

Option User Manual

Turbopump Vacuum Package

Cryostation s-series

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www.montanainstruments.com
support@montanainstruments.com
+1.406.551.2796

MONTANA INSTRUMENTS®
101 Evergreen Drive
Bozeman, MT 59715, USA



Specifications and product information listed in this document are accurate to 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.

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Section 1 - Preface

 **WARNING**

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
- International System of Units (SI) symbols
- System of Imperial Units symbols
- Element, molecule, and compound abbreviations

1.1.2 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:

 **DANGER**

Serious personal injury

Imminent hazards which, if not avoided, will result in serious injury or death.

 **WARNING**

Serious personal injury

Potential hazards which, if not avoided, could result in serious injury or death.

 **CAUTION**

Possible personal injury

Potential hazards which, if not avoided, could result in minor or moderate injury.

NOTICE

Command or Product Safety Notice







Potential hazards which, if not avoided, could result in product damage.

» NOTE

Points of particular interest for more efficient or convenient equipment operation; additional information or explanation.

1.1.3 Graphical Symbols

The following symbols may be used in diagrams, supporting text, and on physical parts:

	Hazard Alert: General Warning		Hazard Alert: High Voltage
	Hazard Alert: Laser Radiation		HDMI port
	CAN bus module		USB port

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: www.montanainstruments.com/About/Warranty

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

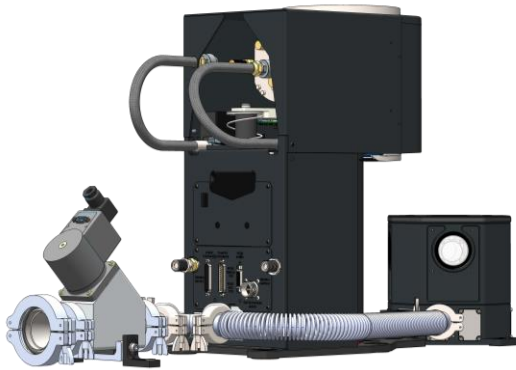
International Sales & Authorized Service

- Visit www.montanainstruments.com/Contact/Sales-Offices for contact information for your local representative.

Section 2 - Option Overview

2.1 Turbopump Vacuum Package

Models	Part Numbers
Turbopump Vacuum Package Assembly (Valve, Gauge, Vacuum Tubing, Wiring)	4117-119-100V, 4117-119-200V
VC1130	4117-520-01



Turbopump Vacuum Package Assembly (shown on s100)



Turbopump Vacuum Control Unit (VC1130 rear panel)

2.1.1 Intended Use

The turbopump vacuum package is an assembly of vacuum hoses, valves, gauges, and components designed for integrating a turbopump with the Montana Instruments Cryostation platforms. The configuration should only be used with compatible Cryostation systems containing the appropriate hardware, software, and electronics.

2.1.2 Components

The turbopump vacuum package consists of a VC1130 model vacuum control unit with integrated Pfeiffer Vacuum® HiPace® 80 turbopump, a full-range Pirani/cold-cathode UHV vacuum gauge, a KF40 electromagnetic vacuum valve, a 4 ft KF50 vacuum hose, a 10 ft chamber vent hose, and several KF clamps, O-rings, and adapter fittings.

Configuration

The UHV gauge is mounted on a manifold inside the main body of the cryostat tower behind the cryocooler. The vacuum valve assembly then connects to the vacuum port on the back panel of the cryostat with a KF25 cross adapter between the two connection points. A KF50 vacuum hose runs from the other end of the valve to the nearby vacuum control unit with integrated turbopump. A 4 ft KF50 hose is provided standard, and up to one additional 4 ft extensions can be added if the vacuum control unit needs to be placed further away from the cryostat.

Rear Manifold Pumping Configuration

In the rear manifold pumping configuration, the sample chamber is pumped out through the crosslink assembly that connects the sample chamber to the cryostat cooling tower. One side of the KF25 cross is capped off.

» NOTE

Due to the location of the UHV gauge, vacuum pressure readings may be up to an order of magnitude lower than actual sample chamber pressure when used in the rear manifold pumping configuration.

Rear Manifold + Side Panel Pumping Configuration

Extra components for the alternative parallel side panel pumping configuration are provided. In this assembly, a 20-in KF25 hose is connected to the KF25 cross inlet between the valve and vacuum port on the back panel of the cryostat. The hose is then routed around the side of the cryostat to a KF25 side panel on the sample chamber.

» NOTE

The rear manifold + side panel pumping configuration will provide greater conductance for pulling vacuum in the sample chamber. **For best turbopump vacuum performance, and for the most accurate sample chamber pressure readings, it is recommended to use this configuration whenever side panel access is available.**

2.1.3 Technical Specifications

Environmental Specifications

Temperature of Environment	5 – 40 °C
Humidity	5 – 80% non-condensing
Altitude	<2000 m

Power Specifications

If configured without the optional cart with electronics rack, the turbopump vacuum package requires one additional wall outlet for the vacuum valve mounted near the back panel of the cryostat.

Model		MVV-32	MVV-33
Mains Power Connector on Unit		Hardwired	
Frequency		50 – 60 Hz	
Maximum Power Consumption		10 W	
Line Voltage		100 – 120 VAC	200 – 240 VAC
Maximum Current Draw		0.1 A	0.05 A
Wall Outlet / Receptacle	N. America & non-EU	Standard NEMA 5-15	NEMA 6-20R single-phase
	CEE Europe (non-UK)	n/a	CEE 7/3 or CEE 7/5 w/ common ground terminal

	UK	n/a	BS1363 (UK) w/ common earth ground terminal
	Israel	n/a	I-32-3 w/ common earth ground terminal
	Cart Power Module	IEC 60320 C13	

2.1.4 Safety Information

The following hazards may be typical for this product:

 **WARNING**

Refer to associated product manuals for complete safety information

- The turbopump vacuum package contains a VC1130 vacuum control unit. Refer to the Cryostation System User Manual for detailed instructions and important safety information regarding this component.
- The VC1130 model contains a Pfeiffer Vacuum® HiPace® 80 turbopump. Refer to the Operating Instructions provided by Pfeiffer for important safety information regarding this component.
- The turbopump vacuum package contains a VAT Series 264 KF40 HV inline valve with electromagnetic actuator. Refer to the Operating Instructions provided by VAT for important safety information regarding this component.
- The turbopump vacuum package contains an Agilent® FRG-700 Pirani Inverted Magnetron Gauge. Refer to the Operating Instructions provided by Agilent for important maintenance and safety information regarding this component.

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.
- Do NOT disturb vacuum tubing while the turbopump is operational.

Risk of turbopump damage due to improper use

Venting the system at rotor speeds higher than 250 Hz may cause damage to the turbopump

- Do NOT vent the system when the turbopump is rotating faster than 250 Hz. Observe rotational speed on the UI to ensure safe rotating speeds prior to manual venting.
- If the system control unit unexpectedly shuts down prior to turning off the turbopump, turn off the main power to the vacuum control unit and wait at least 15 minutes before venting the system.

Section 3 - Option Installation & Handling

3.1 Packaging Contents

The turbopump vacuum package components will arrive packed with the rest of the system. Depending on the system configuration and options, the hoses, clamps, fittings, and valve assembly will be packed in the accessory box. The UHV gauge will be pre-installed on the manifold inside the cryostat.

3.2 Installing the Turbopump Vacuum Package

NOTICE

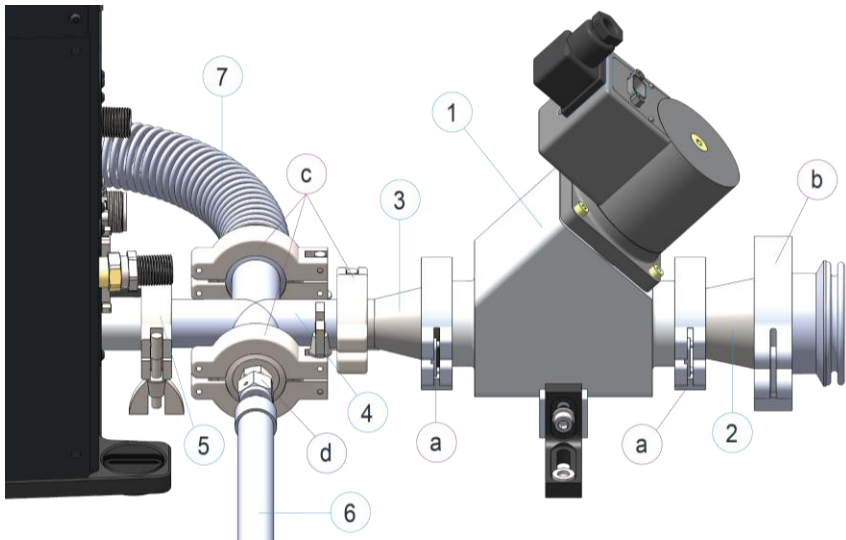
Keep vacuum hoses, valves, and components free of contaminants

The vacuum hoses and fittings will ship with caps or covers. When not in use, replace the covers to help keep the components free of dust and debris that may inhibit future vacuum performance.

3.2.1 Installing the Vacuum Valve Assembly

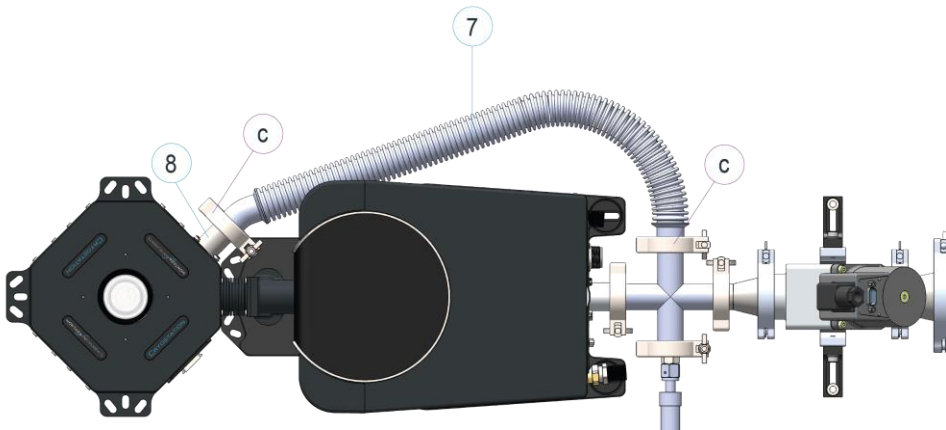
The vacuum valve assembly connects to the back panel of the cryostat cooling tower. Some of these components may ship partially pre-assembled.

1. Locate the vacuum valve ① and fittings.
2. Connect the KF40 to KF50 adapter flange ② to the back port on the valve using a KF40 clamp and O-ring ①. Tighten the wing nut to secure.
 - a. The KF50 vacuum hose will attach to the KF50 end of this adapter flange using a KF50 clamp and O-ring ②.
3. Next, connect the KF40 to KF25 adapter flange ③ to the front port on the valve using another KF40 clamp and O-ring ①. Tighten the wing nut to secure.
4. Attach the KF25 cross ④ to the KF25 adapter using a KF25 clamp and O-ring ③.
5. Connect the opposite side of the cross to the rear VACUUM LINE port ⑤ on the back panel of the cryostat. Tighten the wing nuts to secure.
6. Connect the KF25-VCO adapter ④ to the left-facing inlet of the KF25 cross ④ using a KF25 clamp and O-ring ③. Then, connect one end of the chamber vent line ⑥ to the VCO adapter ④.



Steps 7 and 8 should only be completed for the side panel pumping configuration. If not using this configuration, ensure a KF25 cap is installed on the right-facing inlet of the KF25 cross (4).

7. Connect the 20-inch KF25 hose (7) to the right-facing inlet of the KF25 cross (4) using a KF25 clamp and O-ring (c).
8. Route the hose around the side of the cryostat body and connect to the KF25 port (8) on the lower sample chamber housing using a KF25 clamp and O-ring (c). Tighten all wing nuts to secure.



Next, the valve should be suspended off the optical table by installing the bracket support components.

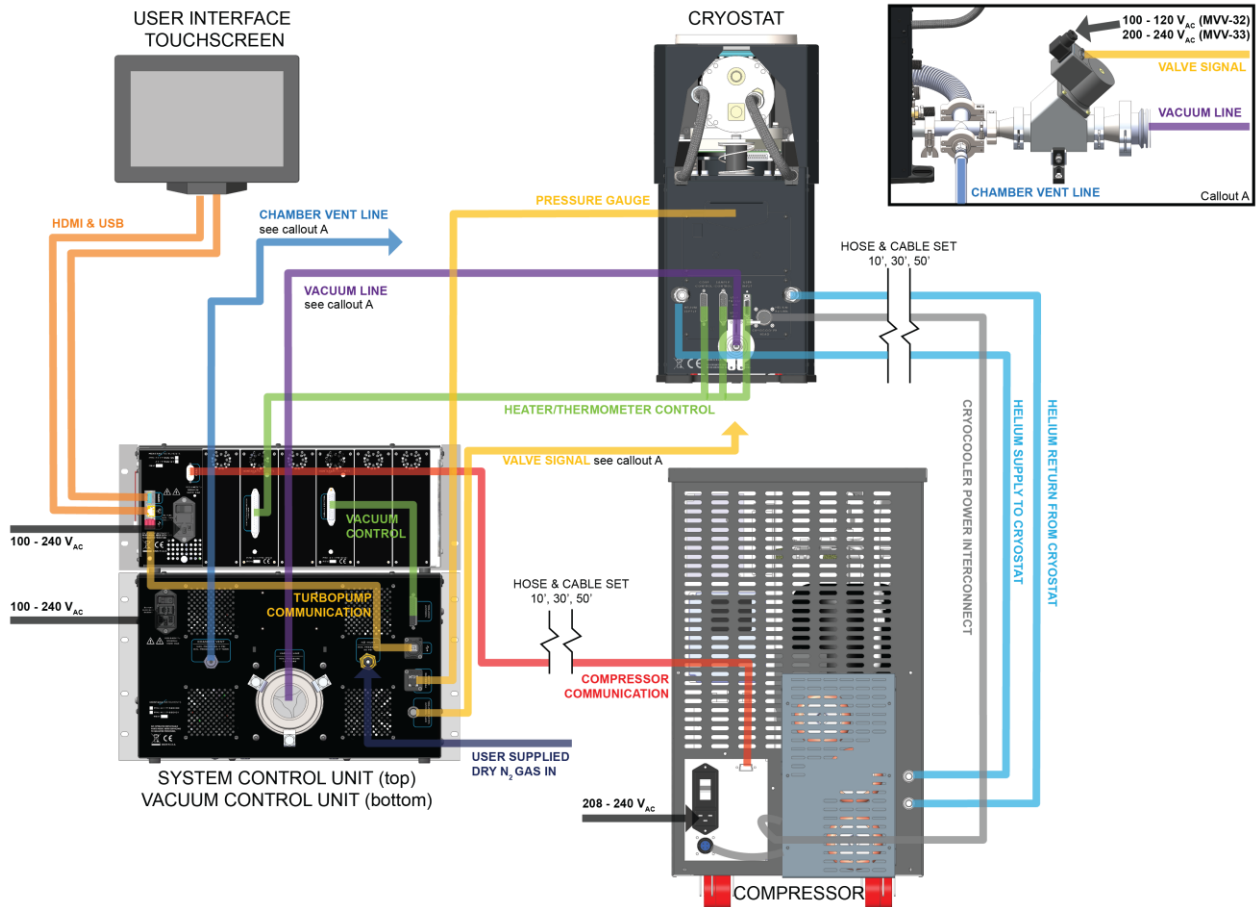
9. Locate the valve support brackets and hardware. Slide the U-shaped bracket ⑨ directly underneath the vacuum valve such that the valve rests on the Sorbothane pad.
10. Attach a right-angle bracket ⑩ to either side of the middle bracket ⑨ using M6 socket head screws ⑤. The middle bracket ⑨ should be suspended slightly off the optical table.
11. Secure the two right-angle brackets ⑩ to the optical table with appropriate hardware.



3.3 Connecting System Cables and Power

NOTICE

Only use cables and hoses provided or approved by the manufacturer
 Only use the cables and hoses in the manner described below.



The standard communication cables and hoses between system components do not change. Refer to the System User Manual for instructions on connecting the standard system cables and other components.

Turbo Control Cables: _____

1. Locate the turbopump communication USB cable. Connect one end to either of the USB ports on the rear face of the system control unit. Connect the other end to the USB port on the rear face of the vacuum control unit.
2. Locate the pressure gauge ethernet cable. This will typically be pre-connected to the UHV gauge that is inside the main body of the cryostat tower and coiled and cable-tied to the back of the cryostat. Carefully cut the cable tie to uncoil the cable, taking care not to cut the cable or other hoses. Ensure one end is connected to the UHV gauge inside the cryostat body. Connect the other end to the `PRESSURE GAUGE` location on the rear face of the vacuum control unit.

3. Locate the DSUB9 to 4-pin circular connector valve signal cable. Connect the DSUB9 end to the vacuum valve located behind the cryostat body. Connect the circular end to the EXT. VACUUM VALVE CONTROL location on the rear face of the vacuum control unit.

Vacuum Line: 

4. Locate the KF50 vacuum hose. Connect one end to the VACUUM LINE flange location on the back of the vacuum control unit. Connect the other end to the KF50 flange on the back of the vacuum valve assembly near the back panel of the cryostat. Tighten the wing nuts to secure.

Chamber Vent Line: 

1. Locate the 10 ft flexible vacuum hose with VCO connections. Connect one end to the CHAMBER VENT location on the back of the vacuum control unit. Connect the other end to the KF25 cross inlet on the vacuum valve assembly near the back panel of the cryostat.

Valve Power: 

After all other cables are connected, the vacuum valve can be connected to power.

1. Connect the vacuum valve power cord to the appropriate 100 – 120 VAC (MVF-32 valve) or 200 – 240 VAC (MVF-33 valve) wall outlet power source.

NOTICE

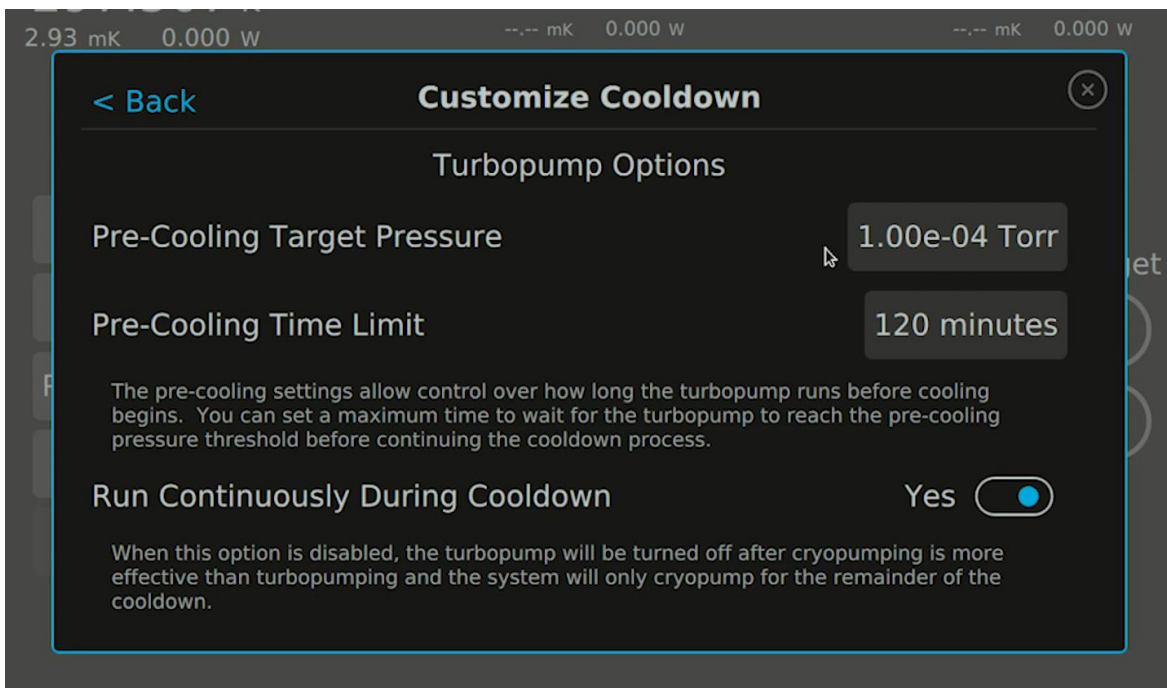
Valve power requirements vary by model

- The power requirements for the valve depend on the valve model. Refer to the *Technical Specifications on page 12* to determine which model you have based on your geographic location and available receptacle.
- If ordered with the optional cart with electronics rack, the valve power will plug directly into the cart power module.

Section 4 - Option Usage & Operation

4.1 Primary Operations

The primary operations below cover turbopump-specific settings for the instrument. Refer to the System User Manual for detailed user interface control functions and operating procedures.



4.1.1 Cooling Down with the Turbopump

Before initiating a cooldown, customize the options for how the turbopump will be used during the cooldown cycle:

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. Press the COOLDOWN command button. On the popup, press CUSTOMIZE COOLDOWN > to adjust the cooldown parameters.
3. To help clean out the system before cooling down, enable the Platform Bakeout and/or Dry Nitrogen Purge procedures. It is recommended to run one or more purge cycles, especially if the sample chamber has been exposed to atmosphere or if the system will be kept cold for an extended period of time.
4. On this same popup, scroll down to the Turbopump Options controls. Press the value input boxes to set the parameters.
 - a. **Pre-Cooling Target Pressure:** Pressure threshold to reach before cooling begins. The turbopump will be used to pump out the vacuum space to this pressure before any cryopumping occurs.

- b. **Pre-Cooling Time Limit:** Sets a maximum time limit for the pre-cooling target pressure procedure. After the time has elapsed, the cooldown cycle will begin even if the pressure threshold has not been reached.
 - c. **Run Continuously During Cooldown:** When toggled to `NO`, the turbopump will be turned off and valved off after cryopumping takes over. When toggled to `YES`, the turbopump will remain on for the duration of the cooldown until the system is warmed back up.
5. Once all parameters are set as desired, press `<BACK` in the top left corner of the popup. Press `COOLDOWN` to start the cooldown procedure.

4.1.2 Pulling Vacuum with the Turbopump

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. In a `PULL VACUUM` procedure, the turbopump will be used to reach the target pressure.

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, press `CUSTOMIZE PULL VACUUM >` to adjust the vacuum parameters.
 - a. **Target Vacuum Pressure:** Pressure threshold to reach before the turbopump turns off and the sample chamber is valved off. To keep the pump running indefinitely, enter a pressure value that the system cannot reach, such as 0 Torr.
3. Once all parameters are set as desired, press `<BACK` in the top left corner of the popup. Press `PULL VACUUM` to start the vacuum procedure.

» NOTE

- At any time during the `PULL VACUUM` procedure, press the `STOP` command button to turn off the vacuum pump and valve off the sample chamber.
- To access the sample chamber again, use the `VENT` command to vent the chamber to atmospheric conditions.

Section 5 - Maintenance & Troubleshooting

5.1 Care & Maintenance

5.1.1 Vacuum System Best Practices

Recommended vacuum 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.

- Keep vacuum hoses, valves, and components free of contaminants. When the vacuum tubing or ports are open, use the provided covers to help keep dust and other debris out of the vacuum system.
- When you will not be using the cryostat, keep the lid on the sample chamber to keep it free from dust and moisture. Keep the sample chamber under vacuum whenever possible by using the `PULL VACUUM` command button.
- Before cooling down or pulling vacuum, enable the Platform Bakeout and Dry Nitrogen Purge procedures to help clean out the vacuum system. The Dry Nitrogen Purge is especially useful if the sample chamber has been exposed to atmosphere for an extended period of time.
- Avoid using too much grease in the system on O-rings and sealing surfaces as it can outgas and contaminate surfaces. A thin layer (just enough so the surface is shiny) is sufficient for most applications.

5.1.2 Component Maintenance

The following maintenance procedures will need to be completed on the vacuum system components. Refer to the associated third-party product manuals for detailed instructions on these maintenance procedures.

UHV Gauge Cleaning: Every 9-12 Months

The Pirani-cold cathode UHV vacuum gauge requires cleaning approximately every 9-12 months. To clean the gauge, it must be removed from the manifold inside the main body of the cryostat tower behind the cryocooler.

» NOTE

The actual cleaning procedure for the gauge can be found in the *Agilent Inverted Magnetron Pirani Gauge FRG-700 FRG-702 Operating Instructions* manual provided with the system. The user will need an Agilent FRG-700 full range gauge maintenance kit for replacing some parts while cleaning. The kit (part number FRG700MAINT) can be ordered from Agilent directly.

1. On the touchscreen UI, navigate to `MENU > SYSTEM SETTINGS` and select `POWER OFF`.
2. Fully power down the System Control Unit and Vacuum Control Unit by toggling the power switch on the back of each unit OFF (o).

3. Fully power down the compressor by toggling the power switch on the back of the unit OFF (o).
4. On the back panel of the cryostat, remove the top cover plate above the hose and cable connections by removing the four black M3 screws holding it in place (circled red below). Do not remove the lower cover plate which contains the external connectors and internal PCB.
5. Carefully reach inside the cryostat body and unplug the ethernet cable attached to the UHV gauge.
6. Next, remove the KF connector attaching the gauge to the manifold.
7. Carefully remove the gauge from the cryostat, taking care not to contact any internal components or the PCB.



Cryostat back panel access point to UHV gauge

8. Once removed, the gauge should be cleaned according to the instructions in the Agilent Pirani Gauge manual.
9. After the gauge has been properly cleaned, reverse steps 4-7 above to re-install it in the cryostat.

Turbopump Oil Reservoir: Every 4 Years

The oil reservoir on the turbopump needs to be changed approximately every 4 years (run time). This maintenance is typically completed with the 20,000 Hour Maintenance for the Cryostation. This procedure should only be completed by or under the direction of an authorized service representative.

5.2 Diagnostics & Troubleshooting

5.2.1 Vacuum System Diagnostics

The UI displays a pressure reading for the attached UHV gauge.

Unable to Achieve Desired Vacuum

If the pressure reads higher than expected, follow the diagnostic steps in the System User Manual (Section 7.3.3 Vacuum Check) to check for a leak or other vacuum issue. In addition to checking the sample chamber vacuum housing, lid, and window O-rings, the turbo hoses or fittings may be the source of the leak:

1. Check all KF fittings for any debris or fibers on the O-rings.
2. Ensure all KF fittings are properly seated and the wing nuts are tightened down securely.

If the issue persists, please contact an authorized service representative.

OverPressure Reading

If the pressure reads `OVERPRESSURE`, this is likely due to a sensitivity issue with the UHV gauge. The gauge tends to lose accuracy above 300 Torr. An `OVERPRESSURE` reading under atmospheric conditions is normal and does not typically require any additional troubleshooting.

5.2.2 Turbopump Errors

The User Interface displays and logs errors communicated by the Pfeiffer turbopump. The error code will be displayed in a popup and can also be found under `MENU > EVENT LOG`. For further details, cross-reference the error code with the troubleshooting information in the Pfeiffer user manual.

If there are any other issues with the turbopump option, please contact an authorized service representative.

Section 6 - Appendices

6.1 Related Documentation

For a copy of associated documentation, see below:

Document Number	Document Title	Location
4100-DOC001	System User Manual: Cryostation s-series	www.montanainstruments.com/library/files/4100-DOC001.pdf
DOC102	General Terms and Conditions of Sale	www.montanainstruments.com/About/Terms
DOC103	Limited Warranty Agreement	www.montanainstruments.com/About/Warranty
DOC104	End User License Agreement	http://www.montanainstruments.com/about/EULA

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

Document Number	Document Title	Original Manufacturer
PT0208	Operating Instructions: HIPACE 80 Turbopump	Pfeiffer Vacuum
TQNa74e1	Operating Instructions: Inverted Magnetron Pirani Gauge FRG-700 FRG-702	Agilent Technologies
277387EF	Installation, Operating & Maintenance Instructions: VAT Series 264, DN 25 - 40	VAT Valve

