System User Manual

CryoCore®
Closed-Cycle Optical Cryostation

Version: 3.2
September 2022

www.montanainstruments.com
support@montanainstruments.com
Specifications and product information listed in this document are accurate at the time of publishing for a standard system. Options, custom designs, and/or other modifications may cause slight differences. Future design changes to the system, including software updates, may change information.

© Montana Instruments® Corporation, All Rights Reserved

No part of this publication may be reproduced, distributed, or transmitted in any form or by any means, including photocopying, recording, or other electronic or mechanical methods, without the prior written permission of Montana Instruments.

Montana Instruments, Cryostation, CryoCore, and ATSM are trademarks of Montana Instruments Corporation. Other brand names used are the property of their respective owners.
# Table of Contents

**Section 1 - Preface** .......................................................................................................................... 7  
1.1  Conventions Used in this Manual ............................................................................................... 7  
1.1.1  Abbreviations ......................................................................................................................... 7  
1.1.2  International System of Units (SI) Symbols ........................................................................... 8  
1.1.3  System of Imperial Units Symbols ......................................................................................... 8  
1.1.4  Explanation of Safety Warnings ............................................................................................ 8  
1.1.5  Graphical Symbols ................................................................................................................. 9  
1.2  General Hazard Information ..................................................................................................... 9  
1.3  Technical Support Information .................................................................................................. 10  
1.3.1  Warranty & Repairs ............................................................................................................... 10  
1.3.2  Accessories & Replacement Parts ....................................................................................... 11  
1.3.3  Contact Details ..................................................................................................................... 11  

**Section 2 - System Overview** ........................................................................................................ 12  
2.1  Cryostation .................................................................................................................................. 12  
2.1.1  Intended Use .......................................................................................................................... 12  
2.1.2  Components .......................................................................................................................... 12  
2.1.3  Technical Specifications ....................................................................................................... 14  
2.1.4  Safety Information ............................................................................................................... 15  
2.2  System Control Unit .................................................................................................................. 17  
2.2.1  Intended Use .......................................................................................................................... 17  
2.2.2  Components .......................................................................................................................... 17  
2.2.3  Technical Specifications ....................................................................................................... 19  
2.2.4  Safety Information ............................................................................................................... 20  
2.3  Vacuum Control Unit ................................................................................................................ 21  
2.3.1  Intended Use .......................................................................................................................... 21  
2.3.2  Components .......................................................................................................................... 21  
2.3.3  Technical Specifications ....................................................................................................... 22  
2.3.4  Safety Information ............................................................................................................... 23  

**Section 3 - Sample Chamber Configuration** .................................................................................. 25  
3.1  Accessing the Sample Space ....................................................................................................... 25  
3.2  Sample Mounting ........................................................................................................................ 26  
3.2.1  Standard Adjustable Sample Mount .................................................................................... 26
6.2.2 Power and Communication Issues ................................................................. 48
6.2.3 Compressor Issues & Failure Modes .............................................................. 48
6.3 System Checks .................................................................................................... 49
  6.3.1 Temperature Optimization ........................................................................... 49
  6.3.2 Vibration Mitigation ..................................................................................... 51
  6.3.3 Vacuum Check ............................................................................................ 51
  6.3.4 Helium Check .............................................................................................. 52
  6.3.5 Helium Recharge Process ............................................................................ 53
Section 7 - Appendices .......................................................................................... 55
  7.1 Related Documentation .................................................................................... 55
Section 1 - Preface

WARNNG

Read all instructions before using this product
All users must read and understand this manual and all other safety instructions before using the equipment. Retain these instructions for future reference.

This manual is intended for users of the Montana Instruments products and systems described herein. Users include anyone who may physically interact with the system or peripheral equipment, including installing, setting up, or configuring the system or anyone who may operate system components via operating panels, the supplied user interface, or remote interfaces.

This manual may be used by facilities personnel for determining infrastructure requirements in the room or building where the equipment will be installed.

This manual should be referenced by authorized service personnel for important safety and hazard information and other product restrictions.

1.1 Conventions Used in this Manual

The following style conventions are used in this document:

- Vertical bar ( | )
  - Indicates alternative selections. The bar may be used in place of “and” or “or”.
- Alphanumeric List (1., 2., 3...| a., b., c...)
  - Indicates instructions or actions which should be completed in a specific ordered sequence.
- Bulleted List (• | ◦ | -)
  - Indicates instructions, commands, or additional information about an action.
  - May alternatively be used for unordered lists of materials or additional reference notes.
- Courier Font
  - Indicates a label or indicator on a physical product or part.
  - Indicates a system output, such as a display reading.
  - May also be used for URLs, file paths, file names, scripting language, prompts, or syntax.

1.1.1 Abbreviations

The following abbreviations may be used:

- ACM: Ancillary Control Module
- CAN: Controller Area Network
- DMM: Digital Multimeter
- HDMI: High-Definition Multimedia Interface
- MI: Montana Instruments
- PCB: Printed Circuit Board
- TCM: Temperature Control Module
- UI: User Interface
- UPS: Uninterruptible Power Supply
- USB: Universal Serial Bus
- VNC: Virtual Network Computing

### 1.1.2 International System of Units (SI) Symbols

- C: Celsius
- cm: Centimeter
- K: Kelvin
- kg: Kilogram
- m: Meter
- mK: Millikelvin
- MPa: Megapascal
- mTorr: Millitorr
- mW: Milliwatt
- s: Second

### 1.1.3 System of Imperial Units Symbols

- ft, ‘: Foot
- in, “: Inch

### 1.1.4 Explanation of Safety Warnings

Safety and hazard information includes terms, symbols, warnings, and instructions used in this manual or on the equipment to alert users to precautions in the care, use, and handling of the system. The following hazard levels and information are considered:
1.1.5 Graphical Symbols
The following symbols may be used in diagrams, supporting text, and on physical parts:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>🚨 !</td>
<td>Hazard Alert: General Warning</td>
</tr>
<tr>
<td>🚨 ⚡</td>
<td>Hazard Alert: Laser Radiation</td>
</tr>
<tr>
<td>🌐 HDMI</td>
<td>HDMI port</td>
</tr>
<tr>
<td>🕵️ CA</td>
<td>CAN bus module</td>
</tr>
<tr>
<td>🎁 USB</td>
<td>USB port</td>
</tr>
</tbody>
</table>

1.2 General Hazard Information
The following descriptions are of general hazards and unsafe practices that may result in product damage, severe injury, or death.

- The products, parts, and components in this manual are to be serviced by authorized Montana Instruments service representatives only. Failure to do so will void the warranty and may damage the product and/or create a safety hazard.
- Only use all components provided for the intended purpose described herein.
- If the equipment or any component is used or modified in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.
The following hazards may be typical for this product:

⚠️ **WARNING**
**Risk of injury when lifting or moving system components**
System components, including standalone equipment and installed assemblies, may be heavy.
- Use caution when lifting or moving equipment or assemblies. Ensure proper lifting principles are used to avoid injury.
- Equipment or assemblies >20 kg should always be lifted by two or more people or with a suitable lifting device.

⚠️ **WARNING**
**High voltage: danger of electric shock**
Electric shocks and burns from capacitor discharge or power circuits could lead to serious injury or death.
- Before turning on any power supply, the ground prong of the power cord plug must be properly connected to the ground connector of the wall outlet. The wall outlet must have a third prong or must be properly connected to an adapter that complies with these safety requirements.
- Only use replacement power cords or power plugs with the same polarity and power rating as that of the original ones. Do NOT use inadequately rated cables.
- If the equipment or the wall outlet is damaged, the protective grounding could be disconnected.
- Do NOT use damaged equipment until its safety has been verified by authorized personnel.
- Do NOT disconnect or tamper with the operation of the protective earth terminal inside or outside the apparatus.

⚠️ **NOTICE**
**Only clean exterior surfaces with acceptable fluids**
- Only use deionized water, glass cleaner, or isopropyl alcohol to clean the exterior surfaces of any enclosure. Do NOT use any volatile chemicals other than isopropyl alcohol.
- Apply fluid to a clean, lint-free cloth and wipe surface with cloth. Do NOT apply fluid directly to any surfaces or enclosures.

1.3 Technical Support Information

Any technical questions or issues with the system that cannot be resolved with the information in this manual should be referred to an authorized Montana Instruments service representative.

1.3.1 Warranty & Repairs

If the system or parts need to be returned to the Montana Instruments factory or an authorized service center for repair or service, contact an authorized service representative for a return merchandise authorization (RMA) number and instructions on returning the unit.

For a copy of the Limited Warranty Agreement, visit: [https://www.montanainstruments.com/support/warranty-information](https://www.montanainstruments.com/support/warranty-information)
1.3.2 Accessories & Replacement Parts
Only use cables, hoses, accessories, and parts provided or approved by the manufacturer. Follow all instructions for proper installation or replacement.

- To order spare or replacement parts, please contact your local service representative.
- To order new accessories or options, or for more information on other Montana Instruments products and technologies, please contact your local sales representative.

1.3.3 Contact Details
For a complete list of sales and service centers visit: www.montanainstruments.com/Contact

North American Authorized Service
- M-F 8:30am-5pm MST | Call: +1.406.551.2796
- Email: support@montanainstruments.com

North American Sales
- M-F 8:30am-5pm MST | Call: +1.406.551.2796
- Email: sales@montanainstruments.com

International Sales & Authorized Service
- Visit www.montanainstruments.com/Contact for contact information for your local representative.
2.1 Cryostation

2.1.1 Intended Use

The system is a closed-cycle optical Cryostation used to control the temperature and vacuum parameters of an integrated sample environment.

The Cryostation is designed to connect to the system control unit, vacuum control unit, and helium compressor provided by Montana Instruments. The back panel of the Cryostation includes interface locations for these cable and hose connections.

2.1.2 Components

Accessory kit

The CryoCore ships with an operational accessory kit containing basic maintenance and usability equipment:

- Window tool: for removing vacuum window retaining rings
- Helium purge adaptor and recharge adaptor
- Compressor water hose connectors: barb to compression fitting
- Coax SMP extraction tool
- Apiezon® N-grease: for thermal connections
**Figure 1:** Cryostation interconnect diagram - F20-L compressor
Cryostation
The Cryostation consists of the cooling tower assembly and the sample chamber, connected by a baseplate and a semi-rigid bellows assembly. The entire Cryostation assembly is rigidly mounted at either 45° or 90° to the hole pattern on an optical table via screw locations in the baseplate (optical table not included). The Cryostation can be mounted on either imperial or metric optical tables.

Cooling Tower Assembly
The main cooling is provided by a two-stage Gifford-McMahon cryocooler suspended inside the cooling tower assembly. A vibration damping support structure serves to isolate the cryocooler mechanical vibrations from the optical table and sample platform. The cryocooler is part of a closed-loop flow of helium which is pressurized by the separate helium compressor.

The cryocooler has two principal stages, each with thermometers to monitor temperature and heaters for warmup. Stage 1 is thermally coupled to the radiation shield inside the sample chamber. Stage 2 is thermally coupled to the sample mount platform.

Sample Chamber
The sample chamber consists of the lower vacuum housing with interfacing side panels, the sample mount platform and sample mount assembly, a surrounding radiation shield with inner “cold” windows, and the upper vacuum housing assembly with outer “warm” windows.

Thermal fluctuations are damped using both active and passive techniques. The sample platform mitigates the effects of gross thermal contraction during cooldown by using a thermal contraction-canceling design of the sample support structure.

Helium Compressor
The helium compressor is a single-phase, single-speed, water-cooled compressor. Refer to the Operating Instructions provided by the original manufacturer for specific unpacking, setup, and operating instructions and important safety information regarding the compressor.

2.1.3 Technical Specifications

Environmental Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature of Environment</td>
<td>5 – 40 °C</td>
</tr>
<tr>
<td>Humidity</td>
<td>5 – 80% non-condensing</td>
</tr>
<tr>
<td>Altitude</td>
<td>&lt;2000 m</td>
</tr>
</tbody>
</table>
Power Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>F-20L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mains Power Cable</td>
<td>NEMA L6-20P</td>
</tr>
<tr>
<td>Line Voltage</td>
<td>200 – 230 VAC</td>
</tr>
<tr>
<td>Frequency (region specific)</td>
<td>50 Hz or 60 Hz</td>
</tr>
<tr>
<td>Maximum Current Draw</td>
<td>15.0 A</td>
</tr>
<tr>
<td>Maximum Power Consumption</td>
<td>2.6 kW</td>
</tr>
</tbody>
</table>

Chilled Water Requirements

<table>
<thead>
<tr>
<th>Model</th>
<th>F-20L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Connections</td>
<td>Barb fitting for ½” tubing</td>
</tr>
<tr>
<td>Water Inlet Temperature</td>
<td>4° - 27° C (40° - 80° F)</td>
</tr>
<tr>
<td>Cooling Water Pressure (Min/Max)</td>
<td>210 kPa (30 psig) / 800 kPa (116 psig)</td>
</tr>
<tr>
<td>Cooling Water Flow (Minimum)</td>
<td>1.9-3.8 L/min (0.5-1.0 GPM)</td>
</tr>
<tr>
<td>Water Chiller Cooling Capacity</td>
<td>≥3.0 kW (11,000 BTU/hr)</td>
</tr>
</tbody>
</table>

1. Cryostation system performance is validated with input water at 20° C and 1.0 gpm flow rate 
2. Applies only if you are using a water chiller unit connected to the compressor. If using facility water, Temperature, Pressure & Flow are the critical parameters.

Physical Dimensions

<table>
<thead>
<tr>
<th>Component</th>
<th>L x W x H</th>
<th>Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cryostation</td>
<td>56.3 cm x 23.2 cm x 49 cm</td>
<td>29 kg</td>
</tr>
<tr>
<td>Compressor</td>
<td>68 cm x 43 cm x 53 cm</td>
<td>93 kg</td>
</tr>
</tbody>
</table>

2.1.4 Safety Information

The following hazards may be typical for this product:

**WARNING**

Risk of serious injury due to hazards associated with cryocooling
All personnel working with the system must be aware of the potential hazards associated with cryocooling.
- Personnel working with the system should be trained in emergency measures that may be required in the event of an accident.

Risk of suffocation due to potential asphyxiates.
Nitrogen (N₂) and Helium (He) are potential asphyxiates if released into an enclosed area with poor ventilation. A decrease in air oxygen content can be caused by leaks.
- Ensure that proper tubing is used and good connections are made at each connection point to prevent release of these gases.

Risk of explosion due to high pressure if system is not allowed to vent properly.
- Never bolt or otherwise fasten the lid of the sample chamber closed. The lid acts as a safety pressure release in the event of high-pressure accumulation in the Cryostation.

**Risk of cold contact burns.**
Parts of this system are very cold and may cause severe burns to the skin.
- Allow components to warm up to room temperature before touching. If contact occurs, consult a physician immediately.

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Refer to associated product manuals for complete safety information</strong></td>
</tr>
<tr>
<td>- The system includes an SHI F-20L compressor. Refer to the Operating Instructions provided by SHI for important maintenance and safety information regarding this component.</td>
</tr>
<tr>
<td>- If these components are used in a manner not specified by the original manufacturer, the protection provided by the equipment may be impaired.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NOTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Take care when moving the Cryostation</strong></td>
</tr>
<tr>
<td>- Do NOT tilt the Cryostation more than 45 degrees. Inverting the Cryostation will cause damage.</td>
</tr>
<tr>
<td>- The Cryostation and sample chamber are a single unit. The attached sample chamber must be supported at all times. Do NOT lift the Cryostation by the sample chamber.</td>
</tr>
<tr>
<td>- Do NOT lift the Cryostation by the cryocooler tube or the top of the main body enclosure.</td>
</tr>
<tr>
<td>- The Cryostation ships with red locking plugs and a shipping support to prevent damage to sensitive components. Do NOT remove these until after the unit has been attached to the table.</td>
</tr>
</tbody>
</table>

**Take care when moving the compressor**
- Do NOT tilt the compressor. Doing so may damage the unit.
- The compressor is on casters for moving. Ensure casters are locked prior to operating.

**Risk of product damage due to improper use**
- Never disconnect the vacuum hose while the temperature of any stage of the Cryostation is below 285 K. Never open the case or vent valves when the temperature of any stage is below 285 K.
- Only use dry nitrogen gas with the Cryostation. Do NOT substitute other gases for system venting.
- Avoid using any material in the sample chamber that may outgas or otherwise contaminate the optical windows and Cryostation surfaces.
- When manually operating heaters, monitor the Stage 1 and Stage 2 temperatures to ensure these temperatures do NOT rise above 350 K. Temperatures above 350 K may damage critical components within the system.
2.2 System Control Unit

<table>
<thead>
<tr>
<th>Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC1160</td>
</tr>
</tbody>
</table>

2.2.1 Intended Use
The system control unit is a device used for instrumentation control of Montana Instruments products. It provides both the electronics hardware and software interface for communicating with other devices and controlling various instrument parameters.

2.2.2 Components
The system control unit consists of an outer enclosure, single board computer, peripheral cards, a touchscreen user interface display, and several communication ports. The enclosure is compatible with a standard 19-inch equipment rack (4U) and can be mounted with other rack mount devices. It can alternatively be placed independently on a table or shelf.

User Interface Touchscreen
A 10-inch touchscreen display provides the main user interface control for the system. The software can alternatively be monitored and controlled via a VNC interface or remote scripting.
Enclosure Communication Ports

**SC1160 (two peripheral cards) rear enclosure**

**HDMI**
The HDMI port on the rear face of the enclosure is used to interface with the touchscreen display.

**USB**
Two USB ports are available on the rear face of the enclosure. One of these is used to interface with the touchscreen display.

Four USB ports are available on the front face of the enclosure. These can be used for communicating with an external storage drive (only a single USB storage drive is supported at one time).

**Ethernet**
An ethernet port is available on the rear face of the enclosure for connecting with a local network or computer. A local network connection is required for controlling the instrument via the remote graphical display or scripting features, and a network internet connection is required for remote technical support.

**Ancillary Control Module (ACM)**
An ACM peripheral card in the attached system control unit is used to control the valves and pumps in the vacuum control unit. The DSUB25 port (VACUUM CONTROL) on the ACM is used to interface with the vacuum control unit.
Temperature Control Module (TCM)
A TCM peripheral card in the system control unit is the communication interface used to control the thermometry and heaters located on the cryocooler stages, platform, and user channels and display those readouts in the UI.

The DSUB37 port (HEATER/TEMPERATURE CONTROL) on the TCM card connects to the DSUB37 port on the back panel of the Cryostation.

2.2.3 Technical Specifications

Environmental Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature of Environment</td>
<td>5 – 25 °C</td>
</tr>
<tr>
<td>Humidity</td>
<td>5 – 80% non-condensing</td>
</tr>
<tr>
<td>Altitude</td>
<td>&lt;2000 m</td>
</tr>
</tbody>
</table>

Power Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Model SC1160</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mains Power Connector on Unit</td>
<td>IEC 60320 C14</td>
</tr>
<tr>
<td>Line Voltage</td>
<td>100 – 240 VAC</td>
</tr>
<tr>
<td>Frequency</td>
<td>50 – 60 Hz</td>
</tr>
<tr>
<td>Maximum Current Draw</td>
<td>6.65 A</td>
</tr>
<tr>
<td>Wall Outlet / Receptacle</td>
<td></td>
</tr>
<tr>
<td>N. America &amp; non-EU</td>
<td>Standard NEMA 5-15</td>
</tr>
<tr>
<td>CEE Europe (non-UK)</td>
<td>CEE 7/3 or CEE 7/5 w/ common ground terminal</td>
</tr>
<tr>
<td>UK</td>
<td>BS1363 (UK) w/ common earth ground terminal</td>
</tr>
<tr>
<td>Israel</td>
<td>I-32-3 w/ common earth ground terminal</td>
</tr>
<tr>
<td>Cart Power Module</td>
<td>IEC 60320 C13</td>
</tr>
</tbody>
</table>

Physical Dimensions

<table>
<thead>
<tr>
<th>Component</th>
<th>L x W x H</th>
<th>Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC1160</td>
<td>43 cm x 38 cm x 17 cm</td>
<td>13.6 kg</td>
</tr>
</tbody>
</table>
2.2.4 Safety Information

The following hazards may be typical for this product:

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk of injury due to sharp edges</strong></td>
</tr>
<tr>
<td>The interior of the enclosure contains sheet metal parts that may have sharp edges.</td>
</tr>
<tr>
<td>• When working inside the enclosure (authorized service personnel only), exercise caution to avoid getting cut by these edges.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High voltage: danger of electric shock</strong></td>
</tr>
<tr>
<td>Electric shocks and burns from capacitor discharge or power circuits could lead to serious injury or death.</td>
</tr>
<tr>
<td>• Prior to accessing the enclosure or when otherwise servicing the unit (authorized service personnel only), completely power down the system and unplug the power cable.</td>
</tr>
<tr>
<td>• If power must be applied to diagnose issues or otherwise, a grounding strap must be applied to the arm interfacing internal components.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NOTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Peripheral cards must not exceed 600 W to avoid product damage</strong></td>
</tr>
<tr>
<td>• The system control unit can supply a maximum power of 600 W across all installed peripheral cards. Ensure the cumulative power of all installed peripheral cards (maximum power rating of all cards added together) does not exceed 600 W.</td>
</tr>
<tr>
<td><strong>Transportation and installation</strong></td>
</tr>
<tr>
<td>• When not in a rack unit, the enclosure should not be stacked on any other equipment, nor should other equipment be placed on it.</td>
</tr>
<tr>
<td>• Allow 8 cm minimum clearance from any ventilated face (sides, front) and 20 cm clearance in the rear for cables and hoses.</td>
</tr>
<tr>
<td>• Do NOT move the unit while operational. Remove all cables prior to moving. Lift the enclosure by using both handles on the front face.</td>
</tr>
</tbody>
</table>
2.3 Vacuum Control Unit

2.3.1 Intended Use
The vacuum control unit is a device used for vacuum control of Montana Instruments cryostats. It is designed to connect to the system control unit and Cryostation provided by Montana Instruments. It is recommended to locate the vacuum control unit near both connected apparatuses.

2.3.2 Components
The vacuum control unit consists of an outer enclosure, diaphragm (roughing) pump, ¼ inch vacuum coupling O-ring connection, two valves, and several communication ports. The enclosure is compatible with a standard 19-inch equipment rack (6U) and can be mounted with other rack mount devices. It can alternatively be placed independently on a table or shelf.

The roughing pump is used to achieve a rough vacuum. A high vacuum is achieved with cryopumping. During cooldown, the sample platform temperature lags the Stage 1 temperature in the Cryostation by ~100 K so that remaining particles are trapped by the charcoal adsorbers, keeping the sample clean and free from contamination. When venting after warmup, a dry nitrogen purge (if attached) is used to clean the vacuum system.
Enclosure Communication Ports

VC110 enclosure, rear

DSUB25 (VACUUM CONTROL)
The DSUB25 port on the rear face of the enclosure is used to interface with the system control unit Ancillary Control Module. This connection allows the system control unit to control the pumps and valves in the vacuum control unit and display roughing pump, vent valve, case valve, and system pressure readouts in the UI.

3-Socket Connector (COMPRESSOR CONTROL)
The 3-socket connector on the rear face of the enclosure is used to interface with the compressor. This connection provides a remote ON/OFF control to the compressor.

2.3.3 Technical Specifications

Environmental Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Specification Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature of Environment</td>
<td>5 – 25 °C</td>
</tr>
<tr>
<td>Humidity</td>
<td>5 – 80% non-condensing</td>
</tr>
<tr>
<td>Altitude</td>
<td>&lt;2000 m</td>
</tr>
</tbody>
</table>
### Power Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>VC1110</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mains Power Connector on Unit</td>
<td>IEC 60320 C14</td>
</tr>
<tr>
<td>Line Voltage</td>
<td>100 – 240 VAC</td>
</tr>
<tr>
<td>Frequency</td>
<td>50 – 60 Hz</td>
</tr>
<tr>
<td>Maximum Current Draw</td>
<td>1.9 A</td>
</tr>
<tr>
<td>Wall Outlet / Receptacle</td>
<td></td>
</tr>
<tr>
<td>N. America &amp; non-EU</td>
<td>Standard NEMA 5-15</td>
</tr>
<tr>
<td>CEE Europe (non-UK)</td>
<td>CEE 7/3 or CEE 7/5 w/ common ground terminal</td>
</tr>
<tr>
<td>UK</td>
<td>BS1363 (UK) w/ common earth ground terminal</td>
</tr>
<tr>
<td>Israel</td>
<td>I-32-3 w/ common earth ground terminal</td>
</tr>
<tr>
<td>Cart Power Module</td>
<td>IEC 60320 C13</td>
</tr>
</tbody>
</table>

### Physical Dimensions

<table>
<thead>
<tr>
<th>Component</th>
<th>L x W x H</th>
<th>Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>VC1110</td>
<td>43 cm x 38 cm x 26.5 cm</td>
<td>24 kg</td>
</tr>
</tbody>
</table>

### 2.3.4 Safety Information

The following hazards may be typical for this product:

**WARNING**

**Risk of injury due to sharp edges**

The interior of the enclosure contains sheet metal parts that may have sharp edges.

- When working inside the enclosure (authorized service personnel only), exercise caution to avoid getting cut by these edges.

**WARNING**

**High voltage: danger of electric shock**

Electric shocks and burns from capacitor discharge or power circuits could lead to serious injury or death.

- Prior to accessing the enclosure or when otherwise servicing the unit (authorized service personnel only), completely power down the system and unplug the power cable.
- If power must be applied to diagnose issues or otherwise, a grounding strap must be applied to the arm interfacing internal components.
## NOTICE

**Risk of product damage due to improper use**
- Do NOT kink vacuum tubing or install vacuum tubing in an area where it may be pinched.
- Ensure all vacuum clamps and fittings are secured tightly prior to operation.

**Transportation and installation**
- When not in a rack unit, the enclosure should not be stacked on any other equipment, nor should other equipment be placed on it.
- Allow 8 cm minimum clearance from any ventilated face (sides, front) and 20 cm clearance in the rear for cables and hoses. For the VC1130, allow 30 cm rear clearance.
- Do NOT move the unit while operational. Remove all cables prior to moving. Lift the enclosure by using both handles on the front face.
3.1 Accessing the Sample Space

Before starting the Cryostation, check inside the sample space for any foam inserts. These are used only for shipping and should be removed before cooling the system down for the first time.

**NOTICE**

*Keep sample chamber and surfaces clean*
- Always wear clean gloves when working in the sample chamber to avoid getting oils on the surfaces.
- Take care not to touch the optical windows on the lid, window assembly, or the internal radiation shield. Window covers are provided to keep the windows clean.
- Be sure to keep the O-ring seals clean and free from debris. Do NOT set the housing down on an O-ring seal unless there are protruding bosses to keep it from touching the surface.
- When working inside the sample chamber, use extreme caution not to drop screws down into the chamber assembly.

Start with the system at room temperature and the chamber vented to atmospheric conditions.

1. Carefully lift the top lid from the sample chamber and place it on the table with the protruding bosses down. The lid may sit on the bosses without compromising the clean surface inside the lid.
2. Using two hands, carefully lift the Upper Vacuum Housing from the sample chamber. Place the window assembly on the table so that it rests on a flattened corner (not on a window). This will keep the interior surfaces and windows clean and free from scratches.
3. Lift the lid from the radiation shield to remove it.
4. Unfasten the four M3 button head screws on each side of the radiation shield. Lift up and over any sample mount structures to remove.
**NOTICE**

**Take care when reassembling the sample chamber**

- Before replacing the vacuum housing & lid, carefully check O-rings for any loose fibers or debris (this could affect vacuum performance).
- Take care not to overtighten screws when replacing the radiation shield. If a torque wrench is accessible, set the torque value to 5 in-lbs.

### 3.2 Sample Mounting

The system includes an adjustable sample mount assembly with R2D12 electrical sample mount adapter.

#### 3.2.1 Standard Adjustable Sample Mount

The standard general purpose adjustable sample mount includes a thermally damped post with standard interface bolt pattern than can be mounted vertically or horizontally to position the sample at various distances and angles with respect to any of the optical windows – it will be factory-configured in the vertical orientation.
Installing the Sample Mount Base

The base of the sample mount assembly attaches to a platform spacer on the sample mount platform. It can be rotated with respect to the mounting hole locations to achieve various orientations.

1. Apply a thin layer of N-grease to the bottom of the sample mount spacer.
2. Place the sample mount spacer on the sample mount platform. Align the screw locations in the spacer with the corresponding hole pattern on the platform.
3. Apply a thin layer of N-grease to the bottom of the sample mount base.
4. Place the sample mount base on the platform or platform spacer. Align the screw locations in the sample mount with the corresponding hole pattern on the mounting surface.
5. Using four M3x25mm brass slotted pan head screws, four M3 spacers, and M3 Belleville washers (concave side down), attach the sample mount and spacer to the mounting surface. Tighten screws until the washer is compressed.

Installing the Damped Post

The sample or optional R2D12 electrical sample mount is attached to the square flat surface on the end of the thermally damped post (the “damper”). To install the damper in the sample mount base.

1. Decide on the orientation. The post can be mounted horizontally or vertically. Slide the damper through the horizontal or vertical post location in the base.
   a. The sample mount end can face either direction.
2. The damper can slide in or out of the hole location to position the sample at various locations, such as close to a window. Adjust the damper to the desired location.
3. Once the damper and sample are in the desired location, tighten the adjustment screw so the post can no longer move.

3.2.2 R2D12 Electrical Sample Mount Option

The R2D12 is a cryogenic optimized circuit board with 12 DC electrical contact pads and 2 RF coax SMP connections. The mount accommodates a 10 mm square sample. It is compatible with Montana Instruments exchange boss mounts (ø 6.35 mm).

Installing the Exchange Boss Adapter

The circuit board connects to a fixed exchange boss sample mount via a quick-change connector clamp with set screw. The exchange boss adapter must be installed on the end of the damped post first.

1. Apply a thin layer of N-grease to the bottom of the exchange boss adapter.
2. Place the exchange boss adapter on the end of the damped post. Align the screw locations in the spacer with the corresponding hole pattern on the post.
3. Using four M1.6x10mm screws, attach the adapter to the post.

Installing the R2D12

The bottom of the circuit board has a connector ring that fits around the protruding boss (ø 6.35 mm cylinder) on the exchange boss adapter.
1. Loosen the set screw on the PCB connector ring clamp.
2. Place the connector ring clamp over the protruding boss on the adapter.
3. Tighten the set screw to secure the clamp around the boss.

Wiring the R2D12 Sample Mount

The DC wires that run to the sample mount are routed from the mount, under the thermal clamps and exit the sample chamber via the DC1 & DC2 PCB sockets in the sample chamber, which output to the external DC1 & DC2 sockets. Refer to Wiring Schematics for details.

The RF coax lines that run to the sample mount are also routed through the thermal clamps and exit the sample chamber through the SMP connectors on the sample chamber side panel.

3.2.3 Mounting a Sample

Before mounting a sample, carefully remove the sample mount from the platform.

1. Remove the previous sample from the face of the mount. Clean off residual grease with a Kimwipe or lens tissue (use a small amount of isopropanol or acetone if needed)
2. Apply a thin layer of new N-grease to the sample mount surface. Use a flat tool (not metal or cotton) to spread the grease out evenly in a thin layer, taking care not to scratch the surface.

**NOTICE**

Do not use N-grease for temperatures above 300 K

Apiezon® N-grease becomes significantly less viscous at 305 K. If the user plans to operate above 300 K, it is recommended to use an alternative sample mounting material to ensure a vertically mounted sample does not slide off the sample mount.

**NOTE**

Depending on the sample, VGE, silver paint/paste, or copper SEM tape can be used in place of N-grease.

3. Using tweezers, set your sample on top of the grease layer and press down gently to ensure a good thermal connection.
Step 1: Clean surface & apply grease

Step 2: Re-grease mounting surface

Step 3: Attaching new sample

**NOTE**
To check if the sample is secure, hold sample mount horizontally so the sample faces down and forcibly tap the mount with a finger.

### 3.3 Mounting a Thermometer

The sample thermometer wiring harness is connected to the User 1 system control temperature channel via the User 1 thermometer (USER1 THERM) pins on the sample chamber circuit board. Refer to *Wiring Schematics* for these pin locations. Ensure the wiring harness is routed under a thermal clamp.

The standard adjustable mount uses a plug style thermometer that attaches to a mounting hole location at the end of the sample mount damped post. If the thermometer needs to be re-installed, refer to the instructions below.
**NOTICE**

*Cernox® thermometer wires are extremely fragile.*

Handle wires with care to avoid breaking.

1. Remove any VGE (the adhesive lagging the thermometer wire) with isopropyl alcohol or acetone. Clean off any residual VGE.
2. Clean off the area where the thermometer will be mounted with isopropyl alcohol or acetone.
3. Attach the thermometer, ensuring the bottom is in even, flat contact with the mounting surface.
   a. **With Clamp:** Apply a thin layer of N-grease to the bottom of the thermometer. Clamp it down securely, ensuring no part of the thermometer “springs up” from the surface.
   b. **Without Clamp:** Apply a small amount of VGE (thinned with acetone or isopropyl alcohol) to the bottom of the thermometer, wait 10 seconds, then place on the mounting surface. Use a small weight to apply pressure and hold the sensor in place while it cures (24 hours under ambient conditions or 30 minutes under 60 °C heat).

---

*Step 3a: Thermometer clamped to mounting surface*
Step 4a: Wire is NOT lagged around post cylinder

4. To properly lag wire, apply VGE to approximately the first 0.5 inches (1 cm) of wire and press to a metal surface. Do not encase the wire in VGE.
   a. For damped post plus PCB to fit inside the sample chamber in vertical configuration, wire lagging must remain only around the square portion of the post. It should not contact the cylinder of the post as that may prevent the post fully seating in the “down” position, causing collision between the user's sample and the top radiation shield window.

» NOTE

- Be sure the thermometer and wire are completely dry before pulling vacuum or cooling down the system. The wire should not touch the radiation shield or sample mount.
- The sample temperature may read higher than the platform.
3.4 Windows

3.4.1 Window Covers
The sample chamber has five optical access locations. The system ships with window covers in place. The window covers are removed by turning counter-clockwise until the notches are aligned with the openings in the window retaining ring. To replace the covers, re-align the notches and turn clockwise until the cover locks in place.

» NOTE
If the system is running, use care when removing the window covers, as this may loosen the retaining ring holding the window in place.

3.4.2 Window Replacement
Vacuum Windows
For replacing outer (warm) vacuum windows, a special window tool is provided in the accessory kit:

1. Align the tabs on the window tool with the corresponding notches in the Delrin retaining ring holding the window in place.
2. Use the window tool to loosen the retaining ring by turning counter-clockwise.
3. Remove the retaining ring to access the window.
4. Prior to reinstalling the window, check the O-ring to ensure it is clean and free of debris and has a very thin layer of L-grease (just enough so the surface is shiny).
5. Reinstall the window by carefully setting it centered on the O-ring, ensuring the O-ring is fully covered by the window. Avoid having to re-position the window, as this may spread L-grease onto the clear aperture.
Steps 1-2: Using window tool to unscrew retaining ring

Step 3: Removing retaining ring

Window centered on O-ring

---

**NOTICE**

**Take care when handling and removing windows**

- Handle the radiation shield and windows carefully to prevent scratches or fingerprints.
- Before using the window tool, remove the housing from the system.
- Take care not to use too much force on the window tool as this could cause it to slip and damage the window.
Radiation Shield Windows

The inner (cold) windows on the radiation shield are held in place with a tension ring.

1. The radiation window holders are removed by unscrewing the threaded tension ring.
2. Remove the window from the tension ring by pressing it out of the spring fingers. Some force may be required.
3. Prior to reinstalling the window, add a very thin layer of N-grease to the edge of the spring fingers. This layer should be thin enough so none of the grease spreads onto the optic when re-assembled.
4. Reinstall the window by press fitting the tension ring onto the window. Ensure the spring fingers hold the window tightly and evenly.
5. For threaded tension rings, add a small amount of N-grease to the threads before screwing back in place.

| Step 1: Unscrewing threaded tension ring | Pressing window out of tension ring | Pressing tension ring onto window |

**NOTE**

- The threaded holders can be adjusted to allow the sample to be positioned closer to external optics. Always ensure that no portion of the radiation shield touches the outer housing and that the radiation and vacuum windows do not collide with one another.
- If a radiation window is removed, the added heat load can be as much as 50 – 100 mW per window. Depending upon the emissivity and thermal conductivity of the sample, local heating of the sample from this excessive radiation can cause the sample to be several degrees warmer than the cold platform it is mounted to.
3.5 Sample Chamber Wiring

3.5.1 Types of Wiring
Various applications require different types of wiring. Always select the optimal wire for the application with the appropriate diameter (between 32-40 gauge). Longer wires are ideal -- the length of wiring between stages should be at least 2 in (5 cm).

- **32 AWG Phosphor Bronze wire**: _low thermal conductivity and good for moderate power transmission_
  - Recommended use: Building additional wiring harnesses
  - Raises temperature ~5.0 mK per wire
- **Copper wire**: _high thermal conductivity and good for high power transmission_
  - Recommended use: Wiring harness for high power transmission when high base temperatures are acceptable
  - Raises temperature ~300 mK per wire

» NOTE
See our [Cryostation Wiring Guide](#) for details, theory and illustrations.

3.5.2 Thermal Lagging Techniques
To minimize the effects of wiring heat loads on the base temperature, all incoming wiring (including coax cables) must be properly thermally lagged to Stage 1 of the cryocooler via the radiation shield.

Wiring must route under the thermal clamp locations:

1. Unscrew the two M2.5 screws on the top of the thermal clamp. Remove the top cover.
2. Wrap a small piece of Kapton® tape around the wires to help prevent electrical shorts.
3. Place the wires on the felt pad. Wires should not cross or touch one another under the clamp.
4. Replace the top cover of the clamp and replace the two screws. Do NOT overtighten.
5. Check to ensure wires do not touch the inside of the radiation shield.

» NOTE
Ensure there are a few inches of wire before and after the thermal clamp. A 10-inch (25 cm) wire should be thermally lagged such that 5 inches (12.5 cm) is outside of the thermal clamp and the remaining 5 inches (12.5 cm) is inside of the 4K sample space.
3.5.3 User Wiring Interfaces

The Cryostation provides integrated connectors for user DC feedthroughs and a user thermometer.

**NOTICE**

**Do NOT remove sample chamber circuit boards**
- The black printed circuit board should not be removed. The black Delrin screws holding it in place should remain loose. Overtightening can cause the board to flex and make it difficult to obtain a proper vacuum seal.
- The Operational wiring and cables must remain connected for the system to be operational. Do NOT modify these connections.

**User DC Connections**

User DC connections allow users to route wiring to header pins on the sample chamber circuit board. These available connections can be used to interface with external connections and devices.

**User Temperature Channels**

A sample thermometer is provided and the temperature and stability outputs can be viewed in the touchscreen UI.

**NOTE**

The provided sample thermometer is symmetric, so it can be connected to Pin 1 in either orientation.
3.5.4 Wiring Schematics

All wiring must be routed from the sample chamber circuit board under the thermal clamps into the cold space.

<table>
<thead>
<tr>
<th>User Interface</th>
<th>Internal Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature Channel</td>
<td>PCB</td>
</tr>
<tr>
<td>USER 1</td>
<td>USER1 THERM</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### User Temperature Channels

<table>
<thead>
<tr>
<th>Sample Chamber</th>
<th>External</th>
<th>Sample Chamber</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC1 (J10), PIN 1</td>
<td>DC1 (J11), PIN 1</td>
<td>DC2 (J12), PIN 1</td>
<td>DC2 (J13), PIN 1</td>
</tr>
<tr>
<td>DC1 (J10), PIN 2</td>
<td>DC1 (J11), PIN 2</td>
<td>DC2 (J12), PIN 2</td>
<td>DC2 (J13), PIN 2</td>
</tr>
<tr>
<td>DC1 (J10), PIN 3</td>
<td>DC1 (J11), PIN 3</td>
<td>DC2 (J12), PIN 3</td>
<td>DC2 (J13), PIN 3</td>
</tr>
<tr>
<td>DC1 (J10), PIN 4</td>
<td>DC1 (J11), PIN 4</td>
<td>DC2 (J12), PIN 4</td>
<td>DC2 (J13), PIN 4</td>
</tr>
<tr>
<td>DC1 (J10), PIN 5</td>
<td>DC1 (J11), PIN 5</td>
<td>DC2 (J12), PIN 5</td>
<td>DC2 (J13), PIN 5</td>
</tr>
<tr>
<td>DC1 (J10), PIN 6</td>
<td>DC1 (J11), PIN 6</td>
<td>DC2 (J12), PIN 6</td>
<td>DC2 (J13), PIN 6</td>
</tr>
<tr>
<td>DC1 (J10), PIN 7</td>
<td>DC1 (J11), PIN 7</td>
<td>DC2 (J12), PIN 7</td>
<td>DC2 (J13), PIN 7</td>
</tr>
<tr>
<td>DC1 (J10), PIN 8</td>
<td>DC1 (J11), PIN 8</td>
<td>DC2 (J12), PIN 8</td>
<td>DC2 (J13), PIN 8</td>
</tr>
<tr>
<td>DC1 (J10), PIN 9</td>
<td>DC1 (J11), PIN 9</td>
<td>DC2 (J12), PIN 9</td>
<td>DC2 (J13), PIN 9</td>
</tr>
<tr>
<td>DC1 (J10), PIN 10</td>
<td>DC1 (J11), PIN 10</td>
<td>DC2 (J12), PIN 10</td>
<td>DC2 (J13), PIN 10</td>
</tr>
</tbody>
</table>

### User DC Connections
4.1 System Control Options

4.1.1 User Interface
The touchscreen display provides the primary user interface control of the system.

General Navigation
The example screen above shows the general layout, navigation, and controls for the UI. Not all controls and views will be available for all instruments.

1. **All Channels View**: Displays live status readouts of temperature, stability and heater power for all attached channels of a given instrument. Press a channel to bring up its operation controls and settings. Channel names can be customized in the **MENU**.

2. **Selected Channel Operational View**: Displays the live status readouts and associated controls for the selected channel.
   a. **Function Buttons**: Buttons with action statements tell the system to do something.
   b. **Adjustment Buttons**: Circular buttons with icons provide operational control.
c. **Input Settings:** Buttons with numerical values and units show the current input settings for a given command. To set new values, use the adjustment controls (if available) or press the display box to open an input popup dialog.

3. **Display Screens:** Choose which screen view to display. Alternate screens (when available) may show different readouts or have different control settings.

4. **Screen Lock:** Lock the touchscreen.

5. **Menu:** View or customize instrument and system settings. Other sub-menu features include:
   a. **Remote Connections:** VNC and scripting parameters.
   b. **Data:** Download system data onto a connected USB Flash Drive.
   c. **Event Log:** Historical log of system level events for reference or diagnostics.
   d. **Maintenance:** Displays any recommended maintenance procedures.
   e. **Tech Support:** Settings for assisting technical support personnel.

<table>
<thead>
<tr>
<th>NOTE</th>
</tr>
</thead>
</table>
| • Press and hold a command or input settings button to show on-screen help for that operation. Drag off the button before releasing to avoid executing the operation.  
• The control buttons do not have on-screen help. Pressing and holding will execute the associated operation. |

**Application UI: Cryostation**

**Channel Types**

- **Temperature Channel:** Displays live readouts of thermometers (temperature, temperature stability) and heaters (applied power) in the system.
  - **Platform:** The primary channel used to control the system. These commands will drive control operations across the Cryostation, compressor, and vacuum control unit.
  - **User 1:** The User 1 temperature channel displays the sample thermometer temperature readout.

<table>
<thead>
<tr>
<th>NOTE</th>
</tr>
</thead>
</table>
| • If the sample thermometer is not being used, it is recommended to turn it off to reduce noise on other temperature channels.  
• Navigate to MENU > INSTRUMENT SETTINGS > USER 1. Toggle the Temperature Channel Enabled switch to the left to disable. |

**Display Screens**

- **Sample Chamber:** Displays temperature channel controls and readouts. This screen is used to run most primary system operations.
- **Graphs:** Displays real-time system data in graphical form.
- **Overview:** Displays system status readouts for all connected sub-systems. Press any value to pull up detailed information and additional control settings (if available) for that parameter.
  - **Vacuum System:** status of pumps | valves | N2 input | pressure gauges
  - **Cooler:** status of the cryocooler/compressor | Stage 1 and Stage 2 temperature channels
  - **Sample Chamber:** status of all sample chamber temperature channels
4.1.2 Network Interface

To utilize any of the provided network services, the system control unit must be connected to a local network using the Ethernet port on the rear face of the enclosure.

Each service uses a different network port number for communication. You may need to work with your IT department to configure these ports to be allowed through the firewall on your network.

To find your system’s IP or MAC address:

1. On the touchscreen UI, navigate to **MENU > REMOTE CONNECTIONS**
2. Scroll down to find the system’s unique IP and MAC addresses. Your IT department may need to configure the network to provide network access to the device.

**Webserver | Onboard Documentation**  
Standard HTTP port 80

The onboard webserver provides direct access to system-specific documentation, instrument scripting documentation and examples, web-based data dashboard links, select service documents, and other support materials.

To access the onboard documentation:

1. From an external computer connected to the same local network, use a web browser to navigate to the system’s IP address (example: http://102.123.1.34).

**Remote Graphical Display | VNC Viewer**  
Non-standard HTTP port 2224

The user interface can alternatively be viewed or controlled via an external computer using Virtual Network Computing (VNC) technology. The external computer must have a VNC viewer program installed (several free options are available, including www.realvnc.com and www.tightvnc.com). When Remote Graphical Display is enabled, the VNC connection will mirror the UI control screen.

To enable Remote Graphical Display:

1. On the touchscreen UI, navigate to **MENU > REMOTE CONNECTIONS**
2. Toggle the Remote Graphical Display switch to **ENABLED**
3. Follow the onscreen directions for connecting to the IP address using a VNC viewer software

The VNC connection is password protected using a unique password for each system. The password is provided with your system documentation and in the onboard file QUICK START GUIDE – NETWORK INTERFACE CONNECTIONS. If lost, contact an authorized service representative to retrieve a copy.

**Remote Scripting**  
Non-standard HTTP port 47101

The instrument can alternatively be programmatically controlled via scripting commands using an external computer.

To use external scripting with the instrument:

1. On the touchscreen UI, navigate to **MENU > REMOTE CONNECTIONS**
2. Toggle the Instrument Scripting switch for the desired instrument to **ENABLED**
3. Follow the onscreen directions for opening the onboard scripting documentation, then use the available instructions for scripting with the instrument.

Remote scripting commands can be sent using an encrypted SSH tunnel. Refer to the onboard Instrument Scripting documentation on the webserver for further details.

**Data Dashboards**

- **Non-standard HTTP port 8050**

Data dashboards allow the user to view and analyze system data from a web browser.

To enable and view data dashboards:

1. On the touchscreen UI, navigate to **MENU > REMOTE CONNECTIONS**
2. Toggle the Data Dashboards switch to **ENABLED**
3. From the onboard documentation, click the **SYSTEM DATA DASHBOARD** link to access the system data.

**MI Remote Support**

- **Secure SSH tunnel port 2223**

The Montana Instruments Remote Support connection is used by authorized service representatives to remotely access your system to provide diagnostic and troubleshooting support. If the system is behind a NAT/Firewall, the firewall must allow the system to connect a Secure SSH tunnel on port 2223 to `mirs.montanainstruments.com`.

### 4.2 Primary Operations

#### 4.2.1 Turning on the System

Before starting the power up procedure, ensure that the power switches on the back of the system control unit and the front of compressor are toggled to **OFF (o)**.

1. If a dry nitrogen source is connected to the system, verify the pressure is set to ~15 psi.
2. Ensure the black circuit breaker switch on the front of the compressor unit is toggled to **ON (|)**.

   **NOTICE**

   The green power switch should remain **OFF (o)** during operation as this is controlled by the remote ON/OFF control.

3. Turn on power to the vacuum control unit by toggling the power switch on the back of the unit **ON (|)**.
4. Turn on power to the system control unit by toggling the power switch on the back of the unit **ON (|)**.
5. Next, turn on the system control unit by pressing the power button on the front of the unit. This power button will glow when the unit is on.
The software will initialize and run automatically. The UI will indicate the software is **INITIALIZING** while the system checks for and establishes connection with the attached peripheral cards. After the screen shows **READY** the system is ready for operation.

### 4.2.2 Controlling System Temperature

The **PLATFORM** temperature channel is used to drive control operations across the Cryostation, compressor, and vacuum control unit.

#### Cooling Down the System

1. In the UI for the **CRYOSTATION** instrument, navigate to the **SAMPLE CHAMBER** display screen and select the **PLATFORM** temperature channel to bring up its operation controls.
2. In the **PLATFORM TARGET** input box, enter the target temperature value. To reach the lowest possible base temperature, enter 0.0 K. Press **SET** to confirm.
3. Press the **COOLDOWN** command button. On the popup, confirm or adjust the custom parameters for the cooldown, then press **COOLDOWN** again to start.

The cooldown cycle will begin.

<table>
<thead>
<tr>
<th><strong>NOTE</strong></th>
</tr>
</thead>
</table>
| • The Stage 1 and Stage 2 temperatures will drop quicker than the platform. The platform will drop faster after Stage 1 reaches 30 K.  
• When the platform has reached a stable temperature, the ring surrounding the platform status readouts will change from flashing to solid. |

**Vacuum States During a Cooldown**

- When a cooldown is initiated, the system will first establish a rough vacuum.  
  - During this process the system will automatically check for leaks. If vacuum cannot be established, an error message will show in the UI and the cooldown process will be aborted. See **System Diagnostics** for troubleshooting information.
- After proper vacuum level is established, the compressor will turn on; this may take up to 30 minutes.
- The pressure will continue to drop to a high vacuum state leveraging cryopumping.

<table>
<thead>
<tr>
<th><strong>NOTE</strong></th>
</tr>
</thead>
</table>
| • To achieve the best vacuum levels, set the cooldown target temperature to the system base temperature and allow the system to stabilize there before controlling to higher temperatures. This temperature set point is necessary to take full advantage of cryopumping.  
• The VC1110 pressure gauge can only readout to ~0.1 mTorr. If pressure is below this value, the UI readout will indicate **HIGH VAC**. |

**Adjusting Platform Temperature**

The platform temperature may be changed at any time by setting a new value using the **PLATFORM TARGET** input box. If the user is setting incremental temperature set points, the **COOLDOWN** and **WARMUP** buttons do not need to be pushed.
Warming Up the System

A warmup operation is used to bring the system to room temperature to access the sample chamber. The system may be warmed up actively with heaters at any time, including during a cooldown.

1. In the UI, navigate to the SAMPLE CHAMBER display screen and select the PLATFORM temperature channel to bring up its operation controls.
2. Press the WARMUP command button. On the popup, press WARMUP again to confirm.

An active warmup is much faster than using the STOP command. The heaters will automatically shut off when the entire system reaches 295 K, but the sample chamber will remain under vacuum.

Stopping a Cooldown or Warmup

At any time during a cooldown or warmup, the process can be stopped.

1. In the UI, navigate to the SAMPLE CHAMBER display screen and select the PLATFORM temperature channel to bring up its operation controls.
2. Press the STOP command button. On the popup, press STOP again to confirm.

This action will stop running the compressor/cryocooler and turn off any heater power going to the cryocooler stages and sample chamber platform. The system will begin to warm up naturally, but it will remain under vacuum.

4.2.3 Venting and Pulling Vacuum

Vent to Access the Sample Chamber

After a cooldown and warmup cycle, the system remains under vacuum until the user is ready to access the sample chamber. To access the chamber:

1. In the UI, navigate to the SAMPLE CHAMBER display screen and select the PLATFORM temperature channel to bring up its operation controls.
2. Press the VENT command button. On the popup, confirm or adjust the custom parameters for the vent procedure, then press VENT again to confirm.

The sample chamber will be vented to atmospheric conditions.

> NOTE
Choosing to “Vent Continuously” will cause nitrogen (when attached) to flow through the chamber, even after the chamber is opened. This can help to keep the vacuum space as clean as possible during quick sample exchanges. To stop the flow of nitrogen when “Vent Continuously” is used, press the STOP command.

Keep the Sample Chamber Under Vacuum

When the system is not in use, it is recommended to keep the sample chamber under vacuum to prevent moisture and contaminants from entering the sample space. To keep the system under vacuum:
1. In the UI, navigate to the SAMPLE CHAMBER display screen and select the PLATFORM temperature channel to bring up its operation controls.

2. Press the PULL VACUUM command button. On the popup, confirm or adjust the custom vacuum parameters, then press PULL VACUUM again to start.

The sample chamber will pull vacuum until the target vacuum pressure threshold is met.

<table>
<thead>
<tr>
<th>NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Since this is an independent operation without cryopumping, the system will likely only be able to achieve a rough vacuum state. To stop the vacuum pump(s), press the STOP command. The sample chamber will remain at the current vacuum level until a COOLDOWN or VENT procedure is initiated.</td>
</tr>
</tbody>
</table>

4.3 Moving the System

If the system ever needs to be moved to a different lab or location, follow the steps below or reach out to Montana Instruments Service team for guidance:

1. Save any important data on the system.
2. Gracefully power down the unit by:
   a. Tap (press and release) the power button on the front of the system control unit -or-
   b. On the touchscreen UI, navigate to MENU > SYSTEM SETTINGS and select POWER OFF
3. Remove the helium and vacuum hoses, paying special attention to ensure the O-rings remain in place.
4. Remove the remaining cables and electrical connections.

If the system needs to be shipped, follow the remaining steps below

5. Reverse the steps in the unpacking section of the installation guide: replace the red locking rings and c-spacers and lock the red shipping support down on the tri-flange. Then, unbolt the system from the optical table.
6. Re-pack the system in original packaging. Some components must be packed upright on a pallet to avoid damage.

<table>
<thead>
<tr>
<th>NOTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Follow all handling instructions for the individual components as outlined in General Hazard Information section.</td>
</tr>
<tr>
<td>• If you are uncomfortable with moving the system on your own, or if you need to order any replacement packaging, please contact an authorized service representative.</td>
</tr>
<tr>
<td>• Do NOT attempt to disassemble any components of the system beyond the original state as shipped from the Montana Instruments factory.</td>
</tr>
</tbody>
</table>
Section 5 - Care & Maintenance

5.1 System Care

Recommend system care procedures should be followed by any users of the system. For further information on any of these procedures, contact an authorized service representative for assistance.

5.1.1 When Working in the Sample Chamber

- Keep surfaces clean. Avoid touching any surfaces inside the sample space with your fingers as oils or other foreign contaminates can easily be transferred to the surfaces, the sample, or optics. **Always wear clean gloves.**
- Use proper grease and adhesives in the sample chamber. The accessory kit includes N-grease.
  - Please ensure that adhesives are intended for cryogenic use and are not outgassing.
  - Factory recommendation is Apiezon® L-grease for O-rings
- Avoid using too much grease – a thin layer (just enough so the surface is shiny) is best for metal-to-metal surfaces, samples, and O-rings. Too much grease can outgas and contaminate other surfaces in the sample chamber.
- Inspect, wipe, and grease O-rings. Every 10-15 uses the exposed O-ring surface should be wiped with a dry Kimwipe or lens tissue and a thin layer of appropriate grease applied.
- Check to ensure wires are preserved. Make sure wires do not overlap under thermal clamps and ensure the clamps are not too tight. Make sure wires do not touch the radiation shield or contact the sample mount directly after the thermal clamp.

5.1.2 When You Will Not Be Using Your Cryostation

- Keep the lid on the sample chamber to keep it free from dust.
- Supply a slight amount of nitrogen to keep the system clean and dry.
  - Use the `VENT` command with "Vent Continuously" enabled to keep nitrogen flowing through the chamber at atmospheric conditions.
- Keep the sample chamber under vacuum. Use the `PULL VACUUM` command button to pull and keep the chamber under a medium vacuum state.

5.1.3 Standard Checks Before Every Cooldown

- Ensure radiation shield is bolted down and secured. Make sure all radiation shield windows are in place.
- Ensure the sample is mounted properly.
- Ensure wiring from sample thermometers or other internal components does not touch the inside of the radiation shield.
- Check that the software starts up and reads all thermometers. The temperature channel values should be slightly fluctuating, indicating the thermometer readings are active.
- Check the helium pressure to ensure the value is 210 psi. See *Helium Check* for details.
5.1.4 Periodic Checks Every 6-12 Months

- Inspect VGE joints and repair if needed. VGE can flake off after several thermal cycles.
  1. Clean off old VGE with acetone or isopropyl alcohol then add a thin layer of VGE in the same location.
- Replace extra VGE yearly. VGE has a limited shelf life of one year.

<table>
<thead>
<tr>
<th>NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>O-rings rarely need to be replaced unless they are nicked or damaged. If damaged, use Teflon-tipped tweezers or your fingers to remove the O-ring. Do NOT use metal-tipped tweezers or other sharp objects as this could damage the aluminum housing.</td>
</tr>
</tbody>
</table>

5.2 Long-Term Maintenance

The maintenance procedures below must be completed by a certified technician. This can be done onsite without removing the equipment or disturbing the optical setup. Contact an authorized service representative to schedule maintenance.

5.2.1 Cryocooler Maintenance

The GM cryocooler normally needs maintenance every 10,000 hours of operation. After extended use, some of the bearings and bushings will wear down.

Other indicators of needing cryocooler maintenance include:

- System begins to have trouble cooling. The achievable base temperature drastically degrades.
- System begins to make a cogging or grinding noise in the cryocooler that persists continually.

<table>
<thead>
<tr>
<th>NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Periodic chirping as the cryocooler runs is normal as the bearings wear in.</td>
</tr>
</tbody>
</table>

5.2.2 Compressor Maintenance

The compressor requires adsorber maintenance after approximately 30,000 hours of operation. Refer to the Technical Manual provided by Sumitomo for specific maintenance instructions.
Section 6 - Diagnostics & Troubleshooting

This section contains information for basic system diagnostics and troubleshooting advice. Diagnostics or repairs outside of the scope of this section should be completed by an authorized service representative.

6.1 Expected System Performance

Each system ships with a Certificate of Performance to demonstrate the factory acceptance specifications for the system. The base temperature, stability, and vibrations tests are conducted on the standard platform with the Cryostation mounted to the optical table. The vibrations are measured with a capacitive sensor bolted to the table and measures the peak-to-peak displacement in nanometers to a test fixture bolted to the sample platform.

Please contact an authorized service representative if the factory specifications are not met.

6.2 System Diagnostics

6.2.1 Performance Issues

If a degradation in performance or other failures are experienced, check for these common issues:

<table>
<thead>
<tr>
<th>Problem/Symptom</th>
<th>Possible Cause</th>
<th>Solution/Suggestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>System is unable to reach target temperature or cooldown takes longer than expected</td>
<td>See Temperature Optimization</td>
<td></td>
</tr>
<tr>
<td>System does not meet vibration specifications on sample stage</td>
<td>See Vibration Mitigation</td>
<td></td>
</tr>
<tr>
<td>System will not pull rough vacuum – leak check failed</td>
<td>Vacuum leak</td>
<td>See Vacuum Check</td>
</tr>
<tr>
<td>System condensing moisture on sample, windows, exterior of sample chamber or vacuum case (black cylinder surrounding cryocooler). Exterior surfaces are cold to the touch.</td>
<td>Radiation (inner) and vacuum (outer) window are touching</td>
<td>Adjust windows so they do not touch. For low working distance setups, the windows may touch under vacuum, so be sure to check again after pulling vacuum.</td>
</tr>
<tr>
<td>Sample thermometer not working</td>
<td>Not properly installed or activated.</td>
<td>Make sure the temperature channel is enabled. Navigate to MENU &gt; INSTRUMENT SETTINGS &gt; USER 1. Toggle the Temperature Channel Enabled switch to the right to enable.</td>
</tr>
</tbody>
</table>
### 6.2.2 Power and Communication Issues
If the system will not turn on, run commands, or display readouts, check for these common issues:

<table>
<thead>
<tr>
<th>Problem/Symptom</th>
<th>Possible Cause</th>
<th>Solution/Suggestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>System throws electrical breaker</td>
<td>Wall power issue</td>
<td>1. Check the wall voltage using an AC voltmeter (digital multi-meter on the AC setting) to ensure it is in the defined ranges for each piece of equipment.</td>
</tr>
</tbody>
</table>
| UI screen is black / does not turn on | Communication issue with system control unit | 1. Make sure all cables and power cords are connected properly. See *Error! Reference source not found.* for details.  
2. Ensure the power switch on the back of the system control unit is ON ( | ).  
3. Ensure the power button on the front panel is ON (glowing).  
4. Power cycle the system control unit. Toggle the power switch on the back of the unit OFF ( o ) then back ON ( | ).  
5. Press the **RESET** button on the back of the UI touchscreen display. |
| UI controls are frozen or non-responsive | Touchscreen display issue | 1. Press the **RESET** button on the back of the UI touchscreen display. |
| Compressor is not being turned on automatically | Communication issue with compressor | 1. Make sure all cables and power cords are connected properly. See *Error! Reference source not found.* for details. Check to make sure the compressor remote on/off cable is properly connected to the **ACCESSORY** port.  
2. Ensure the black circuit breaker switch on the front of the compressor is ON ( | ).  
3. Ensure the green power switch is OFF ( o ).  
4. Power cycle the compressor. Toggle the black circuit breaker switch on the front of the unit OFF ( o ) then back ON ( | ). |
| System does not initialize | Communication issue with vacuum control unit | 1. Make sure all cables and power cords are connected properly. See *Error! Reference source not found.* for details.  
2. Ensure the power switch on the back of the vacuum control unit is ON ( | ).  
3. Power cycle the vacuum control unit. Toggle the power switch on the back of the unit OFF ( o ) then back ON ( | ). |
| Vacuum pressure reading in UI indicates “SensorErr” | | |

### 6.2.3 Compressor Issues & Failure Modes
If the compressor is experiencing issues, refer to the Technical Manual provided by Sumitomo for troubleshooting instructions.
6.3 System Checks

For the system to achieve optimal performance, several aspects of the system must be handled carefully. Neglecting any one of these may have a significant impact on the base temperature or vibration performance. There are several basic checks users can do to help diagnose general problems.

6.3.1 Temperature Optimization

The Cryostation platforms are optimized to control heat loads coming into the sample. To ensure the lowest possible base temperatures, follow the best practices below.

1. Use proper thermal lagging techniques for any wiring (including coax) entering the sample space. Ensure thermal clamps are tightened down. See Thermal Lagging Techniques for details.

2. Avoid “touches” between the various stages (such as a platform component touching a Stage 2 component, or a Stage 2 component touching a Stage 1 component), as these become sources of heat flow.
   a. Ensure wiring or cabling does not come in contact with the inside of the radiation shield.
   b. Ensure the radiation shield or radiation windows do not come in contact with any part of the outer vacuum housing or windows. For low working distance setups, the windows may touch after the vacuum is pulled.

3. Always use the appropriate wire and size for the application. See Sample Chamber Wiring for details.
   a. Avoid using copper wire unless absolutely required. The electrical conductivity of phosphor bronze is typically sufficient for most applications.

4. Ensure the screws holding the platform to the support base and the screws securing the radiation shield are in place and tightened (5 in-lbs.). Failure to tighten the screws will reduce the ability of the system to pull heat from the sample platform and may increase vibrations.

5. Ensure a thin layer of N-grease or another thermal grease is used between metal-to-metal interfaces for proper thermal connection.

6. Use inner “cold” windows or blanks on the radiation shield whenever possible. The added heat load can significantly increase the base temperature of the platform.

7. Check the helium pressure. If there is a helium leak, cooling performance will be hindered significantly. See Helium Check for details.

**NOTE**

During a cooldown, the system will steadily ramp down in temperature to ~6 K, then can take longer to reach and stabilize at the base temperature. Options and energy inputs (i.e. laser power) may impact cooldown times and cause slightly higher base temperatures.

Identifying Heat Loads

The expected temperatures and temperature gradients of the Stage 1, Stage 2, Platform and Sample under various operating conditions can be used to identify the source of an unwanted heat load. These
temperatures should only be used as a general reference. It is recommended to use actual data from a previously successful cooldown on your system as a more accurate reference guide.

The base temperature for a CryoCore under normal operating conditions is depicted below. The gradient between the platform and sample will change depending on the type of sample mount and other options.

Heat Load Between Stage 1 and Stage 2
In the example below, Stage 2 has a higher-than-normal temperature, as does the Platform and Sample. However, Stage 1 is colder than normal. The temperature gradient between Stage 2 and the Platform and the Platform and the Sample is normal. This indicates that the heat load is coming in between Stage 1 and Stage 2.

<table>
<thead>
<tr>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Platform</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>24 K</td>
<td>5.0 K</td>
<td>5.3 K</td>
</tr>
<tr>
<td>Temperature Gradient</td>
<td>+0.4 K</td>
<td>+0.2 K</td>
<td></td>
</tr>
</tbody>
</table>

Possible Cause: Crosslink rod touching the side wall. Contact an authorized service representative for instructions to perform a touch test.

Heat Load Between Platform and Sample
In the example below, the Stage 2, Platform, and Sample temperatures are high. However, the most critical issue is the large temperature gradient between the Platform and Sample. The heat load is most likely coming in between the Platform and Sample, and since the Sample is high, the temperatures of the Platform and Stage 2 are also being pulled up.

<table>
<thead>
<tr>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Platform</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>28 K</td>
<td>3.0 K</td>
<td>5.1 K</td>
</tr>
<tr>
<td>Temperature Gradient</td>
<td>+0.2 K</td>
<td>+1.5 K</td>
<td></td>
</tr>
</tbody>
</table>

Possible Causes: The most likely culprits are those described in the Temperature Optimization section, such as wires touching the radiation shield, wires touching the sample mount directly after the thermal clamp, use of improper wires, loose screws, missing N-grease, or missing radiation windows.

Heat Load Between Stage 2 and Platform
In rare cases, a higher-than-normal gradient may exist between Stage 2 and the Platform. This is typically caused by loose screws underneath the platform, which should not be accessed by users. If this heat load is present, contact an authorized service representative.

Heat Load on Sample Thermometer
If the sample is reading higher than normal, but all other temperatures are in a normal range, the most likely cause is an improperly mounted or lagged sample thermometer. Refer to Mounting a Thermometer.
6.3.2 Vibration Mitigation

The Cryostation and sample chamber have several vibration damping design features to reduce the effects of cryocooler mechanical vibrations on the sample platform. To ensure the lowest possible mechanical vibrations, follow the best practices below.

1. Rigidly bolt the system to the optical table using all available mounting locations in the baseplate.
2. Ensure all screws inside the sample space are tightened down.
3. Ensure that the red shipping rings and spacers beneath the shipping rings have been removed. The red shipping supports at the back of the Cryostation should be locked in the upper position off the tri-flange. See the CryoCore Install Procedure on the product spec page for details. Having any of these components installed can introduce vibrations on the order of several microns.
4. Ensure the helium hoses are not touching other cabling or the optical table. They should also not be pressed against a wall or another surface. There should be a gentle 180° bend in the hoses to avoid any lateral tugging on the Cryostation as helium runs through them.
5. Ensure the vacuum hose is not in contact with anything moving, as this hose is somewhat springy.
6. Ensure that optics are rigidly mounted to the table. Optics could be vibrating due to the Cryostation on the table and mounting them should be carefully considered to reduce this effect.

6.3.3 Vacuum Check

The UI displays a pressure reading for the attached vacuum gauge sensor. If a system leak check fails, or if condensation or freezing is observed on or inside the chamber, a leak may be present. Please check the following:

1. Check to ensure the vacuum gauge properly reads atmosphere (~600-770 Torr) when the system is at room temperature and vented. If it is not, the gauge may not be working properly.
2. Check that the vacuum housing and lid are in place and properly seated. Ensure no wires are pinched between the O-rings.
3. Check the O-rings on the 1) the sample chamber vacuum housing 2) the vacuum housing lid and 3) the vacuum housing outer “warm” windows. Ensure the O-rings have a thin layer of L-grease and are completely free of debris or fibers.
   a. All side panels also have an O-ring interface. Do NOT remove the side panels before consulting with an authorized service representative.
4. Ensure the black Delrin screws holding the sample PCB in place are loose. If overtightened, these can cause the board to flex and compromise the O-ring seal.
5. Although nitrogen is optional, it helps keep the charcoal adsorbers clean and the inside of the Cryostation free from moisture. Using nitrogen is particularly important in humid environments.
   a. Nitrogen purge cycles, as well as a platform bakeout, will help rid the chamber of contaminants prior to cooldown.
6. If a leak detector is accessible, use it to leak check the sample housing, Cryostation, vacuum hose, vacuum connections to find the source of the leak.
7. If the leak persists, please contact an authorized service representative.

There is enough charcoal in the system to freeze particles that may be introduced from a small leak. If there has been a large leak, or if a small leak persists over time, the charcoal adsorbers will need to be recharged. To do this, run a **COOLDOWN** or **PULL VACUUM** operation with **PLATFORM BAKEOUT** (350 K for 60+ mins) and **DRY NITROGEN PURGE** (3+ times) enabled.

### 6.3.4 Helium Check

The helium pressure in the system can be checked when the compressor is idle.

1. Warm the system to room temperature and leave unattended for at least one hour. Do not start a cooldown.
2. Ensure the black circuit breaker on the front of the unit is ON ( | ).
3. Check the helium pressure on the front gauge of the compressor. The value should be 210 psi. If the pressure is too low, helium will need to be recharged. See [Helium Recharge Process](#) for details.

### Helium Hose Fittings

Improper attachment or missing O-rings on the helium hose fittings can cause a loss in helium pressure and hinder cooling performance. To inspect fittings on the back of the compressor and Cryostation:

- Ensure the fittings are straight.
- Ensure there is a **single** O-ring at each end of the hose and at each connection point. The O-rings have a tendency to dislodge from the hose and stay on the fitting (or vice versa).
  - If this happens, the errant O-ring must be carefully removed and replaced in the correct location before reconnecting, otherwise it will not seat properly.

---

*Hose with extra O-ring*  *Extra O-ring removed*  *Left: Fitting missing O-ring  Right: proper O-ring fitment*
6.3.5 Helium Recharge Process
If the helium pressure is low (below 210 psi), the system must be recharged with pressurized helium. If any contamination gets into the helium lines, compressor, or Cryostation, the system must be flushed and recharged. The equipment needed for these procedures is listed below:

- Helium gas cylinder: *UHP Helium (99.999%)*
  - It is recommended to use a new/untouched gas cylinder to avoid the risk of using a contaminated gas cylinder from improper handling.
- High-pressure regulator with ¼” F NPT fitting: *Pressure outlet greater than 260 psi*
- Purge and recharge adaptors: *Supplied in accessory kit*

<table>
<thead>
<tr>
<th>NOTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Follow instructions carefully</strong></td>
</tr>
<tr>
<td>To avoid possible contamination, these instructions must be followed carefully.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ear protection recommended</strong></td>
</tr>
<tr>
<td>Venting the helium lines typically creates a loud noise as pressure is released. Be prepared for venting noises when attaching the purge adapter to the helium lines.</td>
</tr>
</tbody>
</table>

Part 1: Connect and Flush the Adapter
1. Connect your high-pressure regulator to your helium gas cylinder. With the cylinder closed, ensure the regulator knob is fully turned in the **DECREASE** position.
2. Attach the recharge adapter A to the regulator using Teflon tape.
3. Open the helium gas cylinder, then increase the regulator to 20 psi.
4. Attach the purge adapter B to the other end of the recharge adapter A until you hear helium bleeding out. Let the helium bleed for a few seconds, then disconnect the purge adapter B.
5. Turn the regulator knob back to the **DECREASE** position.

Part 2: Recharging Helium Levels
6. Disconnect the helium return hose from the back of the Cryostation.
7. Next, connect the hose to the recharge adapter A on the regulator.
8. Slowly increase the pressure on the regulator until the pressure reads 210 psi. Ensure the pressure reading on the front panel of the compressor matches this pressure.
Part 3 (optional): Flushing the System
If there was any contamination in the hoses, compressor, or Cryostation, the system should be flushed. Follow the same steps as above, then:

9. Disconnect the Compressor Remote ON/OFF cable from the **ACCESSORY** location on the front of the compressor.
10. Manually turn on the compressor and cryocooler by switching the green rocker switch on the front of the compressor ON (|). The black circuit breaker switch must also be ON (|).
11. Connect the purge adapter B to the **RETURN** port on the back of the Cryostation where the return line was previously connected.

The purge adapter will begin to bleed helium as the system runs and flushes the lines. Keep the purge adapter connected for 10-15 seconds to allow the lines to flush completely.

12. Once flushed, disconnect the purge adapter B from the back of the Cryostation.
13. Turn off the compressor by toggling the green rocker switch back OFF (o). Reconnect the Compressor Remote ON/OFF cable.
14. Check the pressure reading on the front panel of the compressor to ensure it reads 210 psi. Increase the pressure on the regulator if needed to bring the pressure to the appropriate level.

Part 4: Disconnect
After recharging or flushing the system, turn the regulator back to **DECREASE** and close the helium cylinder. Then, disconnect the return hose from the recharge adapter A on the regulator and reconnect it to the Cryostation **RETURN** port.
### Section 7 - Appendices

#### 7.1 Related Documentation

For a copy of associated documentation, see below:

<table>
<thead>
<tr>
<th>Document Title</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>CryoCore Documentation</td>
<td><a href="https://www.montanainstruments.com/products/cc1">https://www.montanainstruments.com/products/cc1</a></td>
</tr>
<tr>
<td>General Terms and Conditions of Sale</td>
<td><a href="https://www.montanainstruments.com/products/cc1">Direct Link to latest PDF</a> Or find the link at the bottom of our <a href="https://www.montanainstruments.com/products/cc1">homepage</a></td>
</tr>
<tr>
<td>Limited Warranty Agreement</td>
<td><a href="https://www.montanainstruments.com/support/warranty-information">https://www.montanainstruments.com/support/warranty-information</a></td>
</tr>
<tr>
<td>End User License Agreement</td>
<td><a href="https://www.montanainstruments.com/support/warranty-information">Direct link to latest PDF</a></td>
</tr>
</tbody>
</table>

Refer to the associated product manuals listed below for important operating instructions and safety information on provided third-party components.

<table>
<thead>
<tr>
<th>Document Number</th>
<th>Document Title</th>
<th>Original Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>267318A</td>
<td>HC-4E1 and HC-4E2 Helium Compressors</td>
<td>Sumitomo</td>
</tr>
<tr>
<td>280358A</td>
<td>F20L Helium Compressor</td>
<td>Sumitomo</td>
</tr>
</tbody>
</table>