Quantum Design

Physical Property Measurement System

Cryopump High-Vacuum Option User's Manual

Part Number 1083-150, C-2

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Trademarks

U.S. Patents
4,791,788 Method for Obtaining Improved Temperature Regulation When Using Liquid Helium Cooling
4,848,093 Apparatus and Method for Regulating Temperature in a Cryogenic Test Chamber
5,311,125 Magnetic Property Characterization System Employing a Single Sensing Coil Arrangement to Measure AC Susceptibility and DC Moment of a Sample (patent licensed from Lakeshore)
5,647,228 Apparatus and Method for Regulating Temperature in Cryogenic Test Chamber
5,798,641 Torque Magnetometer Utilizing Integrated Piezoresistive Levers

Foreign Patents
U.K. 9713380.5 Apparatus and Method for Regulating Temperature in Cryogenic Test Chamber

CE

Safety Instructions

No operator-serviceable parts are inside. Refer servicing to qualified personnel.

For continued protection against fire hazard, replace fuses only with same type and rating of fuses for selected line voltage.

Observe the following safety guidelines when you use your system:

- To avoid damaging the system, verify that the system power requirements match the alternating current (AC) power available at your location. If the system has not been configured for the correct power available at your location, contact your local service representative before you proceed with the system installation.
- To prevent electrical shock, verify that the equipment is properly grounded with three-wire grounded plugs.
- To prevent electrical shock, unplug the system before you install it, adjust it, or service it.
- Do not spill food or liquids on the system or its cables.
- Refer to the section titled “Safety Precautions” before you install or operate this system. Direct contact with cryogenic liquids, materials recently removed from cryogenic liquids, or exposure to the boil-off gas, can freeze skin or eyes almost instantly, causing serious injuries similar to frostbite or burns.
- Wear protective gear, including clothing, insulated gloves, and safety eye protection, when you handle cryogenic liquids.
- Transfer liquid helium only in areas that have adequate ventilation and a supply of fresh air. Helium gas can displace the air in a confined space or room, resulting in asphyxiation, dizziness, unconsciousness, or death.
- Keep this system away from radiators and heat sources. Provide adequate ventilation to allow for cooling around the cabinet and computer equipment.
- Refer to the manuals for the supplied computer and monitor for additional safety warnings and notices before you operate the system.

Regulatory Information

- This apparatus has been tested to the requirements of the EMC Directive 89/336/EEC.
- This apparatus is defined as ISM Group 1, Class A and B equipment per EN 50011:1991 (industrial and light industrial environment limits of radio frequency emission).
- This apparatus has been tested to the requirement of the Low Voltage Directive 73/23/EEC.
- See the EU Declaration of Conformity for additional regulatory information regarding your PPMS.

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P R E F A C E

Contents and Conventions

P.1 Introduction

This preface contains the following information:

- Section P.2 discusses the overall scope of the manual.
- Section P.3 briefly summarizes the contents of the manual.
- Section P.4 illustrates and describes conventions that appear in the manual.

P.2 Scope of the Manual

This manual discusses the Physical Property Measurement System (PPMS) Cryopump High-Vacuum option. This manual illustrates the cryopump hardware, explains how to install the cryopump, and explains how to use the cryopump to initiate high vacuum.

P.3 Contents of the Manual

- Chapter 1 introduces the Cryopump High-Vacuum option and illustrates the option hardware.
- Chapter 2 explains how to install the cryopump in the PPMS and how to remove the cryopump from the PPMS.
- Chapter 4 contains troubleshooting and maintenance procedures.
- Index is a guide to information organized by key terms and phrases.

P.4 Conventions in the Manual

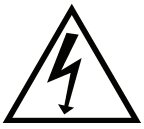
File menu	Bold text identifies the names of menus, dialogs, options, buttons, and panels used in the PPMS MultiVu and VSM software.
File >> Open	The >> symbol indicates that you select multiple, nested software options.
STATUS	**Bold** text and all CAPITAL letters distinguish the names of keys located on the front panel of the Model 6000 PPMS Controller.
`.dat`	The `Courier` font distinguishes characters you enter from the PC keyboard or from the Model 6000 PPMS Controller front panel. It also indicates file and directory names and computer code.
<Enter>	Angle brackets < > distinguish the names of keys located on the PC keyboard.
<Alt+Enter>	A plus sign + connecting the names of two or more keys distinguishes keys you press simultaneously.
Important	Text is set off in this manner to signal essential information that is directly related to the completion of a task.
Note	Text is set off in this manner to signal supplementary information about the current task; the information may primarily apply in special circumstances.

C A U T I O N !

Text is set off in this manner to signal conditions that could result in loss of information or damage to equipment.

W A R N I N G !

Text is set off in this manner to signal conditions that could result in bodily harm or loss of life.



W A R N I N G !

Text is set off in this manner to signal electrical hazards that could result in bodily harm or loss of life.

C H A P T E R 1

Introduction

1.1 Introduction

This chapter contains the following information:

- Section 1.2 discusses the theory of operation for the PPMS Cryopump High-Vacuum option.
- Section 1.3 illustrates the PPMS Cryopump system hardware.
- Section 1.4 discusses safety precautions for the PPMS Cryopump system.
- Section 1.5 has information for contacting Customer Service at Quantum Design.

1.2 Theory of Operation

The PPMS Cryopump High-Vacuum option pumps helium gas from the PPMS sample chamber in order to provide high vacuum. By reaching base pressures near 0.1 mTorr (1 mP), the system is able to achieve thermal isolation for measurement options such as PPMS Heat Capacity (Model P650) and the PPMS Helium-3 Refrigerator System (Model P825).

1.2.1 Pumping Element

The cryopump uses a charcoal sorption pump maintained at liquid-helium temperatures as the active pumping element. The sorption pump is located at the bottom of a stainless steel tube that penetrates through the top plate of the PPMS probe into the belly of the helium dewar (see Figure 1-1). The cold helium gas and liquid in the dewar provide the cooling. During routine sample chamber operations—that is, pumping, venting, sealing, and purging—the sorption pump is always cold and pumping. The cryopump uses a large orifice flapper valve, located on the PPMS top plate, to isolate the sorption pump from the sample chamber during non-high-vacuum chamber operations. A smaller isolation solenoid valve, also located in the top-plate assembly, isolates the sample chamber from the Model 6000 pumping line.

When the system receives a high vacuum request and it is in the proper state (i.e., the sample chamber has been vented, the isolation solenoid has been opened, and the sample space has been pumped out by using the Model 6000 pumping line), it automatically performs the following operations: When the pressure is below about 10 Torr (1 kP), the system closes the isolation solenoid and opens the large flapper valve, thus exposing the sample chamber to the sorption pump. The system monitors the pressure after the chamber has been exposed and indicates high vacuum when the pressure has stabilized at its minimum value.

The isolation solenoid is normally closed. The system opens it when the PPMS sample space is pumped on or vented. When the chamber has been purged, the system closes the isolation solenoid again.

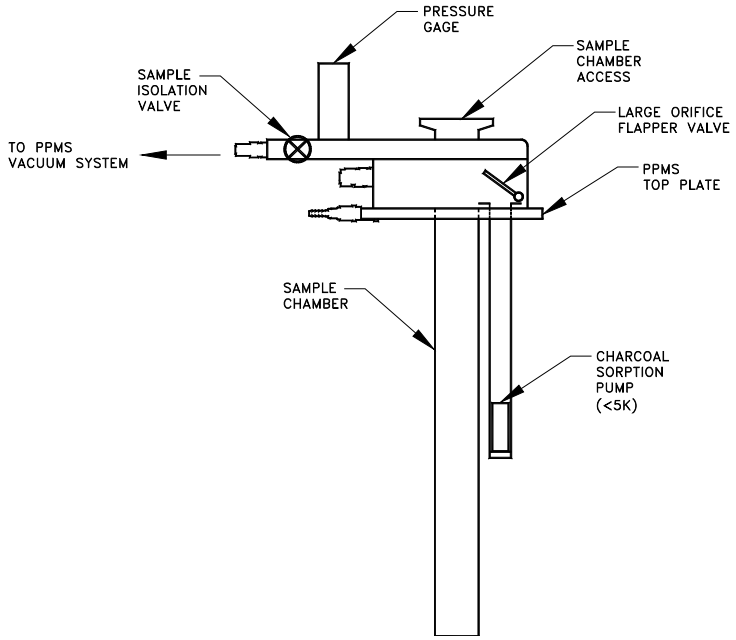


Figure 1-1. Cryopump assembly

1.2.2 Pump Regeneration

Because of the limited capacity of a sorption pump, it is necessary to periodically regenerate the pump in the cryopump system by heating it to liberate the adsorbed helium gas. Typically, the system only needs an in-dewar regeneration. The in-dewar regeneration procedure takes a brief amount of time and is automated through the use of a heater attached to the sorption pump. However, it is important to note that you must manually initiate the regeneration by using the front panel of the Model 6000 PPMS Controller or the PPMS MultiVu software.

Usually the system operates many weeks or months without requiring a regeneration of the pump. The actual time between regeneration operations depends on the number of chamber operations and the amount of water vapor allowed into the sample chamber. Occasionally it will be necessary to perform an out-of-dewar regeneration, in which the entire cryopump assembly is removed from the dewar through the top plate. This procedure takes somewhat longer than the in-dewar procedure, but because the regeneration heater only liberates helium gas, the out-of-dewar regeneration is used to remove water or nitrogen.

Section 4.3 discusses the regeneration process in detail, including factors that will cause a need for the out-of-dewar regeneration.

1.3 Hardware

Table 1-1. Major hardware components shipped with the PPMS Cryopump option

HARDWARE	PART NUMBER	ILLUSTRATION
Cryopump Head Assembly	4083-201	Figure 1-2
Blanking Plate	HPNW40C	Figure 1-3, Item A
Centering Ring	HPNW40B	Figure 1-3, Item B
Cryopump Pumpout Fixture	4083-208	Figure 1-3, Item C
with O-Ring	VON2-224	Figure 1-3, Item D
Cover, Left Side Cryopump	4083-205	Figure 1-4, Item A
Cover, Right Side Cryopump	4083-206	Figure 1-4, Item B
Extension Cap (EverCool systems)	4083-234	Figure 2-7
Sample Space Plug	4083-059	Figure 1-4, Item C
Sample Chamber Baffle Assembly	4078-113	Figure 1-5
Blank Plate Weldment	4078-105	Figure 1-5, Item A
Contact Baffle Assembly	4083-010	Figure 1-5, Item B
Cryopump Cable Assembly	3083-308	Figure 1-6
Expansion Circuit Board	3076-015	Figure 1-7
Port Expansion Box	4076-060	Figure 2-3
Auxspare-to-Expansion-Board Cable	3076-018	
Cable Assembly Jumper	3085-101	
PAL for Motherboard		
Updated ROMs		

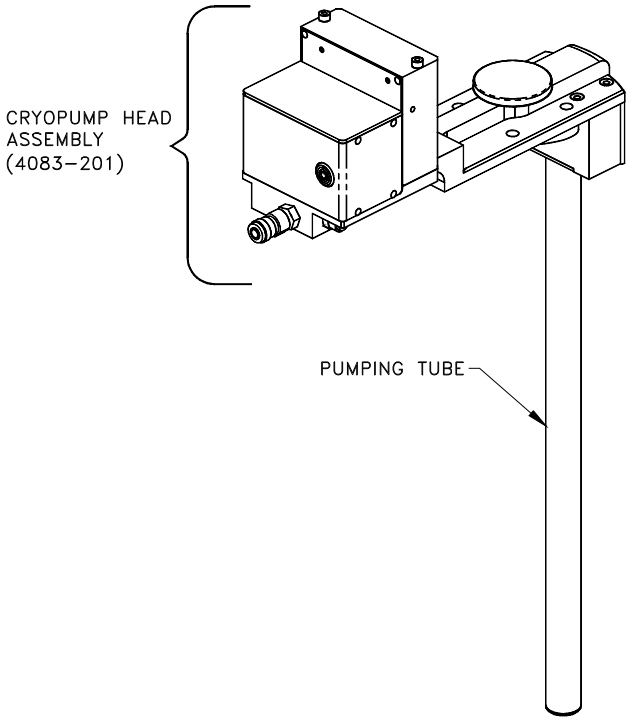


Figure 1-2. Cryopump head assembly and pumping tube

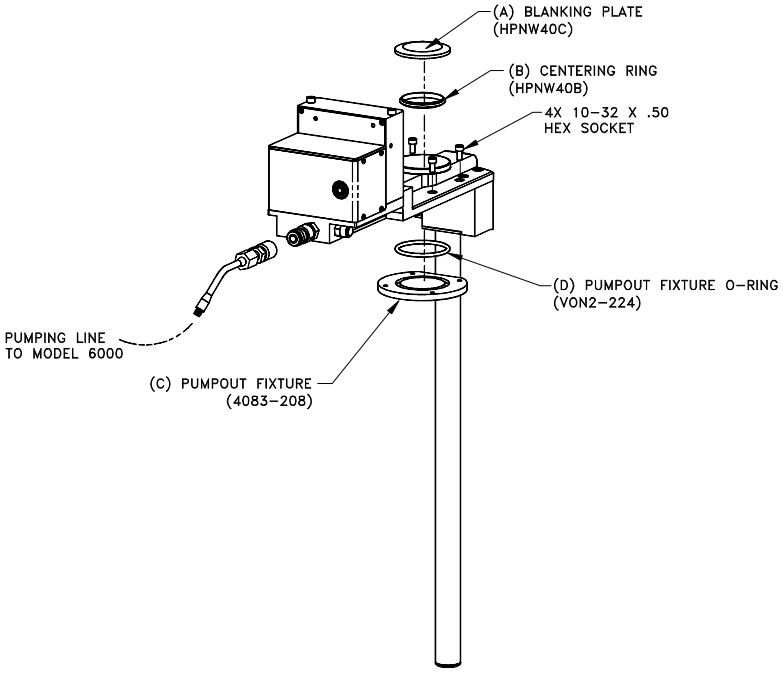


Figure 1-3. Pumpout fixture and blanking plate

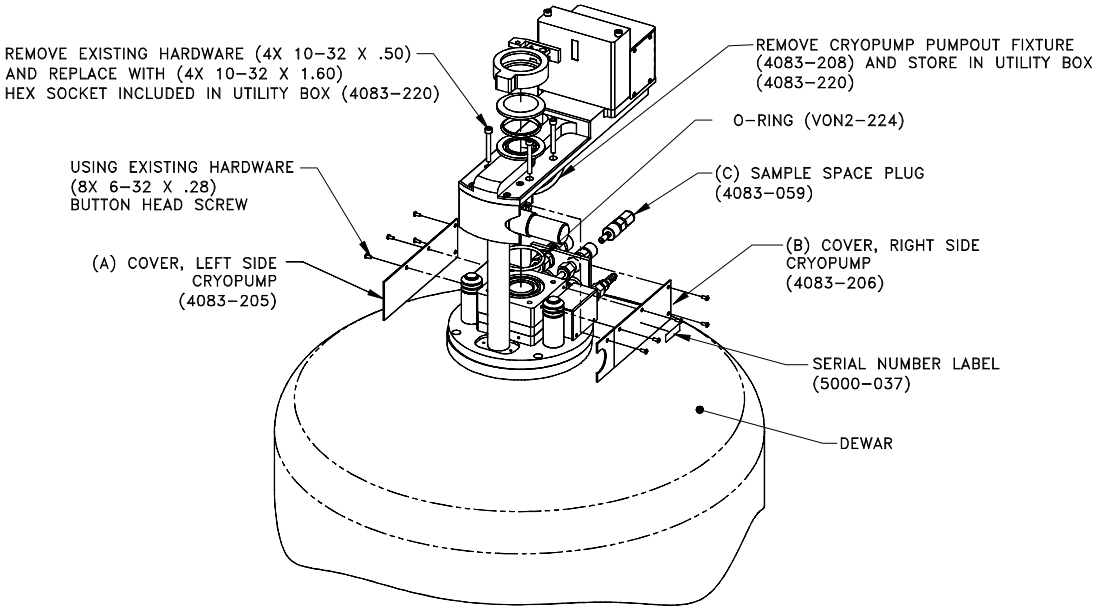


Figure 1-4. Exploded view of installed cryopump

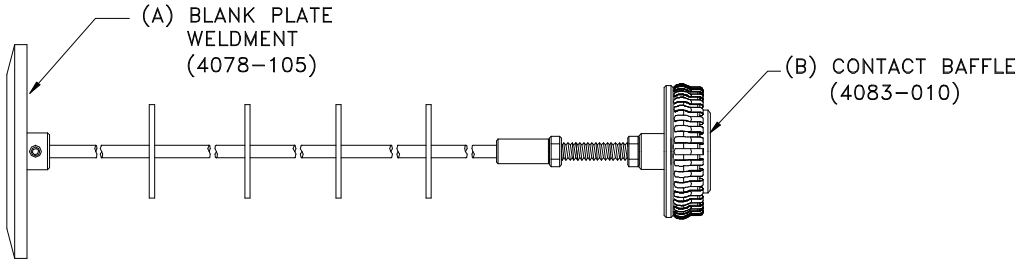


Figure 1-5. Sample-chamber baffle assembly with contact baffle

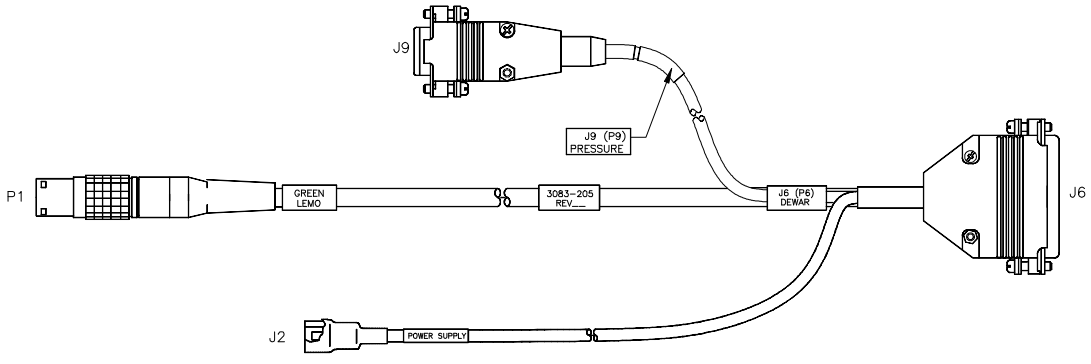


Figure 1-6. Cryopump cable

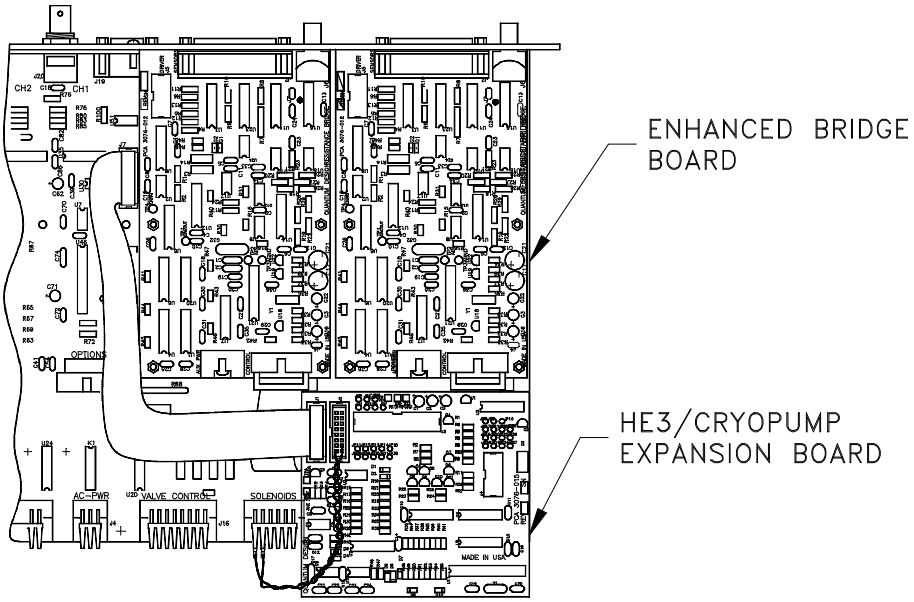


Figure 1-7. Expansion circuit board and enhanced user bridge board in Model 6000

1.4 Safety Precautions

W A R N I N G !

The Cryopump option is used in conjunction with the Physical Property Measurement System (PPMS), so you should be aware of the safety considerations for all the equipment. PPMS-related safety precautions include those for the use of superconducting magnets and for the use of cryogenic liquids, as is reviewed below and in the *Physical Property Measurement System: Hardware Manual*.

Above all, Quantum Design and its staff ask that you use standard safe laboratory procedures.

- Use common sense.
- Pay attention to the state of the system and to your surroundings.
- If the system appears to be behaving abnormally, investigate to see if there is a malfunction. If necessary, take the appropriate action (e.g., troubleshoot, shut down the system, contact Quantum Design).
- Supervise inexperienced users and train them in general electrical safety procedures.

The PPMS has safety features to prevent accidents from causing injury or serious equipment damage. *If you use the equipment in a manner that is not specified by Quantum Design, the protection afforded by the equipment may be impaired.*

1.4.1 Magnets

W A R N I N G !

Any person who wears a pacemaker, electrical medical device, or metallic implant must stay at least 5 m (16.5 ft.)[1] from the PPMS dewar. In addition, personnel should keep all ferromagnetic objects at least 5 m (16.5 ft.) from the PPMS dewar. Verify that all magnetic fields are at zero (0) before you handle the VSM linear motor transport in any way.

The following precautions should be followed to ensure the safety of personnel who work with or around a PPMS with a superconducting magnet. This material is covered in more depth in Chapter 1 of the *Physical Property Measurement System: Hardware Manual.*

- Verify that any person who has a metallic implant or is wearing a pacemaker or electrical or mechanical medical device stays at least 5 m (16.5 ft.) from the PPMS dewar. Large magnetic fields are dangerous to anyone who has a metallic implant or is wearing a pacemaker or other electrical or mechanical medical device.

  Important: The automated control system can turn on the magnet while the system is unattended. Furthermore, the three-dimensional magnetic field of the PPMS will penetrate nearby walls, the ceiling, and the floor. Therefore, your safety considerations should include such adjacent spaces.

- Keep all iron, nickel, and other ferromagnetic objects at least 5 m (16.5 ft.) from the PPMS dewar. Large magnets, such as the PPMS superconducting magnets, can attract iron and other ferromagnetic materials with great force. The observable effects of magnetic fields are listed in Chapter 1 of the *Physical Property Measurement System: Hardware Manual*.

[1] At the current time (November 2004), 5 m should be a large enough distance to protect wearers of metallic implants or medical devices from most magnetic fields produced by Quantum Design magnets. However, the safe distance from newer magnets (in development) could be greater. Hence, personnel who work with and around the superconducting magnets should review thoroughly documentation for new equipment.

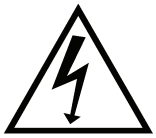
1.4.2 Cryogens

W A R N I N G !

Always wear protective clothing and ensure that the room has good ventilation when you work with cryogenic materials such as liquid helium and liquid nitrogen. These precautions will protect you against cryogenic material hazards: (1) they can expand explosively when exposed to room temperature; (2) they can cause serious burns.

- Always wear protective clothing, including thermal gloves, eye protection, and covered shoes, when you work with liquid helium, liquid nitrogen, or other cryogens.
- Avoid wearing loose clothing or loose gloves that could collect cryogenic liquids next to the skin. The extreme cold of liquid and gaseous cryogens can cause serious burns and has the potential to cause loss of limbs.
- Use cryogens only in well-ventilated areas. In the event a helium container ruptures or there is a helium spill, vent the room immediately and evacuate all personnel. In a poorly ventilated area, helium can displace the air, leading to asphyxiation. Because helium rises, well-vented rooms with high ceilings generally provide the safest setting for working with it.

1.4.3 Electricity



W A R N I N G !

The PPMS is powered by nominal voltages between 100 V to 240 V AC. These voltages are potentially lethal, so you should exercise appropriate care before opening any of the electronics units, including turning off the equipment and disconnecting it from its power source.

- Turn off and unplug all electronic equipment before removing any equipment covers.
- Keep electrical cords in good working condition and replace frayed and damaged cords.
- Keep liquids away from the workstations.

1.5 Contacting Quantum Design

If you have trouble with your PPMS or Cryopump option, please contact your local Quantum Design service representative for assistance. Your service representative will ask you to describe the problem, the circumstances involved, and the recent history of your system.

United States

Quantum Design World Headquarters
6325 Lusk Boulevard
San Diego, CA 92121

Tel: 1-858-481-4400
1-800-289-6996
Fax: 1-858-481-7410

Email: service@qdusa.com
Web: http://www.qdusa.com

Service for Canada, Mexico, the United States, and other countries not listed below

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L.O.T.—Gmbh & Co KG
Im Tiefen See 58
D-64293 Darmstadt, Germany

Tel: 49-6151-880631
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Service for Austria, Belgium, Crete, Croatia, Czech Republic, Denmark, England, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, and Yugoslavia

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Email: lonson.lin@omega-cana.com.tw

Service for Taiwan, Hong Kong, Singapore

C H A P T E R 2

Installation and Removal

2.1 Introduction

This chapter contains the following information:

- Section 2.2 explains how to install the cryopump in the PPMS.
- Section 2.3 explains how to remove the cryopump from the PPMS.
- Section 2.4 explains how to reinstall the cryopump.

2.2 Installing the Cryopump

WARNING!

Always wear protective clothing, including thermal gloves, eye protection, and covered shoes, when you install or remove the cryopump from the dewar or when you work with liquid helium, liquid nitrogen, or any other cryogen. For more information about cryogenic safety, refer to Section 1.4.2 and to the *Physical Property Measurement System: Hardware Manual*.

The Cryopump High-Vacuum option is shipped with an accessories box (Figure 2-1) that holds tools and hardware, such as the items that are installed in or removed from the PPMS during installation of the cryopump. The accessories box contains the following items: cryopump side panels, a blanking plate, a plug removal tool, a 5/32-inch hex Allen key, a 5/64-inch Allen wrench, assorted screws, and a container of Apiezon M-grease.

We strongly recommend that you review a set of procedures before you begin them (e.g., installation, removal). For instance, a review will facilitate the installation and help you prevent air from being cryopumped into the dewar.

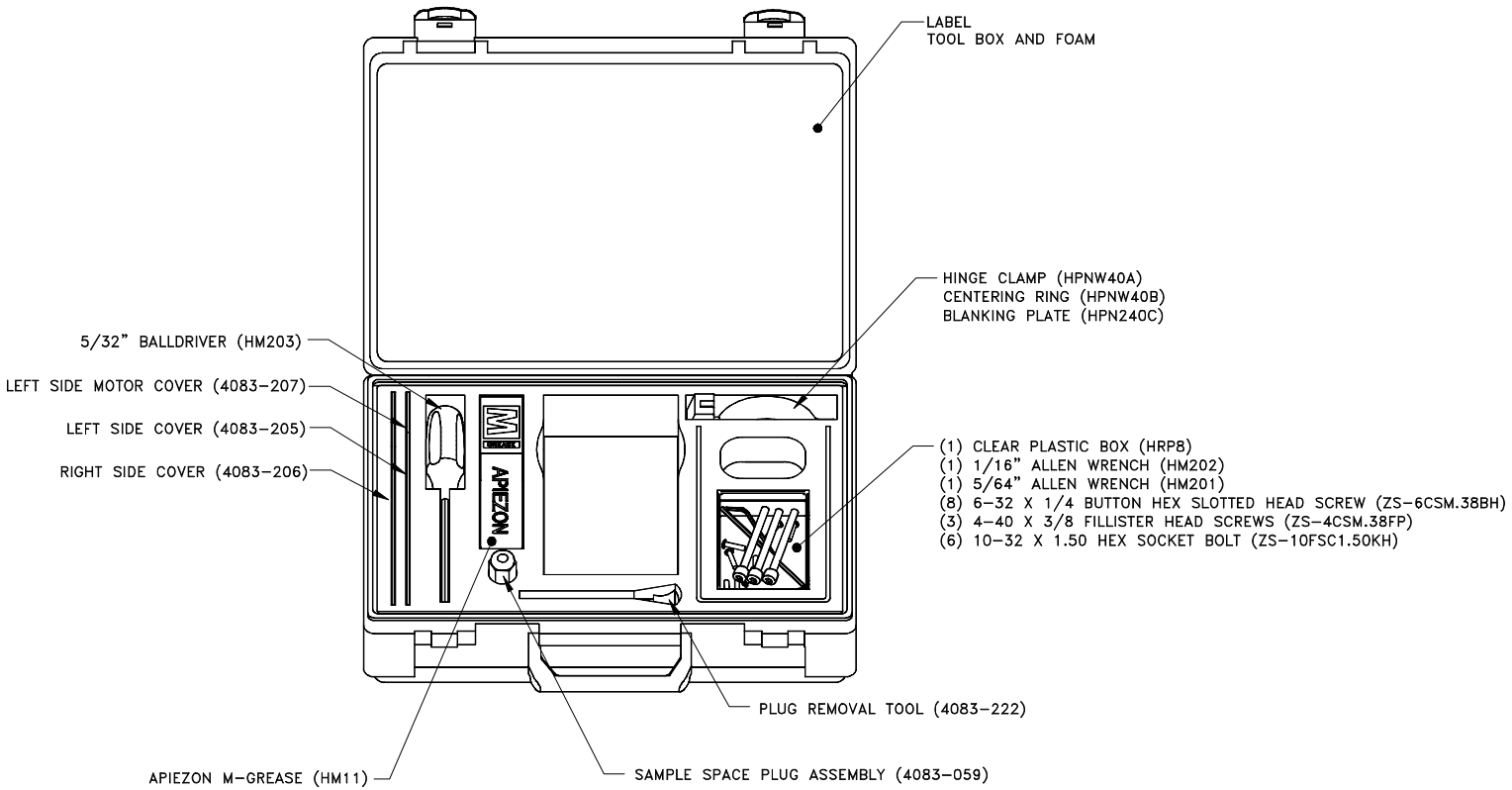


Figure 2-1. Accessories box for the Cryopump High-Vacuum option

C A U T I O N !

In the following procedures, it is important to maintain the sample chamber at or above room temperature. This will prevent the condensation and cryopumping of air into the chamber if it is opened to the atmosphere.

2.2.1 Unpack the Cryopump

C A U T I O N !

Always hold the head of the cryopump carefully and with two hands. Never hold the cryopump by the tube, because the head is heavy and the tube is thin, so the tube can be easily bent and damaged. If the tube is bent, you will not be able to insert it into the dewar.

1. Remove the cryopump system from the packing crate.
2. Verify that you have received all system components. Table 1-1 lists the major hardware components that are shipped with the cryopump.
3. Run the *Heater Continuity Diagnostic Test* to verify that the regeneration heater was not damaged during shipping. If the system does not pass this test, contact Quantum Design.

   Heater Continuity Diagnostic Test
   At room temperature, check continuity between Pins 7 and 8 on the green Lemo connector. The value should be 100 Ω±5Ω. Then check Pin 7 to ground (chassis) for infinite resistance and Pin 8 to ground for the same (refer to the cryopump wiring diagram in Section 4.4 of this manual).

2.2.2 Prepare for Installation

1. Set the PPMS system temperature to 320 K.
2. Vent the system continuously.
3. Put the system in standby mode.
4. Install any software that accompanied the Cryopump option. To install the software, run `setup.exe` from the installation disk(s). The Cryopump option requires PPMS MultiVu version 1.2 or later in order to take full advantage of the cryopump features.

2.2.3 Power Down and Change the EPROMs

If you received new EPROMs, you must install them in the Model 6000 PPMS Controller. The Cryopump option requires EPROMs version 1.80 or later. Complete the following steps to install the EPROMs.

1. Back up the ROM configuration information by running the ROM configuration utility as follows:
   (*a*) Double-click on the **PPMS 32-bit Tools** icon on the PC desktop.
   (*b*) Run the Romcfg32 utility.
   (*c*) Select the **Diag (all Configs including above)** check box.
   (*d*) Select the **Read Configuration** button.
   (*e*) Specify a file name for the configuration you are saving, and select **OK**.
   (*f*) Wait for the program status at the bottom left corner of the screen to change from "reading" to "idle."

Figure 2-2. PPMS 32-bit Tools icon

2. Turn off power to the Model 6000.
3. Remove the power cord from the Model 6000.
4. Remove the lid from the PPMS electronics cabinet.
5. Remove the lid from the Model 6000.
6. Locate the CPU board. When you face the front of the electronics cabinet, the CPU board is the board the furthest to the left and it has the GPIB connected at its back.
7. Remove the two EPROMs from the CPU board.
8. Install the two new EPROMs into the CPU board.
9. Keep the power disconnected from the Model 6000.

2.2.4 Install the Expansion Circuit Board

C A U T I O N !

Work carefully while the cover is off the top of the Model 6000 PPMS Controller, and avoid dropping hardware inside the unit. If hardware is dropped inside the Model 6000, it *must* be retrieved before you restore power to the Model 6000, or it could be severely damaged.

Note: The following procedures involve working with circuit boards. If there is no one available who is experienced with circuit boards, contact Quantum Design for assistance.

To enable the Model 6000 to communicate with the cryopump hardware, the Cryopump/Helium-3 expansion circuit board must be installed in the Model 6000, as explained below.

1. Locate the CPU board in the Model 6000. When you face the front of the electronics cabinet, the CPU board is the board the furthest to the left and it has the GPIB connected at its back.
2. Remove the CPU board by disconnecting the cables, back-panel screws, and fasteners holding the board onto the five standoffs. The large board beneath the CPU board is the motherboard.

3. Check for any chips previously installed in the U55 socket in the motherboard. If the U55 socket is empty, proceed to step 4. If there is already a chip in the socket, its label should read "PPMS_SEL2." If the revision and the "CKSUM" numbers are identical to those on the upgrade chip included with this option, no chip replacement is necessary. If the revision or the "CKSUM" numbers are different between the two chips, replace the chip in the motherboard with the upgrade chip.
4. Hold the "PPMS_SEL2" PAL chip so that the notch on it faces left, indicating that pin 1 is in the correct position.
5. Use gentle pressure to insert the "PPMS_SEL2" PAL chip into the "U55" socket on the exposed circuit board. Work carefully so that you do not bend pins; bent pins require new motherboards. Once the PAL chip is inserted, visually inspect it to verify that there are no bent pins.
6. Reinstall the CPU board.
7. Remove any board installed in the "P3–Option" slot on the Model 6000.
8. Install the expansion circuit board (part number 3076-015) in the location indicated in Figure 2-3. Proceed as follows: (*a*) remove the nut and washer holding the lower right corner of the mother-board, (*b*) attach the provided standoff, (*c*) install the expansion board into the standoff, and then (*d*) reinstall the washer and nut.

   If the standoff does not stand vertically, you may need to bend it to make it straight. The expansion circuit board will not fit unless the standoff is straight. The two connectors on the underside of the board should completely engage the connectors on the motherboard.

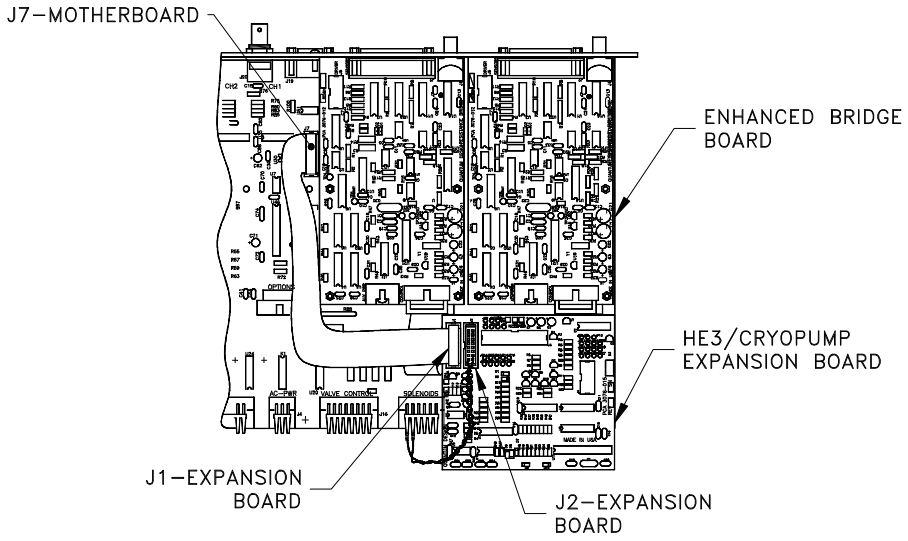


Figure 2-3. Installing the expansion circuit board in the Model 6000

9. Locate the 16-pin connector at the "J7-Aux-Spare" position on the motherboard. *To proceed with the installation, a connector must already be plugged into this position.* Contact Quantum Design if nothing is plugged into the "J7-Aux-Spare" position.
10. Remove the connector plugged into the "J7-Aux-Spare" position on the motherboard, and plug it into the "J2" connector on the expansion circuit board as shown in figure 2-2.
11. Install the "Auxspare-to-Expansion Board" ribbon cable (part number 3076-018) between the "J1" connector on the expansion board and the "J7-Aux-Spare" connector on the motherboard as shown in figure 2-2. Do not let the ribbon cable touch the large resistors above the "Valve Control" connector; these resistors can get very hot. You may want to run the cable under the system bridge board.
12. Reinstall the board you removed from the "P3–Option" slot.

2.2.5 Power Up the Model 6000 and Restore the Configuration

1. Replace the lid on the Model 6000.
2. Reattach the power cord.
3. Turn on power to the Model 6000.
4. Restore the ROM configuration information as follows:
   a. Locate and run the Romcfg32 utility if it is not still running,
   b. Select the **Send to PPMS >> Send Config** menu item, and
   c. Specify the file name you saved above in section 2.2.3.
5. Set the PPMS system temperature back to 320 K and vent the system continuously.

2.2.6 Connect the Pumping Line and Cables

1. Remove the cable and any associated in-line dongles attached to the "P6–Dewar" connector on the back of the Model 6000.
2. Locate the port expansion box (part number 4076-060, Figure 2-4) that comes with the Cryopump option and attach it to the "P6–Dewar" connector.

   The port expansion box is a simple splitter box that allows the existing dewar cable to share the "P6–Dewar" connector with the cryopump cable.

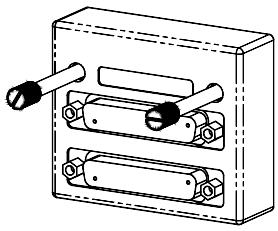


Figure 2-4. Port expansion box

3. Affix the "P6–Dewar" sticker to the port expansion box if the sticker is not already on the box.
4. Reattach the dewar cable and any dongles you disconnected in step 1 to the port expansion box. Refer to Figure 2-5.
5. Place the cryopump head assembly (part number 4083-201) on the edge of a smooth, flat table or work surface that is near the PPMS dewar and electronics cabinet. Position the cryopump head assembly so that the pumping tube hangs straight down over the edge of the table, and make certain you do not scratch the bottom surface of the assembly. Figure 1-2 identifies the cryopump head assembly and the pumping tube.
6. Referring to Figure 2-5, connect the sample space pumping line as follows:
   (*a*) Detach the sample space pumping line from the PPMS probe.
   (*b*) Plug the pumping line into the port at the bottom of the back panel on the cryopump top plate assembly.
   (*c*) Insert the sample space plug (part number 4083-059) into the fitting from which the pumping line was removed.

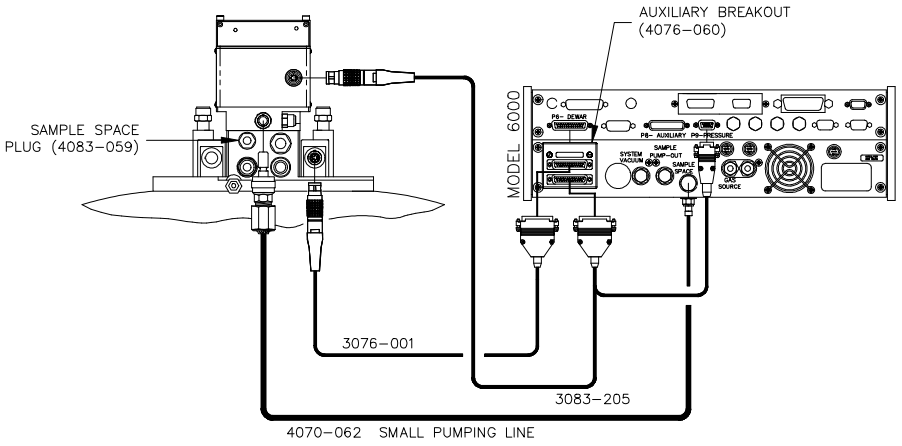


Figure 2-5. Cryopump connection diagram

7. Referring to Figure 2-5, connect the cryopump cable (part number 3083-205, Figure 2-6) as follows:
   a. Plug the 25-pin backshell connector into the "P6–Dewar" port expansion box on the Model 6000.
   b. Plug the 9-pin backshell connector into the "P9–Pressure" port on the Model 6000.
   c. Plug the Lemo-type connector with the green, color-coded band into the cryopump head.

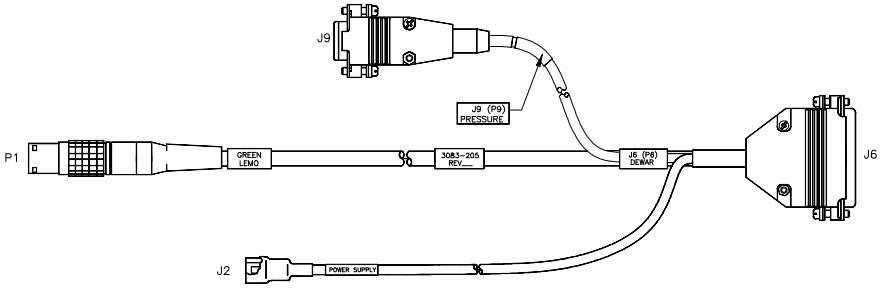


Figure 2-6. Cryopump cable

8. Attach the vacuum gauge power supply as follows:
   a. Plug in any power strip that has been shipped to you (required with older PPMS electronics cabinets. If your system uses an older 220-V cabinet, you must unplug a cable from the existing power strip before you can plug in the new power strip.
   b. Connect the vacuum gauge power supply to the cryopump cable. Automatic voltage detection in the vacuum gauge power supply will only allow the power supply that is compatible with your system.
   c. Connect the vacuum gauge power supply to the system's power strip. If an IEC attachment cable has been shipped to you, plug one end into the power supply and one end into the power strip. If a second attachment cable has been shipped to you, use this cable to connect the new power strip to the old power strip.
9. Use the Model 6000 **CONFIG** menu to configure the Model 6000 for cryopump operation.
   a. Select **CONFIG >> 6. Hardware >> 5. High Vacuum**.
   b. Under **Type of System**, select **Cryopump**.
   c. Press <Alt+Enter> to save the change.

10. Next, use the Model 6000 **CONFIG** menu to activate the cryopump (Pirani) pressure gauge (instead of the Model 6000 internal pressure gauge).
    a. Select **CONFIG>>6. Hardware>>4. Pressure Sensor**

       The Model 6000 display will now show the **Sensor**, **Units**, and **Units/V** settings.
    b. Use the directional keys on the Model 6000 to select "Pirani" for the **Sensor** type. When you are finished, the display should be similar to the example below.

SENSOR:	**PIRANI**
UNITS:	**TORR**
UNITS/V:	**TABLE**

    c. Press <ALT+ENTER> to save the changes.

2.2.7 Regenerate the Charcoal

Note: You will perform an out-of-dewar[1] regeneration of the system before the cryopump is installed or whenever the charcoal has become saturated with non-helium gases.

1. Verify that the cryopump pumpout fixture (part number 4083-208) is attached to the bottom side of the sample chamber opening on the cryopump (refer to Figure 2-7). Four 10-32 × 3/8 socket-head screws attach the pumpout fixture, with the O-ring facing upward, to the cryopump. The screws should be finger tight.
2. Referring to Figure 2-7, sse the blanking plate (see Figure 2-7, part number HPNW40C) and associated centering ring (part number HPNW40B) to cover the top orifice of the cryopump.

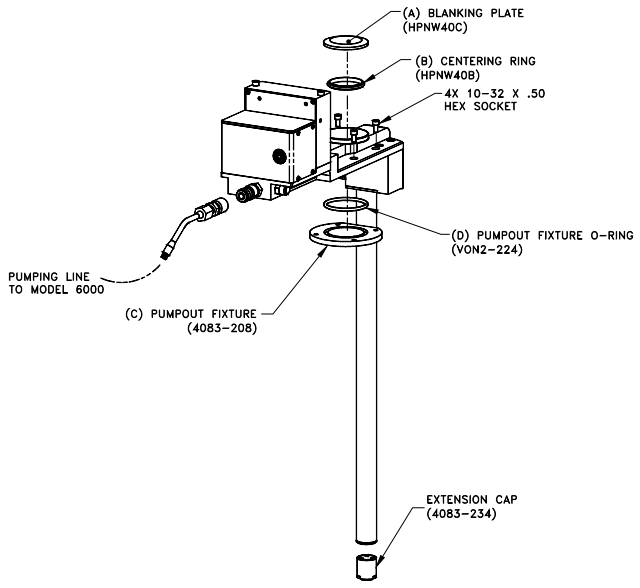


Figure 2-7. Exploded view of pumpout fixture and blanking plate (HPNW40C). Note the extension cap for [1]the cryopump pumping tube, which is used **only with the EverCool option** (see Section 2.2.9)

[1] The out-of-dewar regeneration is sometimes referred to as a warm regeneration.

3. Use the Model 6000 **CTRL** menu to initiate the out-of-dewar regeneration by selecting

   CTRL >> 3. Immediate Operations >> 14. CryoReg >> Regenerate with CryoPump in Room. The flapper valve opens and the system is pumped out. Then the flapper valve closes and the cryopump system is regenerated. This process takes at least 30 seconds. The out-of-dewar regeneration does not use the regeneration heater. You may follow the status of the regeneration by selecting **CTRL >> 1. Interactive Control >> 4. Pump**.

   When regeneration is complete, the message "Vented" appears in all menus that identify the status of the sample chamber. Note that you can run the out-of-dewar regeneration process multiple times.

4. Remove the top blanking plate (HPNW40C).
5. Remove the four 10-32 × 3/8 socket-head screws that attach the pumpout fixture to the cryopump, then remove the pumpout fixture.

We recommend that you review Sections 2.2.8 and 2.2.9 before you begin the procedures. This should prepare you to perform the steps without allowing air to be cryopumped into the dewar.

2.2.8 Remove the PPMS Top Plate Assembly

1. Verify that the system is at room temperature.
2. Connect the sample space pumping line to the PPMS probe head if the sample space pumping line is not already connected (refer to Section 2.2.6).
3. Set the system to vent continuously if it is not already venting.
4. Remove any baffles that are in the sample chamber.
5. Remove the sheet metal housing by undoing the eight screws that attach it to the sides of the PPMS top plate assembly (refer to Figure 2-8). Save the screws for Step 10 below. You also will use these screws in the event you remove the cryopump and re-install the sheet metal housing.
6. Remove the four 10-32 screws that attach the PPMS top plate assembly to the PPMS probe and save them to use in Step 11 below. Then remove the top plate assembly.

   You can bolt the pumpout fixture that is used for regeneration to the PPMS top plate for storage. This storage site will protect the surface of the pumpout fixture and the O-ring seal. (Torquing down the screws is unnecessary; it is sufficient to insert them into the top plate.
7. Verify that the O-ring at the mouth of the sample chamber is clean. Clean the O-ring if necessary.
8. Remove the two Phillips-head screws attaching the blank plate (part number 4078-092) to the opening to the dewar (refer to Figure 2-8). Store the screws in the accessories box for later.
9. **EverCool systems**: Attach the extension cap (4083-254) to the end of the cryopump with some Apiezon M-grease between the cryopump and extension cap (refer to Figure 2-7).
10. Using the eight screws from the sheet-metal housing (Step 5), install the left and right side covers (part numbers 4083-205 and 4083-206) by referring to Figure 1-4 for guidance. The side covers protect the sample chamber wires.
11. Apply Apiezon M-grease to the threads of the four 10-32 screws you removed in Step 6. These screws will be used to hold down the cryopump manifold. Do this *before* you install the cryopump.

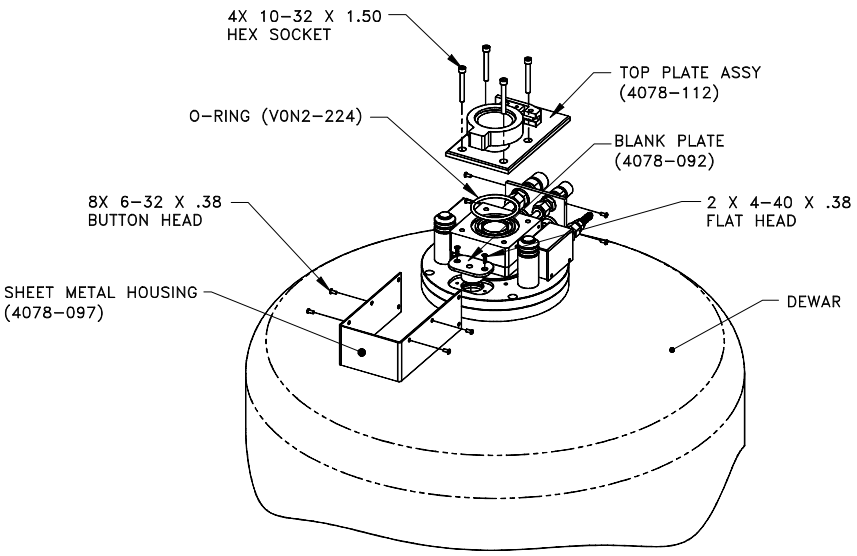


Figure 2-8. Removing the PPMS top plate assembly

12. In the next step, you will remove the blank plate that covers the sample chamber opening. ***To prevent air cryopumping into the dewar through the opening***, be prepared to insert the cryopump into this opening as soon as you remove the blank plate (see Step 1, Section 2.2.9).

13. Use the plug removal tool, which is the long screw in the middle of the blank plate (4078-092), to remove the blank plate from the opening to the dewar

2.2.9 Install the Cryopump

C A U T I O N !

Handle the cryopump carefully by holding the head with two hands. Use your finger to put a small amount of vacuum grease on the inside surface of the O-ring. It is not necessary to remove the o-ring. Carefully insert the tube ***straight*** into the dewar. This tube is thin and easily bent, and a bent tube would prevent the cryopump from working.

1. Working slowly and carefully, slide the cryopump pumping tube into the opening to the dewar.

   Important: You will conserve helium if you insert the cryopump slowly. Watch the amount of gas that boils off during the insertion and slow down the process further if you want to reduce the amount of boil-off.

2. Continue inserting the cryopump until the four 10-32 screws that hold down the cryopump manifold can be inserted and tightened. Use a 5/32-inch hex Allen key to tighten the screws very well so that they compress the O-ring on the sample chamber.

3. Assembly the sample chamber baffle assembly (part numbers 4078-113, 4078-105, 4083-010) and insert the baffle assembly into the top opening of the sample chamber. Figure 2-9 shows the dewar with the cryopump installed.

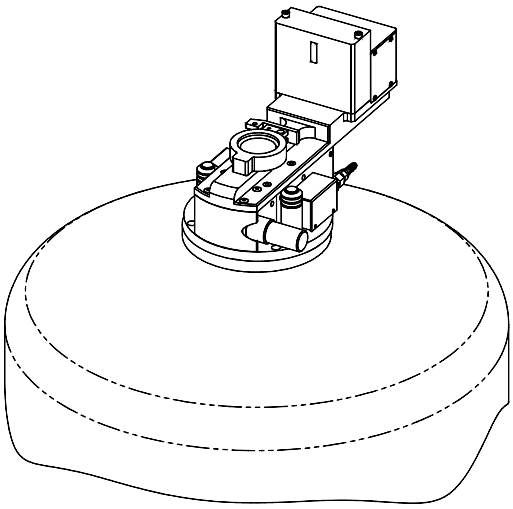


Figure 2-9. Cryopump installed in PPMS

4. Purge the system.
5. After you install the cryopump, let the system stabilize for 30 minutes before you proceed. While you are waiting, you can put the parts you used to install the cryopump back in the accessories box.

   Important: The charcoal ***must*** be cool before the system can enter high vacuum.
6. Verify that the temperature of the sample chamber is 300 K or greater.
7. Verify that the sample chamber is closed.
8. Verify that the pressure gauge has been powered up for at least 30 minutes.

   Important: To obtain accurate results, the pressure gauge must be powered up for at least 30 minutes before you use it. Although you can run the calibration before the pressure gauge is warm, the test results will be suspect.
9. You can now put the cryopump into high vacuum.
   a. Select **Instrument>>Chamber** from the dropdown tool bar at the top of the MultiVu window.
   b. When the **Chamber** dialog box opens, clock on the **HiVac** button to initiate the high-vacuum process.

2.2.10 Run the HiVac Pressure Gauge Calibration Utility

The HiVac Pressure Gague Cablibration utility enables the Cryopump option, calibrates the pressure gauge, and installs the configuration files. It also serves as a test of the operation of the cryopump.

Complete the following steps to run the HiVac Pressure Gauge Calibration utility:

1. Verify that the temperature of the sample chamber is 300 K or greater.
2. Verify that the sample chamber is closed.
3. Verify that the pressure gauge has been powered up for at least 30 minutes.

   Important: To obtain accurate results, the pressure gauge must be powered up for at least 30 minutes before you use it. Although you can run the calibration before the pressure gauge is warm, the test results will be suspect.

4. Open the **Quantum Design** program group, and then select the **HiVac Pressure Gauge.exe Calibration** option. The HiVac Pressure Gauge Calibration utility starts up.
5. Click the picture of the installed gauge.

   For gauge 4083-055: Verify the correct gauge by noting the large red Q logo on the gauge, the centered LED display, and the bolt heads sticking out on top. Follow steps 6 thru 14.
6. Select the `Eyesys.cal` file.
7. Select **OK**. The **HiVac Pressure Gauge Calibration** dialog box opens and displays the **Step 1** tab, which is the first of six tabs in the dialog box. The tabs step you through the tasks you perform to run the utility.

   The **Current pressure in torr** panel at the top of the dialog box indicates the pressure inside the sample space as determined by using the opened `.cal` file for the calibration. The panel is visible in each tab.
8. Select **Purge** to purge the system. The mouse pointer appears again when the system is purged. After the system is purged, select **Next** to open the **Step 2** tab.
9. Select **Vent** to vent the sample chamber. The mouse pointer appears again when the chamber is vented. After the chamber is vented, select **Next** to open the **Step 3** tab.
10. Use a small, nonconductive tool, such as a long-handled wooden toothpick, to press the recessed CAL button that is on the side of the pressure gauge. Press the button until you feel it engage. After you press the CAL button, select **Next** to open the **Step 4** tab.
11. Use the up and down arrows to adjust the displayed pressure until the pressure is between 760 and 780 torr. Notice that a short time delay occurs after you press the up or down arrow and before you see a change in the display. Select **Save** when you have set a pressure. After you have set and saved the pressure, select **Next** to open the **Step 5** tab.
12. Select **High Vacuum** to enable the Cryopump option, and then wait until the pump is at normal operation and the sample chamber status is at HiVac. The mouse pointer appears again when the pump is at normal operation and the chamber status is at HiVac. After the Cryopump option is enabled, select **Next** to open the **Step 6** tab.
13. Press the CAL button on the pressure gauge until you feel the button engage. After you press the CAL button, select **Exit** to close the **HiVac Pressure Gauge Calibration** dialog box.
14. Select **OK**.
15. **For gauge 4083-350**: Verify the correct gauge by noting the large blue Q logo on the gauge, the right offset LED display, and the recessed bolts on top.

    This gauge has a factory calibration. It has been calibrated in Helium. No further calibration is necessary.

    If one wishes to use a different gas in the system, the gauge can be recalibrated for this gas. Or one may wish to simply recalibrate the gauge. The steps for calibration are as follows and may be done out of order.

    a. At atmospheric pressure (~760 Torr), press and hold the mode button for 3 seconds. The display will flash all leds on if successful.
    b. At purged state (must be 5-15 Torr as read on gauge), press and hold the mode button for 3 seconds. The display will flash all leds on if successful.
    c. At High Vacuum state (~1e-5 Torr), press and hold the mode button for 3 seconds. The display will flash all leds on if successful.

    In order to reset the gauge to the factory default calibration:

    a. Press and hold the mode button for more than 10 seconds. The display will flash all leds on if successful.

16. Back up the system ROM configuration to a `.cfg` file as follows: (*a*) double-click on the **PPMS 32-bit Tools** icon on the PC desktop, (*b*) run the Romcfg32 utility, (*c*) select the **Diag (all Configs including above)** check box, (*d*) select the **Read Configuration** button, (*e*) specify a file name for the configuration you are saving, and then (*f*) select **OK**.

2.3 Removing the Cryopump

Warning! Always wear protective clothing, including thermal gloves, eye protection, and covered shoes, when you install or remove the cryopump from the dewar or when you work with liquid helium, liquid nitrogen, or any other cryogen. For more information about cryogenic safety, refer to the *Physical Property Measurement System: Hardware Manual*.

Complete the following steps to remove the cryopump from the PPMS and reinstall the standard PPMS top plate assembly.

1. Set the PPMS system temperature to 320 K.
2. Locate the blank plate, the PPMS top plate assembly, and the sheet metal housing for the PPMS top plate assembly. These components should be in the cryopump accessories box.
3. Use a 5/32-inch hex Allen key to unscrew the four 10-32 screws from the cryopump manifold. Keep the screws in a safe place; you use them to reinstall the standard PPMS top plate.
4. Vent the system continuously.
5. Remove the screws in the cryopump sheet metal side panels, and then remove the side panels.
6. Remove any inserted probe or baffle set.
7. Slowly pull the entire cryopump assembly straight up and out of the cold bath. Removing the cryopump slowly helps avoid damaging it by allowing it to heat up from the top slowly, thus boiling off any nitrogen condensed inside the cryopump.

Caution! Do not move the cryopump any angle or the tube will bend. Sometimes the o-ring may freeze as you lift the cryopump straight out of the dewar, and the tube will stick. If this occurs, do not force the pump to move as it may jolt upward, and you may hurt yourself and damage the tube. Wait approximately one minute until the pump can move freely, then continue to lift it straight out.

8. **Let the cryopump warm to room temperature.**
9. Insert the blank plate (part number 4078-092) into the dewar opening. Refer to figure 2-7.
10. Install the standard PPMS top plate assembly. Use the four screws to attach the top plate assembly to the PPMS probe.
11. Disconnect the sample chamber pumpout line from the cryopump and plug it into the standard port on the back of the PPMS probe head. You must remove the sample space plug (part number 4083-059) to do this.


NOTE

If the cryopump will be out of the sample chamber for a brief time—for example, if you are only going to perform a warm regeneration—steps 12 and 13 are unnecessary.

12. Use the Model 6000 **CONFIG** menu to tell the Model 6000 that the cryopump is removed. Do the following: (*a*) select **CONFIG >> Hardware >> High Vacuum**; (*b*) under **Type of System** option, select **None**; and then (*c*) press <Alt+Enter> to save the change.

13. Install the sheet metal housing if the cryopump will be out of the sample chamber for an extended period of time. Use the eight supplied screws to attach the sheet metal housing.

2.4 Reinstalling the Cryopump

Warning! Always wear protective clothing, including thermal gloves, eye protection, and covered shoes, when you install or remove the cryopump from the dewar or when you work with liquid helium, liquid nitrogen, or any other cryogen. For more information about cryogenic safety, refer to the *Physical Property Measurement System: Hardware Manual*.

1. Perform a warm regeneration. Refer to section 2.2.7.
2. Vent the system continuously.
3. Connect the sample space pumping line to the PPMS probe head if the sample space pumping line is not already connected. Refer to section 2.2.6.
4. Remove the two Phillips-head screws attaching the blank plate to the opening to the dewar. Refer to figure 2-7. Place the screws in the accessories box for safe storage.
5. Use the plug removal tool, which is the long screw in the middle of the blank plate, to remove the blank plate from the opening to the dewar. The plug covers the opening through which the cryopump pumping tube penetrates into the dewar.
6. Slowly and carefully slide the cryopump pumping tube into the opening to the dewar. Slide the pumping tube into the dewar until you can screw down the cryopump.

Caution! Handle the cryopump carefully by holding the head with two hands. Use your finger to put a small amount of vacuum grease on the inside surface of the o-ring. It is not necessary to remove the o-ring. Carefully insert the tube straight into the dewar. Inserting it at an angle may cause the thin tube to bend, which will prevent the cryopump from working.


NOTE

While you insert the cryopump, watch the amount of gas that boils off, and if necessary insert the cryopump more slowly to reduce the amount of boil-off. The more slowly you insert the cryopump, the more helium you conserve.

7. Use a 5/32-inch hex Allen key to install the four 10-32 screws that hold down the cryopump manifold. It is important to tighten these screws very well so that they compress the O-ring on the sample chamber.
8. Install the cryopump sheet metal housing.
9. Insert the baffle assembly.
10. Test the installation by installing the cap, plugging in the pressure gauge, and purging the system. Watch the static pressure to verify that the sample chamber is not leaking.

After you install the cryopump, wait several minutes before you instruct the system to enter high vacuum. *The charcoal must cool before the system can enter high vacuum.*

Remember to put all parts used to install the cryopump back in the accessories box for proper storage.

C H A P T E R 3

Operation

3.1 Introduction

This chapter contains the following information:

- Section 3.2 explains how to perform basic cryopump system operations.
- Section 3.3 explains use of the **Wait** sequence command.

3.2 Cryopump Operation

Operation of the cryopump is handled like other sample-chamber gas-handling commands such as **Vent**, **Purge**, and **Pump Continuous**. To achieve high vacuum in the sample chamber, you simply select a high-vacuum command from the PPMS MultiVu software or from the front panel of the Model 6000 PPMS Controller—just as you would select other chamber commands. The chamber status description that appears on the Model 6000 front panel or in PPMS MultiVu indicates when high vacuum has been achieved. If you are using a sequence to run an experiment that requires high vacuum, you can simply use the **Wait** command, as is explained in Section 3.3. The automatic sequence of events performed by the system is described in Section 1.2. The system automatically terminates high vacuum whenever a different chamber command is issued. PPMS options, such as Heat Capacity (Model P650) or Helium-3 (Model P825), automatically initiate the high-vacuum operation when it is necessary.

When a cryopump system is being operated under normal conditions—that is, it is entering high vacuum less than 100 times per month—you will need to perform an in-dewar regeneration approximately every three months. The in-dewar regeneration procedure should require just a few minutes.

Note: You can perform an in-dewar regeneration more often than once every three months. If you do so, you will find that high-vacuum performance has been enhanced.

An out-of-dewar regeneration is sometimes required to thoroughly clean the sorption pump of air (see Section 4.3). This procedure is more complex and takes longer to perform than the in-dewar regeneration.

3.2.1 Using the Contact Baffle

The contact baffle on the sample-chamber baffle assembly (Figure 3-1) contains a charcoal holder for increased pumping speed at the lowest sample-chamber temperatures. The contact baffle also provides thermal radiation shielding for the lowest region of the sample chamber. The spring contacts ensure that the charcoal holder and bottom baffle are maintained at the same temperature as the PPMS system temperature.

The charcoal on the baffle assembly begins pumping helium gas at temperatures below about 10 K. Hence, even if the sample chamber is "sealed," the pressure in the sample chamber could become equivalent to high-vacuum conditions when temperatures are below 10 K. When temperatures are above 20 K, the charcoal has no effect on the helium in the sample chamber.

In experiments that require exchange gas at temperatures below 10 K, you can remove the charcoal holder from the end of the baffle assembly by simply unscrewing it from the threaded post. When you remove the charcoal holder (e.g., as a necessary part of calibrating calorimeters with the Heat Capacity option), use a method that prevents oils from your fingers from contaminating the charcoal.

The contact-baffle assembly is not required when using the Helium-3 system. The Helium-3 insert provides its own thermal shielding and also contains its own charcoal for these purposes.

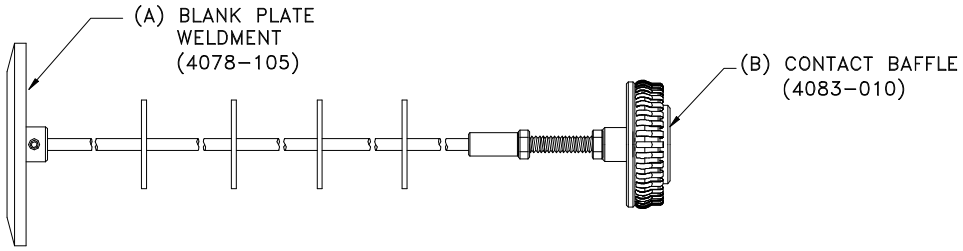


Figure 3-1. Sample-chamber baffle assembly with contact baffle

3.2.2 Initiating High Vacuum

Typically, PPMS options automatically initiate high vacuum. However, in the event you want to manually initiate high vacuum, perform the following steps:

1. Verify that the opening to the sample chamber is sealed. You should be using the contact-baffle assembly (see Figure 3-1) to seal the chamber opening. If you are using the Helium-3 system, verify that the insert is completely seated on the top flange.
2. Purge the sample chamber if the system has recently been opened to the atmosphere.
3. Enable high vacuum. In the Model 6000, the quickest way to issue a high-vacuum command is to select **STATUS >> Chamber >> 6. Pump HiVac**. In MultiVu, open the **Chamber** dialog box (**Instrument >> Chamber**) and click on the **HiVac** button.

   Chamber commands are also located in the **Interactive Control** menu, which you open by selecting **CTRL >> Control Menu >> 1. Interactive Control**. In the **Interactive Control** menu, enable high vacuum by selecting **4. Pump >> Use Cryo Pump**.

a. **PrePump mode.** As soon as you issue the high-vacuum command, the system enters PrePump mode and monitors the pressure. Monitoring the pressure takes a minimum of 30 seconds and might last as long as 2 minutes. The minimum monitoring time is extended as long as the vacuum can be improved. The operation of the temperature control firmware is interrupted so that full pumping force can be applied to pump on the sample chamber.

b. **HiVacEvac mode.** Next, the system enters HiVacEvac mode. In HiVacEvac mode, the flapper valve is open (see Figure 3-2) and the charcoal absorbs the gas in the chamber. The system remains in HiVacEvac mode for a minimum of 30 seconds and up to 2 minutes while it waits for the pressure to stop dropping.

c. **HiVac mode.** After the charcoal has adsorbed all the gas, the system enters HiVac, or high-vacuum, mode. When the pressure returned by the external pressure gauge has not dropped for at least 2 minutes, the Model 6000 front panel indicates that the system has entered HiVac mode. The pressure, as indicated on any of the status panels on the Model 6000 front panel, might *not* show zero.

The **Chamber** panel in the **Status–System** screen on the front panel of the Model 6000 identifies the status of the current chamber operation.

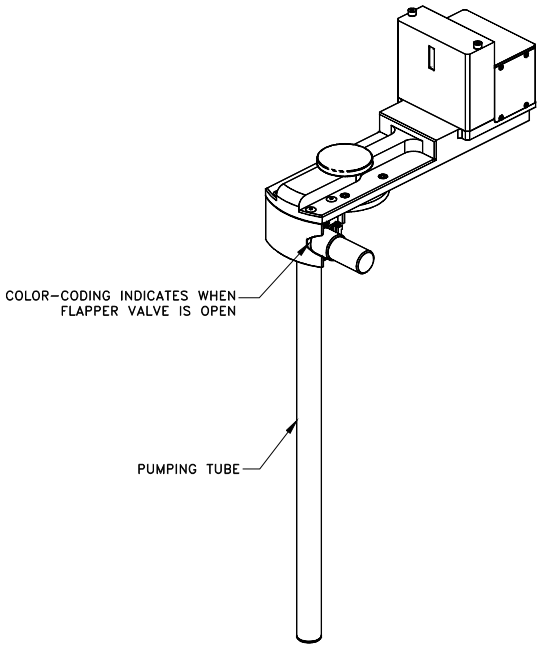


Figure 3-2. Color-coding on the cryopump motor housing indicates when the flapper valve is open and when it is closed. A red stripe is visible when the flapper valve is open and a black stripe is visible when the flapper valve is closed.

3.2.3 Ending High Vacuum

Issuing any chamber command other than a high-vacuum command takes the system out of HiVac, or high-vacuum, mode. For example, if you select **Vent Continuous** while the system is at high vacuum, the system automatically closes the flapper valve to isolate the sorption pump from the sample chamber before it vents the chamber.

The colored stripe on the motor housing should change from red to black when the sorption pump is sealed off from the sample chamber (see Figure 3-2).

3.2.4 Regenerating the Sorption Pump

Periodically, it is necessary to perform a cryopump regeneration operation to restore the pumping capacity of the charcoal sorption pump. The cryopump is regenerated by using an in-dewar procedure to remove helium gas or an out-of-dewar procedure to remove air, water, and nitrogen. The in-dewar procedure is generally required about four times a year—that is, after approximately 500 operations—and takes only a few minutes to perform. The out-of-dewar regeneration procedure might be required approximately once a year, depending on the lab environment and usage practices (see below and Section 4.3).

When it is time to perform an in-dewar cryopump regeneration (based on the number of high-vacuum cycles), the Model 6000 PPMS Controller will notify you. The in-dewar regeneration is an automated procedure that you initiate from the front panel of the Model 6000 or from a PPMS MultiVu sequence.

Use the steps below to perform an in-dewar regeneration:

1. Warm the system to 320 K.
2. Use the steps below to activate the in-dewar regeneration mode from the Model 6000 or from a MultiVu sequence:
   - **Model 6000**. Select **CTRL >> Control >> Immediate Operations >> 14. CryoReg >> Regenerate with CryoPump in Dewar**.
   - **MultiVu**. Double-click on **Execute Commands**, which is in the **Advanced** subgroup in the **Sequence Commands** bar. When the **Execute Commands** dialog box opens, enter "CRYOREG 0" in the text box and click on the **OK** button to insert the command into the sequence.
3. Allow the charcoal to cool back down to helium temperatures before entering high vacuum again. The time required for the charcoal to cool depends on the amount of helium in the dewar. You should wait at least 10 minutes before entering high vacuum, but you might need to wait up to half an hour. Note that the charcoal continues to cool whether the flapper valve is open or closed.

Section 4.3 contains detailed instructions for performing an out-of-dewar regeneration. As is explained there, the process includes removing the cryopump from the PPMS probe. An out-of-dewar regeneration could become necessary if the cryopump has been accidentally exposed to air while it is in the high-vacuum mode, or if the system is routinely operated in a humid environment, in which water often condenses on the probe and baffles.

3.3 Using the "Wait" Sequence Command

If you are using the cryopump as part of a sequence that requires a high vacuum state, you can use the **Wait** sequence command to delay operations until the high vacuum state has been reached.

The **Wait** command is found in the **System** subgroup (see Figure 3-3). As with the other sequence commands, you access the **Wait** command by double-clicking on it. This action opens the **Wait** dialog box (Figure 3-4), which has separate **Condition(s)**, **Delay (secs)**, and **On Error Execute** setting subgroups. The **Condition(s)** subgroup lets you set delays according to **Temperature**, **Field**, **Position**, and **Chamber**. The **Delay (secs)** subgroup has a text box in which you can set the amount of time to delay action after the condition has been met, and the **On Error Execute** subgroup has a dropdown menu in which you can select an action to be executed when the system encounters an error.

To set up a **Wait** command to use with cryopump operations, click in the check box next to **Chamber**, enter any **Delay** time, and select any **On Error Execute** action. Then, click on the **OK** button. The command will be inserted into the sequence, as is shown in the example sequence at the top of Figure 3-4.

Important: Verify that you have clicked in the check box next to **Chamber** before you click on the **OK** button. Otherwise, the system will not consider the vacuum state when it reaches the command.

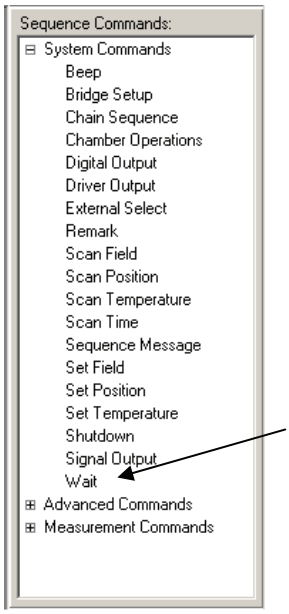


Figure 3-3. Wait sequence command

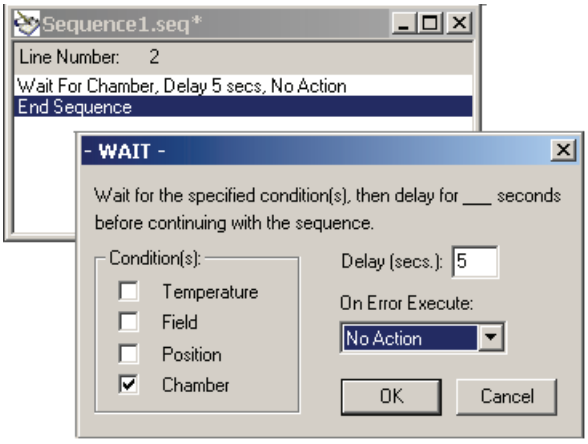


Figure 3-4. Wait dialog box and Wait (for Chamber condition) sequence command

C H A P T E R 4

Troubleshooting and Maintenance

4.1 Introduction

This chapter contains the following information:

- Section 4.2 contains troubleshooting tips.
- Section 4.3 has instructions for the out-of-dewar charcoal regeneration procedure.
- Section 4.4 shows the cryopump-wiring diagram.

4.2 Troubleshooting

This section presents suggestions for dealing with basic problems that might arise with the cryopump. If you have any questions or cannot resolve a problem, please contact Customer Service at Quantum Design.

4.2.1 Failure to Reach High Vacuum

The following problems can prevent the system from reaching high vacuum:

- The system has been exposed to the atmosphere (see Section 4.2.2).
- The flapper valve fails to open or close (see Sections 4.2.3 and 4.2.4).
- The charcoal needs to be regenerated (see Sections 4.2.4 and 4.3).
- The system is leaking (see Section 4.2.6).
- The isolation solenoid is not working.
- *EverCool systems*: The extension cap has not been attached to the pump tube.

4.2.2 Exposure to Atmosphere

If the sorption pump has been accidentally exposed to the atmosphere, it is probably saturated with frozen air and might require an out-of-dewar regeneration (Section 4.3) before it operates properly.

4.2.3 Flapper Valve Fails to Open

The color-coded motor-housing indicator indicates the position of the flapper valve (see Figure 3-2). When the flapper valve opens, the indicator should show red. If it continues to show black, or both red and black, when attempting high vacuum, investigate whether one or more of the following situations has occurred:

- The spring has failed.

  Remove the cover panel and inspect the spring.
- The cam is slipping.
- The flapper valve has frozen shut.

  If the flapper valve fails to open, an error message will be generated in PPMS MultiVu. If this error message appears but the flapper valve indicator displays the red stripe (meaning that the flapper valve is actually open), there is a problem with either the wiring or the limit switch.
- The motor has failed.

4.2.4 Flapper Valve Fails to Close

The color-coded motor-housing indicator indicates the position of the flapper valve (see Figure 3-2). When the flapper valve closes, the indicator should show black. If it continues to show red, or both red and black, when terminating high vacuum, investigate whether one or more of the following situations has occurred:

- The spring has failed.

  Remove the cover panel and inspect the spring.
- The cam is slipping.
- The flapper valve has jammed.

  If the flapper valve fails to close, an error message will be generated in PPMS MultiVu. If this error message appears but the flapper valve indicator displays the black stripe (meaning that the flapper valve is actually closed), there is a problem with either the wiring or the limit switch.
- The micro switch has failed.
- The motor has failed.

4.2.5 System Fails to Regenerate

If the system fails to achieve adequate performance after you have performed a regeneration procedure, investigate whether one or more of the following situations has occurred:

- The regeneration heater has failed.
- The charcoal has been saturated with air (see Section 4.3).
- The pressure gauge has failed.

The "Regen heater may be open" error message might appear if the cryopump was just installed or if the sorption pump was just regenerated. Under these circumstances, the message only indicates that the pressure gauge cannot read a changing pressure. In other words, the pump regeneration was successful. However, if the "Regen heater may be open" error message appears after the cryopump has been installed at least a week, the message indicates that there is a problem with the system, because the system can accumulate helium in a week

4.2.6 Leak in the System

If the system requires frequent out-of-dewar regenerations or never achieves an adequate vacuum, it might have a leak. To investigate this possibility, first verify that the O-ring on the cryopump pumpout fixture and the O-ring on the centering ring have been adequately greased with Apiezon M-grease. Next, verify that the four 10-32 × 3/8 socket-head screws attaching the pumpout fixture to the cryopump are tightened firmly.

If the procedures above do not resolve your problems, call Customer Service at Quantum Design. Leak detection is often a complex task, and our trained personnel can advise you about the best way to approach such a problem.

4.2.7 Vacuum Gauge Does Not Power Up

If the lights on the front of the vacuum gauge are not on, it indicates that the vacuum gauge has not powered up. Verify that the power supply for the vacuum gauge is properly connected (see Section 2.2.6, Step 8).

4.2.8 Cryopump Pumping Tube Fits Poorly in Dewar

In rare instances, the manufacturing tolerances of the dewar prevent the cryopump pumping tube from fitting properly in the dewar. If the installed pumping tube appears to be stressed in any way, you must adjust its location so that the pumping tube will not be bent.

Use the steps below to adjust the location of the cryopump pumping tube:

1. Loosen the four 10-32 screws located near the front of the cryopump manifold.
2. Slide the body of the cryopump forward until the pumping tube fits properly inside the dewar.
3. Re-tighten the four 10-32 screws.

4.3 Out-of-Dewar Regeneration Procedure

The only regular maintenance you will perform on the Cryopump High-Vacuum option is charcoal regeneration. The in-dewar regeneration procedure (Section 3.2.4) releases adsorbed helium from the sorption pump. To remove other gases, you must perform an out-of-dewar regeneration, which involves removing the entire cryopump assembly from the dewar and evacuating the cryopump pumping tube at room temperature.

This section presents the steps for performing an out-of-dewar charcoal regeneration. Before you perform the out-of-dewar regeneration, perform the in-dewar regeneration (Section 3.2.4). You will need to perform an out-of-dewar regeneration only if the in-dewar procedure fails to restore adequate pumping capability to the sorption pump.

Note that you can reduce how often out-of-dewar regenerations are required by basic usage practices, such as closing the sample chamber off from the atmosphere as soon as you have inserted or removed probes and pucks. Also, verify that probe inserts (e.g., the Helium-3 insert) are warm and dry before you insert them into the sample chamber, and always purge the sample chamber after you insert a puck or probe and before you initiate high vacuum. These practices all restrict the amount of moisture to which the sample chamber is exposed.

Instructions for the out-of-dewar regeneration are given in Sections 4.3.1 through 4.3.3.

W A R N I N G !

Always wear protective clothing, including thermal gloves, eye protection, and covered shoes, when you install or remove the cryopump from the dewar or when you work with liquid helium, liquid nitrogen, or any other cryogen. For more information about cryogenic safety, refer to the *Physical Property Measurement System: Hardware Manual*.

4.3.1 Remove the Cryopump from the Dewar

1. Set the PPMS system temperature to 320 K.
2. Use a 5/32-inch hex Allen key to unscrew the four 10-32 screws from the cryopump manifold. Keep the screws in a safe place; you use them to reinstall the standard PPMS top plate.
3. Vent the system continuously.
4. Remove the screws in the cryopump sheet metal side panels, and then remove the side panels.
5. Remove any probe or baffle set.
6. Slowly pull the entire cryopump assembly straight up and out of the cold bath.

   When you remove the cryopump slowly, you help prevent damage to it by allowing it to heat up slowly from the top. This method boils off any nitrogen that has condensed inside it.

C A U T I O N !

Do not insert or remove the cryopump at an angle or the tube will bend. Sometimes the O-ring freezes as you lift the cryopump straight out of the dewar, and the tube will stick. If this occurs, do not force the pump to move because it might jolt upward, injuring you and damaging the tube. Wait approximately one minute until the pump can move freely, then continue to carefully lift it straight out.

7. Insert the blank plate (part number 4078-092) into the dewar opening (refer to Figure 2-7).

   If the cryopump will remain out of the dewar for an extended length of time, you should place the standard PPMS top plate on top of the probe. The standard top-plate assembly (part number 4078-112) will help prevent gases from leaking into the PPMS annulus.

4.3.2 Perform the Out-of-Dewar Regeneration

1. Verify that the cryopump has warmed to room temperature.
2. Use the four 10-32 × 3/8 socket-head screws to attach the cryopump pumpout fixture (part number 4083-208), with the O-ring facing upward, to the bottom side of the sample chamber opening on the cryopump (see Figure 2-6). Tighten the screws until they are just finger tight.
3. Use the blanking plate (part number HPNW40C) and associated centering ring (part number HPNW40B) to cover the top of the sample-chamber opening on the cryopump (see Figure 2-6).
4. Use the Model 6000 CTRL menu or a MultiVu sequence command to initiate the out-of-dewar regeneration.
   - Model 6000: Select **CTRL >> 3. Immediate Operations >> 14. CryoReg >> Regenerate with CryoPump in Room**. The flapper valve opens and the system is pumped out. Then the flapper valve closes and the cryopump system is regenerated. This process takes at least 30 seconds. The out-of-dewar regeneration does not use the regeneration heater. You can follow the status of the regeneration by selecting **CTRL >> 1. Interactive Control >> 4. Pump**.
   - MultiVu: Insert the out-of-dewar regeneration command into a sequence, then run the sequence while the cryopump is out of the dewar.

     To insert the out-of-dewar regeneration command, double-click on **Execute Commands**, which is in the **Advanced** subgroup in the **Sequence Commands** bar. When the **Execute Commands** dialog box opens, enter "CRYOREG 1" in the text box and click on the **OK** button to insert the command into the sequence.
5. When regeneration is complete, the message “Vented” will appear in all menus identifying the status of the sample chamber.
6. Remove the top blanking plate (part number HPNW40C).
7. Remove the four 10-32 × 3/8 socket-head screws attaching the pumpout fixture to the cryopump. Then remove the pumpout fixture.
8. You can bolt the regeneration pumpout fixture to the PPMS top plate for storage. This storage method protects the surface of the pumpout fixture and the O-ring seal. Note that you only need to insert the screws into the top plate, you do not need to torque them down.

4.3.3 Re-Install the Cryopump

1. Vent the system continuously.
2. Remove the two Phillips-head screws that attach the blank plate (part number 4078-092) to the dewar opening (refer to Figure 2-7). You can store the screws in the accessories box.
3. Use the plug-removal tool, which is the long screw in the middle of the blank plate, to remove the blank plate from the opening to the dewar. The plug covers the opening through which the cryopump pumping tube penetrates into the dewar.
4. Slowly and carefully slide the cryopump pumping tube into the opening to the dewar, continuing until you can screw down the cryopump.

C A U T I O N !

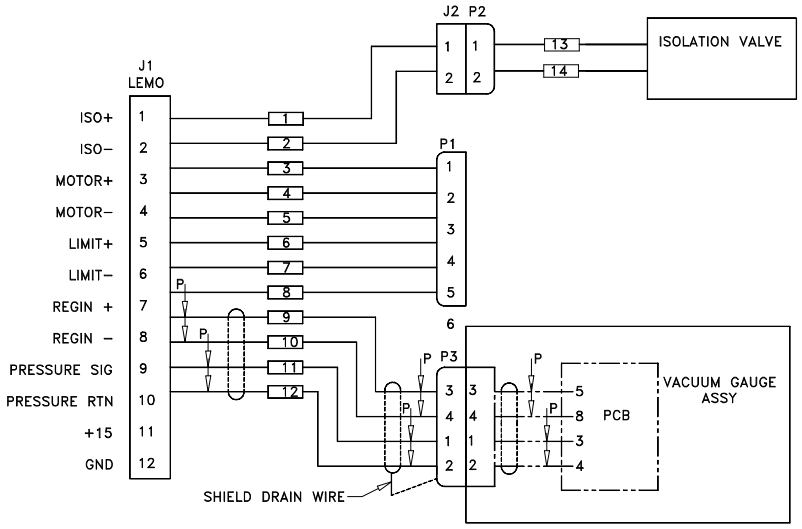
Handle the cryopump carefully by holding the head with two hands. Use your finger to put a small mount of vacuum grease on the inside surface of the O-ring. It is not necessary to remove the O-ring. Carefully insert the tube straight into the dewar. Inserting it at an angle can cause the thin tube to bend, which will prevent the cryopump from working.

5. Use a 5/32-inch hex Allen key to install the four 10-32 screws that hold down the cryopump manifold. It is important to tighten these screws firmly so that they compress the O-ring on the sample chamber.
6. Install the right- and left-side covers that protect the wires of the sample chamber (Figures 1-4 and 2-1, part numbers 4083-205 and 4083-206).
7. Insert the baffle assembly.
8. Test the installation by installing the cap, plugging in the pressure gauge, and purging the system. Watch the static pressure to verify that the sample chamber is not leaking.
9. After you install the cryopump, wait several minutes before you instruct the system to enter high vacuum.

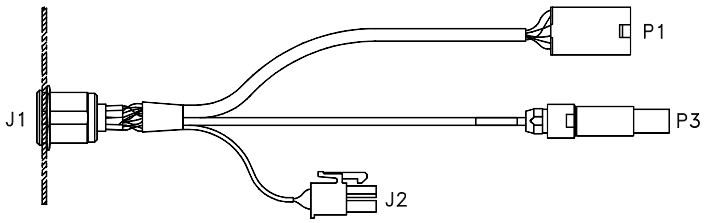
   Important: The charcoal ***must cool*** before the system can enter high vacuum.
10. Return the parts you used to install the cryopump back to the accessories box.

4.4 Wiring Diagram

Figures 4-1A and 4-1B show the pinouts for the green, color-coded Lemo connector on the cryopump cable. (Figure 2-5 illustrates the cryopump cable.)



A. Wiring diagram for green Lemo connector on cryopump cable



B. Internal cryopump cables connected to green Lemo connector on cryopump cable

Figure 4-1. Cryopump wiring diagram

I n d e x