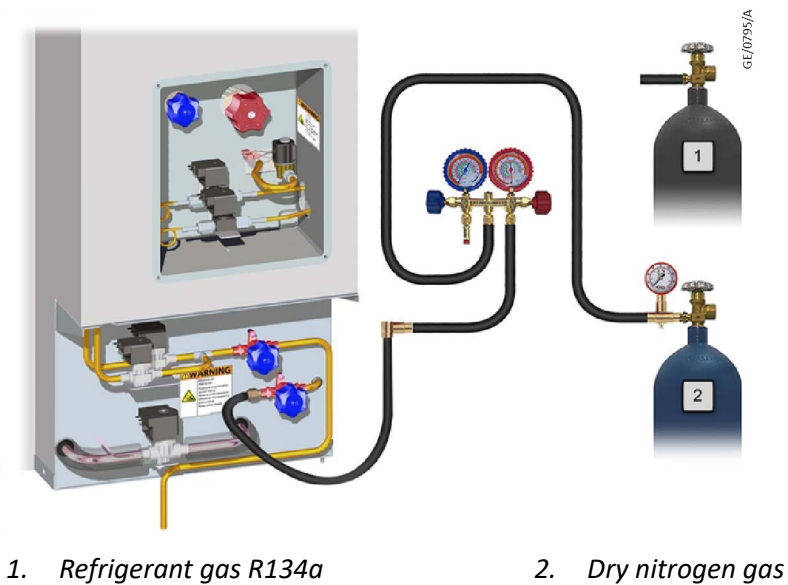
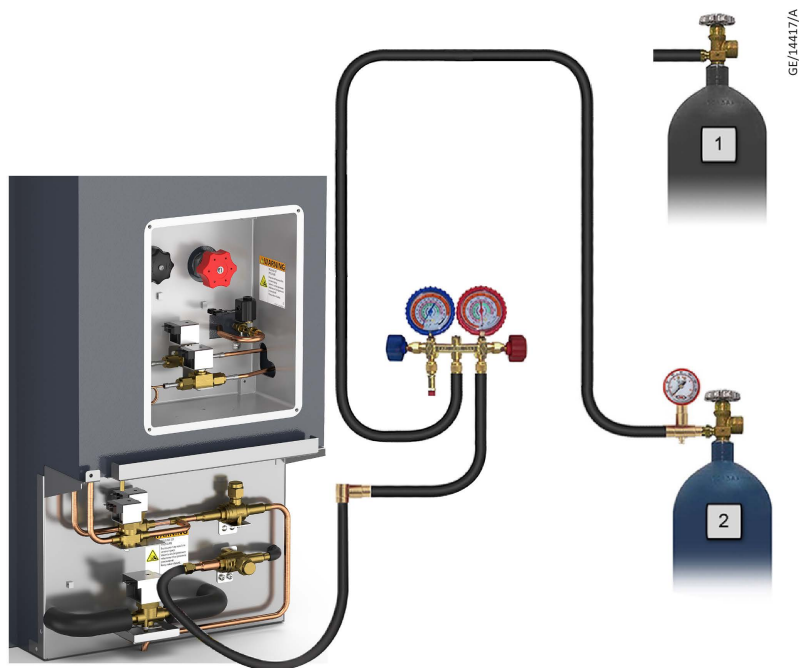
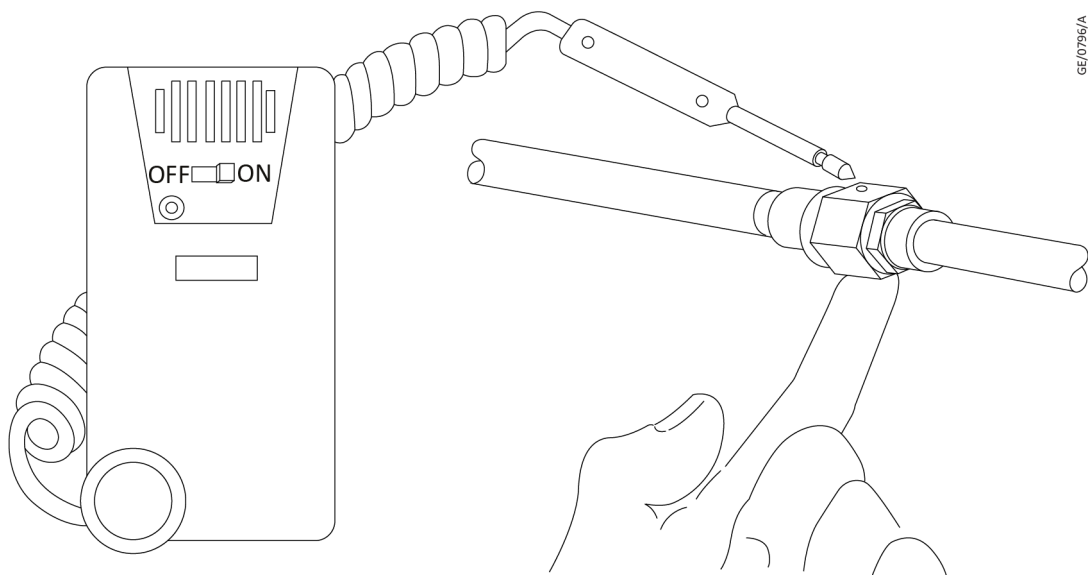


Figure 69 Leak check - pressurize with nitrogen (MaxCool 1500 & 2200)

1. Refrigerant gas R134a

2. Dry nitrogen gas

Figure 70 Leak-checking couplings

5.11.3 Correct a leak in a Parker UltraSeal compatible or Cajon VCR coupling

1. Cover the lower access hole with a finger and apply leak detector soap to the higher access hole.
Observe the higher access hole for at least 2 minutes.
If a bubble forms, verify that the coupling is tightened to within specification.
2. Check for leak again.
 - If the leak is repaired, return to the previous procedure.
 - If the coupling still leaks, reassemble the coupling as follows:

- a. Open the discharge valve on the manifold to release the gas in the refrigerant line and cryosurface.
 - b. Disassemble the coupling.
 - c. Check the coupling's sealing surfaces to make sure they are not scratched or damaged.
 - d. Re-assemble the coupling using a new o-ring or gasket and following the instructions found at on page 95 or [Install Cajon VCR couplings \(optional fitting\)](#) on page 96.
 - e. Leak check the coupling again.
 - If the coupling still leaks, contact us.
 - If the leak is repaired, return to the previous procedure.
3. Return to the check refrigerant lines procedure.

5.12 Evacuate the refrigerant line and cryosurface

Item	Description
Electrical Category	Type 1 - Equipment is fully de-energised
Tools	Vacuum pump with a 1/4 inch SAE male flare connection that is capable of pumping down to at least 0.05 torr (6.5 Pa) Thermistor or thermocouple type vacuum gauge (Granville-Phillips Convectron works well for this purpose) Service manifold gauge set with hoses (manifold) 1/4 inch ratchet valve wrench 7/16 inch open-end wrench 9/16 inch open-end wrench (important) 5/8 inch open-end wrench 15/16 inch open-end wrench Adjustable wrenches as required Coil Magnets (3) for single circuit, (6) for dual circuit
Materials	Cylinder of dry nitrogen gas with a regulator

WARNING: CHEMICAL HAZARD



Failure to have a qualified refrigeration technician to do all refrigeration work could result in personal injury or system damage.

Have a qualified refrigeration technician do all refrigerant work.

1. Connect the vacuum pump, vacuum gauge, and service manifold. See [Figure: Cold valve box setup to evacuate refrigerant line and cryosurface](#).
2. Open both valves on the service manifold.
3. On the following valves, remove the solenoid coils and place coil magnets on the valve stems: See [Figure: Cold valve box](#) and [Figure: Coil magnet on solenoid valve](#).
 A magnet kit, 840317, (6 magnets) is available from us to support it.
 Single circuit:
 - VLV5 in the cold valve box

- VLV6 in the warm valve assembly.

Dual circuit:

- VLV5, VLV11 in the cold valve box
- VLV6 and VLV12 in the warm valve assembly.

4. Turn on the vacuum pump and evacuate the refrigerant line and cryosurface to 13 Pa (0.1 torr).
5. Allow the vacuum pump to continue pumping for at least 30 minutes.

 Note:

The vacuum pump should evacuate the refrigerant line and cryosurface to 13 Pa (0.1 torr) within 30 minutes.

If not, there may be a leak which must be corrected.

6. Close the evacuation valve while the vacuum pump is still pumping.
Turn OFF the vacuum pump.
Carefully remove the hose from the evacuation valve.
Recheck the tightness of the brass top nut on the evacuation valve to prevent leaking.
7. Reinstall the protective cap and flare nut with bonnet onto the output port of the evacuation valve.
Torque to 13.6 to 20.3 Nm (10 - 15 lb ft). See [Figure: Install cap and flare nut on evacuation valve](#).
8. Remove the magnets and reinstall the solenoid coils on the valves.

 Note:

Improper tightening of the refrigerant lines or caps may cause damage or leaks.

Always use the correct size wrench.

Always use two wrenches when connecting to or installing the refrigerant lines or cap on the evacuation valve.

Use one wrench to hold the valve nut.

Use the other wrench to tighten the fitting or cap.

 Note:

It is very important to re-install the protective cap and flare nut with bonnet onto the evacuation valve to prevent refrigerant leaks.

9. Go to the [Table: Installation checklist](#). Initial and date this task.

Figure 71 Cold valve box setup to evacuate refrigerant line and cryosurface

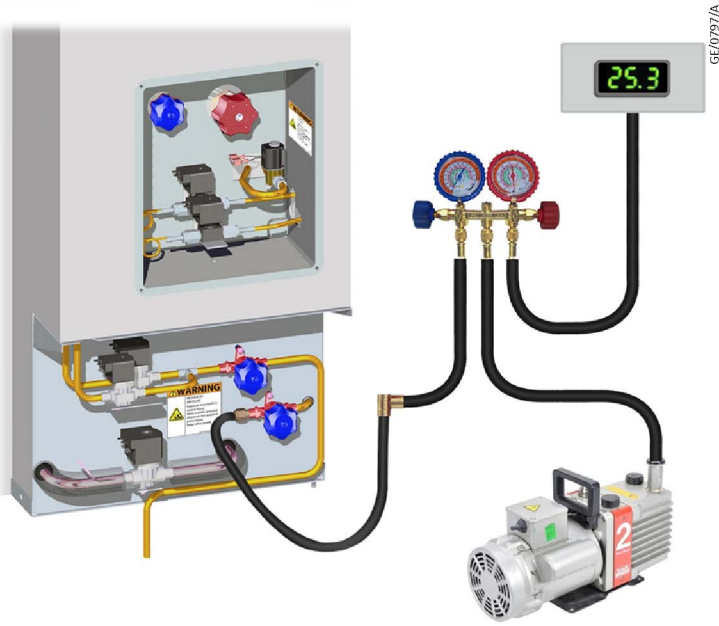


Figure 72 Cold valve box setup to evacuate refrigerant line and cryosurface (MaxCool 1500 & 2200)

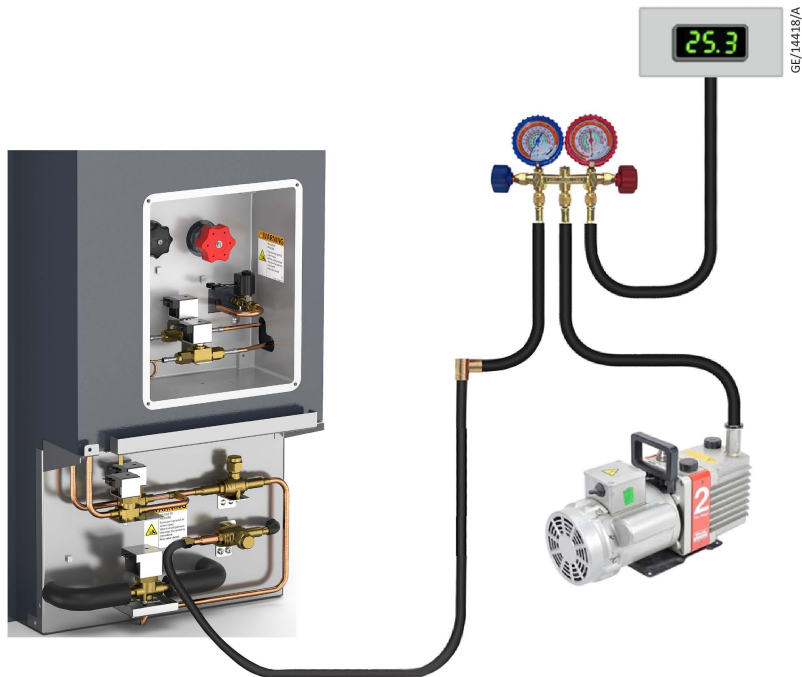
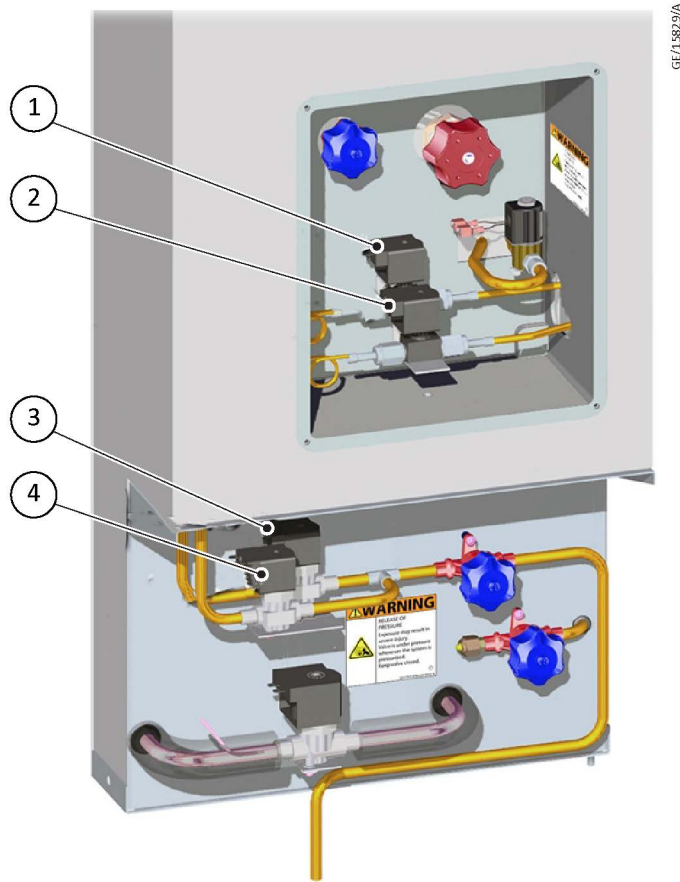


Figure 73 Cold valve box (MaxCool 4000H and 2500L)



- | | |
|-----------------------|------------------------|
| 1. VLV5 Cool Ckt 1 | 2. VLV11 Cool Ckt 2 |
| 3. VLV6 Defrost Ckt 1 | 4. VLV12 Defrost Ckt 2 |

Figure 74 Cold valve box (MaxCool 1500 and MaxCool 2200)

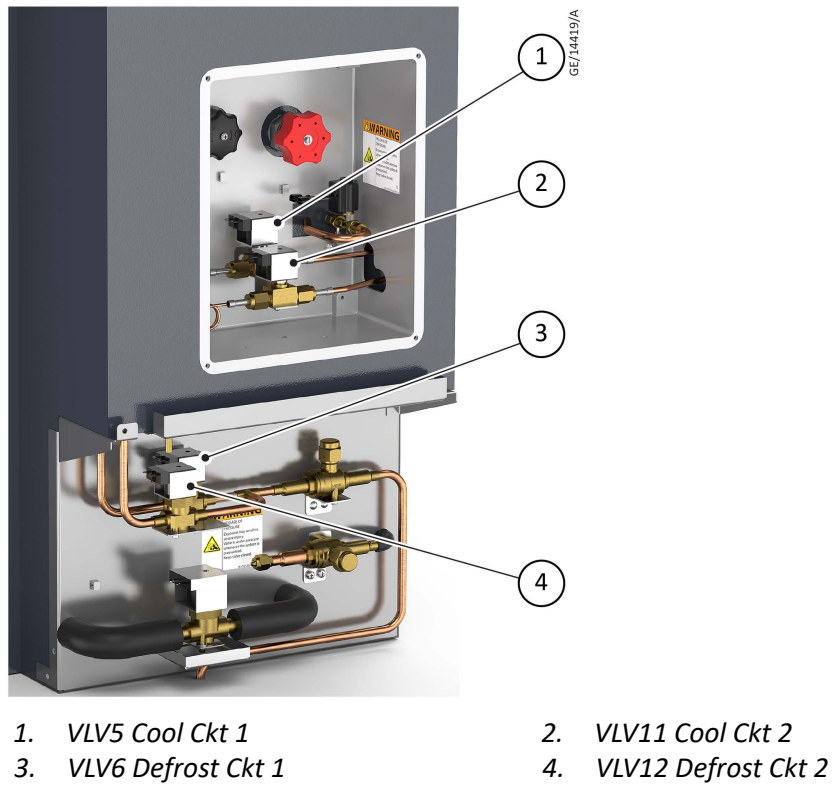


Figure 75 Coil magnet on solenoid valve



Figure 76 Install cap and flare nut on evacuation valve

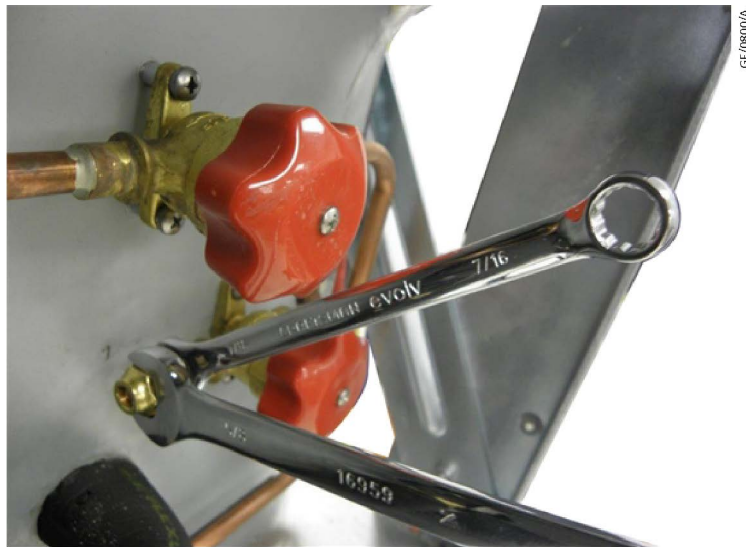


Figure 77 Install cap and flare nut on evacuation valve (MaxCool 1500 & 2200)



5.13 Connect the refrigerant line thermocouples (type T)

Item	Description
Electrical Category	Type 1 - Equipment is fully de-energised
Tools and materials:	Torque wrench, 0.34 Nm (3 lb inch) range (optional) Phillips screwdriver Small straight blade screwdriver Wire stripper (a thermal wire stripper is preferred) Small labels or tape Miniature Male Thermocouple Miniature thermocouple connectors (included in our refrigerant line kit)

Each system may have up to 13 type T thermocouples depending on configuration.

Table 19 Complete thermocouple list for unit with all options

Thermocouple	Customer Installed	Description	Note
TC 1		Compressor discharge	
TC 2		Refrigerant liquid line	
TC 3		C1 return	
TC 4		Coldest liquid	
TC 5		C2 return	Optional
TC 6		Rapid balance pressure check	
TC 9	Yes	C1 inlet	
TC 10	Yes	C1 outlet	
TC 11	Yes	C2 inlet	Optional
TC 12	Yes	C2 outlet	Optional
TC 13		C1 feed	
TC 14		C2 feed	Optional
TC 16		Buffer line	

For all units:

- Several commands are available to get the individual thermocouple values by name.
- Each circuit has factory installed thermocouples for the feed and return lines. Other thermocouples may be added as desired by the user for monitoring their process. Each cold chuck should have a thermocouple.
- Thermocouple junction must be either a commercially made junction or must be a soldered or welded junction.
- Thermocouple junction must NOT be a simple twisted wire junction.

 Note:

If the refrigerant line was made by someone other than us, make sure the thermocouples are properly installed. Refer to [Install the refrigerant lines](#) on page 88.

1. Locate the low voltage box on the refrigeration unit and remove the terminal access cover. See [Figure: Location of low voltage box and thermocouple terminals, standard](#) (for MaxCool standard) and [Figure: Location of low voltage box and thermocouple terminals, front access](#) (for MaxCool with front access).
2. Pass the thermocouple wires through the thermocouple wire pass-through. To access the pass through, push in on the foam insulation at the left corner of the coolant supply return connections and pass the wires behind the sheet metal front panel. Then, pass the wires behind the interface panel to the thermocouple terminal block.
3. Locate the external thermocouple terminal block in the low voltage box. See [Figure: Location of low voltage box and thermocouple terminals, standard](#) (for MaxCool standard) and [Figure: Location of low voltage box and thermocouple terminals, front access](#) (for MaxCool with front access).
4. On the refrigerant line, locate the thermocouple wires labelled COIL IN and COIL OUT.
 - Fold a small piece of tape around each thermocouple wire next to its label.
 - Label the tape "Circuit 1" on the COIL IN and COIL OUT thermocouple wires coming from the first refrigerant circuit.
 - Label the tape "Circuit 2" on the COIL IN and COIL OUT thermocouple wires coming from the second refrigerant circuit.
5. Strip about 1/4 inch (6 mm) of insulation from the end of each thermocouple wire.

 Note:

Do not nick the conductor. The wire may break at the nick from system vibration and can result in damage to the equipment.

6. Tighten the thermocouple wires onto terminals of the miniature thermocouple connector (included in our refrigerant line kit) and plug the connector into the designated location.
See [Figure: Thermocouple connectors](#).
7. Minimum recommended Thermocouple usage is Coil In and Coil Out for each refrigerant circuit. If you are working on a single circuit system, connect the Thermocouple wires as follows:

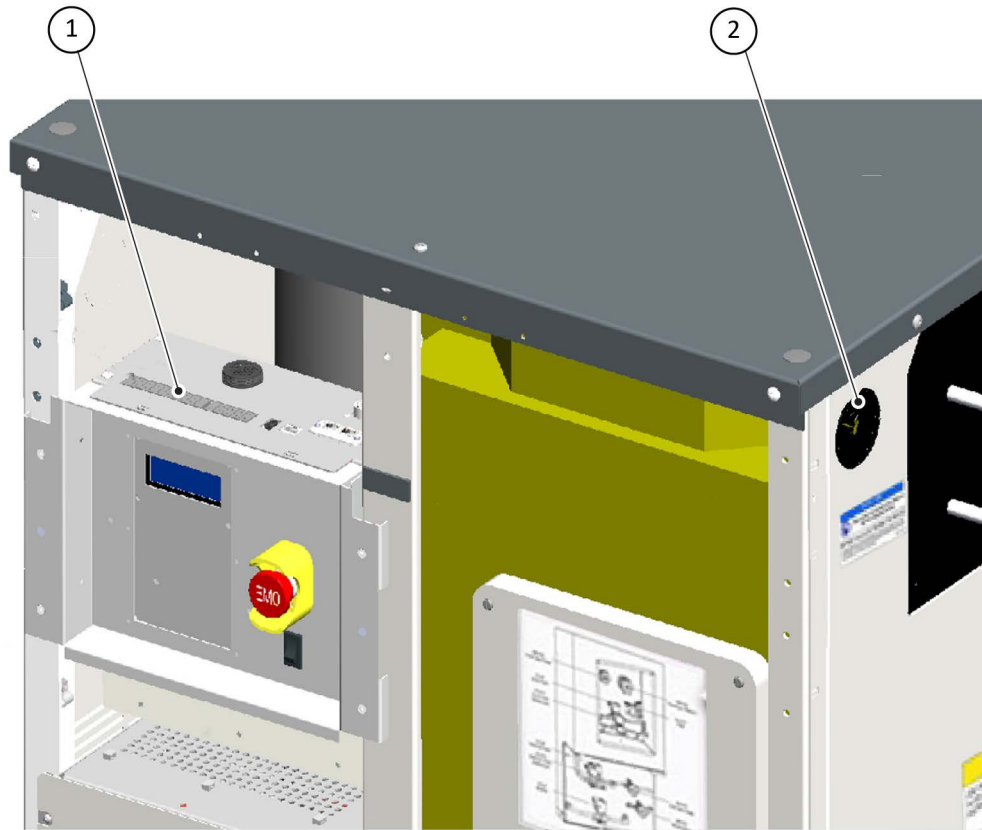
- Position # 9: COIL IN
- Position # 10: COIL OUT

If you are working on a dual circuit system, connect the Thermocouple wires as follows:

- Position # 9: #1 Line COIL IN
- Position # 10: #1 Line COIL OUT
- Position # 11: #2 Line COIL IN
- Position # 12: #2 Line COIL OUT

8. Go to the [Table: Installation checklist](#). Initial and date this task.

Figure 78 Location of low voltage box and thermocouple terminals, standard

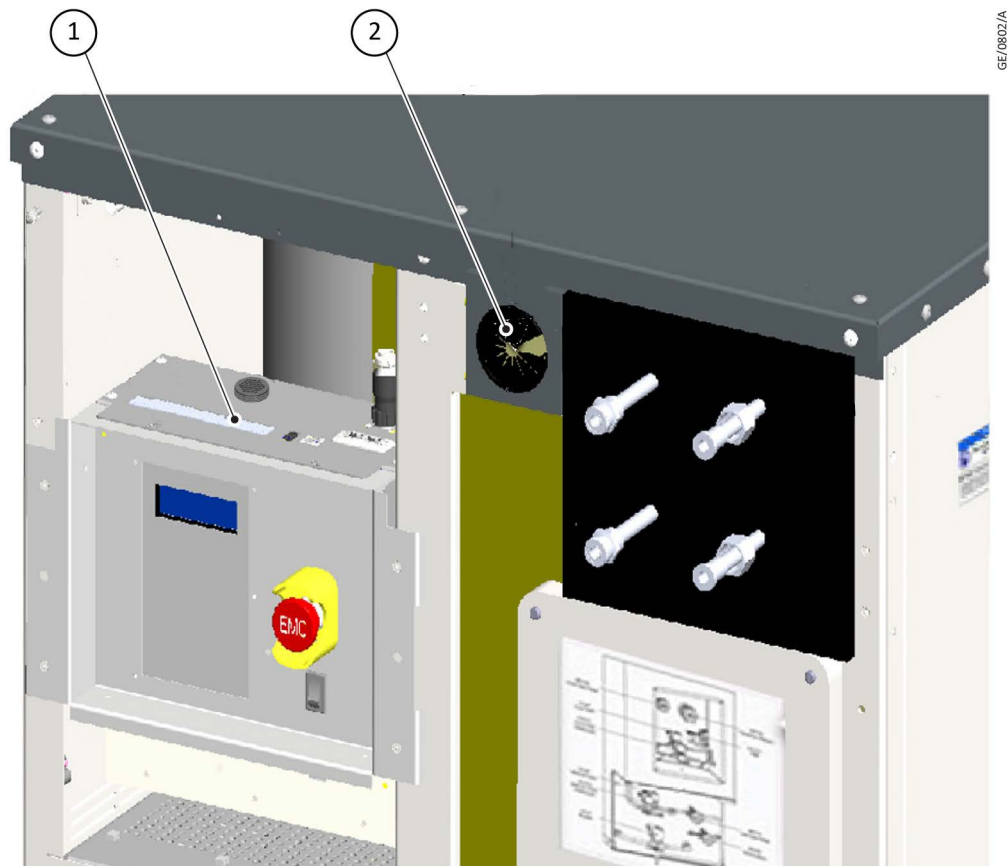


GE/0801/A

1. Thermocouple connectors

2. Thermocouple wiring pass-through

Figure 79 Location of low voltage box and thermocouple terminals, front access



1. Thermocouple connectors
2. Thermocouple wiring pass-through

Figure 80 Thermocouple connectors



5.14 Preliminary check of the system

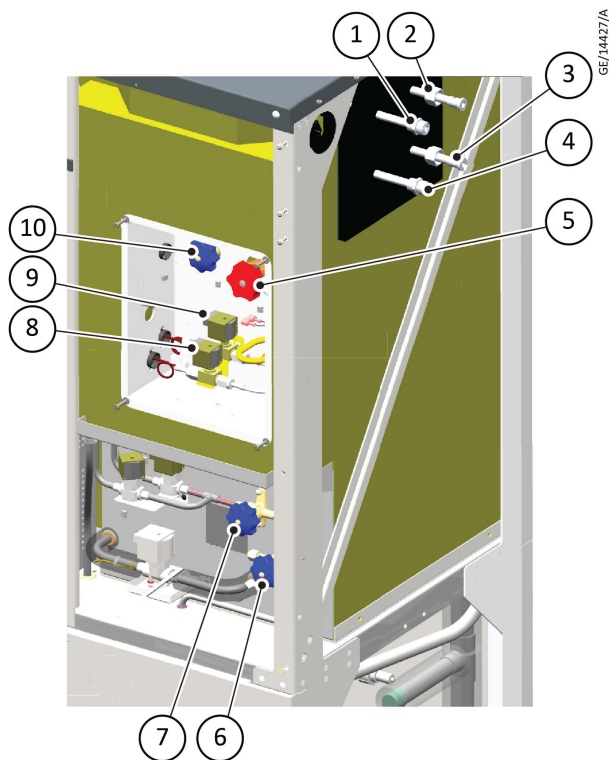
Item	Description
Electrical Category	Type 1 - Equipment is fully de-energised
Tools and materials:	8 mm or 5/16 open wrench (only for MaxCool 2200 & 1500)

 Note:

Do not open the isolation valves at this time or the unit may be damaged.

Follow the instructions that follow in proper sequence to avoid damage to the equipment.

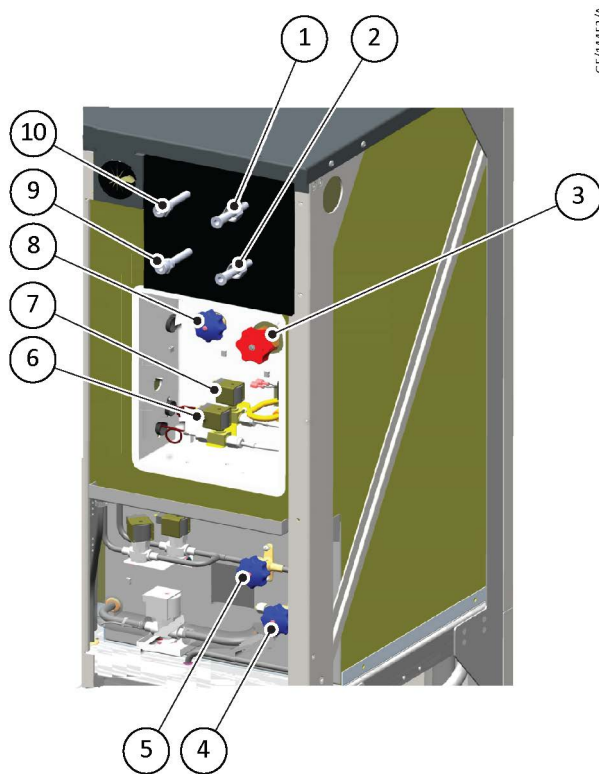
1. Make sure you have performed all of the tasks up to this point on the installation checklist.
2. Perform the following tasks before opening the isolation valves on the refrigeration unit: Refer to on page 115 (for MaxCool standard), on page 116 (for MaxCool with front access).
 - a. Check the refrigerant line and cryosurface for leaks
 - b. Evacuate the refrigerant line and cryosurface
3. Open the cold box on the right top panel of the refrigeration unit and locate the red hand valves.
4. Locate the valves labelled as follows: Refer to on page 115 (for MaxCool standard), on page 116 (for MaxCool with front access).
 - MV101 - Hot gas feed
 - MV102 - Cold gas feed
 - MV103 - Common return
5. Turn each of these hand valves completely counter-clockwise to fully open each valve.
6. Turn each hand valve clockwise 1/4 turn from full open.
7. Wait 10 minutes for the pressure to equalise in the system. The pressure may drop 35 - 70 kPa (5 - 10 psig) as the refrigerant mixture enters the refrigerant line and cryosurface. Record balance pressures in the Installation checklist (refer to [Table: Installation checklist](#)).
8. If the back side of the system is not accessible, disregard this step. If the back side of the system is accessible, locate the pressure gauge and read the pressure value. This is the Static Pressure. See [Figure: Pressure gauge on back of refrigeration unit](#). Record the pressure reading in a maintenance log for future reference.
9. Inspect the valve box cover to make sure the rubber seals are intact.
10. Reinstall the valve box cover and securely screw it into place, covering the hand valves. The gasket should form a seal to keep out water vapor.
11. Start the cooling water.
12. Confirm the cooling water flow meets specifications found in [Cooling water](#) on page 63.
13. Go to the [Table: Installation checklist](#). Initial and date this task.

Figure 81 Illustration of valve location and names, standard (* asterisk denotes optional item)

- | | |
|--------------------------|---------------------------|
| 1. Circuit 2 feed line* | 2. Circuit 1 feed line |
| 3. Circuit 1 return line | 4. Circuit 2 return line* |
| 5. MV103 common return | 6. MV107 evacuation |
| 7. MV101 hot gas feed | 8. VLV11 cool Ckt 2* |
| 9. VLV5 cool Ckt1 | 10. MV102 cold gas feed* |

 Note:

Valve color and type may vary depending on the model. Specific tool may be required to operate the valves. Refer to the section [Preliminary check of the system](#) on page 114 for the tool requirements.

Figure 82 Illustration of valve location and names, front access (* asterisk denotes optional item)

- | | |
|--------------------------|---------------------------|
| 1. Circuit 1 return line | 2. Circuit 2 return line* |
| 3. MV103 common return | 4. MV107 evacuation |
| 5. MV101 hot gas feed | 6. VLV11 cool Ckt 2* |
| 7. VLV5 cool Ckt1 | 8. MV102 cold gas feed |
| 9. Circuit 2 feed line* | 10. Circuit 1 feed line* |

Note:

Valve color and type may vary depending on the model. Specific tool may be required to operate the valves. Refer to the section [Preliminary check of the system](#) on page 114 for the tool requirements.

Figure 83 Pressure gauge on back of refrigeration unit

5.15 Insulate exposed refrigerant tubes and couplings

WARNING: FLAMMABLE MATERIALS AND CHEMICALS



Fumes from the adhesive Armstrong 520 are a source of ignition and suffocation and may cause fire and serious injury or death.

- Make sure there is adequate ventilation and no ignition source when using the Armstrong 520 adhesive.
- Read the label and follow the instructions on the container.

Note:

Armaflex tape is extremely difficult to remove and makes the feed-through nut bind when unscrewed and may result in damage to the equipment.

Do not get Armaflex tape or Armstrong 520 adhesive on the threads of the feed-through.

Properly insulating the exposed tubes and couplings keeps them dry. Penetrating moisture adds heat load to the cryopump and can cause corrosion or leaks.

Item	Description
Electrical Category	Type 1 - Equipment is fully de-energised
Tools	Large pair of scissors or knife
Materials:	Insulation materials shipped with unit ▪ Tubes of closed-cell pipe insulation ▪ Sheet of closed-cell pipe insulation ▪ Armaflex Insulation Tape ▪ Armstrong 520 adhesive

5.15.1 Insulate exposed tubes between the refrigeration unit and the refrigerant line insulation:

Refer to [Figure: Insulating exposed tubes and couplings, standard](#) (for MaxCool standard) and

[Figure: Insulating exposed tubes and couplings, front access](#) (for MaxCool with Front Access),

[Figure: Cutaway view A-A showing sheet insulation on refrigerant lines at system](#) and

[Figure: Cutaway view B-B showing sheet insulation on refrigerant lines to cryosurface](#).

1. Cut the tubes of insulation so that they will fit snugly between the refrigeration unit and the refrigerant line's insulation. Cut each tube of insulation lengthwise.
2. Fit a smaller diameter tube of insulation around each exposed tube. Apply adhesive to the lengthwise slits in the insulation. Close the lengthwise slits to form an air-tight seal.
3. Fit the larger diameter tubes of insulation around the smaller diameter tubes of insulation. Seal each lengthwise slit shut with adhesive. (It is best to stagger the lengthwise seams.)
4. Cover the insulated refrigerant line bundle with a spiral wrap of Armaflex Insulation Tape. Overlap the previous wrap of insulation tape by at least 1 inch to ensure there are no gaps.
Alternately, cut sheet insulation the same length as the tubes of insulation and wrap the sheet once around the refrigerant line bundle, allowing the sheet to overlap 2 - 3 inches (50 - 75 mm). Put adhesive on the last 1 - 1.5 inches (25 - 40 mm) of the overlapping sheet to secure it in place.
5. Seal both ends of the refrigerant line bundle with tape or insulation tape. Secure the insulation around the refrigerant line bundle to the refrigerant line's insulation and to the unit's panel. Flare the tape so that it connects the insulation directly to the system panel.
6. Use the tape or sheet Insulation to insulate all remaining exposed tubes and refrigerant components between the refrigerant line insulation and the feed-through.
7. Cover the exposed tubes between the pre-insulated refrigerant line and the feed-through with a spiral wrap of Armaflex Insulation Tape. Overlap the previous wrap of insulation tape by at least 1 inch to ensure there are no gaps.
If using sheet insulation, fit the sheet of insulation onto the exposed tubes. Wrap the insulation around the exposed tubes three times. Put adhesive on the last 1 - 1.5 inches (25 - 40 mm) of the overlapping sheet to secure it in place.
Seal both ends of the insulation with tape to secure the insulation on to the insulation of the refrigerant lines and to the feed-through. Do not put the tape closer than 1 - 2 inches (25 - 50 mm) to the threads on the feed-through.
8. Go to the [Table: Installation checklist](#). Initial and date this task.

Figure 84 Insulating exposed tubes and couplings, standard

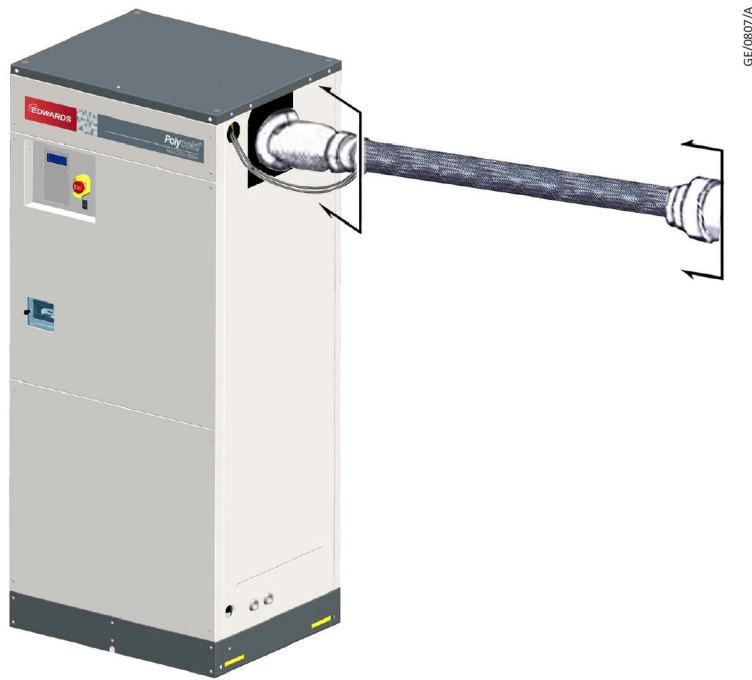


Figure 85 Insulating exposed tubes and couplings, front access

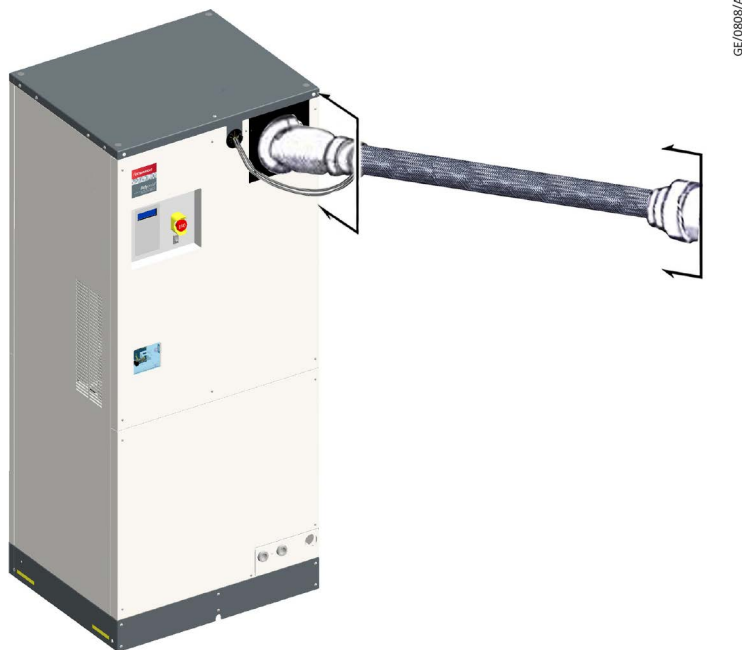
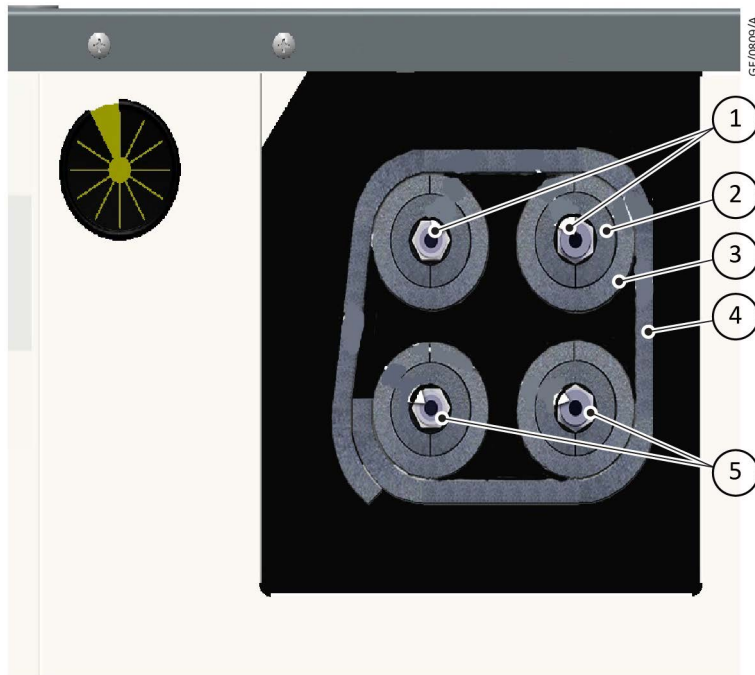
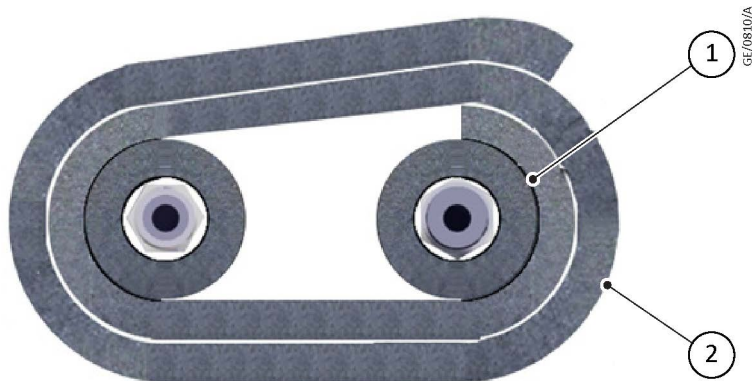


Figure 86 Cutaway view A-A showing sheet insulation on refrigerant lines at system



- | | |
|--|---|
| 1. Circuit 1 refrigerant lines | 2. Small diameter insulation on refrigerant line |
| 3. Large diameter insulation on refrigerant line (with seams offset) | 4. Outtrap of sheet insulation or armaflex insulation tape on refrigerant line bundle |
| 5. Circuit 2 refrigerant lines (optional) | |

Figure 87 Cutaway view B-B showing sheet insulation on refrigerant lines to cryosurface



- | | |
|--|--|
| 1. Small diameter insulation of refrigerant line | 2. Outer wrap of sheet insulation or armaflex insulation tape on refrigerant line bundle |
|--|--|

Figure 88 View of armaflex insulating tape on refrigerant line bundle on system, standard**Figure 89** View of armaflex insulating tape on refrigerant line bundle on system, front access

5.16 Startup and test

Item	Description
Electrical Category	Type 2 - Equipment is energized. Energized circuits are covered or insulated
Tools and materials:	No tools required

The startup and test section requires that the system is fully installed and that the vacuum chamber is operational.

1. Confirm that cooling water is on and flowing properly through the system.
2. Turn ON the electrical power source for the refrigeration unit.
3. Move CB-1 to the ON position. See [Figure: Move CB-1 to ON](#).
4. Wait for the system to boot up. Boot up takes less than one minute. When boot up is complete, the system HMI screen displays information.

5. On systems equipped with the EMO, twist the EMO switch clockwise to confirm that it is in the Out or disengaged position. See [Figure: Set compressor switch to ON \(optional EMO shown\)](#).
6. Move the compressor On/Off switch to the ON position. See [Figure: Set compressor switch to ON \(optional EMO shown\)](#)
The unit should go to the Standby mode. See [Figure: Standby mode](#).
7. Let the unit stay in the Standby mode for 30 minutes for the "Polycold Stack" to reach operating temperature. The Polycold Stack is the heat exchangers and other components that are encased in insulating foam.
8. Evacuate the vacuum chamber where the cryosurface is installed to at least 0.01 torr (1.33 Pa).
9. After the 30 minutes of Standby, scroll through the menu to check the temperature and pressure parameters. See [Figure: Check parameters](#).
 - Circuit feed, return, coil in, and coil out temperatures should be positive values.
 - Coldest liquid temperatures should be below -80 °C.
10. Record the temperature and pressure parameter data.
11. Select Cool. See [Figure: Select cool mode](#).
 - Wait 5 minutes if the refrigeration line plus coil is 6 metres (20 feet) or less.
 - Wait 10 minutes if the refrigerant line plus coil is longer than 6 metres (20 feet).
 - When pressed, the Cool LED blinks slowly.
12. Check the coil inlet and coil outlet temperatures to make sure that they reach the desired temperatures.
13. Select Defrost. The unit automatically goes in to standby when defrost is complete.
14. Allow the unit to remain in standby for 5 minutes.
15. Repeat the Cool, Defrost, and Standby cycle two or three times.
16. For systems with dual refrigerant circuits, repeat steps 9 through 15 for channel 2.
17. Go to the [Table: Installation checklist](#). Initial and date this task.

Figure 90 Move CB-1 to ON

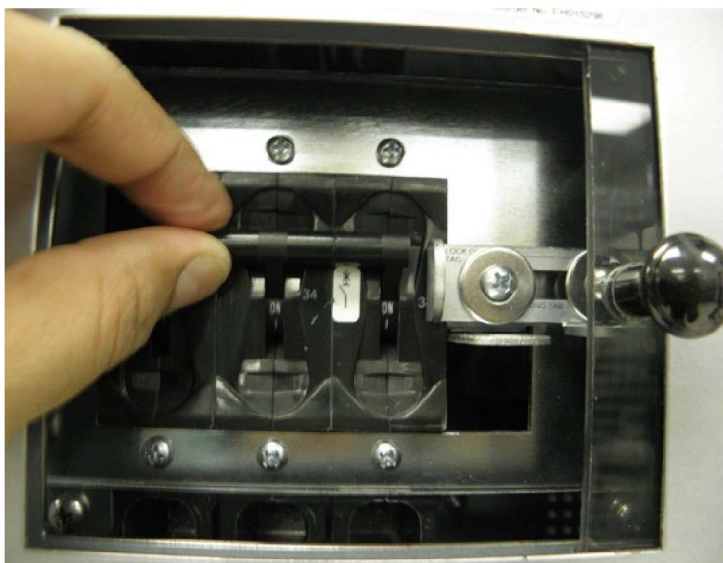


Figure 91 Set compressor switch to ON (optional EMO shown)



Figure 92 Standby mode

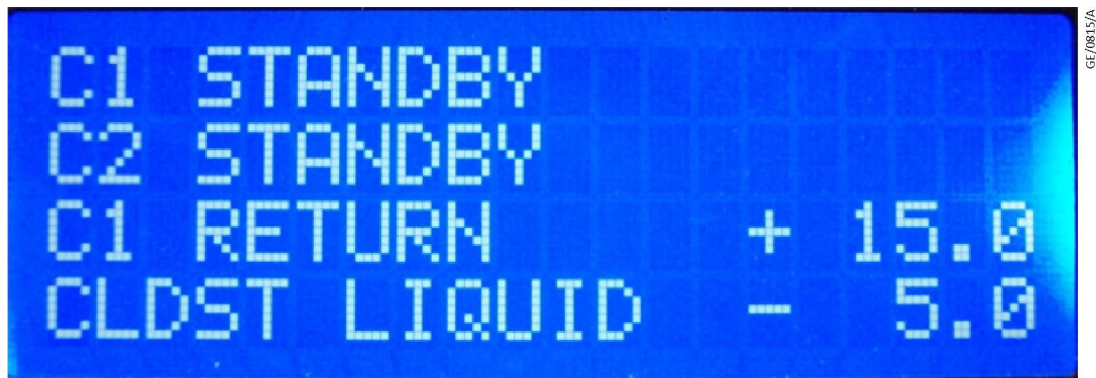


Figure 93 Check parameters



Figure 94 Select cool mode



5.17 Evaluate the system / place into service

Item	Description
Electrical Category	Type 2 - Equipment is energised. Energised circuits are covered or insulated
Tools and materials:	No tools required

This section requires that the system Startup and Test procedure is complete and the unit is still running in Standby.

Unless you are installing a remote interface, this is the last task for installing a system.

WARNING: ELECTRIC SHOCK



The compressor electrical box contains hazardous voltages. Failure to have a qualified electrician to do all electrical work could result in serious injury or death.

- Do not reach inside the unit with power applied.
- Have a qualified electrician perform all electrical work.

CAUTION: EXTREME TEMPERATURE



The compressor's heads and discharge line may be hot when operating. Contact with the hot surface may result in minor or moderate injury.

- Do not reach inside the compressor compartment when the unit is operating.
- Do not touch the compressor's heads or discharge lines.

1. With the system in Standby, make sure the minimum water flow rate is adequate for the temperature of the water. See [Cooling water](#) on page 63.
2. Select LOCAL.
3. Listen to the compressor. It should run continuously without cycling or turning OFF.
4. If the back side of the system is not accessible, disregard this step.
If the back side of the system is accessible, remove the unit's lower rear panel and locate the oil sight glass on the body of the compressor. The oil level should be 1/8 to 1/2 full on a compressor that has been running for at least 60 minutes. Preferred level is 1/8 full. See [Figure: Compressor oil level sight glass](#).
Record the compressor oil level after the compressor has run for at least 60 minutes.
5. Check the direction of the flow of the cooling water.
 - The left water line is the water OUT or drain line.
 - The right water line is the water IN or supply line.
 - The OUT line should be warmer than the IN line.
 - If the OUT line is cooler than the IN line, then turn off the unit, disconnect the water lines, and connect the supply and drain lines to the proper ports.
6. Record the pressures and temperatures in [Table: Cryochiller pressures and temperatures in standby for 60 mins](#).
7. Evacuate the vacuum chamber where the cryosurface is installed to at least 0.01 torr (1.33 Pa).
8. Select Cool and wait 30 minutes.

Note:

If it is a dual circuit system, select Cool for both refrigerant circuits.

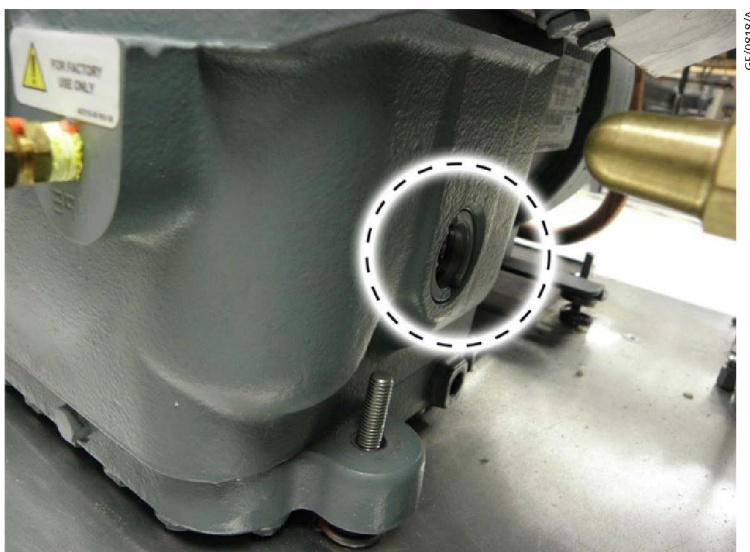
9. Check the outlet temperature of the cooling water. The drain line (OUT) should be 16 to 41 °C (60 to 105 °F). If not, adjust the water flow to attain a temperature in this range.
10. If there is any ice or water on the refrigerant line, turn OFF the unit and remove the ice or water. Apply additional insulation at the points where ice was formed or another complete layer of insulation if the lines were icy. Re-evaluate the cryopump starting at Step 1 of this section.
11. Record the pressures and temperatures in [Table: Cryochiller pressures and temperatures in cool mode for 60 mins.](#)
12. Select Defrost.

Note:

If it is a dual circuit system, select Defrost for both refrigerant circuits.

13. Record the time it takes for the cryosurface to defrost. Actual Defrost Time: _____ minutes. When the defrost completes, the unit automatically switches to Standby. The default temperature is 20 °C.
14. Open the vacuum chamber. The cryosurface should be dry and at room temperature or warmer.
15. Recheck the balance pressure (see [Balance pressure](#)), and cooling water temperature (see [Table: Water flow and inlet water temperature](#)), to verify that the system is operating within specifications. Check that TC8, and TC10 if a dual circuit, are at or near 20 °C.
16. Record all measurements taken in this task in a maintenance log for future use as a baseline.
17. Go to [Table: Installation checklist](#). Initial and date this task.

Figure 95 Compressor oil level sight glass



5.17.1 Table: Cryochiller pressures and temperatures in standby for 60 mins

Table 20 Cryochiller pressures and temperatures in standby for 60 mins

Item	Acceptable range for MaxCool 4000H	Acceptable range for MaxCool 2500L	Acceptable range for MaxCool 2200	Acceptable range for MaxCool 1500	Your measurements
Suction pressure	21 to 345 kPa (3 to 50 psig)	21 to 345 kPa (3 to 50 psig)	21 to 345 kPa (3 to 50 psig)	21 to 345 kPa (3 to 50 psig)	_____ kPa (psig)
Discharge pressure	689 to 2068 kPa (100 to 300 psig)	689 to 2068 kPa (100 to 300 psig)	689 to 2068 kPa (100 to 300 psig)	689 to 2068 kPa (100 to 300 psig)	_____ kPa (psig)
Discharge line (TC #1)	80 to 125 °C	80 to 125 °C	80 to 125 °C	80 to 125 °C	_____ °C
Liquid line (TC #2)	15 to 38 °C	15 to 38 °C	15 to 38 °C	15 to 38 °C	_____ °C
Coldest liquid temperature (TC #4)	-120 to -154 °C	-130 to -156 °C	-130 to -154 °C	-130 to -154 °C	_____ °C

5.17.2 Table: Cryochiller pressures and temperatures in cool mode for 60 mins

Table 21 Cryochiller pressures and temperatures in cool mode for 60 mins

Item	Acceptable range for MaxCool 4000H	Acceptable range for MaxCool 2500L	Acceptable range for MaxCool 2200	Acceptable range for MaxCool 1500	Your measurements
Suction pressure	21 to 414 kPa (3 to 60 psig)	21 to 414 kPa (3 to 60 psig)	21 to 414 kPa (3 to 60 psig)	21 to 414 kPa (3 to 60 psig)	_____ kPa (psig)
Discharge pressure	689 to 2827 kPa (100 to 410 psig)	689 to 2827 kPa (100 to 410 psig)	689 to 2827 kPa (100 to 410 psig)	689 to 2827 kPa (100 to 410 psig)	_____ kPa (psig)
Discharge line (TC #1)	80 to 128 °C	80 to 128 °C	80 to 128 °C	80 to 128 °C	_____ °C
Liquid line (TC #2)	15 to 41 °C	15 to 41 °C	15 to 41 °C	15 to 41 °C	_____ °C
Coldest liquid tempera- ture (TC #4)	-80 to -150 °C	-100 to -155 °C	-30 to -154 °C	-30 to -154 °C	_____ °C
Coil IN temperature	-96 to -145 °C (application based)	-118 to -155 °C (application based)	-115 to -154 °C (application based)	-115 to -154 °C (application based)	_____ °C
Coil OUT temperature	-80 to -145 °C (application based)	-102 to -155 °C (application based)	-100 to -154 °C (application based)	-100 to -154 °C (application based)	_____ °C
Maximum coil IN - Coil OUT difference	20 °C	20 °C	20 °C	20 °C	_____ °C

5.18 Installation checklist

Use the checklist when installing the cryochiller to make sure a correct installation is done.

 Note:

Before installing the cryochiller, check the specifications and site requirements in this manual.

Table 22 Installation checklist

	Name	Completion
1.	Inspect and unpack unit - Record Balance Pressure	Balance Pressures: _____
2.	Move to location	-
3.	Remove compressor hold-down nuts	-
4.	Connect cooling water	-
5.	Connect electrical power and adjust transformer tap settings accordingly	-
6.	Install the cryosurface / cryobaffle	-
7.	Install the refrigerant lines	-
8.	Route condensate drain tube	-
9.	Install seismic restraints (optional)	-
10.	Check the refrigerant lines and cryosurface / cryobaffle for leaks	-
11.	Evacuate the refrigerant lines and cryosurface / cryobaffle	-
12.	Connect the refrigerant line thermocouples	-
13.	Preliminary check of the cryochiller – Record Balance Pressure	-
14.	Insulate exposed refrigerant tubes and couplings	-
15.	Startup and test	-
16.	Evaluate the cryochiller / Place into service	-

6. Interfacing

Interfacing refers to the methods for communication with control of the system.

6.1 General interface information

The system interfaces with many different communication and control protocols. Actual available interfaces are dependent on the model. The available interface options are as follows:

- Human Machine Interface (HMI) (standard)
- Ethernet (standard)
- Profibus
- EtherCAT
- Profinet
- DeviceNet
- 24 V Remote

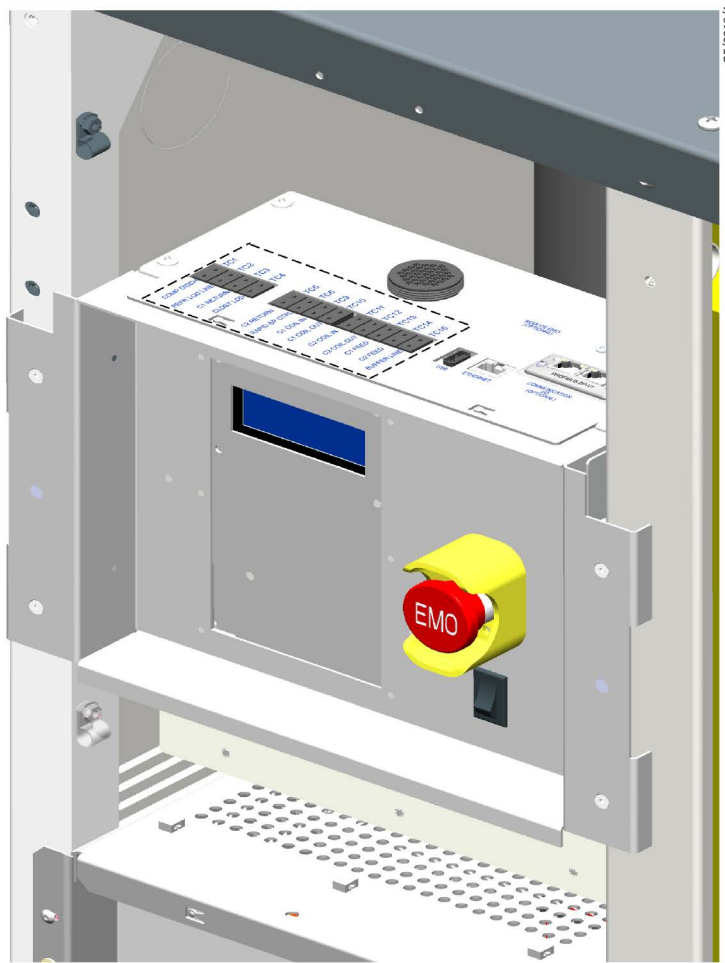
All interfaces can connect to external terminals on the panel on top of the low voltage box. The connections that are available on each unit depend on the communications options ordered with that unit.

6.1.1 General interface rules

For information on commands, see Host commands.

- Only one interface can be in "Control" at a time.
- "Set" commands can only be executed by the interface that is in "Control".
- "Get" commands can be executed by any interface at any time if the security level is satisfied. See Security levels.
- Interface control is set by Ethernet using the command `SYSTEM_CONTROL_MODE` or by the HMI.
- The system is set to Local mode, or HMI control, when the Remote key is pressed and system is in remote mode.
- The default control mode becomes the control interface when the Remote key is pressed.
- The Remote LED is ON when in Remote mode and OFF when in Local mode.
- The system is set to the default "Control" mode when the system boots or when the Remote key is pressed when the system is in local mode.
- The default "Control" interface can be set by the command `SYSTEM_CONTROL_MODE_DEF` or by the HMI.

Figure 96 Interface communication connections (low voltage box interface connection panel)



6.2 Human Machine Interface - HMI

The HMI consists of a 4-line display and a keypad for navigation and selection.

6.2.1 Navigation keys

Figure 97 HMI display and keyboard



Use Navigation keys to select the display menus.

- Use arrow keys to move the cursor up and down to scroll through screen menus.
- Use enter key to select the highlighted item.
- Use arrow keys to increase or decrease the selected screen value.
- Use enter key to increment through the characters of a displayed value.
- Use enter key to save the value after the incrementing past the last character.

6.2.2 Cool/Standby/Heat keys

Press the Cool, Heat, or Standby mode keys to set the mode for each circuit.

Each mode has a green LED which is illuminated when the mode is active.

6.2.3 Remote key

Remote key allows Remote / Local interface control.

- When Remote LED is lit, the remote interface is active. Remote interface is set by the SYSTEM_CONTROL_MODE_DEF command.

- When Remote LED is NOT lit, the controlling interface is the HMI local interface keypad.
- HMI local must be active to change modes and change values using the keypad and the HMI display.
- HMI local is not required to be active in order to browse the HMI screens.

6.2.4 OK LED

- If OK LED is lit, it indicates the compressor contactor is closed. (compressor on).
- If OK LED is not lit, it indicates the compressor contactor is not closed.

6.2.5 Fault LEDs

Fault LED (amber and red) indicates a warning or fault has occurred.

Red fault LED is reserved for high pressure faults.

Some faults cause the compressor contactor to open (compressor OFF).

6.2.6 Reset button

Reset button can perform 2 functions.

- Acknowledges alarms / faults the same as the RESET_ALARMS command.
 - If the alarm / fault condition still exists, then the alarm / fault does not clear.
 - If the alarm / fault is acknowledged and cleared, the amber / red fault LED turns off.
- Turns ON compressor if compressor was turned OFF by an alarm / fault condition and the compressor switch is in the ON position (contactor closed).

6.3 HMI display

Use navigation keys to move to each display menu and make selections.

- HMI display is 4 rows with 20 characters per row.
- Use Arrow keys to scroll cursor up and down through current screen selections.
- Use Enter key to select highlighted item.
- Pressing an Arrow key to move the cursor past the end of a nested display returns you to the next higher display.
- If the highlighted item has a right arrow (>), then Enter will bring you to a nested sub-menu.
- If the highlighted item does not have a right arrow (>), then Enter toggles the selection or allows data entry using the up and down arrows.

HMI display

- Press the up and down arrow key to advance to additional items on the same menu.
- Asterisk at the end of a menu item (*) indicates the current setting.
- Up and down arrows in the display indicate more display selections are available. Use the up and down arrows to advance up and down in the display.
- Right arrow (>) at the end of a menu line indicates this entry has additional nested pages. Use the enter key to display the nested menu.

- After a period of inactivity, the display selection returns to the previous display until it reaches the home screen display. The period of inactivity is configurable.
- Selecting a nested display opens the nested display at the selection that was last displayed.
- Numeric values in the display may be either a reported value or a set point value.
- Reported display values cannot be changed.
- Set point display values may be changed by using the enter key to open the value for setting and then using the up and down arrows to change the value of each digit and using the enter key to move to next digit and then use the Enter at the last digit to store the value.
- Display illustrations in this chapter show the full list of screen options for each nested display.

6.3.1 HMI home screen display

Home screen is the default HMI display that is displayed at initial power up and after a configurable internal 30 seconds (default) of HMI keyboard inactivity at each of the nested menus.

The 4-line display shows the mode for each circuit plus user programmable information as shown in the tables below.

LN2, LN3 and LN4 values are programmed from the appropriate HOME SCREEN LN (number) MEAS selection in the MONITOR CONFIG display under CONFIGURATION display. Selecting the blank selection for the LN value leaves that line blank.

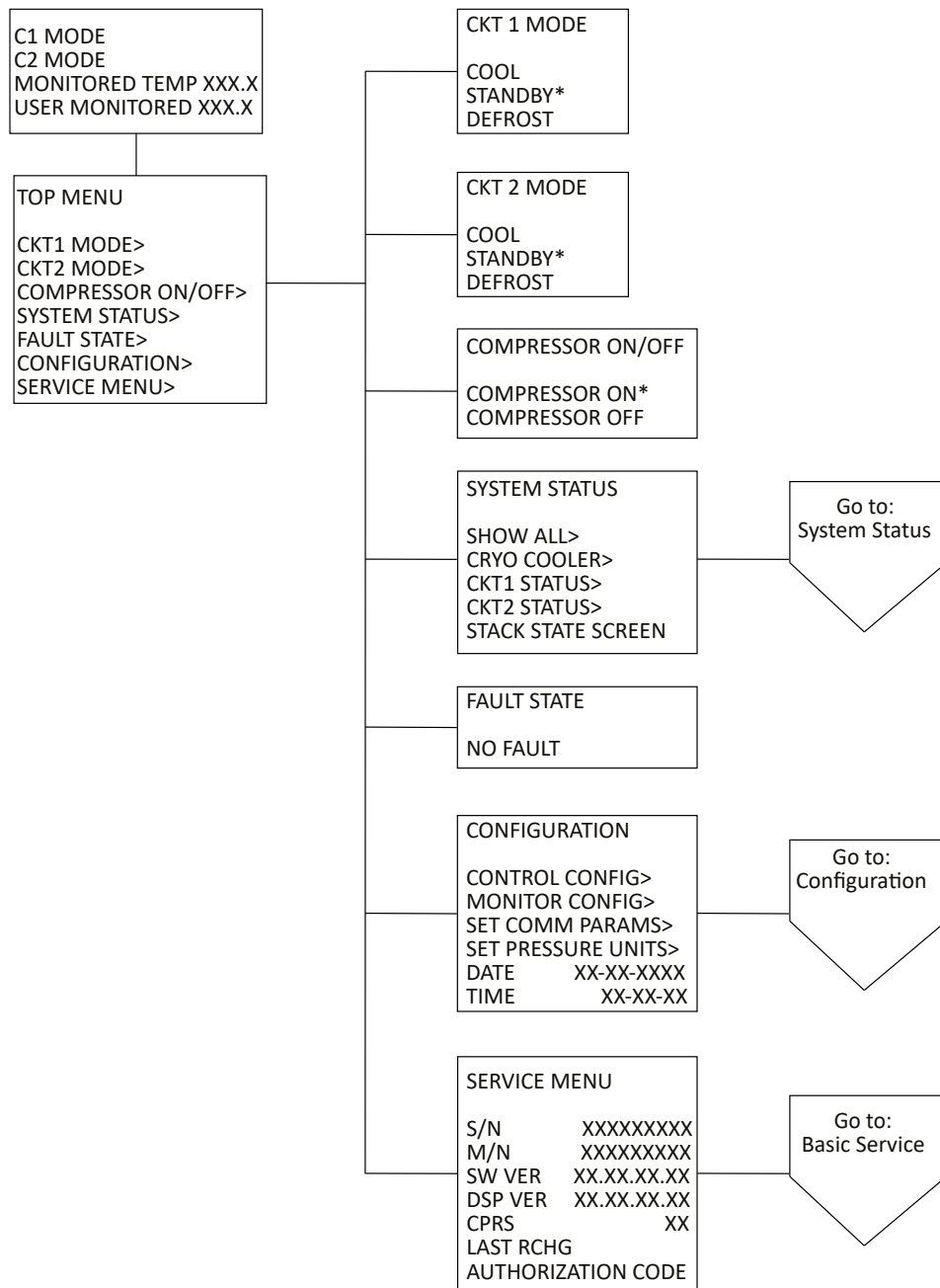
Table 23 Default HMI home menu for single circuit

Single circuit home screen	Description
C1 (mode)	Static display of the specific mode of Circuit 1
1 user selected value from LN2 list	Static display of selected LN2 value
1 user selected value from LN3 list	Static display of selected LN3 value
Up to 8 user selected values from LN4 list	Static display if only 1 LN4 value is selected. Scrolling display of all selected LN4 values if 2 or more values are selected.

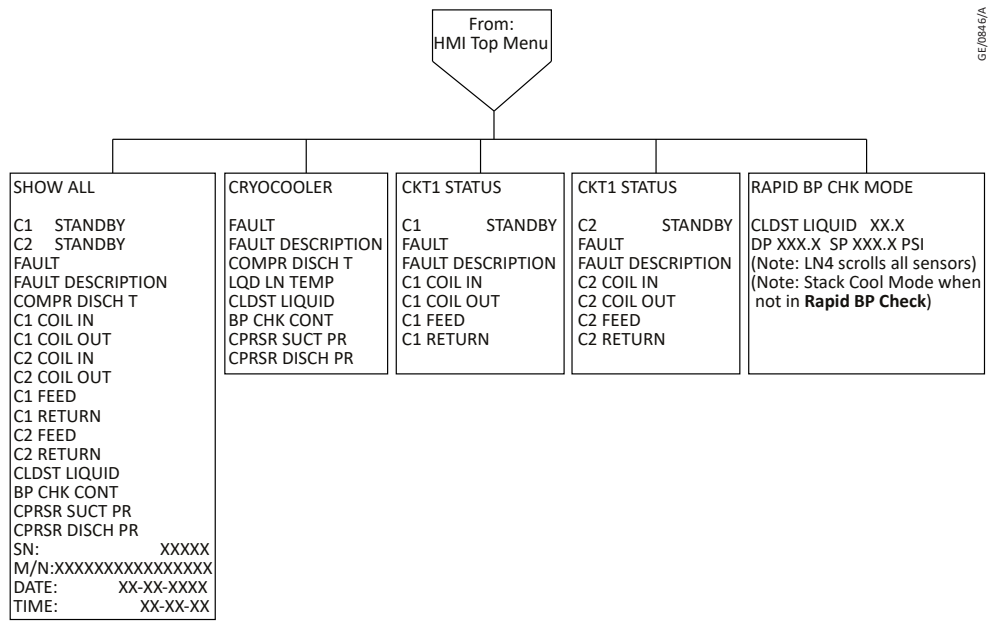
Table 24 Default HMI home menu for dual circuit units

Dual circuit home screen	Description
C1 (mode)	Static display of the specific mode of Circuit 1
C2 (mode)	Static display of the specific mode of Circuit 2 On Base models, this may only read "Cool"
1 user selected value from LN3 list	Static display of selected LN3 value
Up to 8 user selected values from LN4 list	Static display if only 1 LN4 value is selected. Scrolling display of all selected LN4 values if 2 or more values are selected.

6.3.2 HMI top menu



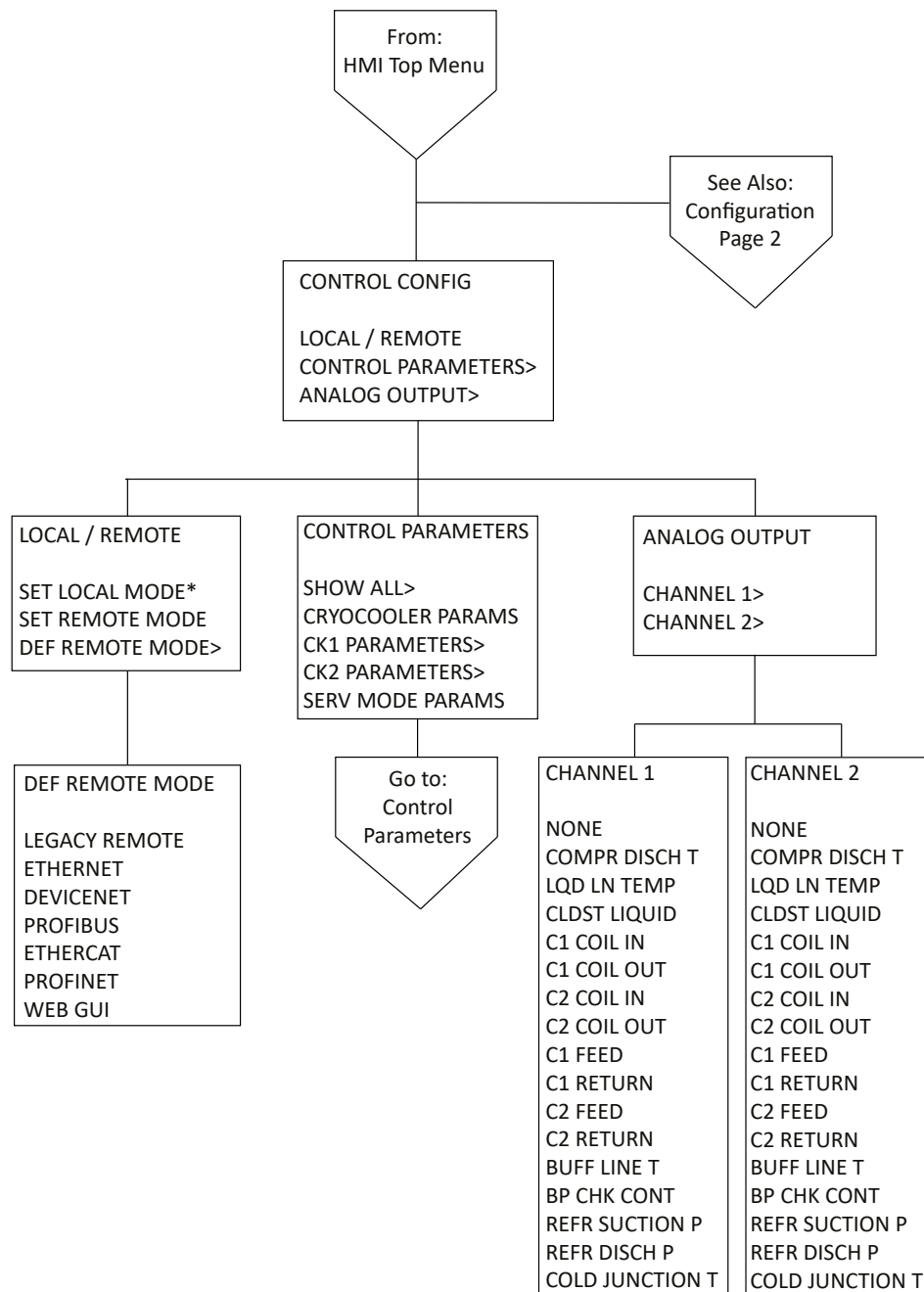
6.3.3 System status



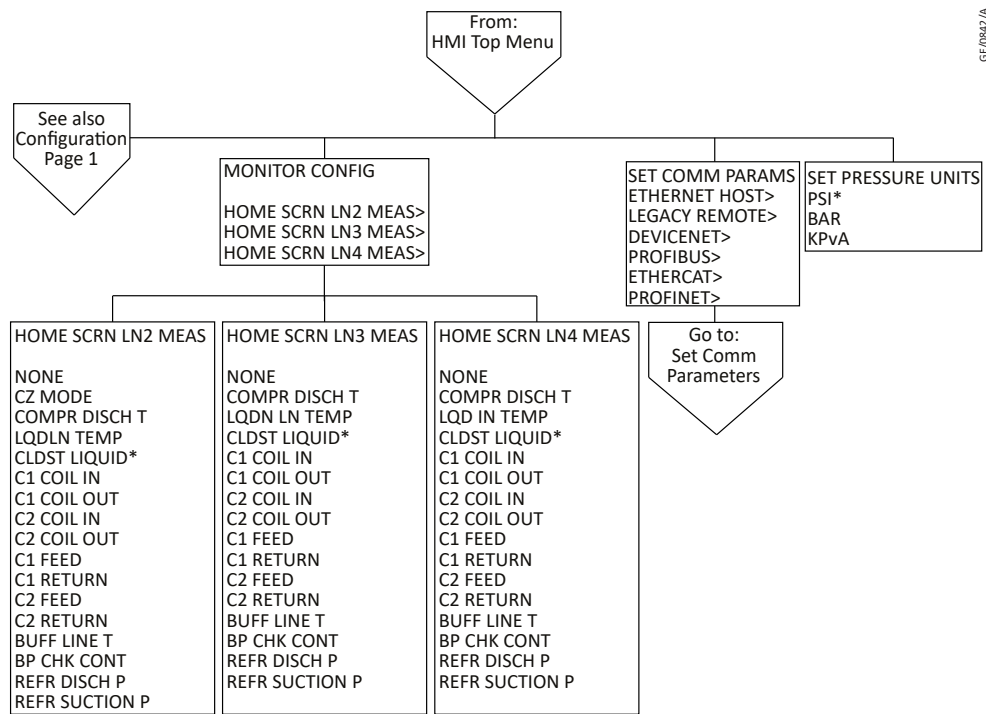
GE/0846/A

6.3.4 Configuration page 1

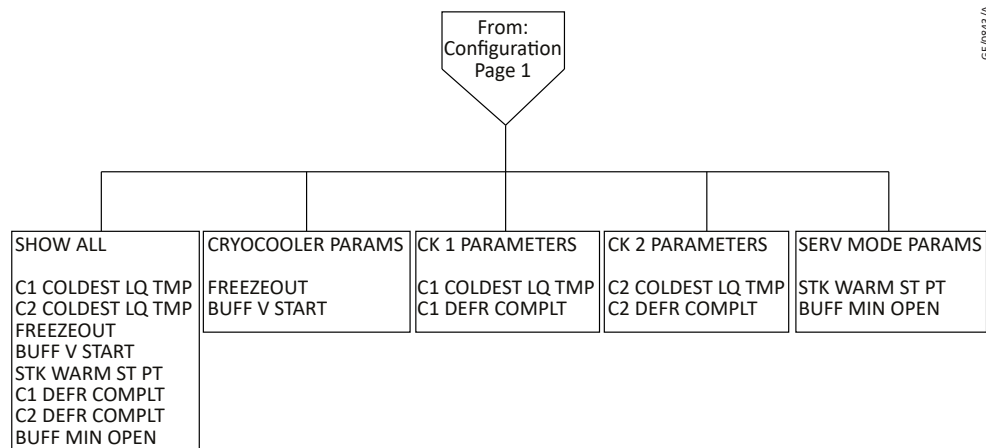
GE/0841/A



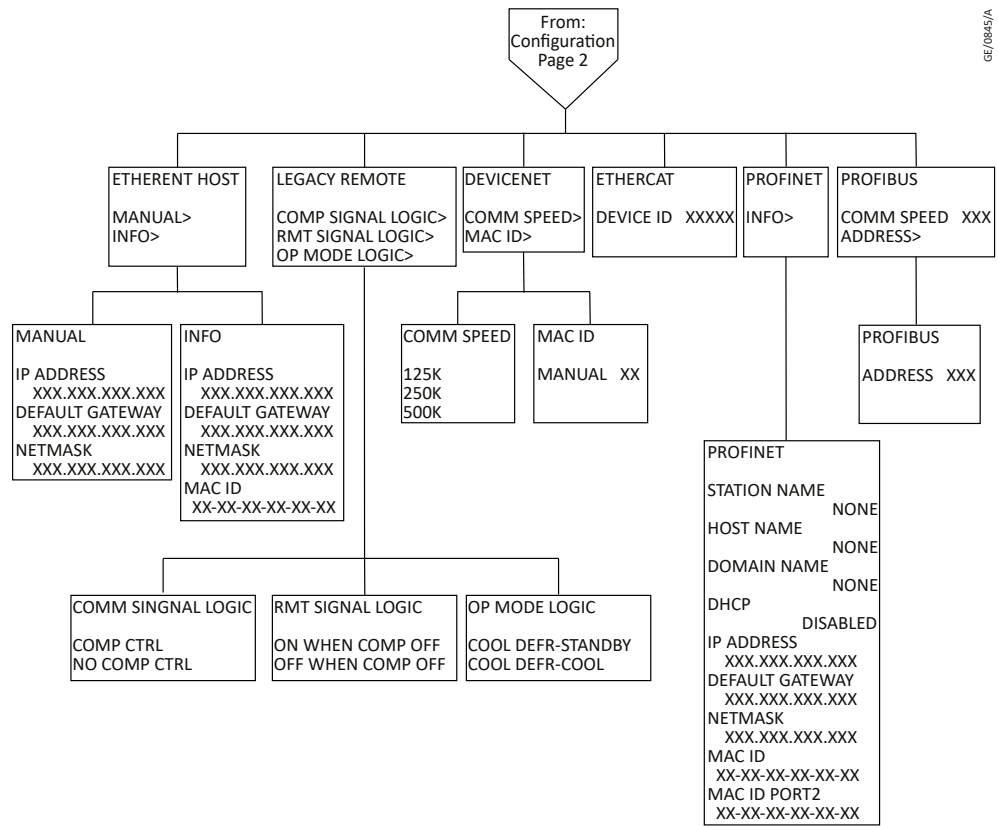
6.3.5 Configuration page 2



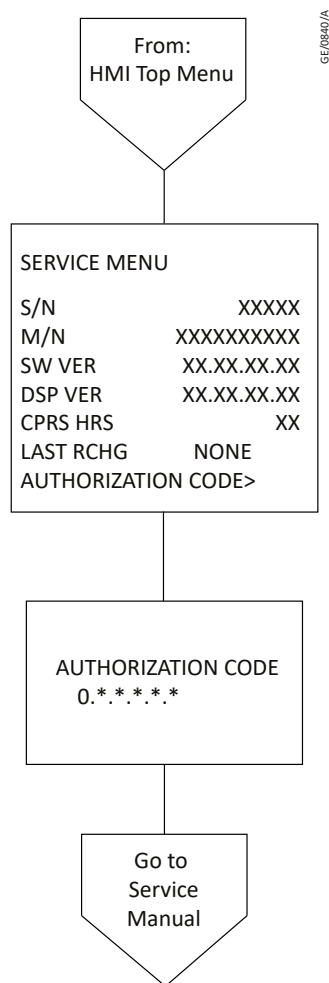
6.3.6 Control parameters



6.3.7 Set comm parameters



6.3.8 Basic service



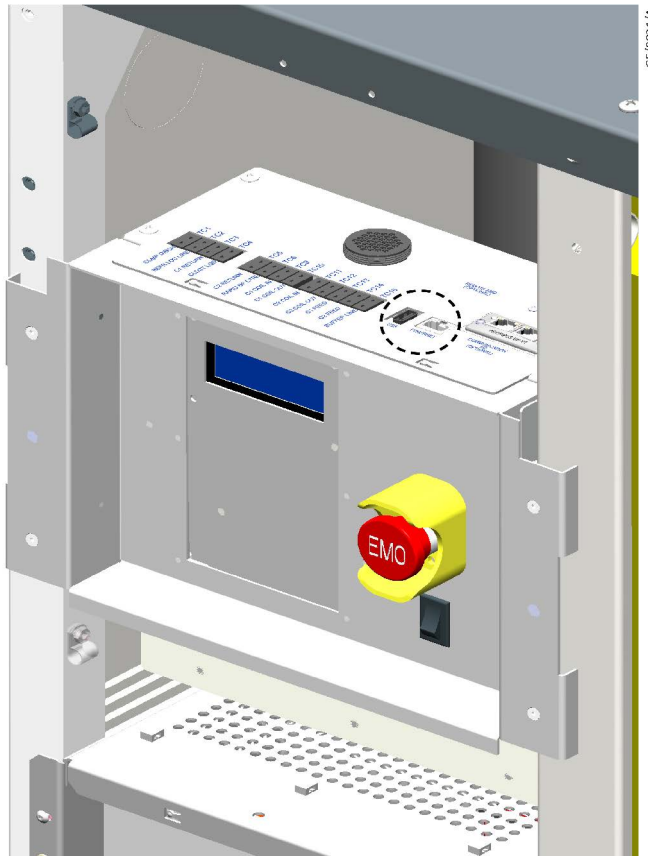
6.4 Ethernet

Host and Service Ethernet communication is a standard feature on all MaxCool units. Ethernet connection requires specific protocols for setting IP and Mask addresses. Set the Cryochiller Ethernet settings using the HMI - Configuration - Set Comm Params - Ethernet menus. Set PC settings as stated below. The Cryochiller is a non DHCP connection. The host or service PC will not automatically set the IP address. If the IP address is changed, a new connection using the new IP address must be made.

Port	Host or service port RJ45 on the communications panel
Cable	Crossover CAT5 / 6 cable with RJ45 connector Standard CAT5 / 6 is OK if computer supports auto crossover.
IP Address	(nnn.nnn.nnn.nnn) First 3 fields same as Cryochiller. 4 th field must be different Host command IP_ADDRESS HMI "Set Comm Params - Ethernet Host"
Network Mask (Subnet Mask) (Subnet)	(nnn.nnn.nnn.nnn) Same mask as Cryochiller - recommended Host command NETWORK_MASK HMI "Set Comm Params - Ethernet Host"

Default Gateway	(nnn.nnn.nnn.nnn) May be left blank or all zeros Host command DEFAULT_GATEWAY HMI "Set Comm Params - Ethernet Host"
Speed	10/100 Mbps
Protocol	IEEE 802.3 10Base-T, IEEE 802.3u 100Base-TX

Figure 98 Ethernet host and service connections



6.5 Profibus

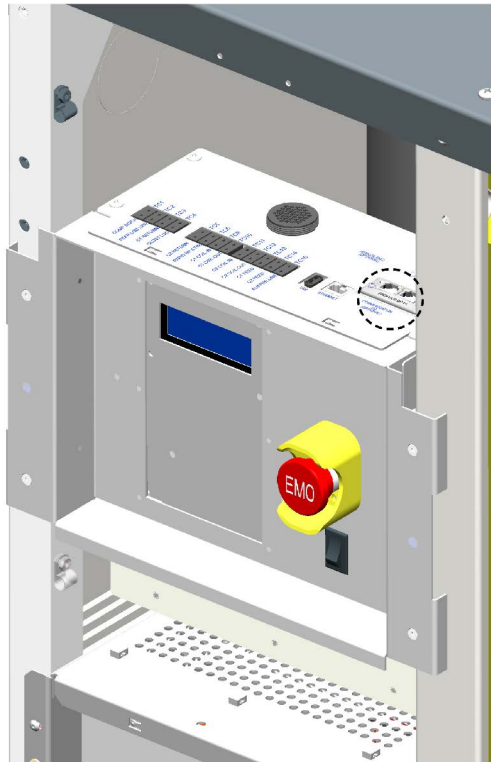
Profibus communication is an available option. Refer to Profibus Interface User Manual, p/n 501937.

Profibus is a communication protocol designed for controlling process equipment. It uses its own hardware and software command set to retrieve system data and to control some functions such as Mode selection and turning the compressor ON and OFF.

Port	Standard ProfiBus DB9 connector on top of low voltage box Route through pass-through on communications panel
Cable	Standard ProfiBus DB9 cable
"Slave ID" Address	1-125 Host command PROFIBUS_PARAMS, ADDRESS HMI "Set Comm Params"

Speed	9.6 K, 19.2 K, 45.45 K, 93.75, 187.5 K, 500 K, 1.5 M, 3 M, 6 M, 12 M Set by: Profibus master controller Read by: Host command PROFIBUS_PARAMS,SPEED HMI "Set Comm Params"
Configuration	Profibus DP-V0 Slave Use appropriate GSD file to configure Profibus on host system

Figure 99 Profibus pass-through and low voltage box top panel connection (optional)



6.6 DeviceNet

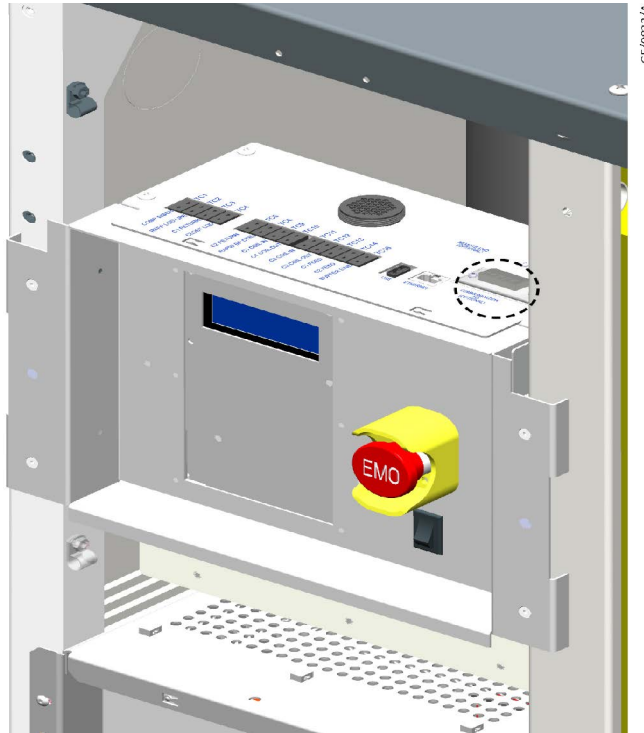
DeviceNet communication is an available option. Refer to DeviceNet Interface User Manual, p/n 501936.

DeviceNet is a communication protocol designed to interconnect control devices for data exchange. It uses its own hardware and software command set to retrieve system data and has the ability to control some functions such as Mode selection and turning the compressor ON and OFF.

Port	Connects to a standard microsealed DeviceNet connector on the Communications Panel
Cable	Standard DeviceNet 5-pin microsealed cable
Mac ID	(0-63) Host command DEVICENET_PARAMS HMI "Set Comm Params"
Speed	(125, 250, 500 Kbps) Host command DEVICENET_PARAMS

	HMI "Set Comm Params"
Protocol	Common industrial protocol (CIP), ODVA DeviceNet specification

Figure 100 Communication connection (optional)



6.7 Profinet

Profinet communication is an available option. Refer to Profinet Interface User Manual, p/n 501938.

Profinet is a communication protocol designed for controlling process equipment. It uses its own hardware and software command set to retrieve system data and to control some functions such as mode selection and turning the compressor ON and OFF.

Cable	Shielded twisted pair cables and RJ45
Topology	Line, tree or star
Maximum Stations	Almost unlimited
Baud Rate	100 Mbit/s
Data	each node: up to 1.500 bytes per telegram frame
Installation	Switched Ethernet transmission

6.8 EtherCAT

EtherCAT communication is an available option. Refer to EtherCAT Interface User Manual, p/n 501939.

EtherCAT is a communication protocol designed for controlling process equipment. It uses its own Hardware and software command set to retrieve system data and to control some functions such as mode selection and turning the compressor on and off.

Cable	Ethernet 100 T twisted pair cables with RJ45 connectors
Topology	Line, tree or star
Maximum Stations	65535
Baud Rate	100 Mbit/s (full duplex)
Data	Up to 1.500 Byte per telegram frame
Installation	100m distance between two nodes in the network

6.9 24 V remote interface

The optional 24 V interface connection allows for direct wiring for inputs to and outputs from the system similar to earlier PFC models.

The 24 V may be isolated or non-isolated. Both isolated and non-isolated can control single circuit or dual circuit systems. See System operational state commands.

24 V Remote pins are either incoming commands or outgoing data.

- Incoming command lines carry control signals from the remote user to the system.
- Incoming command lines are referred to as "Operate".
- Outgoing data information lines send data from the system to the remote user.
- Output data lines are either active or inactive.

The optional non-isolated and isolated 24 V remote interfaces include two analog outputs from -2.0 V d.c. to +2.0 V d.c.. Each analog output can be configured to output the signal from one of the 21 different temperature thermocouples or one of two different pressure transducers.

For temperature the output is

- -2.0 V d.c. for -200 °C
- 0 V d.c. for 0 °C
- +2.0 V d.c. for +200 °C

For pressure the output is

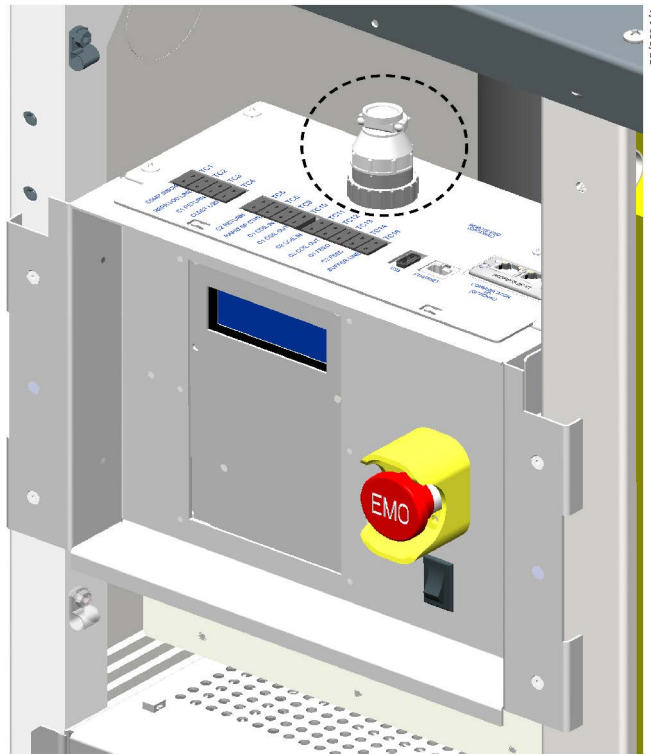
- -2.0 V d.c. for -500 psi
- 0 V d.c. for 0 psi
- +2.0 V d.c. for +500 psi.

Difference between MaxCool and PFC

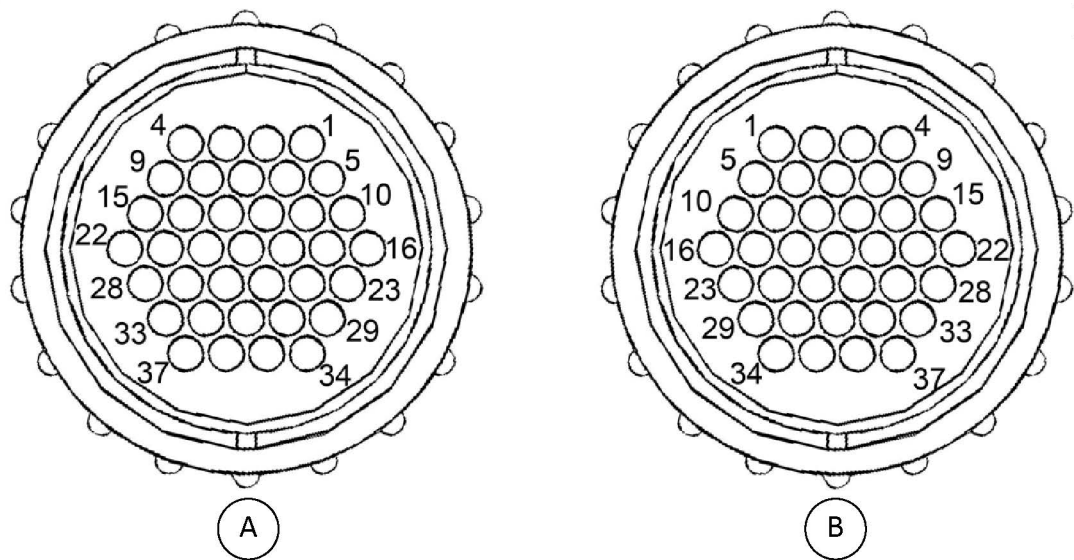
- MaxCool Cryochiller remote provides 2 set point relays instead of optional on the PFC.
- MaxCool Cryochiller remote provides 1.2 A maximum to power external devices.

Item	Non Isolated (standard)	Isolated
Power	24 (-25/+17%) V a.c. / d.c. 10 mA	
Port on Cryochiller	37-pin bulkhead connector (female pins)	37-pin bulkhead connector (male pins)

Item	Non Isolated (standard)	Isolated
Connector	37 pin (Amp CPC-23) Male pins Use kit 840104-00	37 pin (Amp CPC-23) Female pins Use kit 840105-00
Input Connections	Customer-supplied external switch closes and returns the 24 V a.c. (10 mA) provided by the system when active.	Customer-supplied 24 (-25/+17%) V a.c. / d.c. (10 mA) power must be applied to the input pin to activate internal opto isolator when active.
Output Connections	24 V a.c. (10 mA) output from system when active. 1.2 A maximum total output. Customer must supply external relay or indicator to detect the output.	Internal relay contacts in the system close when active. Contact rating is 10 A Customer must supply 24 V a.c. / d.c. power which is returned by the output relay contacts when output is active.

Figure 101 24 V Remote communication connection

- If power is OFF, the compressor is off, and this mode is called OFF.
- If power is ON and the COOL mode is not active and the DEFROST mode is not active, this mode is called STANDBY.
 - This is the default mode when the compressor is first switched on.
- If power is ON and the COOL mode is active and the DEFROST mode is not active, this mode is called COOL.
 - The unit will remain in COOL until the customer selects either DEFROST, STANDBY or OFF.
- If power is ON and the COOL mode is not active and the DEFROST mode is active, this mode is called DEFROST.
 - DEFROST will automatically end when the return thermocouple reaches +20 °C by default, but the user can select a different temperature if they want.
 - When DEFROST ends, the unit will automatically return to STANDBY mode

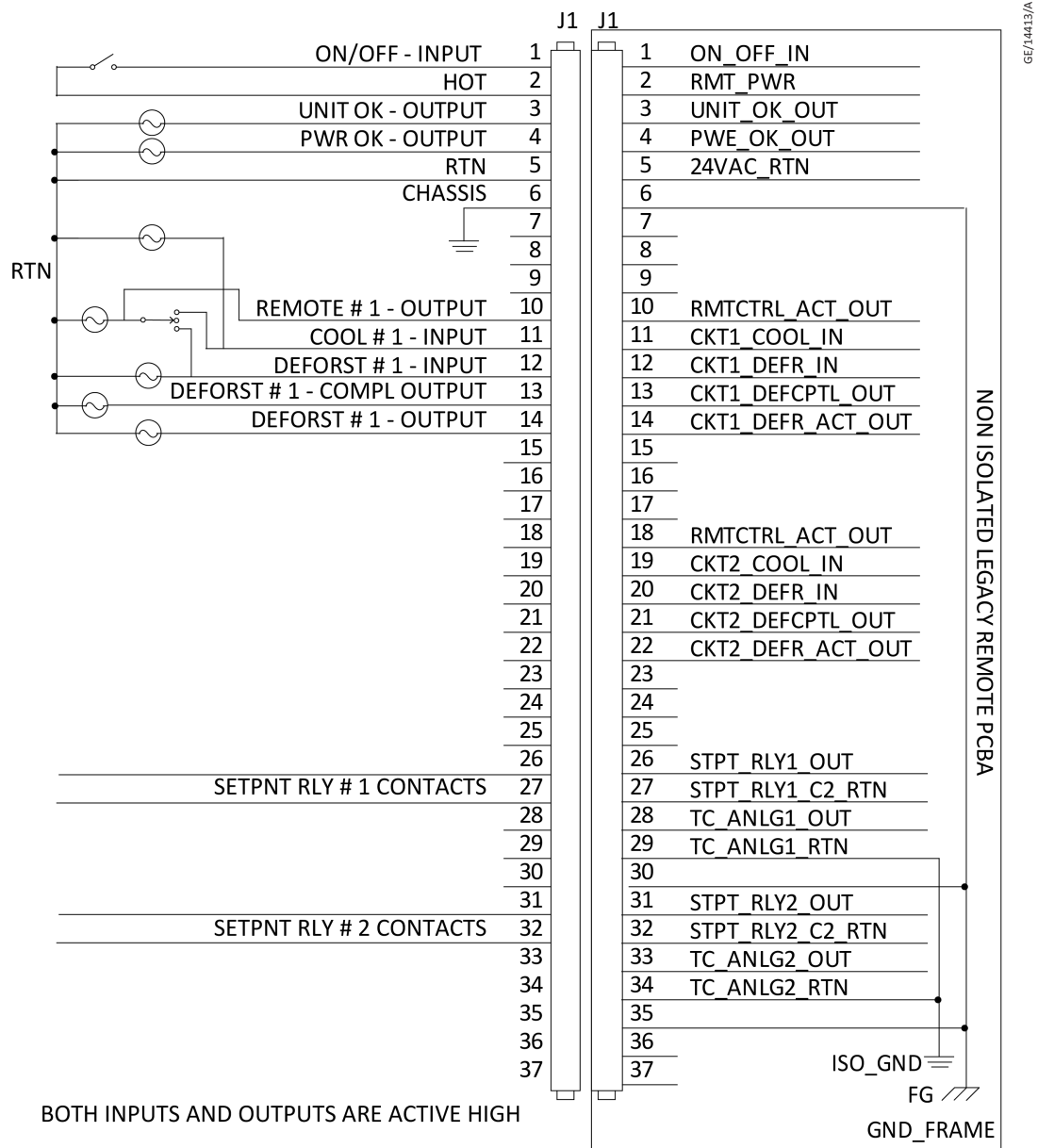
Figure 102 24 V I/O connector wire-side pin-out

A. *Isolated pin sequence female pins, wire side view*

B. *Non-isolated pin sequence male pins, wire side view*

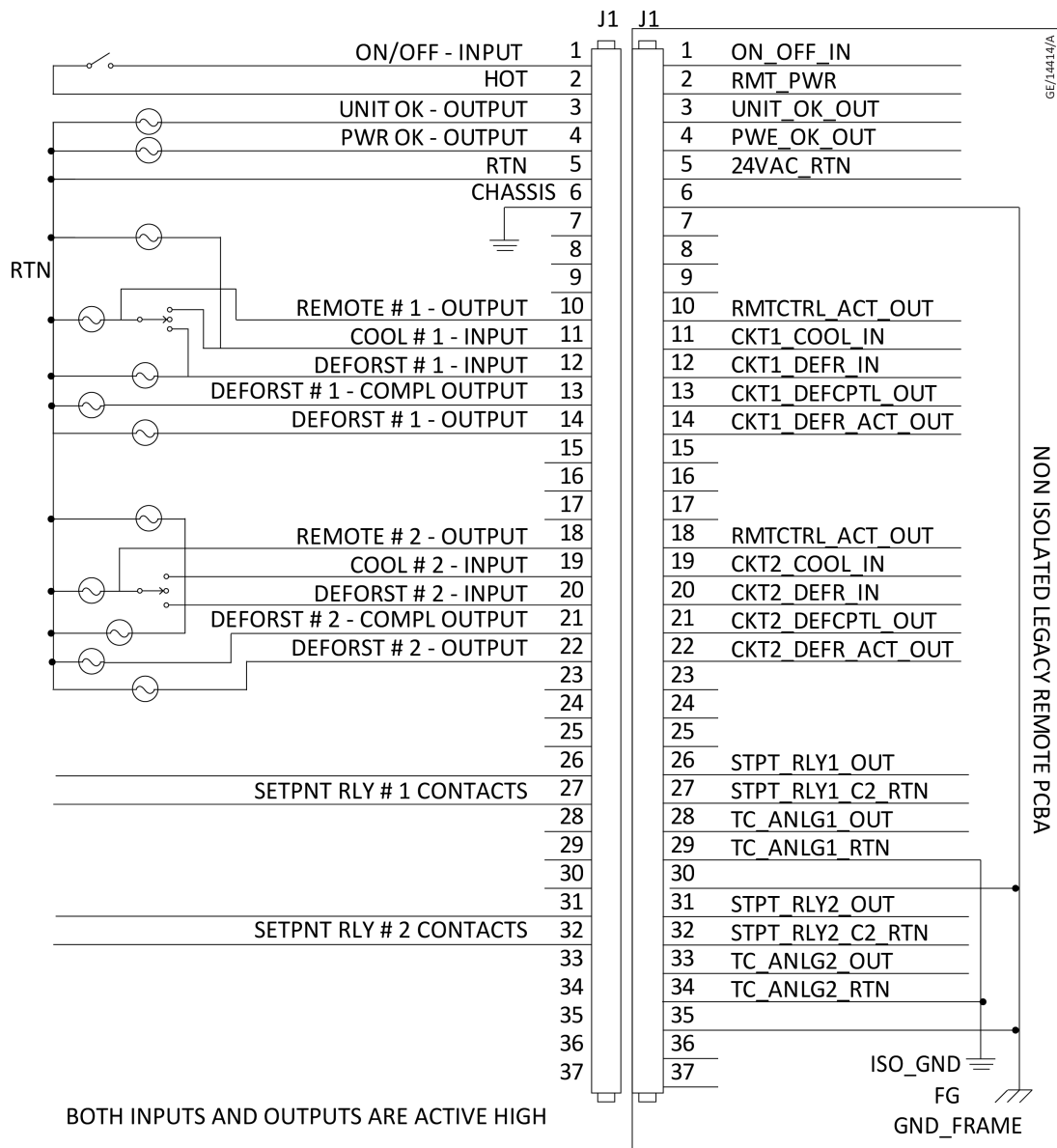
6.9.1 24 V single circuit non-isolated

If a system with the new 24 V non-isolated interface is replacing a PFC unit that used the standard PFC remote interface, note that the Cryochiller non-isolated remote has some differences. Carefully review the wiring information in this section.

Figure 103 24 V single circuit non-isolated

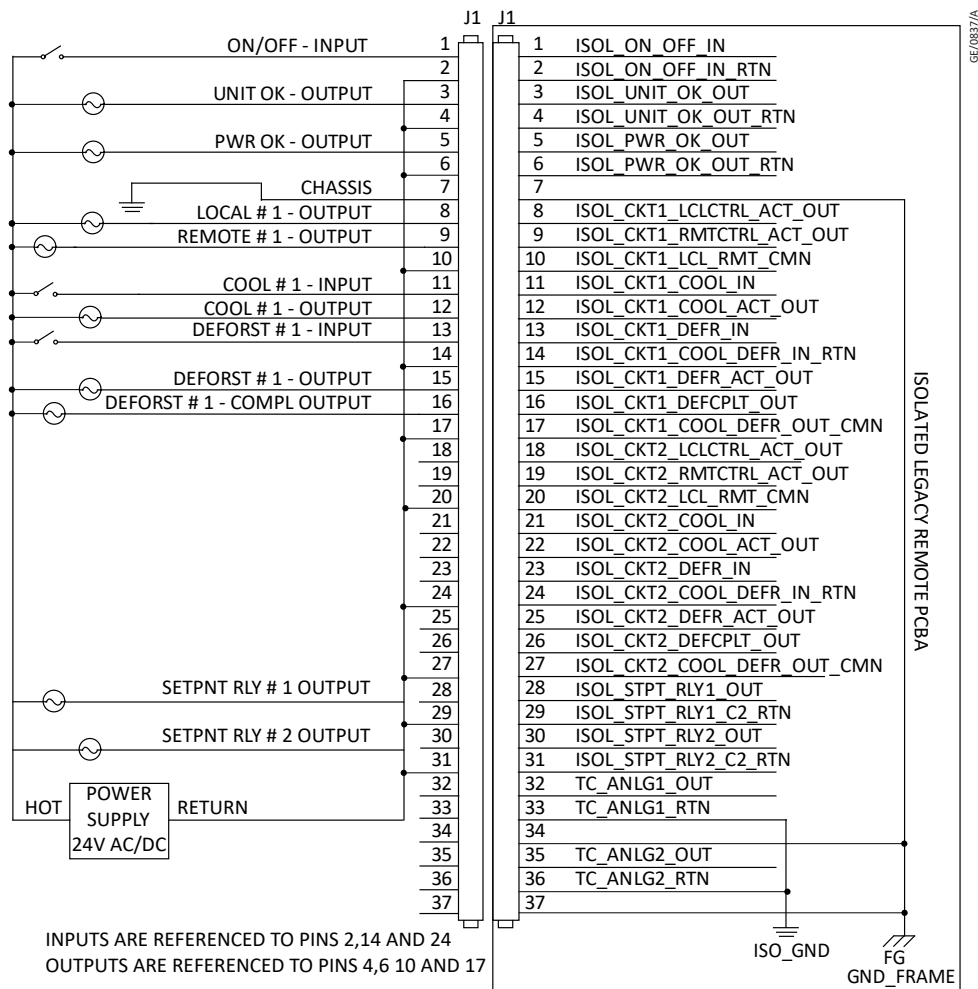
6.9.2 24 V dual circuit non-isolated

If a system with the new 24 V non-isolated interface is replacing a PFC unit that used the standard PFC remote interface, note that the Cryochiller non-isolated remote has some differences. Carefully review the wiring information in this section.

Figure 104 24 V dual circuit non-isolated

6.9.3 24 V single circuit isolated

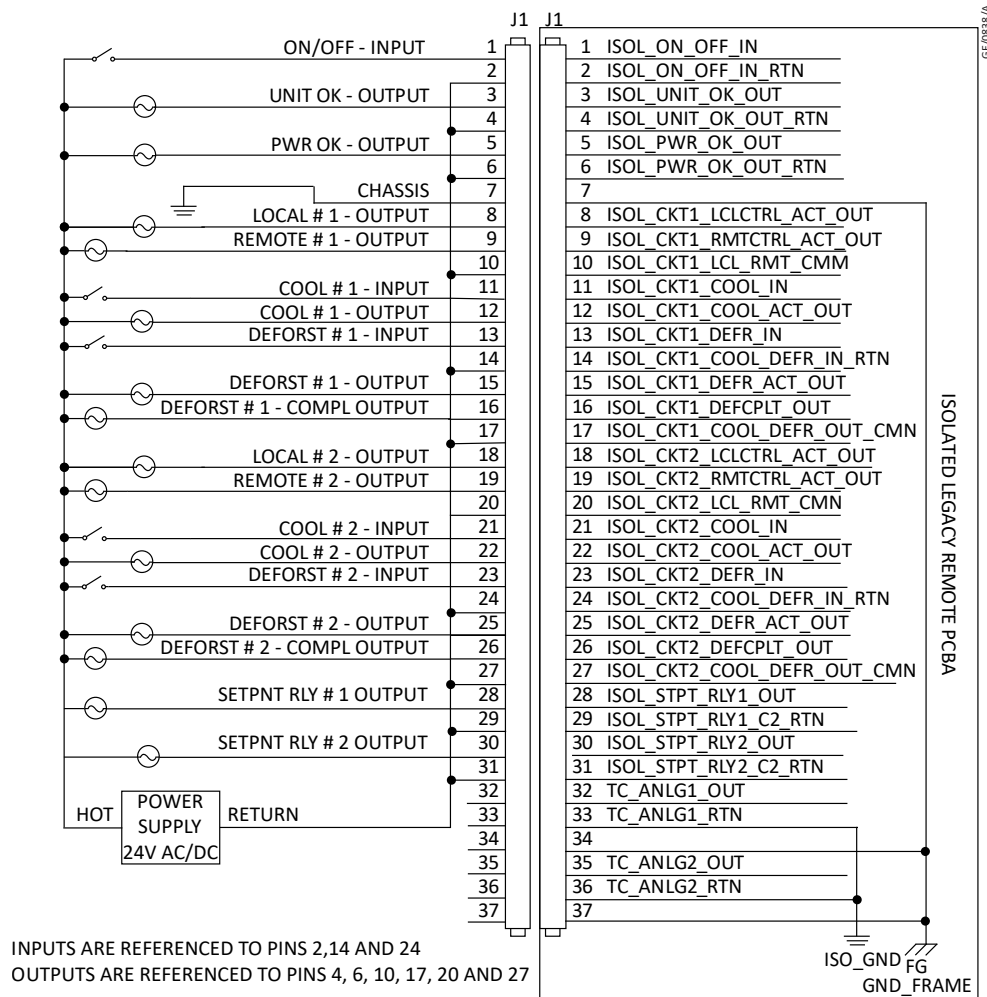
If a system with the new 24 V isolated interface is replacing a PFC unit that used the optional PFC isolated remote interface, note that the Cryochiller isolated remote has some differences. Carefully review the wiring information in this section.

Figure 105 24 V single circuit isolated

1. External power supply can be connected per customer requirements (reversible supply support).
2. Active HIGH inputs and active LOW outputs. - Wire as above.
3. Active LOW inputs and active HIGH outputs. - Wire as above but reverse polarity of external power supply.
4. Active HIGH input and active HIGH outputs. - Connect GND signal at the INPUT_COMMON TERMINALS (Pin 2, 14 and 24 of 37-Pin CPC connector) and +24 V at the OUTPUT_COMMON TERMINALS (Pins 4, 6, 10 and 17 of 37-Pin CPC connector).
5. Active LOW inputs and active LOW outputs - Connect +24 V at the INPUT_COMMON terminals (Pins 2, 14 and 24 of 37-Pin CPC connector) and GND signal at the OUTPUT_COMMON terminals (Pin-4, 6, 10 and 17 of 37-Pin CPC connector).

6.9.4 24 V Dual circuit isolated

If a system with the new 24 V I/O isolated interface is replacing a PFC unit that used the optional PFC isolated remote interface, note that the Cryochiller isolated remote has some differences. Carefully review the wiring information in this section.

Figure 106 24 V I/O dual circuit isolated

1. External power supply can be connected per customer requirements (reversible supply support).
2. Active HIGH inputs and active LOW outputs. - Wire as above.
3. Active LOW inputs and active HIGH outputs. - Wire as above but reverse polarity of external power supply.
4. Active HIGH input and active HIGH outputs. - Connect GND signal at the INPUT_COMMON TERMINALS (Pins 2, 14 and 24 of 37-Pin CPC connector) and +24 V at the OUTPUT_COMMON TERMINALS (Pins 4, 6, 10, 20, and 27 of 37-Pin CPC connector).
5. Active LOW inputs and active LOW outputs - Connect +24 V at the INPUT_COMMON terminals (Pins 2, 14 and 24 of 37-Pin CPC connector) and GND signal at the OUTPUT_COMMON terminals (Pin-4, 6, 10, 17, 20, and 27 of 37-Pin CPC connector).

6.9.5 24 V Remote Installation

1. Locate the remote control plug parts kit that shipped with the unit. Note that the customer must provide a cable that is suitable for their interface requirements. Multi-strand cable with minimum 18 AWG (0.75 mm² cross-sectional area) wires.

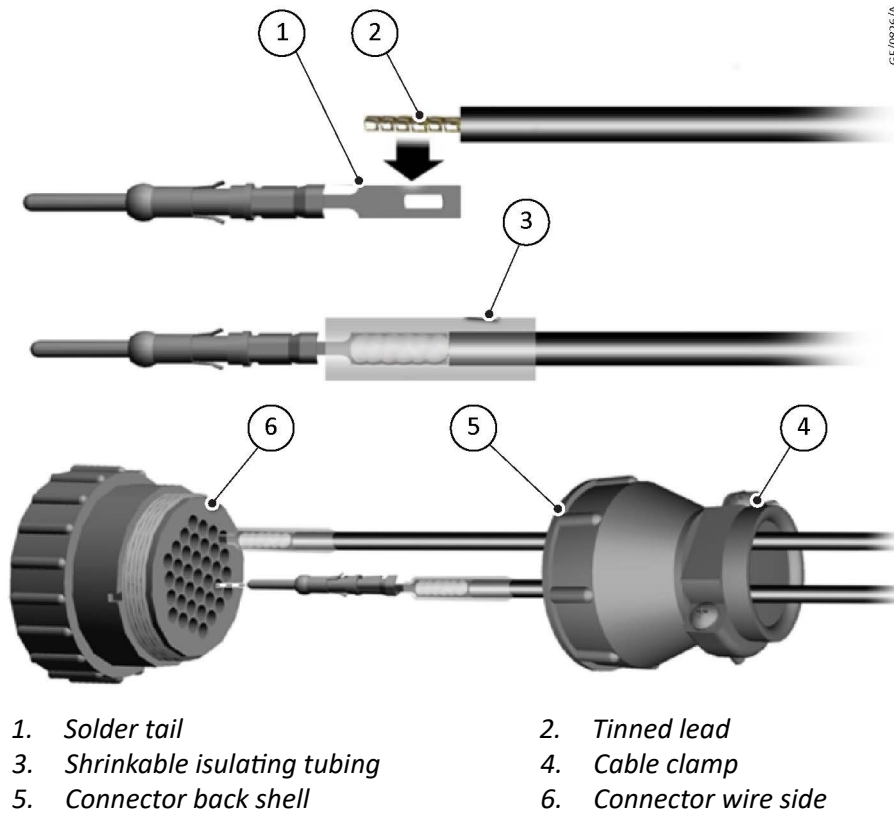
 Note:

Remote wires should be 40 feet (12.2 m) or less to prevent voltage drop which can result in unit damage. If remote wires longer than 40 feet are required, check the voltage at the remote control panel.

Do not use the remote function if the voltage at the remote panel is less than 22.2 volts. Contact our service department.

2. Slide the back shell of the connector over the cable.
3. Remove no more than 13 mm (1/2 inch) of the outer cable jacket that covers the cable wire bundle.
4. Strip 4 mm (5/32 inch) of insulation from each of the wires and pre-tin each wire.
5. Solder each wire to the solder tail of a pin. Do not insert the wire into the hole on the solder tail.
6. Cut the heat shrinkable insulating tubes into 13 mm (1/2 inch) lengths. Slide one of the insulation tubes onto each soldered wire but do not shrink at this time.
7. Insert each pin into the appropriate contact socket on the back side of the connector. Push each pin in until it clicks into place. Gently tug the wire to confirm the pin is properly inserted.
8. Slide the 13 mm (1/2 inch) long insulating tubes down to the connector so that they cover the uninsulated wire and solder joint. Shrink the insulating tubes in place using a heat gun.
9. Thread the connector back shell onto the connector and screw it on until tightened firmly.
10. Install the cable clamp using the two screws provided and tighten it over the cable jacket so it firmly holds the cable. The cable clamp may be reversed for large or small cables.

Figure 107 24 V remote solder-tail connector wiring (non-isolated male pins shown)



7. Operation

7.1 Introduction

The system is ready to operate as soon as it is installed.

Basic startup consists of only a few steps:

- Turn ON the cooling water and ensure it is flowing through the system.
- Turn ON the power at the electrical power source for the refrigeration unit.
- Switch CB-1 to the ON position.
- Wait about a minute for the system to boot up and the HMI screen to display information.
- Turn the EMO switch clockwise to set it to the disengaged position, if equipped.
- Switch the compressor ON/OFF switch to the ON position.
- The system operates in Standby mode while it cools the internal stack and gets ready for normal operation.

To manually operate the unit,

- Set the unit to Local control by pressing the Remote key to turn OFF the LED. When the Remote LED is not lit, the system is in Local control.
- When ready, select Cool by pressing the Cool key.
- When ready, select Defrost by pressing the Heat key.

The system has many different methods of operation that can be used to meet the specific needs of your application.

This chapter discusses the standard operating methods as well as other methods used for a variety of different application requirements and system configurations.

Review this chapter and your application to ensure that you use the appropriate features and get the best performance from your system.

7.2 Cryochiller Lockout/Tagout

WARNING: LOCKOUT / TAGOUT



Working with energised equipment may cause sudden movement or electrical shock and may result in death or serious injury.

- All energy must be removed from the equipment per the facility's Lockout / Tagout procedure before servicing.
- If local procedures are not available, follow the procedure for Lockout / Tagout in OSHA Standard 29CFR 1910.147.

A slide bar that is attached to the high voltage box cover is provided as the Lockout / Tagout device.

When the high voltage box cover is removed, the Lockout/Tagout device is also removed, and Lockout / Tagout procedures must be performed on the input power to the system.

To use the Lockout/Tagout device:

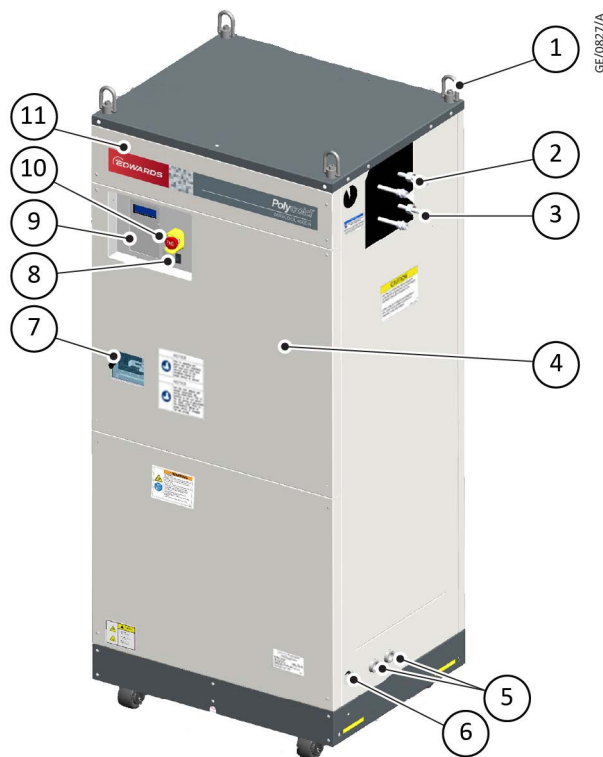
1. Turn off the main circuit breaker.
2. Slide the Lockout/Tagout bar across the circuit breaker to prohibit the circuit breaker from being turned on.
3. Apply the Lockout/Tagout device to hold the slide bar in place.

To remove the high voltage box cover:

1. Apply Lockout/Tagout procedures at the source of the input power.
2. Turn off the main circuit breaker and move the Lockout/Tagout slide bar to the Lockout / Tagout position.
3. Remove the high voltage box cover.

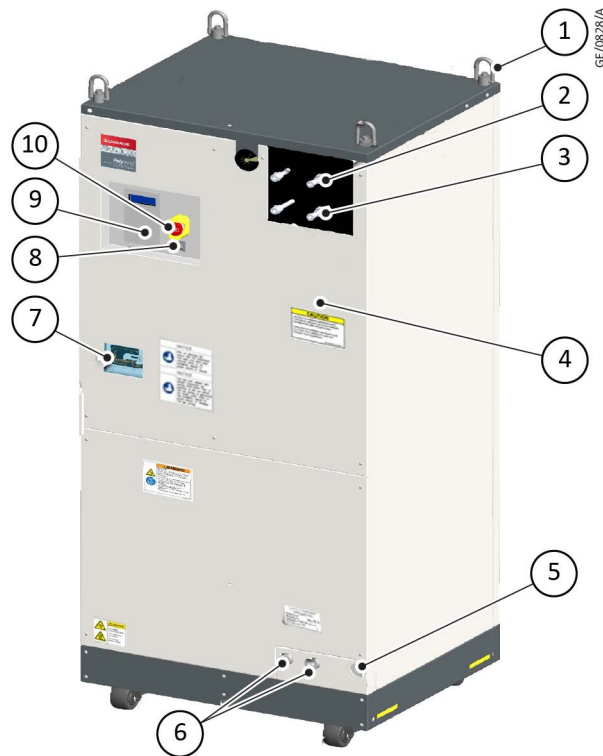
7.3 System components

Figure 108 Illustration of system components, standard



- | | |
|--|--|
| 1. Lifting rings (optional) | 2. Circuit 1 refrigerant lines - feed (left), return (right) |
| 3. Circuit 2 refrigerant lines - feed (left), return (right) | 4. Valve access panel |
| 5. Cooling water in/out | 6. Power in |
| 7. Circuit breaker CB1 (CB3 behind panel) | 8. Compressor ON/OFF switch |
| 9. HMI display and keypad | 10. EMO Switch (optional) |
| 11. Communications panel | |

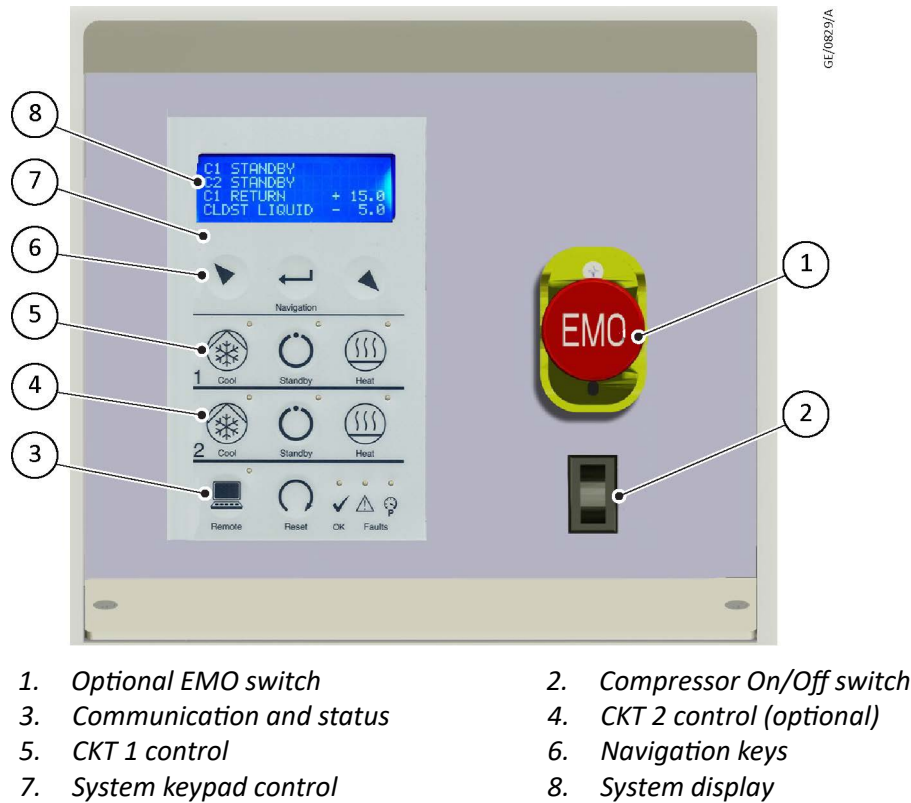
Figure 109 Illustration of system components, front access



- | | |
|---|--|
| 1. Lifting rings (optional) | 2. Circuit 1 refrigerant lines - feed (left), return (right) |
| 3. Circuit 2 refrigerant lines - feed (left) return (right) | 4. Valve access panel/communication panel |
| 5. Power in | 6. Cooling water in/out |
| 7. Circuit breaker CB1 (CB3 behind panel) | 8. Compressor ON/OFF switch |
| 9. HMI display and keypad | 10. EMO switch (optional) |

7.4 Local controls and indicators

Figure 110 HMI keyboard and display



7.4.1 HMI keypad

Table 25 System key descriptions

Symbol	Switch or indicator	Function
 	Up or Left Arrow Down or Right Arrow	Move cursor up or down or left or right. Increase or decrease the value of a highlighted field.
	Enter	Selects the current highlighted field. Enters the current submenu designated by > character Advances to next character in a selected field. Saves the current value after last character is selected  Note: <i>Cannot go backwards. Enter and redo if an error is created.</i>

Symbol	Switch or indicator	Function
	Cool	Places associated refrigeration circuit in Cool Mode Green LED flashing ▪ when cold cycle is running Green LED on solid ▪ when unit is in cool mode
	Standby	Places associated refrigeration circuit in Standby Mode Green LED on solid ▪ when in Standby mode ▪ when defrost is complete
	Heat	Places associated refrigeration circuit in Heat (Defrost) Mode Green LED flashing ▪ when defrosting Green LED on solid ▪ when defrost is complete
	Remote	Toggles the system between Remote and Local mode. Green LED on solid when system is in Remote mode Green LED off when system is in Local mode
	Reset	Resets faults
	OK	Green LED on solid ▪ when the compressor contactor is on and contacts are closed.
	Faults - General (!) Faults - Pressure (P)	Amber General LED on solid ▪ when a general fault has occurred. See HMI message Red Pressure LED on solid ▪ when high pressure fault has occurred. See HMI message

7.4.2 LED status table

Table 26 LED status table

Status / LED	Cool LED	Standby LED	Heat LED	OK LED	Remote LED	Faults LED
Power on compressor off	Off	Off	Off	Off	Off	Off if no fault
Power on compressor on	As set	As set	As set	On when contactor on	As set	Off if no fault
At cool	On	Off	Off	On when contactor on	As set	Off if no fault
Standby	Off	On	Off	On when contactor on	As set	Off if no fault
Defrost in process	Off	Off	Flash	On when contactor on	As set	Off if no fault
Defrost complete	Off	On	On	On when contactor on	As set	Off if no fault
Rapid BP check	Off	Off	Off	On when contactor on	As set	Off if no fault
Fault	As set	As set	As set	On when contactor on	As set	On

7.5 Single circuit modes of operation

The system must have a proper refrigerant line and cryosurface connected to it in order to operate in any mode, including standby.

The Base Model cryochiller has three modes of operation.

7.5.1 Standby

When the unit is in Standby, the Cool and Defrost solenoid valves are closed. The unit circulates (and cools) the refrigerant in the "stack" in the top of the refrigeration unit. The refrigerant is not pumped to the cryosurface. The refrigerant is coldest when the unit is operating in this mode because it has the least heat load.

All solenoids and valves are closed when in Standby mode with the exception of the following:

- Freezeout prevention valve logic based on the FRZ_PREVENT_SETPT Host command value controlled around the coldest liquid temperature (TC4) thermocouple reading.

Model	Freezeout setpoint
1500	-154 °C
2000	-154 °C
2200	-148 °C
2500	-156 °C
4000	-154 °C

- Logic associated with compressor startup where the buffer valve may be opened.

- Logic for the cylinder unloader solenoid for power management.

If the cylinder unloader solenoid is enabled, it is activated if the unit is in standby for more than the time designated by the command `POWER_MGMT_STANDBY_DELAY`. Default value is 20 minutes. `E_MGMT_ENABLE` is enabled by default if the system is equipped with cylinder unloader.

Compressor will continue to run when in standby mode.

After power up, when the compressor is turned ON, the system always defaults to standby mode.

On system alarm/fault which shuts down the compressor, once the compressor is turned back ON, the system defaults to standby mode.

Standby mode can be selected using HMI or the command line interface.

If the unit is in a standby mode, another mode (cool or defrost mode) can be selected.

7.5.2 Cool

When the unit is put into cool, the cool solenoid valve opens and the defrost solenoid valve closes. Cold refrigerant is pumped into the feed line then to the cryosurface and cools the cryosurface and returns through the return line to the refrigeration unit. Inside the refrigeration unit, the refrigerant releases the heat it absorbed from the cryosurface and then it is pumped through the system to repeat the process.

Cool mode	Description
Cool (standard)	Cool valve is open continuously until the unit is switched to standby or defrost. The cryosurface gets as cold as possible as fast as possible for the applied heat load.

Some MaxCool cryochillers include optional hardware for Power Management. If Power Management mode is engaged while a cryochiller with that optional hardware is in Cool mode, that cryochiller will consume less electrical power; however, the cooling temperature will also become slightly warmer with Power Management engaged. The Power Management option can also be used to control the temperature (within reasonable limits). See the Host Commands manual P/N 502039 for more details on how to engage the Power Management option.

7.5.3 Defrost

When the unit is put into defrost, the cool solenoid valve closes and the defrost solenoid valve opens. Hot refrigerant is pumped from the unit into the feed line then to the cryosurface where it warms the cryosurface and returns through the return line. The unit automatically switches to standby when the return temperature or coil out temperature has reached the programmable set point temperature.

Defrost mode	Description
Standard defrost (standard)	Defrost valve is open until <code>DEFR_SETPT</code> is reached. After <code>DEFR_SETPT</code> is reached, the valve is closed.

7.6 Dual circuit modes of operation

Each refrigerant circuit in the dual-circuit system functions in the same way as the single circuit system. The only difference is that the refrigerant is split into two separate feed and return lines so that it serves two cryosurfaces. Both refrigerant circuits can be put into defrost mode or cool mode or standby mode.

When one circuit is in defrost while the other circuit is in cool, the circuit in cool may warm by a few degrees (nominally about 5 degrees).

The timing of the defrost activity may be considered to maintain your process requirements. If the second circuit is a baffle for a diffusion pump, this is not an issue. However, when both circuits are used to cool cryocoils, you must evaluate the impact on your process when you defrost one circuit while the other circuit is in cool during a deposition process.

If the refrigerant circuits are operated in different modes, the following will happen.

7.6.1 One circuit standby and one circuit cool

The cryosurface being cooled will get several degrees colder than when both cryosurfaces are cooled simultaneously. This is because there is less total heat load on the system. It is not possible, however, to get 100% of the cooling capacity into one circuit simply by not using the other circuit.

7.6.2 One circuit defrost and one circuit cool

The cryosurface being cooled may warm by about 20 °C. The warming is caused by refrigerant from both cryosurfaces being combined in the common return line.

7.6.3 One circuit defrost Vs one circuit standby

The cryosurface being defrosted may have a defrost time that is slightly longer than when both cryosurfaces are defrosted at the same time.

7.7 Compressor safety chain

If the compressor does not start, it is usually caused by an item in the compressor safety chain.

The compressor safety chain consists of several hardware interlocks that cause the compressor to stop or prevent the compressor from starting.

Table 27 Compressor safety chain

Safety chain item	Description
Compressor ON/OFF switch (SW1)	Switch on HMI panel controls compressor contactor. Must be manually turned ON for contactor to close and compressor to run.
Circuit breaker CB1 (CB1)	CB1 controls input power for entire compressor unit. Must be manually turned on or manually reset.

Safety chain item	Description
Circuit breaker CB3 (CB3)	CB3 controls low voltage power to the control PC Board. If off, the main control PC Board loses power and contactor opens and all electrical valves close. Must be manually turned on or manually reset.
Emergency off button (EMO) (if equipped on unit)	EMO provides emergency control for compressor contactor and includes EMO button and Remote EMO connection. If the EMO button is pressed in, the compressor contactor opens. EMO button must be manually disengaged to enable contactor. Additionally, the Remote EMO provides remote emergency control for the compressor contactor. If the Remote EMO connection is open, the compressor contactor opens. The Remote EMO connection must be closed to enable the contactor.
Compressor over temperature switch	Over Temp switch is a thermal cut out switch located inside the compressor motor and wired in series with the compressor power. Opens when compressor motor temperature is above the rated value. Closes when compressor motor temperature is below rated value.
Pressure switch (PS1)	Pressure switch is mounted in compressor discharge line. Wired in series with EMO and SW1. Trigger pressure is preset. Switch opens if discharge pressure is above the rated value. Switch closes when pressure is below rated value.

7.8 System startup

7.8.1 System boot/power-up

1. Before compressor power up, read the pressure gauge and compare the reading to the recorded system static pressure. If the pressure reading is off by greater than 10%, record the value and contact service for advice.
2. Open the circuit breaker access panel.
3. Set CB1 to the UP or ON position.
4. Wait several minutes for the system to fully boot up.
 - Boot up is complete when the 4-line HMI displays shows the "Home" screen.
 - Cool / standby / heat mode LED' are not lit until the contactor is closed.
 - Boot up is not affected by compressor contactor or ON/OFF or EMO switches.

7.8.2 Compressor startup

Use one of the following methods to start the compressor after system boot up completes.

- The compressor switch is in the OFF position when system boot up completes, switch the compressor switch to ON.
- If the compressor switch is in the ON position when system boot up completes, toggle the compressor switch to OFF and then to ON.
- If the compressor does not startup, refer to [Compressor safety chain](#) on page 161 and [Compressor motor troubleshooting](#) on page 169.

7.8.3 Alternate compressor startup

1. Set the compressor switch on the control panel to the ON position.
2. Use the remote button to set the system to local mode (remote LED not lit).
3. Press the reset key to set the compressor contactor to ON.
 - Compressor turns on.
 - OK LED is lit.
4. After the compressor starts, the standby LED is on until the operating mode is changed.

 Note:

Several conditions prevent the compressor starting. See [Compressor motor troubleshooting](#) on page 169.

7.9 Operate the system with a cryocoil

7.9.1 Start and cool the system

1. Follow the system boot/power-up and compressor startup procedures in the previous section.
2. Switch the unit to standby using the HMI or remote control.
3. Monitor the temperature indicated by coldest liquid (TC # 4).
 - TC # 4 monitors the temperature of the refrigerant in the coldest part of the stack and is a good indicator of when to switch to cool mode.
 - For quick cooling when switching to cool, TC # 4 should be 5-10 °C colder than the desired cryocoil temperature.

 Note:

The unit may be operated indefinitely in standby. If the unit is off for more than 12 hours, it may take up to 30 minutes after going into standby to attain complete precooling.

4. Once the unit has cooled to the desired temperature, the circuit may be switched to cool mode any time after the vacuum chamber has achieved vacuum. Most users switch to cool at crossover when opening the high vacuum valve. The cryocoil will start capturing water vapour within 60 seconds.

 Note:

Experiment to determine the shortest pumpdown time for each application. The sooner the unit is switched to cool, the faster the vacuum chamber's pumpdown time will be. However, switching too soon may cause the cryocoil to capture too much water vapour causing the cryocoil's apparent surface temperature to rise and limit the ultimate attainable base pressure.

7.9.2 Defrost the cryocoil



CAUTION: DEFROST HAZARD

If large amounts of water are collected during the vacuum cycle, liquid or ice may drop from the cryocoil during Defrost.

You may need to provide a drip pan or similar device to prevent liquid water from accumulating in an undesirable location.

Defrost allows the "regeneration" of a cryocoil in preparation for the next vacuum cycle.

1. Switch the unit to Defrost using the unit's control panel or remote control.

Note:

Start defrost so that the cryocoil is warm before the vacuum chamber reaches atmospheric pressure. The exact time depends upon the length of the refrigerant line and the size of the cryocoil.

2. By default, the unit terminates defrost when the return temperature of the refrigerant reaches 20 °C. This assures that no additional moisture condenses on the cryocoil from the atmosphere. The thermocouple and the defrost end temperature are user configurable if a shortened defrost cycle is desired.
3. The unit automatically goes into standby when defrost is complete.

Note:

When defrosting one circuit while the other circuit is in cool, the temperature of the circuit in cool may increase.

Review the required temperatures for the affected process to make sure the warming does not affect the process. If the temperature change is not acceptable, wait until the completion of the cool process before performing defrost.

Both circuits may be defrosted at the same time.

7.10 Operate the system with a cryobaffle

An optically transparent cryobaffle enhances the water vapour pumping speed of the turbomolecular pumps and an optically opaque cryobaffle minimises oil backstreaming from oil diffusion pumps. Backstreaming is the process of hot vapour migrating and condensing on cold surfaces. When an oil diffusion pump is in operation, the pump oil heats up and hot oil vapour can travel opposite to the pumping direction and condense on the interior vacuum chamber walls and contaminate the system.

7.10.1 Standby and cool modes

1. Switch the unit to standby using the unit's control panel or remote control.
2. If the compressor switch is turned OFF, turn the switch to ON.
3. When in standby, the refrigeration unit cools the refrigerant so the unit is ready to go into cool mode.

 Note:

If the unit is off for more than 12 hours, it may take up to 30 minutes after going into standby to attain complete precooling.

4. Evacuate the vacuum chamber where the cryobaffle is installed to at least 0.01 torr (1.33 Pa).
5. From standby, select cool and allow the cryobaffle to cool down.
6. Turn on the high vacuum pump. It is not necessary to wait until the cryobaffle has cooled down.

7.10.2 Defrost the cryobaffle

 Note:

If the cryobaffle captures too much water, the cryobaffle's apparent surface temperature will rise and limit the ultimate attainable base pressure. Regular defrosting is recommended to "regenerate" the cryobaffle. Complete defrosting can take 8 hours or more depending upon the amount of moisture captured, the mass of the cold surface, and the vacuum level.

1. When ready to defrost, switch the high vacuum pump to OFF.
2. Switch the refrigeration unit OFF or switch it to Standby.

 Note:

Do not select Defrost if the cryobaffle is not isolated from the oil diffusion or turbomolecular pump. The defrost cycle may release the captured moisture too quickly and damage the equipment.

3. When the cryobaffle is free of moisture, return the system to cool mode as described at the beginning of this procedure.

8. Preventive maintenance

The best way to ensure maximum productivity for your system is through our preventative maintenance servicing option.

We recommend that the user inspects the system at weekly, quarterly, and annual intervals and that they schedule an annual preventative maintenance health check performed by a Polycold authorized service provider.

Benefits of our Preventative maintenance include:

- Improved system reliability
- Decreased cost of replacement
- Decreased system downtime

In addition, our engineer will record any equipment deterioration and recommend. Replacement parts or repair before these items cause system failure. Preventive maintenance will result in savings due to an increase of effective system service life.

8.1 Preventive maintenance schedule

Action	Interval
Ensure the unit is functioning as expected	Weekly
Check temperatures during process	
Check pressures during process	
Check time to cool down	Quarterly
Check system balance pressure	
Inspect valve assemblies for condensation	
Verify that LCD display and HMI keypad are functioning properly	
Verify that insulation is intact	Annually
Verify oil level in compressor is appropriate	
Perform leak check on fittings within the cryochiller and feed-throughs	
Check cooling water flow rate and temperature are within specifications outlined in table 15	
Check cooling water purity and quality are within specification outlined in tables 16 and 17	
Check refrigerant line insulation for condensation and formation of ice	
Check refrigerant lines to ensure they are supported every 3 feet	
Visually inspect HV components for any sign of discoloration or overheating	

9. Fault finding

9.1 Define the problem

You may be able to define and solve the problem by creating a simple statement that describes the problem.

- Observe and list the symptoms of the problem.
- Determine what is happening that is different from what should happen.
- Determine the items that have the problem and those that do not.
- Determine when the problem first occurred and how often it occurs.
- Determine the state of the system when the problem occurred or occurs.
- Reduce the list of symptoms to the primary symptom.
- List the possible causes of the symptom.
- Reduce the list of causes based on what is happening and what is supposed to happen.

9.2 Contacting authorised service

When contacting authorised service, have as much of the following information available as possible.

- Record the model number, part number, and serial number from the equipment.
- Provide installed location.
- Provide name, address, E-mail address, and phone number of person to contact.
- Provide the unit balance pressure by performing rapid balance pressure check procedure as explained in [Rapid balance pressure check](#) on page 178.
- Provide the unit balance pressure by performing rapid balance pressure check procedure.
- List error codes or symptoms.
- List work done on unit before problem occurred, function unit was performing when the problem occurred, actions taken after problem occurred.

9.3 Fault reporting

If a fault occurs, the HMI display automatically goes to the fault state screen and displays the fault and two lines of the available 3 lines of fault data using the format below:

- Line 1 - fault state (menu selection header)
- Line 2 - name of Fault
- Line 3 - fault description line 1
- Line 4 - fault description line 2, if applicable
- (Scroll) - fault description line 3, if applicable

To view current fault information, go to the fault state display, if required. The fault state display shows the current fault and descriptions as stated above.

To view additional faults, if applicable, use the down arrow to display the next fault.

To view all information for the displayed fault, press the enter key to select the current fault and then use the arrow keys to scroll through all three lines of information for the current fault. Note that the arrow keys stay on the selected fault. Press the enter key again to exit the current fault display.

To exit a selected fault, press the enter key. The display goes back to the fault state display and then the arrow keys may be used to scroll through each of the active faults, if applicable.

9.4 HMI and observed errors

9.4.1 Power troubleshooting

Troubleshooting power requires that CB1 and CB2 are turned on.

Fault	POWER FAILURE, No recommendation, Fault LED is Amber
--------------	---

Cause	Control voltage is outside of acceptable limits
Remedy	Check the transformer tap settings and ensure they are correct for your supply voltage. Check supply voltage for deviations beyond the allowable voltage range for this tap setting.

Fault	(No HMI message), No LED indicators, CB1 or CB2 trip, cannot reset.
--------------	--

Cause	Faulty component in the power or control circuit
Remedy	Contact authorised service

Fault	(No HMI message), No LED indicators, system does not boot up, CB1 stays ON
--------------	---

Cause	No input power
Remedy	Check power source fuses, circuit breakers, and wiring. Contact authorised service to repair as needed.

Fault	(No HMI message), Fault LED not lit, system boots up, Compressor will not turn on
--------------	--

Cause	Motor on/off switch fault
Remedy	Contact authorised service to check the switch and replace if required.

9.4.2 Communication troubleshooting

Fault	System does not communicate on Ethernet, Profibus, or DeviceNet, EtherCAT and ProviNet
--------------	---

Cause	System electronics locked-up
Remedy	Power cycle the system. Contact authorised service

9.4.3 Compressor motor troubleshooting

Troubleshooting the compressor motor requires that the system is fully booted up.

Fault	Compressor will not start, No LEDs lit, Compressor switch is off
Cause	Compressor switch must be on for compressor to run
Remedy	Set compressor switch to ON.
Fault	Compressor will not start, No LEDs lit, Compressor switch is on
Cause	Compressor contactor circuit needs to be reset after power up
Remedy	Turn compressor switch OFF and then ON.
Cause	Remote EMO connector or J11 bypass is disconnected
Remedy	Connect remote EMO cable or install J11 EMO jumper.
Cause	Remote EMO signal open at remote device
Remedy	Check continuity on pins 3 and 4 on remote EMO connector. Correct remote EMO condition.
Cause	Remote EMO wiring insufficient must be 16AWG and less than 15 m (50 feet)
Remedy	Check EMO wiring for 16AWG. Correct wiring as required.
Cause	Supply voltage too low
Remedy	Check voltage and correct.
Fault	Compressor will not start, Fault LED flashing
Cause	Compressor contactor circuit needs resetting
Remedy	Press the reset switch.
Cause	A fault that opens the compressor contactor is active
Remedy	Determine what fault is active and resolve the issue. Contact authorised service if fault continues.
Fault	Compressor will not start, Fault LED Amber or Red
Cause	Compressor pressure switch PS1 is open indicating high discharge pressure
Remedy	Wait for pressure to come down below the threshold level. Try to restart the compressor. Try to start the compressor and quickly switch it to defrost mode. Contact authorised service if high pressure continues.
Cause	Compressor thermal cutout switch is open
Remedy	Wait for compressor motor to cool. Contact authorised service if over heating continues.

Fault	EMO SWITCH ALARM, CHECK EMO SWITCH, Fault LED Amber
Cause	EMO switch is pressed in and activated
Remedy	Turn EMO switch clockwise to disengage the switch.
Cause	Remote EMO is active - open
Remedy	Correct remote EMO condition.
Cause	Remote EMO bypass jumper disconnected
Remedy	Connect EMO jumper.
Fault	CONTACTOR CHATTERING, CHECK POWER LINE, Fault LED not lit
Cause	Motor contactor is rapidly opening and closing
Remedy	Verify power supply meets all requirements. Verify control transformer tap settings are correct for supply voltage. Verify transformer output voltage is in the correct range. If all voltages are in spec. contact authorised service.
Fault	ABUSIVE COMP ON ALARM, WAIT 60 SECONDS, Fault LED Amber
Cause	The compressor has been reset too frequently
Remedy	Review cause for multiple resets. If due to faults, investigate root cause of the faults and correct. Contact authorised service if problem cannot be resolved.
Fault	Cannot control the compressor On/Off via remote interface, (24 V I/O, Profibus, DeviceNet, ProfiNet, EtherCAT)
Cause	System is not in remote mode
Remedy	Select the remote button from the HMI keypad, remote LED on keypad will be lit.
Cause	System control mode default is not set to the remote interface
Remedy	Check via the HMI that the correct remote interface is selected for remote operation HMI -> TOP MENU -> CONFIGURATION -> CONTROL CONFIG -> LOCAL/REMOTE -> DEF REMOTE MODE -> selected interface will have an * at the end of the entry.
Cause	Compressor control option disabled (24 V I/O only)
Remedy	Check via the HMI that the compressor control option is enabled HMI -> TOP MENU -> CONFIGURATION -> SET COMM PARAMS -> LEGACY REMOTE -> COMP SIGNAL LOGIC -> COMP CTRL * selected item will have an * at the end of the entry.

9.4.4 Pressure related troubleshooting

Fault	DIFFERENTIAL PRESSURE
Cause	PT1 > PT2 Differential 20 psi PT1 = suction pressure transducer PT2 = discharge pressure transducer alarm L1
Remedy	Pressure sensor fault. Contact authorised service.
Fault	HIGH SUCTION PRESSURE
Cause	PT1 > 270 psi PT1 = suction pressure transducer alarm L1
Remedy	Excessive suction pressure. Contact authorised service.
Fault	REF PRESSURE SWITCH, Fault LED is Red
Cause	Refrigerant discharge pressure switch has activated
Remedy	Excessive balance pressure, contact authorised service.
Fault	LOW SUCTION PRESS, REFRIGERANT LEAK CHECK, BALANCE PRESSURE, Fault LED is Amber
Cause	A low suction pressure condition has occurred
	Check system balance pressure.
Remedy	If pressure has dropped, check for leak. Increase liquid line temperature TC2 by increasing water temperature or reducing water flow rate. Contact authorised service.
Fault	HIGH DISCHRG PRESS, EXCESSIVE HEAT LOAD, Fault LED Red
Cause	Discharge pressure is too high
	Review application to ensure it is within the capability of the unit. Check for excessive heat load.
Remedy	Make sure all thermal radiation shields are in place. Ensure that the unit has a minimum of 5 minutes in standby before switching to cool.

9.4.5 Temperature related troubleshooting

Fault	FREEZOUT PREVENTION, Fault LED not lit
Cause	Freeze out prevention sensor is experiencing a temperature colder than expected
	Check refrigerant.
Remedy	Check freezeout prevention valve and thermocouple. Contact authorised service.

Fault	HIGH DISCHRG TEMP REFRIGERANT LEAK, CHECK BALANCE PRESSURE, Fault LED Amber
--------------	--

Cause	Compressor discharge temperature is too high
Remedy	Check cooling water flow. Wait 2 minutes for discharge temperature to cool down and restart the unit. May need to repeat until TC4 is below -100 °C. Contact authorised service.

Fault	REF LQD LINE TEMP, Fault LED is Amber
--------------	--

Cause	Cooling water flow and / or temperature are outside of acceptable limits. The system turns off due to excessively low cooling water temperature, excessively high cooling water temperature or insufficient flow
Remedy	Check your temperature and flow to ensure it is within acceptable limits.

Fault	LQD LINE START TEMP, Fault LED is Amber
--------------	--

Cause	Cooling water flow and / or temperature are outside of acceptable limits during system start. This fault will occur during startup if the system coolant sensor fails to reach a temperature below 42 °C within 14 seconds
Remedy	Check your temperature and flow to ensure it is within acceptable limits.

Fault	THERMAL OVERLOAD, Fault LED is Amber
--------------	---

Cause	Motor thermostat has tripped
Remedy	Contact authorised service.
Cause	CB1 has tripped
Remedy	Check for cause of excessive thermal load on the cryocoil. Check if supply voltage is below nominal conditions.

Fault	TC reading is +171.8 °C (Open TC Circuit) OR TC reading is - 270.0C (Short TC Circuit)
--------------	---

Cause	TC connector not fully seated into mating connector on E-Box
Remedy	Remove and reseal the appropriate TC connector on the E-box.

Cause	Wires in the TC connector are disconnected
Remedy	Check that the two wires within the TC connector are securely tightened to the terminal screws. Check that the two TC wires, Copper and Constantan are not shorted and are connected to the appropriate screw terminals.

Cause	TC wires on the copper tubing have become unsoldered
Remedy	Check that the solder connection of the TC wire to the copper tubing is secure. (If the TC to copper tubing connection is within the insulating foam of the MaxCool stack) Contact authorised service.
Cause	TC mating connector or TC circuit on PCBA is not functioning
Remedy	Remove one of the known good TC connections from the E-Box and plug into the questionable mating connector. Does the questionable TC reading still display the +171.8 / -270 value? Contact authorised service.

9.4.6 Valve related troubleshooting

Fault	C1 COOL VALVE CYCLE, C2 COOL VALVE CYCLE, NO RECOMMENDATION, Fault LED is Amber
Cause	Cool valve requires replacement
Remedy	Contact authorised service.
Fault	C1 DEFR VALVE CYCLE, C2 DEFR VALVE CYCLE, NO RECOMMENDATION, Fault LED is Amber
Cause	Defrost valve requires replacement
Remedy	Contact authorised service.
Fault	Cryocoil temperature always goes down quickly after defrost complete
Cause	Cool valve stuck open due to refrigerant contamination or in COOL mode for long period
Remedy	Contact authorised service.

9.4.7 Performance related troubleshooting

Fault	Too slow to go to cool, Fault LED not lit, Date and Time rolled back
Cause	Cryosurface full and requires defrosting
Remedy	Defrost the cryosurface. Contact authorised service.

9.4.8 ESA troubleshooting

Fault	If OK LED blinks 3 times
Cause	DSP is in boot mode and failed to go to normal operating mode
Remedy	Turn power off. Wait for about 10 minutes and stay in powered off. Turn power on and see if the unit starts up. If the unit does not starts up and OK LED still blinks 3 times try from step #1 one more time. If the unit does not starts up but OK LED does not blinks, try battery removal and power cycle the unit. If all failed, swap the PCBA and send PCBA for FA.

9.4.9 Date or time troubleshooting

Fault	(No HMI Message) Fault LED not lit Date and Time rolled back
Cause	Internal battery is dead and real time clock has reset to default after recent power cycle
Remedy	Reset the real time clock to correct time using remote interface. Contact authorised service to have battery replaced.

9.5 Remote monitor troubleshooting

This section is for the convenience of remote monitor troubleshooting. The tables below are the same faults as previously listed in this chapter but are listed in numerical order of the bitmask value.

This section lists faults in numeric order of the bit mask value as received from the command ACTIVE_ALARMS. See ALARM_STATUS current alarm status

For assistance in decoding bitmask values, see 32 Bit numbered bitfield.

9.5.1 Bit mask value listing

Table 28 Remote monitor troubleshooting

Bit Mask Value / Problem	Possible Cause	Corrective Action
Bit 0 Not used	N/A	N/A
Bit 1 Not used	N/A	N/A

Bit Mask Value / Problem	Possible Cause	Corrective Action
Bit 2 Freeze out prevention active Fault LED Amber Compressor ON	Coldest Liquid Temperature (TC4) (2 °C low-side dead band in effect when FRZ_RREVENT_SETPT > -158 °C) When FRZ_PREVENT_SETPT > -158 °C, then Alarm when TC4 is lower than 2 °C below FRZ_PREVENT_SETPT When FRZ_PREVENT_SETPT < -158 °C, then... Alarm when TC4 is lower than FRZ_PREVENT_SETPT Warning L2	Check freezeout prevention valve. Check freezeout TC instal- lation and operation.
Bit 3 Not used	N/A	N/A
Bit 4 Differential Pressure Fault LED Amber Compressor OFF	PT1 > PT2 Differential 20 psi PT1 = Suction Pressure Transducer PT2 = Discharge Pressure Transducer Alarm L1	
Bit 5 High Suction Pressure Fault LED Amber Compressor ON	Suction Pressure Transducer (PT1) PT1 > 270 psi Alarm L1	Excessive Suction Pressure Contact Authorised Service
Bit 6 Not used	N/A	N/A
Bit 7 High discharge pressure Fault LED Red Compressor OFF	Pressure Transducer PT2 shows high discharge pressure which indicates excessive heat load PT2 > 3102.6 kpa (450 psi) Alarm L1	Check system load and performance
Bit 8 High discharge temperature LED Amber Warning: Compressor ON Alarm: Compressor OFF	Compressor Discharge Temperature (TC1) too high TC1 80 to 125 C is normal TC1 125 to 148.9 °C at startup is normal TC1 135 to 148.9 °C for 30 minutes Warning L2 TC1 135 to 148.9 °C for 40 minutes Alarm L1 TC1 145 to 148.9 °C for 2 minutes Warning L2 TC1 >149 °C immediate Alarm L1	Contact authorised service High discharge temper- ature warning during system start up is acceptable
Bit 9 Rapid Balance Pressure Check Valve Cycle Count Fault LED Amber Compressor ON	Rapid Balance Pressure Check Valve Cycle Count has exceeded limit CRYO_VALV_OPEN_CNT for Rapid Balance Pressure Check Valve > VALVE_CYCLE_WARN Alarm L1	Contact authorised service

Bit Mask Value / Problem	Possible Cause	Corrective Action
Bit 10 Input power out of range Fault LED Amber Warning: Compressor ON Alarm: Compressor OFF	Input voltage out of range of PWR_WARN_BAND Voltage outside of range of PWR_WARN_BAND for 10 seconds Warning L2 - Comp On (10 seconds to restart compressor) Voltage outside of range of PWR_WARN_BAND for 30 minutes Alarm L1 - Comp Off (10 minutes to restart compressor) Voltage above 33.2 V for 1 minute Alarm L1 -Comp Off (10 seconds to restart compressor)	Check and correct the input voltage
Bit 11 Refrigerant liquid line temp Fault LED Amber Warning: Compressor ON Alarm: Compressor OFF	Refrigerant Liquid Line Temperature (TC2) multiple conditions TC2 < 12 °C for 1 minute. Warning L1 TC2 < 8 °C for 2 minutes Alarm L1 TC2 > 43 °C for 40 seconds Alarm L1 TC2 > 50 °C for 20 seconds Alarm L1 TC2 > 60 °C for 10 seconds Alarm L1	Check cooling water flow and temperature
Bit 12 Refrigerant Liquid Line Temp (TC2) before and during operation Fault LED Amber Compressor OFF	Cooling water is poor Before Comp start TC2 > 80 °C Comp will not start After Comp start TC2 > 80 °C for 14 seconds, then Alarm L1 Comp OFF	Water temperature too high. Check cooling water flow and temperature
Bit 13 Refrigerant Pressure Switch Fault LED Red Compressor OFF	Pressure switch is open Pressure switch fault Alarm L1	Check refrigerant pressure Contact authorised service
Bit 14 Low Refrigerant Suction Pressure Fault LED Amber Compressor OFF	PT1 < -17.9 kpa (-2.6 psi) Alarm L1 PT1 < -4.13 kpa (-0.6 psi) for 5 minutes Alarm L1	Low refrigerant pressure Possible refrigerant leak Contact authorised service
Bit 15 Thermal Overload Fault LED Amber Compressor OFF	Absolute difference between PT2 and PT1 < 137.9 kpa (20 psi) for 20 seconds Alarm 1 30 minutes to restart compressor OR "Aux" contact pair on the Contactor is 1 (open), and contactor is programmed to be 0 (closed) Alarm L1	Wait 30 minutes to clear. Check input power and load. Check for cause of thermal overload. Check the contactor operation. Check the "Aux" contact set on the Contactor.
Bit 16 Not used	N/A	N/A
Bit 17 Not used	N/A	N/A
Bit 18 Not used	N/A	N/A

Bit Mask Value / Problem	Possible Cause	Corrective Action
Bit 19 Not used	N/A	N/A
Bit 20 Buffer Valve Cycle Count Fault LED Amber Compressor ON	Buffer Valve cycle count has exceeded limit CRYO_VALV_OPEN_CNT for Buffer Valve > VALVE_CYCLE_WARN. Alarm L1	Contact authorised service
Bit 21 Cylinder Unloader Valve Cycle Fault LED Amber Compressor ON	Cylinder Unloader Valve Cycle Count has exceeded limit CRYO_VALV_OPEN_CNT for Cylinder Unloader valve > VALVE_CYCLE_WARN Alarm L1	Contact authorised service
Bit 22 Cool Valve Cycle Fault LED Amber Compressor ON	Cool Valve Cycle Count has exceeded limit CIRC_VALV_OPEN_CNT for Cool valve > VALVE_CYCLE_WARN Alarm L1	Contact authorised service
Bit 23 Defrost Valve Cycle Fault LED Amber Compressor ON	Defrost Valve Cycle Count has exceeded limit CIRC_VALV_OPEN_CNT for Defrost valve > VALVE_CYCLE_WARN Alarm L1	Contact authorised service
Bit 24 Freezeout Valve Cycle Fault LED Amber Compressor ON	Freezeout Valve Cycle Count has exceeded limit CRYO_VALV_OPEN_CNT for Freezeout valve > VALVE_CYCLE_WARN Alarm L1	Contact authorised service
Bit 25 Not used	N/A	N/A
Bit 26 Not used	N/A	N/A
Bit 27 Not used	N/A	N/A
Bit 28 EMO Switch Fault LED Amber Compressor OFF	EMO switch is open Alarm L1	Check EMO switch Twist EMO switch CW to reset
Bit 29 Not used	N/A	N/A
Bit 30 Contactor Chatter Fault LED not lit Compressor ON	Compressor Contactor is chattering ON/OFF due to low voltage or power issues Warning L2	Check input power Check Transformer tap setting
Bit 31 Abusive Comp On/OFF Fault LED Amber Compressor ON	Compressor has been turned ON/OFF 3 times within 1 minute Alarm L1	Wait one minute to clear before compressor allowed to start

9.6 Rapid balance pressure check

Rapid balance pressure check, sometimes referred to as stack warm, is a method to rapidly check the equalised system pressure to confirm proper system charge. Balance pressure is the pressure of the refrigerant when the compressor is at rest and the suction and discharge pressures have equalised to the same pressure.

Rapid balance pressure check is done by rapidly warming the system and then allowing the suction and discharge pressure transducers to reach equilibrium. Once at equilibrium, the pressure gauge reading is the balance pressure. This pressure is very close to the static pressure and very useful for service purposes.

The amount of time that it takes the system to reach the end of the rapid balance pressure check is dependent on the state of the system, the load of the system, and the temperature and flow rate of the cooling water. Nominal rapid balance pressure check takes approximately 15 minutes. Note that unlike other products, the system does not require 48 hours to reach balance pressure.

The vacuum chamber should be in a vacuum state when operating the rapid balance pressure check mode. Operating this feature when the cryosurface is not in a vacuum environment may cause excessive heat loss and the process may not be able to complete.

When rapid balance pressure check is completed, some service functions may be performed. However, charge removal requires a waiting period of a minimum of 12 hours.

9.6.1 Static pressure Vs rapid balance pressure

Static pressure is different from balance pressure due to the fact that static pressure requires that the unit is at rest and at ambient temperature for 48 hours or longer. Balance pressure and static pressure may be different by 5 to 20 psi.

To make the rapid balance pressure check more relevant, the user should perform a rapid balance pressure check soon after installation. This value should be recorded for future reference.

9.6.2 Rapid balance pressure check procedure

 Note:

For dual circuit, defrost needs to be performed before running a rapid balance pressure check.

1. Verify the vacuum chamber is in a vacuum state, typically 10 - 3 torr or below.
2. Use the HMI keypad to go to the SERVICE MENU and press "Enter".
3. Scroll to the AUTHORIZATION CODE. Press "Enter".
4. Enter the authorisation code 02030B for security level 2 (default operator access). Press "Enter". See Security levels.
5. Scroll down to "INIT RAPID BP CHECK". Press "Enter".
6. The system performs a rapid defrost and stops the rapid balance pressure check procedure when the endpoint has been reached.

7. Wait until the suction and discharge pressure transducers reach equilibrium. This typically takes about 5 minutes.
Note that the transducers may not read the same value when at equilibrium but may have a slight offset due to gauge accuracy.
8. When the transducers are at equilibrium and hold a steady value, take a pressure reading. This is the balance pressure.

10. Transport and storage



WARNING: ELECTRICAL HAZARD

Contact with energised equipment can cause electric shock and result in death or serious injury. Avoid contact with electrical circuits. Disconnect electric energy before disassembling electric service.



CAUTION:

Refrigerant removal or charging must be performed by our Service personnel or our authorised service providers. Customers must never attempt to add or remove refrigerant from the system.

If the system is to be shipped, it must be properly packaged to ensure it arrives undamaged.

Note:

The original shipping crates or equivalent must be used when shipping the cryochiller. If the original crates are lost or damaged, contact us for replacements.

Item	Description
Electrical category	Type 2 - Equipment is energised. Energised circuits are covered or insulated.
840164-XX	Shipping kit XX designates the kit version for the system
Tools and materials	Standard tool kit and refrigerant line tools. Moisture, shock, and tip indicators as required

10.1 Packing procedure

1. Evacuate the refrigerant from the refrigerant lines and cryosurface by performing the Zero Line Loss procedure if the unit is connected with refrigerant lines and cryosurface. See [Zero line loss procedure](#) on page 181 (185307).
2. Carefully disconnect the cryosurface, refrigerant lines, and thermocouples and package them for shipment.
3. Disconnect all external wiring and facilities connections.
4. Lock down the compressor to the frame by installing the double lock-down nuts on each of the x4 compressor bolts.
5. Secure all panels firmly in place with shrink wrap or a similar product.
6. Firmly secure the system to a shipping pallet and cover with a cardboard enclosure. Use the bolts, pallet, shipping materials and the shipping containers saved while unpacking of the unit.
7. Add shipping indicators, if required.

10.2 Zero line loss procedure

This procedure is used to pull the refrigerant back into the system.

Safety requirements

Note:

Untrained or improperly equipped personnel performing this procedure may cause damage to the equipment.

Only our trained personnel should perform this procedure.

Personnel performing this procedure must read and understand this procedure and have the proper tools and supplies ready before starting.

Personnel performing this procedure must know the applicable safety codes, facility safety procedures, safety equipment, and emergency contact information.

Table 29 Technical information

Electrical category	Type 2 - Equipment is energised. Energised circuits are covered or insulated
Tools	Standard Hand Tools Open end or adjustable wrenches (1) 1/16 inch crow foot wrench or deep socket wrenches Service menu access code Four-port refrigeration manifold: (2) 1/4 inch. evacuation lines, (1) 1/4 inch. Evacuation line with ball valve installed
Materials	None

10.2.1 Zero Line Loss Setup



CAUTION: EXTREME COLD

The valve box is extremely cold during device operation. Touching the valves in the valve box before defrosting them may cause minor or moderate injury. Do not attempt to handle the valves until they have been defrosted.

1. Select the Remote button to shut off the remote. This will put the system into local mode.



2. If the chiller is cold, select the heat key on the HMI to begin the defrost process.



 Note:

The system takes an average of 5 minutes to complete this process. The actual time will depend on your setup.

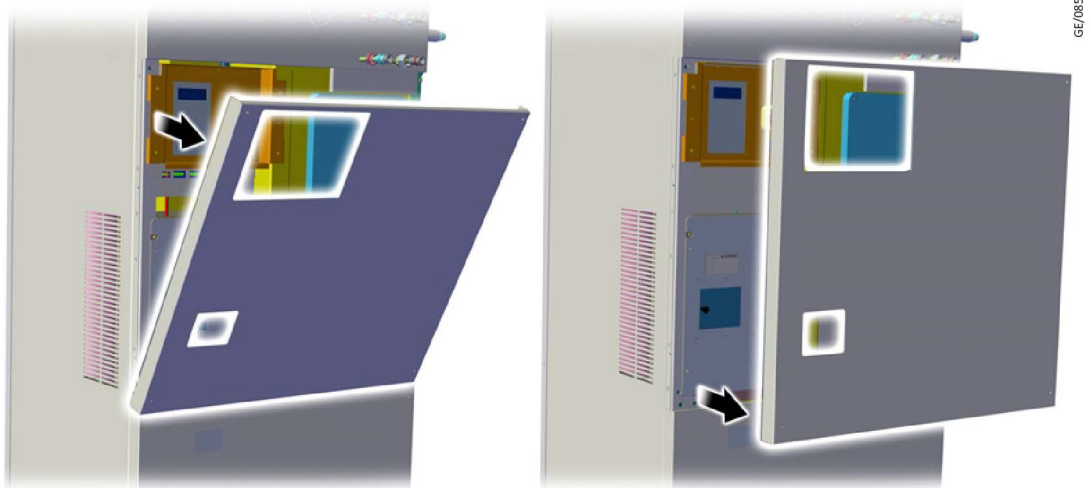
3. Wait for the standby and heat indicators to illuminate, signalling when the defrost cycle is complete.



4. Loosen the screws(x4) on the upper panel.



5. Remove the upper panel and set aside.



6. Loosen the screws(x4) on the lower panel.



7. Remove the lower panel and set aside.



8. If ice is present on the cold box cover, use a heat gun or fan to melt the ice on the outside of the cold box.

 Note:

Do not point the heat gun directly on the mylar insulation for more than 15 seconds at a time. This insulation is prone to melting.

9. Loosen the screws(x4) using a standard philips screwdriver and take off the cover to open the cold box.
10. If ice is present, use a heat gun or a fan to warm up the valves in the valve box.

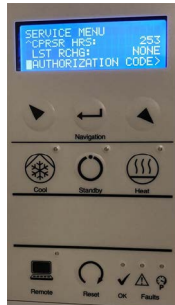
 Note:

Hold the heater gun at least 1 ft (0.3 m) away from the valves, and do not point directly at plastic.

11. Use the HMI keypad arrows to navigate from the main menu to the service menu, and select the navigation key to select.



12. Scroll to AUTHORIZATION CODE. Select navigation.



13. Input the LEVEL 3 authorization code 02030C to access the function. A menu of service options will appear. Use the up and down arrows to scroll through a list of letters and numbers. Select the navigation key after each one to select.



14. Scroll down to ZERO LINE LOSS. Select navigation.



15. Scroll down to AGREE. Select navigation.



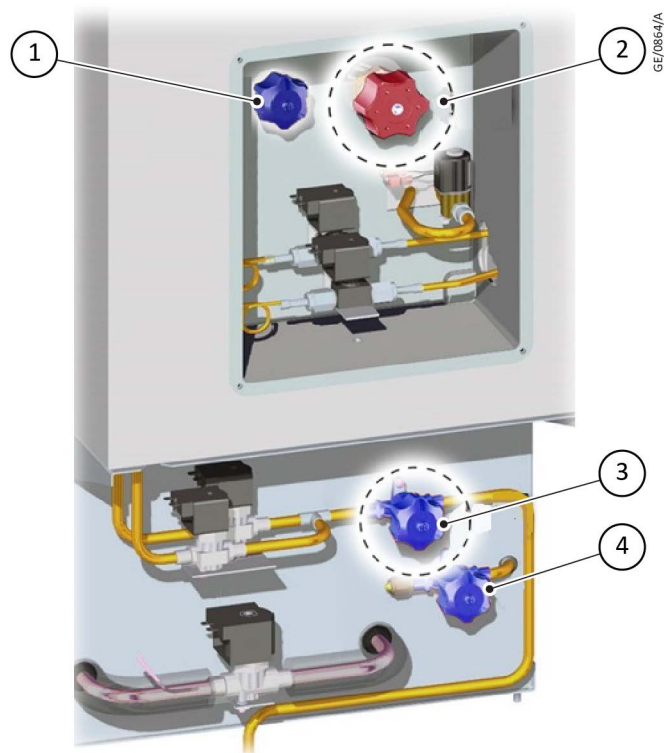
10.2.2 Check valves

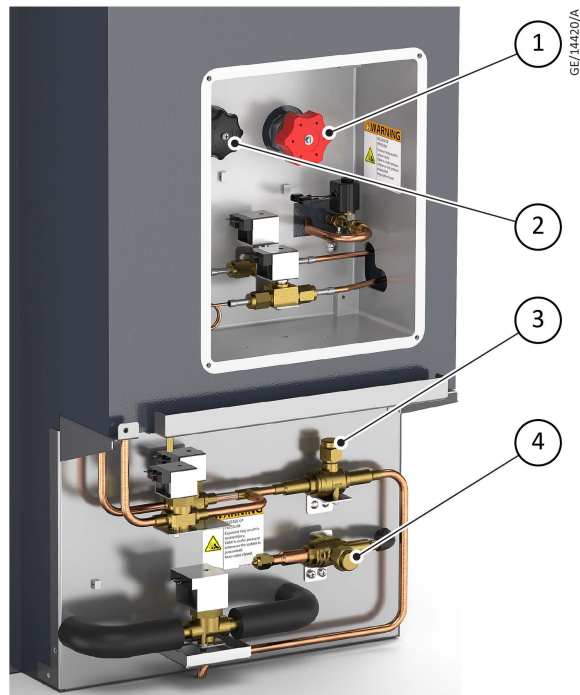
1. Set the compressor to the OFF position.



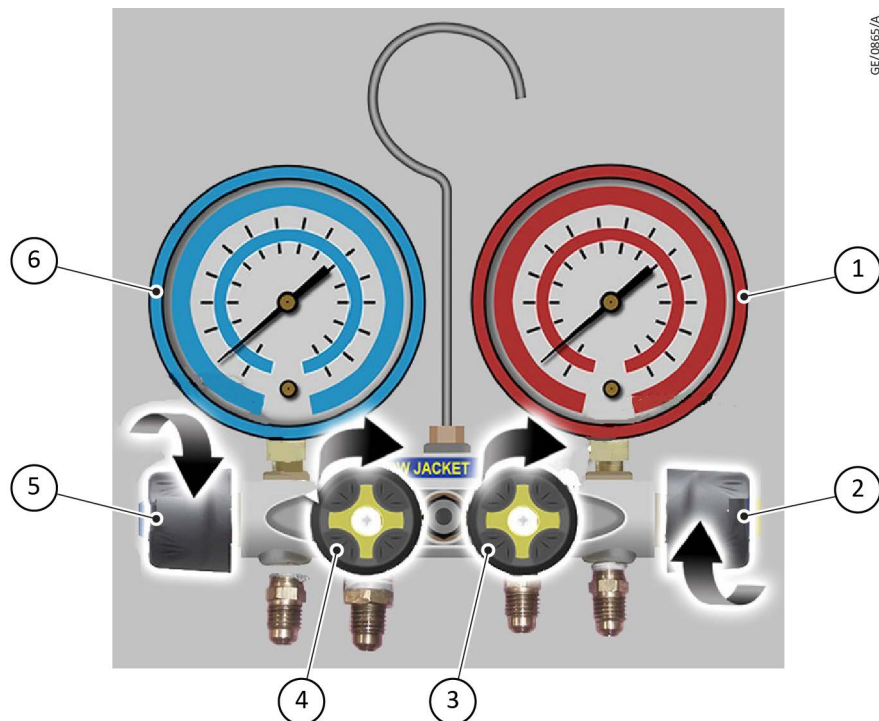
2. Close the following hand valves:

- Cold gas feed
- Hot gas feed
- Common return





- Before connecting the refrigeration manifold, verify all four hand valves are closed. If needed, turn each one clockwise until secure to close.



- Low pressure gauge
- High pressure gauge
- Vacuum (roughing) pump hand valve
- Vapour charging hand valve

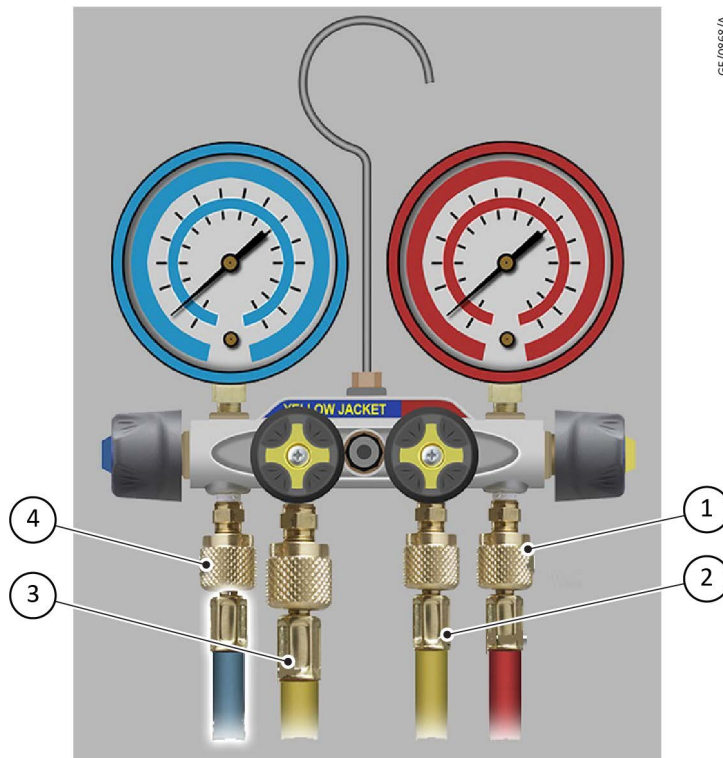
5. Low pressure hand valve
6. High pressure hand valve
4. Perform a visual inspection of the 1/4 inch evacuation lines to confirm the o-rings are in good condition (free of cracks, rot, and debris). If needed, clean the o-rings with compressed Nitrogen or Argon air, clean the o-rings using a dry towel, or replace the o-rings with new.
 - Good o-rings:



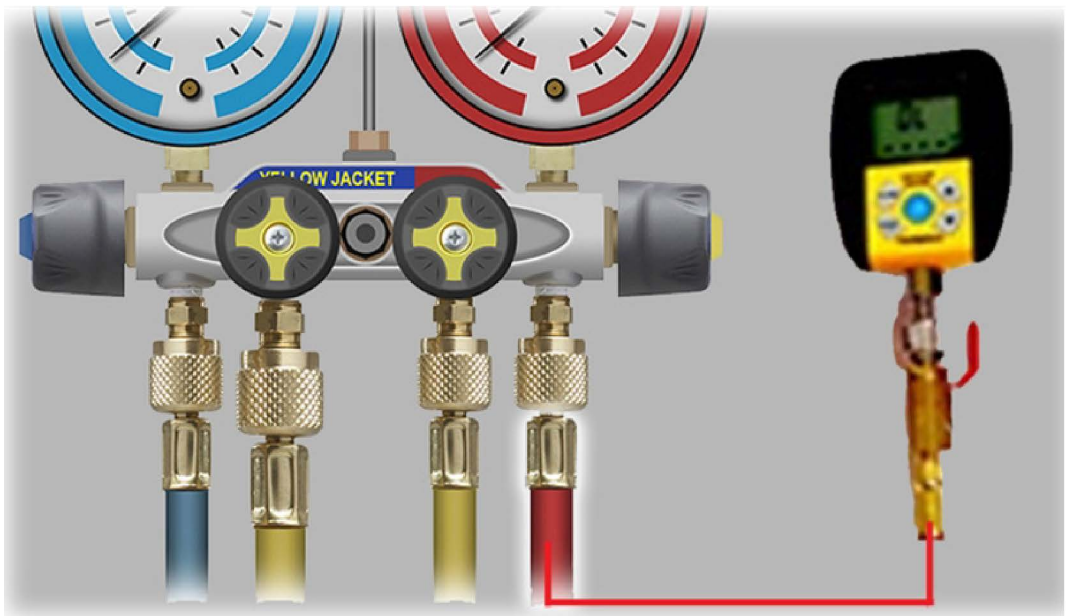
- Bad o-rings:



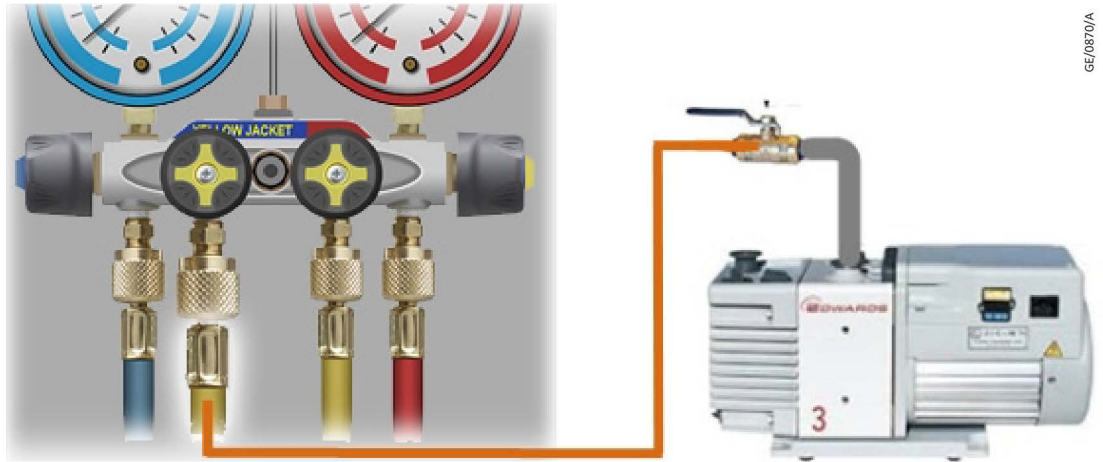
5. Connect all 1/4 inch evacuation lines (x4) to the refrigeration manifold. Ensure the line with the mini ball valve is placed on the low pressure line.



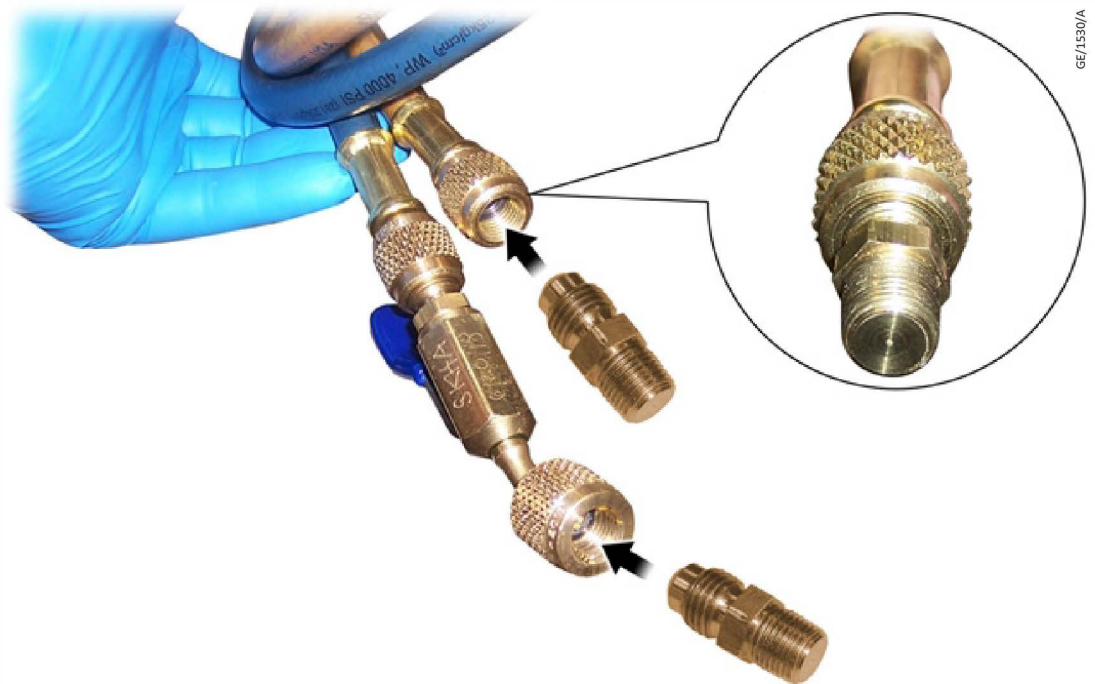
1. Low pressure line with mini ball valve
 2. Vacuum (roughing) pump line
 3. High pressure line
 4. Vapour charging line
6. Connect the high pressure line to a vacuum gauge.



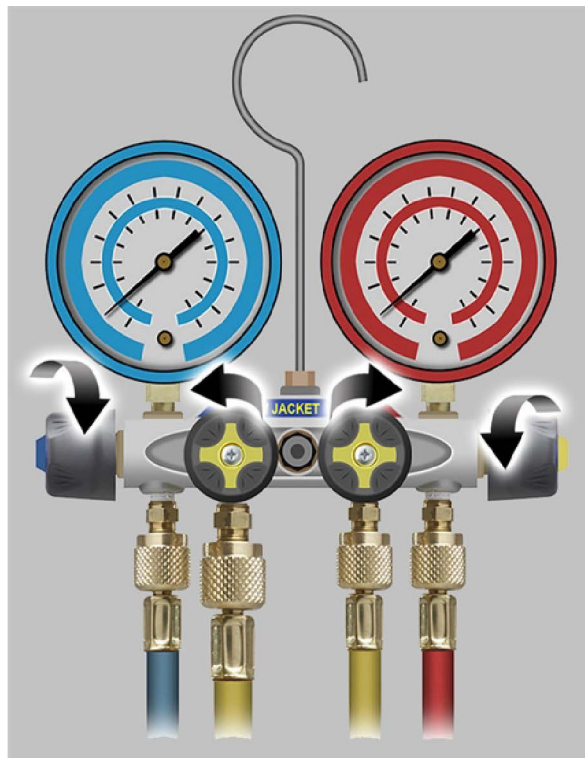
7. Connect the vacuum line to the roughing pump.



8. Install blank offs to the 1/4 inch low pressure and vapour charging lines.



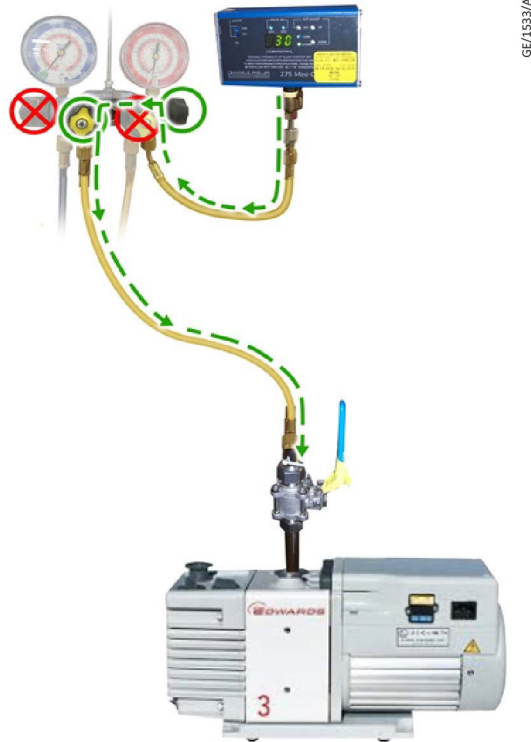
9. On the refrigeration manifold, open the valves for the vacuum line and the vacuum gauge.



10. Turn the roughing pump on and open the ball valve.



11. Let the roughing pump run until the vacuum gauge reads below 50 microns.



12. Close the ball valve on the roughing pump. The vacuum gauge should rise 50 - 80 microns per minute. This will confirm a vacuum.



Note:

A bad connection may cause vapour to come from the roughing pump. If this happens, immediately close the ball valve to the roughing pump. You will then need to re-check all connections, then try again.

10.2.3 Procedure

1. Once vacuum is confirmed, disconnect the blank off from the vapour charging line.



2. Use a 5/8 crescent wrench to remove the cap from the flare fitting port on the evacuation valve.

Figure 111 MaxCool 4000H and 2500L

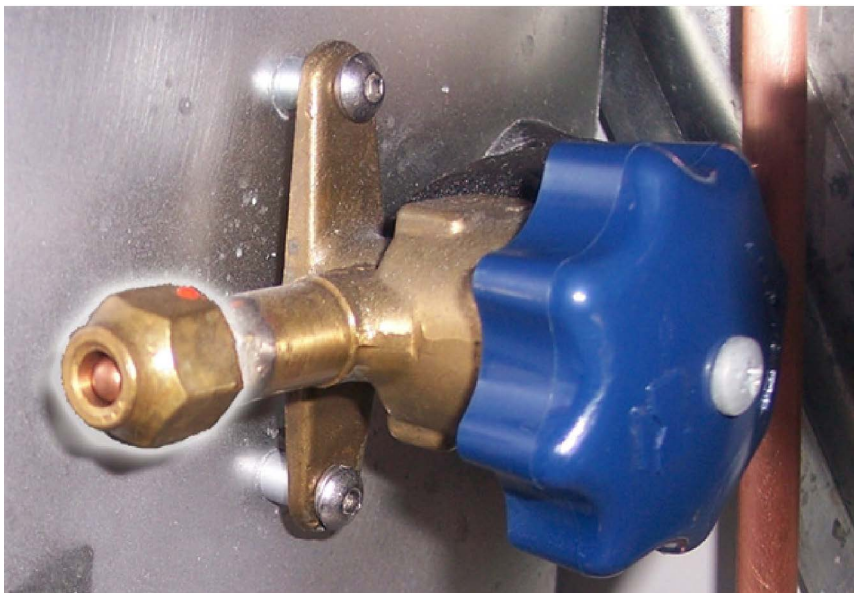


Figure 112 MaxCool 1500 and MaxCool 2200



3. Clean off any debris from the flare fitting with a paper towel or clean cloth.

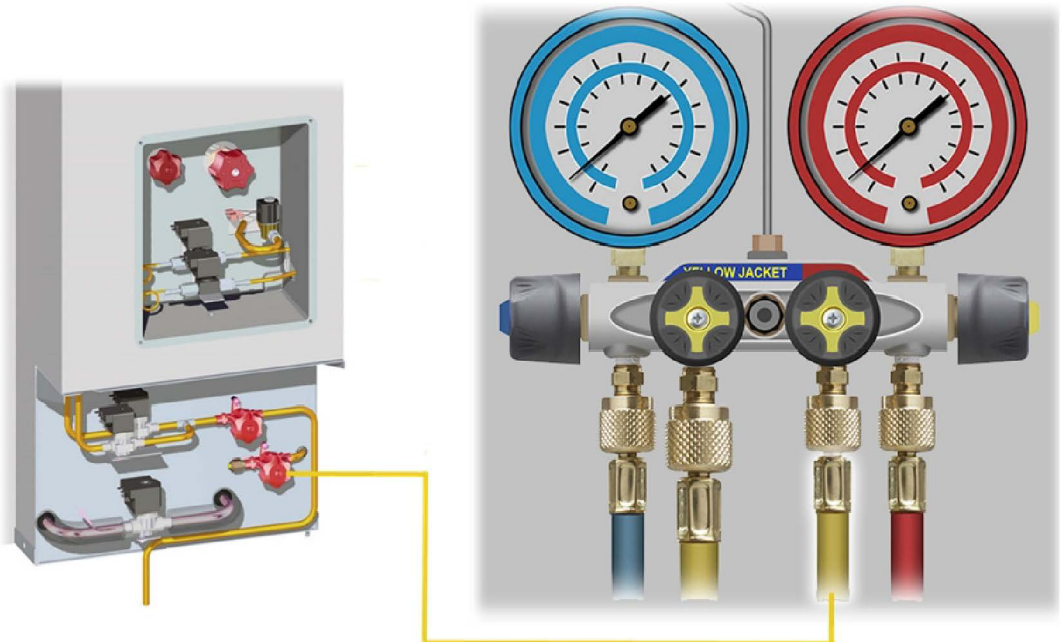
Figure 113 MaxCool 4000H and 2500L



Figure 114 MaxCool 1500 and MaxCool 2200



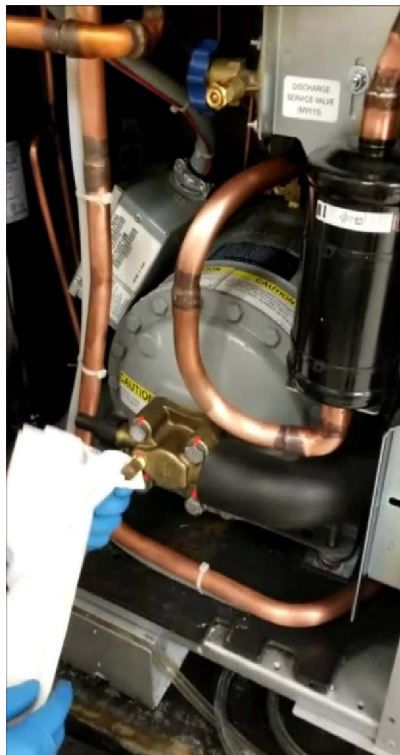
4. Connect the vapour charging line to the evacuation flare fitting port in the valve box.



5. Use a 5/8 crescent wrench to remove the cap from the flare fitting port on the compressor.



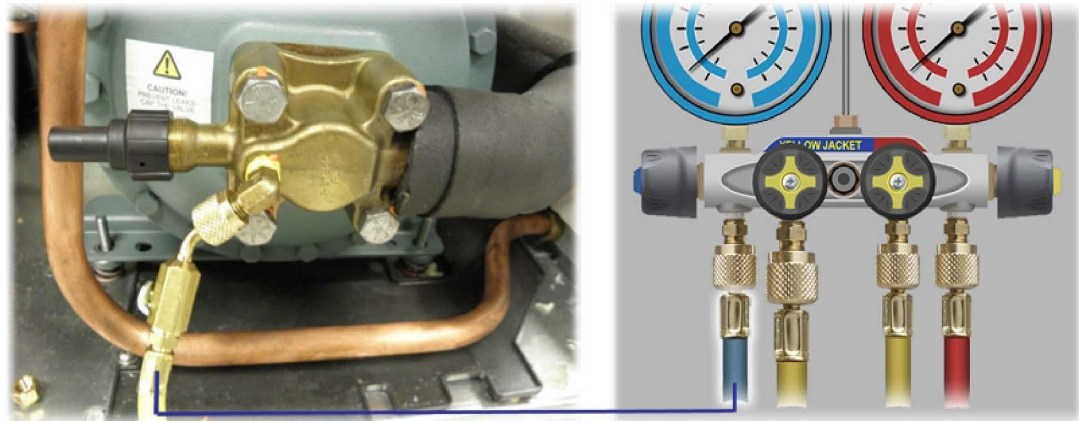
6. Clean off any debris from the flare fitting with a paper towel or clean cloth.



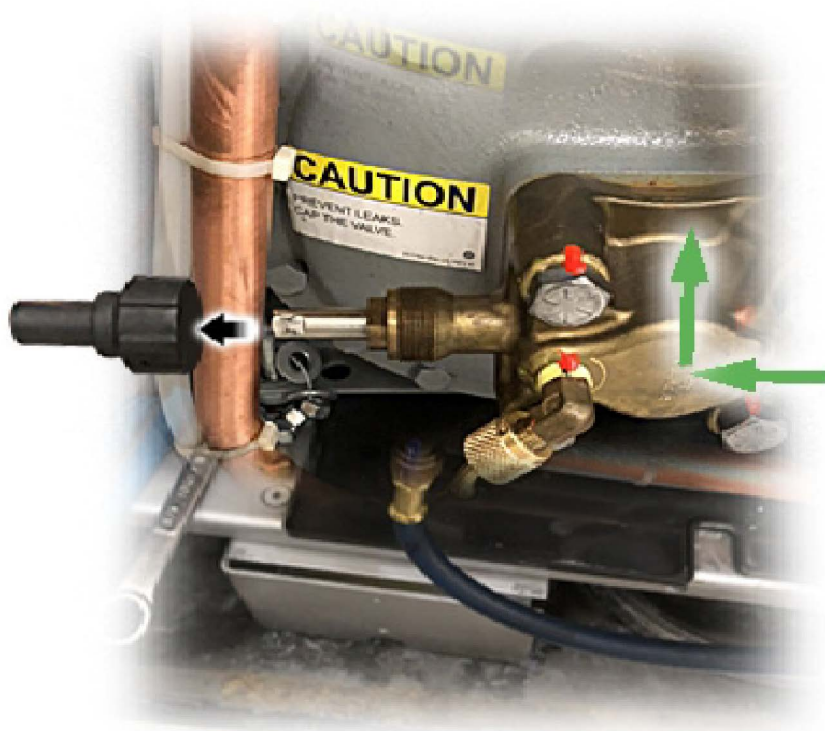
7. Verify the mini ball valve on the 1/4 in. low pressure line is closed.



8. Connect the low pressure line to the flare fitting port at the compressor suction valve located on the back of the compressor.



9. On the compressor, disconnect the suction valve cap by rotating counter clockwise.



10. Loosen the packing nut 1/4 to 1/2 turn to freely move the stem valve.



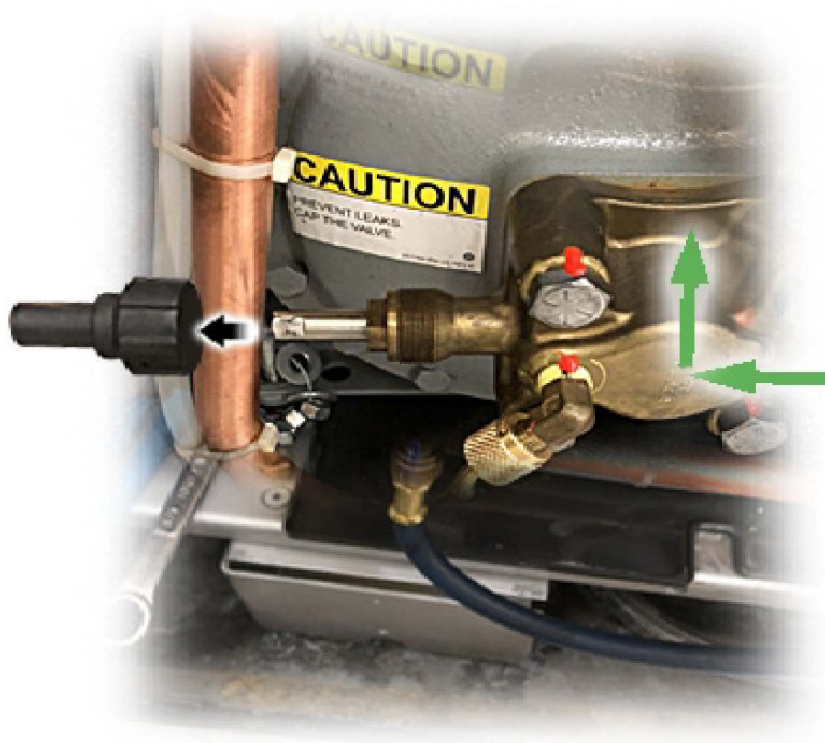
11. Rotate the stem valve in the clockwise position until the stem is secure on the front seat.



12. Tighten the packing nut to secure this position.



13. Put the suction valve cap back on to prevent any accidental moving of the stem valve.



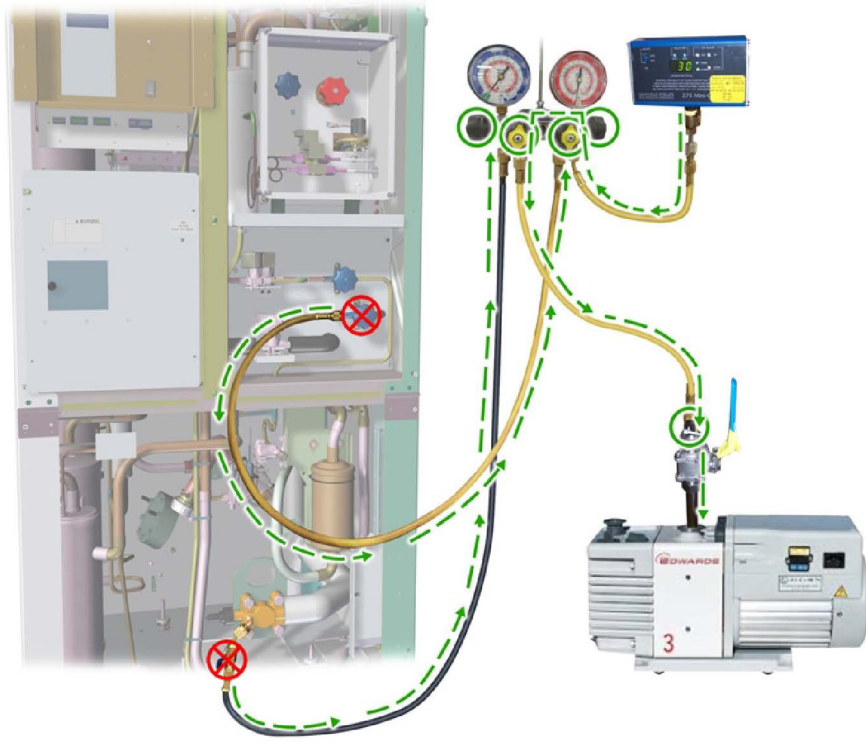
14. Open the ball valve on the roughing pump.



15. Open all valves (x4) on the refrigeration manifold.

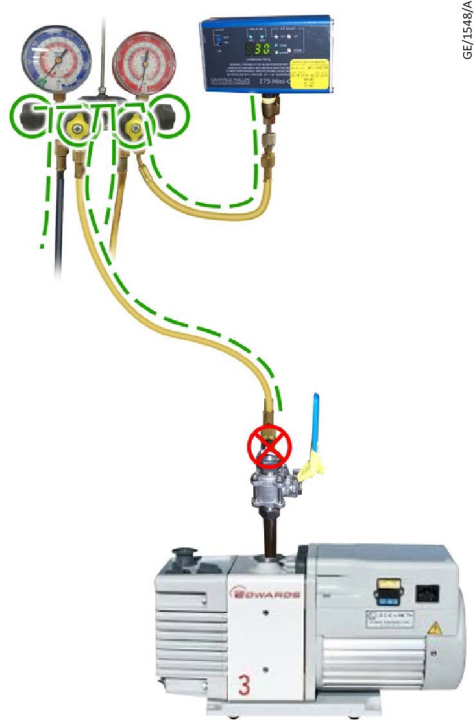


GE/1546/A

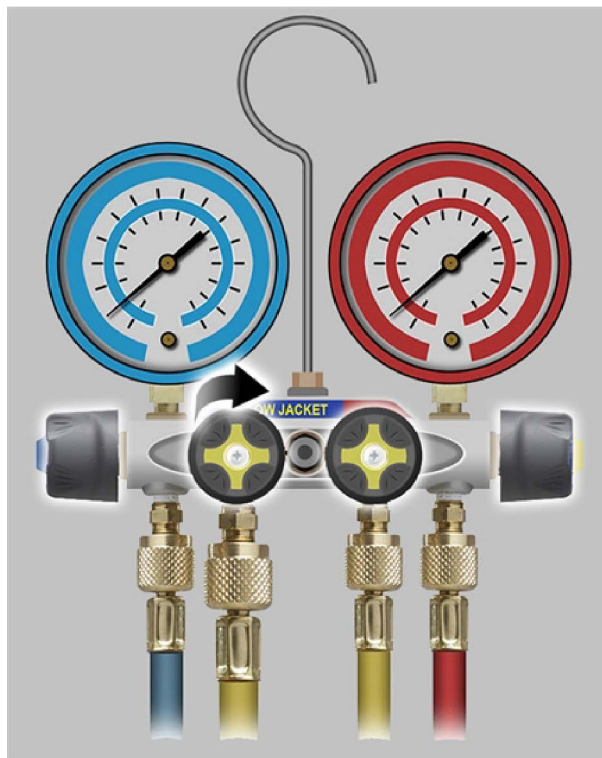


GE/1547/A

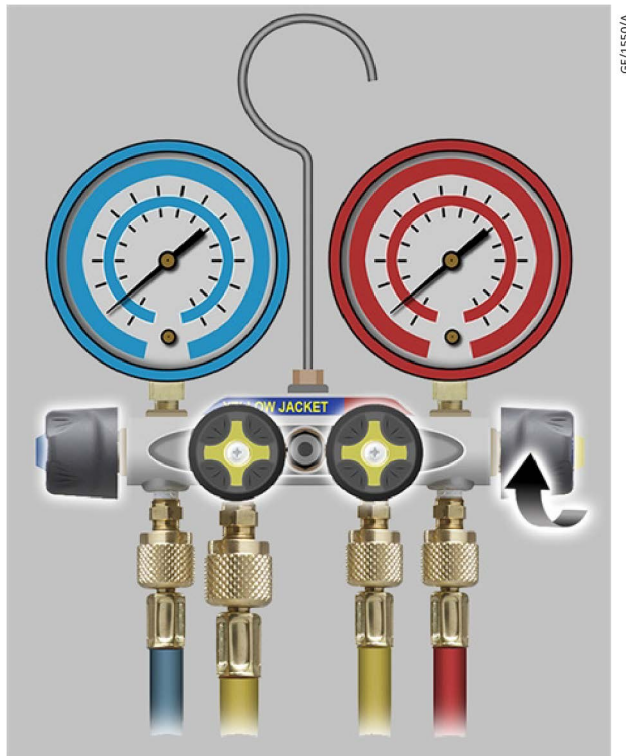
16. Evacuate the lines of the refrigeration manifold to 50 microns. Close the ball valve on the roughing pump to check the rate of rise (50 - 80 microns per min) to confirm the vacuum.



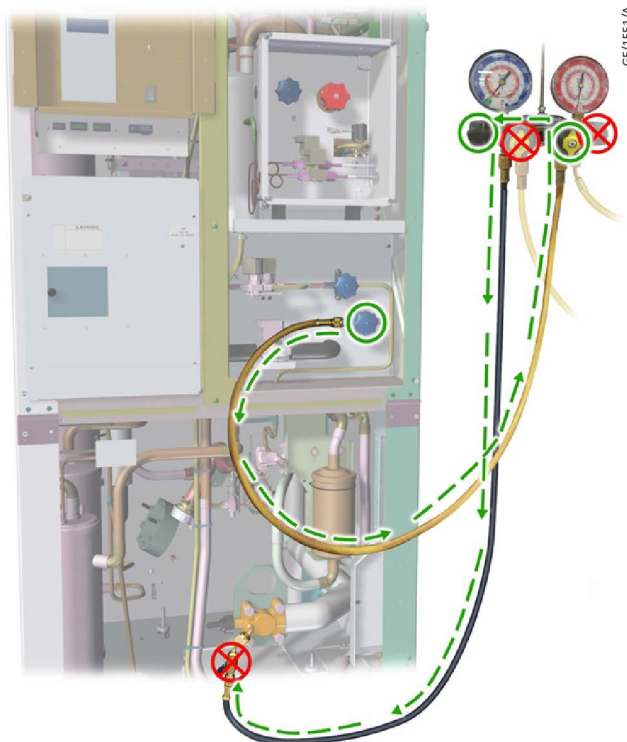
17. Close the evacuation valve at the refrigeration manifold to isolate the roughing pump and vacuum gauge.



18. Close the vacuum pump hand valve at the refrigerator manifold and immediately proceed to the next step.

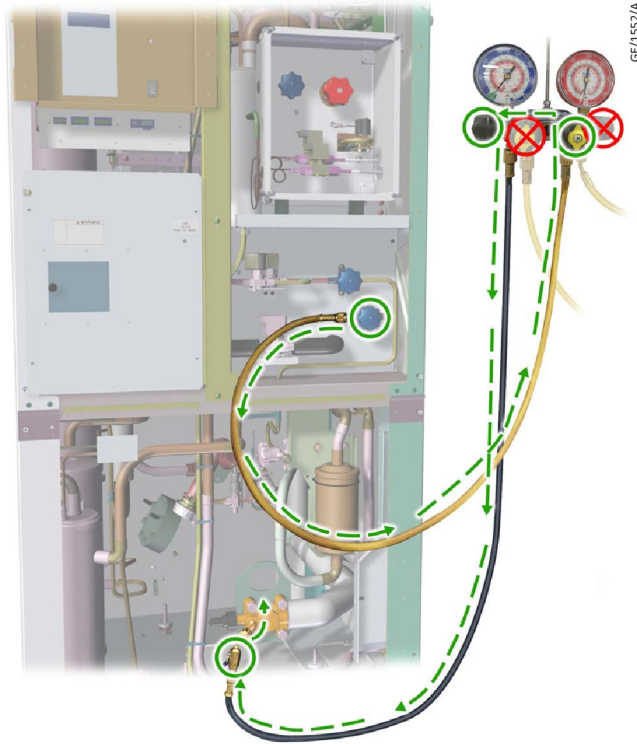


19. Open the evacuation valve in the valve box to introduce the refrigerant to the refrigeration manifold.



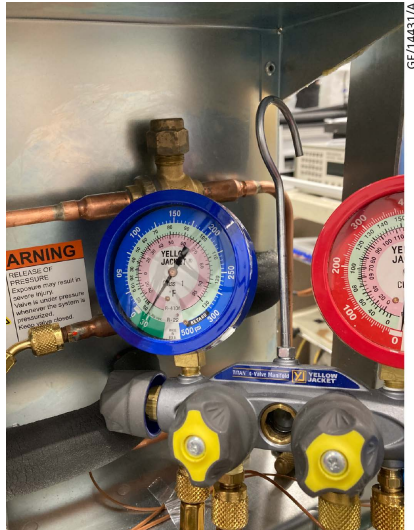
20. Turn the compressor to the ON position and let it run for 45 seconds - 1 minute.

21. Open the mini ball valve on the 1/4 inch compressor suction service valve line.

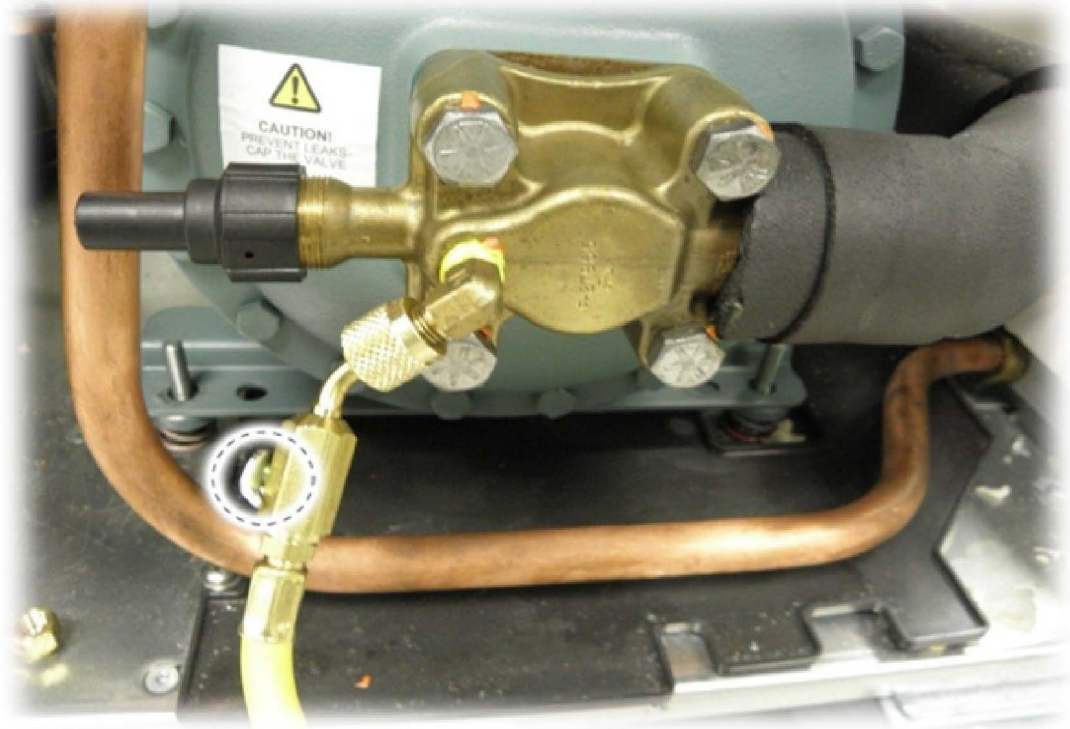


22. Continue with the vacuum extraction until the compound pressure gauge reads 15 inches mercury (50.8 kPag) (7.36 Psig) or lower.



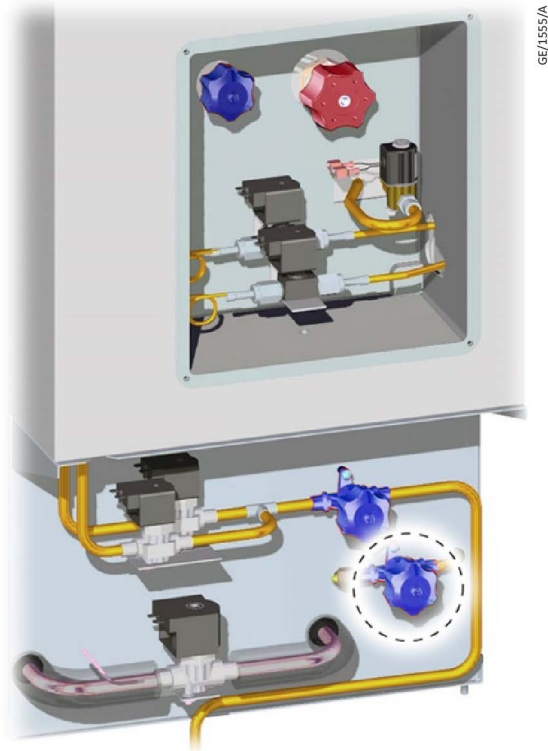


23. Close the mini ball valve on the compressor suction service valve.



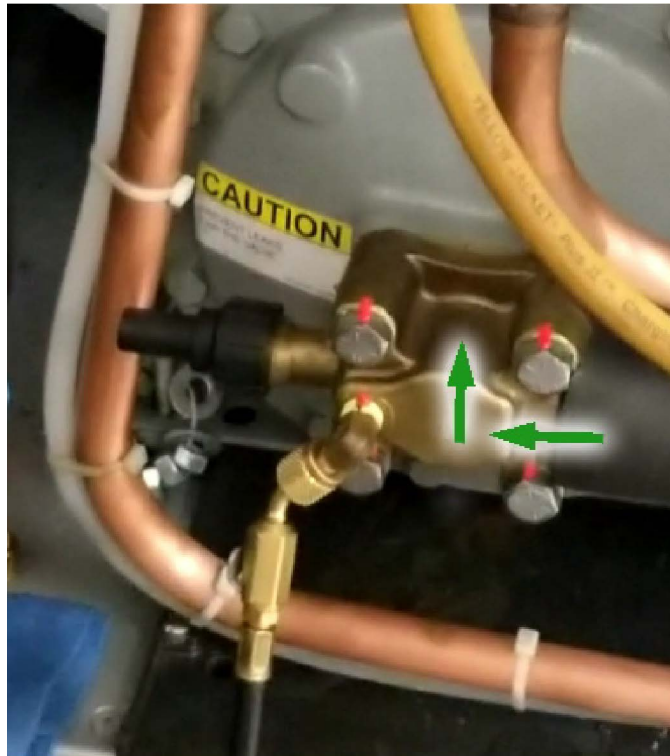
24. Turn the compressor off by switching the compressor switch to OFF.
25. At the refrigeration manifold, observe the compound gauge for 2 minutes. A good connection will not raise the pressure.
- If the connection is good and the pressure does not increase, turn the compressor suction service valve fully out to the seated position.
 - If the pressure increases, close the hand valves on the refrigeration manifold tighter, then start over from step 17.

26. Confirm that the evacuation port hand valve is closed.



27. Select the enter key on the HMI keypad to acknowledge the zero line lost test is completed to reset the system back to its normal state.

28. Loosen and remove the suction valve cap at the compressor.



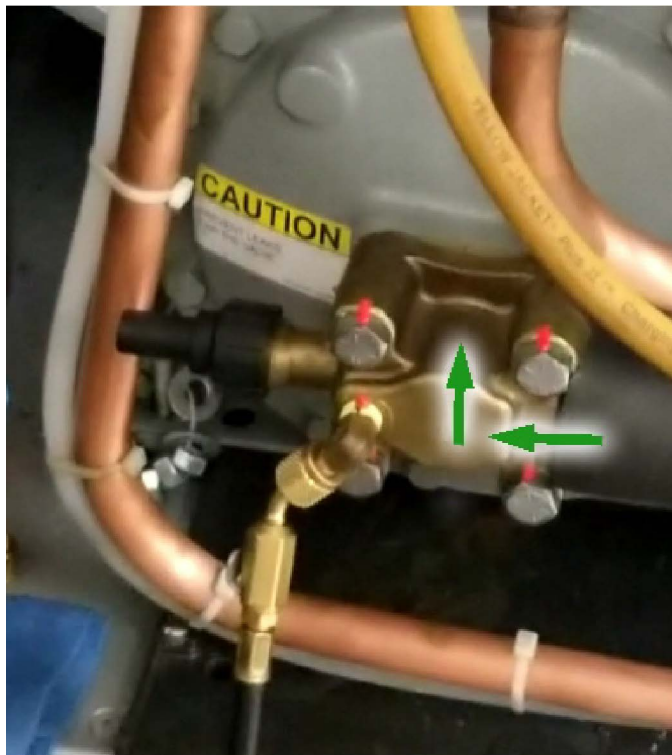
29. Loosen the packing nut 1/4 to 1/2 turn until the stem valve moves freely.



30. Rotate the stem valve in the clockwise position until stem is secure on the back seat.



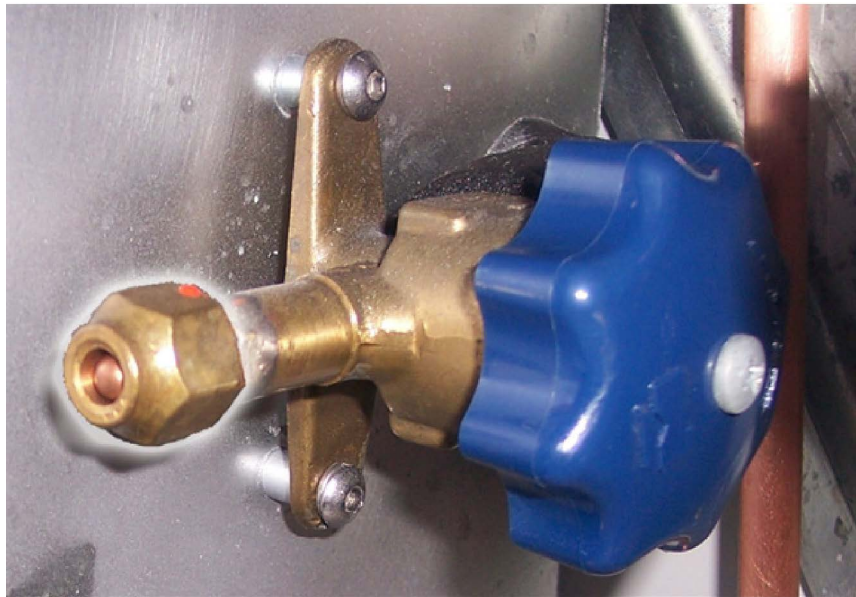
31. Reinstall the suction cap.



32. Disconnect all 1/4 inch evacuation lines used during the zero line lost test.

33. Reinstall the caps on the evacuation hand valve and the compressor low pressure service suction port.

Figure 115 MaxCool 4000H and 2500L



GE/1588/A



GE/1539/A

Figure 116 MaxCool 1500 and MaxCool 2200



34. Disconnect and remove the refrigeration manifold from the roughing pump.

11. Spares and accessories

11.1 Spares and fixtures

The system does not require special tools or fixtures for normal operation or servicing. A kit of tools and maintenance items comes with each unit.

The tables below list the supplied tools, recommended tools, and optional tools.

Table 30 *Optional spares and fixtures for the system*

Part number	Description and use
810004-00	O-ring removal tool
810030-07	2.5 inch spanner (commonly shipped with cryocoils)

Table 31 *Recommended spares and fixtures for the system*

Part number	Description and use
	7/16 inches, 9/16 inches, 1 inches, 1-1/16 inches, 1-5/16 inches, 1-11/16 inches wrenches for valve maintenance
	1-1/16 inches deep socket for valve maintenance
	1-1/16 inches crow foot for valve maintenance
	1-3/4 inches deep socket for valve maintenance
	Adjustable wrenches, as required, if inch wrenches are not available

11.2 Accessories

Refer to the system documentation for installed components and options.

Table 32 *Optional accessories for the system*

Part number	Description and use
840164-XX	Insulation kit. Components dependent on the system configuration.
840302-00	Lift ring option
183933	Cryochiller caster kit
440119-XX 440140-XX 440120-XX 440215-XXXX	Refrigerant line set (feed and return)
235074	Remote EMO kit (4-pin 11 CPC) (16 to 18 AWG)
840104-00	24 V non-isolated remote connector (37-pin 23 CPC) With backshell and pins For use with customer cable
840105-00	24 V isolated remote connector (37-pin 23 CPC) With backshell and pins for use with customer cable
840317	Magnets kit

11.2.1 Maintenance items

Maintenance items are dependent upon system configuration and application. For a list of these items please contact our Technical Support Team with your model and serial number so that we may identify the necessary parts.

12. Service

When contacting our division for technical support, follow the procedures described here and have the following information available:

1. Unit information:
 - Serial number, model number, name of tool
 - Balance pressure of the unit when the coldest liquid is at ambient temperature (20-25 °C) or immediately after completing the rapid balance check procedure
 - TC readouts in cool mode and standby after 30 minutes
2. Site information:
 - Company name, site location, street address, city, state zip
3. Contact information:
 - Primary contact name, phone, and E-mail
 - Secondary contact name, phone, and E-mail
4. Describe the malfunction observed and any error codes received during the failure:
 - Time that the issue has been occurring
 - Work that was done on the equipment prior to the error
 - Actions taken after the error and the results of those actions
 - Other information that may assist the specialist

12.1 Customer support information

You can reach our global customer operations teams around the world at the times and phone numbers below.

Edwards Location	Contact Numbers
North America	+1 800-FOR-GUTS (800-367-4887) (US, Canada)
Europe	+49 1804-CALL-GUTS (1804-2255-4887)
Japan	+81-45-620-6979
China	+886-21-136 8172 7921
Taiwan	+886-3-5525225
Korea	+82-31-288-2500
Singapore	+65-6464-1481

 Note:

For additional contact information, go to our web site www.Edwards Vacuum.com.

12.2 Return the equipment or components for service

Before you send your equipment to us for service or for any other reason, you must contact Polycold Customer Care to get a RMA number and fill out necessary forms, per guidance.

EU Declaration of Conformity



Edwards Vacuum LLC,
6416 Inducon Drive W,
Sanborn,
NY,
USA 14132

Documentation Officer:
Jelena Havelkova, Spielberk Office Centre, Holandska 10,
Brno, 63900 Czech Republic,
Tel: +42(0) 734 418 896,
Email: documentation@edwardsvacuum.com

Declare under the sole responsibility of the manufacturer that the following product

- Polycold® Cryogenic Refrigeration Unit;
- XC8800 MT / HC, MaxCool 2000 / 2500L / 4000F / 4000H / MC2200 / MC1500
- Part number:
- Serial number:

Is in conformity with the relevant requirements of European CE legislation. The fulfilment of the Essential Safety Requirements set out in Annex I has been demonstrated:

2014/68/EU Pressure Equipment Directive
Group 2, Category II, Conformity Assessment Module: A2
Notified Body: TÜV SÜD Industrie Service GmbH Westendstrasse 199 80686 München, Germany
Notified body: No 0036
Certificate Number: USA-21-05-70-001 Revision 1

Assembly / Component	Category	Module
Pressure Switch	IV	B+D
Pressure Relief Valve	IV	B+D
Oil Separator	I	A
Expansion Tank	II	H1
Phase Separator	I	A
Suction Accumulator*	II	A2
Suction Accumulator*	II	H1
Heat Exchanger**	I	H
Piping System	Article 4(3)	

* Only one used in the system
** Only used in MaxCool 2500L

2014/35/EU Low voltage directive (LVD)

2014/30/EU Electromagnetic compatibility (EMC) directive
Class A Emissions, Controlled Immunity

Based on the relevant requirements of harmonised standards:

EN 378-2:2016	Refrigerating systems and heat pumps – Safety and environmental requirements – Part 2: Design, construction, testing, marking and documentation
EN 60204-1:2006 +A1:2009	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
EN 61010-1:2010 +A1:2019	Safety requirements for electrical equipment for measurement, control and laboratory use. General requirements
EN 61000-6-2:2005	Electromagnetic Compatibility (EMC) - Part 6-2: Generic Industrial Immunity Standard
EN 61000-6-4:2007	Electromagnetic Compatibility (EMC) - Part 6-4: Generic Industrial Emission Standard

This declaration, based on the requirements of the listed Directives and EN ISO/IEC 17050-1, covers all product serial numbers from this date on: 2023-11-28. This declaration becomes invalid if modifications are made to the product.

This is a sample EU legal declaration.
Find the signed legal declaration in the product packaging.
You must retain the official signed legal declaration for future reference.

Design Signatory – Tanya Palmer, VP of Engineering,
Haverhill, MA, USA

Manufacturing Signatory – Jerry Fargo, General
Manager, Haverhill, MA, USA

ADDITIONAL LEGISLATION AND COMPLIANCE INFORMATION

EU EMC Directive: Industrial equipment

Caution: This equipment is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments.

EU RoHS Directive:

This product is supplied as a component on "large-scale stationary industrial tool" under Article 3 (3). In accordance with Article 2 Paragraph 4(d) this product is not in the scope of the 2011/65/EU RoHS (recast) Directive."

EU REACH Regulation Compliance

This product is a complex article which is not designed for intentional substance release. To the best of our knowledge the materials used comply with the requirements of REACH. The product manual provides information and instruction to ensure the safe storage, use, maintenance and disposal of the product including any substance based requirements.

Article 33.1 Declaration

This product contains Candidate List Substances of Very High Concern above 0.1%ww by article as clarified under the 2015 European Court of Justice ruling in case C-106/14.

- 1,2-dimethoxyethane (EDGME)
This substance is sealed within the case of the compact lithium coin cell battery and is essential to the long life and reliable performance of the battery.
- Lead (Pb)
This substance is present in certain steel / brass / electrical or electronic components.

Additional Applicable Requirements

WASTE FRAMEWORK DIRECTIVE (EU)

SCIP Number: 30b665cb-44ac-4235-a04d-265b4c59049f

材料成分声明
China Material Content Declaration

部件名称 Part name 	有害物质 Hazardous Substances					
	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr VI)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
电子元件和控件 Electronics and Controls	X	O	O	O	O	O
铜管管件 Brass pipe fitting	X	O	O	O	O	O
铜接头 Brass connectors	X	O	O	O	O	O
电机（泵和机械增压泵） Motors (pump and mechanical booster)	X	O	O	X	O	O
电控箱 Electrical Assy	X	O	X	O	X	O
换热器及阀门 Heat Exchanger/Valve Assy	X	O	O	O	O	O
压缩机室 Compressor Compartment Assy	X	O	O	O	O	O
通讯及遥控接口 Customer communication Assy	X	O	X	O	O	O
包装及附件 Packaging/Accessory Assy	X	O	O	O	O	O
O: 表示该有害物质在该部件的所有均质材料中的含量低于 GB/T 26572 标准规定的限量要求。 O: Indicates that the hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in GB/T 26572. X: 表示该有害物质在该部件的至少一种均质材料中的含量超出 GB/T26572 标准规定的限量要求。 X: Indicates that the hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement of GB/T26572.						

